

GEM R&D Overview

Matthew Posik
Temple University

May 9, 2015

EIC Tracking R&D Workshop
Temple University, Philadelphia PA

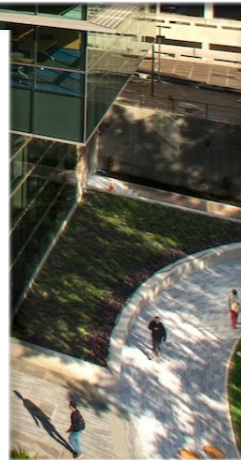
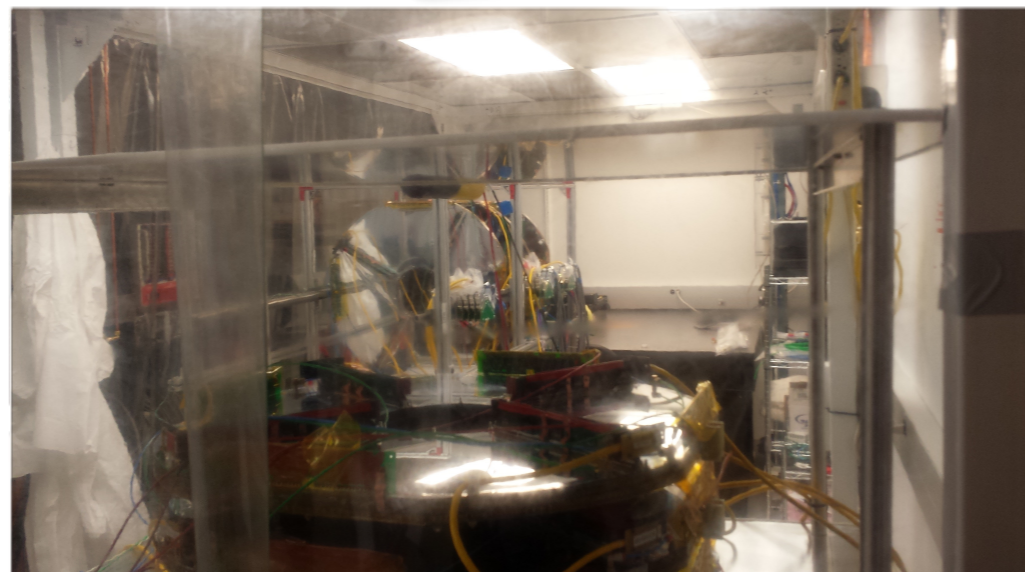
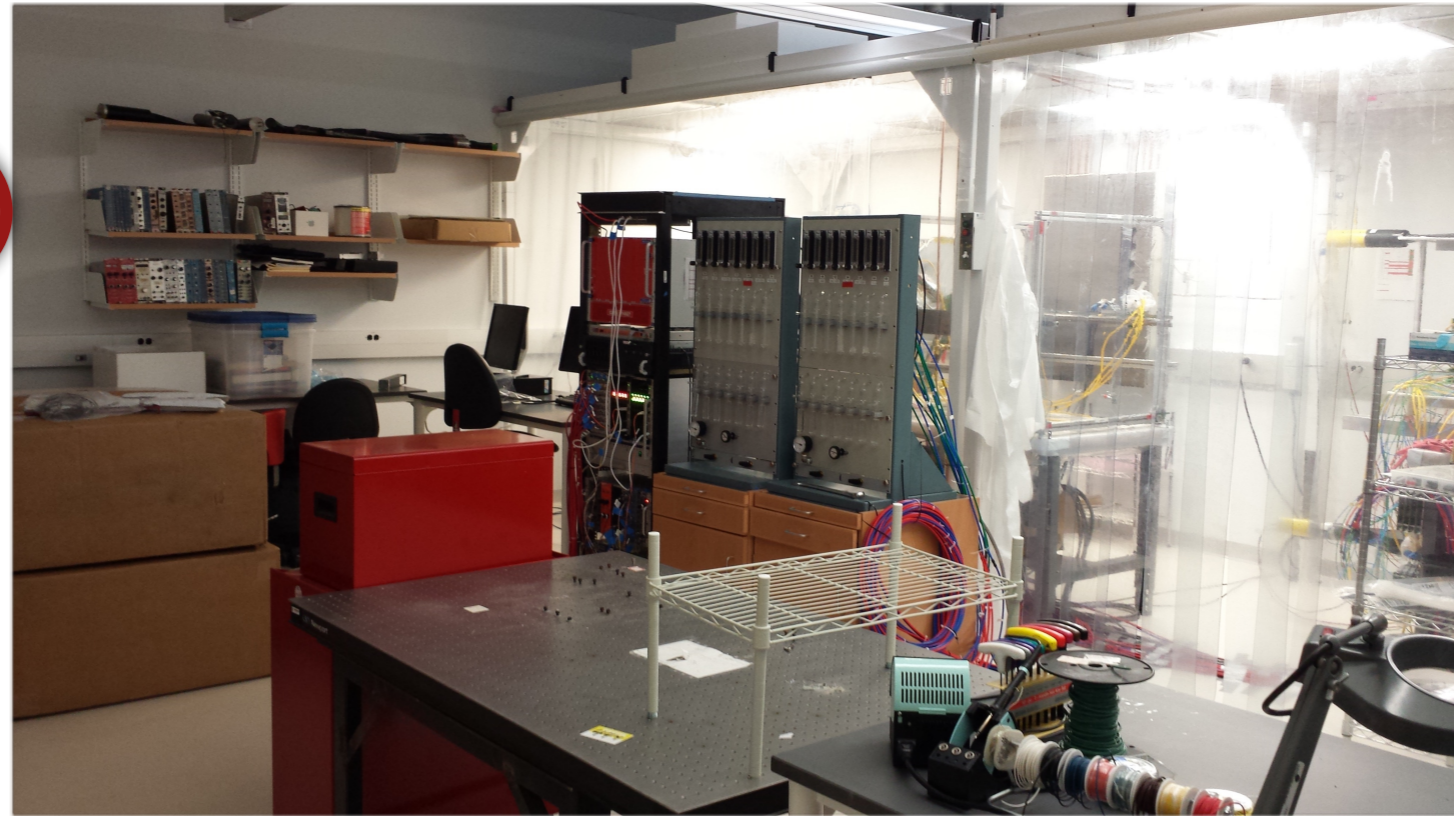
New Temple Facilities

SERC



New Temple Facilities

Detector Lab

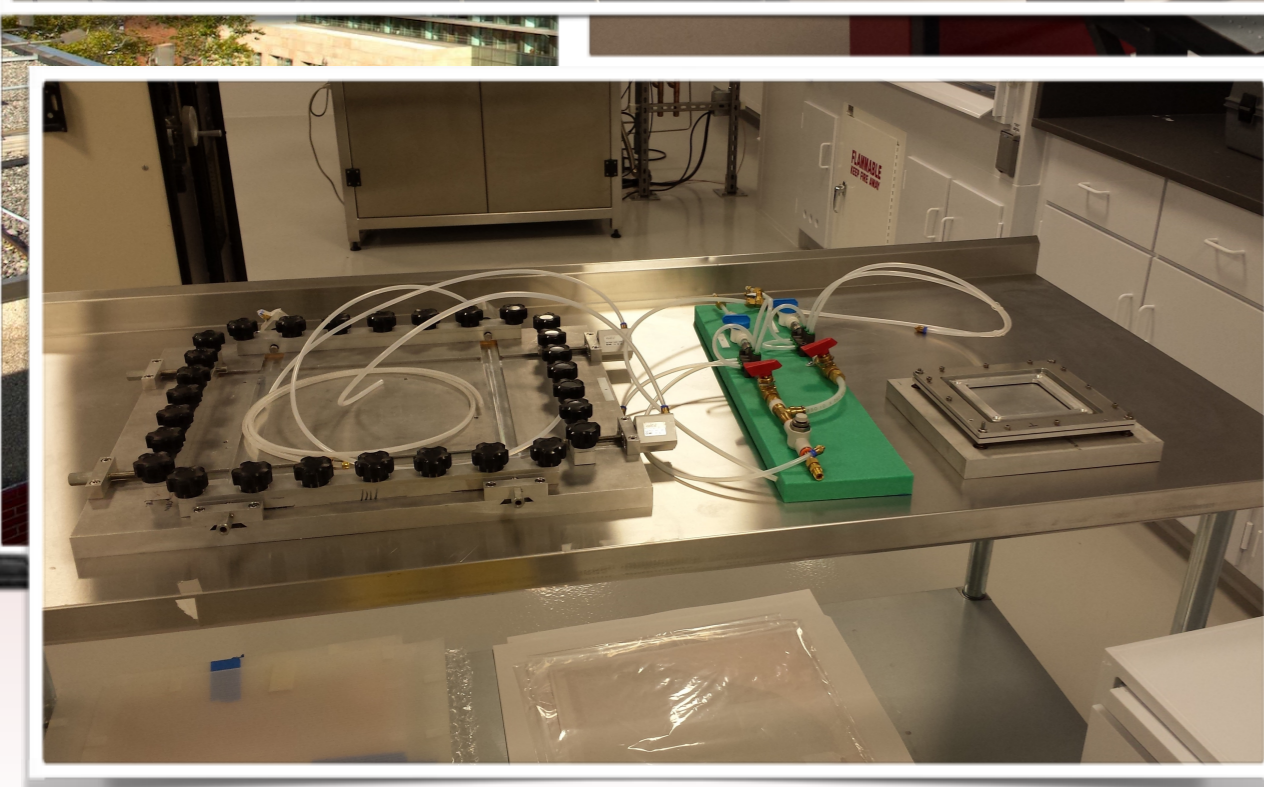


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New Temple Facilities

Dedicated Clean Room



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New Temple Facilities



Lots of change over the past year!

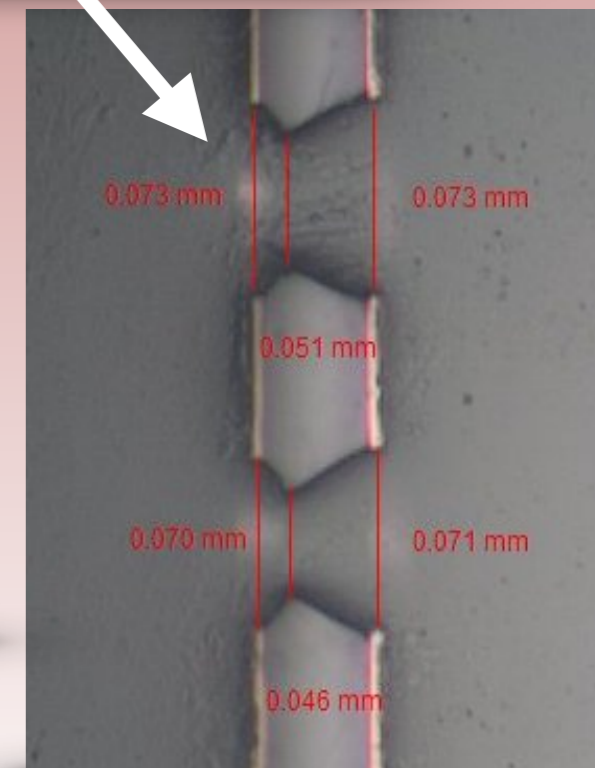
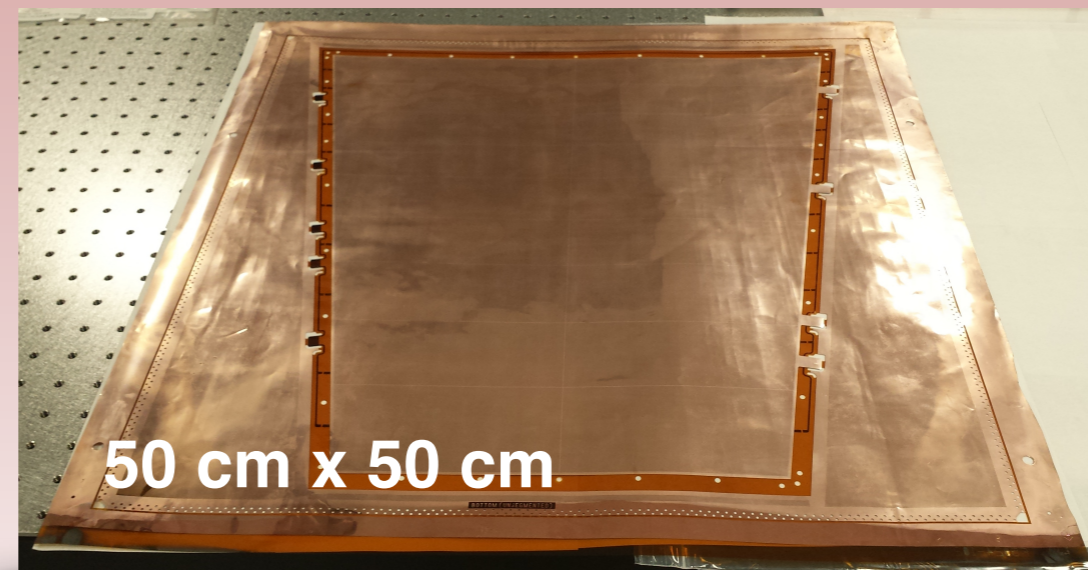
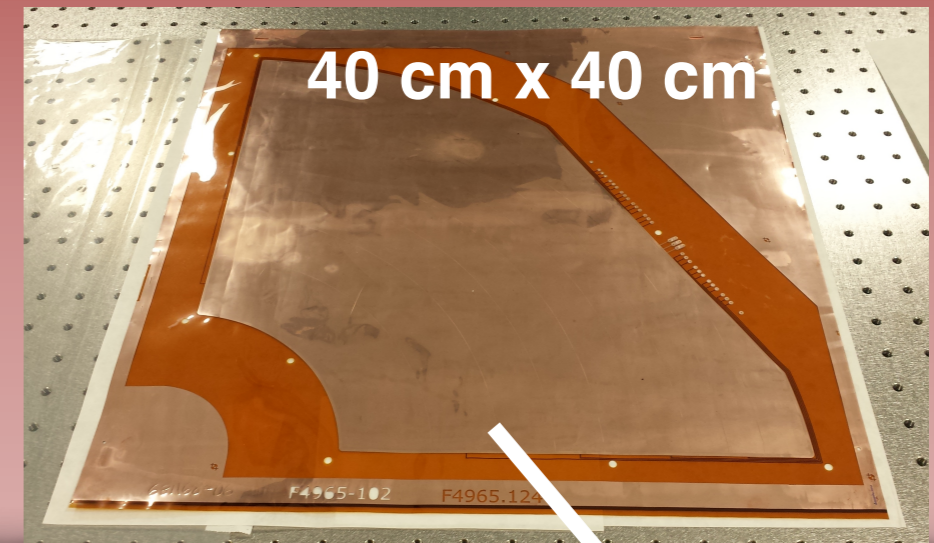
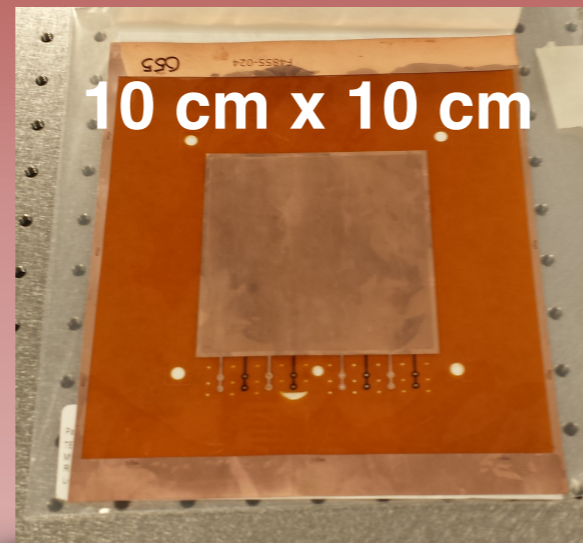


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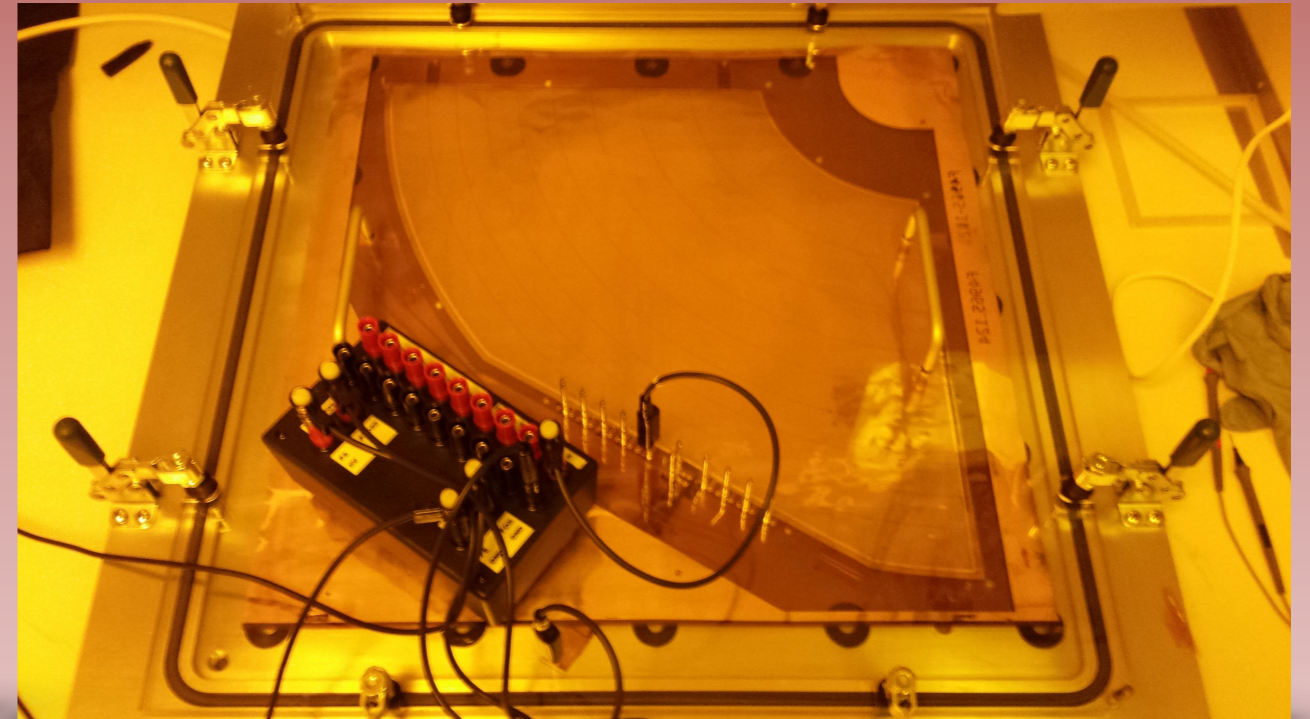
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Ultimate Goal Tech-Etch GEM Foils

- GEM technology is making its way into many new detectors
- Leads to concerns about GEM availability
- **Tech-Etch** will produce commercially available GEM foils
- Produced via single-mask process
- Currently **Tech-Etch** production facilities only able to handle foils up to 50 cm x 50 cm



GEM Electrical Testing

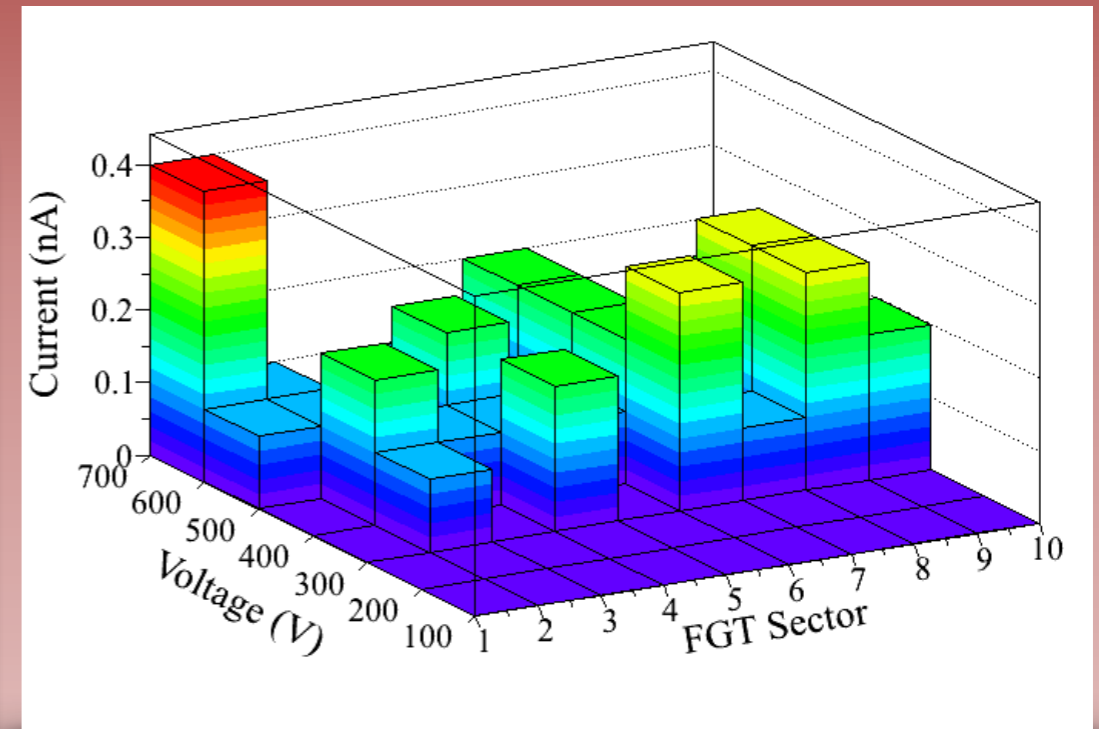


- Electrical tests done in **clean room**
- Test enclosure flushed with **nitrogen**

GEM Electrical Performance

A variety of foils have been tested

1. **Tech-Etch** 10 cm x 10 cm (24 foils)
 2. **Tech-Etch** 40 cm x 40 cm (3 foils)
 3. **CERN** 10 cm x 10 cm (3 foils)
- **All foils** showed **excellent** electrical properties with a **leakage current** \sim **1 nA**
 - These **single-mask** foils used **APICAL** as the polyimide material
 - Previous **Tech-Etch double-mask** foils used **KAPTON** material and had much **larger** leakage current (\sim **10 nA**)



Flush time \sim 1hr

GEM foil current Leakage
F4855-*

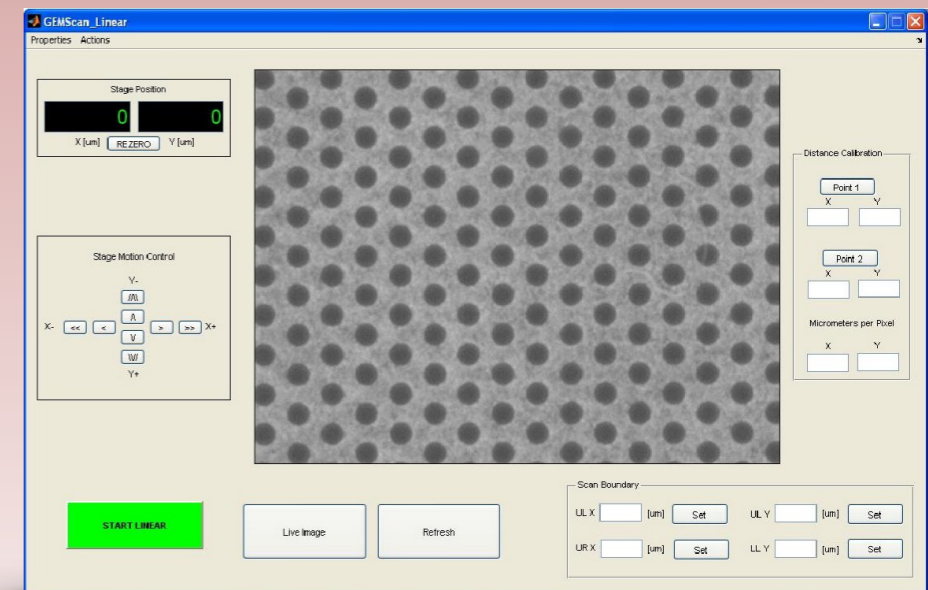
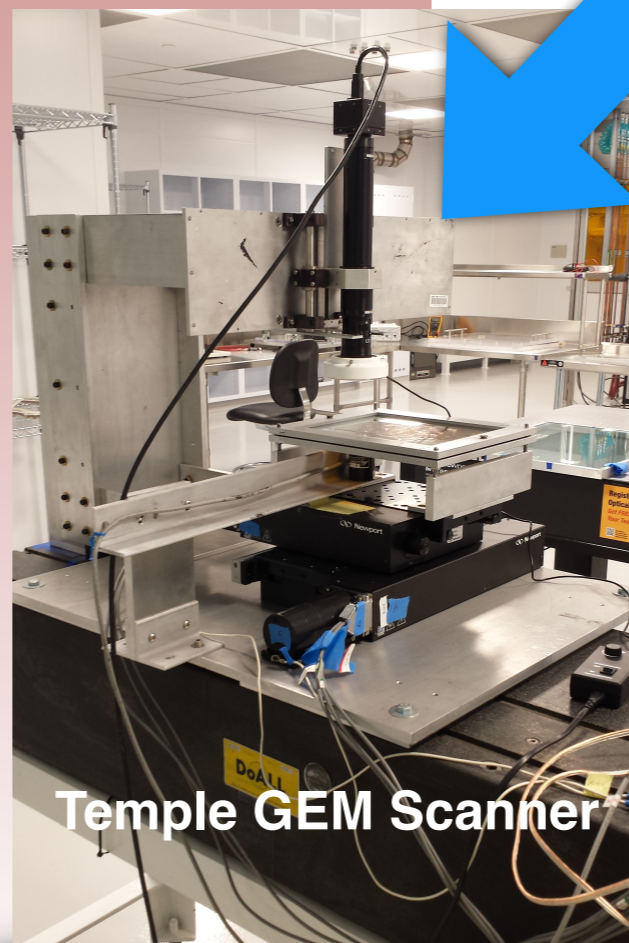
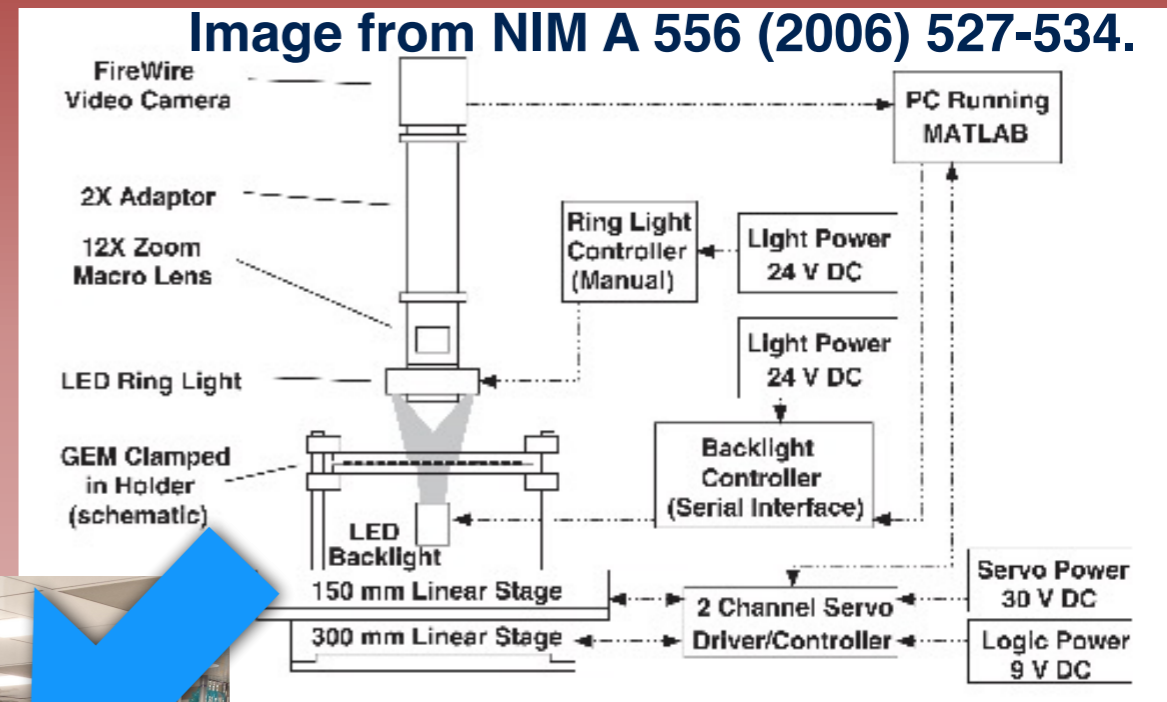
Foil #	100	200	300	400	500	600
7	< 1nA	< 1nA	< 1nA	< 1nA	< 1nA	< 1nA
3	< 1nA	< 1nA	< 1nA	< 1nA	< 1nA	< 1nA
4	< 1nA	< 1nA	< 1nA	< 1nA	< 1nA	Trip
5	< 1nA	< 1nA	< 1nA	< 1nA	< 1nA	< 1nA
8	< 1nA	< 1nA	< 1nA	< 1nA	< 1nA	Trip
1	\sim 16nA	\sim 87nA	\sim 275nA	-	-	-
1	\sim 2nA	\sim 14nA	\sim 47nA	> 100nA	-	-

leak after * look at

Tripped after \sim 30 sec

GEM Optical Analysis

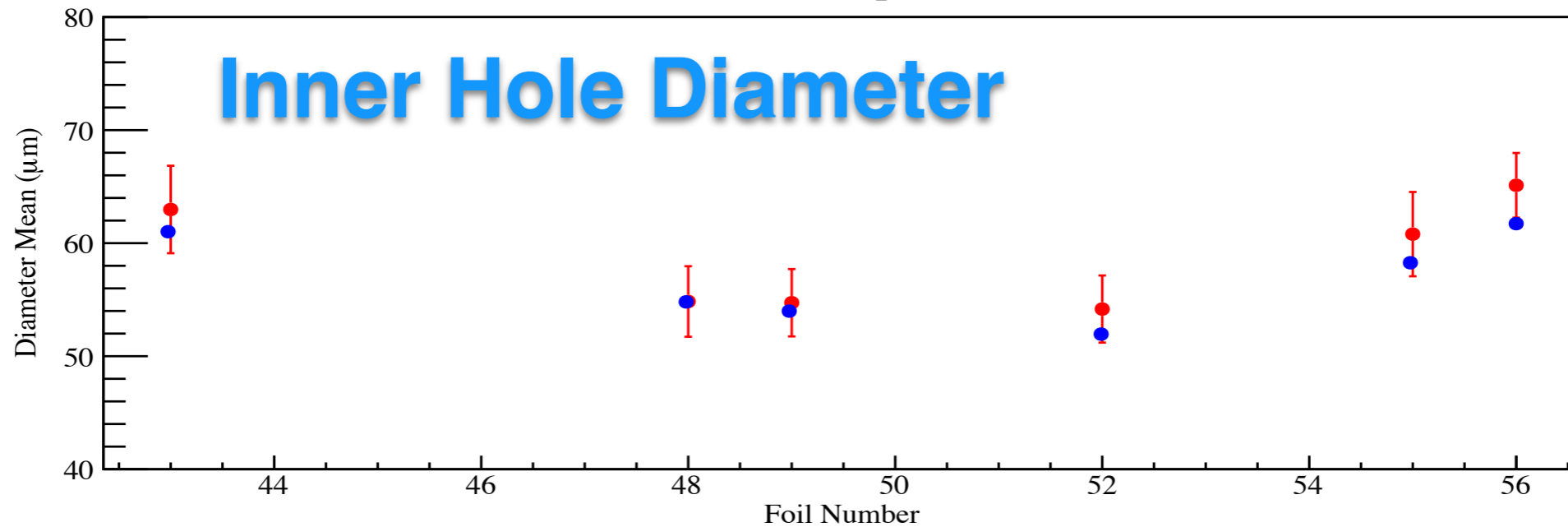
- **Automated** 2D scanner
- X/Y stage traverse **30 cm/ 15 cm**
- High res **CCD camera** with 12x magnification
- **Lighting selection** allows for sensitivity to **inner** or **outer holes**
- Image analysis is handled in **MATLAB**



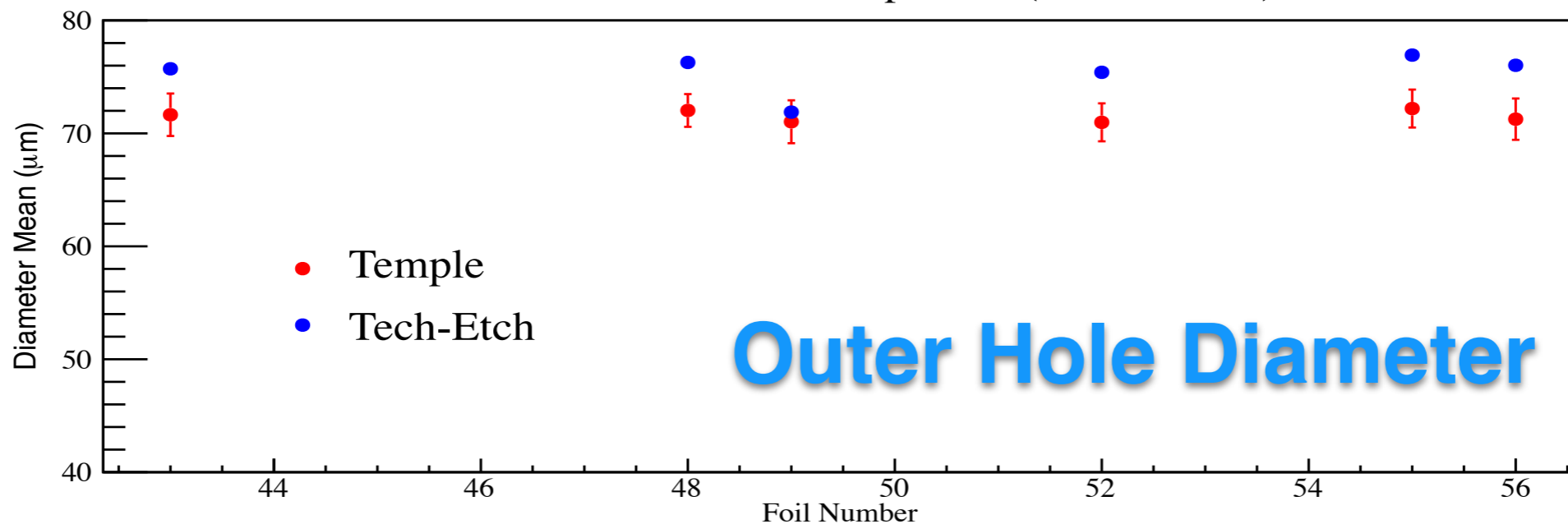
MATLAB GUI

GEM Optical Analysis Measurement Comparisons

Inner Hole Diameter Comparison (Lot# 626524)



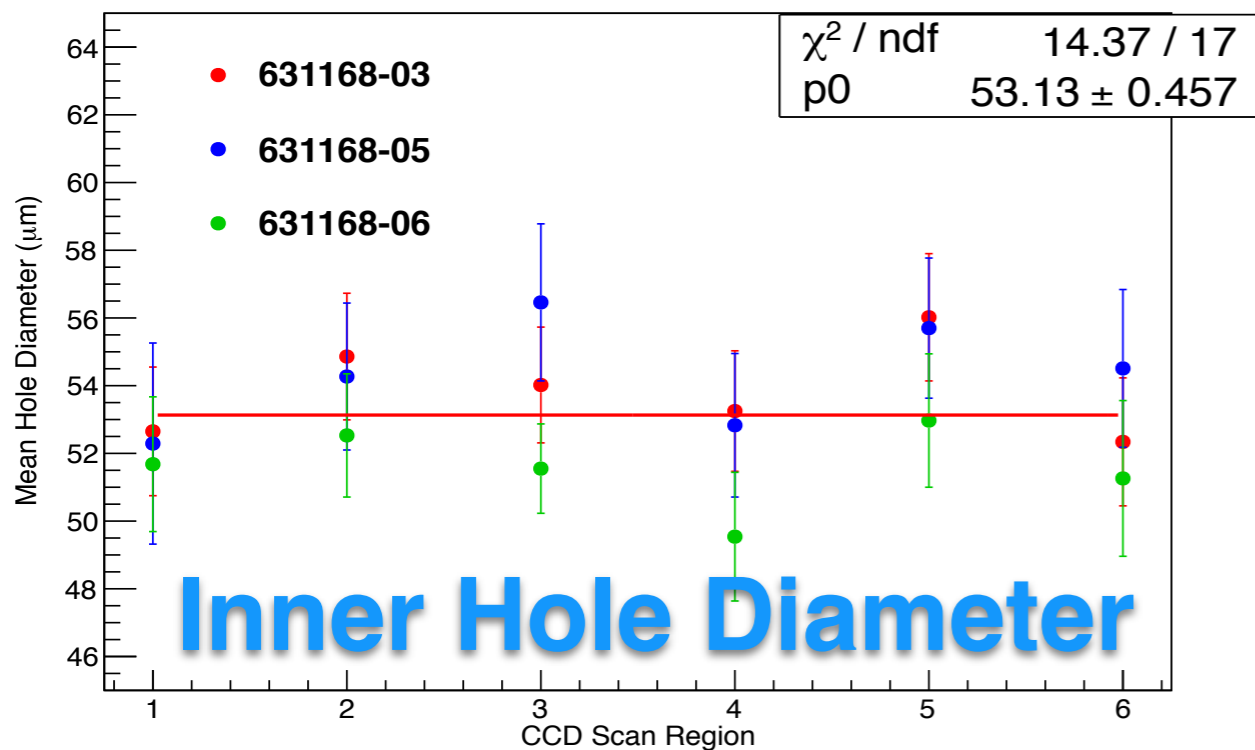
Outer Hole Diameter Comparison (Lot# 626524)



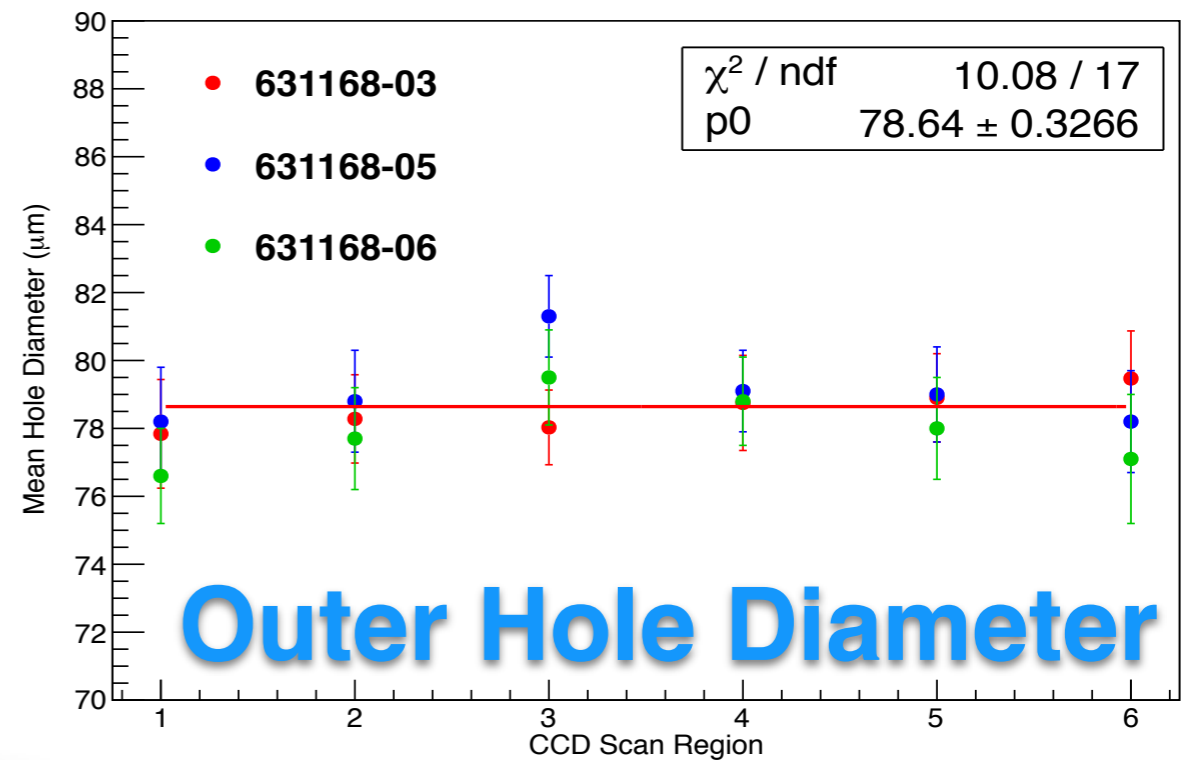
10 cm x 10 cm Foils

GEM Optical Analysis Measurement Comparisons

Foil Lot #631168 (Inner Holes)



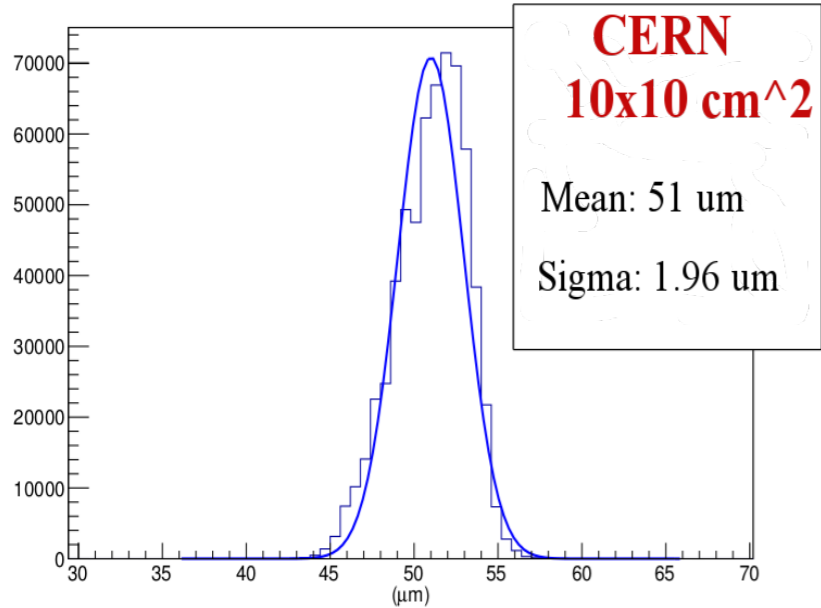
Foil Lot #631168 (Outer Holes)



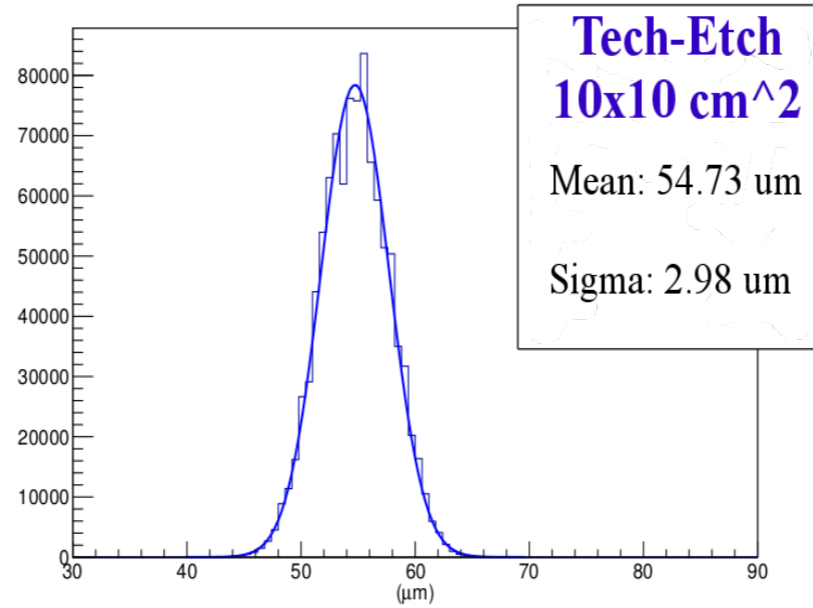
40 cm x 40 cm Foils

GEM Optical Analysis CERN Foil Comparisons

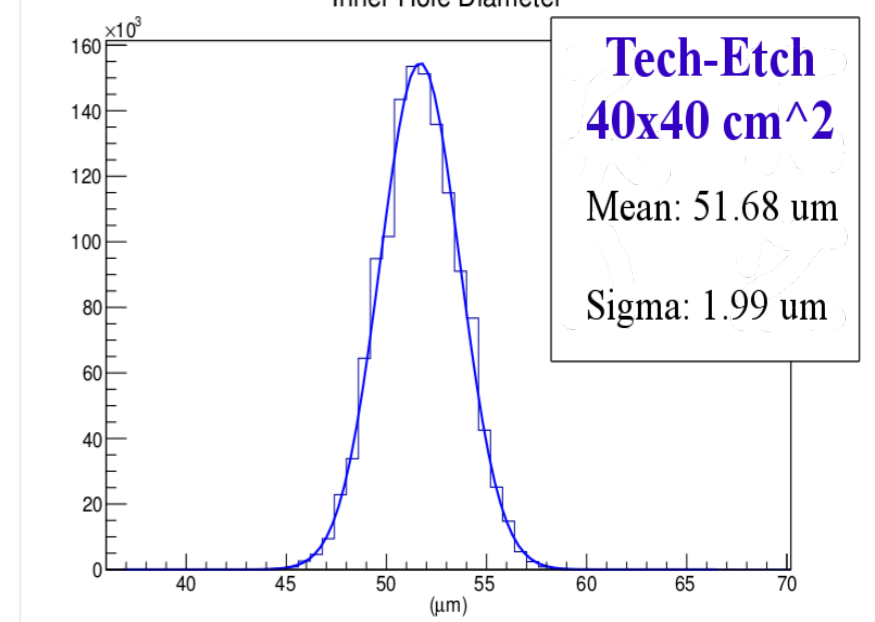
Inner Hole Diameter



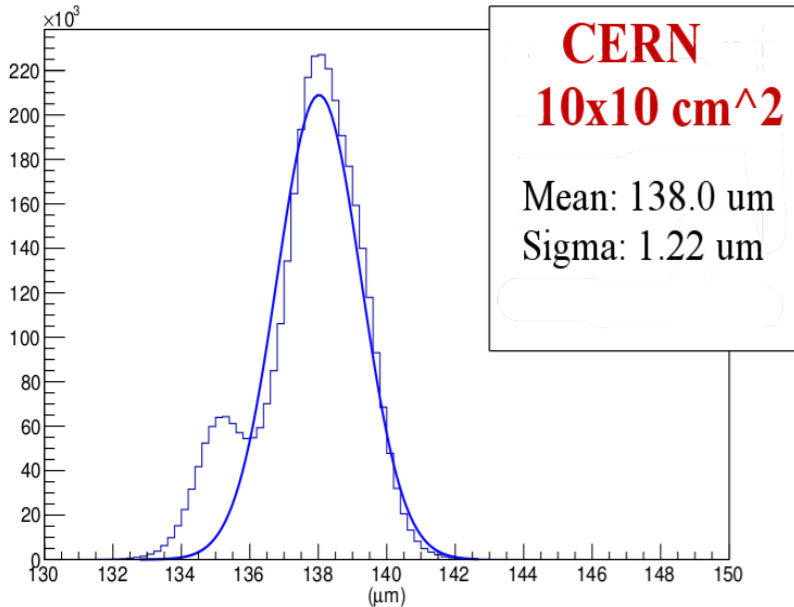
Inner Hole Diameter



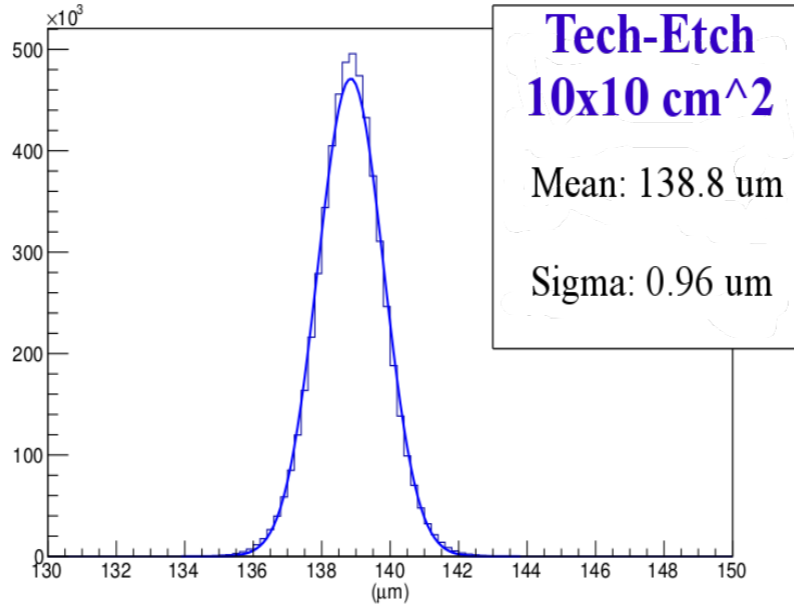
Inner Hole Diameter



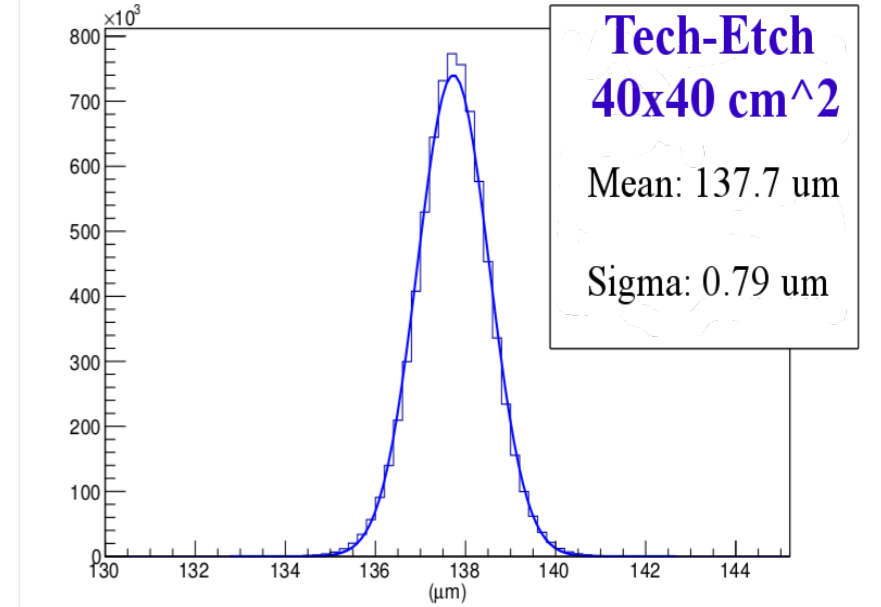
Inner Hole Pitch



Pitch



Inner Hole Pitch



Future GEM R&D

- **Tech-Etch** is finalizing their **50 cm x 50 cm** GEM foil production process
- **Final 50 cm x 50 cm** foils **expected soon**
- **Actively** looking into **upgrading** their production facilities to handle GEM foils on the order of **1 meter long** (given the go-ahead to allocate floor space!)
- This upgrade will be **critical** to a **US commercialized** GEM foil facility for an **EIC**
- **Temple** is now actively working on **redesigning** GEM scanner to **accommodate larger foils**