

# U.S. Fusion Energy Sciences

## Program Perspective

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

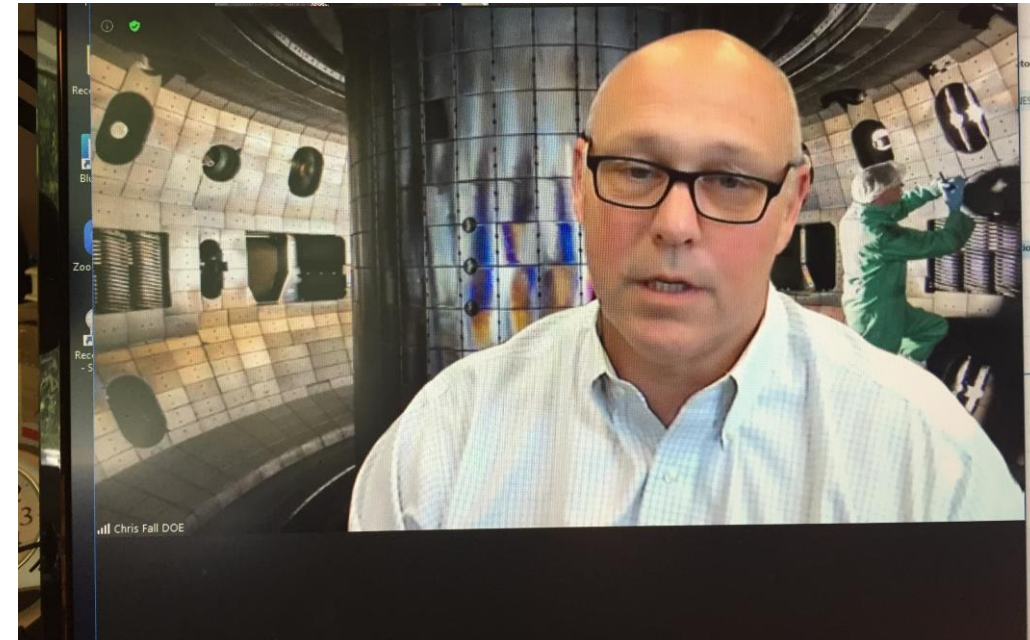
**Fusion Energy Sciences Advisory Committee Meeting**  
**December 7-10, 2020**



U.S. DEPARTMENT OF  
**ENERGY**

Office of Science

- **Many institutions worked remotely since mid-March**
  - Impressive efforts to continue research progress
- **DOE has a three-phase “Return to Workplace” plan**
  - Several labs and DOE have gone to Phase 2
- **Meetings and conferences are being held virtually:**
  - IAEA Fusion Energy Conference (Oct 2020 → May 2021)
  - APS-DPP Annual Meeting (November 13-17, 2020)
  - ITPA meetings (including ITPA Coord Comm Mtg)
  - FESAC (December 7, 8, and 10, 2020)
  - Fusion Power Associates Meeting (December 16-17)
  - And others



**Dr. Chris Fall: Director, Office of Science**  
*Office of Science Leadership Live meeting*

**DOE’s capabilities contribute to the fight against the virus:**

<https://www.energy.gov/science/articles/doe-tackling-challenge-coronavirus>

# SC Solicitations and Awards Management

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The DOE Office of Science (SC) Program Offices have been making accommodations for researchers and institutions in their awards management to be responsive to the impacts of the COVID-19 pandemic.

- On March 13, SC issued guidance to the research community regarding accommodating interruptions due to the COVID-19 pandemic.
- Updated guidance on SC's response to delayed research progress as a result of the pandemic and Q&As was issued in September. (<https://science.osti.gov/grants/Policy-and-Guidance/COVID>).
- SC has supported the Federal (OMB) and DOE award flexibilities that allow institutions to continue to charge the salaries and benefits of award personnel to SC awards if the recipient institution permits salaries to continue to be paid in the event of emergencies or disasters.

# SC Accommodations for Applicants and Awardees

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- In March, **SC immediately extended the application deadlines** for FY 2020 solicitations and made individual accommodations for Principal Investigator (PI) submissions beyond those deadlines upon request.
- **SC has responded promptly to requests for no-cost extensions on awards.**  
*(SC received an 18% increase in the requests for no-cost extension between March 1 and August 30 compared to the same period last year.)*
  - ~57% of requests referenced “COVID,” “coronavirus,” or “pandemic.”
- **SC has accommodated late progress reports.**  
*(About 31% of progress reports received between March 1 and August 30 were late; this was no change from the same time period last year.)*
  - ~ 52% of progress reports “COVID,” “coronavirus,” or “pandemic.”
- SC Programs have ongoing conversations with PIs about the reallocation of funding within existing awards and making accommodations for new start dates.
- **No impacts to SC peer reviews, award selection, and issuance of awards.**



# Understanding the Impacts to SC Research

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In May, SC established an internal task group focused on identifying the impacts of the COVID-19 pandemic on SC research funded through financial assistance (grants and cooperative agreements).

- SC has been engaging scientific professional societies, university associations, and other Federal agencies to obtain up-to-date information on the impacts to institutions and research communities.
- In October, SC and the Association of American Universities (AAU) co-hosted a focused roundtable discussion with university Senior Research Officers.
- In early December, SC will issue a survey to its PIs. This voluntary survey will focus on questions related to impacts to research progress and award personnel (primarily graduate students and postdocs).

**The efforts of the task group serve to inform a corporate SC response to the impacts that is open, transparent, and equitable within available resources.**

# SC PI Survey on COVID-19 Related Impacts

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- SC is issuing a voluntary survey to all Principal Investigators (PIs) of current SC financial assistance research awards to gain greater understanding on how the COVID-19 pandemic is negatively affecting research progress and personnel on SC research awards.
- The scope includes SC-sponsored research awards and awards administered by SC through the DOE SBIR/STTR Programs Office. This *does not* include non-research awards (e.g. conference travel only) or awards to DOE laboratories.
- Survey questions focus on **impacts to research progress** and budget, the sources of research impacts, and related **impacts to award personnel** (primarily graduate students, postdocs).
- PIs are asked to roll up impacts associated with any subawards on the primary award.
- SC is partnering with the Oak Ridge Institute for Science and Education (ORISE) to conduct the online survey. All responses will be anonymous to SC; information will be provided to SC in aggregate form.
- The survey will be launched the week of December 7. Survey information will be emailed to PIs through PAMS. The survey will be open for ~2 weeks.
- All questions from PIs and recipient institutions regarding the survey should be directed to: [SC.PISurvey@science.doe.gov](mailto:SC.PISurvey@science.doe.gov)

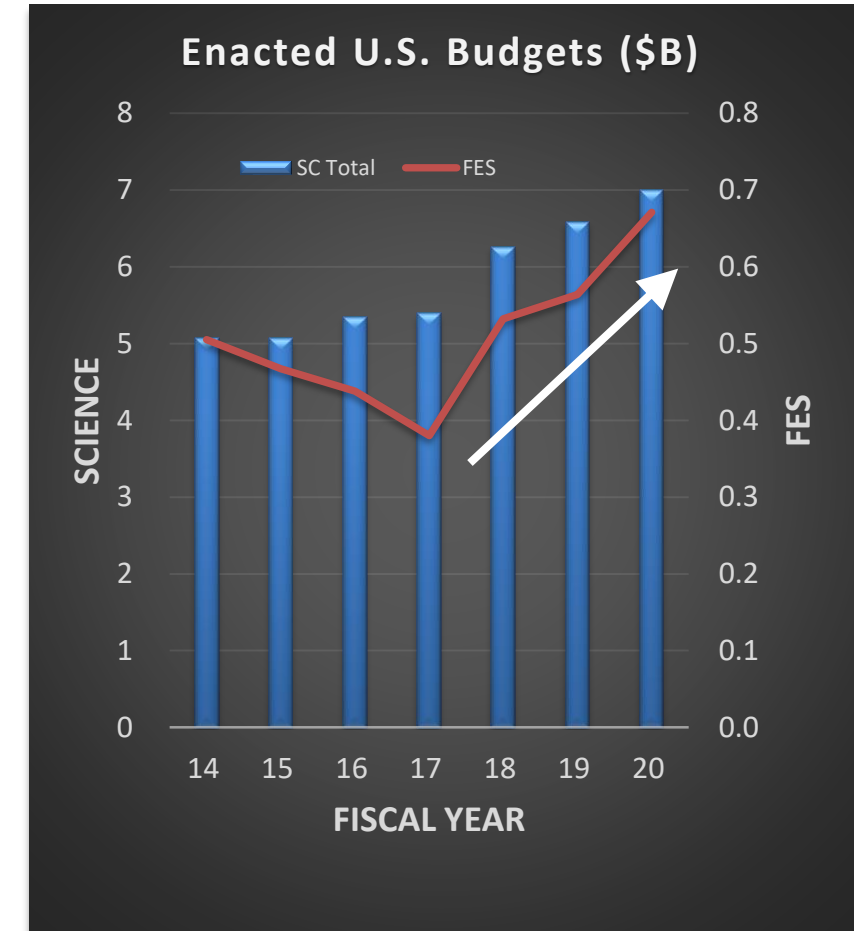


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# ***1. Budget Updates***

- **FY 2021 Budget Request:**
  - House and Senate marks were issued
  - Operating under a Continuing Resolution until December 11
  - The FES budget request includes initiatives on quantum information science, artificial intelligence and machine learning, microelectronics, and fusion acceleration
- **FY 2022 Budget Request:**
  - FES held 14 individual budget planning meetings with major research institutions and community research coordination organizations
  - Currently awaiting pass back from OMB on the proposed budget request



Recent enacted budgets have enabled accelerated progress throughout the program





FOA Title	Status
<p><b>High-Energy-Density Laboratory Plasma Science</b></p>	<p><b>Issued</b> Closes on 02/18/2021 LOIs due: 12/20/2020</p>
<p><b>Collaborative Research in Magnetic Fusion Energy Sciences on Long-Pulse International Stellarator Facilities</b></p>	<p><b>Issued</b> Closes on 01/25/2021 Preapplications due: 12/14/2020</p>
<p><b>Opportunities in Frontier Plasma Science (Lab call only)</b></p>	<p><b>Issued</b> Closes on 03/26/2021 LOIs due: 02/12/2021</p>
<p><b>Early Career Research Program</b> <i>Please note no separate Lab call this year; Lab applicants must submit to the FOA; for more information, check: <a href="https://science.osti.gov/-/media/grants/pdf/foas/2021/SC_FOA_0002421.pdf">https://science.osti.gov/-/media/grants/pdf/foas/2021/SC_FOA_0002421.pdf</a></i></p>	<p><b>Issued</b> Pre-apps due: 11/20/20 @ 5 pm ET Pre-app response date: 12/17/20 Proposals due: 02/16/21 @ 5 pm ET</p>
<p><b>Office of Science Annual (“Open”) FOA</b> For all other areas, please submit to the Office of Science Annual (“Open”) FOA: <a href="https://science.osti.gov/-/media/grants/pdf/foas/2021/DE-FOA-0002414.pdf">https://science.osti.gov/-/media/grants/pdf/foas/2021/DE-FOA-0002414.pdf</a> <i>Check with your FES Program Manager before submitting</i></p>	<p><b>Issued</b> Open from 10/01/2020 – 09/30/2021</p>

**NOTE:** Planned FOAs are tentative, subject to FY 2021 budget appropriation by Congress

Check <https://science.osti.gov/fes/Funding-Opportunities> for updates



## ***2. Programmatic Updates***

## DIII-D

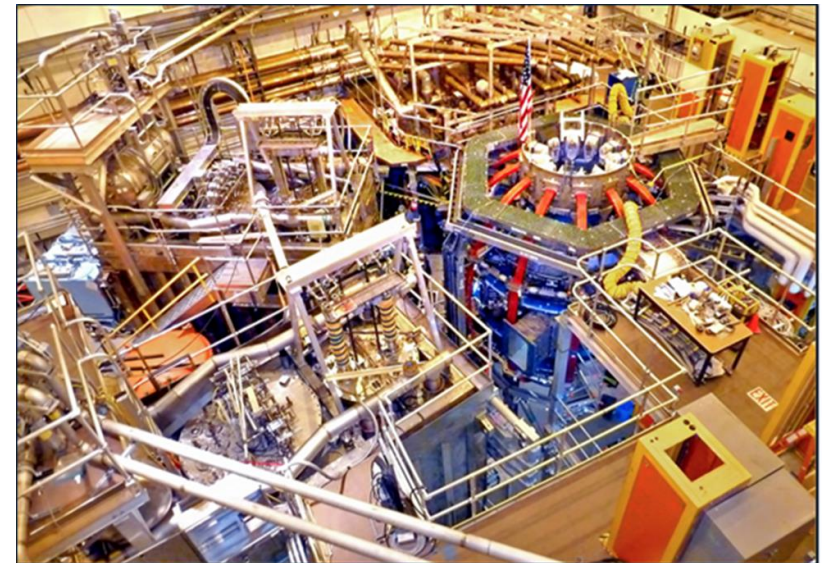
- New DIII-D leadership: Richard Buttery and George Sips
- 18-week experimental campaign planned
  - One-week hydrogen campaign
  - One-week Frontier Science Campaign
- Complete helicon commissioning and conduct experiments
- Three new gyrotrons arriving to fill all available sockets
- Vent in latter half of year to install new lower hybrid antenna on center post and replace helium liquefier



DIII-D operating with control room virtually empty

## NSTX-U

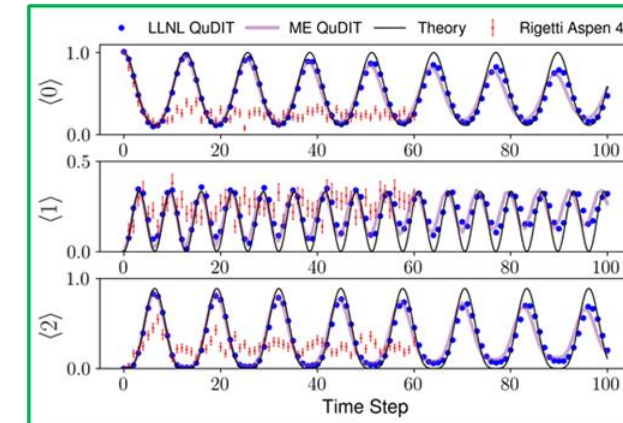
- Recovery project is proceeding
- Delivery of six production inner Poloidal Field (PF) coils, with three spare coils being fabricated
- 80% production complete on Center Stack Casing
- Delivery of the first production Plasma Facing Component tiles



NSTX-U Test Cell

## Recent highlights from FES-supported QIS research:

- **First Room-Temperature Superconductor Could Spark Energy Revolution**
  - Univ of Rochester team discovered world's first superconductor that operates at room temperature, opening new paths for quantum device design
- **First-ever quantum simulation of nonlinear plasma interactions**
  - Performed on the LLNL Quantum Design and Integration Testbed (QuDIT) quantum computing hardware platform



First-ever quantum simulation of nonlinear plasma interactions - 2020

## Programmatic Updates

- First meeting of the recently established **National Quantum Initiative Advisory Committee (NQIAC)** was held on October 27, 2020 (<https://science.osti.gov/About/NQIAC/Meetings/202010>)
- DOE, NIST, and NSF are holding the **National Quantum Initiative (NQI) Virtual Community Meeting** this week (December 7-10) -- *PI meeting; by invitation only*

Department of Energy

## Department of Energy Announces \$625 Million for New Quantum Centers

JANUARY 10, 2020

[Home](#) » Department of Energy Announces \$625 Million for New Quantum Centers

Centers to Support National Quantum Initiative

WASHINGTON, D.C. - Today, the U.S. Department of Energy (DOE) announced up to \$625 million over the next five years to establish two to five multidisciplinary Quantum Information Science (QIS) Research Centers in support of the National Quantum Initiative.

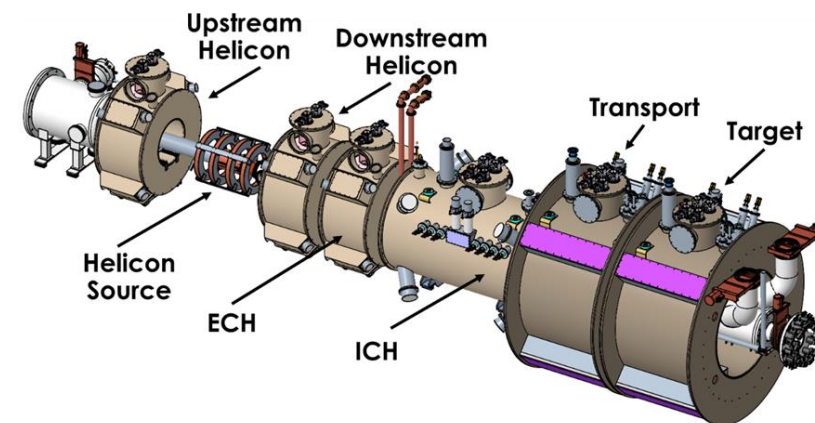


# Materials Plasma Exposure eXperiment (MPEX)

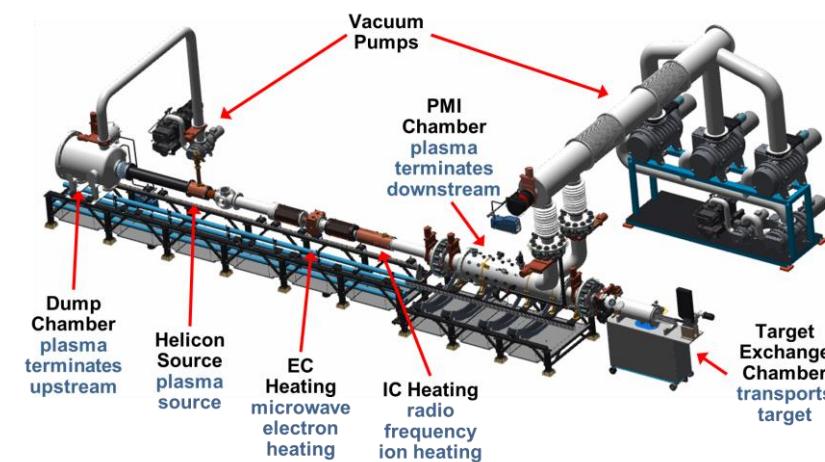


Under Secretary Paul Dabbar cuts ribbon at MPEX site

- **Critical Decision - 1, "Approve Alternative Selection and Cost Range,"** was approved on February 3, 2020
- **Critical Decision - 3A (CD-3A), "Approve Long-Lead Procurements,"** was approved on October 29, 2020

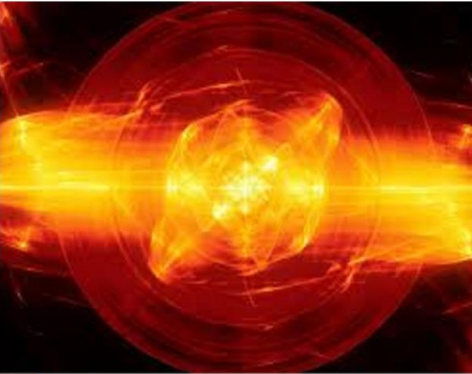


MPEX Magnets



MPEX Heating and Support Systems without Magnets





## Innovation Network for Fusion Energy

The INFUSE program will accelerate fusion energy development in the private sector by reducing impediments to collaboration involving the expertise and unique resources available at DOE laboratories. This will ensure the nation's energy, environmental and security needs by resolving technical, cost, and safety issues for industry.

[Read More](#)

< [Second annual INFUSE Workshop scheduled](#) >



Dennis Youchison,  
Director



Ahmed Diallo,  
Deputy Director

- **Innovation Network for Fusion Energy (INFUSE)** program for fusion R&D continued in FY 2020 with a Congressional allotment of \$4.0M
  - Second-round INFUSE awards were announced December 3
  - 10 awards were recommended across 8 companies involving 5 DOE laboratories; 3 awards are to companies with foreign ownership
- **2<sup>nd</sup> Annual INFUSE Workshop** was held virtually on Dec. 1 & 2, 2020, organized by ORNL and PPPL and co-hosted by the Electric Power Research Institute (EPRI) and the Fusion Industry Association (FIA)
  - **195** registered participants: DOE (6) including ARPA-E, UKAEA (2), IAEA (1), DOE national labs (53), EPRI (9), universities (22), private companies (95), and utilities (7)
  - The workshop included a roundtable discussion, presentations from the participating labs and private companies and from utilities; breakout rooms for targeted discussions
  - The presentations will be available at the INFUSE website

The GAMOW Program represents a new kind of partnership between SC-FES and ARPA-E focusing on priority areas for fusion technology research, and is aimed at bridging the gap in traditional mission spaces of SC-FES and ARPA-E. The GAMOW Program is jointly funded and managed by ARPA-E and FES, with each providing ~\$15 M in funding of the 3-year program



FES partnered with ARPA-E on four BETHE awards to support tech development for HTSC solenoid for pulsed tokamaks (CFS), permanent magnet stellarator (PPPL), ArF lasers (NRL), and IR to UV experiments (LLE). Total FES investment = \$15M / 3 years.

GAMOW Project title	Team	Lead PI
Fusion Energy Reactor Models Integrator (FERMI)	<b>Oak Ridge National Laboratory</b> ; Lawrence Livermore National Laboratory; HyPrComp Inc; University of California-Los Angeles	Vittorio Badalassi
Renewable low-Z wall for fusion reactors with built-in tritium recovery	<b>University of California-San Diego</b> ; Idaho National Laboratory	Eric Hollmann
Interfacial-Engineered Membranes for Efficient Tritium Extraction	<b>Colorado School of Mines</b> ; Idaho National Laboratory	Colin Wolden
EM-ENHANCED HYPOR LOOP FOR FAST FUSION FUEL CYCLES	<b>Savannah River National Laboratory</b> ; Clemson University; University of South Carolina-Columbia	George Larsen
Dirtect LiT Electrolysis Process Modeling & Scale up	<b>Savannah River National Laboratory</b> ; Clemson University	Brenda Garcia-Diaz
Advanced HTS Conductors Customized for Fusion	<b>University of Houston</b>	Venkat Selvamamickam
High Efficiency, Megawatt Class Gyrotrons for Instability Control of Burning Plasma Machines	<b>Bridge 12 Technologies, Inc</b> ; Oak Ridge National Laboratory; Massachusetts Institute of Technology	Jagadishwar Sirigiri
WIDE BAND GAP SEMICONDUCTOR AMPLIFIERS FOR PLASMA HEATING AND CONTROL	<b>Princeton Fusion Systems</b> ; United Silicon Carbide; NREL; Princeton University	Michael Paluszek
AMPERE - Advanced Materials for Plasma-Exposed Robust Electrodes	<b>University of California-Los Angeles</b>	Richard Wirz
Advance Castable Nanostructured Alloys for First-Wall/Blanket Applications	<b>Oak Ridge National Laboratory</b> ; University of Michigan	Lizhen Tan
ENHANCED Shield: A Critical Materials Technology Enabling Compact Superconducting Tokamaks	<b>Phoenix LLC</b> ; University of Wisconsin-Madison; Massachusetts Institute of Technology; Brookhaven National Laboratory	Ross Radel
ULTRA HIGH FLUX DT NEUTRON SOURCE FOR ACCELERATED TESTING OF FUSION MATERIALS AND SUBSYSTEMS TO REACTOR-RELEVANT DPA LEVELS	<b>Stony Brook University</b> ; University of Tennessee: Knoxville; Massachusetts Institute of Technology	Lance Snead
Plasma Facing Component Innovations by Advanced Manufacturing and Design	<b>Oak Ridge National Laboratory</b> ; Georgia Institute of Technology; Texas A&M University; Livermore National Laboratory	Yutai Kato
Microstructure Optimization and Novel Processing Development of ODS Steels for Fusion Environments (MONDO-FE)	<b>Pacific Northwest National Laboratory</b> ; North Carolina State University; Ames Laboratory	Dalong Zhang

- FES established LaserNetUS in FY 2018 in response to National Academy report
- Network renewed for another 3 years.
- LaserNetUS is a scientific ecosystem to efficiently and effectively do science.
- The Network puts an emphasis on participation by students, postdocs, and early career scientists; FES provides mobility funding to encourage travel within the network.

# LaserNetUS



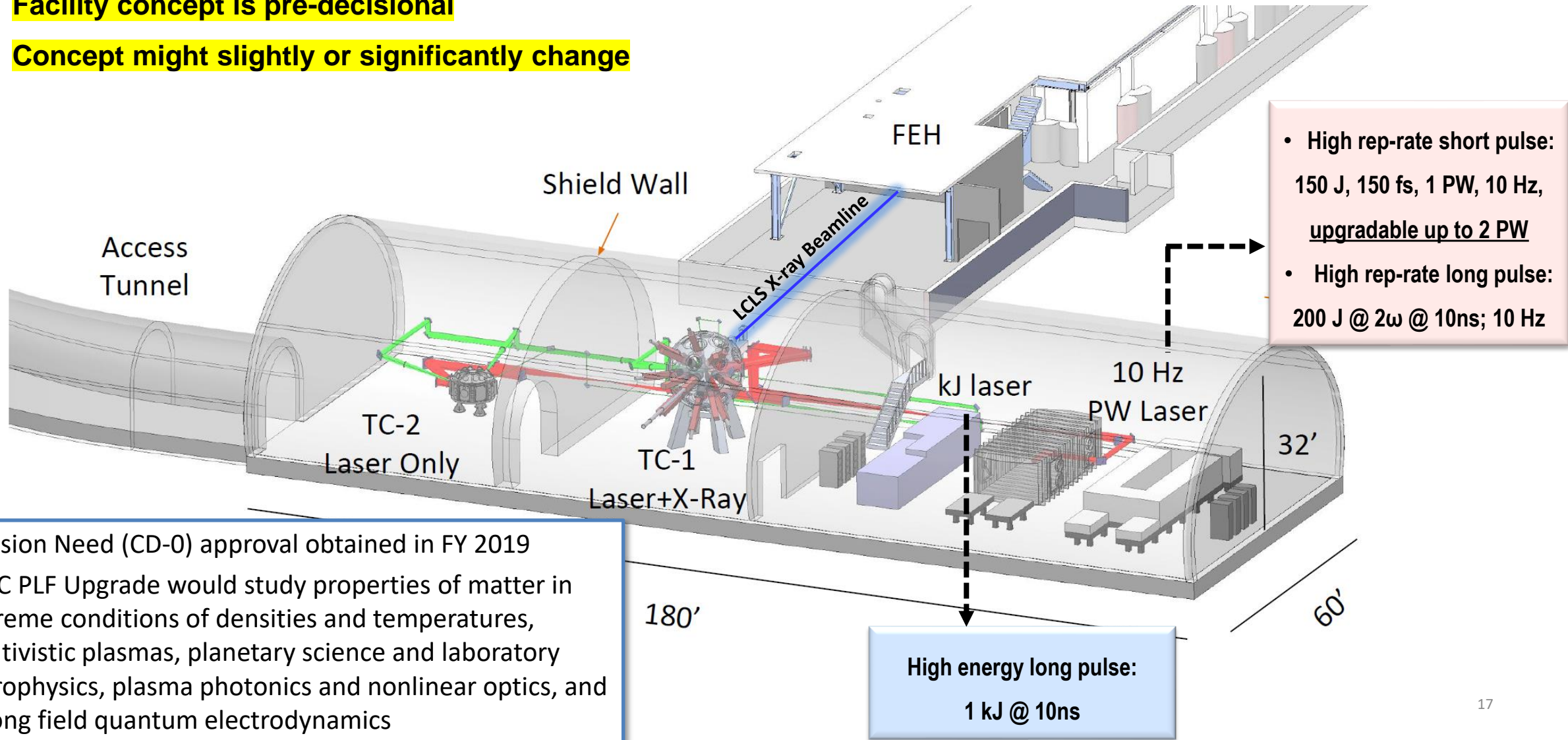
The Advanced Laser Light Source (ALLS) in INRS, Canada, is now available for user time





# MEC Petawatt Upgrade: Pre-CD-1 Design Concept

- Facility concept is pre-decisional
- Concept might slightly or significantly change



- Mission Need (CD-0) approval obtained in FY 2019
- MEC PLF Upgrade would study properties of matter in extreme conditions of densities and temperatures, relativistic plasmas, planetary science and laboratory astrophysics, plasma photonics and nonlinear optics, and strong field quantum electrodynamics

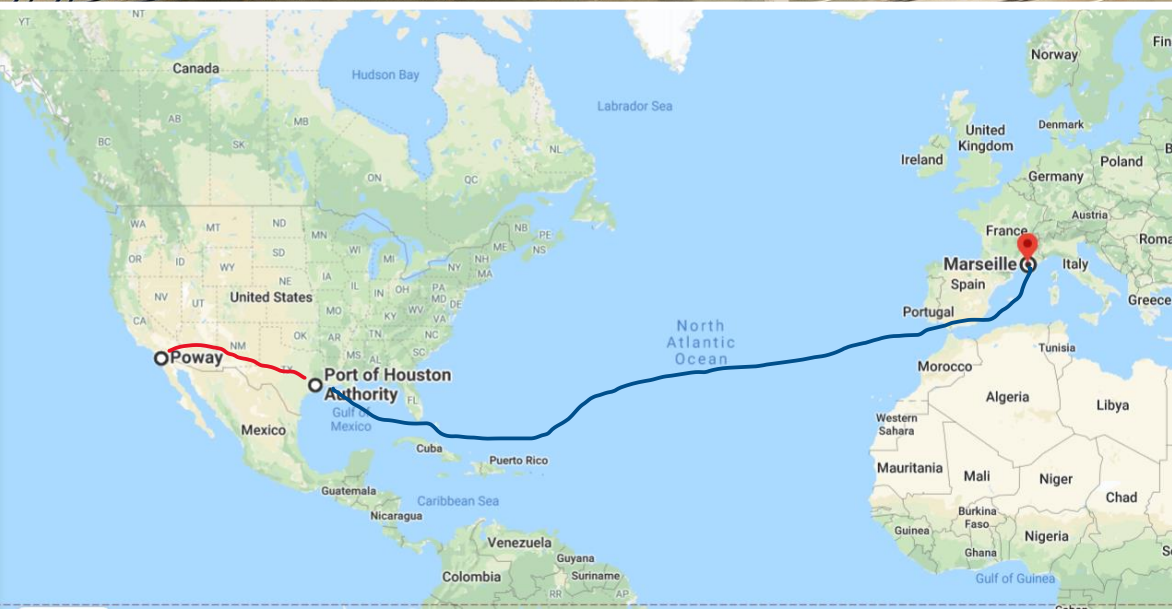


## ***3. ITER Updates***



# Central Solenoid Module 2 ready for testing; Module 1 shipping plan endorsed by independent review

Modules in different stages of fabrication at General Atomics in Poway, California  
October 2020



Transport of central solenoid module from GA (Poway, CA) to Port of Houston by girder trailer, and then by ship to ITER



# Construction progress at ITER Complex

A drone tour of the ITER site is updated several times a year





Delivery of D-shaped toroidal field coil #5 (of 18) at Fos Harbor, being loaded onto modular transporter for journey to ITER site



28 nov. 2020



## *4. People*



## FES made three university awards and three laboratory awards in FY 2020



**Dr. Federica Coppari**  
LLNL  
*Expanding Capabilities  
to Unlock the Mysteries  
of Complex Warm Dense  
Matter*



**Prof. Kevin Field**  
Univ. Michigan  
*Precipitate Stability and  
Helium Trapping in  
Advanced Steels*



**Prof. Benedict  
Geiger**  
Univ. Wisconsin  
*Experimental Study of  
Turbulence Impurity  
Transport in 3D  
Magnetic Fields*



**Prof. Ranganathan  
Gopalakrishnan**  
Univ. Rochester  
*Thermodynamics and  
Transport Models of  
Strongly Coupled Dusty  
Plasmas*



**Dr. Paul  
Humrickhouse**  
INL  
*Toward a  
Technology-  
Inclusive Whole  
Device Model*



**Dr. Elijah Martin**  
ORNL  
*Investigation of Helicon and  
Lower Hybrid Wave Coupling  
with the Edge Plasma for  
Current Drive Optimization  
in the Tokamak Using Laser  
Spectroscopy*



## FY 2017 Cohort



Neff

Nichols

## FY 2019 Cohort

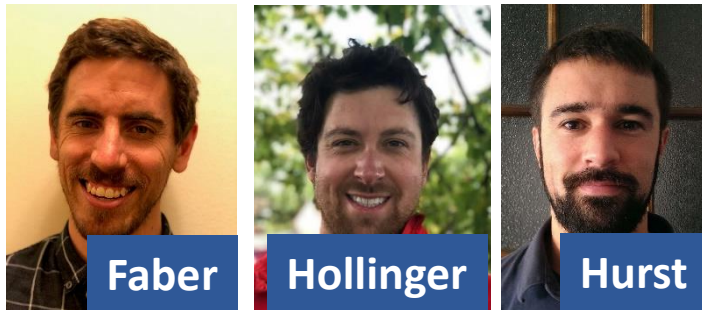


Campbell

Groselj

Younkin

## FY 2018 Cohort



Faber

Hollinger

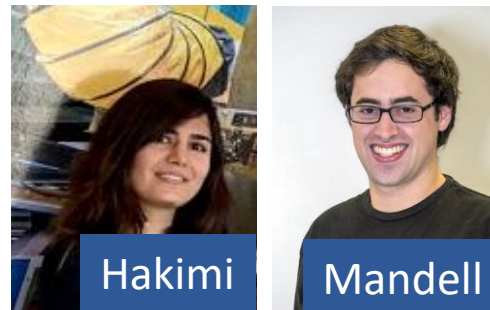
Hurst



Stagner

Sweeney

## FY 2020 Cohort



Hakimi

Mandell



Cote

## FY 2021 Cohort APPLICATION PERIOD IS NOW OPEN!

- Completed applications are to be submitted by **Monday, January 4, 2021, 4:00 p.m. Eastern Standard Time.**
- Recommendation Forms are to be submitted by Monday, January 4, 2021, 4:00 p.m. Eastern Standard Time.

<https://www.ora.gov/doe-fes-postdoc/default.html>



## ***4. Program Planning***



# Fusion regulatory framework

- U.S. Congress has expressed its interest on understanding the regulatory approach for Advanced Nuclear Reactors, including nuclear fusion reactors
  - *Nuclear Energy Innovation and Modernization Act*, S.512 (January 2018)
  - *Nuclear Energy Innovation Capabilities Act of 2017*, S.97 (January 2018)
- FES, along with the Nuclear Regulatory Commission (NRC) and the Fusion Industry Association, hosted the DOE-NRC Public Forum on Regulatory Framework for Fusion Energy, which was held as a virtual meeting on October 6, 2020
  - Opening remarks from DOE, NRC & FIA
  - Presentations are posted online (<https://science.osti.gov/fes/Community-Resources/Workshop-Reports>)
- NRC staff have started developing options for Commission consideration on licensing and regulating fusion energy systems



**Paul Dabbar**  
DOE Under Secretary for Science



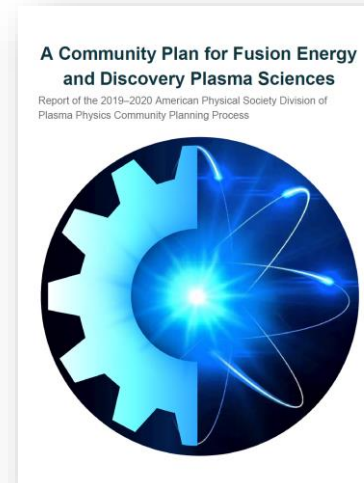
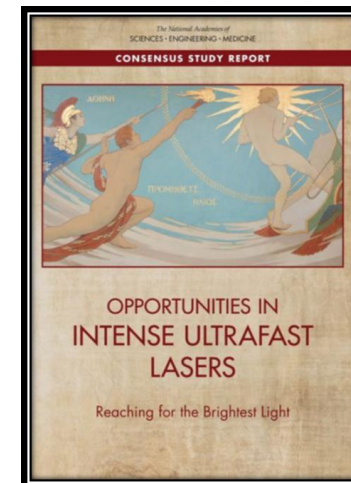
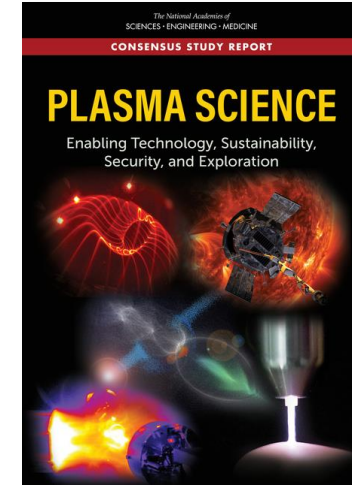
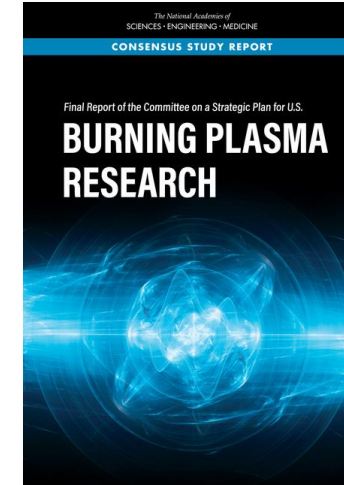
**Kristine Svinicki**  
Chair, Nuclear Regulatory Commission



**Andrew Holland**  
Executive Director, Fusion Industry Association



Title	Source	Date
<i>Opportunities in Intense Ultrafast Lasers</i>	NASEM	Dec 2017
<i>Burning Plasma Research</i>	NASEM	Jan 2019
<i>Brightest Light Initiative: The Future of Intense Ultrafast Lasers in the U.S.</i>	Community workshop	Workshop held Mar 2019
<i>A Community Plan for Fusion Energy and Discovery Plasma Sciences</i>	FES Community Planning Process	Mar 2020
<i>Plasma Science: Enabling Technology, Sustainability, Security, and Exploration</i>	NASEM Decadal Assessment	May 2020
<i>Powering the Future: Fusion and Plasmas (A Long-Range Plan)</i>	FESAC	Dec 2020
<i>Key Goals and Innovations Needed for a U.S. Fusion Pilot Plant</i>	NASEM	Expected late-Jan / early-Feb 2021



# Long-range strategic planning activities

## Phase-1

Community awareness

Subfields community  
self-organization

FESAC charge issued

APS DPP town hall  
meetings

Final CPP workshop (Houston)

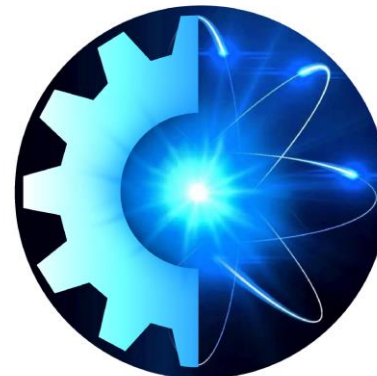
## Phase-2

Phase 2, led by FESAC/FESAC Subcommittee, took input from Phase 1 to develop the final long-range plan  
Long-range plan will be presented at FESAC meeting (December 7, 8, and 10)

- FES requested APS-DPP to organize CPP program committee and sponsor CPP workshops and travel
- The CPP encouraged and received broad engagement from the entire U.S. fusion and plasma physics community
- Frequent town halls, webinars, hundreds of small group discussions among subject matter experts, dedicated workshops, and focus group discussions were held.
- Hundreds of white papers and initiative proposals were submitted by the community throughout the process.

### A Community Plan for Fusion Energy and Discovery Plasma Sciences

Report of the 2019–2020 American Physical Society Division of Plasma Physics Community Planning Process



### Powering the Future Fusion & Plasmas

A long-range plan to deliver fusion energy and to advance plasma science




A Report of the Fusion Energy Scientific Advisory Committee

2020





- **This is the first time:**
  - A long-range plan has been developed for the entire FES program
  - The community has been substantially involved in the development of such a plan
- **Thoughts:**
  - The plan is ambitious
  - The plan is timely
  - The plan describes consensus
- **Thankful that:**
  - The community was so strongly involved (Phase 1)
  - The FESAC subcommittee invested so much time and effort (Phase 2)
  - DOE leadership allowed enough time for this process



**Appreciation to everyone  
involved in preparing this  
long-range strategic plan**