HK 40: Heavy-Ion Collisions and QCD Phases VI

Time: Thursday 16:15–18:00 Location: PHIL C 601

HK 40.1 Thu 16:15 PHIL C 601

Machine-learning-based modeling of particle production in pp collisions measured by ALICE — •Maria Calmon Behling, Mario Krüger, Jerome Jung, and Henner Büsching — Institut für Kernphysik, Goethe Universität Frankfurt

During the data-taking campaigns Run 1 and Run 2 at the LHC, the ALICE collaboration recorded a large amount of proton-proton (pp) collisions across a variety of center-of-mass energies ($\sqrt{s}$). This dataset is well suited to study the energy dependence of particle production. Deep neural networks (DNNs) provide a data-driven approach to capture the multidimensional dependence of particle production on fundamental observables like the charged-particle multiplicity (N_{ch}), the transverse momentum (p_{T}) and $\sqrt{s}$.

In this talk, ALICE measurements of N_{ch}- and p_{T}-dependent inclusive charged-particle spectra at various center-of-mass energies are parametrized with DNNs. Together with a DNN-based particle composition, this is used to provide particle-differential predictions for a wide range of energies. The DNN predictions are compared to existing measurements as well as to commonly used event generators. The results allow estimating the transverse energy of the final-state particles, which is directly related to the initial energy density of the collisions.

Supported by BMFTR and the Helmholtz Association.

HK 40.2 Thu 16:30 PHIL C 601

Measurement of η mesons in pp collisions at $\sqrt{s}$ =13.6 TeV with ALICE at a magnetic field of B = 0.2 T — •Laura Gansbartl for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe Universität Frankfurt am Main

The ALICE experiment at CERN investigates the properties of the Quark Gluon Plasma (QGP). One key probe to study the QGP, dileptons, offers direct access to the medium's temperature. At low transverse momentum (p_{T}), the dilepton spectrum is dominated by η meson Dalitz decays, making an accurate description of the low-p_{T} η yield essential for precise dilepton measurements.

The low-p_{T} region is experimentally challenging for η reconstruction due to large combinatorial background and low reconstruction efficiency. In ALICE, the accessible p_{T} range can be extended by reducing the magnetic field strength from $B = 0.5\,\mathrm{T}$ to $B = 0.2\,\mathrm{T}$, which significantly improves the reconstruction of very low-p_{T} tracks.

This talk addresses the ALICE Run 3 analysis of η meson production in pp collisions at $B = 0.2\,\mathrm{T}$, measured via the Dalitz decay channel. Photons are reconstructed using the Photon Conversion Method (PCM), while the electrons are reconstructed as primary tracks. The current status of the analysis will be presented.

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HK 40.3 Thu 16:45 PHIL C 601

Measurement of π^0 and η mesons in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.36 TeV using ML-based photon identification — •Isabel Kantak for the ALICE Germany-Collaboration — Physikalisches Institut, Heidelberg, Germany

Neutral pions and η mesons serve as sensitive probes of the quark-gluon plasma (QGP) formed in heavy-ion collisions. In the low p_{T} region, light mesons provide insight into hadronisation processes and the evolution of the QGP. High p_{T} measurements, on the other hand, are essential for studying the mechanism of parton energy loss mechanism and the resulting suppression of light mesons in the QGP medium. Furthermore, precise measurements of π^0 and η mesons are indispensable for direct-photon analyses, as they constitute the dominant sources of decay photons.

Photons are reconstructed via the Photon Conversion Method (PCM). A machine learning-based photon identification method has been implemented. The BDT method enhances photon purity without compromising efficiency, thereby improving statistical significance of the reconstructed meson spetra. In this contribution, I will discuss the performance of ML-based photon identification and the current status of π^0 and η mesons in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.36$ TeV. I will present invariant yield measurements as a function of centrality and compare the results to those obtained with standard cut-based techniques.

HK 40.4 Thu 17:00 PHIL C 601

ML-based direct photon and neutral meson measurement in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV in the ALICE experiment at LHC — •Abhishek Nath for the ALICE Germany-Collaboration — Ruprecht Karl University of Heidelberg, Heidelberg, Germany

The ALICE experiment at LHC-CERN aims to analyze the properties of the quark-gluon plasma (QGP) formed during heavy-ion collisions. Neutral meson yields determine R_{AA} and constrain parton energy loss, whereas direct photons from thermal and hard-scattering sources probe the QGP temperature. However, large photon backgrounds from neutral meson decays hinder direct-photon extraction, causing significant loss of precision at low p_{T} in Run 2 heavy-ion Pb–Pb data. To overcome this limitation, we introduce a machine learning-based approach for photon candidate selection within the Photon Conversion Method (PCM). An XGBoost classifier trained on Monte Carlo simulations anchored to the Run 2 Pb–Pb $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV dataset replaces traditional cut-based selections to provide data samples with simultaneously optimized photon efficiency and purity.

In this talk, I will present the application of this ML-enhanced PCM analysis, showing updated transverse momentum spectra for π^0, η, and direct photons. The resulting R_{AA}, η/π^0 ratio, and direct photon excess ratio (R_γ) are then compared with the traditional cut-based measurements as well as with state-of-the-art theoretical model predictions.

HK 40.5 Thu 17:15 PHIL C 601

Study of neutral meson production in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.36 TeV as a function of centrality — •Anna Pishchaeva for the ALICE Germany-Collaboration — Physikalisches Institut, Universität Heidelberg

Photons that are produced throughout the spacetime evolution of quark-gluon plasma (QGP) are an ideal probe to study its characteristics, since they do not interact with the medium. To access the information carried by the photons that come directly from QGP, one must subtract the background of photons from neutral mesons decays (mainly π^0, η). Furthermore, the energy loss of partons traversing the QGP medium in the high p_{T} region can be studied with a nuclear modification factor of π^0 and η.

In this cut based analysis, photons are reconstructed using the photon conversion method (PCM). Neutral pions and η mesons are identified as peaks in the two-photon invariant mass at their corresponding rest mass. This talk presents results for Run 3 on the neutral pions and η meson production in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.36$ TeV. The obtained invariant differential yields of π^0 and η in the current analysis are presented and compared to charged pions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV.

HK 40.6 Thu 17:30 PHIL C 601

Hadron-photon correlations in pp collisions in ALICE — •Julius Kinner for the ALICE Germany-Collaboration — Universität Münster

Ultrarelativistic proton and heavy-ion collisions are measured with ALICE at the LHC, allowing the study of quantum chromodynamics and the quark-gluon plasma. Two interesting observables are jets, collimated hadrons created by a hard scattering, and direct photons, created directly in the collision and not stemming from particle decays.

The production of direct photons and inclusive photons in jets, and their relations, can be studied via angular two-particle correlations using the $\Delta\varphi$ and $\Delta\eta$ of trigger and associated particles. High-p_{T} charged particles are used as triggers and proxies for jets, and electromagnetic probes as associated particles.

Correlation functions of associated γ and π^0 are calculated with the photon conversion method and an invariant mass analysis of $\pi^0 \to \gamma\gamma$, using ALICE data from pp collisions at $\sqrt{s} = 13.6\,\mathrm{TeV}$, which is a work in progress. This is done as the continuation of a phenomenological study with PYTHIA simulations, which was carried out in the context of a possible measurement of angular jet-direct-photon correlations with the subtraction method (subtracting the decay-photon contribution from inclusive photons) to study the electromagnetic structure of jets.

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HK 40.7 Thu 17:45 PHIL C 601

Measurement of radius dependent jet suppression in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV with a novel mixed-event approach — •Nadine Alice Grünwald for the ALICE Germany-Collaboration — Physikalisches Institut, Universität Heidelberg

The Quark-Gluon Plasma (QGP) is produced in heavy-ion collisions where quarks and gluons are deconfined and new physics phenomena emerge. The ALICE experiment is dedicated to measure heavy-ion collisions at the LHC where the QGP can be studied using jets from partons, which are produced in the early stage of the collisions.

In this talk mixed events as a new approach to describe the uncorrelated background in jet measurements in heavy-ion collisions in ALICE are presented.

The resulting charged-particle jet R_{AA} measurements have high precision over a broad kinematic range, reaching significantly lower jet p_{T} values as compared to the traditional analyses. Various jet resolution parameters are studied to measure the radius dependence of the jet energy loss and thereby the redistribution of the lost energy to the surrounding QGP medium. Comparison of these measurements to theoretical calculations including the medium response will provide new insight into jet quenching phenomenology and its underlying mechanism.