U.S. DEPARTMENT OF ENERGY | Office of Science

THE DOE LONG-TERM ACCELERATOR R&D STEWARDSHIP PROGRAM

Eric R. Colby, M. Zisman, DOE Office of High Energy Physics
E. Lessner, DOE Office of Basic Energy Sciences
M. Farkhondeh, DOE Office of Nuclear Physics

IPAC 2015
Richmond, VA
May 8, 2015

Program Contacts: Eric.Colby@Science.DOE.GOV , Michael.Zisman@Science.DOE.GOV

Outline

- **Origin and Motivation of Accelerator Stewardship**
- **Mission and Goals**
- **Elements of the Stewardship Program**
  - Research Program
  - Accelerator R&D Facilities
- **Information Resources**

In 2011 the Senate noted the interest generated by the Accelerators for America's Future Workshop, and asked DOE to develop a plan

"The [SEWD] Committee directs the Department to submit a …

10-year strategic plan … for accelerator technology research and development …"

The strategic plan should be based on the results of the Department's 2010 workshop study, Accelerators for America's Future, …"

Senate Report 112-075, p. 93. (Ordered to be printed September 7, 2011)

DOE responded with a strategic plan for Accelerator R&D Stewardship

- **Accelerator R&D Stewardship Mission:**
  - Support fundamental accelerator science and technology R&D
  - Disseminate accelerator knowledge and training
- **Program Implementation:**
  - **Facilitate access to** national laboratory accelerator **facilities** and infrastructure **for industrial and U.S. government agency users/developers** of accelerators and related technology
  - **Develop innovative solutions to critical problems**, **to the benefit of both the broader user communities and the DOE discovery science community**
  - Serve as a catalyst **to broaden and strengthen the community** that relies on accelerators and accelerator technology

Goals of Long Term Accelerator R&D Stewardship

- **Enhance the accelerator technology capabilities of U. S. industry** by engaging the U. S. accelerator R&D ecosystem in a manner that also enhances the ability of the DOE Office of Science and other federal agencies to carry out their missions
- **Drive a limited number of specific accelerator applications towards practical, testable prototypes in a 5-7 year timeframe**
- **Foster collaboration** between developers of accelerator technology and experts who apply accelerator technology
- **Support basic R&D,** necessary for sustained innovation across a broad range of accelerator applications

Accelerator Stewardship Program Elements

- **Research Program**
  - Accelerator Stewardship Solicitations
    - "FY 20XX Research Opportunities in Accelerator Stewardship"
      - Applied and Basic R&D
  - SBIR/STTR Solicitations (Some topics tailored to mesh with AS program)
- **Accelerator R&D Test Facilities**
  - Brookhaven Accelerator Test Facility (open now!)
    - Dedicated Stewardship User Facility
    - Upgraded facility planning for first users in 2018
  - Accelerator Stewardship Test Facility Pilot Program (starting up now!)
    - Pilot Program to assess demand for lesser-known SC accelerator capabilities
- **Future**
  - New Stewardship thrusts, added through RFIs, studies, and workshops
    - Energy & Environmental Applications of Accelerators (this summer!)

Outline

- Origin and Motivation of Accelerator Stewardship
- Mission and Goals
- Elements of the Stewardship Program
  - **Research Program**
  - Accelerator R&D Facilities
- Information Resources

R&D Program is Divided into Applied R&D and Basic R&D

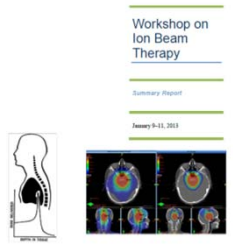
Applied Accelerator Research (called "Track 1" in solicitations)

- This category is for focused R&D efforts aimed at solving a specific accelerator application problem in a specific area. The desired end goal is a working prototype technology after 1-2 grant cycles.
  - Eligibility: all domestic organizations.
  - Teaming and cost-sharing are *expected*.
  - Proposal format: Technology development plan.

Basic Accelerator Research (called "Track 2" in solicitations)

- This category is for long-term generic accelerator R&D aimed at improving the theory, computational tools, and fundamental physical and technical understanding of accelerator science.
  - Eligibility: domestic academia *only*.
  - Teaming and cost-sharing: encouraged, but not expected.
  - Proposal format: Research proposal.

FY 2015 Applied Research (Track 1) Topics



Topic 1.1: Particle Therapy Beam Delivery Improvements

Technical Contact: Michael Zisman, (301)-903-2718, Michael.Zisman@science.doe.gov

Targeted R&D leading to one of:

- Less massive and more compact beam delivery systems capable of delivering ion beams from protons up to carbon that are suitable for patient therapy,
- Technology that can provide for rapid (seconds) scanning of the beam over a tumor volume in three dimensions, that is both transversely and longitudinally,
- Beam diagnostic technologies for ion beam therapy, with emphasis on increased readout speed and accuracy of position and dose.

Proposals to design an accelerator or accelerator complex are outside the scope of this call, and such proposals will be declined without review

Stewardship customer: NIH/NCI.
References: DOE/NIH Workshop on Ion Beam Therapy (January 9-11, 2013)
http://science.energy.gov/hep/research/accelerator-rd-stewardship/workshop-reports/
Related calls: NIH PAR-13-096, PAR-13-371 (both now closed).

FY 2015 Applied Research (Track 1) Topics

Topic 1.2: Ultrafast Laser Technology Program

Technical Contact: Eric Colby, 301-903-5475, Eric.Colby@science.doe.gov

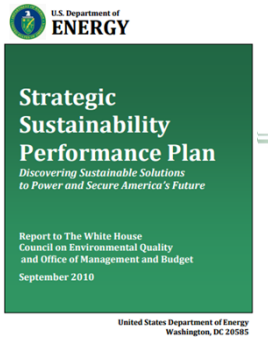
Targeted R&D in one or more of the following areas:

- Ultrafast gain materials capable of very high average power,
- Increased robustness and reduction in size of optical components,
- Innovations in laser architectures, cryogenics, other advanced thermal management techniques,
- Wavelength extension further into the infrared,
- Improvements in laser quality.

Proposals to develop full-scale demonstration laser systems are out of the scope of this FOA, and will be declined without review.

Stewardship customers: SC/BES, SC/NP, SC/FES, DoD, and DHS. SC/HEP also benefits.
References: Workshop on Laser Technology for Accelerators (January 23-25, 2013). http://science.energy.gov/hep/research/accelerator-rd-stewardship/workshop-reports/
Related calls: CRNBAA14-002, BAA-N00173-02, BAA-AFOSR-2014-0001, BAA-RQKM-2013-0005.

FY 2015 Applied Research (Track 1) Topics



Topic 1.3: Energy Efficiency Improvements Compatible with Office of Science Accelerators

Technical Contact: Eric Colby, (301)-903-5475, Eric.Colby@Science.doe.gov

R&D leading to new concepts in very high efficiency power conversion systems in two categories:

- **Plug-Compatible Concepts** -- targeted at upgrading existing power supplies, modulators and/or klystrons that are currently in service. Designs must be as close to plug-compatible as possible.

- **Revolutionary Concepts** -- Developments in this area must offer revolutionary gains in efficiency. While plug-compatibility is not required, a cost/benefit analysis must be included in the application to support the claim that the differential cost of developing, deploying, and operating the new power system components will generate a positive return on investment over a 10-year time period.

Stewardship customers: SC/BES, SC/NP, and Industry. SC/HEP also benefits.
References: E.O. 13514, and DOE's 2010 Strategic Sustainability Performance Plan
http://www.energy.gov/sites/prod/files/edg/media/DOE_Sustainability_Plan_2010.PDF
Related calls: none.

FY 2015 Basic Research (Track 2)

Topic 2.0: Long-Term Generic Accelerator R&D

Technical Contact: Michael Zisman, (301)-903-2718, Michael.Zisman@science.doe.gov

Basic research aimed at improving the theory, computational tools, and fundamental physical and technical understanding of accelerator science.

Topic areas include: beam physics, advanced computational methods for accelerator design and analysis, beam diagnostics and feedback control, new superconducting materials, new materials and coatings for accelerator components, novel power sources for accelerators, new particle sources, novel magnet designs, novel lattice designs, and novel technologies for secondary beam production.

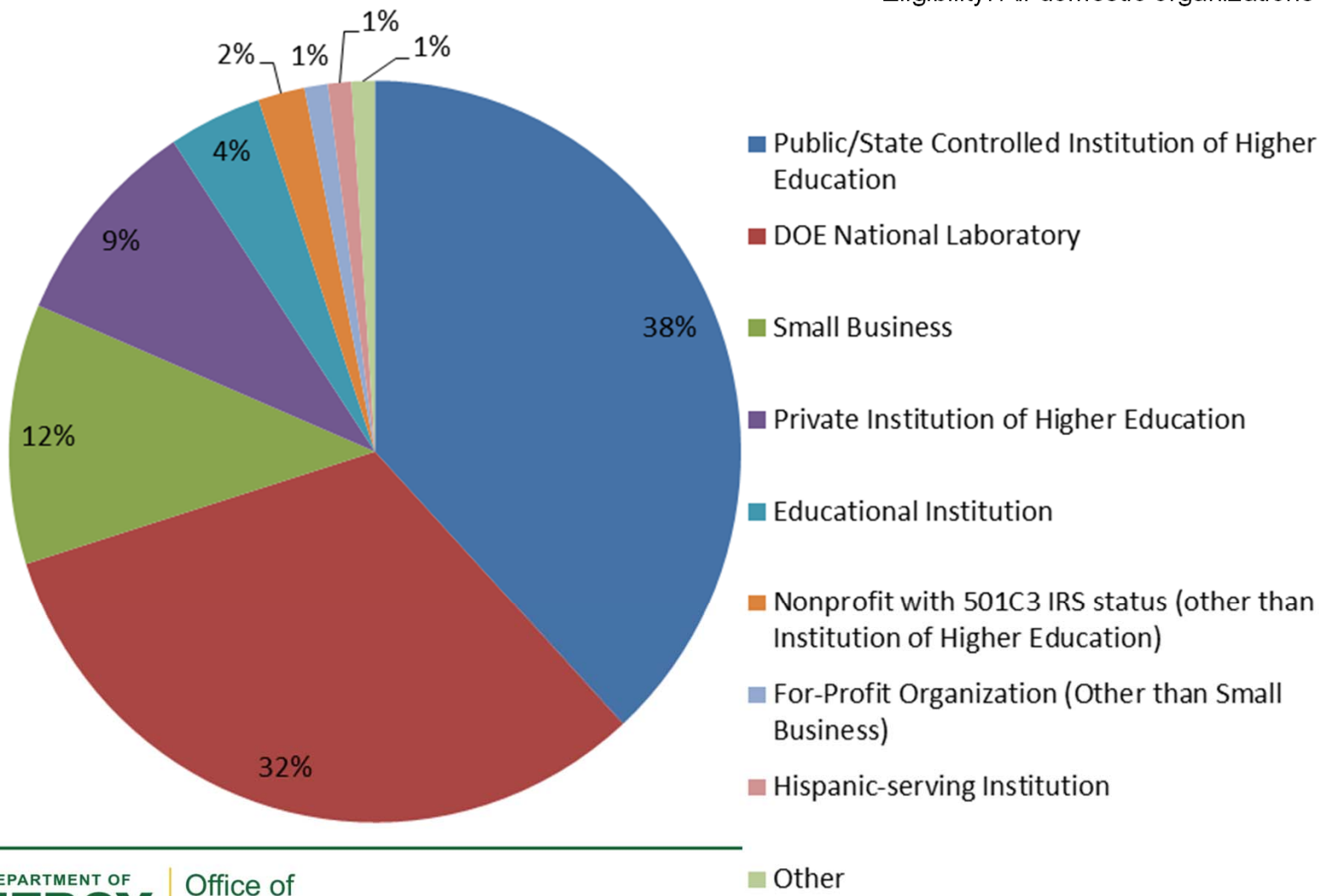
Significant increases in performance (flux, brightness, polarization, coherence, stability, reliability, flexibility) and **decreases in cost** (construction cost, operating cost, physical size, complexity) are sought.

Stewardship customer: varies by topic area.
References: Advisory committee reports, workshop reports, NAS reports, industry technology roadmaps, etc.
Related calls: NSF PD-13-7243.

FY2015 Call brought a very strong response from a diverse community

- **98 Letters of Intent (LOIs) received, totaling $138M !**

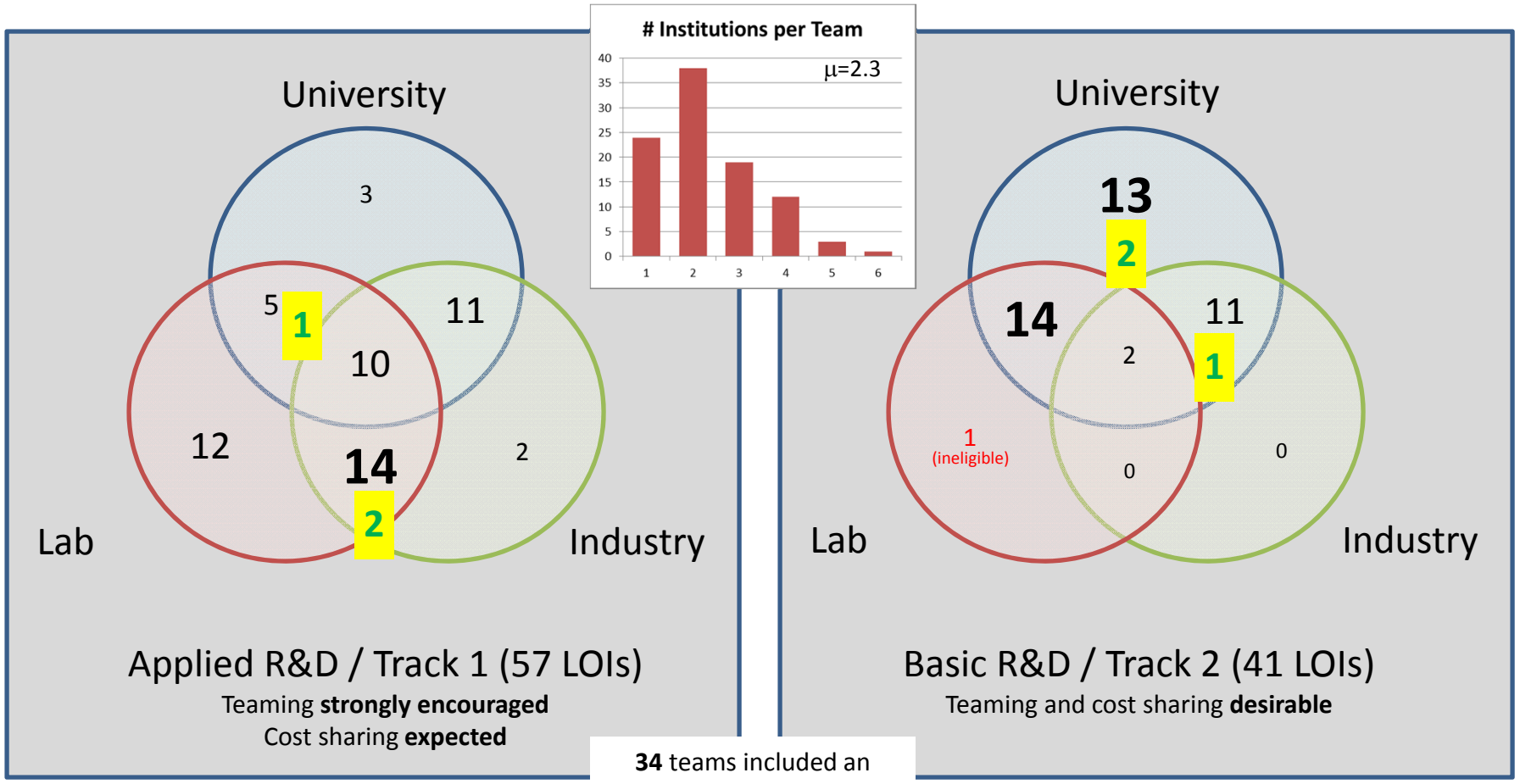
Eligibility: All domestic organizations



Teaming and Cost Sharing were Strong

- **Teaming plans as written in the LOI Responses**
  - Numbers indicate how many LOIs involved which types of participants

Awards



Applied R&D / Track 1 (57 LOIs)

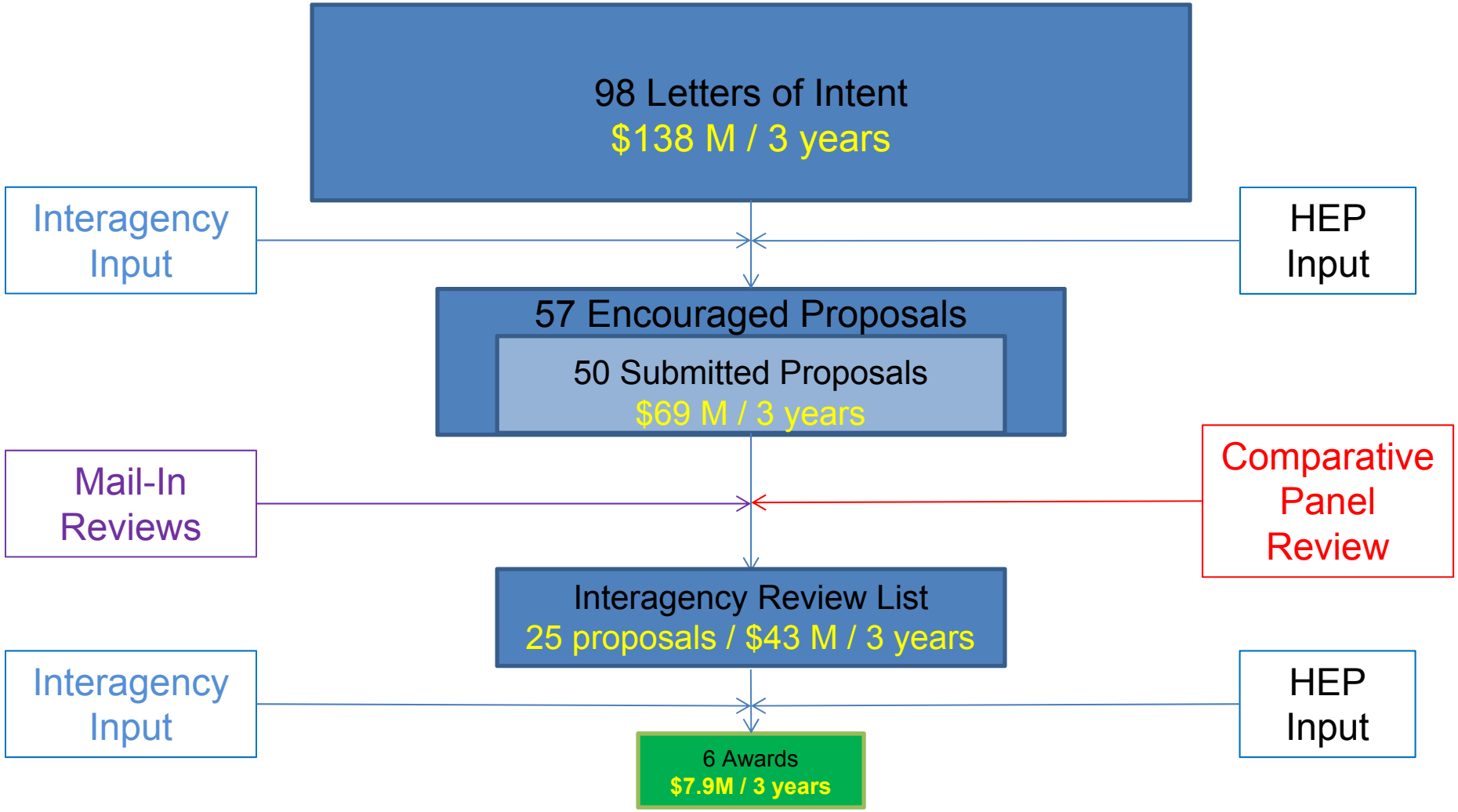
Teaming **strongly encouraged**
Cost sharing **expected**

Basic R&D / Track 2 (41 LOIs)

Teaming and cost sharing **desirable**

34 teams included an organization not previously funded by HEP

FY 2015 Stewardship Selection Process



Merit Criteria for Accelerator Stewardship Proposals

(in addition to the usual 10CFR605 criteria)

QUALITY OF THE ACCELERATOR R&D STEWARDSHIP OPPORTUNITY

In the questions that follow, the term "**Stewardship customer**" is used broadly to refer to the entity (other than HEP) whose mission or research objectives encompass the proposed work. The Stewardship customer can be another Office of Science (e.g., BES, NP, FES), another DOE program office (e.g., NNSA, EERE, ARPA-E) another federal agency (e.g., NIH, DoD), or industries that use accelerator technology.

1. Does the proposed work require significant scientific or technical advances in accelerators or accelerator-related technology? (Accelerator-related technology includes such things as: superconducting magnets and RF cavities, RF and magnet power systems, specialized laser systems, specialized diagnostics and controls, and so on.)

2. Will the proposed work result in substantial impact on the Stewardship customer's needs **and** result in some synergy with the HEP mission? (synergies might include: developing additional expertise or facilities relevant to present or future HEP-supported work).

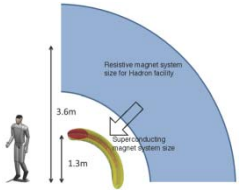
3. For the primary participating institution(s), is the activity reasonably consistent with the institution's primary mission? (e.g., if a National Laboratory is involved, is the activity consistent with that Laboratory's primary mission?)

4. Is the PI/collaboration arguably the best performer/provider for the Stewardship activity? Are other entities capable of providing a substantially similar (or superior) capability?

5. What evidence is there that the Stewardship customer endorses the goal? Does this proposal address issues that have been identified in writing (e.g., advisory committee reports, workshop reports, white papers, roadmaps) by the Stewardship customer? Does the Stewardship customer participate substantially and materially in this effort (e.g., by co-funding, cost-sharing, in-kind donation or equipment, donation of effort)?

FY 2015 Stewardship Awards

BERKELEY LAB
Bringing Science Solutions to the World



VARIAN medical systems

$850k Cost Share

Compact Superconducting Combined Function Gantry Magnets

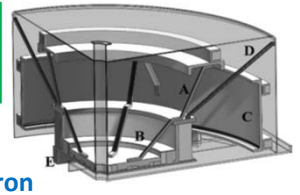
PAUL SCHERRER INSTITUT
PSI

Gantry Optics Design
Cost share

ProNova
Redefining the Future of Cancer Treatment

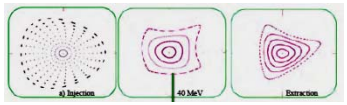
$405k
Cost share

Ironless Variable Energy Superconducting Proton Cyclotron



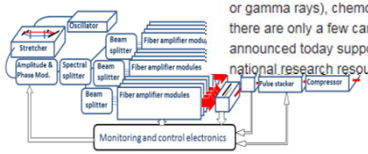
Massachusetts Institute of Technology

TEXAS A&M UNIVERSITY



Advanced Beam Dynamics for High Power Cyclotrons

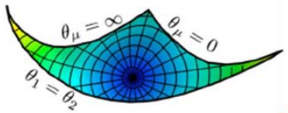
UNIVERSITY OF MICHIGAN



SLAC NATIONAL ACCELERATOR LABORATORY

BERKELEY LAB
Bringing Science Solutions to the World

High Peak & Average Power Laser Technology R&D

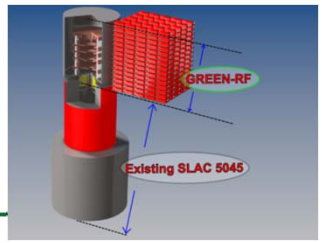


Innovative Accelerator Control and Optimization

CORNELL UNIVERSITY
FOUNDED A.D. 1865

Energy Efficient LCLS-I Klystron Replacements

CPI
Communications & Power Industries



Lawrence Livermore National Laboratory

U.S. DEPARTMENT OF ENERGY | Office of Science

FY 2015 Stewardship FOA Summary

- **FY 2015 FOA Formulated with input from 3 workshops, the Accelerator Task Force, an Executive Order, and DOE-SC Offices**
- **Reduced Funding ($10M vs. $19.2M) led to a much-reduced program**
  - 98 LOIs→50 Proposals→6 awards
  - 3 of 6 were funded at ~half of the requested amount; all were funded below request
  - Many, many outstanding proposals could not be funded
- **Some helpful advice for the future: Please read future FOA carefully!**
  - Topic descriptions are specific for a reason
  - The benefits of the R&D should be strongly and clearly articulated and should cite documentation of the need
- **Expect FY 2016 FOA will be later than FY 2015 FOA (June) by 2-3 months**
  - Will continue many of the topics from the FY 2015 FOA
  - Informed by the Workshop on Energy & Environmental Applications of Accelerators

Energy & Environmental Applications of Accelerators

Preparation for this very broad topic area began with a 2014 Request for Information

- 235 pages of input!
  - 28% Industry
  - 28% Academia
  - 31% National Laboratories
  - 10% Private Individuals
  - 56% Environmental Applications / 38% Energy Applications / 6% Other

Preparation continues with a Workshop being planned for this Summer

- **Assess the state of any existing** accelerator and non-accelerator based **technology** currently d… application. **Document cost and performance criteria** to be used as a benchmark for … accelerator based technology.
- **Document current and proposed** Federal and State environment… …ments for the application and identify any issues with regard to th…
- **Develop performance criteria** for accelerator … …nsider total system costs for production and operation. **Assess t**… …ental **benefits if the accelerator technology meets the crit**… …ccelerator component of the system.
- **Identify techni**… …e art of accelerator technology compared to the above specifi… …lated technologies such as power supplies or magnet technology.
- … **R&D** relevant to the application of accelerator technology to E&E challenges.
- … **needed to bridge technical gaps**, and any environmental analysis and testing required to … use
- **D… elop a list of R&D and regulatory compliance issues**, include rough order-of-magnitude funding estimates

If you are interested in participating in this workshop, and especially if you have experience in applying accelerator technology in the energy & environmental area, please contact: Eric.Colby@Science.doe.gov

Workshop outcome: A Report detailing high-impact applications, with the issues and required accelerator R&D for each

Outline

- Origin and Motivation of Accelerator Stewardship
- Mission and Goals
- Elements of the Stewardship Program
  - Research Program
  - **Accelerator R&D Facilities**
- Information Resources

Accelerator Stewardship R&D Facilities

Two Major Program Elements:

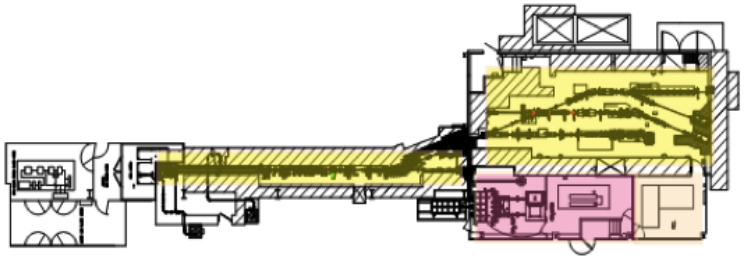
- **Brookhaven Accelerator Test Facility ("ATF") is operated as an Office of Science User Facility dedicated to Accelerator Stewardship**
- **Accelerator Stewardship Test Facility Pilot Program ("ASTFPP") will explore making lesser-known SC accelerator R&D infrastructure more accessible**

Brookhaven Accelerator Test Facility

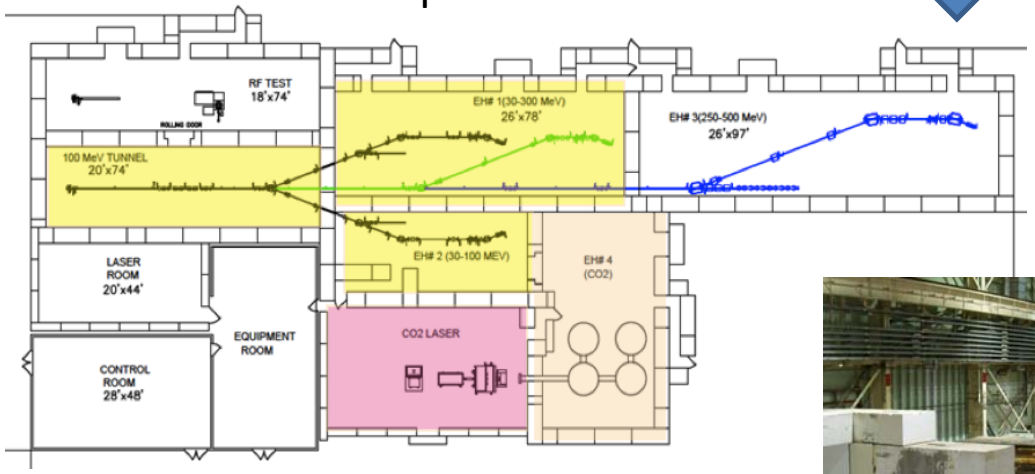
- **The ATF has operated throughout its 25 year history as an HEP user facility dedicated to advanced accelerator R&D, accepting user proposals based on scientific merit.**
  - Scientific progress from R&D conducted at the BNL-ATF has enabled key advances in more fields than just HEP
    - ATF currently supporting 21 experiments, roughly half support long-term R&D that is predominantly of interest to BES, NP, DARPA, DNDO & others
    - Just authorized its first proprietary user
  - Serves a broad population of laboratory, university, and industry users
  - Has a rich tradition of serving as a training ground for accelerator physicists
- **The ATF is now supported under the Stewardship program**
  - Increased priority for technology demonstrations
  - Use is free to non-proprietary users
  - A significant facility upgrade ("ATF-II") is approved and funded
- **ATF has been designated an Office of Science User Facility**

Brookhaven Accelerator Test Facility ATF & Upgrade

ATF 5,000sf, single Hall
80 MeV, 1 TW CO_2

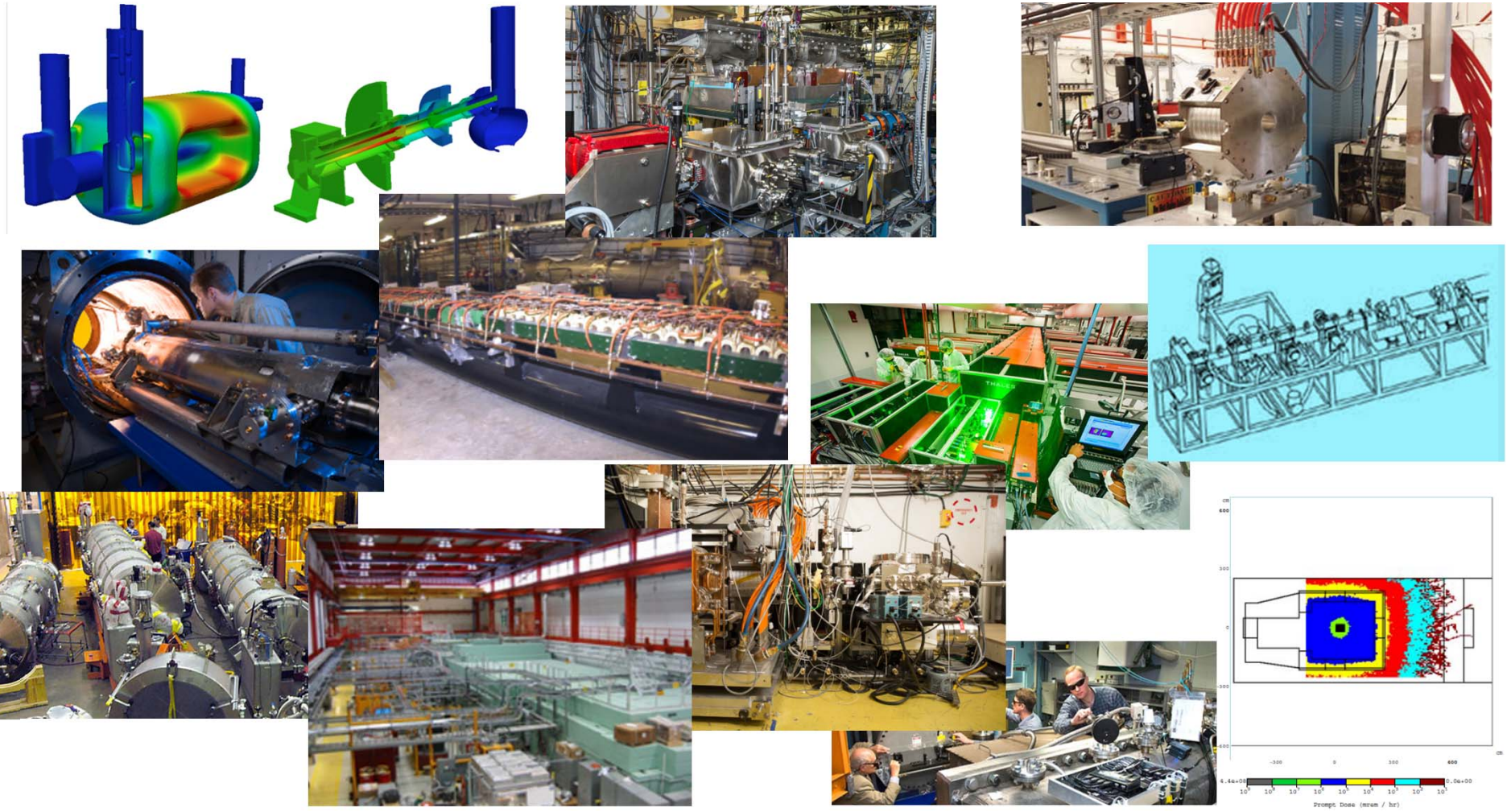


Planned for first user operations in ~2018



ATF II 15,000sf, 3 Halls
150 MeV, 100 TW CO_2

There are more than 50 accelerator R&D test facilities across the SC National Lab complex



Argonne NATIONAL LABORATORY | BROOKHAVEN NATIONAL LABORATORY | Fermilab | Jefferson Lab EXPLORING THE NATURE OF MATTER | BERKELEY LAB Bringing Science Solutions to the World | OAK RIDGE National Laboratory | SLAC NATIONAL ACCELERATOR LABORATORY

Goals of the Accelerator Stewardship Test Facility Pilot Program

- Widely publicize available Office of Science (SC) accelerator R&D infrastructure
  - Through individual, lab-organized outreach events, publicize the lesser-known accelerator R&D infrastructure to a wide audience
- Survey the potential Stewardship demand for this R&D infrastructure
  - Identify potential collaborative activities that bring high added value to both the lab and the Stewardship partner
- Seed fund a few R&D examples
  - A few cases will be selected for FY 15 funding by a peer-review process
- Test the process for engaging Stewardship partners.
  - The business and legal mechanism, outreach methods, general support needs, etc.

The results of this pilot program will be used to formulate a follow-on program for funding Stewardship use of DOE National Laboratory accelerator R&D infrastructure.

Accelerator Stewardship Test Facility Pilot Program Timeline

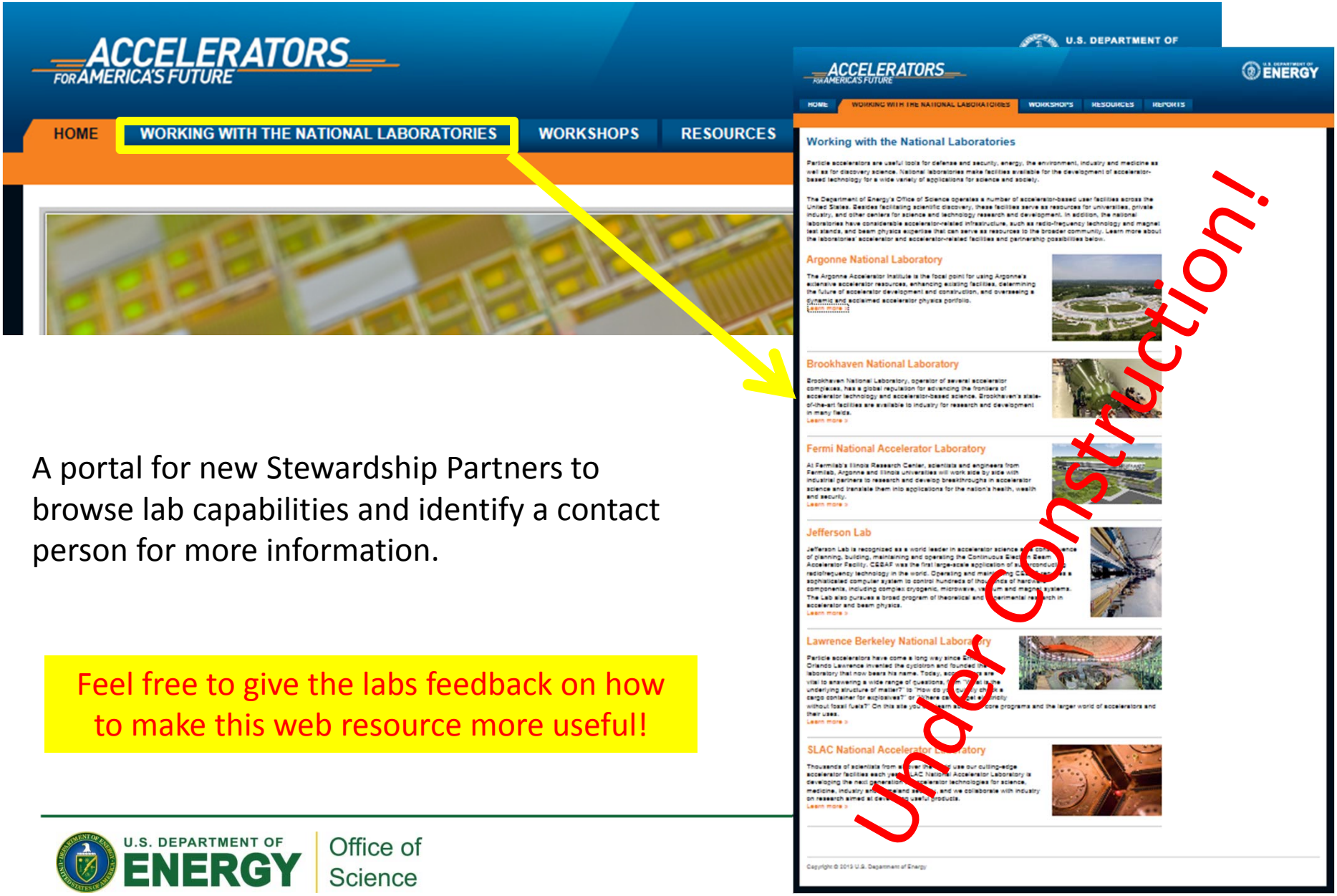
- **April/May** **Labs conduct public outreach events**
  - BNL – done!
  - ANL & FNAL – done!
  - JLAB – done!
  - LBNL – coming soon!
  - SLAC – coming soon!

- **June 15, 2015** **Labs submit proposals for seed funding**
- **June/July** **Proposals are peer reviewed**
- **Aug/Sept** **Seed funding to labs**

- **Spring 2016** **Evaluate results of pilot program**

“One-Stop Shopping” for SC Accelerator R&D Capabilities

http://www.acceleratorsamerica.org



A portal for new Stewardship Partners to browse lab capabilities and identify a contact person for more information.

Feel free to give the labs feedback on how to make this web resource more useful!

U.S. DEPARTMENT OF ENERGY | Office of Science

Summary

- **Eligibility for Accelerator Stewardship program is broad**
  - **It is *not* a Lab entitlement program**
- **"Customer" must actively want (and ideally participate in) the activity**
  - **Pure "technology push" is not sufficient**
  - **This should be documented in all proposals**
- **Activities should accrue some measureable intellectual benefit to HEP and/or other Offices of Science**
- **Stewardship R&D should address high-impact challenges that**
  - **Applied R&D: solve specific problems on ~5-10 year timescale**
  - **Basic R&D: provide broadly useful accelerator science advances**
- **Near-term successes will be vital to the viability of Stewardship**
  - **SC & Congress must hear *from the customers* that this is working**

Useful Information Resources

- **About the HEP Accelerator Stewardship program in particular:**
  - Program Description:
    - http://science.energy.gov/hep/research/accelerator-rd-stewardship/
  - Portal to Office of Science accelerator R&D capabilities:
    - http://www.acceleratorsamerica.org/working-with-labs/index.html

- **More generally, DOE's Office of Technology Transitions maintains:**
  - "How-to" guides for interacting with the labs:
    - http://technologytransfer.energy.gov/
  - A general "Portal" for Business to find DOE Lab facilities of all kinds:
    - http://www.energy.gov/technologytransitions/who-do-i-contact-labs
  - A detailed list of facilities (includes other non-accelerator facilities):
    - http://www.energy.gov/technologytransitions/technology-transitions-facilities-database

Supplementary Materials

Boundary Conditions:
What is Stewardship and what is GARD?

- DOE-HEP has a separately funded, separately managed program in accelerator R&D specifically aimed at supporting its mission called "GARD" = General Accelerator Research & Development.

- Accelerator R&D often has broad impacts beyond the program that funded the work. Differentiating what is HEP-mission and what is Stewardship is important.

- The difference, stated simply, is:

GARD	predominantly impacts the HEP R&D mission
Accelerator Stewardship	predominantly impacts non-HEP applications

- The stewardship proposal must clearly state the goals and impacts of the proposed work.

Boundary Conditions:
"Stewardship Customer's Needs" vs. "synergy with HEP"

- **DOE-HEP funds a program with a distinct mission. As such, HEP-funded activities must be defensible within the context of the mission:**

  The mission of the High Energy Physics (HEP) program is to understand how our universe works at its most fundamental level.

  - Particle accelerators play a key enabling role in HEP experiments.
  - Higher energy and intensity, and lower cost are the primary R&D goals.

- **Two questions must be answered in the affirmative for a proposal to qualify for the Stewardship program:**
  1. **Is there a clear non-HEP customer for the work, and does the proposed work have a potentially *strong impact* on the customer's needs?**
  2. **Will conducting the activity likely result in a *positive impact* on HEP's ability to conduct its mission?**

***"strong impact"* – is defined by the Stewardship Customer.**
"*positive impact*" – can include: enhancing a competence, improving a facility, or developing an industry capability that one day will prove useful to the HEP mission.