

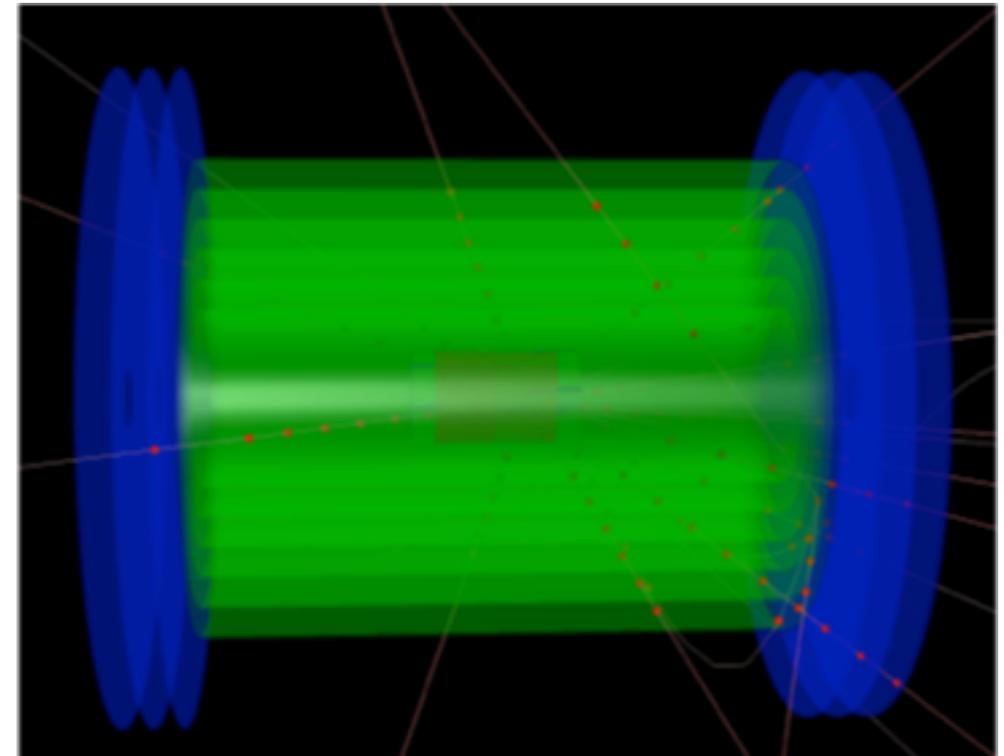
**eRD-3**  
Status Report (FY 18)  
Fast and Lightweight  
EIC Integrated Tracking System  
**Barrel MicroMegas (MM)**  
And  
**Forward Triple- Gas Electron Multiplier  
(GEM)**

Franck Sabatie (PI),      Bernd Surrow (PI),  
Maxence Vandenbroucke   Matt Posik



# Outline

- Introduction
- R&D Program Status
  - Forward GEM tracking
  - Barrel MM tracking
- Summary



# Introduction

## Overview of eRD3 Effort

- This R&D concentrates on a dedicated tracking system based on micro-pattern technology, which focuses on the design and development of fast and lightweight detectors.
  - **Barrel tracking system** based on MM detectors manufactured as cylindrical shell elements.
  - **Rear/Forward tracking system** based on triple-GEM detectors manufactured as planar segments (partly in Collaboration with eRD6).
- Main **generic R&D** goals of eRD3
  - Commercial fabrication of critical detector elements.
  - Utilization of lightweight materials.
  - Test and characterizations of curved 2D MM and commercial GEM detectors.
  - Design and test of new common chip readout system employing CLAS12 DREAM chip.
- eRD3 will now be integrated into eRD6

eRD3 Progress Report FY18

### EIC Detector R&D Progress Report FY18

**Project ID:** eRD3

**Project Name:** Design and assembly of fast and lightweight forward tracking prototype systems for an EIC

**Period Reported:** January 2018 – July 2018 (Status)

**Project Leaders:**

Professor Bernd Surrow and Dr. Matt Posik (Temple University) / Dr. Franck Sabatie (Saclay)

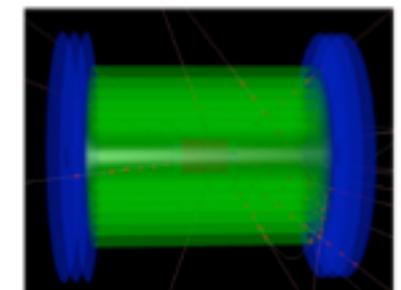
**Date:** June 27, 2018

**Applicant Address:** Temple University  
Department of Physics  
Science Education and Research Center  
1925 North 12th Street  
Philadelphia, PA, 19122

**Contact Persons:** Professor Bernd Surrow and Dr. Matt Posik

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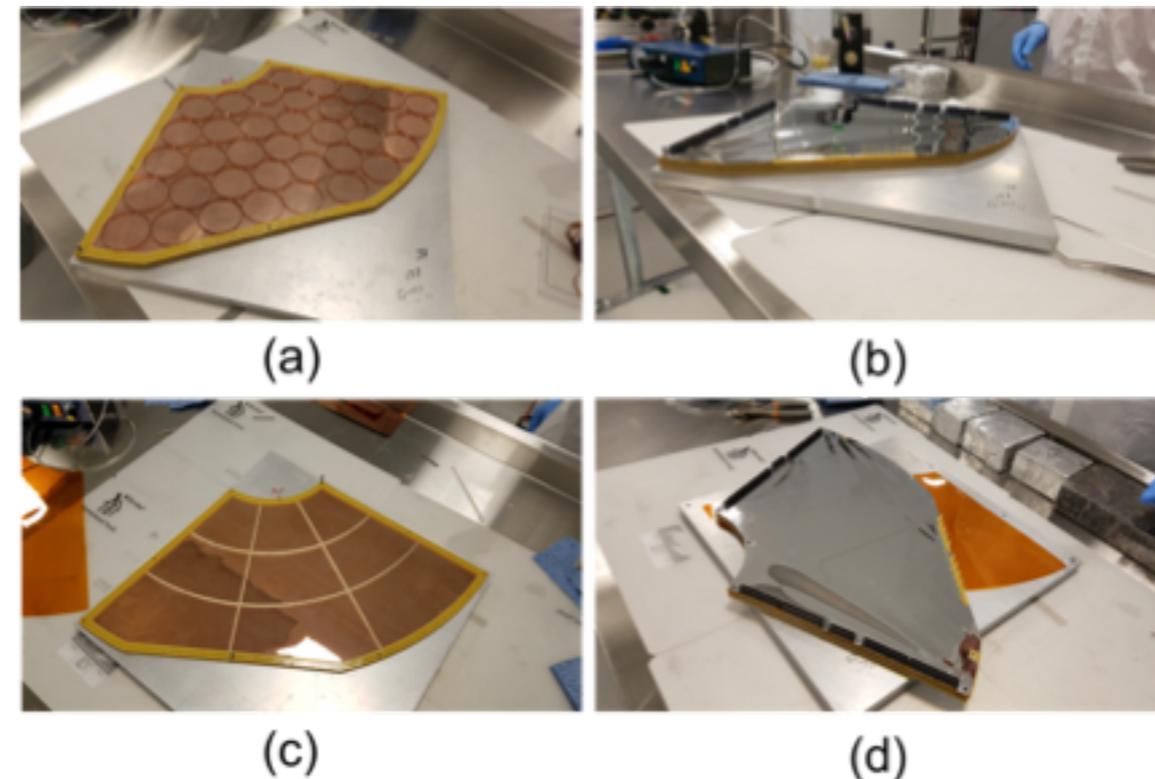
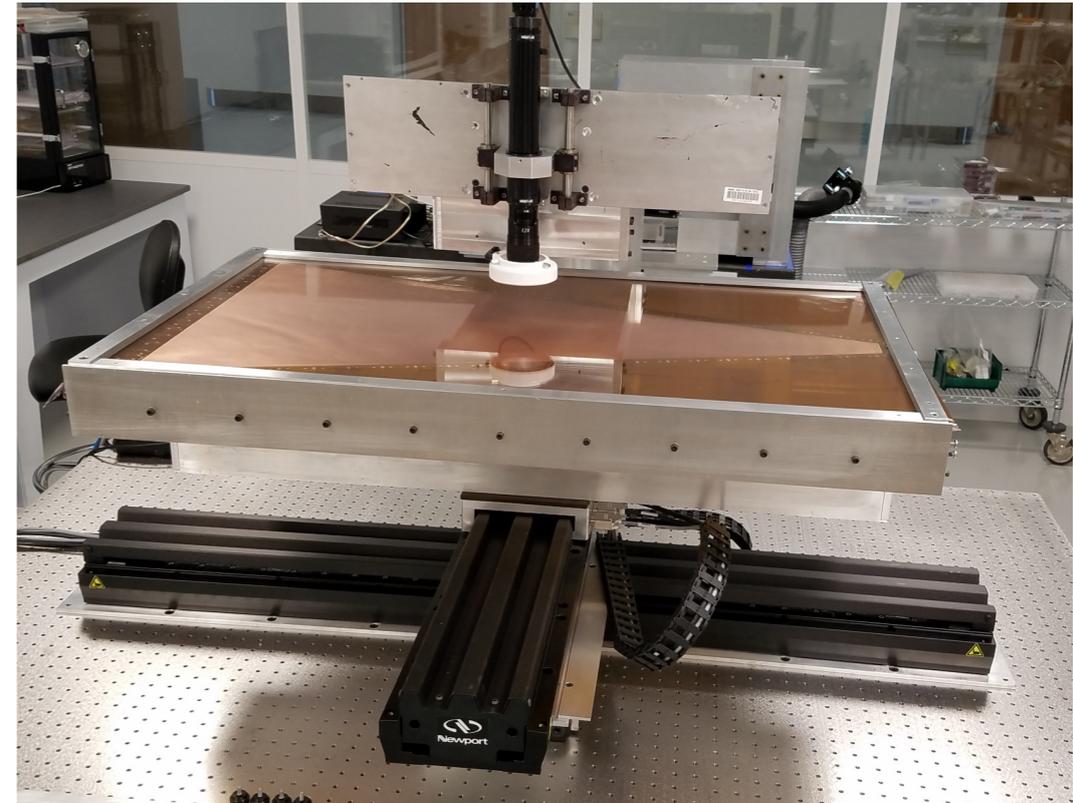


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# Introduction

## Highlights of the triple-GEM R&D program

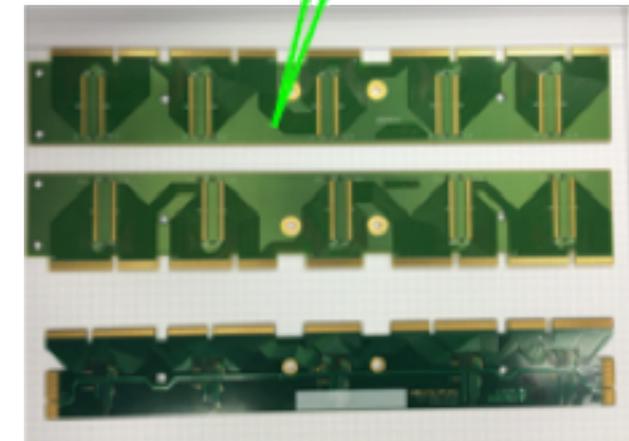
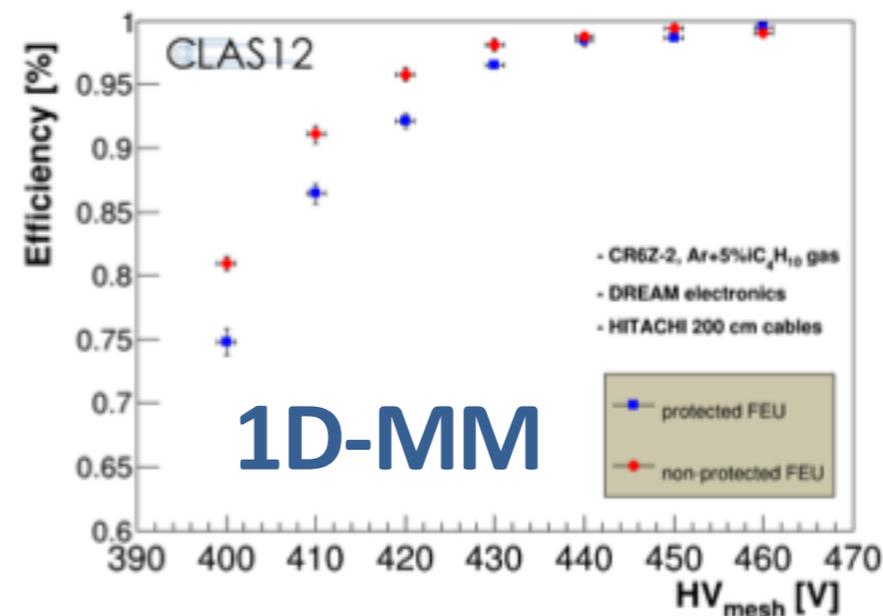
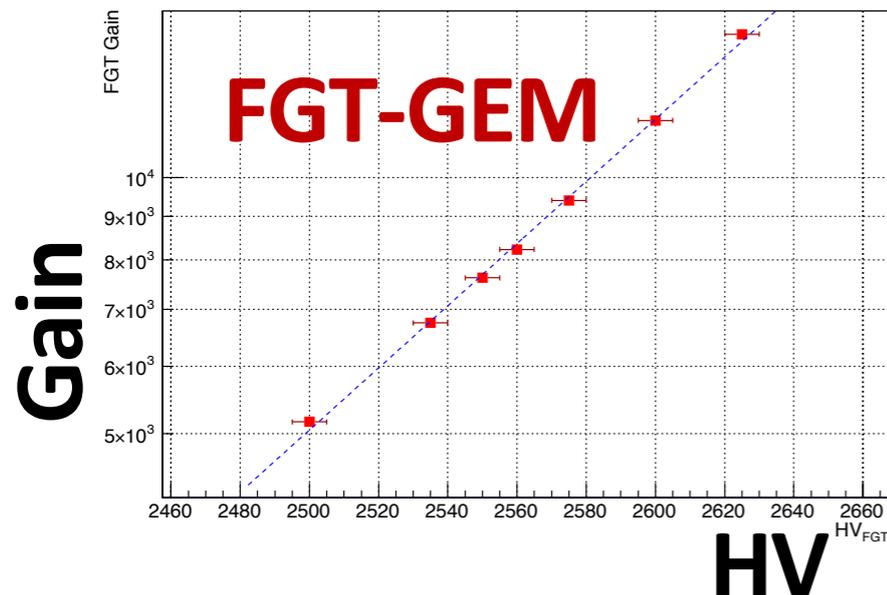
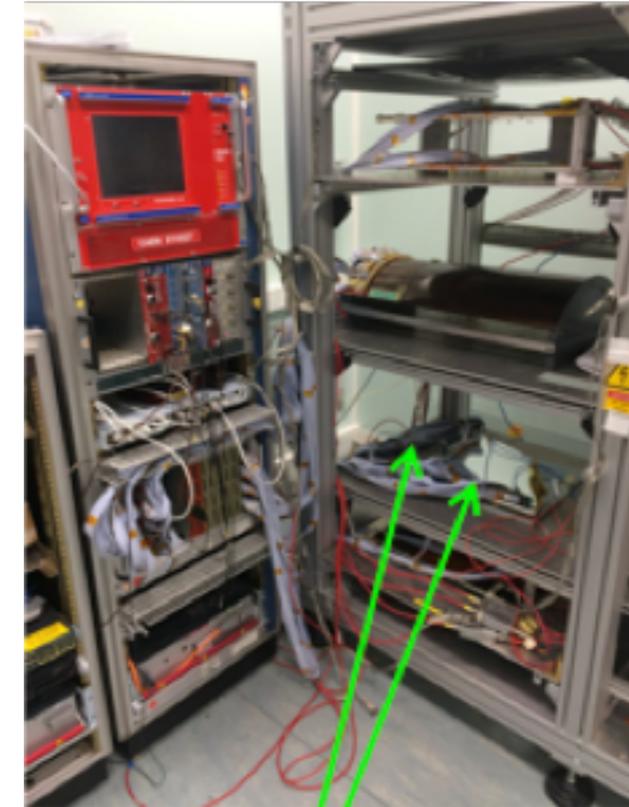
- Setup of dedicated micro-pattern facility including permanent Class 1,000 cleanroom, detector lab and dedicated infra-structure such as gas, HV system, Newport optical benches, DAQ system, and cosmic ray stand.
- Fully operational **large-area CCD scanner** for GEM foils developed and operated inside a permanent Class 1,000 clean room.
  - Scan for various applications in nuclear and particle physics community and commercial sources.
- Tested geometrical and electrical properties of commercially produced Tech-Etch GEM foils ([NIM A 802, 10 ,\(2015\)](#)).
- Assembly and testing of triple-GEM detectors using commercial components. Detectors built using **Kapton spacer rings** and **G10 spacer grids**.
- Submitted MPGD 2017 proceedings ([arXiv:1806.01889](#))
- Beginning detector characterization with cosmics.



# Introduction

## Highlights of the MM R&D program

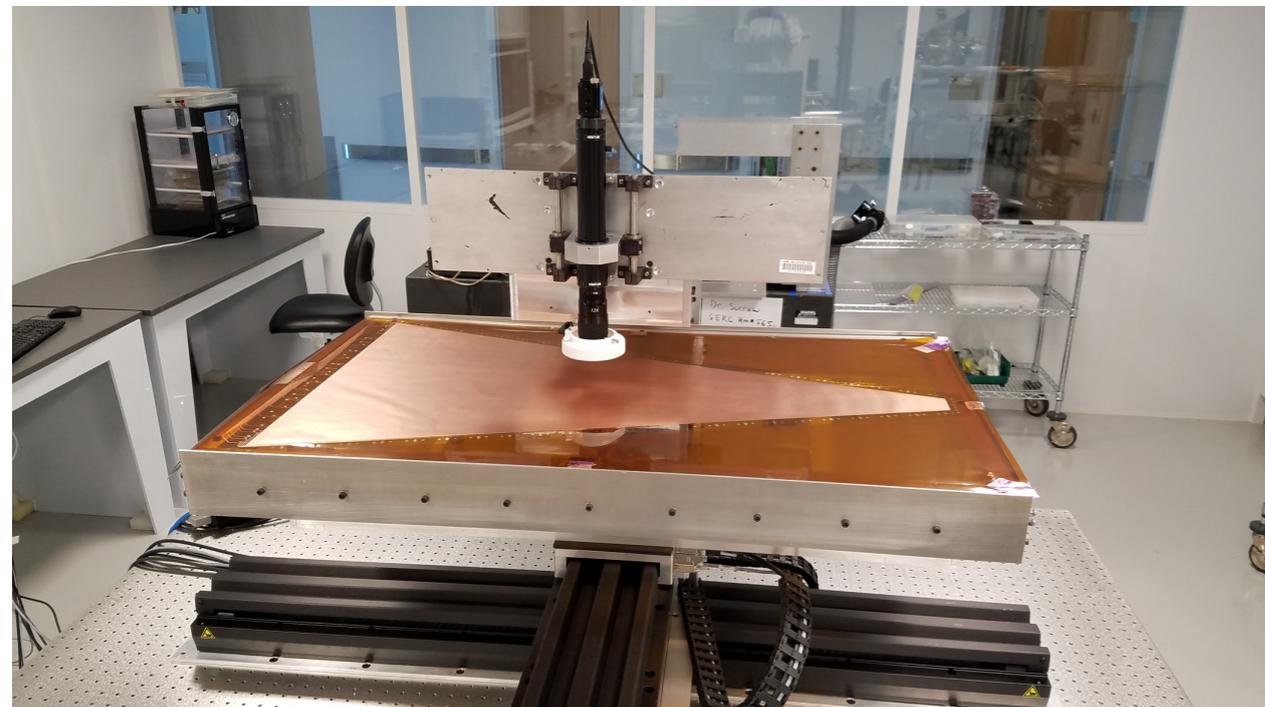
- Testing of the MM 1D prototype detectors and triple-GEM detectors with the DREAM chip readout.
- Component list for the DREAM chip DAQ setup at Temple is available, but no funding to proceed.
- Modular DREAM chip development as previously reported.
- Design of 2D MM prototype design ongoing (no funding to proceed).



# Status: GEM Tracking

## GEM CCD Scanner

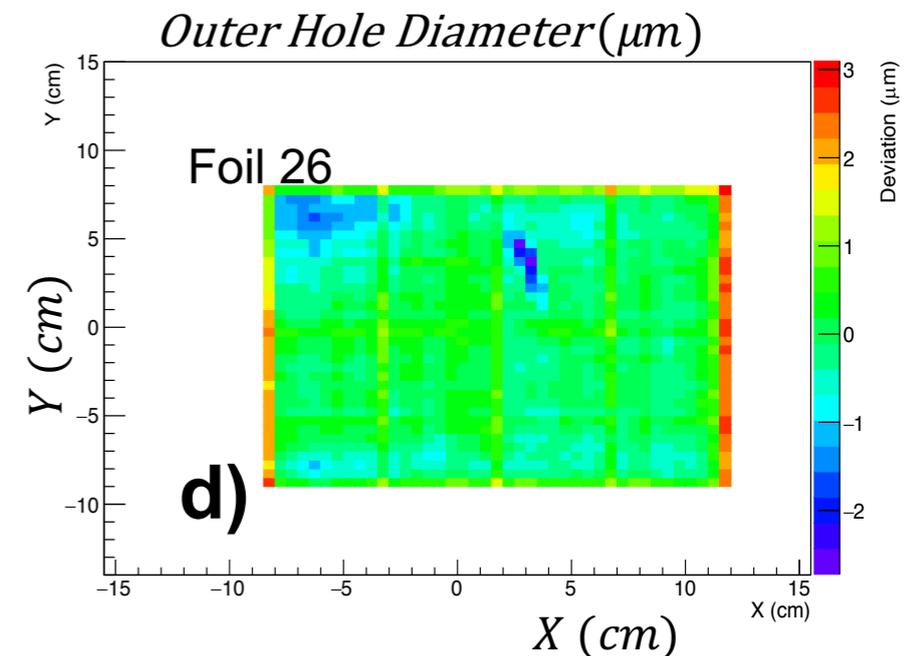
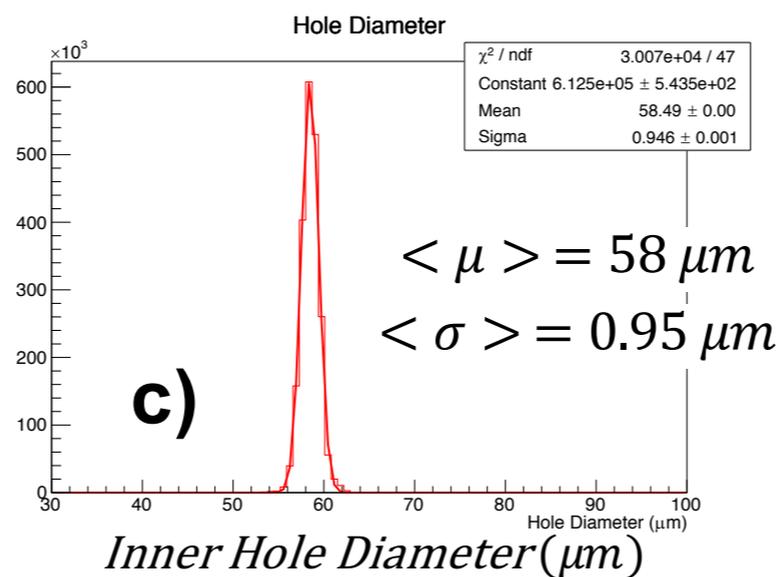
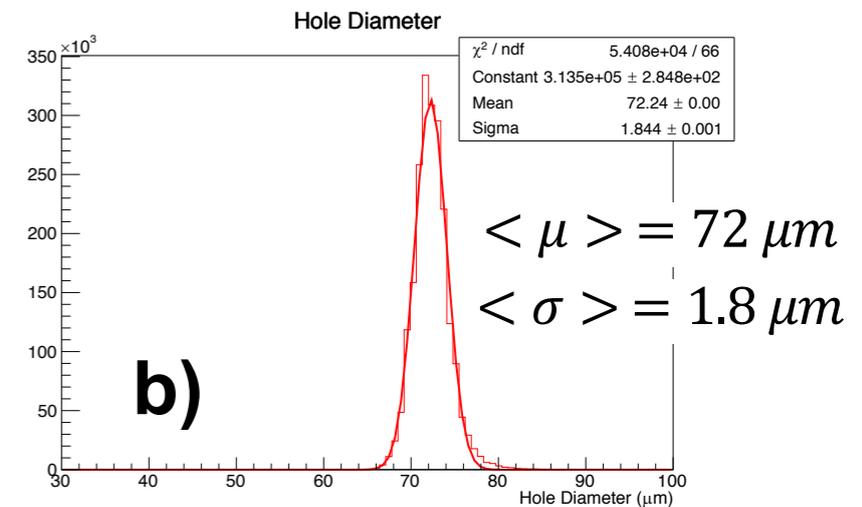
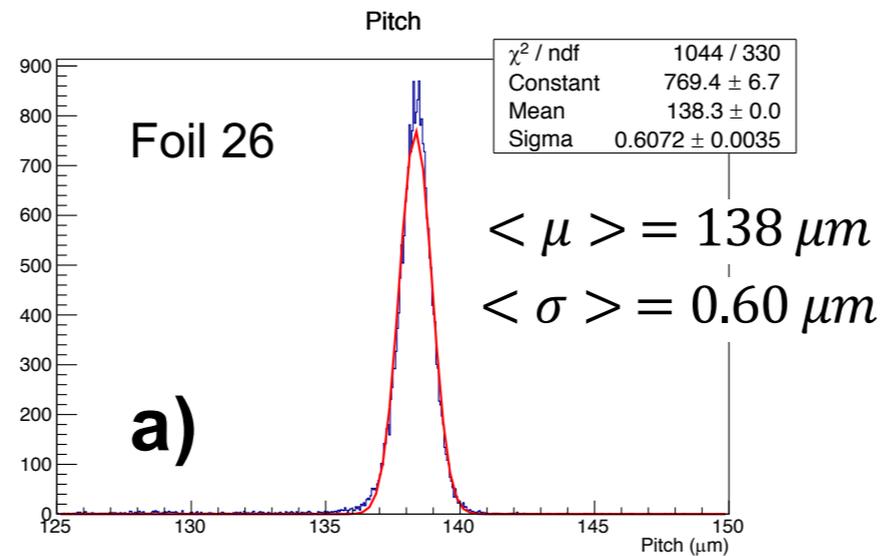
- Large-area CCD GEM scanner continues to serve the **EIC R&D MPGD community** with recent scans of **eRD3+eRD6 common EIC GEM foil** and **eRD6 Cr-GEMs**.
- Scanner also serves the **broader MPGD community** with recent scans of foils for **BONUS** and **Mecaro** (Korean commercial company working with CMS).
- Babu Pokhrel (potential graduate student) is being trained on how to perform and analyze the GEM scans.



# Status: GEM Tracking

## GEM CCD Scanner – BONUS GEM

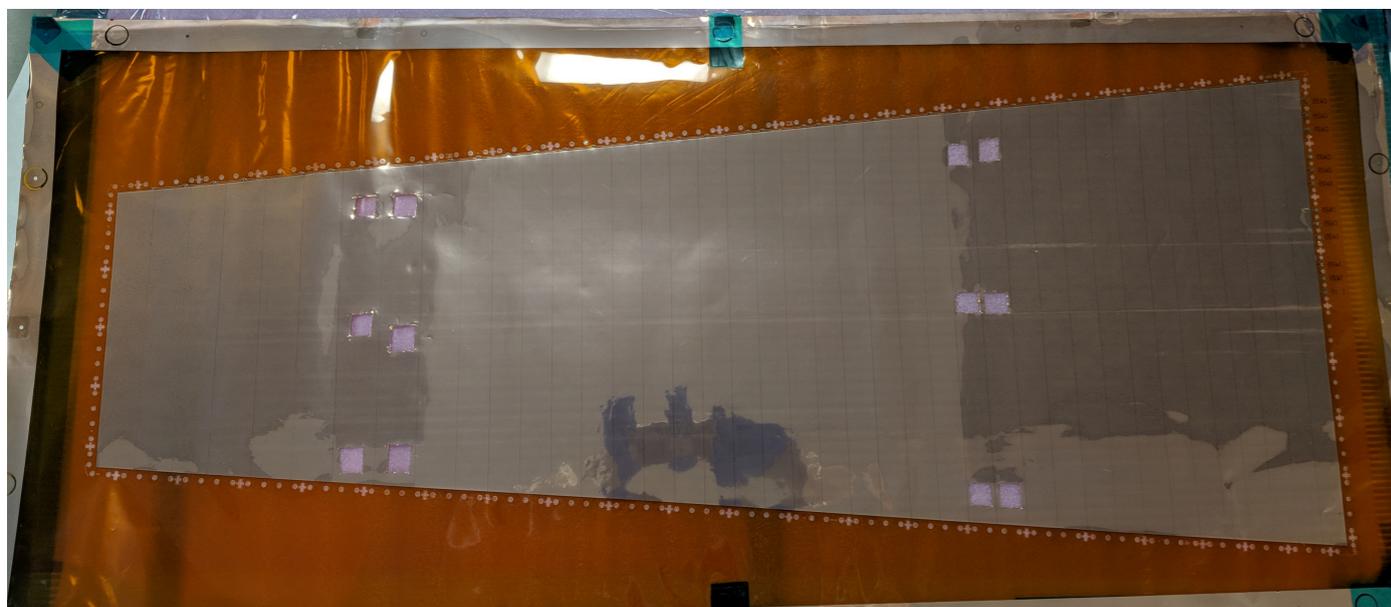
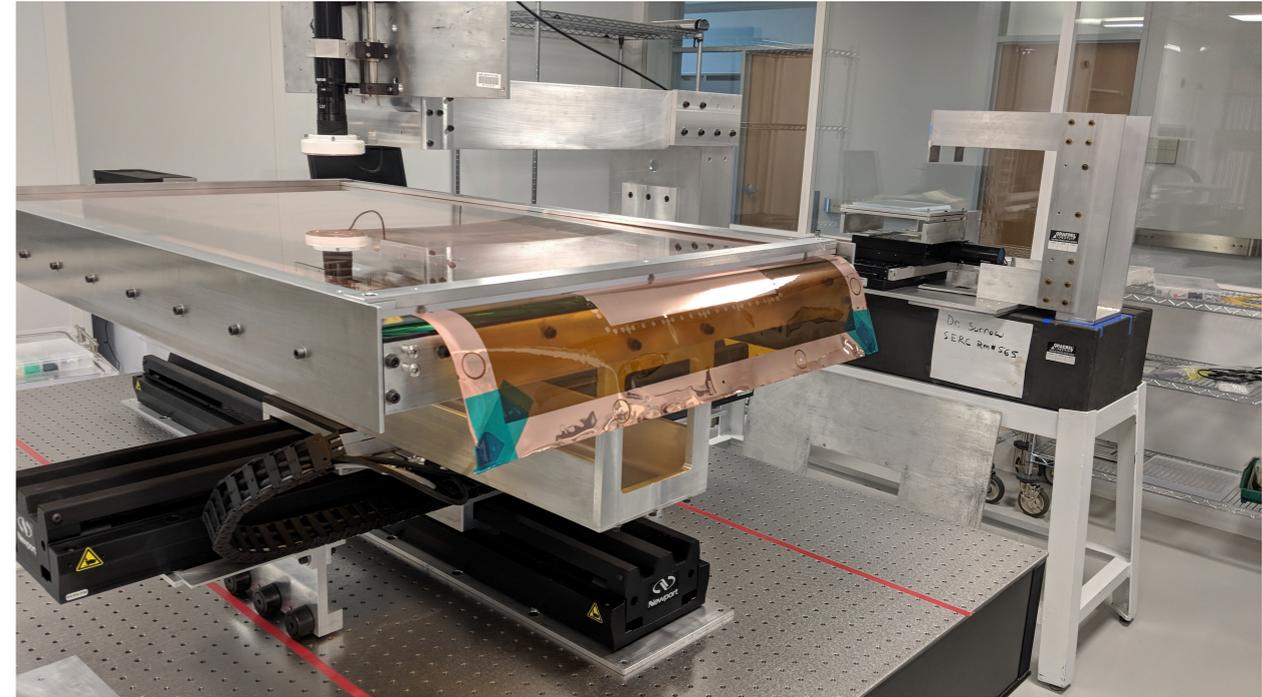
- BONUS experiment had to account for gain changes in their GEM detector during running.
- Sent two foils, produced by Tech-Etch via double-mask technique to be scanned to see if foil geometry could be the cause of the seen gain variations.
- GEM scans show that both foils appear to be within acceptable parameters.
- Geometry of the BONUS GEM foils most likely not the cause of gain variations.



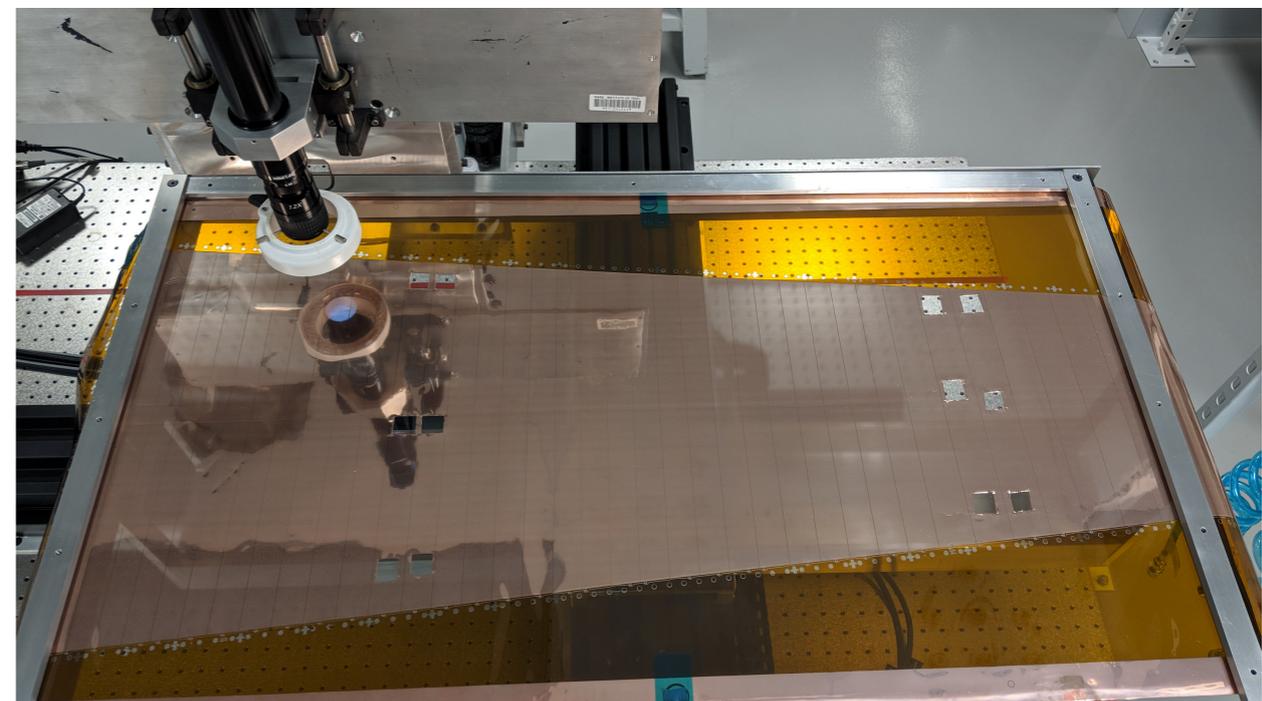
# Status: GEM Tracking

## GEM CCD Scanner – Mecaro CMS GEM

- Mecaro is a Korean company who are working with CERN and CMS to produce large-area GEM foils for the CMS upgrade.
- One test foil was sent to Temple University for scanning analysis.
- Test foil has been scanned and analyzed.



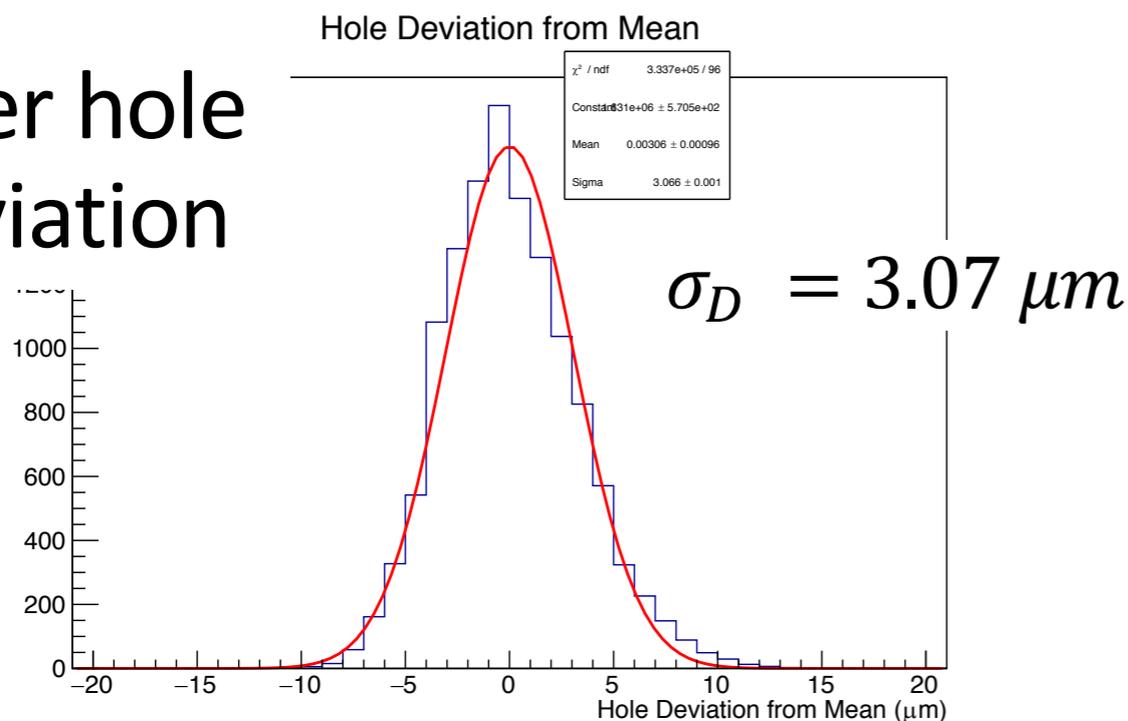
Active area  $\sim 60$  cm x 100 cm



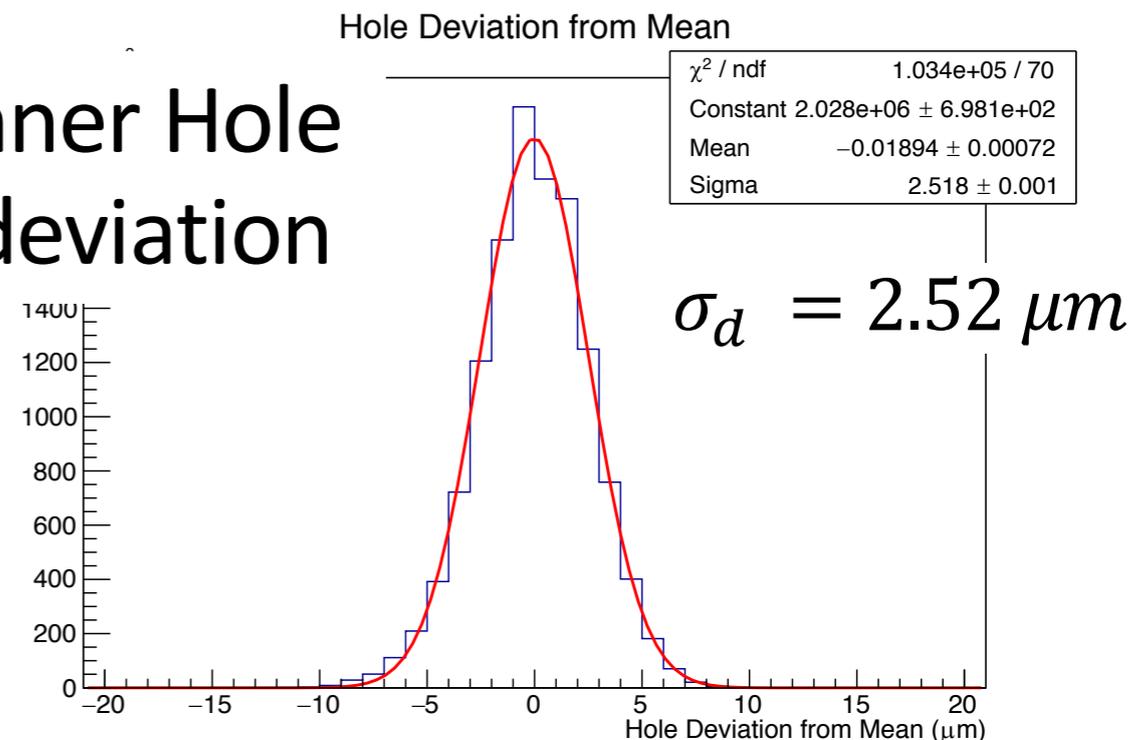
# Status: GEM Tracking

## GEM CCD Scanner – Mecaro CMS GEM: Representative Results

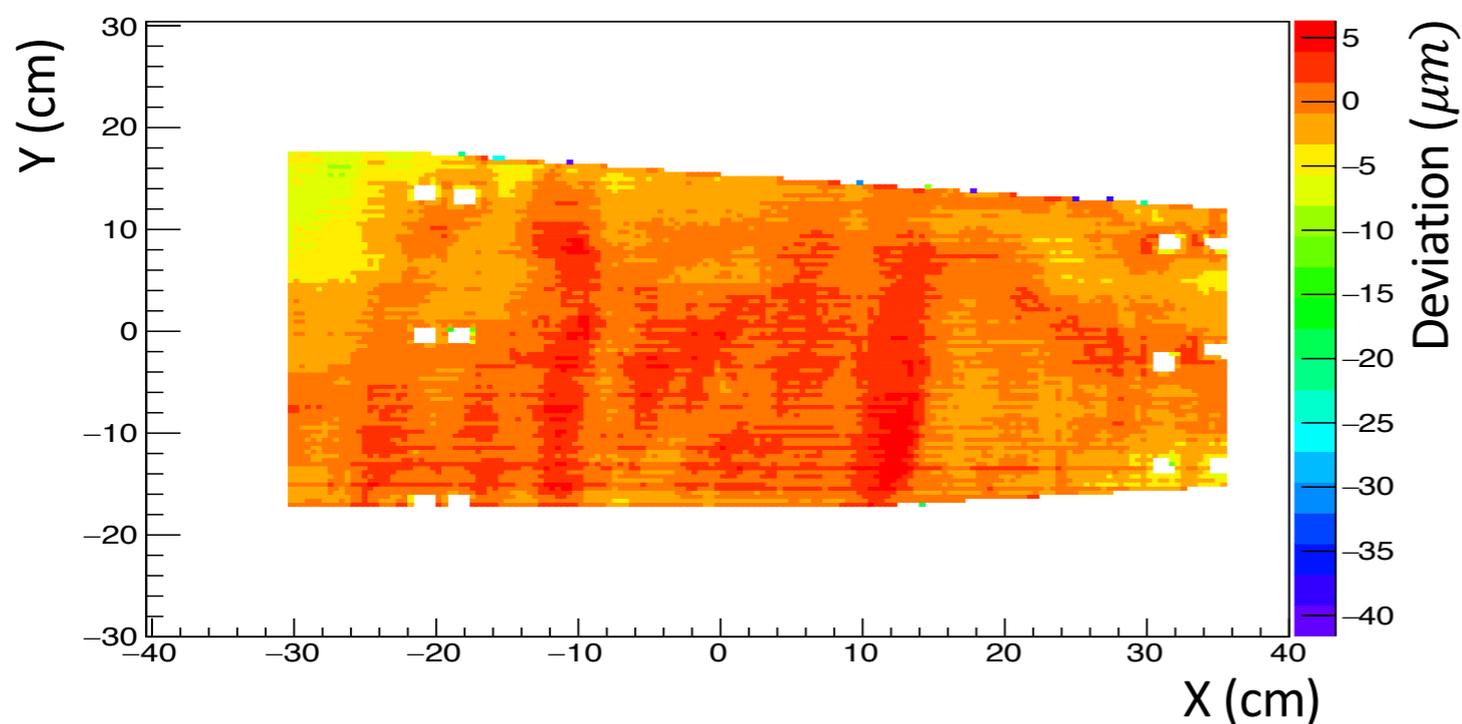
Outer hole deviation



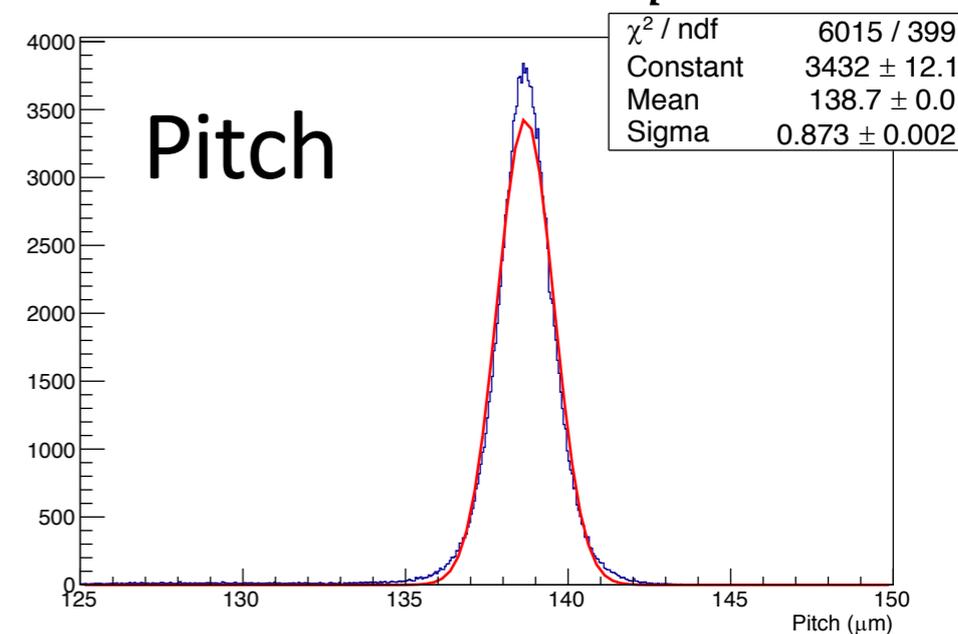
Inner Hole deviation



2D Diameter Deviation from Mean profile yx projection

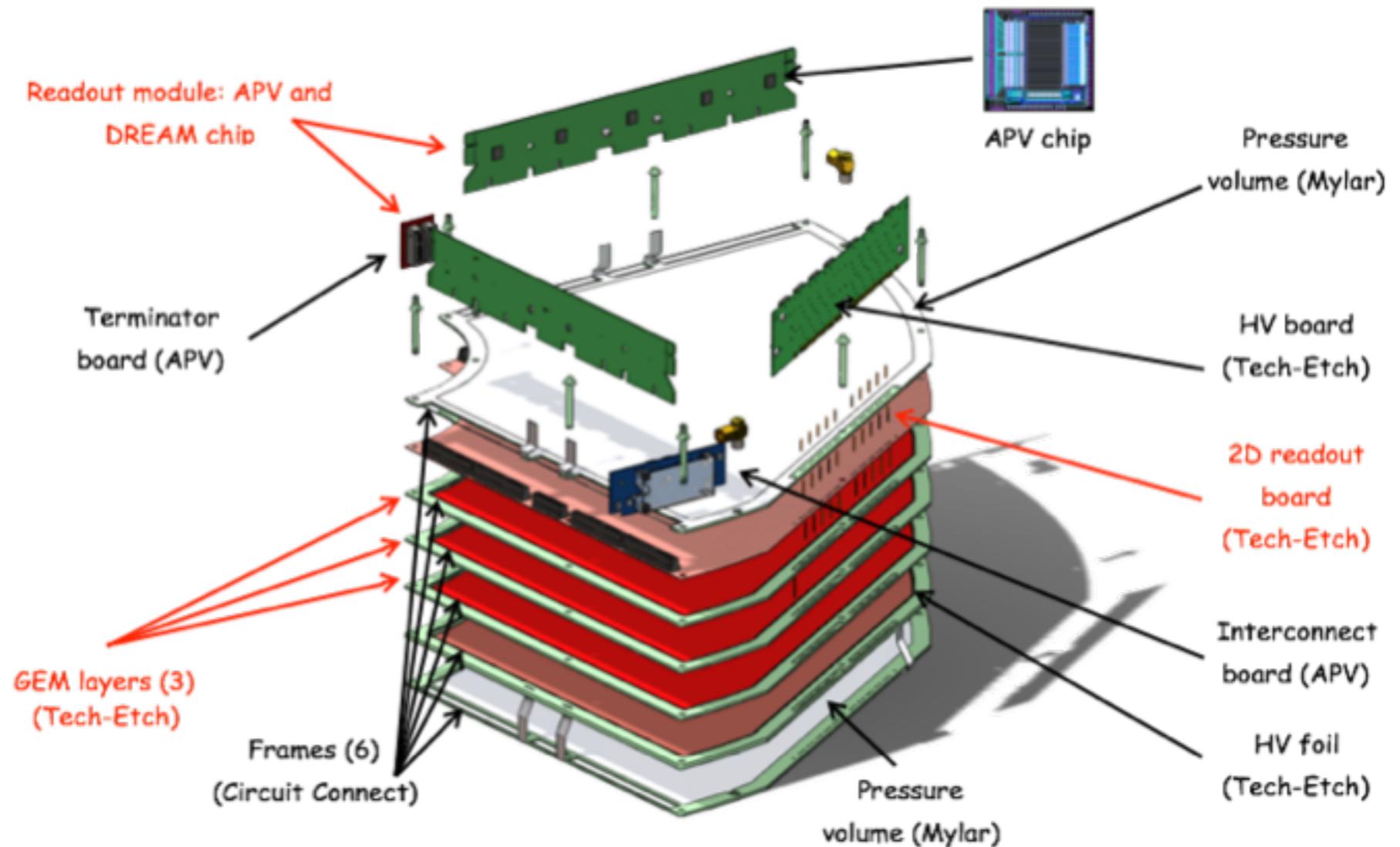


$\langle p \rangle = 138.7 \mu\text{m}, \sigma_p = 0.87 \mu\text{m}$



# Status: GEM Tracking

## Triple-GEM Detector Prototypes: Overview



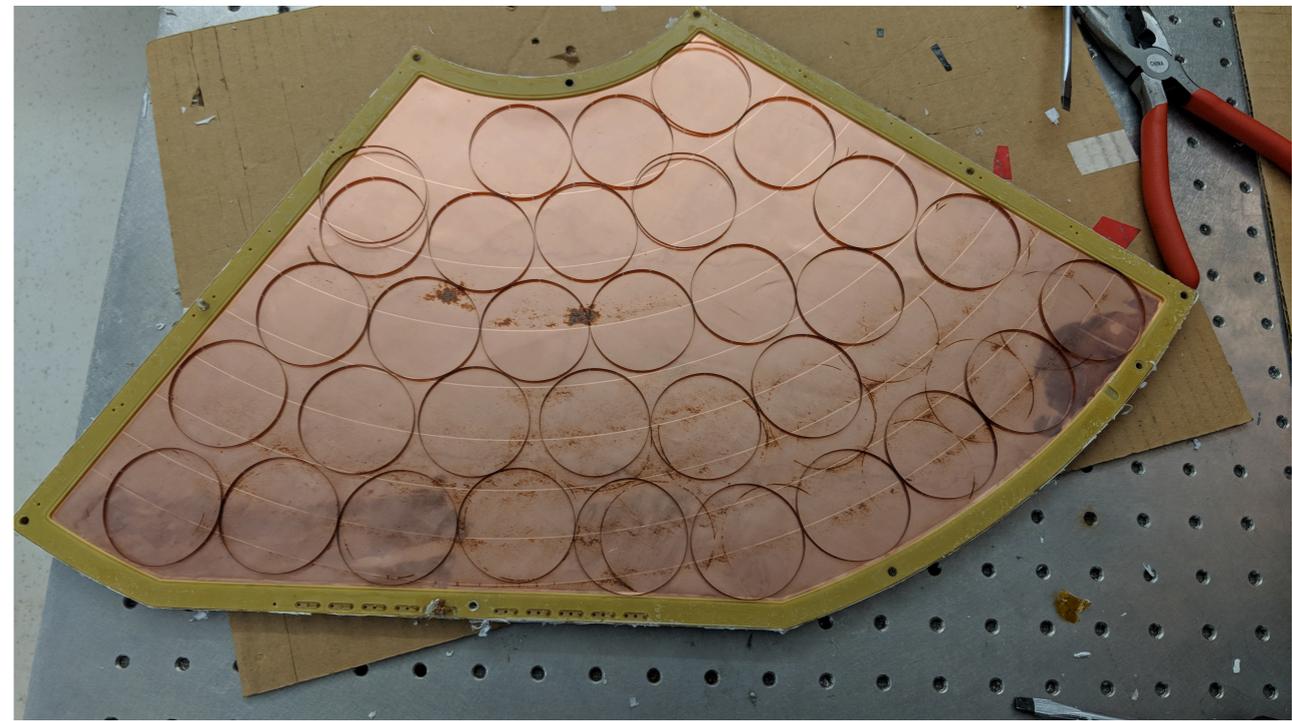
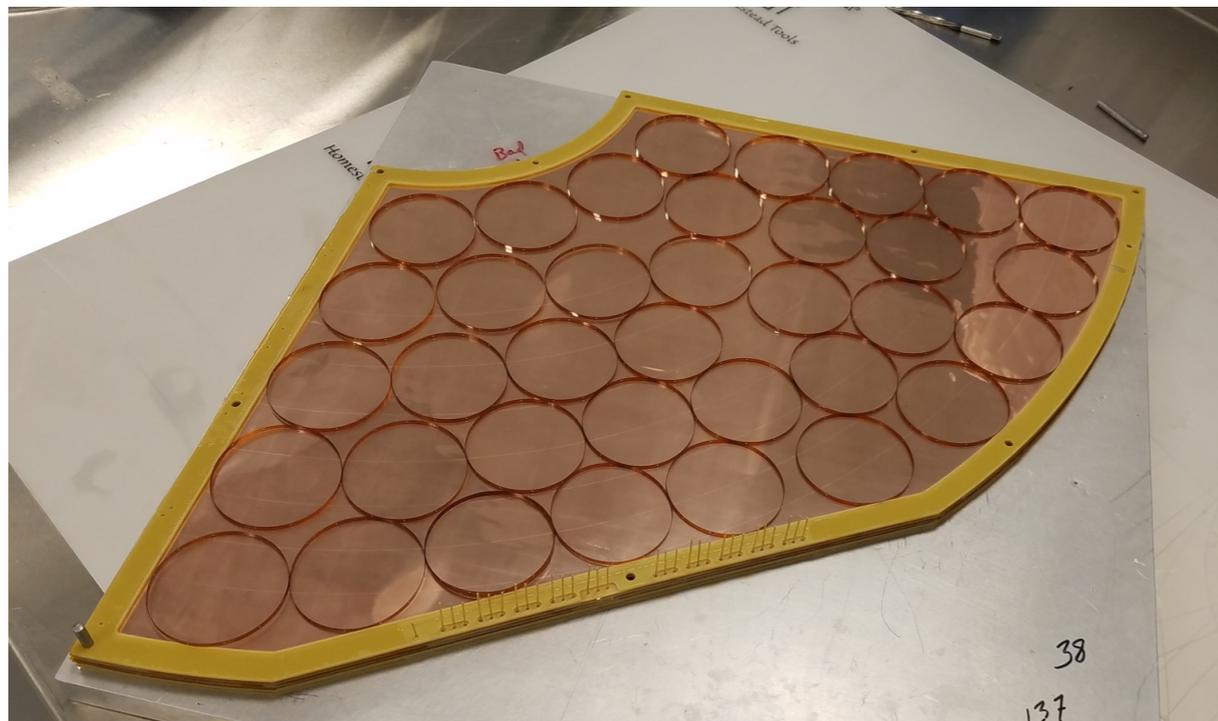
### Prototype Concepts:

1. Commercially produced materials.
2. Kapton spacer rings
3. DREAM chip implementation

# Status: GEM Tracking

## Triple-GEM Detector Prototypes - Assembly

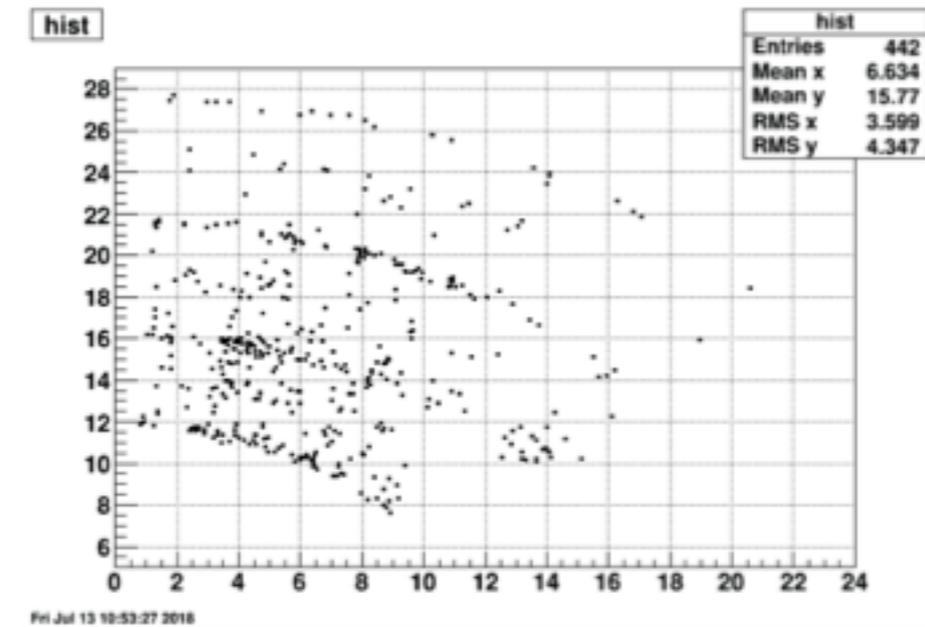
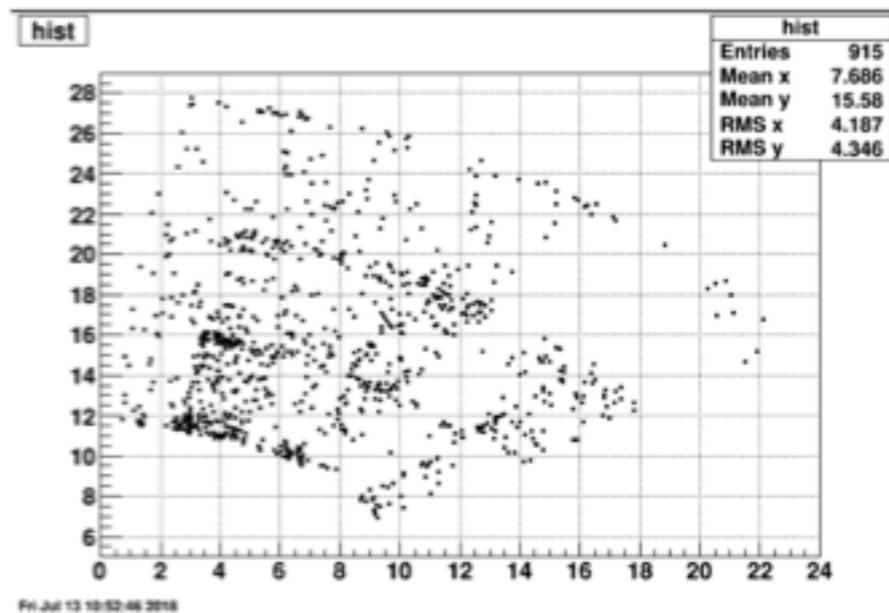
- Two triple-GEM detectors have now been assembled using Tech-Etch components.
- One detector was built using **Kapton** spacer rings. The other detector was built using more traditional **G10 spacer grids**.
- Leakage current of both detectors was measured and found to be satisfactory.
- Commercial prototypes showed **~1.8x higher current** across HV distribution board than the STAR FGT quadrants.
- Commercial prototype **failed** during cosmic ray test— due to **sparking**.
- Cause of sparking is still being investigated.
- New chamber is now being assembled.



# Status: GEM Tracking

## Triple-GEM Detector Prototypes - Assembly

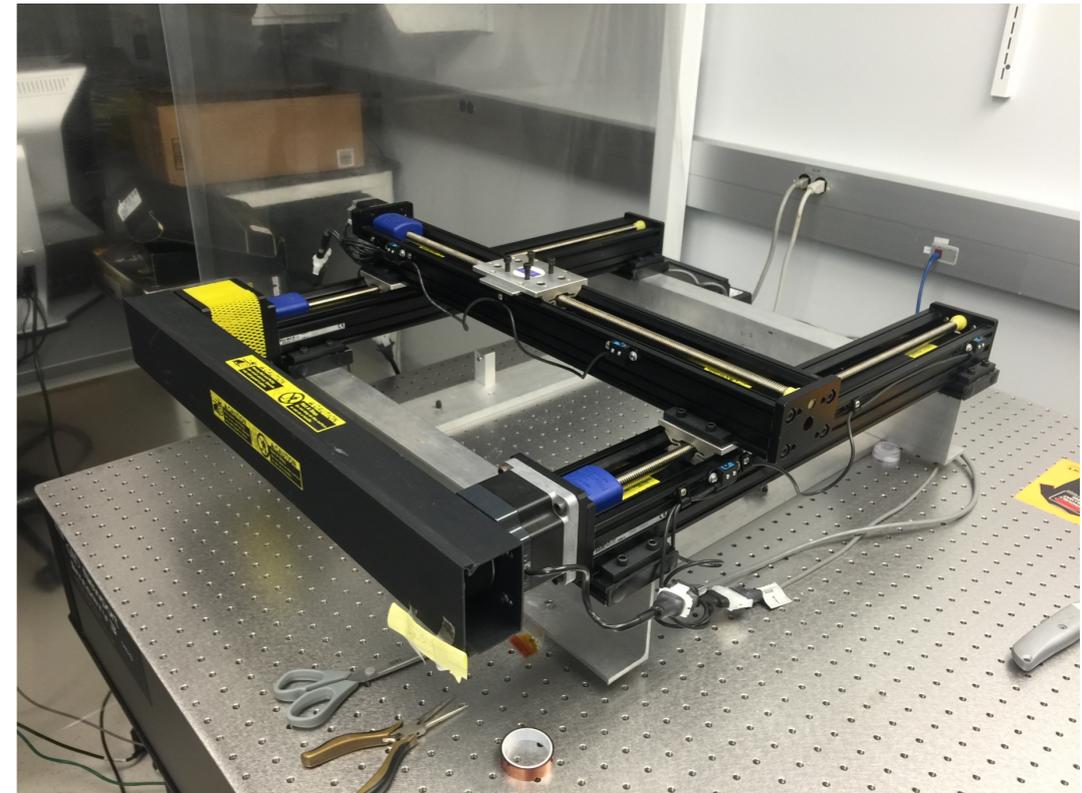
- Two potential graduate students (Santosh Neupane and Biru K.C.) have been working and becoming familiar with the STAR FGT and its DAQ.
- STAR FGT quadrants will be characterized and serve as a reference to the commercial prototypes.
- They have performed leakage current and pedestal measurements and installed the three best quadrants into the cosmic ray stand where cosmic ray data is being taken.
- The electronic mapping of the detector is now being verified/corrected.



# Status: GEM Tracking

## Fe-55 Scanning / X-ray Gun

- Use X-Y gantry with Fe-55 source to measure gains and energy resolution as a function of foil area.
- No shielding needed.
- Current X-Y gantry capable of scanning detectors up to 40 cm x 40 cm.
- X-Y gantry built on 4' x 6' optical table located inside the GEM detector lab cleanroom.

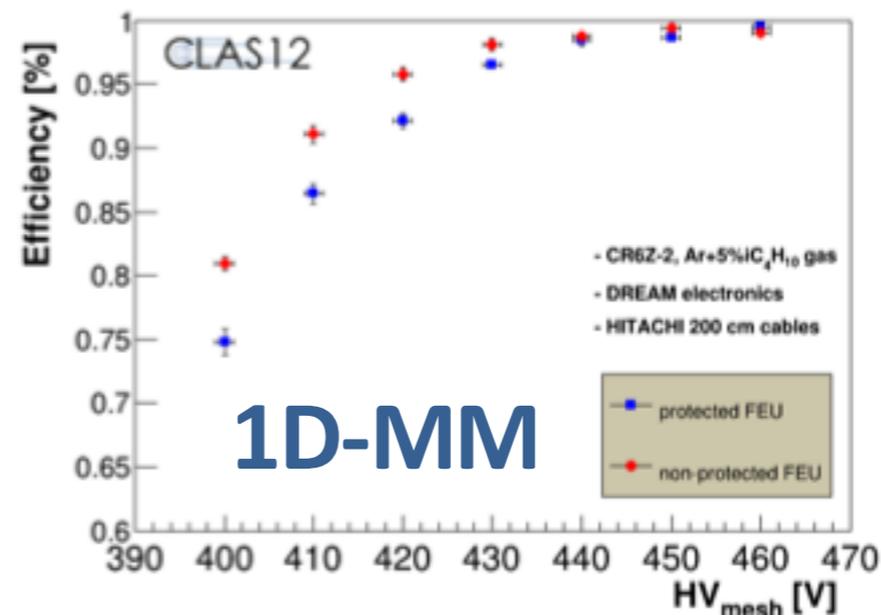
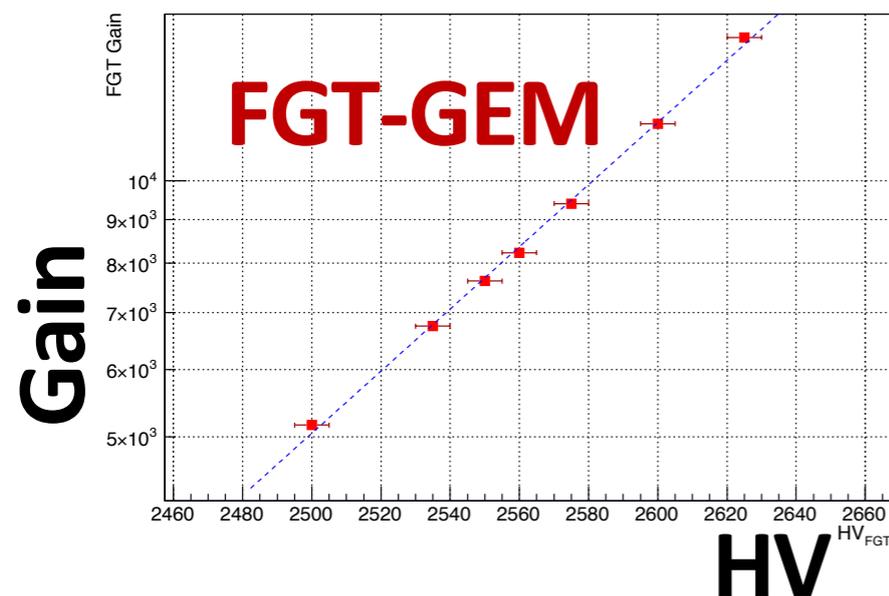
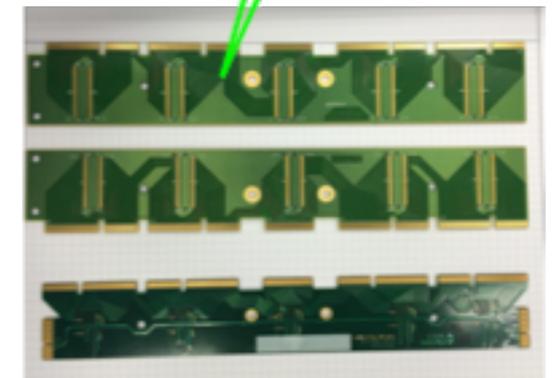


- Mini X-ray gun will be used to provide gain and efficiency measurements.
  - Au target
  - 50 kV / 80  $\mu$ A
- Will have x-ray gun “spray” entire triple-GEM area
- Need radiation enclosure to operate.
- Design Pb-plywood box with interlock system.
- Enclosure should be large ( $\sim$  1.5 m long) enough to accommodate large triple-GEM detectors.

# Status: Barrel MM Tracking

## DREAM chip readout system: MM/GEM

- Further testing of the MM 1D prototype detectors and triple-GEM detectors with the DREAM chip readout.
- Component list for the Dream chip DAQ setup at Temple available, but no funding to proceed.
- Modular DREAM chip development as reported earlier.



# Summary

## Summary

### ➤ Forward GEM tracking

- CCD scanner used outside of generic eRD3 R&D
  - Cr-GEM
  - EIC prototype GEM
  - BONUS
  - Mecaro
- Third triple-GEM prototype being assembled using Kapton spacer rings.
- Starting triple-GEM characteristic via cosmics. X-ray characterization will follow.
- Characterize commercial prototype GEM foils using cosmic rays and X-rays will complete this R&D.
- eRD3 will now fully merge into eRD6 and focus on collaboration with UVa and FIT (see eRD6 Proposal).

### ➤ Barrel MicroMegas tracking

- Successful design and test of 1D MM cylindrical shell.
- DAQ setup for Dream chip designed and tested.
- Began development of modular Dream chip.