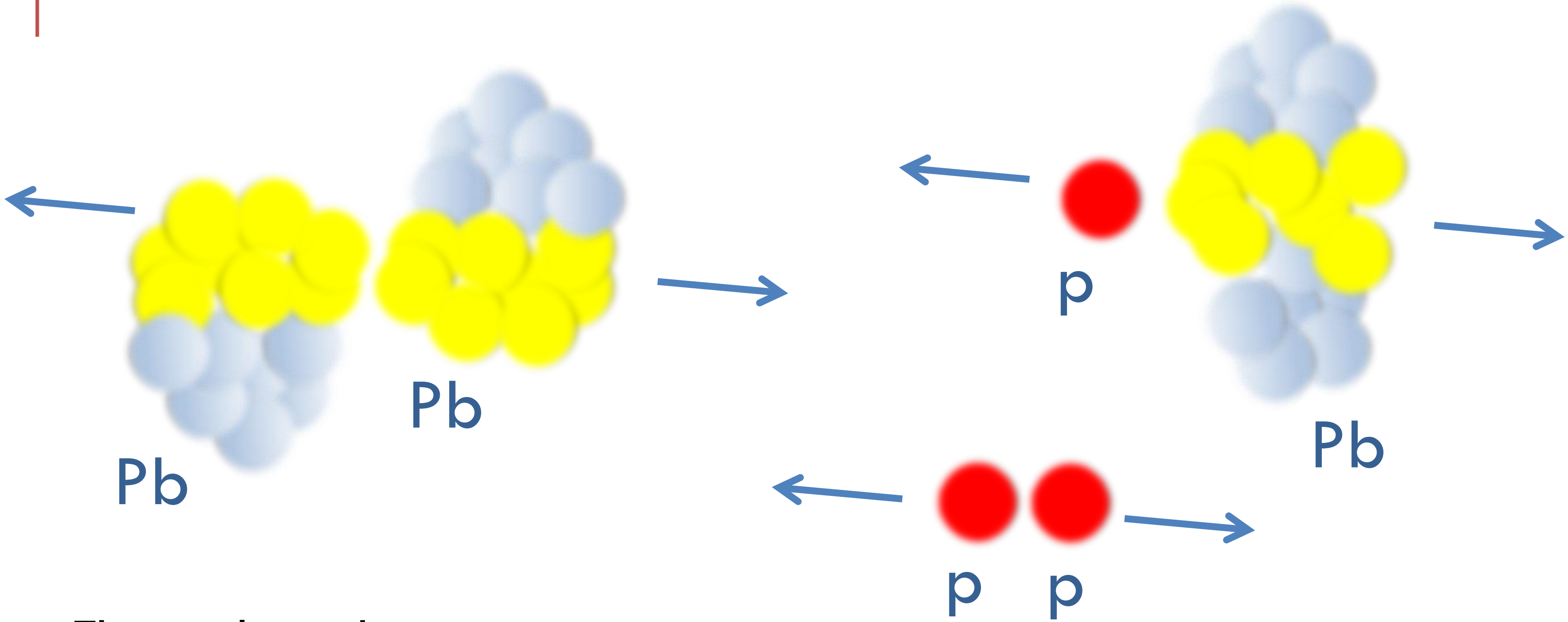
STUDY OF COLLECTIVE EFFECTS IN HIGH-ENERGY HADRON-NUCLEUS COLLISIONS MEASURED WITH ALICE

MPI@LHC – TRIESTE, 23-27 NOVEMBER 2015

ENRICO FRAGIACOMO
INFN TRIESTE

ON BEHALF OF THE ALICE COLLABORATION

RELATIVISTIC HEAVY-ION COLLISIONS



- Thermal production
- Collective flow
- Final state effects

- Initial state effect
- Reference for Pb-Pb

WHY STUDY PROTON-NUCLEUS COLLISIONS

- Proton-nucleus (pA) collisions intermediate between proton-proton an nucleus-nucleus;
- Comparison between systems → separate initial and final state effects due to hot and dense matter;
- At LHC, density of final state particles in p-Pb comparable to Au-Au and Cu-Cu at top RHIC energies;
- Final state effects in pA?

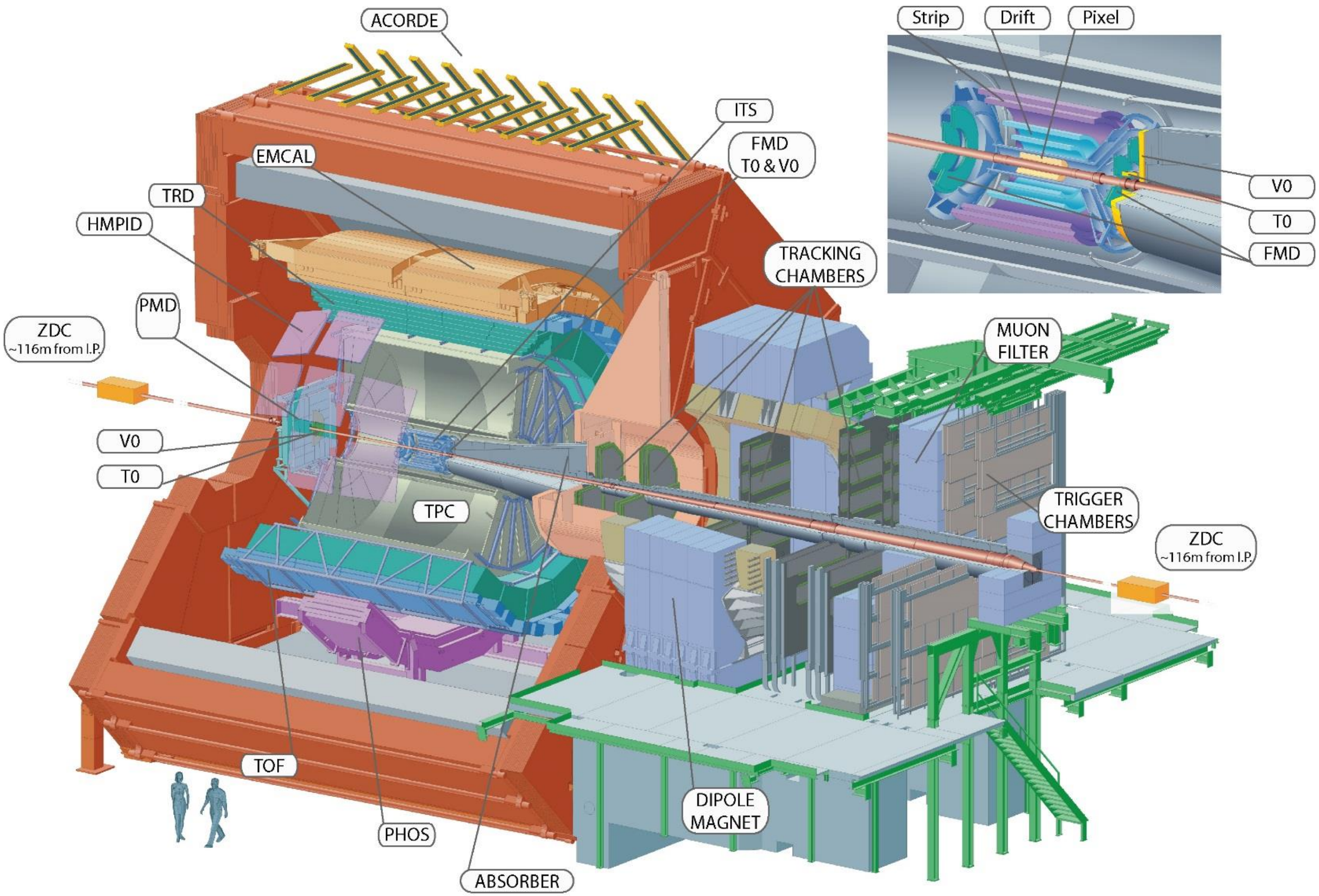
SELECTED RESULTS FROM p-Pb

- Transverse momentum spectra
- Blast-wave fits
- Mean p_T

Other results:

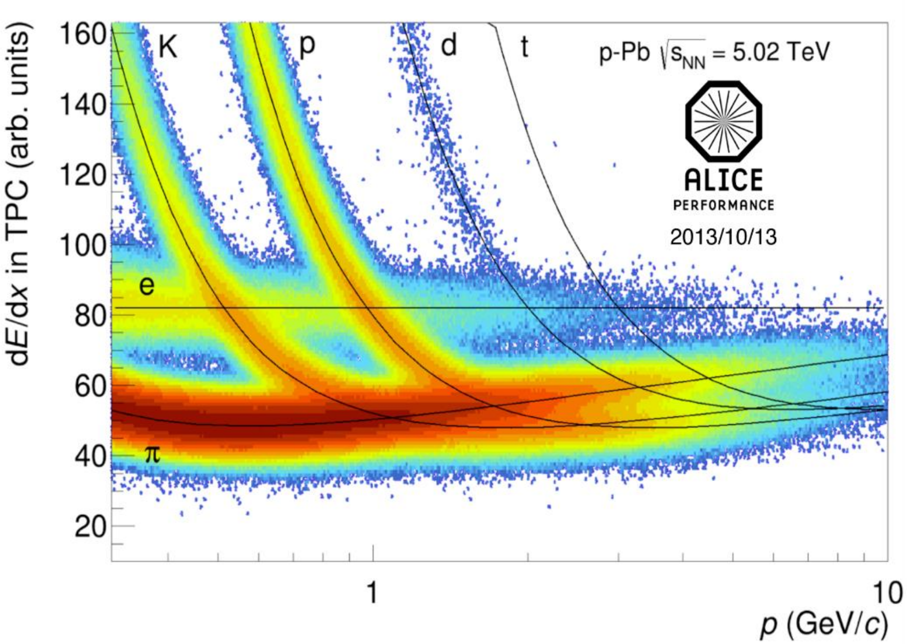
- Angular correlations (→ talk by M. Floris)
- Strangeness enhancement (→ talk by B. Hess)

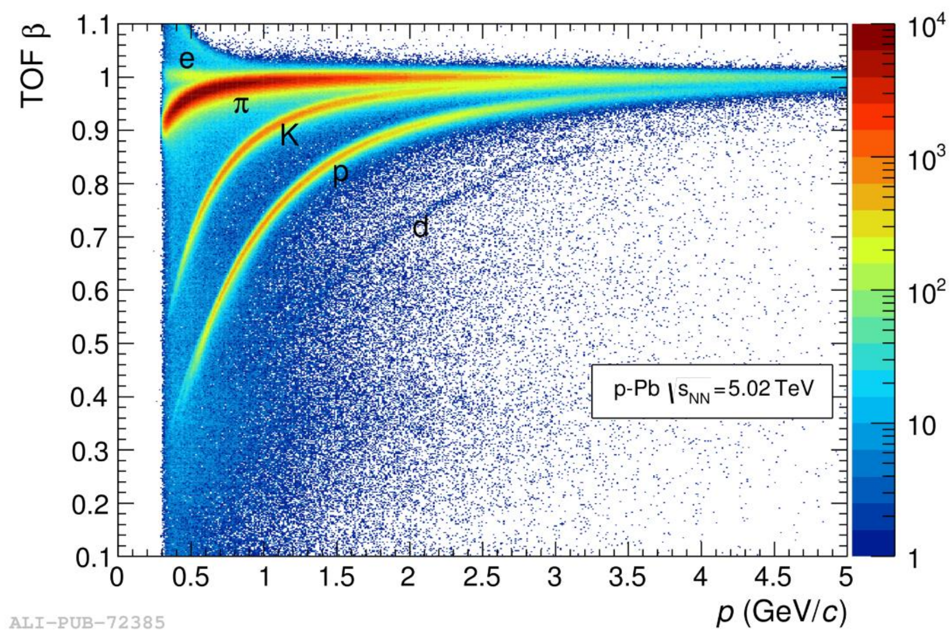
ALICE DETECTOR



PARTICLE TRACKING AND IDENTIFICATION

- Good momentum resolution ~1-5%
- Excellent particle identification capabilities in a large p_T range 0.1-20 GeV/c





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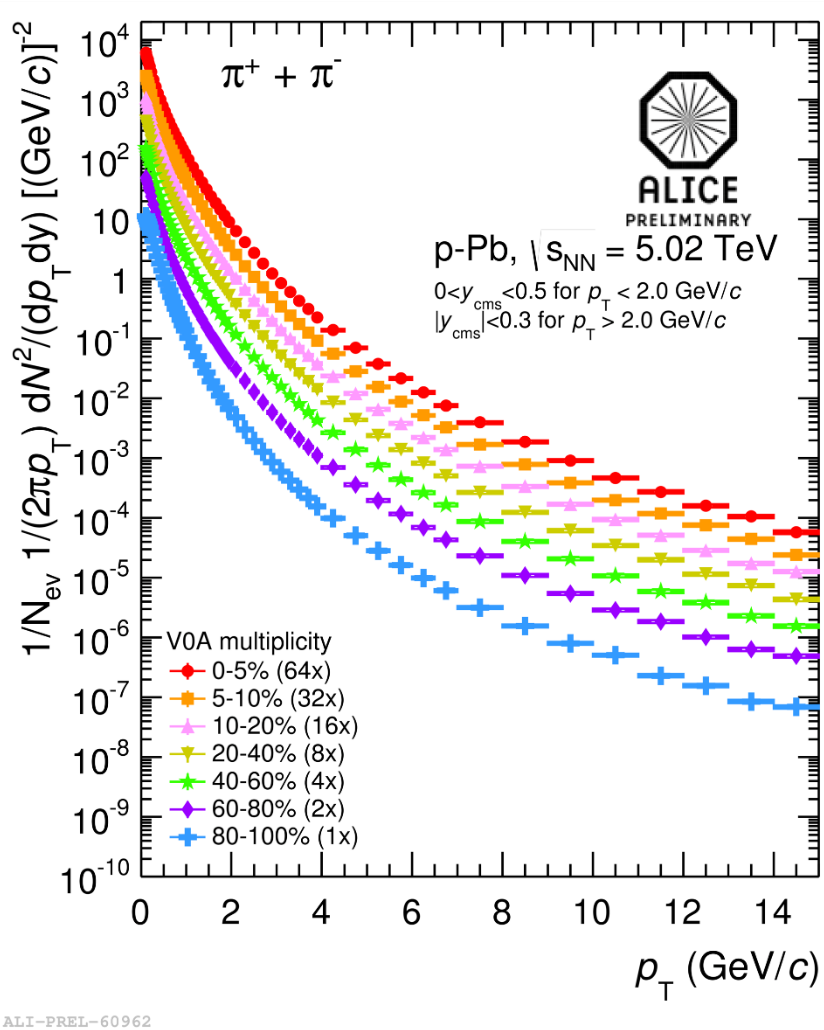
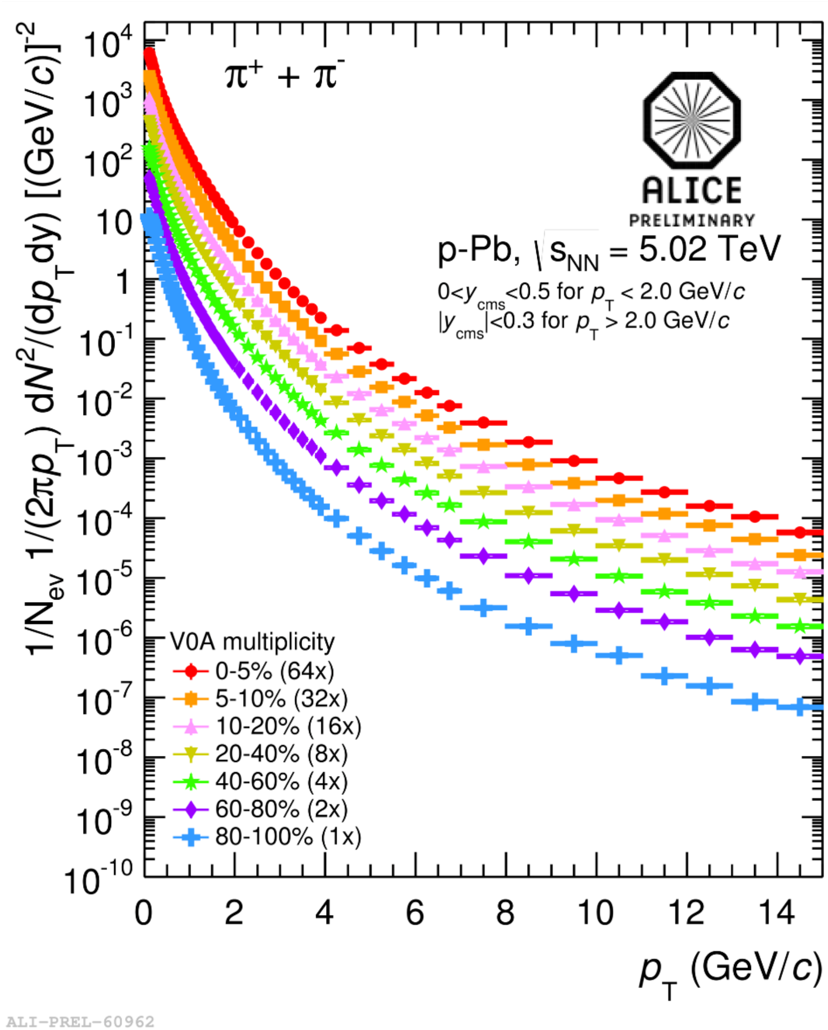
TRANSVERSE MOMENTUM SPECTRA



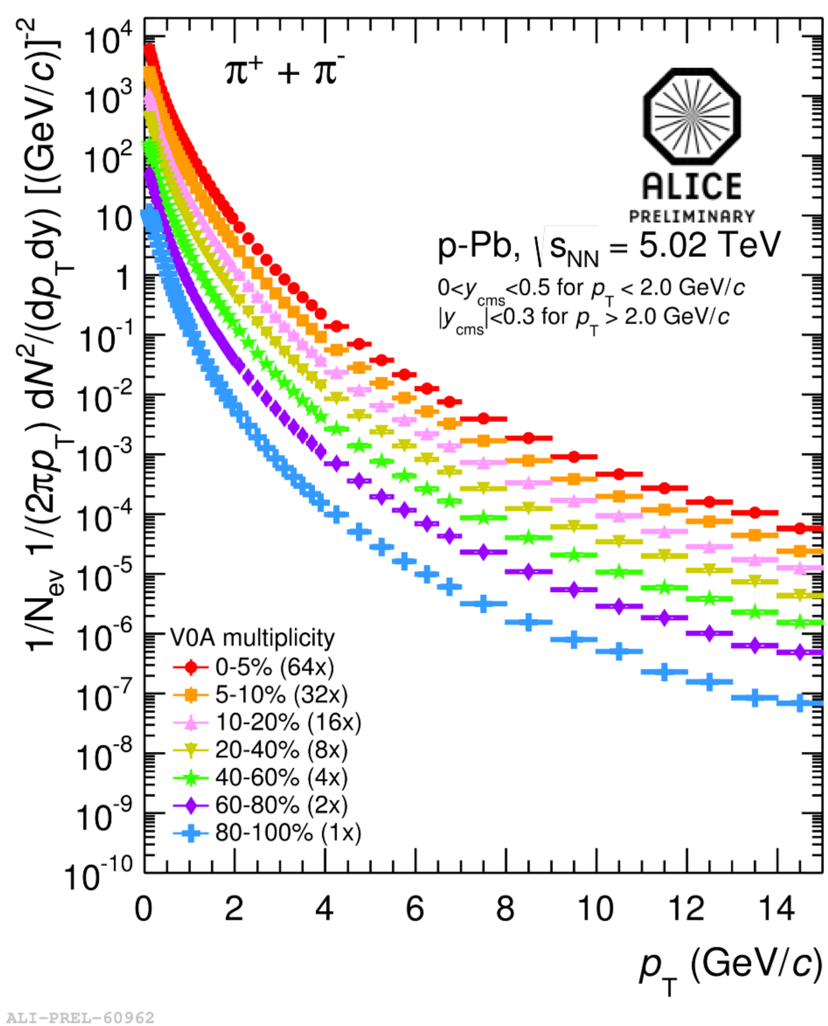
- Hardening with increasing multiplicity

TRANSVERSE MOMENTUM SPECTRA



- Hardening with increasing multiplicity
- In Pb-Pb explained in terms of collective radial expansion

TRANSVERSE MOMENTUM SPECTRA



- Hardening with increasing multiplicity
- In Pb-Pb explained in terms of collective radial expansion
- Radial flow → Blast-wave parameterization
- Combined Blast-wave fit of pion, kaon, proton, K_S^0 and Λ spectra

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BLAST-WAVE FIT PARAMETERS

- Blast-wave fit parameters as function of multiplicity: similar evolution in p-Pb and Pb-Pb

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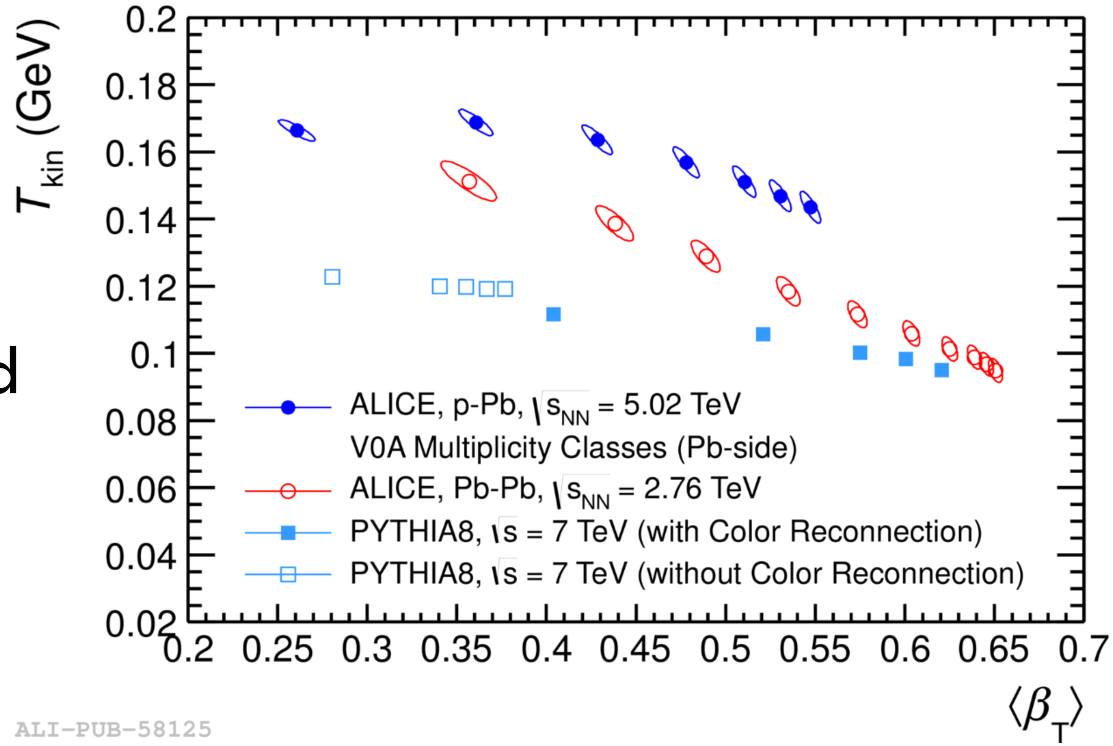

T_{kin} → kinetic freeze-out temperature

$<\beta_T>$ → average radial flow velocity

BLAST-WAVE FIT PARAMETERS

- Blast-wave fit parameters as function of multiplicity: similar evolution in p-Pb and Pb-Pb
- PYTHIA8 pp (no hydrodynamics): same trend if Color Reconnection is on
- Effect similar to flow

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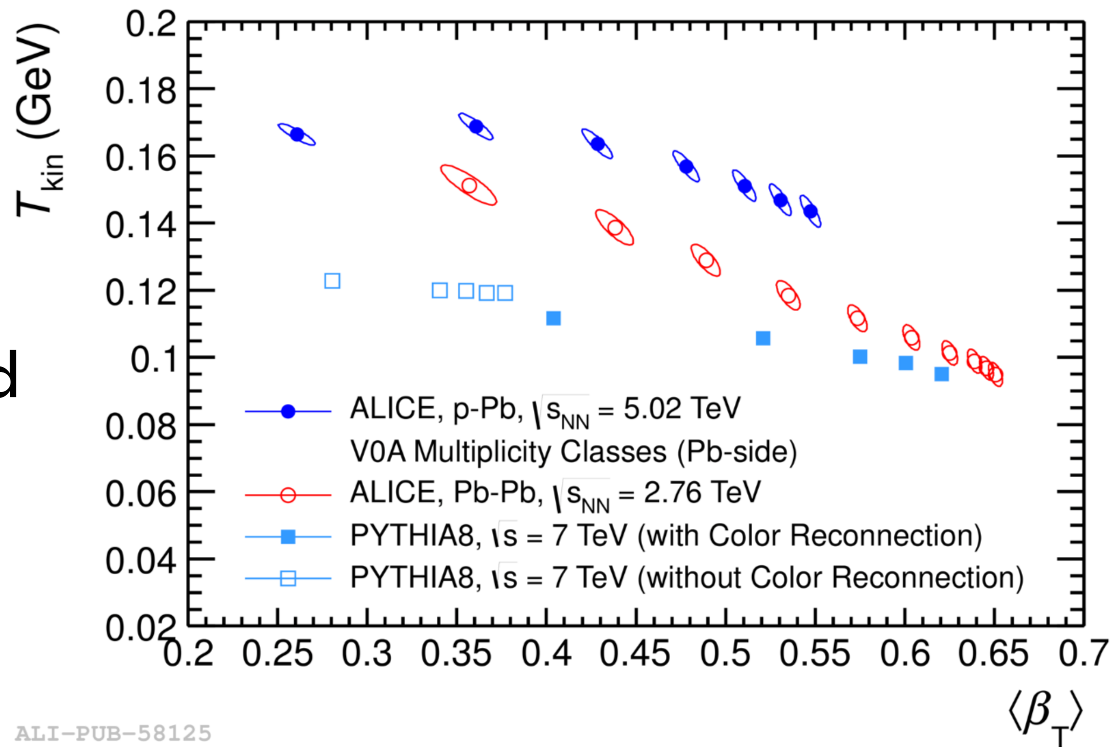
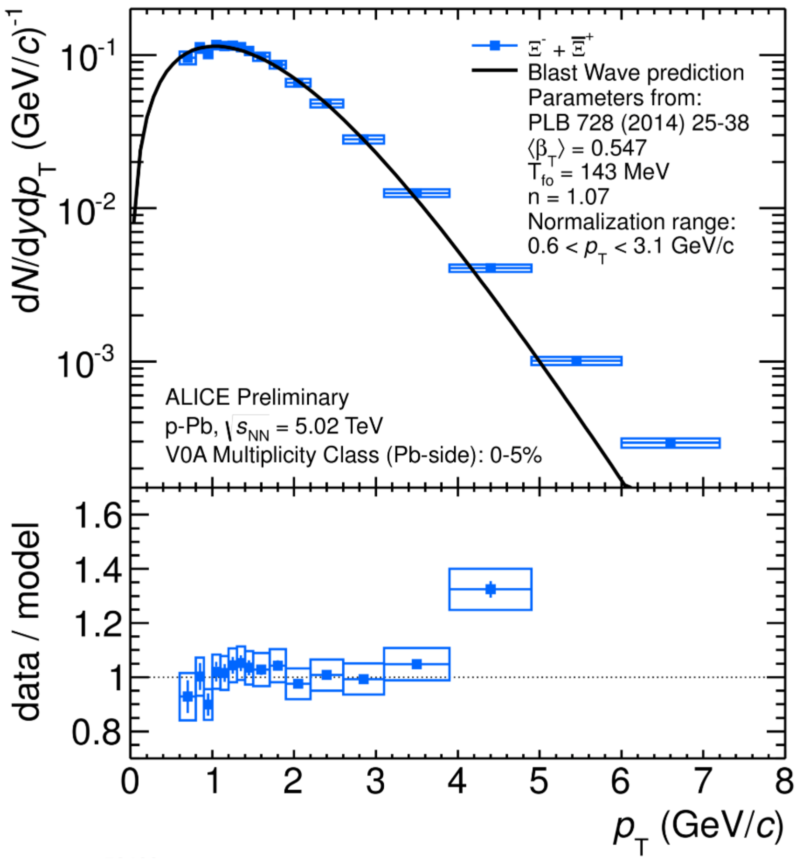
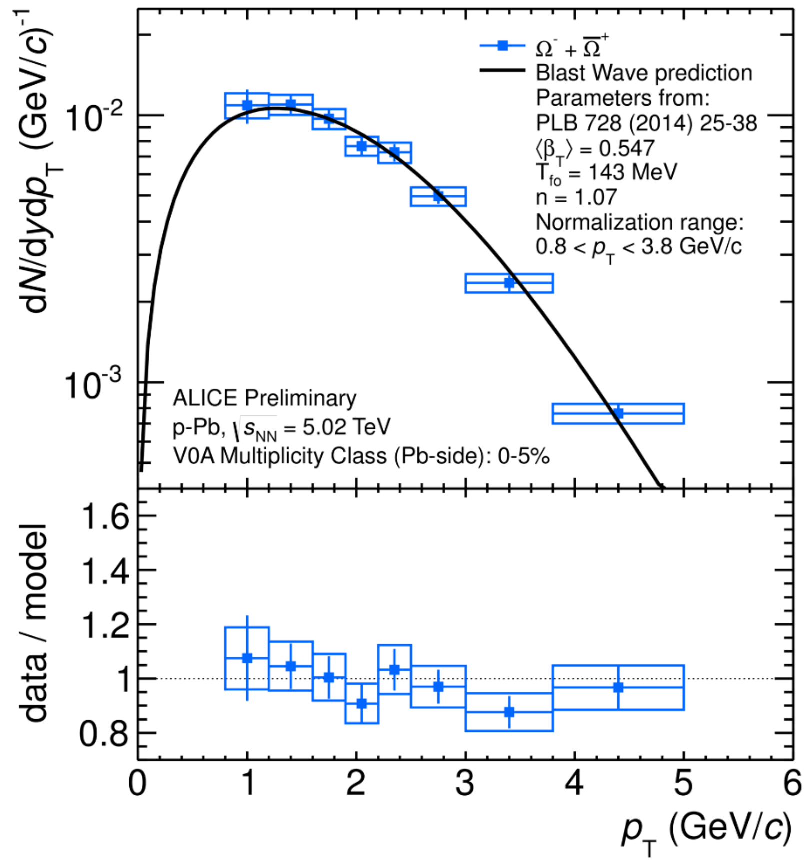


T_{kin} → kinetic freeze-out temperature

$<\beta_T>$ → radial flow velocity

PREDICTING SPECTRA

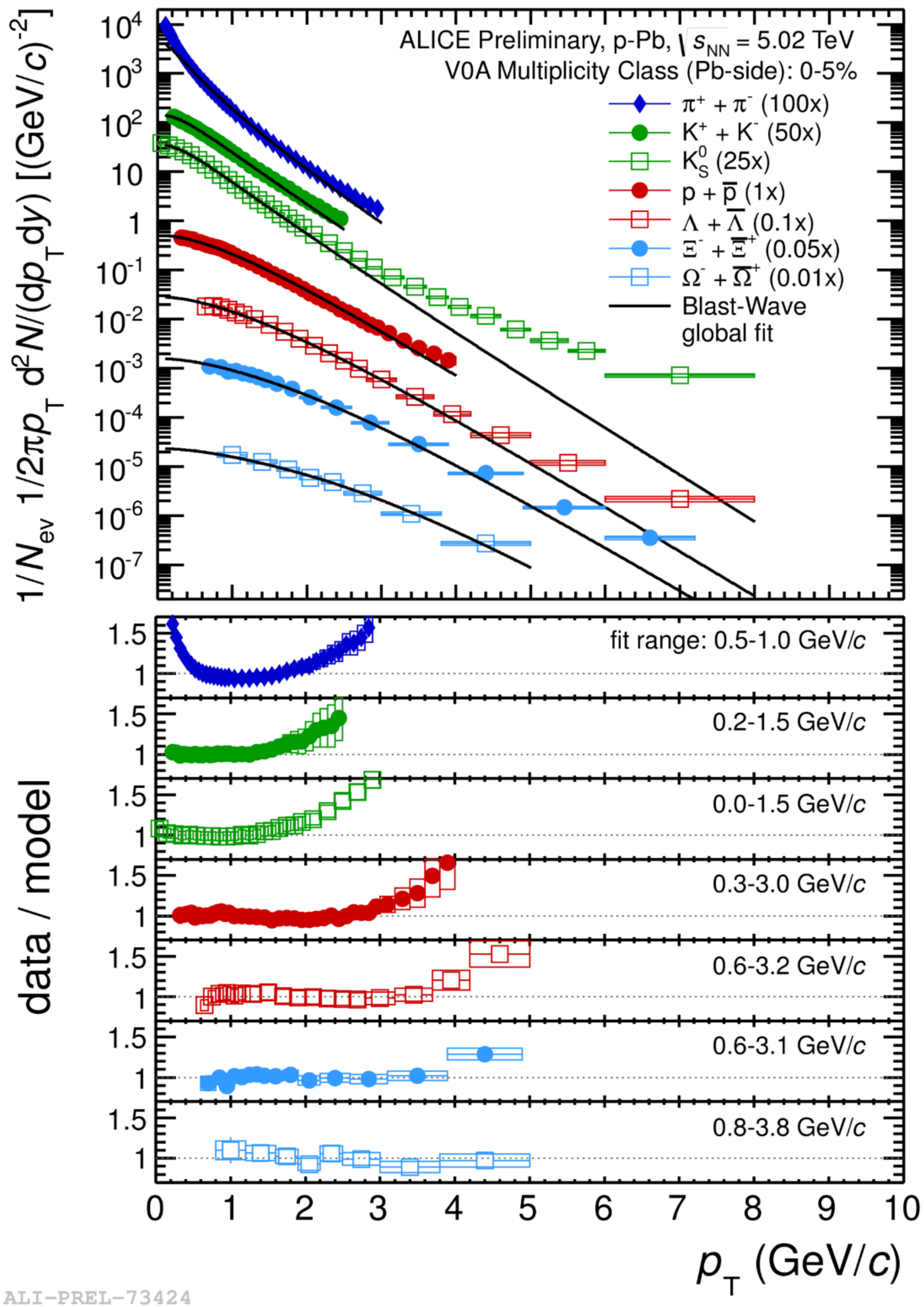




Parameters from combined fit of pion, kaon, proton K_S^0 and Λ spectra describe spectra of Ξ^- and Ω^-.

COMBINED FIT

- Combined fit extended to include Ξ^- and Ω^-.
- Values of fit parameters depend on the fit range



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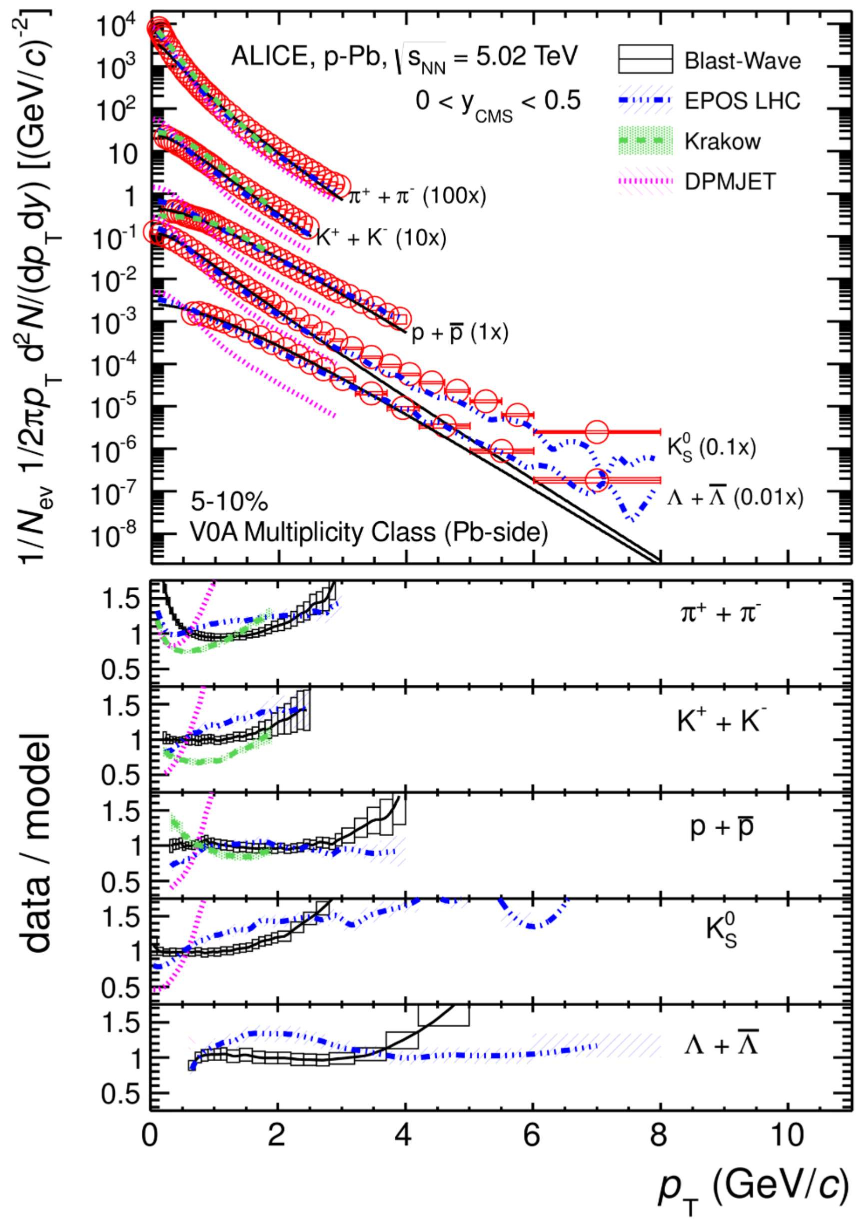
COMPARISON TO MODELS



DPMJET:

- Reproduces pseudo-rapidity distributions in NSD p-Pb collisions

Kraków:

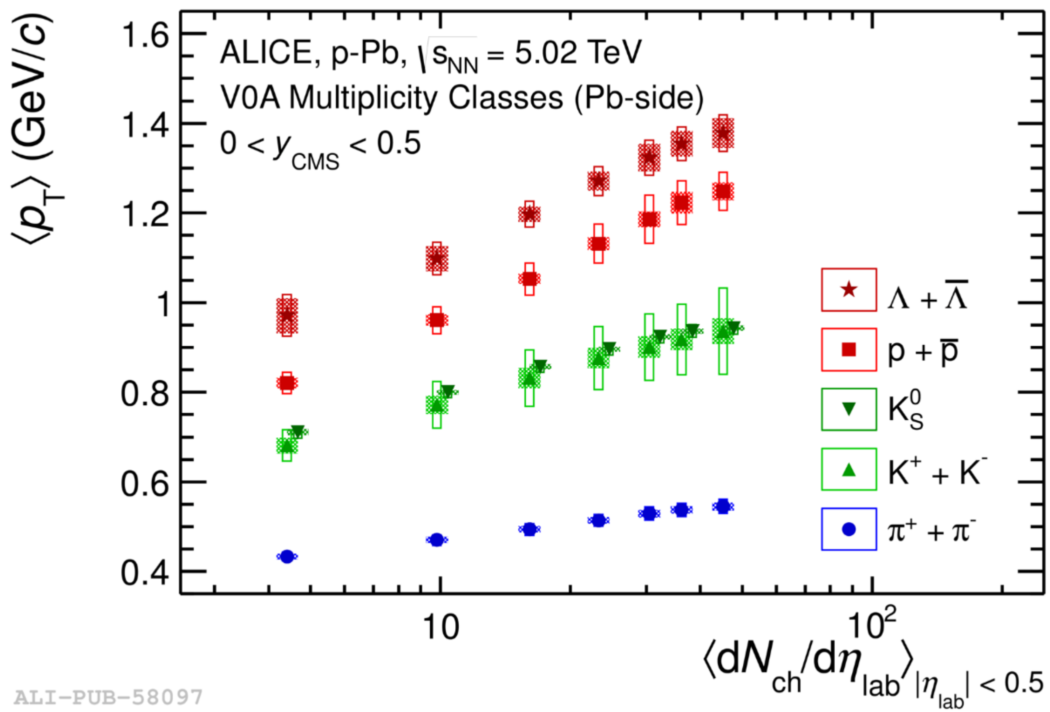
- Expansion of the system via viscous hydrodynamic approach
- Statistical hadronization at freeze-out

EPOS:

- Bulk matter described in terms of hydrodynamics

Models with hydro describe data in p-Pb → flow effects?

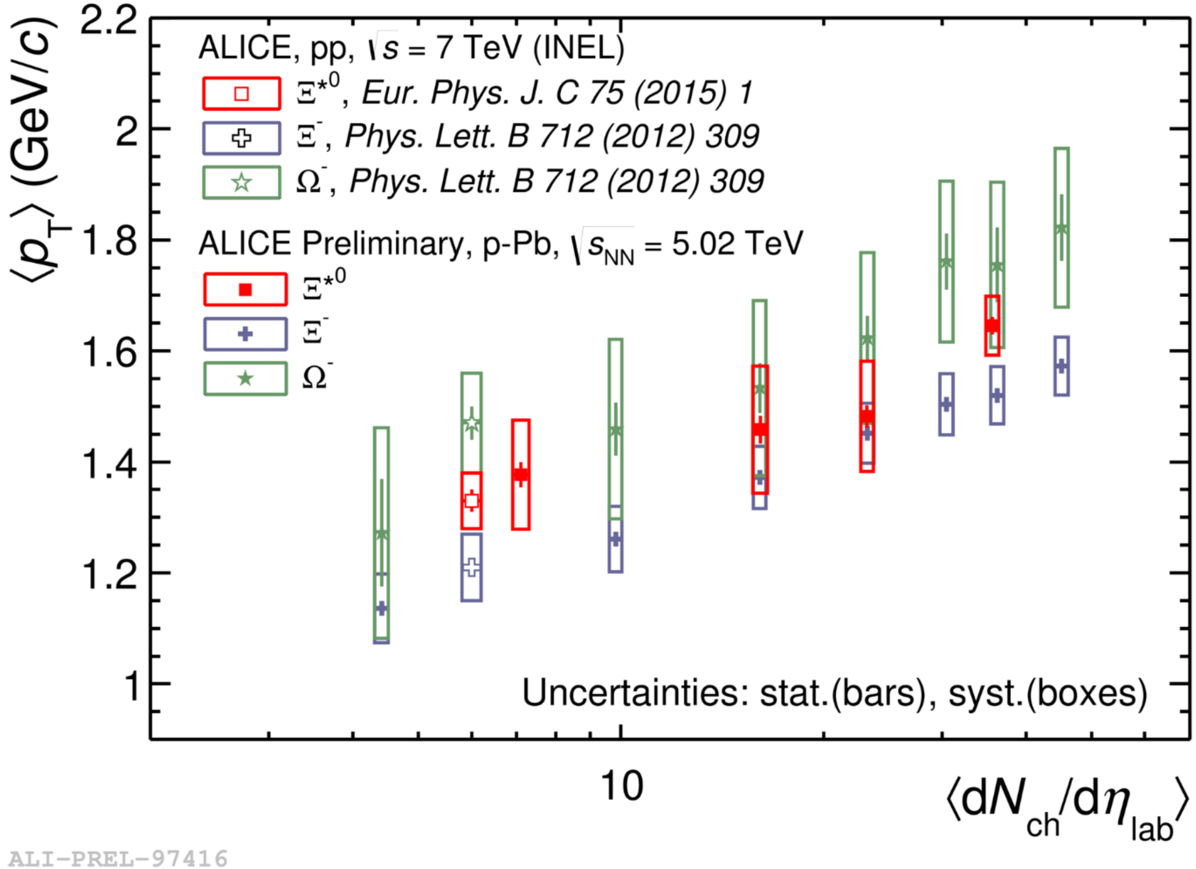
MEAN TRANSVERSE MOMENTUM



Hardening vs. multiplicity stronger for heavier particles (mass ordering) → suggest presence of hydrodynamics

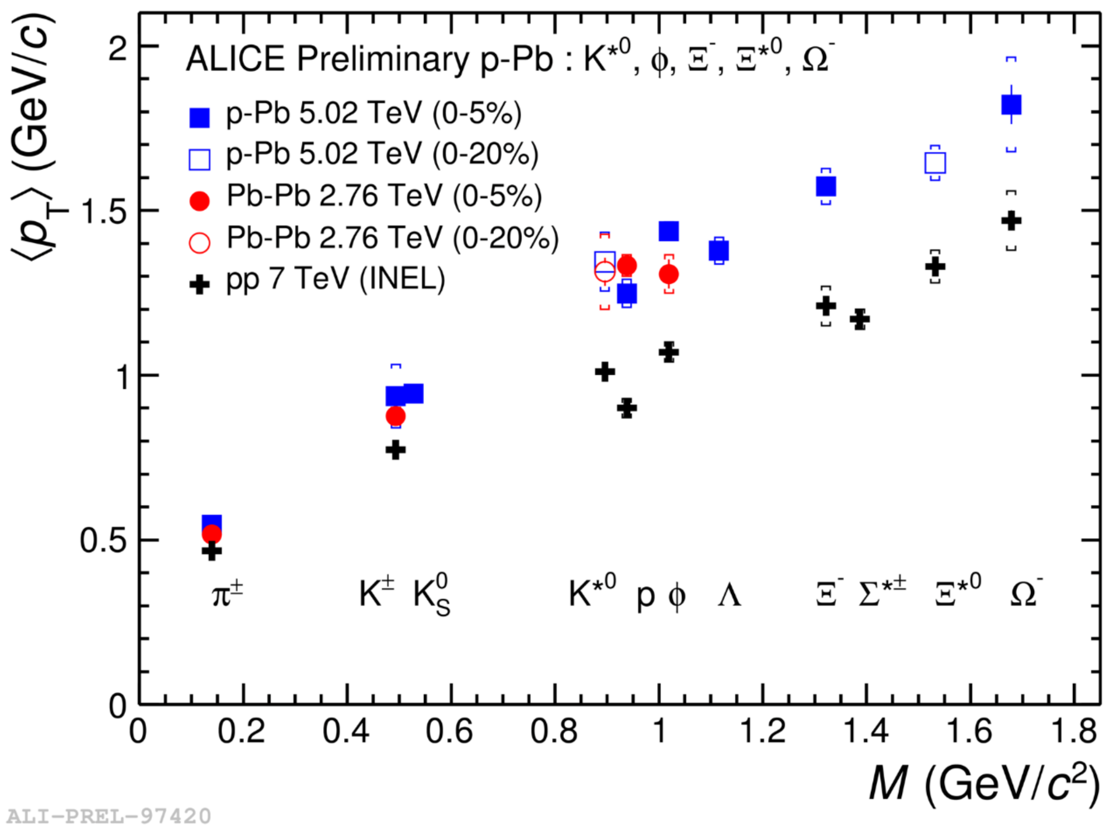
MEAN TRANSVERSE MOMENTUM

Results for $\Xi(1530)^0$ consistent with multi-strange hyperons



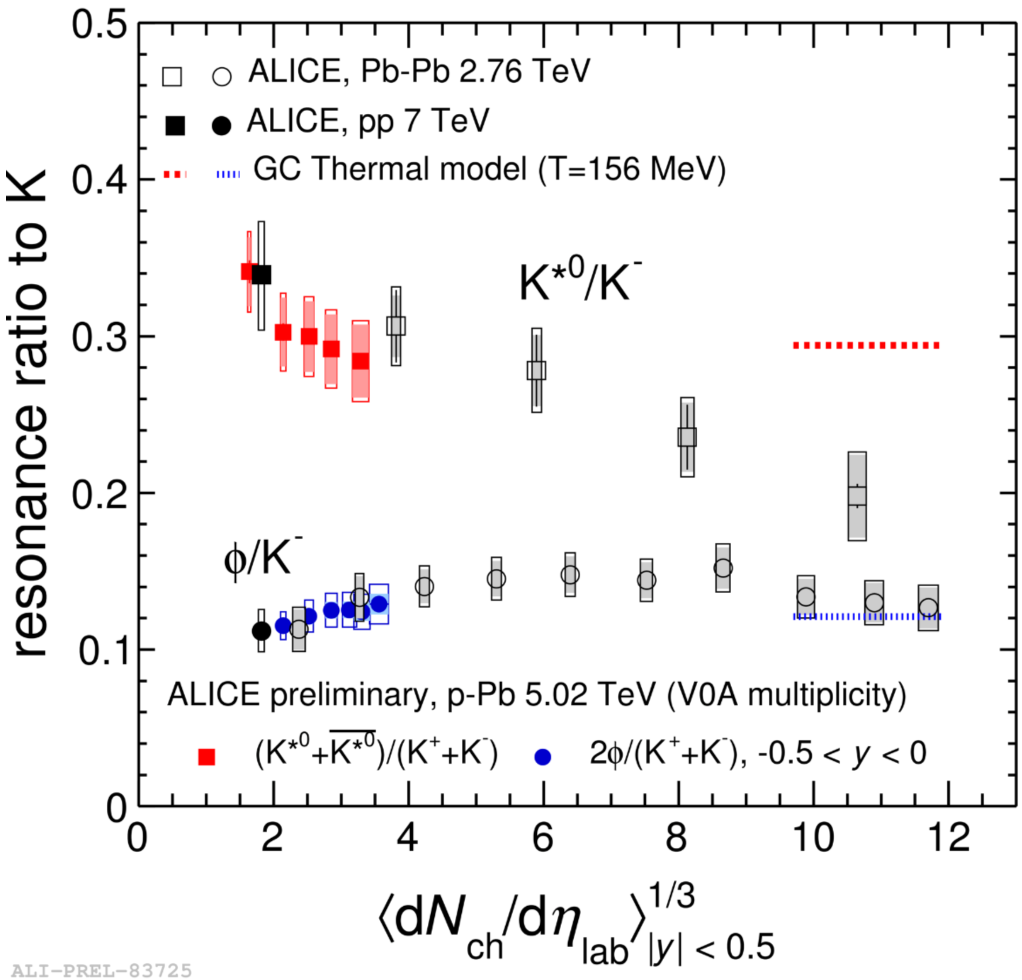
Multiplicity classes for $\Xi(1530)^0$: 0-20%, 20-40%, 40-60% and 60-100%

$<p_T>$ VS. PARTICLE MASS



- Common trend or mesons (baryons) deviate?

RE-SCATTERING IN HADRONIC MATTER



- Suppression of K^{*0}/K^- ratio in central Pb-Pb due to re-scattering effects of K^{*0} daughters in hadronic matter after hadronization
- ϕ not affected due to lifetime longer than K^{*0}
- Trend in p-Pb consistent with pp and peripheral Pb-Pb within uncertainties
- No evidence for re-scattering effects in p-Pb

CONCLUSIONS

- Multiplicity- and mass-dependent hardening of spectra suggestive of hydrodynamics in p-Pb collisions at LHC
- Models with hydro describe data better
- Alternative explanations (e.g. color reconnection) are possible
- No evidence for hadronic matter effects (e.g. re-scattering) in p-Pb collisions