K^0_S & Λ Production in ALICE

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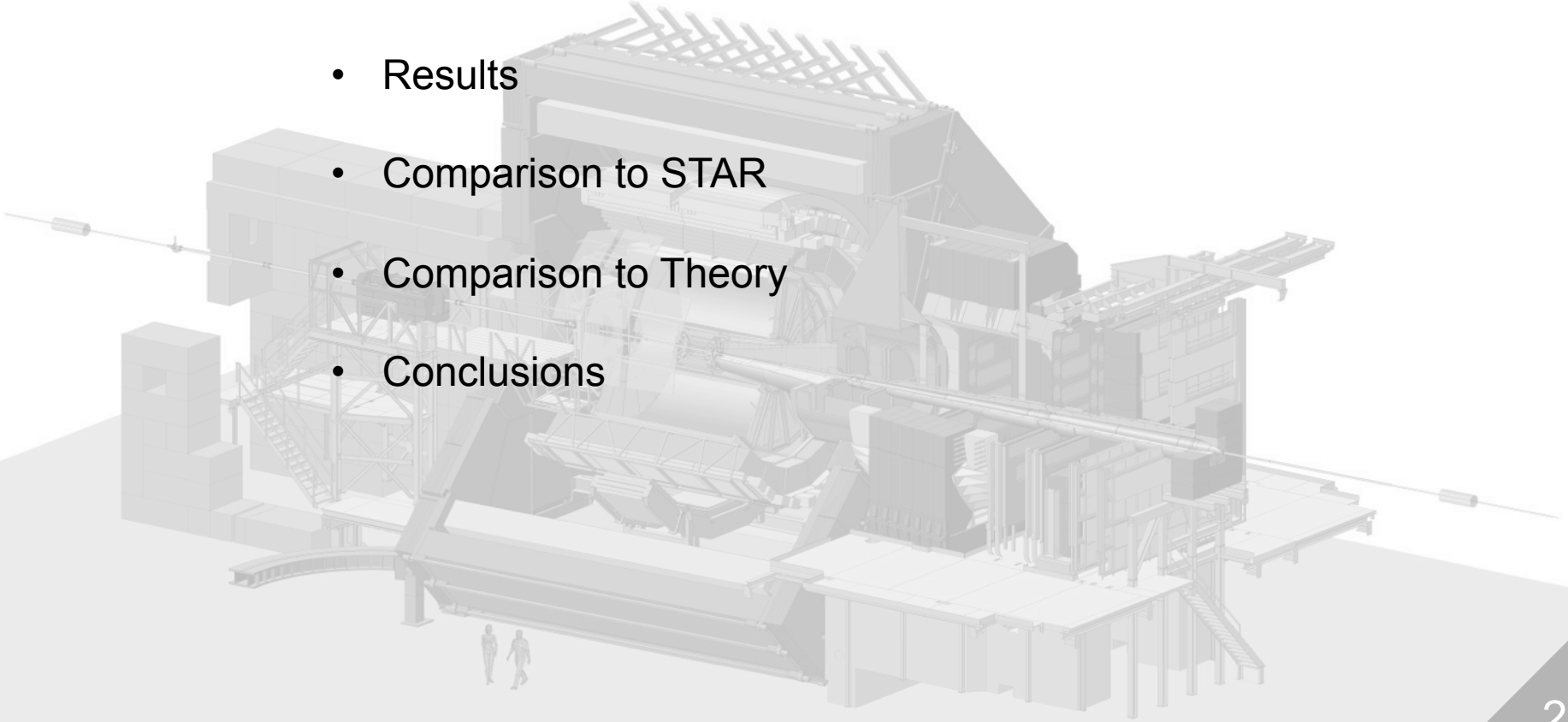
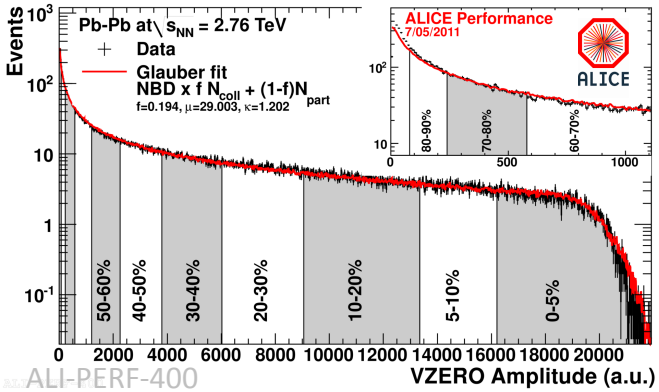
for the ALICE Collaboration

Outline

- The ALICE Experiment
- Motivation
- Reconstruction
- Results
- Comparison to STAR
- Comparison to Theory
- Conclusions



ALICE

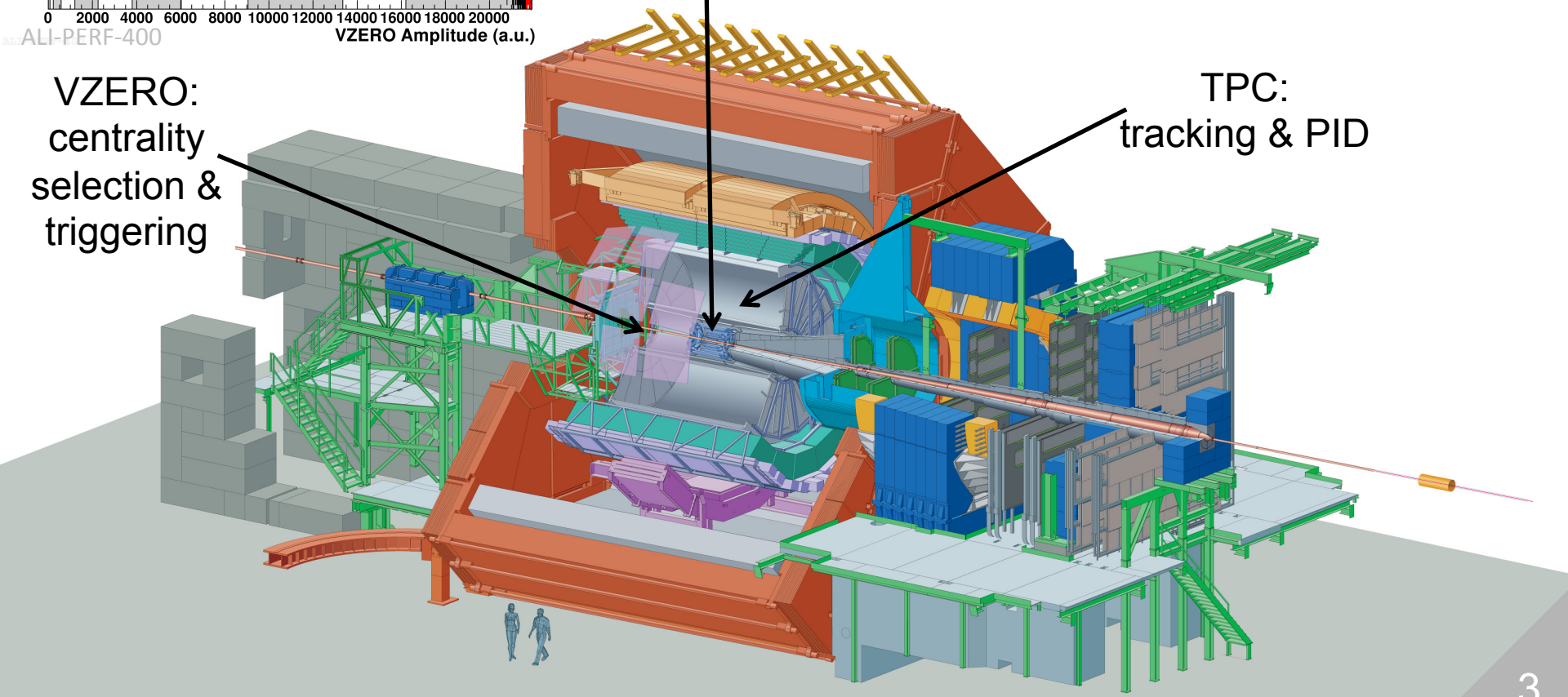


This analysis used events from the 2010 Pb-Pb run	Number of Events
Real Data	1.5 x 10^7
Monte Carlo (w. injected Λ/K^0_S)	1.7 x10^6

ITS: tracking & triggering

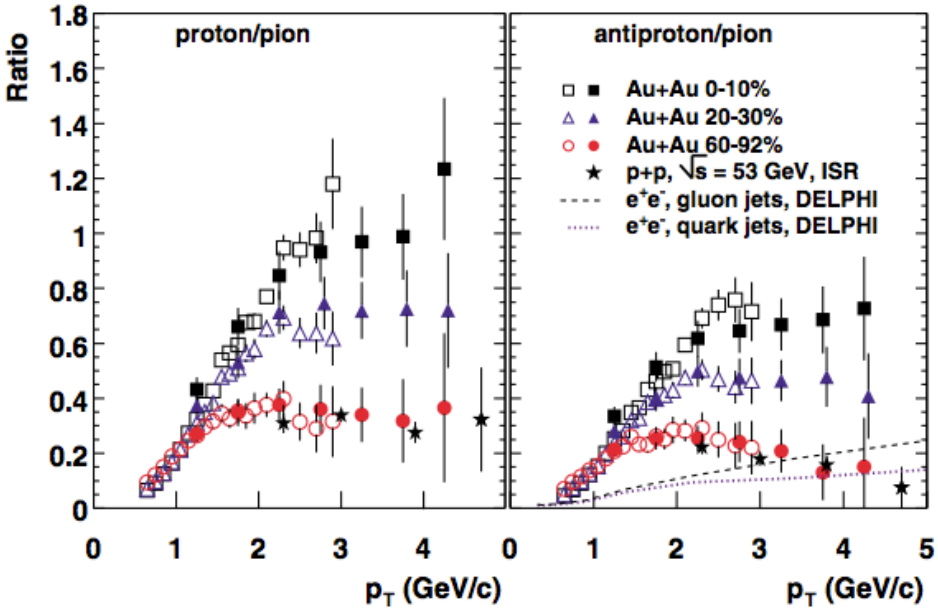
VZERO: centrality selection & triggering

TPC: tracking & PID

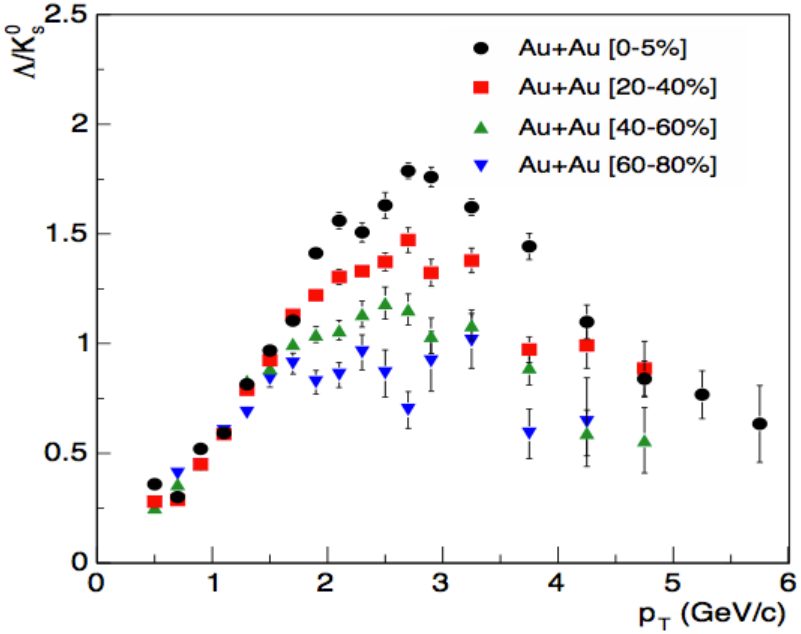


Motivation

- Observed at SPS & RHIC that p/π & Λ/K^0_S ratios are enhanced at intermediate momentum in heavy ion collisions, when compared to pp.
- Possibly due to flow and coalescence
- Examining how this effect evolves with increased energy gives insight into the interplay between fragmentation and potential baryon-enhancing effects such as coalescence.
- Λ & K^0_S can be identified with a single technique over a wide momentum range



S. S. Adler et al. (PHENIX Collaboration), Phys. Rev. Lett. 91, 172301 (2003)



J. Adams et al. (STAR Collaboration), (2006),

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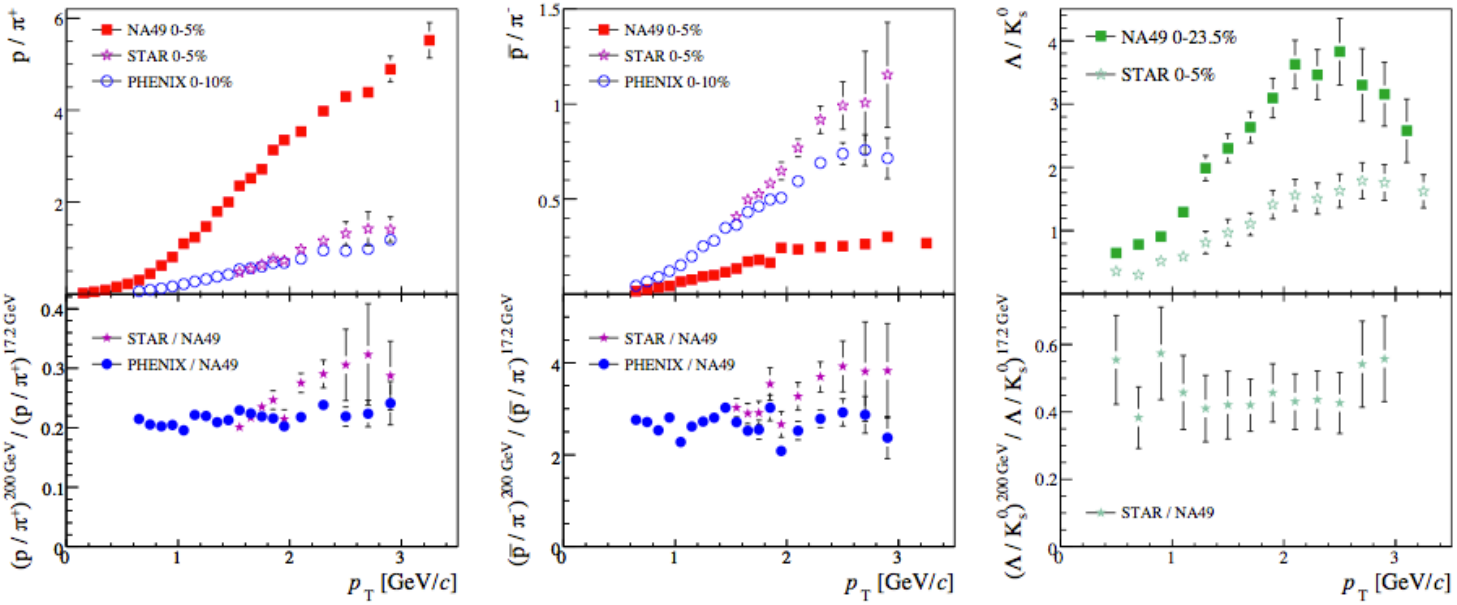
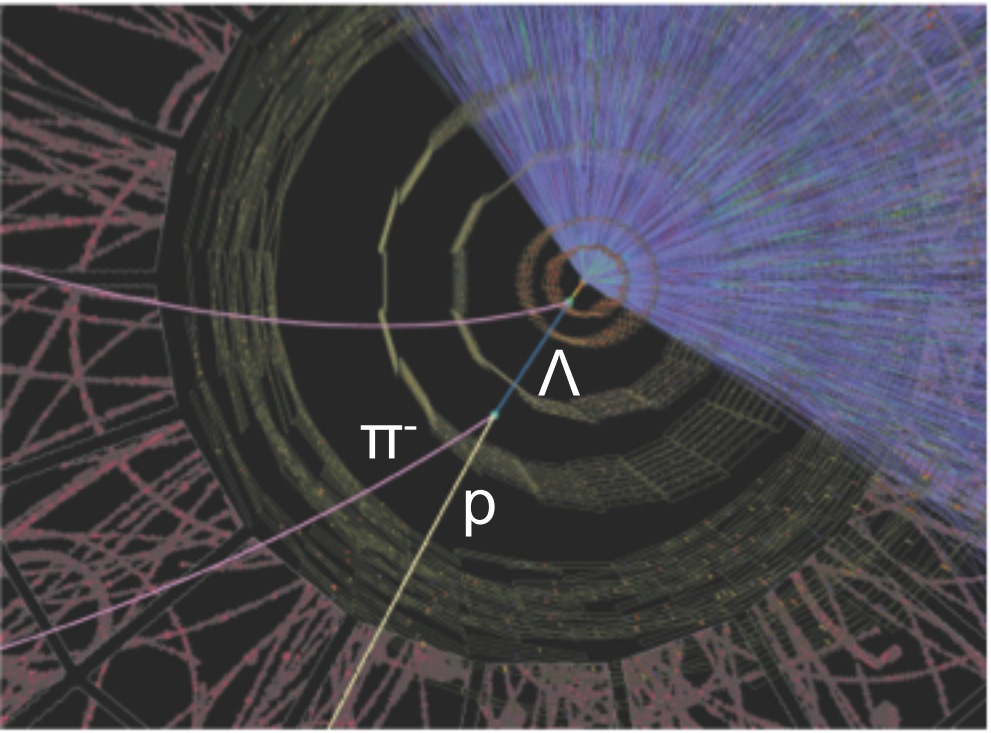


T. Schuster and A. Laszlo (for the NA49 Collaboration). J.Phys. G32 (2006) S479-S482.

Reconstruction

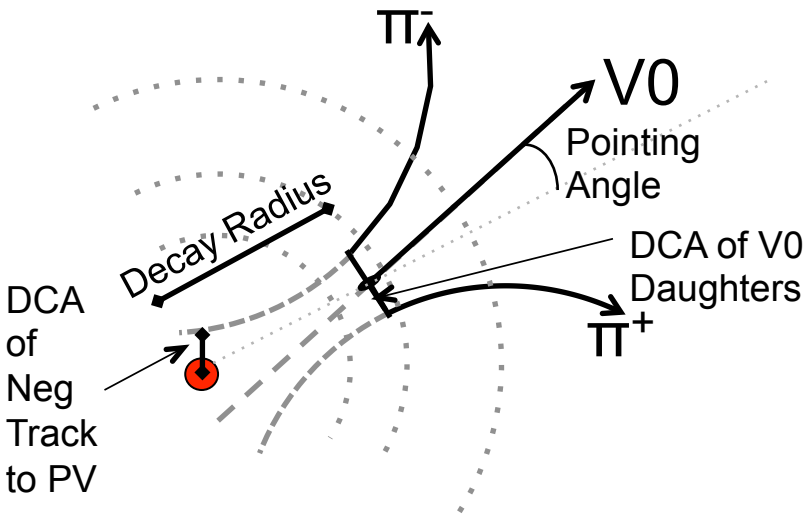


Pb-Pb 5.5TeV Hijing MC Event, not all tracks shown
Alice Physics Performance Report, Volume II (Figure IV)

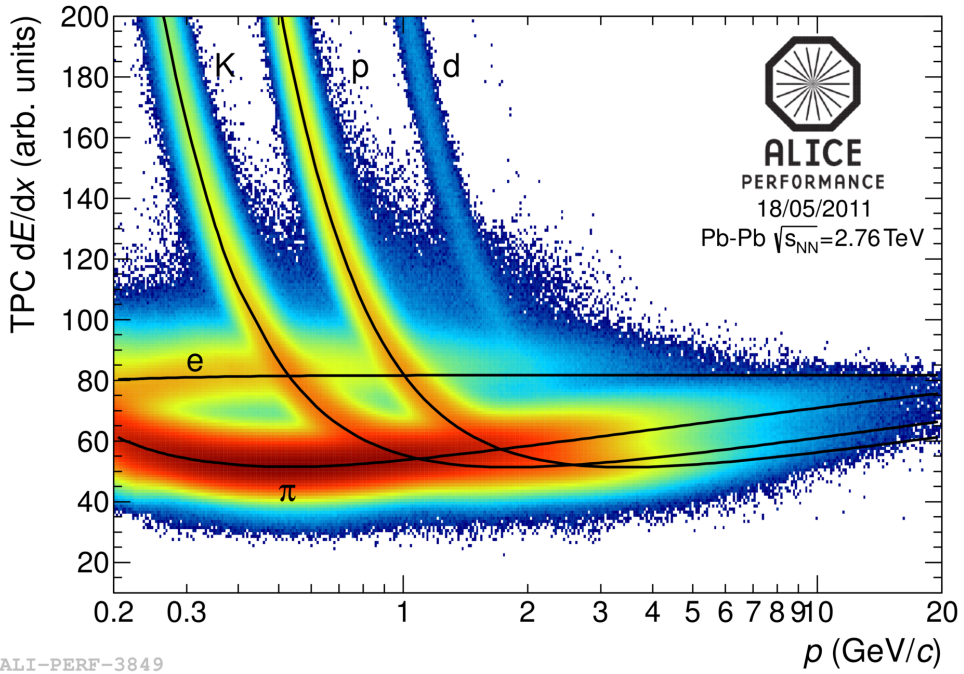
Decay	Branching Ratio
$K^0_S \Rightarrow \pi^+\pi^-$	69.2%
$\Lambda \Rightarrow p\pi^-$	63.9%

True 'V0's can be distinguished from combinatorial background by geometrical cuts on:

- DCA of daughters to each other
- DCA of daughters to primary vertex
- Cosine of pointing angle
- Decay radius



Reconstruction



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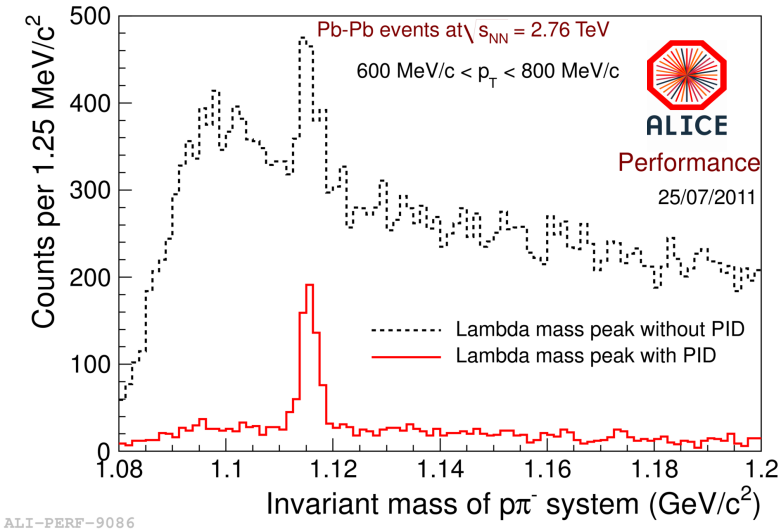
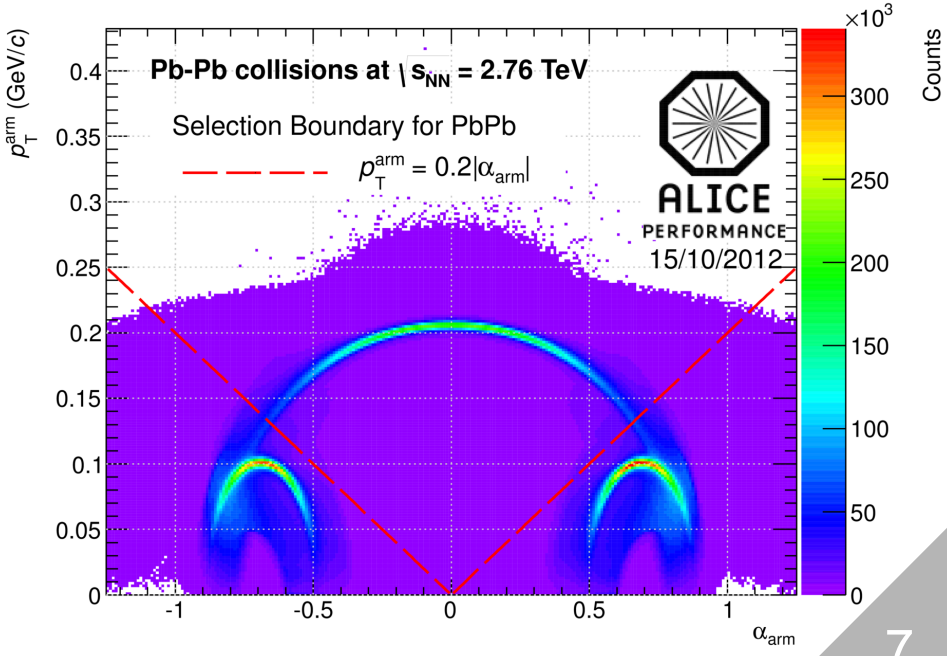


ALI-PERF-9086

Further cuts needed due to high level of combinatorial background in Pb-Pb collisions.

- 3σ cut on TPC dE/dx for proton daughters.
- Cut in Armenteros-Podolanski diagram



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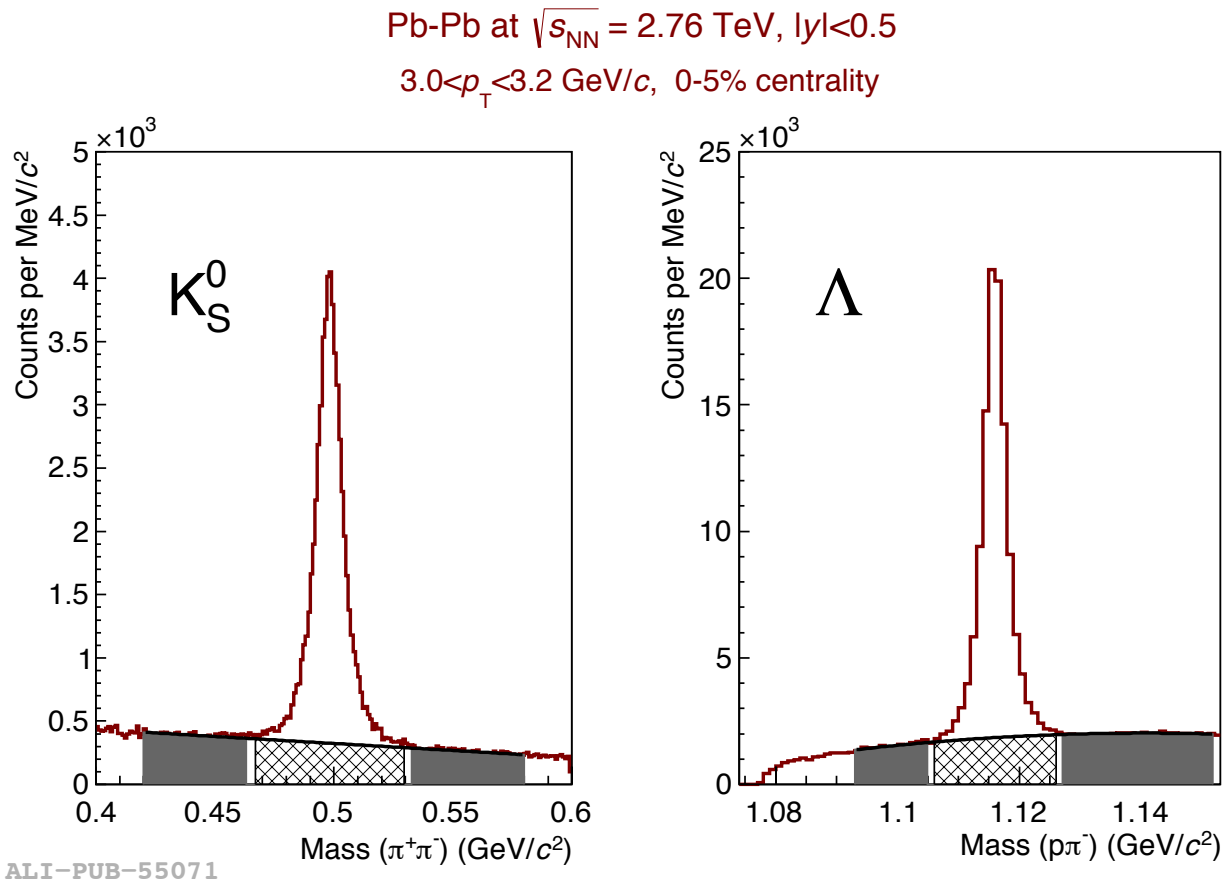
Reconstruction



ALICE Collaboration, (2013), arXiv:nucl-ex/1307.5530

- Peak fitted with Gaussian + 2nd degree polynomial
- 'Sideband regions' fitted with 2nd degree polynomial
- Signal defined as the difference between the counts in the 'peak region' and the background fit

Reconstruction

Decay	Branching Ratio
$\Xi^- \Rightarrow \Lambda\pi^-$	99.887 ±0.035%
$\Xi^0 \Rightarrow \Lambda\pi^0$	99.525 ±0.012%

- Λ coming from weak decays of Ξ are removed
- Ω decay also considered, but found to be negligible

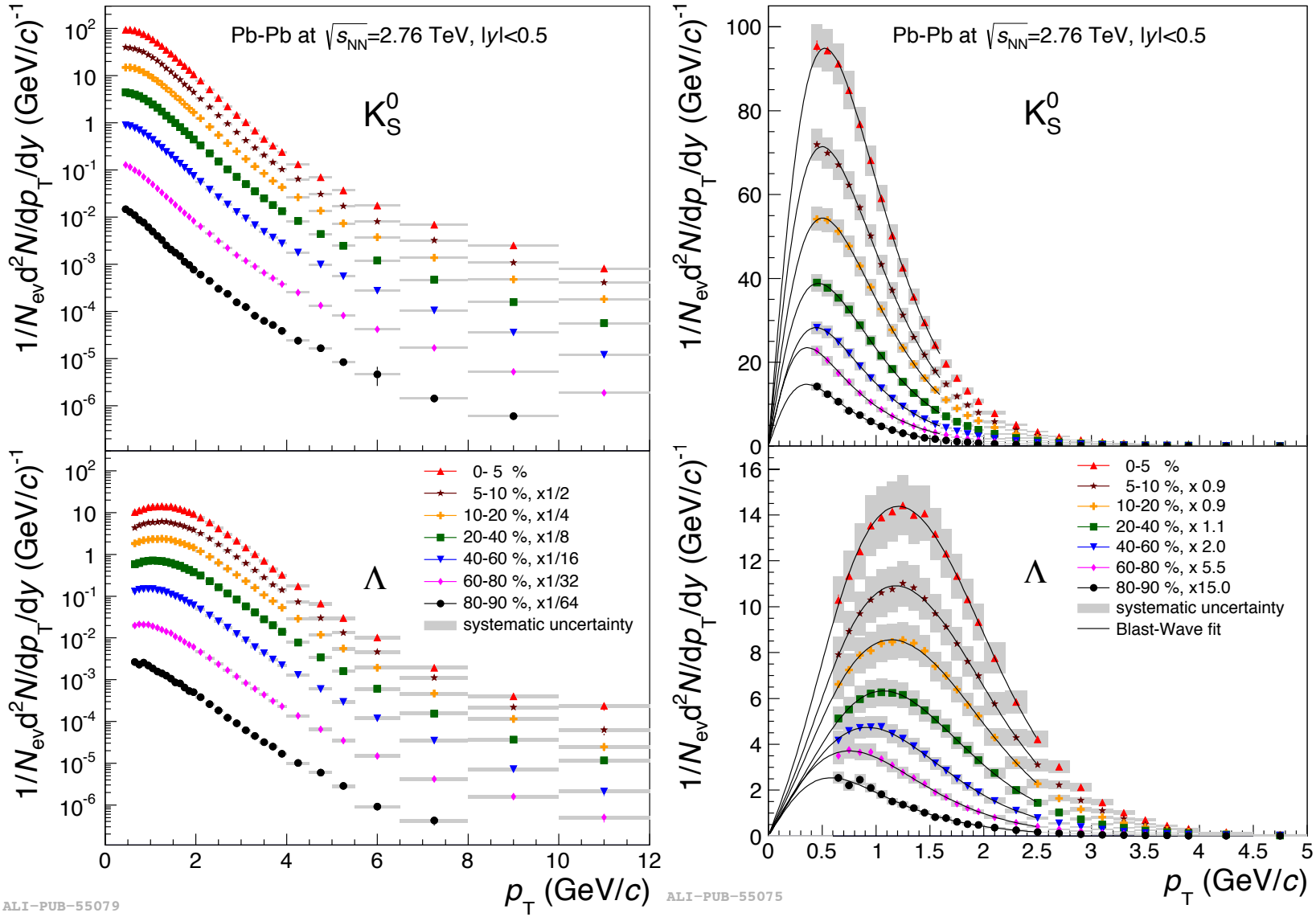
- With MC, we create a Feed-down matrix relating the p_T distribution of Λ to that of Ξ
- This can then be scaled to the measured Ξ p_T spectrum
- The raw yield of primary Λ is then obtained as:

$$\Lambda^{raw}_{primary} = \Lambda^{raw}_{measured} - \sum_j F_{ij} \int_{p_T(bin)} \frac{dN}{dp_T}(\Xi^-)$$

$$F_{ij} = \frac{N_{recon}(\Lambda)^{in\ bin\ i}_{from\ \Xi\ bin\ j}}{N_{generated}(\Xi)_{in\ bin\ j}}$$

- Feed-down varies from ~25% at low p_T to neglible levels at high p_T

Results



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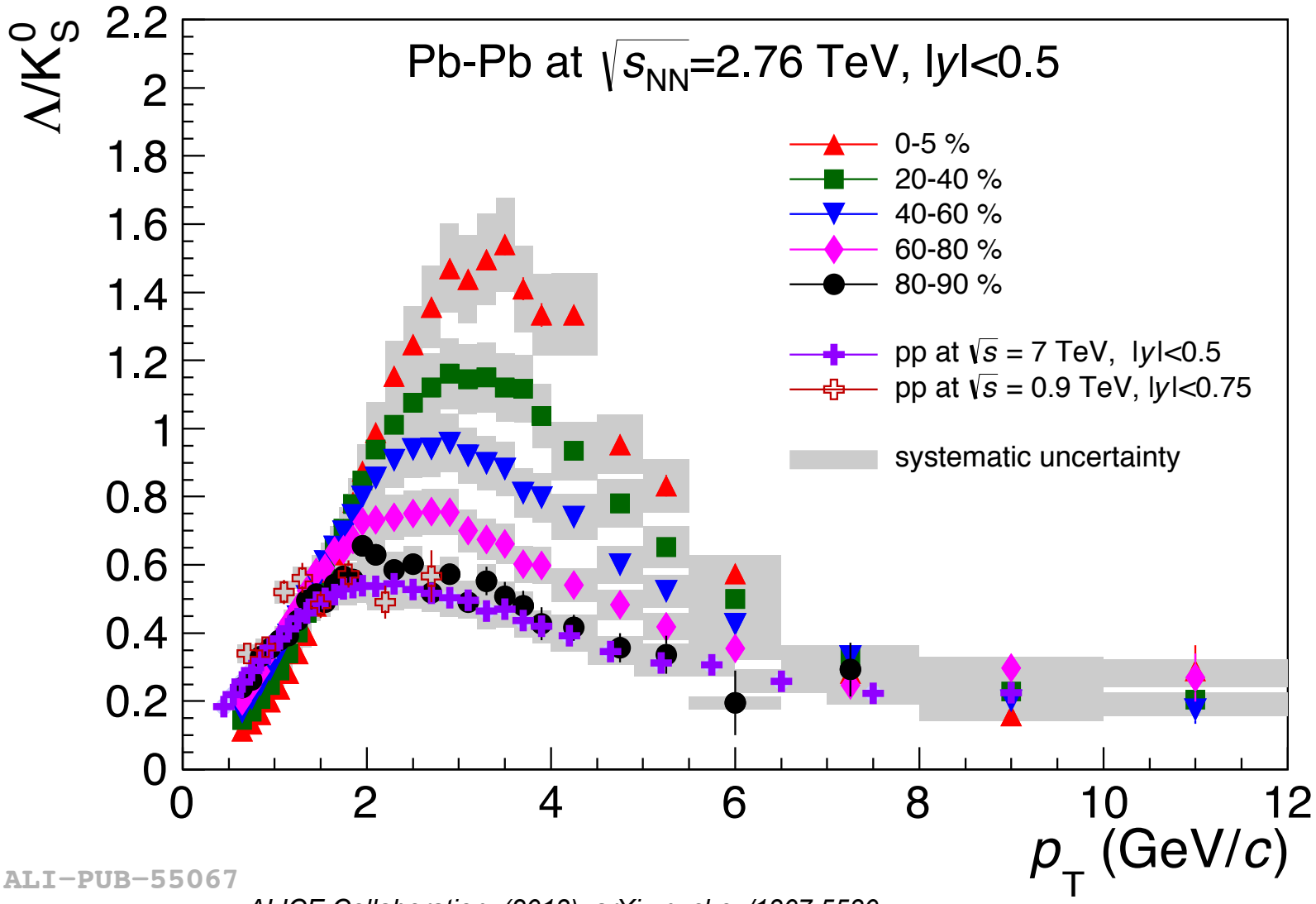
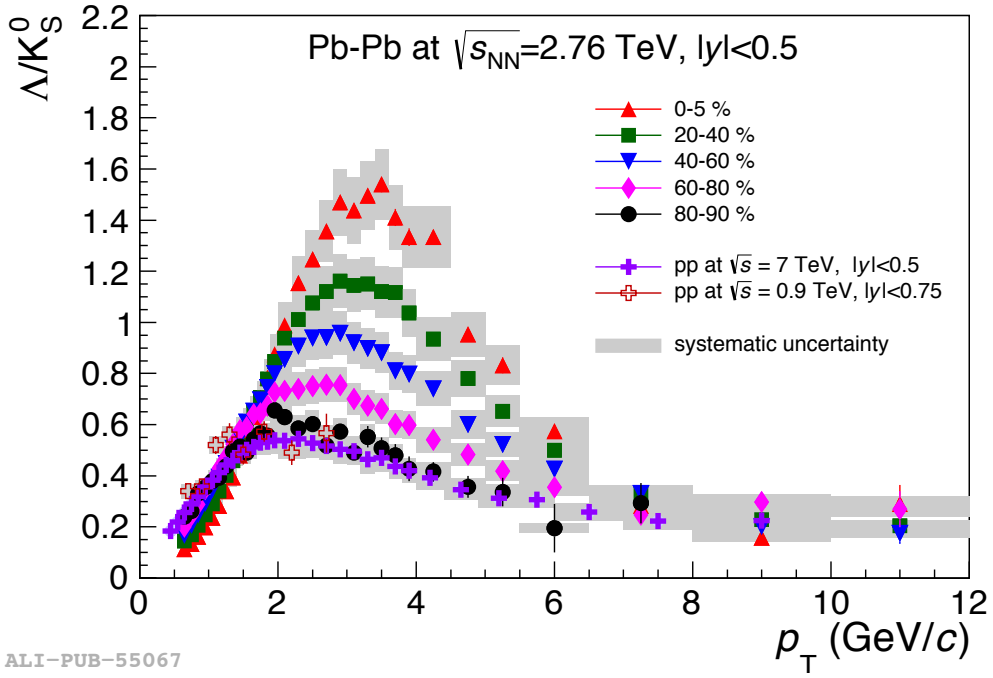
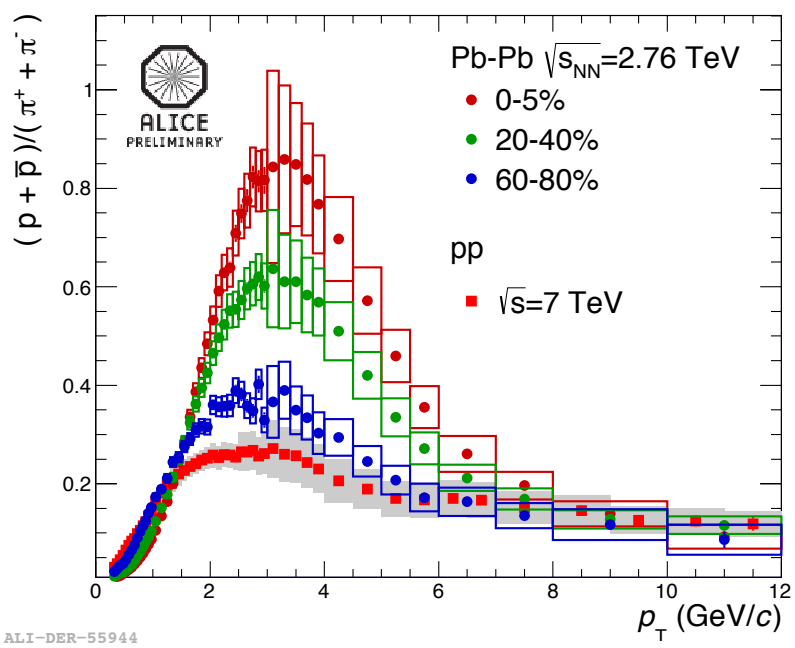


ALI-PUB-55067

ALICE Collaboration, (2013), arXiv:nucl-ex/1307.5530

Results



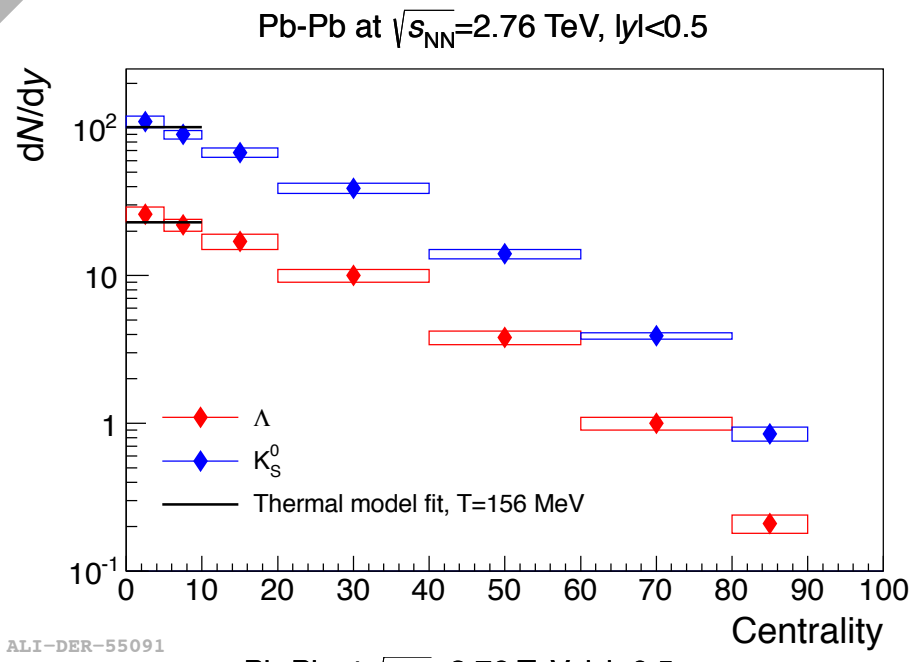


ALICE Collaboration, (2013), arXiv:nucl-ex/1307.5530

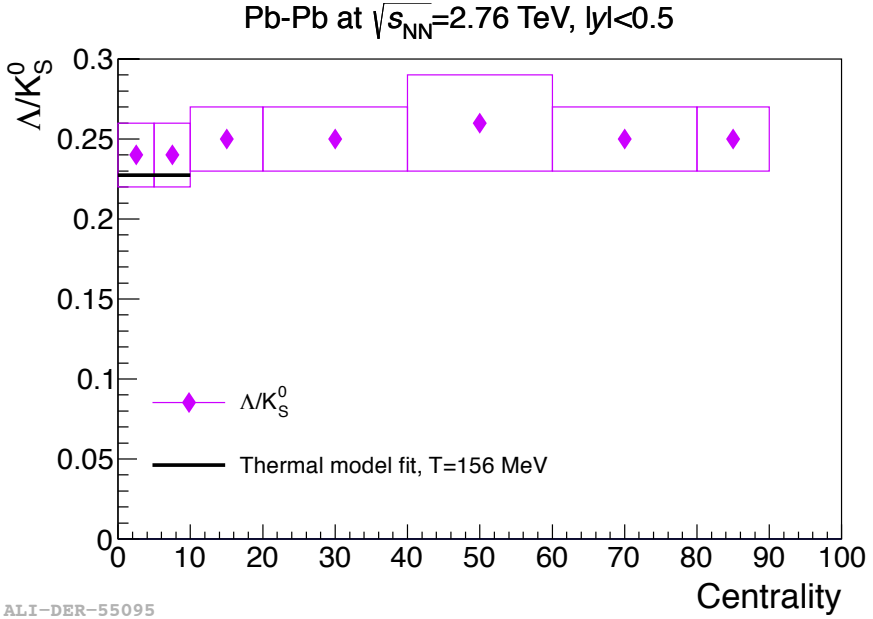
Enhancement of baryons over mesons over same p_T range for both Λ/K^0_S & p/π.

Enhancement in most central events relative to pp appears comparable for both ratios.

Results



ALI-DER-55091

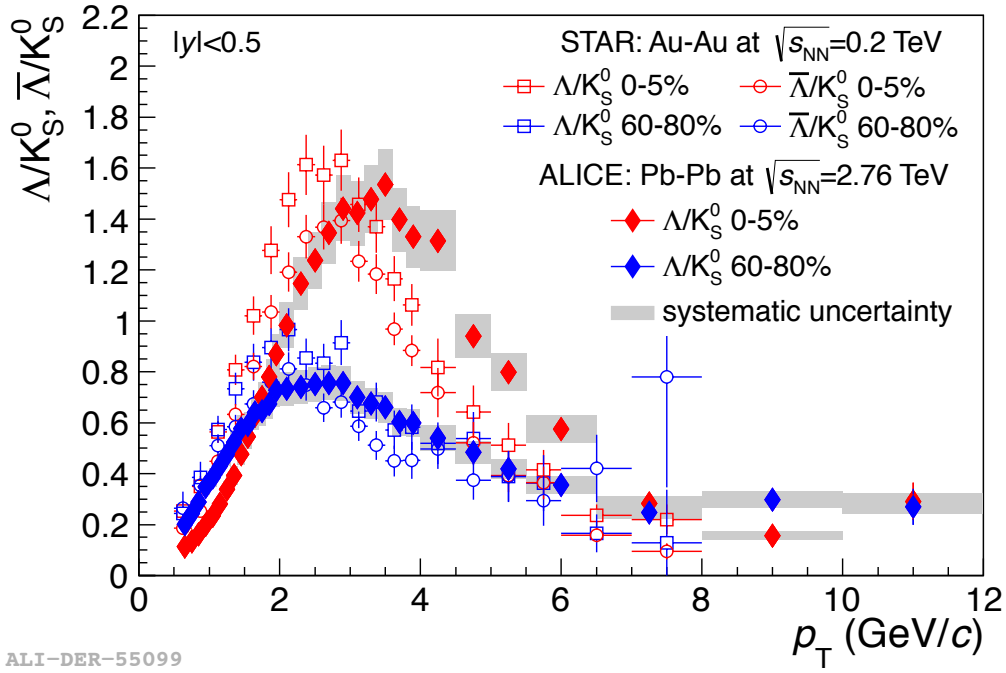


ALI-DER-55095

- Using a blastwave fit to extrapolate to low p_T, the yield of Λ & K^0_S can be integrated over p_T
- The Λ/K^0_S ratio of these integrated yields appears constant with centrality
- Suggests that baryons / mesons are redistributed in p_T rather than enhanced / suppressed

Plot created from values in: ALICE Collaboration, (2013), arXiv:nucl-ex/1307.5530

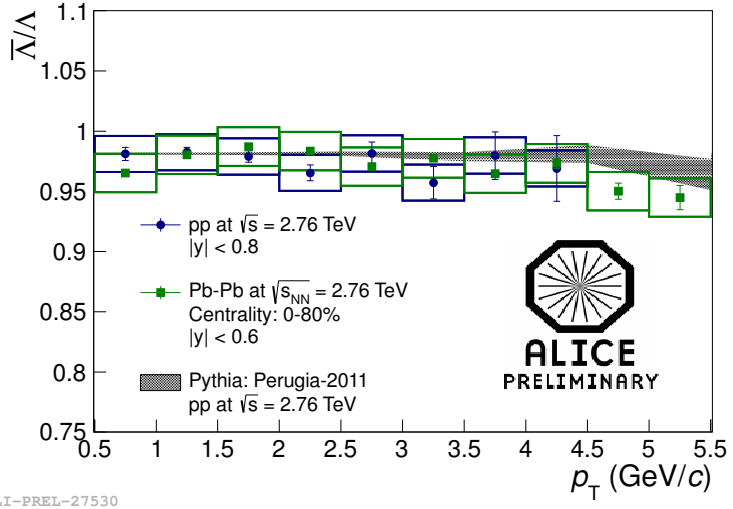
Comparison to STAR



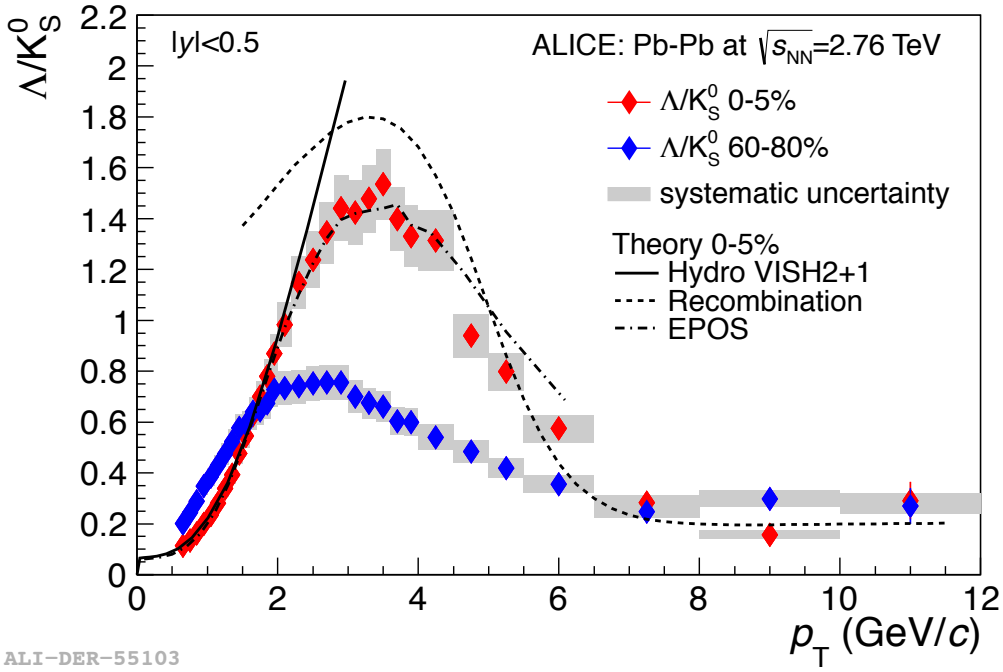
- Plot shows Λ/K^0_S for ALICE, against $\bar{\Lambda}/K^0_S$ and Λ/K^0 for STAR
- $\bar{\Lambda}/\Lambda$ approaches 1 at LHC energies
- The peak moves to higher p_T at LHC energies, and falls off less steeply.
- The height is essentially unchanged

ALICE Collaboration, (2013), arXiv:nucl-ex/1307.5530

STAR points from G. Agakishiev et al. (STAR Collaboration), Phys. Rev. Lett. 108, 072301 (2012), arXiv:nucl-ex/1107.2955



Comparison to Theory



- Plot shows good agreement with hydrodynamic predictions for p_T < 2 GeV/c
- Beyond this point, additional processes are needed
- A quantitative description is challenging

ALICE Collaboration, (2013), arXiv:nucl-ex/1307.5530

Hydro:
H. Song and U. W. Heinz, Phys. Lett. B658, 279 (2008), arXiv:nucl-th/0709.0742 .
H. Song and U. W. Heinz, Phys. Rev. C77, 064901 (2008), arXiv:nucl-th/0712.3715 .
H. Song and U. W. Heinz, Phys. Rev. C78, 024902 (2008), arXiv:nucl-th/0805.1756 .
Recombination: H. Song, S. A. Bass, and U. Heinz, Phys. Rev. C83, 054912 (2011), arXiv:nucl-th/1103.2380 .
EPOS: K. Werner, Phys. Rev. Lett. 109, 102301 (2012).

Conclusions

- Λ & K^0_S spectra and ratios measured in $\sqrt{S_{NN}}$ = 2.76 TeV Pb-Pb collisions over wide transverse-momentum range, and compared to that measured in pp collisions at $\sqrt{S}$ = 900 GeV & 7 TeV
- At high p_T, there is no discernable difference between the Λ/K^0_S ratio in pp or Pb-Pb collisions
  - ➢ suggests that their relative production is dominated by vacuum-like fragmentation
- At intermediate p_T, Λ production is strongly enhanced in Pb-Pb relative to K^0_S, while the integrated ratio remains unchanged
  - ➢ suggests that the particles are redistributed in p_T
- At LHC energies, the Λ/K^0_S enhancement peak is around the same height as for RHIC, but extends to higher p_T

Backup

Backup

Centrality	dN/dy		
	Λ	K^0_S	Λ/K^0_S
0-5%	26+3	110+10	0.24+0.02
5-10%	22+2	90+6	0.24+0.02
10-20%	17+2	68+5	0.25+0.02
20-40%	10+1	39+3	0.25+0.02
40-60%	3.8+0.4	14+1	0.26+0.03
60-80%	1.0+0.1	3.9+0.2	0.25+0.02
80-90%	0.21+0.03	0.85+0.09	0.25+0.02

- Integrated ratio is constant within errors
- Suggests that baryons / mesons are redistributed in p_T rather than enhanced / suppressed