eRD104 & eRD111 - Silicon tracker and services reduction

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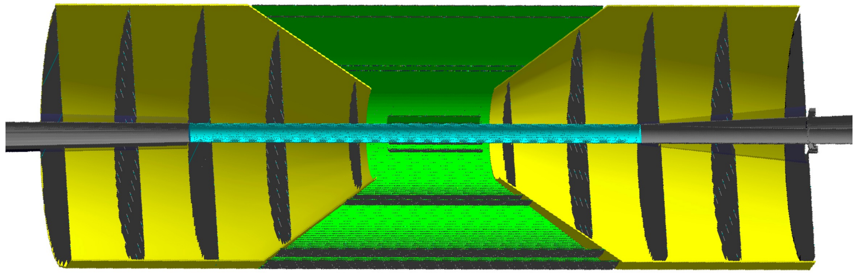
EIC Detector: Tracking Requirements

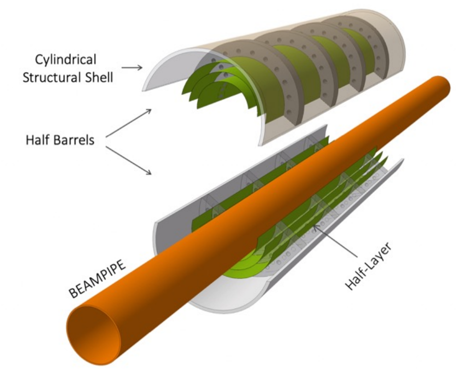
- Wide kinematic coverage
- Good momentum resolution
- High-precision primary vertex determination
- Secondary vertex separation capability



All-Silicon Tracking Detector example: arXiv:2102.08337

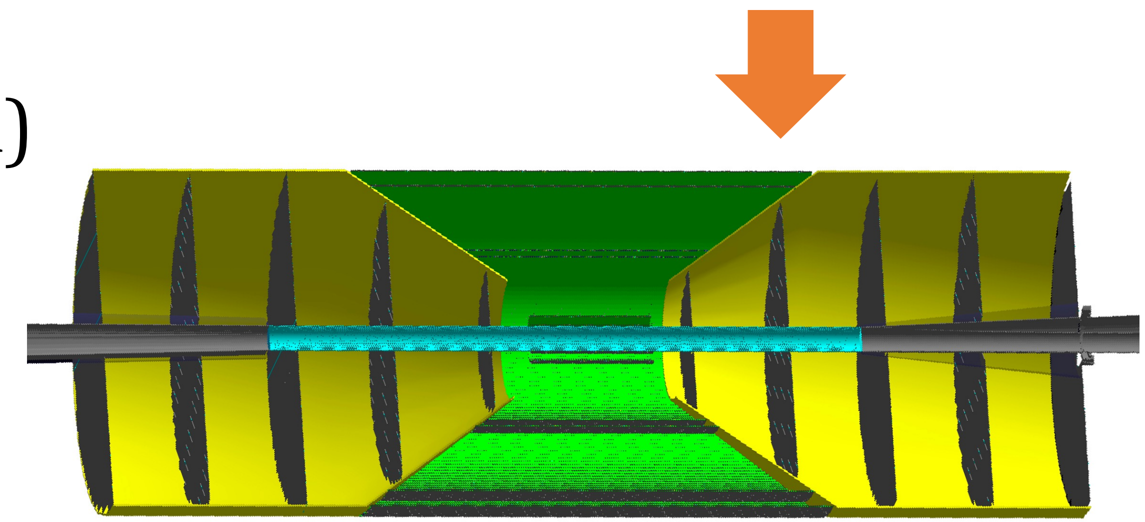
- **Needs detector with:**
  - **high granularity & low material budget**

Towards an EIC Detector 1 Concept



Based on ALICE ITS3 sensor technology (65 nm)

- 3 innermost layers (vertexing)
- 2-3 intermediate layers (sagitta)
- 4-6 silicon discs (forward & backward)



ALICE ITS3 ~0.12 m^2, EIC silicon ~10 m^2

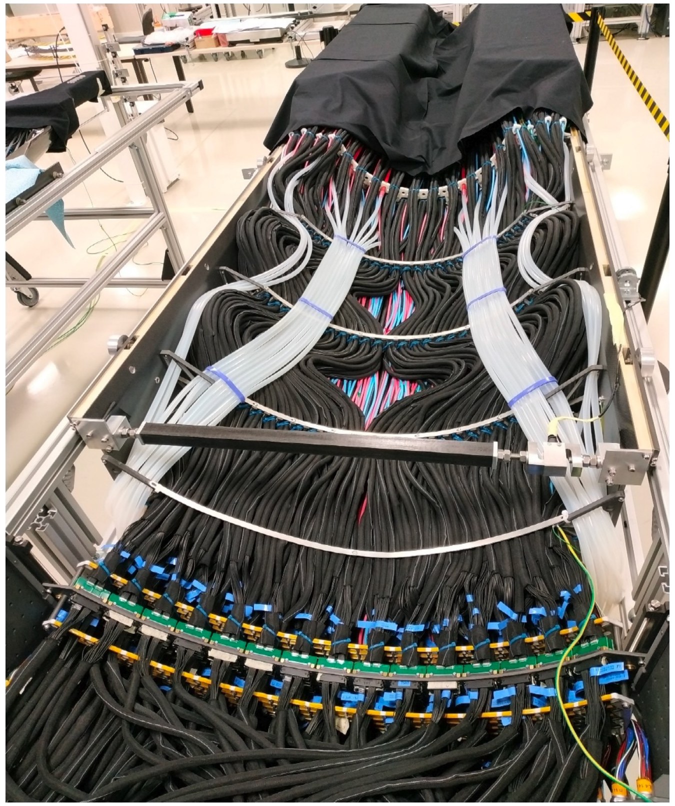
- Wafer-scale not suitable for staves & discs
- Forked sensor design → optimize for large area coverage & yield

Current EIC Tracking R&D

- eRD104: Services reduction
  - Powering & readout
- eRD111: Forming modules from stitched sensors
  - Optimizing the module size & design to meet mechanical requirements and take advantage of the new sensor design
- eRD111: Staves & Discs
  - Conceptual designs
- eRD111: Mechanics, integration, & cooling
  - Support structures, study of air cooling

R&D: Material Budget

- Mass minimization is key, especially in electron-going (backward) direction
  - Base design:
    - 0.24% X/X_0 per layer for discs
    - 0.55% X/X_0 for staves
- eRD104
  - Power & data services reduction
- eRD111
  - Staves & Discs layout options, air cooling



eRD104 Overall Plan

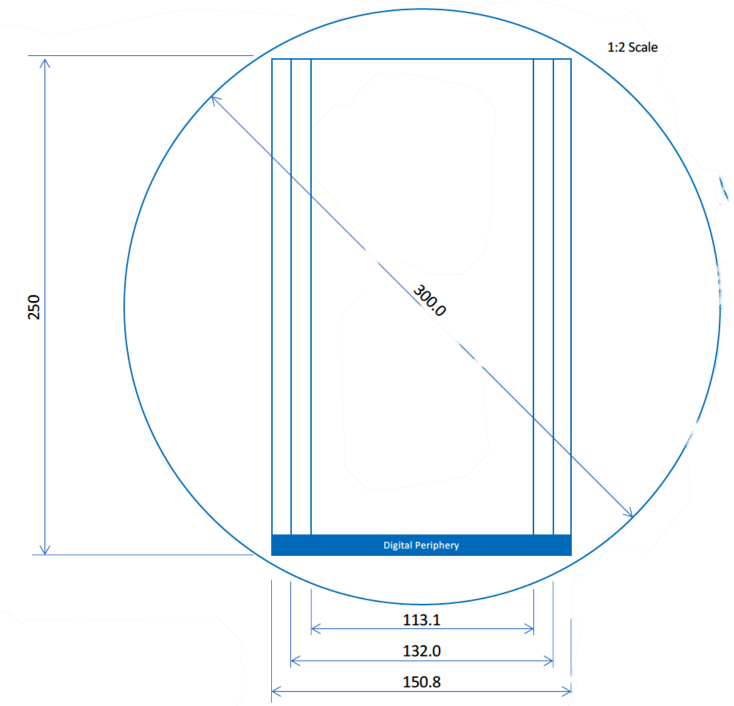
- Powering (Birmingham, RAL)
  - Reduce the number of wires needed to power the detector
    - Investigation of DC-DC converters
      - Low risk, reduced material budget if kept to sides
    - Investigation of serial powering
      - Higher risk, lower material budget
  - Assess detector design goals & apply best optimization
- Data (ORNL, BNL)
  - Optimize system to minimize the service loads from signal transmission
    - Investigation into data aggregation

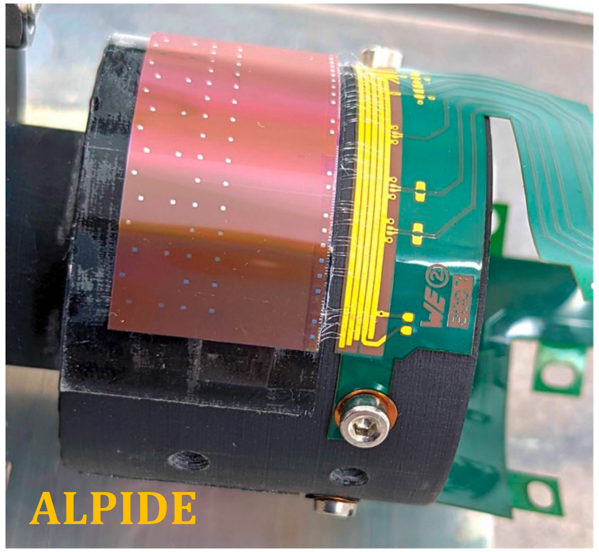
eRD111 Overall Plan

- Forming modules from stitched sensors (INFN Trieste, INFN Bari, Daresbury, Lancaster, Liverpool, Birmingham)
  - Options & optimizations
- Stave & disc construction (LBNL, LANL)
  - Conceptual design options
  - Cooling studies
- Additional infrastructure including mechanics & cooling (LBNL, LANL, JLAB)
  - Up-to-date CAD models
  - Conceptual designs

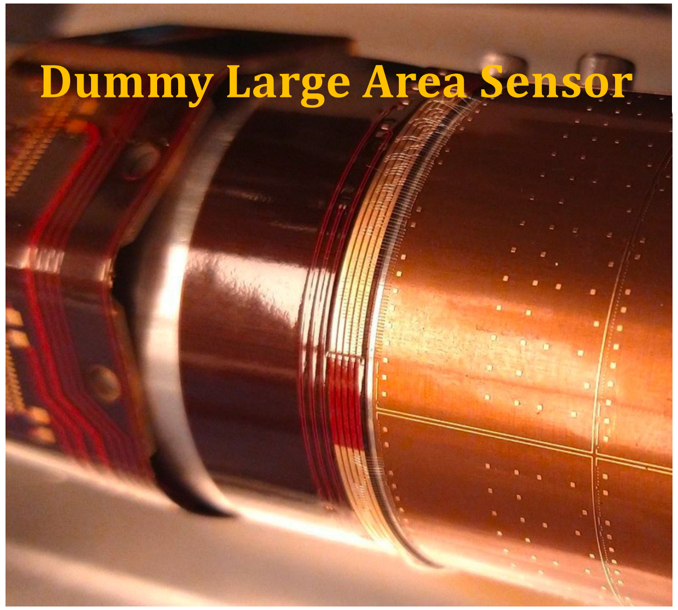
eRD111: Forming modules

- Vertexing:
  - Adapt ITS3 to EIC radii and optimize bending & interconnections
  - Study configuration of sensors into staves & discs based on reticle sizes





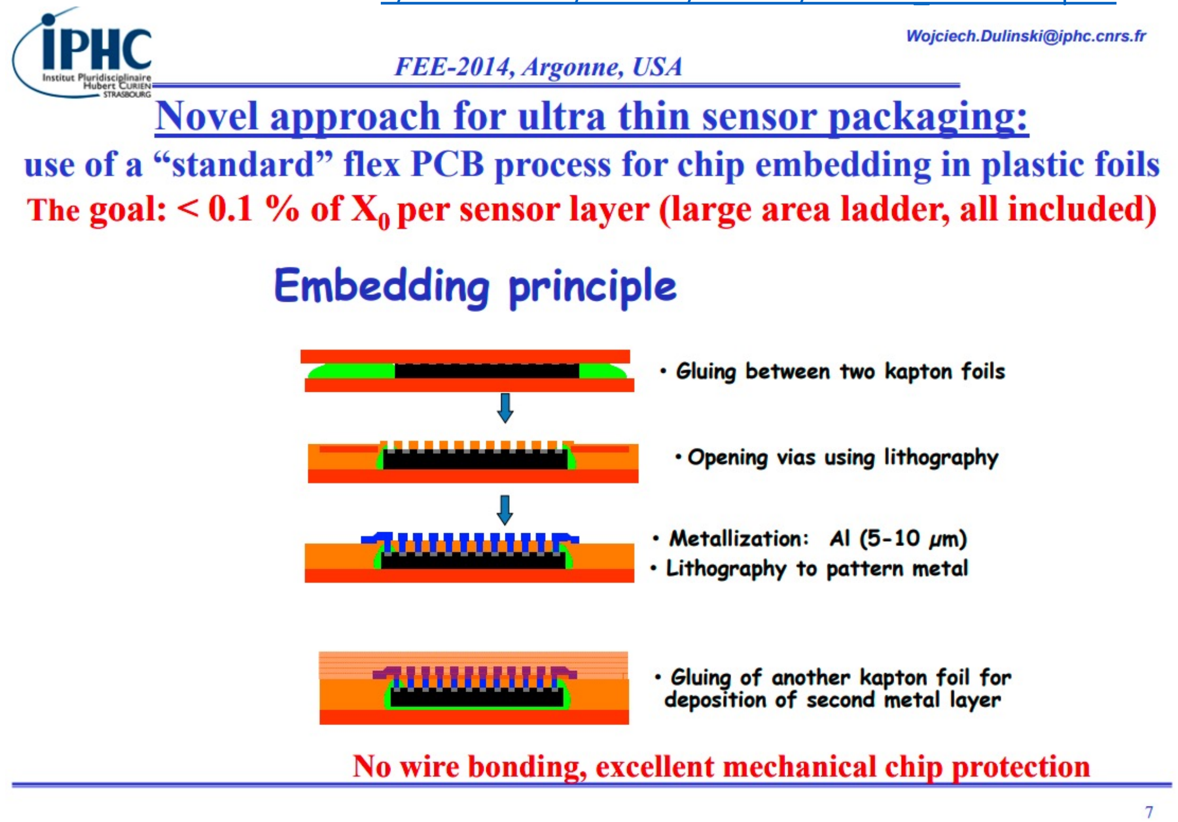
Wire bonding on curved sensors

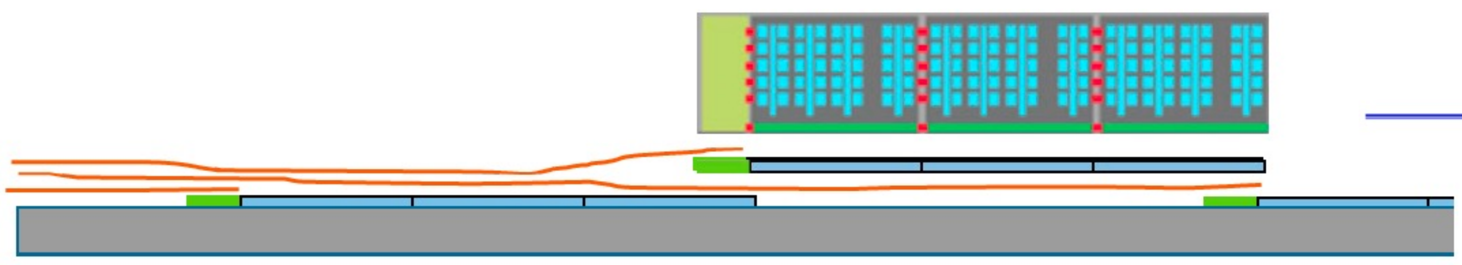


eRD111: Forming modules

- Staves & Discs:
  - Module from sensors & FPC
  - Development of tooling to assemble & test sensors/modules

https://indico.cern.ch/event/276611/contributions/622863/attachments/502969/694527/dulinski_FEE-2014.pdf



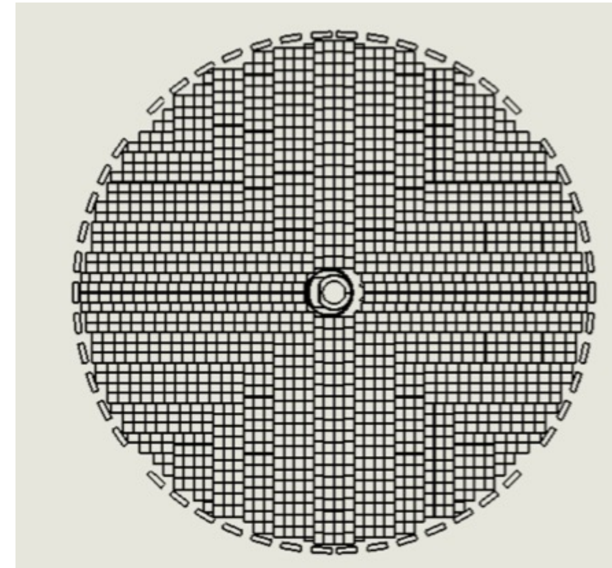


Traditional module: support+FPC+sensor

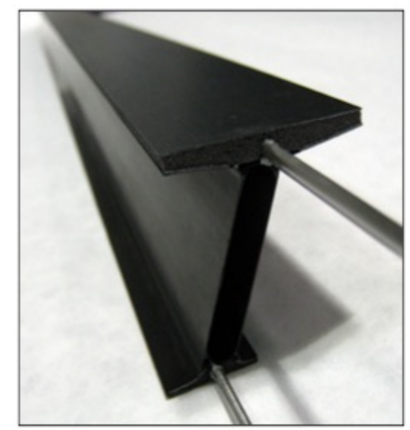
Novel module idea: sensor embedded in Kapton foil

eRD111: Staves & Discs

- Disc concept → Flexible & challenging
  - Plates, staves, etc.
  - Different disc diameters
  - Different inner hole openings
- Stave concepts
  - Truss, I-beam
- Iteration with module group
  - Module sizes/options
  - Buildability & tooling

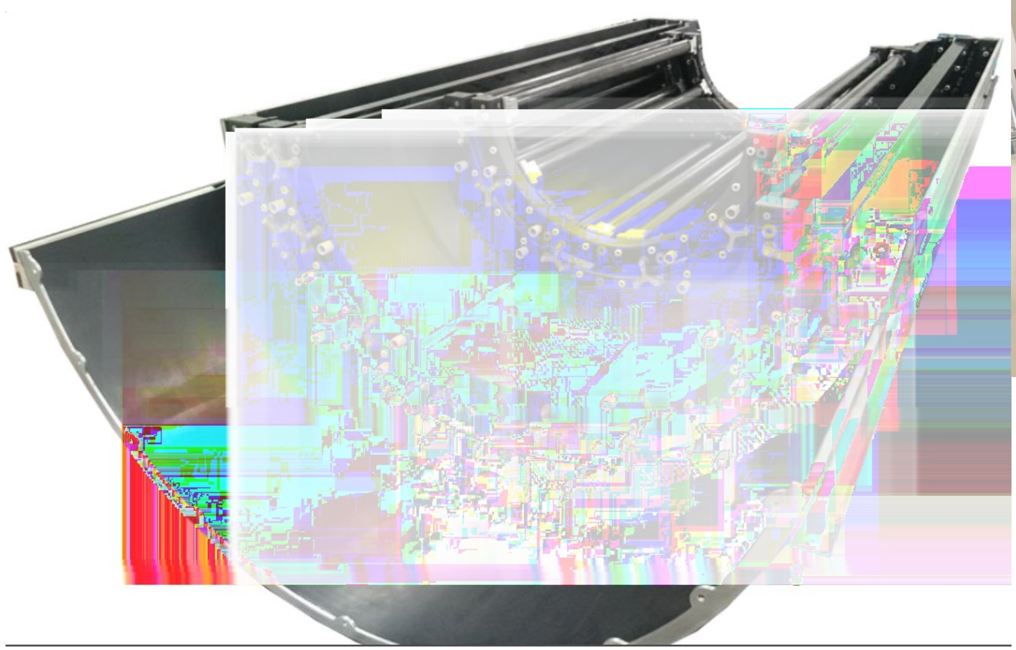


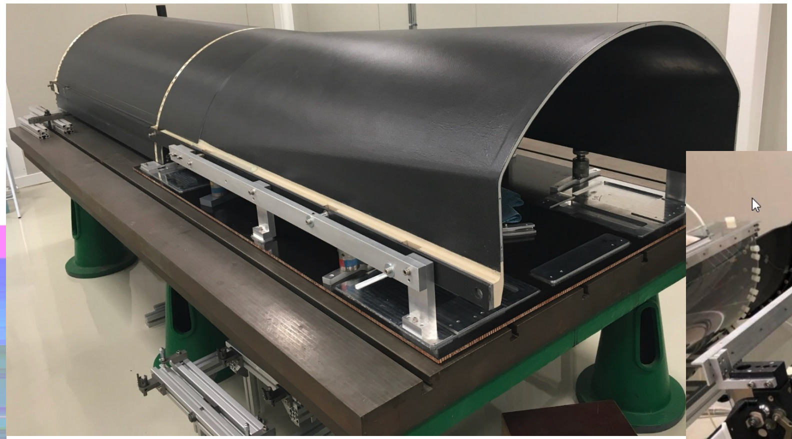
Air cooling options will be studied for both



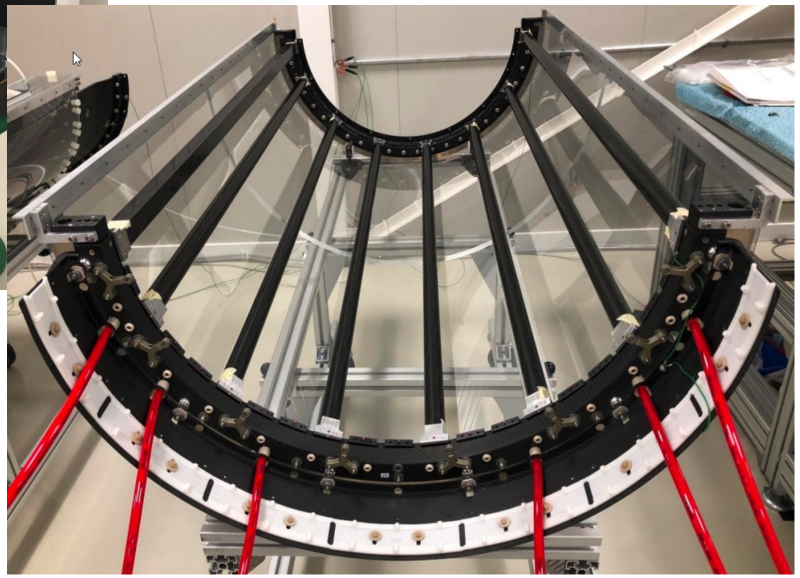
eRD111: Mechanics/Integration

- Detector mechanical structure & assembly/insertion mechanisms
  - Iterate with overall project needs/constraints
  - CAD models





Support structure examples from ALICE ITS2



Summary

- Strict tracking requirements necessary for physics goals at the EIC
  - High granularity & low material budget
- eRD104
  - Power & data services reduction
- eRD111
  - Forming modules
  - Stave & disc design
  - Mechanics/integration/cooling
- Collaboration with EICSC, Detector 1 Tracking & Integration Working Groups, & the EIC Project
  - Key to success!