Design and Construction of a Cylindrical μRWELL & Thin-Gap-GEM-μRWELL Hybrid MPGD Prototypes for Tracking at the EIC

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Where are Micro-Pattern Gaseous Detector Used?

ePIC Tracking Detector

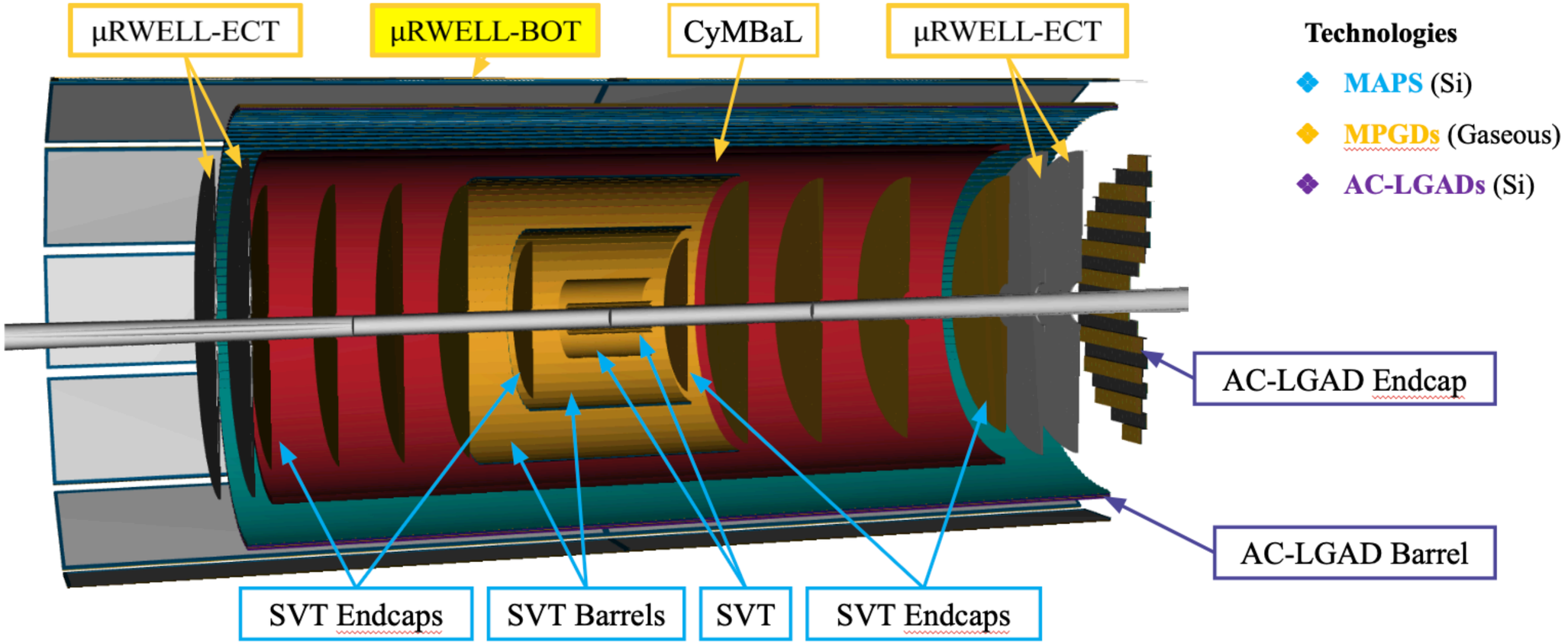
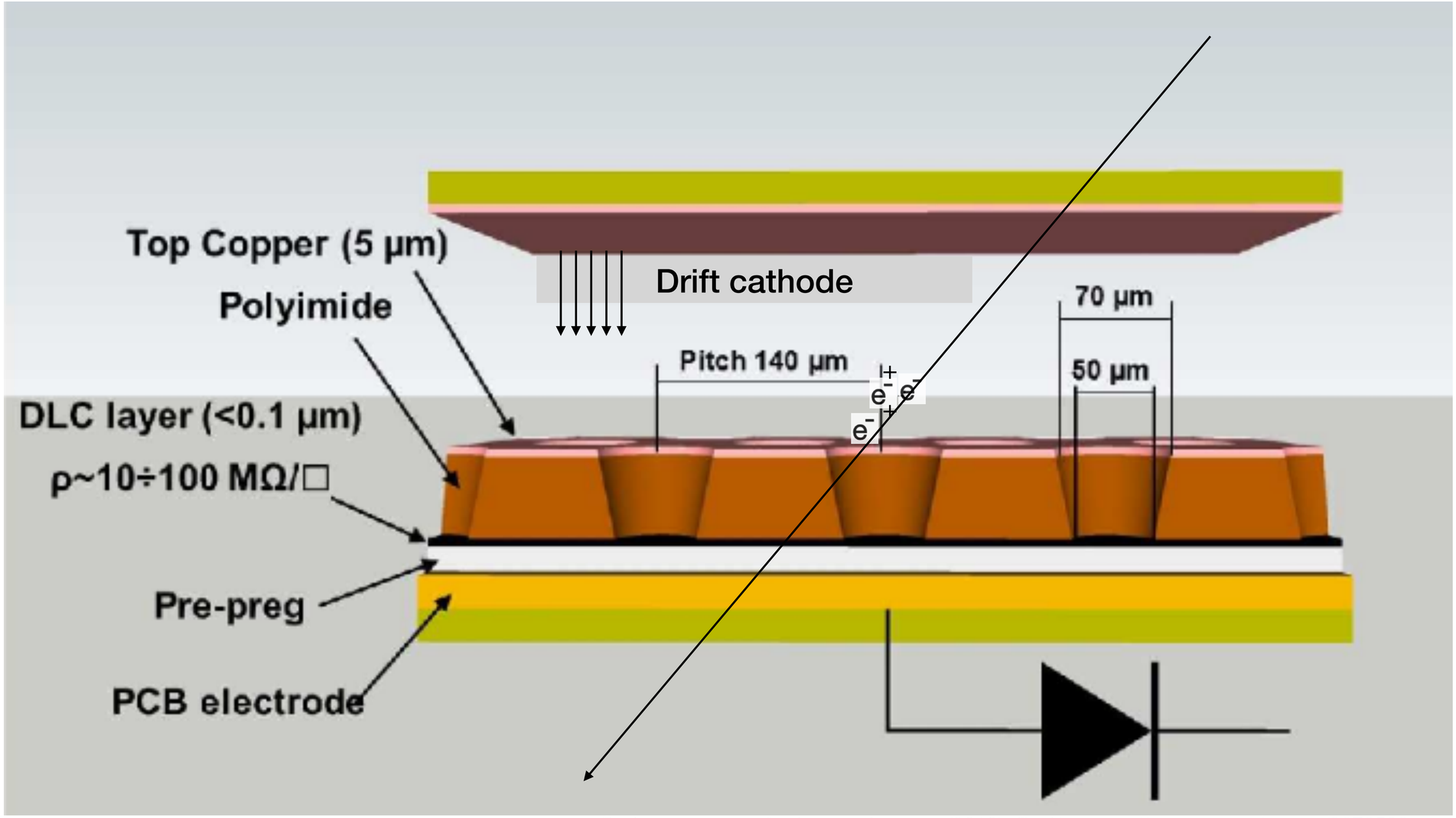


Image source: Gnavo, K "Overview of ePIC Tracking Detector," ePIC TIC Meeting, August 24, 2024.

- For example the current ePIC central tracking system for the EIC has both Micromegas and Micro-Resistive-Well (µRWELL) technologies The µRWELL subsystems are located in the outer barrel and two end caps, Micromegas located in the inner barrel.
- R&D on µRWELL detectors is important and can possibly serve for future detectors and upgrades.

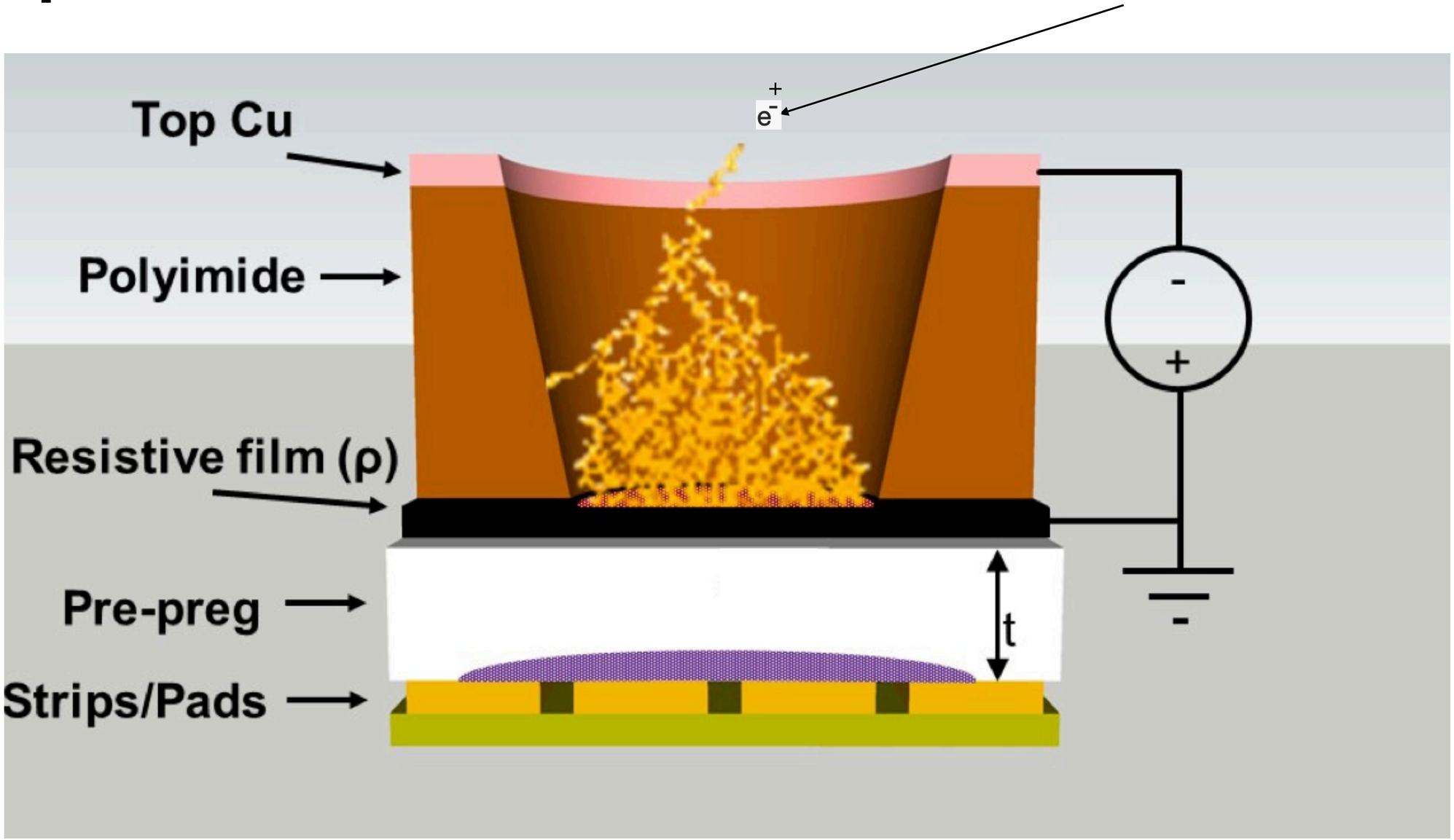
How a Micro-Resistive-Well (μRWELL) detector works



Luparello, G. Development of μRWELL Detector (2019). CERN. https://cds.cern.ch/record/2672599

- The μRWELL is composed of μRWELL/PCB structure , copper Kapton, a resistive layer for discharge suppression & PCB readout

How a μRWELL detector works



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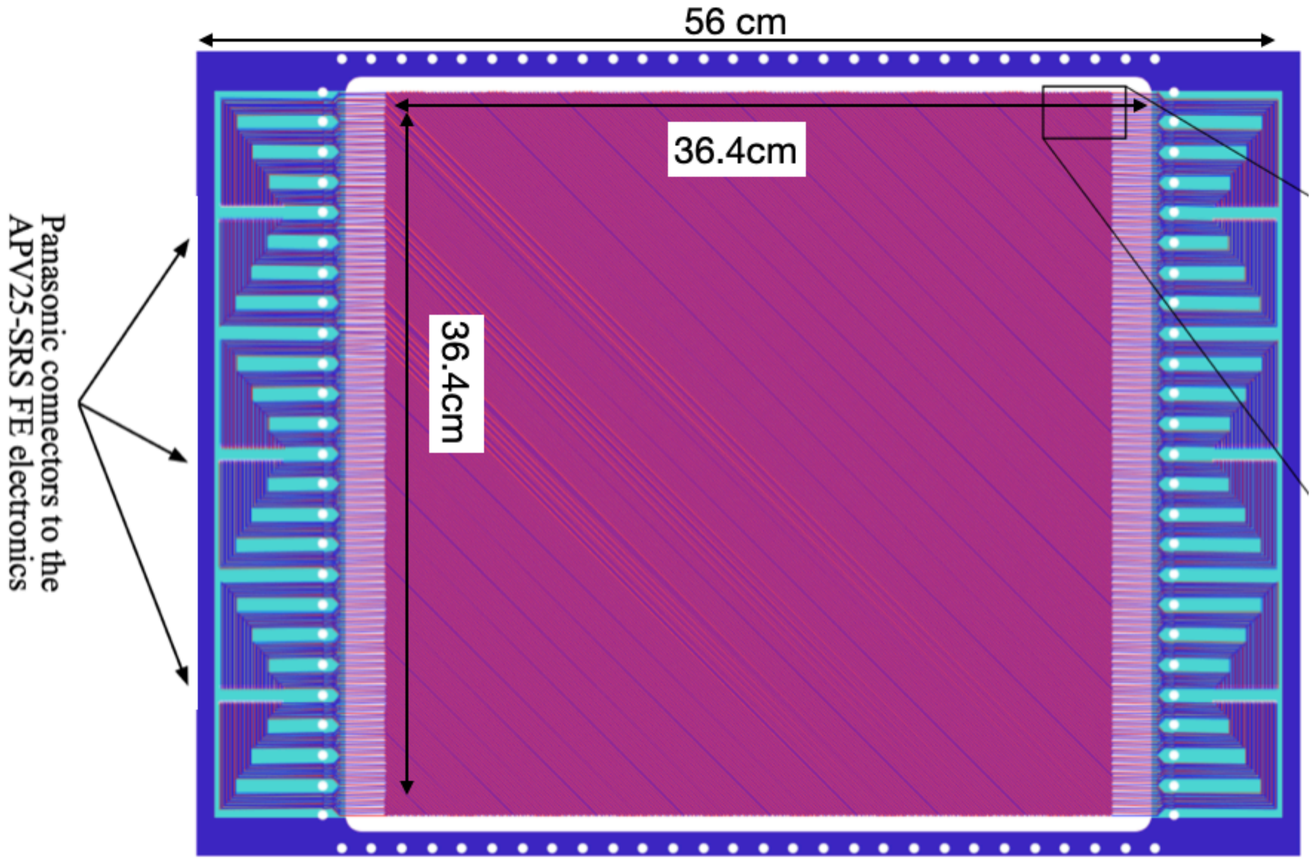
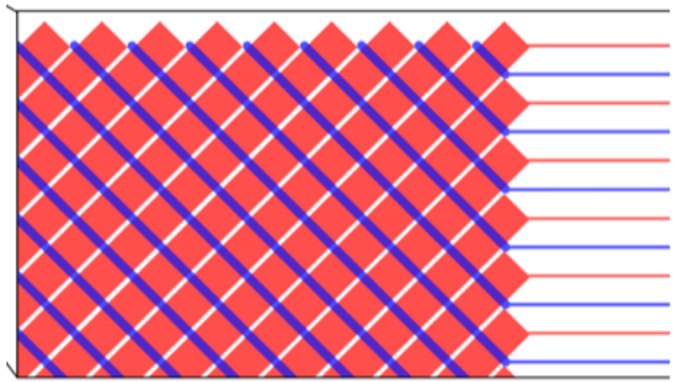
- A particle interacts with the gas creating electron and ion pairs. An electron can get trapped in the well structure and an electron avalanche occurs. The signal can be read out on that strip

Design of μRWELL 2D readout Composite foil structure

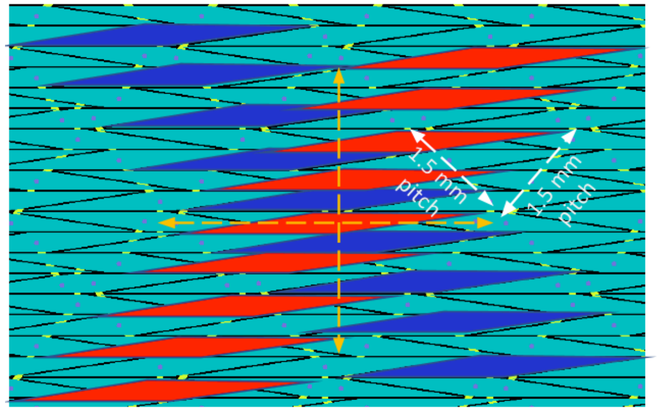


Layout Design of U-V readout *



Capacitive-sharing **straight** strips (from JLab*)

U-strip



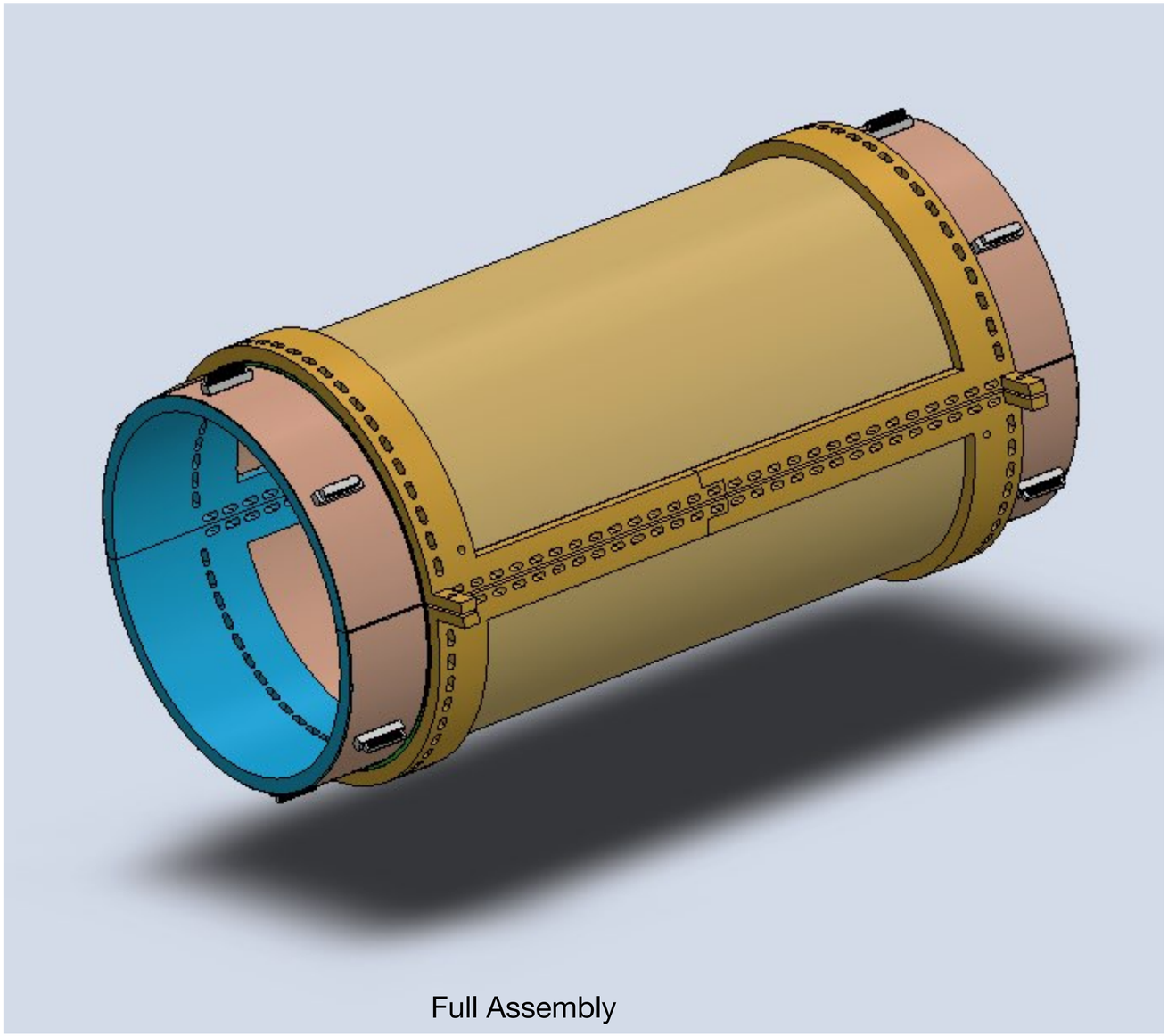
V-strip X-scan range +/- 2 mm

Capacitive-sharing **Zigzag** strips (from BNL**)

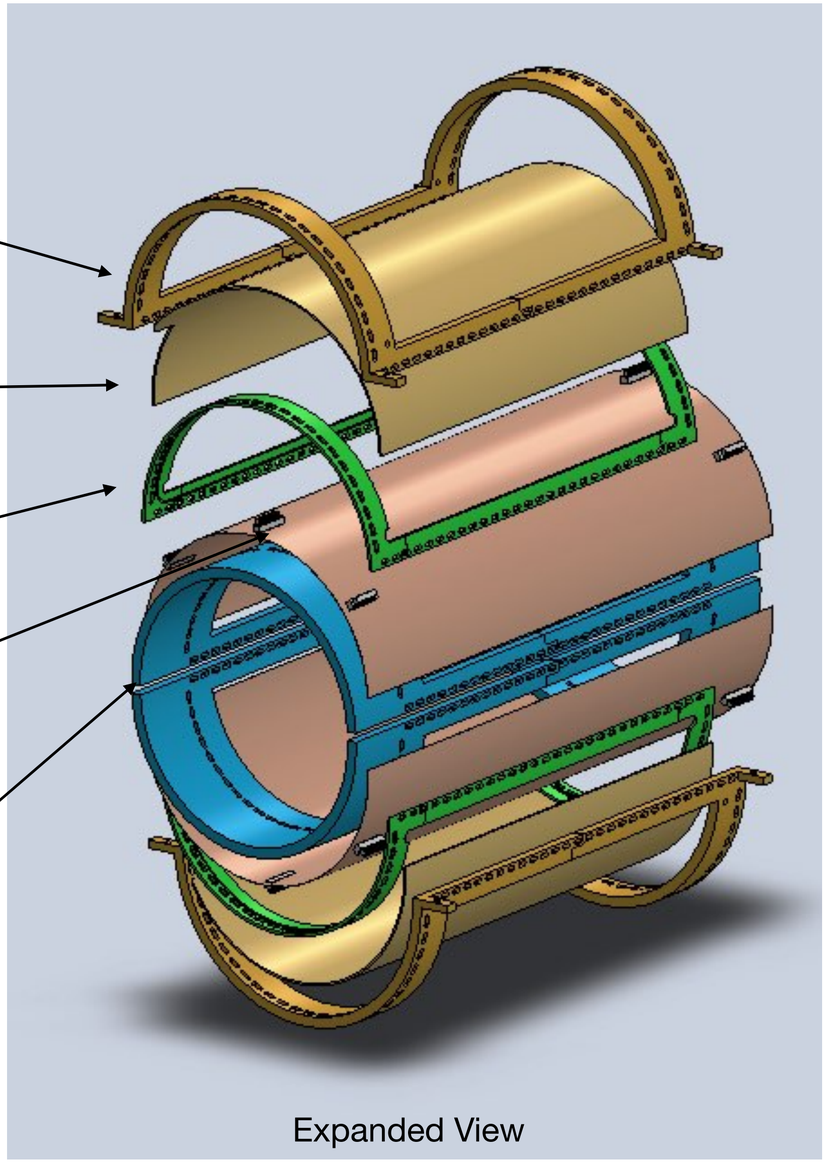
- Two different U-V readout structures: a 2D Capacitive-sharing straight strips and Capacitive sharing zigzag readouts
- Strip pitches: 1.35 mm, total of 768 strips per half-cylindrical chamber

*Gnanvo, K., Liyanage, N., Mehl, B., **Kiselev, A

Design of Cylindrical μRWELL Detector



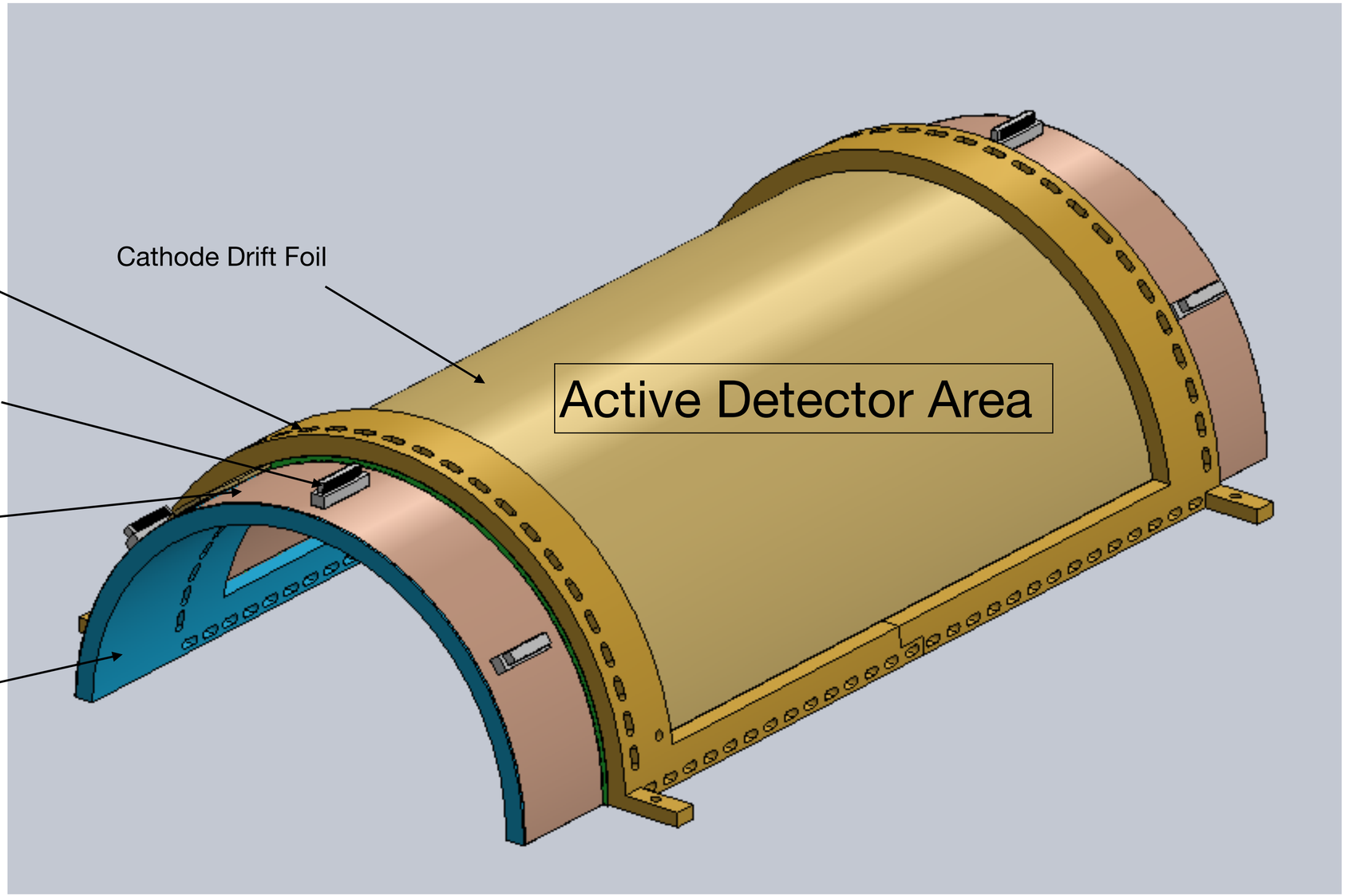
Full Assembly



Expanded View

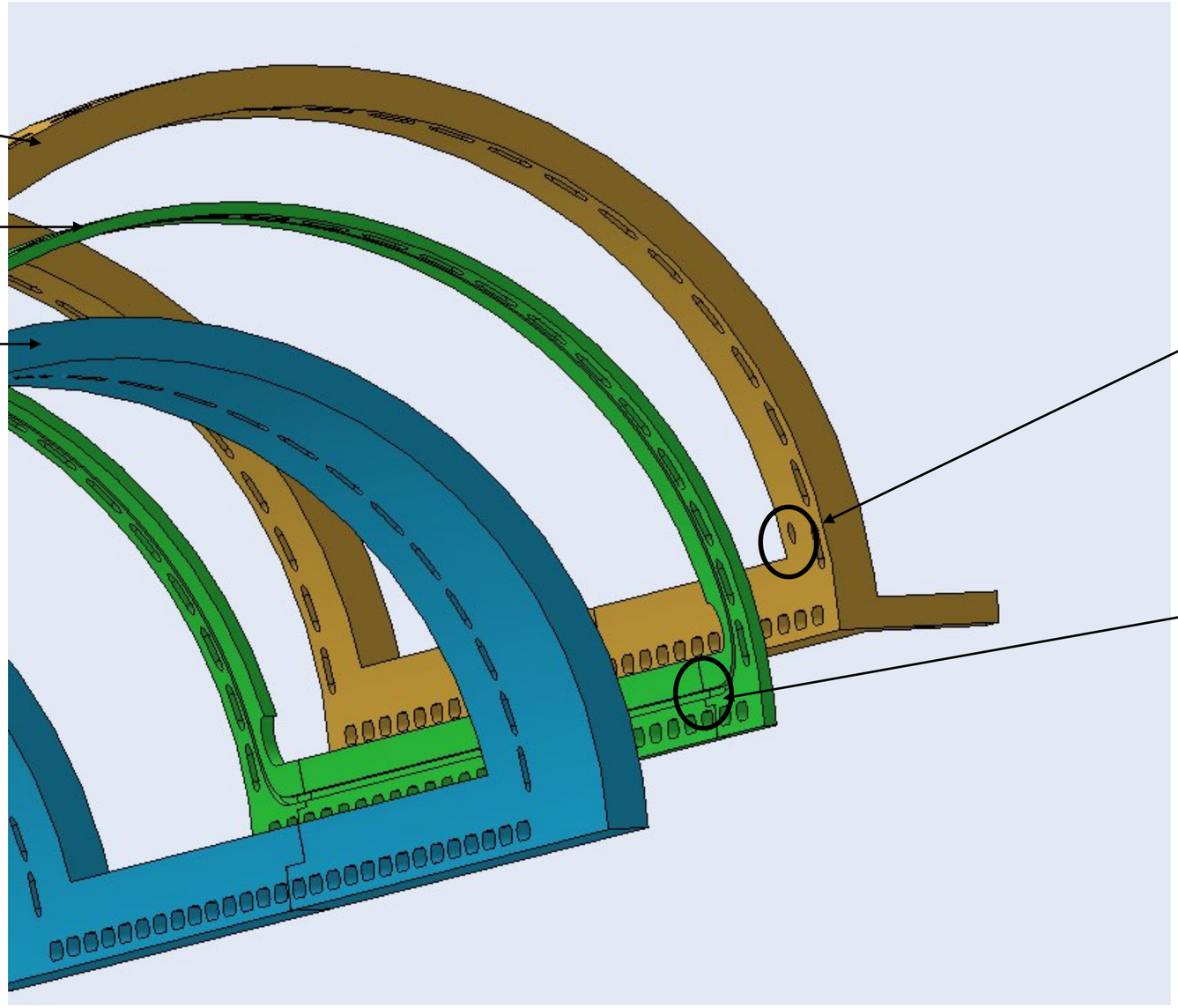
- Prototype consists of two half-cylindrical chambers with different readout structures
- Set of three support frames per half-cylindrical chamber

Design of Cylindrical μRWELL Detector



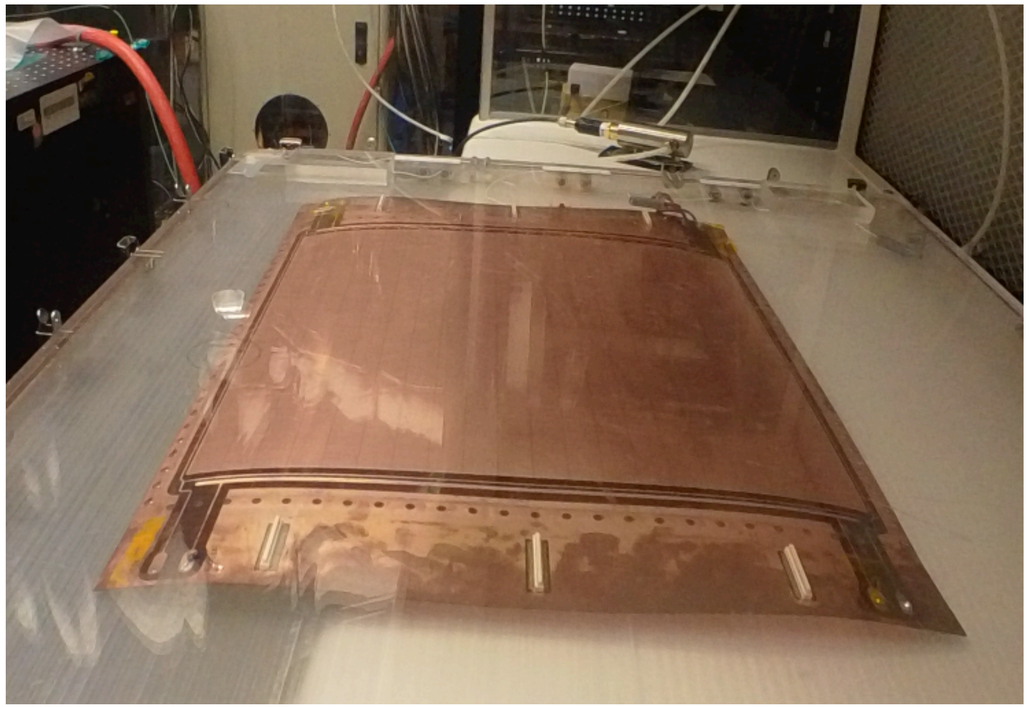
Design of a half-cylindrical chamber

Features: Gas , O-ring, High Voltage box

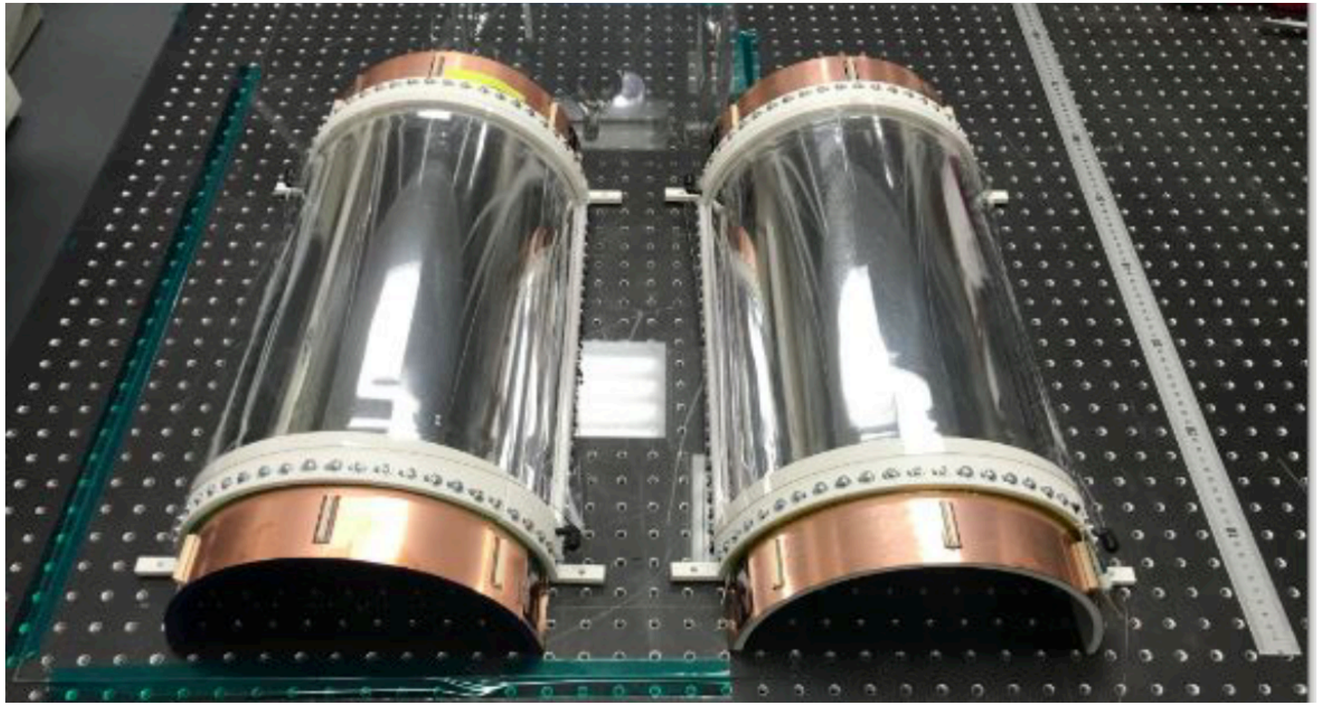


- Prototype consists of 2mm O-ring groove , gas inlet hole and HV Box

1st Attempt of Assembled Prototype

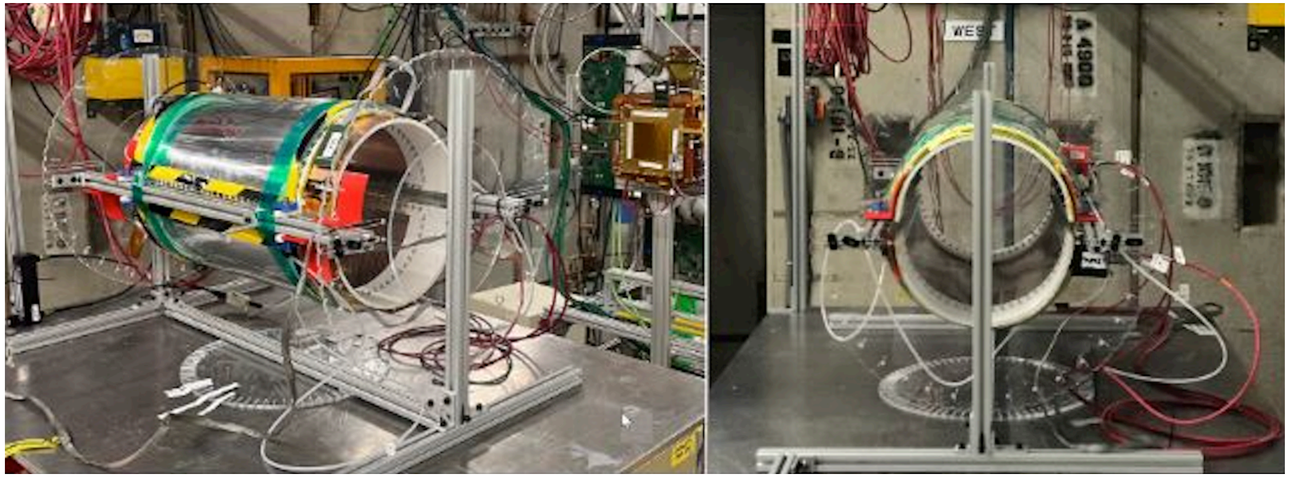


μRWELL foil

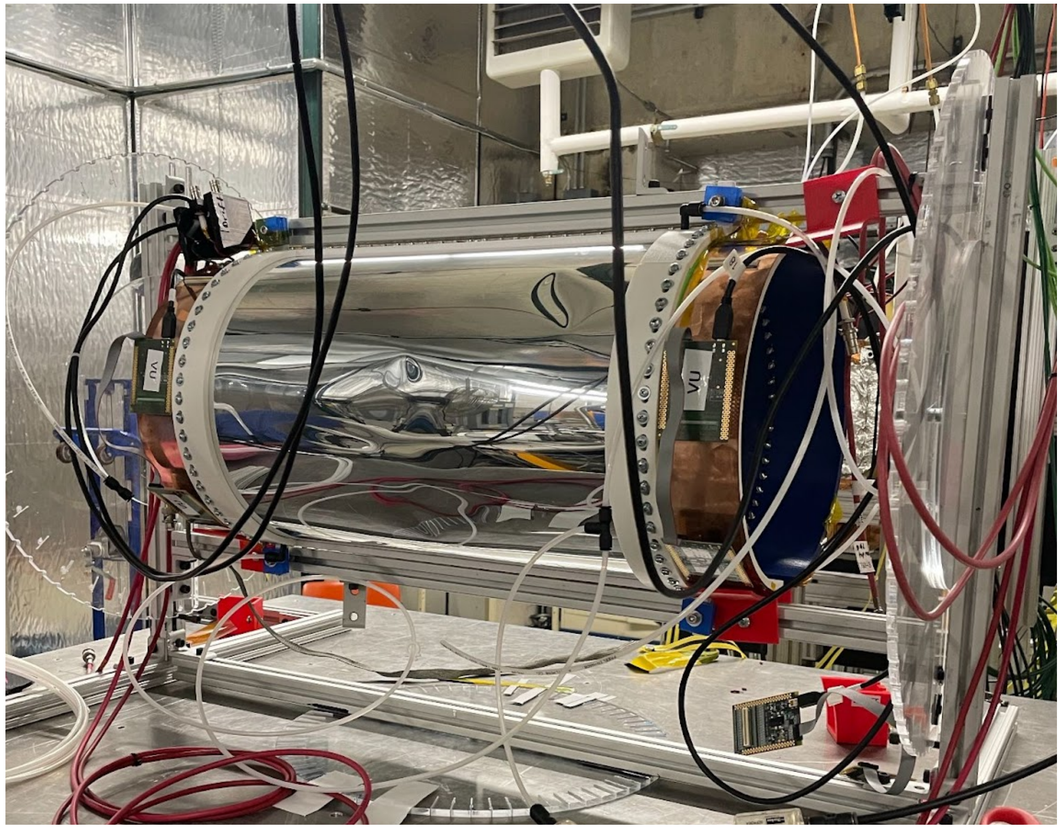


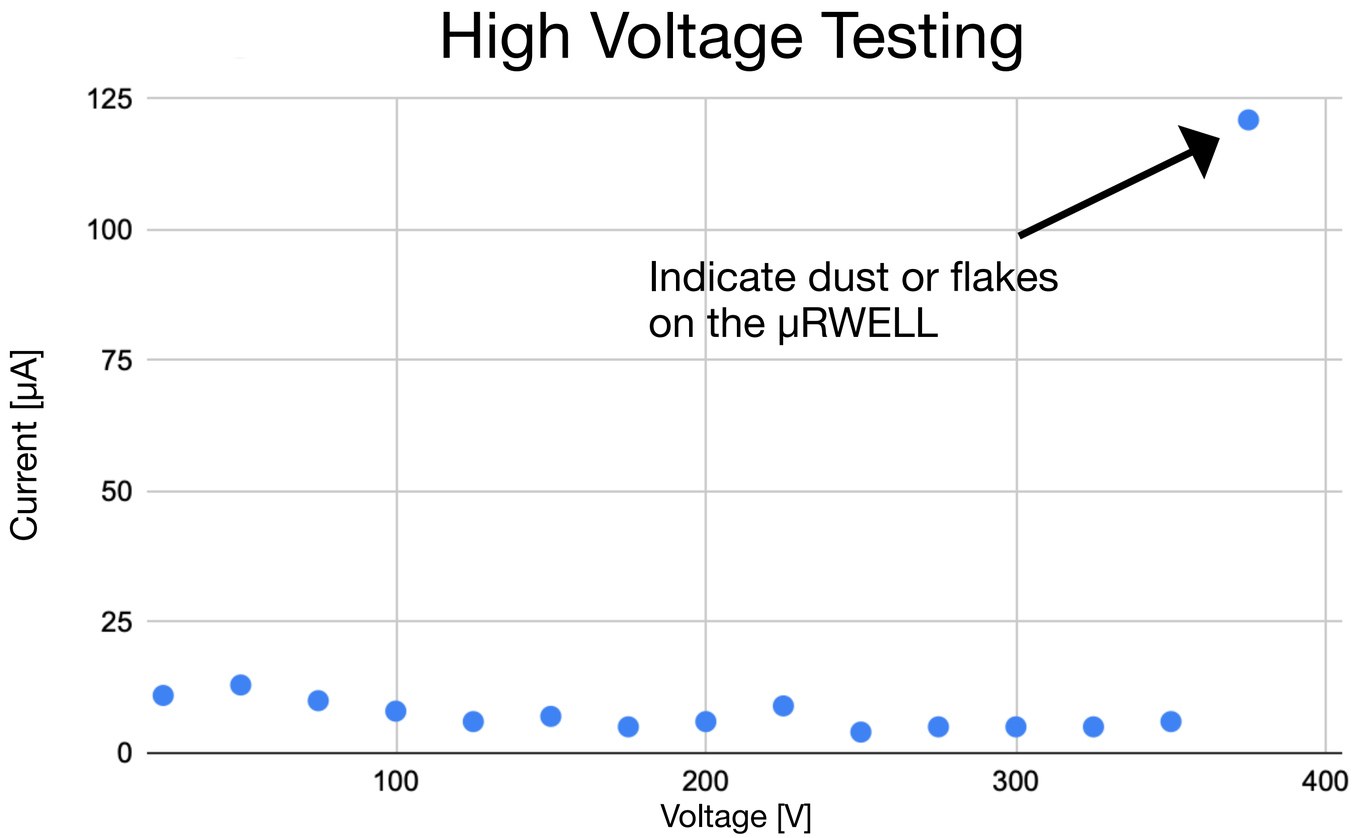
Assembled half Cylinder Detectors Frame and μRWELL

- Full Assembly On Fermilab Beam Line



Problems Encountered Earlier with Cylindrical μRWELL Prototype

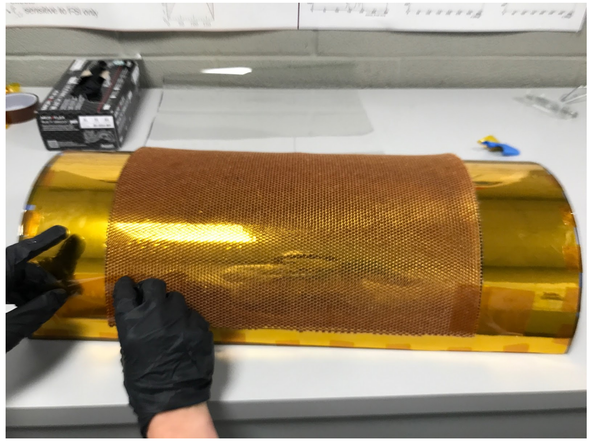




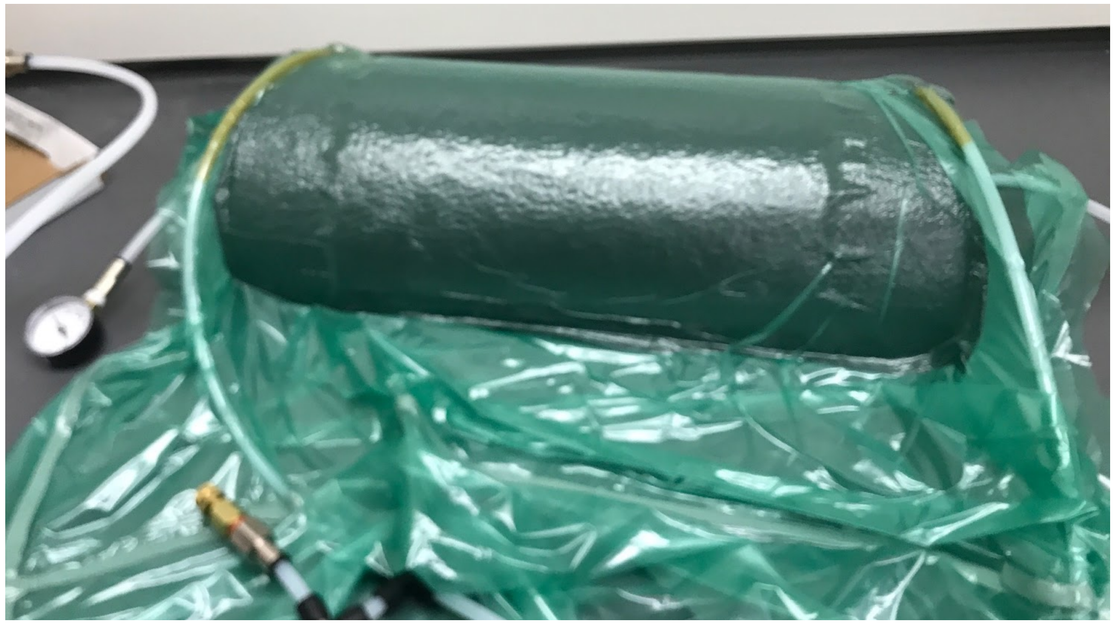
- Dents in drift foil were observed
- During a high voltage test we saw a leakage current, possibly due to dust on the μRWELL foil

Reinforcement Process with Honeycomb

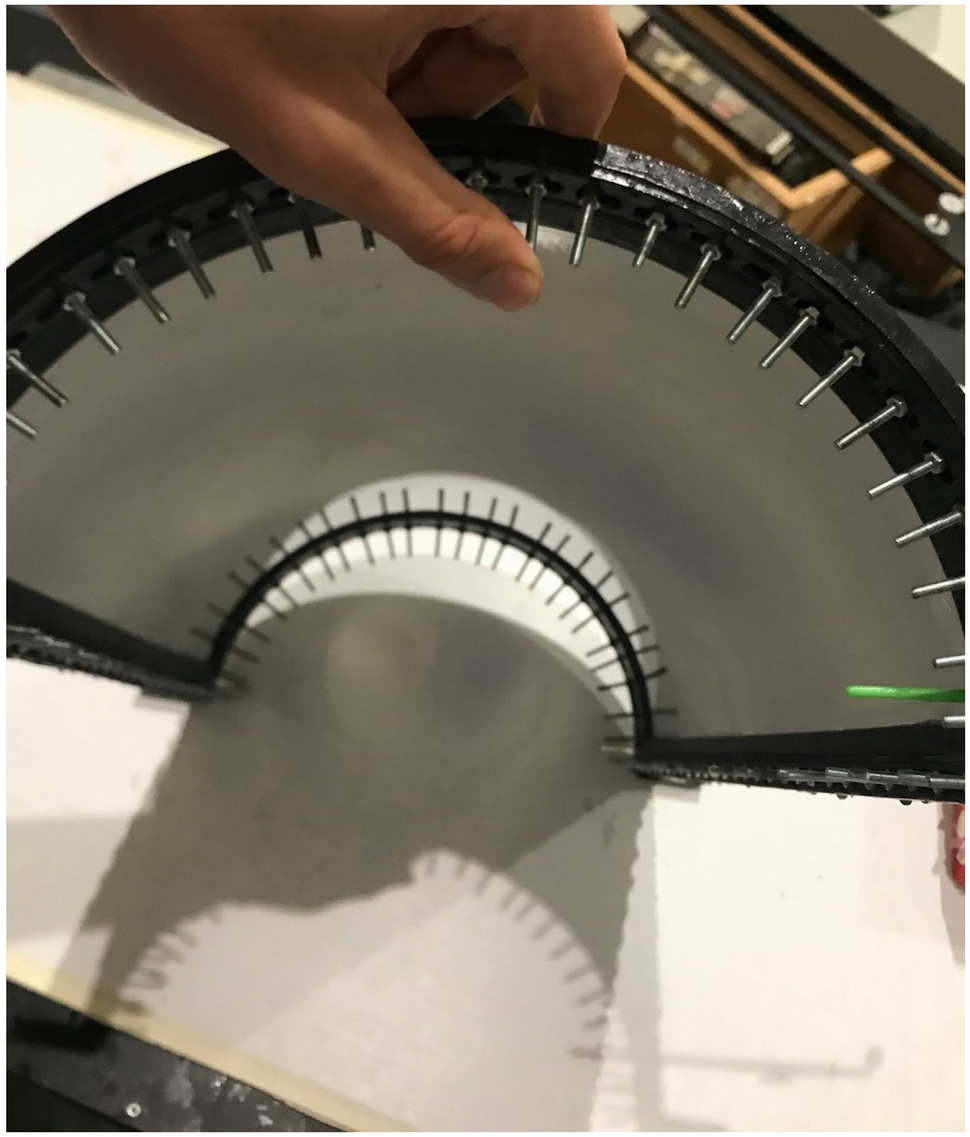
Epoxy/Resin



Honeycomb Gluing

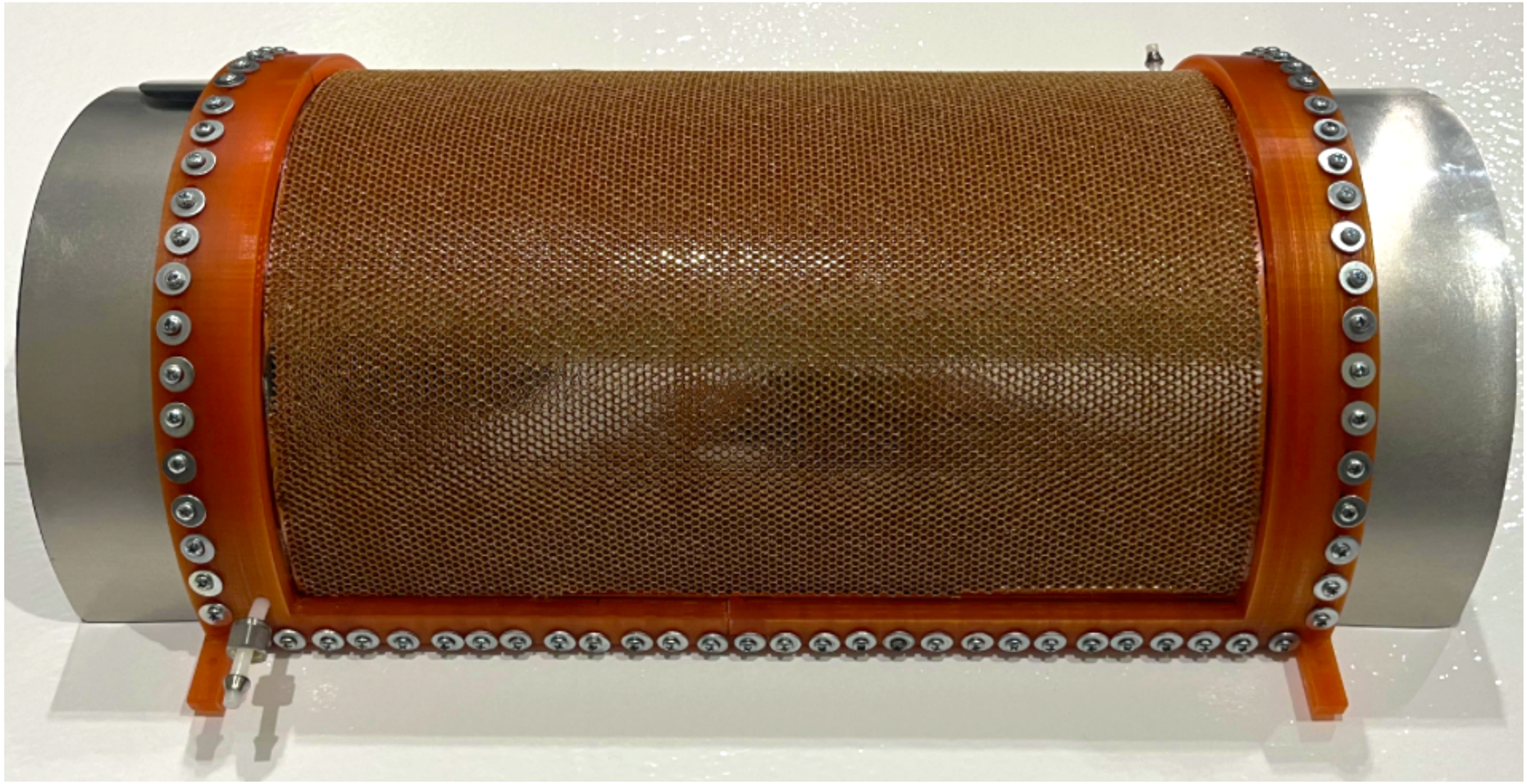


Vacuum Bagging Technique



Smooth Ridged inside

Finished Version



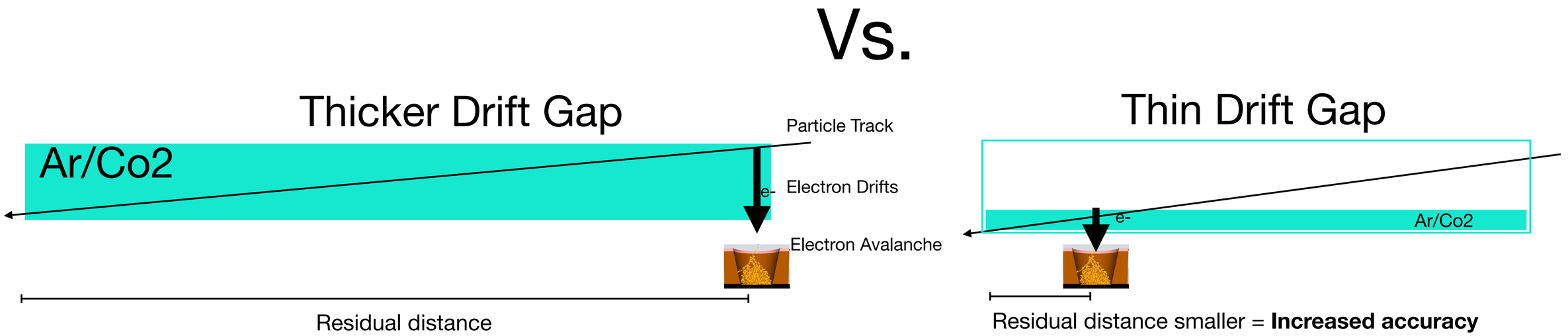
Future Tasks …

- HV Test , Gas Leak test: 11/2024
- Commissioning with sources and cosmic rays: 12/2024
- Participation in Jefferson Lab beam line: 2/2025

Part 2:

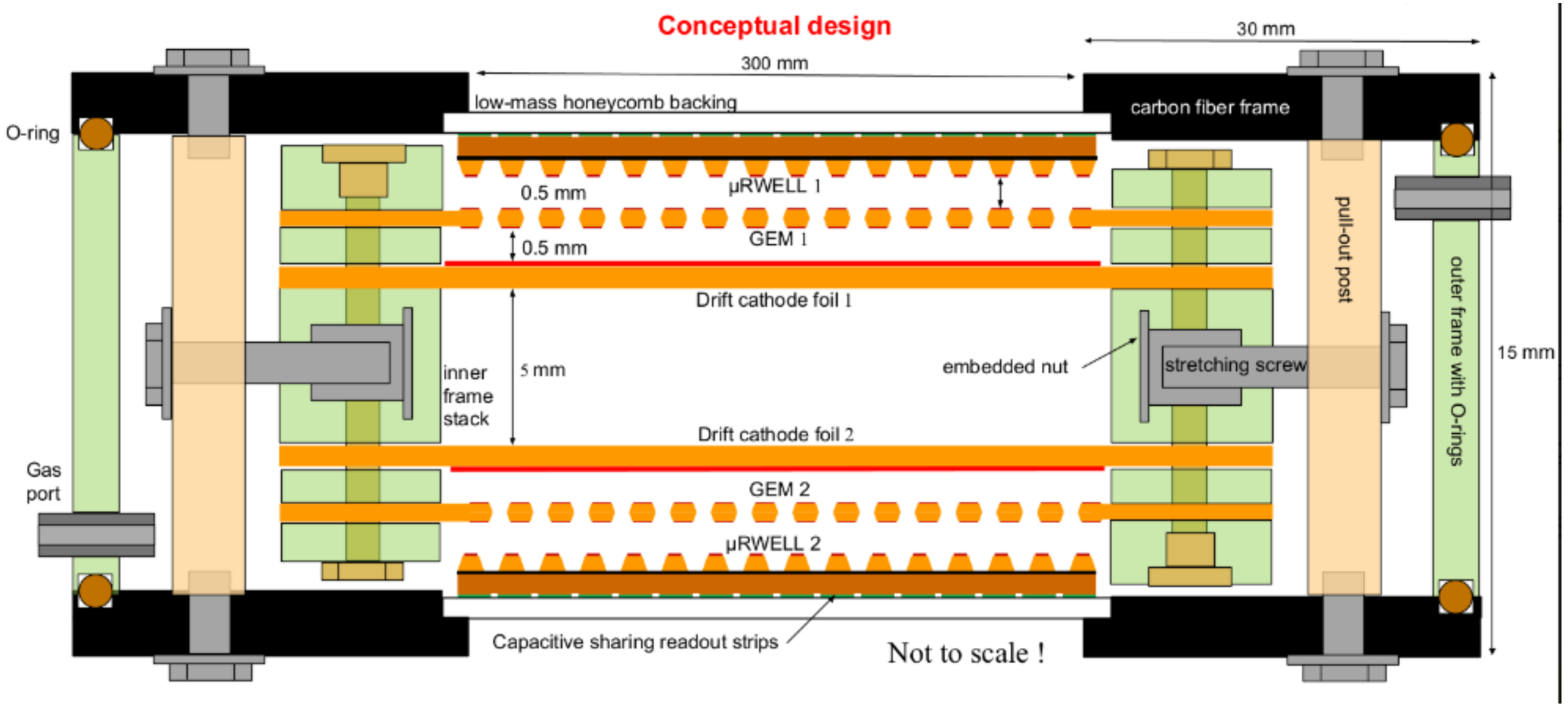
Mechanically Stretched Double-sided Thin-Gap GEM-μRWELL Hybrid (“Double Hybrid”)

Motivations for a Double Hybrid Prototype



- The Motivation is to improve the resolution for tracks that come in at large angles to normal . This requires very small drift gaps and induction gaps.
- But that causes the problem of inefficiency since you might not get much primary ionization enough to get a signal.
- To compensate for using .5mm drift gaps, we include a GEM, and place two detectors onto each other and use signal from both detectors

Conceptual Design of Double Hybrid Prototype



- In this version a μRWELL foils are supported by a composite base frame (black), GEM foils, drift foils between insulating spacer frames, an outer frame that surrounds the pull-outs , T-Nuts for stretching, & Outer O-ring frame for gas sealing
- Frame structure allows for purely mechanical stretching of GEM foils and drift foils and assembly with minimal application of glue

Technical Design of Double Hybrid Prototype

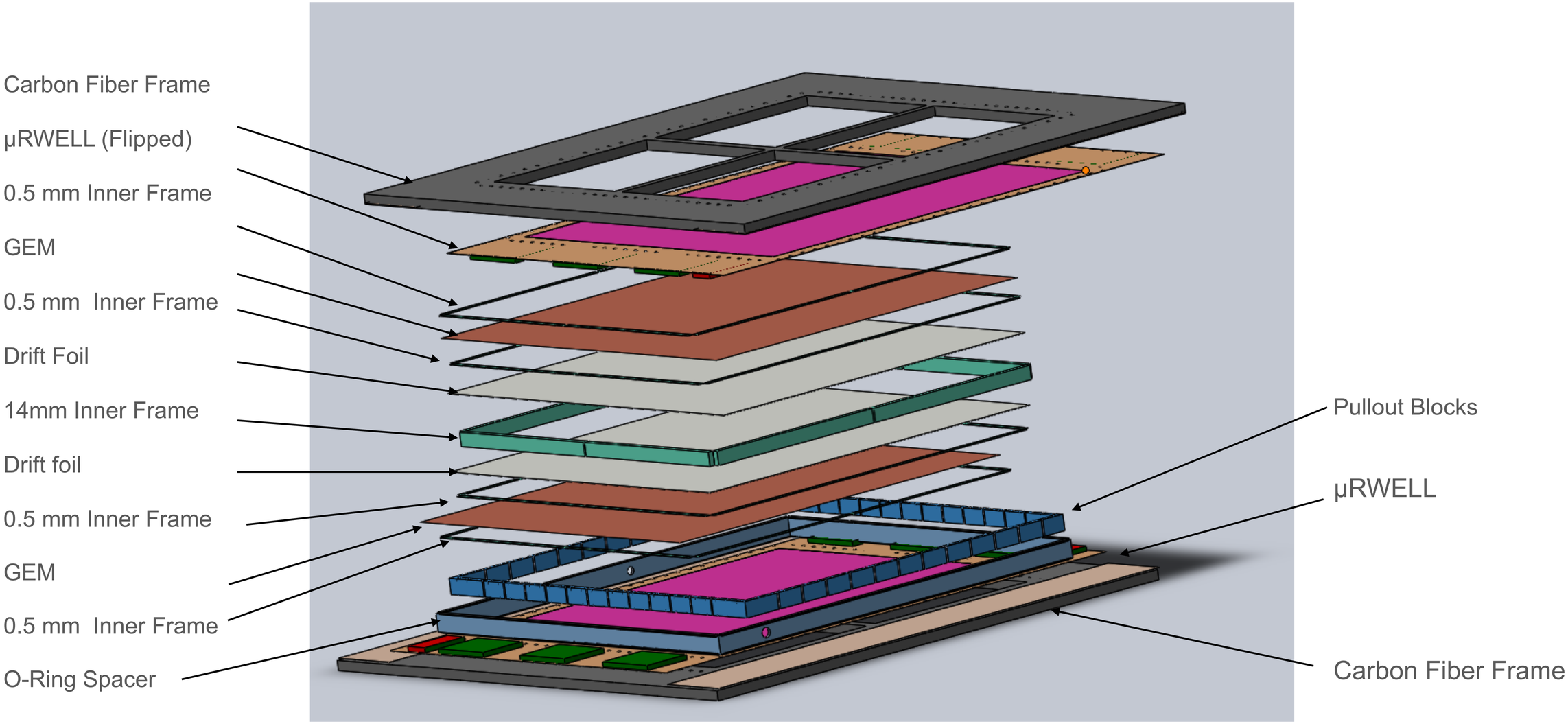
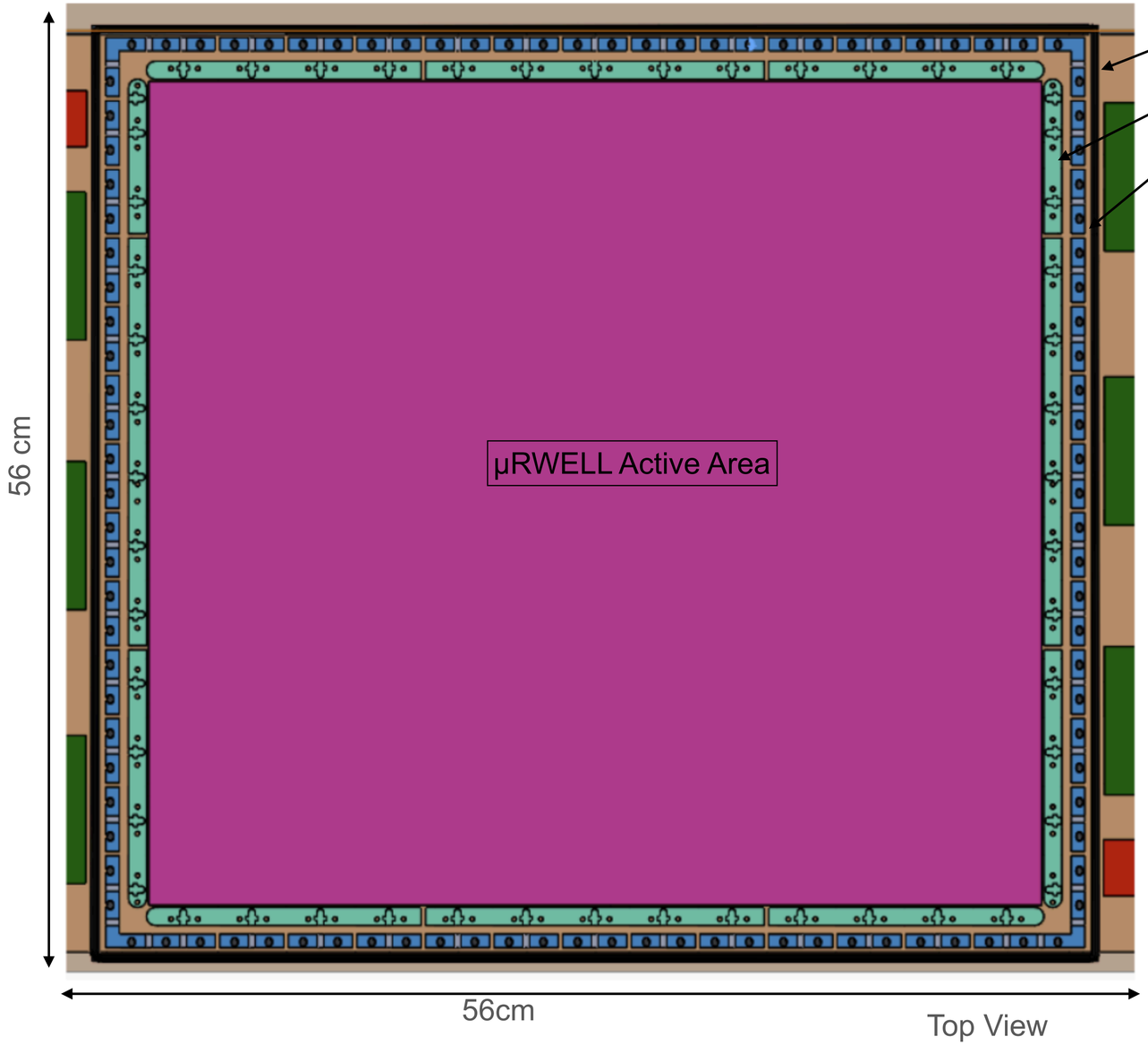
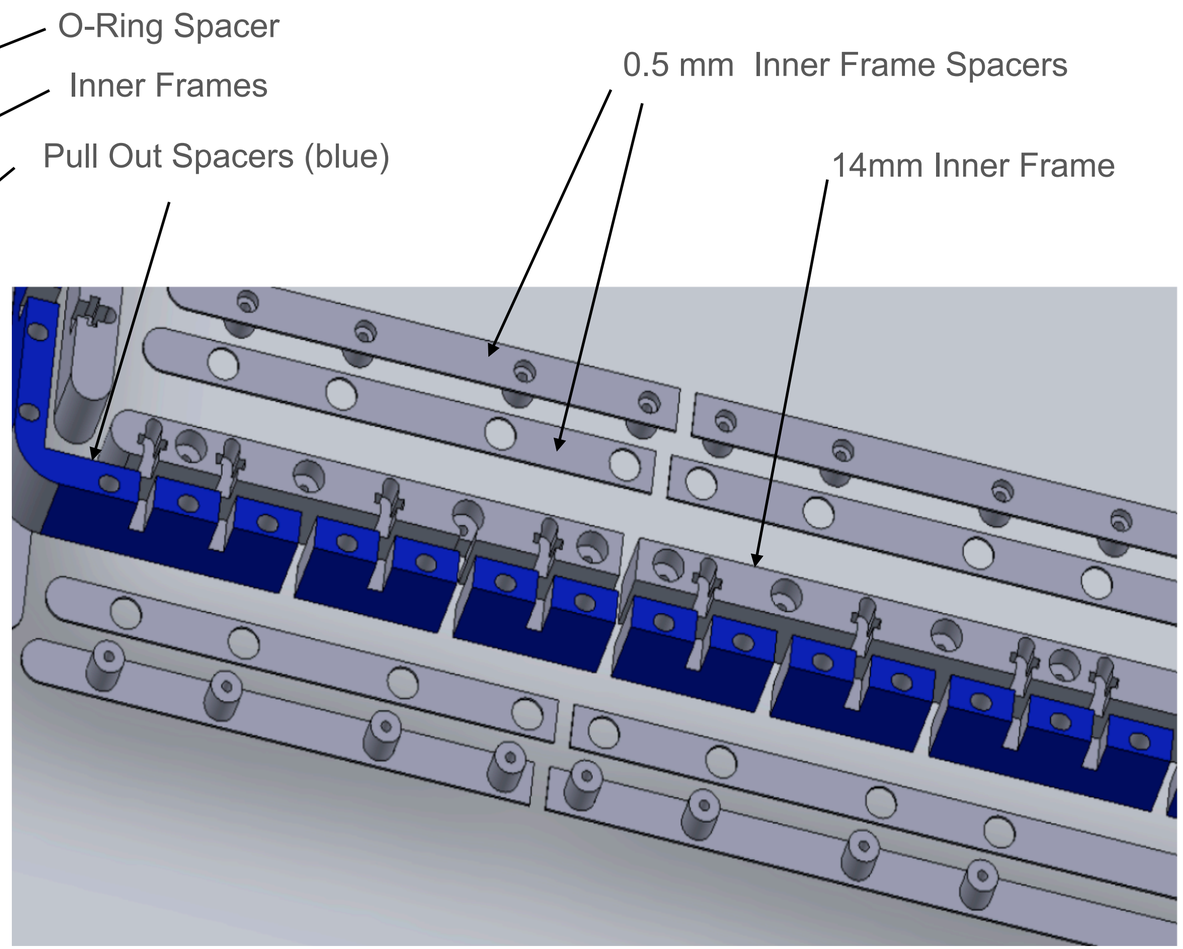


Figure: Expanded View of Prototype Design

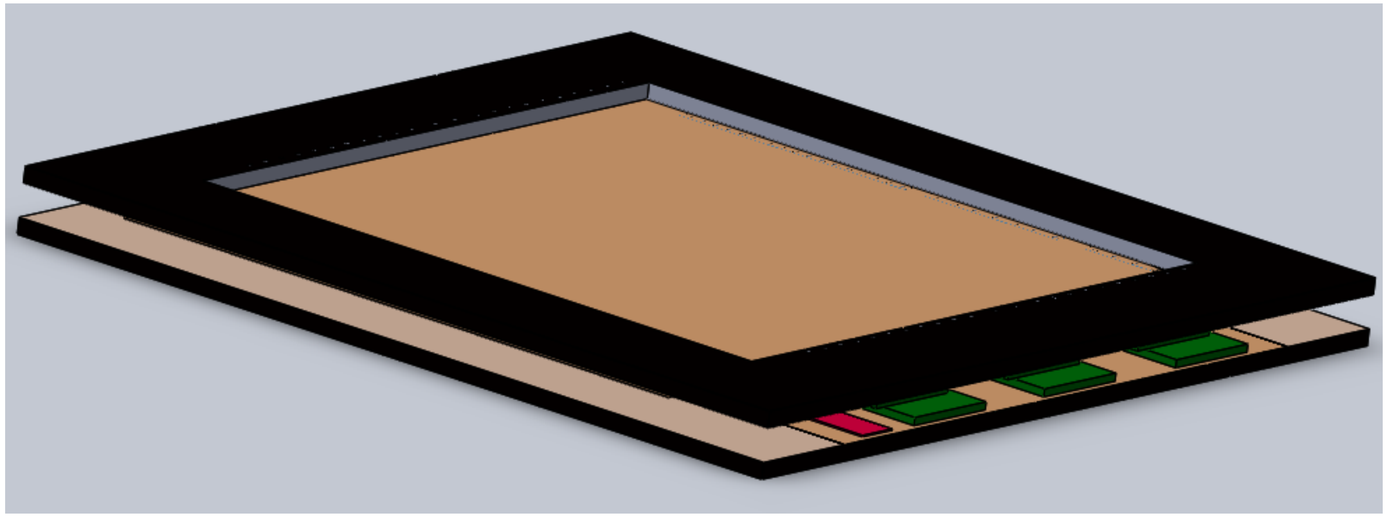
Technical Design of Double Hybrid Prototype



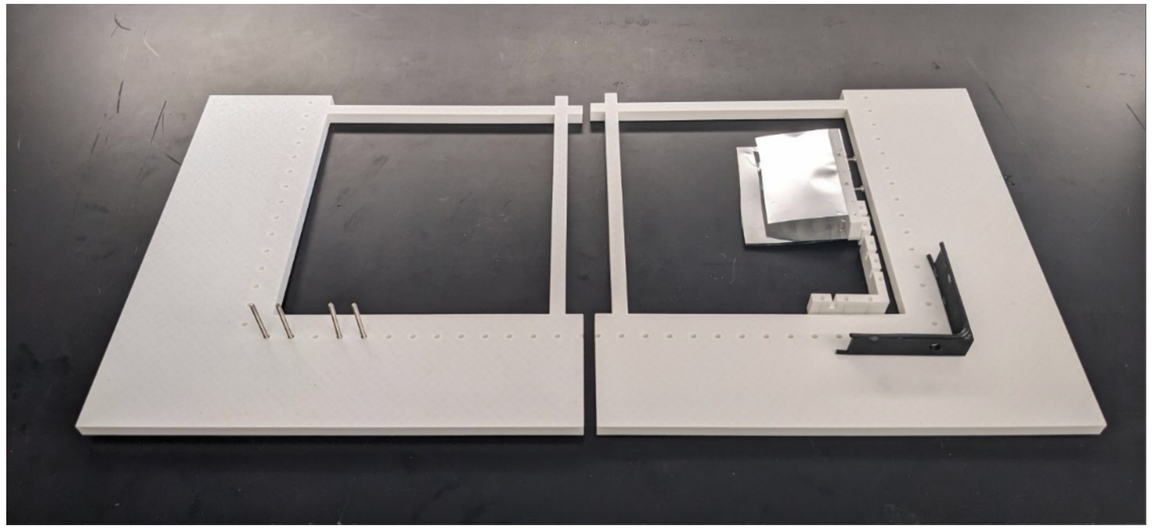


View Of Inner Spacer and Pullouts

Technical Design of Double Hybrid Prototype & 3D-Prints

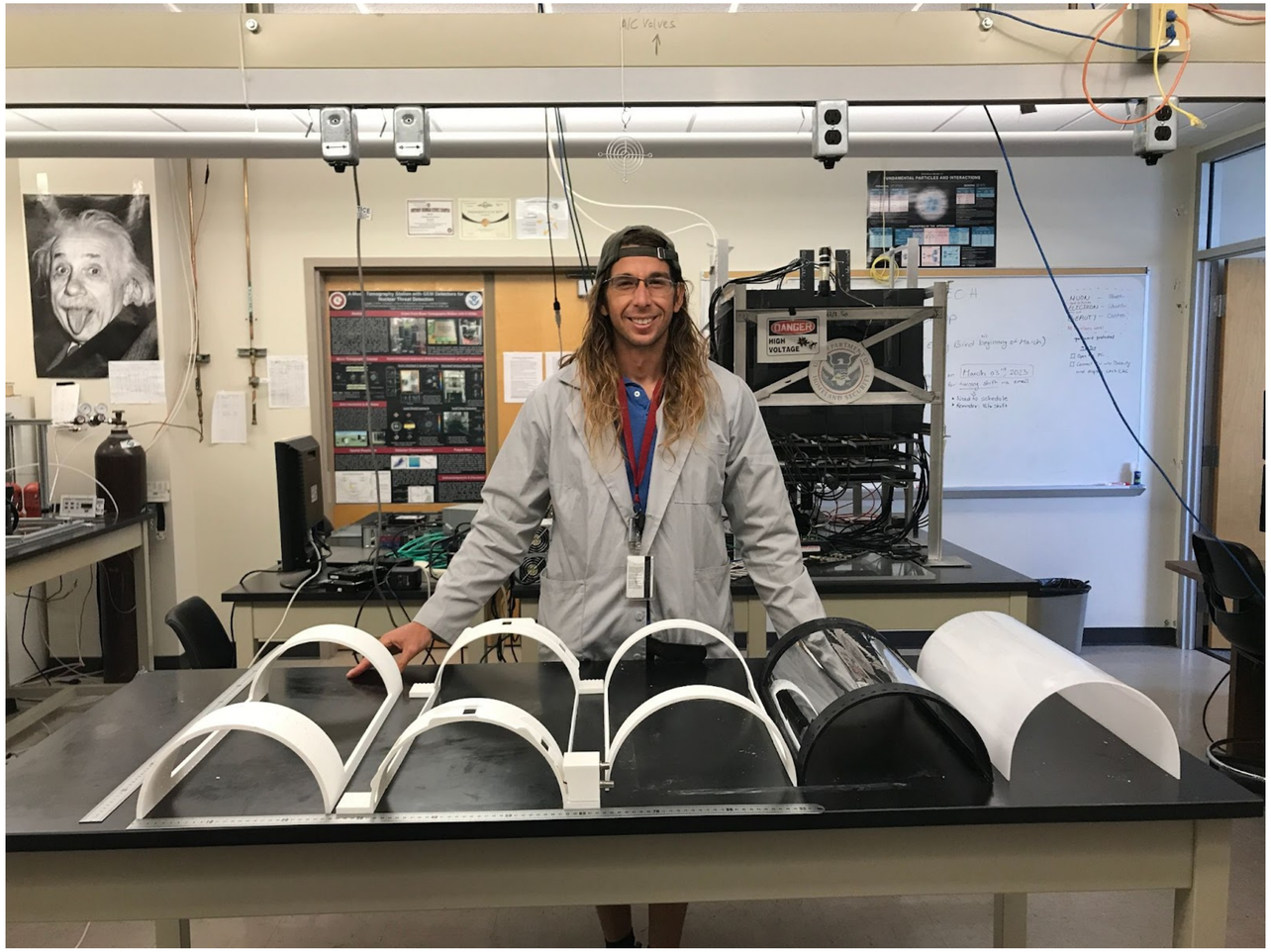


Assembly Of Double Hybrid Detector



Early 3D Prints

Conclusion



- A prototype cylindrical μRWELL detector, has been developed !
- Designing & prototyping was rather tricky with 3D printed frames, yet successful
- Plans to go to Jefferson Test beam in February 2025 !

References

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The End