Work Summary

Liverpool FASER Meeting

February 7, 2025

Pawan Johnson

My work thus far ...

- 2024 DQ Checks for Tracking Variables
  - Presented at Physics General Meeting on 17 December
  - Link to Slides
- Followup to the 2024 DQ Checks
  - Almost finished up with the underlying work
  - Writing up the slides
  - Hoping to send out early next week
- Working on ALMA9 Efficiency Checks for DP
  - Almost finished up
  - Hoping to send around/present before Monday

2024 DQ Checks

- Look at all of 2024 Data and compare it to 2023
- Focus was on the Track Variables
- Expected good agreements?
- But agreements weren't straightforward
  - Variables like Positions were fine.
  - Momenta were not
  - Most variables were quite different
  - Attributed to the changed background and changed optics
  - Made one to one correspondence with 2023 data difficult

2024 DQ Checks – Some Plots

- We knew the beam crossing angle changed
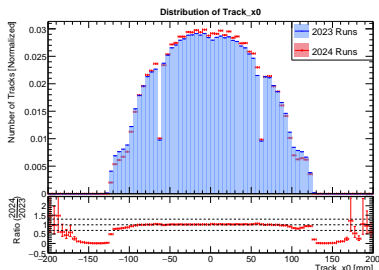- From -160 μrad in 2023 to +160 μrad in 2024
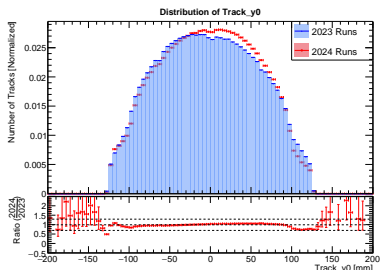

Figure: Track x0

Figure: Track y0

- We observed the corresponding shift in the the track positions

2024 DQ Checks – Some Plots

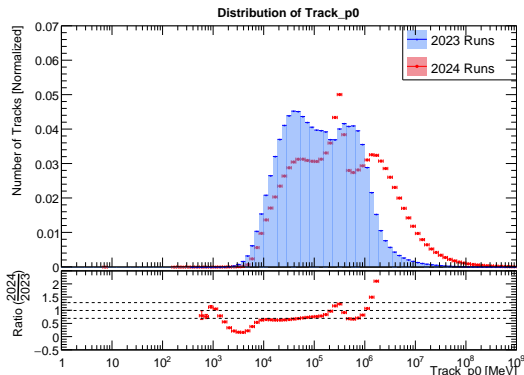- That had huge implications on the observed background

Figure: Track p0

- Lot more high-momenta-positively charged muons in 2024
- This had non-trivial effects on the other track parameters

Follow Up on 2024 DQ Checks

- Do a momentum binning to see if we can have a more equitable correspondence between 2023 and 2024
- Some new variables were introduced in the 2024 data
  - module_eta0, module_phi0
  - which describes the first tracking module hit by the track
- Start looking at the track parameters as a function of the starting module of the track
- Also needed updates to the 2024 runlist [Preliminary]
- Updates to the Yield Plots
- Comparative analysis between four run periods in 2024
- Should be sent out early next week

2024 DQ Followup – Some Plots
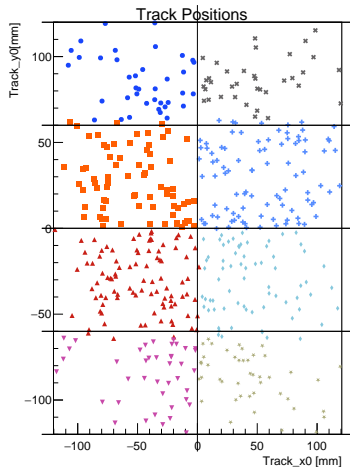
Figure: Track Points across Module

Figure: Module Numbering

- Four central modules : 2,7,3,6
- Four outer modules : 1,8,4,7

2024 DQ Followup – Some Plots

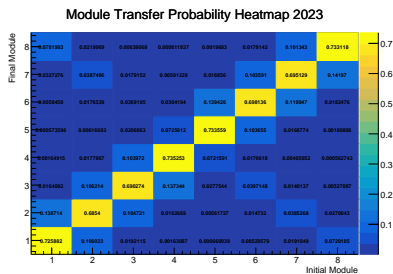- Wanted to see where the end module of the track

Figure: Probability of Transfer to a final module given a starting module [2023 data]
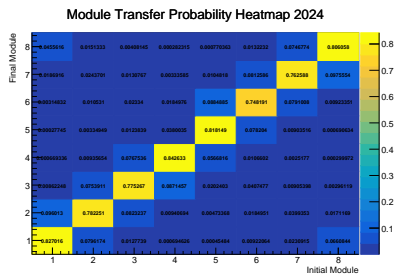

Figure: Probability of Transfer to a final module given a starting module [2024 data]

- We mostly transfer to the same final module
  - Some transfers to the module top/below
  - Some transfers to module on left/right (diagonal line)

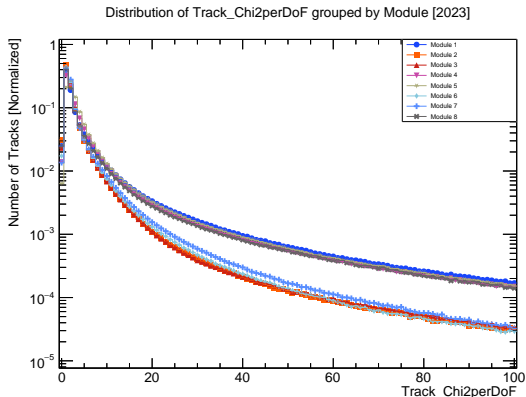# 2024 DQ Followup – Some Plots

Distribution of Track_Chi2perDoF grouped by Module [2023]

Figure: Track Points across Module

- Some of the parameters factor out nicely with the central/outer module definition

Track Reconstruction Efficiency for ALMA9

- Objective was to validate the track reconstruction for Dark Photon samples in ALMA9.
- Dark Photon samples have closely separated tracking making reconstruction difficult.
- Idea was to see if ALMA9 "performs" better than CENTOS7
- Sined already worked out the studies on single muon
- Ansh started out looking at the Analysis Cutflows
- Hoping to present on Monday in the Offline Software Meeting

DarkPhoton Tracking CutFlow

Selection	ALMA9				CENTOS7				ΔEff.
	Pass	All	Eff.	Cum. Eff.	Pass	All	Eff.	Cum. Eff.	
≥ 1 LongTracks	56989	60000	94.98	94.98	56002	60000	93.34	93.34	1.64
≥ 2 LongTracks	46416	56989	81.45	77.36	45210	56002	80.73	75.35	0.72
$=2$ LongTracks	37807	46416	81.45	63.01	36746	45210	81.28	61.24	0.17
Opposite Charge	32427	37807	85.77	54.04	30375	36746	82.66	50.62	**3.11**
MaxRadius < 100	31489	32427	97.11	52.48	29520	30375	97.19	49.20	-0.08
goodTrack Cuts									
≥ 7 Layers	31435	31489	99.83	52.39	29472	29520	99.84	49.12	-0.01
$\chi^2/$**DoF** < 25	31121	31435	99.00	51.87	27710	29472	94.02	46.18	**4.98**
≥ 7 DoF	31115	31121	99.98	51.86	27706	27710	99.99	46.18	-0.01

Table: Comparison of efficiency and cumulative efficiency for ALMA9 and CENTOS7.
Note: The Cutflow is at an Event Level (not track level), thus the conditions have to met by all tracks in the event.

- Highest improvment in goodTrack Cut of $\chi^2/$DoF < 25
- Better ChargeID in ALMA9?

Track Efficiency for ALMA9 – Some Plots
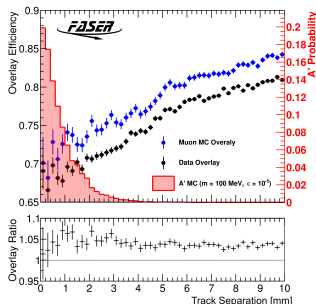
- Had an existing overlay study on Track Reconstruction

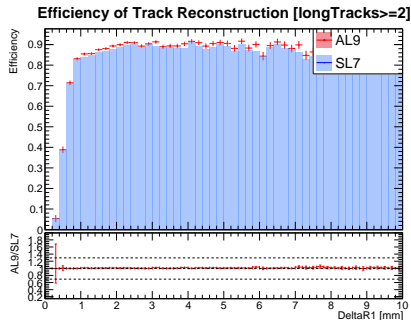**Figure:** Overlay plot from Dark Photon Analysis

Figure: Track Efficiency (≥ 2) as a function of distance between the tracks at the final station

- Discrepancy with overlay studies
- But atleast good agreement between ALMA9 and CENTOS7

Work to start on

- Start on FASER Monte Carlo Production
  - Read up on Twiki [Link]
  - Possibly get involved with John?
- Extended Dark Photon Search
  - Develop selection for $\mu^+\mu^-$
  - Develop selection for $\pi^+\pi^-$
  - Waiting on the samples from Eric
  - Can be done as an exercise for earlier work.

Thank you!