

XLV International Symposium on Multiparticle Dynamics

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Book of Abstracts

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Proton Structure from ep and pp / 0

Combination of Measurements of Inclusive Deep Inelastic ep Scattering Cross Sections and QCD Analysis of HERA data

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A combination is presented of all inclusive deep inelastic cross sections previously published by the H1 and ZEUS collaborations at HERA for neutral and charged current ep scattering for zero beam polarisation. The data correspond to an integrated luminosity of about 1 fb^{-1} and span six orders of magnitude in negative four-momentum-transfer squared, Q^2 , and Bjorken x . The correlations of the systematic uncertainties were evaluated and taken into account for the combination. The combined cross sections were input to QCD analyses at LO, NLO and at NNLO, providing a new set of parton distribution functions, HERAPDF2.0. The analysis was extended by including HERA data on charm and jet production. The inclusion of jet-production cross sections made a simultaneous determination of these parton distributions and the strong coupling constant possible. An extraction of $x\text{F}_3(\gamma\text{Z})$ and results on electroweak unification and scaling violations are also presented.

Proton Structure from ep and pp / 1

Combination of D^* Differential Cross-Section Measurements in Deep-Inelastic ep Scattering at HERA

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H1 and ZEUS have published single-differential cross sections for inclusive *Dmeson production in deep-inelastic ep scattering at HERA from their respective final data sets. These cross sections are combined in the common visible phase space region of photon virtuality $Q^2 > 5 \text{ GeV}^2$, electron inelasticity $0.02 < y < 0.7$ and the D meson's transverse momentum $p_T(D) > 1.5 \text{ GeV}$ and pseudorapidity $|\eta(D)| < 1.5$. The combination procedure takes into account all relevant correlations yielding significantly reduced experimental uncertainties. To extend the kinematic range down to $Q^2 > 1.5 \text{ GeV}^2$, double-differential cross sections are also combined with a subset of earlier D^* data. Perturbative next-to-leading order QCD predictions are compared to the results.*

High Energy and High Pt Interactions / 2

Search for QCD Instanton-Induced Processes in DIS at HERA

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Signals of QCD instanton-induced processes are searched for in deep-inelastic scattering (DIS) at the electron-proton collider HERA in the kinematic region defined by the Bjorken-scaling variable $x > 10^{-3}$, the inelasticity $0.2 < y < 0.7$ and the photon virtuality $150 < Q^2 < 15000 \text{ GeV}^2$. The

search is performed using H1 data corresponding to an integrated luminosity of $\sim 350 \text{ pb}^{-1}$. Several observables of the hadronic final state of the events are exploited to identify a potentially instanton-enriched domain. Two Monte Carlo models, RAPGAP and ARIADNE, are used to estimate the background from the standard DIS processes, and the instanton-induced scattering processes are modeled by the program QCDINS. In order to extract the expected signal a multivariate data analysis technique is used.

Poster session / 9

PERSPECTIVE STUDY OF EXOTICS AND BARYONS WITH CHARM AND STRANGENESS

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The spectroscopy of exotics states with hidden charm together with the spectroscopy of charmed and strange baryons is discussed. It is a good testing tool for the theories of strong interactions, including: QCD in both the perturbative and non-perturbative regimes, LQCD, potential models and phenomenological models. An understanding of the baryon spectrum is one of the primary goals of non-perturbative QCD. For this purpose an elaborated analysis of charmed hybrids and tetraquark spectrum together with spectrum of charmed and strange baryons is given. The recent experimental data are analyzed. But much more data on different decay modes are needed before firmer conclusions can be made. These data can be derived directly from the experiments using a high quality antiproton beam with momentum up to 15 GeV/c planned at FAIR and proton-proton collisions with momentum up to 26 GeV/c planned at the superconducting accelerator complex NICA that is being built in Dubna nowadays.

Poster session / 10

Colour Inside Environment

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V.I.Kuvshinov

It is shown that in the model of stochastic QCD vacuum colour quark confinement can be described as decoherence of pure colour state of the particle into the mixed quantum state with equal probabilities for different colours as a result of density matrix evolution. Quantum functions of Purity, Fidelity and von Neuman entropy for one- and multi-particles states are calculated.

Soft photon yield in nuclear interactions at Nuclotron

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First results of soft photon study in nuclear interactions at 3.5 GeV per nucleon are presented. These photons have been registered at Nuclotron (LHEP, JINR) by an electromagnetic calorimeter built of SVD Collaboration. The obtained spectra confirm the excess yield in the energy region less than 50 MeV in comparison with theoretical predictions and agree with previous experiments at high-energy interactions.

Poster session / 12

Two Component model for hadroproduction: from pp to heavy-ion collisions

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The transverse momentum spectra of hadrons produced in high energy collisions can be decomposed into the two components: the exponential ("thermal") and the power ("hard") ones. Thus, charged hadron spectra produced in proton-proton and heavy-ion collisions from ISR to LHC are considered simultaneously within this model. The parameters of the model are found to vary with the type of the collision, the charged multiplicity and the measured pseudorapidity region. We discuss the possible origin of this effect, and speculate that it is linked to confinement. Moreover, the proposed model allows to extract the thermal hadron production from the whole statistical ensemble and for the case of heavy-ion collisions the change in the particle production dynamics is observed when reaching the critical temperature.

Finally, the observed dependences are used to make predictions on the charged hadron production at LHC-energies, which are tested on already available experimental data.

Multiparticle Correlations and Fluctuations / 13

The tau-model of Bose-Einstein correlations – recent results

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Some new results concerning the tau-model of Bose-Einstein correlations will be presented.

Multiparticle Correlations and Fluctuations / 14

Searching for hidden sectors in multiparticle production at the LHC

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Most signatures of new physics beyond the Standard Model have been studied on the transverse plane with respect to the beam direction. In this work we rather consider the effect of a hidden sector (i.e. Hidden Valley model) on rapidity correlations, moments and cumulants of multiplicity distributions in multiparticle production with an special emphasis in the prospects for the forthcoming LHC results.

Status of QCD / 15

Deconfinement and Equation of State in QCD

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I will review the current status of equation of state calculations and deconfinement transition in 2+1 flavor QCD obtained using lattice calculations. I will discuss aspects of deconfinement related to fluctuations of conserved charges and screening of color charges in the deconfined medium using expectation value of Polyakov loop and Polyakov loop correlators.

Status of QCD / 16

Determination of α_s from the QCD static energy

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We present the latest determination of the strong-coupling constant from the quantum chromodynamics static energy. It comes from comparing three-loop perturbative QCD with 2+1 unquenched lattice data and provides up to date one of the most accurate low-energy determinations of α_s .

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Strangeness enhancements in heavy-ion collisions from SPS to LHC

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The study of strange and multi-strange particle production in high-energy collisions of heavy nuclei is considered as a unique tool to investigate the properties of the hot and dense matter created in the course of collision. These processes are sensitive to the reaction dynamics, as there is no net strangeness content in the initial state of colliding nuclei. In particular, an enhanced production of strange particles in A-A with respect to p-p interactions was one of the earliest proposed signatures of a deconfined QGP creation. The results of strangeness enhancement measurements from the WA97/NA57 (SPS), STAR (RHIC) and ALICE (LHC) experiments are briefly reviewed. The energy, centrality and strangeness content dependencies of enhancements are discussed.

Poster session / 18

Recent results on low-energy e+e- annihilation into hadrons obtained using initial state radiation with the BABAR detector

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The BABAR Collaboration has an extensive program of studying hadronic cross sections in e+e- collisions at low-energies, which are accessible at center-of-mass energy of about 10.6 GeV via initial-state radiation. Our measurements allow significant improvements in the precision of the predicted value of the muon anomalous magnetic moment. We report here the most recent results on several processes, including e+e- → K_S⁰ K⁺ π⁰ and e+e- → K_S⁰ K⁺ π⁺ η. Each cross section is measured up to 4.5 GeV and the internal structure of the final hadronic states is studied. With the same technique we have also studied the charge asymmetry in the e+e- → π⁺π⁻ and μ⁺μ⁻ reactions. The measured asymmetry is compared with QED predictions for muons, and theoretical models for pions. A clear interference pattern is observed for pions in the vicinity of the f₂(1270) resonance.

Diffraction and Pomeron / 20

Diffractive phenomenology and Pomeron physics at the LHC era

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It is shown that “soft” proton-proton collisions at the LHC, from 2 TeV and beyond are dominated by Pomeron exchange. This is quantified e.g. by fitting the elastic scattering cross-section to the available (7 and 8 TeV) data, where the contribution from secondary Reggeons is shown to be smaller than the relevant experimental errors. A tiny Odderon contribution is also scrutinized and its parameters are defined. Due to Pomeron dominance, Regge factorization can be effectively used to relate e.g. double diffraction dissociation (DD) to single proton dissociation (SD) and elastic scattering. Predictions for SD and DD cross sections and their ratios for the RUN-2 LHC measurements are obtained. A dipole Pomeron model of diffractions dissociation compatible with unitarity is constructed and a dip in the t dependence of SD cross section around -1 GeV is predicted.

Poster session / 21

Flavor Tagging TeV Jets for BSM and QCD

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We present a new scheme for tagging b-jets with $p_T > 500$ GeV called “mu_x tagging.” At the LHC, the primary method to tag b-jets relies on tracking their charged constituents. However, when highly boosted, track-based b-tags lose efficiency, and the probability to mistag light jets rises dramatically. Using muons from B hadron decay and defining a particular combination “x” of angular information and boost estimation, we find fairly flat efficiencies to tag b-jets, c-jets and light-jets of $\epsilon_b = 14\%$, $\epsilon_c = 6.5\%$, and $\epsilon_{\text{light}} = 0.65\%$, respectively. We demonstrate the usefulness of this new scheme by showing the reach for discovery of a leptophobic Z' in the dijet channel.

Multiparticle Correlations and Fluctuations / 22

Quantum properties of QCD string fragmentation

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A simple quantization concept for a 3-dim QCD string is used to derive properties of QCD flux tube from the mass spectrum of light mesons and to predict observable quantum effects in correlations between adjacent hadrons. The quantized fragmentation model is presented and compared with experimental observations.

Poster session / 23

Status and prospects of the search for neutrinoless double-beta decay with the CUORE experiment

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The CUORE experiment, expected to start operations in early 2016, will search for neutrinoless double beta decay of ^{130}Te and will be one of the most competitive neutrinoless double beta decay experiments in the near future.

Its demonstrator (CUORE-0) has reported in 2015 no evidence for neutrinoless double-beta decay and placed a lower bound on the decay half-life, $T(0\nu)1/2 > 2.7 \times 10^{24}$ yr at 90% C.L.

The CUORE projected sensitivity is 9.5×10^{25} yr at the 90% confidence level, which corresponds to an upper limit on the effective Majorana mass in the range of 50–130 meV.

I will discuss the status of the CUORE experiment and give a brief update on the background rejection techniques that may significantly improve the search sensitivity of bolometric detectors to fully explore the inverted neutrino mass hierarchy.

Multiparticle Correlations and Fluctuations / 24

The Study of Two Anti-proton Interaction via Correlation Measurement at STAR

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The two-particle correlation at small relative momenta is influenced by the nuclear force between two particles, which has been intensively studied for nucleons or nuclei but not much for anti-nucleons or anti-nuclei. In this talk, we present the (anti)proton-(anti)proton correlation function in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV based on data taken by the STAR experiment at RHIC. We show the attractive nuclear force between two anti-protons, and present the measurement of the two key parameters that characterize the corresponding strong interaction, namely, the scattering length and the effective range. Our measurement serves as a useful verification of CPT symmetry. Of equal importance as a direct knowledge of the interaction among two anti-protons, the simplest system of antinucleons(nuclei), our result provides a fundamental ingredient towards understanding the structure of more sophisticated anti-nuclei and their properties.

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Study the particle transverse-momentum spectra at LHC with nonextensive statistics

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The hydro-dynamics inspired thermal approach - Blast-Wave (BW) model - implemented with non-extensive Tsallis statistics (TBW) has gained increasing interest in heavy-ion physics. With the come out of recent LHC results on particle production of various species, it is a good opportunity to use this approach to interpret the data. The p_T spectra, from both p+p and Pb+Pb collisions, are systematically studied within TBW model, and compared to the RHIC results. Good agreement between the data and the fit is achieved over a broad kinetic range - 0-10 GeV/c for p+p collisions and 0-5 GeV/c for Pb+Pb collisions. A detailed fit to non-strange, single-strange and multi-strange particle species separately will be given. Together with the observations at lower energy, the physics implication of the particle production during the fireball evolution in heavy-ion collisions will be discussed.

Diffraction and Pomeron / 26

A model for soft interactions based on the CGC/saturation approach

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I discuss a model based on Coloured-Glass-Condensate/saturation and the BFKL Pomeron. I show that this model successfully describes the elastic, diffractive and inclusive data at LHC energies. The talk is based on material appearing in arXiv:1408.3811, arXiv:a502.05202 and arXiv: 1503.04294

Proton Structure from ep and pp / 27

Measurement of the Collins asymmetries for kaons and pions in e+e- annihilation at BABAR

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Inclusive hadron production cross sections and angular distributions in e+e- collisions shed light on fundamental questions of hadronization and fragmentation processes. We present measurements of the Collins azimuthal asymmetries in inclusive production of hadron pairs, in the e+e- → h1 h2 X annihilation process, where the hadrons (either kaons or pions) are produced in opposite hemispheres.

The data collected by the BABAR detector allow the determination of the Collins fragmentation function as a function of hadron fractional energies and transverse momenta for the up, down and strange quarks. These data can be combined with semi-inclusive deep-inelastic-scattering data to extract the transversity distribution function, which is the least known leading-twist component of the QCD description of the partonic structure of the nucleon.

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On the chaoticity dependence on energy deduced from Bose-Einstein correlations of pion-pairs produced in pp collisions

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The energy dependence of the strength parameter also called the chaoticity, derived from Bose-Einstein correlations (BEC) of pion-pairs produced in proton-proton collisions is investigated. Considered are the one and three dimensions (1D, 3D) of the BEC analyzed in terms of a Gaussian and / or exponential distributions. A marked difference is observed between the dependence of the chaoticity on energy in the 1D and the 3D analyses. The experimental data are examined in terms of the relation between the pion sources and the BEC dimension R which in turn are deduced from the charged outgoing particle multiplicity. This approach follows the 1D chaoticity general energy behavior as obtained from the BEC analyzes of the proton-proton collision data. Prediction for the chaoticity dependence on energy is obtained over a multi-TeV energy range based on a model of independent pion sources. The decrease of the chaoticity value with energy is expected within the framework of this approach.

Astroparticle Physics / 29

Measurement of the muon content in air showers at the Pierre Auger Observatory

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The muon content of extensive air showers produced by the ultra-high energy cosmic rays is an observable sensitive to the composition of the primary particle and to the properties of hadronic interactions driving the air-shower cascade. We present different methods to estimate the muon number at the ground and the muon production depth using measurements of the longitudinal, lateral, and temporal distribution of particles in the air showers recorded by the Pierre Auger Observatory. The results, obtained at about 140 TeV center-of-mass energy for proton primaries, are compared to the predictions of LHC-tuned hadronic interaction models for different primary masses. The models exhibit a deficit in the predicted muon content. The Pierre Auger Observatory is a hybrid detector sensitive to muons and the combination of these results with other independent mass composition analyses such as Xmax provides additional constraints on hadronic interaction models for energies beyond the LHC reach.

Collective Phenomena in High Energy Collisions / 30

De-Confinement in small systems: Clustering of color sources in high multiplicity pbar-p collisions at $\sqrt{s}=1.8$ TeV

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It is shown that de-confinement can be achieved in high multiplicity non jet $\bar{p}p$ collisions at $\sqrt{s}=1.8$ TeV Fermi National Accelerator Laboratory(FNAL- E735) experiment. In this paper we use the same data but analyze the transverse momentum spectrum in the framework of the clustering of color sources. This frame-work naturally predicts the reduction in the charged particle multiplicity with respect to the value expected from the number of independent strings. The initial temperature and energy density are obtained from the data via the color reduction factor $F(\xi)$ and the associated string density parameter ξ . The energy density $(\varepsilon/T^4) \sim 11.5$ for $\langle dN_c/d\eta \rangle \sim 25.0$ is close to the value for 0-10% central events in Au+Au collisions at $\sqrt{s_{NN}}=200$ GeV. The shear viscosity to entropy density ratio (η/s) is ~ 0.2 at the transition temperature of 167 MeV.

Astroparticle Physics / 31

Cosmic ray interaction models: an overview

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I shall review the state-of-the-art concerning the treatment of high energy cosmic ray interactions in the atmosphere, discussing in some detail the underlying physical concepts and presenting a comparison of model results with selected accelerator data. Further, the relation of basic characteristics of hadronic interactions with the properties of nuclear-electromagnetic cascades induced by primary cosmic rays in the atmosphere will be addressed.

Multiparticle Correlations and Fluctuations / 32

Bayesian model comparison for one-dimensional azimuthal correlations

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In the context of data modeling and comparisons between different fit models, Bayesian analysis calls that model best which has the largest evidence, the prior-weighted integral of the likelihood function over model parameters. Evidence calculations automatically take into account both the usual chi-squared measure and an Occam factor which quantifies the price for adding extra parameters. Applying Bayesian analysis to 1D projections onto azimuth of 2D angular correlations from 200 GeV AuAu collisions, we consider typical model choices including Fourier series and a Gaussian plus combinations of individual cosine components. A power-spectrum analysis is also performed. We find that models including a Gaussian component are consistently preferred over pure Fourier-series parametrizations, sometimes strongly so. For models including a Gaussian an additional cylindrical quadrupole is required in some cases but rejected for 0-5%-central collisions. Higher harmonics are always rejected.

Poster session / 33

Systematic study of real photon and Drell-Yan pair production in p+A (d+A) interactions

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We investigate nuclear effects in production of Drell-Yan pairs and direct photons in proton-nucleus collisions. For the first time, these effects are studied within the color dipole approach using the Green function formalism which naturally incorporates the color transparency and quantum coherence

effects. Numerical results for the nuclear modification factor are compared with available data. Besides, we present a variety of predictions for the nuclear suppression as function of transverse momentum p_T , rapidity and invariant mass of the lepton pair that can be verified by experiments at RHIC and LHC. We found that the nuclear suppression is caused predominantly by effects of quantum coherence (shadowing corrections) and by the effective energy loss induced by multiple initial state interactions. Whereas the former dominates at small Bjorken x_2 in the target, the latter turns out to be significant at large x_1 in the projectile beam and is universal at different energies and p_T .

Diffraction and Pomeron / 34

Evidence for Non-Exponential Elastic Proton-Proton Differential Cross-Section at Low $|t|$ and $\sqrt{s} = 8$ TeV by TOTEM

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The TOTEM experiment has made a precise measurement of the elastic proton-proton differential cross-section at the centre-of-mass energy $\sqrt{s} = 8$ TeV based on a high-statistics data sample obtained with the $\beta^* = 90$ optics. Both the statistical and systematic uncertainties remain below 1%, except for the t -independent contribution from the overall normalisation. This unprecedented precision allows to exclude a purely exponential differential cross-section in the range of four-momentum transfer squared $0.027 < |t| < 0.2$ GeV² with a significance greater than 7 sigma. Two extended parametrisations, with quadratic and cubic polynomials in the exponent, are shown to be well compatible with the data.

In this invited talk, presented for the TOTEM Collaboration, I will also overview the present status, the recent preliminary results and the upgrade plans of the TOTEM experiment at CERN LHC.

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Study of baryonic decays of B mesons at BABAR

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We report on recent searches for baryonic B decays using the whole BABAR dataset of 471 million B anti-B pairs. Although about 7% of all B decays have baryons in the final state, known exclusive decay modes account for only about 10% of these decays, and very little is known about the mechanism of baryon production in weak decays or in the hadronization process. By studying such decays we can learn more about these mechanisms. We will report on recent analyses of several baryonic B decays and their resonant substructure, including the study of s - \bar{s} suppression in such decays, the study of threshold enhancement in the invariant baryon-antibaryon mass, and the observation of the decay $B_0 \rightarrow \Lambda_c \bar{p} K^+ K^-$.

Poster session / 36

Nuclear effects in direct photon and Drell-Yan production at the LHC

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Using the color dipole formalism we study production of direct photons and Drell-Yan pairs in pA interactions. Real photons and lepton pairs produced in a hard scattering are not accompanied with any final state interaction, either energy loss or absorption. Consequently, the associated observables may serve as more efficient and cleaner probes for nuclear modification effects than inclusive hadron production. We have shown that shadowing effects in production of lepton pairs coming from the coherence are suppressed at large invariant masses and at very large pT at mid-rapidities. Besides, we present a systematic analysis of the nuclear effects and perform predictions for nuclear suppression as a function of pT, rapidity and dilepton invariant mass that can be verified by the LHC experiments. We include and analyze also a contribution of coherent effects associated with gluon shadowing affecting the observables predominantly at small and medium-high pT.

Collective Phenomena in High Energy Collisions / 38

p-p minimum-bias dijets and nonjet quadrupole in relation to conjectured collectivity (flows) in high-energy nuclear collisions

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Recent observations of ridge-like structure in p-p and p-A angular correlations at the RHIC and LHC are interpreted to imply collective motion in smaller systems. It is argued that if correlations representing flows in A-A collisions appear in smaller systems collectivity must extend to the smaller systems. But the argument could be reversed to conclude that such structures appearing in A-A collisions may not imply flows. In this talk I present spectrum, correlation and fluctuation data from RHIC p-p and Au-Au collisions and p-p, p-Pb and Pb-Pb results from the LHC described accurately by a two-component (soft+dijet) model of hadron production. I also present a significant p-p nonjet (NJ) quadrupole (v_2) component with nch systematics directly related to A-A quadrupole systematics. The combined data suggest that soft, dijet and quadrupole components are independent of one another in all cases, inconsistent with hadron production from a common bulk medium exhibiting collective motion.

Poster session / 39

Jet production in the ColorFul NNLO framework

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In this talk I present the computer implementation of a general framework for NNLO calculations using the ColorFul NNLO subtraction scheme. This implementation identifies all singular regions automatically, assigns counter terms to them and if equipped with a phase space integrator, provides predictions for any IR-safe differential observable. The numerical framework will be illustrated through the case of 3-jet production in electron-positron annihilation.

Collective Phenomena in High Energy Collisions / 40

Overview of quarkonium production in heavy-ion collisions at LHC

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Quarkonium has been regarded as one of the golden probes for the deconfined phase transition to the quark-gluon plasma (QGP) since late 80's when the relativistic heavy-ion experiments started at AGS and SPS. The heavy quarkonia can be generated in gluon-gluon scatterings at early stage of the collision as the large momentum transfer is required. Later the binding potential between a quark and antiquark in quarkonium is screened by surrounding light quarks and antiquarks. Thus, the various quarkonium states are expected to be melt at different temperatures depending on their binding energies, which allows us to characterize the QCD phase transition. The suppression of the J/psi and Upsilon yields in Pb + Pb collisions was observed at the Large Hadron Collider (LHC). In this presentation, we review the quarkonium data at LHC, and discuss possible implications related to the propagation of quarkonia in the deconfined hot, dense matter.

Astroparticle Physics / 41

Extensive Air Shower and cosmic ray physics above 10^{17} eV

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Cosmic Rays above 10^{17} eV allow studying hadronic interactions at energies that can not be attained at accelerators yet.

At the same time hadronic interaction models have to be applied to the cosmic-ray induced air-shower cascades in atmosphere to infer the nature of cosmic rays. The reliability of air-shower simulations has become the source of one of the largest systematic uncertainty in the interpretation of cosmic-ray data due to the uncertainties in modeling the hadronic interaction driving the air-shower development.

In this presentation a review will be done on the current understanding of the nature of cosmic rays above 10^{17} eV, and on role of air showers as probes to test hadronic interaction models at energies well beyond those achieved at accelerators.

Poster session / 42

Particle production beyond the thermal model

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The statistical hadronization (or thermal) model yields good results when compared to e.g. hadron production rates in LHC heavy-ion data. However, the distribution functions in p_T , rapidity y and η clearly show deviations from thermal behaviour.

Such non-equilibrium effects can to a certain extent be accounted for in a relativistic diffusion model with three sources - two fragmentation sources, and a mid-rapidity source arising from gluon-gluon collisions - that merges with the thermal model only for time to infinity. Given the short interaction times of AuAu at RHIC or PbPb at LHC, the fragmentation sources still contribute substantially, providing good results when compared to $dN/d\eta$ distributions for produced charged hadrons from PHOBOS and ALICE, and also for asymmetric systems such as dAu at RHIC and pPb at LHC. The particle content of the sources is investigated as function of $\sqrt{s_{NN}}$ and found to differ substantially for central and fragmentation sources.

Astroparticle Physics / 43

Measurements of the proton-air cross section with high energy cosmic ray experiments.

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Detecting Ultra High Energies Cosmic Rays (UHECRs) enables us to measure the proton-air inelastic cross section σ_{p-air}^{inel} at energies that we are unable to access with particle accelerators. The proton-proton cross section σ_{p-p} is subsequently inferred from the proton-air cross section at these energies. UHECRs experiments have been reporting on the proton-air inelastic cross section starting with the Fly's Eye in 1984 at $\sqrt{s} = 30$ -TeV and ending with the most recent result of the Telescope Array experiment at $\sqrt{s} = 95$ -TeV in 2015. In this talk, I will present the methods and experimental results from some of these experiment.

Multiparticle Correlations and Fluctuations / 44

Universality of particle production and energy balance in hadronic and nuclear collisions

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Universality of multihadron production in AA and hadronic interactions is studied using collision energy and centrality dependencies of the measured charged particle mean multiplicity. The study uses the framework of an effective-energy approach combining the constituent quark picture and Landau relativistic hydrodynamics and relating hadronic and nuclear collisions. The energy dependence of the multiplicity and the pseudorapidity density of head-on AA collisions are well reproduced. The multiplicity centrality dependence reveals a new scaling between the measured and estimated pseudorapidity spectra. Using this scaling, called the energy balanced limiting fragmentation scaling, all centrality spectra are described. This elucidates the difference in centrality dependence of multiplicity at RHIC and LHC and also the RHIC midrapidity density vs multiplicity. A new regime in AA collisions is indicated at ~ 1 TeV. Predictions are made for the multiplicities in pp and AA collisions at LHC.

Collective Phenomena in High Energy Collisions / 45

Strong-Coupling Effects in a Plasma of Confining Gluons

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For the first time we investigate non-equilibrium dynamic properties of a plasma consisting of confining gluons resulting from Gribov quantization [1]. For this purpose we employ the infrared-improved Gribov dispersion relation of gluons in the kinetic theory setup in the relaxation time approximation and determine the exact in- and out-of-equilibrium evolution of the system. In the static case the resulting equation of state of the studied system provides a good qualitative description of the pure-gluon lattice QCD data down to the vicinity of the phase transition [2,3,4], thus permitting a study of the non-equilibrium phenomena in a plasma that exhibits crucial features of the QCD phase transition. In the case of local thermal equilibrium we observe Bjorken-like cooling of the boost-invariant expanding system. Out of equilibrium, by matching to the first order viscous hydrodynamics, we calculate bulk [3] and shear [5] viscosity of the system. We find significant enhancement of the bulk to shear viscosity ratio close to the transition temperature and its universal scaling behavior, in line with the one expected in a strongly-coupled theories [5]. We interpret the onset of strongly-coupled features in the system as the possible explanation of the close to perfect fluid behavior of the quark-gluon plasma.

References:

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- [2] D. Zwanziger, Phys. Rev. Lett. 94, 182301 (2005)
- [3] W. Florkowski, R. Ryblewski, N.Su, K.Tywoniuk, arXiv:1504.03176,
- [4] S. Borsanyi, G. Endrodi, Z. Fodor, S. D. Katz and K. K. Szabo, JHEP 1207, 056 (2012)
- [5] W. Florkowski, R. Ryblewski, N.Su, K.Tywoniuk, arXiv:1509.01242.

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J/psi production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV with ALICE at the LHC

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The ALICE Experiment at the Large Hadron Collider (LHC) provides excellent capabilities to study charmonium production at low transverse momentum (p_T). At central ($|y| < 0.9$) and forward rapidity ($2.5 < y < 4$), J/ψ are reconstructed via their leptonic decay channels down to $p_T = 0$. We will present ALICE results on the inclusive J/ψ nuclear modification factor R_{AA} as a function of collision centrality, rapidity and p_{T} , as well as results on the J/ψ $\langle p_T \rangle$ in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. At mid-rapidity, we will also report the separation of prompt and non-prompt J/ψ down to $p_{\mathrm{T}} = 1.3$ GeV/c. The measurements provide, in combination with results from lower energies and theoretical predictions, detailed information on the different mechanisms related to the presence of the hot medium produced in heavy-ion collisions.

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Hadronic resonances production in pp, p-Pb and Pb-Pb collisions measured by ALICE at the LHC

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Hadronic resonances are used to study the properties of the strongly interacting hot and dense matter produced in ultra-relativistic heavy-ion collisions. The medium produced in such collisions evolves through different stages, including an early partonic phase which is succeeded by a hadronic phase. Since resonance yields may be modified by rescattering and regeneration after hadronization, they can be used to study the properties of the hadronic phase. Furthermore, resonances can also be used in the systematic study of the baryon to meson anomaly at intermediate- p_T as well as understanding the flavor dependence of parton energy loss at high- p_T . The ALICE collaboration has performed a comprehensive set of resonance measurements in pp, p-Pb as well as Pb-Pb collisions at LHC energies. These measurements include the p_T spectra, integrated yields, mean p_T , nuclear modification factors and p_T -differential ratios which will be presented and compared to theoretical model predictions.

Poster session / 48

Event-by-event dynamical fluctuations of K/π , p/π , and K/p in Pb-Pb collisions with ALICE

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Non-statistical event-by-event fluctuations in relativistic heavy ion collisions have been proposed as probe of phase instabilities near the QCD phase transition. The observable v_{dyn} , which is given in terms of the moments of identified-particle multiplicity distributions, is used to quantify the magnitude of the dynamical fluctuations in event-by-event measurements of given particle ratios. The ALICE detector at the LHC is well suited for the study of v_{dyn} , due to its excellent particle identification capabilities. Particle identification that is based on the measurement of the specific ionization energy loss dE/dx works well on a statistical basis, however, suffers from ambiguities when applied on the event-by-event level. A novel experimental technique called the "Identity Method" was recently proposed to overcome such limitations. In this contribution, we will present

results for v_{dyn} for K/π , p/π , and K/p , which applies the Identity Method to Pb-Pb data from ALICE.

Collective Phenomena in High Energy Collisions / 49

Recent results from NA61/SHINE

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The aim of the NA61/SHINE ion programme is to explore the phase diagram of strongly interacting matter. The main physics goals are the study of the onset of deconfinement and the search for the critical point of strongly interacting matter. These goals are pursued by performing an beam momentum (13A - 158A GeV/c) and system size (p+p, p+Pb, Be+Be, Ar+Sc, Xe+La) scan.

This contribution reviews results and plans of the NA61/SHINE experiment. In particular, recent inclusive spectra of identified hadrons in inelastic p+p and centrality selected Be+Be interactions at the SPS energies will be shown.

The energy dependence of the signals of deconfinement, the “horn”, “step” and “kink”, show interesting behaviour in p+p interactions. Furthermore, the Be+Be data suggest collective flow to develop even in collisions of relatively light nuclei.

Status of QCD / 50

Parton distribution functions and the structure of the proton: the CT14 QCD global analysis

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An overview on the new parton distribution functions (PDFs) up to next-to-next-to-leading order (NNLO) from the CT14-TEA global analysis of quantum chromodynamics will be given.

Predictions for important LHC processes, especially Higgs boson and top-quark pair production at 7, 8, 13 TeV, will be presented, and main features and impact of CT14 PDFs on LHC physics will be discussed.

Diffraction and Pomeron / 51

Hard diffraction in Pythia8

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We present a new model for hard diffraction in Pythia8. The model uses the Pomeron approach pioneered by Ingelman and Schlein, factorising the diffractive cross section into a Pomeron flux and a Pomeron PDF, with several choices for both implemented in Pythia8.

The main feature of the model is that it allows for any Pythia8 hard process to be generated diffractively, and includes an option of restricting the number of MPIs in the diffractive system to ensure survival of the rapidity gap. The new model has been used in a Monte Carlo study on diffractive dijet production from which preliminary results will be shown.

High Energy and High Pt Interactions / 52

Measurement of observables sensitive to coherence effects in hadronic Z decays with the OPAL detector at LEP

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A study of QCD coherence is presented based on a sample of about 397,000 e⁺e⁻ hadronic annihilation events collected at $\sqrt{s} = 91$ GeV with the OPAL detector at LEP. The study is based on four recently proposed observables that are sensitive to coherence effects in the perturbative regime. The measurement of these observables is presented, along with a comparison with the predictions of different parton shower models. The models include both conventional parton shower models and dipole antenna models. Different ordering variables are used to investigate their influence on the predictions.

Multiparticle Correlations and Fluctuations / 55

Results on minimum bias interactions, underlying event and particle production, and Bose-Einstein correlations from ATLAS

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Measurements of the properties of charged particle production are presented from proton-proton collisions at different centre-of-mass energies in the range of 0.9 to 13 TeV and compared to various Monte Carlo event generator models. Furthermore particle distributions sensitive to the underlying event in proton-proton collisions have been measured and are compared to theoretical models. The production properties of mesons and baryons are presented and compared to predictions.

The effects of space-time geometry in the hadronization phase has been studied in the context of Bose-Einstein correlations between charged particles, for determining the size and shape of the source from which

particles are emitted and for interpreting of quark confinement effects. Bose-Einstein correlation parameters are investigated in p-p collisions at 900 GeV and 7 TeV, up to very high charged-particle multiplicities.

Proton Structure from ep and pp / 56

Studies of ATLAS measurements sensitive to the Proton Structure

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Several measurements performed by the ATLAS collaboration are either useful to constrain the proton structure or are affected by its associated uncertainties.

Measurements of the W+c production and the inclusive W and Z differential cross sections are found to constrain the poorly known strange-quark density at low x. Similarly, the ratio of W+/W- production is found to constrain the valence quarks at low x. Drell-Yan cross section measurements performed above and below the Z peak region have a different sensitivity to parton flavour, parton momentum fraction x and scale Q compared to measurements on the Z peak and can also be used to constrain the photon content of the proton.

Measurements of the inclusive jet and photon cross sections are standard candles and can be useful to constrain the medium and high x gluon densities.

Precision electroweak studies performed by ATLAS can be limited by the current knowledge on the proton structure. ...

Poster session / 57

Combined analysis of charm-quark fragmentation-fraction measurements

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A summary of measurements of the fragmentation of charm quarks into a specific hadron is given. Measurements performed in photoproduction and deep inelastic scattering in e+p, pp and e+e- collisions are compared, using up-to-date branching ratios. Within uncertainties, all measurements agree, supporting the hypothesis that fragmentation is independent of the specific production process. Presented averages of the fragmentation fractions significantly improved precision compared to the individual measurements. Implications of results for other physical quantities' measurements are considered.

Astroparticle Physics / 58

Searches for Dark Matters at the ATLAS experiment

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Searches for strongly produced dark matters in events with jets, photons, heavy-flavor quarks or massive gauge bosons recoiling against large missing transverse momentum in ATLAS are presented. These “MET+X” signatures provide powerful probes to dark matter production at the LHC, allowing us to interpret results in terms of effective field theory and/or simplified models with pair production of WIMPs. Recent ATLAS results on dark matter searches at LHC Run I and the connection to astroparticle physics are discussed.

Proton Structure from ep and pp / 61

Photon and photon+jet production measurements with the ATLAS detector

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Isolated prompt photons provide a direct probe of short-distance physics, complementary to that provided by measurements of jets or vector-bosons and are sensitive to the gluon density of the proton. The inclusive prompt photon cross sections have been measured by the ATLAS collaboration at various centre-of-mass energies of pp collisions over a wide range of transverse momenta. These experimental results are reported in different fiducial regions covering a wide acceptance and are compared to next-to-leading order QCD calculations with different models of the parton content of the proton. The diphoton and photon+jet system cross sections have also been measured as a function of several kinematic variables.

Poster session / 62

Associated quarkonium production at ATLAS as a new probe of QCD

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We present new measurements of the associated production of quarkonium with a vector boson or an additional quarkonium state using the ATLAS Run-1 dataset. These rare processes provide new insight into QCD

models of quarkonium production, but also provide new opportunities to study double parton scattering, including cross-section measurements in single and double parton scattering dominated regimes and a precise assessment of the σ_{eff} parameter governing the effective spatial area of parton-parton interactions at a variety of energy scales.

Poster session / 63

Studying $b\bar{b}$ production and small angle correlations in the $J/\psi + \mu$ final state

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We present a new measurement of $B\bar{B}$ hadron production at the LHC using the inclusive decay modes $B(B\bar{B}) \rightarrow J/\psi + X \rightarrow \mu\mu + X$ and $B\bar{B}(B) \rightarrow$

$\mu + X$. Using this three muon final state differential cross sections are presented, giving new constraints on B hadron production kinematics in particular at small separation angles between the $b\bar{b}$ pair. Further corrections are also determined to allow theory comparisons directly at the B hadron level.

Status of QCD / 67

Recent results on hadron structure observables using lattice QCD simulations

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We give an overview of recent results on hadron structure observables using lattice QCD simulations with physical values of the quark masses.

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Recent results on flow and correlations from the ATLAS experiment

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Measurements of soft particle production have provided valuable insight on properties of the evolution of the quark-gluon plasma in Pb+Pb collisions at the LHC. In particular, measurements of flow harmonics using the azimuthal angle distributions of low-pT particles directly test hydrodynamic model descriptions of its evolution. The large acceptance of the ATLAS detector enables the measurement of event-by-event flow and the correlations between different harmonics. Results will be presented from a variety of two-particle and multi-particle measurements in Pb+Pb and proton-Pb collisions.

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Jet measurements in p+Pb and Pb+Pb with the ATLAS Experiment at the LHC

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Jets provide a powerful tool for probing the dynamics of the quark-gluon plasma created in Pb+Pb collisions at the LHC. The modification of high-pT jets as they propagate in the quark-gluon plasma provides insight on structure of the plasma at short-length scale. Such modifications have been observed in a variety of measurements of single jet, dijet, photon-jet and charged-particle fragmentation functions. Recent results of jet modifications in proton-lead and Pb+Pb collisions will be presented.

Diffraction and Pomeron / 72

Measurement of diffractive and exclusive processes with the ATLAS detector

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The ATLAS collaboration has carried out a study diffractive dijet production at 7 TeV pp collisions at the LHC, i.e. events with a hadronic system containing at least two jets in addition to a large region of pseudorapidity devoid of hadronic activity. The data distributions are compared with Monte Carlo models and the rapidity gap survival probability has been estimated in the kinematic region with high diffractive contribution.

Prospects for exclusive jet production studies with the forward proton tagging capability of the AFP sub-detector of ATLAS will be discussed. A first look at data taken jointly with the ATLAS and LHCf detectors in a p+Pb run will also be shown.

In addition the measurement of the exclusive $\gamma+\gamma \rightarrow l\bar{l}$ production cross-section in proton-proton collisions at a centre-of-mass energy of 7 TeV has been carried out.

Collective Phenomena in High Energy Collisions / 73

A viscous blast-wave model for high energy heavy-ion collisions

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Using a viscosity-based survival scale for geometrical perturbations formed in the early stages of relativistic heavy-ion collisions, we model the radial flow velocity during freeze-out. Subsequently, we employ the Cooper-Frye freeze-out prescription, with first-order viscous corrections to the distribution function, to obtain the transverse momentum distribution of particle yields and flow harmonics. For initial eccentricities, we use the results of Monte Carlo Glauber model. We fix the blast-wave model parameters by fitting the transverse momentum spectra of identified particles at the Large Hadron Collider (LHC) and demonstrate that this leads to a fairly good agreement with transverse momentum distribution of elliptic and triangular flow for various centralities. Within this viscous blast-wave model, we estimate the shear viscosity to entropy density ratio $\eta/s \simeq 0.24$ at the LHC.

[1] A. Jaiswal and V. Koch, arXiv:1508.05878 [nucl-th].

Poster session / 74

Relativistic second-order dissipative fluid dynamics at finite chemical potential

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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 the second-order evolution equations for the shear stress tensor and the dissipative charge current can be decoupled. We find that for large chemical potential, the charge conductivity is small compared to the coefficient of shear viscosity. Moreover, we also show that the limiting behaviour of the ratio of heat conductivity to shear viscosity is qualitatively similar to that obtained for a strongly coupled conformal plasma.

[1] A. Jaiswal, B. Friman and K. Redlich, arXiv:1507.02849 [nucl-th].

First Results from LHC Run II / 77

First LHCb results from pp collisions at 13 TeV (35'+5')

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By using the very first Run II LHC data LHCb measured the cross-sections for quarkonia, beauty and charm productions. Results exploits the new “Turbo” stream procedure allowing the analysis of particle candidates selected at trigger level without the need of offline reconstruction. First results are presented.

Collective Phenomena in High Energy Collisions / 78

LHCb results from proton ion collisions

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Proton-lead and lead-proton data taking during 2013 has allowed LHCb to expand its physics program to heavy ion physics. Results include the first forward measurement of Z production in proton-lead collisions as well as a measurement of the nuclear modification factor and forward-backward production of prompt and displaced J/ψ, Ψ(2S) and Upsilon. Angular particle correlations have also been measured for events of varying charged particle activity.

Diffraction and Pomeron / 79

Breakdown of QCD factorization in hard diffraction

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Production of heavy photons (Drell-Yan), gauge bosons, Higgs bosons, heavy flavors, which is treated within the QCD parton model as a result of hard parton-parton collision, should be treated as a bremsstrahlung process seeing in the rest frame of the target. The main observation is a dramatic breakdown of diffractive QCD factorization due to the interplay between soft and hard interactions, which dominates these hard diffractive processes.

Multiparticle Correlations and Fluctuations / 80

Event-by-event fluctuation and correlation measurements at the LHC energies in ALICE

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Event-by-event fluctuations in relativistic heavy-ion collisions may reveal important information about the QCD phase transition and can be used for characterizing the hot and dense system formed in heavy-ion collisions. Fluctuations of many observables are associated with thermodynamic quantities of the strongly interacting system. The event-by-event fluctuations of the mean transverse momentum, temperature, multiplicity and net-charges are related to the fundamental properties of the system. In this presentation, we will discuss the recent results from ALICE experiment on event-by-event fluctuations and particle correlations at LHC energies for Pb-Pb, p-Pb and pp collisions. Along with that the results of balance functions analysis at LHC energy will be shown. We will also make comparisons to the measurements at lower beam energies from different experiments and discuss the prospect for these studies at LHC energies.

Diffraction and Pomeron / 82

Recent CMS results regarding forward physics and diffraction

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Recent CMS results regarding forward physics and diffraction are reviewed. The differential diffractive cross section is measured as a function of $\xi = M_X^2/s$ in the region dominated by single dissociation (SD) and double dissociation (DD), where M_X is the mass of one of the two final-state hadronic systems separated by the largest rapidity gap in the event. The cross section is also measured as a function of the width of the central rapidity gap in the region dominated by DD, as well as for events with a forward gap over 8.4 units of pseudorapidity. The total SD and DD cross sections are extracted.

The observation of a hard color-singlet exchange process in events with a large rapidity gap between two leading jets (jet-gap-jet) is reported. The fraction of jet-gap-jet to all dijet events is measured as a function of the second leading jet transverse momentum and the size of the pseudorapidity gap. The measured fractions are compared with predictions as well as Tevatron data. Furthermore, also the observation of exclusive Y production in pPb collisions at 5.02 TeV per nucleon is reported.

Proton Structure from ep and pp / 84

PDF constraints and α_s from CMS

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Recent results on PDF constraints and α_s from CMS are presented

Multiparticle Correlations and Fluctuations / 86

Underlying event and correlation results from CMS

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The underlying event activity in pp collisions, measured using events with a leading charged particle or a leading charged particle jet, lends credence to multiparton interactions. The activity is measured independently in the two halves of the region transverse to the leading object, containing the maximum and minimum activities. Complementary to the underlying event analysis, the observation of long-range two-particle correlations in high energy heavy ion collisions opens opportunities to explore novel QCD dynamics in quark gluon plasma (QGP), the hot dense matter created in heavy ion collisions. We present selected results of the underlying event activity and particle correlations in various collision systems.

Collective Phenomena in High Energy Collisions / 87

New results on collective phenomena in small colliding systems at CMS

Authors: Sergey Petrushanko¹; Zhenyu Chen²

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New results of two- and multi-particle correlations in pp and pPb collisions will be presented. The measurements are performed as a function of multiplicity. In very-high-multiplicity events, a long-range near-side two-particle correlation is observed. Azimuthal anisotropy harmonics (v_n) are extracted as a function of η , p_T and multiplicity, using two- and multi-particle correlations. Identified particle v_2 and v_3 are also studied for strange hadrons. Possible physics implications of the data are discussed in the context of various theoretical models. New results of two-particle correlations in pp collisions at 13 TeV are compared to lower energy data to study the energy dependence of long-range correlation phenomena.

First Results from LHC Run II / 94

First 13 TeV results from CMS (35'+5')

Author: Sergey Petrushanko¹

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An overview of the first Run II results from CMS, including 13 TeV measurements of $dN/d\eta$ of charged hadrons, the dijet ridge, inclusive $t\bar{t}$ and single top production among others.

Poster session / 95

The weighted GMD for multiplicity distributions at LHC energies

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A new distribution is obtained from the Generalised Multiplicity Distribution (GMD). This distribution is derived by a weighted sum of the GMD over the initial number of gluons, removing the dependence of the model on a specific initial state for QCD evolution. The distribution is shown to describe multiplicity data at various LHC energies, possibly providing information on gluon production. Comparisons are made with other multiplicity distribution models.

Poster session / 96

A convoluted Generalized Multiplicity Distribution and associated phenomenologically analogous Lee-Yang phase transitions

Author: Qixiang Leong¹

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A new distribution is obtained from a convolution of the Generalized Multiplicity Distribution (GMD) with the Negative Binomial Distribution (NBD). This distribution models the charged particle production from hard and soft processes, with comparisons made with other multiplicity distribution models. A phenomenologically analogous Lee-Yang phase transition is examined using the new model.

Poster session / 97

Global and Local Temperature Fluctuations in High Energy Heavy-ion Collisions

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Temperature fluctuations may have two distinct origins, first, quantum fluctuations that are initial state fluctuations, and second, thermodynamical fluctuations. We discuss a method of extracting the thermodynamic temperature from the mean transverse momentum of pions, by using controllable parameters such as centrality of the system, and range of the transverse momenta. Event-by-event fluctuations in global temperature over a large phase space provide the specific heat of the system. We present Beam Energy Scan of sp. heat from data, AMPT and HRG model prediction. The production of a large number of particles in every event, it is possible to divide the phase space into small bins and obtain local temperature for each bin. The origin of the local fluctuations has been studied with the help of event-by-event hydrodynamic calculations, which diminishes with the elapse of time. We discuss the hydrodynamic calculations and a feasibility study at LHC using AMPT simulated data.

Astroparticle Physics / 98

Theoretical Interpretations of IceCube Results

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IceCube telescope has detected \sim TeV-PeV neutrinos of astrophysical origin. Currently, their origin is still unknown. In this talk, we will review the main recent theoretical explanations for these high-energy neutrinos. Both scenarios of a Galactic origin (such as the Fermi bubbles, cosmic rays in the halo, or other Galactic sources) and of an extragalactic origin (such as active galactic nuclei, starburst galaxies, or some types of supernovae) will be discussed. These results will also be presented in the context of multi-messenger astronomy: We will show how observations of gamma-rays and cosmic rays could help disentangle between the different scenarios.

Multiparticle Correlations and Fluctuations / 100

Finite size of hadrons and Bose-Einstein correlations in pp collisions at 7 TeV

Author: andrzej bialas¹

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I shall report the recently published paper [PLB748(2015)9], written together with Wojtek Florkowski and Kacper Zalewski. Starting from the observation that the composite nature of hadrons implies space-time correlations between produced particles, we studied consequences of this effect for the Bose-Einstein correlation function of identical particles. The expected magnitude of these effects is evaluated using the recently performed blast-wave model analysis of the data for pp collisions at $\sqrt{s} = 7$ TeV.

Diffraction and Pomeron / 101

Central Exclusive Production in Proton-Proton Collisions with the STAR Experiment at RHIC

Author: Wlodek Guryn¹

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We shall describe the physics program with tagged forward protons, focusing on Central Exclusive Production (CEP) in polarized proton-proton collisions at the Relativistic Heavy Ion Collider (RHIC), with the STAR detector at $\sqrt{s} = 200$ GeV. Preliminary results in CEP of two oppositely charged pions and kaons produced in the processes $pp \rightarrow pp\pi^+\pi^-$ and $pp \rightarrow ppK^+K^-$ shall be presented. Those Double Pomeron Exchange (DPE) processes, allow the final states to be dominated by gluonic exchanges. Silicon strip detectors placed in Roman Pots were used for measuring forward protons. The preliminary results are based on the measurement of the recoil system of charged particles in the STAR experiment's Time Projection Chamber (TPC). Ionization energy loss, dE/dx , of charged particles was used for particle identification (PID). In addition to those preliminary results, the present status and future plans of the diffractive physics at RHIC shall be described.

Diffraction and Pomeron / 102

Exclusive Central $\pi^+\pi^-$ Production in Proton Antiproton Collisions at the CDF

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Exclusive central hadronic systems from hadron collisions result primarily from double pomeron exchange, and these have very restrictive quantum numbers: $I^G J^{PC} = 0^+(\text{even})^{++}$. This “quantum number filter” is a powerful tool for meson spectroscopy in the isoscalar sector, especially for glue-rich states. In addition it provides information on the nature of the pomeron.

We have measured exclusive $\pi^+\pi^-$ production in proton-antiproton collisions at $\sqrt{s} = 0.9$ and 1.96 TeV in the Collider Detector at Fermilab. We selected events with exactly two oppositely charged particles, assumed to be pions, in $|\eta| < 1.3$ with no other particles detected in $|\eta| < 5.9$. The central $\pi^+\pi^-$ was required to have rapidity $|y| < 1$. By requiring no other charged particles, these events are dominated

by double pomeron exchange.

The data is valuable for understanding the pomeron in a region of transition between non-perturbative and perturbative QCD.

Collective Phenomena in High Energy Collisions / 103

Multiplicity dependence of strange and multi-strange hadron production in pp collisions at $\sqrt{s} = 7$ TeV measured with the ALICE experiment

Author: Rafael Derradi de Souza¹

¹ State University of Campinas - Brazil

The measurement of identified particle production rates as a function of event activity in small colliding systems has recently become of particular interest in understanding how observations performed in these systems relate to the much larger ones created in Pb-Pb collisions. Strangeness production may provide a valuable tool to probe changes in particle production mechanisms.

We report on measurements of the transverse momentum spectra of strange hadrons in pp collisions at 7 TeV with ALICE. To investigate the possibility of collective-like behavior, we study how the pT-differential Λ/K^0_S ratio is altered with multiplicity.

Furthermore, strangeness production is seen to be enhanced with respect to non-strange particles in pp collisions with progressively higher multiplicity, as evidenced by rising hyperon-to-pion ratios. These observations are compared to similar measurements performed in p-Pb and Pb-Pb collisions as well as to predictions from QCD-inspired models.

Status of QCD / 104

Overview of QCD measurements at high pT

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This talk gives an overview of QCD measurements at high pT at the LHC and other colliders. Recent results on inclusive jet, dijet and multijet production measurements are presented together with results of α_S extraction and constraints on the PDFs of the proton. Precision measurements of vector bosons ($V = W, Z$ or γ) in association with jets allow for stringent tests of perturbative QCD. The measurements are compared to next-to leading order calculations and event simulations that devise matrix element calculations interfaced with parton showers.

Status of QCD / 105

Heavy quark masses from lattice QCD.

Author: Andrew Lytle¹

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I will review progress in quark mass determinations from lattice QCD simulation, focusing on results for charm and bottom mass. These are of particular interest for precision Higgs studies. Recent determinations have achieved percent-level uncertainties with controlled systematics. Future prospects for these calculations will also be discussed.

Proton Structure from ep and pp / 106

Recent progress in PDF set combinations for the LHC

Author: Andy Buckley¹

¹ *University of Glasgow*

The current PDF4LHC recommendation to estimate uncertainties due to parton distribution functions (PDFs) in theoretical predictions for LHC processes involves the combination of separate predictions computed using PDF sets from different groups, each of which comprises a relatively large number of either Hessian eigenvectors or Monte Carlo (MC) replicas. We present a strategy for the statistical combination of individual PDF sets, followed by different reduction algorithms to end up with a small number of either Hessian eigenvectors or MC replicas. We illustrate our strategy with the combination of the recent NNPDF3.0, CT14 and MMHT14 NNLO PDF sets.

Diffraction and Pomeron / 107

Recent progress in exclusive and semi-exclusive processes in proton-proton collisions

Author: Antoni Szczurek¹

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I will review recent progress in exclusive production of mesons and dileptons in proton-proton collisions.

This includes exclusive production of J/ψ , ψ' and ρ^0 mesons as well as production of two pions, two leptons, two photons or two charged Higgs bosons.

In the case of the charmonia a k_t -factorization method with unintegrated gluon distributions is applied. A possible sign of the onset of saturation will be given. The charmonium wave function effects will be discussed.

In the case of ρ^0 and $\pi^+ \pi^-$ production we apply a model of tensor pomeron, a new concept being actively developed and tested in recent 2 years, to the production of continuum and resonances. A discussion of processes with electromagnetic dissociation (large rapidity gap) will be discussed as an example for dilepton production. Exclusive production of two charged Higgs boson will be discussed in the context of searches for these exotic objects at the LHC and FCC.

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Recent progress in exclusive and semi-exclusive processes in proton-proton collisions

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First Results from LHC Run II / 110

First Run 2 results from ALICE (35'+5')

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The ALICE Collaboration is collecting data with both Minimum Bias and Muon triggers with pp collisions at $\sqrt{s} = 13$ TeV in the ongoing LHC Run II. An excellent performance of tracking and

PID in the central barrel and in the muon spectrometer has been obtained. First results on the charged-particle pseudorapidity density and on identified particle transverse momentum spectra at 13 TeV will be presented.

First Results from LHC Run II / 111

Early Run 2 Soft QCD Results from the ATLAS Collaboration (25'+5')

Author: Dick Greenwood¹

¹ ATLAS

Since a few months the LHC has started to deliver pp collisions at the unprecedented centre-of-mass energy of 13 TeV. The ATLAS collaboration has analysed this very early Run 2 data taken in both special conditions with very low pileup and those dedicated to high pT physics. This talk is an overview of soft QCD Results at 13 TeV. The properties of minimum bias interactions as well as the “underlying event” accompanying hard scatters were studied using tracks. A reasonable agreement with models tuned to lower energy data is observed. A first measurement of the total inelastic pp cross section was performed.

First Results from LHC Run II / 112

Early Run 2 Hard QCD Results from the ATLAS Collaboration (25'+5')

Author: Dick Greenwood¹

¹ ATLAS

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Since a few months the LHC has started to deliver pp collisions at the unprecedented centre-of-mass energy of 13 TeV. The ATLAS collaboration has analysed this very early Run 2 data taken in both special conditions with very low pileup and those dedicated to high pT physics. This talk is an overview of hard QCD Results at 13 TeV. The production of high pT jets, photons and diphotons were studied. The inclusive jet cross section is found to agree well with the prediction of perturbative QCD calculations performed at NLO accuracy. The production cross sections for W and Z bosons in their electron and muon decays was measured. In general agreement is found with the expectation of NNLO QCD calculations and interesting sensitivities to the proton structure functions are observed already at this stage. The top production cross section, measured in different top decay channels at 13 TeV, is compared to theoretical calculations.

Proton Structure from ep and pp / 113

HERAFitter project and its related studies

Author: Hayk Pirumov¹

¹ DESY

The uncertainties of protons parton distribution functions (PDFs) play a dominant role for the precision tests of the Standard Model (SM) and they also impact substantially the theory predictions of Beyond SM high mass production. We present the HERAFitter project which provides a unique open-source software framework for the determination of the proton's PDFs and for the interpretation of the physics analyses in the context of Quantum Chromodynamics (QCD).

We report here the highlighted results based on the HERAFitter functionalities, as well as novel studies performed by HERAFitter. The latter includes the QCD analysis of the recent Drell-Yan production measurements at Tevatron.

Reference of studies that the abstract covers are:

- [1] "HERAFitter Open Source QCD Fit Project", arXiv:1410.4412 [accepted by EPJC]
- [2] "QCD analysis of W- and Z-boson production at Tevatron", arXiv:1503.05221 [accepted by EPJC]

Astroparticle Physics / 114

Measurements at LHC and their relevance for ultra-high energy cosmic rays

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Many LHC measurements have already been used to improve hadronic interaction models and thus lowered the model dependence of cosmic ray data analyses. However, the LHC still has a lot more potential to provide crucial information, which has not been fully exploited so far. Since the start of Run2 the highest accelerator beam energies are reached and no further increase can be expected for a long time. First data of Run2 are published and the fundamental performance of cosmic ray hadronic interaction models is scrutinized. The relevance of LHC data in general for cosmic ray data analyses is demonstrated. It is also shown in what aspects the current measurements are still incomplete and how they can be further improved.

Astroparticle Physics / 115

High energy neutrinos from the Cosmos: Recent results from the IceCube Neutrino Telescope

Author: Elisa Resconi¹

¹ *TU Munchen*

The neutrino observatory IceCube is opening a new observational window to the Universe. IceCube, which has been constructed in the icecap at the South Pole, is taking data since Spring 2011 in full configuration. The first years of data revealed the existence of extremely high neutrinos at the PeV scale. The observed diffuse neutrino flux is with high probability of astrophysical origin. In this talk I will summarize the recent observation and discuss the on-going searches for counterparts focusing in particular on the discussion of BL Lacs.

High Energy and High Pt Interactions / 116

Latest results on top production from the CMS and ATLAS collaborations: inclusive and differential measurements

Author: Judith Katzy¹

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In proton-proton collisions at the LHC, pairs of top and anti-top quarks are expected to be mostly produced through gluon fusion and the large number of $t\bar{t}$ pairs can be used to test the predictions of Quantum Chromodynamics. Measurements of the top quark production cross sections in proton-proton collisions at 7 and 8 TeV with the ATLAS and CMS detectors at the Large Hadron Collider are presented. Both inclusive and differential cross-section measurements are compared to the theoretical predictions. We also present measurements of the spin correlation between top and anti-top quarks as well as of the top-quark charge asymmetry which constitute important tests of QCD and are sensitive to potential contributions from new physics. Besides being compared to different predictions from the standard model the measurements the results are also used to extract the strong coupling constant and the pole mass.

High Energy and High Pt Interactions / 119

Studies of jet cross-sections and production properties with the ATLAS and CMS detectors

Author: Judith Katzy¹

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Several aspects of jet production in pp collisions have been measured by the ATLAS and CMS collaborations. The jet production cross sections probe the dynamics of QCD and can constrain the parton proton structure. Double-differential cross sections for inclusive, di-, three- and four-jet final states are measured at different centre-of-mass energies of pp collisions with the ATLAS detector and are compared to expectations based on NLO QCD calculations.

The distribution of the jet charge has been measured in dijet events using pp collision data at 8 TeV with the ATLAS detector. Jet-jet energy correlations are sensitive to the strong coupling constant. Measurements of multi-jet systems with a veto on additional jets, probe QCD radiation effects. These measurements constitute precision tests of QCD in a new energy regime. Studies of large-radius jet properties including N-subjettiness, splitting scales and other jet substructure related quantities will be presented.

High Energy and High Pt Interactions / 120

Supersymmetry searches at LHC in hadronic final states

Author: Judith Katzy¹

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Despite the absence of experimental evidence, weak scale supersymmetry remains one of the best motivated and studied Standard Model extensions. This talk summarises recent ATLAS and CMS results for searches for supersymmetric (SUSY) particles, with an emphasis on strong production in both R-Parity conserving and R-Parity violating SUSY scenarios. The searches involve final states including jets, missing transverse momentum, light leptons, taus or photons. A particular emphasise will be given to the fully hadronic SUSY searches their backgrounds and problematics related to the way that they are estimated. Sensitivity projections for the data that will be collected in 2015 are also presented.

High Energy and High Pt Interactions / 121

Resummed Results for Hadron Collider Observables

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This talk will provide a summary of progress in the resummation of observables for hadron colliders, focusing in particular on event shape observables. Event shapes and jet rates are invaluable QCD tools for theoretical calculations and experimental measurements. I will revise the definition of these observables in hadron collisions, and give a review of the state-of-the-art results for their resummation. Then I will detail how recent work on the resummation of event shapes in electron-positron annihilation can allow us to extend resummation of generic hadronic event shapes to NNLL accuracy.

High Energy and High Pt Interactions / 122

Recent developments in Monte-Carlo Event Generators

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With Run II of the LHC having started, the need for high precision theory predictions whose uncertainty matches that of the data to be taken necessitated a range of new developments in Monte-Carlo Event Generators. In this talk I will give an overview of the progress in recent years in the field and what can and cannot be expected from these newly written tools.

High Energy and High Pt Interactions / 123

Measurements of Vector Boson plus jets with the ATLAS and CMS detectors

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The production of vector bosons ($V = W, Z$ or γ) in association with jets is a stringent test of perturbative QCD and is a background process in searches for new physics. The differential cross-section measurements from CMS and ATLAS collaborations would be presented. The multijet topologies and event shape variables represent a particular interest to test multi-leg LO and NLO MC predictions interfaced with parton showers and study the resummation techniques.

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World average of the strong coupling constant

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Status of QCD / 126

Theory status of jet physics

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Status of QCD / 127

The 2015 World Summary of α_s

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¹ Max Planck Institute für Physik

A preliminary preview will be given on the recent update of α_s measurements and the new world average value of $\alpha_s(M_Z)$, which is currently prepared for the 2015 edition of PDG's Review of Particle Properties.

Diffraction and Pomeron / 128

Recent diffractive results from HERA

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The exclusive dijet production in diffractive deep inelastic e^+p scattering has been measured with the ZEUS detector at HERA using an integrated luminosity of 372 pb^{-1} . The measurement was performed for γ^*p centre-of-mass energies in the range $90 < W < 250 \text{ GeV}$ and photon virtualities in the range $Q^2 > 25 \text{ GeV}^2$. Energy and transverse-energy flows around the jet axis are presented. The cross section is presented as a function of β , the Bjorken variable defined with respect to the diffractive exchange and, in bins of β , as a function of ϕ , the angle between the γ^* -dijet plane and the γ^*e plane in the rest frame of the dijet final state. The results are compared to predictions from models which are based on different assumptions about the nature of the diffractive exchange.

The cross section of the diffractive process $ep \rightarrow eXp$ is measured at a centre-of-mass energy of 318 GeV, where the system X contains at least two jets and the leading final state proton p is detected in the H1 Very Forward Proton Spectrometer. The measurement is performed in photoproduction with photon virtualities $Q^2 < 2 \text{ GeV}^2$ and in deep-inelastic scattering with $4 < Q^2 < 80 \text{ GeV}^2$. The results are compared to NLO QCD calculations based on diffractive parton distribution functions as extracted from measurements of inclusive cross sections in diffractive DIS. A complementary process, ZEUS present measurements of the diffractive production of isolated ("prompt") photons in photoproduction, with and without a jet. Cross sections are evaluated for centrally produced photons with jets as a function of the photon and jet transverse energy and pseudorapidity, and also for the fraction of incoming photon energy imparted to the photon-jet system. Comparison is made to predictions from Rapgap.

A measurement is presented dijet cross sections in diffractive deep-inelastic ep scattering at HERA using data collected by the H1 experiment. The investigated phase space is spanned by the photon virtuality in the range of $4 < Q^2 < 100 \text{ GeV}^2$ and by the fractional proton longitudinal momentum loss $x_{\text{pom}} < 0.03$. The resulting cross sections are compared with NLO QCD predictions based on diffractive PDFs and the value of the strong coupling constant is extracted.