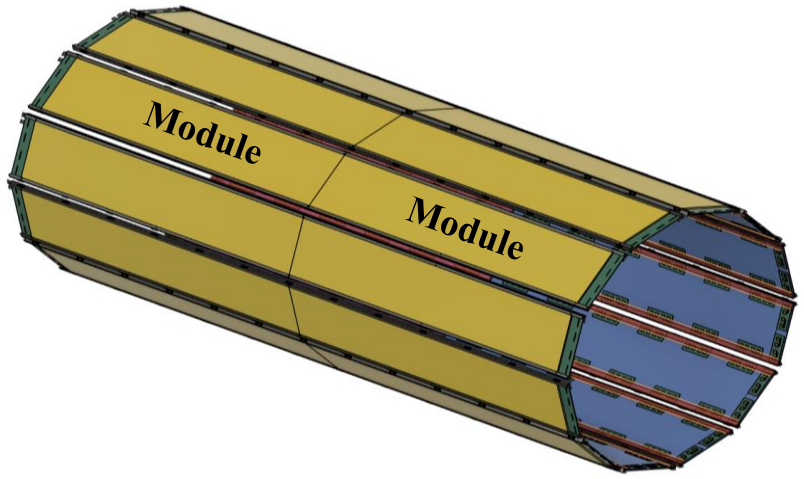
MPGD-DSC – General

Update on PED Test Article design

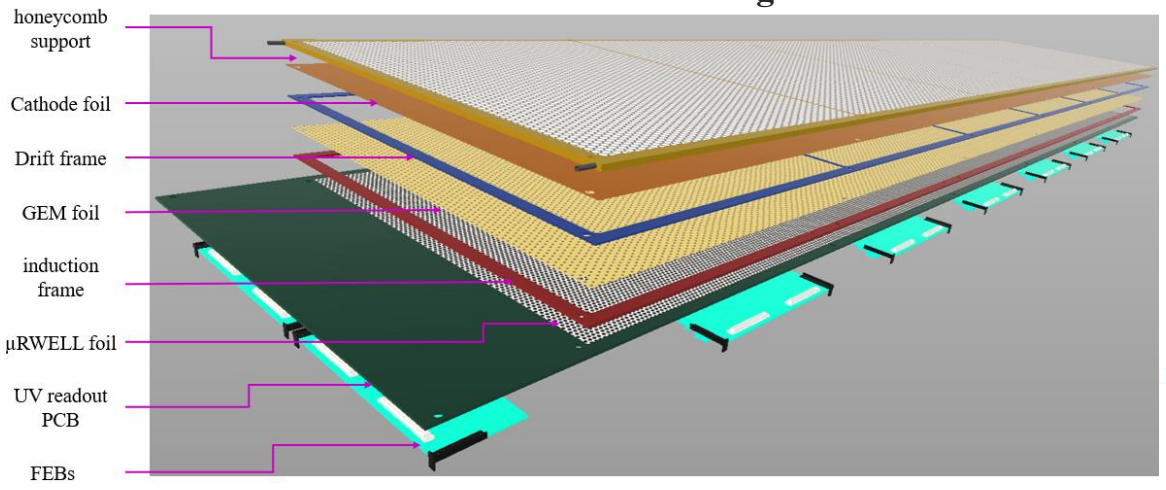
Kondo Gnanvo – September 04, 2025

ePIC MPGD Barrel Outer Tracker: µRWELL-BOT

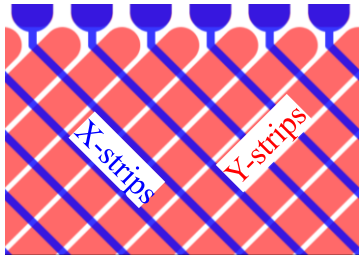
µRWELL-BOT layout

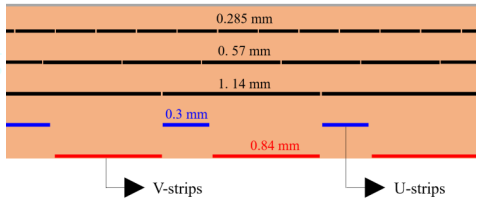


Module design



capaSh X-Y strip readout





24 planar detector modules:

- 12 sectors in r*φ × 2 modules in z ➔ No overlaps
- R_{min} = 72.5 cm; R_{max} = 75 cm
- Novel Thin-gap GEM-µRWELL hybrid technology
- ASIC: SALSA (under development @ Saclay): 64 chs
- ~86k readout electronic channels

Module

- Overall dimension: 180 cm in z × 36 cm in r*φ
- Active area: 170 cm in z × 33 cm in r*φ
- Capacitive-sharing "X-Y" strips readout @ 45° w.r.t detector
- 14 FEBs / module Total: 3,584 chs / module
- Hirose connectors: 140 pins (128 signals + 12 grounds)

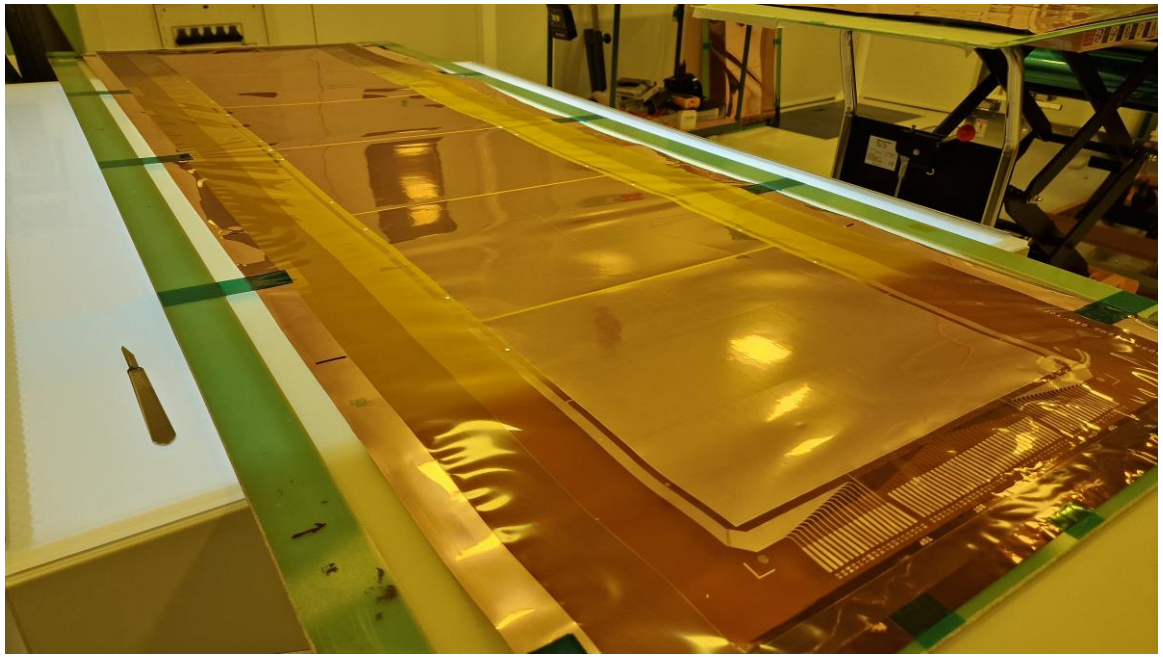
Expected performance

- Spatial resolution: < 100 µm in r × φ & < 150 µm in Z
- Time resolution ~10ns
- Efficiency ≥ 95%
- Material budget ~2% X0

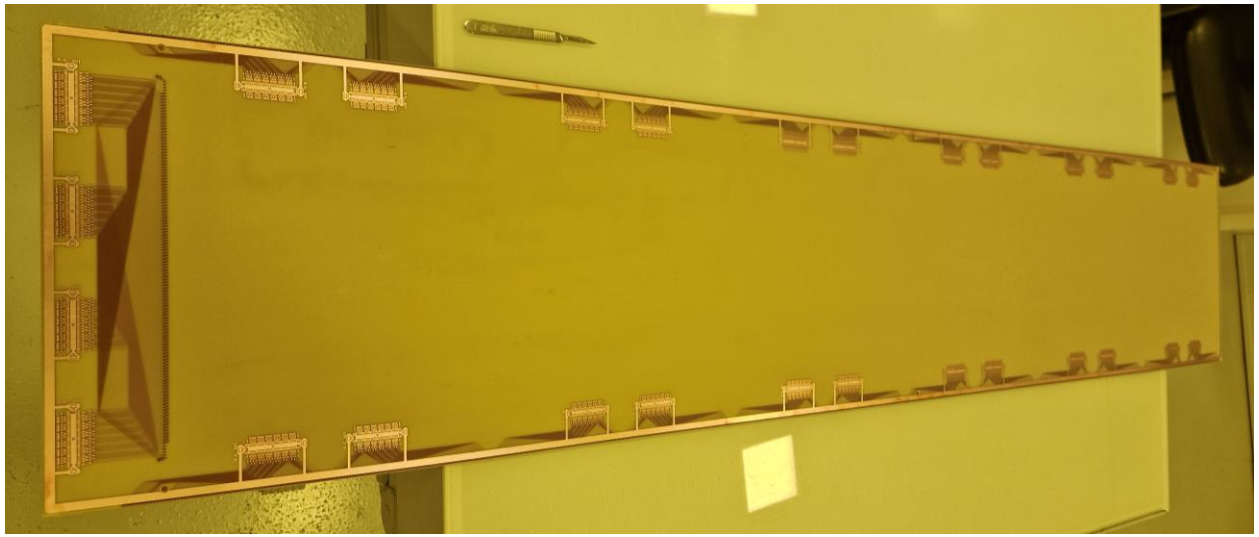
µRWELL-BOT module: CERN are mostly complete

- GEM foil & µRWELL / X-Y strip readout (in hand)
  - Delivered at JLab yesterday (September 3rd)
- Cathode foil is already competed (in hand)
- Frames from RESARM (in hand)
- 30 Hirose-to-Panasonic adapter (in hand)
  - We could then test the test article with APV25 electronics while waiting for SALSA
- We have all detector parts in hand (almost) for the assembly in Sept.

µRWELL / CapaSh readout PCB: Front view



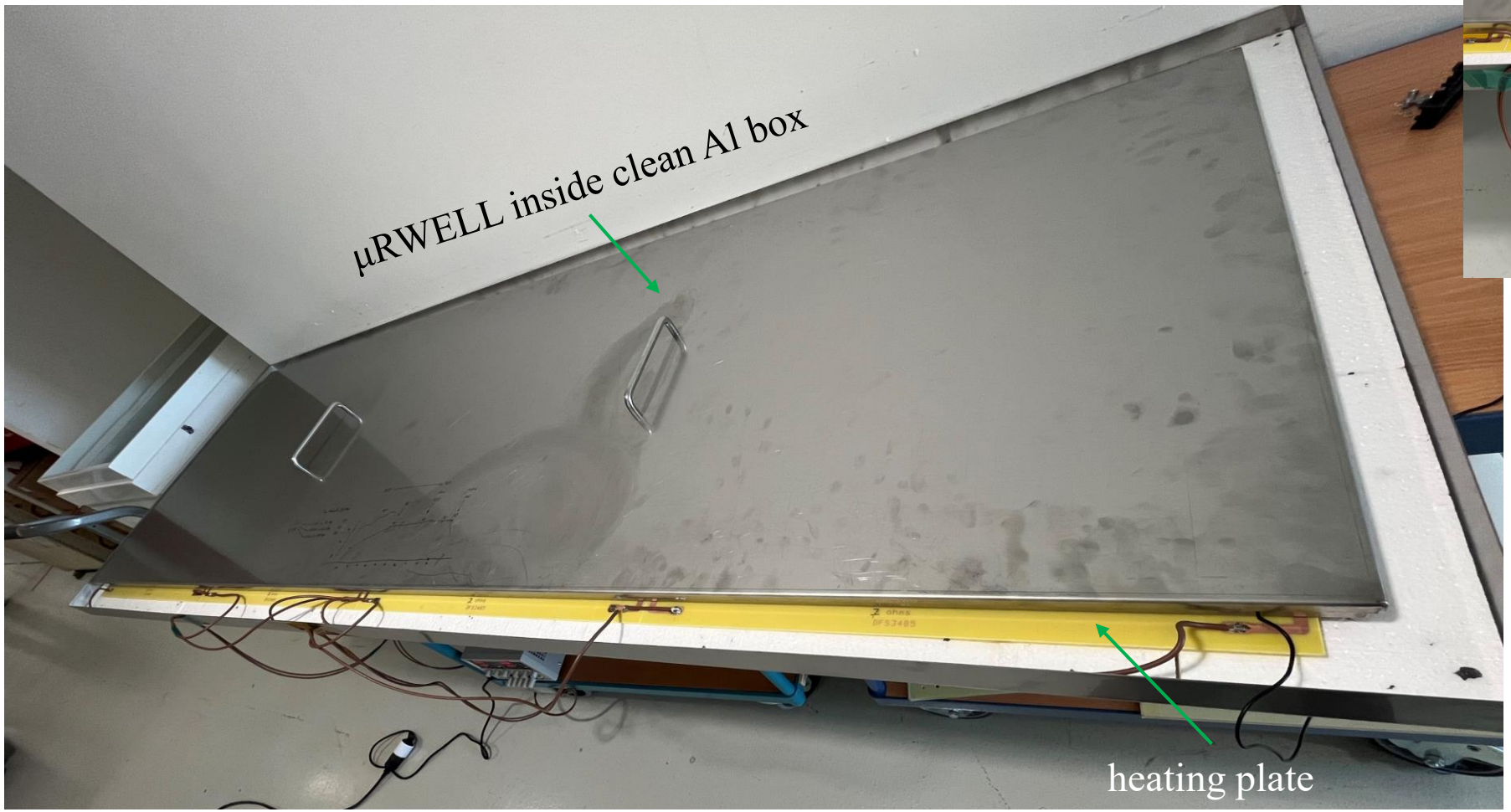
GEM foil

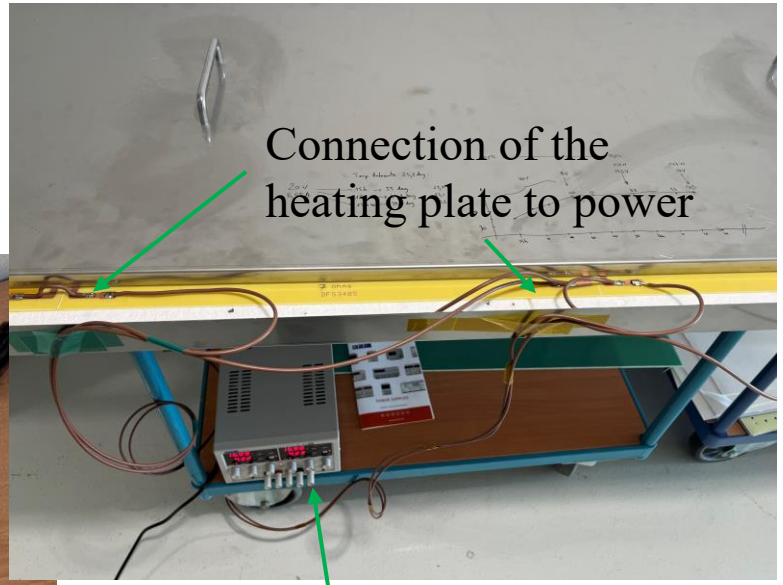


µRWELL / CapaSh readout PCB: back view

μRWELL-BOT Test article parts: Successfully tested at CERN

- μRWELL tested @ CERN at 680 V ➔ all sectors connected together < 2 nA
- @ 700 V, leakage current reaches ~ 200 nA ➔ we went back to 680 V
- μRWELL will operate at a maximum voltage of 450 V





Subject: QC Test report on 3305-B detector.

Right after production and drying @ 80degC during 4 hours, the detector have been tested at 500V in open air , the leakage current of each sector was below 5nA.

After this test, the detector have been placed in a box heated at 50 degC in ambient air for electrical cleaning . After 9 days the detector was able to handle 680V with less than 2nA leakage current (all sectors connected) .

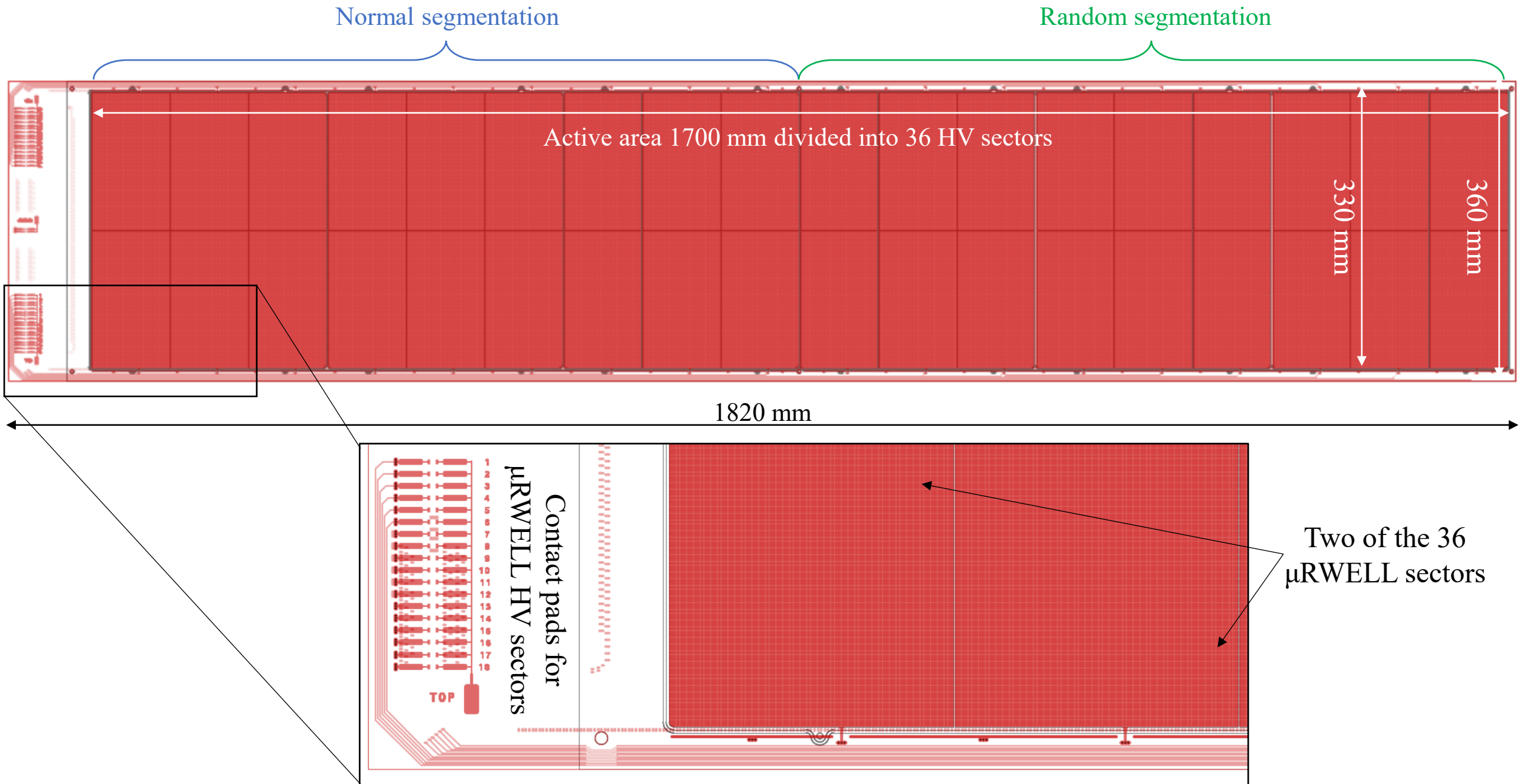
For short periods of less than 30s , the detector is able to handle more voltage :

-At 690V the leakage current rise to a few tens of nA .
-At 700V peaks of current can reach 100 to 200 nA.

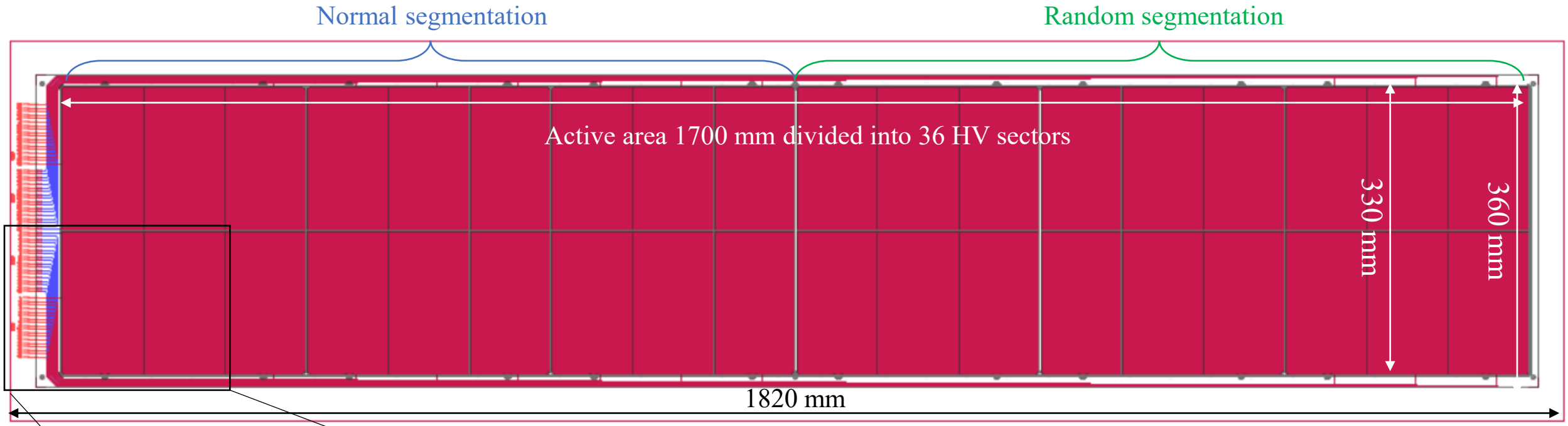
The voltage increase steps during the 9 days were the following :

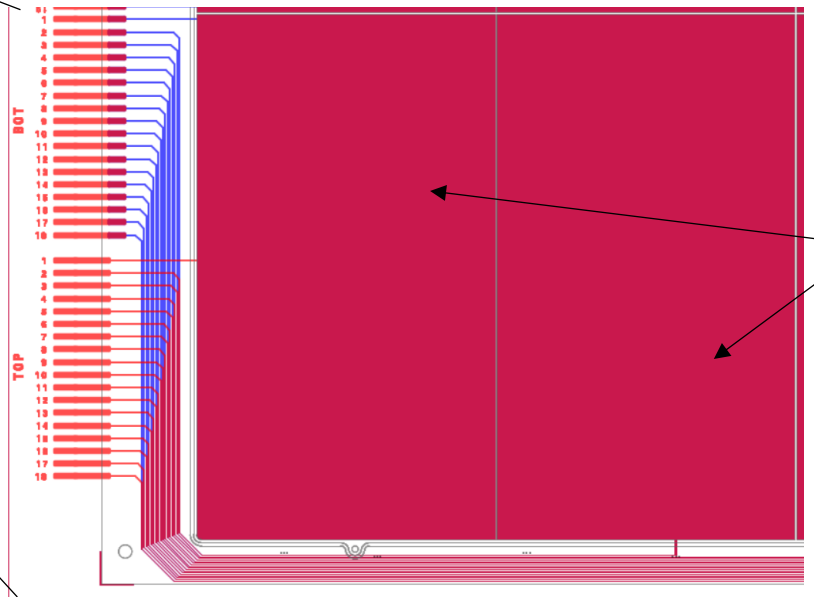
Apply 300V → wait one day → leakage current below 1nA
Increase to 400V→ wait one day → leakage current below 1nA
Increase to 500V→ wait one day → leakage current below 1nA
Increase to 550V→ wait one day → leakage current below 1nA
Increase to 600V→ wait one day → leakage current below 2nA
Increase to 625V→ wait one day → leakage current below 2nA
Increase to 650V→ wait one day → leakage current below 2nA
Increase to 660V→ wait half day → leakage current below 2nA
Increase to 670V→ wait half day → leakage current below 2nA
Increase to 675V→ wait half day → leakage current below 3nA
Increase to 680V→ wait half day → leakage current below 3nA

PED Test Article Module – µRWELL layer design

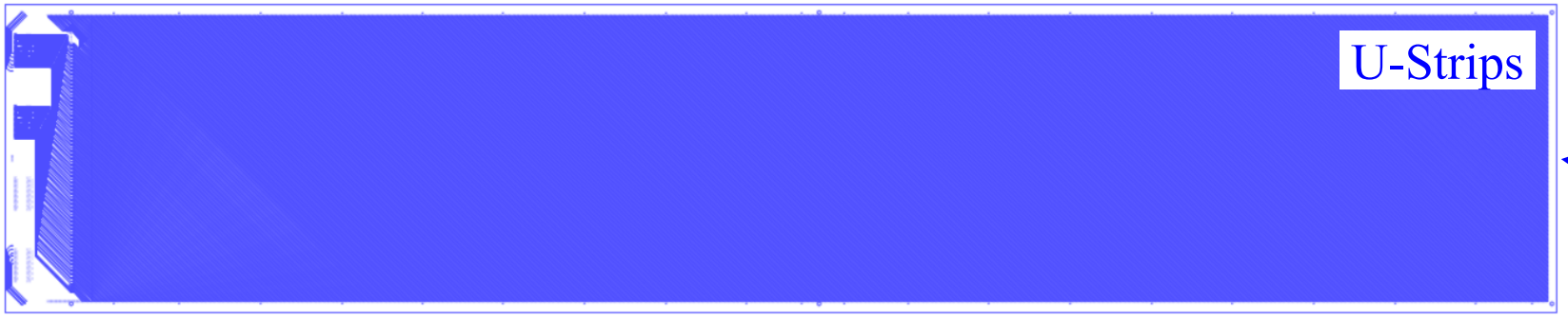


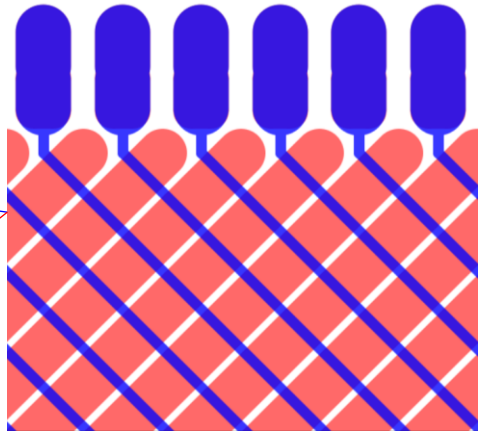
PED Test Article Module – GEM foil design



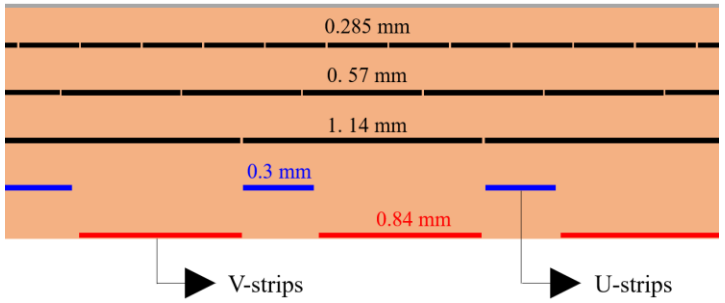


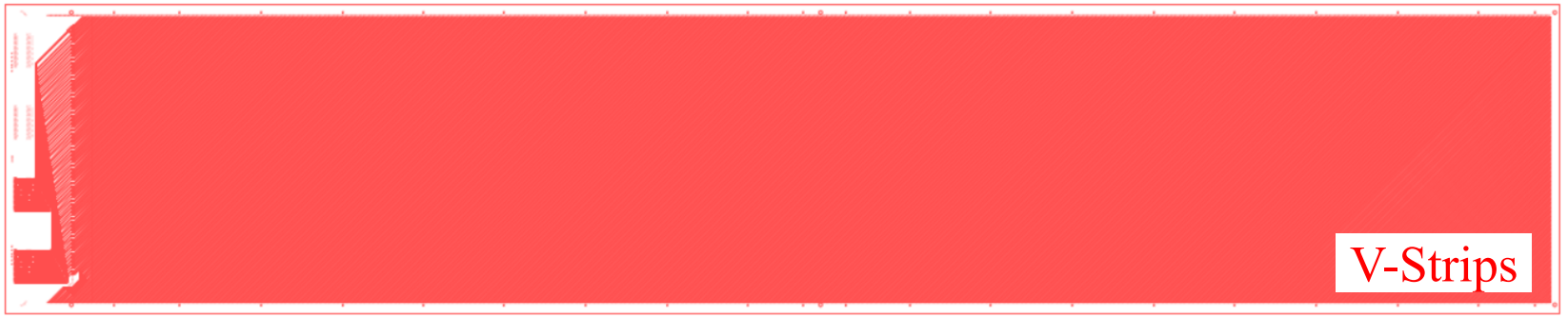
PED Test Article Module – Capacitive-sharing U-V strip design

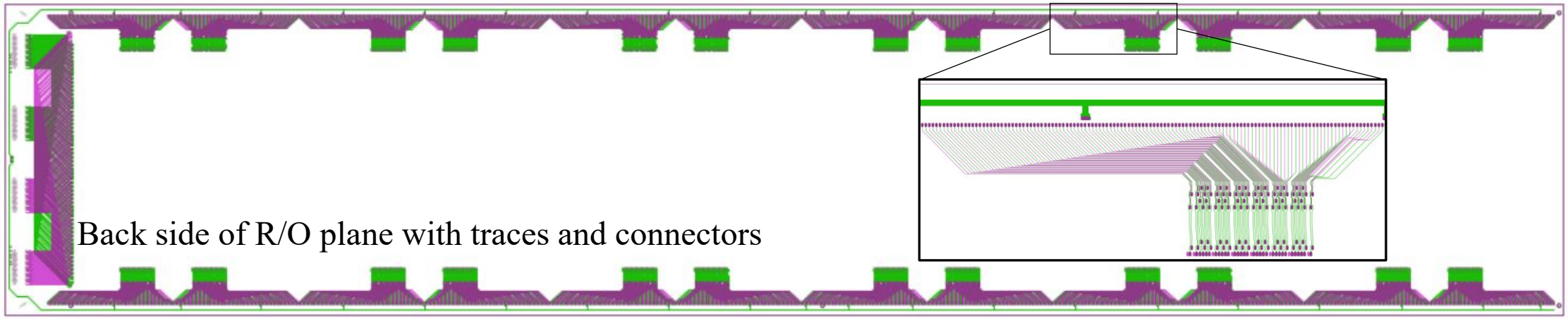




3-layers capaSh U/V strip readout





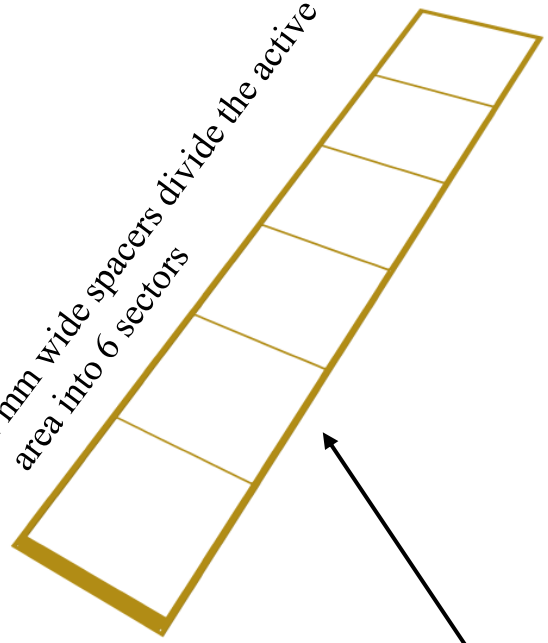


Back side of R/O plane with traces and connectors

PED Test Article Module – Support frames

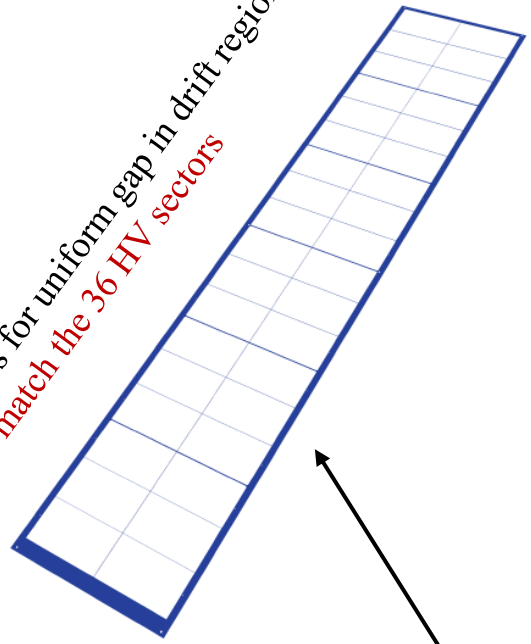
Honeycomb support: Top frame

2 mm wide spacers divide the active area into 6 sectors



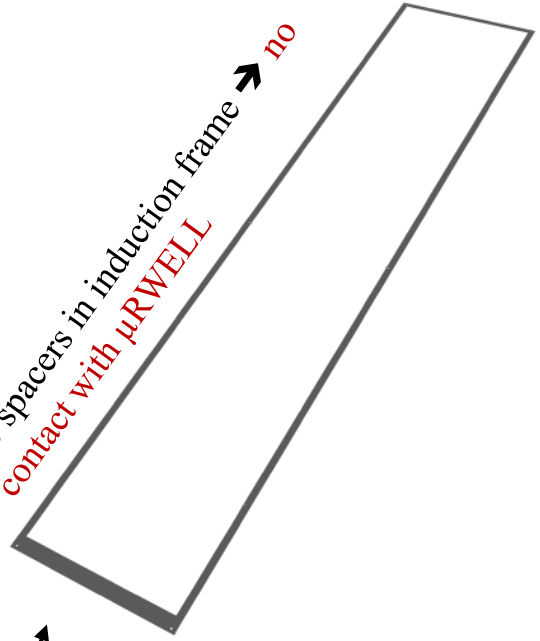
GEM top support: Drift Frame

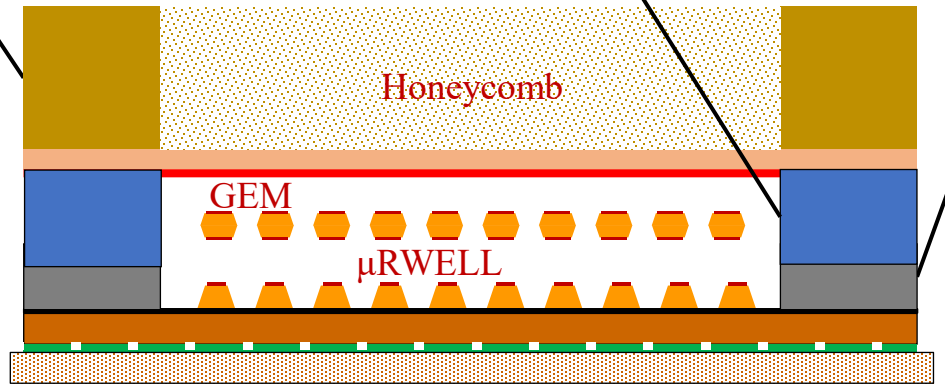
Spacers for uniform gap in drift region match the 36 HV sectors



GEM bottom support: Induction Frame

No spacers in induction frame → no contact with µRWELL





Support frames set for µRWELL-BOT test article module