Full triple-GEM digitization in magnetic field

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From last presentation – Mar 30th '17

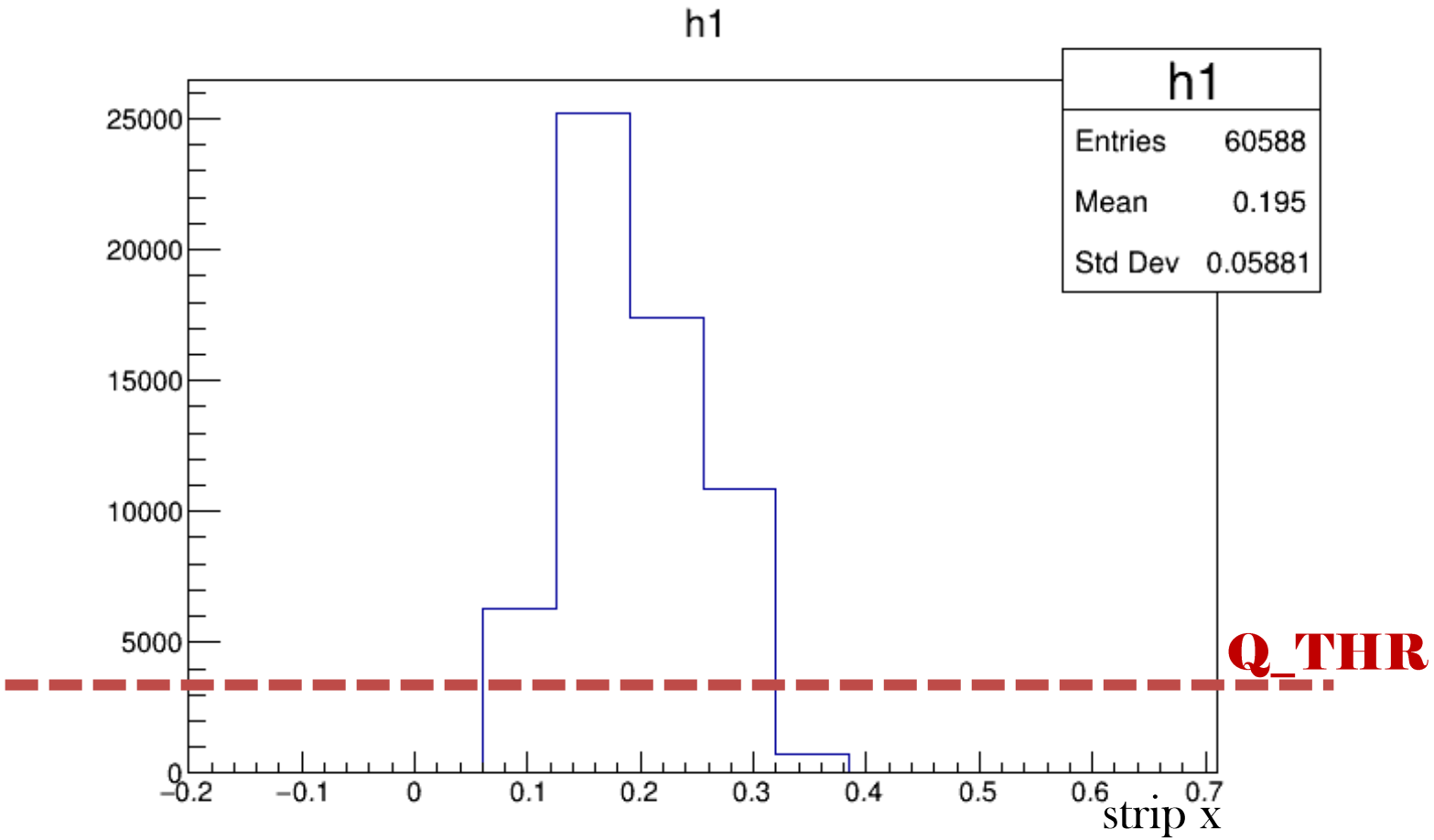
- Simulation of the signal formation on the anode (!)
  - Maxwell?
  - APV simulation on 1° step
  - Interact with the TIGER group for final electronics
- μTPC reconstruction (!)
- Noise (info from testbeams)
- Charge threshold
- Test on tracks @ different angles
- Tune the simulation with testbeam results (!)
- Use dE/dx from Geant4 as input

Updated situation

- Simulation of the signal formation on the anode ✓DONE simplified
  - Maxwell?
  - APV simulation on 1° step
  - Interact with the TIGER group for final electronics
- µTPC reconstruction ✓DONE
- Noise (info from testbeams) ✓DONE
- Charge threshold ✓DONE
- Test on tracks @ different angles
- Tune the simulation with testbeam results (!)
- Use dE/dx from Geant4 as input ✓ALMOST DONE

Charge Threshold

- Q_threshold applied for strip readout
- Tunable to resemble the real readout



Random Electronic Noise

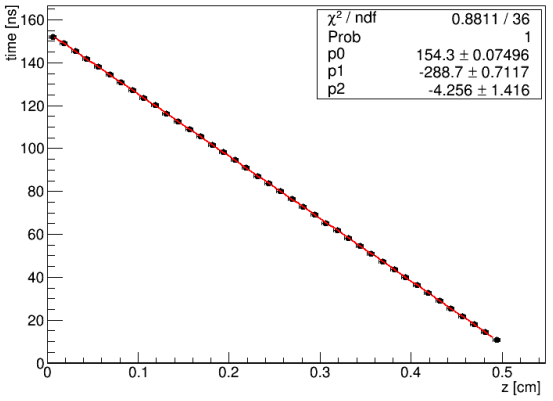
- Electronic noise applied:
  - Sampled from a **Gaussian**, $\mu = 0$, $\sigma = Q\_threshold$
  - Tunable on the **pedestal** data from TB (now it is tuned on the simulated gain values)
  - On **each strip**
  - Applied **before the simulation** of the signal

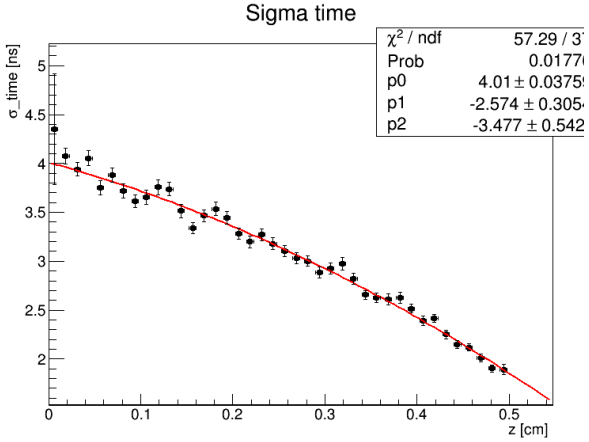
Time of the electrons (1)

SIMPLIFIED VERSION

Time values (and uncertainty) calculated from GARFIELD in the same way as the x displacement

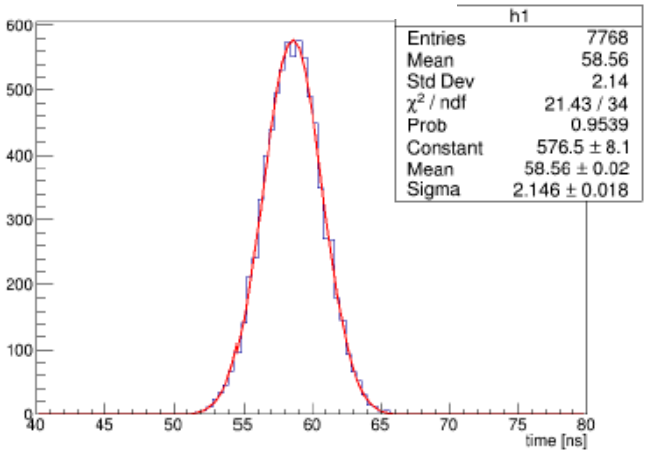
DRIFT GAP



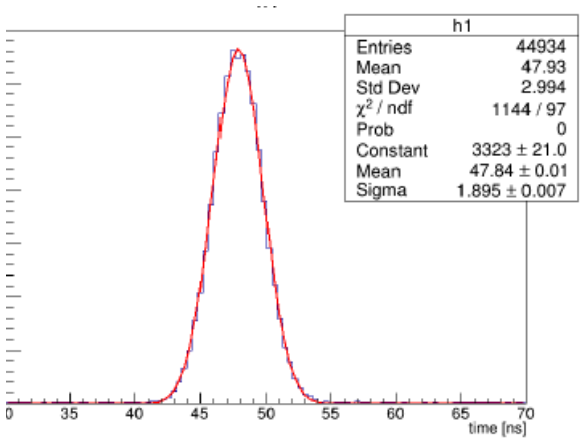


- t depends on z in the drift gap, does not in the transfer/induction gaps
- In digitization code: sampling from gaussian with μ and σ from GARFIELD

TRANSFER GAP



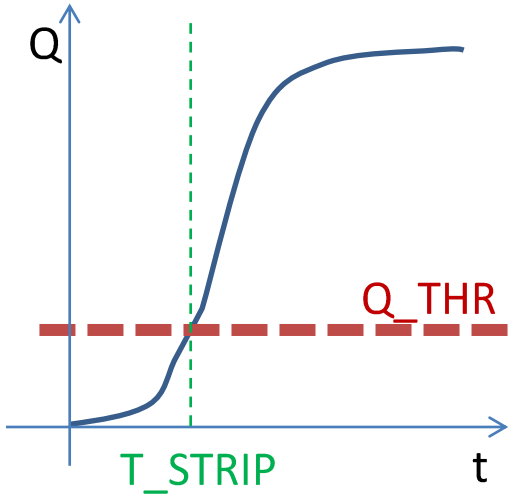
INDUCTION GAP



Time of the electrons (2)

SIMPLIFIED VERSION

- For each electron arriving on a strip, the time is computed
- The charge is also calculated and when the total charge on the strip (forming the signal) crosses the Q_threshold the time of the i-th electron is taken as signal time

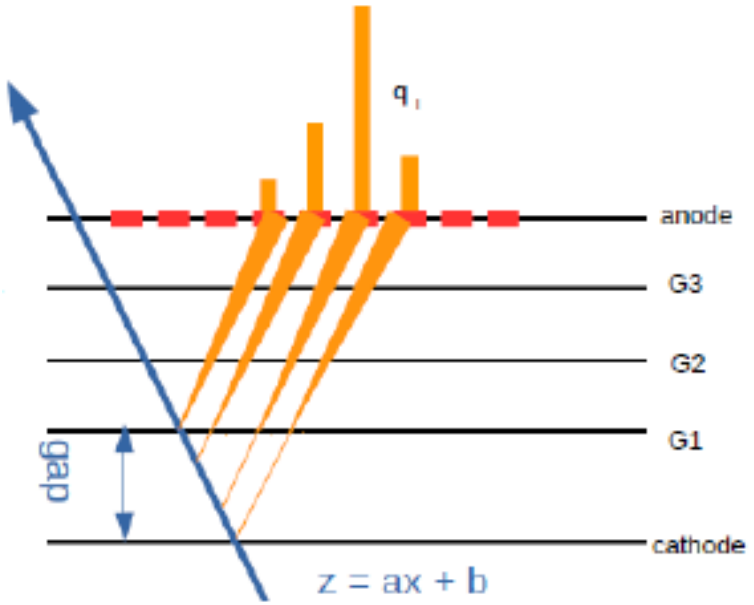


- **NEXT TO DO:**
  - more realistic signal/readout simulation

μ-TPC reconstruction

- For each firing strip we have the signal time t_i
- For now we apply a constant drift velocity = 3.5 cm/μs (from GARFIELD)
- The position is calculated $z_i = v_d \times t_i$
- The z_i vs x_i (position of the strip) is plotted and fitted with a line
- The $x_{\mu\text{-TPC}}$ is computed

$$x = \frac{\frac{gap}{2} - b}{a}$$



- **NEXT TO DO:**
  - Study $v_d(E)$
  - Implement Lorentz angle correction

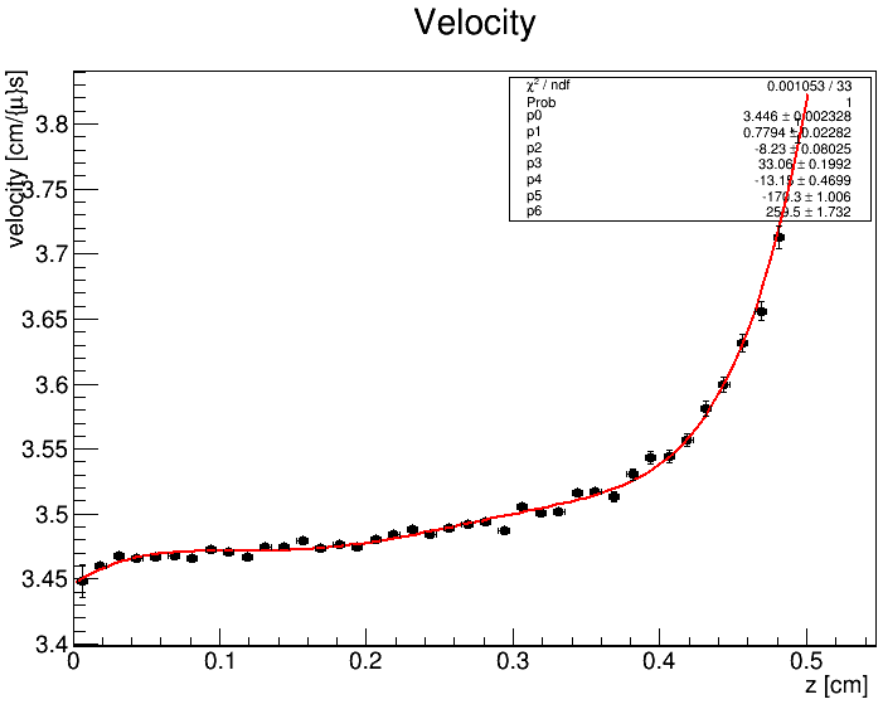
dE/dx GARFIELD *vs* GEANT4

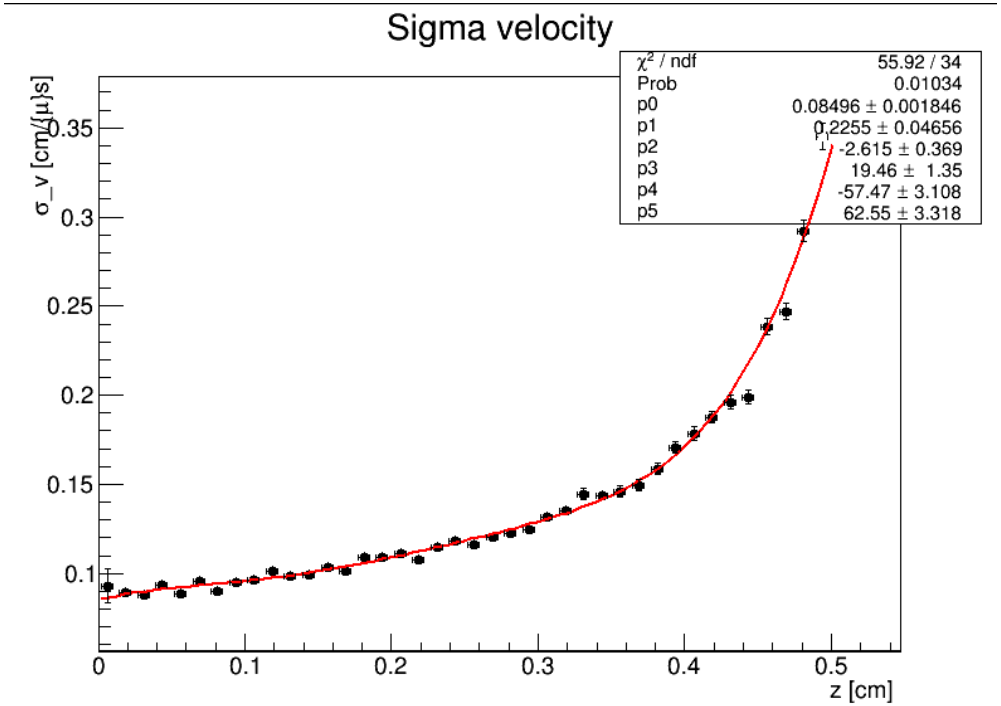
- The class of Geant4 **G4ElectronIonPair** provides the number and positions of the electrons from ionization along the particle track
- We want to use these as starting point for digitization, instead of sampling them inside the code

- **ONGOING:**
  - finalization of the drift gap simulation in GEANT4
- **NEXT TO DO:**
  - comparison of the results obtained with GARFIELD and GEANT4

SPARE

drift velocity





$$[\text{HERE}]\ V\_drift = \frac{(x\_anode - x\_generation)}{(t\_arrival - t\_generation)}$$