EIC_NET Silicon Vertex update

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• Giornata EIC_NET – 28 March 2022





• EIC Silicon Consortium activities update

• eRD104 – eRD111 projects

• ALICE ITS3 synergies



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Silicon Consortium for the EIC

EIC NET

- Coordinating effort towards the EIC silicon tracker
 - Independent of the detector proposal
 - Open to all EIC interested groups
- Monthly General Meetings (<u>https://indico.bnl.gov/category/386/</u>)
 - SC activity progress reports
 - Involving participants & presenters from all proto-collaborations
- Weekly Coordination Meetings
 - Promoting activity progress and coordinating institutional relationships
 - **G. Contin (INFN)**, G. Deptuch (BNL), **D. Elia (INFN)**, L. Greiner (LBL), L. Gonella (Birm.), P. Jones (Birm.), I. Sedgwick (RAL), E. Sichtermann (LBL)



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Design: mostly independent of proposal



• ECCE

- 3-layer silicon vertex
- 2-layer silicon sagitta layers
- 4+5 disk endcaps

• ATHENA

- Si Vertex Tracker: 3 layers
- Si inner barrel Tracker: 2 layers
- 5+6 Si Tracker disks

- Same idea, same constraints:
 - Available sensor design: ITS3 65nm CMOS monolithic sensors
 - Crucial interaction with ALICE ITS3 to access the technology
 - Bent silicon for innermost layers
 - Large area staves & discs



Silicon Consortium actions



- Promoting SC institutes' participation in ITS3 activities
 - Sensor design: participation partially started (only RAL)
 - Sensor characterization: test systems requested, shadowing other groups
 - ITS3 leaders and conveners well aware of the SC interests
 - Formalization depends on higher level agreement
- Promoting MoU between ALICE/CERN and EIC/DOE
 - Contacts with Luciano Musa, Elke, Rolf started last summer
 - Relationship should be regulated by CERN/DOE agreements
- Finding and planning resources for:
 - EIC-specific development
 - Contribution to ITS3 development



EIC Detector R&D program



The EIC SC participates in the Detector R&D program for FY2022

- eRD104 Silicon Services Reduction
 - Services Reduction
 - Powering System
 - Readout System
- eRD111 Si-Vertex (excluding sensors)
 - Forming modules from stitched sensors (INFN+UK Groups)
 - Staves and Disks
 - Additional infrastructure including mechanics and cooling
- Funds have been delayed until now by US Budget continuing resolution
 - Mostly intellectual work for FY2022
 - INFN Bari and Trieste participating with their own resources





EIC Detector R&D program – active tasks



- Large Area Sensor development for staves and disks
 - Yield, optimal sensor size, geometry (Ian Sedgwick RAL, Grzegorz Deptuch BNL)
 - Layout study for staves and disks (Leo Greiner, Nikki Apadula LBL)
 - Implications on the mechanics (Jim Fast Jlab)

- Power system reduction
 - Serial powering ideas from ATLAS (Peter Phillips RAL)

- Data reduction
 - On-detector data aggregation with FPGA and high-speed data transmission (Jo Schambach – ORNL)



Sensor development and characterization



- Items not included in the Detector R&D Program
 - Signs that they will become soon Project R&D items
- Contribution to ITS3 sensor design
 - RAL well integrated with a specific SEU structure
 - BNL and LBL will hopefully start soon, too late for the ER1 submission
- Contribution to ITS3 sensor characterization
 - Participation in meeting and training sessions
 - Test systems requested
 - Services like mass producton wire-bonding and fabrication/assembly of test systems have been offered
- Bari and Trieste active as ALICE institutes





ITS3 progress report: ER1 sensor design



- ER1 sensor submission scheduled for end of April
 - Main goals: learn and prove stitching technology in 65 nm CMOS
 - Exploring technology options, power distribution, signal routing, yields
 - Large area chips including 18 um and 22.5 um pixel matrices



Additional chips for SEU tests, tranceivers, receivers, other structures
<u>Alex Kluge (CERN) | VCI2022</u>







MLR1 sensor testing



- Now progressing well, numerous active sites
- Test system hardware and firmware commissioned
- Transistors: no show stoppers
- DPTS, APTS, CE65
 - Exploring operating points for all parameters for all MLR1 structures
 - Measuring response to Fe55
 - Investigating effect of reverse bias on response
 - Investigating effects of different process implementations and implants
- Beam test data being analyzed, more beam time booked





MLR1 beam tests: efficiency and fake hit rate







Layer assembly: optimisation of gluing



Magnus Mager (CERN) | HEP2022



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Layer interconnection

- The first row of ALPIDEs will be wire-bonded to an edge-FPC like in the final detector
- Wire-bonding developed together with sensor design, mechanics layout, assembly procedure and interconnection circuits
- The other ALPIDEs will be contacted with long wires departing from an exoskeleton mimiking the L1

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EIC

NÉT

long wires for testing

edge bonds (like final ITS3)

Conclusions



- Detector proposal choice not affecting silicon tracker development
- EIC Silicon Consortium pursuing tracker development
 - Effort to include all interested EIC Institutes
 - Funding to eRD projects becoming available (needed by US institutes)
 - Silicon R&D soon to become Project R&D → more funds
 - INFN participation limited to Bari and Trieste only intellectual work so far
- EIC SC participation in ITS3 crucial
 - Slowed down by lack of funding
 - Needs to be formally regulated by DOE/CERN, EIC/ALICE, SC/ITS3 agreements (working on it...)





Backup slides











MLR: multiple layer per reticle, ER: engineering run,

BM: breadboard module, EM: engineering module, QM: qualification module, FM: final module

Magnus Mager (CERN) | ITS3 | LHCC | 08.03.2022 | 3



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