

# Quark Matter 2012

## Probing Initial Fluctuations with Two Particle Transverse Momentum Correlations in Pb - Pb Collisions at 2.76 TeV

Claude A. Pruneau, for the ALICE Collaboration



### Summary

- Study of two-particle correlation functions  $R_2$  and  $\Delta p_T \Delta p_T$  differential correlations for (+,+), (-,-), and (+,-) charged particle pairs vs. collision centrality in Pb - Pb collisions at  $s_{nn}^{1/2} = 2.76$  TeV.
- Shape & amplitude exhibit strong dependence on collision centrality.
- Studied Fourier decompositions in  $\Delta\phi$  as a function of  $\Delta\eta$ .
- Measured coefficients  $v_2\{R_2\}$ ,  $v_3\{R_2\}$ , and  $v_4\{R_2\}$  are ...
  - **Constant for  $|\Delta\eta| > 0.6$  and independent of charge combination**
  - In agreement with flow coefficients,  $v_n\{EP\}$ , obtained with Event Plane (EP) Method w/  $|\Delta\eta| > 2$ .
- Measured Coefficients  $v_2\{\Delta p_T \Delta p_T\}$ ,  $v_3\{\Delta p_T \Delta p_T\}$ , and  $v_4\{\Delta p_T \Delta p_T\}$  are ...
  - **Constant for  $|\Delta\eta| > 0.6$  and independent of charge combination**
  - In agreement w/ expectations based on **flow dominance and factorization, i.e. Eq 2.**
  - Support notion that particle correlations are predominantly driven by flow & initial geometry fluctuations.

### Analysis Details

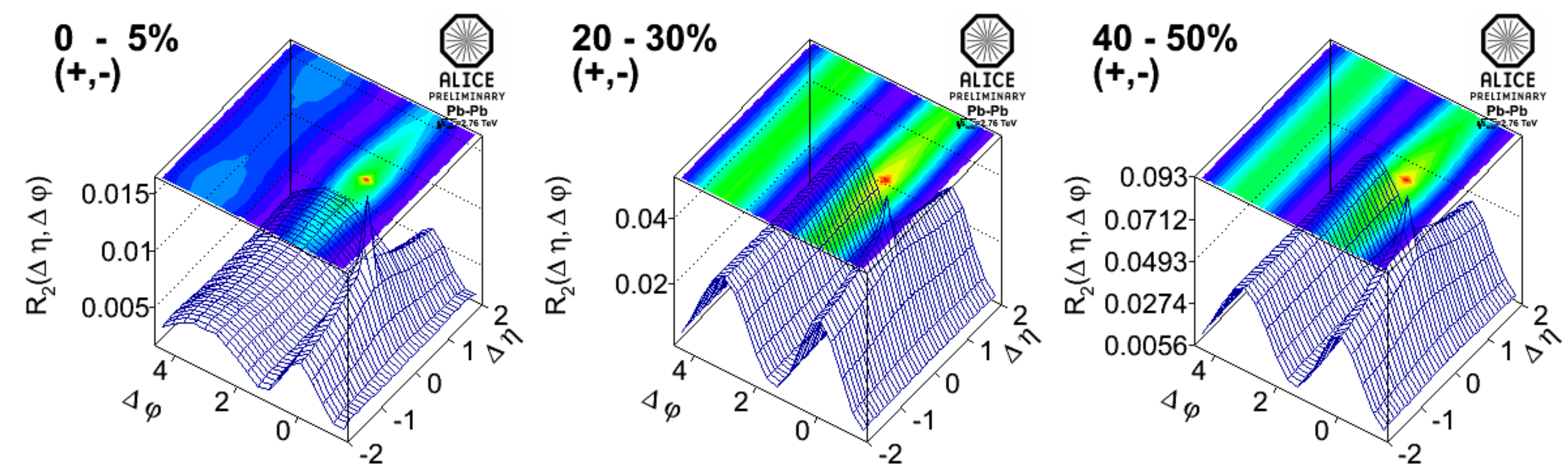
- ~15 million minimum bias Pb - Pb events.
- Collision centrality determination based on V0 detector.
- Events selected in  $|z_{\text{vertex}}| < 10$  cm range.
- Track Selection
  - $0.2 < p_T < 2.0$  GeV/c.
  - $|\eta| < 1$ .
  - $N_{\text{hits}} > 70$  out of a maximum of 159.
- Analysis carried out using track weights based on event  $z_{\text{vertex}}$ , and track  $\eta$ ,  $p_T$ , and  $\phi$ .

### Number Correlation: $R_2$

$$R_2(\Delta\eta, \Delta\phi) = \frac{\int_{\text{accept}} \rho_2(\eta_1, \phi_1, p_{T,1}, \eta_2, \phi_2, p_{T,2}) d p_{T,1} d p_{T,2}}{\int_{\text{accept}} \rho_1(\eta_1, \phi_1, p_{T,1}) d p_{T,1} \int_{\text{accept}} \rho_1(\eta_2, \phi_2, p_{T,2}) d p_{T,2}} - 1 = \frac{\rho_2(\eta_1, \phi_1, \eta_2, \phi_2)}{\rho_1(\eta_1, \phi_1) \rho_1(\eta_2, \phi_2)} - 1$$

$\Delta\phi = \phi_1 - \phi_2$   
 $\Delta\eta = \eta_1 - \eta_2$

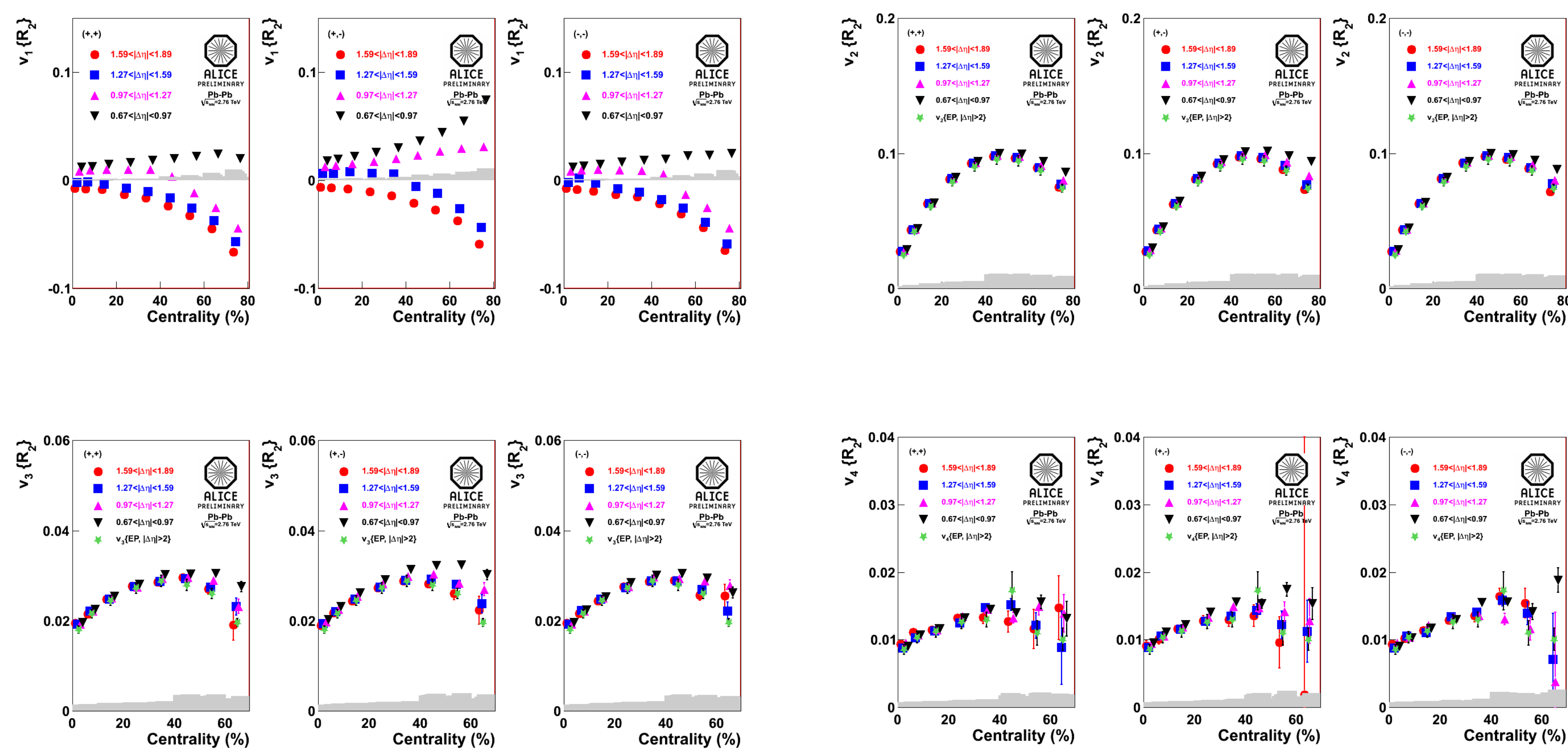
Examples:



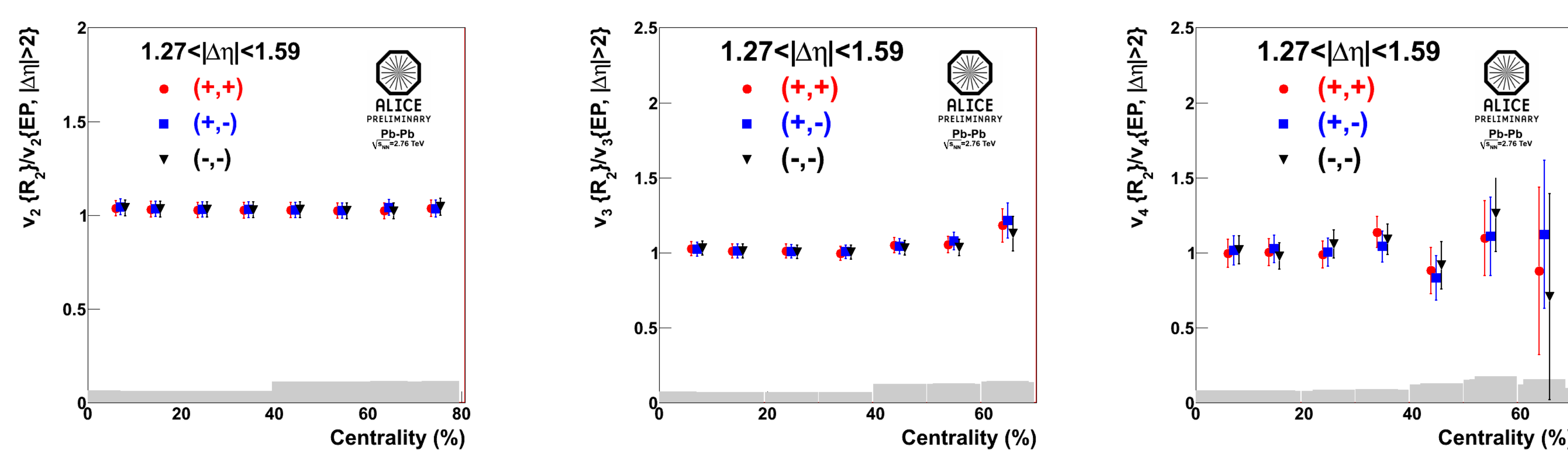
### Fourier Coefficients vs. $\Delta\eta$ Interval

$$f(\Delta\phi) = V_{0\Delta} + \sum_{n=1}^{\infty} V_{n\Delta} \cos n\Delta\phi$$

$$v_n = \text{sign}(V_{n\Delta}) \sqrt{\frac{|V_{n\Delta}|}{2}}$$



### Comparison to $v_n\{EP\}$ obtained with Event Plane Method



### Transverse Momentum Correlations: $\langle \Delta p_T \Delta p_T \rangle$

$$\langle \Delta p_T \Delta p_T \rangle(\Delta\eta, \Delta\phi) = \frac{\int \rho_2(\eta_1, \phi_1, p_{T,1}, \eta_2, \phi_2, p_{T,2}) \Delta p_{T,1} \Delta p_{T,2} d p_{T,1} d p_{T,2}}{\int_{\text{accept}} \rho_2(\eta_1, \phi_1, p_{T,1}, \eta_2, \phi_2, p_{T,2}) d p_{T,1} d p_{T,2}}$$

$\Delta\phi = \phi_1 - \phi_2$   
 $\Delta\eta = \eta_1 - \eta_2$   
 $\Delta p_{T,i} = p_{T,i} - \langle p_T \rangle$

Flow Ansatz:

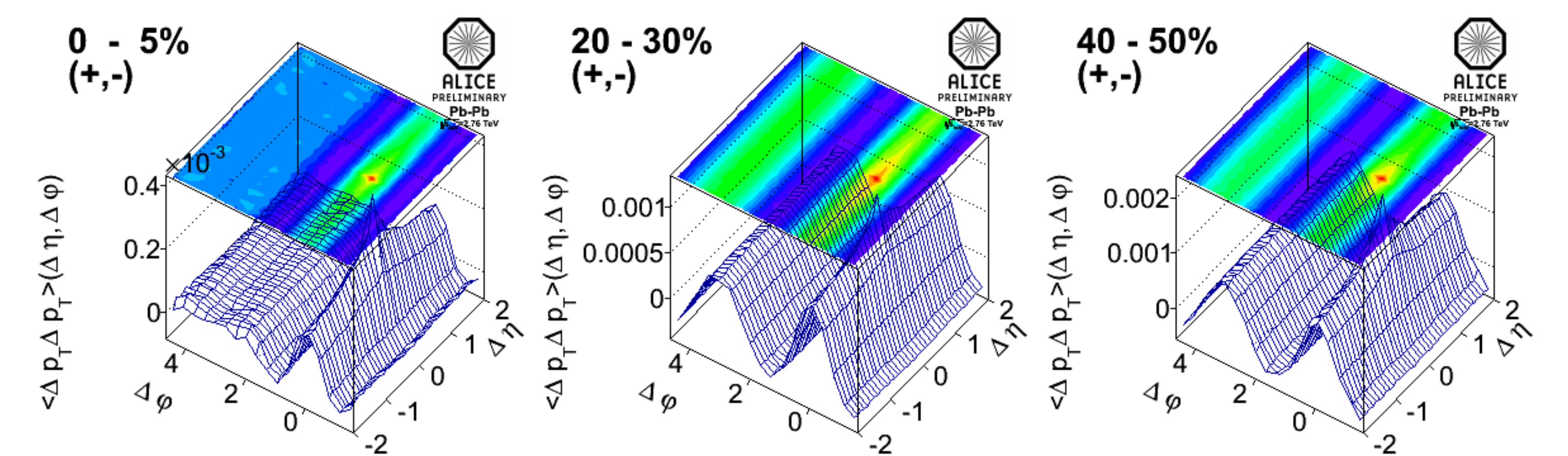
$$\text{Eq. 1} \quad \langle \Delta p_T \Delta p_T \rangle(\Delta\eta, \Delta\phi) = \frac{2 \sum_n (v_n^p(\eta_1) - \langle p_T \rangle(\eta_1) v_n(\eta_1)) (v_n^p(\eta_2) - \langle p_T \rangle(\eta_2) v_n(\eta_2)) \cos(n\Delta\phi)}{1 + 2 \sum_n v_n(\eta_1) v_n(\eta_2) \cos(n\Delta\phi)}$$

$$\text{Eq. 2} \quad v_n \{ \Delta p_T \Delta p_T \} \approx v_n^{pT} - \langle p_T \rangle v_n$$

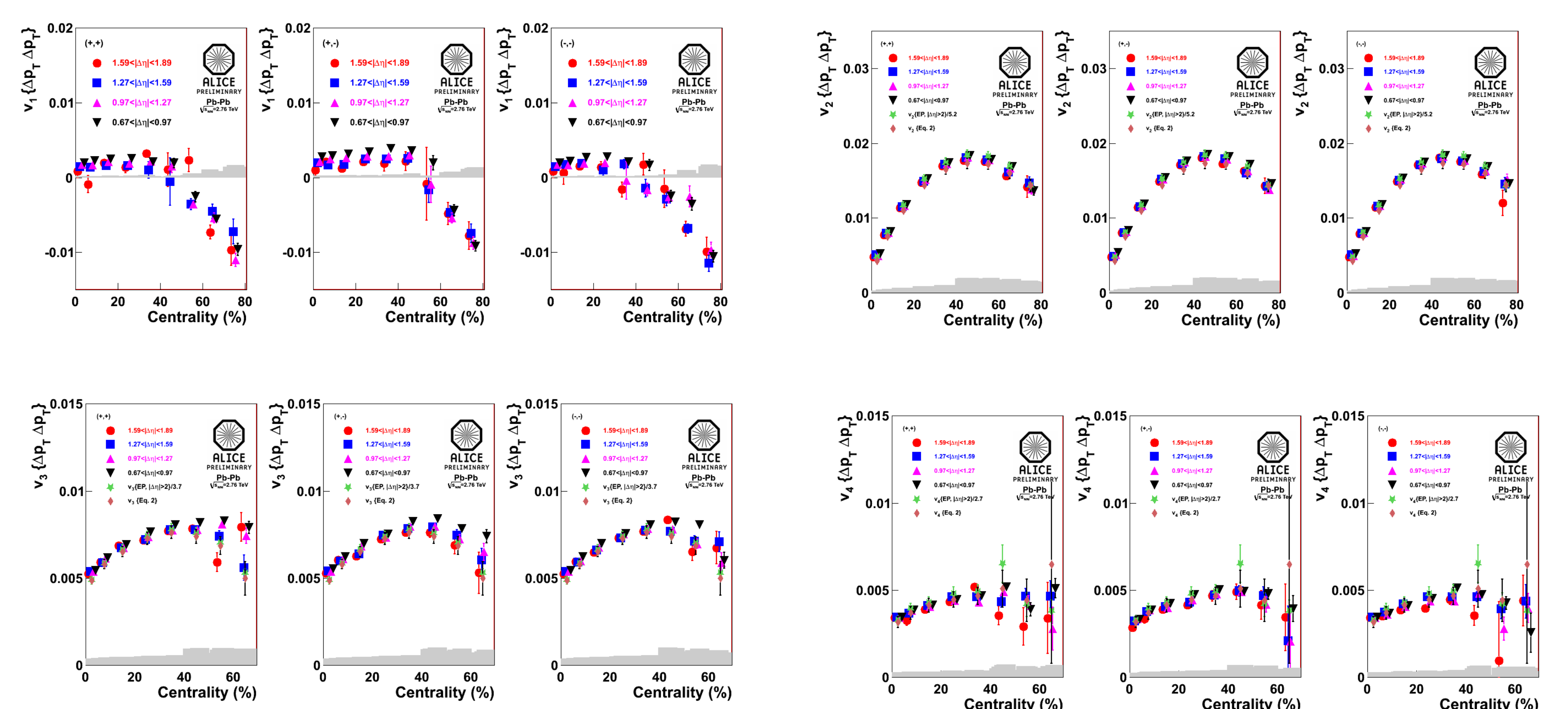
$$v_n(\eta) = \frac{1}{P_n(\eta)} \int P_n(\eta, p_T) v_n(\eta, p_T) d p_T$$

$$v_n^{pT}(\eta) = \frac{1}{P_n(\eta)} \int P_n(\eta, p_T) v_n(\eta, p_T) p_T d p_T$$

Examples:



### Fourier Coefficients vs. $\Delta\eta$ Interval



### Comparison with Equation 2

