**Expression of Interest (EOI)**

**Questionnaire**

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

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

*Thomas Jefferson National Accelerator Facility, or Jefferson Lab*

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

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

Since Jefferson Lab is a host institution, here we detail the laboratory expertise, along with examples, available to the EIC project. *Note that most of these projects were done in close collaboration with Jefferson Lab’s broad and international user community.*

* Superconducting Detector Magnets:
  + Five SC spectrometer dipole magnets
  + Multiple (>10) specialized SC spectrometer quadrupole magnets
  + Two SC solenoid detector magnets
  + Three specialized SC solenoid electron polarimetry magnets
  + Two specialized SC toroidal detector magnets
  + Various SC polarized target magnets (Helmholtz-style)
* Tracking Detectors:
  + Silicon vertex detector
  + Various Wire and Straw Tube Chambers.
  + Various GEM-based tracking detectors, from curved radial Time-Project Projection Chambers to 40+ GEM planes of 40 by 40 cm2 to a large-size 40 cm by 120 cm2 GEM detector.
  + Small Diamond-based trackers for Electron Polarimetry.
* Particle Identification Detectors:
  + Various Aerogel-based Cherenkov Detectors for kaon and proton identification
  + Various Gas Cherenkov Detectors for electron and pion identification
  + Focusing, proximity-focusing or hybrid Ring-Imaging Cherenkov Systems using different radiators
  + A DIRC-based Cherenkov System
* EM Calorimetry Detectors:
  + Various high-resolution homogeneous PbWO4-crystal based calorimeters
  + High-resolution homogeneous PbF2-crystal based calorimeter
  + Various Lead-Glass Calorimeters
  + Various Sampling Calorimeters
* Hadron Calorimetry Detectors:
  + Wavelength-shifting iron and protruded-scintillator based Hadron Calorimeter
* Tagging Detectors
  + Several photon-beam tagging detector systems with resistive tagging magnets and scintillating fiber microscopes as detectors.
  + A forward-angle near-photon electron and photon detection system, consisting of a high-resolution homogeneous PbWO4-crystal based detector.
* Electronics:
  + Design, Engineering and Assembly of Fast-Pipeline Electronics Systems, including ADCs, TDCs, and Trigger Processors, including tracking-based.
  + FPGA programming
* Electron Polarimetry
  + Several high-power lasers
  + One high-gain and one modest-gain laser cavity
  + Photon detection and diamond-detector based electron detector systems
* Infrastructure and Installation
  + Due to the nature of electron scattering experiments with often frequent transitions between large, user-provided specialized experiment, large experience and expert labor in system engineering, installation and de-installation, including magnets, various experimental equipment, beam lines, mechanical, electrical and cabling, cryogenic and LCW systems.

**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.).*

Since Jefferson Lab is a host institution, here we detail where we join other institutions and/or consortia in their Expressions of Interest, and the resources and expertise assumed for these collaborations.

* Detector Magnet:
  + Support for new SC solenoid magnet engineering and design including expert labor in an 8-FTE magnet group, co-led by CEA, Saclay.
  + Support for evaluation of evaluation of the existing BABAR/sPHENIX magnet, in collaboration with CEA, Saclay and BNL magnet engineers.
* Silicon Tracking:
  + Support of the silicon pixel tracking and vertexing effort towards the EIC led by LBNL
  + Available test space and infrastructure for silicon detectors, including clean rooms and various diagnostics equipment.
  + Support for silicon design, component and full-scale operational testing including expert labor (expert staff scientists and a 10-FTE detector support group)
* GEM-based Tracking:
  + Available test space and infrastructure for large-size GEM detector testing
  + Support for GEM detector operational testing, including expert labor in the 7-FTE radiation detector and imaging support group.
  + Provide expertise on transition-radiation detection techniques and support for a possible GEM-based Transition Radiation Detector led by Temple.
* Particle Identification:
  + Access to ex-BABAR DIRC bars – 4 are in use in a DIRC-based Cherenkov, the remaining 8 are in the process to move from SLAC to Jefferson Lab and will be safely maintained.
  + Support for international collaborators on RICH- and DIRC-based systems.
* Backward EM calorimetry:
  + Support for a few-100 PbWO4 crystals and readout owned by a combination of Jefferson Lab and user institutions, this may be an assumption in an EEEmCal consortium proposal led by CUA.
  + Available test space and infrastructure for PbWO4 crystal and/or SciGlass testing.
  + Support for international collaborators on backward EM calorimetry development.
  + Potential contribution of available Pb-glass detectors, owned by a combination of Jefferson Lab and AANL/Armenia, and support for Pb-glass detector-based backup solutions.
* Barrel EM calorimetry:
  + Available test space and infrastructure for homogenous EM calorimetry options such as SciGlass testing.
  + Support for international collaborators on Barrel EM calorimetry development.
* Forward- and Backward Detectors:
  + As needed, provide expertise to the EIC user community for implementation of a low-Q2 electron tagger, a forward PbWO4-based calorimeter, and other detectors.
* Streaming readout:
  + Support on a full-systems engineering approach to high speed, continuous streaming readout adaptable to all (or most) large detector subsystems, led by ORNL.
  + Support on an EIC detector full-system streaming readout implementation, led by INFN.
  + A streaming readout laboratory with access to a fast network switch and the JLab high-performance computational facility to provide a test-bed facility.
  + Further infrastructure, diagnostics equipment and expert labor within the 14-FTE Fast Electronics/Data Acquisition Group on electronics and data acquisition readout design, and expert FPGA programming.
  + Streaming software support from the 12-FTE Scientific Computing Department.
* Software:
  + Support on all aspects of software from physics and detector simulations to online and offline analysis.
  + Contributed in-kind scientific labor effort of EIC Group Staff.
  + Support for visitors working on all aspects of software.
* Computing and Middleware:
  + Support of software and high-level computing tools towards a modern distributed-computing infrastructure to take advantage of JLab-sited and worldwide high-performance computing facilities.
  + Scientific Computing Department providing:
    - High Performance computing expertise.
    - An experimental physics computing infrastructure group supporting:
      * Software for streaming data acquisition and analysis.
      * Software tools and packages.
      * AI/ML.
      * Other R&D projects in support of scientific computing.
  + Infrastructure operations and expert labor within the 6-FTE Scientific Computing Operation Group.
* Electron Polarimetry:
  + Support on electron polarimetry, including providing expertise, and development equipment loan and spin-off on
    - Laser systems
    - Segmented strip (diamond, silicon) and/or pixelated (HVMAPS) detectors
    - RF simulations
  + Providing a test bed for development using the existing Halls A and C polarimeters.
  + Providing an expert scientist/manager to oversee the EIC electron polarimetry.
* IR design / Background studies:
  + Support on vacuum studies of the Interaction Region, and how this and the interaction region beam pipe design will affect the background in the IR.
  + Providing accelerator design support for a potential 2nd Interaction Region.

**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.).*

N/A for Jefferson Lab

**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).*

N/A for Jefferson Lab

**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.)*

N/A for Jefferson Lab

**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).*

Since Jefferson Lab is a host institution, here we detail the assembly and lab infrastructure available to the EIC project, including computing infrastructure.

* Detector test possibilities in all four Halls A, B, C and D and in a dedicated 10-MeV low-current (<1 mA) electron beam facility UITF.
* Test Lab Hi Bay area
  + Air conditioned and humidity controlled
  + 8,724 sq. ft. Physics area in 21,741 sq. ft. total area
  + Dual bridge crane, 2 @ 25 tons each
  + Access to cryogenics
  + Two small clean rooms, 380 and 331 sq. ft.
* Experimental Equipment Laboratory, air conditioned and humidity controlled, hosting a
  + 2,514 sq. ft. large clean room
  + SVT area including diagnostics laboratory and small 533 sq. ft. clean room
* Physics Staging Building
  + air conditioned and humidity controlled
  + 18,000 square feet
  + fork lift accessible and 3-ton gantry
* Experiment Storage Building
  + Ground floor 15,216 sq. ft.
  + Mezzanine 4,986 sq. ft.
  + forklift accessible
* INDRA streaming readout laboratory
  + 341 sq. ft.
  + located next to a similar-size data acquisition laboratory.
  + direct access to a fast network switch and the Jefferson Lab heterogeneous high-performance computational facility.
* Central computing facility
  + Tier III Data Center availability
  + A 100Gbit fully redundant network with two geographically diverse with fully protected 10Gbit Internet connections
  + A virtual machine infrastructure supporting over 500VMs with full data, network, and power redundant.
  + Infrastructure performance, availability, and cybersecurity monitoring
* Scientific Computing resources include:
  + Tier II Data Center availability.
  + >100Million Intel Skylake-equivalent core hours per year for batch processing.
  + >25PB of LTO tape storage.
  + >8PB of online disk storage.
  + Science DMZ and data transfer nodes for grid and cloud computing.
    - Integration with Open Science Grid