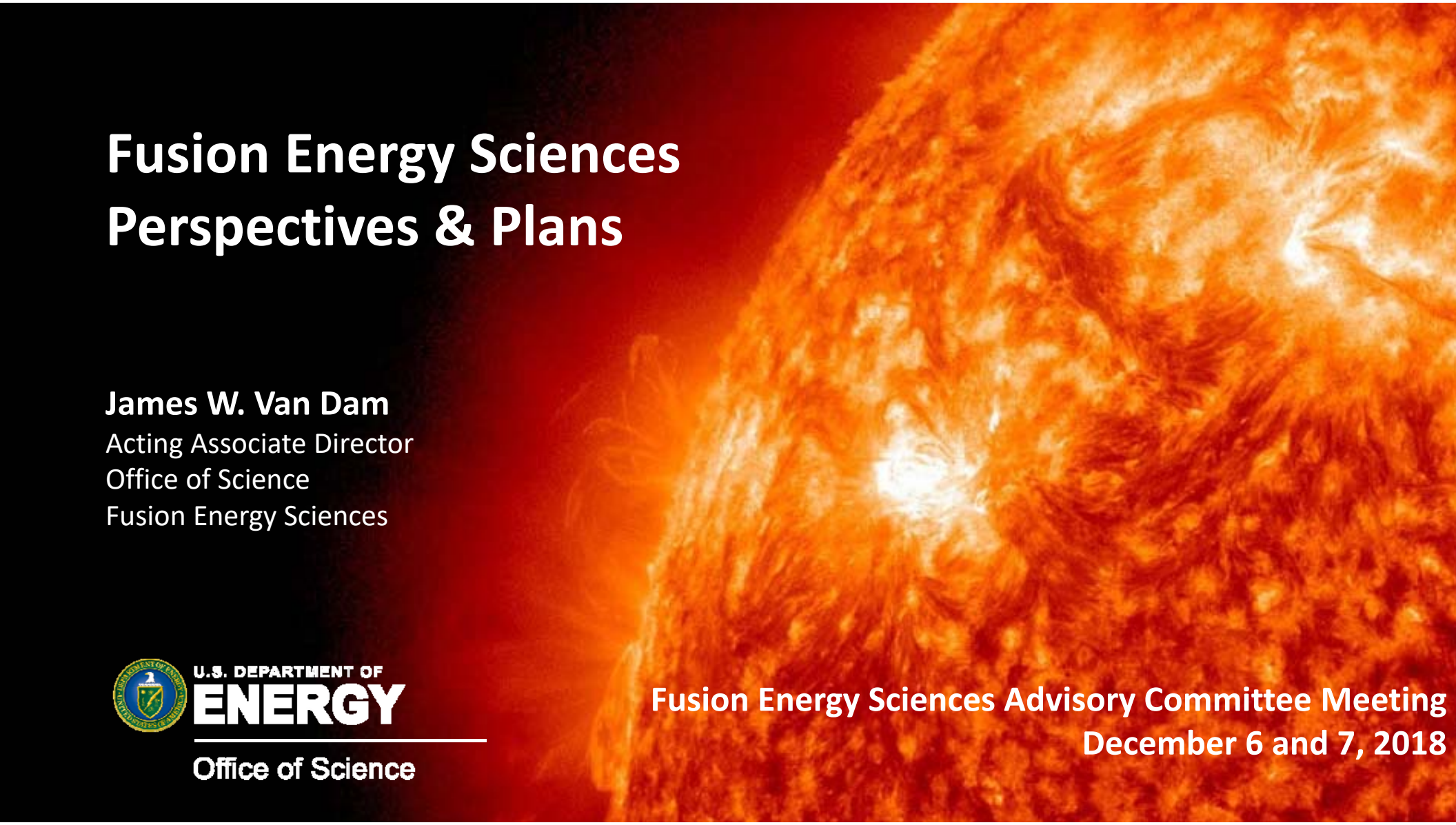
Fusion Energy Sciences Perspectives & Plans

James W. Van Dam
Acting Associate Director
Office of Science
Fusion Energy Sciences



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Fusion Energy Sciences Advisory Committee Meeting
December 6 and 7, 2018

1. Budget Updates

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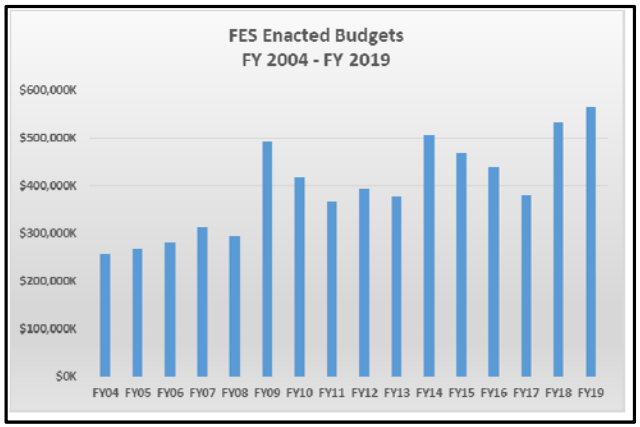
Robust FY 2018 and FY 2019 enacted budgets

Enacted FES appropriations for FY 2018 ($532M) and FY 2019 ($564M) enable accelerated progress throughout the program:

- **ITER**: Continued progress on U.S. Contribution to ITER project with emphasis on highest-priority First Plasma activities
- **DIII-D**: Initiated over $20M of enhancements and infrastructure improvements for the DIII-D user facility to maintain and advance its world-leading research capabilities
- **NTSX-U**: Accelerate the Recovery efforts
- **LaserNetUS**: Established a U.S.-wide network of nine mid-scale laser facilities at universities and national laboratories to expand user access to high-power lasers
- **MPEX Facility**: Initiated the Materials Plasma Exposure eXperiment (MPEX) MIE project as a new world-class high-heat-exposure facility for testing fusion materials
- **Theory & Simulation**: Accelerate progress in Whole-Device Modeling and Exascale readiness; strengthen support for fusion-relevant Machine Learning applications
- **Private-Public Partnerships**: Planning underway to initiate high-impact public-private partnerships as a pilot program to leverage opportunities in critical fusion research areas and accelerate progress toward the development of fusion energy
- **QIS**: Start pilot efforts in Quantum Information Science that can advance both the FES mission and also the development of QIS

DOE Website (August 2, 2018)



Budget Trends

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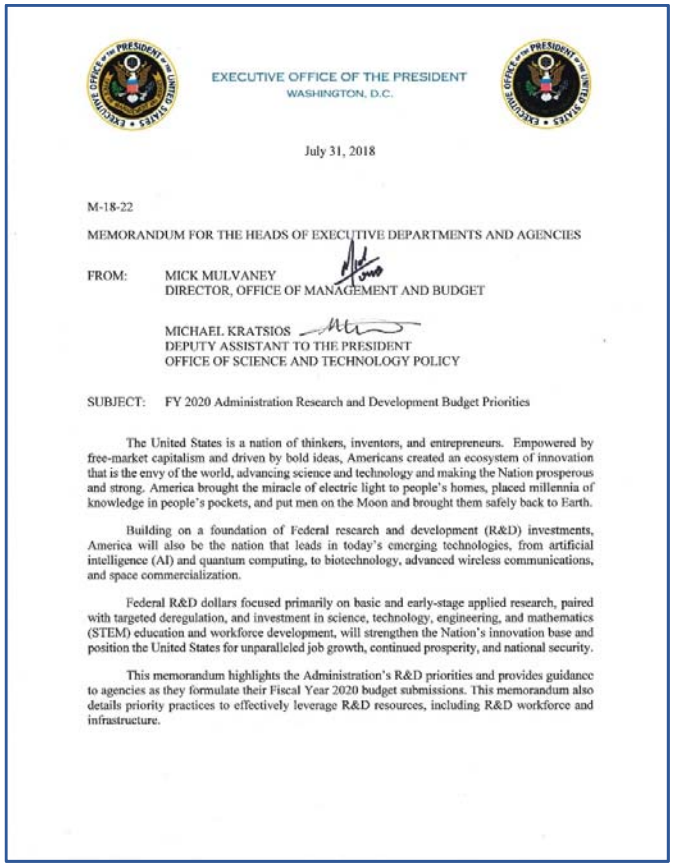
FES program can address several Administration R&D priorities and practices

- **American Leadership in emerging technologies**: FES investments in transformational technologies such as machine learning, quantum information science (QIS), microelectronics, and high-performance computing could accelerate progress in several mission areas.
- **American Energy Dominance**: Research in fusion could contribute to American energy dominance by making available to the American people a robust base-load electricity clean energy technology that relies on widely available and virtually inexhaustible fuel sources.
- **Managing and Modernizing R&D Infrastructure**: Investments in our major fusion facilities and smaller-scale experiments would maintain and modernize our research infrastructure for continuing to conduct world-leading research.
- **Maximizing Agency Coordination :** Established partnerships within DOE (ASCR, BES, NNSA) and outside (NSF) maximize leverage and increase the cost effectiveness of FES research activities.
- **Partnering with Industry:** Private-public collaborations would leverage opportunities in critical fusion research areas (e.g., diagnostics, theory and simulation, materials science, and magnet technology).
- **Technology Transfer**: Research on high-temperature superconductors, additive manufacturing, low-temperature plasmas, and high-energy-density plasmas lead to connections with and spinoffs for U.S. industry.
- **Workforce Training & Education:** The scientific challenges and rigor of fusion plasma physics research contribute to the development of a well-trained STEM-focused workforce, which would help maintain and advance U.S. competitiveness and world-leadership in key areas of future technological and economic importance, as well as national security.



EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON, D.C.

July 31, 2018

M-18-22

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: MICK MULVANEY
DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

MICHAEL KRATSIOS
DEPUTY ASSISTANT TO THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

SUBJECT: FY 2020 Administration Research and Development Budget Priorities

The United States is a nation of thinkers, inventors, and entrepreneurs. Empowered by free-market capitalism and driven by bold ideas, Americans created an ecosystem of innovation that is the envy of the world, advancing science and technology and making the Nation prosperous and strong. America brought the miracle of electric light to people's homes, placed millennia of knowledge in people's pockets, and put men on the Moon and brought them safely back to Earth.

Building on a foundation of Federal research and development (R&D) investments, America will also be the nation that leads in today's emerging technologies, from artificial intelligence (AI) and quantum computing, to biotechnology, advanced wireless communications, and space commercialization.

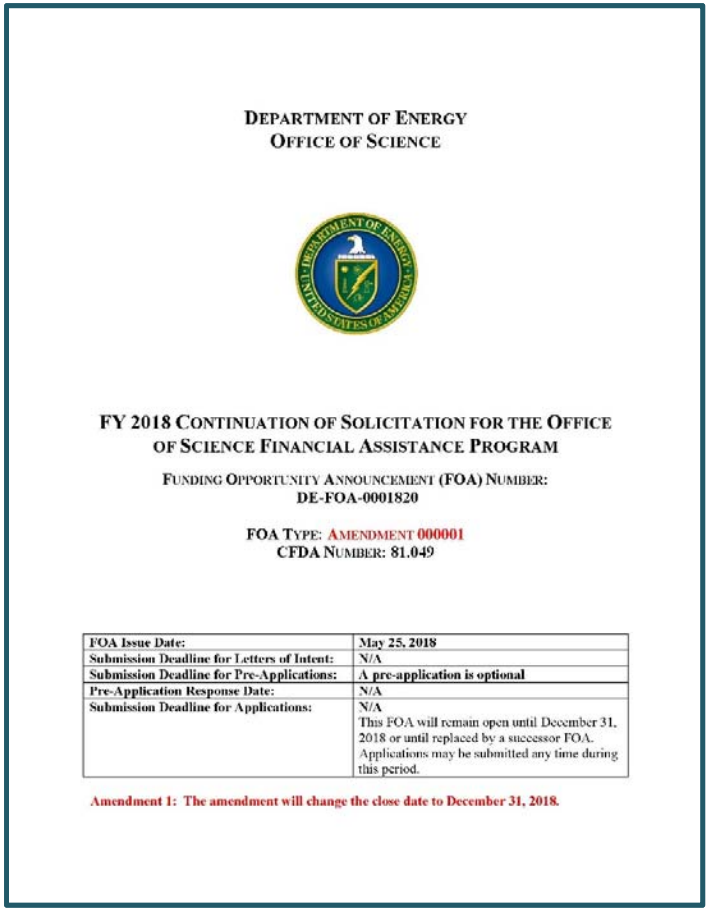
Federal R&D dollars focused primarily on basic and early-stage applied research, paired with targeted deregulation, and investment in science, technology, engineering, and mathematics (STEM) education and workforce development, will strengthen the Nation's innovation base and position the United States for unparalleled job growth, continued prosperity, and national security.

This memorandum highlights the Administration's R&D priorities and provides guidance to agencies as they formulate their Fiscal Year 2020 budget submissions. This memorandum also details priority practices to effectively leverage R&D resources, including R&D workforce and infrastructure.

July 31, 2018 OMB memo on the FY 2020 Administration R&D priorities

Solicitation status

- A number of **Funding Opportunity Announcements** (FOAs) and companion Lab Announcements have not been issued yet due to changes in the SC FOA approval process
  - Two FOAs were recently approved and should be posted soon
- The past practice of issuing FOAs in the fiscal year before the funding year may not be feasible
- The **Annual "open" SC FOA** is always active; please check with your Program Manager about whether you should consider submitting to this FOA, especially if the due date for the submission of your renewal proposal is past or rapidly approaching
- You are also encouraged to check the SC and FES **Funding Opportunities** pages for updates (https://science.energy.gov/fes/funding-opportunities/)



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FY 2018 CONTINUATION OF SOLICITATION FOR THE OFFICE OF SCIENCE FINANCIAL ASSISTANCE PROGRAM

FUNDING OPPORTUNITY ANNOUNCEMENT (FOA) NUMBER:
DE-FOA-0001820

FOA TYPE: AMENDMENT 000001
CFDA NUMBER: 81.049

FOA Issue Date:	May 25, 2018
Submission Deadline for Letters of Intent:	N/A
Submission Deadline for Pre-Applications:	A pre-application is optional
Pre-Application Response Date:	N/A
Submission Deadline for Applications:	N/A This FOA will remain open until December 31, 2018 or until replaced by a successor FOA. Applications may be submitted any time during this period.

Amendment 1: The amendment will change the close date to December 31, 2018.

https://science.energy.gov/~/media/grants/pdf/foas/2018/SC_FOA_0001820.pdf

2. Programmatic Updates

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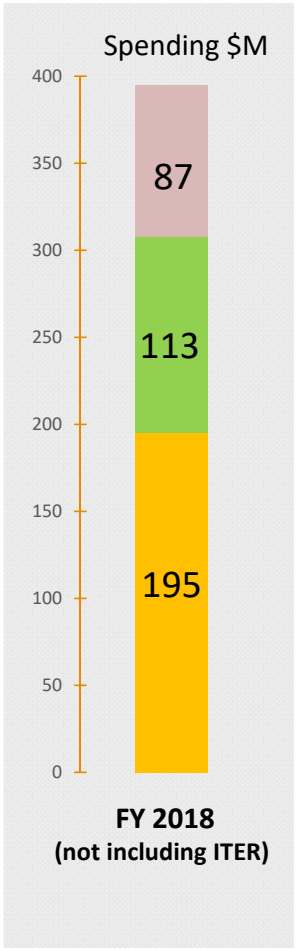
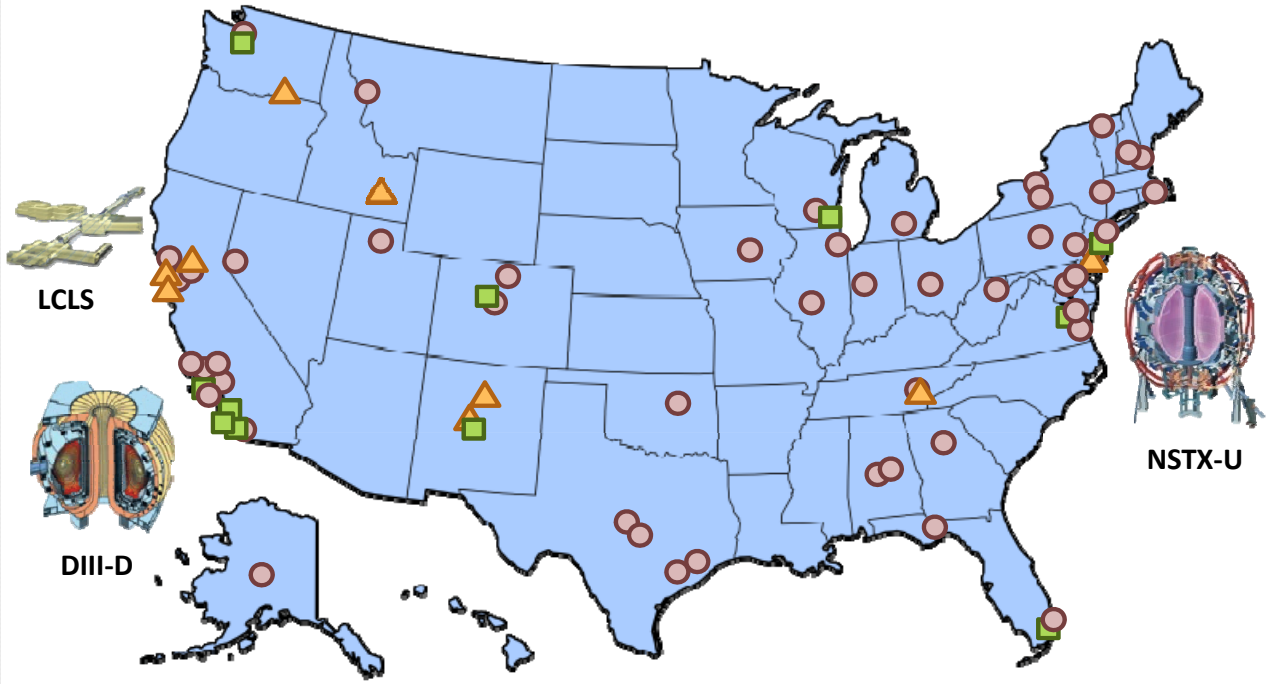
FES research is carried out at a diversity of US institutions



38 universities

11 industry

11 laboratories



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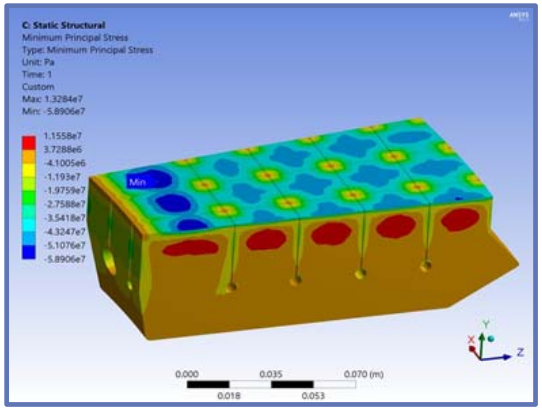
The PPPL project team has made progress towards recovery of NSTX-U

Important reviews, design work, and project activities:

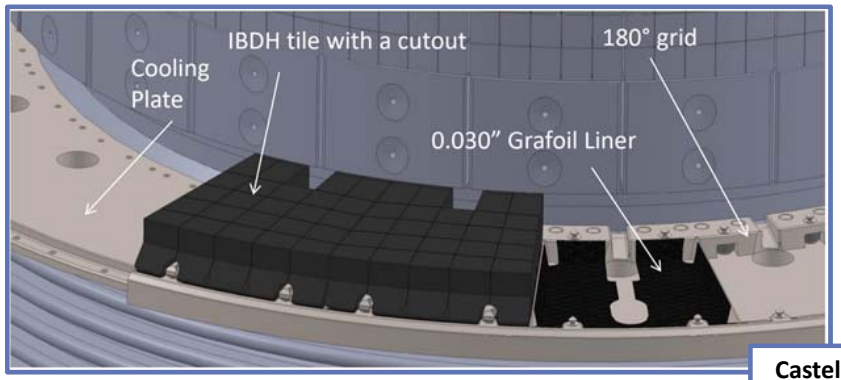
- ✓ A thorough assessment, conducted by 50+ external reviewers, identified all problems requiring repair to recover robust plasma operations
- ✓ PPPL has completed the preliminary design of the NSTX-U Recovery scope
- ✓ Early material procurements, coil prototyping and testing
- ✓ A baseline review of the total project cost and schedule is slated to take place in February of 2019



Engineering analysis of new castellated PFC tile design

TF/OH conductor bundle prior to a casing fit-up lift

Prototype coil testing to full field and current



Castellated tile in situ

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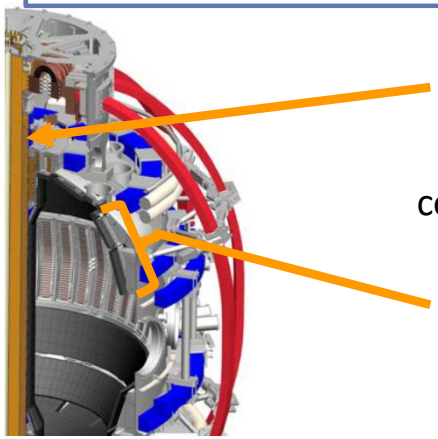
An independent panel of fusion experts reaffirmed the scientific mission for NSTX-U

Prof. Orbach led a DOE OPA subcommittee, which found:

- "Full exploitation of the NSTX-U facility is essential for critical tests of the potential advantages of the spherical tokamak for fusion power production."
- "In its chosen domain of exploration of high- performance, high-β, and low-collisionality plasmas, NSTX-U is and will be the world leader."



NSTX-U central magnet provides **~2 x higher B_T^2** compared to MAST-U

NSTX-U conducting plates provide **~3 x higher total pressure** compared to MAST-U

NSTX-U

MAST-U
Complementary ST facility in the UK
Dedicated on October 18, 2018

Dr. Raymond Orbach *(former DOE Under Secretary for Science, 2006-2009)*

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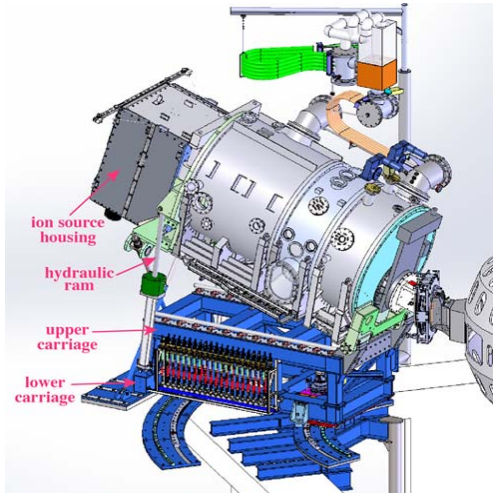
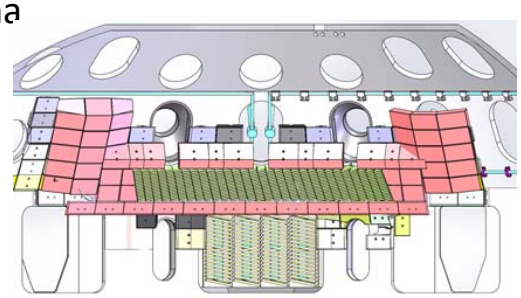
DIII-D Long Torus Opening (LTO)

- **General Atomics will complete the LTO in April 2019 and operate DIII-D for up to 12 weeks in FY 2019**
- **Major ongoing LTO tasks include:**
  - New co/counter off-axis neutral beam modification
  - Top-launch ECCD capability
  - Installation of helicon strip-line antenna
  - New/upgraded diagnostics

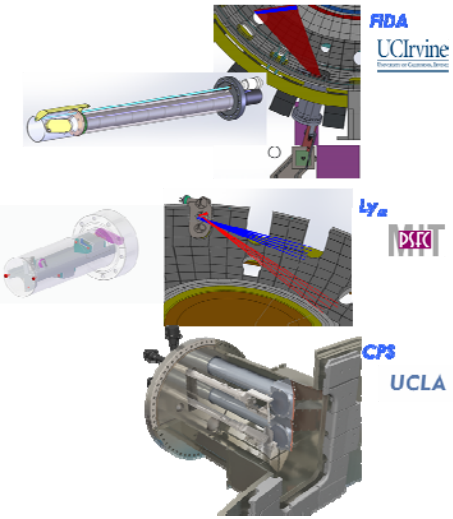


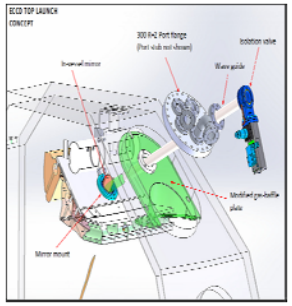
Co/counter off-axis neutral beam

Helicon antenna



New diagnostics





Top launch ECCD

- **Other activities enabled by FY 2018 funding include:**
  - New helium liquefier and 3 replacement gyrotrons on order
  - Start of high-field-side LHCD project
  - New collaboration grants
  - Sustaining engineering work to increase facility reliability

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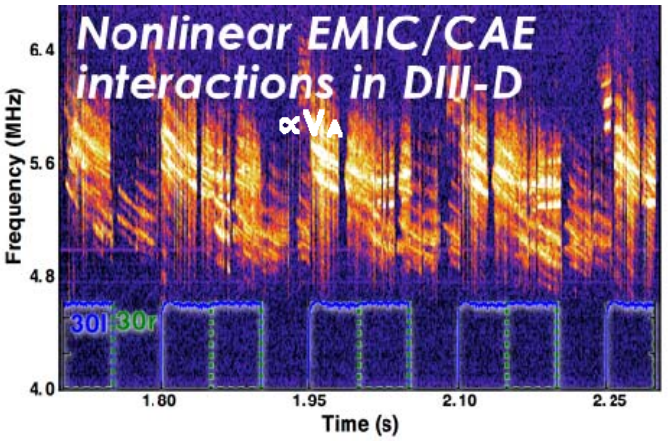
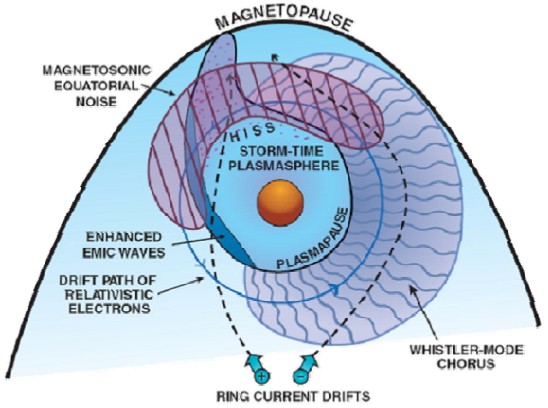
Frontier science experiments on DIII-D

- **In FY 2017, FES started a new initiative to focus some DIII-D experiments on frontier plasma science**
- **Whistler wave experiment resulted in a post-deadline invited paper at the 2017 APS-DPP meeting, a recent PRL paper** (Spong et al., 2018 *PRL* 120, 155002), **and 2018 APS-DPP oral presentation by Z. Williams (U. Wisc)**
- **Four experiments selected in 2018 utilizing 5 run days:**
  - EMIC waves: Leads W. Heidbrink (UCI)/S. Vincena (UCLA))
  - Runaway electrons & plasma waves: Lead D. Spong (ORNL)
  - Positron generation by runaways: Lead P. Aleynikov (IPP)
  - Sawtooth reconnection studies: Lead W. Fox (PPPL)
- **Engagement very positive, with visiting scientists impressed by the quality of DIII-D data**
- **Focus is now on analysis to obtain results from each study**
- **In FY 2019, the program will be assessed to evaluate progress and to integrate review and selection processes**



EMICs de-populate magnetosphere



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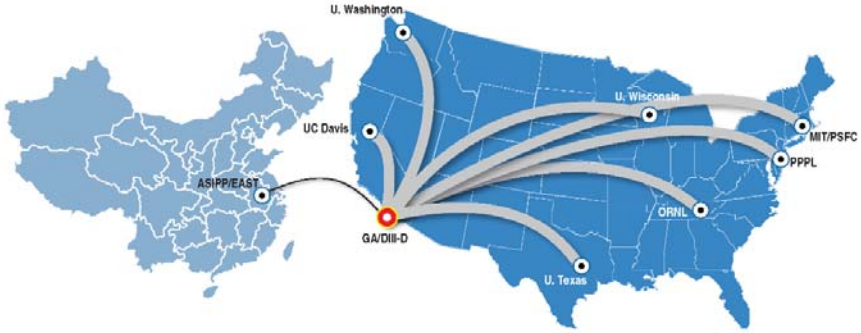
Remote tools are being made available to U.S. institutions to facilitate international collaboration

- **In FY 2018, 7 institutions used remote tools to connect remotely to EAST facility during evening in China**
  - GA, Lehigh U., LLNL, MIT, PPPL, UCLA, U. of Texas
  - 10 days of operations, ~250 shots
- **Services support non-trivial utilization of EAST facility, can be made available to any remote control room in U.S.**
  - Fast bulk data transfer avoiding bottlenecks
  - Real-time data, MDSplus data server
  - Multi-channel audio/video
- **Remote control rooms were also used to provide U.S. support to W7-X during recent campaign (OP1.2b)**

68 scientists from 9 U.S. research institutions can already access the services



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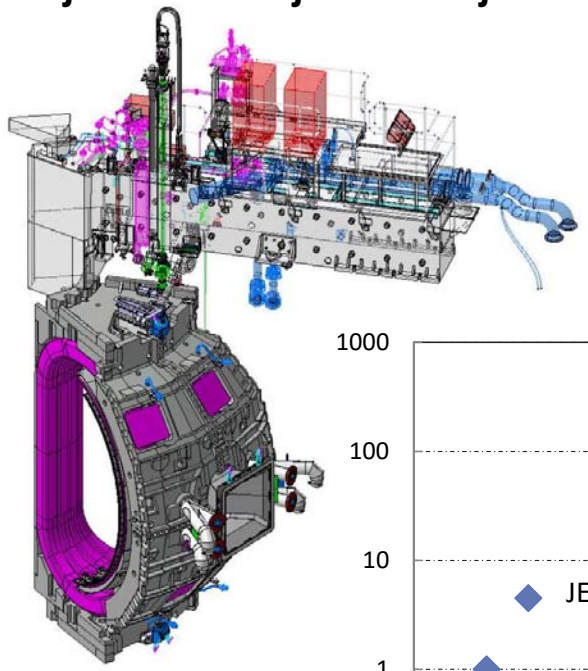
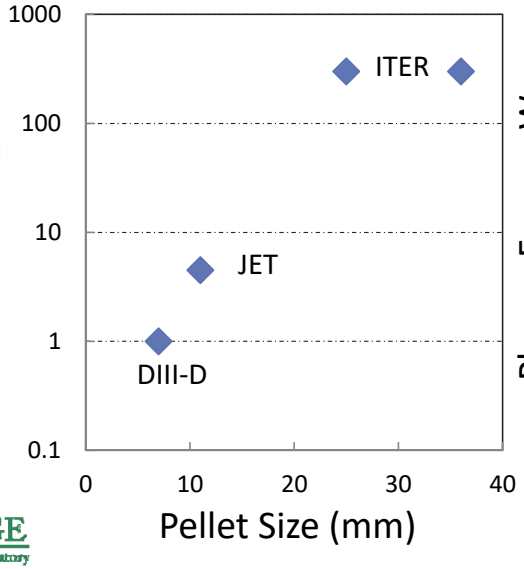
Disruption mitigation with shattered pellet injectors is a U.S. world-leading capability

JET shattered pellet injector (SPI) has ITER-like 3-barrel injector and injection trajectory





JET OAK RIDGE National Laboratory

Status of U.S. Contributions

- D-pellet injector from ORNL tested successfully
- Mechanical punch designed to dislodge high-Z pellets in the largest barrel works in the two smaller barrels
- SPI installed on JET; final commissioning in progress
- Disruption mitigation experiments utilizing JET-SPI are scheduled for the next campaign, starting in May 2019

Large collaborative effort involving JET/EUROfusion, ORNL, USIPO, ITER Organization, EC, and US DOE

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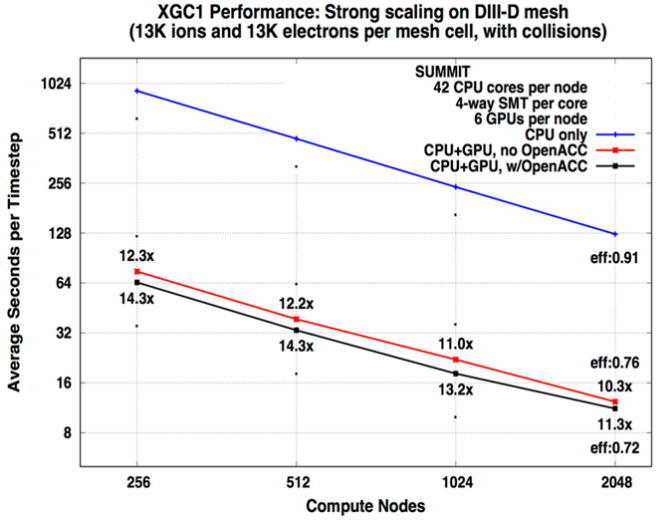
FES SciDAC portfolio continues to emphasize integration and whole-device modeling

- FES SciDAC-4 portfolio has nine multi-institutional and inter-disciplinary projects (seven supported both by FES and ASCR)
  - The ninth project added in FY 2018 is focused on runaway electron avoidance and mitigation
  - 11 universities, 8 DOE national laboratories, and 5 private industry institutions (including small businesses) in 13 states
  - Five of these projects are led by university scientists and the rest include substantial university participation
  - More details can be found at: https://scidac.gov/partnerships/fusion_energy.html
- FES SciDAC research activities are coordinated to accelerate progress toward whole-device modeling and increase synergy with the Theory and Exascale (ECP) programs
- New portfolio addresses research opportunities identified in recent community workshops



Strong scaling of the XGC1 code on maximal available Summit nodes, enabled by Center for Accelerated Application Readiness (CAAR)

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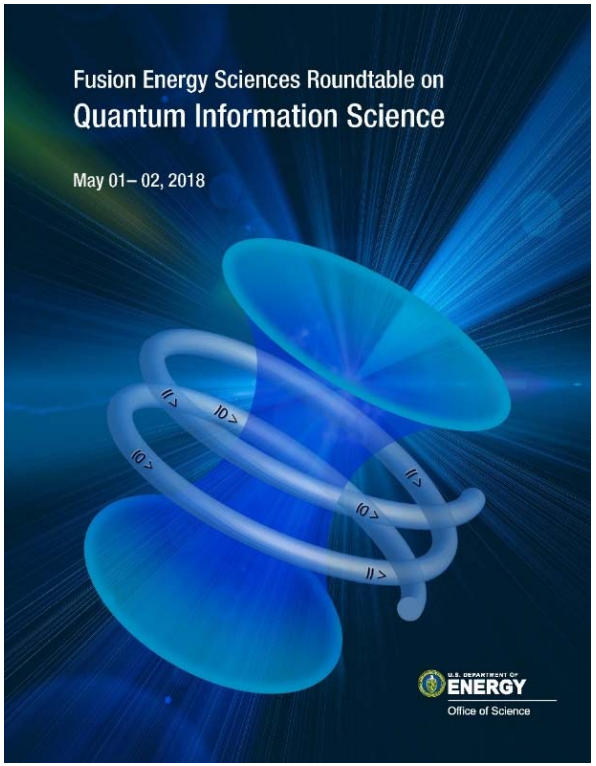
FES is exploring opportunities in QIS

- FES held a Roundtable meeting on **May 1-2, 2018**, to explore its role in **Quantum Information Science (QIS)**
  - Co-chaired by **Thomas Schenkel** (LBNL) and **Bill Dorland** (U Maryland)
  - Attended by **15** participants and several observers
- The meeting objectives were to:
  - Identify fundamental science supported by FES that could advance QIS development; and
  - Explore QIS applications that could have transformative impact on FES mission areas (e.g., fusion and discovery plasma science)
- Identified six compelling **Priority Research Opportunities**



Report available from:
https://science.energy.gov/~/media/fes/pdf/workshop-reports/FES-QIS_report_final-2018-Sept14.pdf

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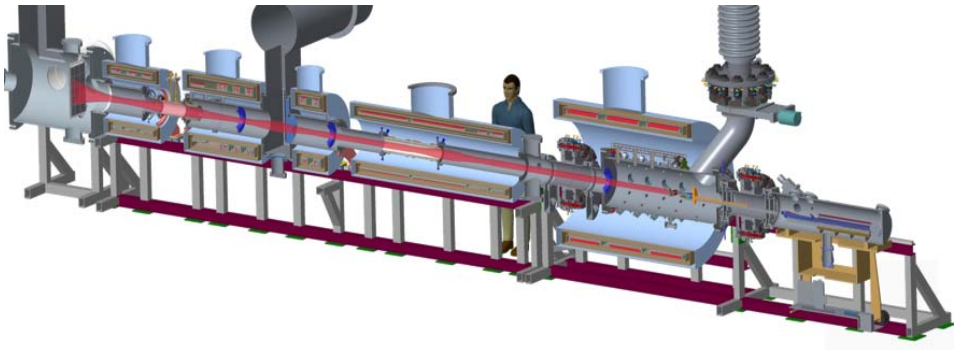
Materials Plasma Exposure eXperiment (MPEX) new MIE Project

- FES has initiated a new Major Item of Equipment (MIE) project with approval of the Scientific Mission Need for a Linear Divertor Simulator in March of 2018
- This project will enable new experimental capability for reactor-relevant plasma-materials interaction studies, including high-heat exposure of neutron-irradiated samples
- In response to the mission need, FES has begun development of the Materials Plasma Exposure eXperiment (MPEX), which is based on the Proto-MPEX Source Experiment at ORNL
  - Conceptual design of the MPEX device began at ORNL in the summer of 2018 and is currently ongoing, with completion expected by the end of summer 2019
- Construction of the MPEX device will result in a significant expansion of fusion materials science experimental capabilities in the U.S.

Proto-MPEX Source Experiment

MPEX conceptualization



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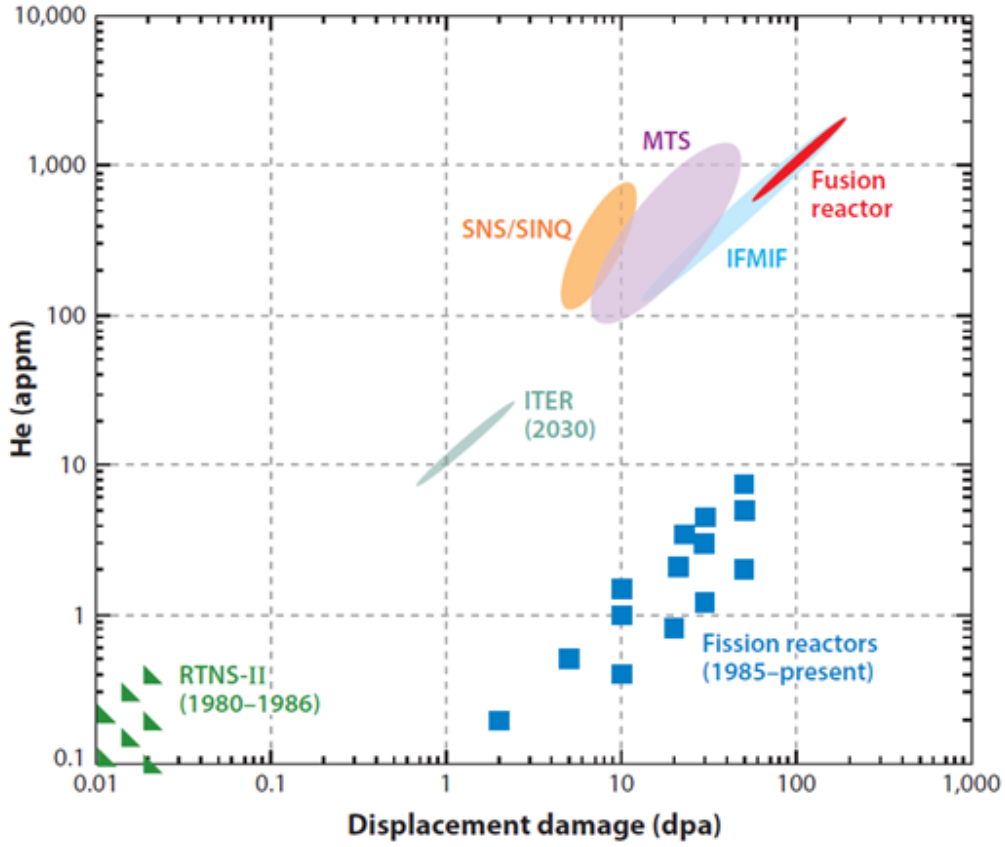
Fusion Prototypic Neutron Source Workshop

- **Workshop**: 33 members of the US fusion materials community, the Virtual Laboratory for Technology, and private industry met on August 20-22, 2018 to discuss the possibility of the US exploring a near-term, low-cost Fusion Prototypic Neutron Source
- **Outcome**: Initial discussion indicated that there is significant scientific value in an intermediate next-step device on the road to IFMIF or one of its variants (e.g., DONES/AFNS)
  - The source must be "near term" (construction possible in ≤ 3 years) and of moderate cost
  - The goal is to provide scientific understanding to enable a Fusion Nuclear Science Facility, not engineering data required for full licensing
- **Minimum required source characteristics:**
  - 8-11 dpa/CY in the high flux zone
  - ~10 appm He/dpa in Fe
  - ≥ 50 cm3 in the high flux zone
  - 300 – 1000 °C, with three independent temperature zones actively monitored and controlled
  - Flux gradient ≤ 20%/cm in the plane of the sample



Summary of He dose relationships important for steels

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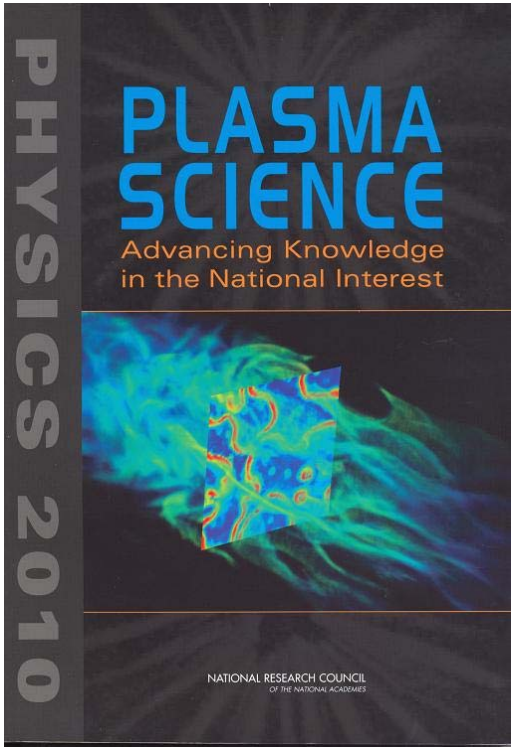
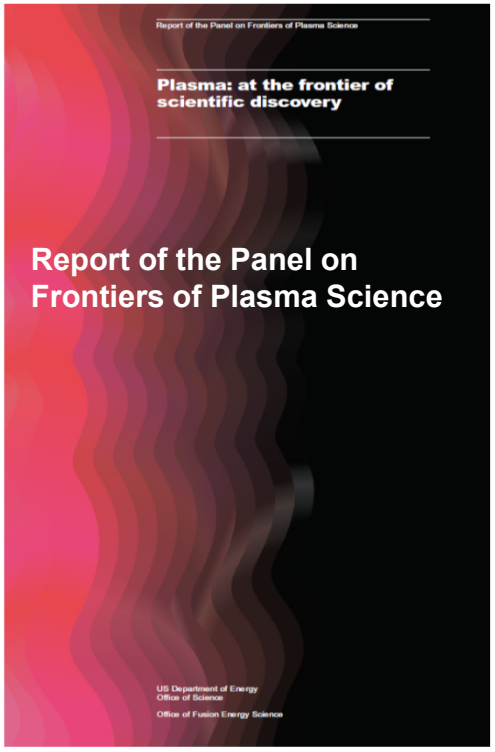
A new intermediate-scale user facility for dusty plasma research was awarded in 2018



"Several areas of basic plasma science would benefit from new intermediate-scale facilities." (2010 Decadal Study)



"There is a need for creation and exploration of new regimes in the laboratory." (2016 PSF Report)

FES awarded $1.5M of FY18 funds over three years to Auburn University to operate the Magnetized Dusty Plasma Experiment (MDPX), an intermediate-scale, integrated, collaborative plasma science user facility

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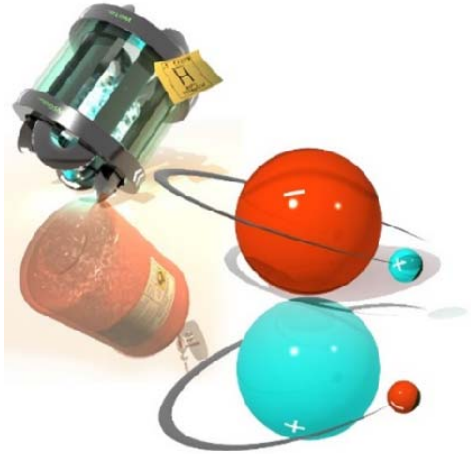
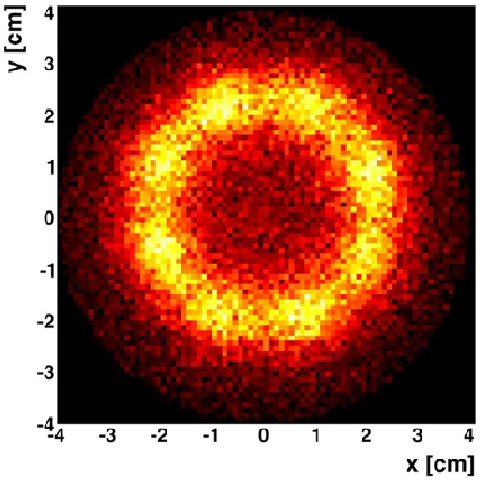
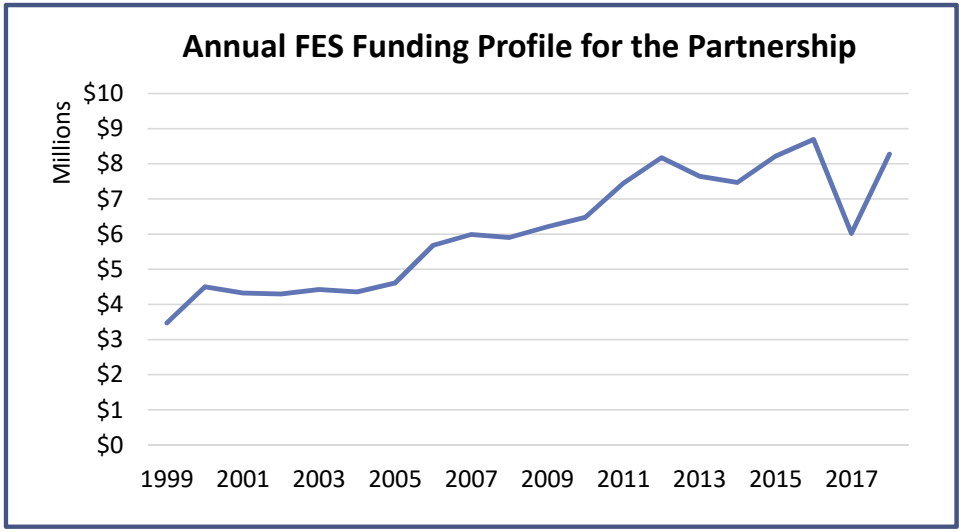
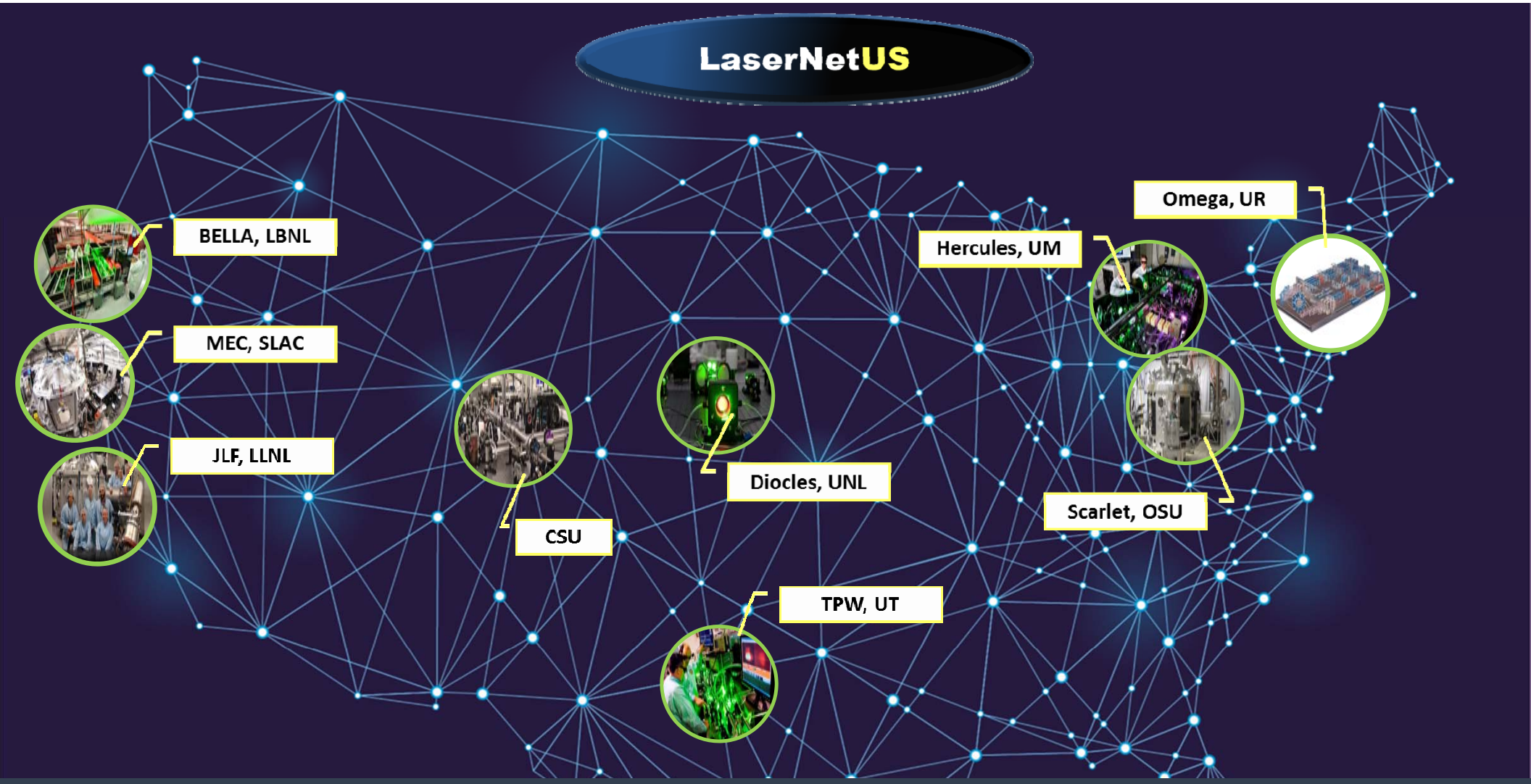
NSF/DOE Partnership: Over $8 million funded by FES in 2018







- FES provided $8.3 million FY18 funds for the Partnership, supporting 11 new or renewal proposals in basic plasma, non-neutral/dusty plasma, HED plasma, and low temperature plasma
- This includes $2.5 million over five years for antihydrogen research led by the University of California-Berkeley, collaborating with ALPHA
- Also, includes $2.3 million for Basic Plasma Science User Facility's (BaPSF) continuing operation and research at UCLA



FES established LaserNetUS in FY18 in response to National Academy report recommendations

The network provides broad access to state-of-the-art facilities for the entire community

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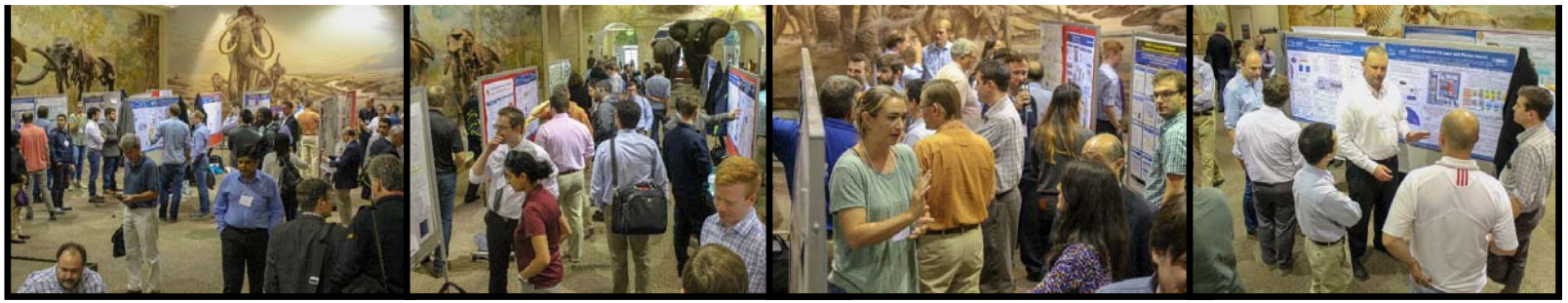
LaserNetUS First Annual Meeting

60 Posters mainly from students and postdocs



3. ITER Updates

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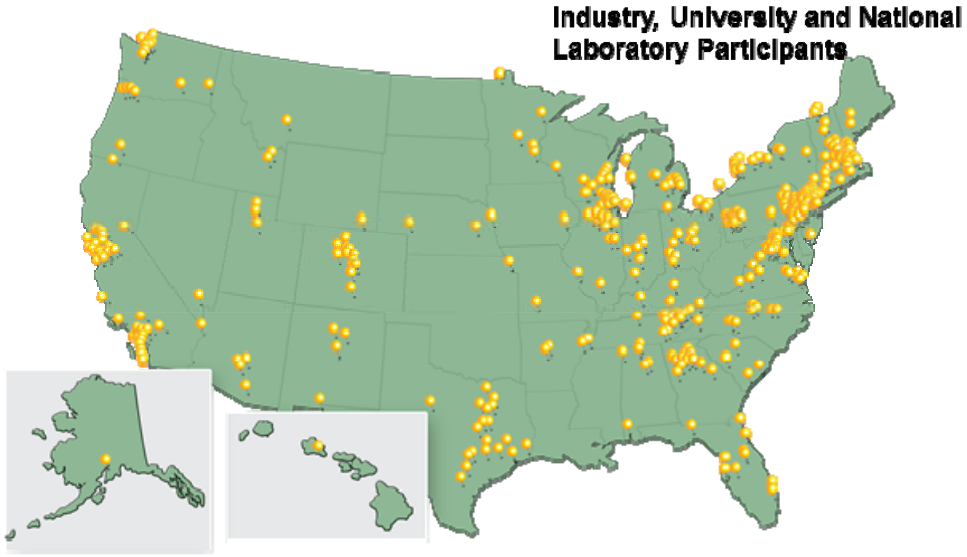
Progress of U.S. ITER project

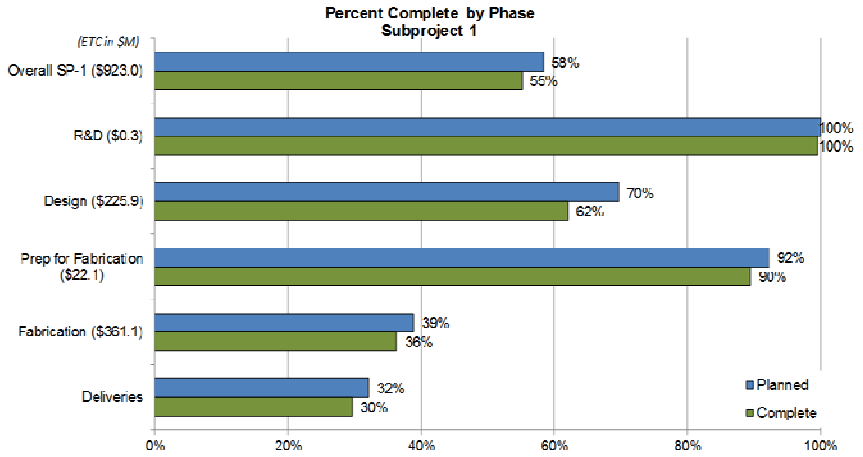
Total Contract Awards: ~$1B
as of June 2018

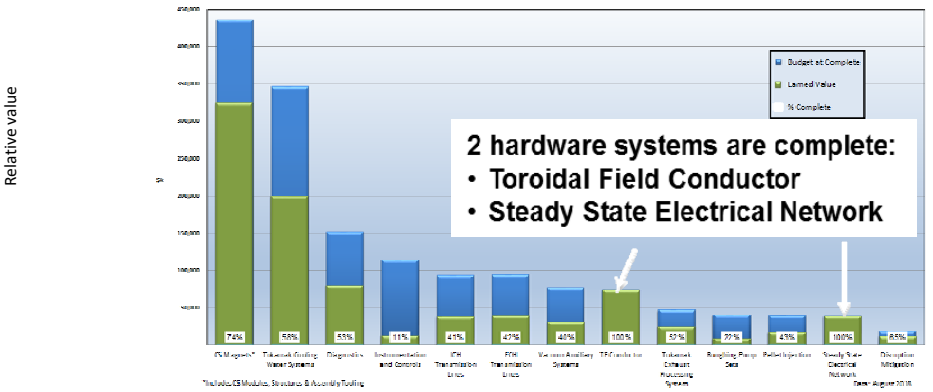
>80% of fabrication awards for U.S. ITER project remain in the U.S.

- 600+ contracts to U.S. industry, universities, and national laboratories in 44 states
- 500+ direct jobs, 1100+ indirect jobs per year



US ITER Subproject-1 (First Plasma) is 55% complete





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Current status of ITER complex

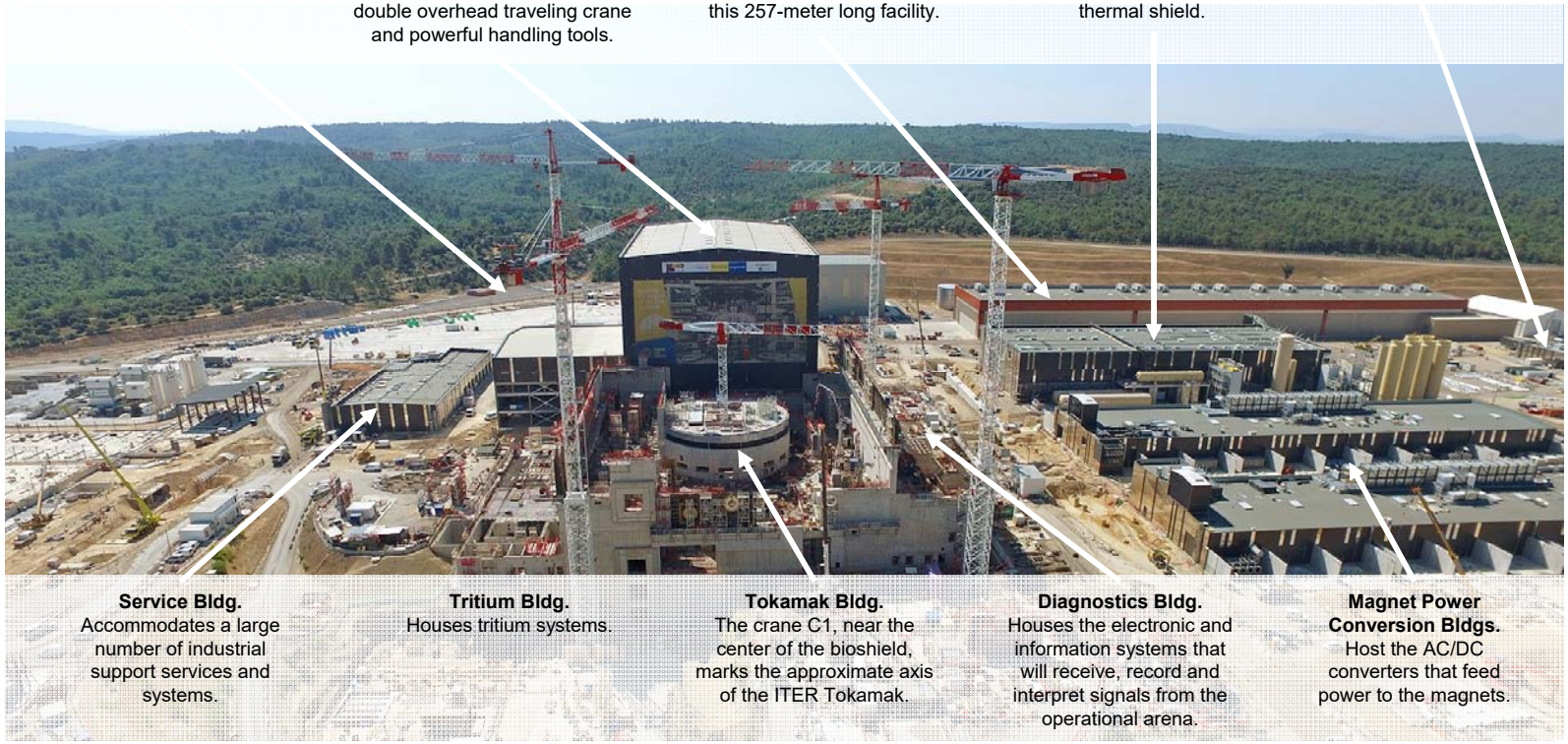
Radio Frequency Bldg.
Hosts the radio wave-generating systems that will contribute to heating the plasma.

Assembly Hall
Components will be pre-assembled in this 6,000-square-meter building, equipped with a double overhead traveling crane and powerful handling tools.

Poloidal Field Coils Winding Facility
Four of the six poloidal field coils will be produced by Europe in this 257-meter long facility.

Cryoplant
Will provide coolant to the Magnet Systems, the cryopumps and the thermal shield.

400 kV Switchyard
Connects the site to the grid.



Service Bldg.
Accommodates a large number of industrial support services and systems.

Tritium Bldg.
Houses tritium systems.

Tokamak Bldg.
The crane C1, near the center of the bioshield, marks the approximate axis of the ITER Tokamak.

Diagnostics Bldg.
Houses the electronic and information systems that will receive, record and interpret signals from the operational arena.

Magnet Power Conversion Bldgs.
Host the AC/DC converters that feed power to the magnets.

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View of ITER worksite

Courtesy ITER Organization (Tim Luce, 2018 FPA talk)

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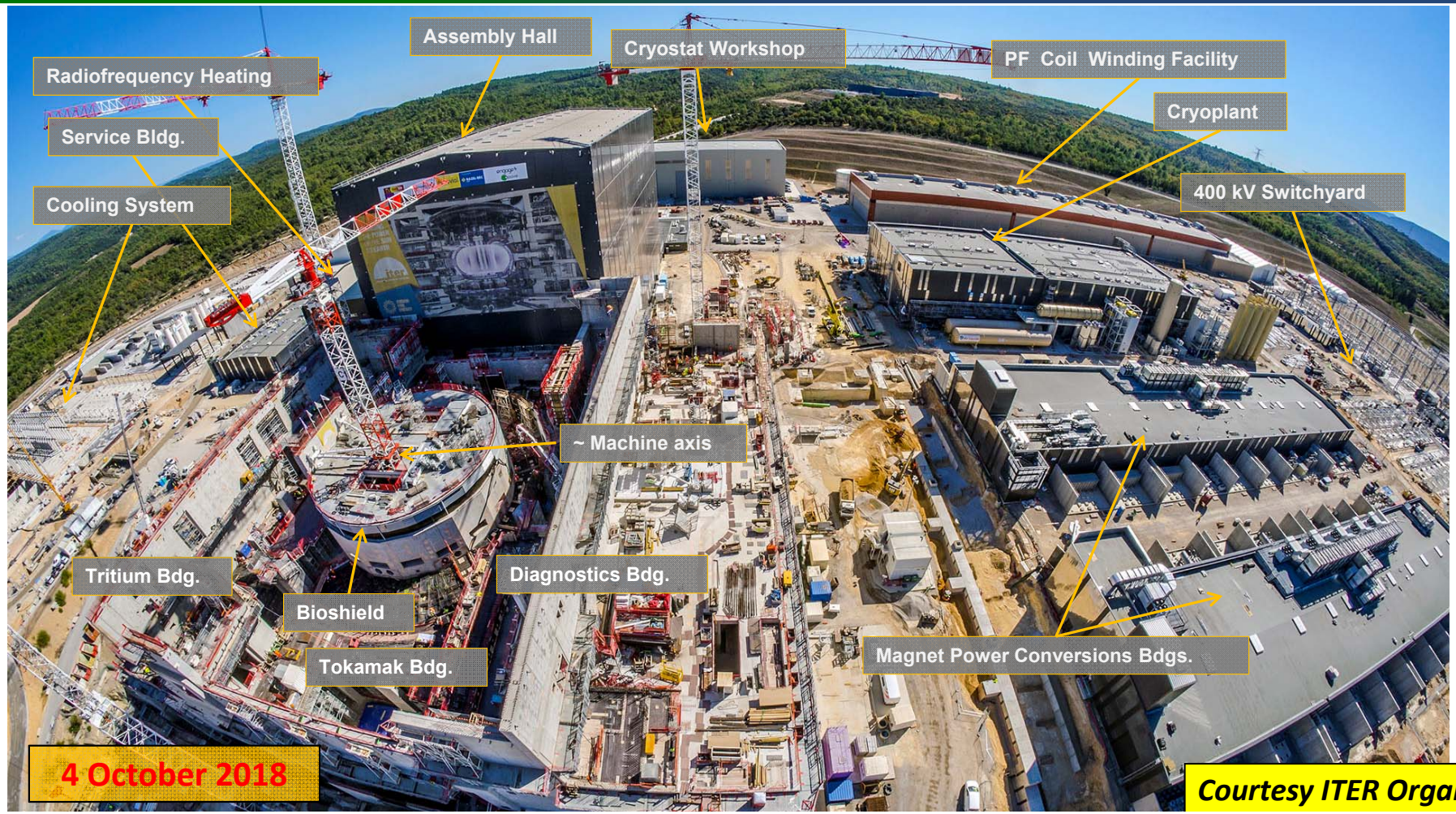
ITER worksite progress



Courtesy ITER Organization

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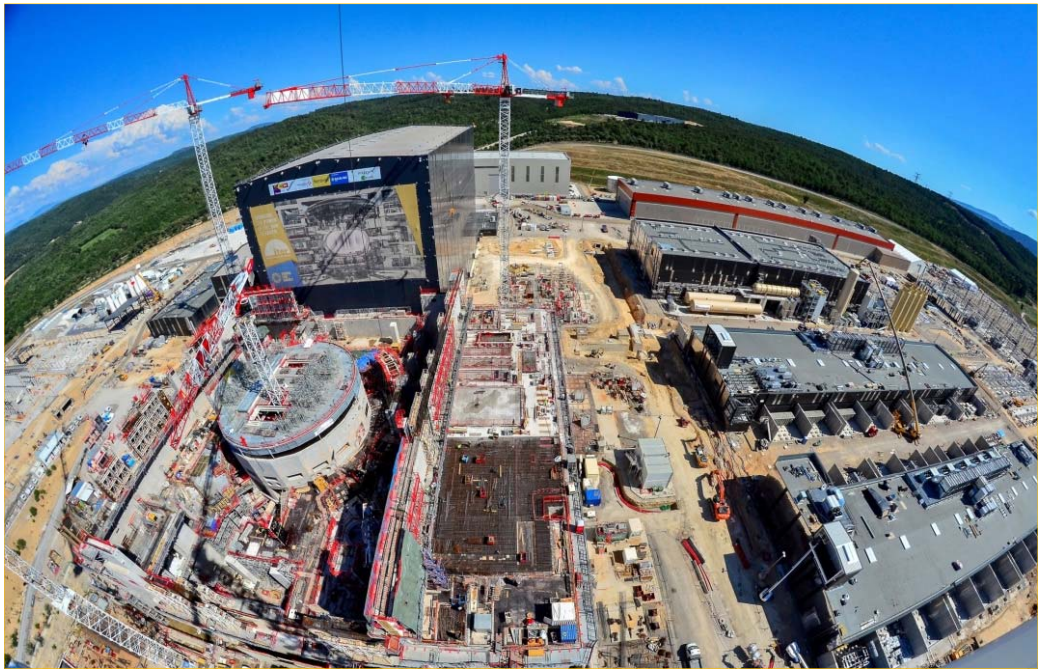
Rapid progress in construction of buildings

View in February 2015:

View in July 2018:



Courtesy ITER Organization

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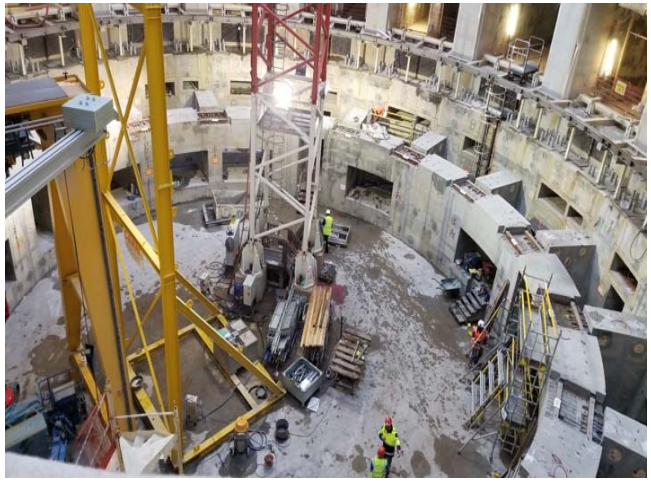
First machine component brought into the ITER tokamak pit

The tokamak complex continues to take shape. The tokamak bioshield is now hidden behind the walls of the tokamak building.

On November 26, the first machine component - a cryostat feedthrough for poloidal field coil #4 - entered the tokamak pit. This is no small feat; the component is 10 meters long and weighs 6.6 tons. This auspicious occasion marks the beginning of five years of tokamak assembly activities.

The tokamak pit is being prepared for the first tokamak components.

Photos & text from USBPO eNews and ITER Newsline



On the night of November 26, the first machine component was delicately lowered 30 meters down onto the tokamak pit floor, marking the beginning of five years of intense assembly activities. ©ITER Organization.

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Examples of U.S. hardware for ITER

First U.S. hardware installed in the Tokamak Complex
Drain tanks fabricated in the U.S. were also the first nuclear-certified components delivered to the ITER site.

Energizing of the Steady State Electrical Network delivered by the U.S. to the ITER site

Central Solenoid Module 1 at General Atomics (Poway, CA facility)

Drain tank being lifted into the tokamak facility

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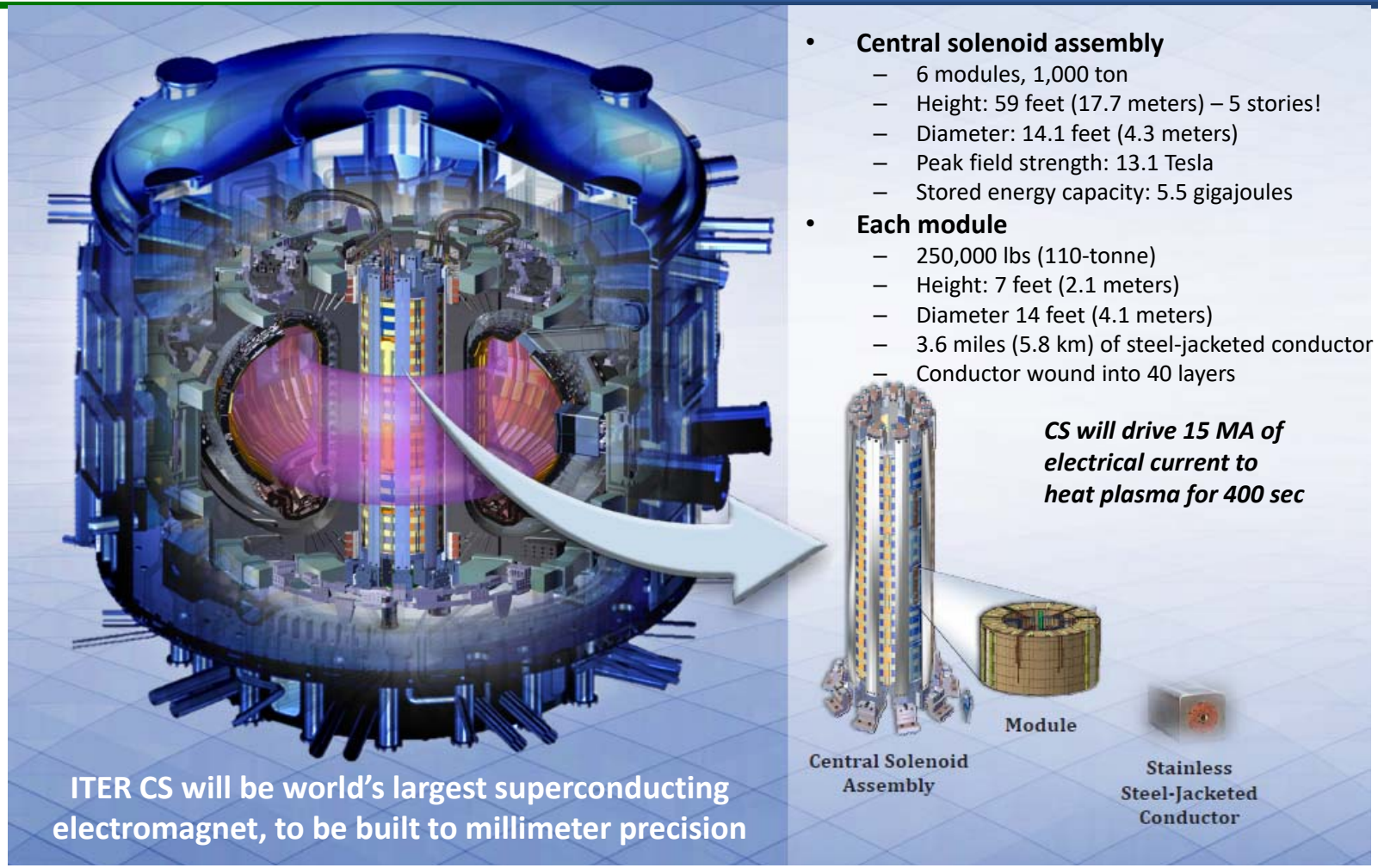
ITER contracted to use US coil fabrication for its central solenoid



- **Central solenoid assembly**
  - 6 modules, 1,000 ton
  - Height: 59 feet (17.7 meters) – 5 stories!
  - Diameter: 14.1 feet (4.3 meters)
  - Peak field strength: 13.1 Tesla
  - Stored energy capacity: 5.5 gigajoules
- **Each module**
  - 250,000 lbs (110-tonne)
  - Height: 7 feet (2.1 meters)
  - Diameter 14 feet (4.1 meters)
  - 3.6 miles (5.8 km) of steel-jacketed conductor
  - Conductor wound into 40 layers

CS will drive 15 MA of electrical current to heat plasma for 400 sec

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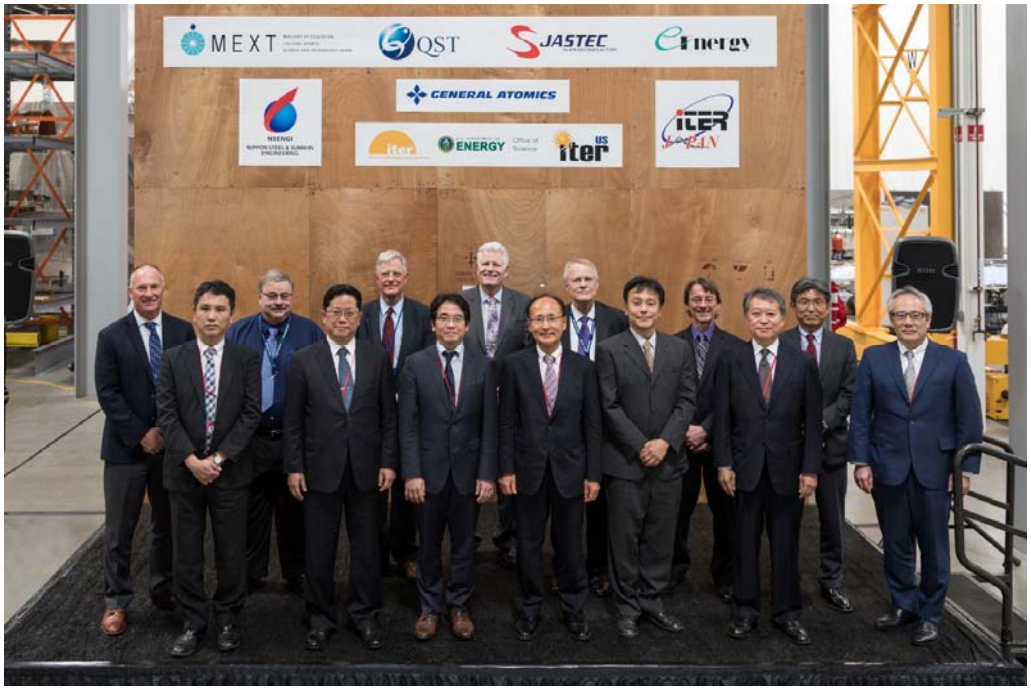
MEXT-QST-DOE-GA celebration of final delivery of Japanese superconductor for ITER central solenoid



May 3, 2018 at General Atomics:
51 spools of niobium-tin superconductor = 43 km

4. Program Planning

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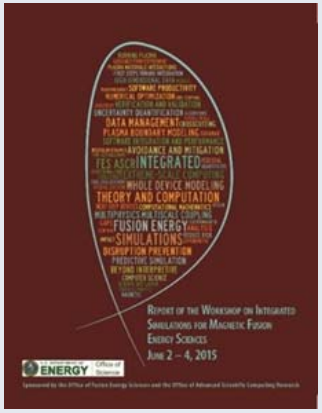
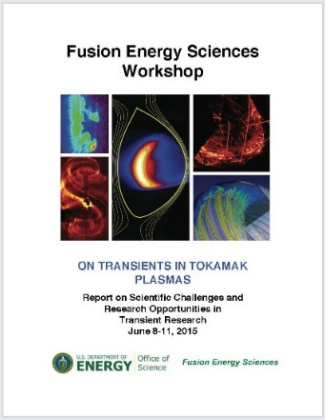
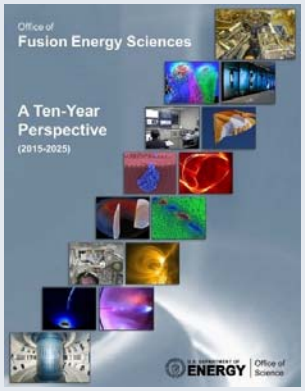
FES strategic choices are informed by community and Advisory Committee input

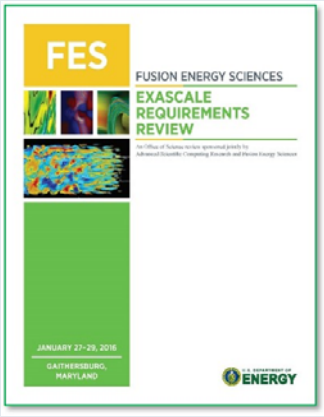




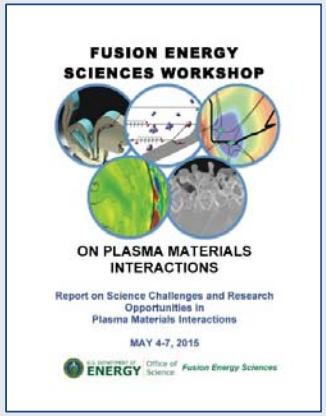
2015 Applications of Fusion Energy Sciences Research



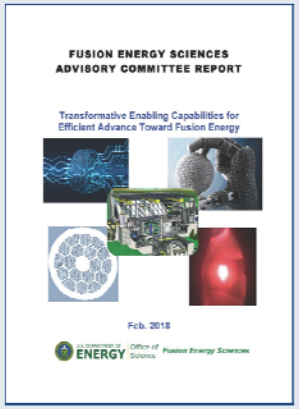
2015 FES 10-year Perspective



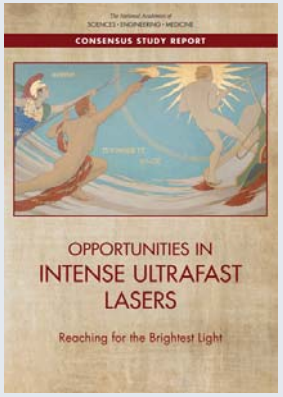
2016 FES Exascale Requirements



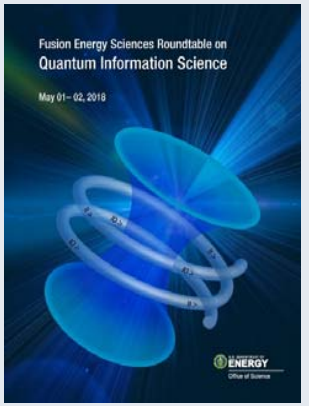
2015 Community Workshops:
Integrated Simulations, Transients, Plasma Materials Interactions, & Plasma Science Frontiers



2018 FESAC Transformative Enabling Capabilities



2017 FES NAS Report on Intense Ultrafast Lasers



2018 FES Roundtable on QIS

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National Academy report on intense ultrafast lasers

Recommendations

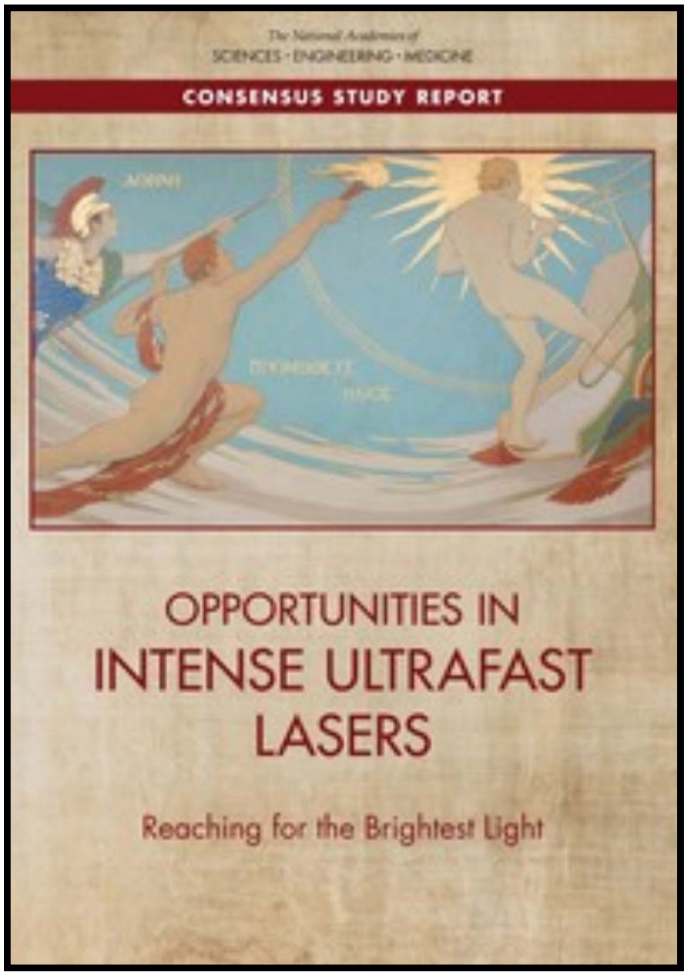
1. **DOE should** create **a broad national network** (universities, industry, government labs) in coordination with OSTP, DOD, NSF, and others.

2. US research agencies should engage stakeholders to **define facilities and laser parameters** that will best serve research needs.

3. **DOE should** lead development of **an interagency national strategy** for developing and operating large- and mid-scale projects, and developing technology.

4. **DOE should** plan **for at least one large-scale open-access, high-intensity laser facility** that leverages other major science infrastructure in the DOE complex.

5. Agencies should create U.S. programs that **include mid-scale infrastructure, project operations, development of technologies; and engagement in research at international facilities such as ELI.**



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National Academy burning plasma interim report was issued on December 21, 2017


PREPUBLICATION COPY – SUBJECT TO FURTHER EDITORIAL CORRECTION

INTERIM REPORT OF THE
COMMITTEE ON A STRATEGIC PLAN
FOR U.S. BURNING PLASMA RESEARCH

Committee on a Strategic Plan for U.S. Burning Plasma Research
Board on Physics and Astronomy
Division on Engineering and Physical Sciences

A Consensus Study Report of
The National Academies of
SCIENCES • ENGINEERING • MEDICINE

THE NATIONAL ACADEMIES PRESS
Washington, DC
www.nap.edu

The interim report notes that:

- Burning plasma research is essential to the development of magnetic fusion energy
- The U.S. has contributed leading advances in burning plasma science
- ITER is the only existing project to create burning plasma at reactor scale
- The U.S. should develop a national strategic plan leading to a fusion demonstration device

Full report is expected by the end of 2018

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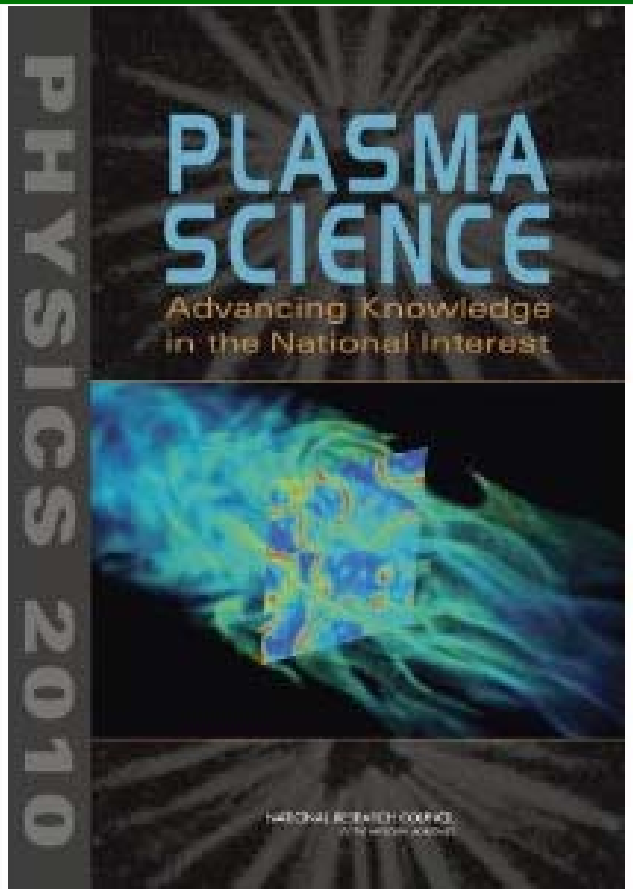
Physics 2020: A Decadal Assessment of Plasma Science



2010 Plasma Decadal Survey
(Chair: Steve Cowley)

- **Objective**
  Conduct a study of the past progress and future promise of plasma science and technology and provide recommendations to balance the objectives of the field in a sustainable and healthy manner over the long term
- **Multiple federal sponsors**
  - DOE (FES, HEP, NNSA, ARPA-E)
  - NSF
  - DOD (AFOSR, ONR)
- **Co-Chairs:**
  - Mark J. Kushner (U. Michigan)
  - Gary P. Zank (U. Alabama-Huntsville)
- **Names and bios of committee members:**
  https://www8.nationalacademies.org/pa/projectview.aspx?key=51149
- **Meetings so far:**
  - First public committee meeting was held on October 15 (Wash DC)
  - Town Hall was held November 6 during APS-DPP Meeting (Portland)
  - Next meeting will be January 10-11 (Irvine)
- **Report at this meeting by Prof. Kushner**

FESAC 2018 Committee of Visitors

- **Charged to consider and provide evaluation of:**
  - ***Process***: The efficiency and quality of the processes used by FES to solicit, review, recommend, monitor, and document awards and declinations for universities, national laboratories, and industry
  - ***Quality and Standing***: The breadth, depth, and quality of the resulting program portfolio, and providing an evaluation of the program's national and international standing
  - ***Project management***: FES's management of its portfolio of line item construction and Major Items of Equipment projects, including the U.S. Contributions to ITER project

- **COV review chronology:**
  - Review panel met at DOE Germantown August 7-9
  - Concluding briefing to FES on August 10
  - Request for FES factual check September 25
  - FESAC consideration of the report at today's meeting

- **Sincere thanks to the COV panel members**
  - Co-chairs Dr. Gert Patello and Prof. Fred Skiff

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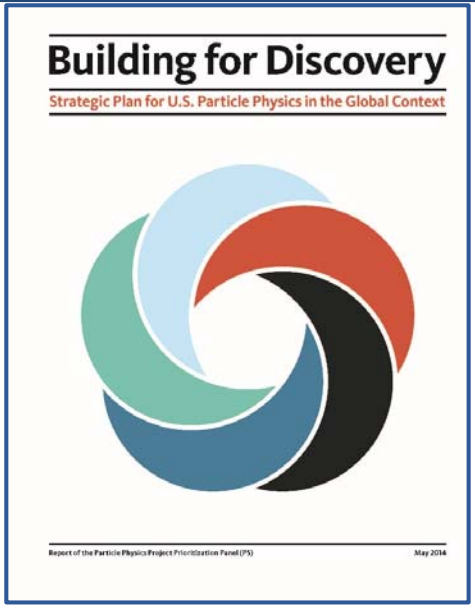
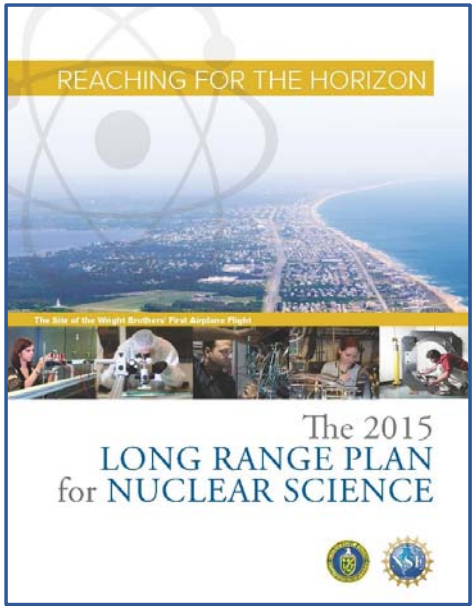
Long-range strategic planning activity for FES program

- Recent community input via workshops and other activities have informed the strategic priorities of the FES program, as reflected in the *FES Ten-Year Perspective* plan
- The community self-organized two workshops last year to provide valuable input to the burning plasma study by the National Academy of Sciences
- We are now ready to take the next step toward the development of a comprehensive long-range plan for the FES program, following a process similar to the one used by the Office of Science High Energy Physics and Nuclear Physics programs for the development of the HEP P5 report and the NP Long Range Plan
- The plan will be comprehensive, including all FES program areas (viz., MFE, General Plasma Science, HEDLP, etc.)
- A charge is being issued to FESAC at today's meeting
- FESAC subcommittee activities will be preceded by intensive community activities (e.g., workshops, townhall meetings, etc.) to be coordinated by APS-DPP and APS





New charge to FESAC (1)

This letter requests that the Fusion Energy Sciences Advisory Committee (FESAC) undertake a **new long-range strategic planning activity for the Fusion Energy Sciences (FES) program.**

The strategic planning activity—to encompass the entire FES research portfolio (namely, burning plasma science and discovery plasma science)—should identify and prioritize the research required to advance both the scientific foundation needed to develop a fusion energy source, as well as the broader FES mission to steward plasma science.

In developing recommendations within this long-range strategic planning activity, FESAC should take into account the following aspects:

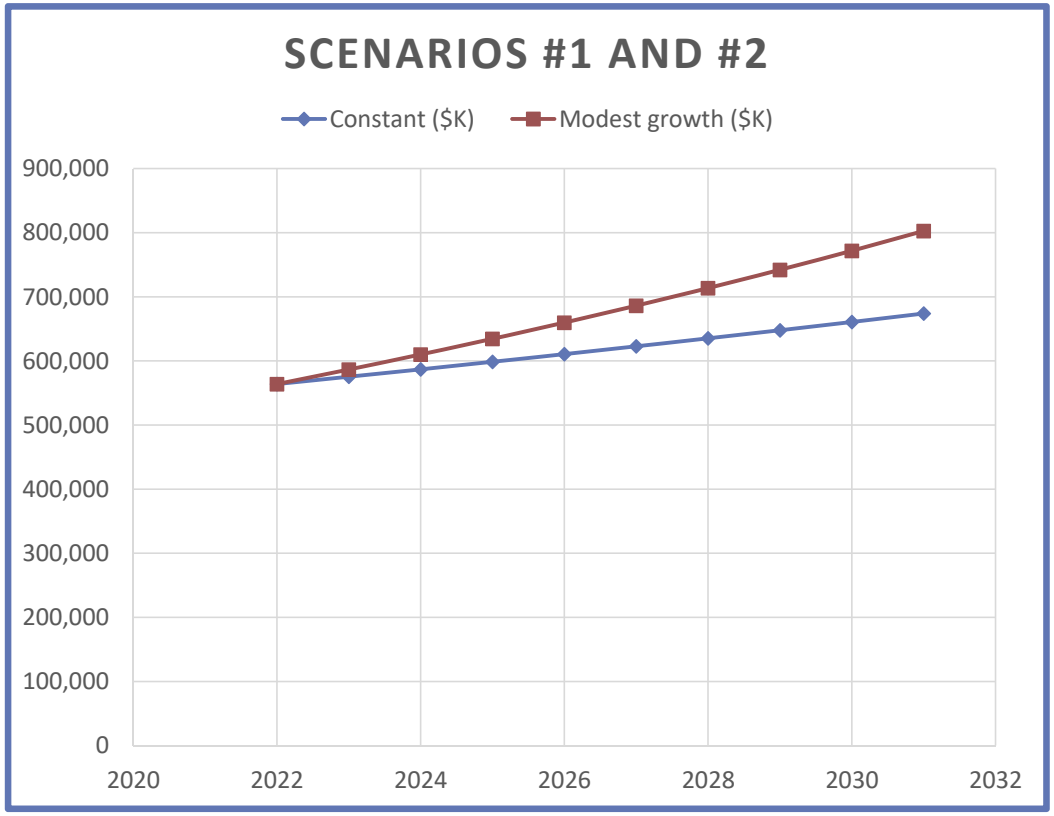
- Identifying specific research areas, across the entire FES portfolio, in which the U.S. should establish or enhance global leadership.
- Maintaining a healthy and flexible program, which incorporates the roles and contributions of universities, national laboratories, and industry, to deliver science results throughout the next decade.
- Maintaining, upgrading, and/or pivoting current small-, mid-, and large-scale facilities, including DIII-D and NSTX-U, and also initiating new experiments/facilities/projects.
- Identifying international collaborative opportunities or partnerships that can give U.S. scientists access to devices outside of the U.S. with unique capabilities.
- Providing support for private-public partnership ventures.
- Positioning the U.S. to obtain maximum benefits in the ITER burning plasma science era.
- Considering the future budgetary constraints described below, as well as the technical readiness and feasibility for any activity to proceed.

New charge to FESAC (2)

Your report should provide recommendations on the priorities for an optimized FES program over the next ten years (FY 2022-2031) under the following three scenarios with the FY 2019 enacted budget for the FES program as the baseline:

- Constant level of effort (defined as the published OMB inflators for FY 2022-2031)
- Modest growth (use 2% above the published OMB inflators)
- Unconstrained budget: For this scenario, please list, in priority order, specific activities (beyond those mentioned in the previous budget scenarios) that are needed to achieve and maintain a leadership position addressing the scientific opportunities identified by the community.

Within each of the three scenarios, assume that the U.S. Contributions to ITER project will continue through this entire period.



New charge to FESAC (3)

The FESAC activity in addressing this charge should commence after the completion of community-led activities to provide broad input to this long-range planning. This two-phase approach for long-range planning is similar to that used by both the High Energy Physics program and also the Nuclear Physics program within the DOE Office of Science.

- **For the first phase**, we have asked the American Physical Society's Division of Plasma Physics (DPP) to lead with the organization of community-led activities (such as discussions, town halls, workshops, and any other forums it chooses). We want the community to be actively involved in this long-term planning process. We are grateful that the DPP leadership is willing to provide this valuable sponsorship of the community-driven first phase.

- **The second phase** of the process involves this charge to FESAC. Although this charge will be discussed at the December 6 and 7 FESAC meeting, no FESAC subcommittee to address the charge will be formed at that time. Toward the end of the community's process to develop its important input for planning, a FESAC subcommittee shall be formed to carry out the work of developing the long-range plan.

We would appreciate receiving the report from FESAC by **December 2020**, if possible.

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Fusion program prioritization will adapt the HEP (P5) and NP (LRP) processes

Phase 1: Community-organized activities

Community Awareness
Inform the community that a FESAC charge is coming

Done (Nov 5 letter)

↓

Subfield community self-organization
Community plans how to fill gaps from Madison & Austin meetings

In process (thanks to DPP)

↓

FESAC charge issued
18-24 month clock starts with budget guidance/scenarios

Today

↓

FES tasks APS-DPP to convene topical town hall meetings
Subfield white papers, talks, virtual meetings (esp. early-career scientists); build on 2017-2018 community organization and NAS reports; community demographics & diversity; followed by homework revisions & priorities

↓

"Snowmass" meeting
~10 day meeting where all subfields attend

Fusion program prioritization will adapt the HEP (P5) and NP (LRP) processes

Phase 2: FESAC Working Group

FESAC chair & vice chair select Working Group with FES concurrence
Solicit nominations from community; working group meetings discussing the four frontiers

↓

FESAC Working Group convenes Resolution Meeting
5 days with open & closed sessions; discussions and writing sessions with final draft recommendations

↓

FESAC vote & report transmittal

↓

Stakeholder briefings
FES community, OMB, OSTP, Congress, international partners

Reminder: Language in H.R. 589

- Not later than two years after the date of enactment of this Act, the Secretary shall submit to Congress a report on the fusion energy research and development activities that the Department proposes to carry out over the 10-year period following the date of the report under not fewer than 3 realistic budget scenarios, including a scenario based on 3% annual growth in the non-ITER portion of the budget for fusion energy research and development activities:
  - Identify specific areas of fusion energy research and enabling technology development in which the U.S. can and should establish or solidify a lead in the global fusion energy development effort
  - Identify priorities for initiation of facility construction and facility decommissioning under each of the three budget scenarios
  - Assess the ability of the fusion workforce of the U.S. to carry out the activities identified, including the adequacy of programs at institutions of higher education in the U.S. to train the leaders and works of the next generation of fusion energy researchers.
- In order to develop the report, the Secretary shall leverage best practices and lessons learned from the process used to develop the most recent report of the Particle Physics Projet Prioritization Panel of the High Energy Physics Advisory Panel.
- No member of the Fusion Energy Sciences Advisory Committee shall be excluded from participating in developing or voting on final approval of the report required.

5. People

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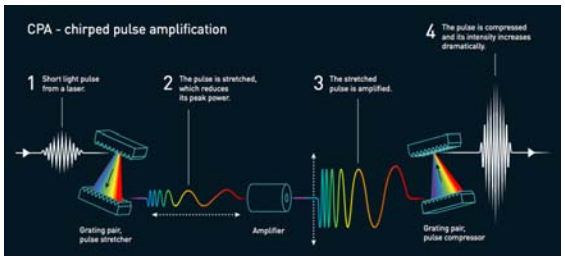
2018 Nobel Physics Prize for CPA led to the development of high-power lasers for HEDP

2018 Nobel Prize in Physics

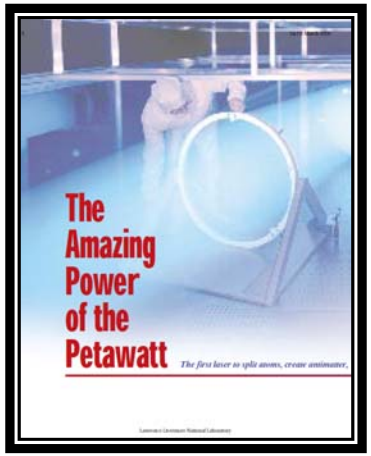
Donna Strickland & Gerard Mourou: "Compression of amplified chirped optical pulses" (Optics Communications, 1985)

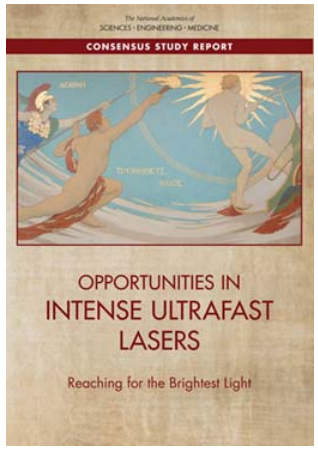


Chirped pulse amplification (CPA)

Congratulations!

- **First Petawatt Laser**
- **LLNL, May 23, 1996**





Congratulations to Sir Steve

Investiture ceremony at Buckingham Palace (October 11, 2018)

- KNIGHTS BACHELOR, Sir Steven Charles Cowley FRS FREng
- “For services to Science and to the Development of Fusion Energy”

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DOE senior leadership updates

Mr. **Paul M. Dabbar** was sworn in as Under Secretary for Science on November 7, 2017

- Has visited a number of U.S. and overseas fusion facilities and institutions

Dr. **Chris Fall** was nominated on May 18, 2018, as the Director of the DOE Office of Science

- Dr. Fall is presently the Principal Deputy Director of ARPA-E
- Subcommittee hearing was held June 26, 2018
- Awaiting final Senate confirmation

Mr. **Kurt Heckman** is a senior advisor in the Office of Science

- Will work for the incoming Director of the Office of Science

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FES staff updates

Dr. **Mark Foster** entered phased retirement status in July 2018

- He is working half-time, assisting Matt Lanctot and Curt Bolton to assume program manager responsibilities for DIII-D and Measurement Innovation programs, respectively

Mr. **Jeff Thomas** (PE, PMP, CCP) joined FES on September 16, 2018

- He is the new ITER program manager

Dr. **Sam Barish** plans to enter phased retirement status later in December 2018

- He will work half-time
- He will continue to manage the stellarator program and FESAC
- Other duties will transition elsewhere

Dr. **Guinevere Shaw** will join FES on December 9, 2018

- She will manage the fusion nuclear science portfolio

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2018 FES Early Career awards

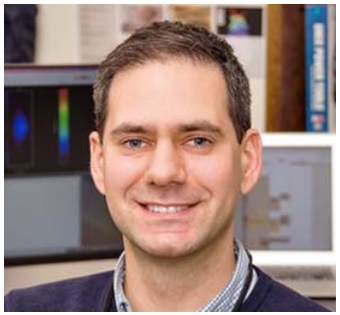
Dr. Sam Lazerson (PPPL)
Energetic particle confinement in stellarators

Dr. Tammy Ma (LLNL)
Laser-driven particle acceleration for novel HED and ICF applications

Dr. Alex Zylstra (LANL*)
Nuclear astrophysics with inertial fusion implosions
** Moved to LLNL*

Prof. David Donovan (U. Tennessee)
Impurity transport in magnetically confined fusion

Prof. Kentaro Hara (Texas A&M)
Self-organization in low-temperature magnetized plasmas



Dr. Nate Ferraro (PPPL)
Modeling of ELM suppression and mitigation

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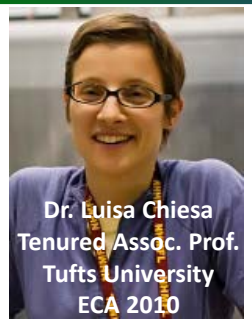
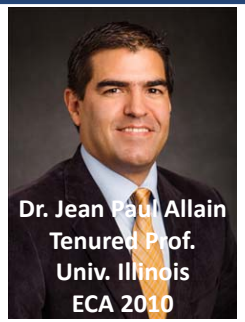
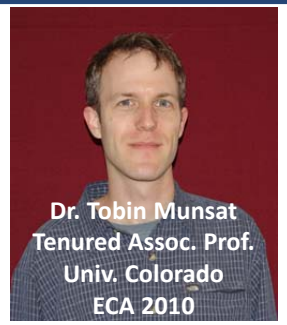
Among 25 FES Early Career awardees, 12 out of the 14 university awardees have already achieved tenure


Dr. Stanislav Boldyrev
Tenured Prof., UW
ECA 2010


Dr. Luisa Chiesa
Tenured Assoc. Prof.
Tufts University
ECA 2010

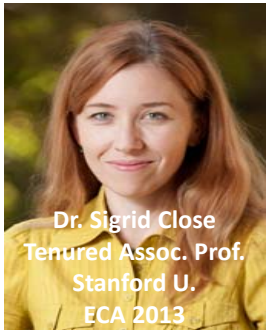

Dr. Jean Paul Allain
Tenured Prof.
Univ. Illinois
ECA 2010


Dr. Tobin Munsat
Tenured Assoc. Prof.
Univ. Colorado
ECA 2010

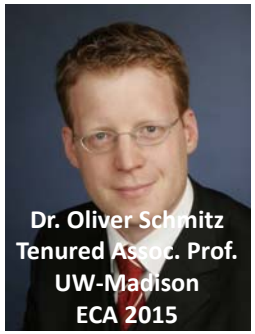

Dr. Christoph Niemann
Tenured Assoc. Prof., UCLA
ECA 2011


Dr. Anne White
Tenured Assoc. Prof., MIT
ECA 2011


Dr. Kai Germaschewski
Tenured Assoc. Prof., UNH
ECA 2011


Dr. Sigrid Close
Tenured Assoc. Prof.
Stanford U.
ECA 2013


Dr. Lorenzo Mangolini
Tenured Assoc. Prof.
UC-Riverside
ECA 2015


Dr. Oliver Schmitz
Tenured Assoc. Prof.
UW-Madison
ECA 2015


Dr. Peter Bruggeman
Tenured Assoc. Prof.
U. Minnesota
ECA 2016


Dr. Devesh Ranjan
Tenured Assoc. Prof.
Georgia Tech
ECA 2016

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FES Early Career awardees have also received other recognition

PECASE Award
- Daniel Sinars (SNL) 2012
- Sigrid Close (Stanford U) 2014
- Stephanie Hansen (SNL) 2017

R&D 100 Award
- Vlad Soukhanovskii (LLNL) 2012

APS Weimer Award
- Anne White (MIT) 2014
- Felicie Albert (LLNL) 2017

Fabre Prize
- Felicie Albert (LLNL) 2017

Cryogenic Society of America Roger W. Boom Award
- Luisa Chiesa (Tufts U) 2016

FPA Award
- Daniel Sinars (SNL) 2014
- Anne White (MIT) 2014
- Francesco Volpe (Columbia U) 2015
- Adam Sefkow (U Rochester) 2017

American Geophysical Union SPARC Education and Outreach Award
- Sigrid Close (Stanford U) 2017

APS Fellows
- Yuan Ping (LLNL) 2015
- Daniel Sinars (SNL) 2015

Fabre Prize

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FES Postdoctoral Researcher Program – CY 2018

FY17&18

Marlene Patino
Plasma Material Interaction Studies at PISCES (UCSD)

Anton Neff
DIII-D Impurity Collector Probe Analysis (ORNL)

Jacob Nichols
Whole-Device Modeling (U. Tenn. – Knoxville)

FY18&19

Ben Faber
Stellarator Optimization (UW Madison)

Reed Hollinger
Relativistic Laser Interactions (Colorado State)

Ryan Sweeney
Disruption Mitigation (MIT)

Luke Stagner
Runaway electrons (GA)

Noah Hurst
Electron plasma fluids (UCSD)

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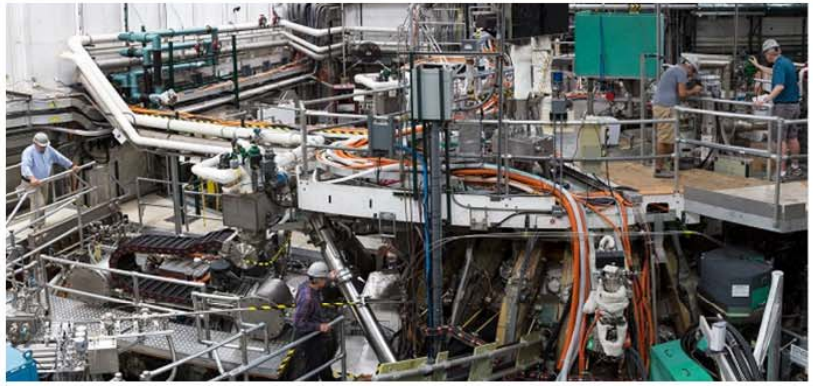
DOE Fusion Energy Sciences Postdoctoral Research Program



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