Multiple tracks

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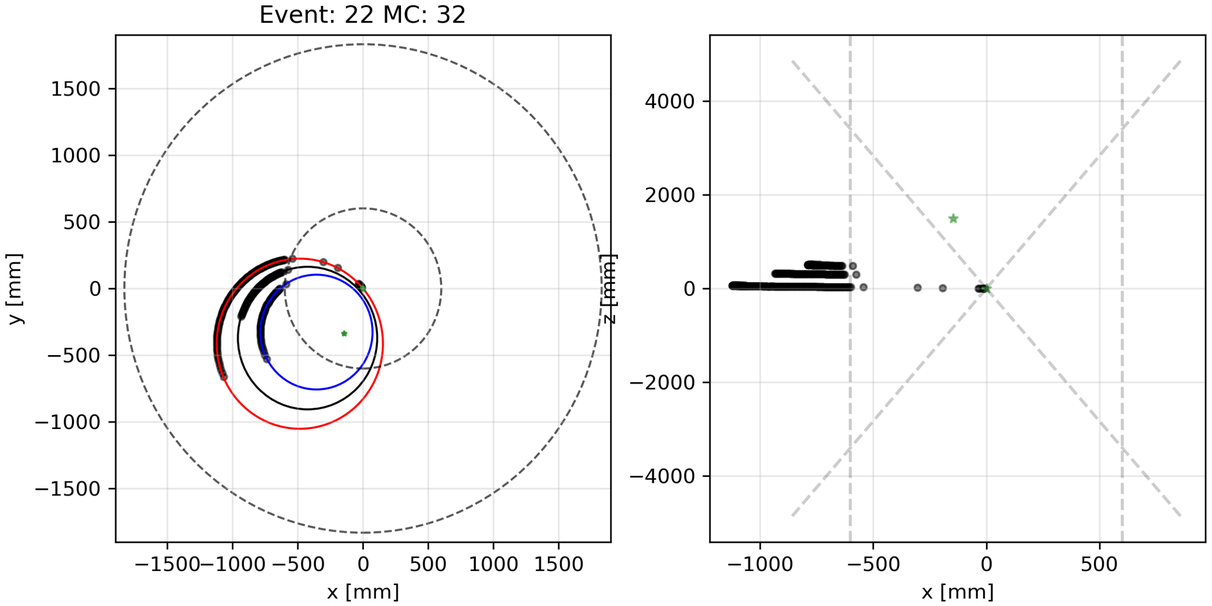
Intro.

- Inspect the first 50 events in the /cefs/higgs/zhangkl/Production/24122/E91_bb/****00200.root
- Find 62 MC particles associated with multiple tracks
  - Multiple-track issue occurs very often in b-jet, about 0.6 per b-jet

- These SingleMC-MultiTracks associations are caused by different reasons
  1. Multi-loops
  2. Track ambiguity
  3. Beam pipe event
  4. γ conversion
  5. γ conversion-like

Multi-loops

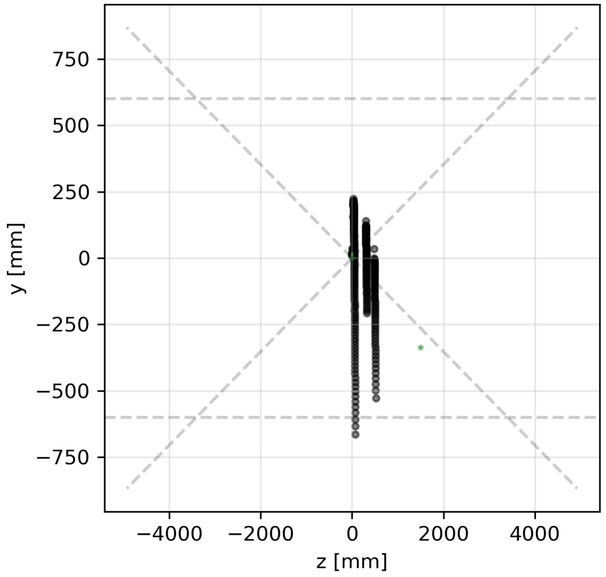


Rec Trk info:

Chi2: 334.1; NDF: 262.0; NHits: 134

Chi2: 87.73; NDF: 106.0; NHits: 56

Chi2: 141.2; NDF: 126.0; NHits: 66



MC info:

PDG=-2212

isDecayedInTracker=False

isCreatedInSimulation=False

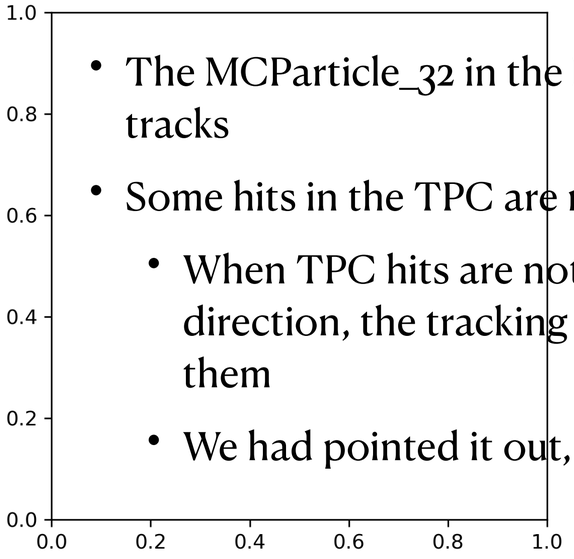
isBackscatter=False

isStopped=False

start x=0.0; y=0.0; z=0.0

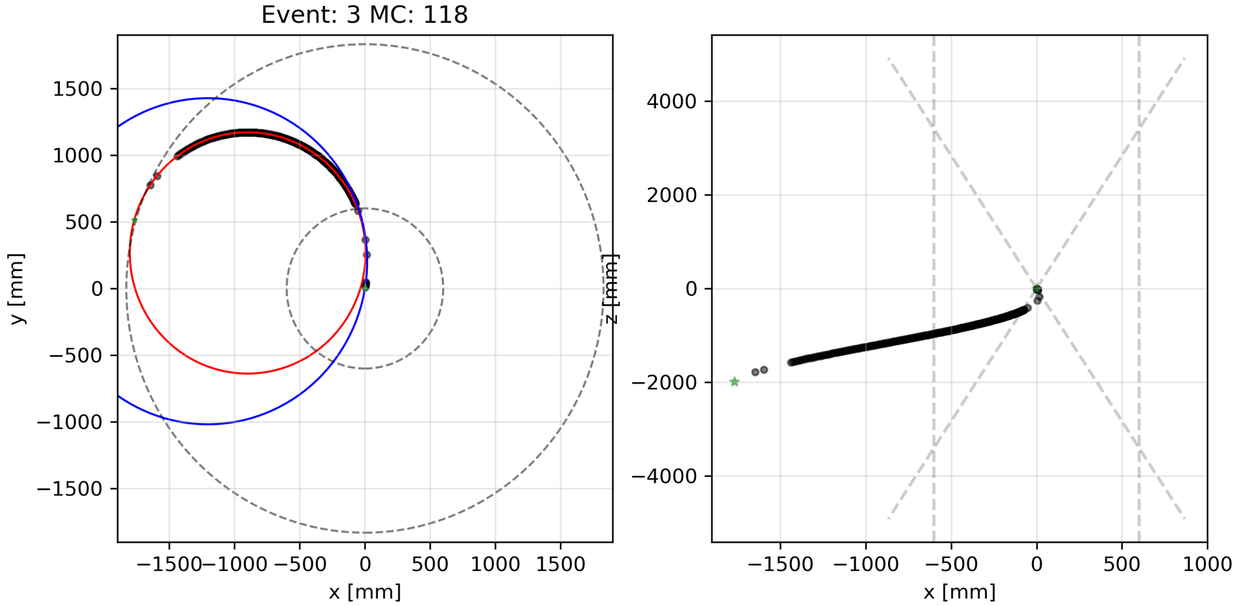
end x=-147.; y=-335.; z=1497.

θ=87.14°



- The MCParticle_32 in the Event_22 is reconstructed as 3 tracks
- Some hits in the TPC are missing
  - When TPC hits are not parallel to the radial direction, the tracking algorithm fails to recognize them
  - We had pointed it out, <u>Page2 MyPreviousTalk</u>

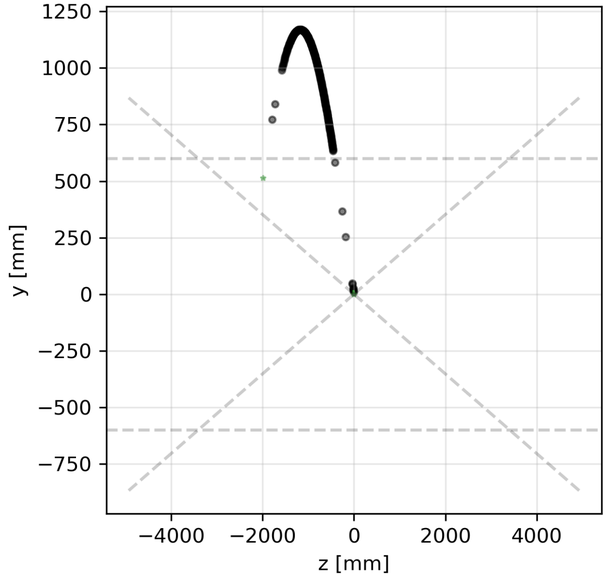
Track ambiguity



Rec Trk info:

Chi2: 441.3; NDF: 444.0; NHits: 225

Chi2: 15.27; NDF: 12.0; NHits: 9



MC info:

PDG=11

isDecayedInTracker=False

isCreatedInSimulation=False

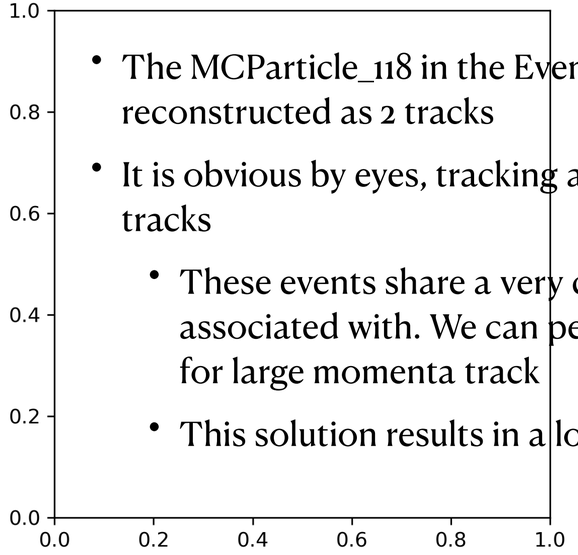
isBackscatter=False

isStopped=False

start x=0.003; y=0.014; z=-0.01

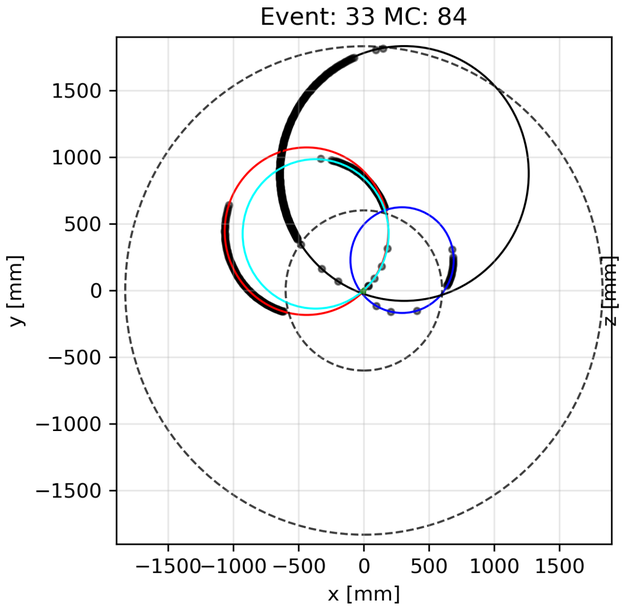
end x=-1769; y=512.9; z=-1994

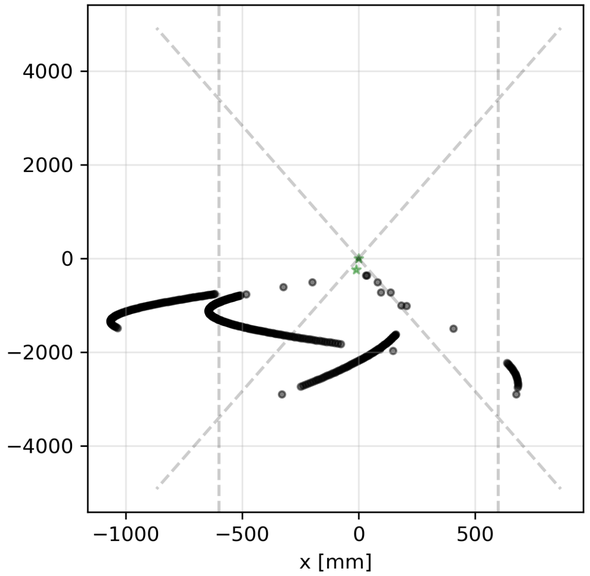
θ=125.0°



- The MCParticle_118 in the Event_3 is a single electron but is reconstructed as 2 tracks
- It is obvious by eyes, tracking algorithm recognises it as two different tracks
  - These events share a very common feature, one track has few hits associated with. We can peak one by cutting on the number of hits for large momenta track
  - This solution results in a loss of precision (hits are missing)

Beam pipe





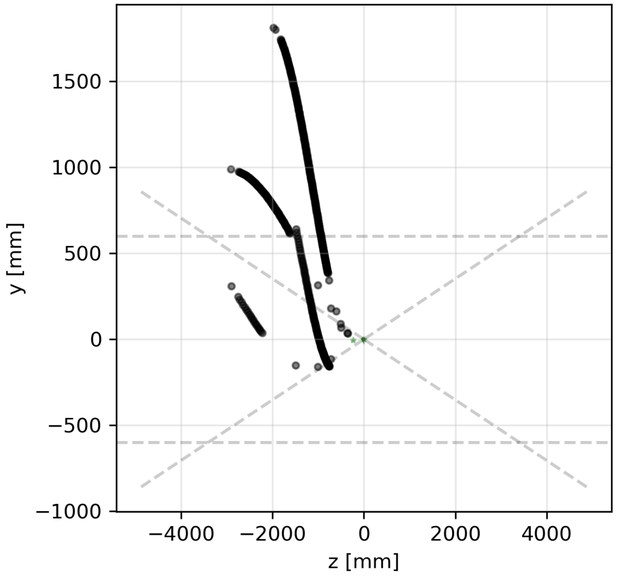
Rec Trk info:

Chi2: 230.4; NDF: 228.0; NHits: 117

Chi2: 79.83; NDF: 40.0; NHits: 23

Chi2: 461.8; NDF: 450.0; NHits: 228

Chi2: 287.4; NDF: 156.0; NHits: 81



MC info:

PDG=211

isDecayedInTracker=False

isCreatedInSimulation=False

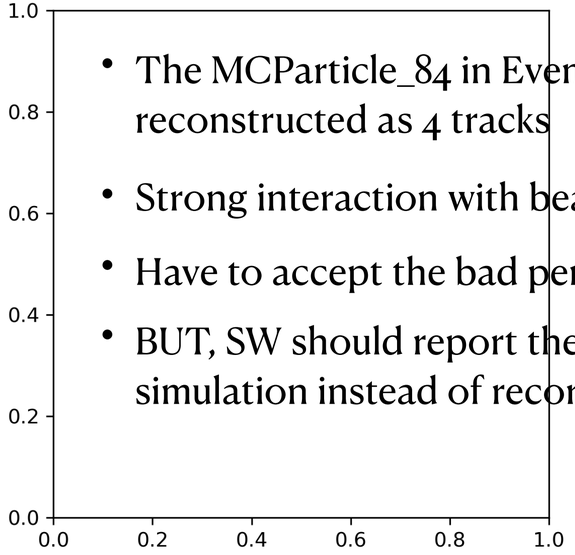
isBackscatter=False

isStopped=False

start x=0.027; y=0.143; z=-1.73

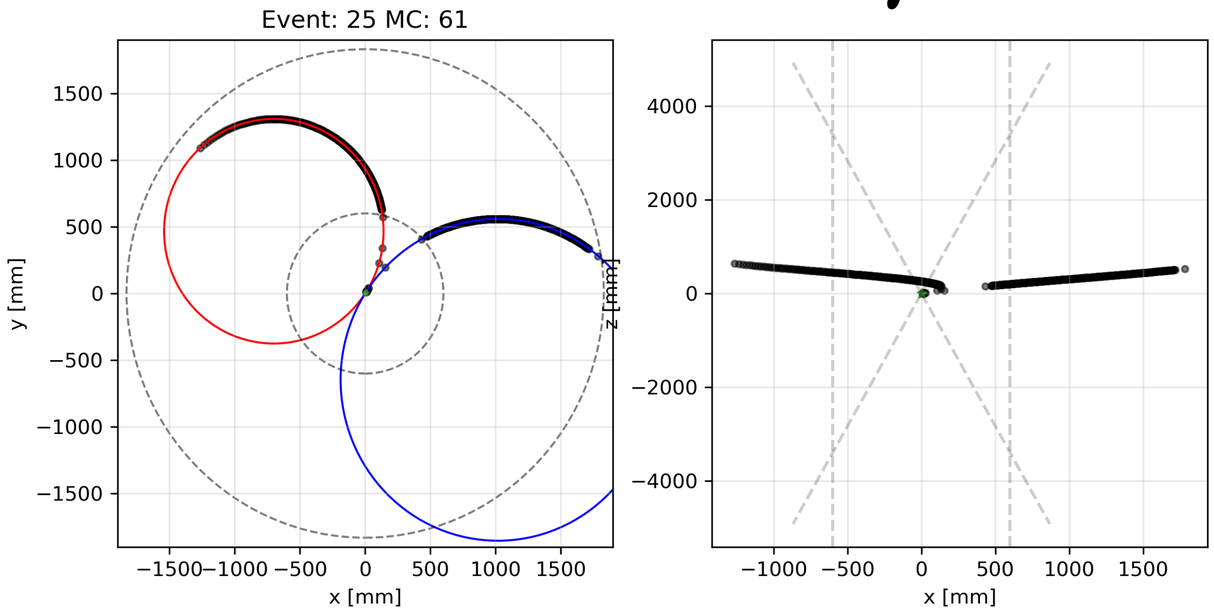
end x=-10.0; y=-5.11; z=-241.

θ=177.2°



- The MCParticle_84 in Event_33 is a charged pion. It is reconstructed as 4 tracks
- Strong interaction with beam pipe, $\theta_{gen} = 177°$
- Have to accept the bad performance in end-cap region
- BUT, SW should report these particles are generated in simulation instead of recording all the tracks as a single particle

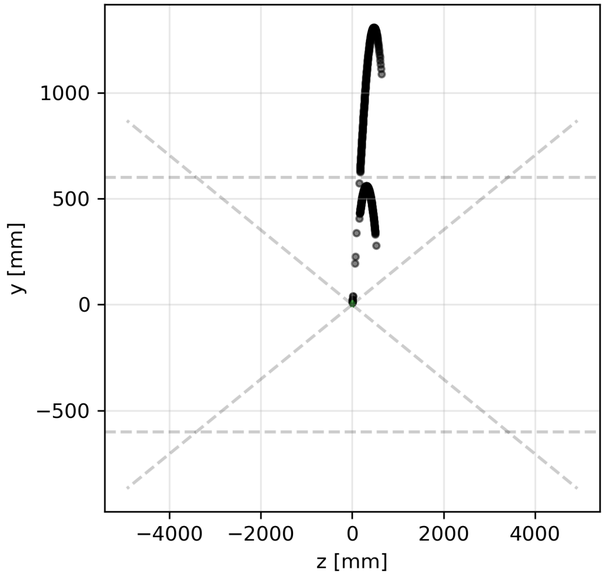
γ conversion



Rec Trk info:

Chi2: 417.5; NDF: 424.0; NHits: 215

Chi2: 447.0; NDF: 456.0; NHits: 231



MC info:

PDG=22

isDecayedInTracker=False

isCreatedInSimulation=False

isBackscatter=False

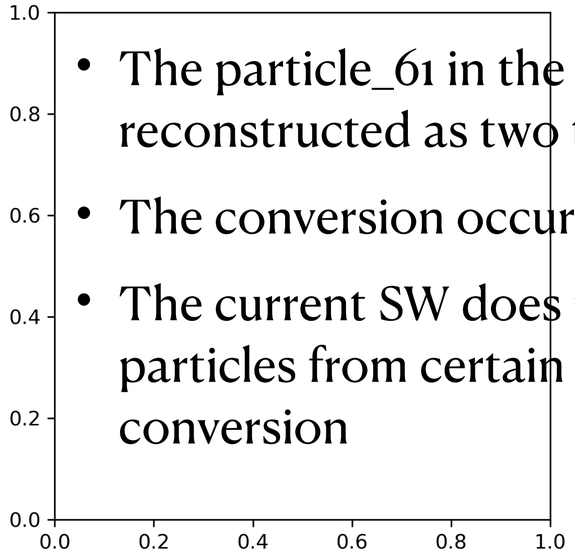
isStopped=False

start x=0.000; y=0.000; z=9.820

end x=5.583; y=8.607; z=2.682

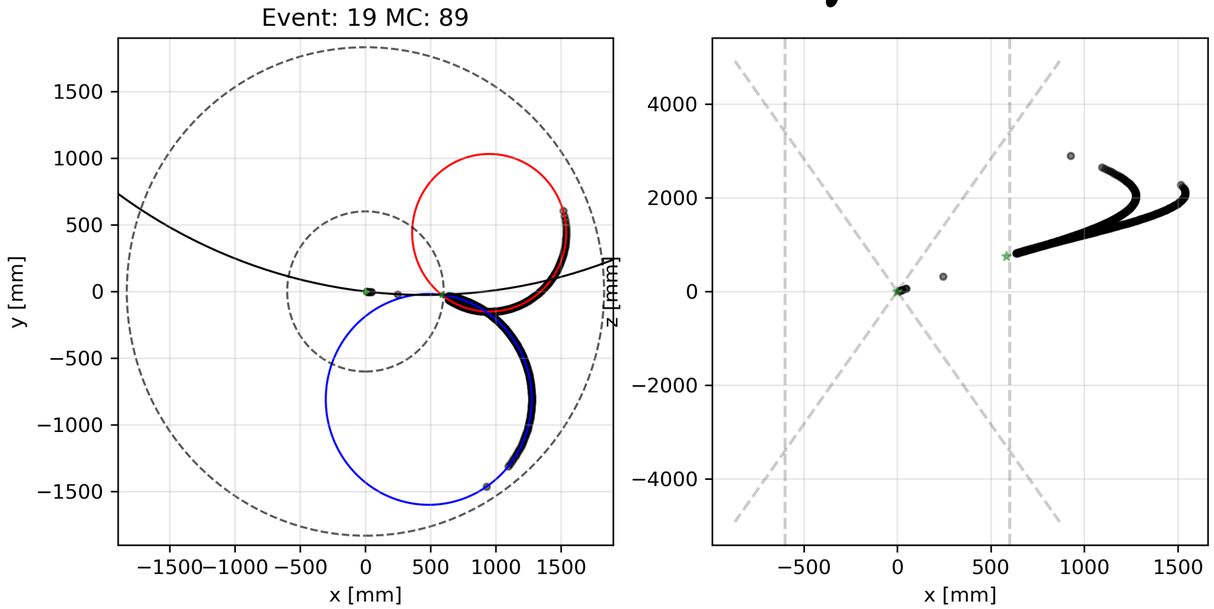
θ=75.34°

- SW reports its end, but does not record its daughters and they are not in the MC container



- The particle_61 in the event_25 is a photon, but is reconstructed as two tracks
- The conversion occurs with the VXD-L1
- The current SW does not record the secondary particles from certain processes, such as gamma conversion

γ conversion like

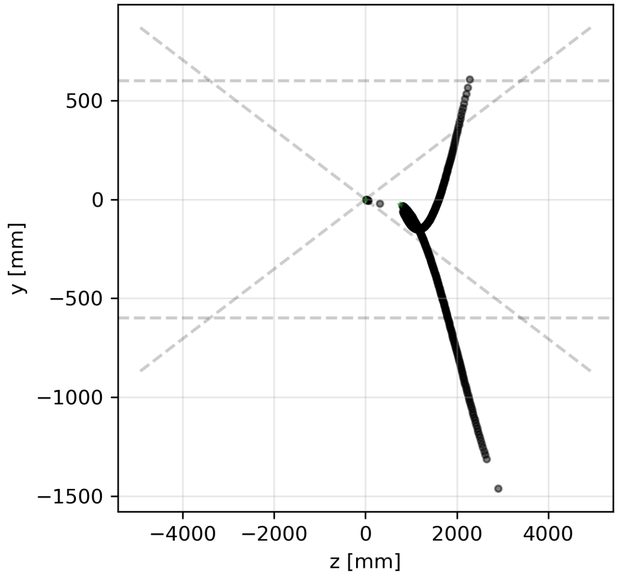


Rec Trk info:

Chi2: 388.5; NDF: 394.0; NHits: 200

Chi2: 498.2; NDF: 426.0; NHits: 216

Chi2: 8.288; NDF: 8.0; NHits: 7



MC info:

PDG=-211

isDecayedInTracker=False

isCreatedInSimulation=False

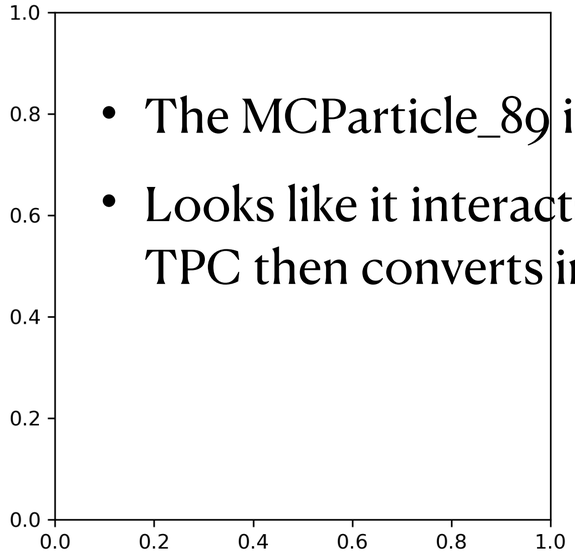
isBackscatter=False

isStopped=False

start x=0.281; y=-0.04; z=0.401

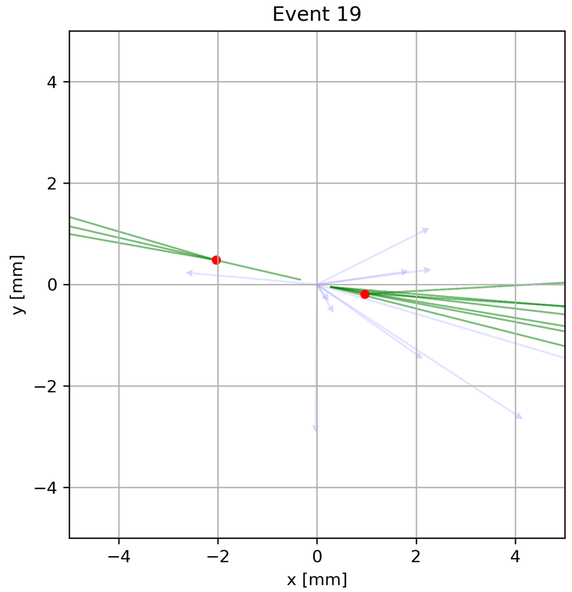
end x=583.9; y=-24.8; z=754.5

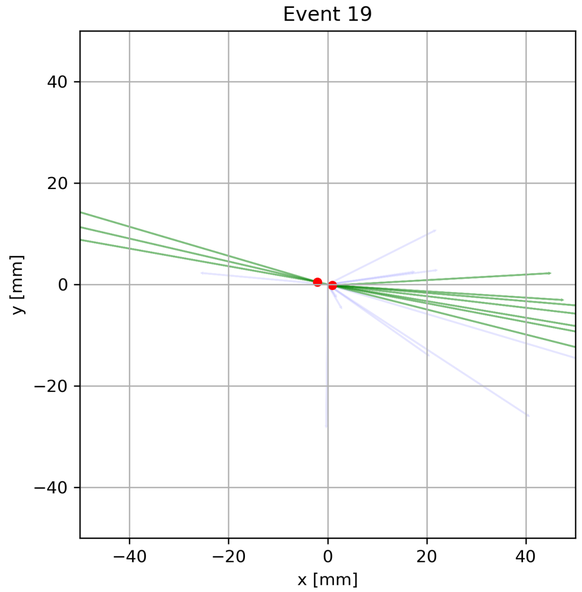
θ=37.78°

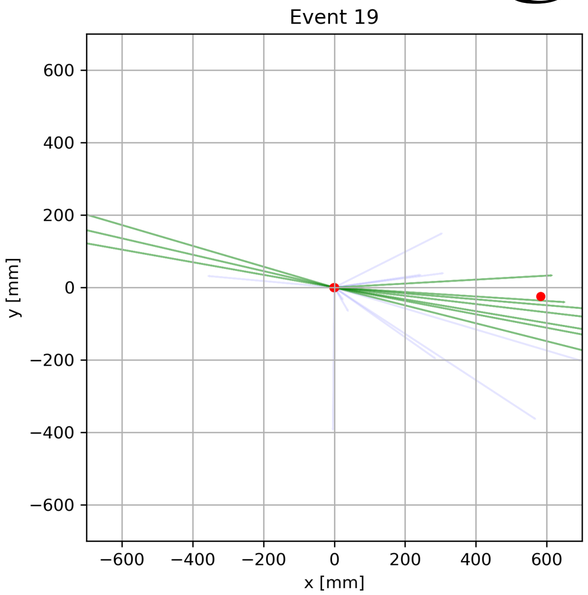


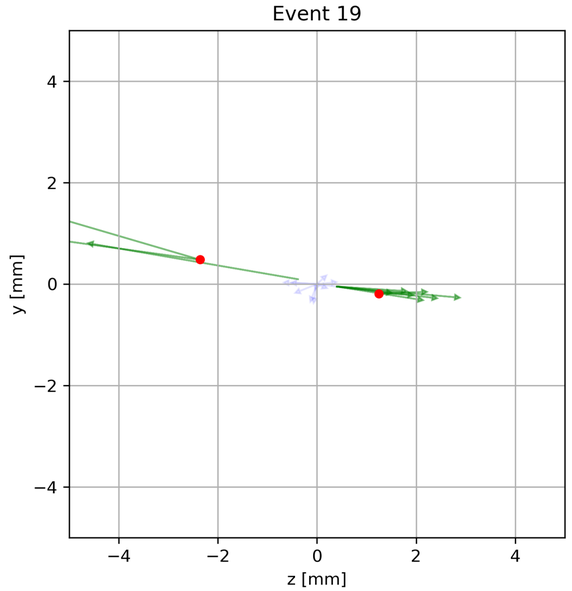
- The MCParticle_89 in Event_19 is a negative pion
- Looks like it interacts with the inner barrel of TPC then converts into two other particles

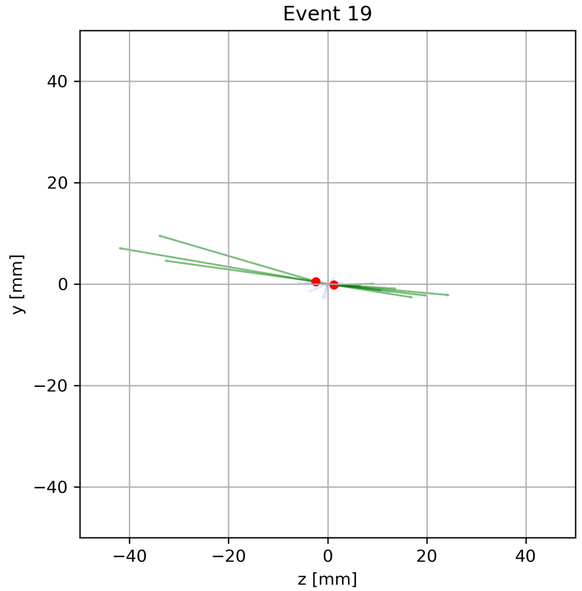
Effects on vertexing

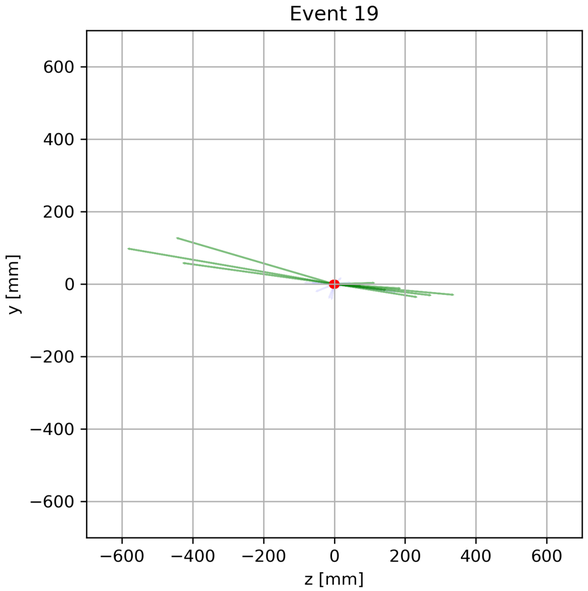






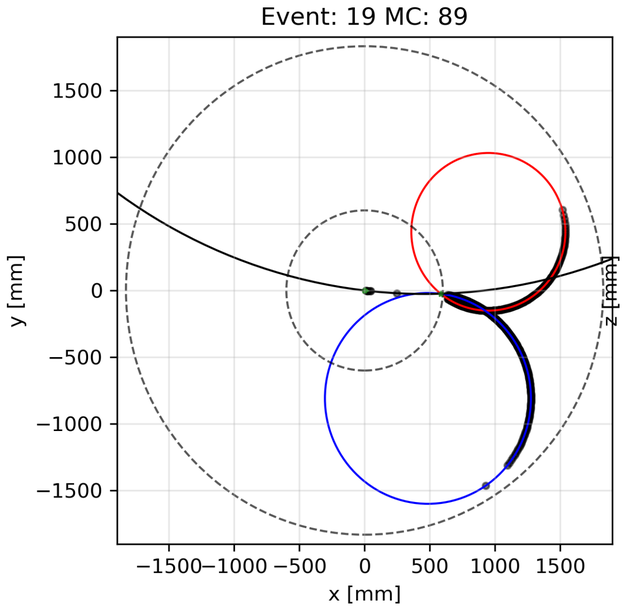


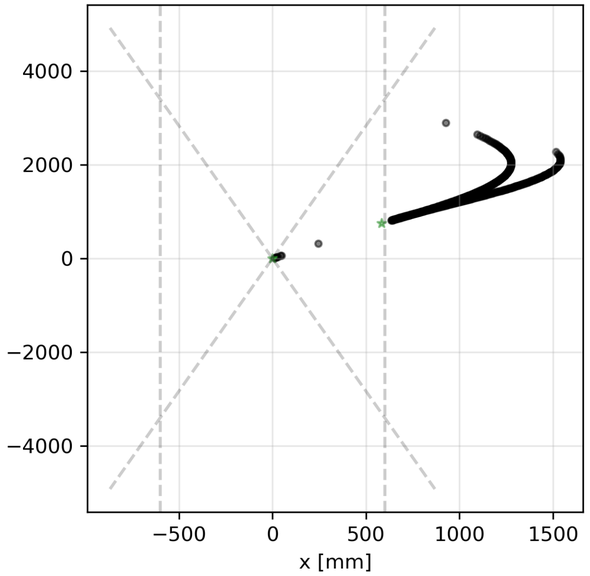




- Secondary vertex buildup in Event_19
  - Red points are reconstructed vertices
  - Green lines are truth charged stable MC particles with starting point != 000
  - Blue lines, truth charged stable MC, starting point = 000
- Looks like there is a fake reconstructed vertex
  - x=583, y=24, z=753
  - Nrk=3
  - BUT, no truth particles originate from there

Effects on vertexing





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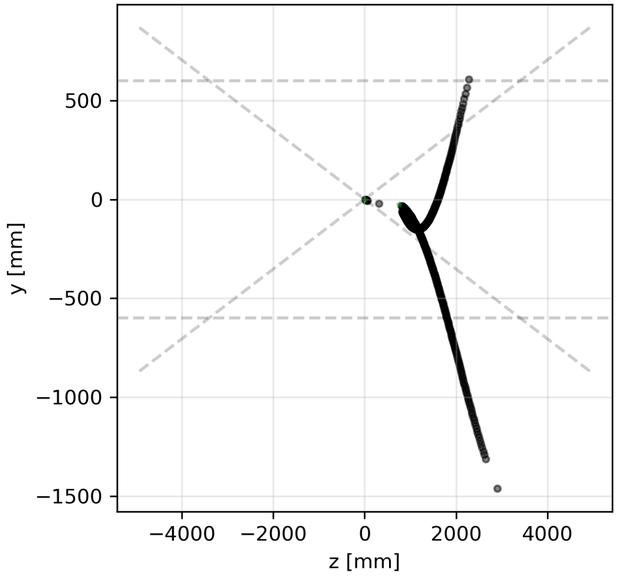

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end x=583.9; y=-24.8; z=754.5

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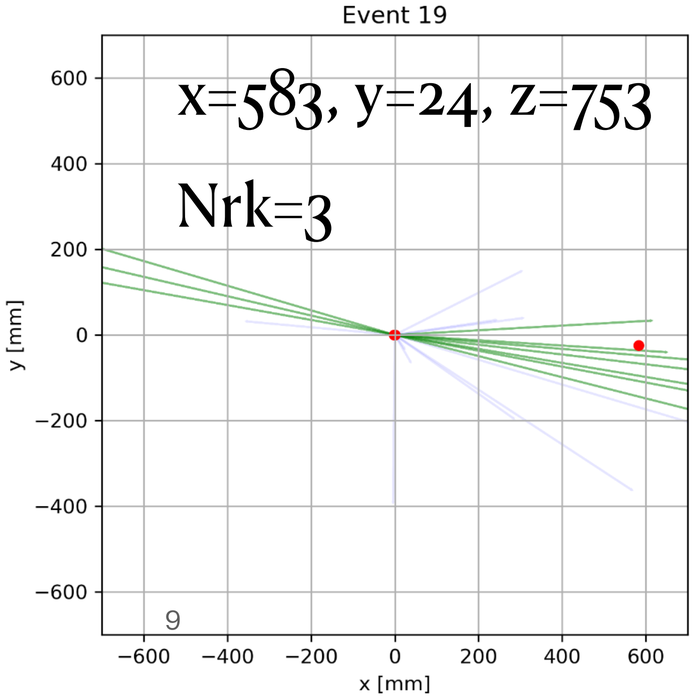
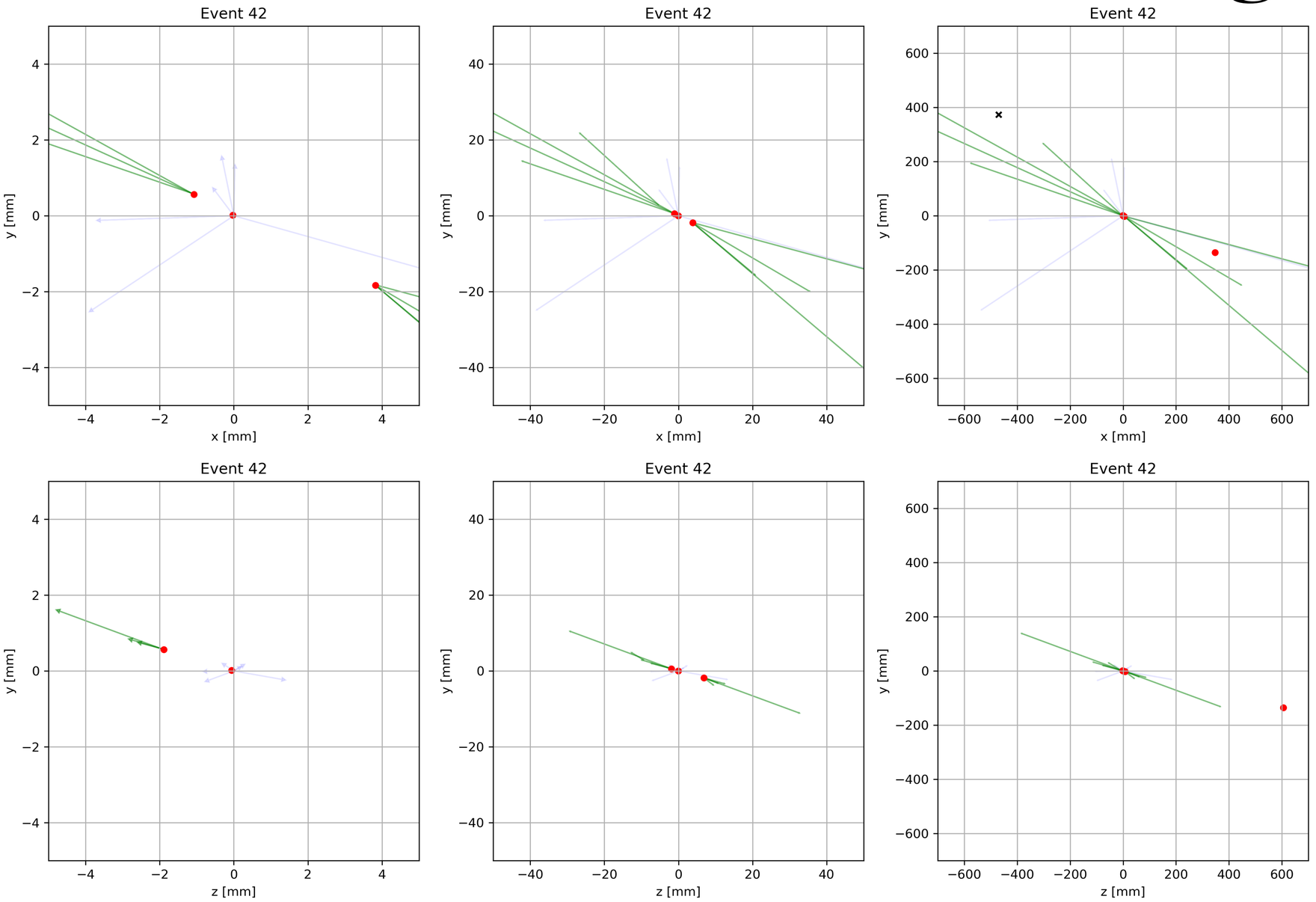


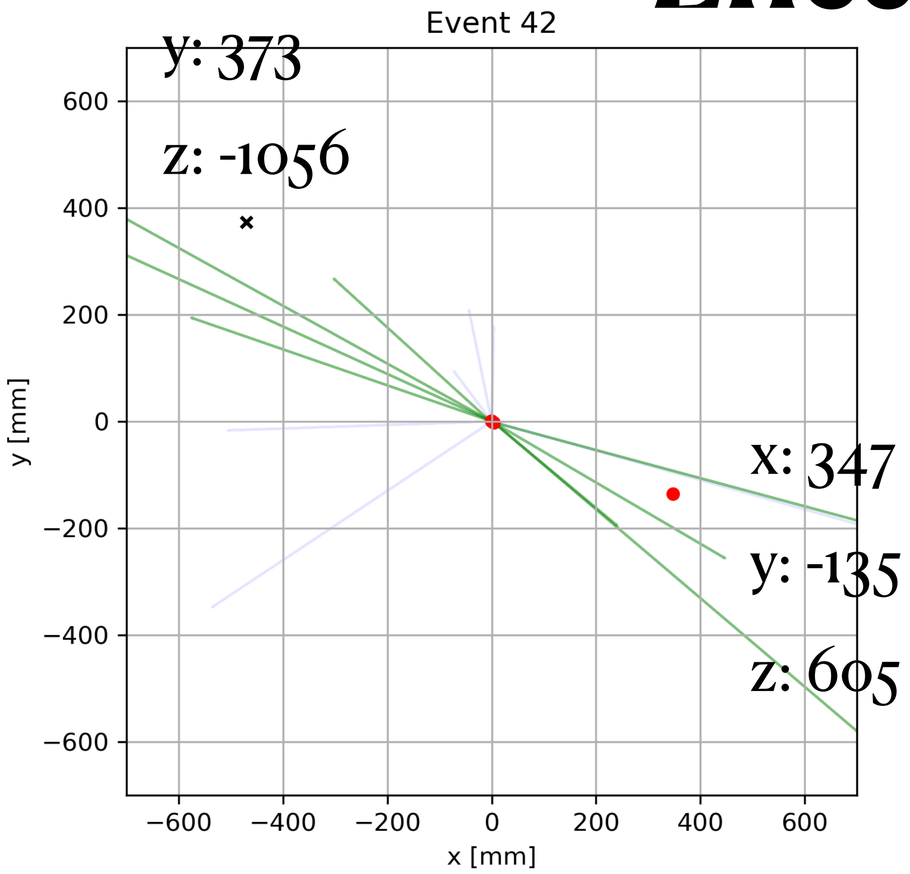
- The MC_89 in the Event_19 is a negative pion, which interacts with inner barrel of TPC and converts to two charged particles
- SW does not record this process
- Tracks for this pion and its daughters are associated to this pion, which is represented as a multiple tracks issue

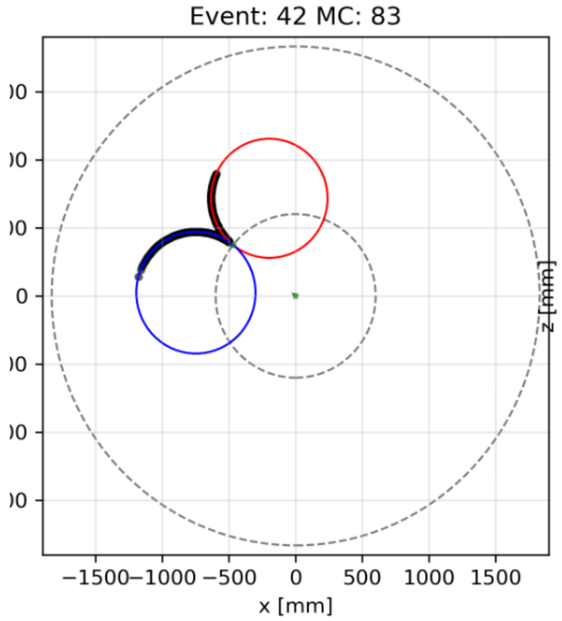
Effects on vertexing

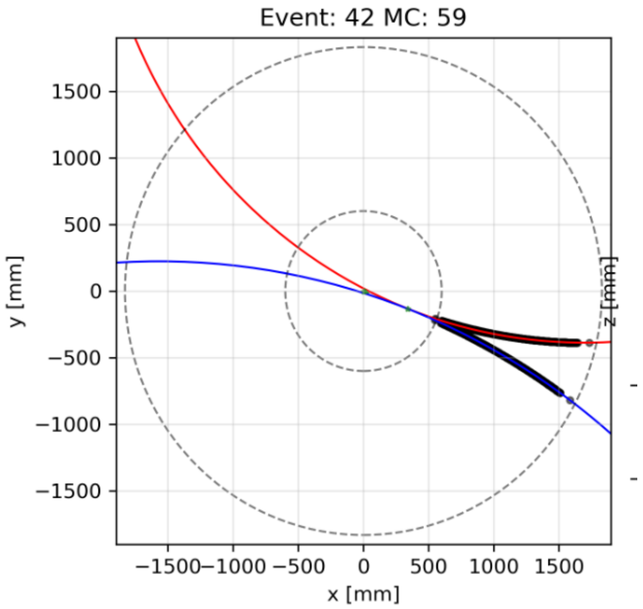


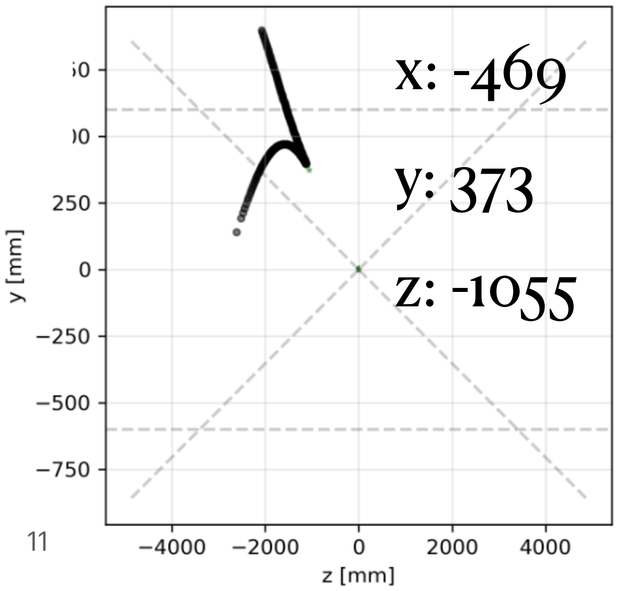
- Secondary vertex buildup in Event_42
- There are 2 fake vertices
  - x: -469, y: 373, z: -1056; Ntrk=2
  - x: 347, y: -135, z: 605; Ntrk=2
- To evaluate the efficiency/purity of vertexing algorithm, we expect green lines originate from there

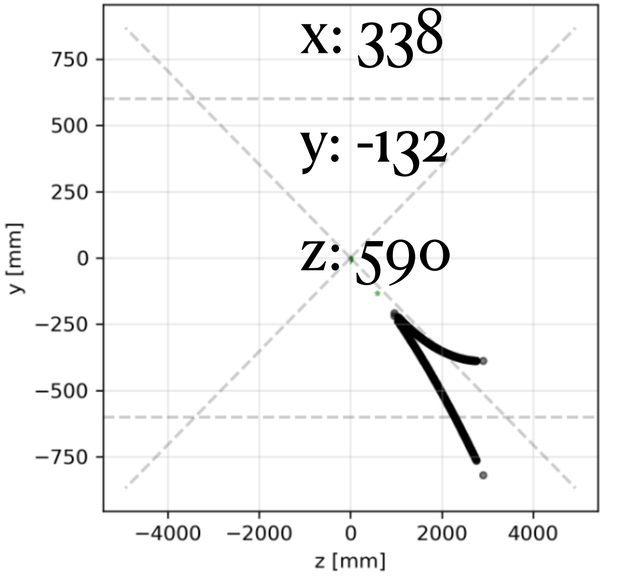
Effects on vertexing





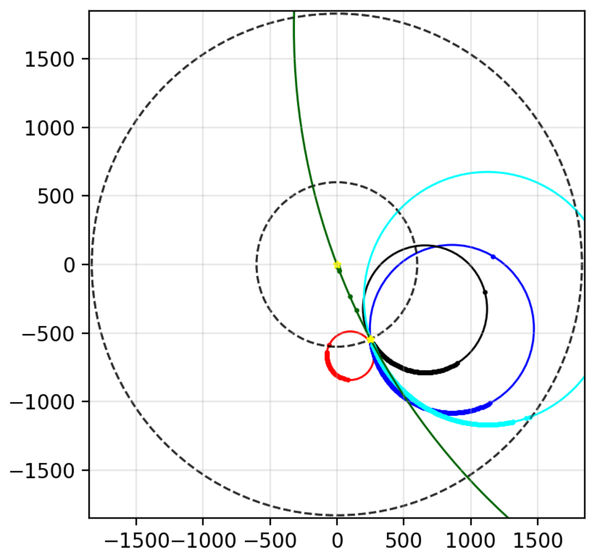


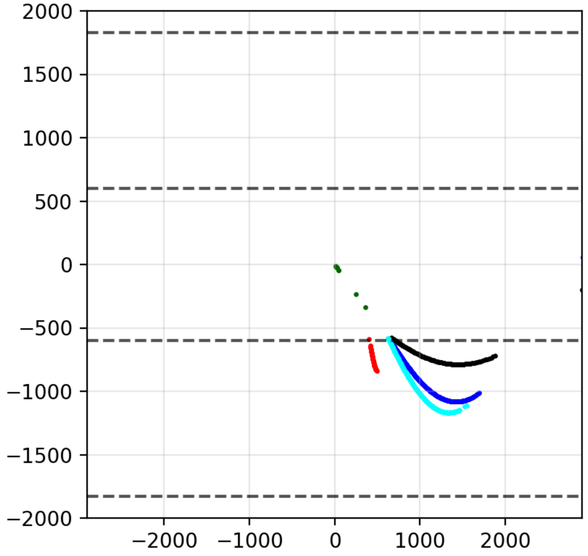




- The MCParticle_59 and 83 in the Event_42 are photons which convert to two electron pairs
- Two track-pairs associated to photons accordingly, which represented as two multiple-tracks instances
- Reconstruction algorithm recognises them but the truth says there are nothing

Effects on TOF and PID





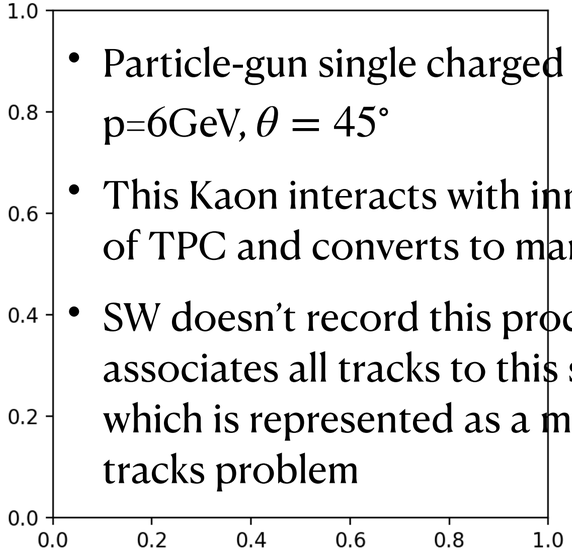
Reduced Chi2: 166.2 DNF: 76.0
NHits: 41 Curvature: -1

Reduced Chi2: 338.7 DNF: 354.0
NHits: 180 Curvature: -1

Reduced Chi2: 224.7 DNF: 204.0
NHits: 105 Curvature: -1

Reduced Chi2: 449.0 DNF: 444.0
NHits: 225 Curvature: -1

Reduced Chi2: 8.098 DNF: 10.0
NHits: 8 Curvature: -1



- Particle-gun single charged Kaon, p=6GeV, $\theta = 45°$
- This Kaon interacts with inner barrel of TPC and converts to many particles
- SW doesn't record this process and associates all tracks to this single kaon, which is represented as a multiple tracks problem

- Demange on ToF efficiency
  - Truth report this single particle doesn't decay in tracker. So the expected ToF efficiency $\frac{\text{Trk}_{\text{has TOF}}}{\text{Trk}} = 100\%$. But, In reality, only the cyan trajectory has TOF hit, we get efficiency as $1/5 = 20\%$
- Demange on PID efficiency
  - Trajectory length using cyan, but the flight-of-time is green + cyan, which results in a wrong χ^2

Summary

- These SingleMC-MultiTracks associations are caused by different reasons
  1. Multi-loops
  2. Track ambiguity
  3. Beam pipe event
  4. γ conversion
  5. γ conversion-like

- I gained above insights by eyes with limited statistics. Therefore, it is difficult to provide a precision report on the fraction of each part
  - 64 multiple tracks instances in 50 E91_bb events
  - 2 in 50 particle-gun single Kaon events
  - 3, 4 and 5 are absolutely dominant
- Bullets of 3, 4 and 5 are the same thing, SW doesn't record the processes occurring with detector material