Introduction

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EIC SC general meeting

9 May 2022

eRD104: scope and tasks

- Investigate methods to significantly reduce the services load for an EIC MAPS based tracking detector.

- Efforts are concentrated on the areas where the bulk of the detector services exists: powering distribution and the readout system.

- Powering:
  - Radiation tolerant DC-DC converter, serial powering architectures with integrated regulators.
  - Preliminary work: https://www.eicug.org/web/sites/default/files/Powering-options-for-an-EIC-silicon-tracker.pdf

- Readout:
  - Data aggregation on detector using radiation tolerant FPGAs, high speed optical links.

eRD104: deliverables, milestones, labor force

- FY22 services reduction deliverables will include:
  1. Build upon the initial assessment of possible benefits of serial/DC-DC converters powering schemes and detail possible configurations with analysis of architectural benefits/weaknesses and assessment of current and upcoming DC-DC converter candidates in written report form.
  2. Single branch construction, testing and characterization of existing DC-DC converter candidates in likely architectures with written report. This work can be extended to other detector configurations/needs with appropriate consultation and architectures/requirements.
  3. Research into existing serial powering schemes used by ATLAS and other experiments with analysis and extrapolation into EIC case.
  4. If feasible, get example hardware and characterize. Otherwise examine on-chip or hybridized regulators.
  5. Examination of capabilities of components needed for multiplexing (rad-hard FPGAs and optical modules) and preliminary studies of the tradeoffs in architectural approaches.
  6. Written progress report.

Milestone Description	**Date**
report on serial powering	2022/04/29 → **2022/08***
report on DC-DC powering	2022/06/24 → **2022/10***
FY22 assessment report on powering options	2022/09/29
erd104 FY22 report	2022/09/30

eRD104 award letter: "The timelines were adjusted to accommodate the delayed start of the R&D program". EIC SC coordination is seeking clarification with Thomas Ullrich.
* New date shown by Thomas https://indico.bnl.gov/event/15371/contributions/62793/attachments/40749/

Topic	**Institutions involved**	**Contact Person**
Powering System	University of Birmingham, STFC RAL PPD	Laura Gonella (Univ of Birmingham), Fergus Wilson (RAL)
Readout system	ORNL, BNL	Jo Schambach (ORNL)

eRD104: budget

- Budget requested: $48.2k

Task	Mechanical Engineer (h)	Electrical Engineer (h)	Mechanical Technician (h)	Electrical Technician (h)	postdoc (h)	staff (h)	student (h)	materials (k$)	cost by institution (k$)
eRD104									
Powering									
UK groups		160			320	180	120	5	0
Readout									
ORNL		80				320			16.24
BNL		160				40			32

Total budget needs for FY22:

ORNL: $16.2k

BNL: $32k

- Awarded: $48k

eRD111: scope and tasks

- Development of a full tracking detector solution composed of next generation 65 nm MAPS sensors.
- Forming modules from stitched sensors.
- Stave/disc construction.
- Mechanics and cooling.

eRD111: deliverables

Forming modules from stitched sensors

The FY22 efforts in forming modules from stitched sensors deliverables will include:

1. Study of how to adapt the ITS3 based mechanical and electrical characteristics to the nominal EIC vertexing layer radii based on the available reticle sizes, and optimization of the bending and interconnection techniques for the resulting configuration
2. Study of how to configure sensors into staves and discs based on reticle sizes and possible yield configurations on a 12” wafer.
3. Study of optimizing the number of stitched sensor units into a module composed of an aluminum flex PCB and optimized number of sensors. Flex PCB (aluminium conductor) manufacturing capabilities will play a significant role. Prototype designs may be run as a test fabrication and assessed.
4. The need for tooling to assemble and test sensors in module form will be investigated (this was a very significant part of the ALICE development for ITS2).
5. This will inevitably be a survey effort and will need to be further optimized once yield figures are known. Nevertheless this work is needed to form requirements for the large-area sensor design in a multiple sensor => single readout chaining. This will inform the functionality needed to be built into the forked sensor design.
6. A written report covering this will be delivered.

eRD111: deliverables

Staves and Discs

Staves and Discs deliverables for FY22 will be:

1. Conceptual designs with analysis ready to be prototyped.
2. Initial simple prototype ”proof of concept” test pieces to be used in cooling and mechanical testing.
3. Written reports detailing the results and evaluating suitability for final design (parameters will inevitably change, but we need to evaluate the design concepts in the framework of the current knowledge).

Mechanics, integration and cooling

Deliverables for the Mechanics, integration and cooling for the aforementioned FTE composition and level of effort in FY22 will include:

1. Updated and maintained CAD model of evolving silicon tracking detector design in conjunction with EIC project detector constraints including beam pipe, assembly, integration envelopes, etc.
2. Design concepts for the full set of detector supports including cylinders, shells, services channels, connection points to global supports with detector assembly, integration, and connection to services aspects addressed. This will be in written form and in CAD model form.
3. Initial analysis of the design and possibly prototype pieces of the carbon fiber structures involved in the tracking detector as a written report.
4. Analysis of the cooling options for the staves and discs (vertexing layers are an ongoing topic with the ITS3 work). Preliminary design of water cooling options with segmentation and architecture. Investigation into and analysis of using air cooling in a sandwiched carbon foam configuration for staves and discs. All in written report form. If feasible, initial analysis prototypes and results with a report in written form.

eRD111: milestones, labor force

Milestone Description	Date
report on modules options/optimizations	2022/08/08
report on baseline stave designs	2022/04/27 → 2022/10*
report on baseline disc designs	2022/06/08 → 2022/12*
report on simple disc and stave models	2022/12/21 (FY23)
up-to-date silicon tracking CAD models	2022/06/15 → 2022/12*
report on mechanics conceptual design	2022/07/27
ERD111 report for FY22	2022/09/21

eRD111 award letter: "The timelines were adjusted to accommodate the delayed start of the R&D program". EIC SC coordination is seeking clarification with Thomas.
* New date shown by Thomas Ullrich https://indico.bnl.gov/event/15371/contributions/62793/attachments/40749/

Topic	Institutions involved	Contact Person
Forming modules from stitched sensors	INFN Trieste, UK groups (Daresbury, Lancaster, Liverpool, Birmingham), INFN Bari	Giacomo Contin (INFN Trieste) Domenico Elia (INFN Bari) Roy Lemmon (Daresbury)
Staves and Discs	LBNL, LANL, UK groups (Daresbury, Lancaster, Liverpool)	Nikki Apadula (LBNL) Walter Sondhem (LANL) Roy Lemmon (Daresbury)
Mechanics, integration and cooling	LBL, LANL, JLAB,	Ernst Sichtermann (LBNL) James Fast (JLAB)

eRD111: budget

- Budget requested: **$240.8k**

Task	Mechanical Engineer (h)	Electrical Engineer (h)	Mechanical Technician (h)	Electrical Technician (h)	postdoc (h)	staff (h)	student (h)	materials (k$)	cost by institution (k$)
eRD111									
Modules									
INFN	40	40				160	80		0
UK groups	40	40				180	80		0
Staves and Discs									
LBNL	160	40	80	40	300	320	80	12	79.98
LANL	160								33.28
UK Groups	120	40	40			160	80	6	0
Mechanics, Integration and cooling									
LBNL	240	40	60	40	480	480	120	12	96.44
LANL	120							6	30.96
JLAB						320			0

Total budget needs for FY22:

LANL: $64.2k

LBNL: $176.6k

- Budget awarded: **$240.8k**