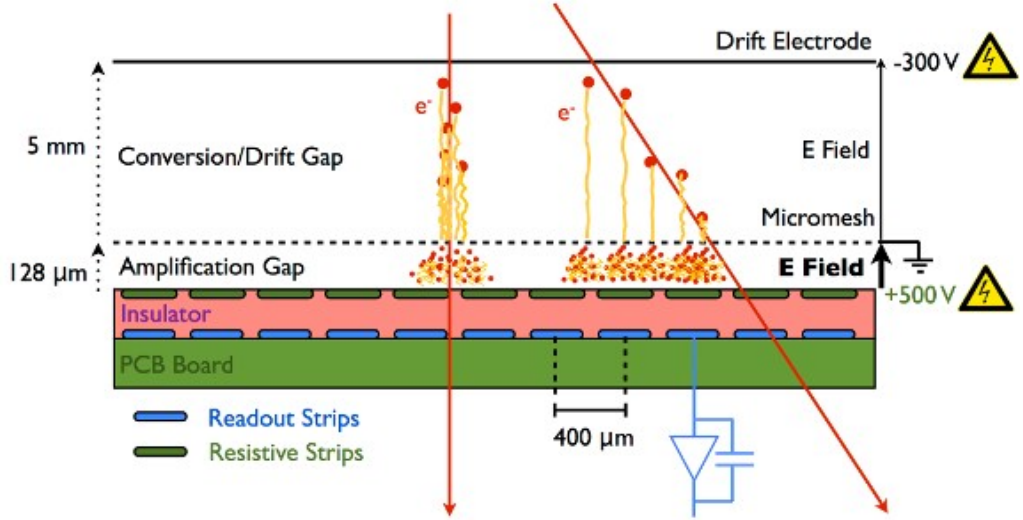
2D Micromegas trackers for EIC
Beam test update

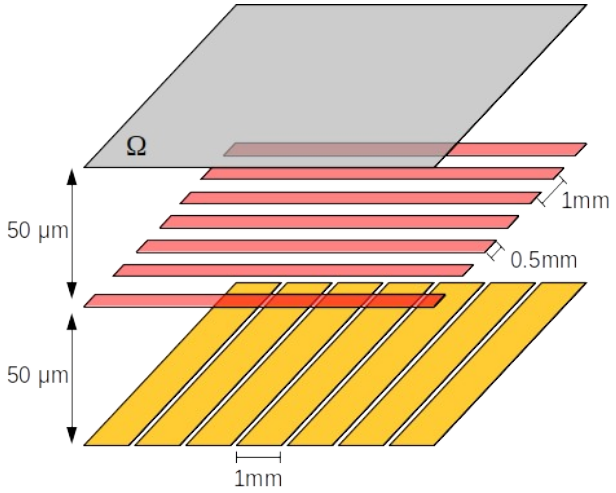
S. Polcher Rafael, F. Bossù,
A. Bonenfant, M. Boonekamp, A. Francisco, C. Goblin, C. Libourel, V. Maâch, I. Mandjavidze, M. Vandenbrouck

Introduction: Micromegas trackers



Acker, A. et al. The CLAS12 Micromegas Vertex Tracker. Nucl. Instrum. Methods (2020).

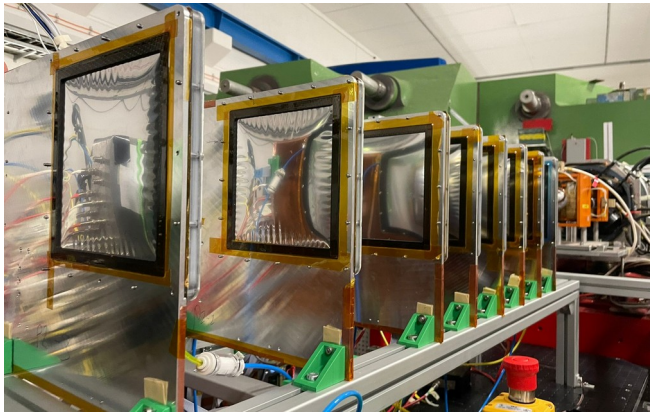
- A low field region where crossing particles ionize the gas. The electrons created are guided to the mesh.
- High field region below the mesh for amplification.
- The signal is induced on readout strip or pads at the bottom.

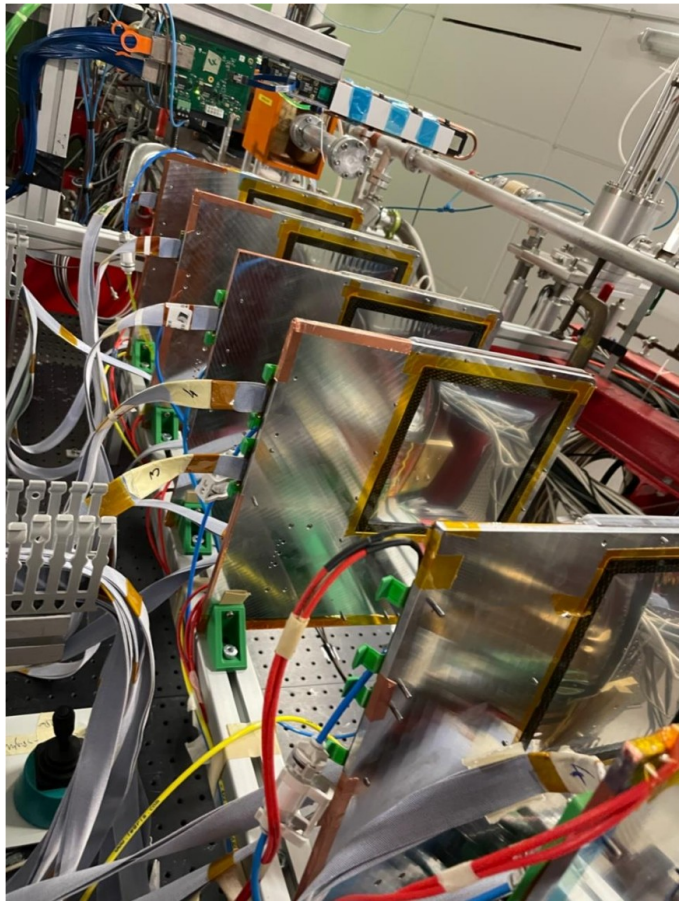


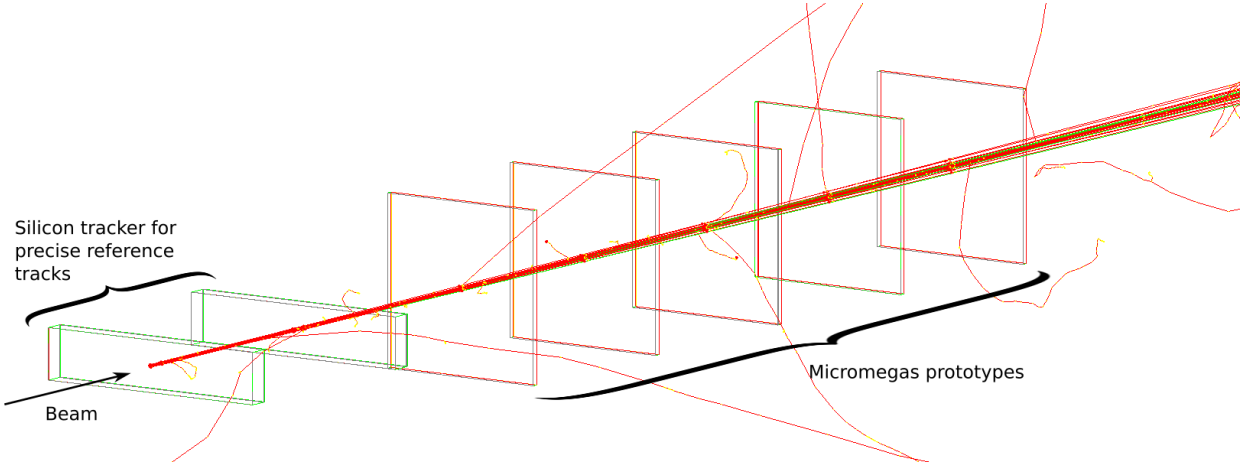
- To meet ePIC's needs: 2D trackers with low material budget (~0.05%X0) and strip readout to limit the number of readout channels
  - Resistive layer above the readout.
  - Signal is induced on the resistive and read by strips is both directions through capacitive coupling.

Beam test at MAMI

- In June 2023, beam test on a 880MeV electron beam at MAMI in Mainz.
- We tested prototypes with different variations of readout patterns and resistive patterns.

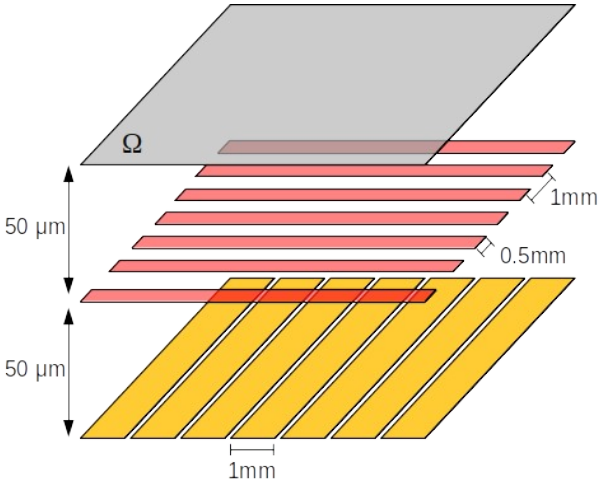


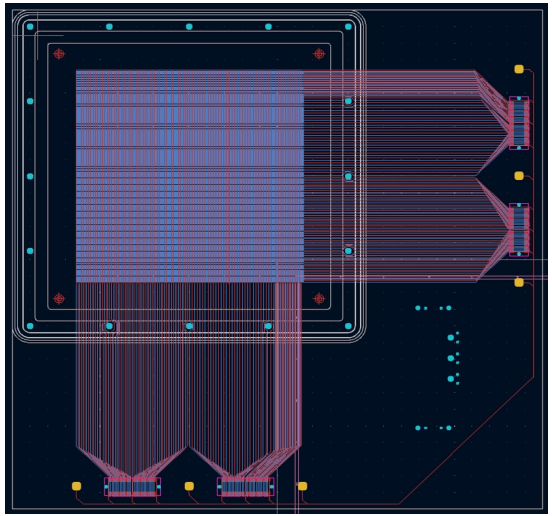


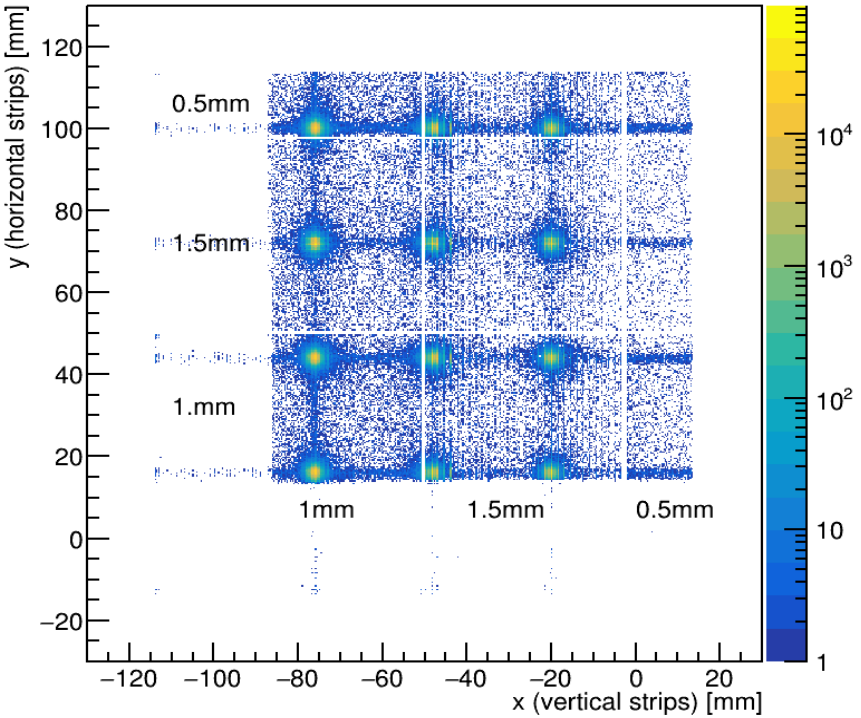


D1 & D2 prototypes

- Prototypes with an active area of 10x10cm
- High resistivity ~10 MΩ/□
- X and Y strips on two different layers
- D1 has multiple strip pitch on the same detector
- D2 has multiple inter-pitch



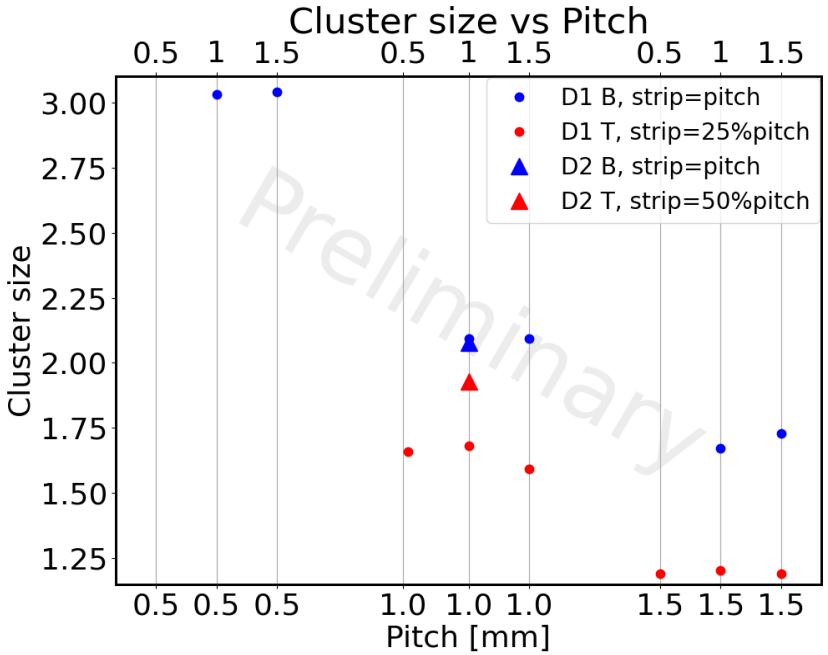




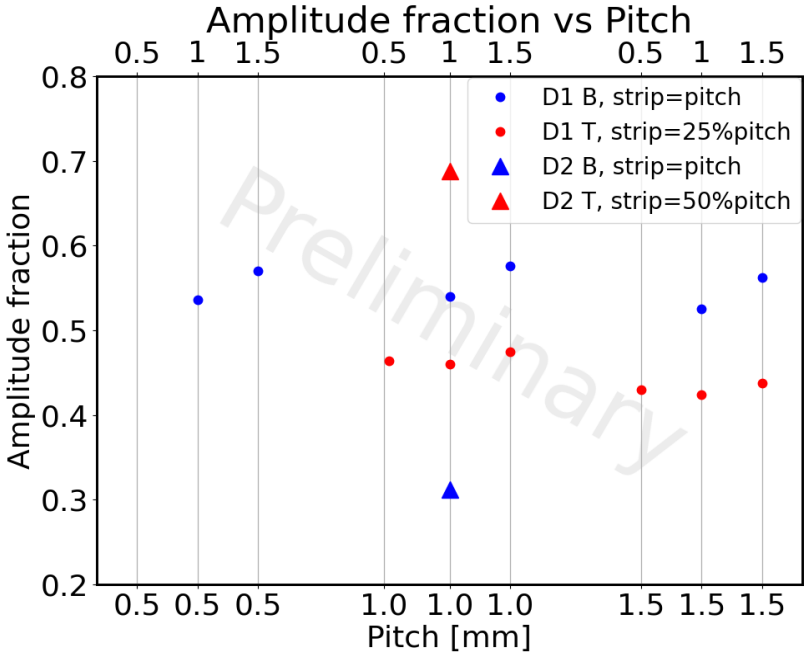
We took runs moving the detector to hit the different regions

D1 & D2 cluster size and amplitude fraction

- Strips on top with large inter-strip have a smaller cluster size but share the signal more evenly between the two layers.
- Small inter-strip on top, the bottom layer is screened by the top one.

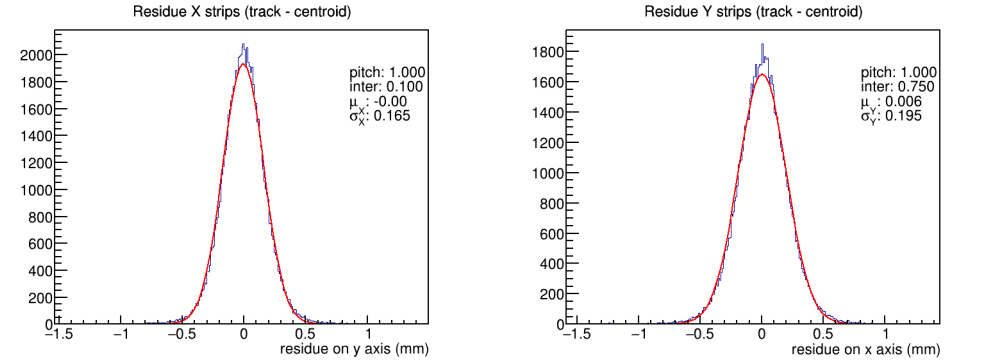


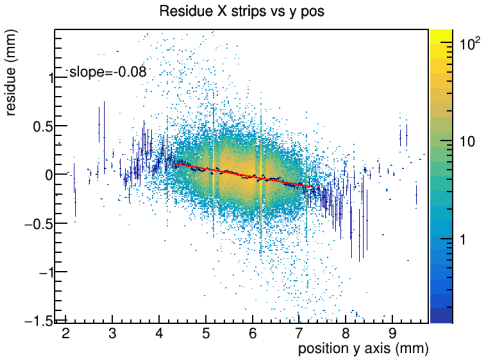
Average number of strips fired in a cluster

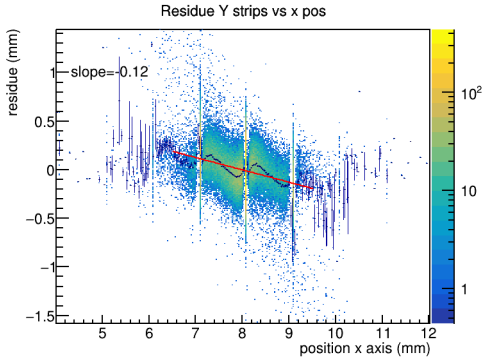


Fraction of the total cluster amplitude carried by strips in each direction. T is on top, B on the bottom

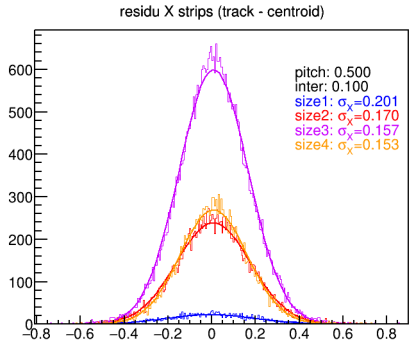
D1, a detailed look at residues

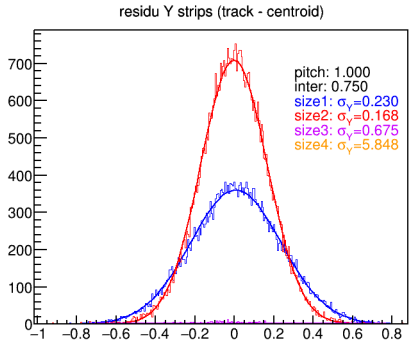


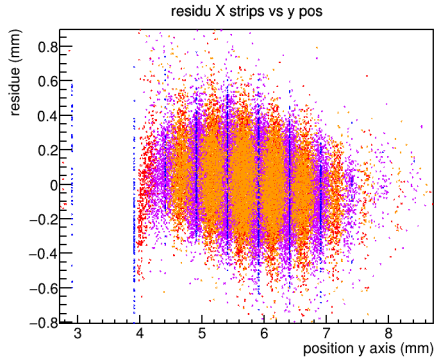


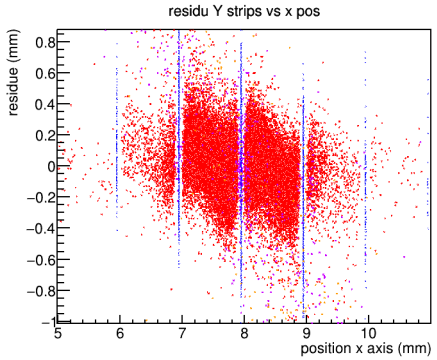


1mm strips on top (Y) and on the bottom (X).
The slope is due to msc.





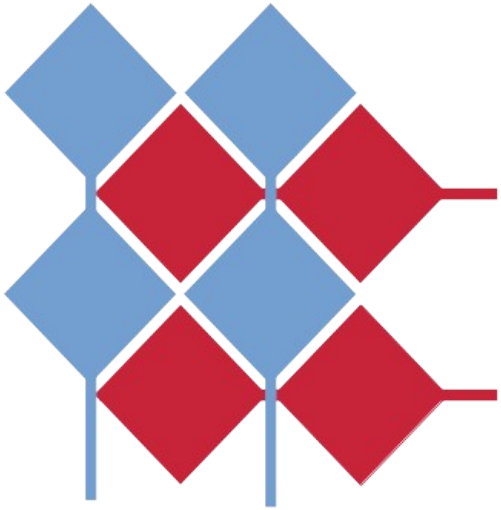


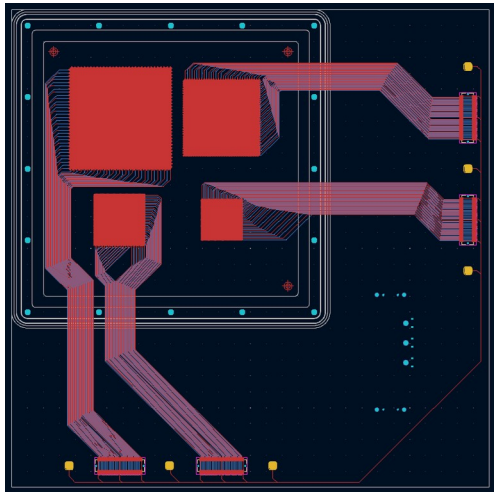


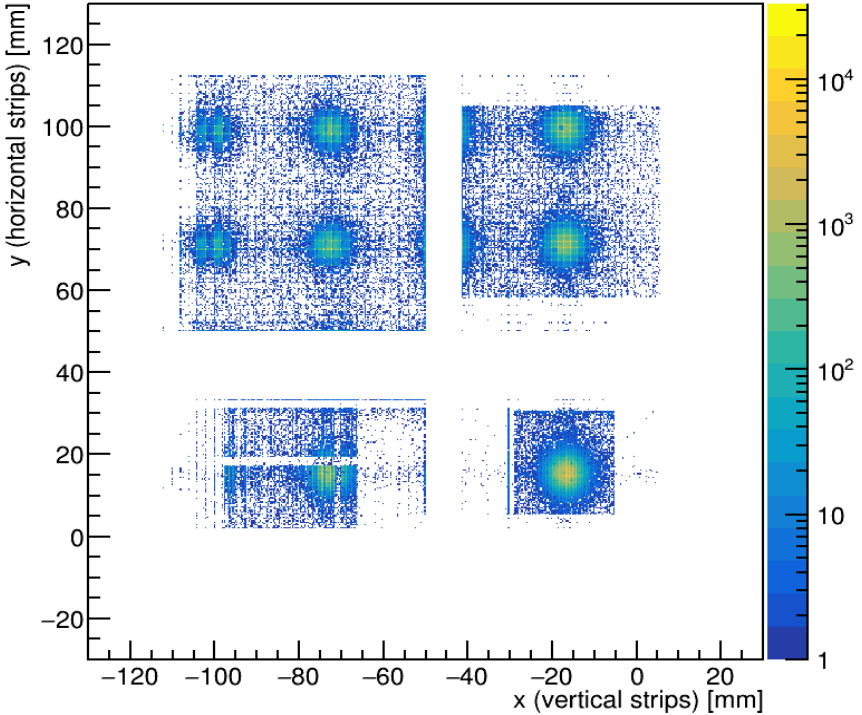
1mm strips on top (Y) and 0.5mm strips on the bottom (X).
Residues broken down by cluster size.

D3 & D4 prototypes

- Prototypes with an active area of 10x10cm with 3 different pitch
- Low resistivity ~300 kΩ/□
- Strips made of interconnected square pads. X and Y on the same plane
- D3 has resistive strips in the y direction
- D4 has a full resistive layer



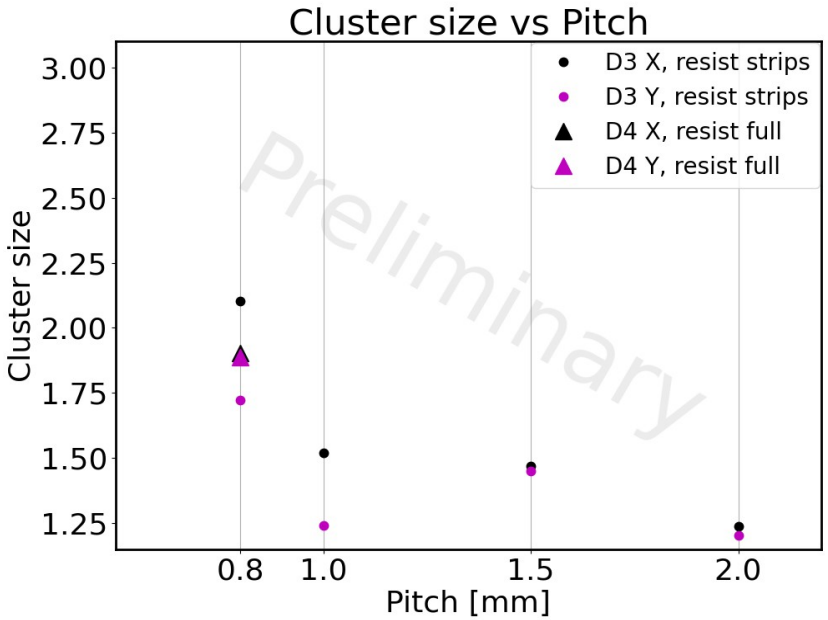




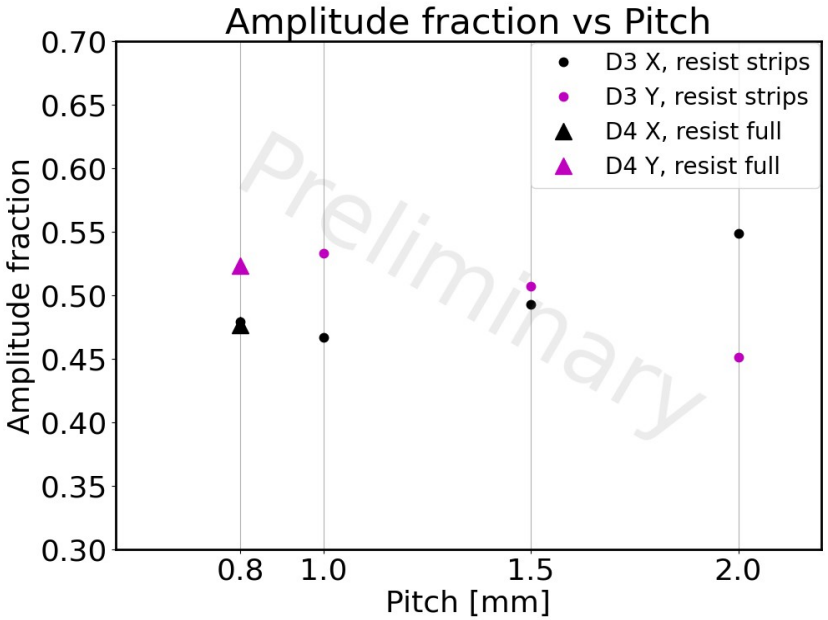
We took runs moving the detector to hit the different regions

D3 & D4 cluster size and amplitude fraction

- Charge sharing in X from the resistive strips on D3
- Amplitude is evenly shared

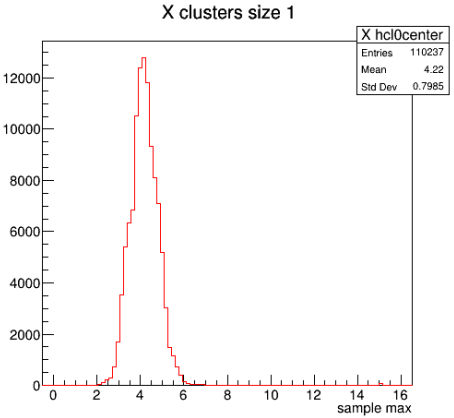


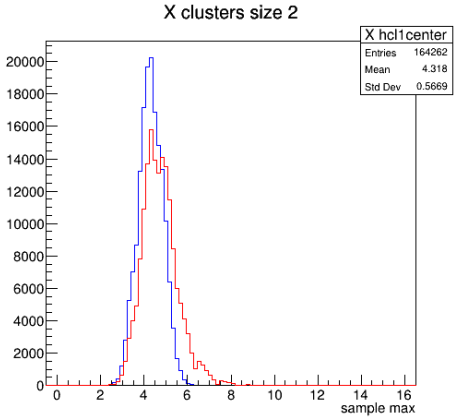
Average number of strips fired in a cluster

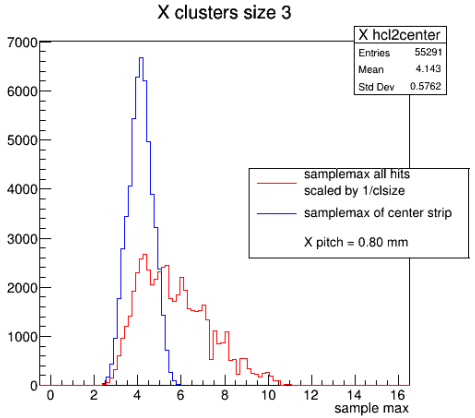


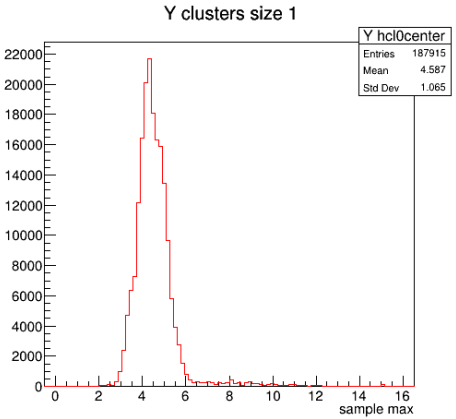
Fraction of the total cluster amplitude carried by strips in each direction.

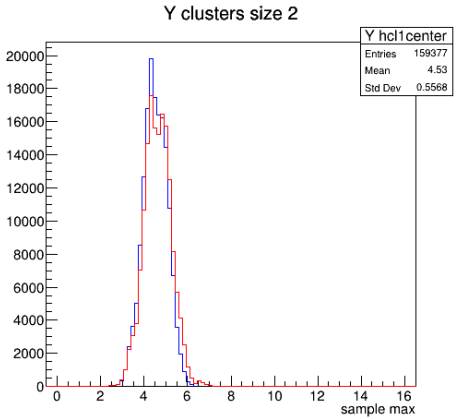
D3, closer look at charge spreading

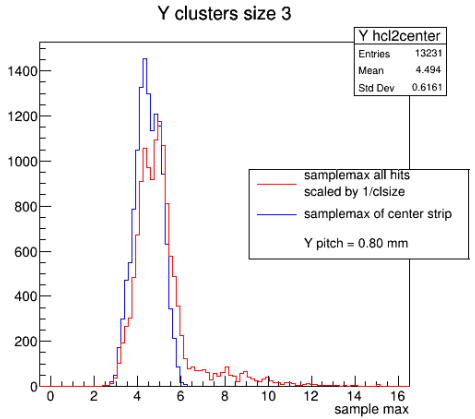










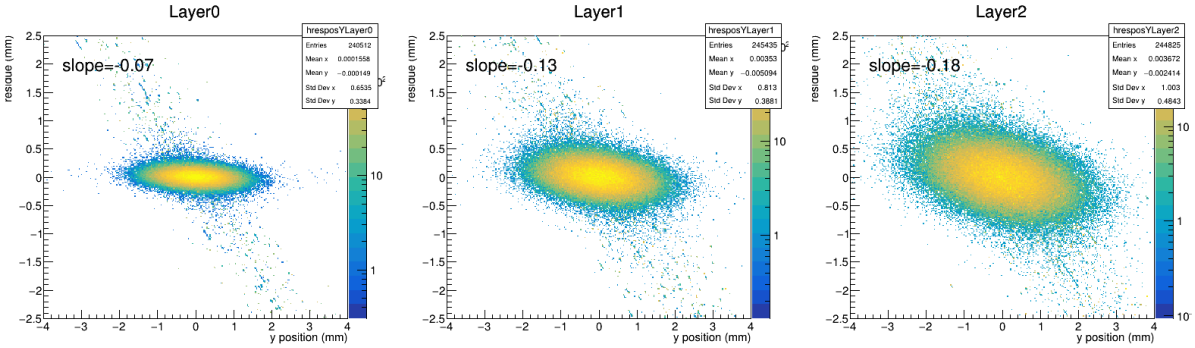


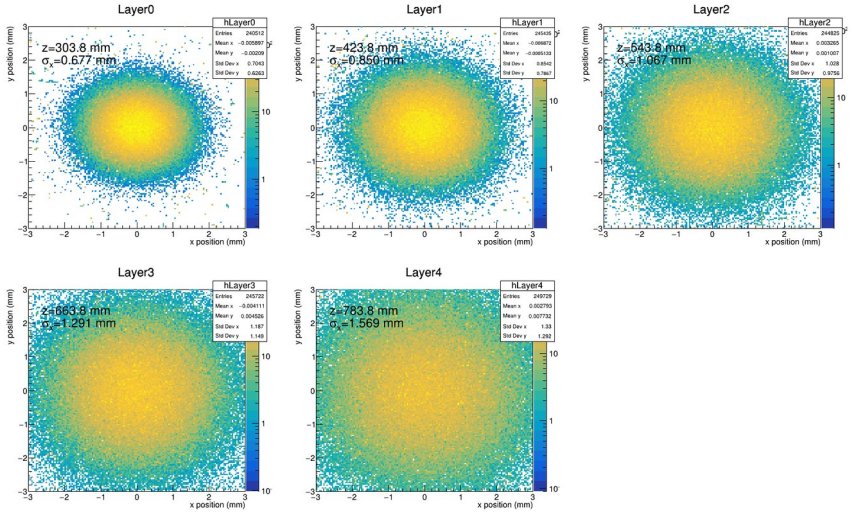
X strips are orthogonal to the resistive strips → charge spreading.

Y strips in the direction of the resistive strip, no charge spreading.

Geant4 simulation

- The detectors are far away from the beam pipe, from 35cm to 78cm
- Low energy electron beam → strong multiple scattering contribution
- Geant4 simulation to estimate it

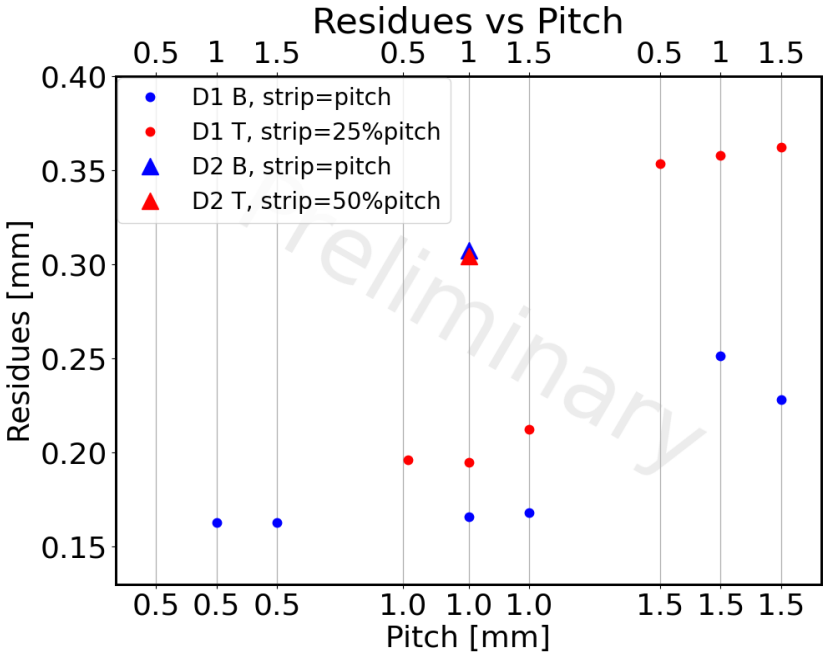


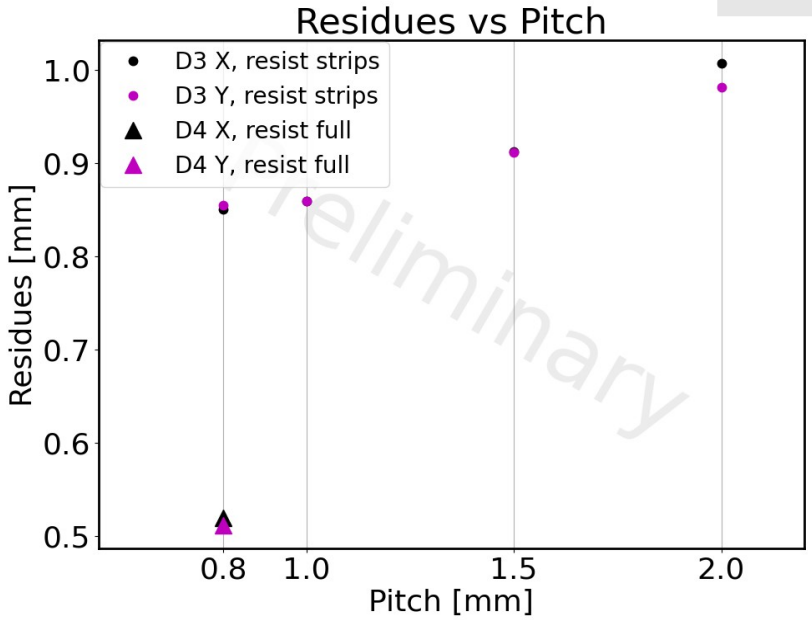


Residues

- Residues are dominated by multiple scattering
- We may be reaching the reference tracker limit for small pitch in this setup
- Strips with 1mm or small provide a good resolution

Detector	msc [µm]
D1	101 ± 20
D2	212 ± 42
D3	364 ± 73
D4	766 ± 153





Outlook

- D1 with 1mm strips or smaller is a good starting point to meet ePIC requirements. But the strip to inter-strip ratio needs to be carefully chosen.
- The pad-like design with a full resistive layer has the most even sharing between the two directions.
- Need for more data taking with muons to avoid msc and to complete testing.
- More prototypes are in construction to test more resistive layer designs.