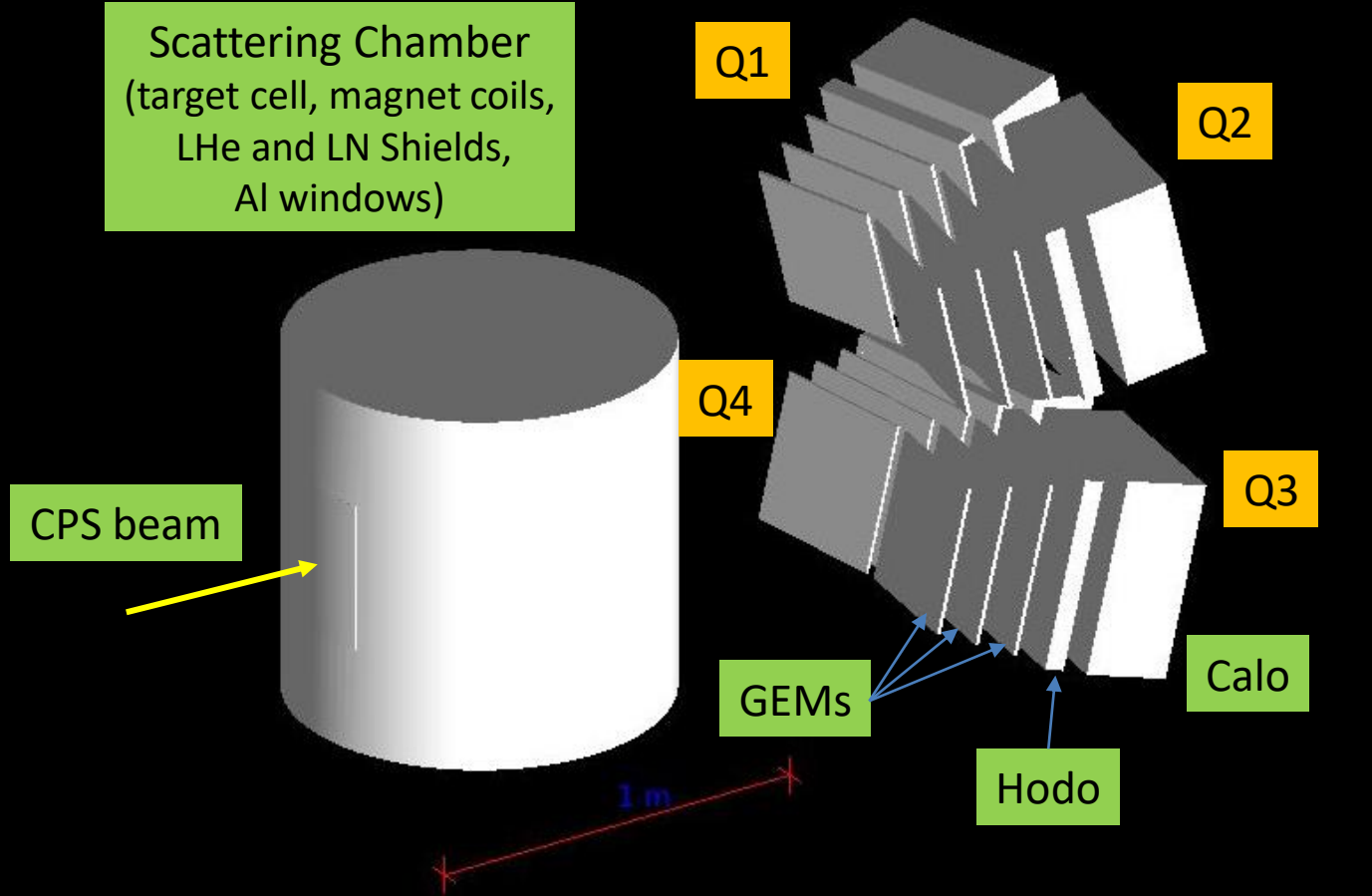


TCS Simulation:
low momentum proton tracking

V. Tadevosyan

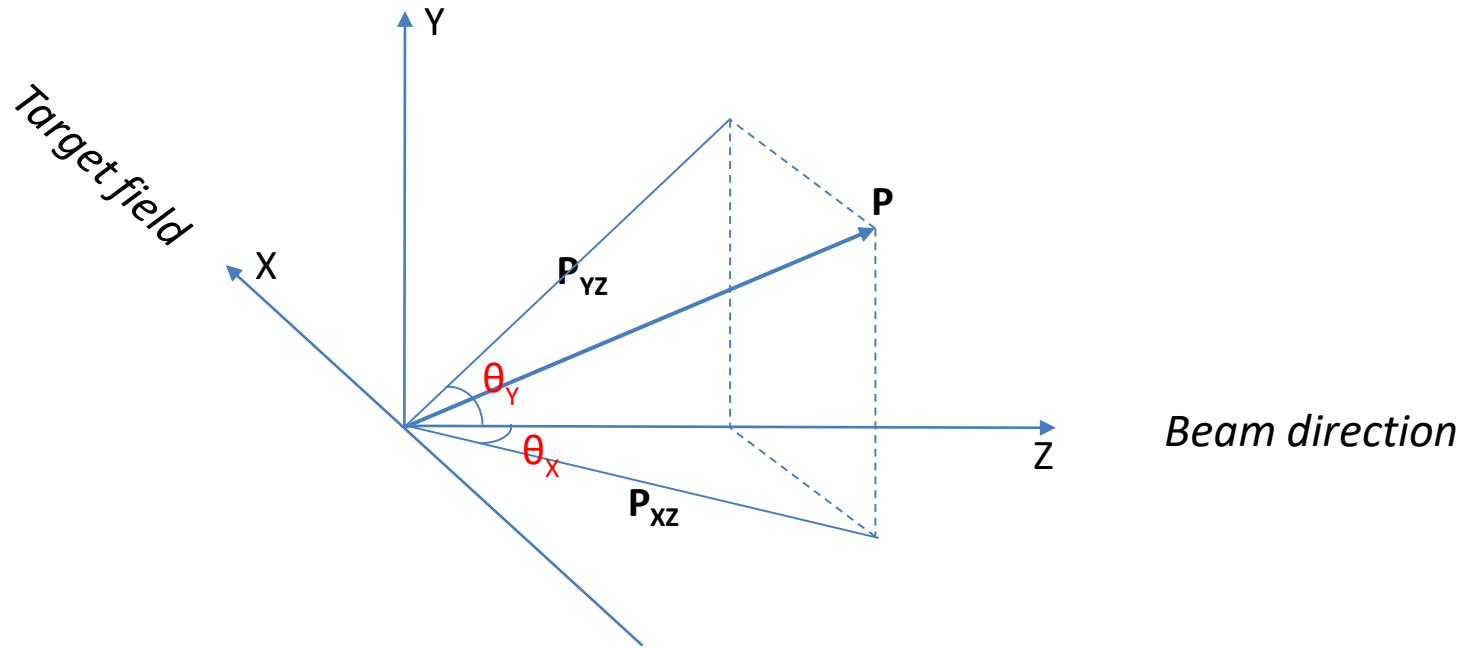
04/15/2020

Setup



- CPS photon beam
- JLab/UVA NH_3 (g2p) polarized target (rotated 90°)
- Triple-GEMs for e^+ , e^- , p tracking
- Hodoscopes for p detection/PID
- $PbWO_4$ calorimeters for e^+ , e^- detection/PID

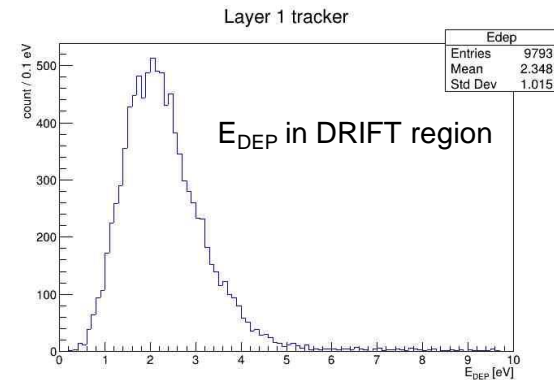
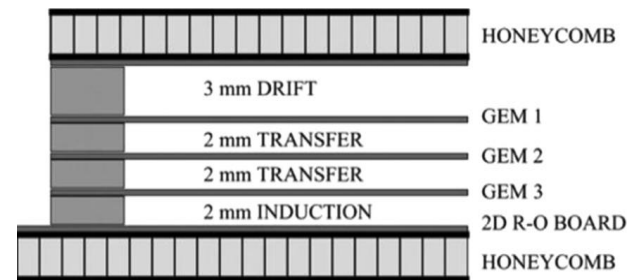
Conventions



Note: detectors positioned at $\theta_X = \pm 10.034^\circ$, $\theta_Y = \pm 14.042^\circ$;
layer 1 GEM trackers at 120 cm from target.

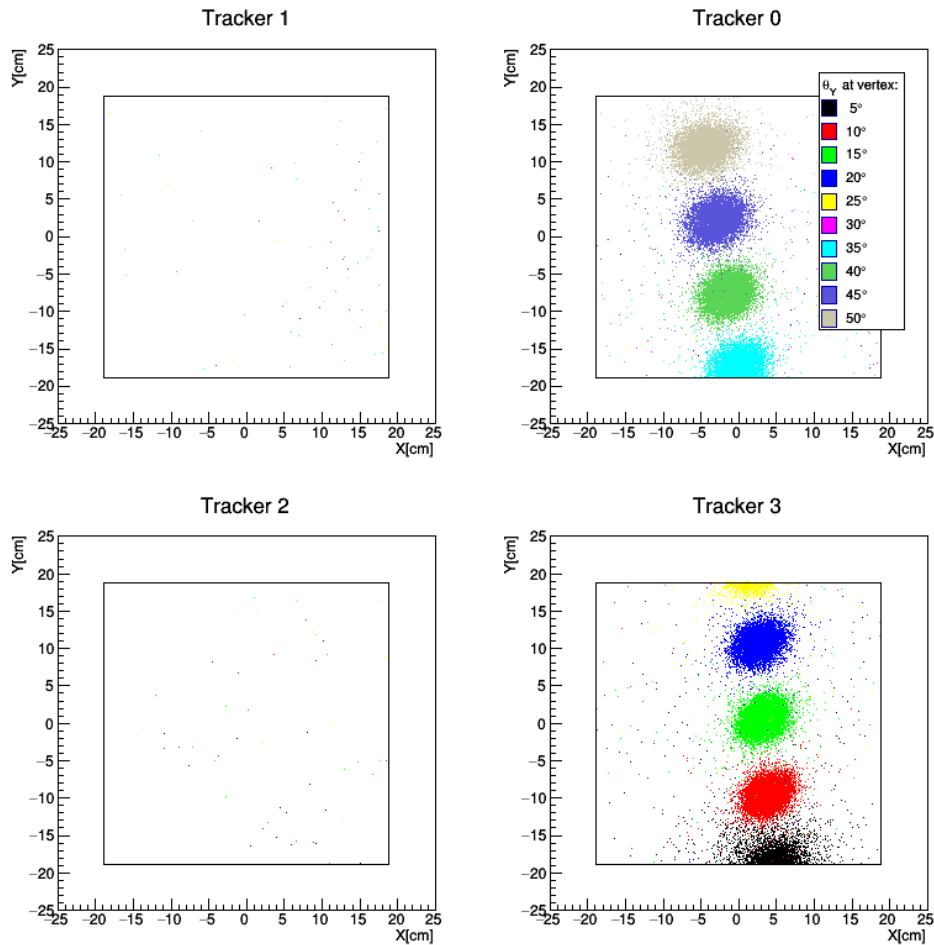
Sampling

- Choose proton momentum 400 MeV/c
- Choose $\theta_x = 10^\circ$ at target (pointing to quarters 1, 4)
- Increment θ_y in steps of 5°
- Sample 10k events at origin for each (θ_x, θ_y)
- Look for hits in layer 1 trackers:
 - $\text{PID}(\text{track}) == \text{PID}(\text{vertex}) \rightarrow$ **proton**
 - $\text{Track ID} == 1 \rightarrow$ **original track**
 - $E_{\text{DEP}} > 0 \text{ eV} \rightarrow$ **signal**



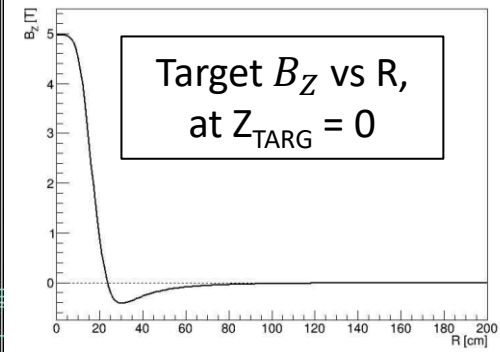
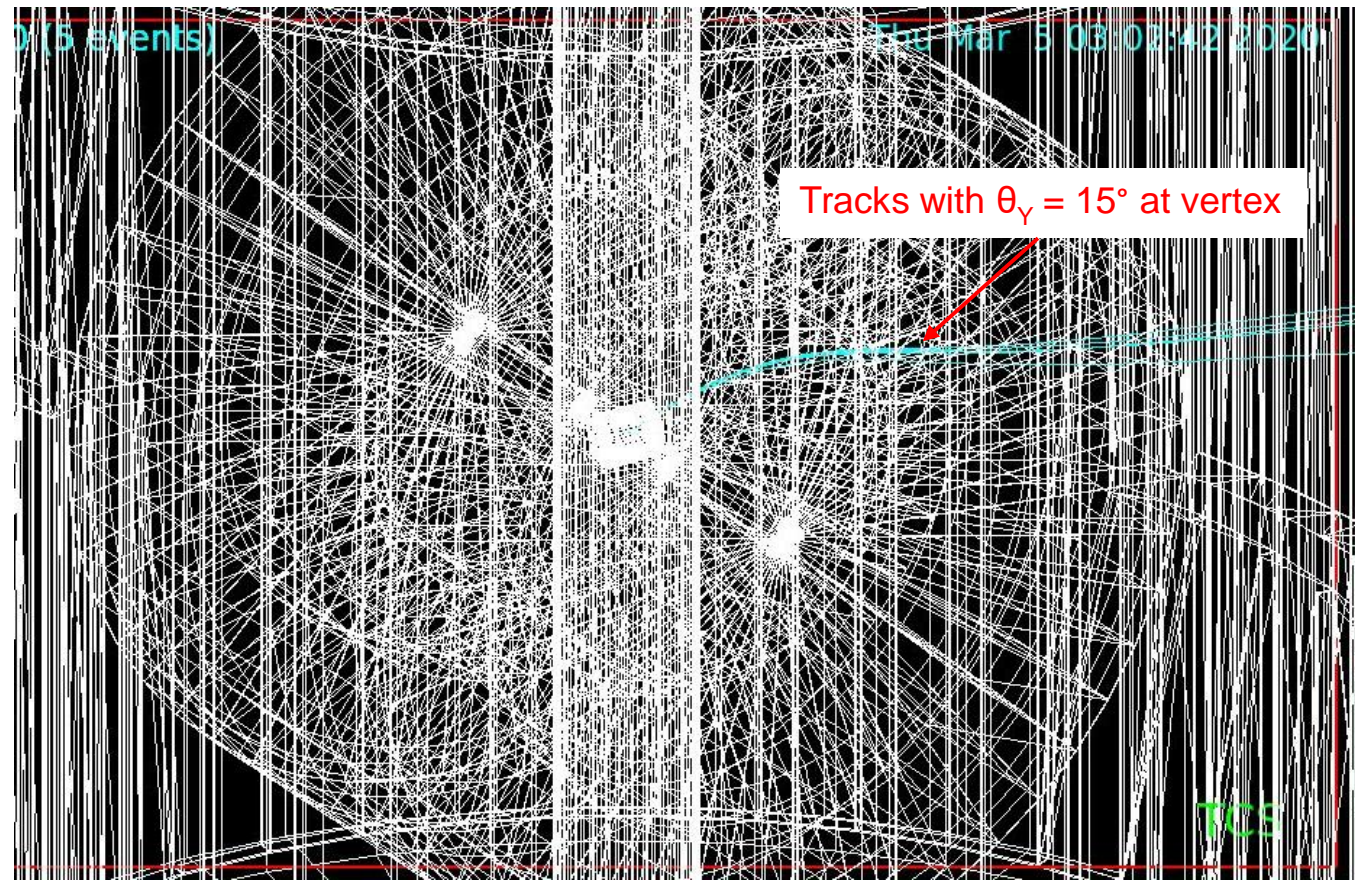
Note: for $P = 0.4 \text{ GeV}/c$, $\int Bdl = 0.7 \text{ T} \cdot \text{m} \Rightarrow \Delta\theta = 0.3 \frac{\int Bdl}{P} = 0.53 \text{ rad} = 30^\circ$

400 MeV/c proton hits in layer 1 trackers



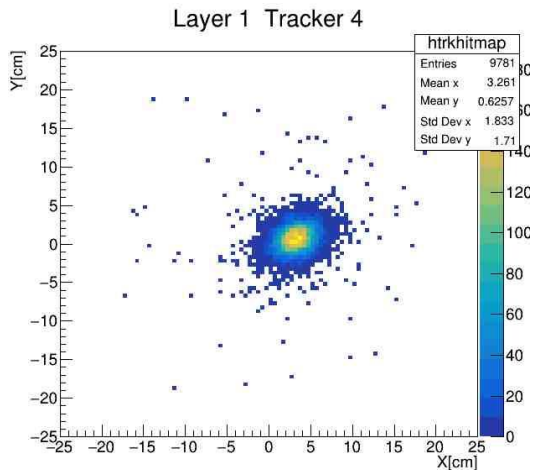
Note: tracks with $\theta_y = 30^\circ$ are lost in between quarters 1 and 4.

Tracks at vertex



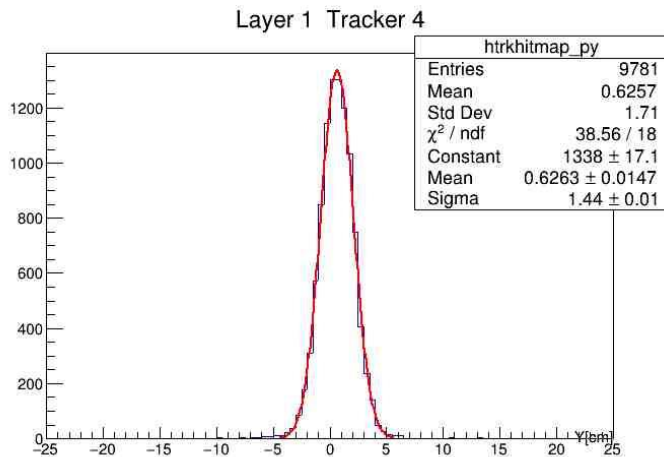
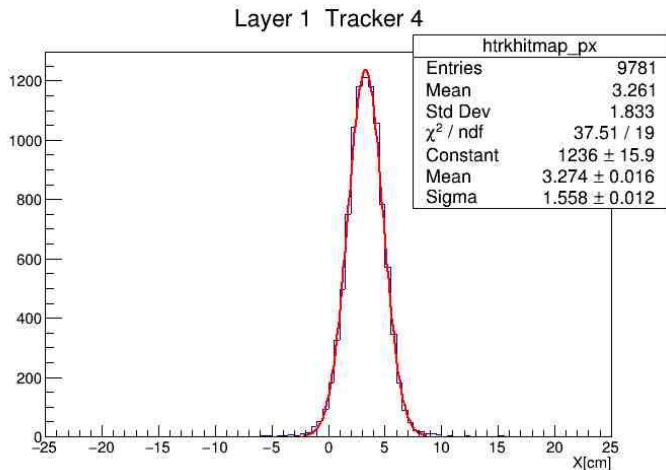
- Deflection within $R < 20\text{cm}$
- Track wiggling due to field flip

Hit pattern



Tracks with $\theta_Y = 15^\circ$ at vertex:

- Hit spot size $\sigma \sim 1.5\text{cm}$
- Noticeable fraction of wide scattered tracks
- Fraction of hits within $R < 4.5\text{cm}$ -- 94.5%



Conclusions

- Significant fraction of 400 GeV/c protons escape target and scattering chamber
- Hit pattern at layer 1 trackers correlates with vertical tracks' deflection angle at vertex
- Noticeable effect from particle interaction with matter on pass:
 - Hit spot of size $\sigma \sim 1.5\text{cm}$
 - Fraction of wide scattered events $\sim 5\%$

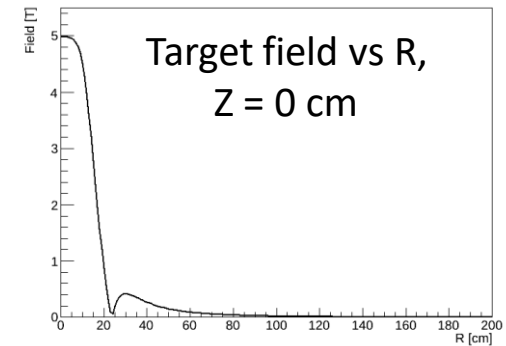
Back up

CPS beam

- 2 mm rastered collinear bremsstrahlung photon beam , $E_{MAX} = 11$ GeV
- Intensity: 1.5×10^{12} equivalent $\gamma/s \rightarrow 2 \times 10^{13}$ γ/s in [10 MeV, 11 GeV] range

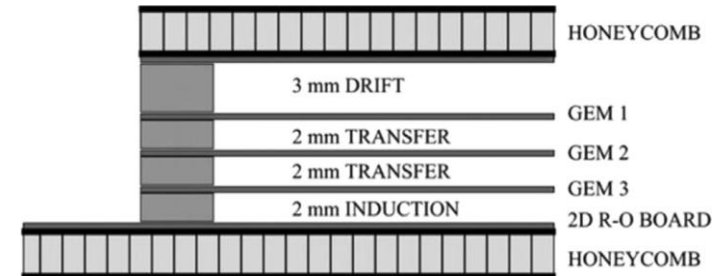
Target assembly

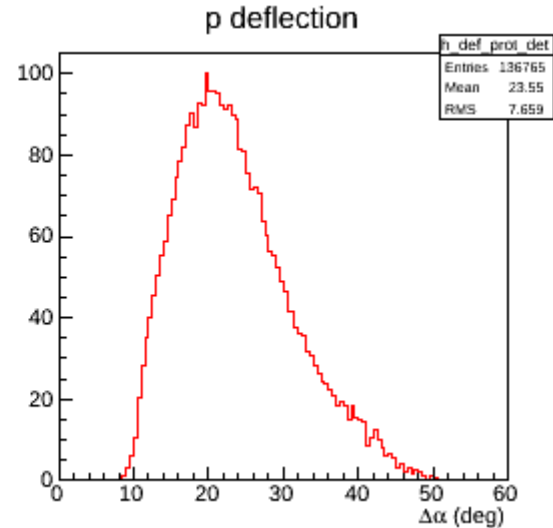
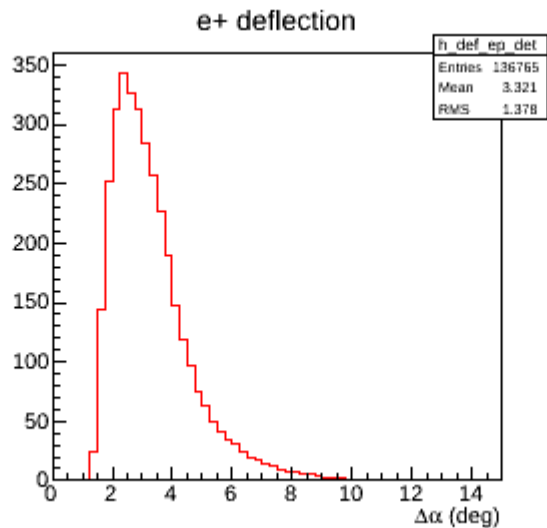
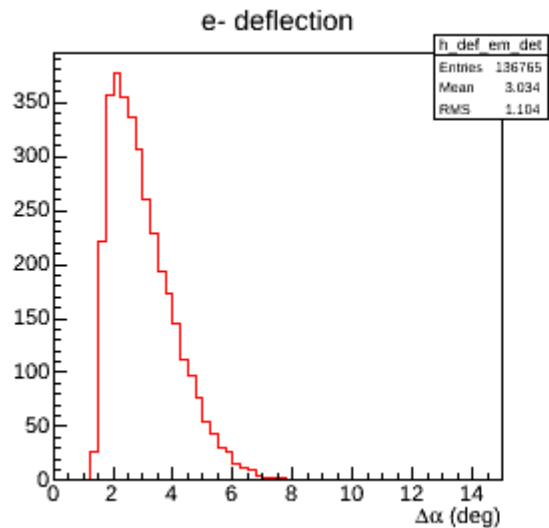
- Scattering Chamber with thin Al windows
- 3 cm target cell, with ammonia beds in LHe
- Magnet coils, LHe and LN Shields
- Chamber & magnet rotated 90°
- Magnetic field map, 5T at center



Trackers

- Like COMPASS triple-GEM detectors
(F.Sauli , NIMA 805 (2016) 2-24)
- Working gas: 70% Ar, 30% CO₂, $\rho = 1.7$ mg/cm³
- Hit signal: energy deposition in the DRIFT region





Deflections of accepted tracks in the target magnetic field ($BdL \sim 0.7$ Tm) relative to directions at target (from *old* simulations, w/ tracker hodoscopes, w/o GEM trackers).