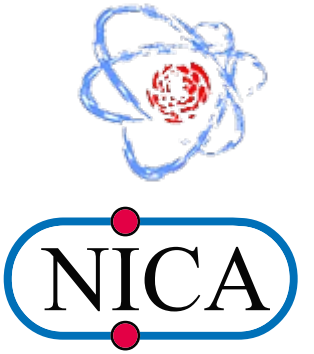
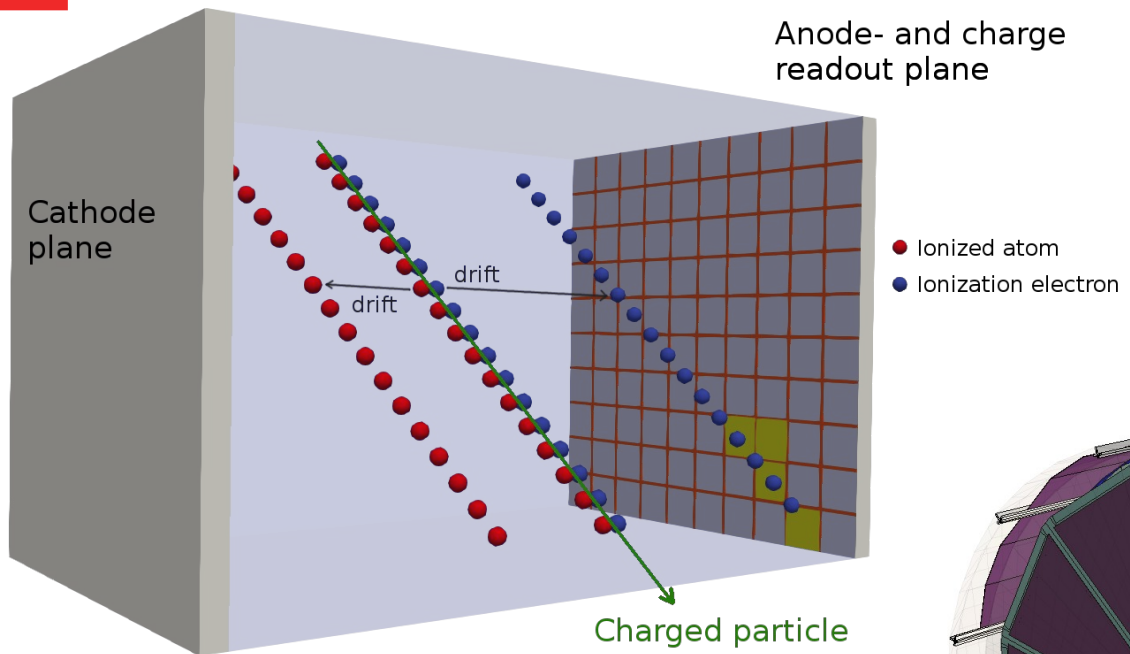


Simulation and reconstruction of electron drift velocity for MPD TPC

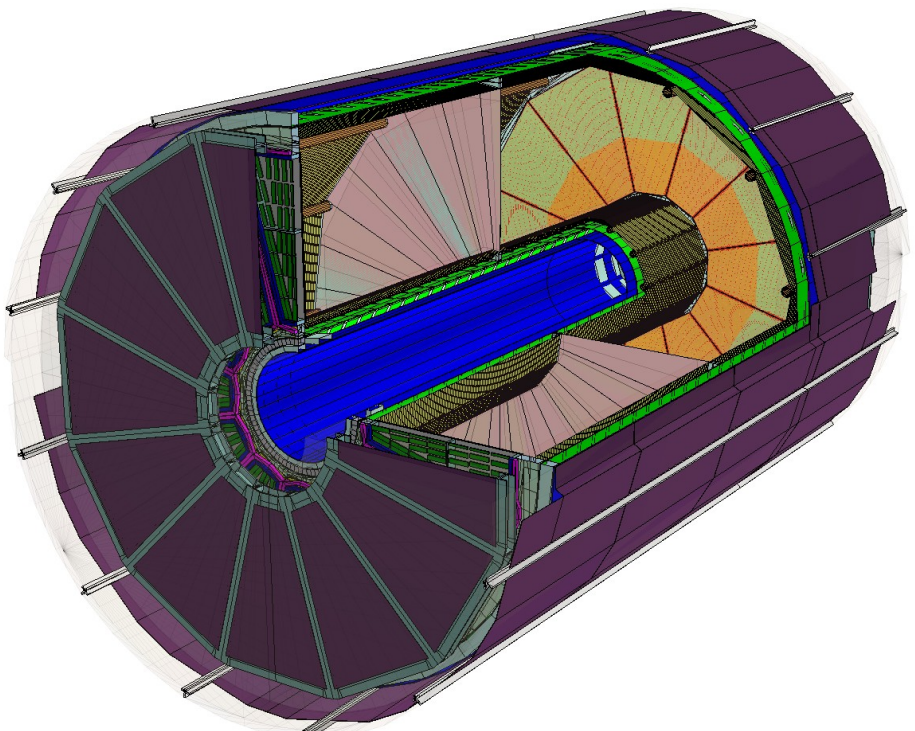
Alexander Bychkov (VBLHEP)

2022

Time Projection Chamber (TPC)



MPD TPC
simulation model



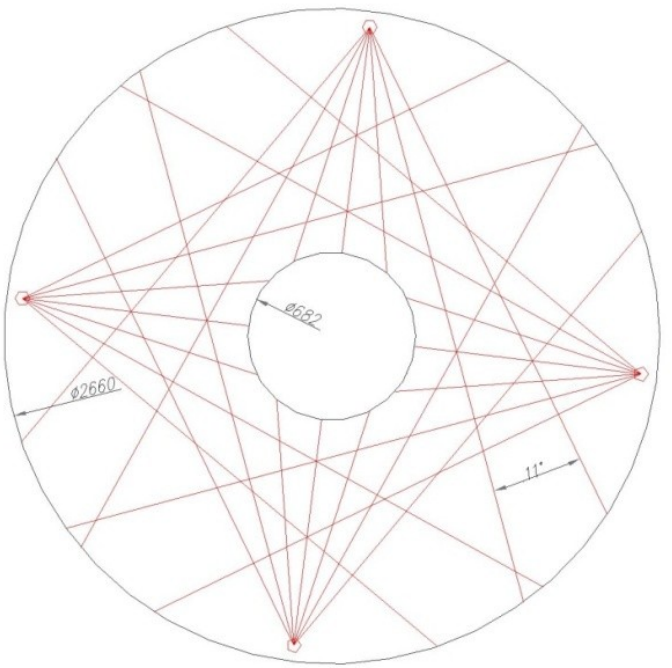
Motivation

- 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 providing corrections of Z coordinate of reconstructed point

TPC calibration laser grid

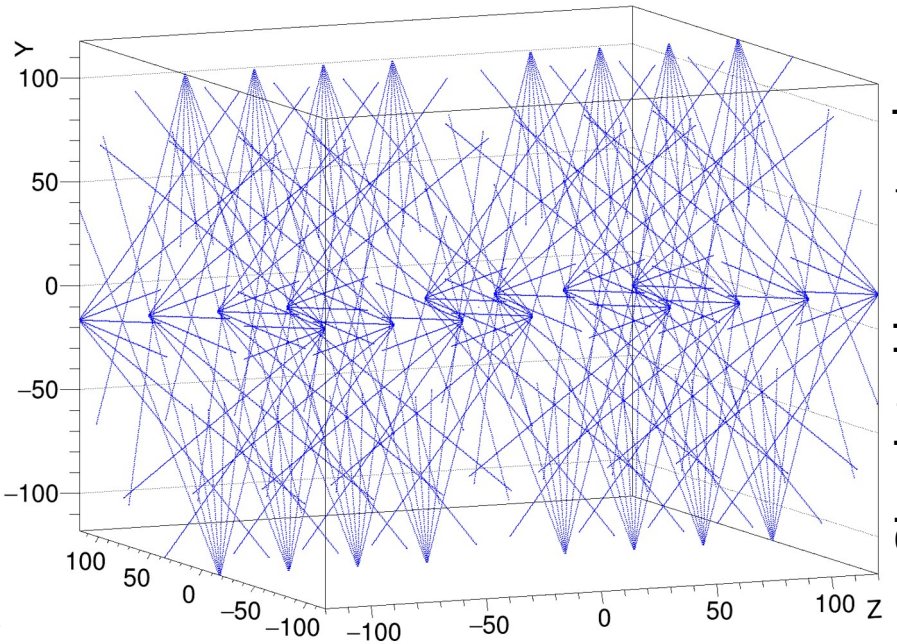
- UV laser system
  - Two pulsed 130 mJ 5-7 ns Nd:YAG lasers
    - ~1mm diameter
  - 224 laser beams in total
  - 112 “tracks” in each half of the TPC
    - 4 planes of laser beams
    - 30 cm between planes
  - 10 Hz impulses
  - The same trigger as for event
    - Laser tracks combined with event tracks

Design of single plane

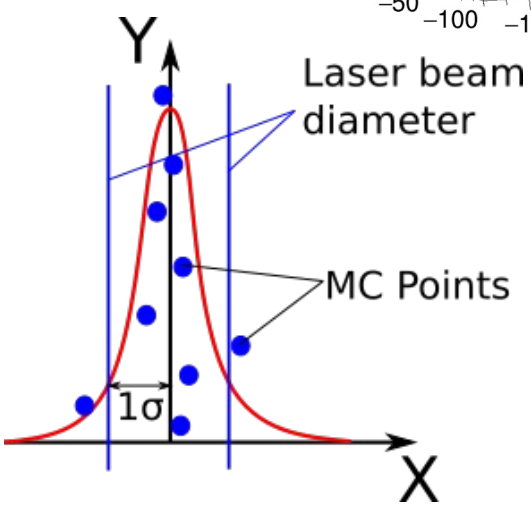


Simulation of laser beams grid with MPDRoot

- High energy muons instead of photons
- No magnetic field
- Abandon muon track where it cross the TPC walls
- Smearing of Monte-Carlo Points across a beam
  - Gauss
  - 1σ = beam diameter



Simulated beam tracks of laser grid

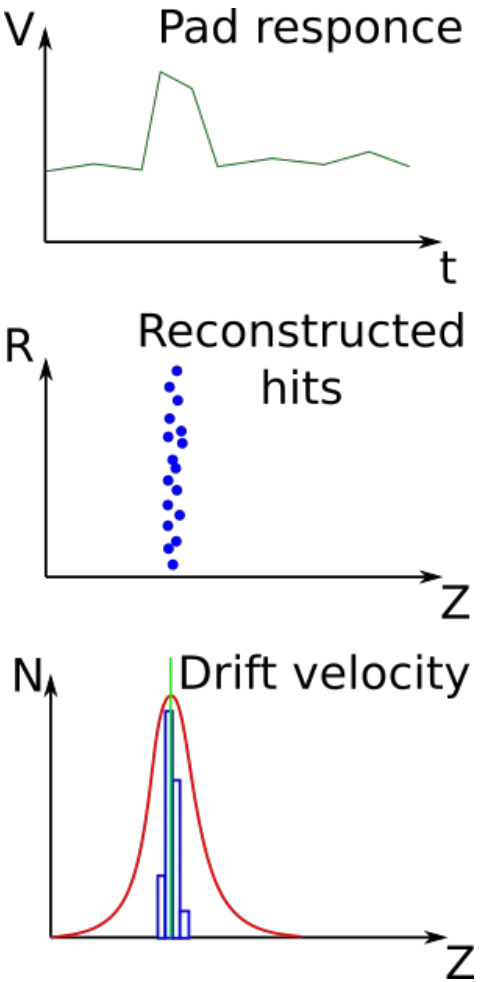


Features of drift velocity calculation algorithm

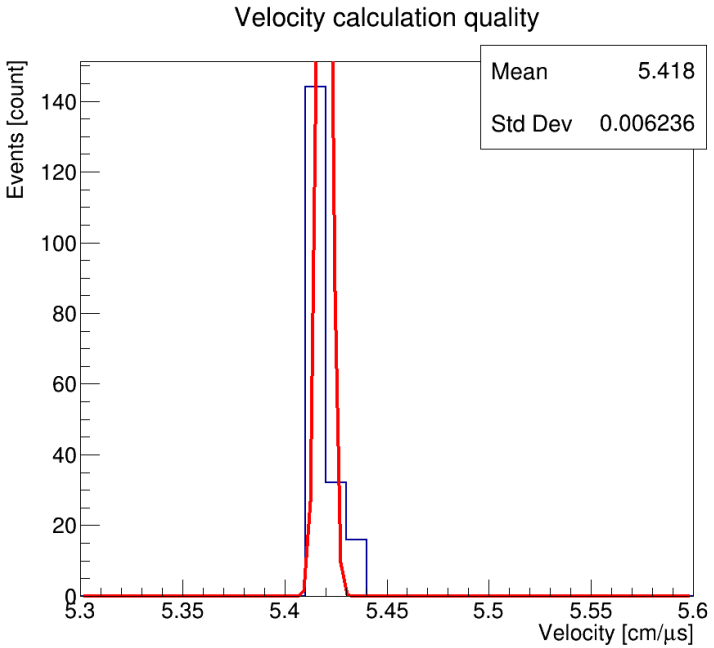
- Finding Z coordinate of laser beams plane
- Easy scalable, can be applied to
  - whole TPC
  - half of TPC
  - sector of TPC
  - area of TPC sector
- Can be adjusted to work with laser grid response only (with/without cosmic muons) or laser grid and event mixed response

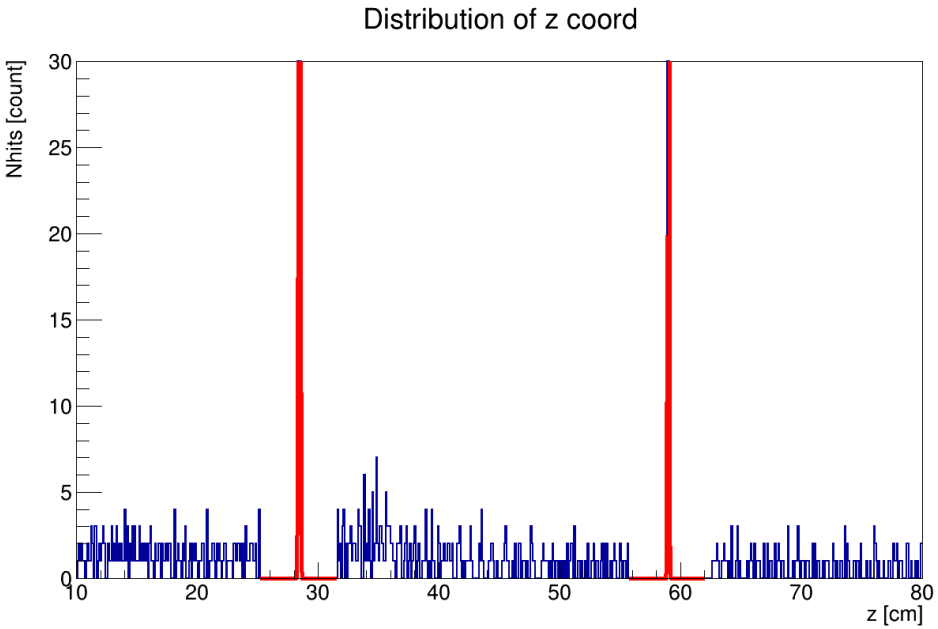
Drift velocity calculation algorithm

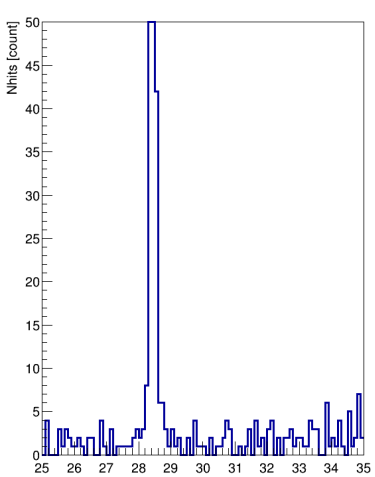
- Based on Z-position / drift-time distribution of all reconstructed points in event
- Laser grid planes forms high peaks on their position
- Wavelet filtering of non laser grid data
  - Rough peak finding and local wavelet transformation for faster calculations
- Gauss fit of the peaks determines measured position of laser grid planes
- Distance between measured and true position of laser grid planes provides adjust information for Z position of reconstructed points

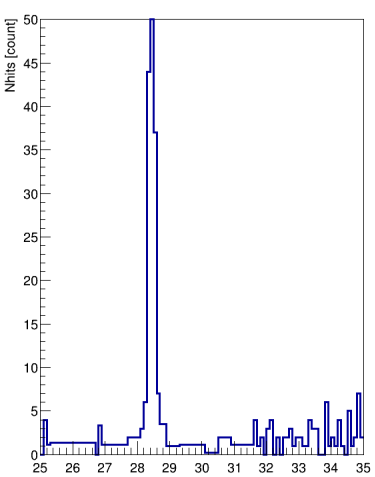


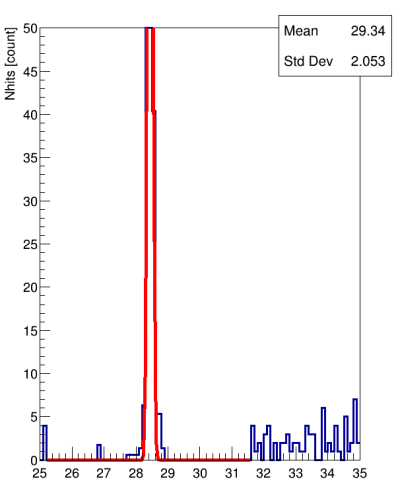
Example


Velocity calculation quality
Mean 5.418
Std Dev 0.006236
Events [count]
Velocity [cm/μs]


Distribution of z coord
Nhits [count]
z [cm]


Nhits [count]
z [cm]


Nhits [count]
z [cm]

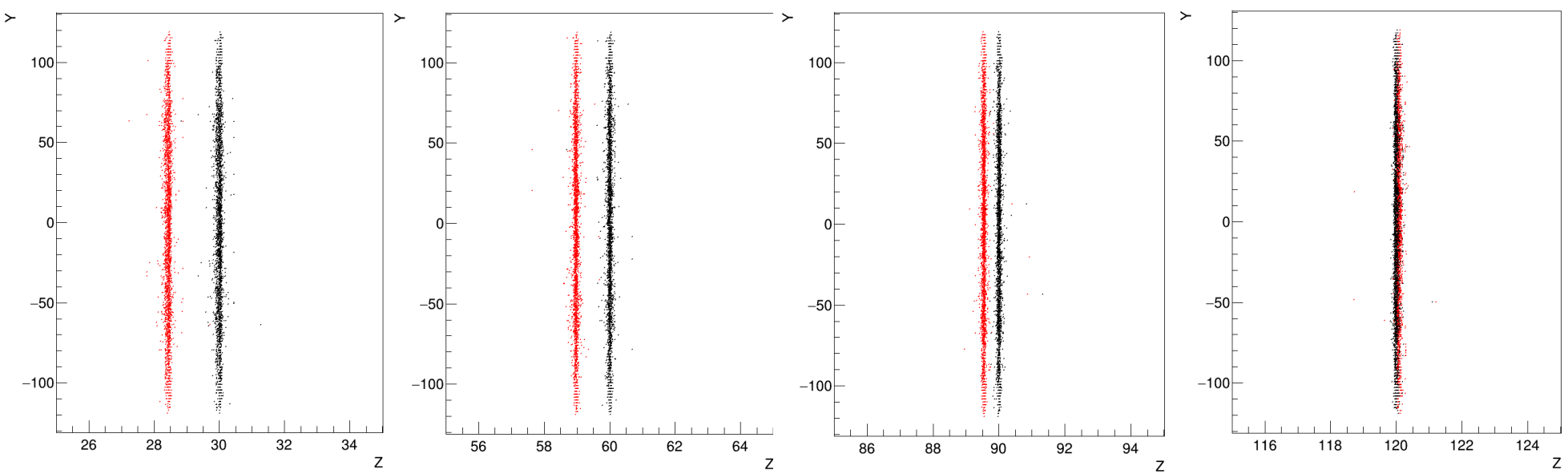

Mean 29.34
Std Dev 2.053
Nhits [count]
z [cm]

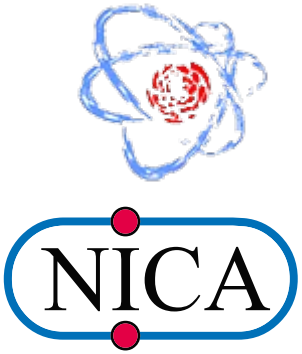
Drift velocity map

- N (500-1000) events of laser grid to acquire enough statistics
- Map is built for every sector
- Drift velocity is calculated 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

Self-test example (drift velocity in half of TPC)

- Theoretical/assumed drift velosity - 5.5 cm/μs
- Drift velocity during simulation - 5.4 cm/μs
- Test on laser grid itself
  - Red — measured position
  - Black — corrected position





Thank you for your attention!

Q&A