# Automated X-ray calibration system for high granularity Micromegas detectors

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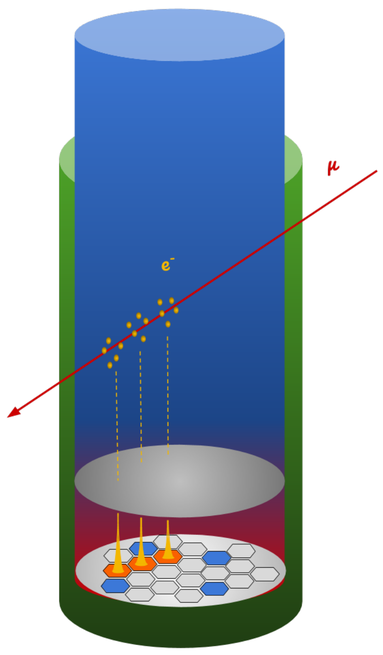
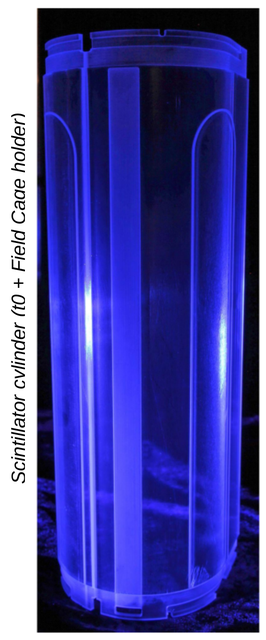
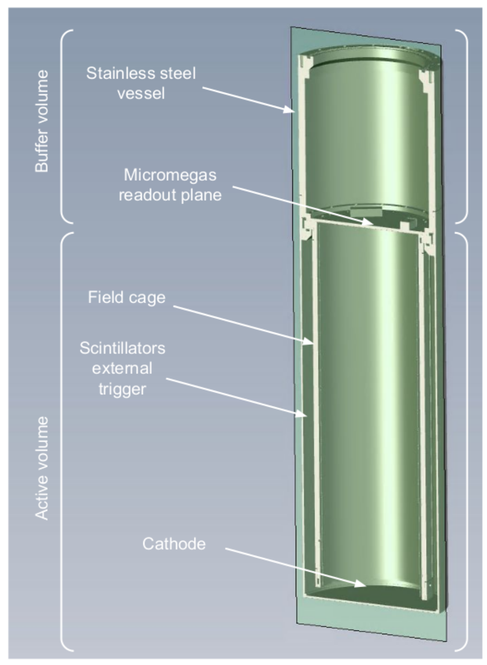
## Context: D3DT Muography Project



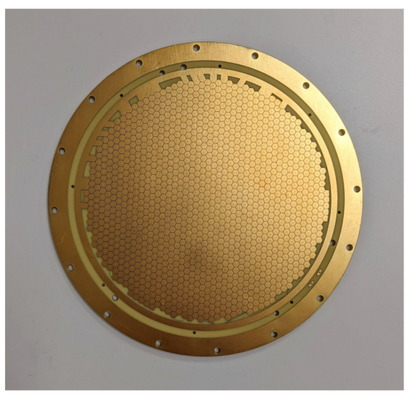




**D3DT** (***D****étecteur* ***3D*** *pour la* ***T****omographie Muonique*) is a new concept muon telescope, based on a Time Projection Chamber, developed to meet specific requirements for new muography applications

- 3D Muon tracking
- 2π Solid Angle acceptance
- Fitting in boreholes

} Geophysics / Geothermal Fields, Mining, Civil Engineering



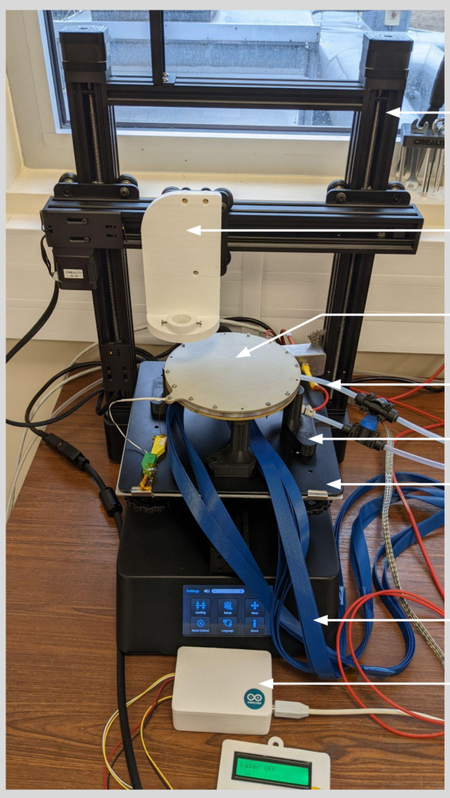
### Micromegas readout

- **1344 pixels** (hexagons ~3mm side)
- 2D Multiplexing → 192 channels (3 x 64)
- 6 to 9 multiplexing factor

**Need to calibrate every single pixel**

- Performance
- Homogeneity
- Multiplexing Routing check

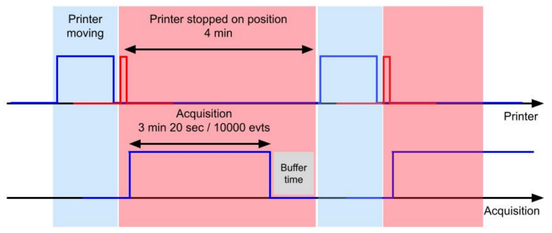
## Setup




**Main setup components** are commercial ones → Easy availability

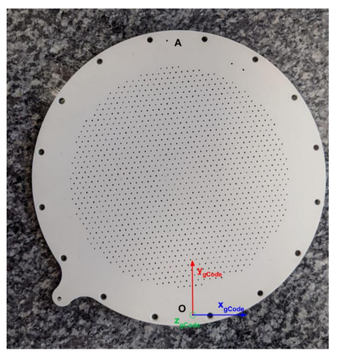
- **3D Printer** (*Creality CP-01*): **$^{55}$Fe** Source movement
  - Adaptation of Laser Cutting Module
  - 0.1 mm precision (w.r.t. 3 mm pixels)

***Arduino***: Synchronization 3D Printer ↔ μM DAQ
- Same DAQ as for muography measurements

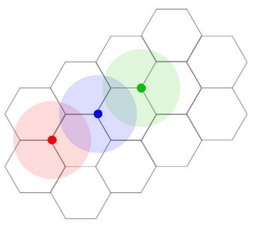



### Perforated cathode

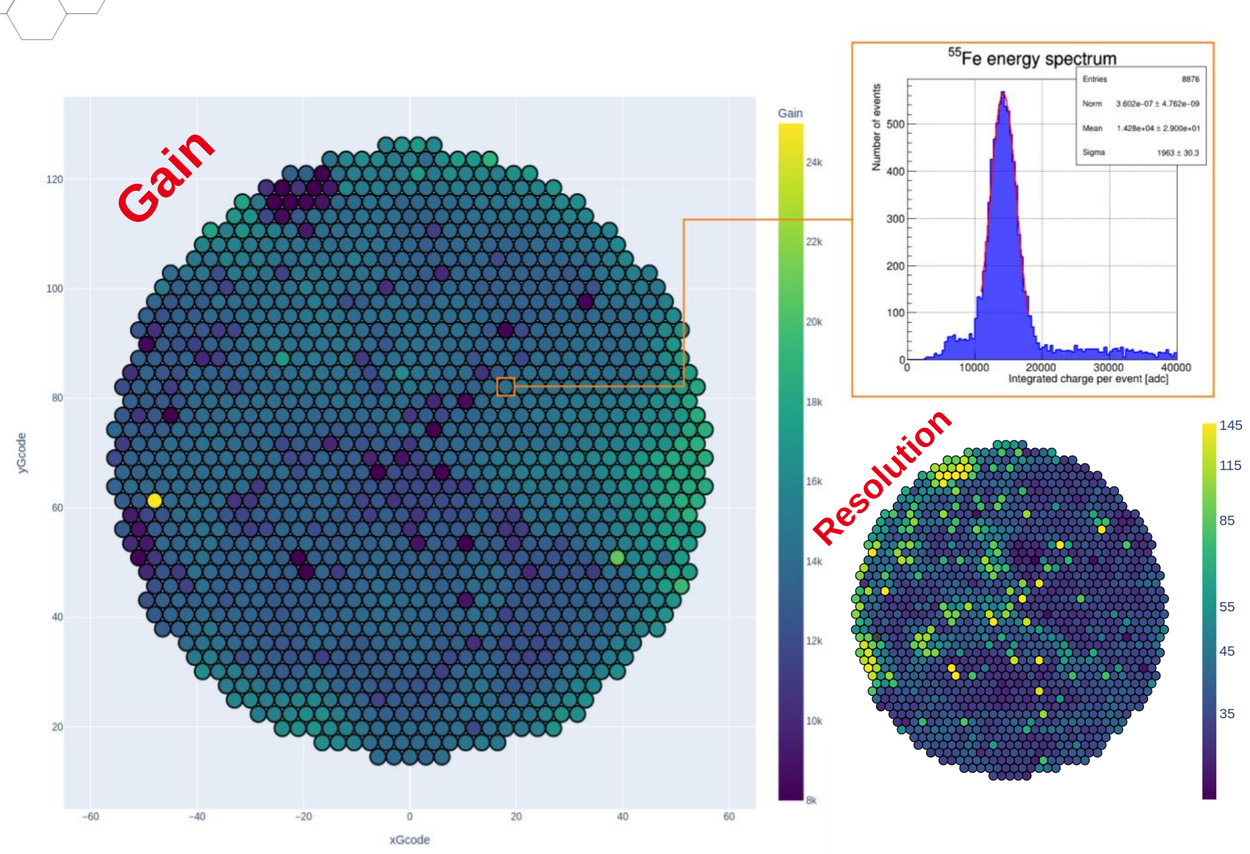
- 3 mm aluminum plate + 12 μm Al-Mylar foil for HV and tightness
- 0.75 mm holes drilled at each desired calibration position
  - It works as collimator as well
  - Numerical command machine file translated to *gCode*
    - Precise source movement by 3D Printer
- Attached to Micromegas with 5mm drift
  - Minimize diffusion effects → Continuous gaz flush

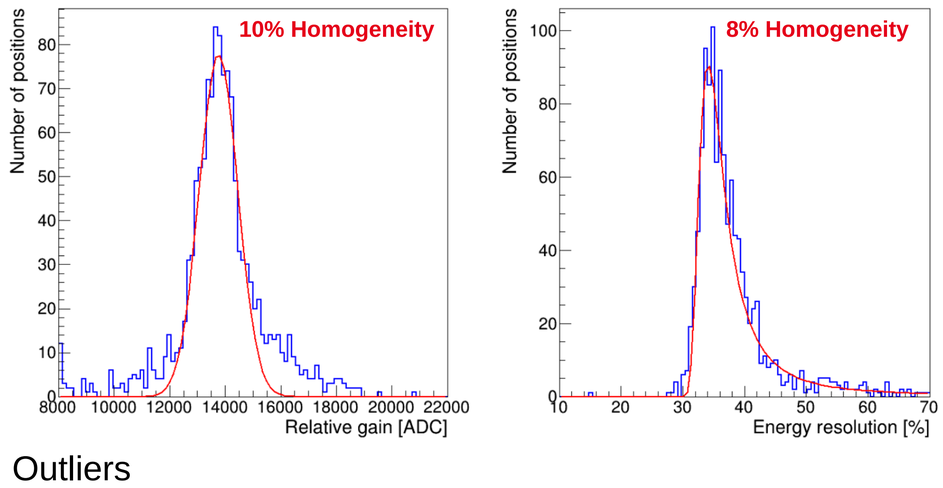


## Results and Performance

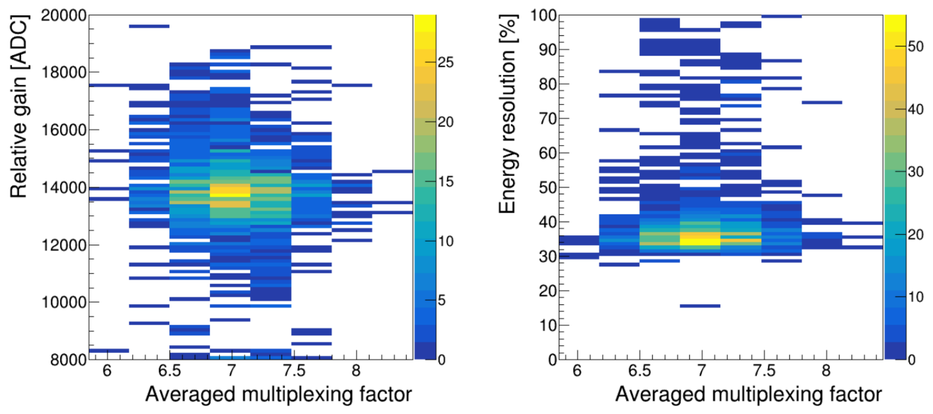


Calibration at the intersection of 3 pixels
- Better charge sharing
- Optimization of number of positions
- Simple Gaussian Fit of the 5.9 keV X-ray (automated as well)




Outliers
- No proper automated fit
- Noisy channels (known issue)




No correlation between multiplexing factor and performance

**This work has been done in the scope of Marion Lehuraux PhD**

More info at:
- https://theses.hal.science/tel-03944830
- NIM A 1045 (2023) 167649

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