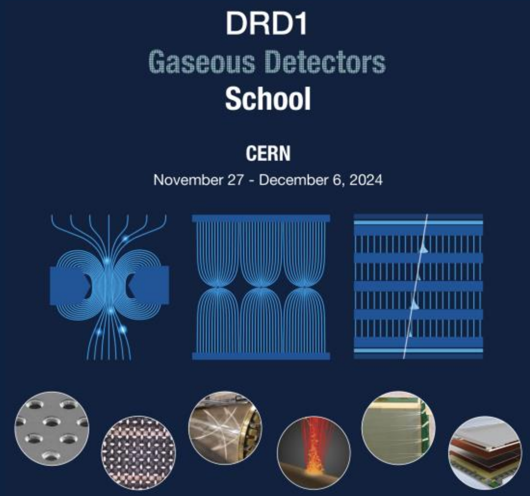
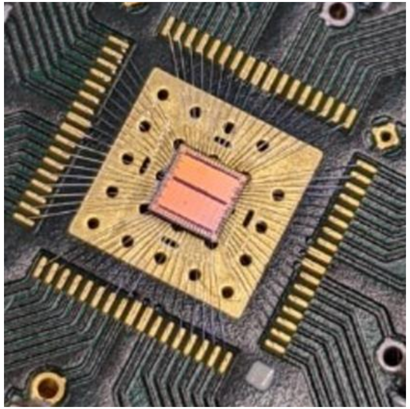
READOUT TECHNIQUES

Position-Sensitive Delay-Line Readouts



Alice Svärdström, Lisa Generoso, Nick Meier, Liu Cong

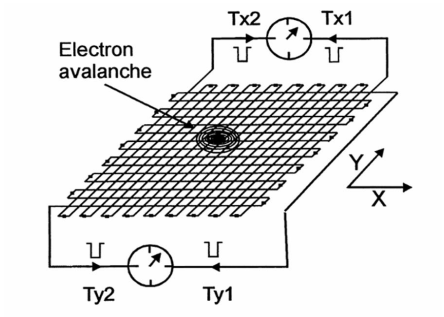
Introduction



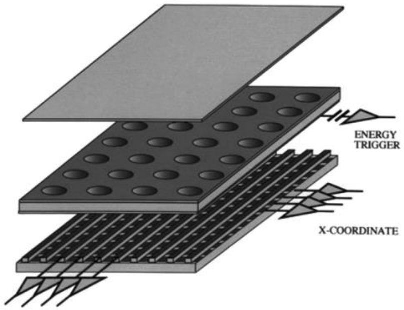
Multi-channel readout electronics

Optical readout

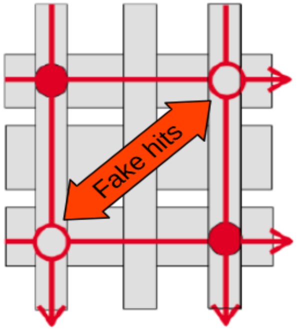
Introduction



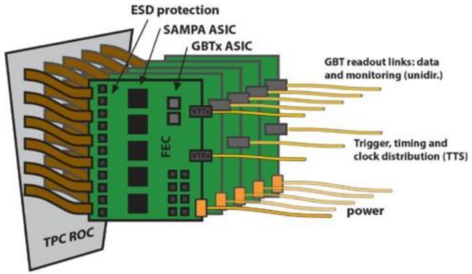
two readout channel



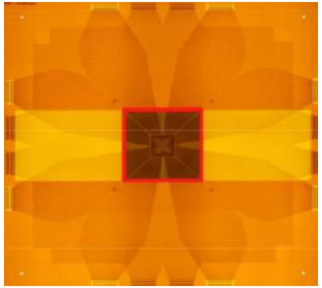
X-Y readout
n+m readout channel



X-Y-U readout
l+n+m readout channel



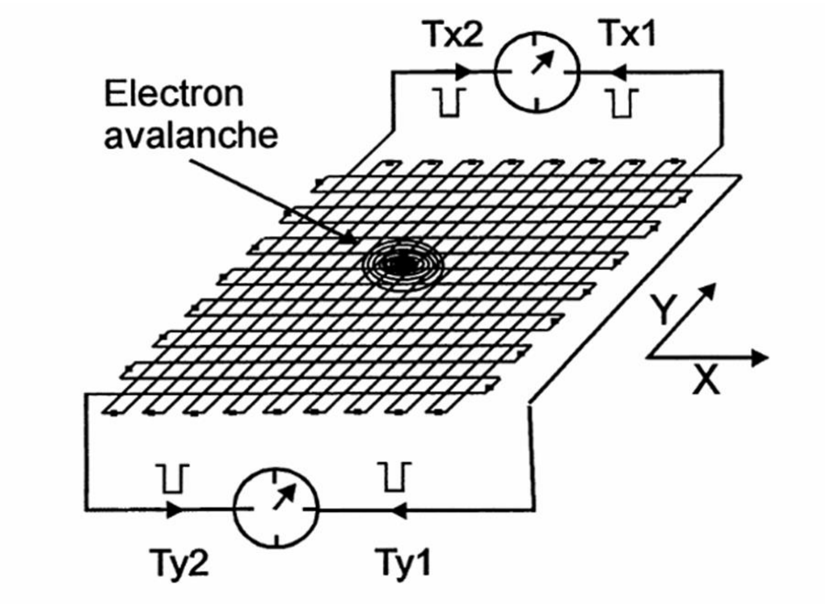
Pad readout
N*m channel readout



Pad + strip readout combined

Introduction

The most common readout technique for two-dimensional gaseous avalanche detectors is based on the Center-of-Gravity readout method and employs a large number of amplifiers and shaping electronics for the channel-by-channel analysis.

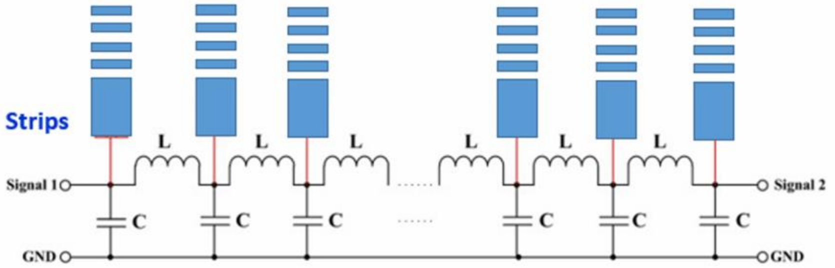


Use fast delay-line circits as readout

- Reduce front-end electronics cost
- Maintaining high spatial resolution

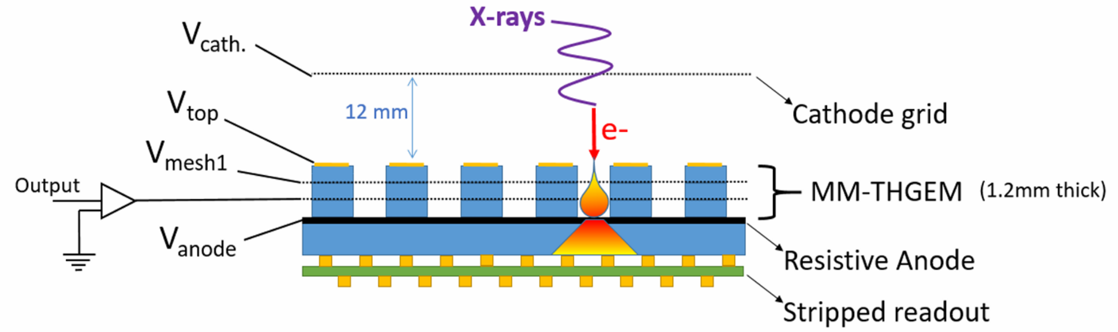
The principle of delay-line readout

- The localization capability is derived from the time difference between the signals sened at the two ends of the delay-line



Introduction

Detectors under test

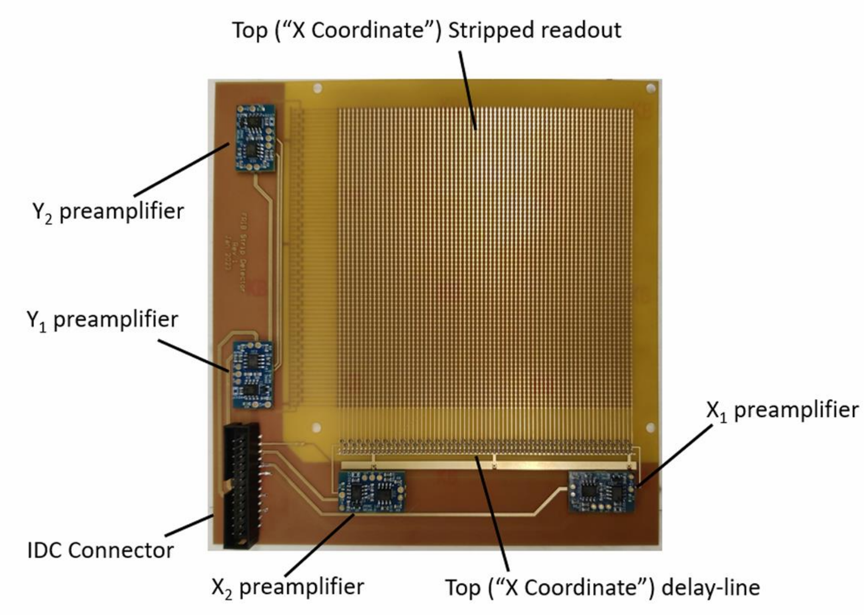


MM-THGEM

- Consist of a metallized-polypropylene drift-cathode foil
- A Multi-Mesh THGEM coupled in cascade to a resistive anode
- The lattter is made of a > 10 MΩ/square Diamond-Like Carbon layer
- 2mm thick FR4 substrate
- A double-sided strip readout electrode is placed behind the resistive-anode plate
- Ar/CH_4 (95% : 5%)

Introduction

2-dimensional stripped readout board

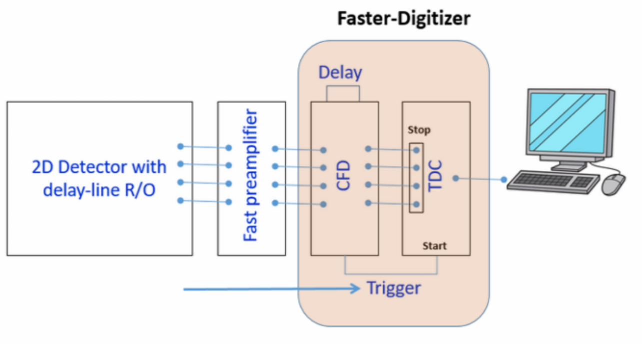


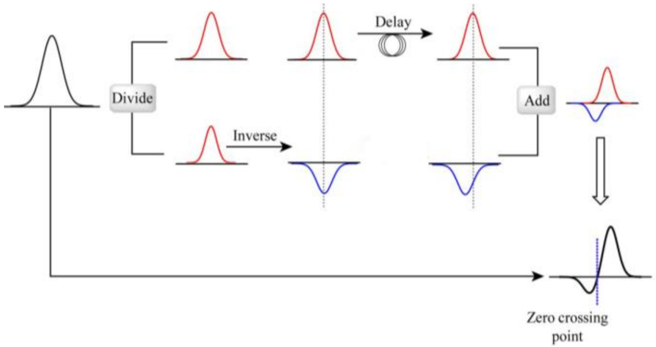
Employ the resisitive anode technique, the induced signal is spread across the readout electrode in such a way as to match the geometrical size of the induced charge with the pitch of the readout strip.

The induced signals were collected on a double-sided X-Y readout electrode.

DAQ System

- From the delay lines we get four signals
  - are amplified in two stages by fast current pre-amplifiers close to the detector and the additionally amplified before entering the digitization chain
  - send signals to Constant Fraction Discriminator (CFD)
    - Produces a NIM output for signals with changing amplitudes but a constant rise time
    - Working principle:
      - When signal crosses the threshold trigger is sent to the TDC
      - Divides the signal into two signals
      - Inverts one signal, delays it and then supper imposes the two signals
      - The zero-point crossing is used for the exact timing of stop signal for the TDC
  - Signal of the TDC is then send to the readout PC





Work Plan

Prepare the detector for operation and data recording

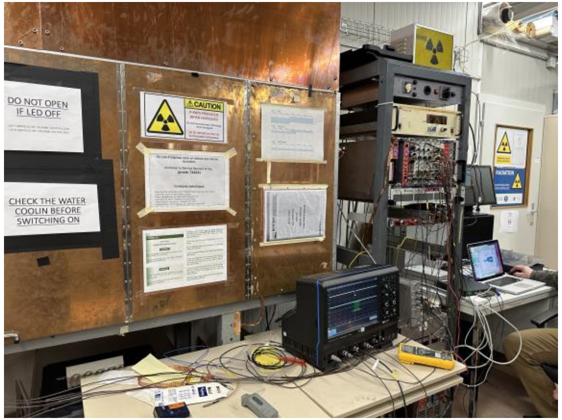
- Verify the assembly of the detector components
- Check gas flow
- Check cable connection, switch on all the electronics components
- Place the X-ray source, change the HVs until preamplifier displays good signals

Verify operation of the detector and prepare electronics for image processing

- Check the output signals of the delay-line fast-preamplifiers using an oscilloscope.
  Objective: increase signal-to-noise ration and minimize signal rise time
- Process the TFA output signals using a Constant-Fraction Discriminator (CFD) for analog-to-digital conversion.
- Process the digital CFD output signal using Time-to-Amplitude Converters (TACs) and the Faster digitizer module for obtaining the final detector image.

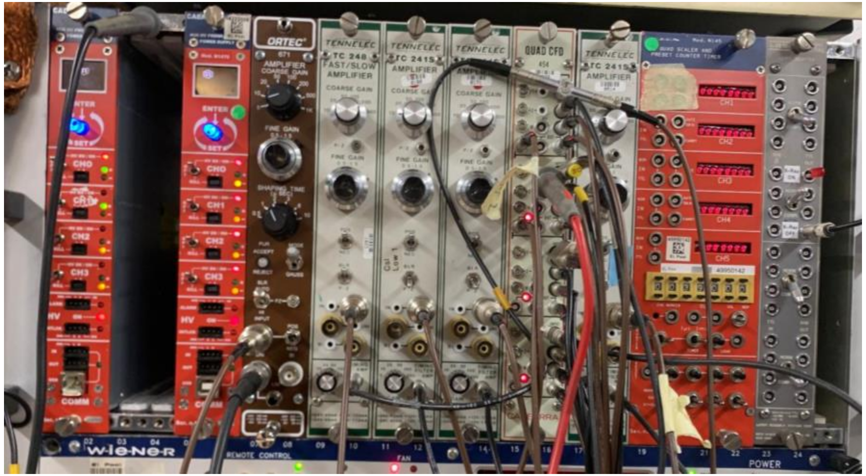
Image processing

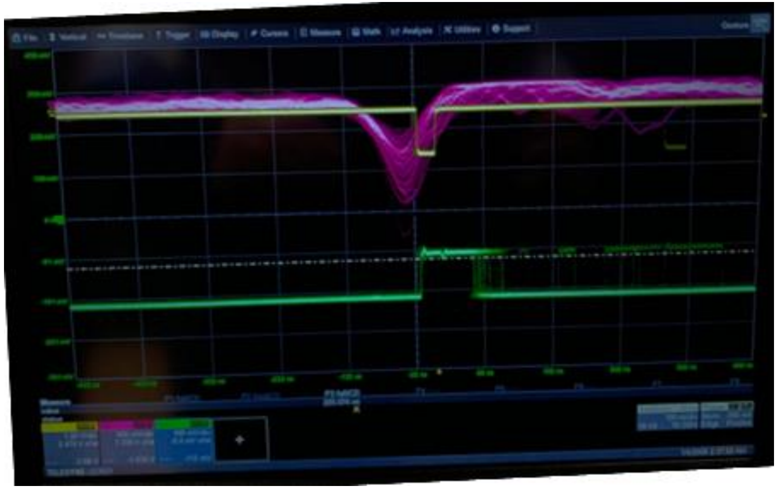
- Record empty field image
- Record the image of an object



Setting up the readout system

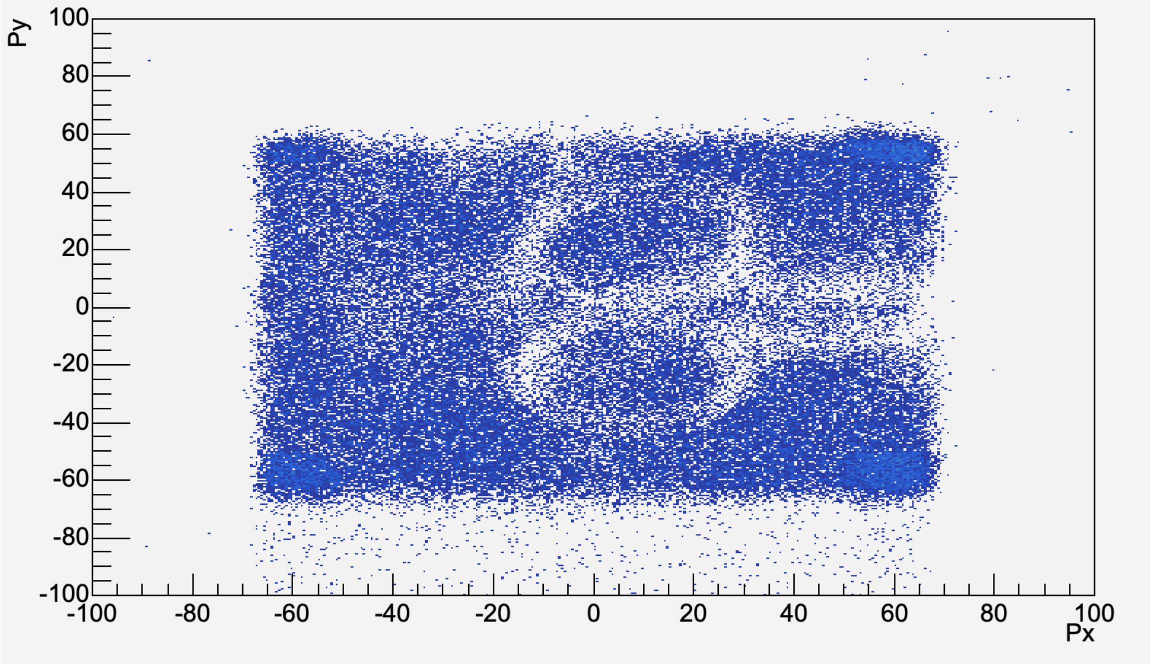
- On the amplifier we could adjust the integration and differentiation time to reduce the effect of noise
- Then on the CFD we adjusted the threshold (to not trigger on noise) and Z-pole (to remove jitter of the signals)





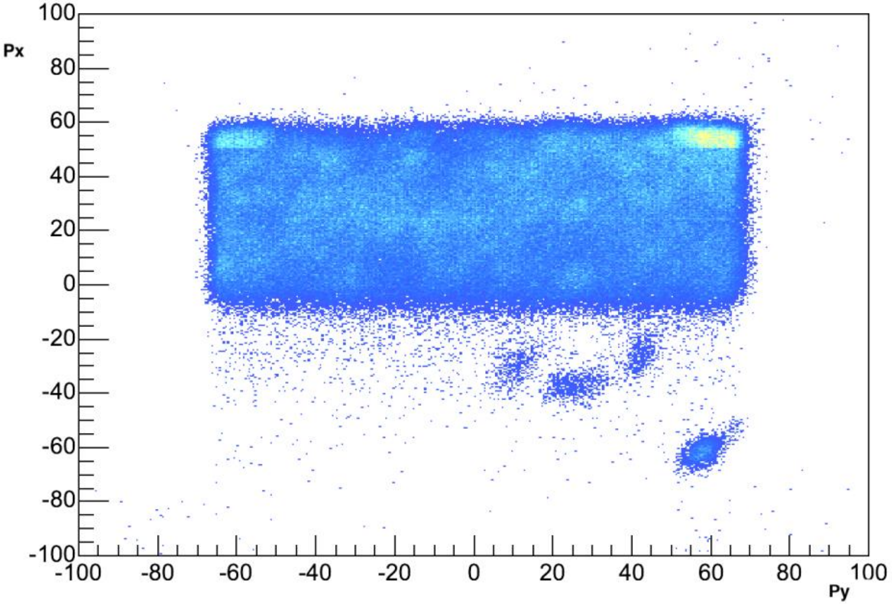
Imaging

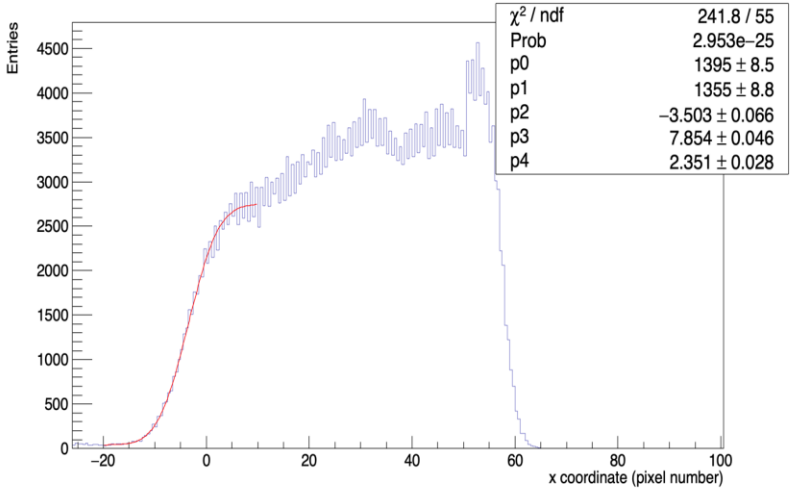
We placed a pair of scissors in front of the chamber and irradiated it with the Fe-55 source



Spatial Resolution

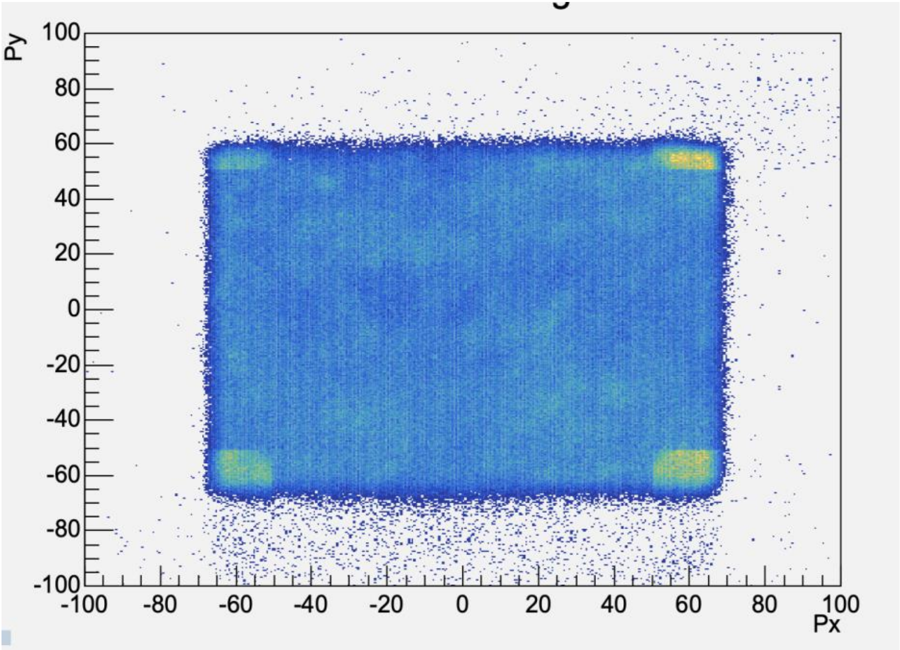
- We covered half of the detector with a rectangular piece of PCB and irradiated it with the Fe-55 source
- We plotted the distribution of the x coordinates and fitted the rising side with an error function, then retrieved a spatial resolution from the sigma (sqrt(p3)*p4*size_of_pad) of ≈13 mm

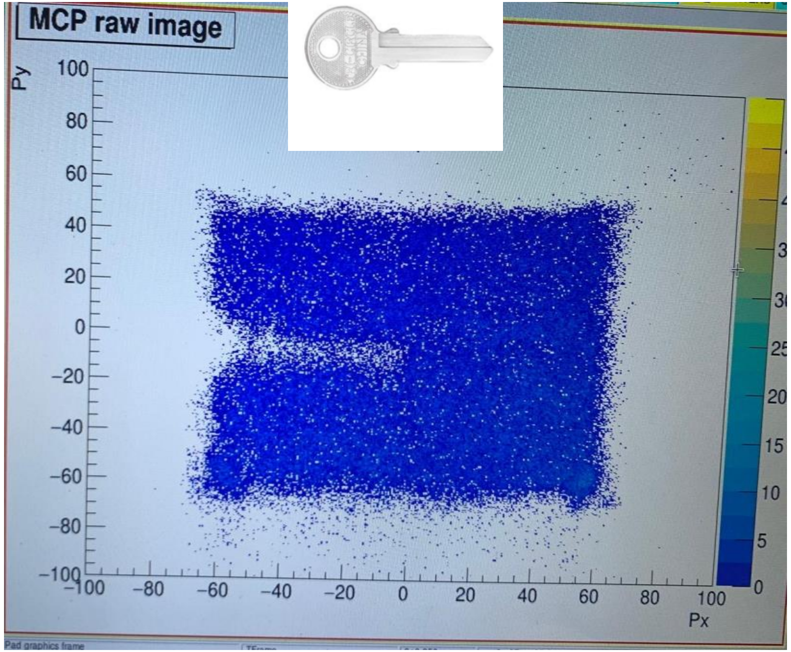




Optimization

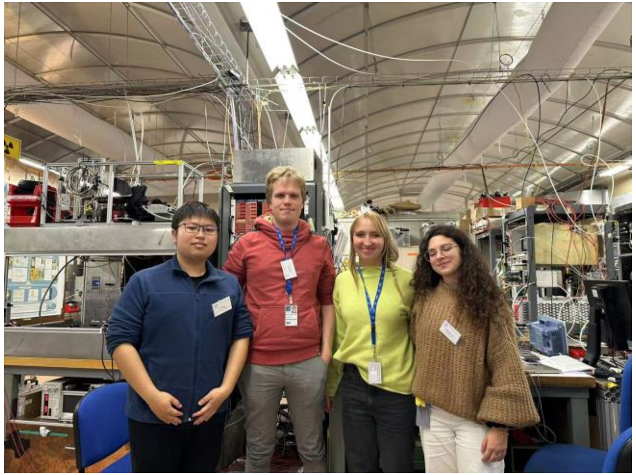
- We figured out that the highlighted spots in the corners were artifacts possibly given by deflections in the lines of the drift field
- We removed this effect by adjusting the filed ratios and increasing the gas flux





Summary

- Understand the Position-sensitive delay-line readouts principle
- Experimental ability to debug the entire system
- Image optimization and daa analysis
- Collaboration, Exchange and Discussion



DRD1 Gaseous Detectors School

Thank you for this School opportunity to

learn, experience, exercise and harvest