

Introduction to FES and Program Mission

SC FES Office Hours

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Fusion Energy Sciences

March 6, 2024



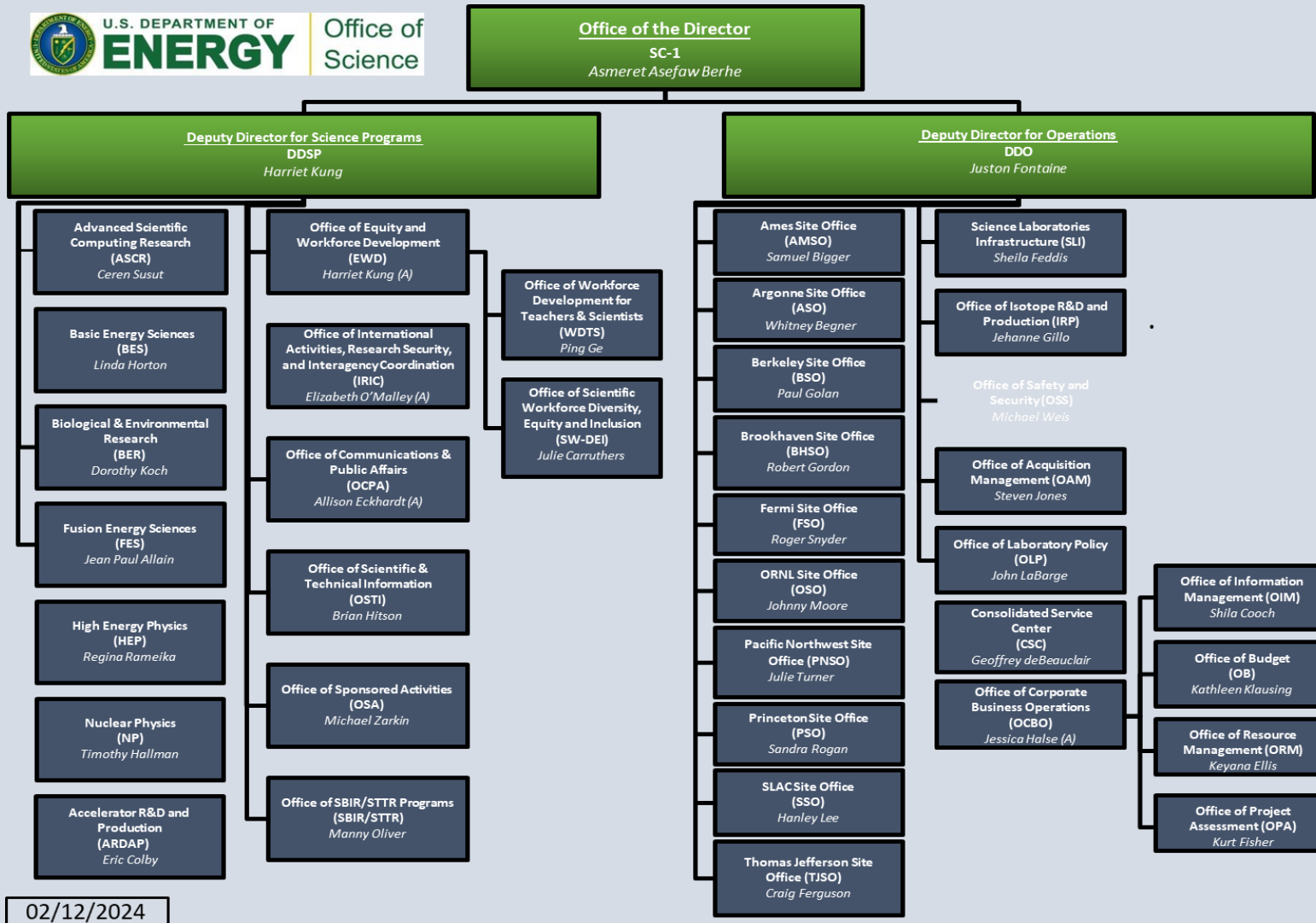
U.S. DEPARTMENT OF
ENERGY

Office of
Science

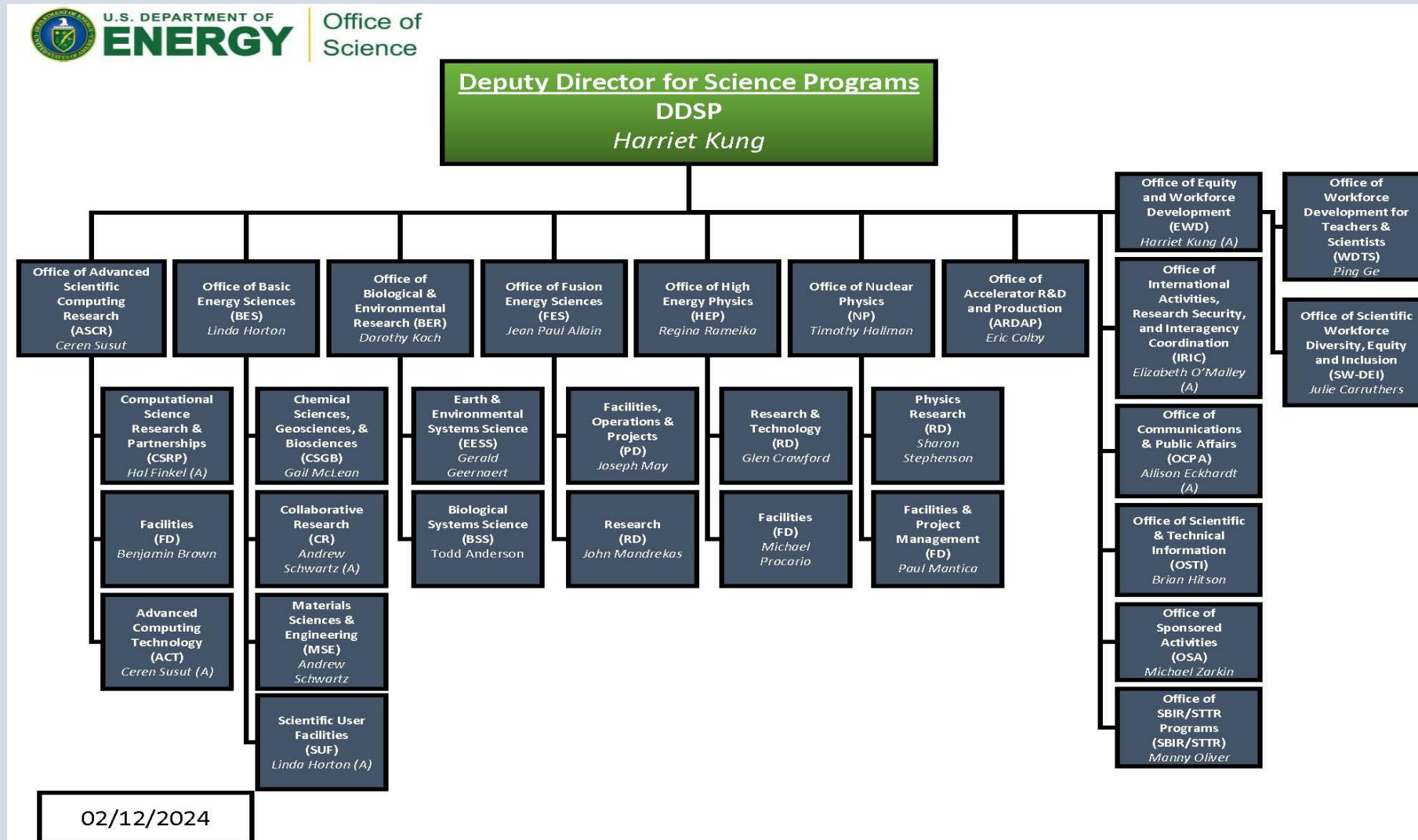
Office of Science Statement of Commitment & other Guidance

- ◆ **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>

SC Organization Chart - 1



SC Organization Chart - 2



FES Mission and Strategic Priorities

MISSION

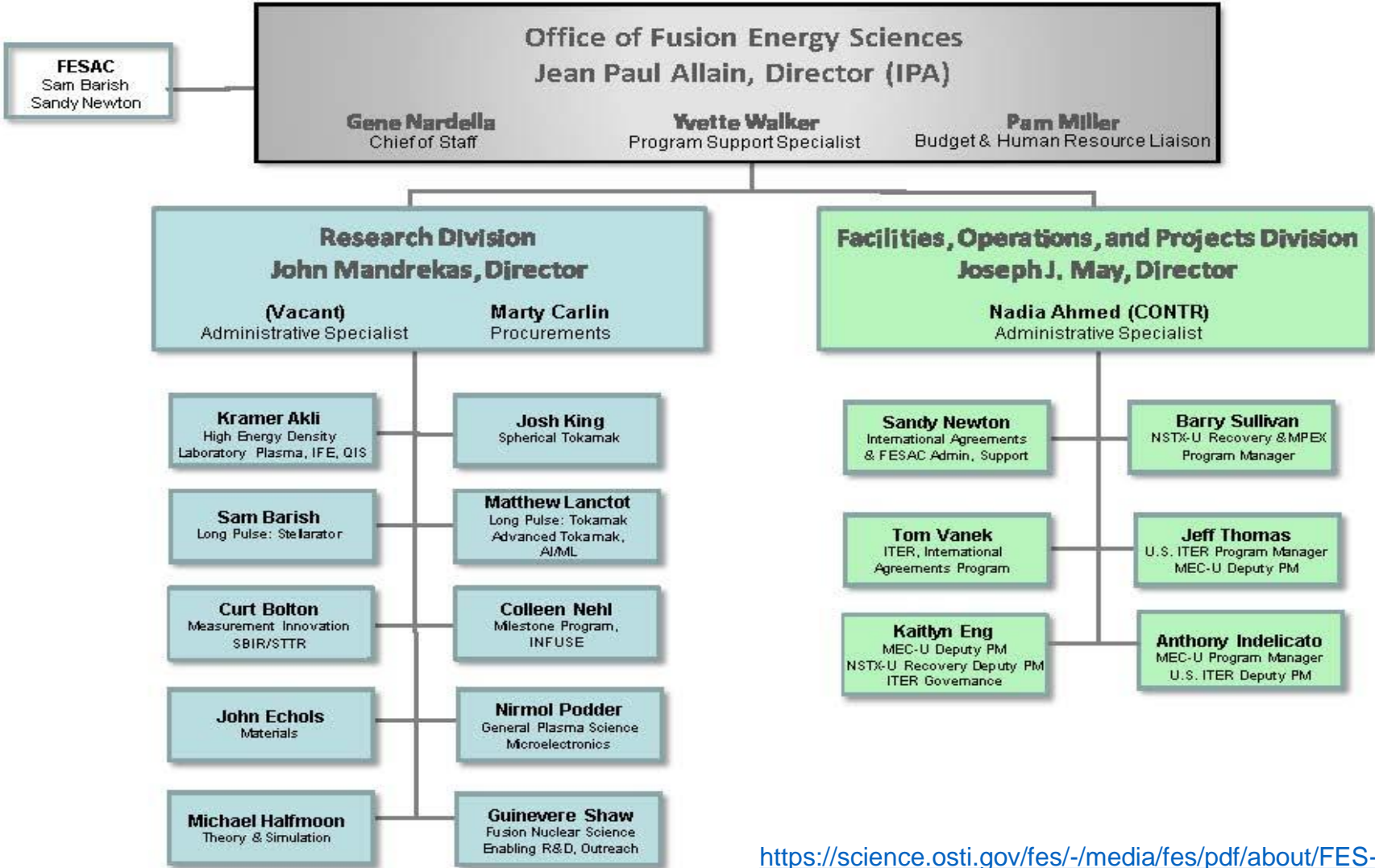
The mission of the Fusion Energy Sciences (FES) program is to expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundations needed to develop a fusion energy source. This is accomplished by the study of the plasma state and its interactions with its surroundings.

The Energy Act of 2020 expanded the scientific mission of FES to support “the development of a competitive fusion power industry in the U.S.”

FES PROGRAM PRIORITIES

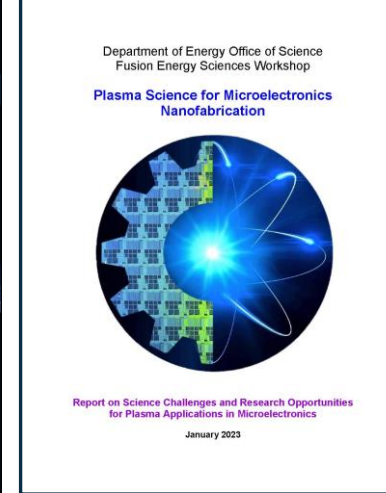
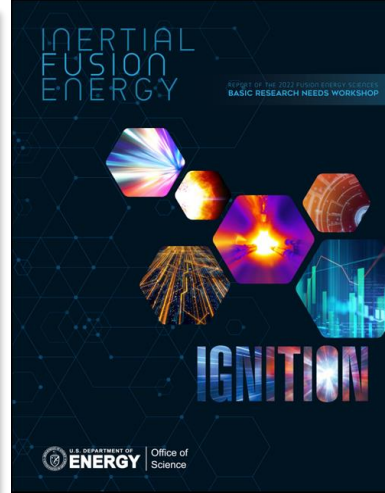
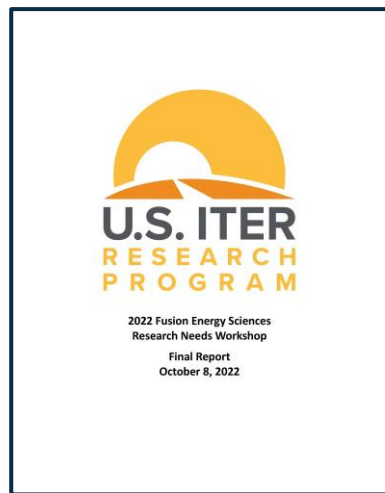
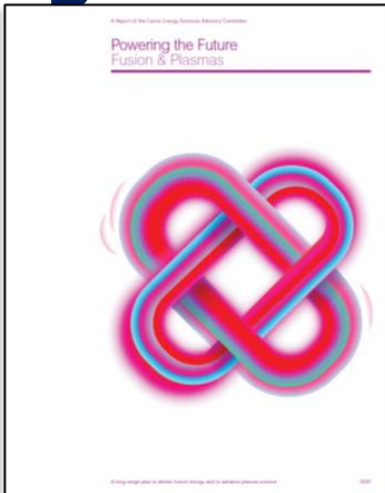
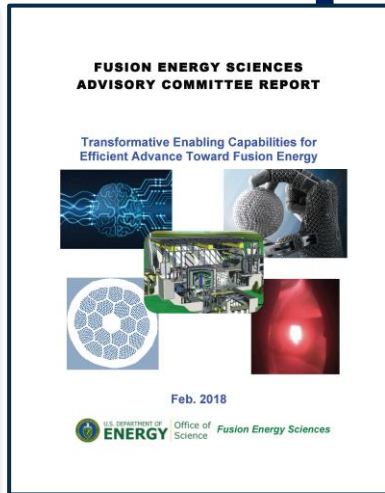
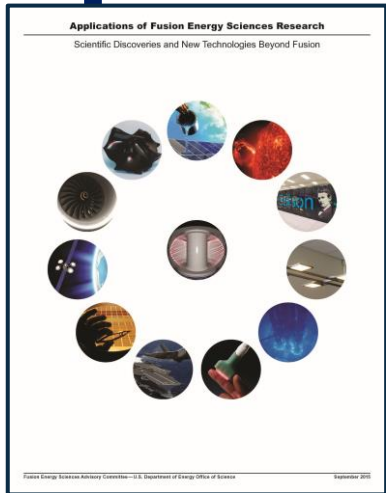
1. Accelerate fusion development as a carbon-free energy source via public-private partnerships (“bold decadal vision”)
2. Support R&D Fusion Centers (“FIRE” centers) to establish S&T basis of a Fusion Pilot Plant (FPP)
3. Continue U.S. participation in ITER to study burning plasma science and technology at power plant scale while expanding Inertial Fusion Energy (IFE) activities
4. Support discovery plasma science and technology
5. Broaden participation in fusion and DEIA activities to enable the program

FES Organization Chart



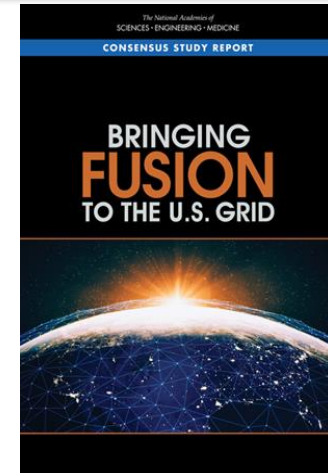
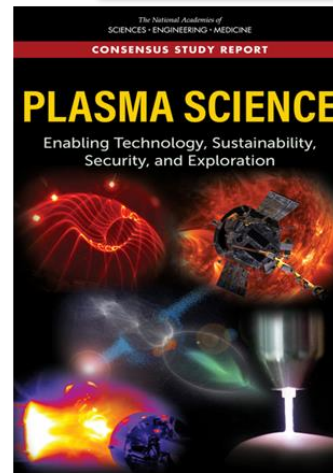
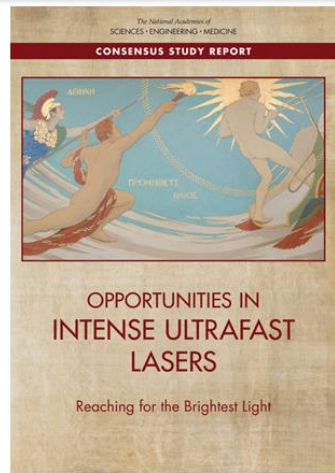
<https://science.osti.gov/fes/-/media/fes/pdf/about/FES-Org-Chart-Feb-2024.pdf>

Advisory Committee, National Academies, and workshop reports inform the program



FESAC

Community Workshops



NASEM

<https://science.osti.gov/fes/Community-Resources>



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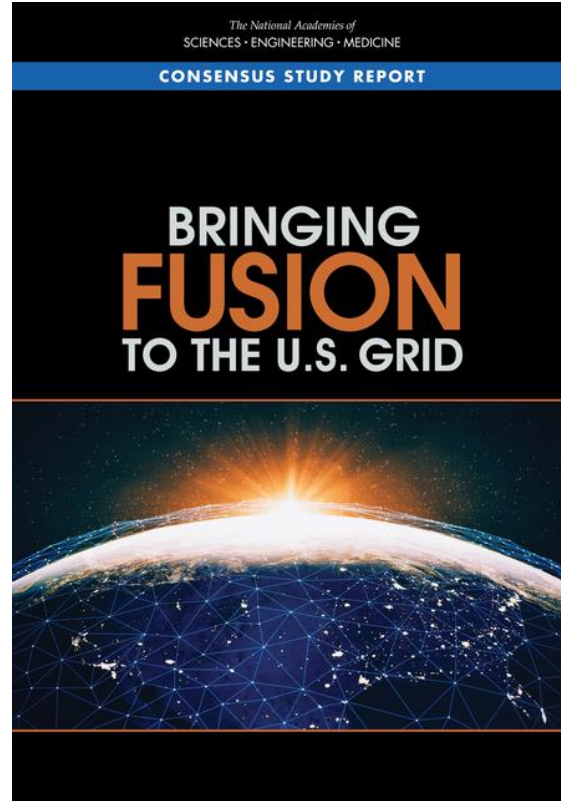
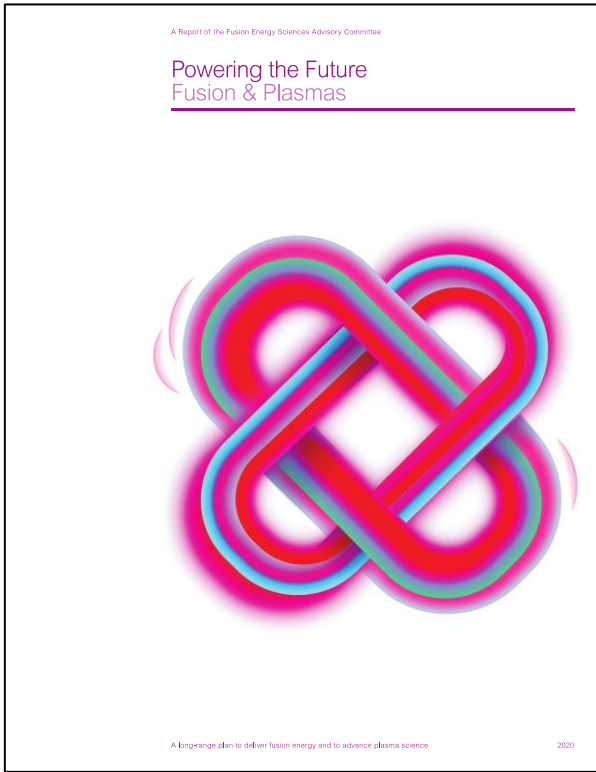


Image credit – Ana Kova / U.S. Fusion Outreach, AIP



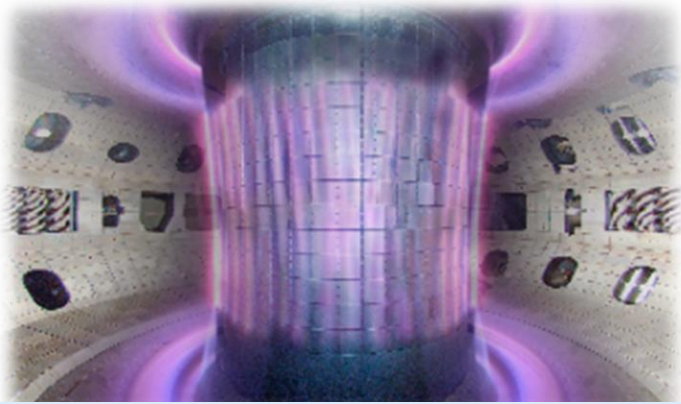
FESAC Long Range Plan is our fusion community’s **“values document”** charting a path to realize fusion energy

Bold Decadal Vision (BDV) for commercializing fusion energy changed the landscape and expectations

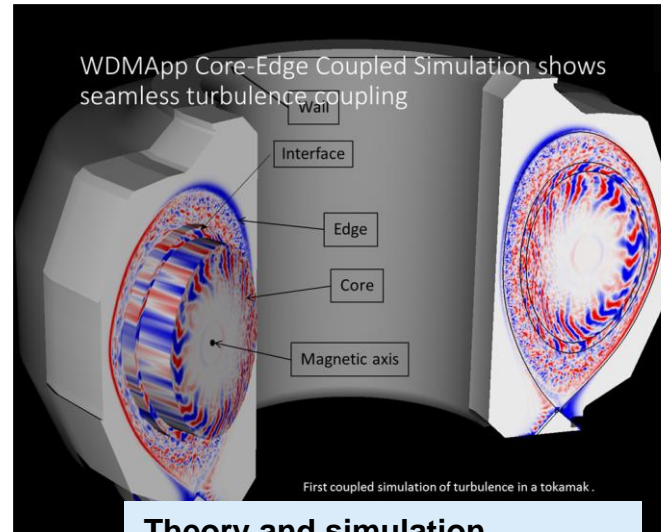
Core Research, Facilities, and Projects

Funding at 64 universities, 15 national laboratories, and 14 private companies

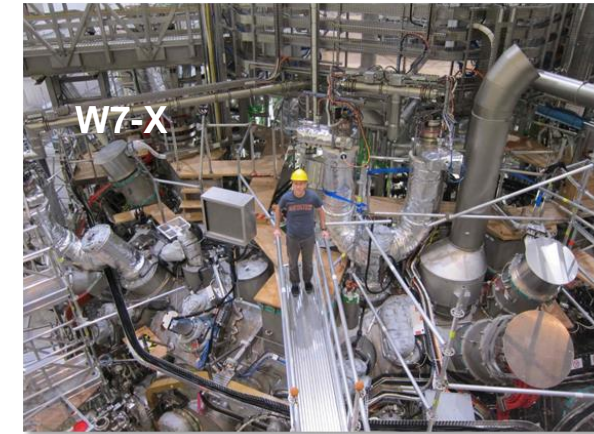
SC user facilities



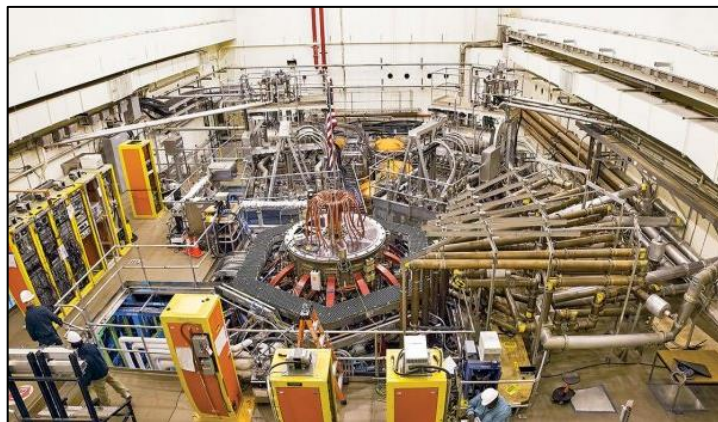
DIII-D National Fusion Facility



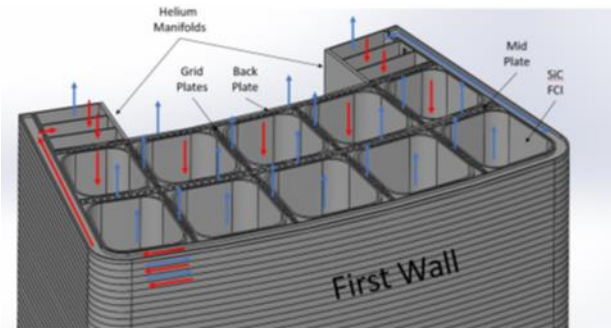
Theory and simulation



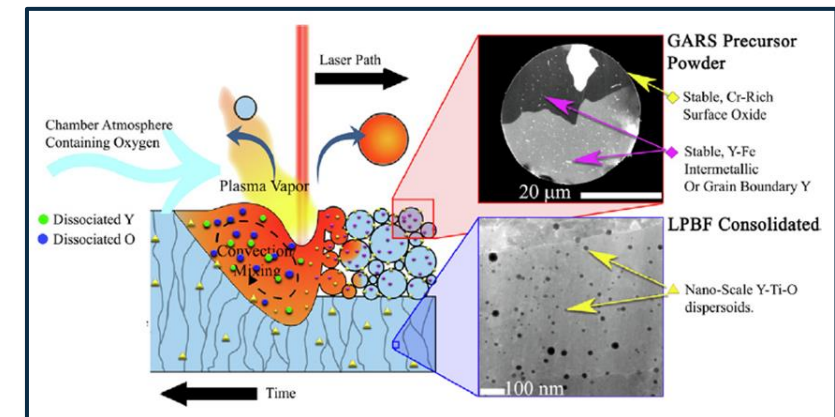
International Collaborations



National Spherical Torus Experiment-Upgrade

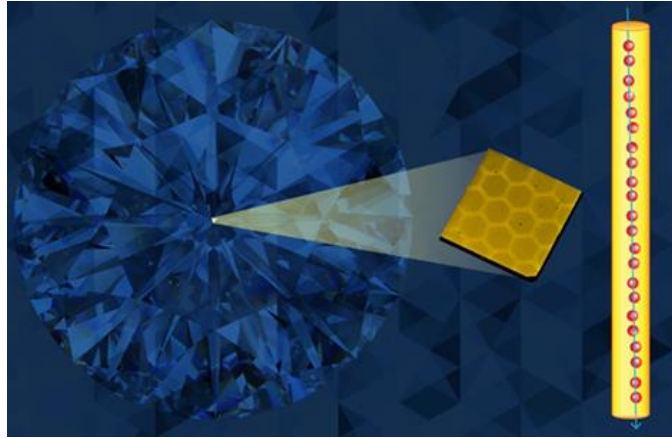


Fusion Nuclear Science

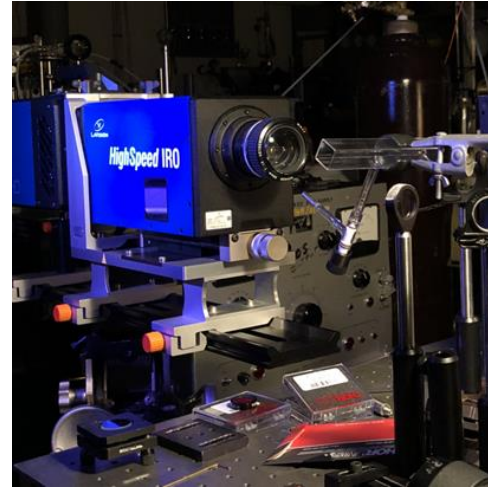


Materials Science / AM

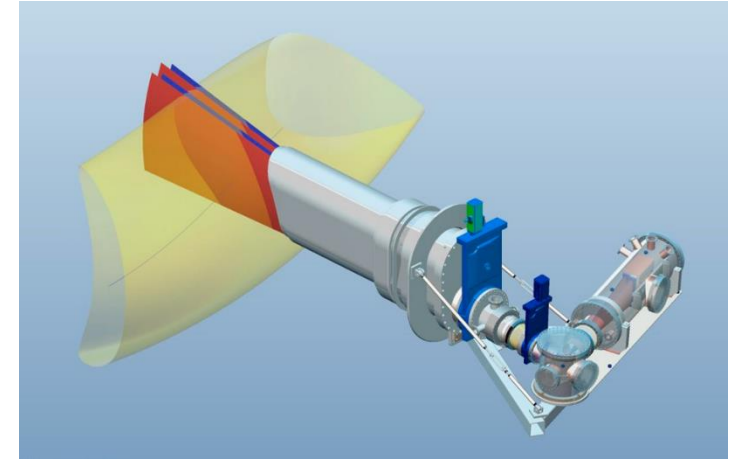
Core Research, Facilities, and Projects (cont.)



Quantum Information Science



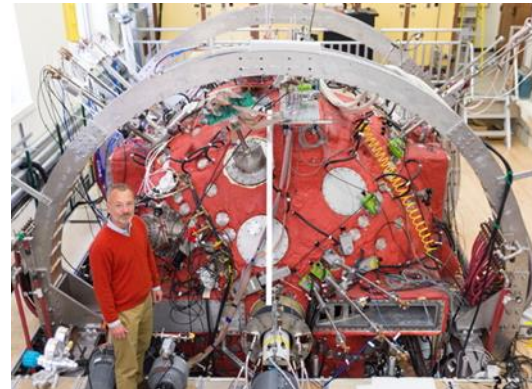
Low Temperature Plasmas & Microelectronics



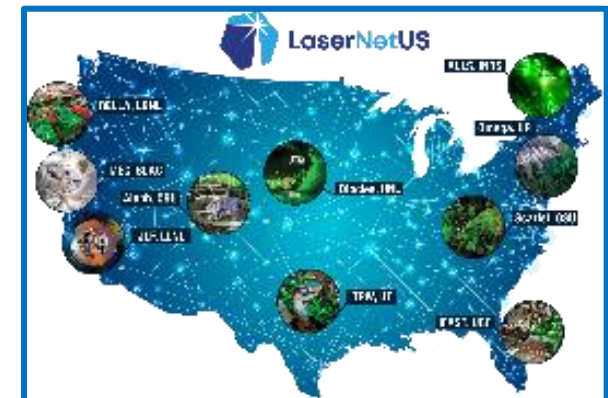
Plasma Diagnostics



AI/ML

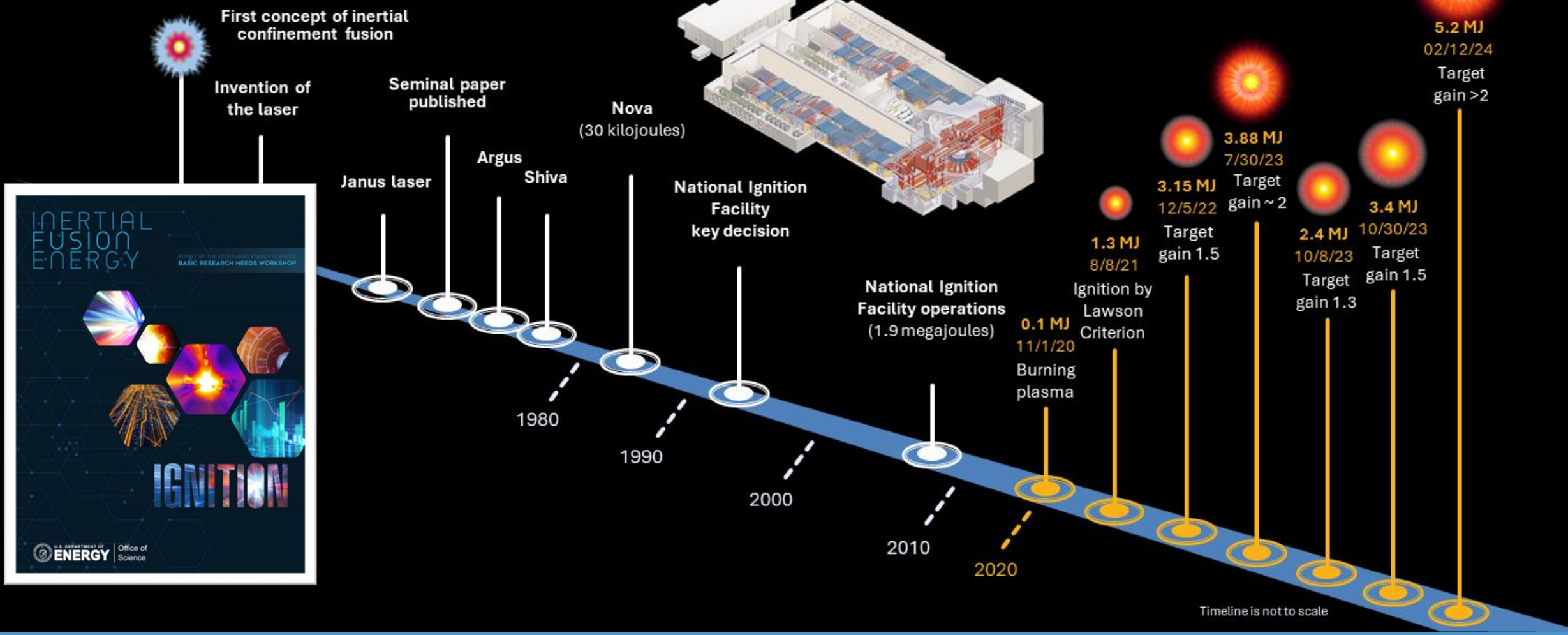


General Plasma Science



LaserNetUS / HEDLP

Inertial Fusion Energy (IFE)

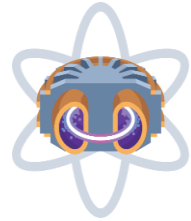


IFE

- ◆ Following the achievement of ignition on NIF, an IFE program was established within FES.
- ◆ IFE activities are guided by the 2022 Basic Research Needs Workshop.

Public-Private Partnerships (PPPs) in Fusion Energy Sciences

- ◆ PPPs in FES leverage decades of public support for fusion R&D and synergy with existing activities
- ◆ Greater available financial resources (public + private) to achieve objectives and accelerate timelines.
- ◆ Stakeholders are committed & aligned by sharing cost.
- ◆ **The private fusion landscape has changed in the last decade.**
- ◆ Increased technical readiness & investment, combined with significant market pull.



INFUSE



- Helps connect private fusion companies to unique lab and university resources
- Since INFUSE launched (FY 2019) FES has invested \$19.3M to date in 90 awards, helping 26 private fusion companies gain access to the capabilities of ten DOE laboratories and eight U.S. universities

Milestone-Based Fusion Development Program

- Purpose: Enable a vibrant domestic fusion sector through PPPs to improve the technical maturity (physics basis, enabling materials/technologies) of fusion concepts
- Awards will be Technology Investment Agreements (TIAs) to enable maximum flexibility
- Eight teams selected for award negotiations from a variety of concepts

Tokamaks

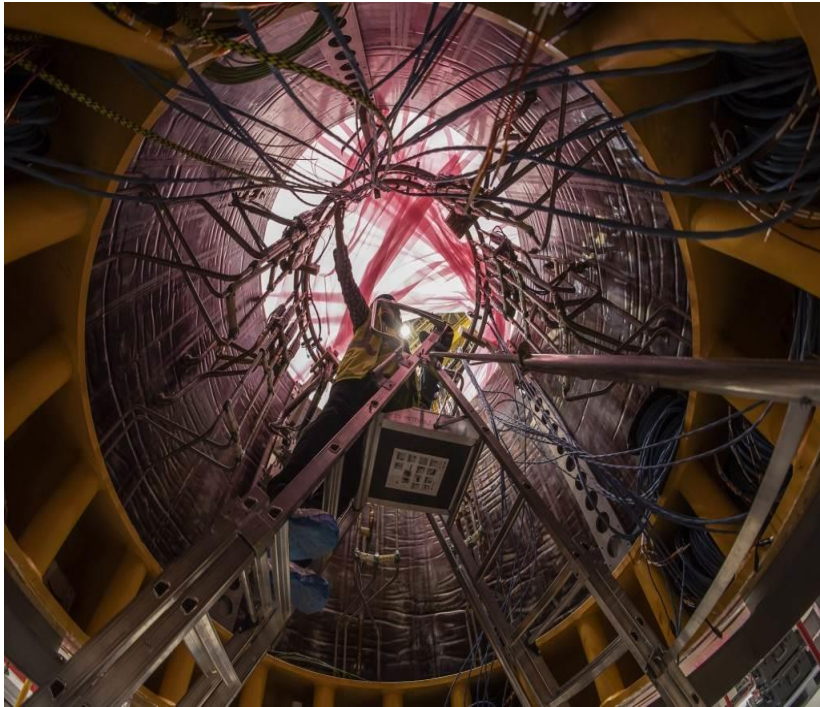
Stellarators

Inertial Fusion Energy

Alternates

U.S. Participation in ITER

Study burning plasma science and technology at power plant scale



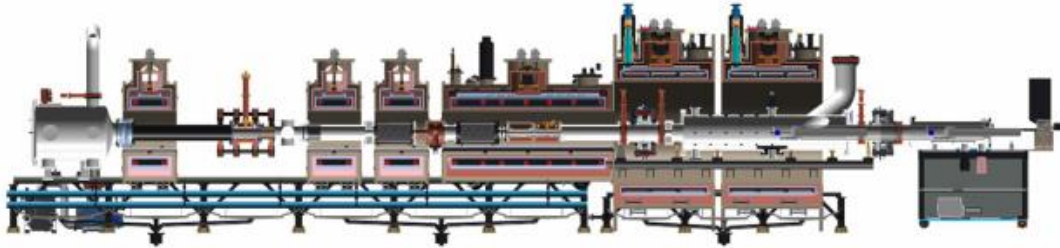
A look inside the first central solenoid module. Five more will stack on top to complete the 18-meter-tall system



Central solenoid module assembly progressing at the ITER site

Other Projects

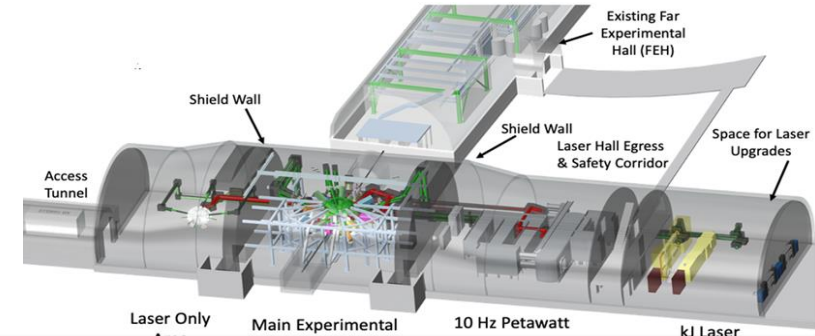
Material Plasma Exposure Experiment (MPEX)



MPEX will deliver world-leading experimental capability for evaluating the performance of plasma-facing materials under fusion energy-relevant conditions

- Steady-state, high-heat-flux plasma exposure for accelerated materials life-time testing under a large range of plasma parameters
- Ability to test neutron-irradiated materials
- Ability to test material samples in unique target geometries
- Under construction (MIE) at **ORNL**

Matter in Extreme Conditions Petawatt Laser Upgrade



- ▶ World-leading laser performance; unique capabilities when combined with LCLS XFEL
 - ▶ 10x higher power @ 10 Hz (Petawatt); 10x higher energy laser (kilojoule)
- ▶ High Energy Density Science
 - ▶ Relativistic HED plasma, Nonlinear optics of plasmas, HED hydrodynamics, Warm Dense Matter
- ▶ Focused fusion-relevant capabilities
 - ▶ Rep-rate and hardened diagnostics, capsule ablator material

Enhance broadening participation and DEIA activities to enable the program



Annual Young Women's Conference on STEM sponsored by PPPL

Fusion Outreach Coordination Team

- ◆ A group of 200+ community members spread across universities, national laboratories, industry, and career stage brought together by their shared motivation to make the fusion and plasma science and technology community diverse, equitable, inclusive and accessible.
- ◆ <https://usfusionenergy.org/>

Reaching a New Energy Sciences Workforce (RENEW)

- ◆ Expand targeted efforts, including a graduate fellowship, to broaden participation and advance belonging, accessibility, justice, equity, diversity, and inclusion in SC-sponsored research.

Funding for Accelerated, Inclusive Research (FAIR)

- ◆ Provide focused investment for enhancing research on clean energy, climate, and related topics at minority-serving institutions (MSIs), including attention to underserved and environmental justice regions.

EPSCoR

- ◆ Support EPSCoR State-National Laboratory Partnership awards and early career awards.

FY 2024 FES Funding Opportunity Announcements

FOA / Lab Call Title	Comments
FY 2024 Continuation of Solicitation for the Office of Science Financial Assistance Program - DE-FOA-0003177	SC Open Call (<i>please contact FES Program Manager before applying</i>)
Research on General Plasma Science Collaborative Research Facilities - DE-FOA-0003267	LOIs due: March 29 Applications due: April 29
Opportunities in Foundational Fusion Materials, Nuclear Science, and Enabling R&D - LAB 24-3295	Pre-proposals due: March 22 Proposals due: May 3
Research in Basic Plasma Science and Engineering - DE-FOA-0003254	Closed (pre-applications received and evaluated; applications due: March 29)
High-Energy-Density Laboratory Plasma Science - DE-FOA-0003222	Closed (applications received and under review)
SC Early Career Research Program	Closed (pre-applications received and under review; applications due: April 25)
Collaborative Research in Magnetic Fusion Energy Sciences on Long-Pulse International Stellarator Facilities - DE-FOA-0003211	Closed (applications received and under review)

Additional FOAs may be issued, depending on the FY 2024 Appropriation

FY 2023 FES Funding Opportunity Announcements

FOA Title	Results
Scientific Discovery through Advanced Computing (SciDAC) – FES Partnerships	12 multi-institutional awards at \$120M for four years
Machine Learning, Artificial Intelligence, and Data Resources for Fusion Energy Sciences	20 awards at \$29M for three years
Innovative Fusion Technology and Collaborative Fusion Energy Research in the DIII-D National Program	9 awards at \$18M for three years
High-Energy-Density Laboratory Plasma Science (joint program with NNSA)	10 FES awards at \$4.65M\$ & 1 NNSA award at \$0.6M for three years (Total: \$5.25M)
SC Early Career Research Program	8 FES five-year awards (4 to universities and 4 to Labs), \$13.5M total, \$5.5M in FY 2023
Research in Basic Plasma Science and Engineering	13 awards at \$8.5M for three years
Research on General Plasma Science Collaborative Research Facilities	17 awards at \$1.5M for one to two years
Quantum Information Science Research for Fusion Energy Sciences	6 awards at \$11.4 for three years

FY 2023 FES Funding Opportunity Announcements – cont.

FOA Title	Results
LaserNetUS for Discovery Science and IFE	10 awards at \$28.5M for three years
Inertial Fusion Energy Science & Technology Accelerated Research (IFE-STAR).	3 multi-institutional awards at \$42M for four years
FES-Reaching a New Energy Sciences Workforce (RENEW)	5 awards at \$6.3M for three years
Funding Accelerated Inclusive Research (FAIR)	3 awards at \$2.2M for three years
Accelerate Innovations in Emerging Technologies	1 award at \$8M.

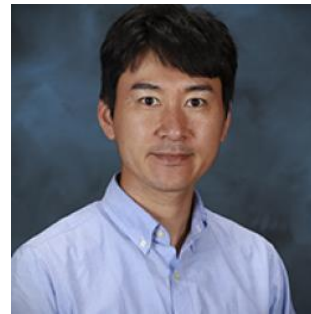
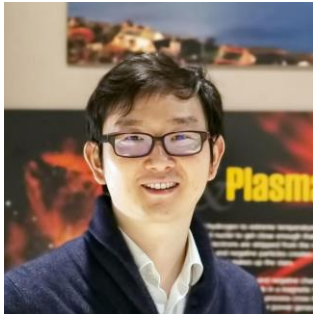
Additional awards in other parts of the program (e.g., Theory & Simulation, Materials Science, etc.) were made through the SC Annual FOA

For more information, check:

- Funding Opportunity Announcements: <https://science.osti.gov/fes/Funding-Opportunities>
- Award information:
 - <https://science.osti.gov/Funding-Opportunities/Award>, and
 - <https://pampublic.science.energy.gov/WebPAMSEExternal/interface/awards/AwardSearchExternal.aspx>

FY 2023 Early Career Research Awards

- The SC Early Career Research Program (ECRP) supports outstanding scientists during the early part of their careers when many scientists do their most formative work.
- Open to tenure-track academic faculty and full-time non-postdoctoral employees at DOE national laboratories and SC scientific user facilities.
- FES made four university and four lab awards in 2023
- Information about past awards and PI profiles can be found in <https://science.osti.gov/early-career> and <https://www.energy.gov/science/listings/early-career-program>



Prof. Elizabeth Paul, Columbia University

Modeling Fast Ion-mode Interactions Toward a Stellarator Fusion Power Plant

Prof. Derek Schaeffer, UCLA

Ion Acceleration by Quasi-Parallel Magnetized Collisionless Shocks

Prof. Chuanfei Dong, Boston University

Reconnection-Driven Turbulent Cascade in Magnetized Collisional and Collisionless Plasmas

Prof. Carasik, Lane, Virginia Commonwealth University

Viability of a Molten Salt Liquid Immersion Breeder Blanket System for Heat Removal and Power Extraction in Fusion Devices

Dr. Holly Flynn, SRNL

The Development of a Real-Time Accountancy Open Framework for Fusion Energy

Dr. Vinicius Duarte, PPPL

Phase-Space Engineering of Suprathermal Particle Distribution for Optimizing Burning Plasma Scenarios

Dr. Takaaki Koyanagi, ORNL

Advanced Additive Manufacturing of Silicon Carbide for Fusion Applications

Dr. Daniel Casey, LLNL

Understanding Implosion Physics Degradations to Advance IFE-Relevant Targets



Future FES Office Hours Topics

- Wednesday, April 3, 2024 – **FES topics in the FY 2024 Open Call.**
- Wednesday, May 1, 2024 – **How to Become an Effective Reviewer.**
- We welcome suggestions for future Office Hours
- For more information, including registration links, please visit <https://science.osti.gov/fes/officehours>
 - Recordings and slides will be posted here after completion of each office hour.

