Status Report (FY15) and Proposal (FY16)

Fast and lightweight

EIC integrated tracking system

Barrel MicroMegas

&

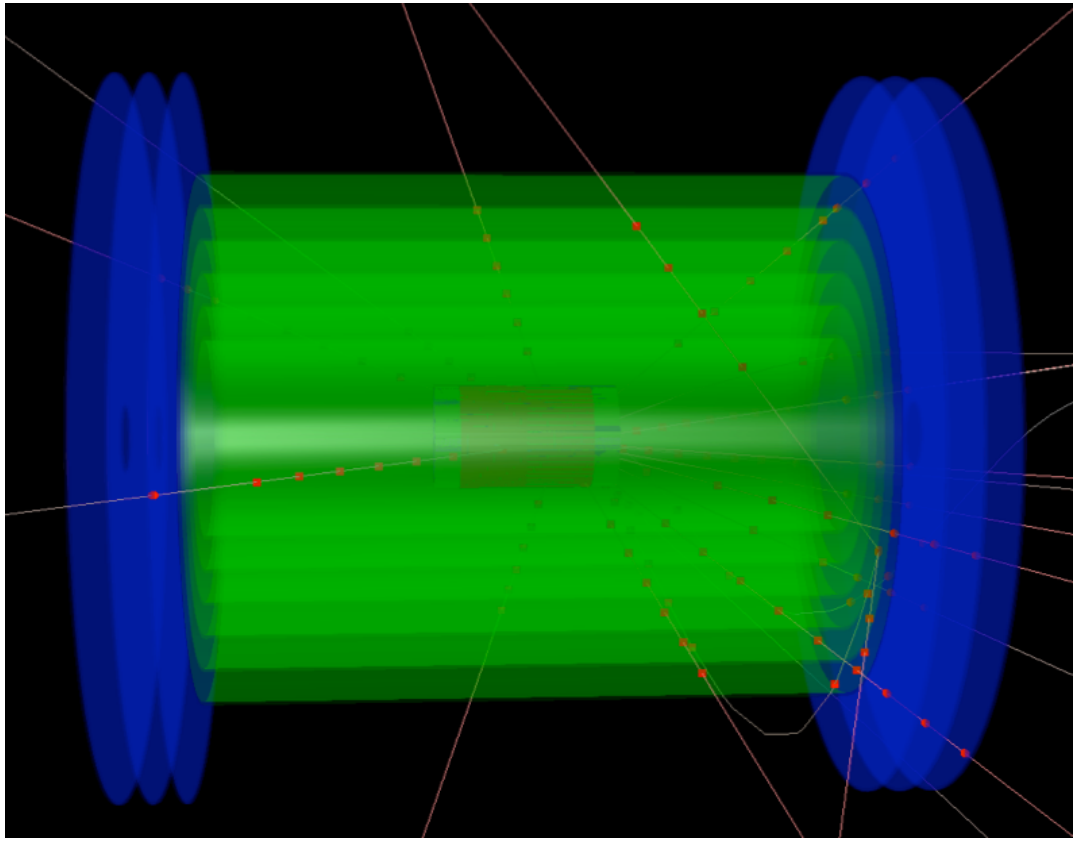
Forward Triple-GEM

Franck Sabatie (PI),
Maxence Vandenbroucke

Matt Posik,
Bernd Surrow (PI)

Outline

- Introduction
- R&D program: Status
  - (1) Forward GEM tracking
  - (2) Barrel MicroMegas tracking
- R&D program: Proposal
  - (1) Forward GEM tracking
  - (2) Barrel MicroMegas tracking
- Summary



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

Introduction

Overview of eRD3 effort

- R&D effort focuses on intermediate tracking system:
  - Barrel tracking system based on MicroMegas detectors (Dedicated barrel / curved MM EIC R&D program) manufactured as cylindrical shell elements and
  - Rear / Forward tracking system based on triple-GEM detectors manufactured as planar segments (Collaboration with eRD6 FIT/UVA)
- R&D effort - Main strategy:
  - Design and assembly of large cylindrical MicroMegas detector elements and large planar triple-GEM detectors
  - Test and characterization of MicroMegas and triple-GEM prototype detectors
  - Design and test of new, common chip readout system employing CLAS12 'DREAM' chip development, ideally suited for micro-pattern detectors
  - Utilization of light-weight materials
  - Development and commercial fabrication of various critical detector elements
  - European/US collaborative effort on EIC detector development (CEA Saclay, and Temple University)

Project ID: eRD3

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

Period Reported: October 01, 2014 - September 30, 2015 (Status) / October 01, 2015 - September 30, 2015 (Proposal)

Project Leaders:
Professor Bernd Surrow (Temple University) / Dr. Franck Sabatie (Saclay)

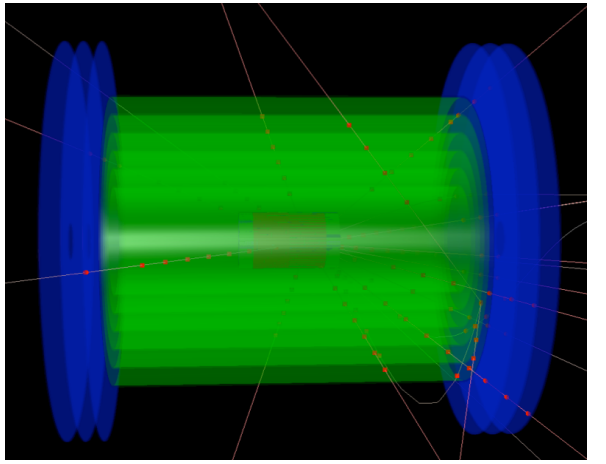
Date: June 15, 2015

Applicant Address: Temple Univesity
Department of Physics, SERC
1925 North 12th Street
Philadelphia, PA, 19122

Contact Person: Professor Bernd Surrow

Email: surrow@temple.edu

Phone: 215-204-7644



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

Introduction

Highlights of triple-GEM R&D program (1)

- Relocation and setup of old labs at Temple University to the new Science Education and Research Center
- Temple University hosted the first EIC Tracking R&D Workshop
- Extensive characterization of single-mask GEM foils
- Submission of paper on single-mask GEM characterization to NIM
- Submitted abstract to 2015 IEEE
- Completion of all testing and tooling stations
- Established reliable commercial source for single-mask produced GEM foils now up to 50 X 50 cm^2
- Completion of common large GEM foil design in collaboration with FIT / UVa (eRD6)

Single-Mask GEM foil (40cm X 40cm) Single-Mask GEM foil (50cm X 50cm)

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

Introduction

Highlights of triple-GEM R&D program (2)

- Paper submitted to NIM
- First EIC tracking R&D workshop hosted at Temple University sponsored by TU CST

arXiv:1506.03652v2 [physics.ins-det] 12 Jun 2015

Research and Development of Commercially Manufactured Large GEM Foils

M. Posik[a,*], B. Surrow[a,*]

[a] Temple University, Philadelphia, Pennsylvania 19122, USA

Abstract

With future experiments proposing detectors that utilize very large-area GEM foils, there is a need for commercially available GEM foils. Double-mask etching techniques pose a clear limitation in the maximum size of GEM foils. In contrast, single-mask techniques developed at CERN would allow one to overcome those limitations. However with interest in GEM foils increasing and CERN being the only main distributor, keeping up with the demand for GEM foils will be difficult. Thus the commercialization of GEMs has been established by Tech-Etch of Plymouth, MA, USA using single-mask techniques.

We report on the electrical and geometrical properties, along with the inner and outer hole diameter size uniformity of 10 × 10 cm^2 and 40×40 cm^2 GEM foils. The Tech-Etch foils were found to have excellent electrical properties. The measured mean optical properties were found to reflect the desired parameters and are consistent with those measured in double-mask GEM foils, and show good hole diameter uniformity over the active area. These foils are well suited for future applications in nuclear and particle physics where tracking devices are needed.

Keywords: GEM, EIC, single-mask, tracking, micro-pattern gas detectors,

1. Introduction

With the invention of the gas electron multiplier (GEM) in 1997 [1], GEM technology has attracted a lot interest from the nuclear and particle physics community, as they are excellent candidates to be used in tracking detectors. GEMs have several attractive features, they function well in high rate environments (better than 10^5 Hz/mm^2 [2]), have superb spatial resolution (40 μm rms [2]), and can cover a large acceptance. Many experiments such as STAR [3], COMPASS [2], and others have already successfully incorporated GEM technology into their tracking detectors.

As GEM technology matures, more and more future experiments and their upgrades, including ALICE [4], Jefferson Lab's Super Bigbite Spectrometer [5], CMS [6], and a potential EIC [7] are looking to build tracking detectors which take advantage of GEM technology. Future GEM detectors will require large area GEM foils to obtain an adequate acceptance. However, currently there are two main constraints preventing the use of large area GEM foils. The first is the limitation associated with the raw material. Standard raw material rolls, consisting of a polyimide layer sandwiched by two copper layers, have a width of about 50 cm, restricting the maximum width of the GEM foil. Recently this issue has been addressed through the investigation of a splicing technique [8] that is used to splice two GEM foils together, resulting in a wider GEM foil. The second limitation facing large area GEM foils is due to the fabrication process by which micro patterns are etched into the copper clad polyimide material, which involves the precise alignment of two masks (described in section 2.2). Obtaining an accurate alignment of two masks becomes increasingly difficult as the GEM foil area increases, which results in limiting the area of the GEM foil. The fabrication limitation of this *double-mask* etching technique has now been overcome by employing a *single-mask* etching technique, which was developed

*Corresponding authors
Email addresses: posik@temple.edu (M. Posik), surrow@temple.edu (B. Surrow)

Preprint submitted to Nucl. Instr. Meth. *June 15, 2015*

EIC Tracking R&D Workshop
(GEM / MicroMegas / TPC)

Temple University
Science Education and Research Center

May 09, 2015

https://https://phys.cst.temple.edu/~surrow/EIC-RD-WORKSHOP/index.html

Program committee:

Klaus Dehmelt (Stony Brook University)
Tom Hemmick (Stony Brook University)
Bernd Surrow (Temple University)
Craig Woody (BNL)

Conference Hotel: DoubleTree Hotel, Center City, Philadelphia
Venue: Science Education and Research Center, Temple University

May 09, 2015: EIC Tracking R&D Workshop (Lecture Hall 116) /
Tour of Micro-pattern Laboratory (447 / 565)

(Detector simulation displays showing backward ( ) / forward ( ) planar triple-GEM detectors together with central TPC (TPC) or MicroMegas (MMT) detectors)

Local organizing committee at Temple University:

Jeff Martoff, Zein-Eddine Meziani,
Jim Napolitano, Nikos Spaveris, Bernd Surrow (Chair)

Sponsors:

College of Science and Technology
TEMPLE UNIVERSITY

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

Introduction

- Highlights of triple-GEM R&D program (3)
  - Agenda:

    https://indico.bnl.gov/conferenceDisplay.py?confId=1104&view=standard

  - Presentations on NSAC process, simulations, TPC R&D, MM R&D, GEM R&D incl. Tech-Etch presentation
  - Tour of lab infrastructure at Temple University, Science Education and Research Center
  - Discussion on intensifying collaboration, in particular the forward GEM R&D program

Saturday, May 9, 2015

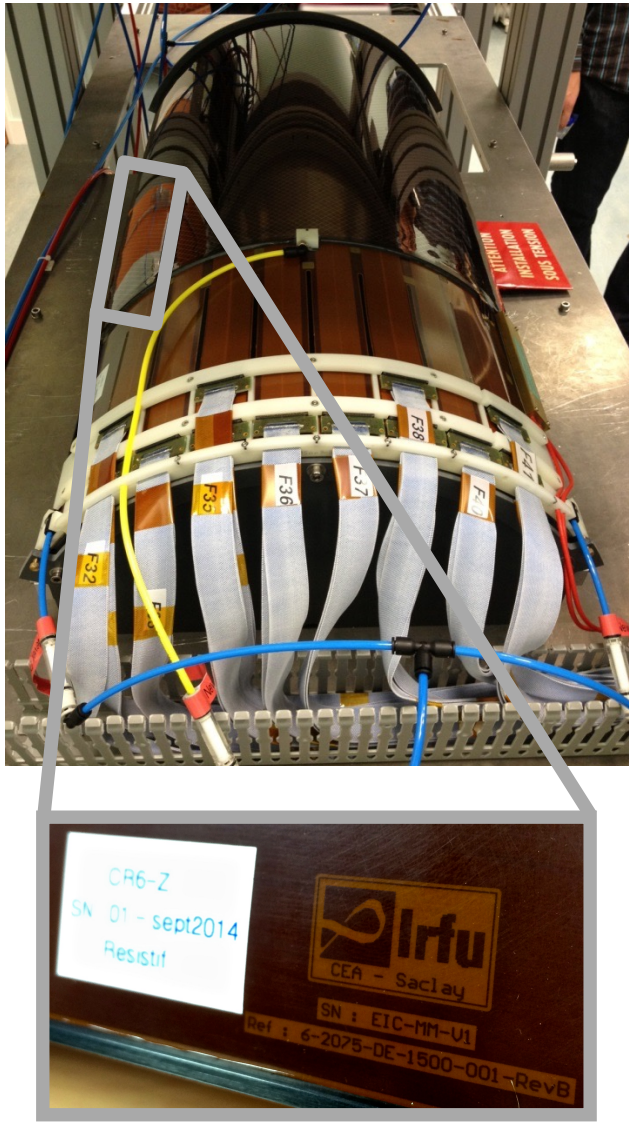
09:00 - 09:10	Welcome / Goals *10'* (116) Speaker: Prof. Bernd Surrow (Temple University) Material: Slides
09:10 - 09:40	NSAC Long Range Plan: One Insider's View *30'* (116) Speaker: Prof. Abhay Deshpande (Stony Brook University)
09:40 - 10:10	Requirements on EIC detector focusing on tracking system *30'* (116) Speaker: Dr. Alexander Kiselev (BNL) Material: Slides
10:10 - 10:40	Discussion / Tracking System Requirements (116)
10:40 - 10:55	BNL: Overview of TPC / Cherenkov R&D work and plans *15'* (SERC (116)) Speaker: Dr. Craig Woody (BNL) Material: Slides
10:55 - 11:15	ALICE: Overview of TPC R&D work and plans *20'* (116) Speaker: Dr. Nikolai Smirnov (Yale University) Material: Slides
11:15 - 11:25	Coffee Break (116)
11:25 - 11:45	sPHENIX: Overview of TPC R&D work and plans *20'* (116) Speaker: Dr. Ron Soltz (LLNL) Material: Slides
11:45 - 12:15	Discussion / TPC R&D (116)
12:15 - 12:35	Saclay: Overview of MicroMegas R&D work and plans *20'* (116) Speaker: Dr. Maxence Vandenbroucke (Saclay) Material: Slides
12:35 - 13:35	Lunch (Temple University)
13:35 - 13:45	TU: GEM R&D work *10'* (116) Speaker: Dr. Matt Posik (Temple University) Material: Slides
13:45 - 13:55	FIT: GEM R&D work *10'* (116) Speaker: Dr. Aiwu Zhang (FIT) Material: Slides
13:55 - 14:05	UVA: GEM R&D work *10'* (116) Speaker: Dr. Kondo Gnanvo (University of Virginia) Material: Slides
14:05 - 14:15	BNL: Results from the Minidrift GEM detector *10'* (116) Speaker: Mr. Bob Azmoun (BNL) Material: Slides
14:15 - 14:25	BNL: Timing issues with the SRS Readout System *10'* (116) Speaker: Mr. Mike Phipps (BNL) Material: Slides
14:25 - 14:35	Tech-Etch Capabilities and Plans *10'* (Temple University (116)) Speaker: Mr. Kerry Kearney (Tech-Etch Inc.) Material: Slides
14:35 - 14:50	Coffee Break (116)
14:50 - 15:20	Discussion / GEM R&D (116)
15:20 - 15:50	Tour of TU detector lab and clean room facility *30'* (116) Speaker: Prof. Bernd Surrow (Temple University)
15:50 - 16:00	Stony Brook: Overview of Forward RICH R&D work and plans *10'* (116) Speaker: Prof. Tom Hemmick (Stony Brook University) Material: Slides
16:00 - 18:00	Discussion / EIC tracking R&D work / Upcoming advisory committee meeting / consortium - collaboration (116)
18:00 - 21:00	Dinner (China Town / Center City)

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

Introduction

Highlights of MicroMegas R&D program

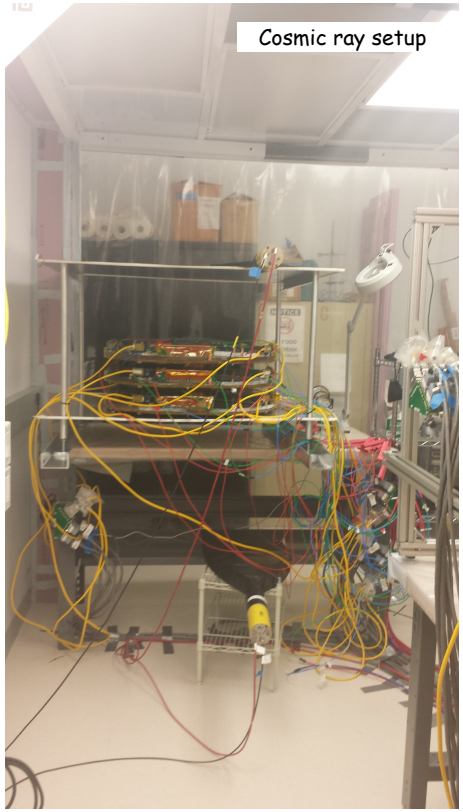
- Managed using internal Saclay support to continue with MicroMegas R&D program at some level for the prototype part
- Design and assembly of barrel MicroMegas large radius 1D (Z) MM detectors (2 prototypes) with resistive readout
- Design and assembly of MicroMegas large radius 1D (Phi) MM detector with resistive readout
- Characterization of MicroMegas detectors in cosmic-ray test stand
- Test of DREAM-chip based DAQ system
- Development of DREAM-chip based triple-GEM readout system

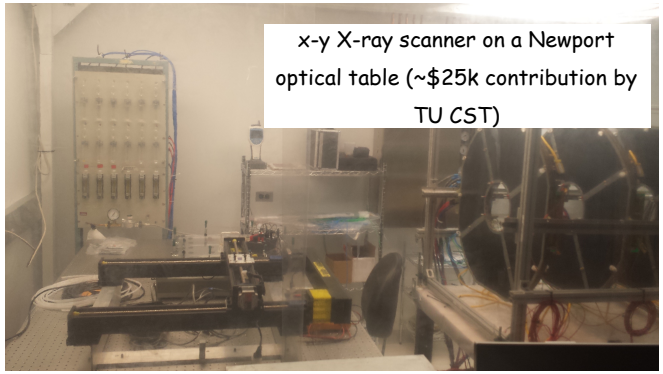


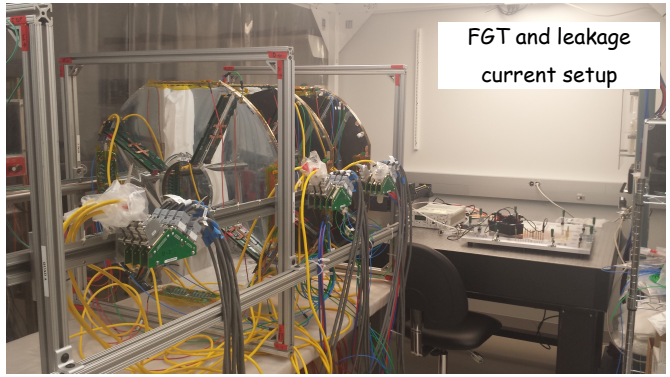
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

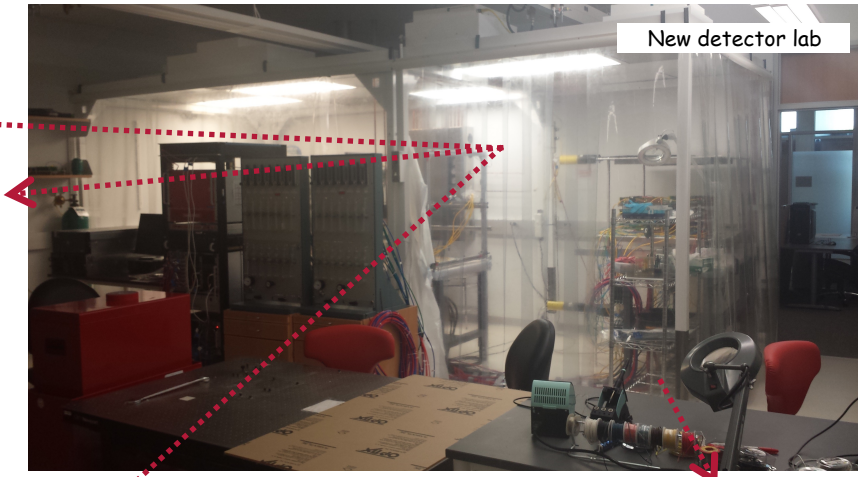
Status - Forward GEM Tracking

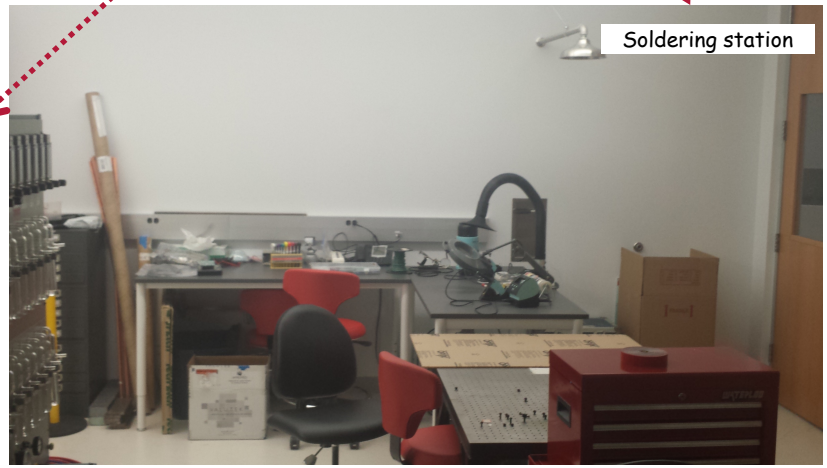
- New Detector Laboratory facility (SERC 447) at Temple University







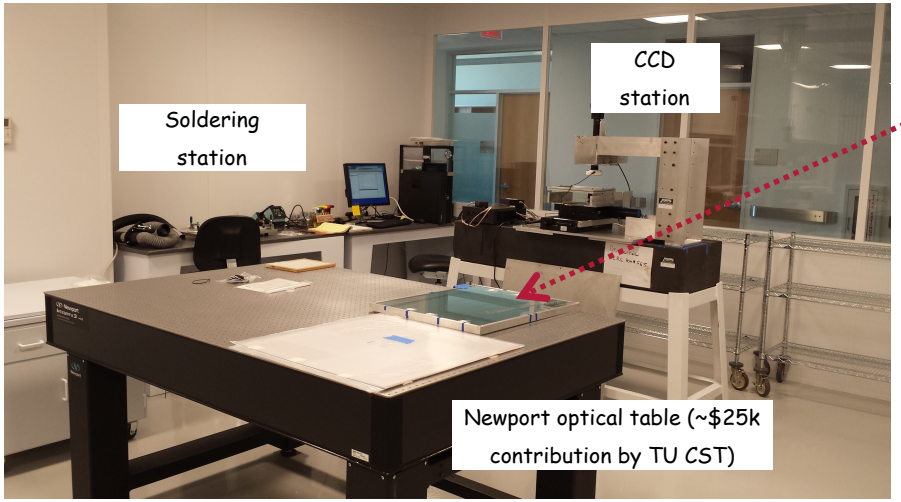


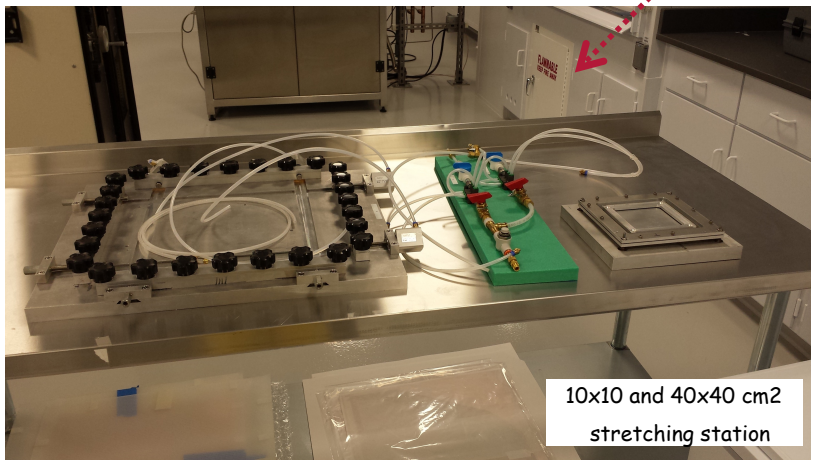


Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Forward GEM Tracking

- New Clean Room facility (SERC 556) at Temple University

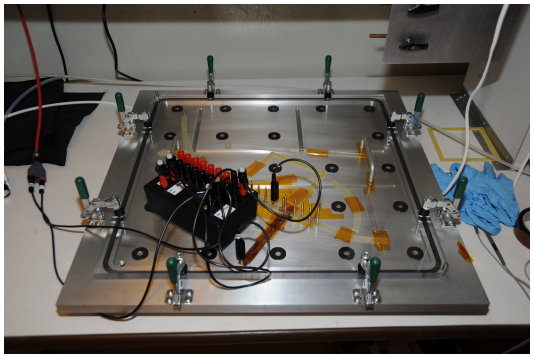


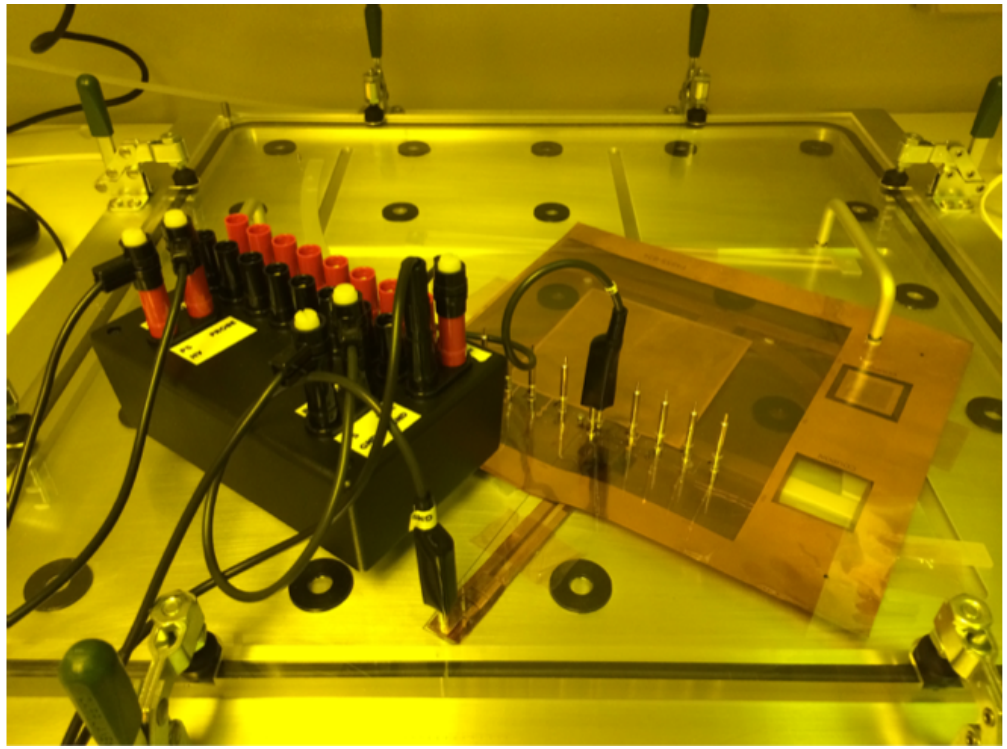


Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Forward GEM Tracking

- Single mask GEM Foil: Electrical tests at Temple University / Leakage current (1)
  - Setup of leakage current measurement at Temple University





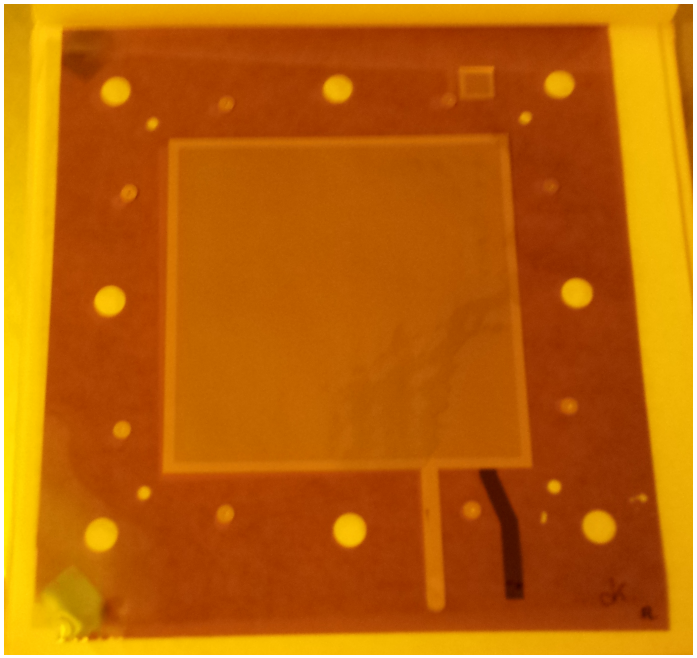
- Setup including nitrogen box with HV connections
- Power supply and nA current measurement

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

Status - Forward GEM Tracking

Single mask GEM Foil: Electrical tests at Temple University / Leakage current (2)

- Setup of leakage current measurement at Temple University
- All Tech-Etch GEM foil leakage currents have been measured consisting of:
  - 3 manufacturing lots of 10 x 10 cm^2 consisting of 6/12/6 foils
  - 3 40 x 40 cm^2 foils
- All foils were found to display consistent leakage currents with typical values < 1 nA
- Tech-Etch found same results when measuring the leakage current prior to shipping



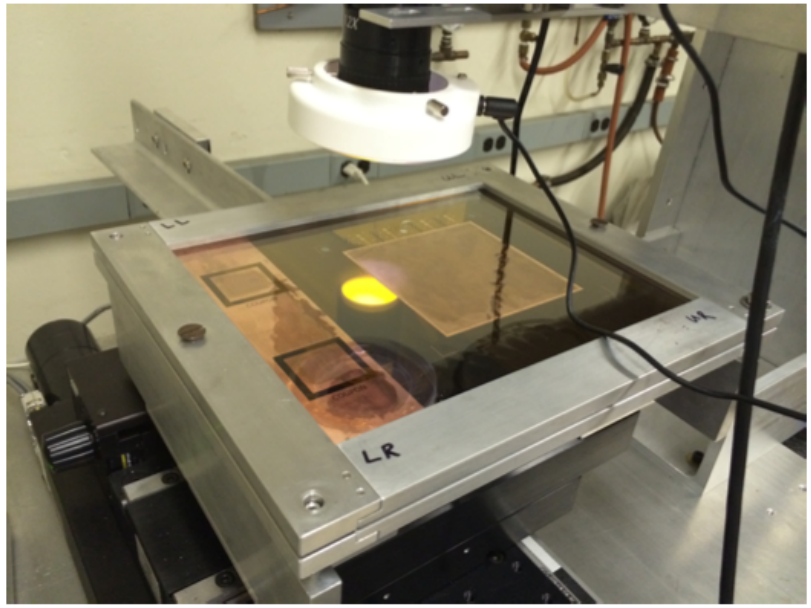
CERN 10 X 10 cm^2 single mask GEM foil

- Critical step for achieving low leakage current was changing polymide material from Kapton to Apical
- Leakage currents from 3 10 x 10 cm^2 single mask GEM foils produced by CERN have also been measured
- CERN foils use same polymide material (Apical) as Tech-Etch
- CERN foils were also found to have typical leakage current < 1 nA

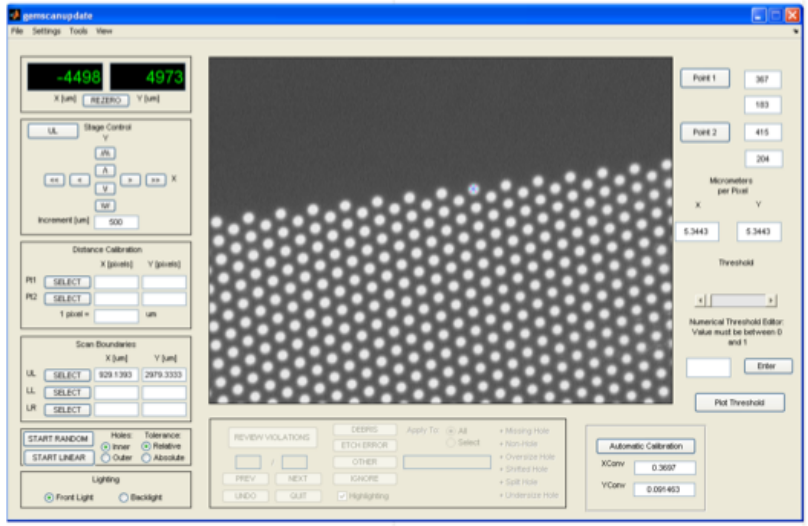
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Forward GEM Tracking

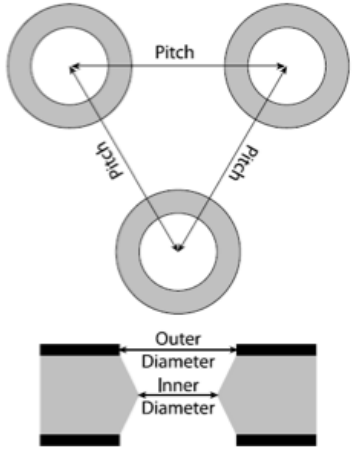
- Single mask GEM Foil: CCD scan setup
  - 2D scanning table with CCD camera fully automated
  - Scan GEM foils to measure hole diameter (inner and outer) and pitch
  - Unique world-wide setup in micro-pattern detector community
  - Critical for feedback in development and QA stage!



(a)



(b)

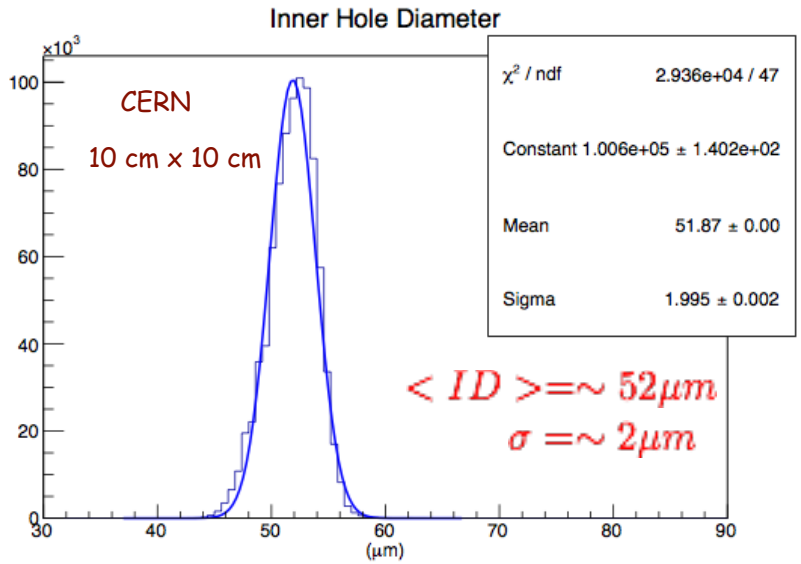


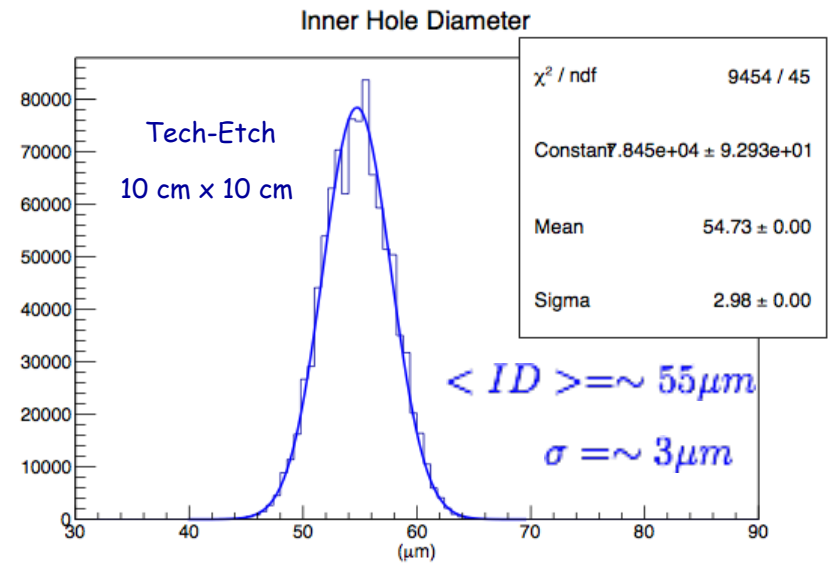
(c)

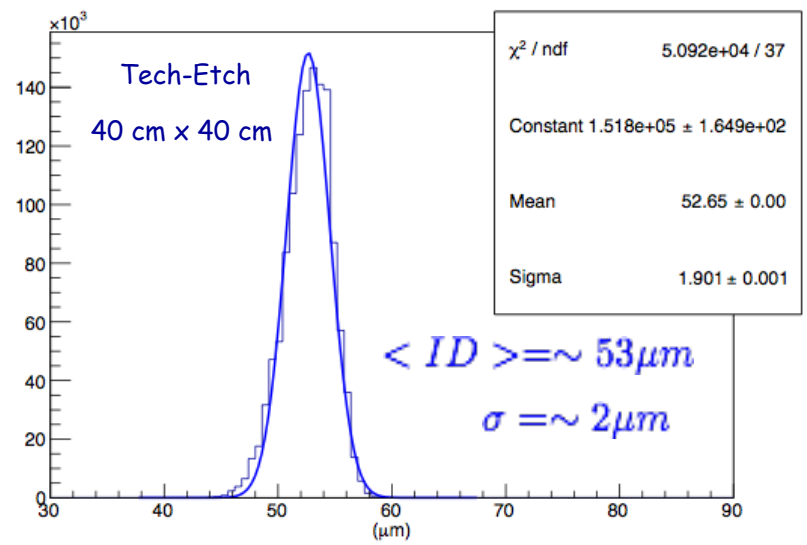
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Forward GEM Tracking

- Single mask GEM Foil: CCD scan results





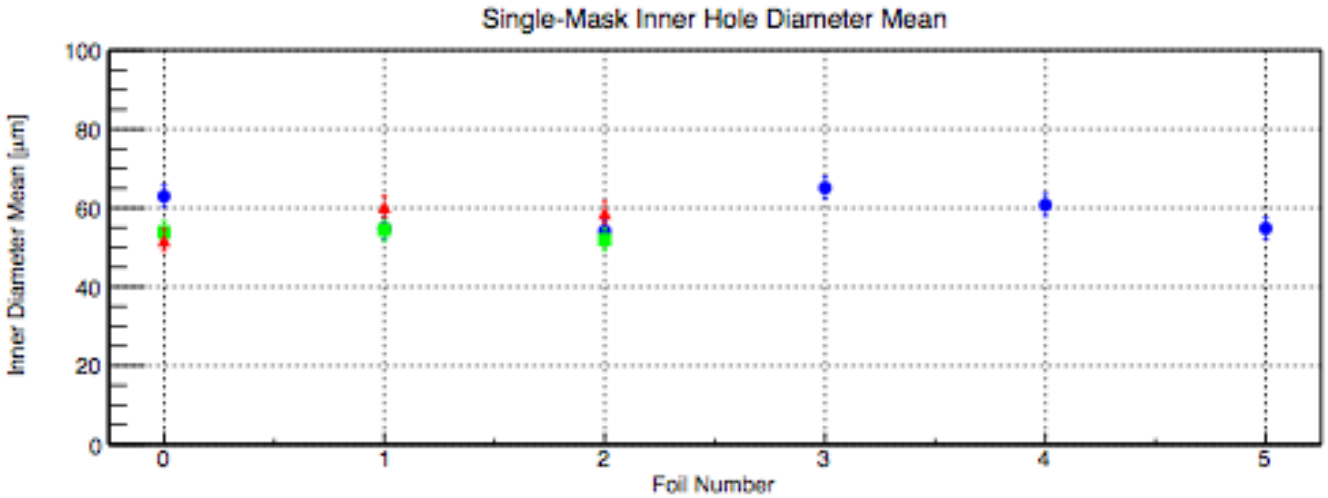


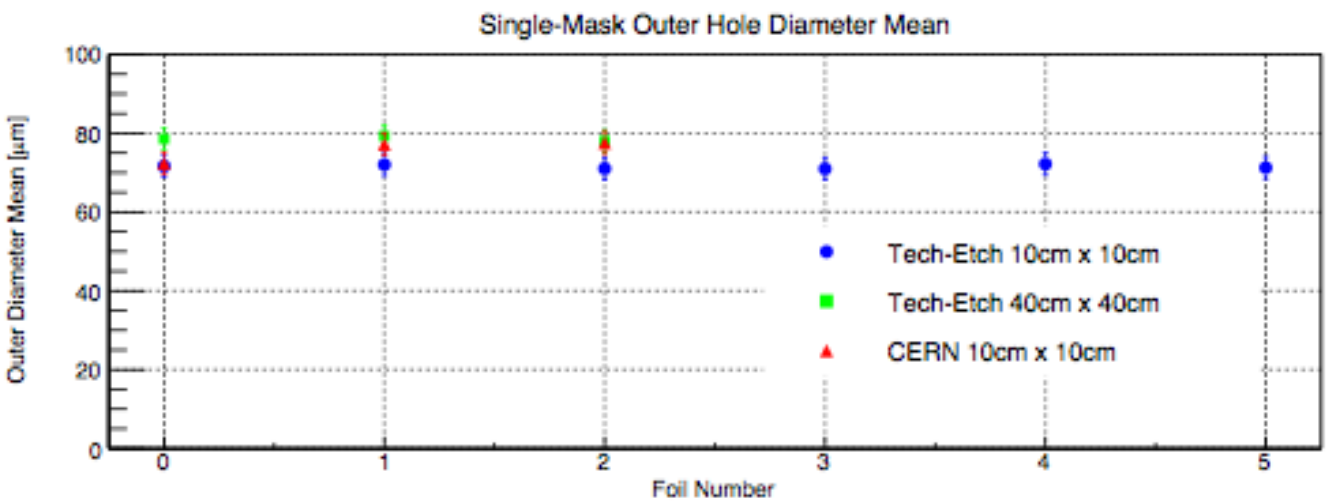
- Inner hole diameter distributions comparisons for CERN and Tech-Etch foils
- All foils have been optically scanned to measure pitch, inner/outer hole diameters, and their uniformity
- In general the CERN foils show similar geometrical properties as the Tech-Etch foils

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

Status - Forward GEM Tracking

- Single mask GEM Foil: CCD scan results (2) / mean foil summary



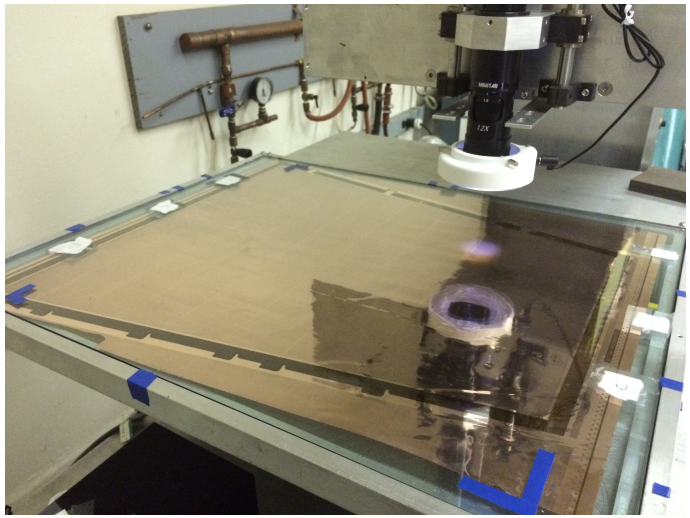


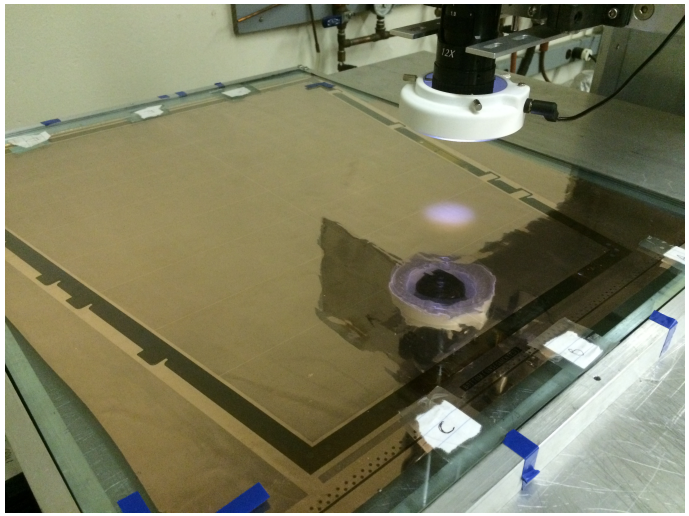
- 6 10cm X 10cm Tech-foils in comparison to 3 40cm X 40cm Tech-Etch foils and 3 10cm X 10cm CERN foils
- Consistency for each production lot
- Consistency between different versions and manufacturing sites

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

Status - Forward GEM Tracking

- Single mask GEM Foil: Large foil scan setup (50 X 50cm^2) (1)
  - First samples of 50 X 50cm^2 single-mask GEM foils were received and scan setup has been prepared
  - Scans underway, but very time consuming: Urgently need upgrade of CCD scan setup
  - Initial results seem not drastically different from previous single-mask scans
  - Tech-Etch is working on optimizing production process of large 50 X 50cm^2 single-mask GEM foils

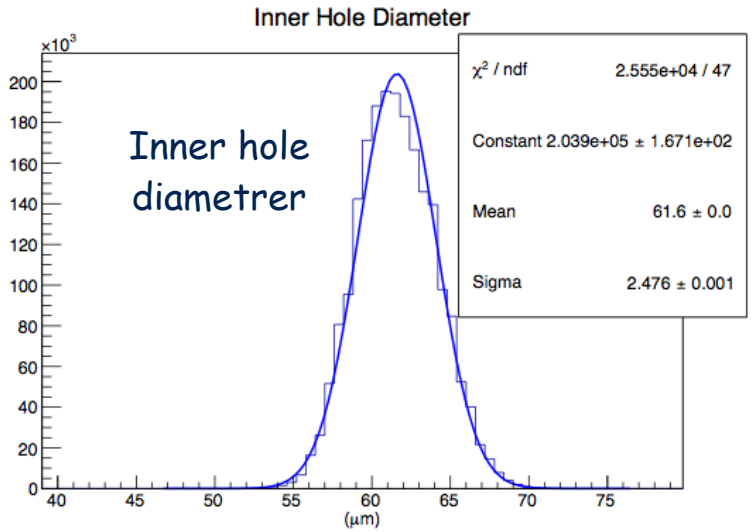


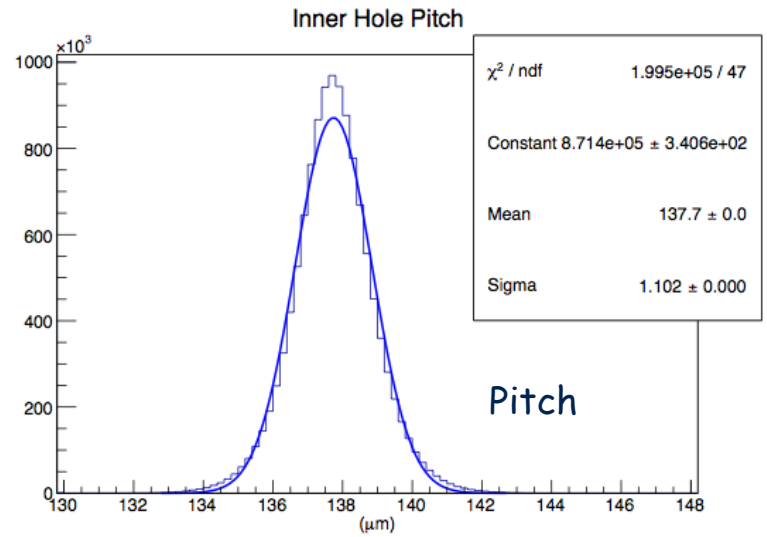


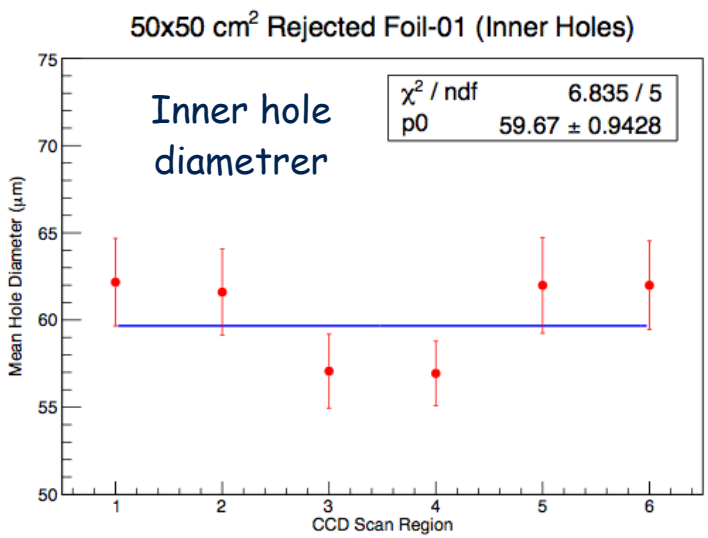
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

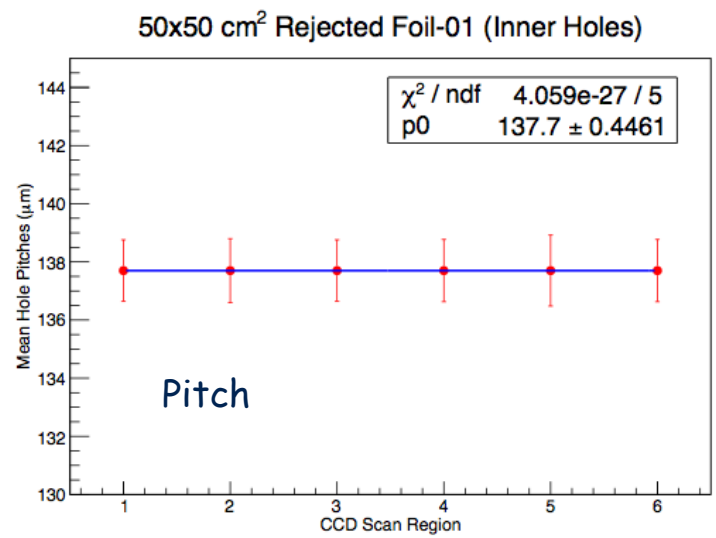
Status - Forward GEM Tracking

- Single mask GEM Foil: Large foil test scans (50 X 50cm^2) (2)







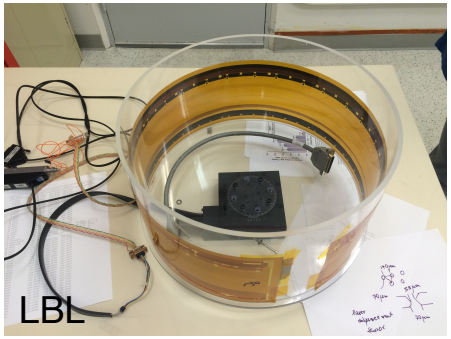


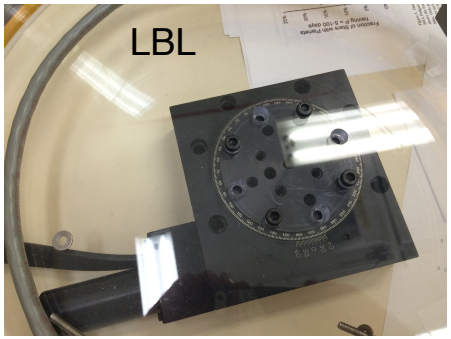
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

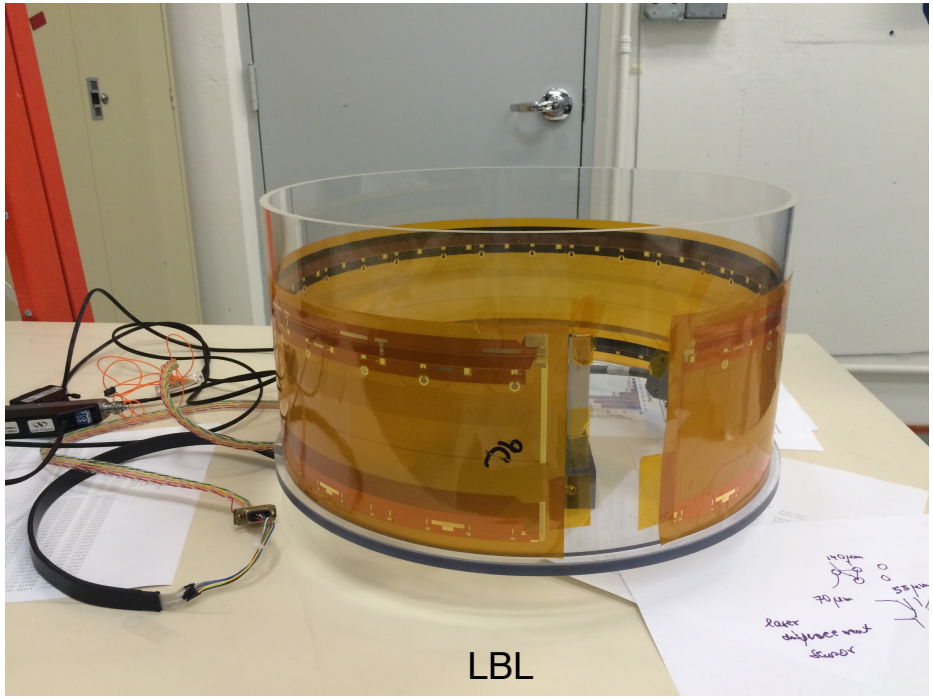
Status - Forward GEM Tracking

Upgrade of CCD scanner

- Urgently needed: Upgrade of CCD scanner at Temple University to accommodate large GEM foils
- LBL visit in September 2014: Tube scanner idea (C. Haber et al.)
- Began assembling major component quotes for: Rotational stage, vertical stage, laser displacement sensor, and CCD camera
- Successful test with lucite material support instead of glass support
- Completion over the summer / fall 2015







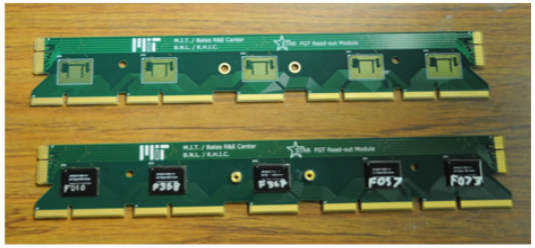
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

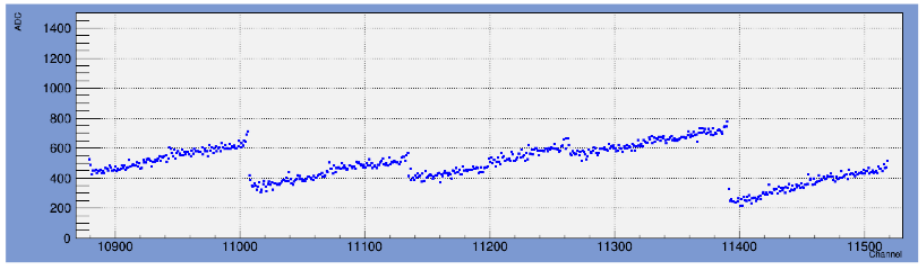
Status - Forward GEM Tracking

- Assembly of 40 X 40cm^2 detectors
  - Complete FEE (APV25-S1) / DAQ system operational
  - Single-mask foils from Tech-Etch
  - Spacer ring material changed from Kapton to Apical / Difficulty with laser cutting of Apical - Might use Kapton!
  - Missing hardware items: Frames / Wider frame width

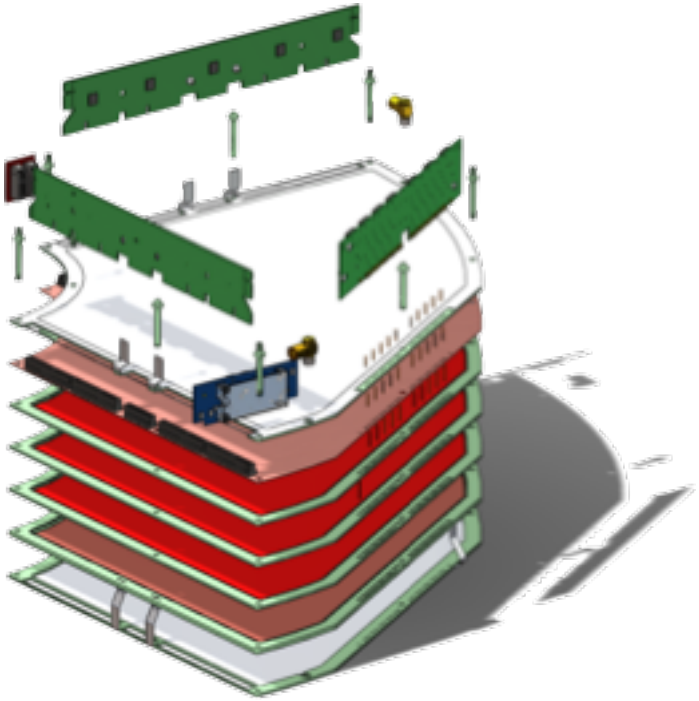
(a)

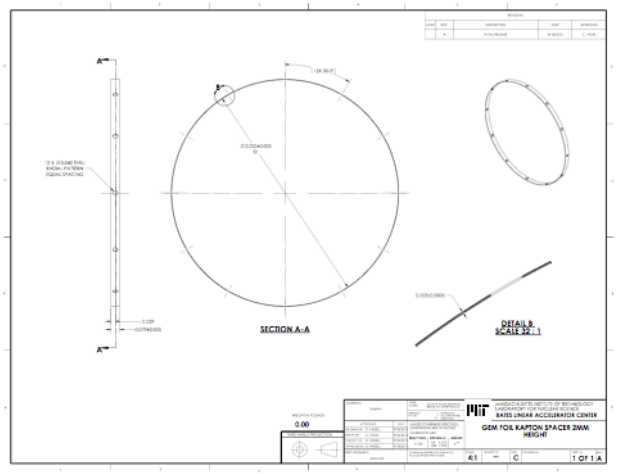
(b)



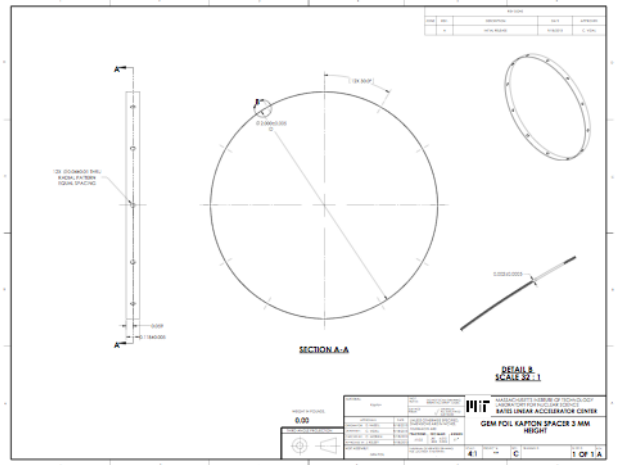


(c)





(a)

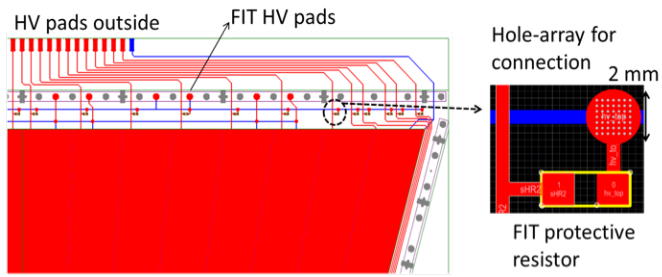


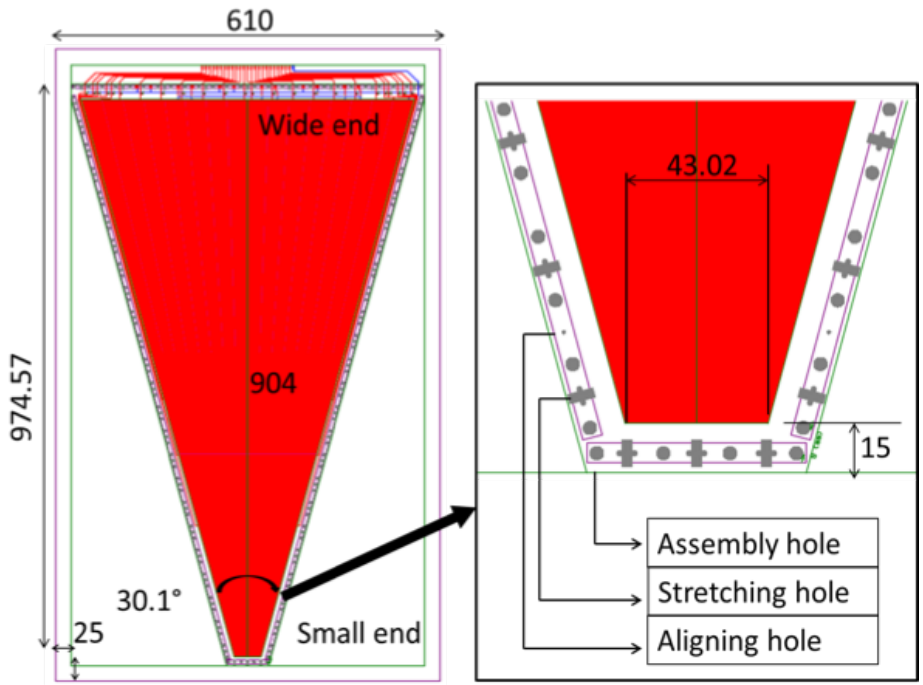
(b)

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

Status - Forward GEM Tracking

- Large EIC segment design
  - Finalized design of large, **dedicated EIC triple-GEM segment** of ~50 X 100cm^2 in collaboration with Florida Institute of Technology and University of Virginia
  - Commercial production of very large GEM foils and 2D readout foils of ~50 X 120cm^2
    - Bi-weekly coordination meetings with Tech-Etch Inc. incl. CERN, FIT, and UVa (GEM foils / 2D readout foils)
    - Tech-Etch strongly motivated to invest into facility upgrade
    - Last step profiting from EIC R&D program ➜ Enormous benefit to wider nuclear and particle physics community!





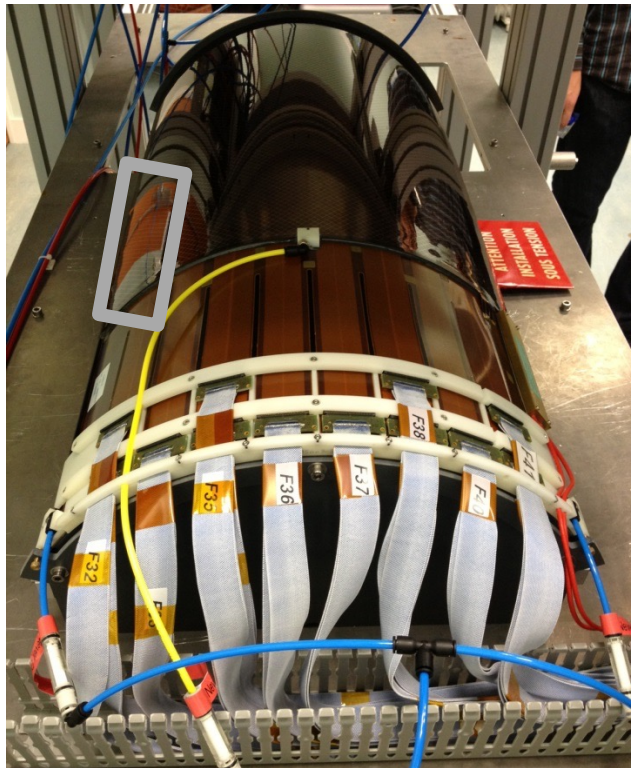
EIC common foil design drawn by Aiwu Zhang (FIT, EIC postdoc)

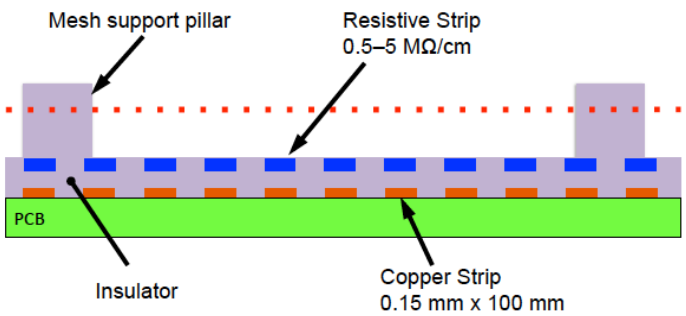
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

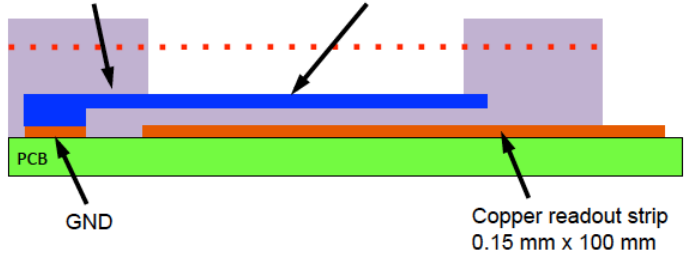
Status - Barrel MicroMegas tracking

Introduction

- Curved MicroMegas for barrel based on carbon structure glued on thin PCB
- Idea validated for CLAS12 tracker
- Need to increase size: PCB size, mesh tension, capacitance and gain homogeneity
- Transition to resistive technology for MicroMegas detectors / No measurable sparking







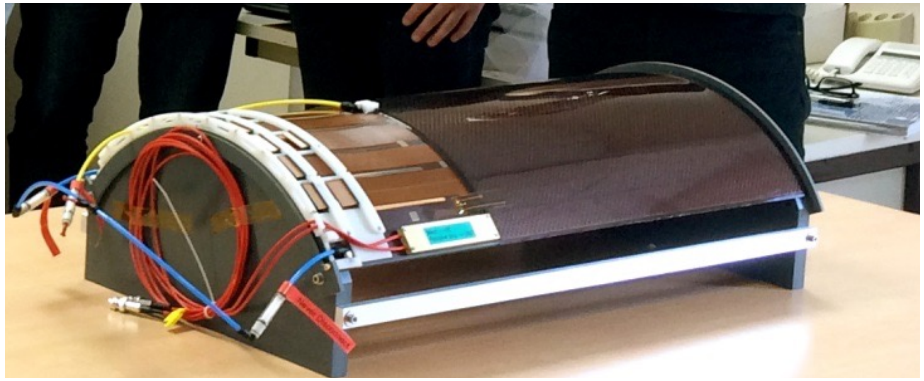
T. Alexopoulos et al., Nucl. Instrum. Meth. A640 (2011) 110.

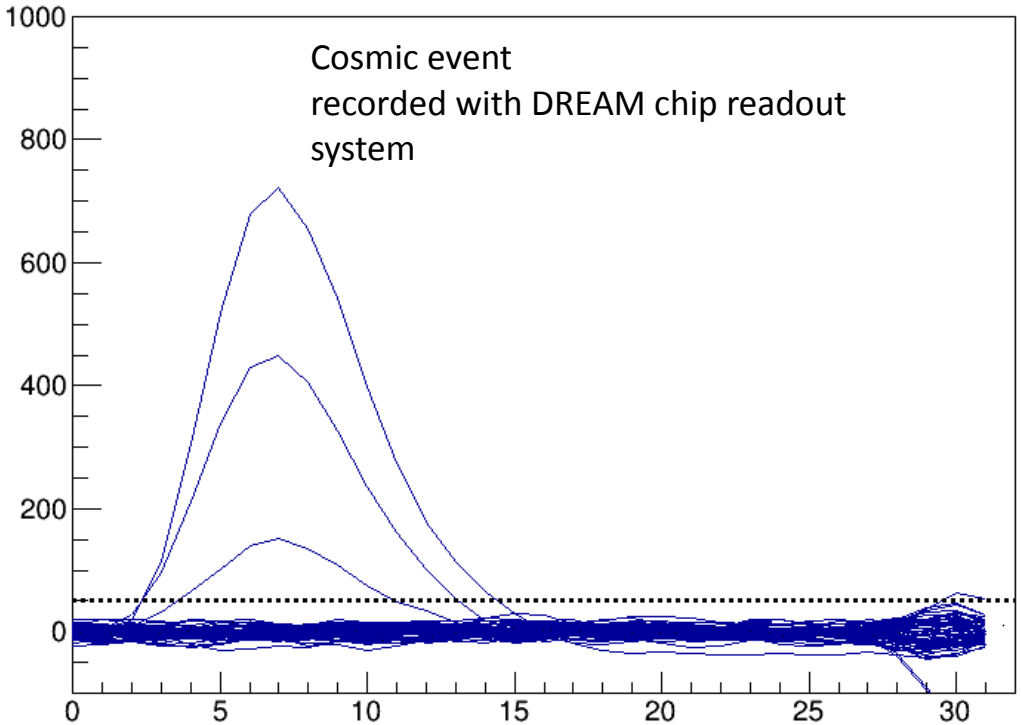
- First dedicated EIC large radius resistive 1D (Z) MM prototype (EIC-MM-V1) with 37x45cm^2
- 120 degree section, R=22.5cm, L=45cm

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

Status - Barrel MicroMegas tracking

- Highlight: 1st Z-layer resistive prototype and cosmic-ray testing

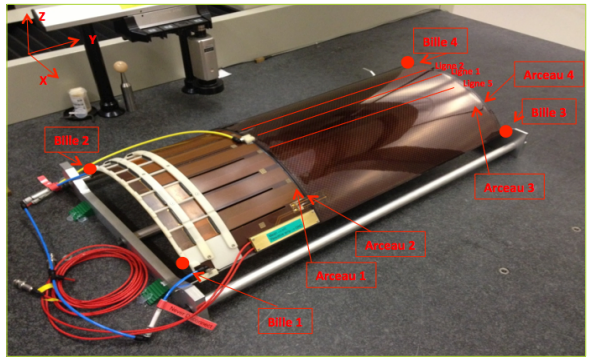


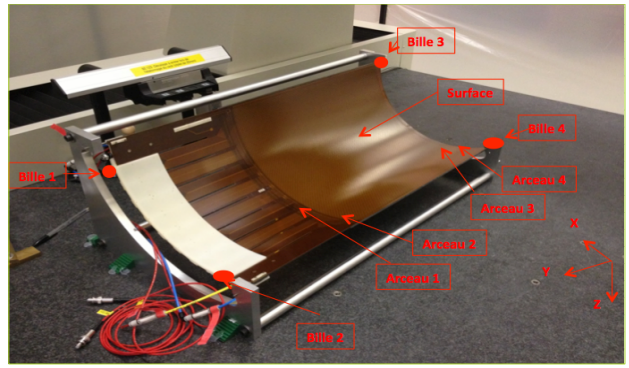


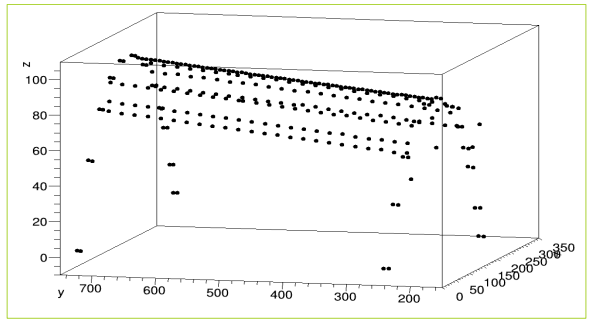
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

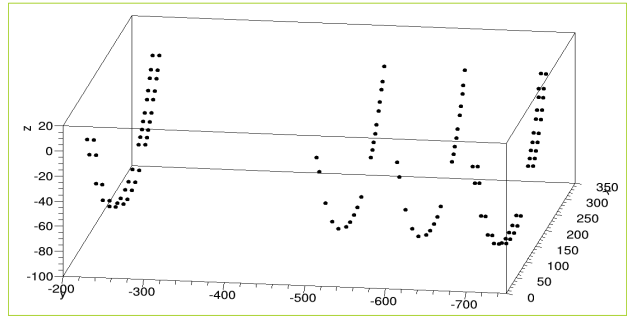
Status - Barrel MicroMegas tracking

- Geometry measurements on cylindrical detectors at Saclay
  - Minimal mechanical support
  - 3D probing machine measuring points:
    - 270 top points (drift side)
    - 120 bottom points (readout side)
    - First results on a "Z" Detector









  - Mechanical precision ~2mm in radius

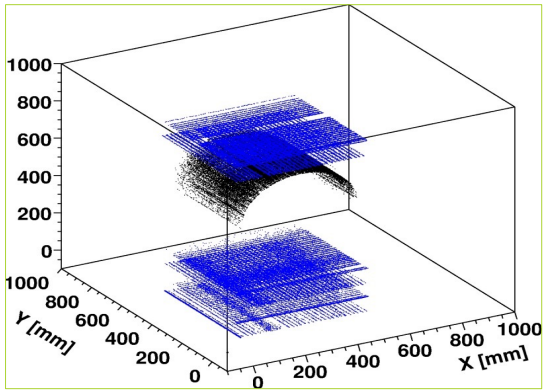
(RMS of cylindrical / ideal curve)

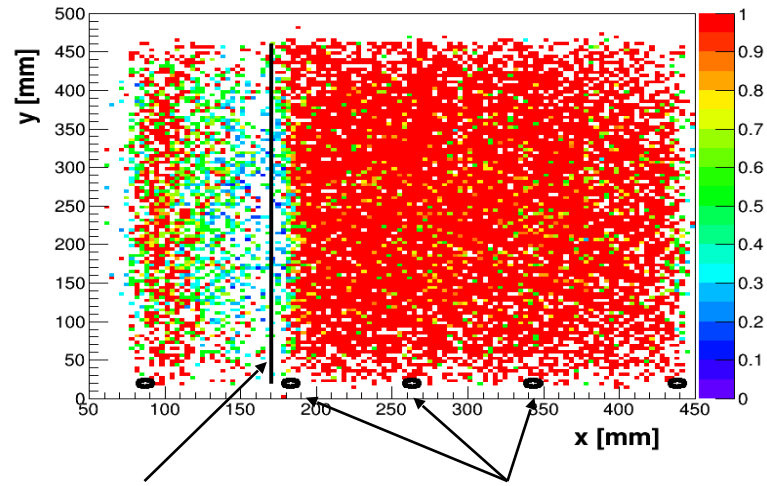
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Barrel MicroMegas tracking

First Z Barrel MM prototype test with cosmic-rays (1)

- Using the shared cosmic ray test facility at Saclay
- Several days after the start of operation, a short developed between the micro-mesh and a resistive strip
- The short induced a large current on a resistive strip
- This current propagates via the ladders toward the ground of the resistive strips creating an inefficiency pattern measured with cosmic rays





position of the shorted resistive strip

position of ground contacts

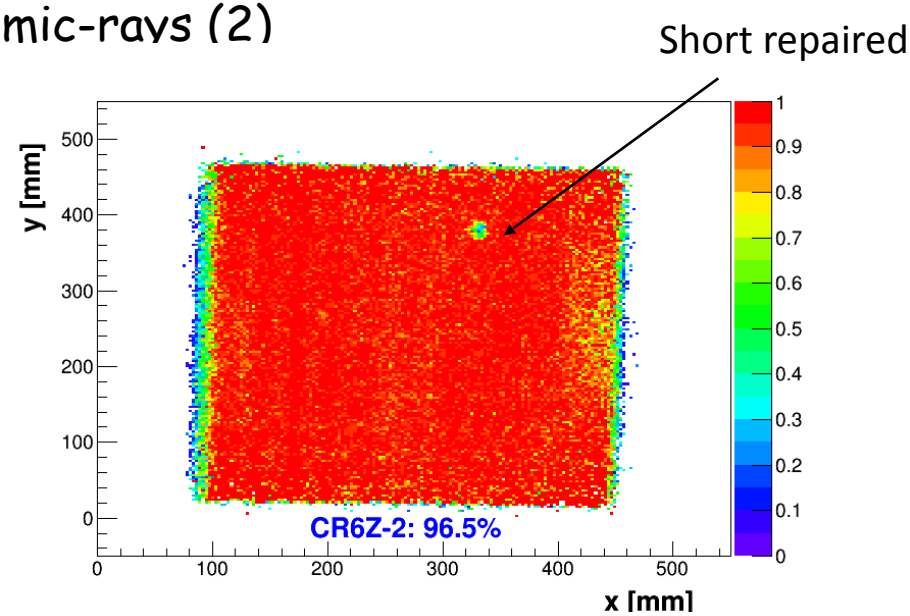
- Replacement of carbon with aluminum for gas inlet distribution
- Suppression of resistive strip interconnections
- Improvement of the cleanness of the assembly procedure

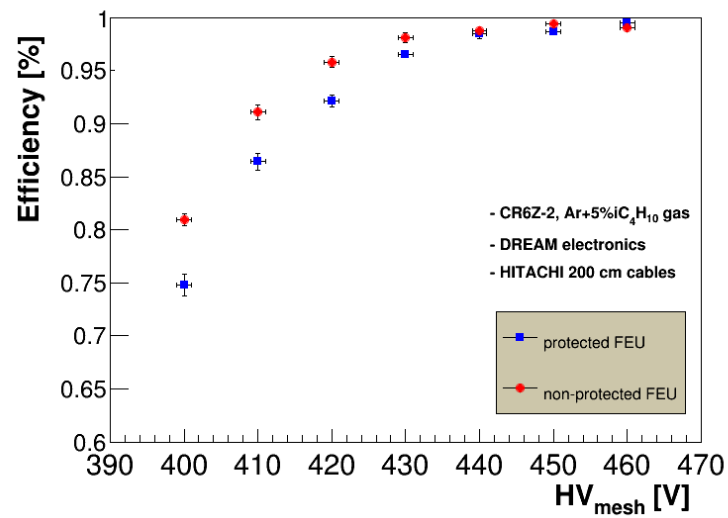
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Barrel MicroMegas tracking

Second Z Barrel MM prototype test with cosmic-rays (2)

- Robustness improved (Several months of smooth operation after start of operation)
- A short developed after a few days and could be repaired
- Overall detector has excellent performance:
  - 96.5% efficiency, somewhat better without spark protection
  - Spatial resolution better than 200μm
  - Time resolution around 25ns
- Successful HV test with 2500V on the drift electrode
- Aluminum frame shows similar performances in mechanical and electrical stability as the previously used carbon frames



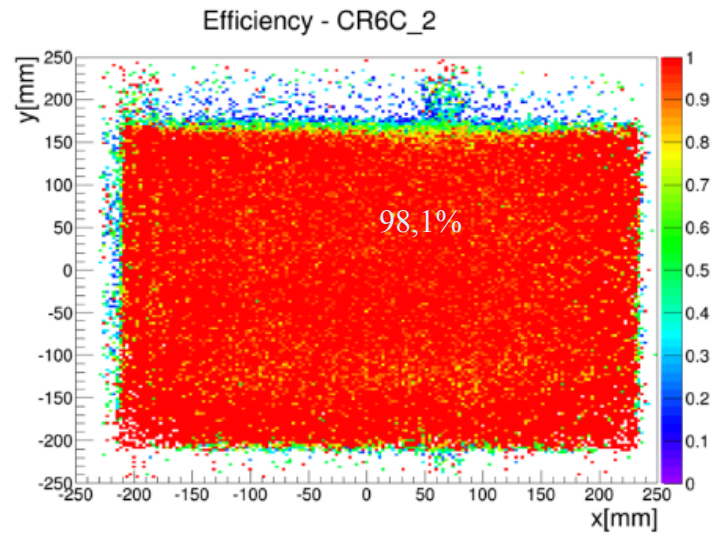


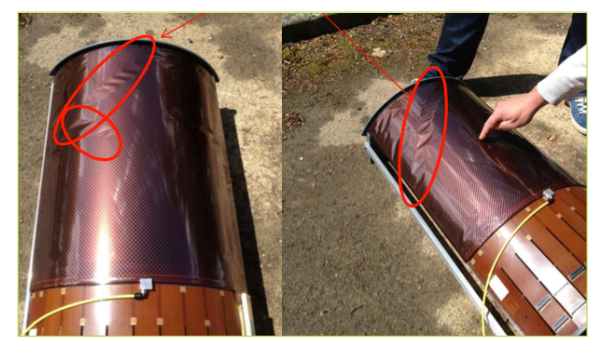
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Barrel MicroMegas tracking

First C Barrel MM prototype test with cosmic-rays

- Using the modification of the Z detectors
- Thinner PCB (100μm)
- Design more complex (Vias in the active area to connect the C strips to connectors)
  - 98.1% efficiency
  - Spatial resolution better than 200μm
  - Time resolution around 25ns
- Production issue on drift electrode at CERN (no proper thermal treatment) limits the HV to 1000V
- Loss of ~2% of channels due to contact issue on the very thin PCB
- Switching from Cu to chrome layer (Flash Chrome) (No copper) / Reduce X_0



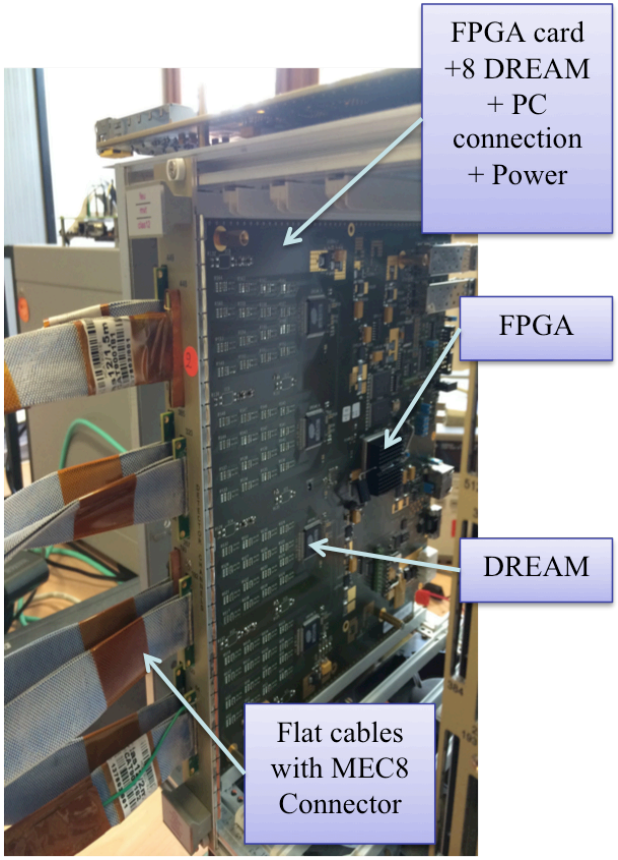


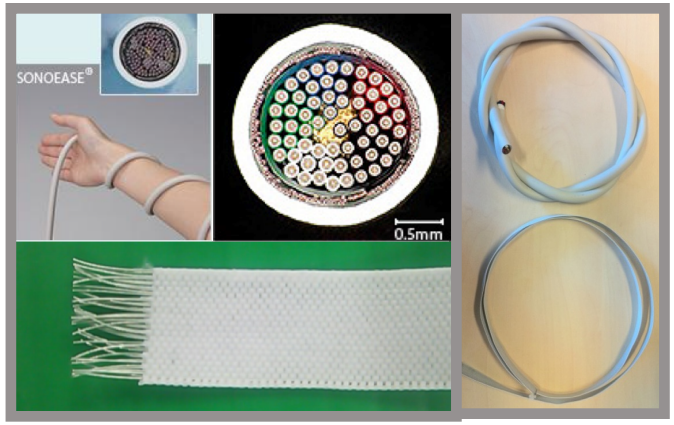
Drift Electrodes not thermally treated

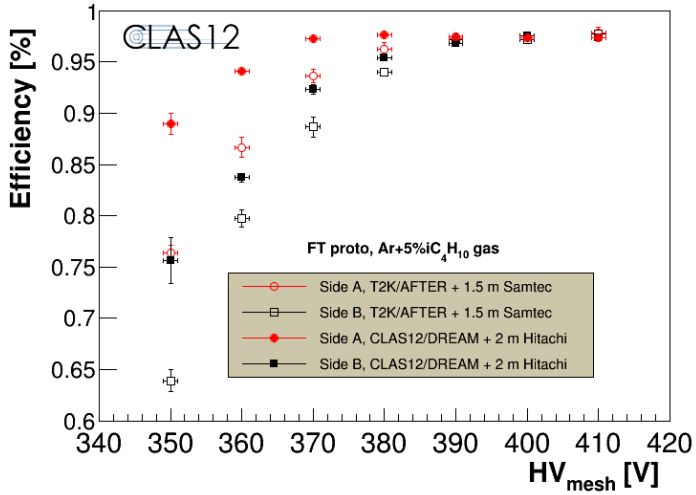
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Front-End Readout System

- Front-End Electronics development







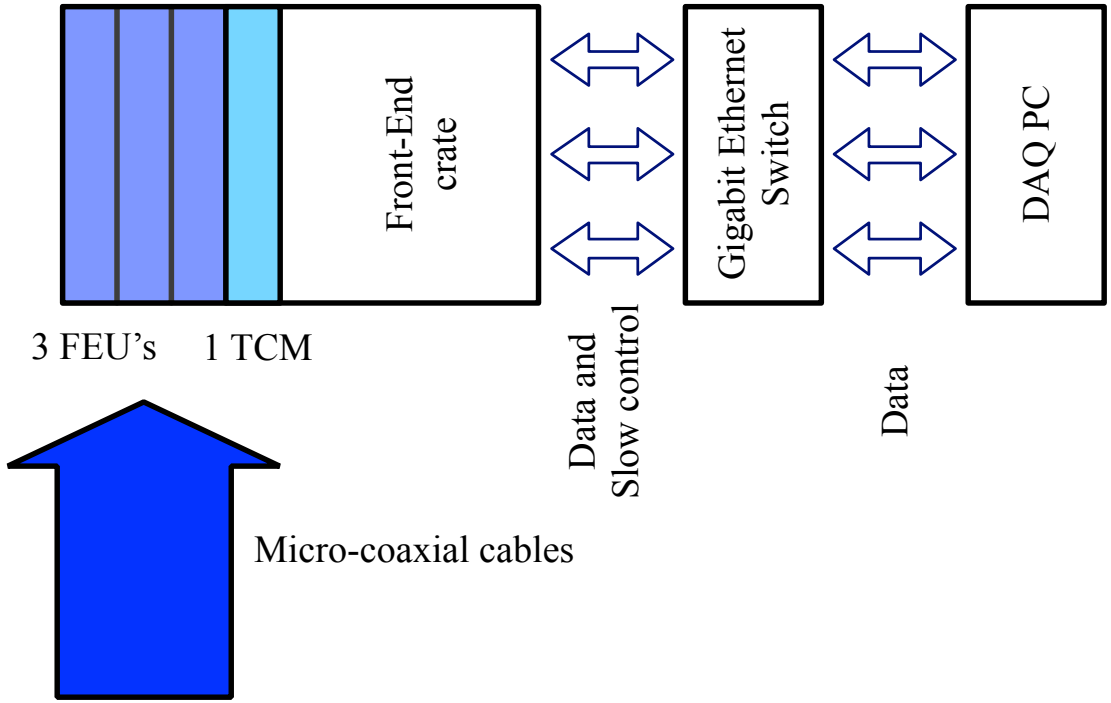
- Successful setup of complete new chip readout system ideally suited for Micro-pattern detectors
- Successful test with MicroMegas detector
- FEE Cards produced and tested with, and, without spark protection circuit - Noise level with 60cm long cylindrical detectors + 2m flat cables ~3000e-

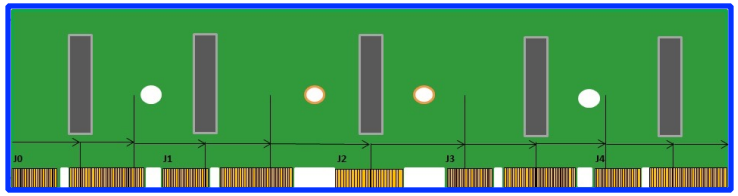
	Dream Chip	APV25-S1 Chip
Number of channels	64	128
Memory size	512	160
Latency	16μs	8μs
Noise (e-RMS)	2100 (On 180pF)	1200 (On 20pF)
Sampling frequency	1-40MHz	10-50MHz
Dynamic range	50-600fC	150fC
Input capacitance	150pF	18pF
Shaping time	70ns	50ns

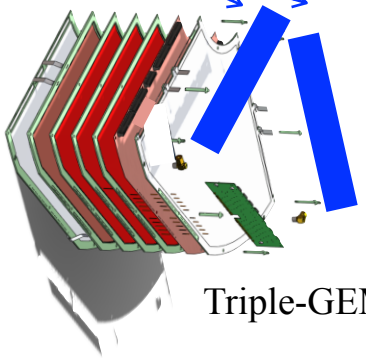
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Status - Barrel MicroMegas tracking

- Goal: FEE setup for triple-GEM configuration
  - Setup of DREAM chip FEE applied to large triple-GEM detectors
  - Design / Fabrication of Very-Front-End-Board
  - Passive readout cards design completed / Actual cards expected within a few days







  - Large triple-GEM detector at Saclay for DREAM readout commissioning before September 2015 - All components available / Transferred to TU afterwards

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

Proposal - Forward GEM Tracking

- (1) Continuation of Large GEM Development at Tech-Etch (CRITICAL!)
  - Successful multi-year development of commercial fabrication of GEM foils by Tech-Etch
  - Critical recent step: Single-mask production
  - Next step: Extension to larger size of ≳ 1m
  - Tech-Etch has received approval to commence with facility upgrades in order to accommodate large GEM foil development (≳ 1m long)
  - Order EIC large sector prototype foils in collaboration with FIT and UVA focusing on different assembly aspects for three prototypes each
  - Total NRE cost estimated at $300k, with Tech-Etch contributing $100k and a cost per foil of $1750 per foil
  - Multi-year staged approach with three institutions (TU,FIT, and UVa) / Funding profile presented by T. Hemmick on behalf for eRD3/eRD6 driven by funding constraints
  - Tech-Etch provided a written commitment to developing large area GEM foils:

Tech-Etch

TECH-ETCH, INC.
45 ALDRIN RD., PLYMOUTH, MA 02360 USA
TEL 508 747-0300 • FAX 508 746-9639

11 July, 2015

Dr. Bernd Surrow
Temple University
1801 North Broad Street
Philadelphia, PA 19122

Re: Production of Large Area GEM Foils

Dear Dr. Surrow,

Tech-Etch has been involved in the fabrication of GEM foils for over ten years, and with this letter I would like to communicate Tech-Etch's commitment to expand our capabilities to include Large Area GEM foils. As you know, we have worked closely with CERN and have acquired a license to fabricate GEM foils using CERN's patented single mask method. We've fabricated hundreds of GEM foils for dozens of institutions, and we are prepared to upgrade our facility and equipment to accommodate your need for 54 large area prototypes in 2016, and production foils starting at some later date.

Tech-Etch is requesting NRE charges of $200,000 for the engineering, tooling, fixturing and equipment modifications necessary to accommodate foils of this size. Additionally, we are estimating a cost of $1750 per foil. It is understood that funds would likely be issued over a two year period. Tech-Etch is willing to begin facility modifications and tooling fabrication as soon as it is confirmed that funding for the first year has been secured.

Sincerely,

TECH-ETCH, Inc.

George Keeler
President

photoetched metal parts □ flexible printed circuits □ precision stampings □ RFI/EMI shielding strips

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

Proposal - Forward GEM Tracking

(2) CCD Scanner Upgrade

- Upgrade current 30 cm x 15 cm CCD scanner to tubular imaging scanner capable of scanning ~ 150 cm x 65 cm.
- Purchase major hardware components: rotational stage (~$20k), vertical stage for camera (~9k), laser displacement sensor, CCD camera (~$300), and stage controllers (~$5k).
- Design and produce plexiglass cylinder (radius ~25 cm for 1.5 m long foil) to wrap foil around.
- Second option is to use two industrial sized linear scanners at 100 cm x 56 cm and 75 cm x 56 x cm (Awaiting quote!)

Option 1

Rotational stage

30 cm vertical stage

Option 2

100 cm x 56 cm

75 cm x 56 cm

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

Proposal - Forward GEM Tracking

- (3) 10 cm x 10 cmTriple-GEM Detector Construction
  - Purchase Tech-Etch single-mask 10 cm x 10 cm foils and frames to build triple-GEM detectors
  - Use these detectors to characterize the gain of Tech-Etch foils and study clustering methods / X-ray scanning
  - All tools and hardware have been acquired with the exception of frames

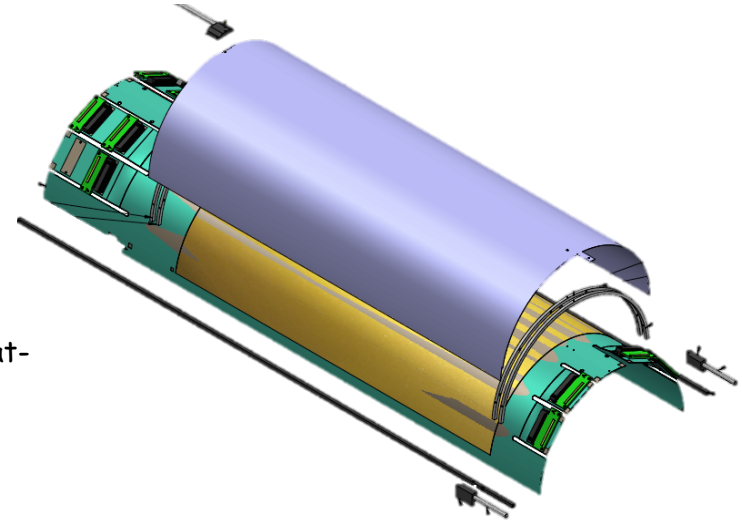
- (4) 40 cm x 40 cmTriple-GEM Detector Construction
  - Purchase Tech-Etch single-mask 40 cm x 40 cm foils and frames to build triple-GEM detectors using Apical ring spacers between the foils.
  - Use these detectors to characterize the gain of Tech-Etch foils / X-ray scanning
  - All tools and hardware have been acquired with the exception of frames

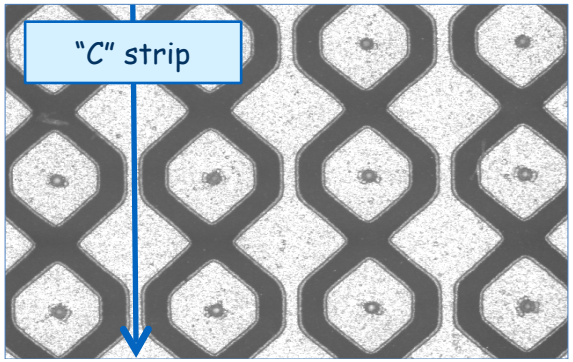
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Proposal - Barrel MicroMegas tracking

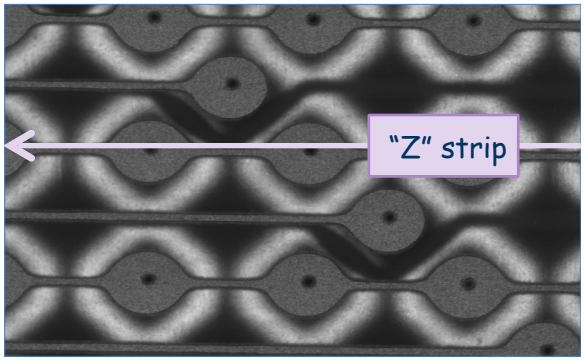
(1): 2D curved resistive prototype, C-Z pattern

- Minimization of dead material with respect to 1D detectors
- High potential for multiplexing: Significant reduction of readout cost
- Tailored for high-flux experiments (resistive)
- Next technological step after 1D-curved-resistive, 2D-curved-metallic and 2D-flat-resistive
- Will profit from experience with CLAS12, Asacusa AMT and Mcube





Read-out pattern (top)

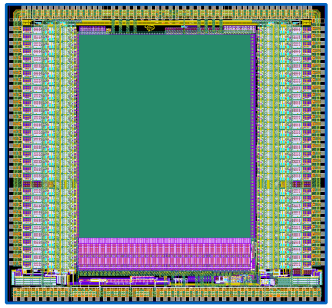


Read-out pattern (bottom)

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

Proposal - Barrel MicroMegas tracking

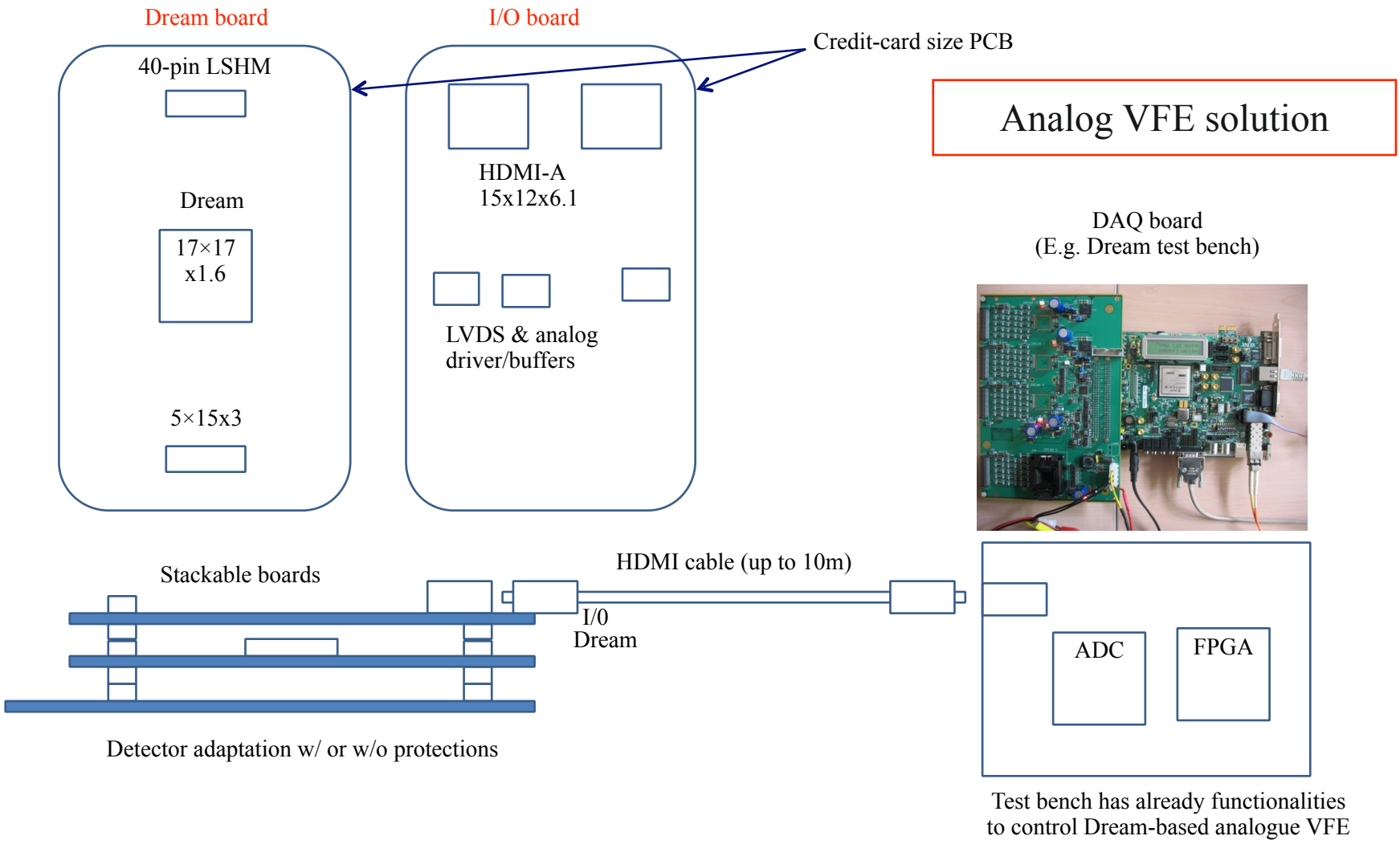
- (2) DREAM chip readout development
  - Reminder: Dream ASICs have been solely used so far in an off-detector front-end configuration
    - 1 to 2m long micro-coaxial cables to transport bare signals from detectors to the front-end
    - Increased noise due to cable capacitances
    - Noise pick-up is not excluded despite cable shielding
  - Goal: Implement a modular Dream-based Very-Front-End (VFE) system to provide various modular configuration for EIC R&D programs (MM / GEM) - Critical beyond APV / SRS system
    - Analog VFE contains only Dream ASIC
      - Remote ADC and digital electronics housed on off-detector front-ends or even on backend electronics
      - Develop a solution for long distance (3, 5, 10m) transmission line for the Dream differential analog output signal
    - Mixed analog-digital VFE contains Dream ASIC and ADC (and possibly some digital signal processing means)
    - Study synchronization (clock-trigger) and control signal distribution
  - Outcome: Improve S/N ratio and Dream-based trigger efficiency



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

Proposal – Front-End Electronics

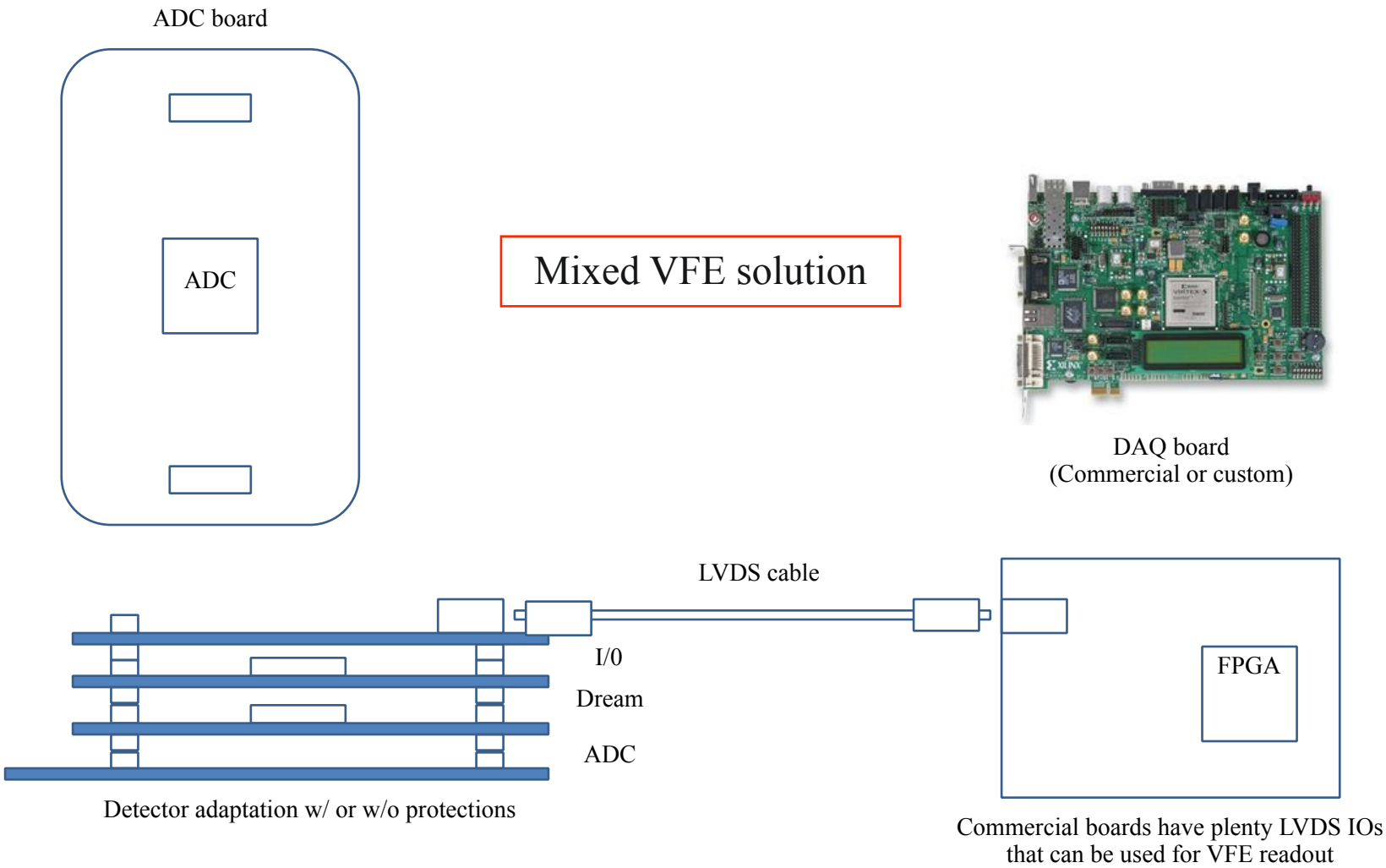
- Layout of modular DREAM DAQ system (1)



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

Proposal - Front-End Electronics

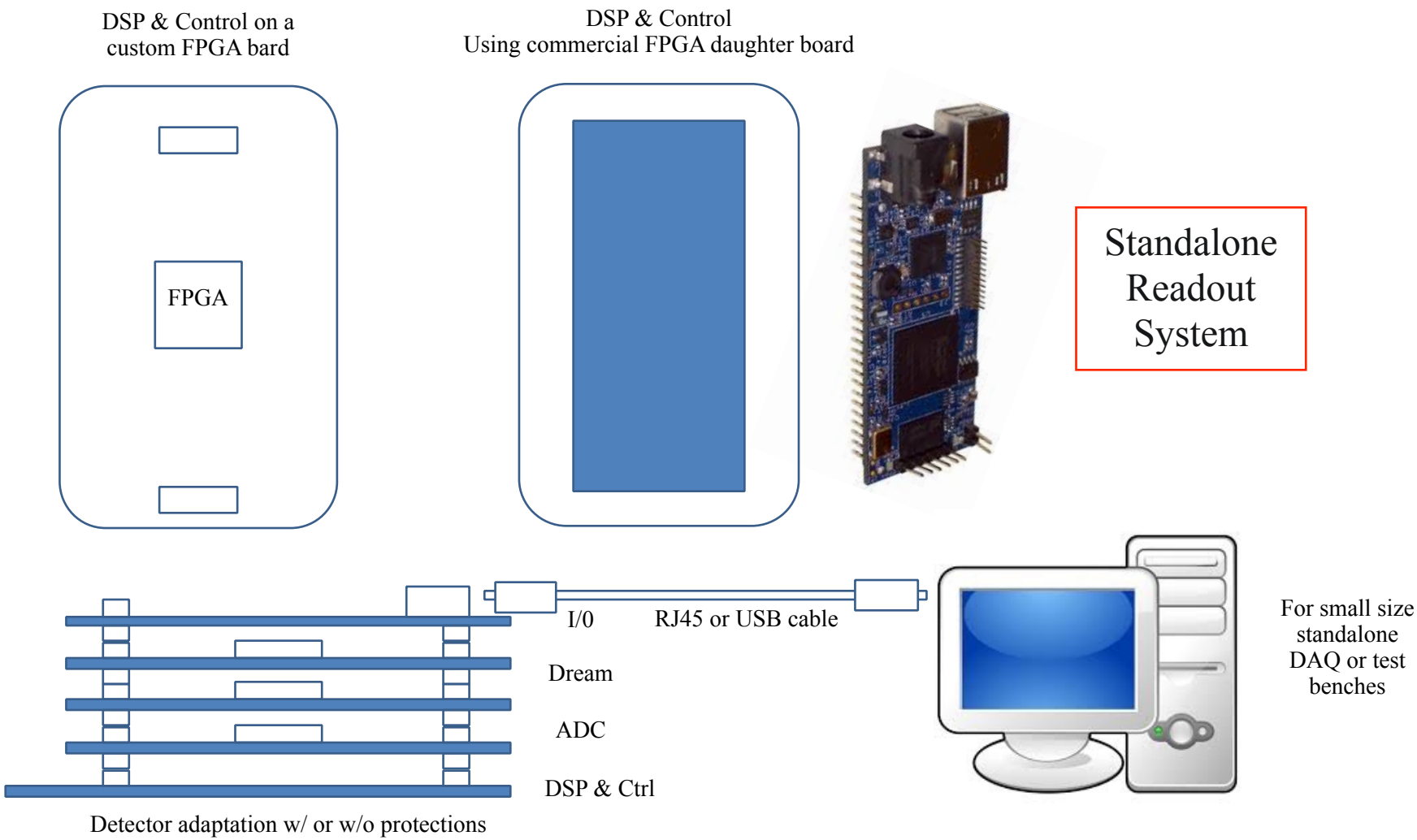
- Layout of modular DREAM DAQ system (2)



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

Proposal - Front-End Electronics

- Layout of modular DREAM DAQ system (3)



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

Budget request FY16

- Overview
  - Highest priority: Continued postdoc support
  - Budget items without overhead:
    - Salary: $45k (Base) + $13k (Fringe benefits) = $58k for FY16
    - Travel: $6k (International - TU/Saclay travel) + $7.5k (BNL/FIT/UVa/JLAB/IEEE)
    - Material: $15k (Frames, HV foils, 2D readout foil, hardware CCD scanner setup)
    - Equipment: $33k (Large GEM foil order / TU portion)
    - Service: $30k (Readout development and 2D MM at Saclay)
  - Total with overhead (51%) for FY16: $179k

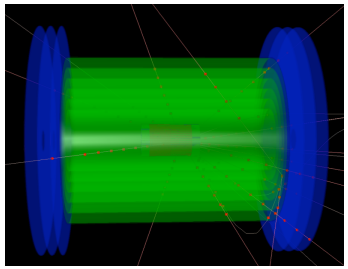
Matt Posik, Maxence Vandenbroucke,
Bernd Surrow (PI) and Franck Sabatie (PI)

Summary / Outlook

Summary / Outlook

Forward GEM tracking

- Successful commercial single-mask production of large GEM foils / Critical characterization of leakage current and optical uniformity at Temple University
- Upgrade of CCD scanner urgently needed
- Assembly of single-mask detectors and X-ray scan
- Large GEM foil design completed and agreement with Tech-Etch worked out - Critical step to complete R&D program



Barrel MicroMegas tracking

- Successful assembly + test of large radius resistive MM detector (1D-Z / 1D-C) using DREAM chip FEE / DAQ
- Design and assembly of 2D MM - Critical step to complete R&D program

FEE

- Successful test of DREAM chip DAQ ➜ Setup for triple-GEM DREAM DAQ system (Integrated readout!)
- Design of modular DREAM readout system - Critical step to complete R&D program

Simulations

- Dedicated farm at Temple University for computing cluster to be used for EIC simulations / Cloud computing configuration in preparation

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