
The eRD EIC program
Patrizia Rossi & Thomas Ullrich
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Giornata nazionale EIC_NET 2022
Electron-Ion Collider
BROOKHAVEN NATIONAL LABORATORY
Jefferson Lab
U.S. DEPARTMENT OF ENERGY
Office of Science

EIC Project R&D: context

wiki page: https://wiki.bnl.gov/conferences/index.php/General_Info

- Efforts on EIC Detector R&D focus:
  - to demonstrate a solution to the fundamental challenges
  - to reduce the risk for individual subdetectors.

- Detector R&D project started before the selection of the reference detector since several subsystems turned out to be quite generic and of priority for all or most detector concepts under consideration .
  - Strategy memo released on August 2021 ➞ 12 R&D projects identified.
  - Groups asked to write a short and concise document laying out:
    - For FY22: R&D plan, Manpower required and available, milestones and timeline, suggested funding profile including funding split among the participating institutions.
    - Preview of remaining R&D after FY22 until completion.

- Plans, milestones and funding profiles were adjusted after meeting with the groups individually. Process completed in October 2021 and presented in DOE OPA review.

EIC Project R&D: context

- The start of project R&D was unexpectedly difficult due the US budget delays (6 months) because of the long Continuing Resolution and the funding being far from ideal.

- All proposals were reviewed carefully and funds were awarded in accordance with the project's priorities and the overall planning status. Milestone timelines were adjusted to accommodate the delayed start of the R&D program (+6 months).

- The project R&D funding was transmitted to the PIs of each R&D project via asking One-page Statement-of-Work (SOW) and associated milestones to establish the contract.

R&D Projects: FY22 Funding

ID	R&D Subject	Institutions that receive funding (need contracts)	Contacts	Fungings
eRD101	mRICH	Georgia State University	Prof. Xiaochun He (GSU) Dr. Marco Contalbrigo (INFN-Fe)	yes
eRD102	dRICH	BNL, Duke University, INFN Ferrara	Dr. Evaristo Cisbani (INFN-Roma) Dr. Marco Contalbrigo (INFN-Fe) Prof. Anselm Vossen (Duke U.)	yes
eRD103	hpDIRC	Catholic University of America, Old Dominion U., Stony Brook U.	Dr. Gregor Kalicy (CUA) Dr. Jochen Schwiening (GSI)	yes
eRD104	Service reduction	Oak Ridge National Laboratory, BNL	Dr. Giacomo Contin (INFN, Trieste) Dr. Grzegorz Deptuch (BNL) Dr. Domenico Elia (INFN, Bari) Prof. Laura Gonella (U. of Birmingham) Dr. Leo Greiner (LBNL) Dr. Iain Sedgwick (Rutherford Lab) Dr. Ernst Sichtermann (LBNL)	yes
eRD105	SciGlass	Catholic University of America, IJCLab-Orsay, INFN-Genova, Kansas University, AANL/Armenia	Prof. Tanja Horn (CUA)	yes
eRD106	Forward EMCAL	N/A	Prof. Huan Z. Huang, Dr. Oleg Tsai (UCLA)	no/delayed
eRD107	Forward HCAL	N/A	Prof. Huan Z. Huang, Dr. Oleg Tsai (UCLA)	no/delayed
eRD108	Cylindrical MPGD	BNL, Florida Inst. of Technology, JLab, Saclay, Temple University	Dr. Kondo Gnanvo (JLab)	yes
	Planar MPGD			
eRD109	ASICs/Electronics	N/A	Fernando Barbosa (JLab)	no/delayed
eRD110	Photosensors	Argonne National Laboratory, BNL, INFN Bologna, INFN Trieste, Mississippi State University	Dr. Pietro Antonioli (INFN -Bo) Prof. Yordanka Ilieva (USC) Dr. Alexander Kiselev (BNL) Dr. Junqi Xie (ANL) Dr. Carl Zorn (JLab)	yes
eRD111	Si-Tracker/no sensors	Los Alamos National Laboratory, Lawrence Berkeley Laboratory	Same as eRD104	yes
eRD112	AC-LGAD	BNL, University of Illinois Chicago, Rice University, UC Santa Cruz, Los Alamos National Laboratory	Prof. Zhenyu Ye (University of Illinois Chicago)	yes

- FY22 budget required readjustment of project fundings in accordance with project's priorities and the overall planning status

- Put on hold until technology choices become clearer

- Put on hold, not enough details to start ASIC development yet

- **~ $1,300K critical for FY22**
- Cut/large reduction of several crucial items which we had to delay (ASICs, FCal, LAPPDs, AC-LGAD).
- **~$900K more needed**

eRD109: ASICs/Electronics

- Substantial R&D will be need for the development of Front-End Electronics: ASIC, Front-End Board (FEB), and Front-End Processor (FEP)
- The choice of using streaming read-out for the EIC excludes several existing ASIC chips.
- ASICs exist for the Si-Vertex detector (the current ALICE ITS chips meet EIC requirements).
- ASICs for the readout of LGADs/AC-LGADS is contained in the LGAD R&D.
- Estimate the need for 3 ASICs : (i) SiPM (calorimetry), (ii) MCP-PMT/PMT (PID), and MMG/GEM2/μRWell (tracking). This will require 3 FEB and likely 1-2 FEP.
- Timeline: ASIC development takes 4-5 years. Developments of the various parts will likely have to occur concurrently. Final requirements can only be established once the detector technologies are finalized
- eRD109: Put on hold since we don't have enough details to start ASIC development yet

EIC Project R&D: where we are

- Decision was made to handle the contracts through the procurement office of both BNL and Jlab
  - If US contracts only -> BNL. If at least one non-US inst. -> JLab

- Points of Contacts have been identified in both laboratories: Anna Mendez (BNL), Sherry Thomas (JLab). They are the interface between the procurement office and the Institution Representatives.

- We are presently working on setting up the contracts, upon receipt of a Statement-of-Work (SOW) and associated milestones. Contracts will be signed with each Institution

Contract Map Projects

Institution	PI	Project R&D	Topic (short)	Contract Lab
Georgia State University	Prof. Xiaochun He	eRD101	modular RICH (mRICH)	BNL
INFN Roma	Dr. Evaristo Cisbani	eRD102	dual RICH (dRICH)	JLAB
INFN Ferrara	Dr. Marco Contalbrigo	eRD102	dual RICH (dRICH)	JLAB
Duke University	Prof. Anselm Vossen	eRD102	dual RICH (dRICH)	JLAB
Catholic University of America	Dr. Gregor Kalicy	eRD103	high performance DIRC (hpDIRC)	BNL
Old Dominion University	Prof. Charles Hyde	eRD103	high performance DIRC (hpDIRC)	BNL
Stony Brook University	Prof. Tom Hemmick	eRD103	high performance DIRC (hpDIRC)	BNL
Oak Ridge National Laboratory	Jo Schambach	eRD104	Service Reduction	BNL
BNL	Dr. Grzegorz Deptuch	eRD104	Service Reduction	direct charging to BNL
Catholic University of America	Prof. Tanja Horn	eRD105	Scintillating Glasses	JLAB
IJCLab-Orsay	Dr. Carlos. Munoz-Camacho	eRD105	Scintillating Glasses	JLAB
INFN-Genova	Dr. M. Battaglieri	eRD105	Scintillating Glasses	JLAB
Kansas University	Prof. Michael Murray	eRD105	Scintillating Glasses	JLAB
AANL/Armenia	Dr. Hamlet Mkrtchyan	eRD105	Scintillating Glasses	JLAB
Florida Institute of Technology	Prof. Marcus Hohlmann	eRD108	Micro Patter Gaseous Detectors (MPGDs)	JLAB
University of Virginia	Kondo Gnanvo	eRD108	Micro Patter Gaseous Detectors (MPGDs)	JLAB
BNL	Dr. Craig Woody	eRD108	Micro Patter Gaseous Detectors (MPGDs)	direct charging to BNL
Saclay, France	Dr. Maxence Vandenbroucke	eRD108	Micro Patter Gaseous Detectors (MPGDs)	JLAB
Temple University	Prof. Bernd Surrow	eRD108	Micro Patter Gaseous Detectors (MPGDs)	JLAB
Argonne National Laboratory	Dr. Junqi Xie	eRD110	Photosensors	JLAB
BNL	Dr. Alexander Kiselev	eRD110	Photosensors	direct charging to BNL
INFN Trieste	Dr. Silvia Dalla Torre	eRD110	Photosensors	JLAB
INFN Bologna	Dr. Pietro Antonioli	eRD110	Photosensors	JLAB
Mississippi State University	Prof. Sanghwa Park	eRD110	Photosensors	handled through BNL
Los Alamos National Laboratory	Xuan Li	eRD111	Si-Tracker	BNL
Lawrence Berkeley Laboratory	Dr. Ernst Sichtermann	eRD111	Si-Tracker	BNL
University of Illinois Chicago	Prof. Zhenyu Ye	eRD112	AC-LGAD sensor and ASICs	BNL
BNL	Dr. Zhangbu Xu	eRD112	AC-LGAD sensor and ASICs	direct charging to BNL
Rice University	Prof. Frank Geurts	eRD112	AC-LGAD sensor and ASICs	BNL
UC Santa Cruz	Prof. Abraham Seiden	eRD112	AC-LGAD sensor and ASICs	BNL
Los Alamos National Laboratory	Dr. Xuan Li	eRD112	AC-LGAD sensor and ASICs	BNL

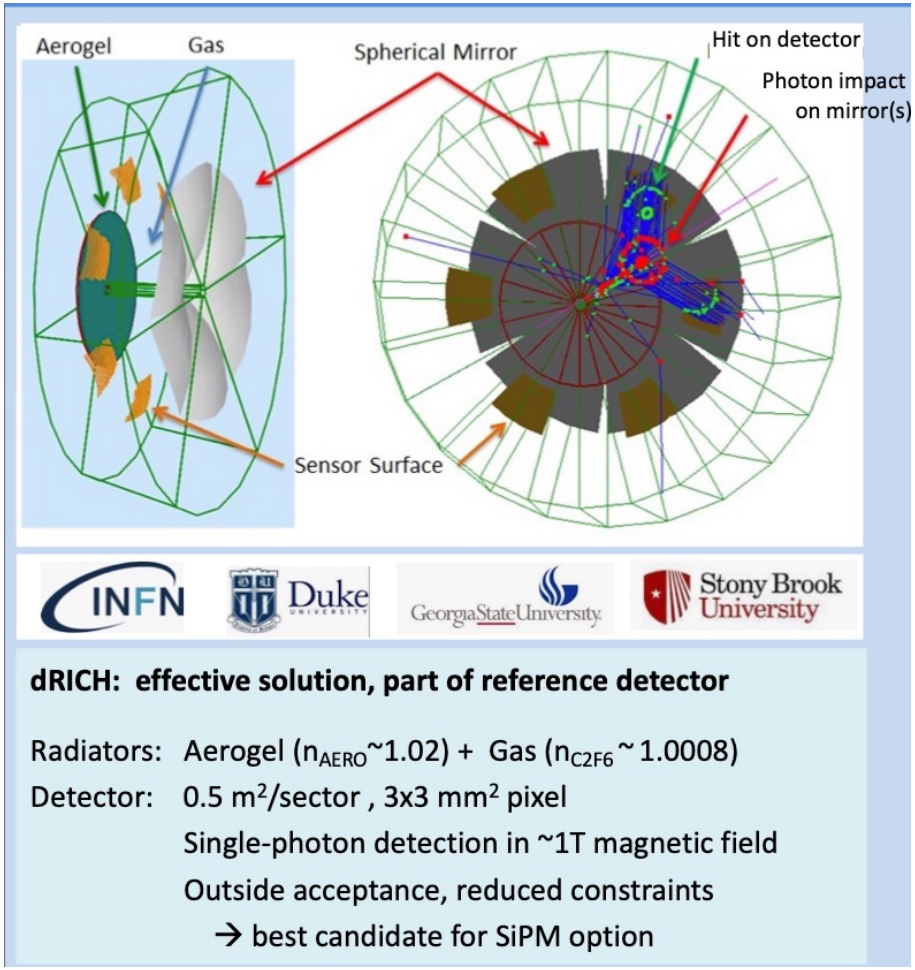
BNL	11
JLab	15
Habdled through BNL	1
Direct charging to BNL	4
TOTAL	31

EIC Project R&D: preliminary assessment

- Preliminary assessment of the milestones in the submitted SOWs:
  - Few milestones kept the original schedule + 6-month shift.
  - Some milestones have been removed because of the funding cut.
  - Few milestones will be completed by the end of FY22.

- Deliberation
  - A 9-month shift in the milestones is acceptable because realistically the contracts will be awarded not before the end of this month.
  - Funds should be obligated by FY22 but we can use them to complete the milestones in 2023.

eRD102: dRICH



Goal: Develop a dual-radiator Ring Imaging Cherenkov detector to provide continuous full hadron identification (π/K/p) separation better than 3σ in the range 3 -50 GeV/c in the forward range. It also offers a e/π separation from few hundred MeV up to about 15 GeV/c.

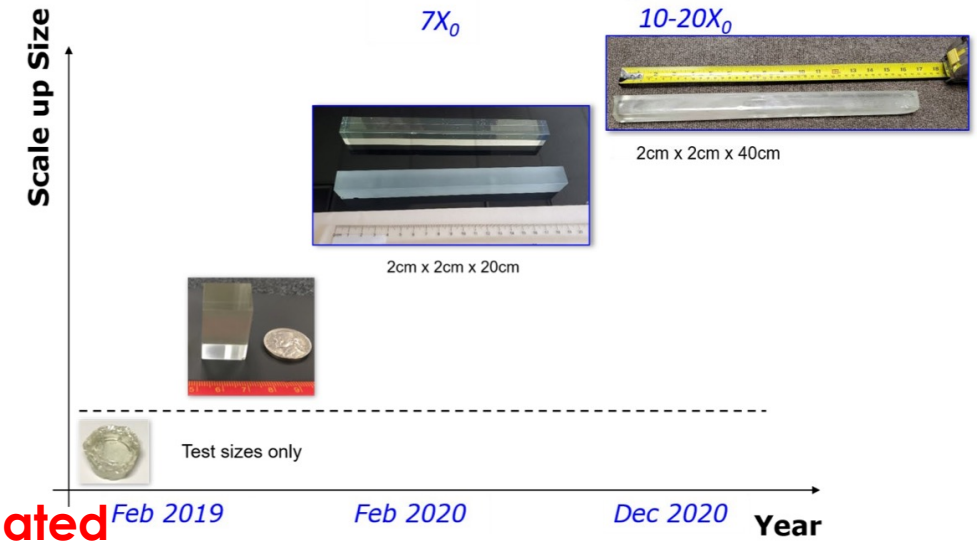
- Main Technical risk:
  - Greenhouse gas: potential procurement issue -> Search for alternatives (not part of the eRD102)
  - Photon detectors
- Commissioning of dRICH prototype to assess:
  - dRICH concept
  - aerogel (and gas) optical performance
  - SiPM usage in realistic experimental conditions

Milestones & Timeline for FY22 - Updated

- Realistic implementation of dRICH into the EIC detector - **10/22**
- Initial assessment based on the first test beams - **12/22**
- Realization of a suitable detector plane for the dRICH prototype - **3/23**

eRD105: Scintillating Glasses

- **Goal**: Demonstrate that SciGlass is a viable solution as precision calorimeter technology.
- Radiation hard material, developed by Scintilex, LLC in collaboration with the Vitreous State Lab at CUA, and optimized to provide characteristics similar to or better than PbWO4.
  - o Fabrication is expected to be cheaper, faster, and more flexible than PbWO4 crystals.
- Tremendous progress made in the formulation and production of SciGlass to improve material properties
- Successful scaleup method demonstrated -> now reliably production of glass samples of sizes up to ~10 radiation lengths.



Milestones and Timeline for FY22 - Updated

- Receive ~25-50 test samples; initially 20 cm and 40 cm, **9/2022**
- Characterize blocks (quality, radiation hardness) at collaborating institutions including cross comparisons for systematic uncertainty, **9/2022**
- Construct a small 3x3 prototype and finalize readout infrastructure, **9/2022**
- Commission the 3x3 prototype, **9/2022**
- Carry out test beam program and validate readout concepts including streaming RO, **3/2023**

eRD110: Photosensors_1

Goal: Reduce current risk associated with lack of reliable highly pixilated photodetectors working at 1.5-3 T.

- On the market (or in development by manufacturer)
  - SiPMs - radiation hardness
  - LAPPD/HRPPD - pixelation
  - MCP PMT – magnetic tolerance
- At the moment no funding available for the characterization of MCP-PMTs

Milestones and Timeline for CY22 – Updated

LAPPD:

- Initial milestones: full evaluation of up to four different LAPPD and HRPPD tiles in the lab and under beam conditions. Evaluation includes determination of quantum efficiency, gain uniformity, operation under high rate, timing and position resolution measurements in a finely pixelated configuration.

INFN

- Completion of the lab equipment for LAPPD characterization at INFN **- 6/2022**
- Timing characterization - **9/2022**

eRD110: Photosensors_2

BNL

	08/2021 proposal	05/2022 SOW
Readout board design and procurement	March-April 2022	May-June 2022
Fermilab beam test	May 2022	June 2022
Spatial resolution report	July 2022	September 2022
Beam test data analysis and report	by October 2022	December 2022
Preliminary LAPPD-for-EIC assessment	by October 2022	December 2022

Few months shift towards the later dates, due to several substantial modifications to the experimental setup for both benchtop and beam test studies made over the Fall 2021

- Out of the four LAPPD / HRPPD models anticipated in the original proposal, in FY22 only two will be testing:
  - Not be renting model#1 (a baseline 20cm Gen II LAPPD) because of the lack of time and a budget reduction,
  - Not be testing model#4 (a 10cm Gen I HRPPD with the internal piexllation) for the same reasons, but primarily because its production by Incom is delayed.

→ in FY22 work on the readout interface for these DC-coupled HRPPDs.

eRD110: Photosensors_2

ANL

Major Milestones:

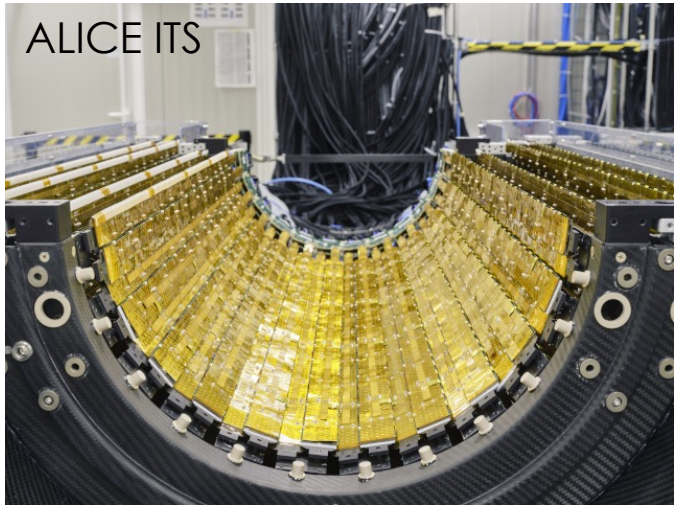
Tasks	08/2021 proposal	05/2022 SOW
Magnetic field test facility at Argonne ready for 20cm tiles	Feb 2022	5/31/2022
Magnetic field test of two available baseline LAPPDs	Mar 2022	6/30/2022
Magnetic field tolerance report by Argonne	Sep 2022	11/30/2022
Magnetic field test of pixel LAPPD and HRPPD	Mar 2022	cancelled
Magnetic field tolerance report on pixel LAPPD and HRPPD	Sep 2022	cancelled

SiPM:

- Comparative assessment of commercial (and prototypes not yet available on the market) of SiPM performance after irradiation - **2/2023** (interim results available at 9/2022)
- Definition of an annealing protocol - **2/2023**

eRD111: Si-Vertex

Goal: Development of a full tracking detector solution composed of next generation MAPS sensors and based on the *developments ongoing at CERN for the ALICE ITS*



- Identified areas of R&D that require development that are particularly challenging and/or extend beyond the existing MAPS implementations
  - Forming modules from stitched sensors
  - Stave/disc construction
  - Additional infrastructure including mechanics and cooling

Milestones and Timeline for CY22

- Report on baseline stave design – **10/2022**
- Report on baseline disc designs – **12/2022**
- Up-to-date silicon tracking CAD models – **12/2022**

eRD111: SOW LANL

1. **Study of how to configure sensors into staves and discs based on reticle sizes and possible yield configurations on a 12” wafer. Depending on the technology.**
2. **Develop and optimize the conceptual designs for the vertex and barrel layers.**
3. **Develop and optimize the conceptual designs for the hadron and electron endcap planes.**
4. **EIC beampipe; bakeout requirements – could affect the inner tracker design.**
5. **Installation and integration issues; how and when will these detectors be installed.**

Timeline

Tasks shall be completed within 12 weeks after receipt of award.

Institutions receiving fundings:
Los Alamos National Laboratory,
Lawrence Berkeley Laboratory

Status of INFN Contract

Mail from Mitch Laney (Jlab procurement manager) **27 June , 2022**

Mitchell Laney <laney@jlab.org> Today at 3:49 PM

To: Patrizia Rossi; Sherry Thomas; **Cc:** Walter Wittmer

The contract has not been written. I merely sent them the terms and conditions and reps and certs so they could review in advance. I'm working on the official RFP package to go to them tis week. More than likely tonight. Once I get their response back I will do the subcontract.

It could be this week. Bare in mind I'm also sitting in an airport going to the EIC review and I'm working on the RFP as we speak. I will do my best to get this awarded in next two weeks. A lot depends on INFN.

Reps and certs: Representations and Certifications – This is where they will affirm to different things.

RFP: request for Proposals. The RFP is comprised of the Solicitation notice, the Bid Schedule, The Reps and Certs, the terms and Conditions, and the SOW.

EIC Project R&D: Tracking the progress

- Milestones, Timeline, and Funding of the Detector R&D projects are tracked in the EIC project portfolio management system (P6) ➜ assessment needed on a regular bases.

- A call will be issued soon for a short (1-2 pages) written report due by October 1st – to show a) how the groups started up, b) progress (even if modest) toward milestones, and c) a preliminary plan for FY23.

- The documentation will be used to get feedback from the Detector Advisory Committee which will review the Detector R&D projects in the October meeting (date not fixed yet).

- Follow up meetings with the groups individually will be scheduled at the beginning of 2023 (January/February) to continue to track progress.

Generic R&D Program

- DOE NP is restarting the EIC generic R&D program in FY22 of scale $2M.
- Such a program would look at new cost-effective detector capabilities for either the detector-1 in the project scope or of use for a detector-2.
- The generic detector R&D program is expected to be governed similar as the successful generic EIC-related detector R&D program that ran through BNL from 2011-2021.
- It will be managed by Jefferson Lab, drawing deeply on BNL's extensive experience managing the previous version of the program.
- The PI will be David Mack (TJNAF). The Program Manager is David Dean (TJNAF).

Generic R&D Program

The call is out!!

Jefferson Lab, in association with Brookhaven National Lab and the DOE Office of Nuclear Physics, is pleased to announce that **the EIC-related generic detector R&D program is resuming and immediately calling for proposals.**

For more information, proposal guidelines, and proposal submission information, see https://www.jlab.org/research/eic_rd_prgm .

Please submit proposals by 5pm EST on July 25, 2022. Your response by then, despite the short deadline, will be greatly appreciated.

EIC R&D HOME | PROPOSAL GUIDELINES AND SUBMISSION | MORE PROGRAM DETAILS

GENERIC EIC-RELATED DETECTOR R&D PROGRAM

Generic R&D Program

GENERIC EIC-RELATED DETECTOR R&D PROGRAM

Proposal guidelines and submission information are located at this link. The deadline for proposals is 5pm EST on July 25, 2022.

Jefferson Lab, in association with Brookhaven National Lab and the DOE Office of Nuclear Physics, has restarted a generic detector R&D program to address the scientific requirements for measurements at the future Electron Ion Collider. This program will support advanced R&D on innovative, cost-effective detector concepts which reduce risk and that either the one detector in the project scope or a second detector could incorporate. (The term "generic" conveys this duality.) The EIC User Group-authored Yellow Report includes requirements for both detectors.

: This program is supported through R&D funds provided to Jefferson Lab by the DOE Office of Nuclear Physics, and is open to all segments of the EIC community. Proposals should be aimed at optimizing detection capability to enhance the scientific reach of polarized electron-proton and electron-ion collisions with center-of-mass energies in the range 30-140 GeV and e-p equivalent luminosities up to a few times 10^{34} $cm^{-2}s^{-1}$. See More Program Details for the broad range of enhanced detector capabilities of interest.

JLab's administration of the program draws on BNL's deep experience in running an earlier version of the program from 2011 to 2021 and is expected to be funded at an annual level of $2M, subject to availability of funds from DOE NP.

Generic R&D Program: Proposal Guidelines_1

The proposal guidelines are downloadable as a .pdf file here. The have been updated for the FY22 proposal cycle.

Proposals should be submitted to: eic_rd_prgm@jlab.org

Questions can be submitted to the committee Chair, Dave Mack: mack"at"jlab"dot"org

1 What R&D Projects Qualify for Funding?

For proposals to qualify for funding, they need to include a well-articulated motivation for their research, both in terms of advancement of technology and improvement in physics reach. The proposed project must address what physics program at an Electron-Ion Collider (EIC) it will enable and why the technologies to be studied have a particular importance for experiments in an EIC environment.

As delineated on the program website , the focus of this EIC-related generic detector R&D program is to evaluate opportunities to achieve new, cost-effective detector capabilities that reduce risk. This program will support advanced R&D on innovative detector concepts that either the one detector in the project scope or a second detector could incorporate. The term "generic" conveys this duality.

TJNAF will share proposals with the Electron-Ion Collider project (EIC). Should EIC determine that a proposal would directly support the project, EIC may use project funds to cover the costs of the work.

In the remainder of this document, the EIC-related generic detector R&D review committee will be referred to simply as "the review committee".

2 Guidelines for Preparing the Proposals and Progress Reports

Generic R&D Program: Proposal Guidelines_2

Some points to keep in mind:

- There should be at most two contact persons, preferably one.
- it should describe why the current state of the art of the instrumentation is not adequate. Tables of performance requirements with a discussion of how the resulting detector specifications will produce a detector that meets the physics goals would be most helpful. Clearly state the expected results (deliverables) of the R&D project.
- When resources are requested, proposals should state where the resources would be directed and the specific responsibilities of the personnel. When graduate students or postdocs are required, the proposal should state who would supervise them and where they would conduct their work
- Every proposal is required to provide a research program with a deliberate schedule for yearly deliverables
- Funds can only be requested for the coming fiscal year (FY), *i.e.*, October 1 until September 30.

Generic R&D Program: Proposal Guidelines_3

- Each proposal should also consider **three budget scenarios** and articulate deliverables under each scenario:
  - a realistic nominal budget (baseline budget),
  - a nominal budget minus 20%, and
  - a nominal budget minus 40%.

  Besides the deliverables, a clear set of intermediate milestones should be presented under each budget scenario and what goals will not be accomplished under the reduced budget scenarios.

- Proponents are encouraged to form research consortia

- At this time, all proposals are considered first time proposals and should not exceed 22 pages.

- Limited support for postdoctoral fellows will be considered. There is tension between the desire for proponents to support postdocs with the hope of renewal, and the review committee's desire to flexibly channel each year's limited funds to the most promising new proposals.

Generic R&D Program: Details

PROGRAM DETAILS

Detector functionality areas of interest include:

1. Particle identification reach at higher momenta and wide rapidity coverage;
2. Calorimetry, including:
    1. Hadronic calorimetry resolutions,
    2. Large-scale production and low-energy photon detection efficiency of possible glass-based electromagnetic calorimetry,
    3. Zero-degree calorimeters, or,
    4. Other means to improve spatial or timing resolution of collision events;
3. Tracking; and,
4. Readout electronics, including:
    1. Silicon photomultipliers,
    2. Large area picosecond photodetectors, or
    3. Application specific integrated circuits for streaming modes.

Funded proposals will be selected on the basis of peer review by an EIC-related Generic Detector R&D Advisory Committee consisting of internationally recognized experts in detector technology and collider physics. The review will be conducted by Jefferson Lab, however voting committee members will not be employed by Jefferson Lab.

The Office of Nuclear Physics (NP) intends to support researching and developing technologies suitable for detectors the Electron-Ion Collider (EIC) may incorporate. Such a program would not duplicate, but would instead synergize, with the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs administered by NP through the Department of Energy, Office of Science.

Conclusions

- Project R&D program started.
- R&D plan for detector 1 is in place.
- Selection of R&D projects concluded. Timelines and milestones defined for all projects but three which are on hold (ASICs/electronics, Forward EMCal & Hcal).
- Contracts with Institutions are being prepared.
- A generic EIC-related detector R&D program of scale $2M is going to start in FY22.

Backup slides

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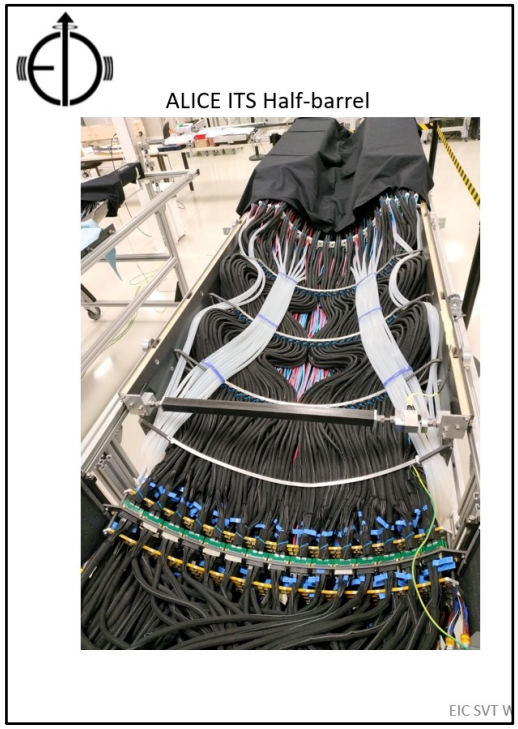
eRD104: Service Reduction

- **Goal**: investigate methods to significantly reduce the services load for an EIC MAPS based tracking detector (but many systems will potentially benefit from this)



- Starting Point - ALICE ITS-2 Current state of the art for MAPS
- The vast majority of the services for the ITS-2 consist of the powering and readout cables
  - Powering: radiation tolerant DC-DC converter, serial powering architectures
  - Data: data aggregation on detector using radiation tolerant FPGAs

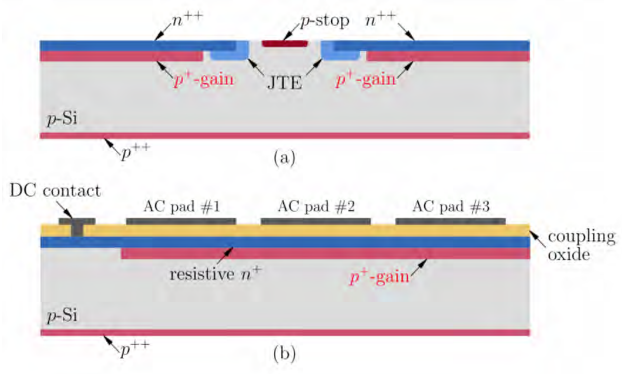
Milestones and Timeline for FY22

- Report on serial powering - **8/2022**
- Report on DC-DC powering - **10/2022**

eRD112: AC-LGAD

Goal: Develop AC-LGAD based systems including sensors, ASIC, and Services for auxiliary detectors (Roman Pots, B0)

AC-LGAD improves on LGAD in terms of timing and position resolution.Substantial synergy with AC-LGAD efforts in HEP



- Could be also used for
  - low-p,p_T ToF
  - Polarimetry
  - Common designs in sensor, ASIC where possible, combine R&D efforts

Milestones and Timeline for CY22

- Small sensor prototypes that meet space resolution specifications with a time resolution of 20-30 ps, -**12/2022.**
- Production of medium/large-area sensors with different doping concentration, pitch, and gap sizes between electrodes to optimize performance by BNL IO and Hamamatsu. BNL expected - **12/2022**

} sensors

- A prototype ASIC design to readout AC LGADs using signal sharing across neighboring electrodes and has 30 ps time resolution with low power consumption - **9/2022.**

} ASIC

eRD112: AC-LGAD

BNL

fabricate and test two small batches of AC-LGAD on 4" epitaxial wafers, whose active thickness will be either 20 (batch no. 1) and 50 um (batch no. 2). Both wafer typologies are already in house. The design of the wafer will be carried out first.

May 10, 2022 – September 30, 2022

LANL

1. Characterize the existing and newly developed AC-LGAD prototype sensors with the exiting 90Sr source test bench at LANL. The expected work period is from June 1 to **September 30, 2022**.
2. Schedule and carry out the irradiation tests for AC-LGAD prototype sensors to check the radiation tolerance with 10^{13} cm^{-2} to $10^{16}cm^{-2}$ n_{eq} doses according to the LANL LANSCE and UT Austin research reactor schedules. If the beam operation is scheduled within the period from June 1 to September 30, 2022, we will lead the setup and contribute to the data analysis in collaboration with other eRD112 colleagues.
3. We will join the eRD112 regular meetings to report the work progress and work on potential publications with other eRD112 collaborators.

eRD112: AC-LGAD

RICE

Testing a variety of AC-LGADs sensors with different thickness of active area and different pixel length configurations with beta source in the lab and by participating in the beam tests at FNAL.
May 15, 2022 through September 30, 2022.

UC Santa Cruz

1. Production of prototype assemblies with sensors loaded and bonded to existing readout boards
2. Characterization studies of the detector assemblies. Characterization studies will include
   - Power consumption
   - Precision I-V and C-V measurements
   - Extraction of the prototype sensor doping profile from analysis of C-V data
   - Determination of fundamental sensor characteristics (gain, rise and fall time, voltage and capacitance at depletion, signal dispersion profile)
   - Determination of higher-level performance characteristics (temporal and spatial resolution).

eRD112: AC-LGAD

UIC

The UIC group will work with other eRD112 groups to design AC-LGAD sensors for EIC. These sensors will be fabricated by BNL instrumentation division (BNL-IO) and by Hamamatsu Photonics K.K. (HPK).

Anticipated Deliverables by UIC group

1. Purchase order of AC-LGAD sensors from HPK
2. Purchase order of testing boards for AC-LGAD sensors
3. AC-LGAD sensors from BNL-IO mounted and wire-bonded on testing boards
4. Testing results on AC-LGAD sensors mounted and wire-bonded on testing boards

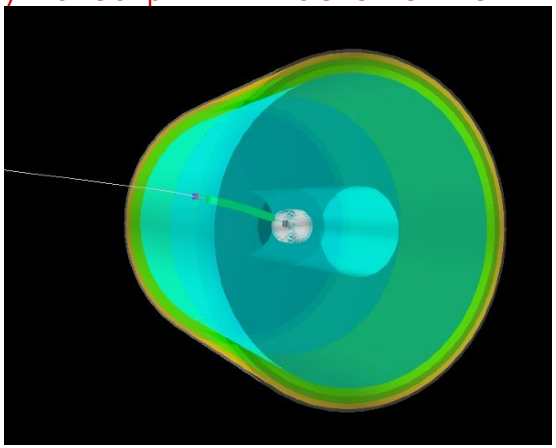
June 1, 2022 to September 30, 2022

eRD108: MPGDs

Goal: develop EIC tracking for different systems

- R&D on three Micro-Pattern Gaseous Detectors (MPGDs)
  - micro-Resistive-Well (µRWELL)
  - micromegas (MM)
  - Gas Electron Multiplier (GEM)
- Applications:
  - µRWELL Layer for seeding DIRC reconstruction
  - Micromegas Barrel Tracker
  - Planar GEM/µRWELL Endcap Tracker (removed)
    - ➥ the initial challenges (ultra-low mass planar detectors) are no longer relevant in the end cap regions of the current EIC detector 1

Cylindrical µRWELL Tracker for the DIRC



Milestones and Timeline for CY22 - Updated

Cylindrical Micromegas Barrel Tracker:

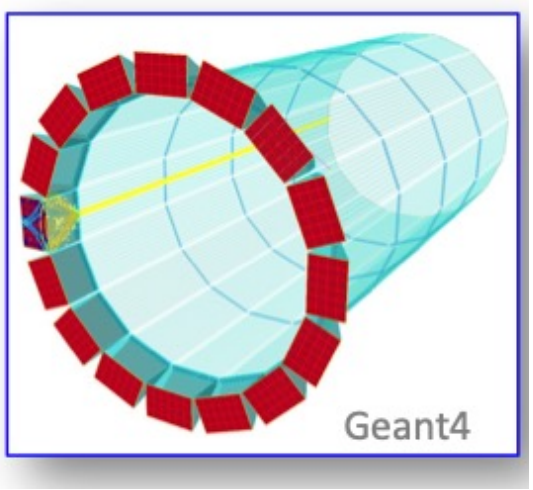
Readout designs (Saclay & BNL) – **9/2022**
Readout foils received (Saclay & BNL) – **12/2022**
Bulk and assembly of prototypes (Saclay) – **4/2023**
Cosmic ray data taking completed (Saclay) – **6/2023**
Analysis and results (Saclay & BNL) – **8/2023**

Cylindrical µRWell:

- Major Milestone: Design completed
  - Mechanical design completed (FIT) – **10/30/2022**
  - Front-end electronics & DAQ design completed (TU) - **9/30/2022**
  - Readout foil design completed (UVa & BNL) – **9/30/2022**
- Major Milestone: Detector Assembled
  - Mechanical assembly completed (FIT) - **4/30/23**
  - Existing (VMM-SRS) front-end electronics & DAQ tested (TU) - **4/30/23**
  - Readout foil produced at CERN (UVa & BNL) - **4/30/23**
- Major Milestone: Detector ready for beam test
  - Integration of detector & electronics and benchtop testing (All) - **6/30/2023**

eRD103: hpDIRC

Goal: Develop fast focusing compact DIRC with coverage reaching 6 GeV/c for π/K, pushing the performance well beyond the state-of-the-art for DIRC counters.



- Based on BaBar DIRC, *PANDA Barrel DIRC*
- Technical risk:
  - Small pixel photon sensor and fast readout electronics performance
  - (risk/opportunity): Reuse of BaBar DIRC bars
- R&D Priorities:
  - Baseline design validation
  - Cost/performance optimization

Milestones & Timeline for CY22

- Assembly of Cosmic Ray Telescope (CRT) in SBU DIRC lab complete - **12/2022**
- Mechanical integration of initial hpDIRC prototype into CRT achieved **-12/2022**

Shifted to Jlab

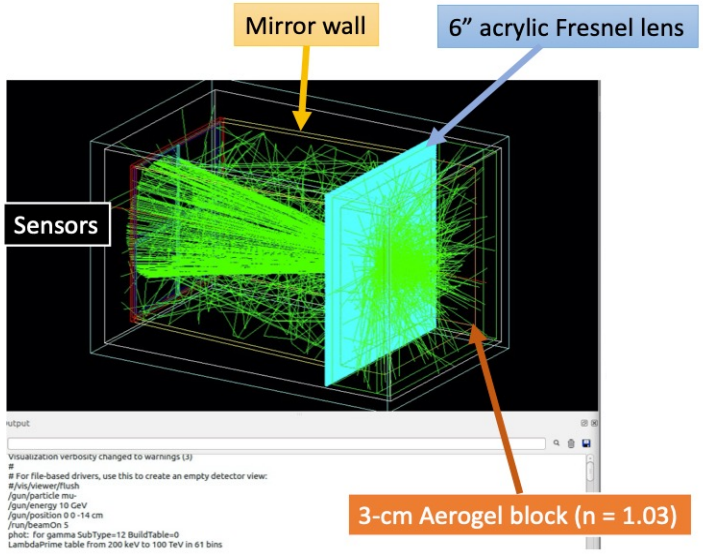
- Optical DIRC lab for BaBar DIRC bar
  New space (EEL-108A) is ready, items have been bought (clean room, laser, table).
  We delayed construction of the clean room that needs about 2-3 days as the techs were busy with preparing for the experiments.

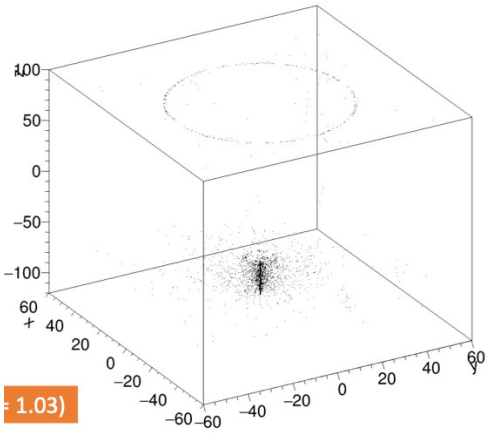
- Complete QA of bars from first disassembled BaBar DIRC bar box, decision about further disassembly strategy
  We have ok from SLAC for a two stage plan for DIRC bars disassembly and QA, first a test module then the real bars (two separate contracts). But they have not given us the info (costs) to set to an IEWO contract yet to start it.

eRD101: mRICH

Goal: Develop sharper and small ring imaging RICH for K/π separation in a momentum range of 3 to 10 GeV/c and e/π separation below 2 GeV/c

- R&D: Validate the concept





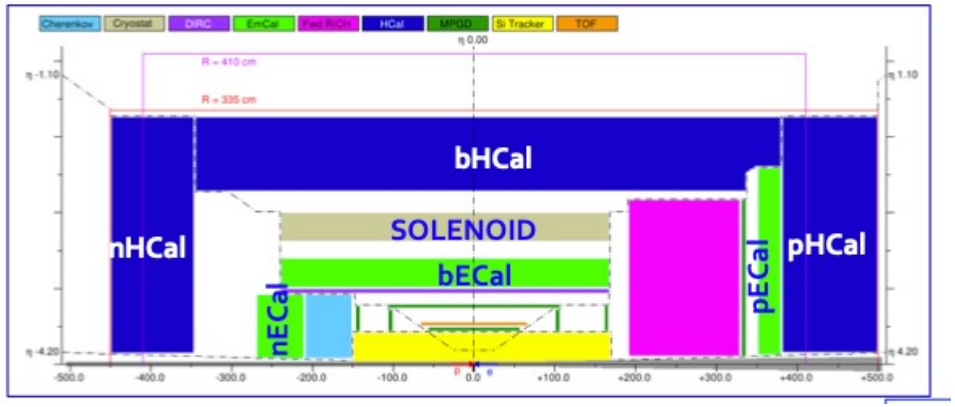
Milestones and Timeline for FY22

- Analyzing the mRICH beam test data taken at JLab and finishing up the data analysis from the 2nd mRICH beam test at Fermilab. Obtain the single photon characterization of the mRICH by the end of **9/2022.**

eRD106_107: Forward EMCal+HCal

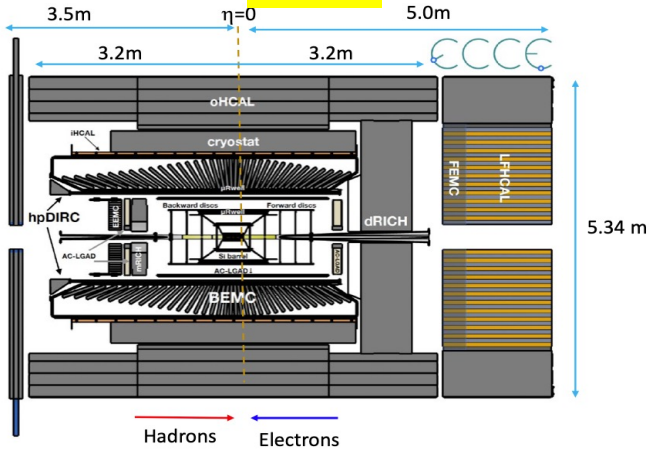
- The endcap calorimeters (EMCal and Hcal) require substantial efforts to merge the projects of the two collaborations, ATHENA and ECCE

ATHENA



- Compensated electromagnetic calorimeter (pECal)
- Fe/Scint (20 mm / 3 mm) sandwich hadronic calorimeter (pHCal)

ECCE



- Electromagnetic calorimeter Pb/ScFi shashlik (FEMC)
- Longitudinally separated hadronic calorimeter (LHFCAL)

- A decision on the submitted proposals is postponed until a selection on what the project detector's technology with be ultimately used for the forward calorimeters will be made.