

PAG-UPC: Past, current and future projects UPC meeting

SMI - STEFAN MEYER INSTITUTE FOR SUBATOMIC PHYSICS

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About the group

- The ALICE Collaboration has several physics working groups (PWGs), which further divides into physics analysis groups (PAGs)
- The group relevant to this workshop: PWG UD (Ultra-peripheral and diffractive), specifically PAG UPC
- Relatively small group (20-30 people), which is convenient.
- Currently, we have meetings every Tuesday at 17:00
 - https://indico.cern.ch/category/4046/

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- Subscribe to upc mailing list to get updates about our group!
 - Go to e-groups.cern.ch
 - Search for alice-upc
 - Click on subscribe

Published Run 1 analyses

- Measurement of the Cross Section for EMD with Neutron Emission in Pb-Pb Collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV Phys. Rev. Lett. 109 (2012) 252302
- Measurement of inelastic, single- and double-diffraction cross sections in pp collisions at the LHC with ALICE Eur. Phys. J. C 73 (2013) 2456
- Coherent J/ Ψ photoproduction in Pb-Pb UPCs at $\sqrt{s_{NN}} = 2.76$ TeV Phys. Lett. B 718 (2013) 1273-1283
- Charmonium and e^+e^- pair photoproduction at mid-rapidity in ultra-peripheral Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV Eur. Phys. J. C 73 (2013) 2617
- Exclusive J/ Ψ photoproduction off protons in ultra-peripheral p-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV Phys. Rev. Lett. 113 (2014) 232504
- Coherent ρ^0 photoproduction in ultra-peripheral Pb-Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV JHEP 09 (2015) 095 '
- Coherent Ψ' photo-production in ultra-peripheral Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV Phys. Lett. B 718 (2013) 1273-1283 '
- Charged-particle multiplicities in proton-proton collisions at $\sqrt{s} = 0.9$ TeV and $\sqrt{s} = 8$ TeV Eur. Phys. J. C 77 (2017) 33 '
- Energy dependence of exclusive J/ Ψ photoproduction off protons in p-Pb UPCs at $\sqrt{s_{NN}} = 5.02$ TeV Eur. Phys. J. C (2019) 79: 402
- Timespan: 2012-2019.
- 2x pp, 2x p–Pb, 5x Pb–Pb

■ 2x PRL, 2x PLB, 4x EPJC, 1x JHEP

What have we learnt



- Proofs that UPCs are feasible and a promising tool for future searches at the LHC.
- First estimates of nuclear shadowing.
- First tries to look for gluon saturation in proton.
- Classification based on presence of EMDs.

Published Run 2 analyses

- Coherent J/ Ψ photoproduction at forward rapidity in ultra-peripheral Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV Phys.Lett. B798 (2019) 134926
- Coherent photoproduction of ρ^0 vector mesons in ultra-peripheral Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV JHEP 06 (2020) 035
- First measurement of coherent ρ^0 photoproduction in ultra-peripheral Xe-Xe collisions at $\sqrt{s_{NN}} = 5.44$ TeV Phys. Lett. B 820 (2021) 136481
- Coherent J/ Ψ and Ψ' photoproduction at midrapidity in ultra-peripheral Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV Eur. Phys. J. C 81 (2021) 712
- First measurement of the |t|-dependence of coherent J/ Ψ photonuclear production PLB 817 (2021) 136280
- Neutron emission in ultraperipheral Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV Phys. Rev. C 107 (2023) 064902
- Timespan: 2019-ongoing.
- 0x pp, 0(1)x p-Pb,
 5(8)x Pb-Pb, 1x Xe-Xe

- 0x PRL, 3x PLB, 1x EPJC, 1x PRC, 1x JHEP
- submitted: 0x PRL, 2x PLB, 1x PRD, 1x JHEP

What have we learnt



- \blacksquare Cross sections measured with precision below 10% \rightarrow impacts numerous models.
- Nucleus scanned in $2D \rightarrow$ sheds light on inner structure of nucleus.
- Clear evidence of shadowing in nucleus.

Ongoing Run 2 analyses

- |t|-dependence of incoherent J/ Ψ (soon to be published)
 - PC: D. Grund, G. Contreras, D. Tapia Takaki
- Coherent J/Ψ at midrapidity in different EMD classes (soon to be published)
 - PC: M. Broz, T. Herman, S, Ragoni, O. V. Baillie
- Coherent J/Ψ polarization in PbPb (soon to be published)
- Exclusive and dissociative J/Psi in pPb (soon to be published)
- Four-pion photoproduction in Pb–Pb (paper draft)
- Azimuthal anisotropies in ρ^0 in Pb–Pb 2015 (paper draft)
- Di-Kaon production in Pb–Pb (paper draft)
- Forward proton emission in Pb–Pb
- Energy dependence of incoherent J/Ψ at forward rapidity
 - Currently, "working on it"
 - PC: V. Filova, T. Herman, G. Contreras
- Multimuons in cosmic rays with ALICE



Run 3 menu

Re-analysis (and analysis extensions) with new data

- ρ^0 at midrapidity
- Coherent J/Ψ at midrapidity
 - Interference effects, |*t*| dependence
 - M. Broz, S. Haidlova, R. Lavicka
- Incoherent J/Ψ at midrapidity
 - Energy dependence, |t| dependence
 - G. Contreras, D. Grund, V. Filova
- Forward dimuon searches $(J/\Psi, continuum)$
 - E. Kryshen, N. Burmasov, G. Contreras
- Semi-forward dimuon searches (J/ Ψ , continuum)
 - E. Kryshen, N. Burmasov, G. Contreras
- Dielectrons at midrapidity

New analyses not done before I

- Open charm photoproduction
 - S. Klein, V. Pozdniakov, G. Contreras, K. Zertova, and many others....
- ρ^0 production at forward rapidity with MFT
 - G. Contreras, D. Krupova
- ρ^0 production at semi-forward rapidity with MFT
 - G. Contreras, D. Krupova, J. Juracka
- |t|-dependence of coherent J/ Ψ at forward rapidity (MFT needed?)
 - G. Contreras, D. Krupova
- J/Ψ at semi-forward rapidities
 - G. Contreras, J. Juracka, D. Krupova
- Inelastic photonuclear interactions $\gamma Pb \rightarrow X$
 - 1) Compare to spectra of pions/kaons/protons... → identification what we actually see.
 - 2) Selecting hard probes $(D^0, \gamma g \rightarrow c\bar{c})$
- Y(1, 2, 3S)
 - Higher mass \rightarrow different scale \rightarrow touching PDFs of different partons?

New analyses not done before II

- $\gamma\gamma \to \tau\tau$
 - R. Lavicka, E. Kryshen, N. Burmasov, P. Buhler, A. Matyja
 - Not feasible before due to non-ideal settings of triggers.
 - Run 3 statistics should be enough for competitive measurement.
 - Systematics is a key.
- $\gamma\gamma \to \gamma\gamma$
 - \blacksquare More likely for ALICE3 as it is difficult to measure γ
- O–O collisions, p–O collisions:
 - ρ^0 : G. Contreras, J. Juracka
- Jets and multiplicity
- Single photon production



Ideas for quick analysis

- Immediate luminosity calculation will have large uncertainty
- Need to understand the running conditions before preparing anchored MC to get detector inefficiencies.
- What we can measure without using above:
 - Azimuthal angle correlations:

$$\rho^0$$
 , $\gamma\gamma
ightarrow e^+e^-$, ${
m J}/{
m \Psi}$?

Polarisation:

$$\rho^0$$
, J/ Ψ , ϕ

- \blacksquare Di-pion/four-pion invariant mass spectrum well above ρ^0
 - $\bullet \ \rho\prime, f_2(1270) \rightarrow \pi\pi$
- Searches like VM+VM.

Non-UPC but related topics

- Luminosity determination
- Pile-up in continuous readout
- Monte Carlo anchoring

Any new ideas?

BACK UP