ALICE overview

ALICE at Lund University (P. Christiansen, Lund)
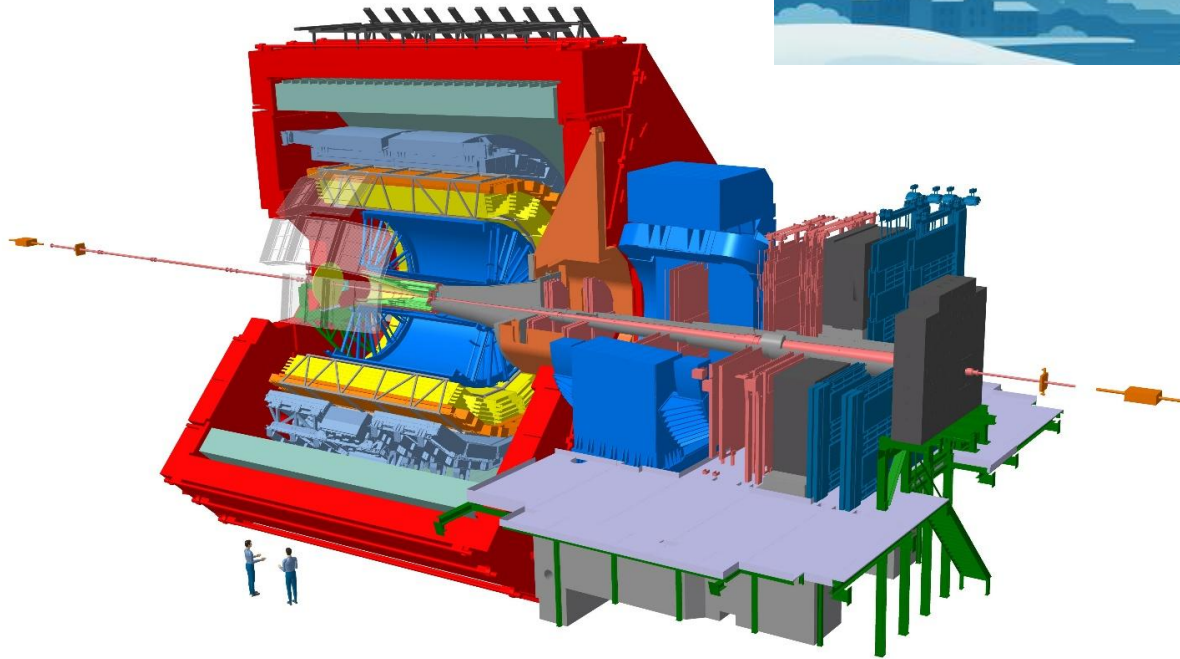

- 3 Seniors: Alice Ohlson, David Silvermyr, Peter Christiansen
- 2 Postdocs: Iaroslav Panasenko, Sushanta Tripathy
- 4 Ph.D. Students: Joachim Hansen, Kaare Iversen, Roman Nepeivoda, Joey Staa

Outline

- Oxygen-Oxygen (OO) and Neon-Neon (Ne-Ne) results

  - Excellent LHC and ALICE performance (July 2025)

    - pO: recorded 7.27 nb-1 | $\approx 3 \times 10^9$ events (93% eff.)

    - OO: recorded 5.01 nb-1 | $\approx 6 \times 10^9$ events (97% eff.)

    - Ne-Ne: recorded 0.84 nb-1 | $\approx 10^9$ events (99.8% eff.!)

- Strangeness production in photonuclear collisions

  - A completely new direction in the small system studies

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The goals of the OO and Ne-Ne runs

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- Test the Pb-Pb-hydro paradigm in a smaller system
  - Pb-Pb large and well established
  - proton-proton (pp) and p-Pb: proton geometry is uncertain

- Imaging by smashing: test nuclear an-initio models

- Search for energy loss
  - Hydro = final state interactions
  - Where is the energy loss in pp?
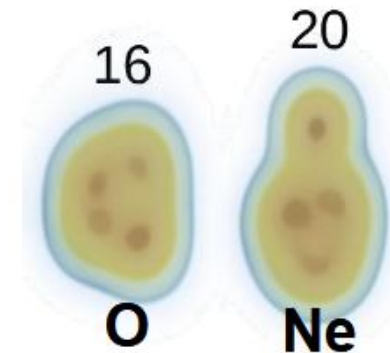
Search for energy loss
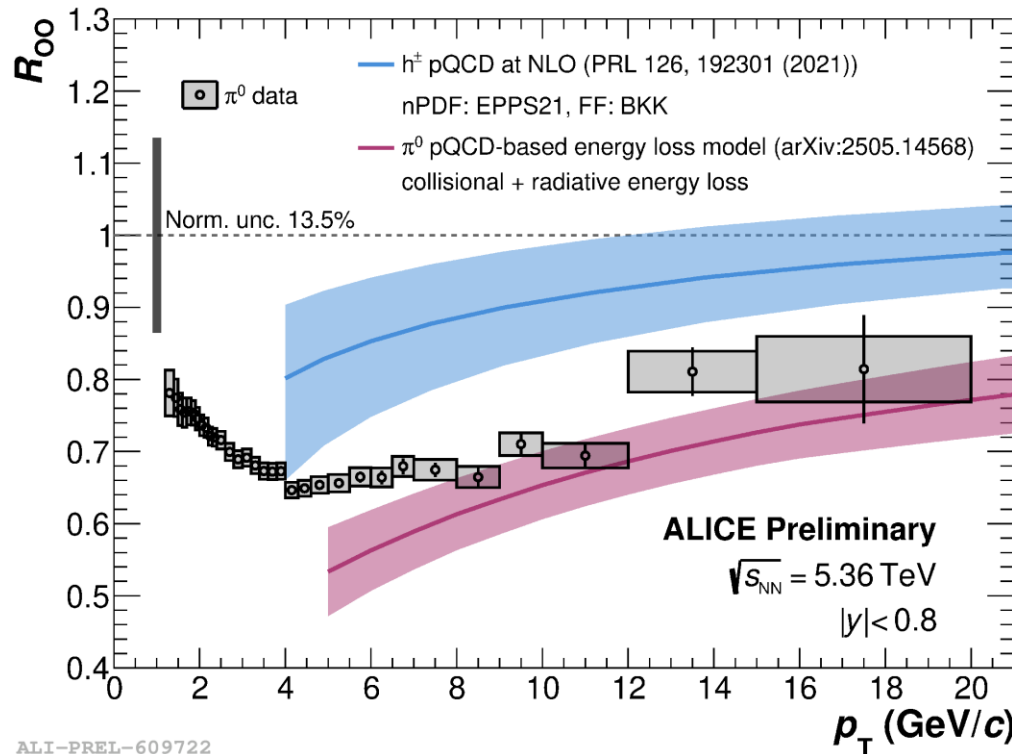
$R_{OO} = 1$
$\rightarrow$ No jet quenching

Nuclear shadowing

Predicted quenching in one model

ALI-PREL-609722

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- Clear evidence for jet quenching

  – Similar observations by CMS (they compare with more models and find several that describe Pb-Pb that fail OO)
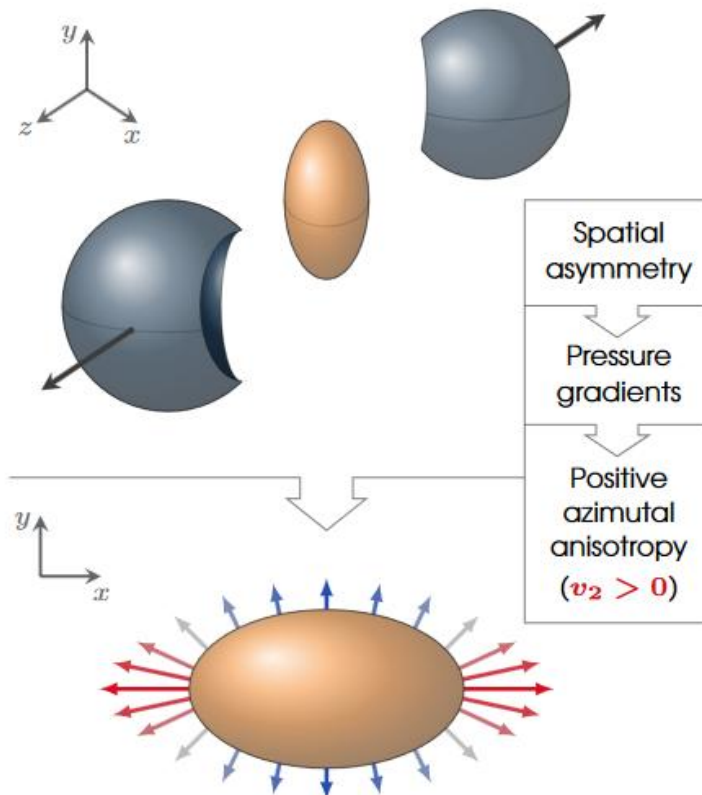
Flow reminder

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Bierlich et al, arXiv:2409.16093

Flow reminder

Collective flow in large systems
(heavy-ion collisions)

Hydrodynamics

Spatial asymmetry

Pressure gradients

Positive azimutal anisotropy ($v_2 > 0$)

PbPb $\sqrt{s_{NN}} = 2.76$ TeV, $220 < N_{trk}^{offline} \le 260$

$\frac{1}{N_{trig}} \frac{d^2 N^{pair}}{d\Delta\eta \, d\Delta\phi}$
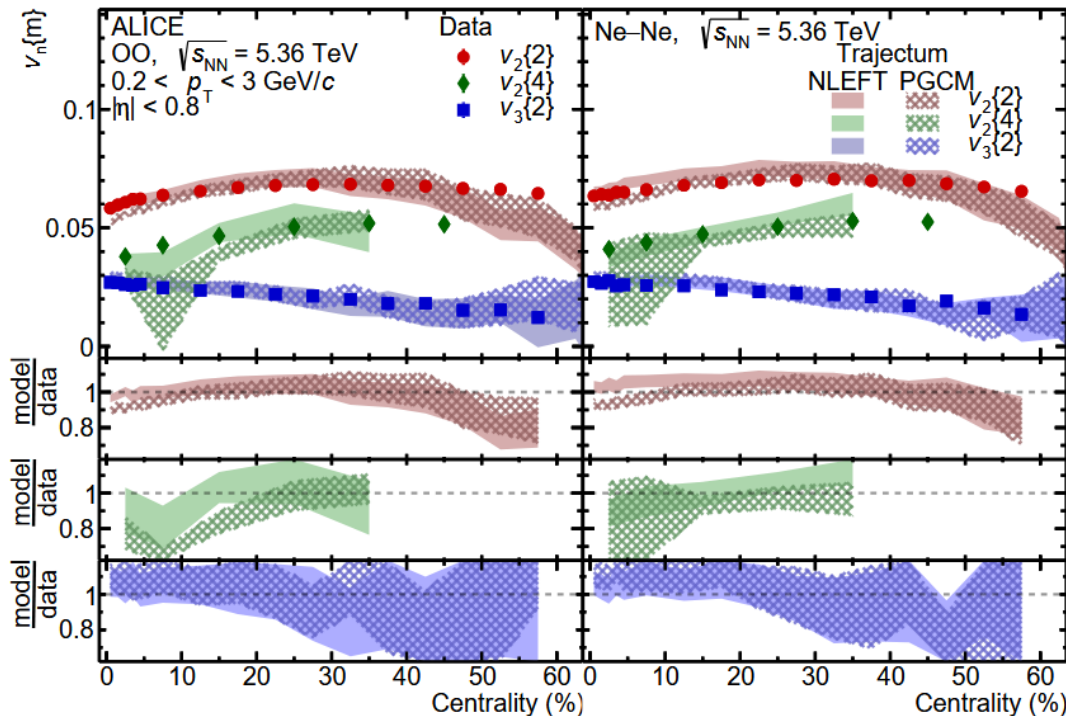
$\Delta\phi$ (radians)

$\Delta\eta$

$1 < p_T < 3$ GeV/c
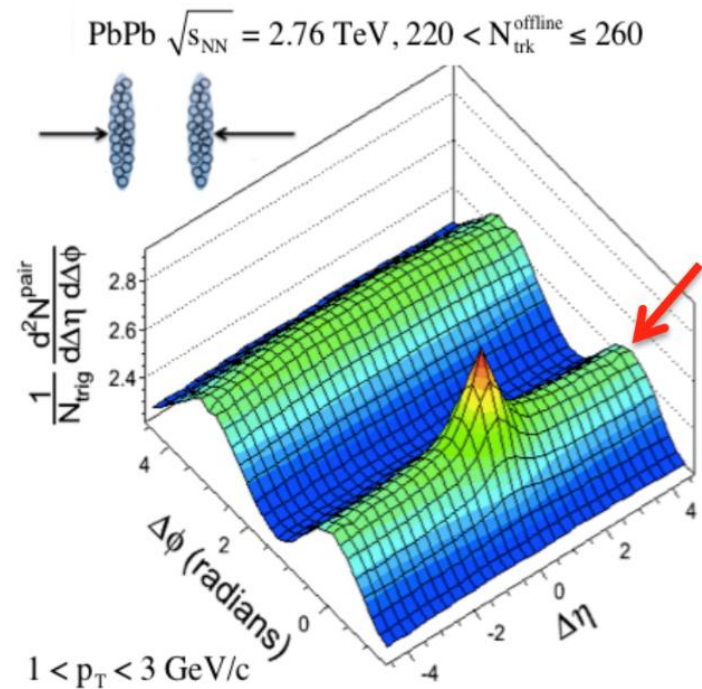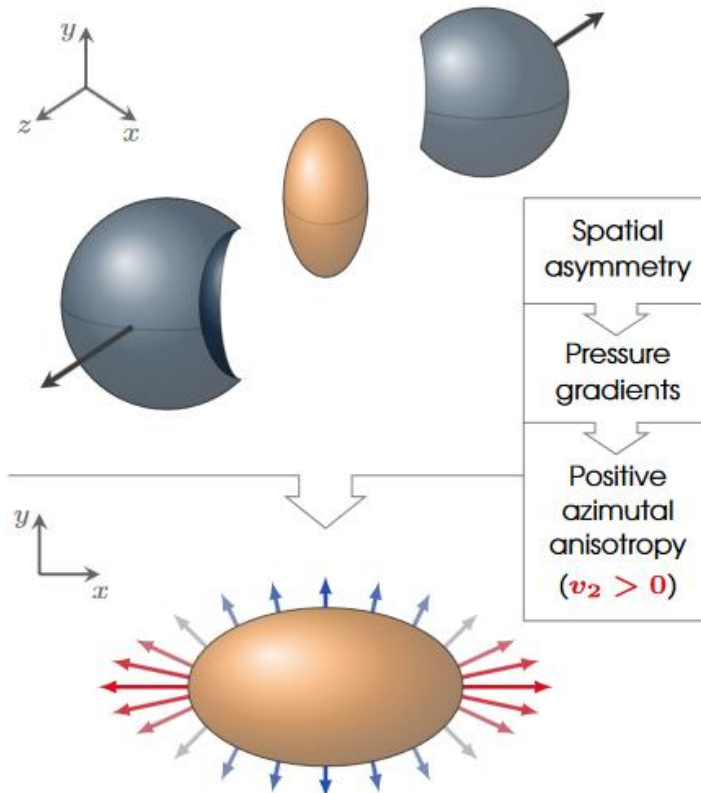
Quantify with flow coefficients:
Elliptic flow: v_2 goes as $\cos(2\Delta\varphi)$
Triangular flow: v_3 goes as $\cos(3\Delta\varphi)$

Bierlich et al, arXiv:2409.16093

Testing the hydro paradigm in a smaller system

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ALICE, arXiv:2509.06428

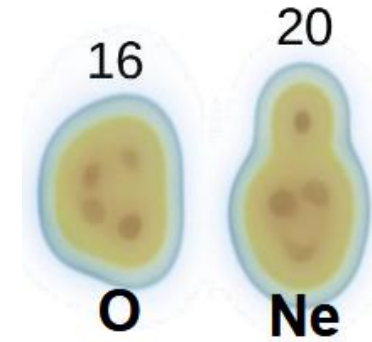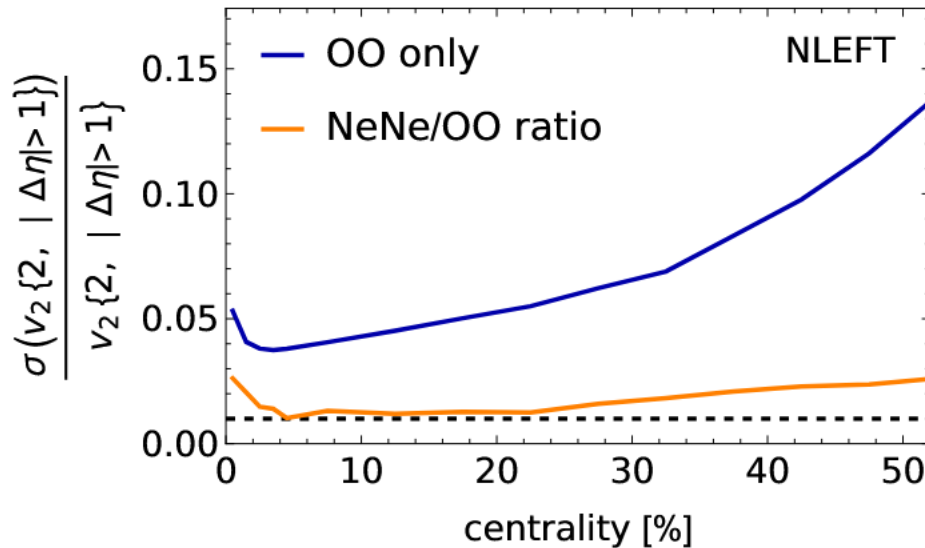Also measured by ATLAS: arXiv:2509.05171 and CMS: arXiv:2510.02580

- NLEFT: Nuclear Effective Field Theory solved on the Lattice.

- PGCM: Mix symmetry-restored shapes using chiral EFT interactions.

- Good agreement between measurements and prediction in the region least sensitive to geometry details (10-50%)

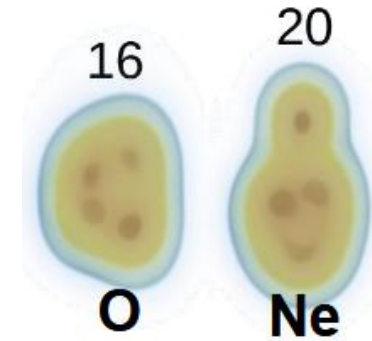# "Imaging by smashing"
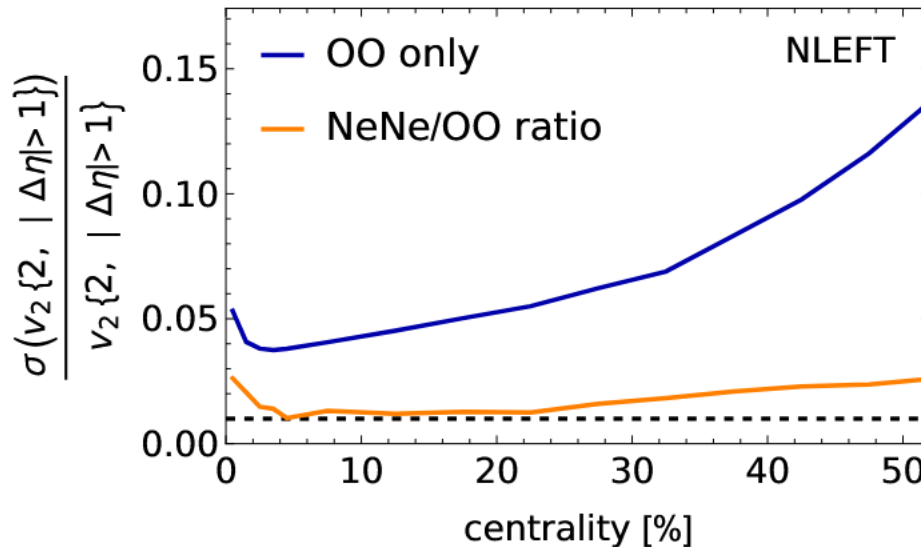
Based on Giacalone et al, arXiv:2402.05995

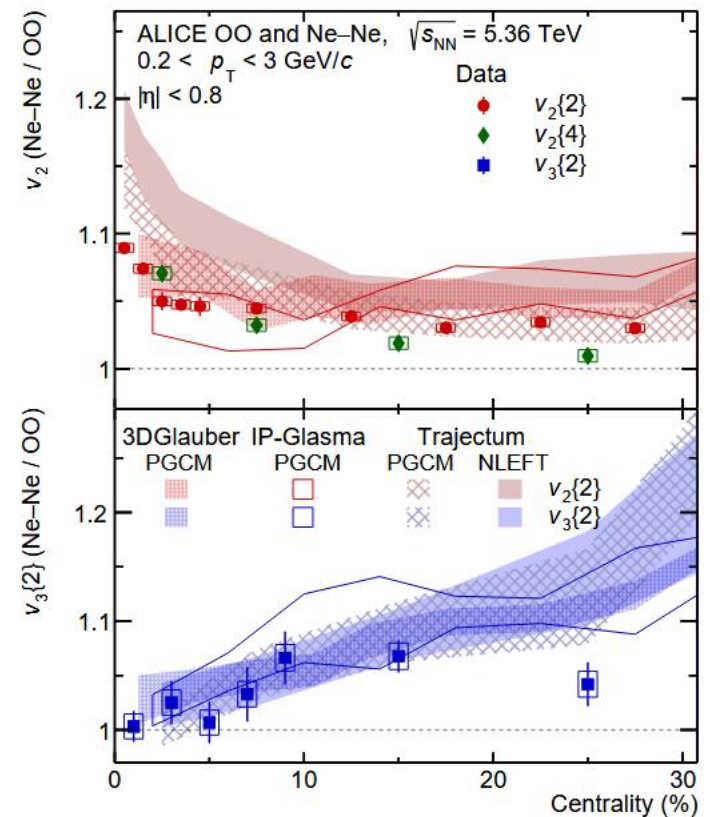- For each model, many systematic uncertainties cancel in the ratio

"Imaging by smashing"

20

16

O   Ne

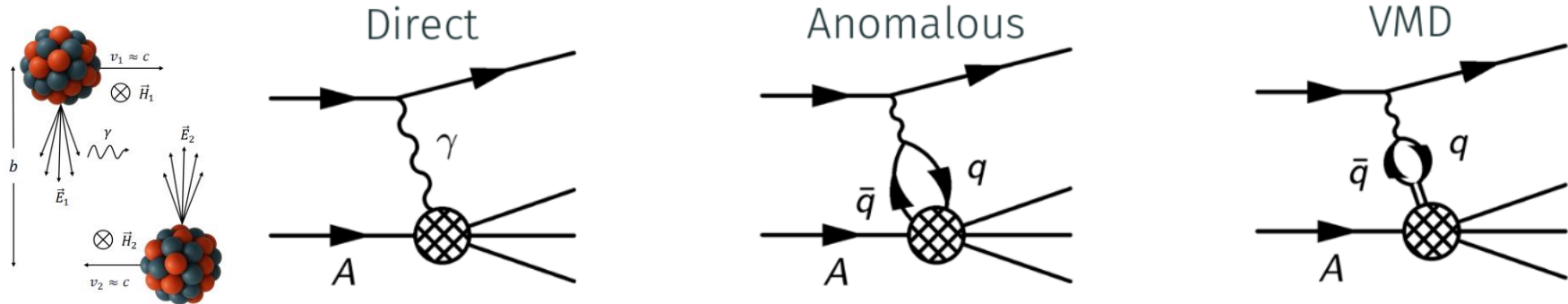Based on Giacalone et al, arXiv:2402.05995

ALICE, arXiv:2509.06428

- For each model, many systematic uncertainties cancel in the ratio
- Model comparisons indicate sensitivity to pre-hydro dynamics and nucleon geometry
- More analyses ongoing to refine conclusions (J. Hansen)

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Photonuclear UPCs

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- Ultra Peripheral Collisions (UPCs)

  – Pb-Pb electromagnetic interactions (b > 2R_{Pb}, $\propto Z^2$)

- Photonuclear UPCs allow us to go to lower multiplicities (than pp) and test systems with a photon in the initial state

- Big interest from Electron Ion Collider community

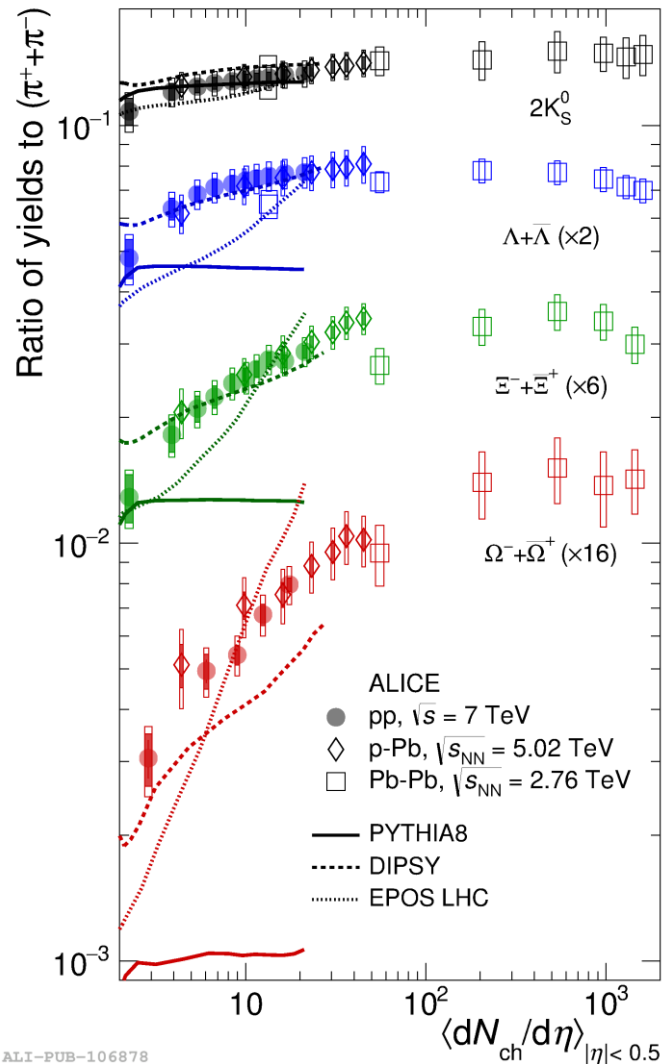 – 2nd dedicated workshop this year in Saariselkä, Finland
    https://indico.global/event/9992/

Flow in UPCs and ep: experimental status

- Observed by ATLAS in γPb at LHC (ATLAS: Phys. Rev. C 104, 014903 (2021))

- Not observed by CMS γp at LHC (CMS: Phys. Lett. B 844 (2023) 137905)
  - Could ATLAS do γp and CMS do γPb and ALICE do both?

- Not observed by H1 and ZEUS at HERA (ZEUS: JHEP 04 (2020) 070, JHEP 12 (2021) 102, H1: H1prelim-20-033)

- If we think γ→ vector meson → "hadron"-hadron interaction should there not, then be flow in all systems? (if multiplicity is large enough) – true for all QGP-like effects

- How about strangeness enhancement?

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Reminder about strangeness enhancement with multiplicity

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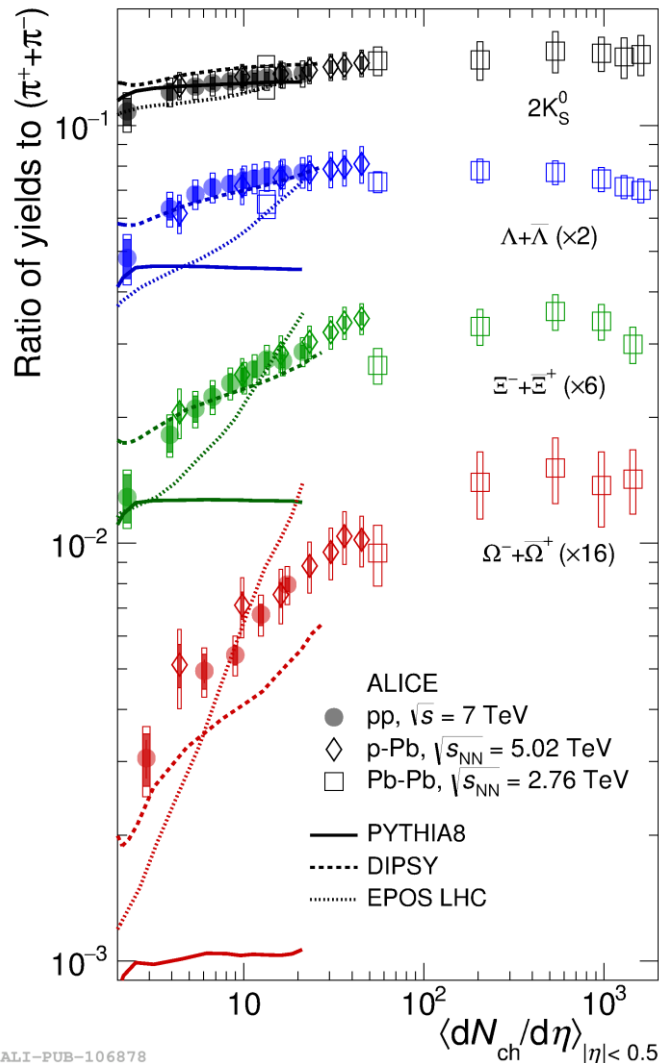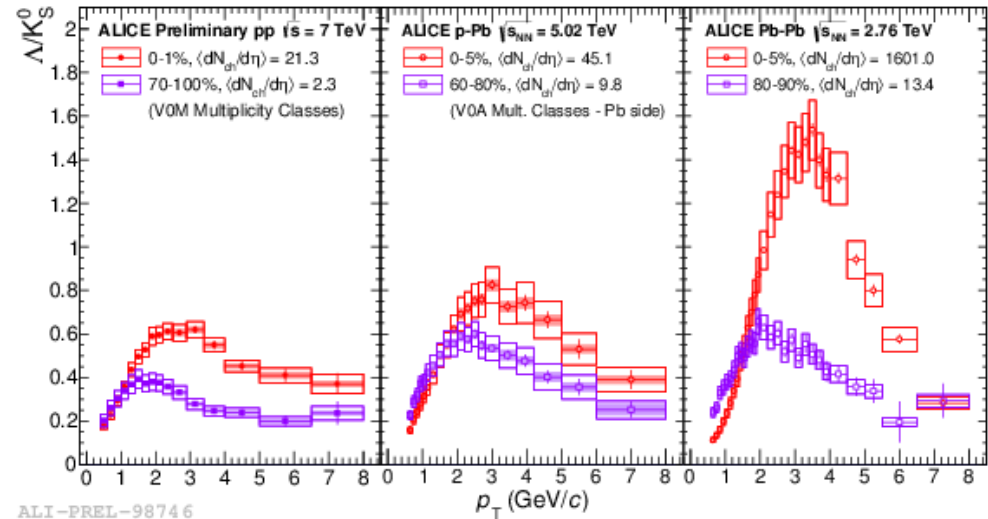

- Strangeness enhancement is observed for integrated particle ratios in all systems (pp, p-Pb, Pb-Pb)

Reminder about strangeness enhancement with multiplicity

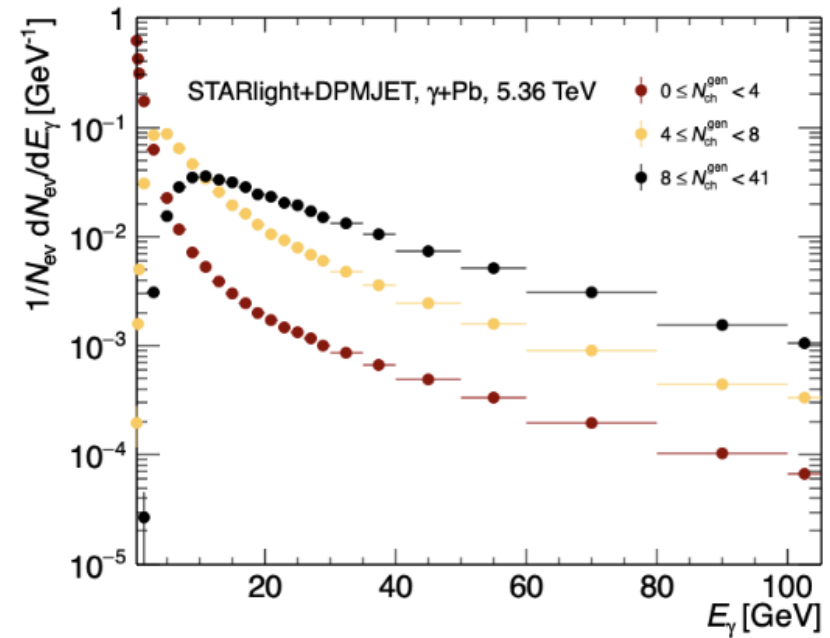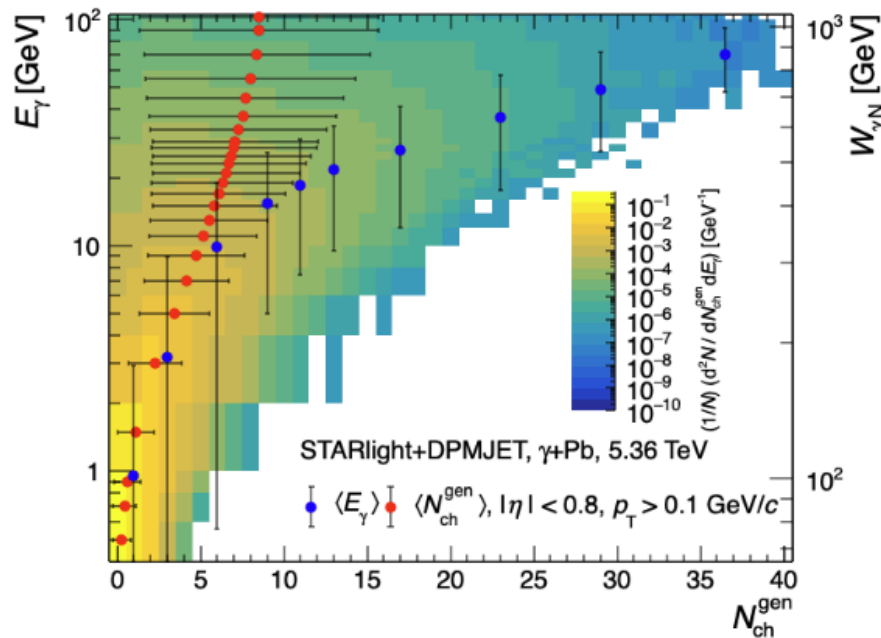ALICE at Lund University (P. Christiansen, Lund)

- Strangeness enhancement is observed for integrated particle ratios in all systems (pp, p-Pb, Pb-Pb)

- For p_T-differential ratios one also observes an enhancement that could be just due to radial flow
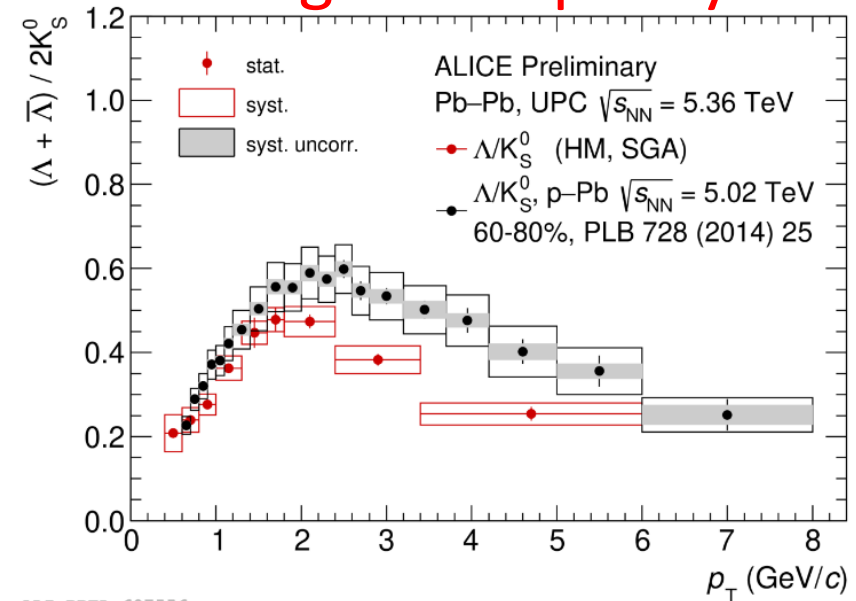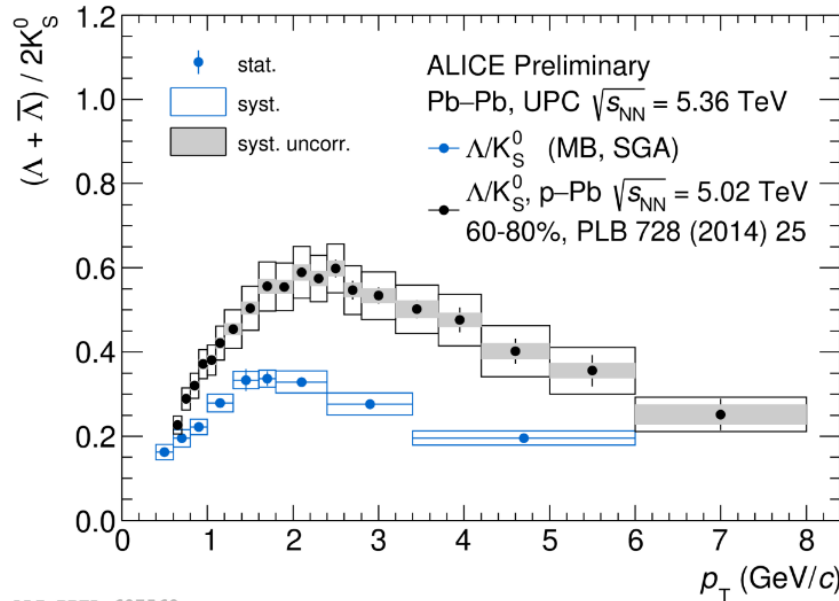
Multiplicity in UPCs Simulation studies

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- Multiplicity will one one hand reflect possible multi-parton interactions (MPIs) as in pp but also reflect how much photon energy is available

Λ/K^0_S vs multiplicity in photonuclear UPCs

MB   High Multiplicity

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ALI-PREL-607560   ALI-PREL-607556

- Significant increase of ratio with multiplicity indicative of radial flow and possible strangeness enhancement

- Work ongoing for publication (R. Neipevoda)

  – With p_T extrapolation and possible inclusion of Ξ

- Big wish for more MC models

Conclusions

- Oxygen-Oxygen and Neon-Neon runs were a huge success
  - Excellent LHC performance
  - Fast analysis by most LHC experiments
  - Qualitatively confirmation of the Pb-Pb paradigm
    - Many details remain to be understood
- UPCs is a growing activity across LHC experiments
  - Strong coupling to EIC and HERA
  - Interest also from small system community
  - Indications of radial flow and strangeness enhancement

Thank You!

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