

Simulations of a laser calibration system and electron drift velocity determination for MPD TPC.

Alexander Bychkov

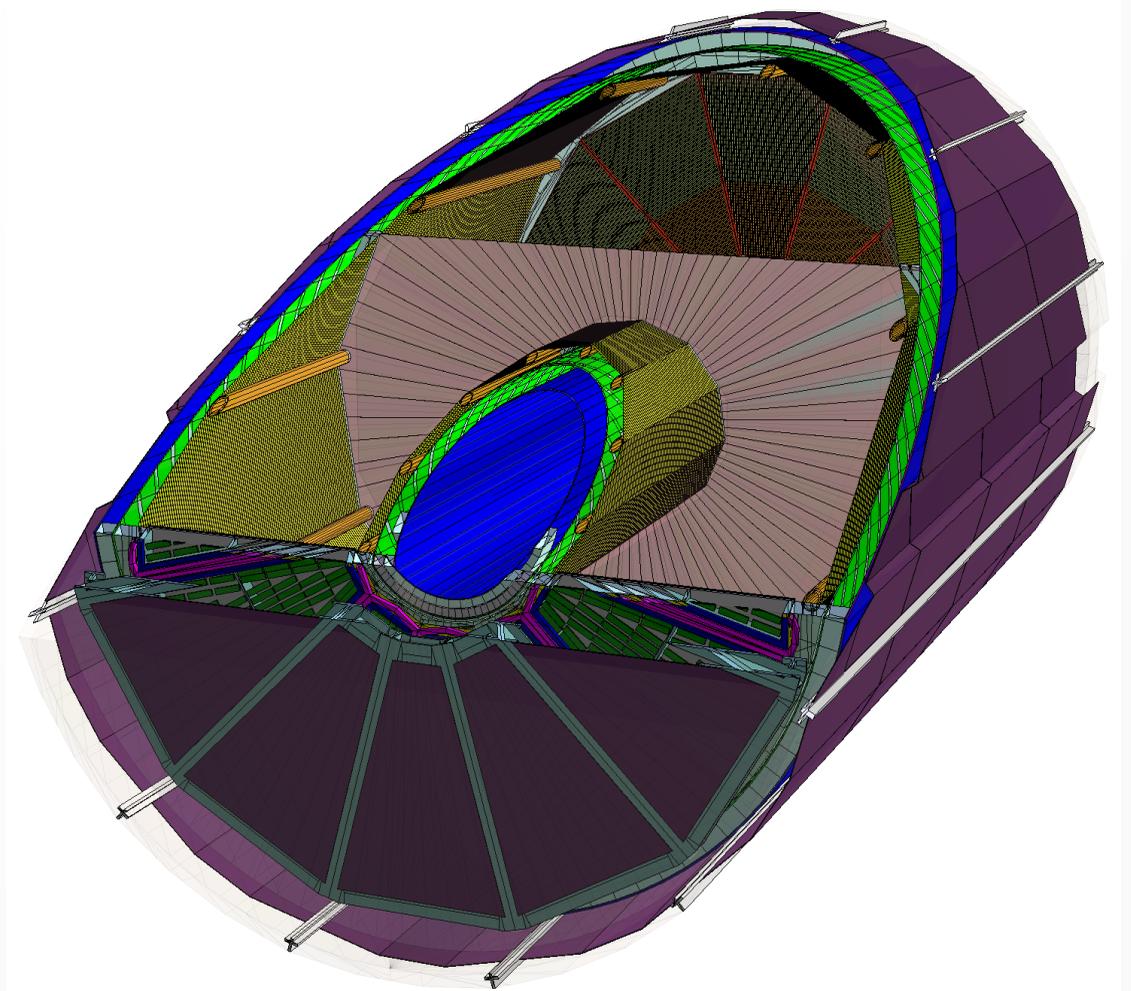
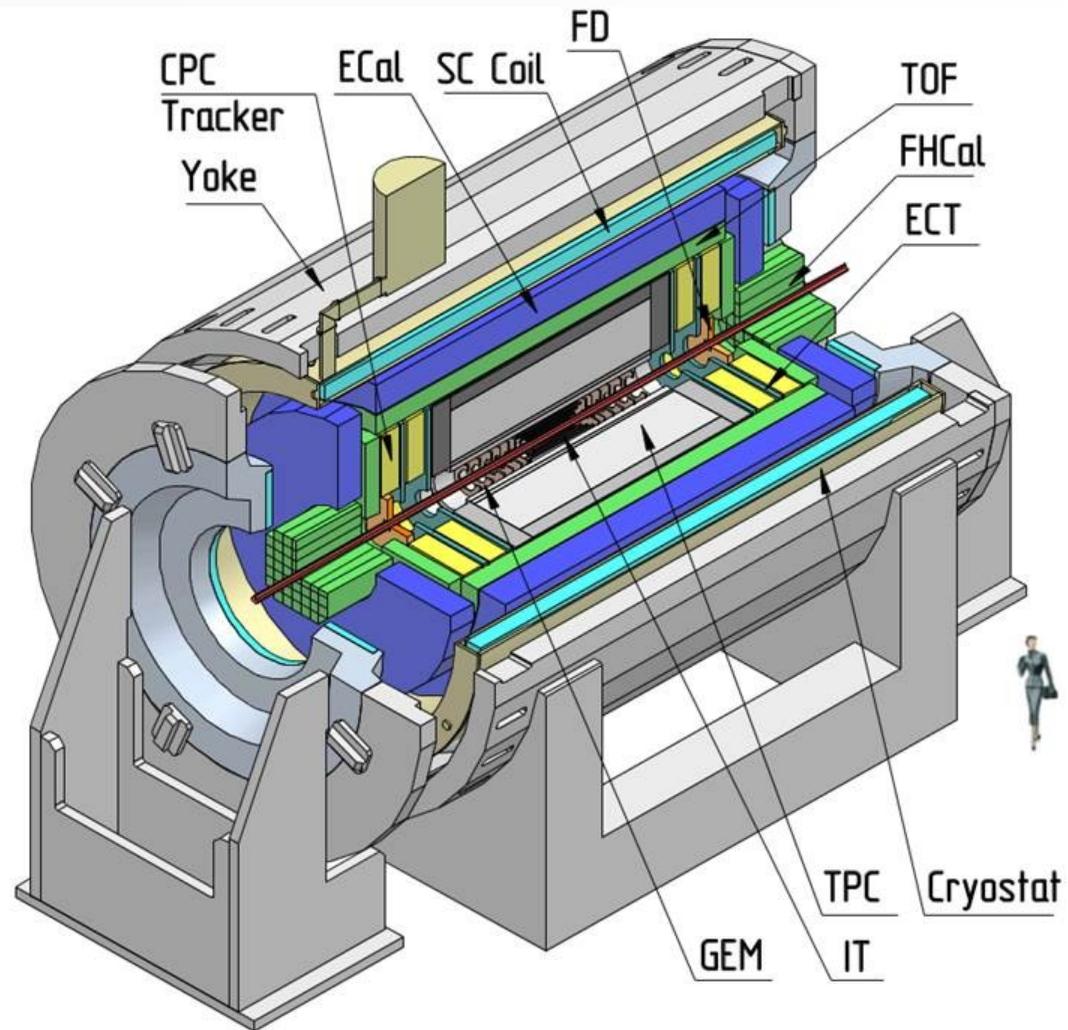
Oleg Rogachevsky

RFBR grants for NICA, 2020

Agenda

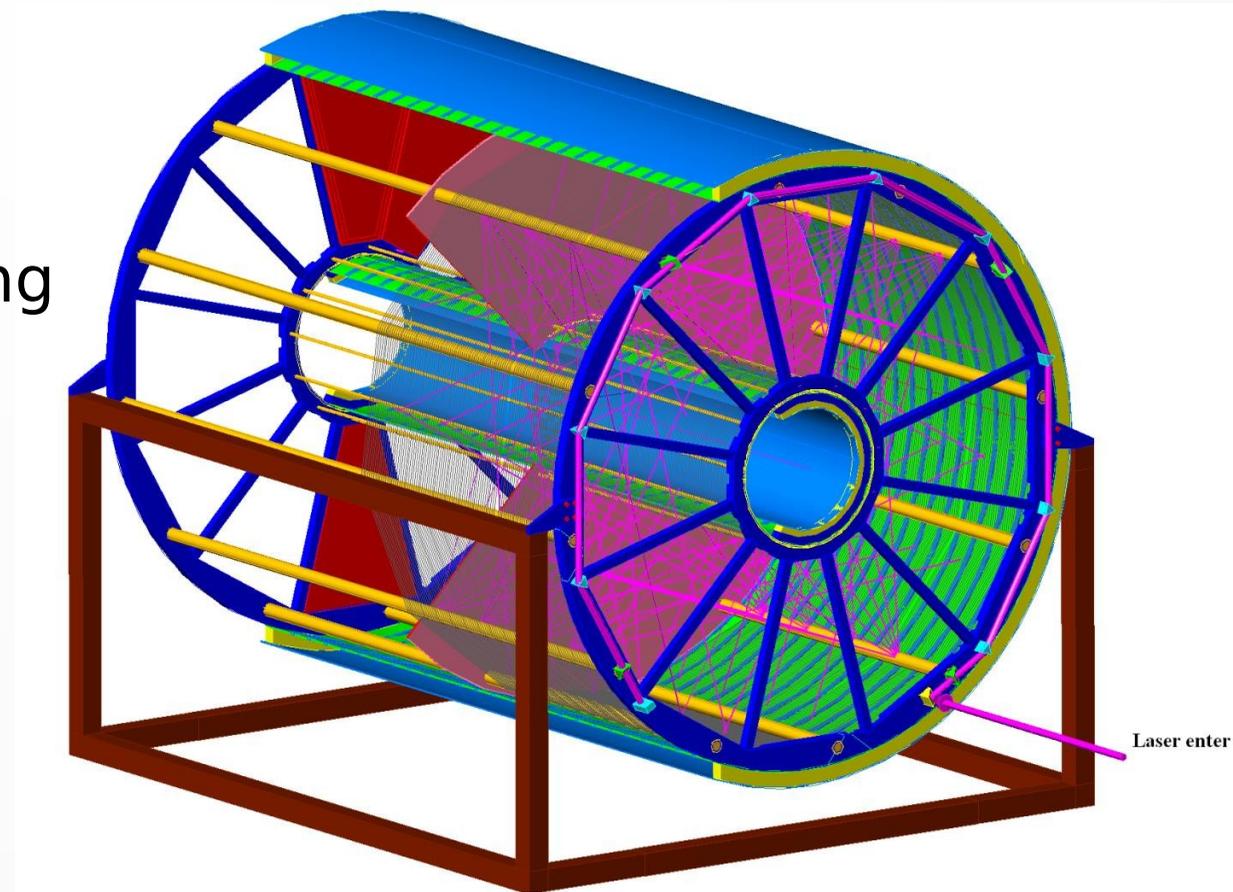
- MPD TPC laser calibration system
- Simulation of laser beams grid with MPDRoot
- Laser beams finding with MPDRoot
- Electron drift velocity calibration

TPC



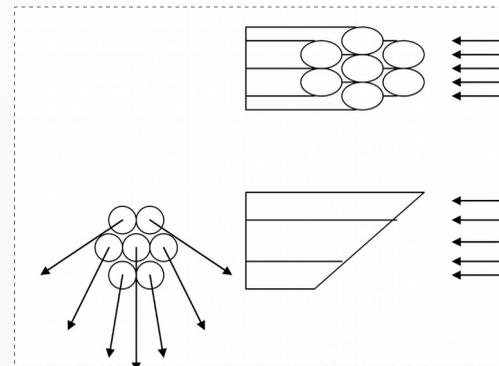
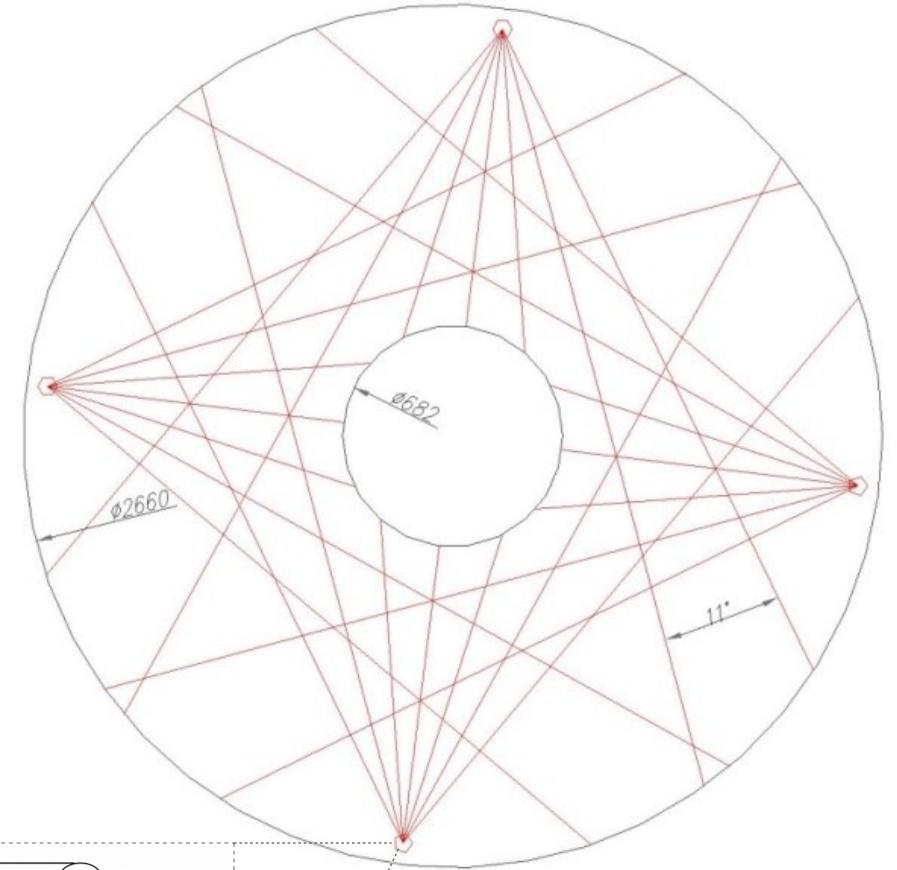
MPD TPC laser calibration system

- UV laser system
- Laser beam tracks at well-defined angles and positions
- Positioning of the laser beams along Z-axis significantly better than the spatial resolution of the TPC
- On-line monitoring of the value of electron drift velocity
- Test system to measure the response of the TPC to straight tracks at known position



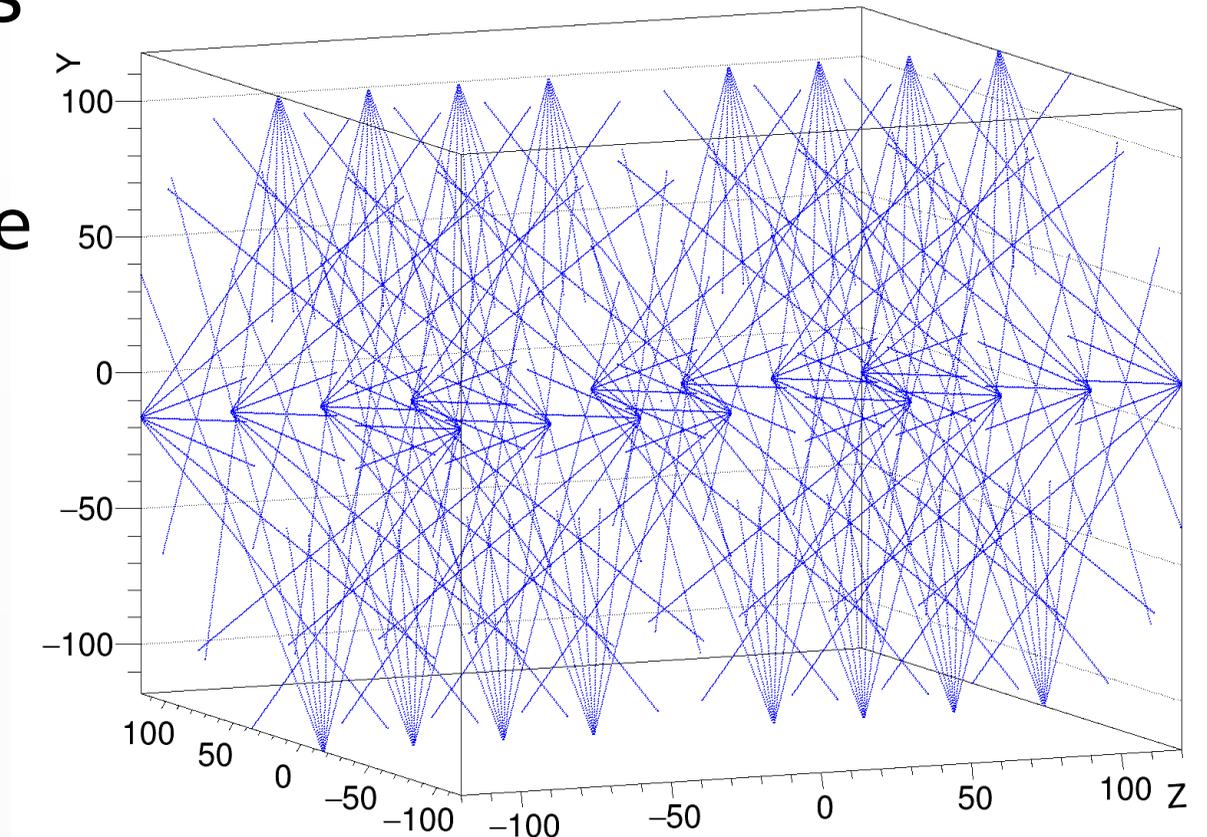
Laser calibration system implementation

- 224 laser beams in total
- 112 “tracks” in each half of the TPC
 - 4 planes of laser beams, 300mm between planes
 - 4 emitters per plane
 - 7 mirrors (laser beams) per emitter



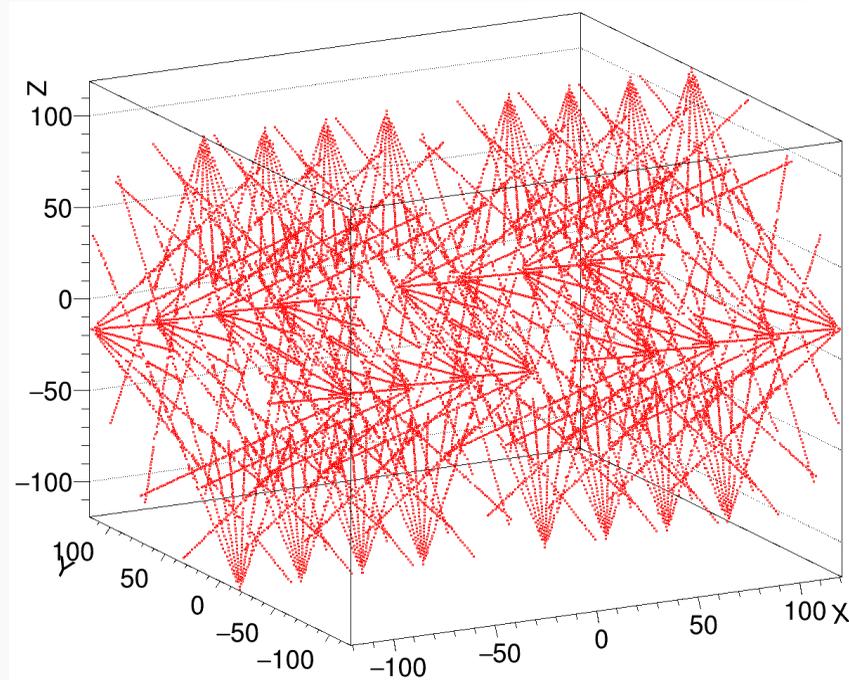
Simulation of laser beams grid with MPDRoot

- Muons instead of photons
 - Photons only in GEANT4
 - Some troubles with acquire MC points of photons in TPC sensitive area
- No magnetic field
- Abandon muon track where it cross the TPC walls

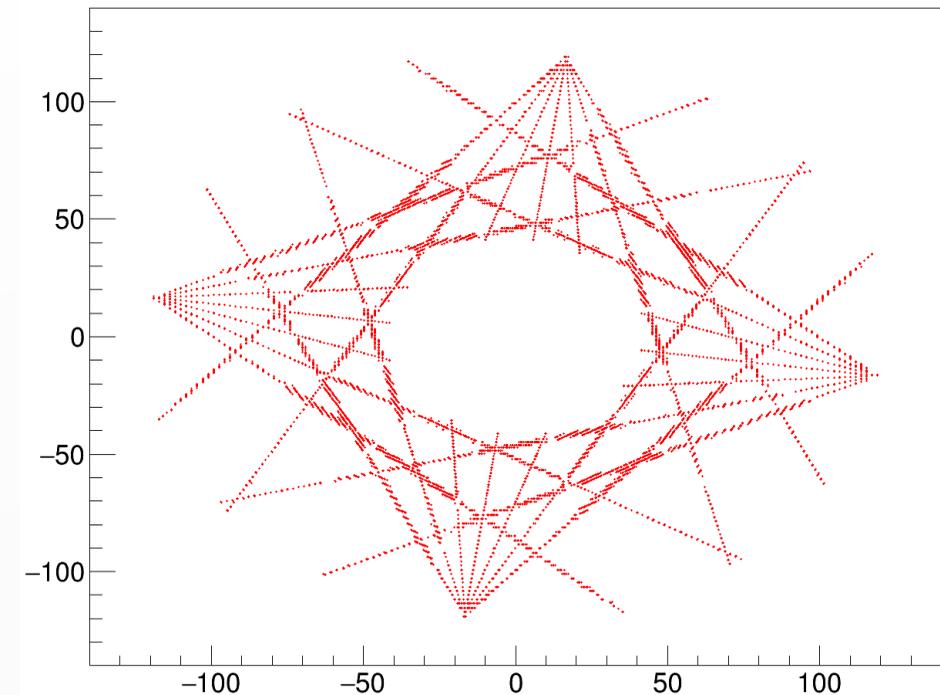


Laser grid reconstruction with MPDRoot

- Reconstructed points of lasers, 3D



- Reconstructed points of lasers, XY projection

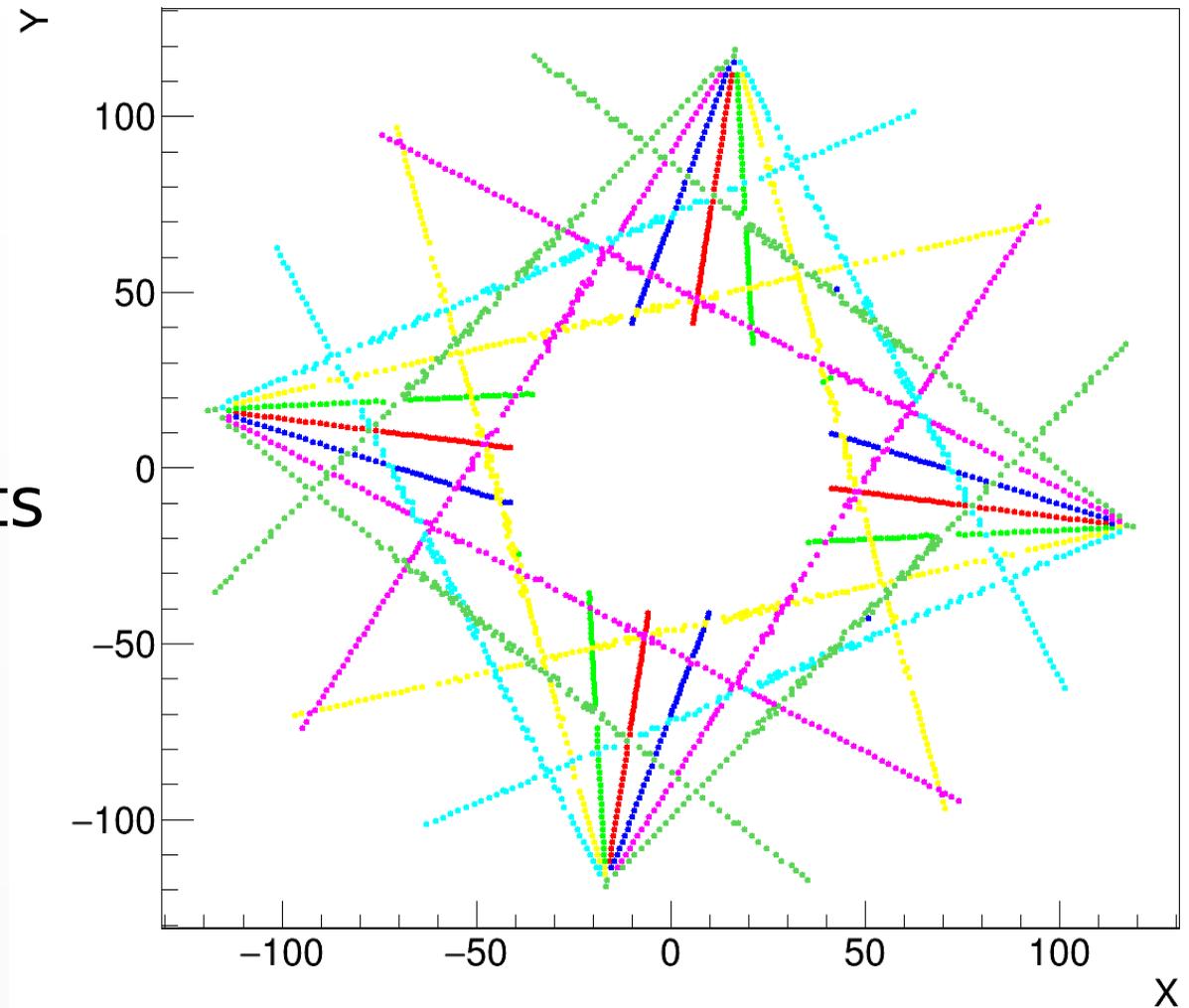


- Simulation of drifting
 - electron distortion from magnetic field
 - clusters longitudinal and transverse diffusion
- Simulation of pad response

Laser finding algorithm

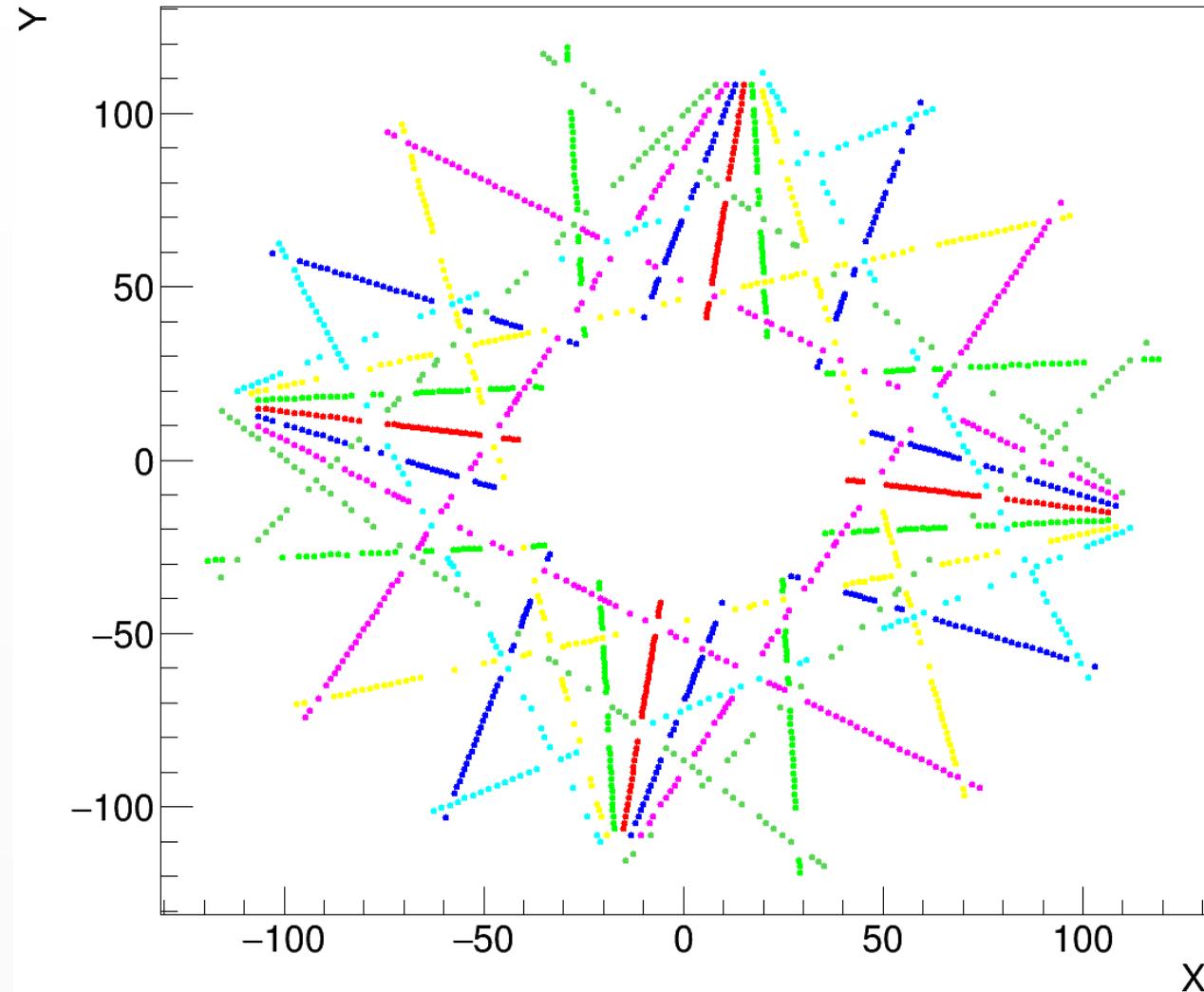
Simple, fast, efficiently parallelizable algorithm:

1. Select all reconstructed points that belongs plane of beams
2. Group all reconstructed points in plane along theoretical beams
3. Calculate drift velocity mean by all reconstructed points belongs to beam



Laser finding algorithm (modified)

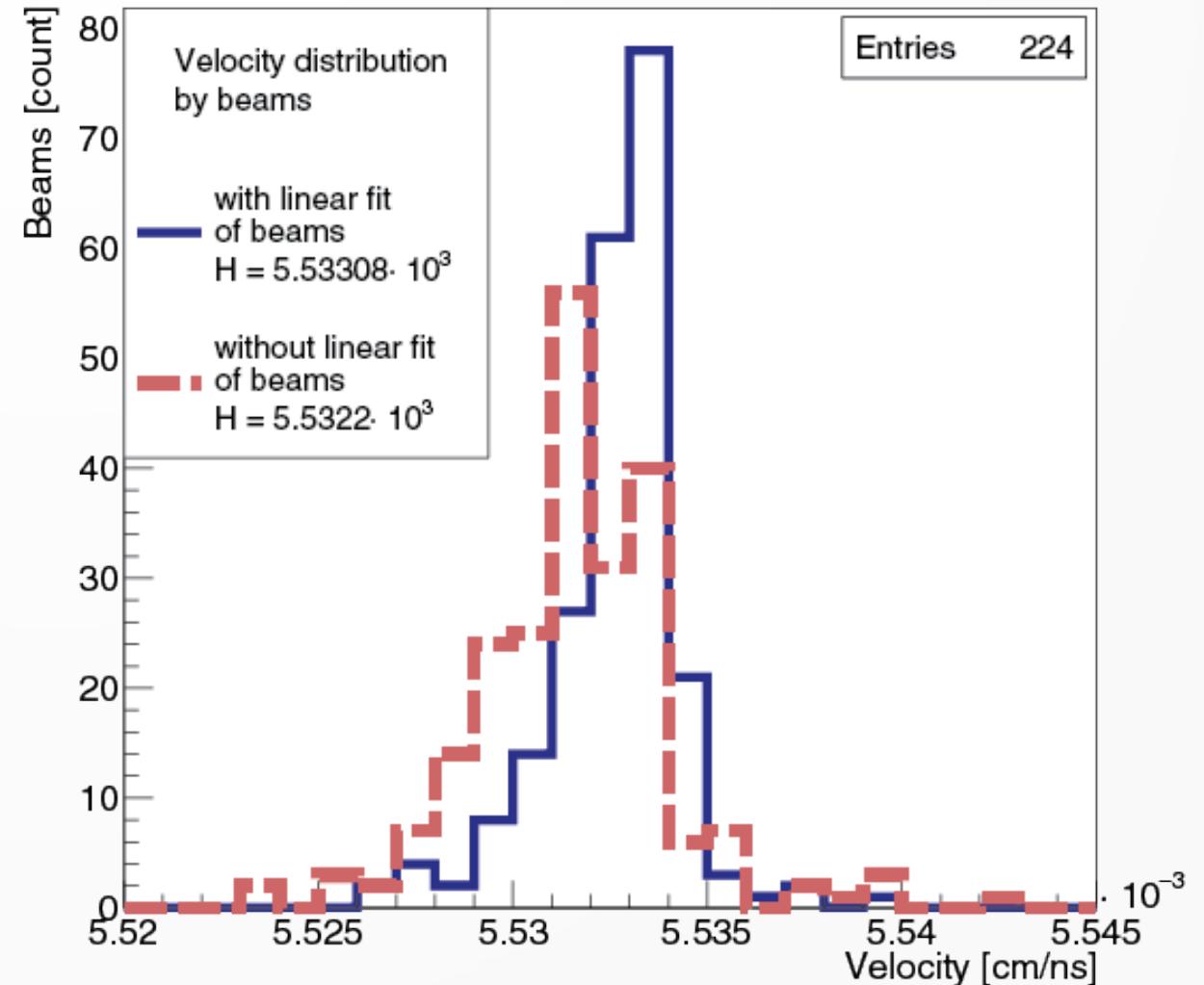
- Followed items are added between steps 2 and 3
 - Linear fit reconstructed points for each beam
 - Filter hits along fitted beam in 3D
- Linear fitting allows to check knowing positions of beams
- Still efficiently parallelizable algorithm



Electron drift velocity determination quality, mean value by 224 beams in single measurement

- Example with same input reconstructed points
- Predefined drift velocity 5.53291×10^3 cm/ns (value by Garfield software)
 - 90% Ar + 10% CH4, 25° C, 1 atm + 2 mbar
- Harmonic mean $H = \frac{1}{\frac{1}{n} \sum_{i=1}^n \frac{1}{x_i}}$
 - usually used to determinate average speed/velocity

Distribution of electron drift velocities



Future plans

- Map of electron drift velocities
 - 2 halves of TPC
 - 12 sectors in each half of TPC
 - 4 planes of beams in each half of TPC
 - 96 parameters in total
- Simulation of space-charged distortions
- Further investigations of using laser calibration system for TPC alignment purposes

Thank you for attention

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