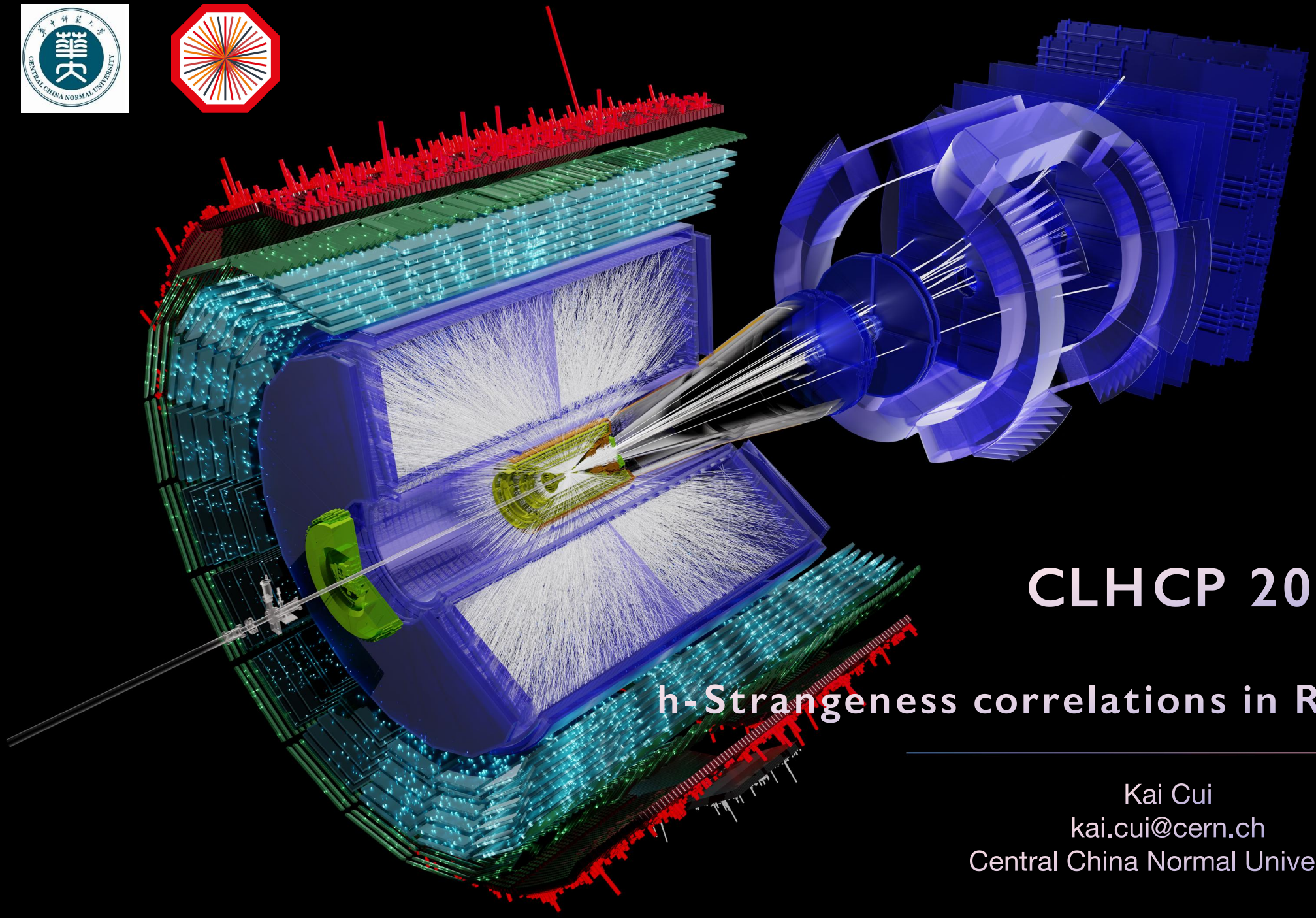

CLHCP 2023

h-Strangeness correlations in Run 3 with Alice

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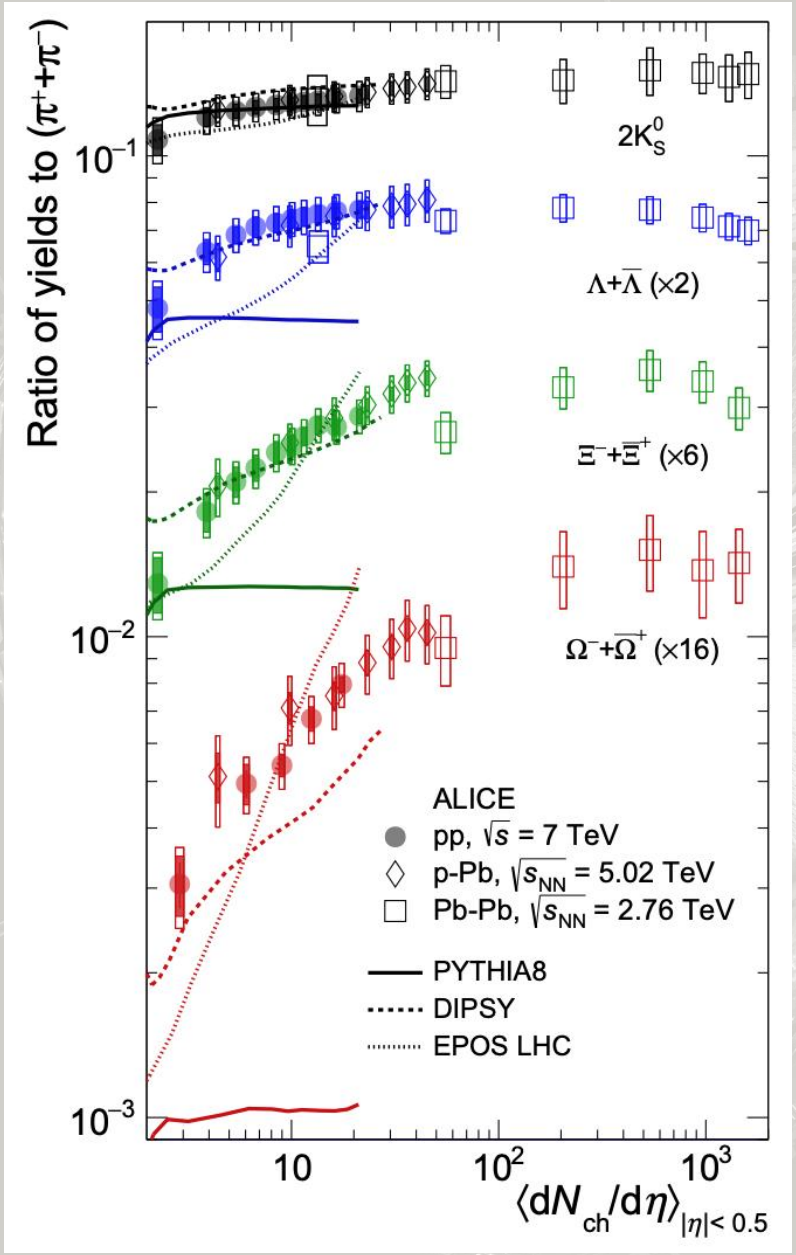
Outlines

- Introduction and motivation
- Data sets and event selections
- Analysis algorithm
- Preliminary results
- Summary

Introduction and motivation



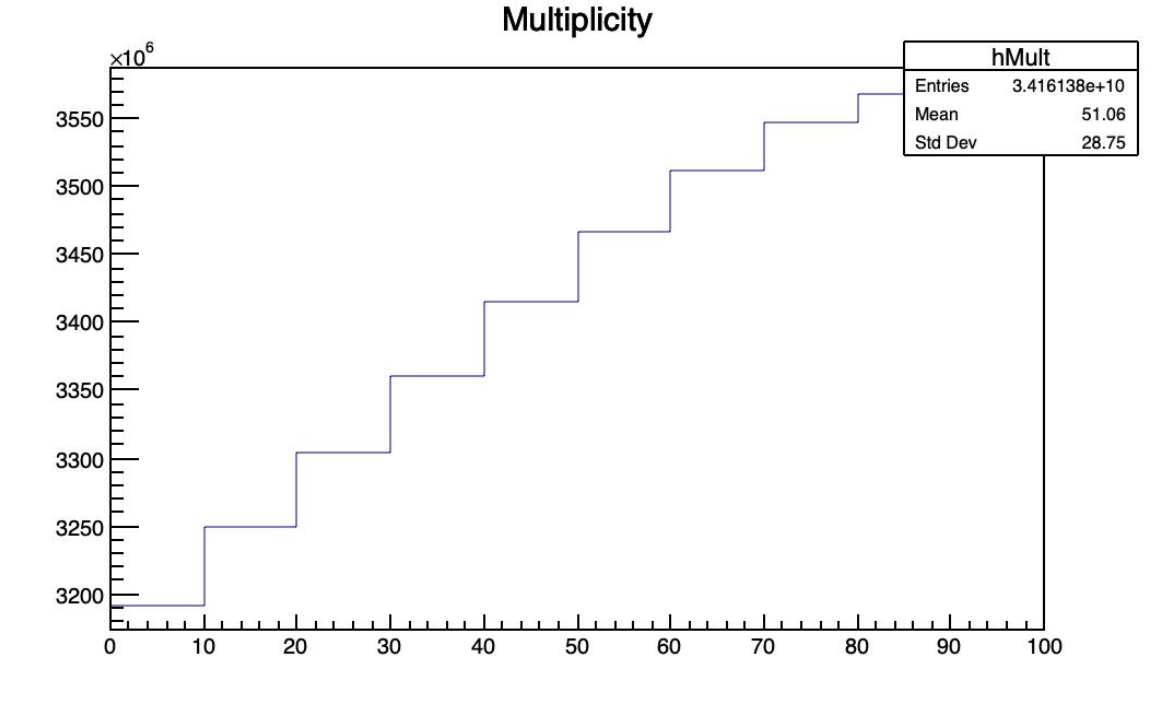
- **Strangeness enhancement**: well-known in small systems by now
- Characterization: if the origin is common in all systems?

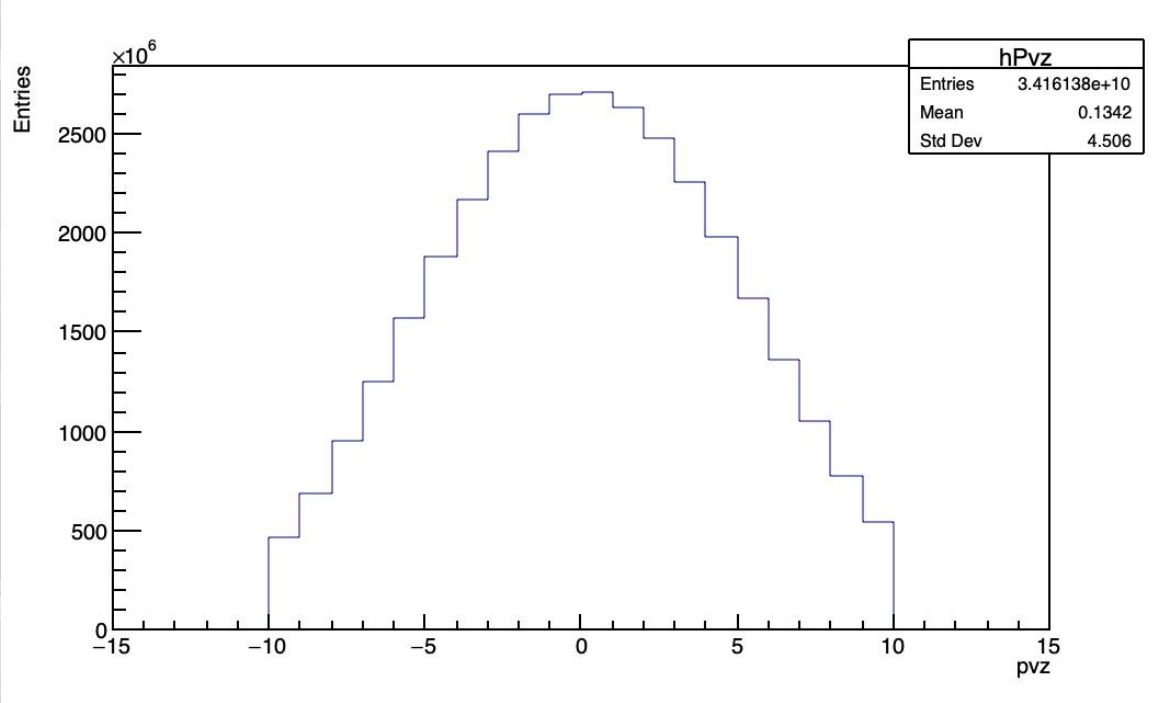
- Is strangeness enhancement correlated with high-momentum or low-momentum physics?

- The relationship between enhancement effect and strangeness

- Previous studies have done in Run 2 (Lund group)
- Now: take advantage of Run 3 data samples!
  - Enormous statistics may allow for very precise study

Event selection plots





- Data: pp 13.6 TeV
- Event trigger: sel8
- PV position: |z| < 10 cm

- Results from : LHC22o_apass4
- Equivalent statistics: 3.550 billion events
- Expect a factor of 100x (at least) in the full 2022 data

Analysis algorithm: two-particle correlations

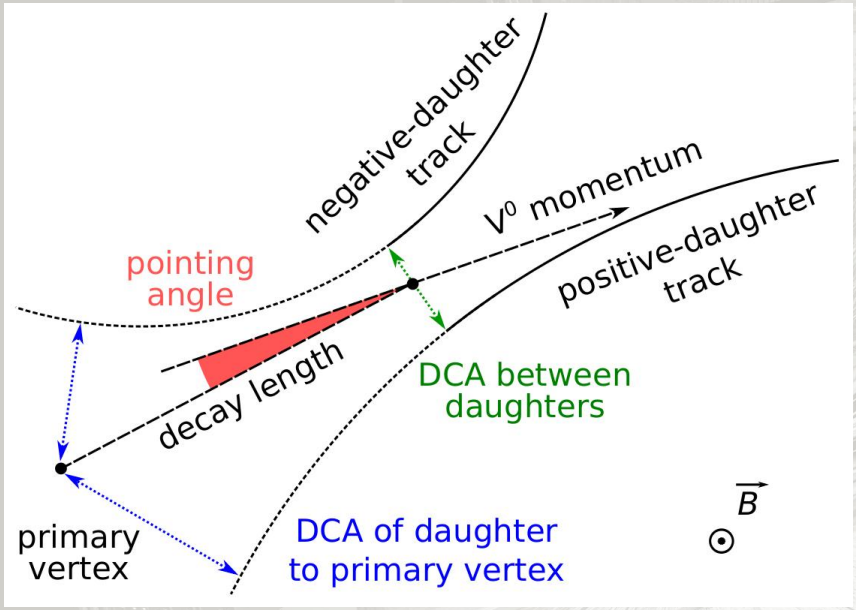
- Tool of choice: two-particle correlations
  - Trigger particle: high-momentum (settable) charged hadron
  - Associated particles: low-momentum (settable) strange particles such as K^0_S, Λ, Ξ^- to Ω^-
- Phase space selections:
  - trigger particles are from $0.0 < p_T < 20.0$ GeV/c
  - associated particles are from $0.0 < p_T < 15.0$ GeV/c
- Event mixing correction done following the usual prescription:

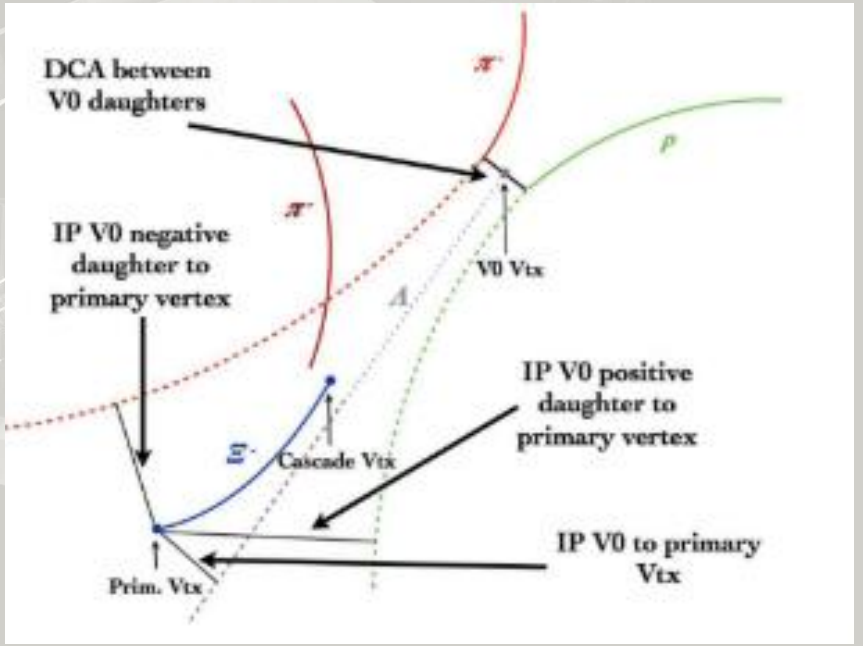
$$C(\Delta\eta, \Delta\varphi) = \alpha \frac{C_{SE}(\Delta\eta, \Delta\varphi)}{C_{ME}(\Delta\eta, \Delta\varphi)}$$

- C: corrected correlation function
- C_{SE}: same-event correlation function
- C_{ME}: mixed-event correlation function
- α: factor such that $C_{ME}(0,0) = 1$

Correlations done in vertex-Z ,p_T trigger and multiplicity bins for proper corrections
+ look at mult dependence

Trigger and strange candidate selection

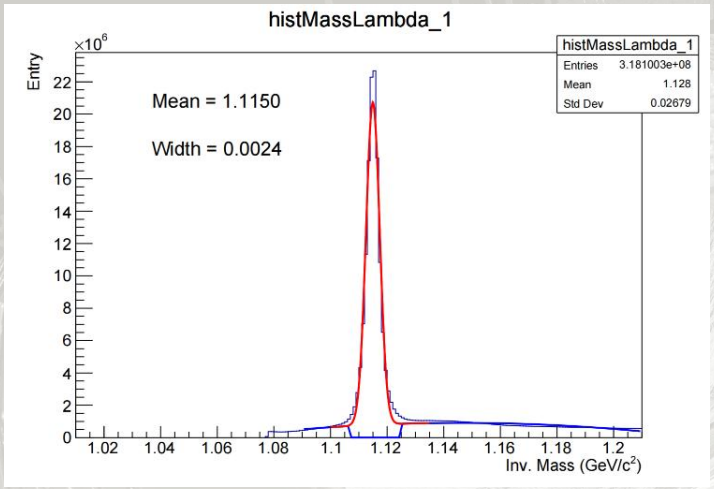




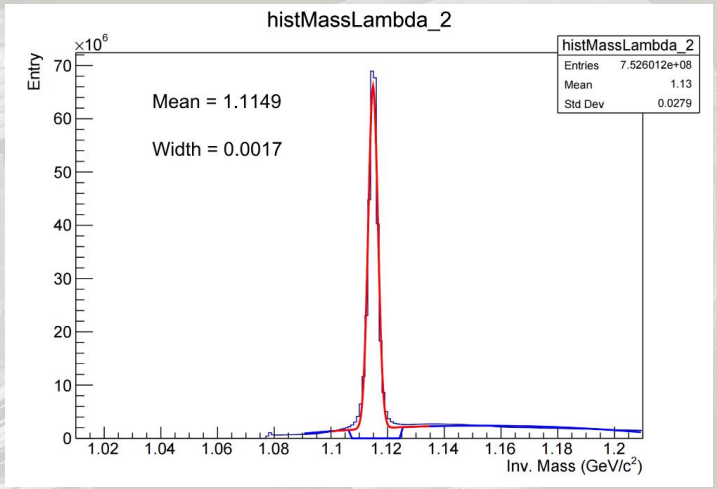
V0 selection	Value
V0 cosine of pointing angle	> 0.97
V0 decay radius (2D)	1.5 cm
V0 DCA between daughters	1.0 cm
Positive/negative DCA to primary vertex (XY)	0.1 cm
Daughter track min number of crossed rows	70

Cascade selection	Value
Cascade cosine of pointing angle	> 0.97
Cascade decay radius (2D)	0. 9 cm
Cascade DCA between daughters	1.0 cm
Bachelor DCA to primary vertex (XY)	0.05 cm
Lambda mass window	10 MeV/c^2
Daughter track min number of crossed rows	70

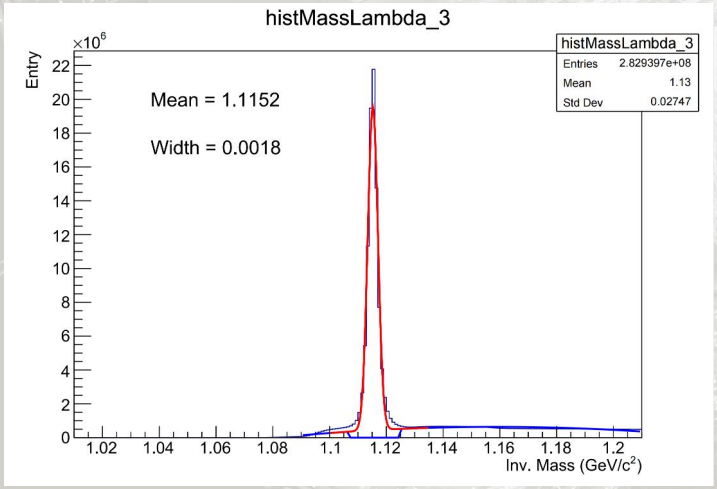
Invariant mass distribution and example fits of Λ



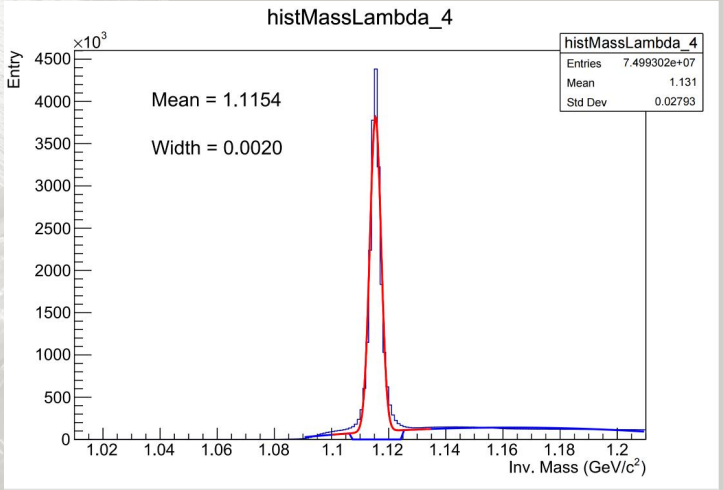
p_T : 0 – 1 GeV/c



p_T : 1 – 2 GeV/c



pT : 2 – 3 GeV/c



p_T : 3 – 4 GeV/c

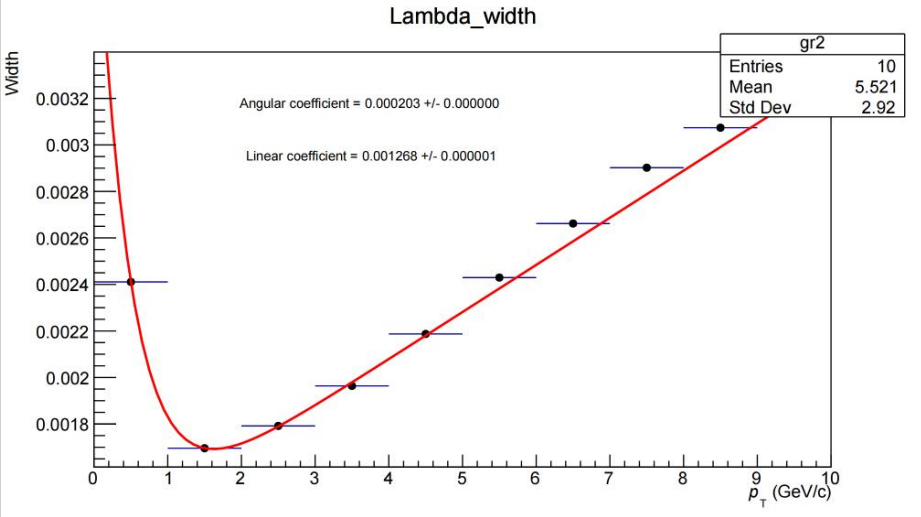
Background Fit:

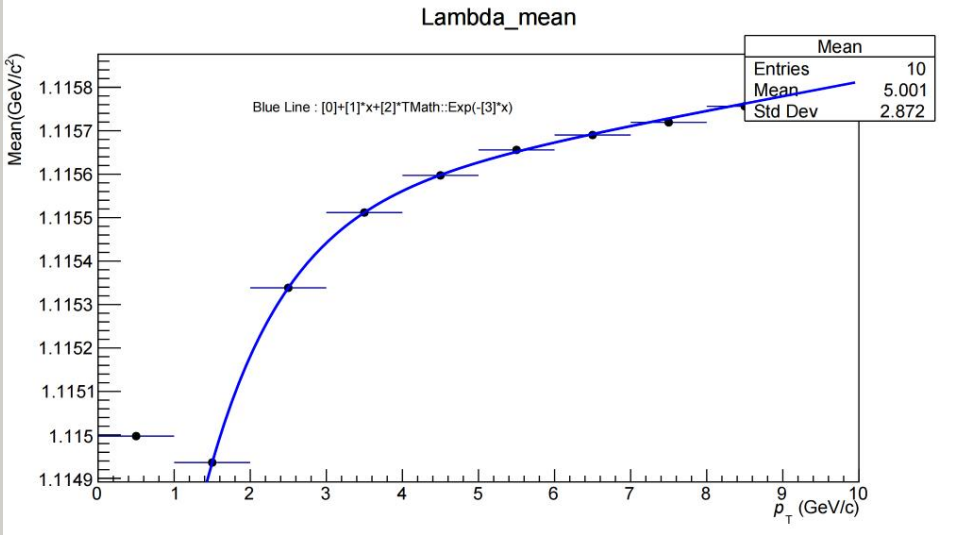
$$A + B * x + C * x\hat{}2$$

Signal Fit:

$$A + B * x + C * x\hat{}2 + gaussian$$

Parametrization for the mean and width of V0 mass





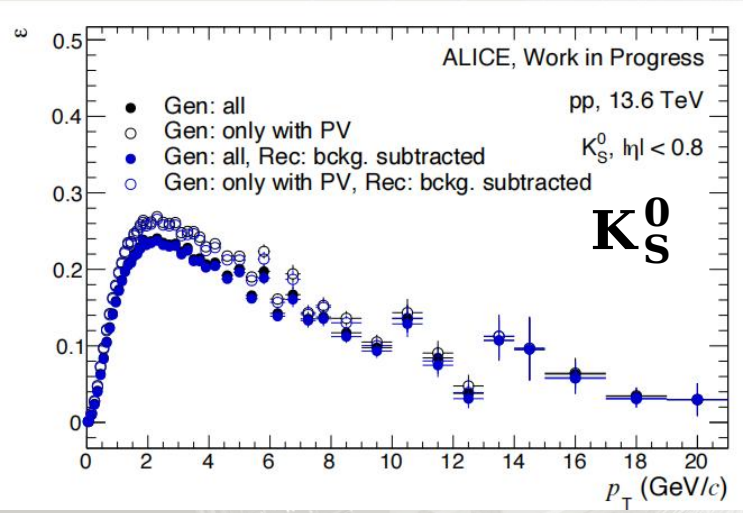
- Necessary as input to the correlation function studies
- Parametrization is configurable: ready to re-parametrize in apass4!

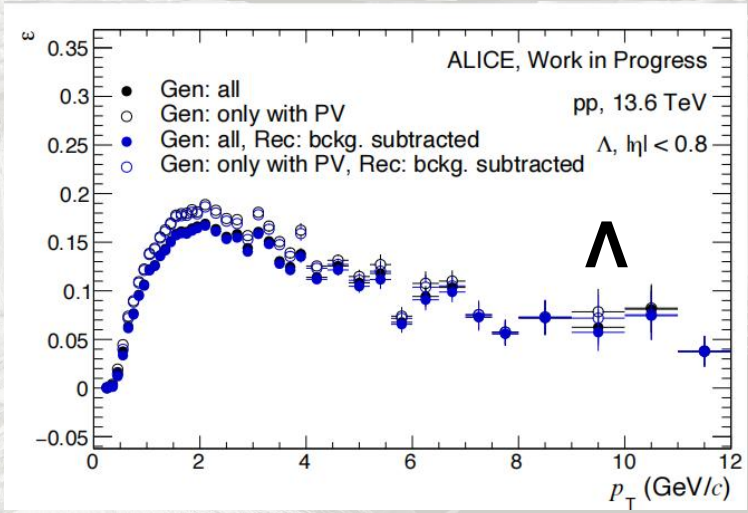
- Current smooth version of parametrization:

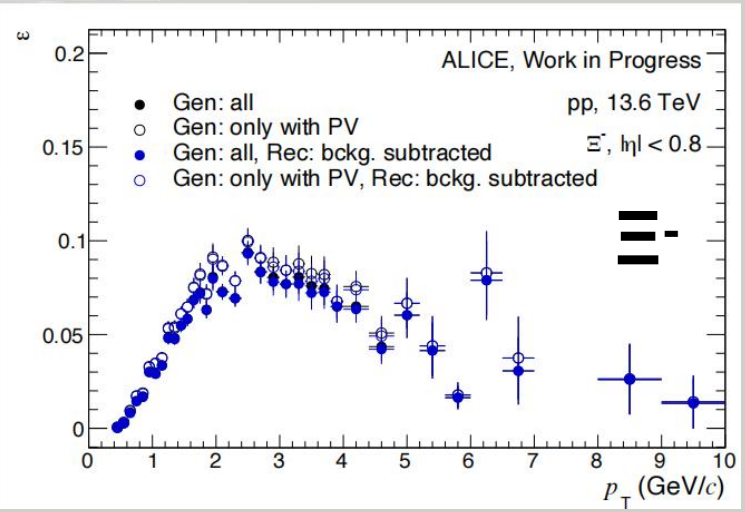
  F(x) = $A + B * x + C * e^{Cx}$

  Will probably be further optimised in the future

Strangeness reconstruction efficiencies

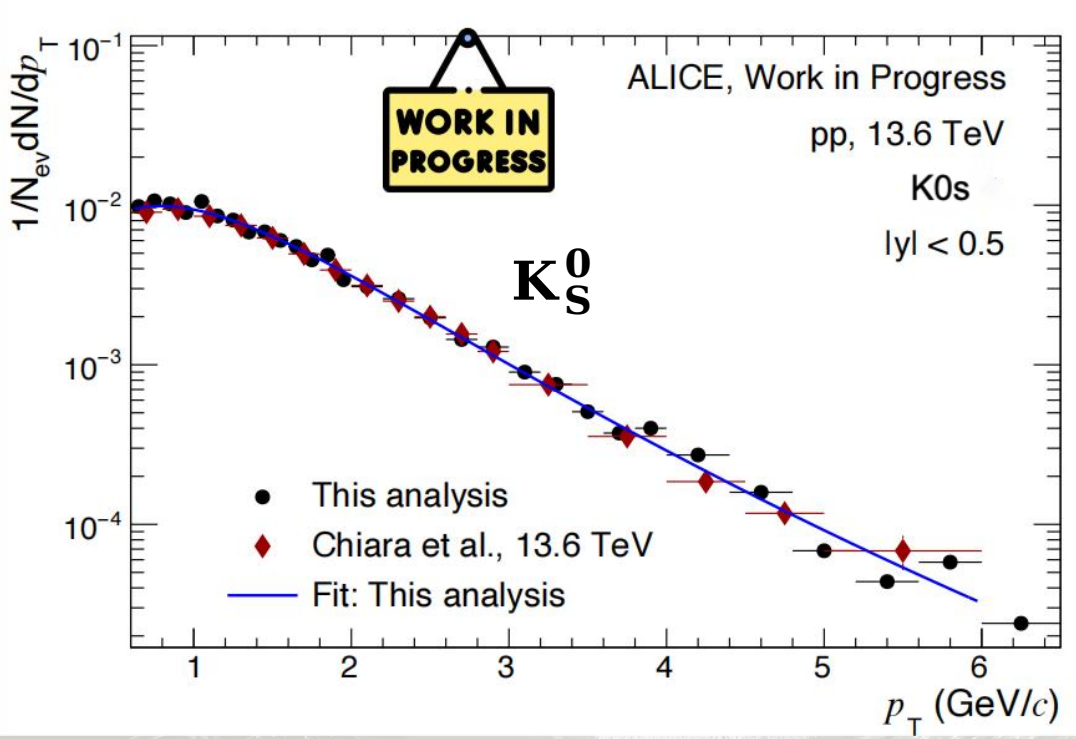


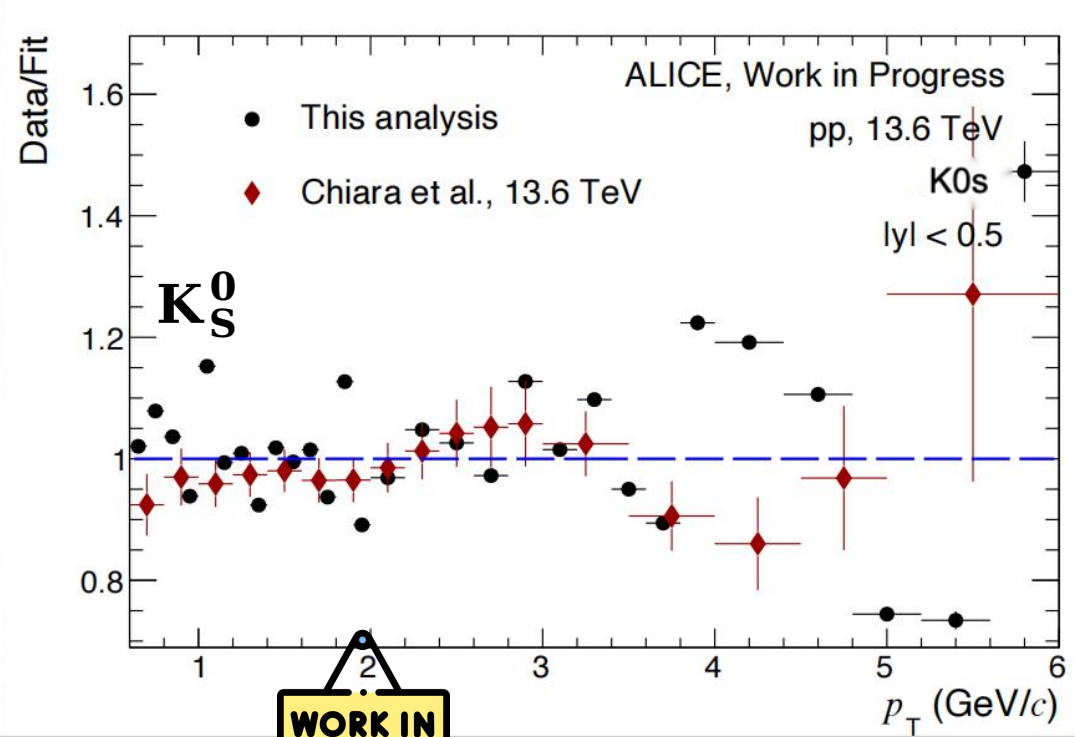




- Efficiencies at maximum: 25% for K^0_S, 15-20% for Λ, 8-10% for Ξ^-
- Essentially compatible with previous Run 3 observations in other analysis
- Note: this is calculated integrated of pseudorapidity
  - Correction procedure for the 2-particle correlation analysis: requires efficiency in pseudorapidity intervals → Much more challenging to calculate

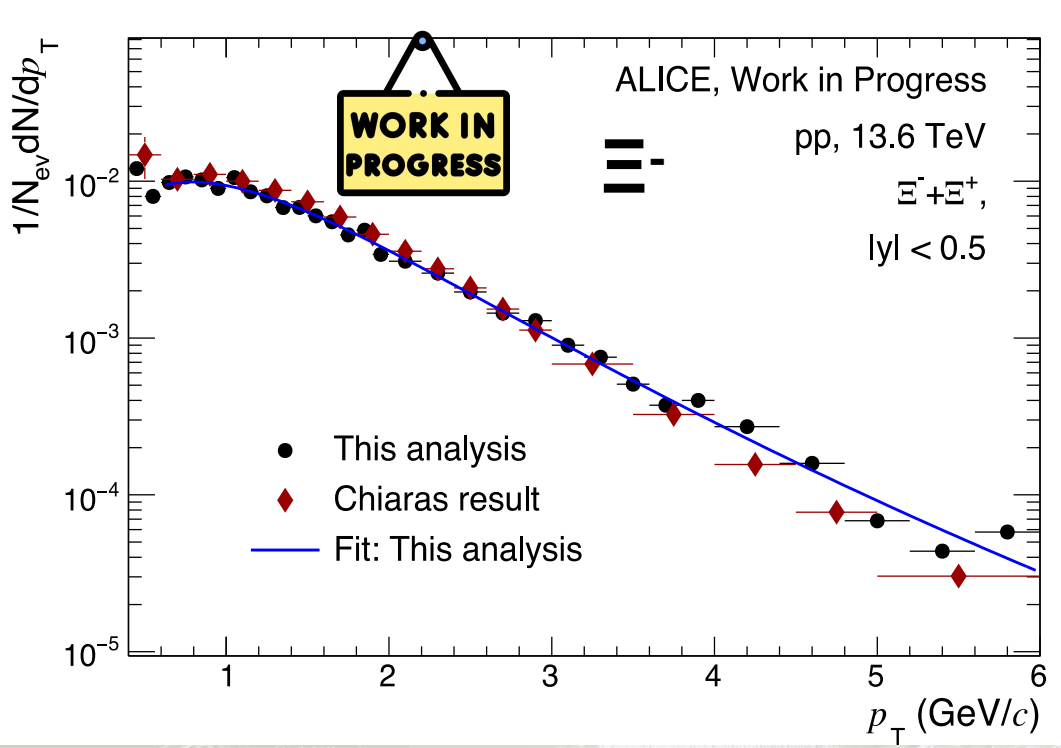
Corrected spectra for cross-check: K^0_S

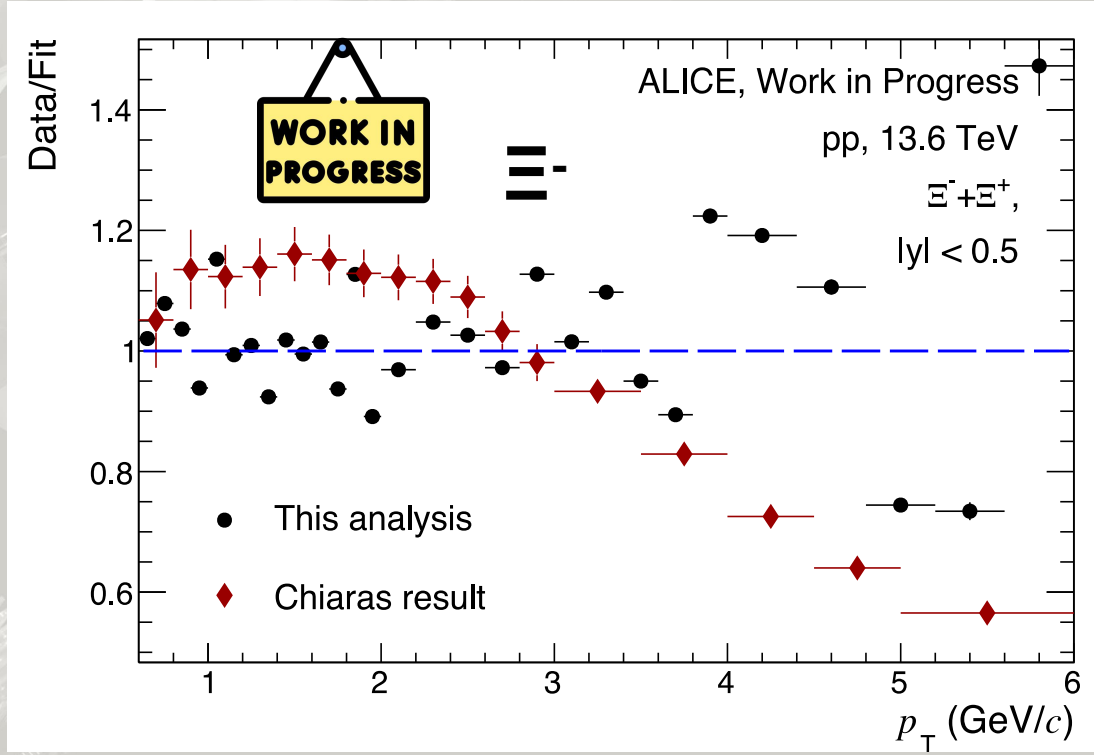




- No event / signal loss corrections applied to 13.6 TeV analysis: still pending
- Right plot
  - Deviation consistent with expected energy dependence
  - Further improvement (corrections) to be done for final comparison and for excitation function study

Corrected spectra for cross-check: Ξ^-

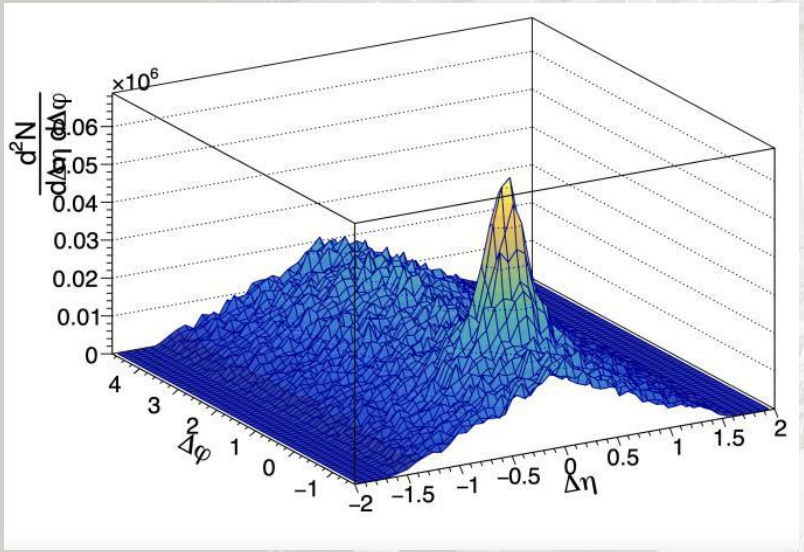




- No event / signal loss corrections applied to 13.6 TeV analysis: still pending
- Right plot
  - Deviation of 10-15% observed, possibly more at large momenta
  - Checks and further tests are ongoing, expected news soon

Mixed event correction

h-K^0_S, signal region, $3 < p_T^{trigg} < 20$ GeV/c, $1.5 < p_T^{assoc} < 2$ GeV/c



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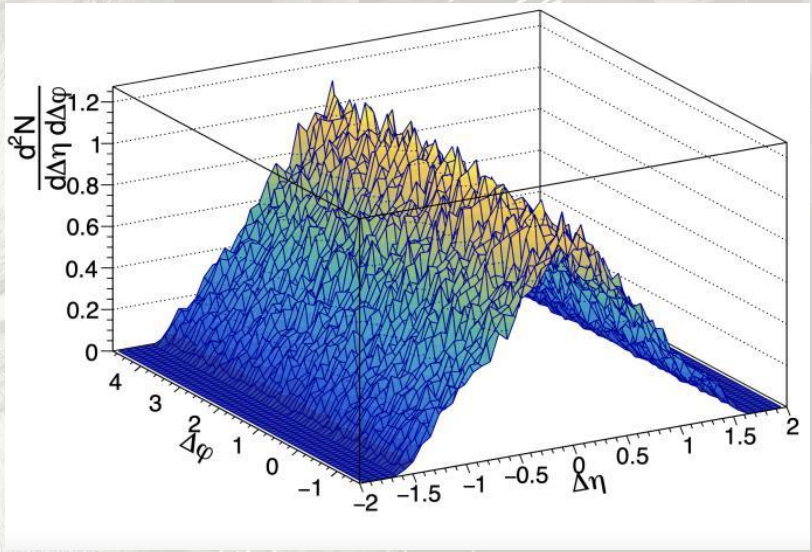

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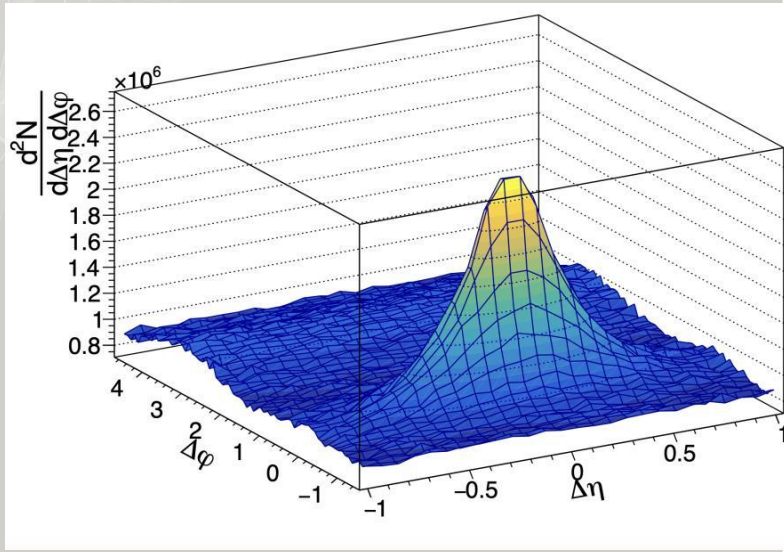


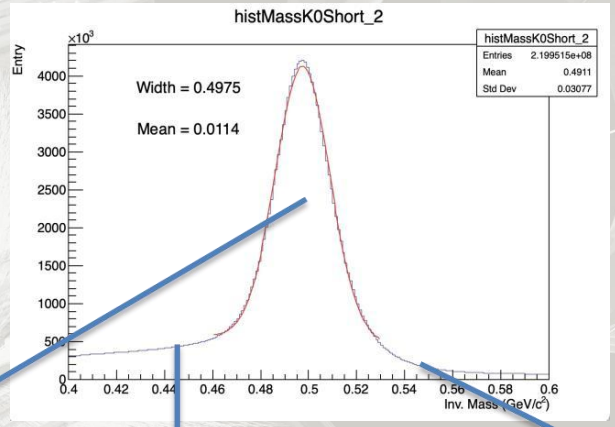
Same-event correlation | Mixed-event correlation | Acceptance-corrected function

$$\frac{\mathrm{d}^2 N_{pair}}{\mathrm{d}\Delta\varphi, \mathrm{d}\Delta\eta}(\Delta\varphi, \Delta\eta) = \sum_i \frac{S_i(\Delta\varphi, \Delta\eta)}{\frac{1}{\alpha_i} M_i(\Delta\varphi, \Delta\eta)}$$

- **Standard method for acceptance correction working as expected**
- **First test for the integrated-in-multiplicity correlation function is ok**

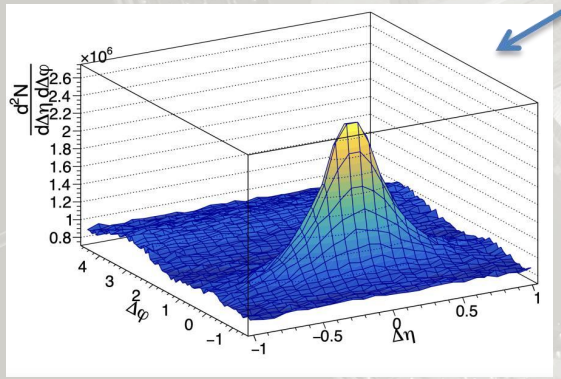
Background subtraction

h-K0S, 3 < pTtrigg< 20 GeV/c, 1.5 < pTassoc< 2 GeV/c



Current definition:

-6σ < left < -3σ < signal < +3σ < right < +6σ



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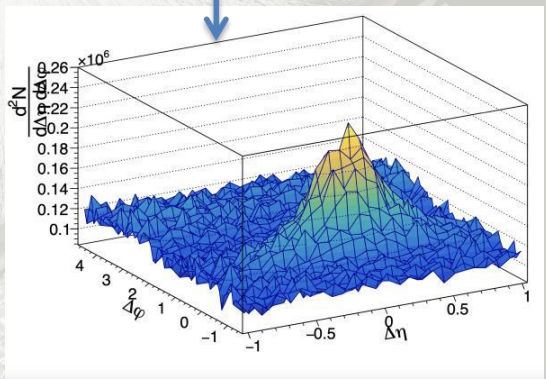

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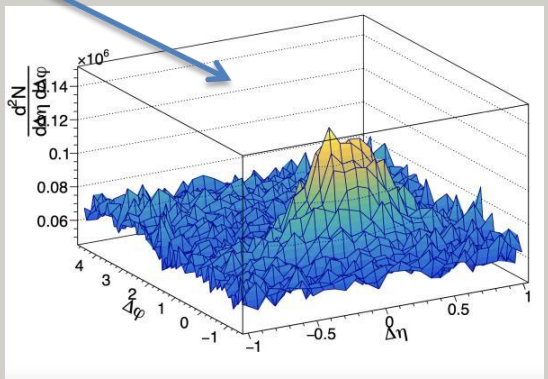
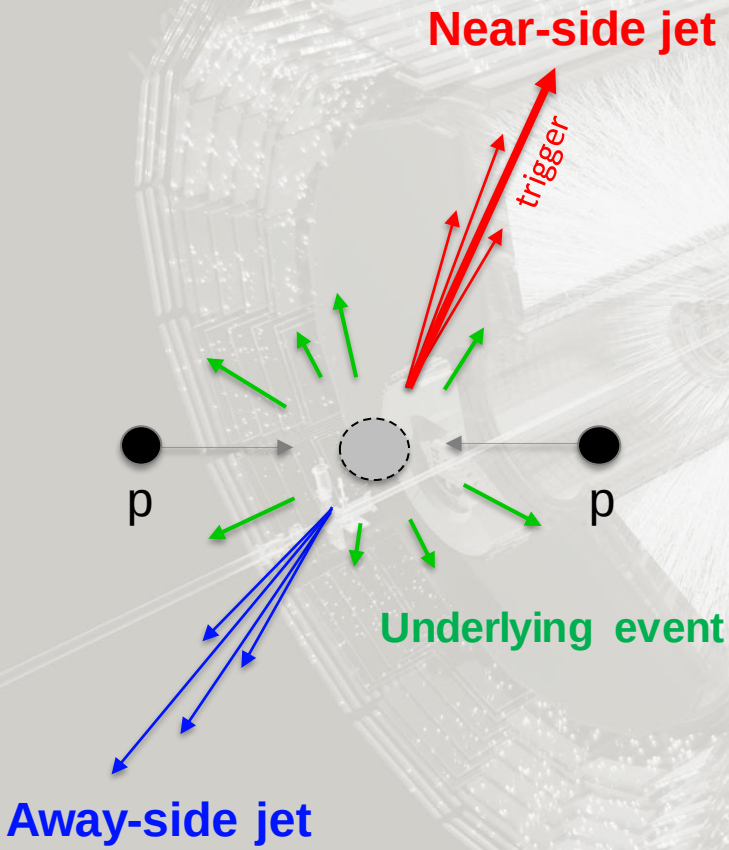


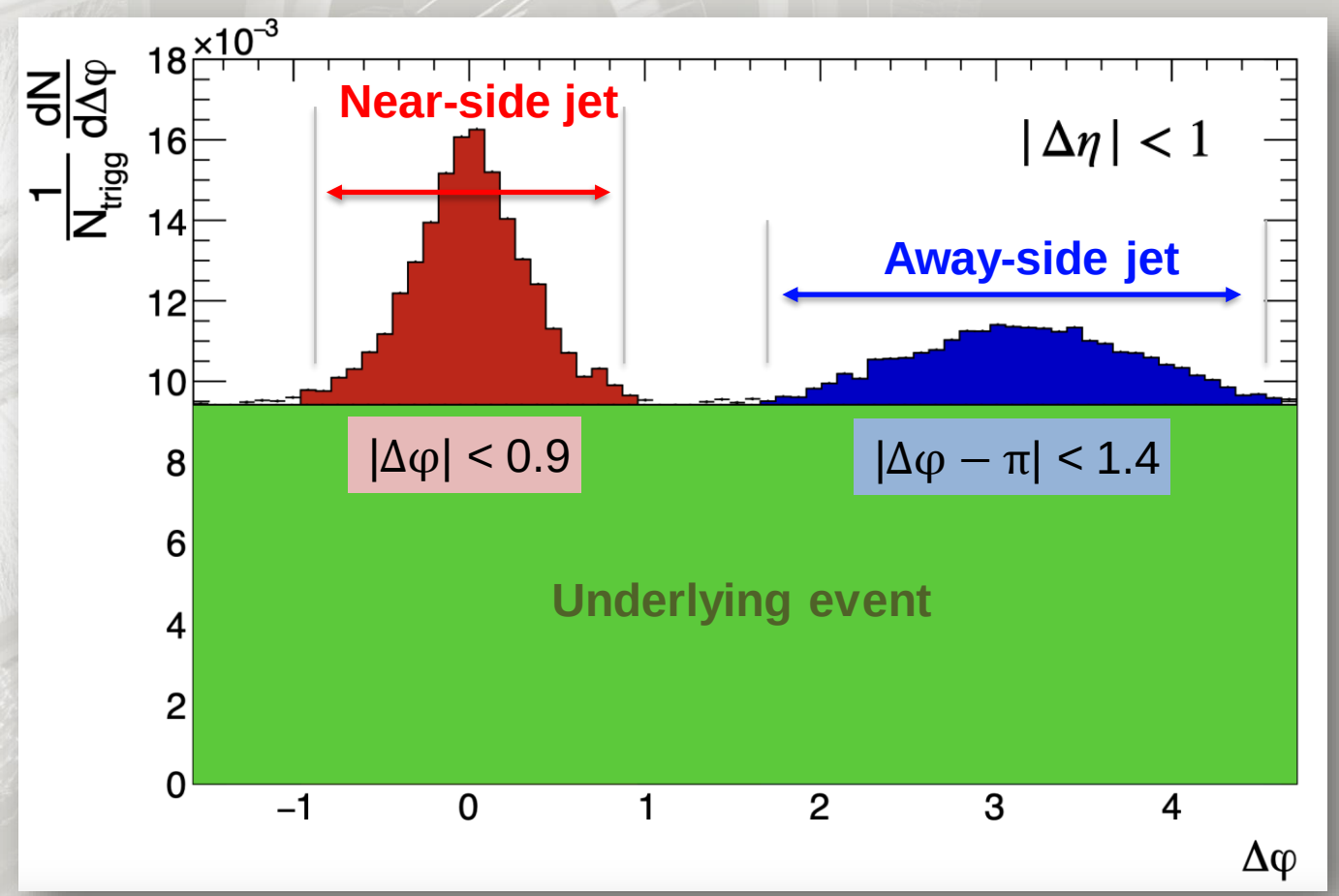
Signal region

Left and right background regions

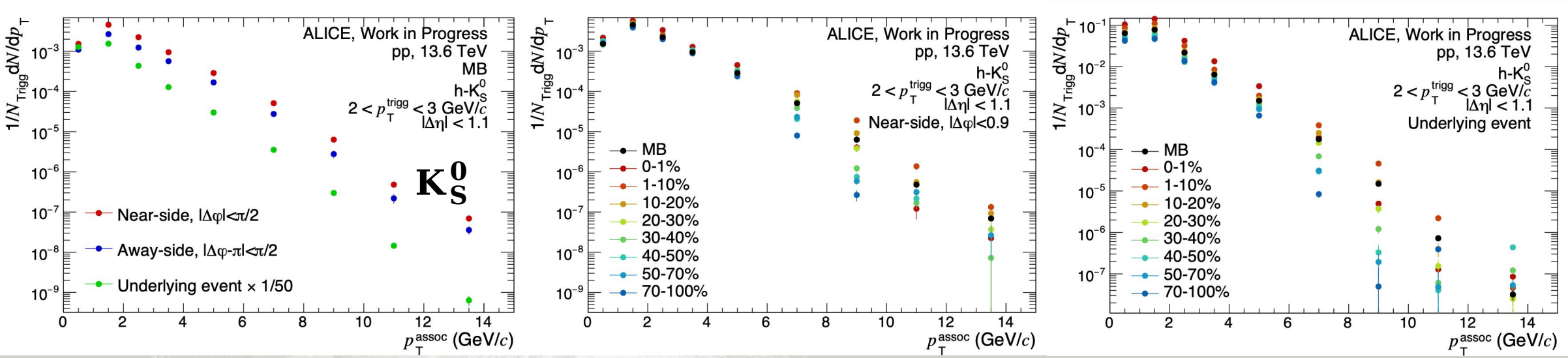
Yield extraction

h-K0S, 3 < pTtrigg< 20 GeV/c, 1.5 < pTassoc< 2 GeV/c





Raw yields



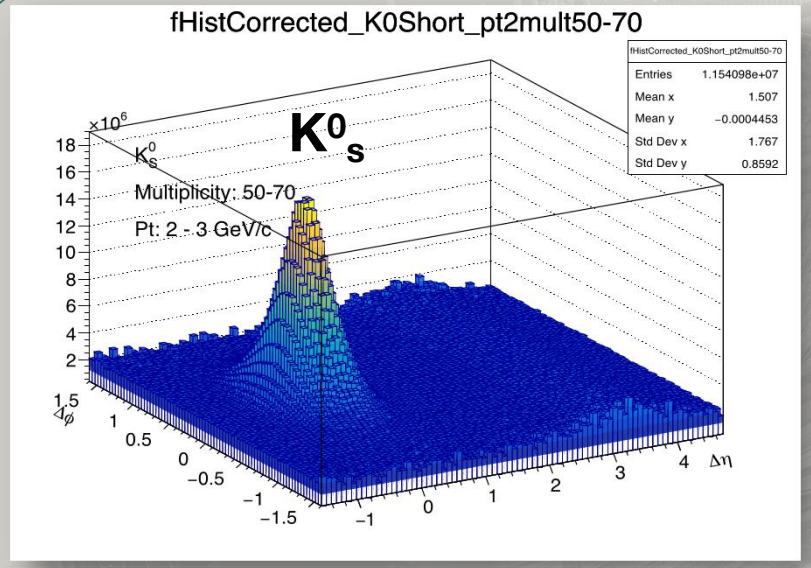
- Spectra associated with jets - harder
- A visible multiplicity dependence both in UE and near-side spectrum (still efficiency uncorrected) is shown

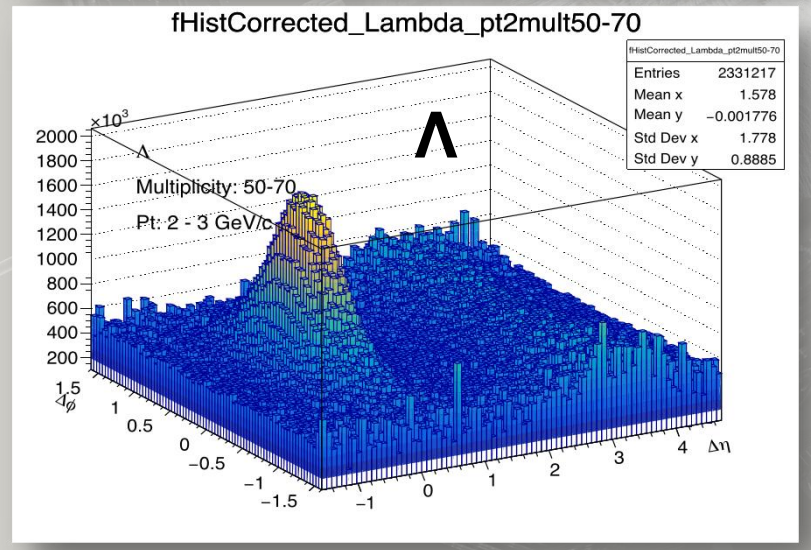
Monte Carlo studies

- PYTHIA
  - **First objective:** Color ropes should reproduce the strangeness enhancement versus multiplicity
  - **Second objective**: Color string shoving should cause a near-side, long-range ridge in 2pc studies

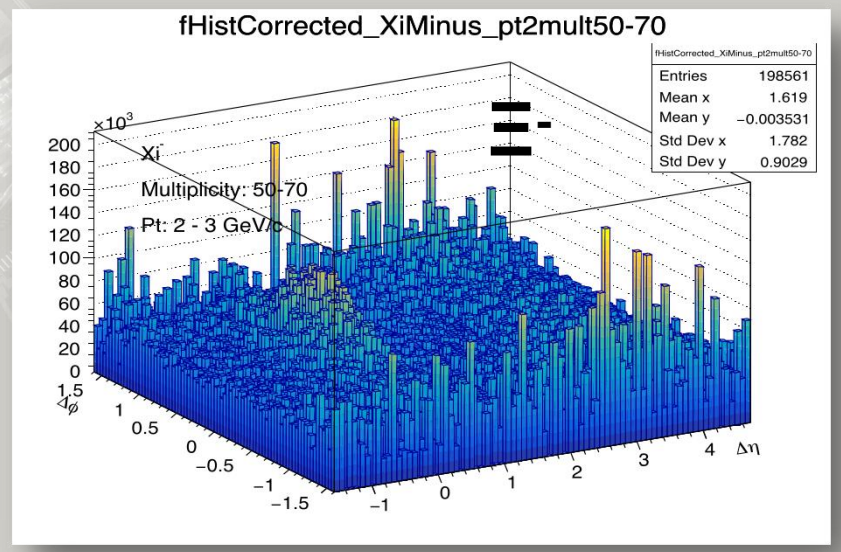
- Complementary effort in this analysis: quantify these effects in near-side, away-side and UE systematically so that this can then be readily compared to the final measurement

Example two-particle correlation plots

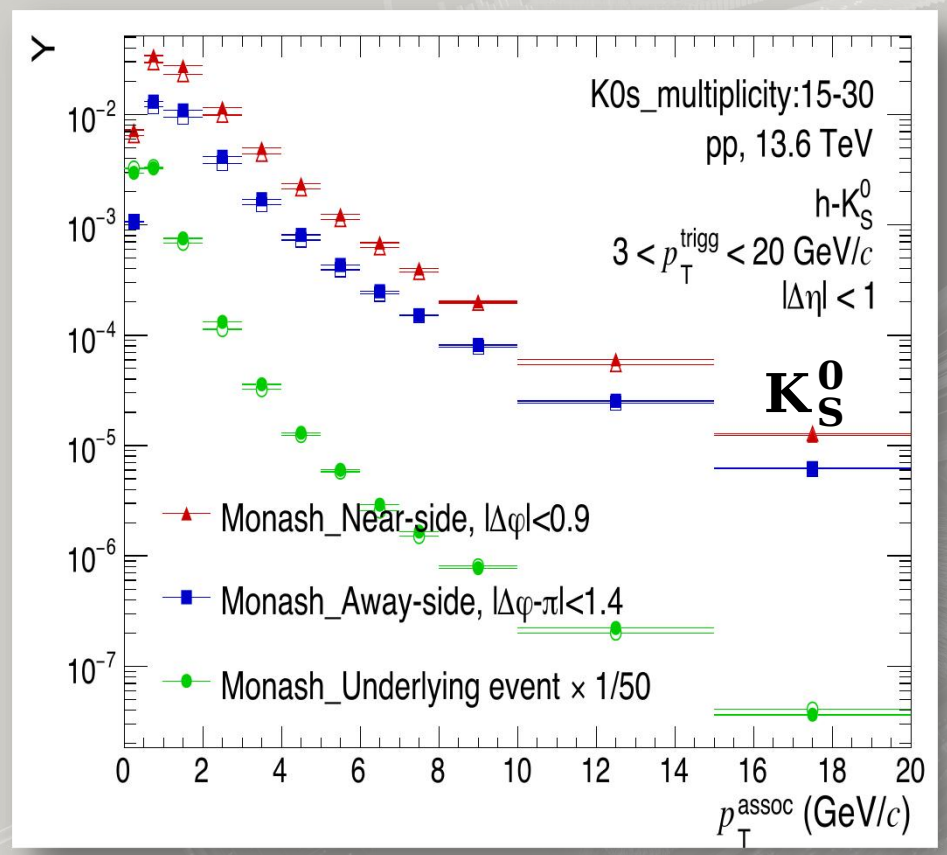


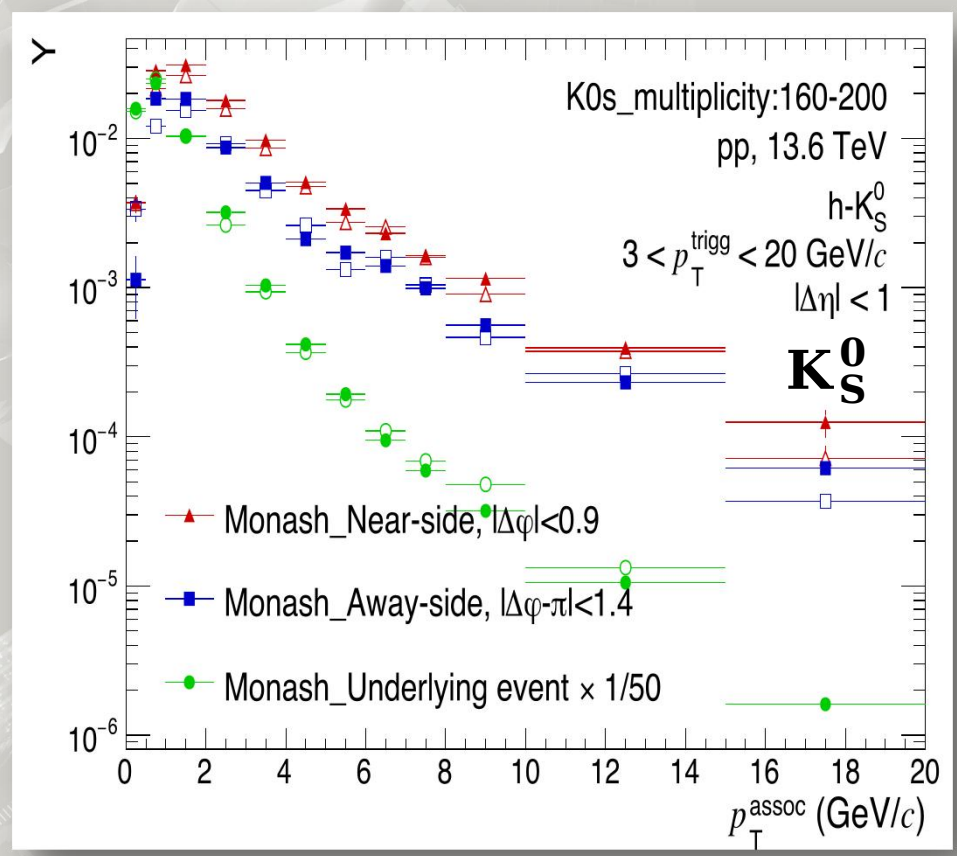


- Correlation functions very well populated for V0s
- Much more statistics-demanding for multi-strange baryons
- For comparing to Run 3 data analysis and to ensure MC modeling isn't a bottleneck, we may need more than 10^{10} events
  - MC LEGO trains restricted to 2×10^9 per train due to Int_t counting
  - Hyperloop on-the-fly MC probably a solution



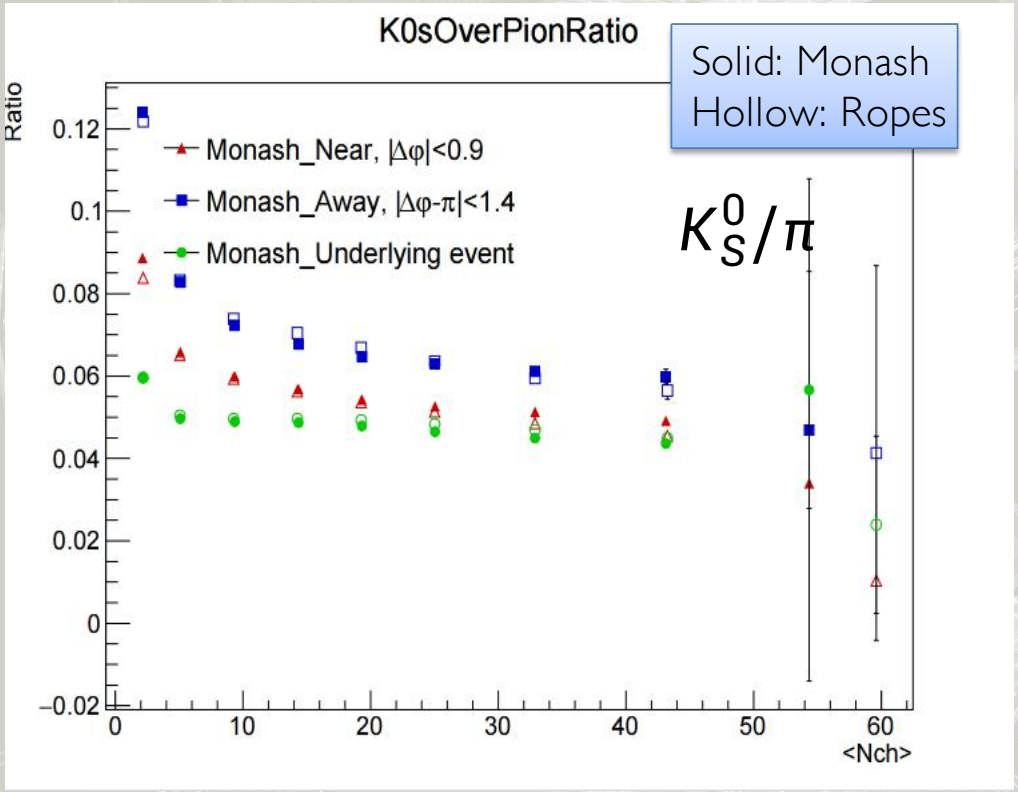
Example: yields as a function of associated p_T

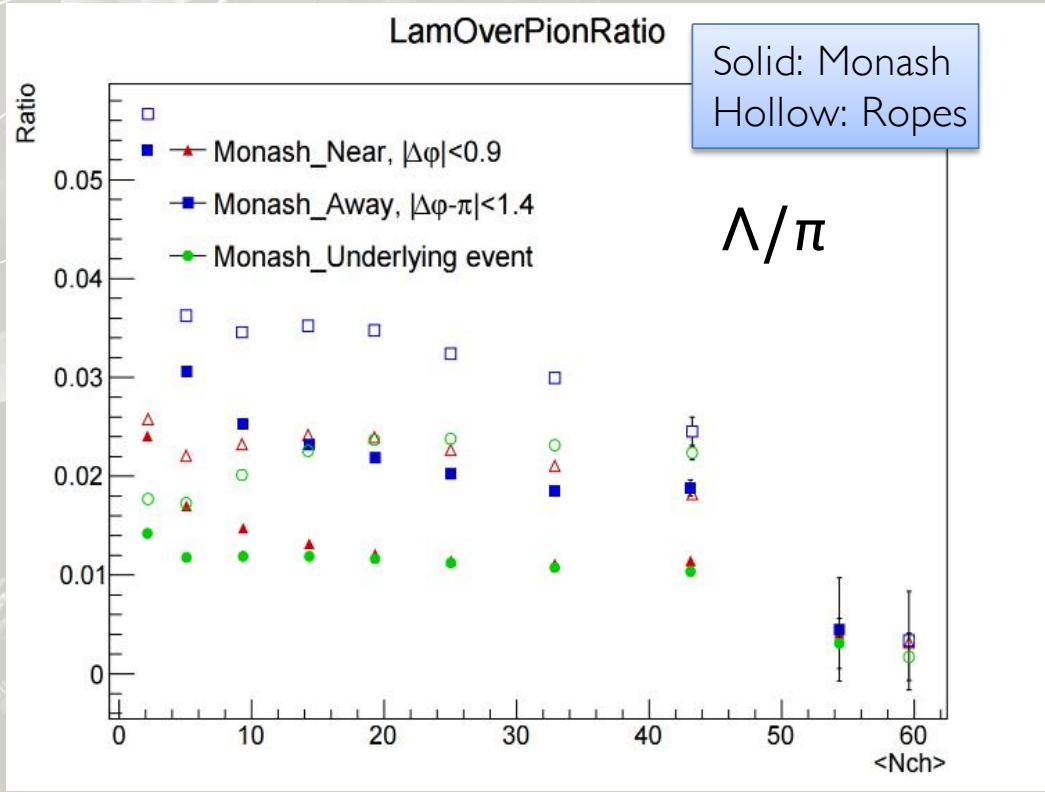




- Extraction in multiplicity bins corresponding to forward charged-particle counters
- Note: Use of multiplicities instead of percentiles: further plots will be done vs midrapidity $\langle dN_{ch}/d\eta \rangle$

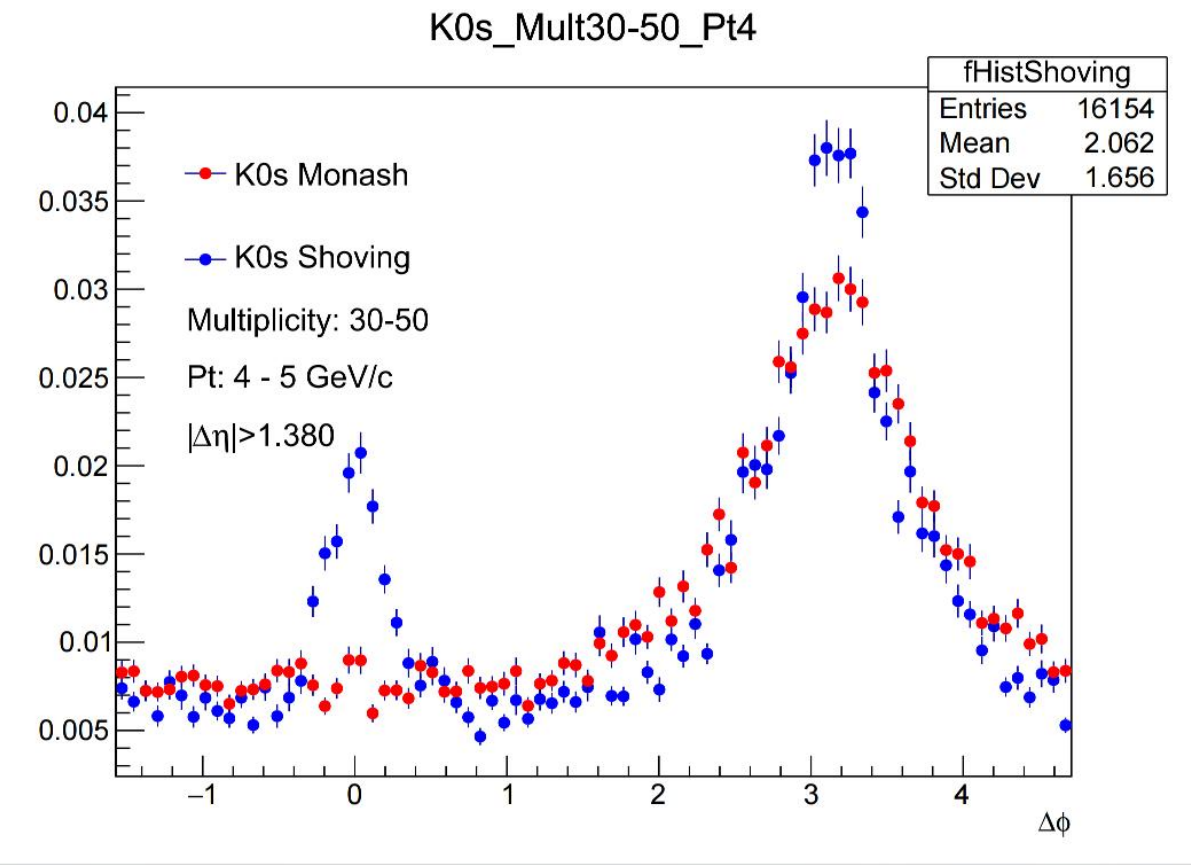
Particle ratios to π as a function of multiplicity: Monash versus Ropes





- Significant dynamical difference whenever color ropes are enabled
- Sizable impact not only in underlying event, but also in near and away sides

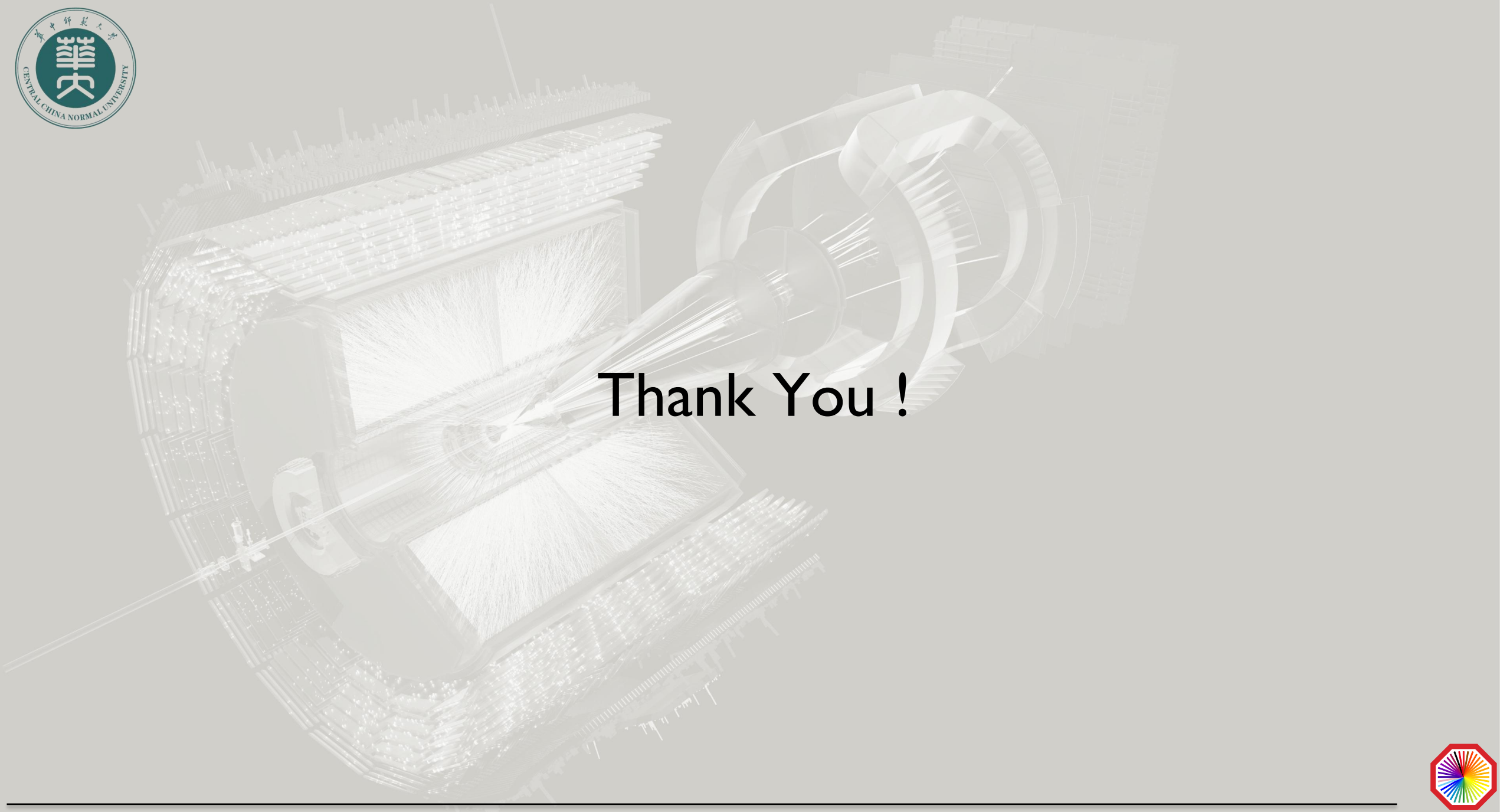
Strangeness collectivity due to string shoving in PYTHIA



- Analysis method: project 2D correlation function using $|\Delta\phi| < \pi/2$ (select near-side+long-range)
- String shoving produces visible near-side long-range ridge, as expected
- Full characterization of momentum, multiplicity and species dependence ongoing
  - Might even require more than 1010 events for very rare particles such as Ω
  - Showcases also why this is a Run 3 analysis!

Summary

- Parametrization for strangeness particles mass
- Corretions
  - Detector acceptance correction
  - Single particle efficiency
  - Background subtraction
- Raw yields
- MC studies



Thank You !