

A preliminary analysis of pilot beam data from ALICE's new ITS and MFT detectors

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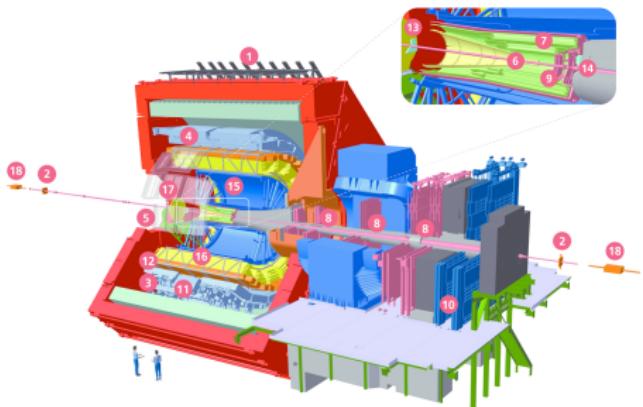
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Honour's Research Project
2022



ALICE Run 3



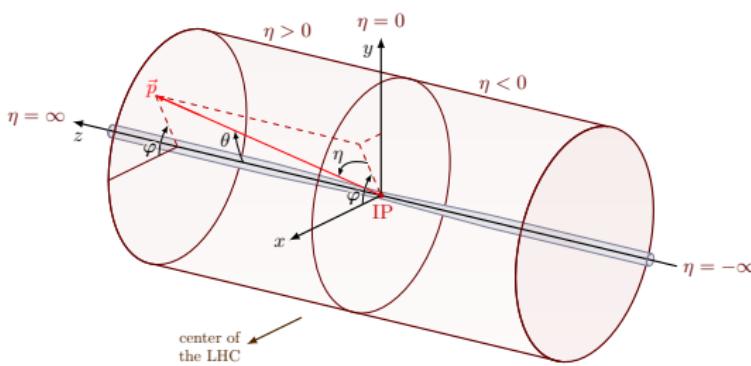
ALICE Run 3 Detector Array

- LHC Run 3 comes with increased \sqrt{s} and luminosity of collisions
- This requires a new untriggered data capture scheme, so detector readout electronics were upgraded at ALICE
- The MFT (9) was added, the ITS (6, 7) was upgraded, and the analysis framework was overhauled entirely
- Learning this framework, and how the MFT and ITS interact with it, was the main goal of this project



Coordinate System

- Z: Distance along Z-axis (cm)
- φ : Azimuthal angle around beam axis
- θ : Polar angle



- p_T : Transverse momentum (GeV/c)

$$p_T = \sqrt{p_x^2 + p_y^2}$$

- y : Rapidity

$$y = \frac{1}{2} \ln \frac{E + p_z}{E - p_z}$$

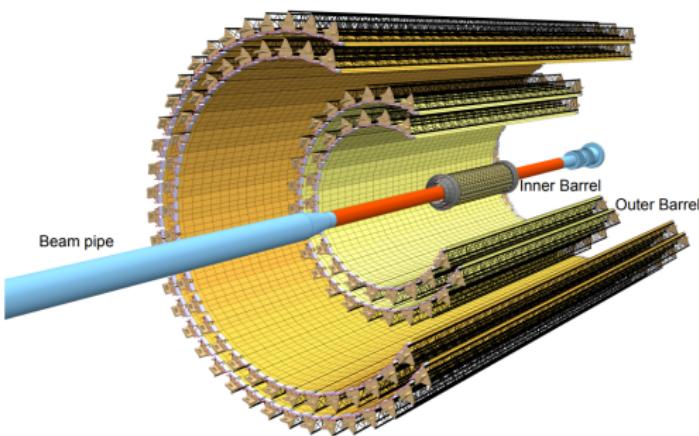
- η : Pseudorapidity

$$\eta = -\ln \tan \frac{\theta}{2}$$



Inner Tracking System (ITS)

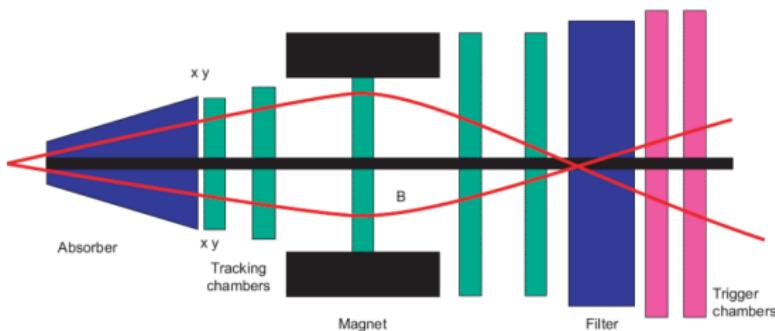
- Fully revamped for Run 3 with 7 layers of brand new pixel detectors
- Used to determine position of the primary vertex and help with particle tracking
- 22.4 mm to 391.8 mm radial extension from IP
- Covers $|\eta| < 1.22$
- Stand-alone tracking has no minimum required number of layers with hits



Muon Spectrometer (MCH)

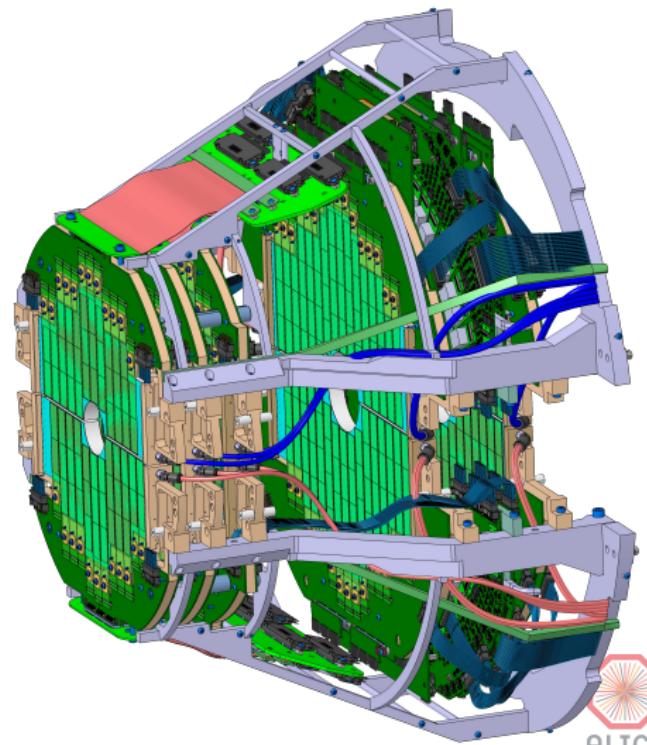
- Used to study various heavy particle decays via their single- and di-muon decay channels
- All detector material sits behind ~ 4 m of hadronic absorber

- Covers $-4 \leq \eta \leq -2.5$
- Outside the range of the ITS so previously had to perform its own tracking and vertexing
- Run 3 added the Muon Forward Tracker in front of the absorber to fill this role



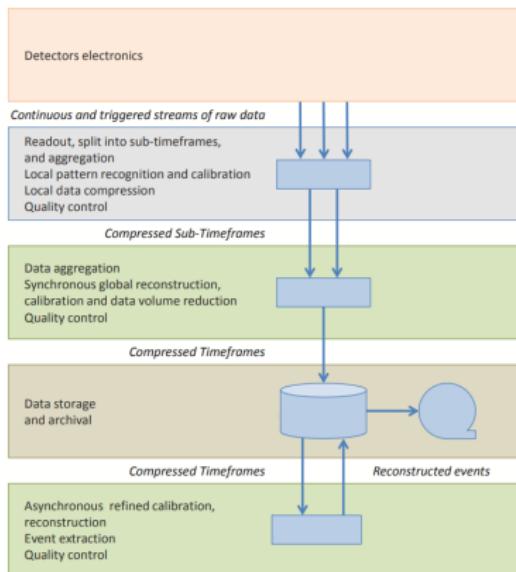
Muon Forward Tracker (MFT)

- Uses the same pixel detector technology as the ITS in a better-suited geometry
- Sits in front of the hadronic absorber, with 5 double-sided disks between -46 cm and -76.8 cm
- Each disk is 1.4 cm thick
- Covers $-3.6 \leq \eta \leq -2.45$
- Reconstructing a track requires hits in 4 of the 5 disks



Online-Offline Analysis Framework (O2)

- Created for Run 3 to deal with untriggered data capture, splitting it into 10 ms “timeframes” in online processing, then compressed timeframes (CTFs), which are saved to disk
- Raw data converted to usable data with “reconstruction passes” in the offline stage, producing Analysis Object Data (AOD) files
- Then analysed with C++ and ROOT to make the most of computational resources and to minimise disk space usage
- Don’t breathe near O₂, or it might break

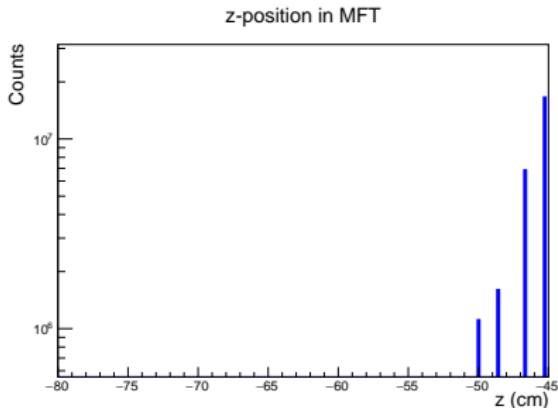
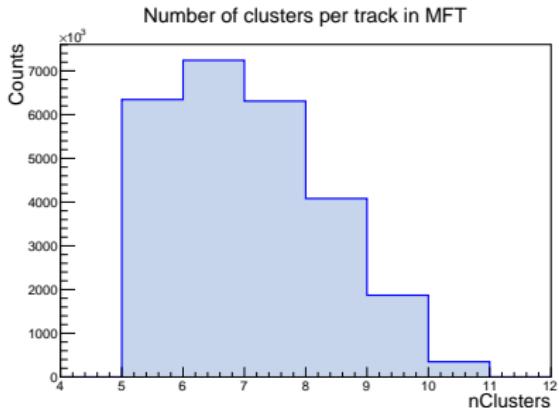
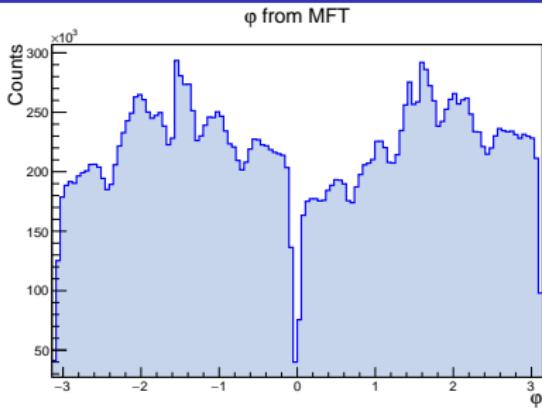
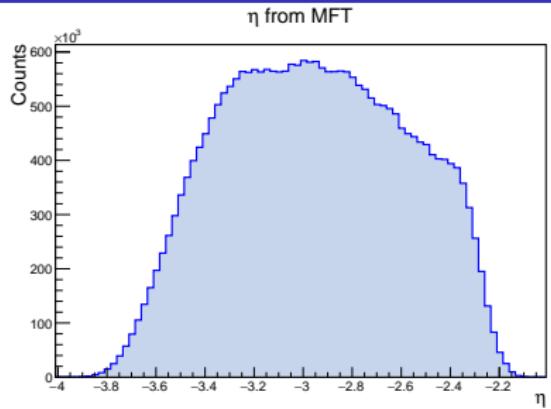


What data are we using?

- Pilot beam runs 505548 and 505645 from October 2021
- Non-nominal centre of mass energy $\sqrt{s} = 900 \text{ GeV}$
- Detectors running: ITS, MCH, MFT, MID, TOF, TPC, TRD
- All plots include data from both runs
- We used data from two different reconstruction passes

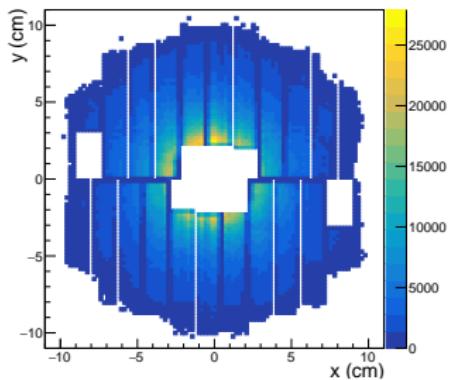


MFT Kinematics (pass 3)

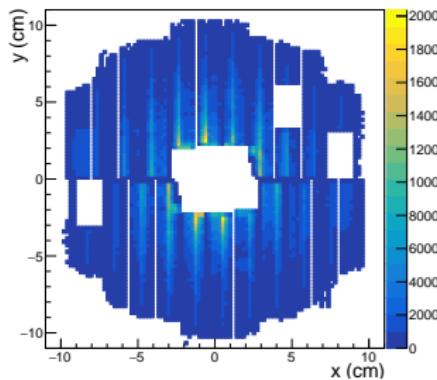


MFT x-y Plots (pass 3)

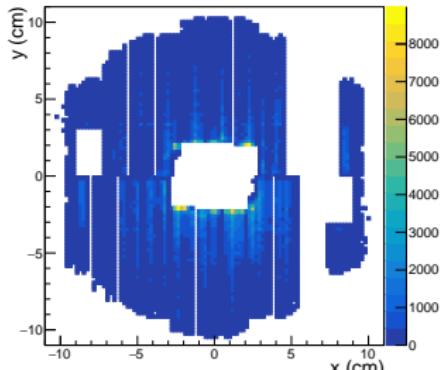
x-y at first MFT plane



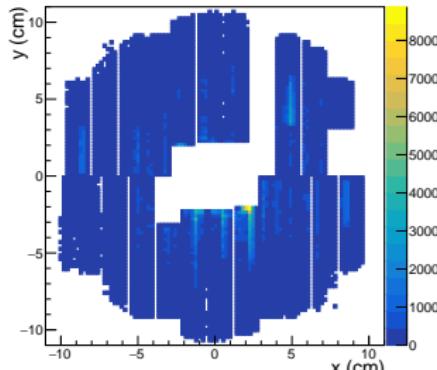
x-y at second MFT plane



x-y at third MFT plane

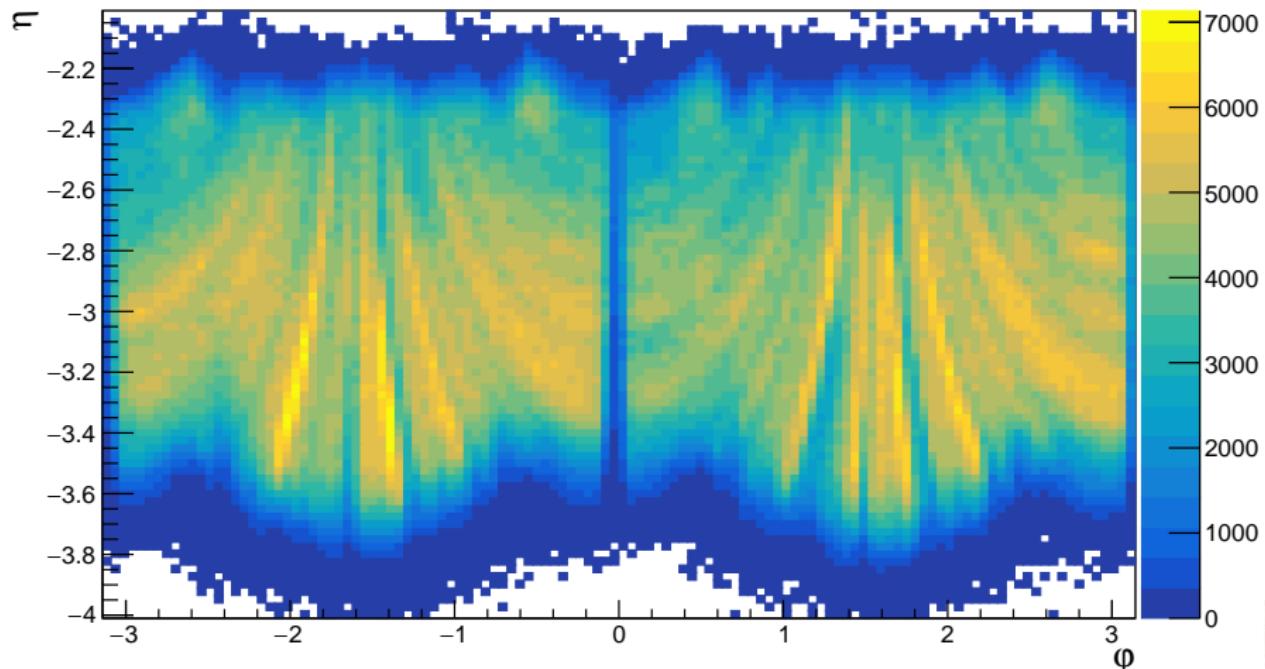


x-y at fourth MFT plane

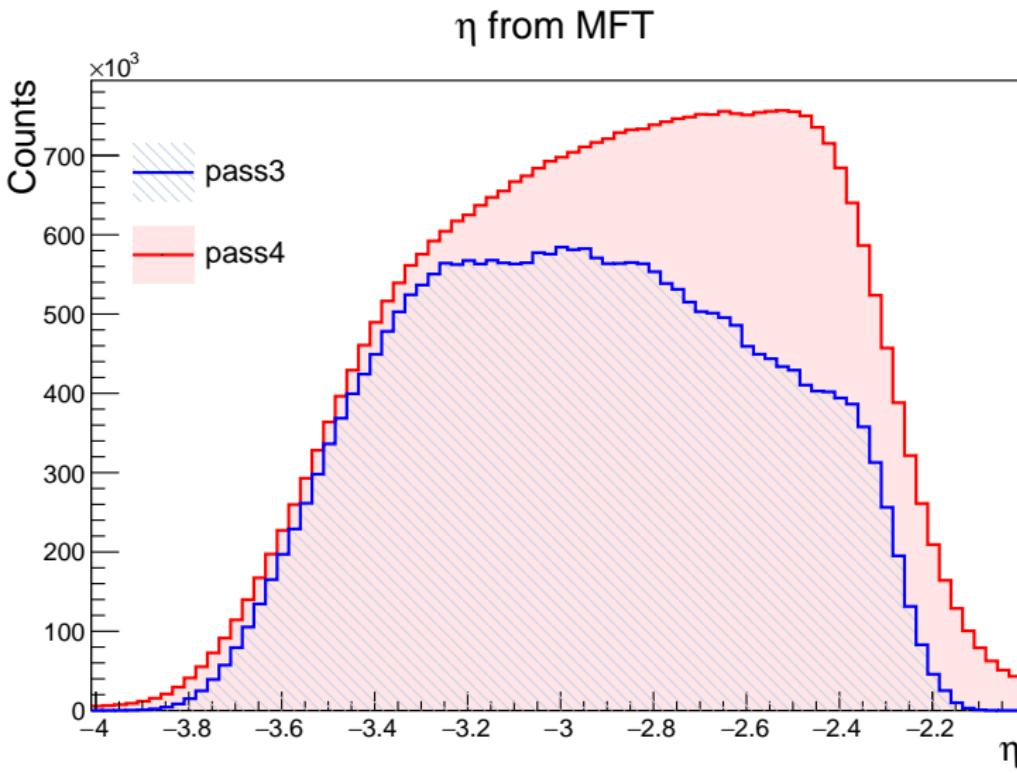


η - φ in the MFT (pass 3)

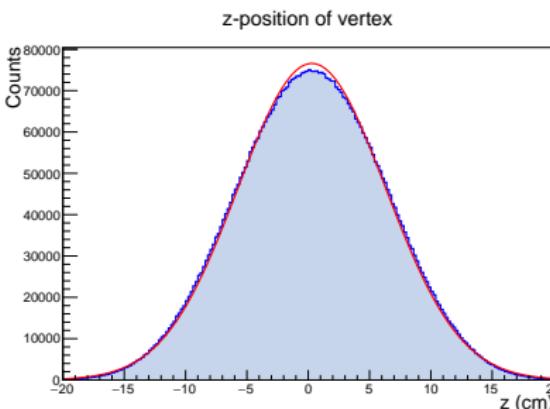
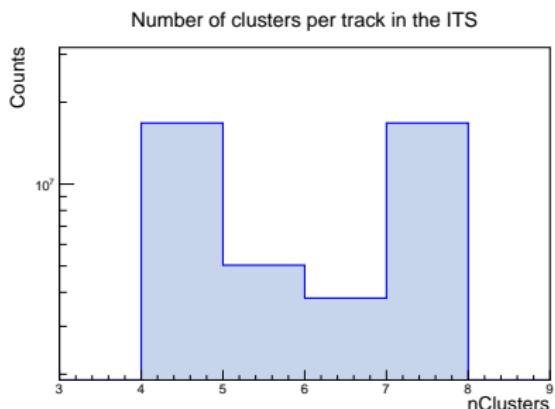
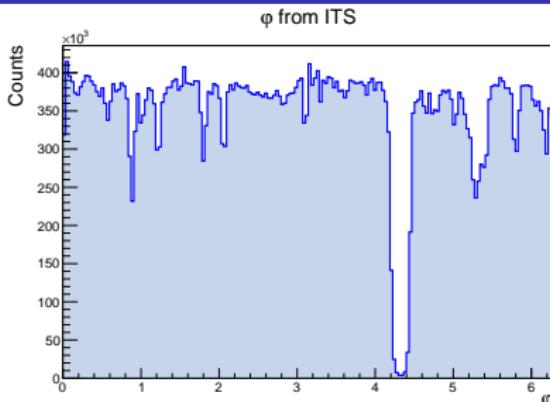
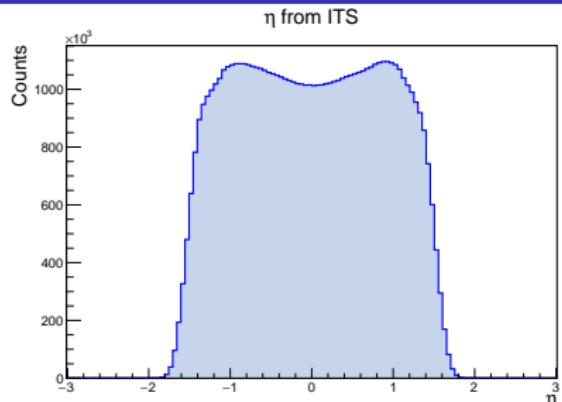
η vs φ in the MFT



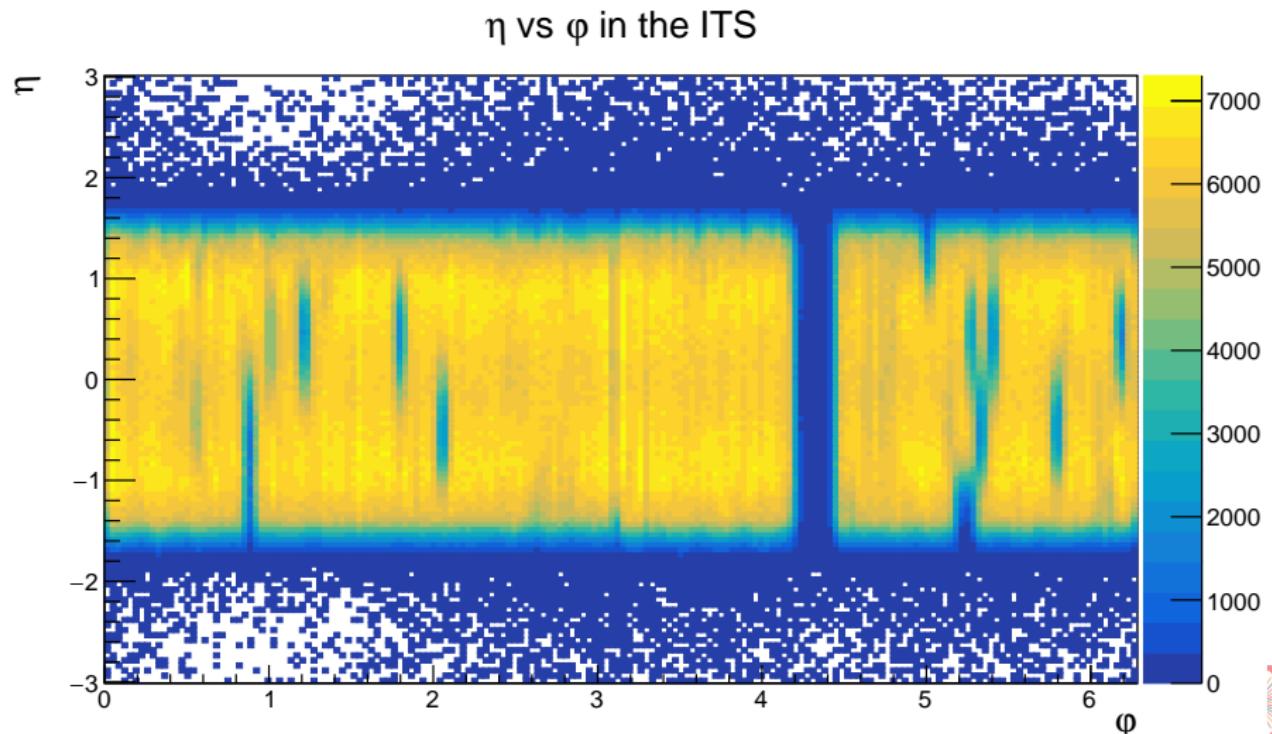
Comparison of η for pass 3 and pass 4 in the MFT



ITS Kinematics (pass 4, hasITS)



$\eta\text{-}\varphi$ in the ITS (pass 4, hasITS)



Conclusion

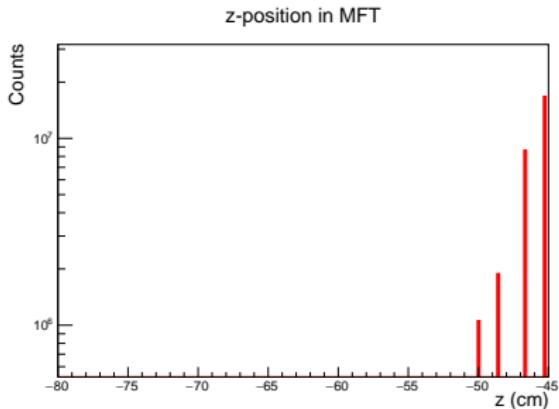
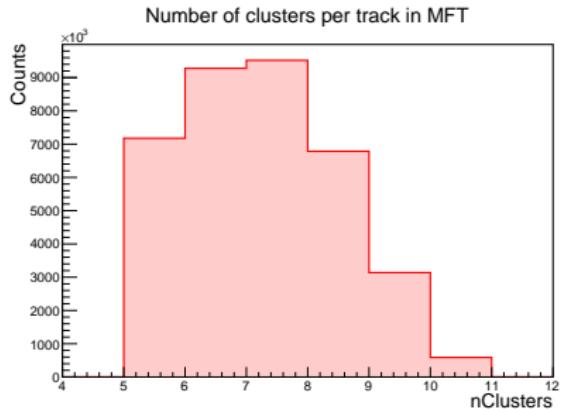
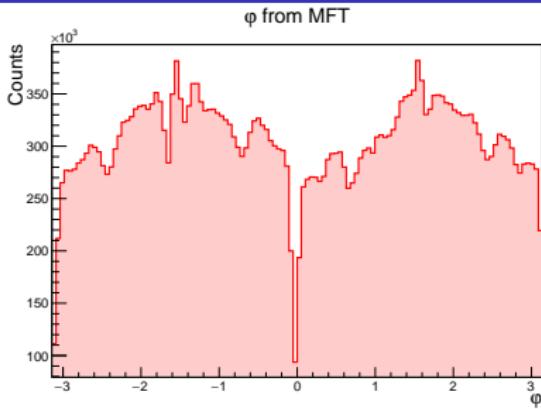
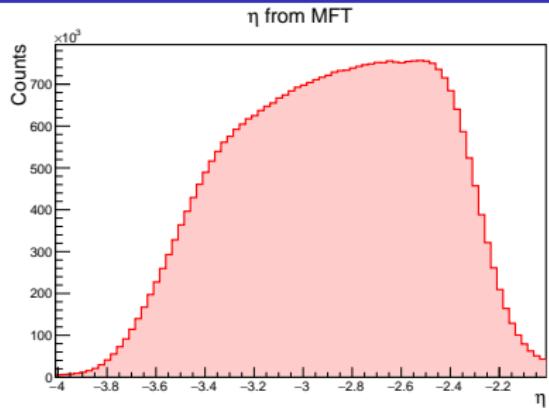
- Doing this fairly basic analysis is not what O2 was made for, so it is often hard to access the variables we want to use
- The documentation is also not made for it, so working out what these variables mean is hard, if not impossible
- If this is going to be studied more, it requires either additions to O2 or analysis at a deeper level, before the AOD's get made



Thank you!

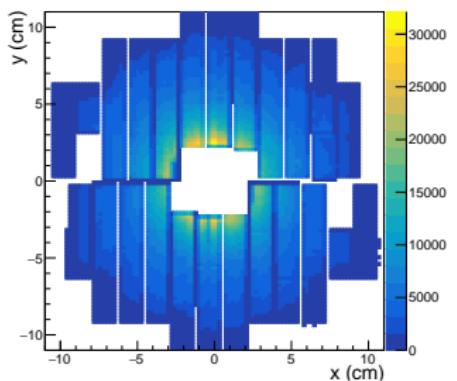


MFT Kinematics (pass 4)

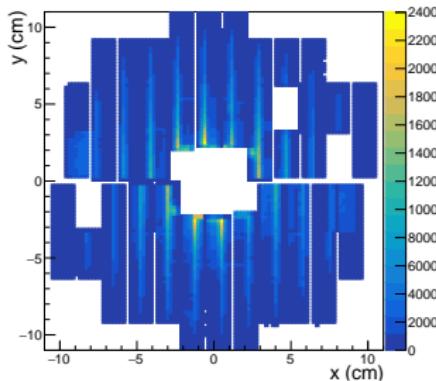


MFT x-y Plots (pass 4)

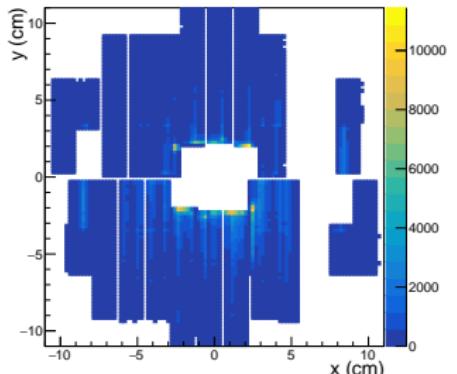
x-y at first MFT plane



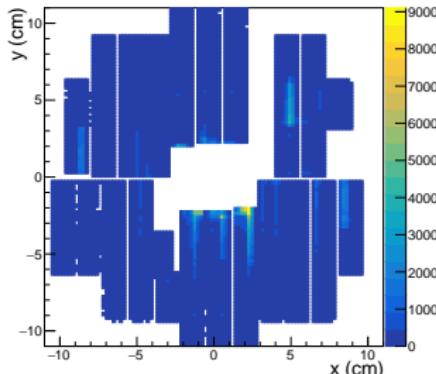
x-y at second MFT plane



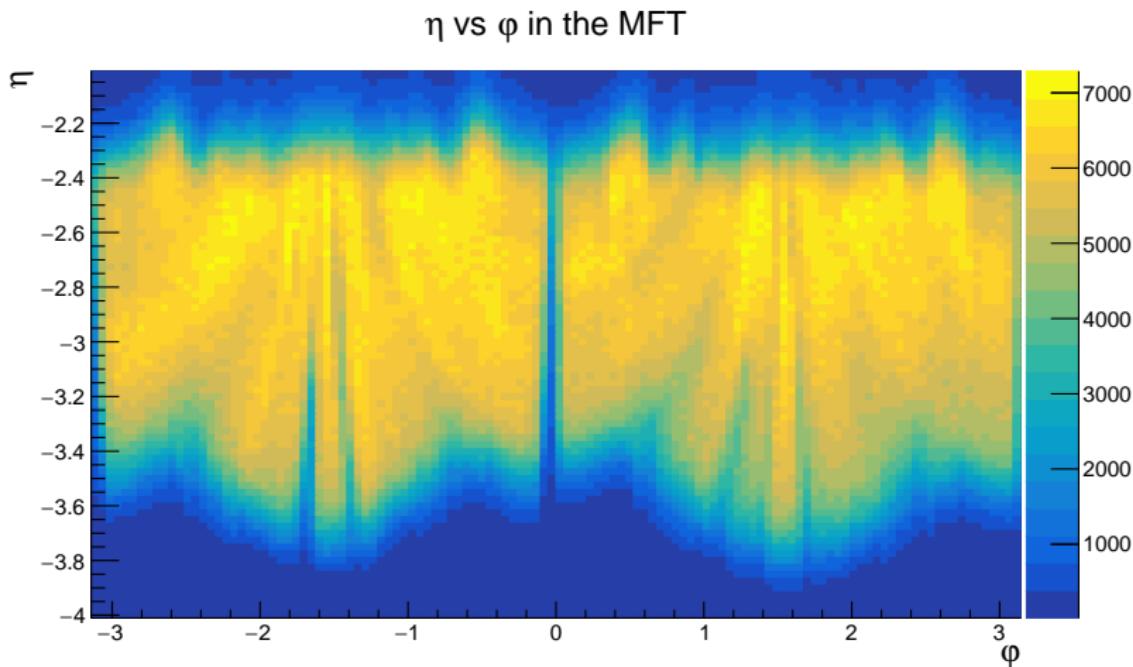
x-y at third MFT plane



x-y at fourth MFT plane



$\eta\text{-}\varphi$ in the MFT (pass 4)



ITS Kinematics (pass 4)

