T 78: Flavour Physics V

Time: Thursday 16:15–18:15 Location: KH 02.014

T 78.1 Thu 16:15 KH 02.014

Measurement of Charm and Beauty Production in Proton–Proton Collisions at $\sqrt{s} = 5$ TeV with the CMS Experiment — •Lucas Karwatzki[1,2], Achim Geiser[1], Alexander Schmidt[2], and Arnd Meyer[2] — [1]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [2]Physics Institute III A RWTH Aachen University, Aachen, Germany

Measuring the charm and beauty production cross sections is not only a crucial test of the Standard Model but also provides valuable input for refining the proton parton distribution functions at low x, and for the determination of the charm and beauty quark masses.

In this talk, I will present a double-differential measurement of the D^*-meson production cross section in transverse momentum p_T and absolute rapidity $|y|$ in proton–proton collisions at $\sqrt{s} = 5$ TeV using the CMS detector. The decay topology of the D^* meson allows access to very low transverse momenta (p_T) and by combining these results for the high-rapidity phase space with LHCb measurements, total cross sections for heavy-flavour production can be measured with only small extrapolation.

D^* mesons can originate either directly from charm-quark hadronisation or from the decay of B hadrons. The longer lifetime of B hadrons enables the use of the impact parameter and decay length significance to effectively separate the two contributions, and therefore allows for the measurement of both the charm and beauty production cross sections.

T 78.2 Thu 16:30 KH 02.014

Measurement of strangeness production in pNe collisions at LHCb — Johannes Albrecht[1], •Theodor Zies[1], Noah Behling[1], Felix Riehn[1], Saverio Mariani[2], and Chiara Lucarelli[2] — [1]TU Dortmund, Germany — [2]Cern

In the Standard Model, the strong interaction is described by quantum chromodynamics (QCD) and is generally well understood. Processes with low momentum transfer (soft QCD) require complex, data-driven models describing hadronic interactions. Measurements of various hadron production cross-sections serve as essential inputs to constrain these models and tune their parameters, ensuring they provide accurate predictions across different energies. A mismatch in the number of muons produced in simulations and data of cosmic-ray induced air showers hints at insufficiencies in current models. In this work, a measurement of the baryon-to-meson and baryon-to-antibaryon strange hadron production cross-section ratios R_{Λ^0/K^0_S} and $R_{\Lambda^0/\bar{\Lambda}^0}$ is performed. Data from fixed-target pNe collisions acquired using the SMOG2 system of the LHCb Upgrade I detector are used, collected during Run 3 of the LHC and corresponding to an integrated luminosity of $\mathcal{L}_{\text{int}} = 225\,\text{nb}^{-1}$ at a center-of-mass energy of $\sqrt{s_{\text{NN}}} = 113\,\text{GeV}$. The results are calculated differentially as a function of transverse momentum and rapidity. A comparison with predictions of the commonly used hadronic interaction models `EPOS-LHC` and `QGSJet` enables the study of how accurately these models describe strangeness production. Overall agreement is observed in most kinematic bins, while the newer tunes of the models show slightly better consistency.

T 78.3 Thu 16:45 KH 02.014

Reconstruction of multi-strange baryons Ξ and Ω in pp collisions at sqrt(s) = 13.6 TeV with the ALICE detector — Bilge Jin ONEN[1] and •Ayben Karasu Uysal[2] — [1]Istanbul Technical University, Istanbul, Turkey — [2]Yildiz Technical University, Istanbul, Turkey

Strangeness production has long been regarded as a key signature of the quark-gluon plasma (QGP), a deconfined state of matter created in ultra-relativistic heavy-ion collisions. Similar features such as collective flow and enhanced yields of strange and multi-strange baryons have also been observed in high-multiplicity small collision systems, including proton-proton (pp) interactions at the LHC. These findings make the study of strangeness a central topic within the ALICE experiment, where pp collisions provide a unique environment to investigate QGP-like effects without the presence of large-volume nuclear matter.

In this work, the reconstruction of the multi-strange baryons Ξ (dss) and Ω (sss) in pp collisions at sqrt(s) = 13.6 TeV is presented using standard topological selections and invariant-mass analysis techniques. The cascade weak decays Ξ- -> Λ π- and Ω- -> Λ K-, with Λ -> p π-, are reconstructed from charged decay tracks identified with the ITS, TPC and TOF detectors. The obtained corrected yields agree with published ALICE results within uncertainties, validating the classical reconstruction. This analysis provides a solid reference for future studies exploring machine-learning-based selection strategies.

T 78.4 Thu 17:00 KH 02.014

Total and differential charm production cross sections in pp collisions at $\sqrt{s} = 13$ TeV — •Aviral Akhil and Achim Geiser — Deutsches Elektronen-Synchrotron, Hamburg, Germany

Charm production sits at the boundary where perturbative QCD begins to lose precision and non-perturbative effects become significant, making it a powerful probe of the strong interaction. To explore this challenging regime, we present measurements of D*-meson differential charm production cross sections at a proton proton center-of-mass energy of $\sqrt{s} = 13$ TeV using the CMS detector. The analysis reconstructs charm hadron decays across the largest accessible phase space to minimize extrapolation to the full charm production region. Results are reported as differential cross sections in transverse momentum and rapidity and compared to QCD predictions as well as to measurements from other LHC experiments. The fiducial cross sections are then extrapolated to the total charm-pair cross section using a data-driven parameterization of charm fragmentation fractions that incorporates recent measurements of meson-baryon ratios dependent on p_T. The use of non-universal, experimentally constrained fragmentation improves the fragmentation treatment relative to earlier extractions. These results provide constraints on key QCD parameters such as the charm-quark mass and parton distribution functions at low momentum fraction and contribute to a more detailed understanding of heavy-flavour production dynamics at the LHC.

T 78.5 Thu 17:15 KH 02.014

$\bar{\Lambda}^0/K^0_S$ production cross-section ratio at LHCb in Run 3 — Johannes Albrecht[1], •Noah Behling[1], Lukas Calefice[2], Biljana Mitreska[3], and Titus Mombächer[4] — [1]TU Dortmund University, Dortmund, Germany — [2]Universitat de Barcelona, Barcelona, Spain — [3]University of Manchester — [4]University of Cincinnati

Hadron production ratios are a useful probe to test and improve hadronisation models. In this work, the production ratio of K^0_S and $\bar{\Lambda}^0$ is studied with Run 3 proton-proton collision data from the upgraded LHCb experiment. These studies are also essential to calibrate and validate the performance of the upgraded detector. The proper operation of all subsystems must be ensured step-by-step to carry out precise measurements with data recorded recently and in the future. The performance of the tracking system can be evaluated with the measured ratio.

Meson-to-baryon ratios and strangeness production also contribute to the understanding of hadronic processes in cosmic-ray-induced extensive air showers, which are dominated by soft-QCD effects in the forward region. In air-shower data, an excess of muons produced with respect to Monte Carlo event generators has been observed, which could originate from mismodelling of the hadronisation process. The LHCb experiment offers a unique environment to test hadronic models in the forward region.

The current status of the analysis and recent studies on detector performance will be presented. Additionally, the connection of collider experiments to air-shower measurements will be discussed.

T 78.6 Thu 17:30 KH 02.014

Charm mesons production asymmetries at LHCb in Run 3 — •Luca Balzani[1], Serena Maccolini[2], and Dominik Stefan Mitzel[1] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneva, Switzerland

Ahead of Run 3 of the LHC, the LHCb detector was profoundly upgraded to leverage the programmed increase in luminosity. Studying the features of the upgraded detector is of paramount importance in order to reliably perform measurements.

Production asymmetries are ideal candidates to investigate the characteristics of the new LHCb detector. These observables depend on the colliding system characteristics but shall not be influenced by experimental effects. Therefore, having these latter contributions under control is essential to perform a consistent measurement. Precise mea-

surements of production asymmetries also allow for a better understanding of QCD models used in Monte Carlo generators, especially in the high-rapidity region. The production asymmetry for neutral charm meson has been measured for the first time in proton-proton collisions at the LHC energies and is part of the first published result from LHCb with Run 3 data. This contribution will discuss the general strategy and the techniques used for the measurement, providing some insights on the characteristics of the new LHCb Run 3 data.

T 78.7 Thu 17:45 KH 02.014

Charm and beauty separation using reconstructed D* mesons with the b-hive framework in CMS — •Shruti Shetty[1], Lucas Karwatzki[1,2], Alexander Schmidt[1], Achim Geiser[2], and Arnd Meyer[1] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]DESY, Hamburg

Reliable separation of charm and beauty hadrons is essential for precision measurements and searches involving heavy flavour at the LHC. In this study, reconstructed $D^* \to D^0\pi_s$ candidates, with $D^0 \to K\pi$ decays, are investigated using simulated proton-proton collision samples from the CMS experiment. For the first time, hadron-level particle identification is implemented within the b-hive framework, a modular training framework for state-of-the-art object tagging in the Python ecosystem used by the CMS experiment. This approach provides the basis for future optimization of charm and beauty identification and its application in physics analyses.

T 78.8 Thu 18:00 KH 02.014

Measurement of the Oscillation Frequency Δm_s with 2024 Data of the Upgraded LHCb Experiment — •Johann Nicolas Himbert[1], Stephanie Hansmann-Menzemer[1], Lennart Uecker[1], Sara Celani[2], and Marc Quentin Führing[3] — [1]Physikalisches Institut Heidelberg University, Heidelberg, Germany — [2]CERN, Switzerland — [3]TU Dortmund University, Dortmund, Germany

The measurement of the oscillation frequency Δm_s in the $B_s^0 - \bar{B}_s^0$ system is an excellent showcase of the capabilities of the upgrade LHCb experiment in Run 3. The LHCb detector in Run 3 is collecting data at a five times larger instantaneous luminosity than in Run 2. To cope with this increased luminosity, all subdetectors and their readout-electronics have undergone major upgrades and a fully software based trigger has been implemented. The later improves the acceptance of softer decays for multi-body hadronic final states, which results in a three times larger yield of signal candidates per fb^{-1}. For the measurement of Δm_s new dedicated Run 3 flavour-tagging algorithms and the excellent decay time resolution of the upgrade detector are exploited to resolve the oscillation. On a small test data set of 1.2 fb^{-1} the decay channel $B_s^0 \to D_s^- \pi^+$ with $D_s^- \to \phi^0(\to K^- K^+)\pi^-$ is studied and the oscillation frequency, Δm_s, resolved with a statistical uncertainty of 0.0156 ps^{-1}.