Simulation and reconstruction of electron drift velocity for MPD TPC.

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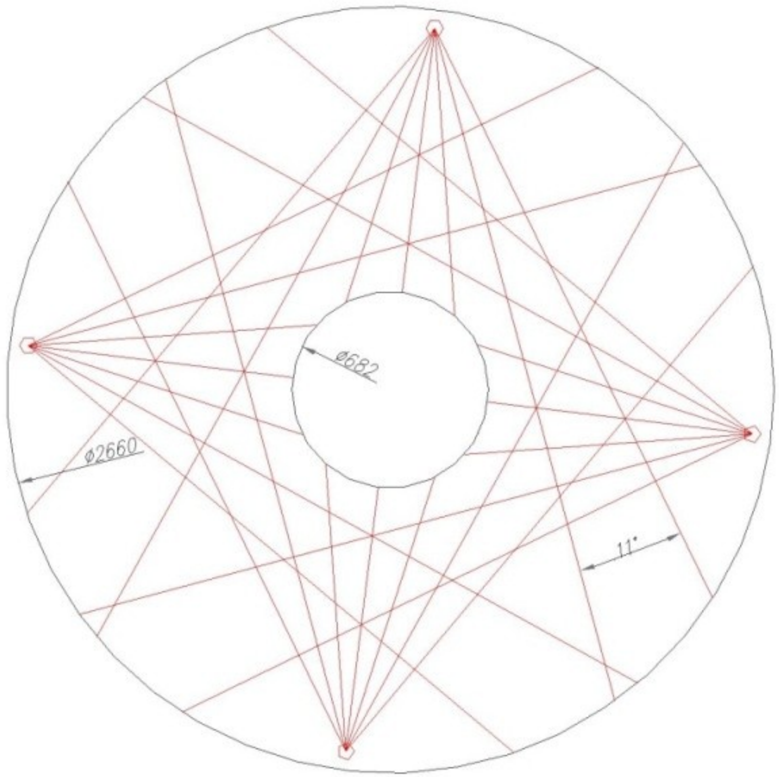
2022

Motivation

- Electron drift velocity in gas depends on external environment:
  - temperature, atmosphere pressure, etc.
- Electron drift time as well as Z coordinate of reconstructed point depends on drift velocity
- Some method is needed to measure electron drift velocity and thus provide corrections of Z coordinate of reconstructed point

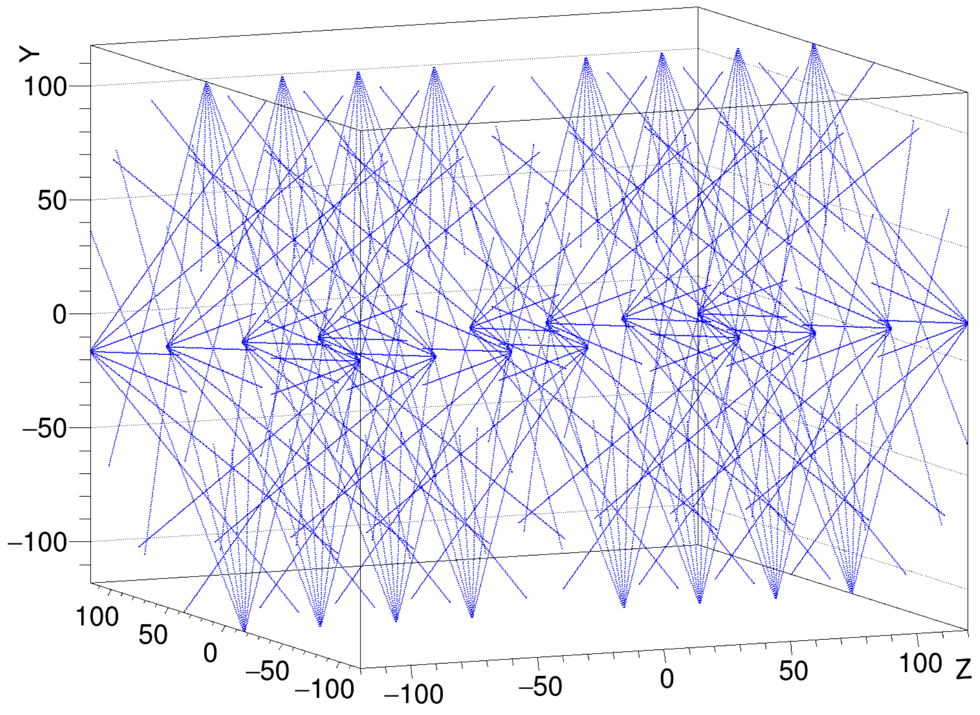
TPC calibration laser grid

- UV laser system
  - Two pulsed 130 mJ 5-7 ns Nd:YAG lasers
  - 224 laser beams in total
  - 112 “tracks” in each half of the TPC
    - 4 planes of laser beams, 300mm between planes



Simulation of laser beams grid with MPDRoot

- Muons instead of photons
- No magnetic field
- Abandon muon track where it cross the TPC walls

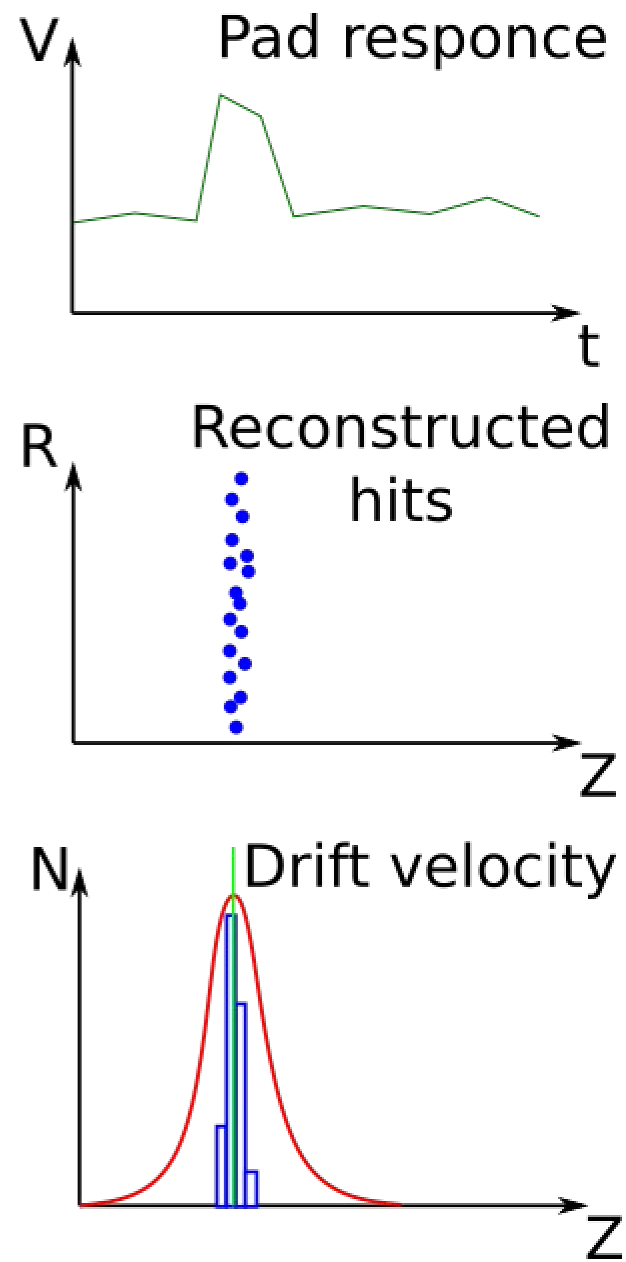


Features of drift velocity calculation algorithm

- Finding Z coordinate of laser beams plane
- Easy scalable, can be applied to
  - whole TPC
  - half of TPC
  - sector of TPC
- Can be adjusted to work with laser grid response only (with/without cosmic muons) or laser grid and event mixed response

Drift velocity calculation algorithm

- Based on Z-position / drift-time distribution of all reconstructed points in event
- Laser grid planes forms high peaks in their position
- Gauss fit of the peaks determines meas position of laser grid planes
- Distance between meas and true position of laser grid planes provides adjust information for Z position of reconstructed points



Drift velocity map

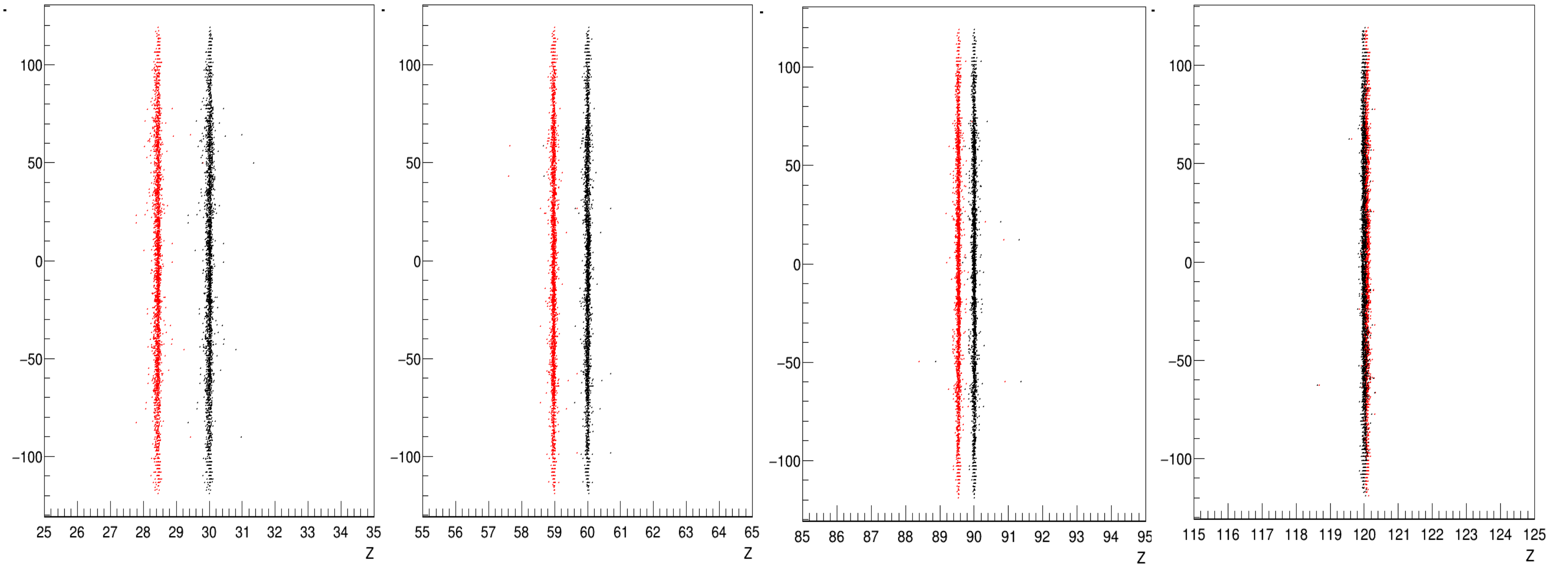
- N (500-1000) events of laser grid to acquire enough statistics
- Map is built for every sector
- Drift velocity calculates for every laser grid plane in each sector
- Adjust information for each reconstructed point obtained as interpolation between data for corresponded laser grid planes
  - Adjust information on pad plane assumed the same as on the nearest to it laser grid plane
  - Adjust information on central electrode assumed the same as on the nearest to it laser grid plane, respectively

Correction Math

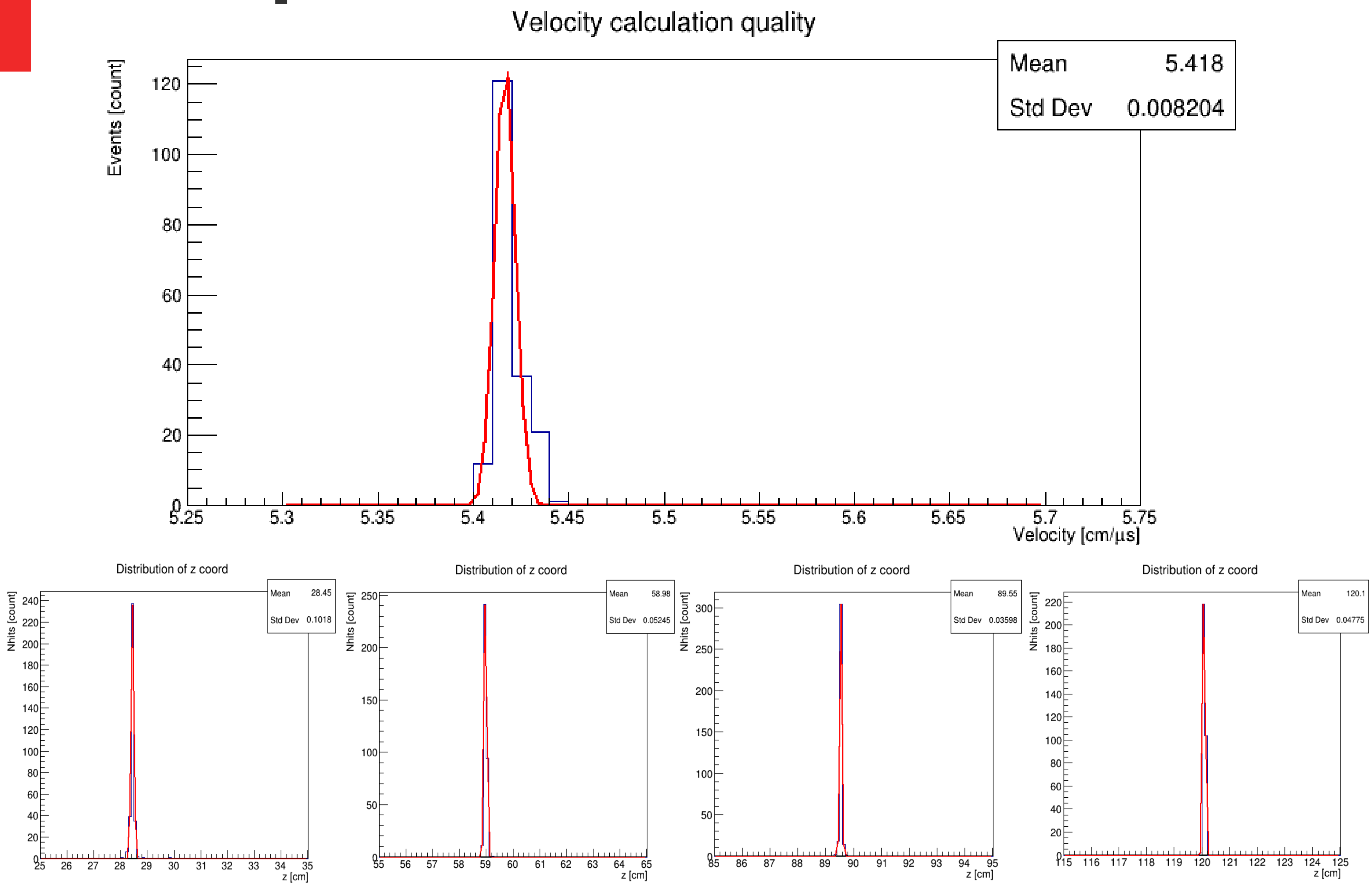
- Based on differences in true (calculated with default theoretical drift velocity) and meas positions of laser grid, instead of differences in drift time for known drift length
- $Z_{corr} = L_{dr} - \left(L_{dr} - |Z_m|\right) \cdot \sqrt{\alpha_{corr}}$
  - Z_{corr} – corrected Z coordinate of hit
  - Z_m – meas with true drift velocity Z coordinate of hit
  - L_{dr} – max drift distance between HV electrode and Pad Plane
  - α_{corr} – correction coefficient
    - $\alpha_{corr} = \frac{1}{N} \cdot \sum_N \left(\frac{L_{dr} - |Z_{layer\,true}|}{L_{dr} - |Z_{layer\,meas}|}\right)^2$
    - $Z_{layer\,true}$ – true position of laser grid layer
    - $Z_{layer\,meas}$ – meas with assumed drift velocity position of laser grid layer
    - N – events count

Example
(drift velocity in half of TPC)

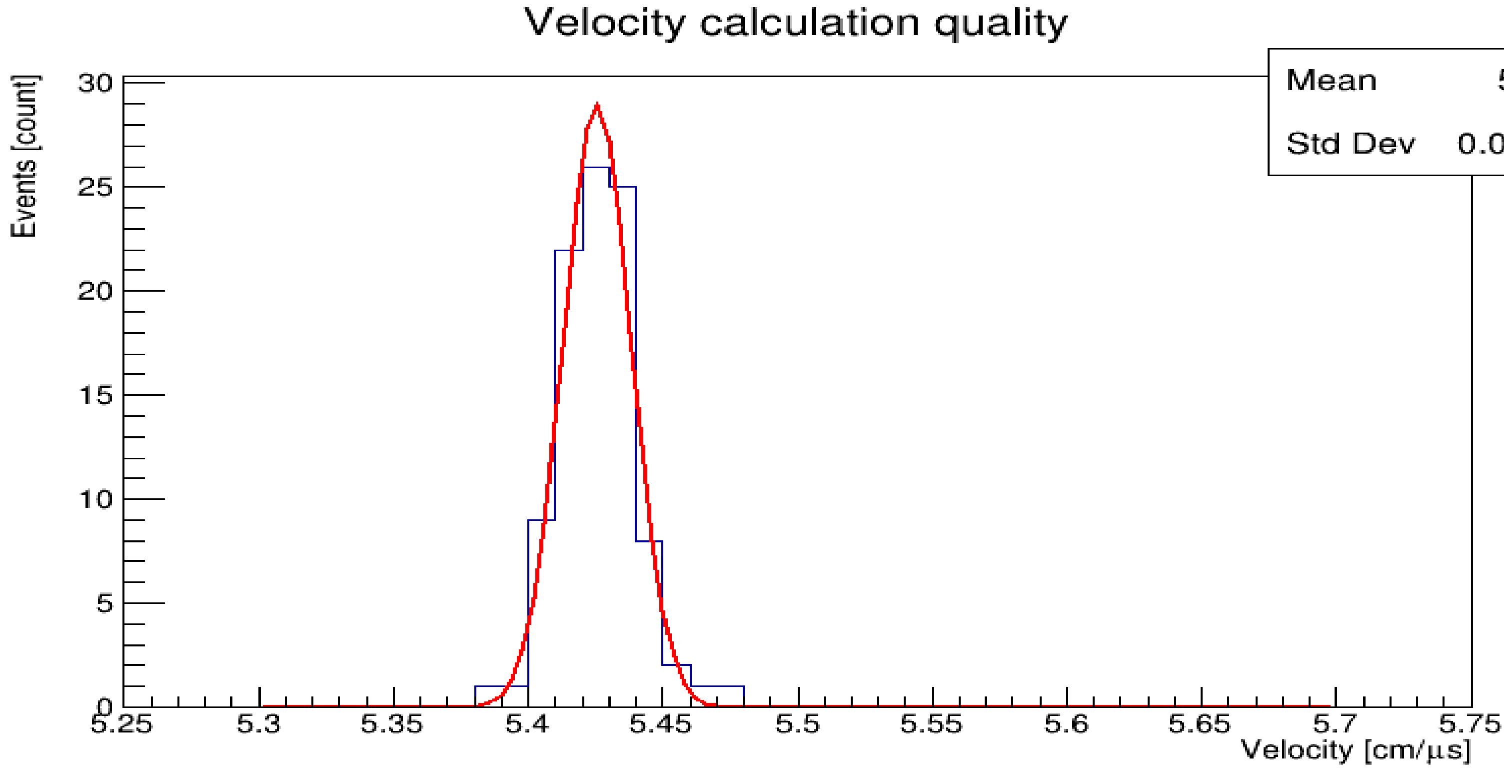
- Source data
  - Assumed drift velocity - 5.5 cm/µs
  - True drift velocity during simulation 5.4 cm/µs
  - Test on laser grid itself
    - Red — meas position
    - Black — corrected position

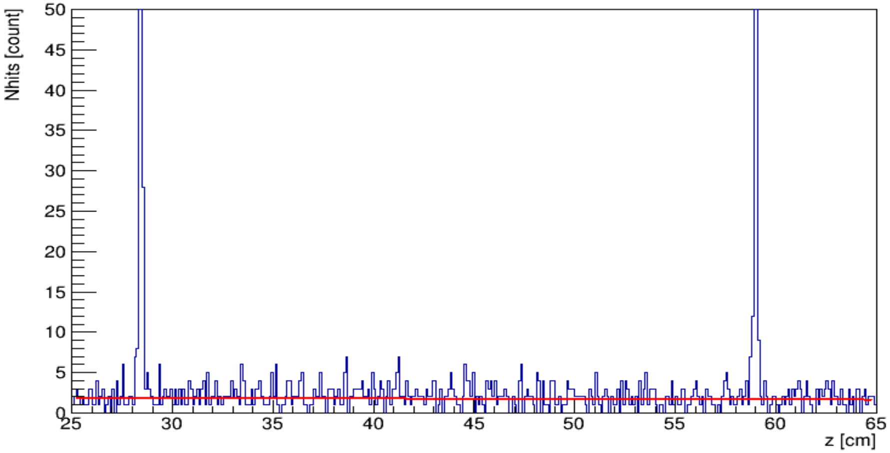


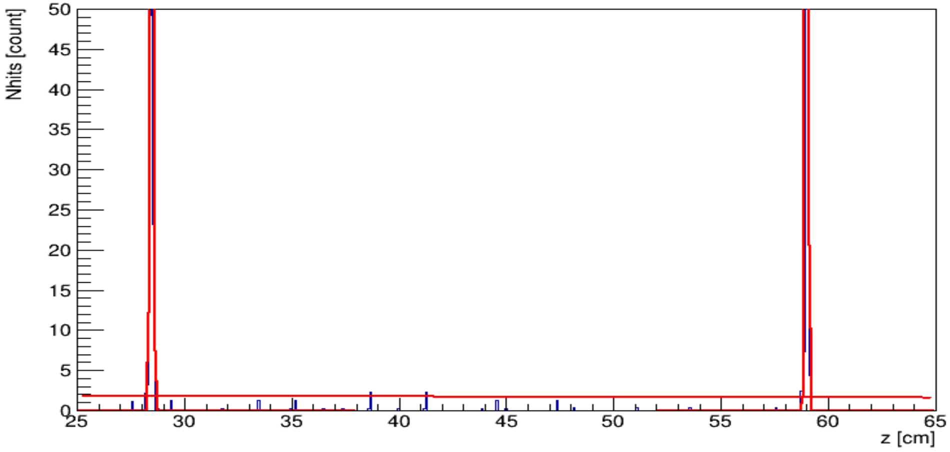
Example


Velocity calculation quality
Mean 5.418
Std Dev 0.008204
Events [count]
Velocity [cm/µs]
Distribution of z coord
Mean 28.45
Std Dev 0.1018
Distribution of z coord
Mean 58.98
Std Dev 0.05245
Distribution of z coord
Mean 89.55
Std Dev 0.03598
Distribution of z coord
Mean 120.1
Std Dev 0.04775
Nhits [count]
z [cm]

Example with “pedestal”







Future plans

- Add Y dimension to make ZY map for each sector
  - this allows to correct to some extent distortions from local charges
- Improvements in reliability
  - Improve quality of removing “pedestal” if it’s exists and automate its detection
- Create a standalone implementation for on-line TPC monitoring