

# DQ Checks of 2024 Data

## Track Variables

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# Introduction

- Verify the quality of track reconstruction in 2024 data
- Compare with 2023 data and identify any discrepancies
- Detailed objectives highlighted in the following TODO List:  
[General Physics Meeting 19 Nov]

# Data Description

- 2024 data can be found in the directories
  - `/eos/experiment/faser/phys/2024/p0011`
  - `/eos/experiment/faser/phys/2024/p0012`
- 2023 data can be found in the directory
  - `/eos/experiment/faser/phys/2023/p0010`
- The runlist (luminosities) used are from:  
`/afs/cern.ch/user/t/torrence/public/faser/runlist/`
  - `../runlist/2024/faser_runlist_2024_stable.csv`
  - `../runlist/2023/faser_runlist_2023_stable.csv`
- Some problematic runs
  - **11214** : (2023) Run with 0 Lumi
  - **16851, 16852** : Directory is empty
- No cuts have been applied, since we want to look at the DQ

# Overview of Tracking Variables

- New tracking variables have been added to the 2024 NTuples
  - Track\_hitSet
  - Track\_module\_eta0
  - Track\_module\_phi0
- There are 56 tracking variables in total (excluding the above)
- They can be broadly classified as:
  - Track Parameters (e.g.  $\chi^2$ , charge, etc.) (10)
  - Track Positions at various modules (24)
  - Track Momentum (angles) at various modules (22)

# Distribution of Track Parameters

- Number of Tracks
- Track Charge
- Track  $\chi^2$
- Track nDoF [in Backup]
- Track In Station [in Backup]
- Track nLayers [in Backup]
- Track Propagation Error

# Distribution of Number of Tracks

- Overall a higher number of tracks in 2024
- Partially can be due to much higher muon rate in 2024
- See this talk to see the difference in backgrounds  
12 April General Meeting

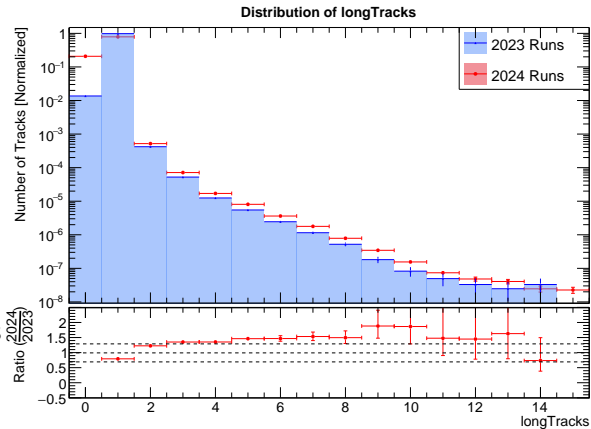


Figure: Distribution of Number of Tracks

# Distribution of Track Charge

- We have a higher percentage of anti-muons
- Consistent with earlier observation of “Much larger population of very high energy positive muons” [see Talk]

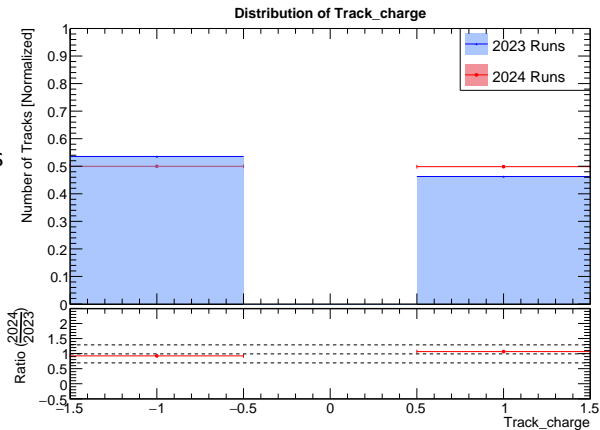


Figure: Distribution of Track Charge

# Distribution of Track $\chi^2$

- Overall we observe a lower Track  $\chi^2$  in 2024
- Do we understand why?

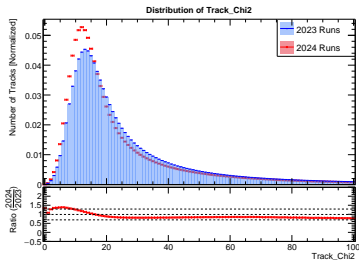


Figure: Distribution of Track  $\chi^2$

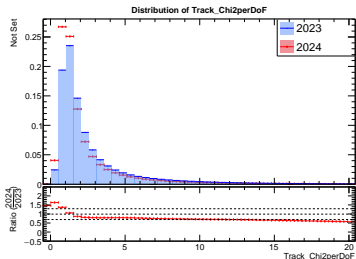
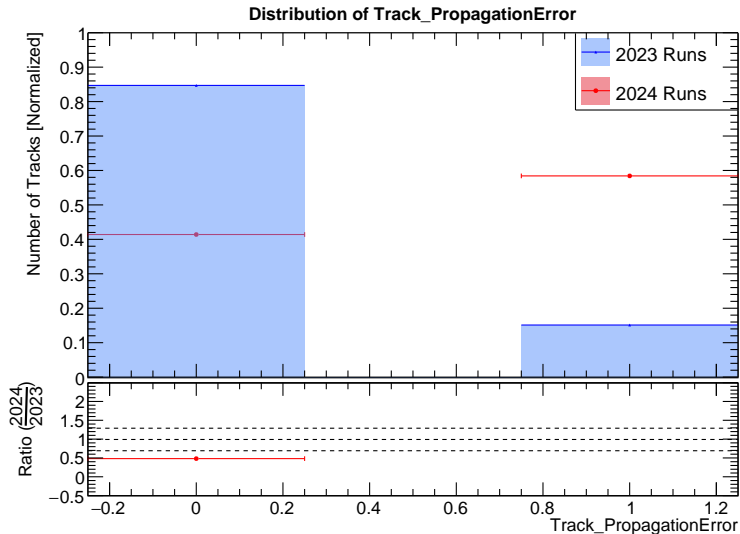


Figure: Distribution of Track  $\chi^2$  per DoF



# Track Propagation Error [SKIP]



**Figure:** Distribution of Track Propagation Error

# Track Positions (x, y)

- Vetonu
- VetoStation 1 [in Backup]
- VetoStation 2 [in Backup]
- Trigger/Timing Station [in Backup]
- Tracking Station 1
- Tracking Station 3
- Preshower 1 [in Backup]
- Preshower 2 [in Backup]
- Calo
- Max Radius

# Track Positions at Vetonu

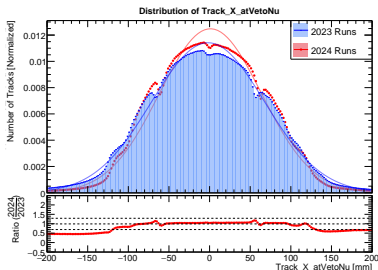


Figure: Track Position x at VetoNu

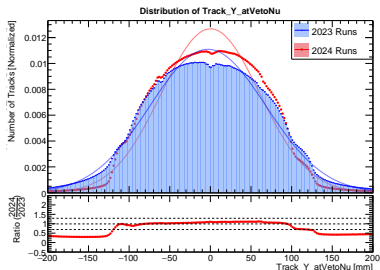


Figure: Track Position y at VetoNu

- Sharper Distribution in 2024: More particles on center? REF?
- The ypeak has shifted to the positive side. Expected with the change in beam crossing angle
- Same comments hold for the rest of the positions.

# Track Positions at Tracking Station 1

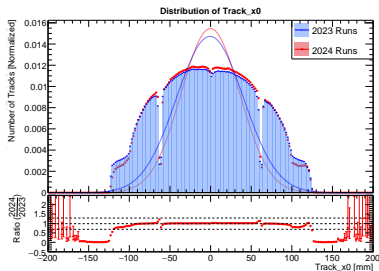


Figure: Track Position x at Tracking Station 1

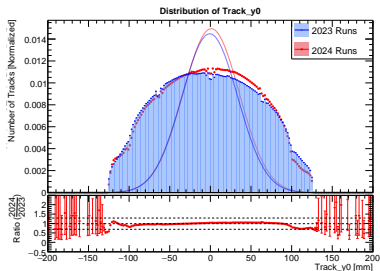


Figure: Track Position y at Tracking Station 1

Only qualitative difference from the VetoNu plots are the sharper peaks here which are from the cut off at 125 mm. And the dips in the x-distributions at around 60mm are from the geometry of the tracking stations.

# Track Positions at Tracking Station 2

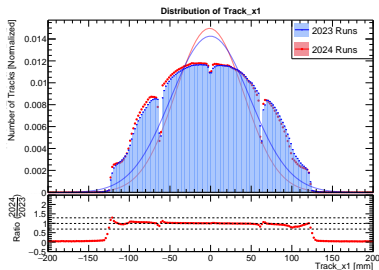


Figure: Track Position x at Tracking Station 2

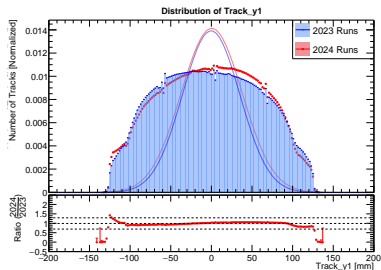


Figure: Track Position y at Tracking Station 2

# Track Positions at Calo

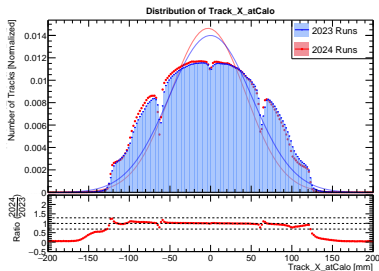


Figure: Track Position x at Calo

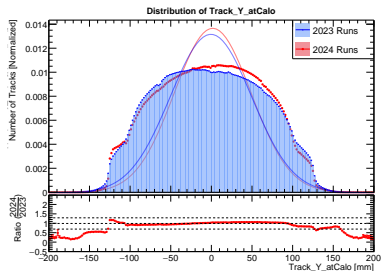
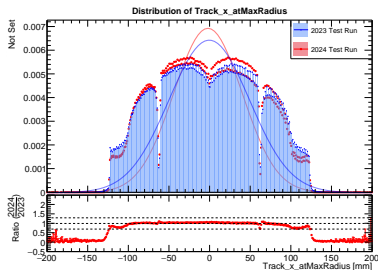
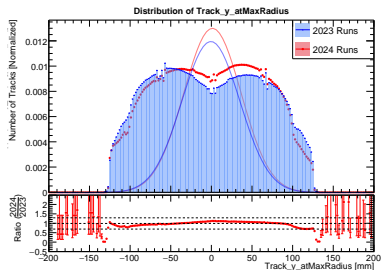


Figure: Track Position y at Calo

# Track Positions at Max Radius



Figure



Figure

# Track Momenta ( $\theta_x, \theta_y$ ) at Various Stations

- Vetonu
- VetoStation 1 [in Backup]
- VetoStation 2 [in Backup]
- Trigger/Timing Station [in Backup]
- Tracking Station 1
- Tracking Station 3
- Preshower 1 [in Backup]
- Preshower 2 [in Backup]
- Calo

Note: Technically not momentum rather angles defined as

$$\theta_x = \arctan \frac{p_x}{p_z} \text{ and } \theta_y = \arctan \frac{p_y}{p_z}$$



# Track Momenta at VetoNu

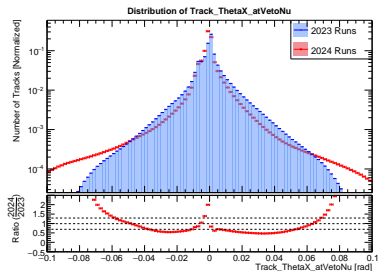


Figure: Track ThetaX at VetoNu

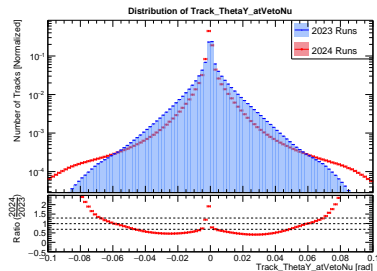


Figure: Track ThetaY at VetoNu

- Needs investigation to understand why the difference

# Track Momenta at Tracking Station 1

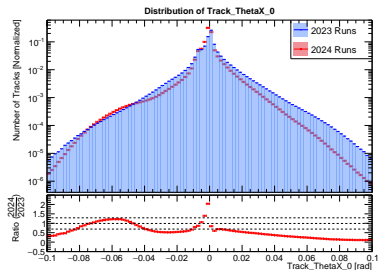


Figure: Track ThetaX at Tracking Station 1

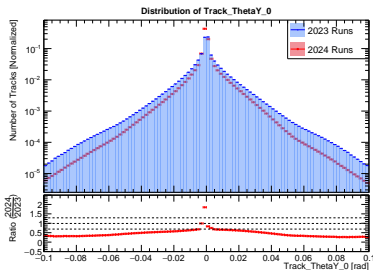


Figure: Track ThetaY at Tracking Station 1

- There is a peak in 2024 data at -0.07 rad. Do we understand why?
- Similar features observed in the Background studies. [See Page 15-16]

# Track momentum at Tracking Station 3

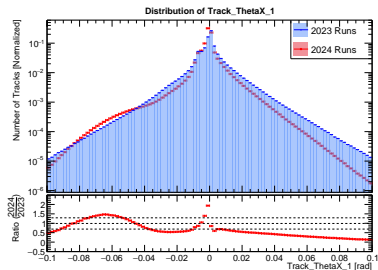


Figure: Track ThetaX at Tracking Station 3

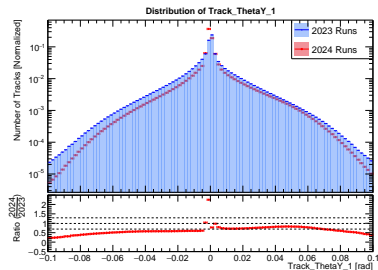


Figure: Track ThetaX at Tracking Station 3

# Track Momenta at Calo

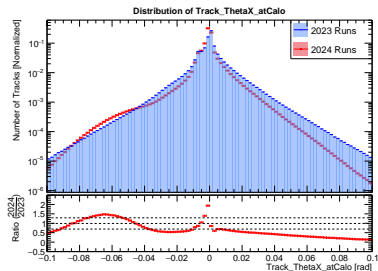


Figure: Track ThetaX at Calo

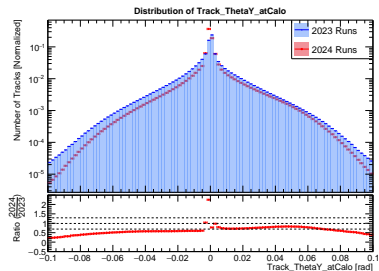


Figure: Track ThetaY at Calo

# Track Momenta at Tracking Station 1

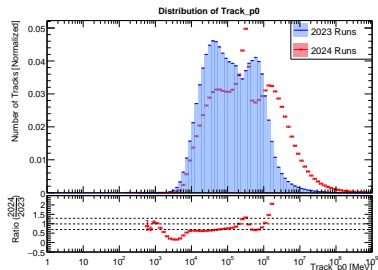


Figure: Track momentum (total) at Tracking Station 1

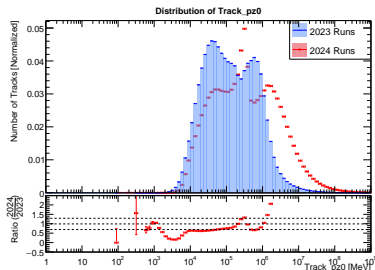


Figure: Track momentum (pz) at Tracking Station 1

- We have more high momenta positively charged muons in 2024.
- Background studies again showed similar features.
- See Page 15-16 of earlier talk

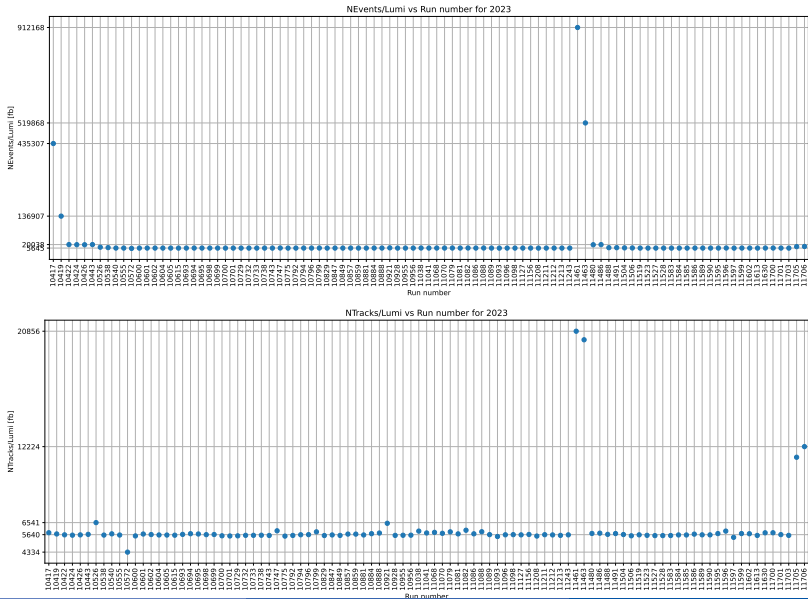
# 2024 Runs Splits

- Due to the higher backgrounds FaserNu had to be replaced every 10 ifb.
- The replacement schedule was as follows

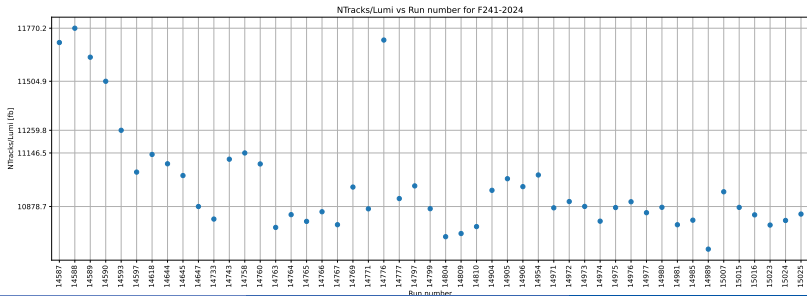
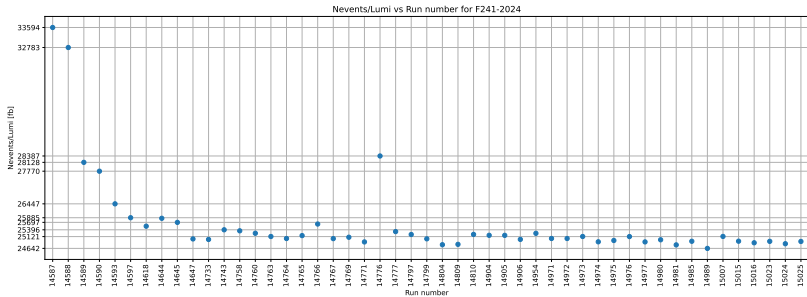
<b>Box</b>	<b>Installed</b>	<b>Removed</b>	<b>Lumi (ifb)</b>
F241	20/3	6/5	11.6
Tungsten only	6/5	12/6	18.5
F242	12/6	8/7	9.9
CaloNu	10/7	4/10	69.8
F243	4/10	22/10	11.9

**Table:** Replacement Schedule [Source: FASER General Meeting 8.11.24]

# Runwise Plots of 2023

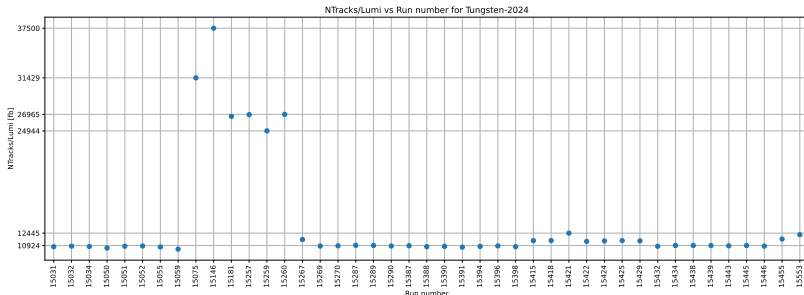
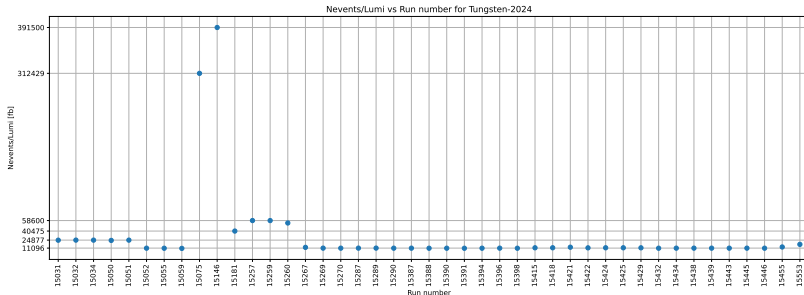


# Runwise Plots of F241- 2024

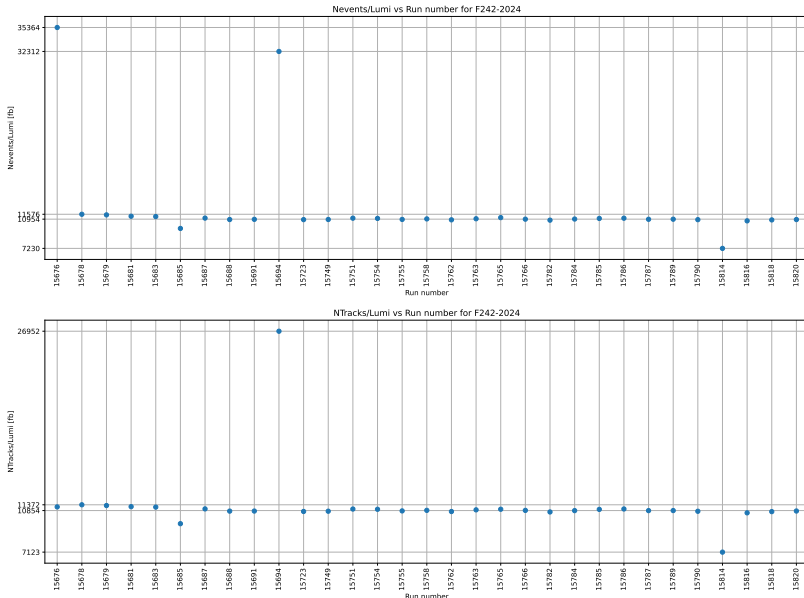




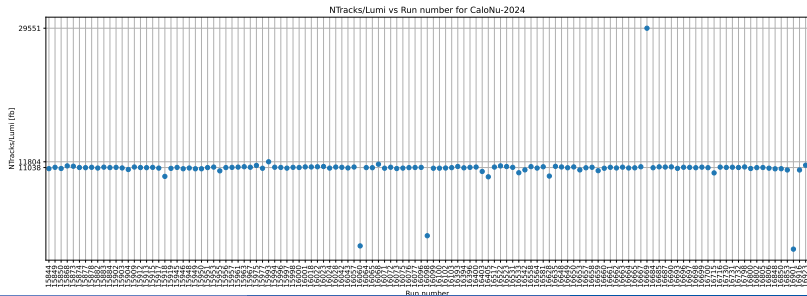
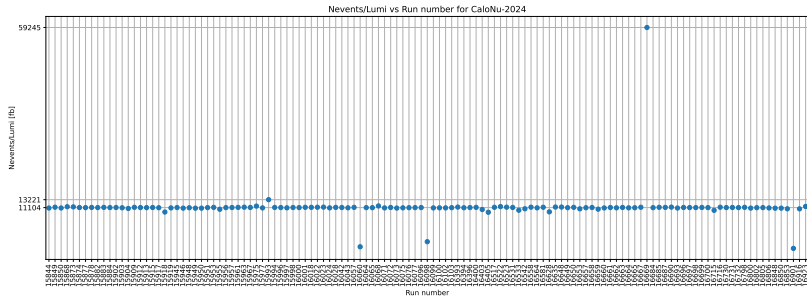
# Runwise Plots of Tungsten only- 2024



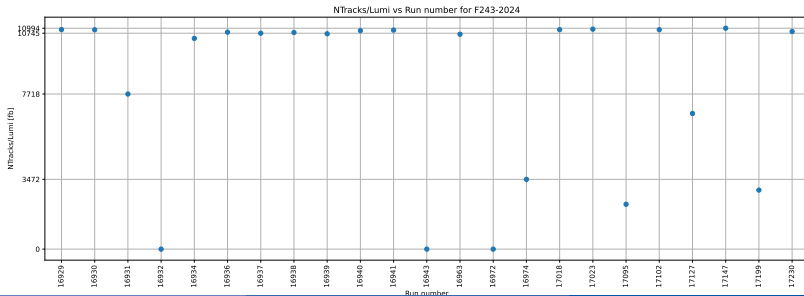
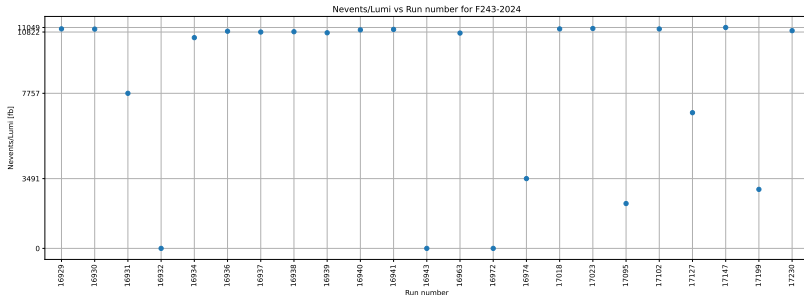
# Runwise Plots of F242- 2024



# Runwise Plots of CaloNu - 2024



# Runwise Plots of F243- 2024



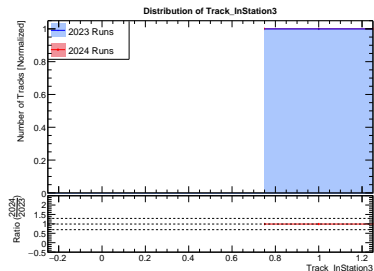
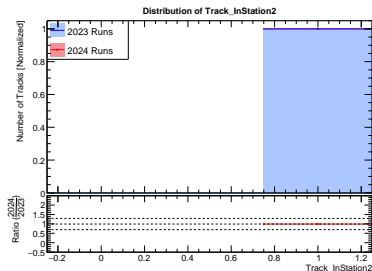
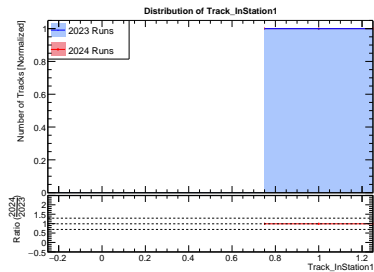
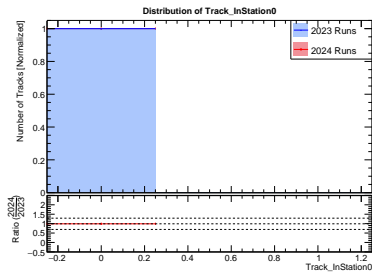
# Forward Direction

- Understand the DQ of other variables
- Investigate and understand the changes in Track Momenta
- Investigate

- Similar plots can be made using the `compareproductions_faser` tool.
- Link to Repo containing the code for plots in this presentation.
- Link to variants of the plots more more filtered like charge separated, good tracks only etc. [Will be Added]
- Detailed Runwise plots were presented by Oscar. [See previous DQ Talk]

# Backup

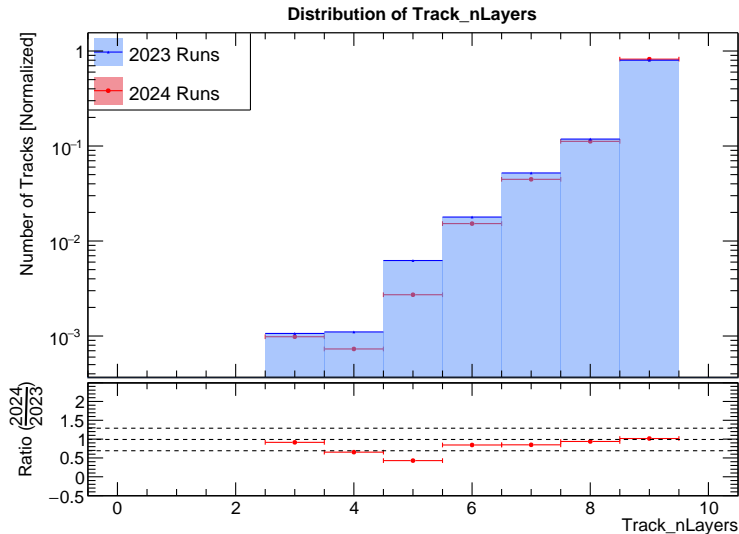
# Distribution of Track in Station [SKIP]



There are always 0 tracks in Station0. Possibly an issue in NTupleDumper. Haven't located this yet.



# Track\_nLayers [SKIP]



**Figure:** Distribution of Track\_nLayers

# Track Positions at Veto Station 1 [SKIP]

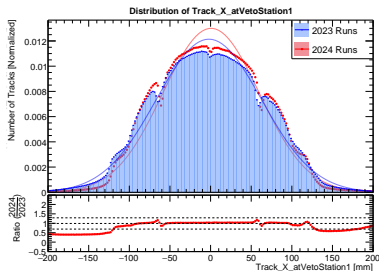


Figure: Track Position x at Veto Station 1

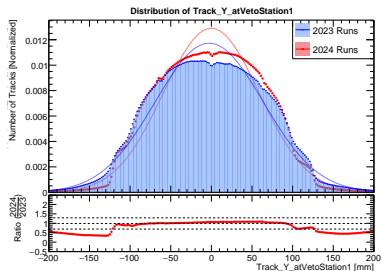


Figure: Track Position y at Veto Station 1

# Track Positions at Veto Station 2 [SKIP]

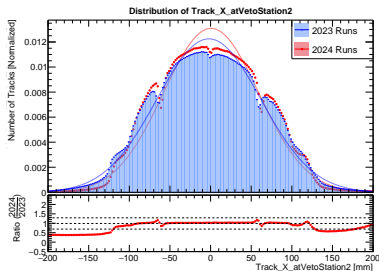


Figure: Track Position x at Veto Station 2

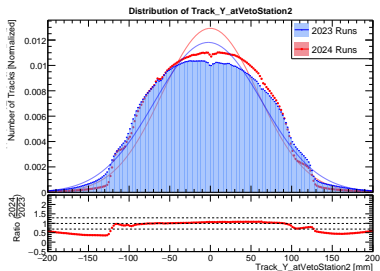


Figure: Track Position y at Veto Station 2

# Track Positions at Trigger [SKIP]

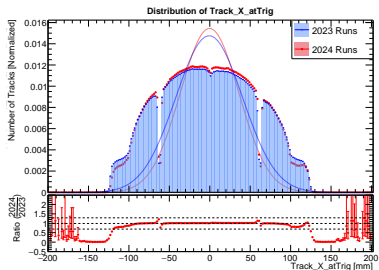


Figure: Track Position x at Trigger/Timing Station

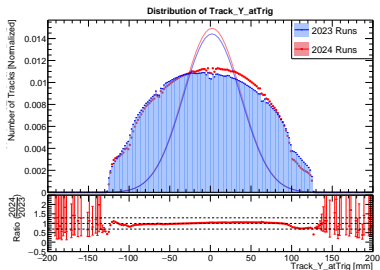


Figure: Track Position y at Trigger/Timing Station

# Track Positions at Preshower 1 [SKIP]

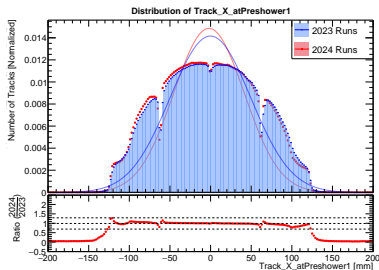


Figure: Track Position x at Preshower 1

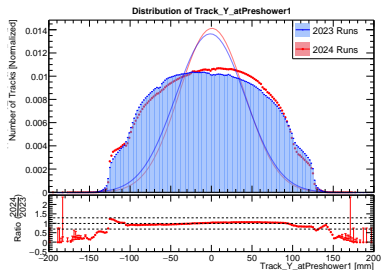


Figure: Track Position y at Preshower 1

# Track Positions at Preshower 2 [SKIP]

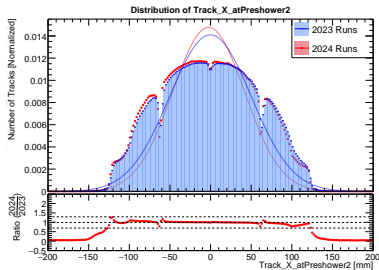


Figure: Track Position x at Preshower 2

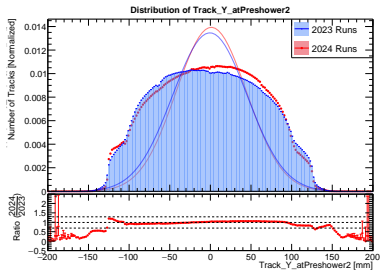


Figure: Track Position y at Preshower 2

# Track Momenta at VetoStation 1 [SKIP]

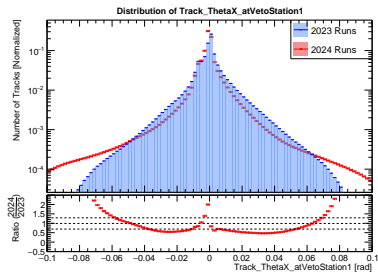


Figure: Track ThetaX at atVetoStation 1

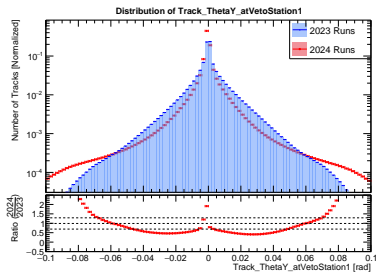


Figure: Track ThetaY at VetoStation 1

# Track Momenta at VetoStation 2 [SKIP]

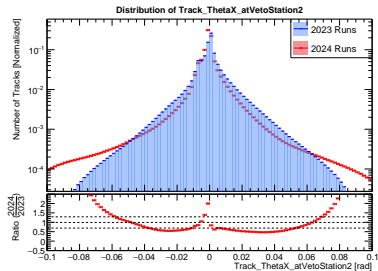


Figure: Track ThetaX at VetoStation 2

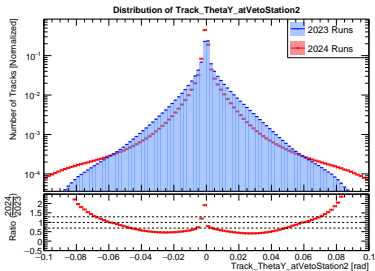


Figure: Track ThetaY at VetoStation 1



# Track Momenta at Trigger [SKIP]

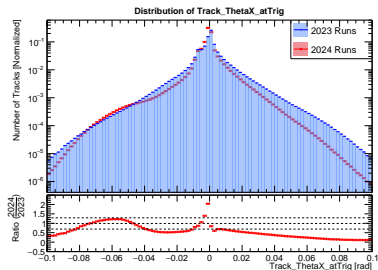


Figure: Track ThetaX at Trigger

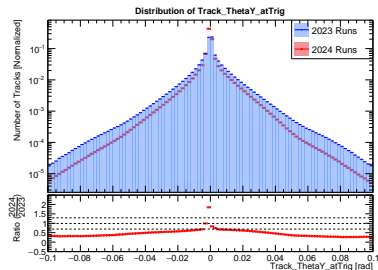


Figure: Track ThetaY at Trigger

# Track Momenta at Preshower 1 [SKIP]

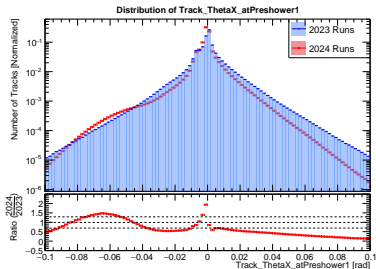


Figure: Track ThetaX at Preshower 1

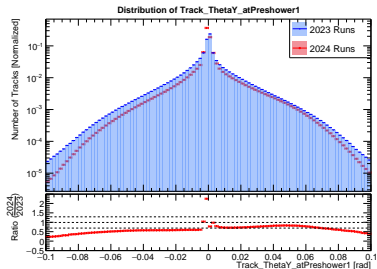


Figure: Track ThetaY at Preshower 1

# Track Momenta at Preshower 2 [SKIP]

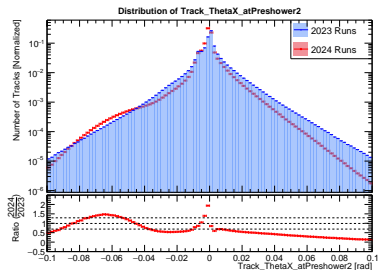


Figure: Track ThetaX at Preshower 2

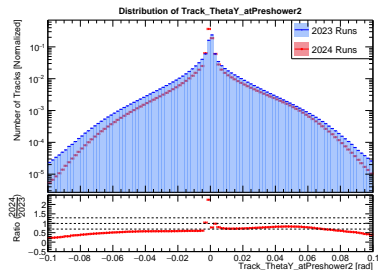


Figure: Track ThetaY at Preshower 2