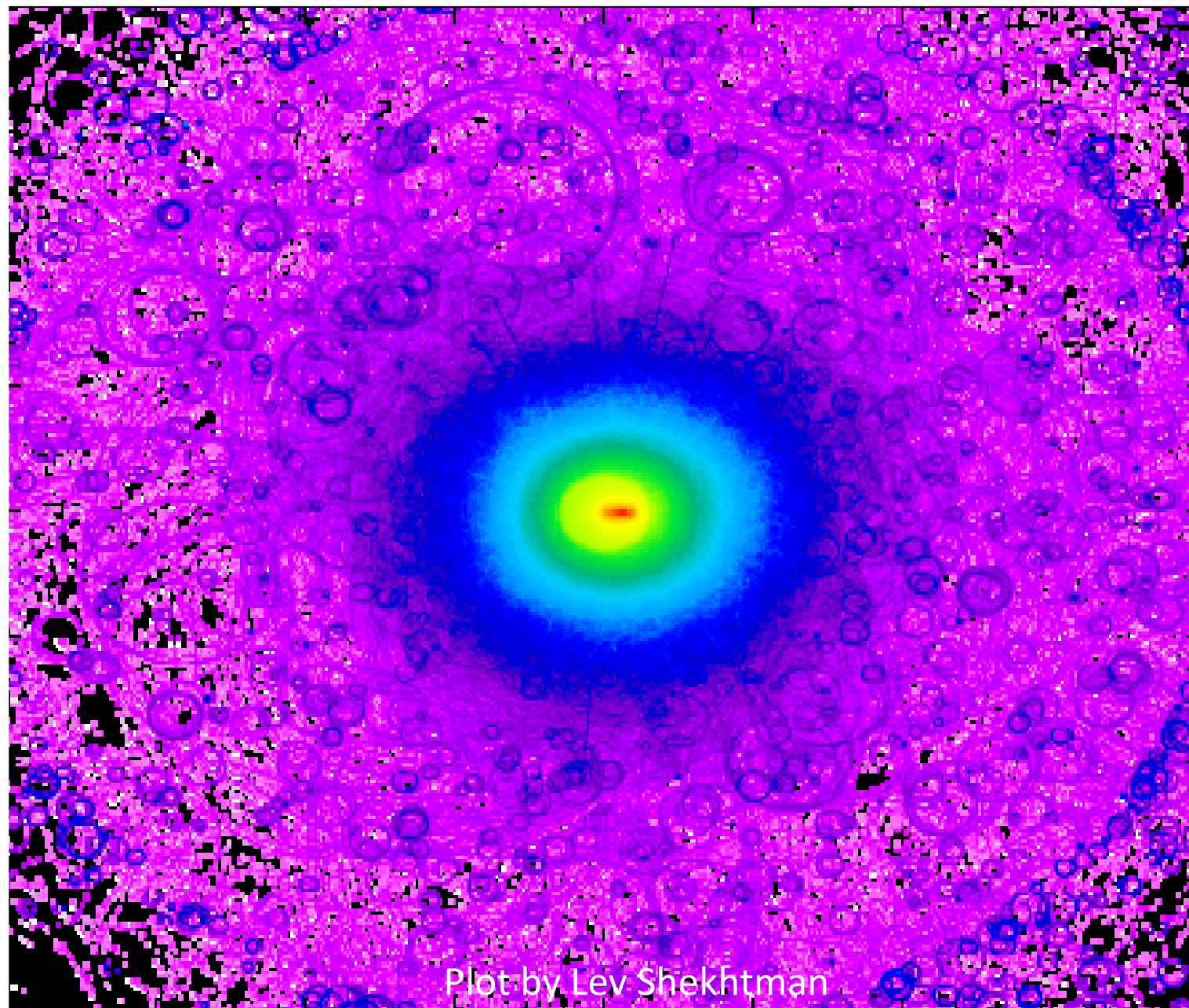


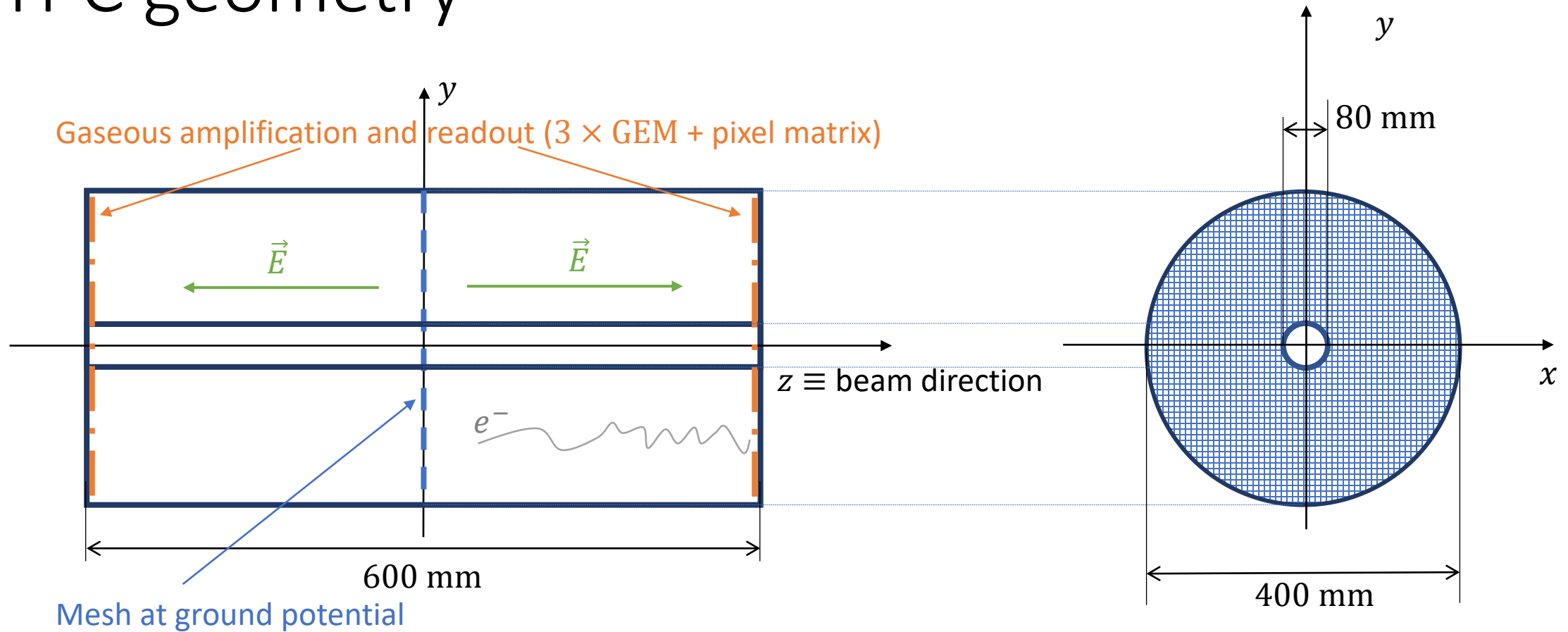
Andrey Sokolov, Lev
Shekhtman, Vijayanand KV,
Vitaly Vorobyev

December 14th, 2021

TPC digitization simulation

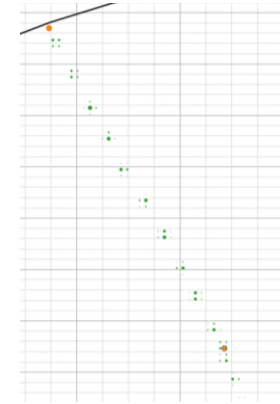
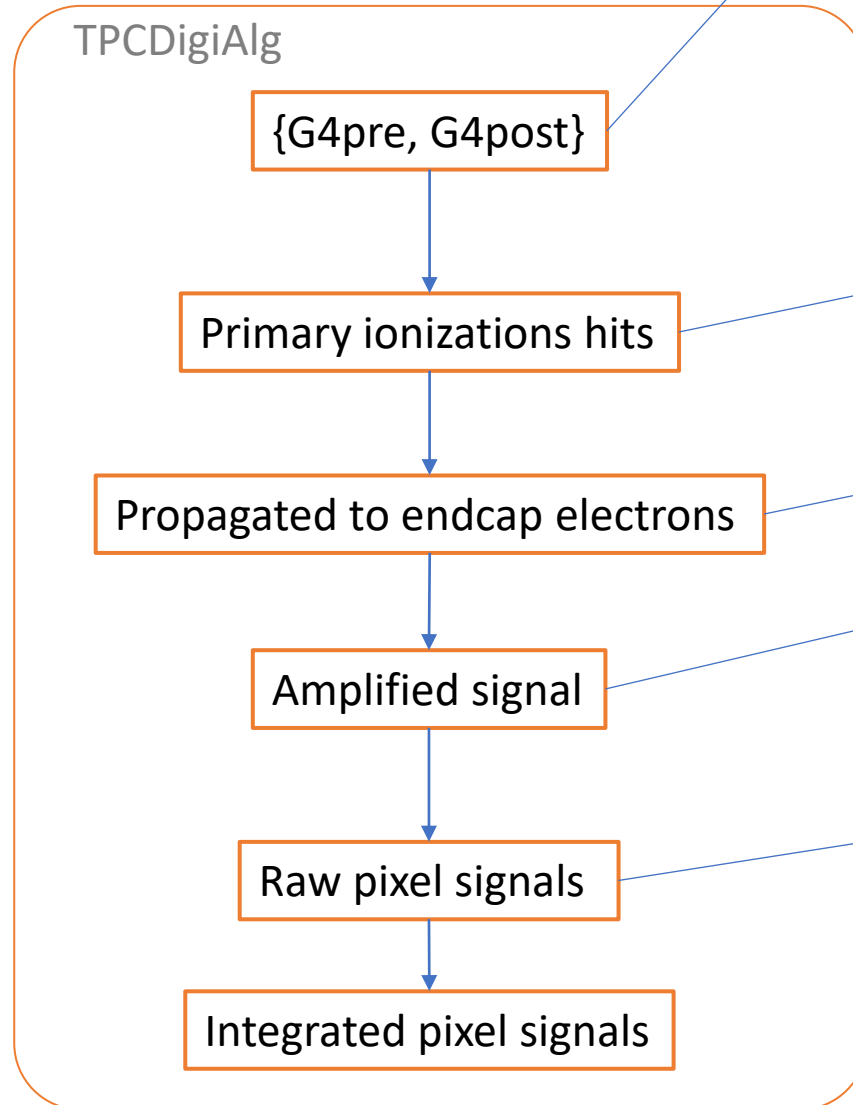
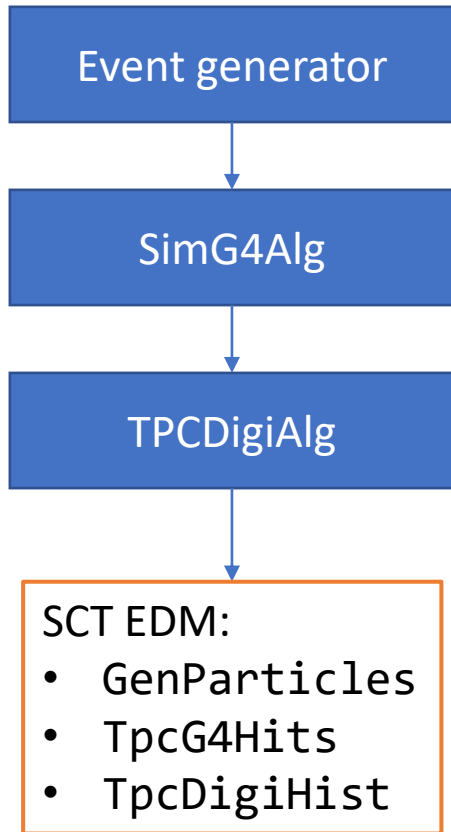


TPC geometry



- Readout: Amplitude $\times$ number of pixels $\times$ 20 MHz (frame = 50 ns)
- Pixel size $\approx$ 2 mm
- Square pixels grid in current simulation

TPC Digitization algorithm

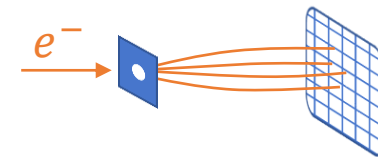


Uniform primary ionization clusters between G4pre and G4post

- $N_{\max}$ - max number of clusters
- $E_{\min}$ - min cluster energy

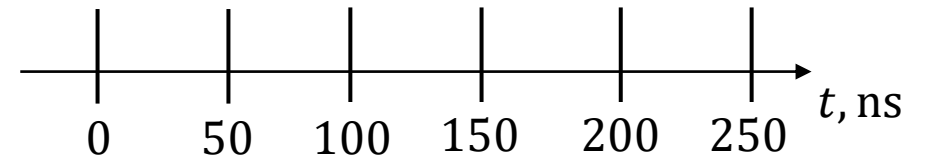
Gaussian diffusion: $\sigma_{\perp}^2(l) = l\sigma_{\perp}^0$,
 $\sigma_{\tau}^2(l) = l\sigma_{\tau}^0$

Gaussian amplification: $a_{\text{amp}}, \sigma_{\text{amp}}$



Gaussian GEM avalanche: σ_{avl}
Projection on pixel via analytical overlap integral

Integral over time frame + Gaussian noise σ_{noise}

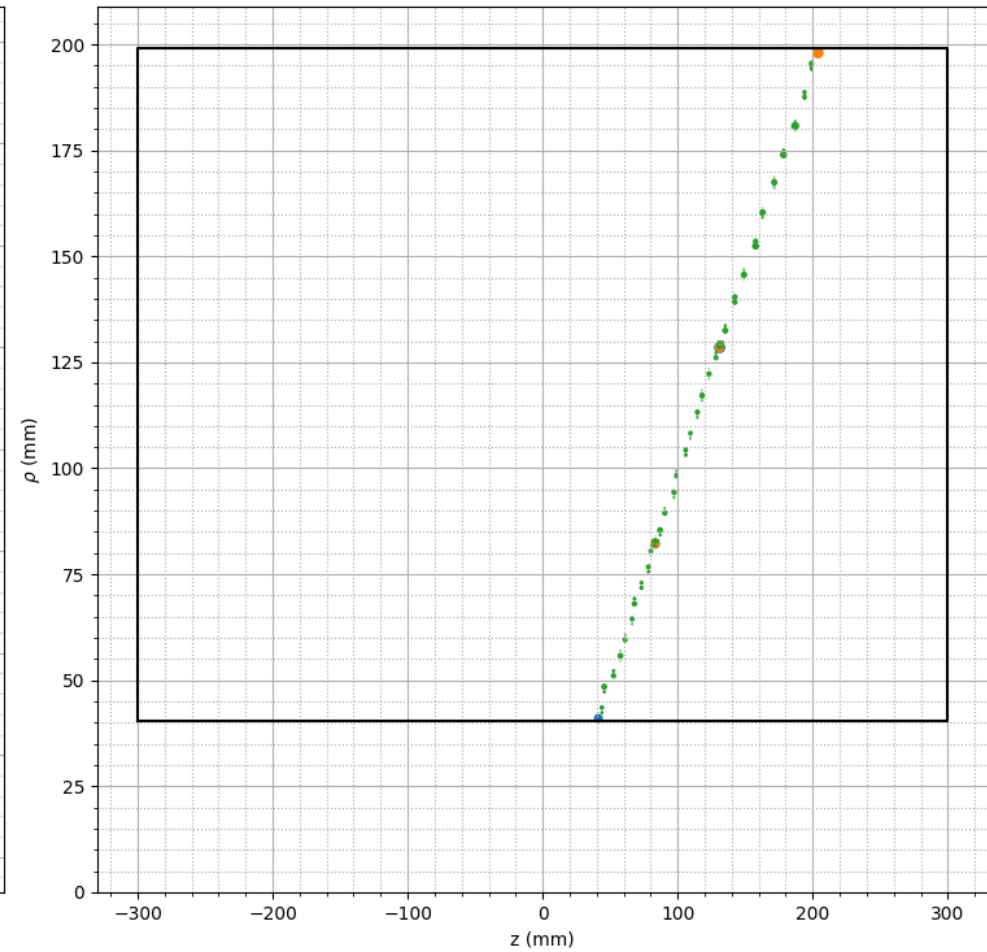
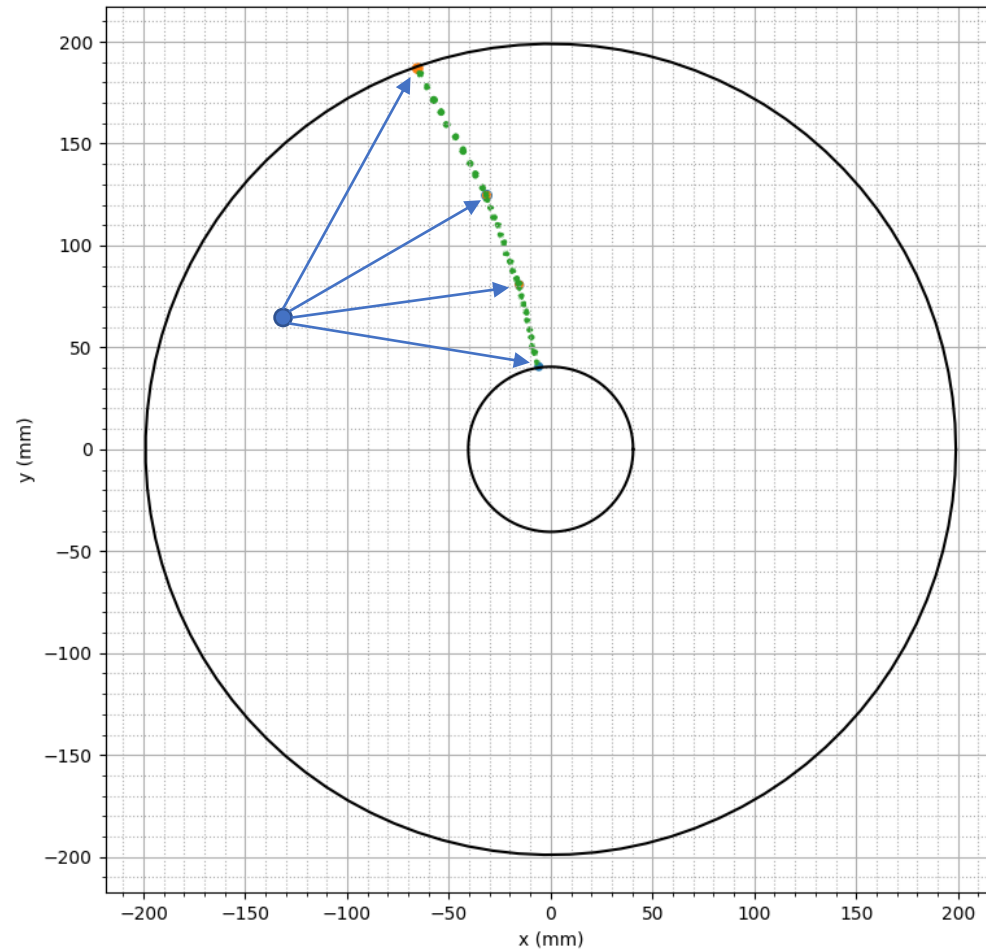


TPCDigiAlg parameters

Name	Default value	Description
padSize	1.0 mm	size of pad (length)
padPitch	0.2 mm	distance b/w adjacent pads (length)
Timewindow	50 ns	time stamp of ADC (time)
longDiffSq	4 μm	longitudinal diffusion (length)
tranDiffSq	1 μm	transverse diffusion (length)
diffCut	5.0	max number of sigmas for tranverse diffusion (sigmas)
driftVel	3.45 cm/ μs	drift velocity (velocity)
amplification	10000	avalanche amplification in triple GEM
avlSigma	0.3 mm	avalanche sigma (length)
sigmaAmpl	2000	sigma of avalanche amplification in triple GEM
sigmaNoise	200	sigma of noise in triple GEM (electrons)
threshold	1000	signal threshold (number of electrons)
ionizationEnergy	30 eV	average ionization energy (energy)
maxClustersPerG4Hit	30	max number of ionization clusters corresponding to a Geant hit

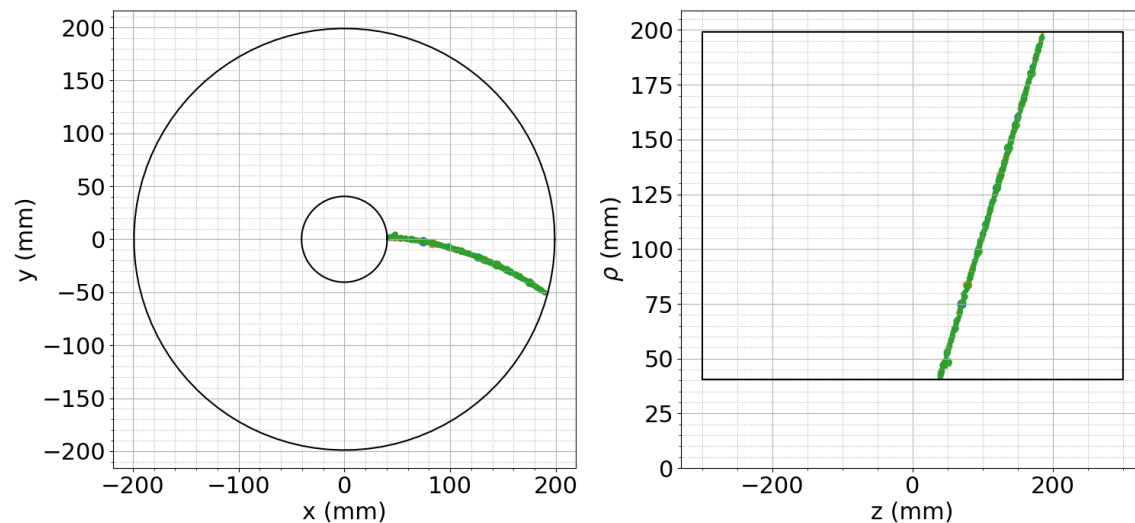
Geant step size issue

Muon 250 MeV

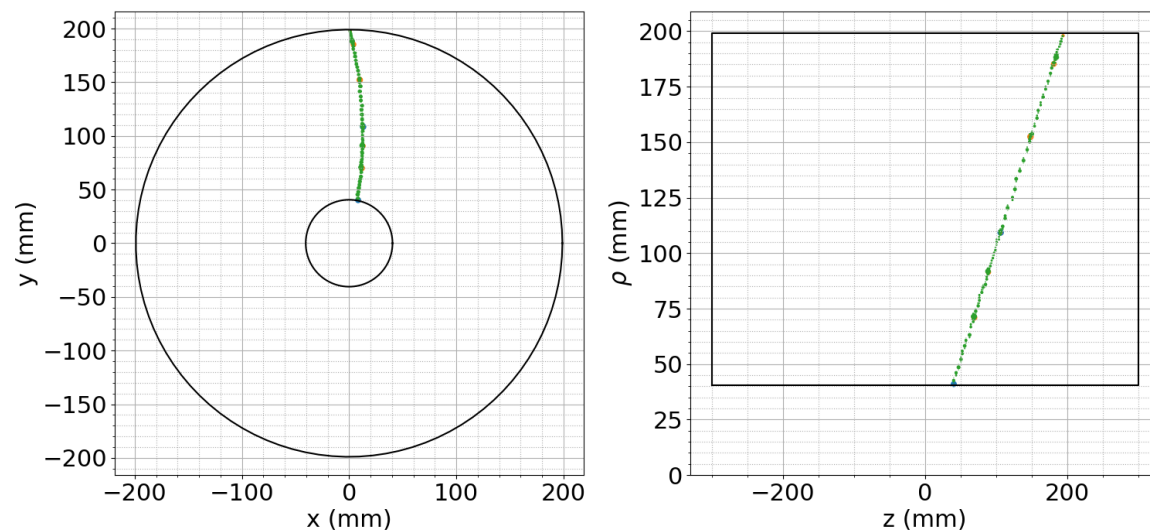


Particle gun 250 MeV

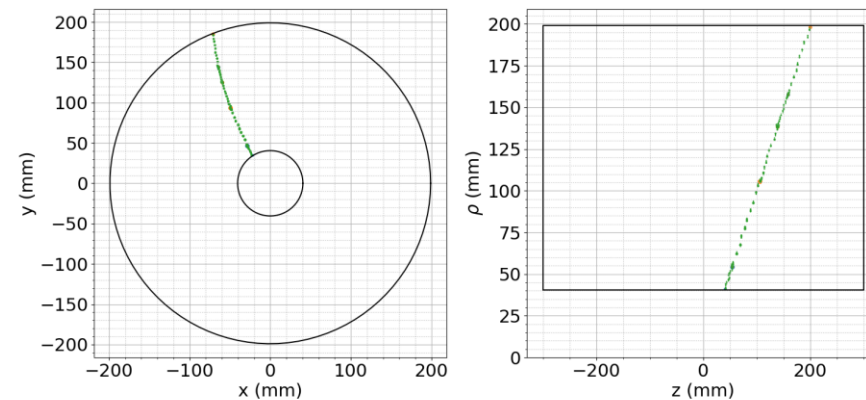
Proton 250 MeV



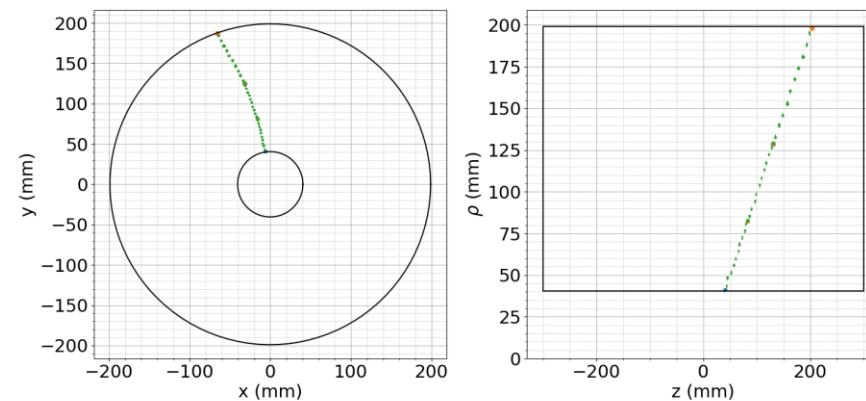
Electron 250 MeV



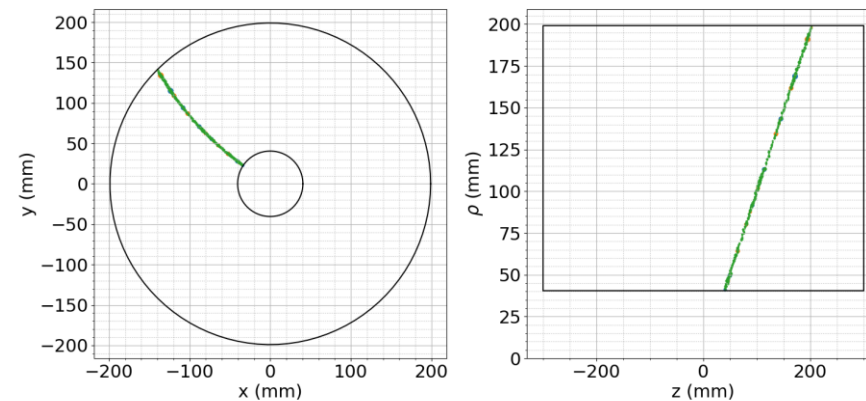
Pion 250 MeV



Muon 250 MeV



Kaons 250 MeV



dE/dx exercise I

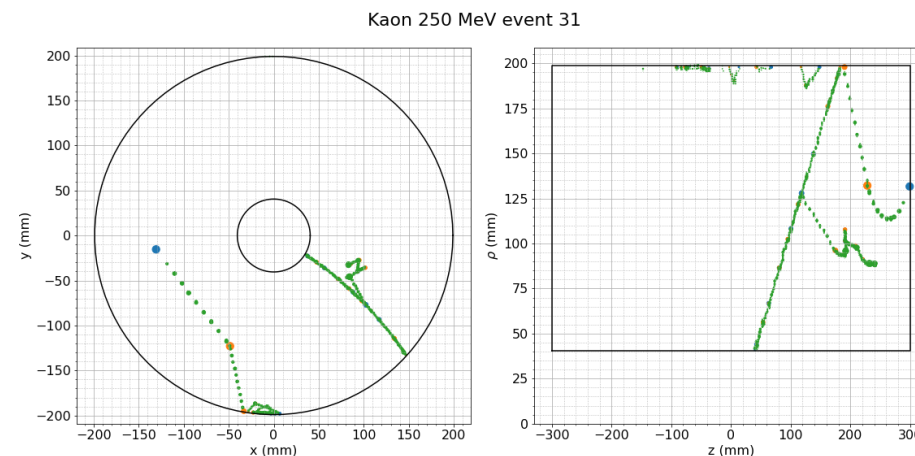
Particle gun input

- Constant polar angle = $\pi/4$
- Uniform azimuth angle
- Particle types: e^- , μ^- , π^- , K^- , p
- Constant momenta: 100, 150, 200, 250, 300, 400, 500, 600, 1500 MeV
- 1000 events for each {particle, momentum} combination

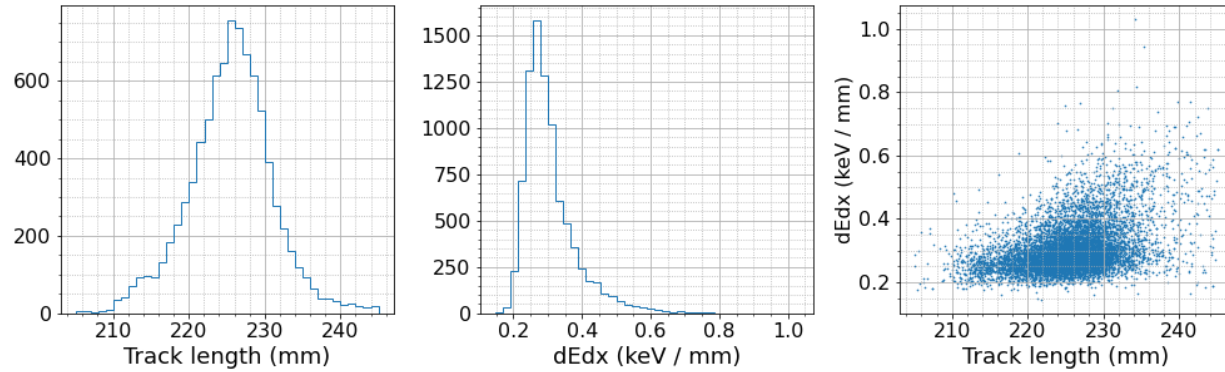
«Tracking»

1. For each time frame find «center of mass» of triggered pixels $\equiv$ 3D hits
2. Connect neighbor 3D hits
3. Profit

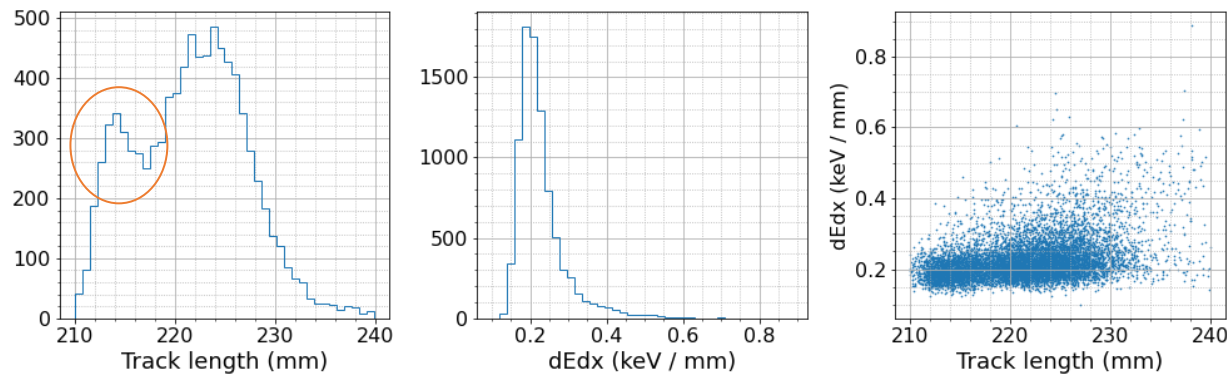
Fancy events should be filtered out



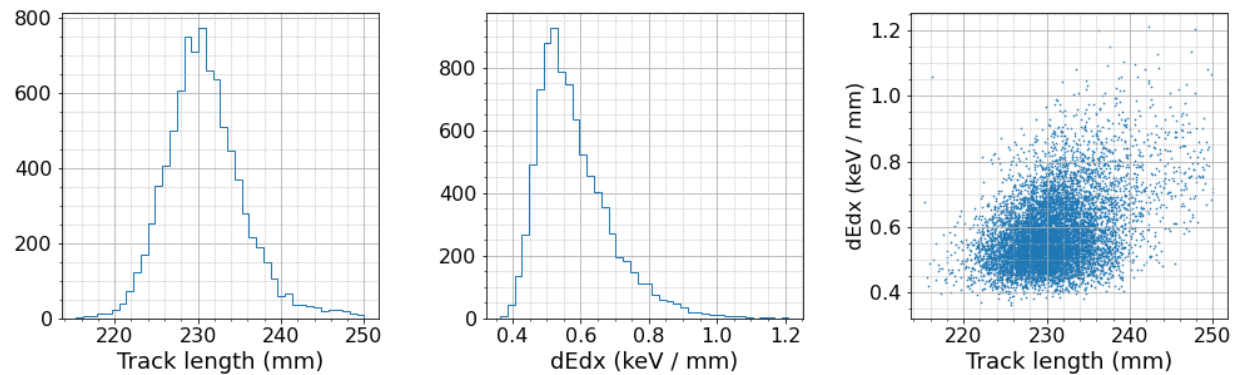
dE/dx exercise II



Kaons 600 MeV

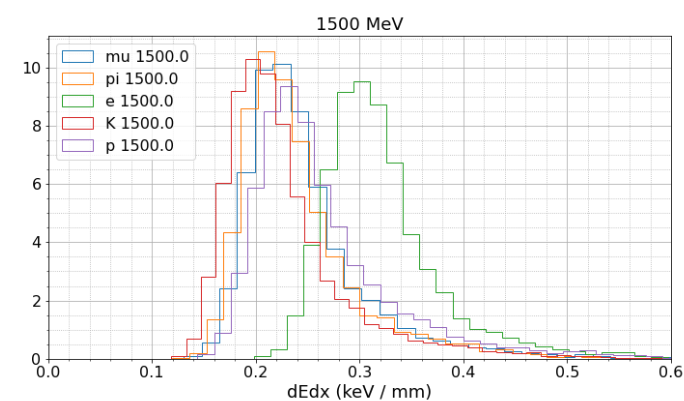
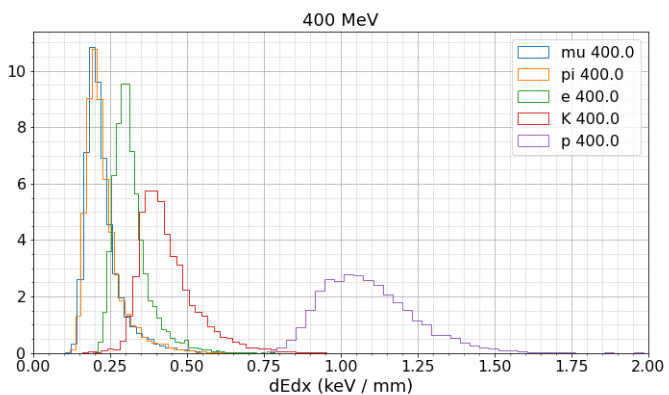
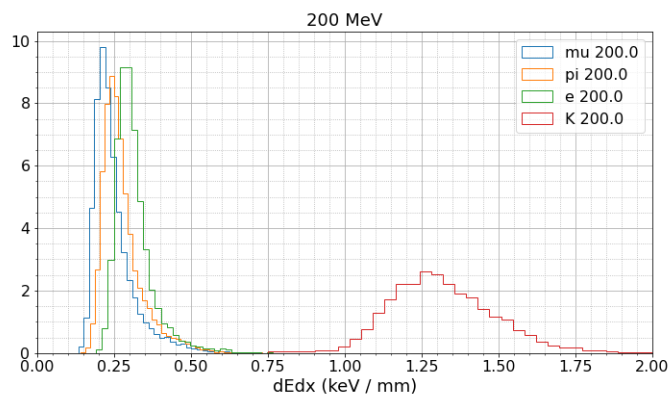
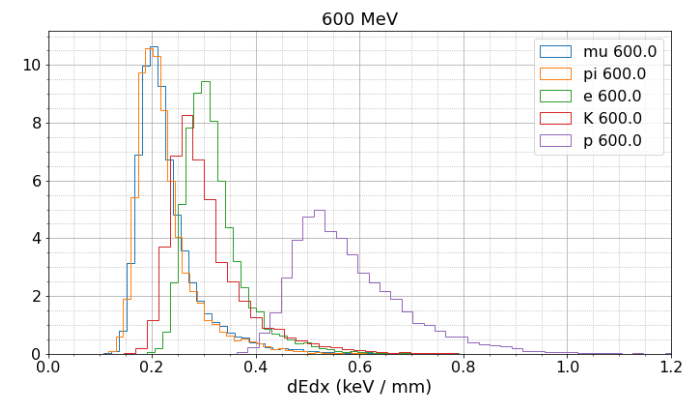
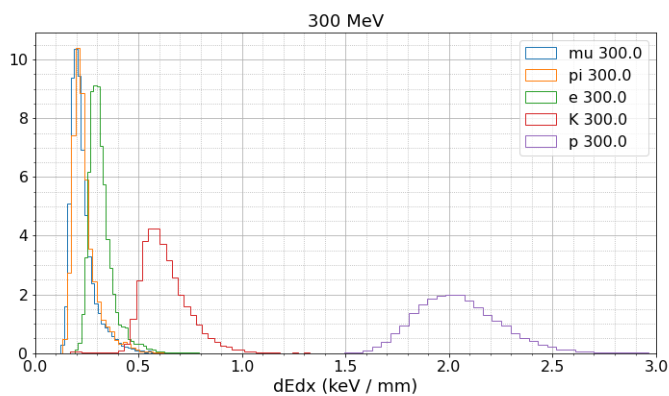
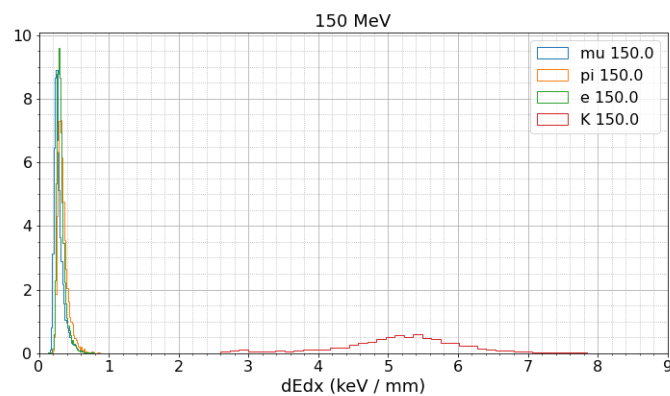
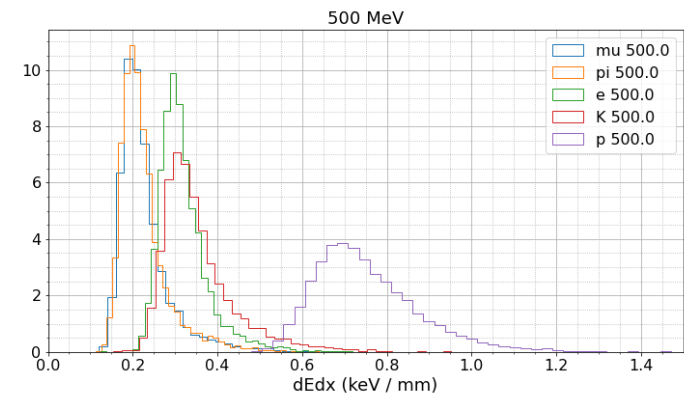
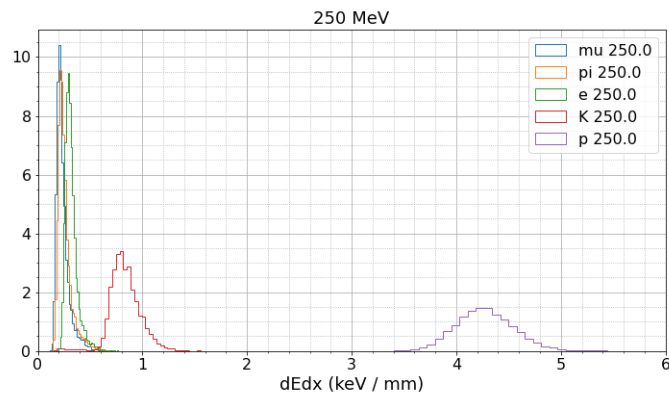
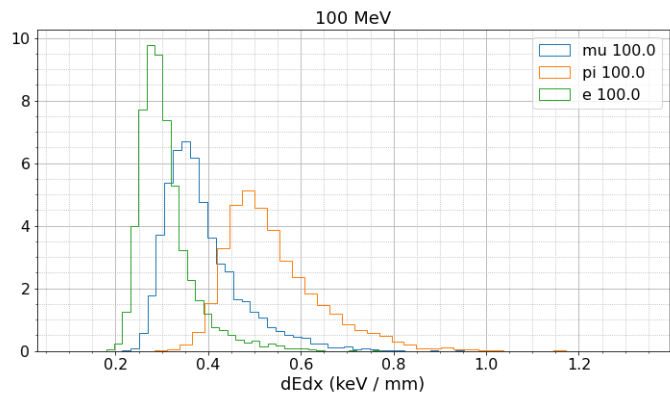


Muons 600 MeV



Protons 600 MeV

dE/dx exercise III



Next steps

1. Investigate dependence on Geant4 step size
2. Implement exponential distribution of distance between primary ionization clusters
3. Cluster finder and cluster fitter: ACTS! <https://acts.readthedocs.io/>
4. Obtain TPC geometry from geometry package, not as TPCDigiAlg parameters