

THE DOE LONG-TERM ACCELERATOR

R&D STEWARDSHIP PROGRAM*

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Abstract

Since the Accelerators for America's Future (AfAF) Symposium in 2009, the U. S. Dept. of Energy's Office of High Energy Physics (DOE-HEP) has worked to broaden its accelerator R&D activities beyond supporting only discovery science to include medicine, energy and environment, defense and security, and industry. Accelerators play a key role in many aspects of everyday life, and improving their capabilities will enhance U.S. economic competitiveness and the scientific research that drives it. Funded for the first time in 2014, the DOE Office of Science Accelerator Stewardship Program has launched initiatives to facilitate access to DOE accelerator infrastructure, develop innovative accelerator technologies that solve critical problems, and catalyze new partnerships across the accelerator user community. We will discuss the formulation and evolution of the Accelerator Stewardship program, the current status of initiatives, and plans for engagement with the accelerator and user communities for future stewardship activities.

INTRODUCTION

The mission of the DOE Long-Term Accelerator R&D Stewardship Program is to:

- Support fundamental accelerator science and technology R&D, and
- Disseminate accelerator knowledge and training.

This mission is implemented through:

- Facilitating access to national laboratory accelerator facilities and infrastructure[†] for industrial and U.S. government agency users and developers of accelerators and related technology,
- Developing innovative solutions to critical problems, to the benefit of both the broader user communities and the DOE discovery science community,
- Serving as a catalyst to broaden and strengthen the community that relies on accelerators and accelerator technology.

First funded in FY 2014 by redirection, the Stewardship program launched with two primary program elements: (1) a dedicated accelerator R&D user facility, and (2) a university-based R&D program. In response to (1), the Brookhaven Accelerator Test Facility ("ATF") was

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[†]Limited to non-mission-critical accelerator R&D infrastructure

identified as a dedicated, central Accelerator Stewardship user facility. The initial university R&D program was created by redirecting ten university grants already awarded in the HEP General Accelerator R&D program.

The Brookhaven ATF [1] has for more than two decades supported experimental accelerator science that has led to world-first demonstrations of new high-gradient acceleration methods, SASE, HGHG, and Compton Scattering radiation generation, new beam diagnostic techniques, and more. The ATF supported 24 experiments in 2014, with a significant proportion of the experiments being funded by federal agencies other than High Energy Physics, and 25% led by industrial partners (primarily small businesses). In 2014, the Accelerator Stewardship program designated the Brookhaven ATF as a dedicated Stewardship accelerator R&D facility, broadening its mission to include accelerator technology development in addition to accelerator science. In 2015 the ATF's broad role has been recognized by the Office of Science by designating it as an Office of Science User Facility. This designation is a formalization of the merit-based approach to facility management that has been ATF's tradition, and raises the visibility of the facility to potential users.

This versatile facility provides medium energy electron beams (80 MeV) of very high quality, and high power CO₂ laser beams (up to 1 TW) together with an expert staff that supports the users. To accommodate the steadily growing demand for the ATF, an upgrade is also being funded through the Stewardship program which will result in a significantly expanded facility (~3x the space) with increased beam energy (~2x) and increased laser energy (~100x). The upgrade, dubbed "ATF-II", is planned to open for new users in 2018.

The ten redirected university grants for launching the Stewardship program were selected after discussions with the Offices of Basic Energy Sciences and Nuclear Physics to identify those with particular strategic long-term interest. The awards included fundamental R&D in beam physics, accelerator simulation codes, advanced superconductors, and cryogenics, with an emphasis on fundamental R&D that would have broad impact across multiple programs.

As a new program in the Office of Science, it is vital that the Accelerator Stewardship program demonstrate success in the near-term. As Accelerator Stewardship, by its definition, serves the needs of stakeholders other than High Energy Physics, it is essential that those stakeholders express an active interest in the R&D, and choose to make use of the results of the R&D when it is

completed. Consequently, emphasis is on R&D challenges that have a clear stakeholder and a near-term (e.g. 5–7 year) technology transition time (defined as the point when the stakeholder adopts the R&D or technology and carries it forward).

CURRENT PROGRAM

Now in its second year, Accelerator Stewardship has issued a Funding Opportunity Announcement (“FOA”), awarded its first cohort of grants, launched a pilot program to facilitate access to National Laboratory accelerator capabilities, and is continuing to identify and develop new program areas through community outreach activities. This access excludes mission-critical accelerator facilities funded by Program Offices within Office of Science

The FY 2015 Funding Opportunity Announcement “Research Opportunities in Accelerator Stewardship” [2] included calls for both applied R&D (with specific topics identified by prior community workshops), and basic R&D (with topics identified by the principal investigator). Building on the extensive community input provided by the Accelerators for America’s Future Workshop in 2009 [3] and an Accelerator R&D Task Force in 2011 [4], two additional focused workshops in the areas of Ion Beam Therapy [5] and Laser Technology for Accelerators [6] were held to identify specific applications and R&D needs for accelerator technology. These workshops, and an executive order [7], provided essential input for the topics included in the FY 2015 Stewardship FOA.

The response to the FY 2015 FOA was very competitive, with 98 letters of intent submitted, and 50 full proposals subsequently submitted in response. Of the 50 full proposals 6 proposals were selected for awards [8]. Of the 6 awards, 3 were funded at roughly half the requested budget value, and all were funded below requested amounts. Consistent with the interagency nature of the Stewardship R&D activities proposed, the traditional merit review step was followed by an interagency review. Agencies that are the stakeholders for the intended R&D activity were asked to evaluate the top-scoring proposals and provide guidance based on agency priorities.

Eligibility for the FOA included all domestic organizations. Ultimately 38% of applicants were from public institutions of higher learning, 32% from national laboratories, 13% from private industry, and the balance from private institutions, 501(c)(3) non-profits, and minority-serving institutions. The awards for FY 2015 were announced on February 10, 2015 [9,10], and were:

FY 2015 Applied R&D Awards

- **Lawrence Berkeley National Laboratory**, the **Paul Scherrer Institute**, and **Varian Particle Therapy, Inc.** will develop light-weight superconducting magnet technology that will reduce the size and weight of particle beam delivery systems by nearly a factor of 10,

- **Lawrence Berkeley National Laboratory**, **Lawrence Livermore National Laboratory**, and the **University of Michigan** will test coherent beam combination in the time, space, and frequency domains to raise the per-pulse energy of fiber lasers by orders of magnitude,
- **SLAC National Accelerator Laboratory** and **Communications & Power Industries, LLC** will develop energy recapture technology that can potentially save \$1M per year in energy costs for LCLS-I by raising klystron energy efficiency to 75%.

FY 2015 Basic R&D Awards

- **Cornell University** will apply advanced optimization techniques to automate the control of complex accelerators,
- **The Massachusetts Institute of Technology** and **ProNova Solutions, LLC** will develop an innovative design for an ironless, variable-energy superconducting cyclotron weighing 6 times less than current proton therapy devices,
- **Texas A&M University** will explore the beam dynamics of strong focusing techniques in cyclotrons to increase the beam power that this workhorse accelerator can produce.

The FY 2015 FOA stressed the importance of collaboration and cost sharing, particularly for the applied R&D track proposals, not only to support the technology transfer goal of the Stewardship program, but more broadly to support to goal of strengthening and broadening the community that uses accelerator technology. Of the proposals submitted, 68% included collaborators, and 34 teams included a “new” collaborating institution that had not previously been funded by HEP. Among the awarded grants, more than \$1.3M of cost sharing is being provided by companies and collaborating institutions.

Accelerator Stewardship Test Facility Pilot Program

A new program has been launched in 2015 to facilitate access to Office of Science (“SC”) accelerator R&D infrastructure, the “Accelerator Stewardship Test Facility Pilot Program” (“ASTFPP”). While National User Facilities, such as the synchrotron light sources, have high visibility and a well-established access process, the accelerator test infrastructure is not as visible, and typically has few non-programmatic users. This infrastructure, and the expertise of the people who built and use it, is a unique and diverse resource. The ASTFPP will provide seed funding to the SC National Labs to perform public outreach events to publicize these lesser-known accelerator R&D capabilities, and to engage outside users in collaborative R&D. The SC National Laboratories are conducting outreach activities in the spring of 2015, and include widely publicized events such

as one-day workshops, tours, surveys, mass e-mail campaigns, and networking meetings.

In the process, an assessment of the quantity and type of demand for these capabilities, and experience in handling the logistics surrounding such use, will be gained. This experience will be evaluated in the spring of 2016, and plans for a follow-on program formulated.

As a permanent information resource for the broader community, a web portal has been constructed to assist potential users in identifying the accelerator R&D capabilities of the SC National Laboratories, and contacts to call for more information. The portal connects the user to lab webpages for the SC labs participating in the ASTFPP [11].

FUTURE STEWARDSHIP ACTIVITIES

Community input and discussions with federal entities that use accelerator technology have made clear that there is very significant demand for translational R&D in accelerator technology, with well more than a billion dollars of proposed activities having been suggested to the Program to date.

In preparation for the FY 2016 Stewardship FOA, another workshop will be held in the area of Energy & Environmental Applications of Accelerators in the summer of 2015. Like the prior workshops, the community will be brought together over several days to assess: (1) the most outstanding high-impact applications of accelerator technology in this area, (2) the present state of the technology, (3) the state of market barriers impeding adoption of the technology, and (4) required R&D to close technical gaps to use accelerator technology for the application. This workshop builds on the responses received following a 2014 Request For Information ("RFI") [12,13], and will inform the creation of an applied R&D topic in the FY 2016 FOA.

In addition to the new Energy & Environmental Applications of Accelerators topic, applied R&D topics first introduced in the FY 2015 FOA will be continued in subsequent years until the challenges have been addressed. The call for basic R&D proposals is also expected to continue.

More generally, broad systemic questions, such as how best to structure HEP's accelerator science funding to foster a strong university community, and how best to strengthen the integration of the university, national laboratory, and private industry accelerator R&D efforts will be assessed through RFIs and possibly through follow-on workshops.

As the Stewardship program grows and evolves, future years will see additional workshops and funded studies to define applied R&D topics in security, defense, industrial, and other applications of accelerators.

Additional information about the Accelerator Stewardship program may be found in the DOE's Office of Science webpages [14]. A portal to the Office of Science National Laboratories' accelerator R&D infrastructure may be found at [11].

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