Report on the DOE HEP Accelerator and Technology Division and on the GARD Review

Eric R. Colby
Office of High Energy Physics
HEPAP Meeting December 5-6, 2024

Acknowledgement: Special thanks to Zachary Goff-Eldredge, Derun Li, Jeremy Love, Helmut Marsiske, and Glen Crawford for materials used in this presentation. Any errors herein are my responsibility.

U.S. Department of ENERGY | Office of Science

Energy.gov/science

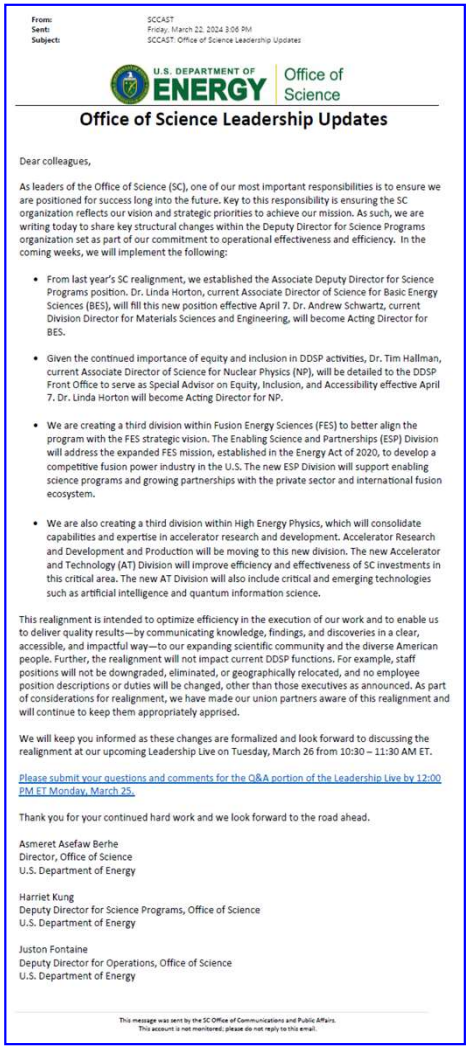
Outline

- Overview of A&T Division
  - Accelerator Programs
  - Instrumentation, Detector, and Microelectronics R&D
  - AI/ML & Computational HEP
  - QIS
  - SBIR/STTR
- GARD Lab Review
- Looking Ahead
  - Planning activities, Funding opportunities,…

Office of Science Realignment

Announced March 22, 2024:

- **Named Linda Horton as Associate DDSP**
  - Named Andy Schwartz acting AD for BES
- **Established a DE&I Special Advisor to the DDSP**
  - Detailed Tim Hallman to this role
  - Named Linda Horton acting AD for NP
- **Established a 3rd Fusion Energy Sciences division**
  - Enabling Science and Partnerships ("ESP") Division
  - *"…develop a competitive fusion power industry…support enabling science programs…"*
- **Established a 3rd High Energy Physics division**
  - Accelerator & Technology ("A&T") Division
  - Concentration of technologies in one division
  - *"…will improve efficiency and effectiveness of SC investments in this critical area…"*
  - Relocated ARDAP programs back into HEP



From: SCCAST
Sent: Friday, March 22, 2024 3:06 PM
Subject: SCCAST: Office of Science Leadership Updates

U.S. DEPARTMENT OF ENERGY | Office of Science

Office of Science Leadership Updates

Dear colleagues,

As leaders of the Office of Science (SC), one of our most important responsibilities is to ensure we are positioned for success long into the future. Key to this responsibility is ensuring the SC organization reflects our vision and strategic priorities to achieve our mission. As such, we are writing today to share key structural changes within the Deputy Director for Science Programs organization set as part of our commitment to operational effectiveness and efficiency. In the coming weeks, we will implement the following:

- From last year's SC realignment, we established the Associate Deputy Director for Science Programs position. Dr. Linda Horton, current Associate Director of Science for Basic Energy Sciences (BES), will fill this new position effective April 7. Dr. Andrew Schwartz, current Division Director for Materials Sciences and Engineering, will become Acting Director for BES.
- Given the continued importance of equity and inclusion in DDSP activities, Dr. Tim Hallman, current Associate Director of Science for Nuclear Physics (NP), will be detailed to the DDSP Front Office to serve as Special Advisor on Equity, Inclusion, and Accessibility effective April 7. Dr. Linda Horton will become Acting Director for NP.
- We are creating a third division within Fusion Energy Sciences (FES) to better align the program with the FES strategic vision. The Enabling Science and Partnerships (ESP) Division will address the expanded FES mission, established in the Energy Act of 2020, to develop a competitive fusion power industry in the U.S. The new ESP Division will support enabling science programs and growing partnerships with the private sector and international fusion ecosystem.
- We are also creating a third division within High Energy Physics, which will consolidate capabilities and expertise in accelerator research and development. Accelerator Research and Development and Production will be moving to this new division. The new Accelerator and Technology (AT) Division will improve efficiency and effectiveness of SC investments in this critical area. The new AT Division will also include critical and emerging technologies such as artificial intelligence and quantum information science.

This realignment is intended to optimize efficiency in the execution of our work and to enable us to deliver quality results—by communicating knowledge, findings, and discoveries in a clear, accessible, and impactful way—to our expanding scientific community and the diverse American people. Further, the realignment will not impact current DDSP functions. For example, staff positions will not be downgraded, eliminated, or geographically relocated, and no employee position descriptions or duties will be changed, other than those executives as announced. As part of considerations for realignment, we have made our union partners aware of this realignment and will continue to keep them appropriately apprised.

We will keep you informed as these changes are formalized and look forward to discussing the realignment at our upcoming Leadership Live on Tuesday, March 26 from 10:30 – 11:30 AM ET.

Please submit your questions and comments for the Q&A portion of the Leadership Live by 12:00 PM ET Monday, March 25.

Thank you for your continued hard work and we look forward to the road ahead.

Asmeret Asefaw Berhe
Director, Office of Science
U.S. Department of Energy

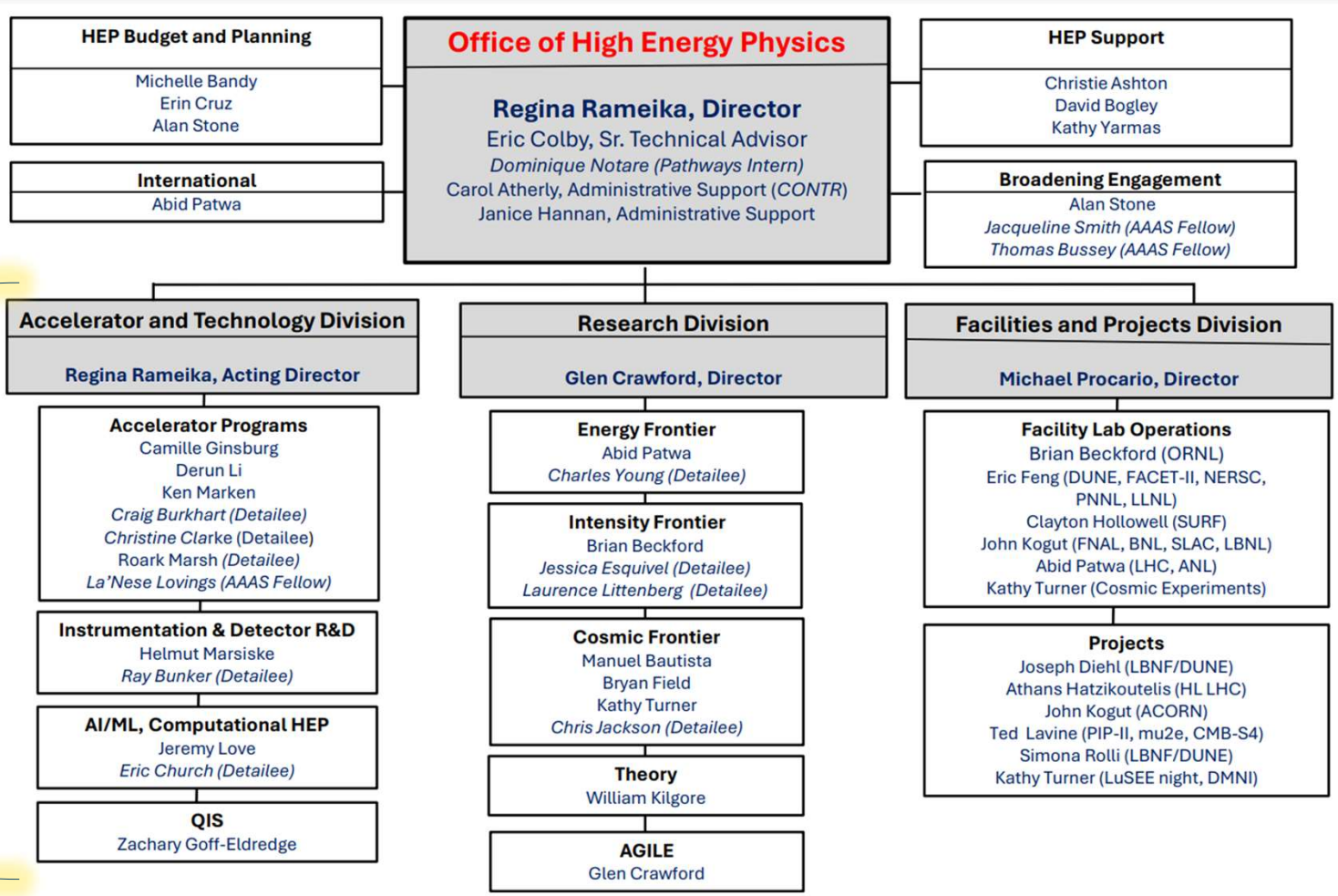
Harriet Kung
Deputy Director for Science Programs, Office of Science
U.S. Department of Energy

Juston Fontaine
Deputy Director for Operations, Office of Science
U.S. Department of Energy

This message was sent by the SC Office of Communications and Public Affairs.
This account is not monitored; please do not reply to this email.

New HEP Organization

New A&T Division

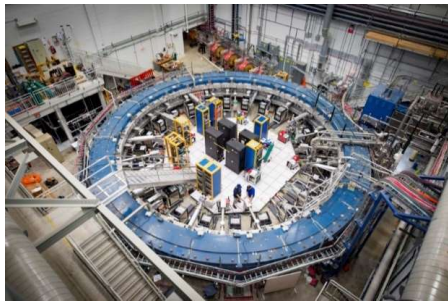


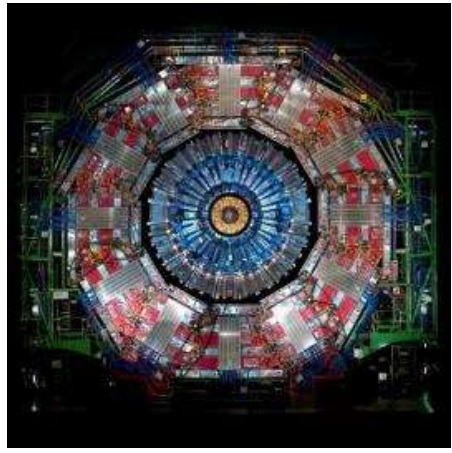
A&T Division is Mission-Driven

- *The mission of the HEP program is to understand how the universe works at its most fundamental level by discovering the elementary constituents of matter and energy, probing the interactions between them, and exploring the basic nature of space and time.*

- A&T Division R&D is correspondingly "mission-driven":
  - Develops and supports a specific portfolio of projects. ***Emphasis is placed on supporting science collaborations in all stages; conducting experiments; and seeking the best possible science results.***
  - Makes ***significant, coherent contributions to facilities/experiments*** selected for the program, including project management.
  - Supports ***R&D that will advance the state-of-the-art in particle accelerators and detectors***, which will lead to new, more capable facilities.
  - Supports ***R&D to enable new and transformative capabilities in QIS, AI/MI***, and crosscutting technology areas

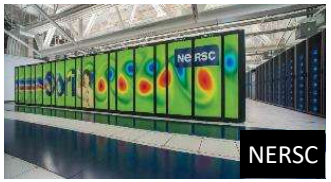
- HEP Prioritization is informed by P5 and subsequent program planning activities
- Cross-SC coordination occurs through topical coordination and joint oversight groups

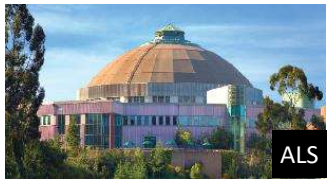


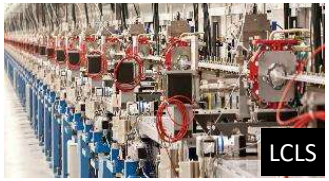


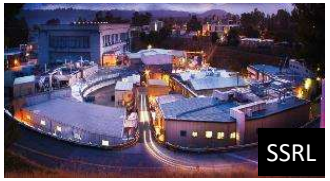
Office of Science User Facilities

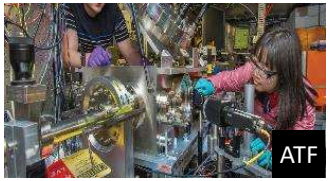
FY 2024
28 scientific user facilities
>39,600 users

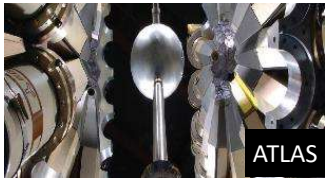








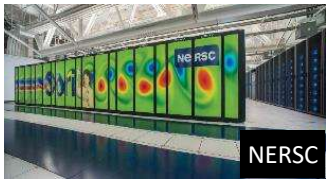


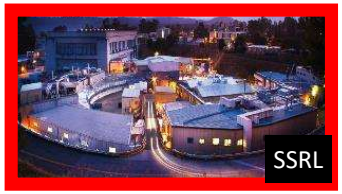


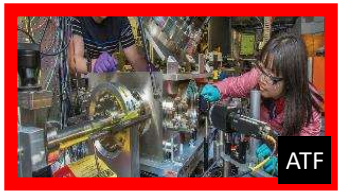
U.S. DEPARTMENT OF ENERGY
Office of Science

Office of Science User Facilities

FY 2024
15 accelerator-based facilities
>14,800 users
(37%)







U.S. DEPARTMENT OF ENERGY
Office of Science

New Accelerator & Technology Division Strengthens and Broadens HEP's Stewardship of Technologies for 21st Century Instruments of Science

The new division works synergistically with other SC programs and federal agencies on five connected technology areas:

- Accelerator Technology
  - General Accelerator R&D – focused on HEP's needs
  - Accelerator Stewardship* – focused on basic R&D benefiting SC programs and industrial applications
  - Accelerator Development* – focused on strengthening US accelerator technology suppliers

  ← formerly ARDAP
- Instrumentation & Detector Technology
  - Next-generation sensors, materials, advanced front-end electronics for extreme environments
- Microelectronics
  - ASICs for integrated sensor/processor/communication architectures
- Computational HEP & Artificial Intelligence/Machine Learning
  - Simulation, data processing, and automation of accelerators and experiments
- Quantum Information Science
  - QIS theory (e.g., quantum error correction, quantum gravity), quantum sensing for HEP experiments

* The Accelerator Stewardship and Accelerator Development activities move back into HEP in FY 2026 from the former Office of Accelerator R&D and Production.

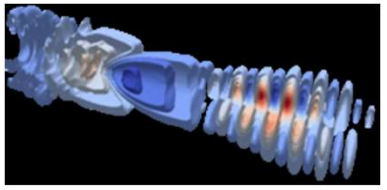
Accelerator Programs

- General Accelerator R&D (GARD)
- Directed Accelerator R&D
- Facility Operations & Experiment Support
- Acceleration Stewardship & Accelerator Development

General Accelerator R&D

Derun Li, Ken Marken, Craig Burkhart (D)
Brian Beckford

- Goals
  - *Support world-leading basic R&D to identify and develop the next generation of accelerator technology. Train the accelerator workforce. Foster international collaboration.*
- Thrust Areas
  - **Accelerator and Beam Physics** (includes modeling, simulation as well as beam instrumentation and controls)
  - **Advanced Accelerator Concepts** (includes beam and laser driven wakefield accelerators, beam manipulations and high gradient RF breakdown studies)
  - **Particle Sources and Targetry**
  - **RF Acceleration Technology** (includes SRF, NCRF and RF Sources)
  - **Superconducting Magnets and Materials**
- User/Test Facility Operations
  - ATF@FNAL, IOTA/FAST at Fermilab, AWA at ANL, BELLA at LBNL and NLCTA at SLAC;
  - Excluding FACET-II@SLAC (Facility Division) and ATF@BNL (ARDAP).
- Workforce Development
  - US Particle Accelerator School
  - DOE Accelerator Traineeship (next call FY 2026)
- International Collaboration
  - US-Japan Collaborative Accelerator R&D and ILC Cost-reduction R&D



LBNL

Fermilab

USPAS

Directed Accelerator R&D
Facility Operations and Experimental Support

Derun Li, Ken Marken, Craig Burkhart (D)
Eric Colby

- Directed Accelerator R&D
  - Goals
    - *Support risk-reduction R&D, technology transfer, and vendor preparation for accelerator technologies needed for a specific HEP facility.*
  - Prior examples: LARP, MAP
  - No currently funded projects, but major technology R&D for (e.g.) a Higgs Factory might have a DARD-funded phase

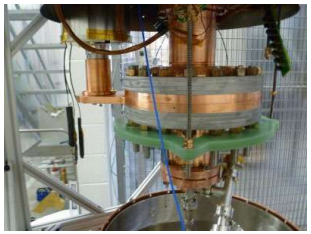
- Facility Operations and Experimental Support (FY 2026-on)
  - Goals
    - *Support the capabilities (facilities and expertise) needed to enable R&D, operations support, and project construction support. Provide greater visibility of what costs are "R&D" and what is "facilities"*
  - Facilities included
    - Accelerator: Fermilab ATF, BELLA, FACET-II, Brookhaven ATF*
    - Detector: Fermilab Detector Infrastructure and Facilities

*Brookhaven ATF funding moves under HEP in FY 2026

Accelerator Stewardship & Accelerator Development

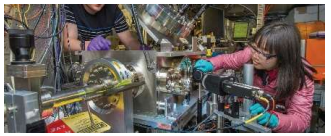
Eric Colby, Camille Ginsburg,
Roark Marsh (D), Christine Clarke (D),
La'Nese Lovings (AAAS), Dominique Notare (Pathways)

- Goals
  - *Support accelerator R&D of broad benefit to federal programs and industry. Facilitate access to accelerator test capabilities. Broaden and strengthen the accelerator community.*
- Research
  - Accelerator Stewardship
    - Support cross-cutting R&D in selected AS&T areas (to TRL ≤4)
    - Support Brookhaven ATF as an SC User Facility and the BeamNetUS network of test beam facilities
    - Support workforce development and building R&D capacity
  - Accelerator Development
    - Transition AS&T to broader uses and develop capable U.S. vendors
- Facilities
  - Brookhaven ATF (dedicated SC User Facility), 9 additional beam test facilities (BeamNetUS)
- SC Coordination
  - Maintain a strategic picture of SC's AS&T needs and worldwide competition, facilitating coordination of R&D across SC
    - SC Accelerator Workforce Roundtable
    - Accelerator Technology Market Sector studies
  - Chair the SC Accelerator Joint Oversight Group



JLAB

beamNetUS
accelerating beam based research



Brookhaven

Accelerator Stewardship Follow-Up Study

Dominique Notare
(Pathways)

- Continuously track "standard" metrics on *active* awards
  - 518 Journal Articles, 584 Conference Papers, 62 New Technologies, 53 Dissertations, 31 patents, 14 new software packages, 10 inventions, 6 book chapters, …
- Wanted a more in-depth look at what happened *after* awards ended
- 68 prior award recipients surveyed to assess follow-on benefits. 36 responded to eight survey questions. Four are shown here:
  - How did the Accelerator Stewardship help you foster collaboration with other people…and advance your professional development?
    - Average score = **6.46 (highest score)**
    - Top answers: **"Led to more support" 36%, "Inspired new experiments" 17%**
  - What were the most important impacts of your Accelerator Stewardship project to the accelerator community or other scientific fields?
    - Average score = **6.20**
    - Top answers: **"Scientific Advancement" 36%, "Increase Interest/Collaboration" 33%**
  - What lasting impact has your project had on advancing workforce development?
    - Average score = **6.12**
    - Including **21 PDs, 13 PhDs, 10 U/Gs, 3 Tech Staff, 6 interns/junior staff**
  - What improvements would you suggest for future iterations of Accelerator Stewardship?
    - Top answers: **changes to strict FOA rules 27%**, **"None" 25%, "More Funding" 14%**

1	2	3	4	5	6	7
Significantly Negative	Moderately Negative	Slightly Negative	Neutral Or N/A	Slightly Positive	Moderately Positive	Significantly Positive

"The Stewardship grant convened a community-wide [SC magnet] workshop that built lasting connections that have been sustained over 2 years since the grant ended."

"The award funded interactions with industry that made the [laser technology] invention possible."

"The Acceleration Stewardship program is excellent but it does not offer enough funding to make the difference that it could with more investment."

"We were able to offer a practical solution for high current CW linacs not available from industry. Most interest is from commercial applications such as food or water sterilization where cost and reliability are most important."

"The two Accelerator Stewardship projects I have worked on helped me establish collaborations with 3 industry partners, 4 universities with their own research institutions, and the air force research laboratory. The program was also instrumental in my professional development, including advancing from post doc to associate scientist and from associate scientist to staff scientist."

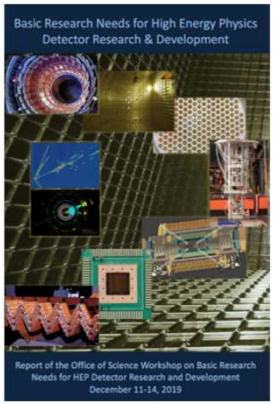
"I have not applied recently because I don't believe the chances of getting funded are worth my effort."

HEP Detector R&D and Microelectronics

Helmut Marsiske,
Ray Bunker (D)

Detector R&D

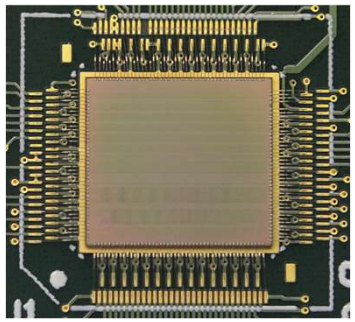
- Goals
  - *Support research leading to fundamental advances in the science of particle detection, and develop the next generation of instrumentation for HEP*
    - *Properly balanced between near-term/low-risk and transformative/long-term R&D and between universities and labs*
    - *Engage researchers from other fields and from industry*
  - *Provide research training in instrumentation, fostering the next generation of detector experts*
  - *Support "infrastructure" required for experimental detector R&D and fabrication*
- Research
  - Generic detector R&D that is broadly applicable, not specific to a single HEP experiment
  - Multi-institutional (consortium) proposals permitted to tackle significant technology challenges
- Workforce
  - Instrumentation Traineeships (next call: FY 2026)
- Facilities
  - FNAL Detector Test Facilities



https://science.osti.gov/-/media/hep/pdf/Reports/2020/DOE_Basic_Research_Needs_Study_on_High_Energy_Physics.pdf

Microelectronics Initiative

- Synergistic with HEP's leading efforts in integration (ASICs, novel materials), extreme environments (high rad, cryo), low power, high speed, and scalability to extreme channel counts and data rate
- HEP participated in the SC-wide Microelectronics Science Research Center Projects for Energy Efficiency and Extreme Environments, with successful applicants notified very recently



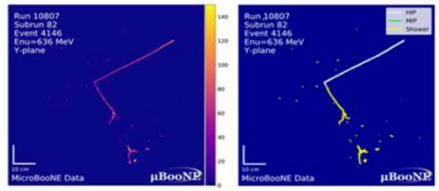
Fermilab

AI/ML & Computational HEP

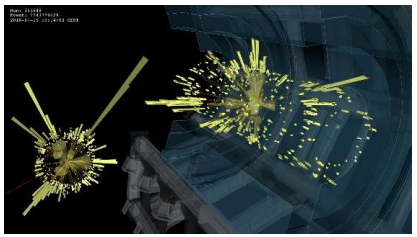
Covered earlier today by Jeremy Love

Jeremy Love,
Eric Church (D)

- AI/ML Initiative
  - Goals
    - *Support R&D that realizes the potential benefit of AI to accomplish the HEP mission by developing new advanced applications, increase the impact of AI on HEP, and broaden participation in HEP AI research*
  - Research
    - **Programmatic AI/ML** – Application of AI/ML to technical challenges that furthers the goals of HEP subprograms
      - Supported through all HEP NOFOs
    - **Core AI/ML – R&D** to develop new AI tools and applications for HEP that go beyond what is currently possible
      - Supported through dedicated calls and CompHEP program
- Computational HEP
  - Goals
    - *Addresses current and future computing challenges of broad interest to HEP programs*
  - Research
    - Priority research into advanced high-performance algorithms, applications of resource aware computing, and development of more advanced community tools
      - Leveraging ASCR resources efficiently (LCFs, SciDAC) where possible
  - Workforce
    - Computational HEP Traineeships (next call FY 2026)



MicroBooNE Collaboration


ATLAS Collaboration

Zachary Goff-Eldredge

Quantum Information Science

Covered earlier today by Zachary Goff-Eldredge

- Quantum Information Science
  - Goals
    - *Support R&D to develop technologies for computation, information processing, and detection that overcome classical limitations using quantum effects, specifically by:*
      - *Seizing the NQI opportunity, uniting the QIS-HEP cutting edges, and opening new horizons*
  - Research
    - National QIS Research Center
      - Fermilab-led Superconducting Quantum Materials and Systems center, leveraging deep SRF expertise and detector expertise to build world-class capabilities in 2D and 3D superconducting technologies and apply those to basic science goals.
    - QuantISED calls for proposals
      - Topics
        - Theory – QIS methods applicable to HEP
        - Sensing – QIS/AMO techniques applied to provide ultrasensitive detection methods
        - Pathfinders – new concepts for experiments that could open new approaches to fundamental science
      - Announcements for the FY25 and ongoing awards coming soon!

Fermilab

SQMS

SBIR/STTR Programs

PM: Ken Marken
TTMs: Derun Li, Craig Burkhart (D), Jeremy Love, Helmut Marsiske, Ray Bunker (D), Eric Colby, Roark Marsh (D), Christine Clarke (D).

- Goals
  - *Stimulate technological innovation*
  - *Use small business to meet Federal R&D needs*
  - *Foster and encourage participation by disadvantaged small businesses*
  - *Increase private sector commercialization of innovations derived from Federal R&D*
  - *Stimulate and foster innovation through cooperative research and development*
  - *Foster technology transfer between small businesses and research institutions*

- We choose topics to complement the A&T core technology programs
  - Awards size/duration
    - $206.5k/1 year for a Phase I
    - $1.15M/2 years for a Phase II
  - Topics include materials, components, software, and modest subsystems
  - Poll Labs for topic suggestions each year
    - Need to keep in mind the 3-year latency!
    - Most successful awards have a “champion” at the Lab

- Recent changes
  - SBIR “tax base” no longer includes facility operations, only R&D
    - Significant reduction in number of awards
  - HEP moved back to “Release 1”

FY 2025 Phase I Release 1 Topics

https://science.osti.gov/-/media/sbir/pdf/funding/2024/FY25-Phase-I-Release-1-Topics07122024V2.pdf

GARD Review *a.k.a.*
DOE Program Review of HEP Laboratory General Accelerator R&D

- A comparative review of the major GARD-funded accelerator R&D programs at the DOE Labs
  - Focused on the largest programs at
    - ANL, BNL, FNAL, LBNL, and SLAC
    - Excludes FACET-II operations (funded separately)
    - Covers roughly 83% of entire GARD portfolio
- Held August 5-9, 2024
  - Five Labs visited in-person on five consecutive days
  - Prior review was 2018
  - This review delayed by covid
- Report is under final review (not yet released)

2024 GARD Review Panelists

Panelist	Institution	Topics
Michiko Minty	BNL	ABP/Instr. & diagnostics
Andrei Seryi	JLab	AAC and ABP
Robert Rimmer	JLab	RF technology
Pietro Musumeci	UCLA	AAC
Sarah Cousineau	SNS	ABP
Felicie Albert	LLNL	AAC
Matthias Liepe	Cornell U.	RF Technology (SRF)
Lance Cooley	FSU	SCM
Yuhu Zhai	PPPL	SCM
Yue Hao	MSU	ABP

GARD Review Charge

For each laboratory's GARD research group, we request a specific evaluation and comment on

1) The quality and impact of the research accomplishments by the group since the last review in 2018.
2) The scientific significance, merit, and feasibility of the proposed research.
3) The competence and future promise of the group for carrying out the proposed research.
4) The adequacy of resources for conducting the proposed research, and cost-effectiveness of the research investment.
5) The quality of support and infrastructure provided by the laboratory.
6) For a laboratory where an experimental facility exists, provide an assessment of:
   - The reliability and cost containment of operation.
   - The condition of the facility. What is the deferred maintenance backlog and its associated risk and cost?
7) For a laboratory where an experimental facility exists, provide an assessment of (continued):
   - How impactful is the experimental portfolio of the facility to achieving the goals of the GARD roadmaps, and accelerator science in general?
   - How to meet users research needs and feedback?
   - Is the facility well suited to conduct these experiments?
   - Could some or all the experimental work be conducted at other test facilities?
7) How does the group benefit the laboratory's experimental program (as applicable) and how well do the group's activities relate to the overall HEP mission?
8) The effectiveness of management in strategic planning, developing, and maintaining appropriate core competencies (including key workforce skills), implementing a prioritized and optimized program, promoting diversity and inclusiveness, and promoting and implementing a safe work environment.

In addition to the review charges, we request Committee members to provide:

- A comparative assessment of each lab's overall performance in these areas relative to its peers, as well as an assessment versus comparable university groups;
- General findings and comments about the status, future promise and alignments with the 2023 P5 recommendations of the programmatic thrust areas listed above, for example:
  - What are the expected deliverables of this research thrust in the next 5-10 years? Are adequate resources in place to plausibly achieve these goals?
  - Do the labs have sufficient technical and management infrastructure to reliably deliver the goals for this programmatic area and respond to new developments?
  - What is the benefit of additional investments in this thrust? What are the likely impacts of reduced investments?
  - Does the current workforce meet present and future R&D needs? Provide comments and suggestions on the future workforce needs in this thrust.

GARD Review findings and final report

- General findings
  - Reaffirmed GARD's vital role advancing accelerator technology and sustaining U.S. leadership
  - Indicated, in light of P5, the need to re-examine the balance of activities in the portfolio
  - Emphasized the importance of strengthening workforce development efforts and fostering collaboration between national labs and universities to ensure a continued pipeline of talent

- Report is under final review (not yet released)

Looking Ahead

- Program Planning
- Funding Opportunities

A&T Program Planning

In addition to the 2023 P5 report, HEPAP, and interagency working groups, the A&T Program develops detailed planning inputs with help from community workshops and roundtable meetings. Upcoming workshops and meeting include:

- Accelerator R&D
  - SC Accelerator Workforce Roundtable meeting -- *scheduled in FY25Q2*
  - Bright Sources Basic Research Needs Workshop -- *planned for later in FY25*
  - Community is encouraged to hold a workshop to refresh and reinvigorate its approach to RF accelerators
  - Additional Accelerator Stewardship workshops -- *are planned*

SC Accelerator Science & Engineering Workforce Roundtable Meeting

- Instrumentation & Detector R&D
  - Coordinating Panel for Advanced Detectors (CPAD) Workshop -- *occurs annually*

CPAD 2024

- AI/ML and Computation HEP
  - SC-wide AI Roundtables -- *report planned for FY25Q3*
  - HEP-focused AI/ML Basic Research Needs Workshop -- *is planned*

Artificial Intelligence (AI) Initiatives in the Office of Science Roundtables
User Facility Science and Operations Roundtable

- QIS
  - Additional HEP QIS workshops -- *are planned*

Funding Opportunities

- Technology R&D Funding
  - SC-wide Calls
    - SC Open Call ⇔ HEP Comparative Review – *FY 2025 cycle under review now*
      - GARD, Detector R&D, Computational HEP, Programmatic AI/ML
    - QIS – National QIS Research Center – *anticipated in FY 2025*
    - SBIR/STTR – HEP topics are in *Release 1*
  - Dedicated HEP-led Calls
    - FY2025 Accelerator Stewardship/Accelerator Development – *planned for FY2025Q2*
    - Core AI/ML : AI for HEP Theory and Data Analysis – *planned for FY2025Q3*
    - QuantISED 2.0 – *FY 2024 cycle under review now*
    - US-Japan – *now planned for FY2026*

Proposal solicitations, previously known as "Funding Opportunity Announcements" or "FOAs" are now called "**Notices of Funding Opportunities**" or "**NOFOs**".

As always, please read the ~~FOA~~ NOFO carefully!
New OMB guidance has led to significant format changes, with some key information moving to different sections w.r.t. the older FOA format.

- Workforce Development and New Research Capability Funding
  - SC-wide Calls
    - Early Career Research Program – *imminent!*
    - EPSCoR Implementation Grants – *Applications due 1/29/2025 (pre-App is required)*
  - Dedicated HEP-led Calls
    - HEP Graduate Traineeships – *next call planned for FY 2026*
    - Supplemental Awards to existing HEP Traineeships (Accelerator & Computing) to include AI/ML thesis topics – *planned for FY2025Q2*

Conclusion

- HEP continues to play a vital role as the high-end innovator and consumer of technology to conduct scientific research
  - Required increases in performance require appropriate levels of risk-taking and investment
  - Many technologies needed for HEP are also needed by programs across the federal government and in industry
    - Working synergistically across programs and with industry is essential
- The restructuring of HEP's R&T Division and reincorporation of ARDAP were both done in recognition of the importance of technology R&D and of HEP's stewardship role for SC and the wider community
  - It is hoped that, in the context of an SC program, it will be possible to grow the overall technology budget without negatively impacting HEP's core research programs
- Exciting work and opportunities lie ahead to align and strengthen the A&T programs
  - Help us when we reach out to you for information, workshop participation, peer review
  - We're always looking for strong candidates to help in the Office – speak with us if you are interested!