

Development of μ RWELL technology for the ePIC ECT and Beyond

2026 / 03 / 14

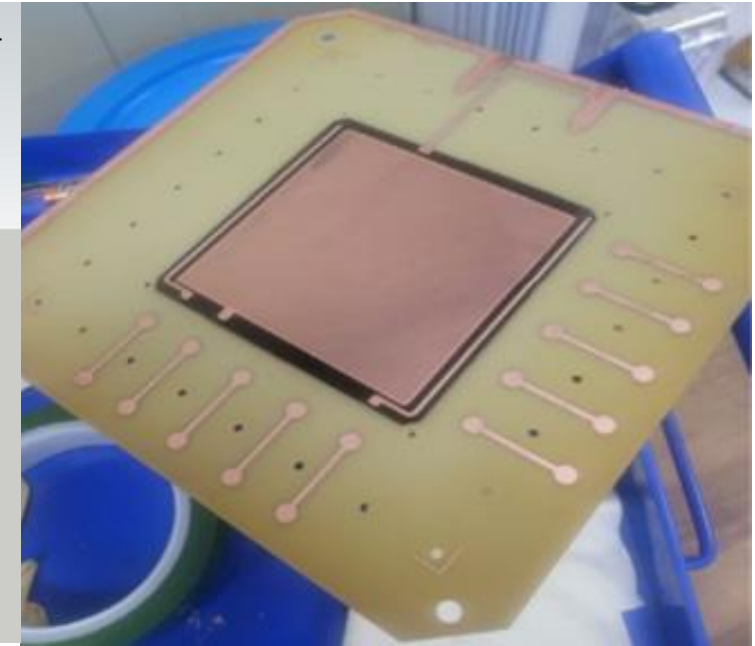
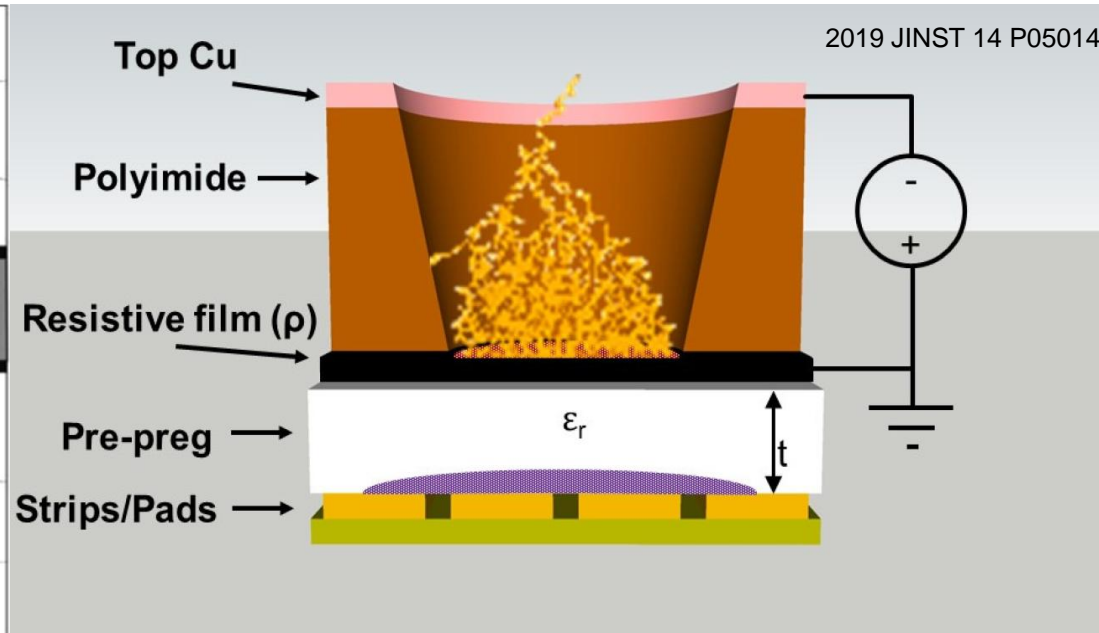
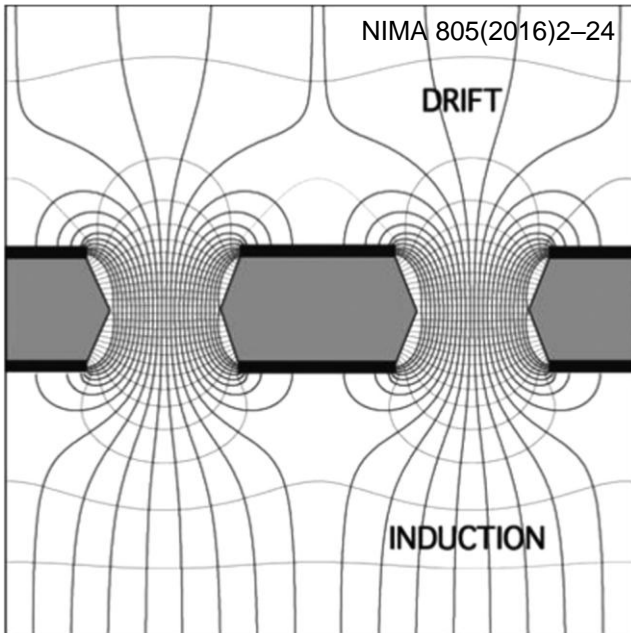
Inseok Yoon (Seoul National University)

핵물리 장래계획 워크숍 @ IBS



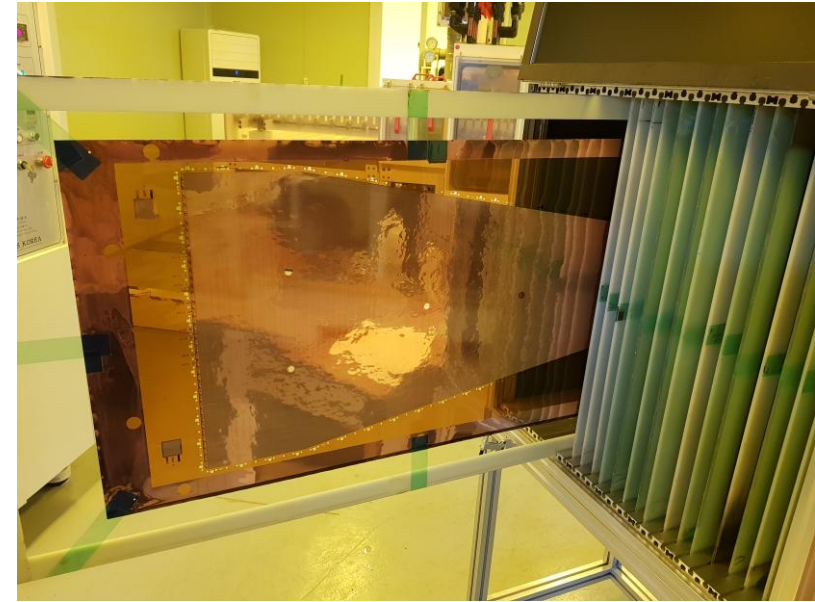
1. Vision & introduction

- Being a major player of MPGD technologies from ePIC to FCC-ee
- GEM & μ RWELL
 - Avalanche region is set by micro-holes
 - Widely adopted by many experiments due to its advantages
 - Serious supply shortage due to production difficulty



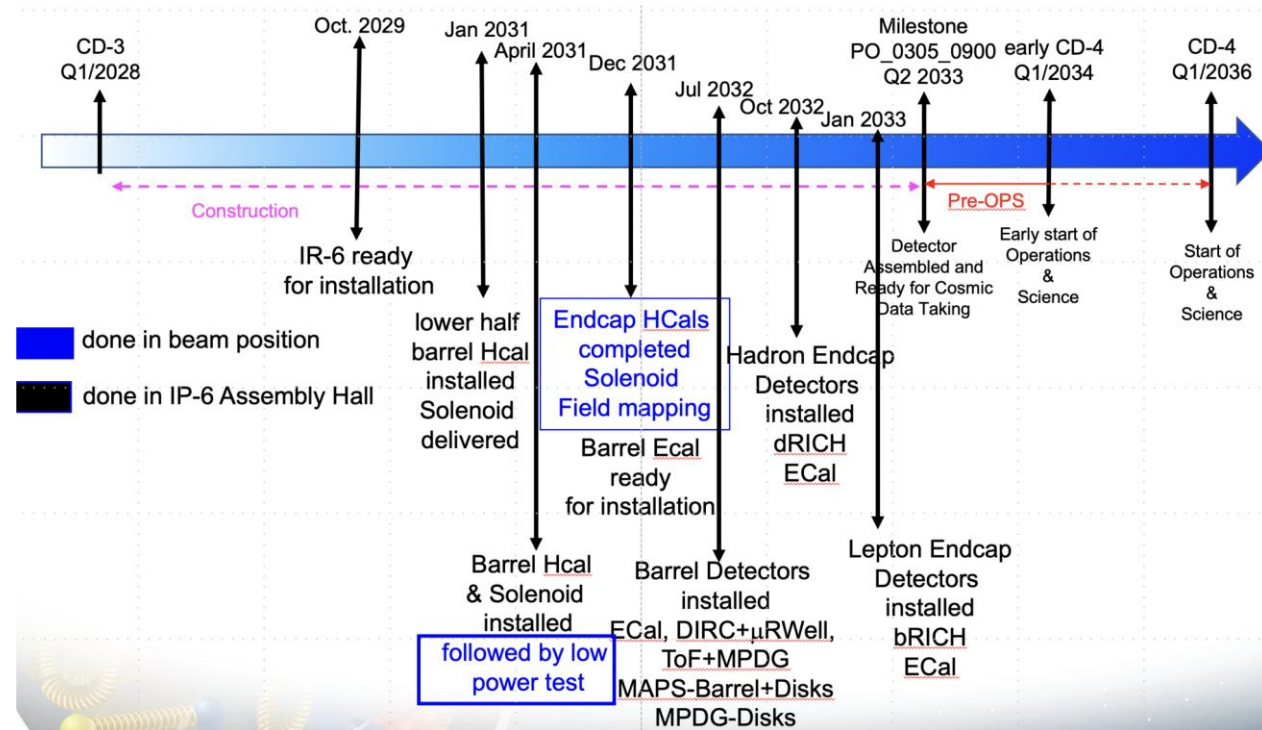
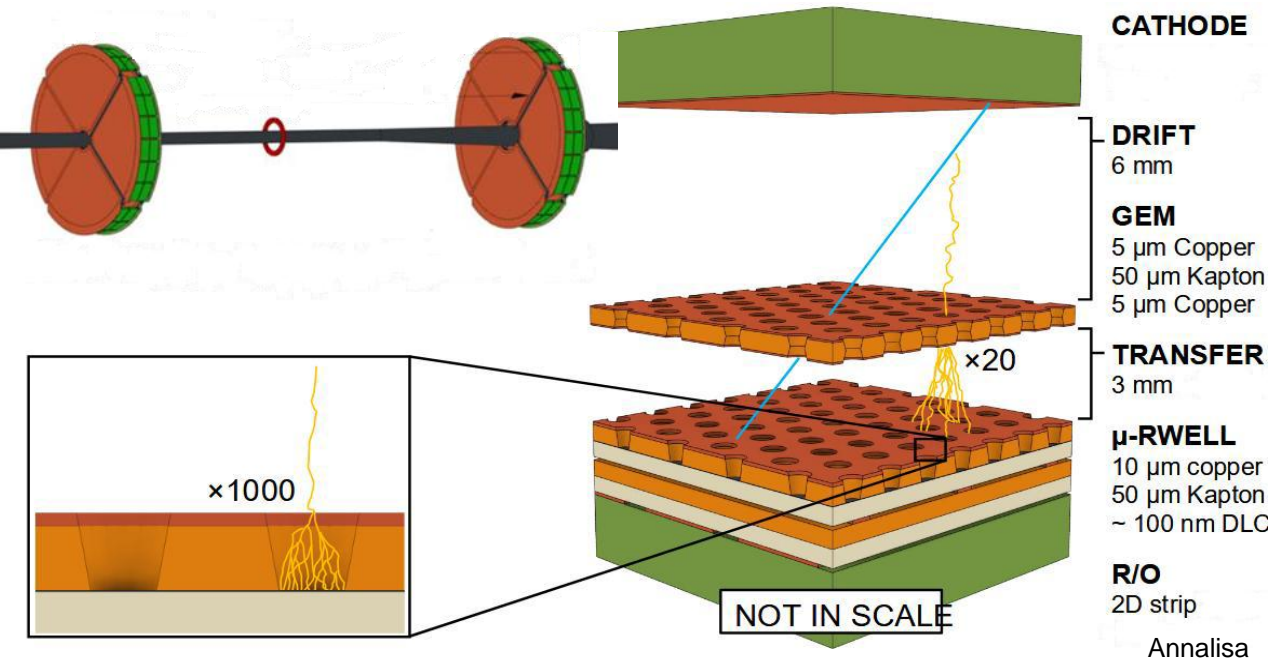
1. Vision & introduction

- Establishing a sustainable MPGD R&D and mass-production infrastructure in Korea
 - Leveraging the successful CMS GEM mass production
 - R&D opportunity through the ePIC ECT project
- Creating a continuous detector development pipeline bridging current and next-generation experiments
 - Seamlessly connecting ePIC, DAMSA, LHCb, and the FCC-ee IDEA
- Building a solid foundation for the Korean nuclear & particle physics community through hardware contributions



2. Short-term plan (2026–2028)

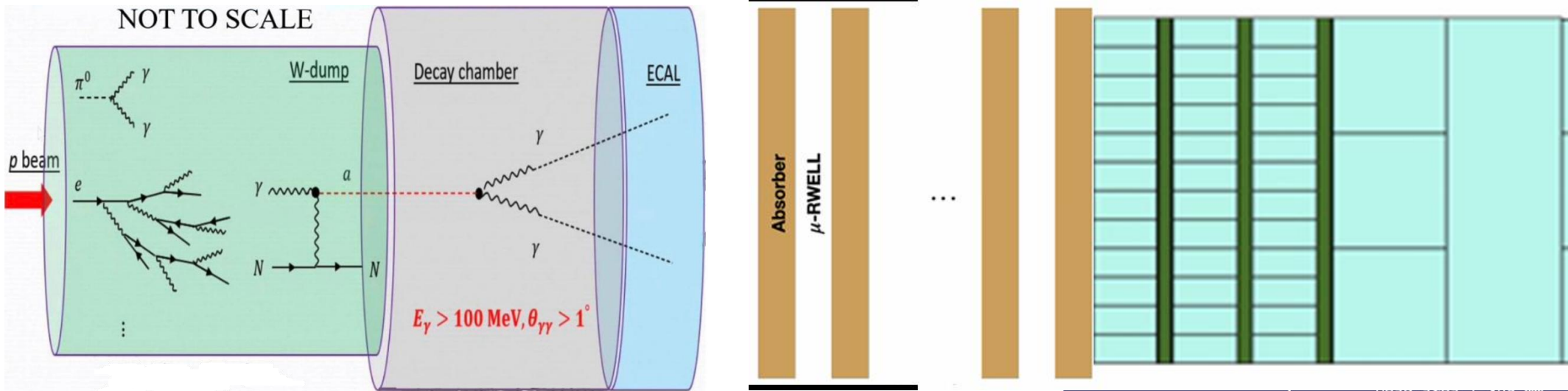
- ePIC ECT as the highest priority



- Small-area μ RWELL R&D in 26, followed by large-area prototyping and mass-production preparation by 27-28
- Single-mask GEM foils production R&D

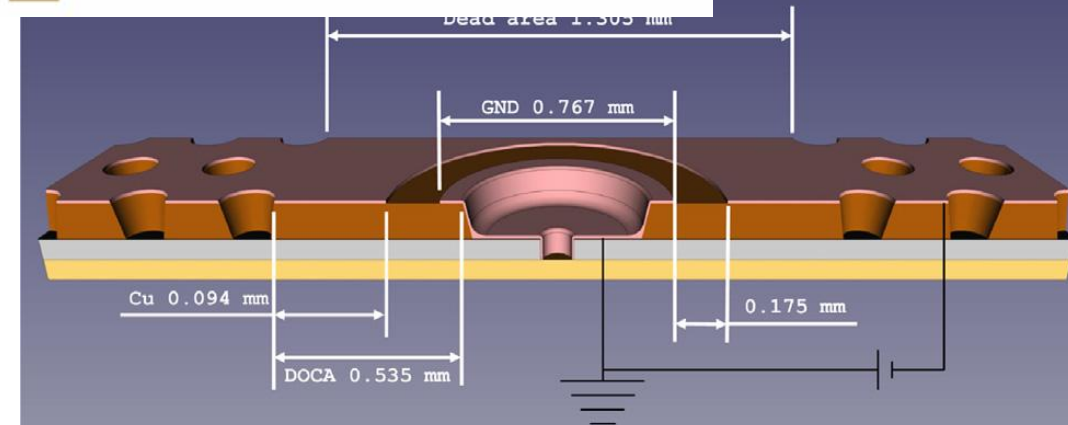
2. Short-term plan (2026–2028)

- Direct application to the DAMSA experiment
 - Developing tracker and pre-shower prototypes this year utilizing the production R&D from the ePIC ECT project



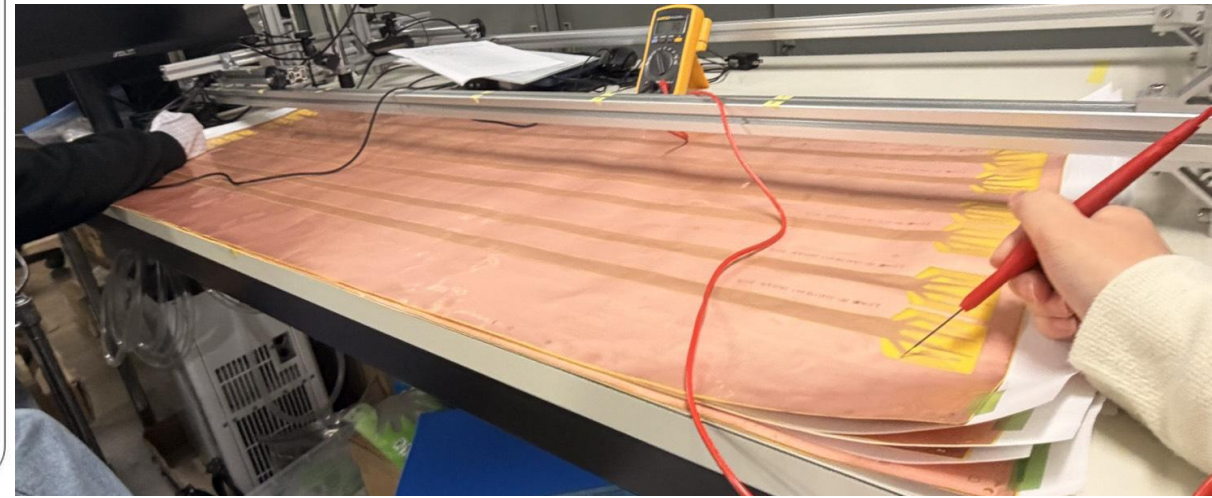
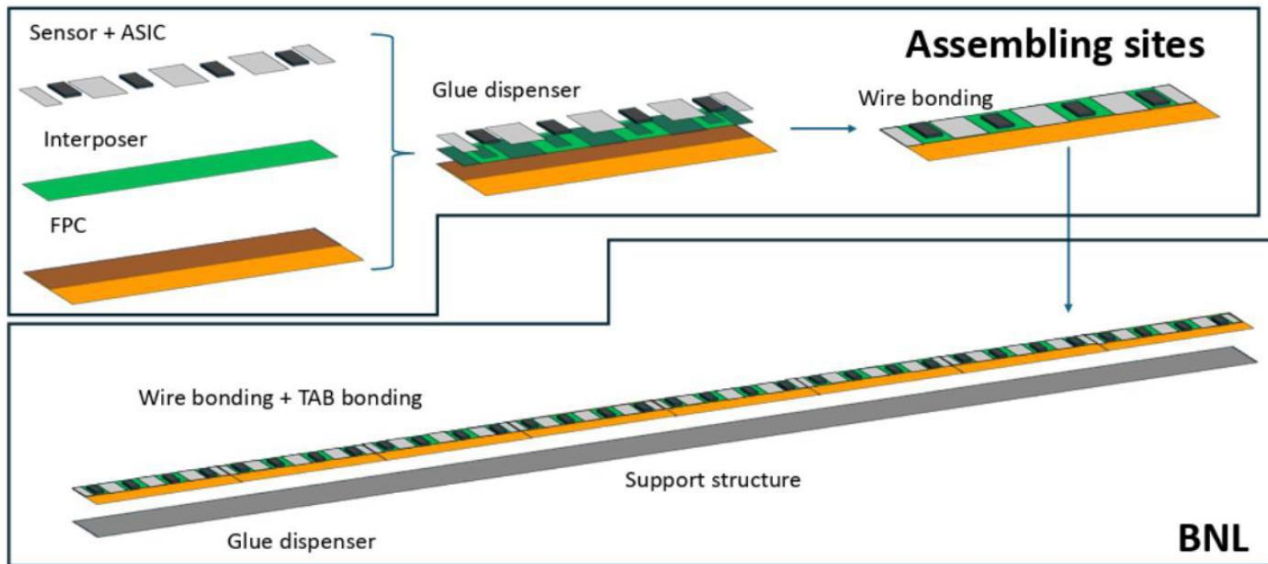
NIMA 1069 (2024) 169725

- R&D for the PEP high-rate μ RWELL
 - Securing core technology for future applications, including the LHCb phase-2 upgrade



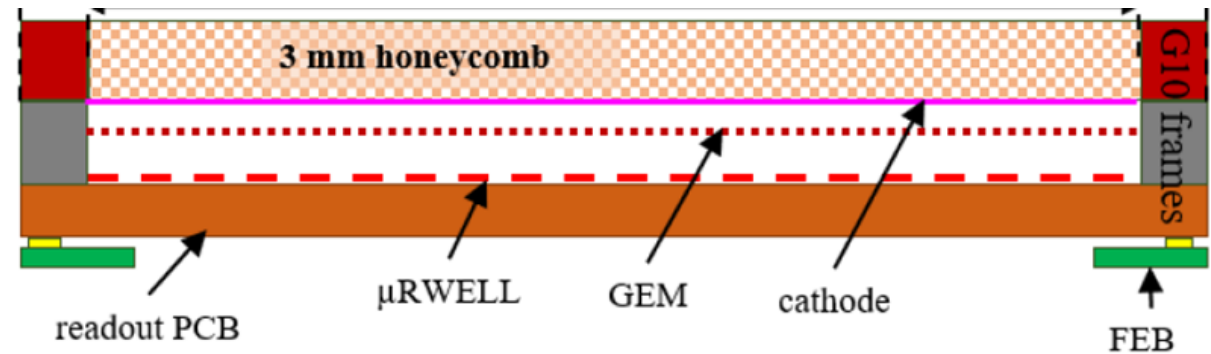
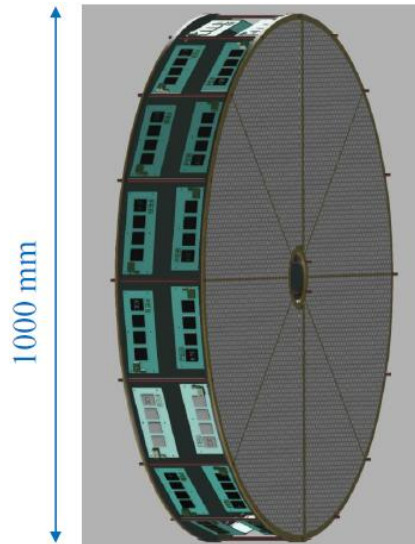
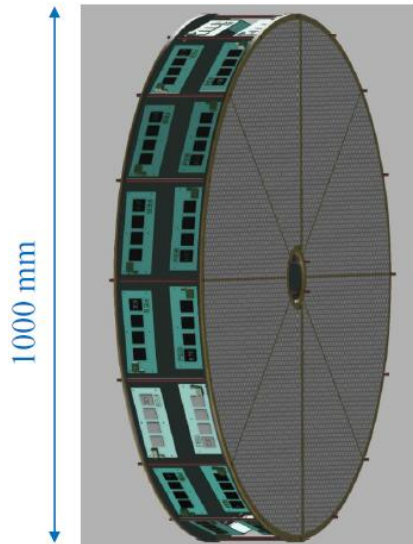
2. Short-term plan (2026–2028)

- Signal FPC for ePIC BToF (collaboration with RIKEN)
 - Leveraging Korea's GEM fine-patterning expertise to fulfill strict requirements (1.3 m length, $<100 \mu\text{m}$ pitch, ~ 700 units) that exceed Japanese manufacturing limits
 - Successfully delivered samples for feasibility test with a domestic partner; RIKEN confirmed flawless continuity for the $70 \mu\text{m}$ pitch
 - Mass production is scheduled



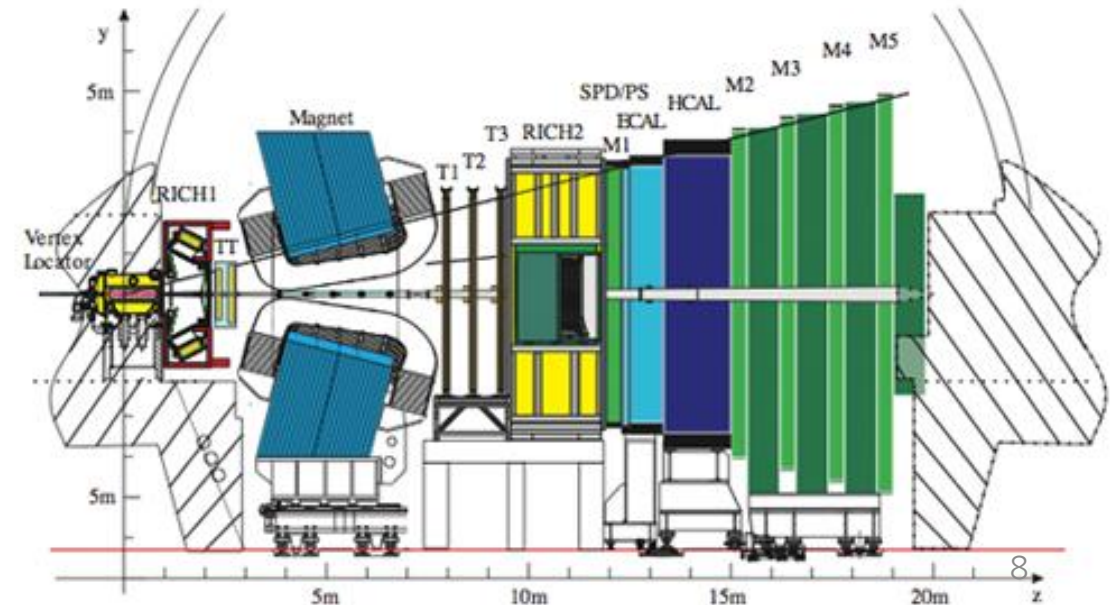
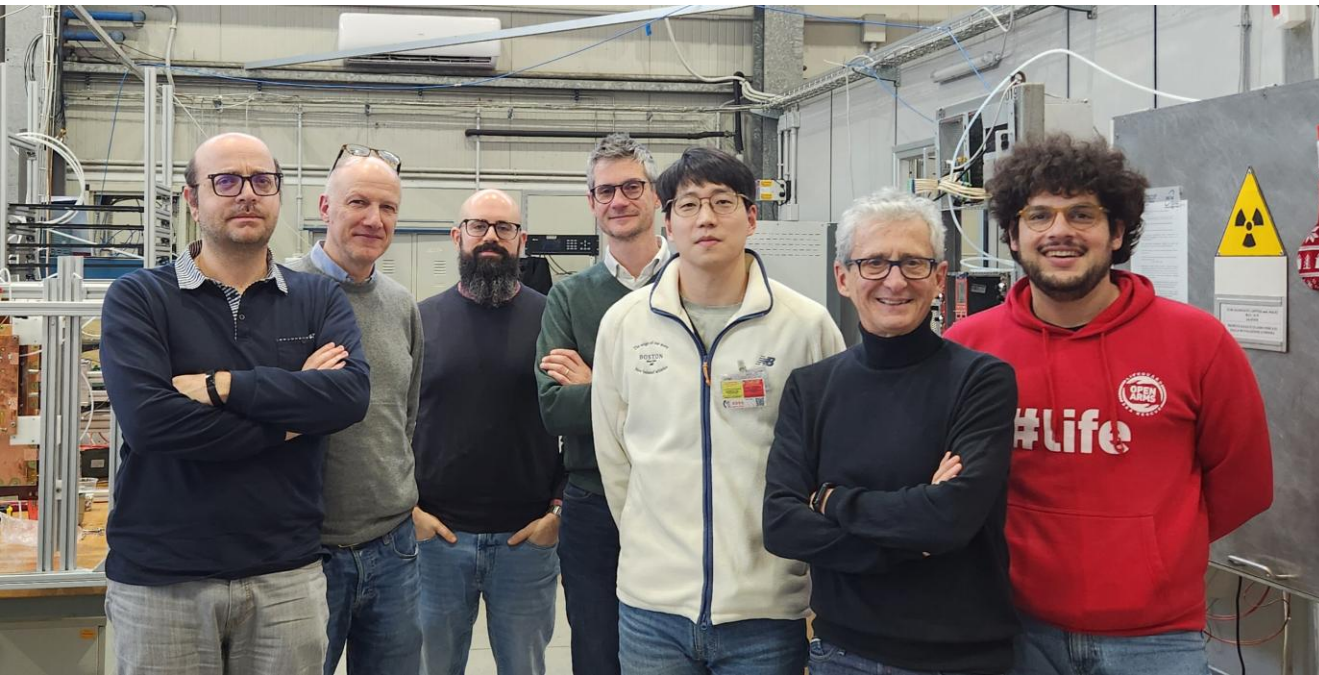
3. Mid-term plan (2029–2031)

- Executing the ePIC ECT in-kind contribution
 - Mass-producing ~20 GEM foils and ~20 μ RWELL PCB (29-30)
 - Detector assembly and QA/QC



3. Mid-term plan (2029–2031)

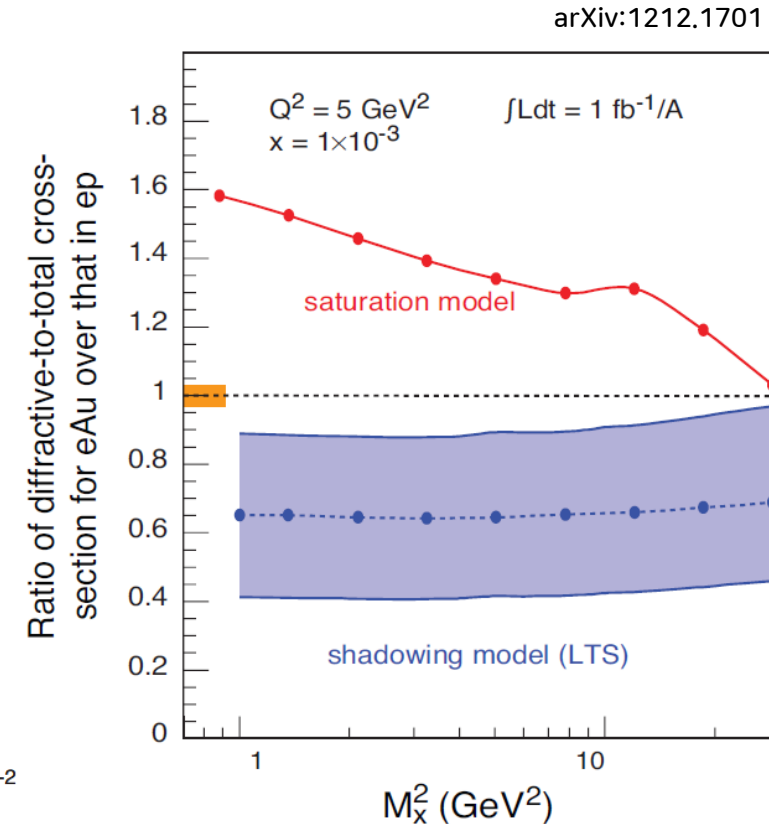
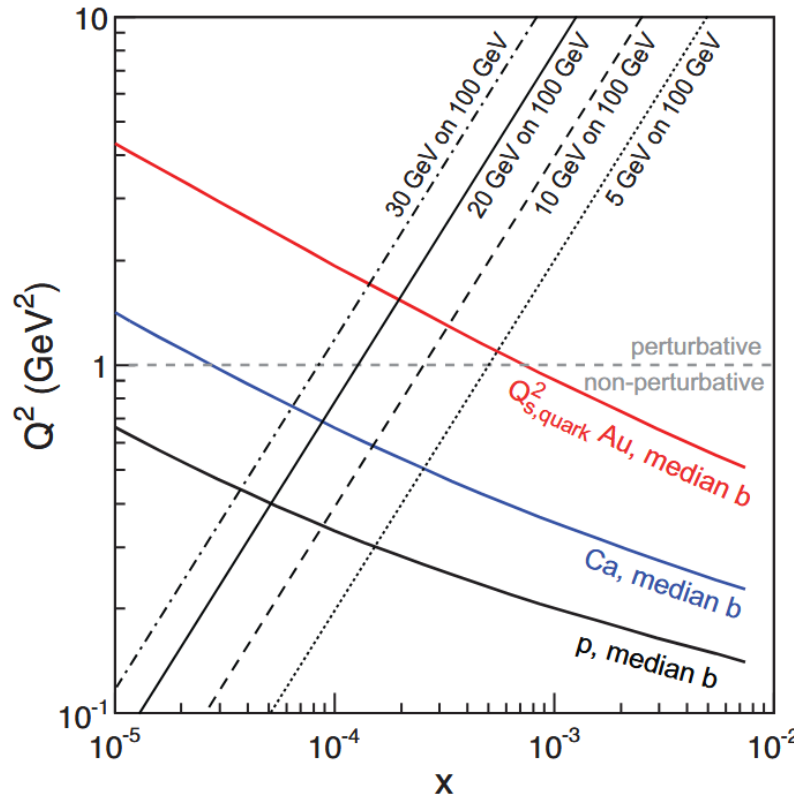
- Potential mass production for the LHCb Phase-2 upgrade?
 - Negotiating (G. Bencivenni, M. P. Lener) a production agreement provided DRDC is established and LHCb finances the material expenses at least
 - Serving as a vital bridge to sustain the domestic manufacturing infrastructure for FCC-ee contributions
 - Decision relies on the consensus of the Korean Community
- My role is to resolve all technical prerequisites



4. Long-term plan (2032–2035+)

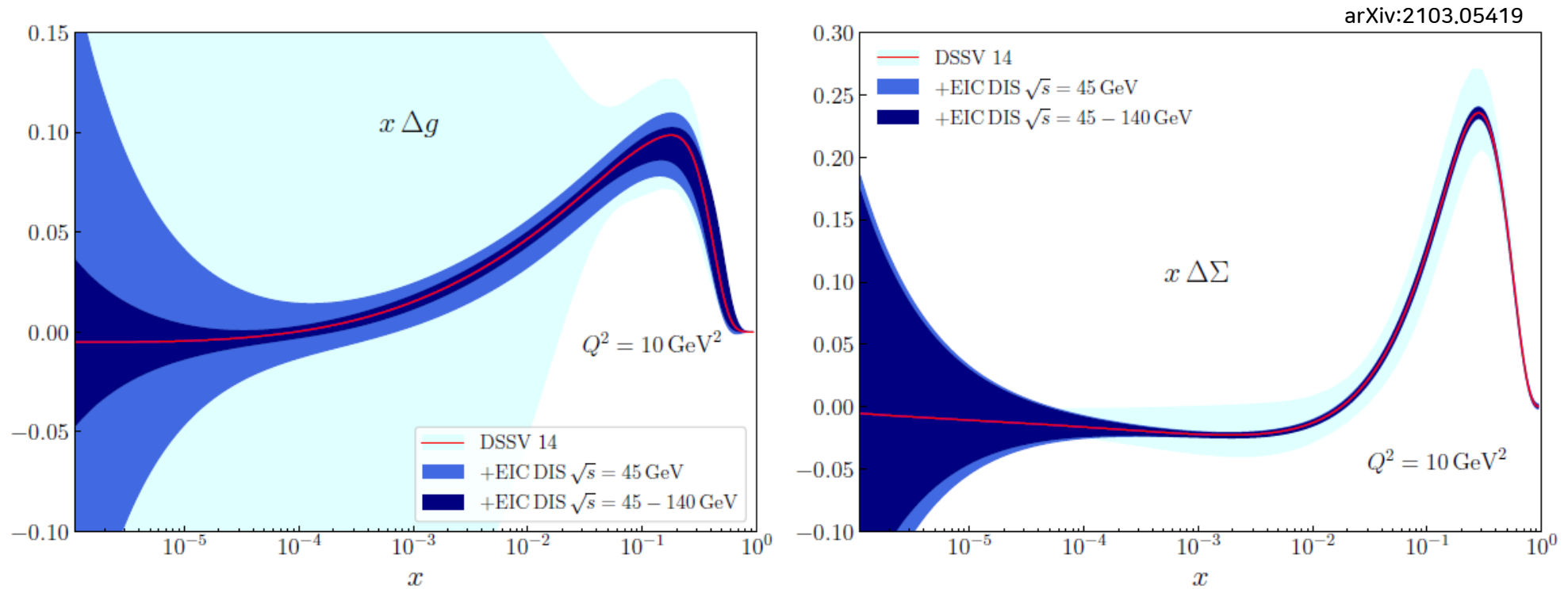
- ECT integration (32) and performance monitoring
- Physics research at the ePIC experiment starting from the 2034 pre-ops phase
 - Initiating with gluon saturation studies prior to the installation of beam polarization components

- Double ratio = $\frac{[\sigma_{diff}/\sigma_{tot}]_{eA}}{[\sigma_{diff}/\sigma_{tot}]_{ep}}$



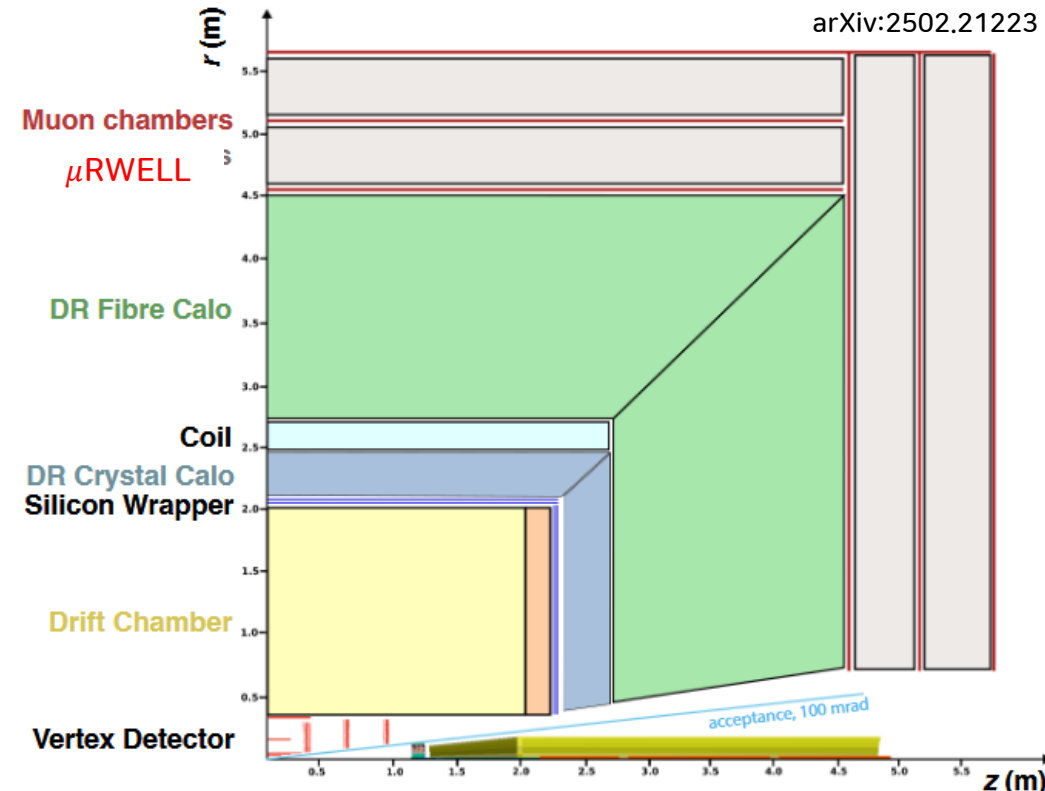
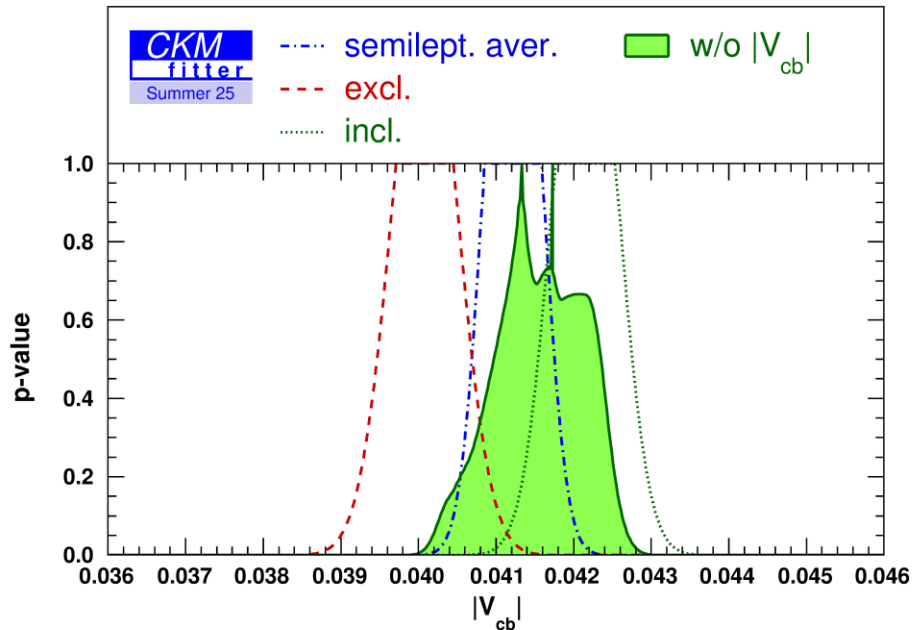
4. Long-term plan (2032–2035+)

- Expanding physics goals into core expertise areas, after installation of beam polarization components
 - Extending the research focus to incorporate TMD and GPD analyses



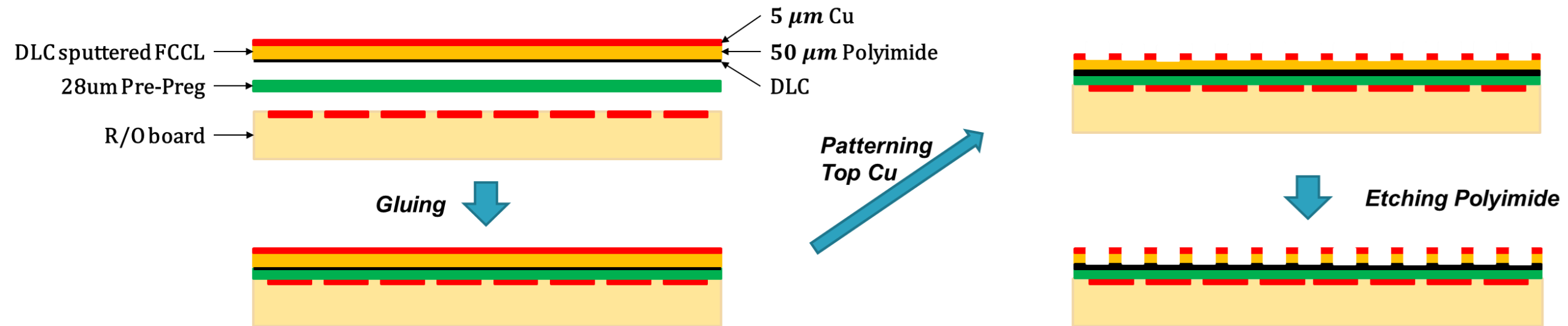
4. Long-term plan (2032–2035+)

- μ RWELL contribution for muon tracker of the FCC-ee based experiment (35+)
 - Aiming to keep the domestic MPGD line active until this phase, using its supply barrier as leverage to support Korean researchers
- Precision measurement of the CKM matrix element V_{cb} at the FCC-ee
 - To resolve the V_{cb} puzzle
 - $ee \rightarrow WW \rightarrow lvcb$



Back Up

Production process



DLC FCCL

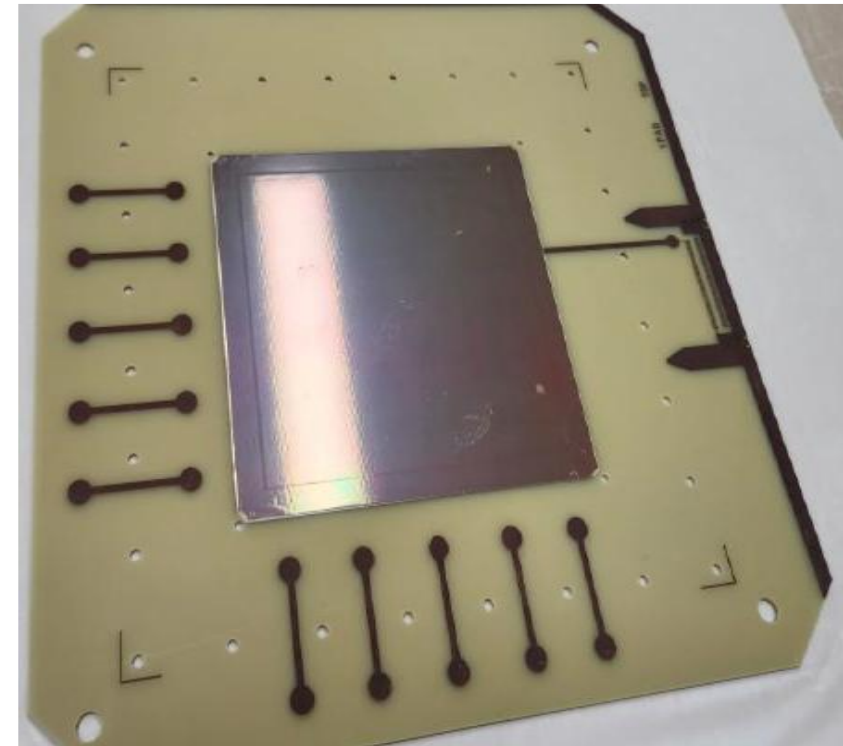
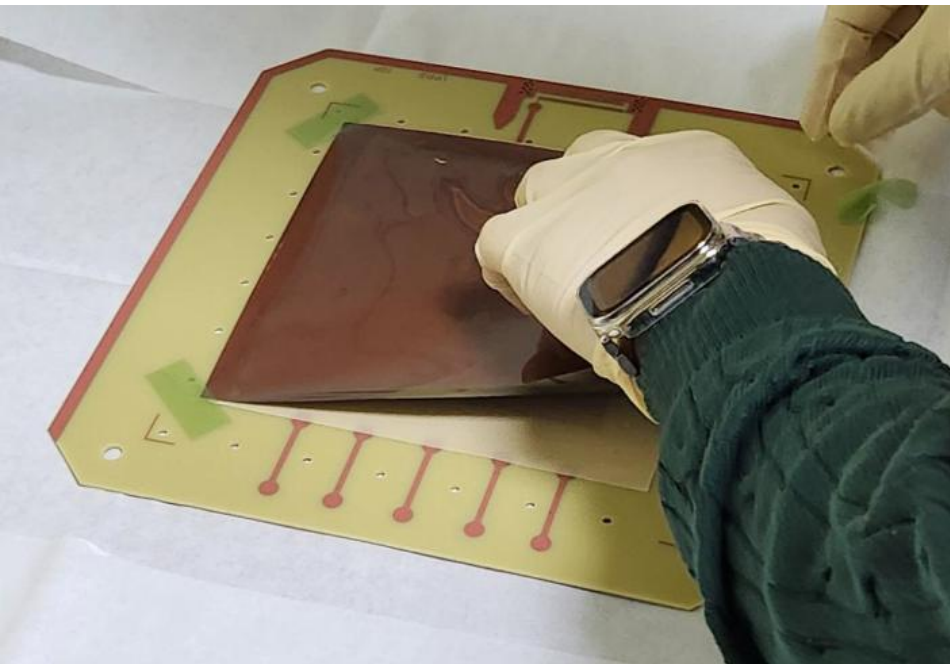
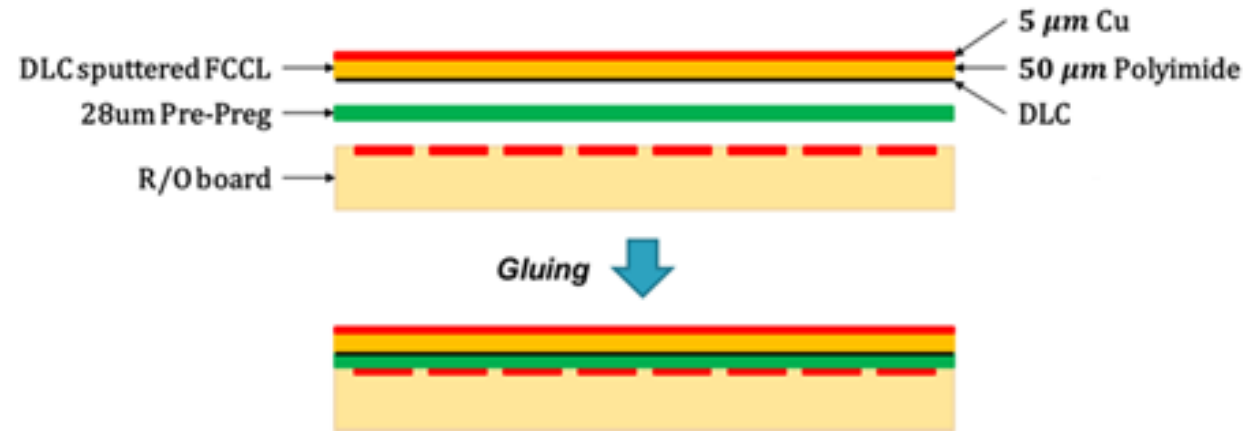
- The first trial was recently completed, yielding promising results
 - Two samples. One sample already passed CERN QC
 - Trek 152-1, 152P-CR-1



3.55×10^9	2.76×10^9	2.91×10^9
3.73×10^9	3.00×10^9	3.00×10^9
4.81×10^9	4.55×10^9	4.276×10^9



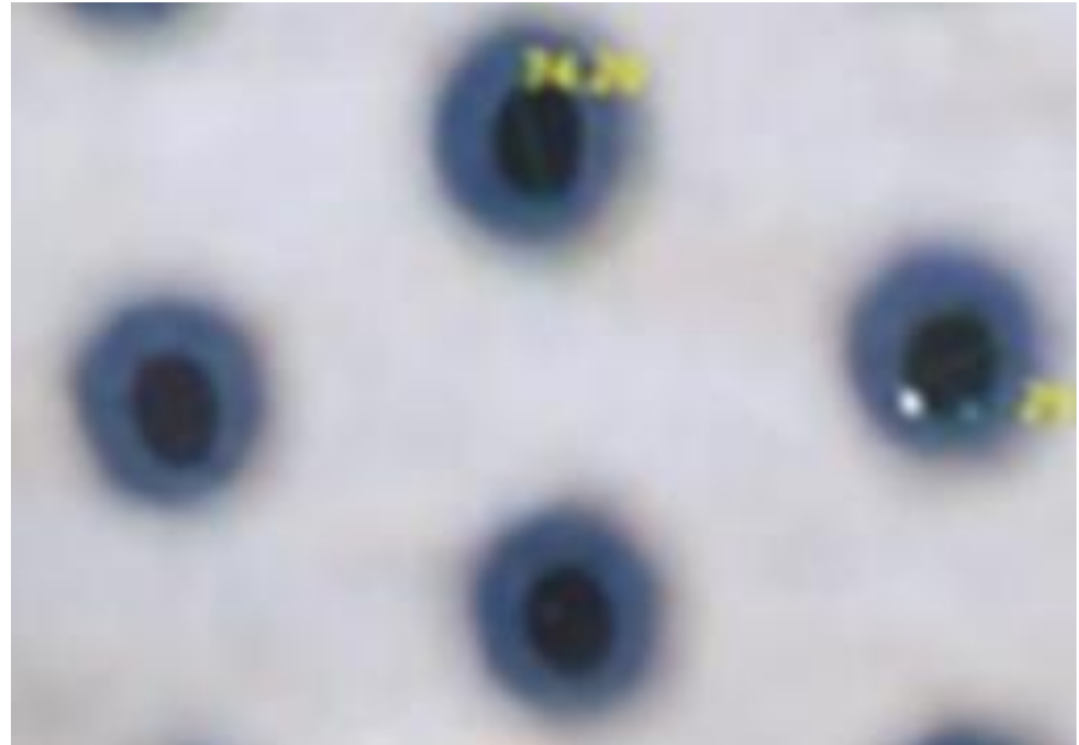
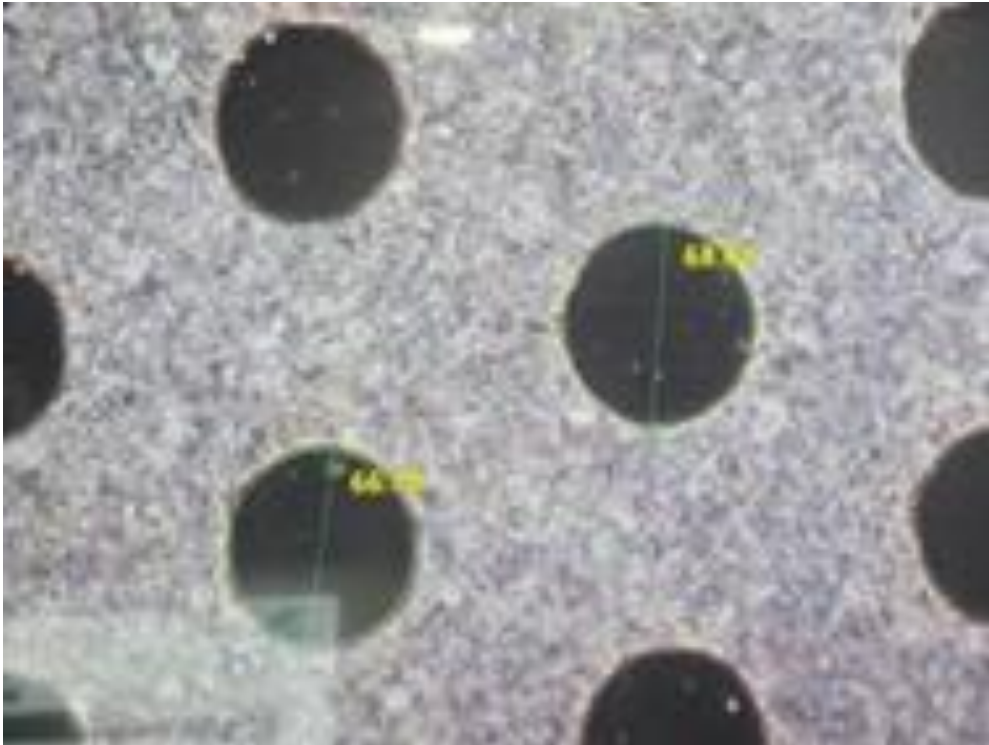
Gluing



Etching



Etching Polyimide



Post process & assembly

