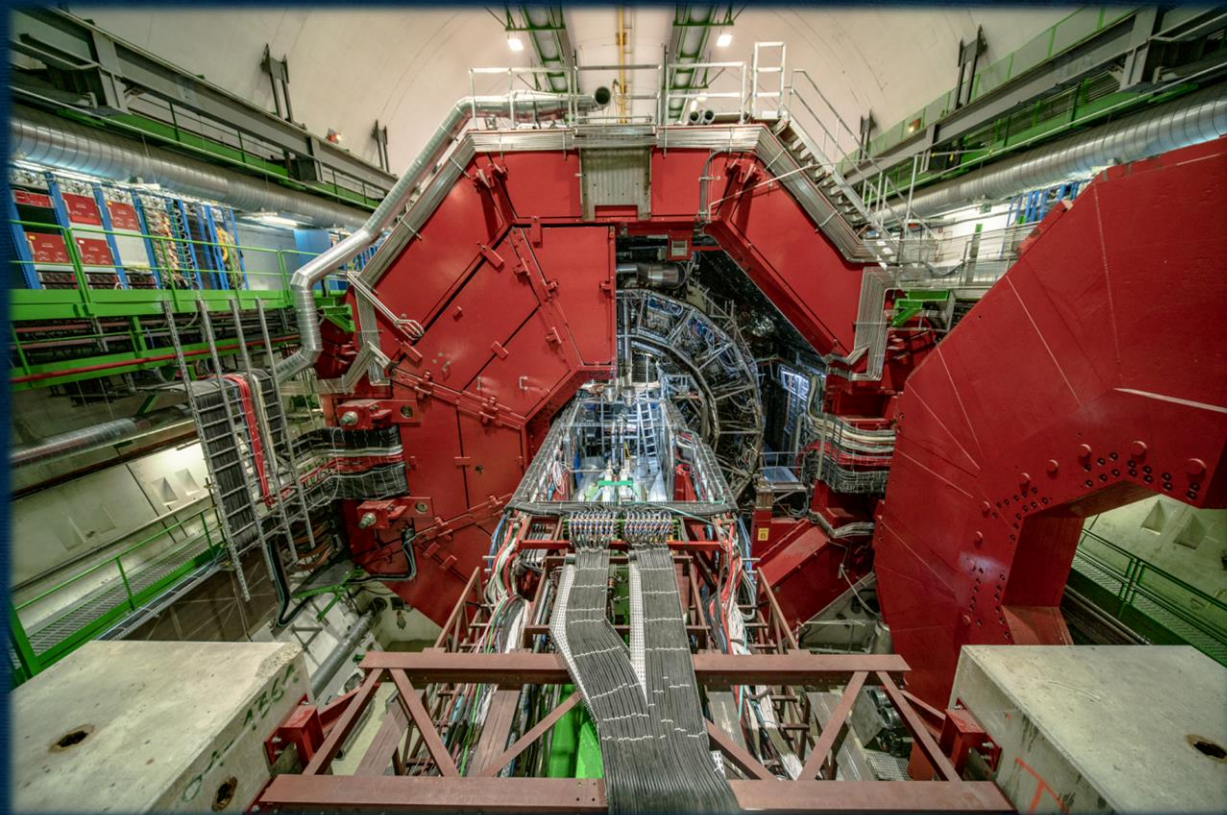




ALICE



Report on JINR-ALICE team activity in 2023



E. Rogochaya

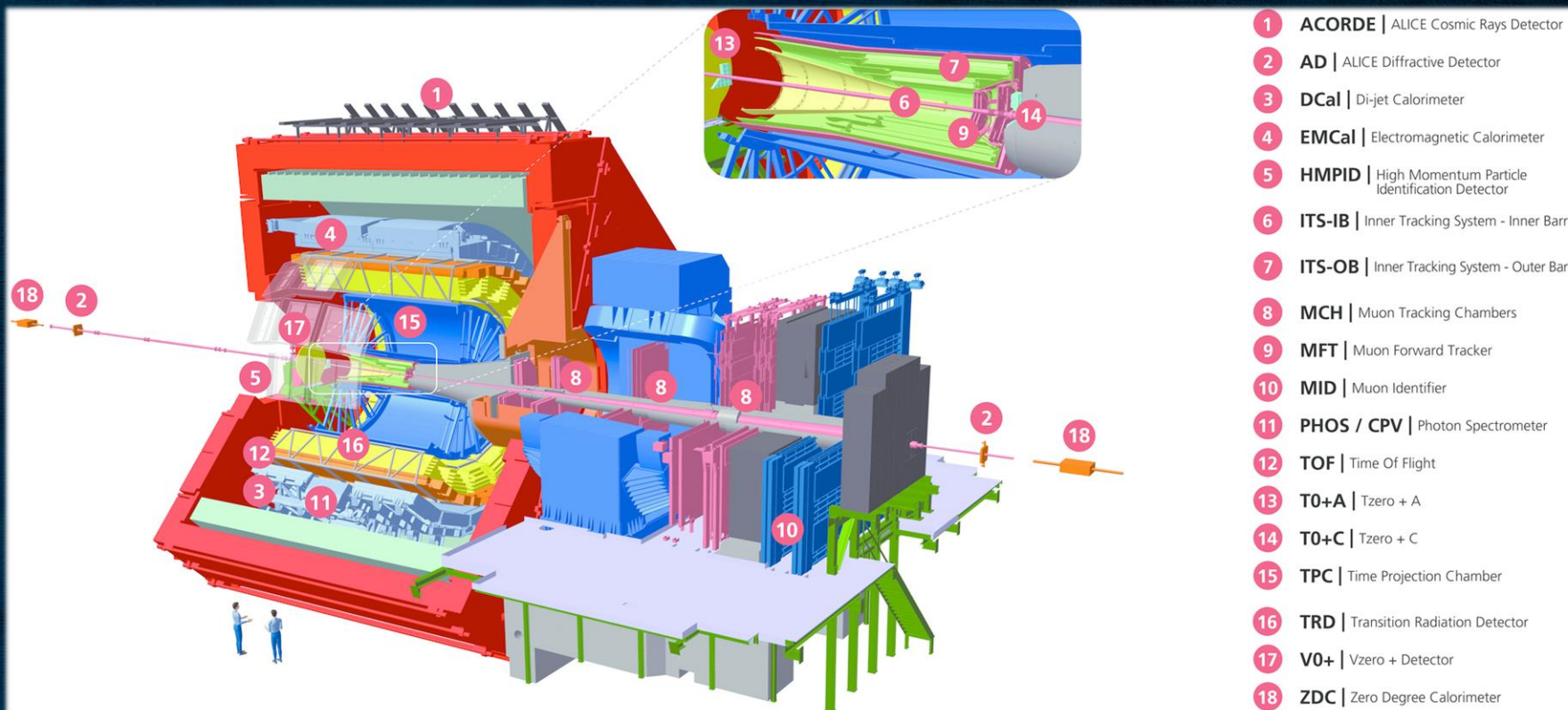
59th Program Advisory Committee
22 January 2024

Activities of JINR-ALICE group

- ✓ Femtoscopy (Bose-Einstein correlations, Coulomb and strong FSI):
 - analysis of two charged kaons correlations in pp, p-Pb and Pb-Pb collisions
 - elaboration of the related analysis software
- ✓ Ultra-peripheral p-Pb and Pb-Pb collisions: study of vector meson photoproduction
- ✓ Development of the thermal model of particle production in pp and A-A collisions
- ✓ GRID computing and software activities
- ✓ Participation in the ALICE maintenance and operation tasks
- ✓ PHOS upgrade

ALICE detector

Actual (Run 3) configuration:



✓ Tracking and vertex:

- TPC
- ITS
- MCH, MFT

✓ Particle identification:

- TPC
- TOF

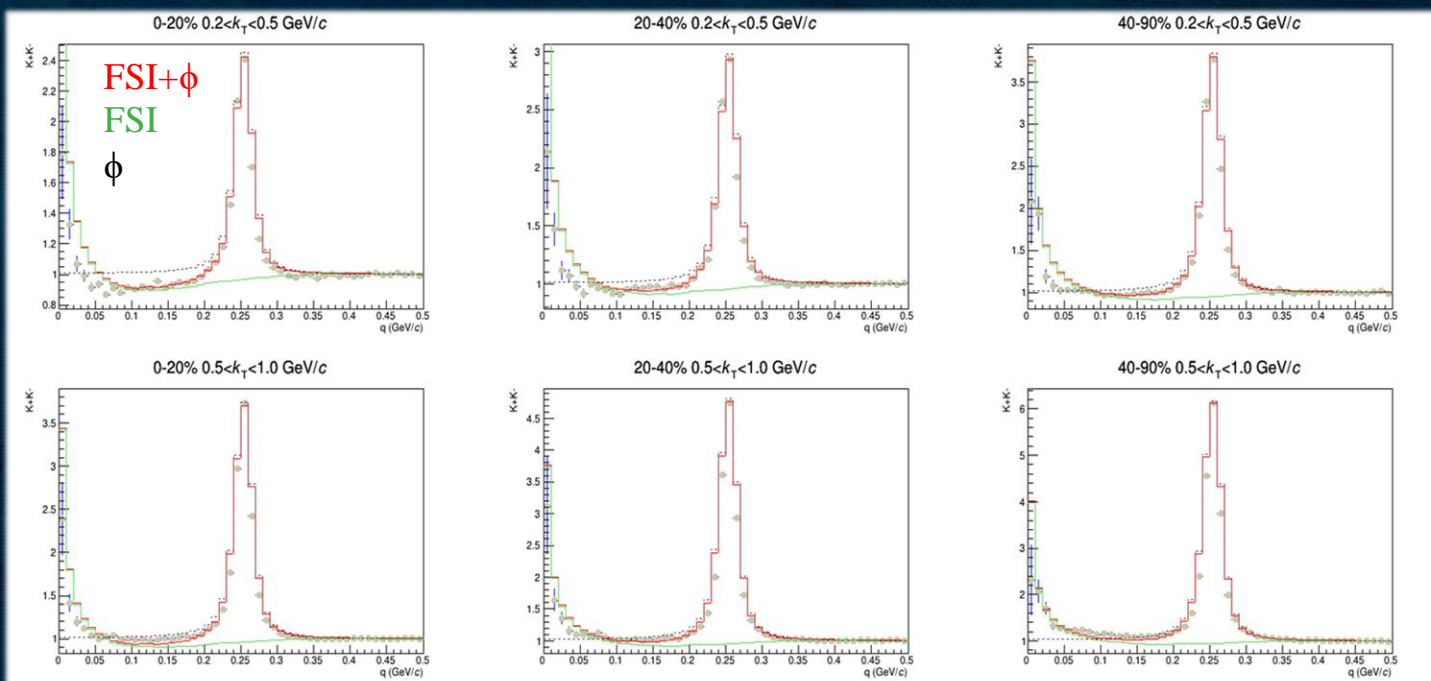
✓ Centrality determination or veto:

- V0
- ZDC

✓ Veto:

- AD

Femtoscopic K^+K^- correlation analysis in p-Pb at 5.02 TeV



$$C = \text{FSI} \cdot \lambda + \text{PHI} + 1$$

- ✓ $\lambda=1$ (and test $\lambda(K^+K^-)=\lambda(K^\pm K^\pm)\sim 0.3$)
- ✓ FSI – Lednický-Lyuboshits model with radius from identical charged kaon study
- ✓ PHI – ϕ peak: convolution of Gaussian (2 MeV) and Breit-Wigner scaled to height of peak in experimental CF
- ✓ Small sizes \rightarrow check the Lednický-Lyuboshits model

- ✓ First results for K^+K^- CF in p-Pb at 5.02 TeV.
- ✓ Significant contribution of the ϕ peak in the region of the strong and Coulomb FSI in comparison to the Pb-Pb data at 2.76 TeV [Phys.Rev.C107 (2023) 054904].
- ✓ Wide Coulomb FSI in comparison to the Pb-Pb analysis.
- ✓ Description looks better for $\lambda=1$.

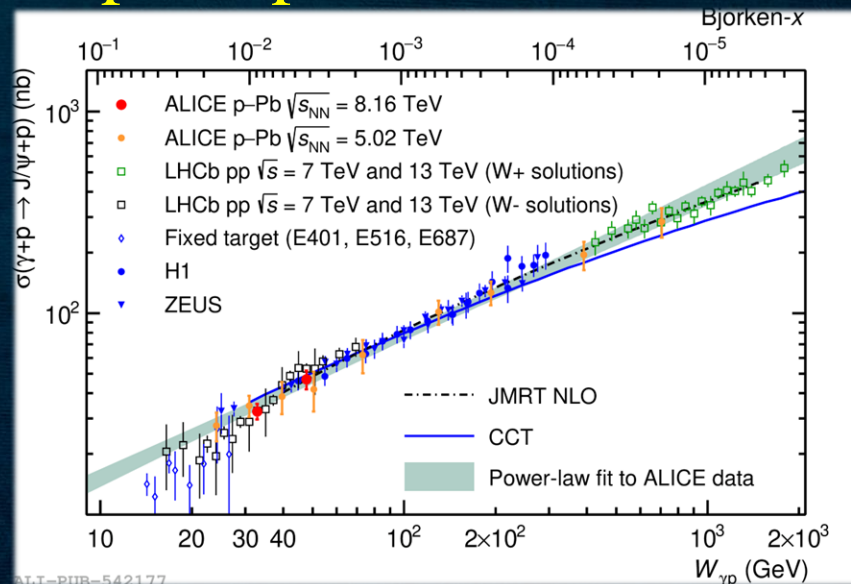
K.Mikhaylov

Vector meson photoproduction in UPC p-Pb at 8.16 TeV

V.Pozdniakov

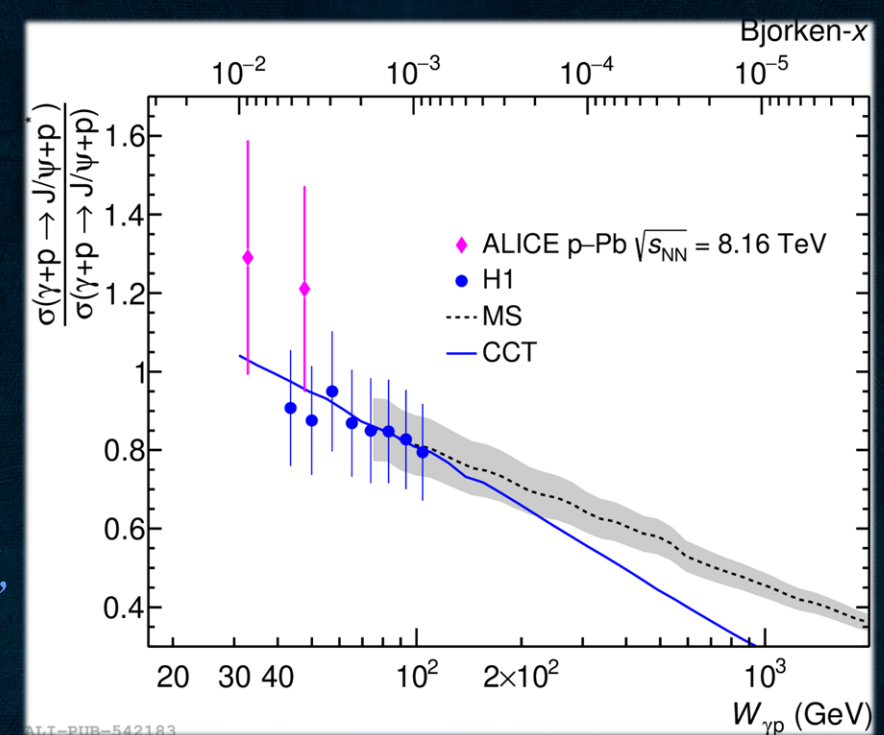
Exclusive J/ψ photoproduction cross section off protons measured as a function of the centre-of-mass energy of the photon-proton system $W_{\gamma p}$:

- ✓ Measurements by ALICE are compatible with the values measured by HERA and LHCb.
- ✓ No deviation from a power law is observed up to about 700 GeV.
- ✓ Future UPC measurements by ALICE will explore the higher $W_{\gamma p}$ range.
- ✓ Published in [ALICE, Phys.Rev.D108 (2023) 11, 112004].

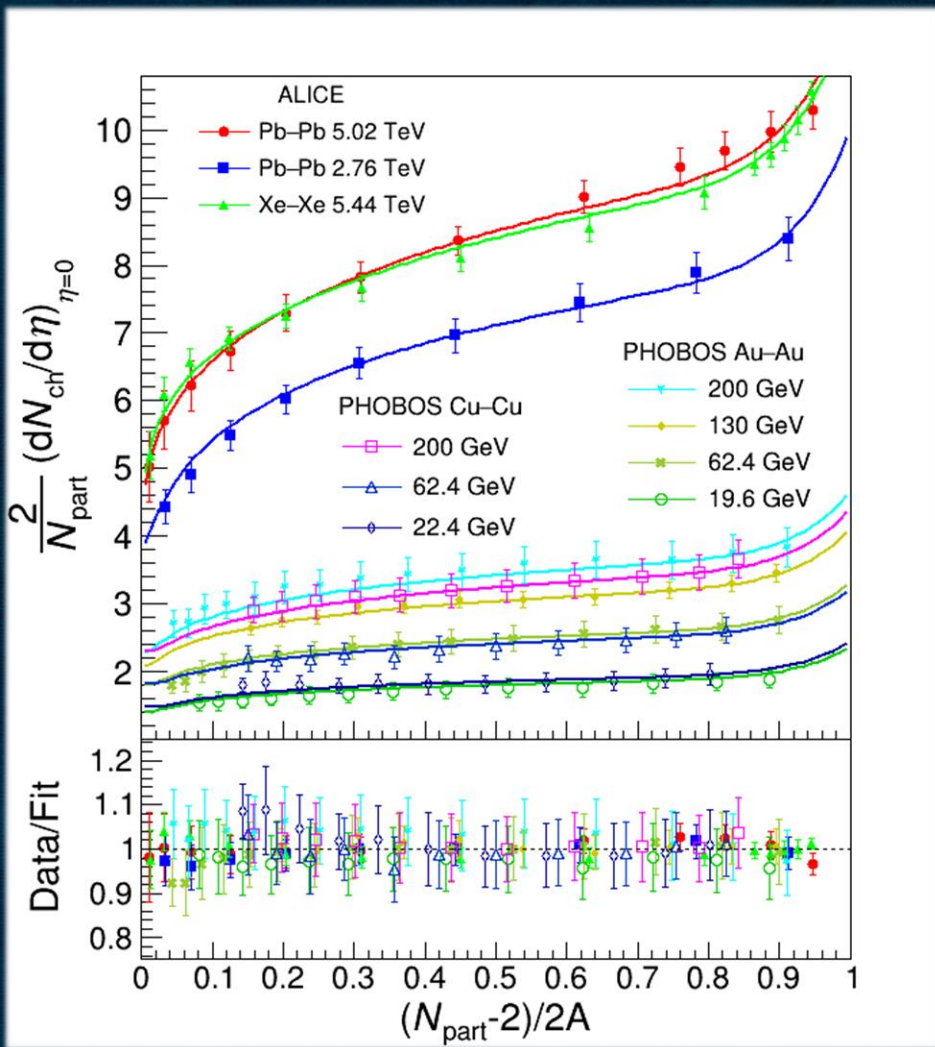


- ✓ Measurements by ALICE are compatible with the values measured by HERA.
- ✓ At high $W_{\gamma p}$, where the gluon saturation regime is expected, the models predict that the ratio vanishes.

Ratio of dissociative to exclusive J/ψ photoproduction cross sections:



Thermal model of particle production in pp and A-A collisions



Modification of the previous model [S.Grigoryan, Eur.Phys.J.A57 (2021) 12, 328].

Model consists of 3 components:

- 1) Boltzmann-Gibbs thermal distribution \rightarrow flow effect
- 2) Tsallis distribution \rightarrow resonance decays
- 3) power-law form \rightarrow QCD hard processes

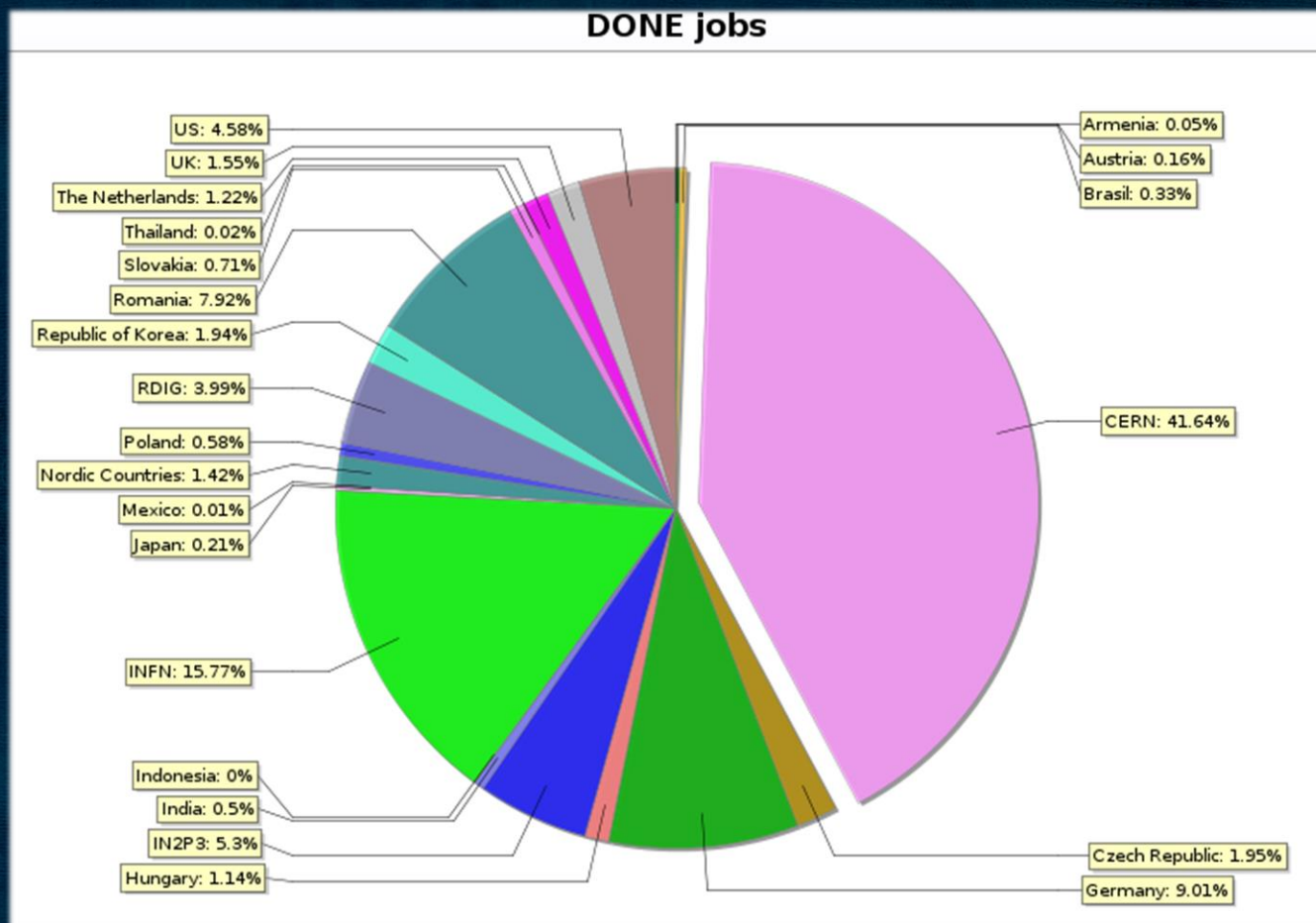
N_{part} - number of the participant nucleons, calculated in the Glauber model

A - atomic number

- ✓ Calculations are in a very good agreement with experimental (ALICE and lower energy) data.
- ✓ Limited value of each curve at $x=(N_{part}-2)/2A=0$ is equal to the charged particle multiplicity density at midrapidity in pp collisions at the corresponding energy.

S.Grigoryan

GRID computing and software activities



The JINR ALICE GRID is a part of 7 Russian ALICE GRID Tier 2 Centers (RDIG – Russian Data Intensive Grid).

The resources of JINR GRID Farm:

- ✓ 13500 cores CPU (40% of the RDIG)
- ✓ 2000 Tb Disk-SE (64% of the RDIG)

JINR provides and increases storage (Tb) and computing (CPU cores) resources for ALICE.

Conferences



- ✓ V.Pozdnyakov, “Exclusive and dissociative J/ψ photoproduction off protons with ALICE”, XXX International Workshop on Deep-Inelastic Scattering and Related Subjects, Michigan SU, USA, March 27-31, 2023.



- ✓ E.Rogochaya, “Studying the size of the emitting source of particles and their strong interaction using femtoscopy”, The European Physical Society Conference on High Energy Physics (EPS-HEP), Hamburg, Germany, August 21-25, 2023.



- ✓ V.Pozdnyakov, “Vector meson photoproduction in UPC with ALICE”, 25th International Spin Symposium (SPIN 2023), Durham, USA, September 24-29, 2023.



ALICE publications with key contribution from the JINR-ALICE group:

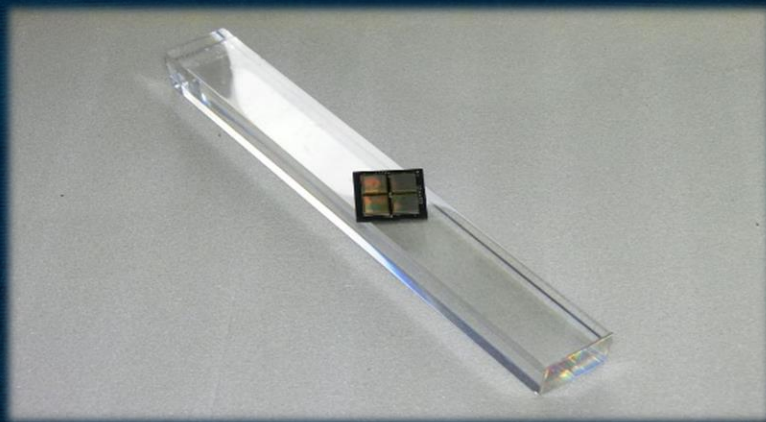
- ✓ “Investigation of K^+K^- interactions via femtoscopy in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV at the LHC”, ALICE Collaboration (S.Acharya et al.), Phys.Rev.C107 (2023) 054904.
- ✓ “Femtoscopic correlations of identical charged pions and kaons in pp collisions at $\sqrt{s} = 13$ TeV with event-shape selection.”, ALICE Collaboration (S.Acharya et al.), arXiv:2310.07509 [hep-ph].
- ✓ “Photoproduction of K^+K^- pairs in ultra-peripheral collisions”, ALICE Collaboration (S.Acharya et al.), arXiv:2311.11792 [nucl-ex].
- ✓ “Constraining the KN coupled channel dynamics using femtoscopic correlation at the LHC”, ALICE Collaboration (S.Acharya et al.), Eur.Phys.J.C83 (2023) 340.
- ✓ “Common femtoscopic hadron-emission source in pp collisions at the LHC”, ALICE Collaboration (S.Acharya et al.), 2311.14527 [hep-ph].
- ✓ Exclusive and dissociative J/ψ photoproduction, and exclusive dimuon production, in p-Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV, ALICE Collaboration (S.Acharya et al.), Phys.Rev.D108 (2023) 11, 112004.

Other scientific activities:

- ✓ K.Mikhaylov, E.Rogochaya and V.Pozdnyakov participate actively in Internal Review Committees (IRC) of various ALICE publications.
- ✓ JINR Institute Review of one of the ALICE publications.
- ✓ Participation in the ALICE central shifts (73).

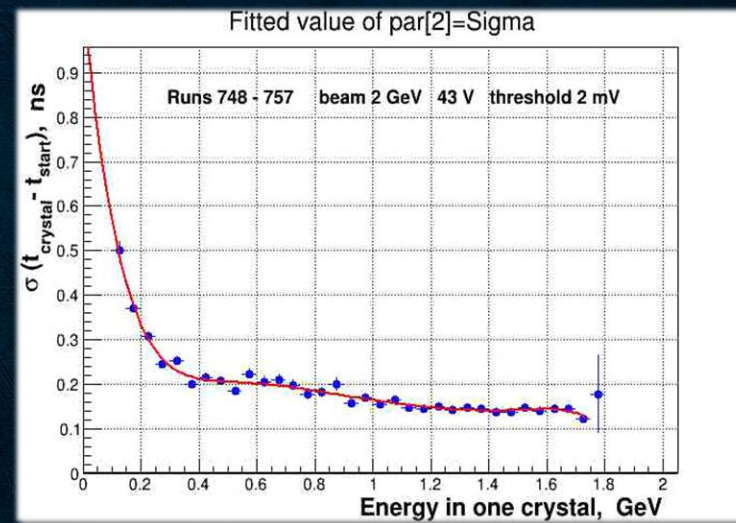


PWO_4 monocrystal and 3-SiPM (Hamamatsu S14160-6015) + 1-SiPM (Hamamatsu MPPC S14160-6010) 2-channel photodetector:

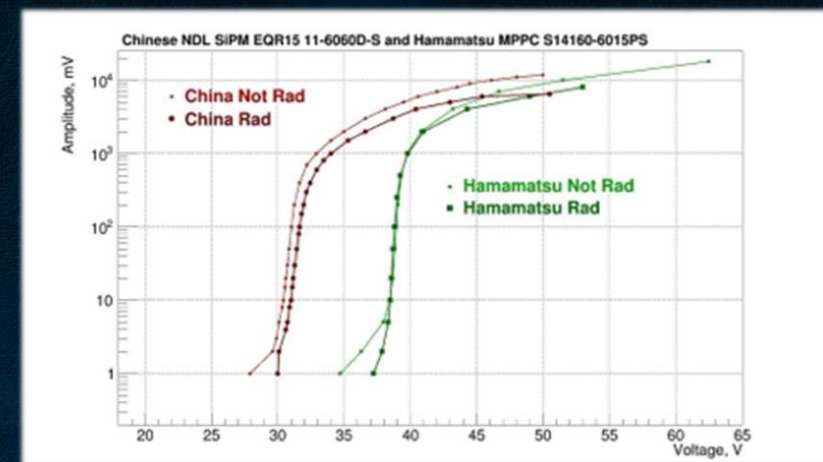


PHOS

Resolution for the difference between time stamps from signals in neighboring crystals:



Voltage dependence of picosecond laser pulse amplitude for irradiated and non-irradiated SiPMs:



- ✓ Excellent time resolution of 100 ps was achieved for 2 GeV energy release.
- ✓ Good energy resolution, up to 2%.
- ✓ First test: *Chinese NDL SiPM EQR15 11-6060D-S* (new technology, 3 times cheaper) compared to *Hamamatsu MPPC S14160-6015*.
Irradiation did not change the response of the detectors to light pulses.

Summary

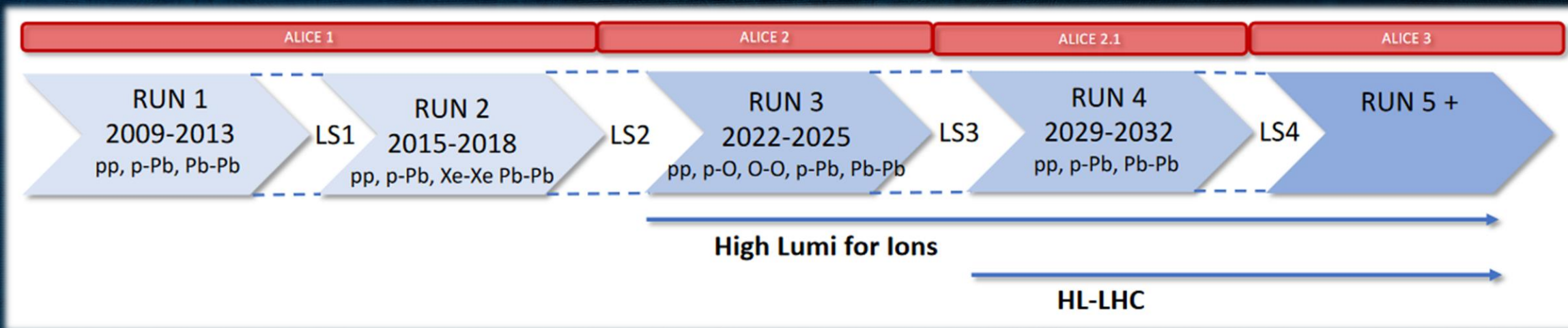
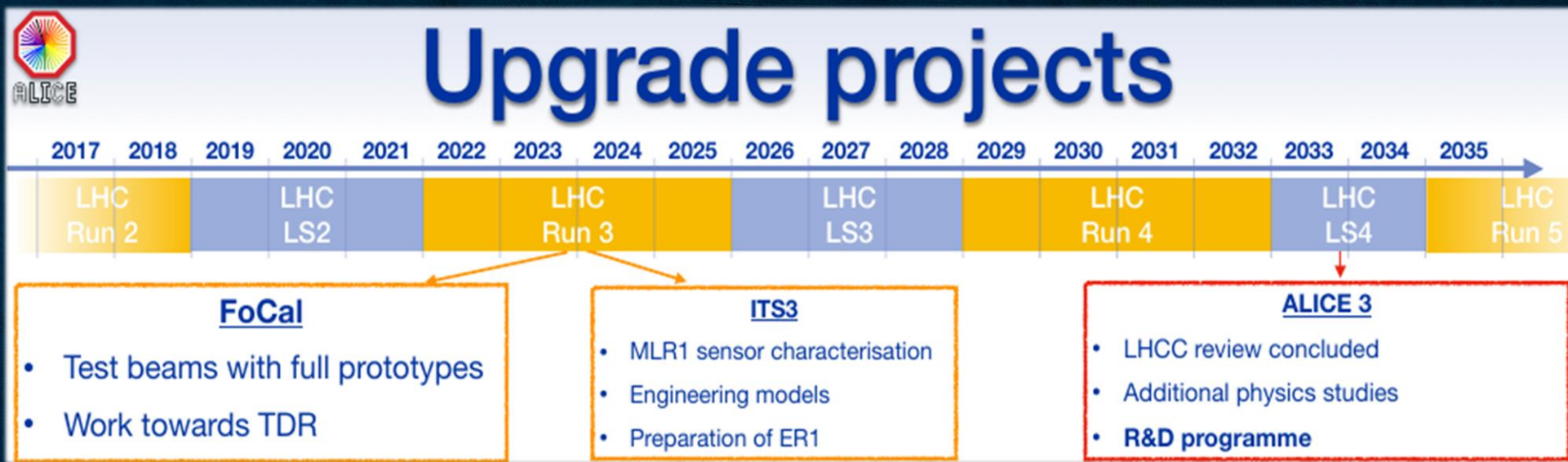
- ✓ JINR-ALICE team
 - carries out successfully physical analyses of experimental data on femtoscopic correlations in pp, p-Pb and Pb-Pb
 - studies vector meson photoproduction in ultra-peripheral p-Pb and Pb-Pb
 - constantly improves the three-component theoretical model of particle production
- ✓ All analyses results were reported at ALICE meetings and international conferences, and the finished ones were prepared for publication in peer-reviewed journals.
- ✓ JINR ALICE GRID facility continues to provide stable computing operation and steady increase of its capacity.
- ✓ PHOS: Excellent time resolution of $140 \rightarrow 100$ ps was achieved for 1-2 GeV energy release.

Plans for 2024

- ✓ Publish paper on 1D and 3D femtoscopic analyses for $K^{\pm}K^{\pm}$ correlations in Pb-Pb collisions at 5.02 TeV.
- ✓ Publish paper on 1D and 3D femtoscopic analyses for $K^{\pm}K^{\pm}$ correlations in p-Pb collisions at 5.02 TeV.
- ✓ Continue 1D femtoscopic analysis for K^+K^- pairs in p-Pb collisions at 5.02 TeV.
- ✓ Finalize the analysis of ρ^0 states in 4-pion coherent photoproduction in ultra-peripheral Pb-Pb collisions at 5.02 TeV and prepare a publication.
- ✓ Start the analysis of ρ^0 meson coherent photoproduction in ultra-peripheral p-Pb collisions at 5.02 TeV.
- ✓ ALICE GRID support in the JINR computing system.
- ✓ Participate in the ALICE shifts and service tasks.
- ✓ Prepare a publication on the new version of Thermal model of particle production in A-A collisions.
- ✓ Prepare photodetectors and electronics for 30 cells of the PHOS calorimeter and perform measurements on the SPS CERN test electron beam in the range 10-150 GeV of electron energies.

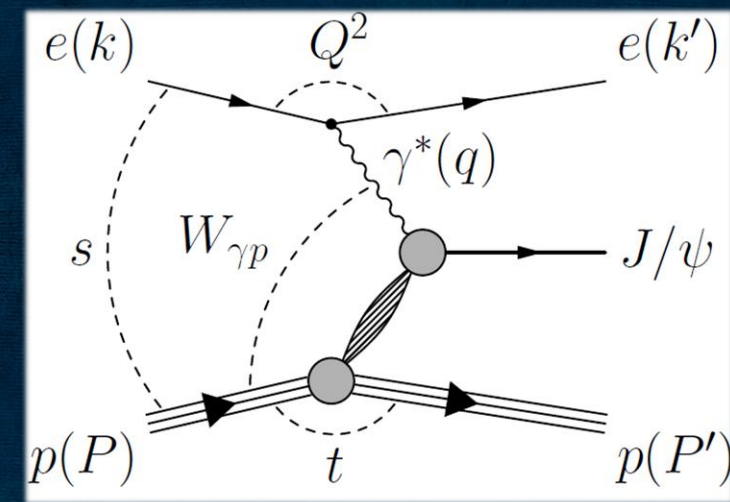
THANK YOU FOR YOUR ATTENTION!

Backup: ALICE schedule



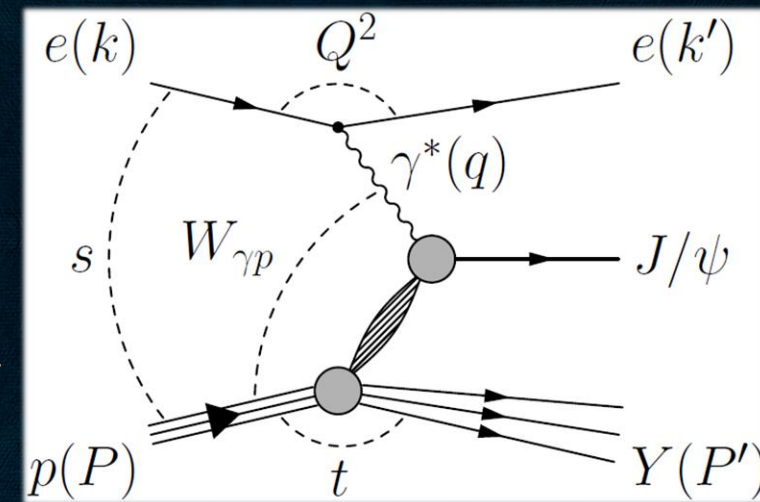
Backup: Ultra-Peripheral Collisions

- ✓ UPC occur when particles/ions collide at impact parameter b greater than sum of nuclear radii \rightarrow UPC are γ -induced reactions.
- ✓ Large charges of colliding ion \rightarrow production of huge γ fluxes.



\leftarrow elastic J/ψ production in which the proton stays intact

proton-dissociative J/ψ production in which the proton dissociates to a low mass excited state with mass $M_Y > m_p \rightarrow$



- ✓ In γ -induced reactions, γ can be represented as a coherent superposition of hadronic fluctuations (ρ , ω , ϕ , J/ψ , etc.) that subsequently interact with the target.