Transverse Spherocity and Multiplicity Dependence of R_2 and P_2 Correlation Functions in pp Collisions at $\sqrt{s}$ = 7 TeV using PYTHIA8

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Transverse Spherocity(S_0)

Transverse Spherocity[2,3]

-Powerful tool to separate soft and hard contributions in an event

$$S_0 = \frac{\pi^2}{4} \min_{\hat{n}} \left(\frac{\sum_i |\vec{p}_{T,i} \times \hat{n}|}{\sum_i p_{T,i}} \right)^2$$

where

$S_0 =$
- **0 → Jetty: Back-to-Back Dijet** (Hard scattering->perturbative QCD)
- **1 → Isotropic: Underlying Event, Soft QCD processes** (non-perturbative QCD)

Fig. 1

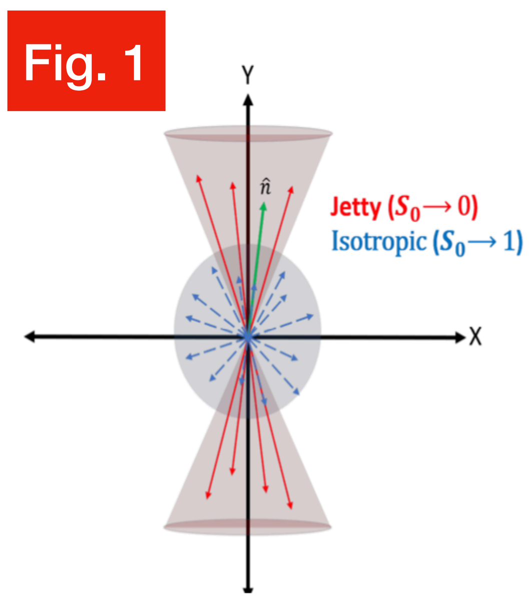
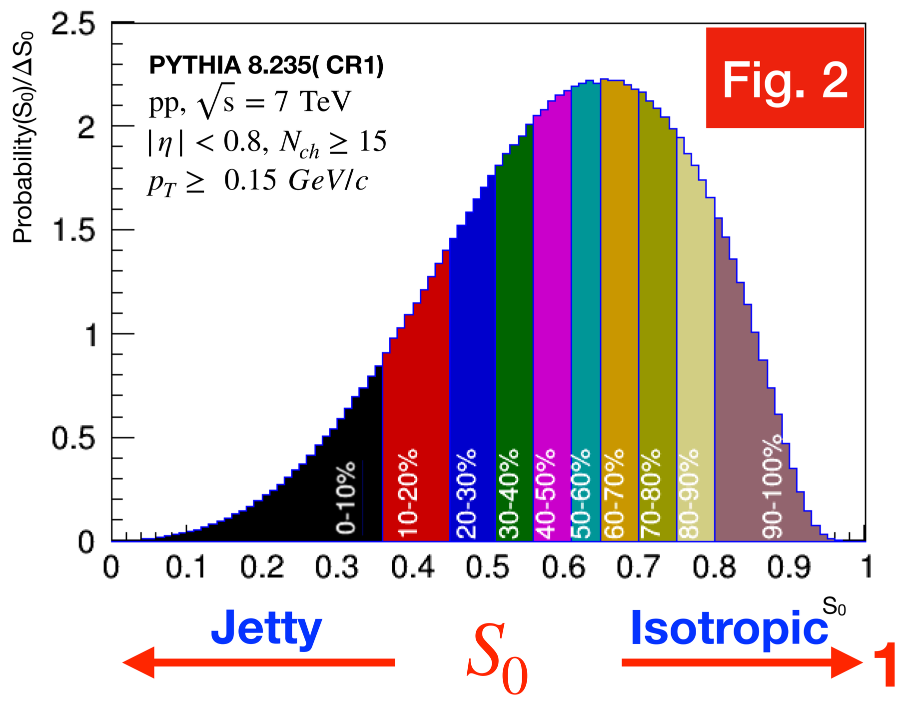


Fig. 2



Jetty ← S_0 → Isotropic 1

S_0 dependence of Mean – p_T

Mean-p_T[4]:

$$\langle\langle p_T \rangle\rangle = \frac{\sum_{i=1}^{N_{ev}} \langle p_T \rangle_i}{N_{ev}}$$

where

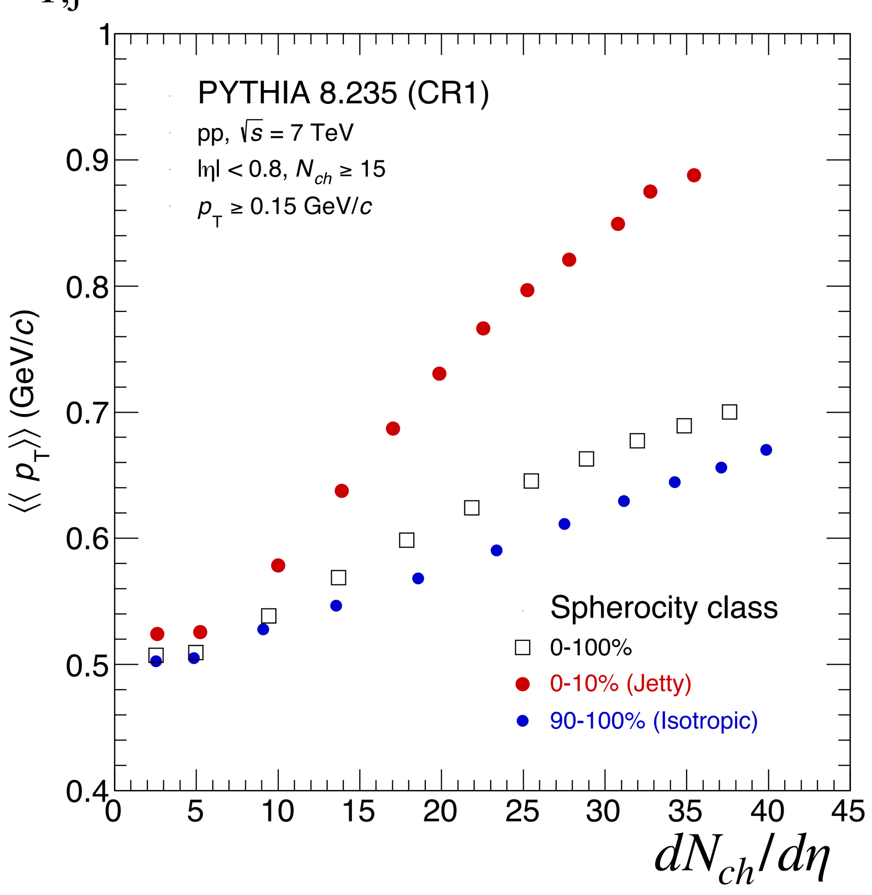
$$\langle p_T \rangle_i = \frac{\sum_{j=1}^{N_{ch}} p_{T,j}}{N_{ch}}$$

Where

N_{ev} : number of events

N_{ch} : number of charged particles in the i-th event

$p_{T,j}$: transverse momentum of the j-th particle in each event.



- **Jetty events have a higher mean-p_T .**
- **Isotropic events have a lower mean-p_T.**

Correlation Observable

1st Observable:

Two-particle differential number Correlation[1,5]:

$$R_2(\Delta\eta, \Delta\varphi) = \frac{\rho_2(\Delta\eta, \Delta\varphi)}{\rho_1 \times \rho_1(\Delta\eta, \Delta\varphi)} - 1$$

✓Sensitive to particle production mechanisms.

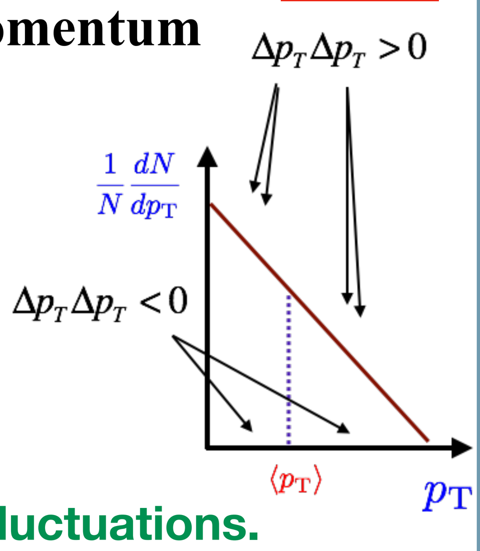
2nd Observable:

Two-particle differential transverse momentum Correlation [1,5]:

$$P_2(\Delta\eta, \Delta\varphi) = \frac{\langle \Delta p_{T,1} \Delta p_{T,2} \rangle (\Delta\eta, \Delta\varphi)}{\langle p_T \rangle^2}$$

Where $\Delta p_{T,i} = p_{T,i} - \langle p_T \rangle$

Fig. 4



✓Sensitive to transverse momentum fluctuations.

Why did we use R_2 & P_2 ?

✓ Dimensionless quantity ✓ Robust observable[5]

Comparison of $R_2(\Delta\varphi)$ and $P_2(\Delta\varphi)$ between V0M and S_0 classes

V0M classes | S_0 classes

Fig. 5

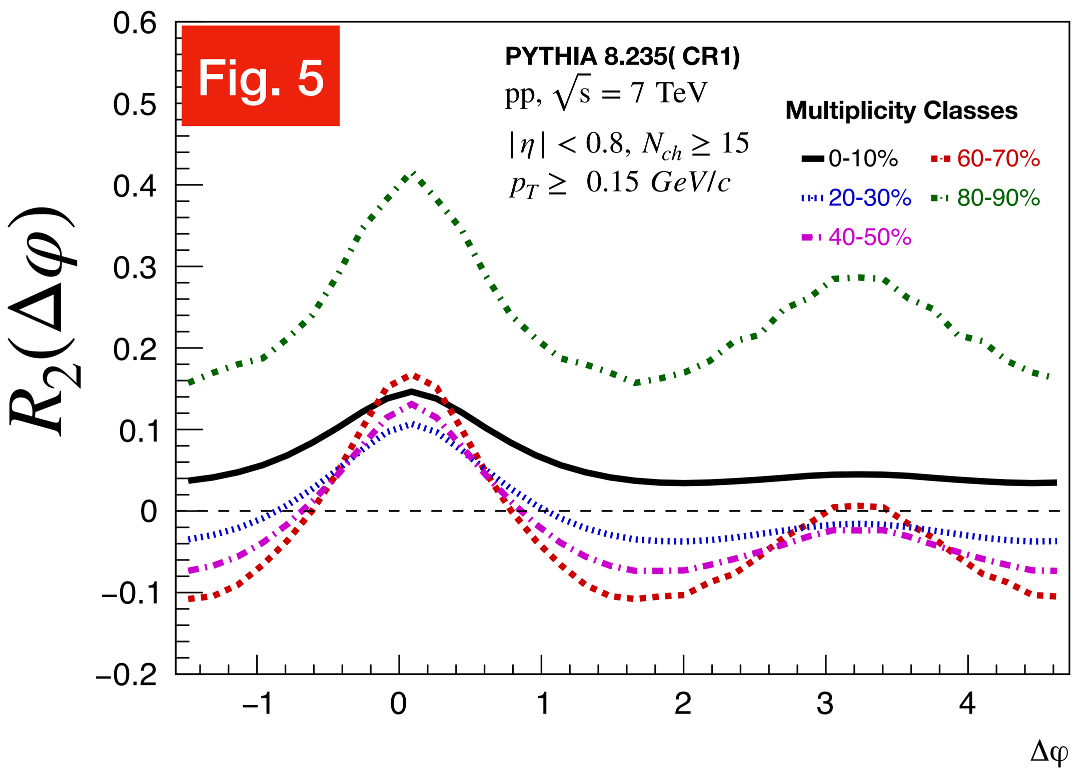


Fig. 6

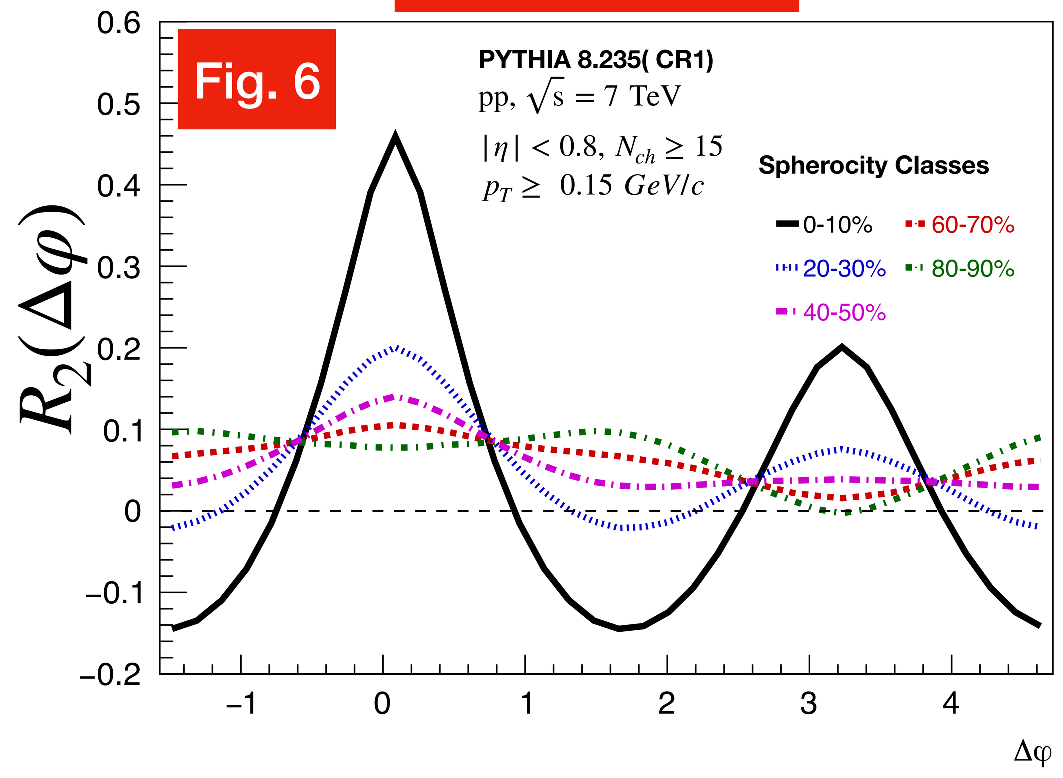


Fig. 7

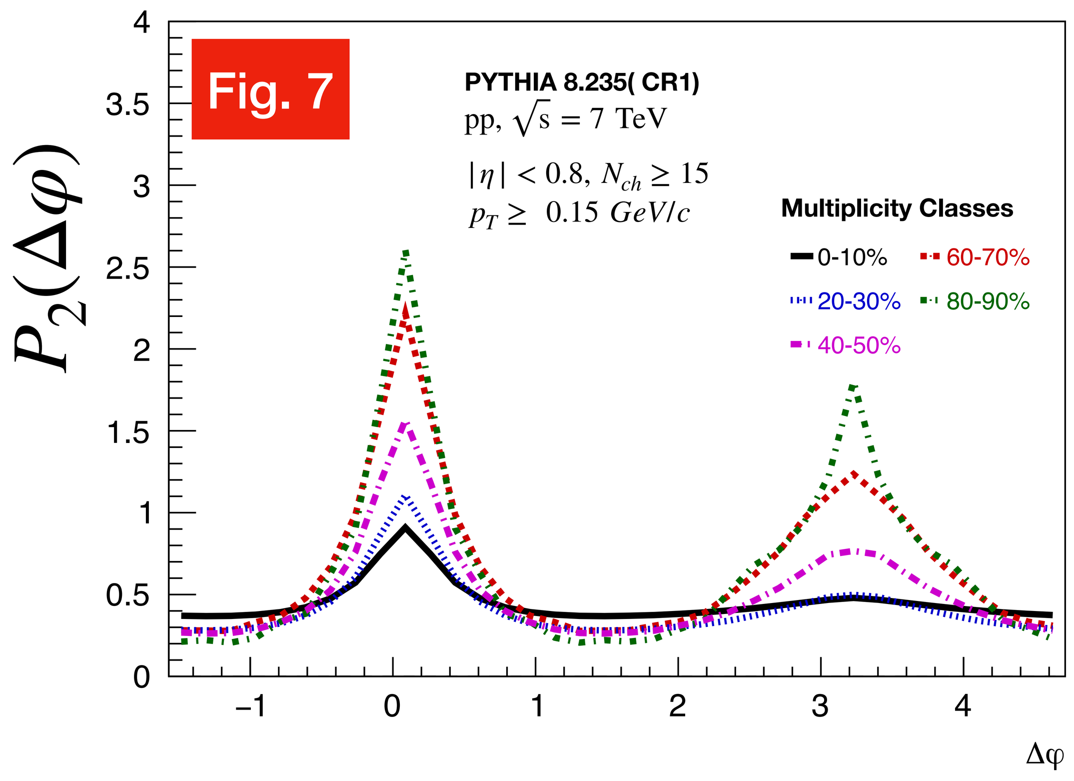
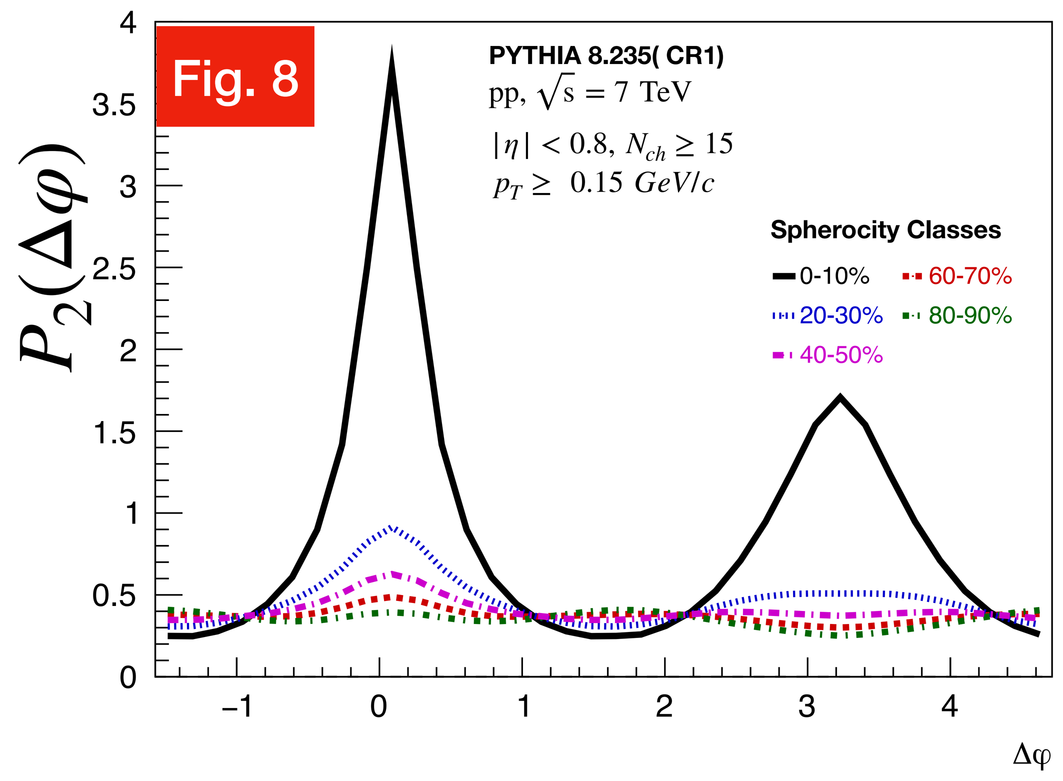


Fig. 8



- **The magnitude of the modulation strongly correlates with spherocity classes as compared to multiplicity classes for both $R_2(\Delta\varphi)$ and $P_2(\Delta\varphi)$.**
- **Clear separation between jetty and isotropic events for both $R_2(\Delta\varphi)$ and $P_2(\Delta\varphi)$ with S_0.**
- **$P_2(\Delta\varphi)$ is narrower than $R_2(\Delta\varphi)$ expected from angular ordering[1] of the p_T of jet constituents.**

Summary

- ☑ **Transverse spherocity and multiplicity dependence of R_2 and P_2 correlation functions in pp Collisions at $\sqrt{s}$ = 7 TeV using PYTHIA8 is performed.**
- ☑ **Jetty events have a higher mean-p_T, whereas isotropic events have a lower mean-p_T .**
- ☑ **P_2 is narrower than R_2 due to angular ordering.**
- ☑ **S_0 evolves as a powerful tool to separate jetty and isotropic events as compared to multiplicity.**

References

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