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Barry University

Construction and first commissioning of the self-stretched gas electron multiplier (GEM) detector

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Outline

Motivation

- Time, cost, and construction environment

Construction

- GEM foil stretching and framing by IR thermal method
- Mechanical self-stretching design

Characterization

- First signal under X-ray
- Gain measurements and rate plateaus

Future Work

- Construction and testing of the Compact Muon Solenoid GEM detectors

Motivation

Time

- Previous methods of construction and foil stretching were measured in days.
- With new assembly techniques complete detectors can be manufactured in hours.

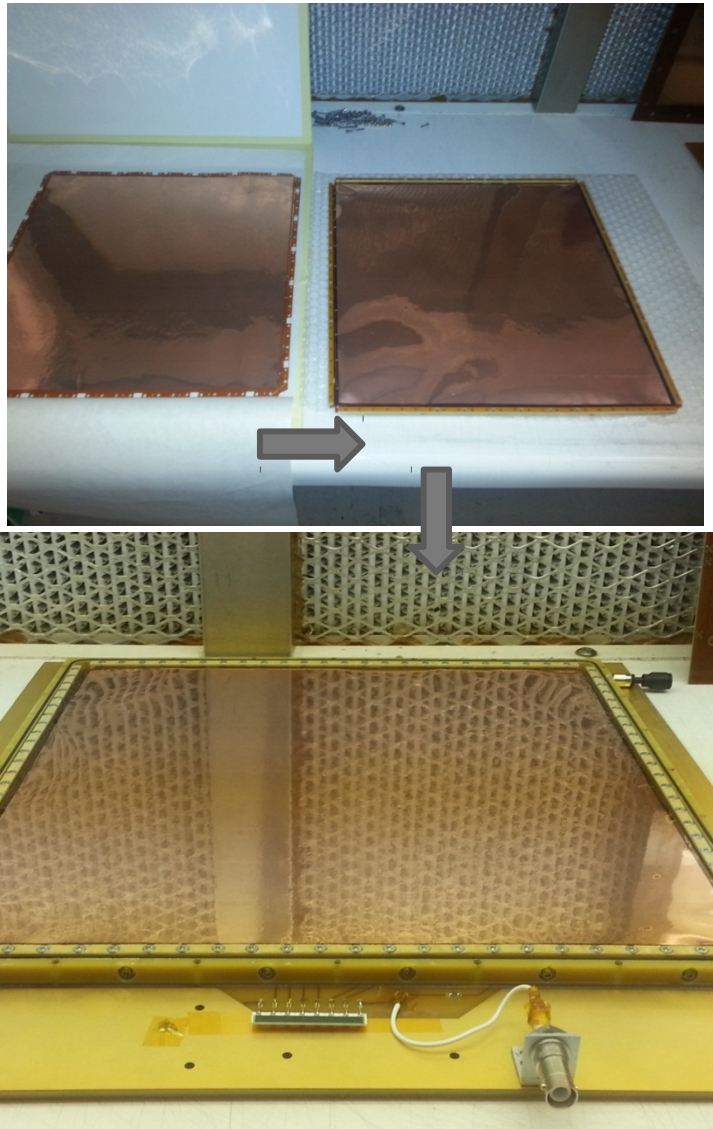
Large Scale Production

- In order for the design to be viable for mass production the required infrastructure was reduced to a minimum.
- Assembly now only requires a clean room facility.

Contrasting Foil Stretching Techniques

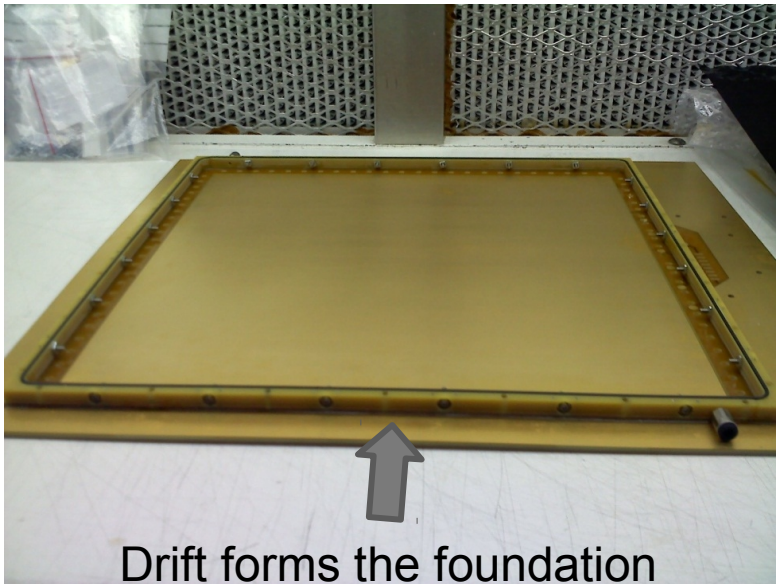
Low cost GEM stretching using IR heating

Mechanical Self-Stretching

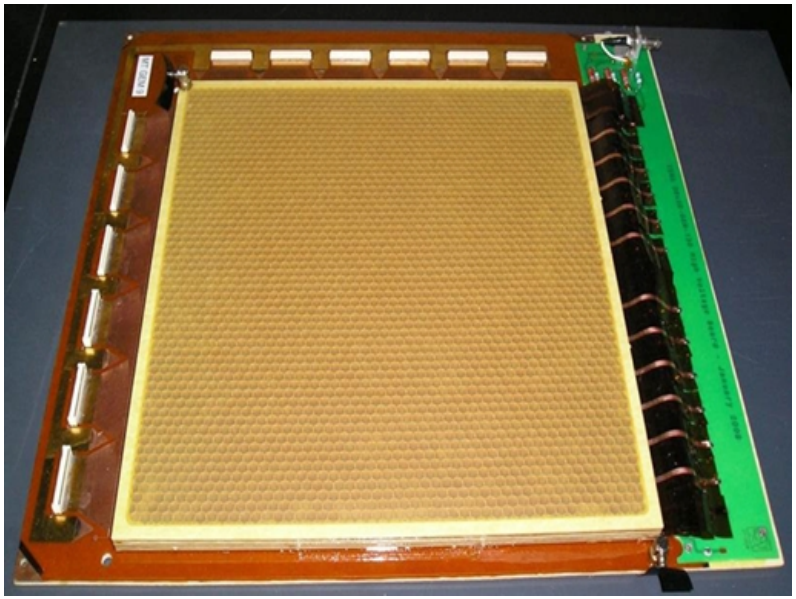


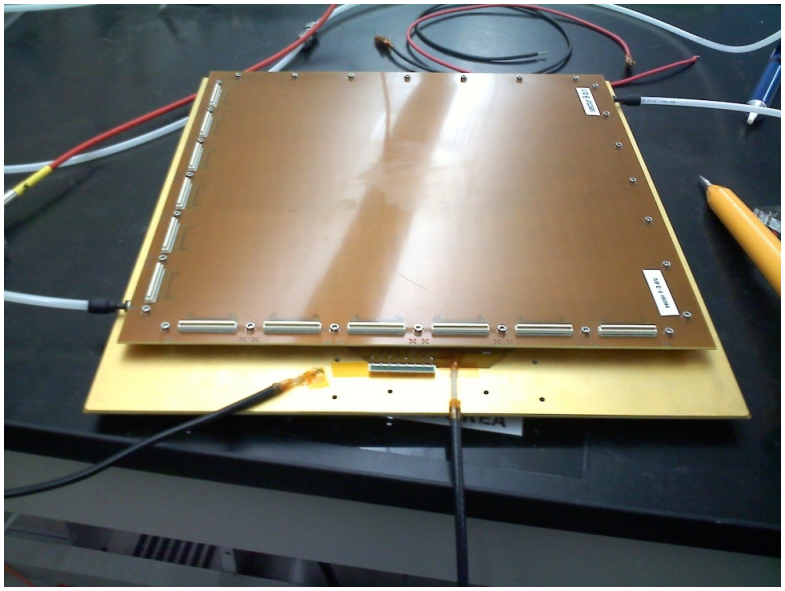
Redesigned Frame

New design integrates the drift and readout into the frame to provide a gas volume with the assistance of an O-ring



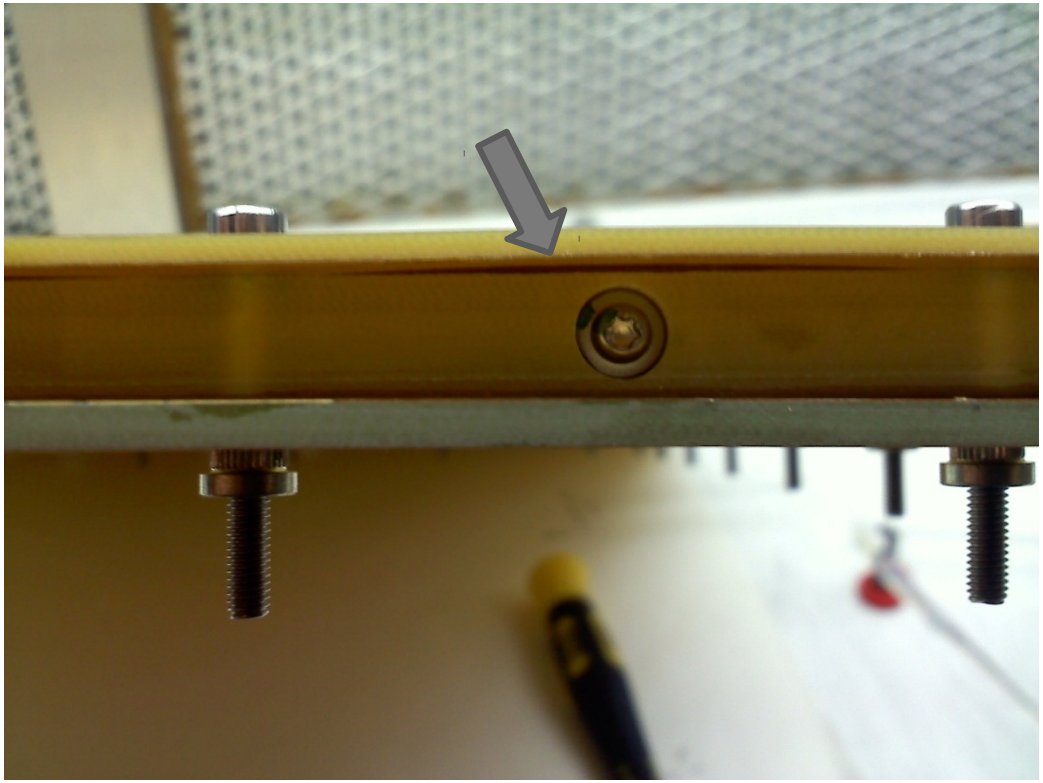
Previous frame style was a single piece coated in glued to seal the gas volume



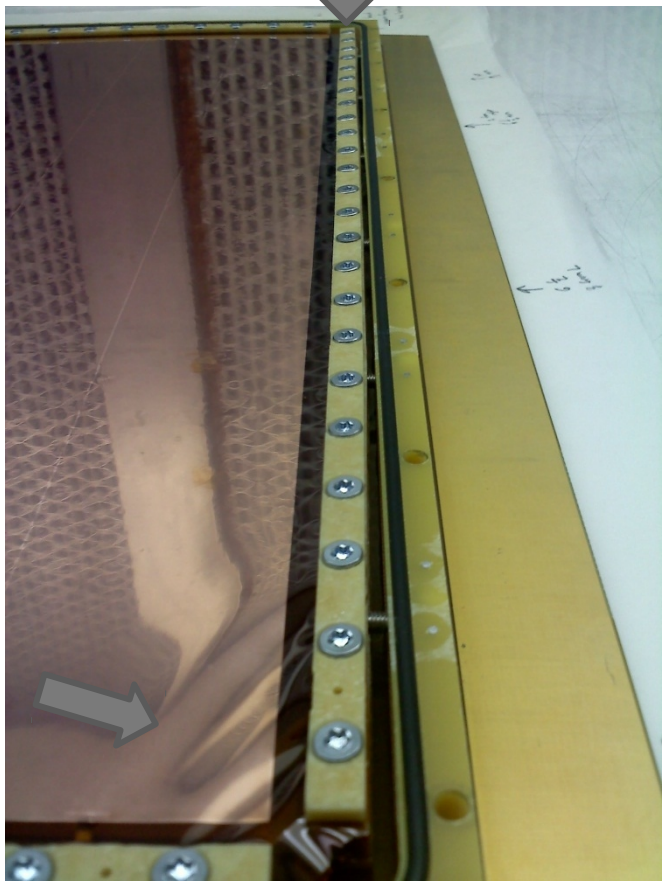


Difficulties in Construction

The screws that secure the foil stack deformed the readout board and compromised the gas volume



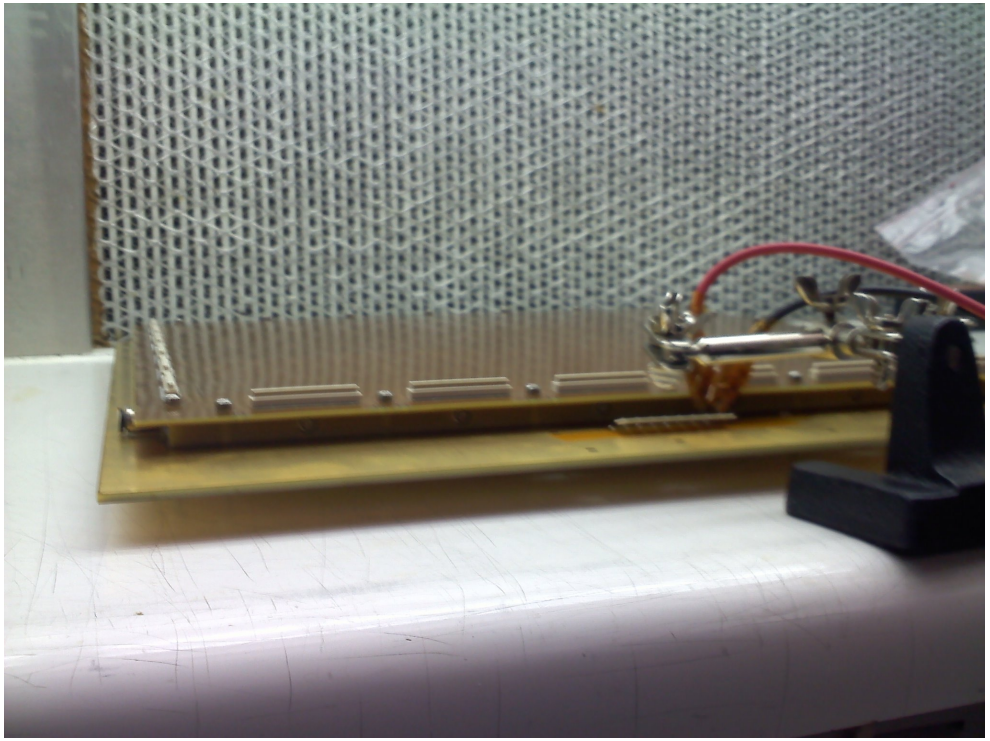
Without the inclusion of corner screws reaching a uniform tightening became more difficult as you move away from the center of the foils



Solutions

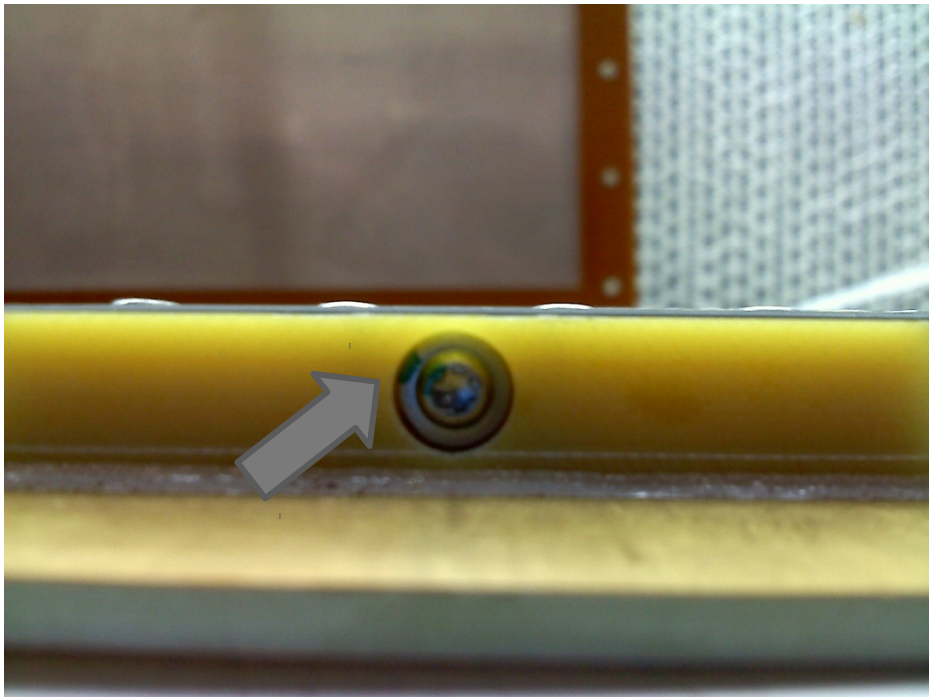
Applying voltage under air

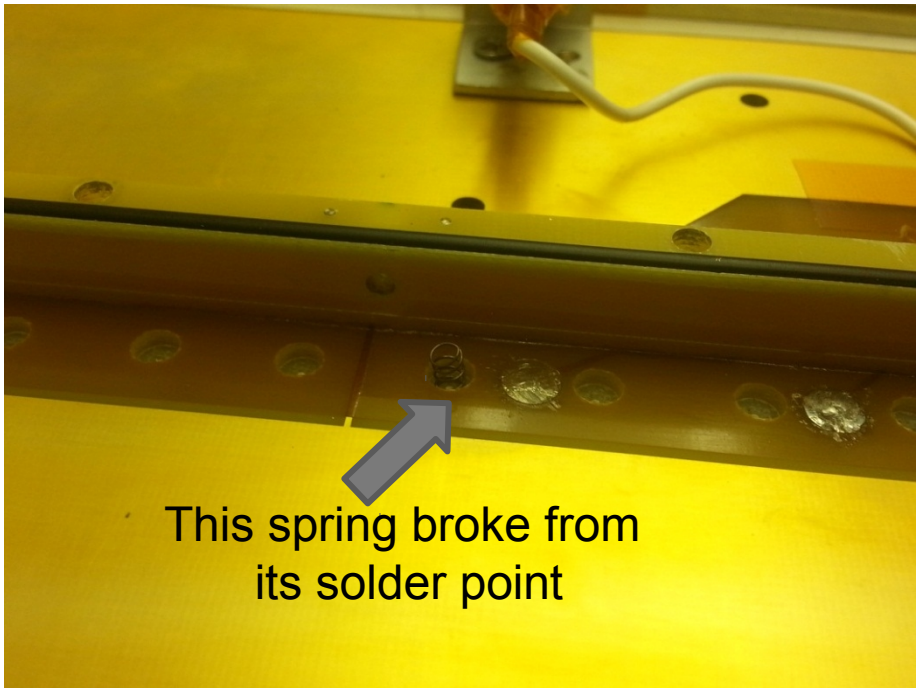
- In order to confirm that the foils for our detector are parallel to each other we apply voltage between the foils under air.
- If we are unable to reach the normal operating voltage between foils then we have identified a problem.



Possible Improvements

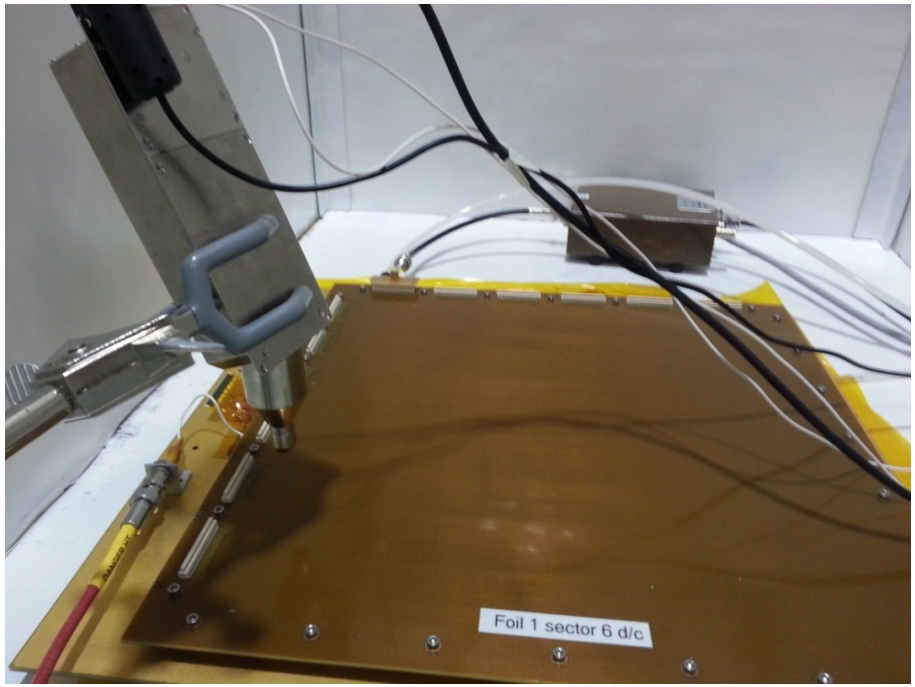
Electrical connection to the foils is made using springs. The problem is that properly securing the springs to their points of contact and the foils is extremely difficult. There is also no way to check that connection is made once you place the foil stack.





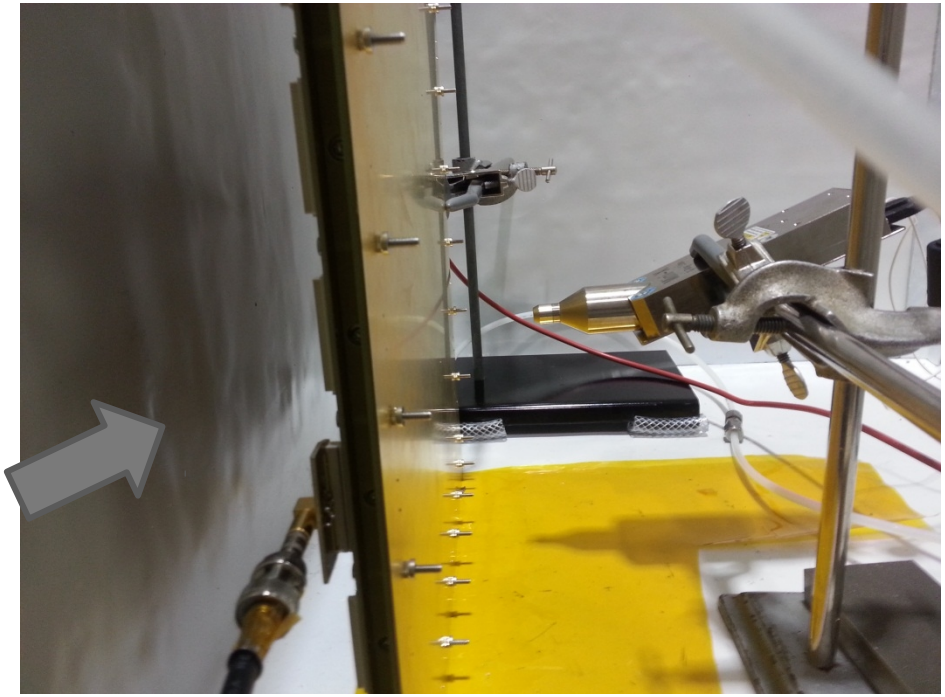
One of the major issues with mass production will be achieving uniform tightening of the foils with precision

First Commissioning



Two arrangements for testing due to the thickness of our frame pieces

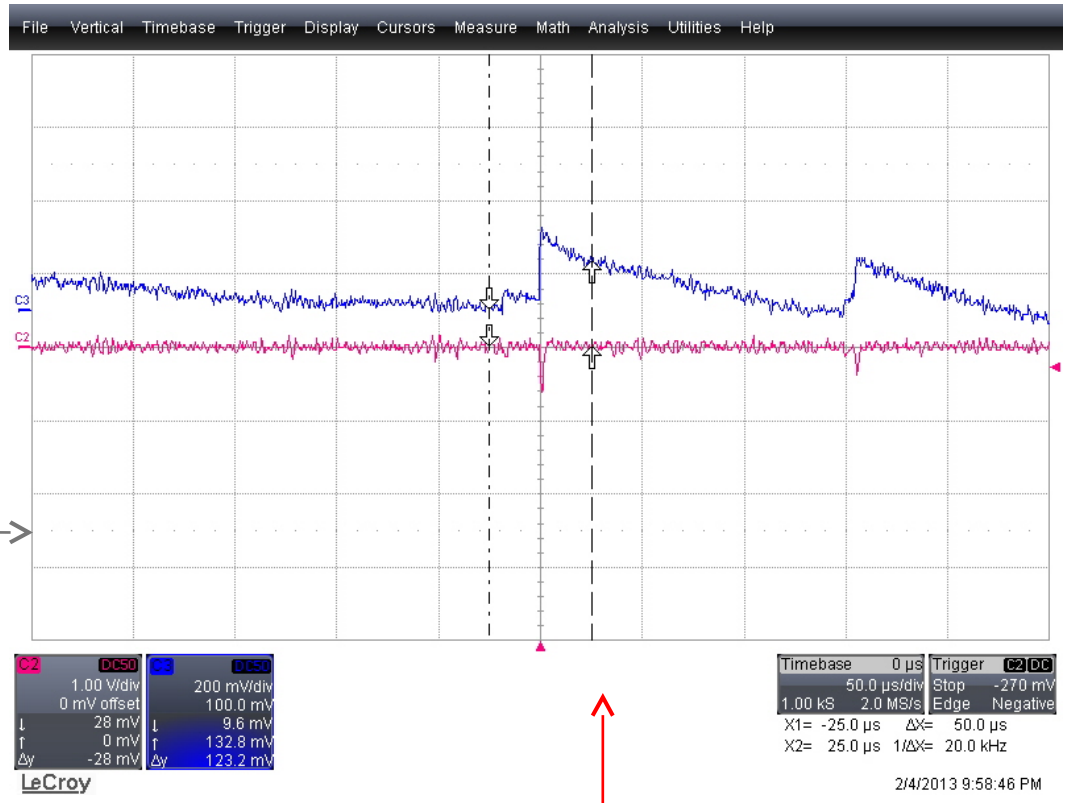
Must pass through our readout and GEM foils to reach the drift gap

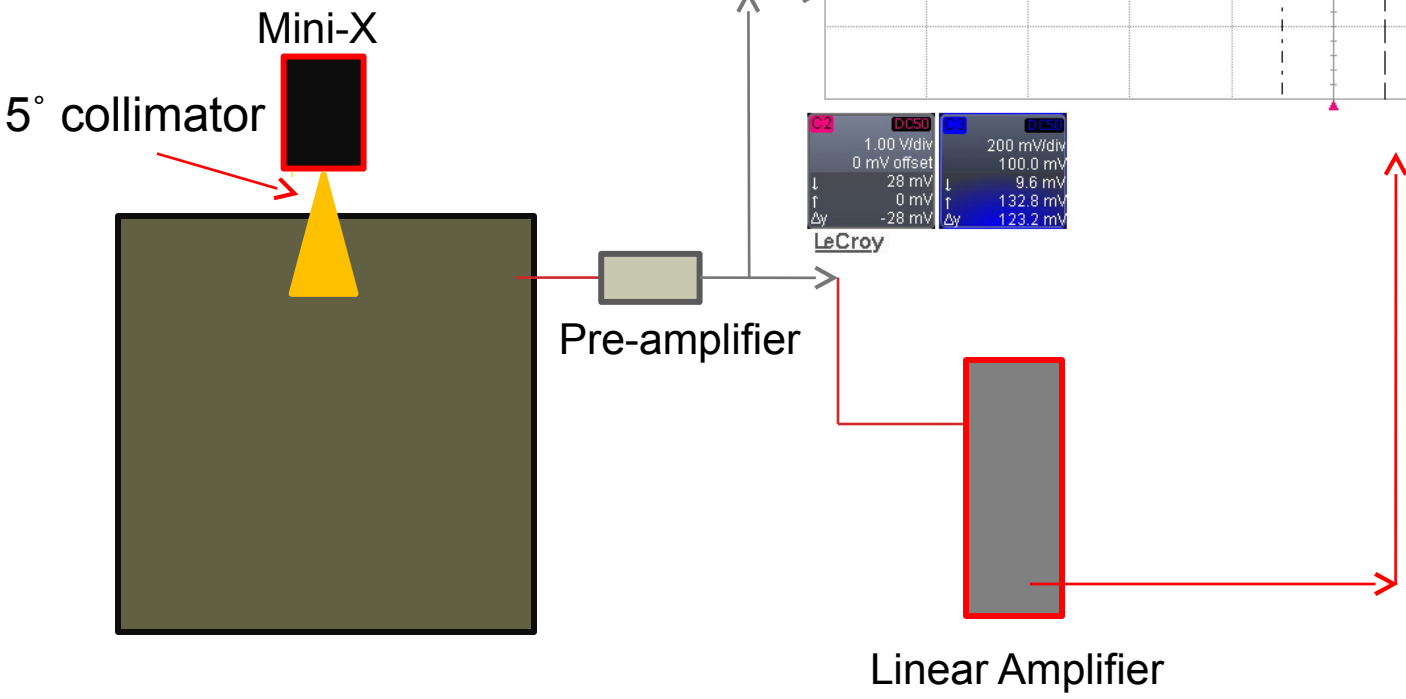


Vertical setup allows us to reach the drift region through minimal material

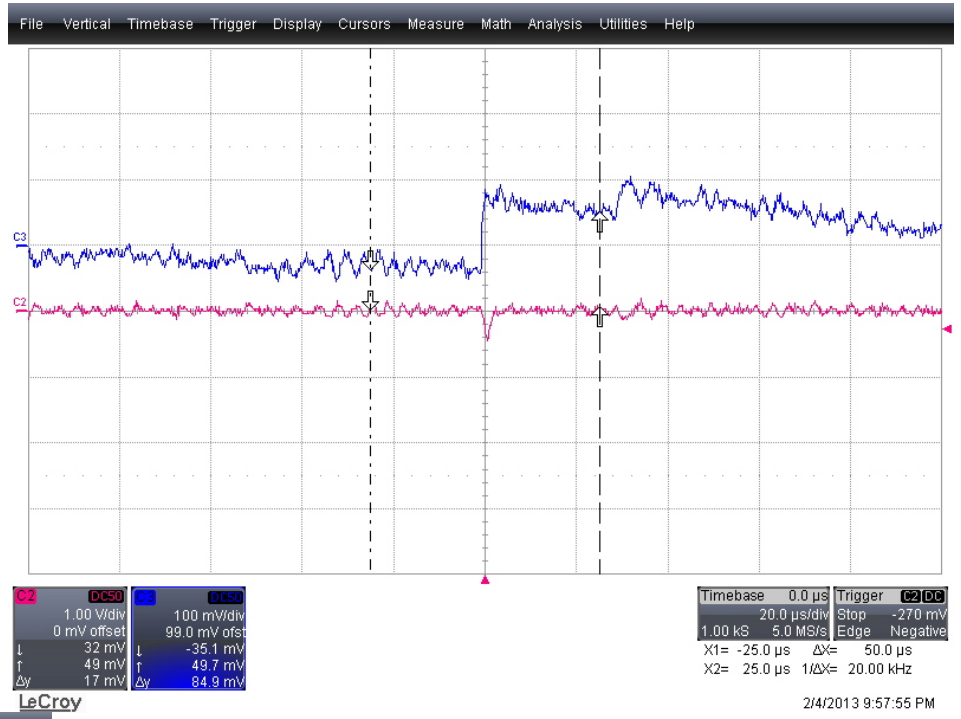
The blue channel is displaying information directly from the pre-amplifier

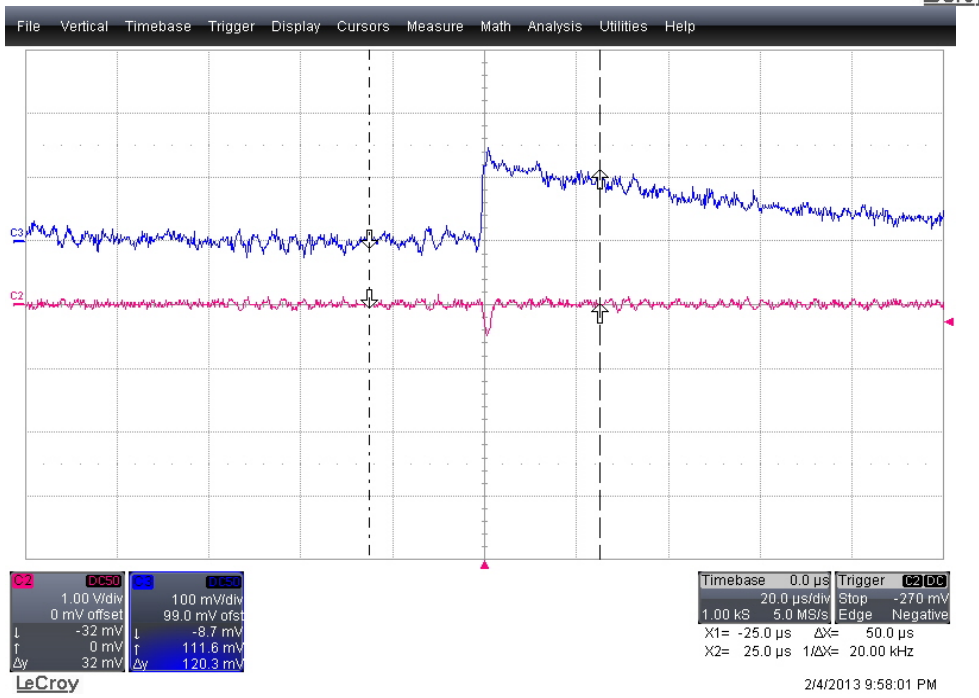
While the red channel is our linear amplifier





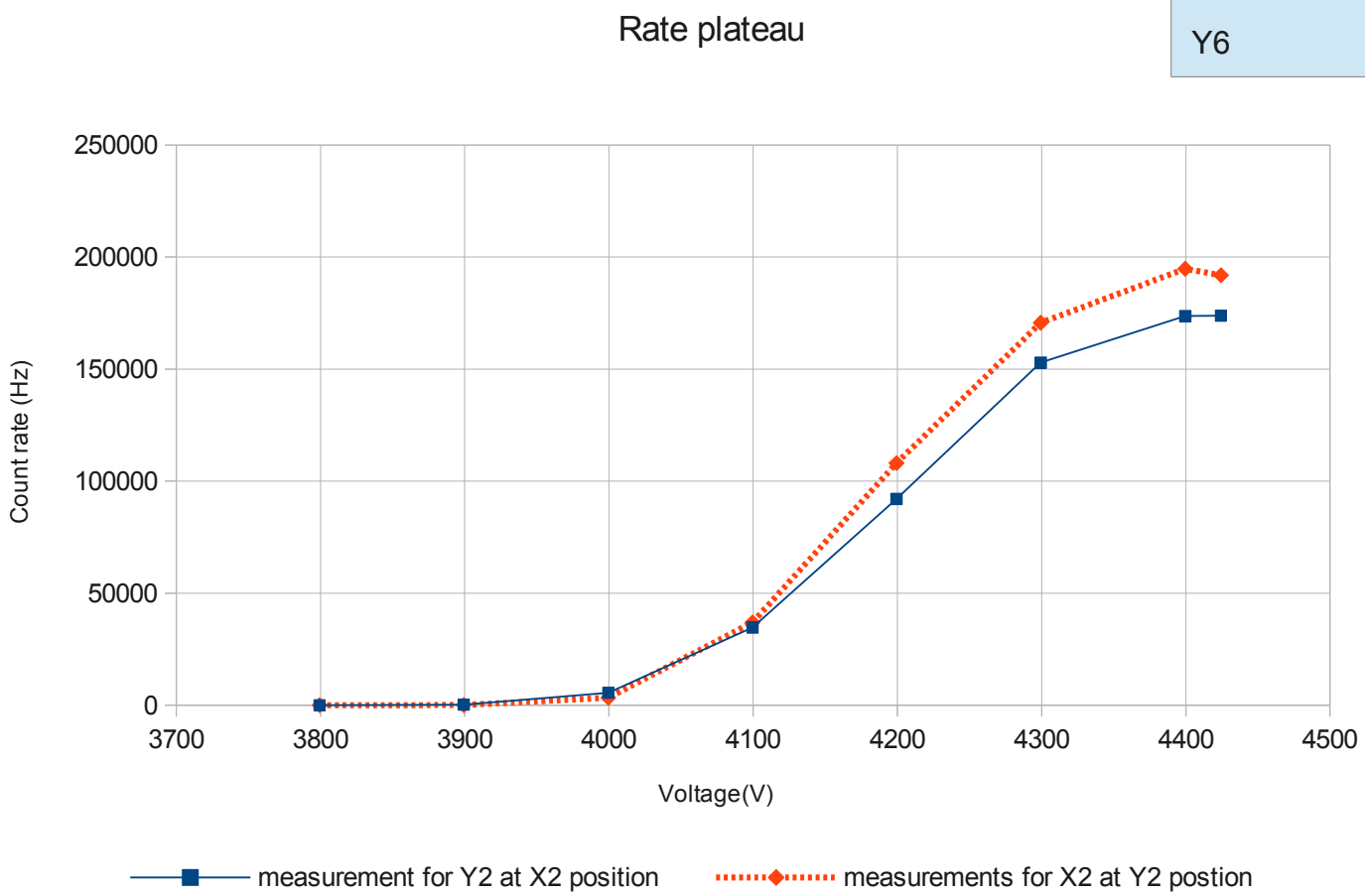
These signals were recorded while operating the detector at 4200 volts and irradiating with the Amptek Mini-X portable X-ray source



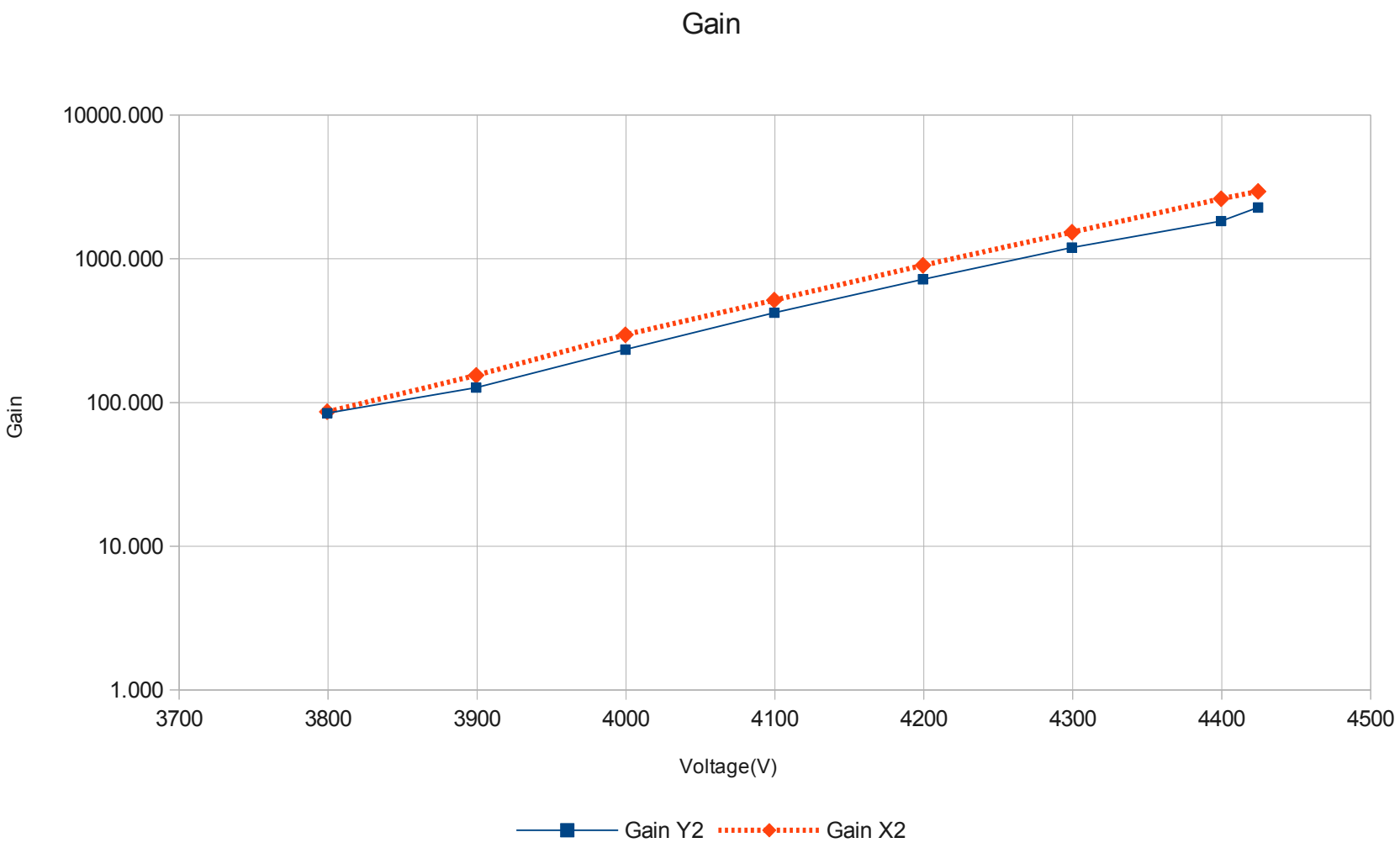


Rate Plateau

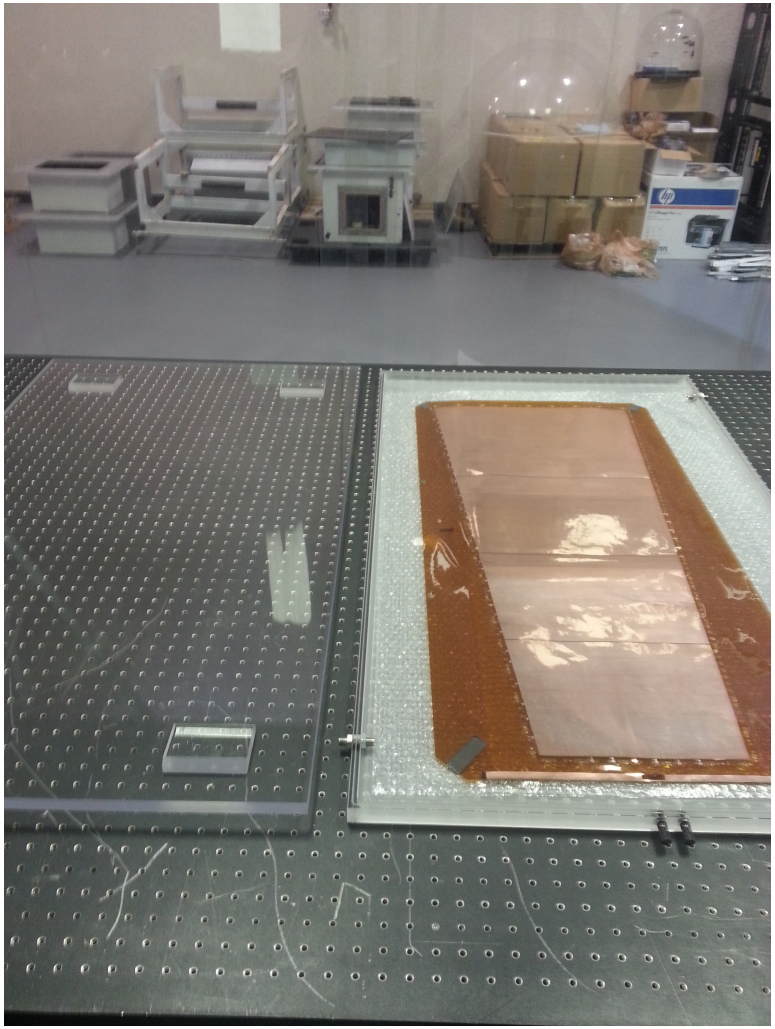
	X1	X2	X3	X4	X5	X6
Y1						
Y2		X				
Y3						
Y4						
Y5						
Y6						



Gain Curves


Gain
10000.000
1000.000
100.000
10.000
1.000
Gain
3700
3800
3900
4000
4100
4200
4300
4400
4500
Voltage(V)
Gain Y2
Gain X2

Conclusion



What is the point?

Now that this design has been proven effective and successful we can move on to a larger scale.

- We will now scale up our design to be used in the CMS experiment at CERN.
- Once we have shown that this we can properly scale this design up to the size required we will experiment with zig-zag readout structures.