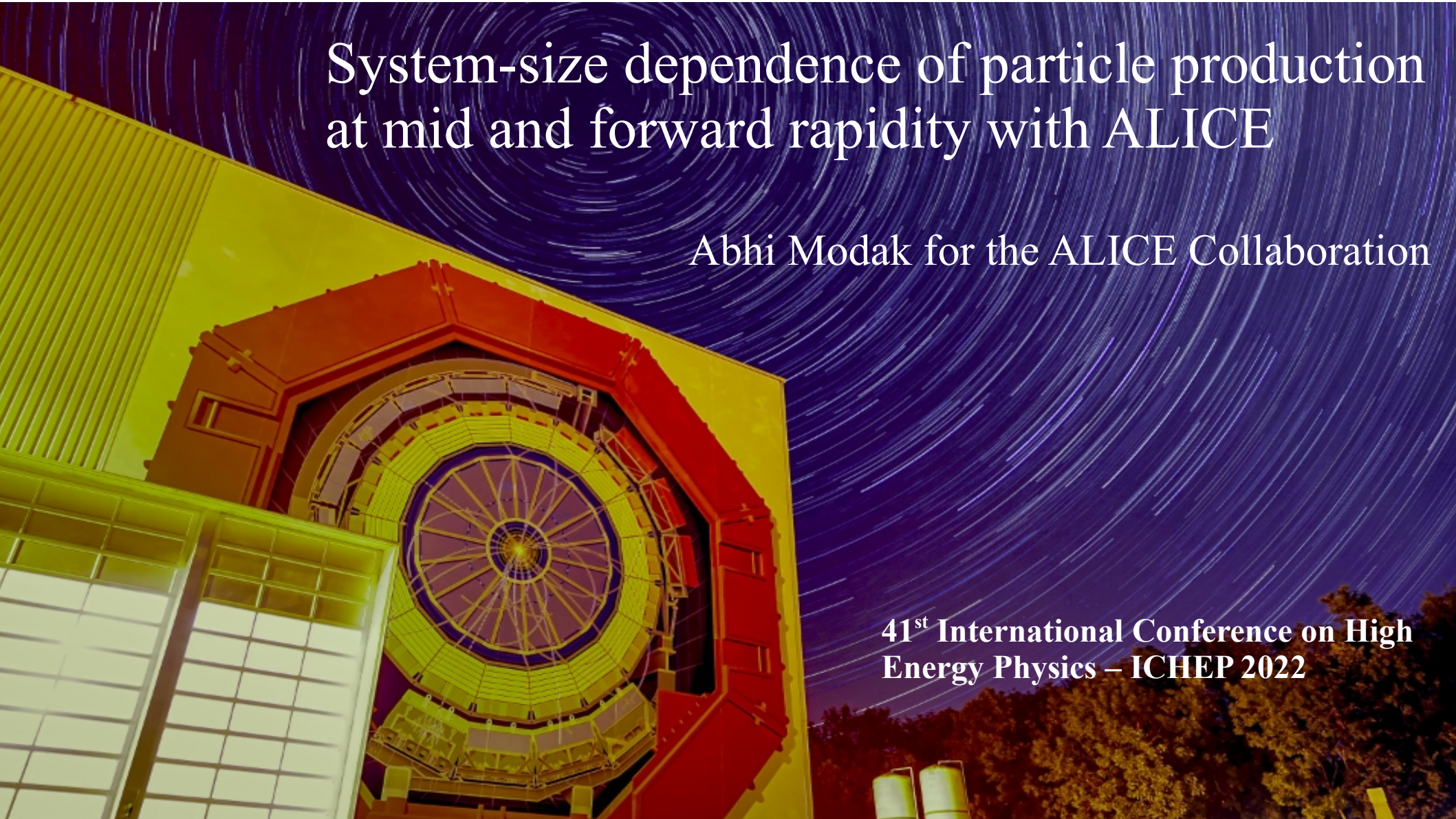


System-size dependence of particle production at mid and forward rapidity with ALICE

Abhi Modak for the ALICE Collaboration

41st International Conference on High
Energy Physics – ICHEP 2022



Particle production at LHC energies:

➤ Results from the interplay between hard and soft QCD processes

Hard QCD processes

- ✓ Described by pQCD calculations

Soft QCD processes

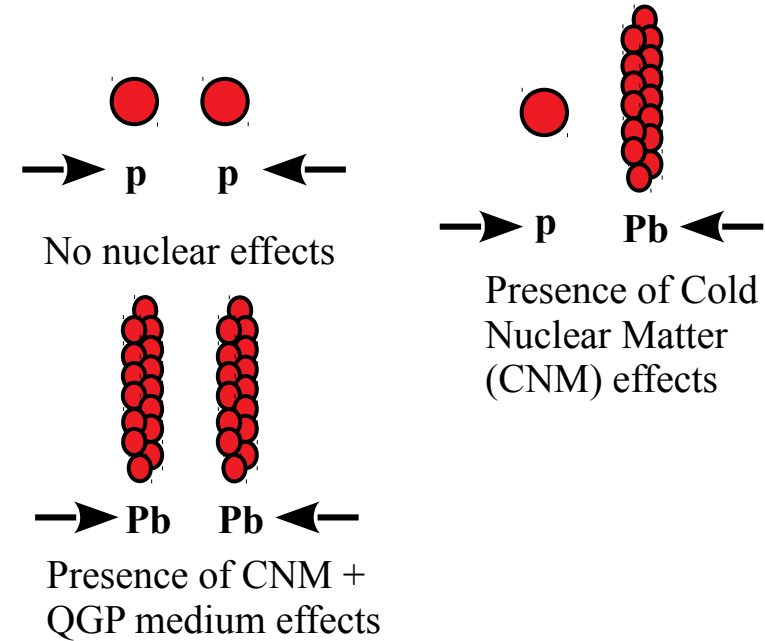
- ✓ $p_T < \sim 1-2$ GeV
- ✓ Need effective theories and statistical models

Observables:

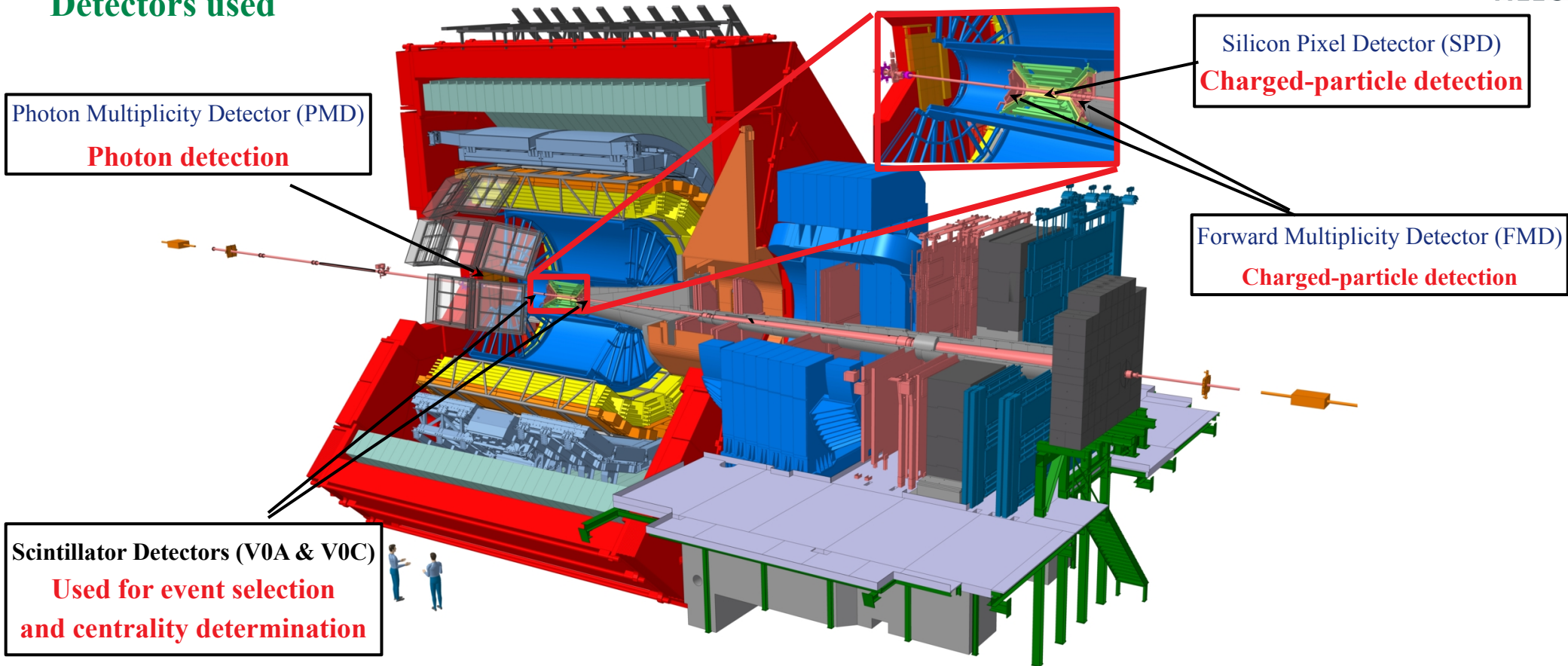
Multiplicity distribution ($P(N)$)

Pseudorapidity density ($dN/d\eta$)

- $P(N)$ and $dN/d\eta$ provide constraints to theoretical models to understand the particle production mechanisms



Detectors used

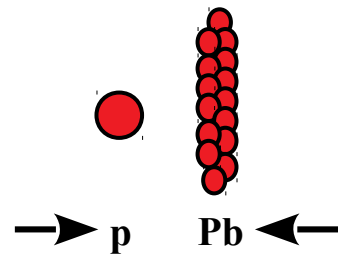
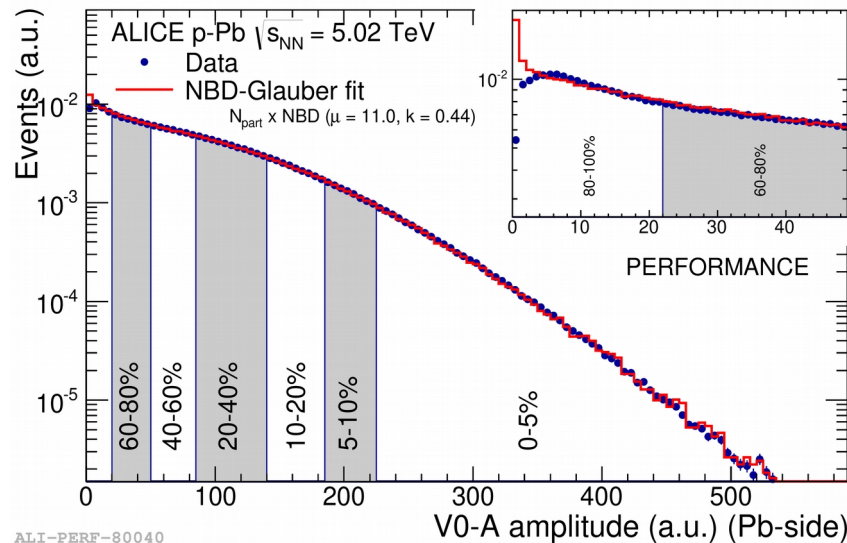
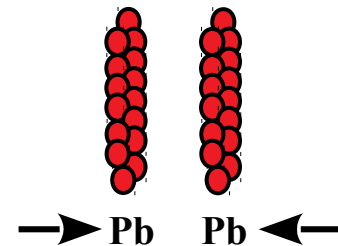
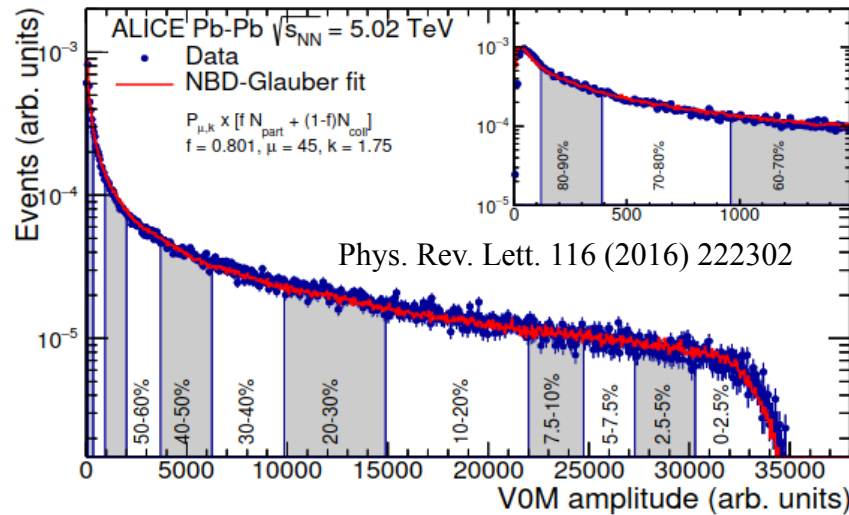
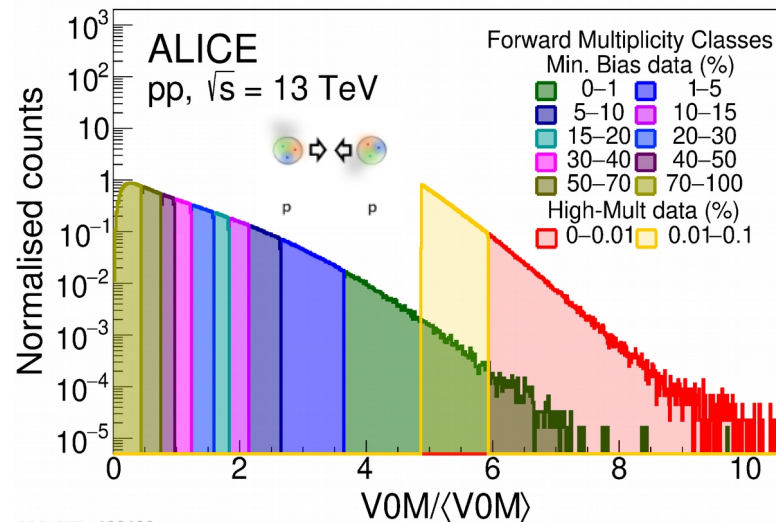


Estimation of centrality/multiplicity class

Centrality classification

- **Pb-Pb:** Performing NBD-Glauber fit to measured V0M (V0A+V0C) amplitude
- **p-Pb:** Performing NBD-Glauber fit to measured V0A amplitude (Pb-going side)
- **pp:** Multiplicity classes are defined based on fractions of visible cross sections. High-multiplicity trigger is defined by the threshold $V0M/\langle V0M \rangle > \sim 4.9$

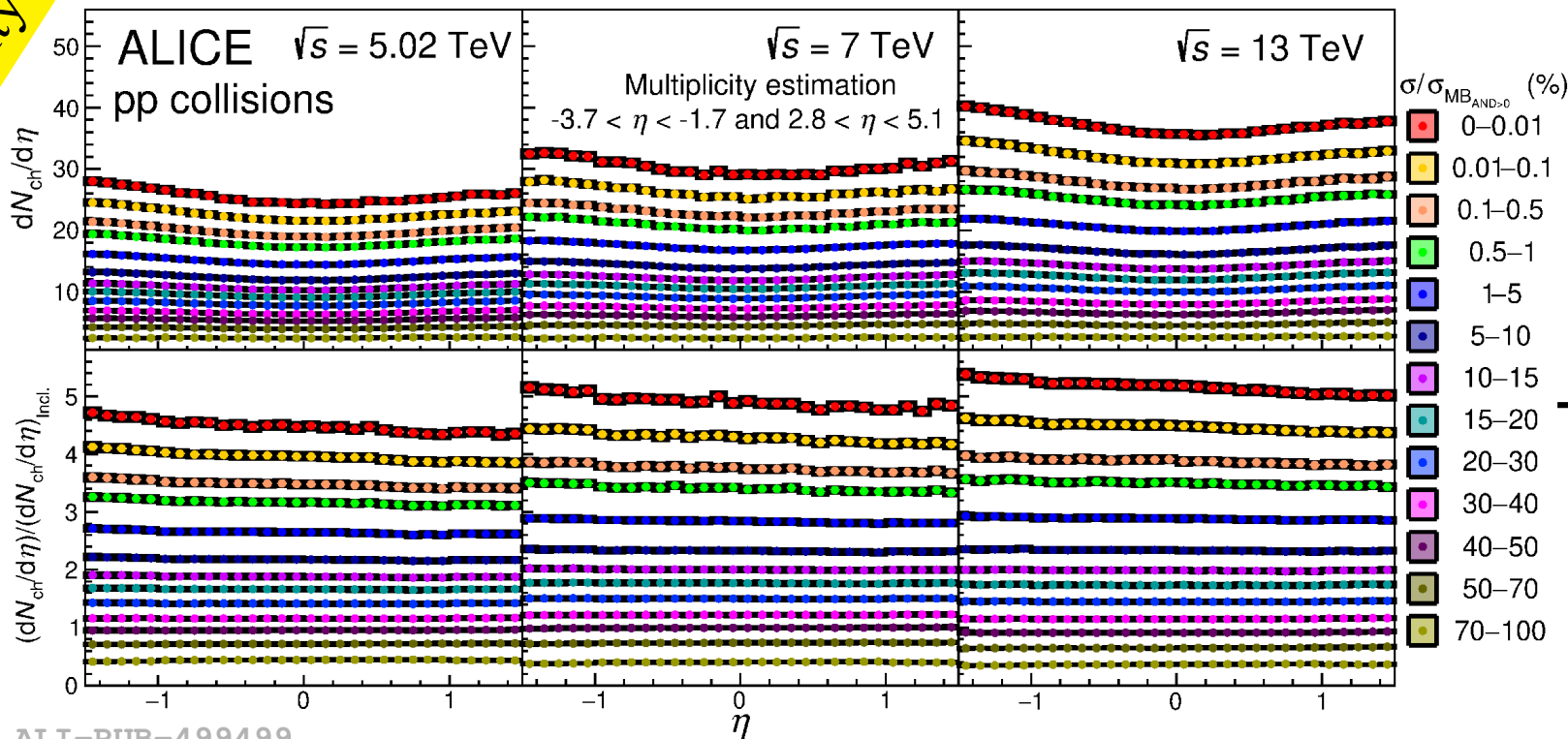
Eur. Phys. J. C 81 (2021) 630



Charged-particle production at midrapidity: $dN_{\text{ch}}/d\eta$ in pp collisions

Eur. Phys. J. C 81 (2021) 630

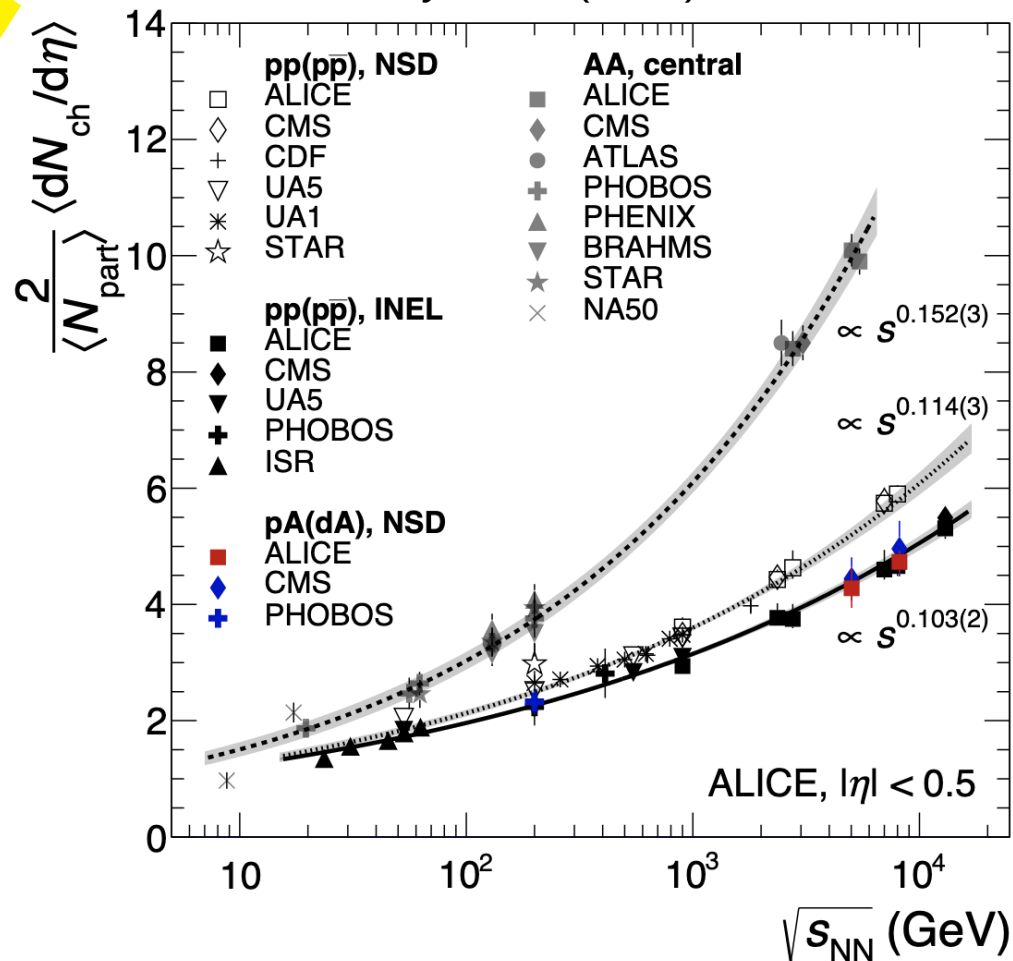
midrapidity



ALI-PUB-499499

➤ $dN_{\text{ch}}/d\eta|_{0-0.01\%}$ are around 5 times larger than $dN_{\text{ch}}/d\eta|_{\text{incl.}}$ for the three different collision energies

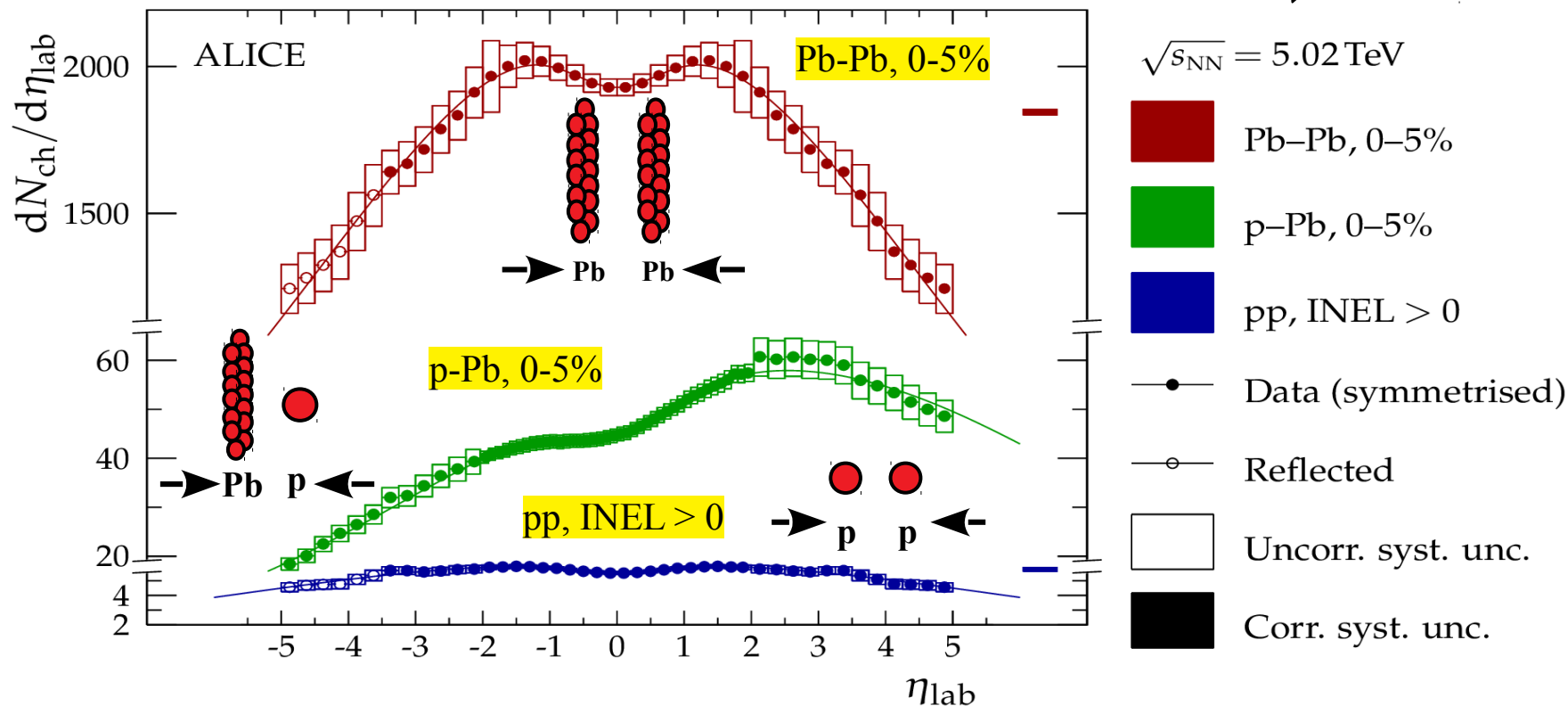
Eur. Phys. J. C (2019) 79: 307



- Steeper rise with system energy for AA than for small systems
- p-Pb and d-A results fall on INEL pp curve, which indicates that the strong rise in AA is not solely related to multiple collisions undergone by the participating nucleons

arxiv: 2204.10210

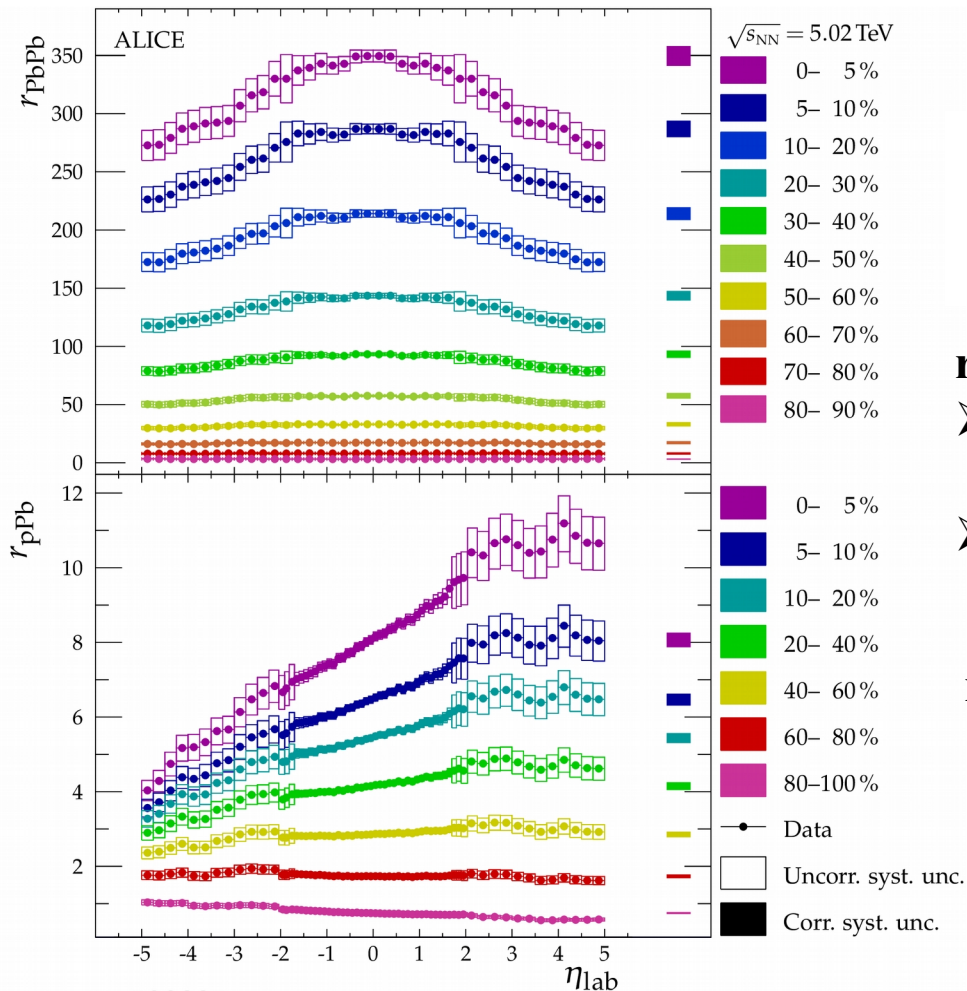
New



ALI-PUB-520989

Charged-particle production at forward rapidity: $dN_{ch}/d\eta$ in pp, p-Pb and Pb-Pb

arxiv: 2204.10210



$$r_X = \frac{dN_{ch}/d\eta|_X}{dN_{ch}/d\eta|_{pp}} \quad \text{X labels centrality classes in p-Pb and Pb-Pb}$$

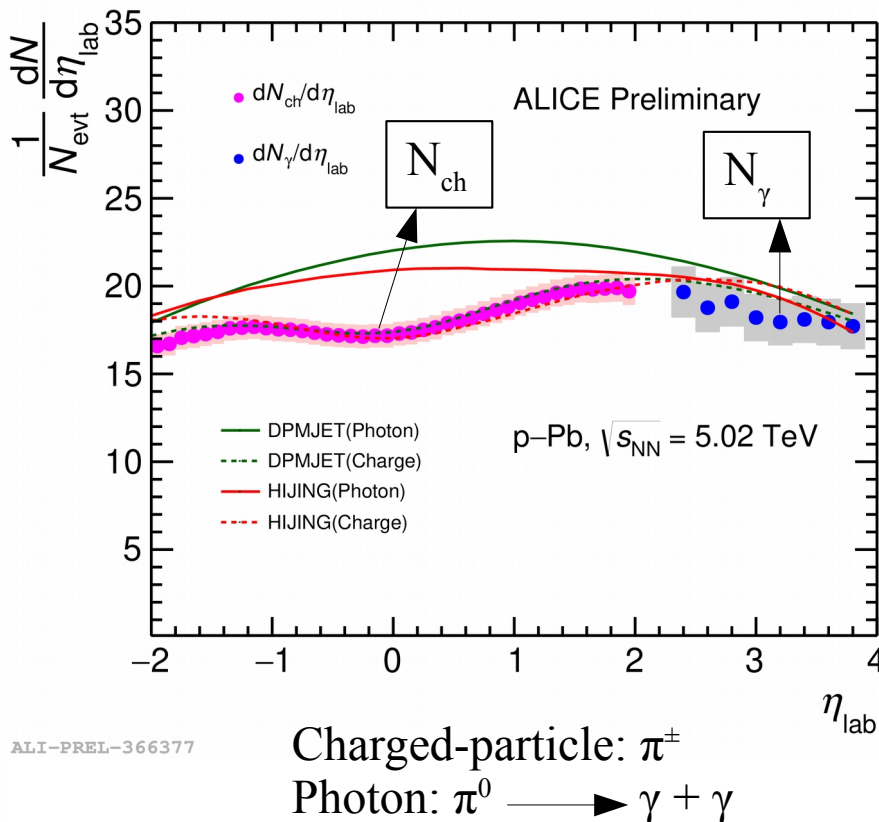
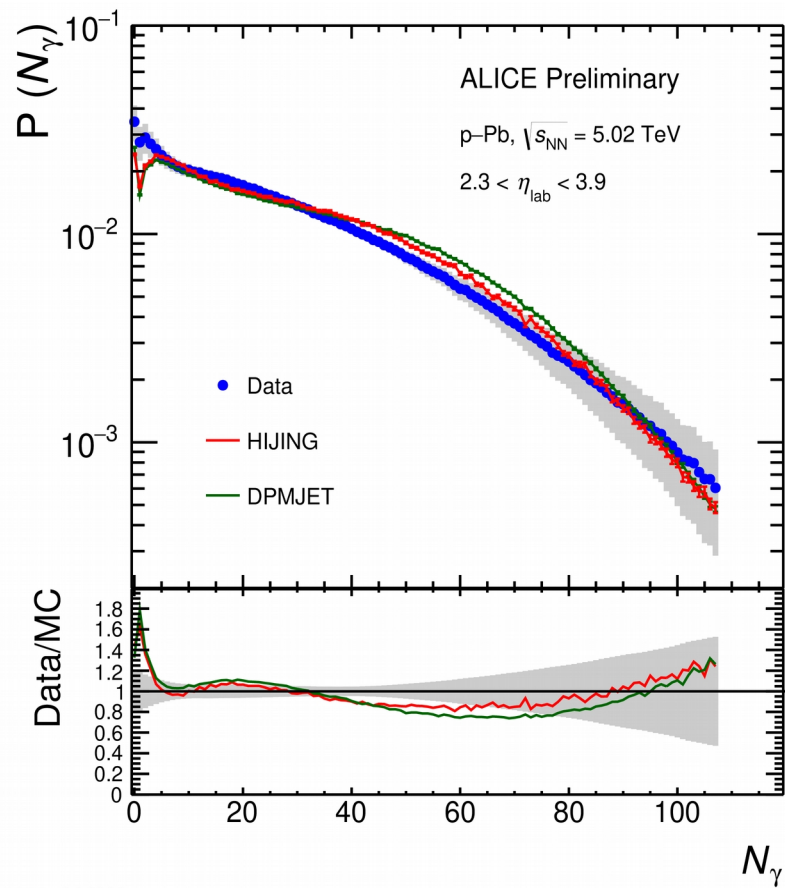
r_{pPb} :

- Nearly linear increase with η from the p-going to the Pb-going direction
- Slope decreases from central to peripheral collisions

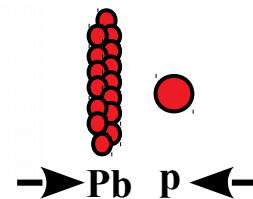
r_{PbPb} :

- Enhancement of particle production around $\eta = 0$

Inclusive photon production at forward rapidity

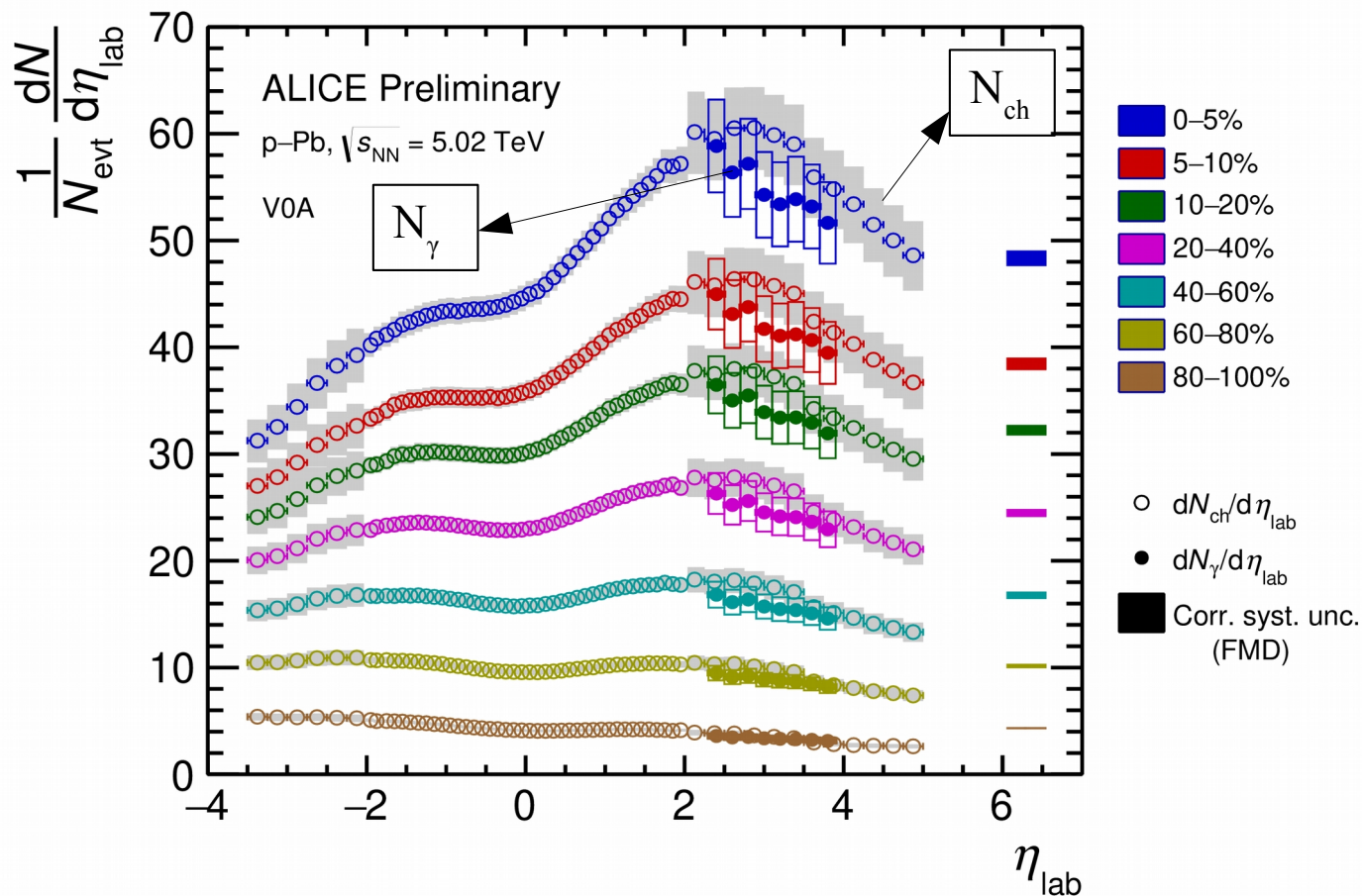


Photons at
Forward
rapidity

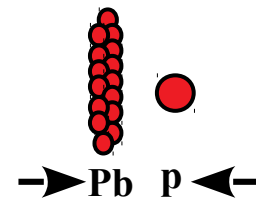


HIJING and DPMJET underestimate
the multiplicity distribution at low N_γ

- Both inclusive photon and charged-particle production is
described fairly well by both models within uncertainties

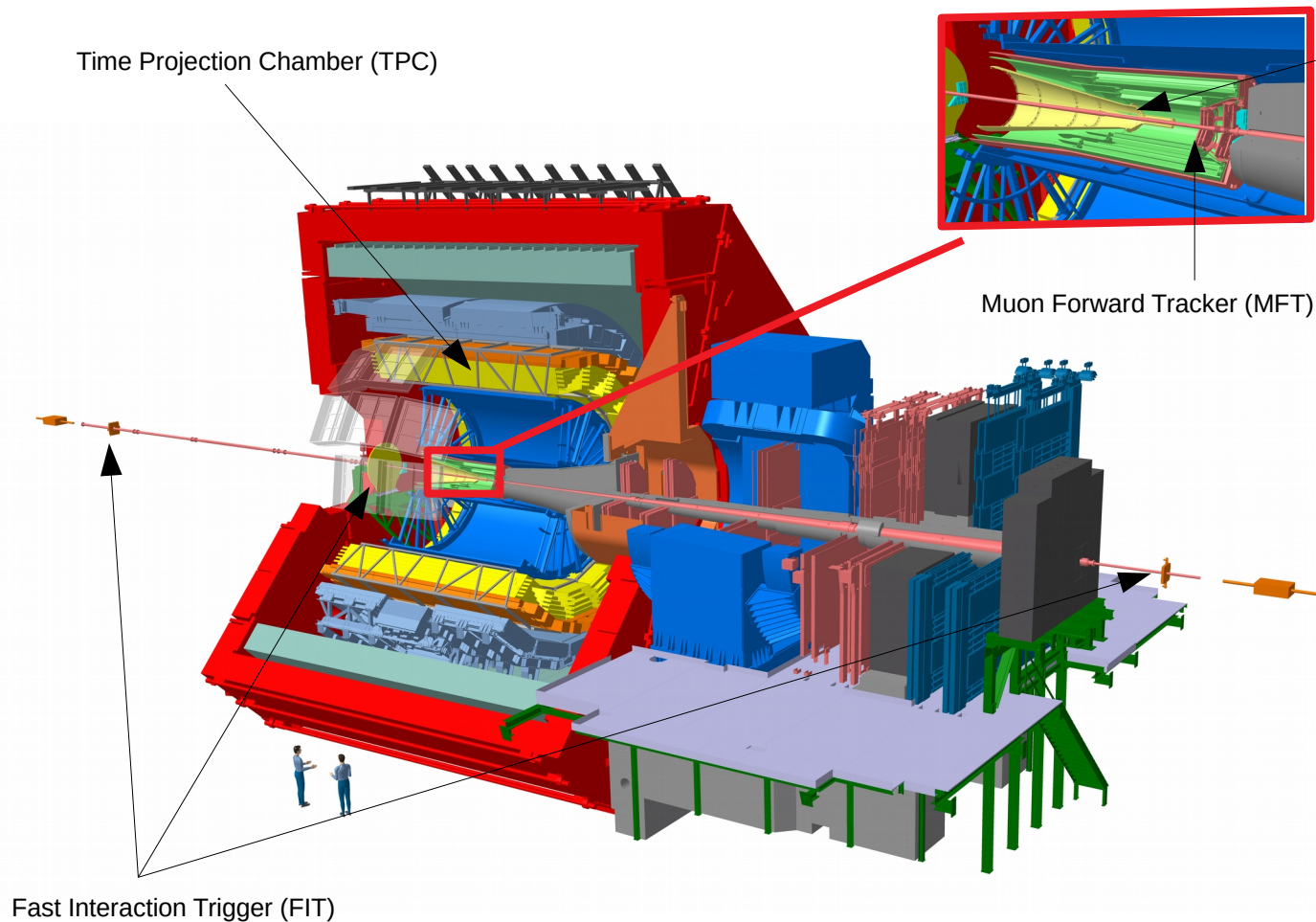


Photons at
Forward
rapidity

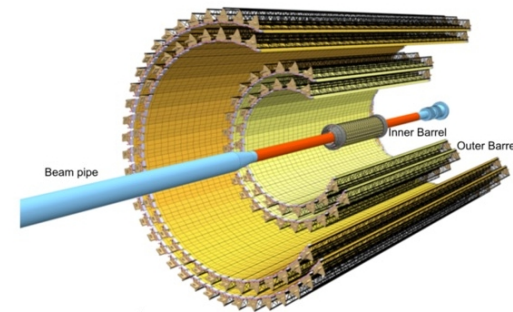


ALI-PREL-366347

Inclusive photons and charged particles have similar dependence on centrality at forward rapidity



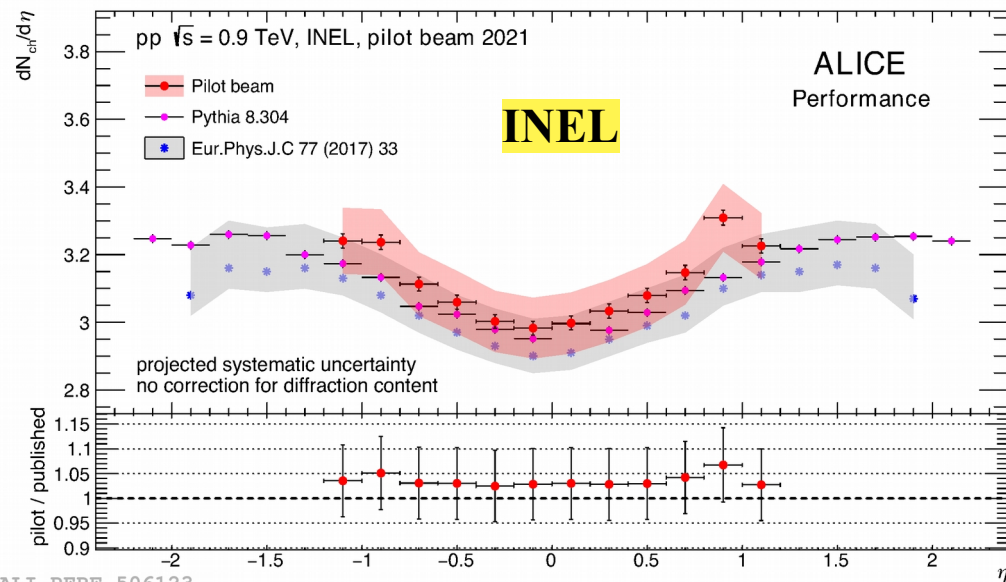
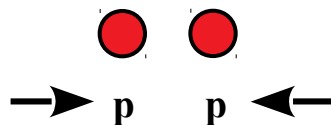
Inner Tracing System (ITS2)



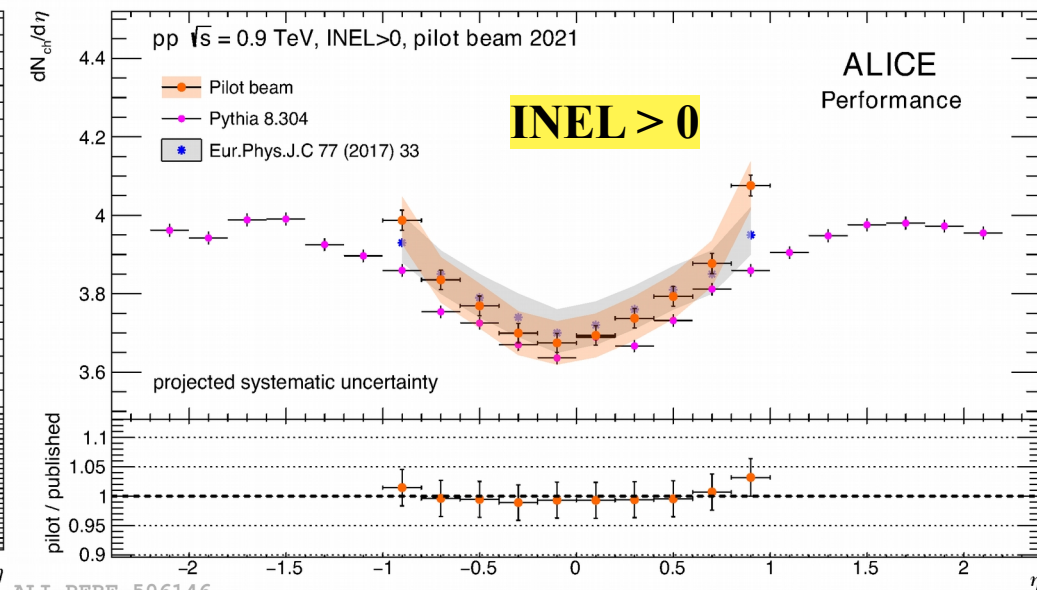
- Monolithic active pixel sensors (MAPS)
- Consists of 7 layers
- High detector efficiency: $>99\%$
- material budget is reduced to 0.35%
- $3\times$ better impact parameter resolution in transverse plane

See Robert's talk
See Magnus's talk

Pilot beam 2021 pseudorapidity density measurement: pp, $\sqrt{s} = 0.9$ TeV



ALI-PERF-506123



ALI-PERF-506146

- Results obtained with ITS2 is consistent with previous ALICE published results
- This performance provides a benchmark of the tracking and reconstruction, as well as new software analysis framework.

ALICE measurements of charged-particle and photon multiplicity for different collision systems at various center-of-mass energies are presented

- ❑ Multiplicity reach (~ 5 times) in HM pp collisions compared to MB
- ❑ Strong rise of $dN_{\text{ch}}/d\eta$ with \sqrt{s} in A-A ($\propto s^{0.152}$) compared to small systems ($\propto s^{0.103}$)
- ❑ Unique coverage of ALICE: ITS + FMD ($-3.4 < \eta < 5$) exploited
- ❑ Inclusive photon and charged-particle production compatible at forward rapidity
- ❑ Good performance of ITS2: gives results consistent with previous ALICE measurements

All these measurements are useful to tune the event generators

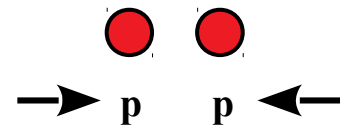
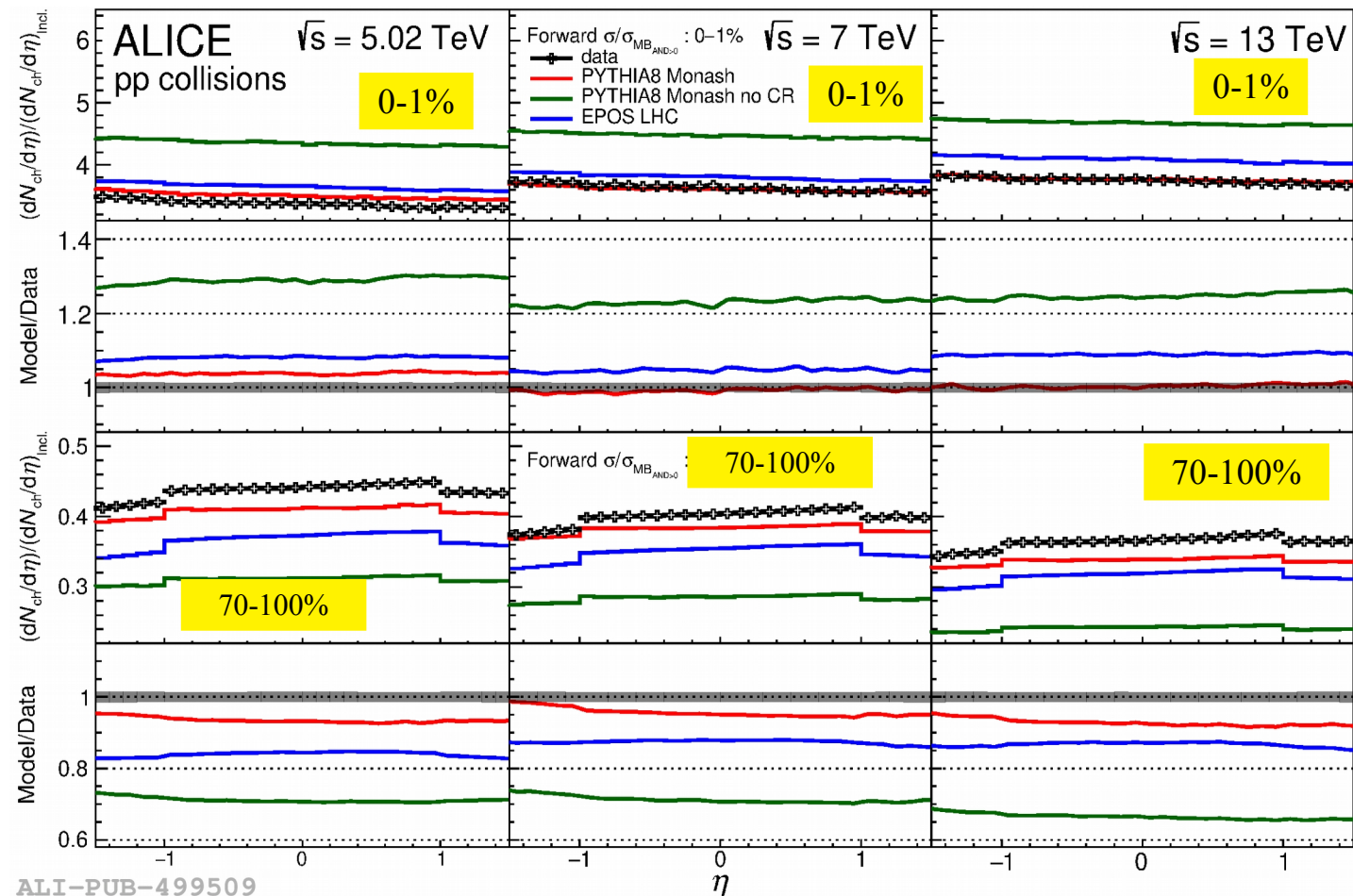
Looking forward to new measurements with combined ITS + MFT ($-3.6 < \eta < 2.5$)

Thank you!

Back up

Charged-particle production in pp collisions: comparison with models

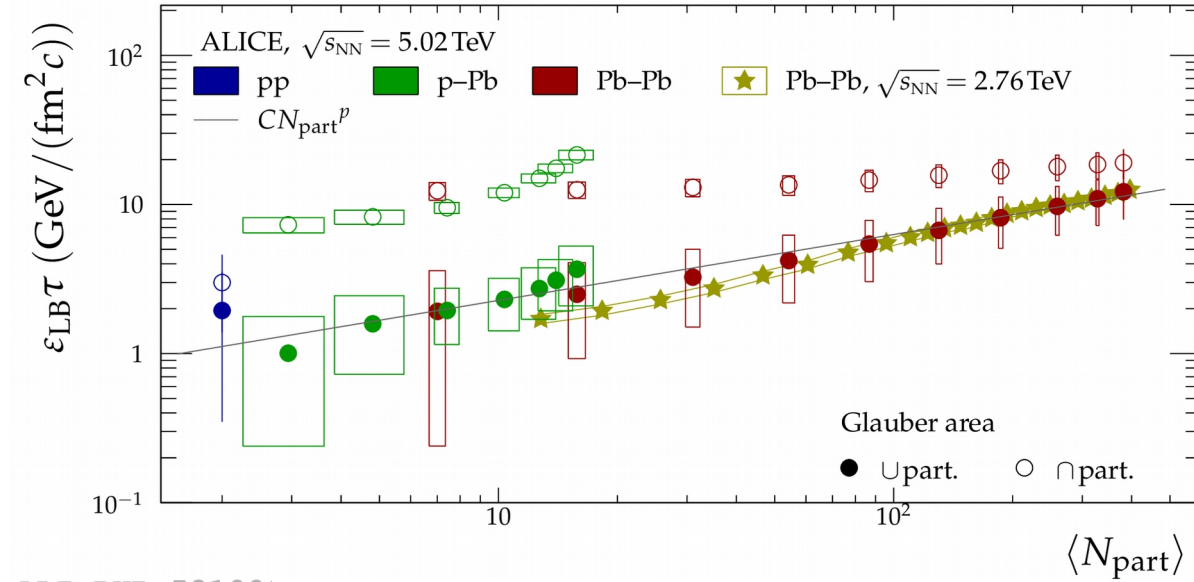
Eur. Phys. J. C 81 (2021) 630



- Color Reconnection (CR) is needed to describe measurements at LHC energies
- PYTHIA 8 including CR explains the data better compared to EPOS LHC

Particle production at forward rapidity: Bjorken energy density

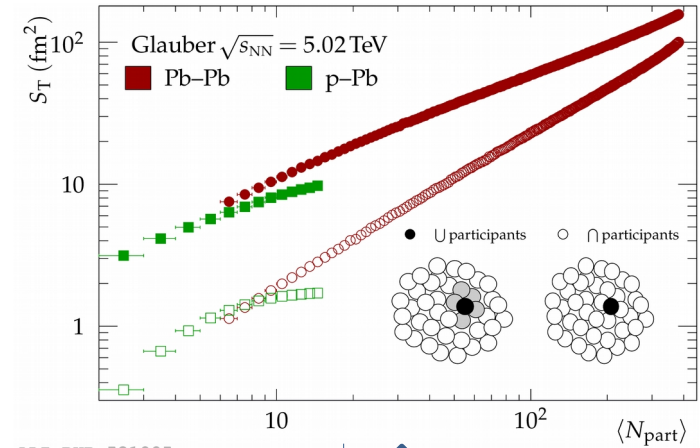
arxiv: 2204.10210



ALI-PUB-52100!

$$\epsilon_{Bj} \tau \geq \epsilon_{LB} \tau = \frac{1}{c} \frac{1}{S_T} \langle m \rangle \sqrt{1+a^2} \frac{1}{f_{total}} \sqrt{1 + \frac{1}{a^2} \frac{1}{\cosh^2 \eta} \frac{dN_{ch}}{d\eta}}.$$

- ϵ_{LB} increases from 1 GeV/(fm²c) to over 10 GeV/(fm²c) with increasing N_{part} for inclusive overlap area S_T
- Trend is illustrated by a power-law (CN_{part}^p): $C = (0.8 \pm 0.3)$ GeV/(fm²c) and $p = 0.44 \pm 0.08$
- For exclusive overlap area S_T , no change in ϵ_{LB} with increasing N_{part}



ALI-PUB-521005

Estimation of S_T

