**Expression of Interest (EOI)**

**Questionnaire**

*(Use this template for your document. The document can be at most 10 pages long, in this style, font and font size, but you can have appendices and do not have to include the tables in the page count. There is no prescribed format of the document, but you are asked to address the questions below. It is understood that maybe not all questions can be answered precisely, everybody is asked to fill the questions as good as currently possible. All submitted public Questionnaires will be viewable here (https://indico.bnl.gov/event/8552/). You can also submit a separate document with certain information you would only like to be viewable by the EIC Project. DEADLINE FOR SUBMISSION: NOVEMBER 1.)*

**Please indicate the name of the contact person for this submission:**

*(we ask for one main contact person per submission. You can as needed provide further contacts, but there should be one primary contact)*

Lynn Wood (lynn.wood@pnnl.gov)

**Please indicate all institutions collectively involved in this submission of interest:**

*(even if institutions can submit on their own, it is highly encouraged to form groups to work together within their country, their geographical region, or as a general consortium)*

Pacific Northwest National Laboratory

**Please indicate the items of interest for potential equipment cooperation:**

*(indicate experimental equipment components, including those integrated in the interaction regions, each separately)*

The PNNL High Energy Physics group has interest in contributing to the streaming data readout design for the EIC.

**Please indicate what the level of potential contributions are for each item of interest:**

*(e.g. indicate if contributions are for full in-kind experimental equipment components – we have provided a rough direct cost estimate for many components in an appendix (see slide 10 & 11 at*

*https://indico.bnl.gov/event/7449/contributions/35863/attachments/27277/41597/EIC.Comp.Det.032020.eca.pptx, if contributions are for partial in-kind experimental equipment components, if contributions are for in-kind labor contributions, etc.).*

Of particular interest to PNNL would be the interfaces between hardware and software, potentially focusing on co-design and heterogenous computing capabilities. PNNL has been heavily involved with the Belle II experiment at KEK for the past decade, providing project management, computing resources, detector design and installation, firmware for readout and triggering, and leadership in software, PID, and physics analysis. Additionally, PNNL is currently executing a combined project with FNAL on ML for accelerators, using streaming data. An interesting avenue to explore would be the potential for streaming reconstruction of beam parameters from the detector data. This data is generally not of interest to the physics analyses but could potentially have a high impact on the operation of the machine. This experience is being combined with other capabilities at PNNL to explore the cutting-edge of data workflow R&D.

Some capabilities available at PNNL relevant to EIC streaming data readout include:

**Center for Advanced Technology Evaluation (CENATE)** – a computing proving ground focused on integrated evaluation of early technologies to predict their potential and guide future systems design. Capabilities include novel technology testbeds for hardware accelerators, instrumentation, advanced memory, network, and system architectures. *(*[*https://cenate.pnl.gov*](https://cenate.pnl.gov)*)*

**Data Model Convergence Initiative (DMC)** – an ambitious five-year investment to create the next generation of scientific computing capability through a multidisciplinary software and hardware co-design methodology. Current projects funded by this initiative include hybrid advanced workflows, domain-aware machine learning for grid analytics, data-model convergence approaches, and memory-centric programming models. *(*[*http://www.pnnl.gov/projects/dmc*](http://www.pnnl.gov/projects/dmc)*)*

**Project 8** – PNNL leads the data streaming and workflow efforts for the upgrade to the Project 8 neutrino mass experiment, where real-time beamforming and triggering on analog RF signals will be required. The R&D for the upgrade’s workflow is focusing on a scalable architecture to move algorithms further up the readout chain. *(*[*https://www.project8.org*](https://www.project8.org)*)*

**Please indicate what, if any, assumptions you made as coming from the EIC Project or the labs for your items of interest:**

*(e.g., indicate if you include engineering and design activities or assume those to come from the EIC Project, if you assume certain material costs to be covered by the EIC Project, if you rely on existing capabilities at the labs, etc. Try to be as inclusive as you can be.).*

PNNL would expect to work together with BNL, JLab, and other EIC groups to develop the streaming readout. We assume that hardware design (ASICs, PCBs, etc.) would be developed by other groups, although PNNL would be interested in testing and evaluation. PNNL assumes that our contribution would be focused on the engineering and design of streaming readout workflows, although other areas of interest are possible as well.

**Please indicate the labor contribution for the EIC experimental equipment activities:**

*(e.g., for each cooperation and/or institution list the number of senior staff, the number of postdocs, and the number of graduate and undergraduate students that you plan to dedicate to the EIC experimental equipment activities. Similarly, please list the number of engineers, designers and technicians included in your potential cooperation).*

The time commitment of members of the PNNL group in the EIC efforts described in this EoI is anticipated to be as follows:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Institution Name | Professor | Research Professor | Staff Scientist | Postdoc | Graduate Student | Undergrad. student | Engineer | Designer | Technician | Total Sum |
| PNNL |  |  | 0.25 |  |  | 0.25 |  |  |  |  |
|  |  | 0.25 |  | 0.25 |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  | 1.00 |
|  |  |  |  |  |  |  |  |  |  |  |

*NOTE: FTE in the above table represents the annual fractional full time equivalent (FTE).*

*NOTE: for a professor, full-time equivalent research time may be limited to 25% max, for a research professor (or a sabbatical) or a staff scientist limited to 50% max, for a postdoc maybe 100%, and for a grad. student perhaps 50% (on average). For an undergraduate student research time (on average) is limited to 20% max.*

*(Repeat this table for each institution, or include the information for the whole group/consortium together in one table as shown above.* ***This reflects an annual average FTE estimate.*** *Please state below for how many years you estimate this average cooperation level to be valid.)*

It is anticipated that the collaborative effort of PNNL to cooperate on the EIC Project is to include (at an annual basis) 0.5 FTE of a staff scientist and 0.25 FTEs of Ph.D. students. We anticipate the duration of this collaborative effort to cooperate on the EIC Project to start at the DESIGN phase and to be for a period of THREE years.

**Please indicate if there are timing constraints to your submission:**

*(e.g., indicate any known or anticipated timing profile assumed in your EOI. This can include anticipated time frames folding in constraints due to ongoing commitments, due to ongoing R&D and its anticipated completion date, etc.)*

PNNL’s involvement in Belle II is ramping down and will be completed after FY22. This involvement is not expected to affect the ability to contribute to the EIC.

**Please indicate any other information you feel will be helpful:**

*(e.g., this could be things like assembly and storage space at your institute, clean rooms and class, special skills or machine shops, or perhaps some pointers to past accomplishments – you can expand on those in an appendix. If you could make existing engineering, design or technician labor available to the EIC experimental equipment but would rely on funds coming from the EIC Project you can also list those here).*

PNNL operates differently than most other national laboratories, with no base grant funding. Instead support is provided by sponsors on a project-by-project basis. From prior project funding experience, the HEP group at PNNL has a reasonable expectation of finding funding relevant for the EIC from sponsors such as DOE-ASCR and internal lab initiatives such as DMC.