Report of the
US ITER Research Program Research Needs Workshop

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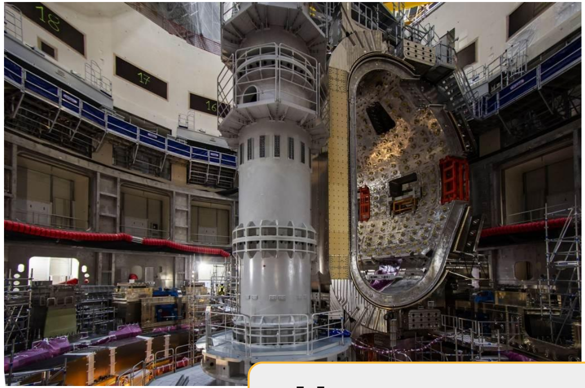
US Burning Plasma Organization Webinar

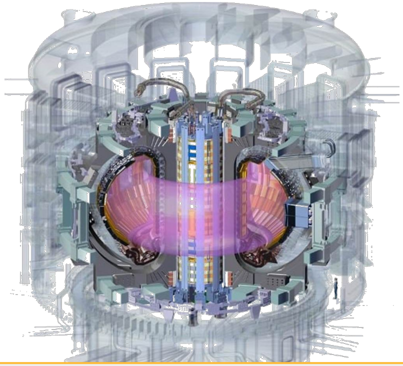
November 17, 2022

https://iterresearch.us

We have a great opportunity!
ITER is over 75% complete for First Plasma

- The U.S. community will be in possession (along with six partners) of a new facility that will
  - Produce 500 MW of fusion power for pulses of 400 s
  - Demonstrate the integrated operation of technologies for a fusion power plant
  - Achieve a deuterium-tritium plasma in which the reaction is sustained through internal heating
  - Test tritium breeding
  - Demonstrate the safety characteristics of a fusion device
- A massive investment by our community, the U.S. government, and the other members





How can we maximize our return on this investment?

Our report begins with these keys to success

- We must establish an equitable, accessible, inclusive knowledge base integrating US and partner developments to support ITER and enable a US FPP
- We must build a structure for maximizing US return on and contribution to ITER advances
- We must support education and preparation of the workforce needed to deploy fusion energy

Taking these steps will ensure that the US investment in ITER will return critical knowledge and experience leading toward realization of fusion energy as a clean, reliable energy source

How we got here: NAS, community, FESAC all stressed the importance of organizing ourselves for ITER's success

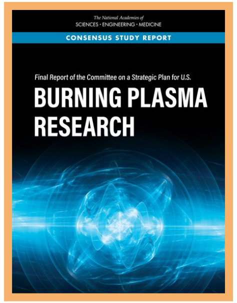
U.S. ITER RESEARCH PROGRAM

Strategic Workshops

Community Planning Workshop

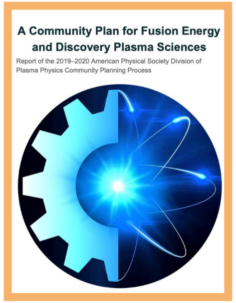
2018 | 2019 | 2020 | 2021

National Academies Dec 2018



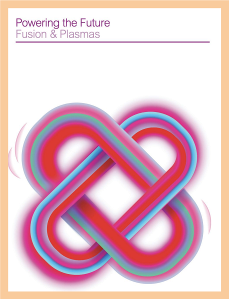
Recommendation:
"The United States should remain an ITER partner as the most cost- effective way to gain experience with a burning plasma at the scale of a power plant."

APS-DPP-CPP Mar 2020



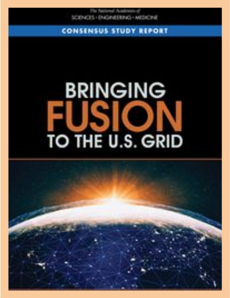
Recommendation:
"Participate fully in ITER to advance our capability to predict, control, and sustain a burning plasma and to obtain the critical science and technology input needed to design a fusion pilot plant."

FESAC Dec 2020



Recommendation:
(funding: constant level of effort scenario)
"Ensure full engagement of the US fusion community in ITER by forming an ITER research team that capitalizes on our investment to access a high-gain burning plasma."

National Academies Feb 2021



Recommendation: "The Department of Energy should assure maximum possible access to ITER information for the members of the fusion pilot plant design teams."

FES responded by charging the community to propose and describe a US ITER Research Program

The workshop should address two major areas:

Research

- Areas of research that offer the most opportunities to contribute to ITER success while bringing back necessary experience for accelerating domestic fusion energy
- Essential ITER research products, capabilities that need to be strengthened, opportunities in commissioning and operational planning, facility maintenance

Organization

- Organization, structure, and modes of operation for flexible, agile, and impactful exploitation
- Balance between on-site presence and remote participation, resources
- Coordination across FES, engagement with private sector
- Workforce development issues

Workshop participants should adopt a long-term, comprehensive perspective on the US engagement in ITER research by considering all phases of ITER

Full text of the charge can be found at https://www.iterresearch.us/charge

The community responded… in force!

In 2022, over 400 of our colleagues gathered (virtually)

and more than 300 others

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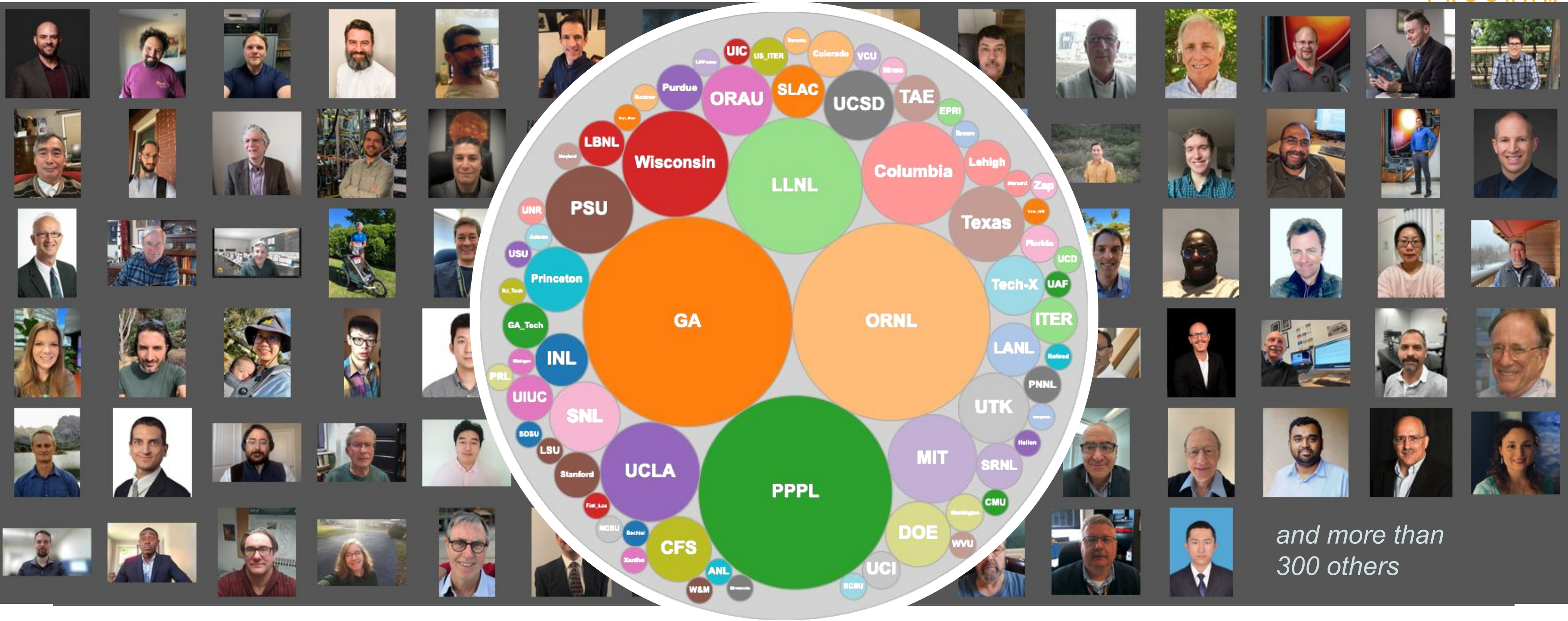
In 2022, over 400 of our colleagues gathered (virtually)

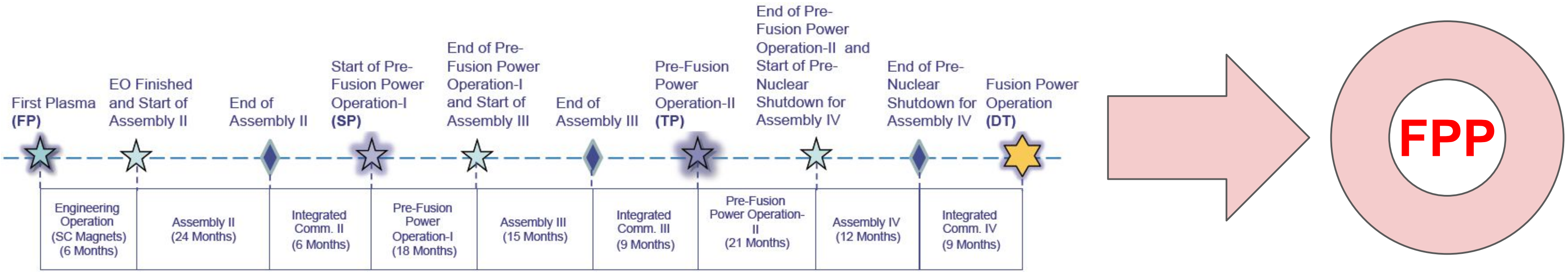
U.S. ITER RESEARCH PROGRAM



Very broad institutional participation too!

Many participants questioned the apparent conflict between ITER and FPP timelines

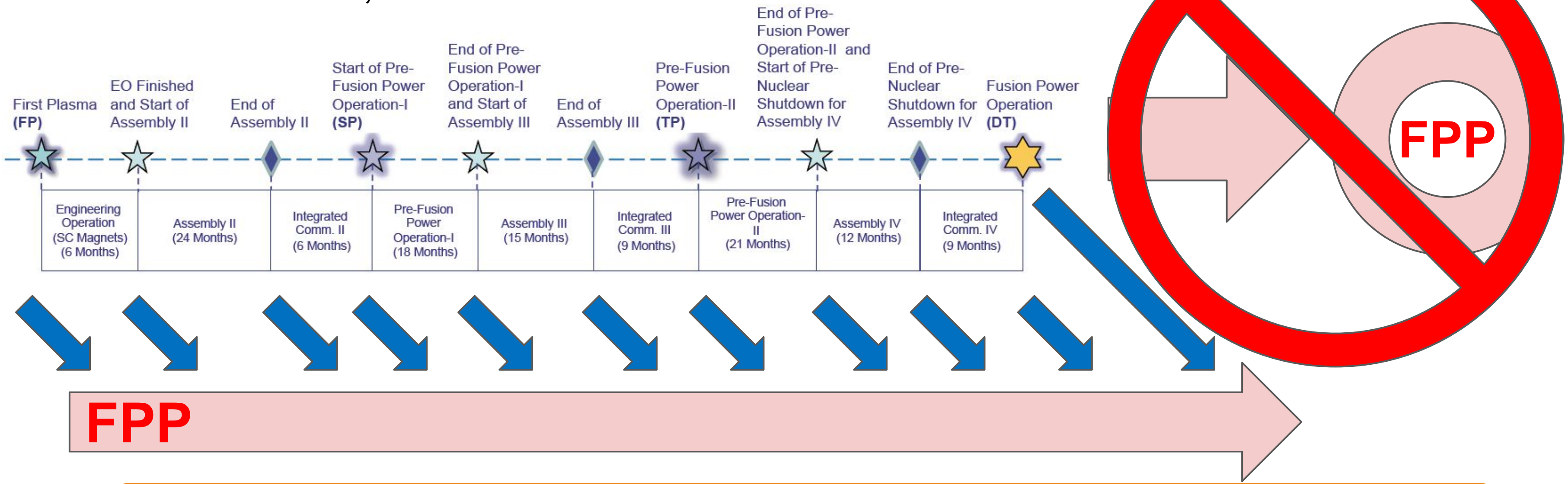
- Given uncertain schedules (both ITER and various FPP visions), the workshop discussions used ITER Research Plan phases as their "calendar"



The report does not assume "first we do ITER, then we start on FPP"

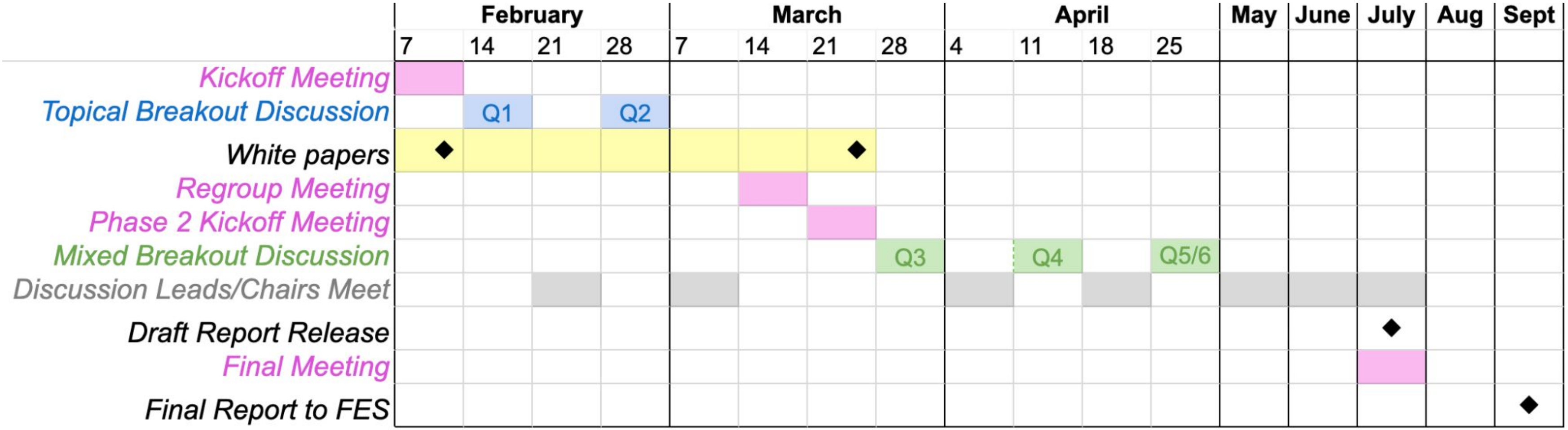
Many participants questioned the apparent conflict between ITER and FPP timelines

- Given uncertain schedules (both ITER and various FPP visions), the workshop discussions used ITER Research Plan phases as their “calendar”
- Not “first ITER, then FPP”



We expect each step of the ITER Research Plan to contribute to a continuous process of developing, testing, and improving pilot plant concepts

The Process

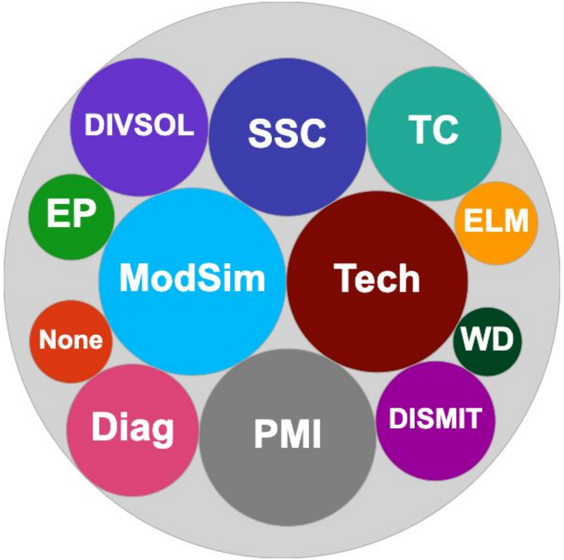


- Deliberations leading to this report were informed by:
  - Large collection of previous reports compiled in the Resource Library section of the website
  - Presentations given at the February 9 and March 23 plenary meetings
  - 81 white papers from participants
  - Topical and mixed breakout discussions
  - 49 chits from participants after the first draft of the report was distributed… all were considered and most impacted the final report
  - *An active and knowledgeable community of over 400 participants*

Phase 1 (Research): Process

Participants were asked to convene in 24(!) topically organized discussion groups

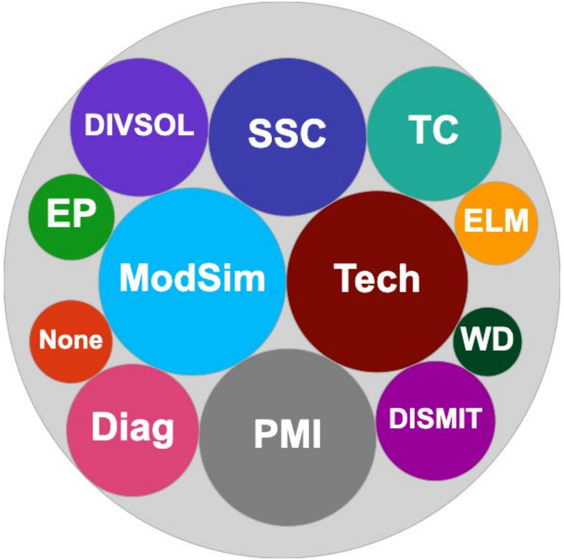
- In 10 scientific and technical topical areas
  - PMI Plasma-Material Interaction (3 groups)
  - EP Energetic Particles (1 group)
  - DIVSOL Divertor and Scrape-Off Layer (2 groups)
  - SSC Scenarios, Stability, & Control (3 groups)
  - ELM Edge localized Mode Control (1 group)
  - DIAG Diagnostics (2 groups)
  - DISMIT Disruption Mitigation (2 groups)
  - MODSIM Modeling & Simulation (4 groups)
  - TC Transport & Confinement (2 groups)
  - TECH Technology & Integrations (3 groups)
- *An additional group began consideration of workforce development issues; this continued through Phase 2*



Breakdown of self-identified topical area discussion group membership

Phase 1 (Research): Process

- Each group met several times in breakout sessions to discuss two questions:
    - *Q1: How can US research most effectively contribute to the success of ITER?*
    - *Q2: What essential ITER research products are needed to strengthen the domestic program to address strategic objectives aimed at the development of a fusion pilot plant?*
- Interspersed with these meetings, the leaders and scribes of the discussion groups met with the workshop chairs to summarize their discussions
- The output was a set of 54 topical initiatives (28 for Q1 and 26 for Q2), described in Appendix E and two General Initiatives
- These were incorporated into seven Research Missions



Breakdown of self-identified topical area discussion group membership

Research directions for US engagement in ITER

ACTION: We must promptly and broadly engage with ITER, to gain knowledge in identified missions and initiatives and to support any needs that may arise in coordination with the US ITER research team and fusion community.

ACTION: We must establish an equitable, accessible, inclusive knowledge base integrating US and partner developments to support ITER and enable a US FPP

54 Topical Initiatives

We propose:

- Two General Initiatives
  - *GI1: Improve US access to and utilization of ITER information*
  - *GI2: Modernize and adapt US codes and data to be IMAS-compatible*
- Seven Cross-cutting Research Missions
  - *Mission 1: Disruption Prevention and Mitigation*
  - *Mission 2: Technology Engagement and Transfer*
  - *Mission 3: Materials Evaluation*
  - *Mission 4: Heat and Particle Exhaust Handling*
  - *Mission 5: Operating Scenarios and Plasma Control*
  - *Mission 6: Modeling, Simulation, and Data Handling*
  - *Mission 7: Core-Edge Integration*

Described in subsequent slides

General Initiative 1: ITER Knowledge

- **Objective: Improve US access to and utilization of ITER information**
  - Embed members of the US program in existing operation and maintenance teams on site to gather knowledge of technologies and techniques that will be required for an FPP.
  - Reduce barriers to access technical information and documents and increase mechanisms to transmit lessons learned.
  - Establish methods for long term ITER knowledge management and internalization by the US fusion program, such as up-to-date searchable document and content management systems, databases, data exchange and storage, know-how and training.

- **Why: Need to internalize ITER information to prevent the US from having to repeat costly lessons already learned in assembly, commissioning, licensing**
  - Need low-barrier access to information such as engineering designs, data, codes, performance statistics, maintenance procedures and logs, operational experience, troubleshooting info, etc.
  - On-site participation gains know-how on inspection technologies, utilities connect/disconnect, tritium containment, automation and remote maintenance, sensor feedback
  - Data mirror allows for faster access for US researchers

General Initiative 2: IMAS Adoption

- **Objective: Modernize and adapt US codes and data to be IMAS-compatible**
  - Develop an IMAS ecosystem to make adoption of existing codes and workflows easier.
  - Develop the infrastructure for converting US experimental data into the IMAS format for inclusion in relevant international databases that can be used for validating ITER operational scenarios.
  - Embrace the ITER modeling and analysis tools, and test, validate, and benchmark IMAS workflows at US experimental facilities.

- **Why: Need to gain, maintain relevance in the ITER research environment and achieve rapid turnaround on results**
  - US could have transformative impact on the development of IMAS and its capabilities, affecting operations and research by ensuring ITER has the best available tools from the US
  - Wider adoption of IMAS allows easier and more consistent comparisons between various codes (verification) and between codes and experiment (validation)
  - Code/software modernization needed: modeling, simulations will underpin design and operational decisions with financial and programmatic implications, nuclear regulations and audit

Overview of Cross-cutting Research Missions

- 7 Research Missions were built from 54 Topical Initiatives
  - Identified using input from poll, where participants ranked top initiatives for US focus
- The Missions and Initiatives address critical products to ensure ITER's success and prepare for an FPP, starting now and continuing through each ITER phase
  - The report specifies timing, which Initiatives fit into each Mission, and **MANY thoughtful details** for each Topical Initiative in the appendix
- Missions are NOT listed in priority order
  - US ITER Research Coordinating Office, working with the Research Team, will be responsible for continually evaluating and prioritizing specific research, deliverables within these Missions
- Missions are living: they will evolve and require a comprehensive view of national and overall ITER Research Program interests
  - Each should have clear objectives, seek to reach completion, be updated periodically
  - Will be part of larger efforts involving the IO and all ITER Members: may need to adjust definition/scope to better interface and take account new research results

Research Mission 1: Disruption Prevention and Mitigation

DISMIT SSC PMI

Objective: Ensure that ITER and subsequent tokamaks can operate without damage or loss of operating time due to plasma disruption.

Why: Disruptions are considered the largest threat to the ITER. This builds on long-standing US leadership in Disruption Prediction, Avoidance, and Mitigation to both protect our investment and maintain progress.

Highlighted Activities:

- Complete the scientific and technical basis, and commission the Shattered Pellet Injection (SPI) DMS
  - Including developing possible alternative DMS technologies
- Develop and validate control techniques to manage core and edge instabilities; integrate this into ITER PCS

Research Mission 2: Technology Engagement and Transfer

TECH DIAG

Objective: Gain understanding of critical fusion technologies, especially those that form the basis for US hardware contributions. Ensure that US hardware contributions fulfill their roles in the ITER program. Ensure that all knowledge of fusion technology, developed by all parties through all phases of the ITER program, is acquired by the US and made available to support our continuing technology and fusion system studies programs and design of an FPP.

Why: ITER commissioning and operation will provide first-hand experience, data on how magnet, thermal, fueling, diagnostic, and tritium handling technologies perform in a burning plasma system. As a partner, we gain critical info from all systems (remote handling, PFCs, etc).

Highlighted Activities

- Become actively involved in commissioning, startup, and operations, especially with US-contributed diagnostics
- Develop synthetic diagnostics and data interpretation workflows for inclusion in predictive simulations for ITER and for plasma control demonstrations
- Utilize ITER to gain experience with control of a reactor scale, long-pulse burning plasma
- Gain experience with a Tritium Fuel Cycle

Research Mission 3: Materials Evaluation

PMI DIVSOL EP

Objective: Address the full scope of 'lifetime' for ITER PFCs, observing PFC performance, characterizing how PMI impacts operations, and quantifying issues and limitations imposed by material migration and slag management. Utilize ITER results to predict PFC lifetime and design advanced materials and PFCs suitable for a FPP.

Why: ITER's PFCs will enter new regimes of long-pulse, high flux that far surpass present-day absolute parameters. Real-time observations of PFC performance (utilizing US provided Upper IR/Visible Cameras) during start of PFPO-1 can inform the FPP strategy during the design phase.

Highlighted Activities:

- Knowledge transfer of ITER PFC component design, installation, performance
- Leverage US modeling capabilities to predict extreme PMI and material response (erosion, cracking, melting, and dust) for ITER PFCs and assess implications/lifetimes
- Evaluate effects of nuclear environment on materials, neutron irradiation in tungsten
- Carry out novel PFC materials studies

Research Mission 4: Heat and Particle Exhaust Handling

DIVSOL PMI ELM

Objective: Predict and control both steady and transient heat and particle fluxes flowing to the divertor and main chamber walls, while reducing the transport of eroded PFC's and any injected impurities upstream.

Why: SOL width scaling greatly impacts the ability to design a robust FPP divertor, viable FPP configurations and operational scenarios. Even early data in PFPO-1 can begin to validate heat flux width scalings and whether effects (turbulence, ELMs, etc) cause favorable broadening. Measures must be taken to ensure peak flux does not exceed materials limits. ELM control is required to avoid uncontrolled first wall/divertor erosion and tungsten impurities.

Highlighted Activities:

- Ensure measurements are obtained to validate heat flux width scaling
- Develop tools, test and demonstrate control of divertor detachment
- Predict/demonstrate control of ELMs, main chamber erosion, impurity influx/outflux

Research Mission 5: Operating Scenarios and Plasma Control

SSC ELM TC DIVSOL DIAG PMI EP TECH

Objective: Prepare a range of operating scenarios and the tools to access and control them to successfully achieve the goals of each stage of the ITER research program.

Why: The US is a current leader, but entirely new challenges await in the burning plasma regime, including control of equilibrium, stability, burn, helium ash, tritium inventory, and investment protection. ITER will have flexible capabilities to develop control in preparation for even higher gain FPP.

Highlighted Activities:

- Develop ITER scenario solutions from breakdown to shutdown,
  - Including techniques for H-mode access, ELM mitigation/suppression and intrinsically non-ELMing regime access
- Test and validate divertor control schemes for an FPP in ITER
- Demonstrate operational pulse planning and control workflow, including limited actuators, alpha heating, and ash removal

Research Mission 6: Modeling, Simulation, and Data Handling

U.S. ITER RESEARCH PROGRAM

MODSIM | DIAG | EP | TC | DIVSOL | PMI | SSC | ELM

Objective: Develop and apply Modeling and Simulation tools in preparation for ITER experiments, which in turn provide input for preparing validated models for application to FPP. Integrate IMAS into all modeling, analysis, and simulation codes (GI2: IMAS Adoption) and improve US access to and utilization of ITER information (GI1: ITER Knowledge).

Why: Each stage of ITER operation will improve the predictive modeling tools that can be applied to other elements of the US fusion portfolio up to and including an FPP.

Highlighted Activities:

- Expand, develop, and validate full and reduced models to enable proactive evaluation of ITER scenarios
- Develop tools to simulate entire ITER discharges in advance, at reactor scale and test the full cycle (analysis, predictions, pulse-design, control)
- Develop new synthetic diagnostic algorithms to simulate the various ITER diagnostics and enable efficient code validation

Research Mission 7: Core-Edge Integration

DIVSOL PMI ELM SSC TC EP

Objective: Determine conditions and control requirements for compatibility between the core, pedestal, and boundary regions of the plasma. Coordinate related Topical Research Initiatives to develop effective solutions which prevent erosion of plasma facing components by maintaining heat and particle loads within acceptable limits while avoiding core impurity contamination and consequent performance degradation.

Why: In present devices, it is not possible to simultaneously achieve a sustained high power density core and a divertor solution at FPP scale heat and particle fluxes. Scoping relies on extrapolations of models that were validated far away from FPP regimes. ITER will extend conditions toward FPP starting in PFPO-2.

Highlighted Activities:

- Drive development of simulations that span the core, pedestal, SOL, PMI, and divertor
  - Leverage existing facilities to test extrapolation, predict ITER behavior and identify potential challenges or methods to operation
- Grow/promote scenarios and experiments on ITER of US interest for core-edge integration
  - Determine if lower pedestal density gradients, turbulence, or small ELMs minimize core imp.
  - Assess operational limits and performance, effects of pulse length, and applicability to FPP

The second phase of the workshop focused on how we should organize ourselves

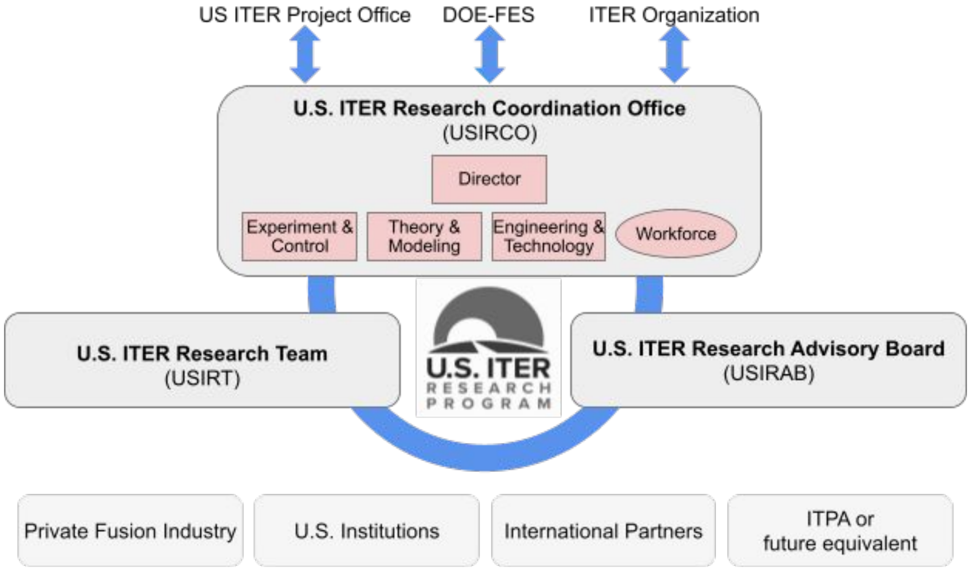
Report chapters:

3. Organizing for effective engagement in ITER
    - Organizational Structure of the US ITER Research Program
    - Infrastructure Needs for the US ITER Research Program
4. Mobilizing a US ITER Research Workforce
    - Workforce Development
    - Working with the Broader Community

ACTION: We must build a structure for maximizing US return on and contribution to ITER advances

We propose a US ITER Research Program, composed of three elements:

- **US ITER Research Team (USIRT)**
  Composed of all individuals contributing to ITER operations and carrying out ITER research for US institutions, charged to propose and execute research and development for ITER and to bring back knowledge and experience to the US program
- **US ITER Research Coordination Office (USIRCO)**
  Responsible for interfacing with DOE and the IO, and for facilitating the broad participation of all US entities in the US ITER Research Team
- **US ITER Research Advisory Board (USIRAB)**
  Responsible for periodically reviewing and reporting on the effectiveness of the US ITER Research Team organization and leadership



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  Research … leadership

- Should have points of contact with the US ITER Project Office (USIPO), the IO and other ITER Members, and with FES
- Should work collaboratively and inclusively with other elements of the US Fusion program
  - All segments of the community have roles to play, including laboratories, universities, and privately funded fusion endeavors
  - FES User Facilities have unique capabilities to support both ITER research by acting as "ITER satellites" as well as in training researchers for roles on ITER
  - USIRCO should work closely with their leadership to leverage those capabilities
  - USIRCO should also look for similar collaborative opportunities with future privately funded facilities

USIRCO: Roles and Responsibilities

- **Roles**
  - Interface with the IO
  - Enable US Research Mission Execution
  - Disseminate ITER results
- **Responsibilities**
  - Provide records of discussion to accompany proposals to carry out ITER research work
  - Ensure and support access to ITER data and software by all US institutions
  - Maintain documentation regarding technical processes and information
  - Identify and address urgent scientific and technical ITER needs
  - Prioritize US research supporting ITER, with input from USIRT, IO, and in cooperation with other elements of the domestic program
  - Work with the IO, DOE, and US entities to expeditiously resolve policies and disputes with regard to intellectual property, review processes, etc.
  - Establish relocation and logistical support for personnel from US institutions at the ITER site
  - Determine appropriate balances in personnel and projects among onsite, offsite, and supporting activities
  - Advocate for and connect participants to funding mechanisms that enable broad participation across all institutions

USIRCO: Authorities and Accountabilities

- **Authorities**
  - Strategically assign personnel/projects in order to execute the US ITER Research Program
  - Direct resources to provide support for all USIRT members to access ITER data
  - Direct resources to provide support for making codes compatible with IMAS
  - Direct resources to hold periodic workshops to collect and disseminate information, promote and engage broad participation from all segments of the community, or other topics as necessary
  - Direct resources for workforce development needs including internships, technical or project management training
  - Direct resources to address urgent, emerging ITER needs. This could include support for supplemental run-time at domestic facilities.
- **Accountabilities**
  - USIRCO reports to DOE/FES on resources needed, both short- and long-term, to fulfill US commitment to and utilization of ITER research and to enable equitable participation by US stakeholders
  - USIRCO reports to DOE/FES on research priorities and interface costs to inform Funding Opportunity Announcements released by DOE
  - USIRCO will periodically report to USIRAB and seek its advice, including on appointments within USIRCO
  - USIRCO will periodically report to the fusion community on the overall status of Research Missions and prioritization of US ITER Research Program activities

ACTION: Provide infrastructure to fully support USIRT members working both on-site at ITER and off-site in the US

- On-site presence is strongly encouraged and should begin immediately, increasing as experimental operation approaches
  - Directly interface with IO and other Members
  - Establish leadership status for US participants
  - Establish and support mechanisms for remote data access and qualification
  - Participate in System and Integrated Commissioning
  - Keep contact with and learn from operation of US-provided hardware
- Enable on-site participation in ITER by:
  - Establishing US ITER Research Program relocation support to help with policies, economics, and logistics of getting more people on the ground at ITER
  - Establishing a satellite office near ITER and workspace at ITER for on-site participants

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Challenges and concerns:

- Difficult for families to relocate to a new country
  - School, spouse's career, housing, language,…
  - Relocation support is essential
- Lack of work space at the ITER site
  - Satellite office proposed as a compromise between fully remote and fully on-site

ACTION: Provide infrastructure to fully support USIRT members working both on-site at ITER and off-site in the US

U.S. ITER RESEARCH PROGRAM

- Most US participants in ITER research will work remotely from the US
  - Provides the broadest possible opportunity for US people to participate in ITER
  - Enables the program to attract individuals whose talents would be unavailable to ITER if it were a requirement to relocate to the project site or travel extensively
  - Maintains connection with domestic fusion research
- Enable remote participation in ITER by:
  - Utilizing efficient communications technologies between remote and local participants
  - Improving data networking throughput between ITER and the US
  - Establishing data and information repositories in the US
  - Creating one or more remote experimental centers
  - Establishing dedicated computational clusters (new and/or existing) for ITER modeling, simulation, and data analysis

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Challenges and concerns:

- Physical distance… state-of-the art remote collaboration technology is essential
- Questions were raised about value of "remote control rooms" vs. work-from-home
- Network speed and capacity… need fast networks and domestic data repositories
- Time zones (but second shift operation at ITER site could align well with US participants)

ACTION: We must support education and preparation of the workforce needed for successful engagement in ITER and FPP

- Establish a DEI and workforce directorate (or lead), located within the leadership of the USIRCO, to coordinate and follow through with the many aspects of DEI and workforce development
- Provide workshops and resources for technical training, as well as for leadership and project management development
- Provide resources for diverse fusion workforce recruitment, including scholarship and fellowship programs to new communities using non-cognitive variable approaches in admission
- Support both domestic and on-site training and internship programs with an intentional approach towards underrepresented communities. This includes ensuring competitive pay/travel/boarding for ITER-internships (both domestic or IO) by supplementing costs if necessary.
- Enable and support joint training programs with private industry

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- Establish a DEI and workforce directorate (or lead), located within the leadership of the USIRCO, to coordinate and follow through with the many aspects of DEI and workforce development

DEI continues to be a major concern within the fusion community. The USIRCO will need to be mindful of DEI issues and keep them at the forefront as we organize a broad and inclusive ITER research workforce.

ACTION: Access to ITER participation, data, and research products must be made open to the entire community (1 of 2)

U.S. ITER RESEARCH PROGRAM

- Create a culture of openness
  - The USIRCO should facilitate making all data, software, and ITER research products openly available except in the relatively rare cases where proprietary information is involved
  - Establish, with urgency, a process whereby US fusion entities, both public and private, can gain access to ITER-generated information and vice-versa, including Intellectual Property
- Broad availability of simulation and data tools
  - Implement a strategy for ensuring that FES-funded theory and model development can be readily extended and applied to ITER where applicable
  - Provide support for making modeling codes IMAS-compatible, and ensure that domestically-developed tools are integrated into IMAS as appropriate [General Initiative - IMAS]
- Include the Technology Community
  - Provide financial support for US fusion technology community engagement in ITER by providing base program support for ITER research, subsidizing contract bids in strategically important areas, and facilitating access to ITER design information and data
  - Ensure robust on-site and remote US participation in the commissioning and operation of US-designed and constructed ITER systems
- Work with the broader domestic and international communities
  - Continue research in support of ITER on domestic and overseas tokamaks under the coordination of the USIRCO in cooperation with facility leadership and with participation from USIRT members. Strengthen participation in international ITER information sharing and planning venues, such as the ITPA

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  - The USIRCO should facilitate making all data, software, and ITER research products openly available except in the relatively rare cases where proprietary information is involved
  - Establish, with urgency, a process whereby US fusion entities, both public and private, can gain access to ITER-generated information and vice-versa, including Intellectual Property

Intellectual property issues were brought up frequently, most often in terms of university and private fusion enterprises, as major obstacles to participation. USIRCO should work together with all concerned (FES, ITER Organization,…) to seek solutions that enable full and broad participation.

ACTION: Access to ITER participation, data, and research products must be made open to the entire community (2 of 2)

U.S. ITER RESEARCH PROGRAM

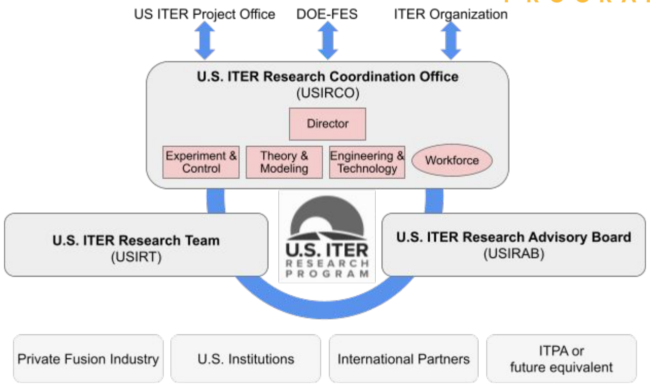
- Open doors to university participation
  - Develop a strategy for engaging faculty at different Carnegie Commission on Higher Education classifications (R1, R2, PUI, MSI) universities in terms of ITER research leadership, funded research projects, and onboarding of newcomer faculty from underrepresented and underserved communities
  - Conduct a series of 3-4 short 1-2 day hybrid workshops with University faculty, researchers, and research administrators from different Carnegie classifications to evolve engagement and gain a consensus for engagement
  - Expand the existing funding model that provides sufficient resources for existing and new faculty to provide meaningful and needed research contributions. This may include expansion of awards, seed grants, supported/split collaboration grants, supported postdocs/faculty salaries, etc.
  - Implement "Go to where they are" engagement strategies with newcomer faculty at different university classifications through engagement workshops
  - Support the creation of joint appointments between faculty and US ITER Research Program national laboratory relationships
- Establish a domestic public-private task force to develop a plan for how the two sides will partner in ITER research, operations, preparations, two-way information exchange, and workforce needs

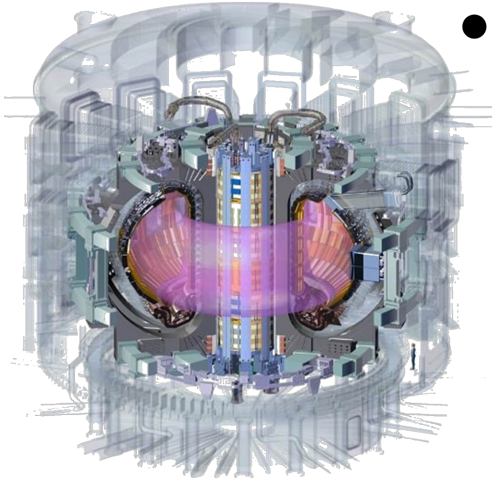
All material from the workshop has been made publicly available at iterresearch.us

- What you can find on the website:
  - Final report
  - Plenary meetings
    - Agendas
    - Videos and slides of presentations
  - White papers
  - Resource Library
- The website will be maintained for at least one year following report submission
  - Likely that this material would be more permanently preserved at the USIRT website (when it exists)

What does a successful engagement in ITER look like?

- Establish the USIRT with the resources needed to ramp up to full capabilities by First Plasma as described in this report
- Get to work on the General Initiatives and Research Missions



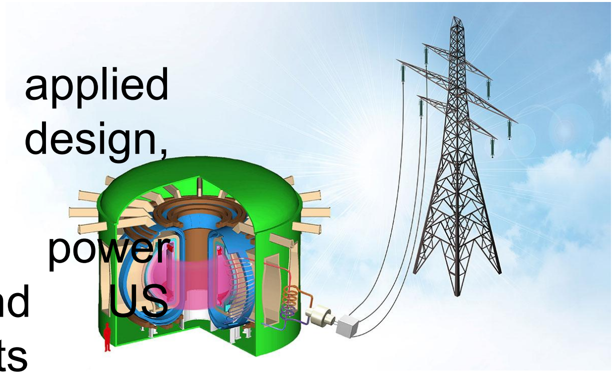


- It's time to put US people on the ground in France
  - System Commissioning is already underway at ITER - it isn't waiting for us…
    there is valuable experience to be gained
  - Full participation in programs that provide on- and off-site opportunities (IPAs, Monaco Fellows, ITER Operations Network,…)

What we'd like to see looking back from a future where fusion energy is well established

- The US became a strong partner in the international ITER Research Team by making contributions that helped to ensure ITER's success

- USIRT researchers had clear goals, brought back essential science and technology, and grew an experienced, diverse workforce to commercialize fusion
  - Early results were applied in active industrial partnerships, technology innovations
  - Researchers validated predictive models and applied critical lessons learned from ITER towards design, construction, and maintenance of an FPP
  - The world hailed the successful control of a power plant scale burning plasma in ITER and US researchers used ITER to test FPP-specific improvements



We are ready for this challenge