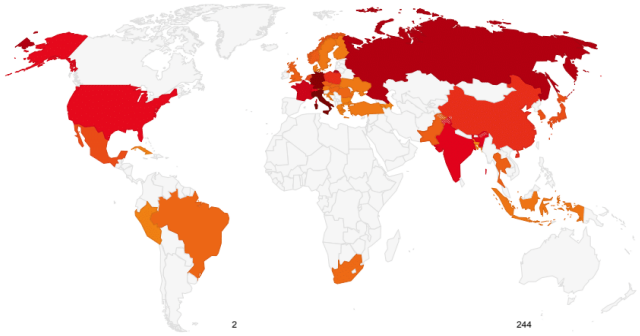
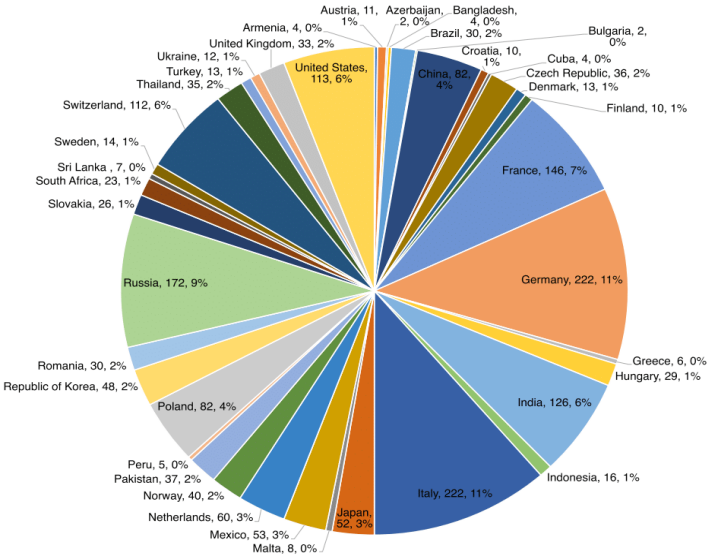
New results obtained in the ALICE experiment with a participation of the JINR team.

B.Batyunya

58th PAC, Dubna, 21.06.2023

The ALICE Collaboration





40 Countries, 176 Institutes (including 19 Associates)

1946 Members, about 1000 signing authors

941 Physicists (including PhD Students)

- 587 PhD Physicists
- 355 PhD Students

52 Senior Engineers

The ALICE JINR group:

-- 13 physicists (6 - analysis, 7 - PHOS);

-- 1 PhD student;

-- 1 expert for the root software updating and GRID computing management.

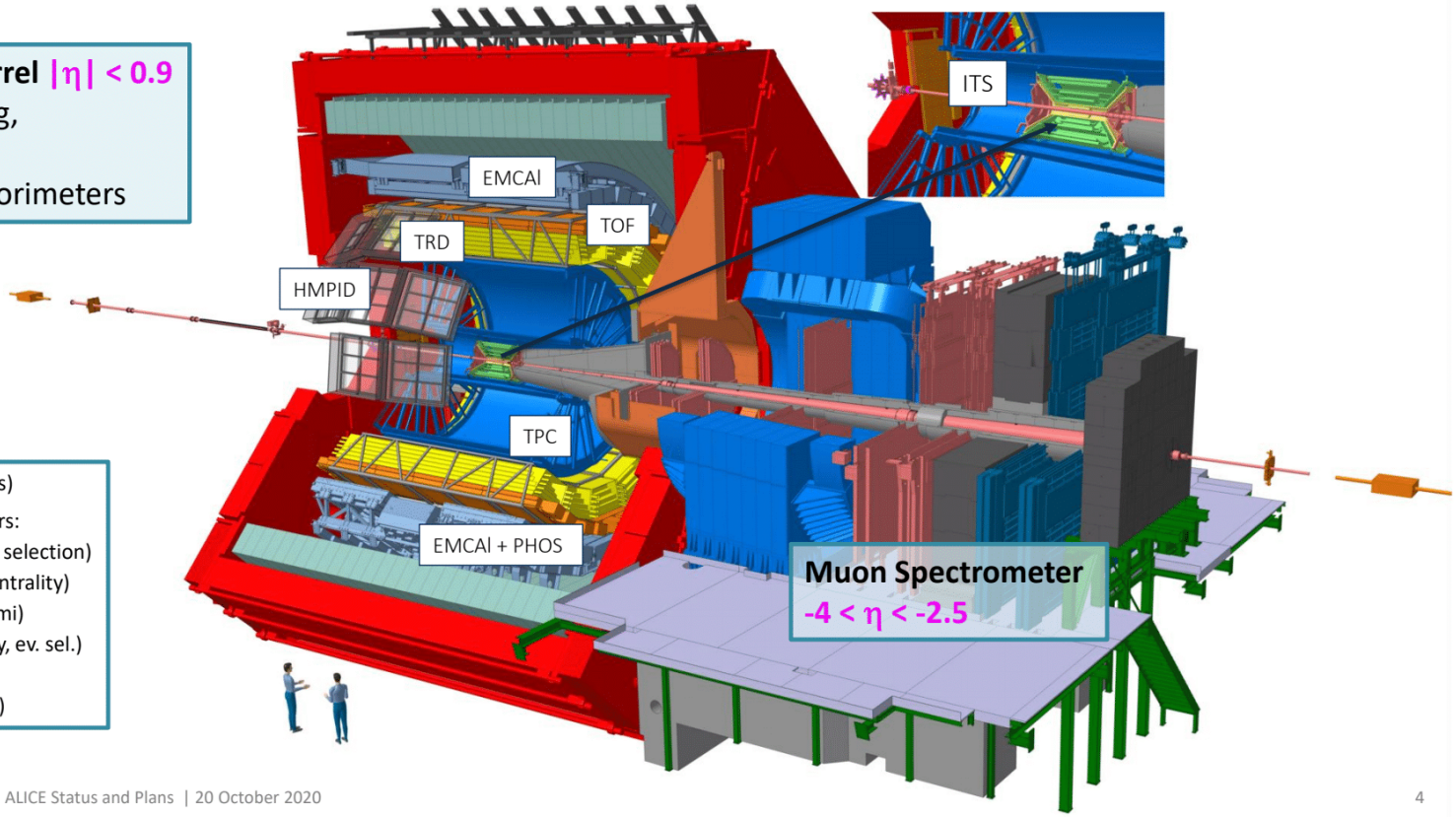
ALICE

Main activity of the Dubna team in ALICE

- Bothe-Einstein correlations (femtoscopy physics):
  Analysis of two-charged kaons correlations in p-p, p-Pb and Pb-Pb collisions. Updating of the analysis software.
- Ultraperipheral collisions of heavy ions:
  Study of vector meson photoproductions in the Pb-Pb and p-Pb collisions.
- Thermal model of particle production in pp and A-A collisions.
- GRID computing and software activities.
- Participation in the ALICE shifts and service tasks.
- Photon Spectrometer (PHOS) upgrade.

The ALICE detector (Run 2)

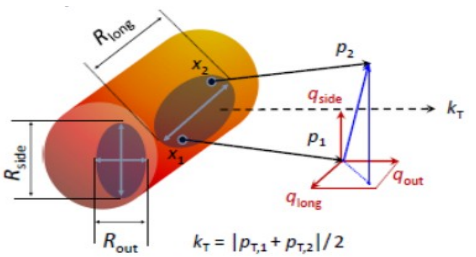
Central Barrel $|\eta| < 0.9$
- Tracking,
- PID
- EM-Calorimeters



ACORDE (cosmics)

Forward detectors:
- AD (difraction selection)
- V0 (trigger, centrality)
- V0 (timing, lumi)
- ZDC (centrality, ev. sel.)
- FMD (N_{ch})
- PMD ($N\gamma$, *Nch*)

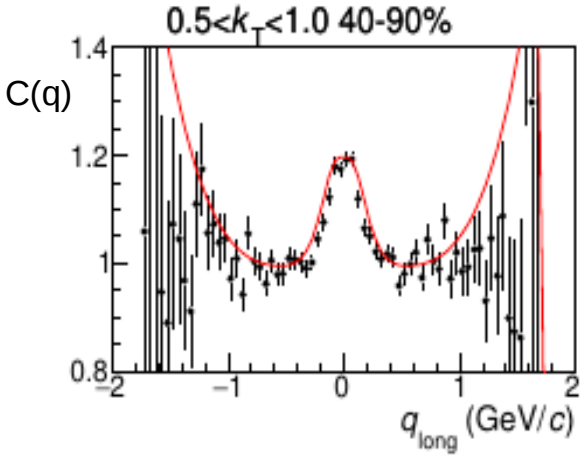
New results were obtained in 3-D femtoscopic correlation updated analysis for identical kaon pairs production in p-Pb collisions at 5.02 TeV. The three radii components (top figure) were extracted from the fit with the formula for a correlation function C(q), $\mathbf{q} = (p_1\text{-}p_2)$, p_1 and p_2 are the momenta of kaons, K(q) – Coulomb factor, λ – correlation strength:

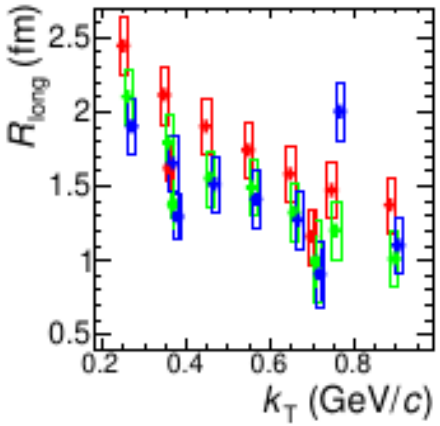


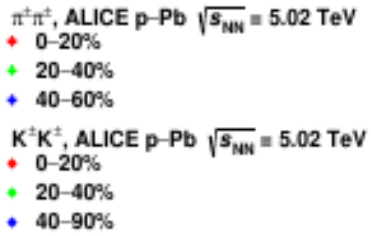
long || beam

$$C(\mathbf{q}) = N(1-\lambda) + N\lambda K(q)\left[1 + \exp\left(-R_{\text{out}}^2 q_{\text{out}}^2 - R_{\text{side}}^2 q_{\text{side}}^2 - R_{\text{long}}^2 q_{\text{long}}^2\right)\right]$$ D(q), **D(q) — polynomial baseline**

The C(q) for the longitudinal direction is shown in the left lower figure. The red line Is the fit result by this formula.







The right lower figure shows the R_{long} versus pair transverse momentum (k_T) for different centralities. The ππ data are presented for comparison. The known strong decrease is seen for both pair types as a consequence of the collective effects, predicted in the models (the same was found for R_{out} and R_{side})

New results were obtained fore kaon emission time with updated analysis of identical $K^{\pm}K^{\pm}$ pair production in p-Pb collisions at 5.02 TeV. Kaon emission time (τ) was extracted using a source radii R_{long} dependence from transverse pair mass ($m_T=(k^2_T+m^2)^{0.5}$) and the following formulas in the iHKM model:

$$R^2_{\mathrm{long}}(m_{\mathrm{T}}) = \tau^2\lambda^2\left(1+\frac{3}{2}\lambda^2\right)$$

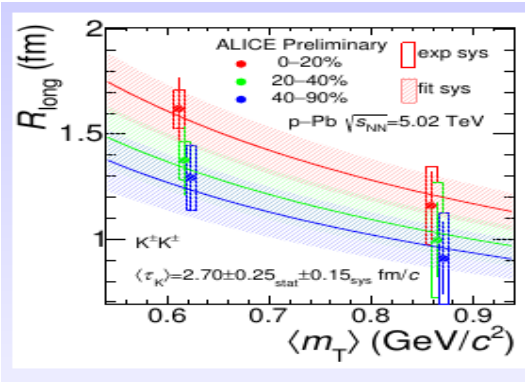
$$\lambda^2 = \left(\frac{\lambda_l}{\tau}\right)^2 = \frac{T}{m_{\mathrm{T}}}\sqrt{1-\bar{\nu}^2_{\mathrm{T}}}$$

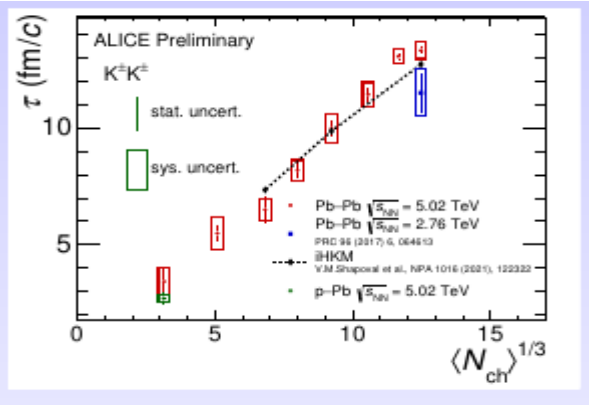
, λ_l- longitudinal homogeneity length, T-temperature, ν_T- transverse collective velocity

The temperature T has been found from the particle momentum experimental spectra describing by:

$$p_0\frac{d^3N}{d^3p} \propto \exp\left[-\left(\frac{m_{\mathrm{T}}}{T}+\alpha\right)\sqrt{1-\bar{\nu}^2_{\mathrm{T}}}\right]$$

, α-strength of collective particle flow.



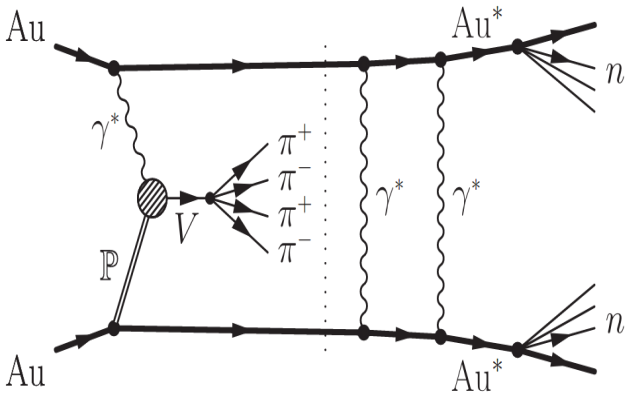


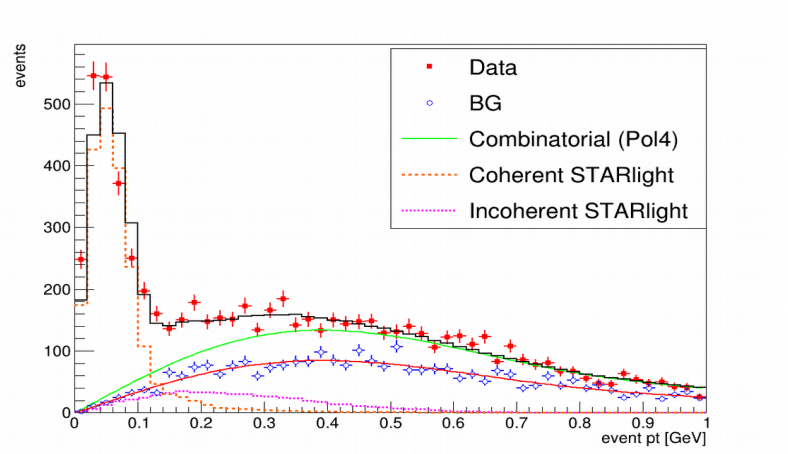
The τ value was obtained by the combined fit used simultaneously the Rlong versus m_T (left figure) and particle spectra. The mean value (2.7 ± 0.25±0.15 fm/c) coincides (right figure) with the one found for Pb-Pb data at the same charged particle multiplicity which corresponds to the same source of the particle emission.

The results were approved in the ALICE for the presentation in EPS-HEP 2023, Hamburg Conference and for the ALICE publication.

New results were obtained with the JINR team participation for four pions coherent photoproduction in ultraperiferel Pb-Pb collisions (UPC) at 5.02 TeV (per nucleon pairs) using updated analysis. In this process vertual photons interact with whole nucleus through pomeron exchange with creating and decays of vector mesons (particulaly ρ^{o}, $\rho^{o'}$) as it's shown by the diagram in the left figure.

The coherent process is selected with the transverse momentum of four pions $p_t(4\pi) < 0.15$ GeV/c according a prediction of STARlight model as it is seen in the right figure.



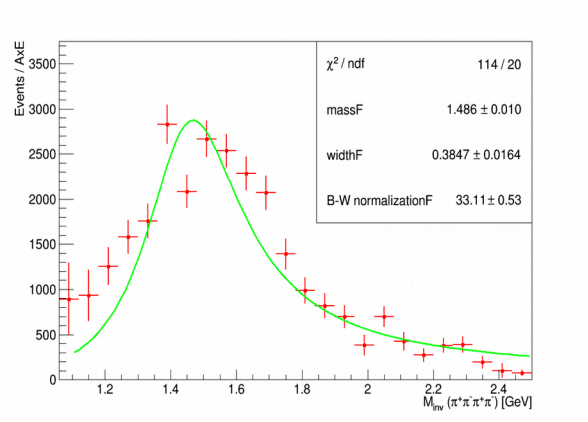


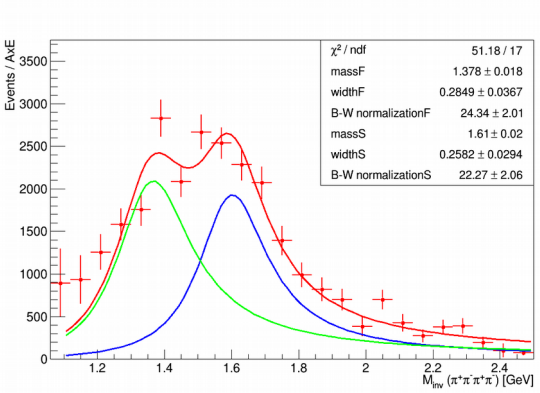
To study the mass and width of possible vector mesons the invariant mass distributions of 4 pions were investigated (see the next slide).

The invariant mass distribution of 4 pions is shown in the left and right figures. The green line in the left figure is the fit result by Breit-Wigner (BW) function

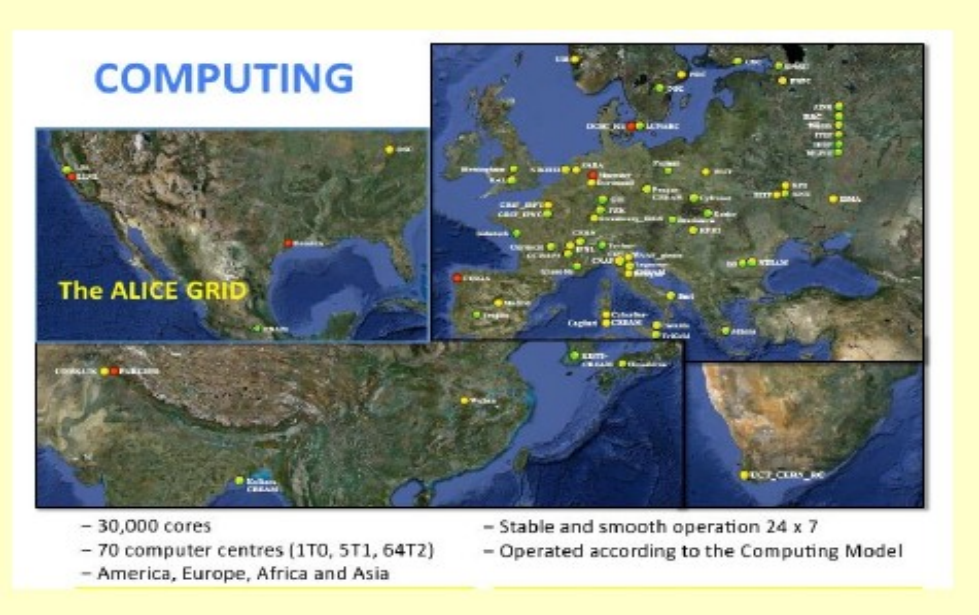
$$BW_{part} = \left| \frac{\sqrt{m_{part} \cdot m_{event} \cdot \Gamma_{event}}}{m_{event}^2 - m_{part}^2 + i \cdot m_{part} \cdot \Gamma_{event}} \right|^2$$

, where the m_{event} and Γ_{event} are the mass and the width of the distribution. The values of these parameters are respectively 1.486 ± 10 MeV and 385 ± 16 MeV and are mostly consistent with the $\rho^0(1450)$ resonance.



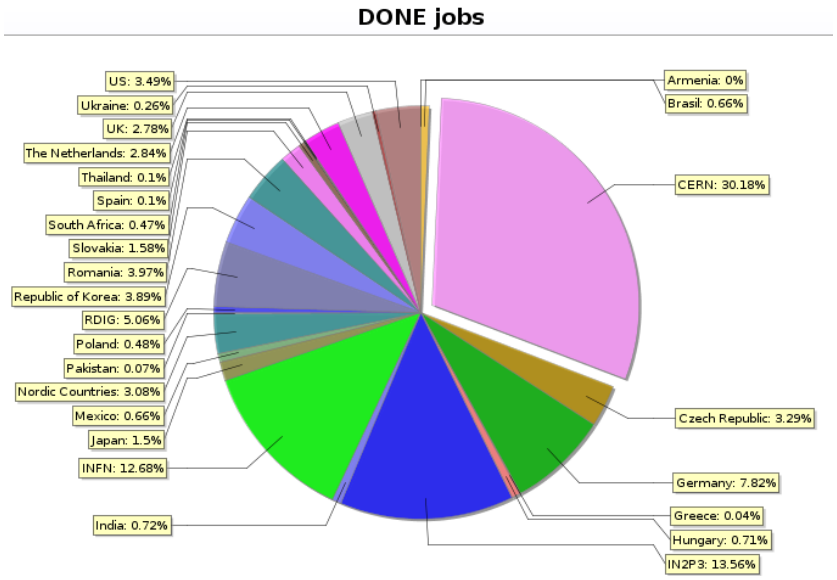


The red line in the right figure is the sum of two BW functions for two resonance states with the parameter values: m_1 = 1378 MeV± 18 MeV, Γ_1 = 285 MeV ± 37 MeV and m_2 = 1610 MeV ±20 MeV, Γ_2 = 258 ± 29 MeV. These values are consistent with PDG's the $\rho^0(1450)$ and the $\rho^0(1700)$. Adding the second BW reduces the χ^2/ndf by a factor of 2. These results were reported in the ALICE Forum and were approved for the ALICE publication.

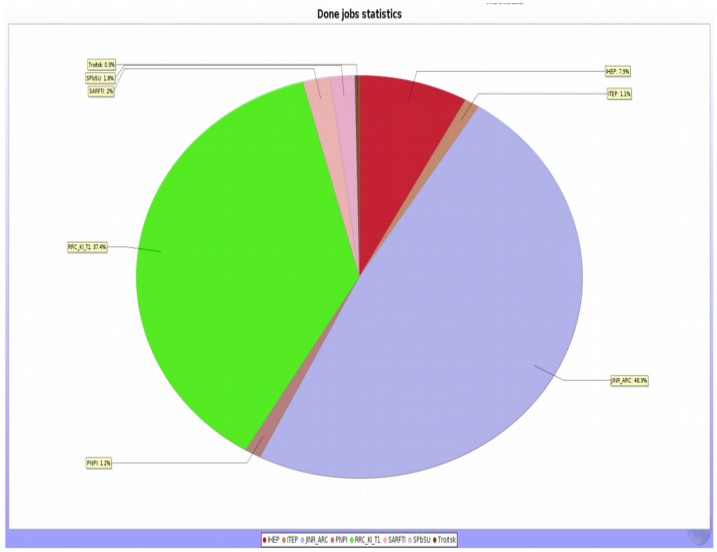


The JINR ALICE GRID is a part of 7-th Russian ALICE GRID Tier 2 Centers (RDIG – Russian Data Intensive Grid).

The resources of JINR GRID Farm:
13500 cores CPU (40% of the RDIG),
2000 Tb Disk-SE. (64%).



RDIG contribution to the ALICE-GRID is 5.1%



The contribution of JINR to the RDIG jobs is 48% .

Conference presentations .

1. V.Pozdnyakov (JINR), on behalf of the ALICE Collaboration), Exclusive and dissociative J/ψ photoproduction off protons vector mesons with ALICE. SIS23, Michigan State University.

ALICE publications with key contributions from the JINR group.

1. Investigation of K^+K^- interactions via femtoscopy in Pb-Pb collisions at $(s_{NN})^{1/2}$ = 2.76 TeV at the LHC., ALICE Collaboration (S. Acharya et al.), Phys. Rev. C 107, 054904 (2023).

2. Constraining the KN coupled channel dynamics using femtoscopic correlation at the LHC. ALICE Collaboration (S.Acharya et al), Eur. Phys. J.,C83 (2023) 340.

Other scientific activities.

– JINR Encouraging Prize in 2022 year for “ Study of vector meson photoproduction processes in ALICE (CERN).

– Participation of K. Mikhaylov (JINR, NRC-ITEP Moscow), L.Malinina (JINR, SINP MSU Moscow) and E. Rogochaya (JINR), V. Pozdnyakov in the ALICE Review Committees for the different ALICE publications.

– JINR Institute review for one of the ALICE publication.

– Participation in the 46 ALICE - DCS shifts (65% of the year quota)

Conclusions

– The JINR ALICE team carries out successfully the new updated physical analysis of the experimental data for the Femtoscopic Correlations in p-Pb collisions.
It was obtained first that kaon emission time coincides with the one found in the Pb-Pb collisions at the same charged particle multiplicity.

– The new updated analysis was used also for the UPC study in Pb-Pb at 5.02 TeV. It was shown that the description of invariant mass 4-pions spectrum by two BW functions reduces χ^2/ndf by factor of 2 and leads to the two $\rho^{0'}$ states consistent with the ones in the PDG.

– All analysis results were reported in the ALICE Meetings
and the publications are under the preparation.

– JINR ALICE GRID site continues to provide a stable operation.

JINR plans for the 2023-24 years.

- Finish the publicvation for 1-D femtoscopic analysis of identical charged pion and kaon pairs in the p-p collisions at 13 TeV with the event sphericity selection.
- Finish 1D and 3-D femtoscopic analysis for $K^{ch}K^{ch}$ pairs in Pb-Pb and p-Pb collisions at 5.02 TeV with the preparation of publications.
- Start the 1-D femtoscopic analysis for $K^{+}K^{-}$ pars in p-Pb collisions at 5.02 TeV.
- Finish the analysis of ρ^0 states photo-productions in the four particles Ultra-Peripheral Pb-Pb collisions at 5.02 TeV with the publication preparation.
- Start the analysis of ρ^0 meson photo-productions in the Ultra-Peripheral p-Pb collisions at 5.02 TeV.
- Preparation of the publication for the new version of Thermal model of particle production in A-A collisions.
- Test at CERN SPS the PHOS prototype on the electron beam with energy of 10-200 GeV for different variants of photodetectors.
- ALICE GRID support in the JINR computing system.
- Participation in the ALICE shifts and service tasks.

Thank you for your attention

Backup

Upgrade projects