

Athena Tracking WG
Technological Readiness and R&D

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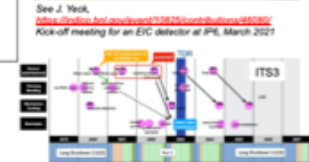
Silicon Vertex and Tracker

- Technological readiness
 - Sensor development compatible with EIC timescale
 - Services and support development apace sensor development
- R&D
 - EIC SC groups integrated with ITS3-WP2 (sensor design), ITS3-WP3 (sensor characterisation), ITS-WP4 (thinning, bending and interconnection)
 - First 65 nm test structures to be delivered by TJ mid-June, next submission planned for beginning 2022 including stitched sensor (EIC institutes RAL/Brunel, BNL, LBNL))
 - Service and support estimates and analysis of powering schemes available
 - <https://www.eicug.org/web/sites/default/files/Powering-options-for-an-EIC-silicon-tracker.pdf>
 - Work well advanced on sensor thinning and bending for vertex layers
 - https://indico.bnl.gov/event/11683/contributions/49635/attachments/34576/56090/EIC_SC_2_0210517_Contin.pdf

Timeline

- The timeline for the development is tied to the sensor development

Year	Main tasks
2021	Submission of the second MLR .
2022	Submission of the first engineering run (ITS) .
2023	Submission of the first engineering run (EIC variant) , second engineering run (ITS3).
2024	Submission of the second engineering run (EIC variant) .
2025	Integration of prototype sensors into disc and stave. Possible contingency submission of EIC variant.



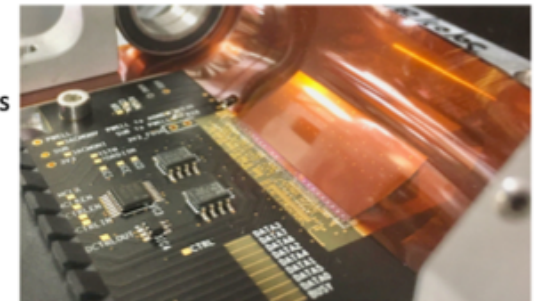
L. Gonella | eRD25 FY21 report | EIC Detector R&D meeting, 24 March 2021

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MLR1 65 nm submission



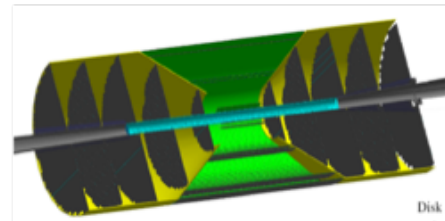
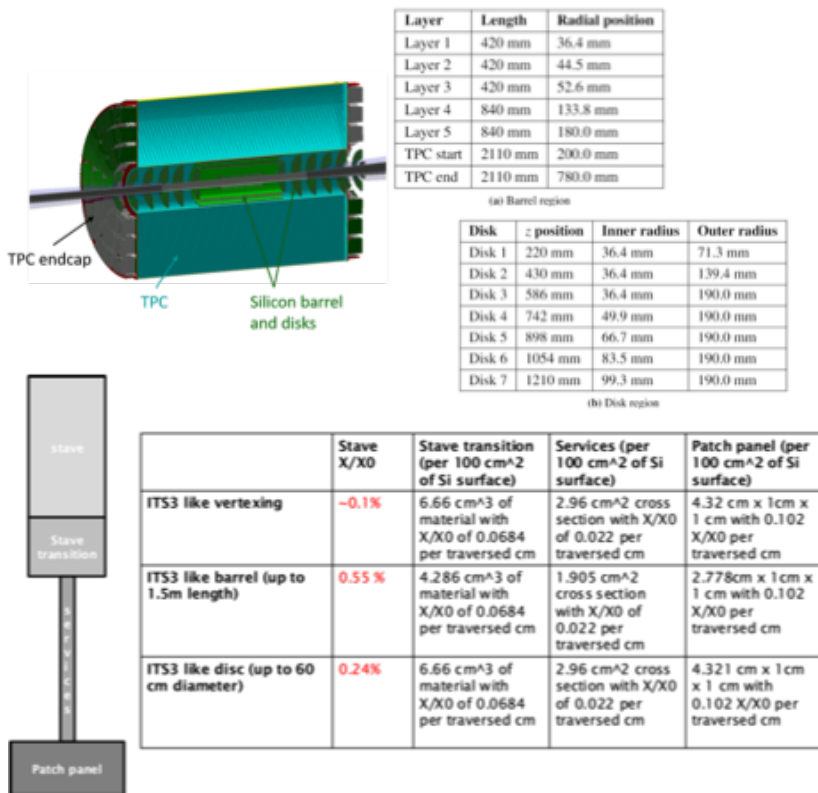
Bent ALPIDE
 (short side)
 18-22 mm radius



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Silicon Vertex and Tracker

- Detector realistic size and services
 - 12-15 m² based on YR hybrid and all-silicon configurations, further layout optimisations ongoing




Barrel layer	radius [cm]	length along z [cm]	Disk number	z position [cm]	outer radius [cm]	inner radius [cm]
			-5	-121	43.23	4.41
			-4	-97	43.23	3.70
			-3	-73	43.23	3.18
			-2	-49	36.26	3.18
			-1	-25	18.50	3.18
1	3.30	30	1	25	18.50	3.18
2	5.70	30	2	49	36.26	3.18
3	21.00	54	3	73	43.23	3.50
4	22.68	60	4	97	43.23	4.70
5	39.30	105	5	121	43.23	5.91
6	43.23	114				

<https://indico.bnl.gov/event/8231/contributions/37955/>
<https://indico.bnl.gov/event/9080/contributions/40920/>

MPGD Trackers: GEMs

GEM End Cap Trackers

- Technological Readiness: very mature and frequently used
- R&D: generic R&D to be completed late this year early 2022
 - assembly and readout structure  under beam test now
- Targeted R&D:
 - Capacitive sharing
 - Streaming readout
 - Support structure (prelim. Design exists)
 - All but CF support material included in simulation

GEM-TRD Tracker

- Technological Readiness: On pace for EIC readiness
- R&D
 - Readout architecture tests to optimize
 - S/N, channel count and resolution: strip, pad, zig-zag
 - Tests of new streaming readout and ML-FPGA
 - Tests of different radiators
 - Large scale prototype
 - Develop recirculation and purification gas system
 - Finalize streaming readout architecture

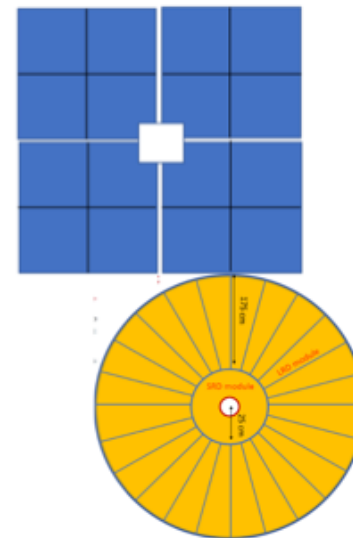
More details: https://wiki.bnl.gov/conferences/index.php/March_2021
Athena Bi-Monthly Meeting June 10th, 2021

Realistic GEM size (preliminary):

- ~ 3 disks per beam direction
- Size/Module: ~100 cm x 50 cm
- ~ 12 modules/disk

GEM service estimates (preliminary):

- HV channel per module
- Gas distribution lines
- If FEE close to the detectors, then LV and data lines
- If far away FEE, long thin coaxial cables



Carbon fiber GEM end cap support structure



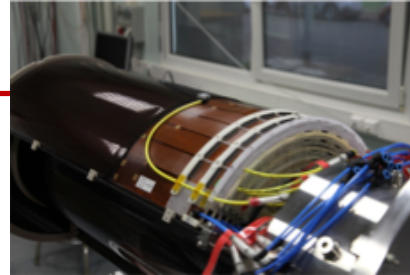
Detector installation



Wheel support frame

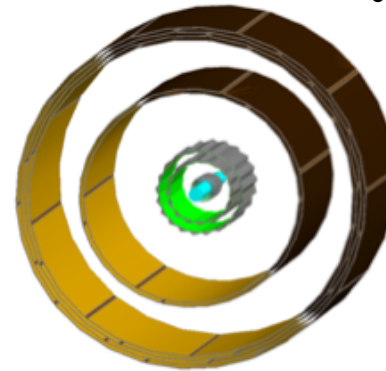
GEM-TRD Examples

MPGD Trackers: Micromegas



Micromegas barrel tracker

- ❑ Technological Readiness:
 - very mature
 - based on CLAS12 MM, taking data since 2017
 - Fulfills the YR requirements (simulations included in YR)
- ❑ Targeted R&D:
 - 2D readout pattern, based on LDRD zigzag studies
 - A large scale 2D prototype to be built in 2023
 - Support structure



Realistic size (preliminary):

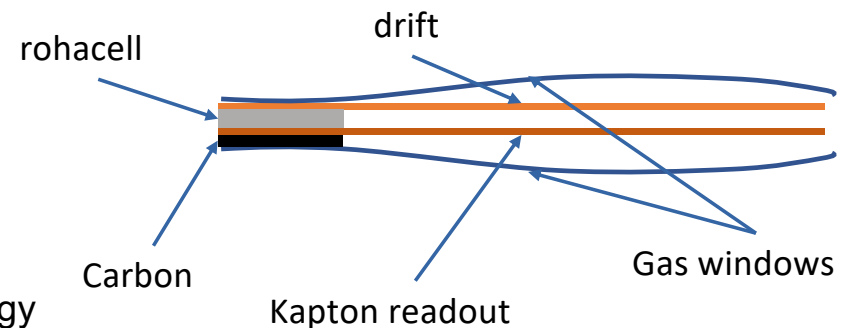
- (up to) 6 layers
- Radii: from 48 to 80cm
- Tile's max size: $\sim 50 \times 75 \text{cm}^2$
- #tiles: (up to) 100 tiles

Service estimates (preliminary):

- (At least) 2 HV channels per tile
- Gas distribution lines
- If FEE close to the detectors, then LV and data lines
- If far away FEE, long thin coaxial cables

Ultra light Micromegas

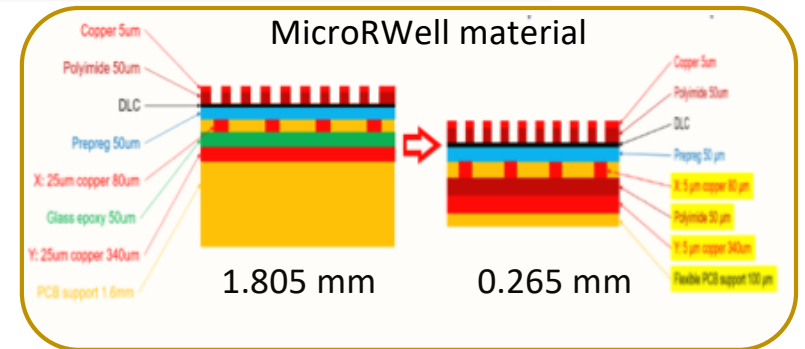
- ❑ Technological Readiness:
 - Preliminary R&D, on the timescale of EIC
- ❑ R&D:
 - Goal: reach less than 0.07% of X_0 in the active region
 - PCB \rightarrow Just a Kapton layer (2021)
 - Inox mesh \rightarrow LASER etched Al or Cu (2022)
 - Cu strips \rightarrow deposited Al (2023)
 - Some of these R&Ds can be ported to the curved technology too



MPGD Trackers: MicroWell

MicroWell End Cap Trackers

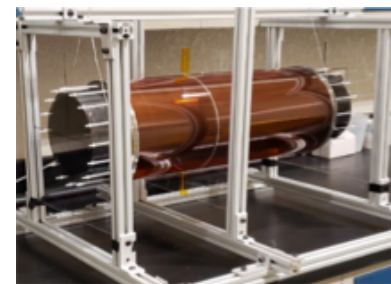
- Technological Readiness: Can be ready for EIC, but more R&D needed
- R&D:
 - Low-mass large-area prototype (synergy with prototyping at JLab)
 - Optimization of readout pattern and channel count – capacitive sharing
 - Large-area MicroWell R&D completed ~ 2023-2024
 - Support structure (see GEM)



MicroWell Barrel Tracker

- Technological Readiness: On the timescale of EIC
- R&D:
 - 2021- Completion of small scale mock-up
 - 2022- test of small cylindrical prototype
 - 2022-2023- Design and building of large radial prototype
 - 2024-2025 – Test of large prototype

More details: https://wiki.bnl.gov/conferences/index.php/March_2021



Service estimates (preliminary):

- similar to micromegas

Size estimates (preliminary):

- similar to GEM for end cap
- similar to micromegas for barrel

Small radial
MicroWell mock-up

