Thomas Jefferson National Accelerator Facility (TJNAF)
DRAFT Statement of Work (SOW)

C.1 INTRODUCTION

Thomas Jefferson National Accelerator Facility (TJNAF or Jefferson Lab or the Laboratory) is one of the U.S. Department of Energy's (DOE or the Department) Office of Science (SC) single program laboratories. The Laboratory is a Federally Funded Research and Development Center (FFRDC) established in accordance with the Federal Acquisition Regulation (FAR) Part 35 and operated under this management and operating (M&O) contract, as defined in FAR 17.6 and DOE Acquisition Regulation (DEAR) 917.6. TJNAF has approximately 850 employees and an annual budget of approximately $238M. TJNAF is located on a federally owned 169-acre site.

TJNAF is one of the nation's crown jewel DOE national laboratories and has a legacy as one of the world's leading nuclear physics research institutions. TJNAF's primary mission is to deliver breakthrough science and technology in nuclear physics; accelerator science and technology; and large-scale user facilities/advanced instrumentation. Today the laboratory's mission is expanding to include high performance computing, data science, and AI, forging unique synergies with nuclear science to benefit American competitiveness and innovation. TJNAF performs pioneering research with national and global partners, and is developing new technologies for science that support U.S. industrial competitiveness. DOE programs are carried out in partnership with academia, the private sector, other DOE national laboratories, the international scientific community, and other government agencies.

TJNAF operates the Continuous Electron Beam Accelerator Facility (CEBAF), an SC scientific user facility supporting approximately 1,650 users, which uses intense polarized electron beams to conduct research supporting the mission of the DOE SC Nuclear Physics (NP) program. TJNAF is the lead for the DOE SC Advanced Scientific Computing Research (ASCR) program's High Performance Data Facility (HPDF) project, which will create a new scientific user facility specializing in advanced infrastructure for data-intensive science in partnership with Lawrence Berkeley National Laboratory. Through the HPDF project TJNAF is evolving from a single program national laboratory to a multi-purpose national laboratory.

The Laboratory also performs work consistent with the DOE mission for entities other than DOE. The Contractor will advance the frontiers of science and technology through broad interdisciplinary R&D programs that answer fundamental questions, solve technical problems (locally, regionally, nationally, and internationally), and develop and apply technologies to address societal needs.

DOE employs a Performance Based Management Contract (PBMC) to enable the Contractor to achieve highly effective and efficient management of the Laboratory resulting in a safe and secure environment, outstanding science and technology

results, more cost-effective operations, and enhanced Contractor accountability.

The Contractor has the responsibility for total performance under the contract, including determining the specific methods for accomplishing the work effort, performing quality control, and assuming accountability for accomplishing the work under the contract. Accordingly, this PBMC provides flexibility, within the terms and conditions of the contract, to the Contractor in managing and operating the Laboratory.

Desired results of this contract include improved Contractor operational efficiencies, allocations of Contractor oversight resources to direct mission work, and streamlined and more effective line management focused on a systems-based approach with increased reliance on the results obtained from nationally recognized experts and other independent reviewers.

Under this PBMC, it is the Contractor's responsibility to develop and implement innovative approaches and adopt practices that foster continuous improvement in accomplishing the mission of the Laboratory. DOE expects the Contractor to employ effective and efficient management structures, systems, and operations that maintain high levels of quality, safety and security in accomplishing the work required under this contract, and that, to the extent practicable and appropriate, rely on national, commercial, and industrial standards that can be verified and/or certified by independent experts.

C.2 IMPLEMENTATION OF DOE'S MISSION FOR TJNAF

The Laboratory's mission focus is in nuclear physics and through the HPDF is expanding to also include computational and data science. TJNAF brings specific strengths and capabilities to the DOE laboratory system to produce excellent science and advanced technologies with the cooperation and involvement of the scientific and regional communities. The current Laboratory core capabilities include Nuclear Physics, Large Scale User Facilities and Advanced Instrumentation, Accelerator Science and Technology, Advanced Computer Science, Visualization and Data, Mechanical Engineering and Design, and Systems Engineering and Design. In support of its SC mission, TJNAF builds and operates major scientific facilities. These facilities serve not only the basic research of the DOE, but they reflect TJNAF and DOE stewardship of national research infrastructure that is made available on a competitive basis to a wide range of university, industry, and government researchers.

C.3 CORE EXPECTATIONS

(a) General

The relationship between DOE and its national laboratory management and operating contractors is designed to bring best practices for research and

development to bear on the Department's missions. Through application of these best practices, the Department seeks to assure both outstanding programmatic and operational performance of today's research programs and the long-term quality, relevance, and productivity of the laboratories against tomorrow's needs, while transforming TJNAF into a thriving multi-program laboratory. Accordingly, DOE has substantial expectations of the Contractor in the areas of: program development and mission accomplishment; laboratory stewardship; and laboratory operations and operational business management.

(b) Program Development and Mission Accomplishment

The Contractor is expected to provide effective planning, management, and execution of assigned research and development programs. The Contractor is expected to execute assigned programs so as to strive for the greatest possible impact on achieving DOE's mission objectives, to aggressively manage the Laboratory's science and technology capabilities and intellectual property to meet these objectives, and to bring forward innovative concepts and research proposals that are well-aligned with DOE missions. The Contractor shall propose work that is aligned with, and likely to advance, DOE's mission objectives, and that is well matched to Laboratory capabilities. The Contractor shall strive to meet the highest standards of scientific quality and productivity, "on-time, on budget, as promised" delivery of program deliverables, and first-rate service to the research community through user facility operation.

The Contractor is expected to demonstrate benefit to the nation from Science and Technology (S&T) R&D investments by transferring technology to the private sector and supporting excellence in scientific, technical, engineering, and mathematics workforce development to the extent such activities are consistent with achieving continuous progress towards DOE's core missions.

The Contractor shall deliver innovative, forefront science and technology aligned with DOE strategic goals in a safe, secure, environmentally sound, and efficient manner, and will conceive, design, construct, and operate world-class user facilities.

(1) Quality of S&T: Produce original, creative scientific output that advances science and technology while achieving sustained scientific progress and impact.

(2) Relevance to DOE Missions and National Needs: Conduct the highest quality scientific research that advances the missions of DOE and other national programs and contributes to U.S. leadership in international scientific and technical communities.

(3) Success in Constructing and Operating Research Facilities &

Equipment: Provide quality strategic planning for facilities/equipment needed to ensure the Laboratory can meet its S&T missions, while effectively and efficiently constructing new and maintaining current S&T facilities and equipment and providing effective, efficient, and reliable operation of user facilities.

(4) Effectiveness and Efficiency of Research Program Management: Provide effective stewardship of Laboratory S&T capabilities, including human expertise, and success in risk management and building relationships with government, universities, and industry.

(c) Laboratory Stewardship

The Contractor shall be an active partner with DOE in assuring that the Laboratory is renewed and enhanced to meet future mission needs. Within the constraints of available resources and other contract requirements, the Contractor, in partnership with DOE, shall:

(1) Maintain an understanding of DOE's evolving Laboratory vision and long-term strategic plan and address the evolution of Laboratory capabilities to meet anticipated DOE and national needs.

(2) Attract, develop, and retain an outstanding workforce, with the skills and capabilities to meet DOE's evolving mission needs.

(3) Renew and enhance research facilities and equipment so that the Laboratory remains state-of-the-art over time and is well-positioned to meet future DOE needs.

(4) Build and maintain a viable portfolio of research programs that generates the resources required to renew and enhance Laboratory research capabilities over time**.**

(5) Build and maintain a positive relationship with the broader national and international research community, to enhance the intellectual vitality and research relevance of the Laboratory, and to bring the best possible capabilities to bear on DOE mission needs through partnerships.

(6) Build a positive, supportive relationship founded on openness and trust with the regional community.

(d) Laboratory Operations and Operational Business Management

The Contractor shall provide leadership to assure mission accomplishment and shall manage and enhance operations to provide an effective and efficient work environment that enables the execution of TJNAF's mission in a manner responsive to customer and stakeholder

expectations. The Contractor shall effectively and efficiently manage and operate the Laboratory through best-in class management practices designed to foster world-class research and project management. The Contractor shall, at the same time, protect and properly maintain DOE property, facilities, and intellectual assets; as well as ensure the health, safety, and security of workers, the public and the environment. The Contractor shall operate the Laboratory in accordance with all applicable laws, regulations, and requirements. The Contractor shall manage the Laboratory cost-effectively, while providing the greatest possible research output per dollar of research investment, and, accordingly, develop, deploy and maintain integrated management systems and practices that are designed to enhance research quality, productivity and mission accomplishment consistent with meeting operational requirements.

C.4 STATEMENT OF WORK

(a) General

The Contractor shall, in accordance with the provisions of this contract, provide the intellectual leadership and management expertise necessary and appropriate to manage, operate, and staff Thomas Jefferson National Accelerator Facility (TJNAF) (also referred to as “Jefferson Lab”); to accomplish the missions assigned by DOE to the Contractor; and, to perform all other work described in this Statement of Work (SOW). DOE missions are assigned through strategic planning, program coordination, and cooperation between the Contractor and DOE.

Inasmuch as the assigned missions of the Laboratory are dynamic, this SOW is not intended to be all-inclusive or restrictive, but it is intended to provide a broad framework and general scope of the work to be performed at TJNAF during the term of this contract. This SOW does not represent a commitment to, or imply funding for, specific projects or programs. All direct work will be authorized by DOE in accordance with the provisions of this contract.

All work under this contract shall be conducted in a manner that protects the environment, assures the safety, health, and security of employees and the public, and protects the safety and security of federal real, personal, and intellectual property. In performing the contract work, the Contractor shall implement appropriate program, operational and project management systems to ensure safe operations; track progress and maximize cost-effectiveness of work activities; develop integrated plans and schedules to achieve program objectives incorporating input from DOE and stakeholders; maintain sufficient technical expertise to manage activities and projects throughout the life of a program; utilize appropriate technologies and management systems to improve cost efficiency and performance; and, maintain Laboratory facilities and

infrastructure as necessary to accomplish assigned missions.

The Laboratory's mission addresses four distinct goals:

- Perform the highest quality research in a manner that ensures employee and public safety and protection of the environment;
- Develop, maintain, and operate unique national scientific user facilities that are available to qualified domestic and international investigators;
- Train future generations of scientists and engineers to promote DOE's national science and workforce goals;
- Transfer knowledge and technological innovations and foster productive relationships among Laboratory research programs, universities, and industry to promote national economic competitiveness.

(b) Research and Development (R&D)

The central mission of the Laboratory is to provide scientific leadership needed to carry out world class science and technological innovation to support the programs and missions of SC and DOE (https://www.energy.gov/science/science-programs). The Laboratory is primarily involved in forefront nuclear physics research and is expanding to serve the DOE and the nation in computational and data science through the design and implementation of the High Performance Data Facility. DOE expects the Laboratory will have a growing impact on multiple scientific and technology disciplines in the coming years. A central aspect of this mission, often involving all of its core capabilities, is the conceptualization, design, construction, and operation of major scientific user facilities available to university, industry and government researchers.

(1) Mission Accomplishment

The science and technology delivered by the Laboratory is to have meaningful impacts on the relevant technical fields and provide quality leadership that advances the mission goals of the DOE, the sponsoring program, and the scientific community. The primary sponsor of work at the Laboratory is the DOE Office of Science.

Additionally, the Contractor is authorized to pursue other DOE and non-DOE programs, subject to required approvals, such as Strategic Partnership Projects (SPP), Cooperative Research and Development Agreements (CRADA) and Laboratory Directed Research and Development (LDRD), that serve to integrate core capabilities and deploy science and technology to industry in support of the broader DOE mission.

The Contractor is expected to maintain a forward-looking science and technology portfolio that is engaged with and cognizant of scientific priorities and emerging opportunities across SC, while also delivering world-leading research for its primary sponsors. This effort typically involves multi-institution collaborations, including universities, other national laboratories and research institutes, the international scientific community, and the private sector; thus, a strong cooperative approach with well-chosen leadership roles is highly desired. The current major programs and synergistic efforts are summarized below:

(i) SC Nuclear Physics (NP)

SC NP is the largest sponsor of work at TJNAF. The focus of this work targets frontier research in experimental and theoretical nuclear physics along with SC initiative programs where NP participates, e.g., artificial intelligence and machine learning, quantum information science, and microelectronics. TNJAF figures prominently in the goals of the nuclear physics community as documented in the 2023 Long Range Plan for Nuclear Science: A New Era of Discovery (https://science.osti.gov/-/media/np/nsac/pdf/202310/NSAC_LRP_2023.pdf). The Contractor shall provide intellectual and technical leadership in international nuclear physics experiments; perform research and development in accelerator science, experimental detector design and computing for the SC NP program, operate NP sponsored user facilities, centers, and initiatives and carry out construction projects supporting nuclear physics area as assigned.

(ii) SC Advanced Scientific Computing Research (ASCR)

TJNAF is the lead for the High Performance Data Facility project, in partnership with Lawrence Berkeley National Laboratory (LBNL). TJNAF and LBNL shall support design, construction, and operation of a world-class HPDF scientific user facility in furtherance of ASCR, SC, and DOE priorities. The mission of the HPDF will be to enable and accelerate scientific discovery by delivering state-of-the-art data management infrastructure, capabilities, and tools. TJNAF will build capabilities to support the DOE's Integrated Research Infrastructure (IRI) in partnership and close coordination with all ASCR User Facilities.

(iii) Electron-Ion Collider (EIC)

TJNAF is partnering with Brookhaven National Laboratory (BNL) to design and establish the EIC at BNL. The EIC will be a particle accelerator that collides electrons with protons and heavy nuclei to unlock the nature of the forces that bind quarks within the protons and neutrons that make up the atomic nucleus. TJNAF staff play integral roles in the EIC project team, including project leadership, and will be responsible for executing roughly one quarter of the EIC project scope. The Contractor is responsible for ensuring that the TJNAF scope commitments to the EIC are completed on time, on budget, and with the expected quality following established DOE and SC project management principles.

(iv) Science and Technology Core Capabilities

TJNAF has developed and demonstrated core capabilities in Accelerator Science and Technology and Computational Science and Technology. The Contractor shall support the continued advancement of superconducting radiofrequency (SRF) capabilities through advanced accelerator research and development that translates to continuous accelerator improvements and reliable production capability for the DOE complex. Through the development, instantiation, and operation of the High Performance Data Facility in partnership with LBNL, TJNAF shall also support expanded access to computational and data infrastructure resources and expertise to advance a broad range of research.

(v) Other Programs

The Contractor is responsible for the conduct of such other programs and activities as the Parties may mutually agree, including:

(A) The providing of the facilities of the Laboratory to the personnel of public and private institutions for the conduct of research, development, and demonstration work, either within the general plans, programs and budgets agreed upon from time to time between DOE and the Contractor, or as may be specifically approved by DOE. The Laboratory facilities shall be made available on such other general bases as DOE may authorize or approve;

(B) The conduct of research and development work for non-DOE sponsors which is consistent with and complementary to the DOE's mission and the Laboratory's mission under the contract, and does

not adversely impact or interfere with execution of DOE-assigned programs, does not place the facilities or Laboratory in direct competition with the private sector and for which the personnel or facilities of the Laboratory are particularly well adapted and available, as may be authorized, in writing, by the Contracting Officer;

(C) The dissemination and publication of unclassified scientific and technical data and operating experience developed in the course of the work;

(D) The furnishing of such technical and scientific assistance (including training and other services, material, and equipment), which are consistent with and complementary to the DOE's and Laboratory's mission under this contract, both within and outside the United States, to the DOE and its installations, Contractors, and interested organizations and individuals.

(2) Research Facilities and Major Scientific User Facilities

Central to the Laboratory's leadership and research and development mission is the design, construction and operation of world-class major scientific user facilities and their utilization to provide impactful science and technology results to DOE, the scientific community, and industry. The Laboratory currently hosts major scientific user facilities for DOE serving thousands of scientists per year. The Contractor is responsible for simultaneously maintaining complementary capabilities critical to leadership and excellence in design, construction, and operation of scientific user facilities in continuous and close collaboration with DOE. Design ranges from upgrades of current facilities to conceptualizing new facilities that meet the evolving needs of state-of-the-art science with new instrumentation technologies. Construction is typically a multi-year, complex process requiring extremely detailed planning and execution to meet requirements on time and within resource limits. Operation requires efficient and effective integration of a wide range of activities including core research programs, research, and development to maintain the capabilities of the facilities, partnerships involving multiple organizations and funding sources, and user support; underpinned and enabled by excellence in safety, security, and business and operational management systems, and productivity. Operation also includes effectively managing the allocation of facility time to optimize the research program of the facility.

The operation of user facilities includes developing and maintaining user communities for the facilities. In addition to the scientific stewardship of the facilities, maintaining user communities requires stewarding the visiting scientists and students that are guests of the Laboratory every year as well as management of the agreements to engage the user facilities. The Contractor shall maintain effective operations of existing and planned user facilities, onsite lodging (as available), other appropriate facilities, and provide effective customer service to ensure user facilities are well maintained, safe, secure, and user friendly.

(i) NP User Facility

The Continuous Electron Beam Accelerator Facility (CEBAF) is operated as a user facility and provides high quality beams of polarized electrons that allow scientists to extract information on the quark and gluon structure of protons and neutrons.

Accelerator: The Laboratory's main research facility is the CEBAF accelerator, which consists of a polarized electron source and injector and a pair of superconducting RF linear accelerators that are 1400 m (7/8-mile) in length and connected to each other by two arc sections that contain steering magnets. The electrons may be circulated through the straight sections of the machine up to 5.5 times. CEBAF is capable of delivering beams of electrons for experiments into as many as three of its experiment halls simultaneously, at up to 10.9 GeV into Halls A, B, and C, and up to 12 GeV, converted to 9 MeV photons, into Hall D.

Experimental Halls: Each experimental hall is equipped with specialized experimental equipment designed to exploit the CEBAF beam. Hall A houses two high-resolution magnetic spectrometers of some 100 feet in length and a plethora of auxiliary detector systems, including the large-acceptance Super BigBite Spectrometer. Hall B is home to the CLAS12, with multiple detector systems and some 100,000 readout channels. Hall C boasts two roughly 80-foot-long, high-momentum magnetic spectrometers that allow for precision scattering experiments, and has housed many unique large-installation experiments. Hall D is dedicated to the operation of a hermetic large-acceptance detector for photon-beam experiments, known as GlueX.

Cryogenic Infrastructure: Jefferson Lab maintains four operating cryogenic plants, three on-site and a fourth

outside the laboratory perimeter. The Central Helium Liquefier building (CHL) houses two large cryogenic plants CHL1 and CHL2 that are responsible for cooling the superconducting radio frequency (SRF) cryomodules that make up CEBAF. The recently upgraded End Station Refrigerator (ESR) supports cryogenic needs in all three experimental Halls A, B and C. The Hall D Refrigerator (HDR) supports cryogenic needs in experimental Hall D. The Cryogenic Test Facility (CTF) refrigerator supports the cryogenic needs at the Test Lab to support the Vertical Test Area (VTA), the CryoModule Test Facility (CMTF), and the Upgrade Injector Test Facility (UITF). The cryogenic plants run 24/7/365 with minimal maintenance intervals.

LERF: The Low Energy Recirculator Facility (LERF) was developed using the lab's expertise in superconducting radiofrequency (SRF) accelerators. As a free electron laser (FEL), the facility was the world's highest-power tunable infrared laser and also provided ultraviolet laser light, including vacuum ultraviolet light, and Terahertz light. Future missions with potentially broader scope are under development, including three-year R&D plan was recently costed for redeveloping the LERF injector as a high-power test bed to demonstrate milliampere polarized electron source production and to study high-power prototype positron production targets.

UITF: The Upgraded Injector Test Facility (UITF) provides a testbed to evaluate new technologies for beam acceleration, such as performance validation of major systems for the Accelerator Improvement Project (AIP)-funded CEBAF Injector Upgrade, advanced photocathode and polarimeter research and development (R&D), Nb3Sn-coated accelerating cavities operating at 4 K, and potential accelerator applications such as environmental remediation with electron beams.

SRF Institute: The superconducting radiofrequency (SRF) institute is responsible for the design, production, refurbishment, test and installation of SRF cavities and cryomodules, and all beam line vacuum for CEBAF, LERF and UITF. The institute also produces and tests SRF cavities, parts and cryomodules for research and development projects and for other national and international facilities. TJNAF's SRF Operations Department within the SRF Institute achieved ISO 9001-2015 certification in May 2023.

(ii) ASCR User Facility

HPDF: The High Performance Data Facility (HPDF) is currently a major project to create a new scientific user facility. The HPDF will serve as a foundational element in enabling DOE's mission goals in high performance computing, AI, and data science. HPDF will provide crucial resources to Office of Science programs to attack fundamental problems in science and engineering that require nimble shared access to large data sets, increasingly aggregated from multiple sources. HPDF will partner and operate in concert with other ASCR Facilities to advance the DOE Integrated Research Infrastructure. HPDF will have a "Hub-and-Spoke" model in which TJNAF, in partnership with LBNL, will host centralized Hub resources and also enable high priority DOE mission applications at "Spoke" sites by deploying and orchestrating distributed infrastructure at the Spokes or other locations.

The facility will be designed to dynamically configure computation, network resources, and storage to access data at rest or in motion, supporting the use of well-curated datasets as well as near real-time analysis on streamed data directly from experiments or instruments. HPDF will play a vital role in enabling the SC user facilities to meld advanced AI, high precision modeling, and data analysis techniques to accelerate scientific insight.

(iii) Accelerator Research and Development

The primary technology of nuclear physics is that of accelerators, and the advance of the field has been closely tied to breakthroughs in accelerator development. Those advances have also driven new discoveries and enabled completely new capabilities in other leading research areas supported by the Office of Science. The Contractor is expected to continue to perform a significant role in research, development, and fabrication support in these technologies, and broadly engages with other communities, for scientific applications across a broad spectrum of research.

Long-term research goals include developing technologies to enable breakthroughs in particle accelerator size, cost, beam intensity, and control. TJNAF has developed a strategic plan for leadership in superconducting radiofrequency (SRF). The laboratory has unique or leading

capabilities in SRF cavity and cryomodule fabrication, testing and performance enhancement. These capabilities are critical to ensure U.S. leadership in advanced accelerator technology R&D.

(iv) NP Scientific Areas and Experiments

SBS: The Super BigBite Spectrometer (SBS) is installed in Hall A and began operation in 2022. The SBS was designed for precise measurements of the proton electric form factor and the neutron electric and magnetic form factors at the highest momentum transfers possible with CEBAF. These electron-scattering measurements provide fundamental tests of QCD.

CLAS12: The CEBAF Large Acceptance Spectrometer for operation at 12 GeV beam energy (CLAS12) in Hall B is used to study electro-induced nuclear and hadronic reactions. This spectrometer provides efficient detection of charged and neutral particles over a large fraction of the full solid angle. CLAS12 is based on a dual-magnet system with a superconducting torus magnet that provides a largely azimuthal field distribution that covers the forward polar angle range up to 35°, and a solenoid magnet and detector covering the polar angles from 35° to 125° with full azimuthal coverage.

GlueX: The Gluonic Excitation (GlueX) experiment searches for and maps out the spectrum of exotic hybrid mesons using a 9-GeV linearly-polarized photon beam incident on a proton target. The detector is nearly hermetic for both charged particles and photons arising from reactions in the cryogenic target at the center of the detector, allowing for reconstruction of exclusive final states. A 2-T solenoidal magnet surrounds the drift chambers used for charged-particle tracking. Two electromagnetic calorimeters cover the central and forward regions, and a scintillation detector downstream provides particle identification capability through time-of-flight measurements.

MOLLER: The Measurement of a Lepton-Lepton Electroweak Reaction (MOLLER) experiment will measure the weak charge of the electron by measuring parity violating asymmetry in electron-electron scattering. The MOLLER major item of equipment is under construction and will be installed in Hall A.

LQCD Research: TJNAF is the home of the NP-supported

special computer cluster for lattice quantum chromodynamics (LQCD) approaches that use first-principle and non-perturbative calculations of strong interaction physics. The LQCD program calculates quantum correlation functions that allow for the extraction of physics observables that are directly related to TJNAF's 12 GeV experimental program.

AI/ML: TJNAF has been applying artificial intelligence and machine learning (AI/ML) techniques to address a variety of operational aspects CEBAF, with a particular emphasis on optimizing SRF cavity operation. Additionally, information-rich data provided with the installation of TJNAF-designed neutron detectors at critical points around CEBAF is being used to build surrogate models to manage field emission. Another project is addressing the task of beam tuning by leveraging graph learning to distill high-dimensional beamline configurations into low-dimensional embeddings and create an intuitive, easy-to-understand visualization for operators. TJNAF has embraced the use of AI/ML on the experimental datasets, spanning all aspects of data collection and analysis. The applications include noise reduction and hypothesis generation in the tracking detectors, exploration of using AI for particle identification and in partial wave analyses, and automated online high-voltage control for the Hall D central drift chambers.

Streaming Readout: TJNAF has begun the second phase of the Streaming Readout Grand Challenge in support of the 12 GeV CEBAF and future Electron-Ion Collider (EIC) programs. The Grand Challenge integrates heterogenous hardware and software components in a distributed pipeline. Initiatives related to this include the JLab Integrated Research Infrastructure Across Facilities project, in collaboration with Oak Ridge National Laboratory (ORNL) and the National Energy Research Scientific Computing Center (NERSC) at Lawrence Berkeley National Laboratory (LBNL).

(v) NP International Collaborations

In accordance with DOE policies, and in consultation with DOE, the Contractor shall maintain a broad program of international collaboration in areas of research of interest to the Laboratory and to DOE. TJNAF is the host laboratory for a number of experiments with large international participation, both ongoing and under construction. In addition to the international engagements around user

facility centered activities, TJNAF has other ongoing international collaborations, including the following listed below.

TJNAF is engaging with several international partners in support of Electron-Ion Collider (EIC) preliminary engineering and design and eventual construction. Design and procurement of the solenoid magnet for the EIC ePIC detector has involved representatives from Saclay in France and the National Institute for Nuclear Physics (INFN) in Italy. Superconducting radiofrequency (SRF) cavity and cryomodule production for the EIC interaction region and the rapid cycling synchrotron involve collaboration with researchers from TRIUMF in Canada and Irene Joliot-Curie Lab (IJCLab) in France.

TJNAF and IJCLab are also collaborating on the construction of an advanced demonstrator for energy-recovered SRF linear accelerator technology, the Powerful Energy Recovery Linac for Experiments (PERLE) project. TJNAF's SRF Institute has been actively supporting developments towards future collider projects, including the Future Circular Collider (FCC, envisioned at CERN) and the International Linear Collider (ILC). This international engagement is an outcome of investments made at the institute while participating in SC accelerator upgrade projects such as the Linear Coherent Light Source II (LCLS-II) upgrade project at SLAC.

Working with DOE Office of Science, the Contractor is closely involved in developing and implementing many aspects of the international agreements that enable these collaborative programs, including overseeing day-to-day execution of US-based projects and research activities with a wide array of international partners and collaborators. The Contractor ensures safe and reliable access to facilities required to perform these activities.

(3) Scientific Program Management

The Contractor shall manage the resources and capabilities of the Laboratory and provide leadership for the Laboratory as a scientific institution supporting the DOE mission. Leadership is essential in methods of integrated line management to ensure intra- and inter-laboratory team building and cooperation while supplying a safe working environment. The Contractor is charged with maintaining and enhancing the intellectual resource base in

order to avoid erosion of the scientific and engineering foundations at the Laboratory and to promote world leadership prominence in areas as mandated by SC. The Contractor is also responsible for the employment of the principal personnel engaged in the SOW efforts and for the readiness and training of all personnel and on-site facility users and collaborators.

Execution of the Laboratory's mission is built on its core capabilities that are each, in turn, an integration of Laboratory personnel, facilities and equipment. The current Laboratory core capabilities include Nuclear Physics, Large Scale User Facilities and Advanced Instrumentation, Accelerator Science and Technology, Advanced Computer Science, Visualization and Data, Mechanical Engineering and Design, and Systems Engineering and Design. These capabilities exist within the Laboratory and provide a foundation to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in support of the SC and DOE missions. The stewardship of these capabilities, involving continuous improvement and development of new capabilities where required, is thus a critical aspect of the Contractor's responsibility for scientific program management at the Laboratory. The Contractor shall direct these core capabilities into creative research projects for DOE in partnership(s) with universities, other federal laboratories and agencies, the international scientific community, and the private sector to meet the mission of the Laboratory and DOE objectives.

The Contractor shall develop and manage partnership activities in support of the DOE mission which is essential to the long-term viability of the Laboratory. Mechanisms for partnerships include strategic partnership projects, cooperative research and development agreements, direct assistance programs, employee temporary assignments, user facility agreements, memoranda of cooperation, memoranda of understanding, memoranda of agreement, license agreements, privately funded technology transfer, and other arrangements as approved by DOE in which research and development resources are leveraged with private sector partners.

The Contractor shall ensure the Laboratory contributes to U.S. technological competitiveness by conducting basic and applied research, and through development and demonstration activities facilitating transfer and deployment of technologies into useful products and processes through partnerships with the private sector. The Contractor shall make it possible for the private sector to join in development/operation activities with the Laboratory to

enhance teamwork and technology transfer. Cooperation with industrial partners may include long-term strategic partnerships aimed at commercialization of Laboratory inventions or the improvement of industrial products. The Contractor may also capitalize on its location by developing productive relationships with regional and local companies and through forums such as conferences, workshops, and traveling presentations. It is anticipated that these organizations will be particularly effective participants in the Laboratory's technology transfer activities in promoting a mutually beneficial relationship between DOE and the communities surrounding the Laboratory.

(c) Protection of Workers, the Public, and the Environment

The safety and health of workers and the public and the protection and restoration of the environment are fundamental responsibilities of the Contractor. The Contractor shall establish an environment, safety and health (ES&H) program operated as an integral, but visible, part of how the organization conducts business, including prioritizing work and allocating resources based on risk reduction. A key element is implementation and sustainment of an Integrated Safety Management System to ensure all work activities, including those performed by subcontractors and others under this contract, are performed in a manner that prevents disruption of the Laboratory's missions by preventing fatalities, minimizing injuries and illnesses, minimizing exposures to hazardous substances and materials, preventing environmental releases in excess of established limits, implements as-low-as-reasonably-achievable releases and exposures, and preventing property loss.

The Contractor shall maintain an organization that supports effective ES&H management by ensuring appropriate levels of ES&H staffing and competence at every level within TJNAF.

The Contractor shall perform all activities in compliance with applicable health, safety, and environmental laws, orders, regulations, national consensus standards, governing agreements and permits executed with regulatory and oversight government organizations.

Incorporating integrated line management, the Contractor shall put in place a system that clearly communicates the roles, responsibilities, and authorities of line managers. The Contractor shall hold line managers, including direct reports, accountable for implementing necessary controls for safe performance of work in their respective area of responsibility. The Contractor shall establish effective management systems to identify deficiencies, resolve them in a timely manner, ensure that corrective actions are implemented, (addressing the extent of conditions, root causes, and measures to prevent recurrence) and

prioritize and track commitments and actions.

(d) Management and Operation of the Laboratory

The Contractor shall manage, operate, protect, maintain, and enhance the Laboratory's ability to function as a DOE national laboratory, provide the infrastructure and support activities, support the accomplishment of the Laboratory's missions, and assure the accountability to the DOE under the results-oriented, performance-based provisions of this contract. The Contractor shall establish and maintain an integrated management system capable of producing implementation-level plans, programs and procedures for the management and operation of the Laboratory. The Contractor shall implement a rigorous, broad scope contractor assurance program to assess the overall performance in and drive continuous improvement of Laboratory operations and management.

The Contractor shall manage facilities and resources to optimize the effectiveness of operations in support of the DOE mission. The Contractor shall maintain critical skill mixes and resources at the Laboratory. The Contractor shall examine Laboratory operations to consolidate work efforts, eliminate duplication of scientific effort, identify underutilized facilities and reduce operational costs. Site planning activities shall be conducted by the Contractor proactively addressing concerns of DOE, regulatory agencies, and stakeholder groups.

(1) Strategic Planning

The Contractor shall conduct a strategic planning process and develop institutional business plans and strategic facility plans in consideration of DOE provided planning guidance and strategic planning material to assure consistency with DOE missions and goals.

(2) Science Mission Management

Consistent with C.3(b) above, the Contractor shall:

(i) Provide the scientific, technical and administrative leadership, management and expertise needed to sustain and enhance TJNAF as an international unclassified user research facility that meets the high expectations and standards of DOE's science program and its related user community;

(ii) Conduct operations that demonstrate efficient and effective integration of a wide range of activities including core research programs, research and development to maintain the capabilities of the facilities, partnerships involving multiple

organizations and funding sources, and user support; underpinned and enabled by excellence in safety, security, and business and operational management systems, and productivity. Operation also includes effectively managing the allocation of scientific user facility resources to optimize DOE mission impact.

(iii) Operate with high reliability and maintain CEBAF and other on site accelerators along with associated beam distribution systems, experimental areas and equipment for the purpose of conducting the approved scientific research program;

(iv) Attract, develop, and retain an outstanding workforce, with the expertise and capabilities needed to meet DOE's evolving mission needs;

(v) Renew and enhance research facilities and equipment so that TJNAF maintains state-of-the-art capabilities over time and is well- positioned to meet future DOE needs;

(vi) Build and maintain, in collaboration with TJNAF's user community, a research program that seeks opportunities with the highest possible scientific merit;

(vii) Provide a support program to the user community that will optimize the overall scientific productivity of TJNAF's research program;

(viii) Design, construct, operate and maintain the related facilities necessary to support the accelerator operations and physics research program;

(ix) Provide the necessary facilities and infrastructure to conduct national and international user research at TJNAF in a safe, cost- effective and timely manner;

(x) Partner with BNL on design and establishment of the EIC at BNL, and deliver the planned TJNAF scope in accordance with established project management principles;

(xi) Partner with LBNL on design and establishment of the HPDF, and deliver planned TJNAF scope in accordance with established project management principles;

(xii) Conduct high-impact experimental and theoretical physics research, including hosting meetings and seminars involving science and technologies related to TJNAF's mission, and publish the results of such research in appropriate scientific

journals;

(xiii) Maintain core capabilities in accelerator science and technology and computational science and technology in support of mission-aligned activities at TJNAF and across the DOE complex;

(xiv) Maintain a vibrant relationship with the broader research community that enhances the intellectual vitality and research relevance of TJNAF and brings the best possible capabilities for DOE mission needs through partnerships; and

(xv) Build a positive, supportive relationship founded on openness and trust with the local community and region.

(3) Business Management

(i) Human Resources Management (HR)
The Contractor shall have an HR system designed to attract and retain outstanding employees in accordance with DOE expectations, policies, and procedures. The Contractor shall maintain a market-based system of compensation and benefit plans to motivate employees to achieve high productivity in scientific research and laboratory operation.

(ii) Financial Management

The Contractor shall maintain a financial management system responsive to the obligations of sound financial stewardship and public accountability. The overall system shall include an integrated accounting system suitable to collect, record, and report all financial activities; a budgeting system that includes the formulation and executions of all resource requirements needed to accomplish projected missions and formulate short- and long-range budgets; an internal control system for all financial and other business management processes; and a disbursements system for both employee payroll and supplier payments. The internal audit group for the Laboratory shall report to the most senior governing body of the Contractor's parent organization(s).

(iii) Purchasing Management

The Contractor shall have and manage a DOE-approved purchasing system to provide purchasing support and subcontract administration. The Contractor shall, when directed by DOE, enter into subcontracts for the

performance of any part of the work under this contract. The Contractor may also enter into subcontracts for the performance of any part of the work under this contract when authorized by DOE.

(iv) Property Management

The Contractor shall have and manage a DOE-approved property management system that provides assurance that the Government-owned, contractor-held property is accounted for, safeguarded, and disposed of in accordance with DOE's expectations and policies. The Contractor shall perform overall integrated effective and compliant planning, acquisition, maintenance, operation, management, and disposition of Government-owned personal and real property, and any Contractor-leased facilities and infrastructure used by the Laboratory in accordance with DOE expectations.

(v) Legal Services

The Contractor shall maintain legal support for all contract activities including, but not limited to, those related to patents, licenses, and other intellectual property rights; subcontracts; technology transfer; environmental compliance and protection; employee and labor relations; contractor ethics; and litigation and claims.

(vi) Information Technology Management

The Contractor shall maintain information systems necessary to meet Laboratory requirements, which includes activities involving general purpose programming, data collection, data processing, records management, report generation, software, electronic and telephone communications, and cyber security. The Contractor shall provide computer resource capacity and capability sufficient to support Laboratory- wide information management requirements.

(vii) Other Services

The Contractor shall provide other services necessary for Laboratory operations, including support to the DOE Thomas Jefferson Site Office.

The Contractor shall furnish technical and scientific assistance (including training and other services, material,

and equipment), which are consistent with, and complementary to, DOE's mission under this contract, both within and outside the United States. The Contractor may provide these services to DOE and its installations, contractors, and interested organizations and individuals, as may be authorized, in writing, by the Contracting Officer.

Subject to necessary approvals, the Contractor may conduct research and development work for non-DOE sponsors which is consistent with, and complementary to, DOE's mission under the contract. This work must not adversely impact or interfere with the execution of DOE-assigned programs or place the facilities or the Laboratory in direct competition with the domestic private sector.

In addition to the services specifically described in other provisions of this SOW, the Contractor shall perform services as DOE and the Contractor shall agree in writing that will be performed from time to time under this contract at TJNAF or elsewhere, as follows:

1. Services incidental or related to the services described in other provisions of this SOW.

2. Services in support of DOE programs when the work involved has been determined by DOE to be within the unique capabilities of the Contractor or when the work involved has been determined by DOE to be within the special scientific and technical capabilities of the Contractor and the urgent need for the services precludes acquiring them from another source.

(4) Project Management

The Contractor shall maintain a project management system, consistent with DOE and SC project management requirements, to ensure that projects are completed within scope, budget, and schedule and ready to meet mission need.

(5) Environmental Management

Unless otherwise directed by the Contracting Officer, the Contractor shall plan and execute the DOE's environmental program activities in accordance with DOE program goals, initiatives, strategies, guidance letters, and approved project baselines in areas such as:

(i) Environmental remediation and facility deactivation, decommissioning, decontamination, and demolition in

accordance with the site's Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Interagency Agreement and with DOE Orders;

(ii) Construction and maintenance of facilities and infrastructure to provide adequate protection of the public, employees, the environment, and Government-owned materials, facilities, and equipment; and

The environmental management program shall be conducted in a safe and cost-effective manner leading to increasing DOE, regulatory and public confidence in cleanup efforts. Program elements will include:

(i) Implementing comprehensive project management systems to track progress, maintain regulatory compliance, and increase cost effectiveness of work activities;

(ii) Developing integrated plans and schedules for involving the participation of DOE, regulators, and other stakeholders in decision making and priority setting of environmental restoration activities; and

(iii) Maintaining technical depth to propose and implement cleanup activities commensurate with commercial practices in the areas of cost, implementation, schedule, and public acceptability.

The Contractor shall establish and maintain systems to effectively manage and implement an environmental restoration program in accordance with goals and objectives set forth by the Department. The systems must ensure that the technical approach is consistent with DOE cleanup strategies to complete all Records of Decision in accordance with the current approved baseline; to implement an overall system to effectively and efficiently manage all groundwater and contaminated soil cleanup activities; to expedite final disposition of facilities awaiting decommissioning and decontamination; and to achieve delisting from the National Priority List. Contractor support shall be provided to DOE as directed by the Contracting Officer.

The Contractor shall be responsible for timely investigations, monitoring, clean-up, containment, restoration, removal, decommissioning and other remedial activity (including any costs for defense of litigation related thereto), for managing the clean-up of oil spills, contamination or releases of any solid wastes, hazardous wastes and constituents, hazardous or radioactive

substances, wastes or materials present in soil, groundwater, air, surface water, facilities and structures (whether subsurface or above ground), as a result of research or other work conducted by the Contractor during the term of the contract.

(6) Community Involvement

The Contractor shall maintain a systematic approach and commitment to engagement with the regional community. The Contractor's overall community involvement program shall:

- maintain a strong, integrated, proactive community involvement and communications program;
- appropriately address the community's substantive concerns;
- ensure the community's awareness of the importance of the long-term basic research supported by DOE and the SC;
- ensure the community has positive relationships with the Laboratory and confidence in its decision-making processes; and
- establish constructive external partnerships in support of DOE's overarching mission and strategic objectives.

(7) International Collaboration

In accordance with DOE policies, and in consultation with DOE, the Contractor will maintain a broad program of international collaboration in areas of research. This collaboration will be both in areas where DOE has formal international cooperation agreements which assign the Contractor a specific role, as well as in areas of general interest to the Laboratory's and DOE's research programs.

This collaboration may include, but is not limited to, such activities as:

(i) Participating in assigned aspects of formal international agreements;

(ii) Maintaining of liaison with peer groups in the international R&D community;

(iii) Participating in programs of international scientific organizations;

(iv) Developing and proposing to DOE, joint experimental

programs and/or work for others from international sponsors; or

(v) Participating in programs involving visits, assignments, or exchanges of staff/students.

(8) Safeguards and Security (S&S)

The Contractor shall provide a fully integrated safeguards and security program to ensure that laboratory sensitive information, property and other interests and activities are protected from theft, diversion, terrorist attack, industrial sabotage, radiological sabotage, chemical sabotage, biological sabotage, espionage, unauthorized access, compromise, and other acts that may have an adverse impact on national security; the environment; or pose significant danger to the health and safety of DOE Federal and contractor employees or the public. S&S programs must be based on the results of vulnerability and risk assessments which are used to design and provide graded protection in accordance with an asset's importance or the impact of its loss, destruction, or misuse. The Contractor shall provide a secure environment protecting property and other assets through the conduct of an integrated risk-based approach to security operations. The Contractor shall establish and maintain policies and procedures for operations in accordance with established DOE requirements. The Contractor shall establish a training program which ensures appropriate personnel are competently trained, and fully qualified to perform the tasks within their assigned responsibilities under both normal and emergency conditions.

(9) Cyber Security

The Contractor shall ensure the development, operation, management, and integration of an ongoing program for cyber security management consistent with DOE requirements. The Cyber Security Program must assess risks associated with computer and network security from both external and internal perspectives. The Contractor shall develop and maintain a structured Cyber Security risk management process to ensure that priorities are established and cyber security risks are managed through a process of identifying and assessing threats, vulnerabilities, asset value, and existing protection measures; developing and implementing appropriate policies and controls; promoting awareness of those policies and controls; and monitoring, evaluating, and improving the effectiveness of policies and controls.

(10) Emergency Management

The Contractor shall maintain an emergency management system in accordance with DOE requirements including, but not limited to, emergency preparedness plans, procedures, response, drills and exercises, occurrence notification and reporting, and operation of an Emergency Operations Center.

(11) Waste Management

The Contractor shall maintain and manage a waste management program in an integrated manner such that waste is managed consistently and in compliance with all applicable regulatory requirements and DOE expectations. Waste management activities include: timely characterization, consolidation, segregation, and storage of waste; treatment that complies with storage and/or disposal criteria; efficient shipment of waste for treatment, storage, and/or disposal; maintaining sufficient and compliant waste storage space at the Laboratory to accommodate waste generation and waste backlog; and implementation of an effective waste minimization and pollution prevention programs.

The Contractor shall execute pollution prevention efforts to advance cost-effective waste reduction, environmental release reduction, environmentally preferable purchasing, and environmental sustainability in facility construction and operation, in all site operations and facilities covered by this contract.

(12) Laboratory Facilities and Infrastructure

The Contractor shall manage and maintain government-owned buildings and facilities at the Laboratory, together with the utilities and associated infrastructure. Recognizing that these facilities are a national resource, they may also be made available, with appropriate agreements, to private and public sector entities including universities, industry, and local, state, and other government agencies. The Contractor shall perform overall integrated planning, acquisition, upgrades, and management of Government-owned, leased, or controlled facilities and real property accountable to the Laboratory. The Contractor shall strive to employ facilities management practices that are best-in-class and integrated with mission assignments and business operations. The maintenance management program shall strive to maintain Government property in a manner that promotes and continuously improves operational safety, worker protection, environmental protection and compliance, property preservation, and cost effectiveness; ensures continuity and reliability of operations, fulfillment of program requirements, and protection of

life and property from potential hazards; and ensures the condition of the assets will be maintained or improved using risk-benefit analysis tools and processes. Adequate investment will be applied to prevent degradation and assure appropriate operation.

The Contractor will implement a capital renewal program to revitalize and/or replace facilities and infrastructure that cannot meet the required functionality in support of mission accomplishment or is inefficient or cannot be adequately maintained.

(13) Access Authorization

The Contractor shall maintain access authorizations for personnel requiring access to classified information. Access to classified briefings and other materials up to the Secret Restricted Data level will be required to properly develop, implement, and manage Laboratory protection programs.

(e) Engagements in Workforce Development

The Contractor shall help ensure that DOE has a sustained pipeline for the science, technology, engineering, and mathematics (STEM) workforce.

To this end, the Contractor shall seek to facilitate the laboratory workforce of tomorrow by working with colleges and universities to initiate new programs that enhance scientific, technical, engineering, and mathematics knowledge at all levels. The Contractor shall encourage participation of faculty and students in Laboratory programs to bring their talents to bear on important research problems and contribute to the development of a future workforce of capable scientists and engineers. The Contractor shall also conduct programs for students and faculty to foster interest in STEM.

The Contractor shall maintain its programs of cooperation with academic communities and with nonprofit research institutions for the purpose of promoting scientific and technical fields of interest to DOE's programs and the laboratory workforce needs. This cooperation may include, but is not limited to, such activities as:

(1) Joint experimental programs with colleges, universities, and nonprofit research institutions;

(2) Interchange of college and university faculty and Laboratory staff;

(3) Student/teacher developmental research programs at the pre-collegiate and collegiate level;

(4) Post-doctoral programs;

(5) Arrangement of regional, national, or international professional, meetings or symposia;

(6) Use of special Laboratory facilities by colleges, universities, and nonprofit research institutes; or,

(7) Provision of unique experimental materials to colleges, universities, or nonprofit research institutions or to qualified members of their staff.

All work in this area must align to mission and workforce needs, funding availability, and appropriate controls to assure responsible execution.

C.5 PLANS AND REPORTS

The Contractor shall submit periodic plans and reports, in such form and substance as required by the Contracting Officer. These periodic plans and reports shall be submitted at the intervals, to the addresses, and in the quantities as specified by the Contracting Officer. Where specific forms are required for individual plans and reports, the Contracting Officer shall provide such forms to the Contractor. The Contractor shall require subcontractors to provide reports that correspond to data requirements the Contractor shall be responsible for submitting to DOE. Plans and reports submitted in compliance with this provision are in addition to any other reporting requirements found elsewhere in other clauses of this contract. It is the intent of DOE to consult with the Contractor to determine the necessity, form, and frequency of any reports required to be submitted by the Contractor to DOE under this contract.