ALICE

Isolated γ - hadron correlations in Pb-Pb at $\sqrt{s_{NN}} = 5.02$ TeV - Update

Carolina Arata
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Enigmass

LPSC GRENOBLE | MODANE

Datasets and analysis cuts

Datasets:

- LHC15o pass2, LHC18q+r pass3
- Trigger: Sum of MB+EMCAL
- ***MC***: pp @5.02 TeV PYTHIA embedded in Pb-Pb MB; γ***-jet events*** (LHC20g3d_GJ_anchLHC15o, LHC20g3a_GJ_anchLHC18qr)

Centralities:

- 0-10 %, 10-30 %, 30-50 %, 50-90 %

$z_{\mathrm{T}} = p_{\mathrm{T}}^{hadr} / p_{\mathrm{T}}^{\gamma}$ *intervals*:

- { [0.05-0.1]; [0.1-0.15]; [0.15-0.2]; [0.2-0.4]; [0.4-0.6]; [0.6-0.8]; [0.8-1.0]; [1.0-1.2] }

Purity estimation:

- ABCD method

Shower shape σ^2_{long}:

Only 5x5 cluster (V2 clusterizer)

- γ $0.10 < \sigma^2_{long} < 0.30$
- Background: $0.40 < \sigma^2_{long} < 2.00$

Isolation

(after UE subtraction with η-band):

- $p_{\mathrm{T}}^{iso} < 2$ GeV/c
- $R_{cone} = 0.2$

Analysis flow

UE subtraction

Purity Correction

Efficiency Correction

Systematic errors

New: *Systematics*

Systematic uncertainties for most sources are estimated with cut variations

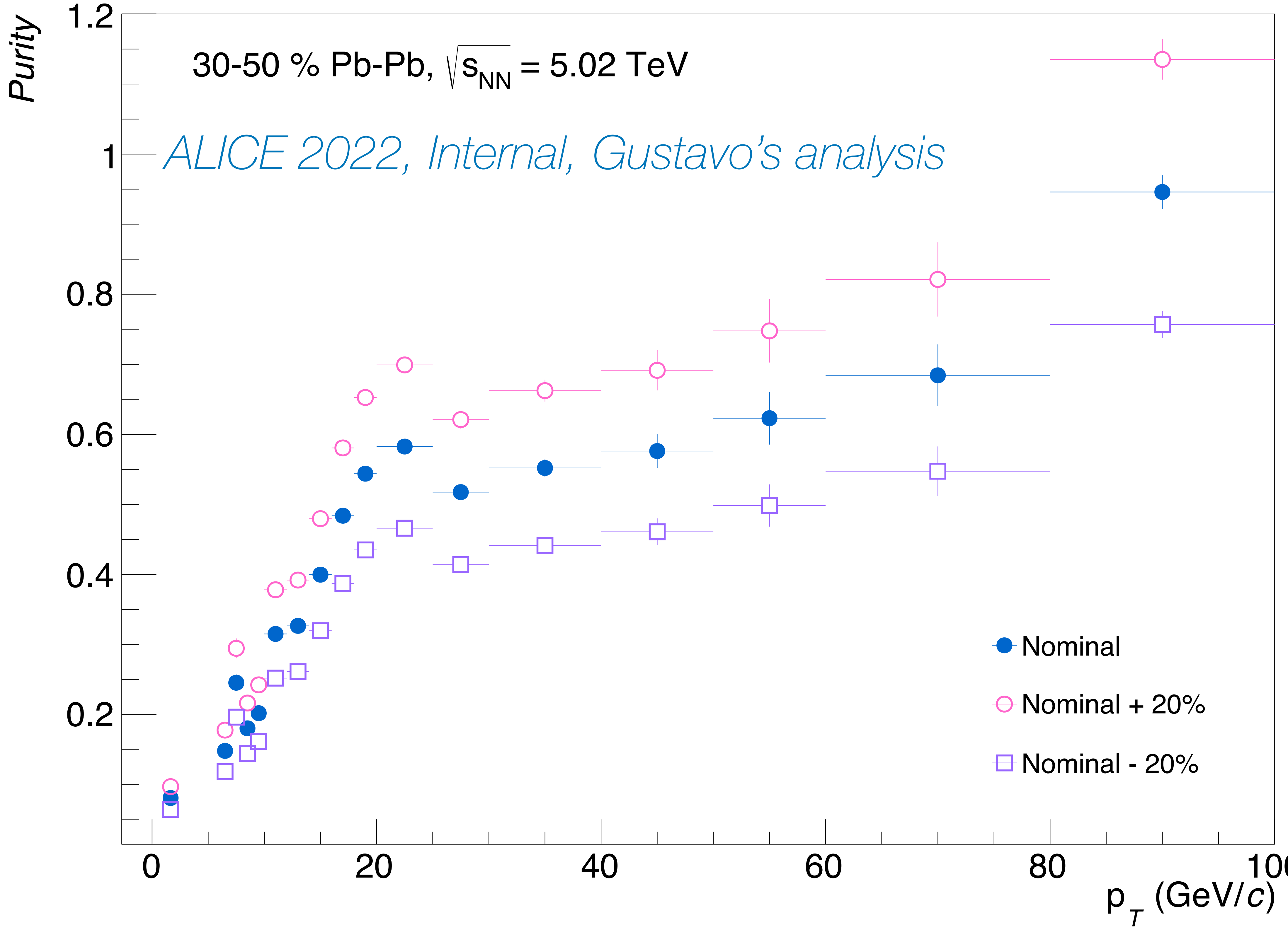
They are evaluated for the z_T function

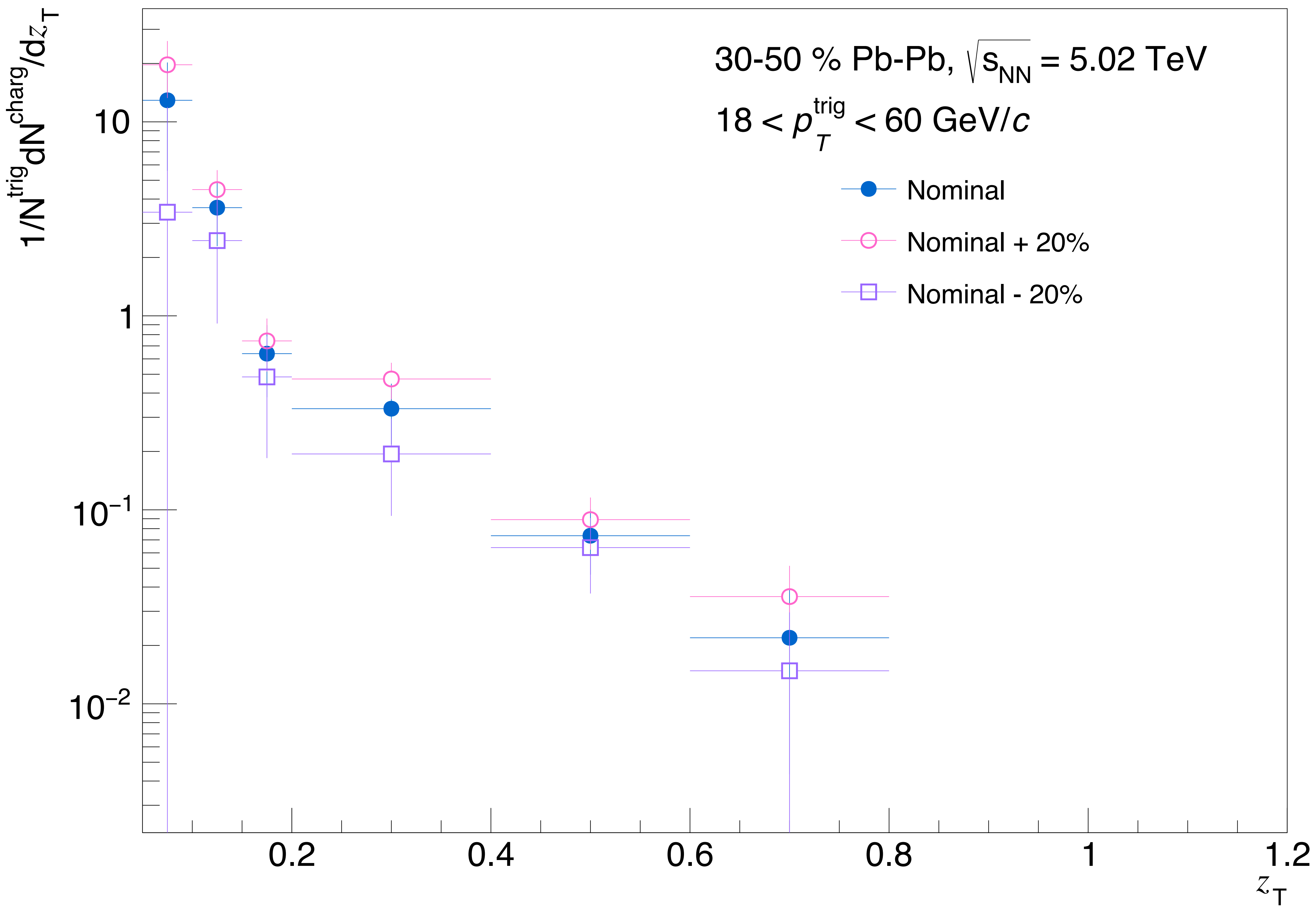
- **Purity**
- **UE estimation uncertainty**
- **Variation of the ΔCentrality cut when pairing events for Mixed**

- Background σ^2_{long} selection
- Tracking Performance

Systematics: *Purity*

Results evaluated with a difference $\pm 20\,\%$ with respect to the *Nominal* purity.





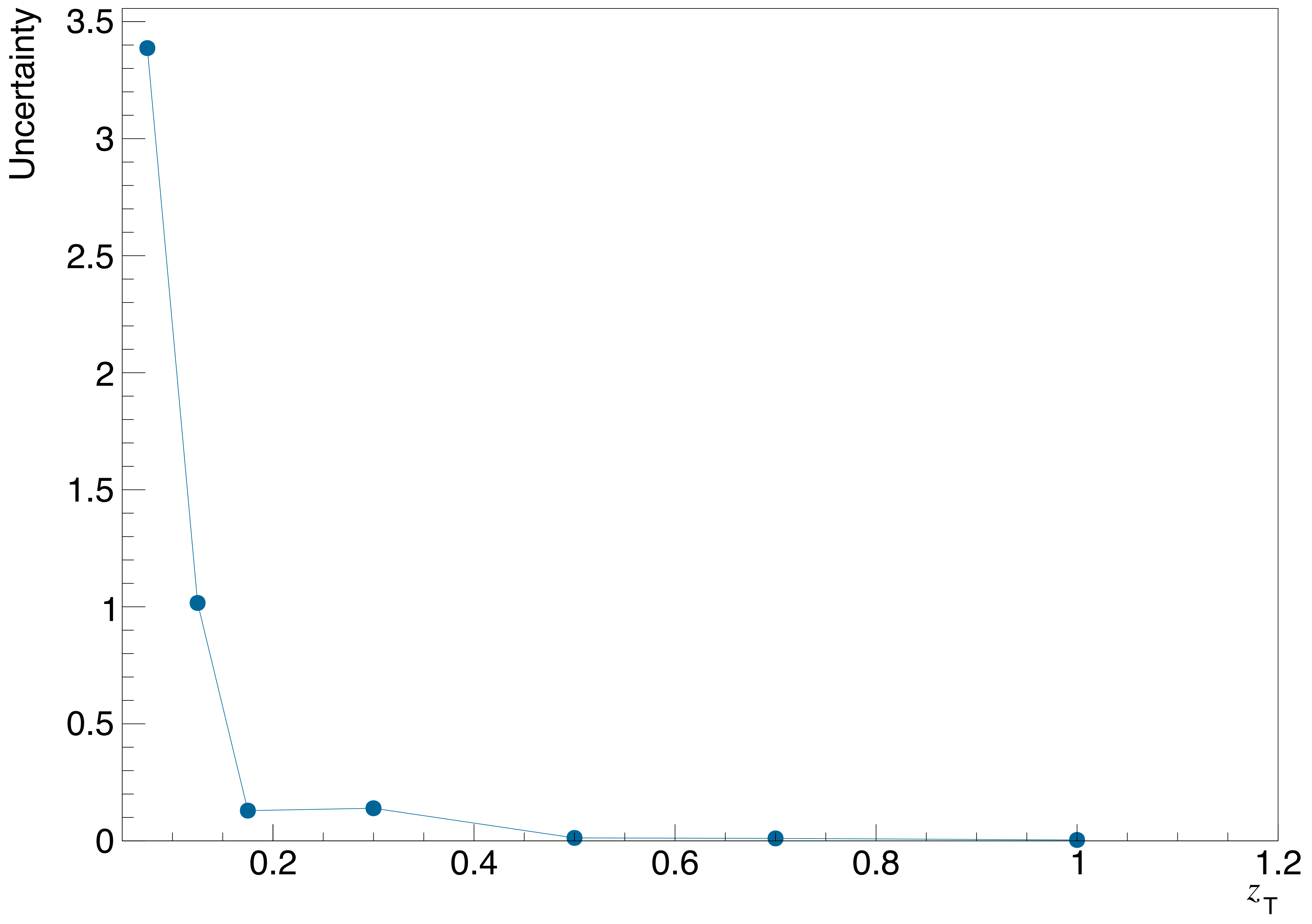
Systematic uncertainty is given by:

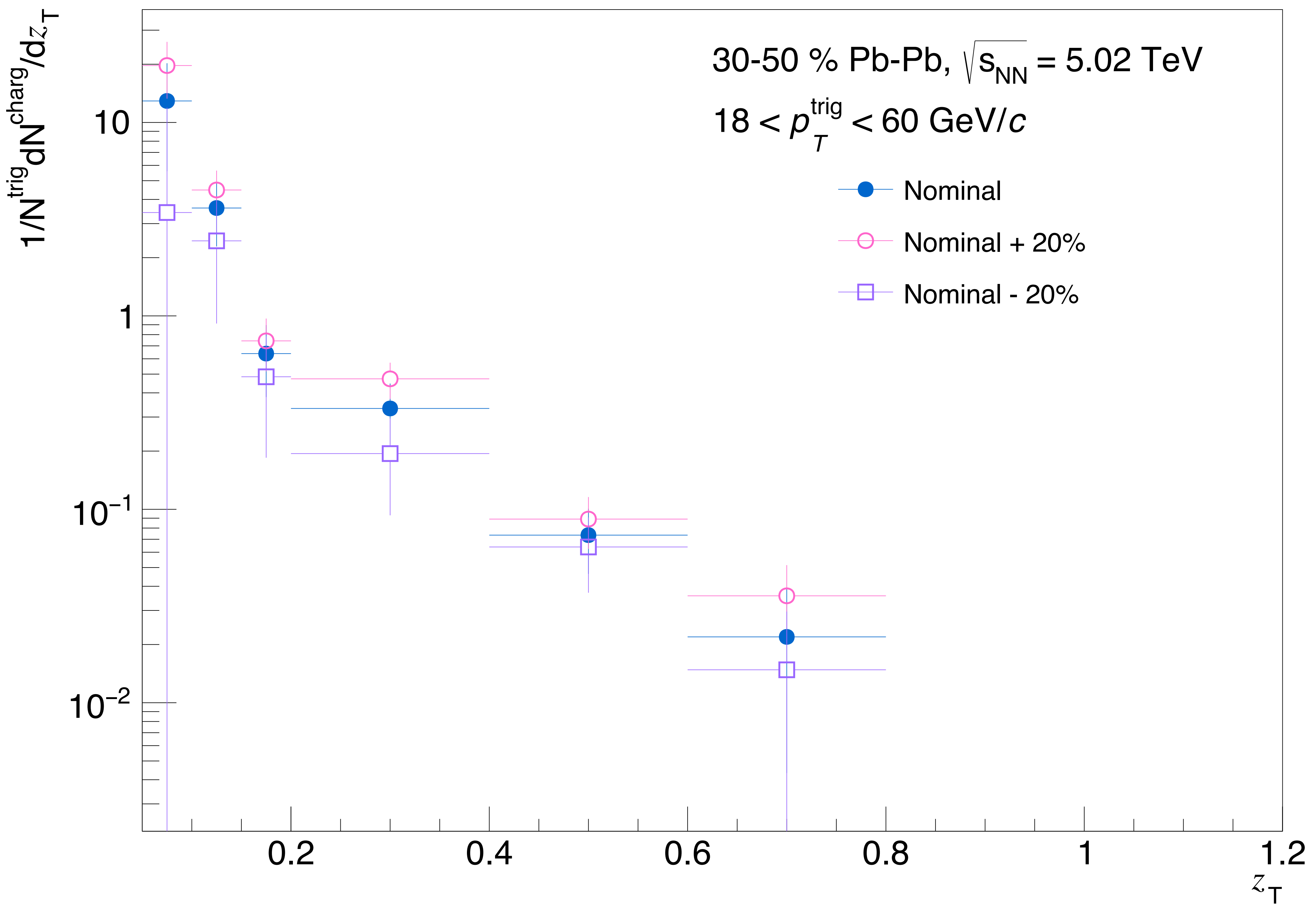
$$[\text{Nominal} + 20\% - (\text{Nominal} - 20\%)]\ /2$$

The first point is driven by the -20% purity→ its uncertainty estimated only with respect the highest purity.

Systematics: *Purity*

Results evaluated with a difference $\pm 20\,\%$ with respect to the *Nominal* purity.





Systematic uncertainty is given by:

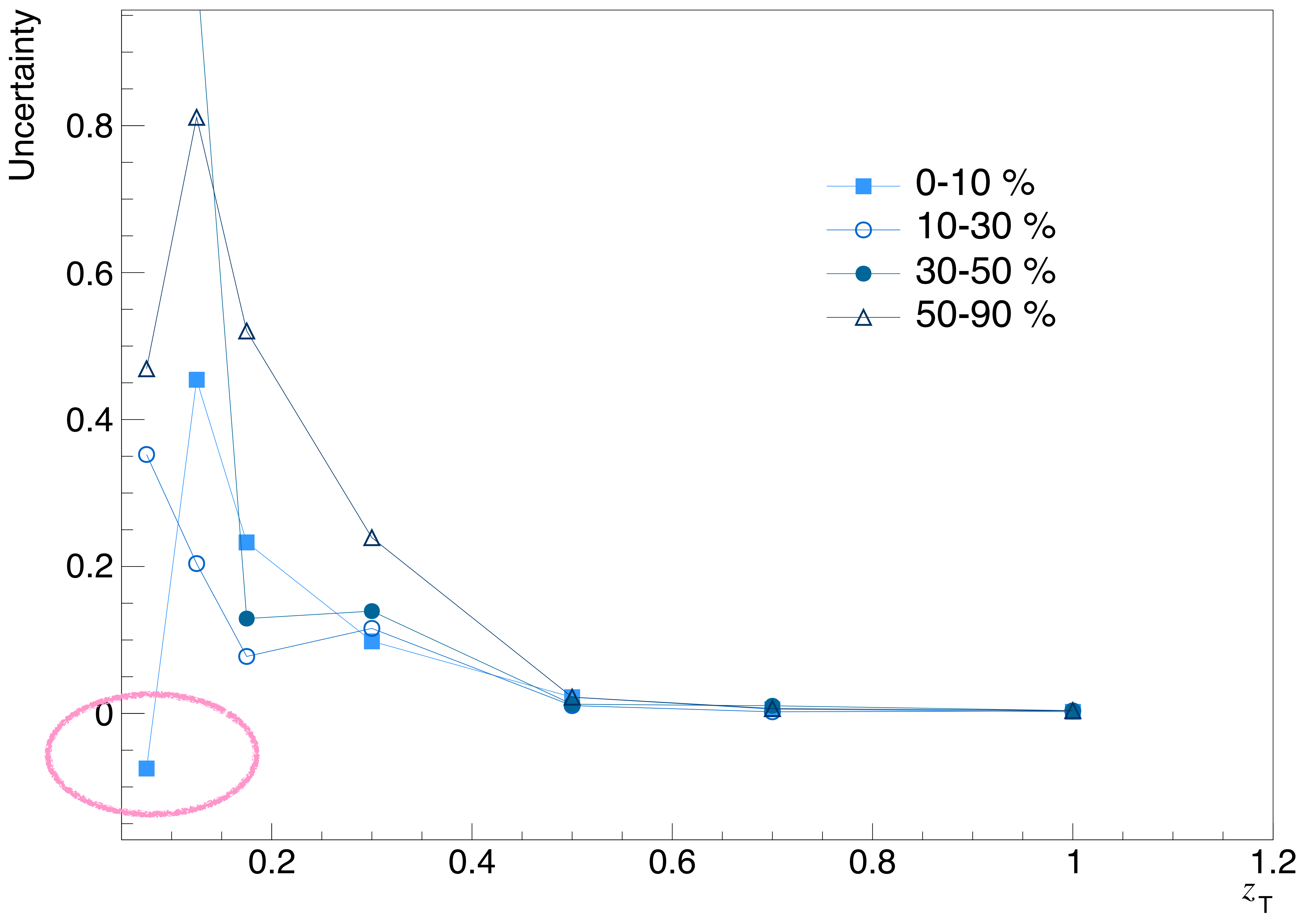
$$[\text{Nominal} + 20\% - (\text{Nominal} - 20\%)]\ /2$$

The first point is driven by the -20% purity → its uncertainty estimated only with respect to the highest purity.

Systematics: *Purity*

Results evaluated with a difference $\pm 20\,\%$ with respect to the *Nominal* purity.

Systematic uncertainties for all the centralities

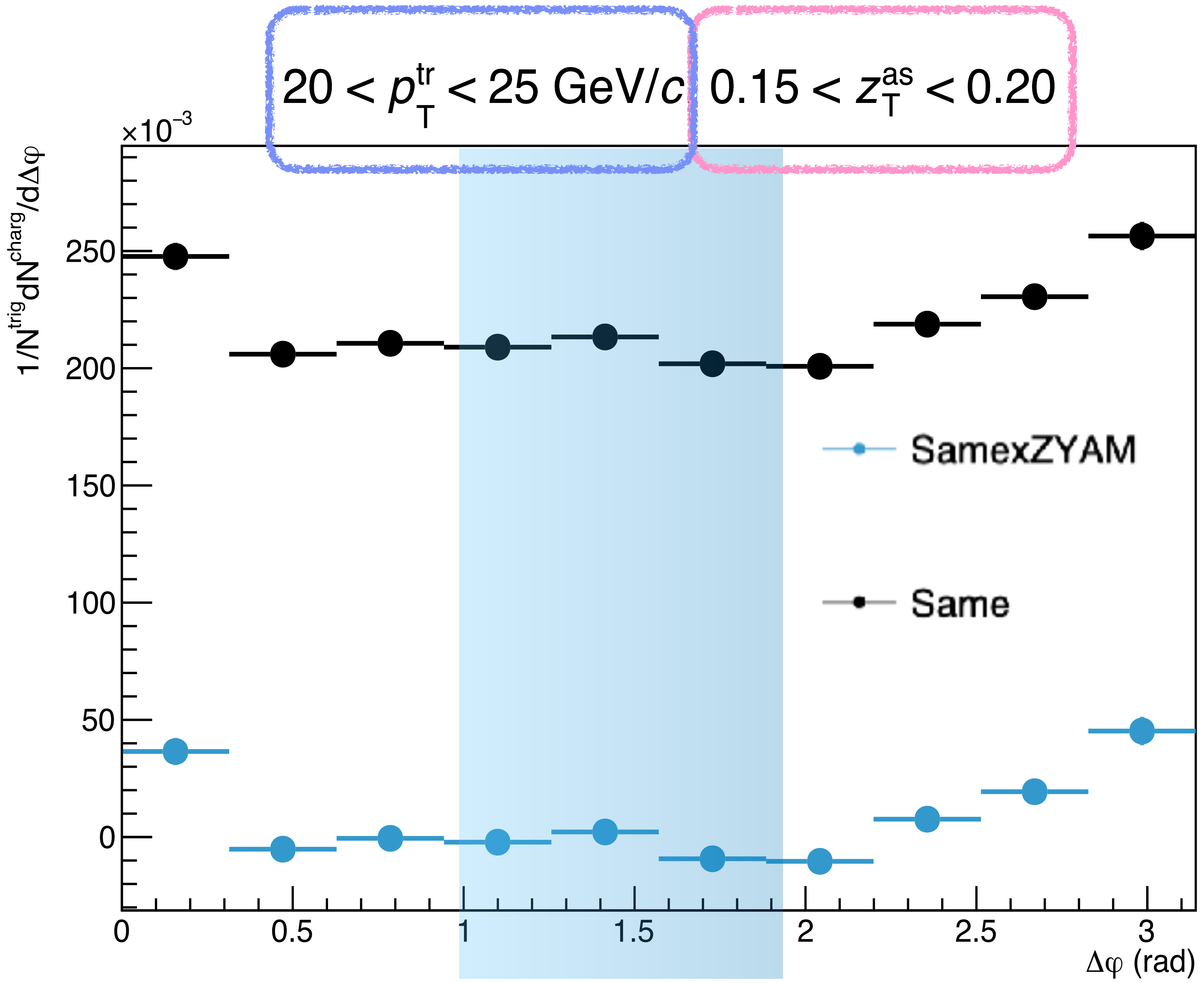


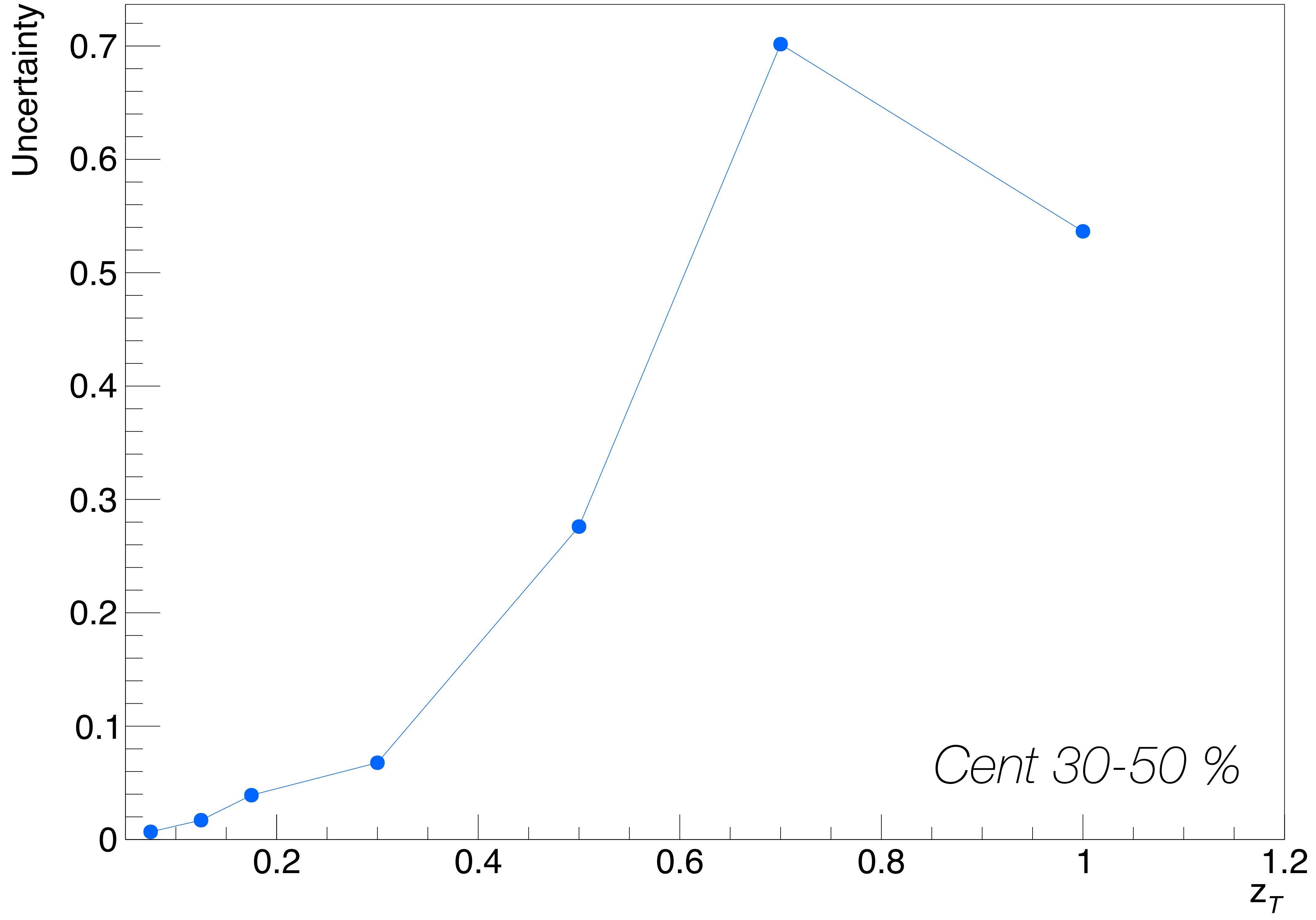
- In 0-10% first point shows negative uncertainty: it will be further investigated

Systematics: *UE estimation uncertainty - ZYAM*

For every p_T^{tr} bin and every $z_{\mathrm{T}} = p_{\mathrm{T}}^{hadr} / p_{\mathrm{T}}^{\gamma}$ bin

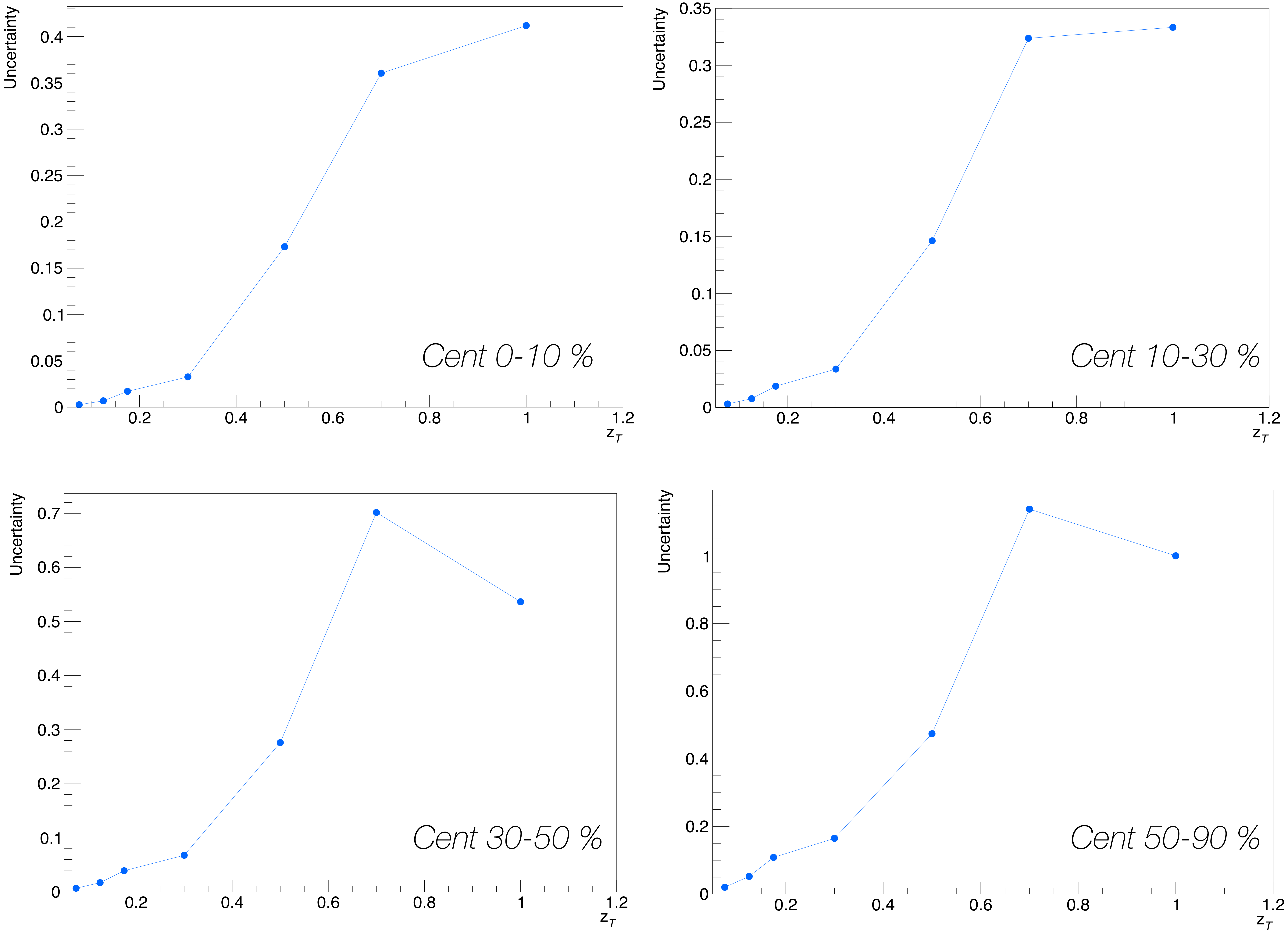
- Evaluated the Integral for applying ZYAM and its error
- The error on the integral measured the uncertainty on UE estimation (systematics)





Various p_T^{tr} bins are merged and the systematic related to the corresponding z_T is obtained

Systematics: *UE estimation uncertainty - ZYAM*



- In general high uncertainties:

driven by Same event statistics

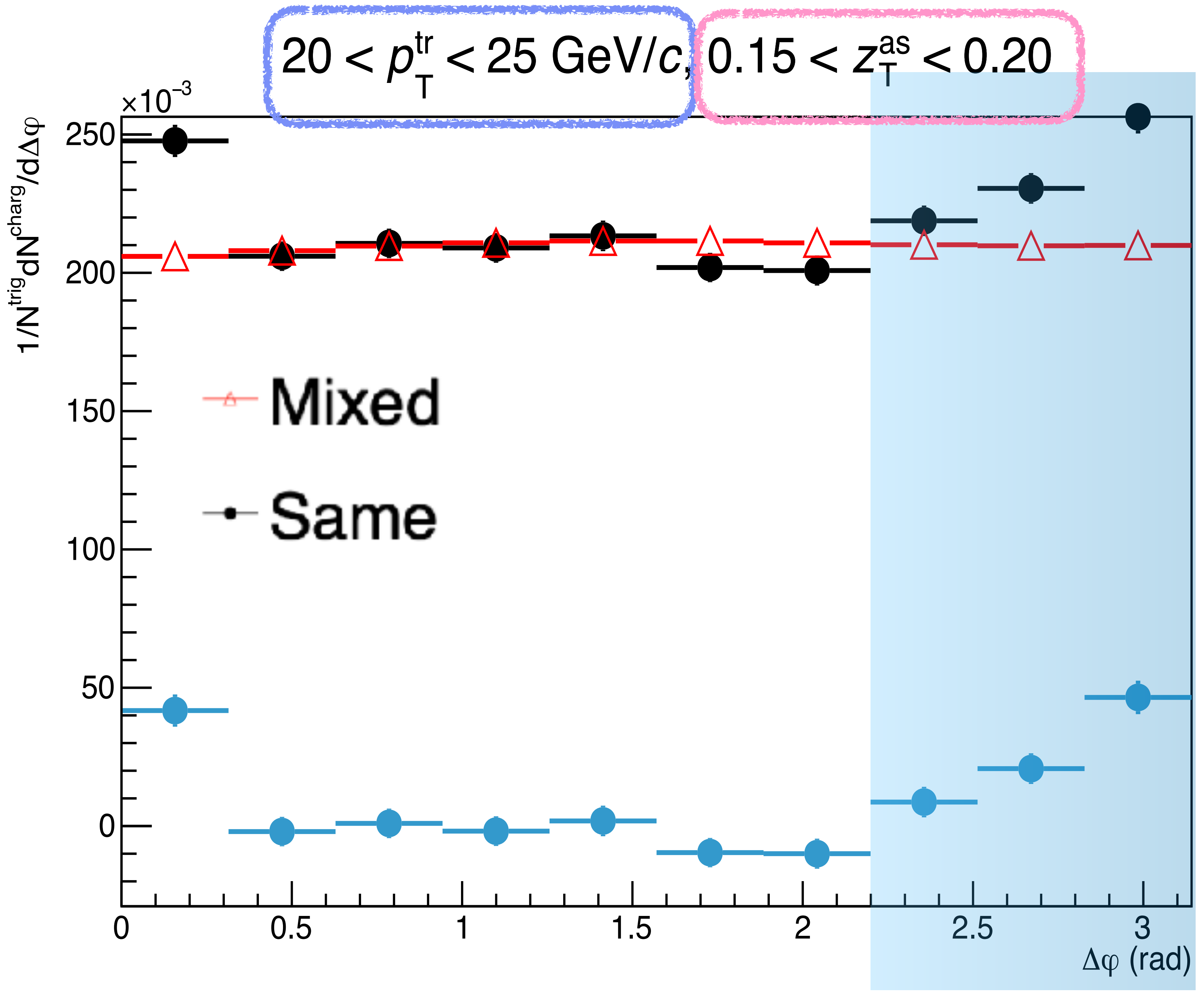
→ real Data

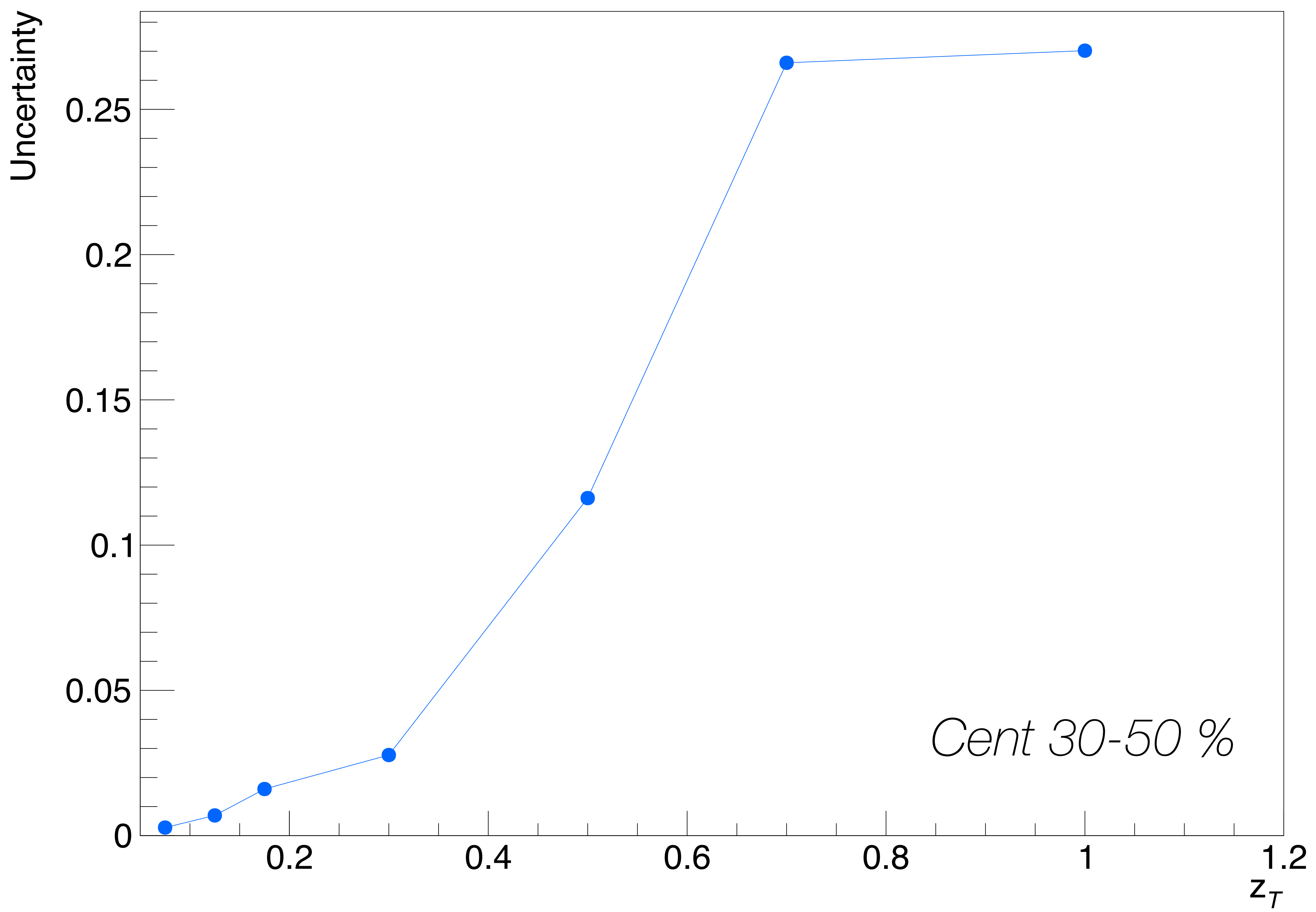
Specially at high z_T

Systematics: *UE estimation uncertainty - Mixed event*

For every p_T^{tr} bin and every $z_\mathrm{T} = p_\mathrm{T}^{hadr} / p_\mathrm{T}^{\gamma}$ bin

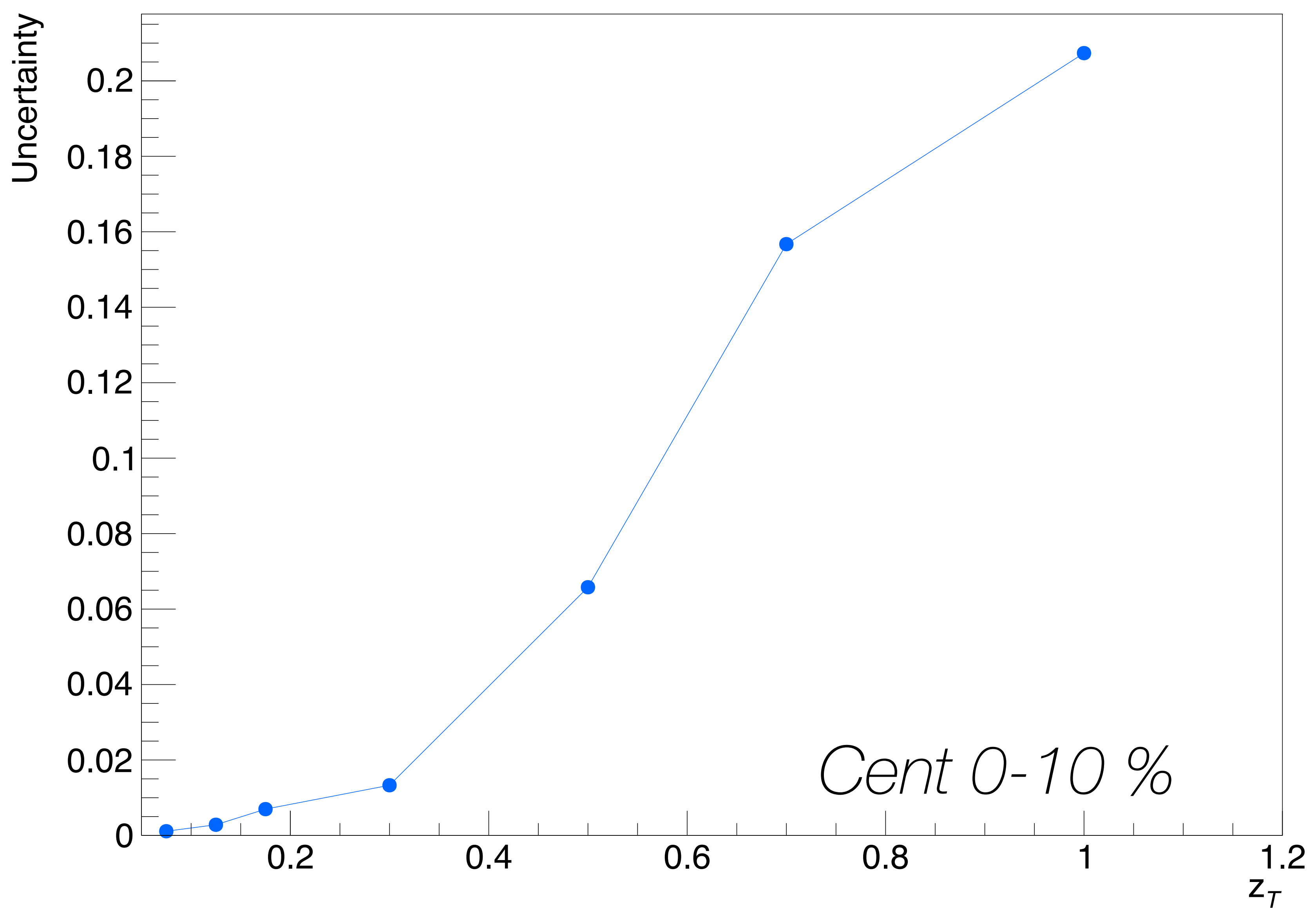
- Evaluated the Integral of Mixed Event away-side and its error
- The error on the integral measures the uncertainty on UE estimation

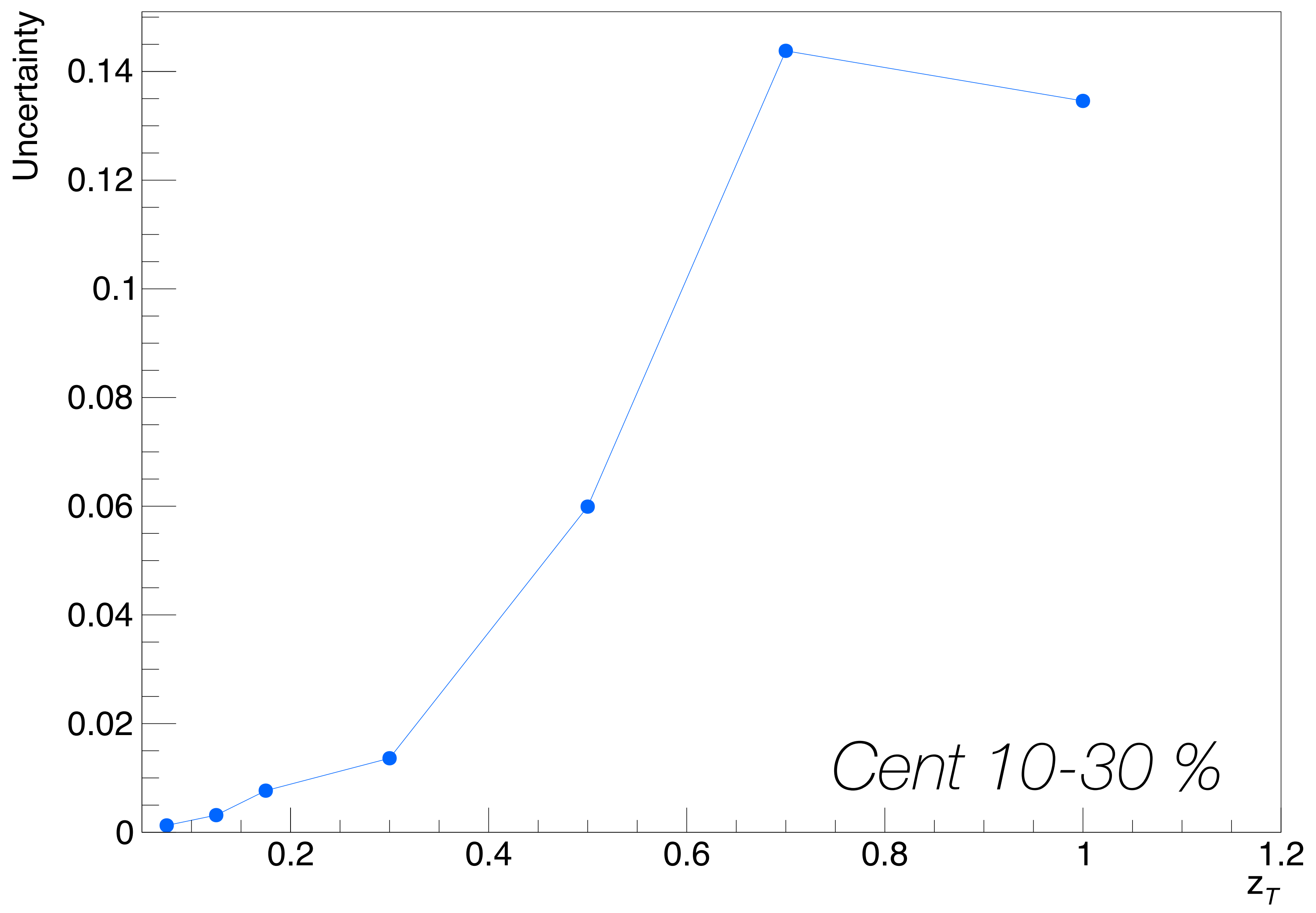


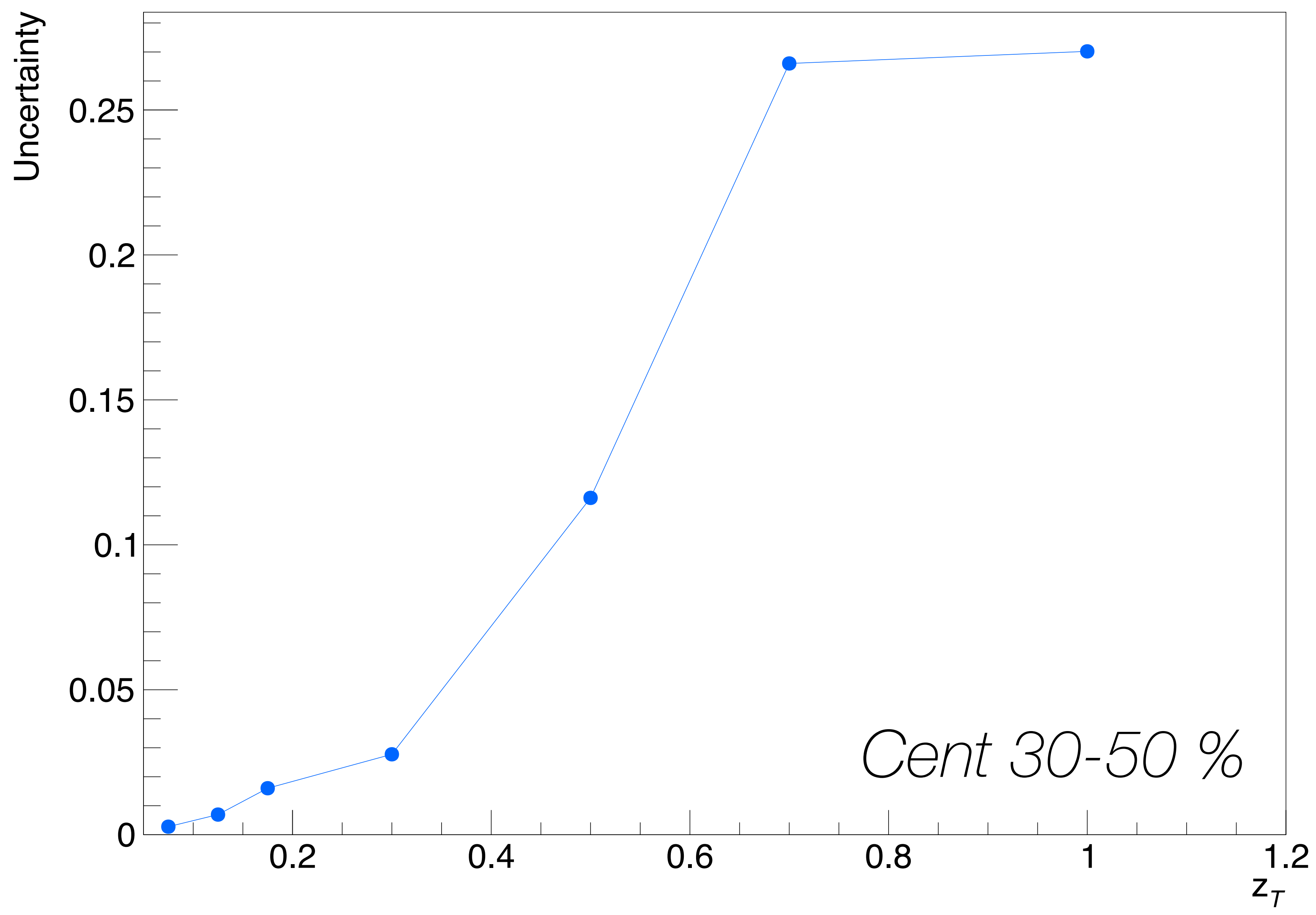


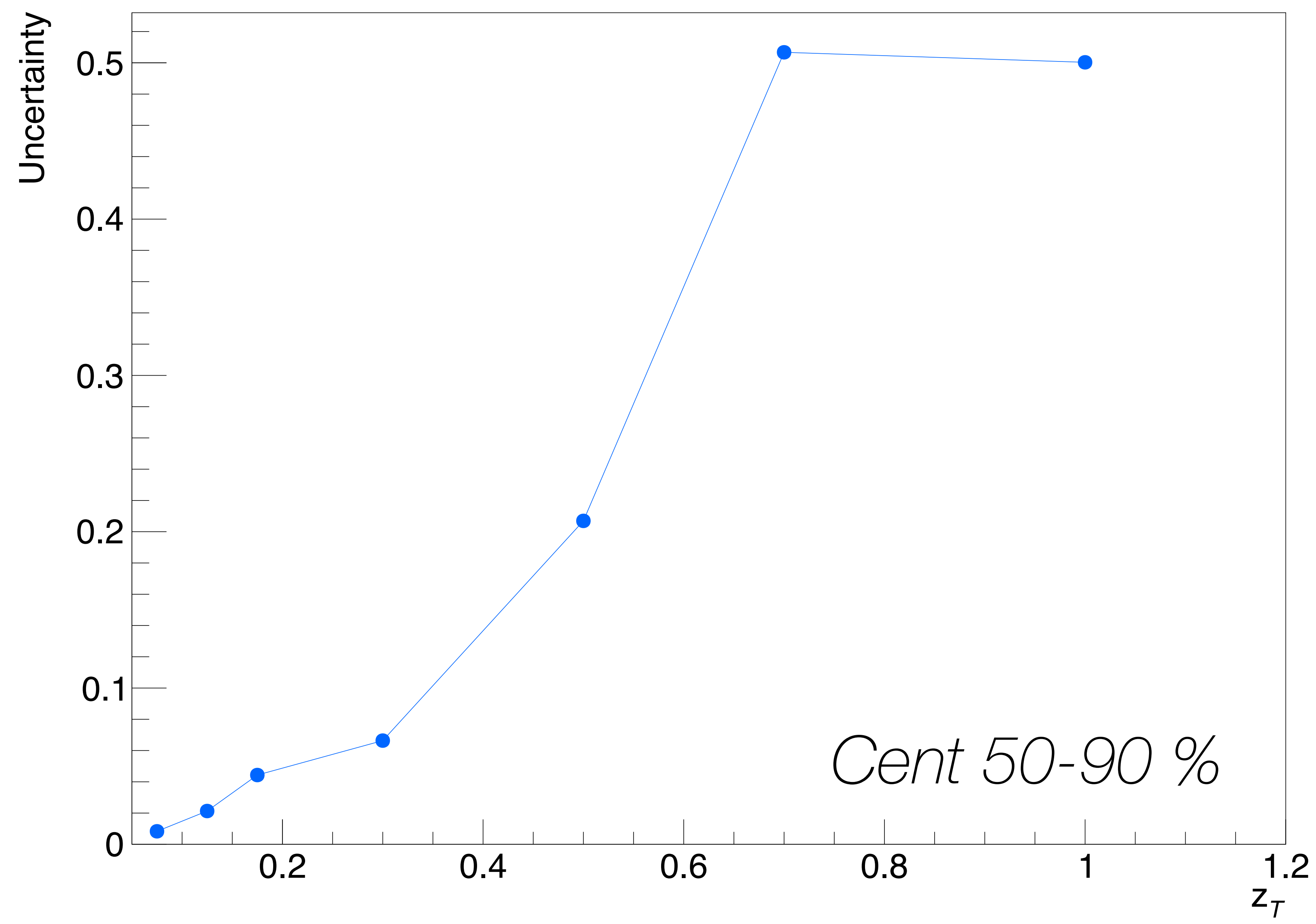
Various p_T^{tr} bins are combined and the systematic related to the corresponding z_T is obtained

Systematics: *UE estimation uncertainty - Mixed*









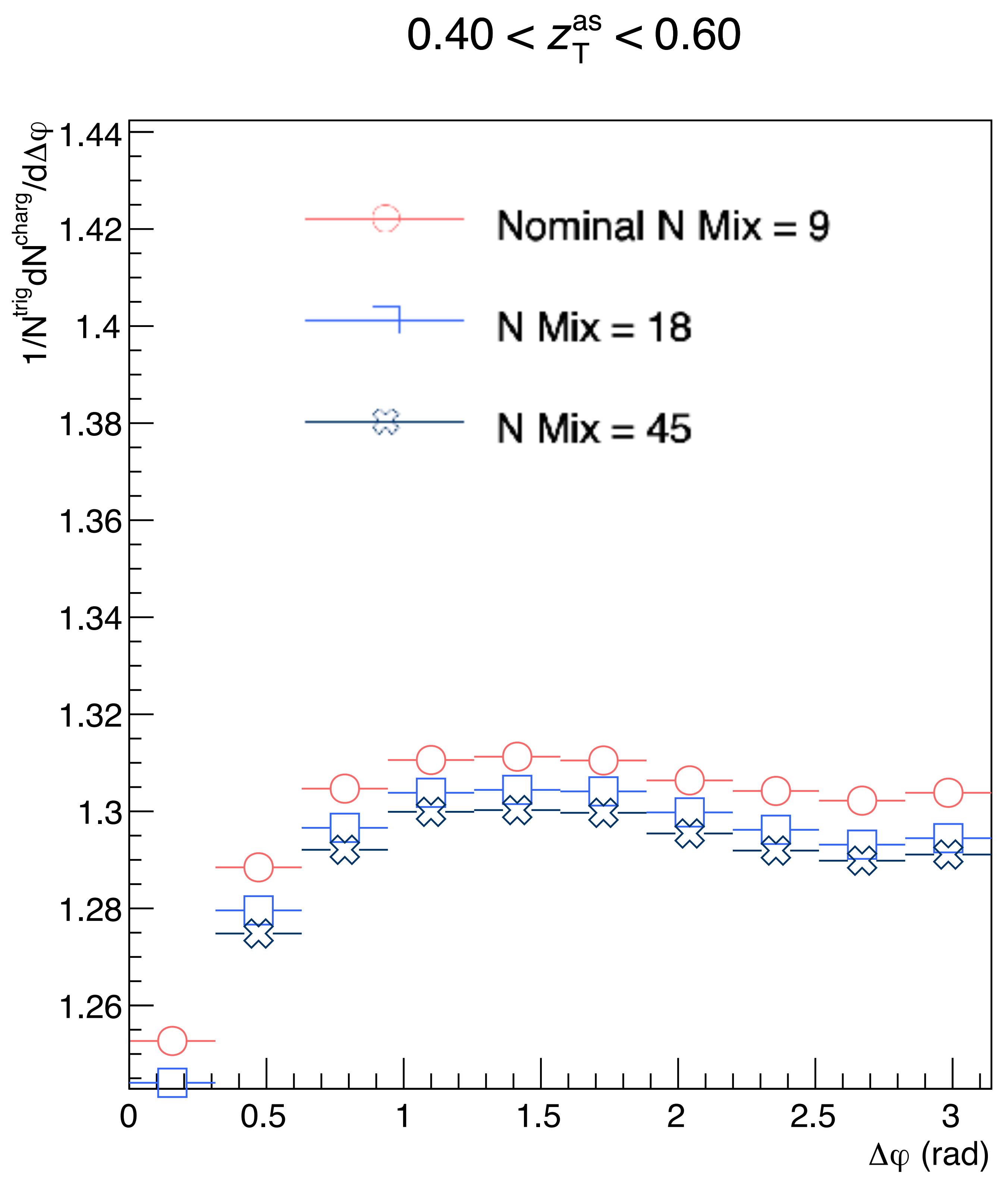
- Lower uncertainty with respect to ZYAM:

Mixed event is less limited by statistics

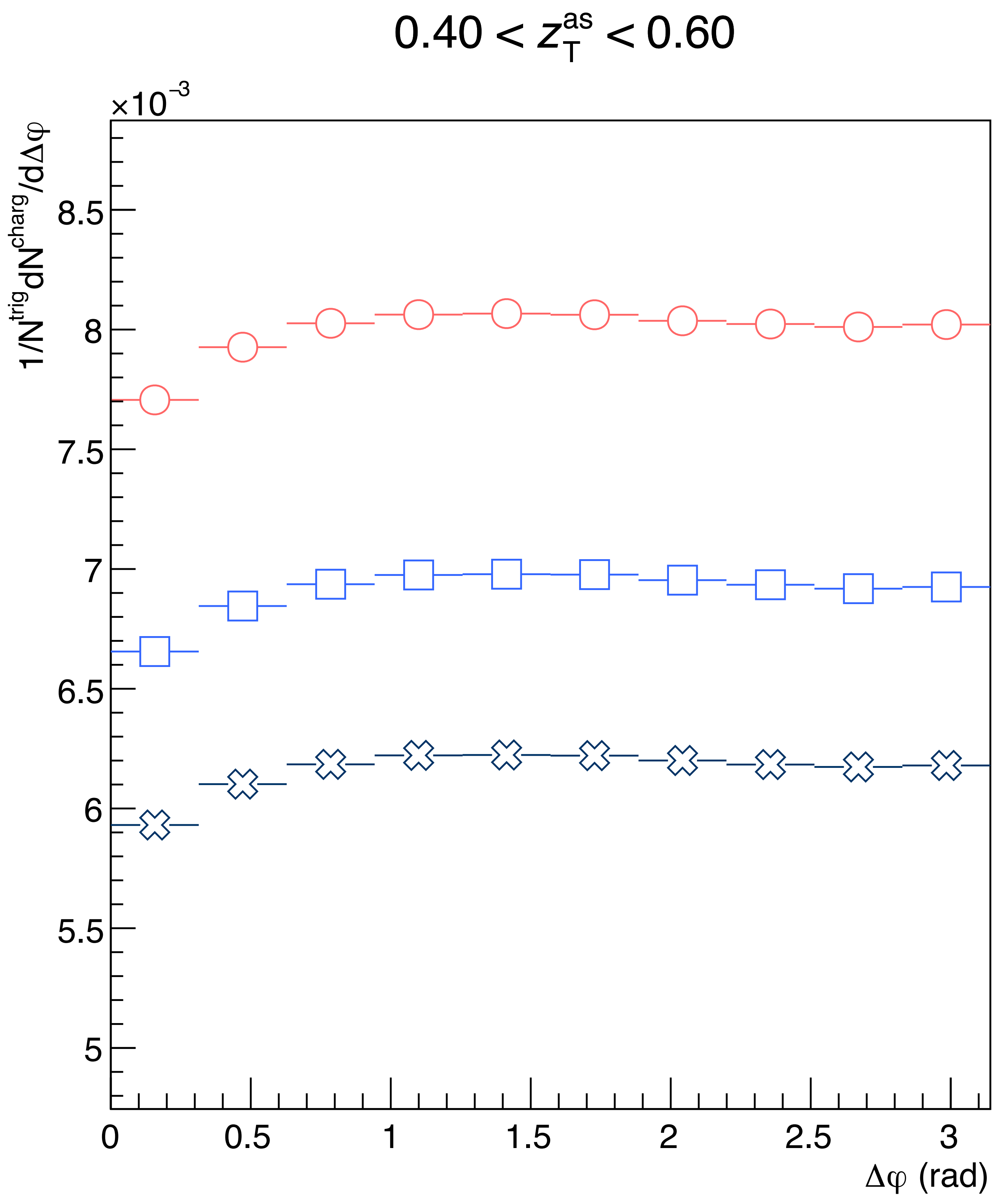
- For this reason Mixed event method will be the reference method for the analysis
- ZYAM will be the control method

Systematics: Δcentrality cut on Mixed Event

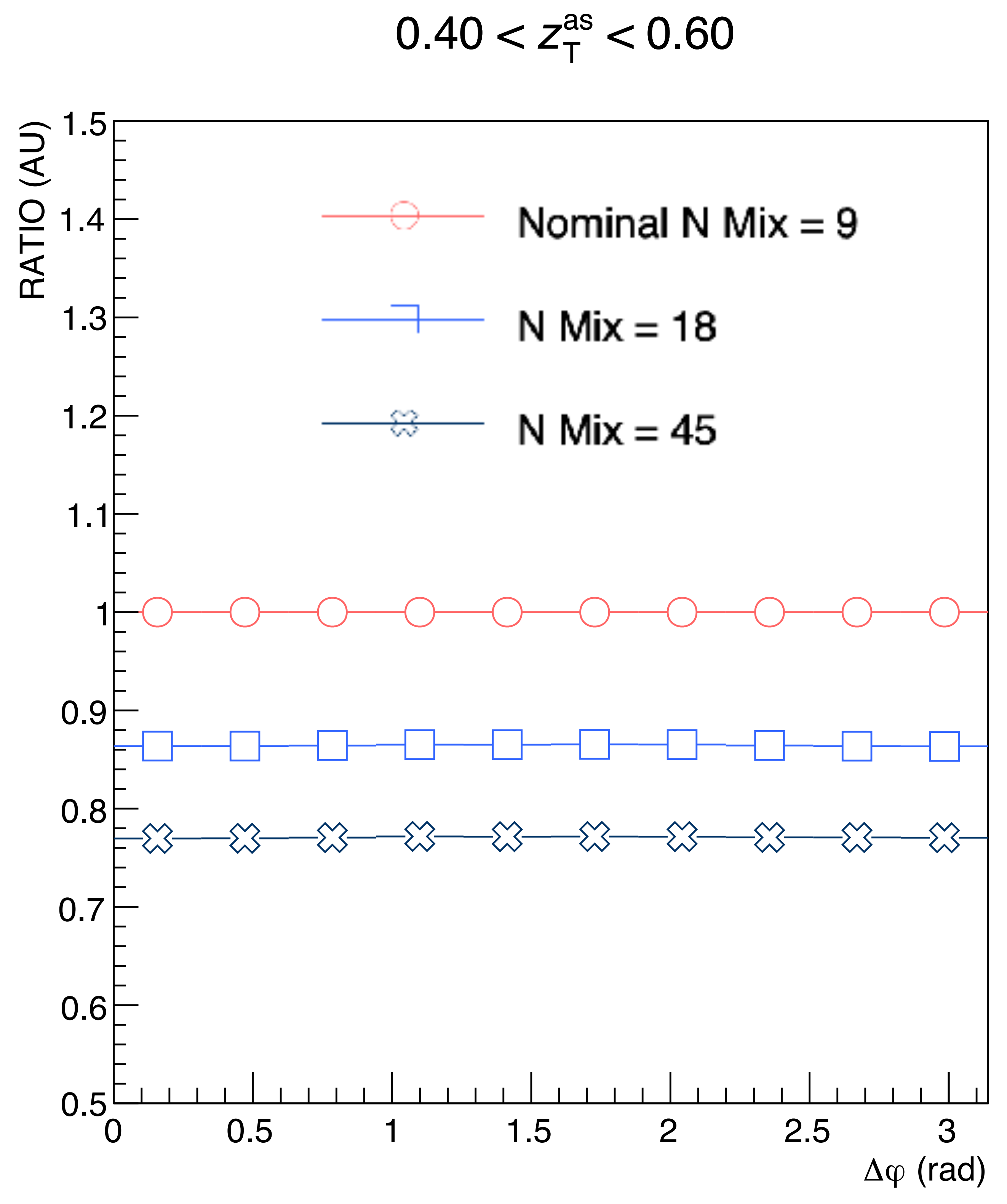
- Varying the condition on the Centrality to fill the Mixed Event pool
- The nominal case is: NMixCentBin = 9
- Checked multiples of 9: NMixCentBin = 18 and NMixCentBin = 45
- Expected negligible effect



Mixed event before Scaling



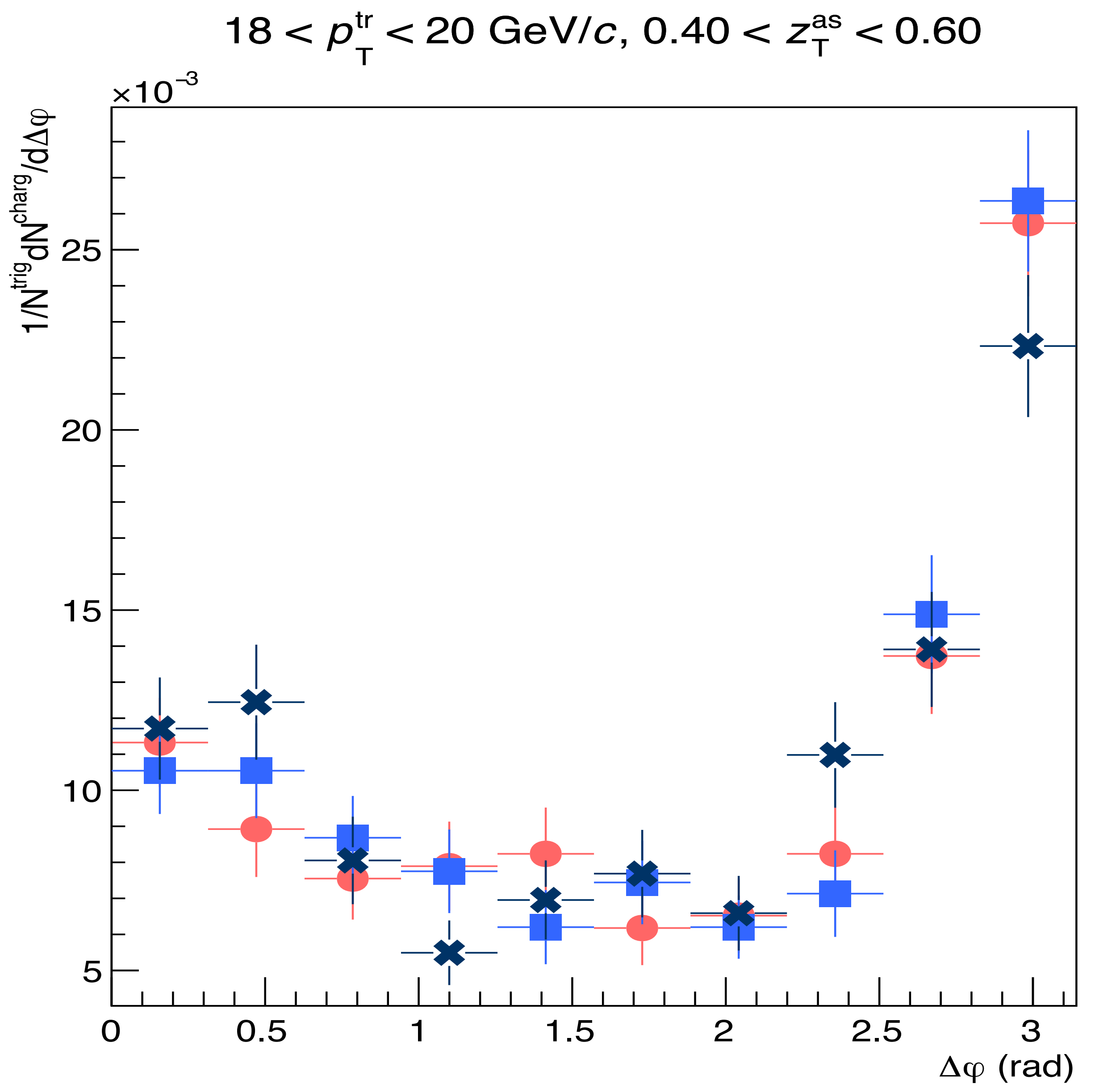
Mixed event after Scaling

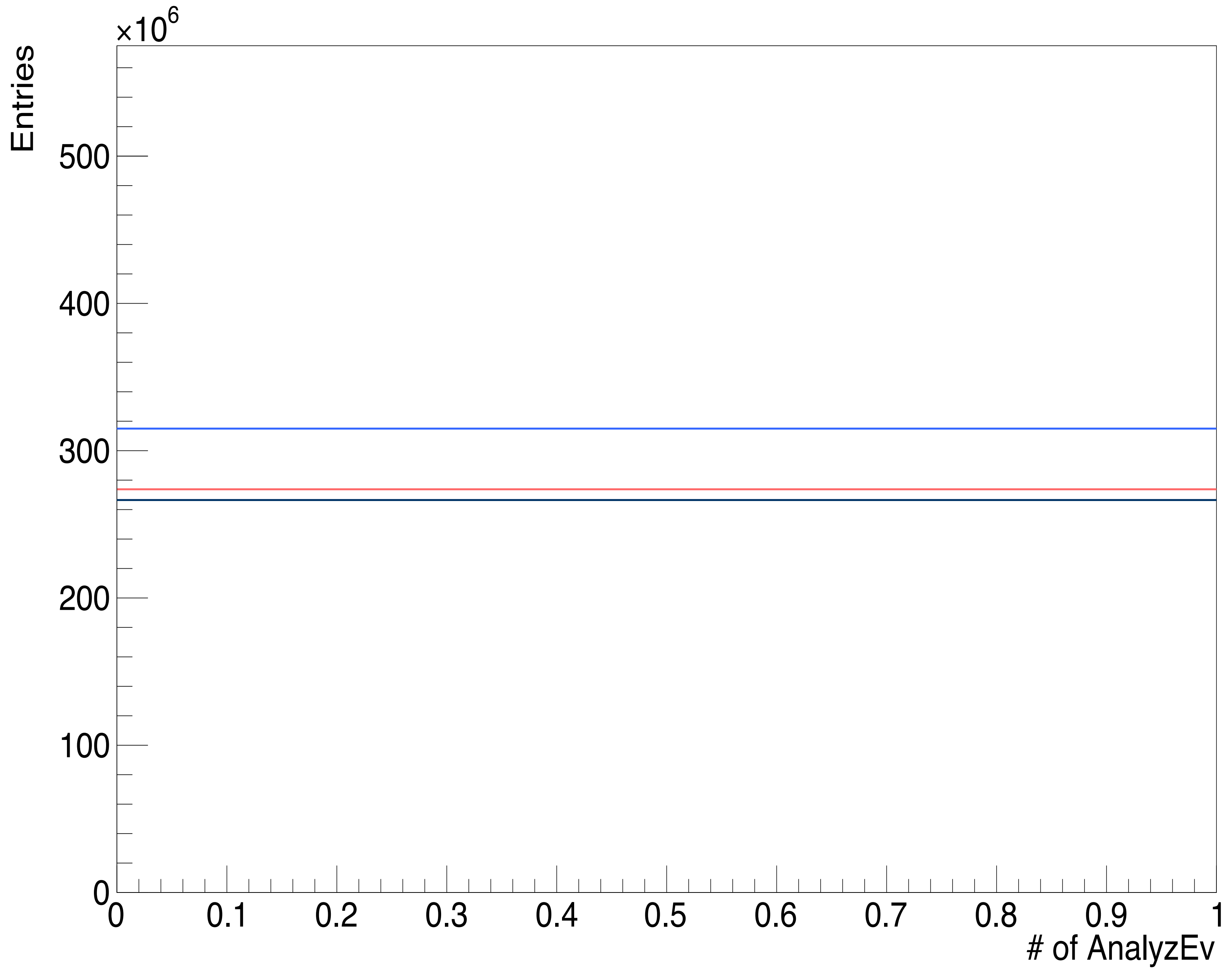


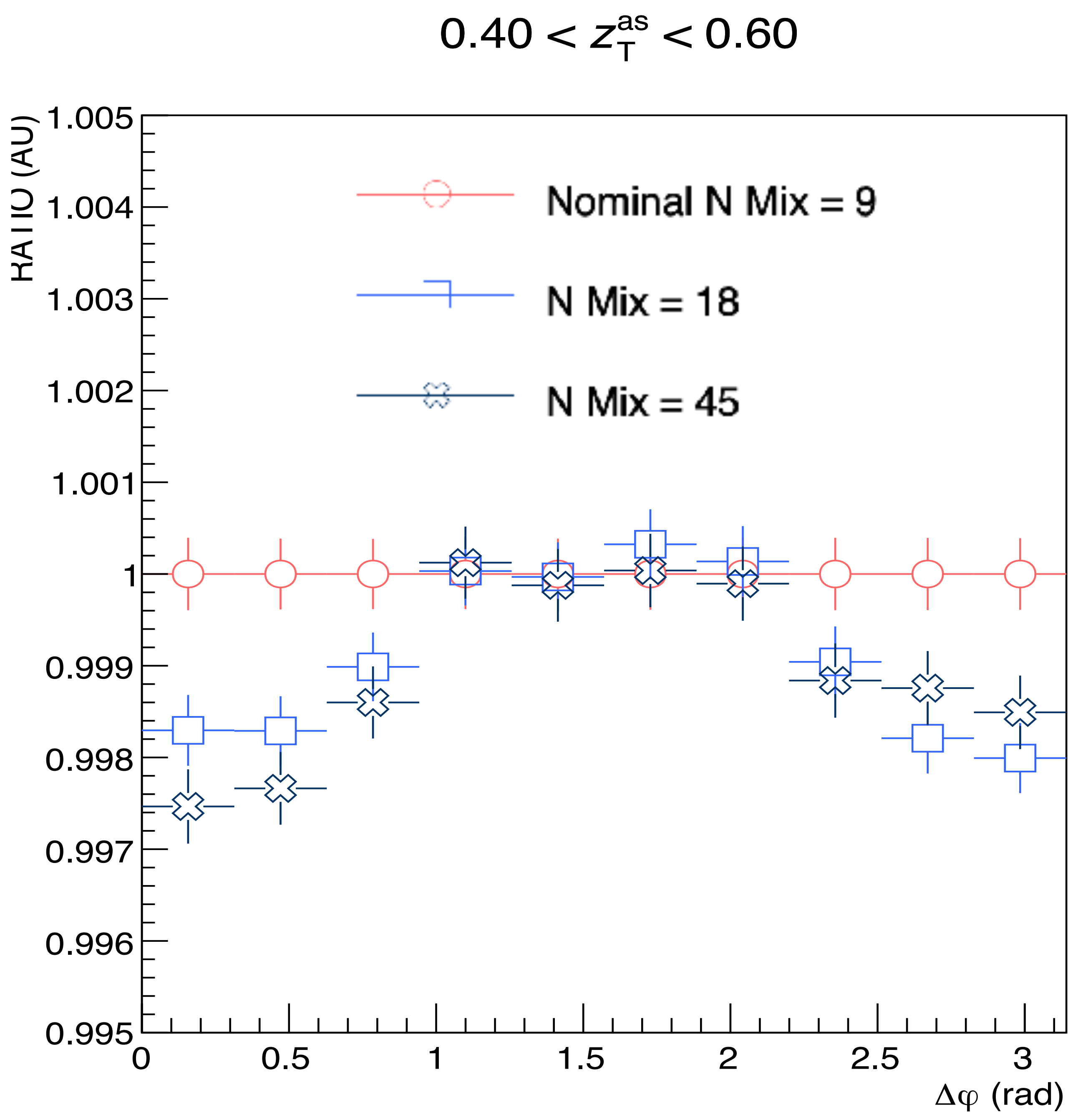
Important Difference, highlighted by the ratio

Systematics: Δ*centrality cut on Mixed Event*

- The nominal case is: NCentMixBin = 9
- Checked multiples of 9: NCentMixBin = 18 and NCentMixBin = 45
- The Mixed before the Scaling is not varying. Check the Same Event





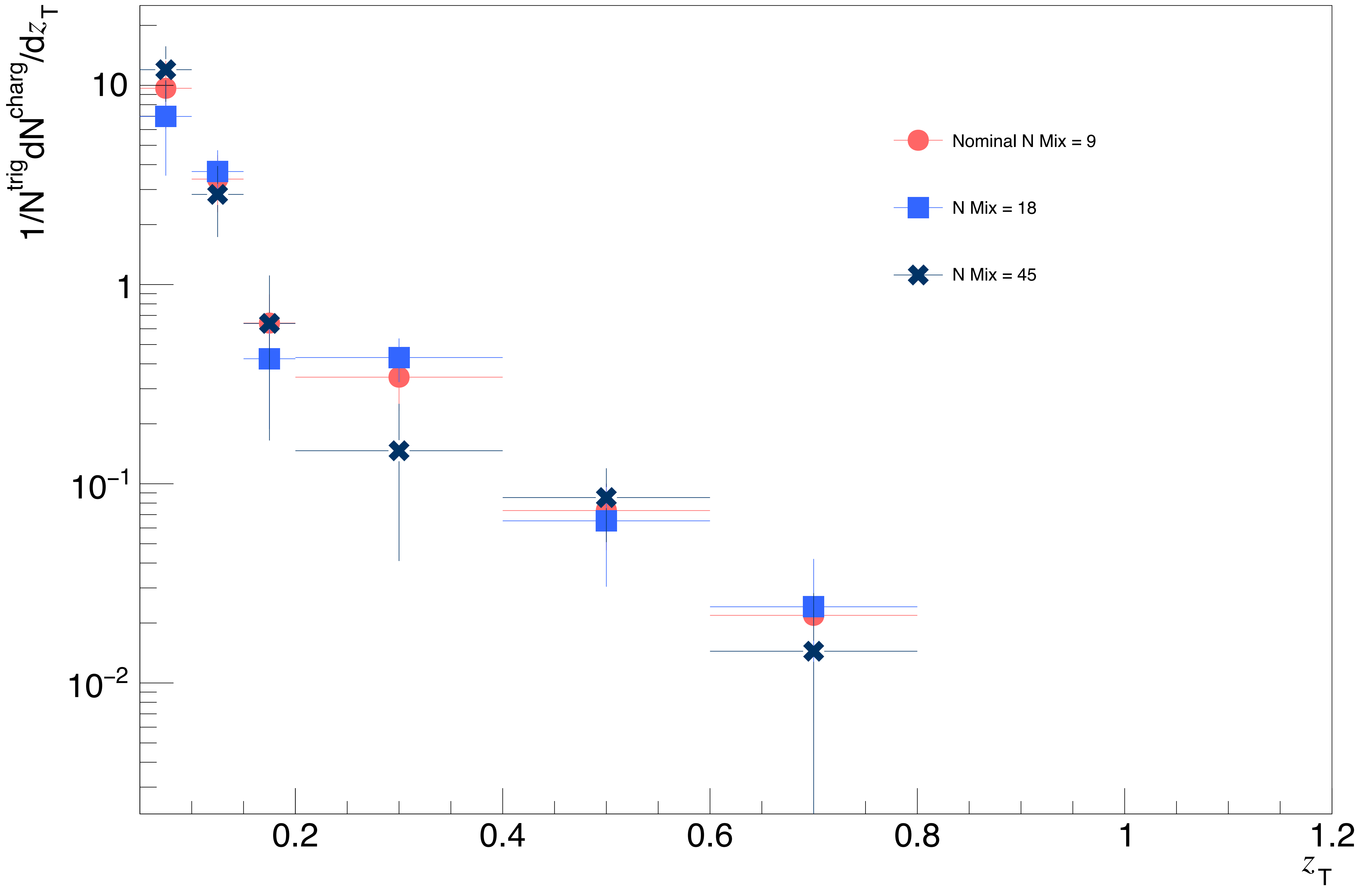


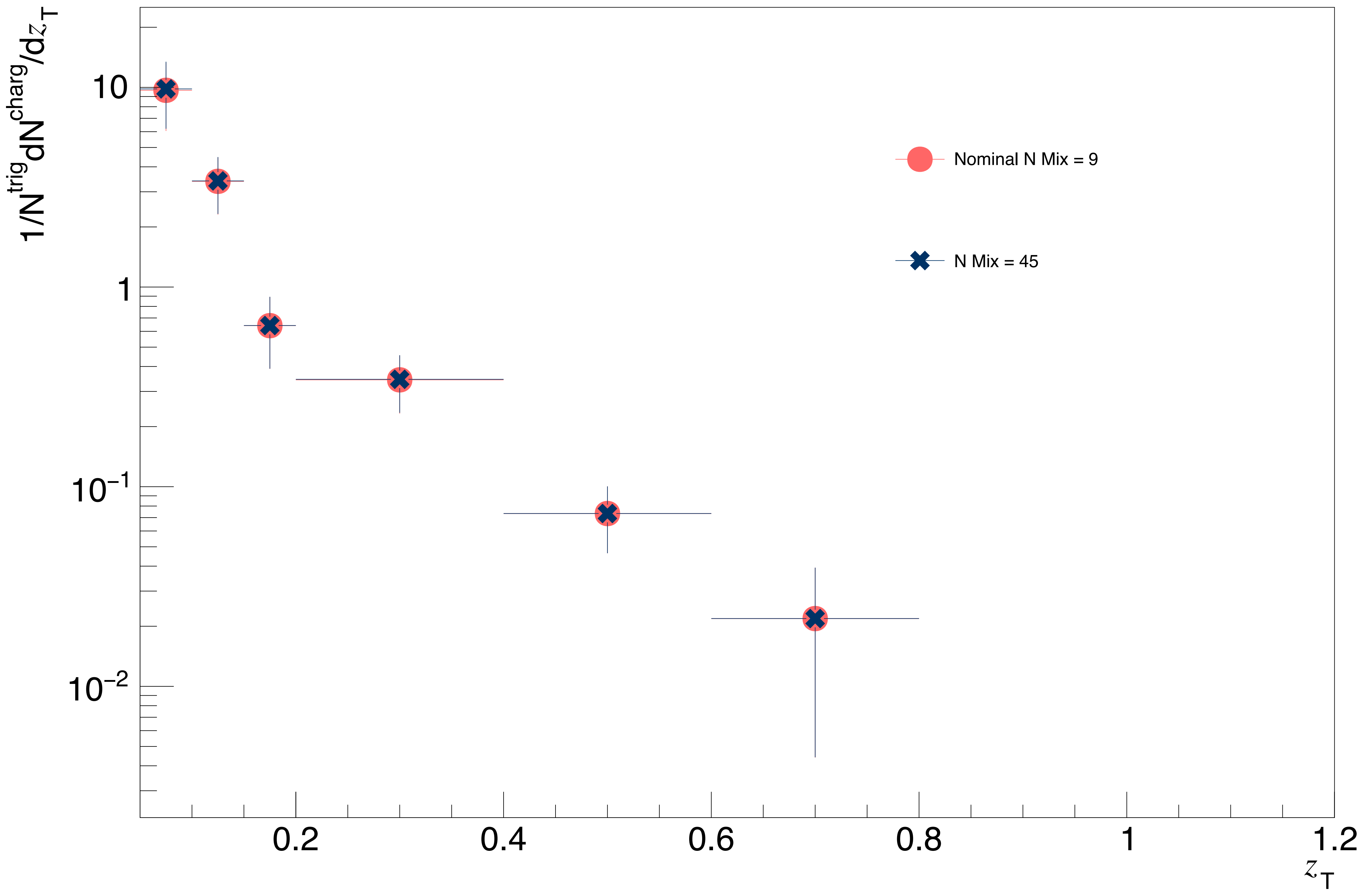
The Same Event fluctuates: different same event in the different trains. Confirmed by different number of analysed events

If we used only one Same event for the various Mixed Event, no differences

Systematics: Δcentrality cut on Mixed Event

- The nominal case is: NCentMixBin = 9
- Checked multiples of 9: NCentMixBin = 18 and NCentMixBin = 45

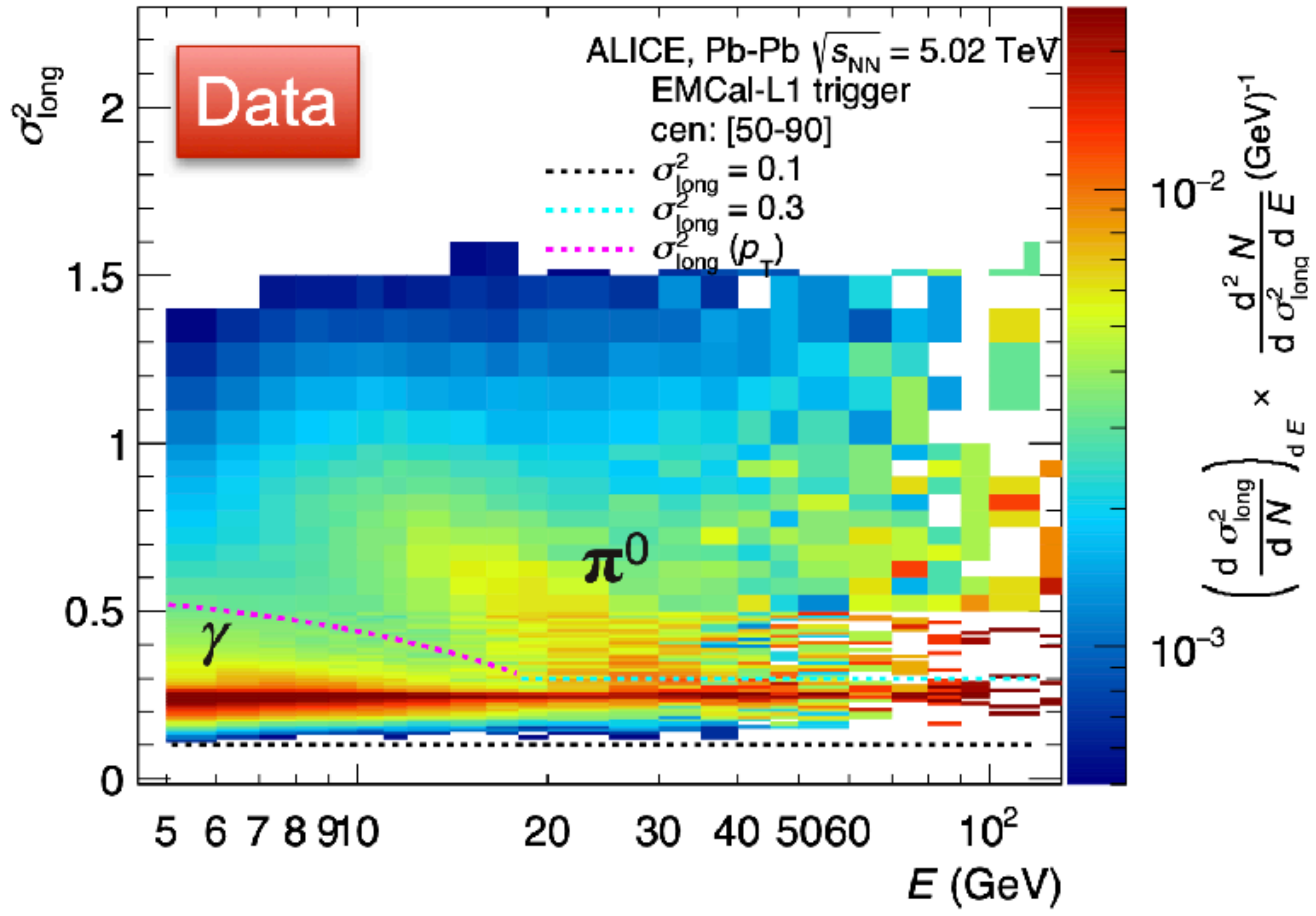


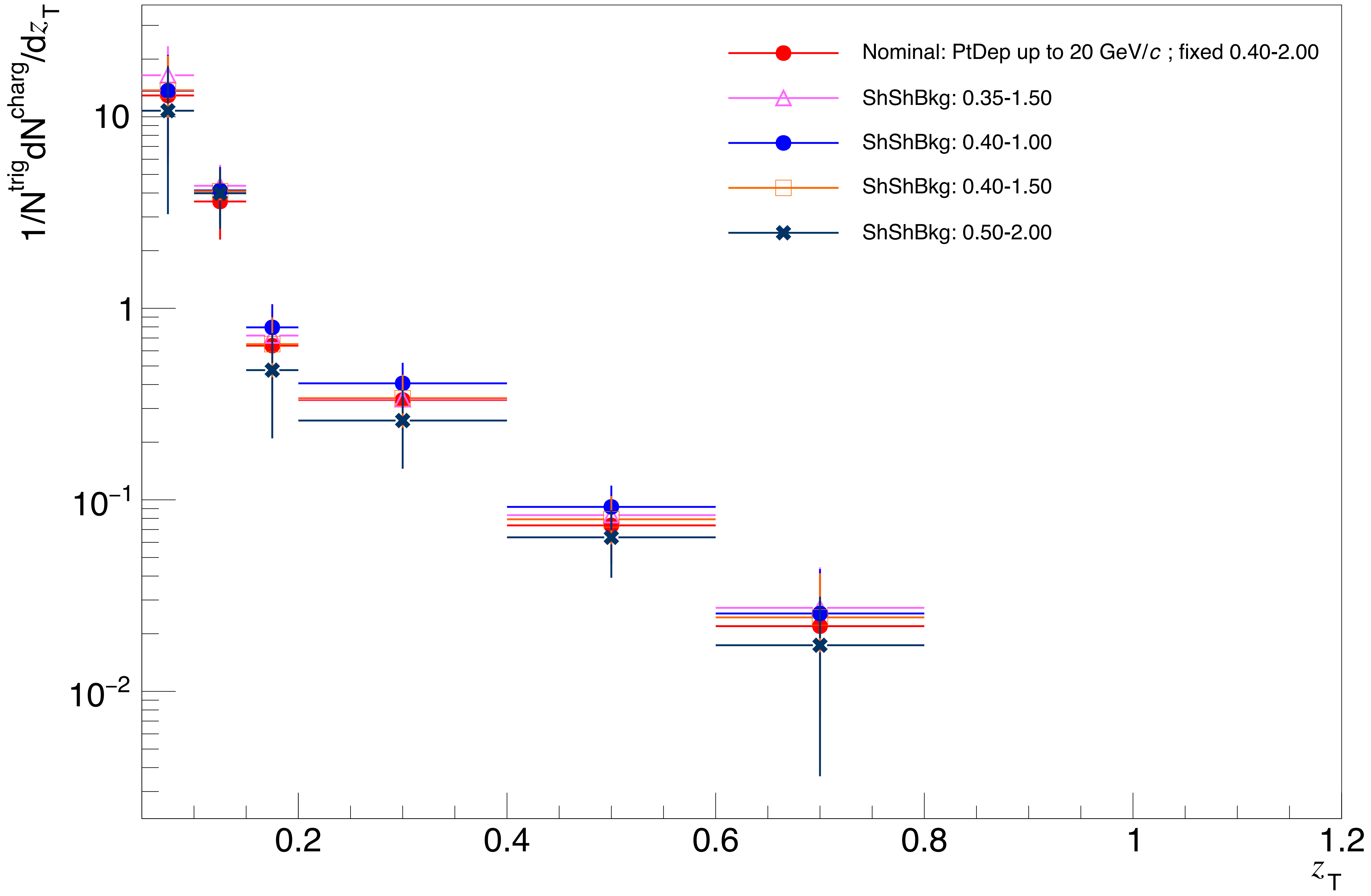


- If we used only one Same event for the various Mixed Events, no differences in the zt distribution
- No systematics

Systematics: *Background* σ^2_{long} *selection*

- Various combination of σ^2_{long} for the background have been tested.





To do list

- Systematics:
  - Background σ^2_{long} selection (ongoing)
  - Tracking performance ***(TO BE DONE)***

- Preparation of the Analysis Note

Thank you for the attention!

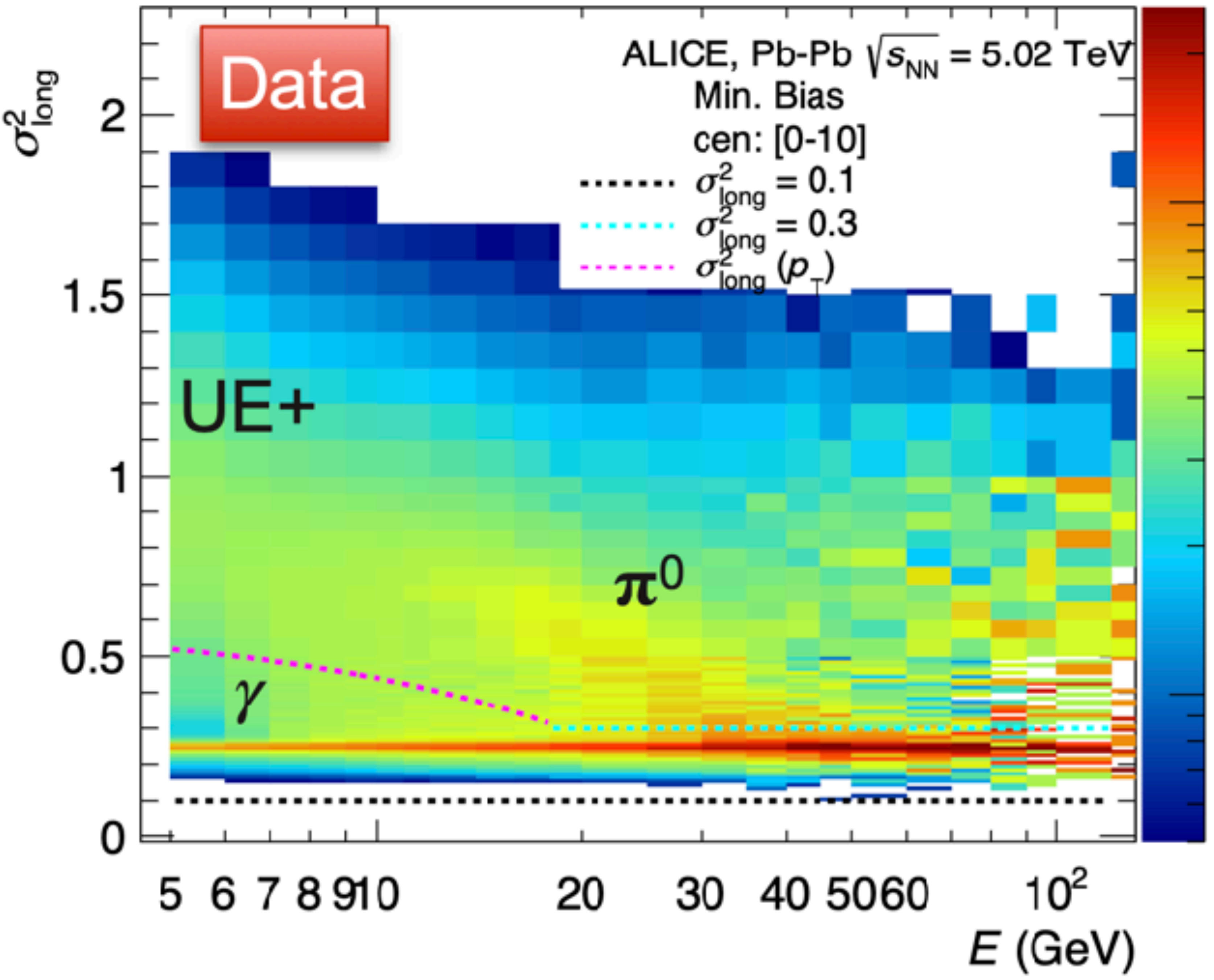
Backup

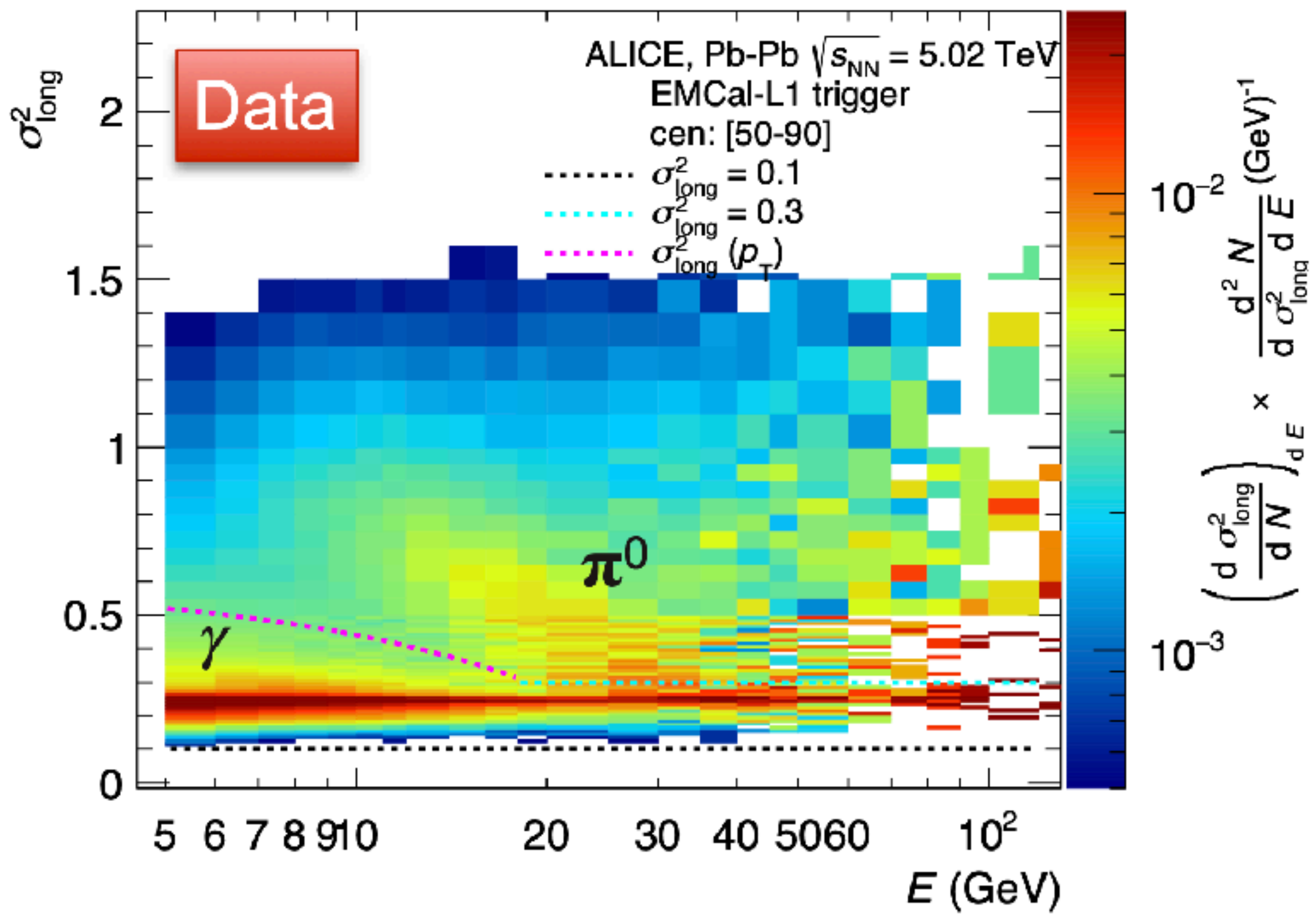
Candidate isolated photons

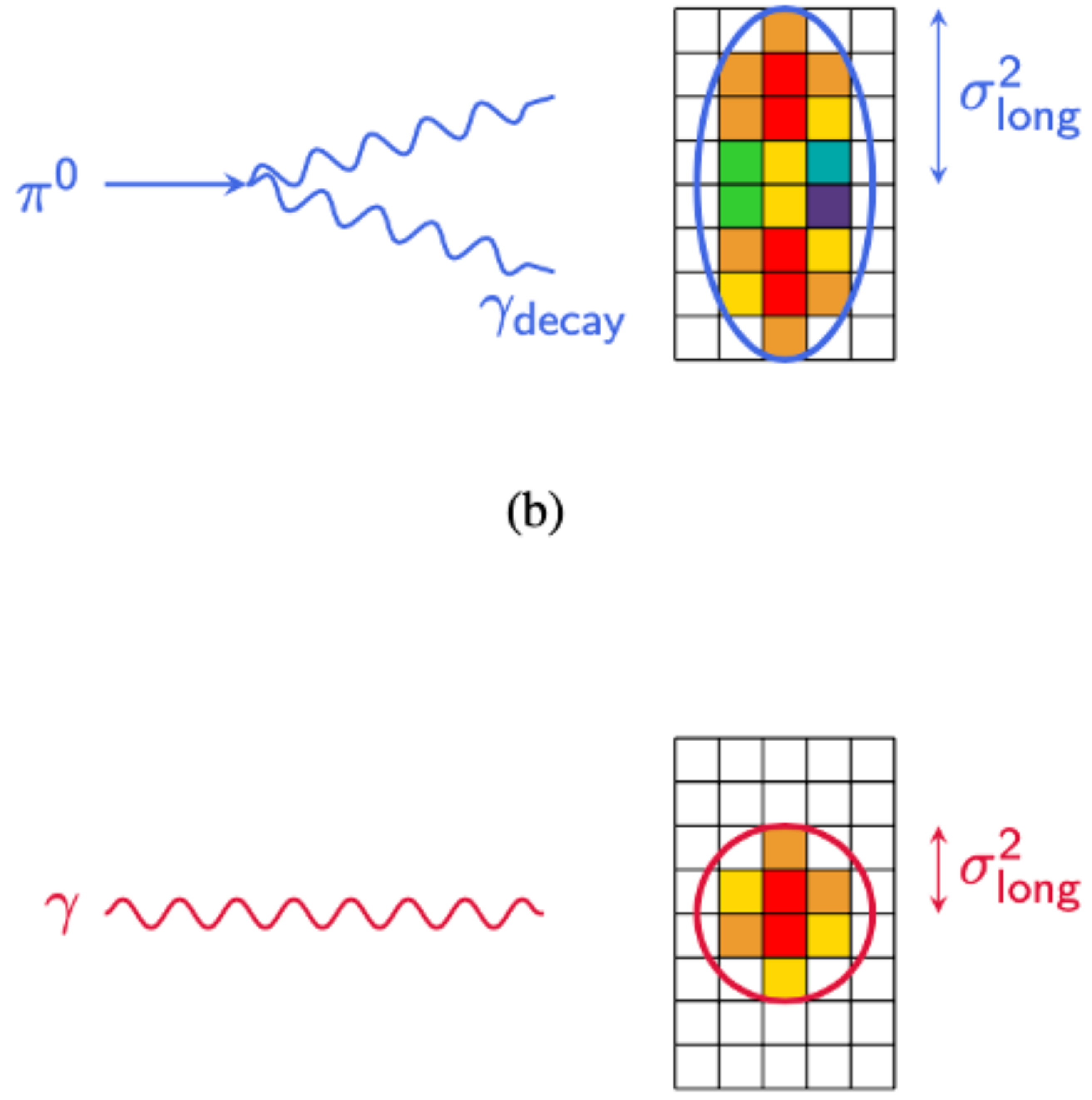
The neutral cluster samples are a mixture of neutral particles.

Photon discrimination with elliptical parametrization: evaluate dispersion of the EM shower.

The semi-major axis σ^2_{long} allows to feature the *type* of photon.







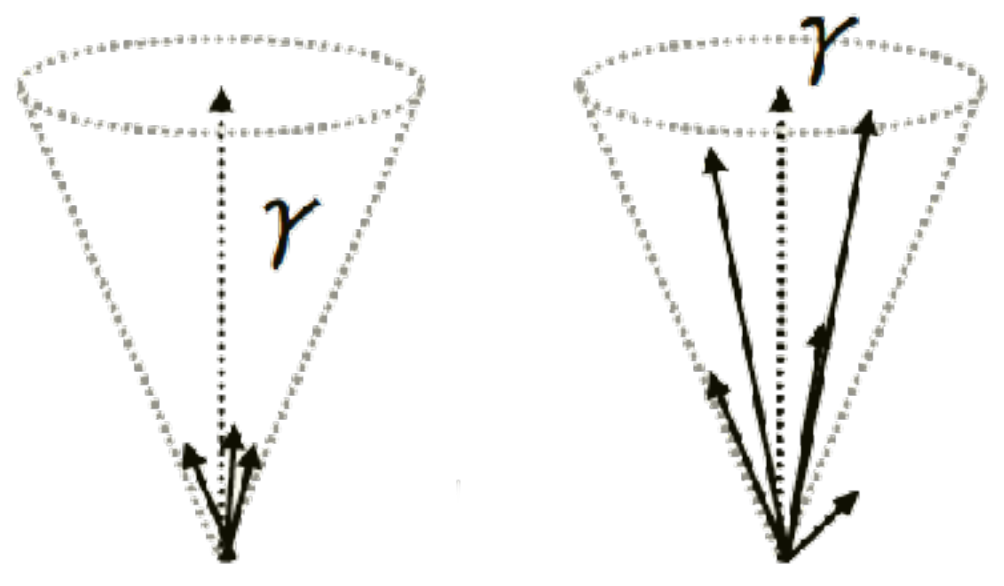
ALICE 2022, Internal, Gustavo's analysis

Isolation method and UE subtraction

Goal: isolate direct photons and reject the largest part of non direct photons

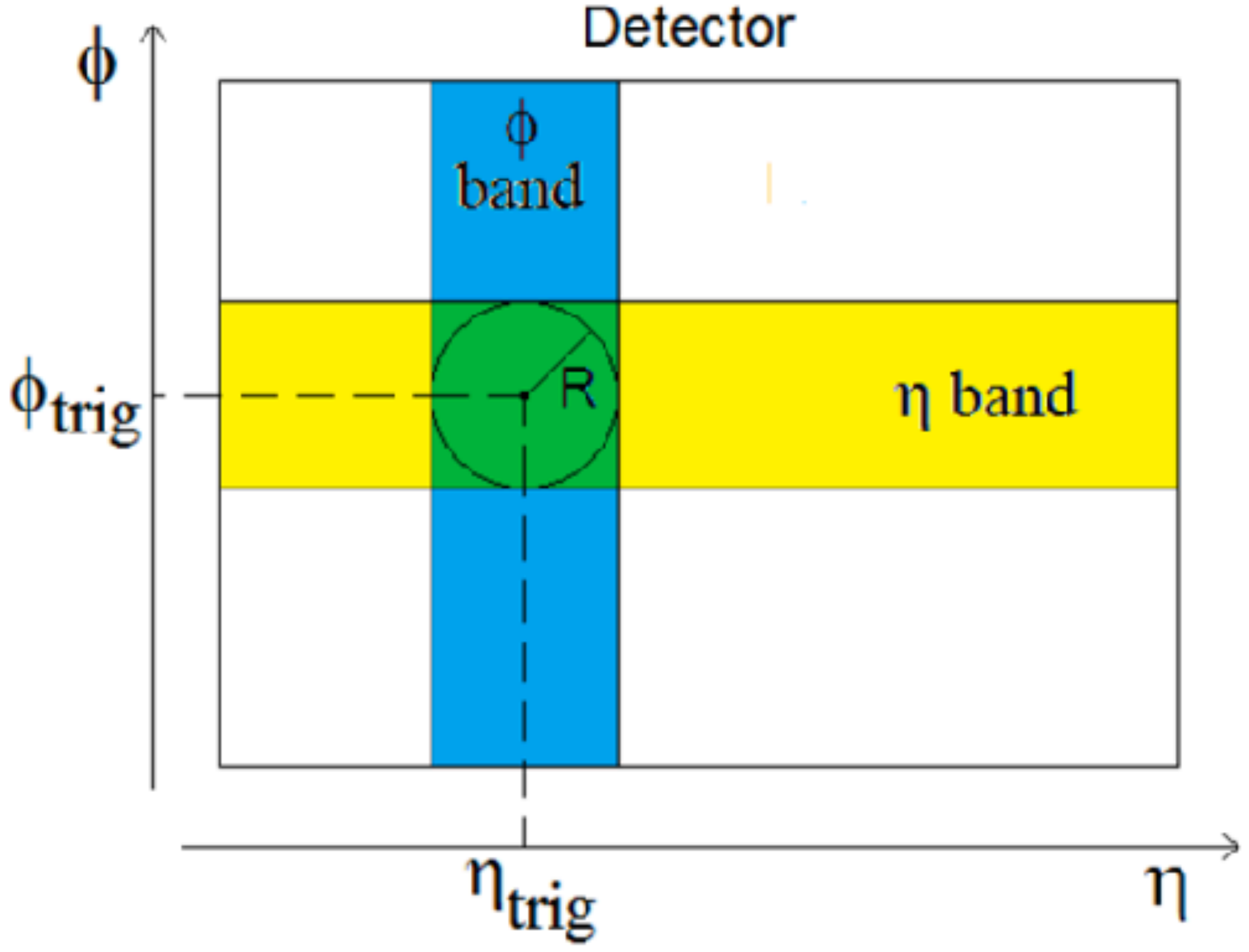
Cone radius around a candidate photon at $(\eta_\gamma, \varphi_\gamma)$:

$$R_{cone} = \sqrt{(\eta - \eta_\gamma)^2 + (\varphi - \varphi_\gamma)^2}$$



In Pb-Pb high multiplicity in final state →subtracting the UE

How? METHOD η-φ bands



The contribution of the UE in the cone is ~ $(\Sigma\, p_{\mathrm{T}}^{iso})_{UE} \cdot A_{cone}$

It's removed from the total transverse momentum in the cone

The final condition on p_{T} that defines a isolated γ is :

$$\boxed{\sum_{cone} p_{\mathrm{T}}^{iso} - (\sum_{UE} p_{\mathrm{T}}^{iso})_{in\,cone} = p_{\mathrm{T}}^{iso} < 2\ \mathrm{GeV}/c}$$

Purity: ABCD method

Divide clusters σ^2_{long}- isolation energy plane into 4 regions ABCD

- A : signal dominated region
- B, C and D : background dominated regions

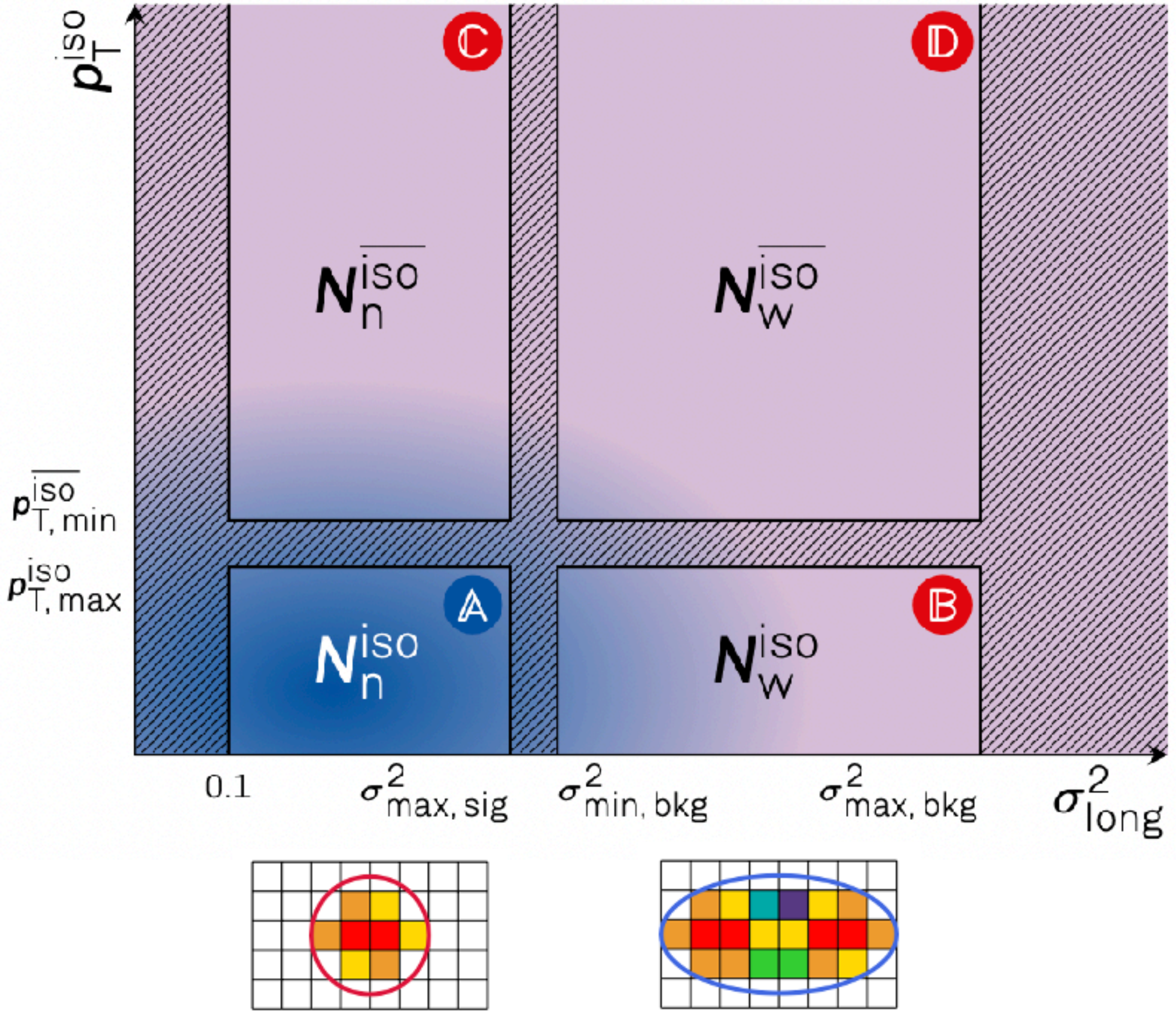
$N = S + B = \gamma_{direct}$ signal + background

- *purity* = *S*/*N* in A region

$$purity = \boxed{1 - \left(\frac{N_n^{\overline{iso}}/N_n^{iso}}{N_w^{\overline{iso}}/N_w^{iso}}\right)_{data}} \times \boxed{\left(\frac{B_n^{\overline{iso}}/N_n^{iso}}{N_w^{\overline{iso}}/N_w^{iso}}\right)_{MC}}$$

Data-driven purity

MC correction factor



Corrections due to:

B isolation fraction depends on the circularity

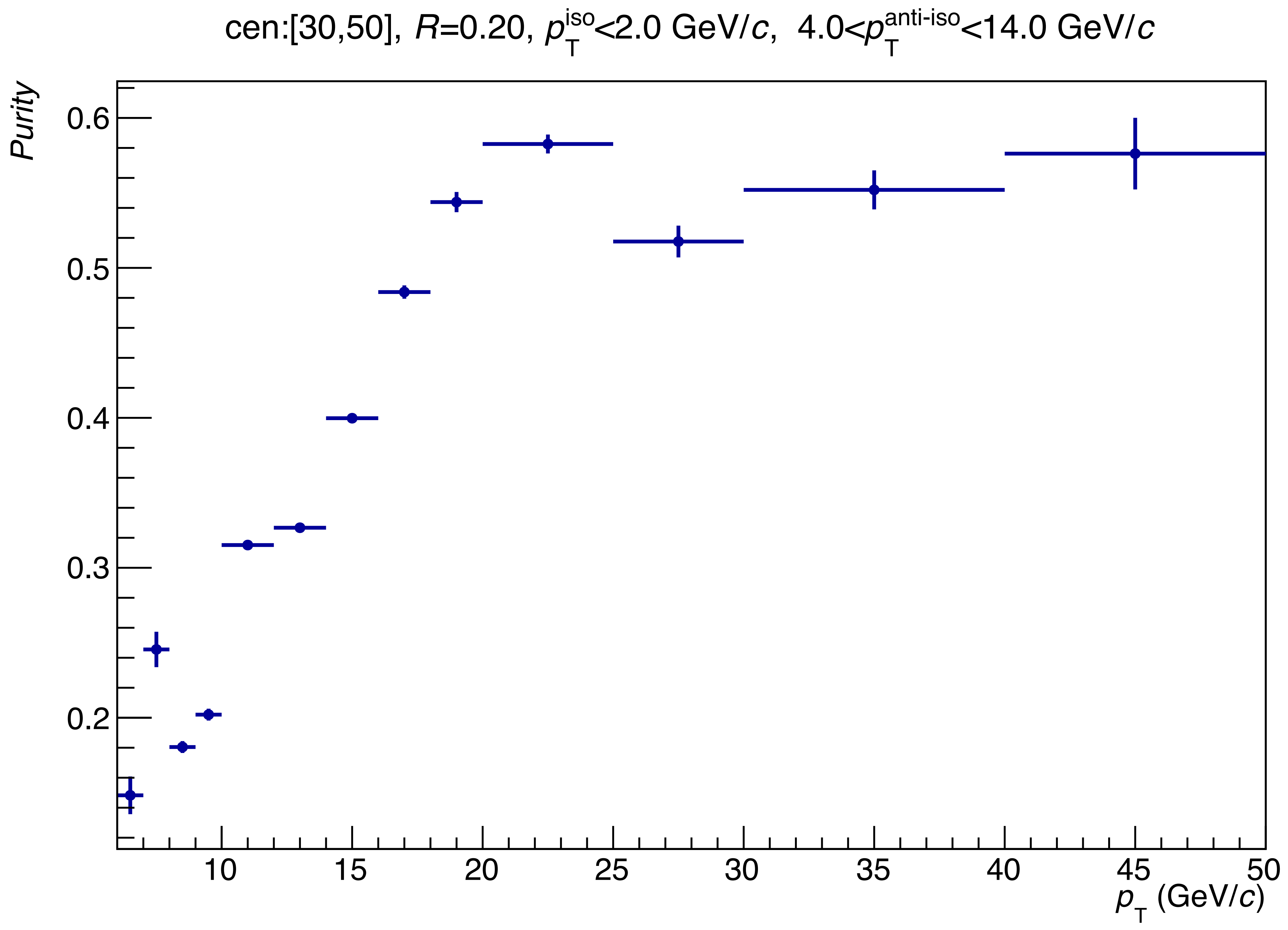
S not contained only in A, it spreads over B, C and D regions

Recap: *Purity Correction*

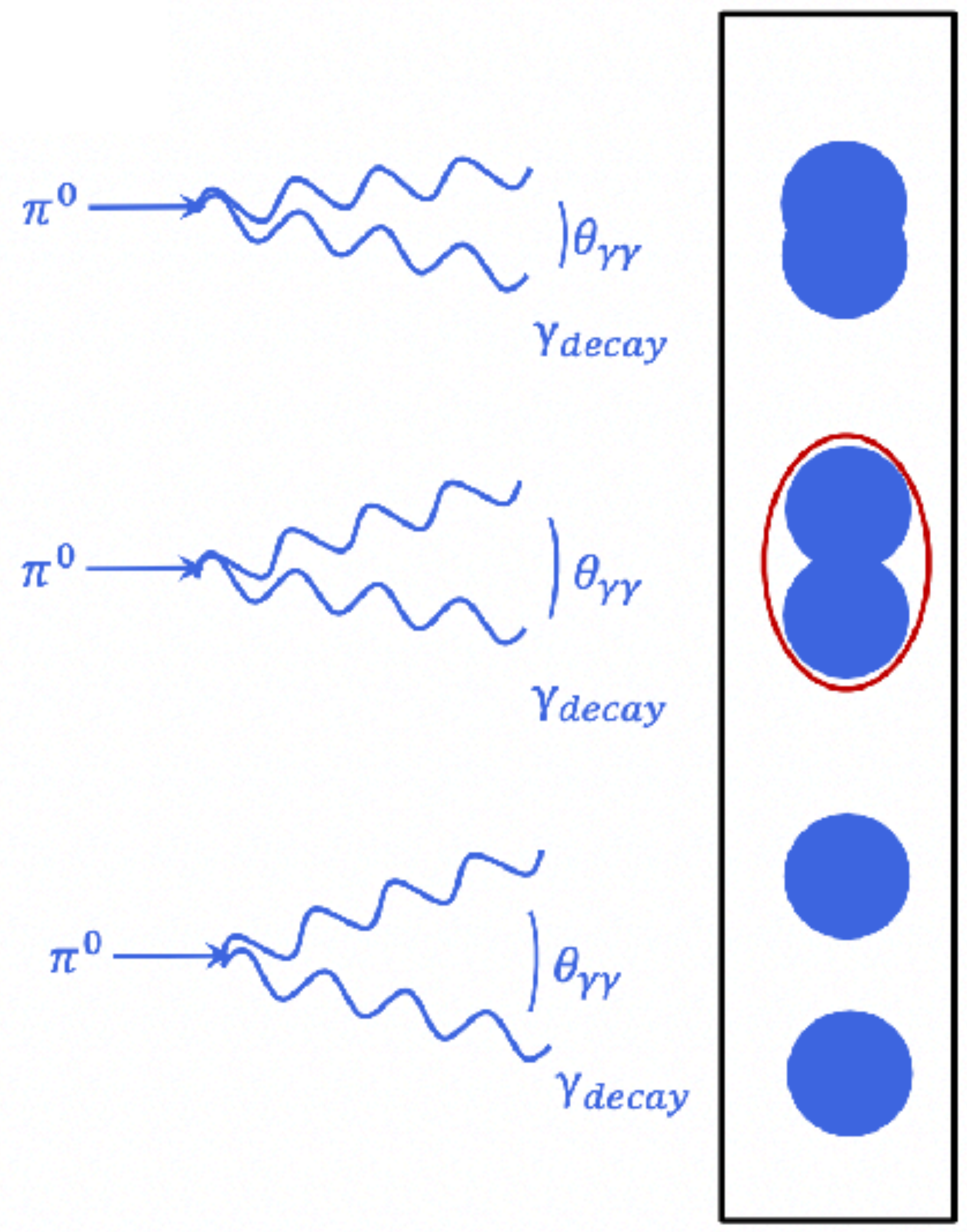
The isolated γ candidate sample ***has to be corrected*** for π^0 accepted = $\text{cluster}^{iso}_{\text{wide}}$

$$\boxed{\gamma^{iso} = \frac{\text{cluster}^{iso}_{\text{narrow}} - (1 - P)\,\text{cluster}^{iso}_{\text{wide}}}{P}}$$

Where P = *Purity*



ALICE 2022, Internal, Gustavo Conesa's analysis



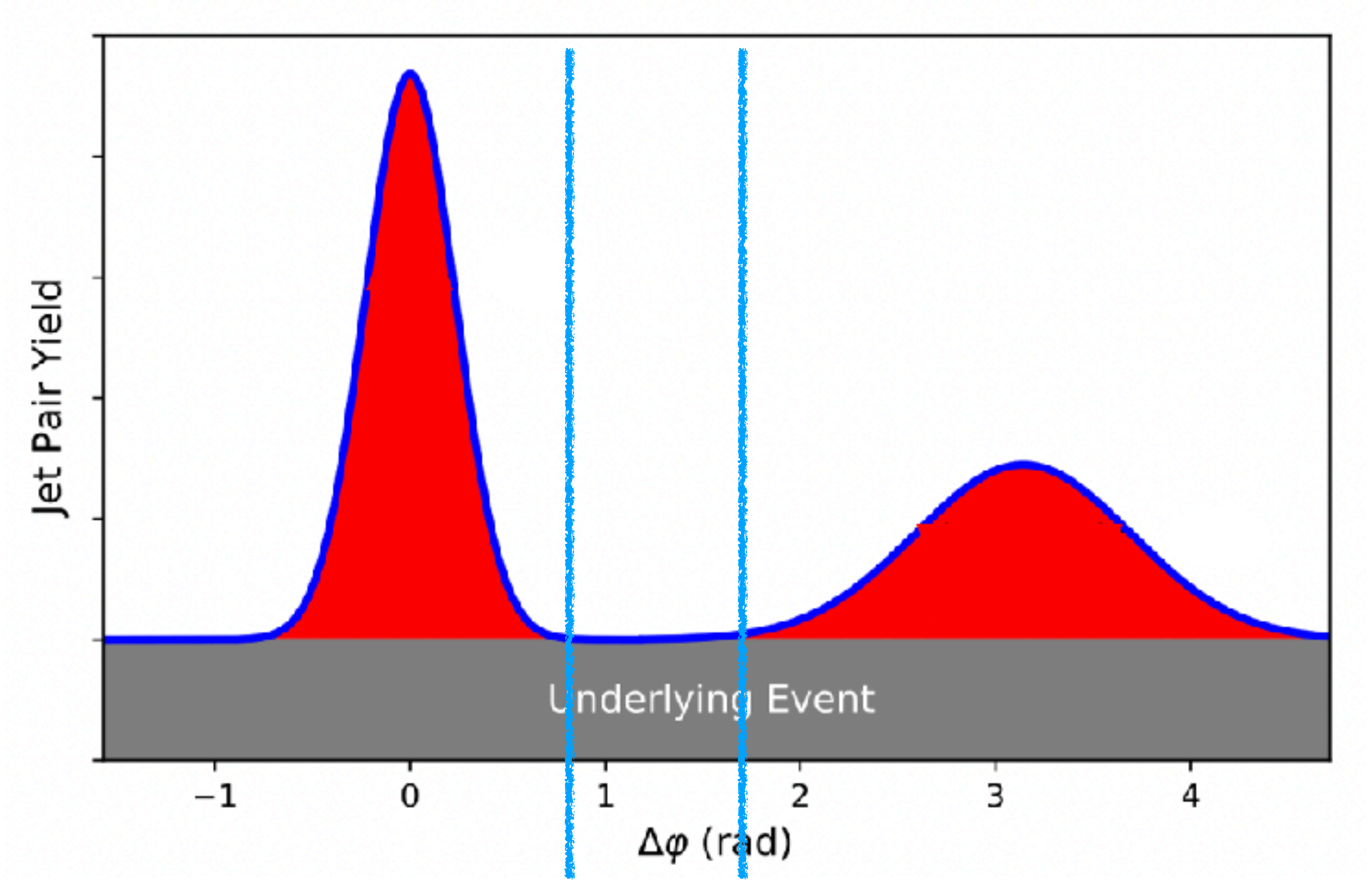
$\text{cluster}^{iso}_{\text{wide}} \rightarrow 0.4 < \sigma^2_{long} < 2.00$

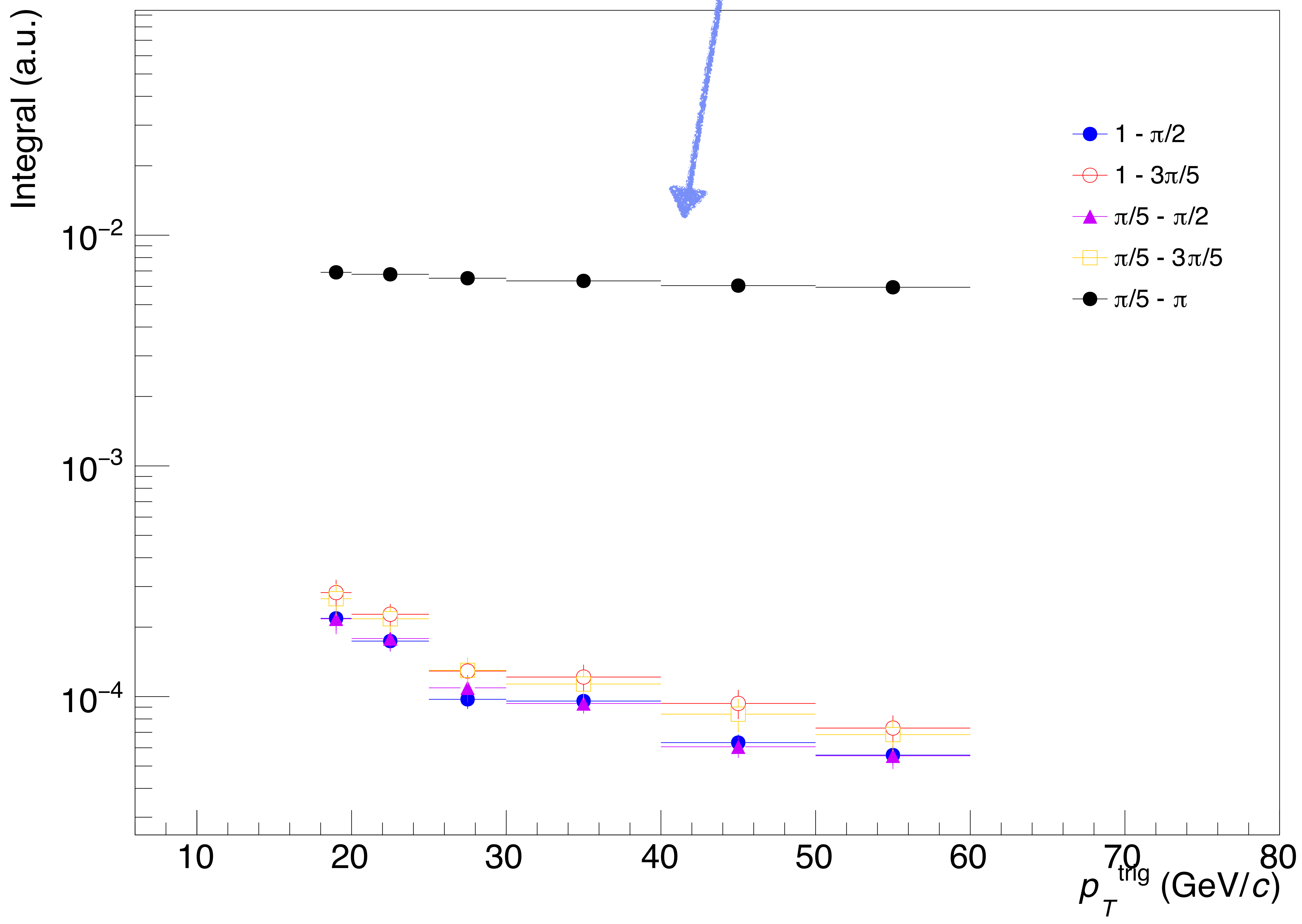
$\text{cluster}^{iso}_{\text{narrow}} \rightarrow 0.1 < \sigma^2_{long} < 0.3$

☑ Purity result not final, but variations not expected to affect much the analysis

Definition of Underlying Event (UE) region

- Careful evaluation of UE region: to exclude away-side or near-side effects.
- Use pure γ***-jet*** MC to see a residual of away-side peak (away-side effect)
- $\Delta\varphi$ regions = {[1-$\pi/2$];[1-$3\pi/5$];[$\pi/5$-$\pi/2$];[$\pi/5$-$3\pi/5$];[$\pi/5$-π]}





Definition of Underlying Event (UE) region

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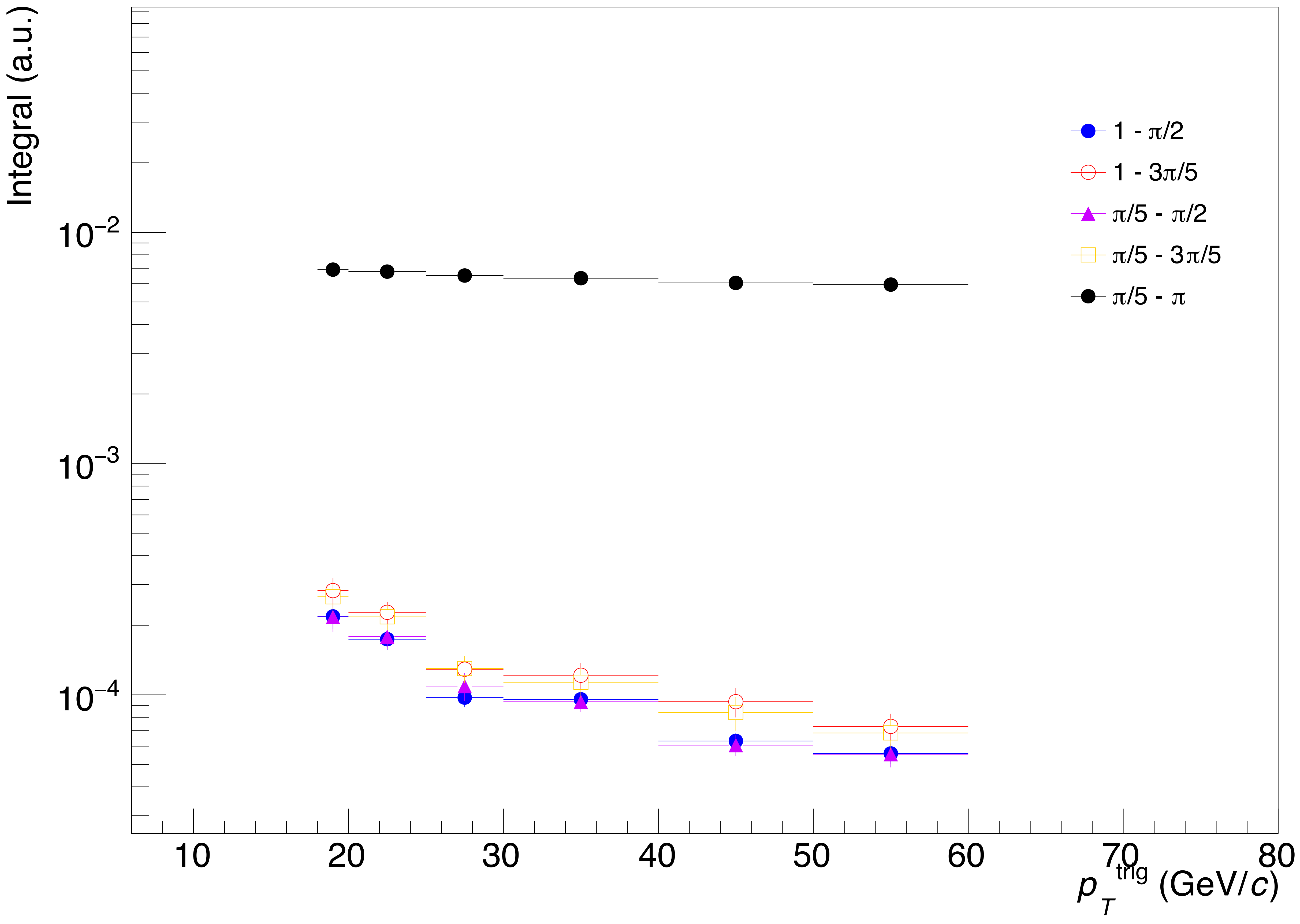
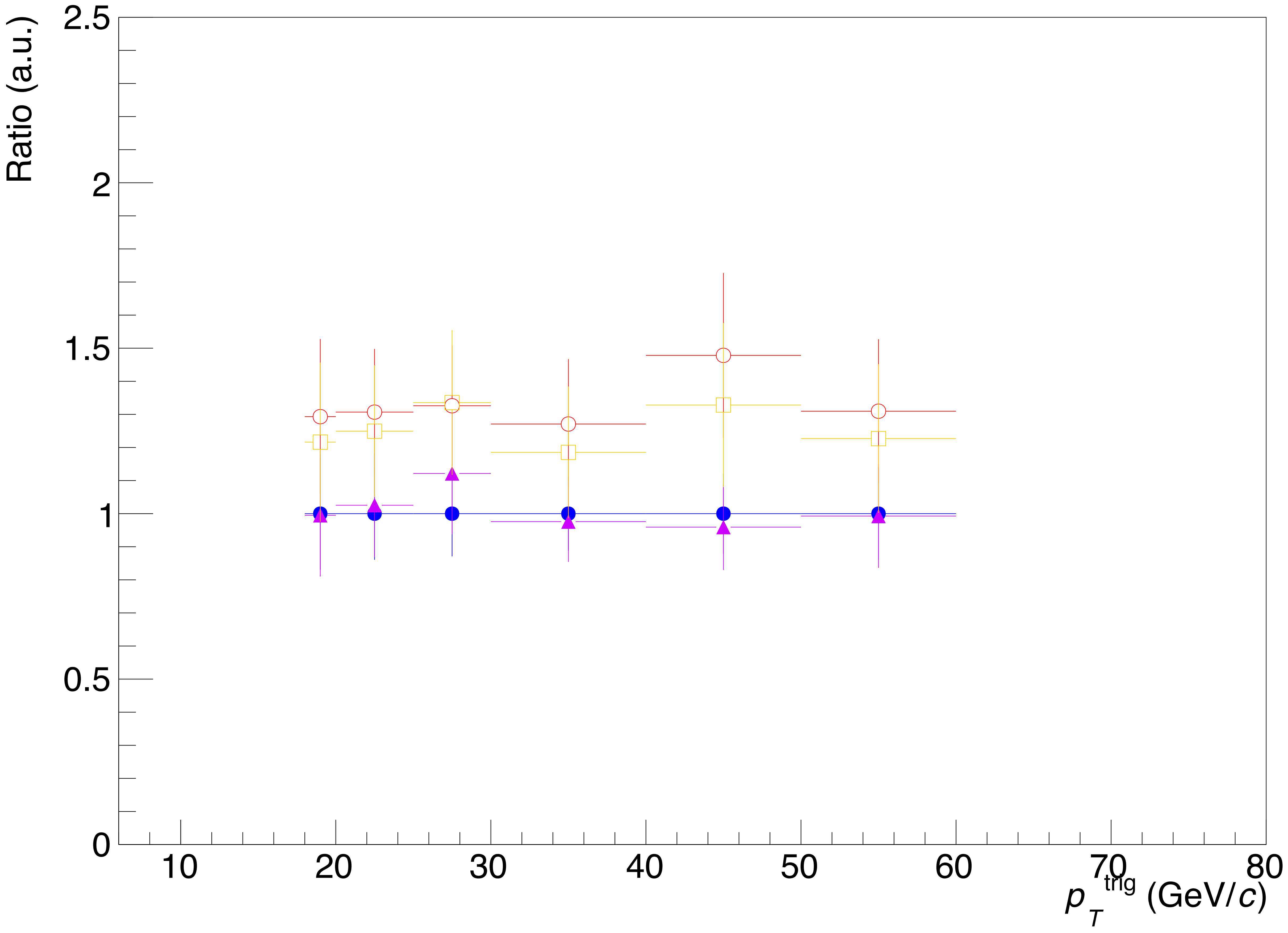




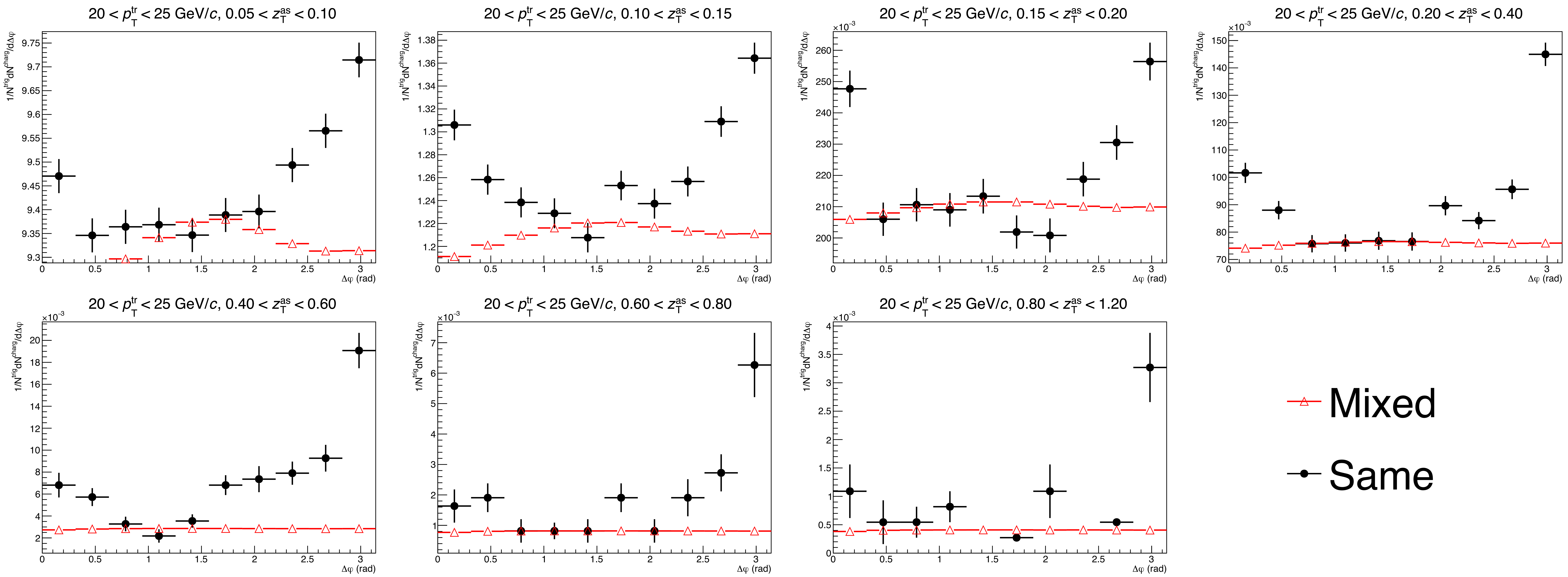
The ranges in red and yellow are still affected by the away-side: EXCLUDED!

The ranges in blue and violet are compatible

Range $\Delta\varphi$ = [1-$\pi/2$] is used.

UE subtraction, method 1: Mixed Event

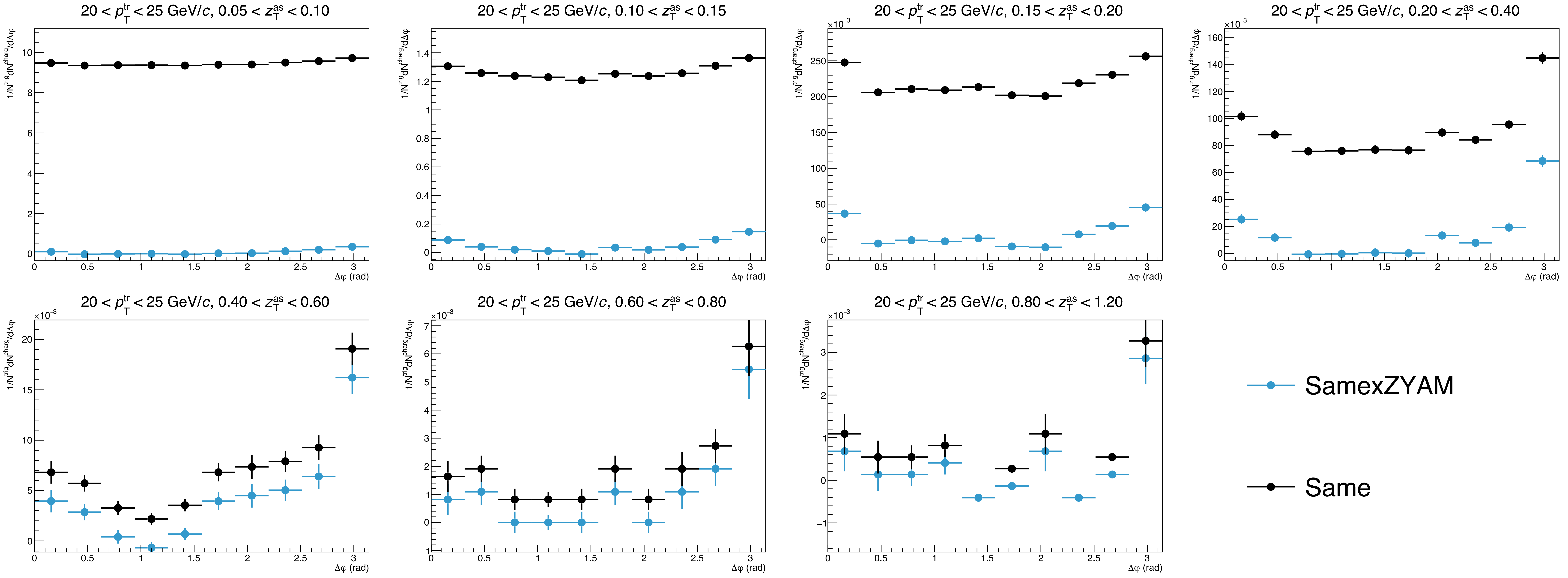
Cent: 30-50%, 20 < p_T^{tr} < 25 GeV/*c*, Isolation ON, 0.1 < σ^2_{long} < 0.3



- Mixed event coincides with the uncorrelated of the Same → method works

UE subtraction, method 2: ZYAM

Cent: 30-50%, 20 < p_T^{tr} < 25 GeV/*c*, Isolation ON, 0.1 < σ^2_{long} < 0.3

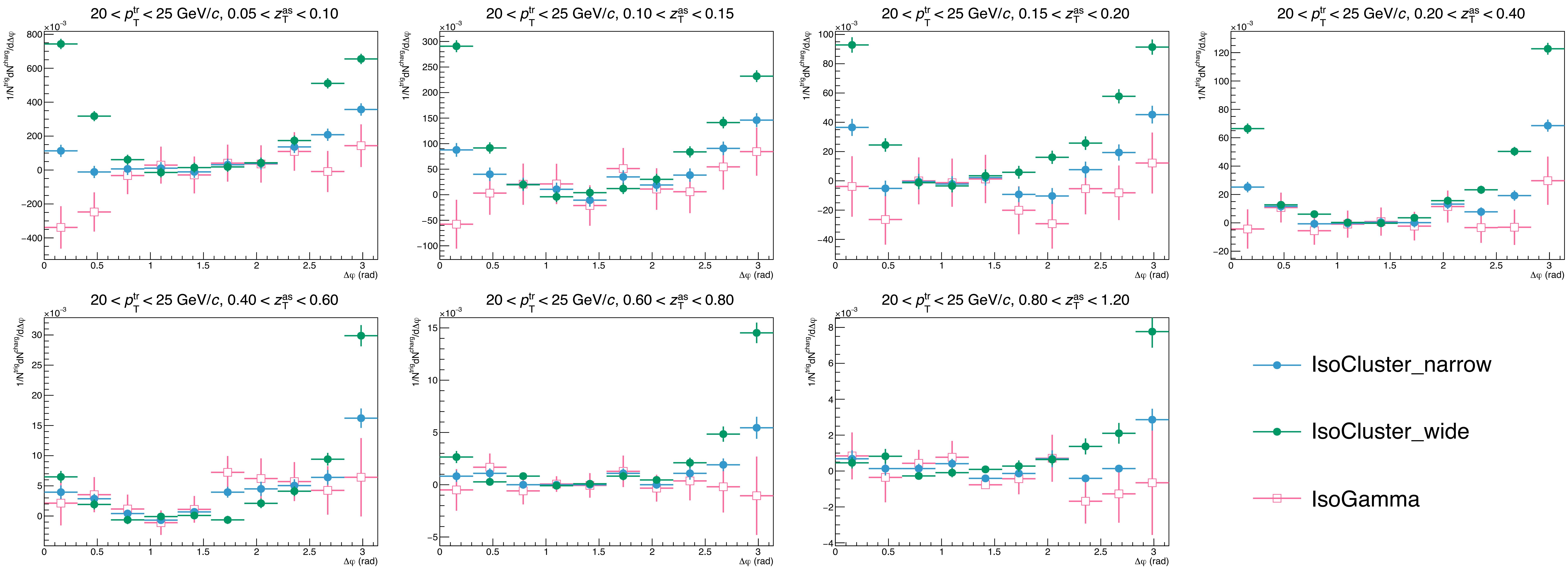


- ZYAM method works
- It doesn't modify the distributions, but it emerges the predominance of the UE

Purity Correction

Cent: 30-50%, Isolation ON

$$\text{IsoGamma} = \frac{\text{IsoCluster\_narrow} - (1-p)\,\text{IsoCluster\_wide}}{p}$$



- High π^0 contamination, effect on the γ^{iso} azimuthal distribution

Evaluation of the z_T function

Cent: 30-50%, 20 < p_T^{tr} < 25 GeV/*c*, Isolation ON, 0.1 < σ^2_{long} < 0.3

- $z_T = p_T^{hadr}/p_T^{\gamma}$ distribution allows to ***access to the parton fragmentation***
- Integration of the area around the away-side peak ($2\pi/3 < \Delta\varphi < \pi$) for every z_T interval to obtain $1/N^{trig}dN^{ch}/dz_T$ distribution

Efficiency Correction

Generated: pure MC of γ^{iso} and of γ^{iso}– hadron correlations

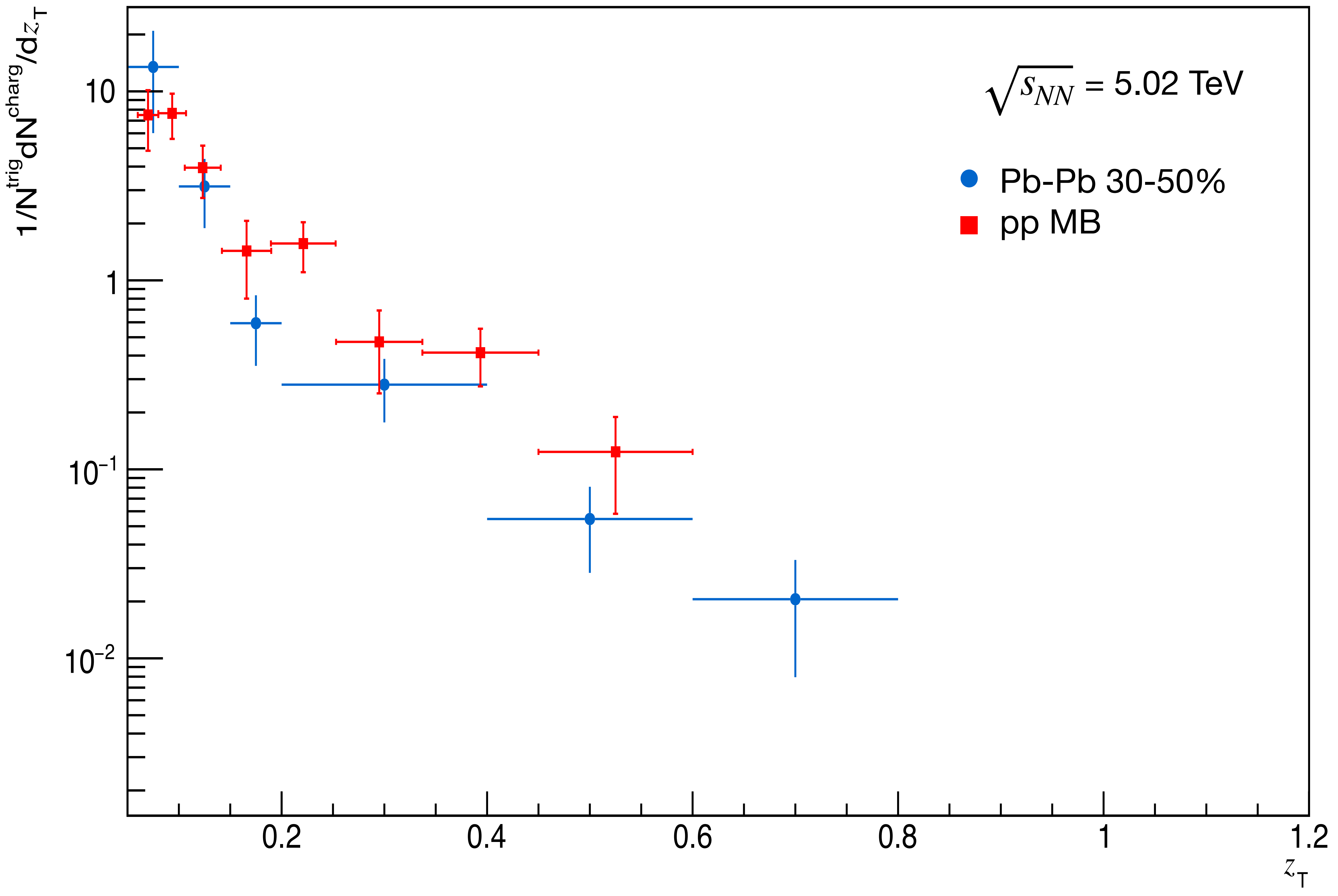
Reconstructed: *embedding* of MinimumBias (MB) data + pure MC

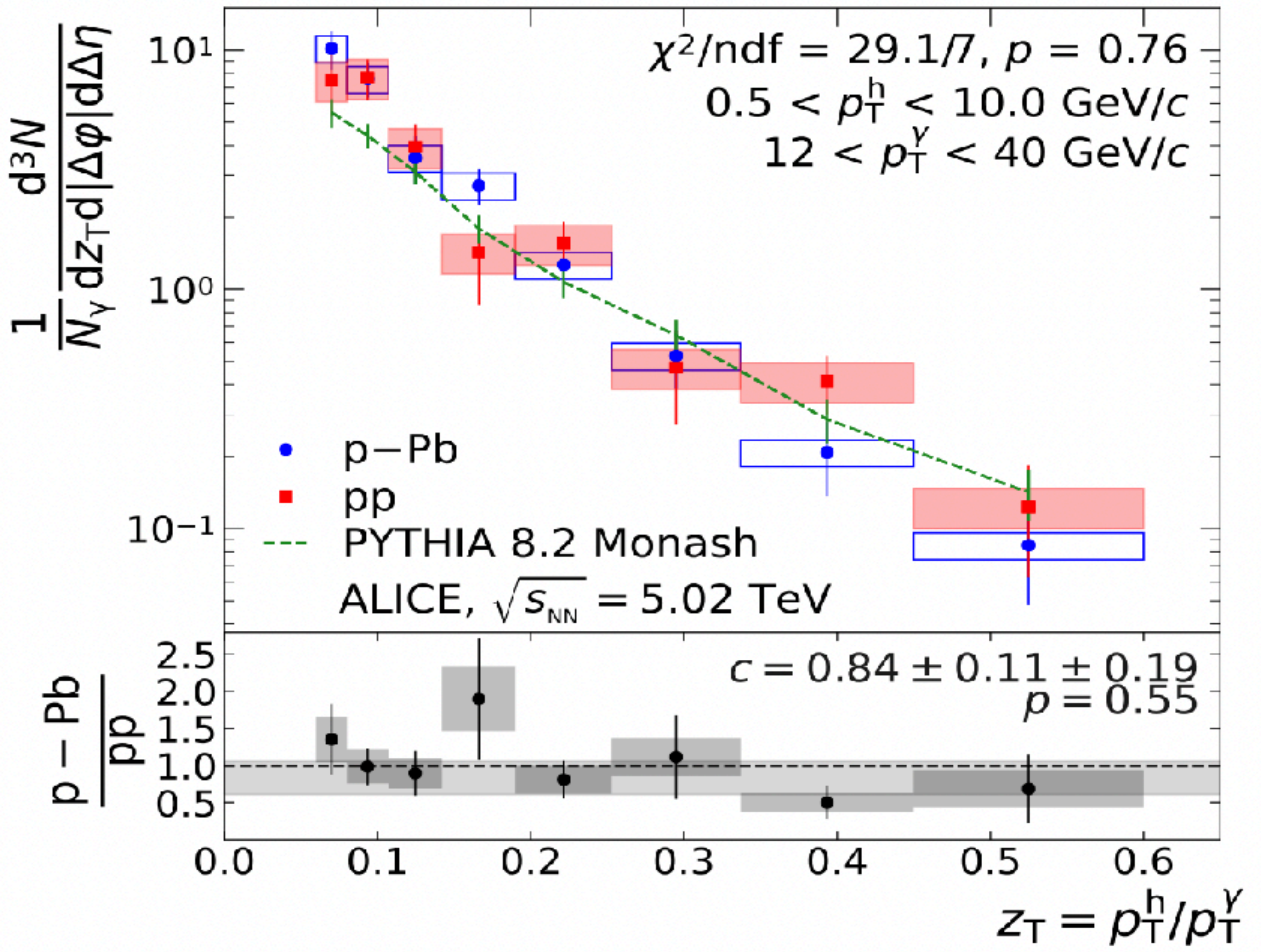
Cent: 30-50%, 20 < p_T^{tr} < 25 GeV/*c*, Isolation ON, 0.1 < σ^2_{long} < 0.3

- The negative values around 0 are related to the isolation
- As before, the integration of the away-side peak is applied to obtain the z_T function

Evaluation of the z_T function

➡ALICE, arXiv:2005.14637





- After Monte Carlo correction, different p_T^{tr} bins are merged
- Visual Comparison with published pp results **Different cuts)**