Υ-h correlation analysis in pPb at 8 TeV

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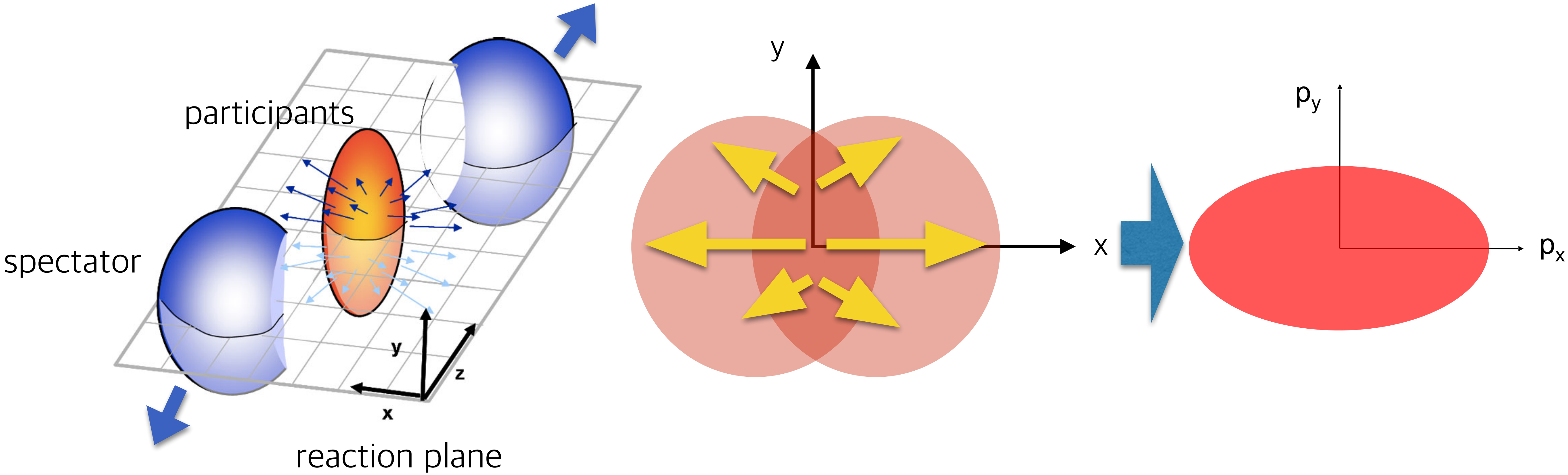
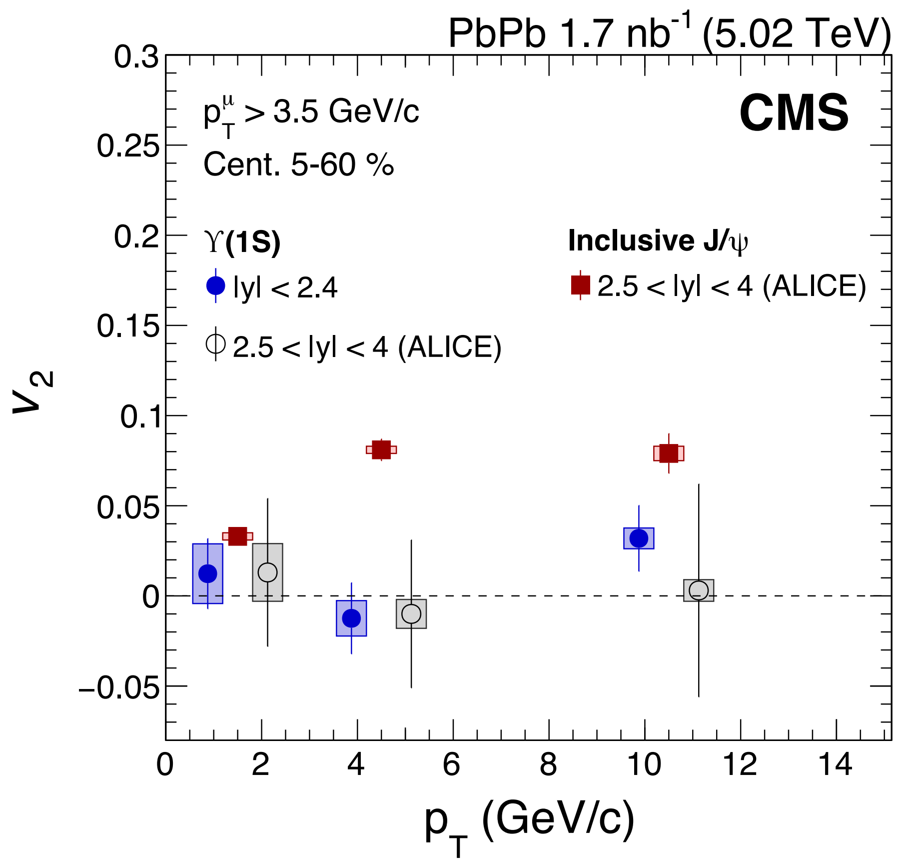
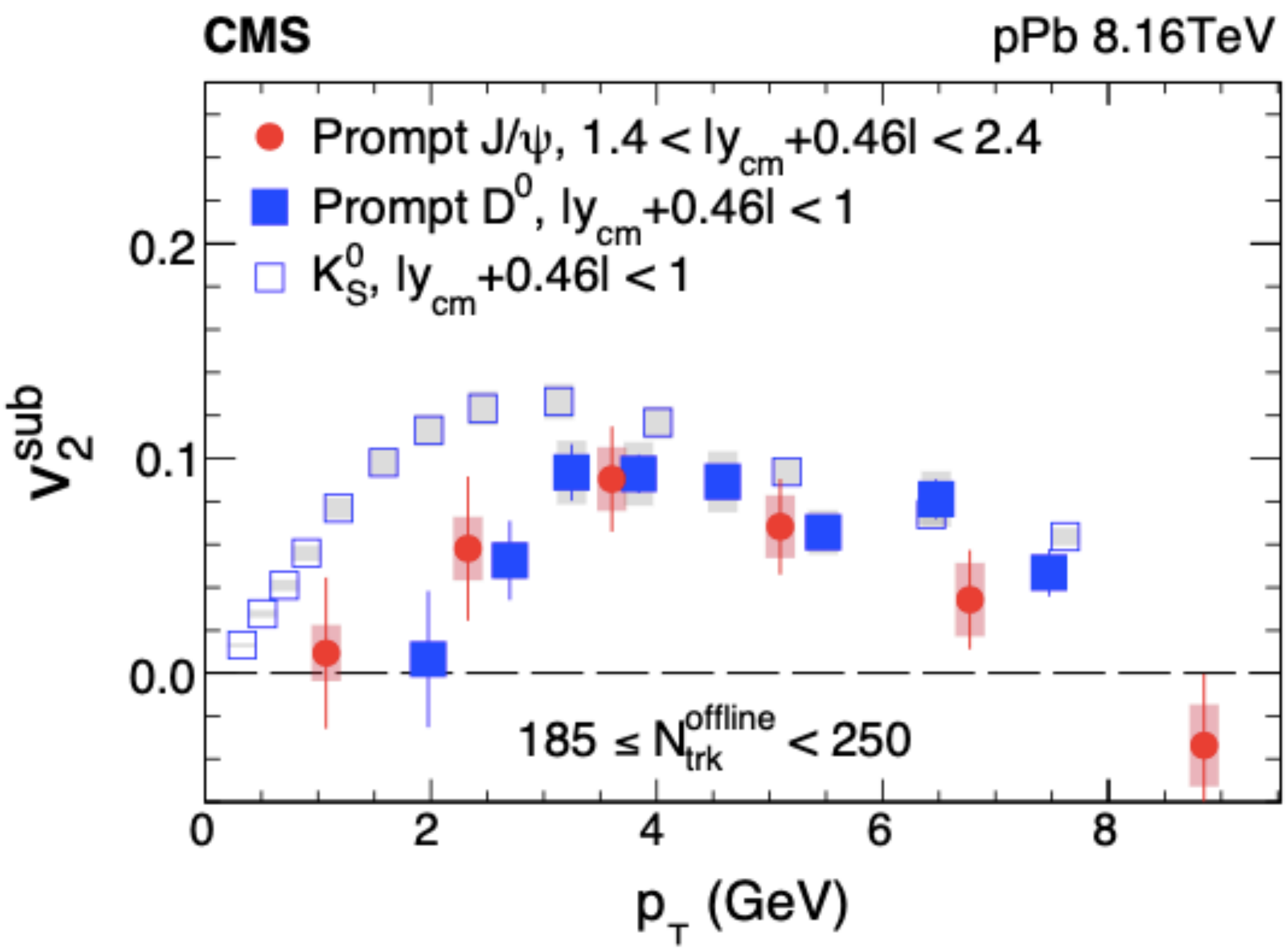
Motivation



- Participants of the collision are distributed in an almond shape region
- Due to the length and pressure difference, spatial anisotropy converted into a momentum anisotropy
- Quarkonia are expected to carry out information on the initial state and the medium effects

Motivation

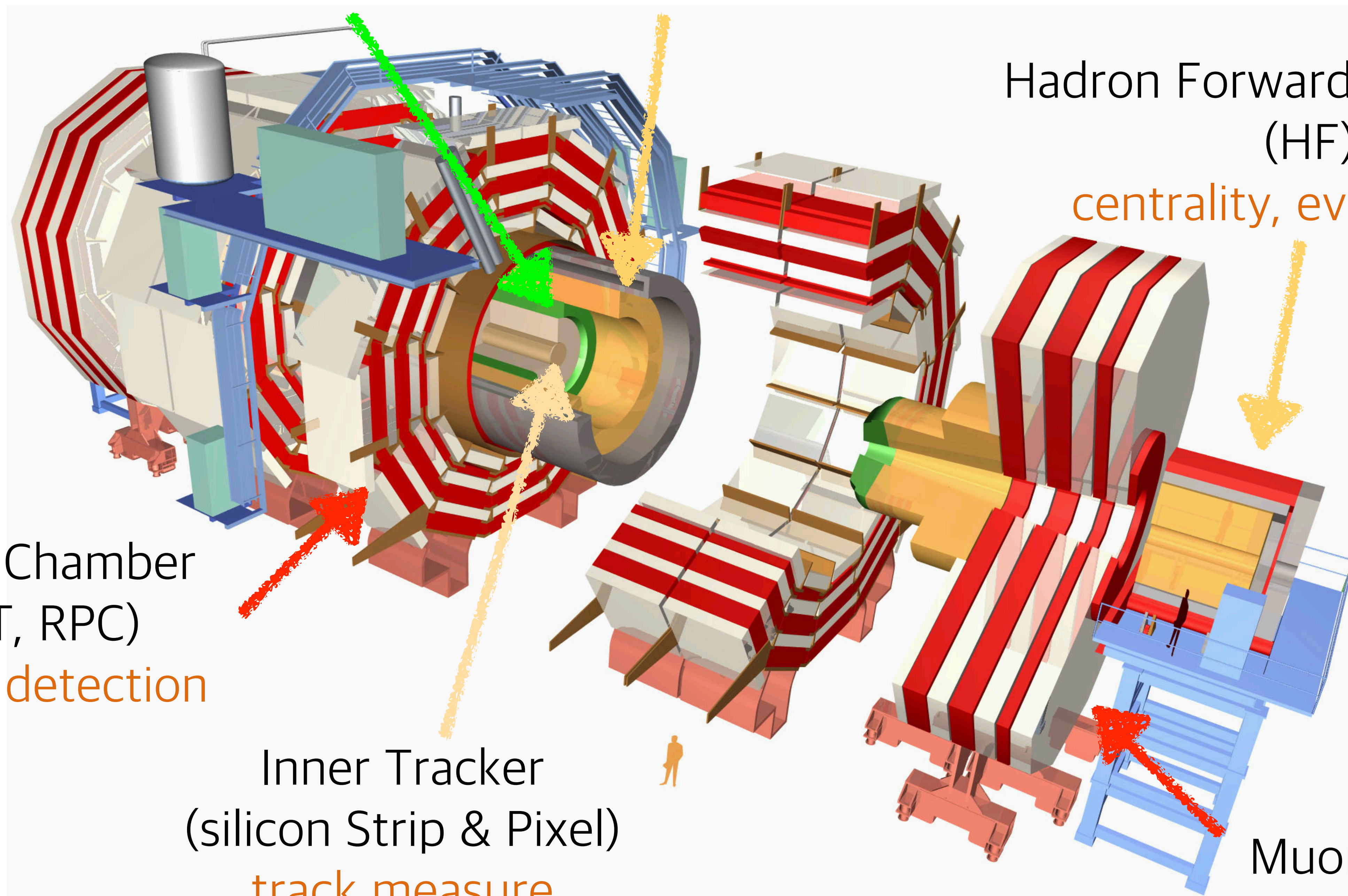




- Zero Υ v_2 in PbPb 5 TeV
- Non-zero J/ψ v_2 in pPb 8 TeV
- First study of Υ v_2 in pPb
- Prove to understand small system

CMS detector

Calorimeters
(Electromagnetic & Hadron)



Hadron Forward Calorimeter
(HF)
centrality, event plane

MuonChamber
(DT, RPC)
Muon detection

Inner Tracker
(silicon Strip & Pixel)
track measure

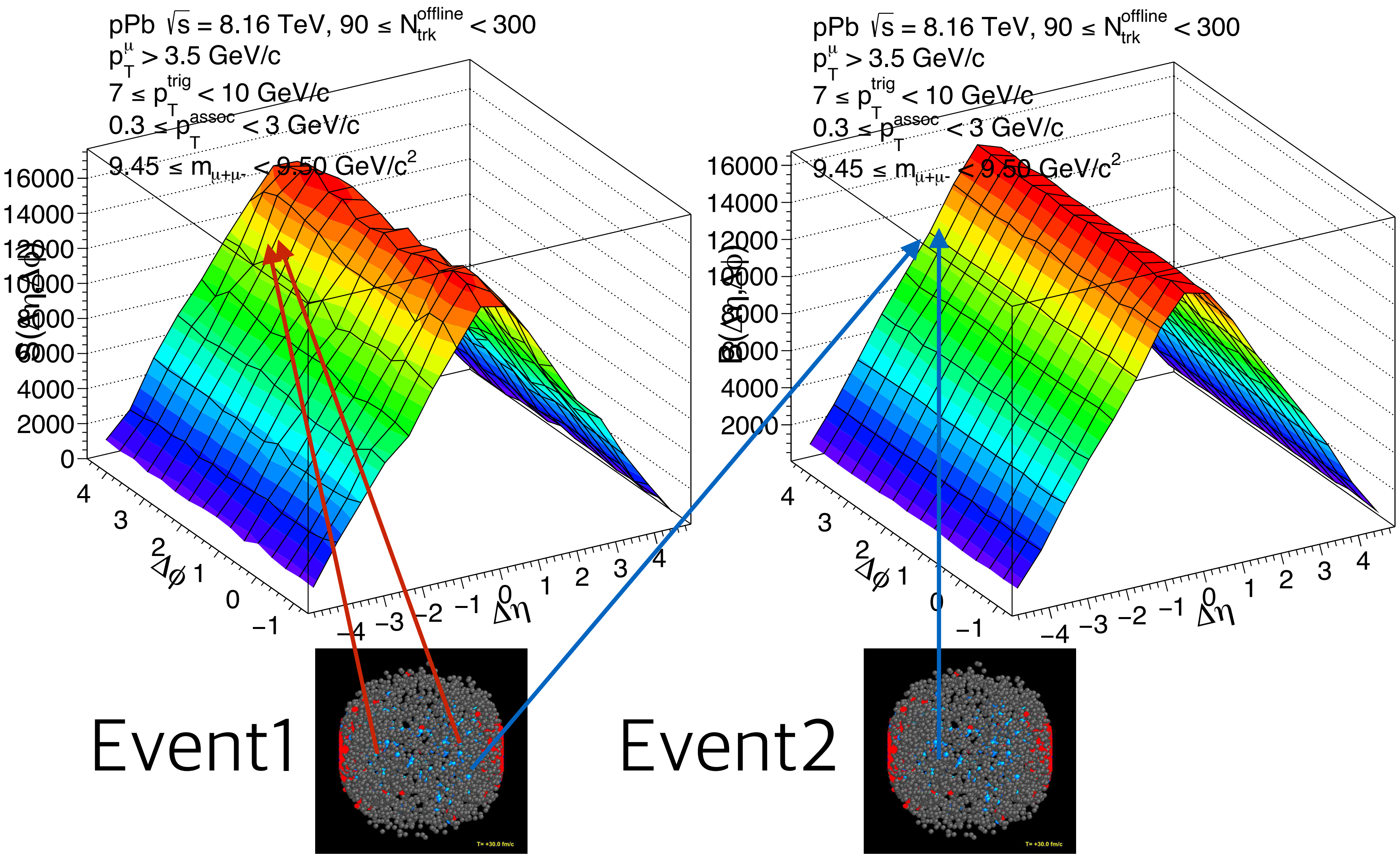
Muon Chamber
(CSC, RPC)
Muon detection

Correlation method

$$S(\Delta\eta,\Delta\phi)=\frac{1}{N_{trig}}\frac{d^2N^{same}}{d\Delta\eta d\Delta\phi}$$

$$B(\Delta\eta,\Delta\phi)=\frac{1}{N_{trig}}\frac{d^2N^{mix}}{d\Delta\eta d\Delta\phi}$$

$$\frac{1}{N_{trig}}\frac{d^2N^{pair}}{d\Delta\eta d\Delta\phi}=\frac{S(\Delta\eta,\Delta\phi)}{B(\Delta\eta,\Delta\phi)}$$



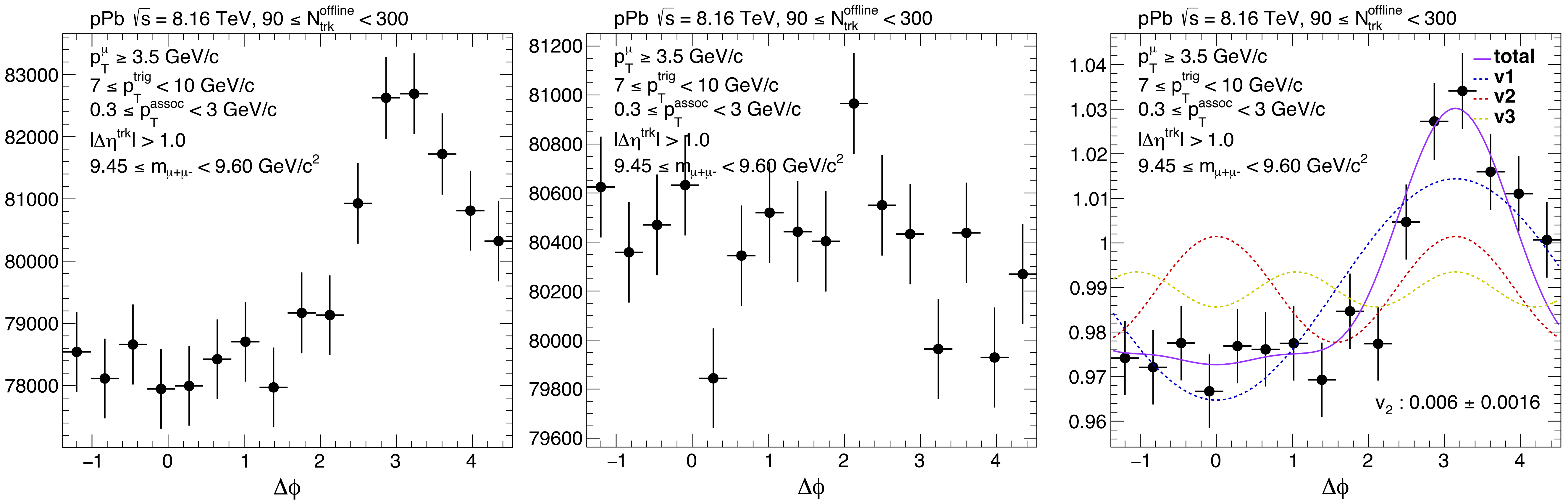
- Two-particle angular correlations in $\Delta\eta$-$\Delta\phi$ (Υ-track)
- $0.3 < p_T^{track} < 3$, $90 \le$ multiplicity < 300
- $|z_{vtx}^1 - z_{vtx}^2| < 2$ cm

dϕ projection

$$S(\Delta\eta,\Delta\phi) = \frac{1}{N_{trig}} \frac{d^2N^{same}}{d\Delta\eta d\Delta\phi}$$

$$B(\Delta\eta,\Delta\phi) = \frac{1}{N_{trig}} \frac{d^2N^{mix}}{d\Delta\eta d\Delta\phi}$$

$$\frac{1}{N_{trig}} \frac{d^2N^{pair}}{d\Delta\eta d\Delta\phi} = \frac{S(\Delta\eta,\Delta\phi)}{B(\Delta\eta,\Delta\phi)}$$

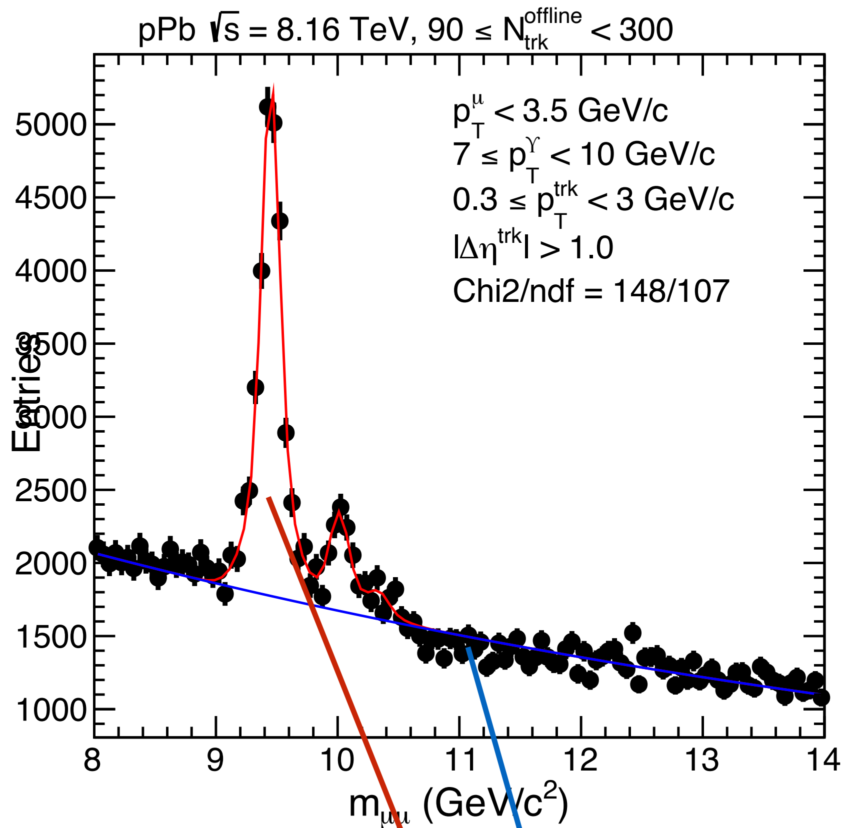


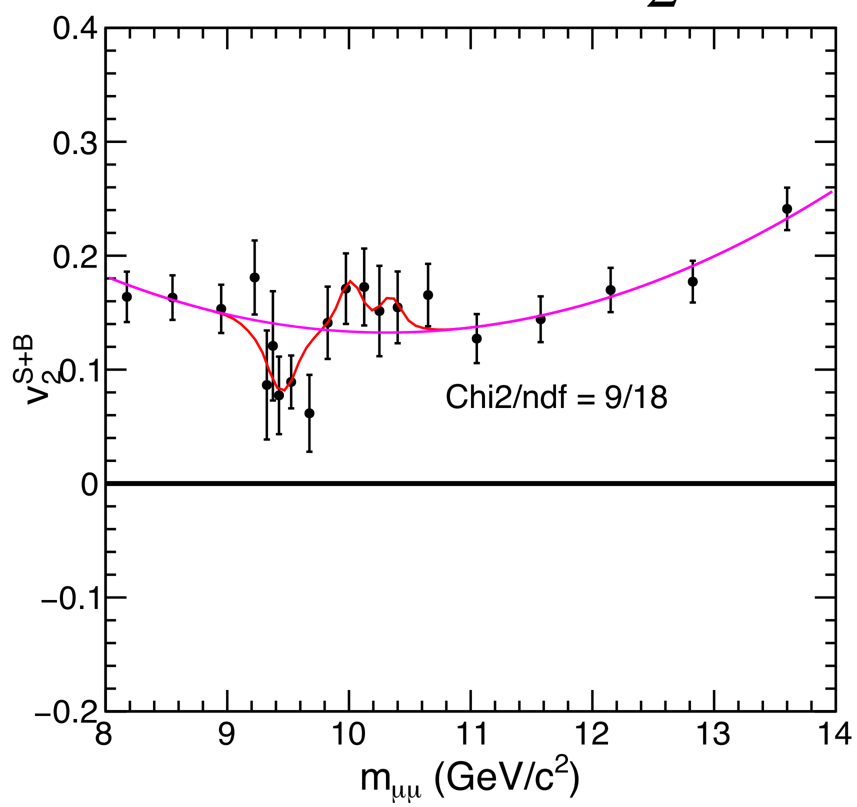
$$\frac{1}{N_{trig}} \frac{dN^{pair}}{d\Delta\phi} = \frac{N_{assoc}}{2\pi}\{1 + \sum_n 2V_{n\Delta}\cos(n\Delta\phi)\}$$

- $|\Delta\eta| > 1$ projected to remove jet contribution
- Ratio fitted with Fourier series

Simultaneous fitting

$$v_2^{S+B} = \frac{v_2^{\mu\mu-trk}}{\sqrt{v_2^{trk-trk}}}$$



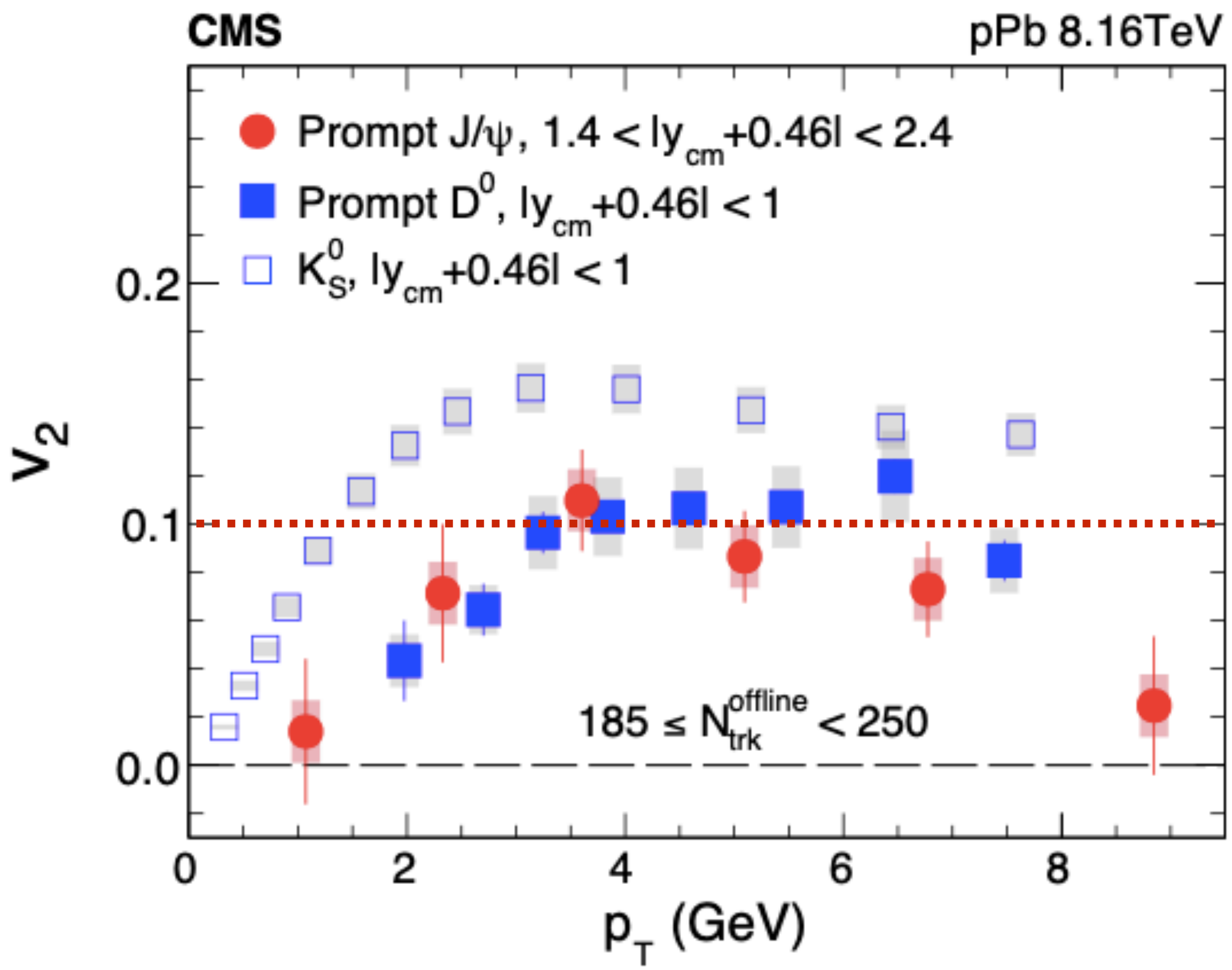


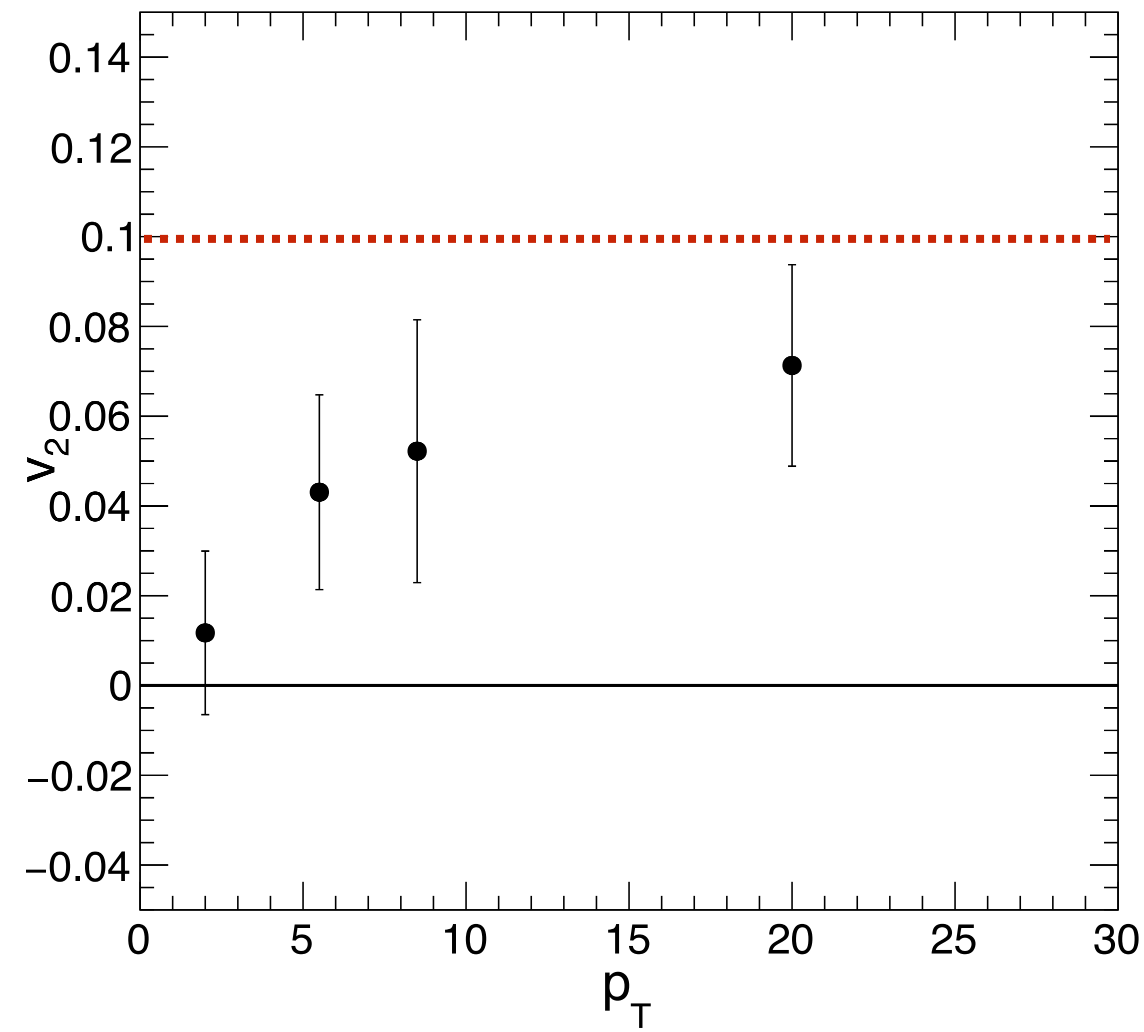
$$f_{sig} = \frac{signal}{signal + background}$$

$$v_n^{obs} = f_{sig} v_n^{sig} + (1 - f_{sig}) v_n^{bkg}$$

- Track component should be subtracted to observe Υ v_2
- Observed v_2 is combination of signal and background di-muon v_2
- Simultaneous fitting is applied to extract signal v_2

High-multiplicity v_2



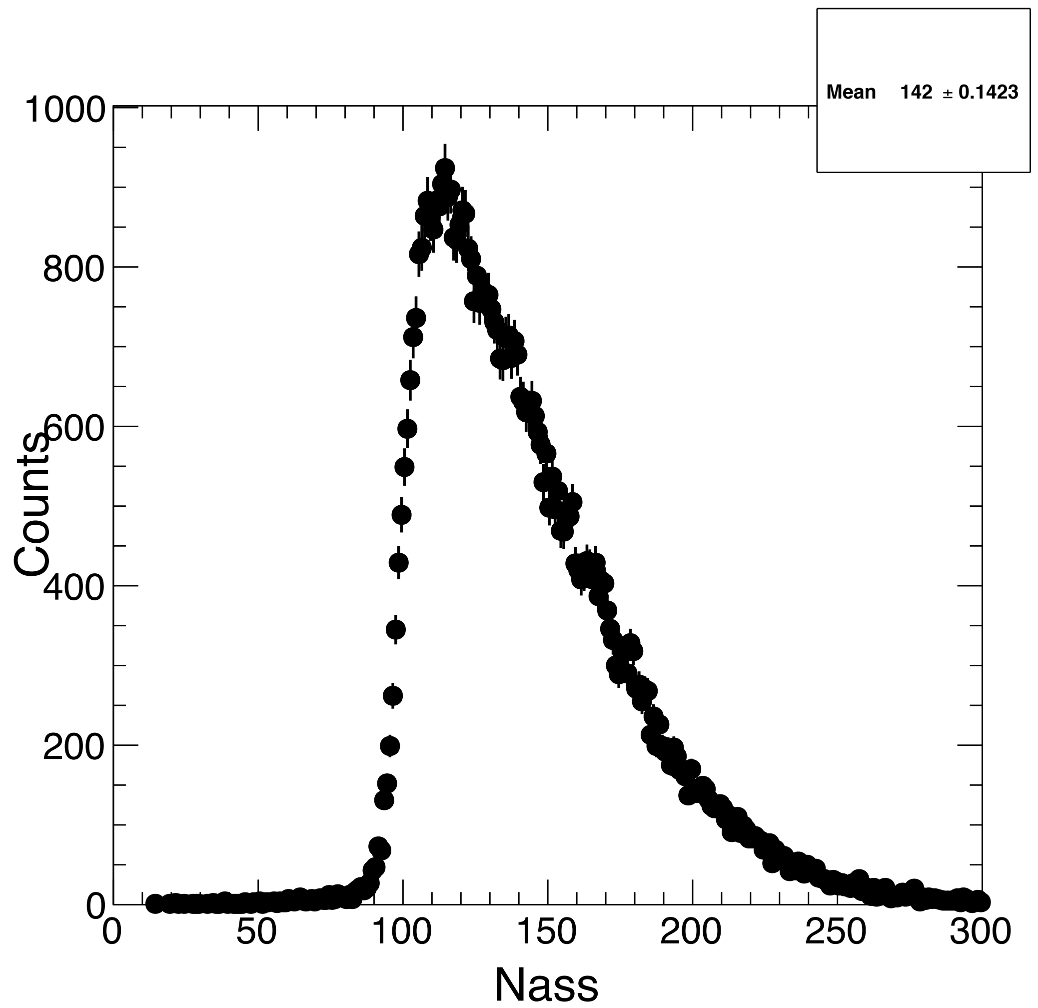


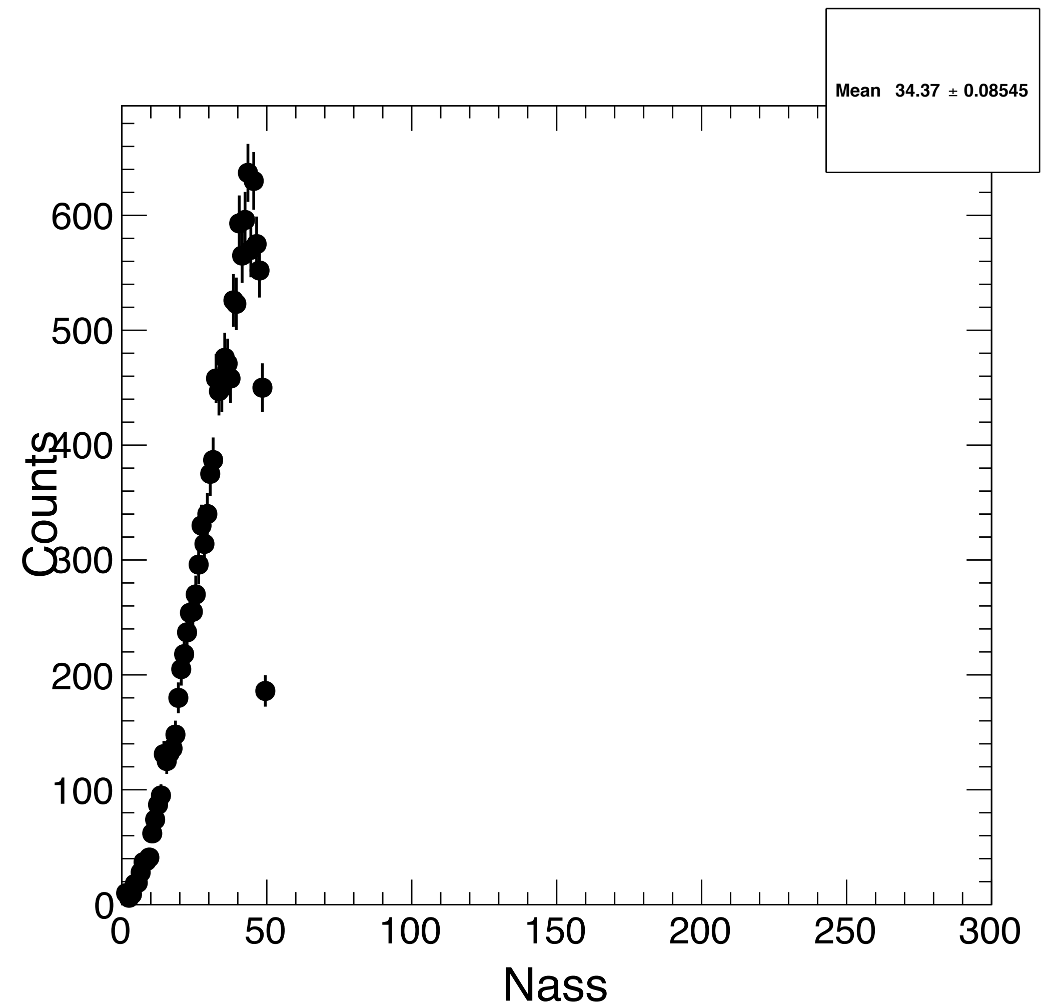
- High-multiplicity ϒ v_2 is non-zero
- Lower than charm mesons

Low-multiplicity subtraction

- Low-multiplicity subtraction is needed to estimate residual contribution from back-to-back jet correlation
- $v_2^{sub} = v_2(high) - v_2(low) \times \frac{N_{assoc}(low)}{N_{assoc}(high)} \times \frac{Y_{jet}(high)}{Y_{jet}(low)}$
- $Y_{jet}^{sig} = \frac{Y_{jet}^{peak} - (1-f)Y_{jet}^{bkg}}{f}$
- $Y_{jet} = Y_{jet}(|\Delta\eta| < 1) - Y_{jet}(|\Delta\eta| > 2)$

Number of associator





- $v_2^{sub} = v_2(high) - v_2(low) \times \frac{N_{assoc}(low)}{N_{assoc}(high)} \times \frac{Y_{jet}(high)}{Y_{jet}(low)}$
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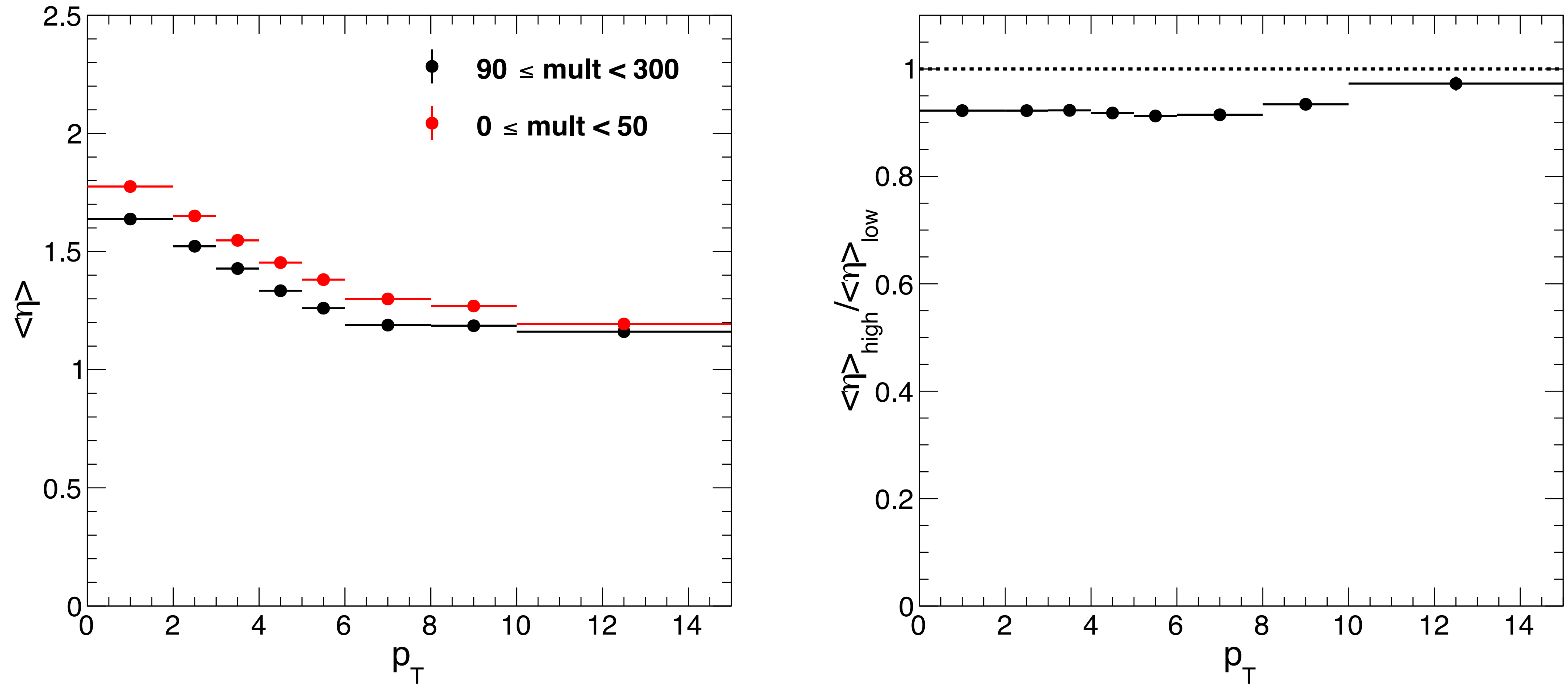
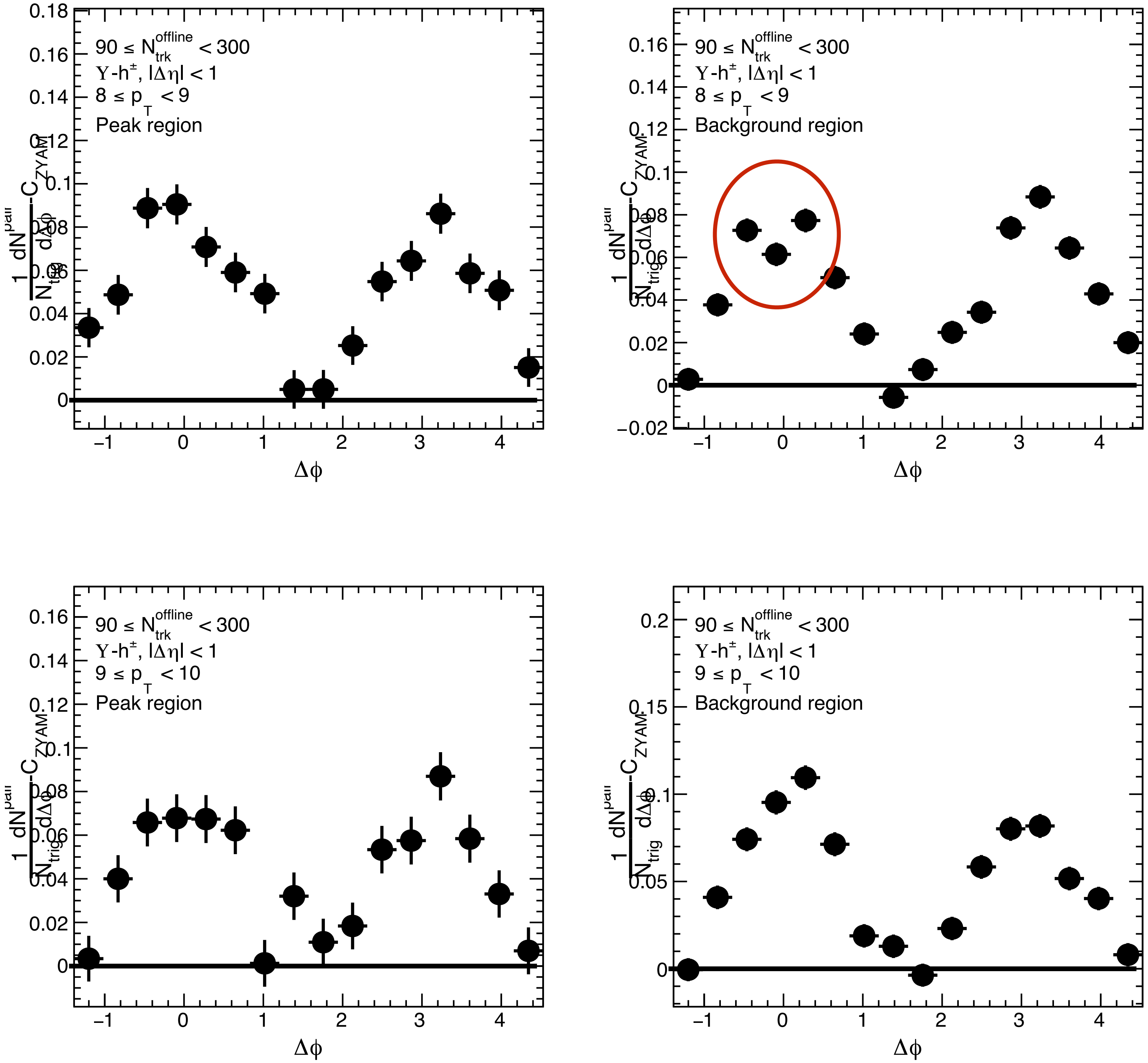
High η truncation



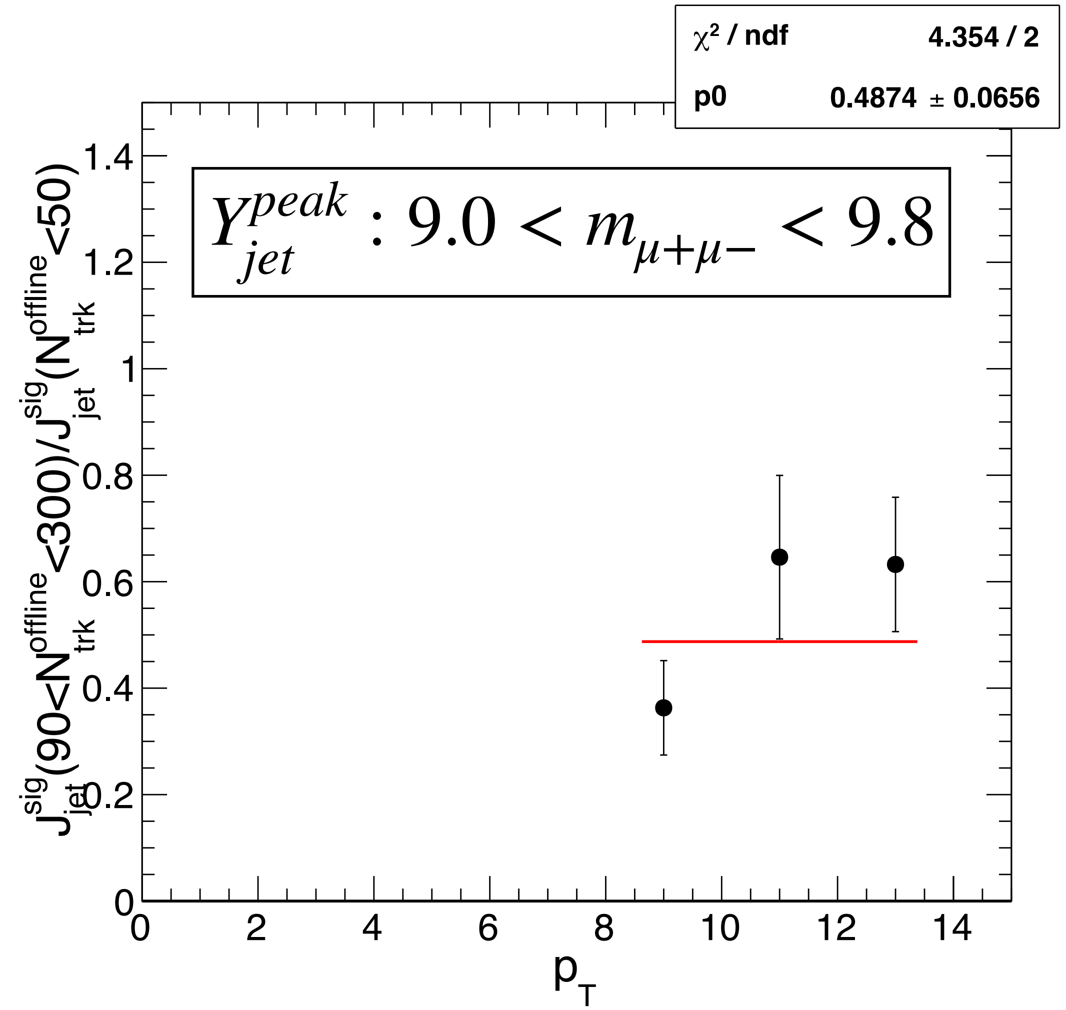
- High η di-muon lose correlate tracks due to CMS detector acceptance
- Need to consider multiplicity dependence of η distribution
- Effects from truncation are largely cancelled

Υ p_T range



- Even if the truncation is cancelled, high-p_T is used to calculate jet yield ratio
- [9, 10, 12, 15]

Yield ratio(Υ)



- $$Y_{jet}^{sig} = \frac{Y_{jet}^{peak} - (1-f)Y_{jet}^{bkg}}{f}$$
- Jet yield ratio could be different for peak region range definition

Summary

- Quarkonia are expected to carry out information on the initial state and the medium effects
- Zero ϒ v_2 in PbPb 5 TeV and non-zero J/ψ v_2 in pPb 8 TeV are studied at CMS
- pPb ϒ v_2 is one of important probe to understand ϒ and small system
- High-multiplicity ϒ v_2 is non-zero but lower than that of J/ψ
- Low-multiplicity subtraction is ongoing

Back up

High-multiplicity

- What is high-multiplicity?
  - No clear definition
  - If there is heavy-ion like phenomena(i.e. ridge) at relatively high-multiplicity, it is high-multiplicity
- How about Υ case?
  - If v_2 is 0, can not define high-multiplicity
  - Should be defined with verified range in the previous analysis
  - Higher than 90 shows higher v_2 than pp

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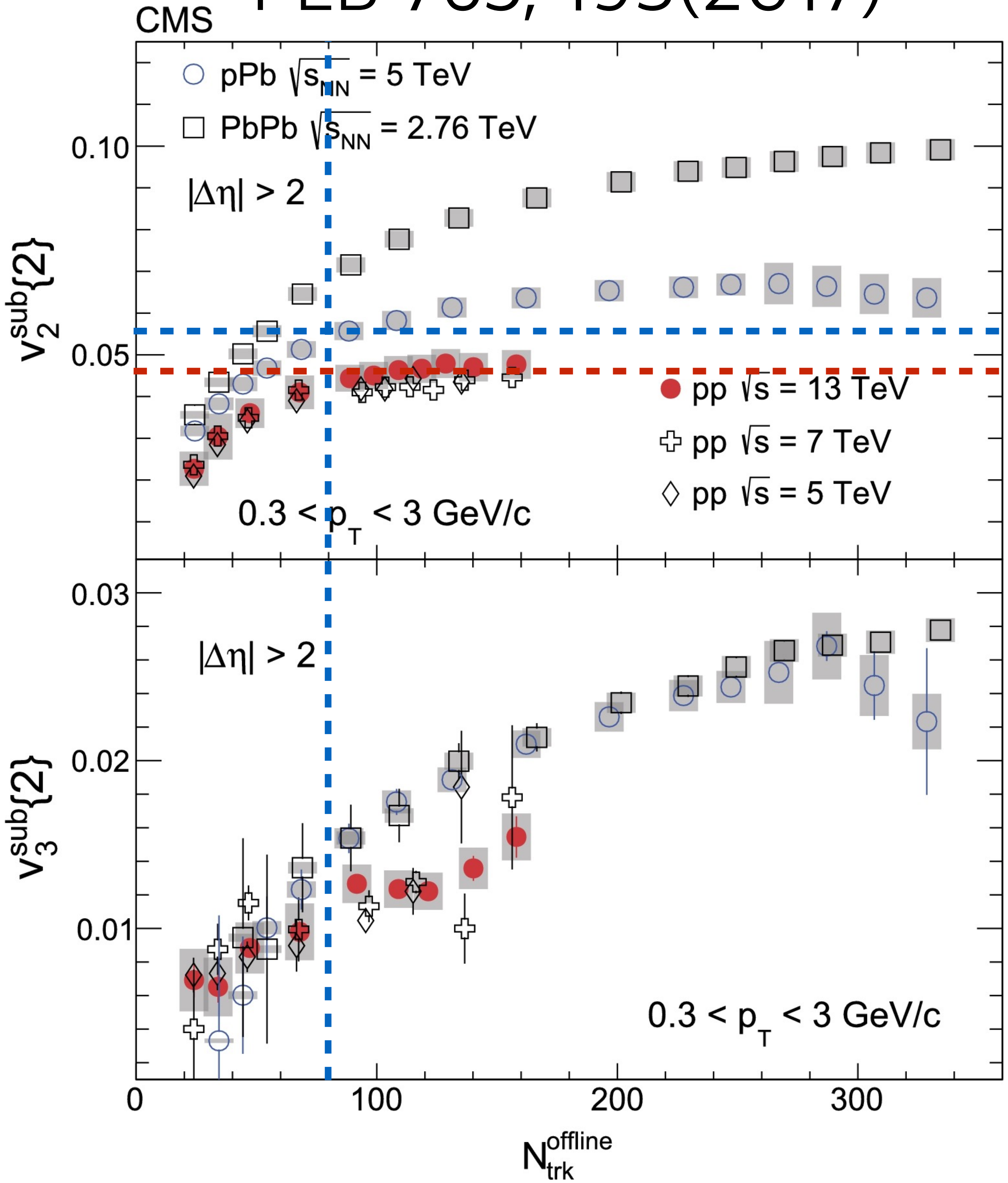
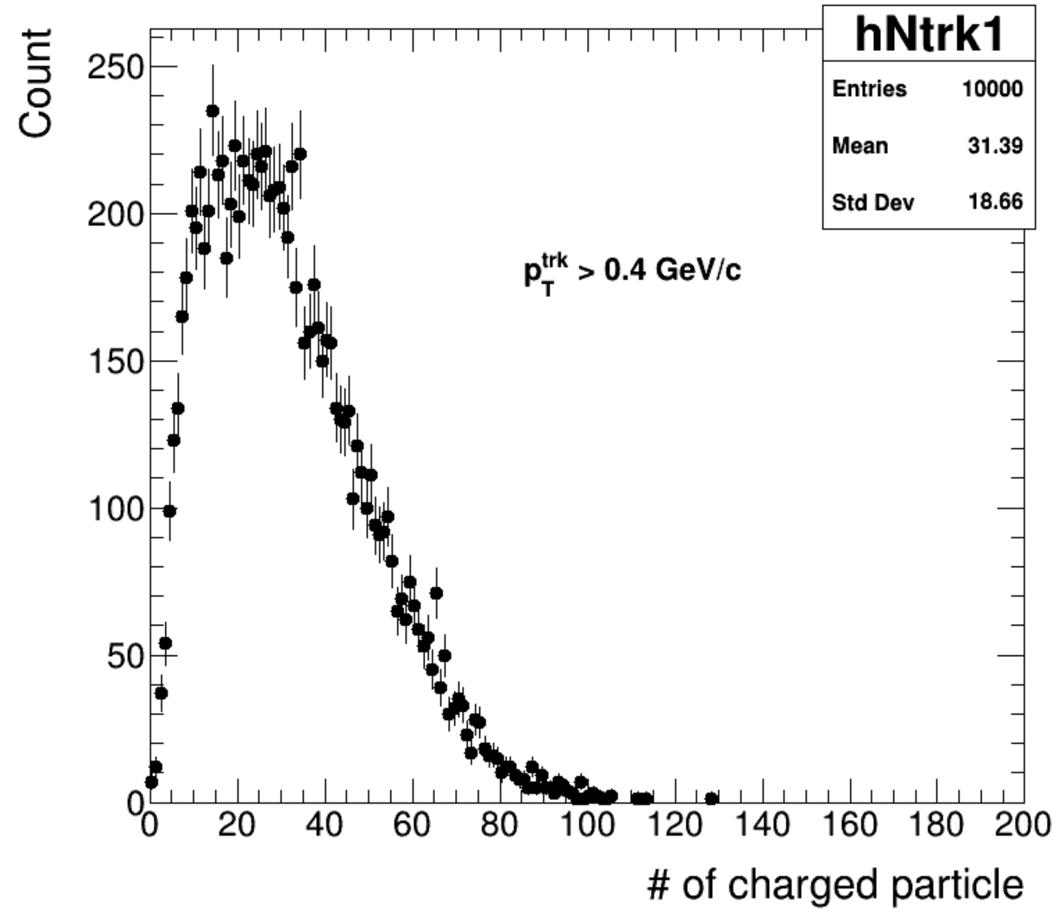
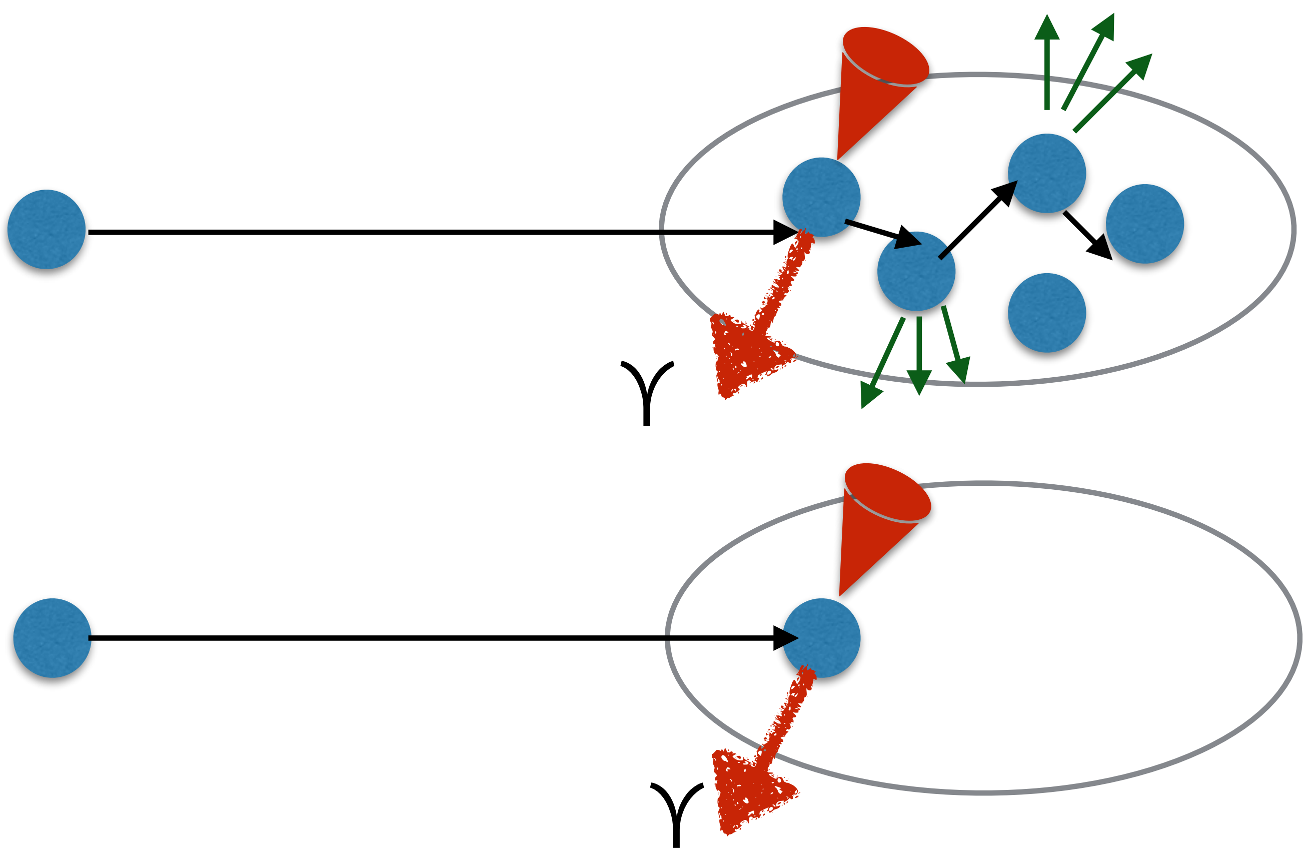


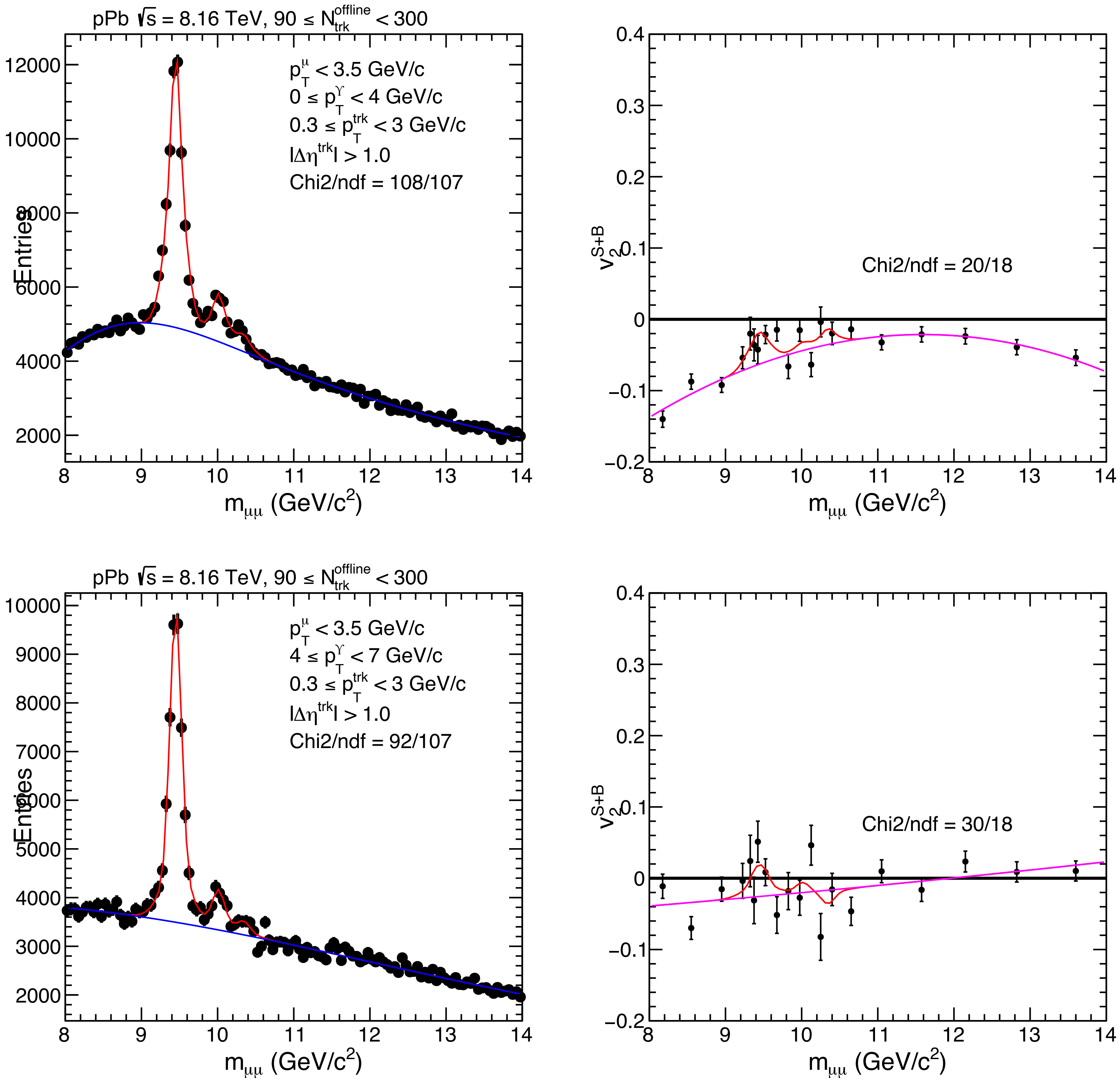
Low-multiplicity



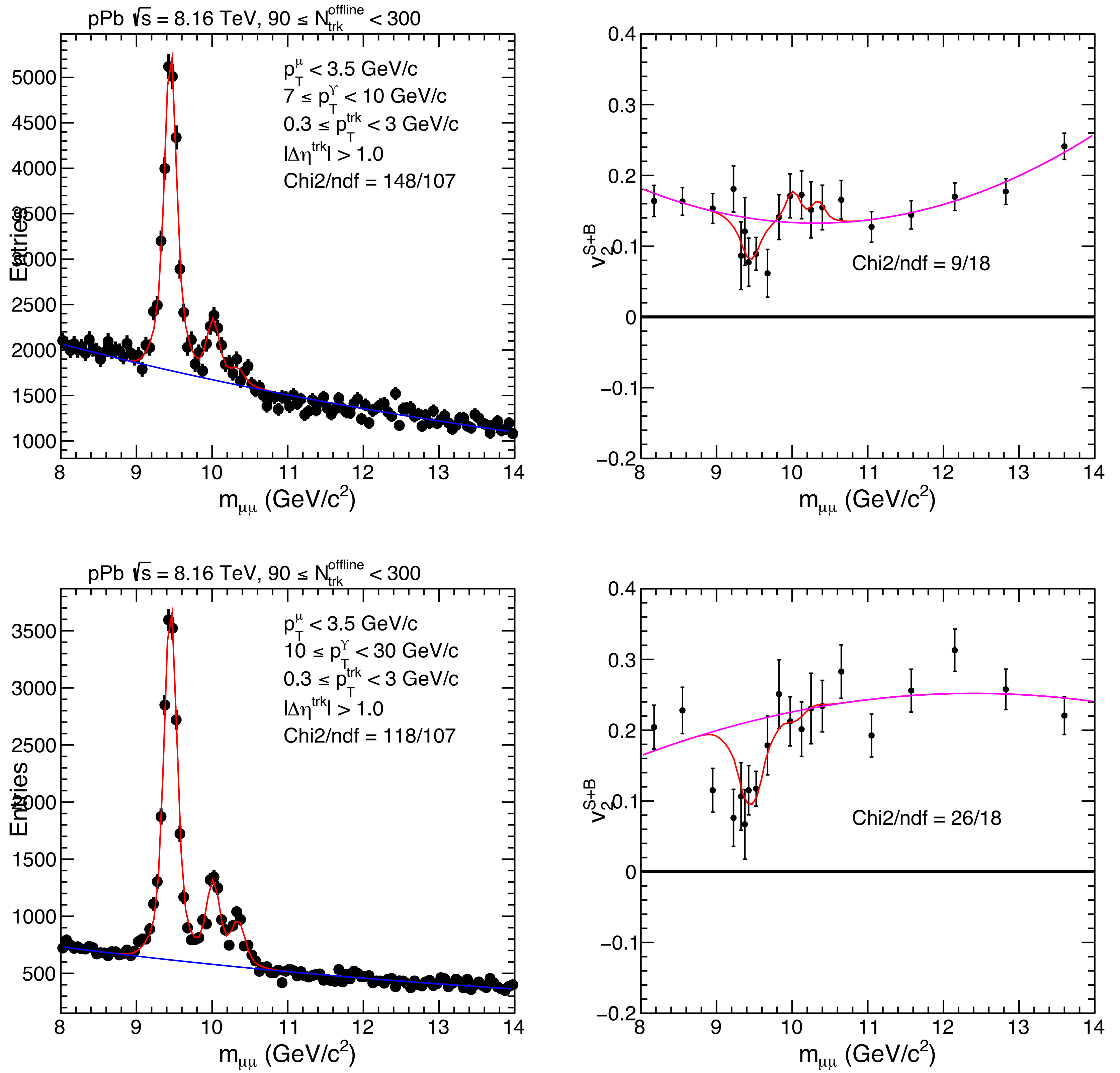


- Low-multiplicity range also need to retain enough ϒ
- Low-multiplicity subtraction is needed to estimate residual contribution from back-to-back jet correlations
- Ncoll == 1 is back-to-back jet correlation case
- Multiplicity 50 (31±18) is tentative multiplicity range

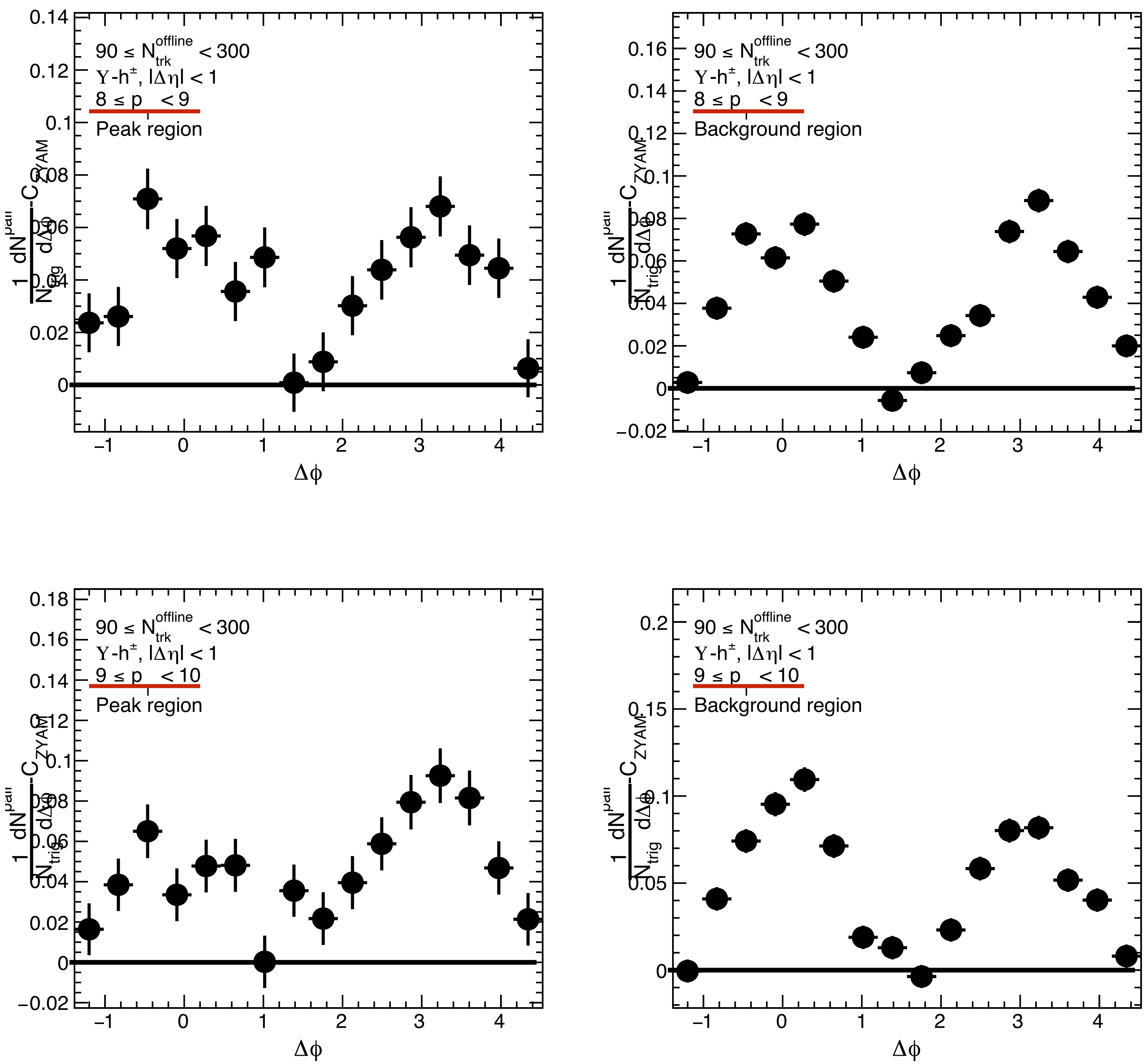
Simultaneous fitting 90 < mult. < 300



Simultaneous fitting 90 < mult. < 300



90 < mult. < 300 (9.2 < m < 9.6)



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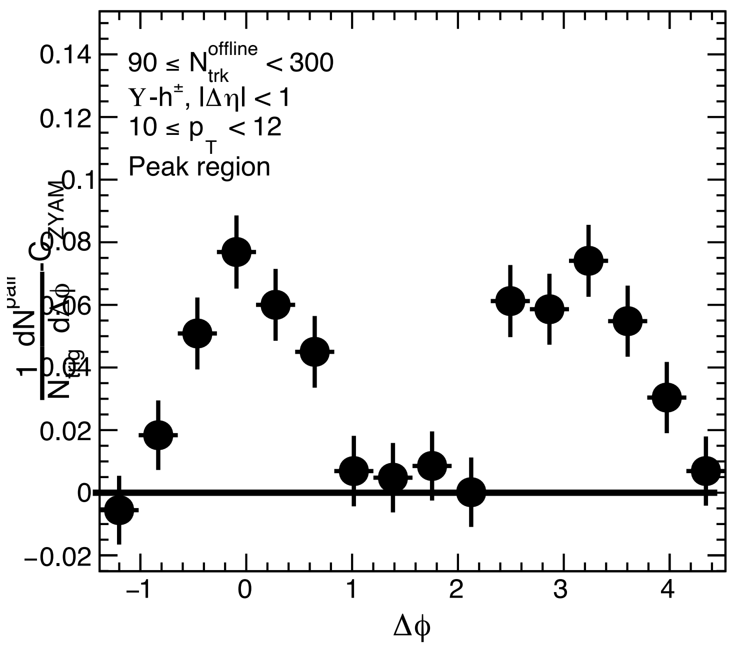
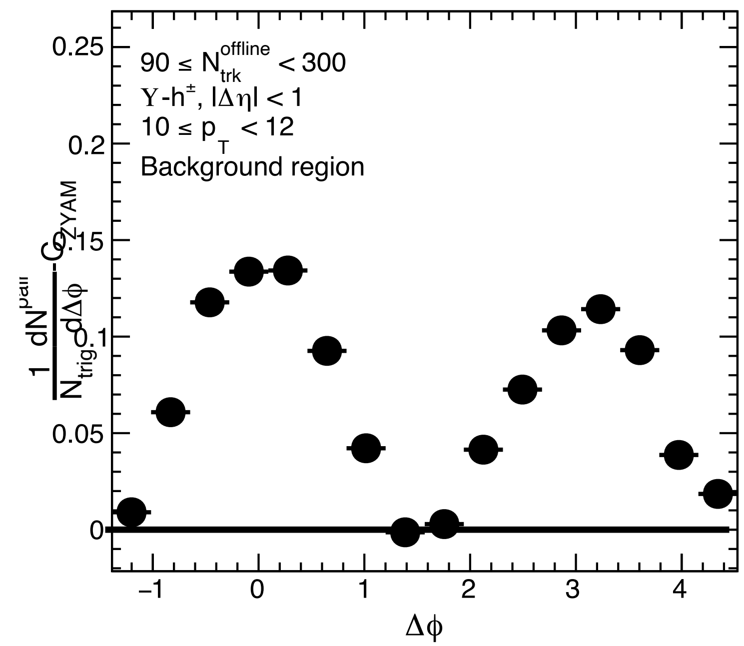
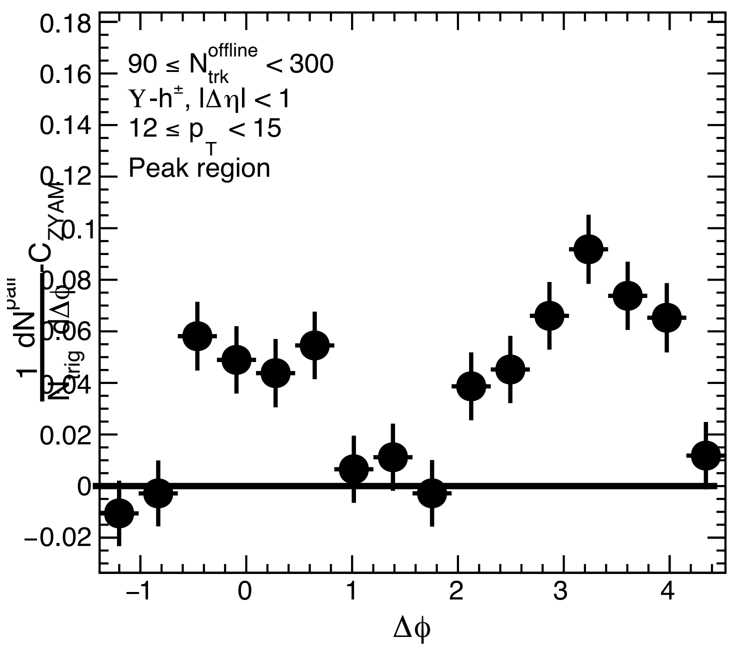
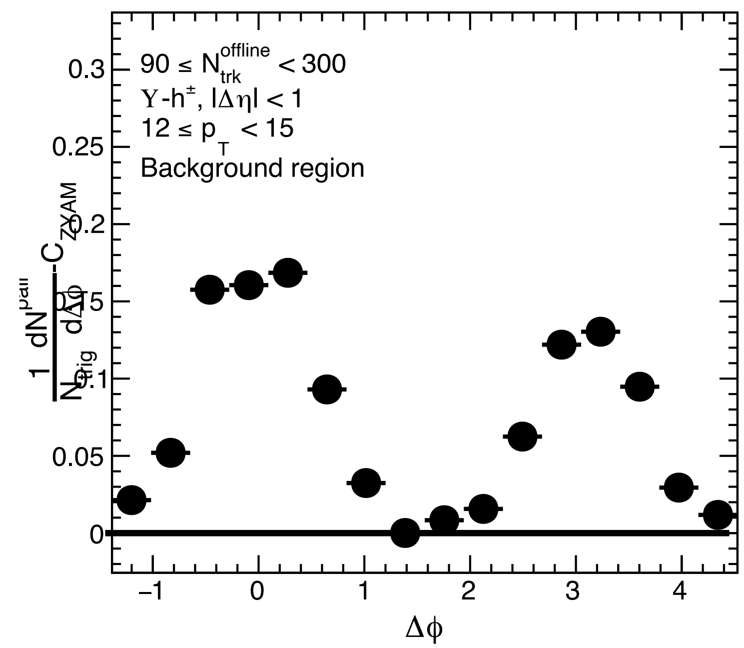
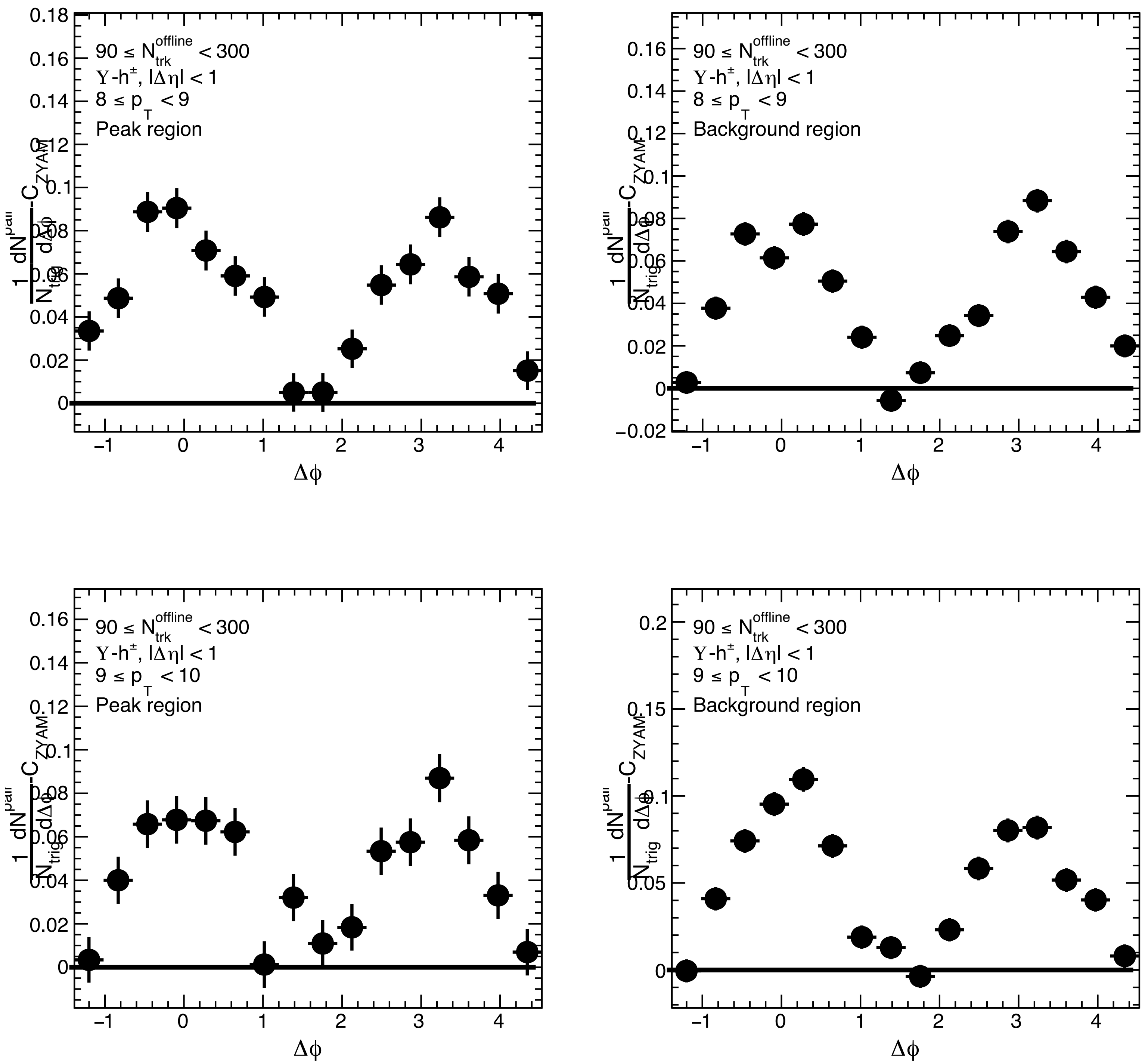








90 < mult. < 300 (9.0 < m < 9.8)



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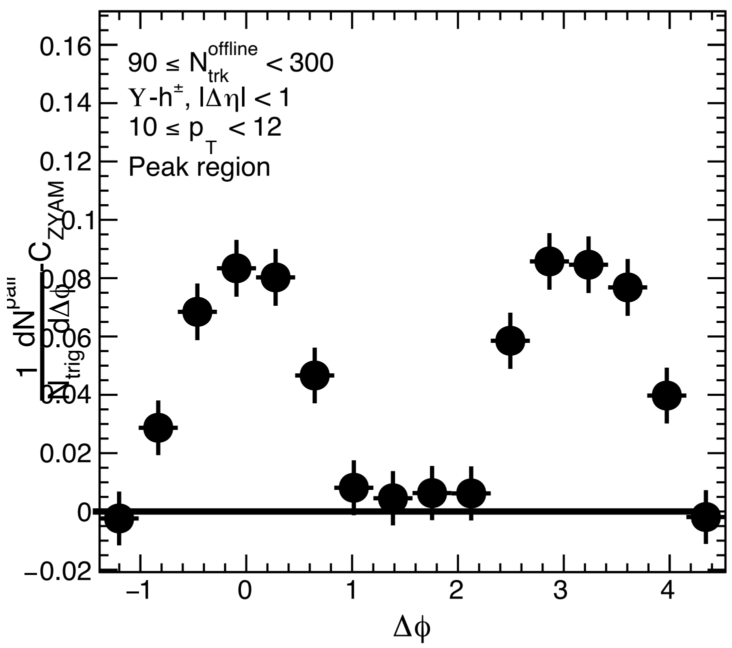
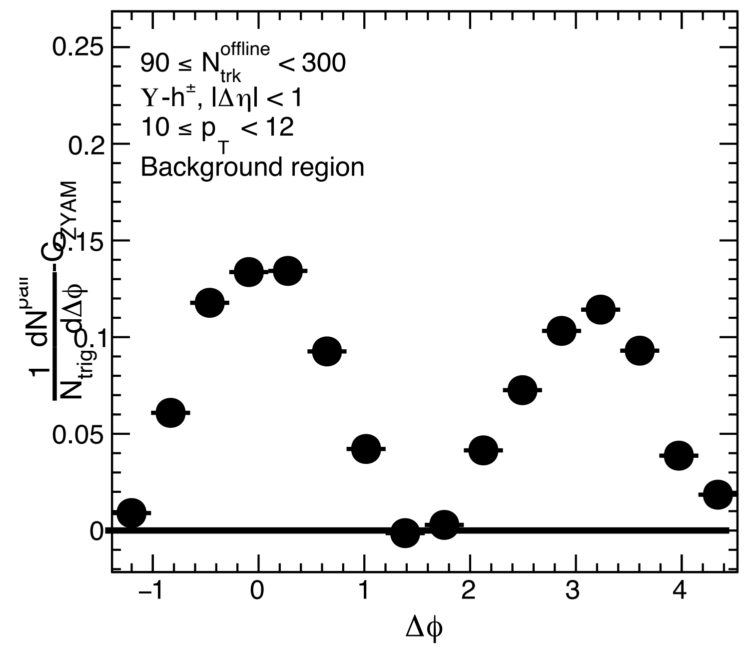
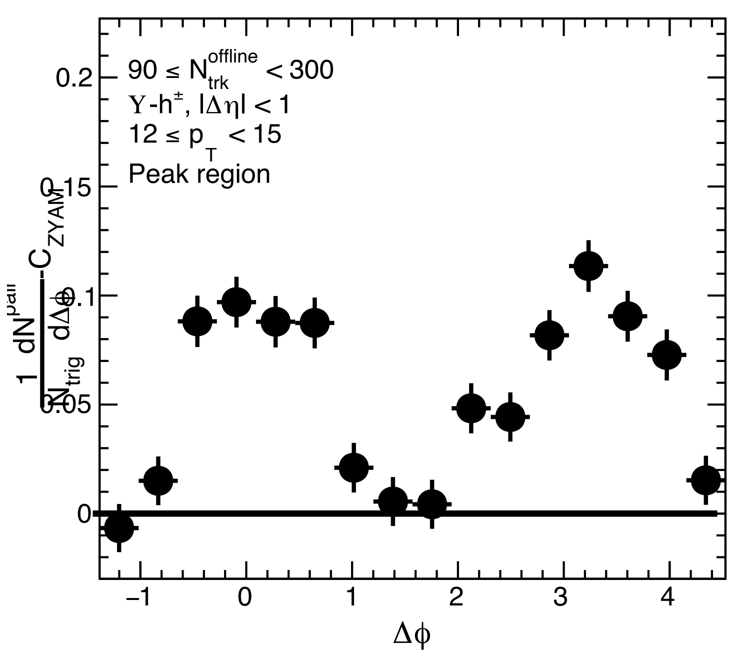
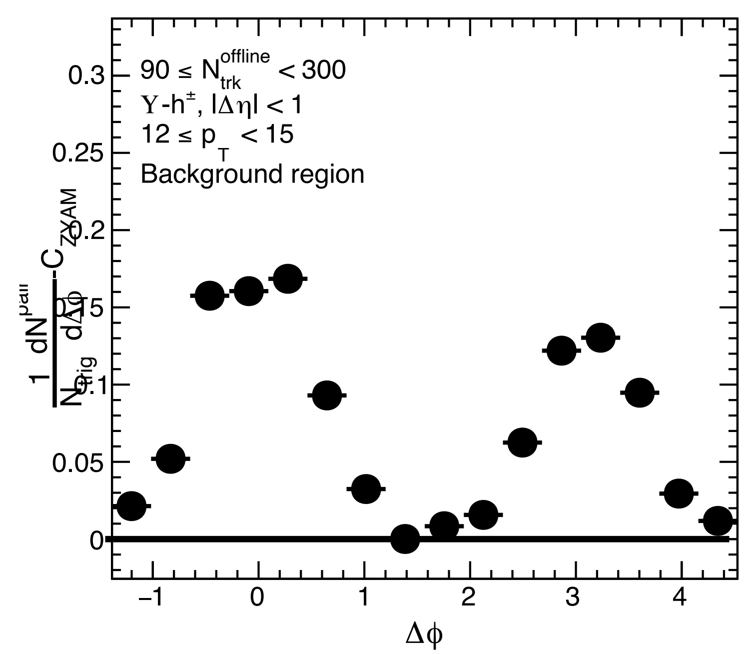
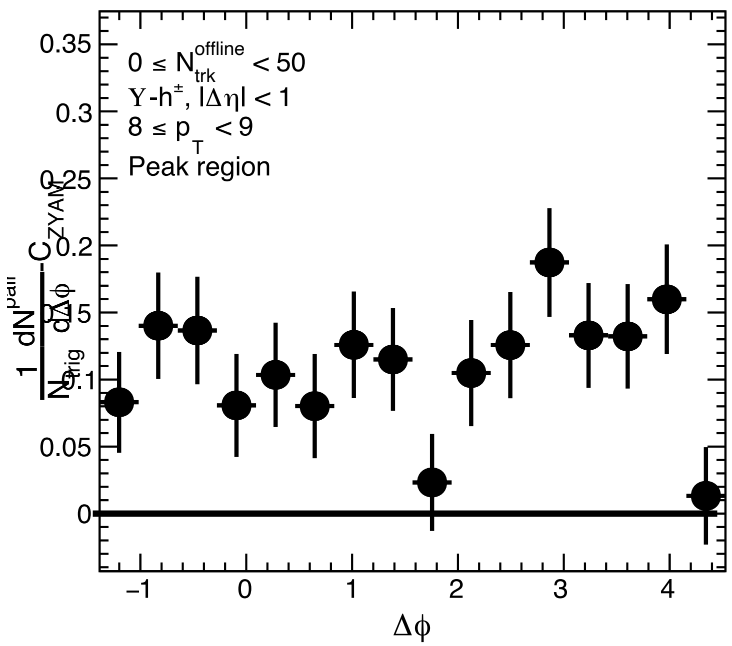


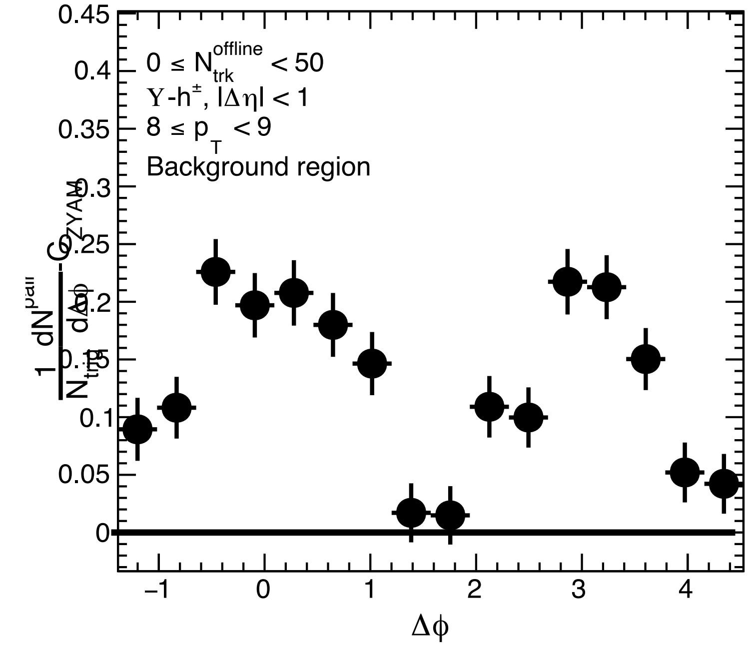


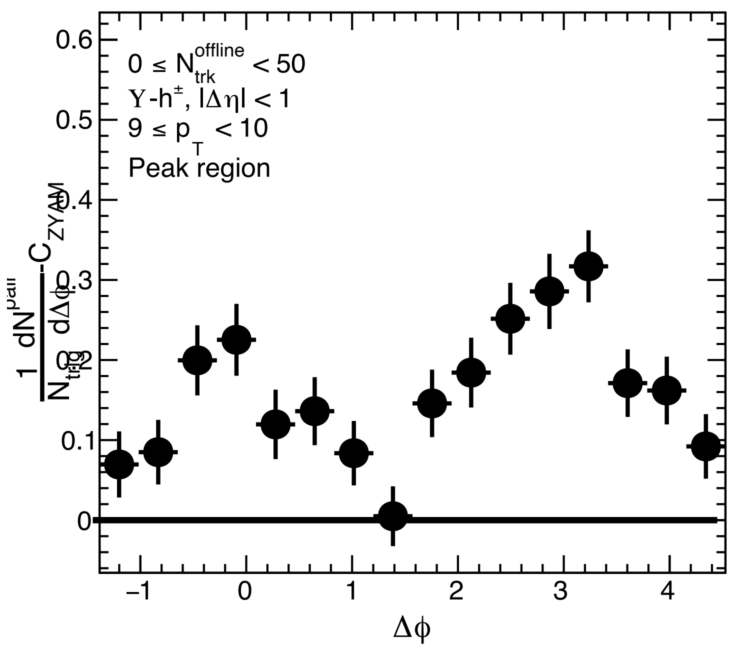


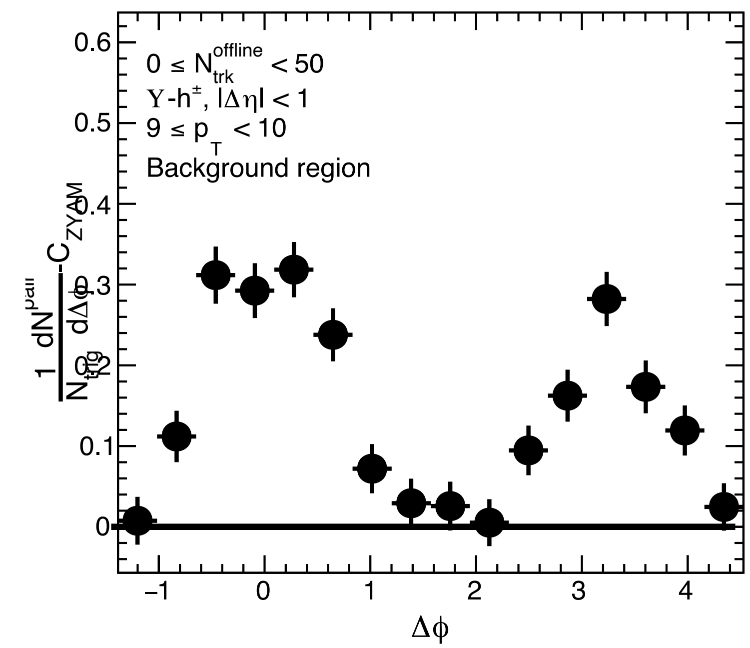


0 < mult. < 50 (9.2 < m < 9.6)









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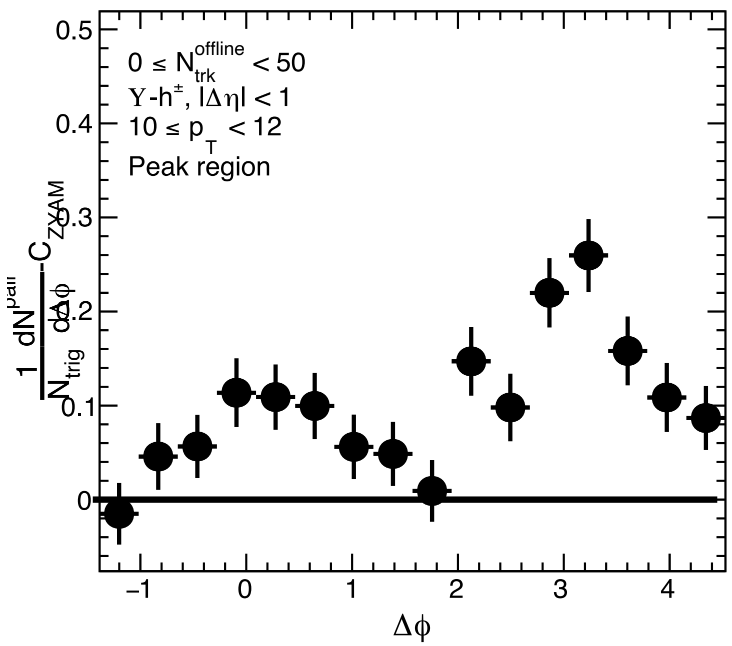

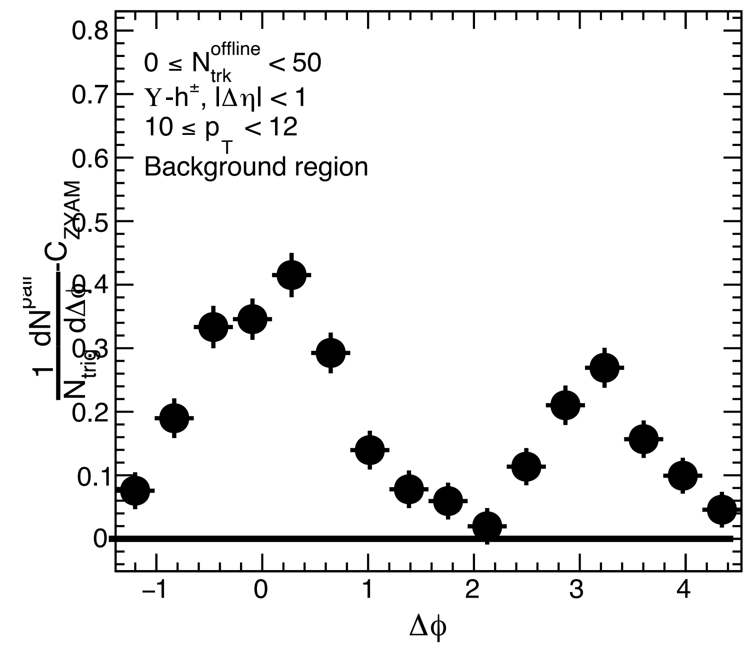

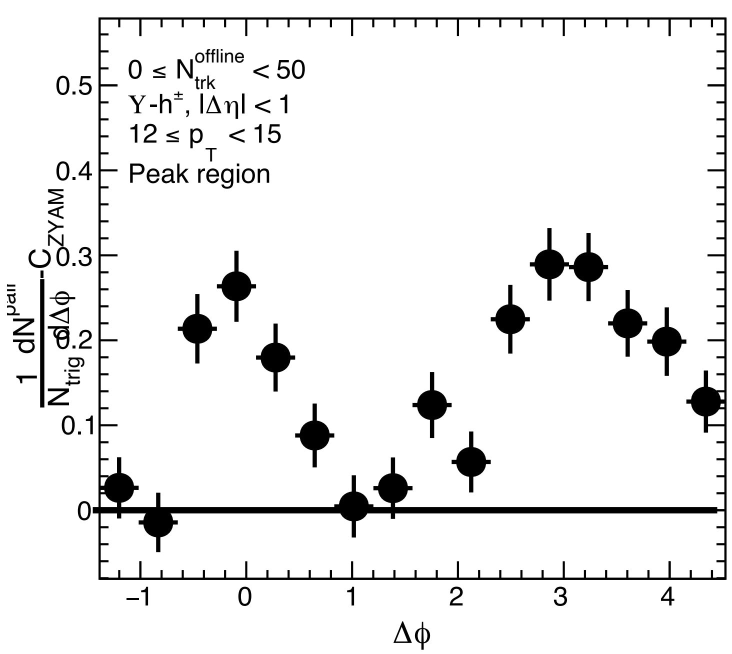

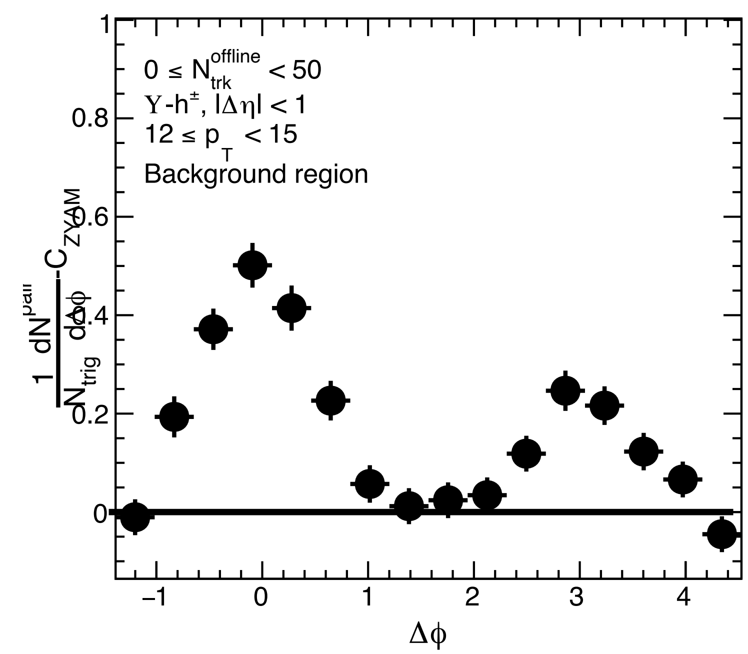

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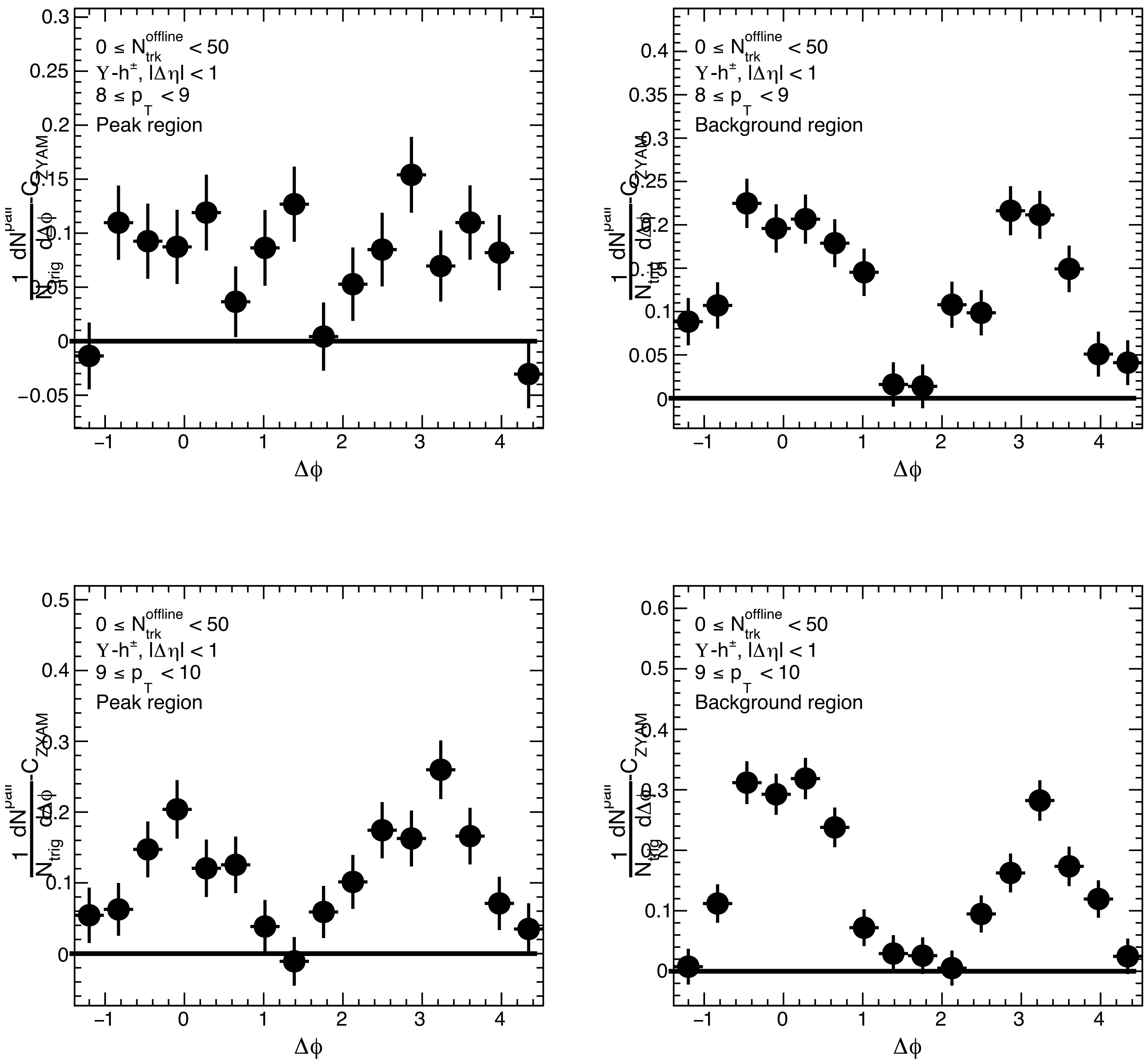

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