# MPGD Production Capability and R&D Plan in Korea

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# KCMS GEM Production – Motivation

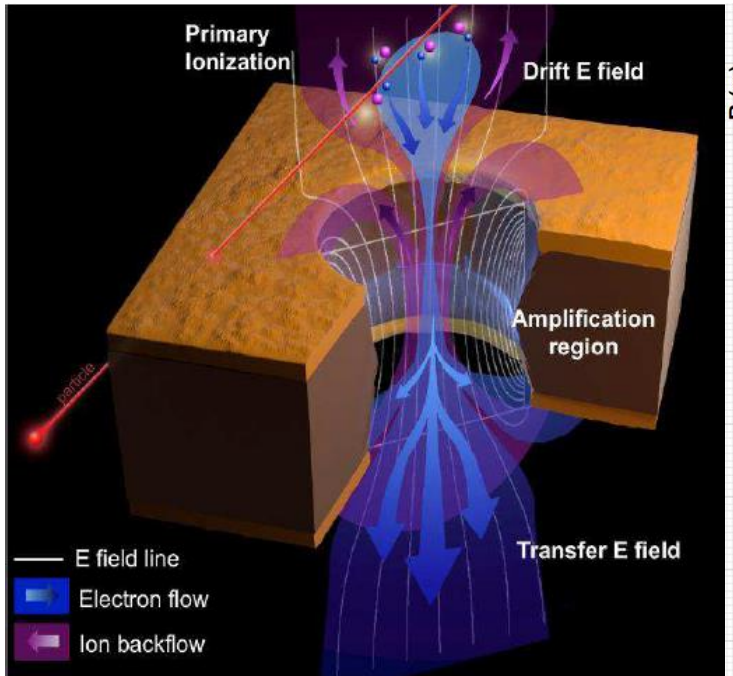
• Three GEM stations: GE1/1, GE2/1, and ME0

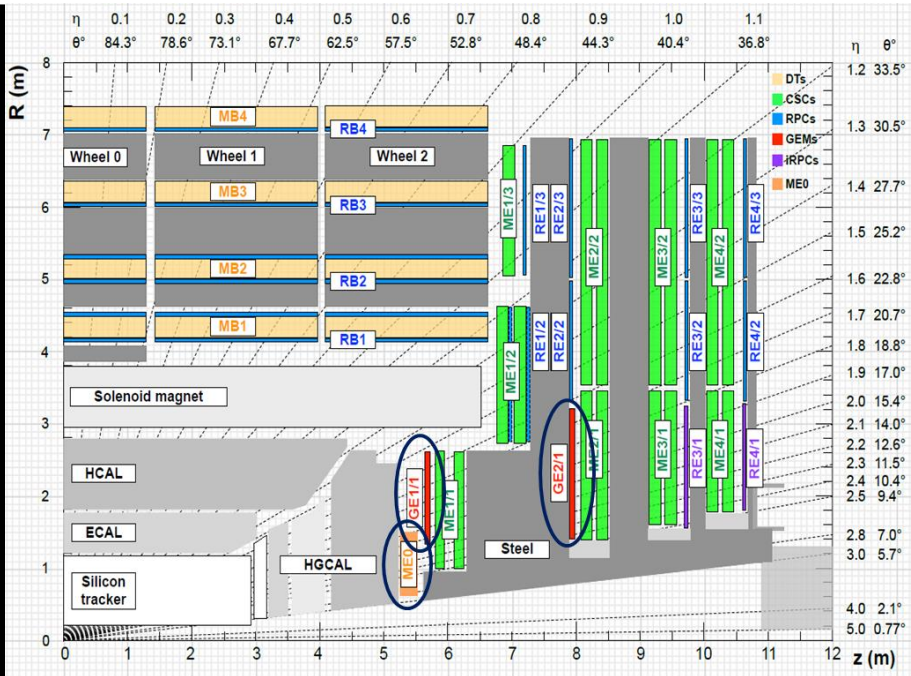
- To maintain trigger performance after HL-LHC upgrade and to increase detector acceptance

- Too many GEM foils for CERN MPT to produce alone

• Korea CMS has taken the responsibility of producing GEM foils

- Half of GE2/1 and all of ME0 foils ~ 1100 foils



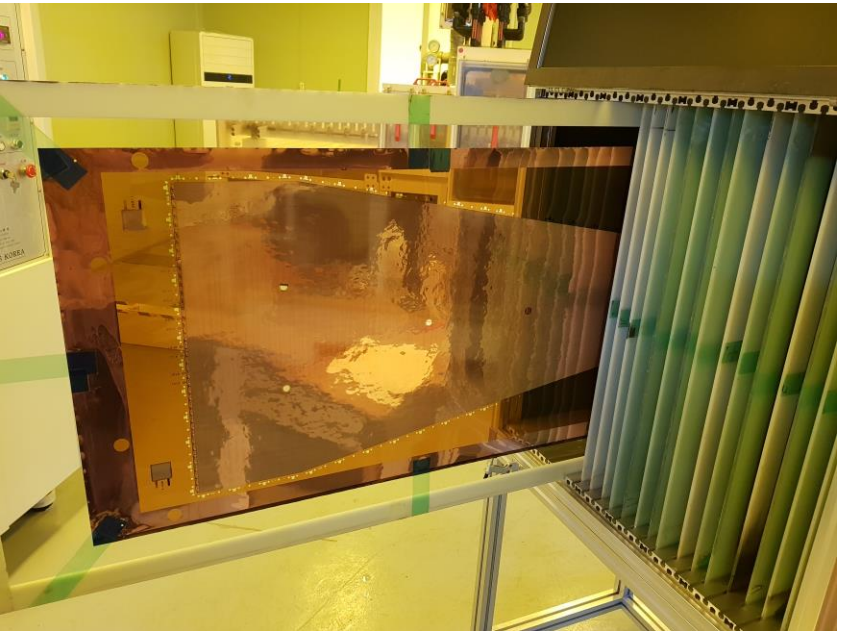



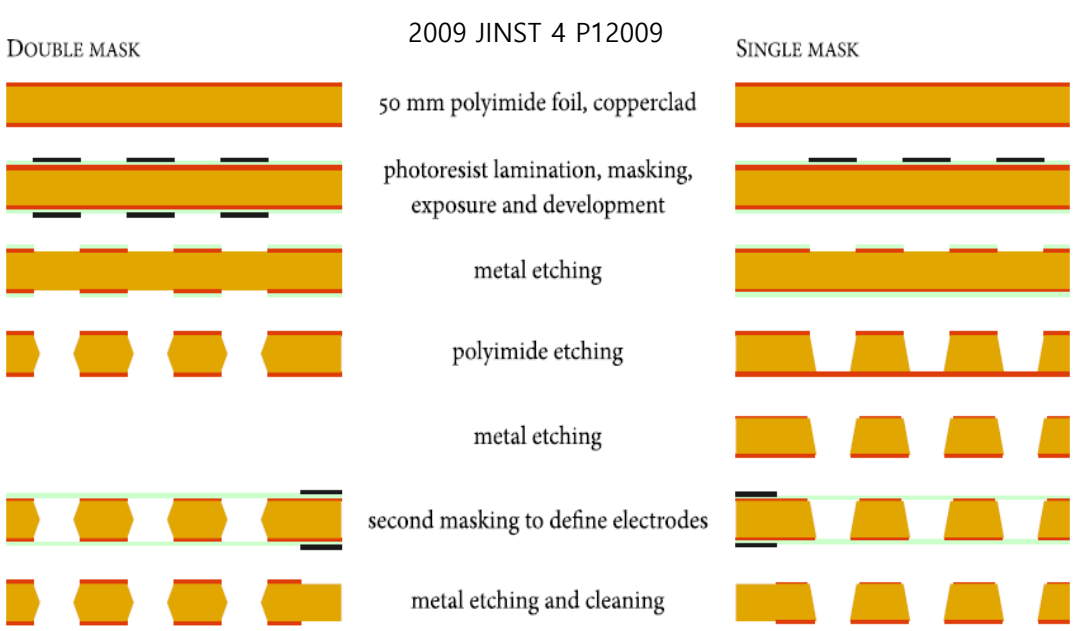
# KCMS GEM Production – Production Capability

• KCMS is one of only two organizations which can produce large size GEM foils

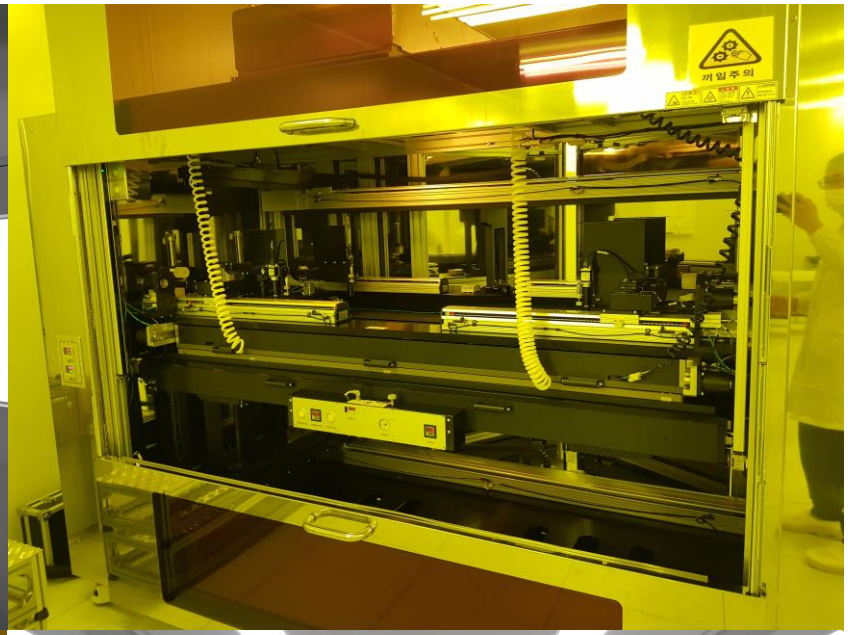
- KCMS uses double-mask technique for faster production, while CERN MPT uses single-mask technique
- Mask alignment become very crucial

  Residual misalignment<5 $\mu m$
- Maximum size ~ $120 \times 60\ cm^2$

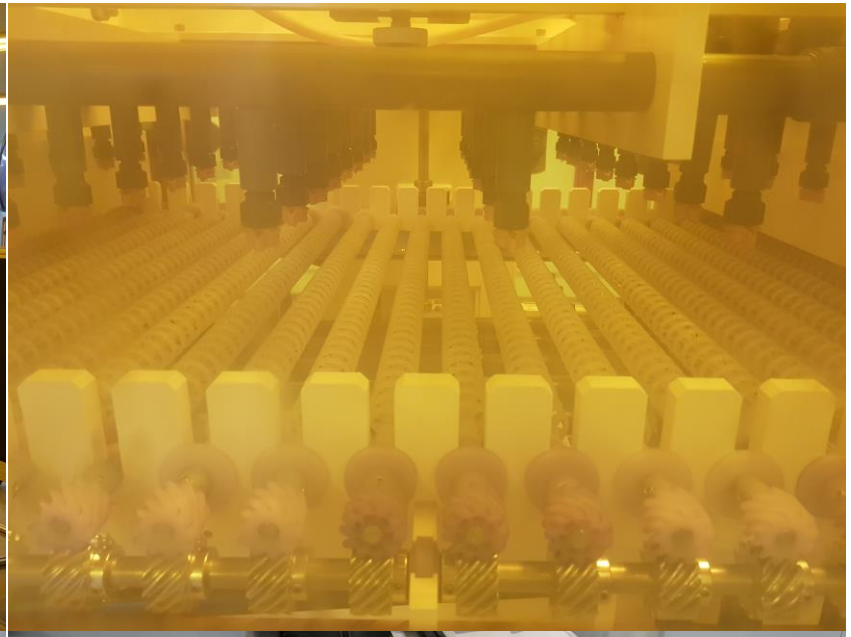
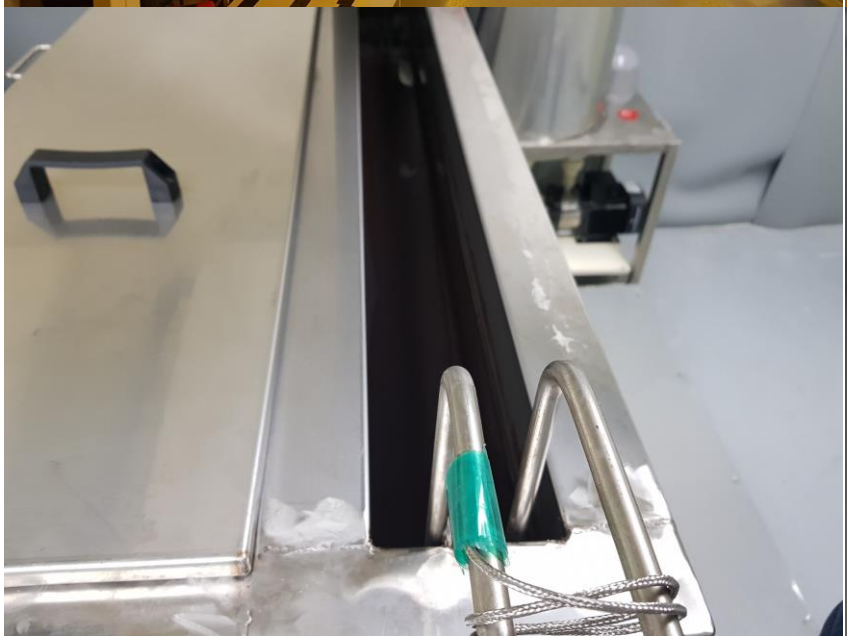




# KCMS GEM Production – Photo & QC Site


# 1. KCMS GEM Production – Chemical Site


# 1. KCMS GEM Production – R&D and Validation

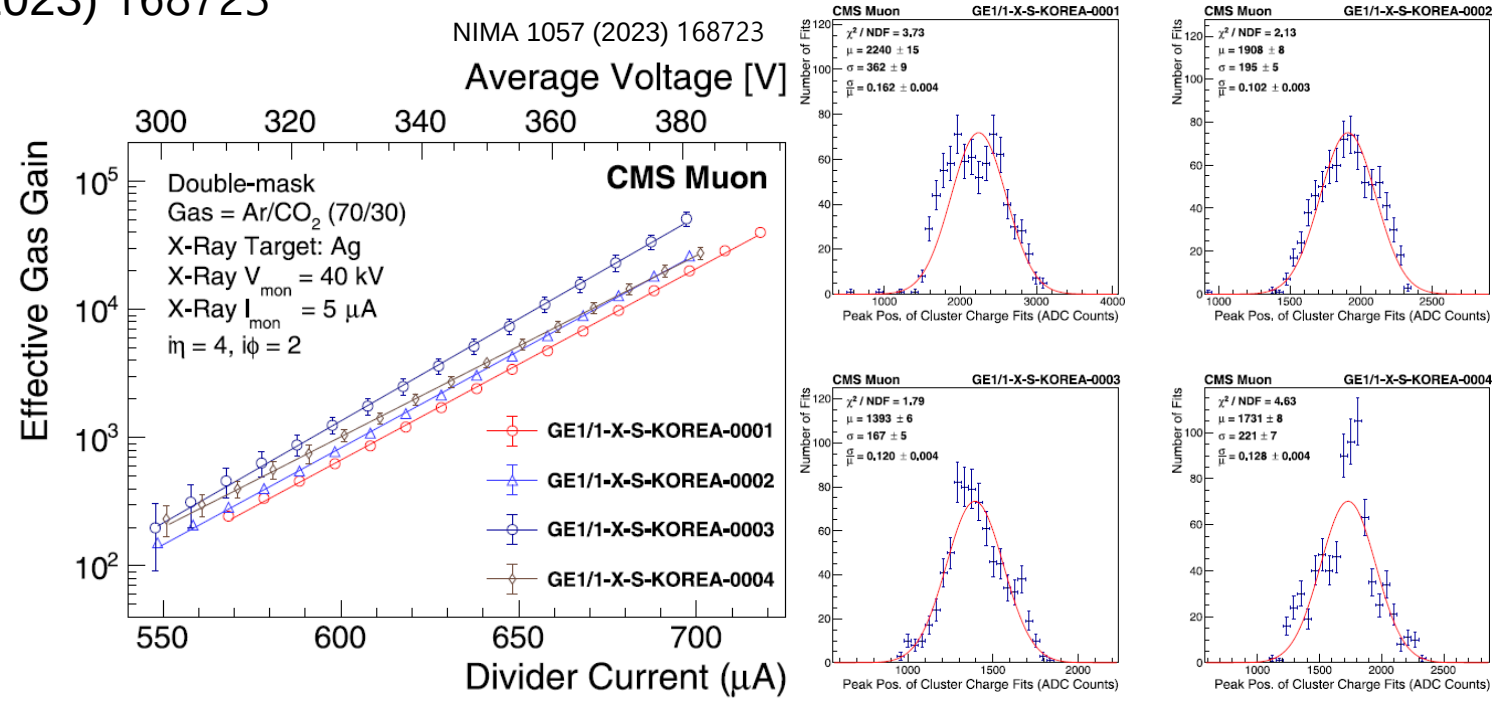
• Production R&D and vendor qualification were done during GE1/1 phase

• First, the quality of the foil was checked optically and electrically, and 4 detectors were assembled

- Detector properties were consistent with CERN detectors and satisfied CMS TDR requirements

- 2023 *JINST* **18** C06010

- NIMA 1057 (2023) 168723



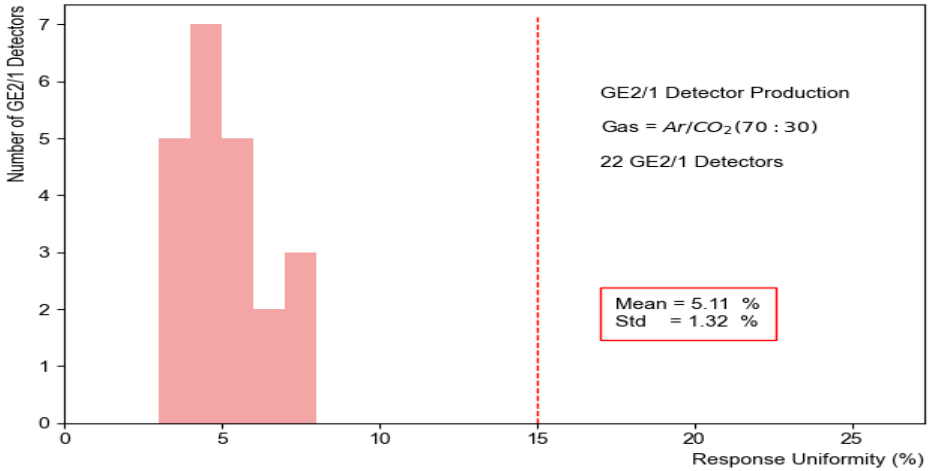
# 1. KCMS GEM Production – Mass Production

- GE2/1 mass production took place, and 292 foils passed QA/QC
  - From 2021 May to 2022 Sep.

- The produced foils were inspected by KCMS personnel through QA/QC protocol before shipping to CERN

- Currently, ME0 mass production is ongoing
  - Scheduled to finish at the end of 2025


Observed RU: 5.11%
TDR requirement: <15%



# 2. $\mu$RWELL Production R&D

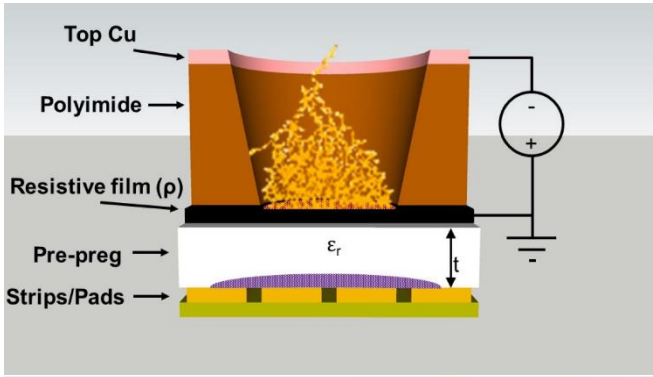
• Discussions are underway to expand our expertise to $\mu$ RWELL production as well

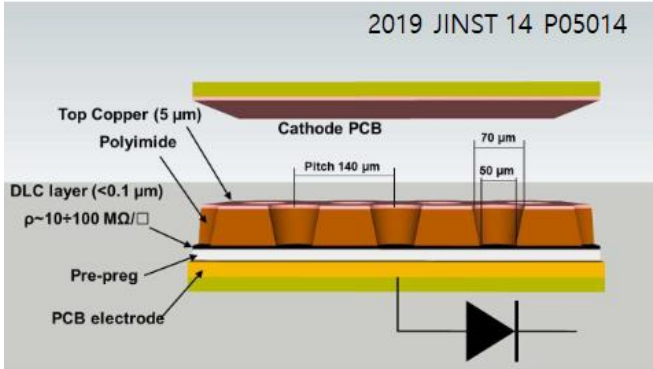
• Micro Resistive Well
- Resistive GEM → spark protected (NIMA 824 (2016) 565–568)
- Single GEM
- Self rigidity

⇒ Simpler structure & easier to assemble

⇒ Cheaper

• Target
- DAMSA experiment
- ePIC experiment

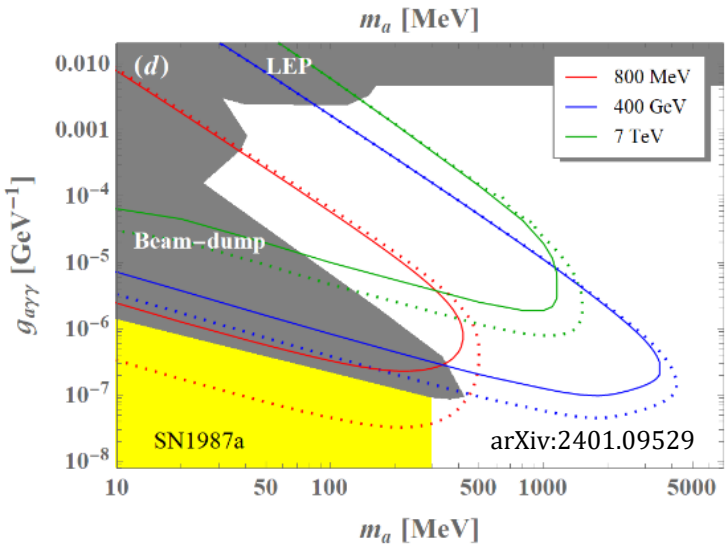


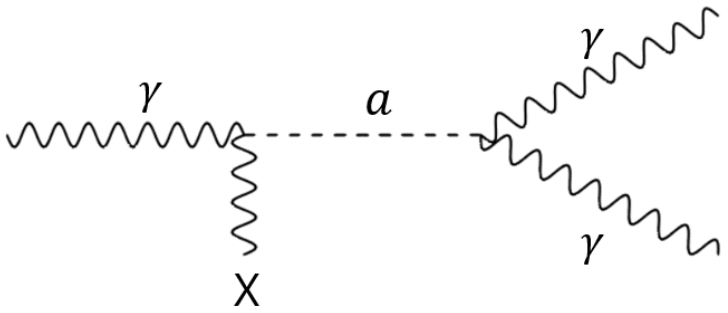



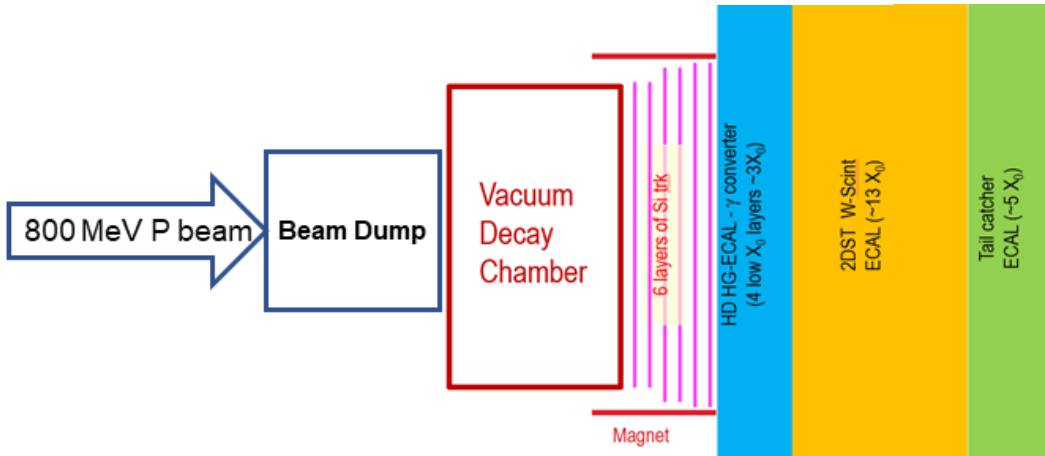
# 2. $\mu$RWELL Production R&D – DAMSA experiment

- Search for $a \to \gamma\gamma$ and $A' \to e^+e^-$ using beam dump of Fermi Lab PIP II
  - PRD **107**, L031901 (2023)
  - To veto Bkg. and to detect $A' \to e^+e^-$, tracker is needed
  - $\mu$RWELL would be harder to neutron Bkg. and cheaper than Si

- The key of the DAMSA experiment is to place the detector directly behind the beam dump
  - To increase “the beam dump ceiling”
  - Large neutron Bkg. is expected



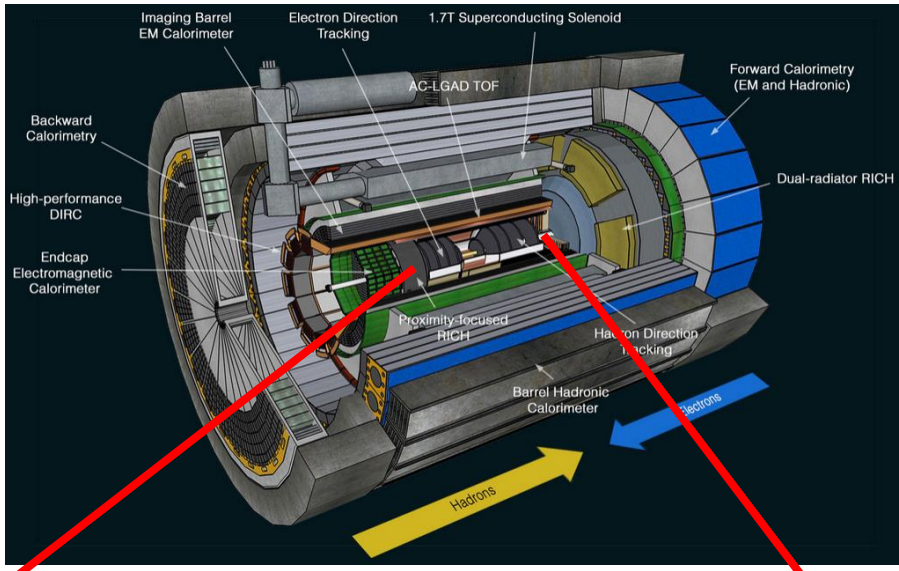



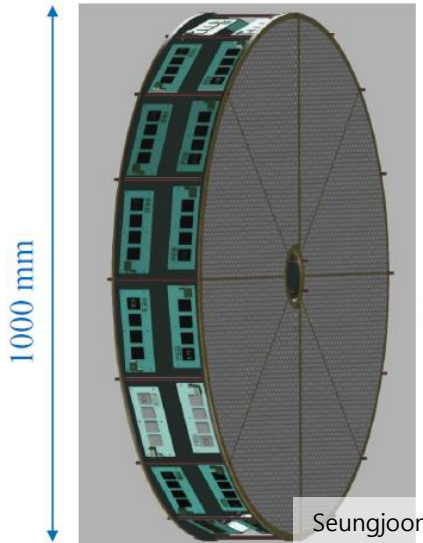



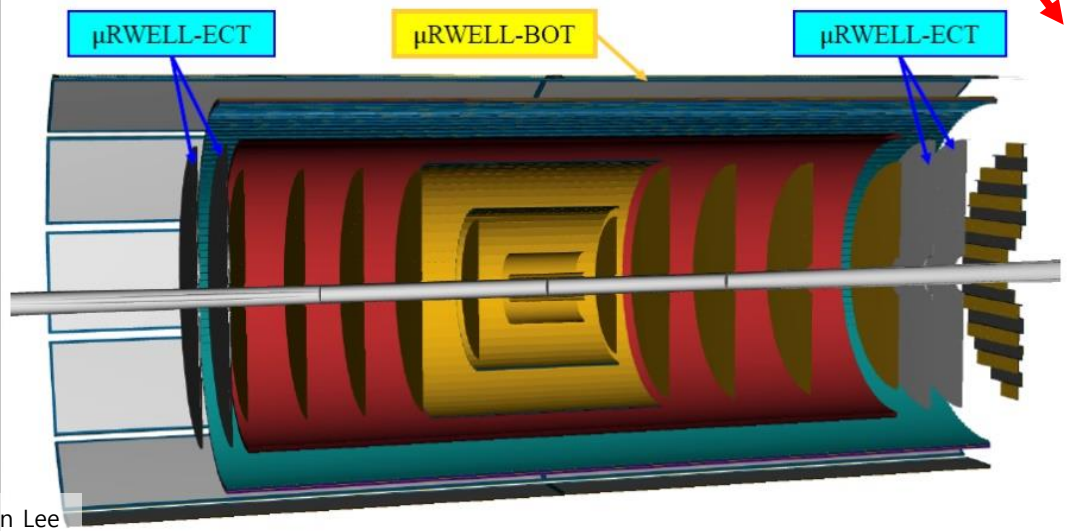
# 2. $\mu$RWELL Production R&D – ePIC experiment

- Electron  Ion Collider
  - Polarization $\sim 70\ \%$
  - $L = 10^{33} - 10^{34} cm^{-2} s^{-1}$
  - $\sqrt{s} = 30 - 140$ GeV
  - Structure of proton and nuclei

- ePIC detector
  - Central tracker: MAPS + MPGD
  - BOT & ECT: GEM+$\mu$ RWELL hybrid



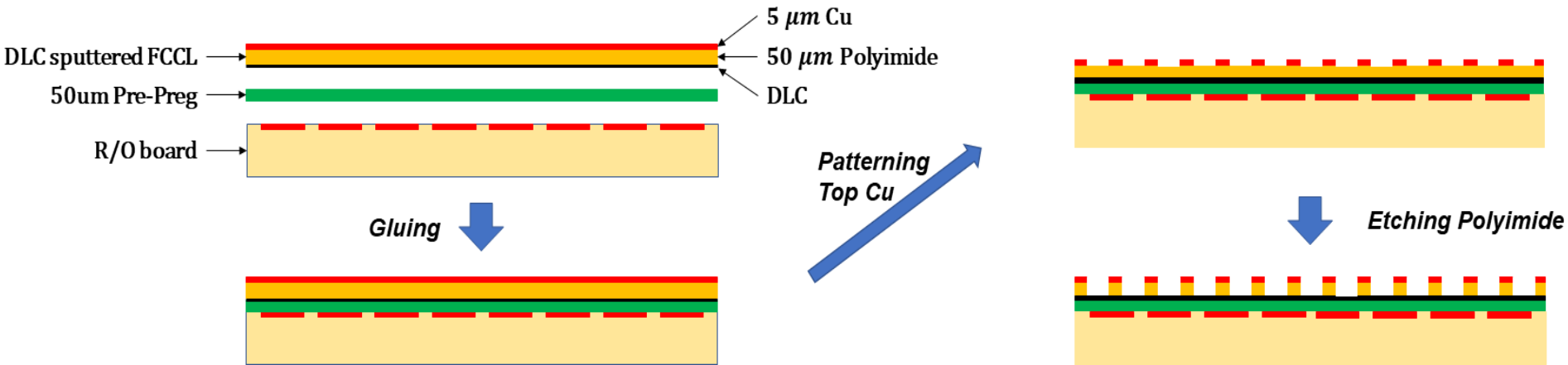



# 2. $\mu$RWELL Production R&D – Plan

- $\mu$ RWELL production R&D in this year
  - $10 \times 10\ cm^2$ $\mu$ RWELL

- GEM and $\mu$ RWELL share production processes

- Discussion with CERN MPT and procurement are ongoing



# Summary

• For CMS Phase-2 upgrades, KCMS has built large size GEM production facilities and succeeded in the production

- Passed a thorough vendor qualification processes
- GE2/1 mass production done. ME0 mass production is in progress
- CMS production will be done around the end of 2025

• Discussions are underway to extend our expertise to $\mu$ RWELL

- $\mu$ RWELL is attractive and shares the production processes with GEM, so we think it can be produced without significant additional effort

• Target experiments

- DAMSA: $\mu$ RWELL tracker
- ePIC: GEM+ $\mu$ RWELL hybrid tracker