U.S. Fusion Energy Sciences:

Achievements and Opportunities 2020



Office of Science

James W. Van Dam

Associate Director, Office of Science Fusion Energy Sciences

Fusion Power Associates Annual Meeting December 16-17, 2020



COVID-19 has impacted all of us

- 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 \rightarrow 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



Utilizing the unique capabilities of DOE to tackle the science and technology challenges associated with COVID-19

DOE's expertise in **high performance computing** provides unparalleled tools for development of medical therapies and for tracing the spread of the virus

These capabilities can accelerate the pace to develop **therapeutic treatments** and to make our nation's **response to the pandemic much more efficient**

3

DOE maintains the world's leading characterization capabilities (X-ray and neutron sources, cryoelectron microscopy, and genomics facilities) for determining pathogen protein structure

These have been **absolutely essential** for understanding SARS-CoV-2 DOE's world-leading capabilities in **materials development and manufacturing scale-up** have addressed crucial **supply-chain** problems

The capabilities will continue to contribute to the fight against COVID from personal protective equipment (PPE) to testing supplies and vaccine manufacturing DOE's complex-wide capabilities in **biological and environmental sciences**, building on biological and national security expertise, can be quickly leveraged to address pandemic response supporting the **national infrastructure for testing** for disease as well as for understanding how **novel pathogens spread**

The NVBL has been supporting CDC, FDA, and other federal agencies in standing up COVID-19 testing

From talk by Dr. Harriet Kung, NVBL Symposium (October 28, 2020)

Understanding the Impacts to Office of Science Research

In May, the Office of Science (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.
- On December 9, SC issued a survey to its PIs. This voluntary survey focuses on questions related to impacts to research progress and award personnel (primarily graduate students and postdocs). The deadline for survey responses is January 5.

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.





1. Budget Updates





- FY 2021 Budget Request:
 - House and Senate marks were issued
 - Operating under a Continuing Resolution extension until December 18
 - 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



Planned FY 2021 FES Funding Opportunity Announcements

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

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



2. Programmatic Updates

DIII-D National Fusion Facility



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FY 2020 Highlights and Achievements

- Facility operated under new protocols with majority of research staff participating remotely via Zoom & Discord
- Productive Joint Research Target activity completed, leading to post deadline IAEA FEC invited presentation
- High-power helicon current drive system installed, and commissioning commenced



DIII-D operating with ~12 persons in control room

FY 2021 Plans

- 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



Helicon antenna installed with protective tiles





ENERGY

- NSTX-U Recovery Project completed Final Design
 - Review panel noted the improvement in engineering design rigor at PPPL
 - The remaining NSTX-U Recovery construction scope of \$45.7M was approved. Baseline completion date (CDE-4) of July 2022 (and early finish in FY 2021)
- An ESAAB-equivalent meeting was held on June 9
 - CDE-3B received final approval for full construction activities
 - Project to evaluate COVID-19 impacts on construction costs and schedule
- Major procurement accomplishments in 2020 include
 - Delivery of six production inner Poloidal Field (PF) coils, with three spare coils being fabricated
 - 80% production complete on Center Stack Casing (CSC)
 - Delivery of the first production Plasma Facing Component tiles
 - FY 2021-25 NSTX-U Five-Year Plan is available online





The NSTX-U Test Cell

FES high-performance computing research



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- The nine FES multi-institutional SciDAC projects continue to make progress toward integration and Whole-Device Modeling
 - More details at: <u>https://scidac.gov/partnerships/fusion</u> <u>energy.html</u>
- The PPPL-led WDMApp project in the SC Exascale Computing Project (ECP) portfolio is making good progress toward the development of core-edge coupling technology with continuum and particle codes
 - Coupling of XGC, GEM, and GENE codes
 - First coupled simulation of turbulence in a tokamak
- US scientists are preparing for use of the first Exascale computing systems in ~2021-2022 (Frontier at ORNL and Aurora at ANL)









FRONTIER Exascale Computer @ ORNL (due in 2021-2022)



AURORA Exascale Computer @ ANL (due in 2022-2023)



Quantum Information Science Updates

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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

Programmatic Updates

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





First-ever quantum simulation of nonlinear plasma interactions - 2020

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.



Artificial Intelligence and Machine Learning

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FY 2020 Highlights and Achievements

- First FES/ASCR solicitation in AI/ML completed
- FES created new AI/ML program to promote data science for fusion and plasma science

FY 2021 Plans

- New awards pursue first year objectives
- AI/ML program will consider alternatives for fusion data platforms
- FES continues to work with ASCR and other Office of Science programs to expand activities in AI/ML and fully exploit SC experimental and supercomputing user facilities





FY 2020 Highlights and Achievements

Ten teams used theory & simulation tools and international facilities to advance burning plasma science

- JET and KSTAR: SPI experiments tested disruption mitigation strategies relevant for ITER and FPP
- KSTAR/DIII-D: Experiments and non-linear simulations reveal accessibility conditions for RMP ELM suppression
- **WEST**: Material surface morphology changes studied using plasma-exposed samples
- JET: US-developed diagnostics and simulation tools used to prepare scenarios for the DT campaign in FY21
- TCV: US diagnostics documented impact of negative triangularity on turbulence and first wall interactions, and contributed to advanced detachment control studies
- **EAST**: DIII-D high- β_{P} scenario extended to 60 seconds
- *AUG*: New fluctuation diagnostics deployed to support detailed validation of US turbulence codes



FY 2021 Plans

- Continue working with international partners to prepare for burning plasma studies
- Continue leveraging U.S. SciDAC program to establish tokamak physics basis



- U.S.-supported x-ray imaging crystal spectrometer (XICS) was used to measure radial electric field in high-performance plasmas for comparison with neoclassical predictions (SFINCS code)
 - Comparison confirmed ion-root conditions achieved
 - Provides confidence in validity of theory at high density with $T_e = T_i$
- EU-US collaboration presently focused on development of continuous pellet fueling system



wing range of the XICS system. The view is limited by the ape

 $\rho = 0.82$

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JT-60SA (QST, JA)

Construction and assembly were completed in March 2020, and the machine is now being commissioned for research operation (JA-EU Broader Approach Program)

HL-2M (SWIP, CN)

Assembled March 2019-September 2020; then integrated commissioning; first plasma ceremony on December 4

MAST-U (CCFE, UK)

U.S. international collaborators are participating in the present experimental campaign on MAST-U following first plasma on October 29

Materials Plasma Exposure eXperiment (MPEX)

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- 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 Heating and Support Systems without Magnets

Continuation of the INFUSE public-private partnership program

- 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 across 8 companies involving 5 DOE laboratories; 3 awards are to companies with foreign ownership
- 2nd 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
- 2021 first-round INFUSE RFA period will begin in January
- Last FPA talk today on the INFUSE program by Daniel Clark

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

	energy.gov	SCIENCE & INNOVATION ENERGY ECONOMY SECURITY & SAFETY 😲 SAVE ENERGY, SAVE Q	GAMOW Project title	Team	Lead PI
				Oak Ridge National Laboratory; Lawrence Livermore National Laboratory;	
		Department of Energy	Fusion Energy Reactor Models Integrator (FERMI)	HyPrComp Inc; University of California-Los Angeles	Vittorio Badalassi
			Renewable low-Z wall for fusion reactors with built-		- · · · ·
		Department of Energy Announces \$29	In tritium recovery	University of California-San Diego; Idano National Laboratory	Eric Hollmann
		Million in Fusion Energy lechnology	Interfacial-Engineered Memoranes for Efficient	Colorado School of Mines: Idabo National Laboratory	Colin Wolden
		Development	EM-ENHANCED Hypor LOOP FOR FAST FUSION	Savannah River National Laboratory: Clemson University: University of South	
		SEPTEMBER 2, 2020	FUEL CYCLES	Carolina-Columbia	George Larsen
		Dirtect LiT Electrolysis Process Modeling & Scale up	Savannah River National Laboratory; Clemson University	Brenda Garcia-Diaz	
Ľ	f	Home > Department of Energy Announces \$28 Million in Fusion Energy Technology Development	Advanced HTS Conductors Customized for Fusion	University of Houston	Venkat Selvamanicka
		WASHINGTON, D.C Today, the U.S. Department of Energy (DOE) announced \$29 million in funding	High Efficiency, Megawatt Class Gyrotrons for	Bridge 12 Technologies, Inc; Oak Ridge National Laboratory; Massachusetts	
	in	for 14 projects as part of the Galvanizing Advances in Market-aligned fusion for an Overabundance of Watts (GAMOW) program, which is jointly sponsored by the Advanced Research Projects Agency-	Instability Control of Burning Plasma Machines	Institute of Technology	Jagadishwar Sirigiri
	0	Energy (ARPA-E) and the Office of Science-Fusion Energy Sciences (SC-FES).	WIDE BAND GAP SEMICONDUCTOR AMPLIFIERS		
GAMOW teams will work to close multiple fusion-specific technological gaps that will be needed to connect a net-energy-gain "fusion core," once it is ready, to a deployable, commercially attractive	FOR PLASMA HEATING AND CONTROL	Princeton Fusion Systems; United Silicon Carbide; NREL; Princeton University	Michael Paluszek		
		fusion system. Projects will address one or more research and development (R&D) categories, including (1) technologies, materials, and superconducting-magnet and fuel-cycle subsystems	AMPERE - Advanced Materials for Plasma-Exposed	University of Colifornia Las Associas	Disk and M.Co.
		between the fusion plasma and balance of plant, (2) cost-effective, high-efficiency, high-duty-cycle, electrical-driver technologies, and (3) cross-cutting areas such as novel fusion materials and	Robust Electrodes	University of California-Los Angeles	
- r		advanced and additive manufacturing for furing relevant materials companyeds and their cost	Wall/Blanket Applications	Oak Ridge National Laboratory: University of Michigan	Lizhen Tan
FES partnered with ARPA-E on four BETHE awards to support tech development for HTSC solenoid for pulsed tokamaks (CFS),		nered with ARPA-F on four BFTHF		our mage national caporatory, on relative of the ingen	
			ENHANCED Shield: A Critical Materials Technology	Phoenix LLC; University of Wisconsin-Madison; Massachusetts Institute of	
		o support tech development for	Enabling Compact Superconducting Tokamaks	Technology; Brookhaven National Laboratory	Ross Radel
		a a b b a a b	ULTRA HIGH FLUX DT NEUTRON SOURCE FOR		
		enoid for pulsed tokamaks (CFS),	ACCELERATED TESTING OF FUSION MATERIALS AND	Stony Brook University; University of Tennessee: Knoxville; Massachusetts	
	normano	nt magnet stellarator (DDDL) ArE	SUBSYSTEMS TO REACTOR-RELEVANT DPA LEVELS	Institute of Technology	Lance Snead
	permane	int magnet stenarator (FFFL), An	Plasma Facing Component Innovations by	Oak Ridge National Laboratory; Georgia Institute of Technology; Texas A&M	
	lasers (N	RI), and IR to UV experiments (ITE).	Advanced Manufacturing and Design	University; Livermore National Laboratory	Yutai Katoh
Total FES investment = $$15M / 3$ years.			Microstructure Optimization and Novel Processing		
		investment = \$15M / 3 years.	Development of ODS Steels for Fusion	Pacific Northwest National Laboratory; North Carolina State University; Ames	
L		,	Environments (MONDO-FE)	Laboratory	Dalong Zhang
19)				

Frontier Plasma Science Active Awards (GPS+HEDLP)

states

FY 2020 funding: ~\$45M

~55% to Universities and Small Businesses ~45% to National Laboratories

NSF/DOE Partnership: FES funding > \$7 million in FY 2020

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NSF/DOE Partnership includes:

- ✓ General Plasma Science
- ✓ HEDLP

FY 2020 FES contribution

- \$4.78M provided for ten new and renewal awards
- Selected research topics ranged from basic/lowtemperature/non-neutral/dusty plasma to HED plasma
- \$2.4M provided to BaPSF for its continued research and operation

- 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 ALLS, INRS BELLA, LBNL Omega, UR Hercules, UM **2**1 MEC, SLAC **Diocles**, UNL CSU Scarlet, OSU Colorado JLF, LLNL TPW, UT BERKELEY LAB

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

JNIVERSITY C

MEC Petawatt Upgrade: Pre-CD-1 Design Concept

3. ITER Updates

ENERGYCentral Solenoid Module 2 ready for testing;Office of ScienceModule 1 shipping plan endorsed by independent review

Historic milestone: ITER Start of Machine Assembly

Office of Science

International virtual celebration on July 28

U.S. Secretary of Energy Dan Brouillette

"It is a pleasure and honor to join you for such an important event taking place during extraordinary times. This year has been full of challenges for all of us, so I appreciate the opportunity to be with you in celebrating this significant milestone for the ITER project and the future of energy.... It's an incredible engineering achievement to consider.... It is a profound story of human endeavor, and the best is yet to come.... The ITER effort has also helped to renew enthusiasm and optimism about the commercial promise of fusion energy.... We in the United States are hopeful about a bright future for fusion energy, and we look forward to the assembly of the reactor and to the promise of what we will learn soon from the testing after First Plasma...."

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 (<u>https://science.osti.gov/fes/Community-Resources/Workshop-Reports</u>)
- NRC staff have started developing options for Commission consideration on licensing and regulating fusion energy systems

Kristine Svinicki Chair, Nuclear Regulatory Commission

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

Paul Dabbar DOE Under Secretary for Science

The National Academies of SCIENCES • ENGINEERING • MEDICINE

CONSENSUS STUDY REPORT

PLASMA SCIENCE

Enabling Technology, Sustainability, Security, and Exploration

NASEM 2020 Decadal Assessment of Plasma Science

- **Chairs**: Prof. Mark Kushner (Michigan) and Prof. Gary Zank (Alabama-Huntsville)
- Task: 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
- Multiple federal sponsors:
 - DOE: FES, HEP, NNSA, and ARPA-E
 - NSF
 - DOD: AFOSR and ONR
- Public release of report: May 28, 2020
- A digital copy of the report is available <u>https://www.nap.edu/initiative/committee-on-a-decadal-assessment-of-plasma-science</u>

New NASEM Fusion Pilot Plant study

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- "Key Goals and Innovations Needed for a U.S. Fusion Pilot Plant"
 - Follow-on activity to the 2019 NASEM BPM report
 - In developing and carrying out a plan for building a Pilot Plant, key goals need to be established for all critical aspects of the Pilot Plant. Identify those key goals, independent of confinement concept, which a Pilot Plant must demonstrate during each of its anticipated phases of operation.
 - List the principal innovations needed for the private sector to address, perhaps in concert with efforts by DOE, to meet the key goals identified in the first bullet.
 - Report expected late-January / early-February 2021
 - More information in: <u>https://www.nationalacademies.org/our-work/key-goals-and-innovations-needed-for-a-us-fusion-pilot-plant</u>

Committee chair: Dr. Richard Hawryluk (PPPL)

2019 NASEM Report on Burning Plasma Research

Long-range strategic planning activities

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- 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.

"Powering the Future: Fusion and Plasmas"

Preface

This report provides a decade-long vision for the field of fusion energy and plasma science, presenting a path to a promising future of new scientific discoveries, industrial applications, and ultimately the timely delivery of fusion energy. We identify critical areas for research and development and prioritize investments to maximize impact. The research community worked hard over a year-long process to convey a wealth of creative ideas and its passion to accelerate fusion energy development and advance plasma science. Their effort culminated in the consensus Community Planning Process report. Our work is based heavily on this report, and we extend our sincere gratitude to our colleagues for their efforts. Following the research community's lead, we worked by consensus in generating this report. Different ideas were listened to and were thoughtfully deliberated until a shared view on each issue emerged. This process allowed us to discuss and appreciate our different points of view and come to consensus language. Ultimately, we speak with one voice in conveying a vision for a vibrant program that will bring significant benefit to society.

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Troy Carter, chair University of California, Los Angeles

Scott Baalrud University of Iowa

Anal Bron

Riccardo Betti University of Rochester

Tyler Ellis Commonwealth Fusion Systems

John Foster

John Foster University of Michigan

Cameron Geddes Lawrence Berkeley National Laboratory

Arianna Gleason SLAC National Accelerator Laboratory

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Ane Lasa University of Tennessee, Knoxville

Jammy Ura

Tammy Ma Lawrence Livermore National Laboratory

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David Schaffner Bryn Mawr College

Oliver Schmitz University of Wisconsin, Madison

Shull

Uri Shumlak University of Washington

Lance L. Inead

Lance Snead Stony Brook University

Wayne Solomon General Atomics

Fail Jack

Erik Trask TAE Technologies

Francois Waelbroeck University of Texas, Austin

Anne White Massachusetts Institute of Technology

Don Rej, ex officio Los Alamos National Laboratory, retired

A milestone report

- Office of Science
- This is the first time:
 - A long-range plan has been developed for the entire FES program
 - The community has been substantially involved in developing such a plan
- Thoughts:
 - The plan is ambitious; timely; and describes consensus
- Thankful that:
 - The community (Phase 1) & FESAC subcommittee (Phase 2) invested so much effort
 - FESAC approved the plan unanimously
- Some links:
 - FESAC Meetings page: <u>https://science.osti.gov/fes/fesac/Meetings</u>
 - Direct link to the draft report: <u>https://science.osti.gov/-</u> /media/fes/fesac/pdf/2020/202012/DRAFT_Fusion_and_Plasmas_Report_120420.pdf
 - Link to the CPP report that informed the FESAC subcommittee report: <u>https://drive.google.com/file/d/1w0TKL_Jn0tKUBgUc8RC1s5fIOViH5pRK/view</u>

5. People

FES staff updates

FES is recruiting for two more program manager positions:

- Parts of the burning plasma science program
- Public-private partnerships

Dr. John Mandrekas became permanent Director of the Research Division of FES on September 13, 2020 Mr. Anthony Indelicato became a program manager in the Facilities-Operations-Projects Division of FES on November 8, 2020

Dr. Kathryn McCarthy Director, US ITER Project Office, and ALD for Fusion and Fission Science & Technology, ORNL

> **Dr. Mickey Wade** Director, Fusion Energy Division, ORNL

Dr. Richard Buttery Director, DIII-D, General Atomics

New leadership

Prof. David Graves Assoc Lab Director, Low Temp Plasma, PPPL **Prof. William Dorland** Assoc Lab Director, Computational Science, PPPL

FY 2020 Early Career Research Awards

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

INI

Toward a

Technology-

Inclusive Whole

Device Model

Investigation of Helicon and Lower Hybrid Wave Coupling with the Edge Plasma for Current Drive Optimization in the Tokamak Using Laser Spectroscopy

Dr. Elijah Martin

ORNL

BTH IAEA

17 October 2020 e, France

28th IAEA Fusion Energy Conference

- FEC 2020
 - Delayed to May 2021
- US contributed papers
 - 30 invited oral talks
- 2019 Nuclear Fusion Award to be presented at the IAEA Fusion Energy Conference to Dr. Nathan Howard (MIT)
 - For the paper "Multi-scale gyrokinetic simulation of tokamak plasmas: Enhanced heat loss due to cross-scale coupling of plasma turbulence" [Nuclear Fusion (2016)]
 - Co-authors were C. Holland, A. E. White, M. Greenwald, and J. Candy

TFTR designated Nuclear Historic Landmark

- The American Nuclear Society (ANS) has bestowed its distinguished Nuclear Historic Landmark designation on the pioneering Tokamak Fusion Test Reactor (TFTR) that ran from 1982 to 1997 at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory.
- The groundbreaking facility laid the foundation for future fusion power plants and set world records for fusion power (10.7 million watts) in 1994 and total fusion energy production (1,500 million joules) from 1993 to 1997.
- The achievements marked a major step toward producing on Earth fusion — the power that drives the sun and stars — as a safe, clean and abundant source of energy for generating electricity

PPPL staff members watching a TV monitor showing the bright flash from the first lightbulb powered by fusion energy (historic first DT shot on TFTR: 10 pm, December 9, 1993)