

eRD6 Tracking and PID Consortium

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Temple University
(For the eRD6 Consortium)

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College of
Science and Technology
TEMPLE UNIVERSITY®

- ❖ **eRD6**: *Tracking and PID detector R&D towards an EIC detector*
- ❖ Generic EIC R&D Program: https://wiki.bnl.gov/conferences/index.php/EIC_R%25D

Consortium Statistics

- ❖ Number of institutions/labs: 7
- ❖ Number of people: 29
- ❖ Number of publications: 23 (list in last slides)

R&D Focuses

- ❖ Central Tracker
- ❖ End Cap Tracker
- ❖ Particle ID

- ❖ Matt Posik will be serving as a link person between eRD6 and the tracking working group
 - **Email**: posik@temple.edu

❖ Brookhaven National Laboratory (BNL)

- **People:** E.C Aschenauer, B. Azmoun, A. Kiselev, M. L. Purschke, C. Woody.
- **Central Tracker:** TPC and TPC/Cherenkov prototypes; zigzag pad readout, Avalanche structure readout.

❖ Florida Institute Of Technology (FIT)

- **People:** M. Bomberger, J. Collins, M. Hohlmann.
- **Central Tracker:** Cylindrical μ RWELL; **End Cap Tracker:** Large area & low mass GEM with zig-zag readout.

❖ INFN Trieste

- **People:** C. Chatterjee, D. D'Ago , S. Dalla Torre, S. Dasgupta, S. Levorato, F. Tessarotto, Triloki.
- **Particle ID:** Hybrid MPGDs for RICH applications; New photocathode materials for RICH detectors.

❖ Stony Brook University (SBU)

- **People:** K. Dehmelt, A. Deshpande, P. Garg, T. Hemmick.
- **Central Tracker:** TPC-IBF; **Particle ID:** Short radiator length RICH, Large mirror coating, Meta Materials.

❖ Temple University (TU)

- **People:** M. Posik, B. Surrow, N. Lukow, A. Quintero.
- **Central Tracker:** Cylindrical μ RWELL; **End Cap Tracker:** Commercial GEMs.

❖ University Of Virginia (UVa)

- **People:** J. Boyd, M. Dao, K. Gnanvo, N. Liyanage, H. Nguyen.
- **Central Tracker:** Cylindrical μ RWELL; **End Cap Tracker:** Large area & low mass GEM with U-V readout.

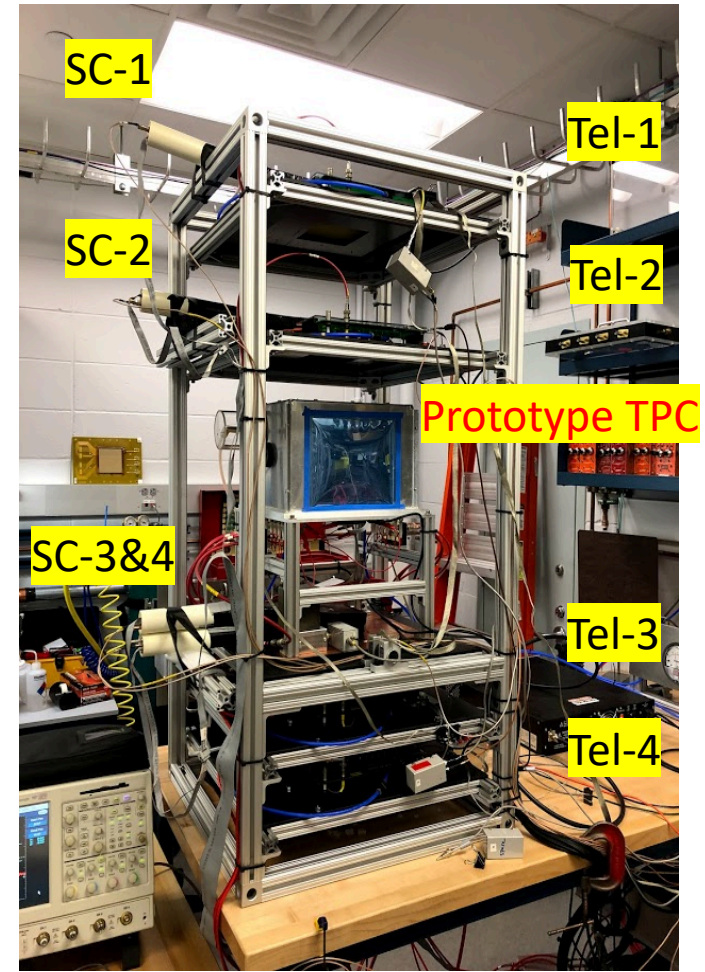
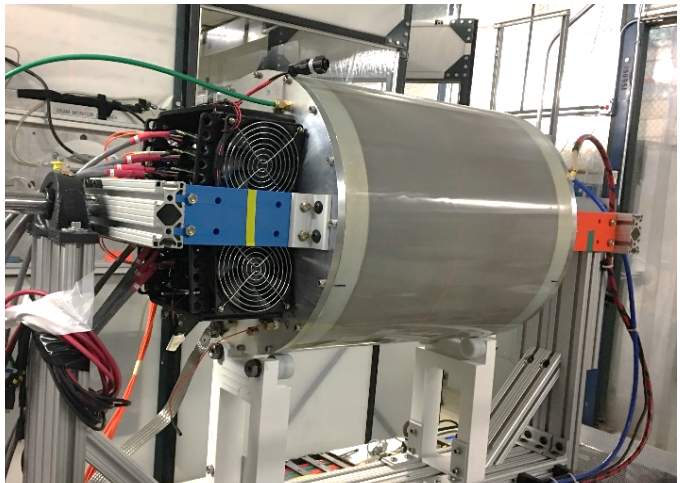
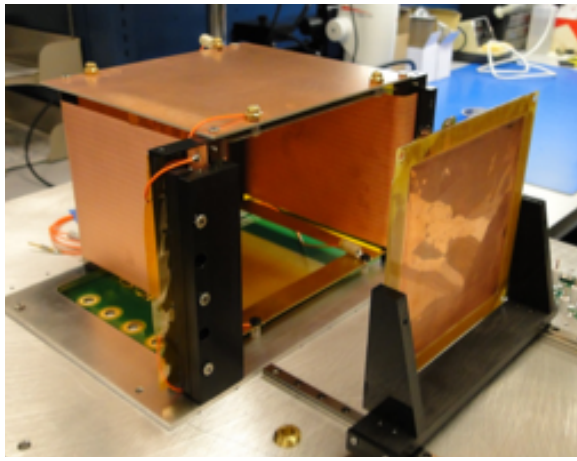
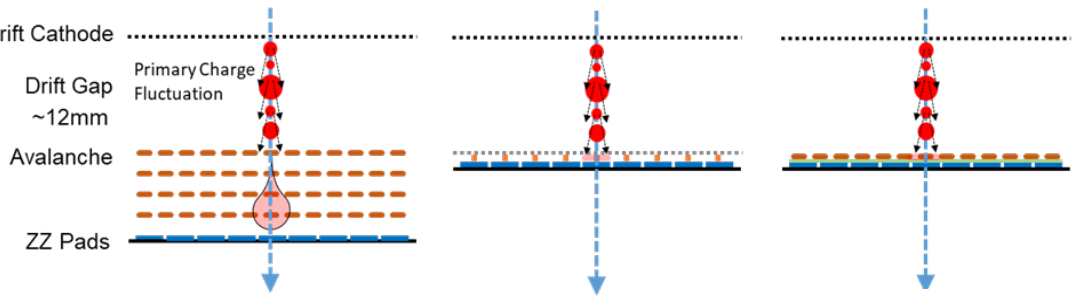
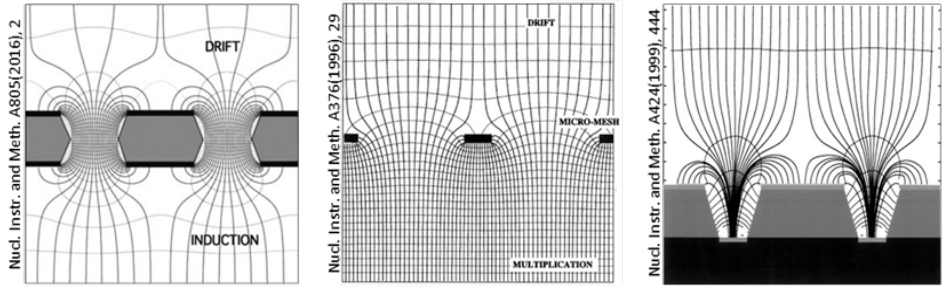
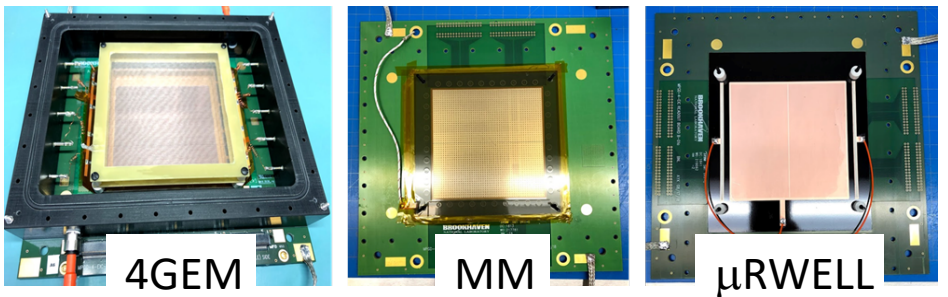
❖ Yale University (YU)

- **People:** D. Majka, N. Smirnov.
- **Central Tracker:** Avalanche structure readout.

The eRD6 R&D Activities: Central Tracking (1)

TPC (BNL, SBU, Yale U)

- MPGD based avalanche structure with zigzag readout for TPC (BNL, Yale U)
- Tests of FE (SAMPA and DREAM) for TPC readout (BNL)
- Investigation to minimize IBF in MPDG based TPC readout (SBU)
- Cherenkov TPC (BNL, SBU)

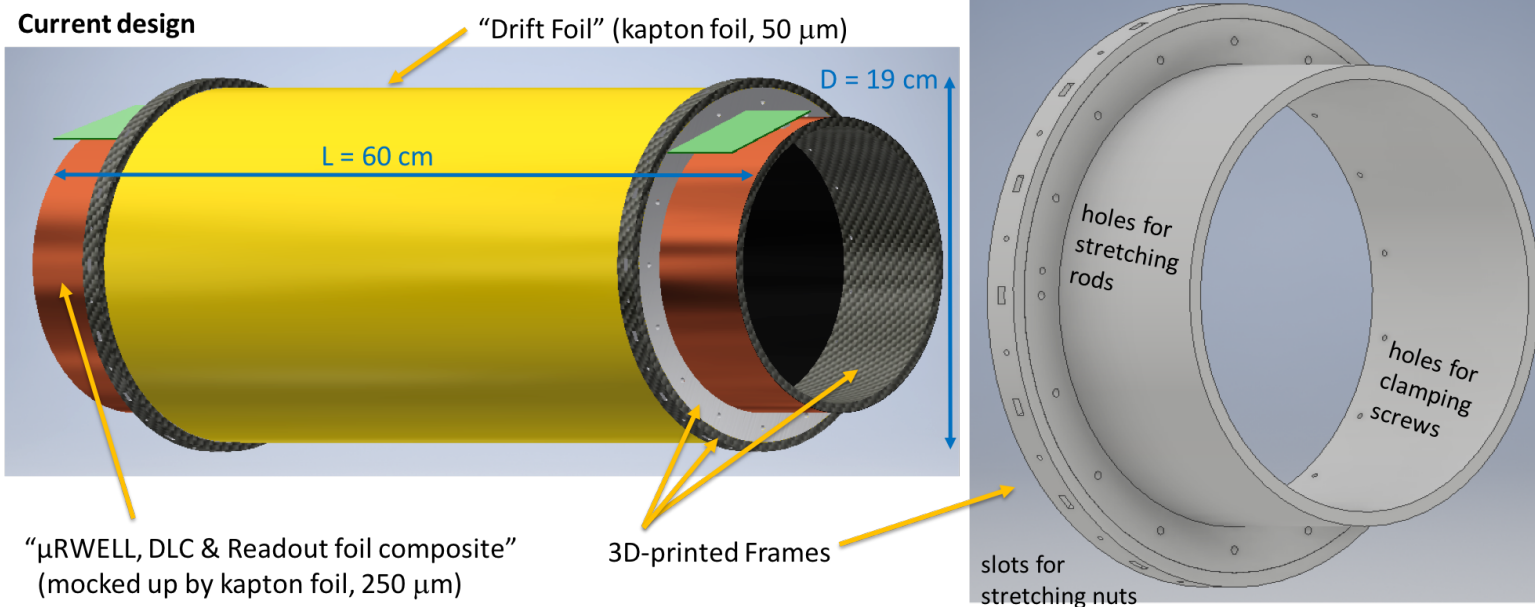


The eRD6 R&D Activities: Central Tracking (2)

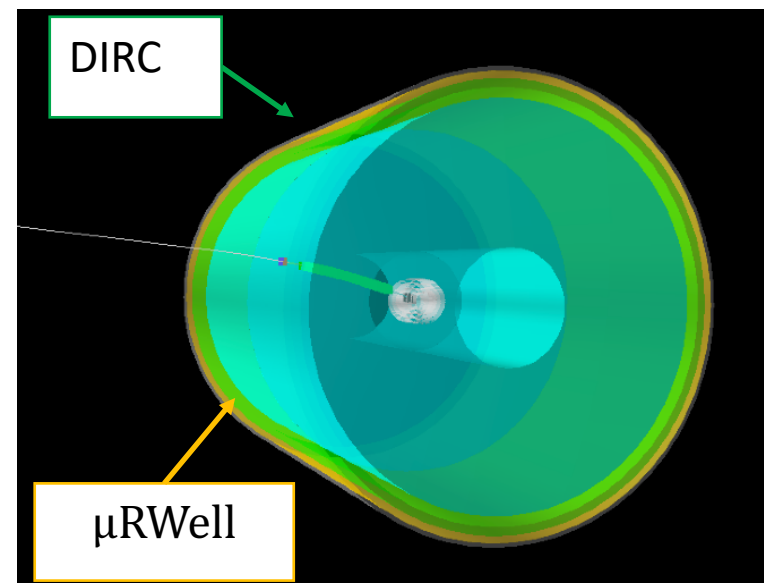
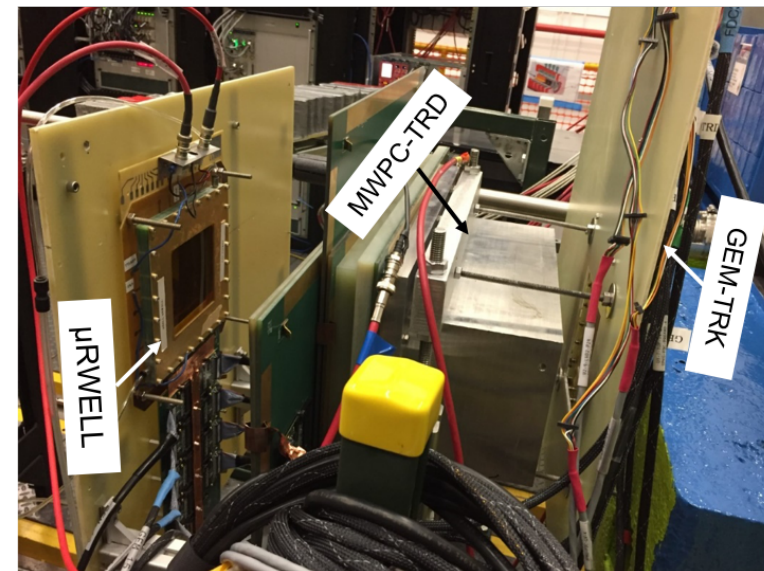
□ Cylindrical μ RWell prototype (FIT, TU, UVa)

- Design of prototype (FIT)
- Simulation of prototype (TU)
- Characterization of small planar prototype with 2D readout strips (UVa)
- Design and characterization of prototype operating in μ RWell (UVa, TU)
- Investigation of new tracking FE (VMM3-SRS) (UVa)

Current design

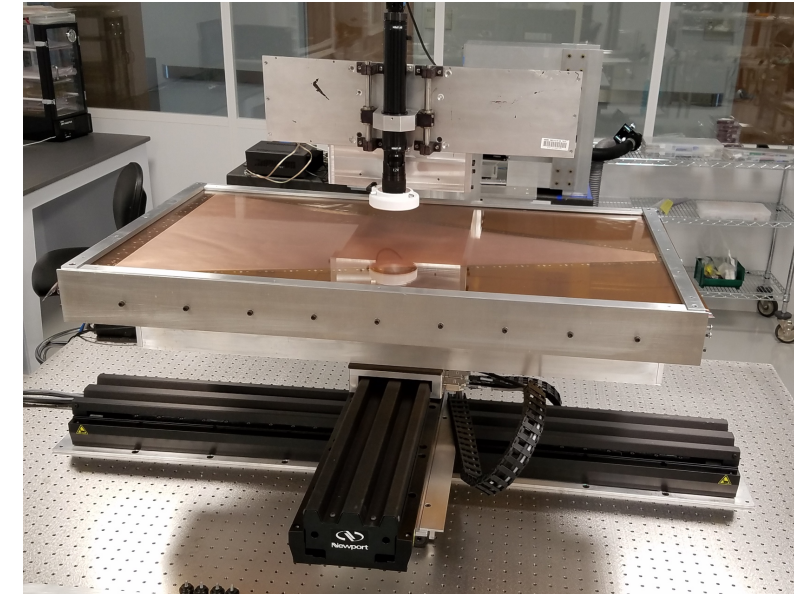
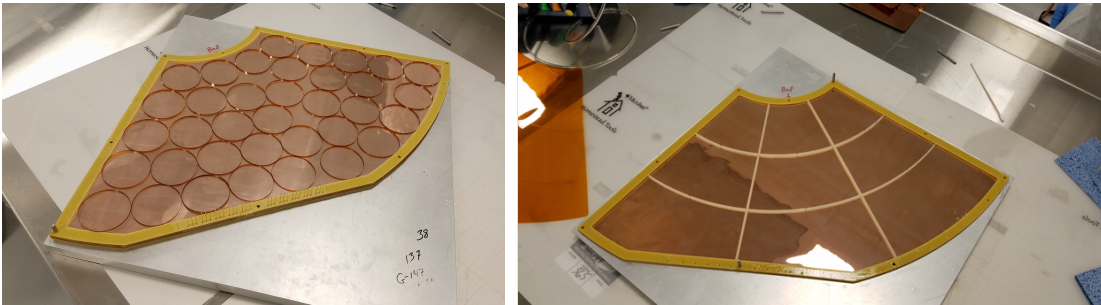


μ RWELL prototype in a test beam setup in Hall D @ JLab

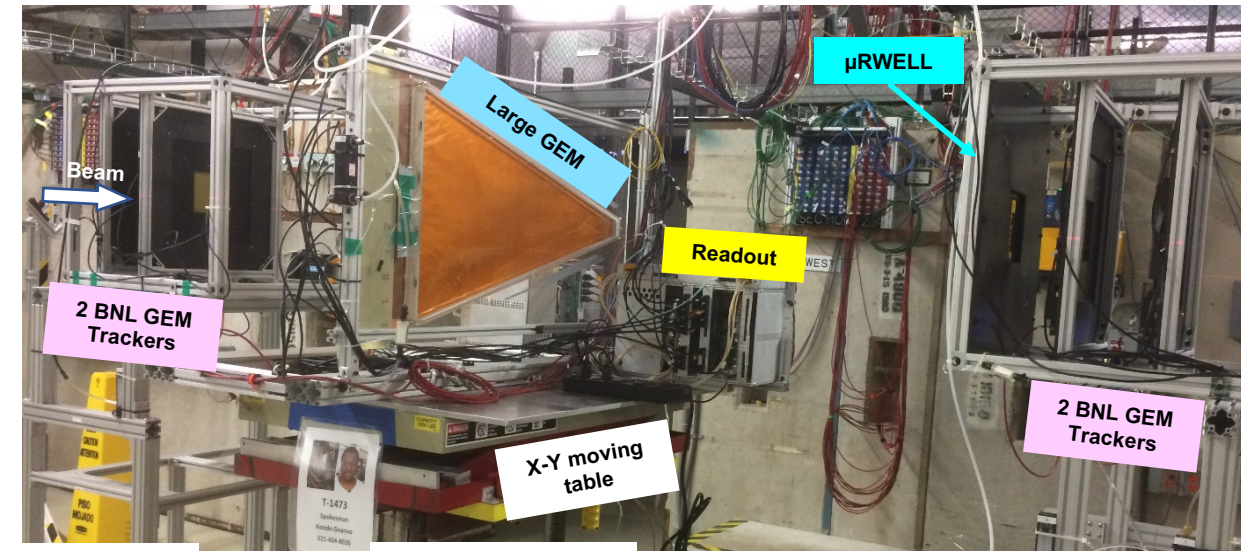
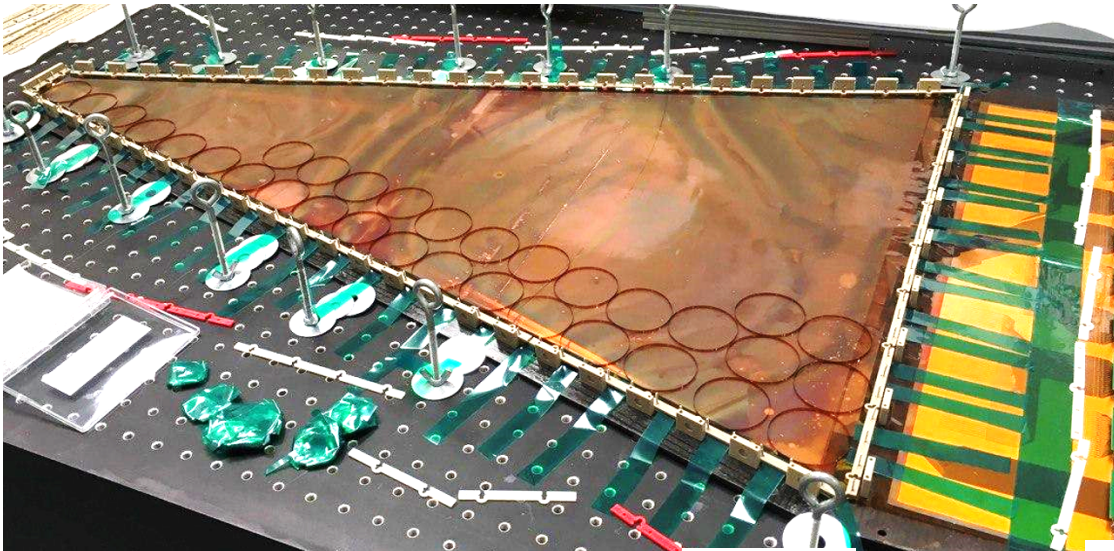


The eRD6 R&D Activities: End Cap Tracking

- **Low Mass Large Area GEM Tracker (FIT, TU, UVa)**
 - Simulation of end cap GEM trackers (FIT)
 - GEM tracker assembly techniques (FIT, TU, UVa)
 - Characterization of large area GEM trackers (FIT, UVa)
 - GEM commercialization and optical foil QA (CCD Scanner) (TU)

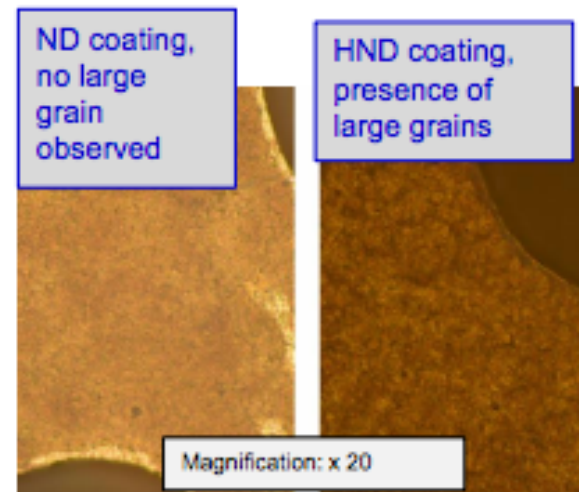
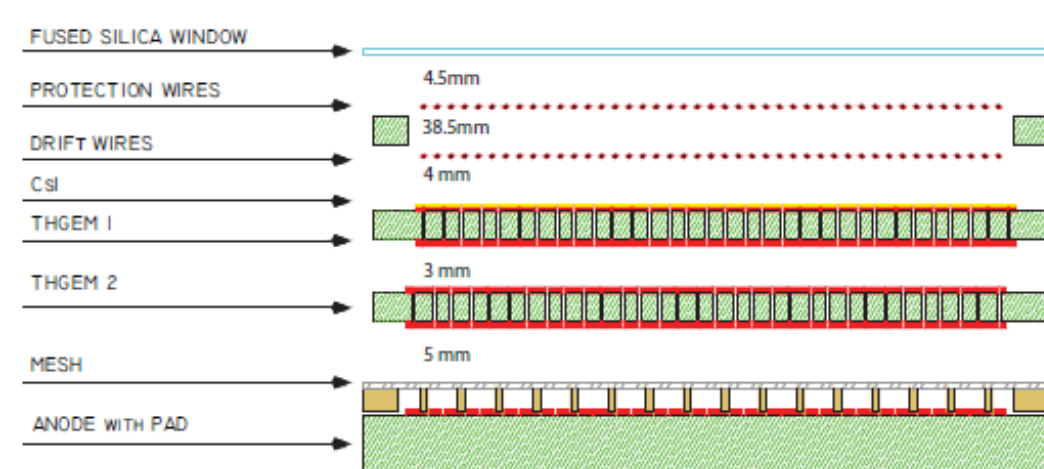


Large GEM Setup in MT6.2b Area at FTBF (June-July 2018)



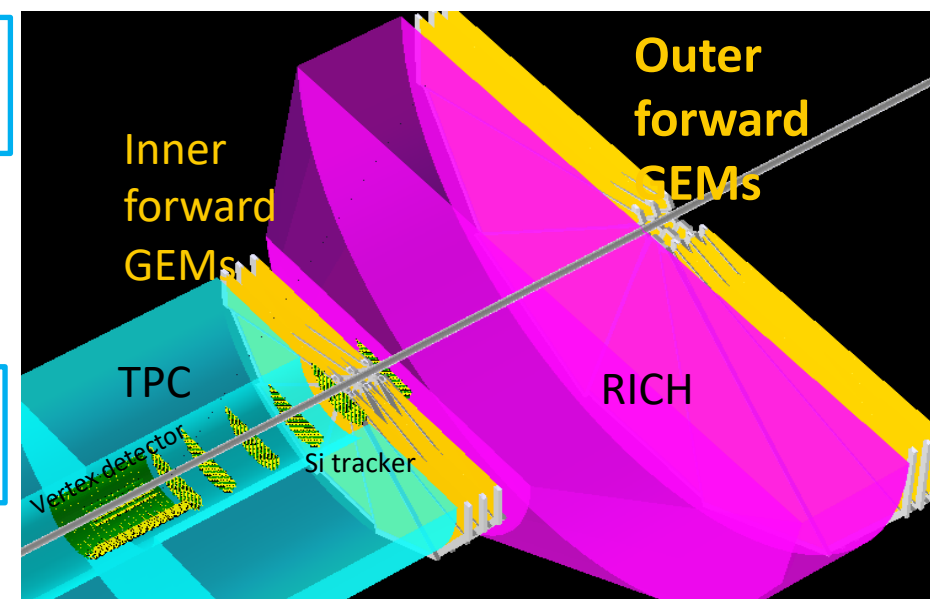
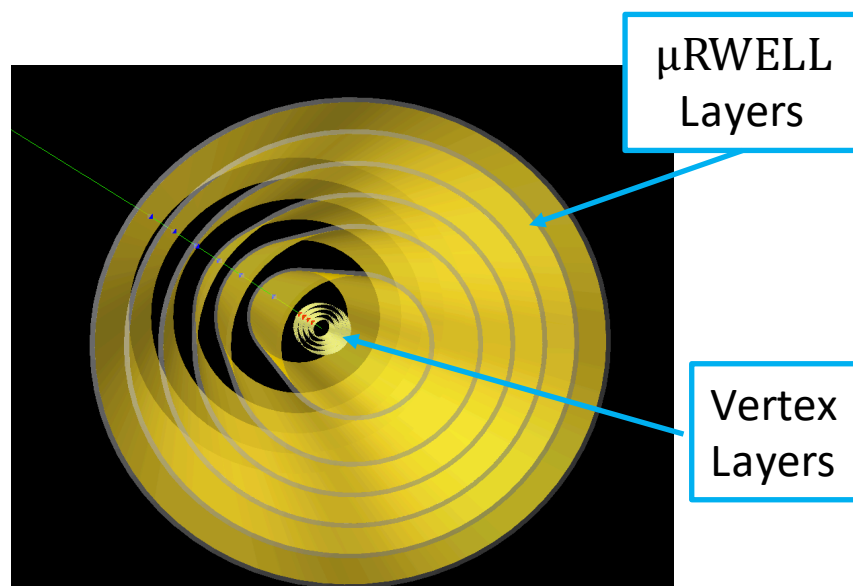
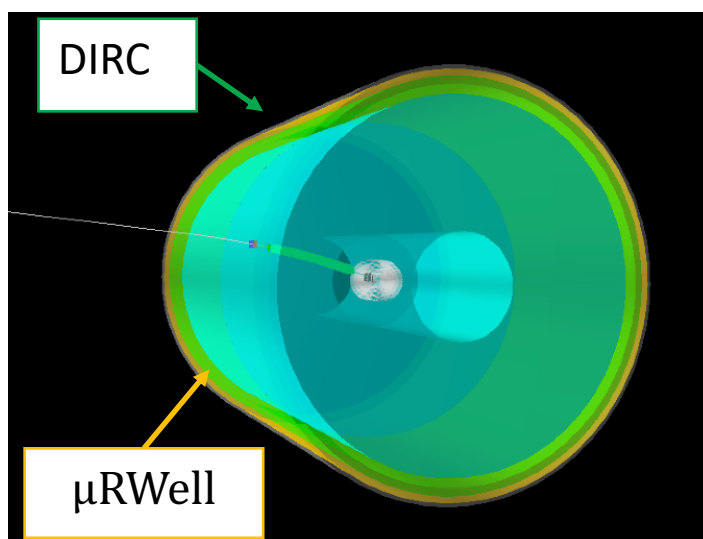
□ PID (INFN, SBU)

- Gaseous single photon detection with hybrid MPGDs for high p RICH (INFN)
- Photocathode development based on nano-diamond particles (INFN)
- Large Mirror fabrication for RICH (SBU)
- Meta Materials (SBU)



□ Simulations (FIT, TU)

- Actively involved in tracking performance studies of central and end cap regions
- Investigating $\mu RWell$ cylindrical trackers and TPC in central region (TU)
- Investigating performance of GEM trackers in the forward region (FIT)



eRD6 Publications

❖ BNL

1. B. Azmoun et al. “Results From a Prototype Combination TPC Cherenkov Detector With GEM Readout”. In: IEEE Transactions on Nuclear Science 66.8 (Aug. 2019), pp. 1984–1992. [issn: 1558- 1578](#). [doi: 10.1109/TNS.2019.2928269](#).
2. Maxence Vandenbroucke et al. “A Study of “Zigzag” Strip Readout for Micromegas Detectors”. In: 2018 IEEE Nuclear Science Symposium and Medical Imaging Conference (2018 NSS/MIC). Nov. 2018, pp. 1–4. [doi: 10.1109/NSSMIC.2018.8824702](#).
3. B. Azmoun et al. “Design Studies for a TPC Readout Plane Using Zigzag Patterns with Multistage GEM Detectors”. In: IEEE Transactions on Nuclear Science (July 2018), pp. 1–1. [issn: 0018-9499](#). [doi: 10.1109/TNS.2018.2846403](#).
4. B. Azmoun et al. “A Study of a Mini-Drift GEM Tracking Detector”. In: IEEE Transactions on Nuclear Science 63.3 (June 2016), pp. 1768–1776. [issn: 0018-9499](#). [doi: 10.1109/TNS.2016.2550503](#).
5. Craig Woody et al. “A Prototype Combination TPC Cherenkov Detector with GEM Readout for Tracking and Particle Identification and its Potential Use at an Electron Ion Collider”. In: 2015. [arXiv: 1512.05309 \[physics.ins-det\]](#). [url: https://inspirehep.net/record/1409973/files/arXiv: 1512.05309.pdf](#).
6. B. Azmoun et al. “Initial studies of a short drift GEM tracking detector”. In: 2014 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC). Nov. 2014, pp. 1–2. [doi: 10.1109/ NSSMIC.2014.7431059](#).
7. M. L. Purschke et al. “Test beam study of a short drift GEM tracking detector”. In: 2013 IEEE Nuclear Science Symposium and Medical Imaging Conference (2013 NSS/MIC). Oct. 2013, pp. 1–4. [doi: 10.1109/NSSMIC.2013.6829463](#).

❖ INFN

1. J. Agarwala et al. “*The MPGD-based photon detectors for the upgrade of COMPASS RICH-1 and beyond*”. In: Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment (2018). [issn : 0168-9002](#). [doi : https://doi.org/10.1016/j.nima.2018.10.092](#) . [url : http://www.sciencedirect.com/science/article/pii/S0168900218314062](#) .
2. J. Agarwala et al. “*Study of MicroPattern Gaseous detectors with novel nanodiamond based photocathodes for single photon detection in EIC RICH*”. In: Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment (2019). [issn : 0168-9002](#). [doi : https://doi.org/10.1016/j.nima.2019.03.022](#) . [url : http://www.sciencedirect.com/science/article/pii/S0168900219303213](#) .

eRD6 Publications

❖ FIT

1. Marcus Hohlmann et al. “*Low-mass GEM detector with radial zigzag readout strips for forward tracking at the EIC*”. In: 2017 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC 2017) Atlanta, Georgia, USA, October 21-28, 2017. 2017. [arXiv: 1711.05333 \[physics.ins-det\]](https://arxiv.org/abs/1711.05333). url: <http://inspirehep.net/record/1636290/files/arXiv:1711.05333.pdf>.
2. Aiwu Zhang et al. “*A GEM readout with radial zigzag strips and linear charge-sharing response*”. In: Nucl. Instrum. Meth. A887 (2018), pp. 184. [arXiv: 1708.07931 \[physics.ins-det\]](https://arxiv.org/abs/1708.07931).
3. Aiwu Zhang and Marcus Hohlmann. “*Accuracy of the geometric-mean method for determining spatial resolutions of tracking detectors in the presence of multiple Coulomb scattering*”. In: JINST 11.06 (2016), P06012. doi: [10.1088/1748-0221/11/06/P06012](https://doi.org/10.1088/1748-0221/11/06/P06012). [arXiv: 1604.06130 \[physics.data-an\]](https://arxiv.org/abs/1604.06130).
4. Aiwu Zhang et al. “*R&D on GEM detectors for forward tracking at a future Electron-Ion Collider*”. In: Proceedings, 2015 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC 2015): San Diego, California, United States. 2016, p. 7581965. doi: [10.1109/NSSMIC.2015.7581965](https://doi.org/10.1109/NSSMIC.2015.7581965). [arXiv: 1511.07913 \[physics.ins-det\]](https://arxiv.org/abs/1511.07913). url: <http://inspirehep.net/record/1406551/files/arXiv:1511.07913.pdf>.
5. Aiwu Zhang et al. “*Performance of a Large-area GEM Detector Read Out with Wide Radial Zigzag Strips*”. In: Nucl. Instrum. Meth. A811 (2016), pp. 30. doi: [10.1016/j.nima.2015.11.157](https://doi.org/10.1016/j.nima.2015.11.157). [arXiv:1508.07046 \[physics.ins-det\]](https://arxiv.org/abs/1508.07046).

❖ SBU

1. M. Blatnik et al. “*Performance of a Quintuple-GEM Based RICH Detector Prototype*”. In: IEEE Trans. Nucl. Sci. 62.6 (2015), pp. 3256. doi :[10.1109/TNS.2015.2487999](https://doi.org/10.1109/TNS.2015.2487999) . [arXiv: 1501.03530\[physics.ins-det\]](https://arxiv.org/abs/1501.03530) .

eRD6 Publications

❖ TU

1. M. Posik and B. Surrow. "Construction of a Triple-GEM Detector Using Commercially Manufactured Large GEM Foils". In: 2018. [arXiv: 1806.01892 \[physics.ins-det\]](#).
2. M. Posik and B. Surrow. "Construction of Triple-GEM Detectors Using Commercially Manufactured Large GEM Foils". In: Proceedings, 2016 IEEE Nuclear Science Symposium and Medical Imaging Conference: NSS/MIC 2016: Strasbourg, France. 2016, p. 8069743. [doi: 10.1109/NSSMIC.2016.8069743](#). [arXiv: 1612.03776 \[physics.ins-det\]](#).
3. M. Posik and B. Surrow. "Optical and electrical performance of commercially manufactured large GEM foils". In: Nucl. Instrum. Meth. A802 (2015), pp. 10. [doi: 10.1016/j.nima.2015.08.048](#). [arXiv:1506.03652 \[physics.ins-det\]](#).
4. M. Posik and B. Surrow. "R&D of commercially manufactured large GEM foils". In: Proceedings, 2015 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC 2015): San Diego, California, United States. 2016, p. 7581802. [doi: 10.1109/NSSMIC.2015.7581802](#). [arXiv: 511.08693 \[physics.ins-det\]](#).
5. M. Posik and B. Surrow. "Research and Development of Commercially Manufactured Large GEM Foils". In: Proceedings, 21st Symposium on Room-Temperature Semiconductor X-ray and Gamma-ray Detectors (RTSD 2014): Seattle, WA, USA, November 8-15, 2014. 2016, p. 7431060. [doi: 10.1109/NSSMIC.2014.7431060](#). [arXiv: 1411.7243 \[physics.ins-det\]](#). [\[physics.ins-det\]](#).

❖ UVa

1. Kondo Gnanvo et al. "Large Size GEM for Super Bigbite Spectrometer (SBS) Polarimeter for Hall A 12 GeV program at JLab". In: Nucl. Instrum. Meth. A782 (2015), pp. 77. [doi : 10.1016/j.nima.2015.02.017](#) . [arXiv: 1409.5393 \[physics.ins-det\]](#) .
2. Kondo Gnanvo et al. "Performance in test beam of a large-area and light-weight GEM detector with 2D stereo-angle (UV) strip readout". In: Nucl. Instrum. Meth. A808 (2016), pp. 83. [doi : 10.1016/j.nima.2015.11.071](#) . [arXiv: 1509.03875 \[physics.ins-det\]](#) .

❖ Yale

1. S. Aiola et al. "Combination of two Gas Electron Multipliers and a Micromegas as gain elements for a time projection chamber". In :Nucl. Instrum. Meth. A834 (2016), pp. 149. [doi: 10.1016/j.nima.2016.08.007](#). [arXiv: 1603.08473 \[physics.ins-det\]](#).