Kérdés, kérés	Kitöltendő	MINTA
Kutatócsoport neve, osztály, intézet rövidítésével	R/NFO/Hadron Physics research group	R/EFO/Gravitational Physics Research Group
Helyesen szerepel-e az angol neve a kutatócsoportnak a honlapon?(nem esetén a helyes nevet kérem megadni)	igen	nem, ~~Wigner~~ Gravitational Physics Research Group
Kutatócsoport https://wigner.hu/hu/kutatocsoportok -n levő oldal (magyar és angol) aktualizálásának időpontja		2024.12.05
Ki szerkeszti a kutatócsoport https://wigner.hu/hu/kutatocsoportok -n levő oldalát?		Gipsz Jakab
Kutatócsoport saját oldalának URL-je	https://hadronphysics.wigner.hu/	https://wigner.hu/en/heavy-ion-physics-research-group
KI szerkeszti a saját aloldalt?	Boldizsár László	Nyúl Béla
Kutatócsoporti honlapon a csoport bemutatásában szereplő 5 szakkifejezés Wikipedia linkjenek jelölése	https://en.wikipedia.org/wiki/Quark%E2%80%93gluon_plasma https://en.wikipedia.org/wiki/Strong_interaction https://en.wikipedia.org/wiki/Glueball https://en.wikipedia.org/wiki/Hadron https://en.wikipedia.org/wiki/Large_Hadron_Collider	5 link hozzáadva (pl. https://wigner.hu/hu/taxonomy/term/105)
Wikipediában a kutatócsoport szakterületéhez kapcsolódó 1 hibás, vagy hiányos szakkifejezés		Neutrondiffrakció – Wikipédia hiányos
Kutatócsoport által kezelt berendezések honlapjának URL-jei	https://home.cern/science/experiments/alice https://home.cern/science/experiments/cms	https://vlab.wigner.hu/

2024

Detection of forward protons and the study of central exclusive production. — We have published the paper on the nonresonant central exclusive production of charged-hadron pairs in proton-proton collisions at √s = 13 TeV [1,2]. A rich structure of interactions related to double-pomeron exchange is observed. A parabolic minimum in the distribution of the two-proton azimuthal angle is observed for the first time (Fig. 1). It can be interpreted as an effect of additional pomeron exchanges between the protons from the interference between the bare and the rescattered amplitudes. We have optimized proton reconstruction with the TOTEM Roman pot detectors for high-β* LHC data [3], aiming for an optimal reconstruction tool for central exclusive physics analyses. The alignment of the Roman pot system is performed through time-dependent adjustments, resulting in a position accuracy of 3 µm in the horizontal and 60 µm in the vertical directions.

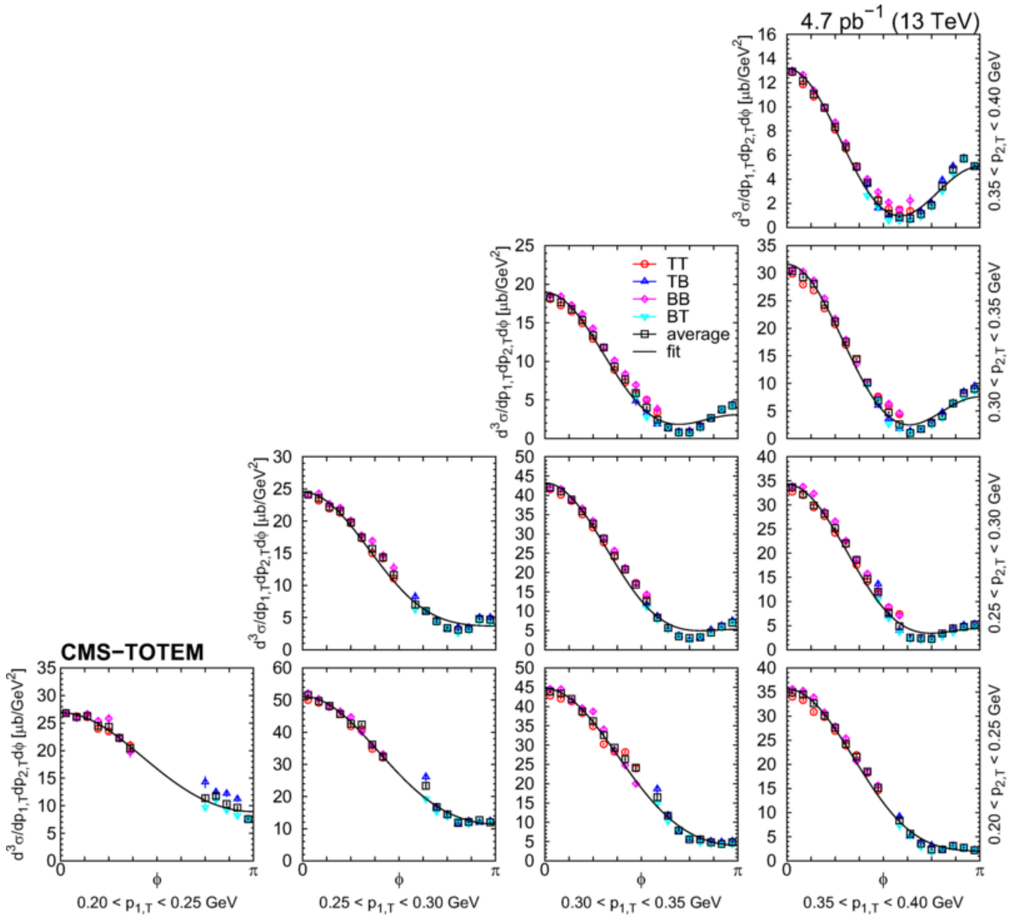

Figure 1. *Distributions of triple-differential cross sections as functions of ϕ in several transvese momentum bins. Results of individual fits with the form $[A(R - \cos\phi)]^2 + c^2$ are plotted with the curves (from Ref. [1])*

Multi-parton interactions in pp collisions using charged-particle flattenicity. — Despite the large amount of soft-QCD results on collectivity in pp and p–Pb collisions (small-collision systems), the origin of these phenomena is not yet fully understood. We explored a novel event classifier, flattenicity, that quantifies the shape of the event using experimental information from both azimuthal and forward/backward pseudorapidity directions [4]. For the first time, the ALICE experiment at the LHC studied the transverse momentum (p_T) spectra of primary charged pions, kaons, (anti)protons and unidentified hadrons as a function of flattenicity and double-differentially as a function of flattenicity and charged-particle multiplicity in pp collisions at √s=13 TeV [5]. Data suggest that, for multi-minijet events, the ratio of event-class dependent pT spectra to that of MB (Qpp) develops a pronounced peak with increasing multiplicity that is mass dependent.

Heavy-flavor production in the ALICE experiment. — Earlier, we have carried out a systematic analysis of heavy-flavor production in the underlying event in connection to a leading hard process in pp collisions at √s=13 TeV. To verify our findings experimentally, we analyzed the D^0 meson yields in terms of the underlying-event within the ALICE Collaboration. It was found that experimental results are consistent with predictions by simulations [6].

The Tsallis-thermometer for charm hadrons from RHIC to LHC energies. — We analyzed the transverse momentum distributions of the identified D mesons from pp, p-A and A-A collisions in the ALICE and STAR experiments covering the center-of-mass energy range between 200 GeV and 7 TeV, within a non-extensive statistical framework. We found that D mesons, which are created in the early stages of a collision, generally follow the trends observed for light-flavor hadrons but they correspond to a higher Tsallis temperature and and the heavy-flavor spectra are produced at earlier stages of the collision. [7]. The analysis was continued by calculating and comparing the spectrum formation times of different heavy and light-flavor mesons (Fig. 2) and baryons at LHC energies and determining limits for the specific heat [8].

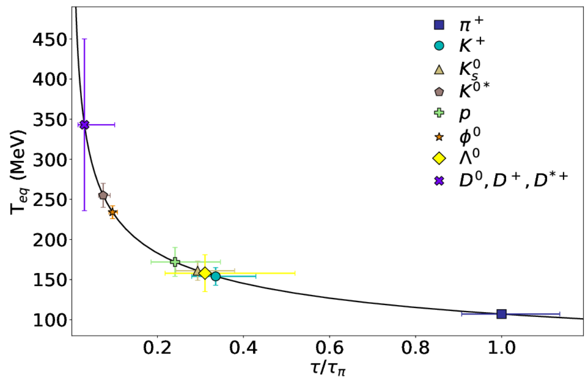

Figure 2. *Relative formation proper times for each hadron species within the Bjorken model. The proper time is expressed in units relative to that of the pion (From Ref. [8]).*

Heavy ion physics. — We contributed to the publication of the overview of high-density QCD studies with the CMS experiment at the LHC, with special emphasis on the space-time evolution of the created system via quantum correlations (femtoscopy) [9]. We took part in the measurement of the pseudorapidity distributions of charged hadrons in lead-lead collisions at $\sqrt{s_{NN}}$ = 5.36 TeV centre-of mass energy [10]. Comparisons are made to various Monte Carlo event generators and to previous measurements of lead-lead and xenon-xenon collisions at similar collision energies. We detail the dependence of particle production on the collision energy, initial collision geometry, and the size of the colliding nuclei.

Detector development for ALICE 3. — The Muon ID for the ALICE3 experiment [11] will be essential for detail-rich open as well as hidden heavy-flavor measurements though the muonic decay channel. This way, exotic hadrons as well as the microscopic dynamics of the quark-gluon plasma can be explored. While the bulk of the work has been carried out by the Innovative Detector Development group, we contribute to the efforts mainly with modeling of the detector response using the GEANT 4 software package, with a focus on multiwire proportional chamber (MWPC) technology.

The underlying event and heavy-flavor baryon enhancement. — Recent experiments from the LHC show an enhancement of charmed baryons compared to expectations. This questions the previously assumed universality of heavy-flavor jet fragmentation across different collisional systems. We investigated the production of charmed baryons in proton–proton collisions at LHC energies with flattenicity-dependent production of the D_0 and the Λ_c and concluded that flattenicity reflects underlying-event activity well, with relatively weak correlation to the event multiplicity. Similar conclusions could be drawn in the beauty sector with Λ_b and B^+. We compared several PYTHIA8 tunes to highlight those capable of reproducing measured data [12].

Intra-jet dynamics. — Recent research showed that dynamics of a high-multiplicity jet in its own system may resemble the soft dynamics of matter. We engaged in phenomenology studies of intra-jet dynamics and found that strangeness enhancement as well as heavy-flavor baryon enhancement is present within the jet reference system, similarly to soft physics.. The first preliminary results are in a preprint [13]. We aim to publish our results in 2025.

Jet fragmentation. — The intrinsic properties of jets from high-energy proton-proton collisions can help us to understand the fragmentation processes that occur after the hard scattering interaction. We have continued to analyze the proton-proton data collected by the CMS detector. The ongoing studies include the comparison of the measured results with various model predictions.

Detection of forward neutrons and high-precision luminosity measurements at CMS. — Continuing our work on the ZDC as a trigger measuring the one-neutron peak, we carried out a detailed analysis for obtaining rate predictions for the proton-proton reference run in the end of October on the basis of data taken in the previous year. We also carried out trigger validation during the whole data-taking period.

We worked on obtaining the XY factorization bias for the proton-proton data from 2023 and started an analysis on the proton-proton data from 2024 as well. The work included carrying out 1D fits, obtaining an additional orbit drift correction, doing 2D fits with various fitting models, and working with simulations in order to obtain the corrections on the visible cross-section. At each step we also examined multiple parameter-dependences of the obtained values and the final correction value we gave with respect to time, with the corresponding RMS and systematic uncertainty.

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