

Comments from DOE ARDAP

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Director, Office of Accelerator R&D and Production (ARDAP, SC-24.2)

Office of Science, U.S. Department of Energy

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U.S. DEPARTMENT OF
ENERGY

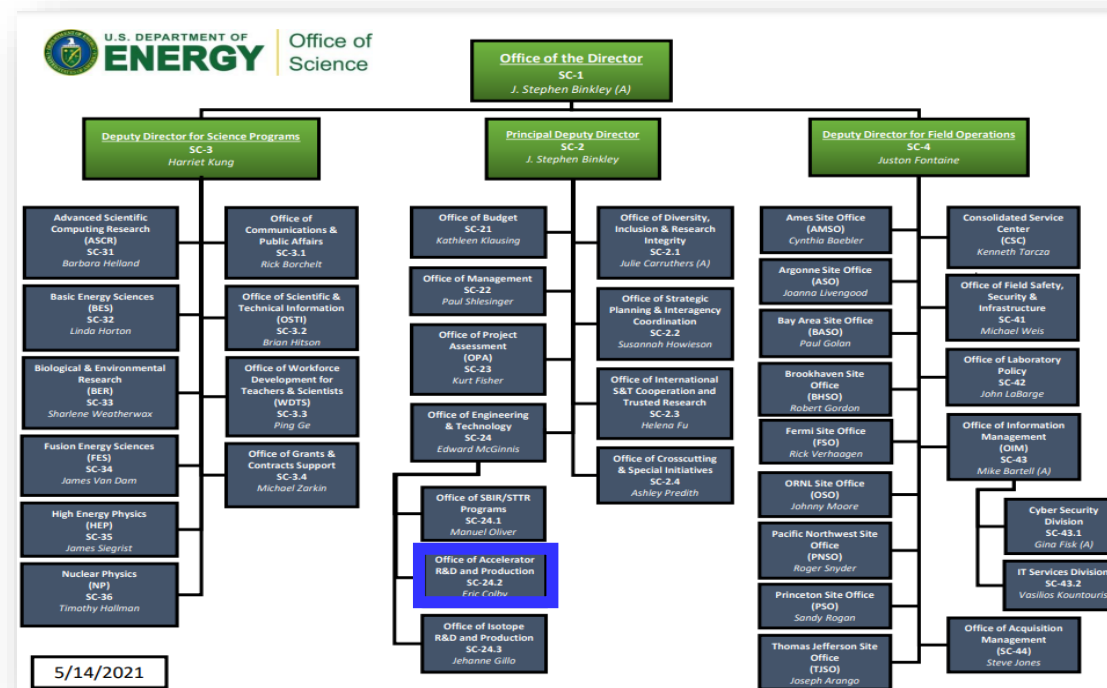
Office of
Science

Accelerator R&D and Production (ARDAP) SC-24.2

At-a-glance

Mission: Ensure a robust pipeline of next-generation Accelerator Science & Technology to support physical sciences research while providing technology advances and industrial strength that position the U.S. to lead the world for decades to come.

- Established: April 12, 2020
 - in recognition of the central importance of accelerators and related technologies to the current and future scientific capabilities stewarded by SC programs
- Budget in FY 2021: \$16.935M
 - Initial budget and activity are the **Accelerator Stewardship program** (SC-35)
 - ARDAP first appears in SC Reauthorization and Appropriation in FY2022
- Staff: ~2.4 FTE across 7 people
 - Director** – Eric R. Colby, 100% time
 - Deputy Director** – Bruce Carlsten (IPA, start date 10/11/21) ~90% time
 - Physicist – Marion White (detailee) (home office: SC-35) ~40% time
 - Budget Support – Erin Cruz, Michelle Bandy (home office: SC-35) ~5% time total
 - A&P Support – Christie Ashton, Carol Atherly (home office: SC-35) ~5% time total
- TRL/MRL Footprint: TRL-1 to -6 and up to MRL-7
 - Cross-cutting basic R&D and
 - Technology maturation, technology transfer, and (coming soon) public-private-partnerships for production
- Activities are tightly integrated with BES, FES, HEP, NP, and IP
 - Coordination with NNSA, DOD, DHS, NIH, and NSF ensure broader USG synergy as well



ARDAP Supports Two Activities Authorized by Congress

Accelerator Stewardship

FY 2014

erations at the Homestake Mine in South Dakota. Within the funds for High Energy Physics, the Committee also recommends \$20,000,000 for Accelerator Stewardship. The Committee recognizes the critical role accelerator technology can play in addressing many of the economic and societal issues confronting the country. The Committee supports the Office of Science's efforts to make unique test facilities available to U.S. industry to accelerate applications of accelerator technology. Testing accelerator technology, such as at beam facilities, is the only, unambiguous way to demonstrate the operational efficacy of a new technology and represents the final step in validating a design concept.

NUCLEAR PHYSICS

FY2014 Energy and Water Development
Appropriations Bill, S. 1245, (June 27, 2013)

Stewardship was in Office of High
Energy Physics from FY14 to FY21

New Scope
in FY 2022

Stewardship mission included in FY22
ARDAP SC Reauthorization language
Stewardship funds basic R&D, “use-
inspired” R&D, and the BNL-ATF

New Development Mission in SC Reauthorization

FY 2022

SEC. 310. ACCELERATOR RESEARCH AND DEVELOPMENT.

“(a) Program.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program to—

- “(1) advance accelerator science and technology relevant to the Department, other Federal agencies, and U.S. industry;
- “(2) foster partnerships to develop, demonstrate, and enable the commercial application of accelerator technologies;
- “(3) support the development of a skilled, diverse, and inclusive accelerator workforce; and
- “(4) provide access to accelerator design and engineering resources.

“(b) Accelerator Research.—In carrying out the program authorized under subsection (a), the Director shall support—

- “(1) research activities in cross-cutting accelerator technologies including superconducting magnets and accelerators, beam physics, data analytics-based accelerator controls, simulation software, new particle sources, advanced laser technology, and transformative research; and
- “(2) optimal operation of the Accelerator Test Facility.

“(c) Accelerator Development.—In carrying out the program authorized under subsection (a), the Director shall support partnerships to foster the development, demonstration, and commercial application of accelerator technologies including, advanced superconducting wire and cable, superconducting RF cavities, and high efficiency radiofrequency power sources for accelerators.

“(d) Research Collaborations.—In developing accelerator technologies under the program authorized in subsection (a), the Director shall—

- “(1) consider the requirements necessary to support translational research and development for medical, industrial, security, and defense applications; and
- “(2) leverage investments in accelerator technologies and fundamental research in particle physics by partnering with institutes of higher education, industry, and other Federal agencies to enable the commercial application of advanced accelerator technologies.

ARDAP first appears in budget requests, authorization language, and appropriation in FY2022

President's Budget Request

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(Other DOE Programs)

FY 2022 Budget Request to Congress (narrative); (budget-in-brief)

- Funding by Appropriation
- Appropriation Language
- Overview
- Advanced Scientific Computing Research
- Basic Energy Sciences
- Biological and Environmental Research
- Fusion Energy Sciences
- High Energy Physics
- Nuclear Physics
- Isotope R&D and Production
- Isotope Production and Distribution Program Fund
- Accelerator R&D and Production**
- Workforce Development for Teachers and Scientists
- Science Laboratories Infrastructure
- Safeguards and Security
- Science Program Direction
- Crosscuts
- Funding by Appropriation by Site
- General Provisions

FY 2022 Energy and Water Development Appropriations

<https://science.osti.gov/budget>

Department of Energy Science for the Future Act (draft H.R. 3593)

6 “SEC. 310. ACCELERATOR RESEARCH AND DEVELOPMENT.

3 “(e) AUTHORIZATION OF APPROPRIATIONS.—There
4 are authorized to be appropriated to the Secretary to carry
5 out the activities described in this section—

6 “(1) \$24,000,000 for fiscal year 2022;

7 “(2) \$25,680,000 for fiscal year 2023;

8 “(3) \$27,477,600 for fiscal year 2024;

9 “(4) \$29,401,032 for fiscal year 2025; and

10 “(5) \$31,459,104 for fiscal year 2026.”.

<https://www.congress.gov/117/bills/hr3593/BILLS-117hr3593rfs.pdf>

Office of Accelerator R&D and Production Missions

- **Stewardship Mission**

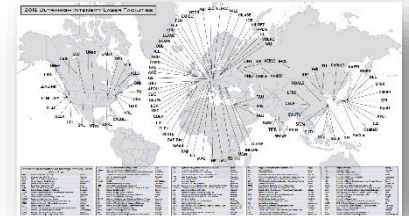
Support fundamental accelerator science and technology development of relevance to industry, medical treatment, and national security, and to disseminate accelerator knowledge and training to the broad community of accelerator users and providers.

- **Development Mission**

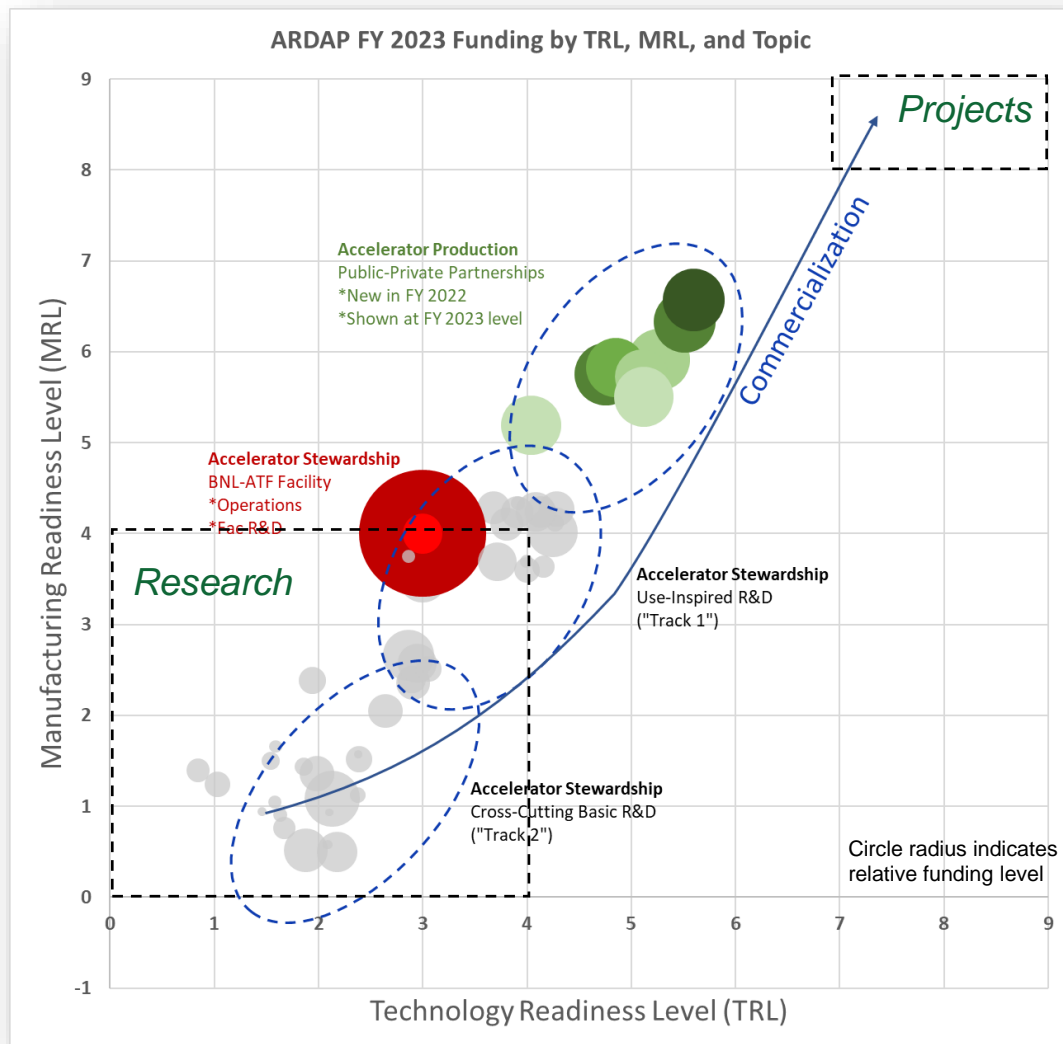
Coordinate and make accelerator R&D and production investments that are aimed at addressing accelerator science and technology gaps to help ensure that future U.S. accelerator-based physical science R&D priorities will be met.

- **ARDAP will fulfill these missions by**

- Identifying and investing in use-inspired R&D technology areas that enable new accelerator applications in industry, medical treatment, and national security,
- Maintaining a strategic picture of AS&T* needs and worldwide competition,
- Facilitating coordination of Programmatic AS&T R&D investments across SC,
- Investing in selected cross-cutting AS&T areas,
- Providing a system engineering perspective for SC facility projects,
- Supporting workforce development, when needed,
- Maturing key AS&T technology and developing capable U.S. vendors,
- Transitioning accelerator technology to broader uses.

A table with multiple columns and rows, likely containing data about various accelerators. The columns include names like "SLAC", "Fermilab", "CERN", etc., and rows list different types of accelerators or projects. The table is partially obscured by a redacted area.

ARDAP's activities are aimed at achieving both technology and manufacturing readiness



The Challenge

- *Research* focuses on achieving low-to-moderate TRL, and MRL advancement is typically not a focus.
- *Projects*, however, focus on building facilities from mature technology.
- A "Valley of Death" must be crossed between the two:
 - Mid-range TRL (TRL4 to TRL7);
 - Mid-range MRL (MRL4 to MRL8).

ARDAP's Response

- *Technology Push* – the Accelerator Production subprogram as aimed at exactly this TRL/MRL range;
- *Market Development* – first-of-kind technical demonstrations to show feasibility of new commercial applications are supported;
- *Community Building* – Teaming requirements, workshops, roundtables, and joint strategic planning exercises are each used to strengthen public/private collaboration.
- *Strategic planning* – understand AS&T needs on a 10-to-20-year time horizon and invest strategically

TRL & MRL Goals of ARDAP's Programs

- Accelerator Stewardship

- Track 1: to TRL-4
- Track 2: to TRL-2
- Track 3: to TRL-1 to -4
- No MRL goal, but early-stage industrial collaboration is strongly encouraged

- Accelerator Production

- TRL-6 and MRL-5 to -7

National Network for
Manufacturing Innovation

NATIONAL NETWORK FOR MANUFACTURING INNOVATION: A PRELIMINARY DESIGN

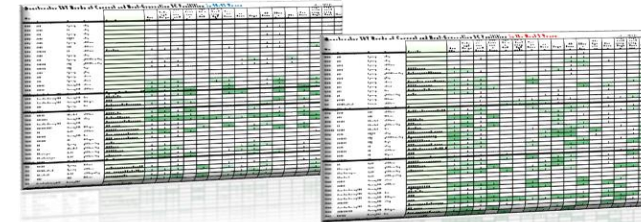
Table 1. Technology Readiness Levels and Manufacturing Readiness Levels, after [21]

TRL 1:	Basic principles observed and reported	MRL 1:	Manufacturing feasibility assessed
TRL 2:	Technology concept and/or application formulated	MRL 2:	Manufacturing concepts defined
TRL 3:	Analytical and experimental critical function and/or characteristic proof of concept	MRL 3:	Manufacturing concepts developed
TRL 4:	Component and/or breadboard validation in a laboratory environment	MRL 4:	Capability to produce the technology in a laboratory environment
TRL 5:	Component or breadboard validation in a relevant environment	MRL 5:	Capability to produce prototype components in a production relevant environment
TRL 6:	System/subsystem model or prototype demonstration in a relevant environment	MRL 6:	Capability to produce prototype system or subsystem in a production relevant environment
TRL 7:	System prototype demonstration in an operational environment	MRL 7:	Capability to produce systems, subsystems or components in a production relevant environment
TRL 8:	Actual system completed and qualified through test and demonstrated	MRL 8:	Pilot line capability demonstrated; Ready to begin Low Rate Initial Production
TRL 9:	Actual system proven through successful mission operations	MRL 9:	Low rate production demonstrated; Capability in place to begin Full Rate Production

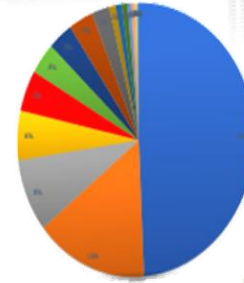
<https://www.manufacturingusa.com/reports/national-network-manufacturing-innovation-preliminary-design>

AS&T Inputs Gathered for Development Mission

- **Inventory of R&D Needs for DOE Facilities**
 - Completed in 2018, refreshed in 2020
 - What are the accelerator facilities of the next decade
 - What AS&T R&D is needed and when
- **AS&T Supplier Survey**
 - December 2020
 - What critical AS&T was purchased, from whom, and how much
 - Covered current projects and recent operations
- **Request for Information on Creating a Robust AS&T Ecosystem**
 - January 2021
 - Status and Future of the Market
 - Workforce Development
 - Models for Technology Transfer
 - Defining an Optimal Federal Role
- **Office of Science Roundtable on Supply Chain Risk Mitigation for Scientific Facilities and Tools**
 - November 2021
 - Covering **all** technologies used for physical science R&D
 - Procurement issues, market conditions, potential mitigation strategies



Two spreadsheets showing data from the Inventory of R&D Needs for DOE Facilities. The spreadsheets contain multiple columns of data, including facility names, R&D needs, and timelines.



DEPARTMENT OF ENERGY

Creating a Robust Accelerator Science & Technology Ecosystem

AGENCY: Office of Accelerator R&D and Production, Office of Science, Department of Energy (DOE).

ACTION: Request for information (RFI).

SUMMARY: The Office of Accelerator R&D and Production, as DOE's coordinating office for accelerator R&D to support the Office of Science research mission, is requesting information on the current state of the accelerator technology market, and for information about successful public-private-partnership models.

DATES: Written comments and information are requested on or before March 15, 2021.

Supply Chain Risk Mitigation for Scientific Facilities and Tools Roundtable

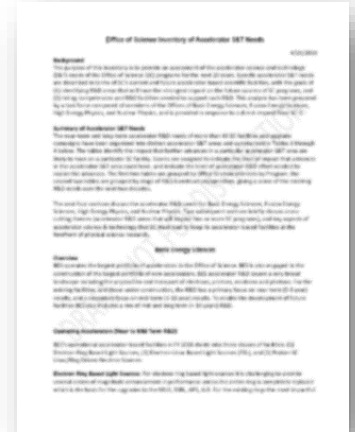
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Sponsored by the U.S. Department of Energy
Office of Science

Co-chairs:

Five Strategic AS&T Investment Areas

The Office of Science completed an inventory of AS&T needs for future scientific facilities and a preliminary analysis of supply chain vulnerabilities in 2018, refreshing the study in 2020.



Five primary technology areas are strategically important for SC facilities

1. Advances in **superconducting accelerator systems**, including SRF, SC magnets, and cryogenic engineering.
2. **Beam physics** and **high-fidelity computer modeling & control**, including better diagnostics, (AI/ML-based) control systems, advanced focusing, and beam cooling techniques.
3. Advances in high intensity **electron, proton, and ion sources**, also including **megawatt-class targets** for secondary particle sources.
4. Higher average power **radiofrequency** and **ultrafast laser sources**, including **power handling devices**, and **high accuracy x-ray optics**.
5. **High-risk high-reward R&D** in advanced materials, particle sources, beam dynamics, acceleration techniques, and other advanced topics.

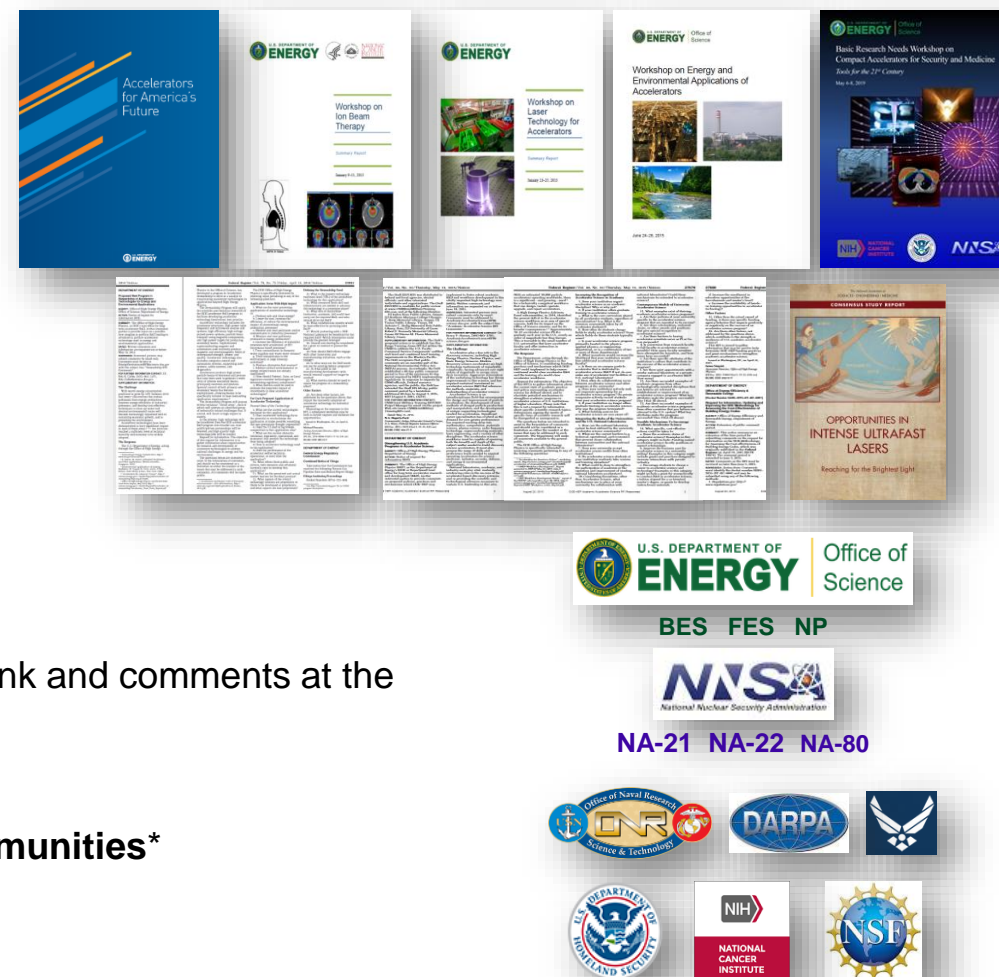
Interagency Coordination

• Strategic AS&T Inputs

- Multi-Agency Basic Research Needs Workshops
 - 2009, 2013, 2013, 2015, 2019,...
- RFIs and Multi-Agency Sponsored NAS Studies
 - 2014, 2015, 2018,...

• Tactical AS&T Inputs

- FOA/LAB Awards (~60% of budget)
 - **Stakeholder federal agencies** provide case-by-case priority rank and comments at the pre-application and award selection phases
- National User Facility Time (BNL ATF) (~40% of budget)
 - Program Advisory Committee members from **stakeholder communities***



* Composed of the dominant facility applicant communities which is typically BES, ONR, SBIR companies, DHS, HEP, NP, and others.

Goals of the Accelerator Stewardship Program

- **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
- **Facilitate access to the accelerator R&D capabilities at the DOE Office of Science National Laboratories**
- **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

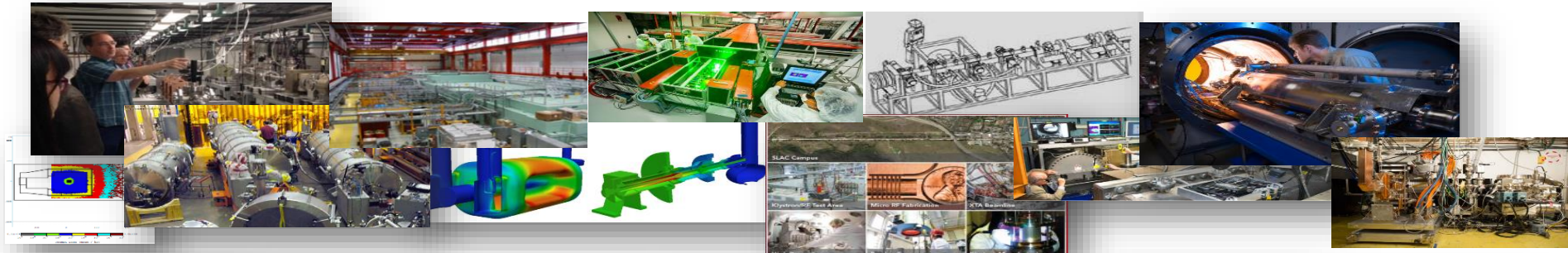
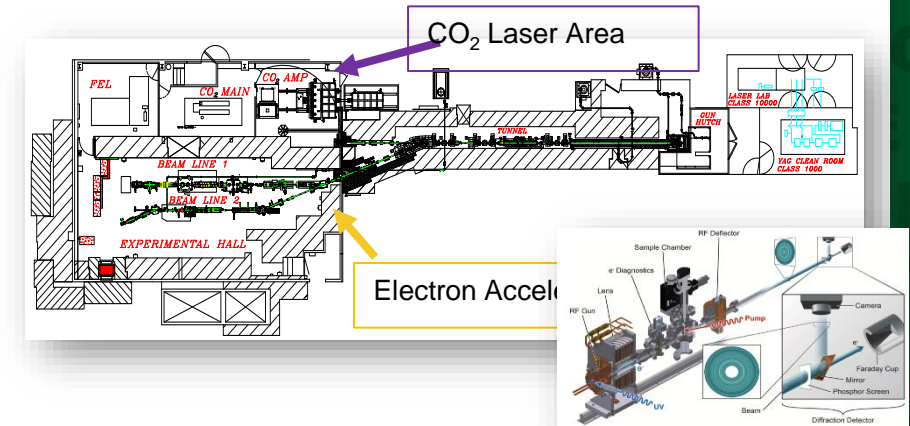
Three Principal Aims for Accelerator Stewardship R&D

- ***Solve high impact problems confronting society***
 - Specifically, bring technology up to ~TRL-4 such that an applied agency or industry is willing to carry the ball forward
 - **Track 1: Early-Stage Applied Accelerator R&D**
 - Focused R&D 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*.
 - Topics defined by workshops: <https://science.osti.gov/hep/research/accelerator-stewardship/workshop-reports/>
- ***Provide the fundamental building blocks of new technological advances***
 - Invest in a range of high impact broadly applicable R&D
 - **Track 2: Basic Accelerator R&D**
 - Long-term foundational 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.
- ***Facilitate access to DOE Accelerator R&D Capabilities***
 - Short-term funding for non-DOE entities to engage the facilities and competences of the DOE National Labs
 - **Track 3: Accelerator Stewardship Test Facility Program**
 - Short-term (12 months or less), non-renewable awards to facilitate access to unique DOE accelerator R&D capabilities
 - **Eligibility:** all domestic organizations except DOE labs.

*TRL = Technology Readiness Level

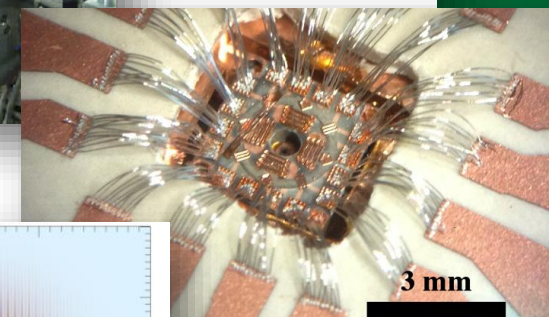
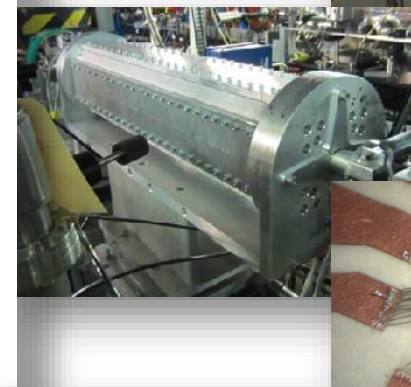
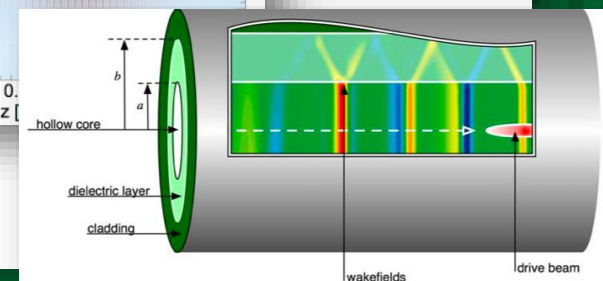
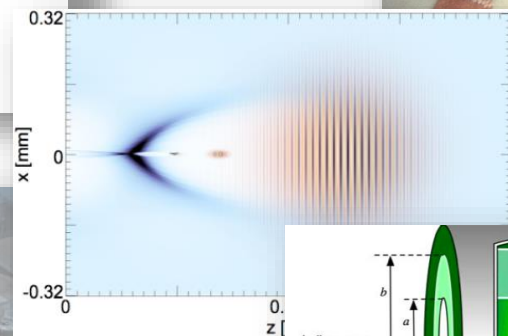
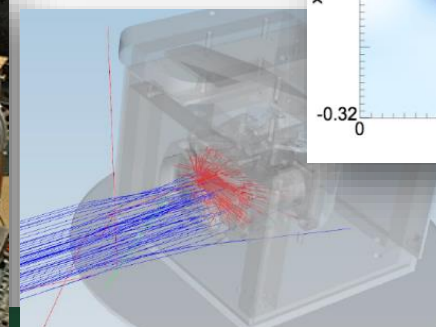
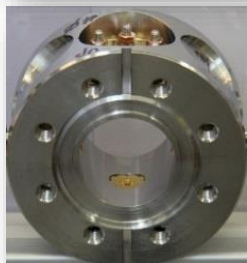
Facilitating Access to Accelerator R&D Facilities

- **Brookhaven Accelerator Test Facility (“ATF”)** is operated as a dedicated National User Facility
 - 80 MeV high brightness electrons, Multi-TW CO₂ laser pulses, TW-class NIR laser pulses and femtosecond diagnostics
 - Ultrafast Electron Diffraction Facility
- **Accelerator Stewardship Test Facility Program (“ASTFP”)** facilitates access to a wide array of DOE National Laboratory Accelerator R&D capabilities
 - By merit-reviewed proposals to “Track 3” of the Accelerator Stewardship FOA (next call is early 2022)
 - Up to \$300k and 12 months to complete a collaborative R&D task at a DOE lab



Brookhaven Accelerator Test Facility

- The ATF is an Office of Science User Facility, providing beam time free of charge to non-proprietary users.
 - Three decades of R&D for science and industry
 - ATF currently supporting 29 experiments and feasibility studies, roughly half support long-term R&D that is predominantly of interest to BES, NP, DOD, DHS & others
 - Serves a broad user population: laboratory, university, industry
 - Rich tradition of training accelerator physicists
- The ATF is an Accelerator Stewardship facility
 - Use is free to non-proprietary users
 - Time awarded by scientific and/or technical merit
 - Significant facility upgrades are underway; more are planned



Take home message

- **ARDAP, through the Accelerator Stewardship program, supports accelerator R&D of broad use to many sciences and applications by:**
 - Funding basic and applied R&D programs
 - Making the BNL-ATF available as a User Facility
 - Facilitating access to >50 accelerator capabilities across the DOE complex
 - Sponsoring workshops, RFIs, and studies to draw the accelerator and application communities together
- **ATF plays an important role in the Stewardship program by providing support for accelerator science, first-of-kind technical demonstrations, and workforce training**
 - I and the ATF staff always welcome your feedback on ways to improve
 - We count on you to do world-class science and report your findings
 - We count on you to suggest new facility capabilities

Application deadline: January 31, 2022

ARDAP is hiring!

Program Manager at GS-15 level

- Develop ARDAP strategy, data calls, analysis
- Manage R&D portfolio
- Run workshops, roundtables, RFIs

Chief Systems Engineer at GS-15 level

- Lead Strat planning, including supply chain issues
- Develop systems engineering guidance
- Nationwide resource for facility construction

USAJOBS

Physical Scientist

[Department of Energy](#)

[Summary](#) [Duties](#) [Requirements](#) [How you will be evaluated](#) [Required documents](#) [How to Apply](#)

Summary

These positions are to be filled under the **OPM Government-Wide Direct Hire Authority Certain STEM Positions** for grades GS 11-15. This serves as a public notice for the use of the Direct Hire Authority in accordance with 5 U.S.C. 3327 and 3330 and 5 CFR 330. Under this recruitment procedure, applications will be accepted for each location/ installation identified in this Public Notice. There may or may not be actual/projected vacancies at the time you submit your application.

<https://www.usajobs.gov/job/615981000>

USAJOBS

General Engineer

[Department of Energy](#)

[Summary](#) [Duties](#) [Requirements](#) [How you will be evaluated](#) [Required documents](#) [How to Apply](#)

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<https://www.usajobs.gov/job/615982700>

N.B. USAJobs postings are generic and are used by many DOE offices. For specific job duties contact Eric.Colby@science.doe.gov

DOE is hiring!

Bipartisan Infrastructure Legislation

- \$62B to DOE in FY22-FY26 including:
 - \$7B batteries
 - \$9.5B hydrogen production and distribution
 - \$3.5B weatherization assistance
 - \$14B grid resilience and modernization
 - \$6B nuclear plant life extension
 - \$10B carbon capture, industrial emission reduction
 - \$2.5B advanced nuclear
 - Expanded Loan Program Office

Applied Program Offices expect to hire 1,000 program managers and analysts



<https://www.energy.gov/articles/doe-fact-sheet-bipartisan-infrastructure-deal-will-deliver-american-workers-families-and-0>

Program Highlights 2014-2021

- **Research: Applied and Basic Accelerator R&D** (~\$55M since 2014)
 - Funded through annual Funding Opportunity Announcements (FOAs)
 - Institutionally diverse: **41 institutions=21 Universities, 8 DOE Labs, 10 Companies, USEPA, Paul Scherrer Inst.**
 - Highly competitive: **8:1** request:funding rate
 - Skin-in-the-game: averaging **20% cost sharing** (voluntary)
 - Highly productive: **16 patents, 321 journal pubs, 351 conf pubs, 45 PhDs, 1 book+10 chapters**
- **Facilities: Open access to a wide range of accelerator capabilities** (~\$37M since 2014)
 - BNL-Accelerator Test Facility (~\$6M/year)
 - Since 2014: Provided **>16,400 hours to users**
 - Currently supports **29** active experiments (**2:1** request:approval rate)
 - Aggressive upgrade profile: historically, **20%** of budget is for facility upgrades
 - **39 journal pubs, 47 conf pubs, 5 PhDs**
 - A.S. Test Facility Program (~\$0.3M/year)
 - Facilitates access to most Office of Science lab accelerator capabilities; sponsors “Open House” events
 - **3 patents+1 business follow-on, 1 journal pub, 8 conf pubs...**
- **Program Planning** (~\$1.8M since 2014)
 - 4 Workshops, 3 RFIs, 1 NAS Study, 1 Data Call, 2 AS&T Sector Strategy Plans
 - Considering PI Meetings in Washington DC to promote contact with other Federal Agencies
 - Coordinated with DHS, DOD-AFOSR,-DARPA,-ONR, DOE-BES, -FES, -HEP, -NP, -IP, -NNSA, NIH-NCI, and NSF-MPS