EICGENR&D2023_01 A Fast Timing MAPS Detector for the EIC

What potential risks of this seemingly promising technology are addressed in section **3.1 Deliverables**, items 3 and 4? I.e., the stitching and testing of a prototype stave? (Note that Items 1 and 2 involve the detailed design of a Fast MAPS Tracker which seems more appropriate for possible future project R&D.)

Are there other potential show-stoppers that must be addressed before this technology could be confidently incorporated into a future EIC project detector? For example, if it were clear that the radiation length of a stave with cooling and power and readout lines was too large, that might suggest related priority topics for the generic R&D program.

EICGENR&D2023_02 Towards a Few-Degree Calorimeter: bridging the Q^2 gap to support the quest for gluon saturation

Figure 6 shows the amount of dead material as a function of pseudorapidity. Please show the effect on the energy resolution, (sigma/E) for these trajectories, and compare to the needed energy resolution.

Could you comment on the construction details for the ZEUS BPC (section 2.3)?

Page 9 section 2.5 mentions longitudinal and transverse segmentation for electron/hadron discrimination. The GAMS and L3 groups concluded transverse segmentation was enough, i.e. electron/hadron discrimination did not particularly improve by adding longitudinal segmentation. Have you studied this, and/or do you have any comments on this? It certainly seems reasonable to have a charged-particle tagger directly in front of the proposed calorimeter.

Table 3 in section 3.1 gives 20 radiation lengths as a proposed thickness. Have you studied shower leakage and effects on energy resolution, transverse position resolution, and e/hadron separation in choosing this number? I,e. is the proposed device "thick enough"?

Are the proposed tests in section 4.4 at JLab Hall D to use tagged photons there? 1-8 GeV?

Please provide some (preliminary) discussion of heat generated, and thus temperatures reached, in electronics and thus the SiPM area.

Please comment on the potential radiation damage to the detector:

- What is the expected range of radiation dose from collision and machine background?
- What is the expected per-tile zero-suppression threshold after the max dose accumulation of one EIC full luminosity run?
- What is the expected performance of the detector after the max dose accumulation of one EIC full luminosity run?

Please discuss the expected hit rate with collision and beam gas interactions in the proposed FDC, and is there any concern for pile-up in the HGROC TOT/TOA TDCs ?

Please compare the proposed FDC with a potential PbWO4 FDC .

Please comment on the discrepancy between the position resolution requirement and the simulated performance.

Please comment on the strategy to obtain T0 for the FDC TOF-based pi/e separation for the low-Q2 events under study.

EICGENR&D2023_03 Generic glass scintillators for EIC Calorimeters (ScintCalEIC) R&D

Can you describe the feedback loop between measurements and the glass suppliers?

Contrary to the title, this proposal has a strong emphasis on photo-sensor arrangement and readout. Can you justify this?

Can the differences in shape be simulated in ray tracing?

What is the size in terms of radiation length of the prototype 40cm blocks? What are the contingencies if the manufacturer cannot deliver?

EICGENR&D2023_04 Feasibility of Organic Glass Scintillators for EIC ZDC

This is an expensive yet interesting proposal. Since labor will dominate the budget, the committee requests more detail about the proposed time commitments for scientists, technicians, and students. BNL proposals often include a very useful “blue table” which summarizes labor, overhead, etc.

What energy range do we expect the neutrons to be and how does that change as they travel through the calorimeter? How 'straight' do the neutrons travel?

What PSD algorithm has been used to give the FoM? How will that be integrated into a potential application?

Do you expect the Cherenkov light will affect the PSD?

What photon sensor do you envisage and do you expect it to have effect on the PSD?

Can the shape studies be performed in ray-tracing Monte Carlo?

Is the planned beam time secured?

EICGENR&D2023_05 Slim Edge for LGADs

Explain in more detail the designs of the edges.

Is simulation supporting your choices?

What designs won't be implemented between 100% and 60% financing?

Why do you not include DRIE (Deep Reactive Ion Etching) in the program? Such a machine may not be available at BNL but they are widely available at University fabs. Inclusion would make the project more complete.

What lithography is needed after the trench etch? Can it be the last step?

What guard ring geometry do you plan to use? How much space does it take?

Can the trench be used to isolate the backside from the front so that the front side is at ground potential?

EICGENR&D2023_06 Photonics-Based Readout and Power Delivery by Light for Large-Area Monolithic Active Pixel Sensors

The motivation seems to be reducing the material budget and improving timing performance. Two related questions:

- Please explain how higher power levels for the amplifier input stage can lead to improved timing performance. Is this generally true for existing MAPS designs, or does this require a new design such as that in the separate proposal (Generic R&D proposal #10)?
- What is the proposed reduction in radiation length in the proposed optical solution compared to conventional power distribution? Have simulations been done to demonstrate what gains are obtained for some physics observable if the proposed reduction in radiation length is achieved?

The budget is entirely labor and split over many people with small fractions of each person's time. Even in Scenario 1 the person spending the <u>most</u> time on this only has 80 hours or 2 weeks of effort for the full year. Are there other resources for labor allocated at BNL to perform this ambitious work? If not, is this level of effort viable with so little effort from each individual? E.g., the time required to prepare safety documentation and train a group of people to safely work with Watt-scale laser fibers should not be underestimated.

EICGENR&D2023_07 R&D for a new concept EIC nucleon polarimeter based on chemical hyperpolarization

Assuming a 1% statistical measurement of the beam polarization in 1 hour, would the machine luminosity be significantly reduced by the target droplets? (If it is not possible to answer that question by the time of the presentation, perhaps one can start with an easier calculation: what would be the amount of material in g/cm2 seen by the proton beam during that hour from droplets versus residual gas?)

Is the flash evaporation during droplet freezing expected to increase the residual gas in the beamline?

EICGENR&D2023_08 Pressurized RICH

Are there other similar proposals for LHC detector upgrades or others to replace fluorocarbons? If so, what can be learned from those studies to apply at the EIC?

The budget narrative refers several times to project R&D funding. Can you provide a breakdown of the aspects of this project where EIC project R&D funds play a role and how that's distinct from the generic R&D request?

Is a test beam campaign requested or required to demonstrate the performance with the existing prototype and Argon radiator early in the project?

EICGENR&D2023_09 Z-Tagging Mini DIRC

Physics case: The proposed detector measures the Z of a fragment. How do we get the mass? How do we get spectroscopy? Does that require a high resolution calorimeter nearby, and is that foreseen? Is the physics case strong enough if it was just to establish coherent scattering for some reactions?

The proposal is simulation. How are they validated?

What is new or special in this proposal concerning DIRC technology?

What has been approximated in the current simulation?

What is the preferred photon sensor solution, taking radiation hardness and external magnetic field into account?

Which alternative technologies (Si-telescope?) have been considered?

Will the detector benefit from higher granularity?

What will a reduced Year 1 program achieve compared to the proposal text?

EICGENR&D2023_10 Large-Area Monolithic Active Pixel Sensors Combining High Spatial and Temporal Resolution

Are there engineering, physics, or computer science faculty at universities who would be interested in collaborating on some aspects of this R&D? In general, this would seem like a way to increase the number of senior person-months per year devoted to arguably important generic R&D without increasing the cost so much that it is out of reach of the current program.

EICGENR&D2023_11 Design, Fabrication and testing of a multi-channel System on a chip for Low-Power High-Density High Timing Precision Readout ASIC for AC-LGADs (HPSoCv3)

How do you envision transition to application in an EIC experiment? What design and implementation steps would be needed?

How well did the waveform sampling and digitizing work in Tiny-HPSOC? Were substantial modifications needed for the next generation?

Test results are modest. Why only a few hundred events? Is it a trigger issue?

Why were the chip bonding issues limiting? Could you use other chips from the submission?

Was the power consumption as expected?

How will the HPSoCV2 be packaged? Is it intended to be bump bonded (direct bond), and if so, is there budget for this? Does the geometry match existing sensors? Is an interposer needed?

EICGENR&D2023_12 R&D of 4D Detectors with EICROC and AC-LGAD at EIC consolidating a US-Japan Consortium

What would be the effect on EICROC testing if this project were not funded?

One of the aims is to improve the design of the EIROC ASIC, but there are no collaborators from the Omega group. Why?

How would the project lead to continuing involvement by Japanese groups in EIC? Are there specific contributions envisioned?

EICGENR&D2023_13 Performance of GridPIX Detector in Magnetic Field with low mass and high efficiency CO_2 cooling

Please summarize the progress made last year on this project. Specify which goals were not completed from last year's proposal (due to the delay in funding, etc.).

Clarify the importance of the development of the CO_2 cooling system at this stage of the GridPIX detector R&D.

Can you quantify the advantage of the test beam at 0.7T with respect to the cosmic test at 4T?

EICGENR&D2023_14 Development of High Precision and Eco-friendly MRPC TOF Detector for EIC

This proposal and others state that standard non eco-friendly gases "… will soon to be forbidden to be used in all U.S. national labs." Is this documented somewhere to clarify these requirements for the EIC?

Previous studies were done with CAEN waveform digitizer DT5742 chip but this proposal describes new SAMPIC or pico-TDC based readout. What are the benefits of these options to justify the development of MRPC with eco-friendly gases?

Previous studies of sMRPC at the Fermilab test beam did not have the required electronics to be successful. If new electronics are being developed for this case, what milestones will be set to ensure the readout is ready in time for the beam tests described in this proposal? Please describe the proposed timeline for the beam tests and the preparation of electronics to meet that timeline.

EICGENR&D2023_15 Fabrication and characterization of the Trench Isolated Low Gain Avalanche Detectors for 4D tracking

Are you aware that multi-pixel TI-LGAD exists?

AIDAInnova TI-LGAD includes TimePix geometry. What will a production at MICRON add to this?

How would the probe testing be done? Are there structures designed to provide information on gain and isolation characteristics?

What is the division of work between RD50/Timepix and this proposal?

The Timepix3/4 process seems to be an integral part of the R&D. What parts are unique to EIC? Is the work in "Test Prototype TI-LGAD sensor" partially paid by R&D funds?

Are both flip chip runs included in this proposal?

How would the work proceed if this proposal is not funded?

Does the TCAD indicate any limitations on gain/breakdown related to the trench depth or spacing? Can you show the TCAD E field map?

Do you plan to study various trench fill materials? Is thermal oxide the only one studied in the base plan? Are other methods consistent with the processing?

Why the mix of 6 epitaxial (epi) and 12 float zone wafers? Aren't the epi wafers the ones that would be used for the experiment?

In reference 15 it states "It is worthwhile to note that even the safest layout in TI-LGAD has IPD lower than 15 µm. Due to these characteristics of TI-LGADs, they are the ideal candidate for segmented LGADs with a pixel size of 100 µm, achieving FF higher than 84%" **How do you plan to achieve your 2-3 micron goal?**

EICGENR&D2023_16 Development of Double-sided Thin-Gap GEM-µRWELL for Tracking at the EIC

Please summarize what has been done in the last year and what remains to be done.

How does your collaboration share expertise during the year?

Do you develop complementary infrastructure to share during the development of different MPGD prototypes?

Where do you see a potential µRWell in the EIC detector, and what would be its advantage?

To follow up on the previous question: does your collaboration have access to simulations which can show how improved position resolution in a thin-gap gaseous detector in the outer part of the detector leads to improved momentum and angle resolution of tracks?

To what extent does your collaboration have the capability to simulate the performance of new designs?

EICGENR&D2023_17 Scintillator Fiber Trackers for the ZDC and off-momentum detectors

Can you briefly summarize what the ZDC will be used for at the EIC?

Please comment on the advantages of using scintillator fiber trackers as the ZDC charged particle vetoing device, compared with other technologies.

Can you explain the aspects of the fibers and their coupling that need to be optimized for the EIC needs? What are the new aspects?

Please highlight the potential knowledge gained by performing the proposed prototyping work on top of the previously published work on the scintillator fiber detectors.

Without Geant4 simulation, please use a back-of-envelope calculation to estimate the physics performance of the proposed design: what is the charged particle rejection factor, what is the expected boost in signal/background ratio in the physics observable, such as Lambda -> n pi0 .

EICGENR&D2023_18 Continuation of EIC KLM R&D Proposal

AI/ML is mentioned a number of times in the proposal, but did not surface in the deliverables explicitly. What is the connection?

Some context, or comparison, of this proposal's device relative to the HCals of the LEP detectors, DELPHI, OPAL and ALEPH, would be useful. These were multi-plate steel-sensor stacks that served as magnet-barrel flux returns, hadronic calorimeters, and first stages of muon taggers.

Some detail about the HELIX experiment electronics would be helpful.

Does ELJEN have access to needed chemicals to manufacture the required scintillators or are there any known supply chain issues? What type of scintillator is planned?

Is Fig.2 right hand panel 1.5 T (text) or 2.0 T (legend on figure)?

What energy resolution sigma/E is forseen for the HCal? How many interaction lengths are planned? What is the relevant energy range for the hadrons, and is shower leakage a concern?

The scintillator discussed is 7.5mm thick, a factor of 8 less than the 6 cm thick scintillator used in CLAS12, for which 55 ps timing resolution is noted. This suggests a factor of 8 fewer photons, modulo light collection issues. Some discussion of possible timing resolution and the means to achieve 50 ps or better would be useful.

Will larger-area SiPMs than exhibited for HELIX in Figure 6 be tested? Some larger SiPMs were tested by C. Woody of BNL as part of prior R&D, in that case for reading out EMCal modules. Has contact with him been made?

Are there any representative waveforms already recorded for the signals from SiPMs coupled to the proposed scintillator(s), or is that part of this R&D?

EICGENR&D2023_19 Superconducting Nanowire Detectors for the EIC

In the progress report Section 4.1,

- What was the proton hit rate in the active area of the sensor (in Hz)?
- Please provide signal height/amplitude spectrum for proton hits
- Is it possible to extract timing resolution from this data?

Could you measure the absolute detection efficiency in the future tests?

In the windowless Roman pot detector application (Concept 1) and B0 tracker application (Concept 2), is there any concern for maintaining a 4K temperature, which includes beam-induced heating and synchrotron radiation absorption?

Assuming the proposed research is successful, please provide an envisioned technical-driven timeline and milestones toward a full-sized sensor as shown in Figure 6. Please comment on the most challenging step(s).

EICGENR&D2023_20 Development of a Novel Readout Concept for an EIC DIRC

A smaller DIRC focal plane still seems like a worthy goal: it would be cheaper to instrument, and would allow for more flexibility in photo-sensor selection. Regarding the latter point though: for the size of focal plane you envision, can you show from a simple calculation that SiPM’s are actually a realistic option? (For noise levels, assume new SiPM’s and a realistic low temperature.)