EICGENR&D2023_16: Development of Double-Sided Thin-Gap GEM-μRWELL for Tracking at the EIC

FY22 Progress Report & FY23 Proposal

EIC GENERIC R&D REVIEW MEETING

Kondo Gnanvo on behalf of Thin Gap MPGD Consortium

October 31, 2023

Jefferson Lab

Outline

FLORIDA TECH

UNIVERSITY of VIRGINIA

Yale University

VANDERBILT UNIVERSITY

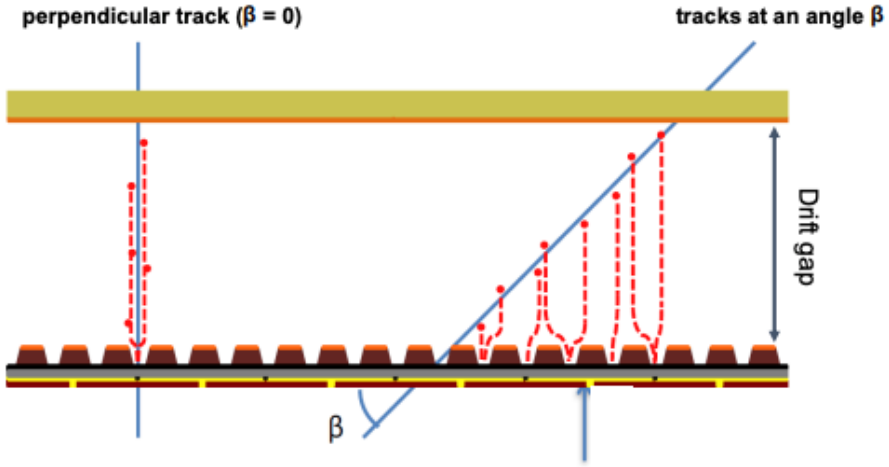
TEMPLE UNIVERSITY

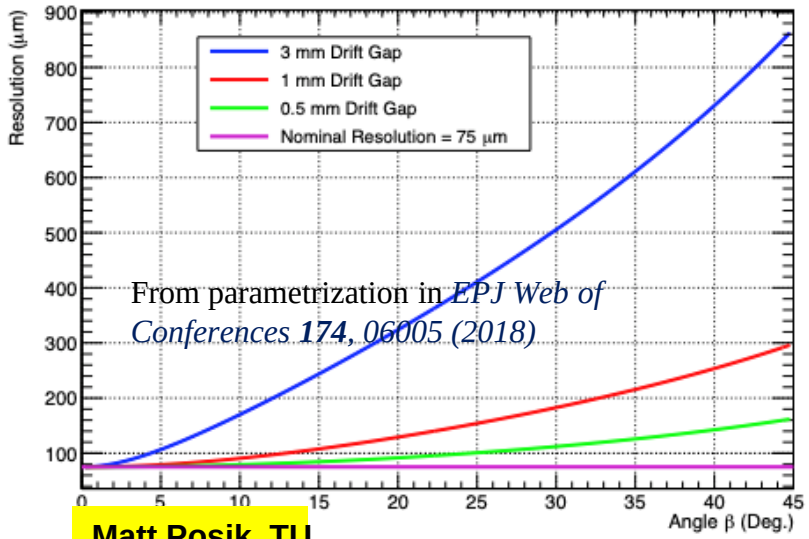
Questions from reviewers

Please summarize what has been done in the last year and what remains to be done

Motivation for Thin Gap MPGD developments

- Current challenges with MPGD trackers
  - Deterioration of spatial resolution with track angle .
  - E × B effect inside magnetic field also negatively impact spatial resolution.
- Steps for addressing the above issues
  - Reduce drift gap to circumvent dependence of resolution on track angle.
  - Reduction of both drift gap and transfer gap/induction gaps will also minimize the E x B effect inside magnetic field





From parametrization in *EPJ Web of Conferences* **174**, 06005 (2018)

Matt Posik, TU

Development of Thin Gap MPGDs for EIC Trackers

K. Gnanvo*[1], S. Greene[4], N. Liyanage[2], H. Nguyen[2], M. Posik[3], N. Smirnov[5], B. Surrow[3], S. Tarafdar[4], and J. Velkovska[4]

[1]Thomas Jefferson National Accelerator Facility, Newport News, VA 23606, USA
[2]University of Virginia, Department Of Physics, Charlottesville VA 22903, USA
[3]Temple University, Philadelphia, PA 23606, USA
[4]Vanderbilt University, Department of Physics and Astronomy, Nashville, TN 37240, USA
[5]Yale University, Physics Department, New Haven, CT 06520, USA

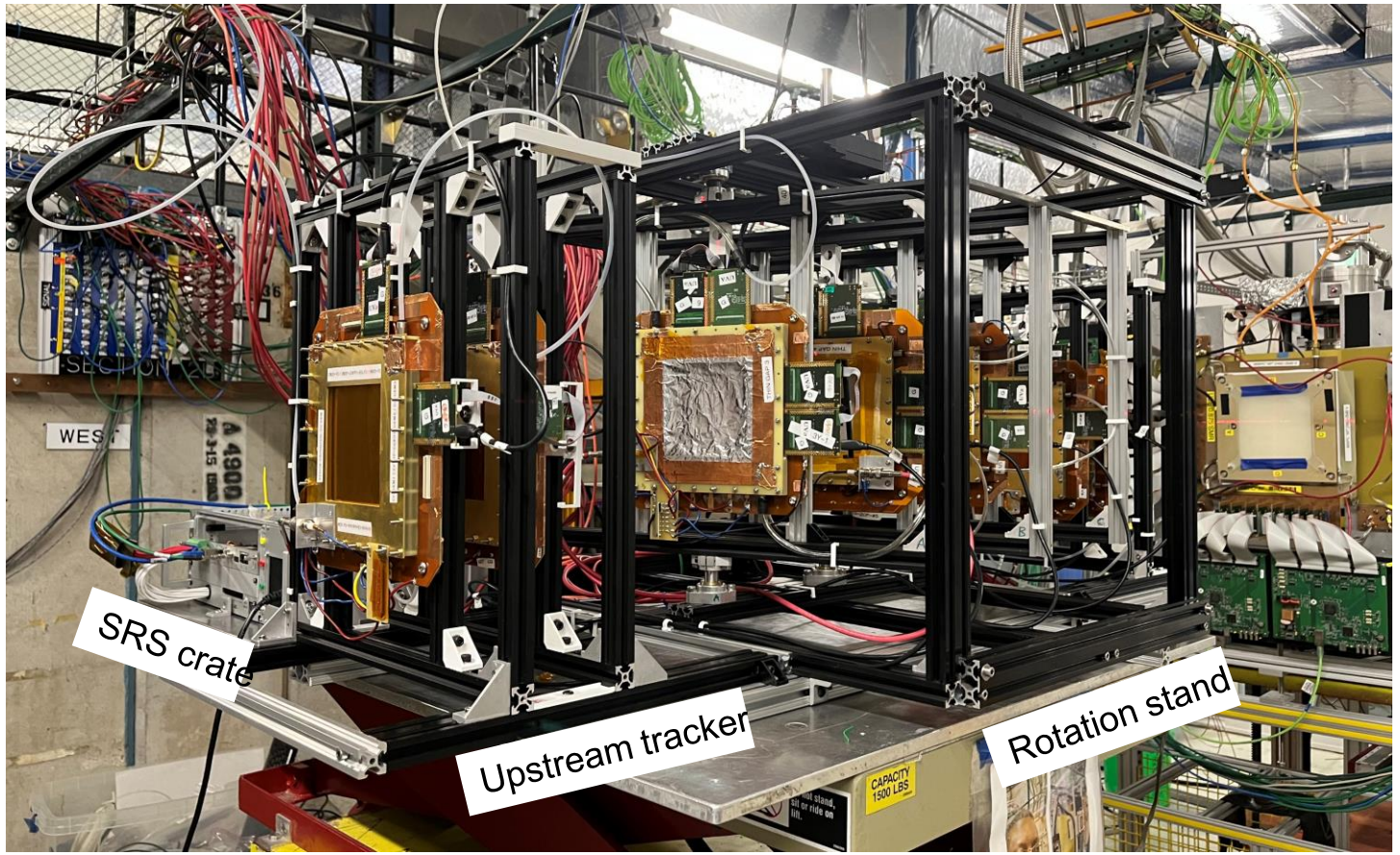
Questions from reviewers

Please summarize what has been done in the last year and what remains to be done

Questions from reviewers

How does your collaboration share expertise during the year?

- All institutions participating to this effort are members of eRD108 and ePIC Detector Subsystem Collaboration (DSC)
- Common test beam ➔ Share test beam setup and equipment i.e., detector stand, DAQ, gas system
- Bi-weekly meeting during the design phase of the prototypes and the analysis of the test beam data
- Common authorship of all peer-review publications
- The Thin Gap MPGD consortium increases with Florida Tech joining the FY23 proposal



Jefferson Lab

FLORIDA TECH

FY22 Progress Report

UNIVERSITY of VIRGINIA

Yale University

VANDERBILT UNIVERSITY

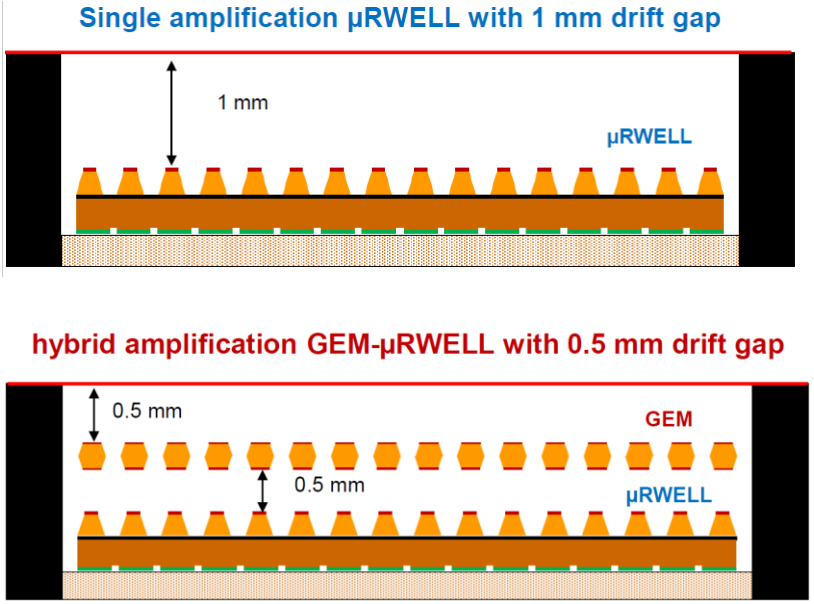
TEMPLE UNIVERSITY

FY22 Progress Report – UVa

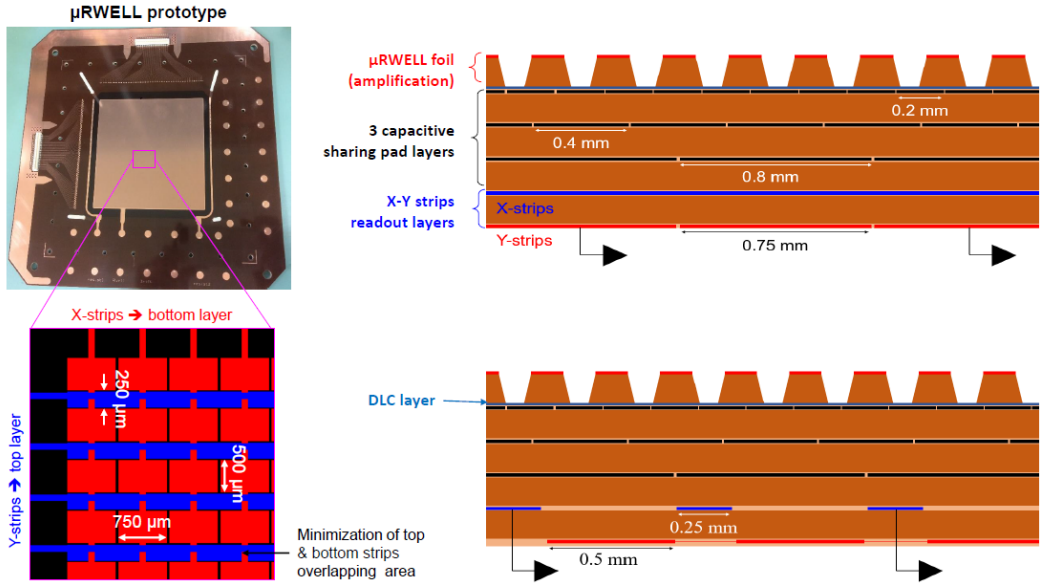
FY22 Progress Report – JLab thin-gap GEM-µRWELL hybrids

- 1 single uRWELL – 1 mm gap
- 2 hybrids: GEMs + µRWELL - 1 mm and 0.5 mm
- R/O plane: Capacitive-sharing X-Y strips (0.8 mm)
- Two beam test campaigns:
  - **FNAL, June 2023 - HV & angle scan**
  - **CERN, July 2023 - B-Field scan**

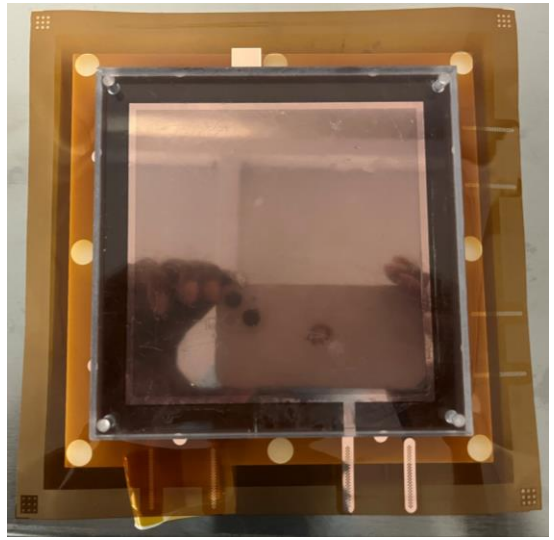
	Type	amplification	Drift gap	Transfer gap	readout
Proto I	Single amplification	µRWELL	1 mm	N/A	Capa-sh X-Y strips (0.8 mm)
Proto II	hybrid amplification	GEM+µRWELL	**1 mm**	1 mm	Capa-sh X-Y strips (0.8 mm)
Proto III	Hybrid amplification	GEM+µRWELL	**0.5 mm**	1 mm	Capa-sh X-Y strips (0.8 mm)



Two configurations for amplification



µRWELL with capacitive-sharing strip readout

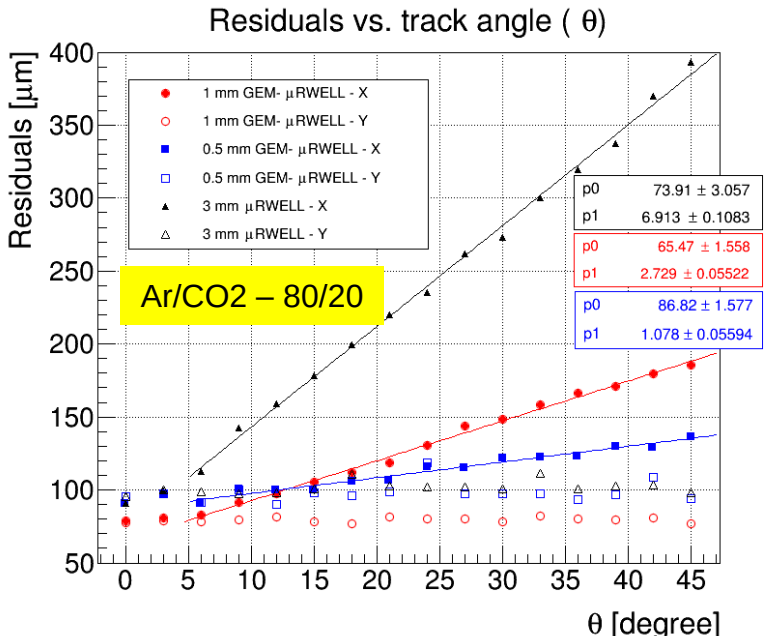


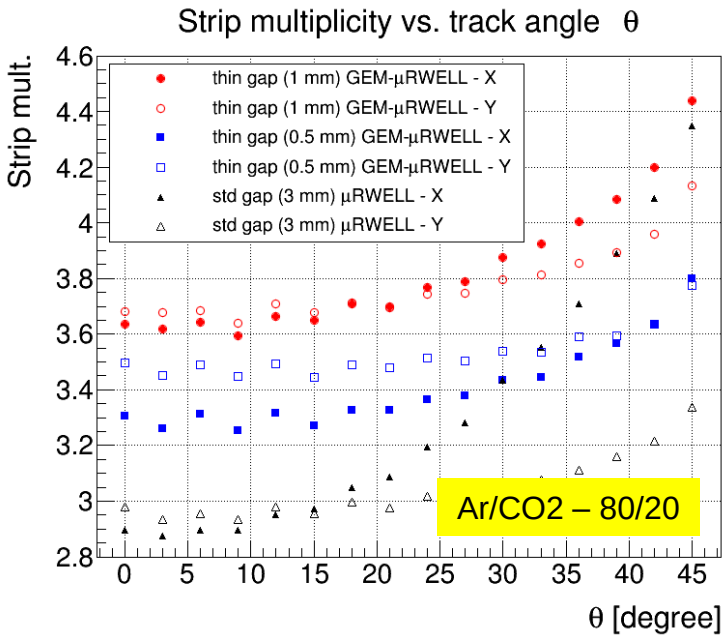
GEM pre-amplification

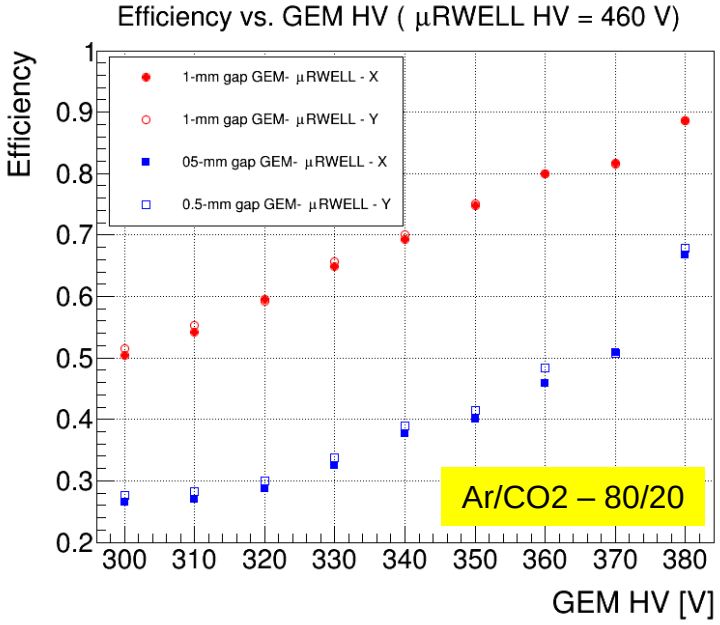
FY22 Progress Report – Performance in beam test

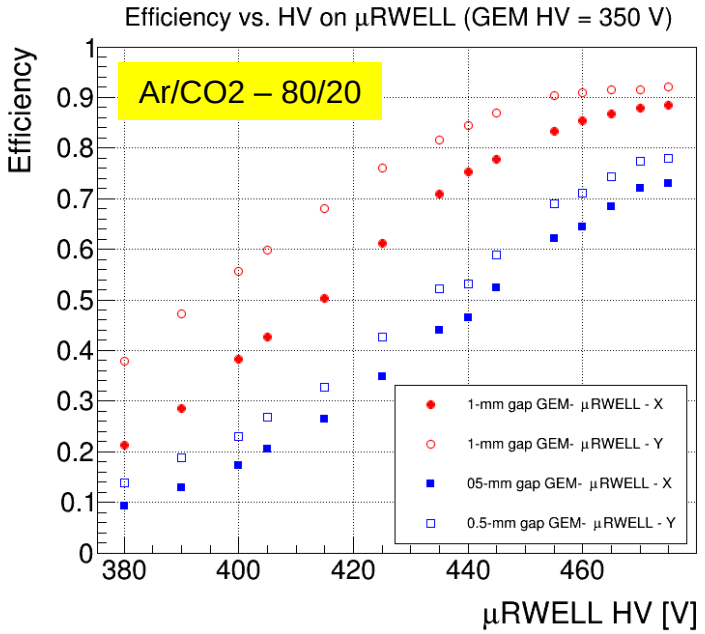
2 GEM-µRWELL protos with capacitive-sharing strips

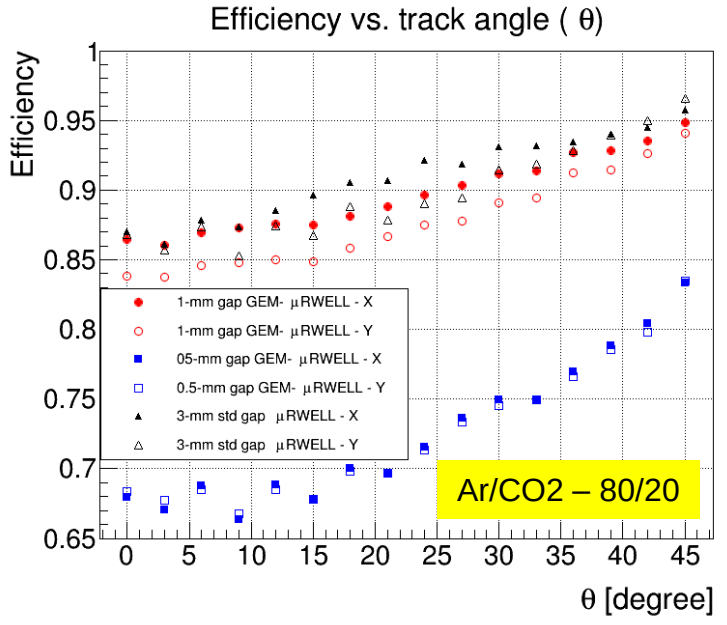
	1-mm proto	0.5-mm proto	3-mm µRWELL
resolution @ 0 degree	80 µm	90 µm	90 um
resolution @ 45 degree	190 µm	140 um	400 um
Efficiency with Ar/CO2	90%	70%	100%











VANDERBILT UNIVERSITY

FY22 Progress Report - VU

Yale University

FY22 Progress Report – Yale U.

Jefferson Lab

FLORIDA TECH

FY23 Proposal

UNIVERSITY of VIRGINIA

Yale University

VANDERBILT UNIVERSITY

TEMPLE UNIVERSITY

FLORIDA TECH

FY23 Proposal:
Mechanically Stretched Double Thin-Gap GEM-µRWELL Hybrid

- Double-sided detector of medium size (30 cm × 30 cm active area) and low mass
- Frame structure allows purely mechanical stretching of GEM foils and drift foils and assembly with minimal application of glue

  => Foil tension can be adjusted during assembly to ensure uniformity of small drift gap (0.5-1mm)

  => Detector can be re-opened to access or swap out components

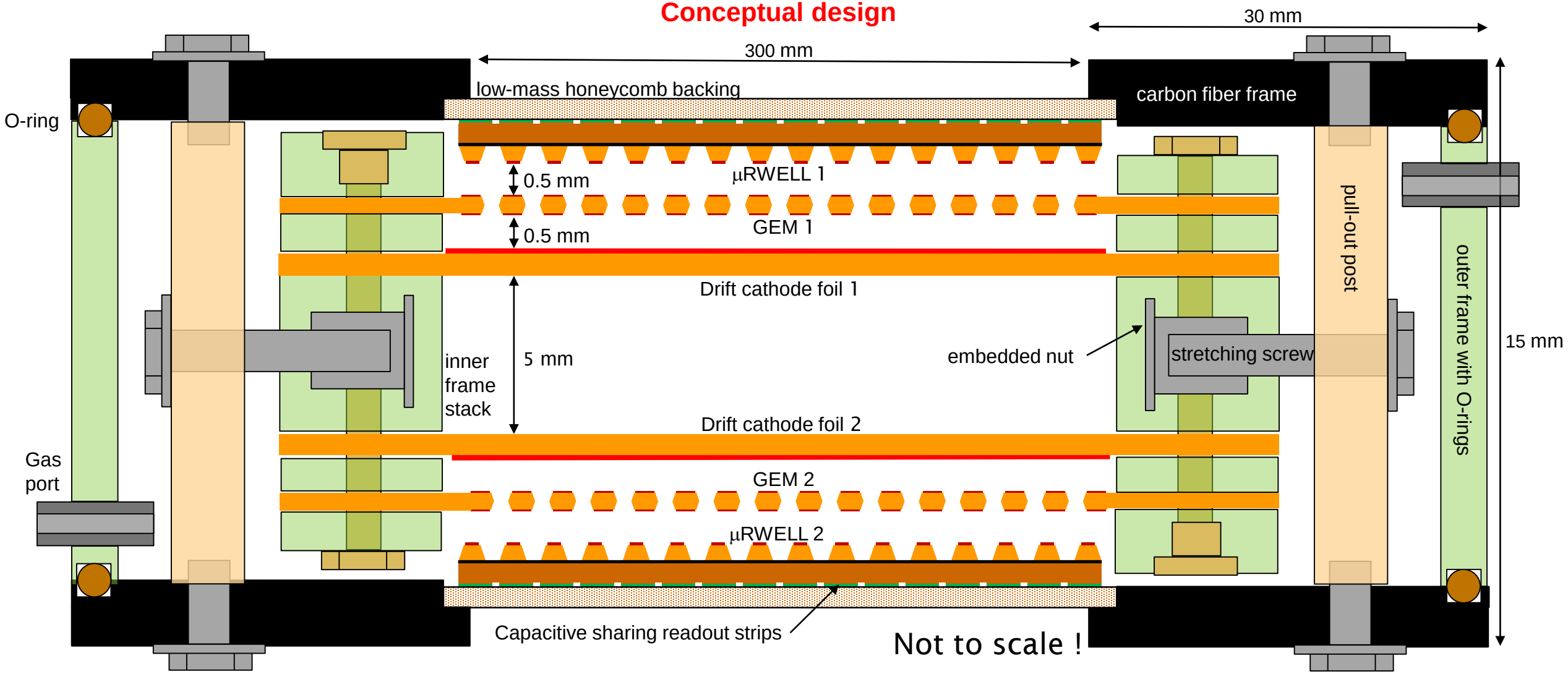
- Use carbon fiber (CF) to provide a stiff outer frame
- Build on experience with mechanically stretched Triple-GEMs from previous eRD6 program and from CMS mass production
- **Approach:**
- Produce technical design and construct a mock-up of the mechanics
- Use Cu-clad Kapton foils as stand-ins for μRWELL and GEM foils
- Investigate and mitigate possible charging up of conductive CF frame with foils under HV

FLORIDA TECH

FY23 Proposal:

Mechanically Stretched Double Thin-Gap GEM-µRWELL Hybrid

Conceptual design



FY23 Proposal – UVa & Vanderbilt

Jefferson Lab

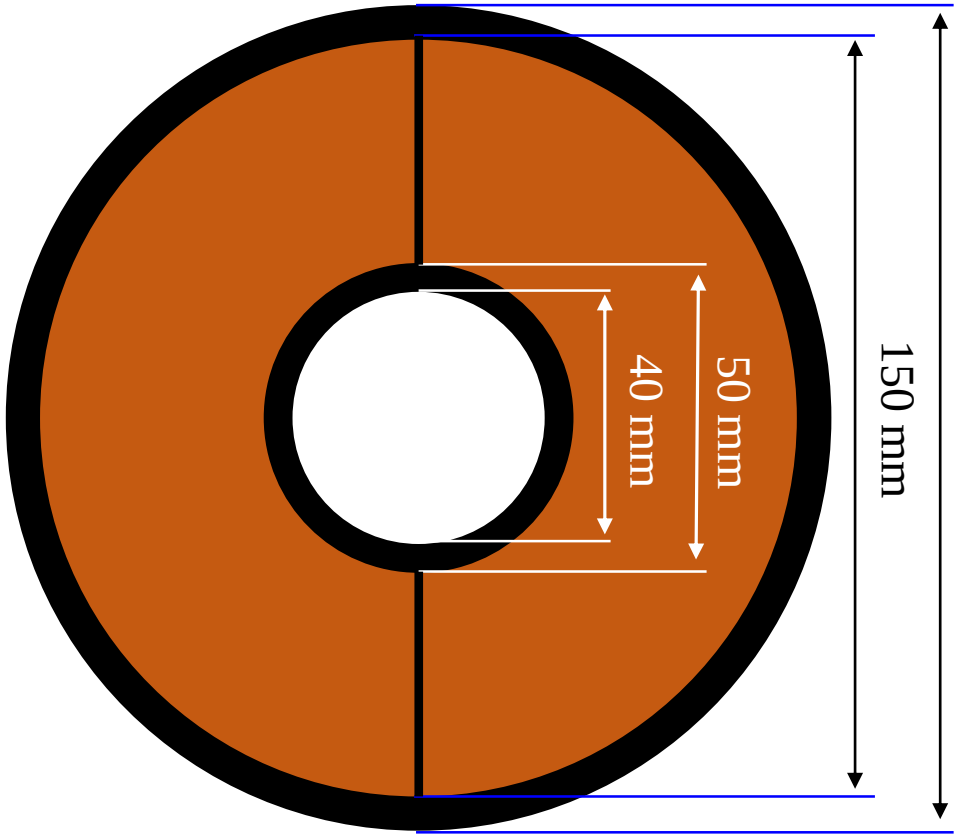
FY23 Proposal:

Double Thin-Gap GEM-μRWELL Hybrid for Tracking in High-η

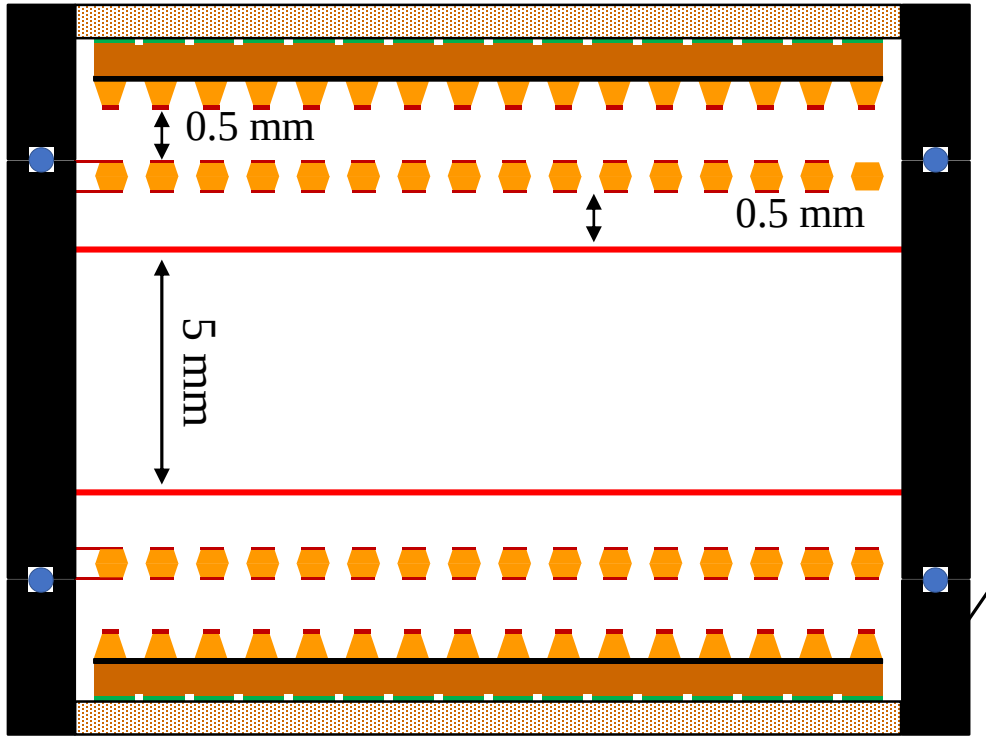
FY23 Proposal:

Double Thin-Gap GEM-μRWELL Hybrid for Tracking in High-η

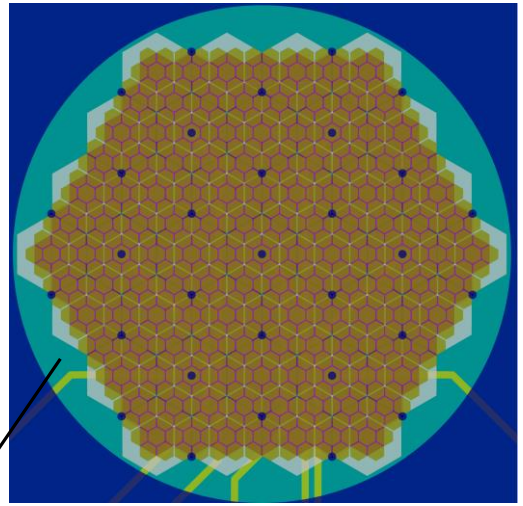
Conceptual design



Top view of high-performance
double thin-gap GEM-uRWELL



Cross section view of high-performance
double thin-gap GEM-uRWELL



Capacitive-sharing
hexagonal pad readout

FY23 Proposal: Budget Request

Jefferson Lab

FLORIDA TECH

Back up

UNIVERSITY of VIRGINIA

Yale University

VANDERBILT UNIVERSITY

TEMPLE UNIVERSITY