Status report on μRWELL-BOT

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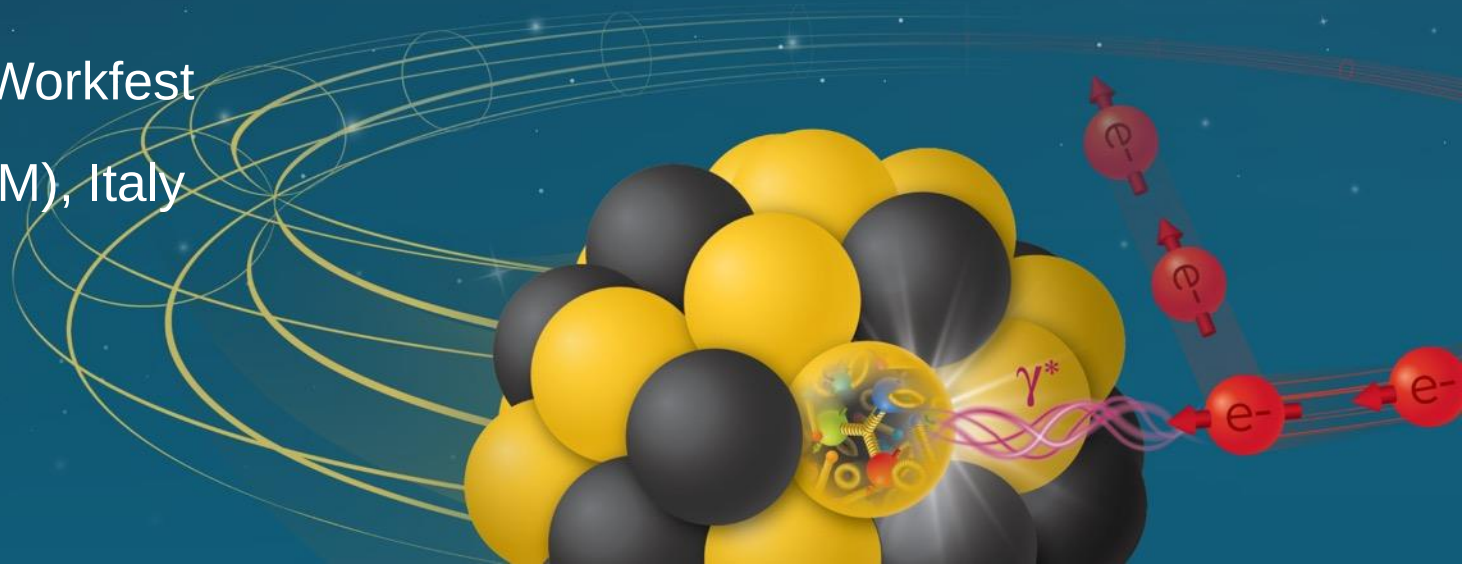
On behalf of the ePIC MPGD DSC

ePIC Collaboration Meeting - MPGD-DSC Workfest

Villa Mondragone, Monte Porzio Catone (RM), Italy

January 24, 2025

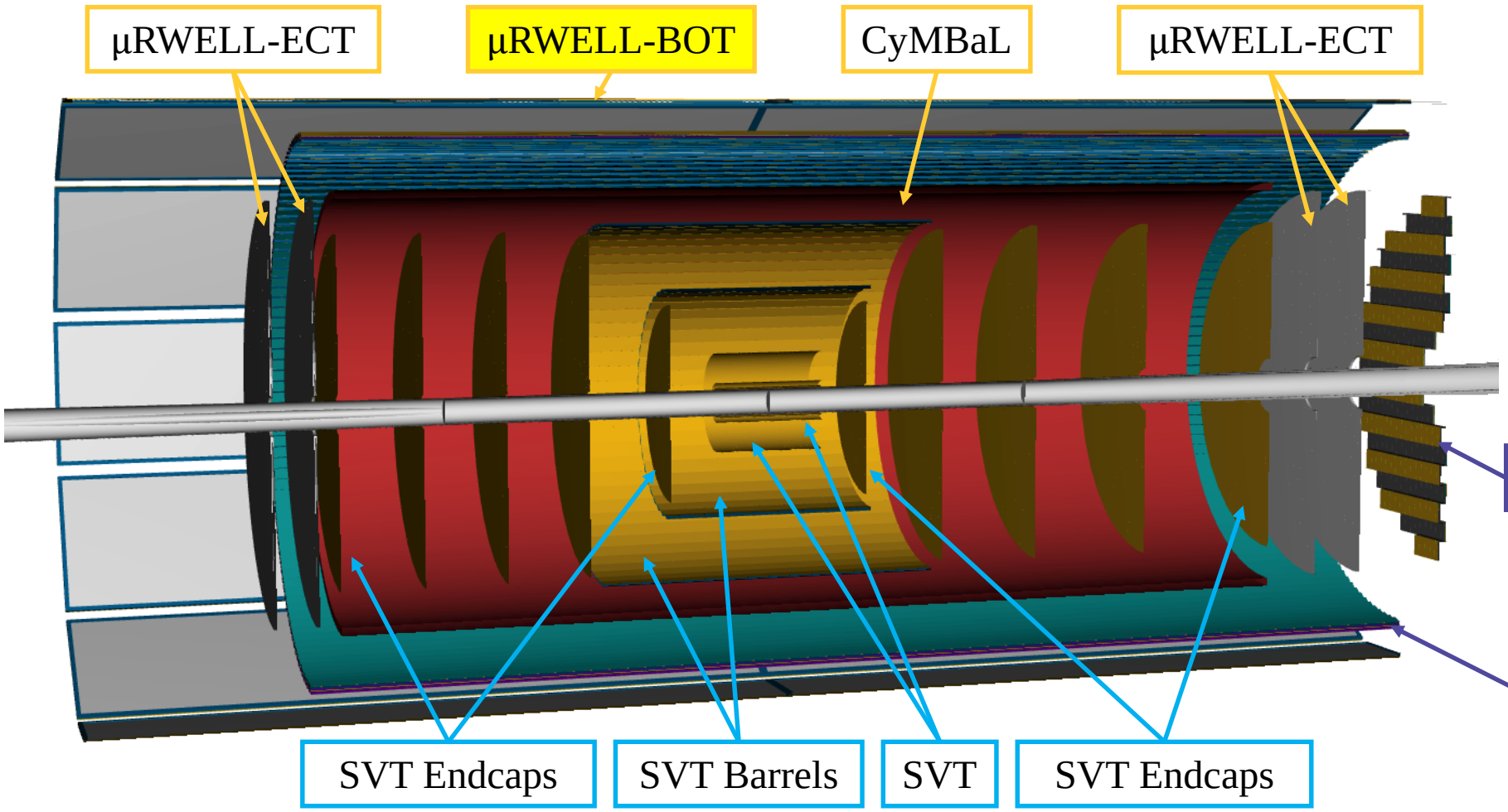
Electron-Ion Collider



μRWELL-BOT core team at JLab:

- **K. Gnanvo -** Project leader for the μRWELL Barrel Outer Tracker (μRWELL-BOT)
- **Seung Joon Lee -** Integration, Electronics …
- **Xinzhan Bai -** Module production, Electronics integration …

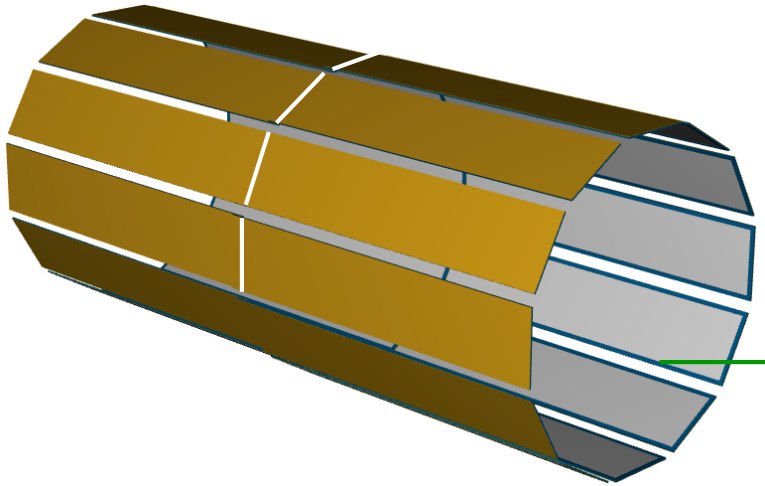
Overview of ePIC Tracking Detector

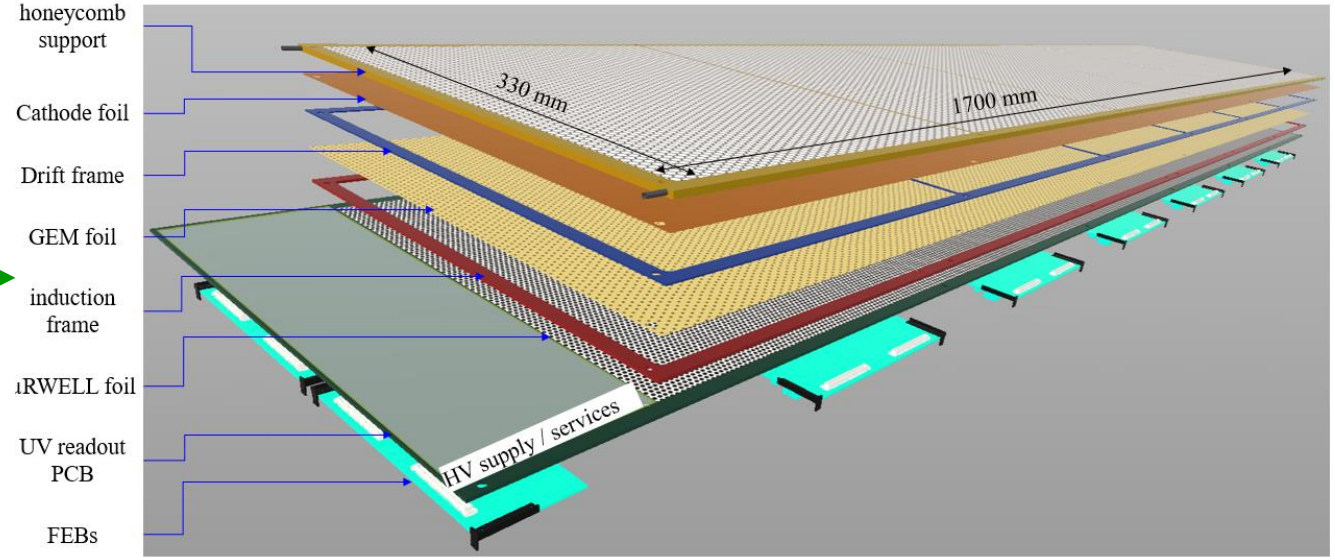


Technologies

- **MAPS** (Si)
- **MPGDs** (Gaseous)
- **AC-LGADs** (Si)

µRWELL-BOT Module:



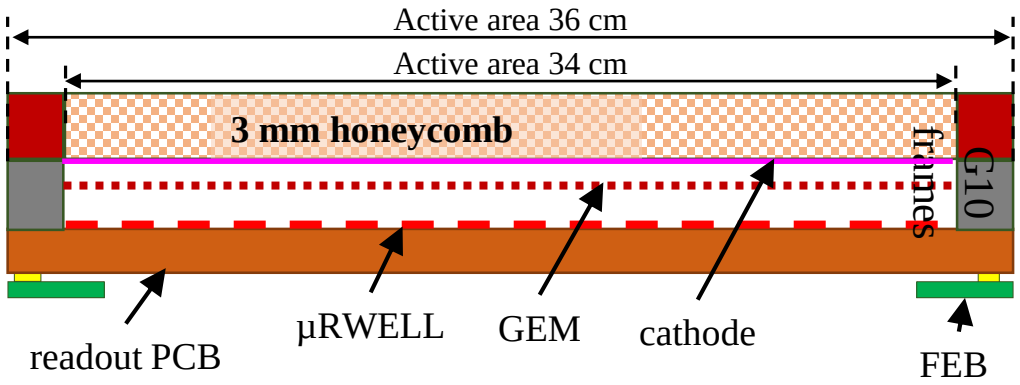


µRWELL-BOT module

- Thin-gap (1-mm drift) hybrid amplification GEM-µRWELL detector
- On-detector Front End Boards (FEBs) based on SALSA chips

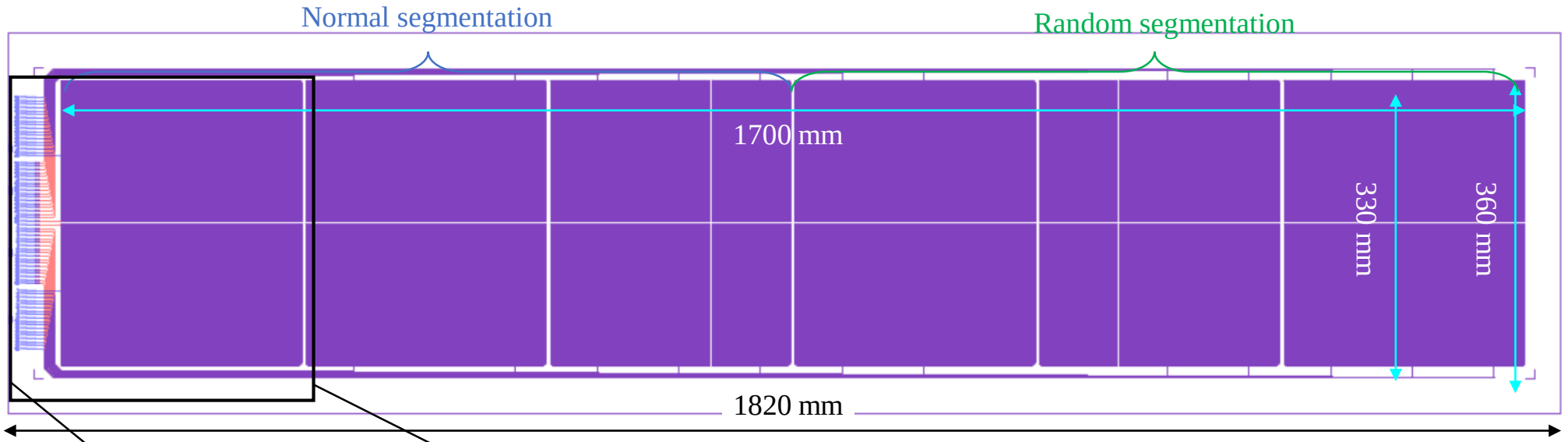
Requirements:

- Spatial resolution:
  - R*phi: < 100 µm,
  - z <100 µm (normal tracks), < 250 µm @ 45^{O}
- Time resolution: 10 ns
- Efficiency ~97%



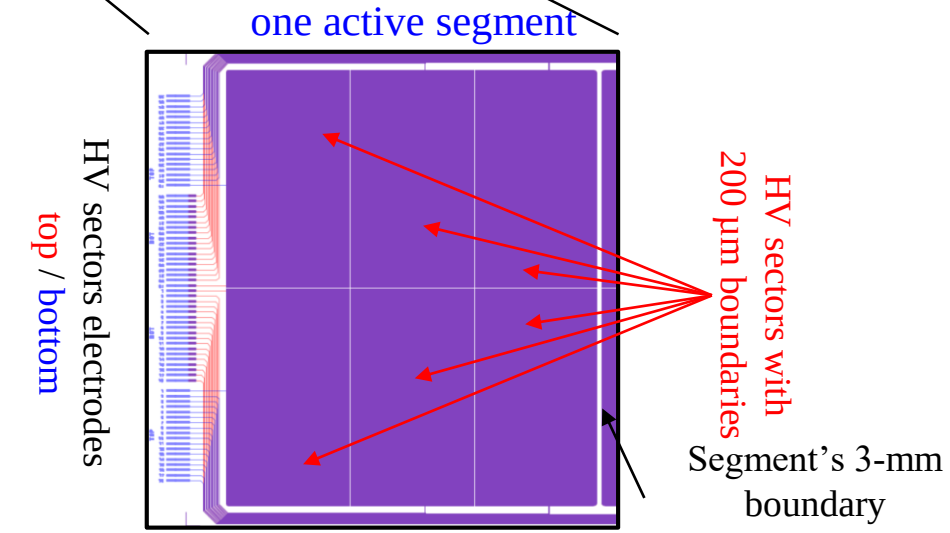
cross-section view of thin-gap GEM-µRWELL detector

Engineering test article: GEM foil



Foil dimension

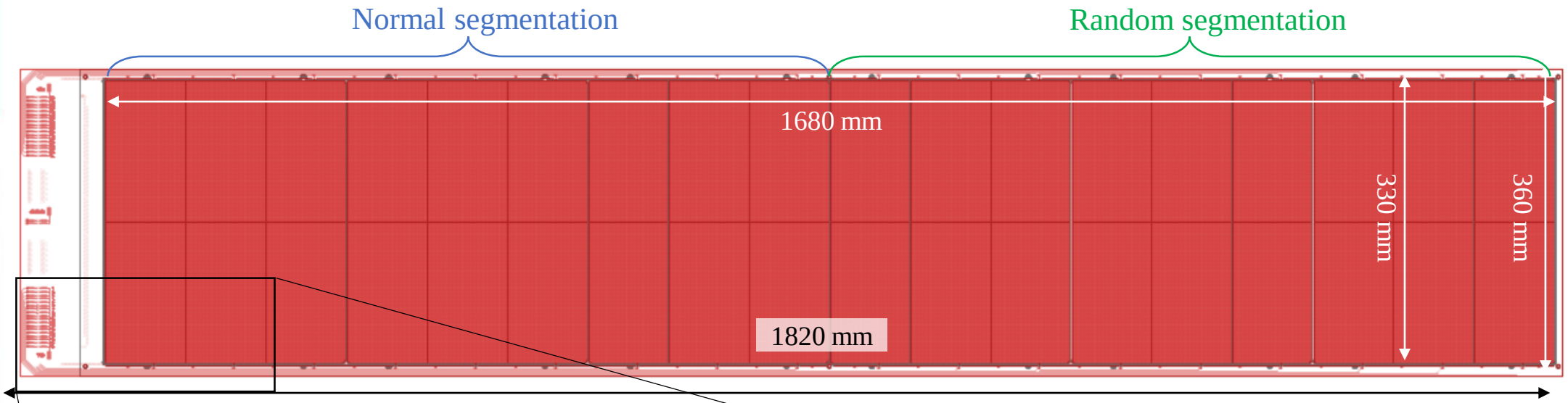
- Total: 1820 mm × 360 mm
- Active area: 1700 mm x 330 mm



- Active area divided into 6 active segments of area 330 mm × 283 mm ➔ separated by 3-mm dead area to be glued to the support frames on top & bottom
- Each segment divided into 6 HV sectors (180 × 96 mm^2) ➔ separated by 200 µm dead area
  - 8 sectors on the left side have normal segmentation
  - 8 on the right with random segmentation ➔ Study impact on efficiency
- Both top and bottom side of the foils are segmented
- Connection to all 76 HV sectors are on the left side of the foil

Latest estimated delivery **May 2025**

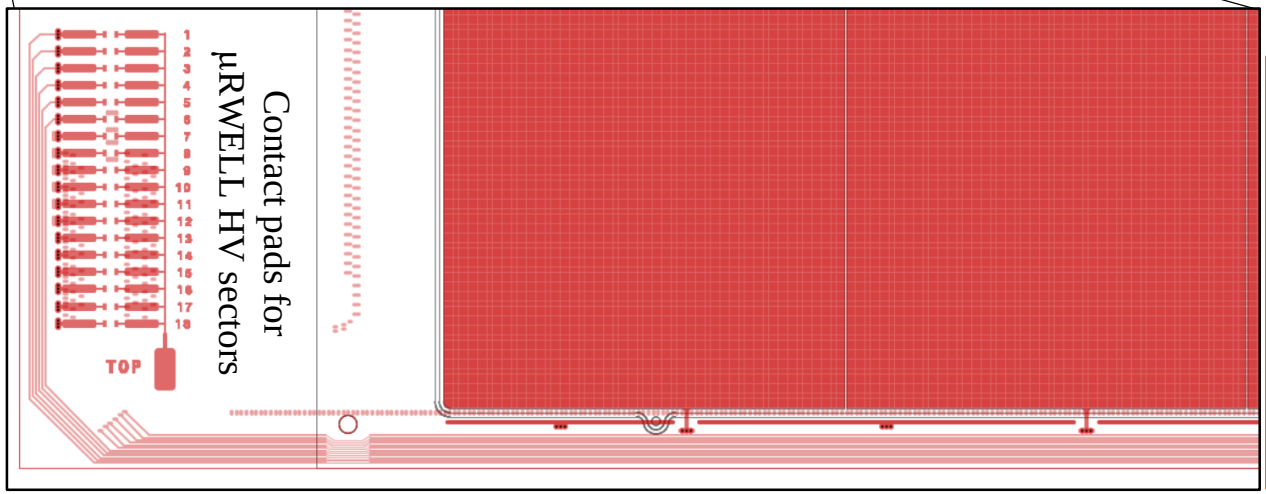
Engineering test article: µRWELL PCB



µRWELL dimension

- **Overall:** 182 cm × 36 cm
- **Active area:** 168 cm x 330 cm

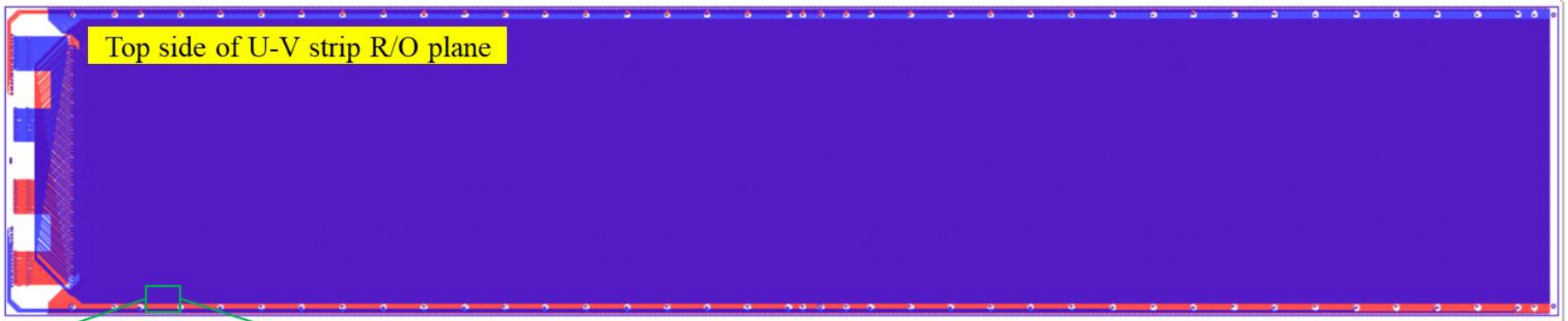
Two of the 36 µRWELL sectors

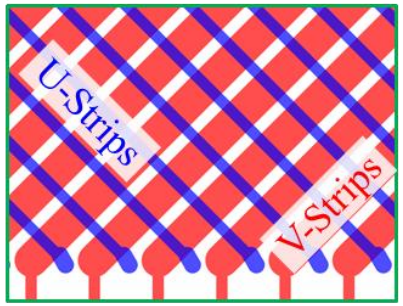


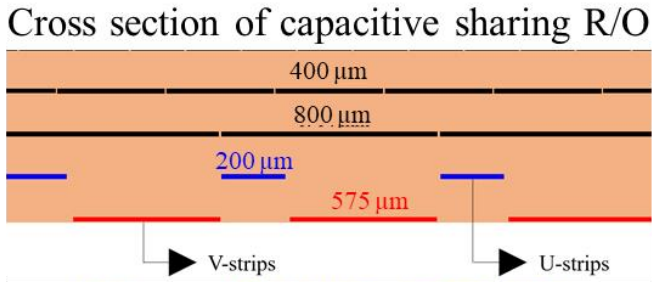
- The active area of 36 HV sectors (180 mm× 96 mm) similar to the HV sectors separated by 100 µm dead area
  - The 18 sectors on the left side have normal segmentation
  - The 18 on the right have a random segmentation ➔ Study impact on detector efficiency
- Connection to all 36 HV sectors on the left side of the foil

Latest estimated delivery **May 2025**

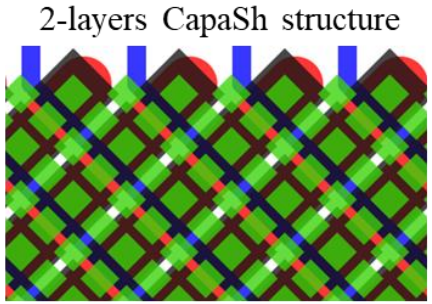
Engineering test article: Capacitive-sharing U/V strip readout

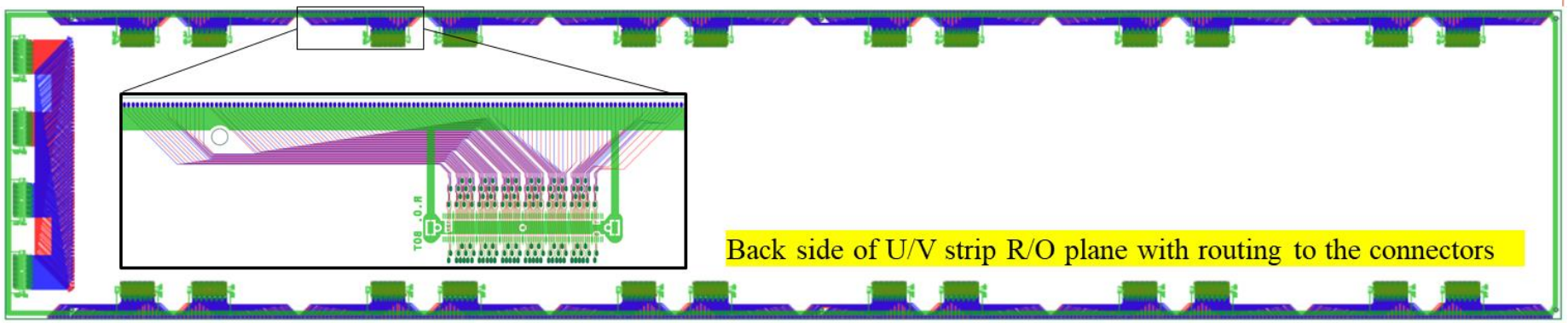






K. Gnanvo, NIM A1047, 167782 (2023)





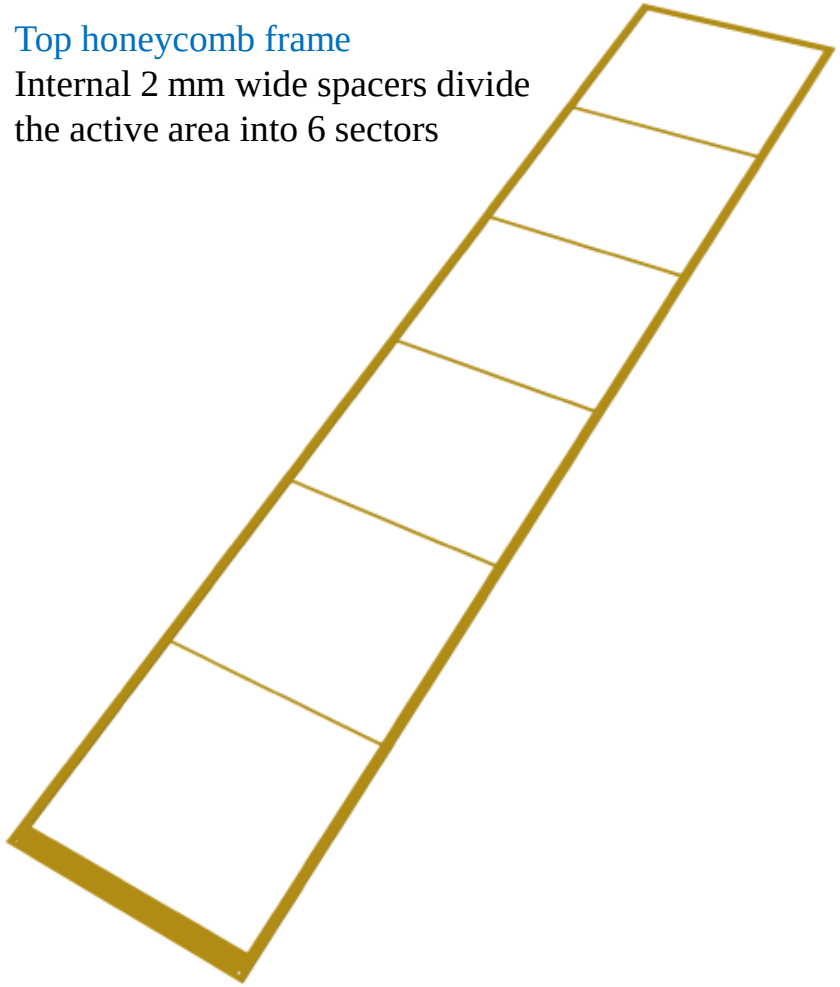
45 degree U / V strips instead of X / Y

- All connectors at the edge the long side of the detector
- Pitch = **800 µm** along U / V axis ➔ 1.14 mm along detector edge
- Strip length = **47 cm** limited strip capacitance concerns
- Width: top strips (U) = 200 µm and bottom strips (V) = 575 µm
- 2 layers of capacitive sharing (400 µm and 800 µm) ➔ square pads along U and V axis
- Total of 3,584 strips ➔ 28 × 140-pins Hirose connectors with 12 ground pins on the back of the PCB

Latest estimated delivery **May 2025**

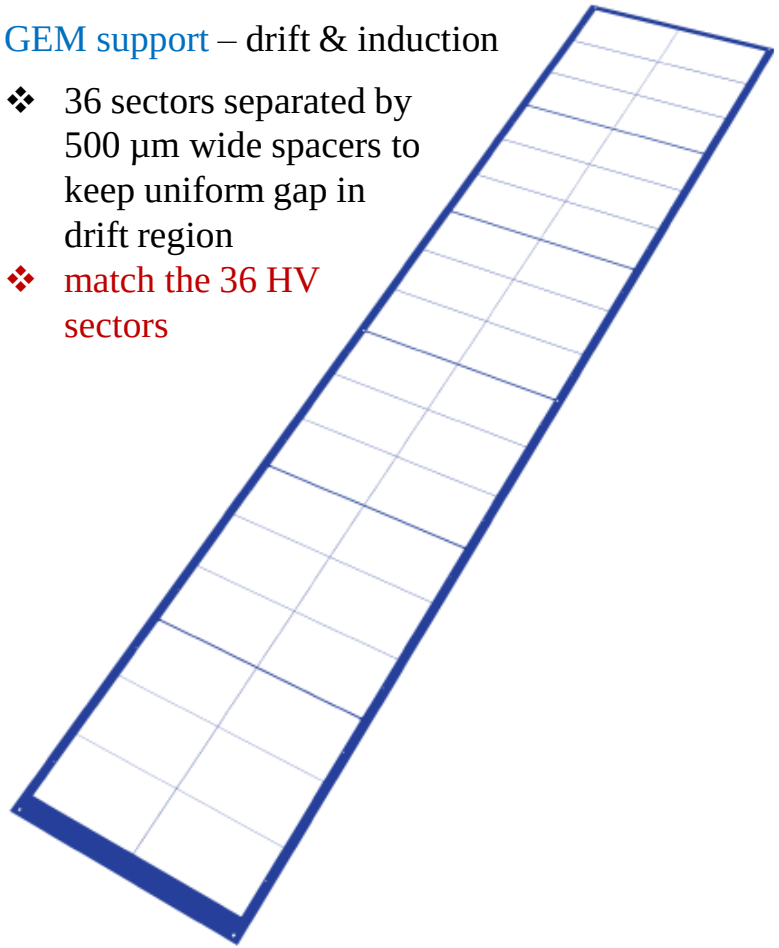
Engineering test article: Support frames

Top honeycomb frame
Internal 2 mm wide spacers divide the active area into 6 sectors



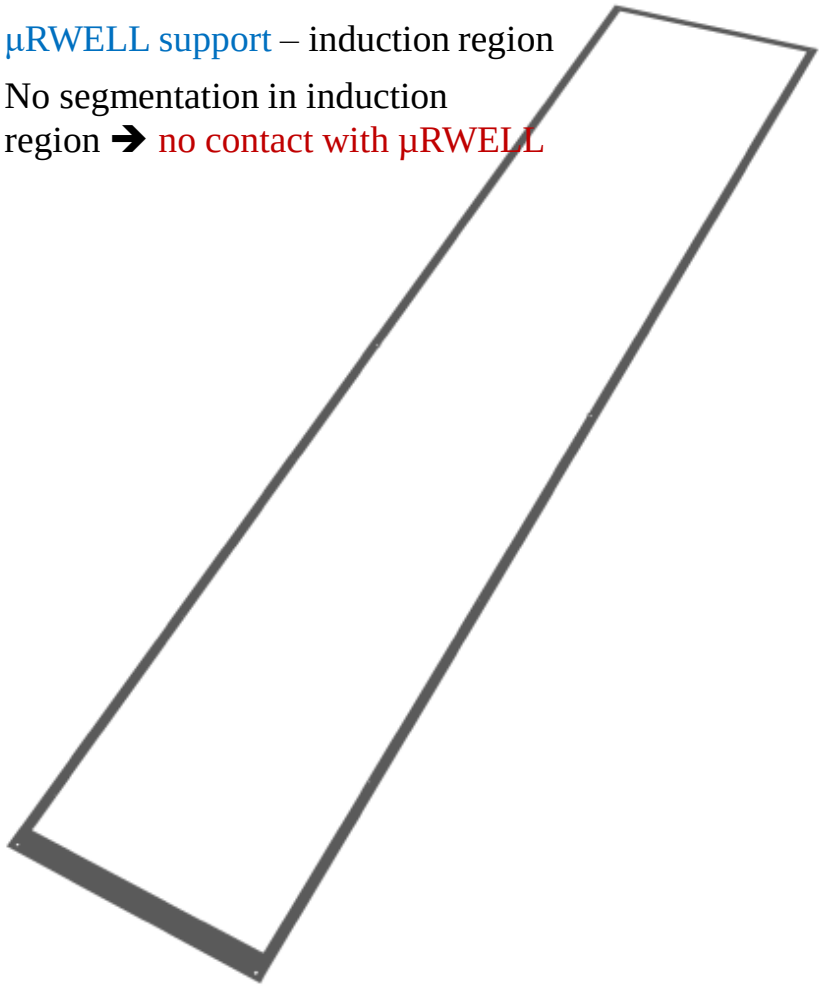
GEM support – drift & induction

- 36 sectors separated by 500 µm wide spacers to keep uniform gap in drift region
- match the 36 HV sectors



µRWELL support – induction region

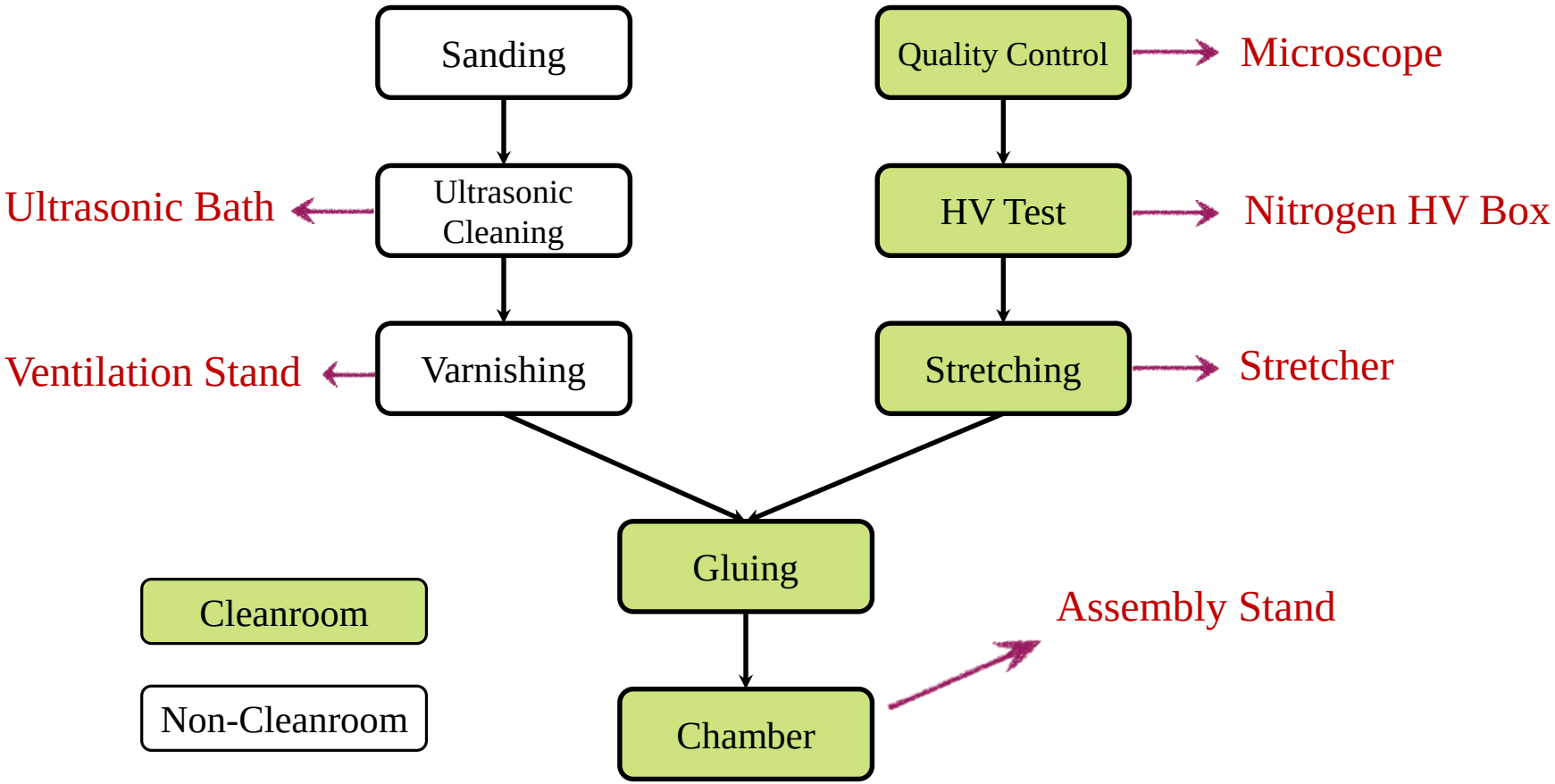
No segmentation in induction region ➔ no contact with µRWELL



Latest estimated delivery **February 2025**

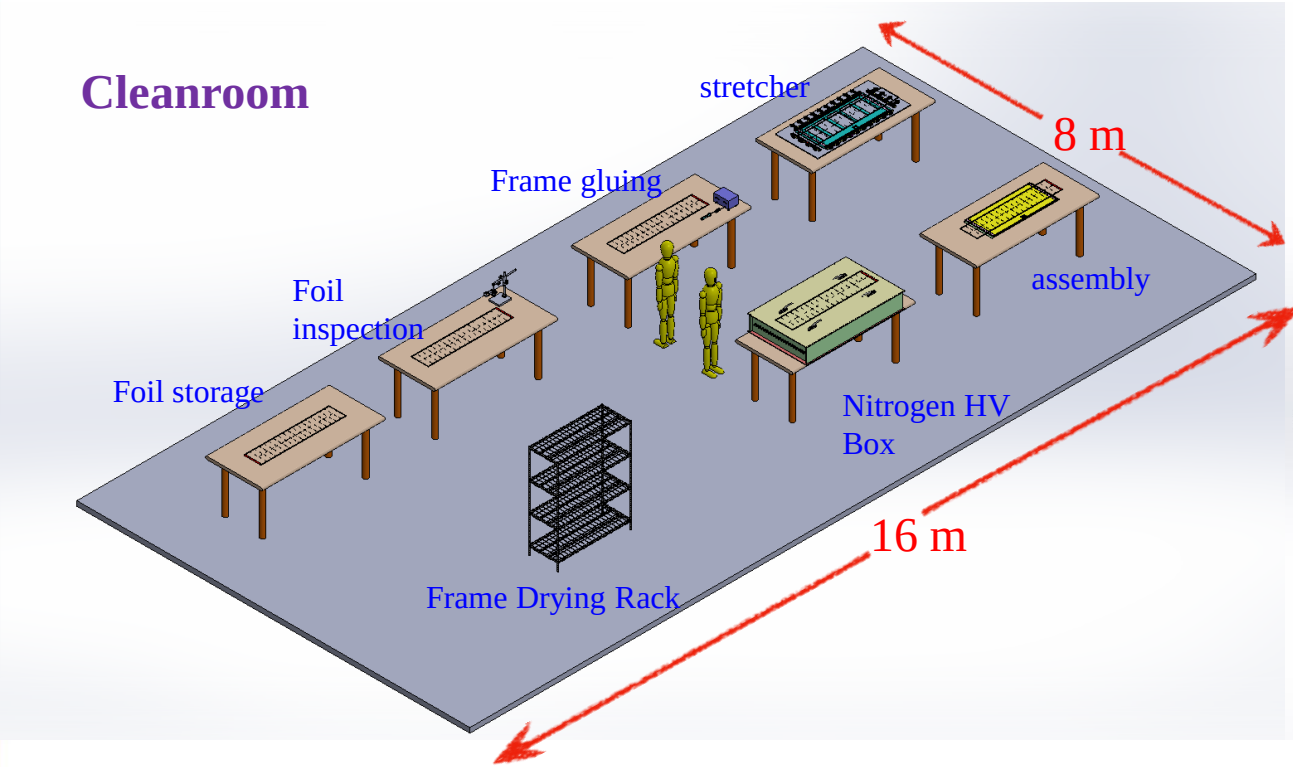
Engineering test article assembly @ JLab: Infrastructure & Equipment needs

Workflow & Equipment

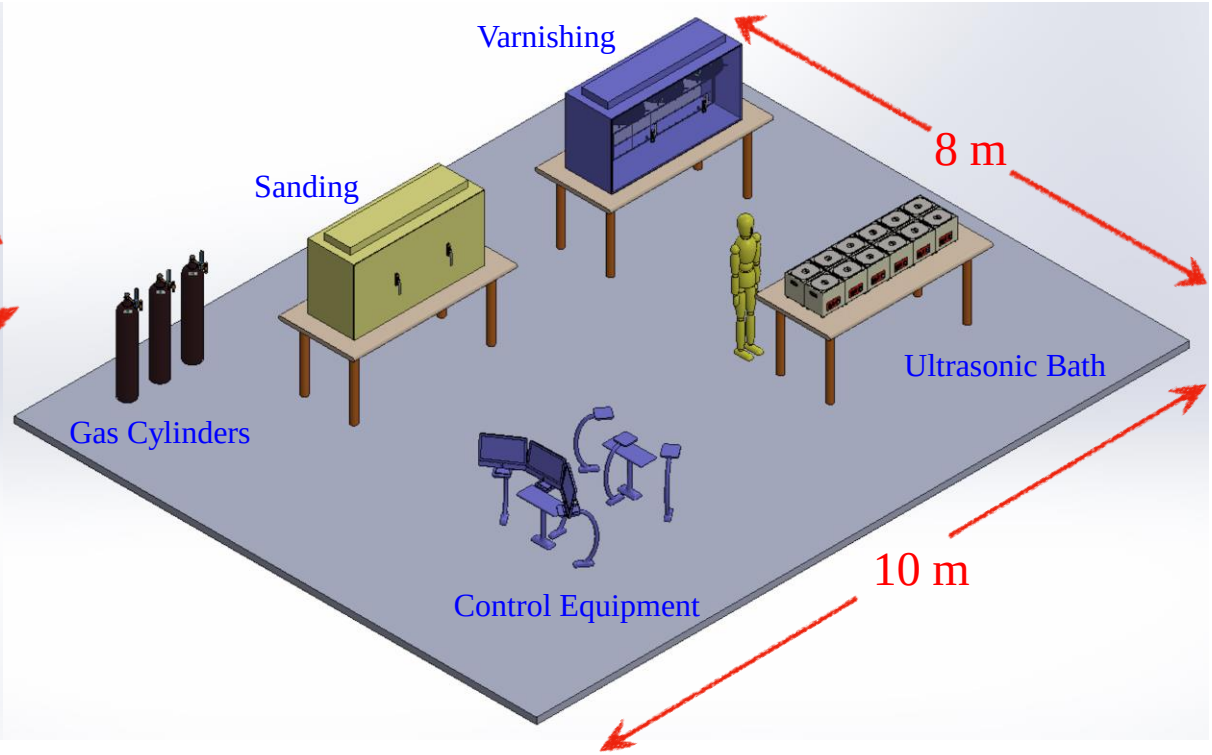


Engineering test article assembly @ JLab: Real estate requirements

- Cleanroom area: 16 m x 8 m (with all necessary equipment in realistic dimensions)
- Non-cleanroom preparation area: 10 m x 8 m



Cleanroom area



Non-cleanroom preparation area

We need to be ready by **April 2025**

Where do we stand with the engineering test article?

- Fabrication of GEM foil and μRWELL PCB at the CERN workshop delayed ➔ Estimated delivery is May 2025 (instead of January)
- Fabrication of all support frames by RESARM (Belgium) is completed ➔ shipment in 2 to 3 weeks after invoice payment
- We started thinking of the infrastructure, space and equipment needed at JLab for the assembly f the test article
  - Space for clean room + equipment
  - Space for detector test + equipment
- If GEM and μRWELL are delivered “in time” in May 2025 ➔ assembly will be completed by August / September 2025
  - In time for test in beam in Fall 2025

Assembly plans: Planning & schedule

06/2025 — PED & validation

- Design of full size µRWELL-BOT completed
- Procurement of GEM foils, µRWELL PCB – **06/2025**
- Assembly at JLab & test in beam **- 12/2025**

12/2026 — Pre-production

- Assembly of one pre-production module (**module#0**)
- Setup of infrastructure and equipment in assembly sites

04/2029 — Production

- Assembly and QA of 9 production modules at assembly sites
- Full characterization at assembly sites of each module on cosmic stand and with radioactive sources

06/2029 — Shipment to JLab

- Shipment of all 24 modules to BNL
- Commissioning at BNL cosmic test stand of all µRWELL-BOT as well as µRWELL-ECT

Commissioning & Installation

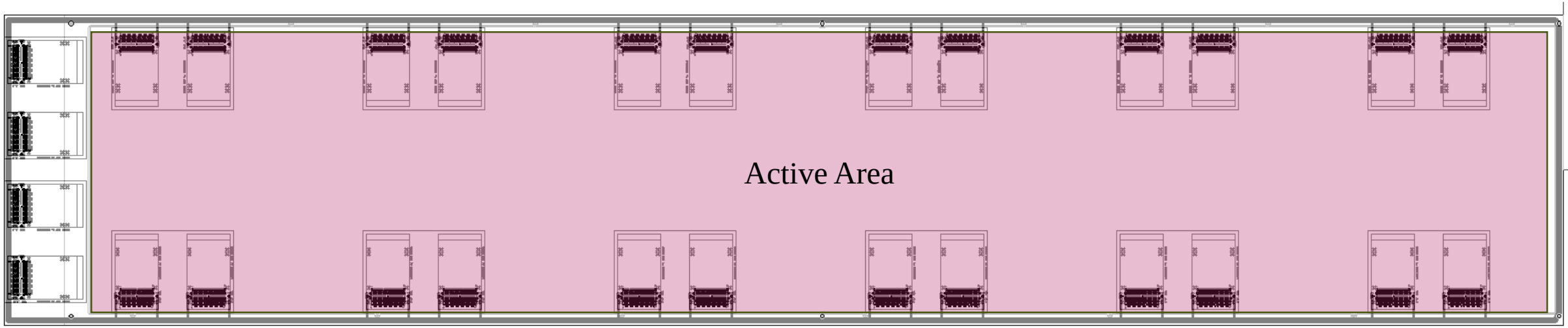
- Commissioning
- Installation

Backup

JLab RD&I: Large Ultrasonic cleaning bath

Specifications	
Inside Dimensions	70″ (L) x 28″ (W) x 24″ (H)
Overall Dimensions	89″ (L) x 33″ (W) x 43″ (H)
Ultrasonic Power	4000 watts (8000 watts peak)
Ultrasonic Generator	(Four) 40 kHz, 1000 watt
Heat Power	4000 watts
Power Requirement	240 VAC, 50/60 Hz, single phase, 39.2A
Filtration System	7GPM nominal pump with (1) polypro strainer (1) 20 in, polypro filter housing (1) 20-micron, polyspun, filter

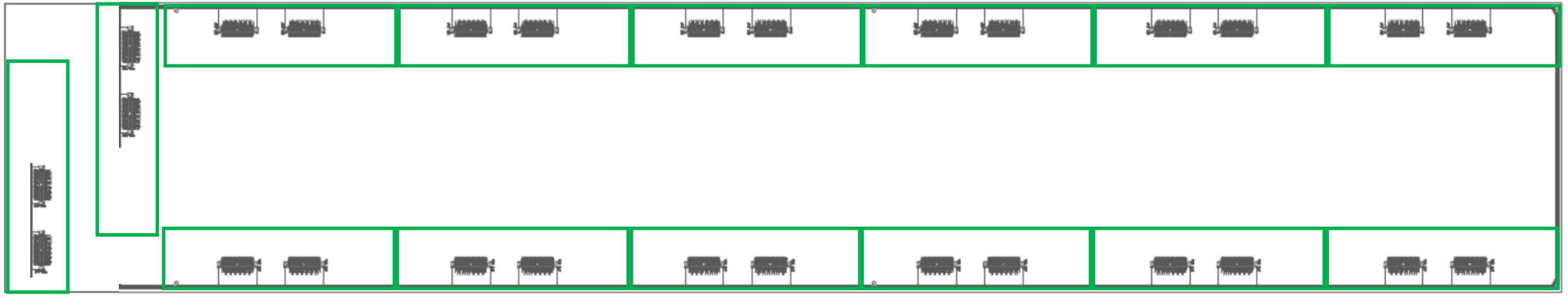
PED Test article: Front End Board (FEB) Layout



- PCB size: 36 cm x 180 cm
- Active Area: 33 cm x 170 cm
- 14 FEBs
- Each FEB has 2 x 144 Hirose FX10 connector (total 256 Channel, 4 x Salsa)
- Each FEB requires 1x DC/DC converter, 1x VTRX board
- Each FEB requires 1xOptical Fiber Connector, 1x Low voltage, and Cooling

Possible FEB arrangement in service area

Option 1: Extend 2 Connectors further ➔ increase the length of the of the PCB by 10 cm



Option 2: Reduce the number of from 4 to 2 Connectors further ➔ increase the strip pitch and remove useless strips