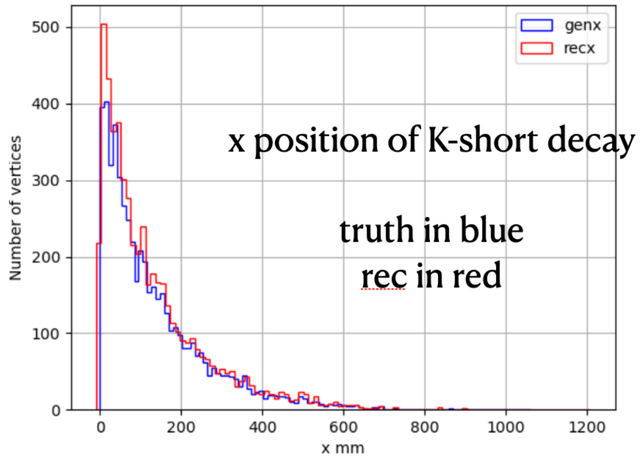
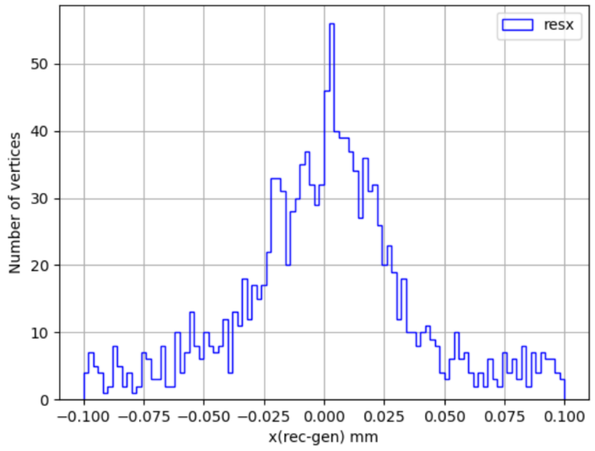
Vtx, Trk, PID

C.Zhang/13Dec2024

Review of remaining issue and updated settings

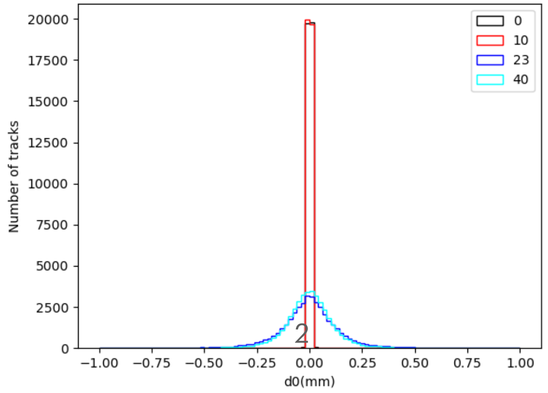
- Precision of secondary vertex is one oder of magnitude worse than primary one





- Precision vs. position
  - x=10 to x=23, the precision decreases a log
  - the chosen particle gun positions for VXD are wrong. Updated as the right table

Layer	R(mm)	muon pair x position
		0, 10
VXD-L1	12.5~18	
		23
VXD-L2	28~35	
		40
VXD-L3	45~53	
		150
ITK-L1	240	

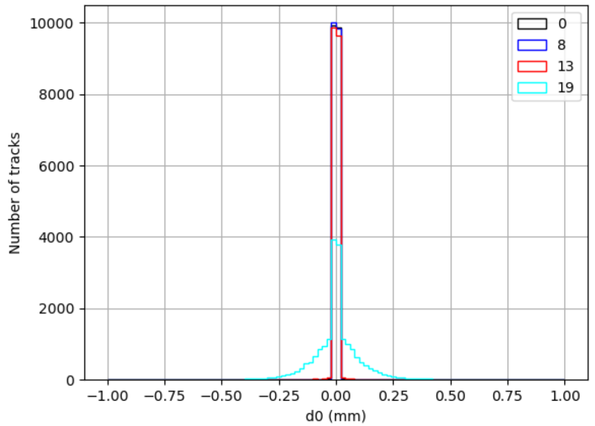


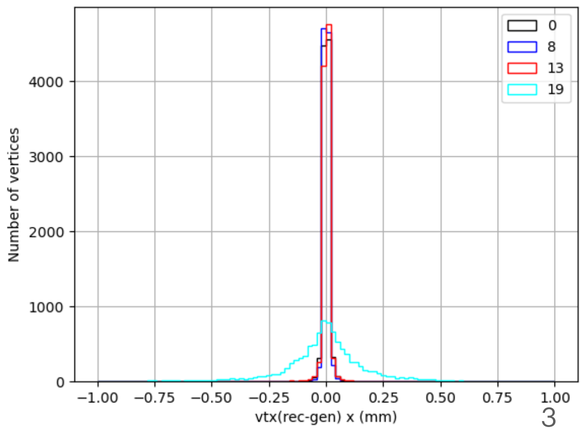
Layer	R(mm)	x position
		0, 8
VXD-L1	11	
		13
VXD-L2	16	
		19
VXD-L3	22	
		25
VXD-L4	27	
		35
VXD-L5	45-50	
		200
ITK-L1	240	
		310
ITK-L2	350	
		530
ITK-L3	570	
TPC	600-1800	
		700
OTK	~1800	

Secondary vertex precision vs. position

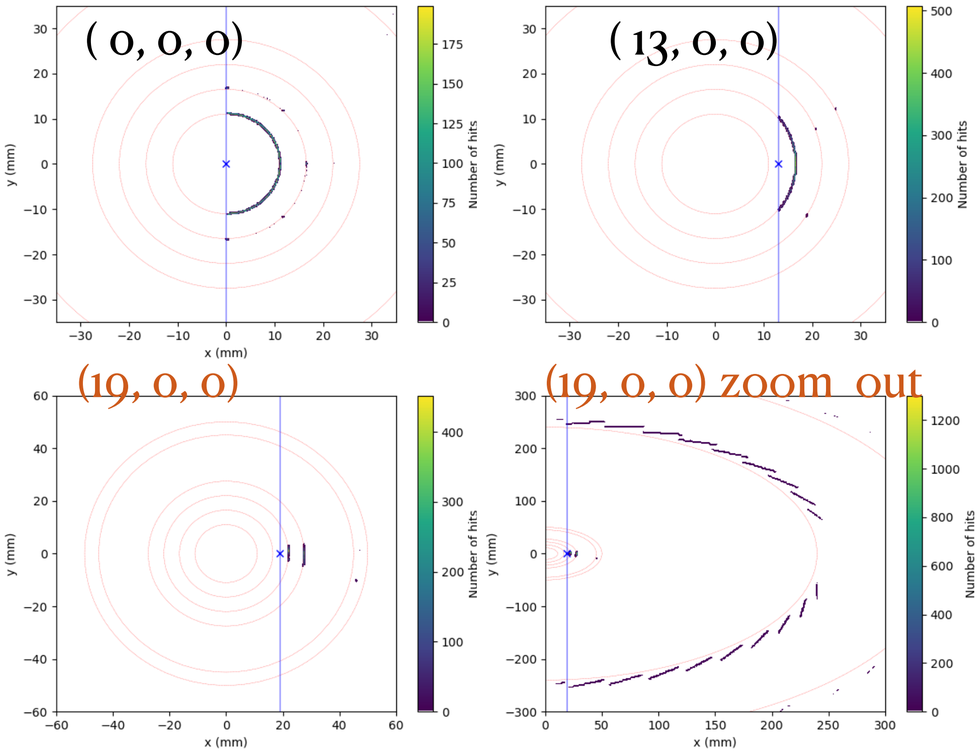
Layer	R(mm)	x position
		0, 8
VXD-L1	11	
		13
VXD-L2	16	
		19
VXD-L3	22	
		25
VXD-L4	27	
		35
VXD-L5	45-50	
		200
ITK-L1	240	
		310
ITK-L2	350	
		530
ITK-L3	570	
TPC	600-1800	
		700
OTK	~1800	

- $\phi_{\mu^+,\mu^-} = -90 \sim 90, \theta_{\mu^+} = 95, \theta_{\mu^-} = 85$, pT=2-5GeV, position (x, 0, 0)
- The order of precision between d_0 and vertex agree with each other
- Precision drops rapidly between 13 and 19





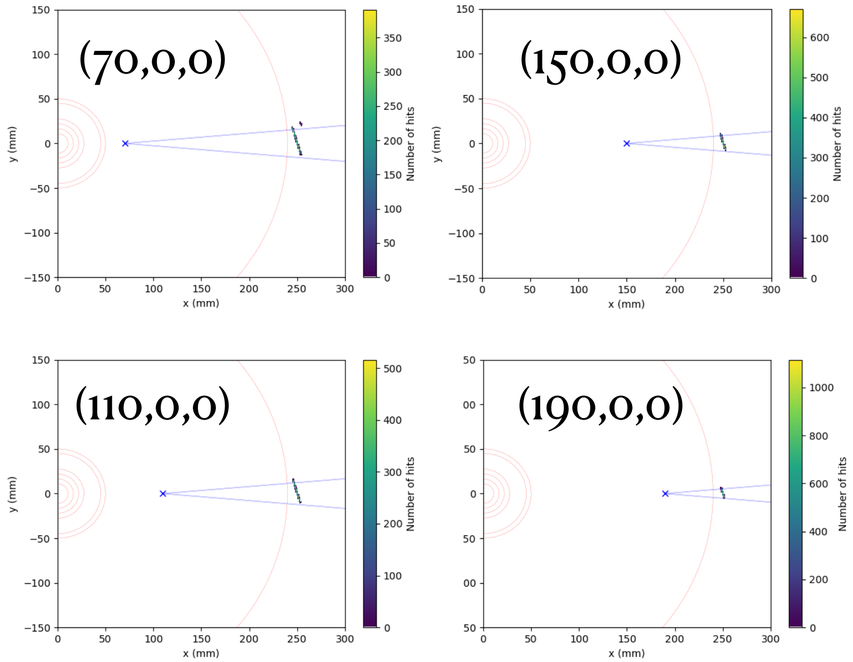
The first hit assigned to TrackState::AtFirstHit



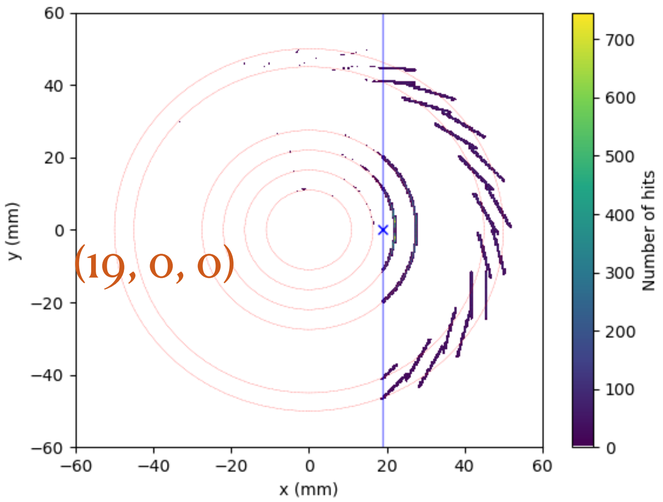
- For muons originate from (19, 0, 0)
  - Expect all first hits to be located around VXD-L3/4, but only 10% are actually there; the rest are around ITK-L1
  - Muon pairs at 100GeV give the same results

The missing innermost hits → Long distance error propagation

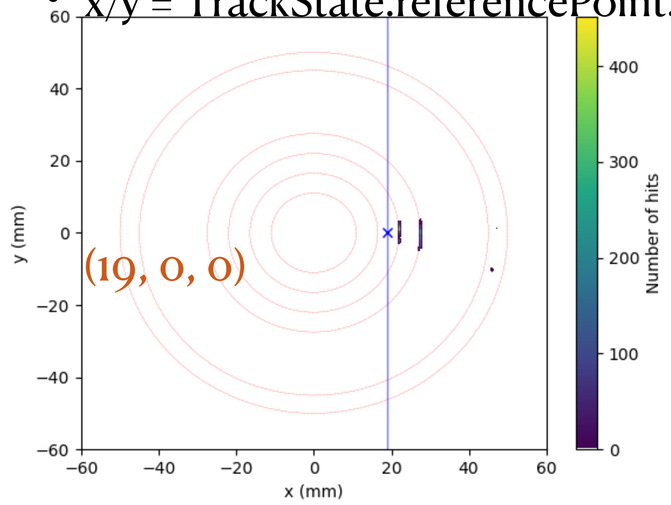
- edm4hep::TrackState contains helix parameters, which is mandatory for vertex fitting
- Inside the vertex detector, sometimes the TrackState::AtFirstHit is not the innermost hit
  - For secondary vertex reconstruction, it triggers a long-distance error propagation which deteriorates precision
- Set the particle-gun as below to avoid VXD hits issue
  - The particle-gun is located between the last layer of VXD and ITK-L1 (all tracks have the same number of silicon hits)
  - Confirm the law of vertex precision changes with propagation distance

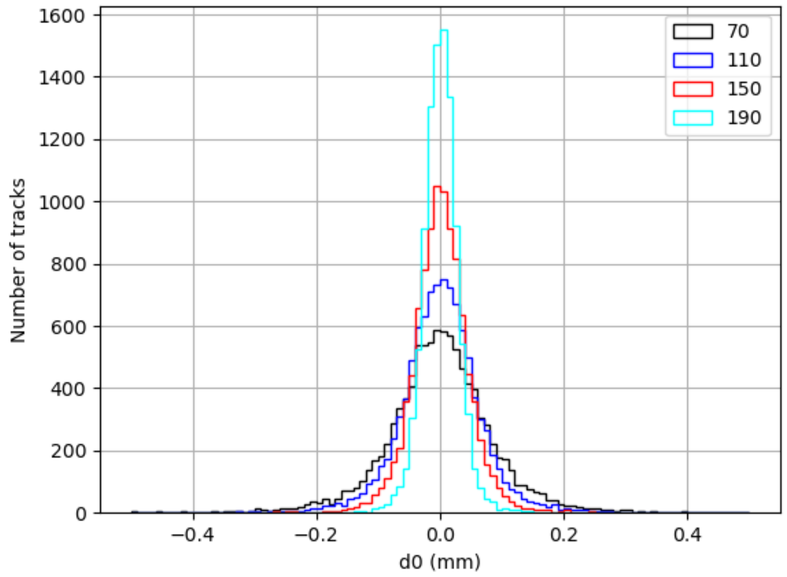


- VXDTrackerHitCollection



- IF TrackState::location == AtFistHit:
  - x/y = TrackState.referencePoint.x/y



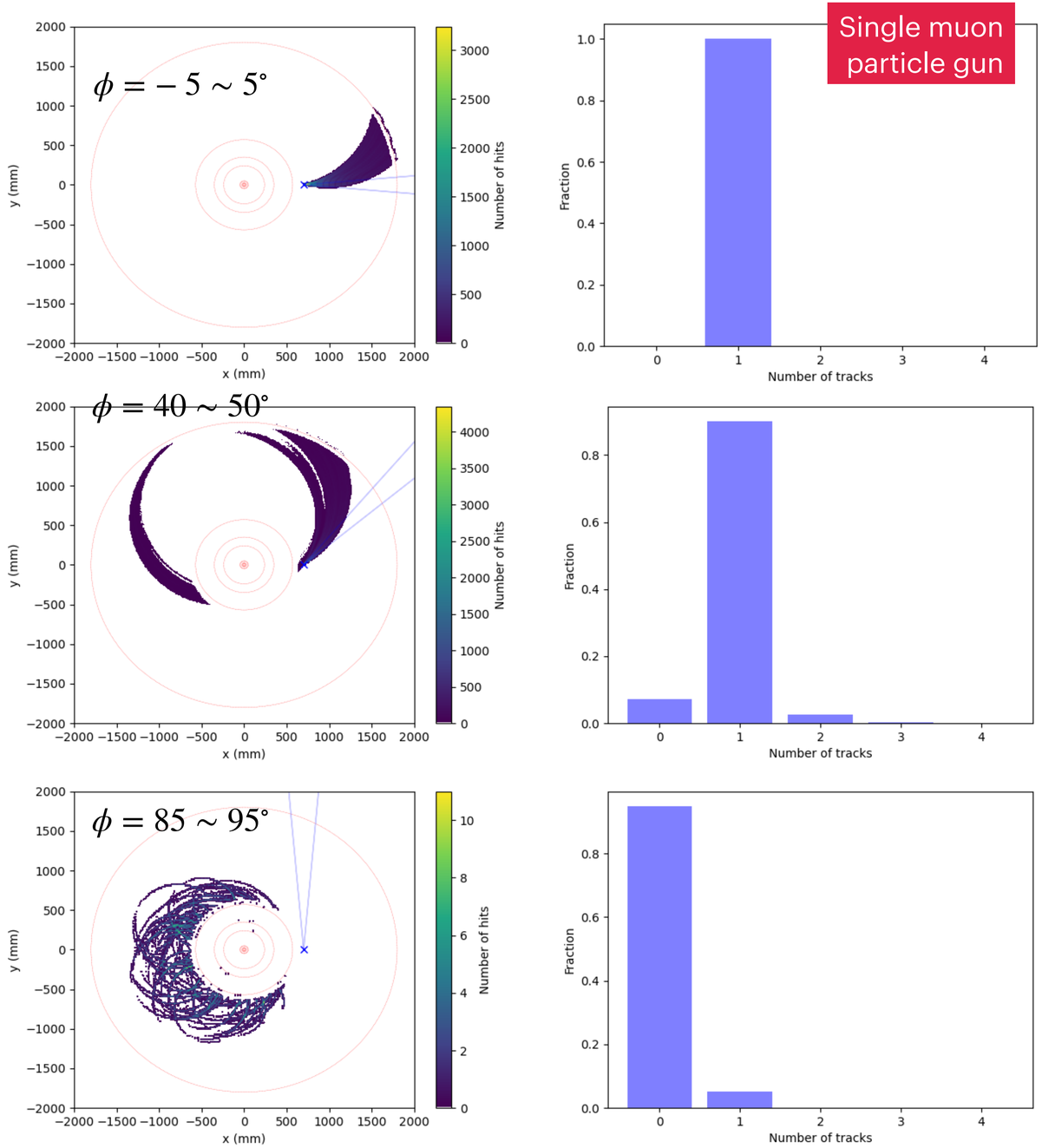


Issue with the number of tracks

- Sometimes, we observe more tracks than expected. For example, single kaon or pion from particle-gun is associated with more than one tracks, and some $K^0_S \rightarrow \pi^+\pi^-$ events have more than 2 tracks

- SW group has explained this issue from several aspects, such as the helix with more than one cycle, muon returning from calorimeter, and so on

- An observation during the study of secondary vertices may be a cross-check with SW group
  - Particle-gun is located in TPC and shoots single muon along different phi angles
  - R=700 mm, z=5mm, pT=1GeV, $\theta = 85$, $\phi = 0 \pm 5,\ 45 \pm 5,\ 90 \pm 5$
  - The higher pT, the more zero-tracks there are



Release validation for 24.12.0 tracks

- Low pT region issue is still ongoing