Update CYGNO simulations

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CYGNO meeting 21/11/19

Summary of simulation activities

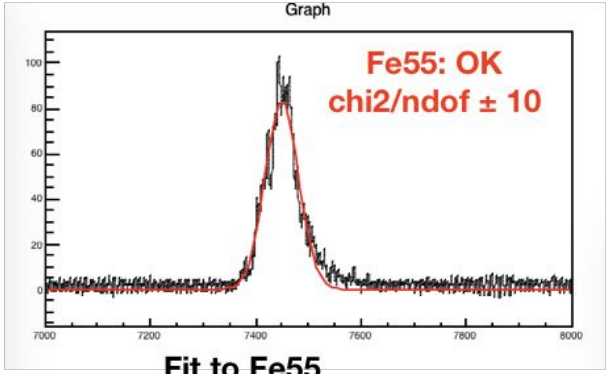
- **Background simulations** with GEANT4
  - ambient gamma/neutrons and shielding studies(Giulia, Gianluca)
  - internal background, radioactivity of the setup (Flavio, Giulia, Gianluca)
- **Signal simulations**: nuclear recoils with SRIM (Emanuele M., Davide)
- **Signal simulation with Geant4:** nuclear and electron recoils (Flavio, Giulia)
- **Drift and detector effect**: simulation of electron drift and diffusion with Garfield (Emanuele M., Davide, Flavio, D. Marques)
- Study of feasibility of **solar neutrino measurements**, electron range in different gas mixtures (Elisabetta, G. Dho, D. Marques)
- **Signal simulation:** PMT waveform (Elisabetta)

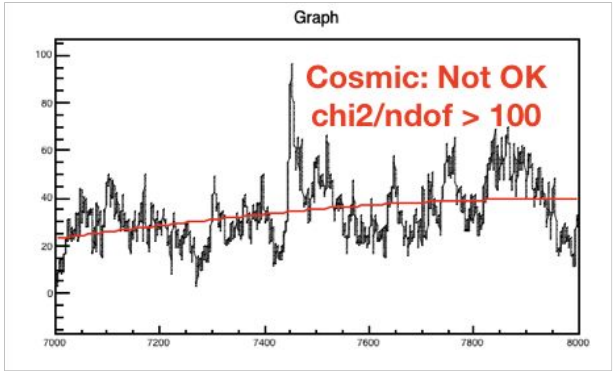
21.11.2019

Goal: simulate PMT signal to start working with Z coordinate

Strategy: fit to the Fe55 peak, and rescale for # of primary electrons (and their spatial spread) to have a template for a single ionisation cluster

(after having reverted the waveform and subtracted the baseline)





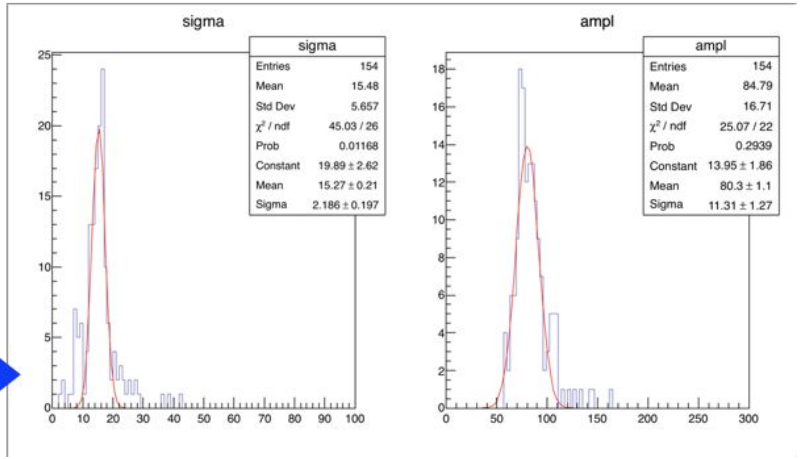
Fit to Fe55

Gaussian fit in range [7000,8000]

Require chi2/ndof <20

2160	1000	40	Pos 0 - Closest to the GEM
2161	1000	40	Pos 1
2162	1000	40	Pos 2
2163	1000	40	Pos 3
2164	1000	40	Pos 4
2165	1000	40	Pos 5

For each position, fit to the distribution of the fitted sigma and amplitude



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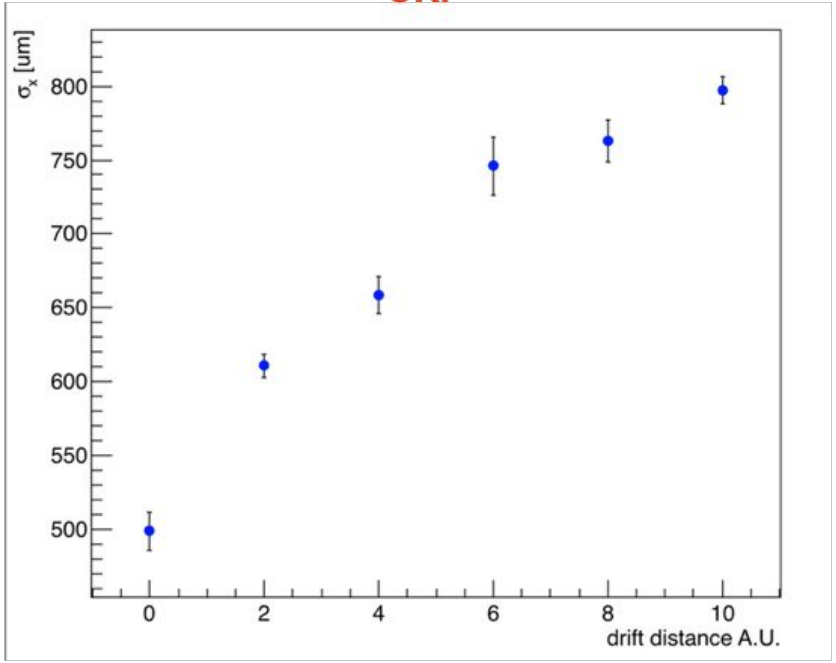
The fitted sigma are expected to show diffusion behaviour as a function of the drift distance —> OK!



Next step: starting from David simulation of primary ionisation cluster in electron tracks and Fe55, try to generate an electron/cosmic waveform and compare to data

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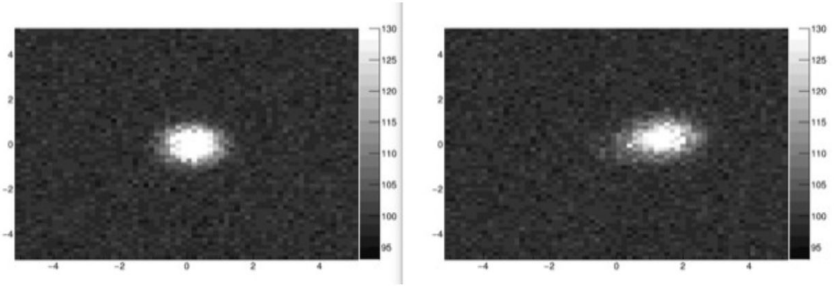
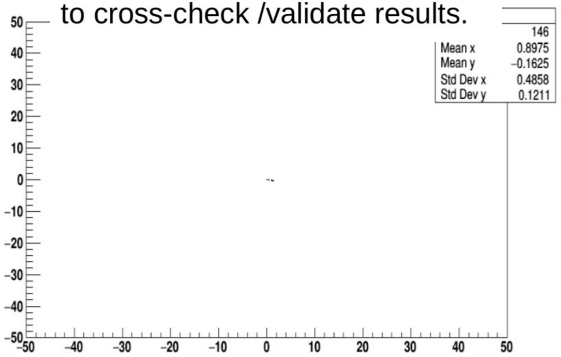
Caveat: will not know real drift distance until lead case is dismounted, but this is just a crosscheck, not really need to determine diffusion from this

D. Marques: simulation with Geant4-Garfield++

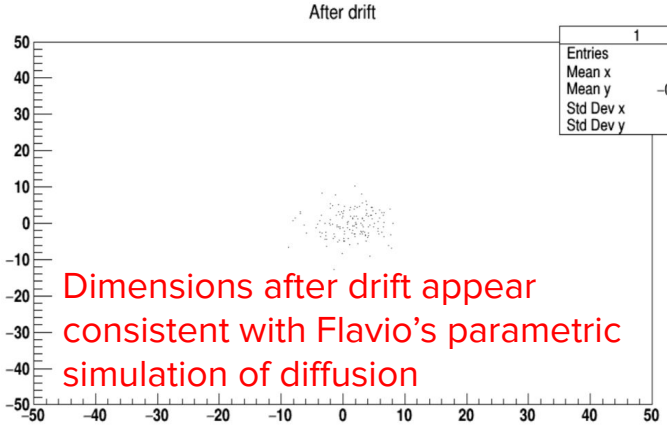
Data obtained (10 keV nuclei and e- recoil)



Next step: Apply the "digitalization/ reconstruction" software to the simulated tracks to cross-check /validate results.



Simulation with GEANT4-Garfield++ interface

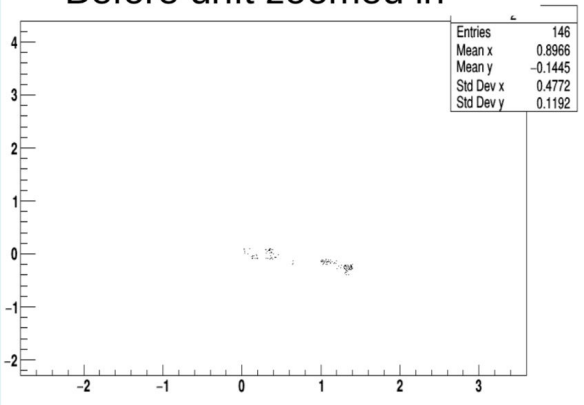


Dimensions after drift appear consistent with Flavio's parametric simulation of diffusion

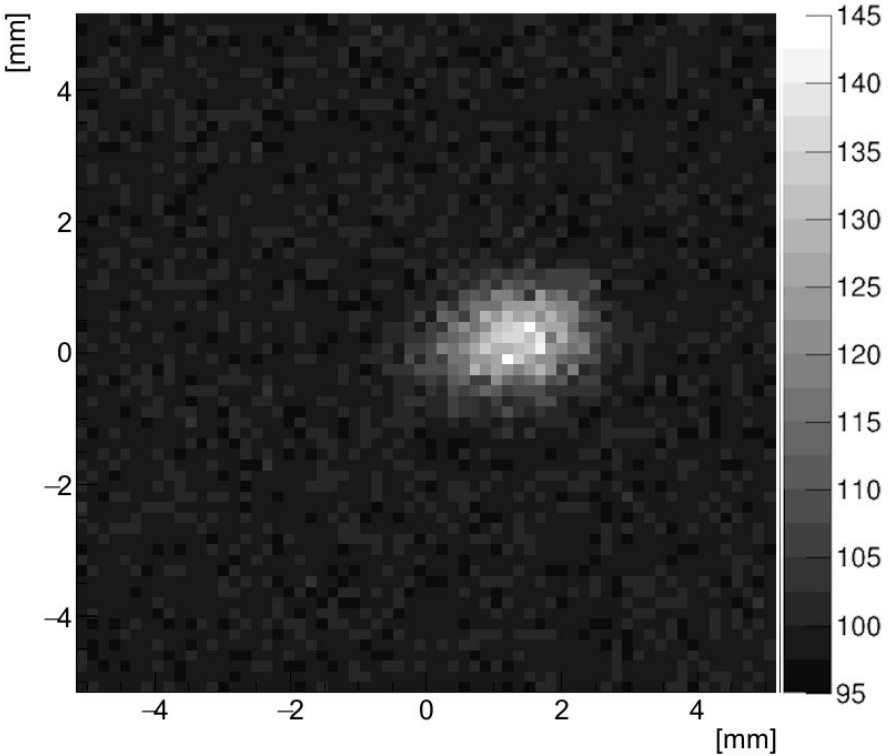
Simulation parameters:
-Energy: 10 keV
-Particle: e-
-Initial position (x,y,z): (0,0,0)
-Momentum (x,y,z): (1,0,0)
-Electric Field: 400 V/cm (top -> bottom)
-Readout plane: xy (at z=-50cm)
-Chamber size: 1m3
-Drift distance: ~50cm

'Before drift' is a xy projection of the track. The actual tracks produced are in 3D

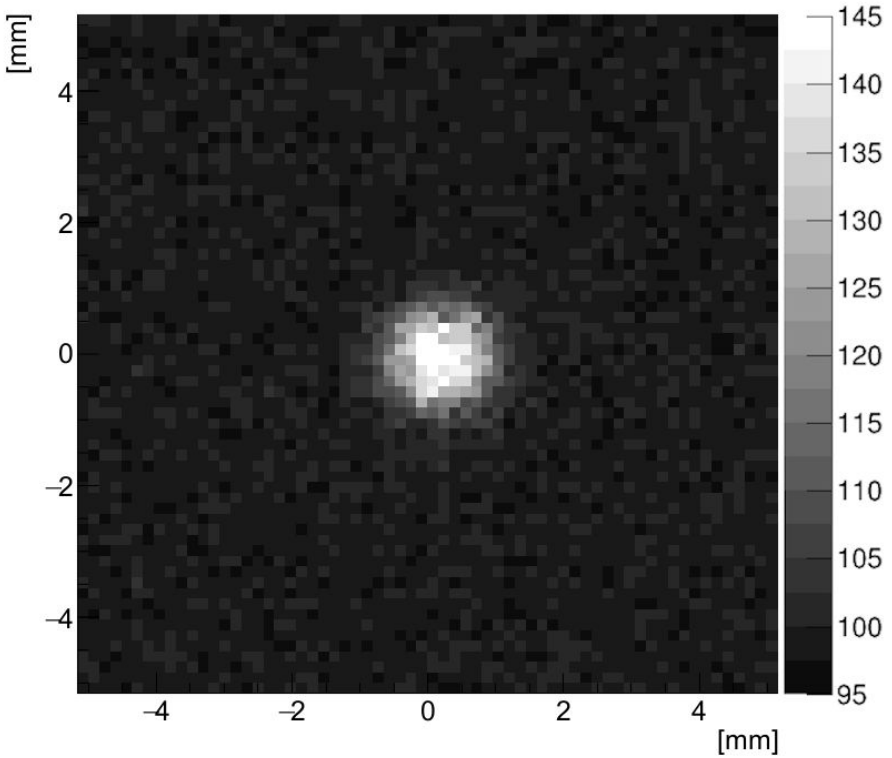
Before drift zoomed in



Tracks of low energy produce only a few hits, than they appear like a bubble

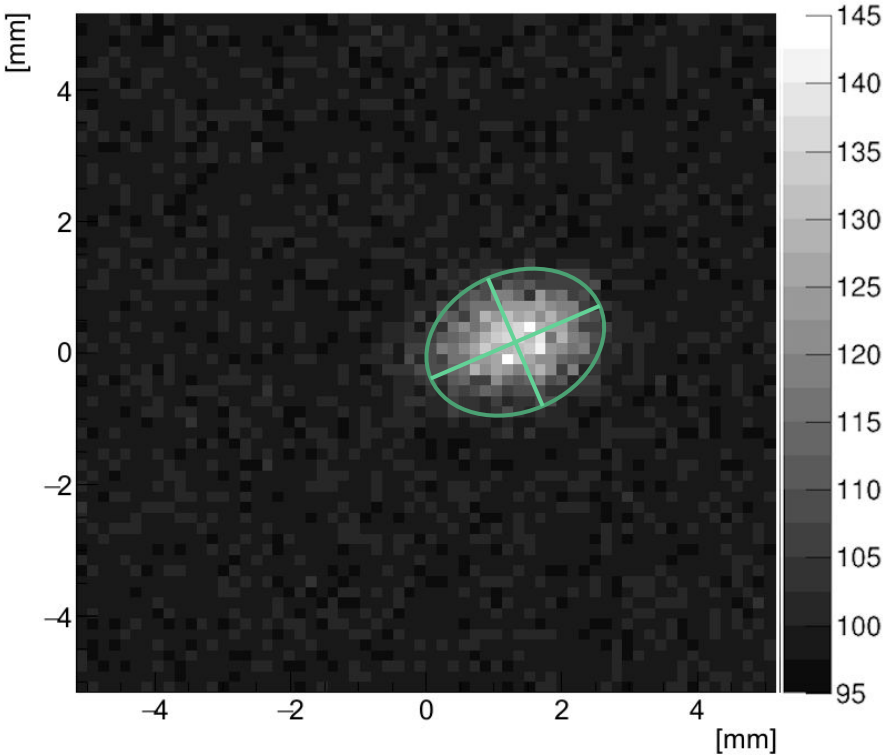


10keV electron

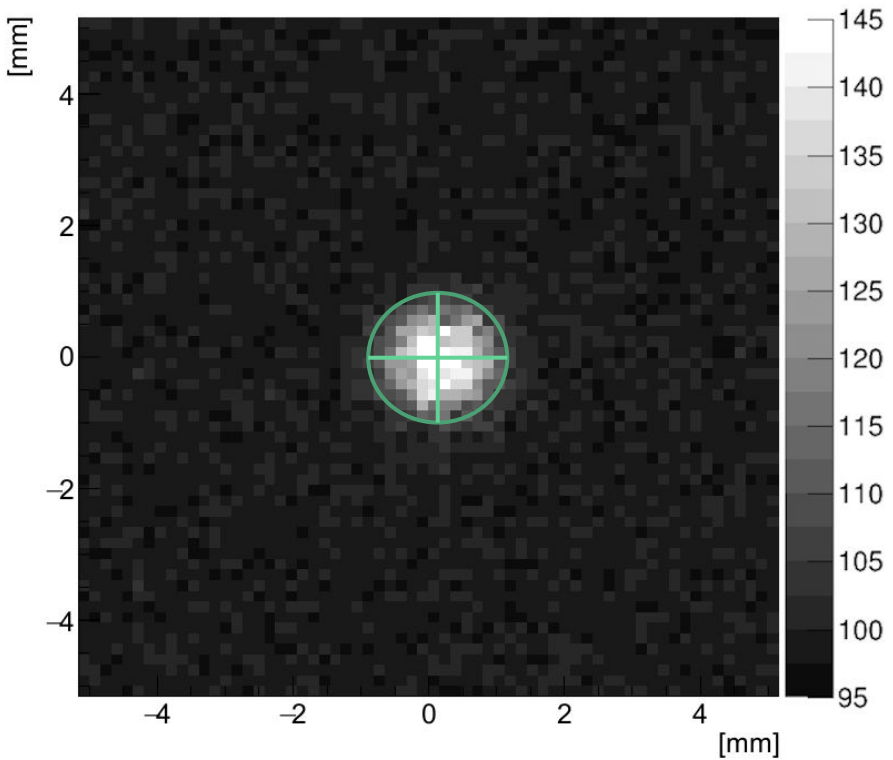


10keV Helium

Can **eccentricity** be a good observable to distinguish ER and NR at low energies (<20keV)?



10keV electron



10keV Helium