IR Thermal Stretching and Framing of Large Area GEM Foils

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Project Goals:

- To stretch large area GEM foils for our muon tomography station without the high initial investment of a cleanroom oven
- This design should be easily scalable to different foil sizes and geometries

Design Considerations

All IR bulbs are not made alike!

Straight vs. C-shaped filament

For straight filament bulbs, the highest intensity light forms a fairly uniform line

For C-shaped filaments, the highest intensity light is more dispersed and non-uniform

We chose straight filament bulbs since we are most concerned with heating the Plexiglas frame

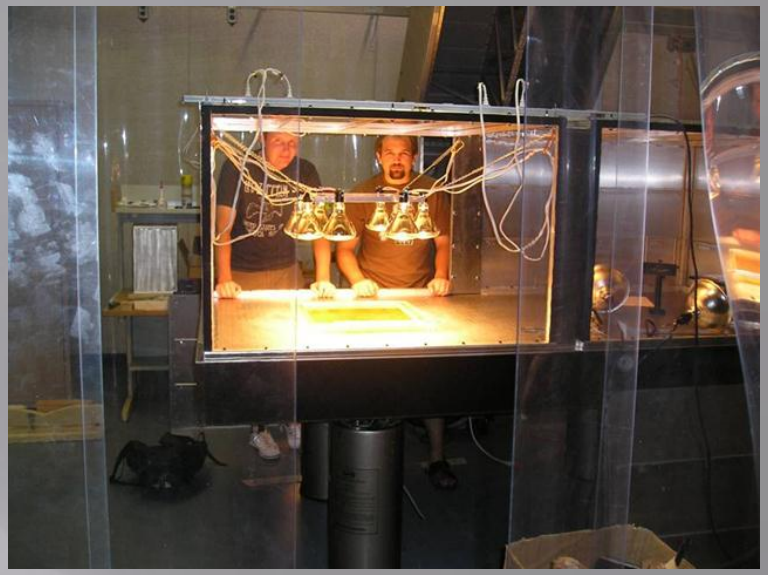
C Filament

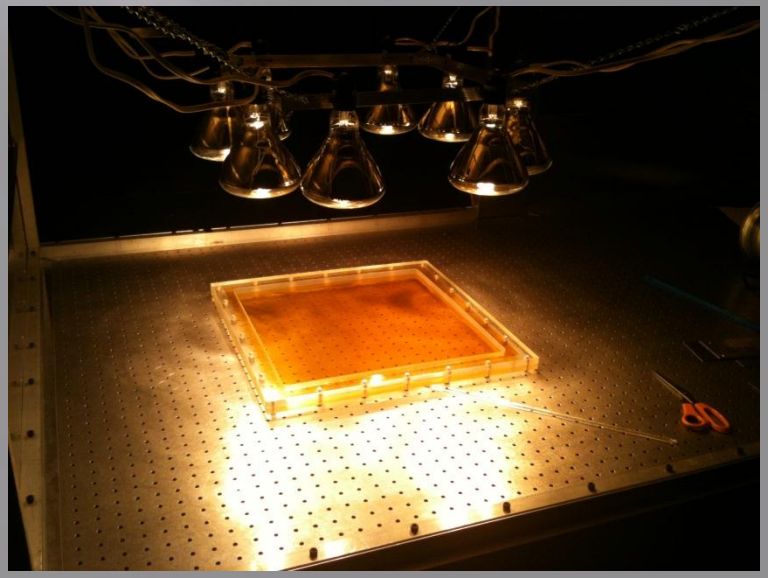
Straight Filament

Design for 30 cm x 30 cm IR array:

8x 250 Watt IR Bulbs, suspended on an aluminum frame inside a 2 m x 1 m optical bench

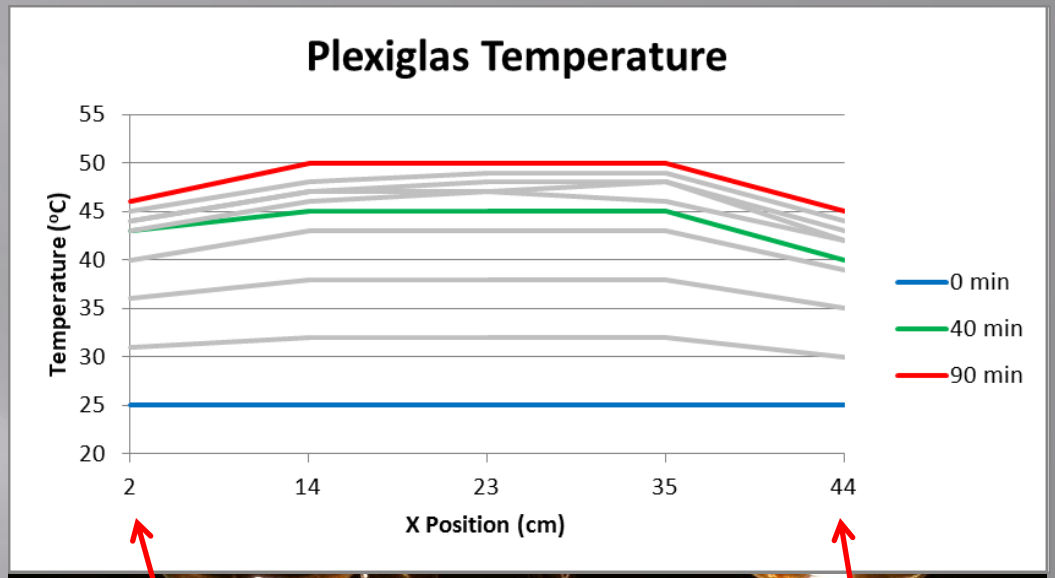
Each pair of bulbs is wired through a dimmer switch to control temperature

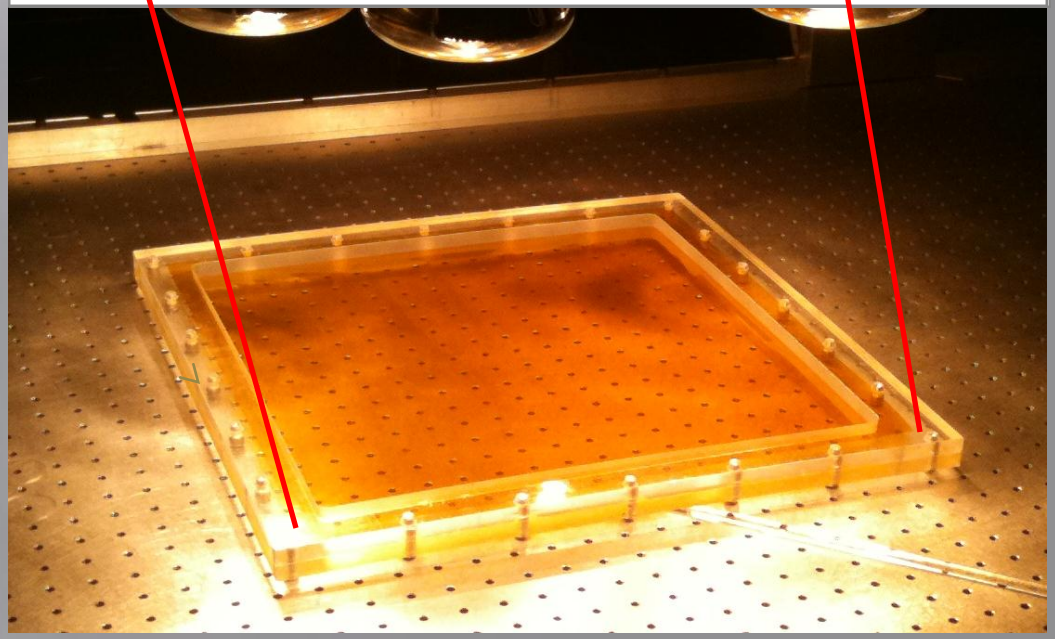




The temperature profile during the heating process was measured

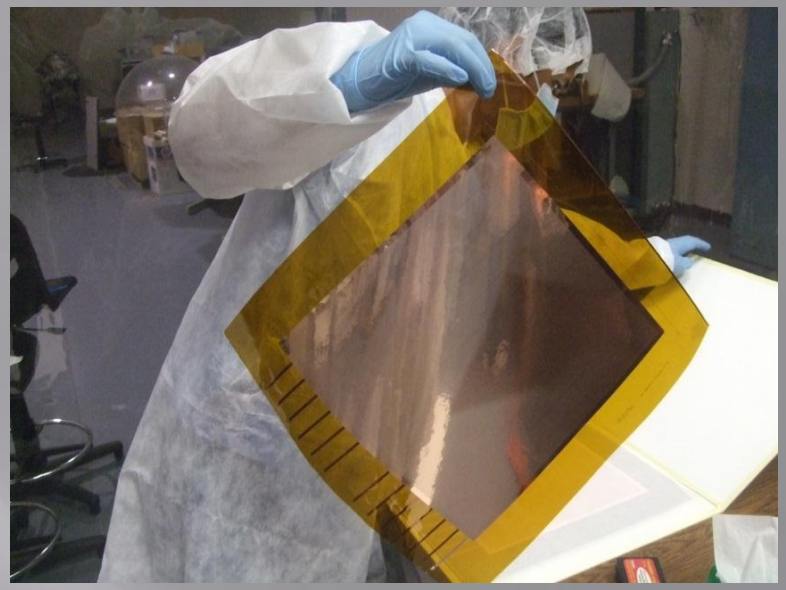
Each line represents the profile across one side of the Plexiglas frame at 10 minute intervals



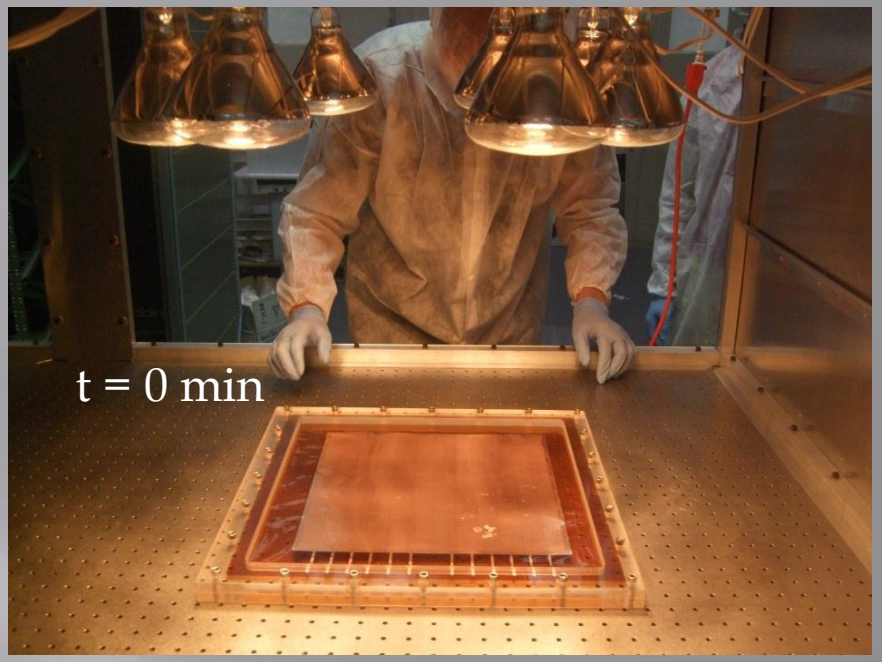


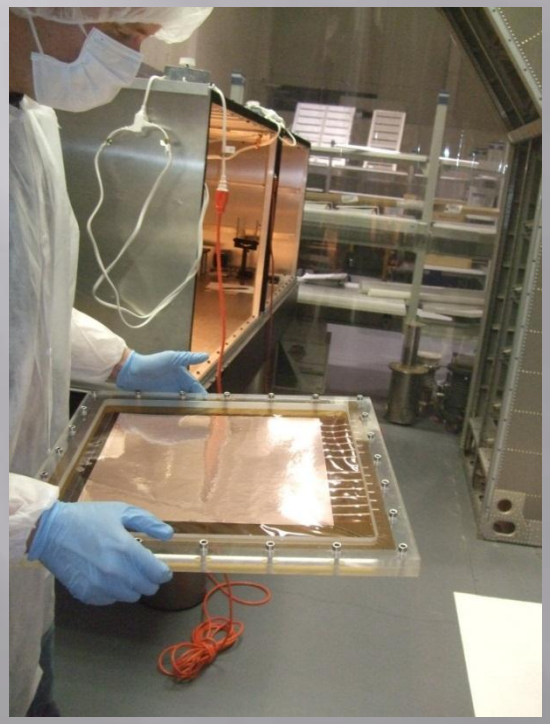
Stretching a 30 cm x 30 cm GEM Foil

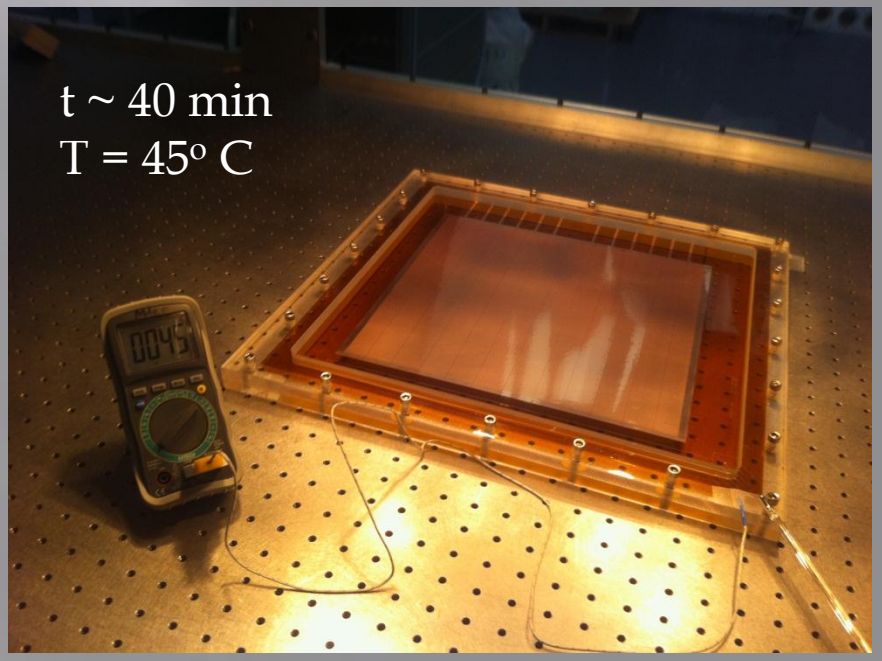
After the Plexiglas frame has been well cleaned, the GEM foil is placed in the frame and secured



The Plexiglas frame is then placed under the IR lamps and allowed to heat for ~40 minutes







Framing the 30 cm x 30 cm GEM Foil

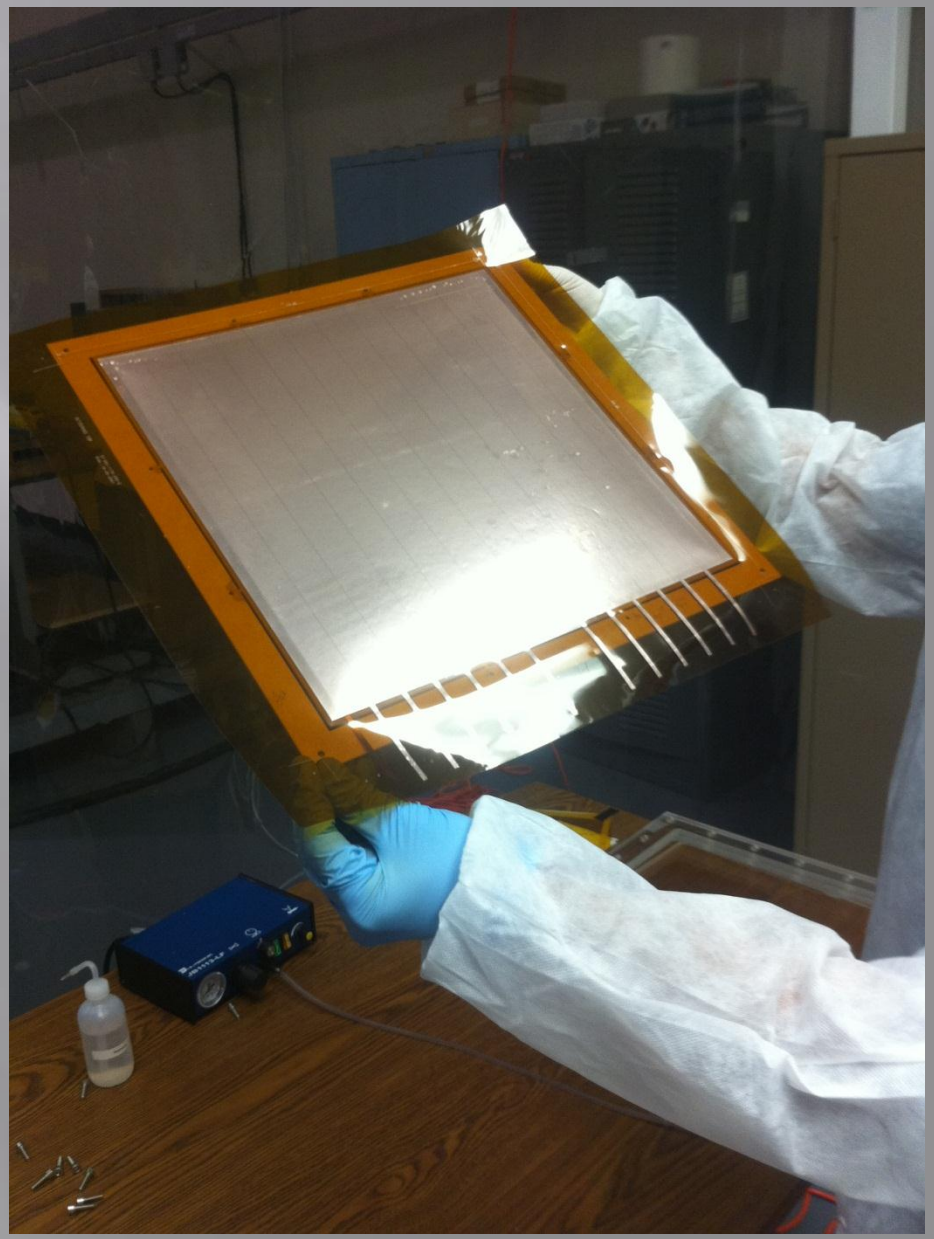
A thin strip of glue is applied to the frame with a pneumatic dispenser

The frame is then placed onto the foil and allowed to cure overnight under the IR lamps

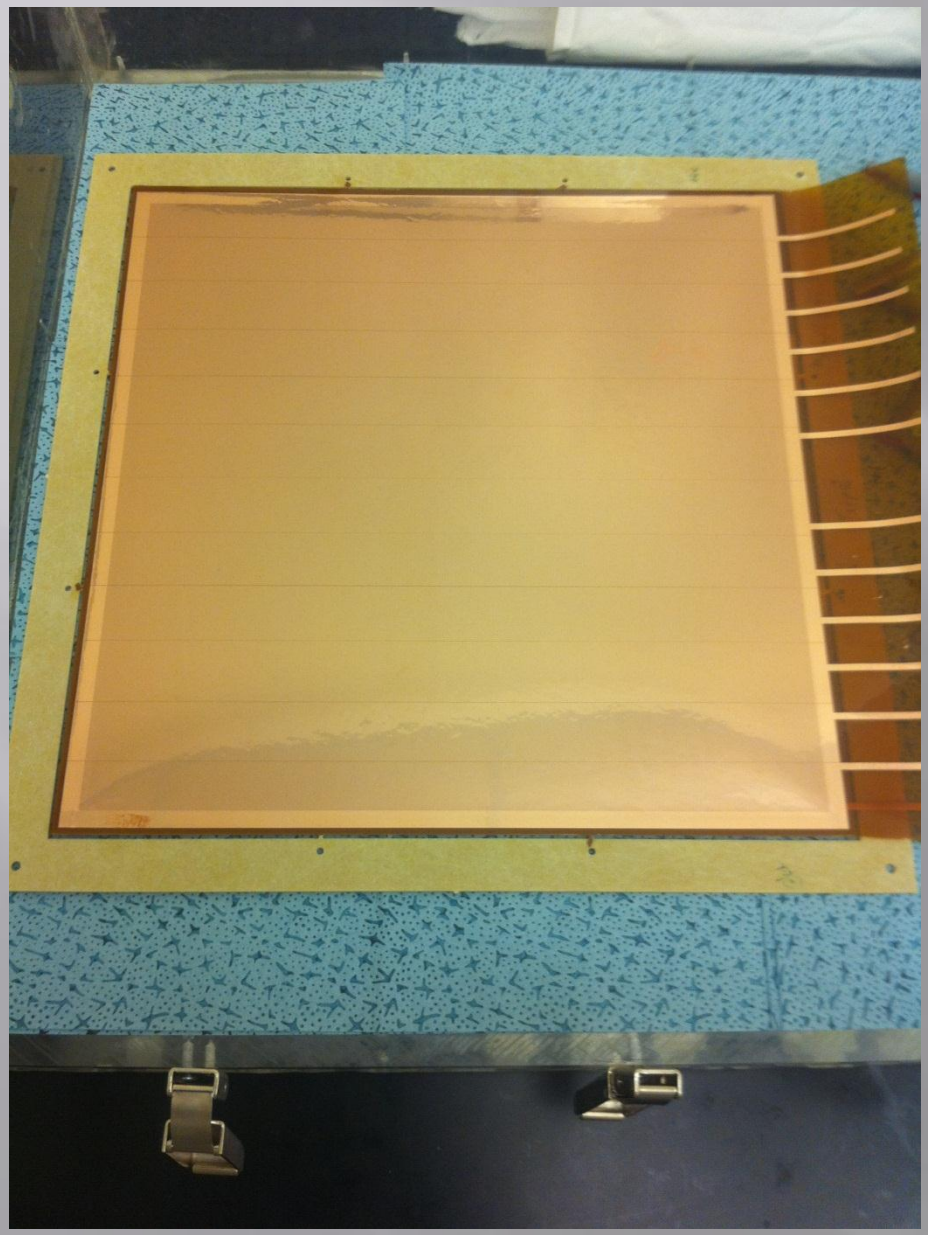
Framing the 30 cm x 30 cm GEM Foil

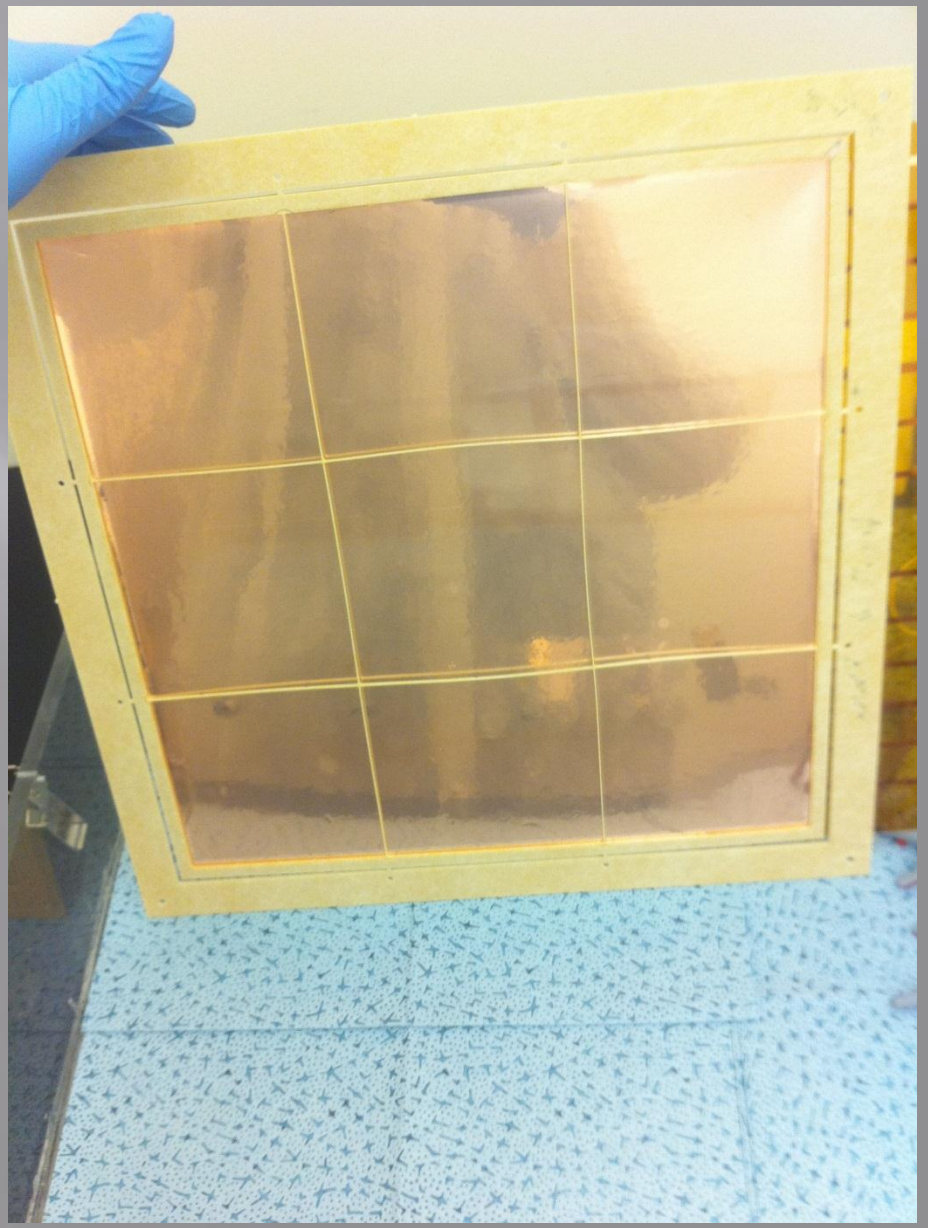
After the glue is cured, the Plexiglas frame is removed, and the excess Kapton trimmed away.

The foil is now framed!



The foil appears well stretched

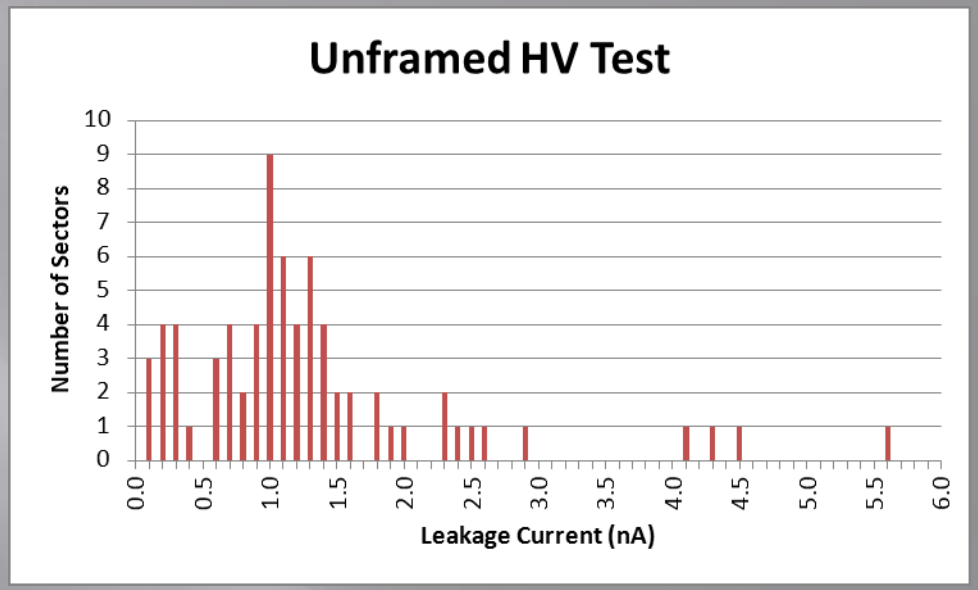


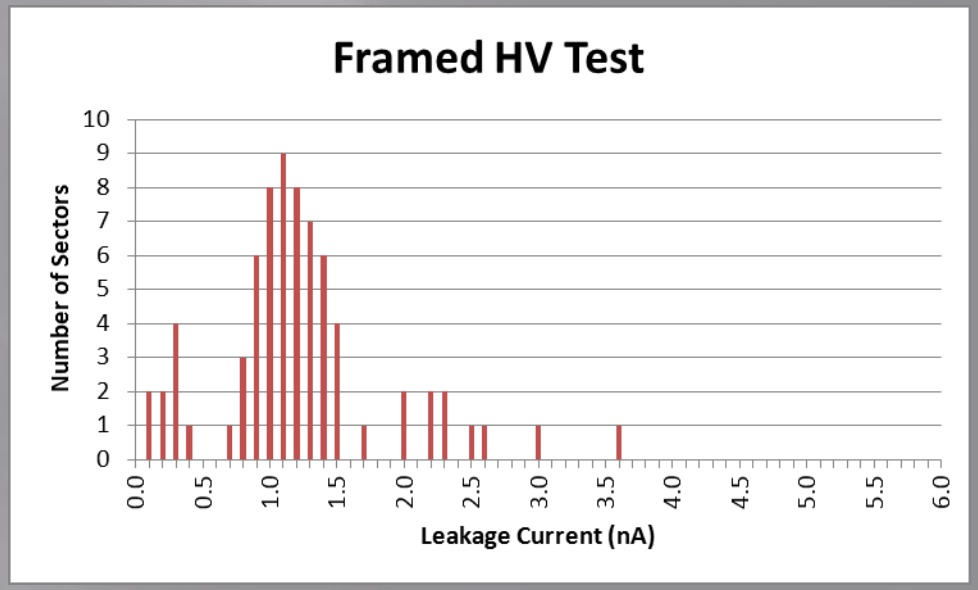


HV Test Results

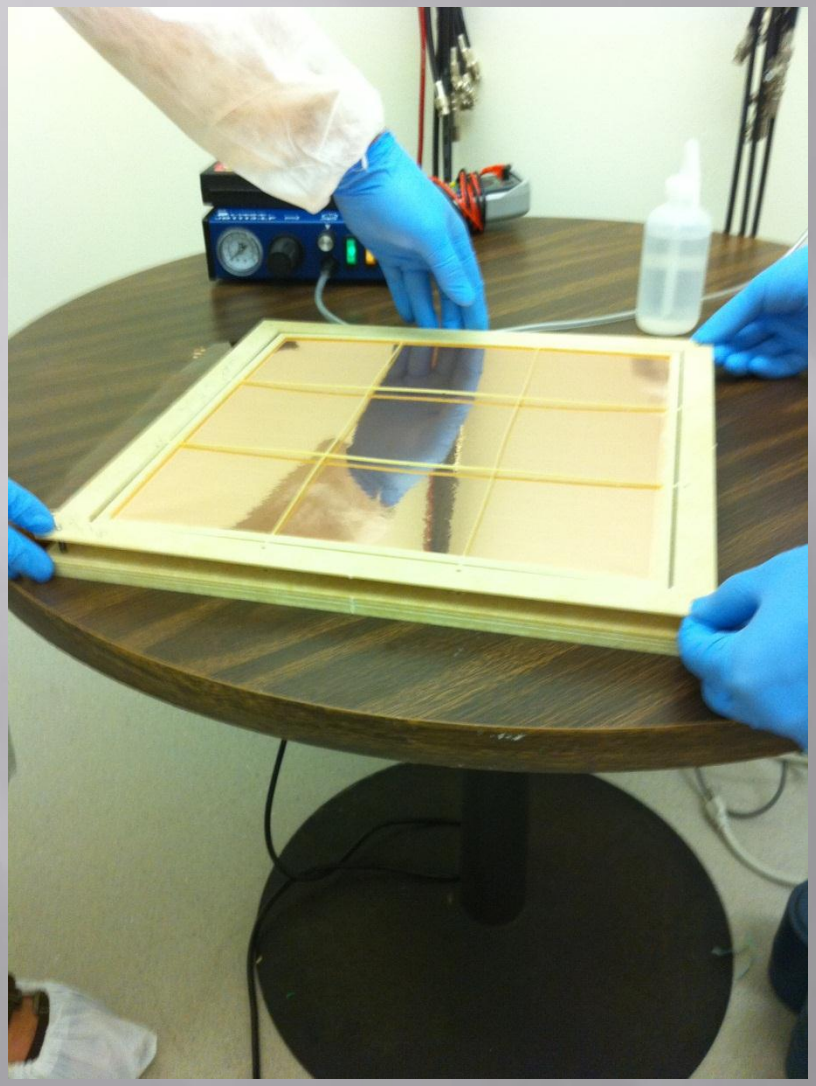
The leakage current at 500 V under N_2 was measured before and after framing

All 6 of our foils were within the validation condition of <5 nA leakage after framing





Stacking the Detector



Results and Conclusion

- Results indicate temperature variation of around 4° C throughout the volume of the Plexiglas frame
- The Plexiglas frame maintains fairly uniform temperature during long periods under the IR bulbs
- IR thermal stretching is a viable and low cost alternative to other heating solutions (we built our IR array for ~160 USD)
- The design is easily scalable to larger foil sizes and different geometries, still at low cost. We plan on thermally stretching a 1 m x 0.5 m drift foil in the coming weeks.

We currently have two 30 cm x 30 cm triple-GEM detectors stacked. We are awaiting machining of the readout boards before final assembly.