Office of Science Statement of Commitment & other Guidance

- **SC Statement of Commitment** – SC is fully and unconditionally committed to fostering safe, diverse, equitable, inclusive, and accessible work, research, and funding environments that value mutual respect and personal integrity. https://science.osti.gov/SW-DEI/SC-Statement-of-Commitment
- **Expectations for Professional Behaviors** –SC's expectations of all participants to positively contribute to a professional, inclusive meeting that fosters a safe and welcoming environment for conducting scientific business, as well as outlines behaviors that are unacceptable and potential ramifications for unprofessional behavior. https://science.osti.gov/SW-DEI/DOE-Diversity-Equity-and-Inclusion-Policies/Harassment
- **How to Address or Report Behaviors of Concern**– Process on how and who to report issues, including the distinction between reporting on unprofessional, disrespectful, or disruptive behaviors, and behaviors that constitute a violation of Federal civil rights statutes. https://science.osti.gov/SW-DEI/DOE-Diversity-Equity-and-Inclusion-Policies/How-to-Report-a-Complaint
- **Implicit Bias** – Be aware of implicit bias, understand its nature – everyone has them - and implicit bias if not mitigated can negatively impact the quality and inclusiveness of scientific discussions that contribute to a successful meeting. https://kirwaninstitute.osu.edu/article/understanding-implicit-bias

Office of Science
Office Hours
Office of Accelerator R&D and Production
"ARDAP"

Eric Colby
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U.S. DEPARTMENT OF ENERGY | Office of Science

Energy.gov/science

3/13/2024

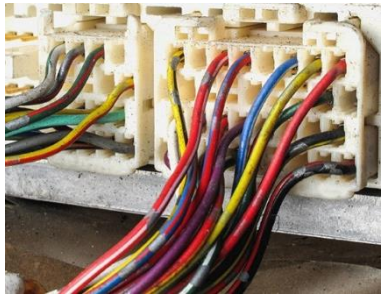
Outline

- Broad overview of how particle accelerators are used
- Specific overview of how particle accelerators are used in scientific research
- How and why Office of Science funds accelerator science and technology
- ARDAP's role in accelerator R&D
- How can we engage? Who's eligible? What do you fund?

How are particle accelerators used?

Impacts and Benefits of Particle Accelerators

- **Impacts**
  - 5.2 million cancer patients are treated each year with particle accelerators [1]
  - $300 B worth of semiconductors are treated annually with ion implanters [2]
  - $85 B worth of tires, insulation, and heat-shrink tubing are processed annually with e-beam systems [3]
  - In 2012, approximately 70 accelerator manufacturers sold more than 1,100 new accelerators with a combined market value of $2.2B [4]
- **As of 2014, an estimated 42,200 accelerators are in operation worldwide [5]**
  - 64% Industrial use [~6% CAGR*]
  - 33% Medical use [~9% CAGR]
  - 3% Basic research [~0.9% CAGR]



[1] E. Zubizarreta, J. Van Dyk, Y. Lievens, Clinical Oncology, **29**(2), p. 84-92, (2017).
[2] M. Florio, A. Bastianin, P. Castelnovo, NIM A, **909** 21-26 (2018).
[3] Industrial Radiation with Electron Beams and X-rays, published by the IIA, (2011).
[4] R. Hamm, M. Hamm, Industrial Accelerators and their Applications, World Scientific, (2012)
[5] A.P. Chernyaev, S. M. Varzar, Phys. At. Nucl. **77** (10), p. 1203-15 (2014).

*CAGR – Compound Annual Growth Rate

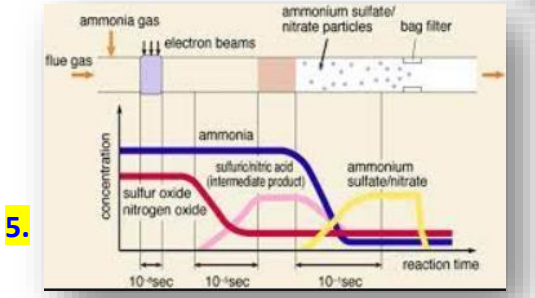
Energy & Environmental Accelerator Applications

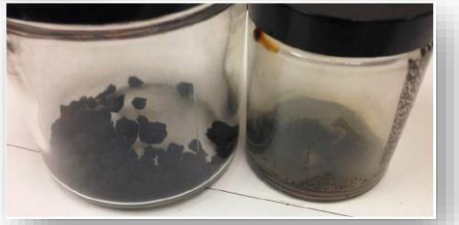
POSSIBLE WITH CURRENT TECHNOLOGY

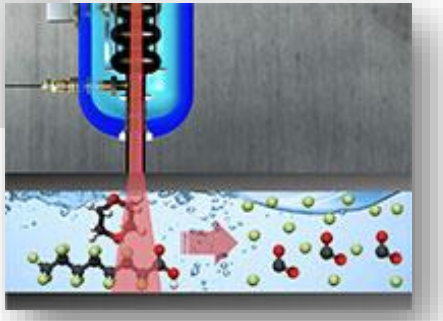
1. Treating the sludge for a city of 100,000
2. Treating the regulated medical waste for 10 cities of 100,000 ea
3. Sterilize water & medical waste at a WHO emergency site of 500 people
4. Sterilizing U. S. Government Mail
5. Treating the power plant SOX/NOX emissions for a city of 100,000

NOT POSSIBLE WITH CURRENT TECHNOLOGY

6. Upgrading heavy crude oil at a single wellhead
7. Treat entire industrial effluent stream of DuPont Circleville, OH Plant
8. Hardening 3 lane-miles per day of interstate highway
9. Emergency water treatment for Elk River, WV MCHM spill (2014)
10. Cleaning up an oil drilling site in two weeks
11. Treating entire domestic water supply for a city of 100,000

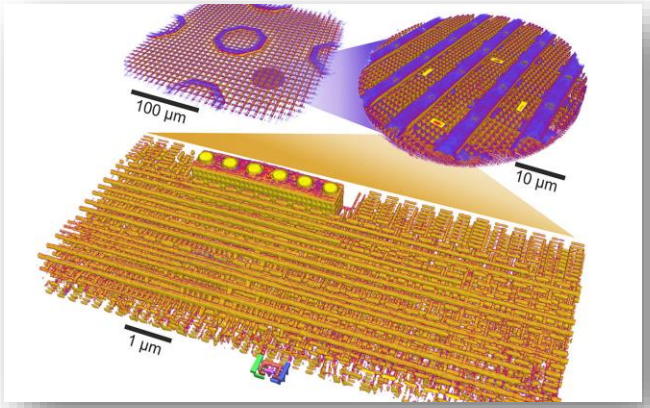




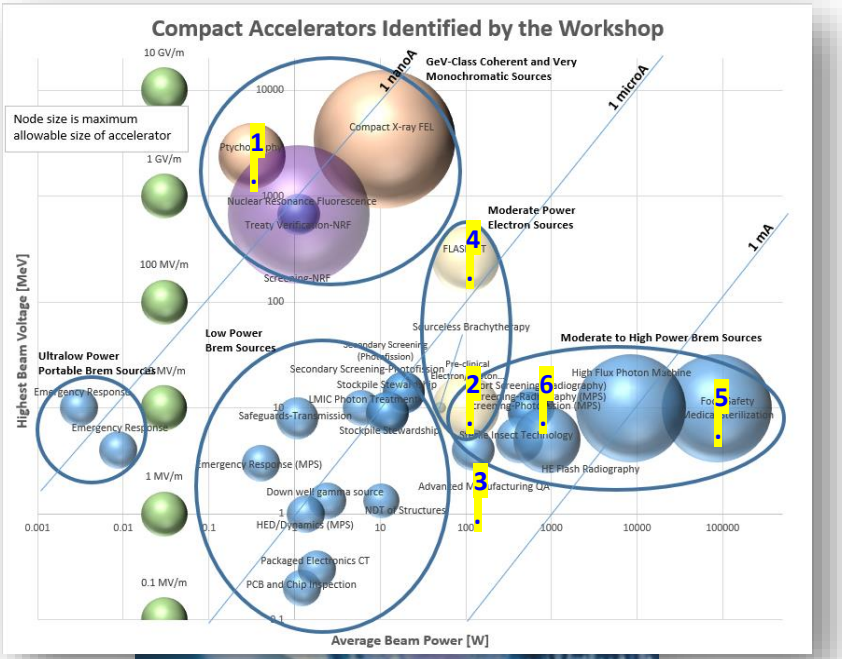


(P) – portable system required

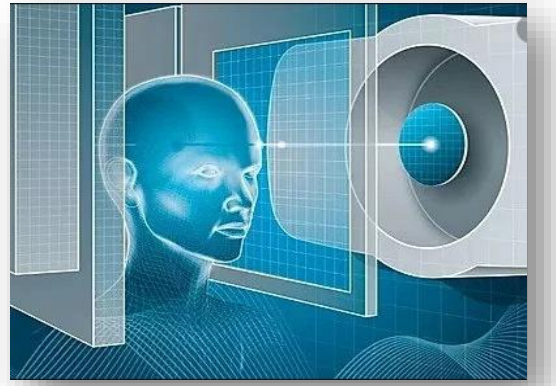
Accelerators in Security and Medicine



1. Ptychography

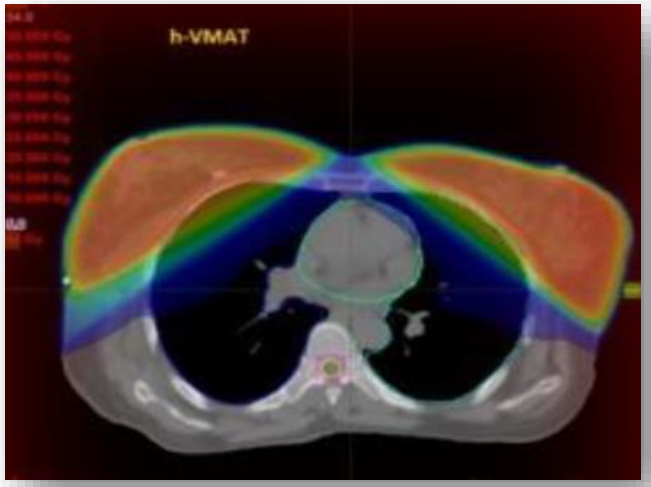


4.

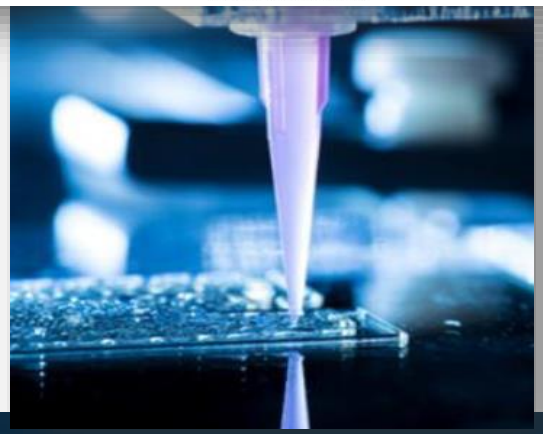


FLASH Radiotherapy

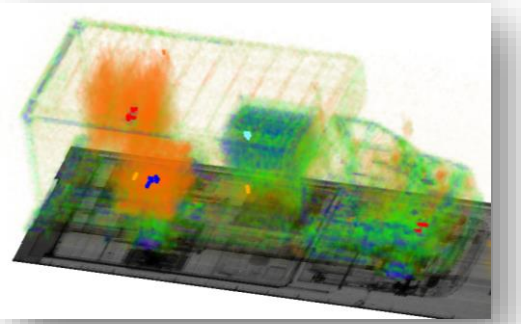
5. Food Safety



2. Conventional Radiotherapy



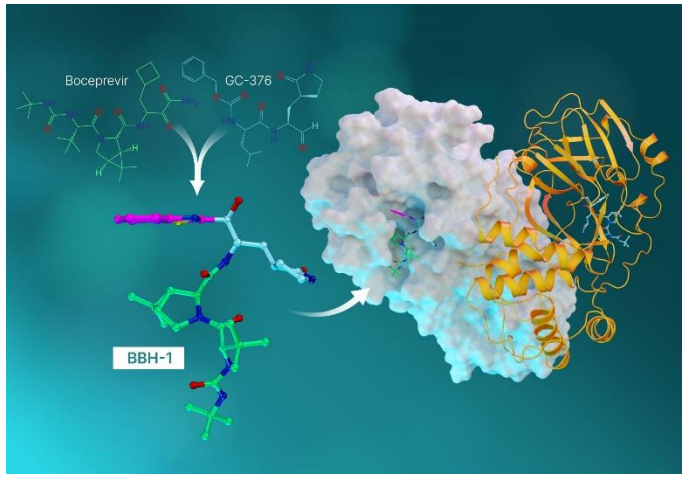
3. Adv. Manufacturing QA



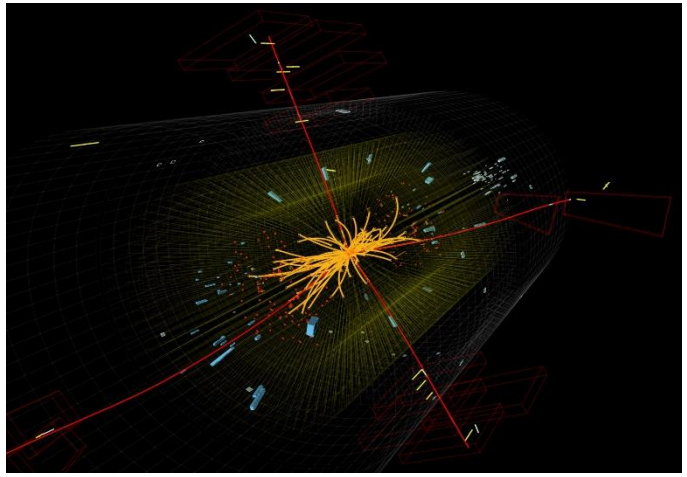
6. Port Screening

How are particle accelerators used in science?

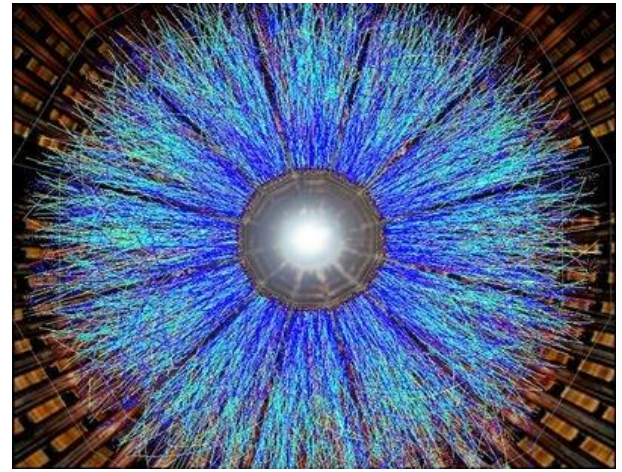
Science enabled by accelerator-based instruments



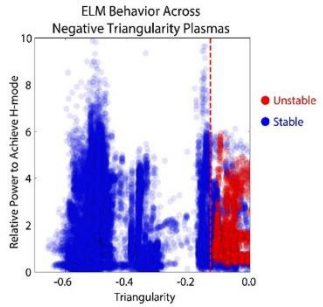
COVID drug intervention



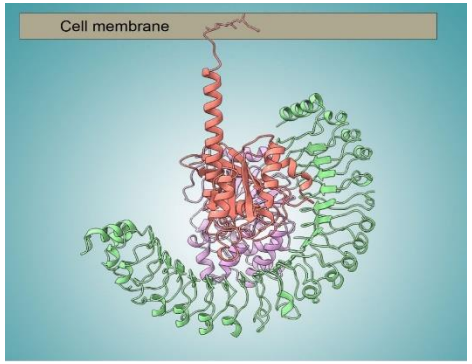
Higgs boson discovery



Quark-gluon plasma



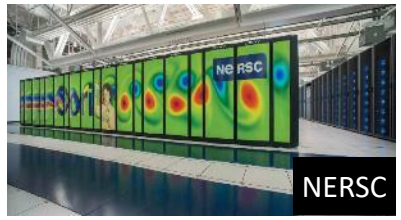
Fusion reactor stabilization

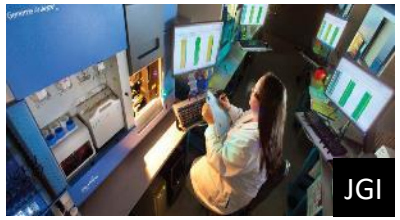


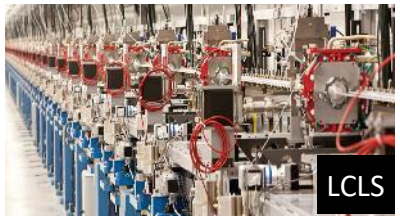
Cell replication signaling

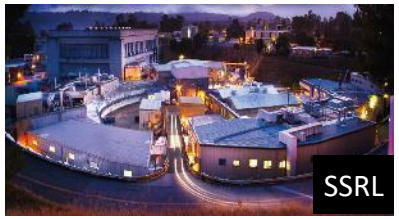
Office of Science User Facilities

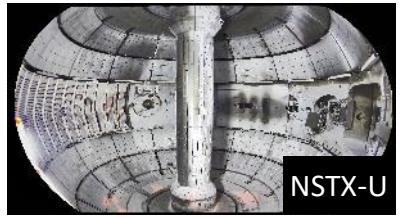
FY 2023
28 scientific
user facilities
>39,500 users

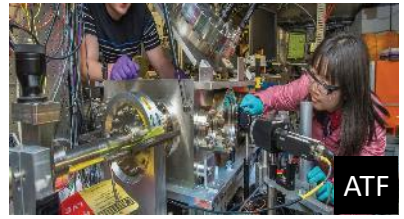












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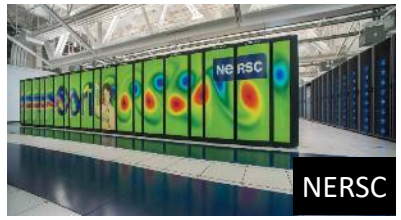
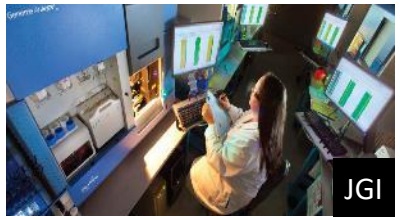
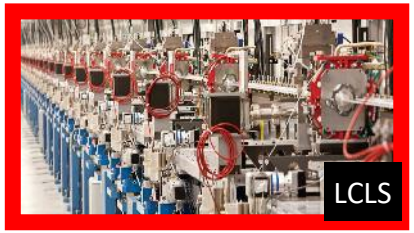
Office of Science

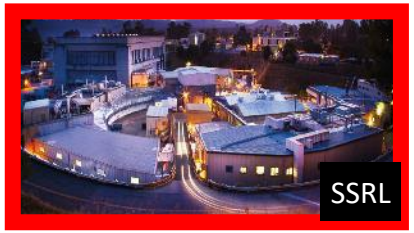
Office of Science User Facilities

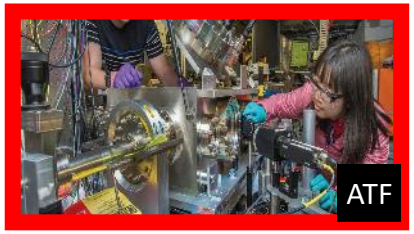
FY 2023
15 accelerator-based facilities
>16,800 users
(43%)











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Accelerator Technology Illustrated

APS (pre-upgrade)
Synchrotron light source
https://youtu.be/jts6HlkYnlE?t=69

SNS
Neutron Source
https://youtu.be/LOYmLVIQFyk?t=88

DIII-D
Fusion tokamak
https://youtu.be/tA7J2s23lB8?t=70

Fermilab
PIP-II
https://youtu.be/XgHJrzONl_s?t=82
Neutrino, muon sources
https://youtu.be/vElqxVUoKSE

CEBAF
Recirculating SRF linac
https://youtu.be/ZBZ5vXptuZ0?t=19

FRIB
Ion linac
https://youtu.be/EPG919lJK8s?t=79

RHIC
Ion Collider
https://youtu.be/ibb6NqTUqK8?t=94

BELLA
Laser Plasma Wakefield Accelerator
https://youtu.be/UWywzMkR6c0?t=231

LCLS-II video, https://youtu.be/6XTII6qaAxc?t=240

Office of Science R&D on Particle Accelerators

Principal areas of R&D interest

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.

Where can I learn about SC's accelerator technology needs?

- Each SC program maintains webpages with reports on its research needs and plans:
  - Basic Energy Sciences: https://science.osti.gov/bes/Community-Resources/Reports
  - Fusion Energy Science: https://science.osti.gov/fes/Community-Resources/Workshop-Reports
  - High Energy Physics: https://science.osti.gov/hep/Community-Resources/Reports
  - Nuclear Physics: https://science.osti.gov/np/Community-Resources/Reports
  - Accelerator R&D and Production: https://science.osti.gov/hep/Research/Accelerator-Stewardship/Workshop-Reports
  - Isotope Program: https://science.osti.gov/Isotope-Research-Development-and-Production/Resources/Reports

How can we find potential collaborators?

- For R&D partners of all types, search for authors of recent papers in your proposed topic area
- For DOE Lab partners specifically, there is the Lab Partnering Service
  https://www.energy.gov/technologytransitions/lab-partnering-service

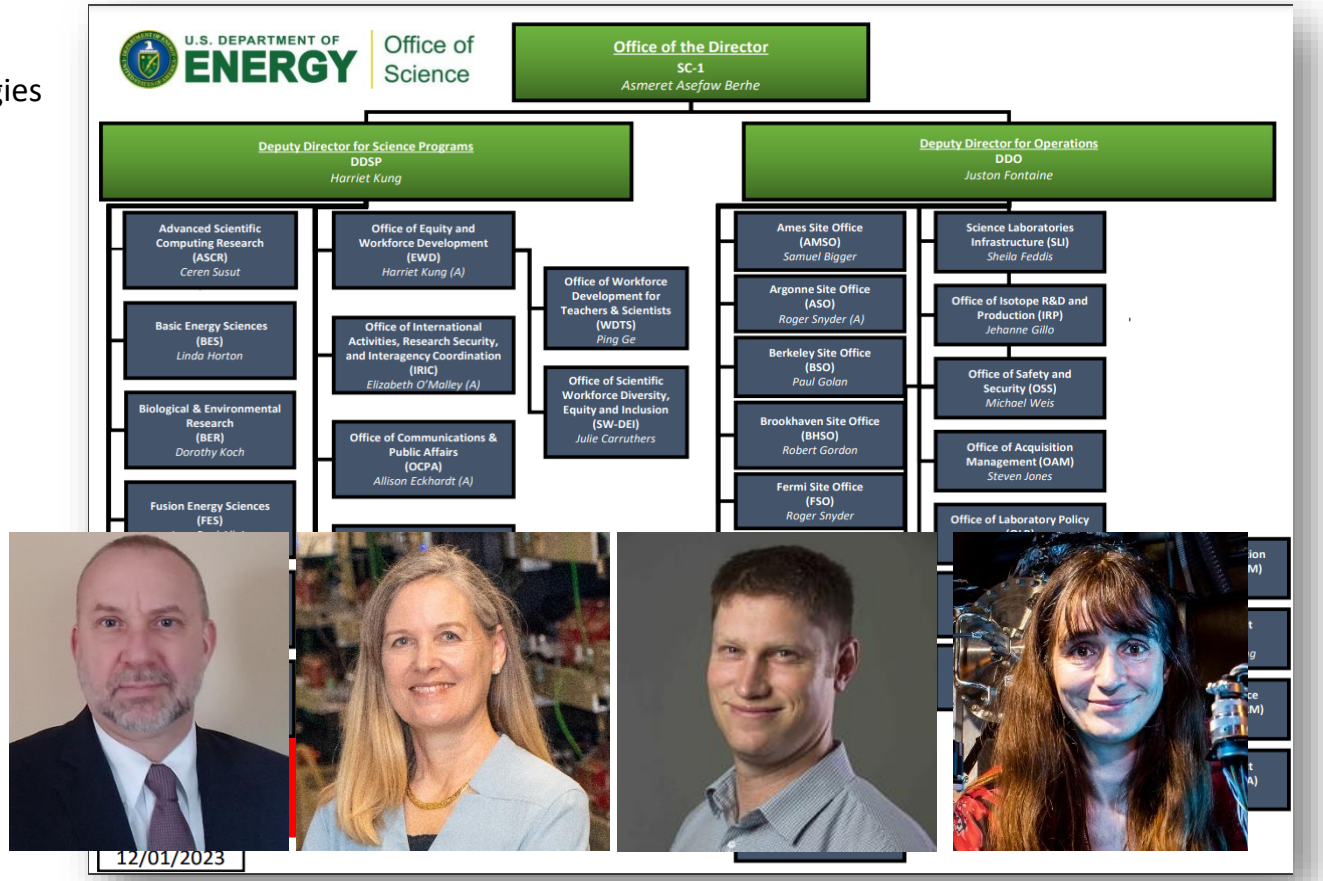
JACoW.org

Lab Partnering Service™

ARDAP's Role in Accelerator R&D

Who we are

- Established: April 12, 2020
  - Recognizing the central importance of accelerators and related technologies
  - CHIPS and Science and first appropriation in FY 2022
  - 2023 Realignment ARDAP moved to SC-3
- Budget in FY 2023: $27.4M
  - Accelerator Stewardship program
    - Operate Brookhaven ATF as SC User Facility
  - Accelerator Development program
  - FAIR and RENEW programs
  - SBIR, EPSCoR, ECRP, and SC-GSR programs
- Staff: ~3.5 FTE
  - Director – Eric R. Colby, 100% time
  - Deputy Director – Camille Ginsburg, 100% time
  - Physicist – Christine Clarke (detailee) 100% time
  - Physicist – Roark Marsh (detailee) ~50% time
  - Budget Support – Erin Cruz, Michelle Bandy (home office: HEP)
  - A&P Support – Christie Ashton, Carol Atherly (home office: HEP)



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What ARDAP does

Coordinate and make investments that address Accelerator Science & Technology (AS&T) gaps, ensuring that future U.S. accelerator-based physical science R&D priorities will be met.

Maintain a strategic picture of AS&T needs and worldwide competition, facilitating coordination of R&D across SC

Support cross-cutting R&D in selected AS&T areas

Support workforce development and build R&D capacity

Transitioning AS&T to broader uses and developing capable U.S. vendors

ARDAP Programs are aimed at strengthening US suppliers

- Ensure US competitive advantage in AS&T on decadal timescale
- **ARDAP Accelerator Research**
  - TRL 1 through TRL 4: Accelerator Stewardship (red rectangle)
  - Cross-cutting basic R&D on concepts and methods needed for multiple SC programs - PIs
  - Stewardship program creates additional market pull for SC-needed technologies, strengthening suppliers
- **ARDAP Accelerator Development**
  - MRL 1 - MRL 7: Accelerator Technology Production (blue rect)
  - ARDAP's Development program partners private industry with labs and universities to develop new (or better) suppliers of targeted technology
- **ARDAP Technology Maturation**
  - (Future) TRL 5 through TRL 7: Accelerator Technology Maturation sub-program (black dashed rectangle)

Accelerator Research		Accelerator Development	
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
Accelerator Tech Maturation			
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

From Technology Readiness Assessment Deskbook, July 2009,
http://www.skatelescope.org/public/2011-11-18_WBS-SOW_Development_Reference_Documents/ DoD_TRA_July_2009_Read_Version.pdf

How can I engage?

Funding Opportunity Announcement ("FOA"):
Research Opportunities in Accelerator Stewardship and Accelerator Development

Accelerator Stewardship

- **Track 1: Use-Inspired Basic R&D** – aimed at transitioning accelerator technology into medical, security, environmental, and industrial applications
- **Track 2: Cross-cutting Basic Accelerator R&D** – aimed at developing the foundations and new concepts of next-generation accelerator technology
- **Track 3: Accelerator Test Facility Program** – providing support for non-DOE institutions to use a DOE SC accelerator R&D capability

TRL≤4

Accelerator Development

- **Track 4a: Accelerator Technology Sector Business Plans** – funded studies of specific sectors of the accelerator technology ecosystem
- **Track 4b: Accelerator Technology Partnerships** – public-private partnerships to strengthen domestic suppliers of accelerator technology

TRL≤6, MRL≤7

Additional Funding Opportunities to Consider

New Research Capability Development

- **EPSCoR** – enhance R&D capabilities of institutions in designated states
  - https://science.osti.gov/bes/epscor
- **FAIR** – enhance R&D capabilities of MSIs and ERIs
  - https://science.osti.gov/Initiatives/FAIR

Career Development

- **Early Career Research Program** – for high-potential candidates ≤10 yrs post-PhD
  - https://science.osti.gov/early-career
- **RENEW** – internships at MSIs and ERIs
  - https://science.osti.gov/Initiatives/RENEW
- **SC-GSR** – 1 year of graduate support at a DOE lab
  - https://science.osti.gov/wdts/scgsr
- **SULI** – summer undergraduate DOE laboratory internships
  - https://science.osti.gov/wdts/suli

Technology Transfer

- **SBIR/STTR** – 1+2 years of funding to launch a new product
  - https://science.osti.gov/sbir/Funding-Opportunities

Office of Science User Facilities

- Open to all interested potential users without regard to nationality or institutional affiliation
- Each facility manages the allocation of facility resources through merit-based peer review of research proposals
- User fees are not charged for non-proprietary work if the user intends to publish the research results in the open literature
- Full cost recovery is required for proprietary work
- https://science.osti.gov/User-Facilities/User-Facilities-at-a-Glance

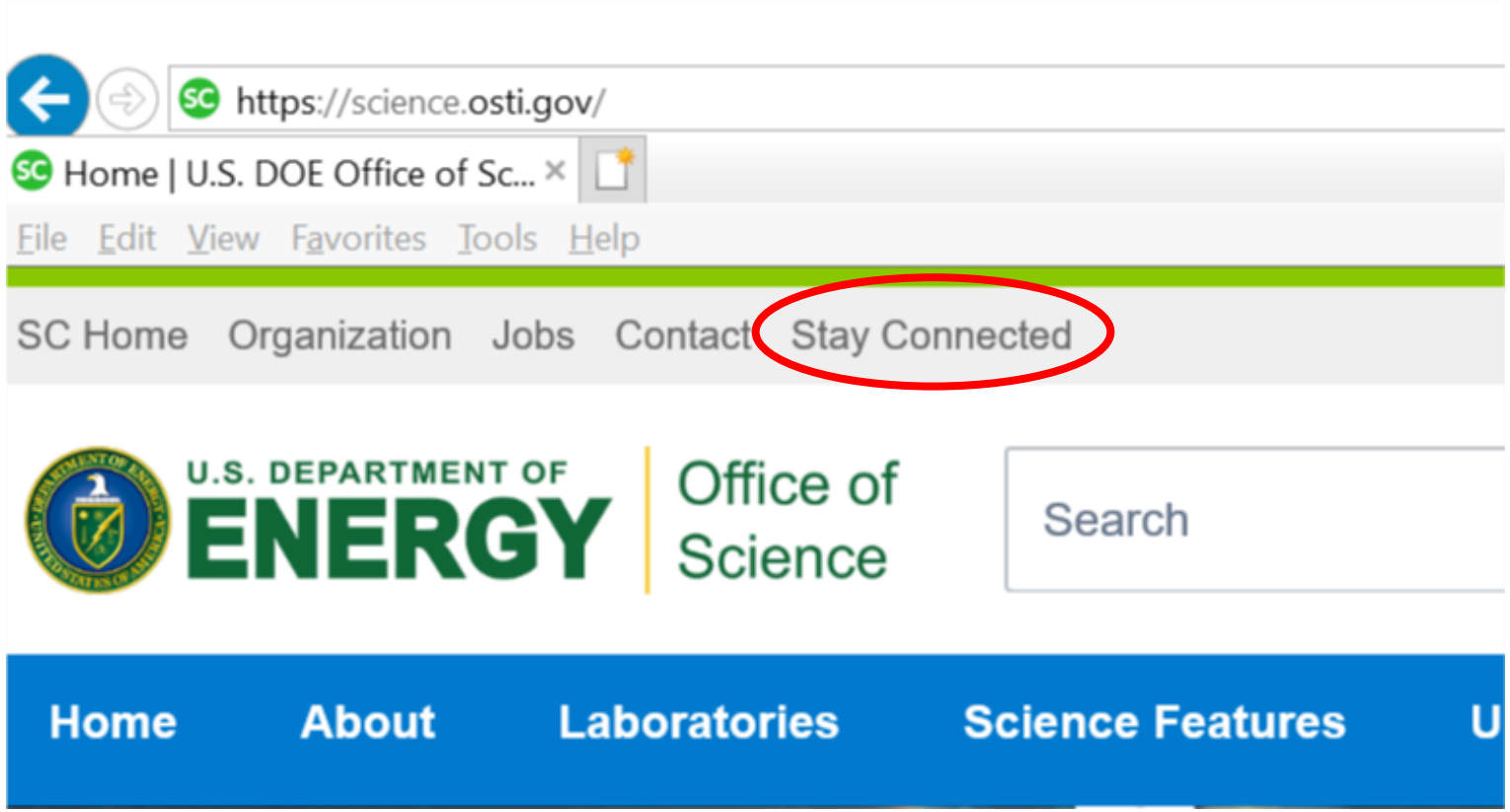
- Two facilities are dedicated to accelerator R&D:

https://science.osti.gov/ardap/Facilities/User-Facilities/ATF

https://science.osti.gov/hep/Facilities/User-Facilities/FACET-II

Stay Connected

- Receive Office of Science news by email or text
- Sign up for topics of interest
  - FOAs
  - Press releases
  - Meetings
  - Scientific topics
  - Program office news
- science.osti.gov
  - Stay Connected



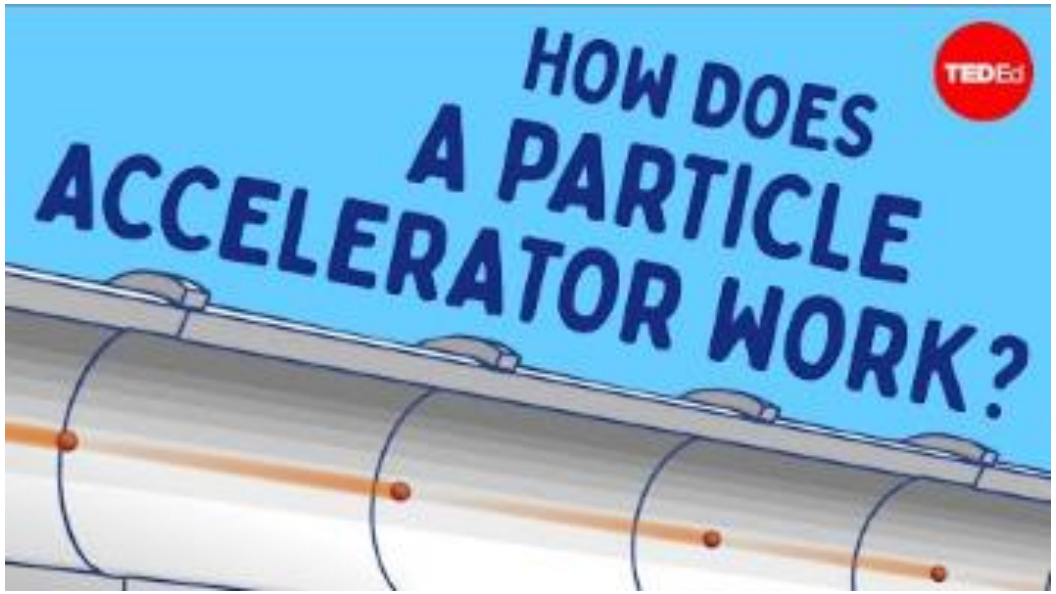
Upcoming Office Hours

- **Please complete the exit survey!**
  - **Tell us what you'd like to discuss at future office hours!**
- **Future Office Hours**
  - Wednesday, March 13, 2024 at 3pm ET – Introduction to Accelerator Science and ARDAP
  - **Wednesday, April 10, 2024 at 3pm ET – FOAs and Facilities for Accelerator Science**
  - **Wednesday, May 8, 2024 at 3pm ET – Writing a strong proposal and managing an award**

- **Reach out!**
  - Eric.Colby@science.doe.gov
  - Camille.Ginsburg@science.doe.gov

FOAs = Funding Opportunity Announcements ('DOE-speak' for "solicitations for proposals")

Don Lincoln movie about accelerator engineering



How does an atom-smashing particle accelerator work? - Don Lincoln 3:36

FY24 ARDAP FOA Tracks, Aims, Funding Amounts, Eligibility & Requirements

	Application Track	Aim	TRL Goal	MRL Goal	Typical Award	Applicant Eligibility	Teaming	Voluntary Cost Commitment	Application Length
Accelerator Stewardship	Track 1	Use-inspired basic R&D	≤TRL-4	None	$2M/ 3 yrs	All domestic	Required	Strongly Encouraged	16 pages
	Track 2	Cross-cutting basic R&D	≤TRL-4	None	$0.5M/ 3 yrs	Domestic universities	Encouraged	Encouraged	16 pages
	Track 3	DOE Test Facility Access for R&D	≤TRL-4	None	$300k/ 1 yr	Non-DOE domestic entities	Required	Encouraged	5 pages
Accelerator Development	Track 4a	R&D leading to Strategic Plans	planning	planning	$200k/ 1 yr	All domestic	Required	Encouraged	6 pages
	Track 4b	R&D Partnerships with private sector	≤TRL-6	≤MRL-7	$2M/ 2 yrs	Domestic companies	Required	Strongly Encouraged	18 pages