# Identified light flavor particle production in "jetty" and "isotropic" pp collisions at $\sqrt{s} = 13$ TeV with ALICE at the LHC

Adrian Nassirpour for the ALICE Collaboration

Lund University, Sweden

[1] A. Ortiz, Adv. Ser. Direct. High Energy Phys. **29** (2018) 343-357 [arXiv:1705.02056 [hep-ex]

[2] ALICE Collaboration, Eur. Phys. J. C **79** (2019) [arXiv:1905.07208 [nucl-ex]

## Motivation

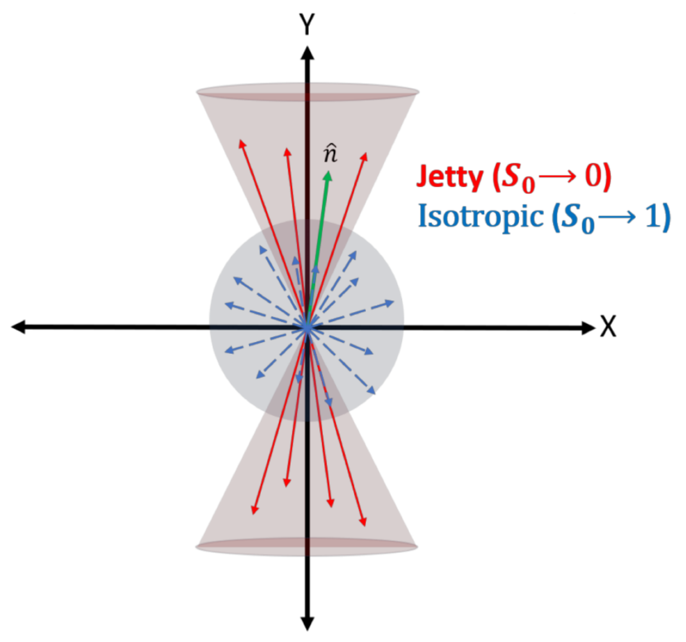
The underlying mechanism of collective behavior and strangeness enhancement in high-multiplicity proton-proton (pp) collisions is not well understood. Transverse spherocity is an event-shape engineering tool that has been proposed to disentangle and isolate events that are either dominated by hard or soft QCD physics, in an attempt to isolate the new soft physics.

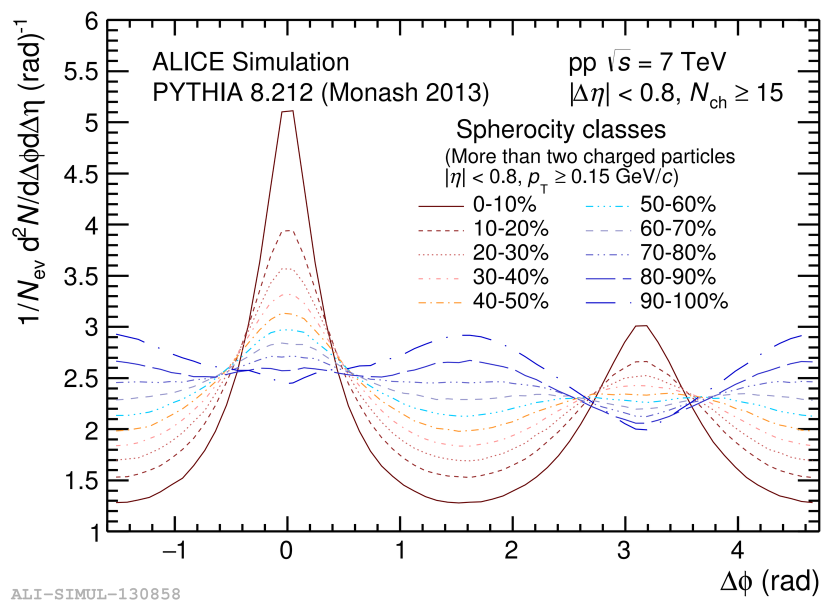
## Idea

- The event topology will reflect the main mode of production for a given event [1]:
  - Events dominated by a single very hard scattering will have pronounced back-to-back jet structures.
  - Events dominated by several soft scatterings will instead have a more isotropic topology.
- Unweighted Transverse Spherocity, $S_O^{p_T=1}$, is calculated using charged tracks and is used to disentangle events based on the event topology.

$$S_O^{p_T=1} = \frac{\pi^2}{4} \min_{\hat{n}} \left( \frac{\Sigma_i |\hat{p}_T \times \hat{n}|}{\Sigma N_{trks}} \right)^2 \qquad (1)$$

  - The transverse momentum of each charged particle track is normalized to 1 ($p_T = 1$). $N_{trks}$ is the number of tracks and $\hat{n}$ a unit vector.
  - Events dominated by mini-jet-like structures: $S_O^{p_T=1} \Rightarrow 0$.
  - Events dominated by isotropic processes: $S_O^{p_T=1} \Rightarrow 1$.
  - The $S_O^{p_T=1}$ only takes the angular component of each track into account, to achieve a similar behavior for neutral and charged particles.

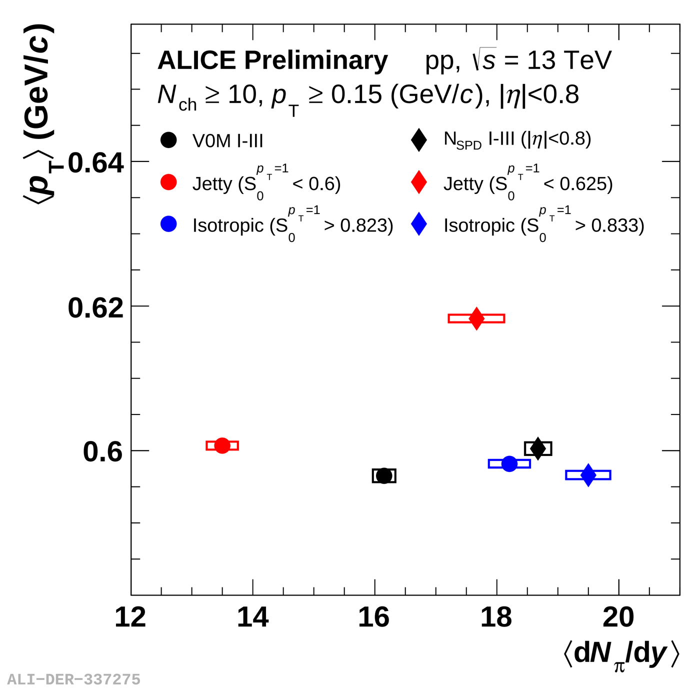


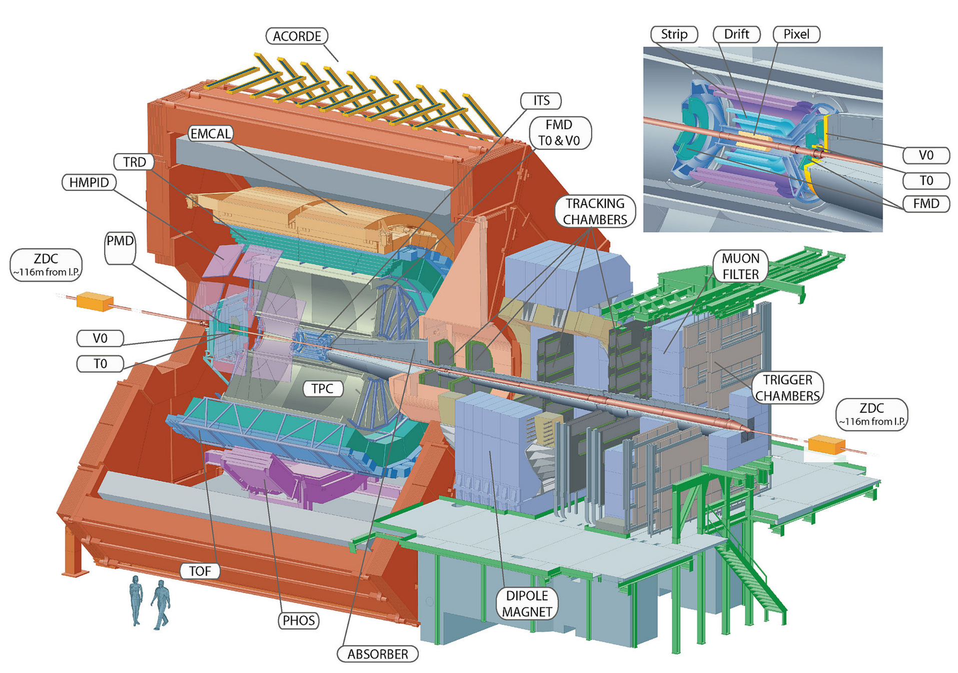




- Events are classified as "Jetty" or "Isotropic" if they are contained within the 0-20% and 80-100% percentiles of the $S_O^{p_T=1}$ distribution respectively.

## Multiplicity Estimators

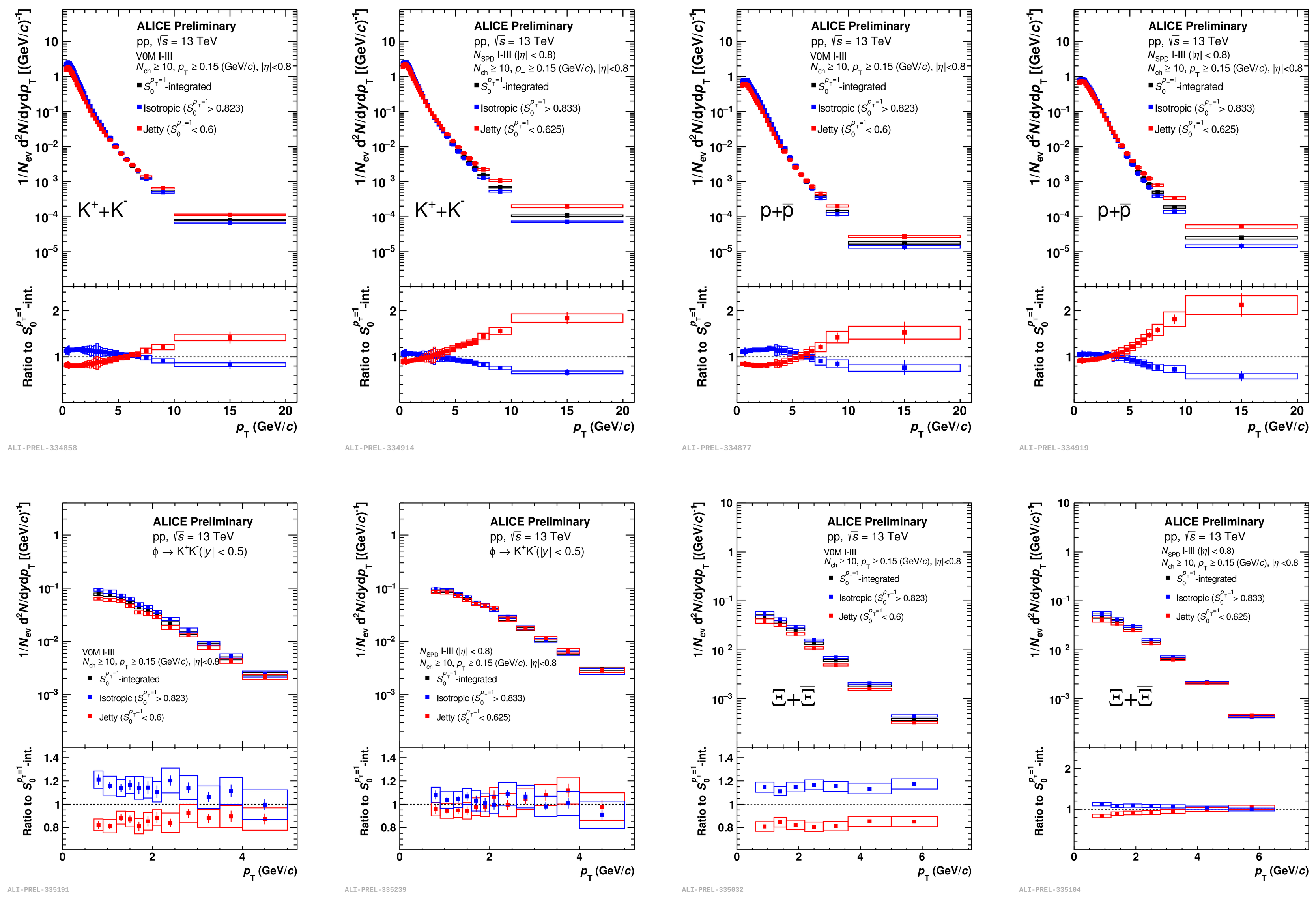
- In addition to the differential $S_O^{p_T=1}$ cuts, the events considered also have a multiplicity cut (top 10%) and require at least 10 charged primary tracks.
- Two different multiplicity estimators from ALICE are used for this analysis, exploiting different multiplicity and pseudo-rapidity regions [2]:
  - The forward multiplicity estimators V0A/V0C (V0M), covering the pseudo-rapidity regions $2.8 < \eta < 5.1$ and $-3.7 < \eta < -1.7$.
  - The mid-rapidity estimator (CL1) counting the reconstructed tracklets ($N_{SPD}$), covering the pseudo-rapidity region $|\eta| < 0.8$.
- The Transverse Spherocity is used to exploit the characteristics of the average charged track multiplicity, $\langle dN_\pi/dy \rangle$.



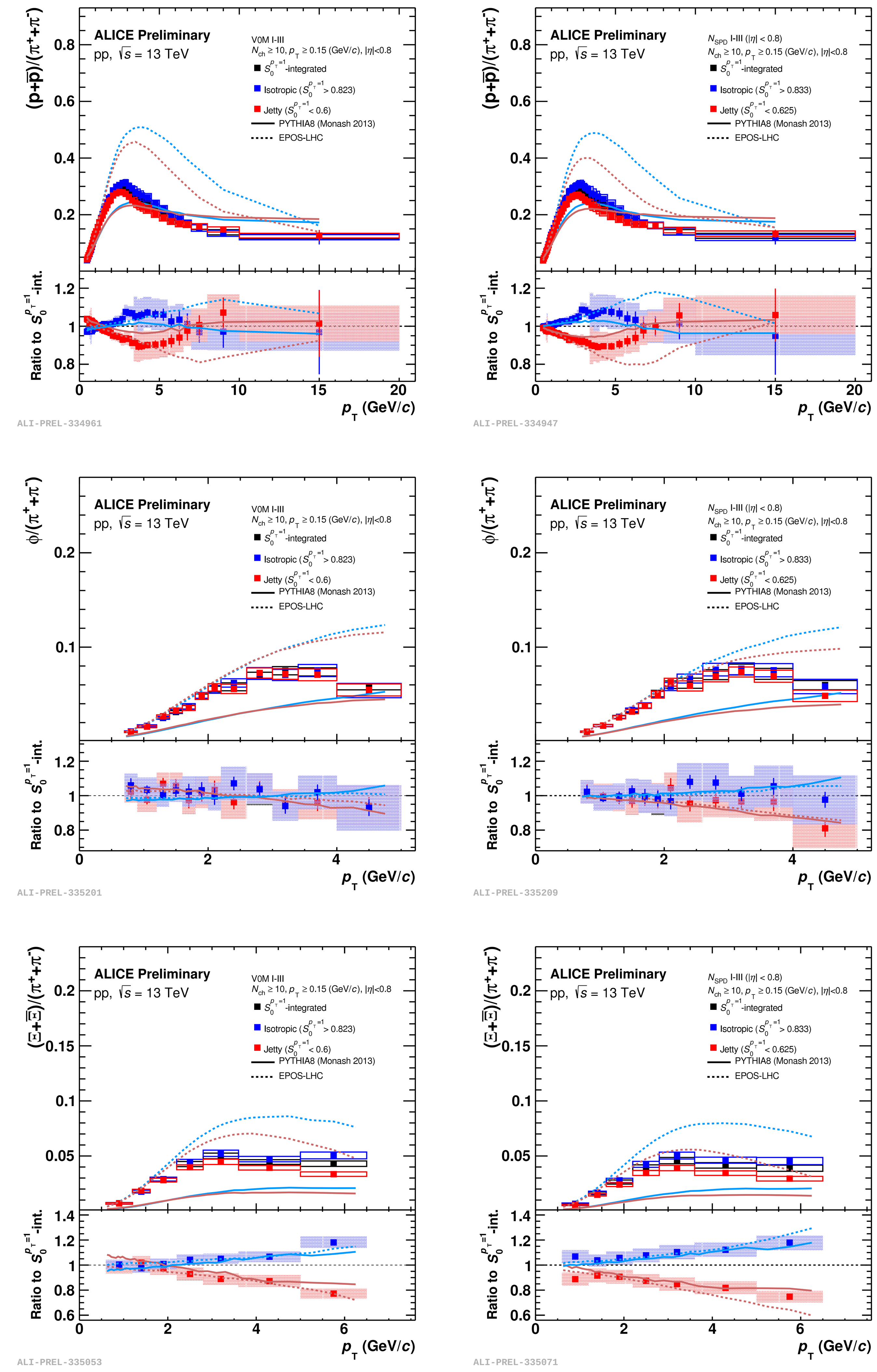
- One can utilize transverse spherocity to study the relative production of strange hadrons, such as the $\phi$ ($s\bar{s}$) and the $\Xi$ ($dss$) to test if they are suppressed in "jetty" and/or enhanced "isotropic" events, which one would expect to be more A-A like.
  - This could indicate the underlying mechanism of strange hadron production.

## Results: Transverse Momentum Spectra as a Function of $S_O^{p_T=1}$




- The $p_T$ spectra indicates that the spherocity selection affects the two different multiplicity estimators differently.

## Results: $S_O^{p_T=1}$ Particle Ratios to Pions




- $S_O^{p_T=1}$ used in conjunction with the mid-rapidity estimator is able to disentangle the two physics regimes.

## Summary and Conclusions

The production of light flavor particles as a function of Multiplicity and Unweighted Transverse Spherocity has been studied. The particle multiplicities are estimated in two different rapidity regions. It is shown that the separation in the spectra between the $S_O^{p_T=1}$ differential yields is different between the mid-rapidity (CL1) and forward multiplicity estimators (V0M). In conjunction with the pion ratios, it seems that the separation in V0M is mainly driven by the $\langle dN_\pi/dy \rangle$ difference, whereas CL1 is able to disentangle events dominated by either hard or soft QCD. Remarkably the $\phi$-to-$\pi$ ratio displays no significant difference between V0M and CL1.