**Trans-National Access to Brookhaven National Laboratory Infrastructures for the Electron-Ion Collider**

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**1. Research objectives**

The Electron-Ion Collider (EIC) is a powerful new facility to be built in the United States at the U.S. Department of Energy’s Brookhaven National Laboratory in partnership with Thomas Jefferson National Accelerator Facility. The EIC will study the substructure of protons, neutrons, and atomic nuclei with the most powerful electron microscope, combining versatility, resolving power and intensity, ever built. The resolution and intensity are achieved by colliding high-energy electrons with high-energy protons or (a range of different) ion beams. The EIC provides the capability of colliding beams of polarized electrons with polarized beams of light ions, and this all at high intensity. Its focus is to reveal how the most fundamental building blocks of visible matter interact to build up the structure and properties of everything we see in the universe today, from atomic nuclei to planets to people. Protons and neutrons, the building blocks of nuclear matter, constitute about 99.9 percent of the mass of all visible matter in the universe. These building blocks are themselves made up of quarks that are bound by gluons that also bind themselves. Thus, the interactions and structures are inextricably mixed, in sharp contrast with more familiar atoms and molecular systems. Indeed, the observed properties of nucleons and nuclei, such as their mass and spin, emerge from a complex, dynamical system governed by quantum chromodynamics (QCD), the theory of strong interaction with quarks and gluons as the fundamental degrees of freedom. Consequently, the quark masses, generated via the Higgs mechanism, only account for a tiny fraction of the mass of a proton.

Key science questions that the EIC will address are:

* How do the properties of protons and neutrons such as mass and spin emerge from quarks and gluons and their underlying interactions?
* How are the quarks and gluons inside the protons, neutrons and atomic nuclei distributed in both momentum and position space?
* How do color-charged quarks and gluons, and jets, interact with a nuclear medium? How do the confined color-neutral hadronic states emerge from these quarks and gluons? How do the quark-gluon interactions create nuclear binding?
* How does a dense nuclear environment affect the dynamics of quarks and gluons, their correlations, and their interactions? What happens to the gluon density in nuclei? Does it saturate at high energy, giving rise to gluonic matter or a gluonic phase with universal properties in all nuclei and even in nucleons?

The EIC accelerator complex is designed to provide high luminosity collisions (up to 1034 cm-2 s-1) of above 70% polarized electron and ion beams over a wide center-of-mass (CM) energy range of 30-140 GeV. This complex is comprised of an existing hadron complex including a modified hadron storage ring (HSR), a new electron storage ring (ESR) with injectors, and a new high-luminosity interaction region (IR) including a 25 mrad crossing angle and beam crabbing. A new energy-recovery linac (ERL) is also required for hadron beam cooling, both to produce required hadron beam emittances and to counteract slow emittance growth from intra-beam scattering. The general purpose detector, ePIC, at the EIC is a unique environment for enabling future detector technologies, which are also needed for other major worldwide facilities, in a synergistic approach towards progressing in the technological field. The detector is realized, by the ePIC Collaboration, at present ~1100 members from 180 Institutions in 25 countries distributed in 4 world regions. In particular, ~50 institutions are from European countries corresponding to almost ~400 collaboration members.

1. **Connection to Transnational Access infrastructures (TAs)**

Given the EIC’s pivotal role in the global landscape of hadron physics, it is of utmost importance that European scientists have facilitated access to BNL to actively participate in the testbeams, preparation, construction, and future operation of the EIC. Such trans-national access is critical for ensuring that Europe remains at the cutting edge of hadronic physics research and can fully capitalize on the scientific opportunities the EIC presents. Without direct access, European researchers would face significant barriers to contributing to, and ultimately benefiting from, this worldwide unique facility, potentially leading to a fragmentation of research efforts and a diminished impact for European science. Now is the critical time as the Electron-Proton/Ion Collider (ePIC) Collaboration, which is starting the detector construction phase. This endeavor benefits from very important and substantial contributions from Europe, including vital detector components, software development, and crucial physics analysis efforts. With the construction of the detector starting and expected to be in full swing during the years 2028 -2033 and commissioning slated to begin immediately thereafter, the physical presence and sustained access of European scientists at BNL will be absolutely critical. Before start of construction BNL as multipurpose lab provides possibilities for test beams at the NSLS-II and NSRL. The construction period will involve intensive work on detector integration, construction, installation, and software validation, all of which require hands-on involvement and close collaboration. Ensuring seamless access during this crucial phase is ensuring the success of the EIC program itself and securing Europe’s stake in its scientific output. Considering the unprecedented importance of the future EIC facility to the global hadron physics community and the substantial European investment already made, there is a clear and compelling need to dedicate funding specifically to facilitate access for all European scientists to BNL’s infrastructures. The importance of EIC for the hadron physics community was already highlighted in the NuPECC Long Range Plan 2024 for European Nuclear Physics that recommends European participation in the construction of the ePIC experiment at the future international flagship facility EIC.

This transnational access request is particularly aligned with two overarching European objectives: to provide simplified and more efficient access to cutting-edge research infrastructures irrespective of their geographical location, and to ensure that emerging, globally significant infrastructures are made available to a wider scientific community. By providing dedicated financial support for trans-national access, we will break down geographical and financial barriers that could otherwise prevent valuable European expertise from directly contributing to the EIC. It will enable a broader range of European researchers, including junior scientists and those from institutions with limited direct travel budgets, to participate in the detector construction, data analysis, and long-term scientific program. This broader participation will enhance the overall quality and impact of European hadron physics research, fostering a more inclusive and productive scientific landscape.

**3. Estimated budget request**

Transnational access will be based on BNL per-diem and housing cost funding for the access described above. In 2025 the per diem per day is $86 / day and housing is $138 per night for a 1-bedroom apartment and for students there a $69 per night dorm rooms available.

We estimate at the high of the construction phase to have at least 30 people for a minimum of a month at BNL. Therefore, we are estimating a cost of $1M for the 5 years of this proposal period (2026 to 2031).

**4. Participating and partner institutions**

Partner Institution: Thomas Jefferson National Accelerator Facility

Armenia

* I. Alikhantan National Science Laboratory

Czech Republic

* Charles University, Faculty of Mathematics and Physics
* Czech Technical University in Prague
* Nuclear Physics Institute, Czech Academy of Sciences

France

* CEA-Saclay
* IJCLab (Orsay)
* Laboratoire Leprince-Ringuet

Germany

* GSI Helmholtzzentrum fuer Schwerionenforschung GmbH
* Karlsruhe Institute of Technology
* University of Wuppertal

Hungary

* Eötvös Lorand University
* University of Debrecen

Italy

* INFN Gruppo Collegato di Cosenza and Dipartimento di Fisica, Università della Calabria
* INFN Gruppo Collegato di Salerno and Dipartimento di Fisica "E.R. Caianello", Università di Salerno
* INFN Laboratori Nazionali del Sud
* INFN Sezione di Bari, Dipartimento Interateneo di Fisica, Università di Bari and Università di Foggia
* INFN Sezione di Bologna and Dipartimento di Fisica e Astronomia, Università di Bologna
* INFN Sezione di Catania and Dipartimento di FIsica e Astronomia, Universita di Catania
* INFN Sezione di Ferrara and Dipartimento di Fisica e Scienza della Terra, Università di Ferrara
* INFN Sezione di Genova and Dipartimento di FIsica, Università di Genova
* INFN Sezione di Padova and Dipartimento di Fisica e Astronomia "Galileo Galilei", Università di Padova
* INFN Sezione di Pavia
* INFN Sezione di Roma
* INFN Sezione di Roma Tor Vergata and Dipartimento di FIsica, Universita di Roma Tor Vergata
* INFN Sezione di Torino, Università di Torino and Università del Piemonte Orientale
* INFN Sezione di Trieste and Dipartimento di Fisica, Universita di Trieste

Israel

* Ben Gurion University of the Negev
* Tel-Aviv University
* The Hebrew University of Jerusalem
* Weizmann Institute of Science

Norway

* The University of Bergen
* University of Oslo, Physics Department

Poland

* AGH University of Krakow
* Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN)
* Warsaw University of Technology, Faculty of Physics

Slovenia

* Faculty of Mathematics and Physics, University of Ljubljana

Spain

* University of Alcala

UK

* Brunel University London
* Daresbury Laboratory
* Lancaster University
* Rutherford Appleton Laboratory
* University of Brimingham
* University of Glasgow
* University of Liverpool
* University of Oxford
* University of York

Ukraine

* Taras Shevchenko National University of Kyiv