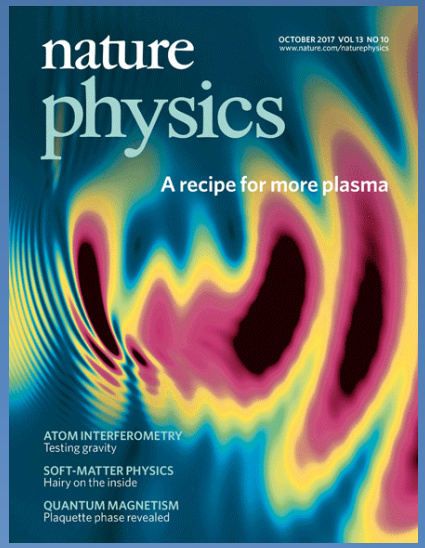

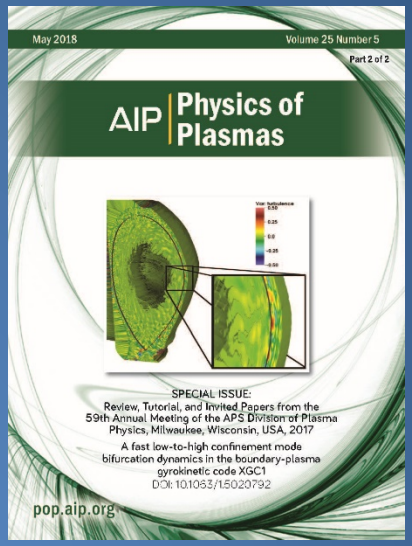

Fusion Energy Sciences Program Overview

John Mandrekas
Office of Fusion Energy Sciences

U.S. DEPARTMENT OF ENERGY
Office of Science

2018 SciDAC-4 PI Meeting
July 23-24, 2018
Rockville, MD

U.S. DEPARTMENT OF ENERGY
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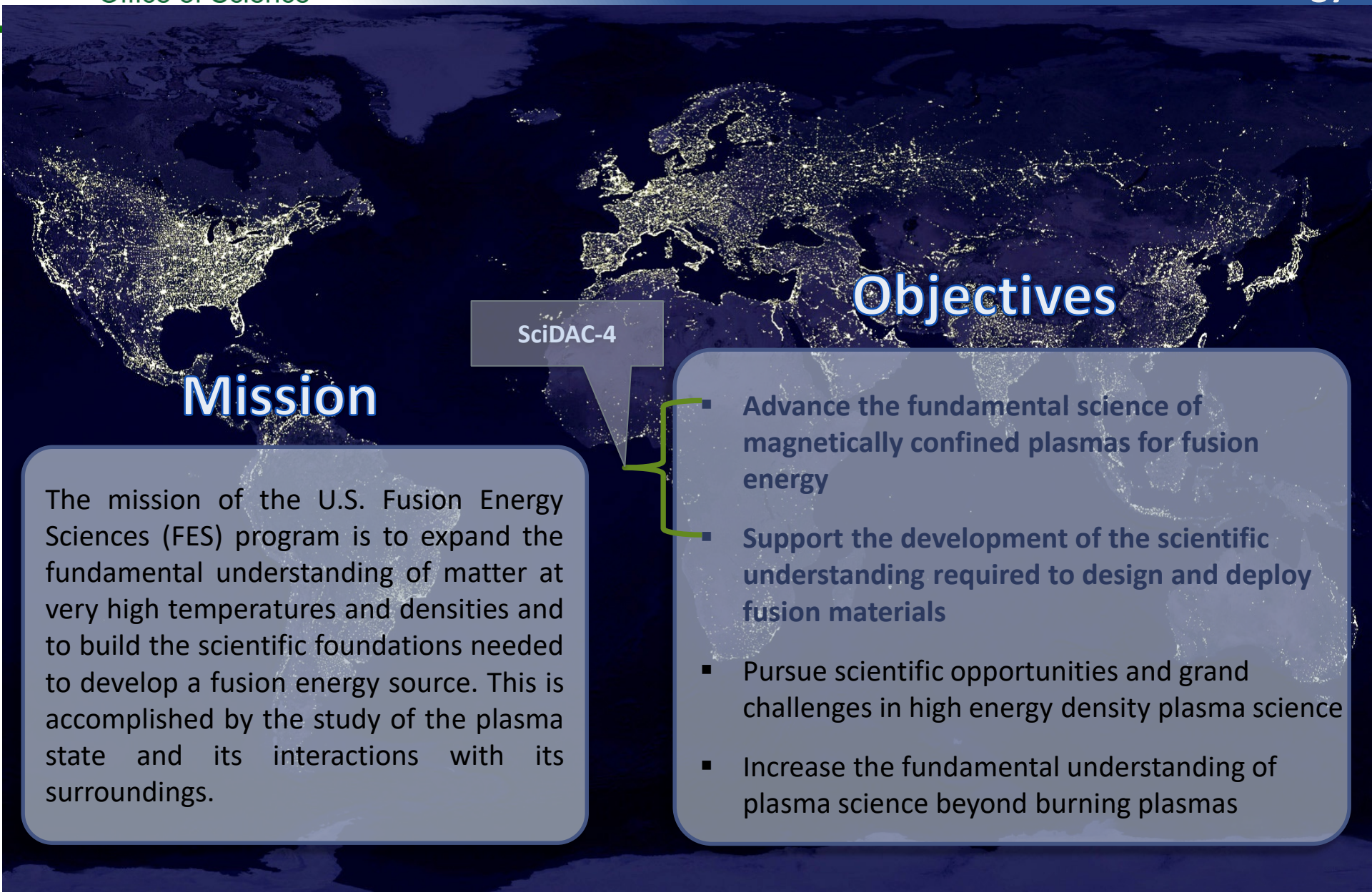
The DOE/SC Fusion Energy Sciences program supports a broad range of plasma science, including the scientific basis for fusion energy



Mission

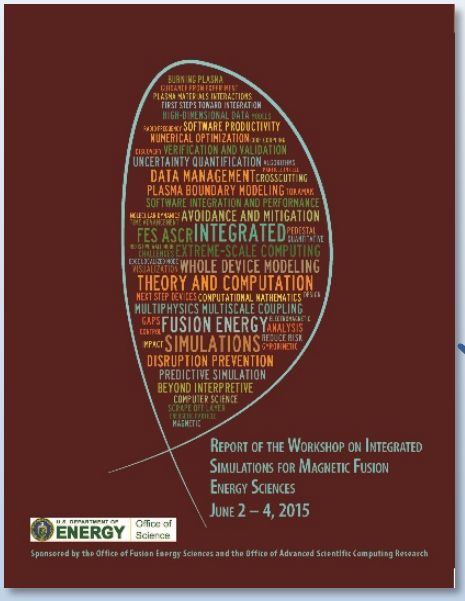
The mission of the U.S. Fusion Energy Sciences (FES) program is to expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundations needed to develop a fusion energy source. This is accomplished by the study of the plasma state and its interactions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

SciDAC-4

Objectives

- **Advance the fundamental science of magnetically confined plasmas for fusion energy**
- **Support the development of the scientific understanding required to design and deploy fusion materials**
- Pursue scientific opportunities and grand challenges in high energy density plasma science
- Increase the fundamental understanding of plasma science beyond burning plasmas

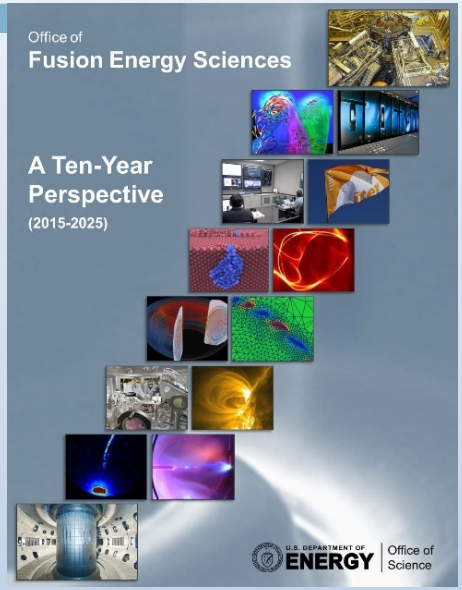
HPC & the Fusion Program

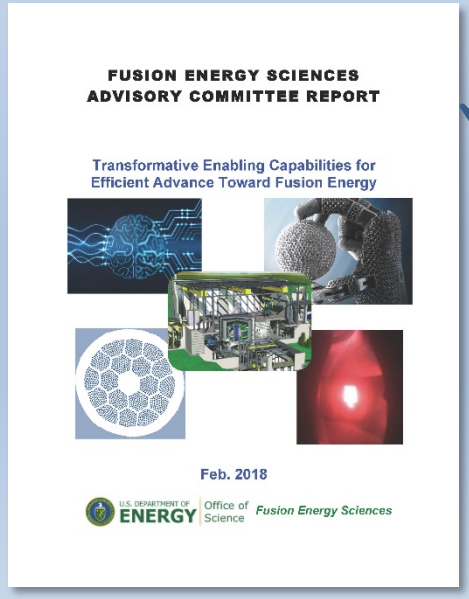


2015 FES/ASCR
Community Workshop on Integrated Simulations for MFES

Major themes of the FES strategic plan

- ***Massively parallel computing*** with the goal of validated whole-fusion-device modeling will enable a transformation in predictive power, which is required to minimize risk in future fusion energy development steps.
- ***Materials scien*** as it relates to plasma and fusion





2018 FESAC TEC Report
Advanced Algorithms was one of the Tier 1 Transformative Enabling Capabilities

January 2016: FES / ASCR Exascale Requirements Review
Identify forefront scientific challenges and opportunities in fusion energy and plasma sciences whose resolution is essential to meeting the FES mission and could be aided by exascale computing over the next decade.

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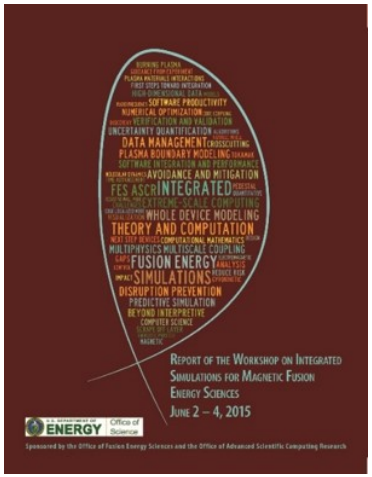
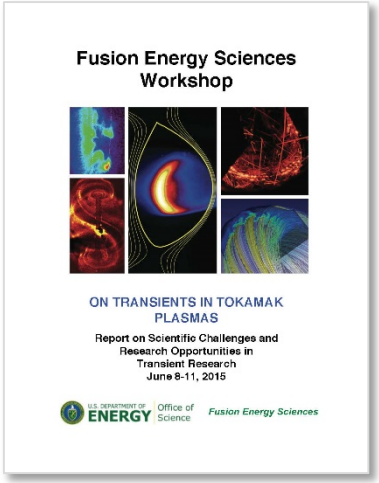
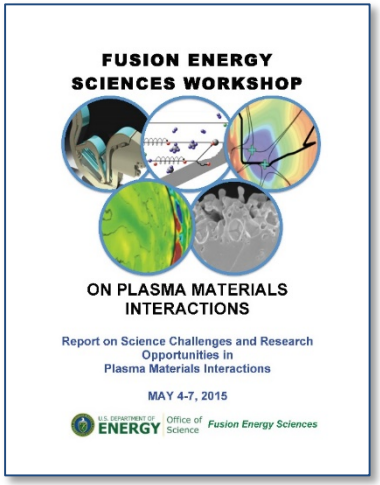
The FES SciDAC-4 portfolio addresses priorities identified in community workshops

- The FES SciDAC portfolio was recompeted in FY 2017
  - FES and ASCR invested $24M in FY 2017 to support **seven** multi-institutional and interdisciplinary SciDAC partnerships – *an **eighth** project, supported by FES, was added in FY 2018*
  - 12 universities, 8 DOE national laboratories, and 5 private industry institutions (including small businesses) in 13 states
- The research activities of the eight partnerships will be coordinated to accelerate progress toward Whole-Device Modeling
- The new portfolio strengthens the U.S. domestic fusion program, advances U.S. world-leadership and competitiveness in fusion simulations, and addresses research opportunities identified in recent community workshops



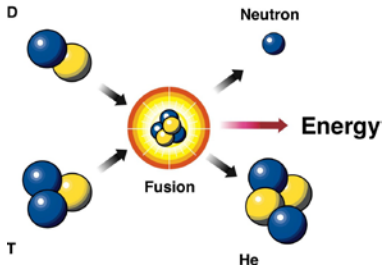


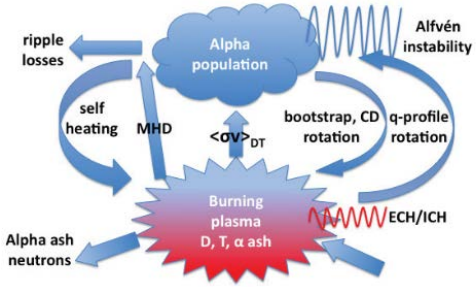


2015 community workshops on Integrated Simulations for Magnetic Fusion Energy Sciences, Transients in Tokamak Plasmas and Plasma Materials Interactions

FES SciDAC portfolio is focused on burning plasma science

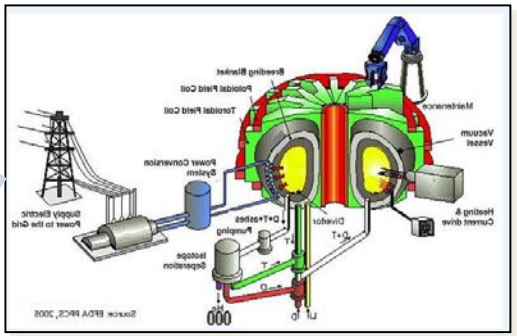
- Plasma must be heated and maintained at thermonuclear temperatures
- Plasma must be confined long enough
  - Must understand and control particle and energy losses due to various loss mechanisms (collisional and turbulence-driven) and transitions to enhanced confinement regimes determined by edge conditions
- Must predict, avoid and / or mitigate deleterious transient events such as plasma disruptions
- Must understand energetic particle confinement and interaction with background thermal plasma
- Must understand plasma – materials interaction under burning plasma conditions
- Must develop a framework for integration and WDM





D. Spong ReNeW 2009

In a burning or self-heated plasma, the fusion process itself provides the dominant heating source for sustaining the plasma temperature

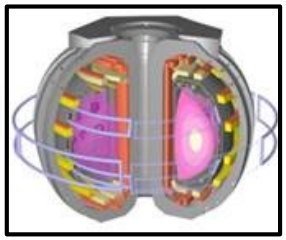


Fusion power on the grid

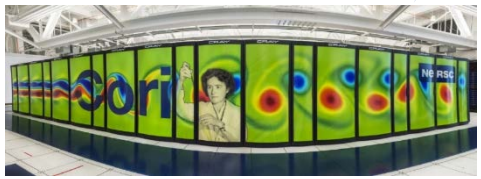
Goal

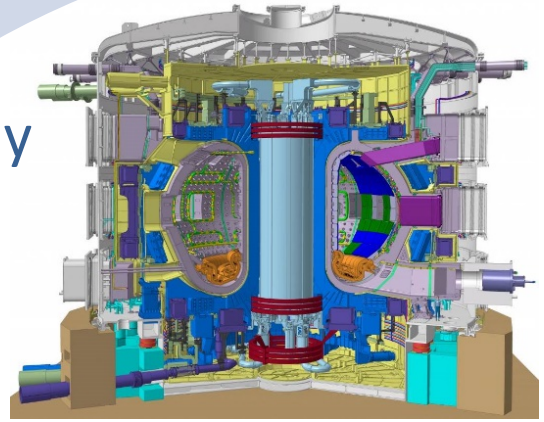
~2025

Today



DIII-D @ GA





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The FES SciDAC-4 Portfolio

Lead PI	Collaborators	Title
Bonoli, Paul MIT	LLNL, ORNL, PPPL, Tech-X, Lodestar*, CompX*	Center for Integrated Simulation of Fusion Relevant RF Actuators
Candy, Jeff General Atomics	LLNL, ORNL, PPPL, UCSD, MIT*, U Colorado*	Advanced Tokamak Modeling (AToM)
Chang, CS PPPL	LANL, LBNL, LLNL, ORNL, U Colorado, U Texas, Lodestar*, UIUC*, MIT*, UCSD*	Partnership Center for High-fidelity Boundary Plasma Simulation (HBPS)
Hatch, David U Texas	LLNL, PPPL, MIT*, U Maryland*	Partnership for Multiscale Gyrokinetic (MGK) Turbulence
Jardin, Steve PPPL	GA, RPI, Tech-X, U Wisconsin, USU, HRS Fusion*, Stony Brook U*	Center for Tokamak Transients Simulations (CTTS)
Lin, Zhihong UC Irvine	GA, LBNL, LLNL, ORNL, PPPL	Integrated Simulation of Energetic Particles in Burning Plasmas (ISEP)
Tang, Xianzhu LANL	ANL, Columbia U, LLNL, PPPL, SNL, U Maryland, U Texas, Virginia Tech	Tokamak Disruption Simulation
Wirth, Brian ORNL / UTK	ANL, LANL, LLNL, PNNL, SNL, UCSD, UIUC, U Mass, GA	Plasma Surface Interactions: Predicting the Performance and Impact of Dynamic PFC Surfaces

* *subcontract*

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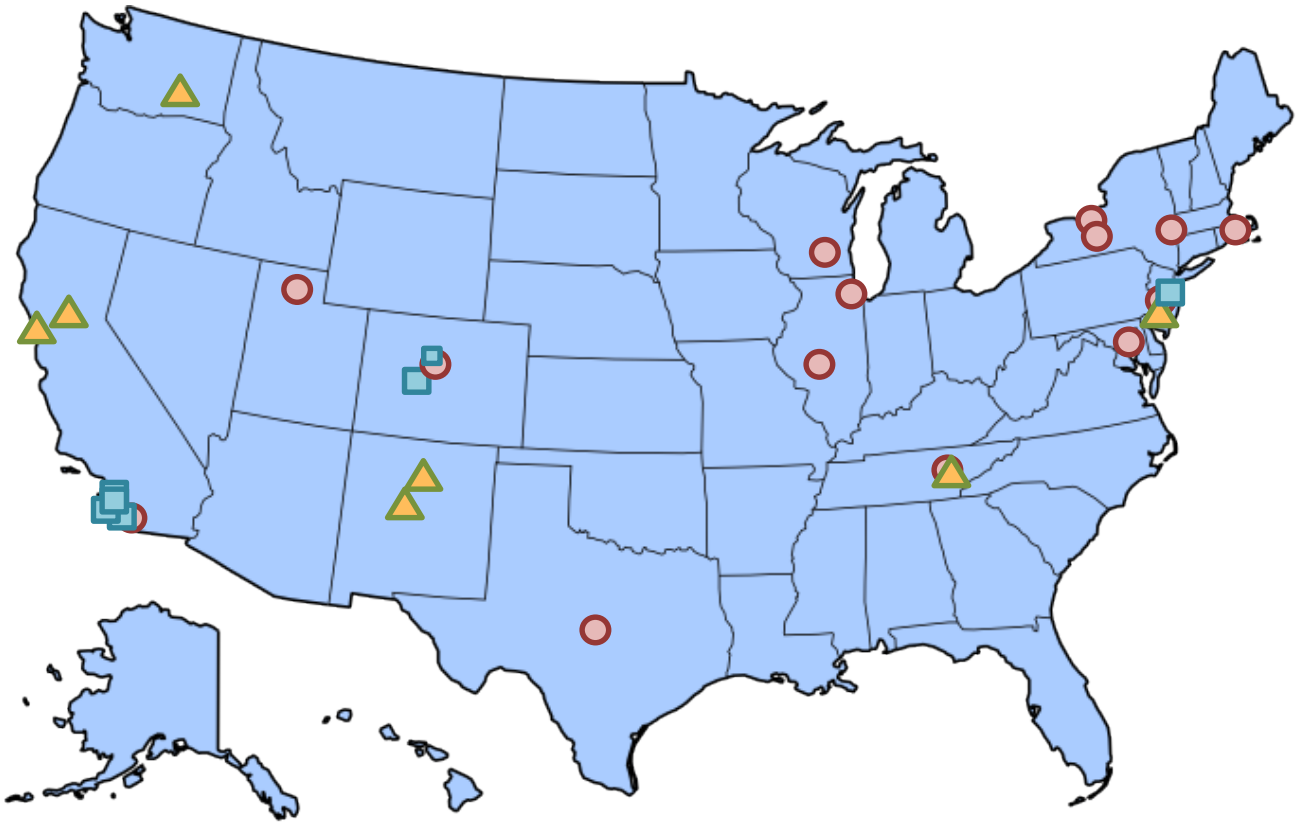
FES SciDAC research is carried out at a diversity of US institutions

12 universities

5 industry

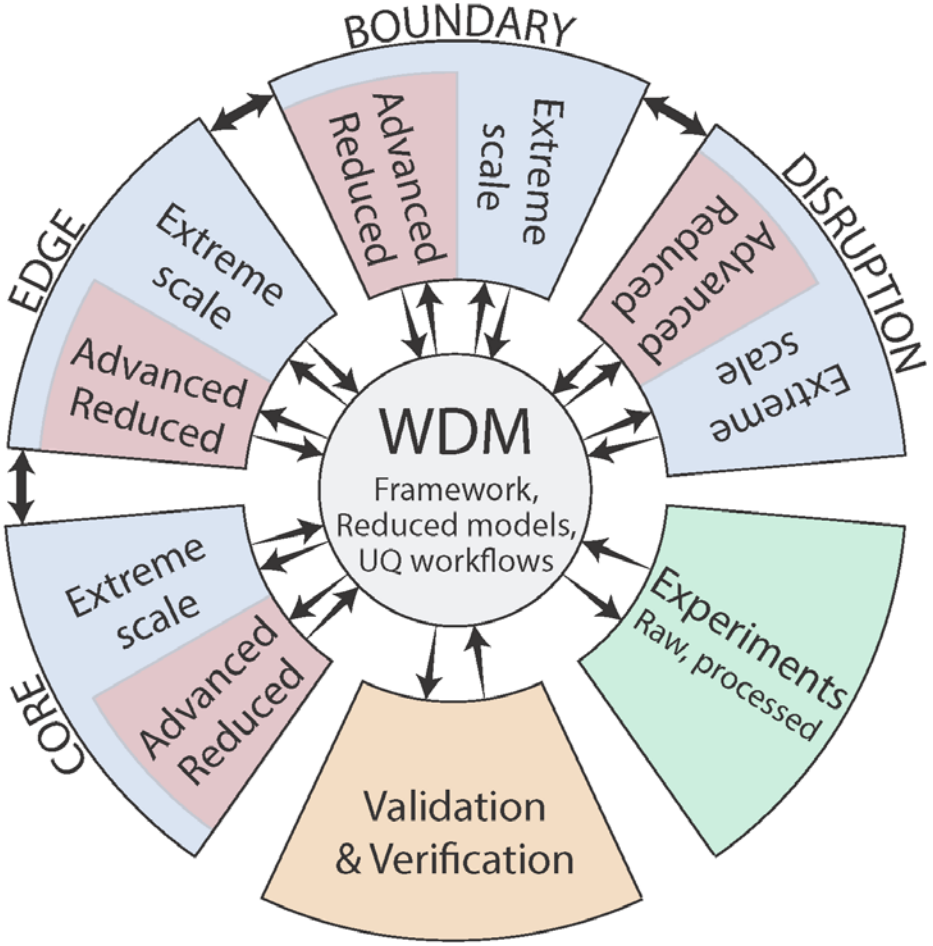
8 laboratories



Challenge: Integration

Five year goal:

- Coordinate the efforts of all eight partnerships to accelerate development of Whole-Device Modeling (WDM) capability
- From the FOA:
  - *"To encourage and facilitate integration and WDM development, the partnerships that will be selected for an award, in addition to their specific scientific objectives, will be expected to dedicate a fraction of their research efforts to work on large-scale integration issues in collaboration with all the other partnerships including the WDM Center"*



2015 FES-ASCR community workshop on Integrated Simulations for Magnetic Fusion Energy Sciences (Bonoli / Curfman McInnes)

Questions?