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

• Needs detector with:
  • high granularity & low material budget

All-Silicon Tracking Detector example: arXiv:2102.08337
Towards an EIC Detector 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 m², EIC silicon ~10 m²**

- 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

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!