Tetraquarks and the phase diagram of QCD

Wednesday, 8 February 2017 08:50 (20 minutes)

We discuss the role of tetraquarks in the phase transitions of QCD. For three very light flavors, tetraquarks may generate a second chiral phase transition. In the plane of temperature and chemical potential ($T$ and $\mu$), tetraquarks must be included in order to use effective models to determine the position of the critical endpoint. The tetraquark condensate is the (color invariant) square of the condensate for color superconductivity. Hence it is natural that in the plane of $T$ and $\mu$, a crossover line for tetraquarks connects smoothly to the transition line for color superconductivity.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: PISARSKI, Robert (BNL)
Presenter: PISARSKI, Robert (BNL)
Session Classification: Parallel Session 5.3: New Theoretical Developments (I)
Track Classification: New Theoretical Developments
Regge trajectories in \((n, M^2)\) and \((J, M^2)\) planes for higher excited states for \(\Lambda_b^0\) baryon

We computed excited state masses of singly heavy \(\Lambda_b^0\) baryon in the framework of Hypercentral Constituent Quark Model. We use hyper coloumb plus power potential, varying \((\nu)\) from S.R.(1/2) to quadratic(2.0), in the calculation of ground and radial excited state masses. After that, orbital excited states are also determine for linear(\(=1.0\)) potential. We also introduced first order correction to the potential. The ground state \(\Lambda_b(5619)^0\) and two orbital excited states \(\Lambda_b(5912)^0\) and \(\Lambda_b(5920)^0\) are found experimentally and our obtained masses for these states are \(m_{\Lambda_b^0}(1/2^+)=5620\), \(m_{\Lambda_b^0}(1/2^-)=5992\) MeV and \(m_{\Lambda_b^0}(3/2^-)=5980\) MeV reasonably close to them. We also compare our results with other theoretical models and they are in good agreement. From this, we also plot Regge trajectories in \((n, M^2)\) and \((J, M^2)\) planes for higher excited states.

**Preferred Track**

Open Heavy Flavors

**Collaboration**

Not applicable

**Primary author:** Ms MARFATIA, Zalak (Sardar Vallabhbhai National Institute of Technology)

**Presenter:** Ms MARFATIA, Zalak (Sardar Vallabhbhai National Institute of Technology)

**Session Classification:** Poster Session
The problem of overlapping formation times

Wednesday, 8 February 2017 09:10 (20 minutes)

When high-energy partons traversing a quark-gluon plasma lose energy via bremsstrahlung or pair production, the quantum duration of that splitting process is known as the formation time. For high energy, the formation time exceeds the mean free time for collisions with the medium, leading to a significant reduction in the splitting rate: the LPM effect. But there are interesting and potentially important corrections to the usual treatment of the LPM effect that arise from situations where the formation times of two consecutive splittings overlap each other, and various attempts have been made over the years to account for these effects. I will summarize recent research on computing the effect of overlapping formation times, while avoiding soft-bremsstrahlung assumptions that have been used in some of the (very interesting) theoretical work of the last few years. I will also explain the bottom line of why finding the size of these effects has potentially important conceptual implications for the Monte Carlo treatment of in-medium splitting of high-energy partons.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary author: ARNOLD, Peter (University of Virginia)
Co-author: Dr IQBAL, Shahin (National Centre for Physics)
Presenter: ARNOLD, Peter (University of Virginia)
Session Classification: Parallel Session 5.3: New Theoretical Developments (I)
Track Classification: Jets and High pT Hadrons
Proton structure fluctuations: constraints from diffraction and applications to p+A collisions

Wednesday, 8 February 2017 09:50 (20 minutes)

Exclusive vector meson production can be used to directly probe the gluon density of a hadron. Measuring the cross section differentially in transverse momentum transfer makes it possible to determine the transverse density profile (via coherent diffraction) and density fluctuations (incoherent diffraction) of the target hadron. This knowledge about the geometric fluctuations of the proton is particularly important for understanding collective phenomena observed in proton-nucleus collisions.

We calculate coherent and incoherent diffractive vector meson production in photon-proton scattering at high energy. We demonstrate that incoherent gamma-p scattering is sensitive to sub-nucleon scale fluctuations, and show that the effect of geometric fluctuations can be disentangled from saturation scale fluctuations.

The Bjorken-x (or energy) evolution of the fluctuations is studied by solving the JIMWLK evolution equation. In particular, we study the energy evolution of the diffractive cross section. This is particularly interesting, as the ALICE collaboration has recently observed the disappearance of the incoherent contribution to the diffractive cross section in ultraperipheral p+A collisions at high energies, which suggests that the proton gets smoother at small x.

The fluctuating proton, constrained by the HERA data, is then used as input for hydrodynamic calculations of azimuthal anisotropy coefficients in proton-nucleus collisions, which we show to be sensitive to initial state geometric fluctuations.

References:

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: Dr MÄNTYSAARI, Heikki (Brookhaven National Laboratory)
Presenter: Dr MÄNTYSAARI, Heikki (Brookhaven National Laboratory)
Session Classification: Parallel Session 5.2: Initial State Physics and Approach to Equilibrium (III)
Track Classification: Initial State Physics and Approach to Equilibrium
Chiral magnetic effect in isobar collisions

Tuesday, 7 February 2017 14:20 (20 minutes)

The quark-gluon matter produced in relativistic heavy-ion collisions may contain local domains in which P and CP symmetries are not preserved. When coupled with an external magnetic field, such P- and CP-odd domains will generate electric currents along the magnetic field — a phenomenon called the chiral magnetic effect (CME). Recently, the STAR Collaboration at RHIC and the ALICE Collaboration at the LHC released data of charge-dependent azimuthal-angle correlators with features consistent with the CME expectation. However, the experimental observable is contaminated with significant background contributions from elliptic-flow-driven effects, which makes the interpretation of the data ambiguous. In this Letter, we show that the collisions of isobaric nuclei, $^{96}_{44}$Ru + $^{96}_{44}$Ru and $^{96}_{40}$Zr + $^{96}_{40}$Zr, provide an ideal tool to disentangle the CME signal from the background effects. Our simulation demonstrates that the two collision types at 200 GeV have more than 10% difference in the CME signal and less than 2% difference in the elliptic-flow-driven backgrounds for the centrality range of 20-60%.

Preferred Track
Collective Dynamics

Collaboration
Not applicable

Primary author: Prof. HUANG, Xu-Guang (Fudan University)
Presenter: Prof. HUANG, Xu-Guang (Fudan University)
Session Classification: Parallel Session 3.2: CME, Vorticity and Spin Polarization (I)
Track Classification: Collective Dynamics
Splitting functions and jet mass distributions in heavy ion collisions

We present the first calculations of the momentum sharing and angular separation distributions between the leading subjets inside a reconstructed jet, as well as the jet mass distribution modification in heavy ion collisions. These observables are sensitive to the early and late stages of the in-medium parton shower evolution and allow us to probe the quark-gluon plasma across a wide range of energy scales. We use the medium-induced splitting functions obtained in the framework of soft-collinear effective theory with Glauber gluon interactions to calculate the subjet distributions. Qualitative and in most cases quantitative agreement between theory and preliminary CMS measurements suggests that the parton shower in heavy ion collisions can be dramatically modified early in the branching history. Predictions for the subjet angular distribution is also presented which will illuminate the nature of the medium-induced radiations. On the other hand, using renormalization group techniques we can resum the jet mass at next-to-leading logarithmic accuracy, with the medium contributions consistently included. We find that the jet mass modification is sensitive to the medium scale and allows for a precise extraction of the medium properties.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary authors: Dr CHIEN, Yang-Ting (Massachusetts Institute of Technology); Dr CHIEN, Yang-Ting (Massachusetts Institute of Technology)

Presenters: Dr CHIEN, Yang-Ting (Massachusetts Institute of Technology); Dr CHIEN, Yang-Ting (Massachusetts Institute of Technology)

Session Classification: Poster Session
Response Functions and Collective Modes of hot QCD medium

The response functions of a particular medium is a basic tool to understand the properties of the medium. In the same spirit, Chromo-electric/magnetic response functions (such as Dielectric permittivity, refractive index, etc.) can be used to understand the medium properties of hot QCD/QGP medium. We first obtain the gluon polarisation tensor in a hot QCD medium which is described in terms of effective quasi-particle degrees of freedom with anisotropy (momentum) within transport theory approach. The effects of the collisions have been neglected since the estimations are done for very near equilibrium situations and for smaller strength of the anisotropy. The response functions (chromoelectric permittivity and chromomagnetic permeability) could be obtained by taking the static limit of the polarization tensor. The hot QCD plasma possess a collective motion due to the fluctuation or perturbation in the equilibrium state, which are termed as quasi-particle collective excitations of the plasma. These excitations have different collective modes known as plasmons of quark-gluon plasma. These modes play an important role in the dynamical evolution of a quark-gluon plasma. The investigation are mainly focussed around such collective modes. Future extension of the work will also include an appropriate collision term in the effective transport equation that has been set-up to determine the response functions.

Reference:

Preferred Track
Collective Dynamics

Collaboration
Not applicable

Primary author: Mr JAMAL, Mohammad Yousuf (IIT Gandhinagar, India)
Presenter: Mr JAMAL, Mohammad Yousuf (IIT Gandhinagar, India)
Session Classification: Poster Session
Plasmon mass scale and quantum fluctuations of classical fields on a real time lattice

Classical Yang-Mills theory calculations are frequently used to study nonequilibrium phenomena in nonperturbative overoccupied systems, especially in the context of ultrarelativistic heavy-ion collisions. We study the limits of the quasiparticle picture of the classical Yang-Mills fields by determining the plasmon mass of the system using 3 different methods. We also demonstrate an algorithm which allows us to simulate quantum fluctuations on top of a classical background field, while keeping the separation between the two manifest. We also test a lattice implementation of the algorithm and demonstrate that the linearization indeed works and that the Gauss’s law is conserved.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: PEURON, Jarkko (University of Jyväskylä)
Co-author: KURKELA, Eero Aleksi (CERN)
Presenter: PEURON, Jarkko (University of Jyväskylä)
Session Classification: Poster Session
Weak decay of beauty baryons in quark-diquark model

The weak decays of $\Lambda_b$ provide valuable information of the CKM parameter $V_{cb}$, fragmentation and hadronisation within the framework of quantum chromodynamics. Recently, LHCb has reported Branching ratios for non-leptonic decay $\Lambda_b^0 \to \Lambda^+ \pi^- = 4.3 \pm 0.51 \times 10^{-3}$. This experimental measurement generates great theoretical interests in semi-leptonic decays of heavy flavour baryons. In the present study, for the description of the $\Lambda_b$ baryon, we employ the quark-diquark model with two body color coulomb plus power potential. The model parameters are fixed using the hyperfine mass splitting for each choice of the potential exponent $\nu$, choice of running strong coupling constant $\alpha_s$ and with different quark mass parameters $m_Q$. These extracted spectroscopic parameters are used to compute decay widths of the non-leptonic and semi-leptonic decays of $\Lambda_b$ baryon. The results for branching ratios of non-leptonic decays $\Lambda_b \to \Lambda^+ \pi^- = 4.91 \times 10^{-3}$ and semileptonic decay widths $\Lambda_b \to X_c l\nu_l= 6.13 \times 10^{10} s^{-1}$ are in good agreement with the predictions with the recent experimental results.

Preferred Track

Open Heavy Flavors

Collaboration

Other

Primary author: MAJETHIYA, Ajay (V S PATEL COLLEGE OF ARTS AND SCIENCE, COLLEGE ROAD, BILIMORA, DIST NAVSARI, GUJARAT 396321, INDIA)

Presenter: MAJETHIYA, Ajay (V S PATEL COLLEGE OF ARTS AND SCIENCE, COLLEGE ROAD, BILIMORA, DIST NAVSARI, GUJARAT 396321, INDIA)

Session Classification: Poster Session
Holographic photon production and flow in heavy ion collisions

Thermal-photon production from the quark gluon plasma (QGP) phase plays an imperative role for direct photon production in heavy ion collisions. In most of theoretical approaches, the emission rate from the perturbative calculation with hard thermal loop resummation is applied. In order to facilitate our understandings for the impact from coupling dependence on the photons from QGP phase, we resort to the AdS/CFT correspondence. Despite the distinction between holographic duals and strongly coupled QCD, former studies in holography have not incorporated the medium evolution and the contributions from other phases, which make the results difficult to be compared with experiments. We thus perform the state-of-the-art computations to embed the photon emission rates from holography into medium evolution and include other contributions for direct-photon production.

In this work, the thermal-photon emission from strongly coupled gauge theories at finite temperature is calculated using holographic models for QCD in the Veneziano limit (V-QCD). The emission rates are then embedded in hydrodynamic simulations combined with prompt photons from hard scattering and the thermal photons from hadron gas to analyze the spectra and anisotropic flow of direct photons at RHIC and LHC. The results from different sources responsible for the thermal photons in QGP including the weakly coupled QGP (wQGP) from perturbative calculations, strongly coupled $\mathcal{N} = 4$ super Yang-Mills (SYM) plasma (as a benchmark for reference), and Gubser’s phenomenological holographic model are then compared. It is found that the direct-photon spectra are enhanced in the strongly coupled scenario compared with the ones in the wQGP, especially at intermediate and high momenta, which improve the agreements with data. Moreover, by using IP-glassma initial states, both the elliptic flow and triangular flow of direct photons are amplified at high momenta ($p_T > 2.5$ GeV) for V-QCD, while they are suppressed at low momenta compared to wQGP. The distinct results in holography stem from the blue-shift of emission rates in strong coupling. In general, compared to experiments, the theoretical results still underestimate the flow in RHIC. In addition, we further evaluate the spectra and flow in small collision systems for future comparisons. We emphasize that thermal photons from the deconfined phase are substantial to reconcile the spectra and flow at high momenta.

The presentation is based on arXiv:1609.07208.

Preferred Track
Electromagnetic Probes

Collaboration
Not applicable

Primary authors: Dr SHEN, Chun (McGill University); YANG, Di-Lun (RIKEN)

Presenter: YANG, Di-Lun (RIKEN)

Session Classification: Poster Session
Cumulants and Correlation Functions vs the QCD phase diagram

Wednesday, 8 February 2017 15:00 (20 minutes)

We will discuss the relation between particle number cumulants and multi-particle correlation functions. It is argued that measuring couplings of the genuine correlation functions could provide cleaner information on possible non-trivial dynamics in heavy-ion collisions. We extract integrated multi-particle correlation functions from the presently available experimental data on proton cumulants. We find that the STAR data contain significant four-particle correlations, at least at the lower energies, with indication of changing dynamics in central collisions. We also find that these correlations are rather long-ranged in rapidity. Based on the signs of genuine correlation functions we provide exclusion plots for the QCD phase diagram.

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary author:  BZDAK, Adam (AGH University of Science and Technology)
Presenter:  BZDAK, Adam (AGH University of Science and Technology)
Session Classification:  Parallel Session 7.2: Correlations and Fluctuations (II)
Track Classification:  QCD at High Temperature
Effect of magnetic field on flow fluctuations in ultra-relativistic heavy-ion collisions

Very strong magnetic fields can arise in non-central heavy-ion collisions at ultrarelativistic energies, which may not decay quickly due to induced currents in the conducting plasma. Presence of very strong magnetic fields in the plasma (of order $10^{15}$ Tesla) during early stages in RHIC has been explored extensively recently primarily in connection with the so-called chiral magnetic effect. An important effect of the presence of such strong magnetic fields in the plasma will be to lead to strong variations in velocities of different types of waves in the plasma. In particular, the velocity varies with the angle between the wave vector and the direction of the magnetic field, and also has non-trivial dependence on pressure gradient. This can qualitatively affect the development of anisotropic flow. It was earlier believed that the magnetic field arising from the collision of initial nuclei peaks to strong values for a very short time, essentially the passing time of the Lorentz contracted nuclei (∼ 0.2 fm for RHIC energies). Subsequently it rapidly decays. However, it was later realized that due to induced currents in the conducting plasma, the magnetic field may survive for much longer time of order several fm, and can lead to interesting effects. We carry out magnetohydrodynamics simulations to study the effects of this magnetic field on the evolution of the plasma. We focus on the elliptic flow as well as the power spectrum of flow fluctuations. Our results show that magnetic field leads to enhancement in elliptic flow. We further find that there are qualitative patterns in the power spectrum of flow fluctuations due to the presence of magnetic field. These features in the power spectrum may provide a clean signal for the presence of strong magnetic field during initial stages. We also show generation of vorticity arising from nontrivial dependence of magnetosonic waves on pressure gradients and magnetic field direction.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: Mr DAS, ARPAN (Institute of Physics, Bhubaneswar, India)

Presenter: Mr DAS, ARPAN (Institute of Physics, Bhubaneswar, India)

Session Classification: Poster Session
Quasiparticle anisotropic hydrodynamics for central collisions

We use quasiparticle anisotropic hydrodynamics to study an azimuthally-symmetric boost-invariant quark-gluon plasma including the effects of both shear and bulk viscosities. In quasiparticle anisotropic hydrodynamics, a single finite-temperature quasiparticle mass is introduced and fit to the lattice data in order to implement a realistic equation of state (EoS). We compare results obtained using the quasiparticle method with the standard method of imposing the EoS in anisotropic hydrodynamics and viscous hydrodynamics. Using these three methods, we extract the primordial particle spectra, total number of charged particles, and average transverse momentum for various values of the shear viscosity to entropy density ratio $\eta/s$. We find that the three methods agree well for small shear viscosity to entropy density ratio, $\eta/s$, but differ at large $\eta/s$, with the standard anisotropic EoS method showing suppressed production at low transverse-momentum compared to the other two methods considered. Finally, we demonstrate explicitly that, when using standard viscous hydrodynamics, the bulk-viscous correction can drive the primordial particle spectra negative at large $p_T$. Such a behavior is not seen in either anisotropic hydrodynamics approach, irrespective of the value of $\eta/s$.

Preferred Track

New Theoretical Developments

Collaboration

Other

Primary author: ALQAHTANI, Mubarak (Kent State University)
Co-author: Dr STRICKLAND, Michael (Kent State University)
Presenter: ALQAHTANI, Mubarak (Kent State University)
Session Classification: Poster Session
Procedure for measuring photon and vector meson circular polarization variation with respect to the reaction plane in relativistic heavy-ion collisions

The electromagnetic field pattern created by spectators in relativistic heavy-ion collisions plants a seed of positive (negative) magnetic helicity in the hemisphere above (below) the reaction plane. Owing to the chiral anomaly, the magnetic helicity interacts with the fermionic helicity of the collision system and causes photons emitted in upper and lower hemispheres to have different preferences in the circular polarization. Similar helicity separation for massive particles, owing to the global vorticity, is also possible. In this talk, we lay out a procedure to measure the variation of the circular polarization with respect to the reaction plane in relativistic heavy-ion collisions for massless photons, as well as similar polarization patterns for vector mesons decaying into two daughters. We propose to study the yield differentially and compare the yield between upper and lower hemispheres to identify and quantify such effects. This procedure will facilitate the investigation of novel phenomena related to chirality, magnetic field and vorticity in the Quark Gluon Plasma.

Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary author: Dr TANG, Aihong (Brookhaven National Laboratory)
Presenter: Dr TANG, Aihong (Brookhaven National Laboratory)
Session Classification: Poster Session
Opening Ceremony

Monday, 6 February 2017 09:00 (20 minutes)

Session Classification:  Welcome
Status of the field and key open questions before QM2017

Monday, 6 February 2017 09:20 (40 minutes)

Preferred Track

Collaboration

Primary author: SCHUKRAFT, Jürgen (CERN)
Presenter: SCHUKRAFT, Jürgen (CERN)
Session Classification: Welcome
STAR

Monday, 6 February 2017 10:00 (20 minutes)

Presenter: SCHMAH, Alexander (Lawrence Berkeley National Lab)

Session Classification: Experimental Preview Talks I
Contribution ID: 50  Type: Oral

PHENIX

Monday, 6 February 2017 10:20 (20 minutes)

Presenter: MCGLINCHEY, Darren (University of Colorado)

Session Classification: Experimental Preview Talks I
Primary author: ADUSZKIEWICZ, Antoni (University of Warsaw (PL))
Presenter: ADUSZKIEWICZ, Antoni (University of Warsaw (PL))
Session Classification: Experimental Preview Talks I
Electromagnetic fields are generated in high energy nuclear collisions by spectator valence protons. These fields are traditionally computed by integrating the Maxwell equations with point sources. One might expect that such an approach is valid at distances much larger than the proton size and thus such a classical approach should work well for almost the entire interaction region in the case of heavy nuclei. We argue that, in fact, the contrary is true: due to the quantum diffusion of the proton wave function, the classical approximation breaks down at distances of the order of the system size.

We compute the electromagnetic field created by a charged particle described initially as a Gaussian wave packet of width 1 fm and evolving in vacuum according to the Klein-Gordon equation. We completely neglect the medium effects. We show that the dynamics, magnitude and even sign of the electromagnetic field created by classical and quantum sources are different.
How to select events which evolved similarly?

Events that started with very similar initial conditions should also evolve similarly and produce similar single-particle distributions of hadrons. This is a natural consequence of hydrodynamic description of a collision. We present a novel method for data analysis. It compares the histograms of azimuthal hadron distributions from each event and organizes the events in such a way that those with similar histograms end up placed close to each other. Those are the ones which underwent similar evolution. Such events can more easily be compared to theoretical simulations where all conditions can be controlled. We illustrate the method on data simulated by the AMPT model. Finally, we speculate about other possible applications of the method.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary author: TOMASIK, Boris (Univerzita Mateja Bela (SK))
Presenter: TOMASIK, Boris (Univerzita Mateja Bela (SK))
Session Classification: Poster Session
Feasibility study of heavy-ion collision physics at NICA JINR

Wednesday, 8 February 2017 16:30 (20 minutes)

The project NICA (Nuclotron-based Ion Collider fAcility) is aimed to study hot and baryon rich QCD matter in heavy ion collisions in the energy range $\sqrt{s_{NN}} = 4 - 11$ GeV. The heavy ion program includes the study of collective phenomena, dilepton, hyperon and hypernuclei production under extreme conditions of highest baryonic density. This program will be performed with the MPD (MultiPurpose Detector) at the NICA collider with the average luminosity of $L = 1 \times 10^{27}$ cm$^{-2}$s$^{-1}$ (for gold-gold collisions).

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
Other

Primary author: Prof. KEKELIDZE, Vladimir (Joint Institute for Nuclear Research (RU))
Presenter: Prof. KEKELIDZE, Vladimir (Joint Institute for Nuclear Research (RU))
Session Classification: Parallel Session 8.2: Future Experimental Facilities, Upgrades, and Instrumentation

Track Classification: Future Experimental Facilities, Upgrades, and Instrumentation
Temperature dependence of shear viscosity in SU(3)-gluodynamics

This report is devoted to the study of temperature dependence of shear viscosity in SU(3)-gluodynamics. To calculate shear viscosity we measured the correlation function of the energy-momentum tensor $T_{12}T_{12}$ for a set of temperatures in the region $T/T_c \in (0.9, 1.5)$. The measurements were carried out using multilevel algorithm which considerably improves the accuracy of the data. The results of the calculation allow to determine temperature dependence of the ratio of shear viscosity to the entropy density $\eta/s$.

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary author: KOTOV, Andrey
Presenter: KOTOV, Andrey
Session Classification: Poster Session
A primary goal of heavy-ion physics is the measurement of the fundamental properties of the quark-gluon plasma (QGP) and the characterization of the initial state that leads to its formation. While these properties—such as temperature-dependent transport coefficients—are not directly measurable, they may be quantitatively estimated through computational models of heavy-ion collisions. The properties of interest are input as model parameters and tuned so that a variety of simulated observables optimally fit corresponding experimental data.

Previous studies [1, 2] have applied Bayesian parameter estimation methods to simultaneously constrain a variety of QGP properties, including the temperature dependence of the specific shear viscosity $\eta/s(T)$ and the scaling of initial entropy deposition, and confirmed a finite QGP bulk viscosity $\zeta/s > 0$. However, this work also demonstrated that more precise estimates of the shear and bulk viscosities could be achieved by including experimental data from multiple beam energies and improving several aspects of the computational model.

In this work, we utilize Bayesian methodology to estimate the parameters of an updated heavy-ion collision model [3] including the parametric initial conditions TRENTO [4], a pre-equilibrium free streaming phase [5], viscous 2+1D hydrodynamics, improved Cooper-Frye particlization, and UrQMD. We calibrate the model to multiplicity, transverse momentum, and flow data from multiple RHIC and LHC beam energies, report the latest quantitative estimates of the temperature dependence of QGP shear and bulk viscosities as well as initial state properties, and validate model predictions of higher-order observables such as flow correlations.

Primary author: BERNHARD, Jonah
Presenter: BERNHARD, Jonah
Session Classification: Parallel Session 2.1: Initial State Physics and Approach to Equilibrium (II)
Track Classification: Collective Dynamics
Peripheral tube model for centrality dependence of di-hadron correlations

The data of di-hadron azimuthal correlations at different centralities for Au+Au collisions at 200 A GeV were presented by the PHENIX Collaboration. It was observed that the away-side correlation evolves from double- to single-peak structure when the centrality decreases. In this work, we show, in terms of the peripheral tube model, that the observed features naturally appear due to an interplay between the flow due to the peripheral tube and the background elliptic flow. A key feature of the present approach is that the event-by-event fluctuating initial conditions is represented by the randomly distributed peripheral tubes. We also carry out numerical simulations by using the hydrodynamical code NeXSPheRIO, and calculate the correlations by the ZYAM method employed by PHENIX Collaboration. It is shown that our results are in reasonable agreement with the data. We also discuss the physical content of the present model and its difference from the viewpoint in terms of eccentricity-flow relationship.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary author: Dr QIAN, Wei-Liang (Universidade de Sao Paulo)

Presenter: Dr QIAN, Wei-Liang (Universidade de Sao Paulo)

Session Classification: Poster Session
Investigating the scaling of higher-order flows in relativistic heavy-ion collisions

The modified number of constituent quark (NCQ) scaling $v_n/n_q^{n/2} \sim K E_T/n_q$ for mesons and baryons and the scaling relation $v_n \sim v_2^{n/2}$ for higher-order anisotropic flows, which were observed experimentally, have been investigated at the top energy of Relativistic Heavy-Ion Collider. It has been found that the modified NCQ scaling can not be obtained from the naive coalescence even by taking into account event-by-event fluctuations but may be due to hadronic afterburner or thermal freeze-out. In addition, we observed that the behavior of the $v_n/v_2^{n/2}$ ratio is sensitive to the partonic interaction. Further insights about the relation between the two scalings are discussed.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: ZHANG, Chunjian (Shanghai Institute of Applied Physics)

Presenter: ZHANG, Chunjian (Shanghai Institute of Applied Physics)

Session Classification: Poster Session
Exotic charmed baryon states at finite temperature

We study doubly charmed baryons at finite temperature. By solving the three-quark Schroedinger equation with lattice simulated quark potential and chiral symmetry restoration at finite temperature, the doubly charmed baryons created in quark-gluon plasma are in the quark-diquark state as a consequence of chiral symmetry restoration. When the diquark state disappears at dissociation temperature $T_{d}^{(2)}$, the three-quark state can still survive till its dissociation temperature $T_{d}^{(3)}$. This indicates an exotic three-quark state in the temperature region $T_{d}^{(2)} < T < T_{d}^{(3)}$.

Preferred Track

Open Heavy Flavors

Collaboration

Not applicable

Primary author: ZHAO, jiaxing
Presenter: ZHAO, jiaxing
Session Classification: Poster Session
Measurement of the D+-meson production in p-Pb and Pb-Pb collisions with ALICE

Open heavy-flavor mesons (particles made of a heavy quark, i.e. charm or beauty, and a light quark) are a unique tool to study and characterize the properties of the Quark-Gluon Plasma (QGP). Heavy quarks are produced in the initial stages of the collisions, and they experience the whole system evolution, interacting with the medium constituents. Since charm and beauty quarks have different mass, their in-medium energy loss is predicted to be different. Therefore, for charmed hadrons, it is crucial to distinguish prompt hadrons (which derive directly from the hadronization of a c-quark or from the decay of excited open charm and charmonium states) from those coming from B-hadron decays. The parton energy loss can be studied by measuring the nuclear modification factor $R_{AA}$, defined as the ratio of the measured yield in nucleus-nucleus collisions to the one in proton-proton interactions, scaled by the average number of binary nucleon-nucleon collisions. Another interesting observable is the elliptic flow $v_2$ at low transverse momentum, which can give insight into the possible participation of heavy quarks in the collective expansion of the medium. Furthermore, the study of open heavy-flavor hadrons in proton-nucleus collisions, in which the formation of an extended QGP is not expected, can provide an important measurement of the Cold Nuclear Matter (CNM) effects, which is crucial for the interpretation of the results from nucleus-nucleus collisions.

In this contribution, the results on D+-meson production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV and p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, are presented. In the latter case, a particular focus on the extraction of the fraction of prompt D+-mesons with a data-driven approach will be given.

Preferred Track
Open Heavy Flavors

Collaboration
ALICE

Primary author: GROSA, Fabrizio (Politecnico e INFN Torino (IT))

Presenter: GROSA, Fabrizio (Politecnico e INFN Torino (IT))

Session Classification: Poster Session
Higher-order baryon number susceptibilities’ interplay between the de-confinement and the nuclear liquid-gas transitions

We use an improved version of the $SU(3)$ flavour parity doublet quark-hadron model to investigate the baryon number susceptibilities near the de-confinement and nuclear liquid-gas transition. The parity doublet model has been improved by adding the six-point interaction of the $\sigma$ (and $\zeta$) meson in the effective mean field Lagrangian, resulting in a good description of nuclear ground-state properties, in particular the nuclear compressibility. The resulting phase diagram of the model agrees qualitatively with expectations from lattice QCD, i.e. it shows a crossover at zero net baryo-chemical potential and a critical point at finite density. Using this model we investigate the dependence of the higher order baryon number susceptibilities as function of temperature and chemical potential. Due to the interplay between the de-confinement and nuclear liquid-gas transition, the experimentally measured cumulants of the net baryon number may show very different beam energy dependence depending on the actual freeze-out temperature.

Preferred Track

Correlations and Fluctuations

Collaboration

Other

Primary author:  Mr MUKHERJEE, Ayon (Frankfurt Institute for Advanced Studies)
Presenter:  Mr MUKHERJEE, Ayon (Frankfurt Institute for Advanced Studies)
Session Classification:  Poster Session
Neutron skin at the LHC

High-energy nuclear collisions are often classified in terms of centrality. Theoretically, the centrality binning is determined by Glauber models which take the nuclear density as an input. The nuclear density is traditionally parametrized by the Woods-Saxon form and is taken to be the same for protons and neutrons. However, according to the theoretical expectations and experimental measurements as well, the tail of neutron density extends farther than that of the protons. This results in growth of the neutron-to-proton ratio at the edges of nuclei—a phenomenon referred to as neutron-skin effect. In high-energy nuclear collisions this relative increase of neutrons at the edges will have an influence on the centrality dependence of high-$p_T$ electroweak observables.

In this talk we present NLO pQCD predictions for the centrality dependence of inclusive high-$p_T$ photon production in Pb+Pb collisions at the LHC taking into account the neutron-skin effect and spatially dependent nuclear PDFs, EPS09s [Helenius, Paukkunen, Eskola, arXiv:1606.09044]. In addition, we consider the ratio between positively and negatively charged hadrons as well as $W$ production [Paukkunen, PLB 745 (2015) 73]. The advantage of these latter observables is that the nuclear modifications of the PDFs largely cancel out allowing for a cleaner study of the neutron-skin effect. According to our predictions, the neutron-skin effect can lead to modifications up to 20% in the most peripheral collisions and could thereby serve as a partial benchmark for the experimental centrality measures. In the future, the neutron skin should play a role in the centrality studies at the planned electron-ion colliders EIC and LHeC.

Preferred Track

Electromagnetic Probes

Collaboration

Not applicable

Primary author: Dr HELENIUS, Ilkka (Tübingen University)

Presenter: Dr HELENIUS, Ilkka (Tübingen University)

Session Classification: Poster Session
Do nuclear collisions create a locally equilibrated quark-gluon plasma?

Wednesday, 8 February 2017 18:10 (20 minutes)

Experimental results on azimuthal correlations in high energy nuclear collisions (nucleus-nucleus, proton-nucleus and proton-proton) seem to be well described by viscous hydrodynamics. It is often argued that this agreement implies either local thermal equilibrium or at least local isotropy. In this note, I present arguments why this is not the case. Neither local near-equilibrium nor near-isotropy are required in order for hydrodynamics to offer a successful and accurate description of experimental results. However, I predict the breakdown of hydrodynamics at momenta of order twenty times the temperature, corresponding to a smallest possible QCD liquid drop size of 0.05 fm.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: ROMATSCHKE, Paul (University of Colorado, Boulder)

Presenter: ROMATSCHKE, Paul (University of Colorado, Boulder)

Session Classification: Parallel Session 8.3: Collective Dynamics (III)

Track Classification: Collective Dynamics
Advanced hydrodynamical description of initial energy density in Cu+Cu, Au+Au, and Pb+Pb collisions at RHIC and LHC

We generalize a previously known class analytic, exact solutions of relativistic, perfect fluid hydrodynamics for the new results of pseudorapidity distributions. These advanced results include a broad centrality range evolution in Cu+Cu, Au+Au, Pb+Pb at RHIC and LHC with a series of acceleration parameter $\lambda$. Based on advanced hydrodynamic energy density estimation which taking acceleration effects into account, a clear energy density corrected ratio dependence of the pressure gradients and volume expanding is first presented.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Other

Primary author: JIANG, Zefang (CCNU)
Presenter: JIANG, Zefang (CCNU)
Session Classification: Poster Session
Chiral Shock Waves

We study the shock waves in relativistic chiral matter. We argue that the conventional Rankine-Hugoniot relations are modified due to the presence of chiral transport phenomena. We show that the entropy discontinuity in a weak shock wave is quadratic in the pressure discontinuity when the effect of chiral transport becomes sufficiently large. We also show that rarefaction shock waves, which do not exist in usual non-chiral fluids, can appear in chiral matter. The direction of shock wave propagation in a vorticity is found to be completely determined by the direction of the vorticity and the chirality of fermions.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: SEN, Srimoyee (University of Arizona)
Presenter: SEN, Srimoyee (University of Arizona)
Session Classification: Poster Session
Bayesian analysis of flow in small and large QGP droplets: the role of subnucleonic structure

Recent measurements of azimuthal particle correlations in small collision systems show striking similarities to flow signatures observed in gold-gold and lead-lead collisions, leading many to question if the origin of small system correlations is hydrodynamic in nature. The ensuing effort to construct a unified hydrodynamic model for small and large collision systems revealed new tension in the QGP initial conditions: heavy-ion collisions appear to prefer saturation based initial conditions [1209.6330, 1505.02677], while small system collectivity is currently best described using a Monte Carlo Glauber model [1502.04745].

It has since been suggested that adding subnucleonic structure to the QGP initial conditions could strongly affect flow in small collision systems and may explain apparent model discrepancies [1405.3605v1]. While practical implementations of subnucleonic structure are relatively straightforward—one simply replaces smooth protons with lumpy protons—there exist large theoretical uncertainties regarding the fluctuated shape of the proton, and corresponding theory predictions are highly model dependent.

In this work, we extend previous efforts to parametrize and constrain the QGP initial conditions using systematic Bayesian analysis and study the effects of subnucleonic structure predicted by a simple constituent parton model. We vary both subnucleonic degrees of freedom, e.g. the constituent parton number and effective parton width, as well as typical transport parameters such as the hydrodynamic starting time and QGP viscosity. The initial conditions are then embedded in an event-by-event hydrodynamic model and calibrated to simultaneously fit charged particle yields, flows and mean $p_T$ for light-heavy and heavy-heavy collisions at RHIC. We finally apply Bayesian parameter estimation methods to extract posterior distributions for the optimal initial condition parameters and comment on the implied viability of related theoretical frameworks.

Preferred Track
QCD in small systems

Collaboration
Not applicable

Primary author: MORELAND, Scott (Duke University)
Presenter: MORELAND, Scott (Duke University)
Session Classification: Parallel Session 6.1: QCD in Small Systems (III)
Track Classification: QCD in small systems
Phenomenological predictions of 3+1d anisotropic hydrodynamics

We make phenomenological predictions for particle spectra and flow in heavy-ion collisions using 3+1d anisotropic hydrodynamics (aHydro) including the effects of both bulk and shear viscosities. The dynamical equations necessary are derived by taking moments of Boltzmann equation allowing for three distinct momentum-space anisotropy parameters. The formulation is based on relaxation-time approximation for the collisional kernel and a lattice-QCD-based equation of state. Evolving the system to late times, we calculate particle production using THERMINATOR modified to account for an ellipsoidal distribution function. We obtain particle spectra for different particle types such as pions, kaons, and protons and elliptic flow, $v_2$, as a function of centrality, transverse momentum, and rapidity. In our model, we have four free parameters, i.e., freeze-out temperature, initial energy density, initial momentum-space anisotropy, and shear viscosity to entropy density ratio. Using a multidimensional fit to LHC experimental data, we extract these parameters. We find good agreement between 3+1d aHydro and available experimental data.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: NOPOUSH, Mohammad (Kent State University)

Co-author: Dr STRICKLAND, Michael (Kent State University)

Presenter: NOPOUSH, Mohammad (Kent State University)

Session Classification: Poster Session
O(g) NLO effects in transport coefficients

Tuesday, 7 February 2017 14:00 (20 minutes)

Transport coefficients of QCD like the shear viscosity $\eta$ and the diffusion of baryon number $D$ have been determined at leading order in perturbation theory by Arnold, Moore and Yaffe (AMY). I will show how these transport coefficients are sensitive to $O(g)$ corrections arising from interactions with soft gluons. These NLO effects enter as corrections to the transverse momentum broadening coefficient $\hat{q}$, to longitudinal momentum broadening, to quark-gluon conversions, to collinear 1$\leftrightarrow$2 processes and to wider-angle bremsstrahlung (semi-collinear processes). These corrections have been computed using a Euclidean formalism pioneered by S. Caron-Huot, which exploits the analytical properties of amplitudes supported on light fronts. There remain only two coefficients whose $O(g)$ corrections are unknown, as I will show.

I will show the effect of all known corrections to the value of the transport coefficients. In particular, the large $O(g)$ contribution to $\hat{q}$ is the leading NLO effect and it reduces the value of the transport coefficients very significantly. I will also estimate the effect of the unknown coefficients.

Preferred Track
QCD at High Temperature

Collaboration
Not applicable

Primary author: GHIGLIERI, Jacopo (CERN (CH))
Presenter: GHIGLIERI, Jacopo (CERN (CH))
Session Classification: Parallel Session 3.1: QCD at High Temperature
Track Classification: QCD at High Temperature
Pion-nucleus Drell-Yan data as a novel constraint for nuclear PDFs

Despite the success of modern nuclear parton distribution functions (nPDFs) in describing nuclear hard-process data, they still suffer from large uncertainties. One of the shortcomings is the lack of data which would constrain the nuclear effects of all parton flavours simultaneously without any a priori assumptions. For example, it has been customary to assume that nuclear modifications for both valence quarks $u$ and $d$ are the same. We have studied the prospects of using the Drell-Yan dilepton process in pion-nucleus collisions as a novel input in the global analysis of nPDFs 1. In a NLO QCD framework, we find the measured nuclear cross-section ratios from the NA3, NA10 and E615 experiments to be largely independent of pion parton distributions and also compatible with the EPS09 and nCTEQ15 nPDFs. These data sets can thus be included in global nPDF analyses without introducing significant new theoretical uncertainties or tension with the other data. In particular, we explore the constraining power of these data sets on the possible asymmetry of the valence-quark nuclear modifications.


Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: PAAKINEN, Petja (University of Jyväskylä)

Presenter: PAAKINEN, Petja (University of Jyväskylä)

Session Classification: Poster Session
Electric conductivity and Baryon diffusion in hot hadronic matter from kinetic theory

Transport coefficients of hot hadron and QGP matter characterize their behavior upon external perturbations. Although this can be interesting by itself, they are important input for many phenomenological models that explain data for heavy-ion collisions. In this talk, we present our recent results from kinetic theory for the electric conductivity in a hot hadron gas (see Phys.Rev.D 93 (2016), 096012). The electric conductivity is recently gaining attention within several new studies about the possibly strong magnetic field influence in heavy-ion collisions. Our mostly analytic method includes 11 (or more) hadron species with their mutual parametrized (resonance) cross sections. It is based on the Boltzmann equation with a linearized collision term, which can be solved for the coefficients with in principle arbitrary precision. We extend the calculations to the baryon diffusion constant, baryon conductivity and heat flow. Below the phase transition, there is so far very little knowledge about these quantities, and kinetic theory serves as a unique quantitative tool which has a clear physical interpretation. Our results for zero chemical potential are contrasted to various strong coupling and lattice QCD results. Furthermore, results for finite chemical potentials can be obtained in the same framework. Baryon diffusion is a rather little explored but very important phenomenon in recent and future baryon-rich experiments, and our results could help to understand their data.

Preferred Track
QCD at High Temperature

Collaboration
Not applicable

Primary author: GREIF, Moritz (University of Frankfurt)
Co-author: DENICOL, Gabriel (McGill University)
Presenter: GREIF, Moritz (University of Frankfurt)
Session Classification: Poster Session
Measurement of neutral mesons in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with PCM in ALICE

Neutral mesons can provide important information on the energy loss of partons traversing the hot and dense state of matter, which is created in high energy heavy-ion collisions. Furthermore, they constitute the largest background contribution for direct photons, which are also a very important tool to study the properties of the Quark Gluon Plasma. In the ALICE experiment, neutral mesons can be measured via their decay to two photons. Apart from the two calorimeters EMCal and PHOS, photons can be reconstructed also via the Photon Conversion Method (PCM). The latter exploits the fact that a photon can convert to an electron-positron pair. These charged particles can be detected via their tracks in the Time Projection Chamber (TPC) and the Inner Tracking System (ITS). The PCM allows the measurement of both photons and neutral mesons, carrying low transverse momenta (down to $p_T \approx 1$ GeV), with very good energy resolution. Apart from presenting the performance of the photon conversion method, first results on the $\pi^0$ and $\eta$ meson production in Pb-Pb collisions with a center-of-mass collision energy per nucleon of $\sqrt{s_{NN}} = 5.02$ TeV will be shown.

Preferred Track

Electromagnetic Probes

Collaboration

ALICE

Primary author: DANISCH, Meike Charlotte (Ruprecht-Karls-Universitaet Heidelberg (DE))

Presenter: DANISCH, Meike Charlotte (Ruprecht-Karls-Universitaet Heidelberg (DE))

Session Classification: Poster Session
Quark self-energy in an ellipsoidally anisotropic quark-gluon plasma

We calculate the quark self-energy in a quark-gluon plasma that possesses an ellipsoidal momentum-space anisotropy in the local rest frame. By introducing additional transverse momentum anisotropy parameters into the parton distribution functions, we generalize previous results which were obtained for the case of a spheroidal anisotropy. Our results demonstrate that the presence of anisotropies in the transverse directions affects the real and imaginary parts of quark self-energy and, consequently, the self-energy depends on both the polar and azimuthal angles in the local rest frame of the matter. Our results for the quark self-energy set the stage for the calculation of the effects of ellipsoidal momentum-space anisotropy on quark-gluon plasma photon spectra and collective flow.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author:  SALEHI KASMAEI, Babak (Kent State University)

Co-authors:  Dr STRICKLAND, Michael (Kent State University); NOPOUSH, Mohammad (Kent State University)

Presenter:  SALEHI KASMAEI, Babak (Kent State University)

Session Classification:  Poster Session
Radiative decay of Singly Heavy Bottom Baryons in the Hypercentral Quark Model

In hadron spectroscopy, various decay processes of the heavy flavour baryons are important to identify the new hadronic states observed experimentally. The strong decays are expected to dominate the branching ratios of heavy flavour baryons. Although the electromagnetic strength is weaker than that of the strong interaction, radiative channels are not phase space suppressed as in the case of pion transitions. Therefore, some radiative decay modes are expected to contribute significantly to heavy baryon branching fractions. In the present study, we employ a simple non-relativistic hypercentral approach with coulomb plus power potential to compute the radiative decays of the single heavy bottom baryons in terms of radiative transition magnetic moments and photon energy. The predicted radiative decay widths of singly heavy bottom baryons are in the range of few eV to KeV.

Preferred Track
Open Heavy Flavors

Collaboration
Not applicable

Primary author: Dr THAKKAR, Kaushal
Co-author: MAJETHIYA, Ajay (V S PATEL COLLEGE OF ARTS AND SCIENCE, COLLEGE ROAD, BILIMORA, DIST NAVSARI, GUJARAT 396321, INDIA)
Presenter: Dr THAKKAR, Kaushal
Session Classification: Poster Session
High statistics study of in-medium S- and P-wave quarkonium states in lattice Non-relativistic QCD

Tuesday, 7 February 2017 15:00 (20 minutes)

Many precision measurements of quarkonium suppression at the LHC, e.g. the nuclear modification factor \( R_{AA} \) of \( J/\psi \), are well described by a multitude of different models. Thus pinpointing the underlying physics is difficult and first principles guidance is needed. In-medium spectral properties, e.g. mass shifts or the broadening of states can help us to understand quarkonium production in a kinetically equilibrated setting. While potential based approaches with lattice input have been used to estimate such modifications, a direct and quantitative determination from first principles lattice QCD is still outstanding.

Advancing towards this goal we present here a high statistics study of bottomonium and charmonium S-wave and P-wave spectral properties at finite temperature using the effective field theory NRQCD on the lattice. This EFT allows us to capture the physics of quarkonium without modelling assumptions in a realistic thermal QCD medium, described by state-of-the-art lattices of the HotQCD collaboration at almost physical pion mass \( [3] \). The availability of two Bayesian methods for spectral functions (MEM and BR \([4]\)) makes it possible to thoroughly test the systematic uncertainties of their reconstruction.

Our new lattice QCD correlation functions and reconstructed spectra corroborate a picture of sequential modification of states with respect to their vacuum binding energy. We find that remnant features of the bottomonium S-wave may survive up to \( T\sim400\text{MeV} \), while the P-wave ground state disappears around \( T\sim300\text{MeV} \). The charmonium analysis hints at melting of the P-wave below \( T\sim190\text{MeV} \) while some S-wave remnant feature might survive up to \( T\sim245\text{MeV} \).

With the inclusion of charmonium spectra, an extended temperature range and increased statistics by more than an order of magnitude our study provides a coherent picture of in-medium quarkonium modification extending significantly beyond our previous results of Ref. \([5]\).


Preferred Track
QCD at High Temperature

Collaboration
Not applicable

Primary author: ROTHKOPF, Alexander (Heidelberg University)
Presenter: ROTHKOPF, Alexander (Heidelberg University)
Session Classification: Parallel Session 3.1: QCD at High Temperature

Track Classification: QCD at High Temperature
Gluonic hot spots and spatial correlations inside the proton

In this talk, based on arXiv:1605.09176, we present a microscopic realization of the hollowness effect observed in proton-proton scattering at $\sqrt{s} = 7$ TeV. The initial collision geometry proposed in our model could impact significantly the interpretation of data specially sensitive to it, like the eccentricities of proton-proton, proton-nucleus and nucleus-nucleus collisions. The hollowness effect, not observed at lower energies, consists in a depletion of the inelasticity density at zero impact parameter of the collision. Counterintuitively, there is more inelasticity when the two protons are at about half a fermi transverse separation that for head-on collisions.

Our analysis is based on three main ingredients: we rely gluonic hot spots inside the proton as effective degrees of freedom for the description of the scattering process. Next we assume that some non-trivial correlation between the transverse positions of the hot spots inside the proton exists. Finally we build the scattering amplitude from a multiple scattering, Glauber-like series of collisions between hot spots. In our approach, the onset of the hollowness effect is naturally explained as due to the diffusion or growth of the hot spots in the transverse plane with increasing collision energy. Furthermore, we will explore the impact of the non-trivial correlations between the transverse positions of the hot spots in the calculation of eccentricities in proton-proton collisions, a highly debated topic nowadays as there are suggestive signals of collective phenomena, associated to the formation of QGP in heavy ion collisions, in this smaller system that may be caused by the initial state geometry.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary author:  SOTO ONTOSO, Alba (UGR/FIAS)

Presenter:  SOTO ONTOSO, Alba (UGR/FIAS)

Session Classification:  Poster Session
Heavy ions at the Future Circular Collider

Wednesday, 8 February 2017 16:50 (20 minutes)

This presentation will review the projected accelerator performance and the physics opportunities for a heavy-ion programme at FCC-hh 1. In addition, the status of the FCC-hh detector design studies will be discussed.

The FCC-hh Design Study will assess the feasibility and potential of a hadron collider with a centre-of-mass of 100 TeV for pp collisions. The status of the project will be summarized.

Operating FCC-hh with heavy-ion beams would provide Pb-Pb and p-Pb collisions at $\sqrt{s_{NN}}$ of 39 and 63 TeV, respectively. Current estimates indicate that a luminosity of about 30/mb could be integrated during a one-month Pb-Pb run, that is more than one order of magnitude above the maximum projections for the LHC. The FCC-hh beams could also be used for fixed-target collisions, either with beam extraction or gaseous target techniques.

The Quark-Gluon Plasma state produced in Pb-Pb collisions at 39 TeV is expected to have initial temperature and energy density substantially larger than at LHC energy, a stronger flow field and freeze-out volume twice as large. The larger temperature could entail novel features, like e.g. abundant in-medium production of charm quarks. The latter could determine an increase in the number of degrees of freedom of the QGP and provide a new tool to study its temperature evolution. New, rarer, hard probes would be available, like boosted top quarks, which could give access to the time-evolution of the medium opacity.

The physics of high gluon densities at small Bjorken-$x$ and the onset of saturation can be studied using pA, AA, and $\gamma A$ collisions. The FCC-hh will provide access to the region down to $x < 10^{-6}$ with perturbative probes like heavy quarks and quarkonia and to the region of high $Q^2$ down to $x \sim 10^{-4}$ with W, Z and top. High-energy photon-photon interactions in ultraperipheral AA collisions will also enable the study of very rare processes such as light-by-light scattering and $\gamma \gamma \rightarrow W^+W^-.$

Detector design studies, focused on multipurpose pp experiments, and a survey of the possible technological solutions are ongoing and will be summarised as well in the presentation.

1 A. Dainese et al., Heavy ions at the Future Circular Collider, arXiv:1605.01389

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

Not applicable

Primary author:  D’ENTERRIA, David (CERN)
Presenter:  D’ENTERRIA, David (CERN)
Session Classification:  Parallel Session 8.2: Future Experimental Facilities, Upgrades, and Instrumentation
**Track Classification:** Future Experimental Facilities, Upgrades, and Instrumentation
Jet evolution in a dense medium: event-by-event fluctuations and multi-particle correlations

Wednesday, 8 February 2017 12:00 (20 minutes)

We study the gluon distribution produced via successive medium-induced branchings by an energetic jet propagating through a weakly-coupled quark-gluon plasma. We show that under suitable approximations, the jet evolution is a Markovian stochastic process, which is exactly solvable. For this process, we construct exact analytic solutions for all the n-point correlation functions describing the gluon distribution in the space of energy [1,2]. Using these results, we study the event-by-event distribution of the energy lost by the jet at large angles and of the multiplicities of the soft particles which carry this energy. We find that the event-by-event fluctuations are huge: the standard deviation in the energy loss is parametrically as large as its mean value 1. This has important consequences for the phenomenology of di-jet asymmetry in Pb+Pb collisions at the LHC: it implies that the fluctuations in the branching process can contribute to the measured asymmetry on an equal footing with the geometry of the di-jet event (i.e. as the difference between the in-medium path lengths of the two jets). We compute the higher moments of the multiplicity distribution and identify a remarkable regularity known as Koba-Nielsen-Olesen (KNO) scaling 2.

These predictions could be tested via event-by-event measurements of the di-jet asymmetry.

References
1 Event-by-event fluctuations in the medium-induced jet evolution
2 Multi-particle correlations and KNO scaling in the medium-induced jet evolution
Measurement of neutral mesons in pp collisions at √s = 8 TeV with ALICE at the LHC

ALICE has measured the invariant cross sections for the production of neutral pion and eta mesons in proton-proton collisions at √s = 8 TeV. Neutral mesons have been reconstructed by means of three different detection systems; using the central barrel tracking detectors of ALICE in order to reconstruct photon conversions (PCM) and the two available calorimeters in the experiment, namely the Photon Spectrometer (PHOS) and Electromagnetic Calorimeter (EMCal).

The reported measurements have been carried out as well using a ‘hybrid’ system which reconstructs meson candidates by combining one EMCal photon with one PCM photon. Thus, this ‘hybrid’ system serves as an important cross-check for the single measurements and additionally measures an almost independent set of meson candidates. By using EMCal and PHOS triggers in addition, the fully combined measurements cover transverse momentum ranges from 0.3 GeV/c for neutral pions (0.4 GeV/c for eta mesons) up to 35 GeV/c for both neutral mesons.

Furthermore, the corresponding \( \eta/\pi^0 \)-ratio will be shown to test scaling laws for particle production. All obtained results will be compared with different Monte Carlo generators as well as NLO pQCD predictions.

Based on the obtained results, an inclusive direct photon measurement is being carried out. The ‘hybrid’ PCM-EMCal system is used to tag neutral pion candidates, which can then be used to extract the direct photon signal. This pion-tagging method will be illustrated and first insight into the analysis will be presented.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: MUHLHEIM, Daniel Michael (Westfaelische Wilhelms-Universitaet Muenster (DE))

Presenter: MUHLHEIM, Daniel Michael (Westfaelische Wilhelms-Universitaet Muenster (DE))

Session Classification: Poster Session
Direct Photon Simulations with POWHEG BOX

Direct photons provide particular insight into nuclear collisions. Since they give immediate access to the energy scale of a hard scattering, direct photons allow further constraints of (nuclear) parton distribution functions, especially on the poorly known distribution of initial state gluons. Direct photons have, moreover, the potential to yield unambiguous information on hot nuclear matter; in contrast to hard partonic probes they are not strongly affected by the medium.

In the last two decades, fixed order calculations of direct photons beyond leading order and resummation methods beyond leading log accuracy came to fruition. Yet, a parton shower Monte Carlo approach beyond leading Order has been neglected so far, which is a pressing issue with respect to the prevalence of shower Monte Carlo generators in the HEP community. Considering that photon fragmentation functions for fixed-order calculations received no major updates in the last two decades, the role of the shower Monte Carlo approach becomes even more significant.

We present the POWHEG BOX implementation of the dominant direct photon production processes $qg \rightarrow q\gamma$ and $q\bar{q} \rightarrow g\gamma$ at Next-to-Leading Order, interfaced with the PYTHIA8 parton shower. We aim for a robust description of direct photons and investigate therefore various simulation parameters of both the hard scattering kernel and the shower Monte Carlo. We present comparisons to direct/isolated photon measurements from ATLAS, CMS and ALICE and evaluate the improvement with respect to the PYTHIA8 standalone description. In preparation of the differential direct photons measurements to come, we will in addition provide a study about gamma-hadron and gamma-jet correlations including isolation criteria.

Preferred Track

Electromagnetic Probes

Collaboration

Not applicable

Primary author: Mr POPPENBORG, Hendrik (Westfaelische Wilhelms-Universitaet Muenster (DE))

Presenter: Mr POPPENBORG, Hendrik (Westfaelische Wilhelms-Universitaet Muenster (DE))

Session Classification: Poster Session
Understanding $J/\psi$ meson hadroproduction has been a long-term effort both experimentally and theoretically. However, none of the existing theoretical models can successfully describe both $J/\psi$ transverse momentum ($p_T$) spectrum and the polarization. Furthermore, the composition of inclusive $J/\psi$ is complicated, including direct production via gluon fusion, parton fragmentation, and feed-down from excited charmonium states and B hadrons. Measurements of $J/\psi$ production at a different beam energy can shed new lights on the understanding of different $J/\psi$ production mechanisms, and help to constrain model calculations.

We report measurements of $J/\psi$ production in p+p collisions at $\sqrt{s} = 500$ GeV in both the di-electron and di-muon channels. By combining measurements from these two channels, the $p_T$ spectrum of $J/\psi$ is measured from 0 to 20 GeV/c and compared with NLO NRQCD and CGC+NRQCD calculations at different kinematic ranges. Feed-down contributions from $\psi(2S)$ is studied in the $p_T$ range of $4 < p_T < 12$ GeV/c. In addition, measurements of the $J/\psi$ production as a function of charged-particle multiplicity will be presented. A strong increase of the relative $J/\psi$ yield with multiplicity is observed for all $p_T$ bins with significant $p_T$ dependence. The results are compared with predications from the Percolation model and PYTHIA8.
I will discuss a novel solution to the sign problem which prevents first principle Monte-Carlo computations of QCD at finite chemical potential (especially important for both the search for the critical point and neutron star physics) as well as real time quantities such as transport coefficients. The solution is based on deforming the region of integration in the path integral into a complex manifold where the sign problem can be mitigated substantially. I will explain the new Monte-Carlo algorithm based on this idea and give examples of interacting quantum field theories (bosonic and fermionic) with nonzero chemical potential as well as real time dynamics where this method successfully solves the sign problem. This approach generalizes the “Lefschetz thimble” method that received much attention lately. I will also compare/contrast with the complex Langevin method.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: Dr BASAR, Gokce (University of Maryland, College Park)

Presenter: Dr BASAR, Gokce (University of Maryland, College Park)

Session Classification: Parallel Session 5.3: New Theoretical Developments (I)

Track Classification: New Theoretical Developments
Measurement of neutral mesons in pp collisions at $\sqrt{s} = 5$ TeV with the ALICE EMCal

Neutral meson production in pp collisions is described by pQCD in a limited kinematic range. Both $\pi^0$ and $\eta$ meson spectra constrain parameters of theoretical models in both perturbative (NLO, NNLO) and non-perturbative regimes (structure function, fragmentation function). Neutral meson spectra in pp are used as a reference for Pb-Pb and p-Pb measurements at the same per nucleon collision energy. Neutral mesons are also sources of decay photons which are a major background for direct photon measurements. We present the current status of measurements of neutral meson spectra carried out by the ALICE experiment in pp collisions at $\sqrt{s} = 5$ TeV with the electromagnetic calorimeter (EMCal) via the invariant mass technique.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: MATYJA, Adam Tomasz (Polish Academy of Sciences (PL))

Presenter: MATYJA, Adam Tomasz (Polish Academy of Sciences (PL))

Session Classification: Poster Session

Track Classification: Jets and High pT Hadrons
Charm $v_2$ is more hydrodynamic than light quark $v_2$

Azimuthal anisotropy $v_2$ is a useful tool for the study of the properties of the quark-gluon plasma (QGP). Recent studies with parton transport models suggest, however, that the majority of light quark $v_2$ comes from the anisotropic escape of partons, not hydrodynamic flow [1-4]. Heavy quarks, produced by hard scatterings at early times in relativistic heavy ion collisions, are regarded as an excellent probe of the QGP. Is charm quark $v_2$ mainly from anisotropic escape or hydrodynamics? In this talk we try to address this question using a multi-phase transport (AMPT) model, which has been very successful in describing experimental data for the bulk matter [5]. We follow the entire evolution history of charm quarks in AMPT and study the development of charm $v_2$ in heavy ion collisions as well as small system collisions at both RHIC and LHC energies. We find the common escape mechanism to be at work for both charm and light quark $v_2$. However, in contrast to naive expectations, the charm $v_2$ appears to be more sensitive to hydrodynamics than light quark’s $v_2$. We then use a simple Monte Carlo simulation to shed insights on the results. Our finding thus highlights the importance of heavy quark flow in the study of the QGP.


Preferred Track
Collective Dynamics

Collaboration
Not applicable

Primary author: Mr LI, Hanlin (Wuhan University of Science and Technology & Purdue University)

Presenter: Mr LI, Hanlin (Wuhan University of Science and Technology & Purdue University)

Session Classification: Poster Session
Rapidity Correlation Structure in Nuclear Collisions

The forces that drive the nuclear collision system towards local thermal equilibrium leave few observable traces. We show that measurements of the rapidity dependence of transverse momentum correlations can be used to determine the characteristic time $\tau_\pi$ that dictates the rate of isotropization of the stress energy tensor, as well as the shear viscosity $\nu = \eta/sT$. We formulate methods for computing these correlations using second order dissipative hydrodynamics with noise. Current data are consistent with $\tau_\pi/\nu \approx 10$ in the temperature independent case. We extend this result to include a realistic equation of state and temperature dependent first and second order transport coefficients. We then discuss how measurements of the beam energy and system size dependence of the rapidity distribution can be used as a precise test of theoretical transport coefficient calculations.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: Prof. MOSCHELLI, George (Lawrence Technological University)
Presenter: Prof. MOSCHELLI, George (Lawrence Technological University)
Session Classification: Poster Session
Exploring the charm content of jets in pp collisions with ALICE

Jets are a fundamental feature of high-energy particle interactions. They result from the fragmentation of hard-scattered partons, a key process of Quantum Chromodynamics (QCD). The study of the charm content of jets is interesting because up to now it has eluded a precise quantitative understanding in the framework of perturbative QCD (pQCD). This is in contrast with other hard processes that are successfully described by pQCD, such as top and bottom production and the inclusive jet cross section. The charm content of jets is known to arise both from prompt production in the process $gg (q\bar{q}) \rightarrow cc$, and from the parton shower of gluons and light-flavor quarks. The relative contribution of these two competing mechanisms is understood only qualitatively and it is known to depend on the center-of-mass energy of the two colliding protons. Furthermore charm hadrons coming from the fragmentation of prompt charm jets are expected to carry a larger fraction of the total jet momentum, as compared to those where the charm content arises later in the parton shower. Therefore the measurement of charm jet fragmentation functions (FFs) can be used to estimate the relative strength of the two mechanisms.

Heavy-flavor jets can also provide important insights into the Quark-Gluon Plasma (QGP) produced in ultra-relativistic heavy-ion collisions, as heavy quarks are predicted to interact with the QGP differently compared to light quarks and gluons. However, their production mechanisms must first be studied in the vacuum, in order to provide a baseline for the observation of possible modifications induced by the presence of the QGP.

We present the current status of the measurement of jets that contain a D meson (D-tagged jets) using the ALICE detector. The aim of the analysis is to extract both the $p_T$ spectrum of the D-tagged jets and the jet-momentum fraction of the D mesons. We identify D-meson candidates via their hadronic decay channels using topological selections and particle identification. These D-meson candidates are combined with the other charged tracks reconstructed by the central tracking system, using the anti-$k_T$ jet-finding algorithm. We extract the yield of D-tagged jets through an invariant mass analysis of the D-meson candidates associated with each jet, in bins of jet $p_T$ and momentum fraction carried by the D meson. For this analysis we use data collected by ALICE with minimum bias triggers in pp collisions at 7 TeV. We will discuss also the perspectives for the same measurement in pp collisions at 8 and 13 TeV using events triggered by the electromagnetic calorimeters.

Preferred Track

Jets and High $p_T$ Hadrons
Collaboration

ALICE

Primary author:  AIOLA, Salvatore (Yale University (US))
Presenter:  AIOLA, Salvatore (Yale University (US))
Session Classification:  Poster Session
Scaling functions for the Inverse Compressibility near the QCD critical point

The QCD phase diagram can be mapped out by studying fluctuations and their response to changes of the temperature and baryon chemical potential. Theoretical studies \(^1\) indicate that the cumulant ratios \(C_n/C_m\), used to characterize the fluctuation of conserved charges, provide a valuable probe of deconfinement and chiral dynamics, as well as for identifying the position of the critical end point (CEP) in the QCD phase diagram. The ratio \(C_1/C_2\), which is linked to the inverse compressibility, vanishes at the CEP due to the divergence of the net quark number fluctuations at the critical point belonging to the \(Z(2)\) universality class \(^1\). Therefore, its associated scaling function can give insight on the location of the critical end point, as well as the critical exponents required to assign its static universality class. Scaling functions for the ratio \(C_1/C_2\), obtained from net-proton multiplicity distributions for a broad range of collision centralities in \(Au+Au (\sqrt{\text{sNN}} = 7.7 - 200 \text{ GeV})\) collisions, will be presented and discussed.


Preferred Track

Correlations and Fluctuations

Collaboration

Other

Primary author: LACEY, Roy (Stony Brook University)

Presenter: LACEY, Roy (Stony Brook University)

Session Classification: Poster Session
We present an ab-initio approach to compute the longitudinal dependence of the initial state by including small-x evolution of the nuclear gluon distributions. We extend the IP-Glasma model by consistently including JIMWLK rapidity evolution and compute event-by-event rapidity distributions of produced gluons and the early time energy momentum tensor as a function of space-time rapidity and transverse coordinates. We show how the effects of small-x evolution manifest themselves in longitudinal (rapidity) correlations of event-by-event multiplicities and transverse geometry and compare our results to various phenomenological models and experimental observations.

1 B. Schenke, S. Schlichting arXiv:1605.07158 (accepted for publication in Phys.Rev. C)
Sphalerons and Axial Charge Production Out of Equilibrium

We report on a first computation of non-equilibrium sphaleron transitions in the Glasma created immediately after the collision of ultra-relativistic nuclei. Based on classical-statistical real time lattice gauge theory simulations, we find that the rate of topological transitions is initially strongly enhanced relative to the thermal equilibrium sphaleron transition rate and decays with time during the thermalization process. We will also demonstrate how our simulations can be extended to include dynamical fermions in order to compute the initial state production of axial charge — a crucial input for the ab initio dynamical modeling of the Chiral Magnetic Effect in heavy-ion collisions.


Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

BEST

Primary author: MACE, Mark (Stony Brook University)
Co-authors: MUELLER, Niklas (Heidelberg University); SHARMA, Sayantan (BNL); SCHLICHTING, Soeren (University of Washington)
Presenter: MACE, Mark (Stony Brook University)
Session Classification: Poster Session
Constituent quarks and systematic errors in midrapidity charged multiplicity \((dN_{ch}/d\eta)\) distributions.

Although it was demonstrated more than 13 years ago that the increase in midrapidity \(dN_{ch}/d\eta\) with increasing centrality of Au+Au collisions at RHIC was linearly proportional to the number of constituent quark participants \((N_{qp})\) in the collision, it was only in the last few years that generating the spatial positions of the three quarks in a nucleon according to the Fourier transform of the measured electric charge form factor of the proton could be used to connect \(dN_{ch}/d\eta/N_{qp}\) as a function of centrality in \(p(d)+A\) and \(A+A\) collisions with the same value of \(dN_{ch}/d\eta/N_{qp}\) determined in \(p+p\) collisions. The several calculations had slightly different methods. One calculation, which only compared its calculated \(dN_{ch}/d\eta/N_{qp}\) in \(p+p\) at \(\sqrt{s_{NN}} = 200\) GeV to the least central of 12 centrality bin measurements in Au+Au by PHENIX, claimed that the \(p+p\) value was higher by "about 30\%" from the band of measurements vs. centrality and suggested a smaller number of subnuclear contributors, e.g. quark-diquark. However the clearly quoted systematic errors were ignored for which a 1 standard deviation systematic shift would move all the 12 Au+Au data points to within 1.3 standard deviations of the \(p+p\) value, or if the statistical and systematic errors are added in quadrature a difference of 35 ± 21\% . The PHENIX method gives a difference of 19±18\%.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author:  TANNENBAUM, Michael (Brookhaven National Laboratory (US))

Presenter:  TANNENBAUM, Michael (Brookhaven National Laboratory (US))

Session Classification:  Poster Session
Achieving High Baryon Densities in the Fragmentation Regions of High Energy Heavy Ion Collisions at LHC and RHIC

Heavy ion collisions at extremely high energy, such as the top energy at RHIC and the typical energy at LHC, exhibit the property of transparency where there is a clear separation between the almost net-baryon-free central rapidity region and the net-baryon-rich fragmentation region. We calculate the net-baryon rapidity loss and the nuclear excitation energy using the energy-momentum tensor obtained from the McLerran-Venugopalan model. Nuclear compression during the collision is further estimated using a simple space-time picture. The results show that extremely high baryon densities, more than ten times larger than the normal nuclear density, can be achieved in the fragmentation regions. Systematic studies including asymmetric collisions, collisions at finite impact parameters and collisions with different nuclei and energy are performed. Our results should provide the initial conditions for the baryon distribution in the ensuing evolution and open a different corner on the QCD phase diagram for experimental probes.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: LI, Ming (University of Minnesota, Twin Cities)
Presenter: LI, Ming (University of Minnesota, Twin Cities)
Session Classification: Poster Session
n Gluon Bremsstrahlung from Maximal Helicity Violating Techniques

We present a new approach to compute the probability for emission of an arbitrary number of gluons radiated from a high-pT probe of the QGP. Our work is an extension of the maximal helicity violating (MHV) method in which the usual soft-collinear factor is classified according to its symmetry under gluon permutations.

For the purposes of illustration, we show the explicit form of the result from 1 to 3 gluon emissions then present the general expression for any generic n numbers of gluons. In particular, we compute for the first time analytically the QCD corrections to the multi-gluon Poisson approximation and evaluate numerically the importance of these corrections. Since all current energy loss calculations assume that the Poisson distribution of photons from QED bremsstrahlung is a good approximation for the multi-gluon radiation in QCD, our results will prove invaluable to leading particle and jet energy loss modellers.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary author: Mr RASOANAIVO, Andrimaina (University of Cape Town)

Presenter: Mr RASOANAIVO, Andrimaina (University of Cape Town)

Session Classification: Poster Session
Probing QCD medium with the measurements of Symmetric 2- harmonics 4-particle cumulant and moments of flow distributions in heavy-ion collisions in STAR.

Relativistic heavy-ion collision experiments aim to study the formation and evolution of a strongly interacting matter called Quark Gluon Plasma (QGP). Initial spatial anisotropy and/or quantum fluctuations of the positions of the colliding nucleons lead to development of anisotropic collective expansion of the QGP medium. The magnitude of anisotropic flow harmonics ($v_n$) fluctuates from collision to collision. Correlations between different order flow harmonics are predicted to be sensitive to transport properties of the produced medium in heavy-ion collision. Magnitudes of measured flow fluctuation are also found to be sensitive to the initial condition and transport properties of QCD medium. Therefore, measurement of such correlations and fluctuation can be used to probe the QCD medium created after the heavy-ion collision. Such measurements can also provide stronger constraints on initial conditions in theoretical models in combination with standard $v_n$ measurements.

We present the magnitude of correlations between different order flow harmonics by measuring Symmetric 2-harmonics 4-particle cumulant in Au+Au collisions. Results will be presented as a function of centrality and center-of-mass energy. Flow fluctuation will be studied using moments of flow distributions as a function of centrality and beam energy starting from 200 GeV to 7.7 GeV. Physics implication of such results will be discussed. Comparison with theoretical model will be shown to extract more information about QCD medium e.g. specific viscosity.
Measurement of neutral mesons in pp and Pb-Pb collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV with the PHOS detector

Neutral mesons such as $\pi^0$ and $\eta$ that decay into two photons are suitable to study parton energy loss in the QGP, since they can be identified, using a fine-segmented electromagnetic calorimeter, in a wide transverse momentum range.

The Photon Spectrometer (PHOS) in ALICE is an electromagnetic calorimeter which is located at 4.6 m from the interaction point.

PHOS consists of 12,544 segments with a $2.2 \times 2.2 \times 18$ cm$^3$ PbWO$_4$ crystal readout by an APD. This fine granularity, possible due to the small Moliere radius of 2.2 cm, allows us to distinguish two photons decaying with a small opening angle from a parent particle up to $p_T = 50$ GeV/c with an invariant mass method.

ALICE recorded about 20 $\mu$b$^{-1}$ of Pb-Pb collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV and 2.5 nb$^{-1}$ of pp collisions at $\sqrt{s} = 5.02$ TeV with minimum bias triggers in 2015.

Additionally, PHOS Level-0 trigger which is based on high energy hits in 4 crystals can extend the $\pi^0$ measurement up to $p_T = 30$ GeV/c in pp collisions.

Clear $\pi^0$ and $\eta$ meson peaks have been extracted in a wide $p_T$ range and in each centrality class via di-photon decay channel with the PHOS detector in ALICE.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ALICE

Primary author: SEKIHATA, Daiki (Hiroshima University (JP))

Presenter: SEKIHATA, Daiki (Hiroshima University (JP))

Session Classification: Poster Session
Measurement of $D^0$-meson elliptic flow in Pb-Pb collisions at $\sqrt{s_{NN}}=5.02$ TeV with ALICE.

Produced in hard-scattering processes in the initial stage of the collision, heavy quarks probe the whole evolution of the deconfined system (Quark-Gluon Plasma) formed in ultra-relativistic heavy-ion collisions. The measurement of the azimuthal anisotropy of D-meson production is crucial to understand charm quark in-medium energy loss and its coupling to the system. ALICE measured a positive D-meson elliptic flow in Pb-Pb collisions at $\sqrt{s_{NN}}=2.76$ TeV at LHC, which suggests that charm quarks with low transverse momentum are influenced by the collective motion of the system. The measurement of $D^0$-meson elliptic flow in Pb-Pb collisions at $\sqrt{s_{NN}}=5.02$ TeV obtained with data from run 2 at the LHC will be presented.

Preferred Track

Open Heavy Flavors

Collaboration

ALICE

Primary author:  ROSSI, Andrea (Università e INFN, Padova (IT))
Presenter:  ROSSI, Andrea (Università e INFN, Padova (IT))
Session Classification:  Poster Session
**Δη dependence of net-charge fluctuations in Au+Au collisions from the Beam Energy Scan at the STAR experiment**

In heavy-ion collision experiments, the study of event-by-event fluctuations provides a powerful tool to characterize and understand the thermodynamic properties of the hot and dense QCD matter. The fluctuations of conserved quantities in a finite phase space rapidity window (Δη), like the net-charge, are predicted to be one of the most sensitive signals of the QGP formation and phase transition [1].

D-measure which is defined by second order cumulant per unit entropy was obtained as a function of Δη in LHC-ALICE experiment at \( \sqrt{s_{NN}} = 2.76 \) TeV Pb+Pb collisions, and it is observed to decrease with Δη [2].

D-measure is considered to become 3-4 in an equilibrated hadronic medium and 1-1.5 in an equilibrated QGP medium [3]. Thus the ALICE results don’t conflict with the theoretical prediction. Δη dependence of the higher order cumulant ratios are also important and predicted to decrease as the Δη become larger [4].

In this study, D-measure and 1st to 4th order cumulant ratios are calculated in Au+Au collisions at \( \sqrt{s_{NN}} = 7.7, 11.5, 14.5, 19.6, 27, 39, 62.4, \) and 200 GeV during Beam Energy Scan in 2010, 2011 and 2014.

We will report Δη, centrality and energy dependence of the net-charge fluctuation and compare STAR Beam Energy Scan results to ALICE results (\( \sqrt{s_{NN}}=2.76\)TeV). Then, we will discuss an energy dependence of the fluctuation as a function of Δη and possible information from the QGP phase transition.

4. Masayuki Asakawa and Masakiyo Kitazawa, Progress in Particle and Nuclear Physics Volume 90, September 2016, Pages 299-342

**Preferred Track**

Baryon-Rich QCD Matter and Astrophysics

**Collaboration**

STAR

**Primary author:** SUGIURA, Tetsuro (University of Tsukuba, Japan)

**Presenter:** SUGIURA, Tetsuro (University of Tsukuba, Japan)

**Session Classification:** Poster Session
Latest results from the EbyE NLO EKRT model

Wednesday, 8 February 2017 09:30 (20 minutes)

We review the recent results from the event-by-event NLO pQCD + saturation + viscous hydrodynamics (EbyE NLO EKRT) model [1,2,3], where we perform a simultaneous analysis of LHC and RHIC bulk observables to systematically constrain the temperature dependence of the QCD matter shear viscosity-to-entropy ratio $\eta/s(T)$, and to test the initial state computation. In particular, we study the centrality dependences of hadronic multiplicities, $p_T$ spectra, flow coefficients, probability distributions of relative elliptic flow fluctuations, and various flow-correlations in 2.76 and 5.02 TeV Pb+Pb collisions at the LHC and 200 GeV Au+Au collisions at RHIC [1,2]. Overall, our results match remarkably well with the LHC and RHIC measurements, and our predictions for the 5.02 TeV LHC run are in an excellent agreement with the latest data. We also explore the applicability of viscous hydrodynamics by quantifying the magnitude of delta-$f$ corrections in the studied flow observables, and by charting the space-time evolution of the Knudsen number for the studied $\eta/s(T)$ parametrizations [3].

3 H. Niemi, K. J. Eskola and R. Paatelainen, work in progress

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: ESKOLA, Kari J. (University of Jyvaskyla)
Presenter: ESKOLA, Kari J. (University of Jyvaskyla)
Session Classification: Parallel Session 5.2: Initial State Physics and Approach to Equilibrium (III)
Track Classification: Initial State Physics and Approach to Equilibrium
Neutral pion and $\eta$ meson production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE at the LHC

The measurement of particle production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV allows the study of fundamental QCD properties at low parton momentum fraction $x$ and high gluon densities. Moreover, it is important as reference for heavy-ion collisions. It can show whether the initial state of the colliding nuclei plays a role in the observed suppression of hadron production at high $p_T$ in Pb-Pb collisions.

In addition, the measurement of neutral mesons is crucial for the background determination of other analyses like the direct photon measurement. As ALICE combines the photon reconstruction via the Photon Conversion Method and the two calorimeters (PHOS and EMCal) $\pi^0$ and $\eta$ mesons can be measured in a broad $p_T$ range in their two $\gamma$ and for the $\pi^0$ also in the $\gamma$-Dalitz decay channel.

This poster will show the combined ALICE $\pi^0$ and $\eta$ invariant differential yields and the $\eta/\pi^0$ ratio. Furthermore, also the $\pi^0$ $p_T$-differential nuclear modification factor $R_{pA}$ will be presented.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ALICE

Primary author: PASSFELD, Annika (Westfaelische Wilhelms-Universitaet Muenster (DE))

Presenter: PASSFELD, Annika (Westfaelische Wilhelms-Universitaet Muenster (DE))

Session Classification: Poster Session
Measurement of neutral mesons in pp collisions at $\sqrt{s} = 5.02$ TeV via photon conversion method with ALICE

Measurement of neutral mesons, such as $\pi^0$ and $\eta$ plays an important role to study parton energy loss in the Quark-Gluon Plasma created in high-energy heavy-ion collisions. Such measurement in pp collisions at $\sqrt{s} = 5.02$ TeV provides a good reference for understanding the mechanisms appearing in p-Pb and Pb-Pb collisions at the same collision energy.

In ALICE, we measure $\pi^0$ and $\eta$ mesons by using calorimeters, and photon conversion method (PCM). These different methods make it possible to measure neutral mesons in a very wide $p_{T}$ range. In the PCM, neutral mesons are measured by detecting decay photons converted in electron-positron pairs which are reconstructed in the ALICE central barrel detectors, Inner tracking system and Time Projection Chamber.

In this poster, we will present a detailed description of the analysis and the status of the measurements will be discussed.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: MURAKAMI, Hikari (University of Tokyo (JP))

Presenter: MURAKAMI, Hikari (University of Tokyo (JP))

Session Classification: Poster Session
Both strong magnetic field and sizable vorticity are present in the hot QCD matter created in non-central heavy-ion collisions. We report new phenomena that the interplay between the magnetic field and fluid vorticity induces the redistribution of the vector charge density and generates an axial current. We show the role of the chiral anomaly underlying in these effects which, however, have not been captured by the conventional anomalous hydrodynamics. We discuss an imprint of these effects on the charged-particle spectrum measured in the experiment and argue that these effect should be implemented and quantitatively studied in anomalous magnetohydrodynamics.

Neutral pion measurement in $pp$ collisions at $\sqrt{s} = 7$ TeV with the PHOS detector in ALICE

Advanced analysis of $pp$ collisions at $\sqrt{s} = 7$ TeV collected by the photon spectrometer PHOS of the ALICE experiment is presented. The 2010 dataset with integrated luminosity $L_{\text{int}} = 7.7 \text{ nb}^{-1}$ has been analysed. Improved energy and timing calibration allow to reconstruct the spectrum of inclusive neutral pions production at midrapidity in the transverse momentum range $0.8 < p_T < 25 \text{ GeV/c}$. PHOS measurements are complemented by other alternative methods of $\pi^0$ reconstruction performed by ALICE. Precision measurement of the $\pi^0$ spectrum allows one to validate perturbative QCD calculations. Comparison of data and different model calculations are discussed.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ALICE

Primary author: Ms PAREEK, Pooja (Indian Institute of Technology Indore (IN))

Presenter: Ms PAREEK, Pooja (Indian Institute of Technology Indore (IN))

Session Classification: Poster Session
Transverse-momentum-dependent gluon distributions and their evolution towards small $x$

Tuesday, 7 February 2017 10:40 (20 minutes)

We study the various transverse-momentum-dependent (TMD) gluon distributions entering the cross section for forward di-jet production in dilute-dense collisions. For each TMD distribution we identify their operator definitions at small $x$ and finite $N_c$ as correlators of Wilson lines. With the result, we show the equivalence between the nearly back-to-back limit of the Color Glass Condensate cross section and the small-$x$ limit of the TMD factorization, at finite $N_c$. We obtain an analytical result for the gluon distributions in the Golec-Biernat-Wusthoff model, their perturbative behavior at large transverse momentum in the McLerran-Venugopalan model, and, numerically, their JIMWLK evolution towards small $x$. We observe geometric scaling regime for all the TMDs after some evolution.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary author: PETRESKA, Elena (Nikhef/VU Amsterdam)
Presenter: PETRESKA, Elena (Nikhef/VU Amsterdam)
Session Classification: Parallel Session 2.1: Initial State Physics and Approach to Equilibrium (II)
Track Classification: New Theoretical Developments
Hydrodynamic Predictions for Mixed Harmonic Correlations in 200 GeV Au+Au Collisions

Wednesday, 8 February 2017 09:30 (20 minutes)

Recent measurements at the LHC involve the correlation of different azimuthal flow harmonics $v_n$. These new observables add constraints to theoretical models and probe aspects of the system that are independent of the traditional single-harmonic measurements such as 2-and multi-particle cumulants $v_n \{m\}$. Many of these new observables have not yet been measured at RHIC, leaving an opportunity to make predictions as a test of models across energies. We make predictions using NeXSPheRIO, a hydrodynamical model which has accurately reproduced a large set of single-harmonic correlations in a large range of transverse momenta and centralities at RHIC. Our predictions thus provide an important baseline for comparison to correlations of flow harmonics, which contain nontrivial information about the initial state as well as QGP transport properties. We also point out significant biases that can appear when using wide centrality bins and non-trivial event weighting, necessitating care in performing experimental analyses and in comparing theoretical calculations to these measurements.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary author:  GARDIM, Fernando (Federal University of Alfenas)
Presenter:  GARDIM, Fernando (Federal University of Alfenas)
Session Classification:  Parallel Session 5.1: Collective Dynamics (I)
Track Classification:  Correlations and Fluctuations
Collective flow in pp collisions at 7 TeV and 13 TeV

Flow measurements in high multiplicity pp collisions at the LHC have indicated the development of collective flow in the small systems created at the LHC energies. Using the event-by-event viscous hydrodynamics+hadronic cascade hybrid model, iEBE-VISHNU, with fluctuating initial conditions, we investigate the azimuthal correlations in pp collisions at $\sqrt{s} = 7$ and 13 TeV with two- and four-particle cumulants. Our calculations of multiplicity dependent second-order azimuthal anisotropy harmonics $v_2$ are comparable with the recent measurements from CMS. The transition from positive to negative values of $c_2 \{4\}$ in high-multiplicity events, which has been taken as an experimental evidence of collectivity, is observed in our hydrodynamic calculations with the same multiplicity cuts and acceptance cuts as the CMS measurements. We further study the mass ordering of anisotropy $v_2$ among different particle species. The calculated elliptic flow $v_2$ exhibits a clear mass ordering at transverse momentum $p_T$ below 2.5 GeV/c among $\pi$, K, p, and $\Lambda$. The comparisons of mass ordering between our model results and measurements from CMS are also presented. At last, we further investigate the effects of multiplicity fluctuations and non-flow on the sign of $c_2 \{4\}$.

Preferred Track

QCD in small systems

Collaboration

Not applicable

Primary author: Dr XU, Haojie (Peking University)
Co-author: SONG, Huichao (Peking University)
Presenter: Dr XU, Haojie (Peking University)
Session Classification: Poster Session
Correlations of heavy-flavour electrons with jets in pp collisions at $\sqrt{s} = 8$ TeV with ALICE

Heavy quarks are widely used in measurements in ultra-relativistic heavy-ion collisions to provide information on the Quark-Gluon Plasma (QGP) properties. This is the case for all particles produced in hard scattering processes, that can be reconstructed in jets, since they are mainly produced before the complete medium formation and can interact with the plasma during its early stages and its evolution.

Heavy-flavour and jet observables can be combined by reconstructing the spectra of jets that are back-to-back with respect to identified heavy-flavour electrons, produced in the fragmentation and decay of heavy quarks. Thus, this heavy-flavour based measurement is directly comparable to theory since heavy-flavour processes can be theoretically calculated and, similarly to the hadron-jet coincidence analysis, the combinatorial background jets subtraction is improved. The final aim is to compare the measurements in pp, p-Pb and Pb-Pb collisions in order to identify the effects of nuclear matter and QGP.

This poster presents the status of the analysis in pp collisions at $\sqrt{s} = 8$ TeV. The electron identification with the ALICE electromagnetic calorimeter, the procedure to subtract non-heavy-flavour decay electrons, as well as the charged-jet reconstruction and selection are discussed.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author:  DOMENICIS GIMENEZ, Diogenes (Universidade de Sao Paulo (BR))
Presenter:  DOMENICIS GIMENEZ, Diogenes (Universidade de Sao Paulo (BR))
Session Classification:  Poster Session
Separate measurements of physics background and the possible chiral magnetic effect in p+Au and d+Au collisions at RHIC

Metastable domains of fluctuating topological charges can change the chirality of quarks and induce local parity violation in quantum chromodynamics. This can lead to observable charge separation along the strong magnetic field produced in relativistic heavy-ion collisions, a phenomenon called the chiral magnetic effect (CME). The magnetic field is generated by spectator protons and therefore best measured by the 1st-order harmonic plane (\(\Psi_1\)) using the spectator neutrons. The 2nd-order harmonic plane (\(\Psi_2\)), on the other hand, estimates the initial participant geometry, connected to the elliptic flow anisotropy (\(v_2\)).

A major background source for CME measurements is the intrinsic particle correlation coupled with \(v_2\). In heavy-ion collisions, the \(\Psi_1\) and \(\Psi_2\) are correlated, thus the CME and the \(v_2\)-induced background are entangled. In small system p+Au and d+Au collisions, the \(\Psi_2\) is entirely due to geometry fluctuations, and thus \(\Psi_1\) and \(\Psi_2\) are uncorrelated. A correlation measurement w.r.t. \(\Psi_1\) is only sensitive to CME while the \(v_2\)-induced background is averaged to zero. Likewise, a correlation measurement w.r.t. \(\Psi_2\) is only sensitive to \(v_2\)-induced background while any CME is averaged to zero.

In this poster, we will present the STAR measurements of three-particle correlation in p+Au and d+Au collisions at \(\sqrt{s_{NN}} = 200\) GeV with respect to \(\Psi_1\) of spectator neutrons measured by the STAR ZDC-SMD detectors. Measurements with respect to \(\Psi_2\) are also reported, which shed light on the background contamination in similar measurements in heavy-ion collisions.

Preferred Track
QCD in small systems

Collaboration
STAR

Primary author: Dr ZHAO, Jie (Purdue University)
Presenter: Dr ZHAO, Jie (Purdue University)
Session Classification: Poster Session
Optimized fluid dynamics for heavy ion collisions

Local momentum anisotropies are large in the early stages of the quark-gluon plasma created in relativistic heavy-ion collisions, due to the extreme difference in the initial longitudinal and transverse expansion rates. In such situations, fluid dynamics derived from an expansion around an isotropic local equilibrium state is bound to break down. Instead, we resum the effects of the slowest nonhydrodynamic degree of freedom (associated with the deviation from momentum isotropy) and include it at leading order, defining a local anisotropic quasi-equilibrium state, thereby treating the longitudinal/transverse pressure anisotropy nonperturbatively. Perturbative transport equations are then derived to deal with the remaining residual momentum anisotropies. This procedure yields a complete transient effective theory called viscous anisotropic hydrodynamics.

The anisotropic hydrodynamic approach, especially after perturbative inclusion all residual viscous terms, has been shown to dramatically outperform viscous hydrodynamics in several simplified situations for which exact solutions exist but which share with realistic expansion scenarios the problem of large dissipative currents. We will discuss the present status of applying viscous anisotropic hydrodynamics to the phenomenological description of the quark-gluon plasma in realistic expansion scenarios. To satisfy the high-performance needs of the JETSCAPE Collaboration, standard and anisotropic viscous hydrodynamics algorithms were implemented on graphical processing units (GPU), leading to a 100-fold speed-up. Results from these accelerated 3+1-dimensional viscous hydrodynamic simulations for event-by-event fluctuating initial conditions will be compared between the standard and anisotropic frameworks and with experimental data.


Preferred Track
Collective Dynamics

Collaboration
JETSCAPE

Primary author: BAZOW, Dennis
**Presenter:**  BAZOW, Dennis  

**Session Classification:**  Parallel Session 8.3: Collective Dynamics (III)  

**Track Classification:**  Collective Dynamics
Particle production in proton-nucleus collisions beyond leading order

The study of particle production in proton-nucleus ($pA$) collisions provides essential information about high-density effects (like gluon saturation) in the nuclear wavefunction and offers a benchmark for the corresponding studies in nucleus-nucleus collisions. The cross-sections for particle production in $pA$ can in principle be computed within perturbative QCD, using the framework of the Color Glass Condensate (CGC). However, recent efforts trying to extend such calculations beyond the leading-order (LO) approximation met with an unexpected difficulty: the next-to-leading order (NLO) prediction for the hadron multiplicity suddenly turns negative at transverse momenta of the order of a few GeV, in a range where perturbation theory was expected to be reliable. This problem triggered much interest and several studies over the last 5 years, but not satisfactory solution has emerged.

In a recent publication 1, we have revisited the previous proposals for the CGC factorization at NLO and identified the source of the negativity problem: this is related to the subtraction method used to separate LO from NLO contributions. To overcome this difficulty, we proposed a new factorization scheme which involves no such a subtraction: the relevant, LO or NLO, perturbative contributions are included once and only once. We have thus obtained a manifestly positive expression for the cross-section for hadron multiplicities in $pA$. On this occasion, we have also extended the resummation program that we recently proposed 2 for the BK and JIMWLK evolution equations to the calculation of cross-sections. Besides its phenomenological implications, this new factorization scheme should provide a better framework for computing particle production in QCD at high energy.

Effects of enhanced bulk viscosity near the QCD critical point

Wednesday, 8 February 2017 15:00 (20 minutes)

Search for the conjectured QCD critical point is one of the major scientific goals for the Beam Energy Scan program at RHIC. The growth of the correlation length is a universal feature for systems near criticality, and observables which are most sensitive to the correlation length should be explored to identify signals of the QCD critical point.

Among all the first-order transport coefficients, bulk viscosity exhibits the strongest dependence on the correlation length. We investigate the effects of bulk viscosity near the QCD critical point on particle spectrum by solving relativistic viscous hydrodynamic equations at finite densities 1. We find that rapidity distributions of charged particles and net baryon number are visibly modified if the fireball passes through the vicinity of the QCD critical point during its time evolution. We also discuss how critical modification of photon emission rate may leave imprints on thermal photon distributions.

1 A. Monnai, S. Mukherjee, Y. Yin, arXiv:1606.00771[nucl-th]

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Not applicable

Primary author:  MONNAI, Akihiko (Institut de Physique Théorique, CNRS/CEA)
Presenter:  MONNAI, Akihiko (Institut de Physique Théorique, CNRS/CEA)
Session Classification:  Parallel Session 7.1: Baryon-Rich QCD Matter and Astrophysics (II)

Track Classification:  Baryon-Rich QCD Matter and Astrophysics
Measurement of the Invariant Yield of Electrons from the Semileptonic Decay of Heavy Flavor Mesons in p+p Collisions at $\sqrt{s} = 200$ GeV in the PHENIX Experiment

Heavy charm and bottom quarks are excellent probes to study the mechanisms by which colored objects lose energy in the QGP. In particular, given their different masses, the differential suppression of charm and bottom can provide important constraints on models describing energy loss mechanisms. The PHENIX experiment has previously used the micro-vertexing capabilities of its silicon vertex detector (VTX) to infer the yield of charm and bottom quarks in Au+Au collisions from measurements of both the invariant yield of heavy flavor electrons and the distance of closest approach to the collision vertex of heavy flavor electrons. This poster will describe the current effort toward the measurement of the invariant yields in the 2015 p+p collision dataset. The invariant yield is a necessary input for the separation of charm and bottom meson yields in p+p, which will provide a precise baseline for the charm and bottom meson yields in heavy ion collisions.

Preferred Track
Open Heavy Flavors

Collaboration
PHENIX

Primary author: ORJUELA KOOP, Javier (University of Colorado Boulder)
Presenter: ORJUELA KOOP, Javier (University of Colorado Boulder)
Session Classification: Poster Session
Viscous anisotropic hydrodynamics for the conformal Gubser flow

*Wednesday, 8 February 2017 15:40 (20 minutes)*

In this work we describe the dynamics of a highly anisotropic system undergoing a boost-invariant longitudinal and azimuthally symmetric radial expansion (Gubser flow) for arbitrary shear viscosity to entropy density ratio. We derive the equations of motion of dissipative anisotropic hydrodynamics by considering the moments method recently derived by Molnar et al. (MNR), Phys. Rev. D 93, 114025 (2016) and arXiv:1606.09019, based on an expansion around an arbitrary anisotropic one-particle distribution function. In order to close the conservation laws, it is needed to choose an additional moment of the Boltzmann equation. This is achieved by selecting the relaxation equation for the longitudinal pressure with a suitable Landau matching condition. As a result one obtains two coupled differential equations for the energy density and the longitudinal pressure which respect the \( SO(3)_r \otimes SO(1, 1) \otimes Z_2 \) symmetry of the Gubser flow in the deSitter space. These equations are solved numerically and compared with the predictions of the recently found exact solution of the relaxation-time-approximation Boltzmann equation subject to the same flow. We also compare our numerical results with other fluid dynamical models. We observe that the MNR description of anisotropic fluid dynamics describes better the space-time evolution of the system than all currently known hydrodynamical approaches.

**Preferred Track**

Collective Dynamics

**Collaboration**

Not applicable

**Primary author:** Dr MARTINEZ GUERRERO, Mauricio (North Caroline State University)

**Presenter:** Dr MARTINEZ GUERRERO, Mauricio (North Caroline State University)

**Session Classification:** Parallel Session 7.3: Collective Dynamics (II)

**Track Classification:** Collective Dynamics
Relativistic dissipative hydrodynamics at finite chemical potential

Starting from the Boltzmann equation in the relaxation time approximation and employing a Chapman-Enskog like expansion for the distribution function close to equilibrium, we derive second-order evolution equations for the shear stress tensor and the dissipative charge current for a system of massless quarks and gluons. The transport coefficients are obtained exactly using quantum statistics for the phase space distribution functions at non-zero chemical potential. We show that, within the relaxation time approximation, the second-order evolution equations for the shear stress tensor and the dissipative charge current can be decoupled. We find that, for large values of the ratio of chemical potential to temperature, the charge conductivity is small compared to the coefficient of shear viscosity. Moreover, we show that in the relaxation-time approximation, the limiting behaviour of the ratio of heat conductivity to shear viscosity is qualitatively similar to that obtained for a strongly coupled conformal plasma.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author:  Dr JAISWAL, Amaresh (GSI Helmholtzzentrum für Schwerionenforschung)
Presenter:  Dr JAISWAL, Amaresh (GSI Helmholtzzentrum für Schwerionenforschung)
Session Classification:  Poster Session
Collision energy dependent Levy analysis of Bose-Einstein correlation functions in Au+Au collisions at PHENIX

The RHIC beam energy scan program allows us to investigate the phase-diagram of QCD matter. The nature of the quark-hadron transition can be studied through analyzing the space-time structure of the hadron emission source. One of the best tools to gain information about the source is the measurement of Bose-Einstein or HBT correlations of identical bosons. In our latest measurements, we utilize Levy-type sources to describe the measured correlation functions. One of the source parameters, the index of stability $\alpha$ is related to one of the critical exponents (the so-called correlation exponent $\eta$), so it may yield information on the nature of the quark-hadron phase transition, particularly it may shed light on the location of the critical endpoint on the phase-diagram. In this poster we report the current status of the analysis of the Levy source parameters (the intercept parameter $\lambda$, the index of stability $\alpha$, and the scale parameter $R$) as a function of transverse momentum and beam energy in Au+Au collisions at $\sqrt{s_{NN}} = 15, 19, 27, 39, 62$ and 200 GeV.

Preferred Track
Correlations and Fluctuations

Collaboration
PHENIX

Primary author: KINCSES, Dániel (Eötvös Loránd University)
Presenter: KINCSES, Dániel (Eötvös Loránd University)
Session Classification: Poster Session
Non-boost-invariant dissipative hydrodynamics

We study the evolution of the one-dimensional, non-boost-invariant evolution of a hot dense system, in similar conditions to the ones found in Quark Gluon Plasma created in heavy-ion experiments. We neglect transverse dynamic, but we relax the assumption of longitudinal boost invariance and rapidity independence.

We compare the results obtained from several formulations of viscous hydrodynamics and a recent approach to anisotropic hydrodynamics, which treats the pressure anisotropy in a non-perturbative fashion.

As expected from previous comparisons, viscous hydrodynamics and anisotropic hydrodynamics have a relatively good agreement in the center (mid rapidity) of the system. However the situation is very different at the edges. All formulations of viscous hydrodynamics provide large negative pressures for large rapidities which may lead to misleading conclusion about particles production. The passage from positive to negative pressure has the character of a shock (sudden change in narrow range of rapidity), and may be problematic for the determination of freeze-out hypersurfaces, especially for event-by-event simulations and small systems.

We found an unexpected dependence of the results of viscous hydrodynamics on the specific treatment of the shear-shear coupling.

Preferred Track
Collective Dynamics

Collaboration
Not applicable

Primary author: TINTI, Leonardo (Jan Kochanowski University)
Presenter: TINTI, Leonardo (Jan Kochanowski University)
Session Classification: Poster Session
Quantifying Chiral Magnetic Effect from Anomalous Viscous Fluid Dynamics

Tuesday, 7 February 2017 15:20 (20 minutes)

Abstract:

Chiral Magnetic Effect (CME) is the macroscopic manifestation of the fundamental chiral anomaly in a many-body system of chiral fermions, and emerges as anomalous transport current in hydrodynamic framework. Experimental observation of CME is of great interest and significant efforts have been made to look for signals of CME in heavy ion collisions. Encouraging evidence of CME-induced charge separation has been reported from both RHIC and LHC, albeit with ambiguity due to potential background contributions. Crucial for addressing such issue, is need of quantitative predictions of CME signal with sophisticated modeling tool.

In this talk we report a recently developed Anomalous Viscous Fluid Dynamics (AVFD) framework, which simulates the evolution of fermion currents in QGP on top of the data-validated VISHNew bulk hydro evolution. With realistic initial conditions and magnetic field lifetime, the predicted CME signal is quantitatively consistent with measured charge separation data in 200GeV AuAu collisions. We further develop the event-by-event AVFD simulations that directly compute CME-induced two-particle correlations as well as the non-CME background. Finally we report predictions for the upcoming isobaric (RuRu v.s. ZrZr) collisions that could provide the critical test of the CME in heavy ion collisions.

Preferred Track

Collective Dynamics

Collaboration

BEST

Primary author:  SHI, Shuzhe (Indiana University)
Presenter:  SHI, Shuzhe (Indiana University)
Session Classification:  Parallel Session 3.2: CME, Vorticity and Spin Polarization (I)
Track Classification:  Collective Dynamics
Performance of ALICE EMCal and DCal in Electron Identification

A Large Ion Collider Experiment (ALICE) is a major experiment at the Large Hadron Collider (LHC) at CERN. It is specifically designed to investigate the Quark-Gluon Plasma (QGP), a state of matter in which quarks and gluons are momentarily deconfined. The QGP is short-lived, and must therefore be studied indirectly by identifying the final-state particles produced in heavy-ion collisions. The final-state particle of interest in this poster is the electron. Electrons must be identified to study, for instance, the semi-leptonic decay channels of heavy-flavor hadrons. Because heavy-flavor quarks are created early in the collision, they travel and interact with the QCD medium. This makes them an important probe of the QGP.

One of the detectors important in identifying electrons is the Electromagnetic Calorimeter (EMCal). The ALICE EMCal is a ... Finally, the EMCal detector is used to improve statistics at high-$p_{\text{T}}$ using the EMCal gamma trigger.

The energy loss and shower shape parameters in the EMCal can be used to distinguish electrons from hadrons...data from pp ($\sqrt{s}$ = 13 TeV) and Pb-Pb ($\sqrt{s_{\text{NN}}}$ = 5.02 TeV) collisions.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ALICE

Primary author: GAUGER, Erin Frances (University of Texas (US))
Presenter: GAUGER, Erin Frances (University of Texas (US))
Session Classification: Poster Session
Initial conditions for hydrodynamics from weakly coupled pre-equilibrium evolution

Tuesday, 7 February 2017 11:00 (20 minutes)

We use effective kinetic theory to simulate equilibration in heavy-ion collisions. We construct a map for out-of-equilibrium initial state to the energy-momentum tensor at a time when hydrodynamics becomes applicable. We apply this map to IPGlasma initial conditions and demonstrate a smooth transition to hydrodynamics. In a phenomenologically favorable range of $\eta/s$ values, equilibration can be well approximated by a fixed function of a scaled time variable $(\tau T)/(\eta/s)$. This scalable kinetic equilibration can be readily applied to other initial state models to provide perturbatively controlled description of pre-equilibrium energy and transverse momentum flow evolution.

References:

Preferred Track
Initial State Physics and Approach to Equilibrium

Collaboration
Not applicable

Primary author: MAZELIAUSKAS, Aleksas
Co-authors: PAQUET, Jean-Francois (Stony Brook University); SCHLICHTING, Soeren (University of Washington)
Presenter: MAZELIAUSKAS, Aleksas
Session Classification: Parallel Session 2.1: Initial State Physics and Approach to Equilibrium (II)
Track Classification: Initial State Physics and Approach to Equilibrium
Reconstruction of neutral-triggered full recoil jets in $\sqrt{s_{NN}} = 200$ GeV p+p collisions at the STAR experiment

In heavy-ion collisions, the study of recoil jets tagged by high transverse-momentum “direct photons” ($\gamma_{\text{dir}}$) should provide a measurement of the partonic energy loss in the hot, dense medium produced in such collisions\footnote{X.-N. Wang, Z. Huang, and I. Sarcevic, Phys. Rev. Lett. 77, 231 (1996)}. Since a $\gamma_{\text{dir}}$ does not interact strongly with the medium, it closely approximates the initial energy of the recoiling parton. It is also interesting to compare the recoil jets tagged by $\gamma_{\text{dir}}$ to those tagged by high transverse-momentum $\pi^0$. In contrast to the $\gamma_{\text{dir}}$, high transverse-momentum $\pi^0$ are assumed to be biased towards being produced near the surface of the medium. Moreover, the production mechanisms of $\gamma_{\text{dir}}$ favor recoiling quarks over gluons, but the production mechanisms of $\pi^0$ show no such preference. Thus the comparison of $\gamma_{\text{dir}}$-tagged recoil jets to $\pi^0$-tagged recoil jets may shed light on the path-length and color-factor dependence of in-medium partonic energy loss.

To establish a vacuum fragmentation reference, we present the measurement of the yields of full recoil jets (recoil jets consisting of both charged and neutral particles) in p+p collisions. The yields are measured using the STAR Time Projection Chamber and Barrel Electromagnetic Calorimeter in p+p collisions at $\sqrt{s_{NN}} = 200$ GeV tagged by neutral-particle triggers recorded during the running year 2009. The neutral-particle triggers satisfy $9 < E_{\text{trig}}^T < 20$ GeV and $|\eta^T| < 1$, and are separated into a sample of identified $\pi^0$ triggers and a sample of triggers with an enhanced fraction of $\gamma_{\text{dir}}$. Jets are reconstructed from charged tracks and neutral towers with $p_T > 0.2$ GeV/c and $E_T > 0.2$ GeV respectively and $|\eta| < 1$ using the anti-$k_T$ algorithm for resolution parameter $0.3 \leq R \leq 0.6$. To assay the effect of reconstructing full jets versus charged-only jets in such studies, the yields of charged recoil-jets are compared to the yields of full recoil-jets. The data are corrected for instrumental effects and compared to Pythia simulations\footnote{T. Sjöstrand, S. Mrenna and P. Z. Skands, Comput. Phys. Commun. 178 (2008) 852 [arXiv:0710.3820 [hep-ph]]}.

Preferred Track

Jets and High pT Hadrons

Collaboration

STAR

Primary author: Mr ANDERSON, Derek (Cyclotron Institute, Texas A&M University)

Presenter: Mr ANDERSON, Derek (Cyclotron Institute, Texas A&M University)

Session Classification: Poster Session
PHENIX results on three particle Bose-Einstein correlations in \( \sqrt{s_{\text{NN}}} = 200 \text{ GeV} \) Au+Au collisions

Bose-Einstein correlations of identical hadrons reveal information about hadron creation from the sQGP formed in ultrarelativistic heavy ion collisions. The measurement of three particle correlations may in particular shed light on hadron creation mechanisms beyond thermal/chaotic emission. In this poster we show the status of PHENIX measurements of three pion correlations as a function of momentum differences within the triplets. We will analyze their shape through the assumption of Levy sources and a proper treatment of the Coulomb interaction within the triplets. We plan to determine Levy parameters scale (\( \tilde{H} \)), shape (\( \alpha \)) and three particle correlation strength (\( \lambda_3 \)), where the latter, together with two particle correlation strength \( \lambda_2 \), encodes information about hadron creation mechanisms. From a consistent analysis of two- and three-particle correlation strength we may be able to establish an experimental measure of thermalization and coherence in the source.

Preferred Track
Correlations and Fluctuations

Collaboration
PHENIX

Primary author: BAGOLY, Attila (Eötvös Loránd University)
Presenter: BAGOLY, Attila (Eötvös Loránd University)
Session Classification: Poster Session
Hydrodynamic fluctuations and two-particle correlation functions

The field of high-energy nuclear collisions has witnessed a surge of interest in recent years in the role played by hydrodynamic fluctuations. Hydrodynamic fluctuations may have significant effects on systems created at RHIC, FAIR or NICA whose trajectories in the QCD phase diagram pass near a possible critical end point (CEP). To test for the existence of such a CEP, it is vital to understand the connections between a system’s proximity to the CEP and the properties of observables used in probing heavy-ion collisions. So far, the properties of the two-particle correlation function, as defined by HBT interferometry, have remained unexplored in this respect. We discuss the effects of event-by-event hydrodynamic fluctuations on both the two-particle correlation function and the HBT radii extracted from it. For simplicity, we assume a system characterized by Bjorken symmetry and study the fluctuations of the correlation function and HBT radius along the longitudinal direction as functions of rapidity distance $\Delta y$. We show how these quantities are affected by hydrodynamic fluctuations along trajectories in the QCD phase diagram which pass close to the CEP.

Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary author: PLUMBERG, Christopher
Presenter: PLUMBERG, Christopher
Session Classification: Poster Session
Measurements of J/psi polarization in p+p, p+Au and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV by the STAR experiment

Quarkonium production mechanisms in hadron collisions are not fully understood. Different models on quarkonium production can describe the measured production cross-sections in p+p collisions but have significantly different predictions on quarkonium polarization. Measurements of J/psi polarization in p+p collisions can distinguish these models to test the fundamental theory on quarkonium production. Measurements of J/psi polarization in p+Au and Au+Au collisions can provide insights into cold and hot nuclear matter effects on quarkonium production, which has been used extensively to study the properties of Quark-Gluon Plasma. In this poster, we will present the measurements of J/psi polarization in p+p collisions at $\sqrt{s} = 200$ GeV using data taken in 2012 by the STAR experiment. We will also present the progress on J/psi polarization measurements in p+Au and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV using the data taken in 2011 and 2015.

Preferred Track
Quarkonia

Collaboration
STAR

Primary author: LUO, Siwei
Presenter: LUO, Siwei
Session Classification: Poster Session
Rapidity dependent flow fluctuations at RHIC

Wednesday, 8 February 2017 11:20 (20 minutes)

We study elliptic and triangular flow and their dependence on rapidity using 3+1D hydrodynamic simulations with initial conditions (Nexus) that contain realistic fluctuations in all 3 dimensions. We compare to experimental data from STAR and find that long range, two particle $v_3$ correlations agree reasonably well with measurements. We find that an apparent decrease of $v_3$ with pseudorapidity in traditional measurements is not, in fact, a dependence on $\eta$, which is negligible within the TPC acceptance, but instead is a dependence on relative pseudorapidity due to a lack of perfect correlation between $v_3$ at different rapidities. We also observe short-range correlations, due to rapidity dependent fluctuations in the initial condition. While the short-range correlation is slightly smaller in both magnitude and range, it serves as a demonstration that short-range correlations are not necessarily generated only by non-flow sources such as jets, but can have a significant contribution from purely hydrodynamic effects.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary authors: GRASSI, Frederique; Dr NORONHA-HOSTLER, Jacquelyn (University of Houston); LUZUM, Matthew

Presenter: LUZUM, Matthew

Session Classification: Parallel Session 6.2: Correlations and Fluctuations (I)

Track Classification: Correlations and Fluctuations
NLO + Parton Shower Calculation of Heavy Flavour Electrons with Nuclear PDFs

Heavy flavour (beauty and charm) quarks are of special interest for the study of the Quark-Gluon Plasma as they are predominantly produced in the initial hard-scattering processes and participate in the entire evolution of the system created in heavy-ion collisions. Thus, heavy flavours are an excellent probe to study in-medium energy loss (mechanisms) in nuclear collisions by measuring, for instance, the nuclear modification factor $R_{AA}$ or the azimuthal anisotropy and especially the elliptic flow $v_2$ of heavy-flavour particles. Experimentally, heavy flavours are often investigated using measurements of electrons from heavy-flavour hadron decays. These electrons can be separated statistically from the background originating from light flavours and gluons and provide insight into the colour charge (quark vs. gluon) and mass (charm vs. beauty) dependence of parton energy loss. In this poster, we present the relative contribution of electrons from beauty hadron decays to the yield of electrons from heavy-flavour hadron decays estimated with Monte Carlo simulations based on POWHEG. The calculations are performed for p–p and Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. Nuclear effects are taken into account using the nuclear parton distribution functions EPS09 and nCTEQ15. These calculations serve as an essential ingredient to separate the contributions of charm and beauty quarks in the measurements of the $p_T$-differential invariant cross section and elliptic flow of electrons from heavy-flavour hadron decays.

Preferred Track

Open Heavy Flavors

Collaboration

Not applicable

Primary author: HERRMANN, Florian (Westfaelische Wilhelms-Universitaet Muenster (DE))

Presenter: HERRMANN, Florian (Westfaelische Wilhelms-Universitaet Muenster (DE))

Session Classification: Poster Session
Direct $\gamma$-hadron correlations in Pb-Pb collisions at $\sqrt{s_{\text{NN}}}=5.02\text{ TeV}$ with ALICE

Jet modification by the hot and dense medium created in heavy-ion collisions has been demonstrated by a variety of observables. A modification like the softening and broadening of the jet fragmentation can be probed optimally with direct $\gamma$-hadron correlations. The direct photon, produced in hard scatterings back-to-back with a parton, serves as a calibration of the away side jet and can thus provide less-biased insight into how the medium affects the away side jet fragmentation. The aim of the presented analysis is to show the modification of the fragmentation function $f(z_T)$ due to the medium and pin down the energy lost and recovered at different angles away from the jet axis.

This poster outlines the analysis strategy and performance for $\gamma$-hadron correlations with the recently collected Pb–Pb data at $\sqrt{s_{\text{NN}}}=5.02\text{ TeV}$, measured with the EMCal and DCal detectors of the ALICE experiment.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ALICE

Primary author: EPPLE, Eliane (Yale University)
Presenter: EPPLE, Eliane (Yale University)
Session Classification: Poster Session
Background subtraction in jet-hadron and di-hadron correlations using the reaction plane fit method

Jet-hadron and di-hadron correlations are sensitive to the low momentum and large angle modifications induced by interactions with the medium and allow higher precision measurements than jet-by-jet measurements because the background can be determined by averaging over several jets. However, the combinatorial background has limited the precision of these measurements. The Zero Yield At Minimum method, the standard method, has limitations, particularly at low momenta where modifications may broaden the jet. Typically the Fourier coefficients of the azimuthal asymmetries ($v_n$) of the background are taken from independent measurements of flow coefficients. This means that the standard method is also not robust to effects which lead to different $v_n$ in jet-like correlations, including the impact of different $v_n$ due to flow and due to jet quenching at high momenta.

We present an alternate method, the Reaction Plane Fit (RPF) method, which uses the reaction plane dependence of the $v_n$ to constrain the shape and level of the background in the background dominated region at large $\Delta y$. We demonstrate the efficacy of this method using a toy model. We then apply the RPF method to di-hadron correlations relative to the reaction plane measured by STAR. We present the correlation functions and calculate the yields, per-trigger yield modification factor ($I_{AA}$), and the widths. Using this method, the shape of the correlation functions show little shape dependence relative to the reaction plane, an increasing $I_{AA}$ with decreasing momentum. This is consistent with the broadening and softening of jets seen in measurements of full jets at the LHC, rather than the “Mach cone” structure observed in earlier studies.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary author: NATTRASS, Christine (University of Tennessee (US))

Co-author: MAZER, Joel Anthony (University of Tennessee (US))

Presenter: NATTRASS, Christine (University of Tennessee (US))

Session Classification: Poster Session
HIJING++ a HIC Monte Carlo for the Future Generations

Results with the new HIJING++ will be presented here for hadron production in high-energy heavy ion collisions. The recently developed HIJING++ version based on the latest version of PYTHIA8 and contains all the nuclear effects has been included in the HIJING2.1. We also included an improved version of the shadowing parametrization and jet quenching. Here we summarize the mayor changes of the new program code beside the comparison between experimental data.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary author: Dr BARNAFOLDI, Gergely Gabor (Wigner RCP Hungarian Academy of Sciences (HU))

Presenter: Dr BARNAFOLDI, Gergely Gabor (Wigner RCP Hungarian Academy of Sciences (HU))

Session Classification: Poster Session
Measurement of $J/\psi$ azimuthal anisotropy in U+U collisions at $\sqrt{s_{NN}} = 193$ GeV by the STAR experiment

The existence of Quark-Gluon Plasma (QGP) is predicted by lattice QCD at high temperatures or large nuclear densities. Various probes were proposed to study this phase of matter, among which $J/\psi$ suppression due to color screening of the quark potential in the QGP is of special interest since this mechanism implies the formation of the defined matter. However, contribution from the recombination of charm and anti-charm quarks in the medium complicates the interpretation of the observed modification to the $J/\psi$ production in heavy-ion collisions. Measurements of the second-order harmonic coefficient ($v_2$) of $J/\psi$ azimuthal anisotropy can help disentangle different contributions. For primordial $J/\psi$ produced at the beginning of the collisions in hard scatterings, $v_2$ is expected to be close to zero, whereas regenerated $J/\psi$ should inherit the anisotropy of the constituent charm quarks.

$J/\psi$ $v_2$ has been measured by the STAR experiment to be consistent with zero for $J/\psi$ $p_T > 2$ GeV/c in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. Since U+U collisions are expected to create medium of higher energy density compared to Au+Au collisions, the relative contribution of primordial and regenerated $J/\psi$ could be different. Therefore, U+U collisions provide a unique opportunity to test the current understanding of $J/\psi$ production mechanisms. First results on $J/\psi$ $v_2$ measured via the di-electron channel in U+U collisions at $\sqrt{s_{NN}} = 193$ GeV will be presented in this poster, and the implications on the $J/\psi$ production mechanism will be discussed.

Preferred Track
Quarkonia

Collaboration
STAR

Primary author: HARLENDEROVÁ, Alena (STAR)
Presenter: HARLENDEROVÁ, Alena (STAR)
Session Classification: Poster Session
Confinement and chiral phase transitions from correlated ensemble of instanton-dyons

Confinement and chiral phase transitions are remarkable nonperturbative phenomena emerging from QCD and QCD-like theories. A theoretical understanding of these transitions and their interrelations is of fundamental importance. While it is widely perceived that their dynamics arises from nontrivial topological configurations in Yang-Mills theories, a concrete and sophisticated realization of such idea is an outstanding challenge. We report significant progress along this direction by the construction of a new framework based on correlated ensemble of instanton-dyons, namely the constituents of the finite-temperature instantons with non-trivial holonomy. We present a comprehensive numerical study of confinement properties in SU(2) Yang-Mills theory at finite temperature, obtaining important observables such as the effective holonomy potential, the static-quark potentials from Polyakov loop correlators as well as spatial Wilson loops, among others. These results are compared with lattice data. Furthermore, with the inclusion of dynamical quarks in the system, we study the nontrivial interplay between confinement/deconfinement and chiral symmetry breaking/restoration phase transitions and make predictions for how such transitions are influenced by the fermion flavor number $N_f$ in the ensemble.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: LOPEZ-RUIZ, Miguel Angel (Indiana University)
Co-author: LIAO, Jinfeng (Indiana University)
Presenter: LOPEZ-RUIZ, Miguel Angel (Indiana University)
Session Classification: Poster Session
Inclusive muon yield from charm and bottom quark production at forward rapidity in p+p and p+Au collisions at sqrt(s) = 200 GeV in the PHENIX Detector

PHENIX has studied the production of muons from the semi-leptonic decay of heavy-flavor mesons in the forward rapidity region 1.2<|eta|<2.2. The measurement of heavy quark production in p+p collisions is important as a baseline for studying hot and cold matter effects in heavy-ion collisions, and is a test of pQCD theory. In p+Au collisions, we can study cold-nuclear-matter (CNM) effects on heavy flavor production. Measurement of charm and bottom yields will help to understand flavor dependence of CNM effects. In 2015, a high-statistics dataset of p+p and p+Au collisions was collected with the Forward Silicon Vertex (FVTX) detector in PHENIX at RHIC. The complete PHENIX silicon vertex tracking system (VTX+FVTX) allows us to measure a precise primary vertex as well as the radial distance of muon tracks to the collision vertex. The distributions of radial distances for tracks from short-lived heavy-flavor mesons (D and B) and long-lived light-flavor mesons (π± and K±) are sufficiently different to enhance the signal-to-background ratio, and allow the separation between charm and bottom. This poster reports the current status of heavy-flavor muon analysis in p+p and p+Au collisions at 200 GeV with the PHENIX FVTX.

Preferred Track

Open Heavy Flavors

Collaboration

PHENIX

Primary author: BOK, Jeongsu (New Mexico State University)

Presenter: BOK, Jeongsu (New Mexico State University)

Session Classification: Poster Session
Jet-Hadron correlations in pp and Pb-Pb collisions with ALICE

Jet energy loss in the Quark Gluon Plasma (QGP) is an active area of research, with many different measurement techniques attempting to determine its properties. One technique is to measure the azimuthal correlations of a trigger jet and the associated hadrons in the event. These measurements, known as jet-hadron correlations, are expected to be sensitive to broadening and softening of an associated recoil jet due to jet quenching. To help get a handle on energy loss, the path length of the recoil jet can be varied by imposing a surface bias condition on the trigger jet population. Previous measurements with such a bias at RHIC have already shown jet-hadron correlations to be a useful tool for studying energy loss. In particular, by comparing heavy ion measurements to pp, the correlations exhibit a strong suppression of higher $p_T$ hadrons, which is balanced by an excess of lower $p_T$ hadrons.

For this analysis, the azimuthal jet-hadron correlations are constructed from a trigger R=0.2 full (charged + neutral) jet, which is correlated with charged hadrons. In an effort to enhance the surface bias and reduce the impact of the background, jets are required to pass a leading constituent cut and are reconstructed using only high energy and momentum constituents. We present the current status of the analysis, including measurements of associated hadron yields and widths in central Pb–Pb data collected at $\sqrt{s_{NN}} = 2.76$ TeV by the ALICE Collaboration. These measurements will also be compared to jet-hadron correlations measured in pp.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ALICE

Primary author: EHLERS, Raymond (Yale University (US))
Presenter: EHLERS, Raymond (Yale University (US))
Session Classification: Poster Session
The suppression of neutral pion production in high-energy heavy-ion collisions was one piece of evidence of parton energy loss in the hot medium produced at RHIC and thus a convincing signature for the Quark-Gluon Plasma (QGP). The p(d)+A system had previously been considered as a baseline to study the cold nuclear matter effects that are also present in A+A collisions but are difficult to disentangle from the effects of the QGP. Recently, measurements from p(d)+A have indicated that there may be effects from a strongly interacting medium even in these systems. In further study of these interesting systems, RHIC collided $^3$He+Au in 2014 and p+Au in 2015. A comparison of the $p_T$ and centrality dependent yields, as well as $R_{AA}$, will contribute to the systematic study of these systems. In this poster, we report the $\pi^0$ yields and $R_{AA}$ in $^3$He+Au, d+Au, and p+Au collisions at $\sqrt{s_{NN}} = 200$ GeV at PHENIX.

**Preferred Track**

Jets and High $p_T$ Hadrons

**Collaboration**

PHENIX

**Primary author:** APADULA, Nicole

**Presenter:** APADULA, Nicole

**Session Classification:** Poster Session
The spinodal instability in the baryon-rich quark matter

The spinodal instability, i.e. the self-amplified deviation from the equilibrium state during a first order phase transition, of the baryonic rich quark matter is studied by both using the linear response theory and solving the Boltzmann equations with the test particle method. The former approach includes the quantum effect but only works near equilibrium, while the second one is semi-classical but capable of describing a highly non-equilibrated system. In the first approach, we obtain both the spinodal boundaries of the unstable modes with different wavelengths and the growth rates of them at a certain temperature and baryon density in the early stage of phase separation. We find the spinodal boundaries shrink with the wavelengths of the unstable modes, and the spinodal instability is suppressed by a repulsive vector interaction. In the second approach, we study the spinodal instability of the baryonic rich quark matter in both a static box and an expanding fireball by investigating the time evolution of the quantities such as the scaled density moments, the event distribution of the particle numbers in a sub-volume, the event distribution of the anisotropic flows, and the dilepton yield.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Not applicable

Primary author: Dr LI, Feng (Frankfurt Institute for Advanced Study)
Presenter: Dr LI, Feng (Frankfurt Institute for Advanced Study)
Session Classification: Poster Session
Upsilon ground state formation and dissociation inside quark-gluon plasma

Heavy quarkonia can be used as probes in heavy-ion collisions since the yield will contain imprint of the initial states and in-medium evolution, which can be used to extract properties of the cold and hot nuclear matters. This use of quarkonium as a probe is complicated by several factors: the competition between dissociation and recombination of quarkonium inside the quark-gluon plasma (QGP) and the feed-down contributions from excited states to the ground state. Among different quarkonium states, bottomonium ground state \( \Upsilon(1S) \) is a special probe because of its smaller size and longer thermalization time. A clear understanding of the fate of \( \Upsilon(1S) \) inside QGP can tell us more information about the suppression mechanism: whether it arises solely from the suppression of excited states, or originates from the suppression of both the ground and excited states. To this end, a consistent treatment of formation and dissociation is needed.

We use potential non-relativistic quantum chromodynamics (pNRQCD) to study \( \Upsilon(1S) \) inside QGP. The dissociation has been studied in pNRQCD but not the formation. The potential terms for the color singlet and octet can be calculated under the weak coupling assumption or fitted from lattice QCD results of the quarkonium free energy. The singlet and octet wave functions are calculated by solving the corresponding Schrödinger equations. Then the wave functions are used to calculate the in-medium rates of \( \Upsilon(1S) \) formation and dissociation, which are at leading order through a color dipole interaction. The rates depend on the quarkonium velocity relative to the medium. The two rates are compared as a function of the plasma temperature. Its connection to the phenomenological studies of Upsilon production from heavy-ion collisions will be discussed, together with a future plan to incorporate quarkonium formation and dissociation into transport models for heavy quarks.

Preferred Track

Quarkonia

Collaboration

Not applicable

Primary author: YAO, Xiaojun (Duke University)
Presenter: YAO, Xiaojun (Duke University)
Session Classification: Poster Session
Believe it or not: Exact Calculations of Superdense Nuclear Matter Equation of State in Compact Stars by FRG Method!

We propose a novel technique, using the expansion of the effective potential in a base of harmonic functions, to study the Functional Renormalization Group (FRG) method at finite chemical potential. Within this theoretical framework we determined the equation of state and the phase diagram of a simple model of massless fermions coupled to scalars through Yukawa-coupling at the zero-temperature limit 1.

We compared our results to the 1-loop and the mean field approximation of the same model and other high-density nuclear matter equation of states. Here, we present our exact, FRG-based equation of states calculation to describe the superdense nuclear matter inside compact astrophysical objects for the first time. We calculated the mass-radius relation for a compact star using the Tolmann-Oppenheimer-Volkov equation, which was compared to other results as well 2.

References:

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Not applicable

Primary author: PÓSFAY, Péter (Wigner Research Centre for Physics)
Presenter: PÓSFAY, Péter (Wigner Research Centre for Physics)
Session Classification: Poster Session
Vector boson-tagged jet production in heavy ion reactions at the LHC

Electroweak boson-tagged jet measurements provide a promising experimental channel to accurately study the physics of jet production and propagation in dense QCD medium. In this talk, we present theoretical predictions for the nuclear-induced attenuation \( R_{AA}^2(V + J) \) of the differential cross section for photon-tagged and Z0-tagged jet production in heavy ion collisions, and provide theoretical interpretations to the recent LHC data. In particular, we identify the flavor origin of the vector boson tagged jet production and discuss its implications for the energy loss of the recoiling parton shower. By further using SCET with Glauber gluons improved energy loss model, we demonstrate quantitatively the significance of collisional and radiative energy loss, as revealed in the strong momentum asymmetry \( d\sigma/dx_{V,J} \) in central lead-lead reactions. We show how the collective constraints form momentum imbalance shifts \( \Delta x_{V,J} \), and tagged jet \( I_{AA} \), combined with the absence of significant cold nuclear matter modification help constrain the transport properties of the QGP.

Preferred Track
Electromagnetic Probes

Collaboration
Not applicable

Primary author: Dr XING, Hongxi (Northwestern University / Argonne National Laboratory)

Presenter: Dr XING, Hongxi (Northwestern University / Argonne National Laboratory)

Session Classification: Parallel Session 5.4: Jets and High pT Hadrons (IV)

Track Classification: Electromagnetic Probes
Contribution ID: 199

Type: Oral

ALICE

Monday, 6 February 2017 11:30 (20 minutes)

Preferred Track

Collaboration

Presenter: TIMMINS, Anthony Robert (University of Houston (US))

Session Classification: Experimental Preview Talks - II
Contribution ID: 200

Type: Oral

ATLAS

Monday, 6 February 2017 11:50 (20 minutes)

Preferred Track

Collaboration

Presenter: JIA, Jiangyong (State University of New York (US))

Session Classification: Experimental Preview Talks - II
CMS

Preferred Track

Collaboration

**Presenter:** LEE, Yen-Jie (Massachusetts Inst. of Technology (US))

**Session Classification:** Experimental Preview Talks - II
LHCb

Monday, 6 February 2017 12:30 (15 minutes)

Preferred Track

Collaboration

Primary author: ROBBE, Patrick (Universite de Paris-Sud 11 (FR))
Presenter: ROBBE, Patrick (Universite de Paris-Sud 11 (FR))
Session Classification: Experimental Preview Talks - II
Collective flow from pp to AA

Monday, 6 February 2017 14:00 (30 minutes)

Preferred Track

Collaboration

**Primary author:** LI, Wei (Rice University (US))

**Presenter:** LI, Wei (Rice University (US))

**Session Classification:** Plenary Session I: Equilibration, flow and QGP parameters
Determination of QGP parameters from global Bayesian analysis

Monday, 6 February 2017 14:30 (30 minutes)

Preferred Track

Collaboration

**Primary author:** Prof. BASS, Steffen A. (Duke University)

**Presenter:** Prof. BASS, Steffen A. (Duke University)

**Session Classification:** Plenary Session I: Equilibration, flow and QGP parameters
Equilibration and hydrodynamics at strong and weak coupling

Monday, 6 February 2017 15:00 (30 minutes)

Preferred Track

Collaboration

Primary author: VAN DER SCHEE, Wilke (MIT)
Presenter: VAN DER SCHEE, Wilke (MIT)
Session Classification: Plenary Session I: Equilibration, flow and QGP parameters
Jet energy loss and equilibration

Monday, 6 February 2017 15:30 (30 minutes)

Preferred Track

Collaboration

Primary author: ZAPP, Korinna Christine (Instituto Superior Tecnico (PT))
Presenter: ZAPP, Korinna Christine (Instituto Superior Tecnico (PT))
Session Classification: Plenary Session I: Equilibration, flow and QGP parameters
Hydrodynamic modeling from pp to AA

Thursday, 9 February 2017 09:00 (30 minutes)

Preferred Track

Collaboration

Primary author:  YAN, Li (CNRS)
Presenter:  YAN, Li (CNRS)
Session Classification:  Plenary Session II: Collective dynamics from pp to AA
Collective behavior in small systems

Thursday, 9 February 2017 09:30 (30 minutes)

Preferred Track

Collaboration

Presenter: OHLSON, Alice (Ruprecht-Karls-Universitaet Heidelberg (DE))

Session Classification: Plenary Session II: Collective dynamics from pp to AA
Origins of collective behavior in small systems

Thursday, 9 February 2017 10:00 (30 minutes)

Preferred Track

Collaboration

Primary author: SCHENKE, Bjoern (Brookhaven National Lab)
Presenter: SCHENKE, Bjoern (Brookhaven National Lab)
Session Classification: Plenary Session II: Collective dynamics from pp to AA
Hard processes in small systems

Thursday, 9 February 2017 10:30 (30 minutes)

Preferred Track

Collaboration

Primary author: PEREPELITSA, Dennis (University of Colorado Boulder)
Presenter: PEREPELITSA, Dennis (University of Colorado Boulder)
Session Classification: Plenary Session II: Collective dynamics from pp to AA
Search for critical behavior – status and future

Thursday, 9 February 2017 11:30 (30 minutes)

Preferred Track

Collaboration

**Primary author:** CAINES, Helen (Yale University)

**Presenter:** CAINES, Helen (Yale University)

**Session Classification:** Plenary Session III: Search for Critical Phenomena and Chiral Anomalies in Heavy-ion Collisions
Search for chiral anomaly effects – status and future

Thursday, 9 February 2017 12:00 (30 minutes)

Preferred Track

Collaboration

Primary author: SORENSEN, Paul (BNL)
Presenter: SORENSEN, Paul (BNL)
Session Classification: Plenary Session III: Search for Critical Phenomena and Chiral Anomalies in Heavy-ion Collisions
Lattice QCD results on soft and hard probes of strongly interacting matter

Thursday, 9 February 2017 12:30 (30 minutes)

Preferred Track

Collaboration

Presenter: Dr KACZMAREK, Olaf (University of Bielefeld)

Session Classification: Plenary Session III: Search for Critical Phenomena and Chiral Anomalies in Heavy-ion Collisions
Beam energy scan theory: status and open questions

Thursday, 9 February 2017 13:00 (30 minutes)

Preferred Track

Collaboration

Primary author:  PETERSEN, Hannah (Frankfurt Institute for Advanced Studies)
Presenter:  PETERSEN, Hannah (Frankfurt Institute for Advanced Studies)
Session Classification:  Plenary Session III: Search for Critical Phenomena and Chiral Anomalies in Heavy-ion Collisions
Medium modification of jet production (RHIC + LHC)

Friday, 10 February 2017 09:00 (30 minutes)

Preferred Track

Collaboration

Presenter: CUNQUEIRO MENDEZ, Leticia (Westfaelische Wilhelms-Universitaet Muenster (DE))

Session Classification: Plenary Session IV: Jet Quenching
Medium modification of jet structure (RHIC + LHC)

Friday, 10 February 2017 09:30 (30 minutes)

Preferred Track

Collaboration

Primary author: VERWEIJ, Marta (CERN)
Presenter: VERWEIJ, Marta (CERN)
Session Classification: Plenary Session IV: Jet Quenching
Jet modifications in event-by-event hydrodynamically evolving media

Friday, 10 February 2017 10:00 (30 minutes)

Preferred Track

Collaboration

**Primary author:** Dr NORONHA-HOSTLER, Jacquelyn (University of Houston)

**Presenter:** Dr NORONHA-HOSTLER, Jacquelyn (University of Houston)

**Session Classification:** Plenary Session IV: Jet Quenching
Jet quenching with strong coupling

Friday, 10 February 2017 10:30 (30 minutes)

Preferred Track

Collaboration

Presenter:  PABLOS, Daniel (Universitat de Barcelona)
Session Classification:  Plenary Session IV: Jet Quenching
Photon and dilepton observables: experimental overview

Friday, 10 February 2017 11:30 (30 minutes)

Preferred Track

Collaboration

Primary authors: CAMPBELL, Sarah (Columbia University); CAMPBELL, Sarah (Columbia University (US))

Presenters: CAMPBELL, Sarah (Columbia University); CAMPBELL, Sarah (Columbia University (US))

Session Classification: Plenary Session V: Electromagnetic radiation
Photon and dilepton flow from pp to AA

Friday, 10 February 2017 12:00 (30 minutes)

Preferred Track

Collaboration

Primary author:  PAQUET, Jean-Francois (Stony Brook University)
Presenter:  PAQUET, Jean-Francois (Stony Brook University)
Session Classification:  Plenary Session V: Electromagnetic radiation
Heavy flavor production, flow and energy loss (experiment)

Friday, 10 February 2017 14:00 (30 minutes)

Preferred Track

Collaboration

Primary author: DONG, Xin (Lawrence Berkeley National Lab)
Presenter: DONG, Xin (Lawrence Berkeley National Lab)
Session Classification: Plenary Session VI: Heavy Flavor and Quarkonia
Heavy flavor production, flow and energy loss (theory)

Friday, 10 February 2017 14:30 (30 minutes)

Preferred Track

Collaboration

Primary author: GRECO, Vincenzo (University of Catania)
Presenter: GRECO, Vincenzo (University of Catania)
Session Classification: Plenary Session VI: Heavy Flavor and Quarkonia
Quarkonium production in AA (experiment)

Friday, 10 February 2017 15:00 (30 minutes)

Preferred Track

Collaboration

Primary author: SCOMPARIN, Enrico (INFN)
Presenter: SCOMPARIN, Enrico (INFN)
Session Classification: Plenary Session VI: Heavy Flavor and Quarkonia
Quarkonium production in AA collisions from SPS to LHC (theory)

Friday, 10 February 2017 15:30 (30 minutes)

Preferred Track

Collaboration

Primary author:  RAPP, Ralf (Texas A&M University)
Presenter:  RAPP, Ralf (Texas A&M University)
Session Classification:  Plenary Session VI: Heavy Flavor and Quarkonia
Global and local spin polarization in AA collisions

Friday, 10 February 2017 16:30 (30 minutes)

Preferred Track

Collaboration

Presenter: WANG, Qun (University of Science and Technology of China)
Session Classification: Plenary Session VII: Other Recent Developments
Chiral and magneto-hydrodynamics for heavy-ion collisions

Friday, 10 February 2017 17:00 (30 minutes)

Preferred Track

Collaboration

Primary author: HIRONO, Yuji (Brookhaven National Laboratory)

Presenter: HIRONO, Yuji (Brookhaven National Laboratory)

Session Classification: Plenary Session VII: Other Recent Developments
Status of nuclear PDFs after the first LHC p-Pb run

Friday, 10 February 2017 17:30 (30 minutes)

Preferred Track

Collaboration

Presenter: PAUKKUNEN, Hannu (University of Jyväskylä)

Session Classification: Plenary Session VII: Other Recent Developments
Flash Talks

Preferred Track

Collaboration

Session Classification: Plenary Session VIII: Future Facilities and Directions
Gravitational waves and the nuclear equation of state

Saturday, 11 February 2017 09:00 (30 minutes)

Preferred Track

Collaboration

Primary author: SEKIGUCHI, Yu-ichiro
Presenter: SEKIGUCHI, Yu-ichiro
Session Classification: Plenary Session VIII: Future Facilities and Directions
Ultra-peripheral collisions and hadronic structure

Friday, 10 February 2017 18:00 (30 minutes)

Preferred Track

Collaboration

Primary author: Dr KLEIN, Spencer (LBNL)
Presenter: Dr KLEIN, Spencer (LBNL)
Session Classification: Plenary Session VII: Other Recent Developments
Low-x physics in pA collisions and at the EIC

Saturday, 11 February 2017 09:30 (30 minutes)

Preferred Track

Collaboration

Primary author: XIAO, Bo-Wen (Central China Normal University)
Presenter: XIAO, Bo-Wen (Central China Normal University)
Session Classification: Plenary Session VIII: Future Facilities and Directions
The way forward

Saturday, 11 February 2017 11:10 (30 minutes)

Primary author:  ZAJC, William (Columbia University)
Presenter:  ZAJC, William (Columbia University)
Session Classification:  Closing Session
Contribution ID: 233

Type: Oral

2017 Zimanyi Nuclear Theory Medal presentation

Saturday, 11 February 2017 11:40 (10 minutes)

Preferred Track

Collaboration

Session Classification: Closing Session
Elsevier Young Scientist Awards

Saturday, 11 February 2017 11:50 (10 minutes)

Preferred Track

Collaboration

Session Classification: Closing Session
Quark Matter 2018 presentation

Saturday, 11 February 2017 12:00 (15 minutes)

Session Classification:  Closing Session
Quark Matter 2017 closing

Saturday, 11 February 2017 12:15 (15 minutes)

Session Classification: Closing Session
Phi Meson Production in Small Systems at Forward Rapidity with the PHENIX Detector at RHIC

The production of mesons provides key information on the hot and dense state of the strongly interacting matter produced in high-energy heavy-ion collisions. They are sensitive to enhanced strangeness production in the medium. Measurements in different nucleus-nucleus collisions allow us to perform a systematic study of the nuclear medium effects on phi meson production. In addition to effects in hot matter, cold nuclear effects such as soft multiple parton rescattering or the modification of the parton distribution functions in nuclei may be important to interpret heavy-ion data. The PHENIX detector provides the capabilities to measure production in a wide range of transverse momentum and rapidity. We use these capabilities to measure meson production in $d$+Au, $p$+Au, $p$+Al and $^3$He+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. The data can be compared with AMPT calculations to study the various cold nuclear medium effects involved in meson production. In this poster we present the status of the analysis.

Preferred Track
QCD in small systems

Collaboration
PHENIX

Primary author: SARSOUR, Murad (Georgia State University)
Presenter: SARSOUR, Murad (Georgia State University)
Session Classification: Poster Session
Measurement of the sixth order cumulant of net-proton multiplicity distribution in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV from the STAR experiment

Cumulants of conserved quantities is one of the powerful tools to study the QCD phase structure. According to the Lattice Gauge Theory calculation, at small $\mu_B$ a "smooth cross-over" for the transition from QGP to hadronic system occurs in heavy-ion collisions. Experimentally, however, there is still no evidence for the predicted "smooth cross-over". One of the possible ways to test the prediction is to measure the higher order cumulants of net-baryon or net-charge multiplicity distribution.

The STAR experiment measured the fourth order cumulant ratio ($\kappa = C_4/C_2$) of net-proton multiplicity distribution in Au+Au collisions and its value was $\sim 0.92$ at $\sqrt{s_{NN}} = 200$ GeV, which is consistent with hadronic gas. Generally the higher order the cumulant, the more sensitive it is to the correlation length. Thus we might observe the signature with measurements of the sixth order cumulant.

In this poster, we present the centrality, rapidity and transverse momentum dependence of the sixth order cumulant and its ratio ($C_6, C_6/C_2$) of net-proton multiplicity distribution in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV, and compare with Lattice QCD calculations.


Preferred Track

Correlations and Fluctuations

Collaboration

STAR

Primary author: Mr NONAKA, Toshihiro (University of Tsukuba)
Presenter: Mr NONAKA, Toshihiro (University of Tsukuba)
Session Classification: Poster Session
Chiral magnetic effect and anomalous transport from real-time lattice simulations

Tuesday, 7 February 2017 15:40 (20 minutes)

We present a first principles approach to study the dynamics of the Chiral Magnetic Effect and Chiral Magnetic Wave based on real-time lattice simulations with dynamical (Wilson and Overlap) fermions simultaneously coupled to color and electro-magnetic fields. We discuss how these techniques can be used to study the Chiral Magnetic Effect during the pre-equilibrium stage of a heavy-ion collision and present first results obtained within a simplified setup. While for light quarks we observe a dissipationless transport of charges as in anomalous hydrodynamics, we demonstrate that for heavier quarks the effects of explicit chiral symmetry breaking lead to a significant reduction of the associated currents. Within our microscopic approach, we also extract the spectral properties of the fermion fields to establish an intuitive picture of what flows in the Chiral Magnetic Effect.


2 M. Mace, N. Mueller, S. Schlichting, S. Sharma, in preparation

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary authors: MUELLER, Niklas (Heidelberg University); SCHLICHTING, Soeren (University of Washington)

Presenter: MUELLER, Niklas (Heidelberg University)

Session Classification: Parallel Session 3.2: CME, Vorticity and Spin Polarization (I)

Track Classification: New Theoretical Developments
Non-prompt $D^0$-meson production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV in STAR

Heavy flavor quarks ($c, b$) are produced dominantly by the interactions of the initial incoming partons, and thus experience the entire evolution of the hot and dense medium created in high-energy nuclear collisions. Systematic investigations of charm and bottom hadron production in heavy-ion collisions will shed lights into the understanding of the parton energy loss in the Quark-Gluon Plasma (QGP), which can help constrain the transport parameters of the QGP medium.

In this poster, we will present the first measurement of non-prompt $D^0$-meson production from bottom hadron decays using the Heavy Flavor Tracker (HFT) in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV by the STAR experiment. Distributions of the Distance of Closest Approach (DCA) for reconstructed $D^0$-mesons are studied, and fitted with the template distributions for the prompt and non-prompt $D^0$-mesons obtained from Monte Carlo simulations. Fractions of non-prompt $D^0$-mesons are extracted in the transverse momentum region $3 < p_T < 8$ GeV/c. The results are compared to model calculations and physics implications on the bottom production will be discussed.

Preferred Track
Open Heavy Flavors

Collaboration
STAR

Primary author: CHEN, Xiaolong (USTC/LBNL)
Presenter: CHEN, Xiaolong (USTC/LBNL)
Session Classification: Poster Session
Measurements of electron production from heavy flavor decays in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV by the STAR experiment

Heavy quarks are predominantly produced at early stages of high-energy heavy-ion collisions due to their large masses. Studies of interactions between heavy quarks and the Quark-Gluon Plasma (QGP) in different collision systems can provide new insights to the properties of the QGP. Thus measurements of heavy quark production via measuring the electrons from semi-leptonic decays of heavy flavor hadrons, also known as Non-Photonic Electron (NPE), in Au+Au collisions are crucial.

In this poster, we will present the latest measurements of the nuclear modification factor ($R_{AA}$) for NPE production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV from the STAR experiment. We will also discuss the first result on separating NPE production between open charm and bottom hadron decays via the impact parameter method utilizing the Heavy Flavor Tracker.

Preferred Track
Open Heavy Flavors

Collaboration
STAR

Primary author: ZHANG, Shenghui (USTC)
Presenter: ZHANG, Shenghui (USTC)
Session Classification: Poster Session
Measurements of $\Lambda_c^+$ and $D_s^+$ productions in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV from STAR

Tuesday, 7 February 2017 17:30 (20 minutes)

Quark coalescence has been proposed as a new hadronization mechanism to explain the Number-of-Constituent-Quark scaling for meson/baryon elliptic flow as well as the enhancement in baryon-to-meson ratios in heavy ion collisions in the intermediate $p_T$ range ($2 < p_T < 6$ GeV/c) for both light and strange flavor hadrons. If the coalescence mechanism also plays a significant role for charm quark hadronization inside the hot and dense medium, one would expect enhancements in the $D_s^+$ and $\Lambda_c^+$ yields in heavy-ion collisions relative to p+p collisions. The magnitudes of the enhancements are sensitive to the QGP dynamics, e.g. the degree of thermalization for charm quarks, the amount of strangeness enhancement, etc. Knowledge of the yields for different charm hadrons is also critical for determining the total charm quark yield in heavy-ion collisions.

In this presentation, we will report the first measurement of $\Lambda_c^+$ baryon ($cT \sim 60\mu m$) production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV from the STAR experiment. A significantly improved measurement of $D_s^+$ production with about a factor of 7 increase in signal significance compared to the previous results will also be reported. The $\Lambda_c^+$ and $D_s^+$ hadrons are reconstructed through their hadronic decay channels ($\Lambda_c^+ \rightarrow p + K + \pi$, $D_s^+ \rightarrow \phi(1020) + \pi$) using topological selections enabled by the STAR Heavy Flavor Tracker (HFT). The transverse-momentum spectra of $\Lambda_c^+$ and $D_s^+$ as well as their ratios to non-strange D meson will be presented and compared to theoretical calculations. In addition, nuclear modification factor and elliptic flow for $D_s^+$ will be presented. Physics implications on charm quark hadronization mechanisms in the QGP as well as the QGP medium properties will be discussed.

Preferred Track
Open Heavy Flavors

Collaboration
STAR

Primary author: ZHOU, Long (USTC && BNL)
Presenter: ZHOU, Long (USTC && BNL)
Session Classification: Parallel Session 4.4: Open Heavy Flavors (I)
Track Classification: Open Heavy Flavors
Exploiting the universality between the QCD critical point and the three dimensional Ising model, closed form expressions derived for non-equilibrium critical cumulants on the crossover side of the critical point reveal that they can differ both in magnitude and sign from equilibrium expectations. We demonstrate here that key elements of the Kibble-Zurek framework of non-equilibrium phase transitions can be employed to describe the dynamics of these critical cumulants. Our results suggest that observables sensitive to critical dynamics in heavy-ion collisions should be expressible as universal scaling functions, thereby providing powerful model independent guidance in searches for the QCD critical point.

1 Swagato Mukherjee, Raju Venugopalan, Yi Yin, Phys. Rev. C 92, 034912 (2015),

Analysis status on low-momentum direct-photons in Cu+Cu collisions at $\sqrt{s_{NN}} = 200$ GeV at PHENIX

Direct photons in high-energy heavy-ion collisions are a good probe to understand the full space-time evolution of the collision. The PHENIX experiment measured direct photons in p+p, d+Au, and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and discovered thermal photons from Au+Au collisions with internal photon conversions. Recently PHENIX has reported thermal photon production with wide centrality bins in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV via external photon conversions. While the number of participants in Cu+Cu collisions are similar to the one in Au+Au peripheral collisions, the collision geometry is very different. Thus a measurement of low-momentum direct-photons in Cu+Cu collisions can provide important constrains on the origin of the observed direct photons. In this poster we report the current analysis status of a measurement of direct virtual-photons in Cu+Cu collisions at $\sqrt{s_{NN}} = 200$ GeV.

Preferred Track

Electromagnetic Probes

Collaboration

PHENIX

Primary author: HOSHINO, Tomoya

Presenter: HOSHINO, Tomoya

Session Classification: Poster Session
Dynamics of the hadronic phase in ultrarelativistic heavy ion collisions

I will discuss the dynamics of the hadronic phase in ultrarelativistic nuclear collisions in the context of the UrQMD transport model.

I will present results on the hadronic phase effects on final state observables like hadron multiplicity and collective flow. These results show that especially hadron resonance properties and multiplicities, which are very sensitive probes of the hadronic rescattering phase, can be well described by the UrQMD transport model.

Furthermore I will show how the hadronic rescattering decorrelates the initial distributions of conserved charges in a fixed acceptance window of a nuclear collision. Consequently, the calculated change of the correlation, during the hadronic expansion stage, does not support the recent paradigm, namely that the measured final moments of the experimentally observed distributions do give directly the values of those distributions at earlier times, when the system had been closer to the QCD crossover.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: Dr STEINHEIMER, Jan (FIAS, Frankfurt)
Presenter: Dr STEINHEIMER, Jan (FIAS, Frankfurt)
Session Classification: Poster Session
Detector Control System of the new Muon Forward Tracker at ALICE

The ALICE detector is designed for study of Quark-Gluon Plasma in heavy ion collisions at the LHC. Major upgrades of the detector are planned before the LHC run 3 from 2021. Along with a much higher rate capability to fully utilize the luminosity to be delivered, ALICE will also have enhanced physics capabilities with new addition of detector components.

The Muon Forward Tracker (MFT) is one of the approved ALICE upgrade projects. The silicon trackers in front of the hadron absorber of the existing Muon Spectrometer will allow ALICE new measurements with high resolutions of quarkonia via dimuons and open heavy flavors via single muons and also via separation between primary and secondary vertices.

The detector control system of the MFT will be based on new architectures and frameworks, rather than those in the ALICE detector at present, in association with the planned upgrade of the readout electronics of ALICE from the run 3. Its design with technical strategies and the development status will be presented in this poster.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
ALICE

Primary author: SHIGAKI, Kenta (Hiroshima University (JP))
Presenter: SHIGAKI, Kenta (Hiroshima University (JP))
Session Classification: Poster Session
Beam energy dependence of deuteron and anti-deuteron productions in Au+Au collisions at RHIC

Light nuclei have much smaller binding energy compared to the temperature of the system. Consequently, their distributions can be used to probe the freeze-out properties, such as correlation volume and local baryon density of the medium created in high-energy nuclear collisions.

In this talk, we report the results of deuteron and anti-deuteron production in Au-Au collision at $\sqrt{s_{NN}} = 7.7-200$ GeV, measured by STAR at RHIC. The collision energy, centrality and transverse momentum dependence of the coalescence parameter $B_2$ for deuteron and anti-deuteron production is discussed. We find the values of $B_2$ for anti-deuteron are systematically lower than those for deuterons. The difference in $B_2$ for deuteron and anti-deuteron indicate the residual isospin brought in at the beginning of the collisions. The values of $B_2$ are found to decrease with increasing collision energy. The rate of decreasing seems to change around $\sqrt{s_{NN}} = 20$ GeV implying a dramatic change of the equation of state of the medium in these collisions.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

STAR

Primary author: YU, Ning (Central China Normal University CCNU)
Presenter: YU, Ning (Central China Normal University CCNU)
Session Classification: Parallel Session 4.1: Baryon-Rich QCD Matter and Astrophysics (I)
Track Classification: Baryon-Rich QCD Matter and Astrophysics
Measurement of the nuclear modification factor of electrons from heavy-flavour hadron decays in Pb-Pb collisions with ALICE

Heavy quarks (charm and beauty) are produced primarily in the initial hard partonic interactions in heavy-ion collisions. Since they propagate through and interact with the hot and dense QCD matter, measurements of the heavy-flavour production provide relevant information on the early stage of the collisions and parton-medium interaction. A strong suppression of heavy-flavour hadron production has been observed in the most central heavy-ion collisions with respect to binary-scaled pp collisions, and it is thought to be due to energy loss of heavy flavours in the dense matter.

This poster presents measurements of electrons from heavy-flavour decays at central rapidity in Pb-Pb collisions. The dominant source at low $p_T$ is composed of electrons from charm-hadron decays, while at high $p_T$ electrons from beauty-hadron decays represents a large contribution. Thus, the measurement is sensitive to energy loss of charm and beauty in the dense matter. The $p_T$ dependence of the nuclear modification factor of electrons from heavy-flavour hadron decays in Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV is shown up to 18 GeV/$c$ in the most central collisions. The centrality dependence of the nuclear modification factor will also be shown. The measurements at $\sqrt{s_{NN}} = 5.02$ TeV and the prospectives for separating electrons from beauty-hadron decays will be presented.

Preferred Track

Open Heavy Flavors

Collaboration

ALICE

Primary author: SAKAI, Shingo (University of Tsukuba (JP))

Presenter: SAKAI, Shingo (University of Tsukuba (JP))

Session Classification: Poster Session
Deep inelastic scattering in a light-front Hamiltonian approach

We apply the time-dependent basis light-front quantization (tBLFQ) formalism, a Hamiltonian approach which is suitable for non-perturbative problems to the deep inelastic scattering. We calculate the dipole cross section by explicitly evolving the quark-antiquark dipole in the field predicted by the Color Glass Condensate theory. Our formalism enables us to go beyond Eikonal approximation and to include higher Fock sector contributions.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: LI, Meijian (Iowa State University)
Presenter: LI, Meijian (Iowa State University)
Session Classification: Poster Session
Overall momentum balance and redistribution of lost energy in asymmetric dijet events from a multi-phase transport model

Dijet momentum balance in both p+p and Pb+Pb collisions at 2.76 TeV is studied within a multi-phase transport (AMPT) model. We analyze projection $\vec{p_T}$ of transverse momentum $p_T$ of all particles onto leading jet axis, and obtain overall momentum balance in dijet events, which qualitatively fits CMS data for p+p and Pb+Pb collisions. Against the contribution to $\vec{p_T}$ in leading jet direction by large $p_T$ particles, the contribution in the opposite direction in most central Pb+Pb collisions is dominated by soft particles while the soft particle contribution is less than 50% in p+p and peripheral Pb+Pb collisions. Further insights into radial dependence of momentum balance in central Pb+Pb collisions show that the soft particles carrying the balance are scattered at large angles to jet axes in the direction of subleading jet. Since only elastic collisions are included within the model, the description of CMS data implies an important role played by elastic collisions between jet partons with medium partons in explaining redistribution of lost energy from the jet cone.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary author: Mr CHEN, Lin (Central China Normal University)
Presenter: Mr CHEN, Lin (Central China Normal University)
Session Classification: Poster Session
Characterizing the away-side jet correlation with robust flow background subtraction in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV in STAR

Jets are modified in relativistic heavy-ion collisions due to jet-medium interactions. Measurements of jet medium modifications have so far been obscured because of the large underlying anisotropic flow background. In this analysis we devise a method to subtract all orders of the flow background using data themselves. The flow background subtracted away-side jet correlation shape and width with respect to a high-$p_T$ trigger particle ($p_{T\text{ trig}} > 3$ GeV/c) are studied in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV as a function of centrality and associated particle $p_T$. The correlation shape is consistent with Gaussian. The width is found to increase with centrality except for the lowest measured associated particle $p_T$ bin.

In mid-central (20-60%) collisions, the away-side jet correlation is studied as a function of the trigger particle’s azimuthal angle relative to the event plane. Event plane dependent effects are expected to arise from jet-medium modifications, event averaging of away-side jets deflected by medium flow, and/or simply nuclear $k_T$ broadening. Results on the event plane angle dependence of the away-side jet correlations are presented.

Preferred Track
Jets and High $p_T$ Hadrons

Collaboration
STAR

Primary author: JIANG, Kun (University of Science and Technology of China)

Presenter: JIANG, Kun (University of Science and Technology of China)

Session Classification: Poster Session
Neutral pion production in $pp$ collisions at LHC-Run1

Measurement of neutral pion production in $pp$ collisions is useful to test the QCD predictions at high $p_T$ (> 4 GeV/$c$). At low $p_T$, perturbative QCD cannot be applied to predict the particle production and therefore, only phenomenological models can be used. To put constraints on these models, the measurement in a very wide $p_T$ region is very important. Furthermore, the comparison between different collision energies is also important because insight into the particle production mechanism can be obtained by comparing the different particle spectra. The invariant cross sections for neutral pion production measured by the ALICE experiment in $pp$ collisions at LHC-Run1 energies are shown and the particle production mechanism via $x_T = p_T/2\sqrt{s}$ scaling is discussed in this poster.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ALICE

Primary author: YANO, Satoshi (Hiroshima University (JP))
Presenter: YANO, Satoshi (Hiroshima University (JP))
Session Classification: Poster Session
The polarization of direct photons produced in an ultrarelativistic heavy-ion collision reflects the anisotropy of the quark-gluon plasma created in the collision. We describe a general framework, based on the photon spectral functions in the plasma, for analyzing the angular distribution and thus the polarization of dileptons in terms of the plasma anisotropies. The rates of dilepton production depend in general on four independent spectral functions, corresponding to two transverse polarizations, one longitudinal polarization, and – in plasmas in which the anisotropy is not invariant under parity in the local rest frame of the matter – a new spectral function, $\rho_n$, related to the anisotropy direction in the collision. The anisotropy appears in the difference of the two transverse spectral functions, as well as in $\rho_n$. As an illustration we delineate the spectral functions for dilepton pairs produced in the lowest order Drell-Yan process of quark-antiquark annihilation to a virtual photon.

Preferred Track

Electromagnetic Probes

Collaboration

Not applicable

Primary author:  Prof. BAYM, Gordon (University of Illinois)

Presenter:  Prof. BAYM, Gordon (University of Illinois)

Session Classification:  Parallel Session 2.3: Electromagnetic Probes (II)

Track Classification:  Electromagnetic Probes
Excess of $J/\psi$ yield at very low $p_T$ in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and U+U collisions at $\sqrt{s_{NN}} = 193$ GeV measured with STAR experiment

Suppression of $J/\psi$ production in heavy-ion collisions due to color screening of quark and anti-quark potential in the deconfined medium has been proposed as a signature of the QGP formation. Other mechanisms, such as the cold nuclear matter effects and charm quark recombination, can contribute to the observed modification of $J/\psi$ production in heavy-ion collisions. Recently, a significant excess of $J/\psi$ yield at very low $p_T$ ($< 0.3$ GeV/c) was observed by the ALICE collaboration in peripheral Pb+Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV at forward-rapidity, which can not be explained by the above-mentioned effects. It has been hypothesized that such $J/\psi$’s are produced from the coherent photoproduction in Pb+Pb collisions at impact parameters smaller than twice the nuclear radius, which would be very challenging for the existing models developed to describe coherent photoproduction in ultra-peripheral collisions. Measurements of $J/\psi$ production at very low $p_T$ in different collision energies, collision systems, and collision geometries can shed new light on the origin of the excess.

In this presentation we report the STAR measurements of $J/\psi$ production at very low $p_T$ in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and U+U collisions at $\sqrt{s_{NN}} = 193$ GeV at mid-rapidity. Centrality dependence of $J/\psi$ production cross section and nuclear modification factors at very low $p_T$ will be presented.

Preferred Track

Quarkonia

Collaboration

STAR

Primary author: ZHA, Wangmei (USTC/BNL)
Presenter: ZHA, Wangmei (USTC/BNL)
Session Classification: Poster Session
Angular Structure of Jet Quenching within a Hybrid Strong/Weak Coupling Model

Within the context of a hybrid strong/weak coupling model of jet quenching, we study the modification of the angular distribution of the energy within jets in heavy ion collisions, as partons within jet showers lose energy and get kicked as they traverse the strongly coupled plasma produced in the collision. To describe the dynamics transverse to the jet axis, we add the effects of transverse momentum broadening into our hybrid construction, introducing a parameter $K \equiv \hat{q}/T^3$ that governs its magnitude. We show that, because of the quenching of the energy of partons within a jet, even when $K \neq 0$ the jets that survive with some specified energy in the final state are narrower than jets with that energy in proton-proton collisions. For this reason, many standard observables are rather insensitive to $K$. We propose a new differential jet shape ratio observable in which the effects of transverse momentum broadening are apparent.

We also analyze the response of the medium to the passage of the jet through it, noting that the momentum lost by the jet appears as the momentum of a wake in the medium. After freezeout this wake becomes soft particles with a broad angular distribution but with net momentum in the jet direction, meaning that the wake contributes to what is reconstructed as a jet. This effect must therefore be included in any description of the angular structure of the soft component of a jet.

We show that the particles coming from the response of the medium to the momentum and energy deposited in it leads to a correlation between the momentum of soft particles well separated from the jet in angle with the direction of the jet momentum, and find qualitative but not quantitative agreement with experimental data on observables designed to extract such a correlation.

More generally, by confronting the results that we obtain upon introducing transverse momentum broadening and the response of the medium to the jet with available jet data, we highlight the importance of these processes for understanding the internal, soft, angular structure of high energy jets.

Preferred Track

Jets and High pT Hadrons

Collaboration
Not applicable

Primary author: RAJAGOPAL, Krishna (Massachusetts Inst. of Technology (US))
Presenter: RAJAGOPAL, Krishna (Massachusetts Inst. of Technology (US))
Session Classification: Parallel Session 2.4: Jets and High pT Hadrons (II)

Track Classification: Jets and High pT Hadrons
Quantifying pre-thermal chiral magnetic effect with chiral kinetic theory

Chiral anomaly is a fundamental aspect of the quantum theory for chiral fermions. In a many-body system containing chiral fermions, such as the hot quark-gluon plasma created in heavy ion collisions at RHIC and the LHC, the chiral anomaly leads to macroscopic anomalous transport effects. A notable example is the chiral magnetic effect (CME), in which a vector current is generated along an external magnetic field given a nonzero imbalance between right-handed and left-handed fermions in the system. An observation of the CME is of great interest and significant efforts have been made. Current experimental data show encouraging evidences, but suffer from backgrounds. Realistic and quantitative modeling of CME signal is thus critically needed. The magnetic field in heavy ion collisions, however, is likely very short-lived, with its life time shorter than the onset time of hydrodynamics. It is thus a most pressing issue to simulate the CME in the pre-thermal stage in heavy ion collisions. The theoretical tool to do this, is the so-called chiral kinetic theory.

We report the first attempt to utilize this tool for quantifying the pre-thermal CME. Exact solutions for collision-less case as well as the relaxation-time-approximation are obtained and used to compute two different CME-induced consequences: a pre-thermal charge separation across reaction plane, as well as a nonzero anomalous current along B field direction. We discuss the integration of these CME-induced initial conditions with subsequent hydrodynamic evolutions, and the implication of such results for the description of experimental data.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: HUANG, anping (Tsinghua University)
Co-author: LIAO, Jinfeng (Indiana University)
Presenter: HUANG, anping (Tsinghua University)
Session Classification: Poster Session
Upsilon measurements via the di-muon channel in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the STAR experiment

Measurements of quarkonium production have played an important role in understanding the properties of Quark Gluon Plasma (QGP) formed in relativistic heavy-ion collisions. The suppression of quarkonia in the medium due to color screening has been proposed as a direct signature of the QGP formation. However, other effects, such as regeneration of quarkonia by the coalescence of uncorrelated quark-antiquark pairs and co-mover absorption, add additional complications to the interpretation of observed quarkonium suppression. Compared to charmonia, bottomonia suffer much less from regeneration contribution and co-mover absorption. Furthermore, the different bottomonium states may dissociate at different temperatures, known as "sequential melting", which can be used to help constrain the temperature of the medium.

In early 2014, the Muon Telescope Detector (MTD), which provides muon triggering and identification capabilities at mid-rapidity, was fully installed at the STAR experiment. It opens the door to measuring quarkonia via the di-muon channel. In this poster, we present the measurements of $\Upsilon$ suppression in Au+Au collisions at $\sqrt{s_{NN}} = 200$-GeV via the di-muon channel, based on a data sample of 20 nb$^{-1}$ in total taken in RHIC 2014 and 2016 runs. The centrality and transverse momentum dependences are presented and compared to those at the LHC and theoretical calculations.

Preferred Track
Quarkonia

Collaboration
STAR

Primary author: HUANG, Xinjie (Tsinghua Univ.)
Presenter: HUANG, Xinjie (Tsinghua Univ.)
Session Classification: Poster Session
Quark and Gluon Production from an Expanding Strong Color Electric Flux Tube

We study quark and gluon production from an expanding strong color electric flux tube. Firstly, we derive a set of linear equations for quantum fluctuations by employing a mean-field approximation on top of the strong color electric flux tube, which describes the particle production and its backreaction on the flux tube. Second, we carry out numerical simulations and discuss how the flux tube decay through the quark and gluon production to form a quark-gluon plasma. In particular, we discuss the time evolution of (i) the phase space density of produced particles; (ii) the energy balance between the produced particles and the color flux tube; and (iii) the transverse and longitudinal pressure of the system, i.e., the degree of isotropization of the system.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: TAYA, Hidetoshi (The University of Tokyo)
Presenter: TAYA, Hidetoshi (The University of Tokyo)
Session Classification: Poster Session
The production of charmonium states (for instance $J/\psi$ and $\psi(2S)$) is one of the probes studied to investigate the properties of the Quark-Gluon Plasma (QGP) formed in high-energy heavy-ion collisions. Indeed, the presence of a deconfined medium should modify the charmonium production yield, due to a competition of the color screening of the charm quark anti-quark potential and the recombination of charm and anti-charm quarks. In order to quantify those effects occurring in high energy heavy-ions collisions, a reference measurement of the $J/\psi$ production in the absence of a hot medium is needed. This measurement is performed in pp collisions at the same colliding energy.

In this poster, we will present the measurement of the $J/\psi$ production cross section in pp collisions at $\sqrt{s} = 5.02$ TeV measured at forward rapidity with the ALICE detector. A detailed description of the analysis steps will be provided, some of them also being common to the analysis of the inclusive $J/\psi$ nuclear modification factor $R_{AA}$ in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.

**Preferred Track**

Quarkonia

**Collaboration**

ALICE

**Primary author:** Mr AUDURIER, Benjamin (Subatech Laboratory, Nantes, France)

**Presenter:** Mr AUDURIER, Benjamin (Subatech Laboratory, Nantes, France)

**Session Classification:** Poster Session
Probing Transverse Momentum Broadening via Dihadron and Hadron-jet Angular Correlations in Relativistic Heavy-ion Collisions

Tuesday, 7 February 2017 11:00 (20 minutes)

Dijet, dihadron, hadron-jet angular correlations have been reckoned as important probes of the transverse momentum broadening effects in relativistic nuclear collisions. When a pair of high-energy jets created in hard collisions traverse the quark-gluon plasma produced in heavy-ion collisions, they become de-correlated due to the vacuum soft gluon radiation associated with the Sudakov logarithms and the medium-induced transverse momentum broadening. For the first time, we employ the systematical resummation formalism and establish a baseline calculation to describe the dihadron and hadron-jet angular correlation data in $pp$ and peripheral $AA$ collisions where the medium effect is negligible. We demonstrate that the medium effects, especially the so-called jet quenching parameter $\hat{q}$, can be extracted from the angular de-correlations observed in $AA$ collisions. A global $\chi^2$ analysis of dihadron and hadron-jet angular correlation data renders the best fit $\langle \hat{q}L \rangle_{\text{tot}} \sim 14 \text{GeV}^2$ for a quark jet at RHIC top energy, with $L$ the typical traversed medium length. Our approach stands as a new and complimentary method for the extraction of the jet quenching parameter $\hat{q}$ as compared to the JET Collaboration effort.

Further experimental and theoretical efforts along the direction of this work shall significantly advance the quantitative understanding of transverse momentum broadening and help us acquire unprecedented knowledge of jet quenching parameter in relativistic heavy-ion collisions.

References:


Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

Not applicable

Primary author: QIN, Guang-You (Central China Normal University)
**Presenter:** QIN, Guang-You (Central China Normal University)

**Session Classification:** Parallel Session 2.4: Jets and High pT Hadrons (II)

**Track Classification:** Jets and High pT Hadrons
Effect of $p_T$ broadening in inclusive jet and hadron-jet suppressions

The effect of the transverse momentum broadening to the total jet energy loss within a given jet cone-size, and therefore to the nuclear suppression factor are studied. The radiated gluons induced by the medium are mostly collinear with the mother parton. Therefore, the energy carried by the radiated gluons outside of the jet-cone is very small. However, the $p_T$ broadening effect can enlarge the angle between the mother parton and the radiated gluons. We found that this $p_T$ broadening effect is very important, which almost doubled the radiative energy loss. We also studied the collisional energy loss based on the pQCD calculation. We found that the collisional energy loss is very small comparing with the radiative energy loss.

We carried out the calculation for the nuclear modification factor of the single jet production, $R_{AA}$. We found our results can describe the ALICE and ATLAS data with different cone-sizes very well. We also calculated the suppression of the per-trigger yield of hadron-jet production, and compared with the latest data, which is not only sensitive to the full jet energy loss but also sensitive to the leading parton energy loss.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

Not applicable

Primary author: Dr WEI, Shu-yi (CCNU)

Co-authors: ZHANG, Hanzhong (IOPP, CCNU); WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Presenter: Dr WEI, Shu-yi (CCNU)

Session Classification: Poster Session
Measurements of jet fragmentation functions and of their moments in pp collisions at $\sqrt{s} = 2.76$ TeV with the ALICE detector.

Produced in a hard scattering at the early stage of the collision a highly energetic parton is first expected to lose energy in the medium before fragmenting into a hadronic spray of particles called jet. A detailed study of the modification of the jet structure and of its fragmentation pattern in vacuum and in medium should provide insights into the QGP properties. The jet fragmentation functions describe the momentum distribution of hadrons inside a reconstructed jet. In proton-proton (pp) collisions their measurement is important for understanding the mechanisms of parton fragmentation. Such measurements also provide a test of perturbative Quantum Chromo Dynamics (pQCD) as well as a baseline for similar measurements in p-A collisions (revealing potential cold nuclear matter effects) or in A-A collisions (shedding light on the energy loss mechanisms in presence of a hot and dense medium). However, in heavy-ion collisions the presence of a large underlying event and of its event-by-event fluctuations makes the measurement of jet fragmentation functions a challenging task. The use of the fragmentation function moments has been proposed 1 as a way to overcome this difficulty.

The ALICE detector at the LHC has unique tracking capabilities enabling to measure charged particles down to transverse momenta as low as 150 MeV/c. This allows assessing possible modifications of the jet structure and helps constraining the jet fragmentation functions.

We will present the ALICE measurements of charged-jet fragmentation functions in pp collisions at $\sqrt{s} = 2.76$ TeV. The first studies of fragmentation function moments will be discussed. The results will also be compared to model predictions.


Preferred Track
Jets and High pT Hadrons

Collaboration
ALICE

Primary author: SHABETAI, Alexandre (Centre National de la Recherche Scientifique (FR))
Presenter: SHABETAI, Alexandre (Centre National de la Recherche Scientifique (FR))
Session Classification: Poster Session
Online reconstruction of multi-strange hyperons at CBM experiment

The Compressed Baryonic Matter (CBM) experiment at the future facility FAIR in Darmstadt is a dedicated heavy ion experiment which will operate in fixed target mode at beam energies up to 11A GeV for ions delivered by the SIS100 accelerator. In order to explore the QCD phase diagram at high net-baryon densities, CBM holds a wide and rich physics program. One of the main experimental challenges is the measurement of very rare probes, which requires an interaction rate of up to 10 MHz. In this poster, we study the production of multi-strange (anti)hyperons as one of the earliest proposed signatures of the formation of a deconfined QGP.

The reconstruction of multi-strange hyperons in CBM is based on their characteristic weak decay topology, characterized by one or more displaced vertices, and reaches a high reconstruction efficiency of about 20% for $\Lambda$, 8% for $\Xi$ and 5% for $\Omega$.

An online event selection of multi-strange hyperons is developed. In this poster, we discuss its performance, studied with simulated data of Au+Au collisions at various SIS100 energies.

Preferred Track

QCD in small systems

Collaboration

Other

Primary author:  CHERIF, Hamda (GSI)

Presenter:  CHERIF, Hamda (GSI)

Session Classification:  Poster Session
Transverse momentum and pseudorapidity dependence of correlations between different order flow harmonics in Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV

The new multiparticle observables, which are called "Symmetric 2-harmonic 4-particle cumulants" (SC), were recently reported in 1. These quantify the correlation between the event-by-event fluctuations of two different flow harmonics. Because the correlation between different order flow harmonics responds differently to the initial conditions or(and) $\eta/s$, SC provide a strong constraint on the QGP properties in heavy-ion collisions. Furthermore, the higher order to lower order harmonic correlations can be used to understand the viscous correction to the momentum distribution at freeze-out which is probably the least understood part of hydrodynamic calculations [2, 3]. These results have a great potential to constrain the dominant physics in each stage of heavy-ion collisions. In this poster, SC results of lower order harmonics correlations ($v_2$-$v_3$ and $v_2$-$v_4$) with transverse and pseudorapidity dependence will be presented. Also the SC analysis will be extended to higher order harmonics (up to $v_5$), and results will be compared to AMPT and hydrodynamic models.

1 ALICE arXiv:1604.07663
We discuss photon emission at the stage of hadronization as a possible resolution to the direct-photon puzzle. In an ordinary plasma, it is well known that photon emission occurs when a plasma goes back to a normal state through recombination processes such as $e^- + p^+ \rightarrow H + \gamma$ for an electron-proton plasma. This is called the “radiative recombination”. A similar process should take place when a QGP hadronizes. For example, meson formation from a quark and an antiquark will be accompanied by photon emission $q + \bar{q} \rightarrow \text{meson} + \gamma$ to compensate the energy difference between the initial and final states.

In order to compute the number of photons emitted at hadronization, we employ the “recombination model” developed by the Duke group. There, the number of produced hadrons is computed under the assumption that coalescence of valence (anti)quarks just occurs without emission of additional particles, which surely violates energy and entropy conservation. With the photon emission added in this coalescence process, however, energy and entropy can be made conserved. We reinterpret the production formula of hadrons in the original recombination model as that of artificial “resonant states” whose invariant masses are not necessarily equal to the masses of any physical hadrons. We further assume that the “resonant state” decays into a physical hadron and a photon.

This “improved” recombination model has a potential to resolve the direct-photon puzzle: (1) a larger yield of photons since we add photon production at hadronization, which has been overlooked so far, and (2) radiated photons flow similarly as hadrons because photons are emitted in a collimated way with the resonant state’s motion. Moreover, the pt distribution of emitted photons mimics thermal distribution whose effective temperature is essentially given by blue-shifted quark’s temperature and thus becomes much higher than critical temperature.

**Preferred Track**

Electromagnetic Probes

**Collaboration**

Not applicable

**Primary author:** ITAKURA, Kazunori (KEK)

**Presenter:** ITAKURA, Kazunori (KEK)

**Session Classification:** Parallel Session 2.3: Electromagnetic Probes (II)

**Track Classification:** Electromagnetic Probes
Role of hard-sphere repulsive interactions in a comparison to lattice QCD simulations: small strange states from fluctuations of conserved charges

Repulsive baryon and meson interactions in HRG models show sizable effects on higher order fluctuations of conserved charges. When compared to lattice QCD simulations, a point-particle formulation of the Hadron-Resonance Gas model is unable to describe the observables as calculated in Lattice GT, even when hitherto undetected Quark Model States are implemented into the hadronic spectrum used in the ppt-HRG.

Higher order fluctuations of conserved S/Q/B charges point towards the need for a distinctly different description of light quark hadrons and strange particles: the LQCD results are compatible with reduced strange hadron hardcores, in agreement with their smaller cross sections. Implementing this different behaviours of light and strange hadrons into a HRG model allows also to reproduce the measured hadron yields from Heavy-Ion Collisions.

In particular, this treatment completely removes the so-called ‘proton anomaly’ supposedly found by the ALICE collaboration - it is just the neglect of the distinction of the eigenvolume terms which causes this non-anomaly.

Repulsive interactions furthermore allow for a consistent inclusion of exotic resonances, as the kappa meson, which influences key observables, especially in the strange sector.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: ALBA, Paolo Giuseppe

Presenter: ALBA, Paolo Giuseppe

Session Classification: Poster Session
**D± meson production in Au+Au collisions at √s_{NN} = 200 GeV measured by the STAR experiment**

Charm quarks are mainly created in hard processes at the beginning of the heavy-ion collisions and can be used as a tool to study properties of the Quark-Gluon Plasma (QGP). The modification to D-meson production in heavy-ion collision is sensitive to the energy loss of charm quarks in the QGP. The Heavy Flavor Tracker was installed at the STAR experiment in 2014 and enables the topological reconstruction of the decay vertices for open charm mesons. It significantly improves the measurement precision on charm mesons. Besides the measurement on D⁰, D± provides an additional handle and cross-check to study the interaction between charm quark and medium.

In this poster, we will present measurements of D± production in Au+Au collisions at √s_{NN} = 200 GeV. D± mesons are reconstructed topologically via the hadronic decay channel D± → K∓π±π± from the data collected in 2014 with the Heavy Flavor Tracker. The invariant yields of D± and the ratio of D±/D⁰ as a function of transverse momentum as well as centrality will be shown.

**Preferred Track**

Open Heavy Flavors

**Collaboration**

STAR

**Primary author:** KVAPIL, Jakub (Czech Technical University in Prague)

**Presenter:** KVAPIL, Jakub (Czech Technical University in Prague)

**Session Classification:** Poster Session
Results from non-perturbative QCD indicate that chiral symmetry may be restored in the hot and dense matter produced in relativistic heavy ion collisions. This restoration would affect the vector meson mass spectrum and could be examined with the ALICE detector at the LHC. One of the most promising probes to study these effects are dielectrons ($e^+e^-$ and $e^+e^-$) from $\rho$ meson decays since they reach the detector without significant final state interactions.

In order to precisely measure the low-mass dielectron spectrum a high purity sample of $e^+e^-$ pairs will be required. Whilst traditional cut-based methods can provide high purity samples, they suffer from low efficiency. Multivariate particle identification could in future be used to alleviate this drawback.

The main background in the analysis of dielectrons are combinatoric $e^+e^-$ pairs (S/B $\sim 10^{-3}$ for $0.3 < M_{ee} < 1$ GeV/c$^2$). This background contribution can be suppressed by rejecting $e^+$ and $e^-$ tracks that originate from photon conversion processes. Numerous observables allow to discriminate background from signal dielectrons which motivates a multivariate approach in the classification of $e^+e^-$ pairs.

The employed machine learning methods and performance based on Monte-Carlo data will be presented as well as their application in the analysis of LHC Run 2 data.
Effect of hydrodynamic response in QGP on full jet

Wednesday, 8 February 2017 12:00 (20 minutes)

We study modification of full jet structures in the quark-gluon plasma (QGP) medium including effect of the hydrodynamic medium response. The structures and energies of jets in heavy ion collisions are significantly modified by the processes involving strong interactions during the propagation through the QGP medium, i.e., collisional energy loss, $p_T$-broadening, and induced parton radiation. The energy and momentum are deposited into the QGP medium by jets via the collisional energy loss and the $p_T$-broadening due to the energy-momentum conservation. The QGP medium is supposed to respond hydrodynamically to the deposited energy and momentum and flows propagating with the jets are caused. Particles originating from the jet-induced flows are observed as a part of the jets in the actual experiments, and contribute to the modification of the full jet structures. Studying this contribution is not only important for the precise interpretation of the experimental data but also provides a novel opportunity to investigate the collective response of the QGP.

We employ a full jet shower + QGP fluid model composed of transport equations for jet evolution and hydrodynamic equations with source terms for the QGP medium evolution. The transport equations describe the evolution of the three-dimensional momentum distributions of partons in the full jet. In the transport equations, all the processes of the collisional energy loss, $p_T$-broadening and partonic splittings for all partons within the full showering jet are covered. The space-time evolution of the QGP medium is described by (3+1)-dimensional ideal hydrodynamic equations with source terms. The source terms transfer the deposited energy and momentum to the QGP fluid and are constructed with the evolving distributions of the partons in jets obtained as solutions of the transport equations. In this work, we study the shape and energy loss of the full jet in Pb+Pb collisions at the LHC including the effect of the jet-induced flows. We find that the contribution of the particles originating from the jet-induced flows significantly modifies the full jet shape, and especially dominates it at large angles from the jet direction. We also find that this contribution increase the jet-cone size dependence of the full jet energy loss.

References


Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

Not applicable
Primary authors: QIN, Guang-You (Central China Normal University); TACHIBANA, Yasuki (Central China Normal University)

Presenter: TACHIBANA, Yasuki (Central China Normal University)

Session Classification: Parallel Session 6.4: Jets and High pT Hadrons (V)

Track Classification: Jets and High pT Hadrons
Direct photon measurements in pp and Pb-Pb collisions with ALICE

Tuesday, 7 February 2017 10:40 (20 minutes)

Direct photon measurement in heavy-ion collisions provides a valuable set of observables to study the hot QCD medium since these photons are produced at different stages of the collision and escape the medium unaffected. In pp collisions, the direct photon yield at high transverse momentum ($p_T$) are produced in hard scattering (prompt photons), but also in the fragmentation of high $p_T$ partons. Their measurement provides a direct test of pQCD and can constrain the parton distribution functions.

The access to the prompt photon production can be achieved experimentally with isolation techniques.

In heavy-ion collisions, the high $p_T$ component provides information on the initial parton dynamics and nuclear parton densities in nuclei, whereas the low momentum component (below $p_T < 5$ GeV/c) of the direct photon production is dominated by thermal radiation from the hot and dense matter created, carrying information on its space-time evolution, collective flow and temperature.

In this talk, we will present ALICE results of direct photon production in pp reactions at $\sqrt{s} = 7$ TeV using isolation techniques.

The measurement of the direct photon flow in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV will also be presented.

The results will be discussed and compared to theoretical predictions and earlier measurements.

Preferred Track

Electromagnetic Probes

Collaboration

ALICE

Primary author: GERMAIN, Marie (Subatech, IN2P3-CNRS (FR))

Presenter: GERMAIN, Marie (Subatech, IN2P3-CNRS (FR))

Session Classification: Parallel Session 2.3: Electromagnetic Probes (II)

Track Classification: Electromagnetic Probes
Neutral particle-hadron correlation measurements with the ALICE experiment at the LHC

Tuesday, 7 February 2017 09:30 (20 minutes)

Among the probes used to investigate the properties of the Quark-Gluon Plasma, the measurement of the energy loss of high energy partons can be used to put constraints on energy loss models and to ultimately access medium characteristics (such as energy density or temperature). The study of two particle correlations allows to obtain very different constraints compared to the nuclear modification factor. In particular, the correlation of recoiling charged hadrons with high energy $\pi^0$ or direct photons is believed to give a measure of the parton energy loss and insights of the medium induced modification of the fragmentation process.

High energy neutral pions and photons are reconstructed using the ALICE electromagnetic calorimeter EMCal and the charged particles are detected by ALICE main tracking detectors ITS and TPC.

In this talk, we will present the measurements of azimuthal $\pi^0$-hadron correlations in pp and Pb-Pb collisions along with the extracted per-trigger yield modification factor ($I_{AA}$) as well as comparisons with models. The status of the isolated $\gamma$-hadron correlations and $\pi^0$ elliptic flow measurements will also be presented.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: VAUTHIER, Astrid (Centre National de la Recherche Scientifique (FR))

Presenter: VAUTHIER, Astrid (Centre National de la Recherche Scientifique (FR))

Session Classification: Parallel Session 1.3: Electromagnetic Probes (I)

Track Classification: Jets and High pT Hadrons
Hydrodynamic fluctuations in Pb+Pb collisions at LHC

Wednesday, 8 February 2017 11:40 (20 minutes)

Fluctuations have been playing an important role in understanding observables in high-energy nuclear collisions. It is well known that higher harmonics of azimuthal angle distribution, for example, can be attributed to initial fluctuations of transverse profile from event to event. In this presentation, we focus on thermal fluctuations during hydrodynamic evolution of the system in the intermediate stage of the reactions. These fluctuations are also known as hydrodynamic fluctuations and are indispensable for the system to be stabilized in a thermodynamic sense through fluctuation-dissipation theorem 1.

We employ a cutting-edge integrated dynamical model [2,3] which combines fully (3+1)-dimensional relativistic fluctuating hydrodynamics with Monte-Carlo version of the Glauber model as an event-by-event initialization model of the hydrodynamic fields and the hadronic cascade model in the late stage. By using this model, we first adjust initial parameters and transport coefficients to reproduce $dN_{ch}/d\eta$ and centrality dependence of integrated $v_2$ in Pb+Pb collisions at the LHC energy. We then analyze the event-plane correlations between two different rapidity regions $r_\eta(a,\eta^b)$ and between two different $p_T$-regions $r_{p_T}(p^a_T,p^b_T)$. By switching on and off hydrodynamic fluctuations, we quantify the effect of them on these observables.

References

Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary author: SAKAI, Azumi
Presenter: SAKAI, Azumi
Session Classification: Parallel Session 6.2: Correlations and Fluctuations (I)
Track Classification: Correlations and Fluctuations
**D⁰ measurements in pp and Pb–Pb collisions at √s_{NN}=5.02~TeV with ALICE at the LHC**

Heavy quarks (charm and beauty) are effective probes of the QCD matter formed in high-energy nuclear collisions. They are produced in hard partonic scattering processes occurring in the initial stage of the collisions, propagate through the medium and interact with its constituents. Therefore, they probe the entire evolution of the system.

The study of their production in pp collisions provides a test of perturbative QCD (pQCD) calculations at the LHC energies. Moreover, these measurements constitute a reference for the study of nuclear matter effects on heavy quarks in Pb–Pb collisions, where a Quark-Gluon Plasma (QGP) is produced.

In this contribution we present the D-meson production cross sections measured with ALICE at the LHC, via the reconstruction of the D⁰ → K⁻π⁺ in pp collisions at √s = 5.02–TeV. The p_T-differential cross sections will be compared with previous measurements at √s = 2.76, 7 and 8–TeV and with pQCD calculations. The status of the analysis in Pb–Pb collisions at √s_{NN} = 5.02–TeV will be discussed.

**Preferred Track**

Open Heavy Flavors

**Collaboration**

ALICE

**Primary author:** TERREVOLI, Cristina (Università e INFN, Padova (IT))

**Presenter:** TERREVOLI, Cristina (Università e INFN, Padova (IT))

**Session Classification:** Poster Session
Effect of baryon-antibaryon annihilation on thermal model fit to extract chemical freeze-out parameters

Hadron yields obtained from elementary collisions up to heavy-ions have been successfully described by thermal models with a few parameters such as temperature and baryon chemical potential [1, 2]. However, the LHC/ALICE experiment has recently found that the proton and antiproton yields are a factor of 2 too low compared to thermal description [3]. This has been shown to arise from baryon-antibaryon ($\bar{B}B$) annihilations which can still be appreciable after chemical freeze-out because of their large cross-sections while the reverse reactions of multi-particles fusing into a $\bar{B}B$ pair cannot be sustained [4]. In this study, we include the $\bar{B}B$ annihilation effect into the thermal model [5] by introducing one more parameter for the out-of-equilibrium annihilation loss of the protons. We use the quark model description for the annihilation losses of the other (anti-)baryons. We assume annihilation of a $\bar{B}B$ pair produces a certain number of mesons (default 5 pions and kaons depending on the strangeness content) [4, 6]. We fit both heavy-ion data ($\sqrt{s_{NN}} = 6.27$ GeV to 2.76 TeV) and proton-proton collision data ($\sqrt{s_{NN}} = 200, 900, \text{and} 7000$ GeV) at SPS, RHIC and LHC energies. We obtain new chemical freeze-out parameters with significantly improved fit quality in comparison to the default thermal model.

We find that the baryon loss increases with increasing collision energy while the antibaryon loss decreases. We further find a significant increase in the chemical freeze-out temperature compared to the default fit, potentially provoking a rethink of the nuclear phase diagram.

References


Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Not applicable
**Primary author:** Dr DAS, Sabita (Central China Normal University, Wuhan-430079, China)

**Presenter:** Dr DAS, Sabita (Central China Normal University, Wuhan-430079, China)

**Session Classification:** Poster Session
We investigate the response of the QCD ground state at finite temperatures to an anti-parallel electric and magnetic field. Due to the electromagnetic triangle anomaly, both neutral and charged pion condensations are created in the presence of non-vanishing \( \mathbf{E} \cdot \mathbf{B} \).

In the frame of the proper-time Schwinger formalism, we addressed the oscillation obstacle because of the electric field by transforming the integrand into the Bessel function. Apparently convergent results are exhibited for the chiral symmetry breaking and its associated restore temperature as a function of the strength of fields, described by the Nambu–Jona-Lasinio model.

To mimic the effect of chiral anomaly, we thus introduce a chiral chemical potential for comparing. We find out that only a charged pion condensate is produced within non-zero \( \mu_5 \), which slightly differs with the above electromagnetic environment.

**Preferred Track**

New Theoretical Developments

**Collaboration**

Not applicable

**Primary author:** Ms CHAO, Jingyi (Institute of Modern Physics, CAS)

**Presenter:** Ms CHAO, Jingyi (Institute of Modern Physics, CAS)

**Session Classification:** Poster Session
Measurements of off-diagonal cumulants of net-charge, net-proton and net-kaon distributions at STAR

Study of event-by-event fluctuations of conserved charges, i.e. susceptibilities of conserved charges is a powerful tool to understand and characterize the thermodynamic properties of the hot and dense QCD matter. The ratios of 2nd order off-diagonal to diagonal susceptibilities such as $\chi_{B,S}^{1,1}/\chi_{S}^{2}$, $\chi_{Q,B}^{1,1}/\chi_{B}^{2}$, and $\chi_{Q,S}^{1,1}/\chi_{S}^{2}$, are sensitive to the phase of the matter created in heavy-ion collisions. We report various 2nd order off-diagonal cumulants (i.e, covariances) between net-charge, net-proton and net-kaon along with their ratios to the diagonal cumulants (i.e, variances) as a function of centrality at mid-rapidity in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the STAR experiment at RHIC. These results will help to extract the freeze-out parameters by comparing those with theoretical calculations.

As the fluctuation measurements depend on the phase space acceptances, we have studied the transverse momentum and pseudorapidity window dependences of the cumulants. These results will be presented and discussed.

Preferred Track

Correlations and Fluctuations

Collaboration

STAR

Primary author: CHATTERJEE, Arghya (Variable Energy Cyclotron Centre, Kolkata)

Presenter: CHATTERJEE, Arghya (Variable Energy Cyclotron Centre, Kolkata)

Session Classification: Poster Session
Di-hadron correlations in pp collisions at $\sqrt{s} = 13$ TeV within $|\Delta \eta| \leq 8.4$

Di-hadron correlations in relative azimuthal angle and over large pseudorapidity separations ($\Delta \eta$) recently revealed evidence for collectivity in the small collision systems of pp and p–Pb.

In this analysis we investigate the correlations between tracks in the Inner Tracking System and energy deposition in the Forward Multiplicity Detector (FMD) ($1.7 < \eta < 5$, $-3.4 < \eta < -1.7$). This makes it possible to measure di-hadron correlations over the range of $|\Delta \eta| \leq 8.4$ significantly improving on previously published results.

However, the FMD, which only measures clusters and not tracks, is significantly affected by secondary particles produced by other particles interacting with detector material.

A new correction procedure is developed to extract anisotropic flow coefficients in the presence of large numbers of such secondary particles.

**Preferred Track**

Correlations and Fluctuations

**Collaboration**

ALICE

**Primary author:** BOURJAU, Christian (University of Copenhagen (DK))

**Presenter:** BOURJAU, Christian (University of Copenhagen (DK))

**Session Classification:** Poster Session
Event activity-dependence of jet production in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV measured with semi-inclusive hadron+jet correlations by ALICE

Tuesday, 7 February 2017 08:30 (20 minutes)

We report measurement of the semi-inclusive distribution of charged-particle jets recoiling from a high transverse momentum ($p_T$) hadron trigger, for p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV that have been classified by event activity. This coincidence observable is calculable perturbatively in vacuum, and has previously been measured in pp and Pb–Pb collisions at the LHC, providing a new probe to measure quenching. Jets are reconstructed from charged particle tracks using the anti-kt algorithm with low IR cutoff of jet constituents ($p_{T\text{track}} > 0.2$ GeV/c). The analysis applies a data-driven statistical approach to correct the complex uncorrelated jet background, including multi-partonic interactions. Recoil jet distributions are reported for $15 < p_{T\text{jet}} < 50$ GeV/c, for $R=0.2$ and 0.4. Events are classified by signal in the ALICE V0A detector, which measures forward multiplicity, and ZNA, which measures the number of neutrons at zero degrees. The semi-inclusive observable corresponds to the ratio of inclusive cross sections, $d\sigma_{h\text{TRIG}+\text{jet}}/d\sigma_{h\text{TRIG}}$, and comparison of the recoil jet yield in p–Pb collisions with different event activity therefore does not require knowledge of $T_{pPb}$, thereby avoiding the need for geometric modelling. We compare the trigger-normalized recoil jet yield for p–Pb collisions with different event activity to measure the effects of jet quenching in small systems at the LHC.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ALICE

Primary author: KRIZEK, Filip (Acad. of Sciences of the Czech Rep. (CZ))

Presenter: KRIZEK, Filip (Acad. of Sciences of the Czech Rep. (CZ))

Session Classification: Parallel Session 1.2: QCD in Small Systems (I)

Track Classification: Jets and High $p_T$ Hadrons
Measurements of charged jet spectra in pp and PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE

Jets originate from hard scattered partons at the initial stage of collisions. In heavy ion collisions, jets are sensitive to medium effects on the partons traversing the QGP and probe the properties of the hot and dense strongly interacting matter. Measurements of the jet nuclear modification factor ($R_{AA}$) and its centrality dependence with different choices of the jet resolution parameter $R$ are sensitive to the partonic energy loss and probe medium-induced modifications of the jet structure. To quantify these effects in Pb-Pb collisions, the measurement of a pp baseline at the same centre-of-mass energy is crucial.

In this contribution, we will present charged jet spectra in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV and charged jet cross section in pp collisions at $\sqrt{s} = 5.02$ TeV measured with the ALICE detector at the LHC. The pp measurements will be compared to pQCD calculations at NLO accuracy. The cone radius dependence and the dependence on the leading constituent bias of the Pb-Pb spectra will be discussed. The nuclear modification factor $R_{AA}$ and $R_{CP}$ will be compared to similar measurements at $\sqrt{s_{NN}} = 2.76$ TeV.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ALICE

Primary author:  HOSOKAWA, Ritsuya (University of Tsukuba (JP))
Presenter:  HOSOKAWA, Ritsuya (University of Tsukuba (JP))
Session Classification:  Poster Session
Topology and axion’s properties from lattice QCD with a dynamical charm

Wednesday, 8 February 2017 12:00 (20 minutes)

We study QCD for temperatures up to about 500 MeV using the lattice approach. We include two generations of dynamical quarks, with physical strange and charm masses, which are known to be relevant in the explored temperature range. Our lattice discretization - Wilson quarks with a twisted mass term - has good chiral properties at a moderate computational cost. The main focus is the measure of the topological susceptibility, which on one side helps understanding fundamental properties of the quark-gluon plasma, on the other constrains properties of the axion, one serious candidate for dark matter. We contrast and compare the results from several methods for the measurements of the topological susceptibility, and discuss the perspectives towards controlled results in the continuum limit for physical quark masses, and implications for the axions’ search.

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary author: LOMBARDO, Maria Paola (INFN)
Presenter: LOMBARDO, Maria Paola (INFN)
Session Classification: Parallel Session 6.3: New Theoretical Developments (II)
Track Classification: QCD at High Temperature
Event-by-event study of charge separation in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the ALICE experiment

Kharzeev et al. proposed strong P and CP violation in the hot dense matter created in non-central heavy-ion collisions. The strong magnetic field ($B \sim 10^{15}$ T) induces a separation of electric charge along the direction of the magnetic field resulting in the Chiral Magnetic Effect (CME). This effect has been experimentally observed by the ALICE experiment for Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV via multi-particle correlators. We will present an event-by-event study of the localized charge separation effect in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV using the Sliding Dumbbell Method (SDM) which is similar to the Sliding Window Method (SWM) used for neutral-charged fluctuations in Pb-Pb collisions at 158 A GeV at the SPS. In this method, we are calculating the fraction $D_{b_{+}}$, which is the sum of the positive charge fraction on the left side of the dumbbell and the negative charge fraction on the right side of the dumbbell. The whole azimuthal plane is scanned by sliding a dumbbell of size $\Delta \phi = 90^\circ$ in steps of $\phi = 1^\circ$ and calculating $D_{b_{+}}$ for each $\Delta \phi$ region to extract the maximum value of $D_{b_{+}}$ in each event. $D_{b_{+}}$ distributions obtained using the SDM are compared with those of randomly selected dumbbells in each event. The results are presented for different dumbbell sizes of $\Delta \phi = 90^\circ$, $60^\circ$, and $40^\circ$.


Preferred Track
Correlations and Fluctuations

Collaboration
ALICE

Primary author: Ms PARMAR, Sonia (Panjab University (IN))
Presenter: Ms PARMAR, Sonia (Panjab University (IN))
Session Classification: Poster Session
D-tagged jet measurements in p-Pb collisions in ALICE

Heavy charm quarks are produced dominantly in the initial stage of high-energy heavy-ion collisions. They take part in the whole evolution of the medium, interact with the produced Quark-Gluon Plasma (QGP) and lose energy due to collisional and radiative processes. Therefore, they serve as unique probes of the QGP transport properties. Charm quarks can be studied by measuring D mesons that originate from the charm-quark fragmentation. Furthermore, identifying the charm-jets (with D-meson tagging) gives additional information about the energy-loss distribution in the medium. In order to disentangle effects related to the presence of the hot and dense medium, measurements in elementary pp and in p–A collisions are needed. In addition to the charm-jet transverse momentum spectrum, an important observable is the charm fragmentation function (fraction of the jet momentum carried by D mesons), which is still not fully understood even in pp collisions, and provides important constraint for Monte-Carlo event generators. The study of possible charm-jet modifications in p–Pb collisions is an important intermediate step between pp and Pb–Pb collisions that complements the simple pp vacuum case and the heavy-ion case with interplay of many different effects.

D mesons are identified via their hadronic decay channels using information from the ALICE Inner Tracking System to reconstruct decay topologies displaced with respect to the collision primary vertex. The ALICE Time Projection Chamber is used for the tracking and the hadron identification, the hadron selection being improved with the Time Of Flight detector. Charged jets containing D mesons are reconstructed with the anti-$k_T$ algorithm.

In this poster, we will show the status of the D-tagged jets analysis in p–Pb minimum-bias collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV. We will also present the prospects of the analysis with the new dataset to be gathered in the upcoming 2016 p–Pb run at $\sqrt{s_{\text{NN}}} = 5.02$ and 8 TeV. Both the charm-jet transverse momentum spectrum and the charm fragmentation function are studied.

Preferred Track

Open Heavy Flavors

Collaboration

ALICE

Primary author: TRZECIAK, Barbara Antonina (Utrecht University)

Presenter: TRZECIAK, Barbara Antonina (Utrecht University)

Session Classification: Poster Session
Collision Energy and Centrality Dependence of $\phi$-Meson Spin Alignment

Chirality is the only fundamental symmetry in the nuclear matter. The study of the vorticity and possible chiral vortical effect allows us to access this fundamental property of the hot and dense nuclear matter created in high-energy nuclear collisions, especially at the high baryon density region. Global polarization parameters of identified particles can be extracted from the azimuthal distribution of particles relative to the event plane. Recently, STAR has reported global polarization measurement of $\Lambda$-baryons ($J = 1/2$).

The spin alignment of $\phi$-meson ($J = 1$) could be sensitive to hadronization scenarios and possible vorticity of the colliding system. In this talk, a systematic measurement of $\phi$-meson spin alignment parameters from RHIC-STAR detector will be presented in Au+Au collisions at $\sqrt{s_{NN}} = 19.6, 27, 39, 62.4$ and 200 GeV. The beam energy and collision centrality dependence of spin alignment parameters will be discussed in association with the possible vorticity of the collision system.

Preferred Track
Correlations and Fluctuations

Collaboration
STAR

Primary author: SUN, Xu (Central China Normal University)
Presenter: SUN, Xu (Central China Normal University)
Session Classification: Poster Session
Multiplicity fluctuations and collective flow in small colliding systems

Tuesday, 7 February 2017 12:00 (20 minutes)

Recent observation of collective-flow-like behaviors in small colliding systems attracts significant theoretical and experimental interests. In large colliding systems, large collective flow has been interpreted as manifestation of almost-perfect fluidity of the quark gluon plasma (QGP). So it is quite intriguing to explore how small the QGP can behave as a fluid.

In this presentation, we newly develop an initialization model for hydrodynamic simulations by combining a Monte-Carlo version of the Glauber model (MC-Glauber) with an event generator PYTHIA. We further implement this model into an integrated dynamical framework which is based on fully three-dimensional ideal hydrodynamic description of the QGP fluid and kinetic description of the hadron gas. Using this new version of integrated dynamical model, we analyze multiplicity fluctuations and collective flow in small colliding systems at RHIC and LHC energies.

Multiplicity fluctuations play a crucial role in centrality definition of the events in small colliding systems since the fluctuations are, in general, more important as the system size is getting smaller. To consider the correct multiplicity fluctuations, we employ PYTHIA which naturally describes multiplicity distribution in p+p collisions. We superpose p+p collisions by taking into account the number of participants and that of binary collisions from MC-Glauber and evaluate initial entropy density distributions which contain not only multiplicity fluctuations but also fluctuations of longitudinal profiles. Solving hydrodynamic equations followed by the hadronic afterburner, we calculate $p_T$-spectra, elliptic ($v_2$) and triangular ($v_3$) flow in p+Au, d+Au and $^3$He+Au collisions at the RHIC energy and p+Pb collisions at the LHC energy. Although a large fraction of final $p_T$-integrated $v_2$ and $v_3$ comes from the fluid-dynamical stage, the effects of hadronic rescatterings turn out to be also important as well in understanding of the flow data in small colliding systems.

Reference
1 T. Hirano, P. Huovinen, K. Murase and Y. Nara,
“Integrated Dynamical Approach to Relativistic Heavy Ion Collisions,”

Preferred Track

QCD in small systems

Collaboration

Not applicable

Primary author: KAWAGUCHI, Koji
Presenter: KAWAGUCHI, Koji
Session Classification: Parallel Session 2.2: QCD in Small Systems (II)

Track Classification: QCD in small systems
Separating prompt and non-prompt contributions in the dielectron mass spectrum in pp collisions at $\sqrt{s} = 7$ TeV with ALICE

Dileptons are a prime probe of the deconfined state of strongly interacting matter, the Quark Gluon Plasma (QGP), produced in high energy heavy ion collisions, as they are not affected by secondary hard interactions. A measurement of the thermal radiation from the QGP in the dielectron intermediate mass region allows to estimate the medium temperature. In this region the main component of the dielectron continuum is due to correlated semi-leptonic decays of B- and D-mesons. The proper decay length for B-mesons is $c\tau \approx 500 \, \mu m$ and for D-mesons it is 100-300 $\mu m$, hence the reconstructed decay electrons do not point to the primary vertex of the collision.

Combining the measured distance of closest approach ($DCA$) of each single electron into a pair variable $DCA_{ee}$ gives the possibility to separate prompt and non-prompt dielectron pairs.

The analysis in pp collisions allows to study the feasibility of extracting the heavy-quark production with the current Inner Tracking System detector of ALICE and provides a reference for Pb–Pb collisions. In this poster, preliminary results on the $DCA_{ee}$ spectra in pp collisions at $\sqrt{s} = 7$ TeV will be shown and compared to reference distributions from MC simulations.

Preferred Track
Electromagnetic Probes

Collaboration
ALICE

Primary author: SCHEID, Horst Sebastian (Johann-Wolfgang-Goethe Univ. (DE))
Presenter: SCHEID, Horst Sebastian (Johann-Wolfgang-Goethe Univ. (DE))
Session Classification: Poster Session
An effective field theory for QCD thermodynamics

Tuesday, 7 February 2017 14:20 (20 minutes)

We develop an effective field theory for QCD at finite temperature which takes into account the
global symmetries of the problem, including the fact that Lorentz invariance is broken. We discuss
regularization and fixing of parameters in the theory. Some of the predictions of the theory are
presented, for example the curvature of the critical line. The degree of agreement between the
predictions and lattice results shows both that such an approach captures much of the essential
physics, and could be useful to discover the nature of the major remaining corrections.

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary author: Prof. GUPTA, Sourendu (TIFR, Mumbai)
Presenter: Prof. GUPTA, Sourendu (TIFR, Mumbai)
Session Classification: Parallel Session 3.1: QCD at High Temperature
Track Classification: QCD at High Temperature
Production of identified and unidentified charged hadrons in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV

Wednesday, 8 February 2017 16:50 (20 minutes)

In late 2015, the ALICE collaboration recorded data from Pb-Pb collisions at the unprecedented energy of $\sqrt{s_{NN}} = 5.02$ TeV as well as reference data from pp collisions at the same energy. The $p_T$-spectra of unidentified charged hadrons as well as of pions, kaons, protons, $\Lambda$, $\Xi$, $\Omega$, resonances and light (anti-)nuclei are presented. Hydrodynamic and recombination models are tested against the measured spectral shapes at low and intermediate transverse momenta. A systematic study of strangeness production is of fundamental importance for determining the thermal properties of the medium created in heavy-ion collisions. The $p_T$-integrated particle yields are compared to predictions from thermal-statistical models and the evolution of the particle ratios as a function of collision energy and centrality is discussed.

For the study of energy loss mechanisms in the QCD medium at high transverse momenta, the nuclear modification factors $R_{AA}$ are computed and compared with model expectations.

Preferred Track

Collective Dynamics

Collaboration

ALICE

Primary author: JACAZIO, Nicolo (Universita e INFN, Bologna (IT))

Presenter: JACAZIO, Nicolo (Universita e INFN, Bologna (IT))

Session Classification: Parallel Session 8.3: Collective Dynamics (III)

Track Classification: Collective Dynamics
Unified description of \( p_T \) dependent Upsilon suppression in hot QCD matter

Bottomonium are produced in the heavy ion collisions and their production is modified compared with elementary collisions. This modification in the production of bottomonia happens due to the presence of hot and dense QCD matter, named as quark-gluon plasma (QGP) formed in ultra relativistic heavy ion collisions. We present here a comprehensive model based on color screening, collisional damping due to exchange of soft gluons between the \( bb \) pair and gluonic dissociation caused by absorption of gluon which led \( bb \) pair transition from color singlet to color octet state. We have also taken cold nuclear matter effect, mainly shadowing effect, in our consideration as it modifies the quarkonia production in heavy ion collisions. We employ the above model to analyze the data on Upsilon suppression measured in terms of nuclear modification factor, \( R_{AA} \) versus transverse momentum, \( p_T \), and centrality obtained from Pb+Pb collisions at \( \sqrt{s_{NN}} = 2.76 \) TeV LHC energy. We find that our model describes the LHC data reasonably well.

Preferred Track

Quarkonia

Collaboration

Not applicable

Primary author: Mr SINGH, CAPTAIN R. (BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE)

Presenter: Mr SINGH, CAPTAIN R. (BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE)

Session Classification: Poster Session
Multiplicity dependence of identified particle production in proton-proton collisions with ALICE

Tuesday, 7 February 2017 09:50 (20 minutes)

The study of identified particle production as a function of the proton-proton (pp) collision energy and multiplicity is a key tool for understanding similarities and differences between small and large interacting systems. We report on the production of pions, kaons, protons, $K^0_S$, $\Lambda$, $\Xi$, $\Omega$, $K^0$ and $\phi$ measured in pp collisions for $\sqrt{s}$ ranging from 0.9 to 13 TeV.

The multiplicity dependence of identified particle spectra and yields is presented for $\sqrt{s} = 7$ and 13 TeV and compared to results obtained in proton-lead (p-Pb) and lead-lead (Pb-Pb) collisions, unveiling remarkable and intriguing similarities among systems and energies. The production rates of strange hadrons are observed to increase more than those of non-strange particles, showing an enhancement pattern with multiplicity which does not depend on the collision energy.

Even if the multiplicity dependence of spectral shapes can be qualitatively described by commonly-used Monte Carlo event generators, the evolution of integrated yield ratios is poorly described by these models. Finally, these results will also be compared to expectations from hydrodynamics.

Preferred Track

QCD in small systems

Collaboration

ALICE

Primary author: VISLAVICIUS, Vytautas (Lund University (SE))

Presenter: VISLAVICIUS, Vytautas (Lund University (SE))

Session Classification: Parallel Session 1.2: QCD in Small Systems (I)

Track Classification: QCD in small systems
Particle-yield modification in jet-like azimuthal di-hadron correlations with respect to the event-plane in Pb-Pb collisions at $\sqrt{s_{NN}}=2.76$TeV measured by ALICE at the LHC

Heavy nuclei colliding at ultra-relativistic energies at the Large Hadron Collider (LHC) produce a hot and dense state of matter filled with deconfined quarks and gluons. Particles produced by hard-scatterings interact with the hot and dense medium as they propagate through it, in a process known as jet quenching.

The medium-induced modification of the jet-like particle yield can be quantified in azimuthal di-hadron correlations with the observable $I_{AA}$, which is the ratio of the jet peak yield in Pb–Pb collisions to pp collisions. The path-length dependence of the jet modification is investigated by studying $I_{AA}$ as a function of the relative angle between the trigger particle and the event plane. Results are shown as a function of centrality and transverse momentum of the associated particles for Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, and compared to AMPT model calculations.

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: KIM, Hyeonjoong (Yonsei University (KR))

Presenter: KIM, Hyeonjoong (Yonsei University (KR))

Session Classification: Poster Session
Choice of moment and derivation of anisotropic dissipative fluid dynamics

Wednesday, 8 February 2017 15:20 (20 minutes)

We present a derivation of anisotropic dissipative fluid dynamics from the moments of the Boltzmann equation based on an expansion around an arbitrary anisotropic single-particle distribution function 1. We construct such an expansion in terms of polynomials in energy and momentum in the direction of the anisotropy and of irreducible tensors in the two-dimensional momentum space orthogonal to both the fluid velocity and the direction of the anisotropy. From the Boltzmann equation we then derive the set of equations of motion for the irreducible moments of the deviation of the single-particle distribution function from the anisotropic distribution. Truncating this set via the 14-moment approximation, we obtain the equations of motion of anisotropic dissipative fluid dynamics. We further consider a particular choice for the anisotropic distribution function and the boost-invariant expansion of a fluid in one dimension, neglecting deviations from the chosen distribution function 2. In order to close the conservation equations, we need to select in addition a particular moment of the Boltzmann equation. We discuss the influence of the choice of this moment on the time evolution of fluid-dynamical variables and identify the moment that provides the best match of anisotropic fluid dynamics to the solution of the Boltzmann equation in the relaxation-time approximation.


Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary authors: Dr MOLNAR, Etele (Johann Wolfgang Goethe-Universität); NIEMI, Harri
Presenter: NIEMI, Harri
Session Classification: Parallel Session 7.3: Collective Dynamics (II)
Track Classification: Initial State Physics and Approach to Equilibrium
Heavy vs. light flavor jet quenching, flow, thermalization and $D$-hadron correlations from RHIC to the LHC energies

Tuesday, 7 February 2017 18:10 (20 minutes)

Hard hadrons, including heavy flavor and high $p_T$ light flavor hadrons, serve as valuable probes of the quark-gluon plasma (QGP) matter produced in relativistic heavy-ion collisions. We establish a Linear Boltzmann Transport (LBT) coupled to (3+1)-D viscous hydrodynamic model that simultaneously describes the temporal evolution of both heavy and light partons inside QGP on the same footing. Both quasi-elastic and inelastic processes are included in our LBT model for parton energy loss in the de-confined QCD medium. On the freeze-out hypersurface, the hadronization of hard partons into their corresponding color neutral bound states is calculated utilizing our hybrid fragmentation plus jet-thermal coalescence model.

Within this newly developed framework, we demonstrate that while quasi-elastic scattering leads to linear increase of parton energy loss with respect to time and is important at early time, inelastic scattering results in quadratic increase of energy loss at early time but then saturates to linear increase and dominates parton evolution at later time. With proper incorporation of the temperature and energy dependences of parton-medium interaction, we simultaneously describe heavy ($D$ and $B$ mesons) and light flavor (charged hadron) suppression, 2nd and 3rd order harmonic flows for all centrality bins and all collision energies as observed from RHIC to the LHC experiments. The temperature and momentum dependences of the jet transport coefficient ($q$) extracted from our model to data comparison are consistent with the range previously constrained by the JET Collaboration. While $\Delta E_D > \Delta E_\pi > \Delta E_\pi > \Delta E_B$ holds in our framework, we show that such flavor hierarchy in $R_{AA}$ at hadron level can be modified due to the combinatory effect of initial momentum spectra, parton energy loss and fragmentation functions.

We also perform a systematic comparison for the 2nd and 3rd order harmonic flows of heavy vs. light flavor hadrons, from which the degree of heavy quark thermalization inside QGP is investigated as functions of centrality and colliding energy. $D$-hadron and $\pi$-hadron correlation functions are studied for the first time as well and shown to be a good observable to quantify not only the thermalization degree of heavy quarks but also the medium response to the energy deposited by hard probe particles. Comparisons between our predictions and future measurements are expected to provide better insights of the interaction dynamics between hard partons and the QGP.


Preferred Track
Open Heavy Flavors
Collaboration

Not applicable

Primary authors:  QIN, Guang-You (Central China Normal University);  CAO, Shanshan (Wayne State University);  WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Presenter:  CAO, Shanshan (Wayne State University)

Session Classification:  Parallel Session 4.4: Open Heavy Flavors (I)

Track Classification:  Open Heavy Flavors
Magnetic moment and excited states of single heavy baryons using Martin like potential in relativistic Dirac formalism

Recently, many singly heavy baryons have been established in experimental facilities like CLEO, Belle, BABAR, LHCb as well as in Lattice QCD. The description of baryons within the constituent quark model is a very important problem in QCD. Various quark models suggest that all baryons are made of three quarks bounded by strong interactions. Our relativistic quark model gives special emphasis to the construction of the three quark interaction within the Baryon. Here, we have computed the mass spectra of single heavy baryons using Martin-like potential in Dirac relativistic formalism. Electromagnetic properties of baryons are an important source of information on their internal structure. The predicted results (mass spectra and magnetic moment) of single heavy baryons are found to be in agreement with available experimental results and also with other theoretical results.

Preferred Track
Open Heavy Flavors

Collaboration
Other

Primary author: SHAH, Manan (PDPIAS, CHARUSAT)
Presenter: SHAH, Manan (PDPIAS, CHARUSAT)
Session Classification: Poster Session
Rapidity correlations in the RHIC Beam Energy Scan.

Tuesday, 7 February 2017 17:30 (20 minutes)

Rapidity correlations in the RHIC Beam Energy Scan.
Sedigheh Jowzaee for the STAR Collaboration
ajowzaee@wayne.edu

A pair-normalized two-particle covariance versus the rapidity of the two particles, called $R_2$, was originally studied in ISR and FNAL data in the 1970’s and has recently seen renewed interest to study the dynamics of heavy-ion collisions in the longitudinal direction. These rapidity correlations can be decomposed onto a basis set of Legendre polynomials with prefactors $\langle a_{mn} \rangle$, which can be considered the rapidity analog of the decomposition of azimuthal anisotropies into a basis set of cosine functions with prefactors $v_n$. The $\langle a_{mn} \rangle$ values have been suggested to be sensitive to the number of sources, baryon stopping, viscosities, and criticality. The rapidity correlations have been measured by the STAR collaboration as a function of the centrality and beam energy in the range of 7.7 to 200 GeV. The experimental results and comparisons to those from the UrQMD model will be presented.


Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

STAR

Primary author: Dr JOWZAEE, Sedigheh (Wayne State University)
Presenter: Dr JOWZAEE, Sedigheh (Wayne State University)
Session Classification: Parallel Session 4.1: Baryon-Rich QCD Matter and Astrophysics (I)
Track Classification: Baryon-Rich QCD Matter and Astrophysics
Jet-hadron and di-hadron correlations in pp and Pb-Pb with studies relative to the event plane at the LHC with ALICE

Tuesday, 7 February 2017 11:20 (20 minutes)

In relativistic heavy-ion collisions at the Large Hadron Collider (LHC), conditions are met to produce a hot, dense and strongly interacting medium known as the Quark Gluon Plasma (QGP). Quarks and gluons from incoming nuclei collide to produce partons at high momenta early in the collision. By fragmenting into collimated sprays of hadrons, these partons form “jets”. Within the framework of perturbative QCD, jet production is well understood in pp collisions and can be used as a baseline reference for comparing to heavy ion collision systems when studying jet quenching. One approach is to measure the azimuthal correlations of a trigger and the associated hadrons in the event. For a jet trigger, these are known as jet-hadron correlations, while a hadron trigger leads to di-hadron correlations. Such correlations are examined in transverse momentum bins of the trigger, transverse momentum bins of the associated hadrons, and studied as a function of collision centrality. The correlations are expected to be sensitive to broadening and softening of the associated recoil jet due to jet quenching. We present azimuthal jet-hadron correlations constructed from a trigger R=0.2 full (charged + neutral) jet, which is correlated with charged hadrons. In an effort to control the path length of the recoil jet and reduce the impact of the background, jets are required to pass a leading constituent cut and are reconstructed using only high energy and momentum constituents. We present the current status of this analysis in Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. To further probe the path length dependence, we will also present Pb-Pb jets relative to the event plane, which include a highly robust and precise background subtraction method to remove the complex, flow dominated, heavy ion background. The jet yields and widths will be presented for the Pb–Pb analyses and compared to our baseline measurements in pp collisions. In addition, yields and widths for di-hadron correlations in Pb-Pb will be presented.

Preferred Track
Jets and High pT Hadrons

Collaboration
ALICE

Primary author: MAZER, Joel Anthony (University of Tennessee (US))
Presenter: MAZER, Joel Anthony (University of Tennessee (US))
Session Classification: Parallel Session 2.4: Jets and High pT Hadrons (II)
Track Classification: Jets and High pT Hadrons
Space-charge distortions in the ALICE TPC in RUN 2

The Time Projection Chamber (TPC) is the main tracking and particle identification detector of the ALICE experiment at the CERN LHC. With the advent of high luminosity data of LHC RUN 2, unexpectedly large local distortions of the drift paths of ionization electrons are observed at the edges of specific readout chambers. These distortions are caused by ions which leak from the amplification region of the readout chambers, leading to local space-charge accumulation in the drift volume of the TPC. A dedicated correction procedure that was initially developed for the high-rate TPC operation in RUN 3 and beyond has been implemented into the current detector calibration framework to correct the distortions with sufficient precision. The observed distortions will be shown as well as results of the investigation of their origin. Moreover, the correction procedure and its performance will be presented.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ALICE

Primary author:  HELLABAR, Ernst (Johann-Wolfgang-Goethe Univ. (DE))
Presenter:  HELLABAR, Ernst (Johann-Wolfgang-Goethe Univ. (DE))
Session Classification:  Poster Session
Exploring jet sub-structure with jet shapes in ALICE

The heavy-ion physics program at the LHC aims at characterizing the high energy density, high temperature, deconfined partonic state of matter called Quark-Gluon Plasma (QGP). High-momentum partons, that then hadronize in jets, are useful tools to study the QGP properties since they are produced via hard scattering processes and they probe the full evolution of the system, losing energy while passing through it.

In particular the characterization of the jet substructure can bring insight on the microscopic nature of modifications induced on these partons by the medium. These modifications can be studied using a set of jet shape observables like the first order radial moment, the jet momentum dispersion, the difference between the leading and sub-leading jet tracks. Moreover measurements of the jet mass will allow for direct experimental access to the virtuality evolution of partons interacting with the medium.

Measurements of these observables in pp or p-Pb collisions will be presented and compared with theoretical calculations, as well as with Monte Carlo generators, providing important tests of QCD in elementary collisions.

We will present final ALICE results on jet shapes in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, in order to investigate possible modifications of the distribution of particles within the jets. In addition, we present new results on jet mass in Pb-Pb collisions. These measurements have been performed using new techniques for background subtraction and a 2D unfolding procedure to correct the shapes to particle level.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: CAFFARI, Davide (CERN)
Presenter: CAFFARI, Davide (CERN)
Session Classification: Parallel Session 3.4: Jets and High pT Hadrons (III)
Track Classification: Jets and High pT Hadrons
Ultra-Peripheral Pb-Pb collisions, in which the two nuclei pass close to each other but at an impact parameter greater than the sum of their radii, provide information about the initial state of nuclei. In particular, heavy vector meson production, where the particle mass sets a hard scale, proceeds in such collisions by photon-gluon interactions, and gives access to nuclear PDFs. The ALICE collaboration has published measurements of UPC J/Psi and psi(2S) production in LHC Run 1 at forward (J/psi) and mid-rapidity, and has obtained a substantially larger data set in 2015 from LHC Run 2, allowing much more detailed studies of the production mechanism to be performed. In particular, the increased energy and more detailed measurements in the forward region in Run 2 give access to significantly lower values of Bjorken-x than in previous studies. In this talk, the latest available results from Run 2 will be given.
Kaon femtoscopy in Au+Au collisions at the energy from 7.7 to 200~GeV with the STAR experiment

Femtoscopy allows us to measure the space-time characteristics of the system at the moment of particle emission using two-particle correlations. In comparison to the most abundant pions, kaons provide a cleaner probe as they are less affected by resonance decays. Since kaons contain strange quarks and have smaller cross section with hadronic matter than pions, they may be sensitive to different effects and earlier collision stages. In particular, these measurements are of interest with the data from RHIC Beam Energy Scan (BES).

In this talk, we will present the STAR preliminary results on femtoscopic correlations of like-sign and unlike-sign kaons from high-statistics dataset of Au+Au collisions at $\sqrt{s_{NN}}=200$~GeV and Au+Au collisions from BES. The kaon source radii for 200~GeV are compared to those for pions and the Blast-Wave model predictions. The common $m_T$-scaling for pions and kaons would be an indication of the simultaneous thermal freeze-out. The $m_T$-scaling breaking is observed for both 1D and 3D femtoscopic analyses. Such behavior can be interpreted as earlier decoupling of kaons compared with pions.

Moreover, the system of unlike-sign kaons contains $\phi(1020)$ resonance which exhibits high sensitivity. Systematic measurements in the region of resonance are able to provide complementary information about the source-size and can serve as a test of femtoscopic formalism which was developed for measurement at low relative momenta. Experimental results indicate a breakdown of the formalism in the region of the resonance in peripheral collisions. The measured unlike-sign correlation functions are compared to the Lednicky final state interaction model which includes the treatment of the resonance decay.

Finally, the technique of decomposition of the experimental 3D correlation function into the spherical harmonics are used to study the possible difference between positive and negative kaon sources at the BES collision energies.

Preferred Track

Correlations and Fluctuations

Collaboration

STAR
Primary author: LIDRYCH, Jindřich (Czech Technical University in Prague)
Presenter: LIDRYCH, Jindřich (Czech Technical University in Prague)
Session Classification: Poster Session
Investigating the role of coherence effects on jet quenching in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV using the Nsubjettiness jet shape by ALICE

We report measurements of two jet shapes, the ratio of 2-Subjettiness to 1-Subjettiness ($\tau_2/\tau_1$) and the opening angle between the two axes of the 2-Subjettiness jet shape which correspond to the axes of the hardest splitting in the jet. Comparison of these two jet shapes in Pb-Pb and pp collisions highlights the role of coherence effects on jet quenching, in the presence of the QGP medium, by separating two-pronged jets from the rest of the jet population. Coherence effects relate to the ability of the medium to resolve a jet’s substructure, which has an impact on the energy loss magnitude and mechanism of the traversing jet. In both collision systems charged jets are found with the anti-$k_t$ algorithm, a resolution parameter of $R = 0.4$ and a constituent cut off of 0.15 GeV. The reclustering algorithm used to obtain the hardest splitting is the exclusive-$k_t$ algorithm. This analysis uses hadron-jet coincidence techniques in Pb-Pb collisions to reject the combinatorial background and further corrects for background effects by employing various jet shape subtraction techniques and unfolding. Measurements of the Nsubjettiness for jet momenta of $20 - 60$ GeV/c in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV and pp collisions at $\sqrt{s} = 7.00$ TeV will be presented and compared to PYTHIA simulations.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: ZARDSHTI, Nima (University of Birmingham (GB))
Presenter: ZARDSHTI, Nima (University of Birmingham (GB))
Session Classification: Parallel Session 6.4: Jets and High pT Hadrons (V)
Track Classification: Jets and High pT Hadrons
ALICE measurements on $\rho^0$ photoproduction in Pb-Pb ultra-peripheral collisions

The powerful photon fluxes of relativistic nuclei provide a possibility to study photonuclear and two-photon interactions in ultra-peripheral collisions (UPC) where the nuclei do not overlap and no strong nuclear interactions occur. Within Vector-meson Dominance Model (VDM), $\rho^0$ contribution prevails in QCD photon structure function and gamma+A -> $\rho^0$ +A process in heavy-ion UPC is a tool to test, so-called, black disk regime where the target nuclei appears like a black disk and the total $\rho^0$ +A cross section reaches its limit. RHIC and first LHC results have deviated from some Glauber+VDM calculations, which thus call for new data. ALICE reports measurements on $\rho^0$ photoproduction cross sections in Pb-Pb UPC with data taken at $\sqrt{s_{NN}}=2.76$ TeV and new measurements with the data taken at $\sqrt{s_{NN}}=5.02$ TeV. The mid-rapidity cross section of coherent $\rho^0$ photoproduction is measured, and it is compared to theoretical models. The measurements are presented for various nuclei breakup scenarios - without electromagnetic dissociation (EMD) of nuclei and with single or mutual EMD as well.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

ALICE

Primary author: HORAK, David (Czech Technical University (CZ))

Presenter: HORAK, David (Czech Technical University (CZ))

Session Classification: Poster Session
Event Plane dependent dihadron azimuthal correlations with event shape engineering in Au+Au collisions at $\sqrt{s_{NN}}=200\text{GeV}$

In heavy-ion collisions, strong interactions occur between hard scattered partons and the Quark Gluon Plasma. Dihadron azimuthal correlations with high $p_T$ trigger particles are a valuable tool to study the interactions between jets and the medium. Previously, it was shown that dihadron azimuthal correlations are expected to depend on the azimuthal angle of trigger particle relative to the event plane. However, in-medium path length can additionally differ in the same multiplicity class because of the evolution of the system, and thus the strength of long-range correlations (flow), is sensitive to fluctuations in the initial geometry. Event shape engineering (ESE) has been proposed as a powerful method to select the events which have different strength of flow.

We present a study of dihadron correlations for different selections of the trigger azimuthal angle with respect to the event plane in Au+Au collisions at $\sqrt{s_{NN}}=200\text{GeV}$ utilizing ESE.

References

1 Adamczyk et al. (STAR Collaboration), Phys. Rev. C. 89(2014) 41901


Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

STAR

Primary author: Mr AOYAMA, Ryo (University of Tsukuba)
Presenter: Mr AOYAMA, Ryo (University of Tsukuba)
Session Classification: Poster Session
Improvements to the T=0 QCD equation of state and rotating neutron star phenomenology

I will discuss recent progress in the determination of the quark matter equation of state (EoS) and its applications to the phenomenology of neutron stars (NSs). The current state-of-the-art matched QCD EoS comes from the work of Kurkela et al. (2014), in which the authors matched chiral effective theory (cEFT) at low densities to pQCD at high densities. Since then, the $T = 0$, massless-quark, pQCD EoS has been improved beyond $\mathcal{O}(g^4)$. I will discuss these improvements, as well as improvements to the phenomenology of NSs. In particular, I will detail NS phenomenology taking rotation into account, something that was not done in the original work of Kurkela et al. 2014).

Preferred Track
Baryon-Rich QCD Matter and Astrophysics

Collaboration
Not applicable

Primary author:  GORDA, Tyler (University of Helsinki)
Presenter:  GORDA, Tyler (University of Helsinki)
Session Classification:  Poster Session
Hybrid approach to relativistic heavy-ion collisions at the RHIC BES energies

Using a hybrid (viscous hydrodynamics + hadronic cascade) framework, we model event-by-event bulk dynamics of relativistic heavy-ion collisions at the Relativistic Heavy Ion Collider (RHIC) Beam Energy Scan (BES) collision energies, including the effects from non-zero net baryon current and its dissipative diffusion during the evolution. This framework is in full (3+1)D, which allows us to study the non-trivial longitudinal structure and dynamics of the collision systems, for example, the baryon stopping and transport, as well as longitudinal fluctuations. We study hadronic chemistry, identified particle spectra, anisotropic flow, and HBT interferometry over the energy range relevant to the RHIC BES. For the first time, quantitative effects of boost-invariance breaking, net-baryon current/diffusion, and pre-equilibrium dynamics on these hadronic observables will be addressed. Finally, flow predictions for recent d+Au collisions at BES energies will be presented within the same framework. They shed new light on understanding the collective nature of small quark-gluon droplets.

Preferred Track

Collective Dynamics

Collaboration

BEST

Primary author: Dr SHEN, Chun (Brookhaven National Laboratory)
Co-author: MONNAI, Akihiko (Institut de Physique Théorique, CNRS/CEA)
Presenter: Dr SHEN, Chun (Brookhaven National Laboratory)
Session Classification: Parallel Session 4.1: Baryon-Rich QCD Matter and Astrophysics (I)
Track Classification: Collective Dynamics
Exploring the hadronic phase of Pb-Pb collisions with resonances

In heavy-ion collisions, measurements of short-lived hadronic resonances can constrain properties of the late hadronic phase, including its lifetime. Along with stable hadrons, resonances are also used to study the flavor dependence of parton energy loss at high transverse momentum and anomalous baryon-to-meson ratios at intermediate momentum. The ALICE detector, which provides excellent tracking and particle identification capabilities, is uniquely suited for reconstructing various resonances in the high-multiplicity environment produced in central heavy-ion collisions at the LHC energies.

The most recent ALICE results on the production of $\mu(770)^0$ and $\Lambda(1520)$ in heavy-ion collisions complement a comprehensive set of resonance measurements including $K^*(892)^0$, $\phi(1020)$ production rates. These results include a detailed study of the $p_T$ spectra, yields, mean transverse momenta and nuclear modification factors of all resonances measured in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. These data are also used to address the issue of the suppression of short-lived resonances in central Pb-Pb collisions and to set limits on the duration of the hadronic phase. The first results on resonance production in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV from run 2 of the LHC will also be presented. Results are discussed and compared to model predictions and earlier measurements at lower collision energies.

Preferred Track
Collective Dynamics

Collaboration
ALICE

Primary author: BELLINI, Francesca (Universita e INFN, Bologna (IT))
Presenter: BELLINI, Francesca (Universita e INFN, Bologna (IT))
Session Classification: Poster Session
Measurement of the $J/\psi$ elliptic flow at mid-rapidity in $\text{Pb-Pb}$ collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV.

$J/\psi$ measurements at $\sqrt{s_{\text{NN}}} = 2.76$ TeV $\text{Pb-Pb}$ collisions clearly show a smaller suppression than the one expected from color screening, when compared to binary-scaled $\text{pp}$ collisions. An answer to this behavior is presented by models containing a regeneration component. In these models a possible (re)combination of (un)correlated $c\bar{c}$-quarks enhances the $J/\psi$ production. Since those $c\bar{c}$-quarks interact with the bulk medium before forming a $J/\psi$, they should be coupled to the medium flow. Hence the measurement of the elliptic flow ($v_2$) for $J/\psi$ imposes strong constraints on the $J/\psi$ production models in high energy $\text{Pb-Pb}$ collisions.

The ALICE experiment at the Large Hadron Collider (LHC) is a unique tool to study $J/\psi$. It is able to measure the $J/\psi \rightarrow e^+e^-$ decay channel at mid-rapidity ($|y| < 0.9$) and down to $p_T = 0$. New preliminary results on the $v_2$ of $J/\psi$ measured in the $e^+e^-$ decay channel with ALICE in $\text{Pb-Pb}$ collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV will be presented.

Preferred Track

Quarkonia

Collaboration

ALICE

Primary author:  DILLENSEGER, Pascal (Johann-Wolfgang-Goethe Univ. (DE))

Presenter:  DILLENSEGER, Pascal (Johann-Wolfgang-Goethe Univ. (DE))

Session Classification:  Poster Session
Coherent very low transverse momentum $e^+e^-$ pair production in hadronic Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and U+U collisions at $\sqrt{s_{NN}} = 193$ GeV at STAR

Dileptons ($l^+l^-$) are produced in all the stages of the heavy-ion collisions, and escape with minimum interaction with the strongly interacting medium. Thus, $l^+l^-$ pair measurements play an essential role in the study of hot and dense nuclear matter, created in heavy-ion collisions. Recently, a significant excess of $J/\psi$ yield at very low transverse momentum ($p_T < 0.3$ GeV/c) was reported by the ALICE 1 and STAR collaborations in peripheral A+A collisions. These observations may point to evidence of coherent photoproduction of $J/\psi$ in violent hadronic interactions while traditionally coherent photoproduction is thought to only exist in ultra-peripheral heavy-ion collisions when the traversing nuclei remain intact. It is interesting to investigate the $e^+e^-$ pair production in a wider invariant mass region ($M_{ee} < 4$ GeV/c$^2$) at very low $p_T$ in heavy-ion collisions for different centrality bins. If the coherent photoproduction mechanism is confirmed, the coherently photoproduced $e^+e^-$ pairs accompanying violent hadronic collisions may provide a novel probe of the hot and dense nuclear matter. In this talk, we will present $e^+e^-$ pair invariant mass spectra in three $p_T$ bins (0-0.15, 0.15-1, and 1-10 GeV/c) and $p_T$ spectra for $p_T < 0.3$ GeV/c in three mass regions (0.4-0.76, 1.2-2.6, and 2.8-3.2 GeV/c$^2$) in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and U+U collisions at $\sqrt{s_{NN}} = 193$ GeV. The structure of $t$ ($t = p_T^2$) distributions of these three mass regions and comparisons with that in ultra-peripheral collisions will be shown. The centrality dependence of these $e^+e^-$ pair measurements will be reported, and physics implications will be discussed.

Quark susceptibilities in a generalized quasiparticle model

The QCD equation of state as predicted by lattice QCD calculations (lQCD) is well reproduced in terms of effective quasiparticle models. These models so far fail to describe the susceptibilities and underestimate the pressure at finite densities. We present a generalised quasiparticle model where the partonic propagators explicitly depend on the three-momentum with respect to the medium. Within this extended model we reproduce simultaneously the equation of state and the susceptibilities as provided by lQCD. We calculate the shear and bulk viscosity as well as the electric conductivity and compared them to default quasiparticle models. We find a good agreement between our model and available lattice data for all transport coefficients.

Preferred Track
QCD at High Temperature

Collaboration
Not applicable

Primary author: STEINERT, Thorsten (JLU Giessen)
Presenter: STEINERT, Thorsten (JLU Giessen)
Session Classification: Poster Session
Charge Asymmetry Measurements in Au+Au collisions by STAR in Search of the Chiral Magnetic Effect

Metastable domains of topological charges in QCD can cause chirality imbalance and, under the strong magnetic field present in heavy-ion collisions, result in charge separation along the magnetic field, a phenomenon called the Chiral Magnetic Effect (CME). Charge separation can also be caused by intrinsic particle correlations coupled with elliptic flow anisotropy, a major background for the CME search. In this talk, we report results by two analysis methods designed to reduce or eliminate, model-independently, background contributions.

In the first method, a correlator $C_p$ is constructed as the ratio of real-event to shuffled-event differences between positive and negative charge distributions of a correlation variable with respect to the event plane. A second correlator $C_{p\text{, perp}}$ is similarly constructed using the particles perpendicular to the event plane. The shape of the double-ratio $C_p/C_{p\text{, perp}}$ is concave for a CME-associated charge asymmetry and flat or convex for all non-CME associated effects. The observation of a concave shape for $C_p/C_{p\text{, perp}}$ in the data confirms the presence of a CME associated charge asymmetry. Quantification of this signal is obtained via comparisons with data driven simulations.

In the second method, correlators are constructed from multiplicity asymmetries of positive and negative particles across the event plane. The same- and opposite-sign difference is studied as a function of the event-by-event anisotropy of the measured particles. A linear dependence is observed in both real and mixed-events. The intercept or the difference between real- and mixed-events measures the charge separation with reduced flow background.

We present the results obtained via these two methods for Au+Au collisions at several collision centralities and beam energies at RHIC. We discuss our results in terms of the CME search.


Preferred Track
Collective Dynamics

Collaboration
STAR
Primary author: AJITANAND, Nuggehalli (State University of New York at Stony Brook)
Presenter: AJITANAND, Nuggehalli (State University of New York at Stony Brook)
Session Classification: Poster Session
Recent results on light nuclei and antinuclei from ALICE at the LHC

The high collision energies reached at the LHC enable significant production rates of light (anti-)nuclei in proton-proton (pp), proton-lead (p-Pb) and in lead-lead (Pb-Pb) collisions.

The excellent particle identification capabilities of the ALICE detector, based on the specific energy loss in the time projection chamber and the velocity information from the time-of-flight detector, are exploited to identify rarely produced particles such as deuterons, 3H, 3He, 4He and their antiparticles, in addition to light hadrons.

We present a comprehensive set of results on the production of light nuclei and anti-nuclei from LHC Run1 and Run2 in all the available collision systems and at various energies, and compare with predictions from thermal (statistical) models and alternatives using coalescence.

Preferred Track
Collective Dynamics

Collaboration
ALICE

Primary author:  TROGOLO, Stefano (Università e INFN Torino (IT))
Presenter:  TROGOLO, Stefano (Università e INFN Torino (IT))
Session Classification:  Poster Session
Time Evolution of Heavy Quarkonium in the Quark-Gluon Plasma from a Stochastic Potential Model

In relativistic heavy ion collisions, the suppression of heavy quarkonia, such as charmonia and bottomonia, is considered as one of the important signals for the formation of a quark-gluon plasma. Understanding the behavior of heavy quarkonia in such hot matter would enable us in turn to extract the properties of the quark-gluon plasma from experimental data. And while lattice QCD studies have made progress in elucidating fully equilibrated quarkonium, our knowledge of its out-of-equilibrium dynamics relevant for heavy-ion collisions remains scarce.

Here we present numerical results for the non-equilibrium real-time evolution of heavy quarkonium states in the quark-gluon plasma based on a recently proposed stochastic potential model [1-3]. The model adds a noise term to the real-valued Debye screened potential term. This noise term explains naturally the complex potential between a heavy quark and a heavy anti-quark, which has been found by both perturbative calculation and lattice calculation, i.e. the imaginary part is related to nontrivial noise correlations. The addition of the noise term to the potential leads to a stochastic Schrödinger equation, which implements unitary time evolution and provides insight on an important mechanism to play a role in the time evolution of a heavy quarkonium: decoherence of the wave function.

We investigate how the quarkonia evolve with the stochastic Schrödinger equation derived from the stochastic potential. In particular, we show the time evolution of the ground and excited states, and how it depends on the temperature of the environment and the correlation length of the noise.

2 A. Rothkopf, JHEP 1404 (2014) 085
Many-body reactions in baryon-antibaryon annihilation including strangeness

We study the impact of baryon-antibaryon annihilation into three mesons on heavy-ion collisions. The reactions are based on the quark rearrangement model in the light and strange sector. Box simulations with periodic boundary conditions confirm that our implementation of these reactions fulfills the detailed balance relation on a channel by channel basis. We implement these reactions into the Parton Hadron String Dynamics (PHSD) transport model and investigate their importance for different bombarding energies in Pb+Pb and Au+Au collisions. We find a significant impact on antibaryons, Kaons and pions through all energies, although the influence at lower energies is more pronounced. The effect of the $B\bar{B} \leftrightarrow 3M$ reactions on the antibaryons rather than the baryons is notable due to the overall lower multiplicities of the antibaryons. For higher energies a significant net annihilation is found.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Not applicable

Primary author: SEIFERT, Eduard (University of Giessen)
Presenter: SEIFERT, Eduard (University of Giessen)
Session Classification: Poster Session
Performance evaluation of Si PAD detector for the ALICE FoCal development

QCD inspired models predict that a saturated gluon state, so called Color Glass Condensate (CGC) is produced in the nucleon and nucleus at very high energy such as at the Large Hadron Collider (LHC). One of the most sensitive and cleanest probes of CGC effect is the production of isolated photon in the forward region ($3 < \eta < 5$) at intermediate $p_T$ (few $GeV/c$).

The ALICE-FoCal group is working on the R&D process to develop an electromagnetic calorimeter (FoCal-E) which has capability to measure such photons. The final design of FoCal-E consists of low granularity layers (LGL) with silicon pad readout and high-granularity (HGL) layers with Monolithic Active Pixel Sensors. The Nara-W and Tsukuba groups have worked on the R&D of Si PAD detectors, using a prototype consisting of 20 layers of silicon and tungsten with a 64 PAD ($8 \times 8$) per layer with a granularity of $1 \times 1 cm^2$. The main task of the PAD sensors is the energy measurement.

In September 2016, a successful beam test experiment at CERN SPS accelerator with FoCal prototype has been performed.

In this beam test, we used new readout module (Summing Board) which has larger dynamic range compared with last beam test. It enabled us to take the data of higher beam energy (~130 GeV) this time. Moreover, collected data with simultaneous LGL and HGL readout.

In this poster, we would like to report these results and discuss about the future plan of FoCal-E.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ALICE

Primary author: SAKAMOTO, Tomoko (Nara Women’s University (JP))
Presenter: SAKAMOTO, Tomoko (Nara Women’s University (JP))
Session Classification: Poster Session
Effects of rho-meson width on pion distributions and anisotropies in heavy-ion collisions

We study the influence of the finite width of rho meson on the pion momentum distributions and anisotropies. We evaluate the rho-meson properties in the S-matrix framework, and implement them in the hydrodynamical description of the expansion dynamics.

We show that the proper treatment of rho mesons modifies the spectrum of daughter particles, and thus the final observable distributions 1. In particular the yield of pions at low p_T increases, which improves the description of the pion spectrum obtained in the heavy-ion experiments.


Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: HUOVINEN, Pasi (University of Wroclaw)
Presenter: HUOVINEN, Pasi (University of Wroclaw)
Session Classification: Poster Session
EoSization in non-conformal holgraphic shockwave collisions

Understanding the properties of extreme phases of nuclear matter created in relativistic heavy ion collisions is one of the major challenges in theoretical physics. A question that is central to the understanding of the very early stages of such collisions near the cross-over temperature of QCD is: How do non-conformal properties affect the resulting plasma? In this presentation we address this problem in a strongly coupled setup via the gauge/gravity duality by utilizing numerical relativity techniques to describe black hole formation in the gravity side. This allows to access real-time dependent non-equilibrium dynamical quantities like pressure gradients and bulk viscosity. We observe that the equation of state is not obeyed out of equilibrium. We do a systematic explore when the equation of state is applicable again - and will coin this time-scale the EoSization time. The scan in temperature with varying non-conformality shows that EoSization before hydrodynamization can actually happen with only a slight amount of bulk viscosity.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: ATTEMS, maximilian (University of Barcelona)
Presenter: ATTEMS, maximilian (University of Barcelona)
Session Classification: Poster Session
Di-hadron back-to-back correlations in p+p and p+Au collisions at STAR

Our understanding of proton structure and of nuclear interactions at high energy would be advanced significantly with the definitive discovery of the gluon saturation regime. Forward particle production in hadron collisions at RHIC probes gluons at small x where gluon density is high and expected to reach the saturation regime. Until today the golden channel at RHIC to observe strong hints of saturation has been the azimuthal angular correlation between two back-to-back particles produced in p(d)+nucleus collisions. These correlations test the underlying QCD dynamics of the quark-gluon scattering that dominates at forward rapidity. During the 2015 RHIC run, STAR has collected data for di-hadron correlations of neutral pion production at forward pseudo-rapidity (eta=2.6 to 4.0) using its electromagnetic calorimeter in p+p, p+Au and p+Al collisions at √sNN=200GeV. New results from those data will be presented.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

STAR

Primary author: OGAWA, akio (BNL)
Presenter: OGAWA, akio (BNL)
Session Classification: Parallel Session 5.2: Initial State Physics and Approach to Equilibrium (III)
Track Classification: Initial State Physics and Approach to Equilibrium
The onset of fluid-dynamical behavior in relativistic kinetic theory

Relativistic hydrodynamics is the main theoretical framework used to describe the quark-gluon plasma produced in ultra-relativistic heavy ion collisions and, possibly, proton-proton and proton-ion collisions. Therefore, understanding the physical assumptions that enter in the hydrodynamical modeling of heavy ion collisions is crucial. Especially, it is essential to elucidate the reason behind the onset of fluid-dynamical behavior at the very early stages of the collisions.

In this contribution, we investigate the onset of hydrodynamic behavior for a gas of massless particles undergoing Bjorken expansion, a proxy for the dynamical evolution of the quark-gluon plasma produced in heavy ion collisions. In this scheme, we demonstrate that the Chapman-Enskog series, i.e., a gradient expansion in the hydrodynamic variables, has zero radius of convergence and cannot be used to consistently derive relativistic hydrodynamics. On the other hand, we show that the method of moments, traditionally employed to derive Israel and Stewart’s theory of hydrodynamics, converges and can be used to systematically improve the applicability of fluid-dynamical theories. We further discuss what are the extended theories of hydrodynamics that emerge from higher-order truncations of the method of moments and how they can help in the description of heavy ion collisions.

1 G.S. Denicol and J. Noronha, arxiv:1608.07869

Preferred Track
New Theoretical Developments

Collaboration
Not applicable

Primary author: NORONHA, Jorge (University of Sao Paulo)
Presenter: NORONHA, Jorge (University of Sao Paulo)
Session Classification: Parallel Session 8.3: Collective Dynamics (III)
Track Classification: New Theoretical Developments
Centrality dependence of D0 elliptic and triangular flow in Au+Au collisions at sNN=200 GeV at STAR

Tuesday, 7 February 2017 17:10 (20 minutes)

Due to their large masses, heavy quarks are predominantly produced through initial hard scatterings in heavy-ion collisions and, as such, they experience the entire evolution of the hot and dense medium created in such collisions. Therefore, they can provide important insights into the properties of the strongly-coupled Quark Gluon Plasma (sQGP). For instance, the azimuthal anisotropy of charm quarks with respect to the reaction plane over a broad momentum range can provide information on the degree of thermalization for heavy flavor quarks in the medium and the bulk properties of the system. Specifically, at low transverse momenta we can examine the bulk properties in the strongly-coupled regime. Furthermore, several models have predicted that fluctuations in the initial conditions, together with strong charm-medium interactions, could lead to a finite triangular flow $v_3$ for the $D^0$ meson, providing another handle to study the early stages of the collisions.

In this talk we present the measurement of azimuthal anisotropy of $D^0$ mesons in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the Heavy Flavor Tracker at STAR. Compared to previously reported $D^0 v_2$ in minimum-bias collisions, the significance of the new result is improved by a factor of 2-4, allowing the study of the transverse momentum and centrality dependence of $D^0$ elliptic and triangular flow for the first time. The results will be compared with the measurements of other particle species and a series of model calculations. Charm quark dynamics in the sQGP medium will be discussed and the question of whether charm quarks are as thermalized as light quarks will be addressed.

Preferred Track

Collective Dynamics

Collaboration

STAR

Primary author: HE, Liang (Purdue University)

Presenter: HE, Liang (Purdue University)

Session Classification: Parallel Session 4.4: Open Heavy Flavors (I)

Track Classification: Open Heavy Flavors
Measurements of charm and bottom production via semi-leptonic decays in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV by the STAR experiment

Heavy flavor quarks are suggested as excellent probes to study the strongly interacting Quark-Gluon Plasma (QGP) discovered in high-energy heavy-ion collisions. Due to their large masses, charm and bottom quarks are produced dominantly during initial hard partonic scatterings, and thus experience the entire evolution of the QGP. Measurements of heavy flavor production have advanced our understanding of the properties of the QGP.

The Heavy Flavor Tracker (HFT), installed at the STAR experiment since 2014, provides excellent resolution to measure the Distance of Closest Approach (DCA) between reconstructed vertices and tracks. It enables the separation of Non-Photonic Electron (NPE) produced from D- and B-meson decays. In this poster, we will show the fraction of B-meson decay contribution to inclusive NPE in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV as a function of transverse momentum. The result will be compared with both model calculations and the result from the PHENIX experiment.

Preferred Track

Open Heavy Flavors

Collaboration

STAR

Primary author: BAI, Xiaozhi (University of Illinois at Chicago)
Presenter: BAI, Xiaozhi (University of Illinois at Chicago)
Session Classification: Poster Session
Azimuthal correlations of longitudinal structure at midrapidity in Pb-Pb collisions at $\sqrt{S_{NN}} = 2.76$ TeV with ALICE

Longitudinal multiplicity correlations and longitudinal asymmetry studies in heavy-ion collisions have suggested a hint of some asymmetry in the initial geometry and its effects in the final state particle fluctuations. In addition to the expansion of the medium in the transverse direction, commonly quantified using Fourier coefficients ($v_n$), the initial geometry and resulting longitudinal expansion as a function of azimuthal angle enable us to better understand the full 3-dimensional picture of heavy-ion collisions. In this poster, azimuthal correlations of the longitudinal structure of charged particles are reported for Pb-Pb collisions at a nucleon-nucleon center-of-mass energy of 2.76 TeV. Azimuthal angle is divided into regions in-plane and out-of-plane, and coefficients of Legendre polynomials from a decomposition of longitudinal structure at midrapidity ($|\eta| < 0.8$) on an event-by-event basis are estimated in each region for different centralities. Correlations in different azimuthal regions among coefficients of various orders are studied and indicate collective features of longitudinal structure in azimuthal direction. The results are compared with HIJING and AMPT simulations.

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: OH, Saehanseul (Yale University (US))
Presenter: OH, Saehanseul (Yale University (US))
Session Classification: Poster Session
Strange and non-strange particle production in nucleus-nucleus collisions at $E_{\text{kin}} = 0.4 - 2A$ GeV

SMASH is a new hadronic transport model designed to describe the non-equilibrium evolution of heavy-ion collisions. We briefly introduce the model and show that SMASH reproduces the cross sections and maintains detailed balance. To verify that the dynamics at low energies are modeled correctly, we compare pion and proton spectra to measurements by FOPI and HADES. Furthermore, we look at strangeness production in comparison to HADES and KAOS data. Such a hadron transport is also important for the late stages of collisions at RHIC and LHC energies.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: STEINBERG, Vinzent (FIAS)
Presenter: STEINBERG, Vinzent (FIAS)
Session Classification: Poster Session
The magnetized shiny pre-equilibrium QGP

The intense magnetic fields produced at the early stages of a heavy ion reaction make it possible to produce photons from processes otherwise not allowed, for instance, the fusion of gluons. In addition, magnetic fields naturally produce an asymmetry in the emission of electromagnetic radiation, hence they can be considered as a source of the large strength of the coefficient $v_2$.

In this work we compute the fraction of the yield and the asymmetry generated by magnetic fields induced by gluon fusion during the early, pre-equilibrium stage of the reaction. This will be followed by the comparison with most recent data from PHENIX and ALICE.

Preferred Track

Electromagnetic Probes

Collaboration

Not applicable

Primary author:  HERNANDEZ, luis (Department of Physics, UCT)

Presenter:  HERNANDEZ, luis (Department of Physics, UCT)

Session Classification:  Poster Session
Jet energy loss in Boson-jet events in PbPb collisions at 5.02 TeV with CMS

Wednesday, 8 February 2017 09:10 (20 minutes)

A typical approach to study the medium produced in heavy ion collisions is to understand the passage of elementary particles through it. As Z bosons and photons do not participate in the strong interaction, their correlation with jets within the same event is a clean probe of the medium-induced energy loss of (predominantly) quark jets. In this analysis, Z+jet and photon+jet correlations are studied using the high statistics PbPb and pp data taken at a center-of-mass energy of $\sqrt{s_{NN}} = 5.02$ TeV with the CMS detector. The evolution of azimuthal angular distributions and average momentum imbalance between the jet and Z or photon as a function of transverse momentum of the color neutral probe will be presented. In addition the jet $I_{AA}$, as a function of photon $p_T$ and collision centrality is studied.

Preferred Track

Jets and High pT Hadrons

Collaboration

CMS

Primary author: BI, Ran (Massachusetts Inst. of Technology (US))

Presenter: BI, Ran (Massachusetts Inst. of Technology (US))

Session Classification: Parallel Session 5.4: Jets and High pT Hadrons (IV)

Track Classification: Jets and High pT Hadrons
Beam Energy and System Size Dependence of the Viscous Damping of Anisotropic Flow

We present recent STAR measurements of the anisotropic flow coefficients $v_n$ ($n = 1 - 6$) in Au+Au, Cu+Cu, Cu+Au collisions at $\sqrt{s_{NN}} = 200$-GeV and U+U collisions at $\sqrt{s_{NN}} = 193$-GeV and for Au+Au collisions spanning the full range of the first beam energy scan (7 – 200–GeV: BES-I). For a given beam energy, the differential $v_n$ measurements indicate acoustic scaling patterns which reflect the detailed dependence of $v_n$ on collision-system size, eccentricity ($\varepsilon_n$), temperature ($T$) and chemical potential ($\mu_B$). These measurements are important constraints for the $\sqrt{s_{NN}}$ dependence of the viscous coefficient which encode the $T$ and $\mu_B$ dependence of the specific shear viscosity $\eta/s$. The beam energy dependence of the viscous coefficient for a fixed centrality, shows a non-monotonic pattern which could be an indication for the onset of critical reaction dynamics in the BES-I energy range.

Preferred Track
Collective Dynamics

Collaboration
STAR

Primary author: Mr ABDELRAHMAN"MAGDY", Niseem (Stony Brook University)
Presenter: Mr ABDELRAHMAN"MAGDY", Niseem (Stony Brook University)
Session Classification: Poster Session
Jet quenching in a semi-Quark-Gluon-Monopole Plasma: Light and Heavy flavor RAA&v2 at RHIC&LHC

Wednesday, 8 February 2017 15:40 (20 minutes)

Experimental data from heavy ion collisions at Relativistic Heavy Ion Collider (RHIC) and Large Hadron Collider (LHC) as well as first-principle lattice simulations, have provided rich information about the properties of the QCD plasma phase in the $1 \sim 3T_c$ regime. In particular, extensive jet energy loss measurements have allowed unique opportunity for probing the “internal working” of such plasma and for understanding the nonperturbative dynamics that underlies the confinement transition at $T_c$. Significant progress has been made recently in constructing such a microscopic model — the semi-quark-gluon-monopole plasma (sQGMP) which integrates two essential elements of confinements, i.e. the Polyakov-loop suppression of quarks/gluons and emergent magnetic monopoles. Based on sQGMP, a new comprehensive framework for simulating jet energy loss has been developed, called CUJET3.0, which (1) treats the radiative energy loss in the DGLV formalism; (2) convolutes energy loss with a bulk evolution of heavy ion collisions from the state-of-the-art viscous hydrodynamic simulation (VISHNU hydro) that is data-validated; (3) constrains the thermodynamic contents of the plasma constituents by current lattice QCD data. The CUJET3.0 simulation results have successfully passed the test of seven sets of jet quenching (leading-hadron) observables, including light hadrons’ $R_{AA}$ and $v_2$ at AuAu 200GeV and at PbPb 2.76TeV as well as D and B mesons $R_{AA}$ and $v_2$ at PbPb 2.76TeV. In this talk the newest results from CUJET3.0 will be reported, with systematic predictions for the light and heavy flavor $R_{AA}$ and $v_2$ at the LHC 5TeV PbPb collisions. Furthermore, quantification of potential final-state jet attenuation effects from CUJET3.0 for small colliding systems at RHIC and LHC will also be presented.


Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

Not applicable

Primary authors: XU, Jiechen (Columbia University); LIAO, Jinfeng (Indiana University)

Presenter: LIAO, Jinfeng (Indiana University)

Session Classification: Parallel Session 7.4: Open Heavy Flavors (II)

Track Classification: Jets and High $p_T$ Hadrons
We present recent results on measurements of jet substructures using grooming techniques with pp and PbPb data collected with the CMS detector at a center-of-mass energy of 5.02 TeV per nucleon pair. The grooming technique is used to focus on the hard structure of the jet by extracting the two subjets which correspond to the hardest parton splitting. This allows us to study medium-induced gluon emission properties and the evolution of partons through dense QCD matter. The hard jet structure is sensitive to the virtuality evolution of a parton in the medium, as well as the role of (de)coherent gluon emitters. Results and prospects on the transverse momentum balance, mass and angular difference of the two hard subjets over a wide range of jet transverse momentum and various collision centrality selections are discussed.

Preferred Track
Jets and High pT Hadrons

Collaboration
CMS

Presenter:  CHEN, Yi (CERN)
Session Classification:  Parallel Session 3.4: Jets and High pT Hadrons (III)
Track Classification:  Jets and High pT Hadrons
Jet Structure Studies using Jet-Hadron Correlations in PbPb and pp collisions at 5.02 TeV with CMS

Tuesday, 7 February 2017 09:10 (20 minutes)

Jet-hadron correlations are used to extend measurements of the properties of jets beyond classic fixed-R jet reconstruction. New measurements using PbPb and pp collision data at $\sqrt{s_{NN}} = 5.02$ TeV recorded by CMS use a statistical approach that allows for a reliable subtraction of the underlying event beyond the typical distance parameters of jet reconstruction. Measurements of correlated particle densities are extended out to +/-1.5 units of relative azimuth and pseudorapidity. Double-differential measurements of jet fragmentation functions and jet shapes will be presented up to radial distance of R=1 from the jet axis. New results will be compared to the previous measurements at 2.76 TeV.

Preferred Track
Jets and High pT Hadrons

Collaboration
CMS

Primary author: TRAUGER, Hallie Causey (University of Illinois at Chicago (US))
Presenter: TRAUGER, Hallie Causey (University of Illinois at Chicago (US))
Session Classification: Parallel Session 1.4: Jets and High pT Hadrons (I)
Track Classification: Jets and High pT Hadrons
Studies of Heavy Flavored Jets with CMS

Wednesday, 8 February 2017 14:40 (20 minutes)

The energy loss of jets in heavy-ion collisions is expected to depend on the mass and flavor of the initiating parton. Thus, measurements of jet quenching with identified partons place powerful constraints on the thermodynamic and transport properties of the hot and dense medium. We present recent results on heavy flavor jet spectra and nuclear modification factors of jets associated to charm and bottom quarks in both pPb and PbPb collisions. New measurements to be presented include the dijet asymmetry of pairs of b-jets in PbPb collisions and a finalized c-jet measurement in pPb collisions based on new data collected during the 2015 heavy-ion run period at the LHC.

Preferred Track
Jets and High pT Hadrons

Collaboration
CMS

Primary author: JUNG, Kurt Eduard (University of Illinois at Chicago (US))
Presenter: JUNG, Kurt Eduard (University of Illinois at Chicago (US))
Session Classification: Parallel Session 7.4: Open Heavy Flavors (II)
Track Classification: Jets and High pT Hadrons
Global polarization of Lambda hyperons in Au+Au Collisions at RHIC BES

Tuesday, 7 February 2017 16:50 (20 minutes)

Non-central heavy-ion collisions have large ($\sim 10^5 h$) angular momentum which may be transferred, in part, to the quark-gluon plasma through shear forces that generate a vortical substructure in the hydrodynamic flow field. The vortical nature of the system is expected to polarize emitted hadrons along the direction of system angular momentum. $\Lambda$ and $\bar{\Lambda}$ hyperons, which reveal their polarization through decay topology, should be polarized similarly. The vorticity of the fluid is an important parameter for the generation of a Chiral Vortical Effect (CVE).

These same collisions are also characterized by dynamic magnetic fields with magnitude as large as $10^{14}$ Tesla. A splitting between $\Lambda$ and $\bar{\Lambda}$ polarization may signal a magnetic coupling and provide a quantitative estimate of the field strength at freeze out. Details of the magnetic field and its evolution are of particular interest to other novel phenomena, e.g. the Chiral Magnetic Effect (CME).

The STAR Collaboration has made the first observation of global hyperon polarization in non-central Au+Au collisions at Beam Energy Scan energies. A magnetic splitting is hinted at, but the improved statistics and resolution achievable with future runs are required to make a definitive measurement of the magnetic field.

Preferred Track

Collective Dynamics

Collaboration

STAR

Primary author: UPSAL, Isaac (Ohio State University)
Presenter: UPSAL, Isaac (Ohio State University)
Session Classification: Parallel Session 4.2: CME, Vorticity and Spin Polarization (II)
Track Classification: Collective Dynamics
Bottomonia results from the LHC Run 1 and 2 with CMS

Tuesday, 7 February 2017 16:50 (20 minutes)

Bottomonia are important probes of the quark-gluon plasma since they are produced at early times and propagate through the medium, mapping its evolution. They are also considered to be cleaner probes than charmonia due to the lack of regeneration even at the LHC energies. In Run 1 at the LHC, CMS was able to explore multiple measurements of the Y(nS) states in pp and PbPb collisions, down to $p_T = 0$. In PbPb and pp, the production cross sections for all three Y(nS) states were measured at $\sqrt{s_{NN}} = 2.76$ TeV with the exception of the Y(3S) state, which was not observed in PbPb collisions. The suppression of the Y(1S) state was seen to depend on centrality, but not significantly on transverse momentum or rapidity. In Run 2, we have now measured the ground state to excited state ratios of Bottomonia in PbPb and pp collisions at $\sqrt{s_{NN}} = 5.02$ TeV. The $Y(2S)/Y(1S)$ ratio is found to be below 1 over the full centrality range and a weak dependence is found as a function of dimuon kinematics. For the Y(3S) state, an upper limit has been obtained as a function of centrality where a $Y(3S)/Y(1S)$ ratio compatible with 0 is observed over the full centrality range. In this talk, we will present the final CMS results on bottomonium production from Run 1, together with new Run 2 results from the high statistics PbPb data at $\sqrt{s_{NN}} = 5.02$ TeV collected in 2015.

Preferred Track

Quarkonia

Collaboration

CMS

Primary author: FLORES, Chad Steven (University of California Davis (US))
Presenter: FLORES, Chad Steven (University of California Davis (US))
Session Classification: Parallel Session 4.3: Quarkonia (II)
Track Classification: Quarkonia
A variety of effects modify the charmonium production in pPb collisions with respect to pp collisions, like modification of nPDFs, initial-state energy loss and nuclear break-up. The forward/backward ratio of the J/Ψ, previously measured by CMS, is particularly sensitive to such effects. However, both nPDF and initial-state energy loss should modify the ground and excited state in a similar way, while evidence for a different modification of the J/Ψ and Ψ(2S) in pPb have been reported by other experiments. In this presentation, final prompt J/Ψ results in pPb collisions at 5.02 TeV will presented, including the new measurement of the $R_{pA}$ using the 2015 pp data taken at the same energy. New results will also be reported regarding prompt Ψ(2S) meson production in pPb collisions, as a function of transverse momentum and rapidity and down to $p_T = 4$ GeV.
Charmonium production in PbPb collisions requires the inclusion of many phenomena to be understood, such as melting in the quark gluon plasma and statistical recombination, on top of cold nuclear matter effects (modifications of nPDFs, initial-state energy loss, nuclear break-up), better probed in pPb collisions. Final results on the relative $J/\psi$ and $\psi(2S)$ modification, based on the pp and PbPb data collected at $\sqrt{s_{NN}} = 5.02$ TeV by CMS in 2015, will be reported. In addition, new prompt $J/\psi$ results in PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, including the $R_{AA}$, will be presented over a wide kinematic and centrality range ($3 < p_T < 30$ GeV/c, $|y| < 2.4$, and fine event-centrality intervals). The results are compared to those obtained at $\sqrt{s_{NN}} = 2.76$ TeV over the same kinematic range, considering also the $J/\psi$ $v_2$ obtained at the latter energy. Final prompt $J/\Psi$ results in pPb collisions at 5.02 TeV will also be presented, including the new measurement of the $R_{pA}$ using the 2015 pp data taken at the same energy. At last, new results will be reported regarding prompt $\Psi(2S)$ meson production in pPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, as a function of transverse momentum and rapidity and down to $p_T = 4$ GeV.

Preferred Track

Quarkonia

Collaboration

CMS

Primary author: MARTIN BLANCO, Javier (Centre National de la Recherche Scientifique (FR))

Presenter: MARTIN BLANCO, Javier (Centre National de la Recherche Scientifique (FR))

Session Classification: Parallel Session 3.3: Quarkonia (I)

Track Classification: Quarkonia
Open beauty production and modifications in PbPb collisions at 5.02 TeV with CMS

Wednesday, 8 February 2017 16:50 (20 minutes)

Beauty production and phenomena in heavy-ion collisions are considered to be one of the key measurements to address the flavour-dependence of in-medium energy loss in PbPb collisions at the LHC. The CMS experiment has excellent capabilities for measuring b-quark production thanks to the excellent performances of its muon and tracker system, allowing the measurement of $D^0$ and $J/\Psi$ mesons from B meson decays, separately from prompt production, as well as fully reconstructed B mesons. In this talk, CMS will present the first measurement of the $v_2$ Fourier harmonic and the $R_{AA}$ down to $p_T > 3$ GeV/c, for $J/\Psi$ produced in B meson decays, in PbPb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, as a function of transverse momentum, rapidity and event centrality. New measurements of the $R_{AA}$ of non-prompt $J/\Psi$ and $D^0$ from $B$ decay in PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will also be reported. Finally, the measurement of $R_{AA}$ for fully reconstructed B mesons will be shown, for the first time, in PbPb collisions at 5.02 TeV. The results are compared to various model calculations.

Preferred Track

Open Heavy Flavors

Collaboration

CMS

Primary author: WANG, Ta-Wei (Massachusetts Inst. of Technology (US))
Presenter: WANG, Ta-Wei (Massachusetts Inst. of Technology (US))
Session Classification: Parallel Session 8.4: Open Heavy Flavors (III)
Track Classification: Open Heavy Flavors
Observation of charge-dependent azimuthal correlations in pPb collisions with CMS and its implication for the search of the Chiral Magnetic Effect

Tuesday, 7 February 2017 15:00 (20 minutes)

Charge-dependent azimuthal correlations relative to the event plane in AA collisions have been suggested as providing evidence for the chiral magnetic effect (CME) caused by local strong parity violation. However, the observation of the CME remains inconclusive because of several possible sources of background correlations that may account for part or all of the observed signals. This talk will present the first application of three-particle, charge-dependent azimuthal correlation analysis in proton-nucleus collisions, using pPb data collected with the CMS experiment at the LHC at $\sqrt{s_{NN}} = 5.02$ TeV. The differences found in comparing same and opposite sign correlations are studied as a function of event multiplicity and the pseudorapidity gap between two of the particles detected in the CMS tracker detector. After selecting events with comparable charge-particle multiplicities, the results for pPb collisions are found to be similar to those for PbPb collisions collected at the same collision energy. With a reduced magnetic field strength and a random field orientation in high multiplicity pPb events, the CME contribution to any charge separation signal is expected to be much smaller than found in peripheral PbPb events. These results pose a challenge for the interpretation of charge-dependent azimuthal correlations in heavy ion collisions in terms of the chiral magnetic effect.

Preferred Track

Correlations and Fluctuations

Collaboration

CMS

Primary author: TU, Zhoudunming (Rice University (US))
Presenter: TU, Zhoudunming (Rice University (US))
Session Classification: Parallel Session 3.2: CME, Vorticity and Spin Polarization (I)
Track Classification: Correlations and Fluctuations
Charge asymmetry dependence of elliptic and triangular flow in pPb and PbPb collisions with CMS

Tuesday, 7 February 2017 11:00 (20 minutes)

In nucleus-nucleus collisions, the linear dependence found for the elliptic flow harmonic of both positive or negative charged particles as a function of event charge asymmetry ($A_{ch} = (N^+ - N^-) / (N^+ + N^-)$), where $N^+$ and $N^-$ are the number of positive and negative charged particles, respectively) is predicted by the phenomenon known as the Chiral Magnetic Wave (CMW) due to its induced electric quadrupole moment. However, other scenarios are also possible and may provide alternative explanations for the experimental results. New measurements of elliptic ($v_2$) and triangular ($v_3$) flow for positive and negative charged particles as a function of $A_{ch}$ in pPb and PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV are presented, using data collected by the CMS experiment during the LHC runs 1 and 2. The slopes and intercepts of the charged-dependent $v_n$ harmonics vs. $A_{ch}$ are directly compared for pPb and PbPb collisions with similar charged-particle multiplicities, where a strong CMW effect is not expected in very high multiplicity pPb events. Moreover, a comparison is made of the slope parameters between $v_2$ and $v_3$ harmonics normalized by the inclusive charge particle $v_n$ in PbPb collisions as a function of centrality. These results provide a means to discriminate between the CMW and other scenarios such as local charge conservation as possible explanations for the observed charge dependent behavior.
Evidence for collective phenomena in pp collisions with CMS

Wednesday, 8 February 2017 11:40 (20 minutes)

Observation of long-range ridge-like correlations in high-multiplicity pp collisions opened up new opportunities for exploring novel QCD dynamics in small collision systems. Based on data collected in 2015 and 2016 with the CMS detector at the LHC, the second-order ($v_2$) and third-order ($v_3$) azimuthal anisotropy harmonics of $K^0_S$, $\Lambda$ and inclusive charged particles are extracted from long-range two-particle correlations as functions of particle multiplicity and transverse momentum. For the first time in pp collisions, the $v_2$ signals are also extracted from multi-particle correlations, providing direct evidence of the collective nature of observed particle correlations. These results provide new insights on the origin of observed long-range correlations in pp collisions, and may shed light on how quantum fluctuations affect the proton structure at a very short time scale.

Preferred Track

QCD in small systems

Collaboration

CMS

Primary author: CHEN, Zhenyu (Rice University (US))

Presenter: CHEN, Zhenyu (Rice University (US))

Session Classification: Parallel Session 6.1: QCD in Small Systems (III)

Track Classification: QCD in small systems
New insights of multi-particle azimuthal correlations via differential studies in high-multiplicity pPb collisions with CMS

Tuesday, 7 February 2017 08:50 (20 minutes)

The formation of a QGP in heavy ion collisions and the hydrodynamic expansion of the created medium are well established and reasonably well understood. This state of nuclear matter was not expected to be found in reactions involving smaller systems, such as the pA and pp collisions. Nevertheless, a wealth of experimental evidence in recent years has suggested the presence of collective phenomena and a possible QGP medium being formed also in high-multiplicity pPb collisions. A detailed investigation is needed to establish the cause of the observed collective behavior and to determine if, indeed, a QGP medium is being created or if another mechanism is responsible. Final results of differential $v_n$ harmonics in pPb collisions as a function of transverse momentum and pseudorapidity obtained using scalar product, multi-particle cumulant and Lee-Yang Zeros methods are presented in various multiplicity classes. The effect of event plane decorrelations on the observed $\eta$ dependence of $v_n$ is studied in detail. Furthermore, new measurements of correlation between $v_2$ and $v_3$ ($v_4$) harmonics are performed using the technique of symmetric cumulants to gain more insight to the initial state and possible medium response of the pPb system. The results shown in this talk relate to our understanding of the origin of azimuthal correlations in high-multiplicity pPb events and shed light on a potential QGP formation in small system collisions.

Preferred Track

QCD in small systems

Collaboration

CMS

Primary author: GUILBAUD, Maxime (Rice University (US))
Presenter: GUILBAUD, Maxime (Rice University (US))
Session Classification: Parallel Session 1.2: QCD in Small Systems (I)
Track Classification: QCD in small systems
Azimuthal anisotropies at very high $p_T$ from two- and multi-particle correlations in PbPb collision at 5.02 TeV with CMS

Wednesday, 8 February 2017 14:00 (20 minutes)

Studies of azimuthal anisotropies for very high $p_T$ particles in relativistic heavy ion collisions provide crucial information on the path length dependence of the parton energy loss mechanism in the quark-gluon plasma. Final high-precision data on the elliptic ($v_2$) and triangular ($v_3$) anisotropy harmonics of charged particles, obtained with the scalar product method, are presented up to $p_T \sim 100$ GeV/c in PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, using data recorded during the LHC run 2 with the CMS detector. In particular, the $v_3$ harmonic is explored to a very high $p_T$ regime for the first time, allowing for an improved understanding of the effect of initial-state fluctuations on the parton energy loss. The $v_2$ values reaching up $p_T \sim 100$ GeV/c are also determined using 4-, 6- and 8-particle cumulants, shedding new light on the origin of the observed high-$p_T$ azimuthal anisotropies. These new results are compared to theoretical calculations and provide stringent constraints on the parton energy loss mechanisms and the influence of initial-state fluctuations.
Mixed higher-order flow harmonics and nonlinear response coefficients in PbPb collisions at 2.76 and 5.02 TeV with CMS

Wednesday, 8 February 2017 08:50 (20 minutes)

Higher-order flow harmonics ($v_n$ with $n \geq 3$) can be measured either with respect to the event plane of the same order, a lower order event plane, or a mixture of lower order planes (also called mixed higher-order harmonics). Studies of flow harmonics using the same order event plane have been used to extract the transport properties of the hot and dense medium produced in the collisions and to explore initial state effects. The mixed higher-order harmonics have been proposed to have strong sensitivity to the shear viscosity over entropy density ratio ($\eta/s$) of the medium. In this talk, for the first time, the $v_5$ and $v_7$ are measured with respect to the second and third order planes. With the nonlinear component of the flow harmonics extracted based on lower order event planes, the nonlinear response coefficients for $n=4, 5, 6, 7$ are also presented. The mixed harmonic coefficients are studied as a function of charged particle transverse momentum and collision centrality at $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV with the CMS detector. It is found that the nonlinear response coefficients for the odd flow harmonics are larger than for the even harmonics, reflecting a stronger contributions of the nonlinear part for odd harmonics. The results are compared to theoretical calculations with different $\eta/s$ values and provide stringent constraints on the transport properties of the medium produced in heavy ion collisions.

Preferred Track

Collective Dynamics

Collaboration

CMS

Primary author: TUO, Shengquan (Vanderbilt University (US))

Presenter: TUO, Shengquan (Vanderbilt University (US))

Session Classification: Parallel Session 5.1: Collective Dynamics (I)

Track Classification: Collective Dynamics
How brightly does the Glasma shine? Photon production off-equilibrium and the v2 puzzle.

Tuesday, 7 February 2017 11:40 (20 minutes)

Large scale classical statistical simulations confirm 1 that the correct kinetic theory describing the off-equilibrium Glasma is the “bottom-up” thermalization scenario 2. Detailed simulations demonstrate that the bottom-up results match on to relativistic viscous hydrodynamics on time scales of order 1 Fermi for realistic values of the coupling [3]. We explore the detailed implications of this scenario for photon production in the Glasma relative to the QGP [4]. In particular, we argue that the “reheating” phase of the bottom-up scenario will lead to enhanced production rates for photons and may possibly generate the significant flow anisotropies essential for resolving the v2 puzzle. We report on first kinetic simulations of photon production in the expanding Glasma that will quantify our estimates and determine how brightly the Glasma shines relative to the QGP [5].

References:
5 N. Tanji and R. Venugopalan, in preparation.

Preferred Track
Electromagnetic Probes

Collaboration
Not applicable

Primary author: TANJI, Naoto (Heidelberg University)
Presenter: TANJI, Naoto (Heidelberg University)
Session Classification: Parallel Session 2.3: Electromagnetic Probes (II)
Track Classification: Electromagnetic Probes
Dynamical critical fluctuations near the QCD critical point

The recent BES data of the energy dependent $k\sigma^2$ for net protons in Au+Au collisions presented large deviations from the statistical baselines at lower collision energies, and non-monotonic behavior at around 20 GeV, which indicates possible signals for the existence of the QCD critical point 1.

In our recent paper 2, we introduce a freeze-out scheme to the dynamical models near the QCD critical point. Our model calculations for the static critical fluctuations on the freeze-out surface shows that the $C_4$ and $k\sigma^2$ data of net protons can be roughly described. However, $C_2$ and $C_3$ are always over-predicted due to the positive static critical fluctuations. After solving the time evolution equations of the various cumulants of the sigma field, the BNL group found the Skewness and Kurtosis could change their sign after the evolution, which indicates that dynamical critical fluctuations could solve the sign problem of $C_3$ [3]. However, such BNL approach can not be easily combined with our freeze-out scheme to compared with the experimental data since only the zero mode of sigma field are considered there, which already erase the needed spatial information.

Within the framework of Langevin dynamics, we simulate the dynamical evolution of the fluctuating sigma field in position space and calculate the cumulants of the sigma field in the critical regime[4]. Our numerical simulations show that $C_2$ automatically increases as the system evolves in the critical regime, which represents the spontaneous increase of the chiral field’s correlation. Besides, for both $C_3$ and $C_4$, the sign in the earlier times can be remembered during the dynamical evolution due to the memory effects near the critical point[4]. Combined with the freeze-out scheme developed in 2, our calculation provides a possible way to qualitatively describe the different cumulants data of net protons.

4 Lijia Jiang and Huichao Song, in preparation.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary author: Prof. SONG, Huichao (Peking University)

Presenters: Prof. SONG, Huichao (Peking University); Dr JIANG, Lijia (Frankfurt Institute for Advanced Studies)
Session Classification: Parallel Session 6.2: Correlations and Fluctuations (I)

Track Classification: Correlations and Fluctuations
Constraints on 3d-initial condition from experimental data and systematic predictions of longitudinal observables

The description of asymmetric collision systems and longitudinal fluctuations in AA collisions requires a 3D initial condition model consistent with both large and small systems. Particularly, longitudinal fluctuations lead to event plane decorrelations that impact both soft observables and hard-soft correlation calculations.

In this work, TRExo, a parametric initial condition model formulated at mid-rapidity, is extended to include longitudinal dependence. The local longitudinal entropy deposition as a function of space-time rapidity is characterized by its first three rapidity-cumulants, namely the mean, width and skewness, whose dependencies on local participant densities are parametrized in two ways.

The model parameters introduced in this procedure are calibrated by a Bayesian model-to-data comparison using the $dN_{ch, PbPb}/d\eta$ from ALICE and the $dN_{ch, pPb}/d\eta$ from ATLAS simultaneously. The two different parametrizations are investigated and by comparing 3d-TRExo +hydro+UrQMD calculations of the pseudorapidity correlation observable $\langle a_2^2 \rangle$ with ATLAS measurement and it is found that the data clearly favors one parametrization over the other.

After calibrating the initial condition model on selected multiplicity observables ($dN_{ch, PbPb}/d\eta$ and $\langle a_2^2 \rangle$), we calculate pseudorapidity differential flows, event plane decorrelations and compare with available data from ALICE and CMS as a validation of our parametric model. Finally, the pseudorapidity dependence of symmetric flow correlation cumulants is predicted, since these observables should be very sensitive to the event-by-event initial state geometry.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary author: KE, Weiyao (Duke University)

Co-authors: BERNHARD, Jonah; MORELAND, Scott (Duke University)

Presenter: KE, Weiyao (Duke University)

Session Classification: Poster Session
Measurement of the Width and Skewness of Elliptic Flow Fluctuations in PbPb Collisions at 5.02 TeV with CMS

Event-by-event participant geometry fluctuations are studied by measuring the distributions of event-by-event flow harmonics $p(v_n)$. Insight as to the nature of these fluctuations is obtained by calculating from $p(v_n)$ the cumulants and moments associated with the event shape. Flow harmonic distributions in PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV are measured for the integrated $p_T$ ($|\eta|$) range $0.3 \leq p_T \leq 3.0$ GeV/c ($|\eta| \leq 2.4$) using the CMS detector at the LHC. The event-shape engineering technique is used to further divide events into classes based on their ellipticity, which allows for the study of detailed correlations between initial-shape components that would otherwise be destroyed by event-averaging techniques. Hydrodynamic models predict the 2nd order participant eccentricity distributions to have a negative skewness, which is identified as the main source of non-Gaussian behavior in $p(v_2)$ distributions. The skewness for $p(v_2)$ distributions is measured with high precision over the full centrality range. In addition, $p(v_n)$ distributions are fitted with an elliptic power law parameterization to infer the proportionality constant between the flow harmonics and the initial-state geometry. Furthermore, correlations between different order harmonics are measured using the event-shape selection technique.

Preferred Track

Collective Dynamics

Collaboration

CMS

Primary author: CASTLE, James Robert (The University of Kansas (US))

Presenter: CASTLE, James Robert (The University of Kansas (US))

Session Classification: Parallel Session 7.3: Collective Dynamics (II)

Track Classification: Collective Dynamics
The measurement of heavy flavour production is a powerful tool to study the properties of the high-density QCD medium created in heavy-ion collisions as heavy quarks are sensitive to the transport properties of the medium and may interact with the QCD matter differently from light quarks. In particular, the comparison between the nuclear modification factors ($R_{AA}$) of light- and heavy-flavour particles provides insights into the expected flavour dependence of in-medium parton energy loss. Furthermore, azimuthal anisotropy coefficient ($v_n$) of heavy-flavor particles provide insights into the degree of the thermalization of the bulk medium at low $p_T$, and unique information about the path length dependence of heavy quark energy loss at high $p_T$. Using the large statistics proton-proton and PbPb samples collected at 5.02 TeV during the 2015 LHC run, high precision open charm measurements are performed with the CMS detector in a wide transverse momentum range. This allows us to set an important milestone in our understanding of the interactions between charm quark and the medium. In this talk, the most recent results of $R_{AA}$, $v_2$ and $v_3$ of $D^0$ mesons in PbPb collisions at 5.02 TeV are presented and compared to the same results for charged hadrons at the same energy.

Preferred Track

Open Heavy Flavors

Collaboration

CMS

Primary author:  SUN, Jian (Purdue University (US))
Presenter:  SUN, Jian (Purdue University (US))
Session Classification:  Parallel Session 4.4: Open Heavy Flavors (I)
Track Classification:  Open Heavy Flavors
Charged-particle nuclear modification factors in PbPb and pPb collisions at 5.02 TeV with CMS

Using the 5.02 TeV collision-energy per nucleon pair PbPb and pp LHC data of 2015, CMS measured the spectra of charged particles in the $0.5 < p_T < 400$ GeV (pp) and $0.7 < p_T < 400$ GeV (PbPb) transverse momentum ranges for central rapidities. The corresponding nuclear modification factors, $R_{AA}$, are measured in several bins of centrality, from the most central 0-5% to the peripheral 70-90%. The $R_{AA}$ in the 5% most central collisions shows a maximal suppression by a factor of approximately 7-8 in the $p_T$ region of 6-9 GeV, followed by an increase, which continues up to the highest $p_T$ measured. $R_{AA}$ approaches unity in the vicinity of $p_T = 200$ GeV.

Comparisons of the measured nuclear modification factors are made to theory calculations and to measurements at lower collision energies. The newly measured pp spectrum is combined with the previously-published pPb spectrum to construct the pPb nuclear modification factor, $R_{pPb}$. The $R_{pPb}$ exhibits weak momentum dependence and shows a moderate enhancement above unity.

Preferred Track
Jets and High pT Hadrons

Collaboration
CMS

Primary author: BATY, Austin Alan (Massachusetts Inst. of Technology (US))
Presenter: BATY, Austin Alan (Massachusetts Inst. of Technology (US))
Session Classification: Poster Session
D meson nuclear modification factor in PbPb at 5.02 TeV with CMS

The measurement of heavy flavour production is a powerful tool to study the properties of the high-density QCD medium created in heavy-ion collisions as heavy quarks are sensitive to the transport properties of the medium and may interact with the QCD matter differently from light quarks. In particular, the comparison between the nuclear modification factors of light- and heavy-flavour particles provides insights into the expected flavour dependence of in-medium parton energy loss. Using the large statistics proton-proton and PbPb samples collected at 5.02 TeV during the 2015 LHC run, high precision open charm measurements are performed with the CMS detector in a wide transverse momentum range, from few GeV up to approximately 100 GeV. This allows us to set an important milestone in our understanding of energy loss phenomena. In this talk, the most recent results of nuclear modification factor of $D^0$ mesons in PbPb collisions at 5.02 TeV are presented and compared to the charged hadron nuclear modification factor at the same energy.

Preferred Track
Open Heavy Flavors

Collaboration
CMS

Primary author: WANG, Jing (Massachusetts Inst. of Technology (US))
Presenter: WANG, Jing (Massachusetts Inst. of Technology (US))
Session Classification: Poster Session
B meson nuclear modification factor in PbPb at 5.02 TeV with CMS

The study of beauty production in heavy-ion collisions is considered one of the key measurement to address the flavour-dependence of in-medium energy loss in PbPb collisions. In pPb collisions, studies of b-quark production can also provide insights into the relevance of cold nuclear matter effects in the heavy-flavour sector. The CMS experiment has excellent capabilities for measuring b-quark production thanks to the excellent performances of its muon and tracker system. In this talk, we will present the measurement of nuclear modification factors for fully reconstructed B mesons in pPb, and for the first time, pp and PbPb collisions at 5.02 TeV, as a function of transverse momentum.

Preferred Track
Open Heavy Flavors

Collaboration
CMS

Primary author: INNOCENTI, Gian Michele (Massachusetts Inst. of Technology (US))
Presenter: INNOCENTI, Gian Michele (Massachusetts Inst. of Technology (US))
Session Classification: Poster Session
Evidence of nuclear gluon effects in $\gamma$–Pb interactions with CMS

Tuesday, 7 February 2017 08:30 (20 minutes)

The quantum fluctuations of the initial state described by the overlap of two highly Lorentz-contracted nuclei traveling on light-cone trajectories are probably imprinted upon the distribution of particles created in the Quark-Gluon Plasma (QGP). Without assessing these quantum fluctuations in nuclei, fundamental properties of the QGP such as its viscosity-to-entropy ratio cannot be determined to a high precision. By studying coherent J/$\Psi$ photoproduction in $\gamma$–Pb interactions, and comparing it to that J/$\Psi$ photoproduction off the proton, the CMS data together with that from ALICE, have showed that the no-nuclear shadowing hypothesis at low Bjorken-x and $Q^2$ values is rejected with a significant larger than 5 sigmas. The neutron dependence and energy dependence of J/$\Psi$ photoproduction off the Pb, and its connection to these nuclear gluon effects, will be presented for the first time. Furthermore, the experience gained analyzing vector meson photoproduction has been used to study other $\gamma$-Pb processes such as photonuclear jets, and will be discussed in this talk.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

CMS

Primary author: TAPIA TAKAKI, Daniel (The University of Kansas (US))
Presenter: TAPIA TAKAKI, Daniel (The University of Kansas (US))
Session Classification: Parallel Session 1.1: Initial State Physics and Approach to Equilibrium (I)
Track Classification: Initial State Physics and Approach to Equilibrium
‘2+1’ Correlations in Pb–Pb and pp collisions at $\sqrt{s_{NN}} = 2.76$ TeV with ALICE @ LHC

In the early stages of collisions, hard-scattering of the quarks and gluons from incoming nuclei results in the production of high momentum partons which fragment into collimated sprays of hadrons called “jets”. At lower transverse momenta where the event-by-event reconstruction of jets becomes difficult, their event averaged effect generates observable correlations, which have been studied using triggered two-particle angular correlation measurements. To control the di-jet production point, we require two back-to-back trigger particles with different momenta. Using symmetric and asymmetric trigger $p_T$ combinations, we are making an attempt to control the path lengths traversed by the triggers. These antipodal triggers allow us a simultaneous comparison of the near and away sides which is difficult otherwise due to the background subtraction involved on the away side, and so lets us compare the impact of different kinematic cuts on the fragmentation bias.

In this analysis the relative pseudorapidity and azimuthal angle distributions ($\Delta \eta - \Delta \phi$) of particles with respect to both the triggers are constructed, and the yield extracted from a fit to the $\Delta \eta$ projection. The measurement is done in central and semi-central events for three $p_T$ combinations of primary and secondary triggers. Heavy ion measurements have been compared with pp reference data which forms a rigorous baseline for correlation measurements. The variation observed between near and away sides will be presented which will shed light on the modification of the $p_T$ of jet fragments. To further interpret the results in terms of path length dependence, the comparison of these results to JEWEL model simulations will be presented as well.

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: KOYITHATTA MEETHALEVEEDU, Greeshma (IIT- Indian Institute of Technology (IN))

Presenter: KOYITHATTA MEETHALEVEEDU, Greeshma (IIT- Indian Institute of Technology (IN))

Session Classification: Poster Session
Hydrodynamics and the Initial Shape of the Droplet in p+p and p+Pb Collisions at the LHC

In order to test the applicability of hydrodynamics to small systems, we simulate p+p collisions at $\sqrt{s} = 7$ TeV and p+Pb collisions at $\sqrt{s} = 5.02$ TeV using the superSONIC package, which consists of AdS/CFT pre-equilibrium flow, 2+1-dimensional viscous hydrodynamics, and a hadron cascade stage. The initial conditions for hydrodynamics are generated using a Glauber-type model which replaces each nucleon in the collision by three quarks. In this model, the quarks obey a joint Gaussian distribution about a nucleon’s center of mass, and each quark deposits a Gaussian-shaped cloud of entropy in the transverse plane. By varying the parameters of this model, we quantify the effect of quark substructure on observable quantities. Results from the simulations are compared with experimental data from the ATLAS, ALICE, and CMS experiments. In particular, the hydrodynamic approach reproduces the observed distribution of particle multiplicities, and further achieves a quantitatively accurate description of the flow coefficients $v_2$, $v_3$, and $v_4$ at high multiplicities. From this, we draw conclusions about the initial shape of the droplet formed in p+p and p+Pb collisions.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: WELLER, Ryan (University of Colorado at Boulder)
Co-author: ROMATSCHKE, Paul (University of Colorado, Boulder)
Presenter: WELLER, Ryan (University of Colorado at Boulder)
Session Classification: Poster Session
High momentum transfer of vector meson photoproduction with CMS

Both the energy and momentum transfer dependence of vector meson photoproduction off the proton are promising signatures of gluon saturation. In this talk, the momentum dependence of exclusive vector mesons such as $\rho^0$ and $\Upsilon$ photoproduction will be presented. The $\rho^0$ cross section measurement will be presented for $t$ values above 0.5 GeV for the first time, which was never measured for photoproduced $\rho^0$ mesons at HERA. In this talk, the experimental technique developed to measure high $t$ values, which required assessing the proton dissociation background, will be discussed. This method might have important implications for future analyses at the LHC and in future experimental facilities such as the Electron-Ion Collider.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

CMS

Primary author: BOREN, Samuel Steed (The University of Kansas (US))
Presenter: BOREN, Samuel Steed (The University of Kansas (US))
Session Classification: Poster Session
Origin of the mass ordering of $v_n$ from a multi-phase transport

A Multi-Phase Transport (AMPT) model has been shown to describe experimental data well, including the particle spectra and azimuthal anisotropies ($v_n$) of pions and kaons below $p_T$ of ~1.5 GeV/c in heavy ion collisions as well as small system collisions. By following the parton collision history in AMPT, we have found that the opacity in AMPT is relatively small and the parton $v_n$ is primarily produced by the anisotropic escape mechanism. In this study, we investigate the origin and development of the $v_n$ mass ordering of identified hadrons in heavy ion collisions as well as small system collisions at both RHIC and LHC energies. We show that a fraction of the mass ordering arises from kinematics in the quark coalescence hadronization process, while resonance decays tend to reduce the mass ordering. We find that the majority of the mass ordering comes from hadronic rescatterings, although they have little effect on the overall magnitude of charged hadron $v_n$. These findings are qualitatively the same as those from hybrid models that couple hydrodynamics to a hadron cascade. In addition, we find no qualitative difference between heavy ion collisions and small system collisions or between RHIC and LHC energies. Our results from the AMPT study thus demonstrate that the $v_n$ mass ordering may not be a distinctive signature of hydrodynamic collective flow, but can be a quantitative interplay of several physics processes.


Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: Prof. LIN, Zi-Wei (Central China Normal University, East Carolina University)

Co-author: LI, Hanlin (Wuhan University of Science and Technology, Purdue University)

Presenter: Prof. LIN, Zi-Wei (Central China Normal University, East Carolina University)

Session Classification: Poster Session
Extracting $\hat{q}$ in event-by-event hydrodynamics and the centrality/energy puzzle

The final goal of the jet quenching studies is to extract medium parameters that characterize the QGP formed in high-energy nuclear collisions. In our analysis, we combine event-by-event hydrodynamics, within the EKRT formulation, with jet quenching (ASW Quenching Weights) to obtain high-$p_T$ $R_{AA}$, $v_2$ and $v_3$ for charged particles at RHIC and LHC energies for different centralities.

By defining a $K$-factor that quantifies the departure of the transport coefficient, $\hat{q}$, from an ideal estimate, $K = \hat{q}/(2\epsilon^{3/4})$, we fit the single-inclusive experimental data for charged particles. Then, using the fitted $K$-value for each energy and centrality we also compute high-$p_T$ $v_2$ and $v_3$, getting a good agreement with data. As obtained already in previous analyses, this $K$-factor is larger at RHIC than at the LHC but, surprisingly, it is almost independent of the centrality of the collision. We provide some possible explanations to this finding.
Event-by-Event Distributions of Flow Harmonics in U+U Collisions at $\sqrt{s_{NN}} = 193$GeV

Event-by-event measurement of anisotropic flow is crucial to understand the initial state conditions and particle production in heavy-ion collisions. Uranium nuclei provide a unique opportunity to study this, owing to its intrinsic prolate shape and the presence of different overlap configurations in the central collisions like body-body and tip-tip. We present the measurement of the probability distribution of event-by-event flow and multiparticle cumulants in Uranium nuclei collisions at $\sqrt{s_{NN}} = 193$ GeV in STAR. The observed flow vector ($\vec{Q}$) is smeared by statistical fluctuations and non-flow correlations. To subtract this smearing an iterative, data-driven matrix inversion method is used. The distributions of $v_2$ are observed to be Bessel-Gaussian in central and mid-central regions and deviates from Bessel-Gaussian in the peripheral region. The comparison of UU flow distributions with that of AuAu may show the manifestation of the deformed collision geometry of Uranium. From the probability distribution ($p(v_2)$), multiparticle cumulants of $v_2 - v_2\{2\}$, $v_2\{4\}$ and $v_2\{6\}$ are calculated. Unfolded $v_2\{2\}$ and $v_2\{4\}$ are consistent with the results published by STAR Collaboration. The ratio of $v_2\{6\}/v_2\{4\}$ in ultra central region, is observed to be less than unity unlike AuAu where the ratio is observed to be close to unity. This observation suggests a larger deviation of $p(v_2)$ from Gaussian fluctuation expected in U+U collisions than in Au+Au collisions.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

STAR

Primary author: NIE, Maowu (Shanghai Institute of Applied Physics (SINAP))

Presenter: NIE, Maowu (Shanghai Institute of Applied Physics (SINAP))

Session Classification: Poster Session
Heavy-flavor $R_{AA}$ and $v_n$ in event-by-event viscous relativistic hydrodynamics

Wednesday, 8 February 2017 17:30 (20 minutes)

It has recently been argued that event-by-event fluctuations, choice in initial conditions, and proper calculations of $v_2$ are necessary to resolve the long-standing $R_{AA}$ to $v_2$ puzzle for high $p_T$ identified hadrons [1,2]. Here we investigate the effects of full event-by-event fluctuating hydrodynamic backgrounds on the nuclear suppression factor and flow harmonics of heavy flavor mesons and non-photonic electrons. We obtain an $R_{AA}$ for $D^0$ and $B^0$ that is roughly equivalent, in line with recent CMS results, and find similar results for the elliptical flow, triangular flow as well as the multiparticle cumulants in PbPb collisions at both 2.76 TeV and 5.02 TeV. Finally, we propose new experimental observables in the heavy flavor sector that will provide greater insight into consequences of flow fluctuations as well as further constraints on energy loss models.


Preferred Track
Open Heavy Flavors

Collaboration
Not applicable

Primary authors: Mr ALVES GARCIA PRADO, Caio (Universidade de Sao Paulo (BR)); Dr NORONHA-HOSTLER, Jacquelyn (University of Houston)

Presenter: Mr ALVES GARCIA PRADO, Caio (Universidade de Sao Paulo (BR))

Session Classification: Parallel Session 8.4: Open Heavy Flavors (III)

Track Classification: Open Heavy Flavors
Low Momentum Direct Photons in Au+Au collisions at 39 GeV and 62.4 GeV measured by the PHENIX Experiment at RHIC

Direct photons, which are produced during all stages of a heavy-ion collision, directly probe the conditions of their production environment. The large yield and large anisotropy of low momentum direct photons observed in 200 GeV Au+Au collisions poses a significant challenge to theoretical models. Measurements at a lower collision energy may provide new insight on the origin of the low momentum direct photons. PHENIX has already measured the direct photons at 200 GeV via their external conversion on detector material to di-electron pairs. The advantage of this method is a very good purity in photon identification. This method is also used in our current analysis of the direct photons at two lower energies. In this poster we present the status of the measurements of the low momentum direct photons at 39 GeV and 62.4 GeV.

Preferred Track
Electromagnetic Probes

Collaboration
PHENIX

Primary author:  Mr KHACHATRYAN, Vladimir (Stony Brook University)
Presenter:  Mr KHACHATRYAN, Vladimir (Stony Brook University)
Session Classification:  Poster Session
Studying heavy flavor production via unlike-sign and like-sign dimuon mass spectra in p+p collisions at $\sqrt{s_{NN}} = 200$ GeV in the PHENIX Experiment

The dimuon mass spectrum, unlike-sign as well as like-sign, is a unique probe to directly access the different stages of a heavy-ion collision. The unlike-sign intermediate ($1 < m_{\mu^+\mu^-} < 3$ GeV/$c^2$) and high ($4 < m_{\mu^+\mu^-} < 8$ GeV/$c^2$) mass regions are dominated by semi-leptonic decays of open charm and bottom, and therefore provide information about the heavy flavor dynamics. The like-sign dimuon mass spectrum in the high mass region mostly comprise of bottom decays coming from $B^0$ oscillations, which provides a strong constraint to the bottom cross-section. This poster will present the current status of the analysis of open heavy flavor ($c\bar{c}$ and $b\bar{b}$) using the high statistics 2015 p+p data collected with the PHENIX detector in the rapidity range $1.2 < |y| < 2.2$ at $\sqrt{s_{NN}} = 200$ GeV. In this poster, we present the status of the analysis to determine $c\bar{c}$ and $b\bar{b}$ separated yields by exploiting a double-differential fit done simultaneously in mass and $p_T$ , for both unlike and like sign mass spectra, and with $\sigma_{c\bar{c}}$ and $\sigma_{b\bar{b}}$ as free parameters.

Preferred Track

Open Heavy Flavors

Collaboration

PHENIX

Primary author: Mr LEUNG, Yue Hang (Stony Brook University)

Presenter: Mr LEUNG, Yue Hang (Stony Brook University)

Session Classification: Poster Session
Hadrons carrying heavy flavour (charm or beauty quarks) constitute an exceptional probe to study the properties of the Quark-Gluon Plasma (QGP) created in high-energy heavy-ion collisions. Heavy quarks are produced in initial hard parton-scattering processes of the nucleon-nucleon collisions and on short time scales compared to the QGP formation time. Therefore they experience the entire evolution of the medium interacting with its constituents.

The measurement of the nuclear modification factor \( R_{AA} \) of charmed hadrons allows us to gain insight into the colour-charge and parton-mass dependence of energy loss as well as into possible modifications of hadronization in presence of the medium. Results from Pb–Pb collisions at \( \sqrt{s_{NN}} = 2.76 \) TeV indicate that momentum distributions of charmed mesons are modified in Pb–Pb with respect to pp collisions, owing to quenching of heavy quarks in the hot and dense medium. The D-meson \( R_{AA} \) exhibits a suppression of a factor 5-6 for \( p_T \approx 10 \text{ GeV}/c \) in central collisions, with a hint of reduced suppression for \( D_s \) mesons as compared to non-strange D mesons.

Results from Run 2 will allow us to reduce uncertainties and draw firmer conclusions about possible charm recombination at low and intermediate \( p_T \) and about colour-charge and parton-mass dependence of energy loss.

The measurement of the elliptic flow \( v_2 \) provides further insight into the deconfined phase. At low \( p_T \), D-meson \( v_2 \) offers the unique opportunity to test whether also charm quarks participate in the collective expansion dynamics and possibly thermalize in the medium. At low and intermediate \( p_T \), the elliptic flow is also expected to be sensitive to the hadronization mechanism, while at high \( p_T \), it can constrain the path-length dependence of parton energy loss. During the LHC Run 1, ALICE measured a positive \( v_2 \) for \( D^0, D^+, D_s^+ \) mesons in Pb–Pb collisions at \( \sqrt{s_{NN}} = 2.76 \) TeV. The increased statistics of semi-central Pb–Pb events at \( \sqrt{s_{NN}} = 5.02 \) TeV, obtained with the LHC Run 2, provides access to more precise results for non-strange D-meson \( v_2 \) as well as to the first measurement of the \( D_s \)-meson elliptic flow at LHC energies.

In this talk, the elliptic flow of D mesons in Pb–Pb collisions at \( \sqrt{s_{NN}} = 5.02 \) TeV will be presented, together with the status of the D-meson \( R_{AA} \) at the same energy.

**Preferred Track**

Open Heavy Flavors

**Collaboration**

ALICE

**Primary author:** BARBANO, Anastasia Maria (Università e INFN Torino (IT))

**Presenter:** BARBANO, Anastasia Maria (Università e INFN Torino (IT))
Session Classification: Parallel Session 4.4: Open Heavy Flavors (I)

Track Classification: Open Heavy Flavors
Transverse energy in Pb-Pb collisions with ALICE

A prerequisite for producing the Quark Gluon Plasma in heavy-ion collisions is to have a sufficient local energy density, which, traditionally, is estimated via measurements of the produced particle transverse energy ($E_T$). In hadronic collisions the $E_T$ is determined by the initial scattering of the partonic constituents of the incoming nuclei as well as re-interactions among the produced partons, hadrons and the created medium, and so it provides information on the collision dynamics, particularly on the amount of incoming longitudinal energy converted into particle production. The ALICE Inner Tracking System (ITS) and Time Projection Chamber (TPC) are used for measurements of the $E_T$ from charged hadrons and the electromagnetic calorimeters (PHOS and EMCal) are used to measure the $E_T$ from neutral hadrons. Methods for measuring $E_T$ using exclusively the tracking detectors are compared to methods using the combination of the tracking detectors and the calorimeters. Results from Pb-Pb collisions in ALICE are presented and compared to $E_T$ measurements at RHIC and the LHC, as well as to theoretical models.

Preferred Track
Collective Dynamics

Collaboration
ALICE

Primary author: STANKUS, Paul (Oak Ridge National Lab)
Presenter: STANKUS, Paul (Oak Ridge National Lab)
Session Classification: Poster Session
Heavy quarks are mainly produced by hard processes during the early stage of heavy-ion collisions and before the formation of the quark-gluon plasma (QGP). As most of the heavy quarks are expected to propagate through the medium during its evaluation, they can encode information on different stages of the medium. The D⁰ meson is the lightest meson containing a charm quark. Measurement of modifications to D⁰ production in heavy-ion collisions relative to proton-proton collisions can be used to study properties of the nuclear medium.

In addition, asymmetric collisions of ions create systems with asymmetric density distribution, pressure gradient and magnetic field, which provide a good opportunity to study the influence of the asymmetry on particle production. In 2012, the STAR experiment at RHIC recorded Cu+Au collisions at the center-of-mass energy per nucleon pair of \( \sqrt{s_{NN}} = 200 \) GeV. The average number of binary collisions in 0-80% central Cu+Au collisions corresponds to the semi-central Au+Au collisions with centrality of 40-50%. Measuring D⁰ production in asymmetric Cu+Au collisions allows to probe charm quark production in a system with different geometry than that of Au+Au collisions.

In this poster, D⁰ mesons are reconstructed via the hadronic decay channel \( (D^0 \rightarrow K^- \pi^+) \) in Cu+Au collisions. The invariant yield and the nuclear modification factor for D⁰ meson will be shown as a function of transverse momentum. These results will be compared with existing results from Au+Au collisions at the same collision energy and corresponding centrality.

**Preferred Track**

Open Heavy Flavors

**Collaboration**

STAR

**Primary author:** ŠAUR, Miroslav (Nuclear Physics Institute of CAS)

**Presenter:** ŠAUR, Miroslav (Nuclear Physics Institute of CAS)

**Session Classification:** Poster Session
System-size dependence of the charged-particle pseudorapidity density distribution at 5.02 TeV with ALICE

Tuesday, 7 February 2017 12:00 (20 minutes)

The dependence of particle production on the size of the colliding system (pp, p-Pb, and Pb-Pb) is studied using the most recent measurements at $\sqrt{s_{NN}} = 5.02$ TeV from ALICE for $-3.4 < \eta < +5.0$ employing the same methodology for the three colliding systems. Comparing particle production between Pb-Pb and p-Pb collisions to pp collisions as a reference over a wide pseudorapidity range provides insight into the longitudinal (and low-x) nature of the hot and dense medium created in heavy-ion collisions.

Studies from pp collisions at various energies show that the width of the charged-particle pseudorapidity density distribution increases with increasing collision energy. This underlines the importance of investigating the system size dependence of the particle production at the same collision energy. The approximate linearity versus $\eta$ that is found in the ratio of the pseudorapidity density distributions of the different systems indicates a coherent particle production throughout the longitudinal extent of the collision region, while the dependence on pseudorapidity may reflect underlying mechanisms, for example colour fluctuations or Colour-Glass Condensate initial conditions.

Preferred Track
Initial State Physics and Approach to Equilibrium

Collaboration
ALICE

Primary author: CHRISTENSEN, Christian Holm (University of Copenhagen (DK))
Presenter: CHRISTENSEN, Christian Holm (University of Copenhagen (DK))
Session Classification: Parallel Session 2.1: Initial State Physics and Approach to Equilibrium (II)
Track Classification: Initial State Physics and Approach to Equilibrium
Jet energy loss in hadronic re-scattering of Pb+Pb collisions with $\sqrt{s_{NN}} = 5.02$ TeV and $\sqrt{s_{NN}} = 2.76$ TeV at the LHC

In this work, we explore the interplay between soft (low-$p_T$) and hard (high-$p_T$) particles in the hadronic phase of Pb+Pb collisions with $\sqrt{s_{NN}} = 5.02$ TeV and $\sqrt{s_{NN}} = 2.76$ TeV at the LHC.

The partonic jet energy loss is handled by MARTINI in our simulations, given that the bulk dynamics of the QCD medium is calculated with the IP-Glasma pre-thermalization dynamics and the second-order viscous hydrodynamics. The jet-medium interaction in the hadronic stage is handled by the UrQMD model which governs the post-particization dynamics.

It is found that the mini-jets and their interaction with medium become crucial as one extends the hybrid approach toward the intermediate and higher $p_T$ regime. Description of the particle spectra can be improved with mini-jets and their energy loss. We present results for the $p_T$-spectra, nuclear modification factor $R_{AA}$ and the $p_T$-differential flow harmonics of charged and identified (non-strange and strange) hadrons, with an emphasis on the collisional energy loss of jets in the hadronic phase.

In addition, it will be demonstrated that inclusion of the hadronic collisions can change determination of the jet-medium interaction, such as the strong coupling $\alpha_S$, in QGP phase.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

Not applicable

Primary author: Dr RYU, Sangwook (Frankfurt Institute for Advanced Studies)
Co-authors: Dr SHEN, Chun (Brookhaven National Laboratory); MCDONALD, Scott (McGill University)
Presenter: Dr RYU, Sangwook (Frankfurt Institute for Advanced Studies)
Session Classification: Poster Session
D-meson production measurements in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE

Heavy-flavour production in p–Pb collisions is sensitive to Cold Nuclear Matter (CNM) effects such as the modification of the nuclear Parton Distribution Functions (PDFs), initial-stage radiation or energy loss, and multiple scattering of partons in the nucleus. These initial-state effects can induce a significant modification of the heavy-flavour production at low momentum and their measurement is required to understand final-state effects induced by the hot QGP medium in Pb–Pb collisions. In addition to transverse momentum and rapidity differential studies, measurements as a function of multiplicity are sensitive to the dependence of CNM effects on the collision geometry and on the density of final-state particles. The heavy-flavour $p_T$ distribution can be modified by final-state effects in high-multiplicity p–Pb events induced by the formation of a medium with some degree of collectivity.

D mesons are reconstructed in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE at mid-rapidity. The measurement of the D-meson production cross section and its nuclear modification factor $R_{pPb}$ down to $p_T = 0$ will be presented. The measurement of the yields of D mesons as a function of charged-particle multiplicity in p–Pb collisions, and the centrality dependence of the nuclear modification factor will be shown as well.

Preferred Track

Open Heavy Flavors

Collaboration

ALICE

Primary author: FESTANTI, Andrea (Universita e INFN, Padova (IT))

Presenter: FESTANTI, Andrea (Universita e INFN, Padova (IT))

Session Classification: Poster Session
D0-Hadron Correlations in Azimuth and Pseudorapidity in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV

Two-particle correlations have been shown to be sensitive to the dynamics of heavy-ion collisions. In particular, angular correlations on relative azimuth and pseudorapidity provide novel information about jet-like and collective behavior in these collisions. They also provide independent measures of important physical quantities, such as the second-order harmonic coefficient ($v_2$), by separating the quadrupole contribution (related to $v_2$) from $\eta$-dependent contributions such as those coming from jets and jet quenching. These correlations have already been measured for both unidentified and identified light-flavor hadrons. Heavy flavor (HF) quarks (e.g. charm, bottom) are new and ideal probes of these dynamics because they are predominantly formed in the early stage of the collisions, and therefore can be used to study the entire evolution of the hot and dense medium formed by such collisions.

We present here measurements of $D^0$-hadron angular correlations in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV from the Solenoidal Tracker at RHIC (STAR) experiment. The $D^0$ meson is reconstructed via its hadronic decay channel using the Heavy Flavor Tracker (HFT). The correlation structures will be shown as a function of both centrality and $D^0$ meson transverse momentum, and compared to the correlations for light-flavor hadrons. Using these measurements we will be able to extract physical quantities, such as $v_2$, and compare these values to model predictions and to results from other experimental methods.

Preferred Track
Correlations and Fluctuations

Collaboration
STAR

Primary author: JENTSCH, Alexander (UT Austin)
Presenter: JENTSCH, Alexander (UT Austin)
Session Classification: Poster Session
Measurement of low-mass dielectrons in pp collisions at $\sqrt{s} = 13$ TeV with ALICE

Low-mass dielectrons are a unique experimental tool to investigate the hot and dense medium created in ultra-relativistic heavy-ion collisions. Since they are created during all stages of the collision and do not interact strongly, they carry information about the medium properties unperturbed by strong final-state effects allowing us to probe the whole space-time evolution of the system.

Measurement of dielectron production in pp collisions serves as important vacuum reference to quantify modifications observed in heavy-ion collisions. It also provides complementary information on heavy-flavour production via correlated semi-leptonic decays. Recent studies of proton-proton collisions with high charged-particle multiplicities showed surprising results similar to the observations previously seen in heavy-ion collisions. Measurements of low-mass dielectrons could provide additional information regarding the underlying physics processes.

In this poster we present the current status of the dielectron analysis with ALICE central barrel in pp collisions at an unprecedented centre-of-mass energy of 13 TeV. A particular focus of the discussion will be put on the dielectron production in pp collisions collected with a trigger on high charged-particle multiplicities.

**Preferred Track**

Electromagnetic Probes

**Collaboration**

ALICE

**Primary author:** VOROBYEV, Ivan (Technische Universitaet Muenchen (DE))

**Presenter:** VOROBYEV, Ivan (Technische Universitaet Muenchen (DE))

**Session Classification:** Poster Session
Centrality and $p_T$ dependence of $D^0$ triangular flow in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV

Heavy quarks are produced through initial hard scatterings in heavy-ion collisions, and are affected by the hot and dense medium throughout its evolution when propagating in the medium. Several models have predicted that fluctuations in the initial conditions, together with frequent interactions with the QGP medium could lead to a finite triangular flow $v_3$ for the $D^0$ meson. We present the first measurement of the $D^0$ triangular flow using data taken with the STAR Heavy Flavor Tracker in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. The $D^0$ $v_3$ will be compared to light hadron measurements as well as theoretical calculations. Physics implications on the charm-medium interactions as well as the QGP medium properties will be discussed.

Preferred Track

Collective Dynamics

Collaboration

STAR

Primary author: LOMNITZ, Michael (Kent State University)
Presenter: LOMNITZ, Michael (Kent State University)
Session Classification: Poster Session
Evolution of critical fluctuations in a heavy-ion collision scenario

Wednesday, 8 February 2017 16:50 (20 minutes)

We study fluctuations of the sigma field and the net-baryon number on the crossover side of the critical point within the model of nonequilibrium chiral fluid dynamics ($N_{\chi}$FD). Herein, the sigma field as the chiral order parameter is propagated explicitly and coupled to a fluid of quarks. Before investigating these fluctuations in an expanding nonequilibrium medium, we scrutinize the $N_{\chi}$FD model by comparing cumulants of the sigma and net-baryon number fluctuations in a thermalized box to (ratios of) susceptibilities as they are obtained from derivatives of the grand canonical potential. The dynamically determined cumulants follow the trend of the thermodynamic susceptibilities. After implementing a particlization procedure into this model, we study the behavior of the net-proton kurtosis in the critical region and find that it shows the typical shape around the pseudocritical temperature. This demonstrates how critical fluctuations are able to develop in a realistic heavy-ion collision scenario and, moreover, have observable consequences. Finally, we present results for different rapidity windows and transverse momentum cuts.

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary authors: HEROLD, Christoph (Suranaree University of Technology); NAHRGANG, Marlene

Presenter: HEROLD, Christoph (Suranaree University of Technology)

Session Classification: Parallel Session 8.1: Baryon-Rich QCD Matter and Astrophysics (III)

Track Classification: QCD at High Temperature
Electroweak boson production measurements in p–Pb and Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE

Wednesday, 8 February 2017 08:50 (20 minutes)

W and Z bosons are massive weakly interacting probes; insensitive to the strong interaction, they are clean observables of the initial state of heavy-ion collisions. Despite their low production rates, their relatively clean signatures in the leptonic decay channels allow their study in heavy-ion collisions at the LHC. Their measurement in p–Pb and Pb–Pb collisions provides constraints on the nuclear parton distribution functions (nPDFs). In particular, the W and Z rapidity-differential production cross sections and the decay lepton charge asymmetry as a function of rapidity provide stringent tests of nPDFs. Electroweak boson measurements in heavy-ion collisions also constitute a tool to validate the binary scaling of hard processes as well as a reference for medium-induced effects on other probes.

The measurement of electroweak boson production in p–Pb and Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE will be presented. The ALICE muon spectrometer capabilities to detect high $p_T$ muons will be exploited to reconstruct electroweak bosons at large rapidity ($2.5 < \eta_{lab} < 4.0$). These measurements are complementary to the ATLAS and CMS ones at central rapidity, and more precise than LHCb ones with a similar rapidity coverage. Rapidity-differential measurements of W and Z, as well as of the charge asymmetry of W-decay leptons, in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be discussed. First measurements of Z production cross section in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be shown. Results will be compared with model calculations including nPDFs. In addition, the centrality dependence of W yields in p–Pb collisions and of Z production in Pb–Pb collisions will be discussed as a test of binary scaling.

Preferred Track
- Electromagnetic Probes

Collaboration
- ALICE

Primary author:  STOCCO, Diego (Centre National de la Recherche Scientifique (FR))
Presenter:  STOCCO, Diego (Centre National de la Recherche Scientifique (FR))
Session Classification:  Parallel Session 5.2: Initial State Physics and Approach to Equilibrium (III)
Track Classification:  Electromagnetic Probes
Thermal properties and evolution of the axial anomaly for 2+1 flavors

Thermal evolution of the axial anomaly of QCD is investigated in terms of effective theories with 2+1 flavors. Using the Functional Renormalization Group method, it will be shown that mesonic fluctuations are of great importance from the point of view of the thermal behavior of the ‘t Hooft determinant term. Results indicate that fluctuations strengthen the axial anomaly at finite temperature and it does not vanish at the critical point. The phenomenon has been found to have significance in the thermal properties of the mesonic spectrum, especially concerning the eta - eta’ system. Analysis of the spectrum and the anomaly in nuclear medium will also be discussed.

Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary author: FEJOS, Gergely
Presenter: FEJOS, Gergely
Session Classification: Poster Session
An Improved Event Plane Detector for the STAR Experiment

The Beam Energy Scan (BES) program at the Relativistic Heavy-Ion Collider has shown hints of a critical point and first order phase transition at the BES energies. Key measurements for locating the critical point and determining the first order phase transition are limited by poor event plane resolution, limited statistics and a TPC-only centrality determination. Therefore, phase II of the BES program was proposed to take data with upgraded detectors and increased statistics for the further investigation. A new event plane and collision centrality detector (EPD) is planned to replace the existing detector, the Beam-Beam Counter (BBC), with higher granularity and acceptance. The design of the EPD consists of two scintillator discs at $z = \pm 3.75m$ from the center of STAR, covering $2.2 < \eta < 5.1$, the same as the BBC. The detector will be read out by silicon photomultipliers (SiPM) - an inexpensive and magnetic field insensitive replacement for the traditional phototube. A prototype of the detector, consisting of a single sector was integrated into STAR during the 2016 run, the results of which will be shown. The geometry and segmentation of the design optimizes event-plane resolution, centrality determination and flow harmonic measurements. We will discuss the plans to install one quarter of a disc into STAR for the 2017 run.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

STAR

Primary author: EWIGLEBEN, Justin (Lehigh University)

Presenter: EWIGLEBEN, Justin (Lehigh University)

Session Classification: Poster Session
Baryon spectra and antiparticle/particle ratios from the improved AMPT model

The string melting version of a Multi-Phase Transport (AMPT) model can reasonably describe the $dN/dy$ yields, $p_T$ spectra and anisotropic flows of pions and kaons at low $p_T$ in heavy ion collisions at RHIC and LHC energies [1,2]. However, it failed to reproduce the $dN/dy$ and $p_T$ spectra of baryons [2,3]. For example, it overestimates the proton yield at mid-rapidity but underestimates the slope of the proton $p_T$ spectra. In addition, antiparticle/particle ratios from the current AMPT model are unexpectedly above unity for strange baryons.

In this work we improve the quark coalescence model in AMPT. In particular, we have removed the previous constraint that forced the total numbers of mesons, baryons, and anti-baryons in an event to be separately conserved through quark coalescence. Instead, a quark or anti-quark now has the freedom to form either a baryon or a meson, depending on the distance to its coalescence partner(s). We have also changed the order in quark coalescence: previously coalescence partners of all mesons are searched first (ahead of baryons), while now the sequence of meson and baryon formations is dynamically determined.

In this talk we will show that this improved AMPT model can describe baryons much better. In particular, the $p_T$ spectra of protons and $\Lambda$-baryons roughly agree with the heavy ion data at RHIC and LHC, and antiparticle/particle ratios for strange baryons also reasonably agree with the data.


Preferred Track
- New Theoretical Developments

Collaboration
- Not applicable

Primary author: HE, Yuncun (Central China Normal University, Wuhan)
Presenter: HE, Yuncun (Central China Normal University, Wuhan)
Session Classification: Poster Session
Chiral vortical and magnetic effects in anomalous hydrodynamics

Tuesday, 7 February 2017 18:10 (20 minutes)

We employed a 3+1D anomalous hydro with initial condition generated by HIJING to calculate Chiral Vortical Effect and Chiral Magnetic Effect. This allowed us to compare these two effects at different collision energy and centrality. We calculated the charge dependent two-particle correlations with respect to the reaction plane, which is used to compare with current results and also can provide prediction for further experiments.

Preferred Track

New Theoretical Developments

Collaboration

BEST

Primary author: Mr GUO, Xingyu (Tsinghua University)
Co-author: Prof. HUANG, Xu-Guang (Fudan University)
Presenter: Mr GUO, Xingyu (Tsinghua University)
Session Classification: Parallel Session 4.2: CME, Vorticity and Spin Polarization (II)
Track Classification: New Theoretical Developments
Revealing the collision energy dependence of $\eta/s$ in RHIC-BES Au+Au collisions using Bayesian statistics

Tuesday, 7 February 2017 16:50 (20 minutes)

Significant progress has been made in the past few years in determining QGP properties, such as the temperature dependence of shear viscosity over entropy density ratio $\eta/s$. However, $\eta/s$ might depend also on the baryochemical potential $\mu_B$, as has been hinted at in a recent beam energy scan study 1.

It is generally difficult to determine the uncertainties associated with the extracted values of QGP properties, as the computational models used in the analysis typically have numerous interconnected parameters. We utilize novel optimization techniques based on Bayesian statistics and Markov Chain Monte Carlo (MCMC) methods to calibrate the computational model to data. The end result of such an analysis is a conditional probability distribution, which provides a set of data-calibrated parameter values with a full uncertainty quantification. Gaussian process emulators are also used in the analysis to overcome its significant computational expense and predict model results for all needed input parameter combinations. These statistical methods have already been applied with great success to Pb+Pb collisions at the LHC 2.

In this presentation we investigate the $\mu_B$ dependence of $\eta/s$, with collision energy as the control parameter, by performing a Bayesian analysis on RHIC beam energy scan data, applying the same UrQMD + viscous hydrodynamics hybrid model as in 1, to verify if the reported differences between the energies remain significant even when uncertainties are included. We determine the probability distributions for the model parameters for Au+Au collisions at 19.6, 39, and 62.4 GeV; the results indicate that while the uncertainty on the optimal value of $\eta/s$ does increase at lower collision energies, the probability for a large value of the ratio is much higher at 19.6 GeV with the median value 0.24, compared to 62.4 GeV with median value 0.07 [3]. Moreover, we also find that multi-strange hadron yields provide significant constraints on the switching condition between the hydrodynamic evolution and the hadron transport afterburner and thus are essential for a proper model-to-data comparison [4].

1 Iu. Karpenko et al., PRC 91 6, 064901 (2015);
2 J. E. Bernhard et al., PRC 94 2, 024907 (2016);
3 S. A. Bass, talk at CPOD2016 (arXiv:1610.00590);

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Not applicable

Primary author: AUVINEN, Jussi (Duke University)

Presenter: AUVINEN, Jussi (Duke University)
**Session Classification:** Parallel Session 4.1: Baryon-Rich QCD Matter and Astrophysics (I)

**Track Classification:** Baryon-Rich QCD Matter and Astrophysics
Effect of Thermal Fluctuations on Electromagnetic and Hadronic Observables

Geometric and quantum fluctuations in the initial state of heavy-ion collisions leave fingerprints in the measured multi-particle correlation functions. Thermal fluctuations during the quark-gluon plasma (QGP) evolution are another source of dynamical fluctuation. They are conceptually important and can play a crucial role in second-order viscous hydrodynamic simulations 1.

In this work, we present a full calculation of hadronic and photon observables including the thermal fluctuations. The evolution of thermal fluctuations is treated as a linearized perturbation on a hydrodynamic background 2. Effects on event-by-event charged hadron $vn$ distribution, and on event-plane correlations will be addressed. Furthermore, because thermal photons are produced at all stages of evolution, they offer a window on earlier stages when temperatures are high and fluctuations are more significant. We elucidate the effects of fluctuations on electromagnetic phenomenology, with an emphasis on direct photon observables.


Preferred Track

Electromagnetic Probes

Collaboration

Not applicable

Primary author: Mr SINGH, Mayank (McGill University)
Co-author: Dr SHEN, Chun (Brookhaven National Laboratory)
Presenter: Mr SINGH, Mayank (McGill University)
Session Classification: Poster Session
Photon and neutral pion separation in the PHENIX MPC-EX detector

The MPC-EX Si-W preshower sits in front of a PbWO4 electromagnetic calorimeter, and consists of eight layers of thin tungsten plates and Si sensors. It covers the forward pseudorapidity range of 3.1 < \( \eta \) < 3.8 and enabled the study of low-\( x \) partons in the gold nucleus through prompt photon production in \( p+A \) collisions. Each silicon sensor is divided into mini-pad sensors (2mm x 16mm) to provide detailed shape and evolution of EM showers. The MPC-EX is designed to reconstruct and identify neutral pions up to \( \approx 80\text{-}100 \text{ GeV} \). Two photons decayed from a high momentum neutral pion can not be easily separated from a single photon in the preshower detector. By examining topological shapes of showers in the MPCEX, we can distinguish between merged double photons from a neutral pion and a single prompt photon based on a multivariate probability analysis. In this poster we will describe the shower properties which enable separation of prompt photons and \( \pi^0 \)'s with high purity and efficiency. The performance of this topological separation will be presented.

Preferred Track
Jet and High \( p_T \) Hadrons

Collaboration
PHENIX

Primary author: DO, Jaehyeon
Presenter: DO, Jaehyeon
Session Classification: Poster Session
The new Fast Interaction Trigger detector for the ALICE Upgrade

The upcoming upgrade of the CERN LHC injectors during 2019-20 will boost the luminosity and the collision rate beyond the design parameters for several of the key ALICE detectors including the forward trigger detectors. The nominal Pb-Pb interaction and readout rate for ALICE after LS2 will be of 50 kHz. To remedy this problem the Fast Interaction Trigger (FIT) is being designed and constructed. FIT will be the main forward trigger, luminometer, and collision time detector. It will also determine multiplicity, centrality, and reaction plane of heavy ion collisions. The detector will consist of two arrays of Cherenkov radiators with MCP-PMT sensors and of a single scintillator ring. The arrays will be placed around the beam line on the opposite sides of the interaction point: at ~800 mm on the hadron absorber side and at ~3200 mm on the other side where also a 1489 mm diameter scintillator ring will be located. The resolution of the interaction time extracted from the Cherenkov arrays will be equal or better than 40 ps for low multiplicity events and better than 30 ps at higher multiplicities. The centrality and event plane resolution will be similar to those of the present ALICE apparatus. The first prototype of the Cherenkov module together with the frontend electronics are already installed and in operation at ALICE in parallel to the other forward detectors. In the presentation the performance of the prototype will be shown together with the latest refinements of the FIT geometry, new modifications to the MCP-PMT sensor, electronics scheme with digital trigger and continuous readout as well as update on simulation results.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ALICE

Primary author: TRZASKA, Wladyslaw Henryk (University of Jyvaskyla (FI))
Presenter: TRZASKA, Wladyslaw Henryk (University of Jyvaskyla (FI))
Session Classification: Poster Session
Isolated Photon - Hadron Correlations in Heavy Ion Collisions from PHENIX

Direct photon—jet pairs are produced in the initial hard scattering of an ion collision and the photon is not affected by the quark-gluon plasma, while the jet loses energy. Therefore, photon-jet pairs are good systems for studying jet energy loss event-by-event. Obtaining direct photons is challenging because of the myriad of background photons and typically a statistical subtraction method is used in A+A at RHIC. Instead of a statistical method, we use a direct method to obtain isolated photons by using an isolation cut similar to those used in direct photon identification in p+p collisions. This isolation cut provides for a cleaner sample of direct photons, potentially reducing the systematic uncertainties on direct photon-hadron correlations when compared to the statistical subtraction sample. We present the status of centrality-dependent direct photon-hadron angular correlations and fragmentation functions in A+A using recent high-statistics PHENIX datasets.

Preferred Track
- Correlations and Fluctuations

Collaboration
- PHENIX

Primary author: DANLEY, Tyler (Ohio University)
Presenter: DANLEY, Tyler (Ohio University)
Session Classification: Poster Session
Measurements of the nuclear modification factor and elliptic flow of leptons from heavy-flavour hadron decays in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV and 5.02 TeV with ALICE

Heavy quarks, i.e. charm and beauty, are sensitive probes to study the properties of the strongly-interacting matter created in heavy-ion collisions at ultra-relativistic energies, since they are mainly produced in initial hard scattering processes and experience the entire evolution of the system. The heavy quarks traversing the medium lose energy via collisional and radiative processes in the interaction with the medium constituents. The heavy-flavour energy loss can be investigated with measurements of the modification of the transverse momentum distribution of heavy-flavour particles in heavy-ion collisions with respect to binary-scaled pp collisions (nuclear modification factor $R_{AA}$). An observable that complements the investigation of the interaction of heavy quarks with the medium is the elliptic flow of heavy-flavour particles, which is defined as the second harmonic ($v_2$) of the Fourier expansion of the particle azimuthal distribution in momentum space. The measurement of the heavy-flavour particle $v_2$ at low transverse momentum ($p_T$) provides insight into the collective motion of heavy quarks in the medium, while the heavy-flavour particle $v_2$ at high $p_T$ is sensitive to the path-length dependence of the energy loss of heavy quarks in the almond-shaped overlap area in non-central collisions.

The semi-leptonic decay channel of open heavy-flavour hadrons is well suited for heavy-flavour studies in ALICE, since the branching ratio is relatively large (10%) and ALICE has an unique capability for identification of electrons at mid-rapidity ($|y| < 0.8$) and muons at forward rapidity ($2.5 < y < 4$) over a wide $p_T$ range.

In this talk, we will present the ALICE results on the nuclear modification factor and elliptic flow of open heavy flavour hadrons via their semi-electronic decays at mid-rapidity and via their semi-muonic decay channel at forward rapidity in Pb–Pb collisions. Progress on the measurements of leptons from heavy-flavour and beauty-hadron decays in Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV will be discussed. The first results on the $R_{AA}$ and $v_2$ of electrons from heavy-flavour hadron decays in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV and prospects for measurements of electrons from beauty-hadron decays will be presented. The latest results concerning the measurements of the production cross section and nuclear modification factor of muons from heavy-flavour hadron decays as a function of $p_T$ and collision centrality in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will also be shown. The results will be compared with model calculations including the interaction of heavy quarks with the medium.

Preferred Track

Open Heavy Flavors

Collaboration

ALICE
Primary author: MOREIRA DE GODOY, Denise Aparecida (Westfälische Wilhelms-Universität Münster)

Presenter: MOREIRA DE GODOY, Denise Aparecida (Westfälische Wilhelms-Universität Münster)

Session Classification: Parallel Session 7.4: Open Heavy Flavors (II)

Track Classification: Open Heavy Flavors
Van der Waals interactions in hadron resonance gas: from nuclear matter to lattice QCD

An extension of the ideal non-interacting hadron resonance gas (HRG) model is constructed which includes the attractive and repulsive van der Waals (VDW) interactions between baryons. This VDW-HRG model yields the nuclear liquid-gas transition at low temperatures and high baryon densities. The VDW parameters $a$ and $b$ are fixed by the ground state properties of nuclear matter, and the temperature dependence of various thermodynamic observables at zero chemical potential are calculated within VDW-HRG model.

Compared to the ideal non-interacting HRG, the inclusion of VDW interactions between baryons leads to a qualitatively different behavior of 2nd and higher moments of fluctuations of conserved charges, in particular in the so-called crossover region $T \sim 140 - 190$ MeV. For many observables this behavior resembles closely the results obtained from lattice QCD simulations. Detailed comparisons suggest that strange baryons have weaker VDW interactions compared to non-strange ones. We also explore the effect of VDW interactions on the thermal fits to heavy-ion hadron yield data and find that existing agreement of ideal HRG is not spoiled in the VDW-HRG model. Finally, we find that VDW interactions have a substantial influence on the higher orders of fluctuations of conserved charges at finite chemical potential, in the regions where chemical freeze-out in heavy-ion collisions is expected to occur.

Our results imply that VDW interactions play a crucial role in thermodynamics of hadron gas. Thus, the commonly performed comparisons of the ideal HRG model with the lattice data may lead to misconceptions and misleading conclusions, and should therefore be treated with extreme care.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary author: Mr VOVCHENKO, Volodymyr (Frankfurt Institute for Advanced Studies)

Co-author: ALBA, Paolo Giuseppe
Presenter: Mr VOVCHENKO, Volodymyr (Frankfurt Institute for Advanced Studies)

Session Classification: Poster Session
Vorticity in the QGP liquid and Lambda polarization at the RHIC Beam Energy Scan

Tuesday, 7 February 2017 17:10 (20 minutes)

The Quark Gluon Plasma formed in relativistic heavy ion collisions at finite impact parameter has a finite angular momentum perpendicular to the reaction plane and some fraction thereof may be converted into global polarization of final state hadrons along the angular momentum direction. The polarization can be calculated assuming that the spin degrees of freedom are at local thermodynamical equilibrium at the hadronization stage. The hydrodynamical quantity steering the polarization is the thermal vorticity, that is minus the antisymmetric part of the gradient of four-temperature field $\beta^\mu = u^\mu / T$.

Based on this mechanism, we present a calculation of the global polarization of $\Lambda$ hyperons produced in relativistic Au-Au collisions at RHIC Beam Energy Scan range $\sqrt{s_{NN}} = 7 - 200$ GeV with a 3+1 dimensional cascade + viscous hydro + cascade model, vHLLE+UrQMD. Within this model, the mean polarization of $\Lambda$ in the out-of-plane direction is predicted to decrease rapidly with collision energy from a top value of about 2% at the lowest energy examined. We explore the connection between the polarization signal and thermal vorticity and estimate the feed-down contribution to $\Lambda$ polarization due to the decay of higher mass hyperons.

1 F. Becattini et al., Annals Phys. 338, 32-49 (2013);

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: KARPENKO, Iurii (Frankfurt Institute for Advanced Studies)
Presenter: KARPENKO, Iurii (Frankfurt Institute for Advanced Studies)
Session Classification: Parallel Session 4.2: CME, Vorticity and Spin Polarization (II)
Track Classification: Collective Dynamics
Forward high granularity electromagnetic calorimeter for direct photon measurements at LHC

It is widely expected that the growth of parton densities at low x predicted from linear QCD evolution cannot continue indefinitely, and that non-linear effects will lead to gluon saturation. We propose the measurement of forward(3.5 < y < 5) direct photons in a new region of low x(∼ 10^-6) in proton-nucleus collisions at the LHC as a decisive probe of gluon saturation. In order to discriminate decay photons with very small opening angle from neutral pions, which is the dominant background, an extremely high-granularity electromagnetic calorimeter is required, which we propose as a detector upgrade to the ALICE experiment, the Forward Calorimeter (FoCal).

To facilitate the design of the upgrade and to perform generic R&D necessary for such a novel calorimeter, a compact Si/W sampling electromagnetic calorimeter prototype using CMOS pixel sensors with a granularity of 30×30 μm has been built and used for measurements in test beams. This digital calorimeter has shown to have good energy linearity and a very small Moliere radius(∼11mm). We will discuss new results of the R&D with electromagnetic showers, in particular a position resolution of better than 30μm, and first studies of hadron identification performance.

This precise position determination and the detailed knowledge of the electromagnetic shower shape obtained will provide the crucial capability for two-photon separation down to a separation of a few mm. The results show the extremely high potential of this technology for future calorimeter development

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
ALICE

Primary author: WANG, Hongkai (Nikhef National institute for subatomic physics (NL))
Presenter: WANG, Hongkai (Nikhef National institute for subatomic physics (NL))
Session Classification: Poster Session
The ALICE TPC Upgrade Project

Wednesday, 8 February 2017 17:50 (20 minutes)

The ALICE TPC will undergo a major upgrade during the next LHC long shutdown in preparation for the higher luminosity planned for LHC Run-3 to start in 2021. This upgrade will allow ALICE to access new levels of sensitivity for untriggered processes. The present TPC is limited to recording minimum bias lead-lead collisions at a rate of about 1000 Hz. The upgrade will allow recording the full expected lead-lead collision rate of 50 kHz.

The present ALICE TPC uses multi-wire proportional (MWPC) chambers for readout. A gating grid is used to block positive ions created at the anode wires from flowing back into the main drift volume creating track distortions. The gating grid has an intrinsic dead time that limits the maximum collision rate that can be recorded. The goal of this upgrade is to replace the MWPCs and gating grid with Gas Electron Multiplier (GEM) arranged in a configuration that allows one to maintain the spatial and energy resolution of the present TPC. The electronics will be replaced with continuous readout electronics based on a new purpose designed chip. The project involves building 80 quadruple-GEM chambers (72 installed in the TPC plus 4 spares) utilizing 640 GEM foils. In order to accomplish such a large project the design, construction, quality assurance and testing are divided across many institutions and countries.

The motivation for the technology choices, status of the project, construction methods, quality assurance and testing procedures for the GEM foils and new readout chambers will be presented. Results from testing GEM foils, first chambers and readout electronics also will be presented.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ALICE

Primary author: MAJKA, Richard Daniel (Yale University (US))

Presenter: MAJKA, Richard Daniel (Yale University (US))

Session Classification: Parallel Session 8.2: Future Experimental Facilities, Upgrades, and Instrumentation

Track Classification: Future Experimental Facilities, Upgrades, and Instrumentation
Towards measurements of Chiral Magnetic (Vortical) Effect Using Identified Particles from STAR

Tuesday, 7 February 2017 16:30 (20 minutes)

The chiral magnetic effect (CME) and the chiral vortical effect (CVE) have been under intensive theoretical and experimental investigations in recent years. A three-point correlator, $\gamma$, has been used to measure electric/baryonic charge separations across the reaction plane as the experimental manifestation of the CME/CVE. Considerable background sources arising from charge/momentum conservation coupled with elliptic flow anisotropy ($v_2$) have been identified. Disentanglement of background and the possible CME/CVE signal has been the central focal point of theoretical and experimental efforts. We report recent progresses from the STAR experiment in searching for the CME/CVE with identified particles using background suppression methods. The $\gamma$ correlator measurements of $\pi^-\pi$, $\pi^-K$, $p^-\pi$, $K^-K$, $p^-p$, $p^-\Lambda$ pairs are presented as a function of centrality and beam energy in Au+Au collisions from $\sqrt{s_{NN}} = 7.7$ to 200 GeV. We explore the range of background variations to establish where a signal may exist. We use event-shape engineering \cite{3} as well as mixed-event subtraction as a function of the event-by-event elliptic anisotropy \cite{4,5} to reduce the flow background. In addition, preliminary results of small system 200 GeV d+Au collisions will also be discussed. These measurements will represent a major advance in our understanding of possible CME/CVE contributions to the three-point correlation.


Preferred Track
Correlations and Fluctuations

Collaboration
STAR

Primary author: WEN, Liwen
Presenter: WEN, Liwen

Session Classification: Parallel Session 4.2: CME, Vorticity and Spin Polarization (II)

Track Classification: Correlations and Fluctuations
Heavy-flavour hadron decay electron correlations in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with the ALICE detector

Heavy quarks (charm and beauty) are unique probes used to understand the properties of the QCD medium produced in ultra-relativistic heavy-ion collisions. Due to their large masses, they are created in the early stages of the collisions and experience the full evolution of Quark-Gluon Plasma (QGP). They interact with its constituents and lose energy as they travel through the medium. Heavy quarks can be studied by measuring electrons coming from the semi-leptonic decays of heavy-flavour hadrons.

Two particle angular correlation measurements are a powerful tool to study jet quenching especially in $p_T$ regions where direct jet identification is difficult. In such measurements, we observe a near-side peak around $\Delta \phi \approx 0$, formed by particles associated to a high-$p_T$ trigger particle, and an away-side peak around $\Delta \phi \approx \pi$, formed by back-to-back dijets. By studying heavy-flavour angular correlations triggered by electrons from heavy-flavour hadron decays, we can access information about heavy-flavour jet quenching in the QGP. Near-side correlations can be studied to understand if the fragmentation and hadronization of heavy-quarks are modified by medium effects.

In this poster, we present the current status of the ALICE measurement of azimuthal angular correlations of heavy-flavour decay electrons with charged hadrons in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV from the LHC Run 2.

Preferred Track:
Open Heavy Flavors

Collaboration:
ALICE

Primary author: THOMAS, Deepa (University of Texas (US))
Presenter: THOMAS, Deepa (University of Texas (US))
Session Classification: Poster Session
Disentangling flow and signals of Chiral Magnetic Effect in U+U and Au+Au collisions

We present measurements of the charge-dependent, three-particle correlator $\gamma$ and elliptic flow $v_2$ in central and ultra-central U+U and Au+Au collisions at $\sqrt{s_{NN}}=200$ GeV from STAR. The difference $\Delta \gamma = \gamma(\text{like-sign}) - \gamma(\text{un-like-sign})$ measures charge separation across the reaction plane, a predicted signal of the Chiral Magnetic Effect (CME) \(^1\). Although charge separation has been observed, it has been argued that the measured separation can also be explained by elliptic flow related backgrounds \(^2\). To disentangle the two effects, we use triggered samples of U+U and Au+Au collisions for which predictions from flow related backgrounds and magnetic field dependent effects diverge. Our analysis includes events selected based on asymmetries in spectators observed in the Zero-Degree-Calorimeters which preferentially select body-tip events \(^3\). We find that for cases where known, flow driven, background expectations differ from CME related predictions driven by the correlation of the magnetic field and the flow; the data are in better accord with the CME related prediction.


2 S. Schlichting, S. Pratt, Phys.Rev. C83 (2011) 014913


Preferred Track

Collective Dynamics

Collaboration

STAR

Primary author: TRIBEDY, Prithwish (Brookhaven National Lab)

Presenter: TRIBEDY, Prithwish (Brookhaven National Lab)

Session Classification: Parallel Session 3.2: CME, Vorticity and Spin Polarization (I)

Track Classification: Collective Dynamics
Bulk viscous effects on flow and dilepton radiation in a hybrid approach

Tuesday, 7 February 2017 09:50 (20 minutes)

Bulk viscosity has recently been shown to play an important role in describing both photon and hadron observables at the Relativistic Heavy-Ion Collider (RHIC) and the Large Hadron Collider (LHC). The presence of a temperature-dependent bulk viscosity in the hydrodynamical evolution of the medium modifies the development of the hydrodynamic momentum anisotropy differently in the high- and low-temperature regions. Thus, anisotropic flow coefficients of hadronic observables, which are emitted predominantly from low temperatures, are affected differently by bulk viscosity than electromagnetic probes which are radiated during the entire evolution. Starting from the IP-Glasma initial conditions [1,2], we study how thermal dilepton production gets modified owing to the presence of bulk viscosity at RHIC and LHC energies. With calculations at different collision energies we can draw more robust conclusions regarding the role of bulk viscosity in high energy heavy-ion collisions. Dilepton radiation from the dilute phase of the medium will be included for the first time using the Boltzmann-transport model SMASH [3] and compared to previous hydrodynamic approaches to ascertain whether these modifications may be observable in experimental data.


Preferred Track
Electromagnetic Probes

Collaboration
Not applicable

Primary author: Dr VUJANOVIC, Gojko (The Ohio State University)
Co-authors: Dr SHEN, Chun (Brookhaven National Laboratory); PAQUET, Jean-Francois (Stony Brook University)
Presenter: Dr VUJANOVIC, Gojko (The Ohio State University)
Session Classification: Parallel Session 1.3: Electromagnetic Probes (I)
Track Classification: Electromagnetic Probes
Dynamical quarkonia suppression in a realistic AA background

The suppression of the quarkonium states in AA collisions, observed by the STAR and PHENIX collaborations at RHIC and by the CMS and ALICE collaborations at LHC, is one of the most convincing evidence for the creation of the Quark Gluon Plasma (QGP). The precise survival of excited states vs ground states could even allow to measure the highest temperature reached in those collisions, according for instance to the sequential suppression scenario which is substantiated by calculations of the dissociation temperature based on lattice potentials evaluated at finite temperature.

In our contribution, we address the question of charmonium and bottomonium dissociations resorting to a dynamical approach, i.e. the non-linear Schroedinger-Langevin equation (SLE). In this scheme, a time-dependent real potential reflects the Debye-screening of the heavy quark/antiquark pair self interaction, while a fluctuation/dissipation mechanism expresses its hard interactions with the QGP. The SLE enables to treat the transitions to open quantum states and between bound states, which play an important role for excited state final populations. It allows to consider a realistic compact initial state, made of a linear superposition of eigenstates and to preserve quantum coherence and unitarity in the time-evolution of a pair.

In a stationary QGP, our SLE naturally leads to asymptotic distributions of the states following correct statistical weights, which allows to make the link with models based on the hypothesis of statistical recombination. This sanity check is a unique feature of our approach.

We will describe the most important properties of the SLE. We will then present the suppression prediction resulting from the SLE embedded in the state-of-the-art EPOS evolution scenario of the QGP background. Including initial cold nuclear matter effects, the pT and centrality dependences of the yields will be discussed both for RHIC and LHC energies.

References:

- arXiv:1601.01443 (accepted for publication in Nuclear Physics A)

Preferred Track

Quarkonia

Collaboration

Not applicable

Primary author:  Dr KATZ, Roland (University of São Paulo)
Co-author:  GOSSIAUX, Pol (Subatech)
Presenter:  Dr KATZ, Roland (University of São Paulo)
Session Classification:  Poster Session
Measurement of the cumulant of net-proton multiplicity distribution in Au+Au collisions at $\sqrt{s_{NN}}$ =7.7-200 GeV from the STAR experiment

Wednesday, 8 February 2017 14:20 (20 minutes)

One of the main goals of the RHIC Beam Energy Scan program is to search for the QCD Critical Point (CP) and phase transition in heavy-ion collisions. Fluctuations of conserved quantities are highly sensitive to the correlation length, and are directly connected to the susceptibilities in the Lattice QCD. Therefore, they are ideal observables for finding the CP and phase transition signatures.

In this talk, we will present measurements of the cumulants of net-proton distributions from Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7, 11.5, 14.5, 19.6, 27, 39, 62.4 (up to fourth order) and 200 GeV (up to sixth order) measured by the STAR experiment at RHIC. Multi-particle correlation functions are also extracted from the proton and anti-proton cumulants. It is observed that the four-particle correlations are positive. These provide additional insight into the non-monotonic energy dependence observed in fourth order proton fluctuations. Finally, we will discuss the corresponding physics implications.

Preferred Track

Correlations and Fluctuations

Collaboration

STAR

Primary author: ESHA, Roli (University of California - Los Angeles)

Presenter: ESHA, Roli (University of California - Los Angeles)

Session Classification: Parallel Session 7.2: Correlations and Fluctuations (II)

Track Classification: Correlations and Fluctuations
Forward Calorimetry for Heavy-Ion Physics at the STAR Experiment

A forward calorimeter utilizing hadronic and electromagnetic calorimetry at the STAR experiment of RHIC will achieve a variety of physics goals. These goals include studying long-range rapidity correlations, event plane correlations in heavy-ion interactions, and studying the gluon contribution to the proton spin by measuring forward di-jets and forward-mid rapidity jet correlations in proton-proton collisions. Upgrades to the AGS E864 lead-scintillating fiber calorimeter have increased spatial resolution by utilizing cell pixelization. Pixelization increases spatial resolution by replacing a single photosensor on individual 10cm x 10cm cells by a set of nine photosensors, resulting in 3.3cm x 3.3cm pixels. Pixelization was tested with colliding beams at STAR and fixed target test beams at FNAL. Light collection has been optimized and fringe field effects have been minimized by the introduction of Fresnel lenses and mu-metal shielding. A prototype consisting of a 2x3 cell stack was installed into the forward region of STAR for the end of run16. This prototype investigated the introduction of these new techniques as well as a trial of Silicon Photomultipliers (SiPMs) as an alternate to traditional Photomultiplier Tubes (PMTs). SiPMs do not suffer from fringe field effects, but are susceptible to radiation damage by neutrons, so their performance during the prototype operation was analyzed. The prototype observed Au+Au collisions at 200GeV. There is a proposal to install two 9-column x 12-row cell stacks as forward jet detectors at STAR, with 16 cells in each stack pixelized. This poster will discuss the effects of Fresnel lenses on light collection, mu-metal shielding effects on PMTs, and radiation effects on SiPMs.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

STAR

Primary author: BROWN, Daniel (Lehigh University)

Presenter: BROWN, Daniel (Lehigh University)

Session Classification: Poster Session
Upsilon measurements in p+p, p+Au and Au+Au collisions at √sNN = 200 GeV with the STAR experiment

Tuesday, 7 February 2017 17:50 (20 minutes)

Measurements of quarkonium production have played an important role in understanding the properties of the Quark-Gluon Plasma (QGP) formed in relativistic heavy-ion collisions. The suppression of quarkonia in the medium due to color screening has been proposed as a direct signature of the QGP formation. However, other effects, such as regeneration of quarkonia by the coalescence of uncorrelated quark-antiquark pairs, co-mover absorption, and cold nuclear matter effects, add additional complications to the interpretation of the observed quarkonium suppression. Compared to charmonia, bottomonia suffer much less from regeneration contribution and co-mover absorption. Furthermore, different bottomonium states may dissociate at different temperatures, known as "sequential melting", which can be used to constrain the temperature of the medium.

Quarkonium measurements have been traditionally performed in the dielectron channel at STAR. In early 2014, the Muon Telescope Detector (MTD), which provides muon identification and triggering capabilities at mid-rapidity, was fully installed into the STAR experiment. It allows measurements of quarkonia via the di-muon channel with much smaller Bremsstrahlung radiation and thus much better invariant mass resolution than the dielectron channel. In this talk, we will present the measurements of Υ suppression in Au+Au collisions at √sNN = 200 GeV via both the di-muon and dielectron channels. The centrality and transverse momentum dependences will be reported and compared to those at the LHC and theoretical calculations. We will also show the Υ measurements in p+p and p+Au collisions at √sNN = 200 GeV via the dielectron channel using the data taken in year 2015. These measurements provide a significantly improved p+p reference and quantification of the cold nuclear matter effects for Υ measurements at RHIC.

Preferred Track

Quarkonia

Collaboration

STAR

Primary author: YE, ZAOCHEN (UNIVERSITY OF ILLINOIS AT CHICAGO)

Presenter: YE, ZAOCHEN (UNIVERSITY OF ILLINOIS AT CHICAGO)

Session Classification: Parallel Session 4.3: Quarkonia (II)

Track Classification: Quarkonia
Jets and their modifications due to partonic energy loss provide a powerful tool to study the properties of the QGP created in ultrarelativistic heavy ion collisions. For correlation studies of jet energy loss, two complementary trigger object choices offer access to the initial hard parton’s energy: On the one hand, direct-photon–tagged jets are a self-generated tomographic medium probe, unaffected by the medium and hence with an unbiased in-medium path length. They are also expected to exhibit a different flavor-dependence of energy loss, since high-pT direct photons are primarily produced with a quark recoil. On the other hand, reconstructed jets offer the promise of path length control or Jet Geometry Engineering through cut parameters. Previously, A_{J} measurements at STAR observed significant imbalance for anti-k_{T} di-jets with a resolution parameter R = 0.4 and a “hard-core” selection using only constituents with p_{T} above 2.0 GeV/c and a neutral high tower with E_{T} > 5.5 GeV. When soft constituents are included, this imbalance is found restored to the balance of the p+p reference inside the original jet cone, indicative of milder modification due to more surface-biased production.

We present a study of correlated hadrons and semi-inclusive recoil jets coincident with direct photons and neutral pions with 9 < E_{trig} < 20 GeV, as well as with respect to the dijet selection from the above A_{J} measurement. A comparison between the two measurements, and a comparison to similar measurements at RHIC and the LHC establishes new systematic input into the flavor- and path-length dependence of light flavor energy loss in the QGP.

Preferred Track
Jets and High pT Hadrons

Collaboration
STAR

Primary author: Dr SAHOO, NIHAR RANJAN (Texas A&M University)
Presenter: Dr SAHOO, NIHAR RANJAN (Texas A&M University)
Session Classification: Parallel Session 1.4: Jets and High pT Hadrons (I)
Track Classification: Jets and High pT Hadrons
Prospects for ALICE physics with the Muon Spectrometer Upgrade and the new Muon Forward Tracker

ALICE is the experiment specifically designed for the study of the Quark-Gluon Plasma in heavy-ion collisions at the CERN LHC. The ALICE detector will be upgraded during the LHC Long Shutdown-2, planned for 2019-2020, in order to fully exploit the large integrated luminosity that will be provided by the LHC in Run-3 and Run-4.

The Muon Forward Tracker (MFT), an internal tracker added in the acceptance of the existing Muon Spectrometer and designed to cover the pseudorapidity range \(2.5 < \eta < 3.6\), will be part of the ALICE detector upgrade programme, allowing for a crucial improvement of the measurements presently done with the Muon Spectrometer, and giving access to new measurements. The precise estimation of the offset to the primary vertex for the muon tracks, in particular, will permit the statistical separation of open charm \((c \tau \sim 120 - 300 \mu m)\) and beauty \((c \tau \sim 500 \mu m)\) production, including displaced vertices related to \(J/\psi\) production from B-decays, rejecting at the same time a large fraction of background muons coming from pion and kaon decays.

Beyond the installation of the new MFT, the ambitious programme of high-precision measurements expected to characterise the ALICE muon physics after 2020, will also impose the upgrade of the front-end and readout electronics of the existing Muon Spectrometer. A selection of results from the physics performance studies will be presented, together with an overview of the technical aspects of the MFT project and the upgrade of the Muon Spectrometer electronics.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
ALICE

Primary author: Dr URAS, Antonio (Universite Claude Bernard-Lyon I (FR))
Presenter: Dr URAS, Antonio (Universite Claude Bernard-Lyon I (FR))
Session Classification: Poster Session
Anomalous transport model study of chiral magnetic effects in heavy ion collisions

Using an anomalous transport model for massless quarks and antiquarks, we study the effect of magnetic field on the elliptic flows of quarks and antiquarks in relativistic heavy ion collisions. With initial conditions from a blast wave model and assuming that the strong magnetic field produced in non-central heavy ion collisions can last for a sufficiently long time, we obtain an appreciable electric quadrupole moment in the transverse plane of a heavy ion collision. In the absence of the Lorentz force and assuming that the quark-antiquark scattering is dominated by the chirality changing channel, the electric quadrupole moment subsequently leads to a splitting between the elliptic flows of quarks and antiquarks, as expected from the chiral magnetic wave formed in the produced QGP and observed in experiments at the Relativistic Heavy Ion Collider (RHIC).

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary author: SUN, Yifeng (Texas A&M University)
Co-author: Dr LI, Feng (Frankfurt Institute for Advanced Study)
Presenter: SUN, Yifeng (Texas A&M University)
Session Classification: Poster Session
Evidence for chiral symmetry restoration in heavy-ion collisions

Wednesday, 8 February 2017 18:10 (20 minutes)

We study the effect of the chiral symmetry restoration (CSR) on heavy-ion collisions observables in the energy range $\sqrt{s_{NN}} = 3–20\,\text{GeV}$ within the Parton-Hadron-String Dynamics (PHSD) transport approach. The PHSD includes the deconfinement phase transition as well as essential aspects of CSR in the dense and hot hadronic medium, which are incorporated in the Schwinger mechanism for particle production. Our systematic studies show that chiral symmetry restoration plays a crucial role in the description of heavy-ion collisions at $\sqrt{s_{NN}} = 3–20\,\text{GeV}$, realizing an increase of the hadronic particle production in the strangeness sector with respect to the non-strange one. We identify particle abundances and rapidity spectra to be suitable probes in order to extract information about CSR, while transverse mass spectra are less sensitive. Our results provide a microscopic explanation for the "horn" structure in the excitation function of the $K^+ / \pi^+$ ratio: the CSR in the hadronic phase produces the steep increase of this particle ratio up to $\sqrt{s_{NN}} \approx 7\,\text{GeV}$, while the drop at higher energies is associated to the appearance of a deconfined partonic medium. Furthermore, the appearance/disappearance of the 'horn' structure is investigated as a function of the system size and collision centrality. We additionally present an analysis of strangeness production in the $(T, \mu_B)$-plane (as extracted from the PHSD for central Au+Au collisions) and discuss the perspectives to identify a possible critical point in the phase diagram.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Not applicable

Primary author: MOREAU, Pierre (Frankfurt Institute of Advanced Studies)

Presenter: MOREAU, Pierre (Frankfurt Institute of Advanced Studies)

Session Classification: Parallel Session 8.1: Baryon-Rich QCD Matter and Astrophysics (III)

Track Classification: Baryon-Rich QCD Matter and Astrophysics
Measurements of charmonium production in p+p, p+Au, and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the STAR experiment

Tuesday, 7 February 2017 14:00 (20 minutes)

Quarkonium production is an important probe to study the properties of the Quark Gluon Plasma (QGP) formed in relativistic heavy-ion collisions. The suppression of $J/\psi$ due to the color-screening effect in the medium was initially proposed as direct evidence of the QGP formation. However, the interpretation of $J/\psi$ suppression is still challenging due to the regeneration contribution from the coalescence of uncorrelated $c\bar{c}$ pairs in the medium and the cold nuclear matter effects. By comparing productions of different charmonium states in p+p, p+Au, and Au+Au collisions, the cold and hot nuclear matter effects can be systematically studied in detail.

In the 2014 and 2015 RHIC runs, the STAR experiment recorded a large amount of data in p+p, p+Au, and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV for charmonium studies via both the dielectron and dimuon channels. In this talk, we present precise measurements of nuclear modification factors for $J/\psi$ production over a broad kinematic range in both p+Au and Au+Au collisions. We will also present the first measurements of the double ratio of $\psi(2s)$ and $J/\psi$ production rates at mid-rapidity in p+p and p+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. We will compare these results with model calculations and discuss physics implications of the measured cold and hot nuclear matter effects for extracting the QGP properties.

Preferred Track
Quarkonia

Collaboration
STAR

Primary author: Dr TODOROKI, Takahito (Brookhaven National Laboratory)
Presenter: Dr TODOROKI, Takahito (Brookhaven National Laboratory)
Session Classification: Parallel Session 3.3: Quarkonia (I)
Track Classification: Quarkonia
The new Inner Tracking System of the ALICE experiment

Wednesday, 8 February 2017 18:10 (20 minutes)

The ALICE experiment will undergo a major upgrade during the next LHC Long Shutdown (LS2) scheduled in 2019-20 that will allow to study in detail the QGP properties exploiting the increased Pb-Pb luminosity expected during Run 3 and Run 4.

The replacement of the existing Inner Tracking System (ITS) with a completely new ultra-light high-resolution detector is one of the cornerstones within this upgrade program. The main motivation of the ITS upgrade is to provide ALICE with an improved tracking capability and impact parameter resolution at very low transverse momentum, as well as to enable a substantial increase of the interaction rate readout.

The new ITS will consist of seven layers of an innovative Monolithic Active Pixel Sensors with the innermost layers sitting at only 22 mm from the interaction point. This talk will focus on the design and the physics performance of the new ITS, as well as the technology choices adopted. The status of the project and the results from the prototypes characterization will also be presented.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ALICE

Primary author: MARTINENGO, Paolo (CERN)
Presenter: MARTINENGO, Paolo (CERN)
Session Classification: Parallel Session 8.2: Future Experimental Facilities, Upgrades, and Instrumentation
Track Classification: Future Experimental Facilities, Upgrades, and Instrumentation
Measurements of open bottom and charm hadron production through multiple decay channels in p+p, p+Au and Au+Au collisions with the STAR experiment

Wednesday, 8 February 2017 14:00 (20 minutes)

Heavy flavor quarks have been suggested as excellent probes to study the Quark-Gluon Plasma (QGP) created in ultra-relativistic heavy-ion collisions. Significant suppression of open heavy flavor production at large transverse momentum has been observed in Au+Au collisions relative to p+p collisions at \( \sqrt{s_{NN}} = 200 \) GeV at RHIC. Such a suppression can be attributed to the energy losses of heavy flavor quarks due to their interactions with the QGP, which are expected to be different for bottom and charm quarks because of their different masses. In order to fully understand the parton-QGP interactions and thus the QGP properties, it is essential to measure open bottom and charm hadron suppressions separately in Au+Au collisions. Moreover, Cold Nuclear Matter (CNM) effects due to the different initial states in p+p and Au+Au collisions also need to be taken into account when interpreting these results.

In this talk, we will report measurements of open bottom and charm hadron production through multiple decay channels in p+p, p+Au and Au+Au collisions at \( \sqrt{s_{NN}} = 200 \) GeV with the STAR experiment. We will show the first results on open bottom hadron production in Au+Au collisions, where electrons, \( D^0 \) and \( J/\psi \) from open bottom hadron decays are topologically identified utilizing the STAR Heavy Flavor Tracker. These results will be compared to those of open charm hadron production to study the mass dependence of parton interactions with the QGP at RHIC energies. Nuclear modification factor \( R_{pA} \) for electrons from inclusive open heavy flavor hadron decays will also be shown to quantify the CNM effects on open heavy flavor production.

Preferred Track

Open Heavy Flavors

Collaboration

STAR

Primary author: OH, Kunsu (Pusan National University (KR))

Presenter: OH, Kunsu (Pusan National University (KR))

Session Classification: Parallel Session 7.4: Open Heavy Flavors (II)

Track Classification: Open Heavy Flavors
Jet energy loss in small systems with finite-size effects and running coupling

In the LHC and RHIC experiments, strong collective behavior has been observed in high multiplicity events in the p-p and p-A collisions. Such behavior strongly suggests that quark-gluon plasma (QGP) is being created even in small systems when enough entropy is produced.

In this work, we utilize an improved version of MARTINI to calculate the effect of the QGP droplet on the jet energy loss in p-A collisions with the well-calibrated 3+1D hydrodynamics medium1. The two important improvements implemented in this version of MARTINI are the finite medium size effect2 and the running coupling effect3.

Since the system we are dealing with is small, both of these improvements are critical. Using realistic event-by-event initial conditions, we show that systematic measurements of jet quenching in small systems can provide a strong evidence of the QGP formation4.

Rapidity dependence of $R_{pA}$ and harmonic flows of energetic partons in small collision systems will be also presented.

In addition, to access information of the medium structure and of missing jet energies, we provide calculations of jet $R_{pA}$ and di-jet imbalance through the full jet reconstruction.


Preferred Track

QCD in small systems

Collaboration

Not applicable

Primary author: PARK, Chanwook (McGill University)

Co-author: Dr SHEN, Chun (Brookhaven National Laboratory)

Presenter: PARK, Chanwook (McGill University)

Session Classification: Poster Session
The STAR eTOF Upgrade

The first RHIC Beam Energy Scan (BES-I) provided an initial survey of the QCD phase diagram by acquiring data from Au+Au collisions from $\sqrt{s_{NN}} = 7.7$ to 62.4 GeV. Based on those results, a second phase of the BES program, BES-II, has been developed and is scheduled to run in 2019 and 2020. One of the proposed upgrades to STAR for BES-II will be the addition of an end-cap time-of-flight system (eTOF). The eTOF upgrade will employ 36 CBM TOF modules for the duration of BES-II. The eTOF upgrade will extend STAR’s particle identification (PID) capabilities to higher momentum in the forward pseudorapidity range provided by the iTPC upgrade. A fixed-target program, enabled by the eTOF upgrade, will extend the energy scan below the 7.7 GeV lowest energy of BES-I. In this poster, we discuss the improvements that the eTOF subsystem will bring to the physics program of BES-II.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

STAR

Primary author: GEURTS, Frank (Rice University (US))
Presenter: GEURTS, Frank (Rice University (US))
Session Classification: Poster Session
Elliptic flow at intermediate transverse momentum: mass versus quark number

The particle species dependence of elliptic flow ($v_2$) at intermediate transverse momentum ($p_T$) provide a mean to investigate the hadronization mechanism of the dense medium formed in heavy ion collisions. At intermediate $p_T (> 2 \text{ GeV/c})$, $v_2$ of different particles exhibit an interesting scaling behaviour when divided by their constituent number of quarks (NCQ-scaling). At RHIC, the NCQ-scaling was recognized as a hallmark signature of quark like degrees of freedom and particle production via a mechanism of quark recombination. However, recent data from the top-RHIC and LHC energy suggest that scaling is only an approximation and questions the relevance of coalescence as model of hadronization. Here, in the framework of string melting (SM) version of A Multi Phase Transport model (AMPT), we aim to study the source(s) of NCQ-violation at top-RHIC and LHC energies. From our study we infer that large deviation from the perfect scaling at LHC is because of the modification of the $v_2$ generated at the partonic phase by the final stage hadronic re-scatterings together with the extension of linear scaling between hadron and parton $v_2$ upto higher values of hadron $p_T$ because of high phase-space density at the partonic level.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: CHOUDHURY, Subikash (Department of Atomic Energy (IN))

Presenter: CHOUDHURY, Subikash (Department of Atomic Energy (IN))

Session Classification: Poster Session
Quarkonium production in pp collisions with ALICE at the LHC

Quarkonia are mesons formed of either a charm and anti-charm quark pair (J/ψ, Ψ(2S)), or a beauty and anti-beauty quark pair (Upsilon(1S), (2S) and (3S)). In high-energy hadronic collisions such as those delivered by the LHC between 2010 and 2015, quarkonium production results from the hard scattering of two gluons in a process which occurs very early in the collision followed by the hadronization of the heavy quark pair in a bound state. In pp collisions, quarkonium measurements help characterize production mechanisms. These same measurements also provide a reference baseline for p-A and A-A measurements which in turn quantify cold and hot nuclear properties of the Quark-Gluon Plasma (QGP). While charmonia are produced rather abundantly in such collisions, interpreting the measurement of their inclusive production is complicated by the presence of a sizable non-prompt contribution from the decay of b-hadrons. Bottomonia on the other hand have much smaller production cross sections but no non-prompt contribution. Moreover, their heavier mass makes them more suitable for perturbative QCD calculations. In this presentation we will report on forward rapidity ($2 < y < 4$) $J/\psi$, $(2S)$ and latest results in the di-muon decay channel performed by ALICE in pp collisions at a center of mass energy $\sqrt{s} = 13$-TeV, using data collected at the LHC during the 2015 run and corresponding to an integrated luminosity of approximately $3.5 \text{ pb}^{-1}$. These measurements will be compared to corresponding results performed by other LHC experiments at the same energy, to results obtained at lower energies ranging from $\sqrt{s} = 2.76$ to $\sqrt{s} = 8$ TeV, as well as to theoretical models.
Mott-hadron resonance gas and lattice QCD thermodynamics

We present an effective model for low-energy QCD thermodynamics which provides a microscopic interpretation of the transition from a gas of hadron resonances to the quark-gluon plasma by Mott dissociation of hadrons and compare results with data from lattice QCD simulations. We consider the thermodynamics of the Polyakov-loop extended Nambu–Jona-Lasinio (PNJL) model within the self consistent approximation scheme of the \( \Phi \)-derivable approach. This allows us to obtain the Generalized Beth-Uhlenbeck (GBU) equation of state. Our approach goes beyond the mean-field description of quark matter by taking into account hadronic correlations (bound and scattering states) (Annals Phys. 348 (2014) 228-255) as well as their backreaction on the propagator of constituents. The next step in our work is to include more hadronic degrees of freedom than just the low-lying pseudoscalar mesons.

For that purpose we discuss a model for the generic behavior of hadron masses and phase shifts at finite temperature which shares basic features with recent developments within the PNJL model for correlations in quark matter. We also discuss the occurrence of an anomalous mode for mesons composed of quarks with unequal masses which is particularly pronounced for positive kaon and kappo states at finite densities a possible mechanism to explain the “horn effect” for the positive Kion/pion ratio in heavy-ion collisions (arXiv:1608.05383v3).

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: ALEKSANDR, Dubinin (University of Wroclaw)

Presenter: ALEKSANDR, Dubinin (University of Wroclaw)

Session Classification: Poster Session
Within the overwhelming majority of models, light quark and gluon jet quenching in heavy ion collisions is described as resulting predominantly from pQCD-type gluon radiation, but details of the underlying mechanisms differ greatly. One key difference lies in the treatment of the Altarelli-Parisi, AP, splitting functions. While in some models, such as Q-PYTHIA, the splitting functions are directly modified in the medium, this core component remains unchanged in others (e.g. YaJEM). The shared momentum fraction $z_g$ was shown to be a Sudakov-safe measurement of the splitting function $1$.

This quantity measures the $p_T$ ratio between the two dominant branches as determined by the SoftDrop grooming process.

An inclusive measurement of $z_g$ in $p+p$ collisions at top RHIC energy will be presented. The focus of our $Au+Au$ results will be on a comparative study to $p+p$ using the specific di-jet selection introduced in our previous momentum imbalance measurement, i.e. jets geometrically matched to "hard core" jets found using only constituents above 2 GeV/$c$ and with a high tower above 5.5 GeV. Such di-jet pairs were found to be significantly imbalanced with respect to $p+p$, yet regained balance when all soft constituents were included. Individual examination of the splitting behavior of leading and recoil jet adds a new dimension to this observation, and new input to energy loss models.

Measurement of the suppression and azimuthal anisotropy of heavy flavor muons in lead-lead collisions at $\sqrt{s_{\text{NN}}}=2.76$ TeV with the ATLAS detector

Wednesday, 8 February 2017 15:00 (20 minutes)

ATLAS measurements are presented on the production of muons from heavy-flavor decays in $\sqrt{s_{\text{NN}}}=2.76$ TeV Pb+Pb collisions and $\sqrt{s}=2.76$ TeV pp collisions at the LHC. The measurements are performed over the transverse momentum range $4<p_T<14$ GeV and over the 0-60% centrality interval. Backgrounds arising from in-flight pion and kaon decays, hadronic showers, and mis-reconstructed muons are removed using a template-fit procedure. The heavy-flavor muon differential cross-sections and per-event yields are measured in pp and Pb+Pb collisions, respectively. The nuclear modification factor $R_{AA}$ is observed to be independent of $p_T$ within uncertainties and to be less than unity, which indicates suppressed production of heavy flavor muons in Pb+Pb collisions. The heavy-flavor muon yield is also measured as a function of the azimuthal angle difference, $\phi - \Psi_2$, relative to the second-order event plane angle. Fourier coefficients associated with the $\cos(2(\phi - \Psi_2))$ modulation, $v_2$, are measured as a function of $p_T$ and centrality. They vary slowly with $p_T$ and show a systematic variation with centrality that is characteristic of other $v_2$ measurements. The higher-order harmonics $v_3$ and $v_4$ are also measured. These measurements provide insight into the energy loss mechanism of heavy quarks as they propagate through the hot, dense medium produced in heavy ion collisions.

Preferred Track
Open Heavy Flavors

Collaboration
ATLAS

Primary author: COLE, Brian (Columbia University (US))
Presenter: COLE, Brian (Columbia University (US))
Session Classification: Parallel Session 7.4: Open Heavy Flavors (II)
Track Classification: Open Heavy Flavors
Is pQCD energy loss in trouble?

Wednesday, 8 February 2017 12:00 (20 minutes)

Current pQCD calculations for the energy loss of a hard parton moving through a medium of thermalized static scattering centres are inapplicable to the small colliding systems (such as p/d +A) that have, in recent years, hinted at the presence of tiny droplets of QGP through the presence of collective behaviour, strangeness enhancement and quarkonium suppression. The well-known DGLV, ASW, BDMPS-Z, AMY and HT calculations all exploit both the large separation distance (between scattering centre and radiation) and the large system approximations. We relax the large system assumption and recompute the energy loss in the DGLV formalism in order to address the glaring lack of theoretical control over small-system energy loss. Alarmingly, we find that the correction terms dominate at large energies, resulting in ~100% negative correction, calling into question the validity of the large formation time assumption used in all pQCD-based energy loss calculations. Our results demand a complete overhaul of pQCD-based energy-loss calculations for all system sizes.

Preferred Track
QCD in small systems

Collaboration
Not applicable

Primary author:  KOLBE, Isobel (University of Cape Town)
Presenter:  KOLBE, Isobel (University of Cape Town)
Session Classification:  Parallel Session 6.1: QCD in Small Systems (III)
Track Classification:  QCD in small systems
Shear viscosity and entropy of a hadron gas

Microscopic non-equilibrium dynamics are used to calculate the transport coefficients of dense hadronic matter. Specifically, the shear viscosity to entropy density ratio is investigated, and its temperature dependence between 75 MeV and 175 MeV is explored, and the effects of non-zero baryon and strange chemical potentials are probed. This is important to constrain the value of shear viscosity over entropy density used in hydrodynamic calculations of heavy ion reactions at RHIC and the LHC. Calculations are initialized using the corresponding particle densities computed from a thermal model in a hadronic box simulating infinite matter. After an appropriate equilibration delay, the shear viscosity $\eta$ is computed using the Green-Kubo formalism. The entropy density $s$ is obtained using the Gibbs formula and $dN/dp$ spectral fitting to obtain the final (equilibrated) temperatures and chemical potentials of the system. As a check, the results for the entropy and shear viscosity of a massive and massless pion gas are compared to analytic estimates. The shear viscosity to entropy density ratio $\eta/s$ is found to be significantly lower than found in previous similar calculations by Demir & Bass, but in qualitative agreement with other calculations using other methods by Romatschke & Pratt and [Song, Bass & Heinz][3]. This will be the starting point for the calculation of more transport coefficients as functions of $T$ and $\mu_B$.


Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author:  ROSE, Jean-Bernard

Presenter:  ROSE, Jean-Bernard

Session Classification:  Poster Session
Data-driven particle composition correction of tracking efficiency for charged particles with ALICE

The ALICE experiment at the LHC is designed to investigate the properties of the Quark-Gluon Plasma by studying high energy pp, p-Pb and Pb-Pb collisions. The parton energy loss in the medium can be examined by measuring the production of charged particles and their nuclear modification factor at high transverse momentum. In ALICE, charged particles are measured with the Time Projection Chamber. An accurate estimate of the tracking efficiency is a key ingredient for such measurements.

In this poster, we show how tracking efficiencies are obtained based on Monte Carlo simulations with PYTHIA and HIJING event generators for particle production and GEANT to simulate the detector response. In particular, we focus on the data-driven procedure being performed to re-weight the tracking efficiencies of identified particles that account for the different abundances of the various particle species in Monte-Carlo and data.

We present results on the tracking efficiency obtained from this data-driven procedure for the measurement of charged particles, especially in pp and Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: HUHN, Patrick (Johann-Wolfgang-Goethe Univ. (DE))

Presenter: HUHN, Patrick (Johann-Wolfgang-Goethe Univ. (DE))

Session Classification: Poster Session
ϕ meson production in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE at the LHC

Wednesday, 8 February 2017 17:10 (20 minutes)

Quantum Chromodynamics predicts the occurrence of a phase transition from the hadronic matter to a plasma of deconfined quarks and gluons (Quark-Gluon Plasma) at extreme conditions of temperature and energy density. Ultrarelativistic heavy-ion collisions provide the means to study this phase of matter in the laboratory.

Strangeness production is a key tool to understand the properties of the medium formed in heavy-ion collisions: an enhanced production of strange particles was early proposed as one of the signatures of the QGP. The ϕ meson, due to its $s\bar{s}$ valence quark content, provides insight into strangeness production.

The ALICE experiment has measured ϕ meson production in the dimuon channel in the forward rapidity region $2.5 < y < 4$ in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.

The preliminary ϕ meson $p_T$ spectra for different centrality classes and the yield as a function of the collision centrality in the transverse momentum range $2 < p_T < 7$ GeV/c are presented. These results are also compared with the ones previously obtained in Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV.

Preferred Track

QCD at High Temperature

Collaboration

ALICE

Primary author: CASULA, Ester Anna Rita (Universita e INFN, Cagliari (IT))

Presenter: CASULA, Ester Anna Rita (Universita e INFN, Cagliari (IT))

Session Classification: Parallel Session 8.3: Collective Dynamics (III)

Track Classification: QCD at High Temperature
Calibration and Performance of EMCal and DCAL Detectors at ALICE

ALICE at the LHC is designed to explore the quark-gluon plasma (QGP) state resulting from high energy heavy-ion collisions. The ALICE Electromagnetic Calorimeter (EMCal) can be used to measure hard probes of the initial collision, including jets, high \( p_T \) photons, neutral mesons (\( \pi^0, \eta, \omega \)), and electrons. For LHC Run 2 (2015-2018) an additional detector was installed on the opposite side of the beam axis, the Di-Jet Calorimeter (DCal). The DCal provides the angular coverage necessary to facilitate jet-jet, hadron-jet, and \( \gamma \)-jet correlations, while also acting as a same-event background estimator for EMCal measurements in p-Pb and Pb-Pb collisions. In order to accurately perform these measurements, the EMCal and DCal must be calibrated in both energy and time. In this poster we present the current calibration status and the performance of EMCal and DCal.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ALICE

Primary author:  BLAIR, Justin Thomas (University of Texas (US))
Presenter:  BLAIR, Justin Thomas (University of Texas (US))
Session Classification:  Poster Session
Resolution Effects in the Hybrid Strong/Weak Coupling Model

Within the context of a hybrid strong/weak coupling model of jet quenching, we study the consequences of the fact that the plasma produced in a heavy ion collision cannot resolve the substructure of a collimated parton shower within it to arbitrary resolution.

We introduce a screening length parameter, $L_{\text{Res}}$, proportional to the inverse of the local temperature in the plasma, estimating the value of the proportionality constant from both weakly coupled QCD calculations and holographic calculations appropriate in strongly coupled plasma.

We then modify the hybrid model so that when a parton in a jet shower splits, its two offspring are initially treated as unresolved, and are only treated as two separate partons losing energy independently after they are separated by a distance $L_{\text{Res}}$. This modification delays the quenching of partons with intermediate energy, resulting in the survival of more hadrons in the final state with $p_T$ in the several GeV range.

We demonstrate that this effect modifies the jet shapes and jet fragmentations functions, as it makes it more probable for particles carrying a small fraction of the jet energy at larger angles from the jet axis to survive their passage through the quark-gluon plasma.

We analyze the consequences of different choices for the value of the resolution length $L_{\text{Res}}$ on both partonic and hadronic jet shapes and fragmentation functions, as well as on missing-$p_T$ observables.

More generally, we discuss the qualitative consequences, and importance, of including the effects of finite resolution.

**Preferred Track**

Jets and High $p_T$ Hadrons

**Collaboration**

Not applicable

**Primary author:** HULCHER, Zachary (Massachusetts Inst. of Technology (US))

**Presenter:** HULCHER, Zachary (Massachusetts Inst. of Technology (US))

**Session Classification:** Poster Session
Measurement of charmonia production in heavy-ion collisions with the ATLAS detector

Tuesday, 7 February 2017 15:00 (20 minutes)

The suppression of heavy charmonia states in heavy-ion collisions is a phenomenon understood as a consequence of QGP formation in the hot, dense system formed in heavy ion collisions at the LHC. In addition to hot matter effects in heavy-ion collisions, cold nuclear effects may also affect heavy charmonia production. Therefore, a full assessment requires detailed studies on the effects present in both A-A and p+A collisions. Based on p+Pb data collected in 2013 and pp and Pb+Pb data collected in 2015 at the LHC, the ATLAS experiment has studied prompt and non-prompt J/psi and psi(2S)productions via the di-muon decay final states. The production and excited-to-ground state ratios of heavy charmonia measured in both p+Pb and Pb+Pb collision data with respect to that measured in pp collision data will be presented in intervals of transverse momentum, rapidity and centrality.

Preferred Track
Quarkonia

Collaboration
ATLAS

Primary author: LOPEZ LOPEZ, Jorge Andres (Federico Santa Maria Technical University (CL))

Presenter: LOPEZ LOPEZ, Jorge Andres (Federico Santa Maria Technical University (CL))

Session Classification: Parallel Session 3.3: Quarkonia (I)

Track Classification: Quarkonia
The QCD equation of state at finite density from analytical continuation

Tuesday, 7 February 2017 14:40 (20 minutes)

We want to study thermodynamical observables at finite density. Since direct lattice simulations at finite \( \mu_B \) are hindered by the sign problem an efficient way to study the QCD phase diagram at small finite density is to extrapolate observables from imaginary chemical potential. In this talk we present results on several observables for the equation of state. The observables are calculated along the isentropic trajectories in the \((T, \mu_B)\) plane corresponding to the RHIC Beam Energy Scan collision energies. The simulations are performed at the physical mass for the light and strange quarks. \( \mu_S \) was tuned in a way to enforce strangeness neutrality to match the experimental conditions; the results are continuum extrapolated and systematic effects are taken into account for the error estimate.

Preferred Track
QCD at High Temperature

Collaboration
Not applicable

Primary author: GÜNTHER, Jana (University of Wuppertal)
Presenter: GÜNTHER, Jana (University of Wuppertal)
Session Classification: Parallel Session 3.1: QCD at High Temperature
Track Classification: QCD at High Temperature
Femtoscopy with identified charged pions in proton-lead collisions at $\sqrt{s_{\text{NN}}}=5.02$ TeV with the ATLAS detector

Bose-Einstein correlations between identified charged pions are measured for $p+$Pb collisions at $\sqrt{s_{\text{NN}}}=5.02$ TeV with the ATLAS detector with a total integrated luminosity of 28 nb$^{-1}$. Pions are identified using ionization energy loss measured in the pixel detector. Two-particle correlation functions and the extracted three-dimensional source radii are presented as a function of average transverse pair momentum ($k_T$) and rapidity ($y^*_{\pi\pi}$) as well as collision centrality. Pairs are selected with a rapidity $-2 < y^*_{\pi\pi} < 1$ and with an average transverse momentum $0.1 < k_T < 0.8$ GeV. The effect on the two-particle correlation function from jet fragmentation is studied, and a new method for removing its contributions to the measured correlations is described. The measured homogeneity regions are substantially larger in more central collisions, and in central events the radii are observed to decrease with increasing pair $k_T$, which is understood as a signature of collective behavior. In order to relate the freeze-out geometry to particle flow, the radii are also presented as a function of azimuthal angle with respect to the second-order event plane. The amplitude of the azimuthal modulation is shown as a function of centrality and flow vector magnitude $v_2$. A correlation of the source size with the local multiplicity $dN/dy^*$ is demonstrated. The scaling of the extracted radii with the mean number of participants is also used to compare a selection of initial-geometry models. The cross term $R_{\text{ol}}$, which couples the radial and longitudinal expansion of the source, is measured as a function of rapidity. A departure from zero is observed in the proton-going side with 4.8$\sigma$ combined significance for the most central events.

Preferred Track

Correlations and Fluctuations

Collaboration

ATLAS

Primary author: CLARK, Michael Ryan (Columbia University (US))
Presenter: CLARK, Michael Ryan (Columbia University (US))
Session Classification: Parallel Session 6.1: QCD in Small Systems (III)
Track Classification: Correlations and Fluctuations
Single-Track $\pi_0$ Reconstruction with the MPC-EX at PHENIX

An algorithm has been developed for reconstructing high-$p_T$ $\pi_0$s at large pseudorapidities using the MPC and MPC-EX systems at PHENIX. The Muon Piston Calorimeter Extension Upgrade (MPC-EX) to PHENIX is a preshower detector located in front of the MPC, an electromagnetic calorimeter, placed at large pseudorapidity ($3.1<\eta<3.8$). The MPC-EX consists of alternating tungsten plates and micropattern silicon sensors. At momenta above $p \sim 20$ GeV/c, the opening angle of the $\pi_0$ decay photons becomes too small to resolve with the MPC alone. By using the MPC-EX preshower, the the decay photons of $\pi_0$s of up to $p \sim 100$ GeV/c can be resolved. $\pi_0$s are recognized and reconstructed by analyzing the shower shape in the MPC-EX.

Preferred Track

Electromagnetic Probes

Collaboration

PHENIX

Primary author: BRYSLAWSKYJ, Jason

Presenter: BRYSLAWSKYJ, Jason

Session Classification: Poster Session
Cold nuclear matter effects on non-photonic electron production measured in p+Au collisions by the STAR Experiment

Due to their large masses, heavy flavor quarks are dominantly produced in initial hard parton scattering processes in high-energy heavy-ion collisions. They experience the full evolution of the strongly interacting Quark-Gluon Plasma (QGP) created in such collisions. Thus, heavy quarks have been suggested as excellent probes of the properties of the QGP. To study how heavy flavor quarks interact with the QGP, initial-state effects upon heavy flavor production due to the presence of the heavy ions must be understood. These initial-state effects, also known as Cold Nuclear Matter (CNM) effects, need to be studied in collision systems that include a heavy ion but are not expected to produce a QGP, such as p+Au collisions. Non-Photonic Electrons (NPE) from semileptonic decays of open heavy flavor hadrons can serve as a proxy for heavy flavor quarks, and be used to measure CNM effects on heavy flavor production.

In this poster, we will present the first measurement of inclusive NPE production in p+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the STAR experiment. Data were triggered by large energy deposition in the Barrel Electromagnetic Calorimeter, corresponding to integrated luminosities of 140–410 nb$^{-1}$ depending on the trigger threshold, from the 2015 run at the Relativistic Heavy Ion Collider (RHIC). The nuclear modification factor $R_{p,A}$, which is a measure of CNM effects on NPE production, will be reported, and its implications for NPE production in Au+Au collisions will be discussed.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

STAR

Primary author: MILLER, Zachariah (University of Illinois at Chicago)

Presenter: MILLER, Zachariah (University of Illinois at Chicago)

Session Classification: Poster Session
The dipole flow in Cu+Au and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the STAR detectors

The dipole flow originates from the asymmetry in the initial density distributions either due to projectile-target asymmetry (Cu+Au collisions) or due to the event-by-event fluctuations. Unlike the conventional directed flow that is rapidity-odd in symmetric collisions, the dipole flow is rapidity-even and has weak dependence on the pseudorapidity. The dipole flow has a characteristic of zero net transverse momentum in the system. We present the dipole flow, the conventional directed flow, and the average projection of the transverse momentum on the flow direction for charged particles in Cu+Au and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV in the STAR experiment. The directed flow is measured with respect to the spectator planes and with the three-point correlator including the participant planes as functions of the pseudorapidity, the transverse momentum, and collision centrality. Results are compared with the results in Pb+Pb collisions at the LHC. We discuss the system size and initial geometry dependence of the dipole-like fluctuations and their implications.

Preferred Track

Collective Dynamics

Collaboration

STAR

Primary author: NIIDA, Takafumi (Wayne State University)

Presenter: NIIDA, Takafumi (Wayne State University)

Session Classification: Poster Session
Forward-backward correlations between event-mean transverse momenta in Pb-Pb collisions

Forward-backward (FB) correlations are usually measured between observables obtained in an event-by-event analysis in two separated pseudorapidity intervals. The conventional observable for the FB correlations analysis is the charged particle multiplicity. In the present study, instead of the multiplicity, we took an intensive observable, namely the event-averaged transverse momentum of particles measured in each of the two pseudorapidity intervals. The strength of the FB correlations between event-mean transverse momenta is robust against volume fluctuations and thus the centrality determination methods, which provides higher sensitivity of this quantity to the properties of the initial state and evolution of the medium created in AA collisions. The magnitude of the FB correlation strength is obtained for different gaps between pseudorapidity intervals at different centralities of the Pb-Pb collisions measured at \( \sqrt{s_{NN}} = 2.76 \) and 5.02 TeV with the ALICE detector at the LHC. The FB correlations are studied also in different combinations of azimuthal windows, selected within the pseudorapidity intervals. Results are compared to AMPT and HIJING event generators and to the MC model with fusion of quark-gluon strings.

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: ALTSYBEEV, Igor (St Petersburg State University (RU))
Presenter: ALTSYBEEV, Igor (St Petersburg State University (RU))
Session Classification: Poster Session
Probing non-linearity of higher harmonic flow in $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV Pb-Pb collisions

Wednesday, 8 February 2017 08:30 (20 minutes)

Theoretical calculations suggest that higher harmonic anisotropic flow vectors are superpositions of contributions from linear and non-linear hydrodynamic response, each reflecting different sensitivities to the fluctuating initial conditions and properties of the hot and dense matter created in heavy ion collisions 1.

In this talk, we present the first measurement on the non-linear hydrodynamic response of higher harmonic flow using multi-particle correlations in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV. These measurements can be used to study the relation between the linear and non-linear response in different centrality classes.

In addition, the measured centrality dependence of symmetry plane correlations between lower- and higher-order flow vectors can be adequately explained by contributions from non-linear response.

Furthermore, the results of newly proposed non-linear response coefficients $\chi_{m,n}$ will be presented. The measurements provide crucial information on freeze-out conditions, which are poorly constrained by previous flow measurements.

Last but not least, the symmetric cumulants, which probe the correlations between different order flow harmonics, are studied in different kinematic regions ($p_T$ and $\eta$) and include higher harmonics $v_n (n > 3)$. The derived approximate relation between symmetric cumulants and the symmetry plane correlations are investigated, and this allows a direct test of hydrodynamic behavior of the created matter.


Preferred Track

Collective Dynamics

Collaboration

ALICE

Primary author: ZHOU, You (Niels Bohr Institute (DK))

Presenter: ZHOU, You (Niels Bohr Institute (DK))

Session Classification: Parallel Session 5.1: Collective Dynamics (I)

Track Classification: Collective Dynamics
Fluctuations of conserved charges are interesting probes of critical phenomena and freeze-out conditions in strongly interacting matter. In this context, experimental results will be presented on event-by-event analysis of net baryon fluctuation measurements in Pb-Pb collisions at $\sqrt{s_{NN}}=2.76$ TeV, recorded by the ALICE Collaboration at the CERN LHC. In addition to net-protons, used as a proxy for net-baryons, similar results for net-pions and net-kaons will be presented. The analysis will measure second moments of both net-particle and particle distributions. Furthermore, contributions from participant fluctuations and baryon number conservation will be discussed. Particular emphasis will be placed on the quantitative understanding of the centrality and rapidity width dependence of the obtained results. The data will be compared with recent predictions from the Hadron Resonance Gas model (HRG) and Lattice QCD (LQCD).

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author:  RUSTAMOV, Anar (National Nuclear Research Center (AZ))
Presenter:  RUSTAMOV, Anar (National Nuclear Research Center (AZ))
Session Classification:  Parallel Session 7.2: Correlations and Fluctuations (II)
Track Classification:  Correlations and Fluctuations
Relaxation times of shear and bulk viscosities from Kubo formulas

Wednesday, 8 February 2017 10:40 (20 minutes)

The shear and the bulk relaxation times are important ingredients of the second order hydrodynamics whose success in heavy ion phenomenology is unquestioned. Unlike viscosities themselves, field theoretical calculations of the relaxation times are hard to come by in literature, especially for the bulk relaxation time. In this work, we report two field-theoretical analyses involving the shear and the bulk relaxation time. First, by carefully examining the analytic structure of the stress-energy tensor response functions, we have been able to derive, for the first time, a Kubo formula involving both the shear and the bulk relaxation times. Second, by evaluating the Kubo formula within the massless scalar theory, we have so far been able to calculate the shear relaxation time in a simple form. We will then show how this calculation can be extended to calculate the bulk relaxation time as well.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author:  CZAJKA, Alina (McGill University)
Presenter:  CZAJKA, Alina (McGill University)
Session Classification:  Parallel Session 6.3: New Theoretical Developments (II)
Track Classification:  New Theoretical Developments
Multiplicity dependence of jet-like two-particle correlations in pp collisions at $\sqrt{s} = 7$ and 13 TeV with ALICE

Two-particle correlations in relative azimuthal angle ($\Delta\phi$) and pseudorapidity ($\Delta\eta$) have been used to study heavy-ion collision dynamics, including medium-induced jet modification. These correlations have been extensively studied in small collision systems by all the four main LHC experiments. Further investigations showed also the importance of Multiple Parton Interactions (MPI). The latter are employed by pQCD-inspired models which provide a consistent way to describe high-multiplicity pp collisions, where the probability of several parton scatterings per nucleon-nucleon collision is high. In this talk we present the latest ALICE measurements using the data from Run I and Run II at the LHC. The MPI results in pp collisions at an energy of $\sqrt{s} = 13$ TeV will be presented as a function of multiplicity and compared to those in pp collisions at lower energies and in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. Additionally, detailed studies of two-particle azimuthal correlations in pp collisions at $\sqrt{s} = 7$ TeV will be shown as a function of multiplicity including the studies of the near-side jet peak evolution. These measurements complement the recent ALICE results on the anomalous evolution of the near-side jet peak shape in Pb-Pb collisions and serve as a baseline for studies of long-range correlations in pp collisions.

Preferred Track

QCD in small systems

Collaboration

ALICE

Primary author: LAKOMOV, Igor (CERN)
Presenter: LAKOMOV, Igor (CERN)
Session Classification: Parallel Session 1.2: QCD in Small Systems (I)
Track Classification: QCD in small systems
Lattice calculations of the heavy quark potential at non-zero temperature

Tuesday, 7 February 2017 15:40 (20 minutes)

For theoretical understanding of quarkonium production in heavy ion collisions it is important to know the potential between the heavy quark and anti-quark at non-zero temperature. This potential is complex and provides an efficient way to calculate quarkonium spectral functions at non-zero temperature and an important input for dynamical models aiming to describe quarkonium production in heavy ion collisions (see e.g. 1).

I report on the lattice calculations of the heavy quark potential at T>0 in 2+1 flavor QCD at physical quark masses using Highly Improved Staggered Quark formulation. The gauge configurations needed for the high statistics study of the heavy quark potential have been generated by HotQCD and TUMQCD collaborations 2. In this study lattices with temporal extent $N_t = 12$ and 16 are used and the real and imaginary part of the potential are obtained using the moments of the temporal Wilson loops. I study in detail the systematic effects in the determination of the real and the imaginary parts of the potential when using the moment method. It turns out that below the transition temperature the imaginary part is consistent with zero, while above the transition temperature it increases with increasing temperature and separation between the quark and anti-quark till the signal diminishes. The real part of the potential is similar to the zero temperature one for distances smaller than 0.8fm and temperatures smaller than 250 MeV. This analysis significantly extends the preliminary work presented in [3].

I will also discuss the implications of these findings for existence of heavy quark bound state in QGP by calculating the corresponding meson spectral functions with the newly determined potential.

References:

1 P. Petreczky and C. Young, Sequential bottomonium production at high temperatures, arXiv:1606.08421 [nucl-th]
2 A. Bazavov et al (HotQCD), Phys. Rev. D90 (2014) 094503

Preferred Track

Quarkonia

Collaboration

Not applicable

Primary author: PETRECZKY, Peter (BNL)

Presenter: PETRECZKY, Peter (BNL)
Session Classification: Parallel Session 3.3: Quarkonia (I)

Track Classification: Quarkonia
Investigations of anisotropic collectivity using multi-particle correlations in pp, p-Pb and Pb-Pb collisions with ALICE

Wednesday, 8 February 2017 10:40 (20 minutes)

Two- and multi-particle azimuthal correlations have proven to be an excellent tool to probe the properties of the Quark-Gluon Plasma created in Pb-Pb collisions. Recently, the results obtained for multi-particle correlations has been interpreted as evidence for collectivity in the small pp and p-Pb collision systems providing new insights into the systems’ fluctuating initial conditions.

In this talk, we present the first ALICE results of two- and multi-particle cumulants at midrapidity |\eta| < 1.0 as a function of multiplicity in pp collisions at \( \sqrt{s} = 13 \) TeV.

Results will be compared to a broad range of collision systems and energies, including pp collisions at \( \sqrt{s} = 7 \) TeV, p-Pb collisions at \( \sqrt{s_{NN}} = 5.02 \) TeV, and Pb-Pb collisions at \( \sqrt{s_{NN}} = 2.76 \) TeV and \( \sqrt{s_{NN}} = 5.02 \) TeV. The azimuthal correlations obtained from Monte Carlo simulations will be presented for comparison. These results allow further insight into the matter created in pp collisions, and will broaden our knowledge about the initial conditions in such small collision systems.

Using ALICE’s forward detectors, two-particle correlations with a very large \( \Delta \eta \) range of |\Delta \eta| < 8.5 will be also discussed. This should shed new light into the nature of long-range correlations observed in small collision systems, and help probe the extent of the ridge in pp collisions.

Preferred Track

Collective Dynamics

Collaboration

ALICE

Primary author: GAJDOSOVA, Katarina (University of Copenhagen (DK))

Presenter: GAJDOSOVA, Katarina (University of Copenhagen (DK))

Session Classification: Parallel Session 6.2: Correlations and Fluctuations (I)

Track Classification: Collective Dynamics
Measurement of forward-backward multiplicity correlations in pp, pPb and PbPb collisions with the ATLAS detector

Wednesday, 8 February 2017 15:40 (20 minutes)

Recently, theoretical and experimental studies of flow and multiplicity correlations in the longitudinal direction in heavy ion collision have revealed a rich dynamics not probed by traditional measurements that focused only on the transverse direction. Event-by-event longitudinal fluctuations in the initial conditions are expected to result in a strong asymmetry in particle multiplicities at forward and backward (FB) rapidities. In this talk, FB multiplicity correlations are measured in \( pp \), \( p+Pb \) and \( Pb+Pb \) collisions, with a data-driven method utilized to separate long-range FB correlations (LRC) and short-range correlations (SRC). The magnitude of the LRC reveals a significant FB multiplicity asymmetry, quantified by its slope in pseudorapidity \( a_1 \), which decreases with increasing multiplicity and is similar in magnitude across the three collision systems. The measured correlation in \( pp \) collisions is compared in detail with expectations from the PYTHIA 8 and EPOS-LHC models. Both models significantly underpredict the measured \( a_1 \) values (by a factor of two), and PYTHIA 8 is found to significantly overpredict the magnitude of the SRC, even though both of these models were tuned to reproduce the total charged particle multiplicity distributions out to \( N_{ch} \sim 120 \). These findings imply that the measurement of FB multiplicity correlations provides supplementary constraints on multi-particle production mechanisms, including restricting the number of independent sources in \( pp \), \( p+Pb \) and \( Pb+Pb \) collisions.

Preferred Track

Correlations and Fluctuations

Collaboration

ATLAS

Primary author: ZHOU, Mingliang (State University of New York (US))
Presenter: ZHOU, Mingliang (State University of New York (US))
Session Classification: Parallel Session 7.2: Correlations and Fluctuations (II)
Track Classification: Correlations and Fluctuations
Measurement of charmonium production at forward rapidity in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE.

Tuesday, 7 February 2017 15:20 (20 minutes)

ALICE is the LHC experiment dedicated to the study of ultra relativistic heavy-ion collisions where the formation of a hot and dense strongly-interacting medium, a Quark-Gluon Plasma (QGP), is expected. Considerable theoretical and experimental efforts have been invested in the last 30 years to study the properties of the QGP. One of the signals of QGP formation is the charmonium suppression. Measurements from Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV revealed a suppression of charmonium yields in central collisions, compared to binary-scaled pp collisions. However, the magnitude of the suppression is smaller than what was observed at lower energies at the SPS and RHIC, indicating that $J/\psi$ regeneration via recombination of charm and anti-charm quarks plays an important role at LHC energies.

In this contribution, charmonium ($\psi(2S)$ and $J/\psi$) measurements at forward rapidity ($2.5 < y < 4$) in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE will be presented. The analyses are performed in the dimuon decay channel down to zero transverse momentum ($p_T$) with the data sample collected in 2015 (about 7 times more statistics than that collected in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV). Together with results on the $J/\psi$ nuclear modification factor $R_{AA}$ as a function of centrality, transverse momentum and rapidity, new multi-differential measurements will be presented. First results on the $J/\psi$ ($p_T$) and ($p_T^2$) as a function of centrality will be discussed. Preliminary results on the ($\psi(2S)/J/\psi$) ratio as a function of centrality and transverse momentum will also be shown. The results will be compared to various theoretical models as well as to other experimental results.

Preferred Track

Quarkonia

Collaboration

ALICE

Primary author: TARHINI, Mohamad (Universite de Paris-Sud 11 (FR))
Presenter: TARHINI, Mohamad (Universite de Paris-Sud 11 (FR))
Session Classification: Parallel Session 3.3: Quarkonia (I)
Track Classification: Quarkonia
In relativistic heavy ion collisions, a hot medium with a high density of unscreened color charges is produced. Jets are produced at the early stages of this collision and are known to become attenuated as they propagate through the hot matter. One manifestation of this energy loss is a lower yield of jets emerging from the medium than expected in the absence of medium effects. ATLAS has provided a quantification of jet suppression by measurements of jet R_AA in the LHC Run 1. A factor of two suppression was observed in central heavy ion collisions with respect to pp collisions. R_AA was also found to exhibit only a weak rapidity dependence, and a slow (but significant) rise with increasing jet momentum. The high-statistics run 2 data of Pb+Pb and pp collisions provide the opportunity to extend the jet R_AA measurement, to evaluate the center-of-mass-energy dependence of this quantity and to explore new techniques for the study of jet substructure using subjets. This talk will present the Run 1 results on inclusive jet production and new Run 2 results on inclusive jet suppression. It will furthermore present new results on the measurement of jet substructure from the Run 2 data.

Preferred Track

Jets and High pT Hadrons

Collaboration

ATLAS

Primary author:  SPOUSTA, Martin (Charles University)
Presenter:  SPOUSTA, Martin (Charles University)
Session Classification:  Parallel Session 3.4: Jets and High pT Hadrons (III)
Track Classification:  Jets and High pT Hadrons
Dijet measurements in heavy ion collisions with the ATLAS detector

Jet imbalance is a known signature of jet energy loss in the hot, dense medium produced in heavy ion collisions. New measurements of the dijet asymmetry at ATLAS are presented using the 2011 Pb+Pb data from the LHC at $\sqrt{s_{NN}} = 2.76$ TeV using jets reconstructed with the anti-\textit{k}_T algorithm with parameters $R=0.3$ and 0.4. While previous measurements demonstrated a significant effect in the asymmetry, a detailed quantitative understanding was difficult to obtain due to the impact of the finite jet energy resolution. This measurement has been fully unfolded to account for bin migration from resolution effects. It benefits from the major improvements in jet reconstruction in a heavy-ion environment since the original ATLAS dijet measurements. This result demonstrates a centrality and leading jet transverse energy dependence of the asymmetry when compared to the $\text{pp}$ reference data at the same center of mass energy.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ATLAS

Primary author: HAVENER, Laura Brittany (Columbia University (US))

Presenter: HAVENER, Laura Brittany (Columbia University (US))

Session Classification: Poster Session
Holographic jet shapes and their evolution in strongly coupled plasma

Tuesday, 7 February 2017 12:00 (20 minutes)

Recently our group analyzed how the probability distribution for the jet opening angle is modified in an ensemble of jets that has propagated through an expanding cooling droplet of plasma 1. Each jet in the ensemble is represented holographically by a string in the dual 4+1-dimensional gravitational theory with the distribution of initial energies and opening angles in the ensemble given by perturbative QCD. In 1, the full string dynamics were approximated by assuming that the string moves at the speed of light. We are now able to analyze the full string dynamics for a range of possible initial conditions, giving us access to the dynamics of holographic jets just after their creation. We show that, after a period of time that we compute, the string nullifies: the force of gravity accelerates each section of string until it approaches the speed of light. The nullification timescale and the features of the string when it has nullified are all results of the string evolution. This emboldens us to analyze the full jet shape, rather than just the opening angle of each jet in the ensemble as in 1. We find the striking result that the jet shape scales with the opening angle at any particular energy. We construct an ensemble of dijets with energies and energy asymmetry distributions taken from events in proton-proton collisions, opening angle distribution as in 1, and jet shape taken from proton-proton collisions and scaled according to our result. We study how all of these observables are modified after we send the ensemble of dijets through the strongly-coupled plasma.

1 Krishna Rajagopal, Andrey V. Sadofyev, Wilke van der Schee, "Evolution of the jet opening angle distribution in holographic plasma", PRL 116, 211603 (2016)

Preferred Track
Jets and High pT Hadrons

Collaboration
Not applicable

Primary author: BREWER, Jasmine (MIT)
Presenter: BREWER, Jasmine (MIT)
Session Classification: Parallel Session 2.4: Jets and High pT Hadrons (II)
Track Classification: Jets and High pT Hadrons
Jet Fragmentation in p+p, p+Pb and Pb+Pb at ATLAS

Tuesday, 7 February 2017 11:40 (20 minutes)

Jets are an important tool to study the hot, dense matter produced in Pb+Pb collisions at the LHC. Due to the loss of some of the jet's energy outside the jet cone, jet rates have been found to be reduced by approximately a factor of two, in the most central events and over a wide kinematic range. In order to understand precisely how the jets are modified, it is important to measure how the jet momentum is carried by its fragmentation products. The longitudinal momentum fraction of charged particles in jets from Pb+Pb, p+Pb, and p+p collisions have been measured using the ATLAS detector. Proton-proton and p+Pb collisions provide necessary baseline measurements for quantifying the modifications in Pb+Pb collisions. In Run 1, ATLAS collected samples of p+p and Pb+Pb collisions at a center of mass energy of 2.76 TeV and a sample of p+Pb collisions at 5.02 TeV. In Run 2, large samples of p+p and Pb+Pb collisions at 5.02 TeV have been collected providing a complete set of collision systems at 5.02 TeV. In this talk, we present the status of fragmentation function measurements at 5.02 TeV in the context of detailed studies of the fragmentation in p+p and Pb+Pb collisions at 2.76 TeV.

Preferred Track

Jets and High pT Hadrons

Collaboration

ATLAS

Primary author:  SLOVAK, Radim (Charles University (CZ))
Presenter:  SLOVAK, Radim (Charles University (CZ))
Session Classification:  Parallel Session 2.4: Jets and High pT Hadrons (II)
Track Classification:  Jets and High pT Hadrons
Studies of photon-jet correlations in 5.02 TeV Pb+Pb and pp collisions with ATLAS

Wednesday, 8 February 2017 08:30 (20 minutes)

Nuclear collisions which produce a high transverse momentum ($p_T$) prompt photon offer a useful way to study the dynamics of the hot, dense medium produced in these events. Because photons do not carry color charge, they are unaffected by the hot, dense medium. Thus, the outgoing photon serves as a tag of the initial parton flavors, and measures the initial parton $p_T$ before they are quenched by their passage through the medium. In 2015, ATLAS sampled 0.49 nb$^{-1}$ and 26 pb$^{-1}$ of Pb+Pb and pp data at 5.02 TeV, respectively, with a high-level photon trigger that selects $p_T>25$ GeV photons with high efficiency. The larger prompt photon cross-section and integrated luminosity with respect to 2.76 TeV data allow for new, differential studies of photon-jet correlations. In this talk, ATLAS results on photon-jet azimuthal and $p_T$ balance will be presented using $p_T > 60$ GeV photons and $R=0.4$, $p_T > 30$ GeV jets. Double-differential distributions of the jet-to-photon $p_T$ ratio, $x_{Jg}$, and of the azimuthal difference, $\Delta \phi$, will be presented as a function of photon $p_T$ and event centrality. The status of other photon-tagged jet observables will also be discussed.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

ATLAS

Primary author: STEINBERG, Peter Alan (Brookhaven National Laboratory (US))

Presenter: STEINBERG, Peter Alan (Brookhaven National Laboratory (US))

Session Classification: Parallel Session 5.4: Jets and High $p_T$ Hadrons (IV)

Track Classification: Jets and High $p_T$ Hadrons
Study of $b\bar{b}$ production in $p + p$ collisions at $\sqrt{s} = 510$ GeV in the PHENIX experiment at RHIC

Heavy flavor quarks are an important probe of the initial state of the Quark Gluon Plasma formed in heavy-ion collisions. Bottom and charm quarks are produced early in the collision, primarily through hard interactions, and experience the full time evolution of the medium. Understanding bottom quark production in $p + p$ collisions gives a baseline reference for studying larger collision systems.

The measurement of the $b\bar{b}$ cross section gives insight into $b$ quark production mechanisms which can directly test pQCD predictions. The $b\bar{b}$ signal can be isolated by taking advantage of the properties of $B^0$ oscillations in the invariant mass region of 4-10 GeV. Measuring like-sign dimuons within this mass range provides an enriched bottom signal with a minimal amount of open charm background and without any contributions from quarkonia or Drell-Yan pairs.

$b\bar{b}$ will be measured through the semi-leptonic decay like-sign dimuon signal, in the rapidity range $1.2 < |y| < 2.2$ and at $\sqrt{s} = 510$ GeV from data recorded in 2013 at the PHENIX experiment. In this poster, the status of the $b\bar{b}$ production study will be presented.

Preferred Track
Open Heavy Flavors

Collaboration
PHENIX

Primary author: HASELER, Tristan (Georgia State University)
Presenter: HASELER, Tristan (Georgia State University)
Session Classification: Poster Session
Measurements of charged hadron spectra and nuclear modification factors in lead-lead and proton-lead collisions with the ATLAS detector

Measurements of the nuclear modification factor for charged hadrons is an indirect way to understand the jet energy loss mechanism. Charged hadron spectra were measured in Pb+Pb, p+Pb and pp collisions at $\sqrt{s}$, $\sqrt{s_{NN}}$=5.02 TeV. The higher statistical significance of the Pb+Pb data sample with the total integrated luminosity of 0.49nb$^{-1}$, p+Pb sample of 25nb$^{-1}$ and pp sample of 25pb$^{-1}$ allows high precision measurements of the charged hadron spectra and of the nuclear modification factors. The results are presented in wide transverse momentum ranges and investigated in different centrality and rapidity intervals.

Preferred Track
Jets and High pT Hadrons

Collaboration
ATLAS

Primary author: MILOV, Alexander (Weizmann Institute of Science (IL))
Presenter: MILOV, Alexander (Weizmann Institute of Science (IL))
Session Classification: Poster Session
ALICE Measurement of the $J/\psi$ Nuclear Modification Factor $R_{AA}$ at Mid-Rapidity in Pb-Pb Collisions at $\sqrt{s_{NN}} = 5.02$ TeV

Tuesday, 7 February 2017 14:20 (20 minutes)

ALICE at the Large Hadron Collider (LHC) provides unique capabilities to study charmonium production at low transverse momenta. In the early and hottest phase of nucleus-nucleus collisions the formation of a Quark-Gluon Plasma (QGP) is expected. Several QGP induced effects, such as the melting of charmonium states due to color screening and/or a (re)combination of uncorrelated charm and anti-charm quarks, can play a role. While a suppression of $J/\psi$ with respect to pp collisions was indeed observed in heavy-ion collisions at all energies, recent measurements in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV indicate that (re)combination does seem to play an important role in the low pT region at LHC energies.

At central rapidity, corresponding to the range $|y| < 0.9$, $J/\psi$ are reconstructed via their decay into two electrons down to zero pT. We will present new results on the inclusive $J/\psi$ nuclear modification factor $R_{AA}$ as a function of centrality and transverse momentum in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. Due to the now available higher event statistics these data allow a more differential investigation of the evolution of $R_{AA}$ than previous measurements. They provide, in combination with results from lower energies and theoretical predictions, important information on the different mechanisms related to the presence of the hot medium produced in heavy-ion collisions.

Preferred Track

Quarkonia

Collaboration

ALICE

Primary author: JIMENEZ, Tonatiuh (Ruprecht-Karls-Universitaet Heidelberg (DE))

Presenter: JIMENEZ, Tonatiuh (Ruprecht-Karls-Universitaet Heidelberg (DE))

Session Classification: Parallel Session 3.3: Quarkonia (I)

Track Classification: Quarkonia
Measurement of W and Z boson production in 5 TeV pp, p+Pb and Pb+Pb collisions with the ATLAS detector

Wednesday, 8 February 2017 08:30 (20 minutes)

W and Z bosons are short lived and do not participate in the strong interaction. Thus their production yields, observed via dilepton decay channels in proton-lead and lead-lead collisions, provide direct tests of both binary collision scaling and the nuclear modification of parton distribution functions (nPDF). Proton-lead collisions further provide a relatively clean environment for benchmarking nPDFs. The ATLAS detector has a broad acceptance in the muon and electron channels, with excellent performance even in the high occupancy environment of central heavy-ion collisions. ATLAS has recorded 0.49 nb−1 of lead-lead data at a center-of-mass energy of 5.02 TeV per nucleon pair. W and Z production yields are expected to increase by a factor of eight relative to the available Run 1 data at 2.76 TeV. In addition the data can be compared directly to the 29 nb−1 of proton-lead data collected in Run 1. In this talk, W and Z yields, and lepton charge asymmetries from W decays, are presented differentially in rapidity and transverse momentum as a function of centrality in lead-lead and proton-lead collisions.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

ATLAS

Primary author: CITRON, Zvi (Weizmann Institute of Science (IL))

Presenter: CITRON, Zvi (Weizmann Institute of Science (IL))

Session Classification: Parallel Session 5.2: Initial State Physics and Approach to Equilibrium (III)

Track Classification: Initial State Physics and Approach to Equilibrium
Measurements of multi-jet production in pp, p+Pb and ultra-peripheral Pb+Pb collisions with the ATLAS detector

Tuesday, 7 February 2017 09:10 (20 minutes)

Beams of relativistic heavy ions are accompanied by a large flux of equivalent photons, and photon-induced reactions are the dominant interaction mechanism in heavy-ion collisions when the colliding nuclei have transverse separation larger than the nuclear diameter. In these ultra-peripheral collisions (UPC) the photon can provide a clean probe of the partonic structure of the nucleus analogous with deep inelastic scattering. This talk presents measurements of dijet production in ultra-peripheral Pb+Pb collisions performed with the ATLAS detector. Events are selected using requirements on rapidity gaps and forward neutron production to identify the photo-nuclear processes. The relatively clean environment of these events allows for measurements in a region of x and Q^2 where significant nuclear PDF modifications are expected to be present and not strongly constrained by previous measurements.

This talk also presents measurements of four-jet cross sections in pp and p+Pb collisions over a large kinematic range. In addition to higher order QCD effects, the four-jet cross section receives contributions from so-called double parton scatterings (DPS) in which two independent hard scattering processes occur in the same collision. Thus measurements of DPS, which have already been performed in 7 TeV pp collisions, can yield new information on the spacial and momentum correlations between partons in a nucleon beyond single parton distributions. In p+Pb collisions, additional mechanisms for DPS are possible when two partons in the proton scatter off partons in different nucleons in the nuclear target, leading to an enhancement in the four jet rate and a different sensitivity to the underlying correlations. Differential cross sections as well as measurements of momentum and angular correlations, which help disentangle the single and double parton scattering contributions, will be presented.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

ATLAS

Primary author: ANGERAMI, Aaron (Columbia University (US))

Presenter: ANGERAMI, Aaron (Columbia University (US))

Session Classification: Parallel Session 1.1: Initial State Physics and Approach to Equilibrium (I)

Track Classification: Initial State Physics and Approach to Equilibrium
The large equivalent-photon fluxes accompanying Pb ion beams at the LHC initiate photon-photon and photo-nuclear interactions which dominate when the colliding nuclei have large impact parameter (ultra-peripheral collisions). These electromagnetically-induced processes are sensitive to the nuclear wave-function and in particular the nuclear modifications of the nucleon parton distribution functions (nPDFs). As such, they are complementary to the ongoing p+A program at RHIC and the LHC, as well as the upcoming electron-ion collider (EIC) program in the US. The absolute rates of single and multiple neutron emission into one or both zero-degree calorimeters (ZDCs) will be presented, to test theoretical predictions for the photon fluxes as well as the photonuclear absorption. High-mass dilepton pair continuum rates have been measured and compared with theoretical predictions to test expectations for two-photon interactions, and good agreement with model calculations is obtained. Finally, evidence for the elastic scattering of photons $\gamma\gamma \rightarrow \gamma\gamma$ ("light-by-light" scattering) will be presented, a previously unobserved process made possible by the high photon flux and low event pileup provided by the LHC. While of intrinsic interest as a heretofore-unobserved standard model process, it has also been proposed as a clean channel for searches for beyond the standard model (BSM) physics.

**Preferred Track**

Initial State Physics and Approach to Equilibrium

**Collaboration**

ATLAS

**Primary author:** DYNDAL, Mateusz (DESY)

**Presenter:** DYNDAL, Mateusz (DESY)

**Session Classification:** Parallel Session 1.1: Initial State Physics and Approach to Equilibrium (I)

**Track Classification:** Initial State Physics and Approach to Equilibrium
Measuring medium-induced gluons via jet grooming

Tuesday, 7 February 2017 15:00 (20 minutes)

The modifications of jets in heavy-ion collisions are manifest in many measurements. However, inclusive observables are generally susceptible to the quantum mechanical nature of interactions of the jet fragments with the medium. We argue that contemporary jet substructure techniques facilitate a more direct measurement of the radiative mechanism caused by medium interactions. As a concrete example, we focus on jet grooming using the "soft drop" procedure that singles out the two leading jet substructures with largest angular separation inside an energetic jet. The interplay between hard, quasi-collinear vacuum or medium-induced radiation within the reconstructed cone and soft, large-angle emissions that are responsible for out-of-cone energy flow is studied. We find an enhancement of the splitting function at small energy-fractions which is attributed to rare, relatively hard medium-induced gluon radiation affected by LPM interference with the quark-gluon plasma.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary author:  TYWONIUK, Konrad (CERN)
Presenter:  TYWONIUK, Konrad (CERN)
Session Classification:  Parallel Session 3.4: Jets and High pT Hadrons (III)
Track Classification:  Jets and High pT Hadrons
Measurement of the transverse and longitudinal dynamics of collective flow in 2.76 and 5.02 TeV Pb+Pb collisions with the ATLAS detector

Wednesday, 8 February 2017 14:40 (20 minutes)

The collisions of lead nuclei provided by the LHC in Run 2 provide new opportunities to study matter produced at unprecedented temperatures and densities. In particular, the study of the azimuthal anisotropy of produced charged particles not only constrains the initial state of the nuclear collisions and soft particle collective dynamics, but also sheds light on jet quenching via the measurement of flow harmonics at high transverse momenta. In this talk, new ATLAS measurements of flow harmonics from \( v_2 \) to \( v_7 \) in Pb+Pb collisions at \( \sqrt{s_{NN}} = 5.02 \) TeV, performed in a wide range of transverse momenta 0.5-40 GeV, pseudorapidity \((|\eta|<2.5)\) and collision centrality are presented. This includes a first measurement of \( v_6 \) and \( v_7 \), as well as harmonics in ultra-central collisions. A procedure of removing correlations arising from back-to-back jets, recently used in \( pp \) collisions, is implemented in the Two-Particle Correlation method to evaluate \( v_n \) without a jet bias. The scaling relations between the \( v_n \) harmonics are also discussed.

Longitudinal dynamics has recently become a topic of great interest in the study of ultra-relativistic heavy ion collisions. Measurement of the longitudinal fluctuations of the flow harmonic coefficients \( v_n \) and event-plane angles \( \Psi_n \) can provide a more complete picture of space-time evolution of the hot, dense medium formed in heavy ion collisions. Longitudinal flow decorrelations can be modeled with two contributions: magnitude fluctuations and event plane twist. However, existing observables do not separate these two effects. In this analysis, a new 4-particle correlator is used to separate the event-plane twist from magnitude fluctuations in 2.76 and 5.02 Pb+Pb collisions. Results show both effects have a linear dependence on pseudorapidity separation for \( v_{n \leq 5} \), and show a small but measurable variation with collision energy. The correlation of \( \Psi_n \) of different order are also expected to have longitudinal fluctuations due to the non-linear mixing effects between lower and higher order flow harmonics. First measurement of such non-linear mode-mixing effects as a function of pseudorapidity is also presented. These result will help to constrain initial conditions along longitudinal direction and also help understand the longitudinal evolution of the fireball.

Preferred Track

Collective Dynamics

Collaboration

ATLAS

Primary author: MOHAPATRA, Soumya (Columbia University (US))

Presenter: MOHAPATRA, Soumya (Columbia University (US))

Session Classification: Parallel Session 7.3: Collective Dynamics (II)
Track Classification: Collective Dynamics
Phenomenological constraints on the bulk viscosity of QCD

While small at very high temperature, the bulk viscosity of quantum chromodynamics is expected to grow in the confinement region. Although its precise magnitude and temperature-dependence in the cross-over region is not fully understood, recent theoretical and phenomenological studies [1-5] provided evidence that the bulk viscosity can be sufficiently large to have measurable consequences on the evolution of the quark-gluon plasma. In this work, a Bayesian statistical analysis is used to establish probabilistic constraints on the temperature-dependence of bulk viscosity using combined hadronic measurements from RHIC and the LHC. IP-Glasma initial conditions are used to provide realistic event-by-event fluctuations, which are understood to have an important interplay with bulk viscosity. The width of the peak of bulk viscosity, along with the position of the peak in the transition region, are investigated phenomenologically for the first time. A lower but wider peak than the parametrization used in [3-5] is found to be preferred. Constraints on the position of the peak are found to be limited, with tension observed between the values favoured by RHIC and LHC measurements. The relative effect of shear and bulk viscosities on hadronic observables, in particular momentum anisotropies, is investigated.


Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: DENICOL, Gabriel (McGill University)
Presenter: DENICOL, Gabriel (McGill University)
Session Classification: Parallel Session 8.3: Collective Dynamics (III)

Track Classification: Collective Dynamics
New quantum effects in relativistic magnetohydrodynamics

Wednesday, 8 February 2017 08:30 (20 minutes)

Chiral anomaly induces a new kind of macroscopic quantum behavior in relativistic magnetohydrodynamics, including the chiral magnetic effect. In this talk we will present two new quantum effects present in fluids that contain chiral fermions: 1) the turbulent inverse cascade driven by the chiral anomaly; 2) quantized chiral magnetic current induced by the reconnections of magnetic flux. The implications for the evolution of the quark-gluon plasma produced in heavy ion collisions will be discussed.

Preferred Track
New Theoretical Developments

Collaboration
Not applicable

Primary author: Prof. Kharzeev, Dmitri (Stony Brook University and BNL)
Co-author: Dr Yin, Yi (MIT)
Presenter: Prof. Kharzeev, Dmitri (Stony Brook University and BNL)
Session Classification: Parallel Session 5.3: New Theoretical Developments (I)

Track Classification: New Theoretical Developments
Measurement of two- and multi-particle azimuthal correlations in small collision systems with the ATLAS detector

Tuesday, 7 February 2017 11:20 (20 minutes)

ATLAS measurements of two-particle correlations in $\Delta\phi$ and $\Delta\eta$ and multi-particle azimuthal correlations using four, six and eight-particle cumulants are presented for $pp$, $p+Pb$ and low multiplicity $Pb+Pb$ collisions.

For the two-particle correlations, a template fitting procedure is used to subtract the dijet contribution and to extract the genuine long-range ridge correlations. In all collision systems, the ridge correlations are shown to be present even in events with a low multiplicity of produced particles, implying that the long-range correlations are not unique to rare high-multiplicity events. The properties of the correlation are shown to exhibit only a weak energy dependence and are remarkably similar to that observed in $p+Pb$ collisions. Another new aspect of this talk is a detailed study of ridge properties in collisions containing hard processes, characterized by large four-momentum transfer. This may help answering the question whether the ridge arises from hard or semi-hard processes, or if it is the result of mechanisms unrelated to the initial hardness scale.

In order to assess the collective nature of multi-particle production, the correlation measurements are extended to include azimuthal correlations measured using multiparticle cumulants. The presented measurements of multi-particle cumulants $c_2\{2-8\}$ confirm the evidence for collective phenomena in $p+Pb$ and low-multiplicity $Pb+Pb$ collisions. However, for $pp$ collisions, the measurements of cumulants do not yet provide clear evidence for collectivity as they are susceptible to event-by-event multiplicity fluctuations. In order to address this, results from a new modified cumulant method which suppress both the contribution of multiplicity fluctuation and non-flow effects are presented.

Preferred Track
QCD in small systems

Collaboration
ATLAS

Primary author: TRZUPEK, Adam (Institute of Nuclear Physics Polish Academy of Sciences (PL))

Presenter: TRZUPEK, Adam (Institute of Nuclear Physics Polish Academy of Sciences (PL))

Session Classification: Parallel Session 2.2: QCD in Small Systems (II)
Track Classification: QCD in small systems
Measurement of quarkonia production in 5 TeV proton-proton and heavy-ion collisions with the ATLAS detector

The in-medium suppression of $J/\psi$ production in heavy-ion collisions, with respect to pp collisions, serves as a sensitive probe for studying the quark gluon plasma. A full assessment of the suppression requires understanding effects present in the hot and dense medium in the Pb+Pb collisions as well as cold nuclear effects in the small p+Pb collision. Based on Pb+Pb collision data collected in 2015 at the LHC, the ATLAS experiment has studied $J/\psi$ production via the dimuon decay channel. The charmonium states are separated into contributions from B-hadron decays and prompt production.

Preferred Track
Quarkonia

Collaboration
ATLAS

Primary author: TAPIA ARAYA, Sebastian (Federico Santa Maria Technical University (CL))
Presenter: TAPIA ARAYA, Sebastian (Federico Santa Maria Technical University (CL))
Session Classification: Poster Session
Bottomonium measurements at forward rapidity in Pb-Pb and p-Pb collisions with ALICE at LHC

Tuesday, 7 February 2017 16:30 (20 minutes)

The production of heavy quarkonia is an important observable to study the properties of the nuclear matter created in high-energy heavy-ion collisions. Lattice QCD calculations predict a phase transition of the hadronic matter to a deconfined medium of quarks and gluons, the Quark Gluon Plasma (QGP), at extreme energy densities. The bottomonium bound states while passing through the deconfined medium are dissociated into quark-antiquark pair due to color screening. This is visible in data as a suppression of Υ resonances with respect to the proton-proton results scaled by the number of binary collisions. However, the cold nuclear matter effects can also lead to the suppression of Υ resonances in heavy-ion collisions. Cold nuclear effects are studied in p-Pb collisions since the QGP is not expected to be produced. ALICE measures the bottomonium down to zero transverse momentum via the dimuon decay channel at forward rapidity ($y < 4$).

In this presentation, the final results on the nuclear modification factor of Υ measured in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be shown as a function of centrality, transverse momentum and rapidity. The results will be compared with the existing theoretical models. In this context, the Υ measurements in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be discussed as well. Finally, the ALICE results will be compared to results from other experiments.

Preferred Track
Quarkonia

Collaboration
ALICE

Primary authors: Dr LARDEUX, Antoine (University of Oslo (NO)); DAS, Indranil (Saha Institute of Nuclear Physics (IN))

Presenters: Dr LARDEUX, Antoine (University of Oslo (NO)); DAS, Indranil (Saha Institute of Nuclear Physics (IN))

Session Classification: Parallel Session 4.3: Quarkonia (II)

Track Classification: Quarkonia
Measurement of bottomonium production in p+Pb and pp collisions at 5 TeV with ATLAS detector

The production of Upsilon in p+Pb collisions is a key ingredient for understanding ‘cold’ nuclear effects, relevant both for nuclear PDF studies as well as ‘hot’ nuclear matter studies. The ATLAS experiment has measures the Upsilon in its ground and excited states via the dimuon decay channel using 28 nb⁻¹ of p+Pb data at the center-of-mass energy of 5.02 TeV, and 25 pb⁻¹ of pp data. The measurement methods and results will be presented.

Preferred Track
Quarkonia

Collaboration
ATLAS

Primary author: CHEN, Jing (University of Science and Technology of China (CN))
Presenter: CHEN, Jing (University of Science and Technology of China (CN))
Session Classification: Poster Session
Measurements of the dielectron continuum in pp, p-Pb and Pb-Pb collisions with ALICE at the LHC

Tuesday, 7 February 2017 09:10 (20 minutes)

Dielectrons produced in ultra-relativistic heavy-ion collisions at the LHC provide a unique probe of the whole system evolution as they are unperturbed by final-state interactions. The dielectron continuum is extremely rich in physics sources: on top of ordinary Dalitz and resonance decays of pseudoscalar and vector mesons, thermal black-body radiation is of particular interest as it carries information about the temperature of the hot and dense system created in such collisions. Dielectron invariant-mass distribution is furthermore sensitive to medium modifications of the spectral function of short-lived vector mesons that are linked to the potential restoration of chiral symmetry at high temperatures. Correlated electron pairs from semi-leptonic charm and beauty decays provide complementary information about the heavy-quark energy loss.

In this talk, we will present an extensive summary of the LHC Run-1 results in all three collisions systems: pp, p-Pb and Pb-Pb, the former two providing crucial vacuum and cold-nuclear matter references for the latter. Furthermore, we will discuss the status of the ongoing Run-2 pp and Pb-Pb analyses with a focus on pp collisions collected with a trigger on high charged-particle multiplicities and conclude with an outlook for future measurements in Run-3 following the ALICE detector upgrades during the second long shutdown phase.

Preferred Track

Electromagnetic Probes

Collaboration

ALICE

Primary author: VAZQUEZ DOCE, Oton (Technische Universitaet Muenchen (DE))
Presenter: VAZQUEZ DOCE, Oton (Technische Universitaet Muenchen (DE))
Session Classification: Parallel Session 1.3: Electromagnetic Probes (I)
Track Classification: Electromagnetic Probes
Multiplicity and $v_n$ Scaling in Small and Large Systems

Recently, interest in initial state models have increased due to the observation of a "ridge" in small systems (p+p, p+Au, p+Pb, d+Au, p+Pb, etc.). Initial partonic fluctuations in the participant nucleons which comprise small systems, could be important. As a class of candidates, the consequences of constituent quark Glauber models are explored. Multiplicity density is found to scale with the number of quark participants for different systems and centrality’s. Eccentricities show a sizable increase in both p+A and A+A systems, when a large (i.e. close to proton charge radius) quark rms radius is used. We argue that the increase in the two types of systems have different origins. The eccentricities are further used to validate acoustic scaling for a broad range of systems (p+p, p+Au, p+Pb, d+Au, p+Pb, etc.) and energies.

Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary authors: LIU, Peifeng (Stony Brook University); LACEY, Roy (Stony Brook University)

Presenter: LIU, Peifeng (Stony Brook University)

Session Classification: Poster Session
Jet Energy Scale and its Uncertainties Using the Heavy Ion Jet Reconstruction Algorithm in p+p Collisions at ATLAS

ATLAS uses a jet reconstruction algorithm in heavy ion collisions that takes as input calorimeter towers of size $0.1 \times 0.1$ in $\Delta \eta \times \Delta \phi$ and iteratively determines the underlying event background. This algorithm, which is different from the standard jet reconstruction used in ATLAS, is also used in the proton-proton collisions used as reference data for the Pb+Pb and p+Pb. This poster provides details of the heavy ion jet reconstruction algorithm and its performance in p+p collisions. The calibration procedure is described in detail and cross checks using photon-jet balance are shown. The uncertainties on the jet energy scale and the jet energy resolution are described.

Preferred Track

Jets and High pT Hadrons

Collaboration

ATLAS

Primary author: PURI, Akshat (Univ. Illinois at Urbana-Champaign (US))
Presenter: PURI, Akshat (Univ. Illinois at Urbana-Champaign (US))
Session Classification: Poster Session
Studying Geometric Bias for Jet-Hadron Correlations with Monte Carlo Models

A key topic of interest in studies of jets in heavy ion physics is the path-length dependence of jet-medium interactions. In this contribution, Monte Carlo event simulators are used to estimate the path-length traversed by the recoil jet, under a varying range of trigger conditions. These simulations are then used to make predictions for studies of jet-hadron correlations, where a high pT jet is used as a trigger, and the distribution of associated particles from the away-side is examined.

Since we cannot experimentally measure the location of a hard-scatter vertex or the path-length traversed by the resulting partons, we require models to understand the role of path-length in experimental analysis. With Monte Carlo event generators, we can directly track the path-length of the trigger jet and the recoil jet. An especially interesting quantity is how biased the trigger is towards the surface, since the recoil jet from a surface biased trigger is likely to traverse a longer path. This is connected back to experiment by predicting how much jet energy loss resulting in softening and broadening can be observed in jet-hadron correlations.

Conditions that have been considered for their effect on the geometric bias include the pT of the jet, cuts on the constituents used to reconstruct the jet, and the jet’s angle relative to the reaction plane. The Monte Carlo event generators used include JEWEL and YaJEM.

Preferred Track
Jets and High pT Hadrons

Collaboration
Not applicable

Primary author: OLIVER, Michael Henry (Yale University (US))
Presenter: OLIVER, Michael Henry (Yale University (US))
Session Classification: Poster Session
Beam energy dependence of bulk properties via $K^{*0}$ and $\phi$ resonances in Au+Au collisions at RHIC

Resonances are excellent probes to understand the properties and evolution of the QCD medium created in relativistic heavy-ion collisions. Because of their short lifetime, resonances decay inside the fireball and their decay daughters interact with particles present in the medium. If the decay daughters are re-scattered by other hadrons present in the medium, the resonance signal cannot be reconstructed. On the other hand, pseudo-elastic interactions among the hadrons can regenerate resonances. The properties of resonances such as mass, width and yield are decided by the interplay of these processes. The centrality-dependent resonance to non-resonance ratio measured at top RHIC and LHC energies already hints at the dominance of re-scattering in the hadronic phase of the medium at these energies. The elliptic flow parameter, $v_2$, has been widely used as a tool for understanding the dynamics of the system created in the early stages of a collision. Comparison between $K^{*0}$ and $\phi$ is very promising, because the lifetime of these examples differ by a factor of ten, and $K^{*0}$ is expected to be affected more by the hadronic phase. Moreover, both offer the advantage of being vector mesons with masses close to that of the proton.

We report the production of $K^{*0}$ and $\phi$ resonances in Au+Au collisions at $\sqrt{s_{NN}} = 7.7$, 11.5, 14.5, 19.6, 27, 39 and 200 GeV using the STAR detector. We present invariant mass peak position, width, yield and elliptic flow of $K^{*0}$ and $\phi$ at these beam energies, including tests of NCQ scaling. Comparing the relative yield of resonances to non-resonances between RHIC and LHC energies will help us to understand the relative contributions from the hadronic phase at these energies.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

STAR

Primary author: Dr SINGHA, Subhash
Presenter: Dr SINGHA, Subhash
Session Classification: Poster Session
Measurement of J/Psi production as a function of event multiplicity in pp collisions at \( \sqrt{s} = 13 \text{TeV} \) with ALICE

*Tuesday, 7 February 2017 09:30 (20 minutes)*

The availability at the LHC of the largest collision energy in pp collisions allows a significant advance in the measurement of J/\( \psi \) production as function of event multiplicity. The interesting relative increase observed with data at the LHC at \( \sqrt{s} = 7 \) TeV and at RHIC at \( \sqrt{s} = 200 \) GeV is studied now at unprecedented multiplicities at \( \sqrt{s} = 13 \) TeV.

The new measurement, performed at midrapidity in the dielectron channel with ALICE and facilitated by triggering on high-multiplicity events, allows the comparison to J/\( \psi \) production in p-Pb collisions at similar multiplicities. The results are also discussed in comparison to predictions from available theoretical models and to data at lower energies.

**Preferred Track**

QCD in small systems

**Collaboration**

ALICE

**Primary author:** WEBER, Steffen Georg (Technische Universitaet Darmstadt (DE))

**Presenter:** WEBER, Steffen Georg (Technische Universitaet Darmstadt (DE))

**Session Classification:** Parallel Session 1.2: QCD in Small Systems (I)

**Track Classification:** QCD in small systems
Measurement of the longitudinal decorrelation of event-plane angle and flow magnitudes in 2.76 and 5.02 TeV Pb+Pb collisions with the ATLAS detector

Longitudinal dynamics has recently become a topic of great interest in the study of ultra-relativistic heavy ion collisions. Measurement of the longitudinal fluctuations of the flow harmonic coefficients $v_n$ and event-plane angles $\Psi_n$ can provide a more complete picture of space-time evolution of the hot, dense medium formed in heavy ion collisions. Longitudinal flow decorrelations can be modeled with two contributions: magnitude fluctuations and event plane twist. However, existing observables do not separate these two effects. In this analysis, a new 4-particle correlator is used to separate the event-plane twist from magnitude fluctuations in 2.76 and 5.02 Pb+Pb collisions. Results show both effects have a linear dependence on pseudorapidity separation for $v_{2-5}$, and show a small but measurable variation with collision energy. The correlation of $\Psi_n$ of different order are also expected to have longitudinal fluctuations due to the non-linear mixing effects between lower and higher order flow harmonics. First measurement of such non-linear mode-mixing effects as a function of pseudorapidity is also presented. These result will help to constrain initial conditions along longitudinal direction and also help understand the longitudinal evolution of the fireball.

Preferred Track

Collective Dynamics

Collaboration

ATLAS

Primary author: HUO, Peng (State University of New York (US))

Co-author: COLLABORATION, ATLAS (CERN)

Presenter: HUO, Peng (State University of New York (US))

Session Classification: Poster Session
J/ψ yield enhancement at very low transverse momentum in Pb-Pb collisions at \( \sqrt{s_{NN}}=5.02 \) TeV with ALICE

A large excess in the yield of J/ψ at very low transverse momentum compared to the expectations from the nuclear overlap region was recently reported by ALICE in peripheral Pb-Pb collisions at \( \sqrt{s_{NN}}=2.76 \) TeV. The observation, made at forward rapidity \((2.5<y<4.0)\) for \(p_T<300\) MeV/c using the muon spectrometer, is suggestive of coherent J/ψ photo-production, similar to the measurements done in ultra-peripheral collisions, where the nuclei interact only electromagnetically.

During the LHC Run-2, ALICE recorded a large sample of Pb-Pb collisions which allows the measurement of the very low \(p_T\) J/ψ production also at mid-rapidity, in the di-electron decay channel. An important aspect of this analysis is that the reconstruction is done using the central barrel detectors, with a much better momentum resolution, making our new measurement sensitive to key characteristics of the J/ψ coherent photo-production component, like the shape of the transverse momentum spectrum.

Together with the existing results at forward rapidity, in this talk we will present the J/ψ production cross-section in the very low-\(p_T\) range at mid-rapidity in peripheral Pb-Pb collisions at \( \sqrt{s_{NN}} = 5.02 \) TeV. The \(p_T\) distribution shape in the typical region for coherent production will be shown and compared to model expectations. The prospects for a polarization measurement will also be discussed.

Preferred Track

Quarkonia

Collaboration

ALICE

Primary author: ZHOU, Zhuo (University of Bergen (NO))

Presenter: ZHOU, Zhuo (University of Bergen (NO))

Session Classification: Poster Session
Studies collectivity in small collision systems with multi-particle azimuthal correlations with the ATLAS detector

ATLAS measurements of multi-particle azimuthal correlations for produced charged particles in small collision systems (5.02 and 13 TeV pp, 5.02 TeV p+Pb and low-multiplicity 2.76 TeV Pb+Pb collisions) are presented. The correlations are expressed in terms of cumulants $c_n$, which can be directly related to Fourier harmonics $v_n$. A comparison across different collision systems is presented as a function of the charged particle multiplicity $N_{ch}$. These measurements aim to assess the collective nature of multi-particle production. While collectivity is well established in $p+Pb$ and Pb+Pb collisions, its evidence in pp collisions is still a matter of debate. The presented measurements of multi-particle cumulants $c_2 \{2-8\}$ confirm the evidence for collective phenomena in $p+Pb$ and low-multiplicity PbPb collisions. For pp collisions the same conclusion can be derived from two-particle cumulants calculated with the requirement of a large pseudorapidity separation, $|\Delta \eta| > 2$. However, the measurements of $c_4 \{4\}$ cumulants with a method that is not susceptible to event-by-event multiplicity fluctuations, but is biased by higher order non-flow correlations, do not yet provide clear evidence for collectivity. A modified cumulant method is used to suppress both the contribution of multiplicity fluctuation and non-flow effects. The results from this method are presented for pp and p+Pb collisions.

Preferred Track

QCD in small systems

Collaboration

ATLAS

Primary author: BEHERA, Arabinda (State University of New York (US))

Presenter: BEHERA, Arabinda (State University of New York (US))

Session Classification: Poster Session
ATLAS measurements of the ridge in $pp$ and $p+Pb$ collisions

ATLAS measurements of correlations between particle pairs in relative azimuthal angle ($\Delta \phi$) and pseudorapidity separation ($\Delta \eta$) in $pp$ collisions at $\sqrt{s}=2.76$, 5.02 and 13-TeV, and in $p+Pb$ collisions at $\sqrt{s_{NN}}=5.02$-TeV are presented. Prior measurements have shown that in $pp$ collisions with a large multiplicity of produced particles, a long-range structure (the "ridge") develops along $\Delta \eta$ at $\Delta \phi \sim 0$. However, due to the presence of the large away-side jet, the full $\Delta \phi$ dependence of the long-range correlation could not be studied. In this analysis, a template fitting procedure is implemented to determine the contributions from dijets to the correlations, using low-multiplicity events, and to extract the genuine long-range correlation. The long-range correlations are shown to be present even in events with a small multiplicity of produced particles, implying that the long-range correlations are not unique to rare high multiplicity events. The properties of the correlation in $pp$ and $p+Pb$ collisions shown to be remarkably similar.

Preferred Track

QCD in small systems

Collaboration

ATLAS

Primary author: TU, Xiao (Columbia University (US))
Co-author: COLLABORATION, ATLAS (CERN)
Presenter: TU, Xiao (Columbia University (US))
Session Classification: Poster Session
Dileptons ($l^+l^-$) are produced throughout all stages of heavy-ion collisions and escape with minimum interaction with the strongly interacting medium. For this reason, $l^+l^-$ pair measurements play an essential role in the study of the hot and dense nuclear matter created in heavy-ion collisions. Dileptons in the low invariant mass region (up to $M_{ll} \sim 1$-GeV/$c^2$) retain information about the in-medium modification of vector mesons while dileptons in the intermediate mass region (extending out to $M_{ll} \sim 3$ GeV/c$^2$) predominantly originate from charm decays and thermal radiation of the medium. At higher invariant masses, recent studies of $J/\psi$ yields in peripheral A+A collisions by the ALICE\cite{alice} and STAR collaborations showed significant excess at very low momentum transfers ($p_T < 0.3$-GeV/c). These observations may point to evidence of coherent photoproduction of $J/\psi$ in hadronic interactions which conflicts with traditional knowledge of the coherent photoproduction mechanism. It is interesting to investigate the $e^+e^-$ pair production in a wider invariant mass region ($M_{ee} < 4$ GeV/$c^2$) at very low $p_T$ in heavy-ion collisions for different centrality bins in order to study the production mechanism.

This talk will cover $e^+e^-$ spectra with various invariant mass and $p_T$ differentials in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and U+U collisions at $\sqrt{s_{NN}} = 193$ GeV. The structure of the t ($t = p_T^2$) distributions of these mass regions will be shown and compared with the same distributions in ultra-peripheral collisions. Additionally, this talk will cover first measurements of $\mu^+\mu^-$ invariant mass spectra from STAR’s recently installed Muon Telescope Detector (MTD) in p+p and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. Physics implications of the $\mu^+\mu^-$ results will be discussed in the context of STAR’s published $e^+e^-$ results.

**Preferred Track**

Electromagnetic Probes

**Collaboration**

STAR

**Primary author:** BRANDENBURG, James (Rice University)

**Presenter:** BRANDENBURG, James (Rice University)

**Session Classification:** Parallel Session 1.3: Electromagnetic Probes (I)

**Track Classification:** Electromagnetic Probes
Performance and design of ATLAS trigger in p+Pb and Pb+Pb collisions

The peak rate of interactions in high luminosity heavy ion runs in 2015 and 2016 was well above the ATLAS maximum recording rate of around 1kHz. Therefore an active trigger selection is applied relying partly on algorithms used for selection during pp data taking and a set of algorithms dedicated solely for heavy ions. They are used to collect enhanced samples of high multiplicity, ultra-peripheral and azimuthally asymmetric collisions. Contrary to the slowly changing underlying event conditions in nominal pp collisions, the underlying event in heavy ion collisions varies from event to event. Therefore specialised approaches have been developed for events containing hard probes to assure even performance in the environment of peripheral and central events. This poster presents an overview of the strategy and performance of the different triggers used during the Pb+Pb and p+Pb runs.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
ATLAS

Primary author: KREMER, Jakub Andrzej (AGH University of Science and Technology (PL))
Co-author: COLLABORATION, ATLAS (CERN)
Presenter: KREMER, Jakub Andrzej (AGH University of Science and Technology (PL))
Session Classification: Poster Session
Calculation of the Electric Conductivity of Hot Hadronic Matter

The determination of transport coefficients plays a central role in characterizing hot and dense nuclear matter. In the present work we calculate the electric conductivity of hot hadronic matter by extracting it from the rho-meson spectral function, as its zero-energy limit at vanishing momentum. Recent calculations of the electric conductivity in hot nuclear matter have been performed in different approaches but show significantly varying results.

Using hadronic many-body theory, we calculate the rho meson self-energy in a pion gas. Previously the effects of in-medium nucleons and delta particles on the pion cloud of the rho propagator have been calculated. However the effects of thermal pions on the pion self-energies were not included. This requires the determination of the relevant interactions between in-medium pions and the rho meson, and the calculation of these interactions. This calculation requires the dressing of the pion propagators in the rho self-energy with pion-rho loops. To maintain gauge invariance one must calculate vertex corrections to the rho self-energy loops. Using guidance from previous works, we calculate these vertex corrections relativistically. The resulting spectral function is used to calculate the electric conductivity of hot hadronic matter. In particular, we analyze the transport peak of the spectral function and extract its behavior with temperature and coupling strength. Our results suggest that, while obeying lower bounds set by conformal field theories in the strong-coupling limit, the pion gas is a strongly coupled medium.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: ATCHISON, Joseph (Texas A&M University)
Presenter: ATCHISON, Joseph (Texas A&M University)
Session Classification: Poster Session
Radiation Hard Prototype for ATLAS ZDC Upgrade

Increases in luminosity and collision energy at the LHC challenge the radiation hardness of detectors located along the beamline. This problem is especially acute for the ATLAS Zero Degree Calorimeters (ZDCs), which are exposed to about $10^{10}$ rad/yr, rendering the current version of the detector unusable during p+p running. To address this shortcoming and allow for important triggers and access to interesting low-x physics, we have designed a prototype that replaces quartz radiator material with a circulating, liquid hydrocarbon, as well as a new radiator geometry that orients the radiator gaps and tungsten absorber plates along the Cherenkov angle of normally incident particles. Design considerations, results from prototype beam tests at the SPS, and comparisons to GEANT simulation will be presented. The poster will also discuss plans for a material test that will take place at the ZDC’s nominal location in ATLAS during the 2017 p+p run, allowing for important radiation hardness measurements of candidate materials for liquid radiator, reflectors and quartz fibers.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ATLAS

Primary author: PHIPPS, Michael William (Univ. Illinois at Urbana-Champaign (US))

Co-author: COLLABRATION, ATLAS (CERN)

Presenter: PHIPPS, Michael William (Univ. Illinois at Urbana-Champaign (US))

Session Classification: Poster Session
PHENIX measurements of the pseudorapidity dependence of charged particle multiplicity in d+Au collisions at 200, 62.4, 39, and 19.6 GeV

Measurements of the charged particle multiplicity as a function of pseudorapidity help constrain our understanding of collision dynamics and particle production mechanisms. In 2016, RHIC operations included d+Au collisions at 200, 62.4, 39, and 19.6 GeV. This poster presents the current status of analysis of charged particle multiplicities in the 2016 d+Au beam energy scan.

Preferred Track

QCD in small systems

Collaboration

PHENIX

Primary author:  HILL, Kurt Keys (University of Colorado Boulder (US))
Presenter:  HILL, Kurt Keys (University of Colorado Boulder (US))
Session Classification:  Poster Session
PHENIX MPC-EX Detector Performance in Run 16

The PHENIX Muon Piston Calorimeter Extension (MPC-EX) is a Si-W pre-shower detector positioned at forward rapidity (3.1 < |\eta| < 3.8) in front of the already existing MPC. It is a combined charged particle tracker and EM preshower detector with the readout signal of each Si minipad (1.8 x 15 mm) split into high and low gain to provide sensitivity from MIPs up to full energy EM showers. The physics goal for the MPC-EX in Run 16 is to study the gluon distribution at low-x in 200 GeV d+Au running. A firmware update in Run 16 provided stable readout and improved live area of the detector. The MPC-EX was timed in with PHENIX during 200 GeV Au+Au, then later confirmed in 200 GeV d+Au. Pedestals were checked weekly and used to set the zero-suppression thresholds. The leakage current and temperature were monitored and bias voltage was changed if needed. This poster will detail the setup and performance of the MPC-EX detector in Run-16 and the impact of improvements between Run-15 and Run-16 on physics performance.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

PHENIX

Primary author:  PATEL, Milap
Presenter:  PATEL, Milap
Session Classification:  Poster Session
Long range two-particle correlations in $p$-Pb collisions at $\sqrt{s_{NN}}=5.02$ $\text{TeV}$ with ALICE

Correlations measurements as a function of the azimuthal angle and rapidity are very useful for investigating particle productions in high-energy nucleus-nucleus collisions. Long range, near side angular correlations have been observed in high multiplicity $pp$ and $p$-Pb collisions at the LHC energies.

Possible explanations of the long range correlations in high multiplicity $pp$ and $p$-Pb collisions are the collective behavior of the created medium and/or the remnants of the strong color fields created by the dense gluonic field (gluon saturation).

The saturation effects are expected to be enhanced at the forward rapidity region and measurements of the particle productions with large rapidity gaps and the centrality dependence are important to quantify saturation and hydrodynamical final state effects.

We will present results on two-particle correlations between the ALICE central barrel tracking detectors at $-0.9 < \eta < 0.9$ and the ALICE VZERO detectors at $-3.7 < \eta < -1.7$ (V0C) and $2.8 < \eta < 5.1$ (V0A), as well as the V0A-V0C correlations for $p$-Pb collisions at $\sqrt{s_{NN}}=5.02$ $\text{TeV}$.

$v_2$ and $v_3$ in the forward and central rapidity regions from TPC-V0A, TPC-V0C, and V0A-V0C correlations as a function of centrality, $\eta$ gap, and transverse momentum will be compared with AMPT and hydro calculations.

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: SEKIGUCHI, Yuko (University of Tokyo (JP))

Presenter: SEKIGUCHI, Yuko (University of Tokyo (JP))

Session Classification: Poster Session
A Cellular Automaton tracking algorithm for the Upgrade of the Inner Tracking System of ALICE

In view of the LHC Run3 starting in 2021, the ALICE experiment is preparing a major upgrade including the construction of an entirely new inner silicon tracker (the Inner Tracking System) and a complete renewal of its Online and Offline systems.

During its Run3, LHC will deliver Pb-Pb collisions at $\sqrt{s_{NN}} = 5.5$ TeV with a peak luminosity $L = 6 \times 10^{37} \text{cm}^{-2} \text{s}^{-1}$ and an interaction rate of 50 kHz, to be compared to the 8 kHz design interaction rate of the LHC Run1 and Run2. The aim of ALICE is to cope with such a high interaction rate improving at the same time the resolution and the efficiency of its silicon tracker.

In this context, one of the requirements for a prompt calibration of external detectors and a fast offline data processing is to run online the reconstruction of tracks in the Upgraded Inner Tracking System.

A new algorithm based on Cellular Automata has been developed to tackle this issue. In this algorithm the tracking is split in multiple phases to profit from data locality. At first, hit points are organised in sectors of azimuthal angle and longitudinal coordinate; then the algorithm looks for track segments within these sectors of the detector, independently. Track segments with compatible track parameters are marked as neighbours.

Neighbouring track segments are then merged at the final stage using a set of rules defined by the Cellular Automaton mechanism, somewhat similar to the set of rules used in the Conway’s Game of Life.

The obtained computing and tracking performance are compliant with the requirements of ALICE being able to reconstruct tracks of transverse momentum down to 100 MeV/c in events with high track density ($dN_{ch}/d\eta$ up to 2000). The tracking and computing performance of this algorithm will be shown in the case of central Pb-Pb events at $\sqrt{s_{NN}} = 5.5$ TeV.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

ALICE

Primary author: PUCCIO, Maximiliano (Universita e INFN Torino (IT))

Presenter: PUCCIO, Maximiliano (Universita e INFN Torino (IT))

Session Classification: Poster Session
Forward photons in d+Au collisions at 200 GeV in the PHENIX Experiment

A strong suppression of hadron yields in d+Au collisions has been seen at forward rapidities at RHIC, which would be a sign for the onset of gluon saturation in the heavy Au nucleus. Direct photons provide complementary insight towards the physical nature of the suppression of hadron yields since they are directly sensitive to the gluon density at forward rapidities (through gluon Compton scattering) and are not affected by final state effects. Experimentally the ability to isolate direct photons from the background of photons from hadron decays can be achieved with a high spatial resolution preshower detector coupled with an electromagnetic calorimeter. Such detector, the Muon Piston Calorimeter Extension (MPC-EX), has been installed in PHENIX at RHIC and successfully took data for d+Au collisions at 200 GeV during 2016, providing a high statistics dataset for the analysis of prompt photon production. The detector system consists of a highly segmented silicon-tungsten preshower detector coupled to a PbWO4 electromagnetic calorimeter located at $3.1 < \eta < 3.8$. The methodology for photon reconstruction and the status of the photon analysis will be presented here.

Preferred Track

Electromagnetic Probes

Collaboration

PHENIX

Primary authors: Dr PEREZ LARA, Carlos Eugenio (Stony Brook University); Dr PEREZ LARA, Carlos Eugenio (Stony Brook University); PEREZ, Carlos (NIKHEF); PEREZ LARA, Carlos (Universita & INFN, Torino-Unknown-Unknown)

Presenters: Dr PEREZ LARA, Carlos Eugenio (Stony Brook University); Dr PEREZ LARA, Carlos Eugenio (Stony Brook University); PEREZ, Carlos (NIKHEF); PEREZ LARA, Carlos (Universita & INFN, Torino-Unknown-Unknown)

Session Classification: Poster Session
PHENIX results on identified pion, kaon, proton and anti-proton transverse momentum distributions in p+Au collisions at \( \sqrt{s_{nn}} = 200 \text{ GeV} \)

Recent results from small collision systems at RHIC and LHC indicate that many of the signatures of collective behavior observed in AA collisions are also present in small systems in high-multiplicity events. The PHENIX experiment has performed comprehensive studies of long-range particle correlations and anisotropic flow in p/d/He3+Au collisions. Mass ordering has been observed in the \( p_t \) distributions of the anisotropic flow coefficients \( v_n \). In the hydrodynamics description of the system evolution such mass ordering is expected to arise from radial flow, where all particles move with a common flow velocity. Information about the radial flow can be gained more directly from measurements of the transverse momentum distributions of identified hadrons. In this poster, we present the PHENIX the status of ongoing measurements of identified pion, kaon, proton and anti-proton spectra in p+Au collisions at \( \sqrt{s_{nn}}=200 \text{ GeV} \). The measurements are performed as a function of centrality. The spectral shapes will be studied to extract information about possible radial flow in p+Au collisions and its evolution with collision centrality.

**Preferred Track**

Collective Dynamics

**Collaboration**

PHENIX

**Primary author**: PENG, Weizhuang (Vanderbilt University (US))

**Presenter**: PENG, Weizhuang (Vanderbilt University (US))

**Session Classification**: Poster Session
The QCD Equation of State and critical end-point estimates at $6^{th}$ order in chemical potentials

Tuesday, 7 February 2017 15:20 (20 minutes)

The QCD Equation of State (EoS) is fundamental for our understanding of the properties of strong-interaction matter at non-zero temperature and density. In view of the upcoming Beam Energy Scan II program at RHIC, it is important to gain control over the EoS in the entire range of chemical potentials ($\mu_B$) accessible at RHIC, $0 \leq \mu_B/T \leq 3$. This will provide crucial input for the hydrodynamic modeling of hot and dense matter and will allow to clarify whether or not a critical end-point exists in this parameter range.

We present results for the QCD Equation of State at non-zero chemical potentials corresponding to the conserved charges in QCD using Taylor expansion upto $6^{th}$ order in the baryon number, electric charge and strangeness chemical potentials. The latter two are constrained by strangeness neutrality and a fixed electric charge to baryon number ratio. In our calculations, we use the Highly Improved Staggered Quarks (HISQ) discretization scheme at different values of the lattice spacings to control lattice cut-off effects. The light and strange quark masses are adjusted to reproduce physical values of pion and kaon masses. Furthermore we calculate the pressure along lines of constant energy density, which serve as proxies for the freeze-out conditions and discuss their dependence on $\mu_B$, which is necessary for hydrodynamic modeling near freezeout.

We also provide an estimate of the radius of convergence of the Taylor series from the $6^{th}$ order coefficients which gives a new constraint on the location of the critical end-point in the $T$-$\mu_B$ plane of the QCD phase diagram.

Preferred Track

QCD at High Temperature

Collaboration

Other

Primary author: SHARMA, Sayantan (BNL)
Presenter: SHARMA, Sayantan (BNL)
Session Classification: Parallel Session 3.1: QCD at High Temperature
Track Classification: QCD at High Temperature
Global polarization of Lambda hyperons in Pb-Pb collisions at 2.76 TeV

The system created in non-central nucleus-nucleus collisions possesses large orbital angular momentum. Due to this, particles produced in such a system can become globally polarized along the direction of the system’s angular momentum. We present global polarization measurements for $\Lambda$ and $\Lambda$ hyperons in Pb-Pb collisions at $\sqrt{s_{\text{NN}}} = 2.76$ GeV performed with the ALICE detector at the LHC. The global polarization is studied at different collision centralities as well as at different transverse momenta and rapidity regions of the hyperons.

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: KONYUSHIKHIN, Maxim (Wayne State University (US))
Presenter: KONYUSHIKHIN, Maxim (Wayne State University (US))
Session Classification: Poster Session
\(\Lambda_c^+\) production in Au+Au collisions at \(\sqrt{s_{NN}} = 200\) GeV at the STAR experiment

Charm quarks, predominantly produced in the early stage of heavy-ion collisions, are believed to provide unique information on the hot and dense medium created in such collisions. At RHIC, an enhancement in baryon-to-meson ratios for light hadrons and hadrons containing strange quarks has been observed in central heavy-ion collisions compared to p+p and peripheral heavy-ion collisions in the intermediate \(p_T\) range (2 < \(p_T\) < 6 GeV/c). This was explained by the hadronization mechanism involving multi-parton coalescence. \(\Lambda_c^+\) is the lightest charmed baryon with the mass close to \(D^0\) meson, and it has an extremely short lifetime (\(c\tau \sim 60\) \(\mu m\)). Different models predict different levels of enhancement in the \(\Lambda_c^+/D^0\) ratio depending on the degree of charm quark thermalization in the medium and how the coalescence mechanism is implemented.

In this poster, we will report the first measurement of \(\Lambda_c^+\) production in heavy-ion collisions using the recently installed Heavy Flavor Tracker at STAR. \(\Lambda_c^+\) are reconstructed through the hadronic decay channel \((\Lambda_c^+ \rightarrow pK\pi)\) using topological cuts optimized by the Toolkit for Multivariate Data Analysis (TMVA). After correcting for the reconstruction efficiency and acceptance, the transverse-momentum spectrum of \(\Lambda_c^+\) in Au+Au collisions at \(\sqrt{s_{NN}} = 200\) GeV will be presented. The measured \(\Lambda_c^+/D^0\) ratio will be compared with different model calculations, and the physics implications will be discussed.

**Preferred Track**

Open Heavy Flavors

**Collaboration**

STAR

**Primary author:** XIE, Guannan (LBNL/USTC)

**Presenter:** XIE, Guannan (LBNL/USTC)

**Session Classification:** Poster Session
Viscous corrections to inelastic photon production channels in QGP

Photons emitted in heavy-ion collisions are sensitive to the entire history of the system evolution as they are emitted in all stages of the collision. As such they are excellent probes of the out-of-equilibrium nature of a fast evolving system. The degree of out-of-equilibrium is encoded in the transport coefficients (the shear and bulk viscosities) and the so-called $\delta f$ corrections to the equilibrium density function. The importance of these corrections on hadronic observables has been shown in 1. However, their effects on electromagnetic observables has been explored only for the 2-to-2 scattering channels 2. Viscous corrections to the inelastic leading-order photon production channels have been lacking so far. In this work, we will present first calculations of the shear and bulk viscous correction to the Arnold-Moore-Yaffe (AMY) photon production rates which include bremsstrahlung and pair annihilation without relying on the Kubo-Martin-Schwinger (KMS) condition. We fold the rate with a hydrodynamic evolution in order to examine the phenomenological implications on photonic observables in AA collisions. Finally, we will discuss how the methods used in this calculation pave the way for the viscous correction to other processes in QGP where coherence between different scattering sites is important, such as jet-medium interaction.


Preferred Track

Electromagnetic Probes

Collaboration

Not applicable

Primary author: HAUSSON, Sigtryggur (McGill University)

Presenter: HAUSSON, Sigtryggur (McGill University)

Session Classification: Poster Session
Centrality Determination for p+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV by the STAR Experiment

In heavy-ion collisions, properties of the created QCD matter highly depend on the collision geometry or “centrality”. In A+A collisions, centrality is related to the size of the overlap region determined by the impact parameter. In p+A collisions, the term “centrality” is still taken to be a classification of the amount of activity in the collision, which, however, is not strictly related to the impact parameter, but more closely to the number of p+N collisions in a Glauber-like picture. This study focuses on the determination of centrality classes in p+Au collisions at $\sqrt{s_{NN}} = 200$ GeV by the STAR experiment using data taken in 2015. Simulation studies based on the Glauber model and the GEANT modelling of the STAR detector are performed to determine the sensitivity of different sub-detectors with different rapidity coverages to the event centrality. Comparisons of such studies to the data will be presented, and the implications on how to best determine centralities for p+Au collisions will be discussed.

Preferred Track

QCD in small systems

Collaboration

STAR

Primary author: LIU, Yanfang (TAMU)
Presenter: LIU, Yanfang (TAMU)
Session Classification: Poster Session
Low pT direct photon measurement in Au+Au at 200GeV with PHENIX

One of the major goals in heavy ion physics is to study the property of Quark Gluon Plasma (QGP). Direct photons turn out to be golden probes due to their small interaction with the medium. Direct photons are also produced in every known or conjectured stages of the collision hence carrying information of the entire evolution of the system. PHENIX has discovered a large excess of thermal photons at low pT in Au+Au collisions at 200 GeV with a large azimuthal anisotropy. These observations are challenging current state of the art theoretical models. Using the high statistics data sample of Au+Au collisions taken in 2014, PHENIX will be able to reduce the experimental uncertainties on the low pT direct photon measurement and measure flow to higher orders. In these new measurements we detect photons via external conversions to electron-positron pairs. In this poster we will present the improvements and the current status of the analysis.

Preferred Track

Electromagnetic Probes

Collaboration

PHENIX

Primary author:  Ms FAN, Wenqing (Stony Brook University)
Presenter:  Ms FAN, Wenqing (Stony Brook University)
Session Classification:  Poster Session
Distance of Closest Approach and Unfolding Study to Infer Bottom and Charm Quark Production in \( p+p \) Collisions at \( \sqrt{s} = 200 \) GeV in the PHENIX experiment

Heavy quarks, such as bottom and charm, are primarily produced during the initial collision. In heavy ion collisions they experience the full evolution of the hot medium formed. As such they are valuable probes of the properties of the quark gluon plasma (QGP). The PHENIX Collaboration has previously published results in \( \text{Au+Au} \) collisions at \( \sqrt{s} = 200 \) GeV using the PHENIX silicon vertex detector that indicated a different energy loss pattern for bottom and charm quarks. To more accurately measure this effect and produce a well-understood \( R_{AA} \), a similar analysis is being done in the 2015 \( p+p \) collision data set at \( \sqrt{s} = 200 \) GeV. The analysis uses Bayesian unfolding techniques applied simultaneously to the heavy flavor electron yield and the distance of closest approach for heavy flavor electrons in order to provide separated charm and bottom invariant yields. This poster will present the distance of closest approach measurements for electrons from heavy flavor decays, their use in the unfolding procedure, and the status of the analysis.

Preferred Track

Open Heavy Flavors

Collaboration

PHENIX

Primary author: RINN, Timothy (Iowa State University)

Presenter: RINN, Timothy (Iowa State University)

Session Classification: Poster Session
Underlying-event Activity Studies at $\sqrt{s_{NN}} = 200$ GeV by STAR

Underlying-event activity is defined as the soft particle production in proton+proton and proton+nucleus collisions which is not directly related to the final fragmentation of hard-scattered partons. Underlying-event measurements therefore provide a tool to study non-factorizable and non-perturbative phenomena. Systematic measurements of the relationship between the underlying event and jet processes help to disentangle initial and final state effects. Jet-hadron correlations give insights into the jet contribution to the underlying event, which needs to be accounted for when making collectivity measurements in small systems. Underlying-event activity is measured by particle production in the azimuthal direction perpendicular to the leading jet in the event. Measurements of underlying-event activity dependence on the leading jet transverse momentum in p+p collisions at 200 GeV will be presented and a comparison with Monte Carlo simulations, other energies, and asymmetrical collisions will be discussed.

Preferred Track

Jets and High pT Hadrons

Collaboration

STAR

Primary author: Dr YI, Li (Yale University)
Presenter: Dr YI, Li (Yale University)
Session Classification: Poster Session
The x and scale dependence of the transport coefficient $\hat{q}$

Wednesday, 8 February 2017 08:50 (20 minutes)

We take a closer look at the single particle nuclear modification factor ($R_{AA}$) and azimuthal anisotropy ($v_2$) of leading hadrons at high transverse momentum ($p_T$) at both RHIC and LHC collision energies. We focus on the established reduction in the interaction measure $\hat{q}/T^3$ between RHIC and LHC, as discovered by the JET collaboration. The centrality dependence of the $R_{AA}$ and $v_2$ at both these collision energies strongly suggests that the reduction is not caused by a temperature dependence in the ratio of $\hat{q}/T^3$ but rather by an energy dependence of $\hat{q}$.

We study this dependence by introducing an $x$ dependence in the distribution function that is integrated to obtain $\hat{q}$. We conjecture on possible forms of a scale dependence by relating $\hat{q}$ to an object similar to a transverse momentum dependent parton distribution function (TMDPDF). The ensuing operator product is then related to quantities that may be estimated in lattice QCD.

Preferred Track
Jets and High $p_T$ Hadrons

Collaboration
Not applicable

Primary author: KUMAR, Amit (Wayne State University)
Presenter: KUMAR, Amit (Wayne State University)
Session Classification: Parallel Session 5.4: Jets and High $p_T$ Hadrons (IV)
Track Classification: Jets and High $p_T$ Hadrons
The 2015 US Nuclear Physics Long Range Plan calls for a state-of-the-art jet and upsilon detector at RHIC, called sPHENIX, to study the microscopic nature of the QGP, complementing similar studies at the CERN LHC. The sPHENIX detector will provide precision vertexing, tracking and full calorimetry over pseudorapidity $|\eta| < 1.1$ and full azimuth at the full RHIC collision rate, delivering unprecedented data sets for jet and upsilon measurements at RHIC. This will enable the three pillars of the sPHENIX physics program, i.e., studies of jet structure modifications, measurements of heavy-flavor tagged jet production and precision upsilon spectroscopy. In this talk we will present an overview of the sPHENIX detector design, expected construction and running schedule and planned physics program.
Design and test-beam performance of the sPHENIX calorimeter system

The sPHENIX Collaboration at RHIC is planning a major upgrade to the PHENIX experiment by constructing an entirely new spectrometer based on the former BaBar solenoid magnet that will enable a comprehensive study of jets and heavy quarkonia in relativistic heavy ion collisions. The calorimeter system of the sPHENIX experiment will cover an acceptance of ±1.1 units in pseudorapidity and full azimuth with a tungsten-scintillating fiber electromagnetic calorimeter, surrounded by two layers of steel-scintillator sampling hadronic calorimeters. The first prototype of this integrated calorimeter system has been tested at Fermilab in April of 2016, while the second prototype is taking data in early 2017. Design considerations, test beam results and performance projection for the sPHENIX calorimeter system will be presented in this talk.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: Dr HUANG, Jin (Brookhaven National Lab)
Presenter: Dr HUANG, Jin (Brookhaven National Lab)
Session Classification: Poster Session
Comparison of STAR Au + Au $\sqrt{s_{_{\text{NN}}}}$ = 4.5 GeV Fixed-Target and AGS Au + Au Fixed-Target Spectra, Strangeness, Flow and HBT

Wednesday, 8 February 2017 14:20 (20 minutes)

The RHIC Beam Energy Scan (BES) Program was proposed to look for the turn-off of signatures of the quark gluon plasma (QGP), search for a possible QCD critical point, and study the nature of the phase transition between hadronic and partonic matter. The results from the NA49 experiment at CERN have been used to claim that the onset of deconfinement occurs at $\sqrt{s_{_{\text{NN}}}} \approx 7$ GeV, the low end of the BES range. Additionally, studies of several interesting observables during the BES, including $v_1$ of protons and lambdas, $v_2$ of identified hadrons, and net-proton higher moments, show interesting behavior below 20 GeV and could suggest a transition to a hadron dominated regime. Data from energies lower than 7 GeV could help determine whether these behaviors are indicative of phase transitions or criticality. The goal of the STAR Fixed-Target Program is to extend the collision energy range in BES-II with the same detector to lower energies than is feasible at RHIC with colliding beams.

In this talk we present results from STAR’s first dedicated fixed-target test run conducted in 2015 with Au + Au collisions at $\sqrt{s_{_{\text{NN}}}}$ = 4.5 GeV. Direct flow of protons, elliptic flow of identified hadrons, HBT radii, as well as pion, proton, kaon, $K_S^{0}$, and lambda spectra are compared with previous results from the Alternating Gradient Synchrotron (AGS). These results demonstrate that STAR has good event reconstruction and particle identification capabilities for this fixed-target configuration even though it was optimized for colliding beams in the center of the detector. The implications of these results on future STAR fixed-target physics runs are discussed.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

STAR

Primary author: MEEHAN, Kathryn (UC Davis)

Presenter: MEEHAN, Kathryn (UC Davis)

Session Classification: Parallel Session 7.1: Baryon-Rich QCD Matter and Astrophysics (II)

Track Classification: Baryon-Rich QCD Matter and Astrophysics
Di-jet Hadron Correlations In Central Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV at STAR

Jets and their modifications due to partonic energy loss provide a powerful tool to study the properties of the QGP created in ultrarelativistic heavy-ion collisions. For anti-$k_t$ jets with a resolution parameter $R = 0.4$, previous measurements of the di-jet asymmetry $A_J$ at STAR 1 indicate that the observed imbalance of an initial "hard-core" di-jet selection with $p_T^{\text{constituent}} > 2.0$ GeV/c, $p_T^{\text{leadjet}} > 20.0$ GeV/c and $p_T^{\text{subjet}} > 10.0$ GeV/c is restored to the balance of the pp reference when soft constituents are included. The lost energy is recovered in soft constituents within the jet radius.

Jet-hadron correlations with respect to the $A_J$ di-jets allow a differential assessment of the kinematic properties of the soft gluon radiation spectrum induced by partonic energy loss in the QGP. We present charged hadron correlations with respect to the di-jets found in the above $A_J$ analysis, and compare to similar measurements using a single-jet trigger at RHIC, as well as to jet-track correlations at the LHC.


Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

STAR

Primary author: ELSEY, Nicholas (Wayne State University)

Presenter: ELSEY, Nicholas (Wayne State University)

Session Classification: Poster Session
We develop a set of kinetic equations for hydrodynamic fluctuations which are equivalent to nonlinear hydrodynamics with noise. The hydro-kinetic equations can be coupled to existing second order hydrodynamic codes to incorporate the physics of these fluctuations, which become dominant near the critical point.

We first show that the kinetic response precisely reproduces the renormalization of the shear viscosity and the fractional power \( \langle \omega \rangle^{3/2} \) which characterizes equilibrium correlators of energy and momentum for a static fluid. Such fractional powers are known as "long time tails", and were previously discussed by Kovtun, Moore and Romatschke.

Then we use the hydro-kinetic equations to analyze thermal fluctuations for a Bjorken expansion, evaluating the contribution of thermal noise from the earliest moments and at late times. In the Bjorken case, the solution to the kinetic equations precisely determines the coefficient of the first fractional power of the gradient expansion \( \langle \tau/(\tau T)^{3/2} \rangle \) for the expanding system. Numerically, we find that the contribution to the longitudinal pressure from hydrodynamic fluctuations is larger than second order hydrodynamics for typical medium parameters used to simulate heavy ion collisions.

\[ \text{arXiv:1606.07742} \]

**Preferred Track**

New Theoretical Developments

**Collaboration**

Not applicable

**Primary author:** Dr AKAMATSU, Yukinao (Osaka University)

**Co-author:** MAZELIAUSKAS, Aleksas

**Presenter:** Dr AKAMATSU, Yukinao (Osaka University)

**Session Classification:** Parallel Session 6.3: New Theoretical Developments (II)

**Track Classification:** New Theoretical Developments
**Measurement of $\Lambda(1520)$ in pp collisions at $\sqrt{s} = 13$ TeV**

The first measurement of the $\Lambda(1520)$ baryonic resonance in pp collisions at $\sqrt{s} = 13$ TeV, performed using the ALICE detector at the LHC, is presented. The analysis details for invariant mass reconstruction in the hadronic decay channel $\Lambda(1520) \rightarrow pK^- $ are discussed. The invariant mass distributions for various $p_T$ intervals are obtained from $0 < p_T$ (GeV/c) $< 6$. The invariant $p_T$ spectra, integrated yield, $\Lambda(1520) / \Lambda(1115)$ and mean $p_T$ for inelastic collisions are also shown. This measurement serves as a baseline study for measurements performed in Pb-Pb collisions, where modifications to the $\Lambda(1520)$ yields may provide insight into the hadronic stage of system evolution.

**Preferred Track**
Collective Dynamics

**Collaboration**
ALICE

**Primary author:** SETT, Priyanka (IIT- Indian Institute of Technology (IN))

**Presenter:** SETT, Priyanka (IIT- Indian Institute of Technology (IN))

**Session Classification:** Poster Session
Angular momentum direction correlations relevant to measuring polarization phenomena

Effects related to the angular momentum of the mid-rapidity source created in a heavy ion collision are under intense study. While the angular momentum of the collision is completely determined by the impact parameter and the beam direction, the angular momentum of the mid-rapidity source may fluctuate event to event. We study these fluctuations in a Glauber calculation and with the UrQMD transport model. Their relevance to current studies of global hyperon polarization at RHIC will be emphasized.

Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary author:  Mr ADAMS, Joseph (The Ohio State University)
Presenter:  Mr ADAMS, Joseph (The Ohio State University)
Session Classification:  Poster Session
Many-body T-matrix Approach to Strongly Coupled Quark Gluon Plasma

Current experimental findings at RHIC and LHC imply that a strongly coupled quark gluon plasma (QGP) is created in heavy-ion collisions. This calls for a non-perturbative investigation to understand relations between various observables and the underlying physical mechanisms. Considering the difficulties in first principle approaches, we have developed a tractable non-perturbative many-body T-matrix model to investigate the strongly coupled features of the QGP. Through our recent developments [1,2], we can self-consistently solve the thermodynamics of our model including resummed non-perturbative t-channel contributions [3], where two-body resonance and scattering states are treated on equal footing. Inputs of the model are constrained by matching thermal Euclidian-time quantities with lattice QCD, such as static quark free energy, equation of states (EoS), and various susceptibilities. With these constrained inputs, the model can directly calculate various real-time amplitudes and spectral functions that closely relate to observables without involving analytic continuations. More concretely, matching to heavy-quark (HQ) free energy data, we extract a strongly coupled potential [1]. Using this potential as input, we find broad light-parton spectral functions by comparing to the EoS [2]. With these constraints, we obtain large HQ relaxation rates with nontrivial temperature and momentum dependences. Results from implementing these into a HQ transport model will be compared to low-momentum heavy-flavor observables from experiments [4]. We also discuss the calculation of the EoS at finite chemical potential and the comparison to susceptibilities at the finite temperature.


Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary author: LIU, Shuai (Texas A&M University)
Co-author: RAPP, Ralf (Texas A&M University)
Presenter: LIU, Shuai (Texas A&M University)
Session Classification: Poster Session
Reinterpretation of higher harmonics from mini-jet propagation

We investigate effects of mini-jet propagation on collective expansion of the quark gluon plasma (QGP) and, based on this picture, reinterpret higher harmonics ($v_n$) data in Pb+Pb collisions at the LHC energies. In ultrarelativistic heavy ion collisions, a large number of mini-jets are subject to traverse the QGP and are expected to disturb its collective expansion due to deposition of energy and momentum from them. Thus, we focus on hydrodynamic responses to propagation of a large number of mini-jets in the QGP.

We employ a QGP fluid + jet model [1,2] to demonstrate the above idea. We solve (3+1)-dimensional ideal hydrodynamic equations with energy-momentum source terms. As an input, we generate partons by using an event generator PYTHIA with switching off hadronization, combined with a Monte-Carlo version of the Glauber model. Instead of setting initial conditions for hydrodynamic fields, we make these partons propagate until hydrodynamic initial time and, during this stage, they deposit energy and momentum locally. We suppose these deposited energy and momentum are quickly equilibrated to form initial hydrodynamic fields. Although this is rather phenomenological treatment of thermalization/equilibration, this naturally generates not only initial fluctuations of geometry but also those of velocity fields which are often neglected in the conventional hydrodynamic analysis. Subsequently we consider survived partons as mini-jets and simulate hydrodynamic responses to mini-jet propagation. We find mini-jet propagation indeed causes sizable anisotropic flow in the QGP fluid. This suggests conventional hydrodynamic interpretation of flow data based solely on initial eccentricity should be revisited by taking account of correction from mini-jet propagation and initial random velocity fields.

References


Preferred Track
Collective Dynamics

Collaboration
Not applicable

Primary author: OKAI, Michito (Sophia University)
Co-author: TACHIBANA, Yasuki (Central China Normal University)
Presenter: OKAI, Michito (Sophia University)
Session Classification: Poster Session
In-Medium Bottomonium Production in Heavy-Ion Collisions

We study bottomonium production at RHIC and the LHC using a transport model including both suppression and regeneration mechanisms. The transport model utilizes a kinetic rate equation to calculate the centrality dependence of the production yields, and a Boltzmann equation for transverse-momentum ($p_T$) spectra. It has been successful in describing and predicting charmonium data at SPS, RHIC and the LHC. The bottomonium dissociation rates are improved over previous work by using in-medium binding energies from an in-medium T-matrix approach, which, in turn, require to account for both gluo-dissociation (dominant for large binding) and inelastic parton-induced break-up (dominant for weak binding) including interference effects [3]. We also update the equation of state for the bulk medium using lattice-QCD results. For the calculation of the $p_T$-spectra and elliptic flow of the regeneration contribution we use a coalescence model [4] where the input bottom-quark spectra are taken from Langevin transport simulations of bottom quarks [5] to account for their non-equilibrium distributions. We then conduct a systematic analysis of bottomonium observables for the nuclear modification factor as a function of $N_{\text{part}}$ and $p_T$ in comparison to ALICE, CMS and STAR data. The comparison suggests that the centrality dependence of the total yields is sensitive to different scenarios for the screening of binding energies. The off-equilibrium bottom-quark spectra are found to play an important role in both the bottomonium $p_T$ spectra and their predicted elliptic, which helps to disentangle the role of regeneration contributions.

Reference:

1 X. Du, R. Rapp, J. Fox and M. He, in preparation
4 V. Greco, C. M. Ko, P. Levai, Phs. Rev. C68 (2003) 034904

Preferred Track

Quarkonia

Collaboration

Not applicable

Primary author: DU, Xiaojian (Texas A&M University)
Co-author: RAPP, Ralf (Texas A&M University)
Presenter: DU, Xiaojian (Texas A&M University)
Session Classification: Poster Session
Chiral phase transition in a soft-wall model of AdS/QCD

The AdS/CFT correspondence describes many features of non-perturbative QCD. A phenomenological approach called AdS/QCD uses a dilaton field to break conformal symmetry. This describes the linear confinement of hadronic spectra at zero temperature. Using an AdS-black hole metric allows for the study of the behavior of hadrons interacting with a hot, dense medium like the quark-gluon plasma.

We present an improved AdS/QCD model for meson spectra and chiral dynamics at finite temperature and baryon chemical potential. We find a second-order chiral phase transition in the chiral limit, with a critical temperature of 155 MeV and critical baryon chemical potential of 566 MeV, consistent with lattice calculations. For physical quark mass the transition is a rapid crossover, with a pseudo-transition temperature and density of 151 MeV and 559 MeV, respectively. Using a pure AdS-Schwarzschild metric, the light meson bound states are found to melt before the chiral phase transition occurs. This behavior is modified with appropriate parameterization of the metric.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: Dr BARTZ, Sean (Macalester College)

Presenter: Dr BARTZ, Sean (Macalester College)

Session Classification: Poster Session
Azimuthally differential pion femtoscopy with respect to second and third order event plane and the deformation of the source with event shape engineering in Pb-Pb 2.76 TeV

Azimuthally differential HBT is a powerful tool for investigating the source shape at freeze out. In heavy ion collisions, radial and anisotropic flow of the expanding medium have been observed. These hydrodynamic expansions result in the deformation of the initial geometry.

Studying the deformation of the source shape is important for investigating the dynamics of the system evolution.

In the last decade, azimuthally differential femtoscopy with respect to the second order event plane has been measured. The comparison between initial and final source eccentricities indicates the dilution of the source eccentricity by the expanding medium.

It is thought that initial density fluctuations generate higher order azimuthal anisotropy and it is expected to be a good probe to constrain initial conditions and the viscosity of the QGP. However it is not clear how the initial spatial fluctuations evolve to the geometry at freeze out. Azimuthally differential femtoscopy with respect to the third order event plane provides new insights into the medium expansion from the initial geometrical fluctuations to final anisotropies.

The azimuthal anisotropy flow coefficients $v_n$ fluctuate largely even in the same centrality class due to the fluctuations in the participant shape. Recently event shape engineering (ESE) was suggested as a powerful tool to control event-by-event flow fluctuations by selecting the magnitude of flow vectors $q_2$ and $q_3$. Azimuthally differential HBT with ESE offers a detailed analysis of the relation between anisotropic flow and the deformation of the source shape.

In this poster, we present azimuthally differential pion femtoscopy with respect to the second and the third order event plane and the study of how the source eccentricity changes with $q_2$ and $q_3$ selections.

Preferred Track

Collective Dynamics

Collaboration

ALICE

Primary author: TANAKA, Naoto (University of Tsukuba (JP))

Presenter: TANAKA, Naoto (University of Tsukuba (JP))
Experimental study of vector meson in nuclear medium at J-PARC

Hadrons are elementary excitations of the QCD vacuum thus they reflect the property of the vacuum. Indeed it is the chiral symmetry breaking of the QCD vacuum that leads to the generation of hadron mass. The vacuum properties could change according to the environment, namely the temperature and the density but are not well explored. For the understanding of QCD and its structure, it is important to study the hadron properties under different environment.

Our experiment, J-PARC E16, has been proposed to measure hadron mass in nuclear medium, to study a high density part of the QCD phase, in contrast to the studies in rather high temperature part being performed at RHIC and LHC. J-PARC E16 uses p+A->phi+X reactions and the invariant mass of phi meson is reconstructed with e+e- decay. The measured phi mesons may or may not escape the target nucleus at the time of their decay, thus the measurement is sensitive to in-medium changes of hadron mass. As the nuclear targets, CH2, C, Cu and Pb are planned. The advantage of the experiment is the good mass resolution and the ability to collect high statistics for the phi mesons. A mass resolution of 7 MeV/c^2 is expected for phi meson with the spectrometer which is under construction. The large acceptance and the high luminosity capability allow us to collect 10^4 of phi mesons with the full spectrometer, make it possible to measure the dispersion relation for the first time. KEK E325 experiment, the predecessor experiment of J-PARC E16, collected 10^3 of phi mesons with a mass resolution of 10 MeV/c^2 and measured in-medium mass of phi mesons which may be related to the chiral symmetry restoration at normal nuclear density. J-PARC E16 will study this with a better resolution and with 100 times better statistics. Due to budgetary limitations, we adopt staging approach. We start with a limited acceptance (likely 1/3) of the spectrometer by 2018 and take physics data. Then we prepare the full spectrometer for the ultimate goal. A special beam line is being prepared for the experiment and is planned to be completed by 2019. We discuss the expected physics results and report the preparation status of the beam line and the experiment.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
Other
Nuclear Modification of $B$ mesons in Collisions at 200 GeV measured through the $B \rightarrow J/\psi$ decay by the PHENIX Experiment

Heavy quarks are useful probes of nuclear matter since at RHIC energies as they are produced only in initial parton collisions, and thus are sensitive to effects at all stages of the collisions. Because of their large mass, $b$ quarks are expected to lose less energy through gluon radiation than lighter quarks. $J/\psi$ production from the $B \rightarrow J/\psi$ decay is a powerful observable to measure the nuclear modification of $B$ mesons in the relevant $p_T$ range ($p_T \ll m_b$).

PHENIX has measured the production of non-prompt $J/\psi$ from $B \rightarrow J/\psi$ decays in the dimuon channel at forward and backward rapidities, by the analysis of displaced vertex muons from the $B$ meson decay with the Forward Silicon Vertex Detector (FVTX). Comparison of the measured yields in the asymmetric Cu+Au, $p$+Au systems and in $p+p$ collisions can provide insights into the contributions of hot and cold nuclear matter effects.

Preferred Track

Open Heavy Flavors

Collaboration

PHENIX

Primary author: DA SILVA, Cesar Luiz (Los Alamos National Lab)

Presenter: DA SILVA, Cesar Luiz (Los Alamos National Lab)

Session Classification: Parallel Session 8.4: Open Heavy Flavors (III)

Track Classification: Open Heavy Flavors
PHENIX measurements of single electrons from charm and bottom decays at midrapidity in Au+Au collisions

Wednesday, 8 February 2017 15:20 (20 minutes)

Hadrons carrying heavy flavor (charm and bottom quarks) are a sensitive probe of the hot, dense medium created in high-energy nuclear collisions at RHIC because they are generated early in the reaction and subsequently propagate through the created matter.

The PHENIX experiment has measured inclusive open heavy flavor via the measurement of electrons from semi-leptonic decays of hadrons carrying charm or bottom quarks in a variety of Collision systems. After the addition of the silicon vertex tracker, VTX, independent measurements of charm and beauty meson are now possible via off-vertex decays. Using Bayesian unfolding techniques applied simultaneously to the heavy flavor electron yield and the distance of closest approach for heavy flavor electrons, PHENIX measured heavy-quark production of charm and bottom separately using data sets taken in 2011, 2014 and 2015 Au+Au and $p+p$ collisions.

In this talk, we will present the single electrons, from $b$ and $c$ decays separately, nuclear modification factors $R_{AA}$ and their interpretation in view of current theoretical understanding.

Preferred Track

Open Heavy Flavors

Collaboration

PHENIX

Primary author: NAGASHIMA, Kazuya (Hiroshima University)

Presenter: NAGASHIMA, Kazuya (Hiroshima University)

Session Classification: Parallel Session 7.4: Open Heavy Flavors (II)

Track Classification: Open Heavy Flavors
PHENIX measurements of open and hidden heavy flavor in $p + p$, $p + Al$, and $p/d/^{3}\text{He} + \text{Au}$ collisions across a wide range of rapidity.

Despite intense theoretical and experimental investigation, the physical mechanisms governing the suppression of bound quark-antiquark states in nuclear collisions are not yet fully understood. While color screening in a plasma phase is expected to play a role, there are numerous other possible suppression mechanisms that do not require deconfinement, as well as effects on the heavy quark initial state in the nucleus which can also play a role. To study these effects, the PHENIX collaboration has used the flexibility of the RHIC accelerator complex to observe the evolution of open heavy flavor and quarkonia dynamics as both the projectile and target nuclei size are varied. Open heavy flavor in small collision systems can serve as the baseline for interpreting quarkonia production in the nuclear environment, and comparisons of the $\psi(2S)$ with the $J/\psi$ show that in rapidity regions with relatively high hadron density, the larger $2S$ state is preferentially more suppressed than the more tightly bound $J/\psi$. This suggests that late-stage mechanisms may be at least partially responsible for quarkonia suppression in nuclear collisions. In this talk, we will present results on excited-state quarkonia in $p + p$, $p + Al$, and $p/d/^{3}\text{He} + \text{Au}$ collisions and open heavy flavor in small systems, and discuss how these measurements impact our understanding of heavy quark behavior in the quark-gluon plasma.

Preferred Track

Open Heavy Flavors

Collaboration

PHENIX

Primary author: Dr LIM, Sanghoon (LANL)
Presenter: Dr LIM, Sanghoon (LANL)
Session Classification: Parallel Session 8.4: Open Heavy Flavors (III)
Track Classification: Open Heavy Flavors
Forward/Backward asymmetry of $v_n$ in Cu+Au at RHIC-PHENIX

Azimuthal anisotropies of particle production in high energy heavy ion collisions have proven to be an excellent tool for investigating the initial geometry and the bulk properties of the Quark Gluon Plasma (QGP). Azimuthal anisotropy, measured through Fourier coefficients $v_n$, have been measured at mid-rapidity and are used to constrain the initial geometry and viscosity-over-entropy ratio $\eta/s$ of the QGP. Although there are many experimental observables and theoretical models, there are still uncertainties of the initial geometry and the $\eta/s$. Measurements of $v_n$ at forward/backward rapidity provide further insight into initial geometry. It is interesting to measure the $v_n$ coefficients at forward/backward rapidity in Cu+Au collisions, because of the asymmetry in number of participants and geometry in forward and backward direction. In this poster, we will present our work to measure forward/backward asymmetry of $v_n$ coefficients at pseudorapidity $3<|\eta|<4$ in Cu+Au collisions in comparison to results from Au+Au and Cu+Cu collisions.

Preferred Track
Collective Dynamics

Collaboration
PHENIX

Primary authors: Mr NAKAGOMI, Hiroshi (Tsukuba University); NAKAGOMI, Hiroshi (Tsukuba University)

Presenters: Mr NAKAGOMI, Hiroshi (Tsukuba University); NAKAGOMI, Hiroshi (Tsukuba University)

Session Classification: Poster Session
Data-driven analysis of the temperature and momentum dependence of the heavy-quark transport coefficient

Heavy quarks are considered as valuable probes of the quark-gluon plasma (QGP) created in ultra-realistic heavy-ion collisions. However, the simultaneous description of the heavy meson nuclear modification factor $R_{AA}$ and the elliptic flow $v_2$ poses a significant challenge for most commonly used transport modes, especially those based on Langevin transport. We propose a generalized ansatz for the temperature and momentum dependence of the heavy quark diffusion coefficient and subsequently extract its functional form by calibrating against RHIC and LHC data utilizing a Bayesian model-to-data analysis. Using the extracted transport coefficient, our improved Langevin framework is able to simultaneously reproduce the measured $R_{AA}$ and $v_2$ at both RHIC and LHC energies.

The Bayesian analysis used to extract the transport coefficient is set up as follows: a set of input parameters, in which the temperature and momentum dependence of the transport coefficient $D_s$ is encapsulated, are evaluated via an event-by-event heavy flavor transport model. In a (2+1)-dimensional viscous hydrodynamical model describes the QCD medium, heavy quarks propagate according to an improved Langevin equation that incorporates both radiative and collisional energy loss. Hadronization of heavy quarks occurs via a hybrid model of fragmentation and recombination. Those model outputs are used to train Gaussian process emulators that mimic the behavior the heavy quark transport model, and act as a fast surrogate of the transport model to interpolate across the full model parameter space. We then calibrate the model parameters on experimental data via a Markov chain Monte Carlo (MCMC) using Bayes’ Theorem. The final results of the analysis are the posterior probability distribution of all the model parameters that contain the high likelihood parameters range in which the model describes the data optimally. We find that the transport coefficient $D_s$ has a minimum value around critical temperature, and is comparable to lattice QCD calculation. A non-trivial momentum dependence of $D_s$ is observed as well. With the extracted functional form of the transport coefficients, the $R_{AA}$ and $v_2$ of heavy quarks in different centralities at 200 GeV AuAu collisions and 2.76/5.02 TeV PbPb collisions are calculated, and observed to be consistent with the experimental data. The result of p-Pb collisions at 5.02 TeV is calculated and compared with experimental data.

Preferred Track
Open Heavy Flavors

Collaboration
Not applicable

Primary author: XU, Yingru (Duke University)
Co-authors:  BERNHARD, Jonah;  NAHRGANG, Marlene;  CAO, Shanshan (Lawrence Berkeley National Lab)

Presenter:  XU, Yingru (Duke University)

Session Classification:  Parallel Session 8.4: Open Heavy Flavors (III)

Track Classification:  Open Heavy Flavors
Study of Cold and Hot Nuclear Matter Effects on Jets with Direct Photon-Triggered Correlations from PHENIX

Tuesday, 7 February 2017 08:30 (20 minutes)

Direct photons, being colorless objects, provide an unmodified control particle that can be used in conjunction with jets to probe the quark-gluon plasma. To leading order the direct photon momentum balances the momentum of opposing jets and can therefore provide a clean handle on the jet energy. Therefore, angular correlations with direct photons provide a mechanism to study the fragmentation of the opposing jet without performing jet reconstruction. Jet fragmentation modification has been measured previously in PHENIX in central Au+Au collisions. Recent RHIC runs offer the potential to study these observables in heavy ion collisions with greater statistics and over different collision systems including asymmetric collision geometries. In this talk we present results of isolated direct photon-triggered correlations in d+Au collisions and discuss the constraints of cold nuclear matter effects on the fragmentation functions. We also present the latest results with higher statistics on direct photon-triggered correlations in Au+Au collisions including differential measurements of fragmentation function modification. Finally, we present the status of the centrality and collision species dependence of these observables, including comparisons to related di-hadron correlations. Together these results can give a view of jet modification going from small to large system size.

Preferred Track
Jets and High pT Hadrons

Collaboration
PHENIX

Primary author: OSBORN, Joseph (University of Michigan)
Presenter: OSBORN, Joseph (University of Michigan)
Session Classification: Parallel Session 1.4: Jets and High pT Hadrons (I)
Track Classification: Jets and High pT Hadrons
Measurement of $J/\psi$ Meson Polarization at Forward Rapidity in $p+p$ Collisions at $\sqrt{s} = 510$ GeV by the PHENIX Experiment at RHIC

While the study of charmonium production provides a unique opportunity to access basic QCD dynamics, the exact production mechanisms are not yet fully understood. Many different models can adequately describe the cross-section and transverse momentum ($p_T$) distribution of charmonium produced in proton-proton collisions, but predict different polarization. Thus, charmonium polarization measurement can provide a stringent test for various theoretical models of charmonium production.

The PHENIX experiment at RHIC has measured polarization of $J/\psi$ mesons produced in $p+p$ collisions at $\sqrt{s} = 510$ GeV at forward rapidity ($1.2 < y < 2.2$). The measurement was performed in several reference frames (Helicity, Collins-Soper, and Gottfried-Jackson), and includes the results for polar, azimuthal and frame-independent polarization coefficients as a function of transverse momentum. The results will be compared to the theoretical predictions provided by non-relativistic QCD models and to results from other experiments.

Preferred Track

Quarkonia

Collaboration

PHENIX

Primary author: LEBEDEV, Alexandre (Iowa State University)

Presenter: LEBEDEV, Alexandre (Iowa State University)

Session Classification: Poster Session
Quarkonium production and polarization in pp collisions with the CMS detector

Studies of the production of heavy quarkonium states are crucial to improve our understanding of QCD and hadron formation. Large data samples of S-wave quarkonium states decaying in the dimuon channel have been collected by CMS in pp collisions at 7, 8 and 13 TeV, profiting from a very selective trigger and the record-level energy and luminosity provided by the LHC. This allowed the CMS collaboration to perform a series of systematic measurements in quarkonium production physics, including double-differential cross sections and polarizations, as a function of rapidity, transverse momentum, and charged-particle multiplicity, for five S-wave quarkonia: J/ψ, ψ(2S), Y(1S), Y(2S) and Y(3S). CMS can also reconstruct low-energy photons through their conversions to e+e- pairs, then tracked in the high-granularity silicon tracker with a very good precision, resulting in an extremely good mass resolution, so that the J=1 and J=2 χ_c states can be resolved. This allows CMS to determine cross section ratios and feed-down decay fractions involving the χ_c states, in both the charmonium and bottomonium families. This talk presents the CMS quarkonium production results, in pp collisions, placing emphasis on the latest measurements, which include results from the run 2 of the LHC. Preliminary results on the χ_c polarization should also become available in time for this talk. Such measurements provide crucial inputs for a better understanding of quarkonium production as a signal of new physics in Pb-Pb collisions.

Preferred Track

Quarkonia

Collaboration

CMS

Primary author: FERRAIOLI, Chris (University of Maryland (US))

Presenter: FERRAIOLI, Chris (University of Maryland (US))

Session Classification: Poster Session
Studying Parton Energy Loss Using Meson Production in Large Collision Systems from PHENIX

Wednesday, 8 February 2017 10:40 (20 minutes)

A better understanding of the energy loss of partons in the quark-gluon plasma formed in the collisions of heavy ions can be gained by varying the collision system. Recent RHIC runs have provided Cu+Au and U+U collisions. Asymmetric Cu+Au collisions provide a system with similar energy density but different path lengths when compared to Au+Au with the same number of nucleon-nucleon collisions. Also, in the most central Cu+Au events the surface bias is reduced in the Cu-going direction. Similarly the non-spherical nuclear U+U collisions can produce different energy density and surface biases compared to Au+Au collisions. In this talk we present the results from \( \pi^0 \) and \( \eta \) production in large systems. We discuss comparisons with Au+Au and how those comparisons further our understanding of parton energy loss in a quark-gluon plasma.

Preferred Track

Jets and High \( p_T \) Hadrons

Collaboration

PHENIX

Primary author:  ZHARKO, Sergei (Peter the Great Saint-Petersburg Polytechnic University)

Presenter:  ZHARKO, Sergei (Peter the Great Saint-Petersburg Polytechnic University)

Session Classification:  Parallel Session 6.4: Jets and High \( p_T \) Hadrons (V)

Track Classification:  Jets and High \( p_T \) Hadrons
Systematic Study of Highly Asymmetric Systems Using $\pi^0$ Production at PHENIX

Wednesday, 8 February 2017 11:00 (20 minutes)

Single particle production has proven to be a valuable tool to study heavy ion collisions. The observation of collective behavior in $p+$Pb at the LHC and $d+$Au RHIC has spurred speculation that a plasma is formed in small collision systems. Jet production in the same collisions at the LHC and RHIC has an anomalous centrality dependence if centrality is determined the same way as in large ion-ion collisions. One interpretation could be that the nucleus probes the dynamical structure (“color fluctuations”) of the projectile. Hints of gluon saturation effects have been observed at forward rapidities in $d+$Au collisions at RHIC. To systematically explore the physics using very asymmetric systems, RHIC has provided beams of $p+$Au, $p+$Al, $d+$Au and $^3$He+$Au$. Single particle production in these collisions should be sensitive to the physics of energy loss, modifications of the nuclear wavefunction, and the dynamics of the projectile wavefunction. PHENIX Central arms can measure $\pi^0$ at mid-rapidity. New MPC-EX detector allows $\pi^0$ measurement for $3.1 < \eta < 3.8$.

In this talk we present the systematic study of $\pi^0$ production in several very asymmetric collision systems from PHENIX and discuss their impacts on our understanding of the physics of such systems.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

PHENIX

Primary author: NOVITZKY, Norbert (Helsinki Institute of Physics (FI))

Presenter: NOVITZKY, Norbert (Helsinki Institute of Physics (FI))

Session Classification: Parallel Session 6.4: Jets and High $p_T$ Hadrons (V)

Track Classification: Jets and High $p_T$ Hadrons
ϕ(1020) production in pp collisions with ALICE at the LHC

The study of short-lived hadronic resonances in heavy-ion collisions provides information about strangeness production and the hadronic phase of the system. Resonance measurements in pp collisions set the baseline to which heavy-ion collisions are compared as well as contribute to the understanding of particle production mechanisms through comparison with different model predictions. At the LHC, ALICE has collected data in pp collisions at √s = 0.9, 2.76, 5.02, 7, 8 and 13 TeV. The ϕ(1020), which is a bound s̅s state, is reconstructed at mid-rapidity via its hadronic decay channel ϕ → K⁺ + K⁻, both without particle identification and by using the information of the Time Projection Chamber (TPC) and Time of Flight (TOF) detectors to identify the decay products. In this contribution, we report on transverse momentum (p_T) spectra, integrated yields and ⟨p_T⟩ measured for the ϕ-meson in pp collisions at several LHC energies. These include the first results on ϕ production in pp collisions from the Run 2 of the LHC. These results are compared to model calculations.

Preferred Track

QCD in small systems

Collaboration

ALICE

Primary author: Mr TRIPATHY, Sushanta (Indian Institute of Technology Indore (IN))

Presenter: Mr TRIPATHY, Sushanta (Indian Institute of Technology Indore (IN))

Session Classification: Poster Session
PHENIX results on collective behavior in small systems from geometry-controlled experiments at $\sqrt{s_{NN}} = 200$ GeV

Recent measurements in small collisions systems at LHC and RHIC indicate that the particles produced in high-multiplicity collisions exhibit collective behavior very similar to that observed in large systems where QGP is formed. In large systems, it is well established that the final-state particle correlations arise from anisotropic pressure gradients in the initial state of the collisions that drive a near-perfect fluid evolution. Whether QGP is also formed in small collision systems is presently under intense investigation. To study the origin of the collective behavior in small systems, the PHENIX experiment performed a series of geometry-controlled experiments using $p+Al$, $p+Au$, $d+Au$, and $^{3}\text{He}+Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV. The elliptic ($v_2$) and triangular ($v_3$) flow coefficients are measured as a function of $p_T$ for inclusive and identified charged hadrons. Mass dependence is observed in $v_2(p_T)$ indicative of hydrodynamic evolution. The relation of the $v_n$ strengths and the corresponding initial eccentricities in the different systems is studied and compared to several theoretical predictions that invoke different mechanisms for producing final-state particle correlations. The distinct initial geometries provide discriminating power against the models.

Preferred Track

Collective Dynamics

Collaboration

PHENIX

Primary author: XU, Qiao (Vanderbilt University (US))

Presenter: XU, Qiao (Vanderbilt University (US))

Session Classification: Parallel Session 6.1: QCD in Small Systems (III)

Track Classification: Collective Dynamics
Understanding the longitudinal dependence of flow harmonics and possible event plane decorrelations is an important part of properly extracting information on the matter created in heavy ion collisions. Asymmetric systems, by their nature, provide unique insight on the relation between geometry, transverse expansion, and longitudinal dynamics. In 2016, RHIC operations included $d+Au$ beam energy scan at 200, 62.4, 39, and 19.6 GeV. In this talk we present results on the pseudorapidity dependence of elliptic and triangular flow in the 2016 $d+Au$ beam energy scan. Investigations into longitudinal event plane decorrelations over wide pseudorapidity ranges, including between the projectile and target directions, will be presented and compared with model calculations.
Results on elliptic flow in p+p and p/d/³He+A have raised the question of how small a system can be while still exhibiting collective behavior. In 2016, RHIC operations included d+Au collisions at 200, 62.4, 39, and 19.6 GeV. In this talk we present results on elliptic and triangular flow at mid-rapidity as a function of transverse momentum and event multiplicity in d+Au collisions at various energies. We compare these results with several theoretical predictions in scenarios including pre-equilibrium flow, hydrodynamic flow, partonic scattering, and purely hadronic scattering in order to assess the role of each stage in the system evolution for producing collective effects in small systems.
Heavy flavour production in proton-lead and lead-lead collisions with LHCb

Tuesday, 7 February 2017 17:10 (20 minutes)

The LHCb experiment has the unique property to study heavy-ion interactions in the forward region ($2 < \eta < 5$), in a kinematic region complementary to the general purpose detectors. The detector has excellent capabilities for reconstructing quarkonia and open charm states, including baryons, down to zero $p_T$. Notably, it can separate the prompt and displaced charm components. In pPb collisions, both forward and backward rapidities are covered thanks to the possibility of beam reversal. Results include measurements of the nuclear modification factor and forward-backward ratio for charmonia, open charm and bottomonia states. These quantities are sensitive probes for cold nuclear matter effects in heavy flavour production. In 2015, LHCb also participated successfully for the first time in the Pb-Pb data-taking. The status of the forward prompt $J/\psi$ nuclear modification factor measurement for up to semi-central lead-lead collisions will be shown.

Preferred Track
Quarkonia

Collaboration
LHCb

Primary author: WINN, Michael Andreas (Universite de Paris-Sud 11 (FR))
Presenter: WINN, Michael Andreas (Universite de Paris-Sud 11 (FR))
Session Classification: Parallel Session 4.3: Quarkonia (II)
Track Classification: Quarkonia
PHENIX measurements of low momentum direct photons from large ion collisions as a function of beam energy and system size

Tuesday, 7 February 2017 11:00 (20 minutes)

PHENIX has discovered a large yield of low momentum direct photons emitted with large azimuthal anisotropy in 200 GeV Au+Au collisions. The large yield suggests early emission at high temperature, while the large anisotropy points towards late emission when the radial flow of the matter is fully developed, but the temperature is already reduced. This apparent contradiction poses a significant challenge to models that aim to calculate thermal photon production. To further constrain the sources of the low pt photons, PHENIX is analyzing data from Au+Au collisions at lower beam energies of 39 and 62.4 GeV, as well as data from smaller collisions systems Cu+Cu and Cu+Au at 200 GeV. First results from these analyses and from a larger statistics sample of Au+Au at 200 GeV will be presented.

Preferred Track

Electromagnetic Probes

Collaboration

PHENIX

Primary author:  SHARMA, Deepali (Stony Brook University)

Presenter:  SHARMA, Deepali (Stony Brook University)

Session Classification:  Parallel Session 2.3: Electromagnetic Probes (II)

Track Classification:  Electromagnetic Probes
PHENIX results on charged-hadron azimuthal anisotropies in Au+Au collisions at center-of-mass energies from 39 to 200 GeV

Wednesday, 8 February 2017 15:00 (20 minutes)

Measurements of the azimuthal anisotropy coefficients ($v_n$) of particle emission are an established method to characterize the quark gluon plasma (QGP) generated in the high-energy heavy-ions collisions. An important early finding at RHIC was that hydrodynamic calculations can account for the measured anisotropy at low $p_T$ and relate them to the collision geometry. At higher $p_T$, where hard processes are dominant, energy loss of partons traversing the QGP also creates an azimuthal anisotropy in the final-state hadrons which is related to the collision geometry. In order to better understand the interplay between the soft and hard processes, PHENIX measured the charged-hadron $v_n$ coefficients over a wide $p_T$ range (up to 10 GeV/$c$) as a function of centrality and beam energy.

In this talk, we will present new $v_2$ measurements for charged hadrons in 200 GeV Au+Au collisions as a function of $p_T$ and centrality and compare them to those from $\pi^0$ mesons. We will also report the $v_2$, $v_3$, and $v_4$ results for charged hadrons as function of the beam energy from 39 to 200 GeV.

Preferred Track

Collective Dynamics

Collaboration

PHENIX

Primary author: SHIMOMURA, Maya (Nara Women’s University (JP))

Presenter: SHIMOMURA, Maya (Nara Women’s University (JP))

Session Classification: Parallel Session 7.3: Collective Dynamics (II)

Track Classification: Collective Dynamics
New high resolution measurements of open and hidden charm production in proton-nucleus collisions at $\sqrt{s} = 110$ GeV with the LHCb detector.

Tuesday, 7 February 2017 17:50 (20 minutes)

Open and hidden charm production in nucleus-nucleus collisions is considered as a key signature of Quark Gluon Plasma (QGP) formation. In the search of specific QGP effects, proton-nucleus collisions are used as the reference as they account for the corresponding Cold Nuclear Matter (CNM) effects. The LHCb experiment, thanks to its System for Measuring Overlap with Gas (SMOG) can be operated in a fixed target mode with the LHC beams, at an intermediate center-of-mass energy between nominal SPS and RHIC energies. This allows for the required variety of beam-target combinations in a particularly interesting kinematical domain. In 2015, for the first time, reactions of incident LHC proton beams on noble gas targets have been recorded by the LHCb experiment at a center-of-mass energy of 110 GeV and within the center-of-mass rapidity range $-2.3 < y^* < 0.2$. In this talk, we will present the first high resolution measurements on open and hidden charm production obtained under these conditions.

Preferred Track
Open Heavy Flavors

Collaboration
LHCb

Primary author: MAURICE, Emilie Amandine (University of Liverpool (GB))
Presenter: MAURICE, Emilie Amandine (University of Liverpool (GB))
Session Classification: Parallel Session 4.4: Open Heavy Flavors (I)
Track Classification: Open Heavy Flavors
Elliptic and triangular collective flow of charged hadrons in Au+Au collisions from 39 to 200 GeV at PHENIX

A central goal of heavy ion experiments at the RHIC and LHC Collider is to characterize the properties of the strongly coupled Quark Gluon Plasma (sQGP) and the QCD phase diagram. Harmonic Flow measurements of identified particles play an essential role for such studies since they can give insight on the transport coefficients of the sQGP. In this poster we report on the measurements of elliptic and triangular flow for charged hadrons in Au+Au collisions at 39-200 GeV per nucleon pair center of mass energy, measured with the PHENIX detector at the RHIC. The results will be presented as a function of transverse momentum \( p_T \), collision centrality, beam energy for different particle species, and compared with recent measurements at RHIC/LHC.

Preferred Track

Collective Dynamics

Collaboration

PHENIX

Primary author: TARANENKO, Arkadiy (National Research Nuclear University MEPhI (RU))
Presenter: TARANENKO, Arkadiy (National Research Nuclear University MEPhI (RU))
Session Classification: Poster Session
Suppression of \( \Lambda(1520) \) resonance production in Pb-Pb collisions at the LHC

The observation of the modification of hadronic resonance production in heavy-ion collisions allows one to infer the presence of a prolonged hadronic phase after hadronisation. The decay daughters of short-lived resonances suffer re-scattering in the dense hadronic medium, which modifies their correlations and hence the experimentally measured yields. New results on the production of \( \Lambda(1520) \) resonances measured in Pb-Pb collisions at \( \sqrt{s_{NN}} = 2.76 \) TeV with the ALICE detector at the LHC are presented. The integrated production yield ratio \( \Lambda(1520)/\Lambda \) in central Pb-Pb collisions is observed to be suppressed with respect to peripheral collisions and also with respect to pp and p-Pb collisions. Statistical hadronisation models over-predict the measured yield ratio. The suppression adds further support to the existence of a prolonged hadronic phase, as already evidenced in the \( K^*/K \) and \( \rho/\pi \) ratios. The results are also compared to predictions from the EPOS3 Monte Carlo generator, which includes the UrQMD for the hadronic transport treatment. The model reproduces the measured \( p_T \) spectral shapes, \( \langle p_T \rangle \) and the trend of the suppression reasonably well when UrQMD is on, whereas the agreement with the data significantly degrades when the UrQMD is off.

Preferred Track

QCD at High Temperature

Collaboration

ALICE

Primary author: AGRAWAL, Neelima (IIT- Indian Institute of Technology (IN))

Presenter: AGRAWAL, Neelima (IIT- Indian Institute of Technology (IN))

Session Classification: Poster Session
Exotic hadrons, hardronic molecules and resonance production from relativistic heavy ion collisions

High energy heavy ion collisions are found to be excellent factories for producing heavy hadrons and composite particles including light (anti)nuclei. With upgraded detectors, we are now able to measure hadrons beyond ground states. Thus, heavy ion collisions provide new ways of studying exotic hadrons, which are the primary interests in hadron physics, as many experiments other than heavy ion collisions have already found exotic candidates and their existence itself is related to the fundamental problems in QCD.

We discuss here the production of exotic hadrons with strange, charm and bottom quarks in heavy ion collisions, and show how, if measured, the production rates can be used to discriminate between compact multiquark configuration from hadronic molecular configurations [1,2]. We extend our previous study to include newly discovered states such as Zb, X(5568) and Pc, and present realistic estimates on their production yields. We furthermore discuss feasibility of confirming their existence and discriminating their structure from measurements in heavy ion collisions at RHIC and LHC.

Specifically, we consider the coalescence and statistical hadronization model to calculate the production yields of exotic hadrons. We give detailed discussions on the application of the coalescence model to resonant states by including finite decay widths, and show that the production yields are sensitive to structures of exotic hadrons, namely compact multi-quark states or extended hadronic molecule states. We also investigate the production of scalar mesons, Lambda(1405), dibaryons, and Ds mesons in addition to charmonium-like and bottomonium-like states called X, Y, Z, which have been recently reported in several accelerator facilities, Belle, BaBar, BESS, LHCb and so on.


Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

Other

Primary author: CHO, Sungtae (Kangwon National University)
Co-author: LEE, Su Houng (Yonsei University)
Presenter: CHO, Sungtae (Kangwon National University)
Session Classification: Poster Session
Event-by-event charge separation in Au+Au collisions at \( \sqrt{s_{NN}} = 200 \) GeV with the STAR detector at RHIC

Theoretical studies predict that some metastable states leading to the local parity violation may be created in relativistic heavy-ion collisions \(^1\). The interaction of the strong magnetic field produced in the non-central heavy-ion collisions and the deconfined state created in these collisions causes the separation of charges along the axis of the magnetic field. This phenomenon of the charge separation along the axis of the magnetic field and perpendicular to the reaction plane is called the Chiral Magnetic Effect (CME) \(^2\). We investigated the event-by-event charge separation using Sliding Dumbbell Method (SDM), similar to the Sliding Window Method \(^3\). In this method, we evaluate \( D_b^{+-} \), which is defined as:

\[
D_b^{+-} = \frac{N_L^+}{(N_L^++N_L^-)} + \frac{N_R^-}{(N_R^++N_R^-)},
\]

where, \( N_L^+ \) and \( N_L^- \), respectively, are the numbers of positively and negatively charged particles on the left side of the dumbbell, whereas \( N_R^+ \) and \( N_R^- \), respectively, are the numbers of positively and negatively charged particles on the right side of the dumbbell. The whole azimuthal plane is scanned by sliding the \( \Delta \phi = 90^\circ \) dumbbell in steps of \( \phi = 1^\circ \) and calculating the observable \( D_b^{+-} \) for each \( \Delta \phi \) region to extract the maximum value of \( D_b^{+-} \) in each event. We have analysed the events with higher values of \( D_b^{+-} \) and some interesting events displaying back to back charge separation are found. The data has been analysed for different dumbbell sizes i.e., \( \Delta \phi = 90^\circ, 60^\circ \) and \( 40^\circ \) and the results will be presented.

References


Preferred Track

Collective Dynamics

Collaboration

STAR

Primary author: ATTRI, Anjali (Panjab University)
Presenter: ATTRI, Anjali (Panjab University)
Session Classification: Poster Session

February 28, 2020
Fluctuations of conserved charges at zero and finite density

Wednesday, 8 February 2017 16:30 (20 minutes)

We calculate higher order fluctuations of baryon number and electric charge in lattice QCD. The results at real chemical potentials are obtained through analytical continuation of simulations at imaginary chemical potentials. We compare to (or discuss) the STAR proton and electric charge fluctuation data to characterize the chemical freeze-out in view of the new lattice findings.

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary authors: GÜNTER, Jana (University of Wuppertal); BORSANYI, Szabolcs (University of Wuppertal)

Presenter: BORSANYI, Szabolcs (University of Wuppertal)

Session Classification: Parallel Session 8.1: Baryon-Rich QCD Matter and Astrophysics (III)

Track Classification: QCD at High Temperature
Charged particle spectra in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV measured with ALICE

We present the analysis of the transverse momentum ($p_T$) spectra for primary charged particles as well as the nuclear modification factor ($R_{AA}$) in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, using the data collected in November 2015 by ALICE at the LHC. In addition, a new analysis of data at $\sqrt{s_{NN}} = 2.76$ TeV will be presented where the improved analysis methods developed for $\sqrt{s_{NN}} = 5.02$ TeV are used. Comparisons of results at these energies and to model predictions are performed.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: GRONEFELD, Julius Maximilian (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Presenter: GRONEFELD, Julius Maximilian (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Session Classification: Poster Session
Hard Substructure of Jets Probed in p-Pb collisions

Collisions of ultrarelativistic heavy ions provide an opportunity to investigate strongly interacting matter under extreme energy densities and temperatures. Interaction of hard scattered partons with the hot and dense medium leads to a suppression of the observed jet yields, known as jet quenching. Along with other experimental approaches, studies of the jet substructure have the prospects of providing valuable information about jet quenching mechanisms. One of the jet substructure observables is the transverse momentum distribution of hard subjets probed with the Soft Drop algorithm. This algorithm removes soft large-angle components of a jet and identifies a pair of subjets that forms a hard splitting. The momentum balance of the pair is characterized by the $z_g$ observable defined as the fraction of the groomed jet’s transverse momentum carried by the softer subjet. In pp collisions the distribution of $z_g$ is linked to the vacuum QCD splitting functions. It is interesting, therefore, to search for a possible modification of the $z_g$ distribution in proton-nucleus collisions due to the presence of cold nuclear matter. We present the status of the jet substructure analysis with Soft Drop using the data collected by the ALICE experiment in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: LAPI DUS, Kirill (Yale University (US))

Presenter: LAPI DUS, Kirill (Yale University (US))

Session Classification: Poster Session
Anisotropic flow of inclusive and identified particles in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV

Wednesday, 8 February 2017 09:10 (20 minutes)

Measurements of azimuthal anisotropic flow provide valuable information on the properties of the matter created in heavy-ion collisions. In this talk we present the elliptic, triangular and quadrangular flow of inclusive and identified charged particles measured in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV recorded by the ALICE detector. This center of mass energy is the highest attained in the laboratory for heavy-ion collisions. The measurements are presented for a wide range of particle transverse momenta within the pseudo-rapidity region $|\eta| < 0.8$. The results are compared to the measurements at lower energy reported by the LHC experiments and also to theoretical predictions.

Preferred Track
Collective Dynamics

Collaboration
ALICE

Primary author: BERTENS, Redmer Alexander (University of Tennessee, Knoxville)
Presenter: BERTENS, Redmer Alexander (University of Tennessee, Knoxville)
Session Classification: Parallel Session 5.1: Collective Dynamics (I)

Track Classification: Collective Dynamics
Using Event Shape Engineering to investigate the Chiral Magnetic Effect in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV

Tuesday, 7 February 2017 14:00 (20 minutes)

Strong fluctuations of the elliptic flow in heavy ion collisions allow an efficient selection of the events corresponding to a specific initial geometry. This technique, Event Shape Engineering, was applied to select events corresponding to the same centrality, but having very different values of elliptic flow. For those events, we present results on the centrality dependence of the charge-dependent two- and three-particle correlators in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV recorded by the ALICE detector. The charge dependence of the three-particle correlator is often employed as evidence for the Chiral Magnetic Effect (CME). The interpretation of the experimental results is complicated by possible background contributions, including the modulation from elliptic flow. We have used these measurements and a Monte-Carlo Glauber simulation of the magnetic field to derive an upper limit on the CME contribution.

Preferred Track
Collective Dynamics

Collaboration
ALICE

Primary author: DOBRIN, Alexandru Florin (CERN)
Presenter: DOBRIN, Alexandru Florin (CERN)
Session Classification: Parallel Session 3.2: CME, Vorticity and Spin Polarization (I)
Track Classification: Collective Dynamics
Deciphering the Charge Production Dynamics with General Charge Balance Functions in Pb-Pb Collisions at $\sqrt{s_{NN}} = 2.76$ TeV at ALICE

The two-wave quark production scenario can be investigated experimentally by measurements of balance functions of identified particle pairs [1]. In this scenario, quark-antiquark pairs produced in the earlier stages of the collision are pulled apart due to collective effects, while pairs produced during hadronization are unlikely to separate. We present the measurements of such balance functions based on an analysis of data acquired at the Large Hadron Collider (LHC) by the ALICE detector. Balance functions have been measured for identified charged-pion pairs and for identified charged-kaon pairs in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. These balance functions are presented in relative pseudorapidity $\Delta\eta$, relative rapidity $\Delta y$ and relative azimuthal angle $\Delta\phi$. We observe that the charged-pion balance function widths in terms of $\Delta\eta$, $\Delta y$ and $\Delta\phi$ are narrower in central Pb-Pb collisions compared to peripheral collisions. In addition, a comparison between the balance functions of charged-pions and unidentified charged particles will be shown. We will also report on the measurements of charged-kaon balance functions. The findings in this analysis are consistent with the effects of delayed hadronization and radial flow, as well as the two-wave scenario. Detailed model comparisons are performed in order to draw more quantitative conclusions.


Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author:  ALAM, Sk Noor (Department of Atomic Energy (IN))

Presenter:  ALAM, Sk Noor (Department of Atomic Energy (IN))

Session Classification:  Poster Session
Azimuthally differential pion femtoscopy relative to the second and third harmonic in Pb-Pb 2.76 TeV collisions from ALICE

Wednesday, 8 February 2017 15:20 (20 minutes)

Azimuthally differential femtoscopy measurements, being sensitive to spatio-temporal characteristics of the source as well as to the collective velocity fields at freeze-out, provide very important information on the nature and dynamics of the system evolution. While the HBT radii modulations with respect to the second harmonic event plane reflect mostly the spatial geometry of the source, the third harmonic results are mostly defined by the system dynamics. Radii variations with respect to the third harmonic event plane unambiguously signal a collective expansion and anisotropy in the flow fields. Strong fluctuations in the initial geometry of the system lead to fluctuations in the anisotropic flow as well as the shape of the pion source at freeze-out. Event shape engineering (ESE) is a technique proposed to select events corresponding to a particular shape. Azimuthally differential HBT combined with ESE allows for a detailed analysis of the relation between initial geometry, anisotropic flow and the deformation of source shape.

In this talk, we present azimuthally differential pion femtoscopy with respect to second and third harmonic event planes as a function of the pion transverse momentum for different collision centralities. Our results on the dependence of the side-, out-, and long-radii on the pion emission angle with respect to the second harmonic event plane qualitatively agree with theoretical calculations, but the details show significant deviations. The final-state source eccentricity, estimated via side radius oscillations is found to be significantly smaller than the initial state source eccentricity. While the final-state source eccentricity for the second harmonic event plane remains positive in all centralities, the third harmonic event plane eccentricity becomes negative. All these results are compared to existing models. The effect of the selection of the events with high/low elliptic and/or triangular flow is also presented.

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: SALEH, Mohammad Ahmad (Wayne State University (US))
Presenter: SALEH, Mohammad Ahmad (Wayne State University (US))
Session Classification: Parallel Session 7.2: Correlations and Fluctuations (II)
Track Classification: Correlations and Fluctuations
Correlations with identified particles in pp at $\sqrt{s}=7$ TeV and p-Pb at $\sqrt{s_{NN}}=5.02$ TeV

Particle correlations in azimuth ($\phi$) and pseudorapidity ($\eta$) difference are a powerful tool, widely used in all collision systems to study numerous sources of correlations. Examples include the collective behaviour of the QGP medium, jets, quantum statistics or Coulomb effects, conservation laws, and decays of resonances. In this talk, we report such measurements from ALICE with identified particles (pions, kaons, protons, and lambdas) in pp at $\sqrt{s} = 7$ TeV and p-Pb at $\sqrt{s_{NN}} = 5.02$ TeV collisions. The analysis of identified particles in pp collisions reveals differences in particle production between baryons and mesons, which reflect the specific conservation laws for these quantum numbers. For baryon pairs, where both particles have the same baryon number, a near-side anti-correlation structure is observed instead of a peak. Such effects have usually been connected to conservation laws in $e^+e^-$ collisions and were thought to be under theoretical control; however, our results present a challenge to the contemporary models (PYTHIA, PHOJET). In case of p-Pb collisions at LHC energies, we report results of two particle correlations with identified trigger particles (pions and protons) selected from the intermediate $p_T$ range ($2.0 < p_T < 4.0$ GeV/c), where an inclusive baryon to meson enhancement has been observed. Our results are reported as a function of multiplicity. The large enhancement of the baryon to meson ratio observed at intermediate $p_T$ in central heavy ion collisions at RHIC and the LHC can be attributed to coalescence and/or radial flow. These mechanisms may lead to a dilution of the near side jet-like yield, that impacts baryons and mesons differently. For these results, a comparison between data and model predictions (AMPT and EPOS3) will also be presented.

Preferred Track

QCD in small systems

Collaboration

ALICE

Primary author:  Mr SARKAR, Debojit (Department of Atomic Energy (IN))
Presenter:  Mr SARKAR, Debojit (Department of Atomic Energy (IN))
Session Classification:  Poster Session
Heavy-flavor production and medium properties in high-energy nuclear collisions

Both open and hidden heavy-flavor physics in nuclear collisions is entering a new and exciting stage towards reaching a clearer understanding of the new experimental results with the possibility to link them directly to the advancement in lattice QCD. Recent results from experiments and theoretical developments regarding open and hidden heavy-flavor dynamics have been debated at the Lorentz Workshop “Tomography of the quark-gluon plasma with heavy quarks”, which was held in October 2016 in Leiden. In this contribution, common understandings and possible strategies for the upcoming five years will be presented to achieve a profound knowledge of the dynamical properties of the quark-gluon plasma in high-energy nuclear collisions.

Preferred Track
Open Heavy Flavors

Collaboration
Not applicable

Primary author: MISCHKE, Andre (Utrecht University (NL))
Presenter: MISCHKE, Andre (Utrecht University (NL))
Session Classification: Poster Session
Lambda-Kaon Femtoscopy in Pb-Pb Collisions at \( \sqrt{s_{NN}} = 2.76 \) TeV with ALICE

We present results from a femtoscopic analysis of Lambda-Kaon correlations in Pb-Pb collisions at \( \sqrt{s_{NN}} = 2.76 \) TeV by the ALICE experiment at the LHC. All pair combinations of \( \Lambda \) and \( \bar{\Lambda} \) with \( K^+ \), \( K^- \) and \( K^0_S \) are analyzed. The femtoscopic correlations are the result of strong final-state interactions, and are fit with a parametrization based on a model by R. Lednicky and V. L. Lyuboshitz. This allows us to both characterize the emission source and measure the scattering parameters for the particle pairs. We observe a large difference in the \( \Lambda-K^+ (\bar{\Lambda}-K^-) \) and \( \Lambda-K^- (\bar{\Lambda}-K^+) \) correlations in pairs with low relative momenta (\( k^* < 100 \) MeV). Additionally, the average of the \( \Lambda-K^+ (\bar{\Lambda}-K^-) \) and \( \Lambda-K^- (\bar{\Lambda}-K^+) \) correlation functions is consistent with our \( \Lambda-K^0_S (\bar{\Lambda}-K^0_S) \) measurement. The results suggest an effect arising from different quark-antiquark interactions in the pairs, i.e. \( ss \) in \( \Lambda-K^+ (\bar{\Lambda}-K^-) \) and \( uu \) in \( \Lambda-K^- (\bar{\Lambda}-K^+) \). To gain further insight into this hypothesis, we currently are conducting a Cascade-Kaon femtoscopic analysis.


Preferred Track
Correlations and Fluctuations

Collaboration
ALICE

Primary author:  BUXTON, Jesse Thomas (Ohio State University (US))
Presenter:  BUXTON, Jesse Thomas (Ohio State University (US))
Session Classification:  Poster Session
QCD matter physics at the future FAIR facility in Germany

Wednesday, 8 February 2017 17:10 (20 minutes)

Peter Senger (GSI) for the CBM Collaboration

Abstract

The Compressed Baryonic Matter (CBM) experiment will be one of the major scientific pillars of the future Facility for Antiproton and Ion Research (FAIR) in Darmstadt. The goal of the CBM research program is to explore the QCD phase diagram in the region of high baryon densities using high-energy nucleus-nucleus collisions. This includes the study of the equation-of-state of nuclear matter at neutron star core densities, and the search for the deconfinement and chiral phase transitions. The CBM detector is designed to measure rare diagnostic probes such as hadrons including multi-strange (anti-) hyperons, lepton pairs, and charmed particles with unprecedented precision and statistics. Most of these particles will be studied for the first time in the FAIR energy range. In order to achieve the required precision, the measurements will be performed at very high reaction rates of 1 to 10 MHz. This requires very fast and radiation-hard detectors, a novel data read-out and analysis concept based on free streaming front-end electronics, and a high-performance computing cluster for online event selection. The status of FAIR and the physics program of the proposed CBM experiment will be discussed.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

Other

Primary author: Prof. Senger, Peter (GSI)

Presenter: Prof. Senger, Peter (GSI)

Session Classification: Parallel Session 8.2: Future Experimental Facilities, Upgrades, and Instrumentation

Track Classification: Future Experimental Facilities, Upgrades, and Instrumentation
Baryon-baryon femtoscopy in pp collisions at 7 TeV

Femtoscopy studies of protons and Lambda hyperons have been carried out in pp collisions at 7 TeV, as measured by the ALICE collaboration. Contrary to the more complex situation in heavy-ion collisions, the Lambda-proton femtoscopy measurement in pp collisions allows us to investigate the scattering parameters for the hyperon-nucleon pair as the source that characterises the emission of the particle pair can be better constrained.

We present the analysis steps and corrections to obtain the correlation functions, and the method developed to evaluate the feed-down and background contributions to the genuine two-particle correlations. We also report on the study of the particles source for pp collisions carried out with the EPOS event generator. The sensitivity of the method to test different scattering parameters for the Lambda-proton pair are discussed.

Preferred Track
QCD in small systems

Collaboration
ALICE

Primary author: ARNOLD, Oliver Werner (Technische Universitaet Muenchen (DE))
Presenter: ARNOLD, Oliver Werner (Technische Universitaet Muenchen (DE))
Session Classification: Poster Session
Path-integral formula for local thermal equilibrium

Relativistic hydrodynamics, which successfully describes the quark-gluon plasma created in heavy-ion collisions, is formulated based on the assumption that systems are almost in local thermal equilibrium. However, a quantum field theoretical way to handle such a locally thermalized matter has not been clearly clarified.

In this study, we develop imaginary-time formalism for relativistic quantum field theories under local thermal equilibrium. We show microscopically that the Masseiu-Planck functional, which is a thermodynamic potential for locally thermalized systems, plays a role as the generating functional for the expectation values of conserved current operators such as the energy-momentum tensor and electric current in local thermal equilibrium. We also provide the complete path-integral formulation of the Masseiu-Planck functional from a scalar field $\phi$ to a spinor field $\chi$, in which it is written in terms of the emergent thermally curved spacetime with the notable intrinsic symmetry properties: Kaluza-Klein gauge symmetry, spatial diffeomorphism symmetry, and gauge symmetry for external fields. With the help of the symmetry argument, we can construct the nondissipative part of the hydrodynamic equations including the anomaly-induced transport such as the chiral magnetic effect.

References:
2. M. Hongo, in preparation

Preferred Track
New Theoretical Developments

Collaboration
Not applicable

Primary author: Dr HONGO, Masaru (RIKEN, iTHES research group)
Presenter: Dr HONGO, Masaru (RIKEN, iTHES research group)
Session Classification: Poster Session
Fluid dynamical fluctuations of net-baryon number near the QCD critical point

Wednesday, 8 February 2017 15:40 (20 minutes)

The search for the critical point of QCD is one of the main goals of the beam energy scan at RHIC and the CERN-SPS. In equilibrium, correlations diverge at the critical point leading to large event-by-event fluctuations in conserved quantities. For expanding systems like in heavy-ion collisions it is important to study the dynamical formation of long-range correlations in the critical region. The critical mode is the diffusive baryon current and can be described fluid dynamically. We include the propagation of fluctuations in the fluid dynamical equations. Using an equation of state with a critical point we study the evolution of critical fluctuations, Gaussian and non-Gaussian, in static systems to compare to known analytical results. The requirements for the emergence of non-Gaussian correlations from underlying white noise will be explored. We investigate both relativistic and nonrelativistic fluid dynamics. Finally, moving toward more realistic scenarios of heavy-ion collisions, we discuss the development of critical fluctuations in expanding systems.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary author: NAHRGANG, Marlene (Subatech)
Presenter: NAHRGANG, Marlene (Subatech)
Session Classification: Parallel Session 7.1: Baryon-Rich QCD Matter and Astrophysics (II)
Track Classification: Correlations and Fluctuations
Measurements of D mesons in jets in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE at the LHC

Charm quarks are created in the early stages of heavy-ion collisions in hard-scattering processes. Therefore, they are ideal probes of the Quark-Gluon Plasma (QGP). The fragmentation of charm quarks can produce D mesons.

Jets containing a D meson as one of their constituents can be identified as originating from heavy-quark fragmentation. D-tagged jets are a valuable tool to characterize the charm interaction with the QGP. Furthermore, charmed jets can provide complementary information to D-meson measurements to study the mass-dependent energy loss by analysing the modification of the charm-jet yield in Pb–Pb collisions with respect to pp collisions as a function of the jet transverse momentum. A further insight can be obtained with the measurement of the momentum-fraction distribution, which is of particular interest to investigate the possible influence of the medium in the charm-jet fragmentation.

D mesons are reconstructed through an invariant mass analysis of their hadronic decay channels, rejecting the large combinatorial background with topological selections exploiting the relatively large signal lifetime of D mesons and the particle-identification capabilities of the detector. Jets are reconstructed with anti-$k_T$ algorithm using the D-meson candidates and the charged tracks. The ALICE Time Projection Chamber and the Inner Tracking System detectors allow us to measure D mesons and jets down to low $p_T$, where the probes are more sensitive to the effects of the hot medium.

The analysis status of the measurement of D-tagged jets in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be presented.

Preferred Track

Open Heavy Flavors

Collaboration

ALICE

Primary author: OLIVEIRA DA SILVA, Antonio Carlos (Universidade de Sao Paulo (BR))

Presenter: OLIVEIRA DA SILVA, Antonio Carlos (Universidade de Sao Paulo (BR))

Session Classification: Poster Session
Lattice QCD thermodynamics up to the perturbative regime

We study the thermodynamics of the quark gluon plasma with lattice simulations in the continuum limit up to 1 GeV temperature where we show that a perturbative description already applies. We calculate the effect of the presence of charm quark in the equation of state and also describe the topological features of quantum chromodynamics. The talk is based on the paper 1606.07494 (Nature, in press).

Preferred Track
QCD at High Temperature

Collaboration
Not applicable

Primary author: PASZTOR, Attila (Wuppertal University)
Presenter: PASZTOR, Attila (Wuppertal University)
Session Classification: Parallel Session 3.1: QCD at High Temperature
Track Classification: QCD at High Temperature
Study of high baryon density QCD matter at J-PARC-HI

Wednesday, 8 February 2017 17:30 (20 minutes)

The QCD phase diagram has been explored in the high temperature side at RHIC and LHC, while the high density side is barely explored. Systematic studies of the QCD matter from Bevalac to LHC energies have suggested that the highest density QCD matter can be reached around the AGS energies (sqrt(s_{NN})=5-GeV) where a rich production of strange hadrons is expected.

The future heavy-ion program at J-PARC (J-PARC-HI) is focused to explore such a highest density QCD matter. The J-PARC-HI will accelerate ions up to Uranium with the cms energy of sqrt(s_{NN})=2-6.2-GeV at the beam rate up to 1.0e+11 ions per cycle, five orders of magnitude higher than that of AGS. We could reach as 8-10 times higher density as the normal nuclear matter with the Uranium ions. The heavy-ion acceleration scheme consists of a new linac and a booster as the injector, followed by the existing 3-GeV Rapid-Cycling Synchrotron (RCS) and 50-GeV Main Ring (MR). The booster design is much advanced since last year by a new charge exchange injection scheme and multi-charge state acceptance.

Taking advantage of the very high intensity beam, we introduce new event selection quantities, such as strangity (strange hadron fraction) and baryonity (net baryons), on top of the conventional centrality variable, which would exclusively select high-density matter events. We will then primarily measure the probes that were not measured at AGS, namely, electromagnetic probes (photons and lepton pairs), higher-order flow of particles and the fluctuation of conserved charges such as net-baryons. We will also perform systematic measurement of conventional hadronic observables.

A large acceptance heavy-ion spectrometer based on a Toroidal magnet has been designed for the high density QCD matter study. We will show the updated acceleration scheme as well as the detector performance and expected physics result.

A search for the exotic hadrons and nuclei such as dibaryons, kaonic nuclei, and measure hypernuclei is also possible at this cms energy. We will also discuss about this measurement.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

Other

Primary author: SAKAGUCHI, Takao (BNL)

Presenter: SAKAGUCHI, Takao (BNL)

Session Classification: Parallel Session 8.2: Future Experimental Facilities, Upgrades, and Instrumentation
Track Classification: Future Experimental Facilities, Upgrades, and Instrumentation
Hydrodynamic fluctuations in a non-boost-invariant viscous fluid dynamics

Hydrodynamic or local thermal fluctuations are an important source of event-by-event fluctuations in relativistic heavy-ion collisions. It is a challenge to identify and investigate their effects on experimental observables. Application of the theory of hydrodynamic fluctuations to the boost-invariant (Bjorken) flow has shown that long-range (rapidity) two-particle correlations are induced by fluctuations due to propagation of the sound modes. We have studied the effects of these fluctuations using a lattice QCD-based equation of state. We find that these correlations extend over large rapidities for various choices of the shear viscosity to entropy density ratio, underlining the importance of hydrodynamic fluctuations. The boost-invariant solution is only an approximation to the true longitudinal dynamics, valid at mid-rapidity. We have also considered a non-boost-invariant viscous expansion and investigated the effect of hydrodynamic fluctuations within the framework of linearized hydrodynamics. The background solution in this more general case depends explicitly on rapidity. We present our results for the long-range rapidity correlations in this realistic scenario.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

Primary author: CHATTOPADHYAY, Chandrodoy (Tata Institute of Fundamental Research)
Presenter: CHATTOPADHYAY, Chandrodoy (Tata Institute of Fundamental Research)
Session Classification: Poster Session
Jet-induced medium excitation in gamma-hadron and hadron-hadron correlations

Tuesday, 7 February 2017 09:30 (20 minutes)

We use a Linear Boltzmann Transport model (LBT model) coupled to (3+1)D ideal hydrodynamic evolution in real time with fluctuating initial conditions to simulate both the transport of jet shower partons and jet-induced medium excitation. In this coupled approach, soft partons from medium recoil and induced radiation from propagation of energetic shower partons in the Linear Boltzmann transport (LBT) model provide a source term to the 3+1D hydrodynamic evolution of the medium, which in term provide medium profile in real time for the parton shower propagation. With this coupled approach we investigate the hadrons spectrum in the whole transverse momentum region and focus on gamma-hadron and hadron-hadron correlations to study the effect of both jet-induced medium excitations and jet quenching due to parton energy loss.

Preferred Track
Jets and High pT Hadrons

Collaboration
Other

Primary author: CHEN, WEI (CCNU)
Presenter: CHEN, WEI (CCNU)
Session Classification: Parallel Session 1.4: Jets and High pT Hadrons (I)
Track Classification: Jets and High pT Hadrons
Measurement of the rare probes in the CBM experiment at FAIR

The main goal of the CBM experiment at FAIR is to study the behavior of nuclear matter at very high baryonic density in which the transition to a deconfined and chirally restored phase is expected to happen. The promising signatures of this new state are the enhanced production of multi-strange particles, production of hypernuclei and dibaryons. Theoretical models predict that single and double hypernuclei, and heavy multi-strange short-lived objects are produced via coalescence in heavy-ion collisions with the maximum yield in the region of SIS100 energies. The discovery and investigation of new hypernuclei and of hyper-matter will shed light on the hyperon-nucleon and hyperon-hyperon interactions. The key CBM observables include particles containing hidden charm, open charm and low-mass vector mesons decaying into leptons. Particularly demanding is the measurement of open charm particles with very low multiplicities, which is based on the real time selection of displaced vertices with an accuracy of about 50 μm. Results of feasibility studies of the key CBM observables in the CBM experiment are discussed.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
Other

Primary author: Dr VASSILIEV, Iouri (GSI)
Presenter: Dr VASSILIEV, Iouri (GSI)
Session Classification: Poster Session
Study of Jet-related Two-Particle Correlations in Highly Asymmetric Collision Systems with PHENIX

The study of asymmetric systems like d+Au is considered useful for distinguishing initial state cold nuclear matter effects from final state QGP effects. Two-particle correlations in highly asymmetric collisions can access jet physics at high $p_T$, possible collective effects at low $p_T$, and the interplay of the two. This poster presents the status of the measurement of $\pi^0 - h^\pm$ correlations in d+Au and p+p collision datasets at $\sqrt{s_{NN}} = 200$ GeV. We focus on the possible collective effects from hydrodynamical flow and how these impact the extraction of jet properties and modification in the cold nuclear medium.

Preferred Track

Correlations and Fluctuations

Collaboration

PHENIX

Primary author: Mr PUN, Abinash Pun (Ohio University)
Presenter: Mr PUN, Abinash Pun (Ohio University)
Session Classification: Poster Session
Charmonium production in p+Pb and Pb+Pb collisions at LHC energies

Charmonium production is among the promising signatures for quark-gluon plasma formation in relativistic heavy-ion collisions. Here we investigate hot-medium effects on the suppression of the J/Ψ yields in Pb+Pb and p+Pb at $\sqrt{s_{NN}} = 5.02$ TeV in a model that encompasses screening of the real part of the potential, damping of the $c\bar{c}$ binding through the imaginary part, and gluon-induced dissociation.

Recombination plays an essential role for Pb+Pb, but is less important for p+Pb. We investigate the relative importance of cold nuclear matter and hot medium effects in p+Pb. Model results for both systems are compared to recent centrality, rapidity and transverse momentum dependent data from ALICE and CMS.

Preferred Track

Quarkonia

Collaboration

Other

Primary author: MISHRA, Madhukar (Birla Institute of Technology and Science Pilani, Pilani Campus)

Presenter: MISHRA, Madhukar (Birla Institute of Technology and Science Pilani, Pilani Campus)

Session Classification: Poster Session
Reconstruction of short-lived particles with the KF Particle Finder package in the CBM experiment

Short-lived particles that have very small production probability or small branching ratio of the channel suitable for registration are of particular interest in the future heavy-ion experiment CBM at FAIR. Such particles can be reconstructed and investigated only through their decay products.

The KF Particle Finder package was developed for reconstruction and selection of short-lived particles produced in the collisions. More than 100 decay channels of short-lived particles are included to the reconstruction scheme. The package covers signals from most of the physics cases of the CBM experiment: strange particles, strange resonances, hypernuclei, low mass vector mesons, charmonium, and open-charm particles.

Reconstruction of particles is based on the Kalman filter mathematics, that provides high quality of the obtained parameters and their errors. Also, the mathematics includes the mass and topological constraints, which are of particular importance for reconstruction of decay trees like multi-strange hyperons and resonances. The package is geometry independent, that makes it a universal platform for short-lived particles reconstruction and physics analysis.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
Other

Primary author: Dr ZYZAK, Maksym (GSI)
Co-author: Dr VASSILIEV, Iouri (GSI)
Presenter: Dr ZYZAK, Maksym (GSI)
Session Classification: Poster Session
Pseudorapidity dependence of charged-particle anisotropic flow in Pb–Pb collisions at $\sqrt{s_{NN}}=2.76$ TeV in ALICE

Anisotropic flow is one of the key observables in heavy-ion collisions and puts constraints on the QGP equation of state. In particular, the pseudorapidity ($\eta$) dependence of anisotropic flow coefficients provides information on the hydrodynamical response of the system in the context of variations in the particle density.

The ALICE detector provides unprecedented angular coverage at the LHC ($-3.5 < \eta < 5.0$, $0 < \varphi < 2\pi$). We present results for $v_2$, $v_2^{(4)}$, $v_3^{(2)}$, and $v_4^{(2)}$ as a function of $\eta$ in Pb–Pb collisions at $\sqrt{s_{NN}}=2.76$ TeV from our recent paper [1]. We also present anisotropic flow coefficients as function of centrality, and investigate how the shape of the $\eta$ dependence evolves with centrality along with the contribution of flow fluctuations as a function of $\eta$. Additionally, comparisons to hydrodynamical predictions and transport models as well as an investigation of the scaling behavior of harmonics to $dN_{ch}/d\eta$ are done. Finally, we compare our results to RHIC in order to see whether longitudinal scaling holds at LHC energies.


Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: GULBRANDESEN, Kristjan (University of Copenhagen (DK))

Presenter: GULBRANDESEN, Kristjan (University of Copenhagen (DK))

Session Classification: Poster Session
Heavy Quarkonium in a moving QGP medium

We study the behavior of the real and the imaginary parts of the static potential between a heavy quark and its anti-quark, which are in relative motion with respect to the QGP medium. The heavy quark-antiquark complex potential is obtained by correcting both the Coulombic and the linear terms in the Cornell potential through the dielectric function in real-time formalism using the hard thermal loop (HTL) approximation. We show the variation of both the real and the imaginary parts of the potential for different values of velocity when the bound state is aligned in the direction parallel and perpendicular to the velocity of the thermal medium. We find that real part of potential increases with the increase in velocity at short distances and becomes less screened but it decreases with increase in velocity at large distances for the parallel case. On the other hand, the potential decreases with the increase in velocity for the perpendicular case which results in the more screening of the potential. Since the $Q\bar{Q}$ potential is effectively more screened in the moving plasma, it results in the earlier dissociation of quarkonium states in a moving medium. The inclusion of string term makes the potential less screened as compared to the Coulombic term alone for both the cases. Combining all these effects we expect a stronger binding of a $Q\bar{Q}$ pair in moving medium in the presence of string term as compared to the Coulombic term alone. The imaginary part decreases (in magnitude) with increase in velocity and increases (in magnitude) with inclusion of string term. We also calculate the decay width of the quarkonium state and find that width decreases with increase in velocity and increases with the inclusion of the string term. All of these effects leads to the modification of the quarkonium suppression. We also extend our calculation at finite chemical potential and show its effect on the properties of quarkonium states in a moving medium.

Preferred Track

Quarkonia

Collaboration

Not applicable
Primary author: THAKUR, Lata (Physical Research Laboratory, Ahmedabad)

Presenter: THAKUR, Lata (Physical Research Laboratory, Ahmedabad)

Session Classification: Poster Session
A Detailed Study and Synthesis of Flow Observables in the IP-Glasma+MUSIC+UrQMD Framework

Wednesday, 8 February 2017 09:50 (20 minutes)

In this work we use our state of the art IP-Glasma+MUSIC+UrQMD framework to systematically study a wide range of hadronic flow observables at 2.76 TeV and to make predictions at 5.02 TeV \cite{1609.02958}. In addition to the single particle spectra and anisotropic flow coefficients $v_n$, we study event-plane correlations, non-linear response coefficients $\chi_n$, and flow factorization breaking ratios $r_n$, which were presented for the first time in the IP-Glasma framework. Furthermore, we investigate event shape engineering as well higher flow harmonics such as $v_5$, $v_6$, and $v_7$, which were recently measured at 5.02 TeV by the ATLAS collaboration. Taken together, these observables provide a wealth of insight into the collective behavior of the QGP and initial state fluctuations. These quantities shed light on flow correlations in different $p_T$ ranges, flow at fixed system size but different initial geometries, as well as the non-linear hydrodynamic response to the initial state energy anisotropy. By synthesizing this information we can gain further insight into the transport properties of the QGP as well as the fluctuation spectrum of the initial state. Finally, we examine the effect of pre-equilibrium longitudinal flow, which has previously been neglected in phenomenological studies, such as the hadron and direct photon spectra and $v_n$.

\begin{thebibliography}{}
\bibitem{1609.02958}
Scott McDonald, Chun Shen, Francois Fillion-Gourdeau, Sangyong Jeon and Charles Gale.
\newblock Hydrodynamic Predictions for Pb+Pb Collisions at 5.02 A TeV, 2016;
\newblock arXiv:1609.02958.
\end{thebibliography}

Preferred Track
Collective Dynamics

Collaboration
Not applicable

Primary author:  MCDONALD, Scott (McGill University)
Co-author:  Dr SHEN, Chun (Brookhaven National Laboratory)
Presenter:  MCDONALD, Scott (McGill University)
Session Classification:  Parallel Session 5.1: Collective Dynamics (I)
Track Classification:  Collective Dynamics
Dimuon measurements with the CBM experiment at FAIR

The Compressed Baryonic Matter (CBM) experiment at FAIR is designed to explore the QCD phase diagram in the region of large baryochemical potentials. One of the important experimental observables are dileptons, which probe the properties of the matter in the fireball from the first stage of the collision until freezeout. Dileptons will be produced over a wide range of invariant mass region and offer the possibility to investigate the properties of low-mass vector mesons in the dense medium, the temperature of the fireball at intermediate masses, upto the production of charmonia. In order to obtain a complete and high-precision dilepton data set, the CBM setup features both electron and muon detection systems.

A novel Muon Chamber system (MUCH) is under development for CBM consisting of alternating layers of detector triplets sandwiched between absorber slices of varying thickness. Detailed simulations have been performed using both using GEANT and FLUKA to optimize the detector configurations. MUCH will consist of a combination of five sets of absorber and detector stations. The tracks from the Silicon Tracking Station (STS) of CBM will be extrapolated to MUCH to identify muons.

In order to handle the high particle rate on the detectors corresponding to an interaction rate of 10 MHz of Au+Au collisions at CBM, GEM-based gaseous detectors will be used in the first two stations. Large size trapezoidal shaped, triple GEM detectors having progressively increasing pad-sizes will be read out using self-triggered electronics. Prototype detectors with realistic sizes (~2000 sq. cm) have been designed, fabricated and tested in a self-streaming mode using cosmic muons and particle beams. The tests satisfy the basic design criteria of detection efficiency and rate capability of the detector. The design optimization and performance of prototype detectors will be presented.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
Other

Primary author: DUBEY, Anand Kumar (Variable Energy Cyclotron Centre, Kolkata (IN))
Presenter: DUBEY, Anand Kumar (Variable Energy Cyclotron Centre, Kolkata (IN))
Session Classification: Poster Session
Strangeness at finite temperature

Using generalized quark number susceptibilities we obtain continuum extrapolated lattice QCD results for the free energy in various strangeness sectors and compare it with the expectations from the hadron resonance gas model. We use these findings to disambiguate between various spectrum tables. Thus we constrain the abundance of strange mesons and baryons using finite temperature data. This allows to investigate whether the measured hadronic spectrum is missing some additional strange states, predicted by the Quark Model but not yet detected. The implication of our results on the chemical freeze-out parameters is discussed.

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary author: PAROTTO, Paolo (University of Houston)
Presenter: PAROTTO, Paolo (University of Houston)
Session Classification: Poster Session
Production of $\Sigma(1385)^\pm$ and $\Xi(1530)^0$ measured by ALICE in pp, p–Pb and Pb–Pb collisions at the LHC

The measurement of resonances in ultra-relativistic heavy-ion collisions allows one to study the properties of the hadronic medium. Resonances with short lifetimes compared to the duration of the hadronic phase are good candidates to probe the interplay of particle re-scattering and regeneration in the hadronic phase, which result in a modification of the measured yield of resonances. Measurements of $\Sigma(1385)^\pm$ and $\Xi(1530)^0$ have been performed with the ALICE detector at the LHC in pp, p–Pb and Pb–Pb collisions at different energies. We report on the transverse momentum ($p_T$) spectra, their mean values and yields as a function of the event multiplicity. The $p_T$-integrated yield ratios of excited to ground-state hyperons and to pions are discussed as a function of the mean charged-particle multiplicity densities and compared with models.

Preferred Track

Collective Dynamics

Collaboration

ALICE

Primary author:  SONG, Jihye (Pusan National University (KR))
Presenter:  SONG, Jihye (Pusan National University (KR))
Session Classification:  Poster Session
Pinning down the nature of QCD phase transition through the measurement of specific heat and isothermal compressibility

Nature of QCD phase transitions in high energy collisions can be pinned down by studying the behaviour of thermodynamic response functions with respect to $T$ and $\mu_B$.

A first order phase transition is signalled by the divergence of specific heat ($c_v$), whereas for a second order or continuous transition, isothermal compressibility ($k_T$) diverges.

$c_v$ is estimated at the kinetic freezeout hyper surface (at $T_{\text{kin}}$), whereas $k_T$ is at chemical freezeout hyper surface (at $T_{\text{ch}}$).

Thus simultaneous measurements of $c_v$ and $k_T$ as a function of collision energy probes the exact nature of phase transition and can pin down the location of the Critical Point in the ($T, \mu_B$) plane.

The heat capacity is expressed as, $C = \left(\frac{\partial E}{\partial T}\right)_V$, which implies $C^{-1} = \frac{\langle (P_{T_{\text{kin}}}^2 - (T_{\text{kin}})^2)\rangle}{\langle T_{\text{kin}}\rangle^2}$. Thus $c_v$ can be experimentally probed through $\langle p_T \rangle$ distribution.

Similarly, $k_T = \frac{1}{V} \left(\frac{\partial V}{\partial P}\right)$, which gives

$k_T = \frac{\sigma_N^2}{N} \frac{1}{k_B T_{\text{ch}}}$, where $N$ and $\sigma_N^2$ are the number of charged particles and its variance. Thus $k_T$ can be obtained through multiplicity fluctuation of charged particles.

$c_v$ and $k_T$ have been calculated from the mean transverse momentum ($\langle p_T \rangle$) and charged particle multiplicity fluctuations, measured on an event-by-event basis [1,2,3]. Experimental results along with results from the hadron resonance gas (HRG) model and event generators will be presented.


Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary author: BASU, Sumit (Department of Atomic Energy (IN))
Presenter: BASU, Sumit (Department of Atomic Energy (IN))
Session Classification: Poster Session
Predictions for bottomonia suppression in 5.023 TeV Pb-Pb collisions

We compute the suppression of the bottomonia states $\Upsilon(1S)$, $\Upsilon(2S)$, $\Upsilon(3S)$, $\chi_b(1P)$, $\chi_b(2P)$, and $\chi_b(3P)$ states in LHC $\sqrt{s_{NN}} = 5.023$ TeV Pb-Pb collisions. For the background evolution we use 3+1d anisotropic hydrodynamics with conditions extrapolated from $\sqrt{s_{NN}} = 2.76$ TeV and self-consistently compute bottomonia decay rates including non-equilibrium corrections to the interaction potential. For our final results, we take predictions made for $R_{AA}$ as function of centrality, rapidity, and $p_T$ for the $\Upsilon(1S)$ and $\Upsilon(2S)$ states including feed down effects and compare against recently announced ALICE and CMS experimental data. In order to assess the dependence on some of the model assumptions, we vary the shear viscosity to entropy density ratio, $4\pi\eta/s \in \{1, 2, 3\}$, and the initial momentum-space anisotropy parameter, $\xi_0 \in \{0, 10, 50\}$, while holding the total light hadron multiplicity fixed.

Preferred Track

Quarkonia

Collaboration

Not applicable

Primary author: KROUPPA, Brandon (Kent State University)

Co-author: Dr STRICKLAND, Michael (Kent State University)

Presenter: KROUPPA, Brandon (Kent State University)

Session Classification: Poster Session
A faster pixel detector for open bottom hadron measurements at RHIC

Heavy flavor quarks are dominantly produced from initial hard partonic scattering processes in high-energy nuclear collisions. Their interactions with nuclear medium are sensitive to the medium properties. The Heavy Flavor Tracker (HFT) has been successfully integrated into the STAR experiment at RHIC since early 2014. Based on the state-of-the-art Monolithic Active Pixel Sensor (MAPS) technology, the HFT allows precise measurements of open charm mesons ($D^0$, $D^\pm$ and $D_s$) as well as the first measurements of open charm baryons ($\Lambda_c$) and bottom hadron production in heavy-ion collisions over a wide range of transverse momentum.

In this talk we propose a faster pixel detector, based on the next generation of MAPS technology, for precise bottom hadron measurements to study the flavor dependence of partonic energy loss in Au+Au collisions at RHIC. The advantages of the new MAPS sensors are that they have a much better radiation tolerance and a much faster integration time of less than 40 μs, which allow for improved operation in high luminosity environment with less pile-up hits and better tracking efficiency. With the faster pixel detector and integrated luminosity of 10 nb$^{-1}$ for Au+Au collisions and 60 pb$^{-1}$ for p+p collisions at $\sqrt{s_{NN}} = 200$ GeV to be recorded, the nuclear modification factor ($R_{AA}$) for non-prompt $J/\psi$ and $D^0$ from beauty decays and $b$-tagged jets can be measured with good precision according to Monte Carlo simulations. Such precision measurements on bottom production will complete the heavy flavor program at RHIC, and will be complimentary to similar measurements at the LHC.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

STAR

Primary author: WANG, Yaping (Central China Normal University CCNU (CN))
Presenter: WANG, Yaping (Central China Normal University CCNU (CN))
Session Classification: Poster Session
Transverse momentum spectra of primary charged particles in pp collisions measured by ALICE at the LHC

Particle production at collider energies is a result of the interplay of perturbative (hard) and non-perturbative (soft) QCD processes. Hence, the measurements of transverse momentum spectra in pp collisions provide baseline tests of perturbative QCD and constraints for a better tuning of models and event generators. In addition, they constitute a valuable reference to study nuclear effects in nucleus-nucleus and proton-nucleus collisions, in particular allowing one to measure the nuclear modification factors.

The ALICE experiment has collected data pp at 5.02 TeV and the top LHC energy of 13 TeV. The 5 TeV dataset, in particular, is crucial for the comparison with the measurements in Pb-Pb and p-Pb collisions taken at the same energy. We present the measurements of charged particle transverse momentum spectra in pp collisions at the new energies and compare the results to the previous measurements at 7 TeV and 2.76 TeV as well as to the expectations from Monte Carlo event generators.

Preferred Track

Jets and High pT Hadrons

Collaboration

ALICE

Primary author: PEREZ LEZAMA, Edgar (Johann-Wolfgang-Goethe Univ. (DE))

Presenter: PEREZ LEZAMA, Edgar (Johann-Wolfgang-Goethe Univ. (DE))

Session Classification: Poster Session
Event topology dependence of the event-by-event mean $p_T$ fluctuations in high multiplicity pp collisions at 13 TeV

Event-by-event fluctuations contain information on the dynamics and correlations in pp and heavy-ion collisions. In nuclear collisions event-by-event fluctuations of the mean transverse momentum ($p_T$) are used to study collective phenomena. To contribute to the understanding of the collective effects in pp collisions which have been recently shown by experiments at the LHC, and to obtain more details about the origin of the non-statistical fluctuations, in this work we report the multiplicity dependence of the $< p_T >$ event-by-event fluctuations in pp collisions at $\sqrt{s} = 13$ TeV using the ALICE detector. The obtained results for charged particles are consistent with the previous published ALICE results at lower energies. To understand the origin of the $< p_T >$ fluctuations we have implemented a selection based on transverse spherocity to disentangle the contribution from isotropic and pencil-like events. The results are compared with PYTHIA 8 and EPOS 3.

Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: BAUTISTA GUZMAN, Irais (Autonomous University of Puebla (MX))

Presenter: BAUTISTA GUZMAN, Irais (Autonomous University of Puebla (MX))

Session Classification: Poster Session
The Silicon Tracking System of the CBM experiment at FAIR

The Silicon Tracking System is the central detector in the CBM experiment at FAIR. Operating in the 1 Tm dipole magnetic field, the STS will enable pile-up free detection and momentum measurement of the charged-particles originating from beam-target nuclear interactions at rates between 100 kHz and 10 MHz. It will also allow identifying particle decays occurring within the aperture.

The STS consists of 8 tracking stations based on double-sided silicon microstrip sensors equipped with fast, self-triggering read-out electronics. With about two million read-out channels, the STS will deliver a high-rate stream of time-stamped data that is transferred to a computing farm for on-line event determination and analysis. The functional building block is a detector module consisting of a sensor, microcables and two front-end electronics boards. The double-sided microstrip sensors have a strip pitch of 58 μm, are AC-coupled and oriented under 7.5 degree stereo angle. Double metallization is employed for read-out routing. Ultra-thin microcables with up to 60 cm length and a line pitch matching that of the sensor strips transfer the analog signals to the readout electronics at the periphery of the stations where cooling and further infrastructure can be provided without compromising the material budget. The custom-developed read-out ASIC “STS-XYTER” has a self-triggering architecture that delivers time and amplitude information. The detector will be operating within a thermal enclosure of about 2 m$^3$ at below $-5$ °C so that the silicon sensors remain operational up to a particle fluence of $10^{14}$ 1-MeV n$_{eq}$ cm$^{-2}$. The electronics, 16 thousand ASICs, data aggregation and power boards, will dissipate about 40 kW that will be removed with bi-phase CO$_2$ evaporative cooling.

In this contribution, the development status of the STS components and the system integration will be discussed and an outlook on the detector construction given.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
Other

Primary author: HEUSER, Johann (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))
Presenter: HEUSER, Johann (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))
Session Classification: Poster Session
Low-mass electrons pairs from 1.23A GeV Au+Au Collisions with HADES

Tuesday, 7 February 2017 08:50 (20 minutes)

We present a first measurement of low-mass electron pairs for a heavy collision-system at SIS18/Bevalac energies. The data is analyzed in terms of excess radiation above a conventional cocktail of contributions from meson decay after thermal freeze-out. We observe a strong excess radiation which is remarkably well described assuming emission from a thermalized system. The high statistics data allows studying multi-differential distributions. The multiplicity of excess radiation in the mass window 300 to 700 MeV/$c^2$ rises with $A_{part}$ stronger than linear. To gain deeper understanding of the microscopic origin of the excess radiation we started to investigate di-electron radiation emitted from baryonic resonances produced off protons in pion-induced reactions. The data is in support of VMD in electromagnetic transition of excited baryons.

Preferred Track
Electromagnetic Probes

Collaboration
Other

Primary author: GALATYUK, Tetyana (TU Darmstadt / GSI)
Presenter: GALATYUK, Tetyana (TU Darmstadt / GSI)
Session Classification: Parallel Session 1.3: Electromagnetic Probes (I)
Track Classification: Electromagnetic Probes
Lambda polarization and spin correlations in a vortical fluid

Tuesday, 7 February 2017 17:50 (20 minutes)

We computed the fermion spin distribution and correlations in vortical fluid employing event-by-event (3+1)D viscous hydrodynamics. Due to spin-vorticity coupling, the spin polarization density is proportional to the local fluid vorticity at the next-to-leading order of a gradient expansion in a quantum kinetic theory. As a result of strong collective flow, the spatial distribution of local vorticity on the freeze-out hypersurface converts to Lambda spins with intrinsic azimuthal angle distribution and correlation at RHIC and LHC energy. The azimuthal correlation of the transverse spin is shown to have a cosine form plus an offset due to a circular structure of the transverse vorticity around the beam direction and global angular momentum in non-central collisions. The longitudinal spin correlation shows a structure of vortex-pairing in the transverse plane due to the convective flow of hot spots in the radial direction. The dependence on colliding energy, rapidity, centrality and sensitivity to the shear viscosity are also investigated.

Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary author: Dr PANG, Long-Gang (Frankfurt Institute for Advanced Studies, Goethe University)

Presenter: Dr PANG, Long-Gang (Frankfurt Institute for Advanced Studies, Goethe University)

Session Classification: Parallel Session 4.2: CME, Vorticity and Spin Polarization (II)

Track Classification: Correlations and Fluctuations
Strangeness production in heavy-ion collision at energies below the free NN production threshold is an excellent tool to study medium properties of dense baryonic systems. For the first time, a nearly complete set of strange particles has been reconstructed in the 40% most central Au+Au collisions at 1.23A GeV. The data sample includes multi-differential representations of charged and neutral Kaons, Lambdas and Phi-mesons. The multiplicities, together with those for non-strange hadrons, have been analyzed in the context of statistical hadronization models. Overall, a good fit is obtained if an additional parameter ($R_c$) is used to account for canonical strangeness suppression. We find that about 30 % of observed $K^-$ are produced through Phi-decay. If we correct the observed $K^-$ transverse momentum spectra for feed down from $\phi$ decay, all extracted slope parameters also support the assumption of a homogenous emission source for all particle types.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Other

Primary author:  Ms SCHULDES, Heidi (GU Frankfurt)
Presenter:  Ms SCHULDES, Heidi (GU Frankfurt)
Session Classification:  Parallel Session 7.1: Baryon-Rich QCD Matter and Astrophysics (II)
Track Classification:  Baryon-Rich QCD Matter and Astrophysics
Higher moments of e-by-e proton-multiplicity fluctuations in Au+Au collisions at 1.23A GeV

Wednesday, 8 February 2017 17:10 (20 minutes)

The strong rise towards lower collision energies of the fourth moment of the e-by-e net-baryon multiplicity distribution observed by the STAR collaboration has recently triggered high attention. In view of theoretical studies of critical phenomena in the QCD matter phase diagram, this could signal the existence of a critical point. To provide further experimental insight, an extension of the respective excitation function to even lower collision energies is of high importance. We have investigated higher moments of e-by-e proton distributions using data from our high-statistics measurement of Au+Au collisions. Systematic effects have been studied making use of our GEANT-based detector response simulation which includes sophisticated digitizers for all detector systems in use. The data is corrected for detector effects like finite acceptance and multiplicity-dependent reconstruction efficiency using different approaches proposed by Koch and co-workers (arXiv-1206-4286, arXiv-1603-09057, arXiv-1607-07375).

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Other

Primary author: HOLZMANN, Romain (GSI)
Presenter: HOLZMANN, Romain (GSI)
Session Classification: Parallel Session 8.1: Baryon-Rich QCD Matter and Astrophysics (III)
Track Classification: Baryon-Rich QCD Matter and Astrophysics
Collective flow measurements with HADES in Au+Au collisions at 1.23A GeV

Wednesday, 8 February 2017 14:40 (20 minutes)

HADES provides a large acceptance combined with a high mass-resolution and therefore allows to study dielectron and hadron production in heavy-ion collisions with unprecedented precision. With the high statistics of seven billion Au-Au collisions at 1.23A GeV recorded in 2012 the investigation of high-order flow harmonics is possible. Multi-particle azimuthal correlation techniques can be utilized to disentangle the contribution from collective and non-flow process involved in the dynamical evolution of heavy-ion reactions. At low energies v1 and v2, related to directed and elliptic flow, have been measured for pions, charged kaons, protons, neutrons and fragments at the BEVALAC and SIS18, but so far high-order harmonics have not been studied. They allow to characterize the properties of the dense hadronic medium produced in these collisions, such as its viscosity, and provide thus an important reference to measurements at higher energies.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Other

Primary author:  BLUME, Christoph (IKF, Uni-Frankfurt)
Presenter:  BLUME, Christoph (IKF, Uni-Frankfurt)
Session Classification:  Parallel Session 7.1: Baryon-Rich QCD Matter and Astrophysics (II)
Track Classification:  Baryon-Rich QCD Matter and Astrophysics
An exploratory study of direct photon reconstruction with HADES

The High Acceptance Di-Electron Spectrometer (HADES) is located at GSI Darmstadt and aims at exploring the properties of matter at high baryon densities via high precision measurements of di-leptons and hadrons.

In this contribution, we discuss the potential of HADES to reconstruct direct photons from Au+Au collisions at 1.23 AGeV beam energy and present first results obtained from data acquired in a related run in 2012. Given that HADES is not yet equipped with an electromagnetic calorimeter, our analysis relies on an indirect detection of the direct photons. The method employed bases on reconstructing photons undergoing a conversion, via the di-electron pair created in this conversion. The approach is complicated by the fact that HADES is optimized for minimizing the related conversion process, which contributes to the background of other measurements.

We discuss in details the method of the direct photon reconstruction used and describe how to correct for the impact of combinatorial background and Dalitz decays. Moreover, we present an extension of the study to the so-called "direct photon puzzle" observed by PHENIX and ALICE experiments. For this purpose, we use various cocktails with a particular focus on the contribution of photons from baryon decays to the inclusive photon spectra, which is typically not considered as a part of cocktail.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Other

Primary author: DEVEAUX, Christina
Presenter: DEVEAUX, Christina
Session Classification: Poster Session
Interplay of partonic collectivity and energy loss in understanding the Nuclear Modification factors

Nuclear modification factors ($R_{AA}$ or $R_{CP}$) of charged hadrons and identified particles for heavy-ion collisions at RHIC and LHC have been used to quantitatively study the interplay of the partonic collectivity and hadronic suppression. The outward pressure of strongly interacting partonic medium in the early stage of the collision creates radial boost, which is the key factor for Cronin-like peak structures. The structure could be understood and unified in terms of ratio of particle species and their mass dependence at a particular collision energy. The response of the medium in the high $p_T$ region is same for all charged particle species at a given collision energy, but the suppression increases with increasing energy.

The primary goal of the present work is to understand the underlying physics and disentangle the major factors contributing to the shape of the nuclear modification factors. A new observable, Integrated Suppression Fraction (ISF) defined as the normalized area of the $R_{AA}$ structures within a given $p_T$ window, has been introduced. ISF for an intermediate $p_T$ window plotted as a function of collision energy shows an increasing trend for RHIC energies with saturation at LHC energies. This provides a prediction for ($R_{AA}$) for the upcoming $Pb-Pb$ run for $\sqrt{s_{NN}} = 5.02$ TeV. A detailed study of the ISF provides a novel method to understand the role of collectivity and energy loss at these energies. Results for ISF from the available experimental data will be presented and compared to the expected energy loss properties from various theoretical models and event generators from different approaches, such as EPOS, Therminator as hydro-like collective models and also microscopic transport models like UrQMD and AMPT.

Preferred Track

Jets and High $p_T$ Hadrons

Collaboration

Not applicable

Primary author: NAYAK, Tapan (Department of Atomic Energy (IN))

Presenter: NAYAK, Tapan (Department of Atomic Energy (IN))
Session Classification: Poster Session
Conserved charge fluctuations at vanishing and non-vanishing baryon chemical potential from lattice QCD

Wednesday, 8 February 2017 14:40 (20 minutes)

Up to 6th order cumulants of fluctuations of net baryon-number, net electric charge and net strangeness as well as correlations among these conserved charge fluctuations are now being calculated in lattice QCD. These cumulants provide a wealth of information on the properties of strong-interaction matter in the transition region from the low temperature hadronic phase to the quark-gluon plasma phase.

We use results from our 6th order Taylor expansion of the QCD equation of state to construct expansions for second and fourth order cumulants of conserved charges and their correlations, e.g. the second order cumulants can be calculated up to $\mathcal{O}(\mu_B^2)$ in the baryon chemical potential. We show that these low order cumulants strongly constrain the applicability range of hadron resonance gas model calculations. We point out that the latter is inappropriate to describe equilibrium properties of cumulants at finite $\mu_B$ already at $T \sim 155$ MeV.

For vanishingly small baryon chemical potential, we show that fourth order cumulant ratios calculated in QCD start to deviate from hadron resonance gas model calculations already at about 155 MeV, and the sixth order cumulants differ from HRG model calculations even earlier. Even some second order cumulants like the correlations between net-baryon number and net strangeness or net electric charge differ significantly at temperatures above 155 MeV in QCD and HRG model calculations. Since these cumulants are calculated at vanishing chemical potential they can be compared to measurements at the LHC.

**Preferred Track**

Correlations and Fluctuations

**Collaboration**

Other

**Primary author:** KARSC, Frithjof (Brookhaven National Laboratory)

**Presenter:** KARSC, Frithjof (Brookhaven National Laboratory)

**Session Classification:** Parallel Session 7.2: Correlations and Fluctuations (II)

**Track Classification:** Correlations and Fluctuations
Path-Integral Monte Carlo Study of the Magnetic Component of Quark-Gluon Plasma At and Above $T_c$

Wednesday, 8 February 2017 11:00 (20 minutes)

Magnetic monopoles are suggested to play an important role in strongly coupled quark-gluon plasma (sQGP) near the deconfinement temperature. Lattice studies show that near the confinement temperature, $T_c$, quark-gluon plasma (QGP) contains both electric and magnetic quasiparticles. Further studies of the behavior of these quasiparticles at and above $T_c$, such as those by Liao and Shuryak (2006-2009) and D’Elia and D’Alessandro (2007-2009), found that the magnetic component of QGP forms a liquid, and that the magnetic monopoles form a Bose-Einstein condensate as the temperature approaches the critical temperature, creating the dual-superconductor proposed as a mechanism for confinement.

In this work, we conduct path-integral Monte Carlo (PIMC) simulations of magnetic monopoles, in order to study their behavior at temperatures at and above the confinement temperature. First, we sought to replicate the lattice results of D’Alessandro, D’Elia, and Shuryak (2009) through the study of the permutation cycles of one- and two-component plasmas of bosons interacting with a Coulomb potential. We found for the two-component plasma, as they did on the lattice, that as the system approaches $T_c$ from above the exponential suppression of permutation cycles of these bosons decreases before disappearing at $T_c$, indicating a phase transition.

We then study thermodynamics and physical distribution of magnetic monopoles, using the densities and coupling strengths given by D’Alessandro and D’Elia (2007); and Liao and Shuryak (2009). At low temperatures, in addition to the formation of the condensate, we see formation of “droplets” of the magnetic charges at strong coupling. This suggesting that the monopoles are indeed forming a liquid, as seen by Liao and Shuryak in their classical molecular dynamics simulations. At low temperatures and large couplings, there are also signs of crystallization in this system, an interesting analog to systems of extremely high density, such as helium white dwarf stars. We then simulate the system at higher temperatures — along lower densities and strong coupling — and see the breakup of these drops of monopole “liquid.” Finally, we draw conclusions about the contribution of the monopoles to the overall thermodynamics of the QGP above the confinement temperature.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author: RAMAMURTI, Adith (Stony Brook University)

Presenter: RAMAMURTI, Adith (Stony Brook University)

Session Classification: Parallel Session 6.3: New Theoretical Developments (II)
Global view on coupled dynamics of heavy and light flavor observables from EPOSHQ

Wednesday, 8 February 2017 18:10 (20 minutes)

Heavy-flavor observables are excellent probes of the properties of the in-medium interactions, the medium properties and the degrees of freedom of the quark-gluon plasma created in heavy-ion collisions. Progressing toward a quantitative description, we describe, in EPOSHQ, the dynamics of heavy quark coupled systematically to the EPOS3 model: heavy-quarks are produced from the EPOS3 flux tube initial conditions both in momentum and in coordinate space and subsequently propagated in parallel to the fluid dynamical evolution of the viscous QGP. Hadronization of the heavy quarks via coalescence and fragmentation and particlization of the fluid enable us to investigate the importance of the final hadronic rescatterings on the heavy-flavor observables. This global description allows us to draw conclusions from the comparison to a variety of heavy-quark observables in different systems and constrain important aspects in our underlying model for the in-medium interaction, such as the contributions stemming from elastic and inelastic energy loss, or the mass dependence by comparing charm and bottom quark dynamics. We present strategies to quantify the off-equilibrium dynamics of heavy flavor at lower momentum compared to the bulk flow by focussing on the higher-order flow harmonics of B and D mesons and the light, charged hadrons and it’s centrality dependence. At higher momentum path length differences become the driving force of flow observables. Our sophisticated energy loss models and QGP-heavy quark coupling allow us in particular to obtain robust estimates of different contributions to the heavy flavor flow in the intermediate momentum range.

Preferred Track

Open Heavy Flavors

Collaboration

Not applicable

Primary author:  GOSSIAUX, Pol (Subatech)

Presenter:  GOSSIAUX, Pol (Subatech)

Session Classification:  Parallel Session 8.4: Open Heavy Flavors (III)

Track Classification:  Open Heavy Flavors
Measurements of Balance Functions for Identified Particles in Pb-Pb Collisions at $\sqrt{s_{NN}} = 2.76$ TeV at ALICE

Measuring balance functions of different hadronic species holds the prospect of providing a quantitative insight into the chemical evolution of the Quark Gluon Plasma created in ultra-relativistic heavy ion collisions\[1\]. Balance functions have been measured for identified charged-pion pairs and for identified charged-kaon pairs in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV by the ALICE detector at the Large Hadron Collider (LHC). These balance functions are presented in relative rapidity $\Delta y$ and relative azimuthal angle $\Delta \phi$. The charged-pion balance function widths in terms of $\Delta y$ and $\Delta \phi$ appear to be narrower in central Pb-Pb collisions compared to peripheral collisions. Furthermore, we present a comparison between the balance functions of charged-pions, charged-kaons and unidentified charged particles. The results of this analysis agree with the effects of delayed hadronization and radial flow, as well as the two-wave nature of quark production proposed in \[1\]. Detailed model comparisons will also be shown to draw more quantitative conclusions.


Preferred Track

Correlations and Fluctuations

Collaboration

ALICE

Primary author: PAN, Jinjin (Wayne State University (US))

Presenter: PAN, Jinjin (Wayne State University (US))

Session Classification: Poster Session
The intermediate tracking system of the sPHENIX detector at RHIC

The sPHENIX experiment at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory is designed to explore a vast range of physics areas including heavy quarkonia suppression via the three Υ states and tagging of charm and beauty jets. Among the sPHENIX detector systems, precision tracking inside the 1.5 Tesla BaBar superconducting solenoid plays a crucial role to reduce fake track contributions and improve the momentum resolution, thus leading to separation of the three Υ states and to separation of charm and bottom quarks. A charged particle tracking system employing an "Intermediate Tracker", consisting of four layers of the silicon strip detectors placed circumferentially in the radial space from 6–12 cm, will satisfy the above requirements. In this talk, we will discuss the design and technology choices for the sPHENIX intermediate tracking system, the latest status of the prototype detector R&D, and the expected performance based on full Geant4 simulations.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: MITSUKA, Gaku
Presenter: MITSUKA, Gaku
Session Classification: Poster Session
Identification of heavy-flavor jets in sPHENIX using MAPS

The flavor dependence of jet quenching in the QGP is an important tool to study radiative and collisional energy loss in the medium using probes of different mass scales. B-tagged jet nuclear modification measured at LHC has not shown a parton flavor dependence at high $p_T$, where the quark mass is much smaller than the $p_T$ scale. The proposed sPHENIX experiment at RHIC will measure B-tagged jets at lower $p_T \sim 10-30 \text{ GeV/c}$, closer to the B-quark mass scale than measurements at LHC. Monolithic Active Pixel Sensor (MAPS) technology has been proposed to provide precision displaced vertex measurements in high occupancy heavy ion environments. The implementation of a MAPS detector in sPHENIX, physics performance projections and possible impacts to the field of heavy ion physics will be discussed.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: Dr DA SILVA, Cesar Luiz (Los Alamos National Lab)
Presenter: Dr DA SILVA, Cesar Luiz (Los Alamos National Lab)
Session Classification: Poster Session
Modification of Upsilon production in nuclear collisions measured with sPHENIX

Upsilon states provide an excellent probe for studying the screening length in the Quark Gluon Plasma through simultaneous observation of the $\Upsilon(1S)$, $\Upsilon(2S)$ and $\Upsilon(3S)$, using pp, pA and AA collisions. Unlike the charmonium states, the $\Upsilon$ yield in AA collisions due to coalescence of bottom quarks produced in unrelated hard processes is expected to be small at both RHIC and LHC energies. Comparison of the $\Upsilon$ modifications measured at RHIC and LHC therefore provides a relatively direct comparison of the effect of high energy density on three states of different radius and binding energy, at two different initial temperatures of the plasma. The sPHENIX experiment proposed at RHIC will be able to reconstruct $\Upsilon$ states with a mass resolution of approximately 80 MeV, providing a clear separation of the three $\Upsilon(nS)$ states. In combination with the large acceptance of sPHENIX and the high luminosity at RHIC this will provide a high quality measurement of the modification for all three states. The results of simulations showing the performance of sPHENIX as an Upsilon detector will be described, and the expected quality of the measurements will be discussed.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
sPHENIX

Primary author: Mrs SMITH, Krista (Florida State University)
Presenter: Mrs SMITH, Krista (Florida State University)
Session Classification: Poster Session
Jet spectra and jet structure measurements with sPHENIX

The sPHENIX proposal is for a second generation experiment at RHIC, which will take advantage of the increased luminosity due to accelerator upgrades, and allow measurements of jets and jet correlations with a kinematic reach that will overlap with measurements made at the Large Hadron Collider (LHC). Particle jets, formed when a hard scatter parton fragments and then hadronizes into a spray of particles, were proposed as a probe of the Quark Gluon Plasma formed in heavy-ion collisions. As they traverse the QGP, the hard scattered partons probe the medium at a variety of length scales, which is called jet quenching. To answer the fundamental questions of how and why partons lose energy in the QGP, we need to characterize both the medium induced modification of the jet fragmentation pattern and the correlation of the lost energy with the jet axis. Some observables that help elucidate these effects are gamma-jet correlations and jet fragmentation functions, which require the precise tracking and calorimetry that sPHENIX will have. We will show the performance of these observables as well as that for jet and hadron spectra measurements, which are necessary for a baseline understanding, based on detector simulations.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: REED, Rosi Jan (Lehigh University)
Presenter: REED, Rosi Jan (Lehigh University)
Session Classification: Poster Session
The RICH detector for the CBM experiment at FAIR

The CBM fixed-target experiment at FAIR will investigate highly compressed baryonic matter at moderate temperatures in heavy-ion collisions with 2-11 AGeV beam energy for heaviest nuclei at the SIS100 accelerator at FAIR starting in 2022. The CBM experiment aims at understanding and characterizing nuclear matter at high net-baryon densities but moderate temperatures focussing on the investigation of rare probes as for example electromagnetic radiation. Electromagnetic radiation, if measured with high precision, is particularly promising as it carries information on the temperature and evolution of the fireball, in-medium properties of vector-mesons and on the coupling to baryonic resonances. No measurements are available in this energy range so far, thus CBM has a high discovery potential due to the unprecedented reaction rates.

The major detector for clean electron identification in the CBM experiment at SIS 100 will be a RICH detector using CO$_2$ as radiator gas, spherical glass mirrors with reflective Al+MgF$_2$ coating as focusing elements and a photodetector plane consisting of an array of H12700 MAPMTs from Hamamatsu. This detector concept has been tested extensively with a real-size RICH prototype in testbeams and proven to show a high performance. The testbeam evaluations included a detailed study of layers of wavelength-shifting films for enhanced UV sensitivity and the development of MAPMT readout. Several MAPMT sensors were tested in this setup but also for radiation hardness in separate experimental campaigns with thermal neutron and gamma irradiation. As result the H12700 sensor was ordered from Hamamatsu in spring 2015, until now 500 MAPMTs have been measured and tested. The readout electronics is based on the TRB3 developments and focusses on good time resolution while offering moderate amplitude information via time-over-threshold. The close to final readout electronics is available and will be tested in testbeams at COSY and in the lab.

In order to make use of the early delivery of the photosensors with respect to the CBM time scales and to recuperate performance losses of the HADES RICH detector, the HADES RICH detector will be upgraded with these photosensors and readout electronics as developed for CBM. This upgrade program will be finished for the next HADES data taking period starting 2018.

In this contribution we will report on the design and development status of the CBM RICH detector including details from the MAPMT radiation hardness tests, MAPMT series measurements, readout electronics and the HADES RICH upgrade. Feasibility studies of di-electron measurements in CBM will be discussed.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
Other

Primary author: MAHMOUD, Tariq (J)
Presenter: MAHMOUD, Tariq (J)
Session Classification: Poster Session
Track Classification: Future Experimental Facilities, Upgrades, and Instrumentation
Design of the sPHENIX tracker

The latest results on jets and heavy flavor by the LHC experiments demonstrate the need to explore complementary measurements at RHIC, providing lower energies and lower initial virtualities. The proposed sPHENIX detector at RHIC will explore the quark-gluon plasma by measuring jets, b-tagged jets, jet correlations and the three upsilon states. The sPHENIX detector will cover full azimuth and $|\eta| < 1.1$. The former BaBar solenoid will provide a magnetic field of 1.5 T, while Electromagnetic and Hadronic Calorimeters will form the sPHENIX calorimeter system. Resolving the upsilon states, heavy-flavor tagging and high $p_T$ particle tracking inside jets require tracking detectors with good momentum, precision vertexing and low fake rate. Monolithic Active Pixel Detector (MAPS), the Intermediate Silicon Tracker (INTT) and a GEM-based Time Projection Chamber (TPC) collectively will provide tracking in sPHENIX. Based on Geant4 simulations, this tracking system provides the required resolution of less than 2% up to 10 GeV momentum required to resolve the three Upsilon states.

An overview of the sPHENIX tracker design along with key performance measures will be shown in this poster.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: TARAFDAR, Sourav (Vanderbilt University (US))

Presenter: TARAFDAR, Sourav (Vanderbilt University (US))

Session Classification: Poster Session
sPhenix Tracking Performance Simulations

sPHENIX is an upgrade to the PHENIX detector proposed to explore the quark-gluon plasma formed in heavy ion collisions through measurements of jets and upsilons at RHIC in the 2020's. The experiment will feature a 1.5 Tesla superconducting solenoid magnet which was formerly used by the BaBar experiment. A charged particle tracking system will be placed together with an electromagnetic and hadronic calorimeters spanning full azimuthal coverage and 2 units of central pseudo-rapidity. The tracking system will consist of a Time Projection Chamber (TPC) with a GEM-based readout, an intermediate silicon strip tracker (INTT), and a MAPS (Monolithic Active Pixel Detector) micro-vertex detector. The current status of the tracker simulation studies and key performance results will be presented.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
sPHENIX

Primary authors: Dr CANOA ROMAN, Veronica (Stony Brook University); CANOA ROMAN, Veronica (Centro Invest. Estudios Avanz. IPN (MX)); CANOA ROMAN, Veronica

Presenters: Dr CANOA ROMAN, Veronica (Stony Brook University); CANOA ROMAN, Veronica (Centro Invest. Estudios Avanz. IPN (MX)); CANOA ROMAN, Veronica

Session Classification: Poster Session
Susceptibilities from a black hole engineered EoS with a critical point

Currently at the Beam Energy Scan at RHIC experimental efforts are being made to find the QCD critical point. On the theoretical side, the behavior of higher-order susceptibilities of the net-baryon charge from Lattice QCD may allows us to estimate its position via Taylor expansion of the density of states at $\mu_B = 0$. However, even if the series expansion continues to higher-orders, there is always the possibility to miss the critical point behavior due to truncation errors.

An alternative approach to exploring the QCD critical point is using black hole engineering. This method allow us to obtain susceptibilities fitting the lattice data at $\mu_B = 0$ but also can be expanded out to extremely large baryonic chemical potentials as well. Additionally, in the black hole engineered EoS there is a clear critical point at $\mu_B = 725$ MeV and $T = 80$ MeV. In this talk, we obtain the freeze-out line and compare it with the hadron resonance gas model, lattice calculations, and experimental data. We also explore fluctuations at the lowest energies at the beam energy scan to see if there are signatures of the critical point.

Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

Primary authors: RATTI, Claudia (University of Houston); PORTILLO, Israel (University of Houston); Dr NORONHA-HOSTLER, Jacquelyn (University of Houston)
Presenter: PORTILLO, Israel (University of Houston)
Session Classification: Poster Session
R&D Studies for the sPHENIX Time Projection Chamber

The proposed sPHENIX detector design is focused mainly on a physics program of precise upsilon spectroscopy and jet measurements, leading to a requirement for high tracking efficiency and excellent momentum resolution. A time projection chamber (TPC) is proposed as the outer tracking detector for sPHENIX, which has a rapidity coverage of $|\eta| < 1.1$ and full azimuthal coverage. The sPHENIX TPC design has to be optimized for operation in the high rate, high charged particle multiplicity environment that is anticipated at RHIC in 2022. In this presentation, we show the results of R&D, and describe the ongoing efforts to optimize the design of the sPHENIX TPC.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: Dr GARG, Prakhar (SUNY Stony Brook)
Presenter: Dr GARG, Prakhar (SUNY Stony Brook)
Session Classification: Poster Session
sPHENIX TPC mechanical design

The sPHENIX experiments will explore the properties of the quark gluon plasma via measurements of jets and upsilons. sPHENIX will feature a state of the art tracking system which consists of a highly granular MAPS silicon pixel detector, a silicon strip detector (INTT) and a time projection chamber (TPC).

The tracking system will work in continuous read out at high data collection rates, 30kHz, and will be able to provide momentum resolution below 2% at 5 GeV/c, which is suitable for upsilon reconstruction. The TPC will span a radius from 24 to 78 cm and 2.2 units in pseudorapidity, much smaller than any other TPC ever build, and will hold high electric and magnetic fields. The strategy for its construction, mechanical specifications and progress of the outer field cage construction will be shown in this poster.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: DEHMELT, Klaus (State University of New York Stony Brook (US))
Presenter: DEHMELT, Klaus (State University of New York Stony Brook (US))
Session Classification: Poster Session
The state-of-the-art perturbative EoS at all temperatures and chemical potentials

Wednesday, 8 February 2017 17:50 (20 minutes)

I will discuss the new state-of-the-art perturbative Equation of State of quark matter valid at all temperatures and chemical potentials. The new result is accurate to order $g^5$ in the gauge coupling, and is based on a novel framework for dealing with the infrared sensitive soft field modes of the theory. The zero Matsubara mode sector is treated using a dimensionally reduced effective theory, while the soft non-zero modes are resummed using the Hard Thermal Loop approximation.

Preferred Track

QCD at High Temperature

Collaboration

Not applicable

Primary author: KURKELA, Eero Aleksi (CERN)
Presenter: KURKELA, Eero Aleksi (CERN)
Session Classification: Parallel Session 8.1: Baryon-Rich QCD Matter and Astrophysics (III)
Track Classification: QCD at High Temperature
Test Beam Performance of the sPHENIX EMCal Prototype

The sPHENIX detector is a proposed upgrade to the PHENIX detector at the Relativistic Heavy Ion Collider (RHIC). The sPHENIX detector will measure properties of quark gluon plasma (QGP) through the study of jets and hard probes. The electromagnetic calorimeter (EMCal) consists of tungsten powder and epoxy blocks with embedded scintillating fibers. The approximately 7 mm radiation length allows a compact calorimeter with fine segmentation. A prototype EMCal consisting of an 8 by 8 array of towers was tested at the Fermilab Test Beam Facility in April 2016. This poster will present the design and performance of the prototype EMCal and future plans.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author:  BAILEY, Virginia Ruth (UIUC)
Presenter:  BAILEY, Virginia Ruth (UIUC)
Session Classification:  Poster Session
Construction and testing of the sPHENIX hadronic calorimeter prototype

The planned sPHENIX experiment is a major initiative and a key part of the future of heavy ion physics in the US. One of the key pillars of the planned physics program is detailed measurements of jets, which requires hadronic calorimetry over a large solid angle. The sPHENIX hadronic calorimeter (HCal) is a sampling calorimeter comprising alternating layers of steel absorber and plastic scintillator. In this poster we discuss the design and construction of the HCal prototype tested at the Fermilab Test Beam Facility in 2016 and implications for the final design, as well as detailed results on testing and characterization of the scintillators.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: NAGLE, James Lawrence (University of Copenhagen (DK))
Presenter: NAGLE, James Lawrence (University of Copenhagen (DK))
Session Classification: Poster Session
A Prototype of the sPHENIX Hadronic Calorimeter

The proposed sPHENIX experiment is designed to reconstruct jets in heavy-ion collisions at RHIC. A crucial component to reconstructing the energy of jets is the sPHENIX calorimeter system which includes electromagnetic and hadronic calorimeters. The hadronic calorimeter (HCal) is a sampling calorimeter with alternating layers of steel absorber and scintillating tiles. There is an inner and larger outer HCal, located inside and outside of the solenoid detector. Prototypes of the EMCal, inner HCal and outer HCal were tested at the Fermilab Test Beam Facility. Measurements of the energy resolution satisfy the requirements of the proposed sPHENIX physics program and are consistent with GEANT4 simulations.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: SEN, Abhisek (Georgia State University)
Presenter: SEN, Abhisek (Georgia State University)
Session Classification: Poster Session
The Readout and Data Acquisition Design of the sPHENIX Detector at RHIC

The recently established sPHENIX Collaboration at RHIC is upgrading the PHENIX detector in a way that will enable a comprehensive measurement of jets in relativistic heavy ion collisions. The upgrade will give the experiment full azimuthal coverage within a pseudorapidity range of $-1.1 < \eta < 1.1$. In addition to measuring heavy-ion collisions, the new apparatus will provide enhanced physics capabilities for studying nucleon-nucleus and polarized proton collisions, and eventually allow a detailed study of electron-nucleus collisions at an envisioned Electron Ion Collider at Brookhaven.

The upgraded detector will be based on the former BaBar magnet and will include tracking detectors, a new electromagnetic calorimeter, and, for the first time at a RHIC experiment, a hadronic calorimeter. A new technology using a Tungsten-scintillating fiber design for the electromagnetic calorimeter is what enables the full azimuthal coverage, as it achieves a radiation length of just about 7mm, which allows for a very compact design of the device.

The calorimeter signals are measured with silicon photomultipliers and waveform digitizing electronics. The digitized waveforms are read out with custom PCIe boards that allow multiple streams with bandwidths of up to 5GBit/s. The goal is to have a sustained event rate to disk of about 15KHz. Focusing on the calorimeters, we will describe the goals and design of the sPHENIX experiment, the design of the digitizers and other parts of the data acquisition system.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: PURSCHKE, Martin Lothar (Brookhaven National Laboratory (US))

Presenter: PURSCHKE, Martin Lothar (Brookhaven National Laboratory (US))

Session Classification: Poster Session
A Common Readout System for the sPHENIX Electromagnetic and Hadronic Calorimeters

sPHENIX is the next generation detector at the Relativistic Heavy Ion Collider (RHIC) designed to explore the properties of the quark-gluon plasma through measurements of jet properties and 
upsilon spectroscopy. The detector consists of a 1.5T superconducting solenoid, tracking, electromagnetic and hadronic calorimeter with a high speed data acquisition system. The calorimeters use a common readout design based on Silicon Photo-Multipleis (SiPMs) as the optical sensors with the continuous digitization of the analog signals. We will present the design requirements and technology choices, along with preliminary performance results from prototype testing at the Fermilab Test Beam Facility as part of experiment T-1044.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author:  MANNEL, Eric (Brookhaven National Labs)
Presenter:  MANNEL, Eric (Brookhaven National Labs)
Session Classification:  Poster Session
Front End Readout for the sPHENIX Time projection chamber

The sPHENIX is the upgrade project of the PHENIX detector whose operation has just ended. This upgrade project mainly focuses on the detailed measurement of the jets and Upsilons. We have proposed to build a time projection chamber (TPC) as the main tracker for the sPHENIX, which has a radial coverage of 20 cm to 78 cm with rapidity coverage of $|\eta| < 1.1$ and full azimuth. The number of readout channels will be ~200K, and the raw data volume is expected to reach as much as ~4 Gbits/sec. In order to fully exploit the data within the limitation of the bandwidth of the end tape device, we need to introduce a new continuous readout scheme followed by a fast data processing system.

In this presentation, we will show the initial design of the front end readout scheme for the sPHENIX TPC.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author: SAKAGUCHI, Takao (BNL)
Presenter: SAKAGUCHI, Takao (BNL)
Session Classification: Poster Session
Studying Proton Structure, the Partonic Structure of Nuclei, and Hadronization at sPHENIX

The proposed sPHENIX detector at the Relativistic Heavy Ion Collider will take proton-proton, proton-nucleus, and nucleus-nucleus collision data in the early 2020s, opening up new opportunities to study a wide variety of QCD systems and processes. Inclusive and correlation observables involving jets, photons, and heavy flavor at midrapidity will provide sensitivity to partonic structure and dynamics within the proton as well as nuclei and an initial program exploring hadronization in different collision systems. Possible additional instrumentation, in particular in the forward rapidity region, would enable a wealth of further measurements probing the low-x structure of nuclei, long-range collective behavior in small systems, and additional spin-spin and spin-momentum correlations in the proton and in the process of hadronization.

Preferred Track
Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration
sPHENIX

Primary author: KIM, Chong
Presenter: KIM, Chong
Session Classification: Poster Session
B-Jet Tagging Algorithms for sPHENIX at RHIC

Jets initiating from a B-quark (B-jet) are sensitive to the collisional energy loss of the quark when traversing through Quark Gluon Plasma (QGP). Among the light jet background, the rare B-jets can be identified by utilizing some characteristic B-hadron decay properties, such as its long lifetime and semi-leptonic decay modes. With the proposed sPHENIX detector at RHIC, we study a variety of B-Jet tagging algorithms, including the track impact parameter method, secondary vertex method and the lepton tagging method. The algorithm optimization and their performance projection will be discussed based on comprehensive detector and physics simulations.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

sPHENIX

Primary author:  Dr YU, Haiwang (New Mexico State University)
Presenter:  Dr YU, Haiwang (New Mexico State University)
Session Classification:  Poster Session
Heavy quark production in pA collisions in the CGC framework - update and decay leptons -

Heavy quark production in proton-nucleus (pA) collisions at RHIC and LHC provides important information on the gluon saturation dynamics at small-$x$ of a heavy nucleus. We report the update of our Color-Glass-Condensate (CGC) calculation of heavy flavor production including quarkonia, open heavy flavor mesons and decay leptons. Moreover, we will implement more realistic treatment for the initial saturation scale in the target nucleus with the Monte-Carlo (MC) Glauber approach. Within the MC-Glauber approach, we can take into account the initial fluctuation of nucleon distribution and discuss event activity dependence of heavy quark production in pA collisions.

In a series of our papers [1,2,3], we have computed heavy quark production in pA collisions in the CGC framework. Essentially, our calculations have been based on the CGC framework at leading order (LO) with the running coupling Balitsky-Kovchegov equation (rcBK) which includes a subset of next-to-leading order (NLO) correction. A main difference between pp and pA collisions is the choice of the initial saturation scale in the rcBK equation.

We update the evaluation of the nuclear modification factors of $J/\psi$, $D$ meson productions (Refs. [1,2]) by varying the initial saturation scale more systematically and also by extending the calculation with the MC-Glauber implementation. We find that the $R_{pA}$ is quite sensitive to the initial saturation scale for nucleus. In Ref. [3], we have computed heavy flavor decay leptons $l$, which should be compared with the new experimental data.

In this talk, we will first review our previous results and then report our update for $J/\psi$, $D$, and $l$ productions in pA collisions at the LHC energy.

Refs:

Preferred Track
Open Heavy Flavors

Collaboration
Not applicable

Primary author: WATANABE, Kazuhiro (ODU/JLab)
Presenter: WATANABE, Kazuhiro (ODU/JLab)
Session Classification: Poster Session
A new relativistic viscous hydrodynamics code and its application to the Kelvin-Helmholtz instability in high-energy heavy-ion collisions

Relativistic hydrodynamic simulations play a key role in exploring the QGP bulk property and the QCD phase transition from analyses of high-energy heavy-ion collisions at RHIC and LHC. From the intensive study based on relativistic viscous hydrodynamic models with event-by-event initial fluctuations, we can extract detailed information of the bulk feature of the QGP such as transport coefficients and the QCD equations of states. In the quantitative analyses of the QGP property, high-precision numerical treatment on the hydrodynamic calculation is important.

Recently, we developed a new 3+1 dimensional relativistic viscous hydrodynamics code in Cartesian coordinates. In the algorithm, we use a Riemann solver based on the two-shock approximation which is stable under existence of large shock waves. We extend the algorithm in Cartesian coordinates to that in Milne coordinates so that we can efficiently apply it to the analyses of relativistic heavy-ion collisions. We check the correctness of the numerical algorithm by comparing numerical calculations and analytical solutions in various problems for ideal and viscous fluids. The new numerical scheme is stable even with small numerical viscosity, which is very important to discuss the physical viscosities at RHIC and LHC.

We apply our relativistic viscous hydrodynamics code to the analysis of the Kelvin-Helmholtz instability in high-energy heavy-ion collisions. We find that the evolution of the hydrodynamic instability is sensitive to the values of the viscosities and the accuracy of the numerical calculation. We discuss possible existence of the Kelvin-Helmholtz instability originates from longitudinal fluctuations and effects of shear and bulk viscosities on the evolution of the instability.


Preferred Track
Collective Dynamics

Collaboration
Not applicable

Primary author: OKAMOTO, Kazuhisa (Nagoya University)
Co-authors: NONAKA, Chiho (Nagoya University); Dr AKAMATSU, Yukinao (Osaka University)
Presenter: OKAMOTO, Kazuhisa (Nagoya University)
Session Classification: Poster Session
gluon transport in BAMPS and possible BEC phenomenon

We study the equilibration for gluons far from thermal equilibrium in relativistic kinetic theory with Color Glass Condensate (CGC) inspired initial distribution. Using a partonic cascade approach BAMPS with newly developed stochastic scheme for implementing the quantum statistics, we now simulate here a static gluonic matter with elastic collisions. We show that under such an elastic interaction driven case the possibility for gluons to condensate under over-populated initial condition, the kinetic evolution for gluon BEC growing would be demonstrated. We also will discuss about the turbulent scaling solution for over-populated case, both particle cascade and energy cascade would be analysed.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Other

Primary author: Dr ZHOU, Kai (FIAS, Goethe-University Frankfurt am Main)
Presenter: Dr ZHOU, Kai (FIAS, Goethe-University Frankfurt am Main)
Session Classification: Poster Session
Quarkonium spectral functions and heavy quark diffusion of charm and bottom quarks from lattice QCD at finite temperature

Tuesday, 7 February 2017 17:30 (20 minutes)

Quarkonium spectral functions have all information about in-medium properties of heavy quarkonia such as dissociation temperatures, which are important to understand suppression of quarkonium yields in relativistic heavy ion collision experiments at RHIC and LHC, where many interesting results on $J/\psi$ and $\Upsilon$ suppression have been reported already. Since quarkonium suppression can occur through complicated processes not only related to the medium effect but also any other ones such as cold nuclear matter effects, good theoretical understanding of quarkonium behavior in the hot medium is required. Low frequency behavior of the quarkonium spectral functions for the vector channel also tells us transport properties of heavy quarks in quark-gluon plasma, which is important input for hydrodynamic models trying to explain collective phenomena in heavy-ion experiments. Therefore it is important to investigate the quarkonium spectral functions, especially using first-principle lattice QCD calculations.

In this talk we report our recent study on quarkonium spectral functions in lattice QCD at finite temperature. To get correlation functions with high data quality, which is important to extract reliable spectral functions, we performed simulations on very large and fine lattices with a couple of lattice cutoffs towards the continuum limit. Our previous studies on some of these lattices have been reported in [1,2]. At temperatures in a range between $0.75T_c$ and $2.3T_c$ we reconstruct quarkonium spectral functions from temporal Euclidean meson correlators with both charm and bottom quark masses, where to estimate systematic uncertainties we adopt the conventional maximum entropy method as well as two different stochastic methods: one is the stochastic analytical inference based on the Bayes’ theorem and the other is the stochastic optimization method, which does not rely on any prior information (see our preliminary works in [3,4]). We discuss dissociation of quarkonium states from temperature and quark mass dependence of the spectral functions. We also estimate the heavy quark diffusion coefficient using low-frequency behavior of the spectral functions for the vector channel.


Preferred Track
Quarkonia

Collaboration
Not applicable

Primary author: Dr OHNO, Hiroshi (Center for Computational Sciences, University of Tsukuba)
Presenter: Dr OHNO, Hiroshi (Center for Computational Sciences, University of Tsukuba)

Session Classification: Parallel Session 4.3: Quarkonia (II)

Track Classification: Quarkonia
Reconstruction of particles produced at different stages of heavy ion collision in the CBM experiment at FAIR

One of the main purposes of the physics program of the future heavy ion experiment CBM (FAIR, Germany) is to understand the properties of strongly interacting matter at very high baryonic densities and to study the possibility of a phase transition to a deconfined and chirally restored phase of quark matter. The experiment will operate at high interaction rates up to 10 MHz, that requires a full event reconstruction in real time.

In order to make an efficient event selection online a clean sample of particles has to be provided by the reconstruction package called First Level Event Selection (FLES). The FLES package operates in two stages. First, particles registered in the CBM detector system are reconstructed. Then short-lived particles decayed before or inside the setup are searched based on their charged and neutral daughter particles. Since the FLES package is developed to run on many-core computer architectures, the reconstruction of particles is done in parallel that provides a possibility for a global competition between particle candidates. Such a global event topology reconstruction significantly improves suppression of a combinatorial background and provides for further physics analysis a very clean sample of particles produced at different stages of heavy ion collision.

The global event topology reconstruction procedure and the results of its application to simulated collisions in the CBM detector setup are presented and discussed in details.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

Other

Primary author: Prof. KISEL, Ivan (Goethe University Frankfurt, FIAS)

Co-authors: Dr. VASSILIEV, Iouri (GSI Helmholtz Centre for Heavy Ion Research); Dr. ZYZAK, Maksym (GSI Helmholtz Centre for Heavy Ion Research)

Presenter: Prof. KISEL, Ivan (Goethe University Frankfurt, FIAS)

Session Classification: Poster Session
A Novel Semi-Analytic Color Glass Event Generator

The Color Glass Condensate (CGC) formalism with event-by-event fluctuations in the transverse plane, when coupled to viscous relativistic hydrodynamics (e.g. IP Glasma+MUSIC), has led to excellent quantitative agreement with a large number of data sets from high energy nuclear collisions. Recently, some of us have worked out analytic expressions for event-averaged quantities in the CGC formalism based on a near field approximation [Phys. Rev. C 92, 064912 (2015)]. Unlike numerical solutions, the analytic approach provides an intuitive picture of the classical gluon field, and its energy momentum tensor, at the earliest times (tau < 1/Qs). Here we use our previous work as the basis for the construction of an event generator that can provide a dynamical evolution of the system at early times. We calculate the time-evolution of the field strength tensor and the energy momentum tensor event-by-event in full SU(3). Using the previously established analytic methods makes the event generator fast and well controlled. It also makes it easy to single out non-abelian effects in the time evolution and to study them separately. We discuss our method step-by-step and show first results.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: ROSE, Steven (Texas A&M University)
Presenter: ROSE, Steven (Texas A&M University)
Session Classification: Poster Session
Probing jet decoherence in heavy ion collisions

Wednesday, 8 February 2017 11:40 (20 minutes)

A key feature of jet fragmentation in vacuum is colour coherence, which leads to angular ordering of the shower. Recent works have pointed out the importance of colour coherence for jets passing through QCD matter. The results are indicative of a reorganisation of the jet fragmentation in terms of resolved subjets each of which are affected independently by energy loss in the medium. We study this picture in detail for groomed jets in heavy-ion collisions using the "soft drop" procedure which singles out two hard jet substructures. As a direct measurement of colour (de)coherence, we show how wide-angle structures should be strongly suppressed compared to narrow ones. We also discuss the sizeable effects of colour (de)coherence on inclusive as well as jet substructure observables.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary authors: Dr TYWONIUK, Konrad (CERN); Prof. MEHTAR-TANI, Yacine (INT, University of Washington)

Presenter: Prof. MEHTAR-TANI, Yacine (INT, University of Washington)

Session Classification: Parallel Session 6.4: Jets and High pT Hadrons (V)

Track Classification: Jets and High pT Hadrons
The CBM Time-of-Flight system

The CBM experiment aims at exploring the QCD phase diagram at large baryon densities in the beam energy range from 2 A GeV to 11 (35) A GeV at the SIS100 (SIS300) accelerator of FAIR/GSI. For charged particle identification that is required by many observables that are sensitive to the phase structure like collective flow, phase space population of rare hyperons, fluctuations of conserved quantities, ... a high performance Time-of-Flight (TOF) wall with a granularity of about 100,000 channels and a system timing resolution of better than 80 ps is being built. Part of the wall (~ 10,000 channels) will be installed in the forward hemisphere (1.5 < eta < 1.0) of the STAR experiment at RHIC/BNL during the beam energy scan (BES II) campaign planned for 2019/2020. The performance of the detector system as well as the physics reach will be discussed.

Preferred Track

Future Experimental Facilities, Upgrades, and Instrumentation

Collaboration

Other

Primary author: DEPPNER, Ingo-Martin (Physikalisches Institut der Universität Heidelberg)
Presenter: DEPPNER, Ingo-Martin (Physikalisches Institut der Universität Heidelberg)
Session Classification: Poster Session
The origin of the modification of the $z_g$ distribution in AA collisions

Tuesday, 7 February 2017 14:40 (20 minutes)

The measurement of jet substructure provides important detailed information on the dynamics of the jet-QGP interaction. However, our ability to reliably extract such information is contingent on understanding the sensitivity of any given substructure observable to specific features of in-medium jet dynamics. Monte Carlo event generators with transparent physics content and that have been validated for a wide set of observables, e.g. JEWEL, are powerful tools to establish the sensitivity of observables to specifics of jet-QGP interaction. Using the generic procedure we put forward in Eur.Phys.J. C76 (2016) no.5, 288 (arXiv:1512.08107 [hep-ph]) — where we applied it to establish the origin of the excess dijet asymmetry observed in AA collisions as due to fluctuations of the jet fragmentation pattern rather than, as widely believed in the community, to the difference in the amount of matter traversed by the two jets in the pair — we examine the $z_g$ substructure observable recently measured by CMS and STAR. We find straightforward interpretations of the $z_g$ measurement as indicating a QGP-induced modification of the QCD splitting function to be over-simplistic and confounded by the observable sensitivity to fluctuations of the jet-medium interaction pattern. We propose several complementary measurements that can further elucidate the potential of this, and related observables, to give information on in-medium jet dynamics.

Preferred Track

Jets and High pT Hadrons

Collaboration

Not applicable

Primary author: TEIXEIRA DE ALMEIDA MILHANO, Guilherme (Instituto Superior Tecnico (PT))

Presenter: TEIXEIRA DE ALMEIDA MILHANO, Guilherme (Instituto Superior Tecnico (PT))

Session Classification: Parallel Session 3.4: Jets and High pT Hadrons (III)

Track Classification: Jets and High pT Hadrons
Distributions of harmonic flow coefficients and sensitivity to granularity scale

The $v_n$ distributions measured by ATLAS and ALICE may be used to rule out initial condition models. So far few models (IP-Glasma and EKRT) have been able to pass this test. An interesting question is whether the size of the fluctuations plays a part. In a recent paper [J. Noronha-Hostler, J. Noronha, M. Gyulassy Phys. Rev. C 93, 024909 (2016)], it was shown that event-averaged quantities such as $v_n(p_T)$ and $v_n$ exhibit little dependence on the energy scale granularity. Here it is shown that this also applies on an event-by-event basis. Results for a third model, NeXus, leading to good results for the $v_n$ distributions are also shown.

Preferred Track
Collective Dynamics

Collaboration
Not applicable

Primary author: GRASSI, Frederique
Co-authors: Dr GARDIM, Fernando (Federal University of Alfenas); Dr NORONHA-HOSTLER, Jacquelyn (University of Houston); LUZUM, Matthew (Universidade de São Paulo)
Presenter: GRASSI, Frederique
Session Classification: Poster Session
Partial Thermalization of Long Range Correlations in Nuclear Collisions

Is thermalization necessary for hydrodynamic flow in nuclear collisions? The discovery of flow-like azimuthal correlations in pA and high-multiplicity pp collisions raises profound questions about the onset of collective flow and its relation to hydrodynamics. We seek independent experimental information on the degree of thermalization in order to identify those truly hydrodynamic collision systems in which flow is sensitive to equilibrium QCD properties.

We aim to develop a protocol for identifying the degree of thermalization using a combination of momentum and multiplicity correlation observables. To study the effect of thermalization on these correlations, we turn to the Boltzmann equation in the relaxation time approximation with Langevin noise. We derive a new nonequilibrium transport equation for the two-body distribution function that is consistent with the conservation laws obeyed by microscopic scattering processes. We find that these conservation laws constrain the long-range behavior of the correlation observables to behave differently depending on the degree of thermalization. We find that transverse momentum fluctuations in peripheral PbPb collisions at LHC markedly deviate from equilibrium behavior. We propose new measurements that can provide more refined information.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: GAVIN, Sean (Wayne State University)
Presenter: GAVIN, Sean (Wayne State University)
Session Classification: Poster Session
The thermal suppression of heavy quark bound states represents an ideal observable for determining if one has produced a quark gluon plasma in ultrarelativistic heavy-ion collisions. In recent years, however, a paradigm shift has taken place in the theory of quarkonium suppression due to new first principles calculations of the thermal widths of these states. These thermal widths are large, e.g. O(20-100 MeV) for the Upsilon, and cause in-medium suppression of the states at temperatures below their traditionally defined dissociation temperatures. In order to apply the newly developed understanding to phenomenology, however, one must make detailed 3+1d dissipative hydrodynamical models of the plasma including the effects of finite shear viscosity. These effects include not only the modification of the time evolution of the temperature of the system, flow, etc., but also the emergence of potentially large local momentum-space anisotropies which can affect the in-medium properties of the states. I will discuss the setup for these model calculations and present comparisons of theory with data from RHIC 200 GeV/nucleon Au-Au collisions, LHC 2.76 TeV/nucleon Pb-Pb, and LHC 5.023 TeV/nucleon Pb-Pb collisions as a function of number of participants, rapidity, and transverse momentum.
Strange Hadrons Spectra and Directed Flow in STAR Fixed target Experiment

Some QGP signatures, such as number-of-constituent-quark scaling of $v_2$, can be seen to persist down to $\sqrt{s_{NN}} = 7.7$ GeV, while others, such as suppression $R_{CP}$, show a turn-off behavior at low beam energies. Fixed target collisions in STAR allow the center-of-mass energy to go as low as 4.5 GeV. This would provide an opportunity to measure such signatures down to an energy range that can serve as a clean "control" energy in which only a pure hadron gas is expected. In this poster we will present directed flow of strange hadrons $K_S^0$ and $\Lambda$ and their comparison with model calculations (RQMD, UrQMD, AMPT, QGSM with parton recombination, and a hydrodynamics model with a tilted source). Furthermore, we will present spectra of strange hadrons $K_S^0$, $\Lambda$, and $\Xi$.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

STAR

Primary author: Dr TLUSTY, David (Rice University)
Presenter: Dr TLUSTY, David (Rice University)
Session Classification: Poster Session
AdS/CFT predictions for partonic and fragmented momentum, azimuthal, and rapidity correlations of heavy flavors in heavy ion collisions

We compute the suppression, angular, and rapidity distribution of single open heavy flavor and the momentum, angular, and rapidity correlations for pairs of open heavy flavor at RHIC and LHC from an AdS/CFT-based energy loss model. We quantitatively compare these strongly-coupled QGP predictions to the weakly-coupled QGP predictions of Nahrgang et al., PRC90 (2014) [arXiv:1305.3823]. In the strong-coupling energy loss model, we include both the mean energy loss and thermal fluctuations; in the weak-coupling energy loss model, one set of predictions corresponds to the inclusion of purely collisional processes while the other additionally incorporates radiative corrections.

When restricted to leading order production processes, we find that the strongly coupled correlations of high transverse momentum pairs (> 4 GeV) are broadened less efficiently than the corresponding weak coupling based correlations, while low transverse momentum pairs (1 – 4 GeV) are broadened with similar efficiency, but with an order of magnitude more particles ending up in this momentum class. The strong coupling momentum correlations we compute account for initial correlations and reveal that the particle pairs suppressed from initially high momenta to the low momentum domain do not suffice to explain the stark difference to the weak coupling results in momentum correlations for 1 – 4 GeV. From this, we conclude that heavy quark pairs are more likely to stay correlated in momentum when propagating through a strongly coupled plasma than a weakly coupled one.

When initialised at next-to-leading order (aMC@NLO with Herwig++), we observe significant additional broadening of azimuthal correlations, with the angular correlations of low momentum pairs (1 – 4 GeV) essentially washed. However, the momentum correlations remain even when NLO production mechanisms are included. Thus, our conclusion for differences in momentum correlations with leading order production processes should carry over to next-to-leading order production processes once comparable predictions for a weakly-coupled QGP emerge.

Preferred Track
Open Heavy Flavors

Collaboration
Not applicable

Primary author: HAMBROCK, Robert (University of Cape Town)
Presenter: HAMBROCK, Robert (University of Cape Town)
Session Classification: Poster Session
Dynamical evolution of critical fluctuation and its observation

We study the time evolution of conserved-charge fluctuations near the QCD critical point and show how the existence of the critical point is observed in experimental measurements of fluctuation observables in heavy ion collisions.

The soft mode of the QCD critical point should obey a diffusion equation because it is a linear combination of the chiral condensate and conserved densities, i.e., baryon number density and energy density. The baryon fluctuation can represent the critical dynamics, while the chiral fluctuation mode is a slave mode of the conserved densities.

We propose a stochastic diffusion equation in the rapidity space with critical nature being encoded in the time-dependent diffusion coefficient and baryon number susceptibility. We find a novel non-monotonic dependence of the critical fluctuation observables on the rapidity cuts, depending on the approach to the critical point during the time evolution. We show that the effect of critical dynamics could be sustainable as a non-monotonic behavior as the rapidity-window dependence of conserved-charge cumulants at the kinetic freeze-out. We emphasize this rapidity-window dependence as a unique and robust signal for the critical point search in experiments.

Preferred Track
Correlations and Fluctuations

Collaboration
Not applicable

Primary author: SAKAIDA, Miki (Osaka University)
Presenter: SAKAIDA, Miki (Osaka University)
Session Classification: Poster Session
Hydrodynamics with critical slowing down

Wednesday, 8 February 2017 11:40 (20 minutes)

We extend hydrodynamics of a fluid with conserved charge to incorporate the phenomenon of critical slowing down – an essential ingredient for describing the dynamics of QCD matter near the critical point. We develop the general formalism of hydrodynamics with additional critically slow mode extending the validity of hydrodynamics in critical regime. As an application we consider a simple Bjorken model of heavy-ion collision near the critical point.

Preferred Track
New Theoretical Developments

Collaboration
BEST

Primary authors: STEPHANOV, Misha (UIC); Dr YIN, Yi (MIT)
Presenter: STEPHANOV, Misha (UIC)
Session Classification: Parallel Session 6.3: New Theoretical Developments (II)
Track Classification: New Theoretical Developments
Formation of a transient Bose-Einstein condensate in the strong coupling regime

In relativistic heavy-ion collisions, the initial state of the matter formed after the collision can be overpopulated due to the gluon saturation. Recent simulations based on the kinetic theory or the classical statistical approach suggest that the Bose-Einstein condensate is created at a transient stage of the dynamics. While these results make sense for weakly interacting systems, the gauge coupling constant is no longer small for the realistic heavy-ion collisions. Therefore, it is interesting to explore the dynamics of the overpopulated system in a strong coupling regime.

In this study, we investigate the far-from-equilibrium dynamics of strongly interacting systems based on the two-particle irreducible formalism. As a first step, we consider the time evolution of the particle distribution function of the $O(N)$-symmetric scalar field theory within the next-leading order approximation of the $1/N$-expansion.

When the initial state is underpopulated, we found that the distribution function approaches toward the Bose-Einstein (BE) distribution with negative chemical potential before it converges to the BE distribution with zero chemical potential. In contrast to the underpopulated case, overpopulated distributions lead to the condensation of soft modes on top of the Bose-Einstein distribution with positive chemical potential.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: TSUTSUI, Shoichiro (Kyoto University)

Presenter: TSUTSUI, Shoichiro (Kyoto University)

Session Classification: Poster Session
Phase Transitions in Dense Matter

Tuesday, 7 February 2017 16:30 (20 minutes)

As the density of matter increases, atomic nuclei disintegrate into nucleons and, eventually, the nucleons themselves disintegrate into quarks. The phase transitions (PTs) between these phases can vary from steep first order phase transitions to smooth crossovers, depending on certain conditions. First order phase transitions with more than one globally conserved charge, so-called non-congruent PTs, have characteristic differences compared to congruent PTs (e.g., dimensionality of phase diagrams, location and properties of critical points). I investigate the non-congruence of the quark deconfinement PT at high densities and/or temperatures in Coulomb-less models, relevant for heavy ion collisions, neutron stars, proto-neutron stars, supernova explosions and compact star mergers.

Preferred Track

Baryon-Rich QCD Matter and Astrophysics

Collaboration

Not applicable

Primary authors: DEXHEIMER, Veronica (Kent State University); DEXHEIMER, Verônica (Kent State University)

Presenters: DEXHEIMER, Veronica (Kent State University); DEXHEIMER, Verônica (Kent State University)

Session Classification: Parallel Session 4.1: Baryon-Rich QCD Matter and Astrophysics (I)

Track Classification: Baryon-Rich QCD Matter and Astrophysics
A Viscous Blast Wave Model And A Complementary Extraction of Shear Viscosity From Data

We construct a blast wave model with viscous corrections by calculating the viscous stress tensor from the parameterized flow field in the Navier Stokes approximation. We then use statistical Bayesian analysis tools to extract the shear viscosity over entropy ratio at the kinetic freeze-out temperature $T=T_{fo}$ from experimental data. Note that this approach is complementary to the existing extractions from viscous hydrodynamics. While the latter conflates the effects of shear viscosity on freeze-out and on the time evolution of the flow field, and is sensitive to an averaged shear viscosity during that time evolution, our analysis is only sensitive to the shear viscosity at freeze-out and represents its value at the corresponding temperature. Interestingly we find rather small values for the shear viscosity over entropy ratio.

Preferred Track

Initial State Physics and Approach to Equilibrium

Collaboration

Not applicable

Primary author: Mr YANG, Zhidong (Texas A&M University)
Presenter: Mr YANG, Zhidong (Texas A&M University)
Session Classification: Poster Session
Phenomenological QCD equations of state for neutron star mergers and supernovae

*Wednesday, 8 February 2017 17:30 (20 minutes)*

We study neutron star matter equations of state at finite temperature for neutron star mergers and supernovae, including not only thermal quark fluctuations but also the Nambu-Goldstone modes. Our description is based on 3-window modeling in which nuclear matter at $n_B < 2n_0$ ($n_B$: baryon density, $n_0$: saturation density) is smoothly connected to strongly correlated quark matter at $n_B > 5n_0$. Our quark matter at zero temperature is in the color-flavor-locked (CFL) phase with the gap of 100-200 MeV. The latter is significantly constrained by the two-solar mass constraint. Applying a schematic quark model for the $n_B > 5n_0$ domain, we constrain the possible range of the model parameters, and then use them to calculate various quantities of NG modes. Our predictions differ from the weak coupling results for the CFL because we are treating the strongly correlated domain. The resulting equations of state are like neither gapless quark nor nuclear equations of state, due to different temperature dependence of thermal contributions. The difference affects the pattern of gravitational wave signals.

**Preferred Track**

Baryon-Rich QCD Matter and Astrophysics

**Collaboration**

Not applicable

**Primary author:** Prof. KOJO, Toru (Central China Normal University)

**Presenter:** Prof. KOJO, Toru (Central China Normal University)

**Session Classification:** Parallel Session 8.1: Baryon-Rich QCD Matter and Astrophysics (III)

**Track Classification:** Baryon-Rich QCD Matter and Astrophysics
Complexification approach to the sign problem in chiral models

Field-complexification approaches to the sign problems in chiral models at finite chemical potential are examined analytically and numerically.

We apply the thimble integration method to the 1-dimensional Thirring model at finite chemical potential to show that the multi-thimble contributions with alternating signs are important to reproduce the crossover behavior. We also use the complex Langevin method to the same model with a modified sampling, which correctly reproduces the crossover behavior in the relevant chemical potential region.

We will also examine these complexification approaches to the chiral random model at finite temperature and chemical potential to see if the correct phase diagram can be predicted in these approaches.


Preferred Track

New Theoretical Developments

Collaboration

Not applicable

Primary author:  Prof. FUJII, Hirotsugu (University of Tokyo)
Presenter:  Prof. FUJII, Hirotsugu (University of Tokyo)
Session Classification:  Poster Session
The second phase of the Beam Energy Scan at RHIC, BES-II, is scheduled for 2019-2020 and will explore with precision measurements the high baryon density region of the QCD phase diagram. The program will examine the energy regime of interest determined from the results of BES-I. Some of the key measurements anticipated are: the kurtosis of net-protons that could pinpoint the position of a critical point, the directed flow of baryons vs. energy that might prove a softening of the EOS, and the chiral restoration in the dilepton channel. The measurements will be possible with the order of magnitude better statistics provided by the electron cooling upgrade of RHIC and with the detector upgrades planned to extend STAR’s experimental reach. The upgrades are: the replacement of the inner TPC sectors (iTPC) that increases the rapidity coverage of identified particles, the Event Plane Detector (EPD) that improves the triggering and event plane resolution, and the end-cap TOF (eTOF) that extends the PID capabilities to larger rapidities in one hemisphere of STAR. The talk will highlight the physics opportunities enabled by these upgrades.
Dynamics in Phases of QCD

Sunday, 5 February 2017 09:00 (1h 15m)

Preferred Track

Collaboration

Primary author: PRATT, Scott (Michigan State University)
Presenter: PRATT, Scott (Michigan State University)
Session Classification: Student Day
Lattice QCD

Sunday, 5 February 2017 10:15 (45 minutes)

Preferred Track

Collaboration

**Primary author:** BAZAVOV, Alexei (Michigan State University)

**Presenter:** BAZAVOV, Alexei (Michigan State University)

**Session Classification:** Student Day
Probes of the anomalous chiral effects

Sunday, 5 February 2017 11:30 (45 minutes)

Preferred Track

Collaboration

Primary authors:  VOLOSHIN, Sergei (Wayne State University); VOLOSHIN, Sergey (Wayne State University (US))

Presenters:  VOLOSHIN, Sergei (Wayne State University); VOLOSHIN, Sergey (Wayne State University (US))

Session Classification:  Student Day
Electroweak probes

Sunday, 5 February 2017 12:15 (45 minutes)

Preferred Track

Collaboration

Primary author: STEINBERG, Peter Alan (Brookhaven National Laboratory (US))
Presenter: STEINBERG, Peter Alan (Brookhaven National Laboratory (US))
Session Classification: Student Day
Jets in Heavy Ion collisions: experiment

*Sunday, 5 February 2017 15:00 (45 minutes)*

**Preferred Track**

**Collaboration**

**Primary authors:** ROLAND, Gunther (Massachusetts Inst. of Technology (US)); ROLAND, Gunther (MIT)

**Presenters:** ROLAND, Gunther (Massachusetts Inst. of Technology (US)); ROLAND, Gunther (MIT)

**Session Classification:** Student Day
Jets in Heavy Ion collisions: theory

Sunday, 5 February 2017 15:45 (45 minutes)

Preferred Track

Collaboration

**Primary author:** JEON, Sangyong (McGill University)

**Presenter:** JEON, Sangyong (McGill University)

**Session Classification:** Student Day
Electron Ion Collider Physics

Sunday, 5 February 2017 17:00 (45 minutes)

Preferred Track

Collaboration

Primary author: AIDALA, Christine
Presenter: AIDALA, Christine
Session Classification: Student Day
Q&A

Sunday, 5 February 2017 17:45 (45 minutes)

Preferred Track

Collaboration

Session Classification: Student Day
D meson $v_n$ harmonics in PbPb collisions at 5.02 TeV with CMS

Because of their large mass, heavy quarks are produced primarily at early stages of heavy-ion collisions, and therefore experience the full evolution of the system and carry information about the extent of thermalization of the QGP. Azimuthal anisotropy parameters ($v_n$) of charm and bottom hadrons provide unique information about the path length dependent interactions between heavy quarks and the medium. At low $p_T$, the extent to which heavy quarks flow with the medium is a good measure of the interaction strength. At high $p_T$, the $v_2$ and $v_3$ values resulting from path length dependent energy loss mechanisms provide a powerful tool to study these mechanisms with respect to heavy quarks. With the large PbPb data sample at $\sqrt{s_{NN}} = 5.02$ TeV collected by the CMS detector during the 2015 LHC run, azimuthal anisotropy $v_2$ and $v_3$ coefficients of $D^0$ mesons are measured over a wide $p_T$ range and at different centralities. In this talk, results of $D^0$ meson $v_n$ parameters are presented and compared to the charged hadron $v_n$ results at the same energy and to theoretical calculations.

Preferred Track

Open Heavy Flavors

Collaboration

CMS

Primary author: QIU, Hao (Purdue University (US))

Presenter: QIU, Hao (Purdue University (US))

Session Classification: Poster Session
Statistical approach for the calculation for upper limit of $\Upsilon(3S)$ yield

The Compact Muon Solenoid (CMS) observed the strong suppression of excited bottomonia states $\Upsilon(2S)$ and $\Upsilon(3S)$ in PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. The analysis was done by comparing the excited state yield to the ground state yield, and then comparing the results in PbPb and pp. For $\Upsilon(2S)$ state of the 0-5% centrality and $\Upsilon(3S)$ states of minimum bias collisions, the yields were statistically consistent to zero, which leaves the possibility of complete dissociation of loosely bound states by the Quark Gluon Plasma. Therefore the upper limits of the yields are extracted in 68% and 95% confidence level using Feldman-Cousins method. The kinematic range of $\Upsilon$ states covered in this analysis is $|y| < 2.4$ for rapidity $0 < p_T < 30$ GeV/c for transverse momentum.

Preferred Track
Quarkonia

Collaboration
CMS

Primary author:  PARK, Jaebeom (Korea University (KR))
Presenter:  PARK, Jaebeom (Korea University (KR))
Session Classification:  Poster Session
Smashing Matters: Behind the Science Scene

Wednesday, 8 February 2017 18:30 (30 minutes)

Ágnes Mócsy is a theoretical physicist and professor of physics and astronomy at Pratt Institute, Brooklyn, NY. “Smashing Matters: Behind the Science Scene” is her first documentary film, looking behind the scenes of the build up of big science discussed at Quark Matter, revealing relationships, friendships, mentorships that develop as essential parts in the lives of scientists in the high intensity pursuit of their passion. The screening of the 30 min film is followed by a short Q&A.

Presenter: MOCSY, Agnes (Pratt Institute)

Session Classification: Documentary: “Smashing Matters: Behind the Science Scene”
Production of $\Sigma(1385)\pm$ and $\Xi(1530)^0$ measured by ALICE in pp, p–Pb and Pb–Pb collisions at the LHC

Saturday, 11 February 2017 10:00 (5 minutes)

The measurement of resonances in ultra-relativistic heavy-ion collisions allows one to study the properties of the hadronic medium. Resonances with short lifetimes compared to the duration of the hadronic phase are good candidates to probe the interplay of particle re-scattering and regeneration in the hadronic phase, which result in a modification of the measured yield of resonances. Measurements of $\Sigma(1385)\pm$ and $\Xi(1530)^0$ have been performed with the ALICE detector at the LHC in pp, p–Pb and Pb–Pb collisions at different energies. We report on the transverse momentum ($p_T$) spectra, their mean values and yields as a function of the event multiplicity. The $p_T$-integrated yield ratios of excited to ground-state hyperons and to pions are discussed as a function of the mean charged-particle multiplicity densities and compared with models.

Preferred Track

Collaboration

Primary authors:  SONG, Jihye (Department of Physics-Pusan University); SONG, Jihye (Pusan National University (KR))

Presenters:  SONG, Jihye (Department of Physics-Pusan University); SONG, Jihye (Pusan National University (KR))

Session Classification:  Flash talks
Measurement of the longitudinal decorrelation of event-plane angle and flow magnitudes in 2.76 and 5.02 TeV Pb+Pb collisions with the ATLAS detector

Saturday, 11 February 2017 10:05 (5 minutes)

Longitudinal dynamics has recently become a topic of great interest in the study of ultra-relativistic heavy ion collisions. Measurement of the longitudinal fluctuations of the flow harmonic coefficients $v_n$ and event-plane angles $\Psi_n$ can provide a more complete picture of space-time evolution of the hot, dense medium formed in heavy ion collisions. Longitudinal flow decorrelations can be modeled with two contributions: magnitude fluctuations and event plane twist. However, existing observables do not separate these two effects. In this analysis, a new 4-particle correlator is used to separate the event-plane twist from magnitude fluctuations in 2.76 and 5.02 Pb+Pb collisions. Results show both effects have a linear dependence on pseudorapidity separation for $v_{2-5}$, and show a small but measurable variation with collision energy. The correlation of $\Psi_n$ of different order are also expected to have longitudinal fluctuations due to the non-linear mixing effects between lower and higher order flow harmonics. First measurement of such non-linear mode-mixing effects as a function of pseudorapidity is also presented. These result will help to constrain initial conditions along longitudinal direction and also help understand the longitudinal evolution of the fireball.

Preferred Track

Collaboration

Primary author: HUO, Peng (State University of New York (US))

Presenter: HUO, Peng (State University of New York (US))

Session Classification: Flash talks
B meson nuclear modification factor in PbPb at 5.02 TeV with CMS

Saturday, 11 February 2017 10:10 (5 minutes)

The study of beauty production in heavy-ion collisions is considered one of the key measurements to address the flavour-dependence of in-medium energy loss in PbPb collisions. In pPb collisions, studies of b-quark production can also provide insights into the relevance of cold nuclear matter effects in the heavy-flavour sector. The CMS experiment has excellent capabilities for measuring b-quark production thanks to the excellent performances of its muon and tracker system. In this talk, we will present the measurement of nuclear modification factors for fully reconstructed B mesons in pPb, and for the first time, pp and PbPb collisions at 5.02 TeV, as a function of transverse momentum.

Preferred Track

Collaboration

**Primary author:**  INNOCENTI, Gian Michele (Massachusetts Inst. of Technology (US))

**Presenter:**  INNOCENTI, Gian Michele (Massachusetts Inst. of Technology (US))

**Session Classification:**  Flash talks
Azimuthal anisotropies of particle production in high energy heavy ion collisions have proven to be an excellent tool for investigating the initial geometry and the bulk properties of the Quark Gluon Plasma (QGP). Azimuthal anisotropy, measured through Fourier coefficients $v_n$, have been measured at mid-rapidity and are used to constrain the initial geometry and viscosity-over-entropy ratio $\eta/s$ of the QGP. Although there are many experimental observables and theoretical models, there are still uncertainties of the initial geometry and the $\eta/s$. Measurements of $v_n$ at forward/backward rapidity provide further insight into initial geometry. It is interesting to measure the $v_n$ coefficients at forward/backward rapidity in Cu+Au collisions, because of the asymmetry in number of participants and geometry in forward and backward direction. In this poster, we will present our work to measure forward/backward asymmetry of $v_n$ coefficients at pseudorapidity $3<|\eta|<4$ in Cu+Au collisions in comparison to results from Au+Au and Cu+Cu collisions.

Preferred Track

Collaboration

**Primary authors:** NAKAGOMI, Hiroshi (Tsukuba University); Mr NAKAGOMI, Hiroshi (Tsukuba University)

**Presenters:** NAKAGOMI, Hiroshi (Tsukuba University); Mr NAKAGOMI, Hiroshi (Tsukuba University)

**Session Classification:** Flash talks
Charm quarks, predominantly produced in the early stage of heavy-ion collisions, are believed to provide unique information on the hot and dense medium created in such collisions. At RHIC, an enhancement in baryon-to-meson ratios for light hadrons and hadrons containing strange quarks has been observed in central heavy-ion collisions compared to p+p and peripheral heavy-ion collisions in the intermediate $p_T$ range ($2 < p_T < 6$ GeV/c). This was explained by the hadronization mechanism involving multi-parton coalescence. $\Lambda_c^+$ is the lightest charmed baryon with the mass close to $D_0$ meson, and it has an extremely short life time ($\tau_c \sim 60 \mu m$). Different models predict different levels of enhancement in the $\Lambda_c^+/D^0$ ratio depending on the degree of charm quark thermalization in the medium and how the coalescence mechanism is implemented.

In this poster, we will report the first measurement of $\Lambda_c^+$ production in heavy-ion collisions using the recently installed Heavy Flavor Tracker at STAR. $\Lambda_c^+$ are reconstructed through the hadronic decay channel ($\Lambda_c^+ \to pK\pi$) using topological cuts optimized by the Toolkit for Multivariate Data Analysis (TMVA). After correcting for the reconstruction efficiency and acceptance, the transverse-momentum spectrum of $\Lambda_c^+$ in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV will be presented. The measured $\Lambda_c^+/D^0$ ratio will be compared with different model calculations, and the physics implications will be discussed.

Preferred Track

Collaboration

**Presenter:** XIE, Guannan (LBNL/USTC)

**Session Classification:** Flash talks
In-Medium Bottomonium Production in Heavy-Ion Collisions

Saturday, 11 February 2017 10:25 (5 minutes)

We study bottomonium production at RHIC and the LHC using a transport model including both suppression and regeneration mechanisms. The transport model utilizes a kinetic rate equation\(^1\) to calculate the centrality dependence of the production yields, and a Boltzmann equation for transverse-momentum ($p_T$) spectra. It has been successful in describing and predicting charmonium data at SPS, RHIC and the LHC. The bottomonium dissociation rates are improved over previous work\(^2\) by using in-medium binding energies from an in-medium T-matrix approach, which, in turn, require to account for both gluo-dissociation (dominant for large binding) and inelastic parton-induced break-up (dominant for weak binding) including interference effects\(^3\). We also update the equation of state for the bulk medium using lattice-QCD results. For the calculation of the $p_T$-spectra and elliptic flow of the regeneration contribution we use a coalescence model\(^4\) where the input bottom-quark spectra are taken from Langevin transport simulations of bottom quarks\(^5\) to account for their non-equilibrium distributions. We then conduct a systematic analysis of bottomonium observables for the nuclear modification factor as a function of $N_{\text{part}}$ and $p_T$ in comparison to ALICE, CMS and STAR data. The comparison suggests that the centrality dependence of the total yields is sensitive to different scenarios for the screening of binding energies. The off-equilibrium bottom-quark spectra are found to play an important role in both the bottomonium $p_T$-spectra and their predicted elliptic, which helps to disentangle the role of regeneration contributions.

Reference:

1. X. Du, R. Rapp, J. Fox and M. He, in preparation
In this talk, based on arXiv:1605.09176, we present a microscopic realization of the hollowness effect observed in proton-proton scattering at $\sqrt{s} = 7$ TeV. The initial collision geometry proposed in our model could impact significantly the interpretation of data specially sensitive to it, like the eccentricities of proton-proton, proton-nucleus and nucleus-nucleus collisions.

The hollowness effect, not observed at lower energies, consists in a depletion of the inelasticity density at zero impact parameter of the collision. Counterintuitively, there is more inelasticity when the two protons are at about half a fermi transverse separation that for head-on collisions. Our analysis is based on three main ingredients: we rely gluonic hot spots inside the proton as effective degrees of freedom for the description of the scattering process. Next we assume that some non-trivial correlation between the transverse positions of the hot spots inside the proton exists. Finally we build the scattering amplitude from a multiple scattering, Glauber-like series of collisions between hot spots. In our approach, the onset of the hollowness effect is naturally explained as due to the diffusion or growth of the hot spots in the transverse plane with increasing collision energy. Furthermore, we will explore the impact of the non-trivial correlations between the transverse positions of the hot spots in the calculation of eccentricities in proton-proton collisions, a highly debated topic nowadays as there are suggestive signals of collective phenomena, associated to the formation of QGP in heavy ion collisions, in this smaller system that may be caused by the initial state geometry.

**Preferred Track**

**Collaboration**

**Primary author:** SOTO ONTOSO, Alba (UGR/FIAS)

**Presenter:** SOTO ONTOSO, Alba (UGR/FIAS)

**Session Classification:** Flash talks
Susceptibilities from a black hole engineered EoS with a critical point

Saturday, 11 February 2017 10:35 (5 minutes)

Currently at the Beam Energy Scan at RHIC experimental efforts are being made to find the QCD critical point. On the theoretical side, the behavior of higher-order susceptibilities of the net-baryon charge from Lattice QCD may allows us to estimate its position via Taylor expansion of the density of states at $\mu_B = 0$. However, even if the series expansion continues to higher-orders, there is always the possibility to miss the critical point behavior due to truncation errors.

An alternative approach to exploring the QCD critical point is using black hole engineering. This method allow us to obtain susceptibilities fitting the lattice data at $\mu_B = 0$ but also can be expanded out to extremely large baryonic chemical potentials as well. Additionally, in the black hole engineered EoS there is a clear critical point at $\mu_B = 725$ MeV and $T = 80$ MeV. In this talk, we obtain the freeze-out line and compare it with the hadron resonance gas model, lattice calculations, and experimental data. We also explore fluctuations at the lowest energies at the beam energy scan to see if there are signatures of the critical point.

Preferred Track

Collaboration

Presenter: PORTILLO, Israel (University of Houston)

Session Classification: Flash talks
None

added for email list

Preferred Track

Collaboration

Presenter: Dr HEINZ, Ulrich (The Ohio State University)
Exotic dibaryons from lattice QCD simulations at the physical point

added for proceedings

Preferred Track

Collaboration

Presenters: HATSUDA, Tetsuo (Unknown); HATSUDA, Tetsuo (RIKEN)
none

added for proceedings

Preferred Track

Collaboration

Presenter: EVDOKIMOV, Olga (University of Illinois at Chicago (US))