QCD Town Hall Meeting

Final survey Results

September 29, 2022

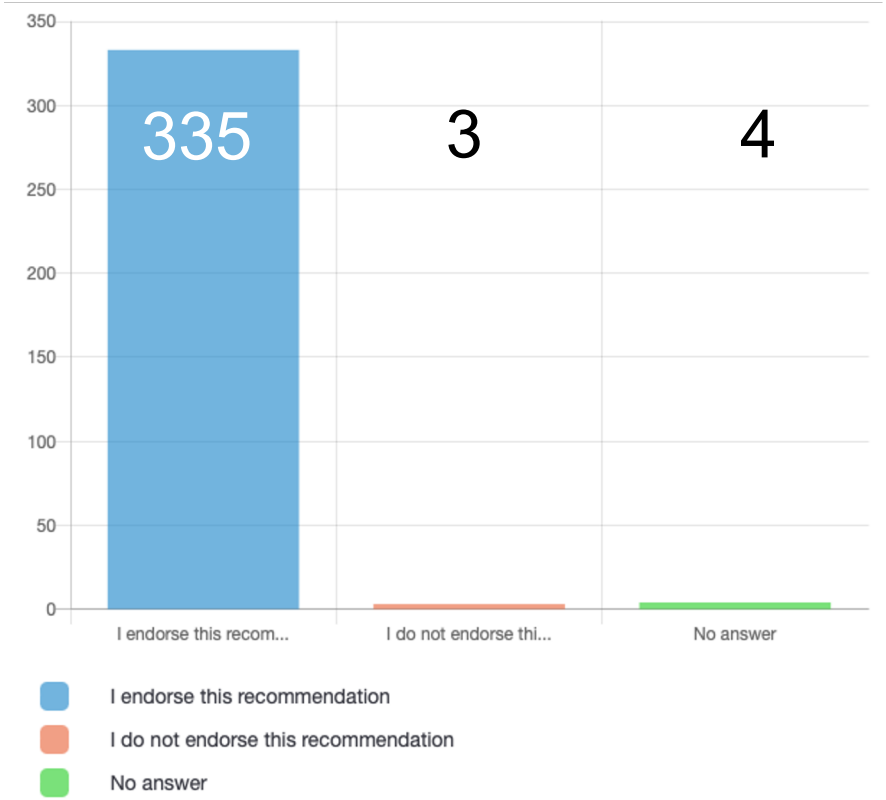
Recommendation 1: Capitalizing on past investments

The highest priority for QCD research is to maintain U.S. world leadership in nuclear science for the next decade by capitalizing on past investments. Maintaining this leadership requires recruitment and retention of a diverse and equitable workforce. We recommend support for a healthy base theory program, full operation of the CEBAF 12-GeV and RHIC facilities, and maintaining U.S. leadership within the LHC heavy-ion program, along with other running facilities, including the valuable university-based laboratories, and the scientists involved in all these efforts.

This includes the following, unordered, programs:

- The 12-GeV CEBAF hosts a forefront program of using electrons to unfold the quark and gluon structure of visible matter and probe the Standard Model. We recommend executing the CEBAF 12-GeV program at full capability and capitalizing on the full intensity potential of CEBAF by the construction and deployment of the Solenoidal Large Intensity Device (SoLID).
- The RHIC facility revolutionized our understanding of QCD, as well as the spin structure of the nucleon. To successfully conclude the RHIC science mission, it is essential to complete the sPHENIX science program as highlighted in the 2015 LRP, the concurrent STAR data taking with forward upgrade, and the full data analysis from all RHIC experiments.
- The LHC facility maintains leadership in the (heavy ion) energy frontier and hosts a program of using heavy-ion collisions to probe QCD at the highest temperature and/or energy scales. We recommend the support of continued U.S. leadership across the heavy ion LHC program.
- Theoretical nuclear physics is essential for establishing new scientific directions, and meeting the challenges and realizing the full scientific potential of current and future experiments. We recommend increased investment in the base program and expansion of topical programs in nuclear theory.

Recommendation 1: Capitalizing on past investments



Recommendation 2: EIC Project

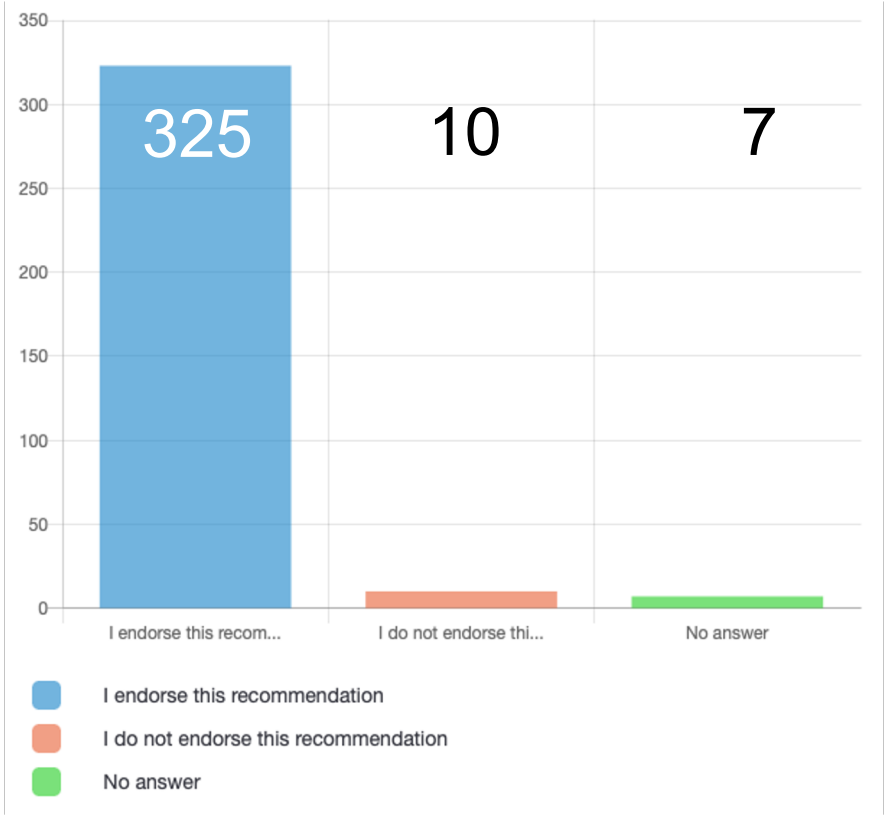
We recommend the expeditious completion of the EIC as the highest priority for facility construction.

The Electron-Ion Collider (EIC) is a powerful and versatile new accelerator facility, capable of colliding high-energy beams ranging from heavy ions to polarized light ions and protons with high-energy polarized electron beams. In the 2015 Long Range Plan the EIC was put forward as the highest priority for new facility construction and the expeditious completion remains a top priority for the nuclear physics community. The EIC, accompanied by the general-purpose large-acceptance detector, ePIC, will be a discovery machine that addresses fundamental questions such as the origin of mass and spin of the proton as well as probing dense gluon systems in nuclei. It will allow for the exploration of new landscapes in QCD, permitting the “tomography”, or high-resolution multidimensional mapping of the quark and gluon components inside of nucleons and nuclei. Realizing the EIC will keep the U.S. on the frontiers of nuclear physics and accelerator science and technology.

- Building on the recent EIC project CD-1 approval, the community-led Yellow-Report, and detector proposals, the QCD research community is committed to continue the development and timely realization of the EIC and its first detector, ePIC. We recommend supporting the growth of a diverse and active research workforce for the ePIC collaboration, in support of the expeditious realization of the first EIC detector.

- We recommend new investments to establish a national EIC theory alliance to enhance and broaden the theory community needed for advancing EIC science and the experimental program. This theory alliance will contribute to a diverse workforce through a competitive national EIC theory fellow program and tenure-track bridge positions, including appointments at minority serving institutions.

Recommendation 2: EIC Project



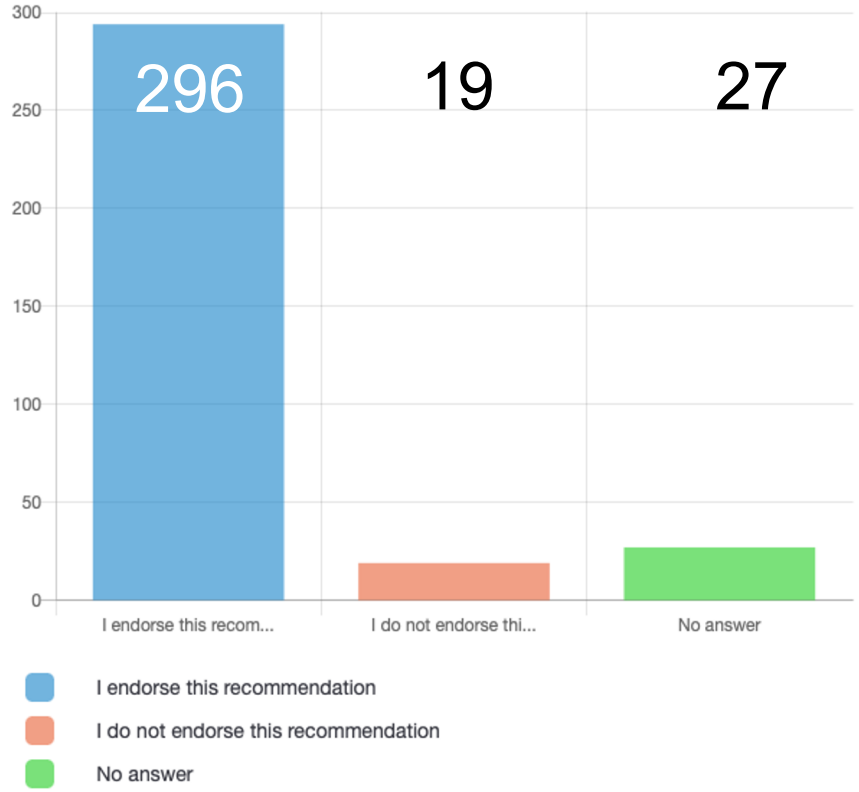
Recommendation 3: Workforce and Conduct

Increasing the U.S. QCD research workforce and participation of international collaborators is vital for the successful realization of the field's science mission. In addition, the nuclear physics research program serves an important role in developing a diverse STEM workforce for the critical needs of the nation. Creating and maintaining an equitable, productive working environment for all members of the community is a necessary part of this development.

We recommend enhanced investment in the growth and development of a diverse, equitable workforce.

- Part of recruiting and maintaining a diverse workforce requires treating all community members with respect and dignity. Supporting the recent initiatives by the APS and DNP to develop community-wide standards of conduct, we recommend that host labs and user facilities require the establishment and/or adoption of enforceable conduct standards by all of the experimental and theoretical collaborations they support. The enforcement of such standards is the combined responsibility of all laboratories, theoretical and experimental collaborations, conference organizers, and individual investigators supported by the nuclear physics research program.
- We recommend development and expansion of programs that enable participation in research by students from under-represented communities at National Labs and/or Research Universities, including extended support for researchers from minority-serving and non-PhD granting institutions.
- We recommend development and expansion of programs to recruit and retain diverse junior faculty and staff at universities and national laboratories through bridge positions, fellowships, traineeships, and other incentives.

Recommendation 3: Workforce and Conduct

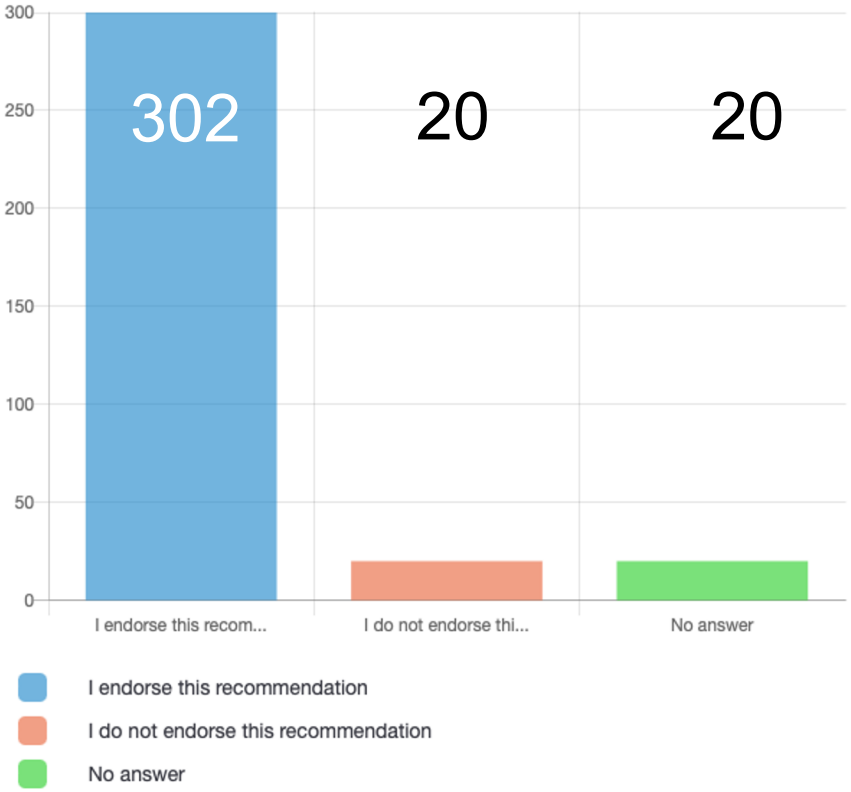


Recommendation 4: Computing

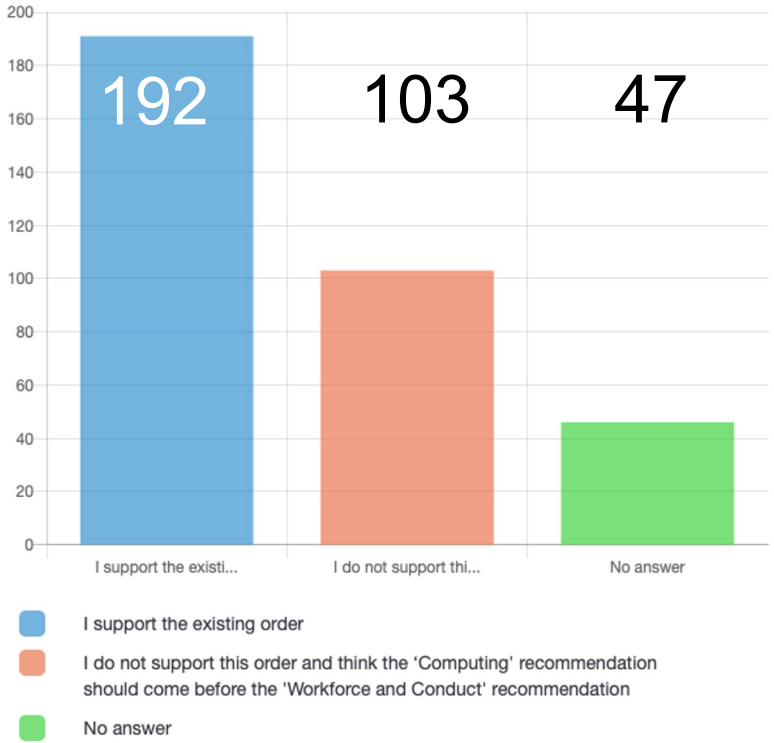
High-performance and high-throughput computing are essential to advance nuclear physics at the experimental and theory frontiers. Increased investments in computational nuclear physics will facilitate discoveries and capitalize on previous investments.

- We recommend increased investments for software and algorithm development, including in AI/ML, by strengthening and expanding programs and partnerships, such as the DOE SciDAC and NSF CSSI and AI institutes.
- We recommend increased support for dedicated high-performance and high-throughput mid-scale computational hardware and high-capacity data systems, as well as expanding access to leadership computing facilities.
- Advanced computing is an interdisciplinary field. We recommend establishing programs to support the development and retention of a diverse multi-disciplinary workforce in high-performance computing and AI/ML.

Recommendation 4: Computing



Do you agree with the current ordering of recommendations 3 and 4, or would you propose to switch between them?

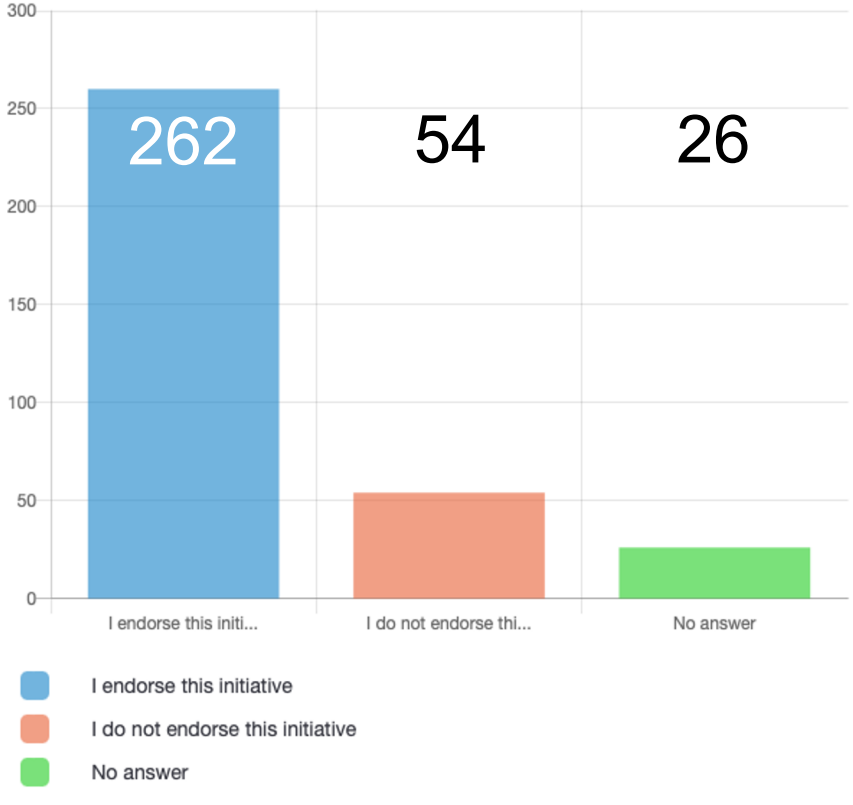


EIC Detector-2 Initiative

We recommend targeted efforts to enable the timely realization of a second, complementary detector at the Electron-Ion Collider

The EIC is a transformative accelerator that will enable studies of nuclear matter with unprecedented precision. The EIC encapsulates a broad physics program with experimental signatures ranging from exclusive production of single particles in ep scattering to very high multiplicity final states in eA collisions. Two detectors will expand the scientific opportunities, draw a more complete picture of the science, and mitigate the inherent risks that come with exploring uncharted territory by providing independent confirmation of discovery measurements. High statistical precision matched with a similar or better level of systematic precision is vital for the EIC and this can only be achieved with carefully optimized instrumentation. A natural and efficient way to reduce systematic errors is to equip the EIC with two complementary detectors using different technologies. The second detector effort will rely heavily on the use of generic detector R&D funds and accelerator design effort to integrate the detector into the interaction region. The design and construction of such a complementary detector and interaction region are interwoven and must be synchronized with the current EIC project and developed in the context of a broad and engaged international EIC community.

EIC Detector-2 Initiative



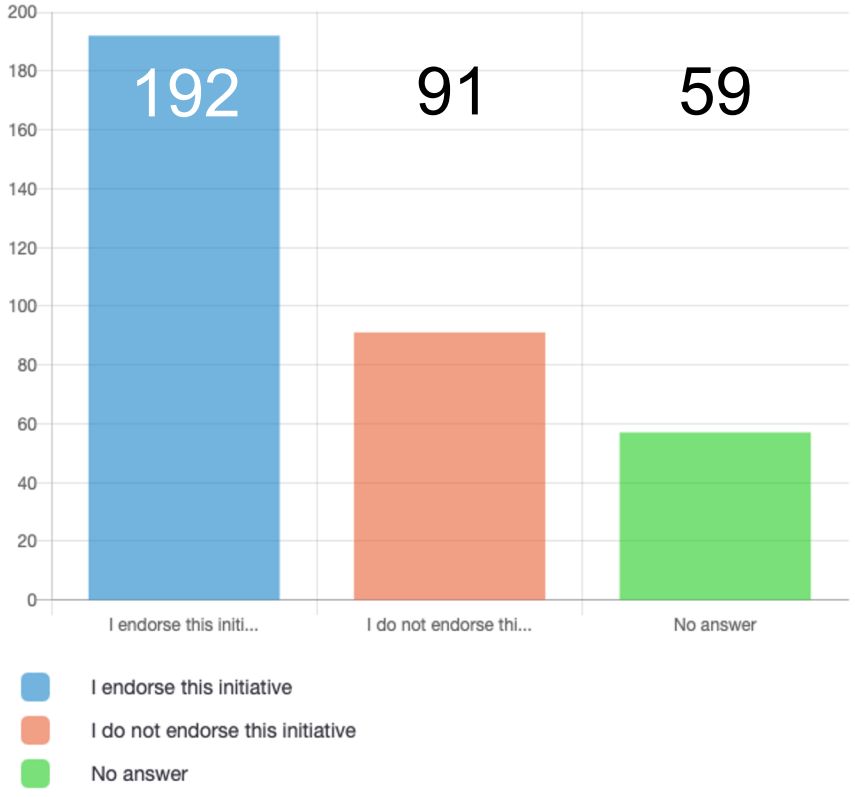
CEBAF Positron Program Initiative

We recommend the allocation of necessary resources to develop high duty-cycle polarized positron beams at CEBAF.

Using the existing 12 GeV CEBAF and capitalizing on innovative concepts for a positron source developed at Jefferson Lab, a high duty-cycle polarized positron beam will enable a unique science program at the luminosity and precision frontier. It will comprise the mapping of two-photon exchange effects as well as essential measurements of the 3D structure of hadrons. It will also offer new opportunities to investigate electroweak physics and physics beyond the standard model.

The PEPPo experiment (2012) demonstrated a new technique for the production of polarized positrons (PRL 116, 2016) at the CEBAF injector. Since then, an extensive physics program has been developed. First presented in 2018 to the Jefferson Lab Program Advisory Committee (PAC), it was then expanded and summarized in 20 peer-reviewed publications (EPJ A58, 2022). Two experiments were already approved by the Jefferson Lab PAC in 2020. The PAC has encouraged a vigorous effort to explore the technical feasibility of such a unique facility. A positron injector concept has emerged with the help of FY21 LDRD funds and an upcoming FY23 LDRD project will study the efficiency of transporting a beam with emittance comparable to the one expected in a positron beam through CEBAF. Following these advances over the last decade, expeditious development of this outstanding worldwide capability now appears achievable.

CEBAF Positron Program Initiative



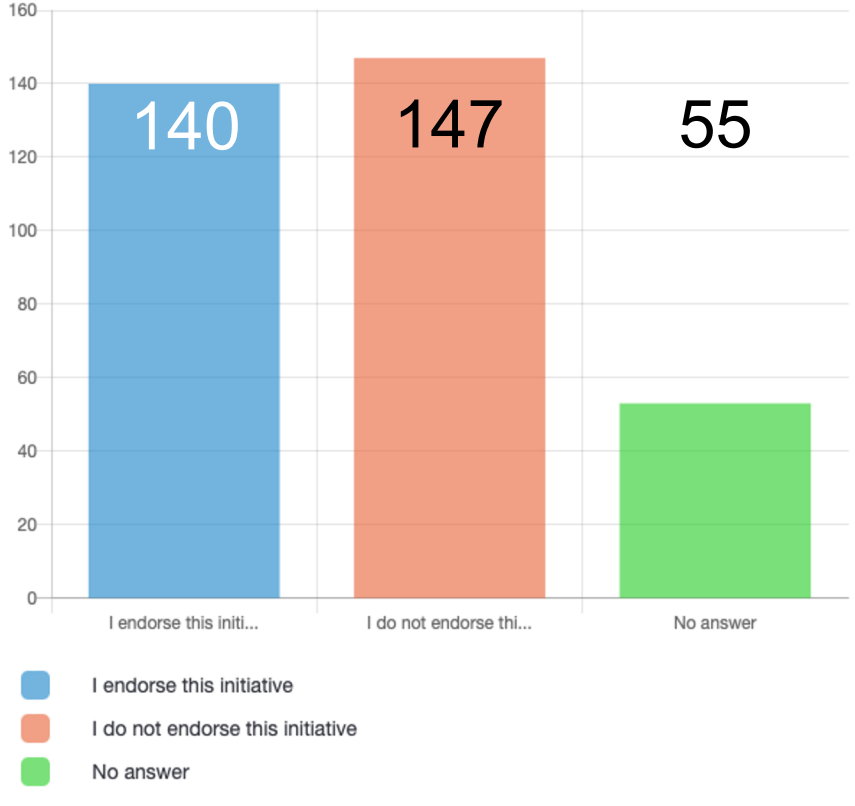
CEBAF Energy Upgrade Initiative

Capitalizing on recent science insights and US-led accelerator science and technology innovations, we recommend a targeted effort to develop a cost-effective technical approach for an energy upgrade of CEBAF. This would provide capabilities to enable a worldwide unique nuclear science program at the luminosity frontier.

The last decade has provided multiple science surprises such as the discovery of exotic states in the charmonium sector at facilities worldwide, the so-called “XYZ” states. Studies of the 3D structure of hadrons and hadronization provided deeper access to quark-gluon dynamics and opened new opportunities for understanding QCD in its full complexity. In addition, mysteries of the visible matter around us remain unsolved, such as a small enhancement of partons found in nuclei at the interface of the quark- and gluon-dominated regions, the so-called “anti-shadowing” region, that to date lacks explanation and can only be further studied at the luminosity frontier.

Capitalizing on recent innovations enabled by accelerator science and technology, a cost-effective energy upgrade of the 12-GeV CEBAF at Jefferson Lab to a 22 GeV facility may become feasible. Such an upgrade would permit a worldwide unique nuclear science program with fixed targets at the luminosity frontier, roughly five decades above that possible with a collider. Beyond its nuclear science opportunities, this will further steward best-in-class accelerator technology within the US.

CEBAF Energy Upgrade Initiative

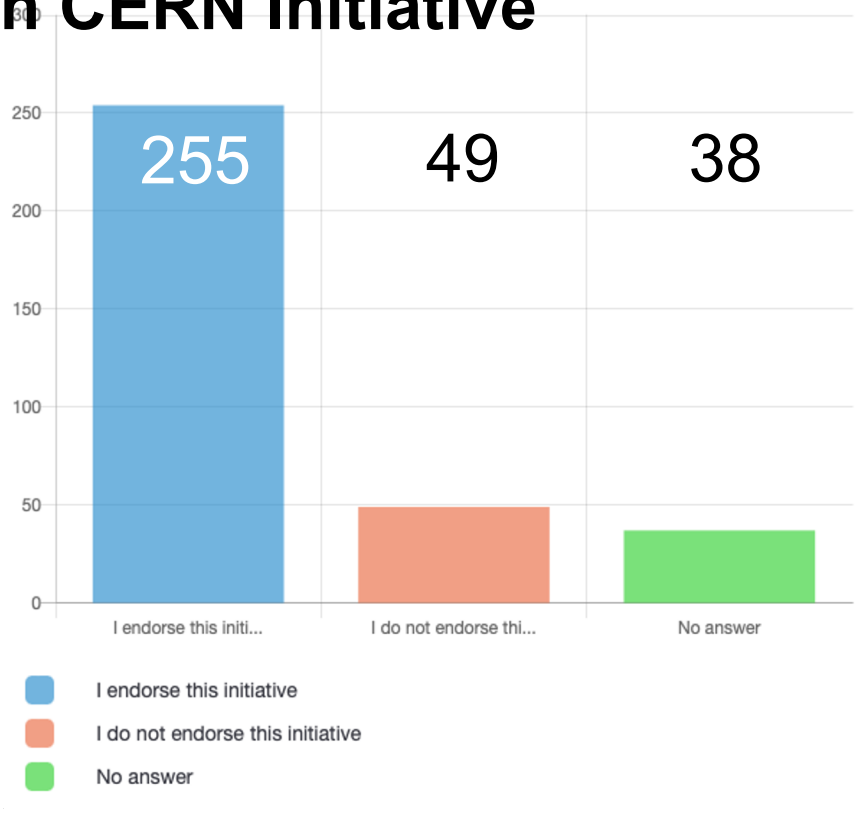


U.S. Participation in LHC Detector Upgrades and Partnership with CERN Initiative

The LHC will remain at the energy frontier of nuclear and particle physics in the coming two decades. Detector upgrades enabled by novel technologies will maximize the potential of the planned high luminosity upgrade and open new opportunities in QCD research.

To maintain U.S. leadership in the nuclear physics program at the LHC, we recommend exploring and supporting targeted detector R&Ds and upgrades to the LHC experiments, led by U.S. groups, that provide unique capabilities. These projects will open new physics opportunities, further stimulate the synergy between US-EIC and CERN-LHC in nuclear science, accelerator and detector technology, and also strengthen partnerships with the international community.

U.S. Participation in LHC Detector Upgrades and Partnership with CERN Initiative

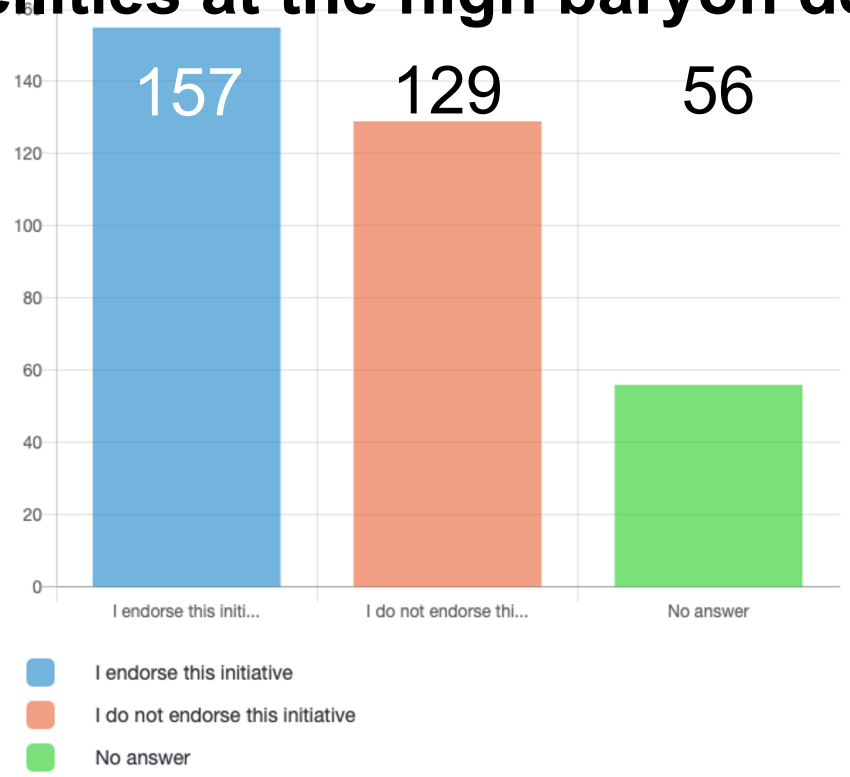


Exploring opportunities for US participation in international facilities at the high baryon density frontier

We wish to maintain US leadership in the exploration of the QCD phase diagram at high baryon density after the completion of the RHIC BES-II program and to build on the success of the BES program, including the search for the QCD critical point, the extraction of the hyperon-nucleon interaction, and the determination of constraints on the nuclear matter equation of state at high baryon density.

We recommend exploring opportunities for targeted US participation in international facilities that will probe the physics of dense baryon-rich matter and constrain the nuclear equation of state in a regime relevant to binary neutron star mergers and supernovae. The upcoming results from RHIC BES-II will help assess which international experiments present the highest potential for new discoveries at high baryon density.

Exploring opportunities for US participation in international facilities at the high baryon density frontier



Nuclear Data Initiative

Nuclear data play an essential if sometimes unrecognized role in all facets of nuclear physics. Access to accurate, reliable nuclear data is crucial to the success of important missions such as nonproliferation and defense, nuclear forensics, homeland security, space exploration, and clean energy generation, in addition to the basic scientific research underpinning the enterprise. These data are also key to innovations leading to new medicines, automated industrial controls, energy exploration, energy security, nuclear reactor design, and isotope production. It is thus crucial to maintain effective US stewardship of nuclear data.

- We recommend identifying and prioritizing opportunities to enhance and advance stewardship of nuclear data and maximize the impact of these opportunities.
- We recommend building and sustaining the nuclear data community by recruiting, training, and retaining a diverse, equitable and inclusive workforce.
- We recommend identifying crosscutting opportunities for nuclear data with other programs, both domestically and internationally, in particular with regard to facilities and instrumentation.

Nuclear Data Initiative