

Opportunities of OO and pO collisions at the LHC



Report of Contributions

Contribution ID: 1

Type: **not specified**

Preparing the CERN Ion Injector Chain for an LHC Oxygen Run

Thursday 4 February 2021 14:30 (30 minutes)

The preparation of the CERN Ion Injector Chain for an LHC Oxygen Run is not straight forward because the Complex has been designed to deliver Lead beams with a very low radiological impact. With Oxygen beams, initial simulations indicate that we cross the safety borders in terms of personnel and equipment protection. Therefore, special measurements need to be put in place. However, there is nonetheless something positive about Oxygen production, it gives much more beam intensity than Lead, which is really an advantage because LHC can quickly accumulate luminosity. In this talk we summarise the beam intensity expectation across the Ion Injector Complex up to the LHC injection, together with an explanation of the different studies and special measurements that have to be put in place to realise such a run in the CERN Ion Injector Chain.

Presenter: ALEMANY FERNANDEZ, Reyes (CERN)

Session Classification: Light-ion beams at the LHC

Contribution ID: 2

Type: **not specified**

LHC machine scenario for a short oxygen run

Thursday 4 February 2021 15:00 (30 minutes)

This talk discusses scenarios for a short oxygen run in the LHC in terms of needed commissioning, machine constraints, beam parameters, and estimated luminosity performance. Both O-O and p-O collisions are discussed.

Presenter: Dr BRUCE, Roderik (CERN)

Session Classification: Light-ion beams at the LHC

Contribution ID: 3

Type: **not specified**

Luminosity determination with heavy-ion beams at the LHC

Thursday 4 February 2021 15:30 (20 minutes)

Presenter: GAGLIARDI, Martino (Universita e INFN Torino (IT))

Session Classification: Light-ion beams at the LHC

Contribution ID: 7

Type: **not specified**

Eccentricities in collisions with 16O and 12C

Thursday 4 February 2021 16:30 (40 minutes)

I will cover eccentricities in collisions with 16O and also 12C, with emphasis on sensitivity to nuclear correlations, in particular, alpha clusterization. Realistic nuclear distribution will be considered and prospects of experimental signatures discussed.

Presenter: BRONIOWSKI, Wojciech (IFJ PAN)

Session Classification: Initial state

Contribution ID: 8

Type: **not specified**

Initial state and non-equilibrium dynamics in small and large systems

Thursday 4 February 2021 17:10 (40 minutes)

Presenter: Prof. SCHLICHTING, Soeren (Universität Bielefeld)

Session Classification: Initial state

Contribution ID: **10**

Type: **not specified**

Collectivity and QGP signals in Large and Small systems

Friday 5 February 2021 14:30 (40 minutes)

Presenter: ZHAO, Wenbin (Peking University)

Session Classification: Soft dynamics of small systems

Contribution ID: 11

Type: **not specified**

Dynamical Modeling of the Collectivity in pO and OO Collisions

Friday 5 February 2021 15:10 (40 minutes)

Small collision systems, such as pO and OO, can provide valuable information about the collisions' early-stage dynamics. They also present high sensitivity to initial state fluctuations at multiple length scales. In this talk, we employ the hybrid IP-Glasma + hydrodynamics + hadronic transport approach to simulate the pO and OO collisions' bulk dynamics at the LHC energies. All the model parameters were fixed in the large heavy-ion collisions. We will discuss the challenges of extrapolating the hydrodynamic description to these small systems and identify new aspects of the many-body properties of the hot QCD matter these small systems can probe.

Presenter: Dr SHEN, Chun (Wayne State University)

Session Classification: Soft dynamics of small systems

Contribution ID: 12

Type: **not specified**

Multiplicity and flow in O+O collisions from the EKRT model

Friday 5 February 2021 16:05 (30 minutes)

We extend the computed EKRT initial conditions from 5 TeV Pb+Pb collisions to O+O collisions at the same collision energy, and compute the subsequent fluid dynamical evolution. We show preliminary predictions for multiplicity and flow observables, and compare the results to the peripheral Pb+Pb collisions at the same collision energy and multiplicity.

Presenter: NIEMI, Harri (Johann Wolfgang Goethe-Universität)

Session Classification: Soft dynamics of small systems

Contribution ID: 13

Type: **not specified**

Bayesian Analysis of Oxygen-Oxygen Collisions

Friday 5 February 2021 16:35 (30 minutes)

We use the Trajectum heavy ion code to generate predictions for OO observables, where we use model parameters which are fitted to PbPb data. We subsequently use the OO predictions as mock data for a Bayesian analysis which includes both the PbPb and OO systems, which allows us to estimate the impact of the future addition of OO data on the quality of Bayesian analyses.

Presenter: NIJS, Govert (Massachusetts Institute of Technology)

Session Classification: Soft dynamics of small systems

Contribution ID: 20

Type: **not specified**

Opening

Thursday 4 February 2021 14:25 (5 minutes)

Presenter: MANGANO, Michelangelo (CERN)

Contribution ID: **21**

Type: **not specified**

Closing

Wednesday 10 February 2021 19:00 (5 minutes)

Contribution ID: 22

Type: **not specified**

Hadron yield ratios in dynamical core-corona initialization from small to large systems

Friday 5 February 2021 17:05 (20 minutes)

The quark-gluon plasma (QGP) formation in small colliding systems is implied from various experimental data at LHC and RHIC. Focusing on one of them, the particle yield ratio, we investigate a possibility of the QGP formation through the dynamical core-corona initialization (DCCI) model. We extend the conventional core-corona picture introducing it into the dynamical initialization framework and demonstrate a dynamical separation of core and corona. In this talk, I give motivation and detailed modeling of the DCCI, and show results of particle yield ratios as a function of multiplicity in p-p, p-Pb and Pb-Pb collisions. I also mention some thoughts on particle yield ratios in p-O and O-O collisions.

Presenters: HIRANO, Tetsufumi (Sophia Univ); KANAKUBO, Yuuka (Sophia Univ.)

Session Classification: Soft dynamics of small systems

Contribution ID: 23

Type: **not specified**

Current status of nPDFs and prospects for pO and OO collisions

Monday 8 February 2021 14:30 (40 minutes)

The global analyses of nuclear parton distribution functions (nPDFs) are going through a phase of rapid development, driven mainly by new constraints from the CERN LHC proton–lead program, and attracting also new groups to join the field. In this talk, I will review the current status of nPDF global analyses. I will concentrate on the opportunities with lighter-ion runs at the LHC and in particular on the prospects of the proposed proton–oxygen (pO) and oxygen–oxygen (OO) collisions in constraining the mass-number dependence of the nPDFs. As a case study, I will present predictions for dijet production at pO, which has a sizable cross section at the 9.9 TeV collision energy and can thus be expected to give constraints for gluon nuclear modifications even at relatively low luminosities.

Presenter: PAAKKINEN, Petja (IGFAE - Universidade de Santiago de Compostela)

Session Classification: Hard probes in pO and OO

Contribution ID: 24

Type: **not specified**

Discovering partonic rescattering in light nucleus collisions

Monday 8 February 2021 15:10 (30 minutes)

Presenter: HUSS, Alexander Yohei (CERN)

Session Classification: Hard probes in pO and OO

Contribution ID: 25

Type: **not specified**

Jet Quenching from light to dense systems

Monday 8 February 2021 15:55 (30 minutes)

Results on pA collisions have demonstrated the potential of light systems in achieving the most surprising discoveries. The presence of fluid-like behaviour and their implications motivate further the determination of the necessary conditions that mark the onset of the QGP phase. Intermediate systems, like pO and OO, will be invaluable to a successful unified particle production description from small (pp) to larger (AA) systems. Signatures of medium-induced modifications in the hard sector were, so far, nonexistent, or quite limited, putting additional stress on the accurate determination of theoretical and experimental uncertainties. In this talk, we aim to discuss novel theoretical and experimental methodologies, focusing on pO and OO, to characterise the short-wavelength QGP properties with unprecedented precision.

Presenter: APOLINARIO, Liliana (LIP (PT))

Session Classification: Hard probes in pO and OO

Contribution ID: 26

Type: **not specified**

The elusive energy loss signal of the Quark Gluon Plasma in OO collisions

Monday 8 February 2021 16:25 (40 minutes)

Presenter: Prof. NORONHA-HOSTLER, Jacquelyn (University of Illinois Urbana Champaign)

Session Classification: Hard probes in pO and OO

Contribution ID: 27

Type: **not specified**

ALICE goals and projections for hard probes measurements

Tuesday 9 February 2021 14:30 (20 minutes)

Presenter: VISLAVICIUS, Vytautas (University of Copenhagen (DK))

Session Classification: Experimental opportunities with OO and pO

Contribution ID: 28

Type: **not specified**

ATLAS contribution

Tuesday 9 February 2021 15:10 (40 minutes)

Presenter: SICKLES, Anne Marie (Univ. Illinois at Urbana Champaign (US))

Session Classification: Experimental opportunities with OO and pO

Contribution ID: 29

Type: **not specified**

Physics opportunities with oxygen collisions in CMS

Tuesday 9 February 2021 16:05 (40 minutes)

Oxygen on oxygen, proton oxygen and photon oxygen collisions at the LHC offer rich physics opportunities both in themselves and as compliments to the current lead based heavy ion program. The extensive rapidity coverage, excellent event reconstruction, and flexible trigger system of CMS make it an ideal detector for exploiting such opportunities. This talk will review potential oxygen measurements with CMS and describe some of the challenges in making such measurements a reality.

Presenter: MURRAY, Michael (The University of Kansas (US))

Session Classification: Experimental opportunities with OO and pO

Contribution ID: 30

Type: **not specified**

Oxygen beams and LHCb: prospects of pO and OO collisions for nuclear and astroparticle physics

Tuesday 9 February 2021 16:45 (20 minutes)

Presenter: Dr DEMBINSKI, Hans Peter (TU Dortmund)

Session Classification: Experimental opportunities with OO and pO

Contribution ID: 31

Type: **not specified**

Oxygen beams and LHCb: prospects of collisions with fixed-targets

Tuesday 9 February 2021 17:05 (20 minutes)

The LHCb experiment has the unique possibility, among the LHC experiments, to be operated in fixed target mode using its internal gas target. After reviewing the results achieved so far in the fixed target configuration, we will discuss prospects for the incoming run, where, thanks to the upgraded target system, a significant improvement in luminosity and a wider choice of the target gas are expected.

The possibility of running with oxygen beams offers novel possibilities for nuclear and astroparticle physics. In particular, collisions of O beams on a hydrogen target can provide measurements of identified charged particle production up to very forward rapidity in the O nucleus rest frame.

Presenter: GRAZIANI, Giacomo (INFN, Sezione di Firenze (IT))

Session Classification: Experimental opportunities with OO and pO

Contribution ID: 32

Type: **not specified**

LHCf achievements at pp and pPb

Wednesday 10 February 2021 14:30 (15 minutes)

The aim of the LHC forward (LHCf) experiment is to provide critical data to test and tune hadronic interaction models used for very high energy cosmic-ray interactions. LHCf measures neutral particles, photons, neutrinos and π^0 s, at very forward region of LHC collisions, and these energetic particles significantly contribute air shower development induced by cosmic-rays. LHCf had several operations with pp and pPb collisions during Run1 and Run2 and published several results. In this talk, we will discuss about these achievement as an introduction of the following talk focusing on pO.

Presenters: MENJO, Hiroaki (Nagoya University (JP)); MENJO, Hiroaki (Nagoya University (JP))

Session Classification: pO for cosmic-ray physics

Contribution ID: 33

Type: **not specified**

Hadronic interactions and air showers : the need of Oxygen beam with LHCf

Wednesday 10 February 2021 15:10 (40 minutes)

In detailed air shower simulations, the uncertainty in the prediction of shower observable for different primary particles and energies is currently dominated by differences between hadronic interaction models. With the general results of the first run of the LHC, the difference between post-LHC model predictions has been reduced at the same level than experimental uncertainties of cosmic ray experiments for X_{\max} measurements, but a deficit in muon production in simulation remains. At the same time new type of air shower observable, like the muon production depth, has been measured adding new constraints on hadronic models. Currently no model is able to reproduce consistently all mass composition measurement possible within the Pierre Auger Observatory for instance. In parallel, only few new measurements at LHC are providing new tests of the models which could help understanding the remaining differences between observed and simulated air showers. LHCf is the only LHC experiment testing the model used for such simulations in the relevant phase space and in combination with central trigger. The measurements in Run 1 and 2, already showed deficiency in the models. Results of LHCf with Oxygen beam which will include the nuclear effects missing in p-p collisions, as originally planed in Run 3, would be crucial to get enough information to solve the problems observed in a proper way and early enough that it can still be applied in the analysis of the current largest cosmic ray experiments.

Presenter: Dr PIEROG, Tanguy (KIT)

Session Classification: pO for cosmic-ray physics

Contribution ID: 34

Type: **not specified**

A Pythia/Angantyr perspective on OO and pO collisions

Wednesday 10 February 2021 17:10 (40 minutes)

Presenter: BIERLICH, Christian (Lund University (SE))

Session Classification: Soft dynamics of small systems

Contribution ID: 35

Type: **not specified**

STAR contribution

Wednesday 10 February 2021 16:50 (20 minutes)

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

Session Classification: Experimental opportunities with OO and pO

Contribution ID: **36**

Type: **not specified**

sPHENIX contribution

Wednesday 10 February 2021 16:30 (20 minutes)

Presenter: PEREPELITSA, Dennis (University of Colorado Boulder)

Session Classification: Experimental opportunities with OO and pO

Contribution ID: 37

Type: **not specified**

ALICE goals and projections for flow and hadron production/interaction measurements

Tuesday 9 February 2021 14:50 (20 minutes)

Presenter: ALTSYBEEV, Igor (St Petersburg State University (RU))

Session Classification: Experimental opportunities with OO and pO

Contribution ID: 38

Type: **not specified**

γ -hadron spectra in $p + \text{Pb}$ collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV

Monday 8 February 2021 17:05 (20 minutes)

Under the assumption that a quark-gluon plasma droplet is produced and its evolution can be described by hydrodynamics in $p + A$ collisions, γ -triggered hadron spectra \cite{Wang:1996yh, Zhang:2009rn} are studied within a next-to-leading-order perturbative QCD parton model with the medium-modified parton fragmentation functions. The initial conditions and space-time evolution of the small QGP droplet are provided by the superSONIC hydrodynamic model \cite{Weller:2017tsr} simulations and parton energy loss in such a medium is described by the high-twist (HT) approach \cite{Wang:2009qb}. The range of scaled jet transport coefficient \hat{q}_0/T_0^3 in this HT approach is extracted from single hadron suppression in $A + A$ collisions with similar initial medium temperature as in $p + A$ collisions. Numerical results for this scenario show that γ -hadron spectra at $p_T^\gamma = 12 - 40$ GeV/ c are suppressed by 5 - 15% in the most central 0 - 10% $p + \text{Pb}$ collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV. The suppression becomes weaker at higher transverse momentum of the γ trigger. As a comparison, γ -hadron suppression in $\text{Pb} + \text{Pb}$ collisions at $\sqrt{s_{\text{NN}}} = 2.76$ and 5.02 TeV is also predicted.

Presenter: XIE, Man (Central China Normal University)

Session Classification: Hard probes in pO and OO

Contribution ID: 39

Type: **not specified**

LHCf motivations and prospects of p-O collisions

Wednesday 10 February 2021 14:45 (25 minutes)

A proton-oxygen run at the LHC would be a unique opportunity to reproduce the collision of a cosmic ray with a light nucleus of the atmosphere. The LHCf experiment will have the possibility to perform direct measurements of the very-forward neutral particle production and the nuclear modification factor without the need of an interpolation of the results in proton-proton and proton-lead collisions. Another advantage of p-O collision is the much smaller contribution of Ultra Peripheral Collisions to the particle production with respect to the p-Pb case, which will lead to more precise measurements for the tuning of the phenomenological hadronic interaction models. LHCf will be able to operate both on the p-remnant and O-remnant side with a dedicated low-luminosity run. A common operation with the ATLAS ZDC is also under discussion.

Presenter: TIBERIO, Alessio (Universita e INFN, Firenze (IT))

Session Classification: pO for cosmic-ray physics

Contribution ID: 40

Type: **not specified**

Discussion on machine development and luminosity

Thursday 4 February 2021 15:50 (25 minutes)

Presenters: KRINTIRAS, Georgios (The University of Kansas (US)); INNOCENTI, Gian Michele (CERN); JOWETT, John (GSI - Helmholtzzentrum für Schwerionenforschung GmbH (DE))

Session Classification: Discussion

Contribution ID: 41

Type: **not specified**

Discussion on initial state

Thursday 4 February 2021 18:05 (25 minutes)

Presenters: GIACALONE, Giuliano (Université Paris-Saclay); JIA, Jiangyong (Stony Brook University (US)); YIN, Yi (IMP)

Session Classification: Discussion

Contribution ID: 42

Type: **not specified**

Discussion on hydrodynamic modelling

Friday 5 February 2021 17:40 (50 minutes)

Presenters: SCHENKE, Bjoern (Brookhaven National Lab); PAQUET, Jean-Francois (Duke University); ZHOU, You (Niels Bohr Institute (DK))

Session Classification: Discussion

Contribution ID: 43

Type: **not specified**

Discussion session on hard probes

Monday 8 February 2021 17:40 (50 minutes)

Presenters: ANDRES, Carlota (LIP, Lisbon); VAN LEEUWEN, Marco (Nikhef National institute for subatomic physics (NL)); WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Session Classification: Discussion

Contribution ID: 44

Type: **not specified**

Discussion on experimental opportunities

Tuesday 9 February 2021 17:40 (50 minutes)

Presenters: OHLSON, Alice (Lund University (SE)); MILHANO, Guilherme (LIP-Lisbon & CERN TH); LEE, Yen-Jie (Massachusetts Inst. of Technology (US))

Session Classification: Discussion

Contribution ID: 45

Type: **not specified**

Discussion on forward physics and cosmic rays

Wednesday 10 February 2021 15:50 (25 minutes)

Presenters: TRICOMI, Alessia (Universita e INFN, Catania (IT)); D'ENTERRIA, David (CERN)

Session Classification: Discussion

Contribution ID: 46

Type: **not specified**

Discussion on on Monte Carlo modelling and experimental opportunities at RHIC

Wednesday 10 February 2021 17:50 (25 minutes)

Presenters: KARPENKO, Iurii (SUBATECH Nantes); TRIBEDY, Prithwish (Brookhaven National Lab); KUNNAWALKAM ELAYAVALLI, Raghav (Yale University)

Session Classification: Discussion

Contribution ID: 47

Type: **not specified**

Workshop summary

Wednesday 10 February 2021 18:30 (30 minutes)

Presenters: Dr MAZELIAUSKAS, Aleksas (CERN); BREWER, Jasmine Therese (CERN); Dr VAN DER SCHEE, Wilke (CERN)

Session Classification: Discussion