

Underlying-event properties
in pp at $\sqrt{s} = 13.6$ TeV

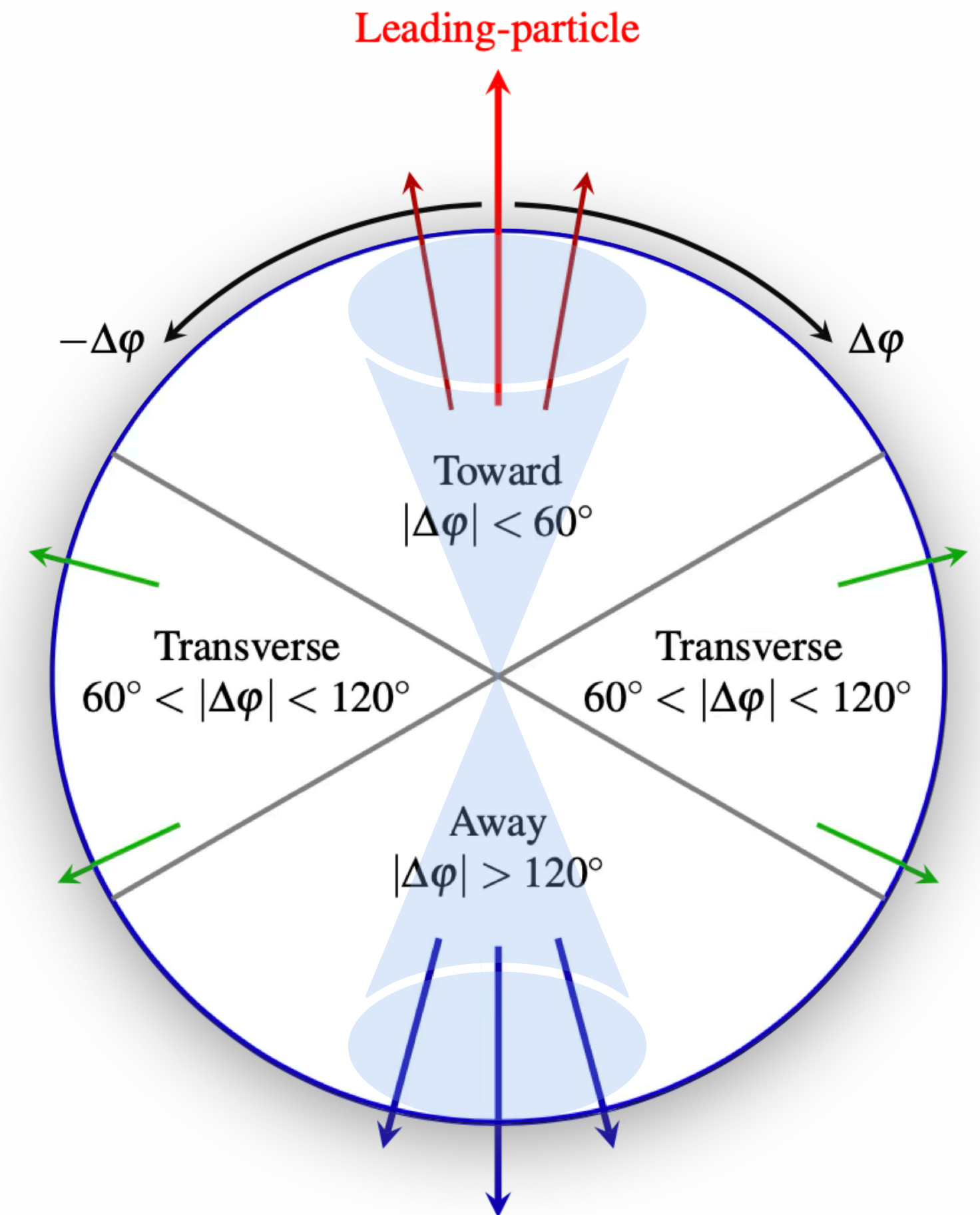
Underlying event (UE)

The particles that are not produced by the main hard scattering constitute the UE, dominated by the multiple-parton interactions (MPIs)

The analysis of the UE focuses on the study of charged particles production in three topological regions

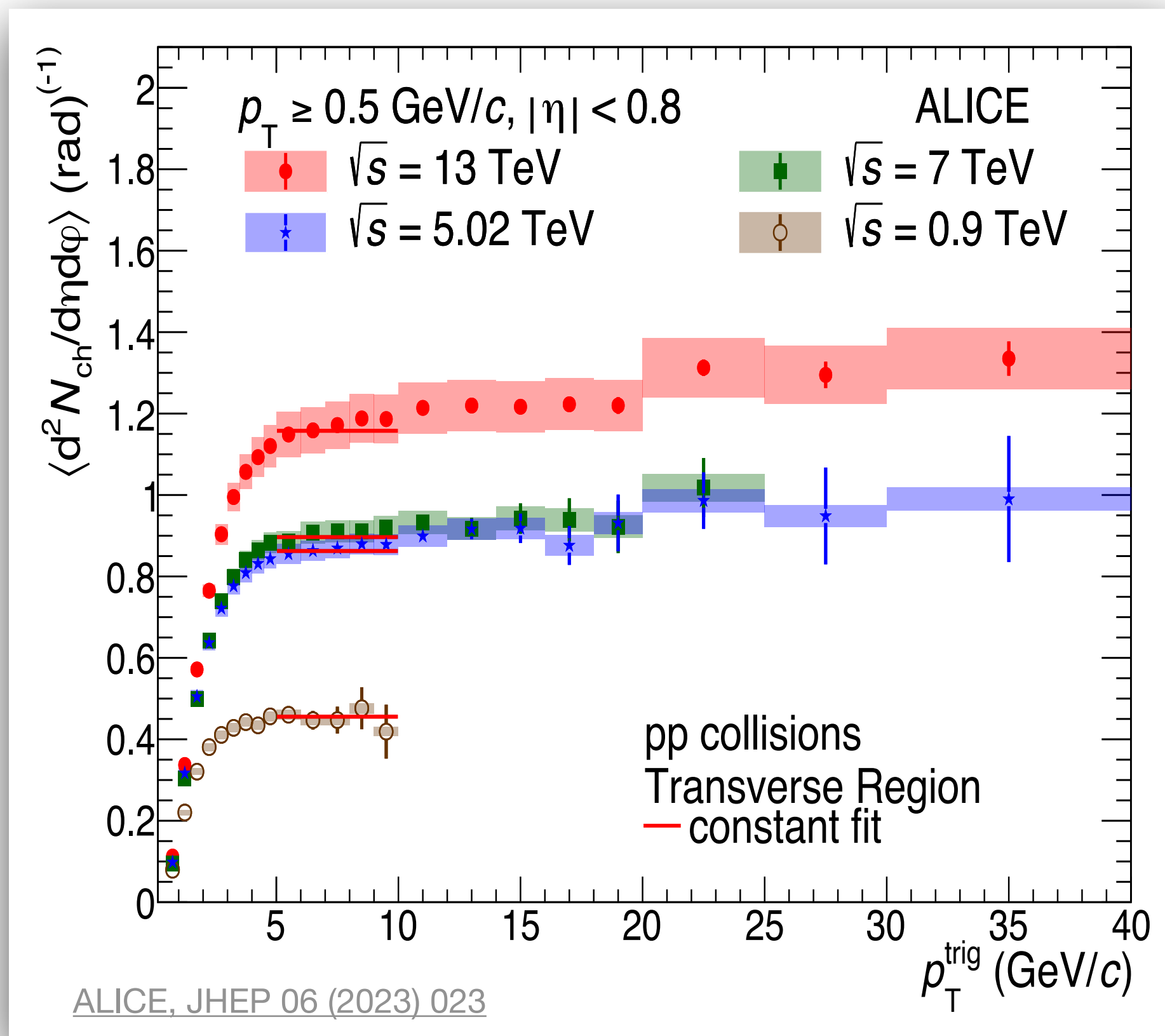


- **Toward** and **away**: dominated by the **hard scattering**
- **Transverse**: sensitive to the **UE**



Current status and prediction

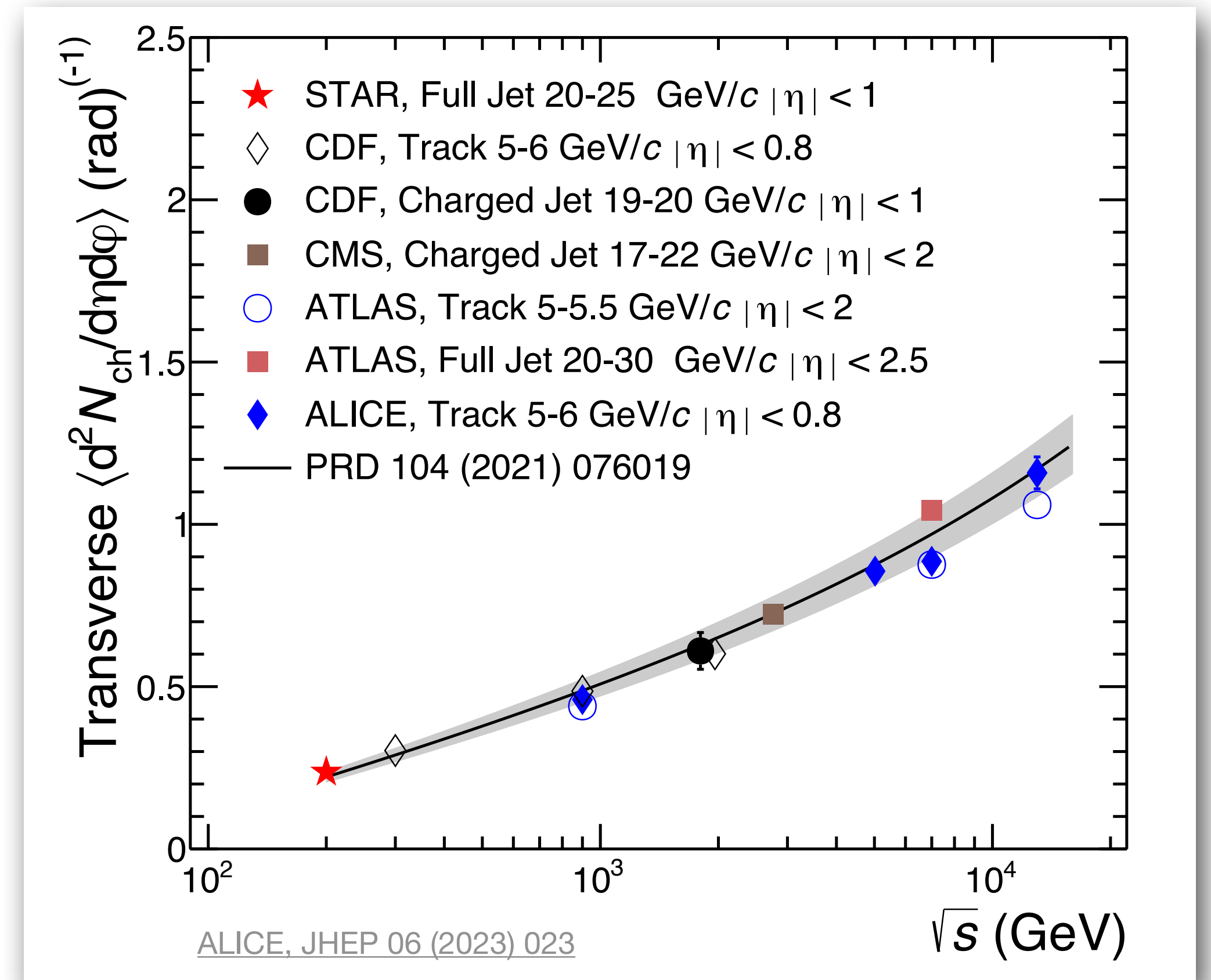
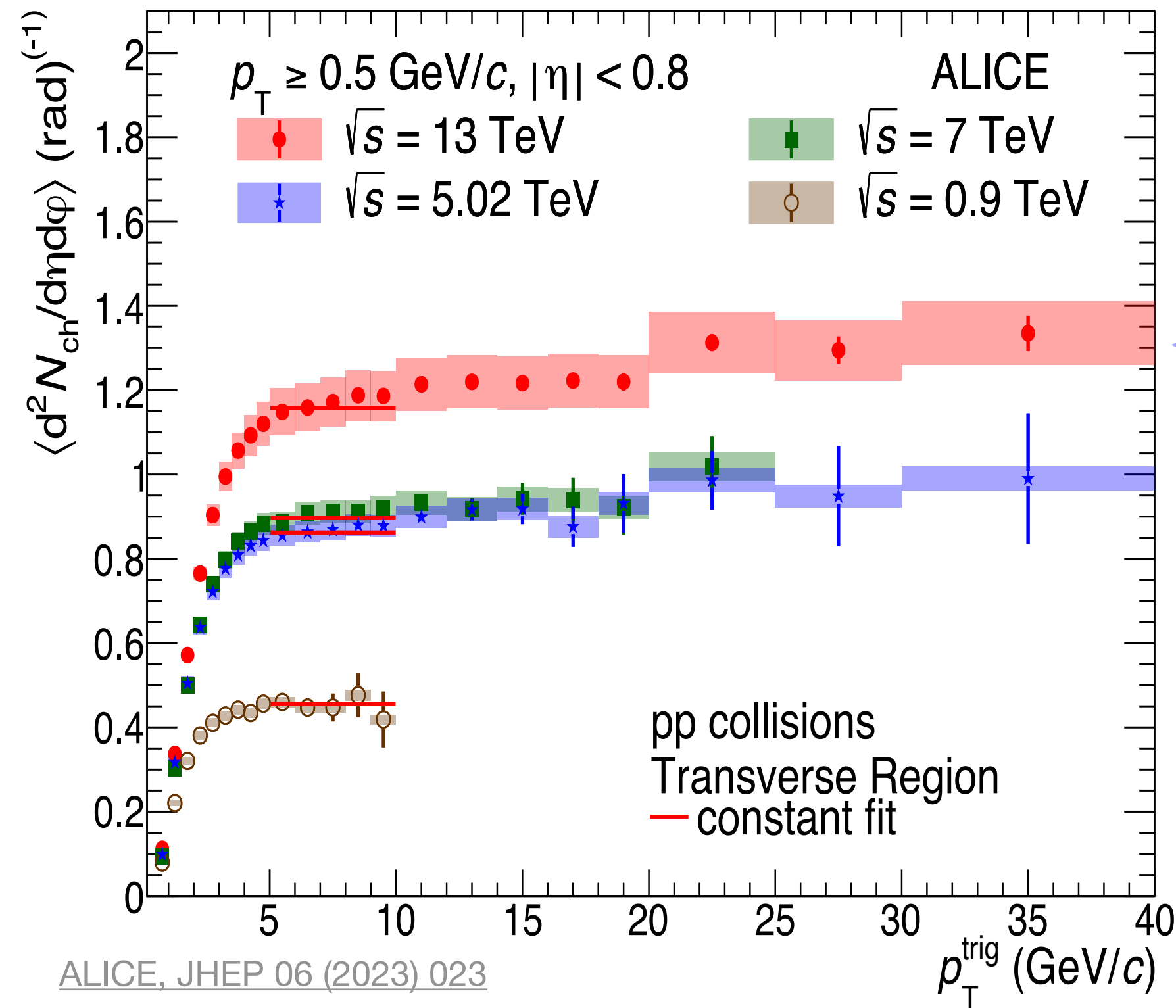
UE activity presents an energy dependence



Current status and prediction

UE activity presents an energy dependence

Plateau value for pp at $\sqrt{s} = 13.6$ TeV is expected to be slightly above (~ 1.2)



Dataset and event selection

Our analysis task is already implemented in O²: </PWGMM/UE/Tasks/uecharged.cxx>

- Dataset: LHC22o (**apass6**)

LHC24b1b (MC)

General purpose anchored to this period

- Standard event selection

sel8 = kIsTriggerTVX
& kNoTimeFrameBorder
& kNoITSROFrameBorder

Additionally we considered kIsGoodZvtxFT0vsPV
and kNoSameBunchPileup

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sel8 = kIsTriggerTVX  
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- Standard track selection

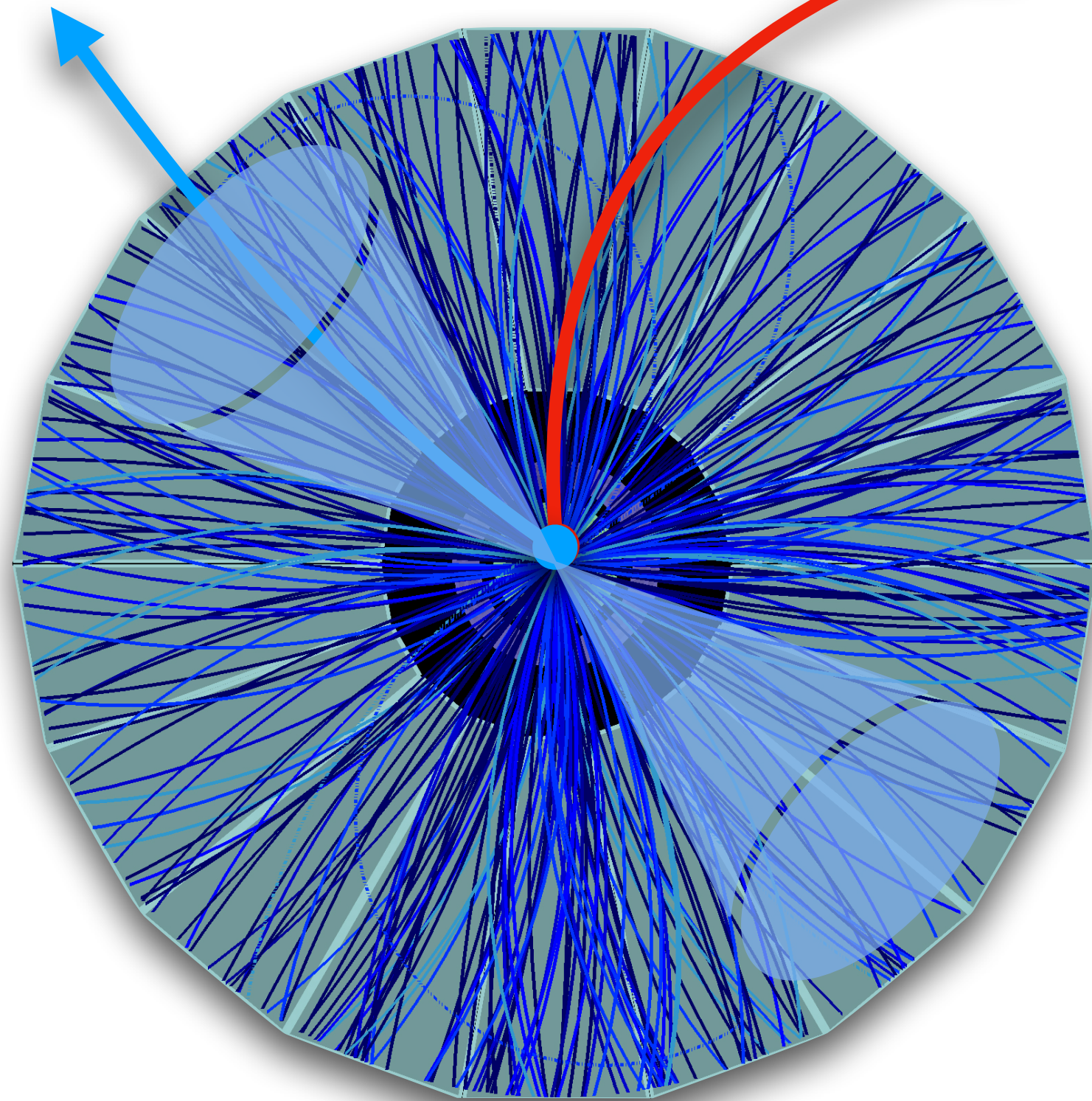
```
selectedTracks.SetPtRange(0.1f, 1e10f);  
selectedTracks.SetEtaRange(-0.8f, 0.8f);  
selectedTracks.SetRequireITSRefit(true);  
selectedTracks.SetRequireTPCRefit(true);  
selectedTracks.SetMinNCrossedRowsTPC(70);  
selectedTracks.SetMinNCrossedRowsOverFindableClustersTPC(0.4f);  
selectedTracks.SetMaxChi2PerClusterTPC(4.f);  
selectedTracks.SetRequireHitsInITSLayers(1, {0, 1});  
selectedTracks.SetMaxChi2PerClusterITS(36.f);  
selectedTracks.SetMaxDcaXYPtDep([](float pt){ return 0.0105f + 0.0350f / pow(pt, 1.1f); }
```

- The value for **SetMinNCrossedRowsOverFindableClustersTPC** needs to be updated

Analysis strategy (transverse region)

highest-transverse-
momentum track (p_T^{trig})

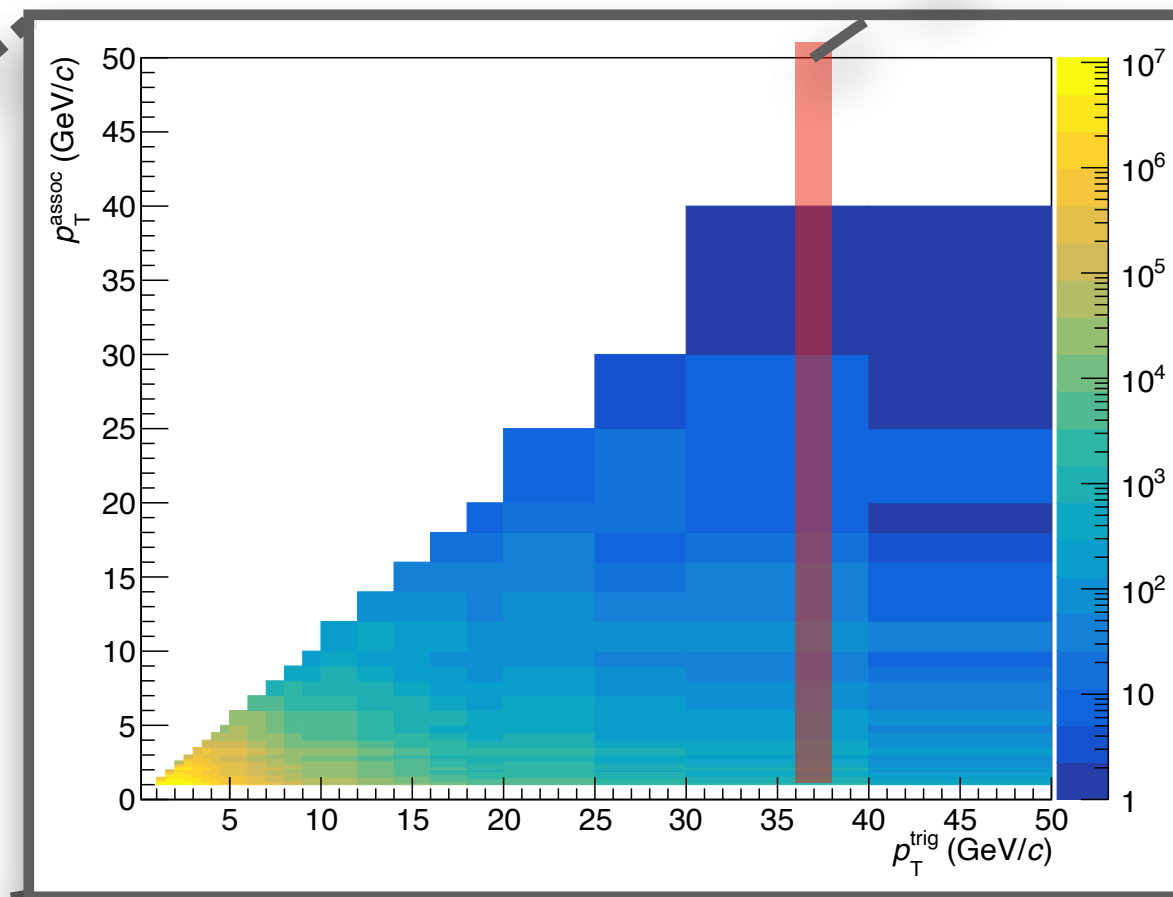
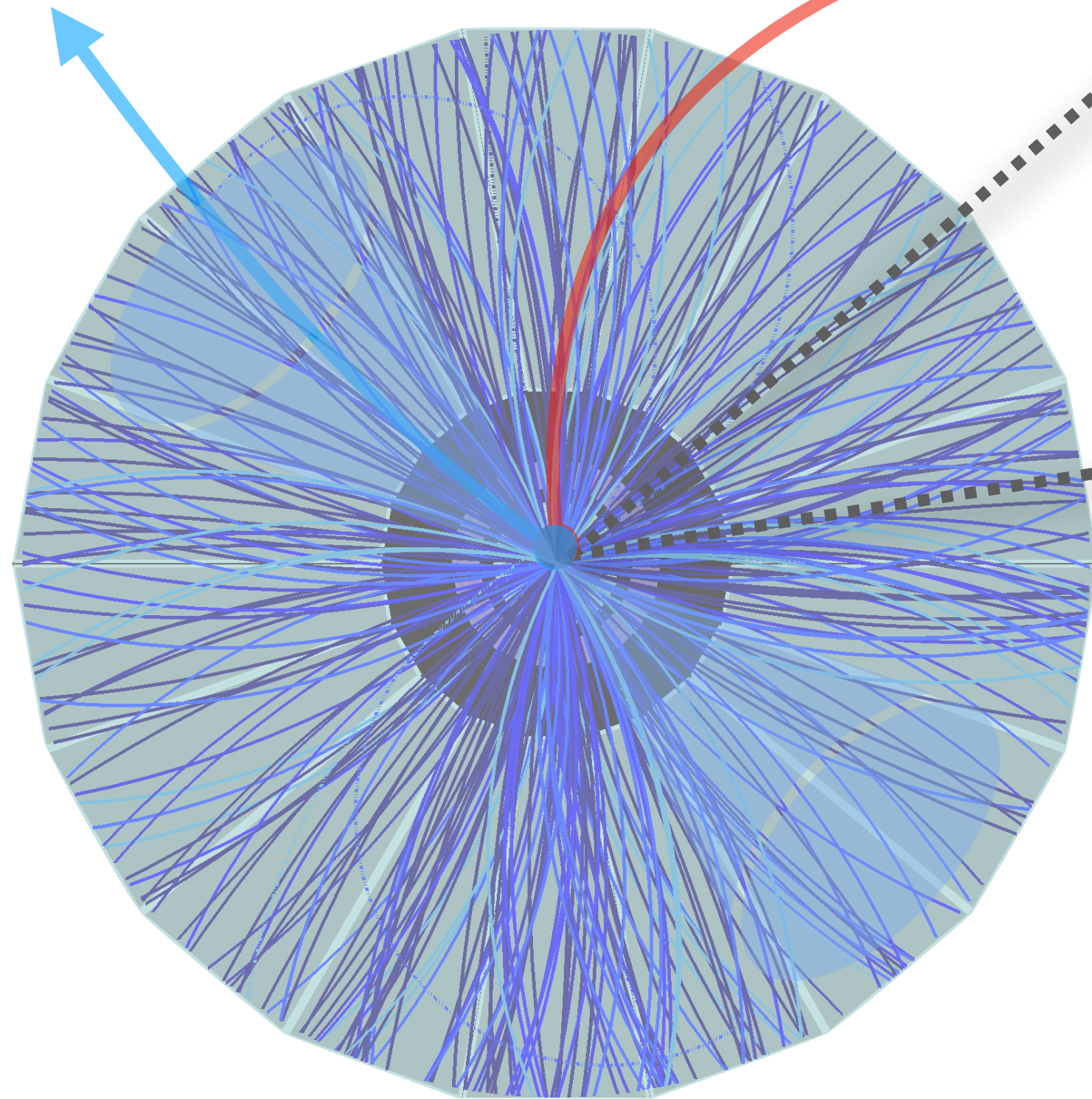
rest of the tracks (p_T^{assoc})



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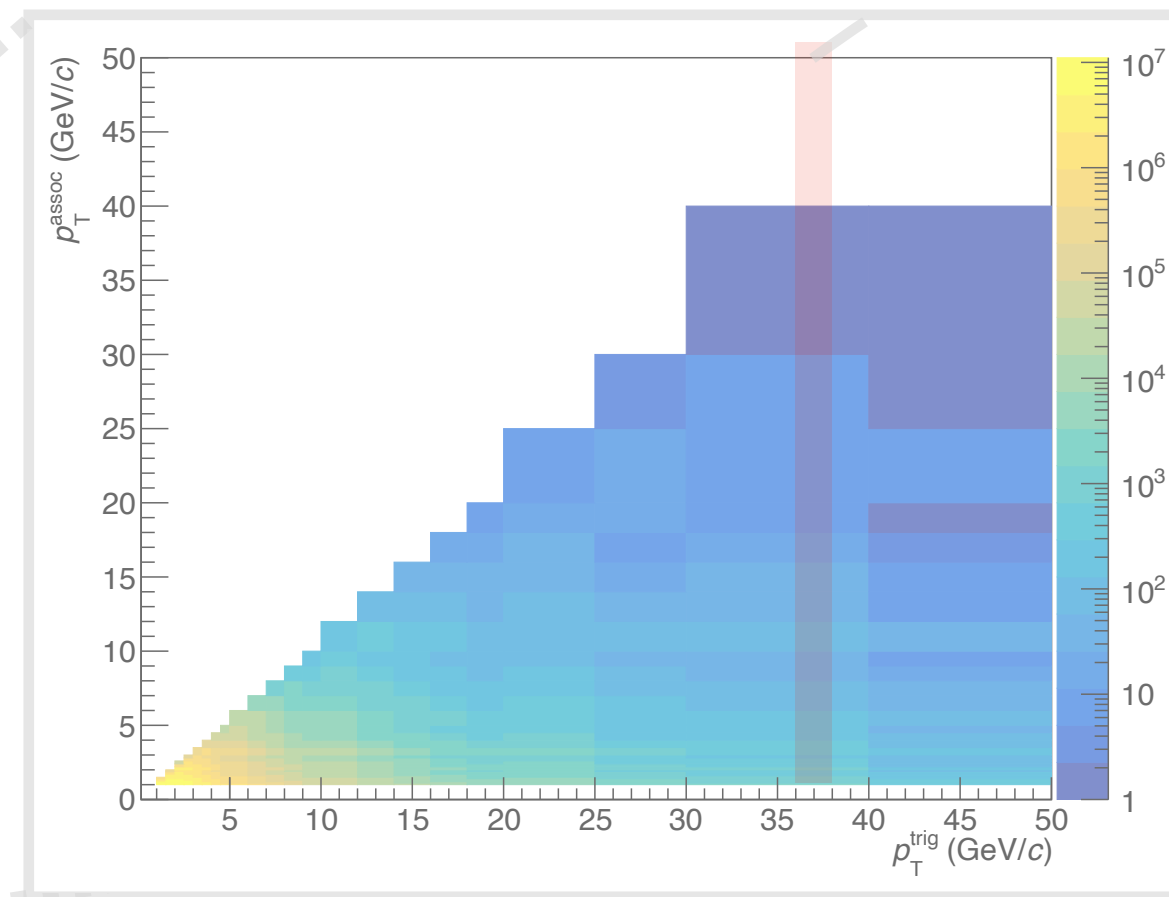
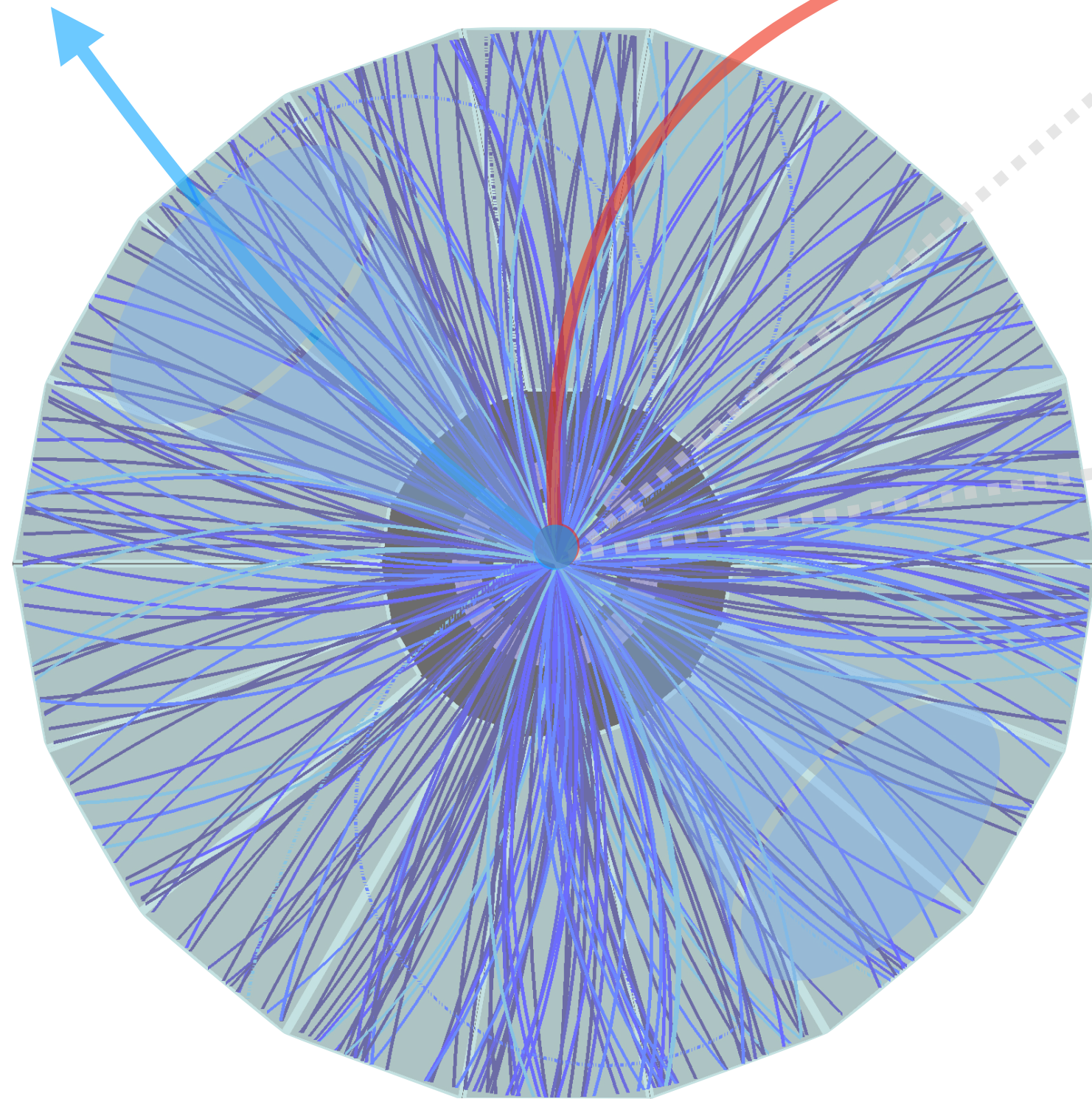
- For each p_T^{trig} , the p_T^{assoc} distributions are obtained and corrected for efficiency and secondary contamination
- The **average particle density** is calculated

$$\left\langle \frac{N_{\text{ch}}}{\Delta\eta\Delta\phi} \right\rangle = \frac{1}{\Delta\phi N_{\text{ev}}(p_T^{\text{trig}})} \int \frac{d^2 N_{\text{ch}}(p_T^{\text{trig}}, p_T)}{d\eta dp_T} dp_T$$

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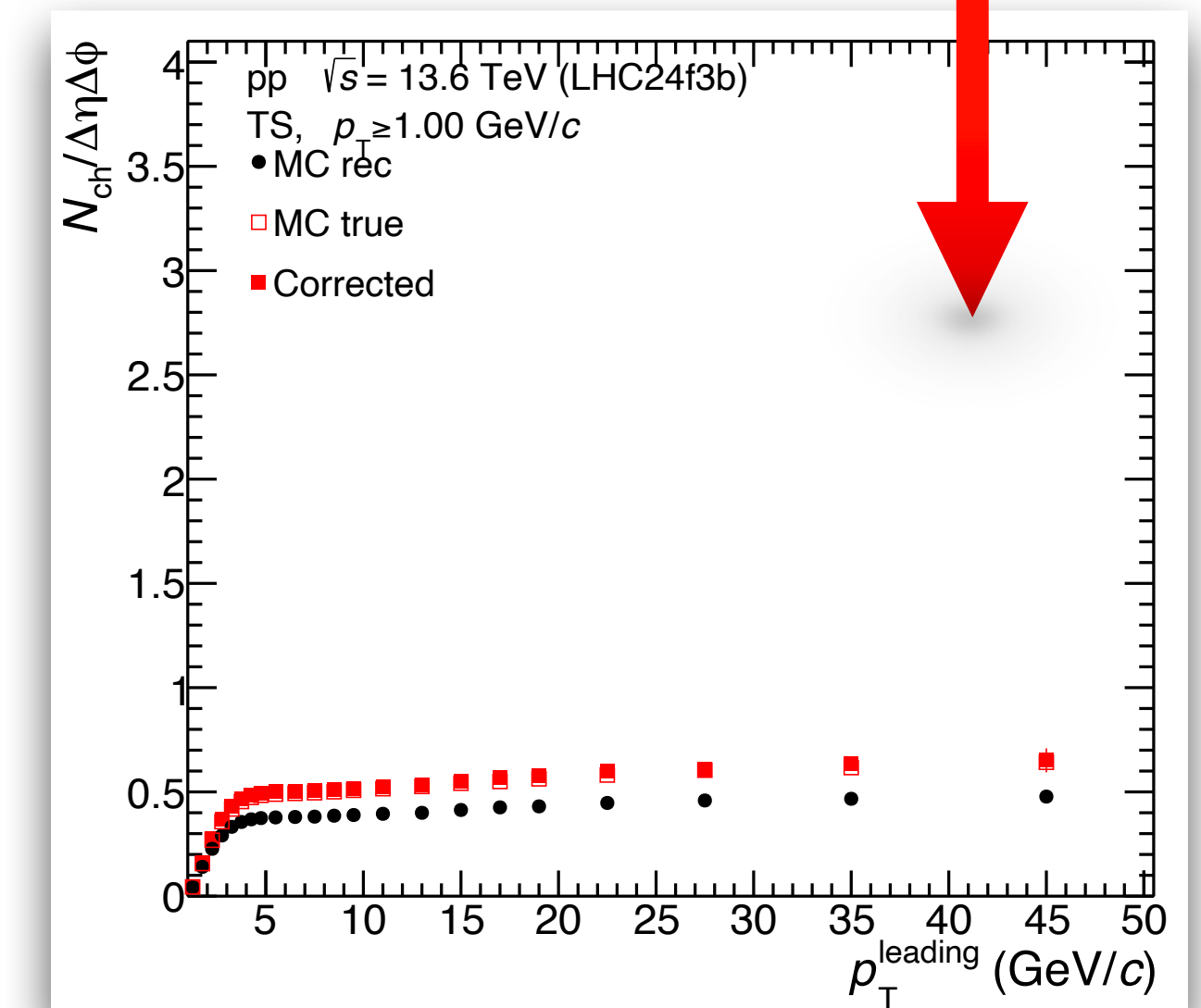
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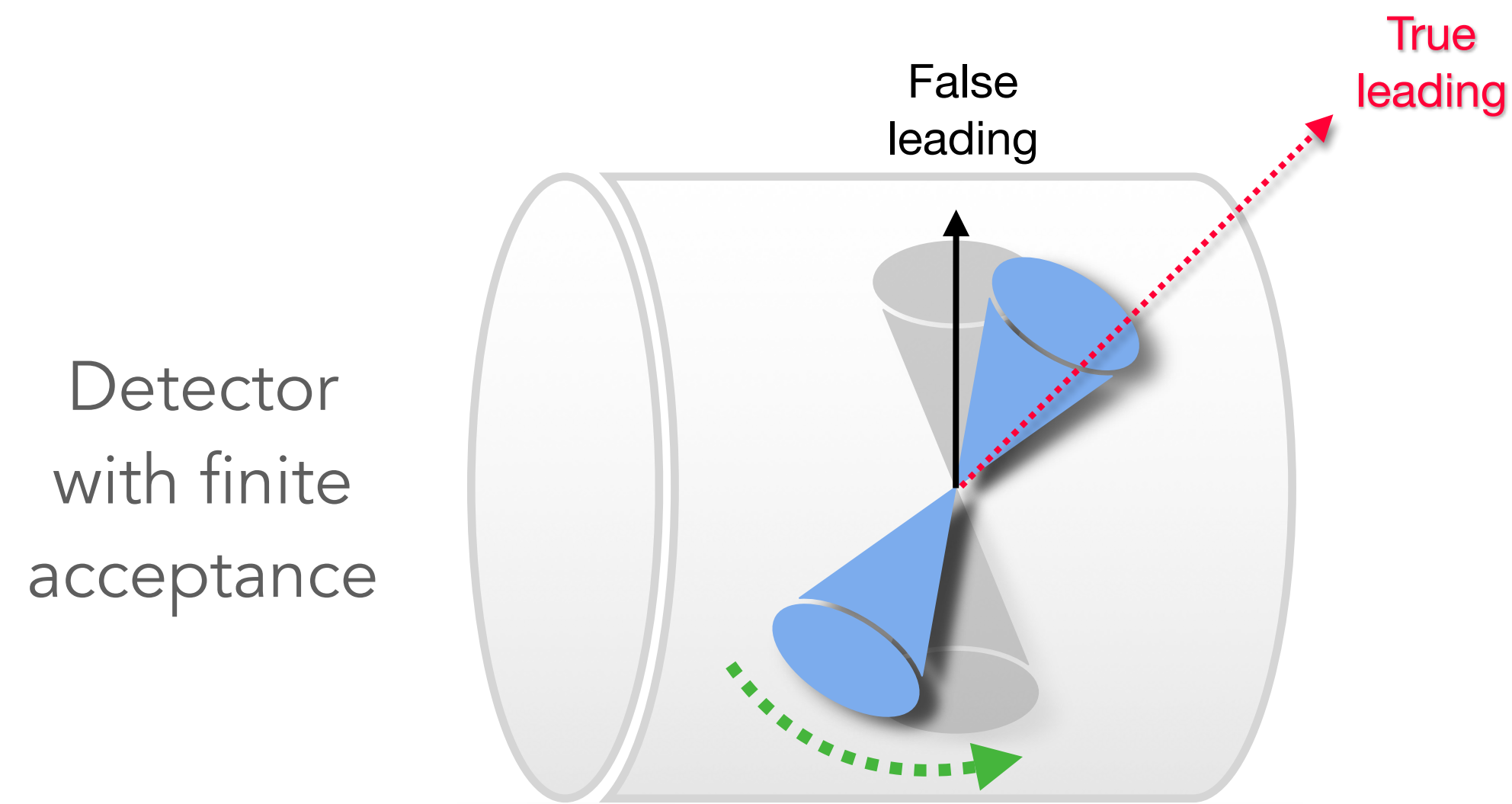
$$\left\langle \frac{N_{\text{ch}}}{\Delta\eta\Delta\phi} \right\rangle = \frac{1}{\Delta\phi N_{\text{ev}}(p_T^{\text{trig}})} \int \frac{d^2 N_{\text{ch}}(p_T^{\text{trig}}, p_T)}{d\eta dp_T} dp_T$$

- The N_{ch} as a function of p_T^{trig} is obtained and corrected for possible bias and misidentification of the leading particle



Corrections

Among the implemented corrections we have the **misidentification of the leading particle**



This could lead to a **rotation of the event topology** and cause a bias in the UE observables

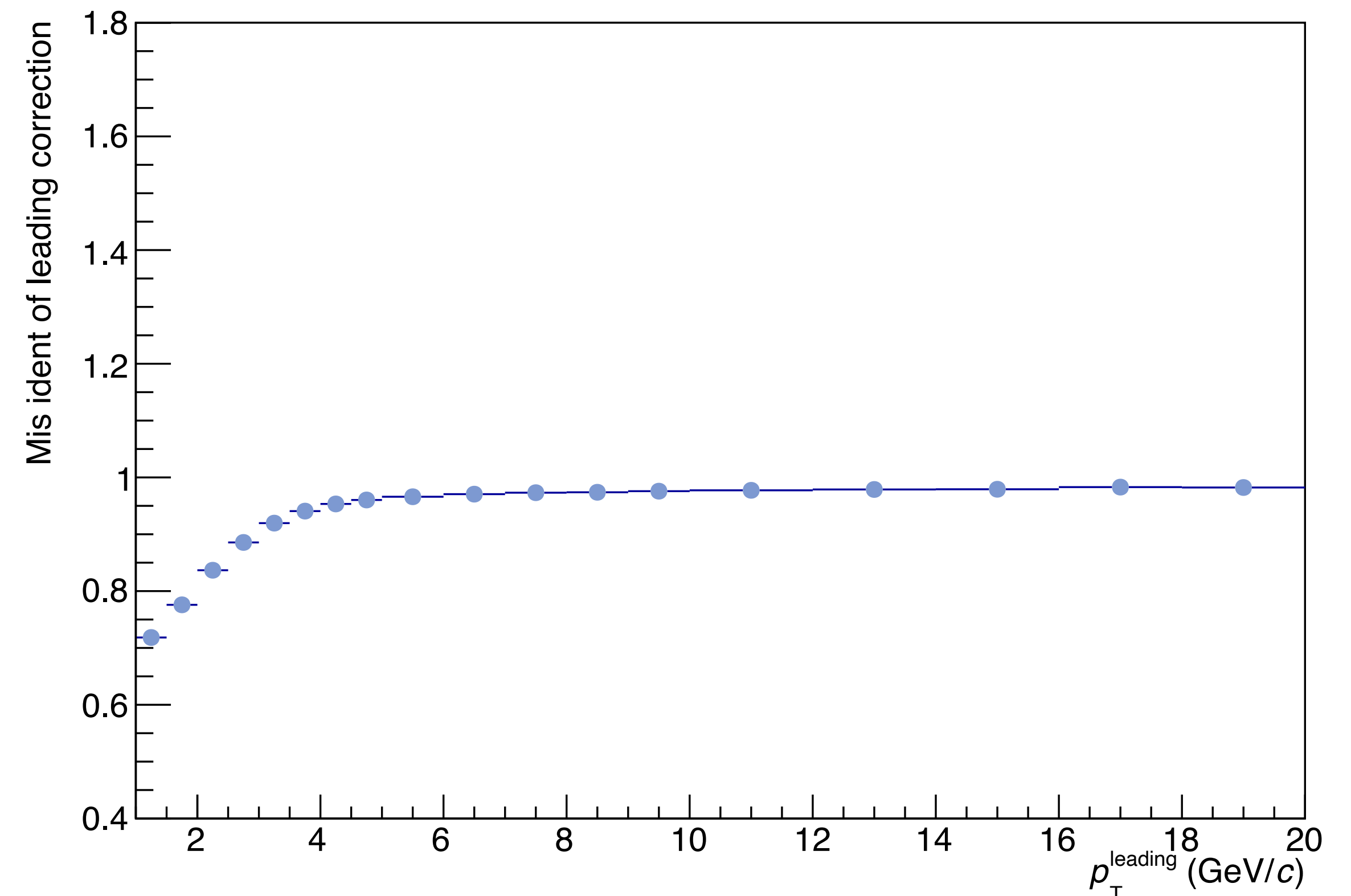
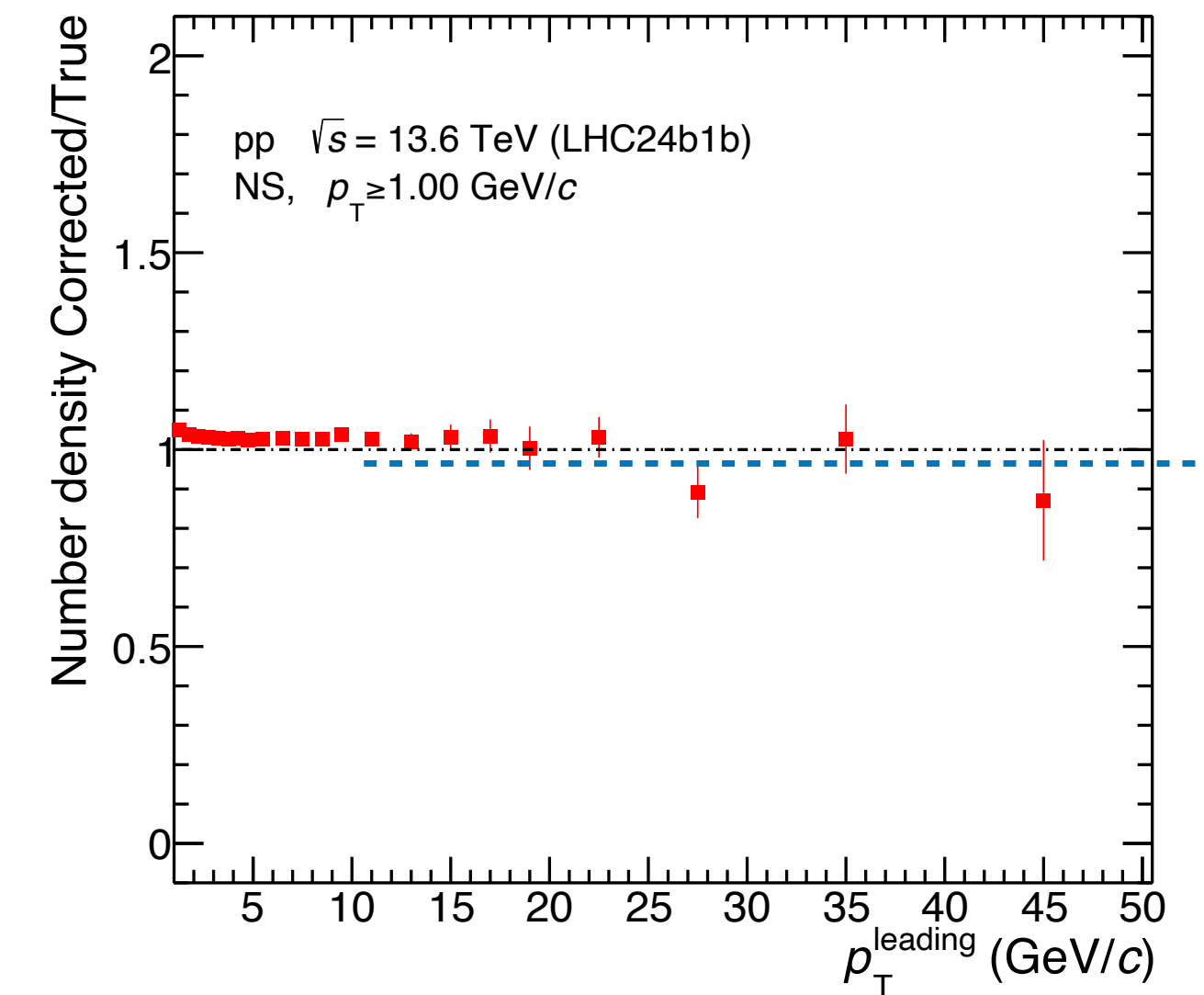
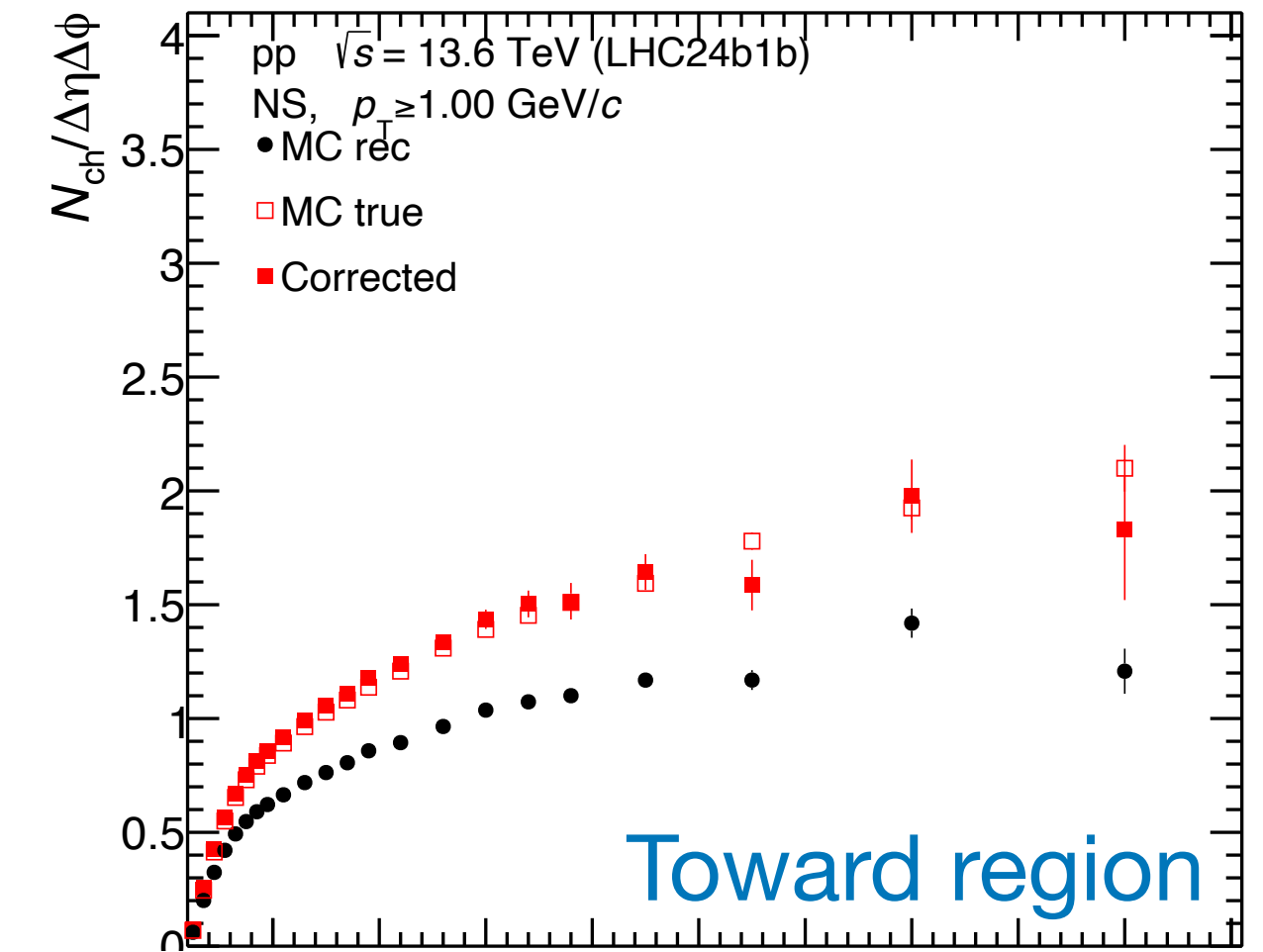
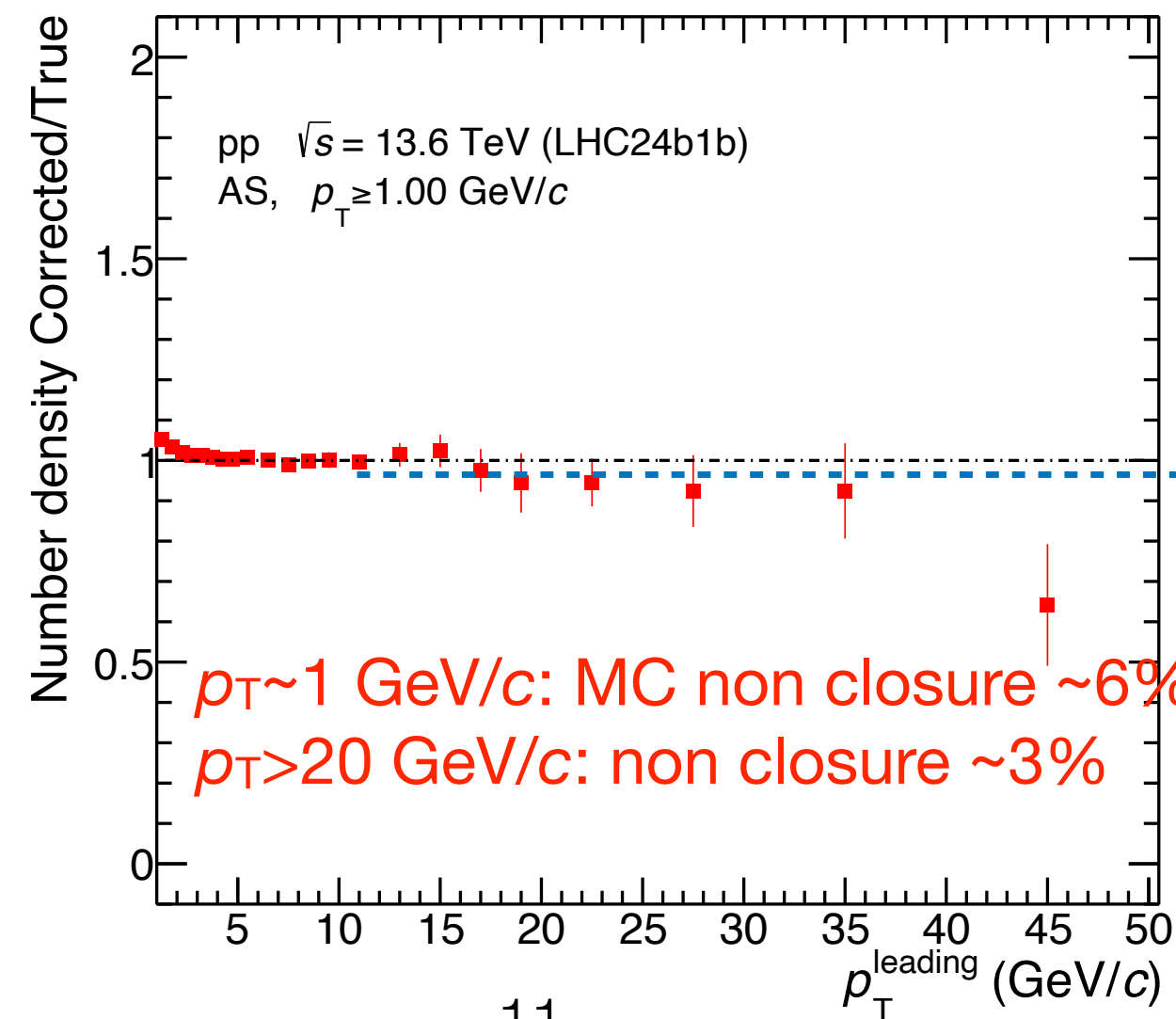
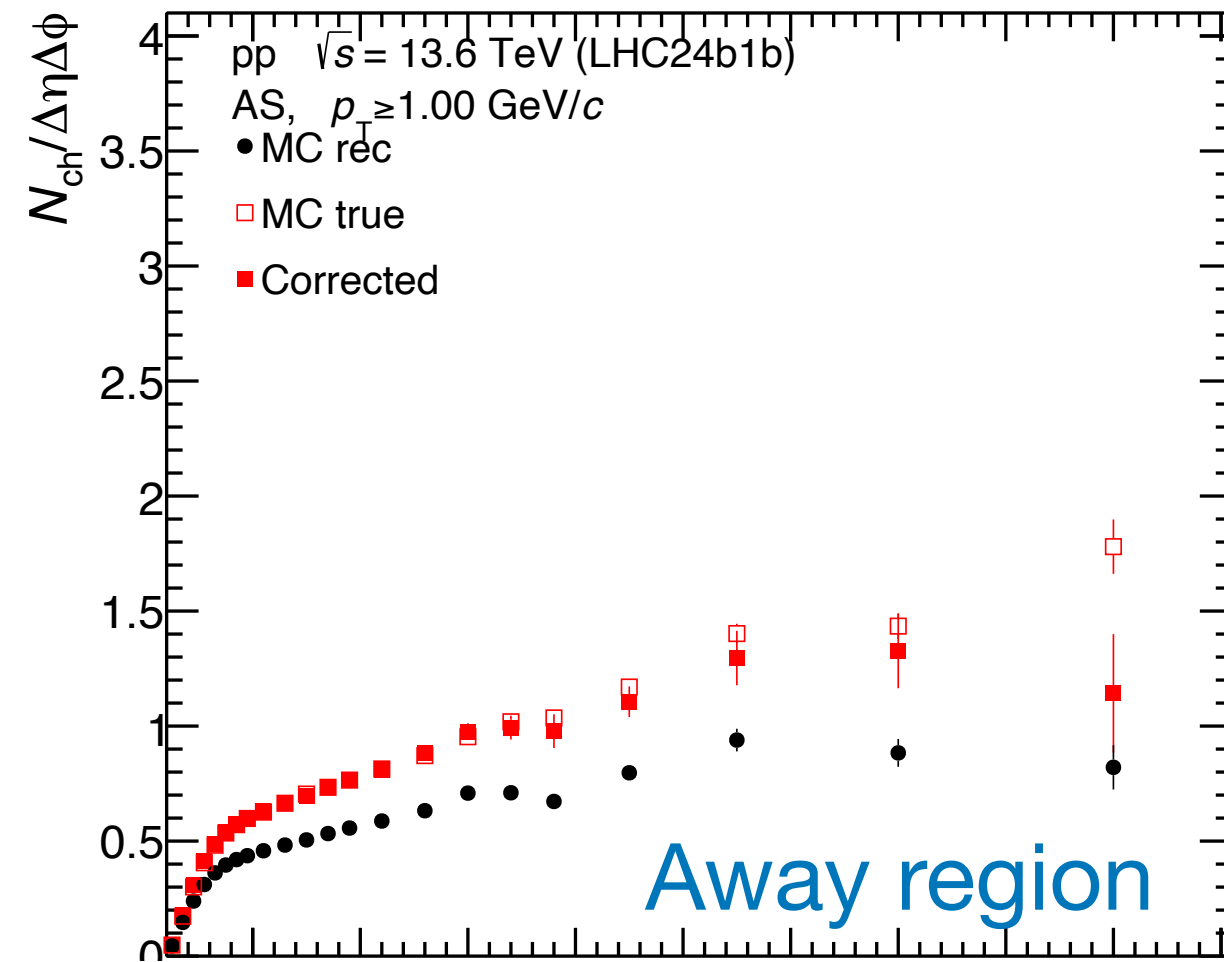
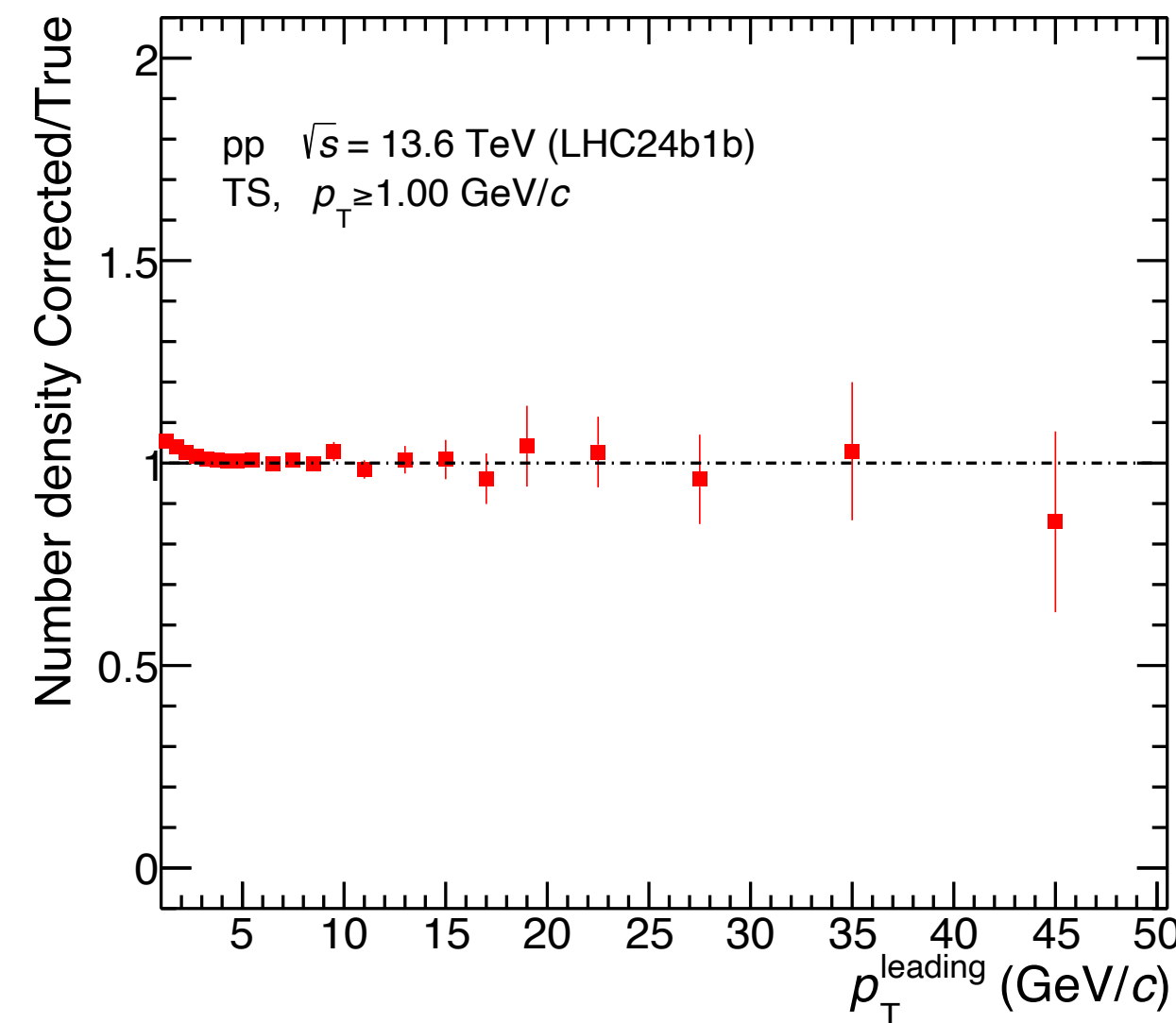
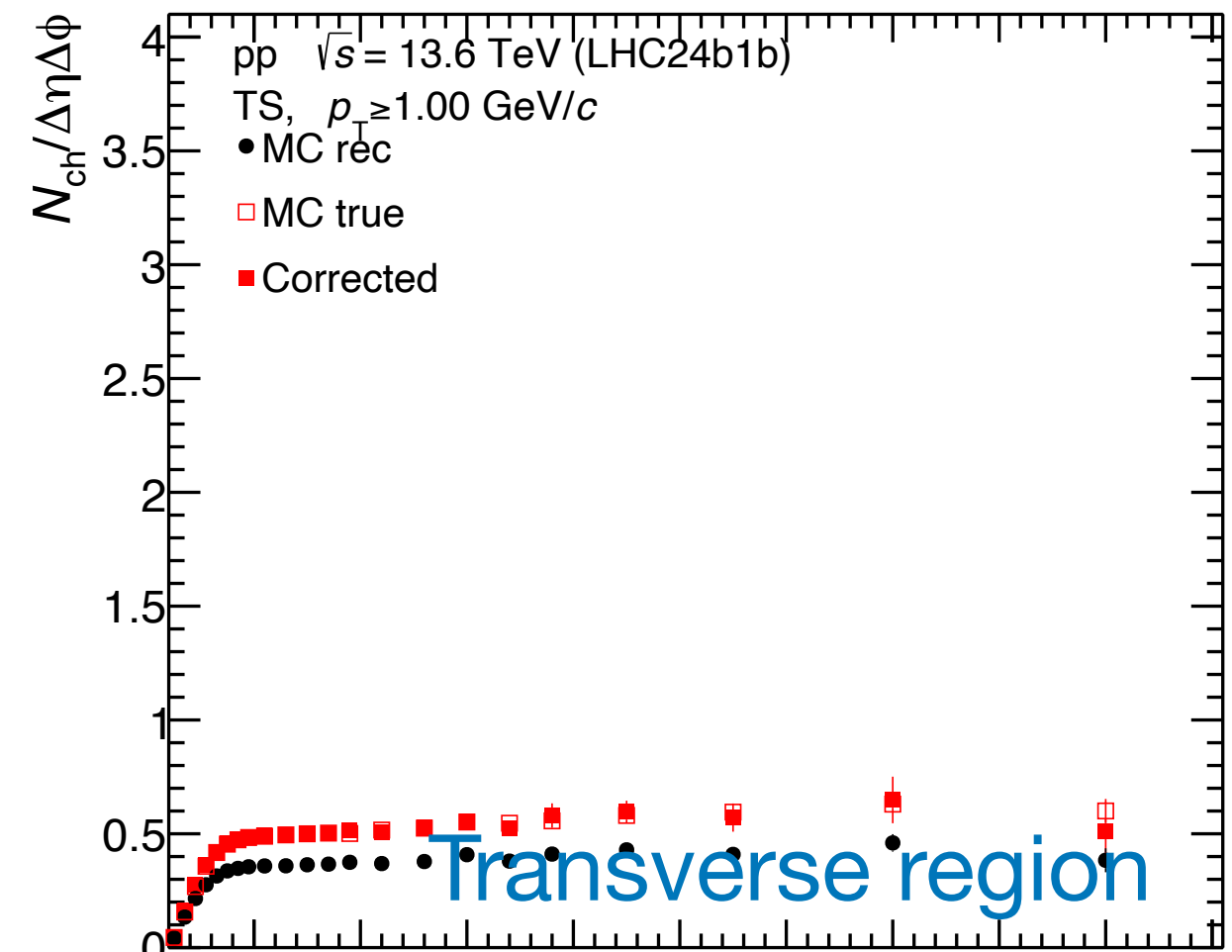


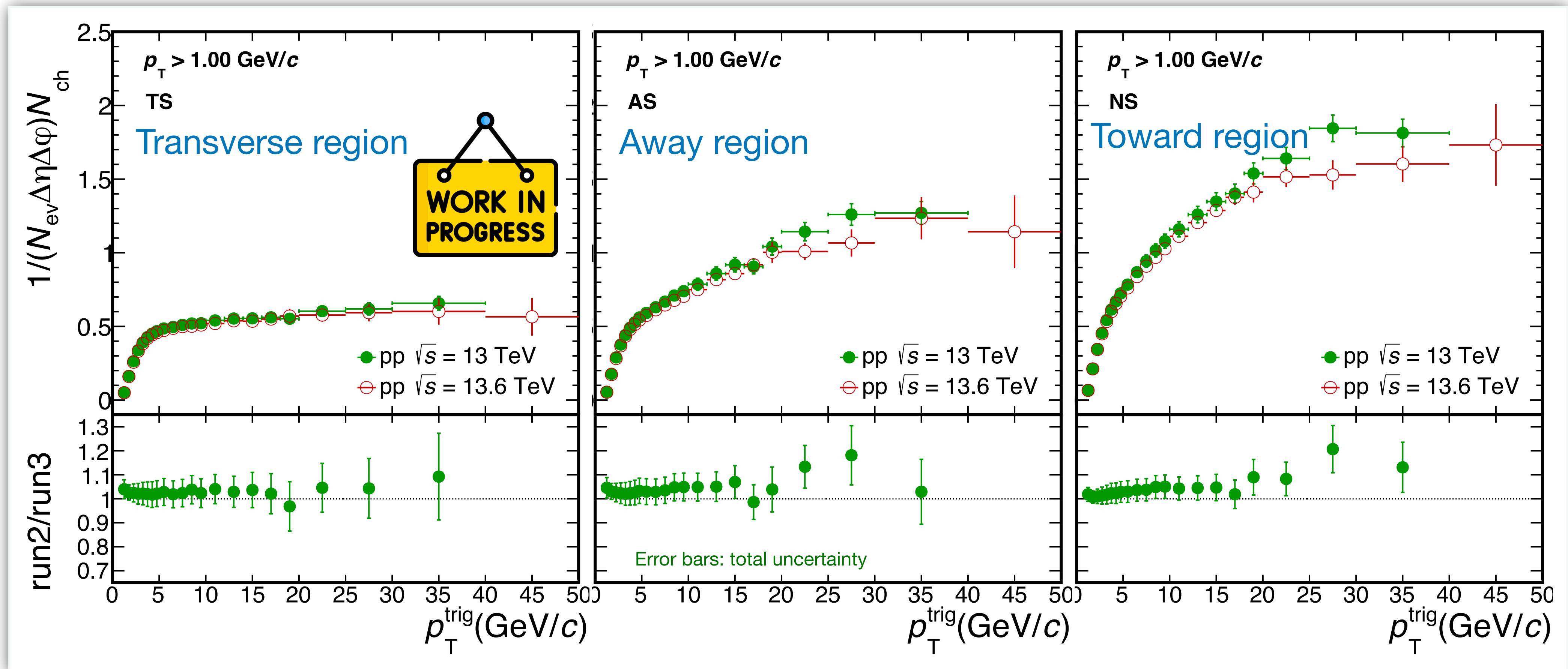
Fig. Correction for misidentification of leading particle

MC closure test

- MC rec: values w detector effects
- MC true: values w/o detector effects
- Corrected: MC rec fully corrected

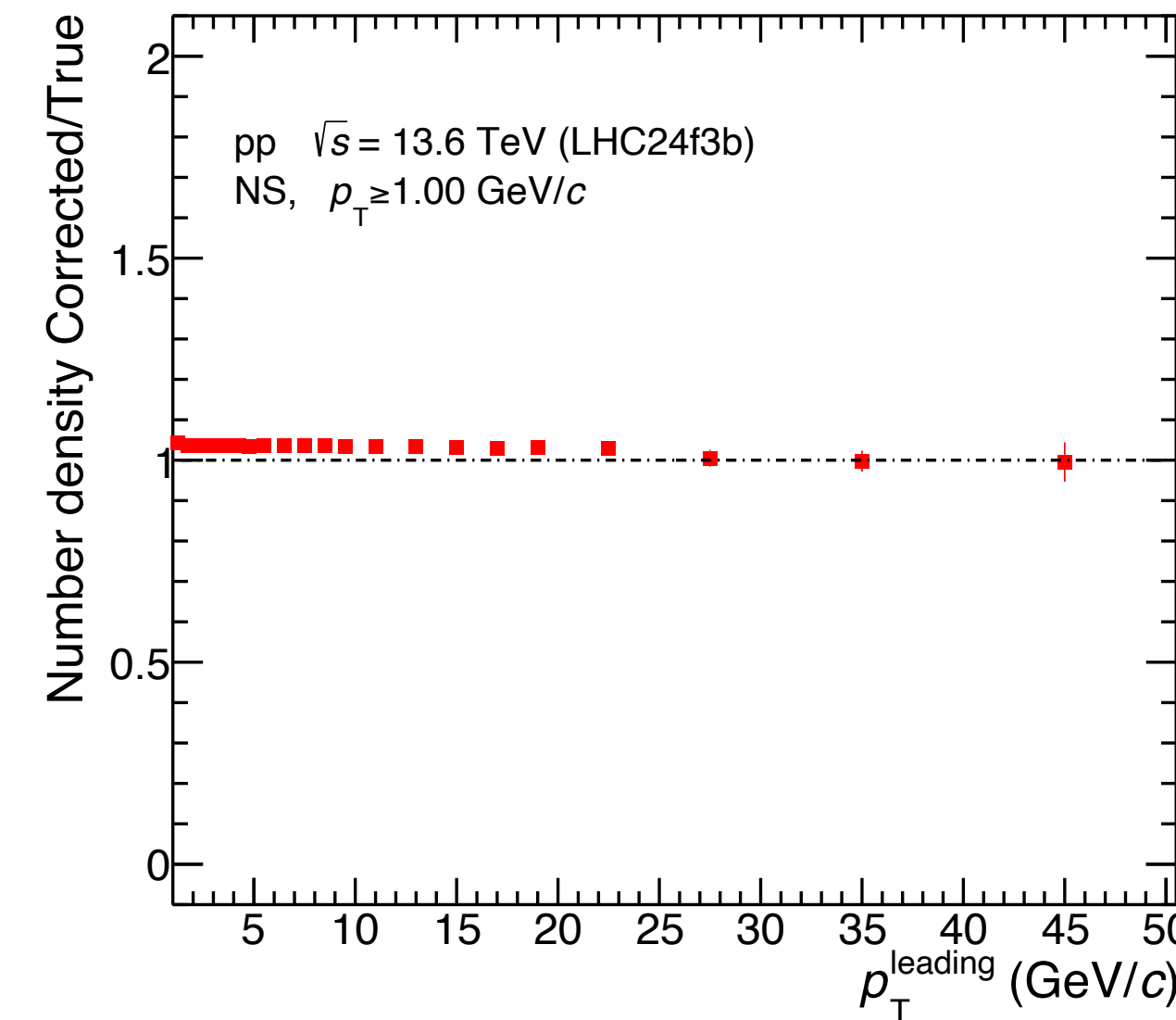
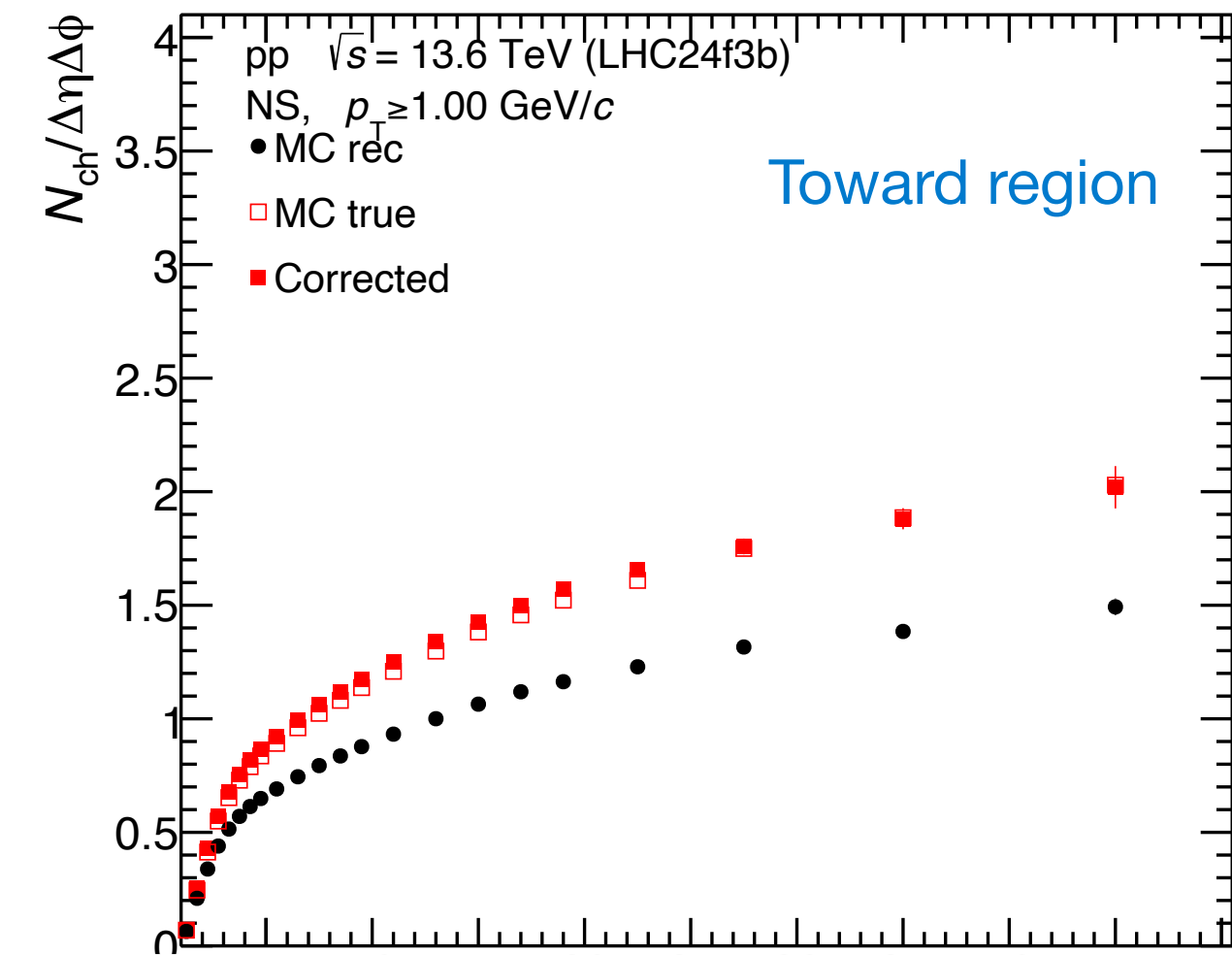
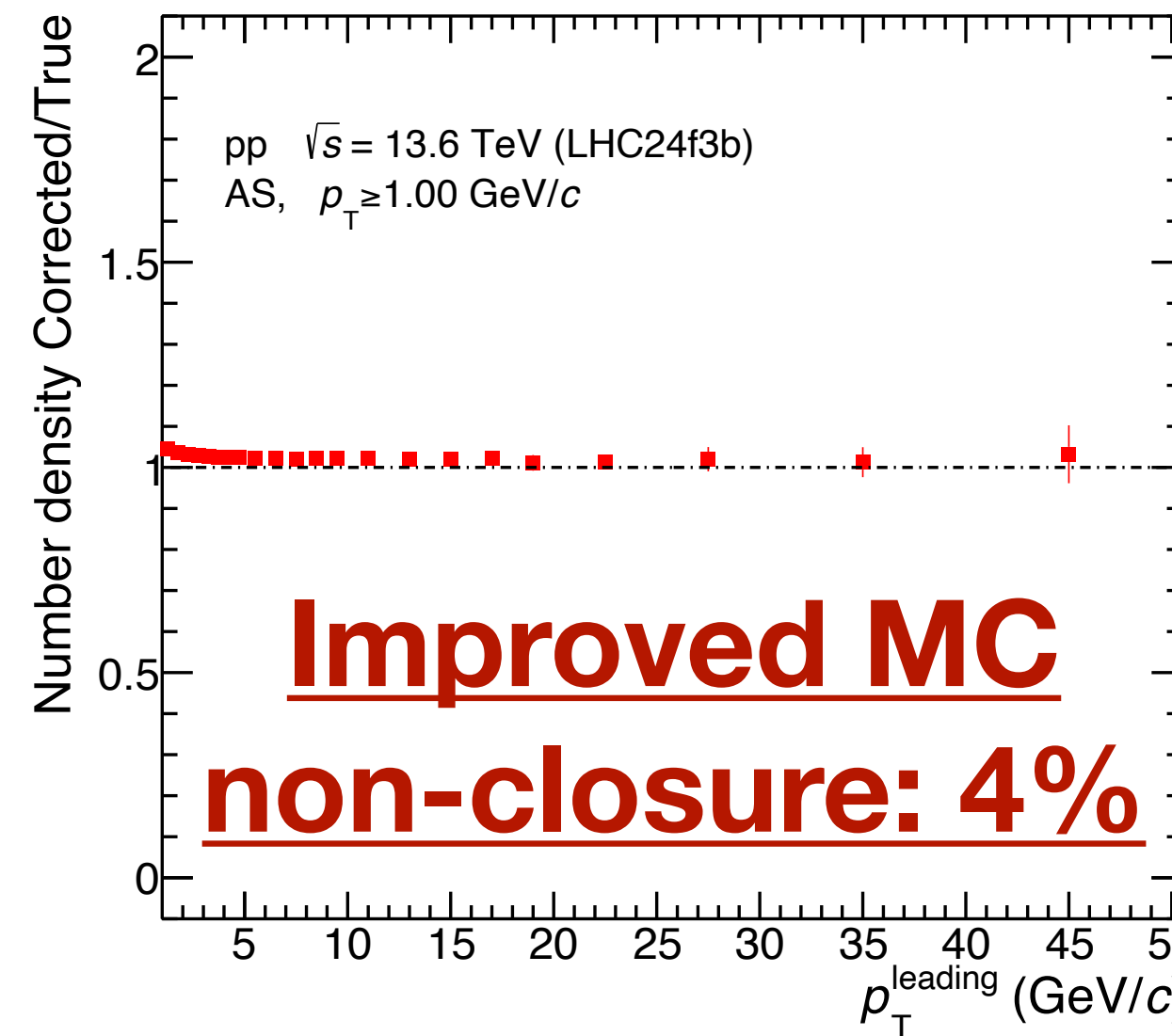
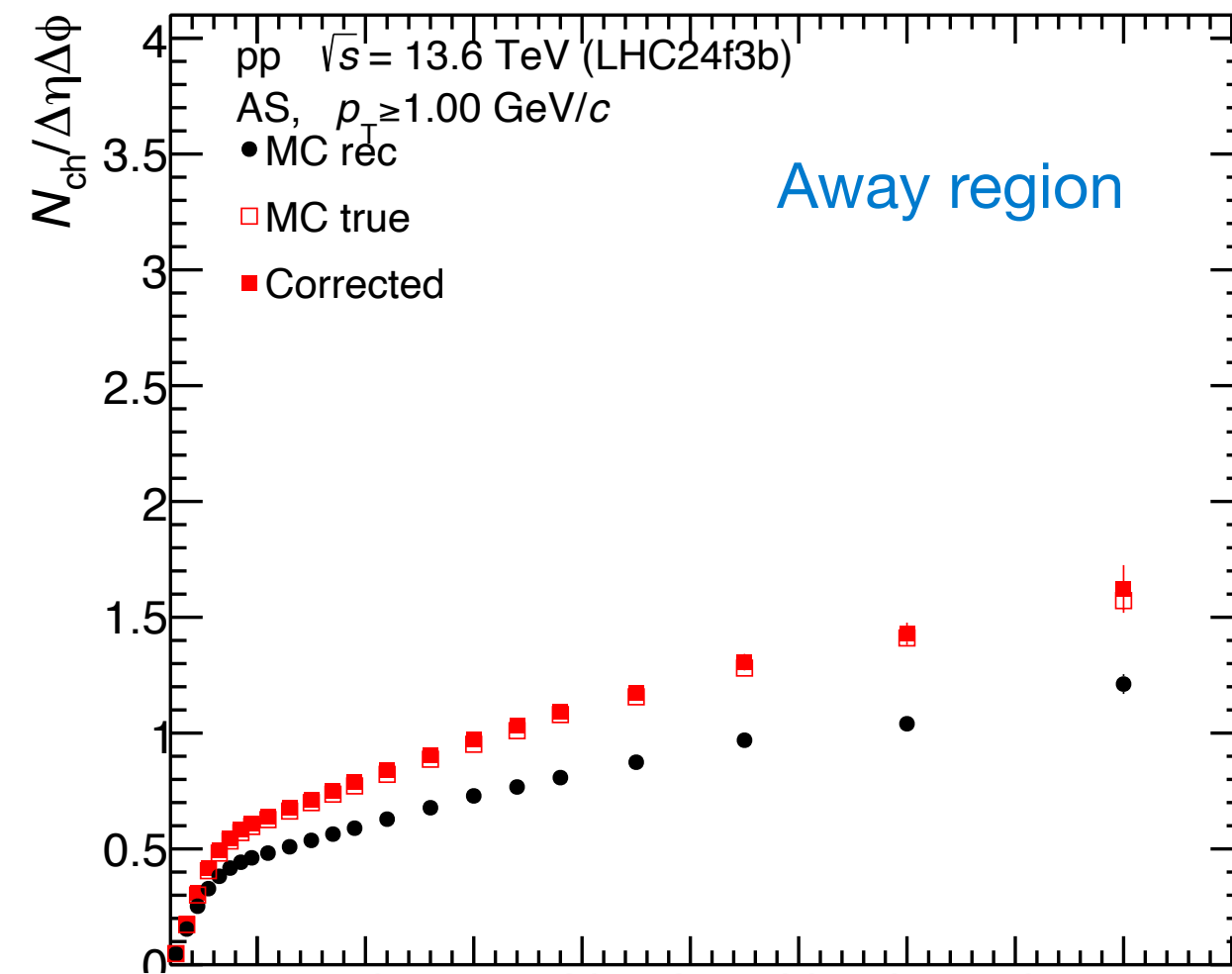
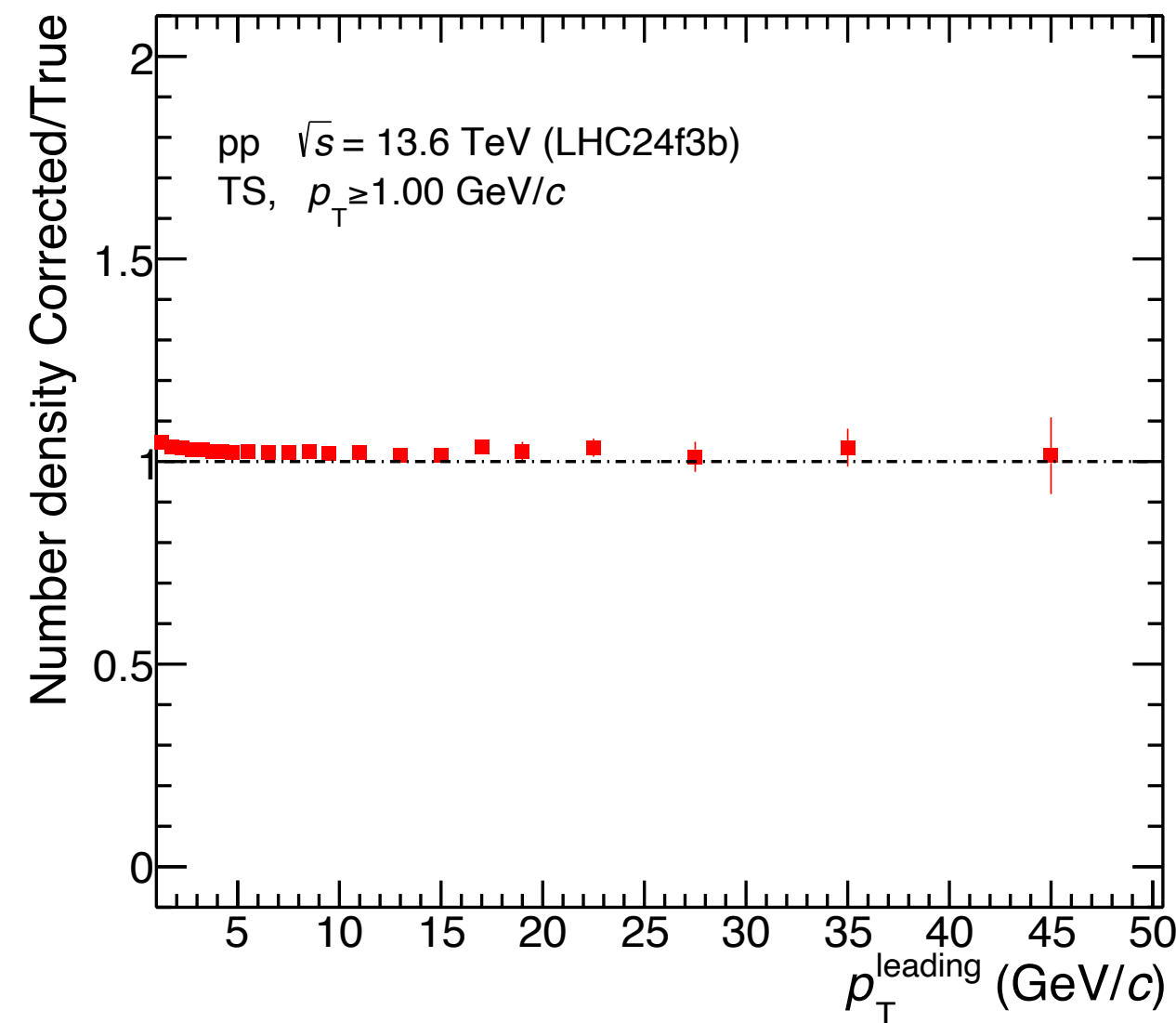
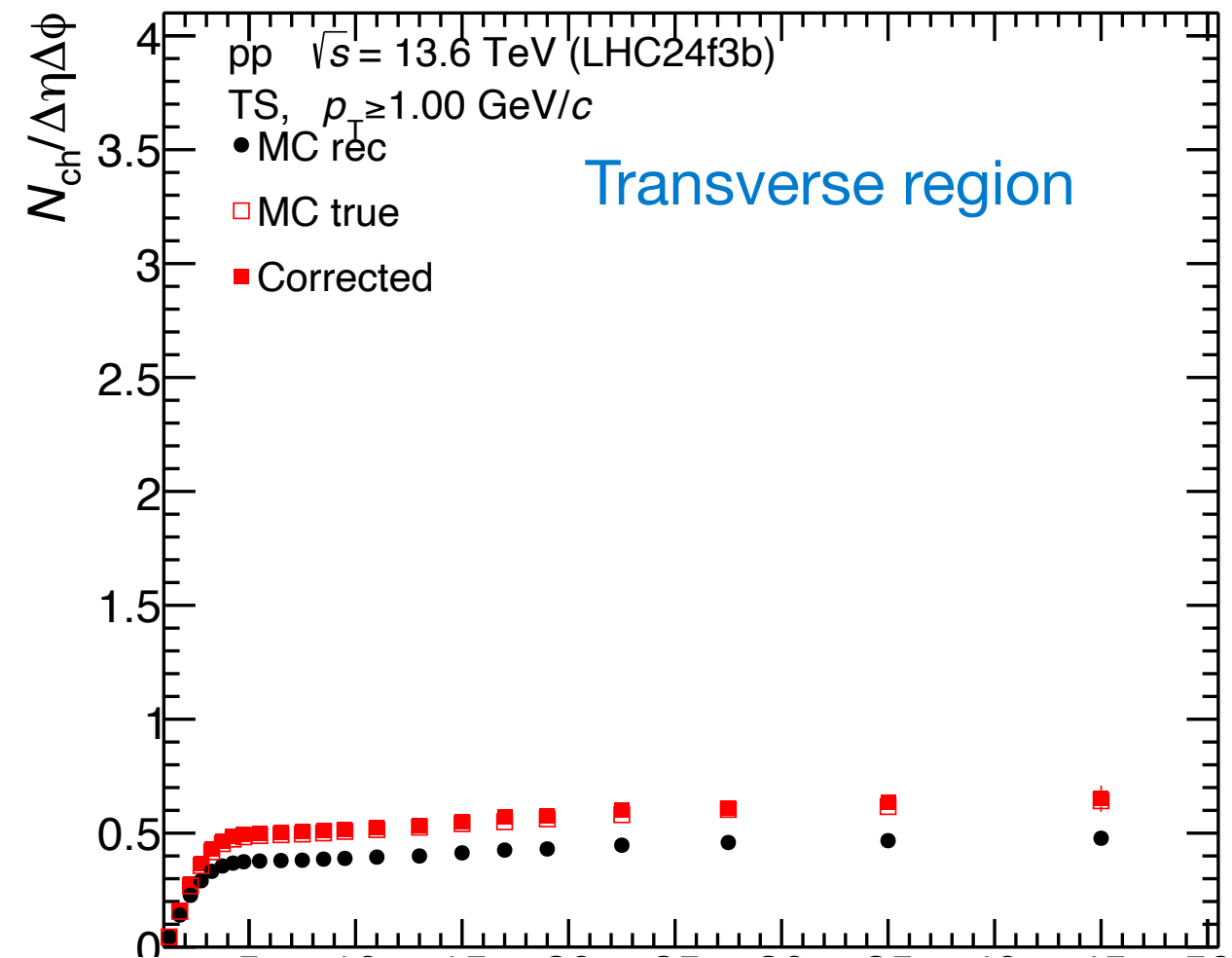


Comparison between Run 2 and Run 3

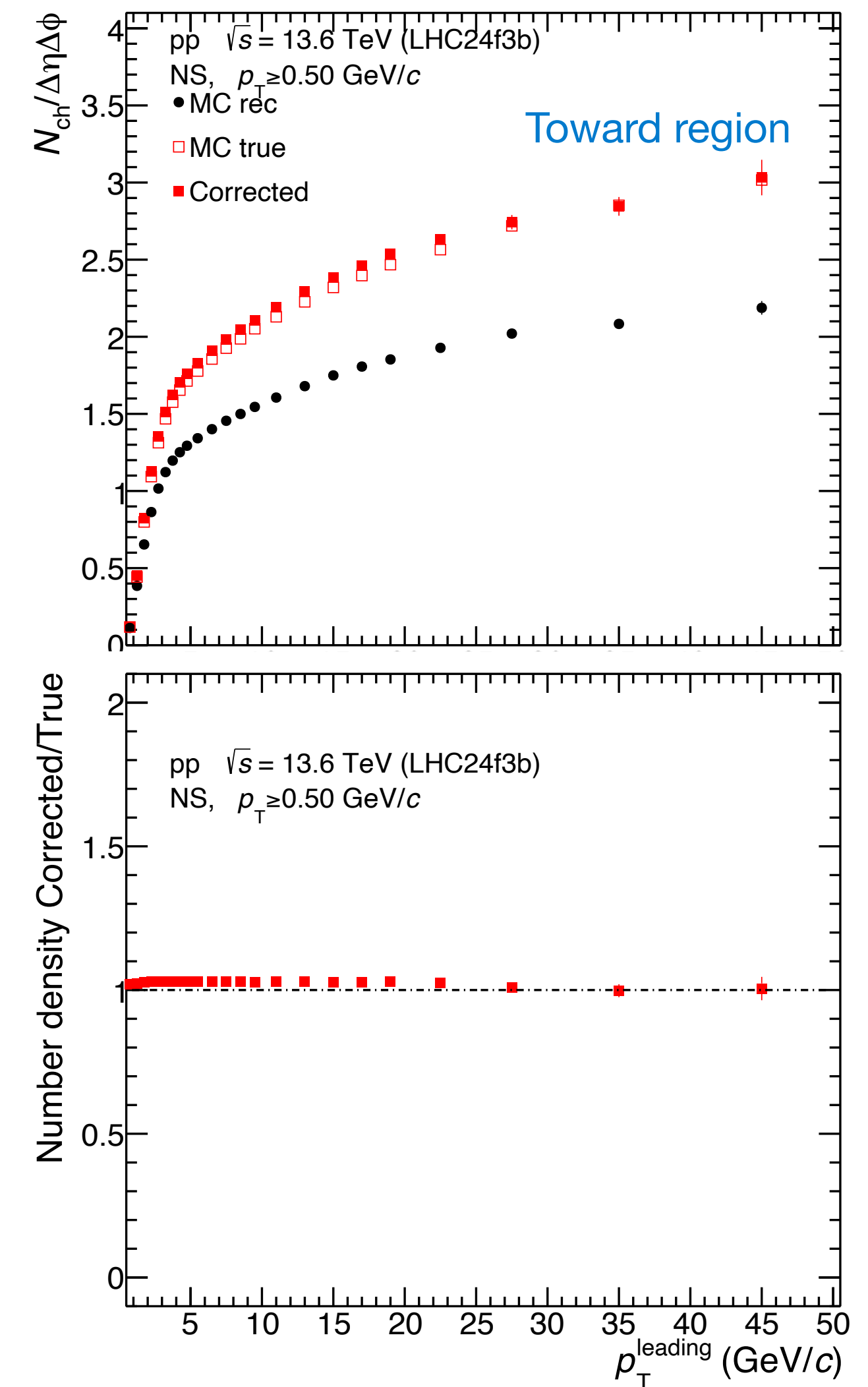
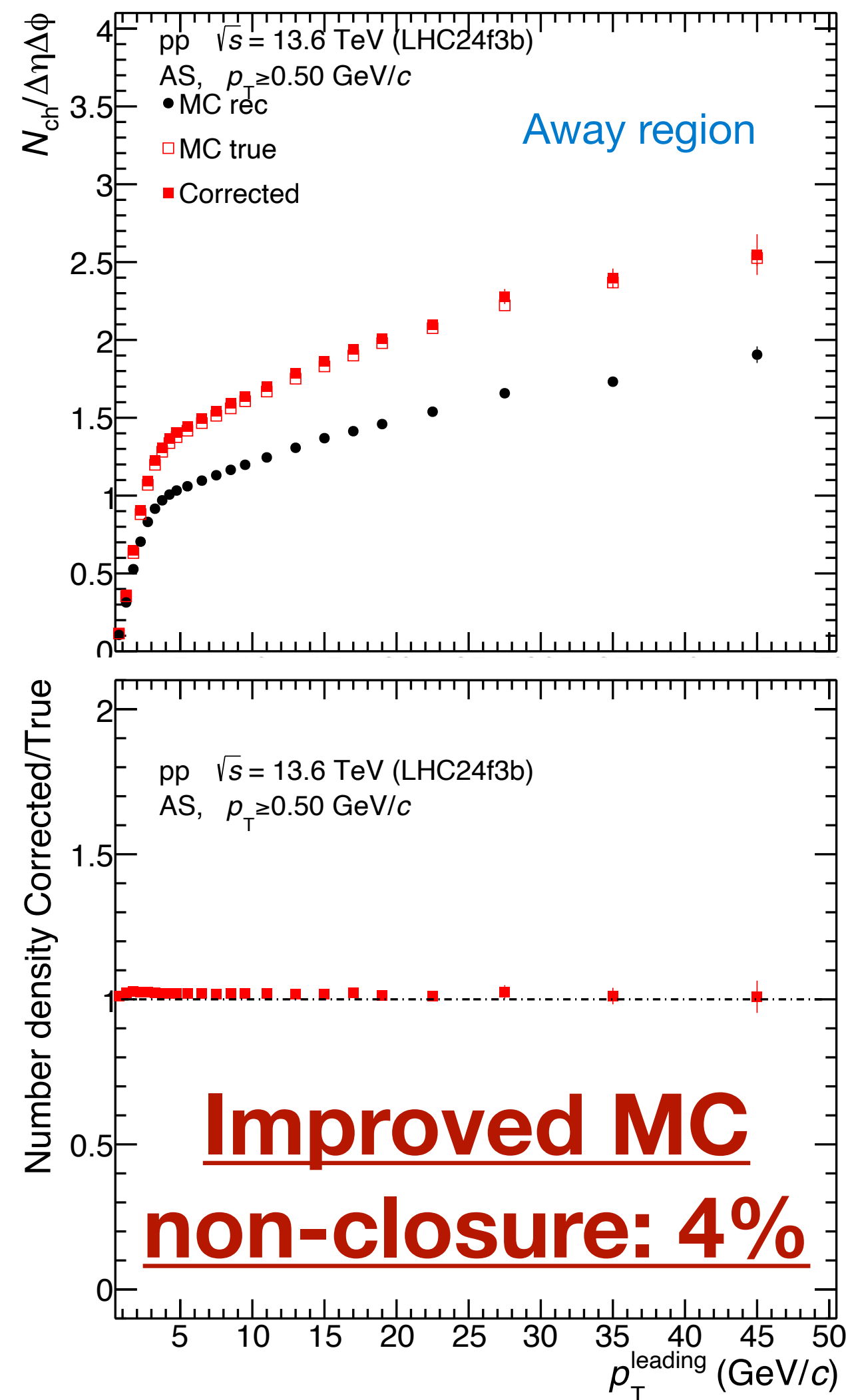
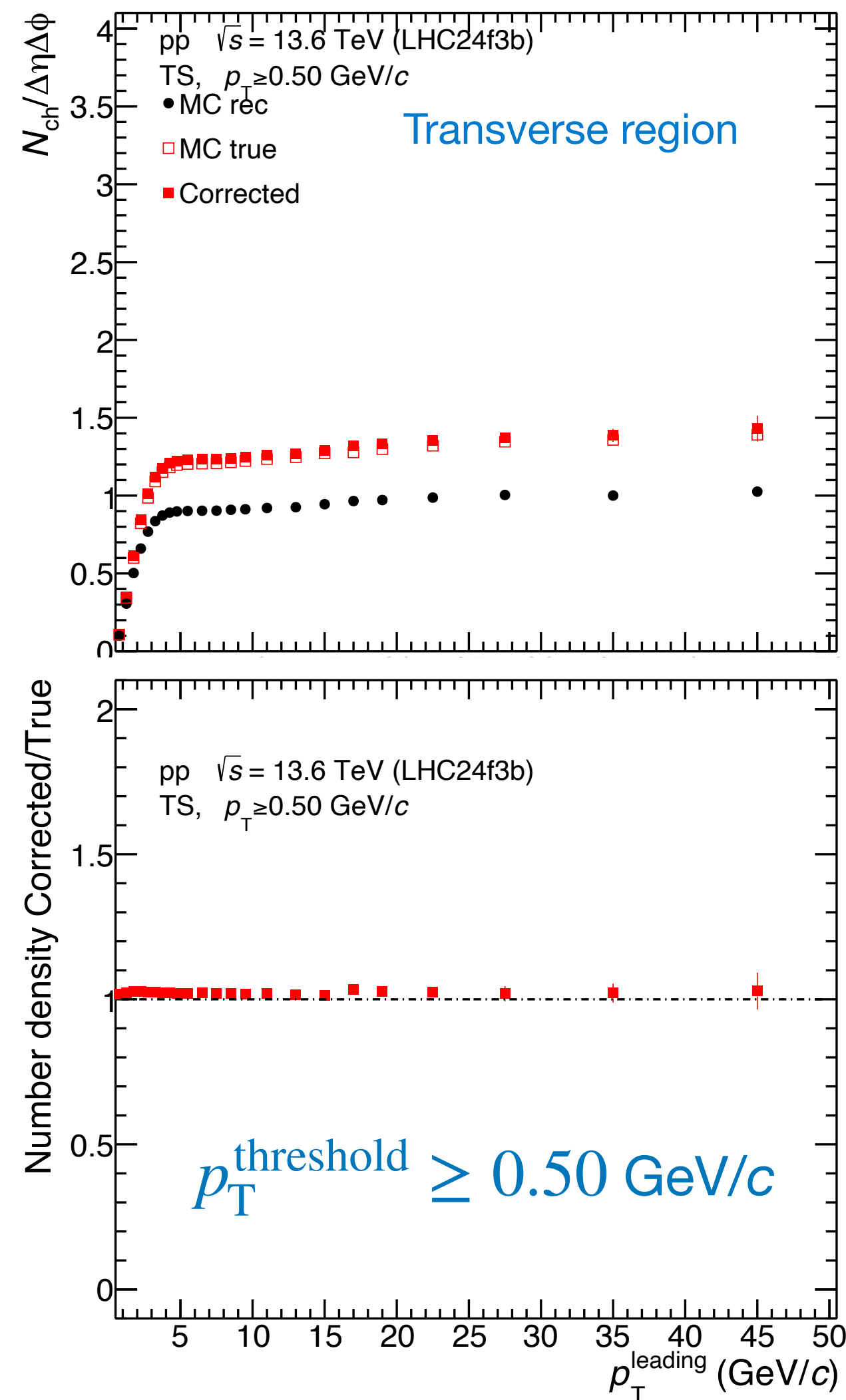


Current results indicate a compatibility between Run 2 and Run 3

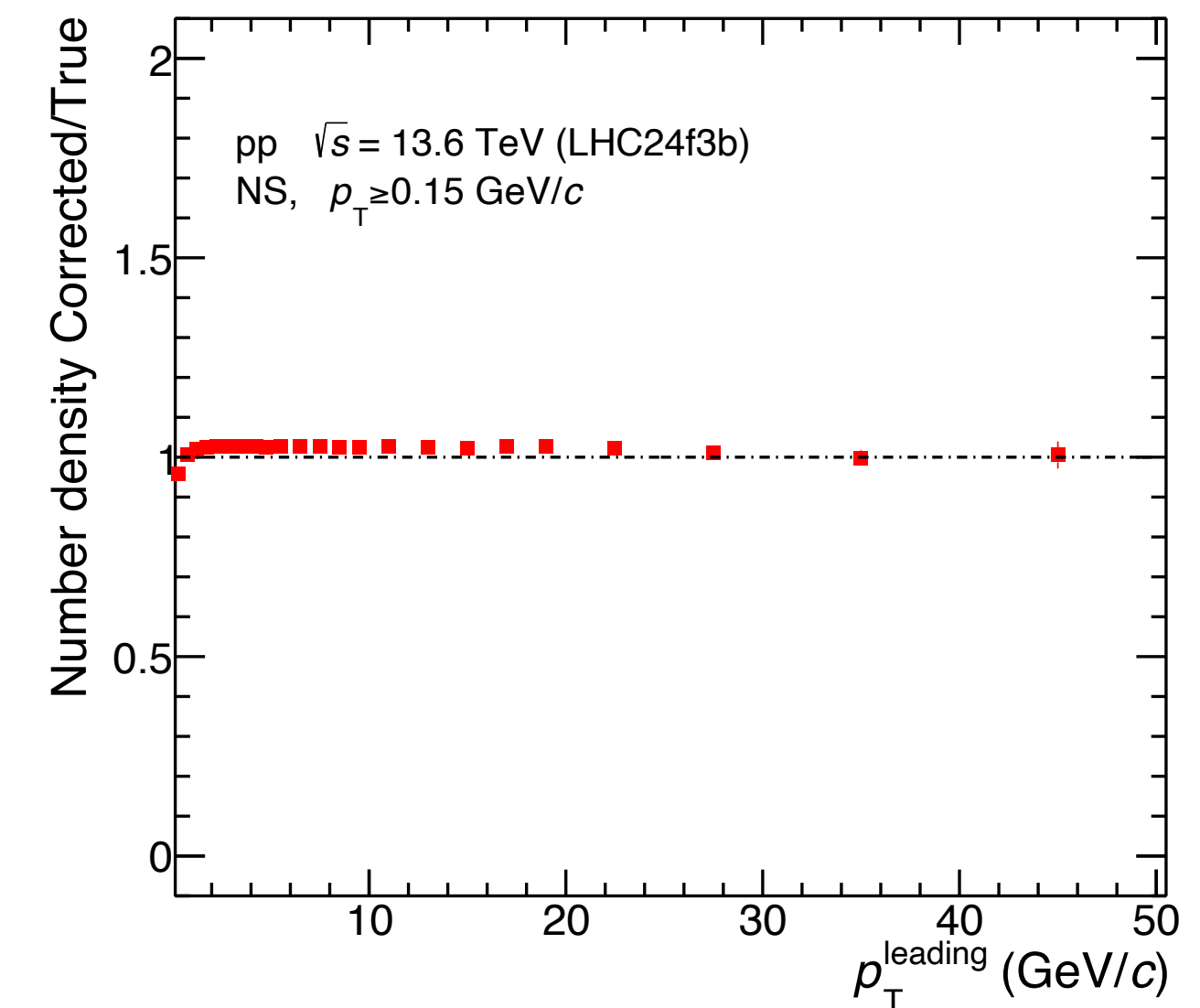
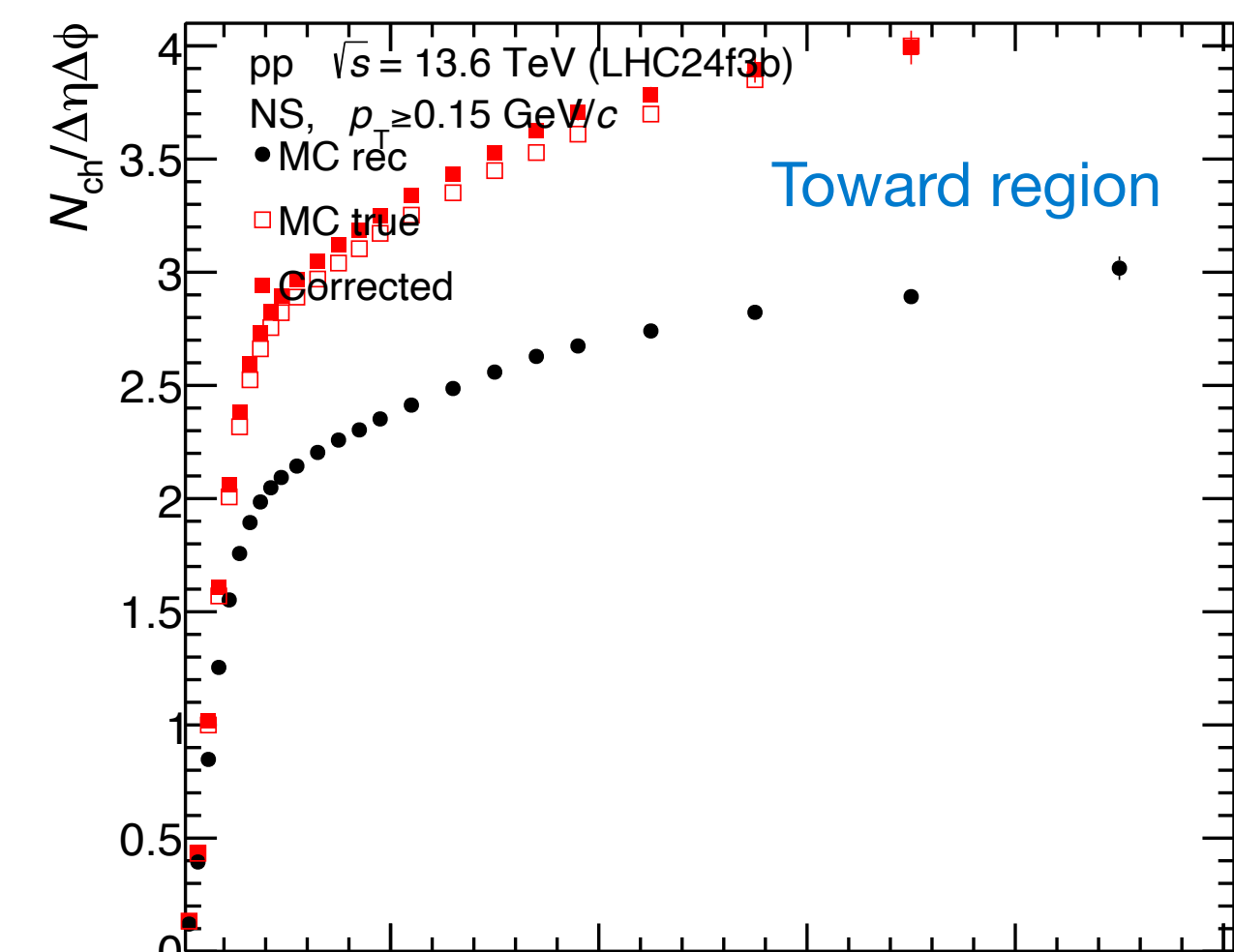
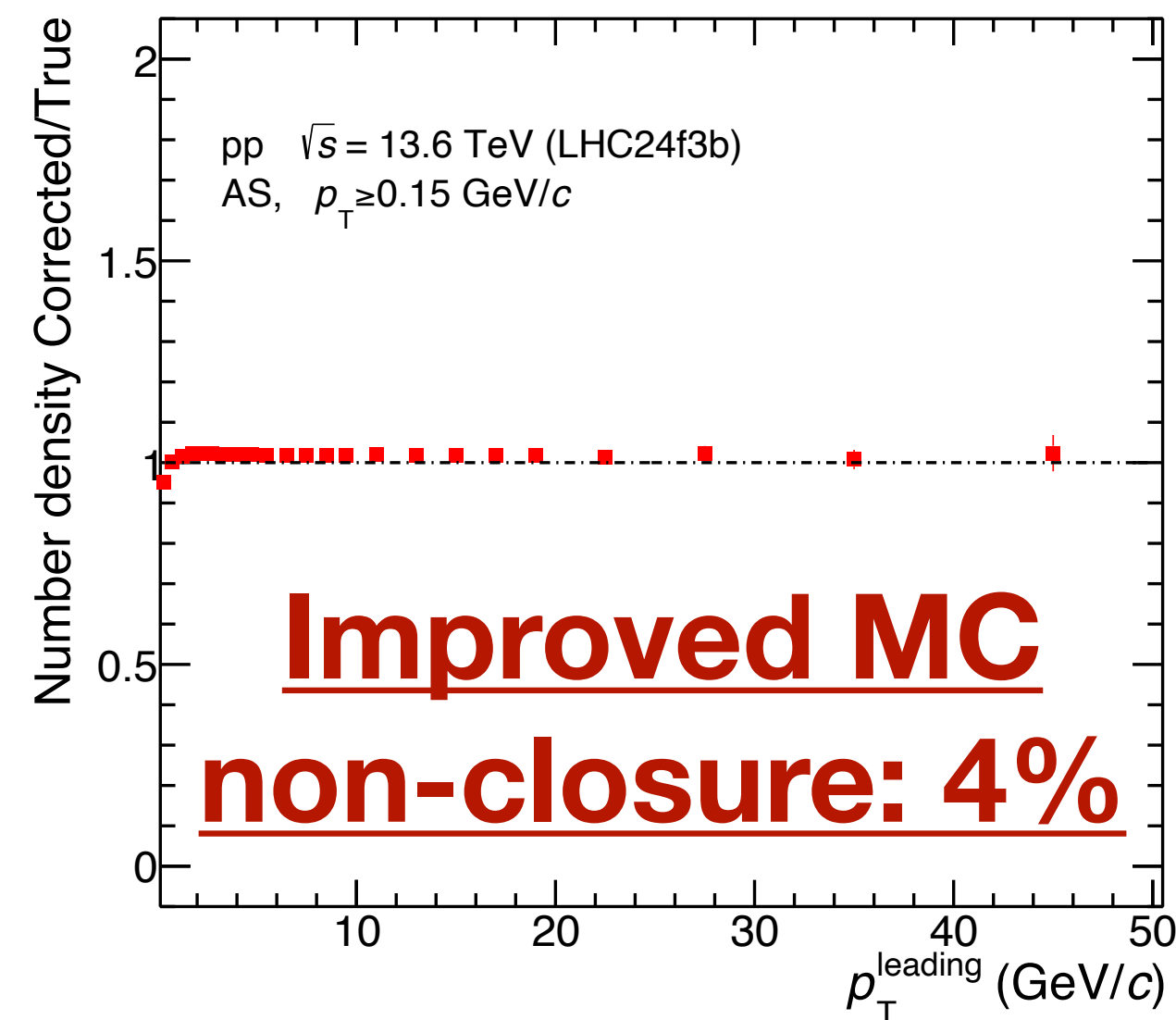
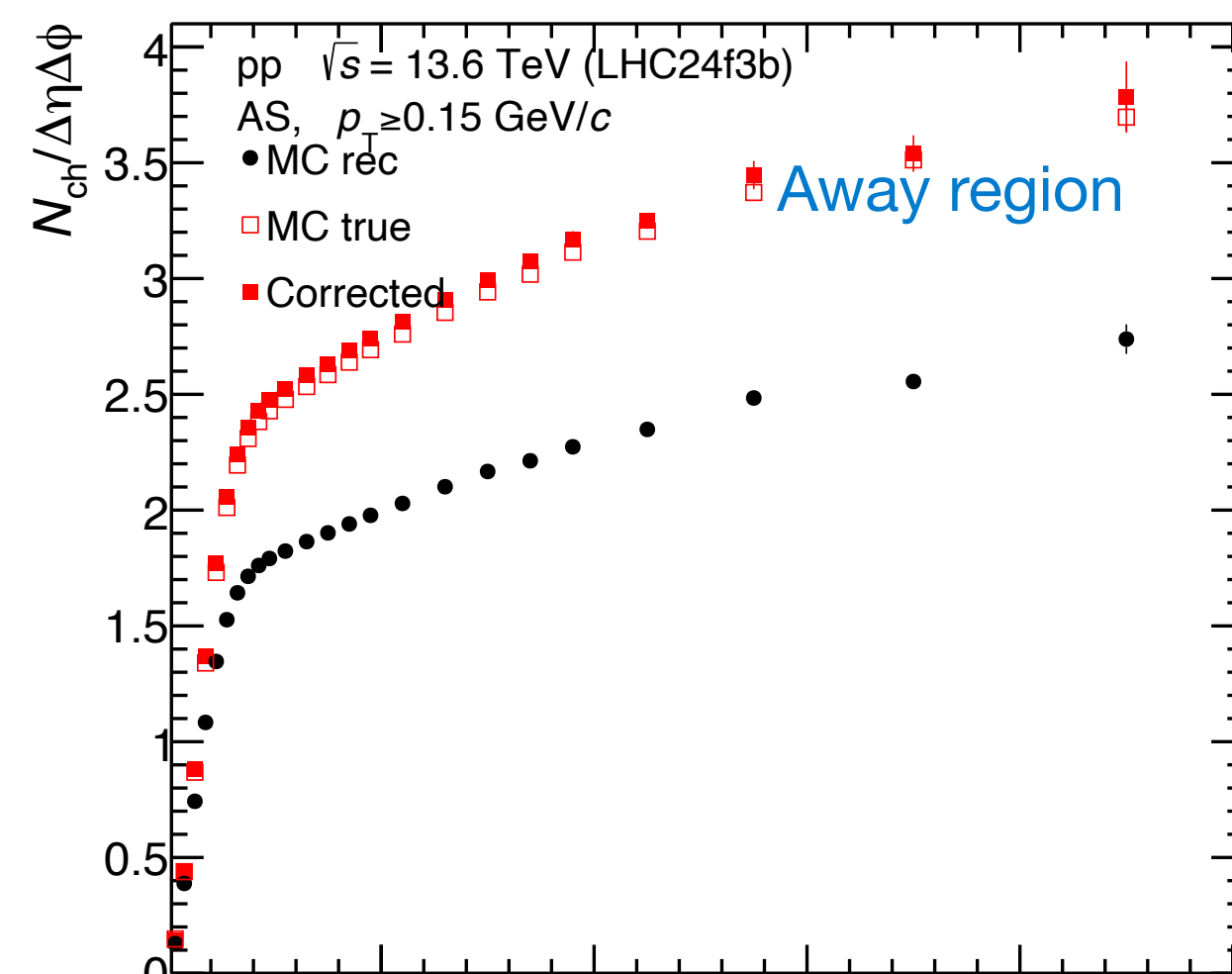
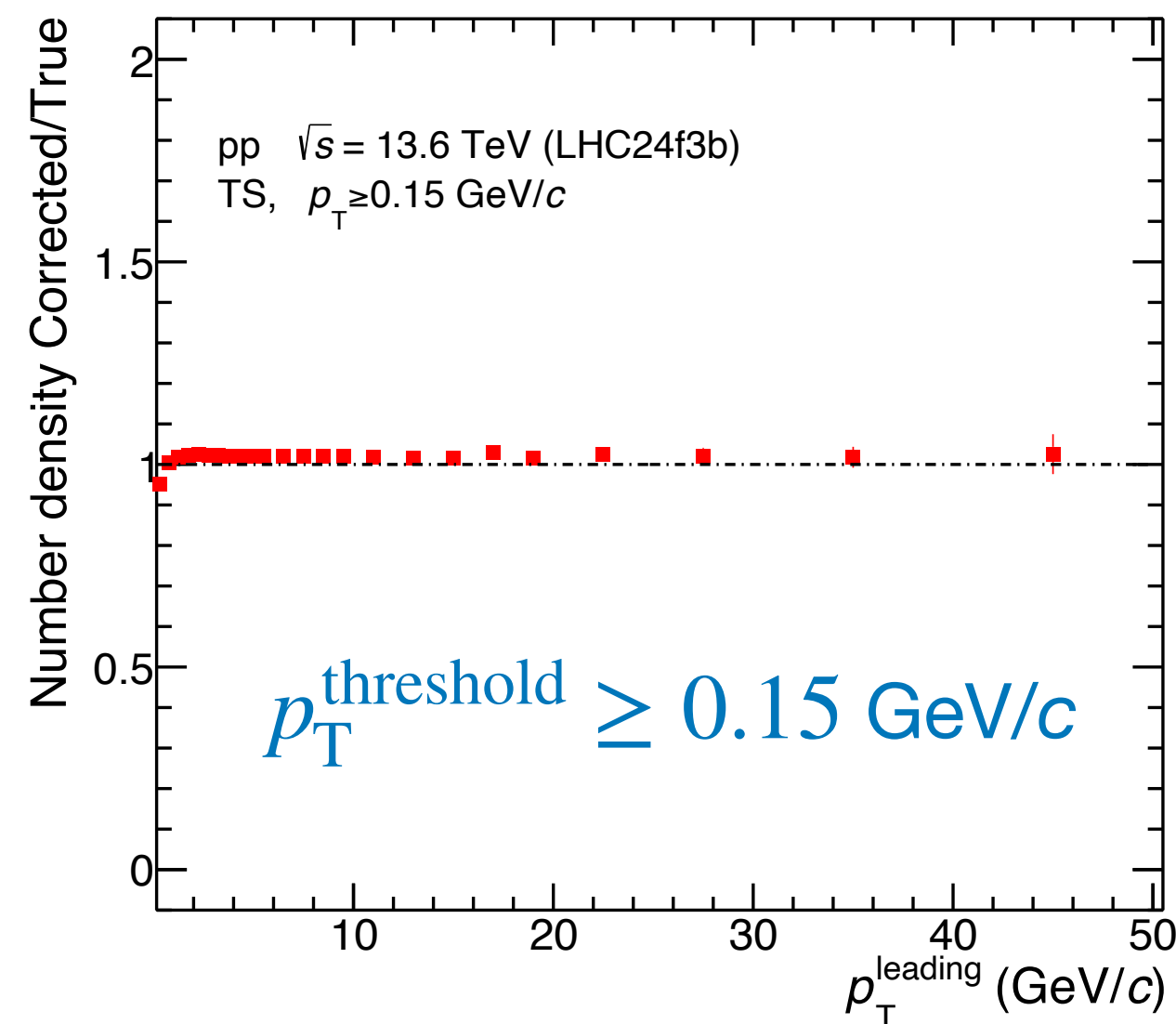
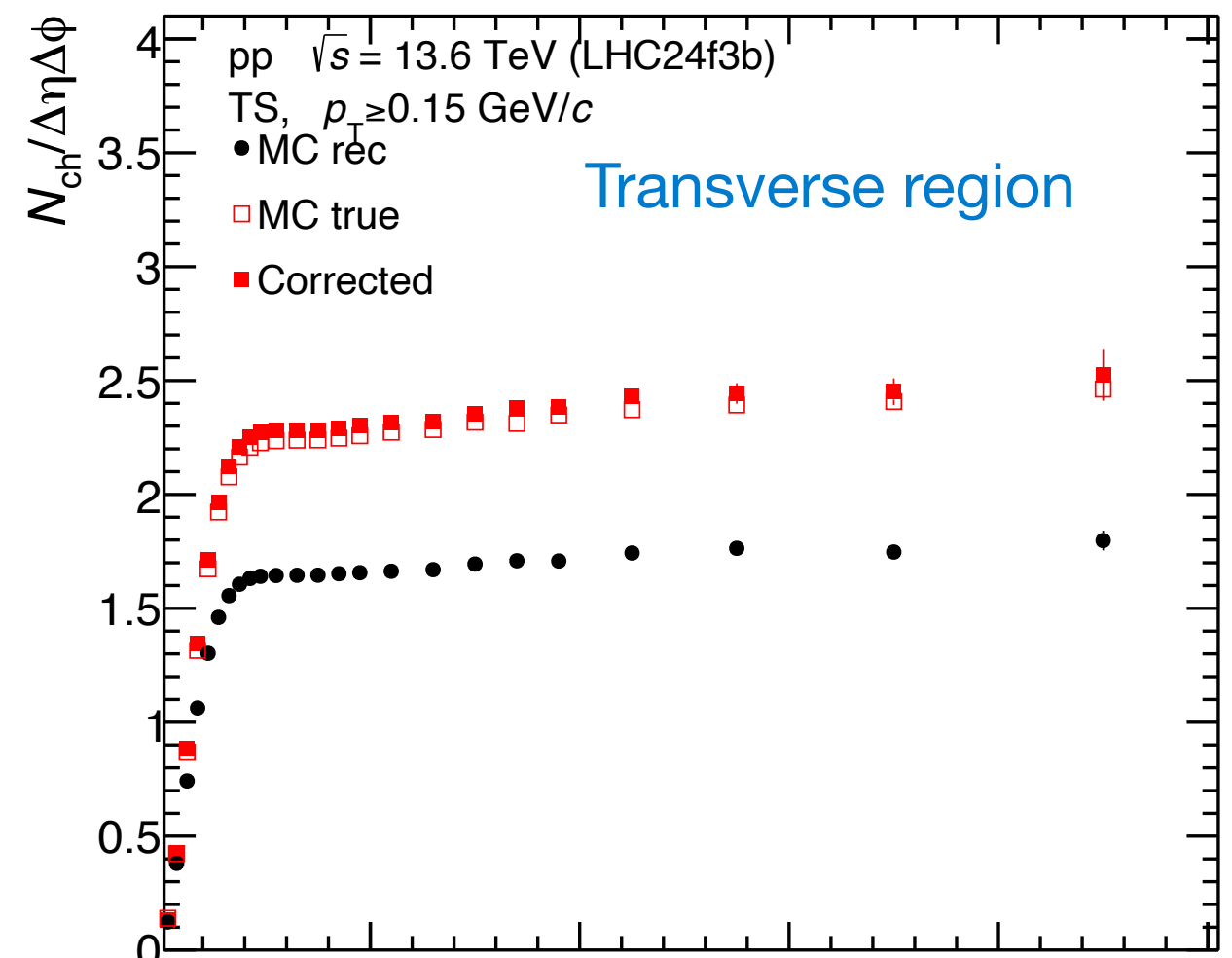
MC closure test (LHC24f3b **apass7**)



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Summary

- A **first look** of the Run 3 data was presented
- **MC non-closure** ~4% to be understood: possible conflict coming from event selection criteria is being investigated
- Comparison between Run 2 and Run 3 data exhibits an **unexpected behavior**, but we expect an improvement with current LHC22o - apass7
- The impact due to the different **interaction rates** will also be studied
- A *publication* of this analysis is our main goal since it represents crucial tool to test and constrain our phenomenological models

