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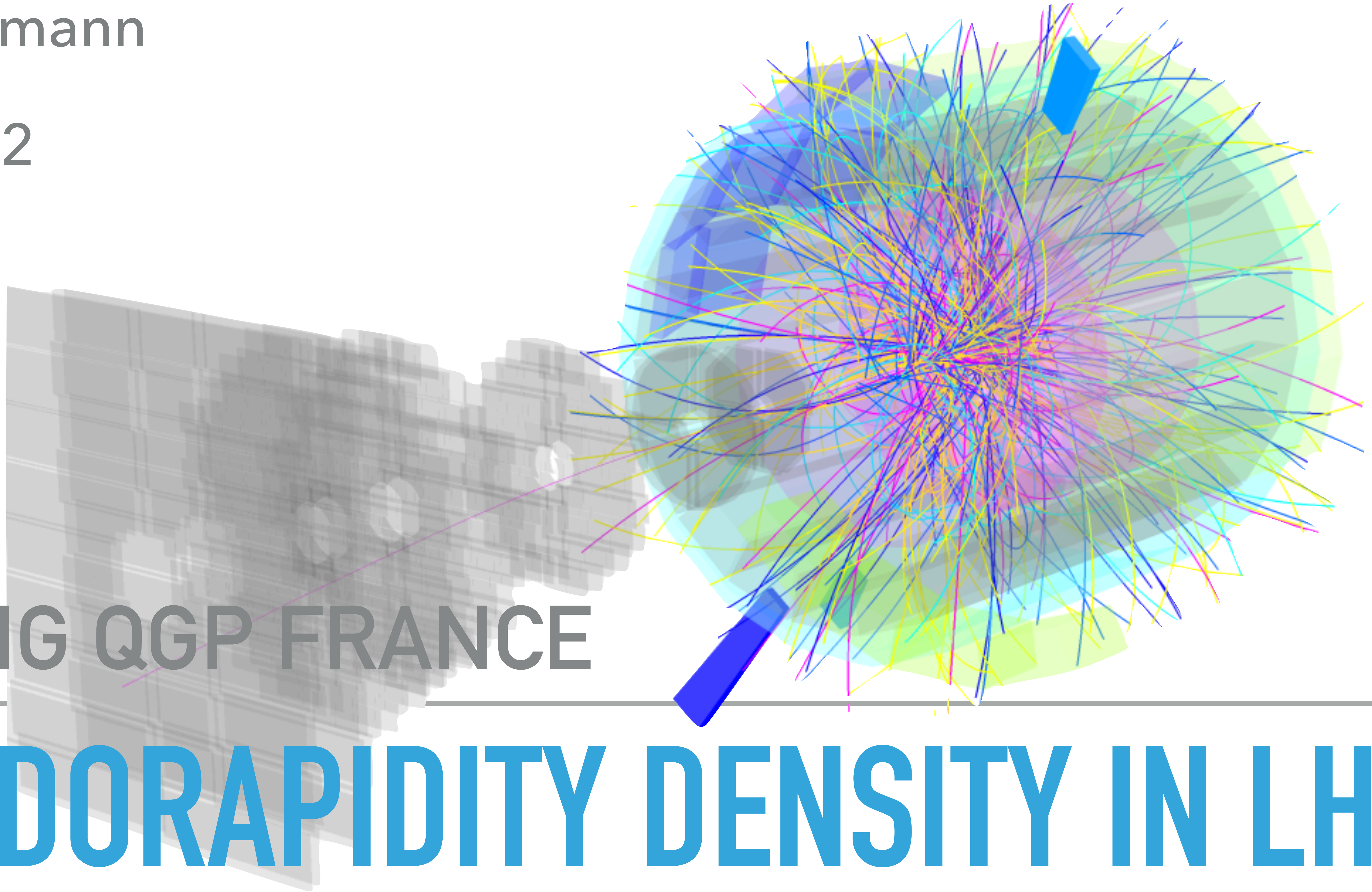


MEETING QGP FRANCE

PSEUDORAPIDITY DENSITY IN LHC RUN3 WITH ALICE

OUTLINE

- The MFT and ITS in ALICE
- MFT global performance plots
- Introduction to the $dN_{ch}/d\eta$ study
- Pseudorapidity density results

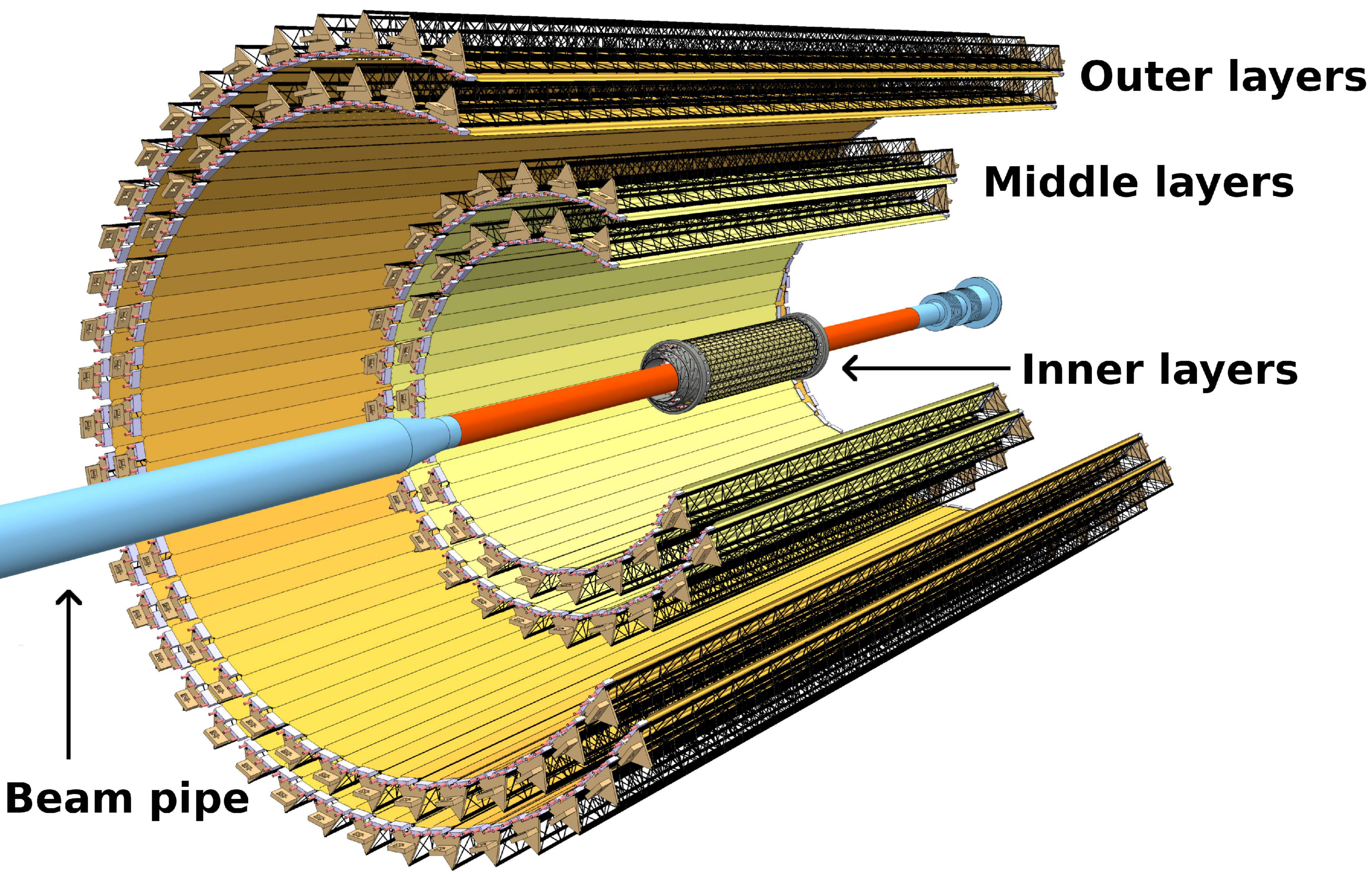
MFT AND ITS INSIDE THE RUN 3 ALICE DETECTOR

- MFT = new detector (installed in the ALICE cavern in 2020)

ITS 2 (INNER TRACKING SYSTEM)

- Seven cylindrical detector layers (from R = 22 mm to R = 400 mm) with CMOS* pixel sensor

- η coverage [-1.2 ; 1.2]

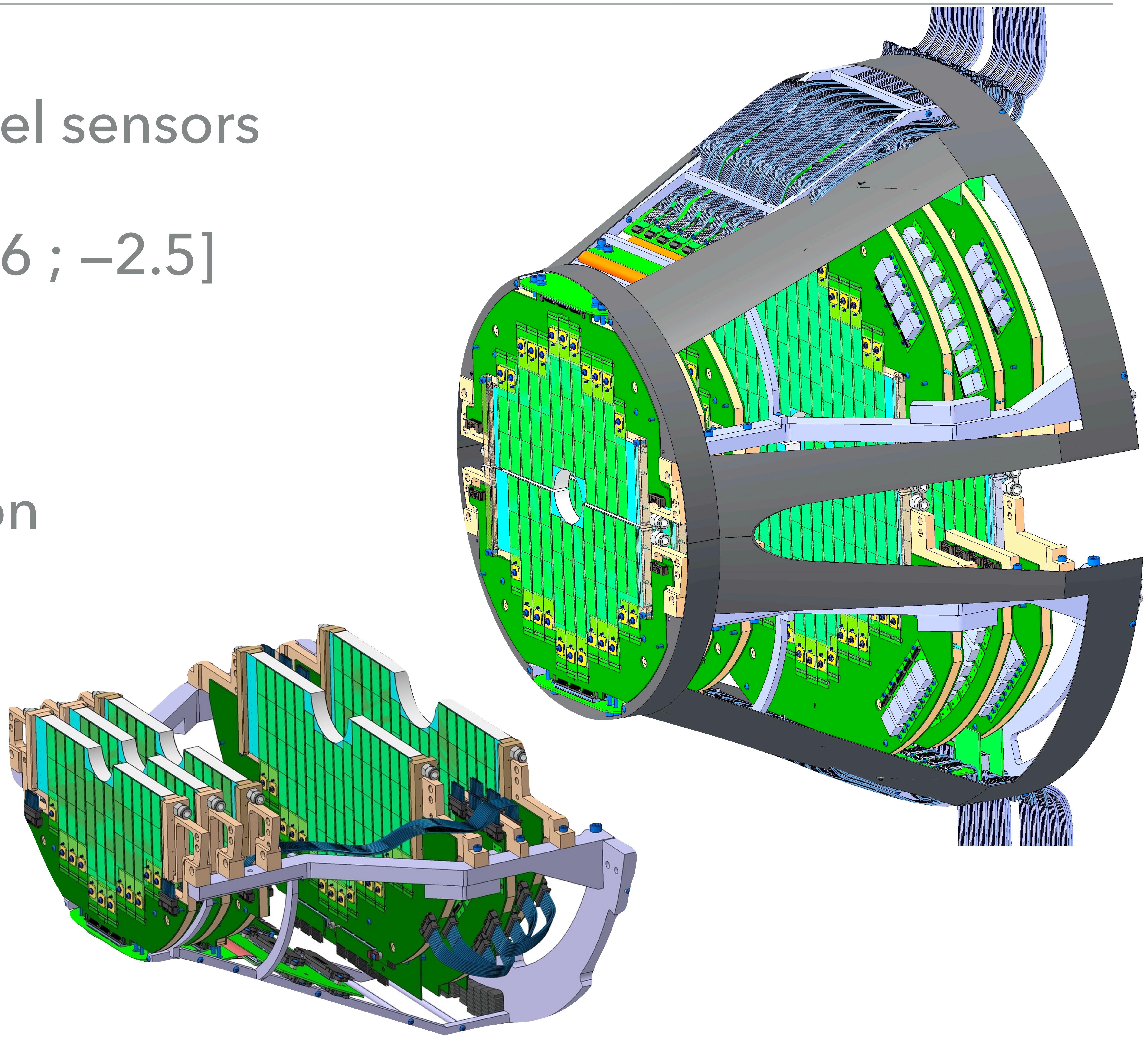


- ITS 2 goals :
  - Reconstruct the primary and secondary vertices
  - Track and identify charged particles at mid rapidity with a low p_T cutoff.

* CMOS : Complementary Metal-Oxide-Semiconductor

THE MFT (MUON FORWARD TRACKER)

- Si-tracking detector, 5 disks, CMOS* pixel sensors
- Nominal η acceptance of the MFT : [–3.6 ; –2.5]
- Goal :
  - Add vertexing capabilities to the muon spectrometer
  - Extend the internal tracking to the forward rapidity region
    - Precise measurement of angular variables (not of p_T)



* CMOS : Complementary Metal–Oxide–Semiconductor

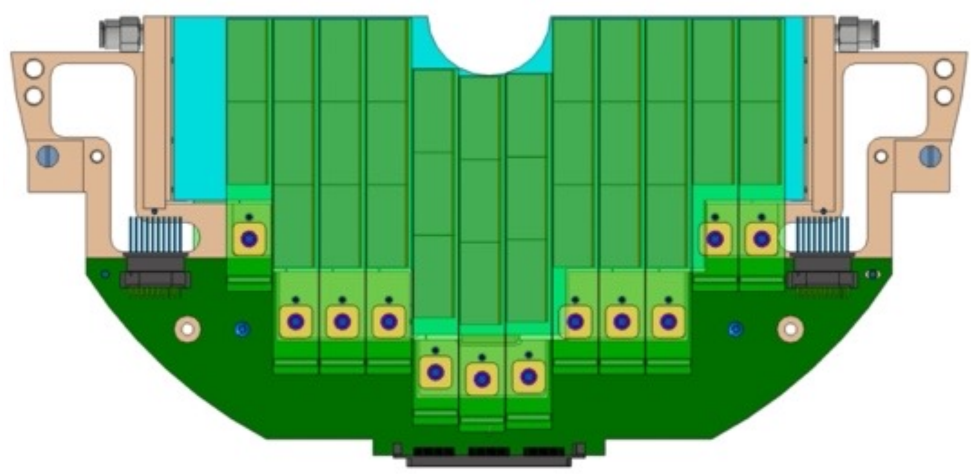
MFT PHYSICS GOALS

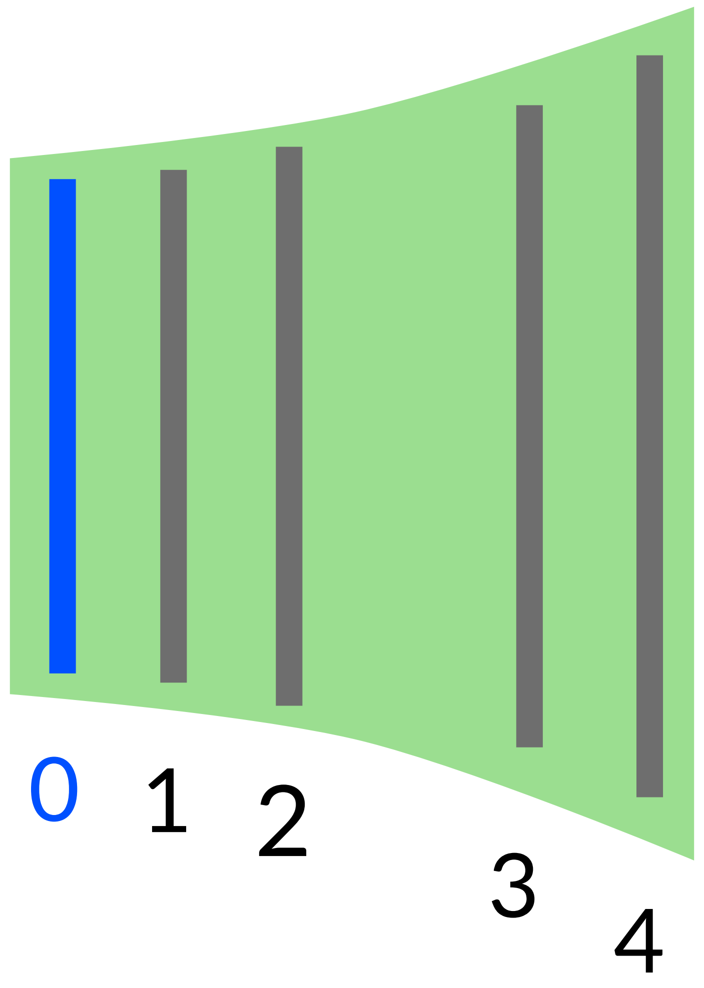
- Provides a separation between prompt and displaced muon production, allowing for the study of :

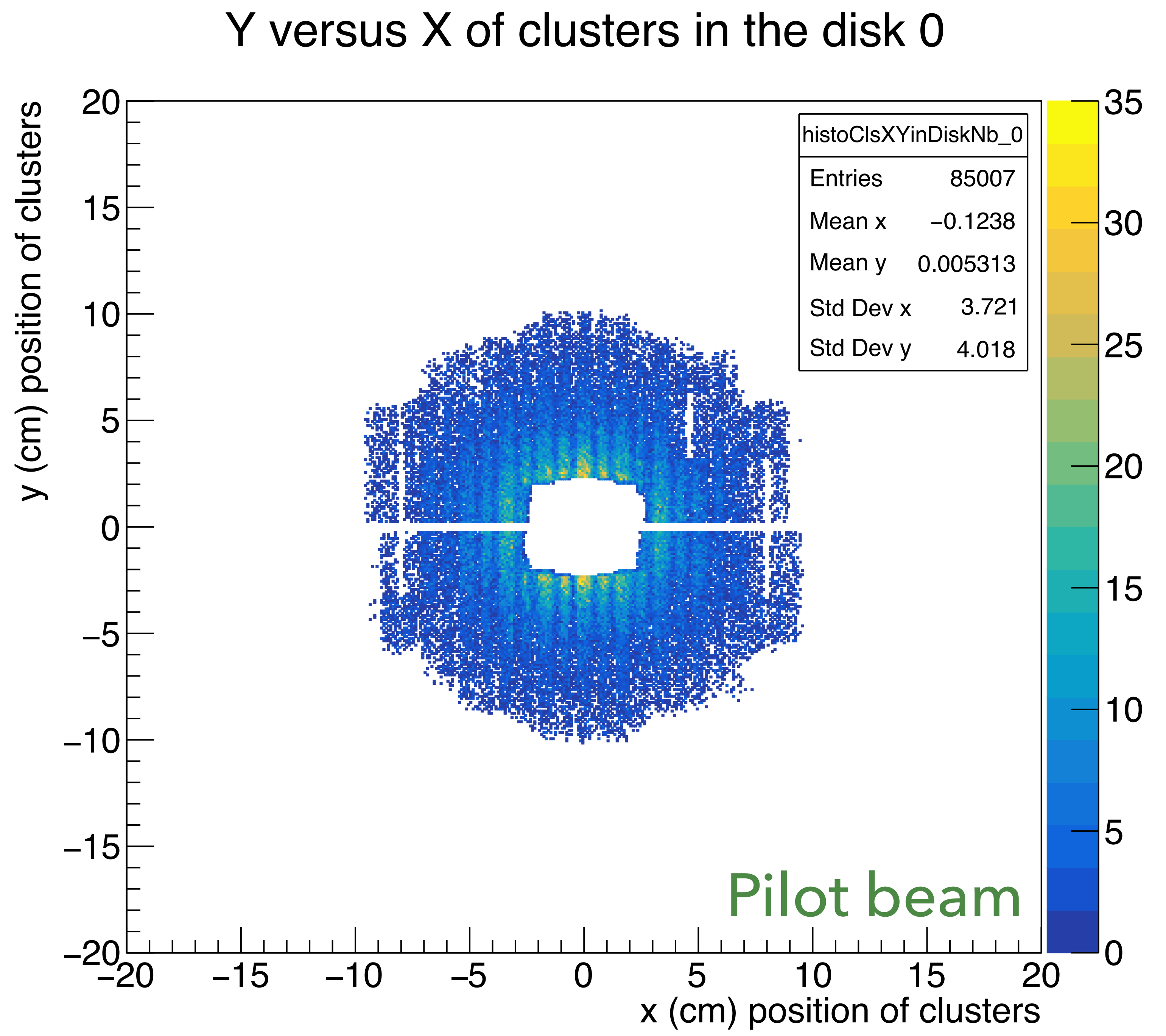
  - in-medium charmonium dynamics (dissociation and regeneration) → measurement of production of prompt J/ψ and $\psi(2S)$, R_{AA}
  - thermalization of heavy quarks in the medium → measurements of the elliptic flow v_2 for charm, beauty and prompt charmonium
  - medium density and the mass dependence of in-medium parton energy loss → charm & beauty p_T - differential production yield

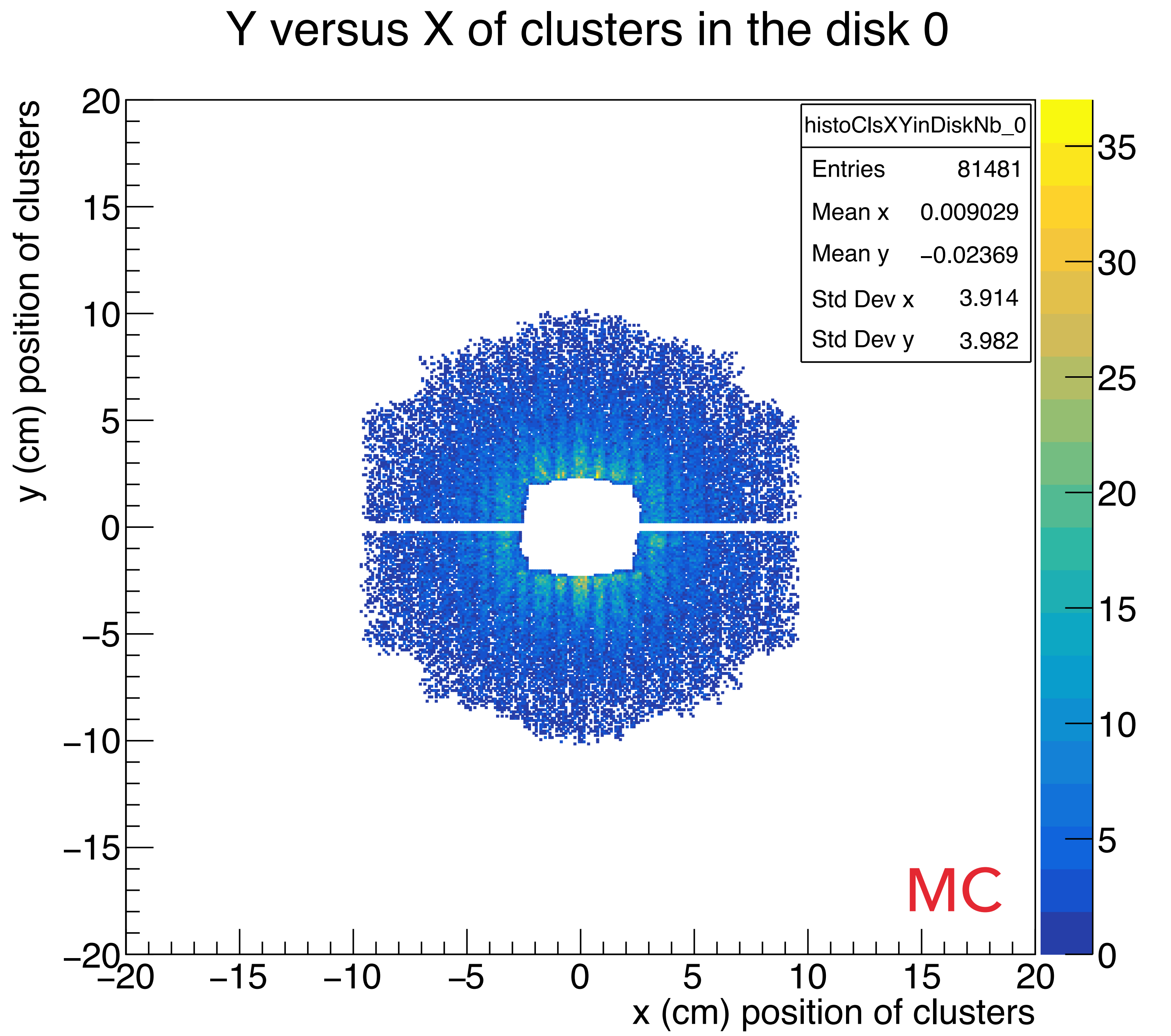
DISK OCCUPANCY: DISK 0

- Pilot beam : short proton-proton run at center of mass energy of $\sqrt{s}$ = 900 GeV, October 2021
- Cluster y versus x for each MFT disk 0
  - Top plot: Pilot beam data
  - Bottom plot: MC





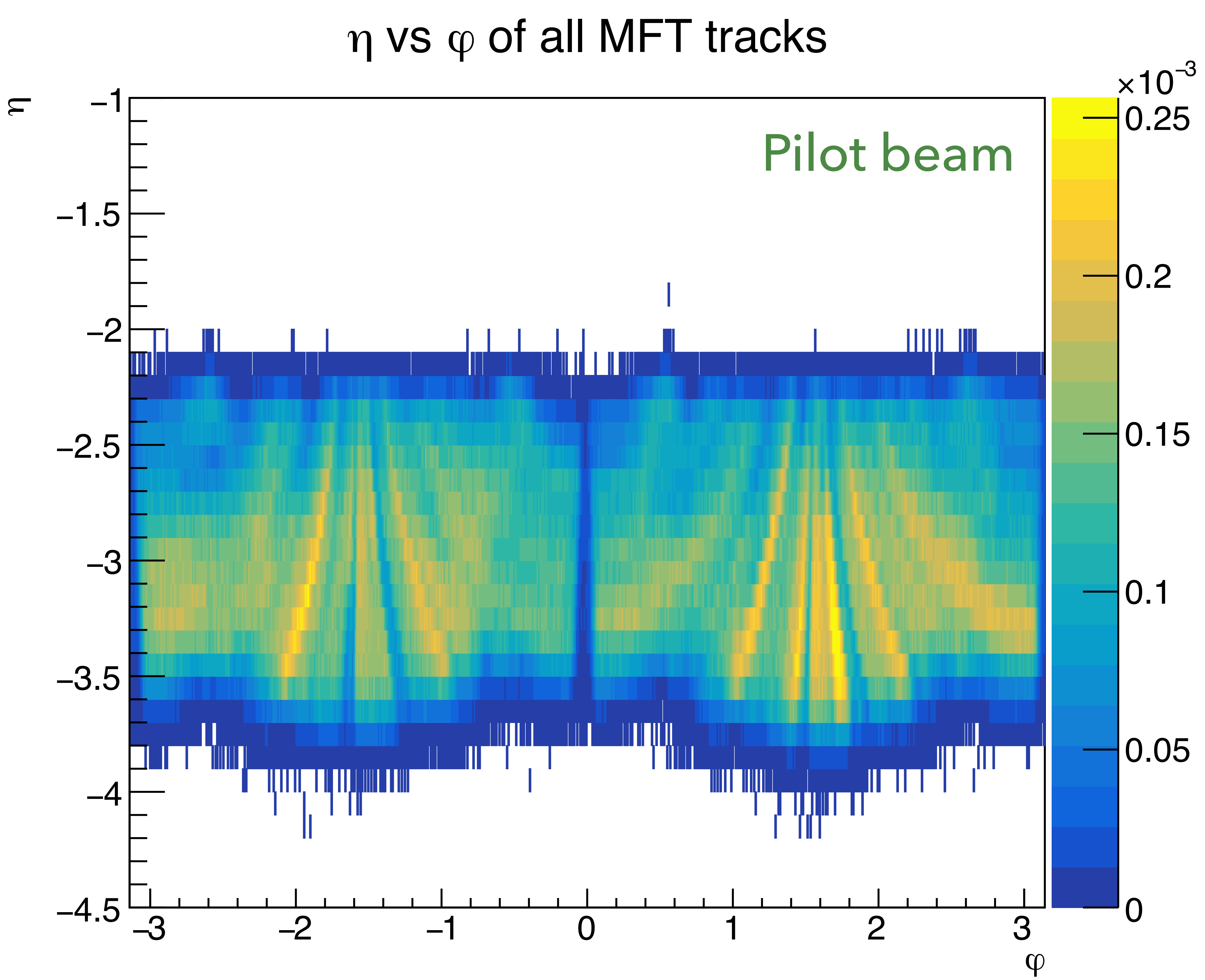


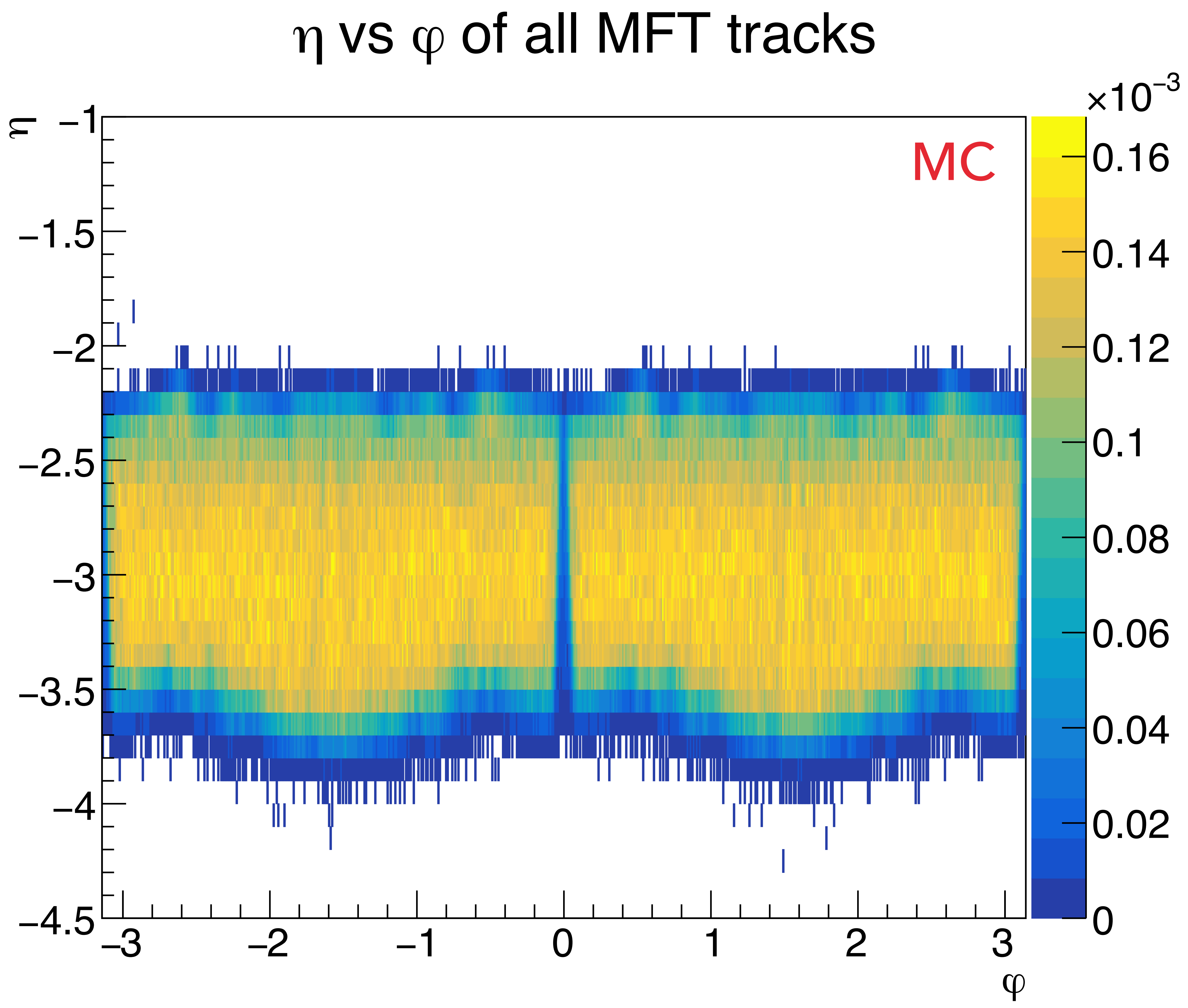


MFT PERFORMANCE PLOTS: RECONSTRUCTED TRACKS

- MFT track means 1 hit in at least 4 different MFT disks
- Structures in the data due to misalignment

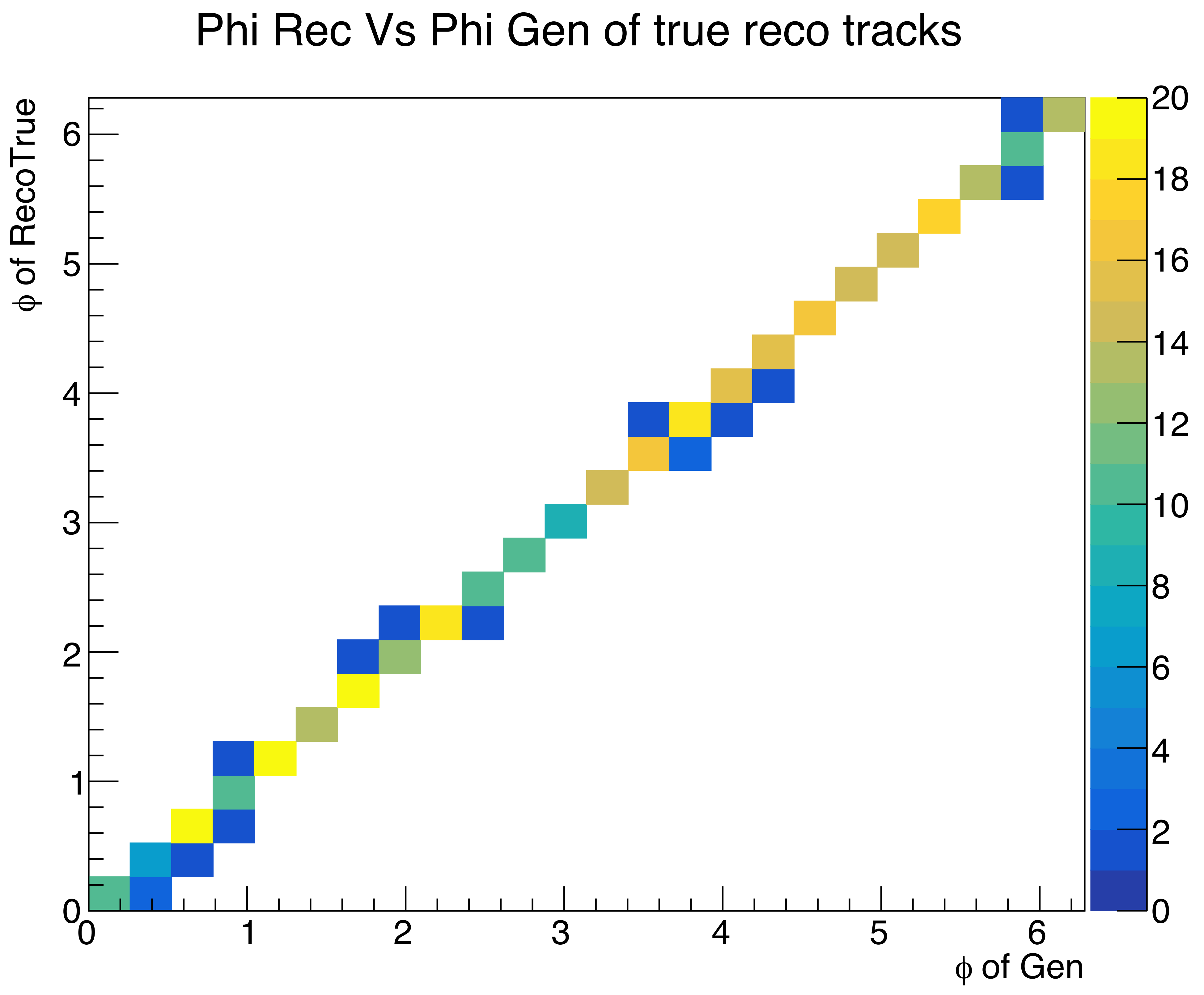
→ Waiting for the alignment

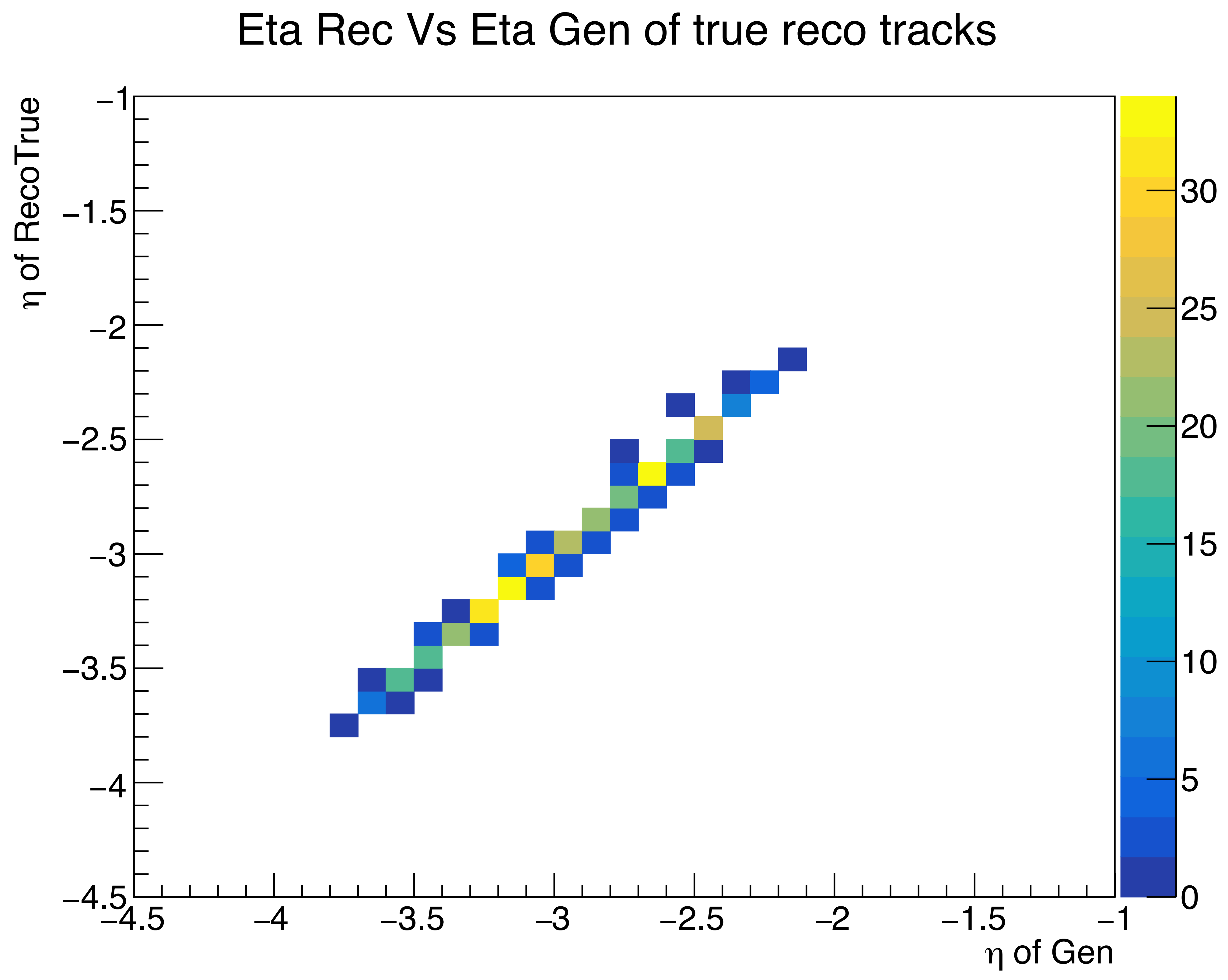




MFT PERFORMANCE PLOTS

- Is the MFT precise in measuring the angular coordinates of the reconstructed tracks ?

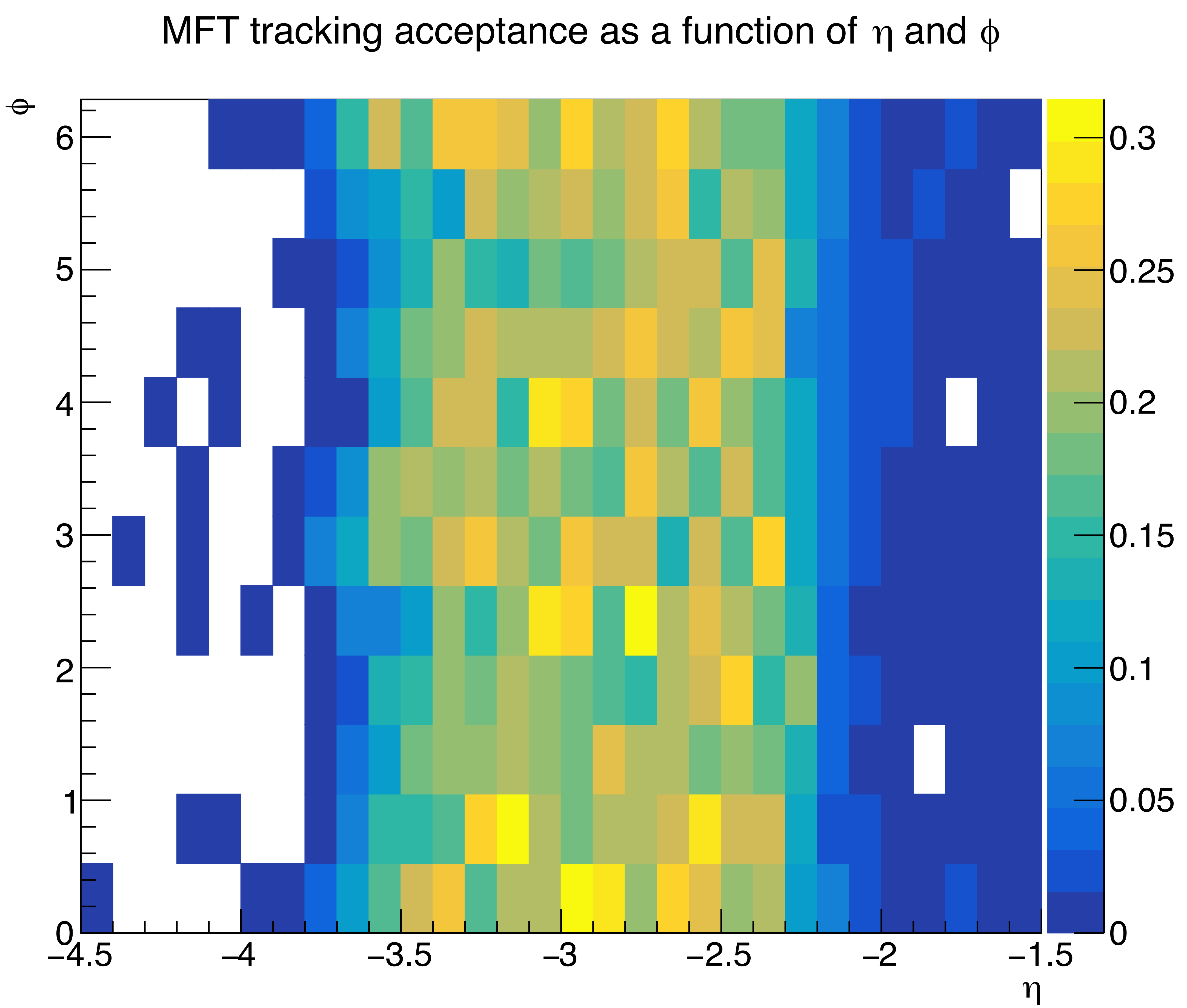




- Good correlation between generated and reconstructed η and ϕ ✓

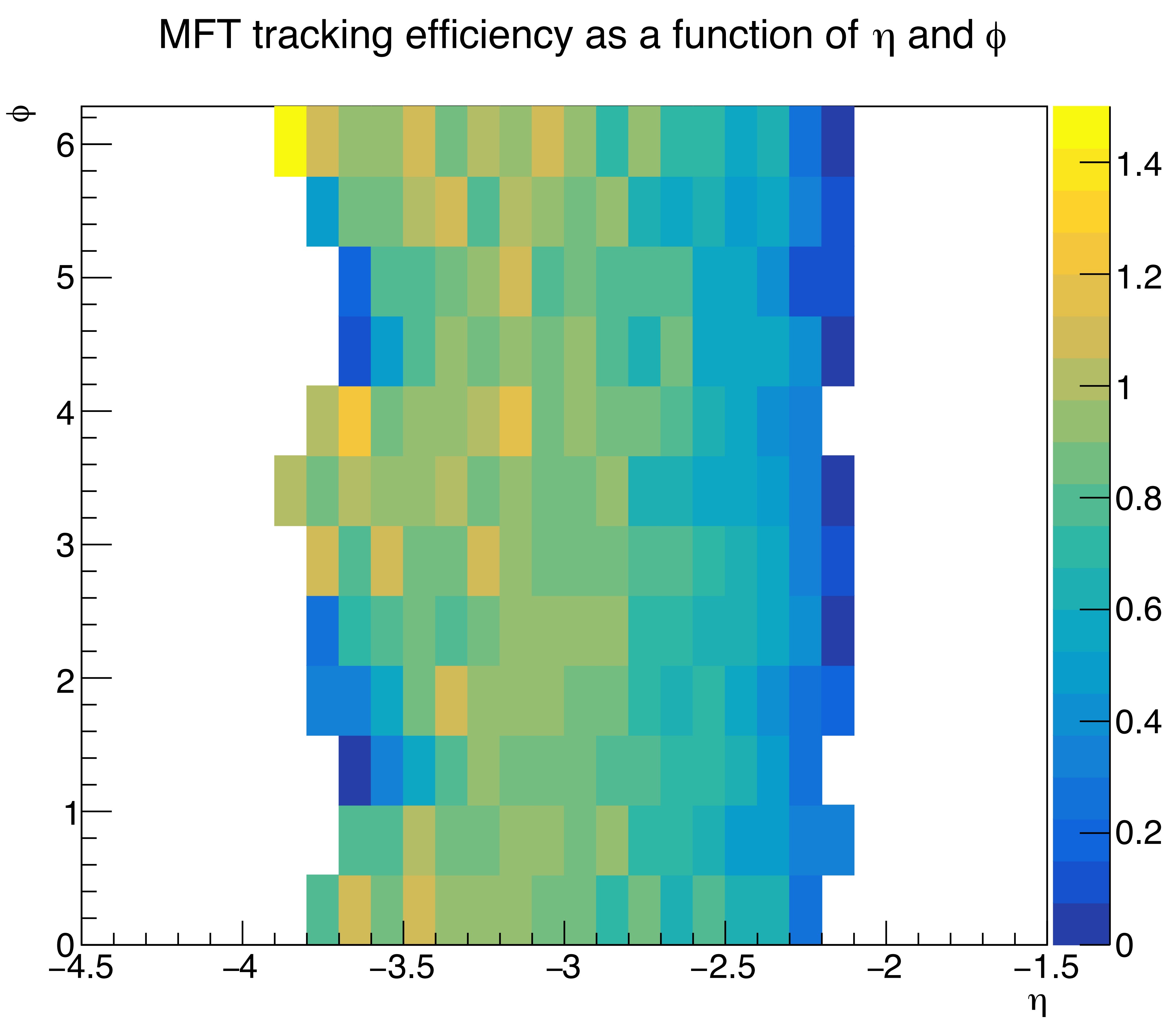
MFT PERFORMANCE PLOTS: GEOMETRICAL ACCEPTANCE

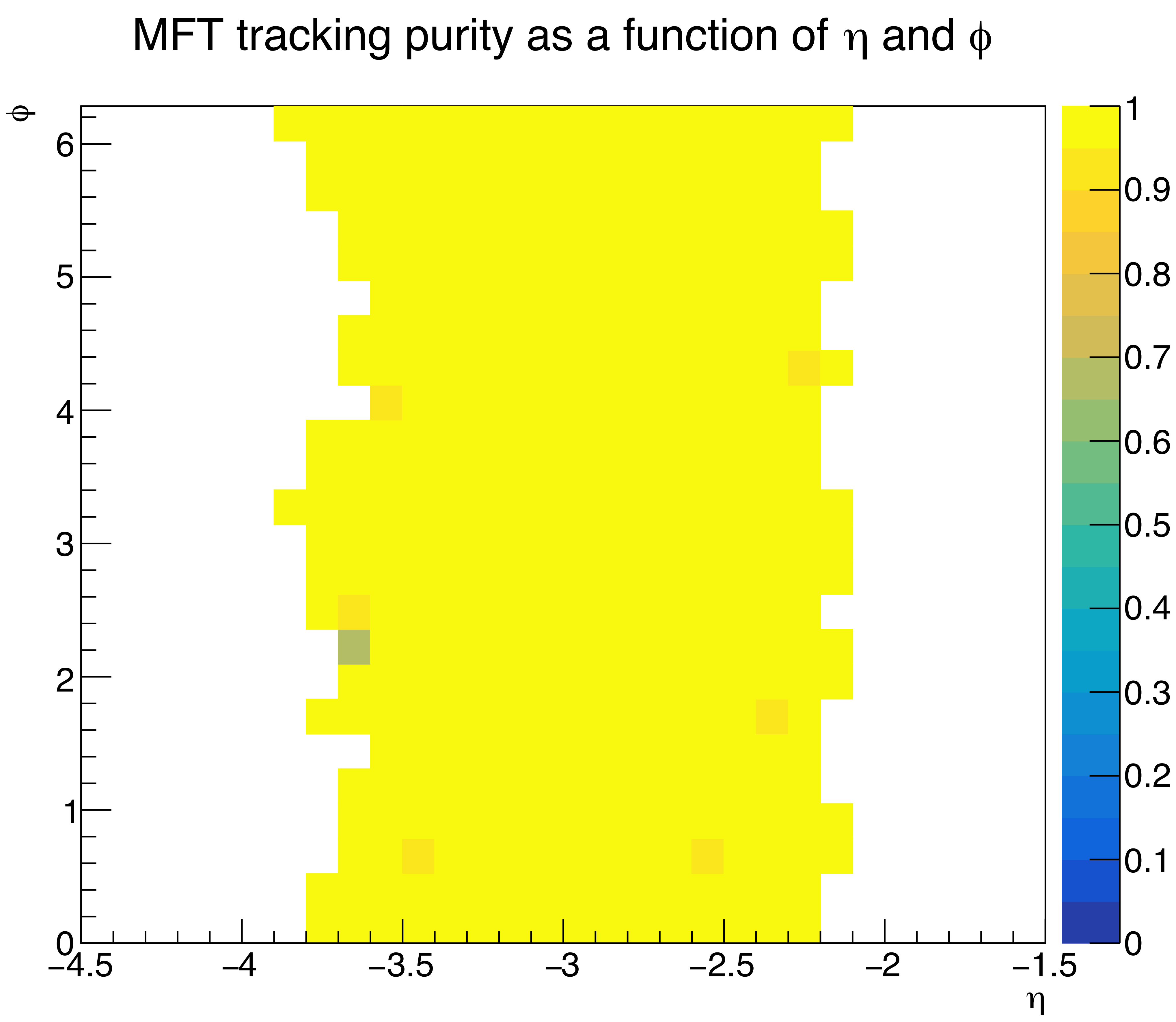
- Definitions :
  - $N^{MFT}_{Trackable}$: Number of MFT trackables. Tracks with clusters in at least 4 MFT disks; reference is MC.
  - N^{MFT}_{Rec} : Number of Reconstructed MFT tracks
  - N^{MFT}_{True} : Number of Reconstructed MFT tracks with correct MC labels (> 80% of clusters from same MC label)



$$A^{MFT} = N^{MFT}_{Trackable} / N^{MFT}_{Gen}$$

MFT PERFORMANCE PLOTS





$$\epsilon^{MFT} = N^{MFT}_{Rec} / N^{MFT}_{Trackable}$$

$$P^{MFT} = N^{MFT}_{True} / N^{MFT}_{Rec}$$

- The MFT is able to reconstruct tracks in the η range : $[-3.6; -2.3]$ with a good purity

DEFINITION : PSEUDORAPIDITY DENSITY

Pseudorapidity density $\frac{1}{N_{events}}\frac{dN_{tracks}}{d\eta}$ (multiplicity distribution versus η)

Common observable, used to estimate particle production and event activity. It is sensitive to partonic structure of the colliding particles and non-linear QCD evolution

Allow us to test detectors and O² *

$$\frac{1}{N_{events}}\frac{dN}{d\eta}\Bigg|_{\eta=\eta'} = \frac{\int_{z_{min}(\eta')}^{z_{max}(\eta')} N_{trk}(z,\eta')/\epsilon_{trk}(z,\eta')}{\int_{z_{min}(\eta')}^{z_{max}(\eta')} \sum_N N_{evt}(z,N)/\epsilon_{evt}(z,N)}$$

N : Number of tracks in that event

ϵ_{trk} : $\frac{N_{trk}^{\text{MC reco}}}{N_{particle}^{\text{MC gen}}}$ track reconstruction Efficiency x Acceptance

ϵ_{evt} : event reconstruction Efficiency x Acceptance

z : z position of the primary vertex of the collision

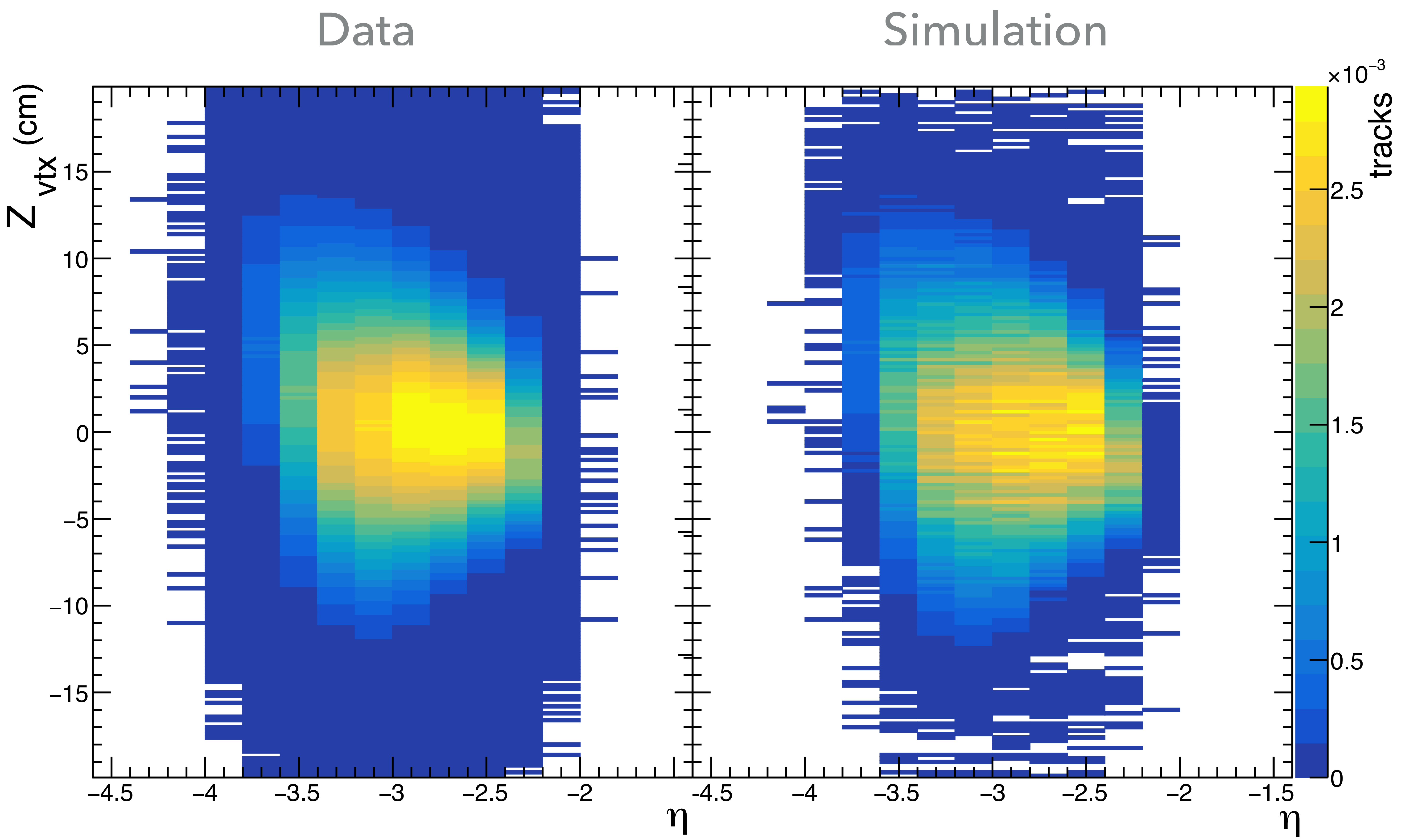
* Online-Offline computing system in ALICE

CORRECTIONS FOR THE MULTIPLICITY MEASUREMENT

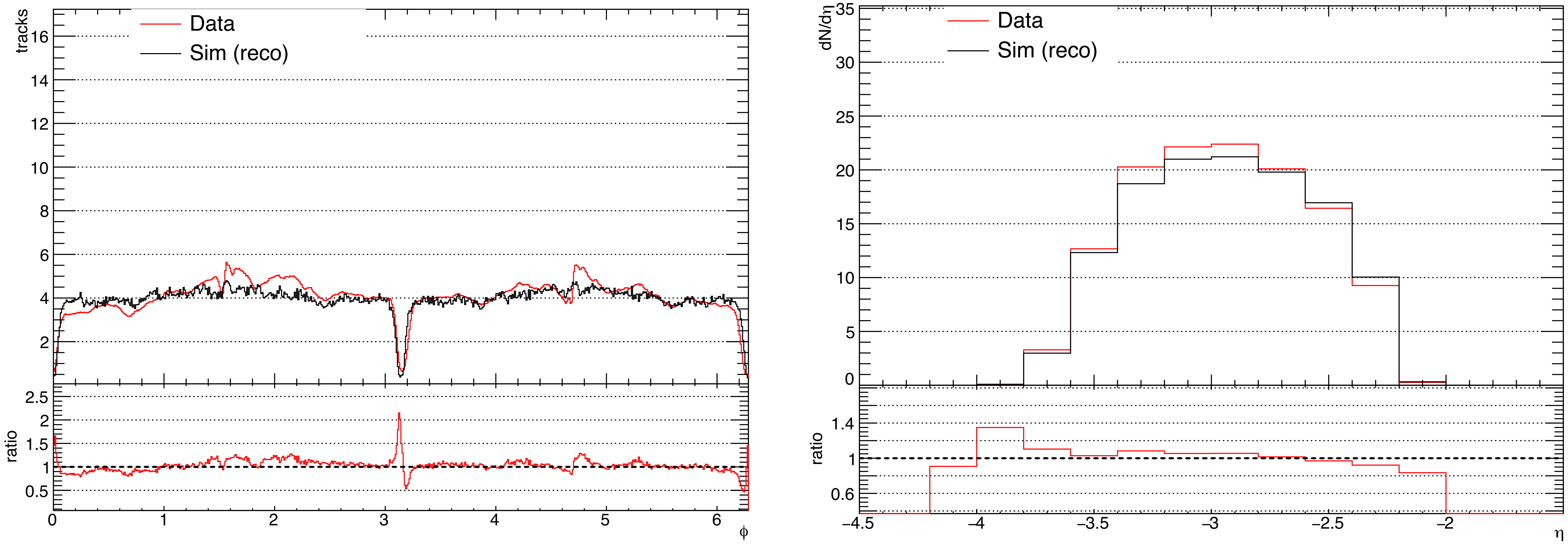
- Two observables to get the $dN_{ch}/d\eta$: N_{ch} and N_{evt}
- 2 types of correction
  - Track to particle correction (difference between the number of measured tracks and the number of primary charged particles) → Track level
  - Triggering efficiency correction (depends on the event class) → Track and event level

PERFORMANCE PLOTS

- Track selection : MFT track (1 hit in at least 4 different MFT disks)
- For correction we chose the following cuts :
  - $|Z_{vtx}| < 12$ cm
  - $-3.6 < \eta < -2.5$
  - No DCA cut
- We need anchored MC sim

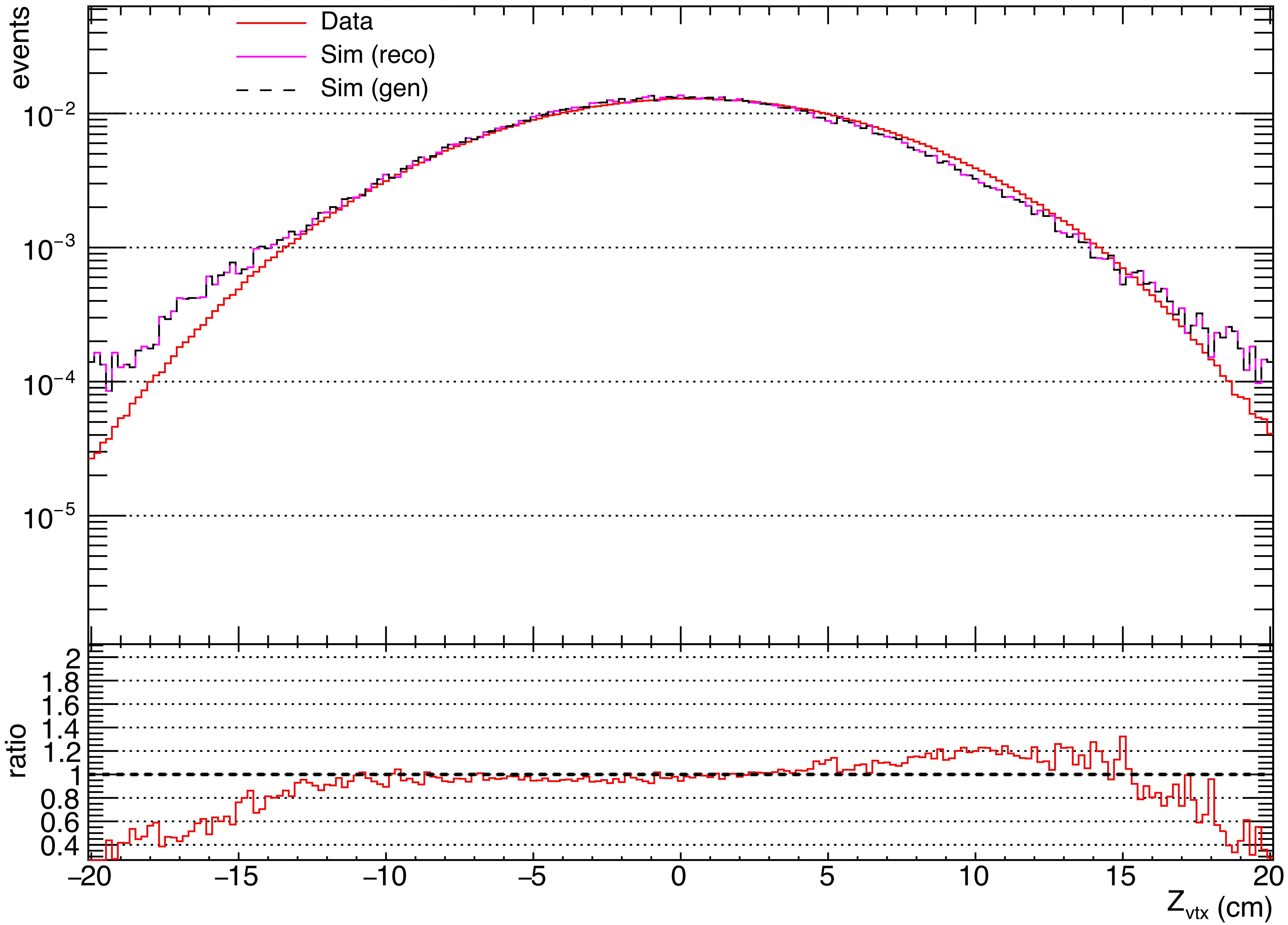


PERFORMANCE PLOTS



PERFORMANCE PLOTS

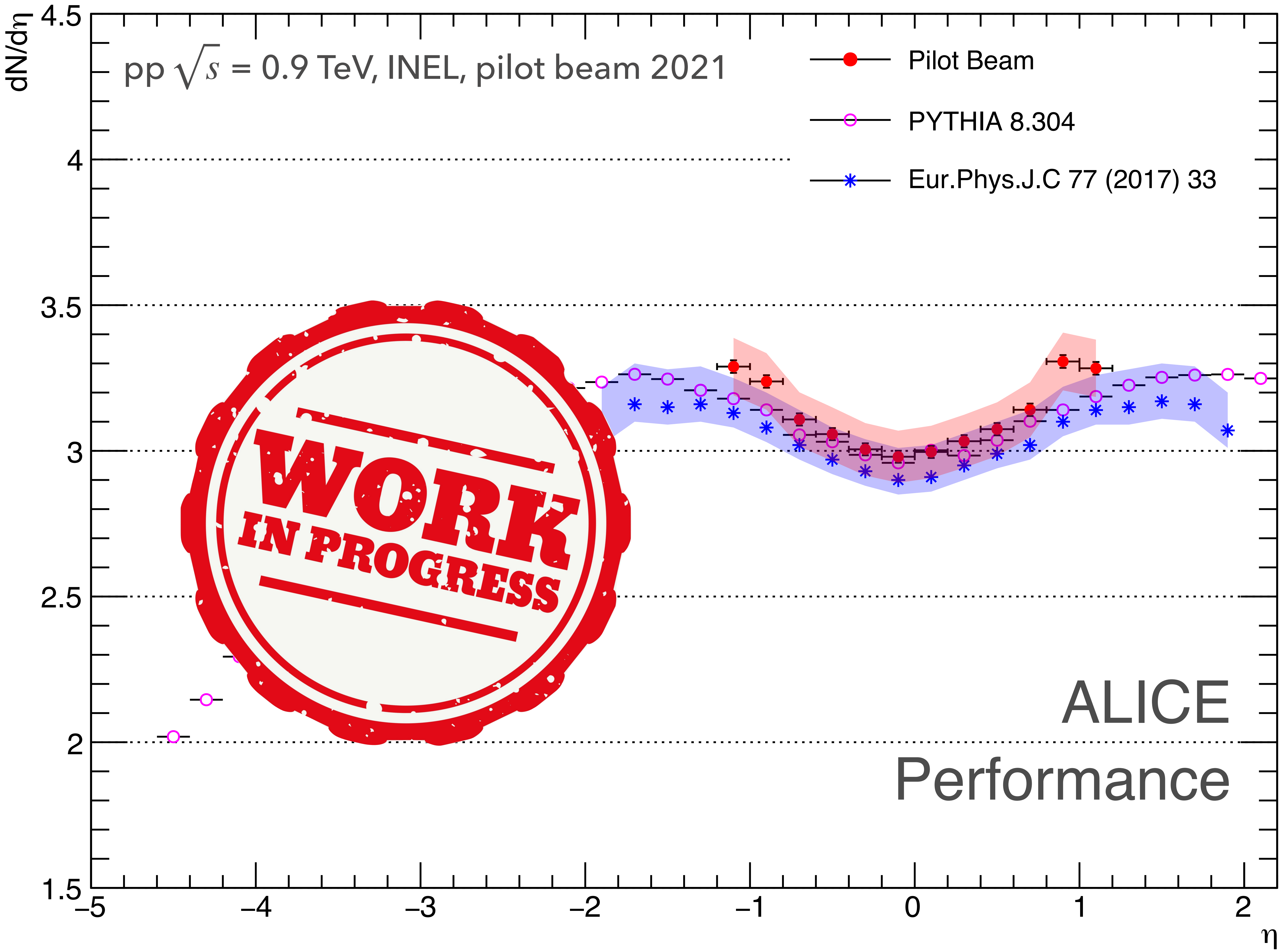
- We study the INEL* event class
- Number of events versus primary vertex position
- $|Z_{vtx}|$ <12 cm



* INEL : All inelastic events

PSEUDORAPIDITY DENSITY RESULTS FOR MFT AND ITS

- Event selection based on FT0* timing
- No systematic uncertainties yet for the MFT data points (e.g : strangeness correction ~6% and ambiguous tracks)
- No correction for the diffractive content yet



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*FT0 : coincidence between FT0-A and FT0-C

CONCLUSIONS

- The MFT is working as expected
  - Still need alignment
- The $dN/d\eta$ study still is a work in progress, systematic uncertainties not computed yet
  - Diffraction tuning when process flags are available in O^2
  - Strangeness content
  - Anchored MC simulation
  - Ambiguous tracks : need a dedicated study
- Final goal : Pseudorapidity density between -3.6 et 1.2 combining ITS and MFT measurement at 0.9 and 13.5 TeV (coming soon)

FUTURE PROSPECTS: FURTHER EXPLOITING STANDALONE MFT

- Finding jet-like structures within the MFT acceptance to characterize hard fragment production at forward rapidity
- MFT allows to separate space phase of a certain signal from the underlying event phase space and then consequently to do correlations between these 2
  - Characterisation of the forward underlying event to estimate the flow of mid-rapidity observables

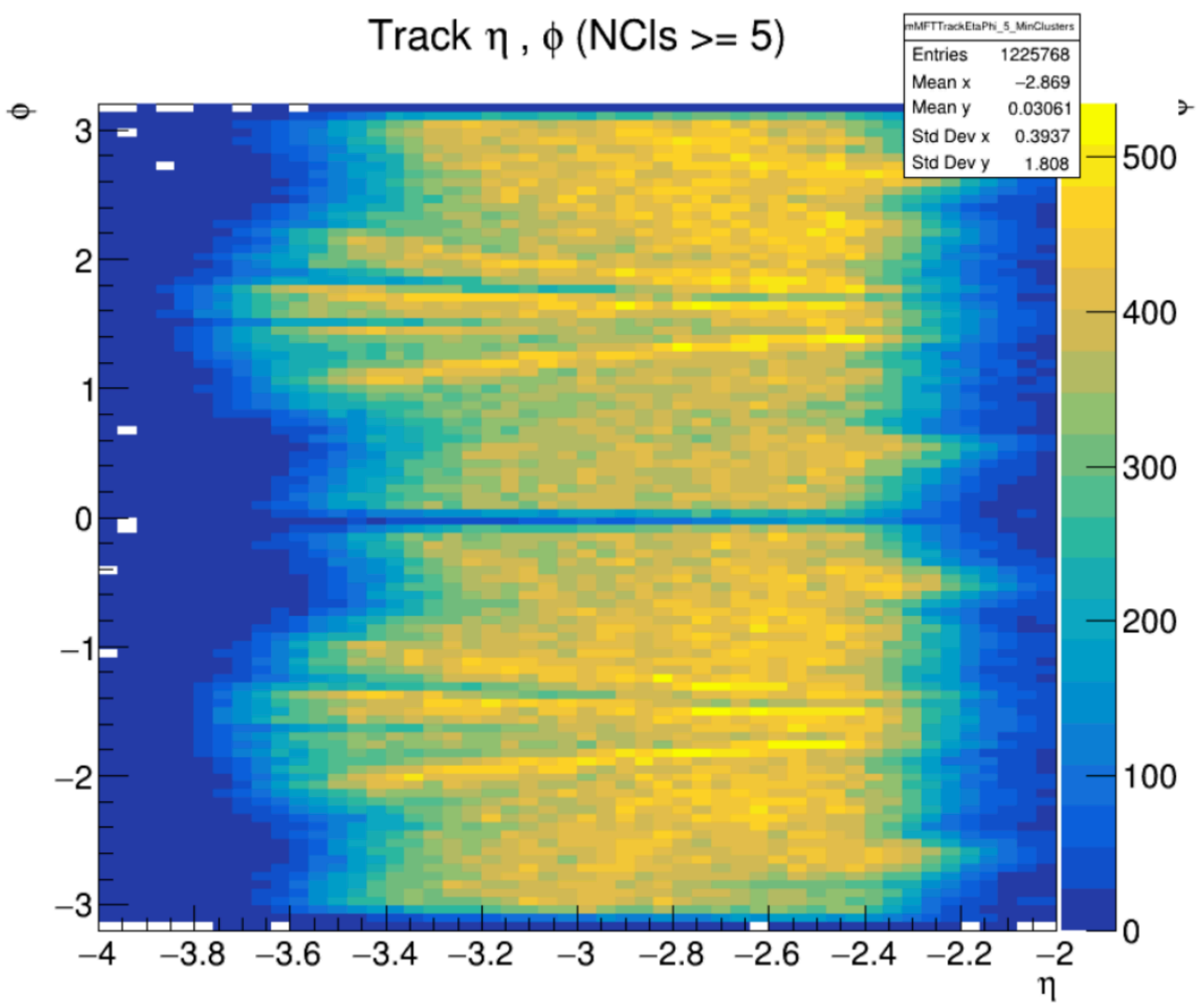
THANKS FOR YOUR ATTENTION

BACKUP

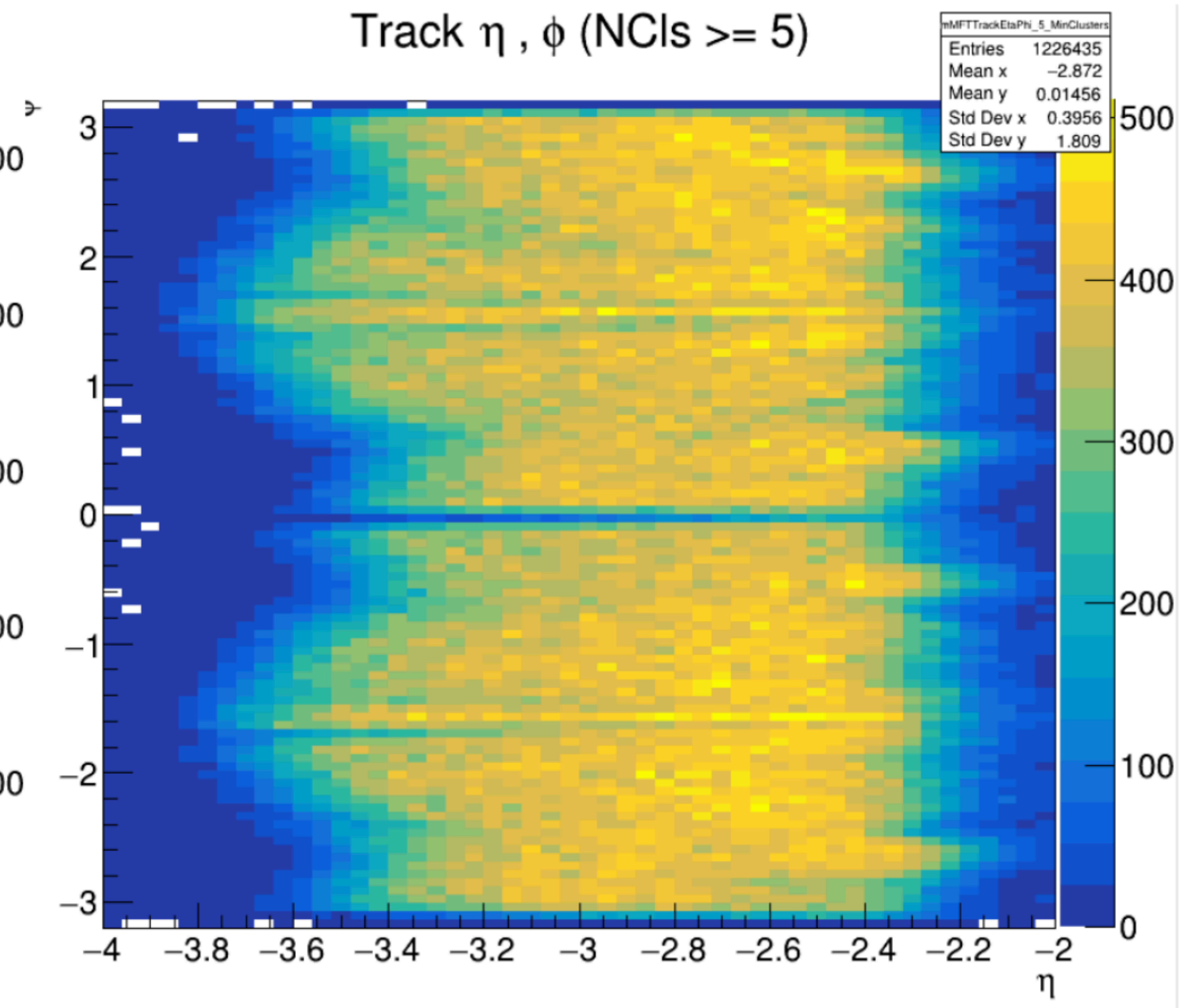
EFFECT OF PREALIGNMENT

- Study made by Robin

Ideal geometry

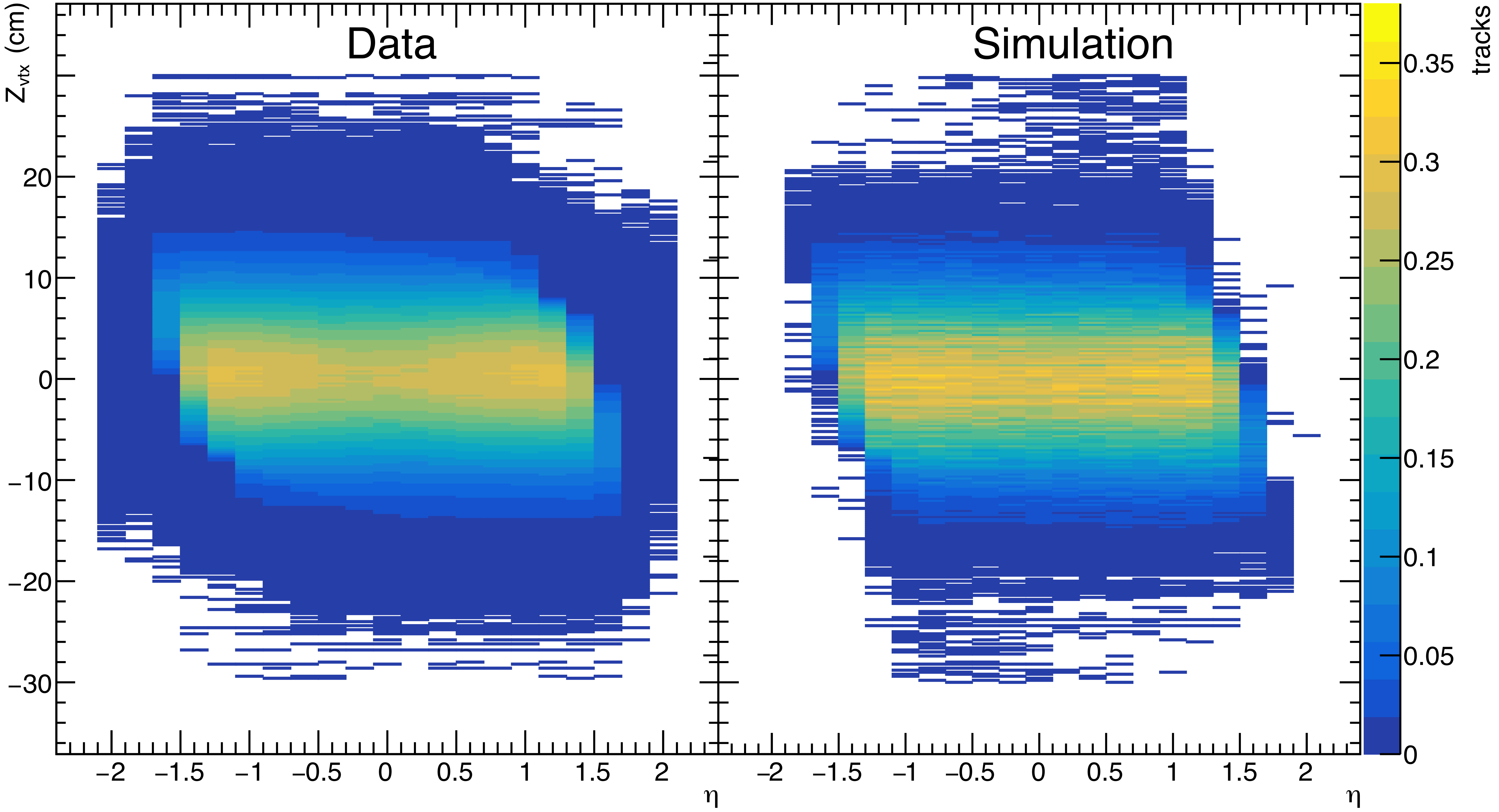


Prealigned geometry



ITS PERFORMANCE PLOTS

- ITS number of tracks vs Z_{vtx} and η



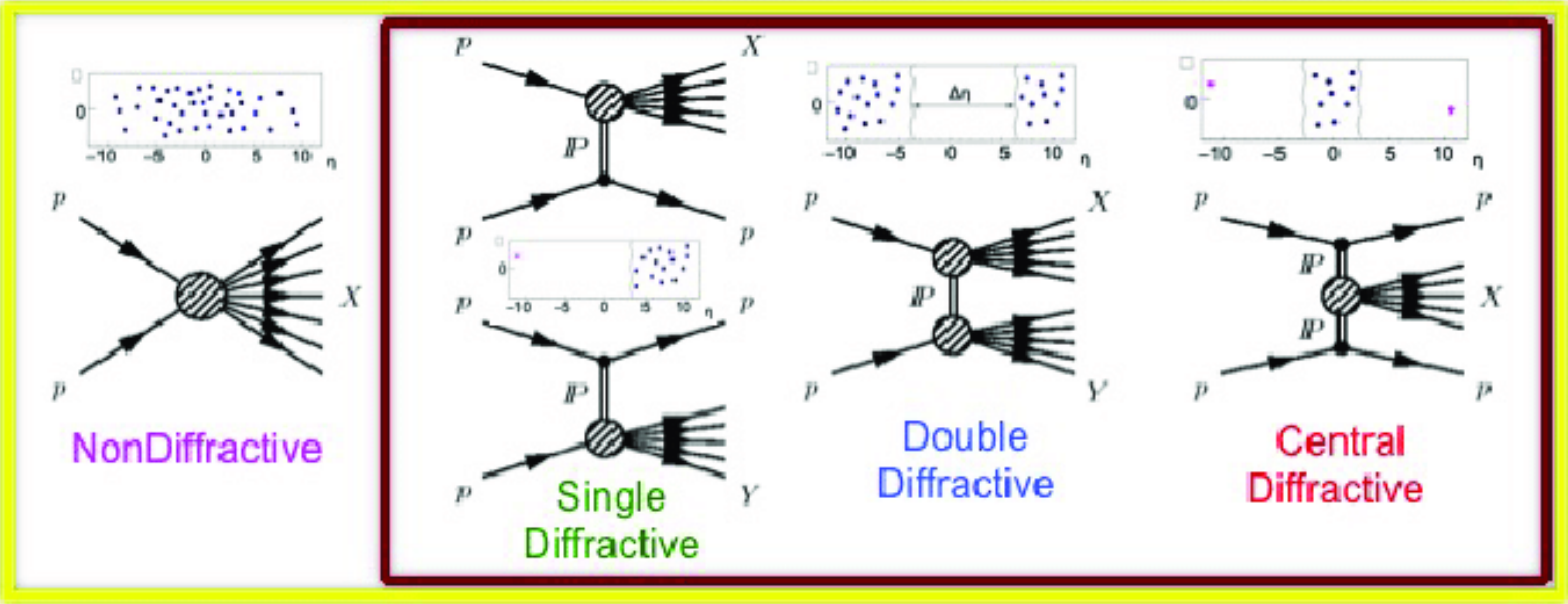
STRANGENESS UNCERTAINTY

- Monte Carlo event generators, used to produce simulations, slightly underestimate the amount of strange particles produced. Charged particle multiplicity definition used by the ALICE Collaboration excludes decay products of strange particles.
- $N^{rec}_{track}(Z,\eta)$ needs to be adjusted so that amount of secondary tracks from strange decay products is matched to data.
- Corresponding uncertainty is evaluated by varying the adjustment factor.

Anton's [Analysis Note, 2017] on pseudorapidity density measurement with O_2 in Run 3 pilot beam data

DIFFRACTIVE PROCESSES

- In pp collisions, some interactions are diffractive



[EPJ Web of Conferences 90, 06004 (2015)]