

10th International Workshop on Multiple Partonic Interactions at the LHC

Monday 10 December 2018 - Friday 14 December 2018

Auditorium Santa Cecilia , Perugia, Italy



Book of Abstracts

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WG1 / 1

From Underlying Event Sensitive To Insensitive: Factorization and Resummation

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In this talk we will discuss the transverse energy spectrum for the Drell-Yan process. The transverse energy is measured within the central region defined by a (pseudo-) rapidity cutoff. Soft-collinear effective theory (SCET) is used to factorize the cross section and resum large logarithms of the rapidity cutoff and ratios of widely separated scales that appear in the fixed order result. We present a framework which can smoothly interpolate between various regions of the spectrum and eventually match onto the fixed order result. This way a reliable calculation is obtained for the contribution of the initial state radiation to the measurement. By comparing our result for Drell-Yan against Pythia we obtain a simple model that describes the contribution from multiparton interactions (MPI). A model with little or no dependence on the primary process gives results in agreement with the simulation. Based on this observation we propose MPI insensitive measurements. These observables are insensitive to the MPI contributions as implemented in Pythia and we compare against the purely perturbative result obtained with the standard collinear factorization.

Cancelled / 2

Particle multiplicities in the central region of high-energy collisions from k_T -factorization with running coupling corrections

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Horowitz and Kovchegov have derived a k_T -factorization formula for particle production at small x which includes running coupling corrections. We perform a first numerical analysis to confront the theory with data on the energy and centrality dependence of particle multiplicities at midrapidity in high-energy p+A (and A+A) collisions. Moreover, we point out a strikingly different dependence of the multiplicity per participant on N_{part} in p+Pb vs. Pb+Pb collisions at LHC energies, and argue that the observed behavior follows rather naturally from the convolution of the gluon distributions of an asymmetric vs. symmetric projectile and target.

WG6 / 3

Multiple parton interactions and collectivity in the context of a two-component model of hadron production

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A two-component (soft + hard) model (TCM) of hadron production in high-energy nuclear collisions has been applied to p_t spectra, particle densities on η , 2D angular correlations and total yields from p-p, p-A and A-A collisions and provides a self-consistent description of charge-multiplicity and collision-energy dependence for a broad array of data. The TCM provides alternative explanations for some observed data trends such as mean- p_t vs n_{ch} and underlying event (UE) vs jet trigger condition. The TCM appears to be in conflict with hadron production models that assume a single component such as PYTHIA (based on multiple parton interactions or MPIs) or freezeout from a flowing bulk medium characterized as a QGP. TCM results also conflict with recent claims of “collectivity” (flows) in smaller collision systems. In this talk I compare results from the PYTHIA Monte Carlo and the TCM with a view to better understanding some emerging conflicts.

Cancelled / 4

χ_c pair production with large rapidity distance and extra gluon emission

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Recently there has been much interest in the pair production of quarkonia. The production of quarkonium pairs is expected to receive an important contribution from double parton scattering (DPS) processes. There remain a number of open problems, especially with the CMS and ATLAS data. The effective cross sections σ_{eff} found from empirical analyses are about a factor 2.5 smaller than the usually accepted $\sigma_{\text{eff}} = 15 \text{ mb}$. Here we discuss single-parton-scattering mechanisms that can mimic the behavior of DPS induced production. Here especially the production of χ -pairs is important. I will discuss the mechanism χ_c pair production with large rapidity separation. Additionally extra gluon emission as a real high order correction to χ_c pair production is taken into account. Virtual corrections are considered as well. Several distribution for two $\chi_{c0}\chi_{c0}$, $\chi_{c1}\chi_{c1}$, $\chi_{c2}\chi_{c2}$ will be shown.

WG3 / 5

Jet substructure as a tool to study Double parton scatterings in V + jets processes at the LHC

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Double parton scatterings (DPS) provide vital information on the parton-parton correlations and parton distributions in a hadron. DPS also constitutes as a background to new physics searches. The measurement of DPS in Vector Boson (V) + jets processes is important because of clean experimental signature and large production cross-section. The available DPS measurements, with V + jets, are dominated by large contamination from V + jets processes produced with single parton scatterings (SPS). In this talk, the importance of jet substructure, in controlling SPS backgrounds for V + jets DPS processes, will be discussed.

WG3 / 6

Double parton scatterings in associated-quarkonium production

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Recent studies of associated-quarkonium production at the LHC and the Tevatron have pointed at values of σ_{eff} significantly smaller than those extracted from jet-related observables, on the order of 5-10 mb. Other studies carried out by LHCb in the forward rapidity region pointed at more usual values close to 15-20 mb. I will report on these and propose possible explanations for such disparate values.

WG4 / 7

Collectivity in small collision systems with ALICE

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Measurements of anisotropic flow provide an important insight into the nature of collectively expanding hot and dense strongly coupled matter in heavy-ion collisions. Over the past years, striking similarities were revealed in numerous experimental results measured in high-multiplicity proton-proton and proton-lead interactions, where no emergence of such a medium was expected.

In this talk, we will present the latest ALICE measurement of flow coefficients and their correlations using Symmetric Cumulants for charged particles with data collected during the LHC Run 2 program in pp collisions at $\sqrt{s} = 13$ TeV, p-Pb at $\sqrt{s_{\text{NN}}} = 5.02$ TeV, Xe-Xe at $\sqrt{s_{\text{NN}}} = 5.44$ TeV and Pb-Pb collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV. In addition, we will present the flow coefficients of identified particles in p-Pb collisions. Such broad spectrum of colliding systems with different energies and a wide range of multiplicity allows for a detailed investigation of their collision dynamics. Non-flow effects, which are azimuthal correlations not originating from a common symmetry plane, are suppressed with the subevent method requiring a separation in pseudorapidity and with the subtraction method. The results are compared to various theoretical models, which provide important insights into initial conditions and into the nature of collective phenomena in different collision systems.

WG3 / 8

A spin on same-sign W boson pair production at the LHC

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In double parton scattering processes, the interparton correlations can have an impact on the size of the cross section and significantly alter the distributions of particles in the final state.

We focus on the production of a pair of W bosons with the same electric charge. We demonstrate that the LHC has the potential to extract non-trivial information on spin-correlations between two quarks inside the proton through the measurement of the rate at which the final state leptons are produced in the same hemisphere compared to the opposite one.

We employ different models for the double parton distributions (DPDs) to study different types of correlations between two quarks and we show that the spin correlations are a prime suspect for the generation of a large asymmetry.

WG6 / 9

Implications of MPI in ALICE multiplicity measurements

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Multiple Partonic Interactions (MPI) refer to those cases where more than one semi-hard partonic scattering occurs within the same pp collision. Their relevance increases at high collision energies. Therefore, it is crucial to deepen the understanding of MPI contributions to particle production in hadronic collisions at the LHC.

ALICE has performed several measurements in small collision systems, like proton-proton and proton-lead, and in large systems, like lead-lead and xenon-xenon. In this talk, a study of the evolution of particle multiplicities with energy and system size will be presented, as well as comparisons between data and models. Besides being interesting in their own right, multiplicity measurements are also used as a baseline to study the particle production. An overview of species-dependent yields, sensitive to the MPI saturation effect, will be shown. The implications of using the underlying event as a multiplicity estimator to probe mechanisms of particle production will be discussed, thus exploring possible improvements to our understanding of QCD.

WG3 / 10

Mini-jet model estimate of the effective cross-section for double parton scattering

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We will present an estimate of the effective cross-section in double parton scattering based on the eikonal minijet model with soft gluon resummation, which was recently applied to the calculation of the total and inelastic non-diffractive proton proton cross-section at LHC and to the estimate of survival probabilities at LHC. Comparison with results from an empirical model modified to take into account recent LHC results at 13 TeV will also be presented.

WG4 / 11

Studying minijets and MPI with rapidity correlations

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We propose and carry a detailed study of an observable sensitive to different mechanisms of minijet production. The class of observables measures how the transverse momenta of hadrons produced in association with various trigger objects are balanced as a function of rapidity. It is shown that the observables are sensitive to the model parameters relevant for the minijet production mechanisms: low- p_T cut-off regulating jet cross-section, transverse distribution of partons in protons, and parton distribution functions. We perform our test at different charge-particle multiplicities and collision energies. The MC models, which describe many features of the LHC data, are found to predict quite different results demonstrating high discriminating power of the proposed observables.

The talk will be based on: arXiv:1806.09016

WG3 / 12

Four-jet and three-jet plus gamma DPS production in pp and pA collisions at the LHC

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In spite of the recent progress in both theoretical and experimental studies many aspects of *multiple parton interactions* (MPI) still require a detail investigation. In particular, *double parton scattering* (DPS) processes can play a dominant role for some specific kinematic regions of multi-jet production, especially in *proton-nucleus* (pA) collisions where the total DPS cross section is approximately $\sim 3A$ times bigger as the corresponding total DPS cross section in *proton-proton* (pp) collisions.

In this talk I will discuss the DPS in four-jet and three-jet plus gamma production processes in pp and pA collisions, and specifically the impact of parton shower effects on predictions for DPS sensitive observables, the role of nuclear effects and the dependence of the DPS cross sections on different kinematical cuts and phenomenological assumptions. Additionally I will consider two different approaches to model *double parton distribution functions*, namely double DGLAP evolution equations and MPI formalism of Pythia event generator, and present a quantitative study of differences and similarities between both approaches.

WG4 / 13

Low-mass dielectron measurements in high-multiplicity pp collisions with ALICE at the LHC

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Electron-positron pairs produced in ultra-relativistic heavy-ion collisions at the LHC carry important information about the system space-time evolution unperturbed by strong final-state interactions. The dielectron continuum is very rich in physics sources: on top of Dalitz and resonance decays of pseudo-scalar and vector mesons, thermal black-body radiation contains the information about the temperature of the hot and dense system created in heavy-ion collisions. Correlated electron pairs from semi-leptonic charm and beauty decays provide information about the heavy-quark energy loss. Such pairs dominate in the intermediate mass region ($1.1 < m_{ee} < 2.7 \text{ GeV}/c^2$) and can be used for complementary studies of heavy-flavour production.

Recently, proton-proton collisions with high charged-particle multiplicities have been found to exhibit interesting phenomena, such as the longitudinal structure in the two-dimensional angular correlation and the enhanced strangeness production. The production of heavy-flavour hadrons that increases with charged-particle multiplicity could be explained by a substantial contribution from multiple parton interactions. Measurements of low-mass dielectrons could provide additional information regarding the underlying physics processes in high-multiplicity pp collisions.

In this talk, we present the latest results of the dielectron analysis with ALICE in pp collisions at $\sqrt{s} = 13 \text{ TeV}$. A particular focus of the discussion is put on the modification of dielectron spectrum in pp collisions collected with a trigger on high charged-particle multiplicities with respect to the inelastic events. The relative increase of dielectron production in high-multiplicity events is compared to the expectations from already measured multiplicity-dependent production of light and heavy hadrons. The production of direct photons in inelastic and high-multiplicity collisions is also discussed.

WG3 / 14

Double Parton Scattering at Short Relative Transverse Distances

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The contributions to the Double Parton Scattering cross section, due to pairs of interacting partons generated by perturbative splitting is enhanced at short relative transverse distances, between the centers of mass of the two partonic collisions. One may thus foresee the interesting possibility of discriminating experimentally between contributions to the double parton scattering cross section, due to interacting parton pairs originated by independent evolution, and contributions, due to interacting parton pairs generated by splitting.

WG2 / 15

MC Modelling and Tuning in CMS

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A new set of CMS underlying-event tunes is presented for the PYTHIA 8 event generator. The tunes use the NNPDF3.1 parton distribution functions at leading (LO), next-to-leading (NLO), or next-to-next-to-leading (NNLO) order in perturbative quantum chromodynamics, and the strong coupling evolution at LO or NLO. Comparisons of the predictions of the new tunes are provided for observables sensitive to the global underlying event, to soft multiparton interactions, and to double-parton scattering contributions, as well as for observables measured in various final states, such as multijet, Drell-Yan, and top quark-antiquark pair production. The measurements characterizing the properties of the underlying event in top quark pair production and the Drell-Yan processes are also presented.

WG1 / 16

Recent results on Minimum Bias and Underlying Event by CMS

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The talk will present the most recent results obtained by the CMS collaboration on minimum bias processes and the so-called underlying event.

Cancelled / 17

Small system physics from CMS: energy and multiplicity dependence of identified particle production

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The CMS collaboration presents two contributions on small-system physics. This contribution will specifically focus on the dependence of identified particle production on energy and multiplicity.

WG4 / 18

Small system physics from CMS: energy and multiplicity dependence of particle correlations

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The CMS collaboration presents two talks on small-system physics. This contribution will focus specifically on the dependence of particle correlations on energy and multiplicity

Cancelled / 19

MPI and heavy ions: CMS results

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The talk will report on the most recent results obtained by the CMS experiment on multiple partonic interactions in heavy-ion collisions

Cancelled / 20

Latest results on double parton scattering measurements from the CMS experiment

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Results on the measurement of double parton scattering processes will be reported based on the Run-I and Run-II high-luminosity data collected in proton-proton running using the CMS experiment. A future outlook of the studies will be presented for the upcoming high-luminosity LHC data-taking periods.

WG2 / 21

Teaching PROFESSOR New Math

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We present a range of improvements to the model parameter tuning program Professor. A severe limitation of the so far applied polynomial surrogates, namely the capture of $\frac{1}{x}$ behaviour of functional forms, is overcome by a new algorithm that calculates multivariate rational approximations thus allowing for more truthful approximations and wider applicability of the method. We also revisit the topic of tuning uncertainties and present a statistically robust method to produce representative tuning-errors. Finally, we present our solutions to address the challenges faced when deploying the tool-chain on HPC resources.

WG2 / 22

LHC tune for hard processes

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The LHCEW group on Jets and EW bosons proposes to produce an LHC tune to provide consistent parameters for the different parton shower and MPI MC generators. The LHC tune will include data from all LHC collaborations, as well as lower energy data. The parameters to be tuned are those of the UE event and intrinsic k_t , but are not connected with the hard process.

The goal is to provide a tune which can be used with any of the higher order calculations to provide consistent predictions.

WG6 / 23

Heavy ion and fixed target results at LHCb

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The LHCb experiment pioneered fixed target physics with LHC beams, thanks to the SMOG internal gas target. The forward geometry of the spectrometer are perfectly suitable for a fixed-target programme that, together with ion collisions, enables unique studies that shed light on cosmic ray physics as well as heavy ion physics. We present the first measurement of antiproton production in proton-helium (pHe) fixed-target collisions at the LHC, which is an input for the modelling of the antiproton flux measured by AMS, and the first measurement of charm production in pHe and pAr fixed-target collisions at the LHC, which is of interest both for discussions of intrinsic charm and as a baseline for future ion-ion collision studies for quark-gluon plasma physics. Using data taken in collider mode, we discuss recent pPb collision measurements of quarkonia and open charm states, which probe nuclear modifications down to low Bjorken- x , and the measurement of J/ψ production in ultra-peripheral PbPb collisions. We conclude by outlining the upgraded version of the fixed-target, SMOG2.

WG6 / 24

Flow harmonic coefficients in small systems at the LHC: initial or final state effect?

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The experimental measurements of non-zero flow harmonic coefficients in p+A, and even in p+p, collisions at LHC energies have generated an ample debate on the heavy ion community in the last lustrum. Considered a golden probe of QGP formation in A+A collisions the interpretation of v_n 's distinct from zero in small collision systems remains unclear. This is so because a reasonable description of the data has been achieved in both the hydrodynamical picture, where the formation of a QGP droplet is assumed, and the Color Glass Condensate framework in which the v_n 's arise from initial state momentum correlations. In this talk, I will review the up-to-date theoretical status and present a novel study in which the impact on the flow harmonic coefficients of two orthogonal effects is gauged. One of them consists in modifying the initial geometry of the colliding protons at the sub-nucleonic level. The other is directly related to variations in the parameters of the hydrodynamical evolution such as the shear viscosity or the particlization temperature.

Cancelled / 25

ATLAS results on quarkonia and its associated production

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Abstract: The associated production of vector boson with quarkonia is a key observable for understanding the quarkonium production mechanisms, including the separation of single and double parton scattering components.

This talk will present the latest differential measurements from ATLAS on quarkonium and associated quarkonium production.

WG1 / 26

Fragmentation studies with the ATLAS detector

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Abstract: Gluon splitting to b-quark pairs is a unique probe into the properties of gluon fragmentation, as identified b-tagged jets provide a proxy for the quark daughters of the initial gluon. If available, we present a measurement of key differential distributions related to $g \rightarrow b \bar{b}$ using data collected with the ATLAS detector at $\sqrt{s}=13$ TeV. Track jets are used to probe angular scales below the standard $R=0.4$ jet radius. The observables are unfolded to particle level in order to facilitate direct comparison with predictions from simulations and provide an important constraint to hadronization models.

If available, a measurement of the properties of jet fragmentation performed with pp data collected with the ATLAS detector at $\sqrt{s}=13$ TeV is presented. Charged particle tracks are used to measure charged particle multiplicity, the jet charge, the summed fragmentation function, the momentum transverse to the jet axis, and the radial profile of the jet. Each observable is unfolded to correct for acceptance and detector effects. Exclusive interpretations in terms of quarks and gluons are provided in order to directly compare with state-of-the-art calculations.

WG1 / 27

Jet Substructure Measurements with the ATLAS Detector

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Abstract: Calculations of jet substructure observables which are accurate beyond leading-logarithmic accuracy have recently become available. Such observables are significant not only for probing a new regime of QCD at a hadron collider, but also for improving the understanding of jet substructure properties that are used in many studies at the Large Hadron Collider. In this talk, we discuss first measurement of jet substructure quantities at a hadron collider, calculated at next-to-next-to-leading-logarithm accuracy. The soft drop mass is measured in dijet events with the ATLAS detector

at 13 TeV, unfolded to particle-level and compared to Monte Carlo simulations. If available, we present a measurement of substructure variables in $t\bar{t}$ and inclusive jet events, using data collected by the ATLAS experiment at $\sqrt{s} = 13$ TeV. The measurements are performed with large-radius jets. They are corrected for detector effects, represented as particle-level distributions and are compared to the predictions of various Monte Carlo event generators.

Cancelled / 28

Measurement of distributions sensitive to the underlying event in inclusive Z-boson production in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector

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Abstract: A measurement of charged-particle distributions sensitive to the properties of the underlying event is presented for an inclusive sample of events containing a Z-boson, decaying to a muon pair. Distributions of the charged particle multiplicity and of the charged particle transverse momentum are measured in regions of azimuthal angle defined with respect to the Z-boson direction. The measured distributions are compared to the predictions of various Monte Carlo generators implementing different underlying event models.

WG4 / 29

Measurements of correlated hadron production with the ATLAS detector

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Abstract: We present studies shedding light on the correlated hadron production. This is an important source of information about the early stages of hadron formation and is not yet understood from first principles. In this talk, we will present the measurement of Bose-Einstein correlations using the ATLAS detector along with an analysis of the momentum difference between charged hadrons in high-energy proton-proton collisions. The latter allows the investigation of observables sensitive to the predictions of the quantized string model.

Cancelled / 30

Monte Carlo generator for the modelling of multijet processes in ATLAS at 13 TeV

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Abstract: Most of the interesting physics at the LHC involves final states with hadronic jets.

We present Monte Carlo event generator configurations used by the ATLAS experiment

to model multi-jet processes in pp collisions at 13 TeV.

The generators are compared to each other for kinematic distributions sensitive both to the kinematic of hard process and to shower and non-perturbative effects.

Recipes for evaluating uncertainties covering differences related to the matrix-element generator and matching, the shower radiation, and hadronisation effects are also discussed.

Cancelled / 31

Status of measurements of diffractive processes with the ATLAS detector

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Abstract: The status of diffractive measurements at the ATLAS experiment will be presented. Diffractive dijet production was identified using empty regions of the ATLAS detector (so-called rapidity gaps). The data are compared with Monte Carlo models and the rapidity gap survival probability has been estimated in the kinematic region with high diffractive contribution. If available, we will present a study of inclusive single diffractive distributions, performed using a sample of pp collision data collected under low-luminosity conditions at $\sqrt{s} = 8$ TeV. Events with a single forward proton measured in ALFA and dissociated system detected in the central detector are selected. Cross sections are measured differentially in the proton fractional momentum loss, the square of its momentum transfer and rapidity gap size. They are corrected back to particle level for interpretation and comparison with theoretical predictions.

WG4 / 32

Modification of inclusive and heavy-flavor jet structures in high-multiplicity pp collisions

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High multiplicity events of small colliding systems at high c.m.s. energies show similar collective features to heavy ion collisions with comparable multiplicities, such as long-range near-side correlations and v_n coefficients [1]. Whether this behaviour may be attributed to the presence of a deconfined state in small systems is an open question. Recent analyses of pp and p-Pb collisions also show an universal enhancement of heavy-flavour particles, that is usually attributed to multiple parton interactions (MPI) and higher gluon radiation associated with short distance production processes [2]. While we cannot expect jet quenching to be detectable in small systems, QCD phenomena at the soft-hard boundary may cause a modification of the jet shapes. Existing and forthcoming data at the experiments of the LHC provide means to access such modifications.

Based on extensive studies with event generators, we give predictions for multiplicity-dependent jet structures in p+p collisions at high jet-pT. We show that the presence of MPI modifies the jet

shapes in high-multiplicity events beyond trivial selection bias, and that such high- p_T multiplicity-differential probes provide a sensitive validation opportunity for models involving different MPI, color reconnection schemes or parton distribution functions [3,4].

Jets from heavy-flavor quarks are expected to undergo different fragmentation than light-flavor jets, due to mass and color charge effects. We show a surprising pattern of multiplicity-dependent structures in jets originating from different flavors [4].

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Cancelled / 33

Multi-parton scattering effects in heavy flavour production at the LHC

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In this talk I will summarize results of our studies of hard MPI effects in heavy flavour sector in pp-collisions at the LHC. During last two years we extend our previous studies of double-parton scattering (DPS) in double charm production to simultaneous production of charm and bottom as well as to double bottom production. We have also analyzed in this context associated production of charm and dijets. The calculations are performed within a factorized ansatz. Each parton scattering is calculated within the kT-factorization approach. The hadronization is done with the help of fragmentation functions. For completeness, we compare results for double- and single-parton scattering (SPS). We identify the regions of phase-space where the DPS dominates over the SPS, using realistic cuts for the LHCb and ATLAS and suggesting future experimental studies at the LHC. Finally, I will also present results of our studies of triple-parton scattering (TPS) effects in the case of triple charm meson production for the LHCb kinematics.

WG6 / 34

Electron-Ion Collider: where do we stand?

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The Electron-Ion Collider (EIC) is the project for a new US-based high-energy high-luminosity facility, capable of a versatile range of beam energies, polarizations, and ion species. Its primary goal is to precisely image quarks and gluons and their interactions inside hadrons, in order to investigate their confined dynamics and elucidate how visible matter is made at its most fundamental level. I will describe the current status of the project and briefly touch upon the main physics questions addressed by such a facility. I will emphasize the synergies of the EIC with present and proposed CERN experiments, in particular with the LHC and the search for evidence of multi-parton dynamics.

WG5 / 35

Prospects and results from the PPS detector

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The talk will present prospects and results from the precise proton-spectrometer (PPS), a new detector born from the collaboration between the CMS and TOTEM experiments at the LHC

WG5 / 36

CMS results on diffraction and exclusive production

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The talk will present an overview of the results on diffraction and exclusive production obtained by the CMS experiment at the LHC

Cancelled / 37

Recent results from TOTEM/CMS

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The talk will present an overview of the most recent results obtained by the TOTEM and CMS experiments on the so-called forward physics

WG6 / 38

System Size Dependence of Heavy Flavor and Quarkonia Production at RHIC

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Particles carrying heavy flavor are important probes to study the properties of the Quark-Gluon Plasma (QGP) created in relativistic heavy-ion collisions at RHIC. They are produced in hard scattering during the earliest stages of nuclear collisions and, because of their high mass, theoretical

calculations are more tractable than those involving light quarks. The RHIC experiments have collected data on p+p, p+Al, p+Au, Cu+Au and Au+Au collisions using silicon vertex trackers with sufficient tracking resolution, in combination with lepton-identification detectors. They have provided results on charm and bottom open heavy flavor production, as well as Jpsi/Psprime ratios and B-to-Jpsi decays. The results on a broad range of systems guide our understanding of the properties of the QGP.

This talk summarizes the latest RHIC experiments' results concerning open and closed charm and beauty heavy quark production measured through their semileptonic decays as a function of system size, rapidity and energy, and their interpretation with respect to the current theoretical understanding on this topic.

WG6 / 39

Heavy-flavour jet measurements with ALICE

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Heavy quarks are produced in hard scattering processes during the early stages of a heavy-ion collision at ultra-relativistic energies. Their annihilation rate is negligible, and they participate in the whole medium evolution losing their energy via radiative and collisional processes while traversing through the Quark-Gluon Plasma (QGP) formed in such collisions. This allows us to study the dynamical properties of the QGP. With ALICE at the Large Hadron Collider, heavy quarks are studied by measuring hadronic decays of D (D*, D⁰, D⁺, D_s) mesons and of Λ_c baryons and semi-leptonic decays of Λ_c and Ξ_c baryons at central rapidity. In addition, electrons from heavy-flavour hadron decays are studied at central rapidity while muons from heavy-flavour hadron decays are investigated at forward rapidity.

The measurement of heavy-flavour jets gives more direct access to the initial parton kinematics and can provide further constraints for heavy-quark energy loss models, in particular adding information on how the radiated energy is dissipated. In order to assess the heavy-flavour production modification in heavy-ion collisions, baseline measurements in pp and p-Pb collisions are needed.

This contribution will include ALICE measurements of the D-tagged charged jets in pp, p-Pb and Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. Studies of the jet-momentum fraction carried by the D meson in pp collisions at $\sqrt{s} = 7$ TeV will also be presented.

WG4 / 40

Quarkonium production as a function of charged-particle multiplicity in pp collisions measured by ALICE at the LHC

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Quarkonium (a bound state of $Q\bar{Q}$ pair) production as a function of charged-particle multiplicity has been measured in pp collisions at the LHC. They exhibit a non-trivial correlation that can lead to a better understanding of the multiple-parton interaction mechanism in the initial state of the collision as well as possible collective effects in small systems. The ALICE detector at the LHC measures quarkonium production down to zero transverse momentum in different rapidity intervals

(mid-rapidity ($|\eta| < 0.9$)) and forward rapidity ($2.5 < \eta < 4$)). Charmonia (J/ψ , $c\bar{c}$) are detected via their decay into di-electrons at mid-rapidity and dimuons at forward rapidity. Bottomonia (Υ , $b\bar{b}$) are detected via their decay into dimuons at forward rapidity. Charged-particle multiplicity is measured using track segments in the silicon pixel detector in $|\eta| < 1$.

In this presentation we will present latest ALICE measurements for relative J/ψ and Υ production as a function of multiplicity in pp collisions at $\sqrt{s} = 13$ TeV. The relative J/ψ or Υ yield is the ratio between the J/ψ or Υ yield measured in a certain multiplicity interval to the multiplicity-integrated yield. The relative J/ψ yields at forward rapidity as a function of charged-particle multiplicity will be presented and compared to previous results at mid-rapidity. We will discuss the first measurement of the relative $\Upsilon(1S)$ and $\Upsilon(2S)$ yields at forward rapidity as a function of the charged-particle multiplicity. In the forward rapidity region, ratios of the relative $\Upsilon(2S)$ over $\Upsilon(1S)$ and $\Upsilon(1S)$ over J/ψ yields as a function of charged-particle multiplicity will also be presented.

WG4 / 41

Measurements of two-particle correlations in e^+e^- collisions at 91 GeV with ALEPH archived data

Authors: Austin Alan Baty¹; Yen-Jie Lee²; Christopher McGinn¹; Gian Michele Innocenti³; Jesse Thaler⁴; Michael Joseph Peters¹; Anthony Badea¹; Marcello Maggi⁵; Paoti Chang⁶; Tzu-An Sheng⁶

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This talk summarizes the results on two-particle angular correlations for charged particles emitted in e^+e^- collisions data collected at 91 GeV with the ALEPH detector at LEP. With the archived data, the correlation functions are studied over a broad range of pseudorapidity η and azimuthal angle ϕ with respect to the electron-positron beam axis and the event thrust axis. Short-range correlations in $\Delta\eta$, which are studied with e^+e^- annihilations which reveal jet-like correlations. Long-range azimuthal correlations are studied differentially as a function of charged particle multiplicity. The integrated associated yield is extracted for the first time from the long range correlation function as a function of the charged particle multiplicity. Those results are compared to predictions from PYTHIA8 and PYTHIA6 event generators and are complementary to the studies of the ridge signals in high multiplicity pp, pA and AA collisions at the RHIC and the LHC.

WG3 / 42

Double parton scattering in final states with jets

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Though already thirty years have passed since the double parton scattering (DPS) effects have been observed for the first time, a strong interest to this topic still persists. In spite of large theoretical and experimental progress, a lot of space is left for improvement of our understanding of the DPS mechanisms. Certain advantages are provided by studies performed in various final states, in particular

it has been shown that precise measurements of correlations in the final states with jets provide an excellent tool to disentangle contributions from single and double parton scattering into production mechanisms.

The talk will cover the recent results from the ATLAS and CMS experiments on the studies of the DPS in the four-jet events as well as in the associated production of heavy mesons and gauge bosons with jets.

WG4 / 43

Effects of geometry initial-state fluctuations on the ridge structure in pp collisions.

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One of the key signatures of collectivity in heavy-ion collisions is the appearance of a ridge structure over wide pseudorapidity interval. Recently it was also found in small collision systems such as proton-proton or proton-ion collisions which origin is still on debate. In this work, contributions from the geometry fluctuations in the initial-state in pp collisions to the ridge structure are estimated from low to high density. Effects show to be relevant for small collision systems unlike in heavy-ion collisions where their effects are negligible.

WG3 / 44

Studies of the Double parton scattering through heavy flavours production

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During last thirty years presence of the double parton scattering (DPS) in the hadronic collisions has been demonstrated by a large number of experiments. Though the underlying mechanisms are still poorly understood. Studies of the events involving heavy flavour production allow to reach very small transverse momentum regions and to test the factorization approach to the DPS description with high precision.

The talk will include latest experimental results on the DPS measurements in the events with double heavy flavour production.

WG5 / 45

Diffraction electroproduction of ρ -meson as discriminating test-field for the unintegrated gluon distribution in the proton

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The unintegrated gluon distribution (UGD) encodes the gluon content in the proton in the high-energy domain and gives the probability that a gluon can be emitted by a colliding proton, with given longitudinal momentum fraction and transverse momentum. The UGD, being a nonperturbative quantity, it is not well known and several models for it have been introduced so far.

The diffractive electroproduction of ρ -meson can get access to the UGDs and distinguish among the existing models, exploiting the discriminating power of helicity amplitude ratios.

Cancelled / 46

Azimuthal asymmetries in the Color glass condensate

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The origin of long-range rapidity correlations observed in p-p and p-Pb collisions at LHC is one of the outstanding questions of strong interactions. The leading theoretical explanations of the so-called “ridge” effect are hydrodynamics and the initial state dynamics, with the latter often described in the Color Glass Condensate (CGC) framework. CGC-based calculations have successfully described many “ridge” data. Nevertheless, some challenges still remain: one of the enduring problems of the CGC-based approaches to correlations has been to obtain a non-vanishing value of the triangular “flow” coefficient v_3 clearly observed in the data. In this talk we analytically show that odd harmonics are generated in the double inclusive gluon production when the first saturation correction in the interaction with the projectile is included in the calculation. We discuss the phenomenological relevance of our findings and present numerical calculations.

WG4 / 47

Energy and multiplicity dependence of identified particle production in small systems with ALICE at the LHC

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One of the key results of the LHC Run 1 was the observation of an enhanced production of strange particles in high multiplicity pp and p-Pb collisions at 7 and 5.02 TeV, respectively.

In addition, the multiplicity dependent results on particle production in pp collisions allowed the discovery of collective-like behavior in small systems at the LHC.

In order to provide further insights into the origin of these new phenomena, new measurements of the multiplicity dependence of the transverse momentum (p_T) distributions of inclusive and identified charged particles from Run 2 at the top LHC energy will be presented.

The p_T spectra are measured at mid-rapidity and over a broad transverse momentum range, providing important input to study particle production mechanisms in the soft and hard regime of QCD. In particular, a power law fit of the distributions for $p_T > 4$ GeV/c is performed to study the hard component of particle spectra.

Furthermore, experimental results on multiplicity-dependent strangeness production have been extended in multiplicity reach and the strangeness enhancement is investigated by measuring the

evolution with multiplicity of single-strange and multi-strange baryon production relative to non-strange particles. Recent measurements of mesonic and baryonic resonances in small collision systems are also investigated in pp and p-Pb collisions to study how hadronic scattering processes affect measured resonance yields, as well as the interplay between canonical suppression and strangeness enhancement. Energy and system-type invariance will be discussed and an extensive comparison with statistical hadronization and QCD-inspired models will be presented.

WG3 / 48

Studies of the double parton scattering using massive vector bosons

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The thirty-year long history of the studies of the double parton scattering (DPS) lead to a large number of measurements in various channels and wide range of the collisions energies. At the LHC era the role of the DPS in the production processes becomes more and more significant as its contribution is expected to increase at higher energies. Estimates of this contribution provide an important information both on the hadron structure and the possible backgrounds for the Standard model (SM) and beyond the SM processes.

Events involving massive vector bosons, which further decay into leptonic or semileptonic final states, provide a clear signature and allow to perform the DPS measurements with high precision. The talk will cover the latest experimental results on the studies of the DPS using double production of massive vector bosons and their production in association with heavy flavours at the LHC.

WG6 / 49

Soft physics from e+e- to AA

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Since the surprising discovery of collective behavior in pp collisions at LHC, hadronization mechanisms has experienced a renewed interest. The prospect that collective behavior in pp and AA collisions might have a common origin, have also prompted efforts to extend MPI models for pp to heavy ion collisions.

In this talk I will outline the efforts of the microscopic model of collectivity implemented in the Pythia 8 event generator, as well as the Angantyr extension of the Pythia MPI model to heavy ion collisions. I will discuss the possibility to further investigate the microscopic model for collectivity with new observables.

WG2 / 50

Rivet for Heavy Ions

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We present new developments in the Rivet framework for comparing theory to experiment, allowing for the first time for easy implementation of – and comparison against – heavy ion data. The framework has notably been extended with tools for centrality estimation and calculation of flow observables, as well as the implementation of several heavy ion analyses. In this talk we will demonstrate some of the capabilities of the framework, and discuss possible future directions.

WG2 / 51

Probing colour reconnection using boosted hadronically decaying top quarks

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One of the largest uncertainty in many top quark measurements is the one on the modelling of colour reconnection (CR) between top quark decay products. There have been several experimental measurements, notably of the pull angle in $t\bar{t}$ events, which were intended to provide useful input to CR modelling, but we have not seen strong sensitivity. In this presentation, we propose a novel way to to construct observables sensitive to CR using a large-radius jet containing all decay products of a boosted hadronically decaying top quark. We construct geometrical areas between the subjects, and measure charged particle activity in those areas. At particle level, we see difference in activity when the areas are constructed between colour-connected subjects, and otherwise.

WG4 / 52

Collectivity and MPI

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We develop a MPI based theory of ridge phenomena in ‘MPI, the origin of collectivity comes out to be quantum interference of different MPIs. We show that in this approach we obtain a picture of ridge phenomena in pp collisions compatible both qualitatively and qualitatively with experimental data.

the talk is based on:

Collectivity from interference

Boris Blok (Technion), Christian D. Jäkel (Sao Paulo U., Sao Carlos), Mark Strikman (Penn State U.), Urs Achim Wiedemann (CERN). Aug 28, 2017. 44 pp.

Published in JHEP 1712 (2017) 074

and
B. Blok and U. Wiedemann, in preparation.

WG3 / 53

Constraining DPD models using sum rules

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Double parton distributions (DPDs) are not only an essential building block needed in factorization theorems to calculate double parton scattering (DPS) cross sections in perturbation theory, but they also contain very detailed information about hadronic structure. However, as presently an extraction of DPDs from experimental data or lattice calculations is not yet feasible, it is common practice to resort to DPD models motivated by physical intuition. One constraint any such model should fulfil are the DPD sum rules by Gaunt and Stirling. We check numerically how restrictive the constraints imposed by these sum rules are and show how they can be used to improve DPD models.

WG2 / 54

Monte Carlo event generator for double parton interactions in proton nucleus collisions

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We summarize the results of the studies of double parton scattering (DPS) off nuclei in the parton model [1] and pQCD [2]. A Monte Carlo implementation of the DPS processes is developed which includes realistic NN correlation in nuclei [3], transverse geometry of hard and soft NN collisions and distribution over the number of wounded nucleons. This implementation is an extension of the Monte Carlo procedure previously developed for processes with one hard collisions [4, 5] and which was applied within the framework of color fluctuation picture for the centrality dependence of the jet production in the proton fragmentation region in pA and DA collisions [6, 7]. Numerical results are presented for the inclusive rate of DPS as well as for the rate of DPS as a function of centrality. Centrality dependence was calculated using the ATLAS collaboration model of centrality for soft processes based on the $\sum E_T$ distribution at large negative (along the nucleus direction) rapidities.

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WG6 / 55

Azimuthal asymmetries on heavy-flavour production from Pb-Pb to pp collisions with ALICE

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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).

Azimuthal anisotropies of particles produced in heavy-ion collisions are used to study initial state geometry fluctuations and collective effects that arise from the long-range interactions with non-zero mean free path, between QGP constituents.

These anisotropies are used to quantify the shear and bulk viscosities, important properties used to characterize this high-density and hot medium.

Heavy quarks, being produced in the early stages of the collisions, lose energy while passing through the QGP, via radiation of gluons or scatterings with partons of the medium. The measurement of the azimuthal anisotropies of hadrons containing heavy quarks, at low transverse momentum, can give insights into their participation in the collective evolution of the system and their possible thermalization.

Recent measurements showed that, also, high-multiplicity proton-proton (pp) and proton-lead (p-Pb) collisions present similar behaviours to the azimuthal anisotropies observed in Pb-Pb collisions and usually associated to the hydrodynamical characteristics of the QGP. The understanding of these effects in high-multiplicity hadronic collisions is still debated.

A review of the most recent ALICE measurements about heavy-flavour azimuthal anisotropies (v_n coefficients) will be presented. Focus will be given on the results obtained with Run2 data in Pb-Pb and p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.

WG3 / 56

Colour Reconnection from Soft Gluon Evolution

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We consider soft gluon evolution of a system of clusters forming the initial state of the cluster hadronization model, in order to constrain colour reconnection models from a perturbative point

of view.

We show that this ansatz produces clusters with properties attributed to a colour pre-confined state and find strong evidence for formerly investigated colour reconnection models based on geometric properties.

We also explore the possibility of colour flows giving rise to baryonic clusters and propose simple parametrizations in order to incorporate the effects of soft gluon evolution in an event generator

In this talk I will present ongoing work in the direction of a perturbatively inspired colour reconnection model based on soft gluon evolution striving towards the ultimate goal of implementing a full model in the Monte Carlo Event Generator Herwig.

WG3 / 57

Efficient numerical evolution of double-parton distributions

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Practical solutions to the evolution equations for double-parton distributions (DPDs) that are accurate but feasible in terms of computing resources are a challenging task in the study of double-parton scattering phenomenology in perturbative QCD. Due to the higher dimensionality of DPDs with respect to single PDFs, a simple extension of the available methods for PDF evolution is computationally prohibitive. We present an efficient method to implement the fast solution of DGLAP equations and interpolation for PDFs and DPDs, based on the use of Chebyshev polynomials. For PDF evolution, our method allows for a higher numerical accuracy using a considerably smaller number of grid points with respect to existing methods. The DPD evolution is realized using an affordable number of grid points, and importantly allows for two independent renormalization scales for the two partons.

WG1 / 58

Physics of small collision systems using UE observables

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In this work we study the underlying event (UE) activity as a function of the highest jet transverse momentum (p_T^{jet}) in terms of the number and summed p_T densities of charged particles in the azimuthal region transverse to the p_T^{jet} direction. The UE activity considering charged particles within different p_T intervals in pp collisions at $\sqrt{s} = 7$ TeV is explored. Albeit MPI saturate for $p_T^{\text{jet}} > 10$ GeV/c, UE still increases with increasing p_T^{jet} . We show that the saturations of both number and summed p_T densities are only observed for low- p_T charged particles ($0.5 < p_T < 2$ GeV/c). Moreover, for the p_T -integrated case ($p_T > 0.5$ GeV/c) the summed p_T density is not sensitive to the

variation of color reconnection (CR). However, at low- p_T it is reduced with increasing CR, whereas an opposite behaviour is found at intermediate- p_T ($2 < p_T < 10$ GeV/ c). We also show that CR produces flow-like behaviour only in the UE region and the effects are reduced with increasing p_T^{jet} due to the hardening of UE.

Finally we study the UE activity associated to identified leading particles. We found that for $2 < p_T < 10$ GeV/ c the UE is sensitive to the leading particle species. We will discuss the origin of this effect in terms of minimum multiplicity associated to produce a given particle species and color reconnection. The outcomes encourage the measurement of inclusive and identified charged particle p_T spectra (over a wide range of p_T) associated to UE aimed at better understanding the similarities between pp and heavy-ion data discovered at the LHC.

WG3 / 59

Double Parton Distributions for the Pion on the Lattice

Author: Christian Zimmermann¹

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Double parton distributions (DPDs) are an important piece in the description of double hard interactions. On the lattice we calculate correlation functions of two local quark currents, which can be related to Mellin moments of DPDs. For the first moment we calculate all contributing Wick contractions for the pion, considering several channels corresponding to the quark polarization. Furthermore, we test to what extent a factorization into a convolution of generalized parton distributions (GPDs) is valid.

WG4 / 60

Investigating the flow-like correlations with new possibility

Author: You Zhou¹

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Multiple experimental measurements have shown strong indications of flow in small collision systems. In this talk, I will examine the selected theoretical models with latest as well as well hidden experimental results in small collisions systems. I will discuss which experimental "evidence" is solid and which might be misinterpreted. In addition, I will show the potential of deep learning in the investigations of flow in small collision systems.

WG3 / 61

Proton Structure at the LHC via double parton scattering

Author: Federico Alberto Ceccopieri¹

Co-authors: sergio scopetta ²; Vicente Vento Torres ³; Marco Traini ; Matteo Rinaldi ⁴

¹ *Universita & INFN, Milano-Bicocca (IT)*

² Perugia University and INFN³ Univ. of Valencia and CSIC (ES)⁴ Perugia University and INFN, Perugia**Corresponding Authors:** vicente.vento@uv.es, matteo.rinaldi@pg.infn.it, sergio.scopetta@pg.infn.it, federico.alberto.ceccopieri@cern.ch

We discuss double parton distribution functions (dPDFs), the main non perturbative ingredients appearing in the double parton scattering cross section (DPS) formula in hadronic collisions. By using recent calculations of dPDFs within Light-Front constituent quark models [1], we investigate the role of correlations induced by relativistic effects on dPDF evaluations [2]. Such distributions are then used to calculate DPS cross section for Same-sign W boson pairs production, a promising channel to look for signatures of double parton interactions at the LHC. We finally describe a connection between the so-called effective cross section, a quantity which encodes the experimental knowledge on DPS, and the mean transverse distance between the two partons active in a give DPS process [4].

References:

[1] M. Rinaldi, S. Scopetta, M. Traini and V. Vento, JHEP12, 028 (2014)

[2] M. Rinaldi and F. A. Ceccopieri, Phys. Rev. D95, no. 3, 034040 (2017)

[3] F. A. Ceccopieri, M. Rinaldi and S. Scopetta, Phys. Rev. D95(2017) no.11, 114030

[4] M. Rinaldi and F. A. Ceccopieri, Phys. Rev. D97(2018) no.7, 071501

WG5 / 62

Central Exclusive Production at LHCb

Author: Daria Savrina¹¹ M.V. Lomonosov Moscow State University (RU)**Corresponding Author:** daria.savrina@cern.ch

With installation of new shower counters (HERSCHEL) along the beampipe the sensitivity of the LHCb experiment to the central exclusive production (CEP) has significantly increased. And the dedicated triggers introduced in the early period of Run 2 allowed to extended dataset for the CEP measurements.

The talk will cover the CEP results of LHCb experiment during Run1 and Run2

WG6 / 63

Low pT direct photon production at PHENIX in small-on-large collisions

Author: Balazs Ujvari¹¹ University of Debrecen**Corresponding Author:** balazs.ujvari@science.unideb.hu

PHENIX has measured low pT direct photon yields and elliptic flow in 200 GeV Au+Au collisions with three different methods and the results are consistent. The yield measurements have been extended to lower collision energies and different colliding systems. It has been found that the integrated yields scale with the respective charged particle density, independent of system size, collision energy or centrality, as long as the colliding systems are large, but the scaling breaks down for p+p. If this signals that a similar radiating medium is formed in all A+A collisions, but it is absent in p+p, it is

a logical question whether there is a visible “turn-on” of medium formation. Using the p+Au and d+Au data collected by PHENIX we will report on the current status of these investigations.

WG2 / 64

Space-time model for colour reconnection.

Authors: Andrzej Konrad Siodmok¹; Boris Blok²; Cody Duncan³; Johannes Bellm⁴; Miroslav Myska⁵; Stefan Gieseke⁶

¹ *Polish Academy of Sciences (PL)*

² *Physics Department*

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⁵ *Czech Technical University (CZ)*

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The idea behind the space-time colour reconnection (CR) is to use the space-time distance between the partons to construct a colour reconnection model. We will describe how the space-time picture is incorporated into Herwig 7 and show the first results of a space-time CR model.

Anniversary Talk / 65

A tale of Nine Cities and Many Partons: developments in MPI since the first MPI@LHC.

Authors: Jonathan Richard Gaunt¹; Paolo Bartalini²

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We discuss progress in the field of MPI studies over the last ten years, focussing mainly on theoretical developments but also including experimental highlights.

WG3 / 66

Two-loop splitting in double parton distributions

Authors: Jonathan Richard Gaunt¹; Markus Diehl²; Peter Plößl³

¹ *CERN*

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We discuss the computation of the 1->2 splitting functions and matching coefficients at two loops, which are required for the computation of DPS cross sections at NLO.

WG4 / 67

Multiplicity dependent J/ψ production in proton-proton collisions with PYTHIA8

Authors: Andreas Morsch¹; Steffen Georg Weber²; Andrea Dubla³; Anton Andronic⁴

¹ CERN

² Technische Universitaet Darmstadt (DE)

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The correlation of charmonium (and also of heavy quarks in general) production with the charged particle multiplicity is of high interest, as it could give new insight into the interplay between hard and soft mechanisms in particle production, both at parton level and at hadronization.

Experimental data shows an intriguing increase of the self-normalized J/ψ yield with multiplicity. In this contribution, a study of prompt and non-prompt J/ψ production as a function of charged-particle multiplicity in inelastic proton-proton (pp) collisions at a centre-of-mass energy of $\sqrt{s} = 13$ TeV based on calculations using the PYTHIA8 Monte Carlo generator is shown.

The microscopic reasons for this behaviour, like the role of multiple parton interactions, colour reconnections and auto-correlations are investigated, in particular to shed light on the origin of the stronger-than-linear increase and the transverse momentum dependence.

The possibility of disentangling auto-correlation effects from other physical phenomena by measuring the charged-particle multiplicity in different pseudo-rapidity and azimuthal regions relative to the J/ψ direction is investigated.

An experimental measurement of J/ψ production as a function of the charged-particle multiplicity measured in the azimuthal transverse region with respect to the J/ψ is suggested.

WG5 / 68

Total, elastic and inelastic cross section measurements in TOTEM

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The TOTEM experiment, located at the interaction point 5 of the LHC, has measured the total, elastic and inelastic proton-proton cross sections in a centre-of-mass energy range from 2.76 to 13 TeV, mostly in dedicated fills with special beam optics. Most recently, TOTEM has performed a series of detailed measurements at $\sqrt{s} = 13$ TeV. The total, elastic and inelastic proton-proton cross-sections were determined using the luminosity-independent method based on the optical theorem. The elastic scattering was investigated in a wide range of the squared four-momentum transfer $|t|$. The study of Coulomb-nuclear interference region down to $|t| \sim 8 \times 10^{-4}$ GeV² allowed in particular the first measurement of the ρ parameter at $\sqrt{s} = 13$ TeV, ρ being the ratio between the real and the imaginary part of the nuclear elastic scattering amplitude at $t = 0$. This measurement, combined with the TOTEM total cross-section results, led to the exclusion of all the models classified and published by

the COMPETE Collaboration. The results obtained by TOTEM are indeed compatible with predictions of a colorless 3-gluon bound state exchange in the t-channel of proton-proton elastic scattering, as postulated by alternative theoretical models both in the Regge-like framework and in the modern QCD framework.

An overview of these measurements will be given.

WG2 / 69

New developments in EPOS

Authors: Klaus WERNER^{None}; Iurii Karpenko¹; Tanguy Pierog²; Gabriel Sophys³; Maria Stefaniak⁴; Benjamin Guiot,^{None}

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We report on recent developments concerning the reunification of the two EPOS branches EPOS LHC and EPOS3, essentially concerning the hadronization of the plasma part.

WG5 / 70

Soft QCD and small-x physics at the LHC and beyond

Author: Hans Van Haevermaet¹

¹ *University of Antwerp (BE)*

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The description of collisions involving hadrons has always been a challenging task, especially at nonperturbative scales and the forward phase space. Being at the end of LHC Run 2 an overview of recent measurements and developments in soft QCD and small-x physics at the LHC is presented, together with remaining open questions and an outlook for future studies that are still missing to improve our knowledge.

Cancelled / 71

A full set of TMD splitting functions in High Energy Factorization

Author: Mirko Serino^{None}

Corresponding Author: mirkos.serino@gmail.com

Interpolating exactly between collinear and BFKL evolution has been a desire of the QCD community for a long time. Generalizing the method of Curci, Furmanski and Petronzio for the computation of collinear splitting functions, in the wake of previous work by Catani and Hautmann, we provide the real parts of a full set of TMD splitting functions which match the DGLAP, BFKL and CCFM

kernels in the appropriate kinematic limits and we discuss our progress in evaluating the virtual contributions.

WG5 / 72

LHC as a photon collider

Author: Christophe Royon¹

¹ *The University of Kansas (US)*

Corresponding Author: christophe.royon@cern.ch

We will discuss the measurements of exclusive di-photon events at the LHC in pp and Pb Pb runs. these events lead to the best possible sensitivities to quartic anomalous couplings between photons, Z and W bosons. We will also give the sensitivities to the search for axion like particles at high mass.

WG5 / 73

The Electron Ion Collider and its implications for high-energy phenomenology

Author: TIMOTHY J HOBBS¹

¹ *Southern Methodist University*

Corresponding Author: tjhobbs@smu.edu

A future electron-ion collider (EIC) will be a dedicated high-luminosity machine with the capability of unraveling many issues in QCD, including a systematic tomographic mapping of the nucleon's internal structure, investigations of the quark-hadron transition, the onset and dynamics of gluon saturation at low x , and the nature of the nuclear medium. In addition to the wealth of information an EIC will yield on hadronic and nuclear physics, it can also be expected to play a powerful complementary role to high energy programs at the LHC and beyond. In this talk I will provide an overview of the physics motivation for the EIC and its possible impact on efforts along the energy frontier.

WG5 / 74

Hadronic interactions in cosmic ray and astro-particle physics

Author: Anatoli Fedynitch¹

¹ *DESY*

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In my talk I will highlight a number of recent developments in particle astrophysics that interface with high-energy physics. A particular focus lies on the importance of hadronic interaction models for the interpretation of Ultra-High Energy Cosmic Ray observations.

Cancelled / 75

Theoretical uncertainties at small x and k_T -improved collinear calculations

Author: Benjamin Guiot,¹

¹ *Valparaiso*

Theoretical uncertainties at small x and k_T -improved collinear calculations

WG5 / 76

Prospects and results from the AFP detector in ATLAS

Author: Vlasios Petousis¹

¹ *Czech Technical University (CZ)*

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Prospects and results from the AFP detector in ATLAS

WG5 / 77

Jet veto cross section measurements in ATLAS

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Jet veto cross section measurements in ATLAS

WG5 / 78

Inclusion of open heavy-flavour data in PDF fits

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I will discuss about the impact of open heavy-flavour data on the gluon and sea quark PDFs in the low x /low Q^2 region and the still open problems in the fitting procedure, with examples/considerations from the experience with the PROSA and the ABMP PDF fits.

Excursion / 79

Guided Tour of Perugia Downtown (for registered participants)

Meeting point for Tour Leaders and Participants:
- hotel "La Rosetta" at 4:30 PM

Excursion / 80

free time in Perugia downtown

Excursion / 81

free time in Perugia downtown

WG1 / 82

WG1 (Minimum Bias and Underlying Event) - Summary

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WG1 / 83

Discussion

WG2 / 84

WG2 (MC Generators and Tuning) - Summary

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WG2 / 85

Discussion

WG3 / 86

WG3 (Double Parton Scattering) - Summary

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WG3 / 87

Discussion

WG5 / 88

WG5 (Low x and Diffraction) - Summary

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WG5 / 89

Discussion

Steering / 90

Introduction

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Steering / 91

next host candidature: Prague

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Steering / 92

next host candidatures: Others

WG4 / 93

WG4 (High Multiplicity) - Summary

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WG4 / 94

Discussion

WG6 / 95

WG6 (Heavy Ions) - Summary

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WG6 / 96

Discussion