DOE/EA-1684-SA-01

Supplement Analysis: Construction and Operation of New Scientific Instruments Linked to the Facility for Rare Isotope Beams

U.S. DEPARTMENT OF ENERGY | Office of Science

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Introduction

The Department of Energy (DOE) has prepared this Supplement Analysis (SA) to evaluate the environmental assessment (EA) (listed below) in light of changes that could have bearing on the potential environmental impacts previously analyzed.[1]

The Council on Environmental Quality (CEQ) NEPA regulations direct agencies to prepare a supplement to either a draft or final EIS if the "agency makes substantial changes in the proposed action that are relevant to environmental concerns" or there are "significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts." (40 CFR 1502.9(c)(1)(i)–(ii)) DOE's NEPA regulations state that when it "is unclear whether or not an EIS supplement is required, DOE shall prepare a Supplement Analysis." (10 CFR 1021.314(c)). DOE guidance and Office of Science NEPA procedures allow for a similar process for EAs. This SA provides sufficient information for DOE to determine whether (1) to supplement the existing EA, (2) to prepare a new EA or EIS, or (3) no further NEPA documentation is required. (10 CFR 1021.314(c)(2)(i)–(ii)).

Existing EA evaluated in this SA:

- DOE Funding of the Construction and Operation of the Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU), East Lansing, Michigan (DOE/EA-1684)[2]

Proposed Change or New Information[3]

Michigan State University (MSU), financially assisted by the DOE Office of Science (DOE-SC), would add new scientific instruments, space, and scientific capability to enhance the science discovery opportunities at the Facility for Rare Isotope Beams (FRIB).

The design, construction, and operation of the FRIB supports the mission of the Department of Energy (DOE) to advance our basic understanding of science and is consistent with the outcome of DOE's procurement process for the design, construction, and operation of a particle accelerator that produces rare isotope beams. DOE determined that the establishment of the FRIB is a high priority for the future of U.S. nuclear science research. The FRIB will establish a highly sophisticated research laboratory that produces intense beams of rare isotopes. These beams enable scientists to study the nuclear reactions that power stars and generate the elements found on Earth; explore the structure of atomic nuclei, which form the core of all matter, and the forces that bind them together; test current theories about

[1] While SAs are defined in DOE NEPA regulations in terms of EISs, DOE sometimes prepares an analysis analogous to an SA when the adequacy of an EA is unclear. This is recognized in DOE's Recommendations for the Supplement Analysis Process, January 2019.
[2] https://www.energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/EA-1684-FEA-2010.pdf (retrieved 7 August 2020)
[3] Throughout this document, the phrase "proposed change or new information" refers to a substantial change in a proposed action that may be relevant to environmental concerns or significant new circumstances or information that may be relevant to environmental concerns and have bearing on the proposed action or its impacts consistent with 40 CFR 1502.9(c).

the fundamental nature of matter; and play a role in developing new nuclear medicines and other societal applications of rare isotopes.

At this time, both the High Rigidity Spectrometer (HRS) instrument and the Isotope Harvesting capability have been formally proposed to be added. Other additional capabilities are also contemplated.

The HRS (Figure 1) is a new instrument that would substantially expand FRIB's potential for discoveries in regard to the properties of rare isotopes, nuclear astrophysics, fundamental interactions, and applications for society, including in homeland security, the energy sector, and industry. The HRS would increase experimental reach by up to a factor of 100, greatly enhancing the impact of research programs of some 1,400 scientists in the FRIB User Organization. The scientific case for HRS has been developed by a collaboration of scientists from 18 U.S. universities and 3 U.S. National Laboratories. The Nuclear Science Advisory Committee (NSAC) in its 2015 Long Range Plan[4] (LRP) stated that "[t]he HRS is necessary to conduct the scientific mission of FRIB." The HRS supports the DOE Strategic Plan Objective 3 – "Deliver the scientific discoveries and major scientific tools that transform our understanding of nature and strengthen the connection between advances in fundamental science and technology innovation." The DOE-SC Office of Nuclear Physics has supported pre-conceptual studies of the HRS and has made a determination of mission need (Critical Decision 0). FRIB has prepared a Conceptual Design Report (CDR) and the HRS project would be completed in seven years, depending on funding profile.

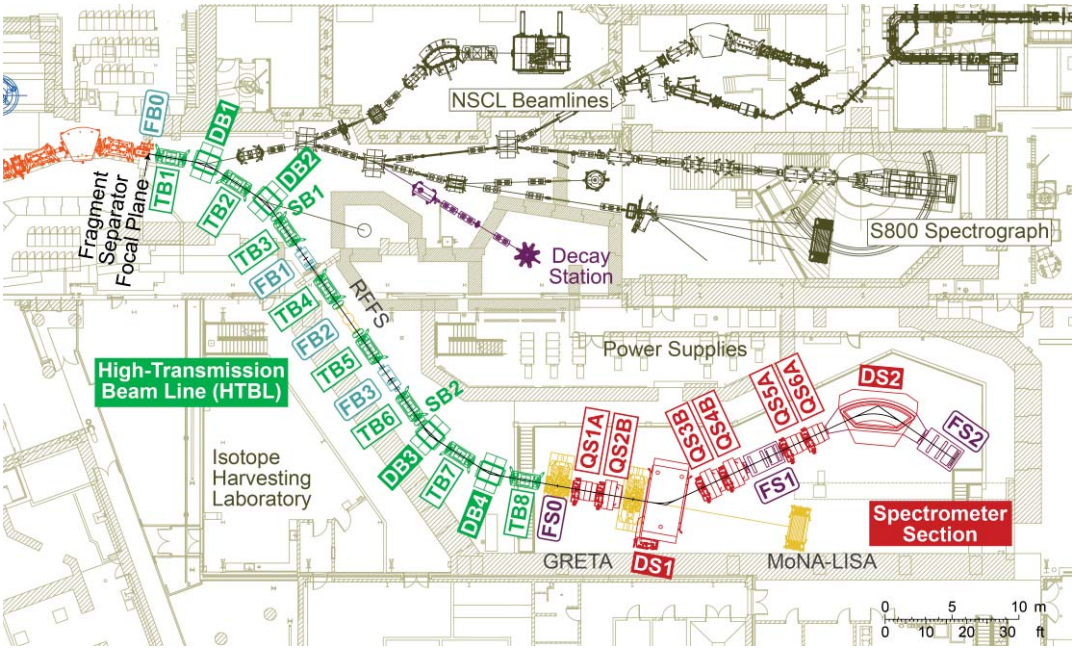

Figure 1: Layout of the High Rigidity Spectrometer (HRS) at FRIB, consisting of the High-Transmission Beam Line (HTBL) and the Spectrometer Section. The device would be located in a new high bay building that was constructed on the FRIB site with non-federal funds.

The addition of Isotope Harvesting capabilities at FRIB is important for providing novel radionuclides for science. The Nuclear Science Advisory Committee's Isotopes subcommittee (NSAC-I) noted

[4] Linked from https://science.osti.gov/np/nsac (retrieved 10 July 2020)

infrastructure investment for isotope harvesting at FRIB as one of the key initiatives to ensure supply of rare isotopes to meet the ever-growing national need. In recommending harvesting infrastructure investment, the NSAC-I report[5] succinctly summarizes the scientific opportunity: "During routine operation for its nuclear physics mission, FRIB will produce a broad variety of isotopes that could be harvested synergistically without interference to the primary user. Research quantities of many of these isotopes, which are of interest to various applications including medicine, stockpile stewardship and astrophysics, are currently in short supply or have no source other than FRIB operation." To realize the promise of radionuclide harvesting, a modest suite of radiochemistry equipment and minor engineering upgrades to FRIB would be required. The key project elements would be harvesting systems integrated into the existing FRIB production target area and a new laboratory for processing the harvested materials (Figure 2). With radionuclide harvesting, FRIB could also provide rare isotopes for applied science and basic science research. Otherwise-unused radioisotopes would be used to support research in multiple fields, specifically: medical research, biochemistry, materials science, plant and soil sciences, radiothermal generator development, astrophysics, and stewardship science. This opportunity is available at FRIB because of two important facts: first, isotopes can be made at FRIB by heavy ion fragmentation reactions, which by their nature yield more isotopes than are needed to support FRIB's physics mission; and second, the important isotopes can be contained in accessible matrices, like water and gas flows, or interchangeable pieces of solid equipment.

Figure 2: Isotope Harvesting laboratory layout. The Isotope Harvesting facility would be located in a new high bay building that was constructed on the FRIB site with non-federal funds.

[5] Linked from https://www.isotopes.gov/node/112 (retrieved 10 July 2020)

MSU has already constructed a small building on the FRIB site (Figure 3) with non-Federal funds independent of the Federal actions specifically named in this SA and with an eye toward future non-determinant actions which would advance science made possible by the FRIB. During the course of design and construction of the small building, it was determined that new Federal missions were possible, namely the High Rigidity Spectrometer and the Isotope Harvesting capabilities.

Other small-scale actions in addition to the High Rigidity Spectrometer and the Isotope Harvesting capability and the associated building and operations, but also linked to enhancing the capability of the FRIB and consistent with the mission of the DOE-SC, would be expected in the future. Although not expressly identified in the original EA, such construction, instrumentation, and operations possibilities were foreseen at that time. All such future actions functionally connected to the FRIB and consistent with its site plan are considered generically in this SA.

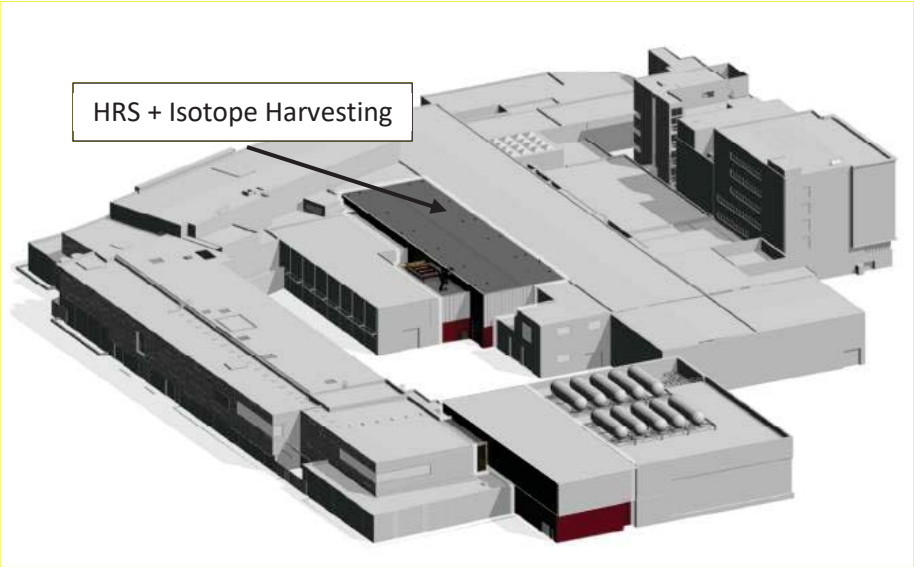

Figure 3: New high bay building constructed by MSU with non-federal funds that would house the HRS and Isotope Harvesting capabilities. The building was substantially completed in December 2019.

Background

The FRIB will provide research opportunities for an international community of approximately 1000 university and laboratory scientists, postdoctoral associates, and graduate students. The research conducted at FRIB will involve experimentation with intense beams of rare isotopes – short-lived nuclei not formally found on Earth – that will enable researchers to address forefront scientific questions in nuclear structure, nuclear astrophysics, fundamental symmetries, as well as enable research to the benefit of society. The FRIB is scheduled for completion in 2022.

To execute this experimentation, scientific instruments would be needed. Some already exist and are in use at the National Superconducting Cyclotron Laboratory (NSCL) at MSU. Others are under construction, or in planning and development stages, and would eventually be deployed at FRIB. At

present, there are two instruments, the High Rigidity Spectrometer and Isotope Harvesting capability that are ready for construction and installation.

Operation of the FRIB and the associated scientific instruments, as indicated in the EA, would result in very low levels of activation of air and groundwater, which MSU intends to manage according to existing Nuclear Regulatory Commission (NRC) license requirements. Doses to workers and members of the public are anticipated to be less than one-tenth of the NRC radiation protection standards, which is documented in the EA.

The addition of the new scientific instruments and capability to FRIB would not fundamentally change the initial EA, since the EA considered FRIB being operated for scientific discovery using advanced scientific instruments. Importantly, the addition of instruments and capability would not increase the amount of rare isotopes and other radioactivity produced at FRIB, but would make better use of the isotopes produced. The analysis below documents that there are no Resource Areas that would be affected by the new scientific instruments and capabilities beyond the initial EA.

Resource Areas Not Analyzed in this SA Document

The following resource areas would not be affected by the proposed change or new information and therefore, consistent with the sliding scale approach (see 40 CFR 1502.2(b)), are not analyzed or only minimally analyzed/discussed in this SA:

- Land Use and Visual Resources – No land use nor visual impacts from the operation of the FRIB were anticipated in the EA. The new scientific equipment would be installed and operated inside the walls of the existing FRIB real property, so the proposed change and new information does not affect the analysis in the EA.

- Geology and Soils – No impact on geology and soils from the operation of FRIB were anticipated in the EA. The new scientific equipment would be installed and operated inside the walls of the existing FRIB real property, so the proposed change and new information does not affect the analysis in the EA.

- Water Resources – Normal facility operations was anticipated to have no adverse impacts on ground water, and the addition of the new scientific instruments, again installed and operated inside the walls of the existing FRIB real property, would not change that expectation. In the EA, groundwater and soil activation was anticipated, and is to be managed according to our NRC type-A broad scope license. The new scientific instruments would involve the manipulation of short- and long-lived radioisotopes. However, as noted in the EA, these would be addressed following the appropriate regulatory authority.

- Air Quality – With the addition of the new scientific instruments, there is still the expectation that no continuous emissions of criteria air pollutants would occur during operations.

- Biological Resources – It is still the case that no threatened or endangered species or critical habitat exist at the FRIB site, so the addition of the new scientific instruments would have no impact in this resource area.

- Noise Impacts – During operations, it was foreseen that noise sources would be relatively minor and consistent with ongoing activities at the National Superconducting Cyclotron Laboratory (NSCL). The new scientific equipment would be installed and operated inside the walls of the FRIB real property, so the proposed change and new information does not affect the analysis in the EA.

- Utilities – Existing utilities would have adequate capacity to support FRIB operation with the inclusion of the new scientific instruments.

- Cultural and Historical Resources – No intact cultural or historical resources are known to exist on the FRIB site, and none were discovered during FRIB construction. The addition of the new scientific instruments would have no impact in this resource area.

- Health and Safety – The EA noted that the FRIB would be operated to ensure no adverse physical or radiological impacts to the public or to those working on or using the facility. An existing and mature environmental, safety, and health program, that is registered to the ISO 9001 (Quality Management Systems), ISO 14001 (Environmental Management Systems), and ISO 45001 (Occupational Health and Safety) standards would be used to manage adverse events at acceptably low levels. The new scientific instruments that would be added to FRIB would be subject to the same environmental, safety, and health program. Prior to installation, the instruments would undergo the same rigorous review process used for FRB construction, that would include a preliminary hazard assessment and safety assessment. Design features, hazard mitigation, and safety controls for the new scientific instruments would be consistent with current FRIB practices. Notably, the new capabilities and instruments make use of the rare isotopes that are being created in the FRIB linear accelerator which was analyzed in the EA and the hazard assessment for which is complete.
    - *Radiological impacts to workers*—Section 4.9.2 of the FRIB EA, Occupational Health and Safety, states:

      > During the period 2004 to 2008, an average of approximately 381 persons were monitored (i.e., assigned a personal radiation dosimeter) for occupational radiation exposure at the NSCL. The average annual recorded dose for these workers was about 13 millirem. The highest dose received by any worker in the reporting period from October 2008 through September 2009 was 388 millirem. These values are well below the U.S. Nuclear Regulatory Commission annual dose limit of 5,000 millirem and the NSCL "as low as reasonably achievable" administrative goal of 500 millirem.

      Section 5.1.9.2.1 of the FRIB EA, Worker Impact from Normal FRIB Operations, indicates that the 500 millirem administrative goal would not change during FRIB operations. Likewise, during the new operations identified in this SA, the 500 millirem administrative goal would not be expected to be exceeded.
    - *Radiological impacts to the public*--Section 5.1.9.2.2.3 of the FRIB EA, Impacts from Release of Radioactive Material to the Atmosphere, states:

> During the operation of the linac, radioactive material that could potentially be released to the atmosphere would be produced by two primary mechanisms: activation of air in the linac tunnel and target area by radiation produced by the beam interacting with matter, and activation of the water in the closed cooling loops for the target and beam stop. U.S. Environmental Protection Agency regulations (40 CFR 61) limit the annual dose to members of the public as a result of air emissions from a facility to 10 millirem. For the FRIB, MSU has committed to a design goal of 10 percent of the regulatory limit (1 millirem per year) as a result of airborne emissions to the nearest receptor. Based on a dose-to-LCF [latent cancer fatality] factor of 0.0006 LCF per person-rem, consistent with the recommendation of the DOE Office of Environmental and Policy Guidance (DOE 2003), this translates to an annual LCF probability of 6 x 10-7 or 6 chances in 10 million.

ALARA barriers intended to ensure the goal is met are described in the FRIB EA. New operations identified in this SA would not change the 1 millirem ALARA goal.

- Waste Management – Section 5.1.10 of the FRIB EA, Waste Management states:

> The types of waste generated during FRIB operations can be estimated from those generated by current NSCL operations (see Table 5–6). The quantities waste volumes would increase to allow for the increased operations of the FRIB. Similar to the NSCL, the types of waste would include low-level radioactive waste, mixed low-level radioactive waste, hazardous waste (nonradioactive waste), and nonhazardous wastes typically associated with the operation of any industrial or laboratory facility. It is expected that all of these waste types and volumes would be managed within the capacities of the existing MSU disposal processes and facilities.

Similarly, an increase in waste generation would be expected as a result of the proposed change or new information. It is likewise anticipated to remain well within the existing capability and capacity of the MSU waste management system. Radiological impacts to workers would be very low, consistent with the MSU ALARA program described above. All waste would be managed consistent with parameters established in FRIB's Nuclear Regulatory Commission license (21-00021-31). Transportation – There were no anticipated incremental transportation impacts associated with FRIB operations. The addition of new scientific instruments may attract new scientific users to FRIB, but the number of these new users who would be on-site at FRIB at any time (~100 persons) is small compared to the normal vehicular and pedestrian traffic in the area of the FRIB site.

- Socioeconomics and Environmental Justice – The new scientific instruments would require technical and scientific staff for operations, however, these staffing levels were already accounted for in determining the operations and support staff in the EA. The EA noted that no high and adverse human health or environmental impacts were anticipated for FRIB operation and, consequently, there would be no "disproportionately high and adverse" effects on minority or low-income populations. The addition of the new scientific instruments and associated operations do not change that previous assessment.

- Cumulative Impacts – The EA noted that operations impacts of FRIB would be small and that those impacts, collectively with other MSU operational impacts, are also expected to be small. The impacts of the installation and operation of new scientific instruments and capabilities at FRIB on the resource categories above are expected to be small, and the cumulative impact would be small as well, as the new instruments and capabilities facilitate scientific discoveries with the same beams that are being made in the FRIB accelerator that was analyzed in the EA.

Resource Areas Analyzed in this SA

The following resources areas could be affected by the proposed change or new information:
None.

Mitigation

Absent resource areas affected by the proposed change, there is no need for mitigation.

Determination

In accordance with the National Environmental Policy Act (NEPA) and CEQ's and DOE's implementing NEPA regulations, DOE prepared this SA to evaluate whether addition of new scientific instruments to the FRIB and associated construction and operations requires supplementing the existing DOE/EA-1684, EA DOE Funding of the Construction and Operation of the Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU), East Lansing, Michigan or preparing a new EA or EIS.

DOE concludes that the new actions would not constitute a substantial change to actions previously analyzed and would not constitute significant new circumstances or information relevant to the EA Therefore, no further NEPA documentation is required.

Approved:

TIMOTHY HALLMAN Digitally signed by TIMOTHY HALLMAN Date: 2020.09.17 09:13:49 -04'00'

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