Strange particle production in jets produced in Pb-Pb collisions

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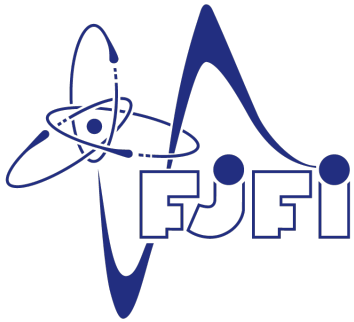
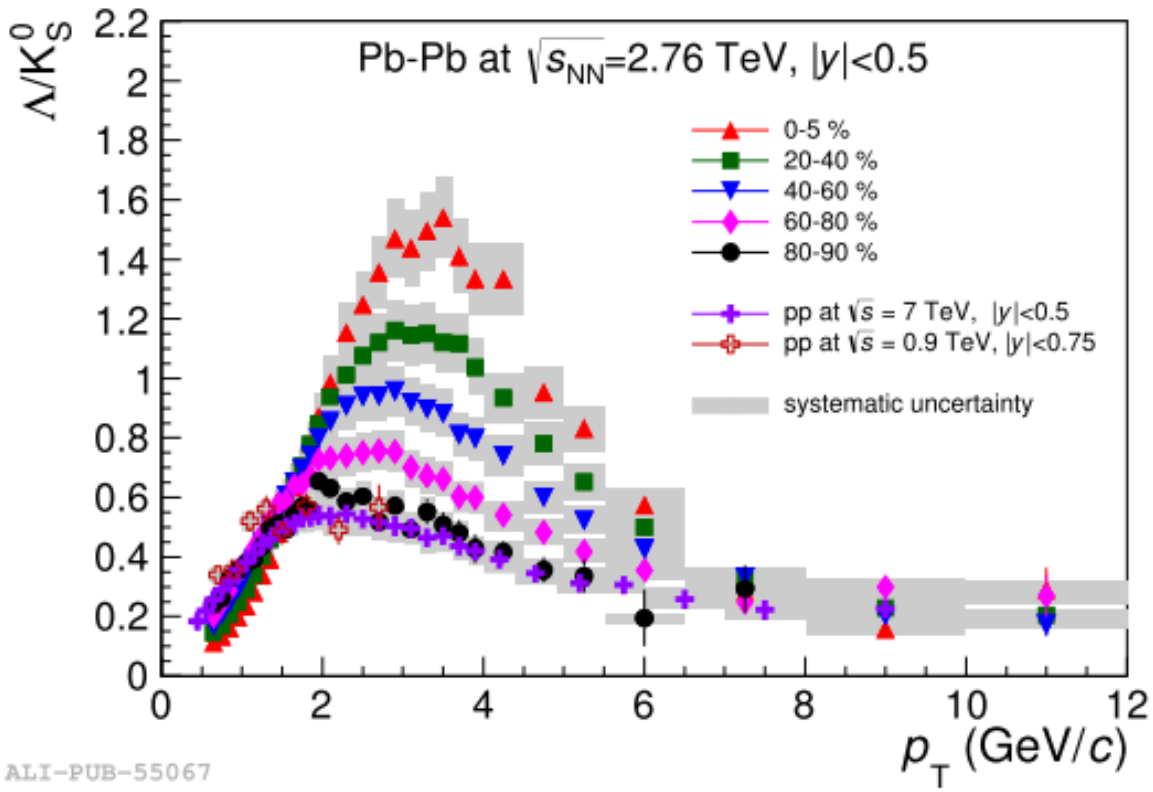
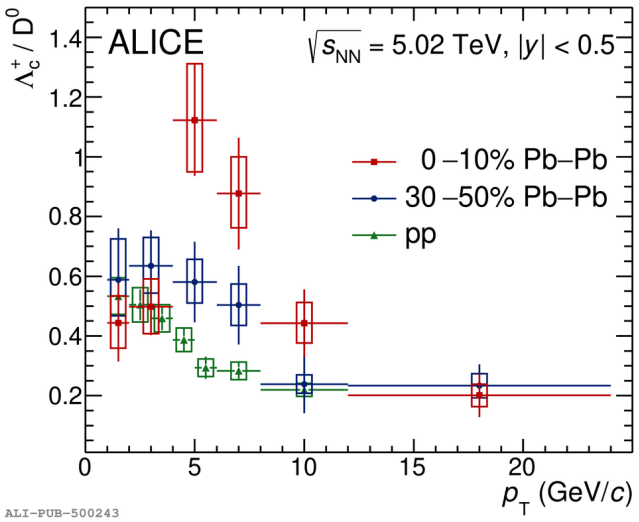


Baryon-to-meson ratio in bulk



ALICE, PRL 111 (2013) 222301

- Inclusive production of light and charm-flavor particles at intermediate p_T $(2-6$ GeV/$c)$ in heavy-ion collisions is enhanced with respect to the ratio in pp collisions

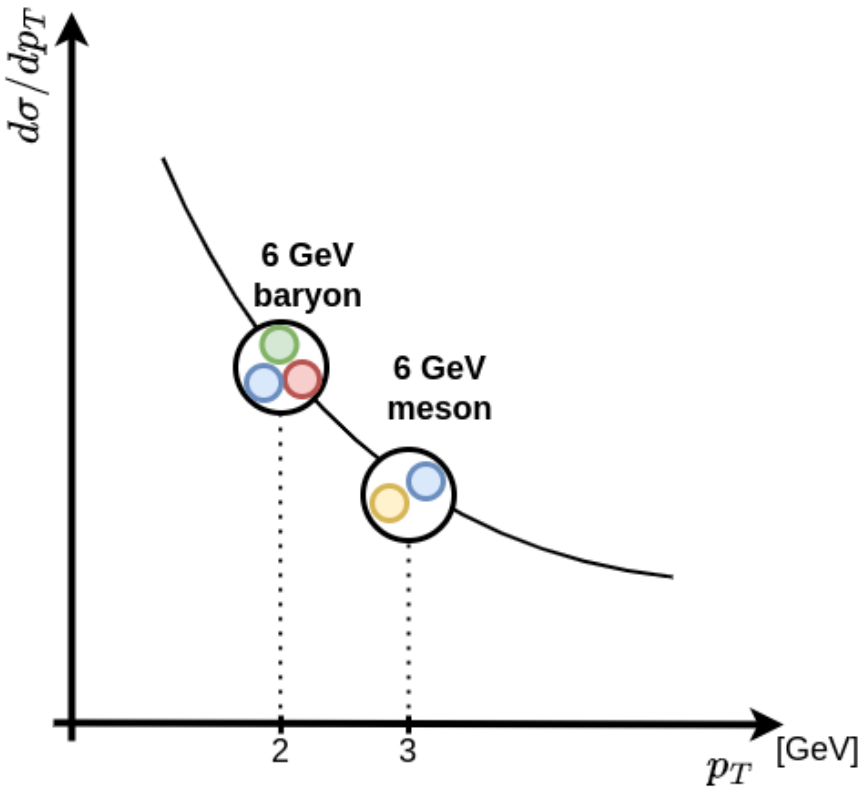


ALICE, Phys.Lett.B 839 (2023) 137796

Hadronization in medium

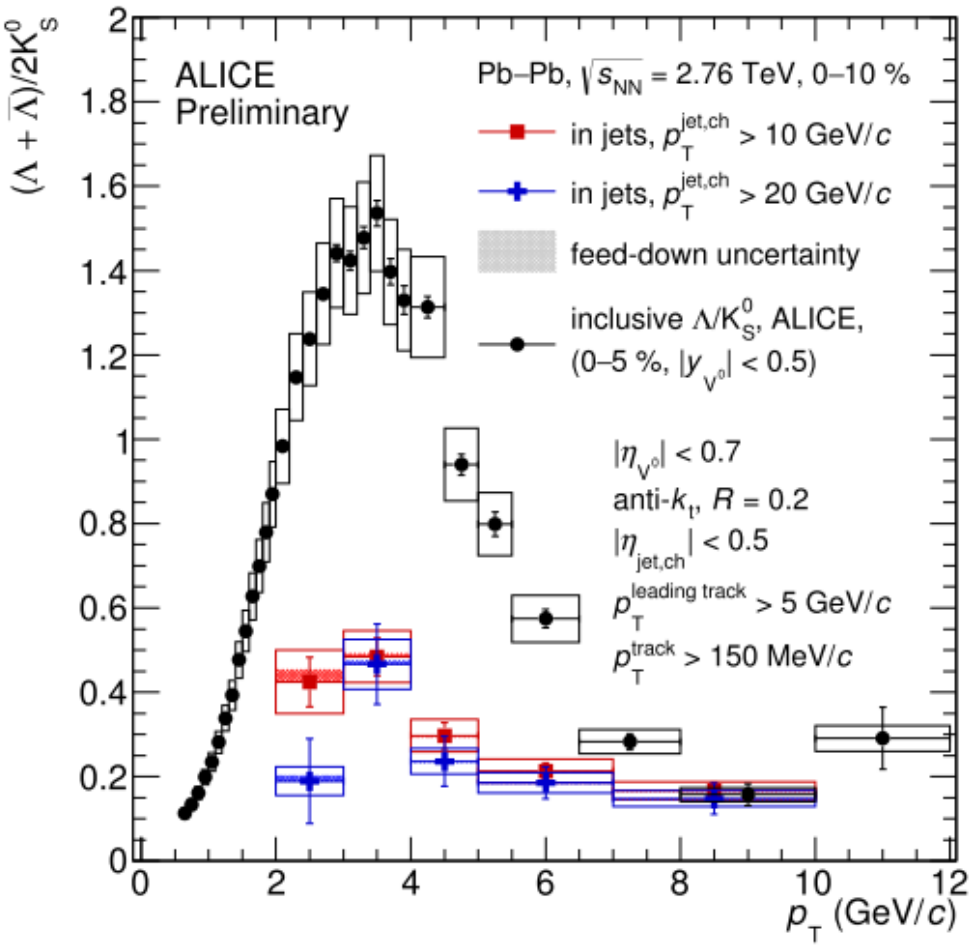
Fries, Müller, Nonaka, Bass: PRL 90 (2003) 202303
Greco, Ko, Lévai: PRL 90 (2003) 202302

- QGP can modify the hadronization: parton recombination and coalescence model
- Recombination dominates at intermediate $p_{\mathrm{T}} = 2 - 6$ GeV/c
- Fragmentation at $p_{\mathrm{T}} > 6$ GeV/c
- Jets are assumed to be produced exclusively by fragmentation of partons created in hard scattering
- Is hadronization in jets influenced by the medium?



$\Lambda/\mathrm{K}^0_\mathrm{s}$ ratios in Pb-Pb collisions

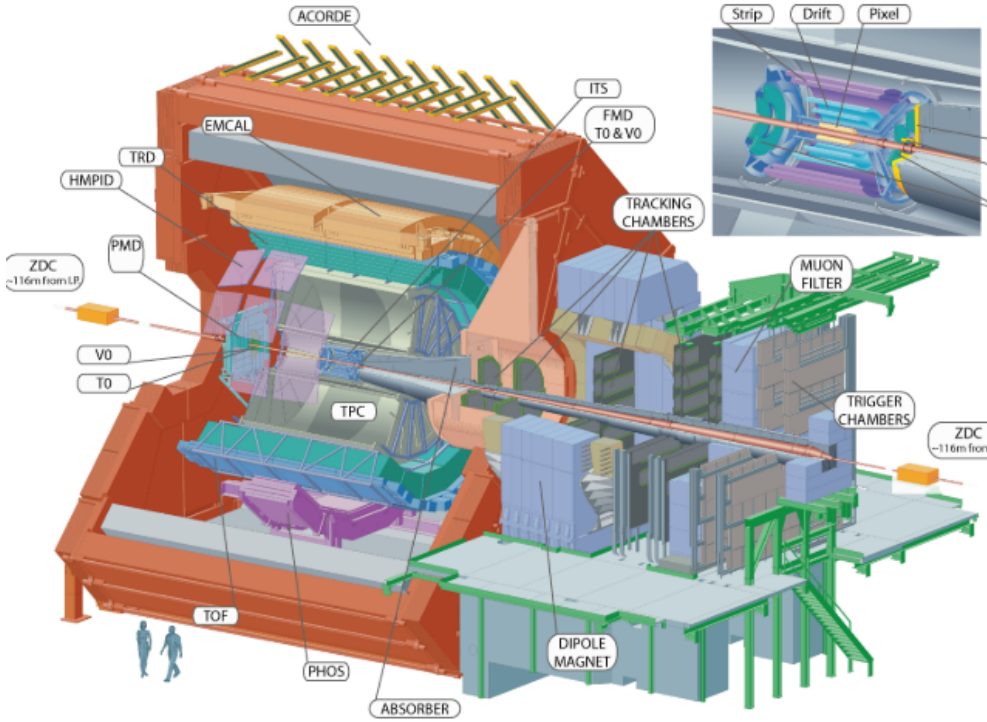
- First preliminary measurement in ALICE from Pb-Pb Run 1 data at 2.76 TeV
- Λ/K^0_s ratio in jets resembles that in pp collisions
- Run 1 data had limited statistics
  - Pb-Pb run 2 data at 5.02 TeV analysis ongoing



V.Kučera, CERN-THESIS-2016-206
A.Zimmermann, CERN-THESIS-2016-183

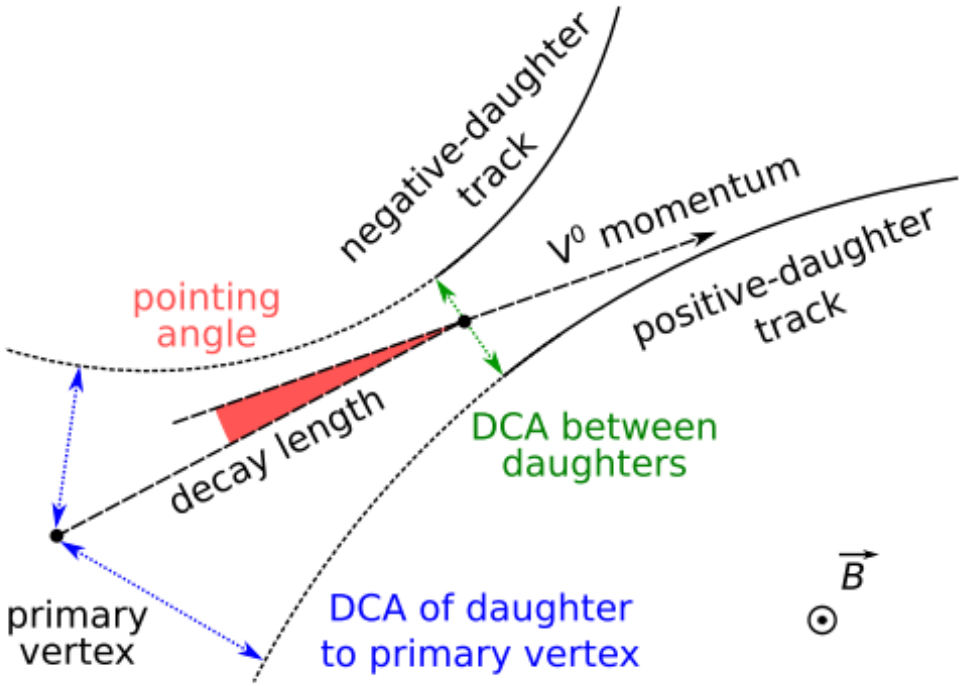
ALICE detector

- Inner Tracking System (ITS) - tracking of charged particles in the central barrel
- Time-Projection Chamber (TPC) - momentum measurement in the range $100\ \text{MeV}/c \leq p_{\text{T}} \leq 100\ \text{GeV}/c$
- ALICE has great PID capabilities



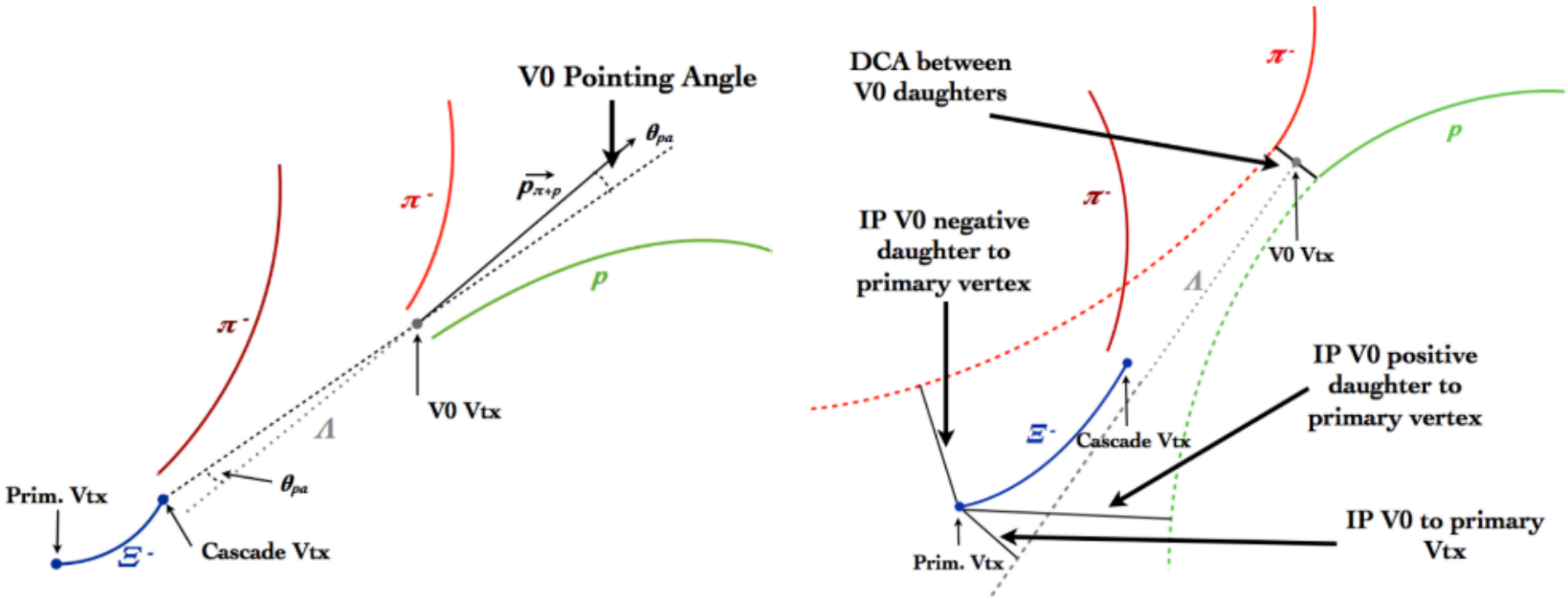
Strange particle reconstruction

- $K^0_s \to \pi^+\pi^-$ (b.r. 69.2%),
- $\Lambda \to p\pi^-$, $\overline{\Lambda} \to p^-\pi^+$ (b.r. 63.9%)
- Reconstruction from daughter tracks
- Tracks that do not originate from the primary vertex
  $\to$ positive and negative tracks pairing and extrapolation to the primary vertex $\to$ DCA cut
  $\to$ parent momentum calculation



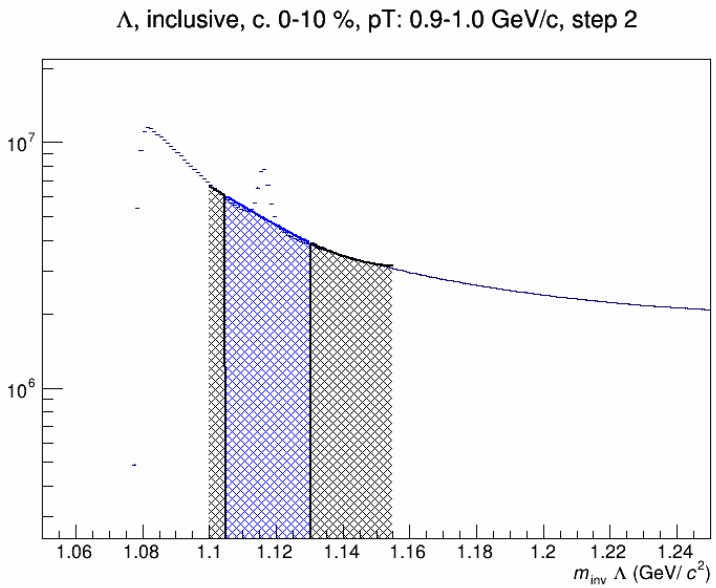
Strange particle reconstruction

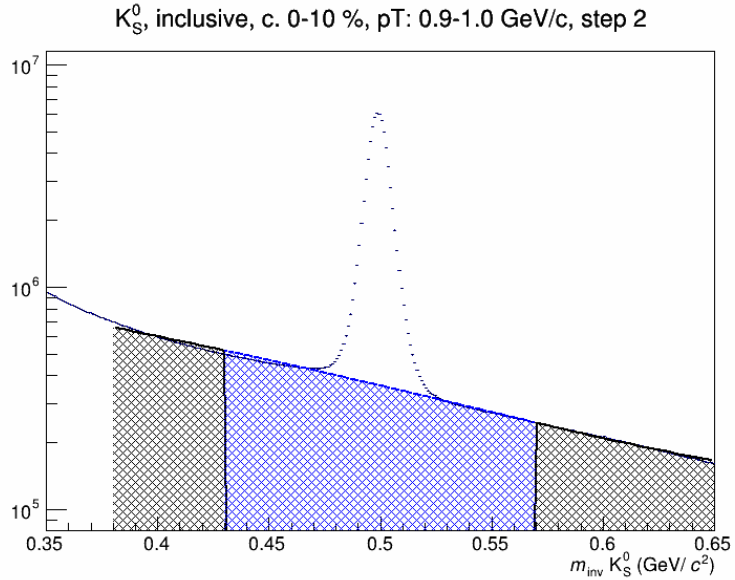
- $\Xi^- \to \pi^- \Lambda$, $\Xi^+ \to \pi^+ \bar{\Lambda}$ (b.r. 99.9%),
- $\Omega^- \to \mathrm{K}^- \Lambda$, $\Omega^+ \to \mathrm{K}^+ \bar{\Lambda}$ (b.r. 67.8%).
- Reconstruction from V^0 decay daughter tracks + bachelor track

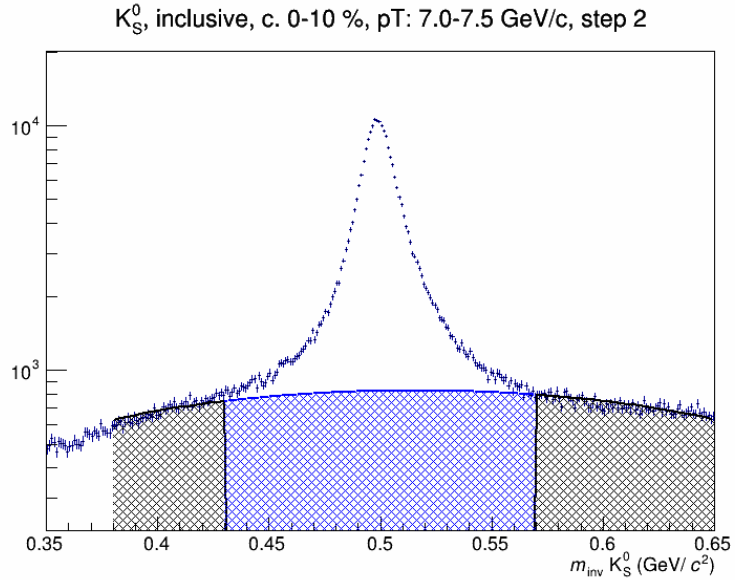


Signal extraction

- Background estimation and signal extraction from invariant mass distribution for each p_T bin
- Side bands polynomial fit





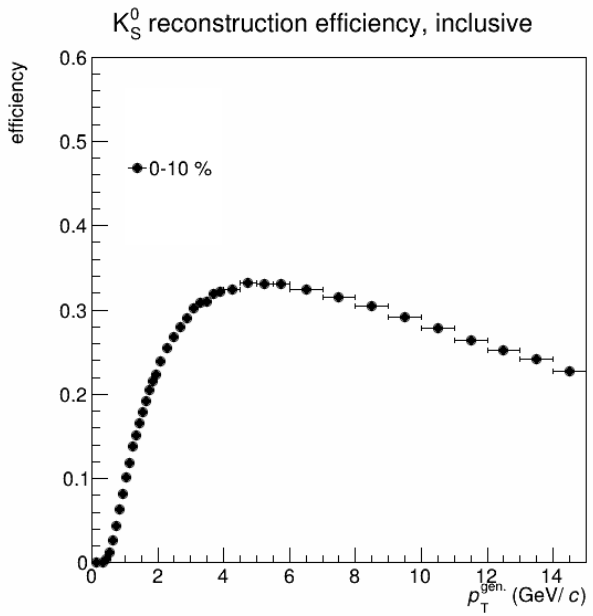


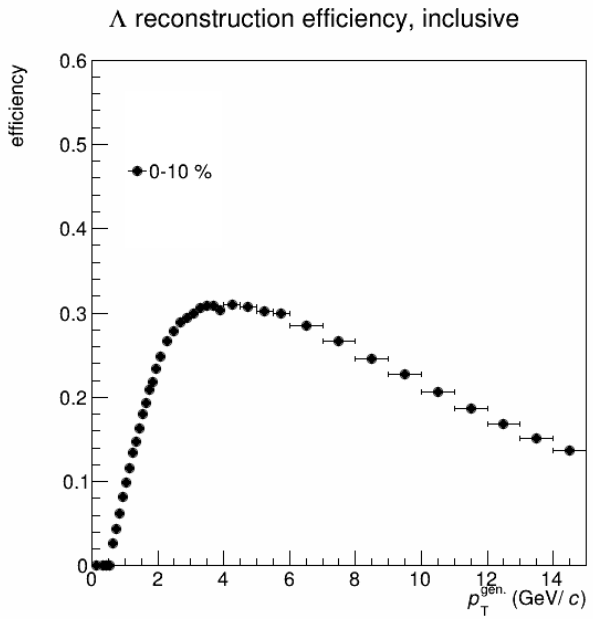
Jet analysis

- Jet algorithm - takes particle-like objects and groups them into jets
- anti-k_t algorithm for signal jet
- k_t for the background estimation
- Tracks of primary charged particles with $p_T \geq 150$ MeV/c and $|\eta_{\mathrm{track}}| < 0.9$
- Resolution parameter $R = 0.2$
- Association of strange particles with jets:
  - $d < D$
  - d - angular distance between V_s^0 momentum vector and the jet axis; D - matching distance

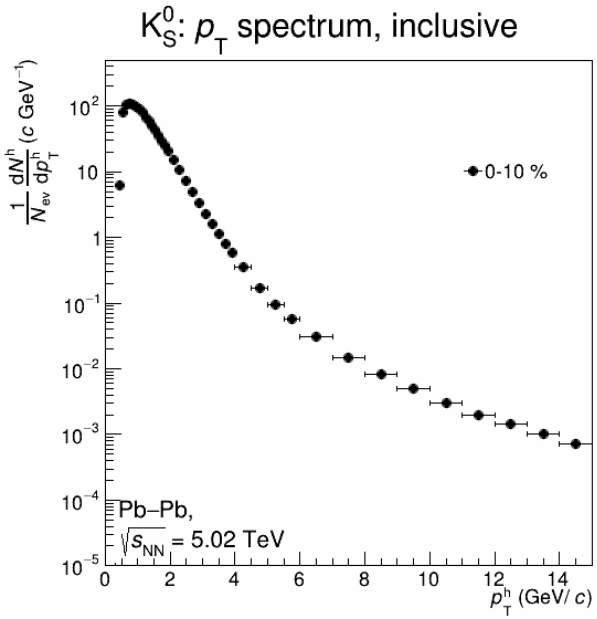
Corrections

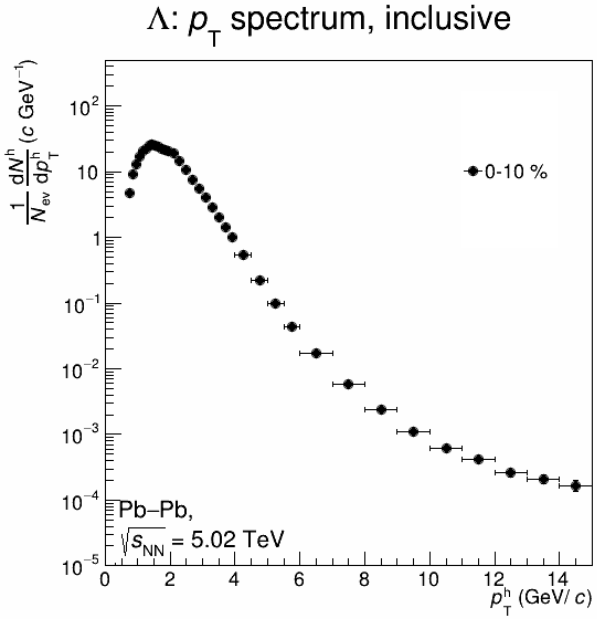
- Reconstruction efficiency correction:
  - MC reconstructed with the same procedure as data
  - $\epsilon = \frac{\text{Reconstructed particles}}{\text{Generated particles}}$
- Underlying event subtraction:
  - V_s^0 in regions with negligible jet production
    $\rightarrow$ V_s^0 are produced by background
  - Different methods:
    - ★ No-Jet events
    - ★ Outside Cones
    - ★ Perpendicular Cones
    - ★ Random Cones
- Feed-down correction
- $N^{\text{jet}} = \left(\frac{N^{\text{JC}}}{\mathcal{N}^{\text{JC}}\epsilon^{\text{JC}}} - \frac{N^{\text{UE}}}{\mathcal{N}^{\text{UE}}\epsilon^{\text{UE}}}\right)(1 - f^{\text{FD,jet}})$

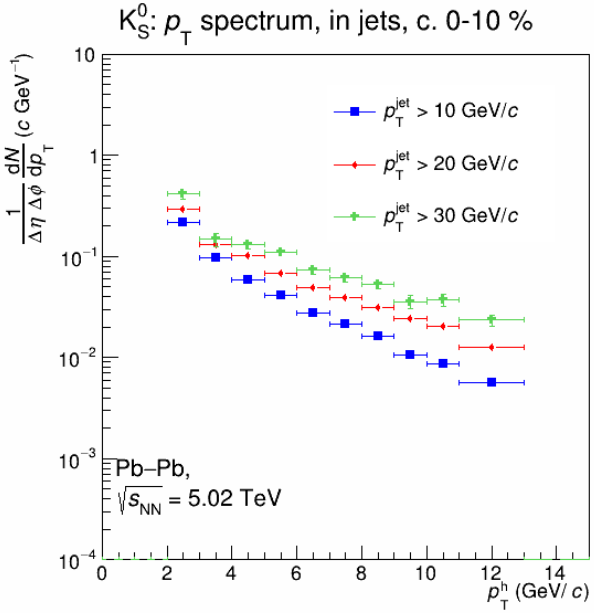


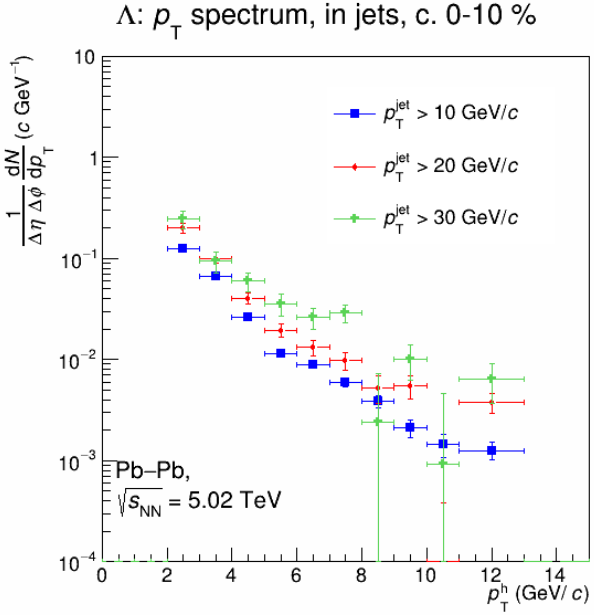


Corrected p_T inclusive and in jets spectra



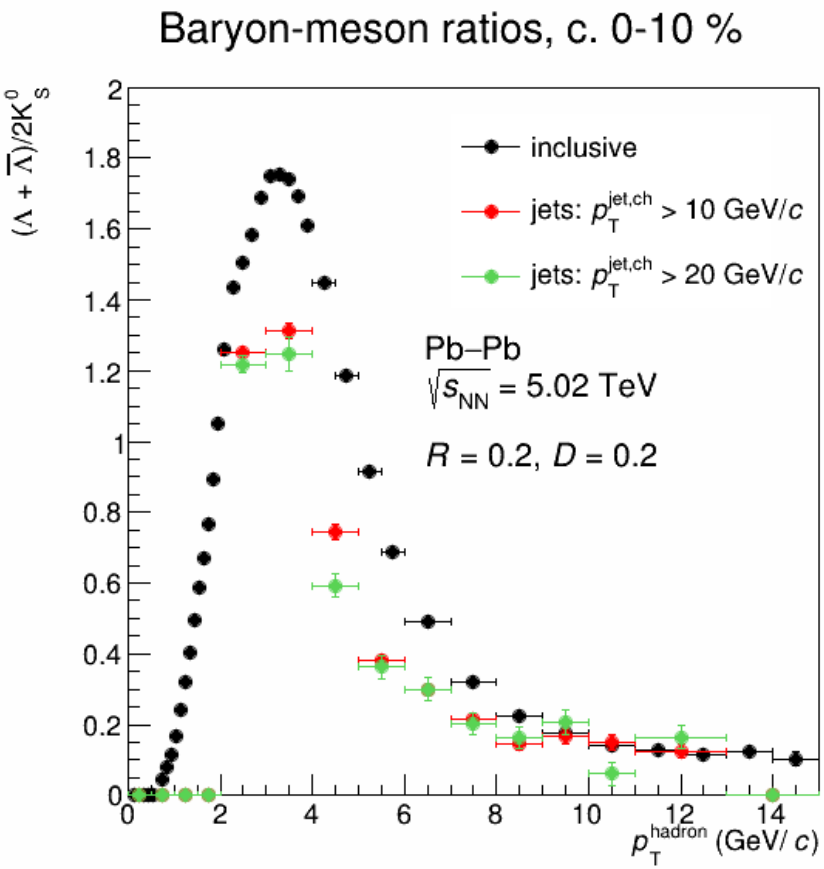




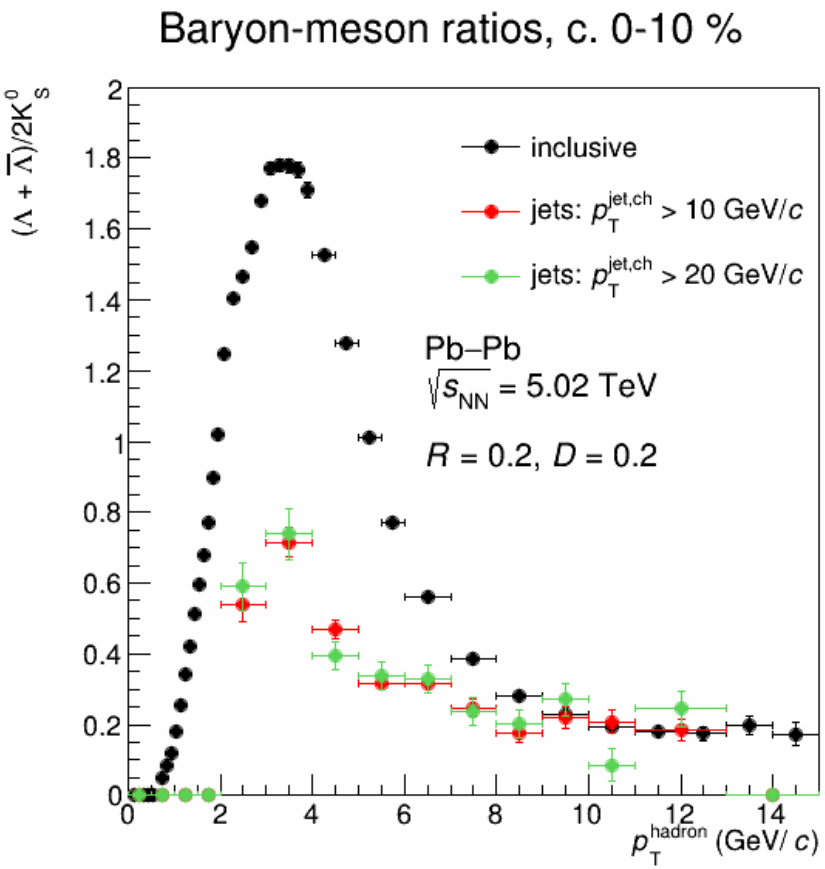


Baryon-to-meson ratio

- $\Lambda/\mathrm{K}^0_\mathrm{S}$ ratio in jets is much lower than inclusive one and resembles that in pp collisions.

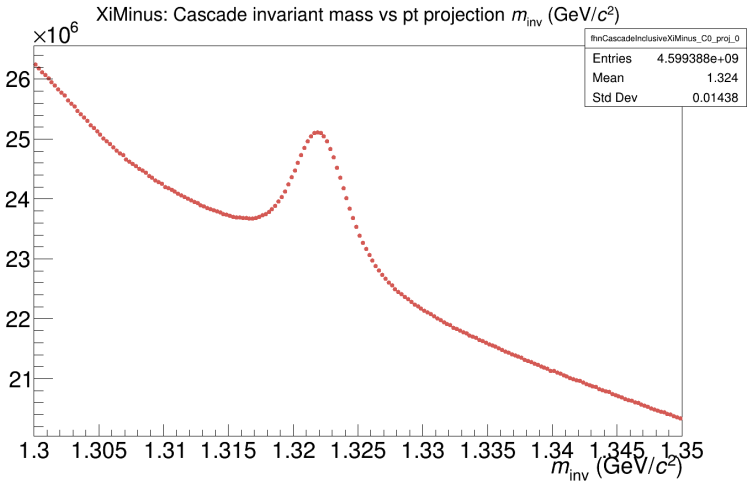


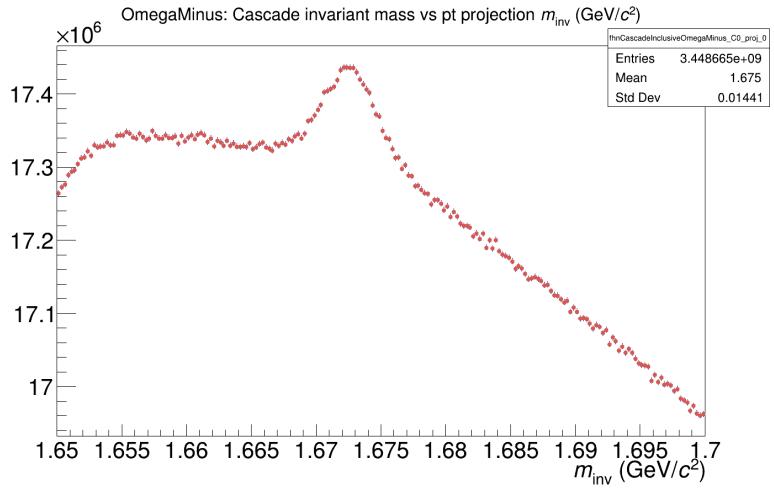
Raw

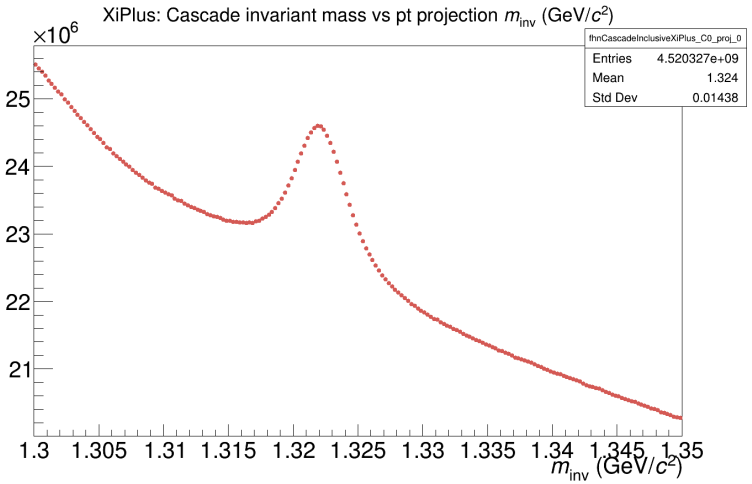


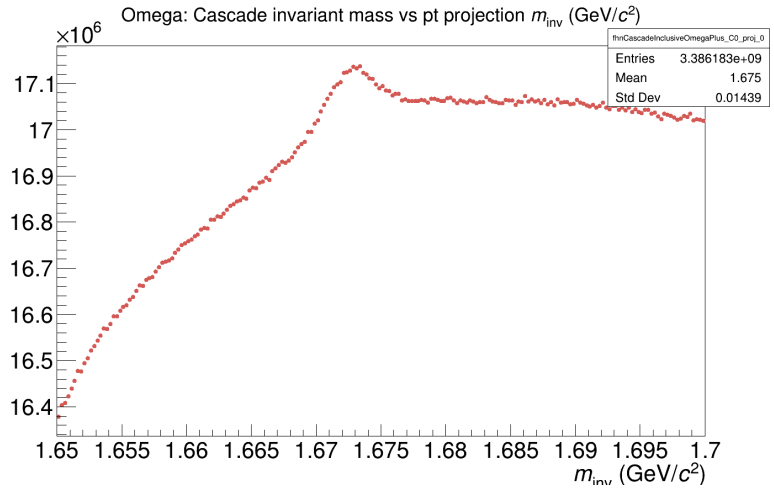
Partially corrected

$\Xi^{\pm}$ and $\Omega^{\pm}$ feasibility study: invariant mass distributions



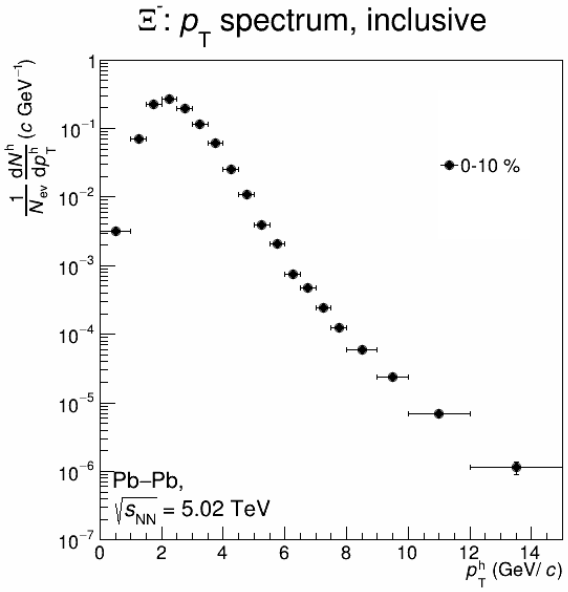


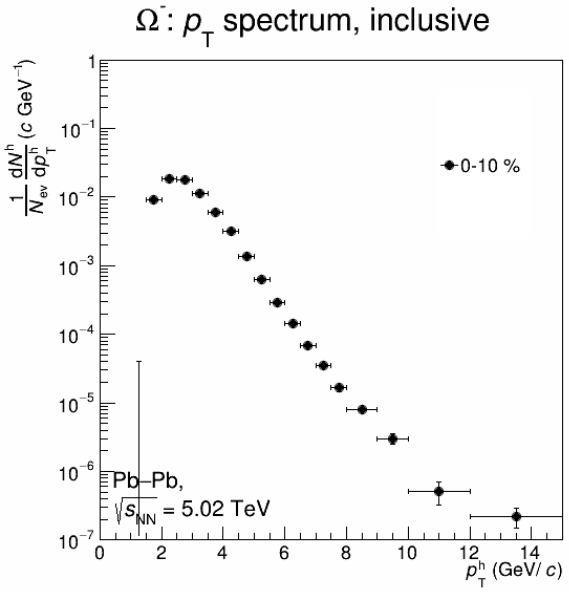


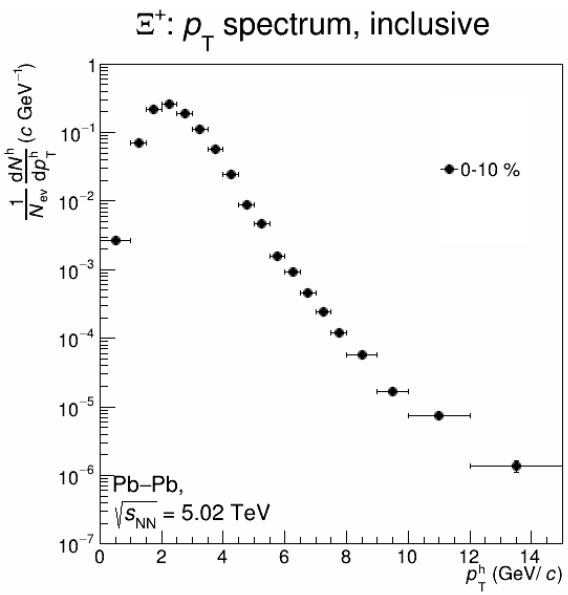


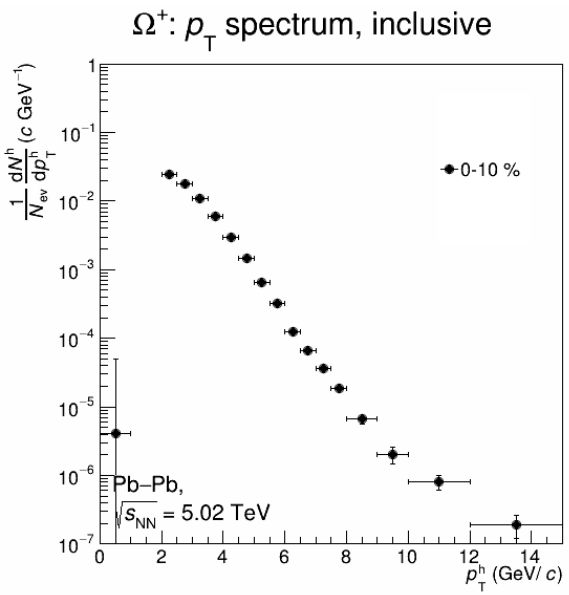
Examples of invariant mass distributions of multistrange baryons with $p_{\mathrm{T}} = 0 - 15$ GeV/c.

$\Xi^{\pm}$ and $\Omega^{\pm}$ feasibility study: inclusive p_{T} spectra

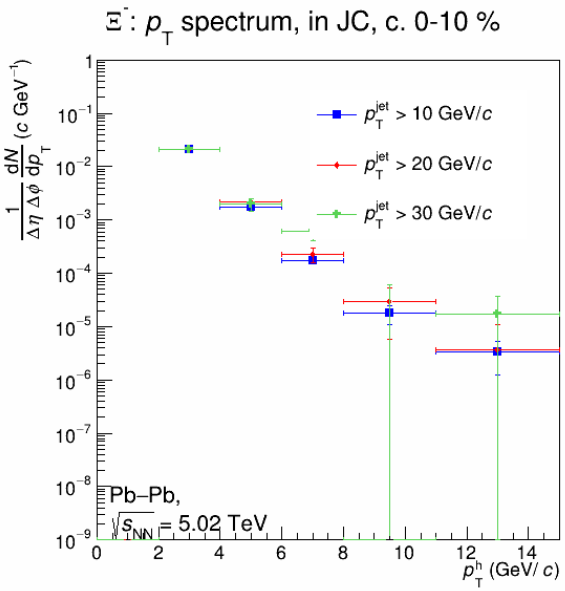


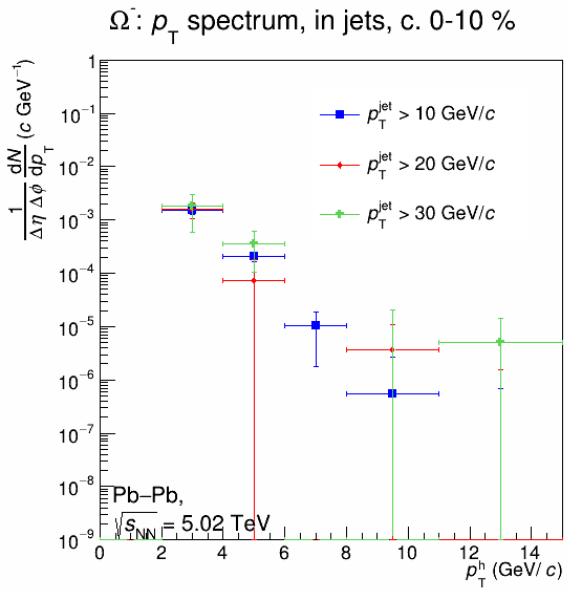


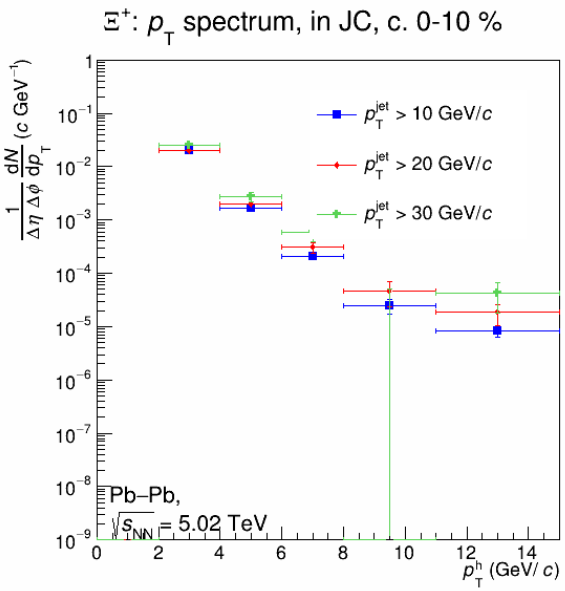


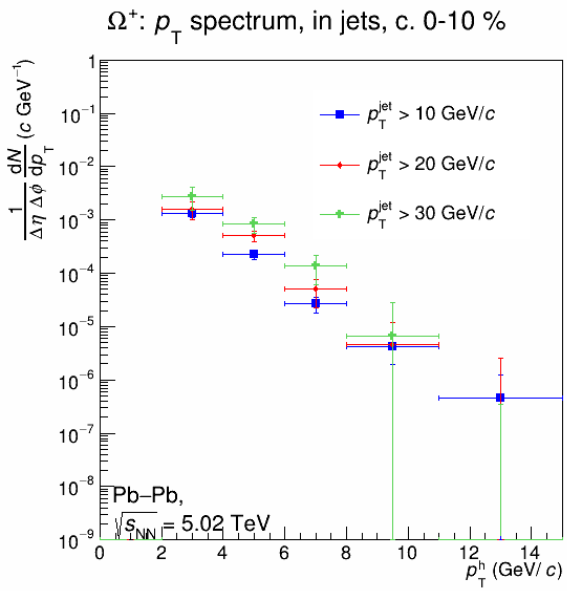


$\Xi^{\pm}$ and $\Omega^{\pm}$ feasibility study: p_{T} spectra in jets



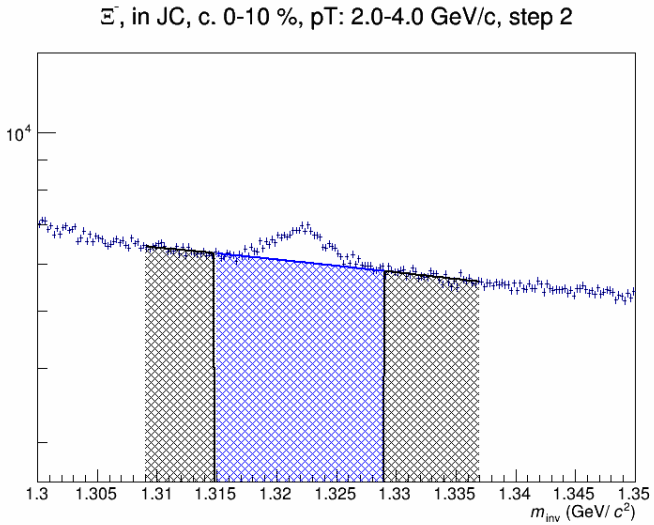


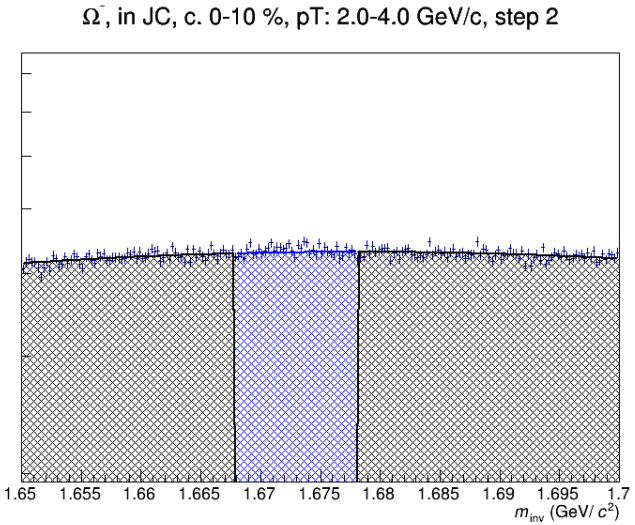


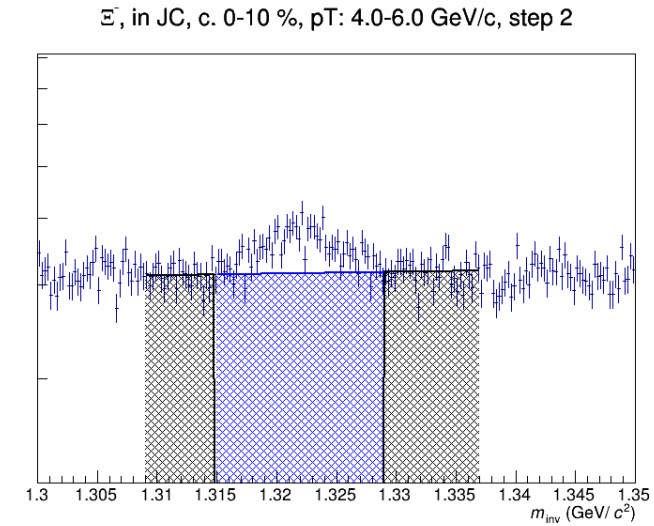


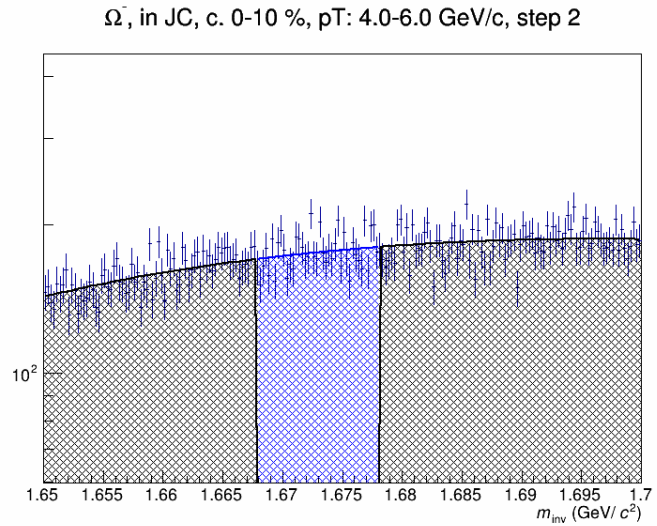
$\Xi^{\pm}$ and $\Omega^{\pm}$ in jets - closer look

- $\Xi^{\pm}$ in jets - probably feasible, $\Omega^{\pm}$ seems combinatorial









Conclusion and outlook

Conclusion:

- $\Lambda/\mathrm{K}^0_\mathrm{S}$ ratio in jets is smaller than inclusive, better statistical precision with Run 2 data
- Study of $\Xi^{\pm}$ in jets feasible with Run 2 data, but $\Omega^{\pm}$ in jets at the moment statistics limited

Outlook:

- Addition of the strange particle directly into the jet reconstruction
- Evaluation of feed-down contribution for Λ baryons from Ξ
- Evaluation of systematic uncertainties