INFN

Brookhaven National Laboratory

Jefferson Lab

U.S. DEPARTMENT OF ENERGY

MPGD ENDCAP Trackers (ECT) for ePIC

GEM–μRWELL technology

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In collaboration with: G. Bencivenni, M. Giovannetti, M. Poli Lener, G. Morello

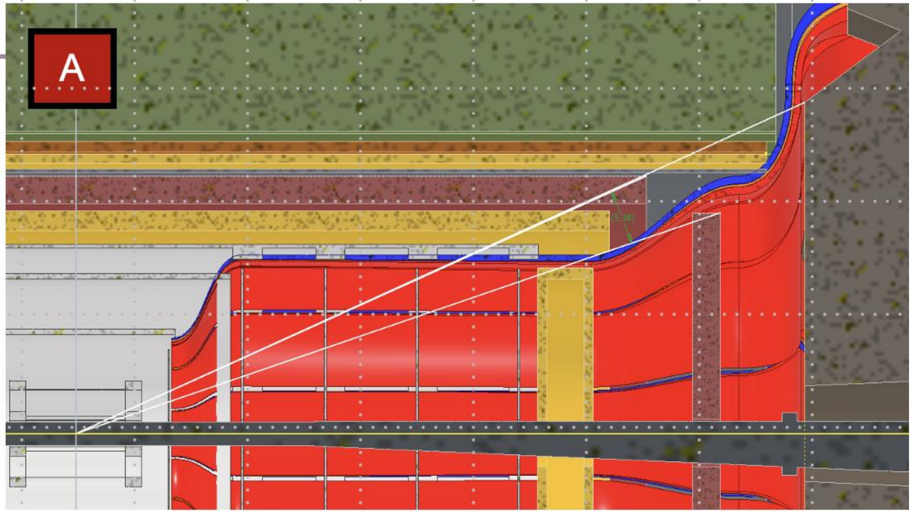
INFN ePIC Referee Meeting
Torino, July 35, 2025

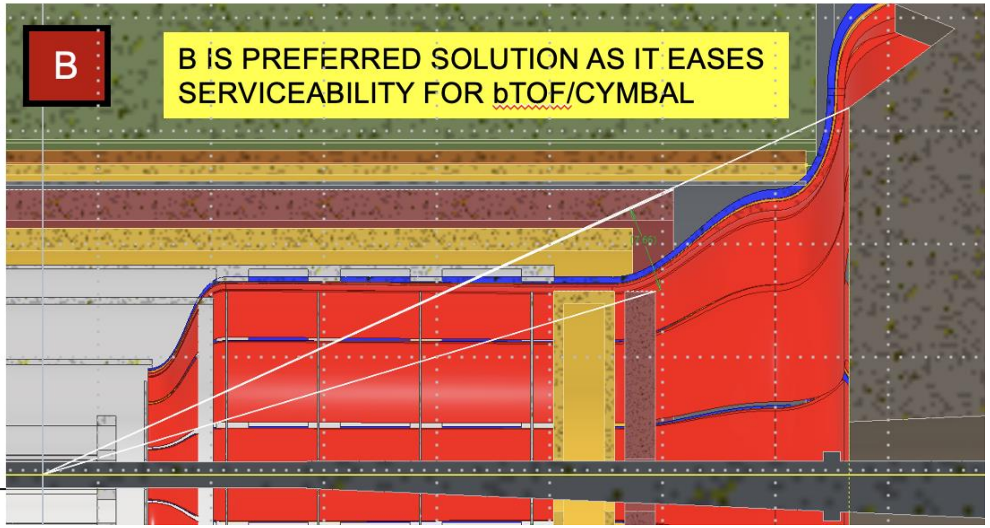
Electron-Ion Collider

The ePIC MPGD End Cap Tracker Envelope and Active Regions

Forward MPGD goes Backwards

- Requires moving the SVT disks towards IP. ToF will either be removable and supported by GST in option A or not removable and supported by the PST in option B.
- MPGD:
  - Inner Face Z: 1285mm
  - Thickness Z: 150mm
  - Outer Radius: 450mm
- A: ToF stays at current location
  - 5.4 deg ToF coverage angle
  - ToF Inner Face Z: 1675mm
  - ToF Thickness Z: 75mm
  - ToF Outer Radius: 600mm
- B: ToF is moved next to MPGD disks
  - 7.7 deg ToF coverage angle
  - ToF Inner Face Z: 1475mm
  - ToF Thickness Z: 75mm
  - ToF Outer Radius: 450mm





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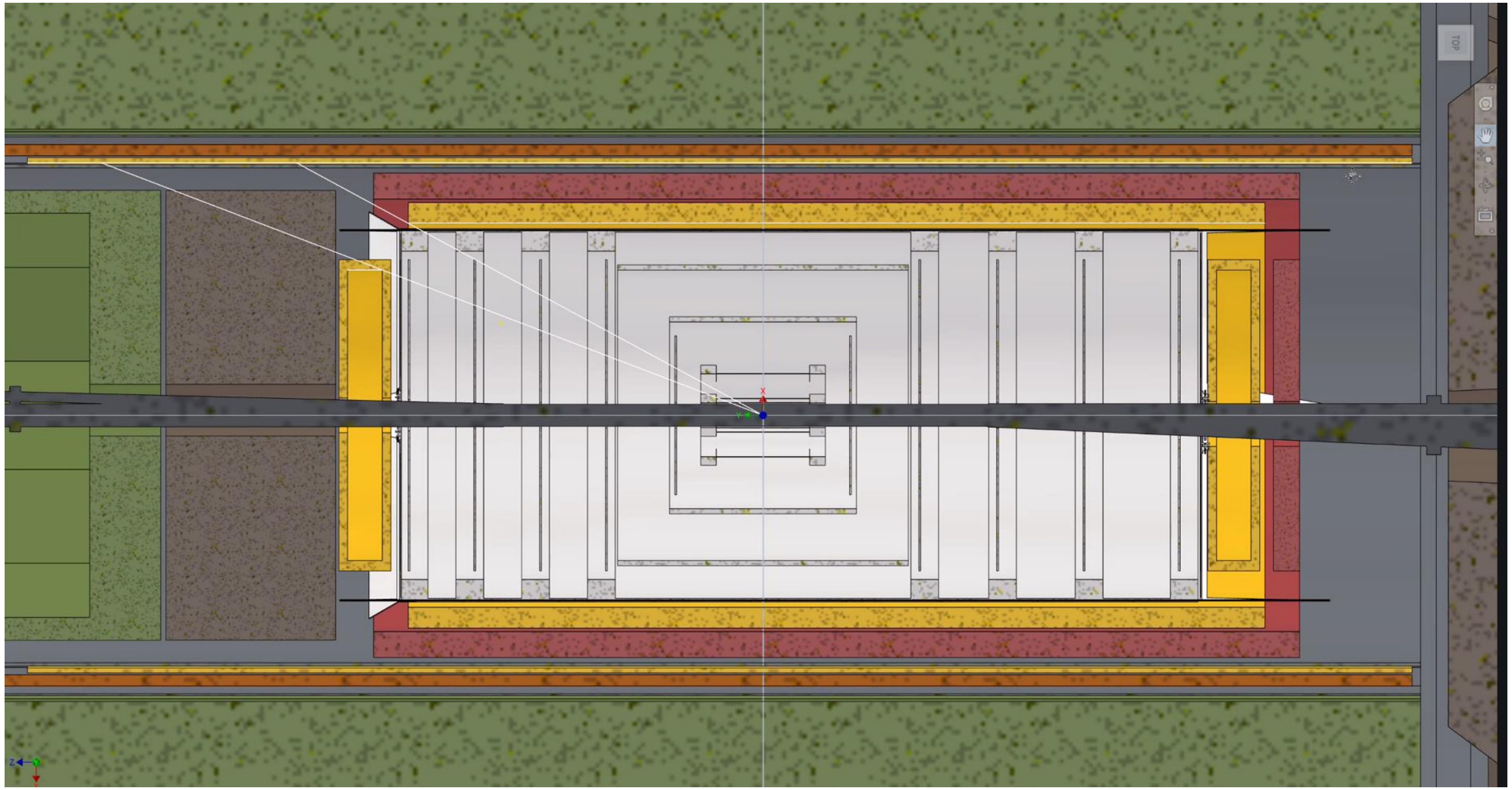

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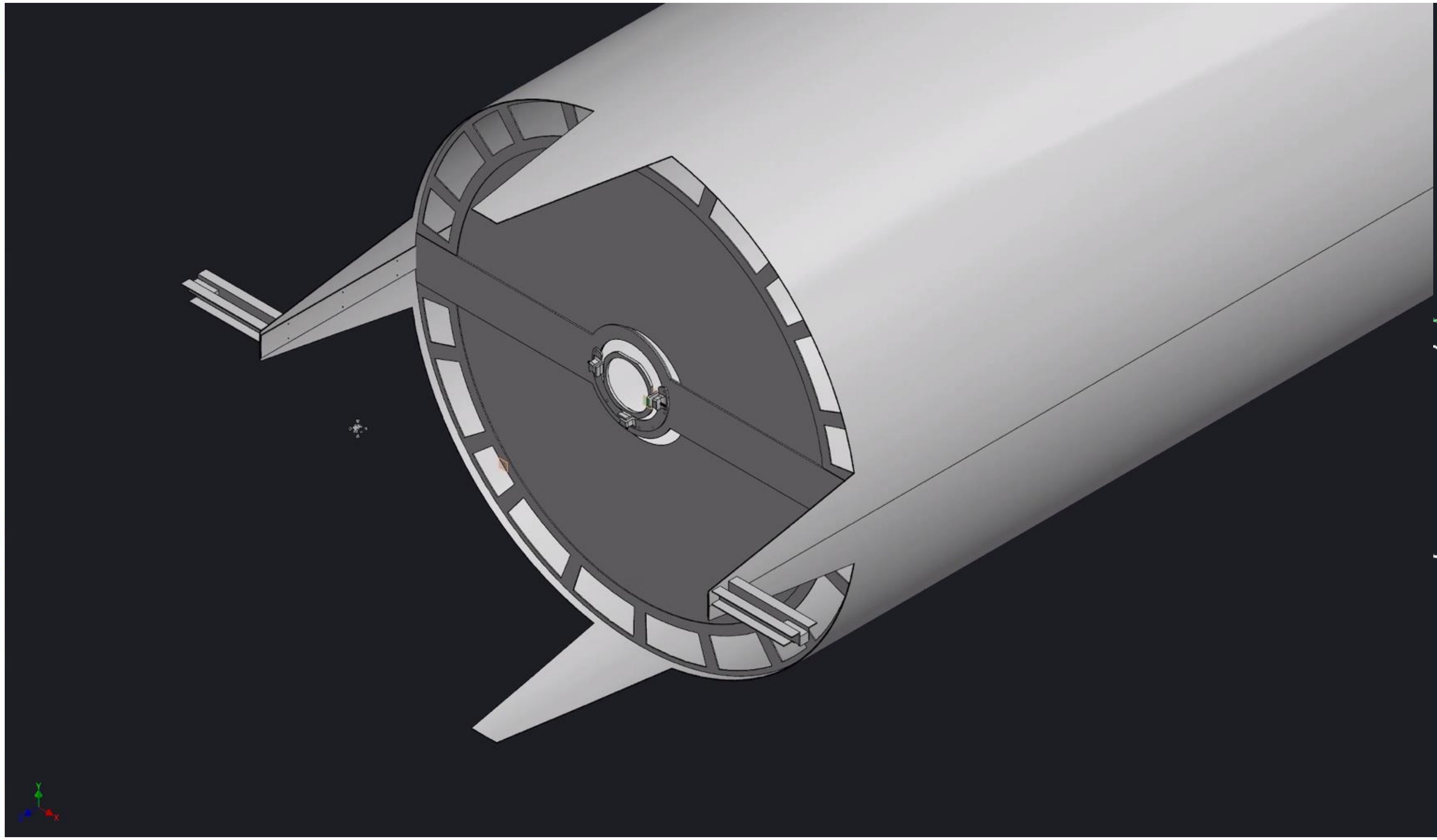

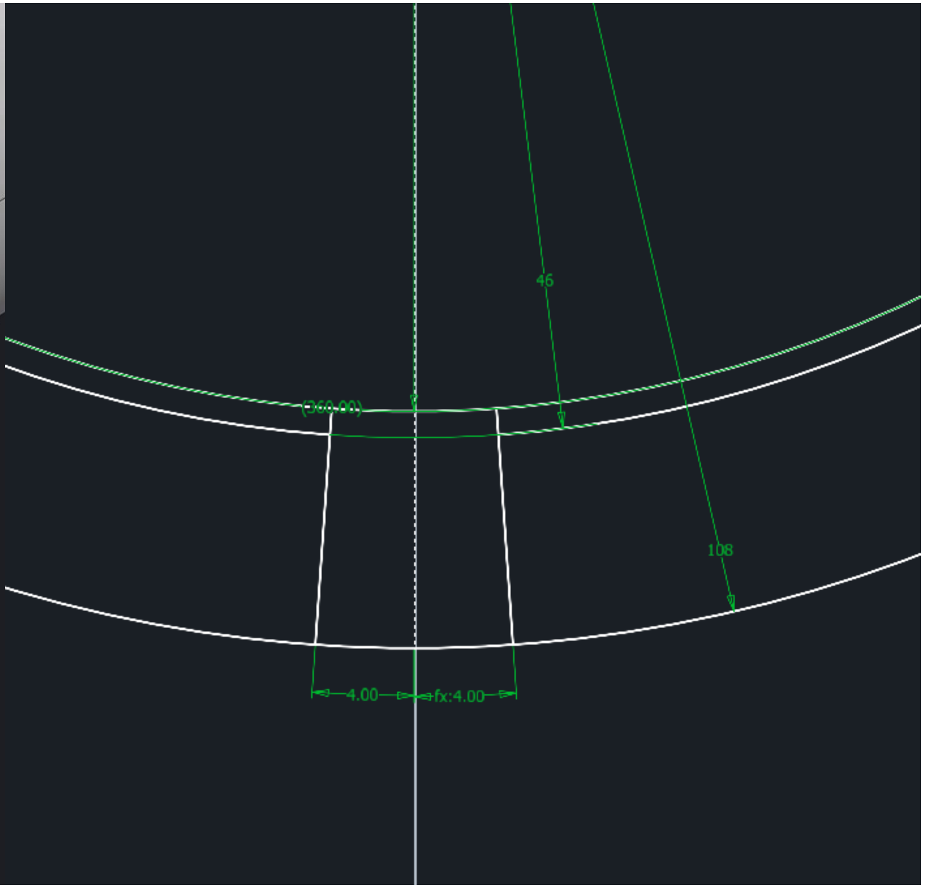

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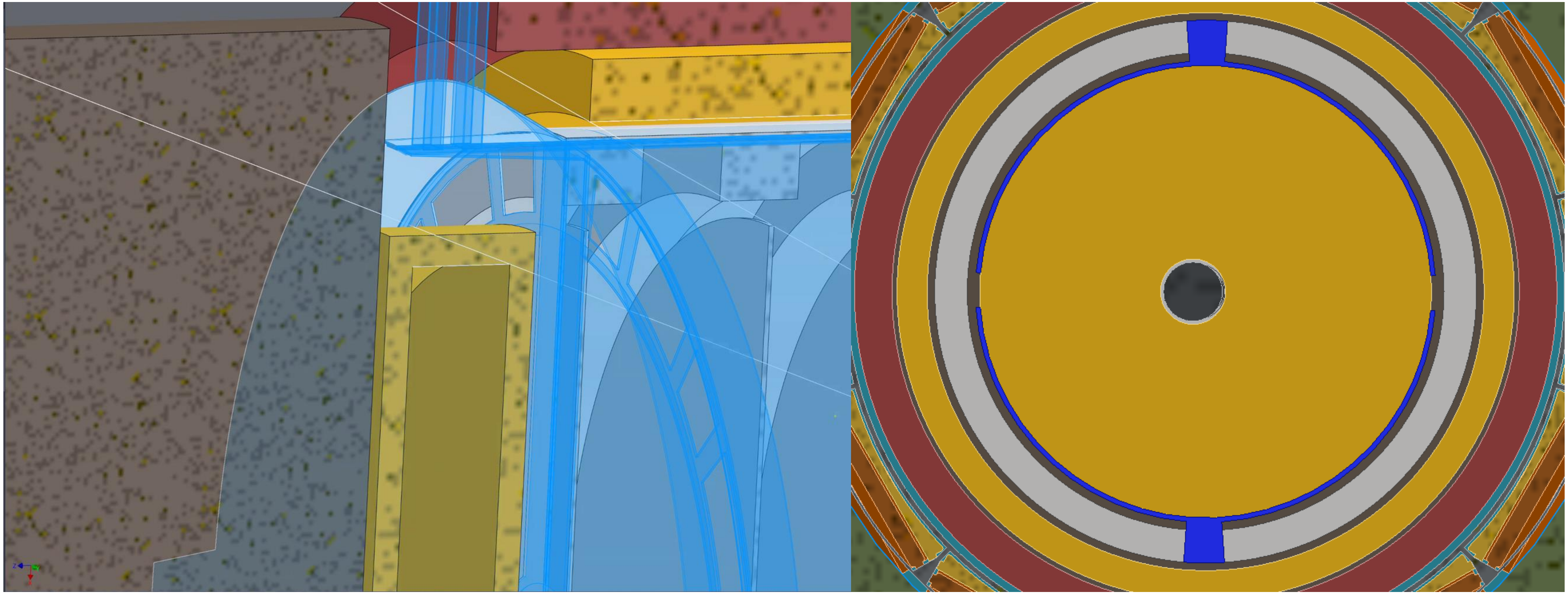

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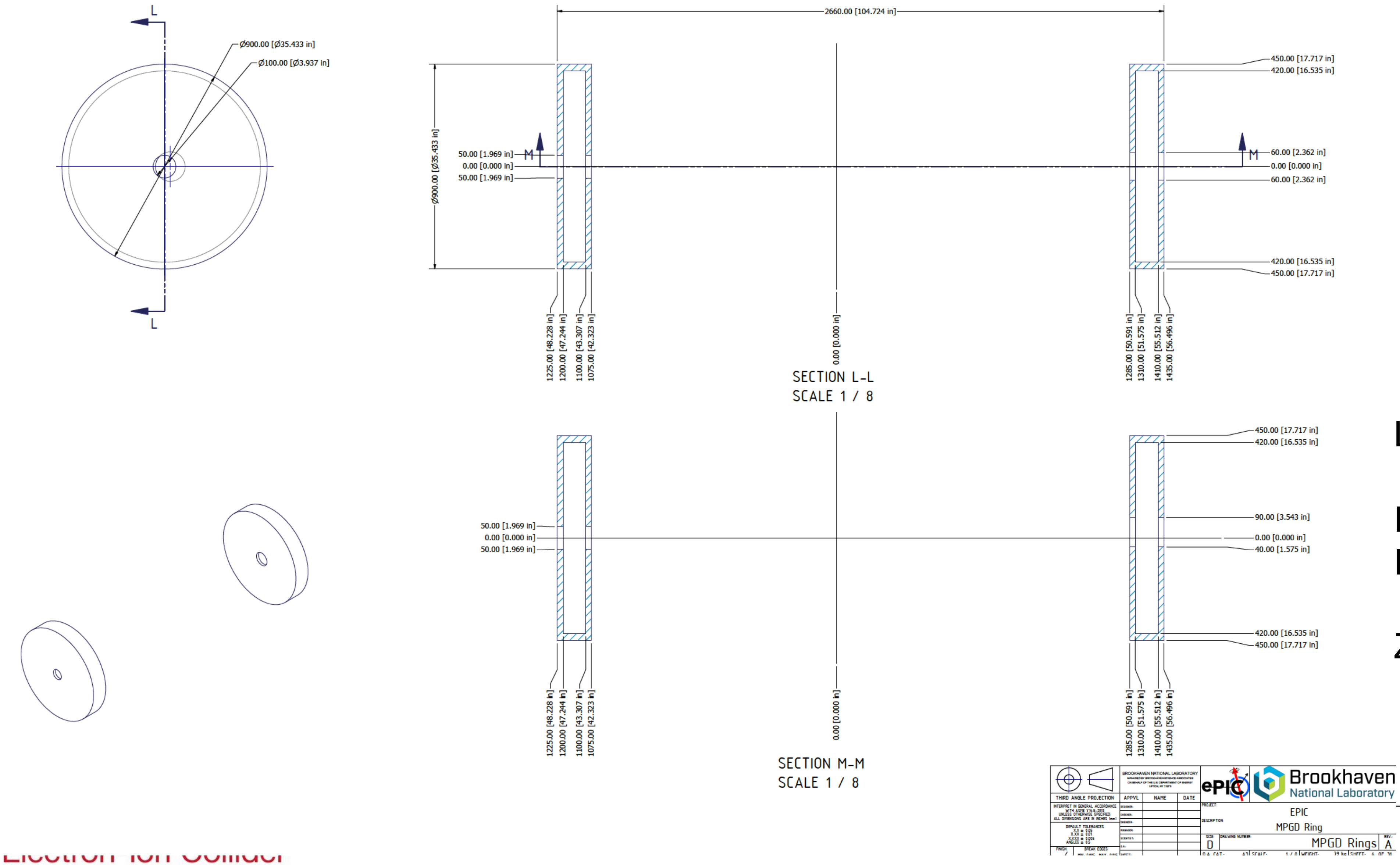


Both Lepton and Hadron disks have the same

Outer Diameter = 45 cm

Lepton ID = 5 cm

Hadron ID1 = 6 cm
Hadron ID2 = 9 cm

Zmin Hadron = 1285 mm

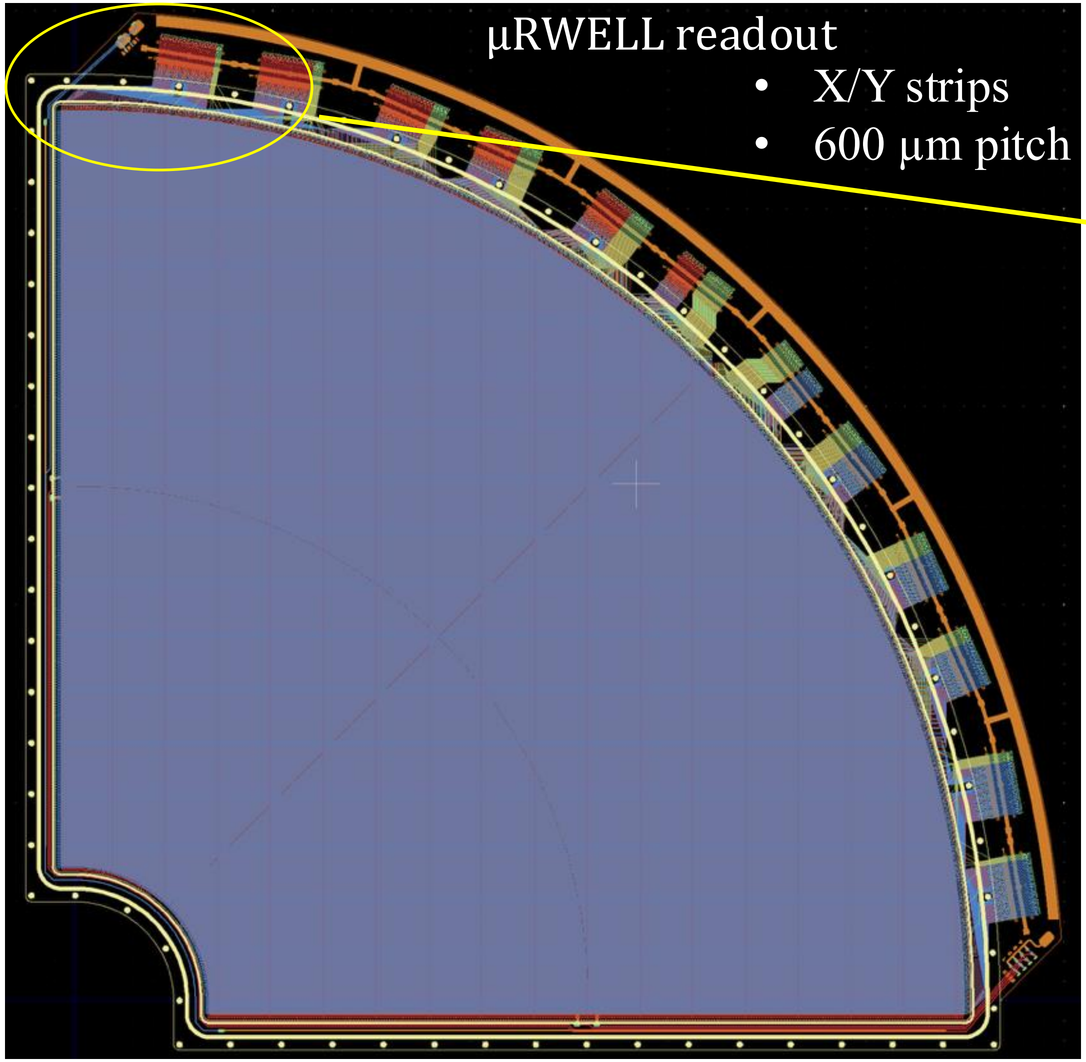
The ePIC MPGD End Cap Tracker Envelope and Active Regions

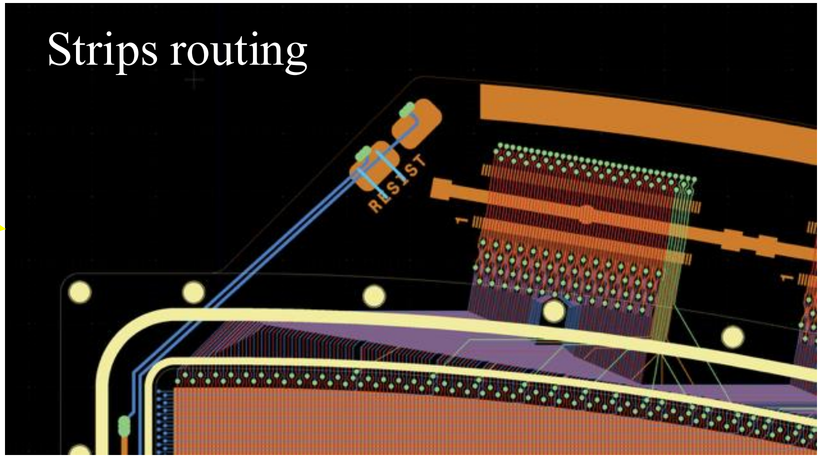
Component	Z (cm)	Inner Active Reg. Radius (cm)	$\|\theta\|$ min (deg)	$\|\eta\|$ max	Outer Active Reg. Radius (cm)	$\|\theta\|$ max	$\|\eta\|$ min
HD MPGD 2	162	10.5	3.35	**3.43**	45	15.52	1.99
HD MPGD 1	148	10.5	4.06	**3.34**	45	16.91	1.9
LD MPGD 1	-111	6	3.09	3.61	45	22.07	1.63
LD MPGD 2	-121	6	2.83	3.69	45	20.40	1.72

Component	Z (cm)	Inner Active Reg. Radius (cm)	$\|\theta\|$ min (deg)	$\|\eta\|$ max	Outer Active Reg. Radius (cm)	$\|\theta\|$ max	$\|\eta\|$ min
HD MPGD 2	141	10.5	4.25	**3.29**	40	15.83	1.97
HD MPGD 1	128.5	10.5	4.68	**3.2**	40	17,29	1.88
LD MPGD 1	-107.5	6.5	3.46	3.5	40	20,4	1,71
LD MPGD 2	-120	6.5	3.1	3.6	40	18.43	1.81

MPGD-ECT: PED Test Article Module

By Stefano Gramigna

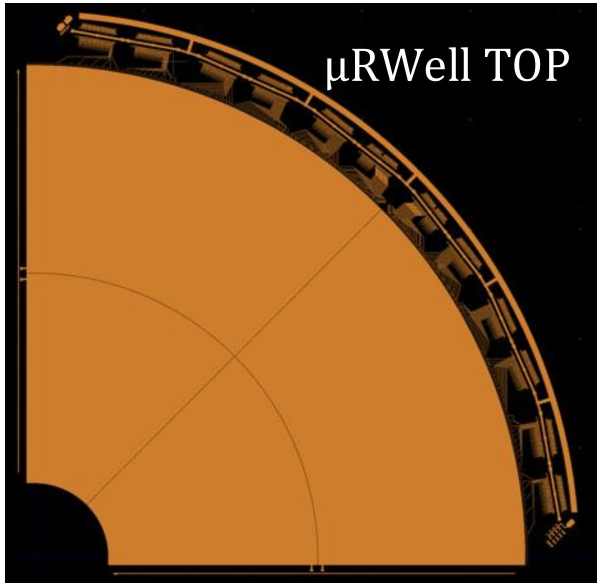


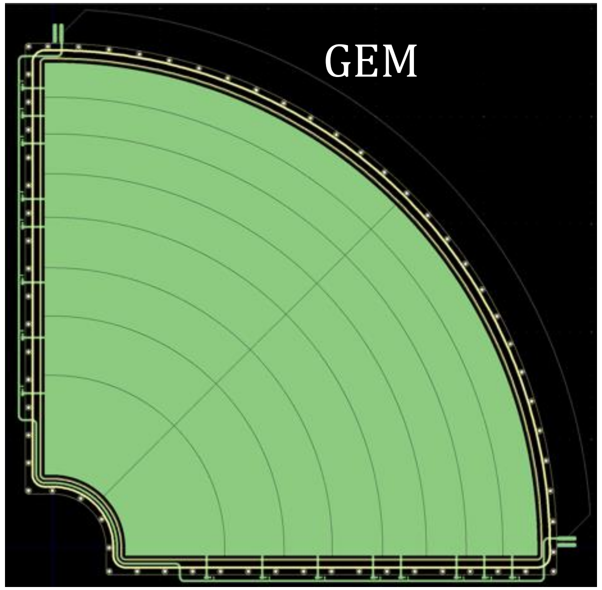


(X, Y) readout

→ no FEB in the active area

Detector delivery expected by Oct. 2025





GEM-μRWELL-ECT: Integration To do list

Send the required inner-radius & clearance numbers (per side) for the MPGD disks, reflecting the current beam-pipe profile and Z positions, and the beam-pipe clearance

- Revisit the definition of envelope for the disk and what part of the services are included in the envelope
- Confirm and share the service-space allocation for MPGD near the four attachment regions (both φ-span and available radial thickness/height), not just total cross-section percentages.
- Identify and propose patch-panel locations
- Coordinate with MPGD on cable-tray tie-ins at the four tabs; state how much of the shared window space can be reserved for MPGD trays.
- Recalculate layout/routing for the reduced-radius scenario: update from 6 → 5 front-end boards, ~625 μm pitch, and quantify impacts on single-hit resolution and acceptance/coverage
- Based on engineering inputs, specify any outer-radius access clearance needed for connector mating if not pre-cabled; if pre-cabling is required, state lead lengths and handling constraints.
- Provide an updated services table to the engineering group
- Since we need to consider the option of coupling the MPGD with PST, we need to understand the constraints on the services and maintenance of the disk

To answer some of these points from our end:

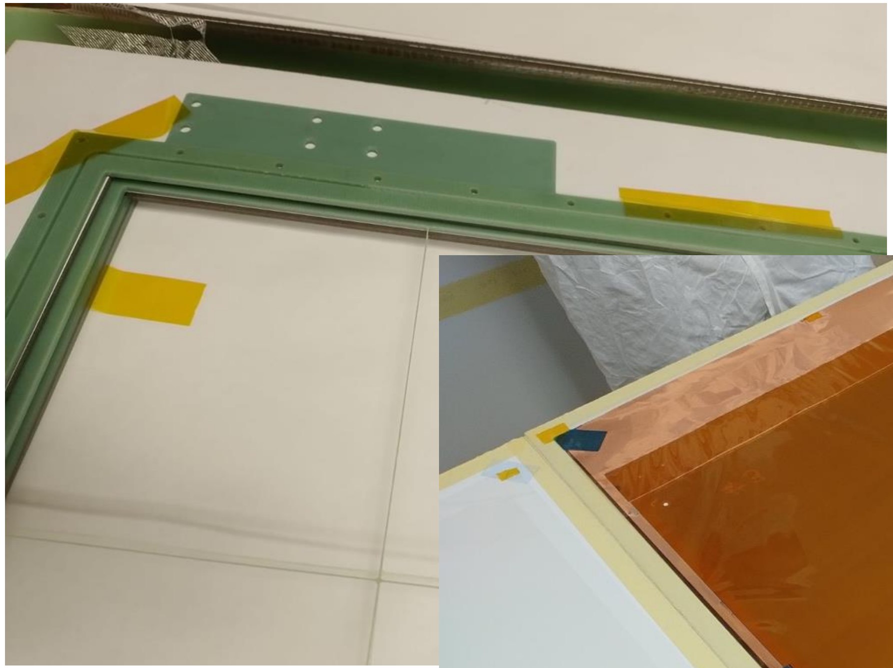
- Send the required inner-radius & clearance numbers (per side) for the MPGD disks, reflecting the current beam-pipe profile and Z positions, and the beam-pipe clearance
    - Attached is a drawing showing the beam pipe dimensions at the relevant locations.
- Revisit the definition of envelope for the disk and what part of the services are included in the envelope
    - I think this needs more discussion, but in this case, I would say the routing into bundles at 12 and 6 o'clock is part of the detector envelope and beyond that is not.
- Confirm and share the service-space allocation for MPGD near the four attachment regions (both φ-span and available radial thickness/height), not just total cross-section percentages.
    - Roland will reply shortly with some images/numbers which should help clarify this.
- Identify and propose patch-panel locations
    - I think we can look at having patch panels near the ends of the GST, but generally we don't have additional space near the detectors for patch panels that isn't in the detector envelope.
- Coordinate with MPGD on cable-tray tie-ins at the four tabs; state how much of the shared window space can be reserved for MPGD trays.
    - Roland's envelope includes the supports.
- Recalculate layout/routing for the reduced-radius scenario: update from 6 → 5 front-end boards, ~625 μm pitch, and quantify impacts on single-hit resolution and acceptance/coverage
    - To be answered by MPGD disk group.
- Based on engineering inputs, specify any outer-radius access clearance needed for connector mating if not pre-cabled; if pre-cabling is required, state lead lengths and handling constraints.
    - To be answered by MPGD disk group.
- Provide an updated services table to the engineering group
    - To be answered by MPGD disk group.
- Since we need to consider the option of coupling the MPGD with PST, we need to understand the constraints on the services and maintenance of the disk
    - To be answered by MPGD disk group.

Preparation for 2025 Test Beam

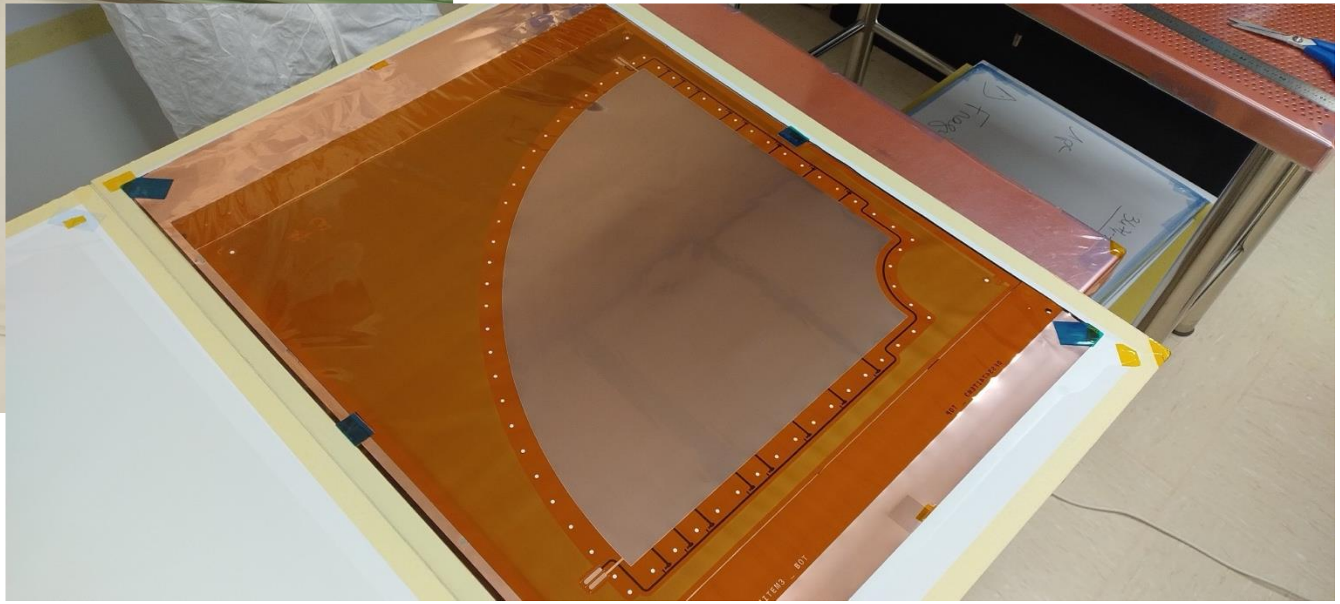
Test Beam Stand

Preparation for 2025 Test Beam

Gluing in the Clean Room



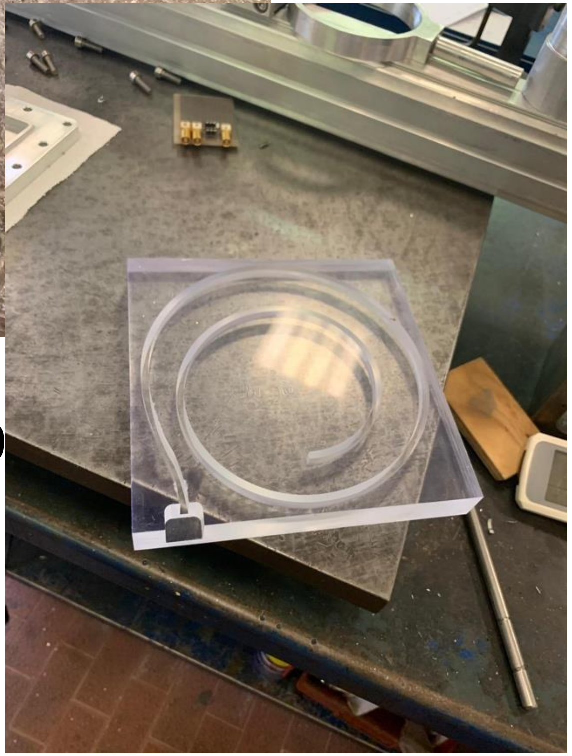
Parts to be Glued



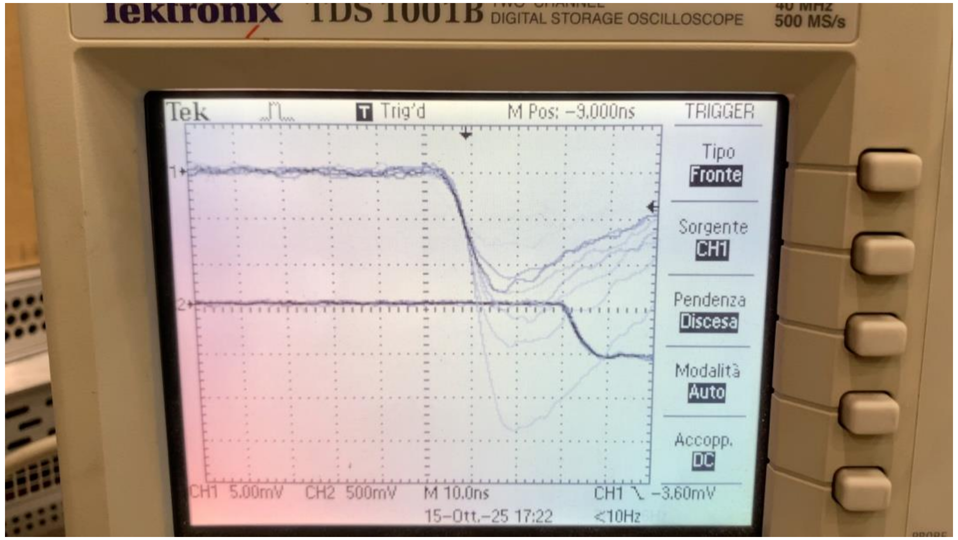
Preparation for 2025 Test Beam

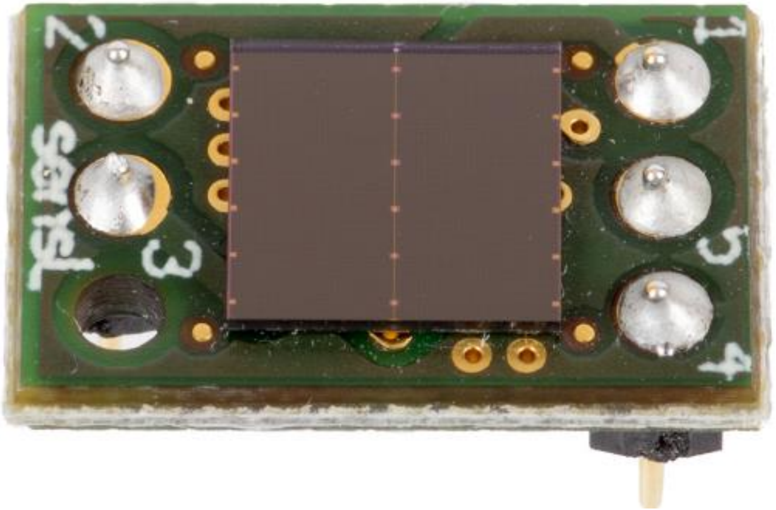
- Gluing on 4 frames is completed
- Glue Transfer technique has been used and complemented with additional glue line of Araldite 2011 in the inner part of the frame, the next day.
- The parts have been carried to CERN with all the parts to be assembled

Preparation for 2025 Test Beam

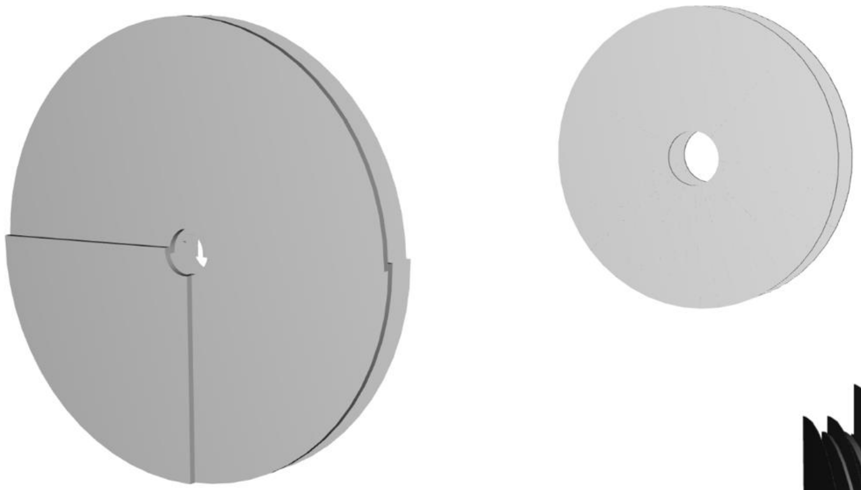


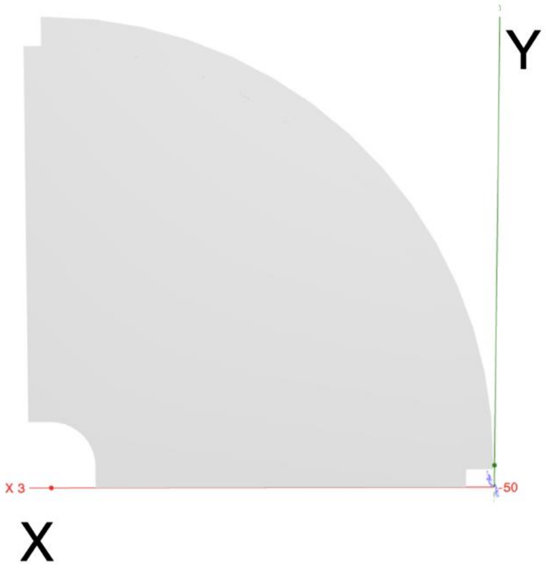
- Plastic scintillator
- Light collected by a bundle of 9 embedded wavelength shifter fibers
- SiPm photosensor being tested Onsemi J series 3002





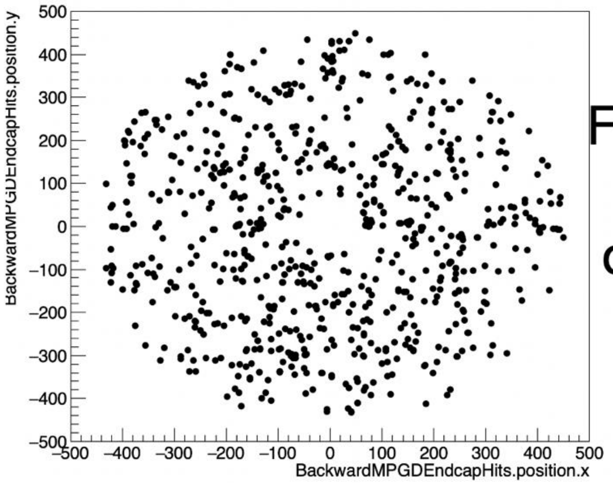
GEM-μRWELL-ECT: Detector Simulation to be updated





By Mariangela Bondì

- A **realistic description** of the geometry and materials of the MPGD disks has been implemented in the detector simulation
- Work is ongoing to enable ACTS tracking with the disks



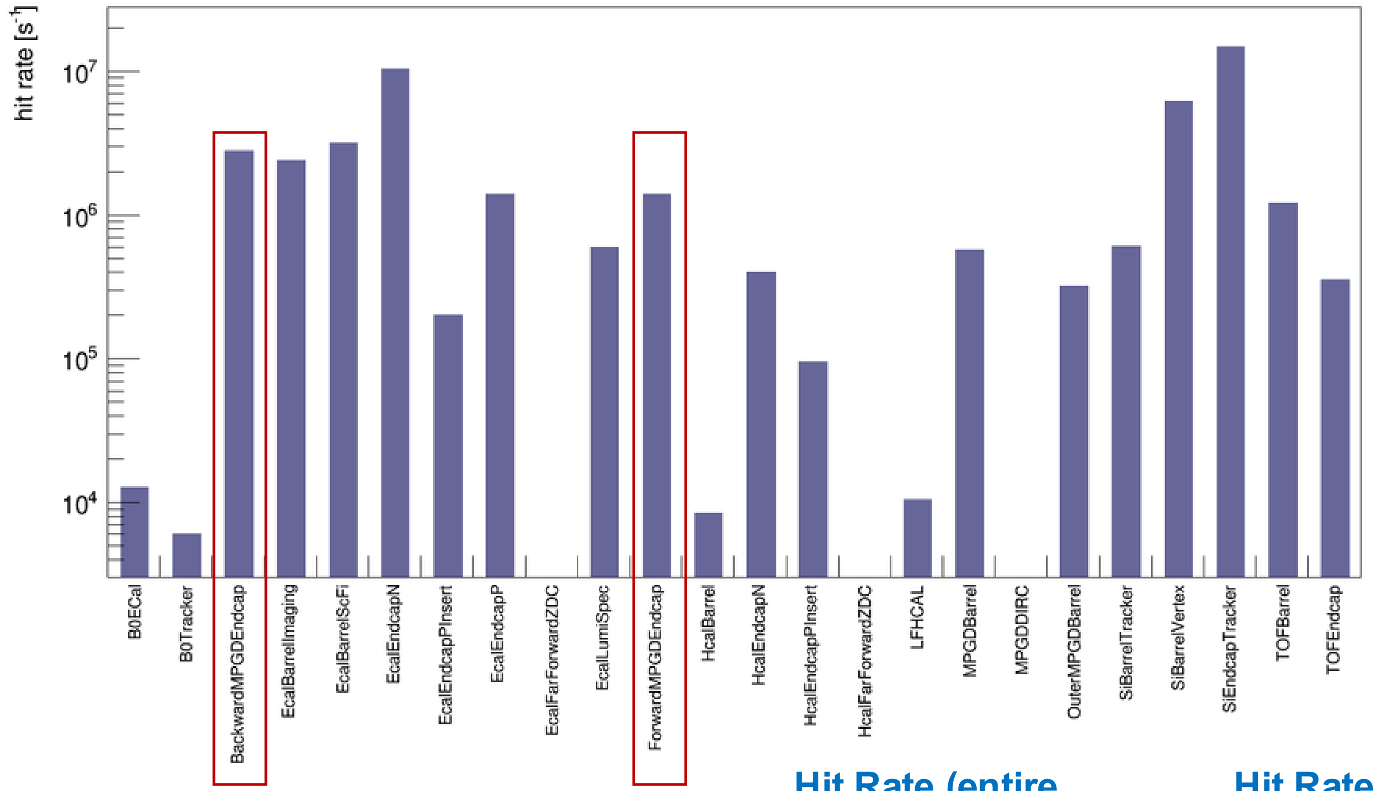
On-going tests

Footprint -

ddsim simulation

Thank you

Background – message by Elke



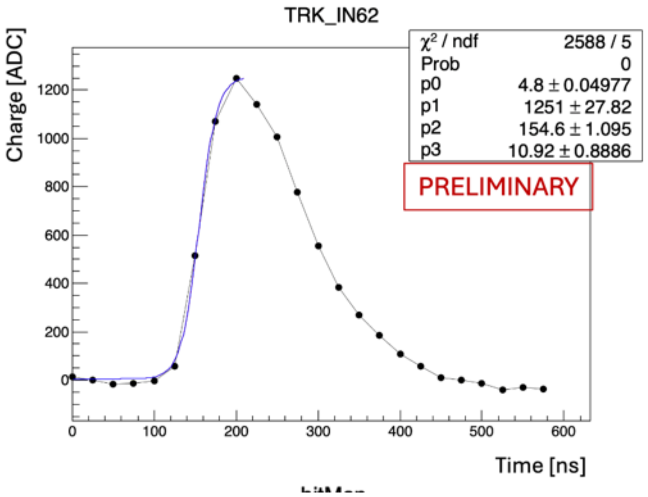
10 GeV electron energy

Sub-detector	Hit Rate (entire subdetector)	Hit Rate (hottest readout channel)	CellID (hottest readout channel)
BackwardMPGDEndcapRecHits	2.77989e+06	102.08	18324865404498963016
ForwardMPGDEndcapRecHits	1.39517e+06	39.8752	18331339328963305810

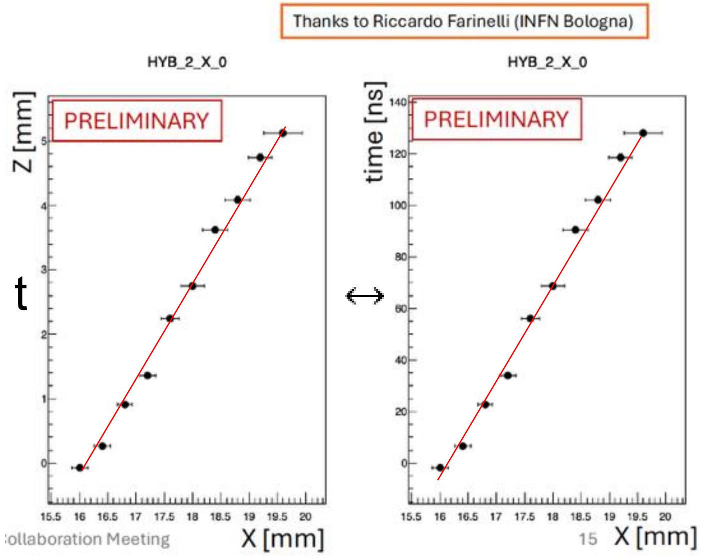
Possible position resolution improvement - μTPC

A possible solution :

- The electrons created by the ionizing particle drift towards the amplification region
- In the μTPC mode from the **knowledge of the drift time** and the **measurement of the arrival time of electrons**, the **track segment in the gas gap is reconstructed**
- The **fit of the analog signal** gives **the arrival time of drifting electrons**.
- By the knowledge of **the drift velocity,** the 3D trajectory of the ionizing particle in the **drift gap** is reconstructed.

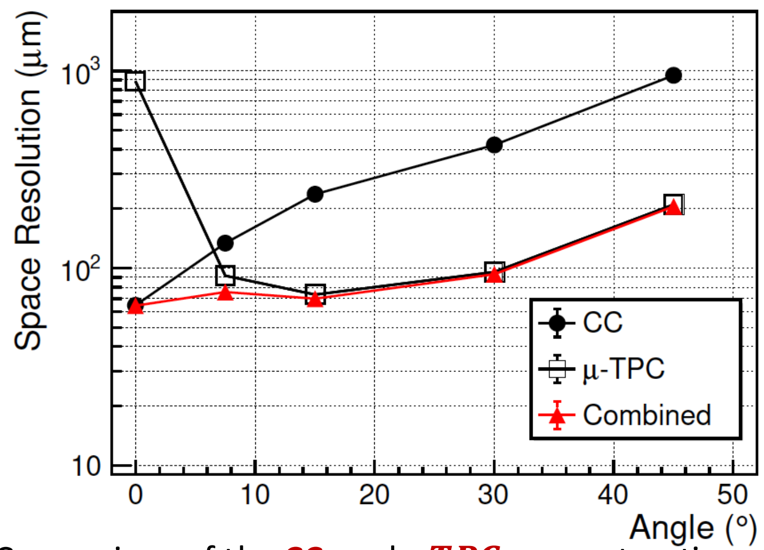


Integrated charge as a function of the sampling time



Example of a track reconstruction using the TPC algorithm.

drift field $E_D = 1\ kV/cm$



Comparison of the **CC** and $\boldsymbol{\mu TPC}$ reconstruction algorithms in function of the impinging angle