Private Facility Research Program

A DOE Fusion Energy Sciences Sponsored Workshop

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U.S. DEPARTMENT OF ENERGY | Office of Science

Office of Science Statement of Commitment & other Guidance

- **SC Statement of Commitment** – SC is fully and unconditionally committed to fostering safe, diverse, equitable, inclusive, and accessible work, research, and funding environments that value mutual respect and personal integrity. https://science.osti.gov/SW-DEI/SC-Statement-of-Commitment
- **Expectations for Professional Behaviors** –SC's expectations of all participants to positively contribute to a professional, inclusive meeting that fosters a safe and welcoming environment for conducting scientific business, as well as outlines behaviors that are unacceptable and potential ramifications for unprofessional behavior. https://science.osti.gov/SW-DEI/DOE-Diversity-Equity-and-Inclusion-Policies/Harassment
- **How to Address or Report Behaviors of Concern**– Process on how and who to report issues, including the distinction between reporting on unprofessional, disrespectful, or disruptive behaviors, and behaviors that constitute a violation of Federal civil rights statutes. https://science.osti.gov/SW-DEI/DOE-Diversity-Equity-and-Inclusion-Policies/How-to-Report-a-Complaint
- **Implicit Bias** – Be aware of implicit bias, understand its nature – everyone has them - and implicit bias if not mitigated can negatively impact the quality and inclusiveness of scientific discussions that contribute to a successful meeting. https://kirwaninstitute.osu.edu/article/understanding-implicit-bias

Outline

- **Private Facility Research (PFR) Program Mission**
- PFR Program Element Descriptions
- Lessons learned from the ST40 pilot project
- Charge Questions
- Workshop Process, Agenda, and Output

FES Mission and Strategic Priorities

MISSION

The mission of the 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.

The Energy Act of 2020 **expanded the scientific mission of FES** to support "**the development of a competitive fusion power industry in the U.S**."

FES PROGRAM PRIORITIES

1. Accelerate fusion development as a carbon-free energy source via public-private partnerships ("bold decadal vision")
2. Support R&D Fusion Centers ("FIRE" centers) to establish S&T basis of a Fusion Pilot Plant (FPP)
3. U.S. participation in ITER to leverage engineering and study burning plasma science technology at power plant scale while expanding Inertial Fusion Energy (IFE) program
4. Support discovery plasma science and technology
5. Broaden participation in fusion and DEIA activities to enable the program

Objective of the Private Facility Research Program

- The goal of the new **Private Facility Research (PFR) Program** is to offer the opportunity for publicly funded researchers to conduct open studies on privately constructed facilities (including non-fusion facilities) for the mutual benefit of all parties.

- This PFR program public-private partnership (PPP) aims to advance fusion and plasma science and technology through the open dissemination of S&T results and data acquired from world-leading private experimental facilities.

- The **INFUSE** and **Milestone** programs **assist** private companies in advancing a **Fusion Pilot Plant (FPP)**, the **PFR Program delivers near-term S&T** objectives enabled by the **privately built facilities** that precede the construction of an FPP.

- Foundational Science **will always** play a role in a ***private fusion industry***

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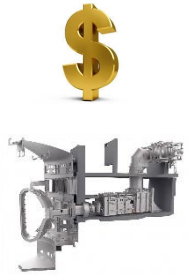
Three Private Facility Research (PFR) Program Elements

1. **Public repositories for private facility data storage**
   - Support both private companies and public institutions to mirror non-proprietary private facility data to public repositories

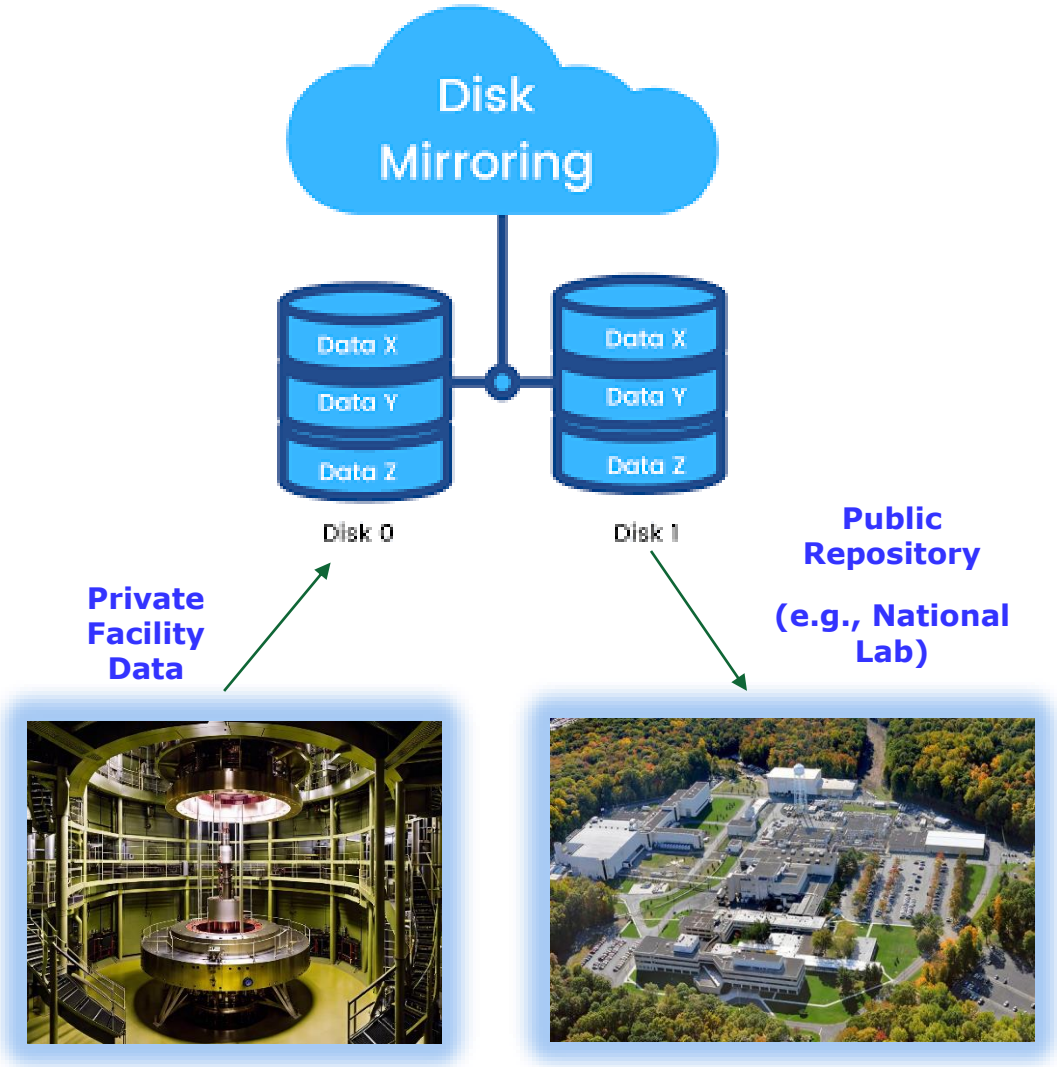
2. **Funding solicitation for public research on private facilities**
   - Follow proven ST40 collaborative research model

3. **Acquiring private facility run-time for public research**
   - Explore modalities to access private facility run-time in support of public researcher experimentation (e.g., staff, hardware, NSUF model)



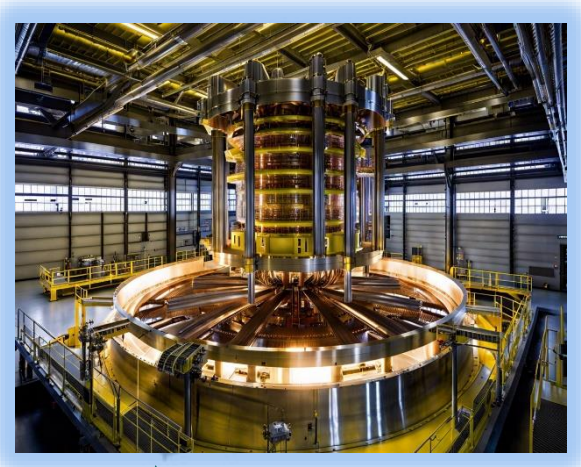
PFR Element 1: Public Repositories for Private Facility Data

- **A fundamental tenet of the PFR program is ensuring publicly supported collaborators have access to private facility scientific data and the freedom to publish results**
  - Mirroring **non-proprietary** data to a public repository ensures public collaborator access (open only to funded collaborators)
  - Data resulting from PFR program sponsored diagnostics are **non-proprietary** (INFUSE program offers proprietary diagnostic assistance)
- **Private facility data mirroring (or an equivalent alternative) will likely be a prerequisite for PFR program participation**
- **Although public researchers must be free to publish without restriction, internal private company review of pubs is anticipated**
  - E.g., 30-day courtesy review period for private co.



PFR Element 2: Solicitation

- **Development of an annual solicitation to fund public researchers to conduct studies on private facilities**
  - The inclusion of private facility capabilities and non-proprietary data availability in the solicitation could inform collaborator proposals
- **Pre-proposals** may be used to ensure PIs are responsive to the solicitation, and to prepare for the anticipated peer-review of full proposals
- **Full Proposals** could contain:
  1. Record of Discussion (RoD) w/ the private company could ensure mutual interest
  2. Standard Project Narrative w/ schedule/plan for completing work
  3. Hardware and/or Diagnostic implementation plans (if applicable)
  4. Notional publication plan (incorporated into RoD)
- For Element 2, funds only support public researchers, but hardware and/or diagnostics of mutual interest may be supported



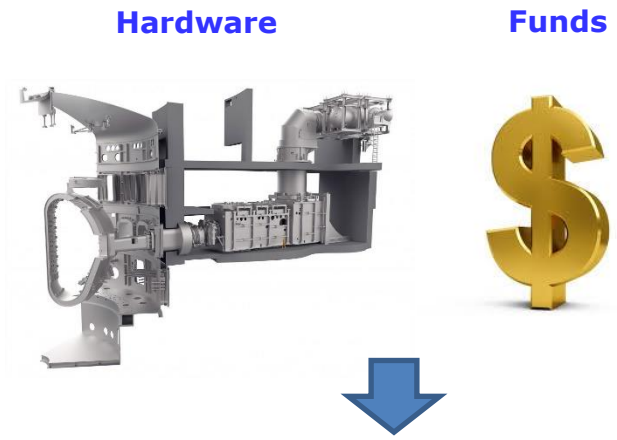
Private Facility

Public Researchers

High Impact Publications

PFR Element 3: Run-time Modalities for Public Research

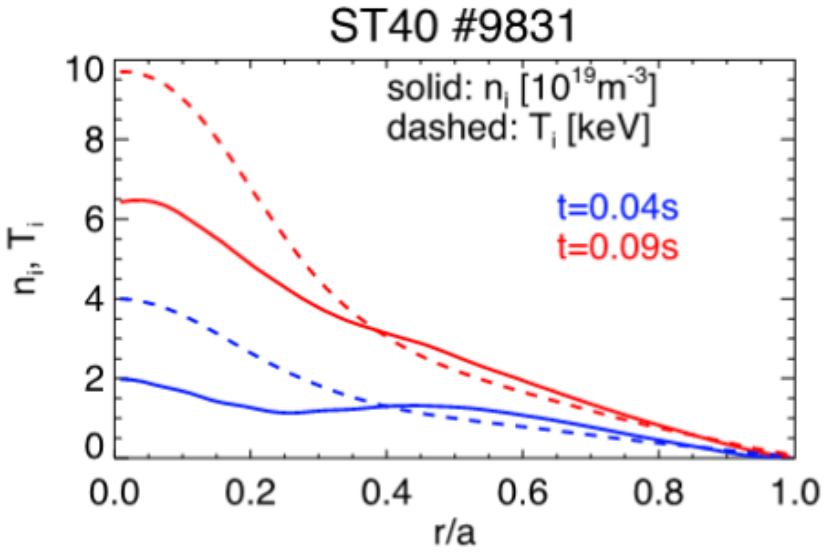
- **Immediate Term -** People/diagnostics for run-time
  - Less transactional: If a company sees value in a world leading researcher serving as a session leader to conduct a mutually beneficial experiment, then they may offer the researcher run-time (e.g., Stan Kaye on ST40)
  - If PFR program supports diagnostic and/or plasma operations expertise that accelerate and/or validate the accomplishment of private/public mission, then experimental leadership may be offered for follow-on studies
- **Longer Term –** Reimbursement/in-kind hardware for run-time
  - **Inverse User Facility model:** FES reimburses private facility operations costs for non-proprietary experiments in a similar manner as SC User Facilities recoup costs from private companies to conduct proprietary work
  - Example: DOE Office of Nuclear Energy purchases hot-cell time from Westinghouse via the Nuclear Science User Facility (NSUF) program to conduct non-proprietary research (Chris Barr will present on this program)
  - **Private Facilities are not User Facilities:** It is anticipated that non-proprietary PFR experiments will strongly overlap with private facility missions
  - **In-kind hardware:** FES could supply an auxiliary heating system to a private facility in exchange for commensurate amount of public researcher run-time

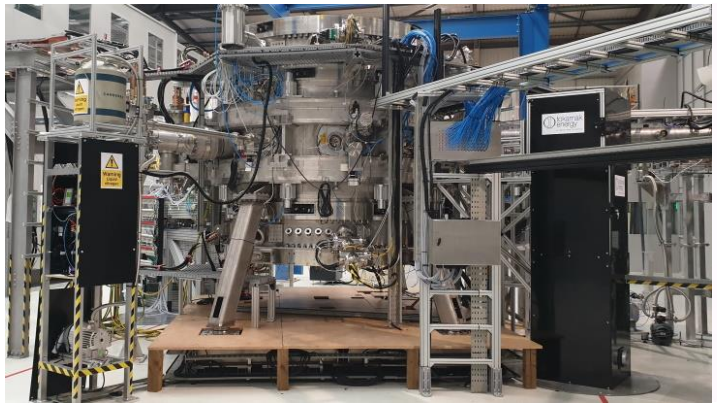


Publicly Sponsored Session Leaders

The Model Works!

- ST40 is owned by the private company Tokamak Energy (TE)
  - Machine Parameters: B_T=3T, I_P=2MA, P_{NBI}=2MW, R_0=0.4-0.6m, A=1.7–2.0, κ=2.5, t_{pulse}=3sec
- **Through ST40 PPPL, ORNL, TE collaboration the T_i necessary for DT fusion (~10 keV) was realized for the first time in a *compact* ST**
  - Present campaign push $nT\tau$
- This achievement was enabled by the following:
  - Private fail fast boldness
  - PPPL expertise in facility ops and interpretative modeling (e.g., TRANSP)
  - ORNL and PPPL's diagnostic expertise





Lessons Learned from ST40 pilot project

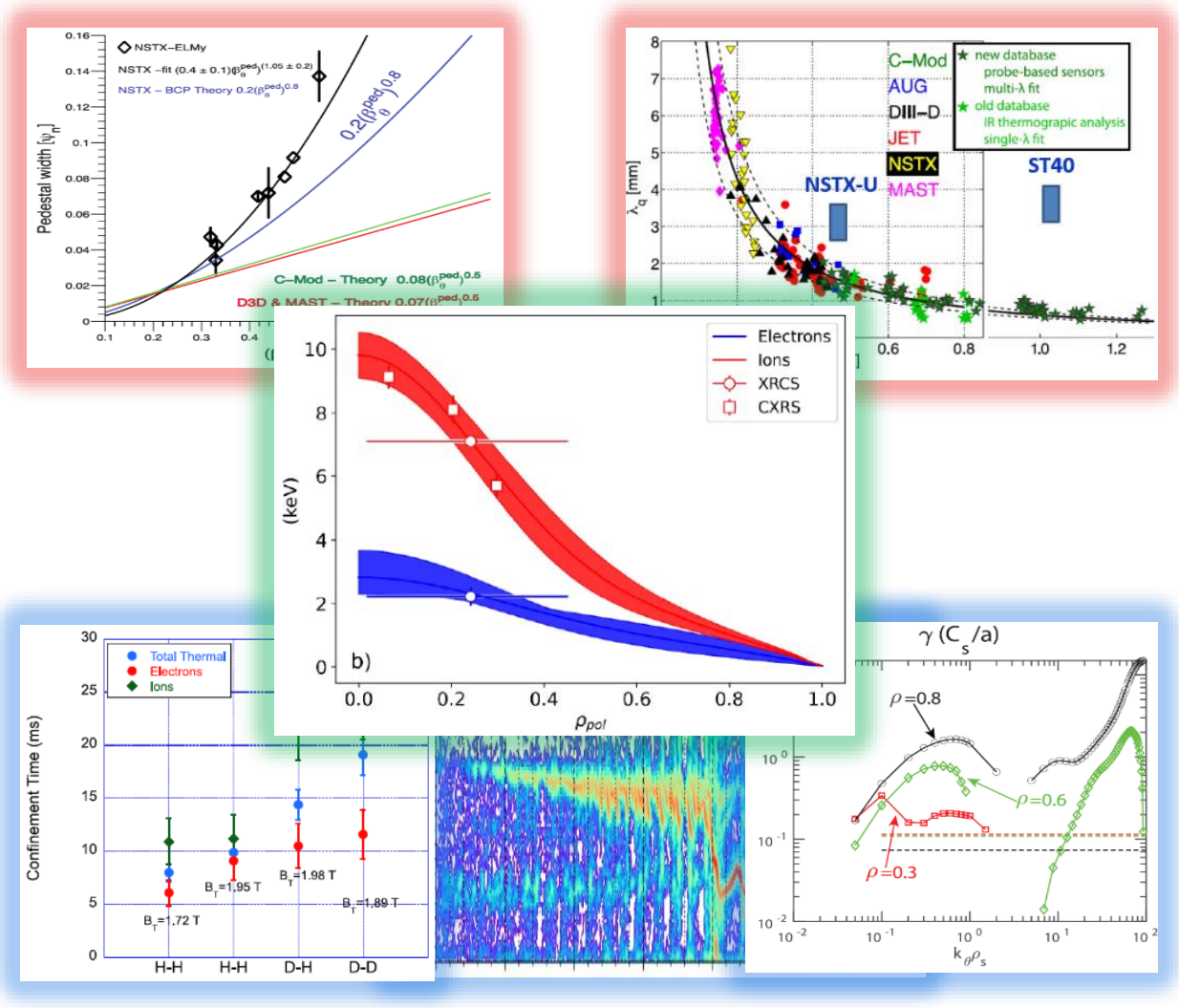
PPPL

OAK RIDGE National Laboratory

Tokamak Energy

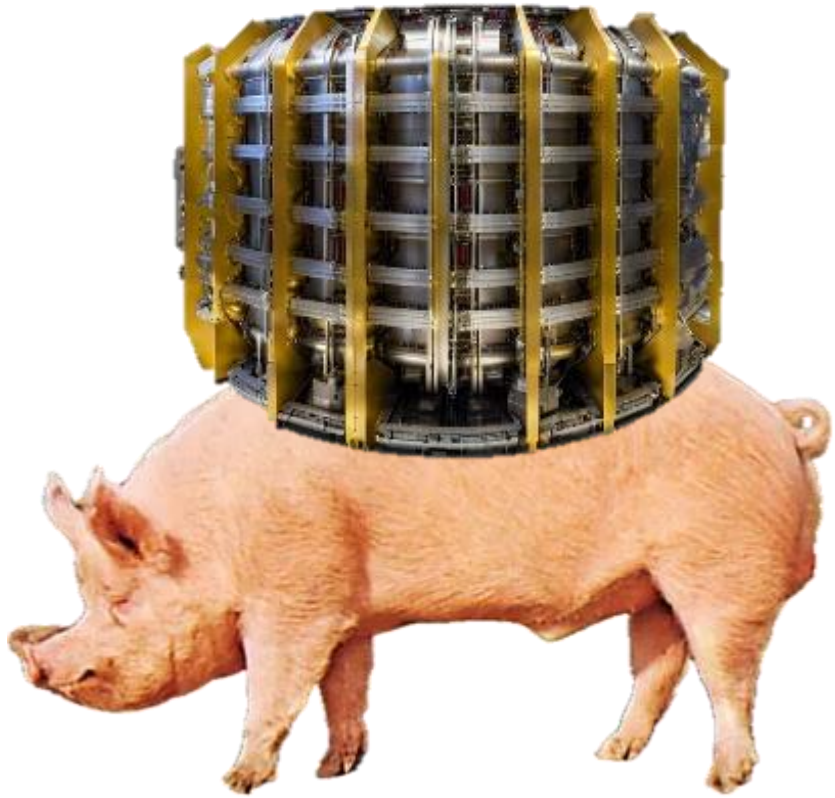
Flexibility is key

- **PPP mission overlap is a prerequisite and collaboration flexibility is needed**
  - **Proposed:** Pedestal structure and λ_q studies, while contributing pulse burst Thomson scattering measurements and TRANSP analysis.
  - **Delivered:** Gyrokinetic analysis of core plasmas, isotopic energy confinement studies, chirping EP mode insights,... Contributed plasma operations and TRANSP expertise as well as CHERS, XCS, IRTV, and Thomson diagnosticians
  - **ST40 Mutual Mission:** Realize T_i ~ 10 keV in an ST for the first time → **Mission Accomplished**
- **Original Position → Tell us when you're ready for our experiments**
- **Revised Position → All-hands-on-deck**
  - E.g., Devon Battaglia, Dennis Mueller (retired)
  - Boronization and TFTR super-shots



There is power in the ‘piggyback experiment’

- **Dedicated collaborator experimental run-time was not possible at the beginning of the ST40 facilities operating life**
  - Private facilities must focus on delivering their investor milestones. *It’s existential.*
- **Research grade plasmas in world-leading, first-of-a-kind facilities, offer many ‘piggyback experiment’ opportunities**
  - Requires sufficient diagnostic coverage - provided by either the private facility, PFR supported researchers, or both
  - ‘Piggyback experiments’ may involve non-perturbative modifications to plasma control programming, or no prior collaborator input and rely only on post discharge analysis
- **Unique facilities offer major scientific opportunities even if you’re not ‘calling the shots’**



Boots on the ground (for hardware)

- **Minutes of Hand-On > Months of Discussion**
  - ST40 collaboration began in earnest during the height of the COVID-19 pandemic
  - Travel restrictions forced initial collaborations to be entirely remote, which was fine for operational assistance that required only computers with access to data and plasma control interfaces
  - CHERS diagnostic (TE supplied) initially had very low SNR
  - ORNL pushed on multiple fronts (e.g., finding spare hardware, exchanging schematics, zoom calls, email) to improve the quality of this vital data
  - After months of remote effort, ORNL staff at JET reviewed the hardware setup in-person, and within ~15 minutes reoriented a camera/detector by 90^0, which increased the CHERS SNR by more than an order of magnitude
- **CHERS was vital to both public and private efforts**
  - Private company bench depth is less than public

OAK RIDGE National Laboratory

Ephrem Delabie

Bart Lomanowski

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Element 1 – Public Repositories for Private Facility Data

1. Discuss the partitioning of proprietary and non-proprietary data and the sharing of non-proprietary data with publicly sponsored PFR program collaborators.
2. The regular (e.g., daily) mirroring of non-proprietary private facility data to a centralized public repository both protects public collaborative research investments and preserves essential data for both public and private benefit, but it is not intended to be the primary data access point. What criteria could warrant public researcher use of data stored in a repository (e.g., in case of company bankruptcy)?
3. Are there alternatives to data repositories that achieve the same protections?
4. The establishment and maintenance of data repositories is non-trivial. Discuss anticipated public and private levels of effort. Should private company costs for establishing public data repositories be supported by FES?
5. Is there private company interest in mirroring their data to a public repository even in the absence of an initial public collaborative research effort?

Element 2: Solicitation (part 1)

6. A fundamental tenet of the PFR program is the freedom of public sector researchers to publish experimental results from private facilities. Identify sensitivities and paths for resolving them (e.g., 1 mo. publication embargo for private company courtesy review).
7. Public sector experimental collaborators are expected to have an appreciable on-site presence at the private facilities (e.g., those contributing diagnostics and other hardware). Discuss preferred paths for site access, safety, and data access?
8. How can public sector scientists most effectively deliver their proposed research objectives given the quickly evolving research plans of private facilities? What flexibility is necessary to ensure timely publication of research results?
9. To ensure both depth and breadth of fusion research within the PFR program solicitation, a tiered system based on nT_τ is being considered. Discuss options for such a tiered system. How should non-fusion efforts be weighted?

Element 2: Solicitation (part 2)

10. How can public sector researchers expedite the achievement of research-grade plasmas on private facilities?
11. What are the preferred methods of assuring mutual research interest of public and private entities? Should private company topical interest statements be included in the solicitation? At the proposal level, are Records of Discussion (RoD) sufficient?
12. In addition to required PIER plans, are there any unique features that could be added to a PFR program solicitation to improve diversity, equity, inclusion, and accessibility?

Element 3: Private Run-time Modalities for Public Research

13. What are the possible modalities for providing FES support for private facility operations for public researcher experimentation? DOE's Office of Nuclear Energy engages in a reimbursement model with private companies through their Nuclear Science User Facility (NSUF) program. Could similar models be applicable to this PFR program? What other programs could serve as a model?
14. Understanding the uniqueness of each facility, are there any general principles that should be applied to determining experimental 'ownership' of a research project?
15. What fraction of operational private facility time could be available for public researchers? How might this availability evolve as company milestones are reached? To what extent can 'piggyback' experiments be used?
16. What is the preferred mechanism for providing FES support for accessing private non-fusion facilities or capabilities to carry out plasma science research for non-fusion applications (e.g., semiconductor nanofabrication)?

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Workshop Process

- We will go into breakout groups and discuss the topics via assignments
- If a generic clarifying question emerges that could improve the discussion for the next group, please let us (Josh and Colleen) know
- The moderators for each of the breakout subgroup are:
  - **Josh King – Group A:** Element Discussion Order = **1,2,3**
  - **Colleen Nehl – Group B:** Element Discussion Order **= 2,3,1**
  - **Carlos Paz-Soldan – Group C:** Element Discussion Order = **3,1,2**
  - **Rich Hawryluk – Virtual Attendees:** Element Discussion Order = **1,2,3**
- Dedicate **~1 hour** of the subgroup time to openly discussing **all the questions**
- Dedicate about the last **30 minutes** of the subgroup time to writing down short answers to a **subset of charge questions** for full committee discussion
- **Full committee meets:** Each group reports out (~10 min. / Group) with full committee discussion (~10 min.) following each groups report out

Remaining Agenda

Time (Eastern)	Thursday, February 29th Sessions
8:45 AM – 9:00 AM	ST40 Pilot Project (PPPL/ORNL/TE collab.) - Stan Kaye (PPPL)
9:00 AM – 9:10 AM	ARPA-E Diagnostic Capability Teams - Ahmed Diallo (ARPA-E/PPPL)
9:10 AM – 9:30 AM	DOE Nuclear Energy NSUF program - Chris Barr (DOE/NE)
9:30 AM – 9:45 AM	Break
9:45 AM – 11:15 AM	Subcommittee Breakout #1
11:15 PM – 12:00 PM	Subcommittee Breakout #2 – 1st half
12:00 PM – 1:00 PM	Lunch
1:00 PM – 1:45 PM	Subcommittee Breakout #2 – 2nd half
1:45 PM – 3:15 PM	Subcommittee Breakout #3
3:15 AM – 3:30 AM	Break
3:30 PM – 3:45 PM	Foundation for Energy Security and Innovation (FESI) - Mary Yamada (DOE/OTT) Concurrently - Moderator prep time for Report Out
3:45 PM – 5:15 PM	Full Committee Report Out and Final Discussion
5:15 PM – 5:30 PM	Thank You and Group Photo
5:30 PM	Adjourn

Workshop Output

- **We are not seeking consensus**
- **All input is being captured**
- **ORISE staff notes** from subgroup meetings and full committee discussions, as well as **zoom chat comments**, **will serve as** the **output** of this workshop.
- **Written subgroup slide answers** to a subset of the charge questions only inform full committee discussion and **won't be recorded as workshop output**
- We expect ORISE notes to be posted on the PFR program workshop website (https://www.orau.gov/2024PFRWksp) and FES website soon after the meeting
- **This is only the first effort** to gather community input for the PFR program
- **FES will certainly continue to engage the community** and revise the PFR program as we learn

Let us know if there are questions

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Meeting Logistics: Jody Crisp (jody.crisp@orau.org)