Monte-Carlo driven studies on light flavour hadron production as a function of Transverse Spherocity

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Motivation

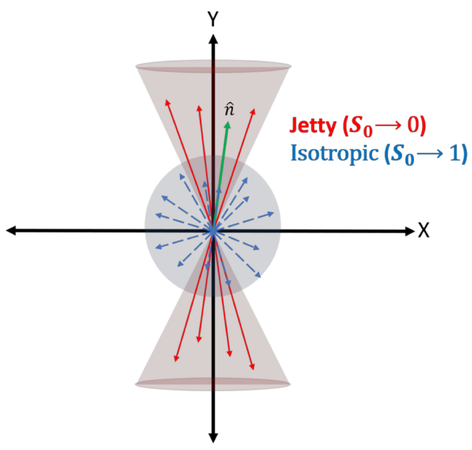
While several signatures of collective behaviour has been observed in high-multiplicity proton-proton (pp) collisions, such as strangeness enhancement, radial flow signals and long-range angular correlations, the underlying mechanism of these signatures is still not well understood. The presence of such signatures are understood in heavy-ion collisions as resulting from a hydrodynamical expansion of a strongly interacting medium. 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 pin-point the underlying mechanism of collective behaviour in small systems.

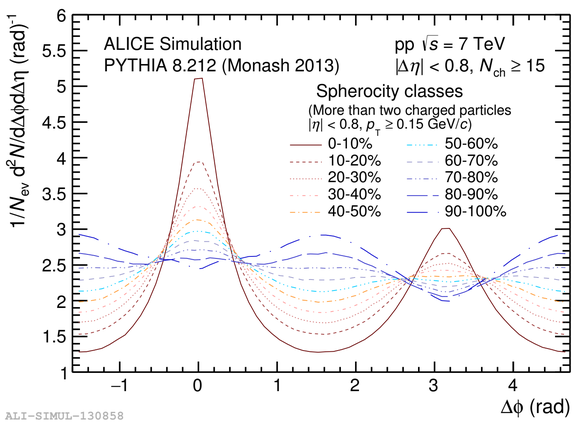
Idea

- The event topology will reflect the main mode of production for a given event::
  - 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.
- Transverse Spherocity, S_O, is used to disentangle events based on underlying event activity.

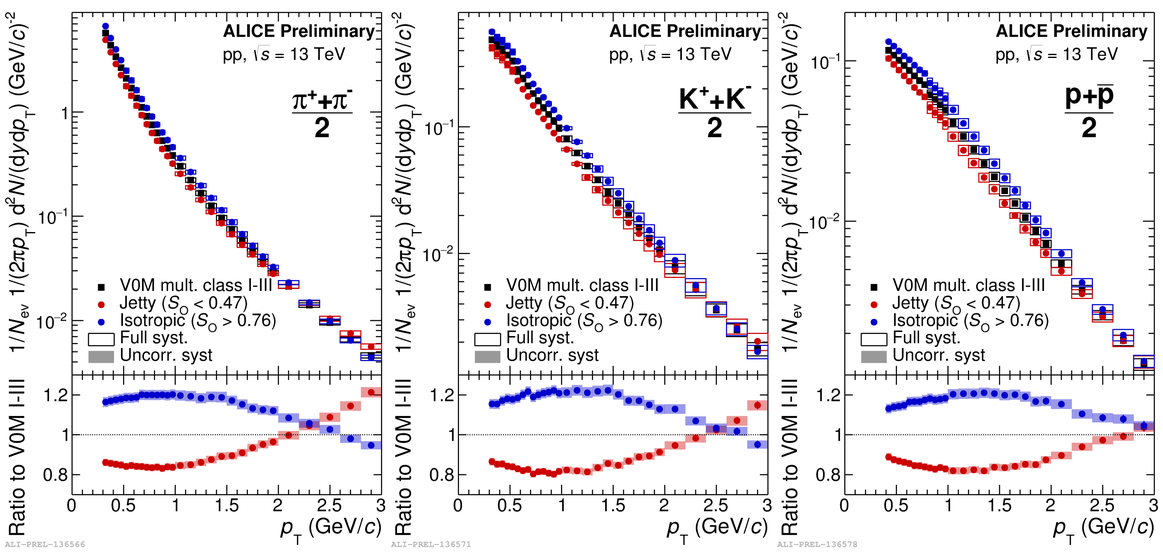
$$S_O = \frac{\pi^2}{4} \min_{\hat{n}} \left(\frac{\Sigma_i |p_{\mathrm{T}} \times \hat{n}|}{\Sigma_i p_{\mathrm{T},i}} \right)^2 \tag{1}$$

  - Events with a small underlying event will be dominated by mini-jet-like structures and will be in the limit of $S_0 \Rightarrow 0$.
  - Events with a large underlying event will be dominated by isotropic processes, and will be in the limit of $S_0 \Rightarrow 1$.
- Events are classified as "Jetty" or "Isotropic" if they are contained within the 0-20% and 80-100% of the S_O distribution respectively.





- π, K, P results are already available for pp collisions at $\sqrt{\mathrm{S}} = 13\,TeV$.
- In addition to the Transverse Spherocity distributions, the events considered also have a multiplicitiy cut (top 10%).
  - Only charged primary particles are used to determine the S_O value, with events containing at least 10 charged primary tracks.

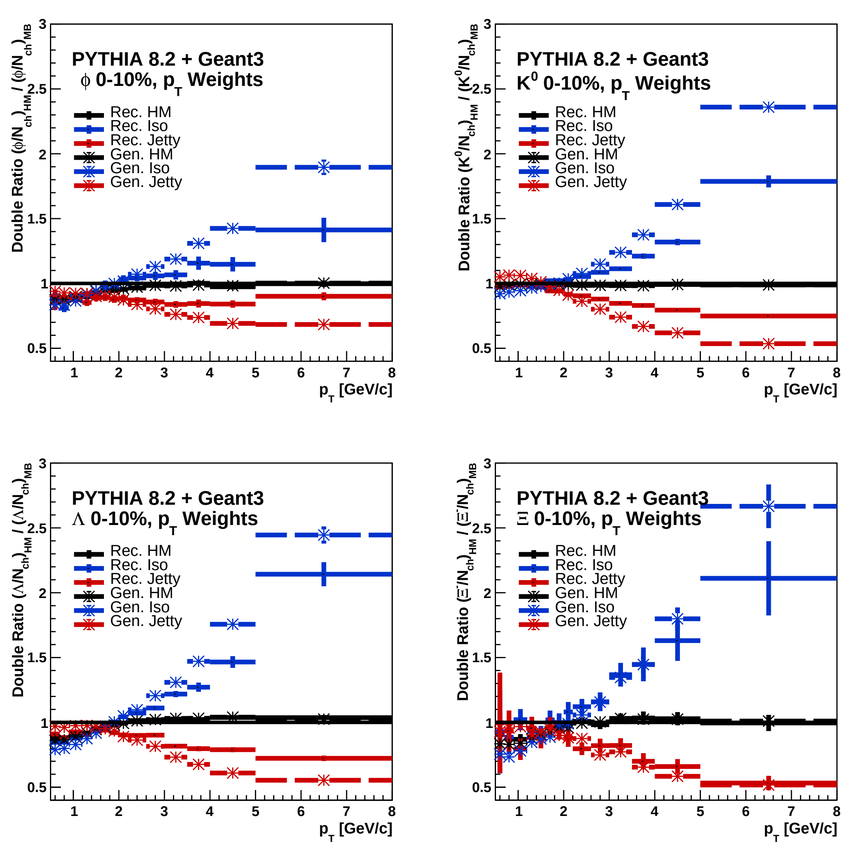


- The idea is to now utilize transverse spherocity to study more complex properties, such as the preferred topology of ϕ mesons production ($s\bar{s}$).
  - This could indicate whether the ϕ production is favoured in events that are dominated by either hard or soft QCD.
  - Does the ϕ behave like a doubly-strange meson (canonical conversation) or a neutrally strange meson (grand canonical conservation) as a function of S_O?.
  - To put this into context, the analysis is also extended to the "V0" particles K^0_s and $\Lambda(\bar{\Lambda})$, and the cascade baryon Ξ.

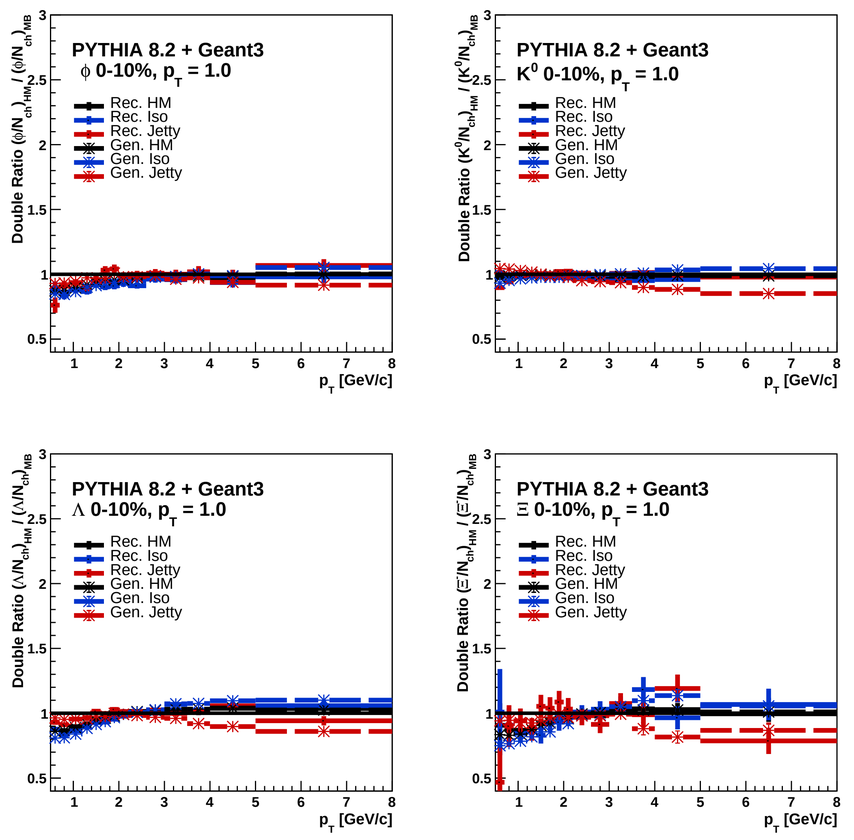
Results & Potential Pitfall: Neutral Jet Bias

- The relative light flavour production can be studied by considering the "double ratio" to the number of charged tracks , N_{ch}:

$$\frac{\left[\left(\frac{dN_{\phi,K^0,\Lambda,\Xi^-}}{dp_{\mathrm{T}}d\eta}\right) / \left(\frac{dN_{ch}}{dp_{\mathrm{T}}d\eta}\right)\right]_{\mathrm{HM,\ Iso,\ Jetty}}}{\left[\left(\frac{dN_{\phi,K^0,\Lambda,\Xi^-}}{dp_{\mathrm{T}}d\eta}\right) / \left(\frac{dN_{ch}}{dp_{\mathrm{T}}d\eta}\right)\right]_{\mathrm{MB}}} \tag{2}$$



- Large enhancement/suppression effects are observed for ϕ, K^0_s, Λ, Ξ^-.
- Effect might be due to neutral jet bias.
  - The particles that are triggered on(charged primaries) are different than the ones observed (resonances, V0s, cascades).
  - Event that has a "charged isotropic" topology can have a "neutrally jet".
  - Event that has a "charged jetty" topology can significant "neutral isotropic" production.
- This bias can be accounted for by forcing p_{T} in Eq.1 to equal 1.0.
  - Only angular component is taken into account
    $\Rightarrow$ measurement is less sensitive to tracks with large p_{T}.



Summary and Conclusions

The production of light flavour particles as a function of Multiplicity and Transverse Spherocity has been studied. In order to avoid large biases on the results, the measurement has to be modified to be made less sensitive to leading jet pilots. This is done by only considering the angular component of each reconstructed track, by fixing the p_{T} magnitude to 1.0. The modified transverse spherocity measurement avoids the large "artificial" enhancement/suppression, and reduces smearing effects, while still showcasing a difference between the two S_O limits.