

Fusion Energy Sciences Program Update

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



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Fusion Energy Sciences Advisory Committee Meeting
March 12 & 13, 2019



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1. Budget Updates

- **Supports Cutting-Edge Basic Research and Leading Scientific User Facilities.** *The Budget provides \$5.5 billion for the **Office of Science** to continue its mission to focus on early-stage research, operate the national laboratories, and continue high priority construction projects. Within this amount, \$500 million is budgeted for Exascale computing to help secure a global leadership role in supercomputing, \$169 million for Quantum Information Science, \$71 million for artificial intelligence and machine learning, and \$25 million to enhance materials and chemistry foundational research to support U.S.-based leadership in microelectronics.*
- **Anticipate the full Administration budget request for FY 2020 to be released next week**

<https://www.whitehouse.gov/omb/budget/>



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2. Programmatic Updates

FY 2019 Funding Opportunity Announcements

FOA / Lab Call	Title	Issued	LOI / Pre-Pr	Proposals
Open: accepting LOIs / preproposals, and proposals				
DE-FOA-0002088	High-Energy-Density-Laboratory Plasma Science	2/21/19	3/21/19	4/22/2019
DE-FOA-0002076 LAB 19-2076	Collaborative Research in Magnetic Fusion Energy Sciences on International Tokamaks	3/7/19	4/4/19	5/9/2019
DE-FOA-0002078 LAB 19-2078	Quantum Information Science Research for Fusion Energy Science	3/7/19	4/4/19	5/9/2019
Closed: awaiting submission of proposals				
DE-FOA-0002037 LAB 19-2037	Low Temperature Plasma Science Centers and Facilities	12/20/18	1/25/19	3/25/2019
DE-FOA-0002019 LAB 19-2019	Early Career Research Program	1/7/19	2/6/19	4/29/2019
DE-FOA-0001973	Theoretical Research in Magnetic Fusion Energy Science	1/11/19	2/11/19	3/26/2019
Closed: proposals received and undergoing merit review				
DE-FOA-0001974	Collaborative Fusion Energy Research in the DIII-D National Program	12/19/18	1/15/19	3/5/2019
NSF 16-564	NSF-DOE Partnership in Basic Plasma Science & Engineering	Ongoing	N/A	10/19/2018

<https://science.energy.gov/fes/funding-opportunities/>

- **Underway:**

- DIII-D: new facility enhancements and refurbishment; expanded user base
- NSTX-U: Recovery/repair activities are being baselined
- Theory/simulation: 9th SciDAC center; QIS FOA; ML/AI workshop
- International: W7-X pellet injection fueling system; JET shattered pellet injector; EAST 3rd shift remote operation
- Materials: MPEX as an MIE project
- General plasma science: 2nd university collaborative research facility
- HEDLP: LaserNetUS

- **Pursuing:**

- Enabling R&D: HTS conductor testing facility
- Nuclear Science: prototypic fusion neutron source
- HEDLP: Petawatt Laser Facility (CD-0)
- Private-public partnership pilot program

AGENDA

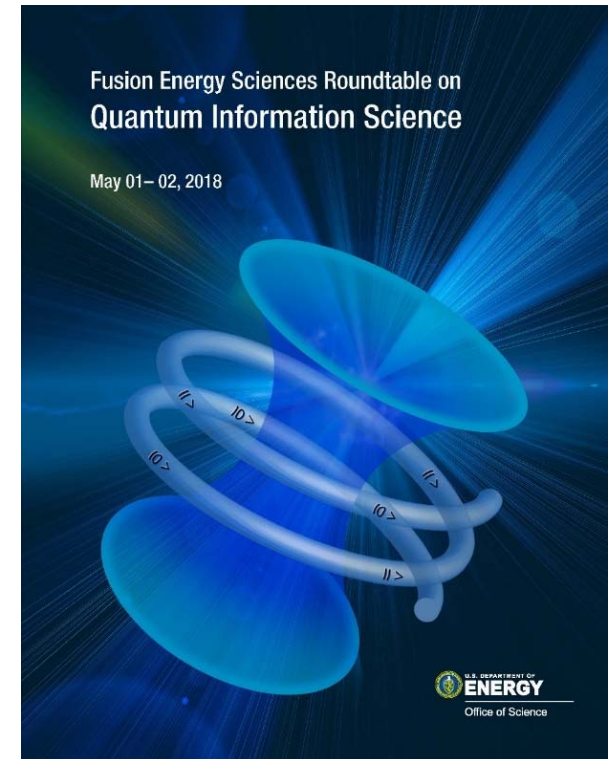
- Inter-agency QIS activities (Jake Taylor)
- SC program office ADs remarks and panel discussion
- Plenary talks (3)
- Lightning round of quantum center pitches (2 minutes each)
- Topical breakout summaries
- Office breakout get-togethers



FES remarks about Quantum Information Science

FES is exploring opportunities in QIS

- **FES held a Roundtable meeting** on May 1-2, 2018, to explore its unique 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
- Identified six compelling **Priority Research Opportunities**
- **FES has just issued a solicitation** (FOA and Lab Call) to competitively select pilot projects in QIS



Report available from:

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

- FES and ASCR are co-sponsoring a joint workshop on “**Advancing Fusion with Machine Learning**”
- The objectives of this workshop are to:
 - Identify areas where application of Machine Learning / Artificial Intelligence (ML/AI) techniques and data science more broadly can have a transformative impact on FES mission areas
 - Identify unique needs and gaps that can be addressed through coordinated partnerships between fusion and computational scientists
 - Explore synergies and opportunities within DOE and outside, including private industry; and
 - Identify research principles for maximizing effectiveness of applying ML/AI methods to fusion problems.
- The findings of the workshop, in the form of a set of **priority research opportunities**, will be summarized in a report that will be submitted to FES and ASCR after the conclusion of the workshop

Dates: April 30 – May 2, 2019

Gaithersburg Marriott Washingtonian Center

Chair: David Humphreys (General Atomics)

Co-Chair: Ana Kupresanin (LLNL)

SC POCs: John Mandrekas & Matthew Lanctot (FES);
Randall Laviolette (ASCR)

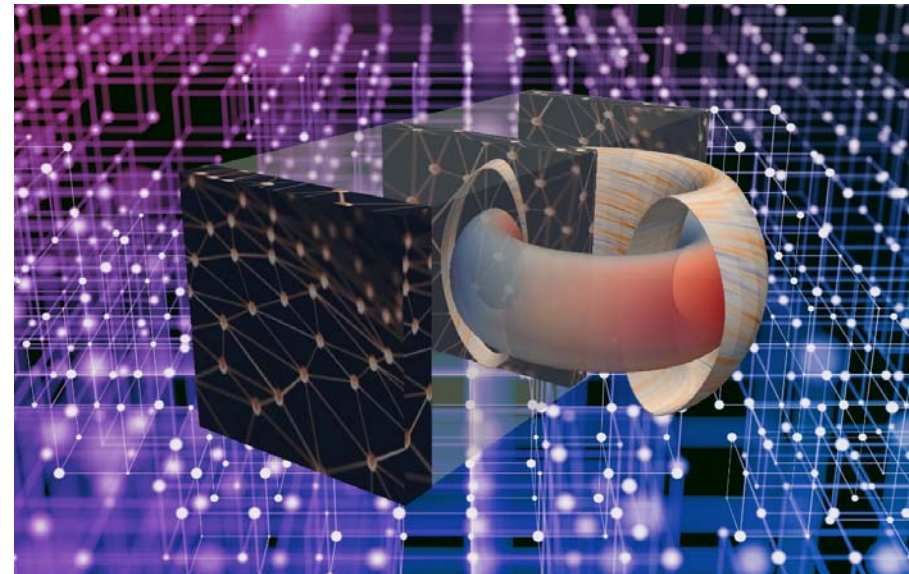
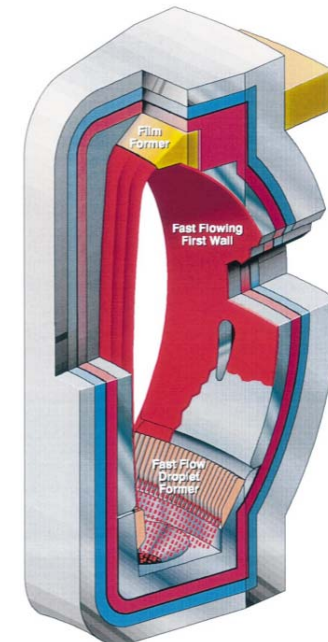


Image courtesy of W. Tang (PPPL)

- **Liquid metal** plasma-facing components have attracted attention due to their potential advantages over solid PFC options, as highlighted in the 2015 Community PMI report
- The national **Fusion Energy Systems Study (FESS)** team recently completed a two-year examination of this class of PFCs from a systems-level perspective in order to identify promising concepts and provide feedback about R&D on the path toward demonstrated viability
 - Details can be found in an upcoming issue of *Fusion Science and Technology*
- A new three-year study, just launched, will examine aspects and implications of the **NAS Burning Plasma Report** from a systems-wide perspective, including high-field magnets, compactness, electricity-first pilot plants, and economy of scale

CLIFF (Convective Liquid Flow First-Wall) Concept



US-Japan Project Arrangement for High Energy Density Science signed on January 23

- A signing ceremony was held on January 23 for a new **Project Arrangement Concerning High Energy Density Science** under the DOE-MEXT Implementing Arrangement Concerning Cooperation in Research and Development in Energy and Related Fields
- This new Project Arrangement will facilitate cooperation in the area of high energy density science, specifically in the research and development of high power lasers and high energy density science with large scale laser facilities
- The signing ceremony took place during a **Japan-US Symposium on Perspective of High Energy Density Science and Technology by High Power Lasers**, held at the Embassy of Japan (Washington, DC) on January 23, 2019



LaserNetUS



BELLA, LBNL



MEC, SLAC



JLF, LLNL



CSU



Diocles, UNL



TPW, UT



Hercules, UM



Scarlet, OSU



Omega, UR

FES funds operations and/or upgrades of 9 laser facilities:

- Six at universities (UNL, CSU, OSU, UM, UT Austin, UR)
- Three at national laboratories (LLNL, SLAC, LBNL)

First LaserNetUS Principal Investigators Meeting was held January 16, 2019 (Rockville, MD)

FES established LaserNetUS in FY 2018 in response to National Academy report recommendations
The network provides broad access to state-of-the-art high-power laser facilities for the entire U.S. community



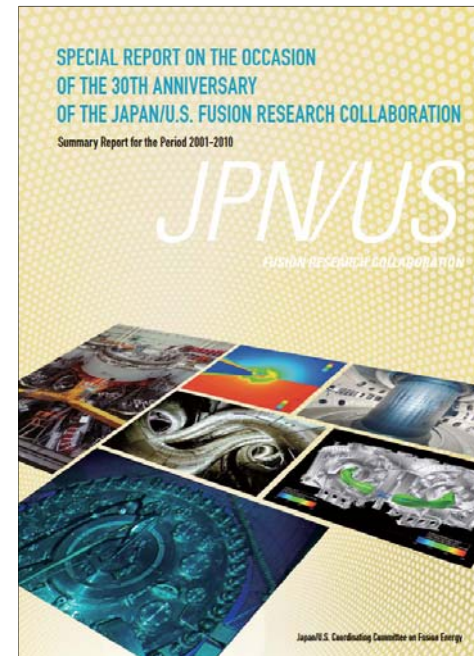
39th Meeting of the JA – U.S.
Coordinating Committee for
Fusion Energy (CCFE)

Televideo Conference
DOE/FES in Germantown, MD
MEXT, NIFS & Toyama U, JA

Wednesday, 6 March 2019

7:00 p.m. EST

- US-Japan Coordinating Committee on Fusion Energy Meeting (CCFE-39)
 - Held March 6 (US) = March 7 (JA), 2019
 - Plans for celebrating 40th anniversary next year
- Planning similar bilateral meetings later this year with EU and Korea



***30th anniversary report
(CCFE, 2011, 234 pages)***



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KSTAR 10th Anniversary Celebration



Congratulations to KSTAR



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3. ITER Updates

DOE Leadership visited ITER site in 2018



Secretary of Energy Rick Perry visited ITER on July 11, 2018



DOE Under Secretary for Science, Paul Dabbar, visited ITER on December 10, 2018

Dr. Bigot has accepted the Council's offer of a second five-year term as Director-General, to begin March 2020.



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The tokamak complex takes shape



The tokamak bioshield is now hidden behind the walls of the tokamak building.



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Tokamak building rises

The concrete walls of the Tokamak Building are rising next to the metal-clad Assembly Building (December 2018).

Photo: ITER Organization





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Sub Sector Assembly Tool Installation

Assembly of the first tool (left) is complete, and the second tool is now in the final phase of assembly.

Photo: ITER Organization





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Looking down into the tokamak pit as it is being prepared for the first tokamak components

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

Photo: ITER Organization



First machine component brought into the ITER tokamak pit

On the night of November 26, 2018, the first metal component of the machine – a cryostat feedthrough for poloidal field coil #4 – entered the tokamak pit. This was no small feat; the component is 10 meters long and weighs 6.6 tons. It was delicately lowered 30 meters down onto the tokamak pit floor. This auspicious occasion marks the beginning of five years of tokamak assembly activities.

Photo: ITER Organization



Diagnostic building ready for systems installation

The lowest basement level of the Diagnostic Building shows embedded plates for the attachment of system supports.

Photo: ITER Organization



Installation of US in-kind hardware at ITER

Three US-supplied drain tanks for the tokamak cooling water system were installed in August 2018





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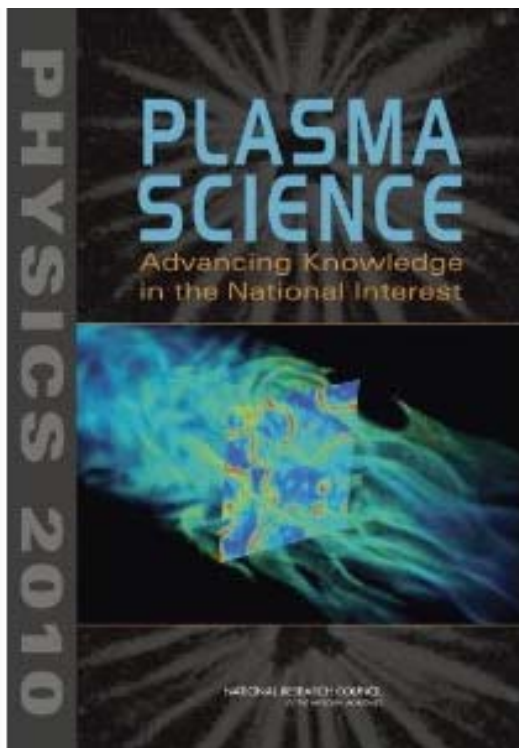
4. Program Planning



- **Final report (December 2018):**
 - ITER plays a central role in U.S. burning plasma research activities and is currently the only existing project to create a burning plasma at the scale of a power plant. Because the ITER partnership is the central focus in the large international effort to develop fusion energy, the United States significantly benefits from participation in the ITER partnership. The U.S. has contributed leading advances in burning plasma science.
 - If the United States withdraws from the ITER project, the national research effort would be significantly disrupted, United States researchers would be isolated from the international effort, and any benefit from sharing the cost in critical burning plasma studies and fusion demonstration would be eliminated. Without ITER, the United States would need to design, license, and construct an alternative means to gain experience creating and controlling an energy- producing burning plasma. The scale of research facilities within the United States would be more costly. The achievement of electricity production from fusion in the United States would be delayed.
- **Report at this meeting from the National Academy BP panel leaders**



Previous Decadal Report



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:**

- Prof. Mark J. Kushner (U. Michigan)
- Prof. Gary P. Zank (U. Alabama-Huntsville)

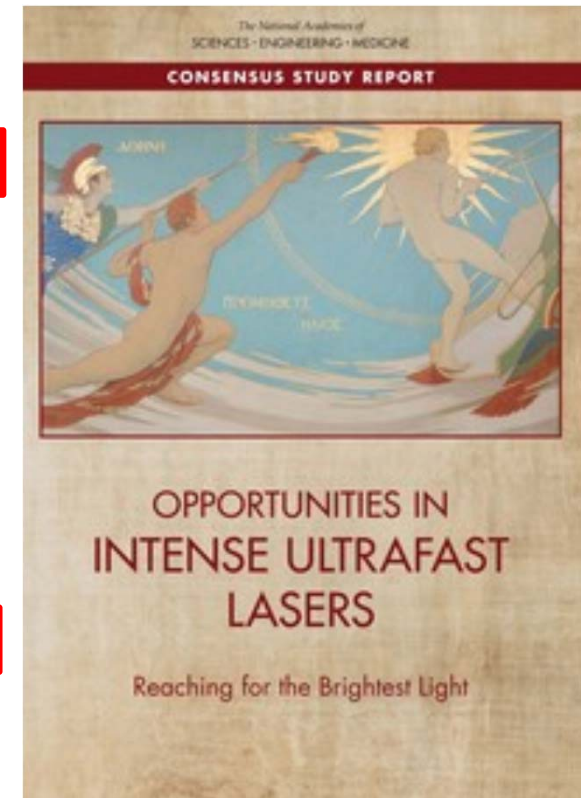
- **Meetings so far:**

- First public meeting on October 15 (Washington DC) – [**FES talk**]
- Town Hall on November 6 at APS-DPP Mtg (Portland)
- Public meeting on January 10-11 (Irvine) – [**FES talk**]
- Public meeting on March 5-6 (virtual)
- Public meeting on March 11-12 (Washington DC) – [**FES talk**]

Opportunities in Intense Ultrafast Lasers: Reaching for the Brightest Light (NAS, 2017)

Recommendations

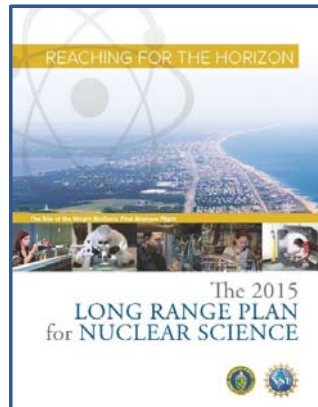
1. DOE should create a broad **national network (universities, industry, government labs)** in coordination with OSTP, DOD, NSF, and others. **LaserNetUS**
2. US research agencies should engage stakeholders to **define facilities and laser parameters** that will best serve research needs.
3. DOE should 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. **CD-0 for Petawatt Laser Facility**
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.**



This report was commissioned by : DOE-SC, DOE-NNSA, DOD-AFOSR, and DOD-ONR

Long-range strategic planning activity launched in FY 2019 for FES program

- The plan will be comprehensive and will include all FES program areas
- Process is similar to that used by the Office of Science High Energy Physics (HEP) and Nuclear Physics (NP) programs for the development of the HEP-P5 report and NP-Long Range Plan



Phase 1: Community-organized activities

Community Awareness

Inform the community that a FESAC charge is coming



Subfield community self-organization



FESAC charge issued



FES tasks APS-DPP to convene topical town hall meetings



"Snowmass" meeting

Phase 2: FESAC federal advisory committee

- **FES is grateful that the community and APS-DPP are undertaking the challenge of long-range planning for the national program**
- **FES is here to help**
 - Discussions with/among FES, DPP Ex Comm leadership, Coordinating Committee leadership, and FESAC chair
 - Funding to support community activities
- **At this meeting, speakers from HEP and NP communities will describe their respective program planning activities**

- **Following approval of the COV report at Dec 2018 FESAC meeting, it was sent to the director of the Office of Science**
- **FES has prepared a written response to the recommendations**
 - It will now go through the DOE concurrence process
 - After DOE approval, it will be posted on the FESAC web page
 - The next COV will assess how FES responded to these recommendations