

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 present on Monday

- 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 $-160 \mu\text{rad}$ in 2023 to $+160 \mu\text{rad}$ in 2024

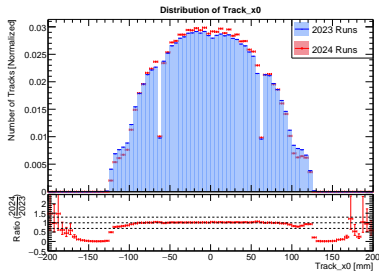


Figure: Track x0

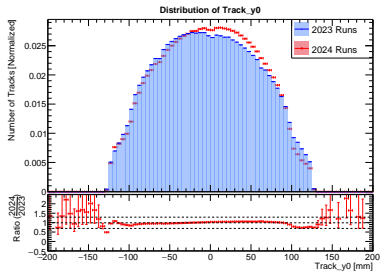


Figure: Track y0

- We observed the corresponding shift in the the track positions

2024 DQ Checks – Some Plots

- That had huge implications on the observed background

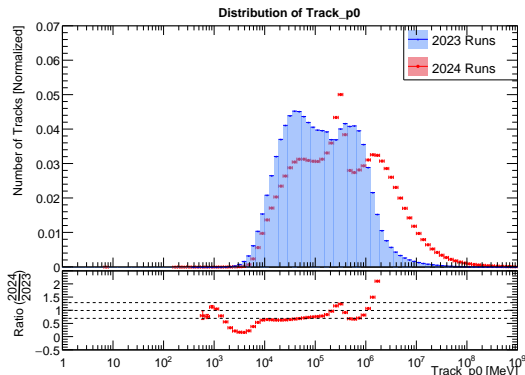


Figure: Track p0

- A 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 run-list [Preliminary]
- Updates to the Yield Plots
- Comparative analysis between four run periods in 2024
- Should be sent out early next week for feedback

2024 DQ Followup – Some Plots

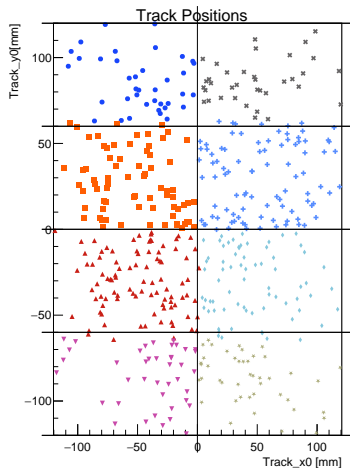


Figure: Track Points across Module

Module 1	Module 8
Module 2	Module 7
Module 3	Module 6
Module 4	Module 5

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 in which module the track ends up in the 3rd station

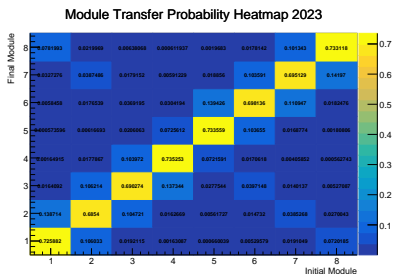


Figure: Probability of Transfer to a final module given a starting module [2023 data]

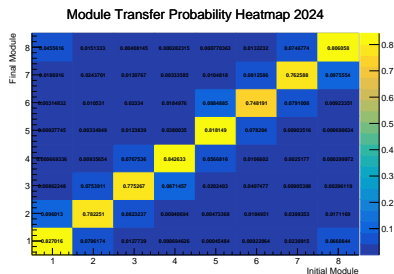


Figure: Probability of Transfer to a final module given a starting module [2024 data]

- 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

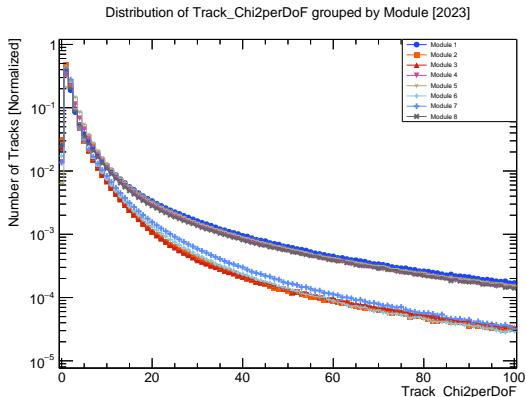


Figure: Track Points across Module

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

Track Reconstruction Efficiency for ALMA9

- The ALMA9 release came with updates to the track reconstruction
- Objective is to validate the track reconstruction for Dark Photon samples in ALMA9.
- Dark Photon samples have closely separated tracks making reconstruction difficult.
- Idea is to see if ALMA9 “performs” better than CENTOS7
- Sinead already worked out the studies on single muon
- Ansh started to look at the Analysis Cutflows
- Hoping to present on Monday in the Offline Software Meeting

DarkPhoton Tracking CutFlow

Selection	ALMA9				CENTOS7				$\Delta\text{Eff.}$
	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
$\chi^2/\text{DoF} < 25$	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 improvement in goodTrack Cut of $\chi^2/\text{DoF} < 25$
- Better ChargeID in ALMA9?

Track Efficiency for ALMA9 – Some Plots

- Had an existing overlay study on Track Reconstruction

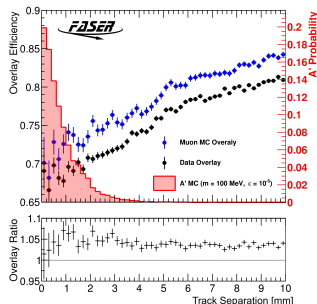


Figure: Overlay plot from Dark Photon Analysis

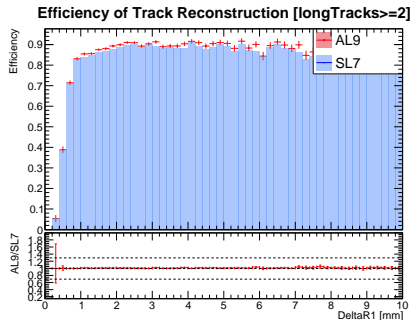


Figure: Track Efficiency (≥ 2) as a function of distance between the tracks at the final station

- Discrepancy with overlay studies
- But at least 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 for samples from Eric

Thank you!