GEM Activities at USTC

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Outline

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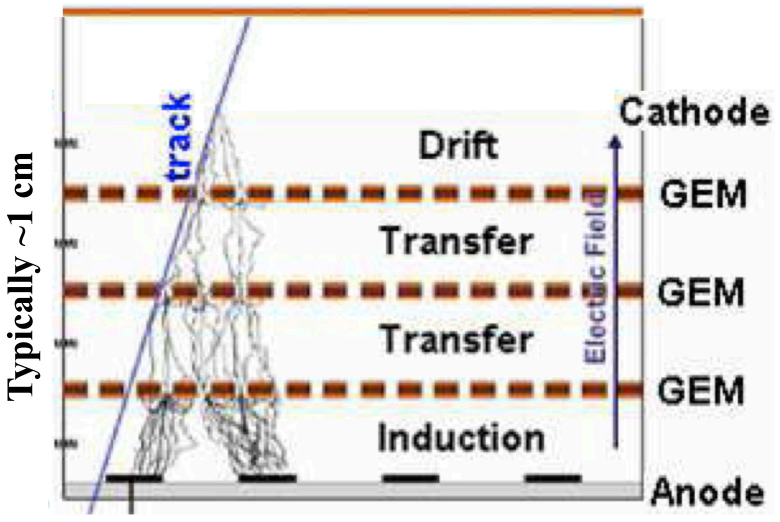
  - Optimization for self-stretching
  - Low-mass design with self-stretching
- Spatial resolution
- Readout developments
- uRWELL: a new tracker solution
- Summary

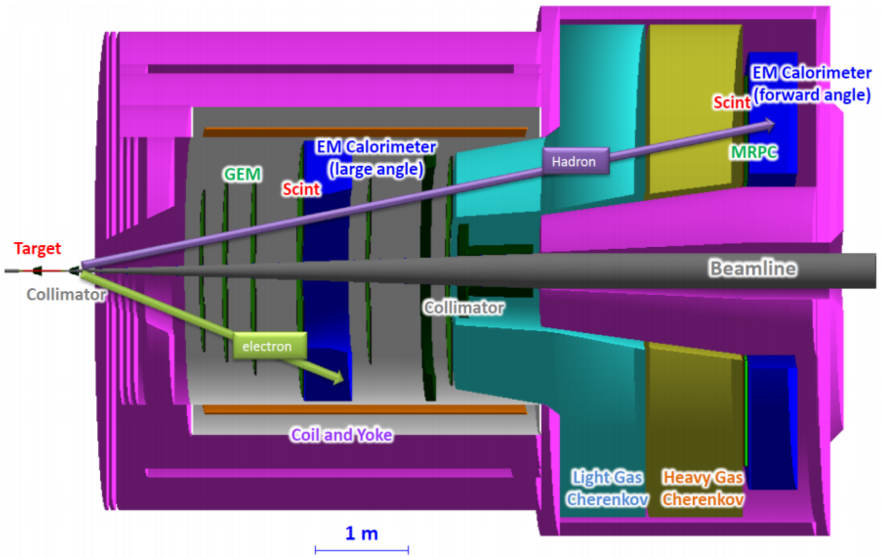
Introduction

- Gas Electron Multiplier (GEM) is one of the most popular micro-pattern gaseous detectors.
- It provides a low-mass and cost-effective solution to high-precision and large-area tracking at high-rate and large-scale experiments such as SoLID.

GEM detector



GEM tracker at SoLID

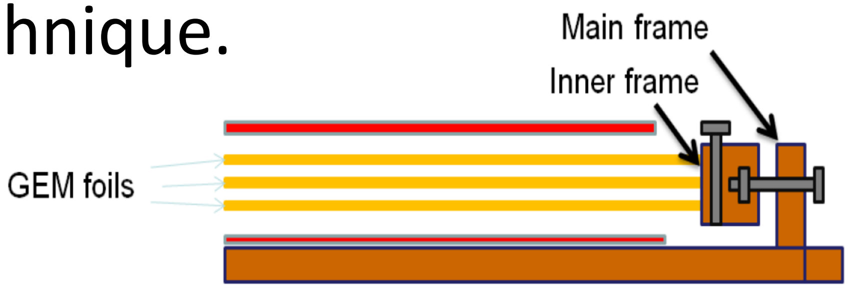


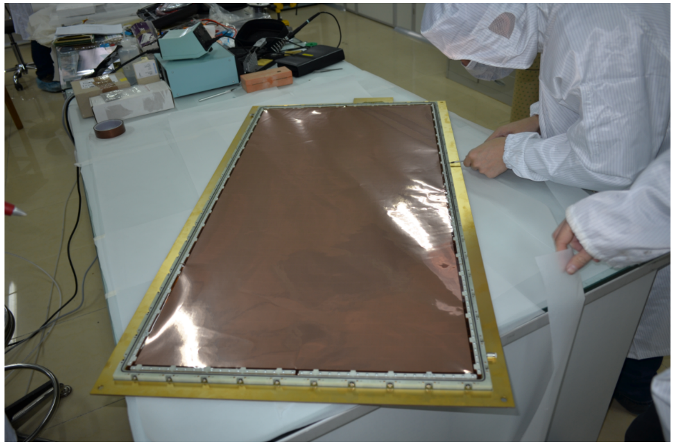
MPGD Lab at USTC

- Central gas supply
- A multi-purpose work station and a large-area regular work bench
- Three detector test platforms

Self-stretching Technique

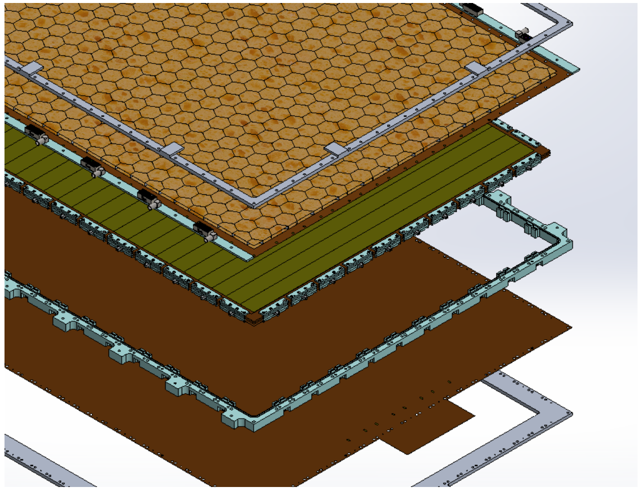
- Self-stretching: a novel GEM assembly technique developed at CERN and the main focus of GEM detector R&D in recent years at USTC.
- Have successfully built several 0.5m*1m GEM prototypes using the technique.
  - **No gluing, easy and fast assembly, highly efficient and labor saving**
  - **No inner spacers, no dead areas, smooth gas flow**
  - **Complete re-opening possible, full detector re-cleaning possible, highly replaceable and repairable, reduced cost**

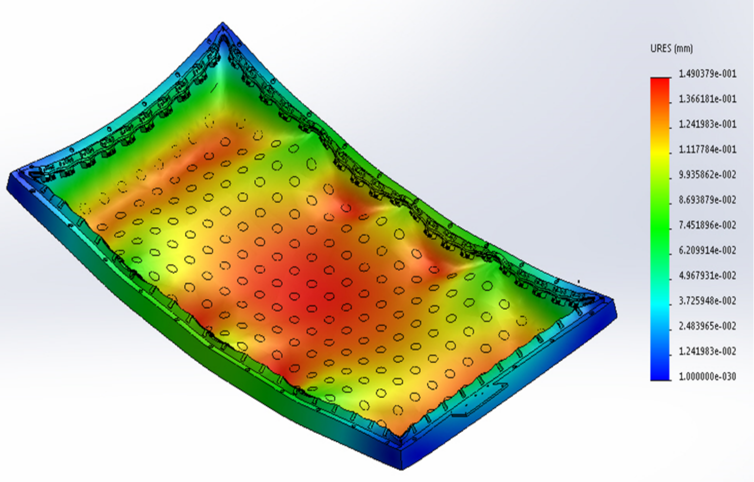




Self-stretching Optimization

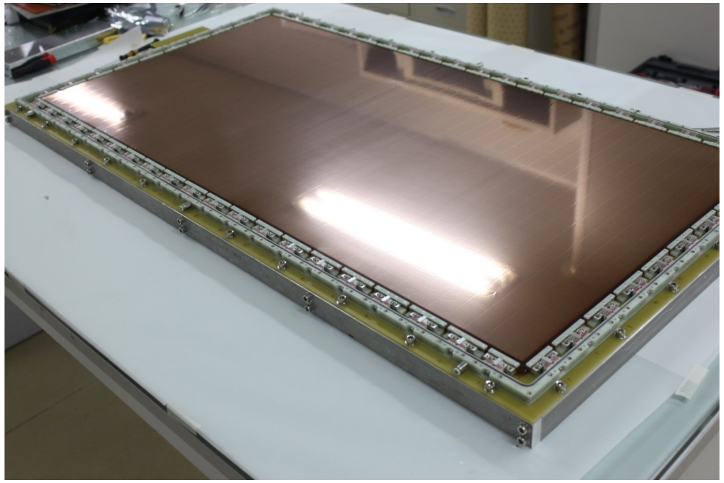
- Lots of effort put in improving the self-stretching technique and optimizing large-size GEM design with the technique.
- As a result, GEM foils get stretched more uniformly with chamber deformation also reduced significantly.

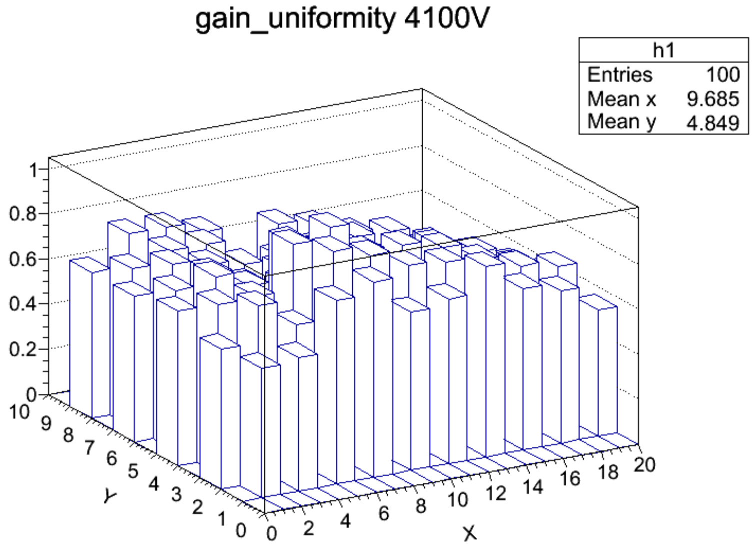




Large GEM with optimized design

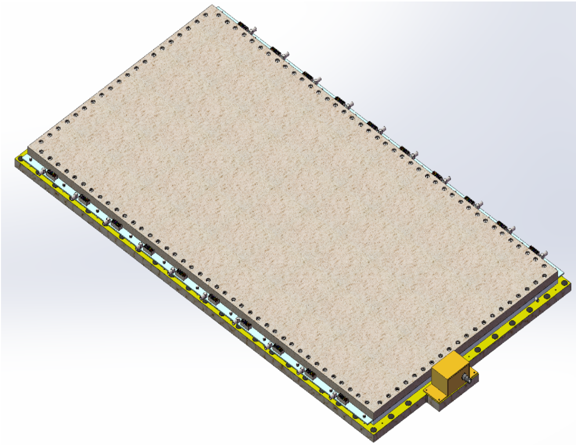
- Active area: 0.5m*1 m
- High quality GEM stretching with no visual wrinkles.
- Very good gain uniformity ~ 15%

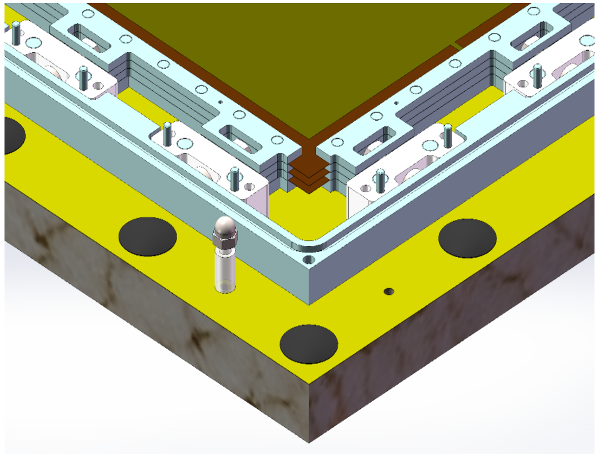




Low-mass Design with Self-stretching

- 0.5m*1m active area with no spacers.
- Drift and readout boards are made of Kapton + Cu
- All screws and nuts are plastic.
- Honeycomb on both top and bottom sides for mechanical support.



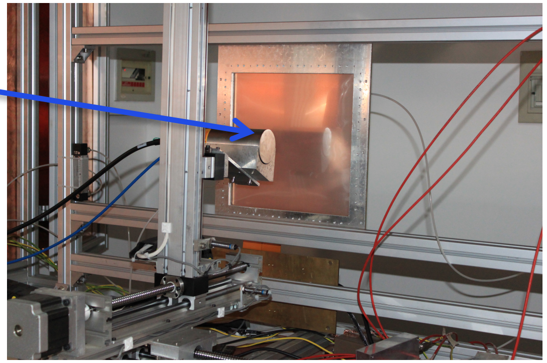


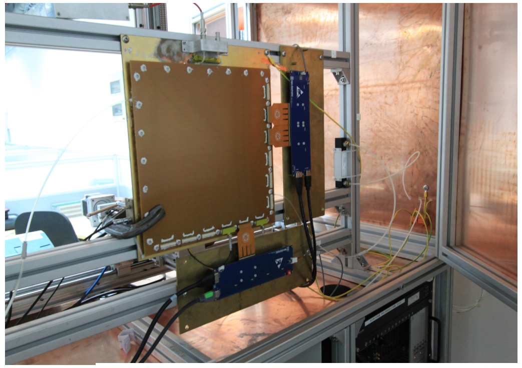
The whole design has been finished.

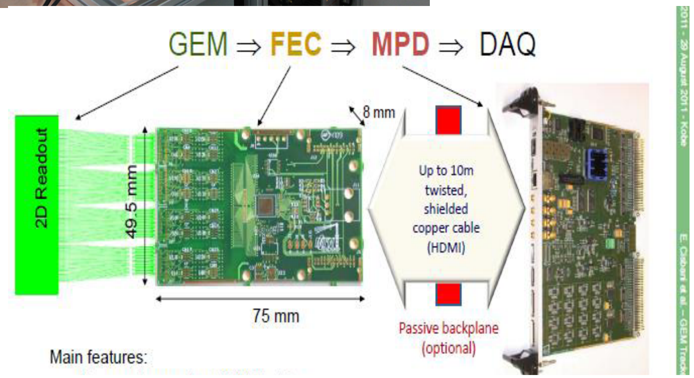
Thanks to Rui De Oliveira for his useful suggestions and technical support.

Spatial Resolution Test

- Tested GEM spatial resolution using collimated X-rays with the APV25-MPD readout system.



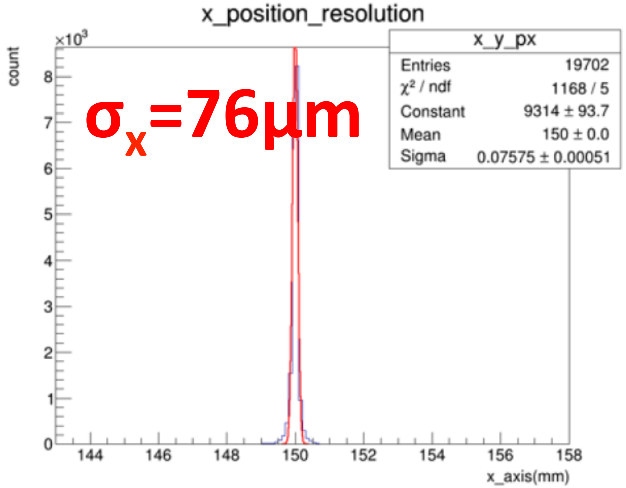


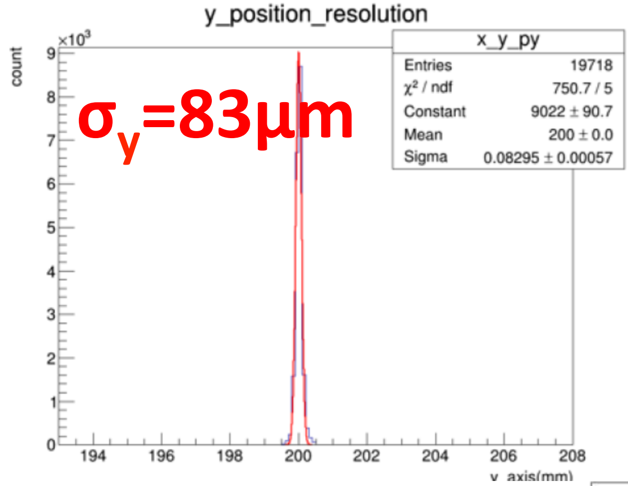


Thanks to Paolo Musico and Evaristo Cisbani for helping us debug the readout system.

Spatial Resolution Results

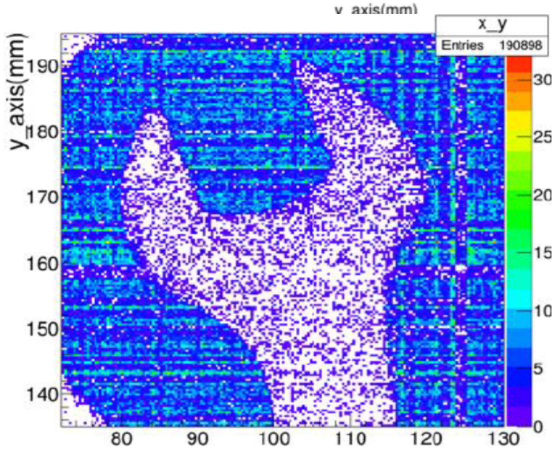
- 2-d readout board with strip pitch ~ 400μm
- Position taken as the center of gravity of charge





Intrinsic resolution better than measurement:

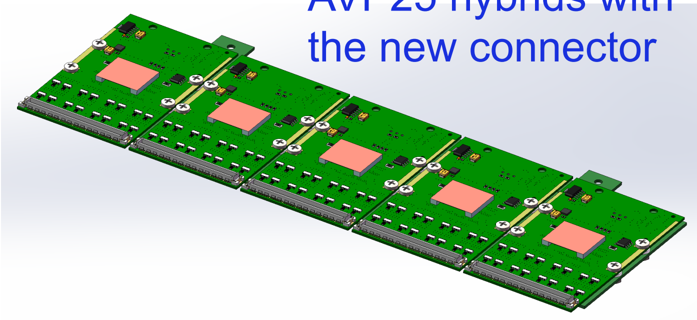
- Slit width
- Range of initial photon-electrons
- common mode noise
- APV25 saturation

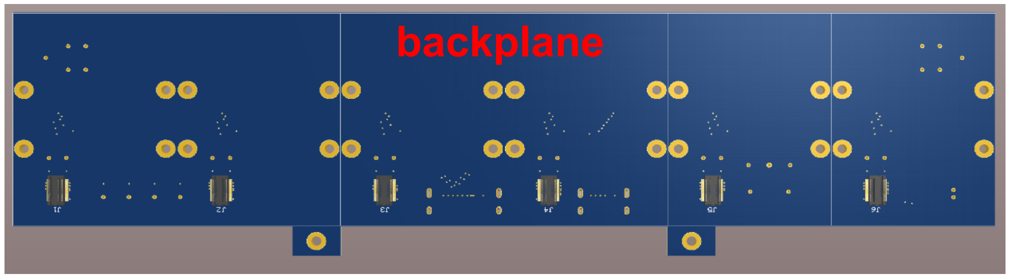


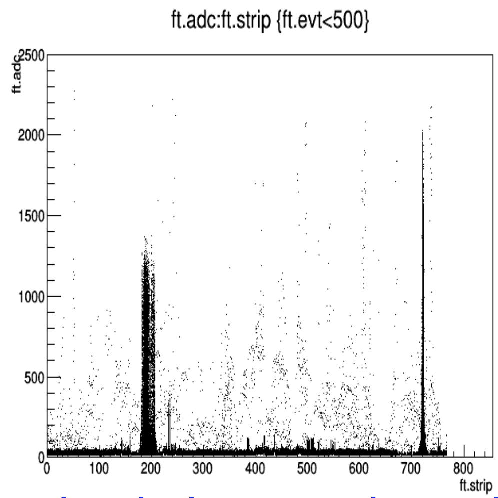
Additional test: 2D X-ray imaging

APV25 hybrid and backplane

- Changed the connector of the APV25 hybrid
  - From Panasonic 130-pin to Hirose 140-pin
- Designed and produced backplanes to host APV25 chips.





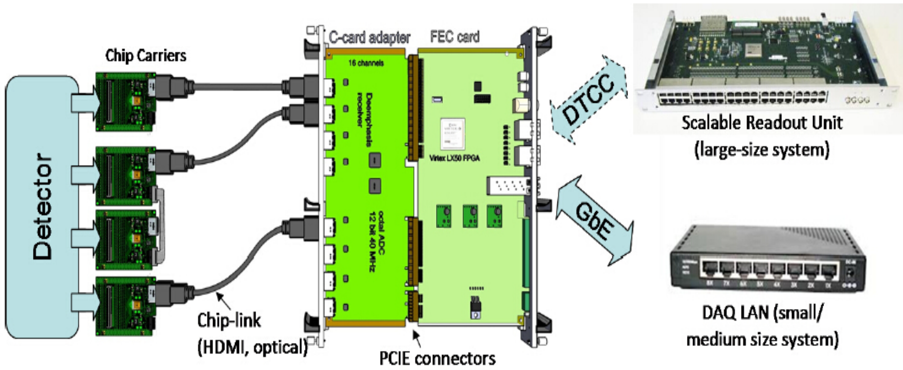


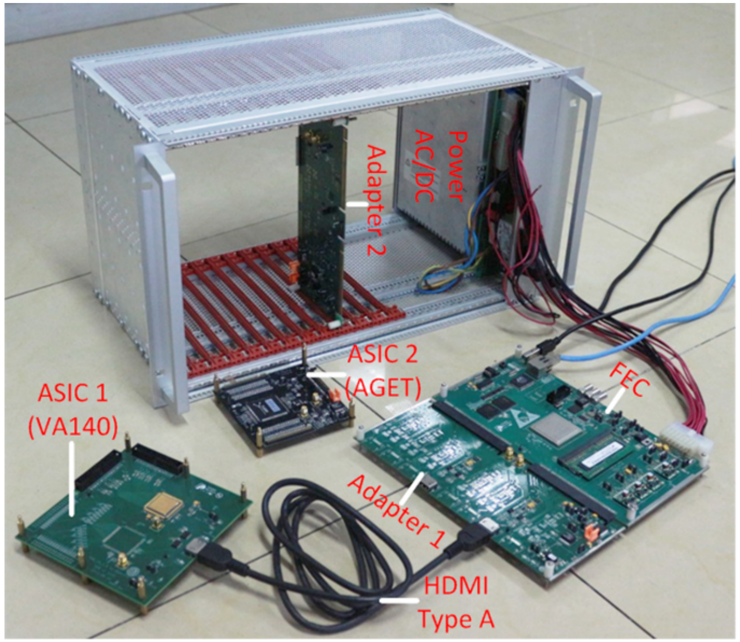
The backplane works well with APV25 and GEM. Noise level quite acceptable.

Thanks to Paolo Musico and Evaristo Cisbani for their help

GEM Readout R&D

- Has been developing a general and scalable readout system for MPDG.
  - Main components: ASIC card, adapter card, front-end card





Front-end Card

- Front-end chip: VA140
  - 64 channels
  - shaping time: 6.5μs
  - ENC<784e (Cd=100pf)
  - Dynamic range: 0-200fC
  - Linearity: 2%
  - Power consumption: 0.3mW/ch
- Design of front-end card

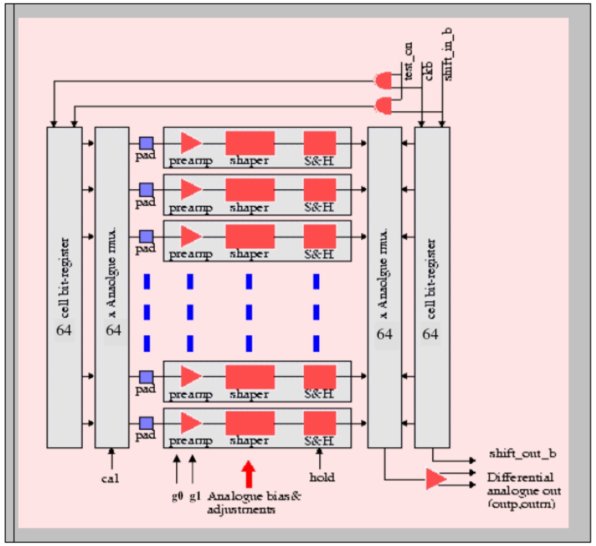
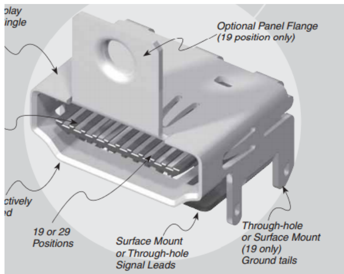
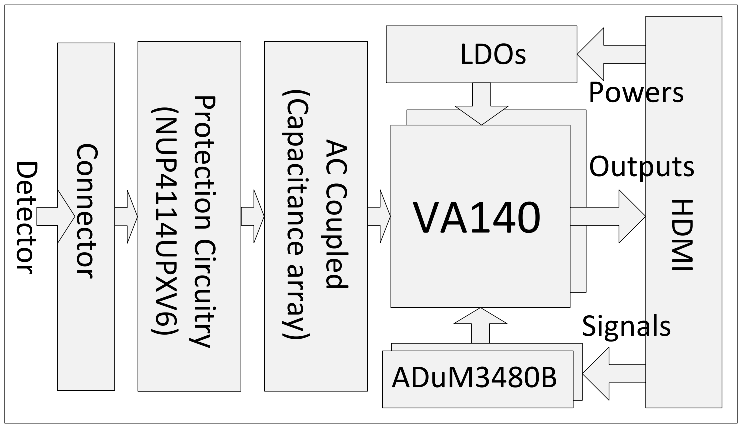
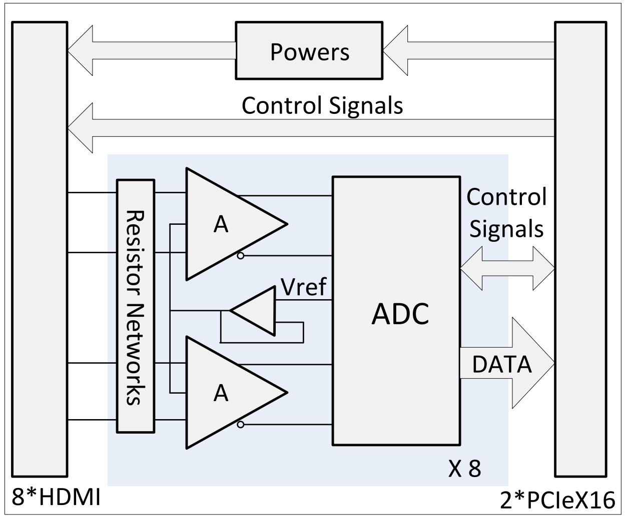


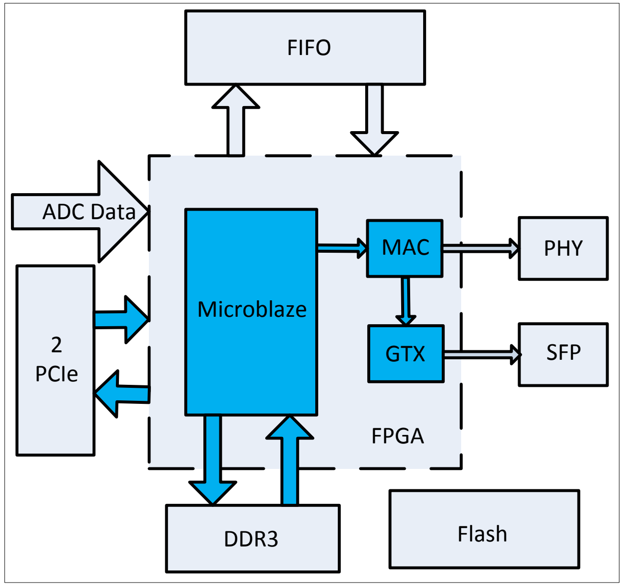
Figure 4: VA140 Architecture





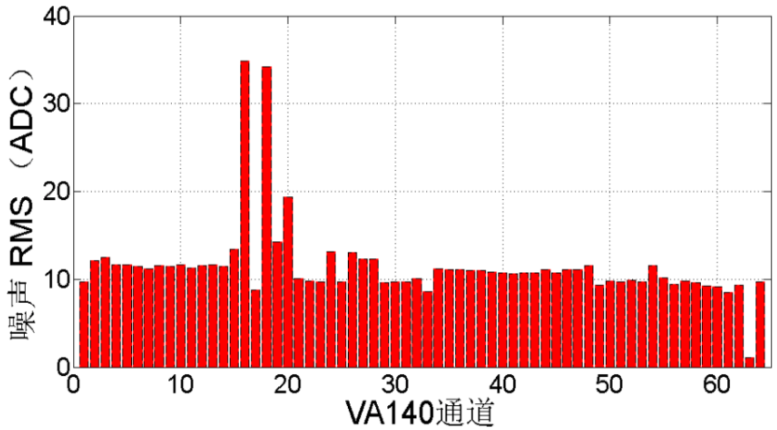
Adapter and DAQ

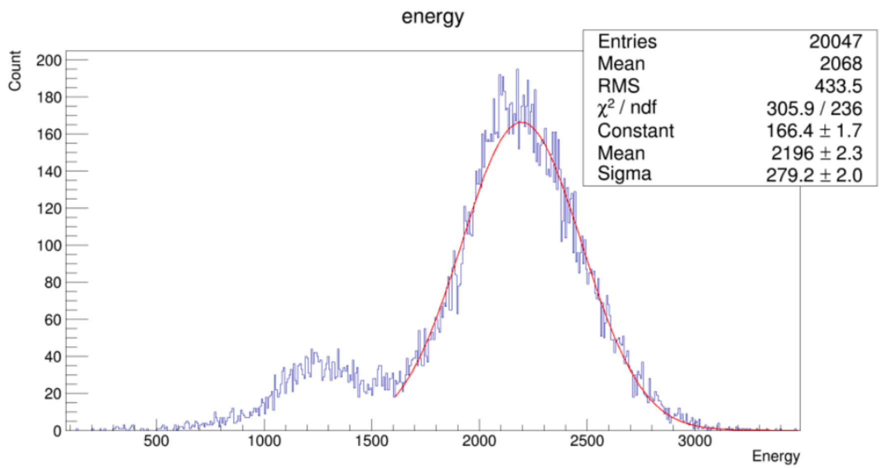




Test with Detector

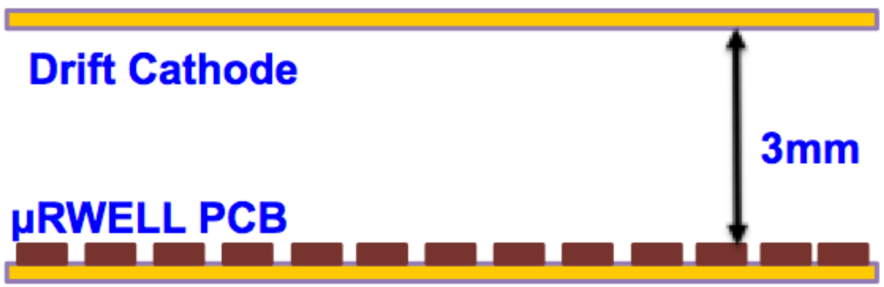
- Noise RMS ~ 0.7fC.
- Clear Fe-55 energy spectrum.
- Still a lot of work to optimize and finalize the readout system with actual detectors.

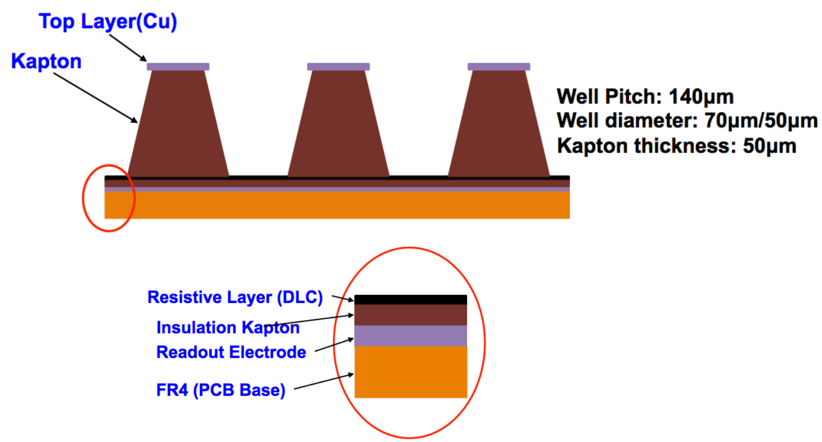




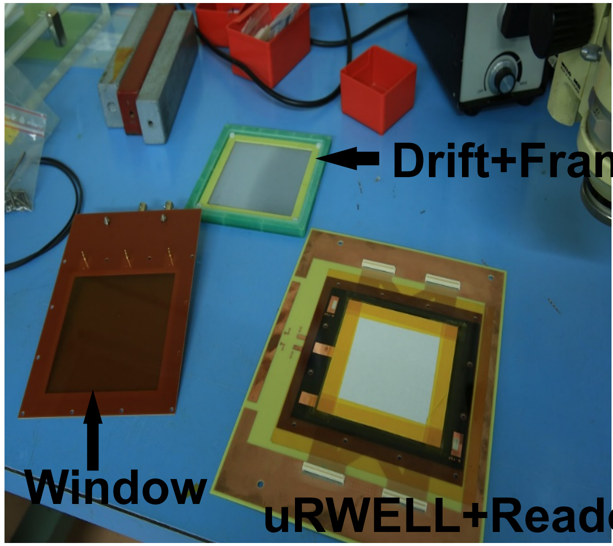
Micro-Resistive WELL: uRWELL

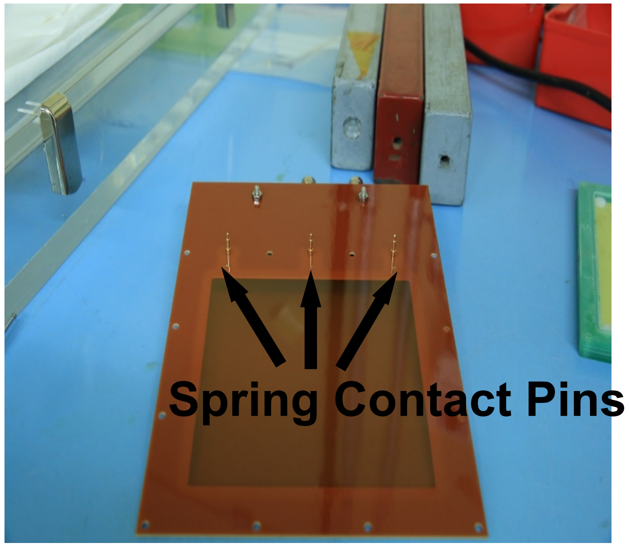
- We are pursuing a new MPGD technology: uRWELL
  - combination of MicroMegas (resistive readout for discharge protection) and GEM (holes for avalanche)
- Advantages
  - simple and compact detector structure
  - no gluing, no spacers, no stretching, no rigid frames
  - easy and efficient assembly
  - suitable for large area application
  - cost effective

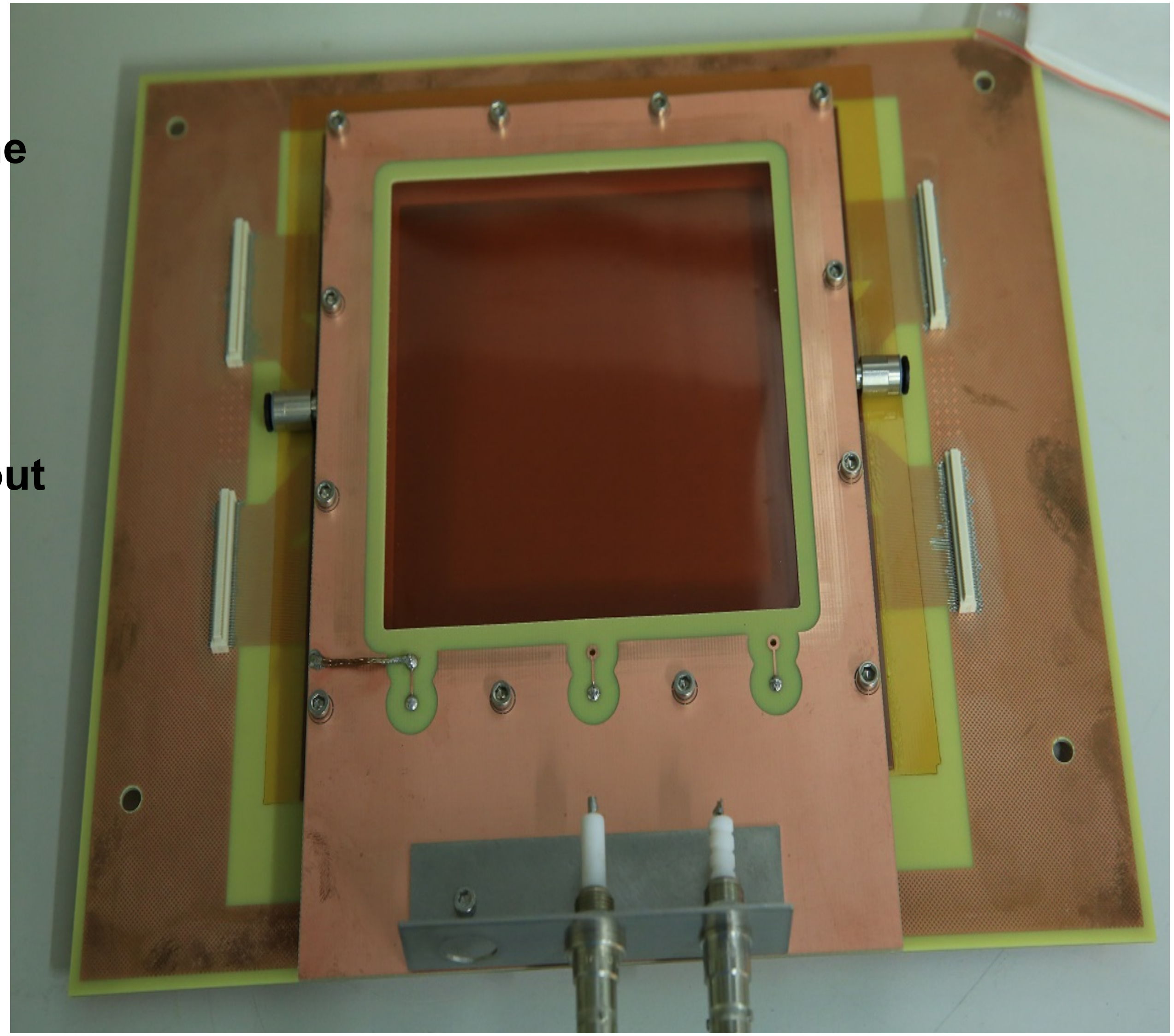




A 10cm*10cm uRWELL Prototype



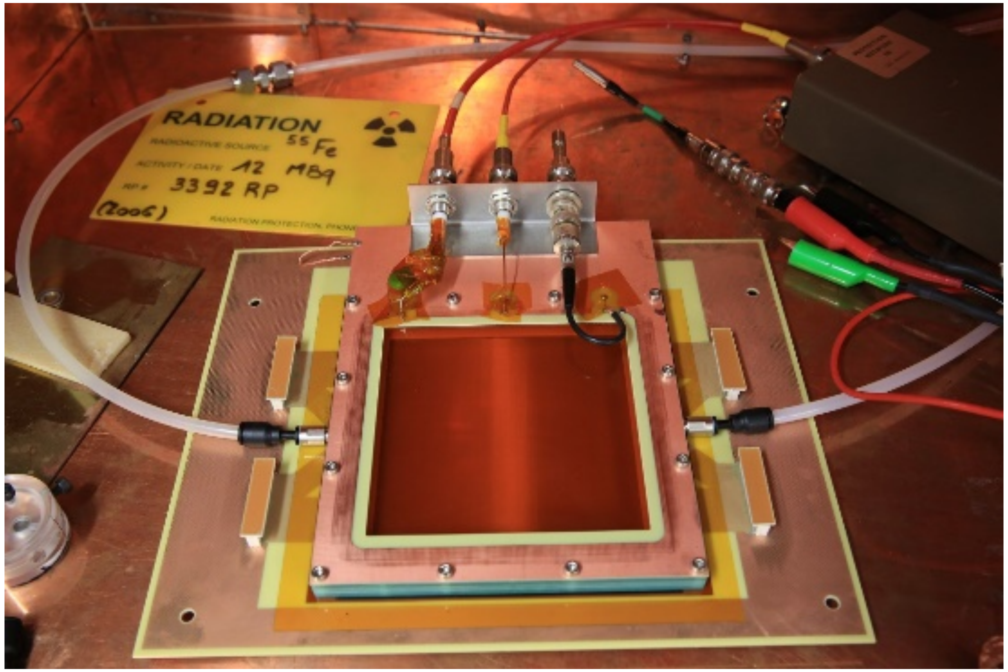


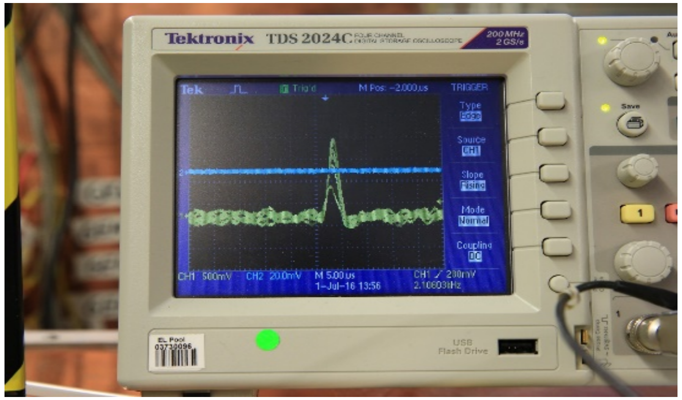


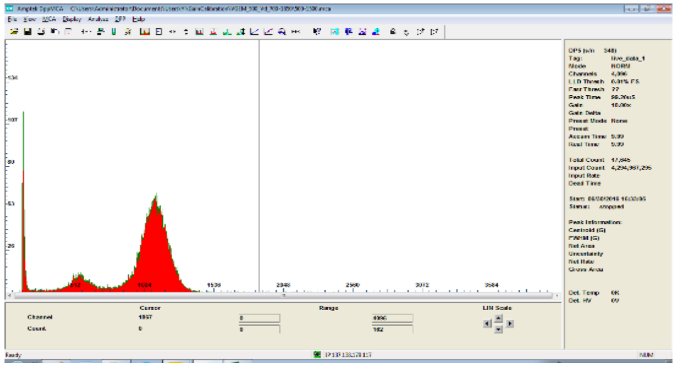
Thanks to Giovanni Bencivenni for sharing experience.

Prototype testing

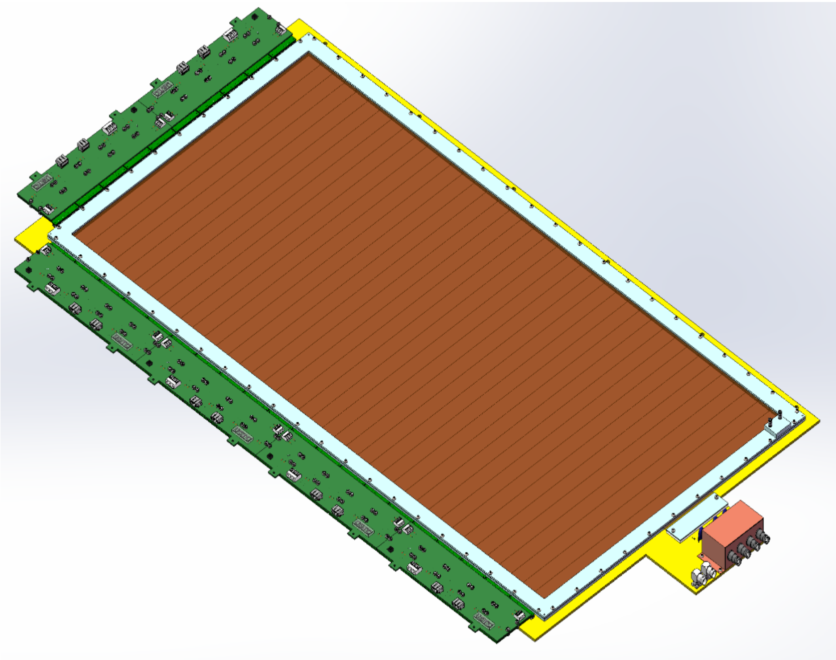
- Tested the prototype with Fe55 X-rays
- Observed distinct signals and acquired a clear energy spectrum.

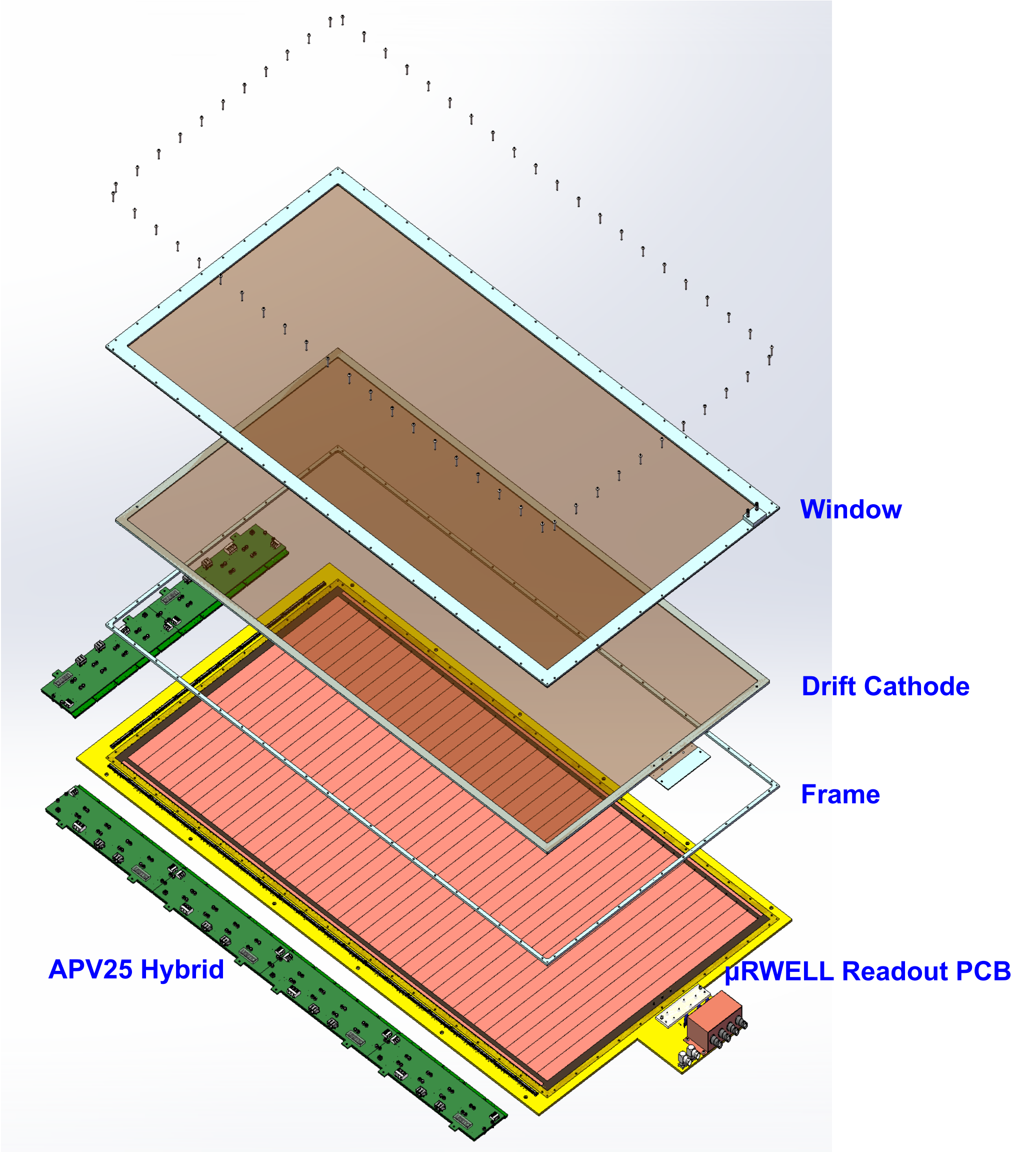






A 0.5m*1m uRWELL Design





Summary

- Active R&D on large-size GEM using self-stretching technique.
  - improved self-stretching technique
  - worked out a low-mass design
- Also a lot of developments on GEM readout
- Pursuing a new MPGD technology, uRWELL, as a promising solution to high-rate and large-area tracking.