Report of the Community Planning Process - Fusion Science and Technology

Presented by Nathan Howard

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Brief Overview of the Process

Goals

- To produce strategic recommendations for each of four topical areas:
    - Magnetic Fusion Energy
    - Fusion Materials & Technology
    - High Energy Density Plasma Physics
    - General Plasma Physics
    - Four cross-cutting areas
- Provide both ***near-term actionable recommendations*** and a long-term strategic outlook (**strategic plan**), highlighting opportunities for US leadership
- To the extent possible, to prioritize among these recommendations with community consensus
- To deliver these recommendations to FESAC by March, 2020 (Done)

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- To produce strategic recommendations for each of four topical areas:
    - Magnetic Fusion Energy
    - Fusion Materials & Technology
    - High Energy Density Plasma Physics
    - General Plasma Physics
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Fusion Science and Technology (FST)

Discovery Plasma Science (DPS)

- Provide both ***near-term actionable recommendations*** and a long-term strategic outlook (**strategic plan**), highlighting opportunities for US leadership
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- To deliver these recommendations to FESAC by March, 2020 (Done)

What is consensus?

- Firstly: Essential everyone given an opportunity to be involved and their voice heard
  - Respect others' opinions and views
  - Look for the positive aspects of ideas

- Consensus will involve compromise
  - It is not: I get everything I want, but is: *A plan I can live with*
  - It is not: A simple majority vote, but is: *A widespread agreement amongst the community*
  - It is not: The loudest voice that wins, but is: *The best ideas that triumph*

- Every public voice of disunity erodes confidence in our community and reduces support from stakeholders

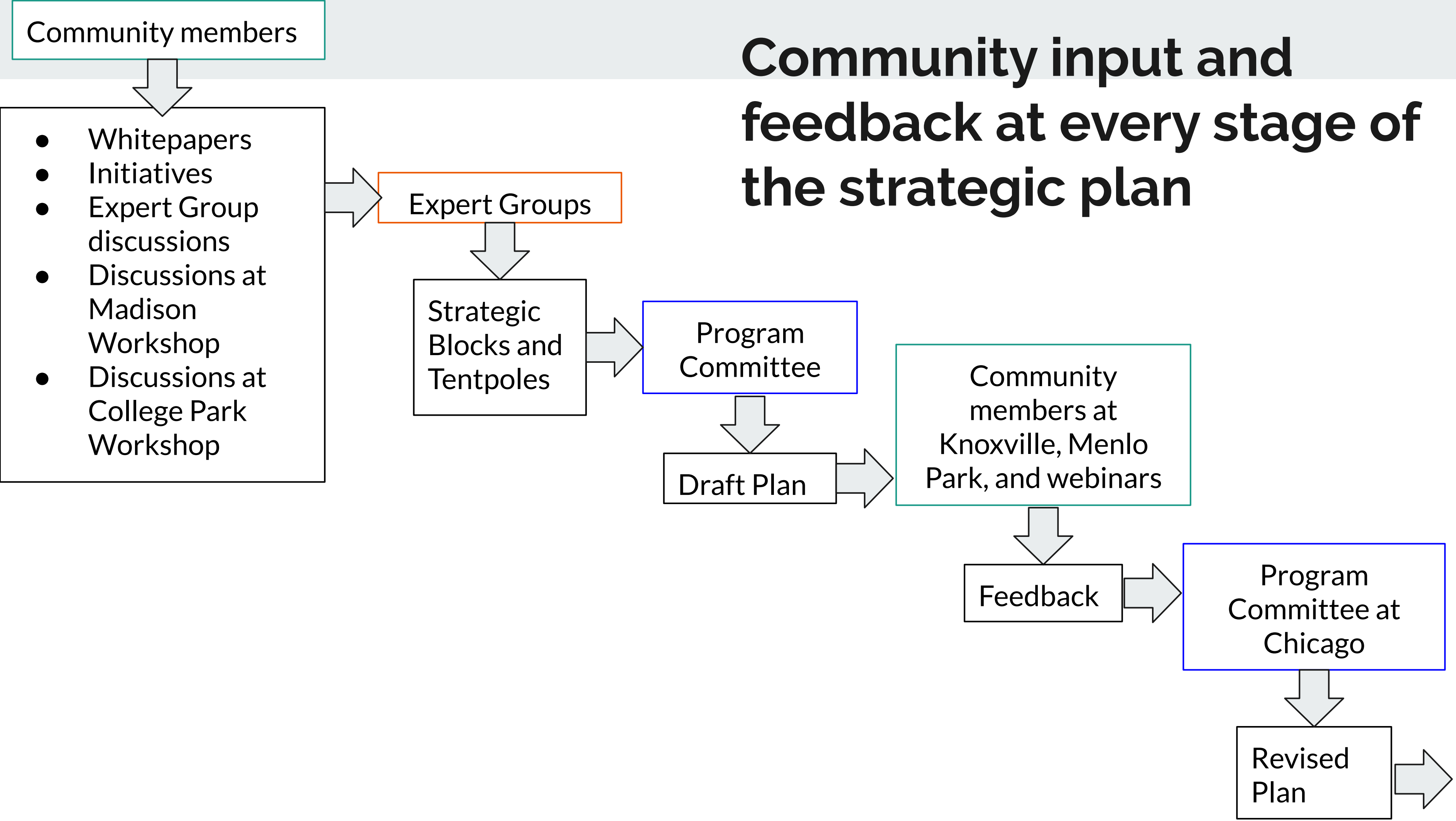
We tried to ensure all voices were heard

- Announcements sent to DPP-CPP Google Group
  as well as APS-DPP, GEC, USBPO, UFA, and ANS mailing lists
- White paper submission open for months (~200 Submitted)
- >100 expert group meetings, open to anyone interested
- 5 focus groups
- 15 webinars
- 6 Town halls
- 5 dedicated workshops

Program Committee was Integral to Success

- The program committee put in a tremendous amount of work to enable a successful outcome in a short amount of time
- Weekly (or more) meetings of the program committees occured in the main topical areas
- Frequent Expert Group and Cross-cut Group meetings (~weekly)
- Periodic check-ins with David Newman and Don Rej
- Weekly meeting of all co-chairs
  - Biweekly meetings with Facilitator
  - Almost daily meetings among MFE +FM&T co-chairs
  - Facilitator provided training sessions for the PC on how to moderate discussions

Community input and feedback at every stage of the strategic plan



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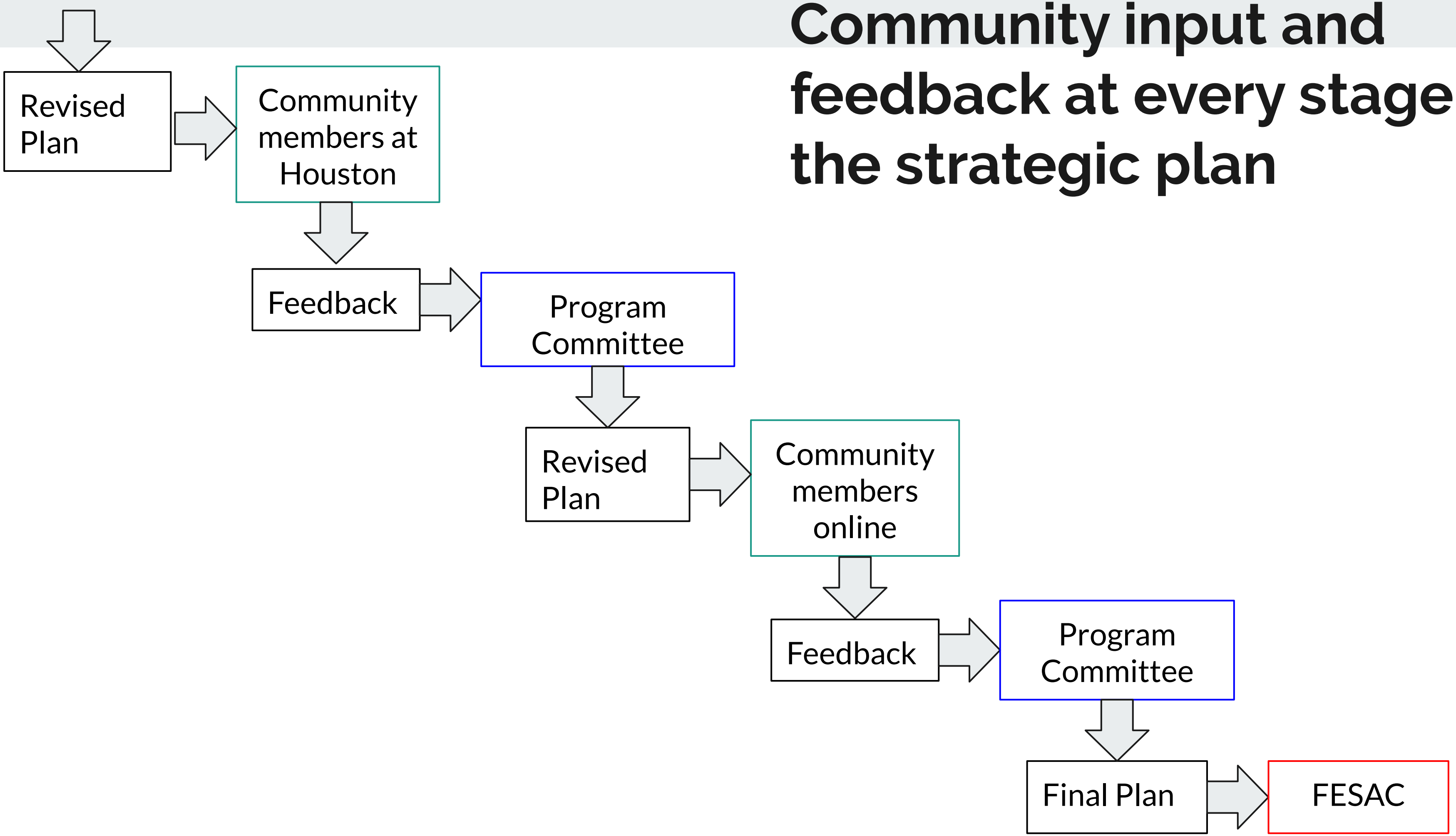


Structure of the Plan

The Plan is Organized into Three Main Parts

- **DPS:** Discovery Plasma Science
  - Primarily based on input from GPS and HEDP topical areas
- **FST:** Fusion Science and Technology
  - Primarily based on input from MFE and FM&T topical areas
  - Includes IFE (from HEDP topical area)
- **CC:** Cross-Cutting Opportunities
  - Input sourced from all topical areas
- The order of the FST, DPS, and Cross-cut chapters is not meant to convey priority

Executive Summary

Statement on DEI

Discovery Plasma Science

Fusion Science and Technology

Cross-Cutting Opportunities

Executive Summary

Statement on Diversity, Equity, and Inclusion

Discovery Plasma Science

DPS Vision, Mission, & Criteria

DPS-Wide Program Recs.

DPS1: Frontiers of Plasma Sci.

Program Recs.

Objectives
- Recs.

DPS2: Plasma Universe

Program Recs.

Objectives
- Recs.

DPS3: Transformative Tech.

Program Recs.

Objectives
- Recs.

Fusion Science and Technology

FST Vision, Mission, & Values

SD1: Burning Plasma

SD2: Handle Reactor Conditions

SD3: Harness Fusion Power

Objective
- Recs.

Objective
- Recs.

Program Rec
- Recs.

Program Rec
- Recs.

Cross-Cutting Opportunities

Theory & Computation
- Recommendations

Measurement & Diagnostics
- Recommendations

Enabling Technology
- Recommendations

Workforce, Diversity, Inclusion
- Recommendations

A Brief Look at the DPS Chapter

Structure of the DPS chapter

DPS-Wide Programmatic Recommendations

- Build
- Support
- Collaborate

DPS1: Explore the Frontiers of Plasma Science

- Specific programmatic recommendation(s)
- Science Objectives
  - Recommendations (topical)

DPS2: Understand the Plasma Universe

- Specific programmatic recommendation(s)
- Science Objectives
  - Recommendations (topical)

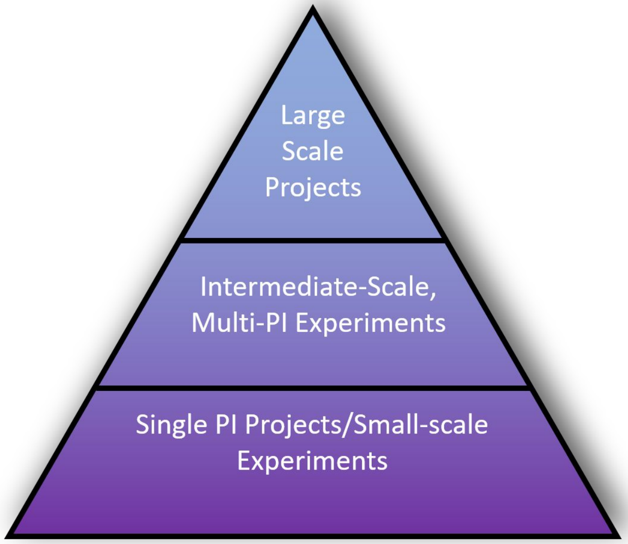
DPS3: Create Transformative Technologies

- Specific programmatic recommendation(s)
- Science Objectives
  - Recommendations (topical)

		DPS1					DPS2			DPS3			
		DPS-A	DPS-B	DPS-C	DPS-D	DPS-E	DPS-F	DPS-G	DPS-H	DPS-I	DPS-J	DPS-K	DPS-L
Build	Invest in an intermediate scale general plasma science facility						x						
Build	Invest in a multi-PW facility that can access intensities beyond the current state of the art	x	x			x			x				x
Build	Invest in facilities over a broad range of scales	x	x	x	x	x	x	x	x	x	x	x	x
Build	Improve and upgrade national HED infrastructure at multiple scales particularly at LaserNetUS facilities	x	x		x	x	x	x	x				x
Build	Couple long pulse multi-kJ and multi-PW lasers with an XFEL, which can be done at the Matter in Extreme Conditions instrument	x			x	x			x				x
Build	Provide upgrades for GPS facilities to leverage current FES investments in frontier-level science.						x	x		x	x	x	
Build	Co-locate plasma devices at established facilities to leverage community expertise across the plasma science community	x	x		x		x	x	x				x
Support	Support steady funding of plasma science	x	x	x	x	x	x	x	x	x	x	x	x
Support	Support fundamental data needs	x	x	x	x	x	x	x	x	x	x	x	x
Support	Support science centers	x					x	x	x				
Collaborate	Further investment in target fabrication capabilities, and in theory and computation support for LaserNetUS experiments	x	x		x	x	x	x	x				x
Collaborate	Establish ZNetUS to coordinate and increase access to pulsed power facilities and necessary computational tools		x	x			x	x	x				
Collaborate	Establish MagNetUSA for a wide range of experimental researchers and for increasing accessibility to DOE supported facilities		x				x	x					
Collaborate	Support collaborative research networks in low-temperature plasma science									x	x	x	
Collaborate	Establish a network program to build new hardware capabilities and support the acquisition of diagnostics to be shared between facilities						x	x	x	x	x	x	
Collaborate	Establish a network program to develop of an open-source, programming ecosystem for plasma physics and advance computational plasma science	x	x	x	x	x	x	x	x	x	x	x	x
Collaborate	Expand partnerships	x	x	x	x	x	x	x	x	x	x	x	x

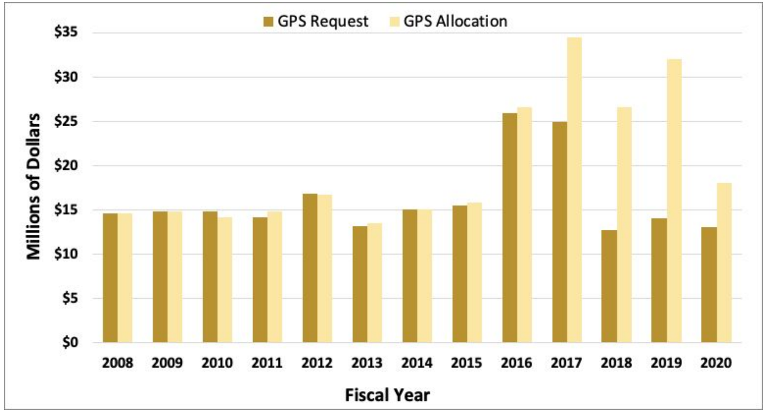
Build

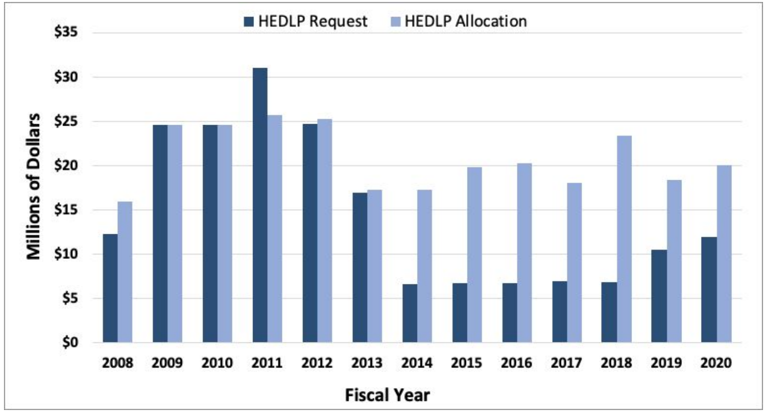
- Invest in new facilities
    - GPS facility to investigate the solar wind in the lab
    - Multi-PW laser, increased repetition rate
    - Broad range of scales
- Upgrade current facilities
    - Upgrade LaserNetUS facilities
    - Couple long pulse multi-kJ and multi-PW lasers with an XFEL
    - Upgrade current GPS facilities
- Co-locate facilities
    - Sources with diagnostics
    - Facilities to create unique states of plasma
        - Ex: Multi-PW laser and dense multi-GeV electron beam to investigate quantum plasmas



Support

- Steady funding of plasma science
  - Stabilize year-to-year variability
  - Reverse the flat/downward trend in funding
- Fundamental data needs
  - Cross sections, AMO data
  - Open access databases
- Create Science Centers
  - To address time-critical science problems
  - Flexible, frequent, allow junior faculty to join

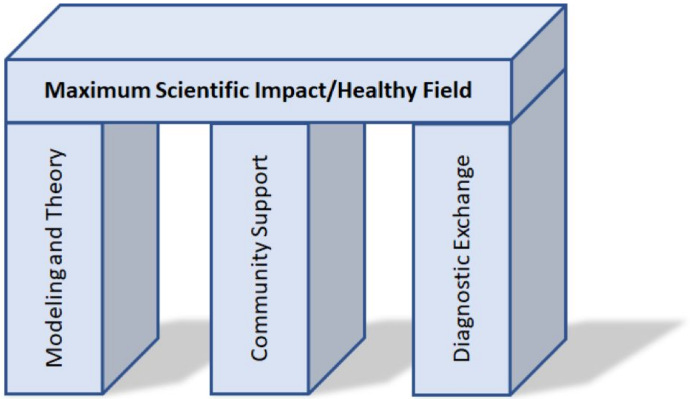




Collaborate

- Expand Networks
  - Expand support for LaserNetUS
  - Establish ZNetUS
  - Establish MagNetUSA
  - Continue support for LTP collaborative research centers
  - Establish a diagnostic support network
  - Establish a network to foster an open source programming ecosystem

- Expand Partnerships
  - Support existing partnerships: FES/NSF, FES/NNSA
  - Establish new partnerships: FES/NASA, FES/NIH, FES/BES, FES/USDA, etc



A Deeper Dive into the FST Chapter

The FST Chapter Outlines a Blue Sky Plan that is Comprised of Strategic Objectives and Program Recommendations

- FST Program Recommendations (PRs) connect the Science Drivers
    - The recommendations span the Strategic Objectives
    - **These are not intended to be the most important recommendations**

- Strategic Objectives (SOs) lie within the individual Science Drivers (with some overlap)
    - Consist of specific, time-phased activities that accomplish the stated goal and provide the information needed to resolve key decisions points

*This plan has a strong emphasis on **near term recommendations** as it is anticipated that a planning exercise should be performed every 5-7 years (as polled at Knoxville).*

Fusion Science and Technology Plan is Advanced Through Science Drivers

Science Drivers

Control, sustain, and predict burning plasma

(SO-D) Tokamak physics basis
(SO-E) Stellarator physics basis
(SO-F) Magnet and H&CD science & technology
(SO-H) Alternative confinement approaches

Handle reactor relevant conditions

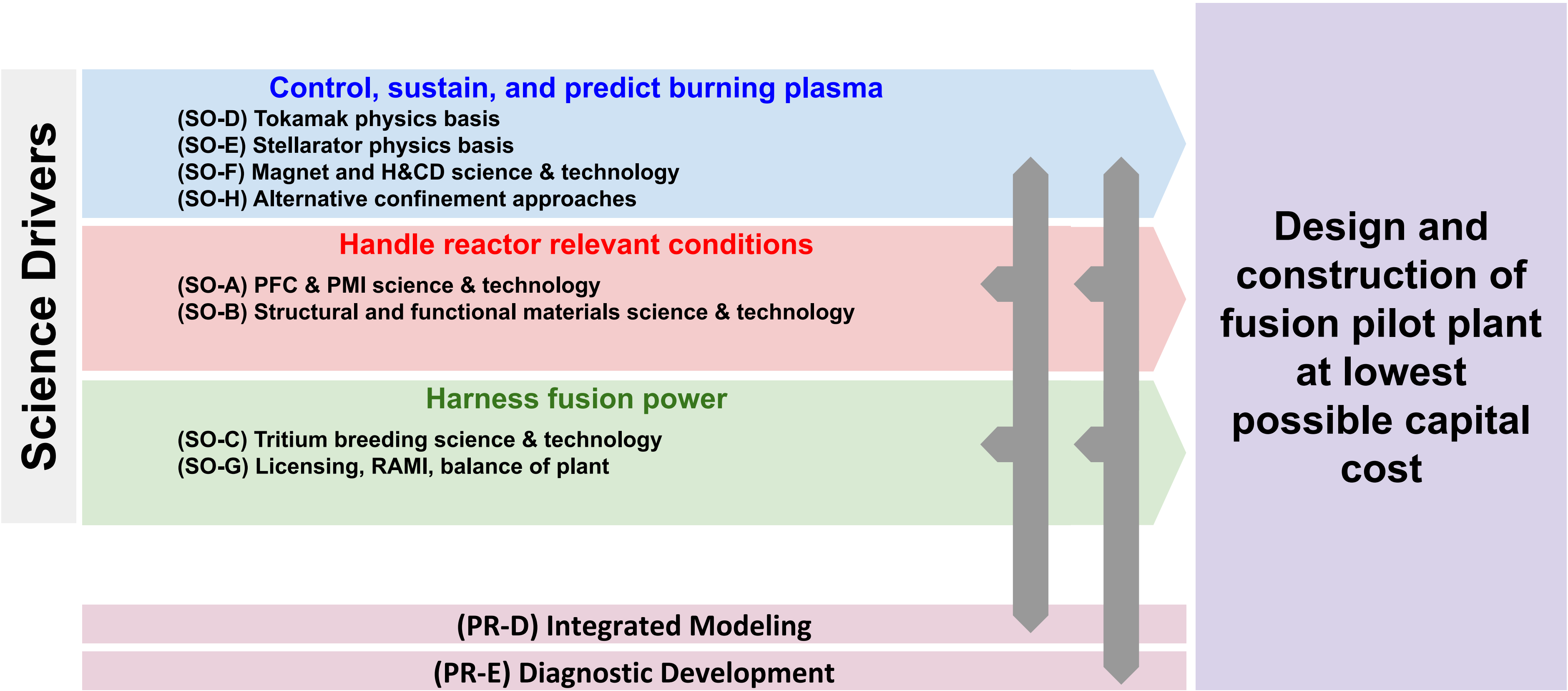
(SO-A) PFC & PMI science & technology
(SO-B) Structural and functional materials science & technology

Harness fusion power

(SO-C) Tritium breeding science & technology
(SO-G) Licensing, RAMI, balance of plant

Design and construction of fusion pilot plant at lowest possible capital cost

Predictive Integrated Modeling, Diagnostic Needs are Critical Across All Areas



All Areas are Interdependent and Must be Integrated in the Design of a Fusion Pilot Plant

(PR-A) Interdisciplinary FPP design studies

Science Drivers

Control, sustain, and predict burning plasma

(SO-D) Tokamak physics basis
(SO-E) Stellarator physics basis
(SO-F) Magnet and H&CD science & technology
(SO-H) Alternative confinement approaches

Handle reactor relevant conditions

(SO-A) PFC & PMI science & technology
(SO-B) Structural and functional materials science & technology

Harness fusion power

(SO-C) Tritium breeding science & technology
(SO-G) Licensing, RAMI, balance of plant

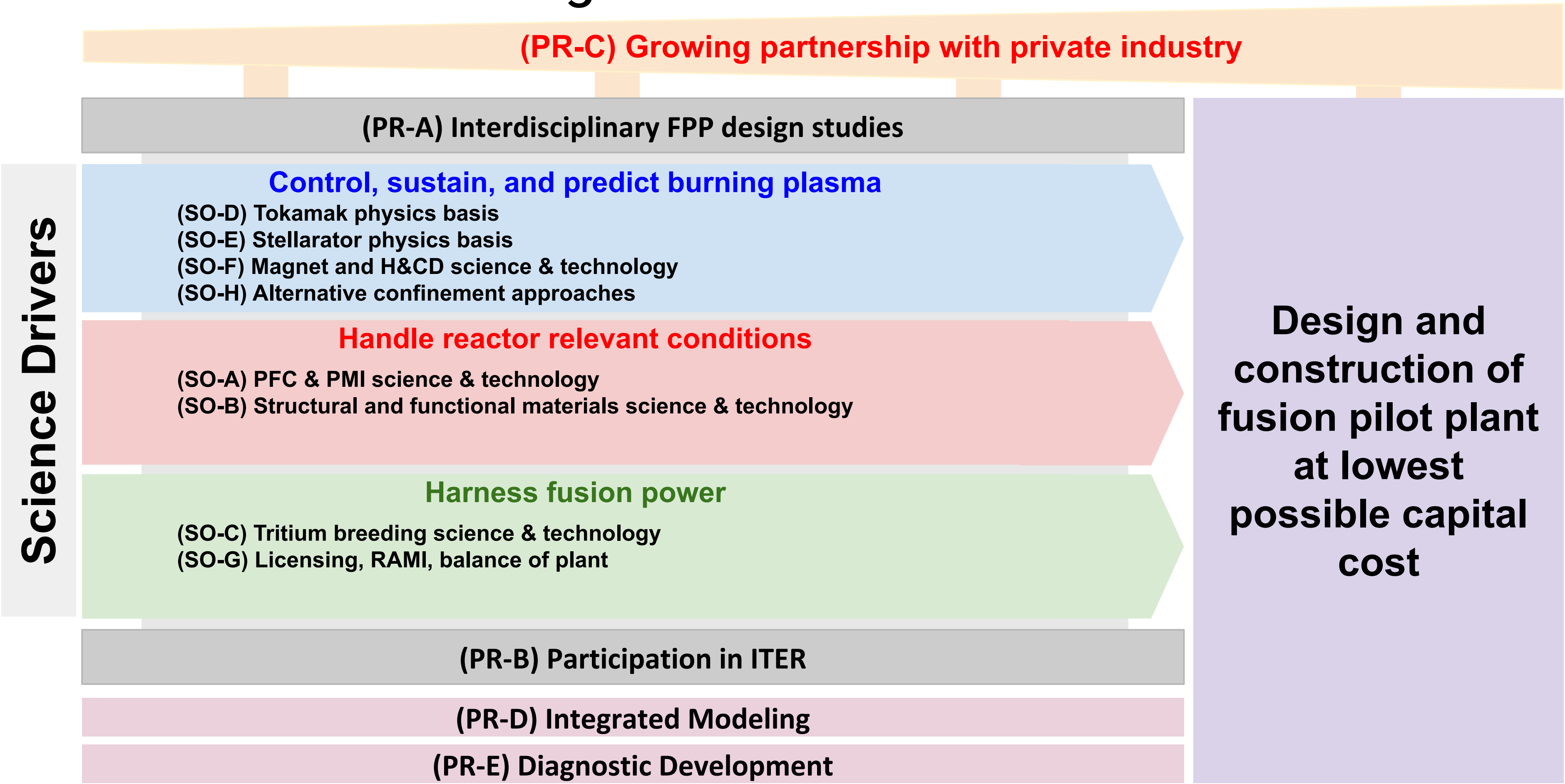
(PR-B) Participation in ITER

(PR-D) Integrated Modeling

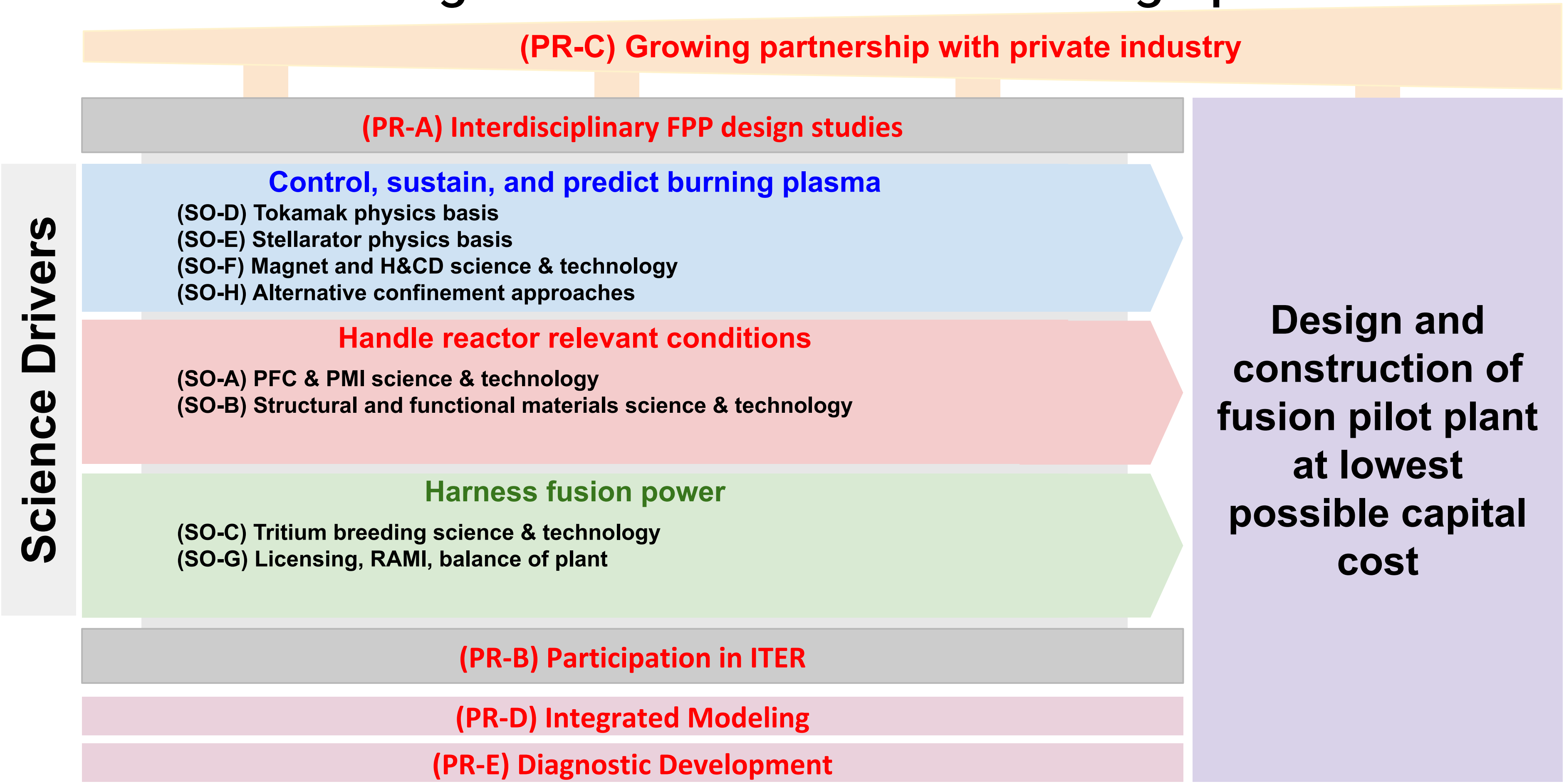
(PR-E) Diagnostic Development

Design and construction of fusion pilot plant at lowest possible capital cost

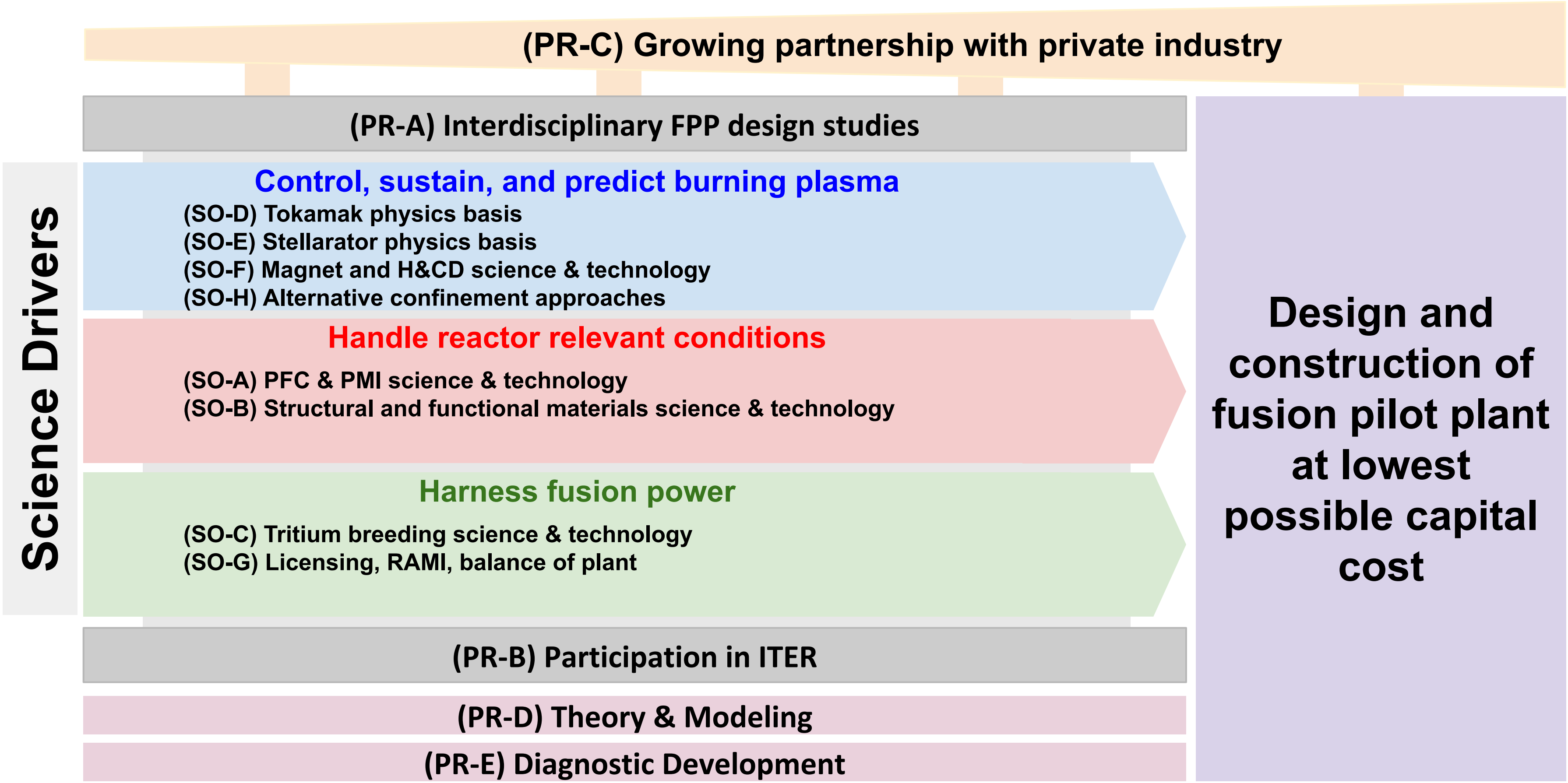
Partnership with Private Industry is a Key Element in Moving Towards Commercialization



“FST Program Recommendations” (FST-PR-A, …) span all SOs and exist throughout the execution of the strategic plan



The Path to the FPP Is Enabled by the Execution of the Strategic Objectives (SO) and Program Recommendations (PR)



Overview of the Strategic Objectives and Program Recommendations

FST SO-A: *Demonstrate solutions for managing high heat and particle loads sufficient to design plasma-facing components for the fusion pilot plant*

- Improve our understanding of plasma material interactions in **solid materials** at FPP relevant conditions and ***demonstrate new actively cooled solid-material PFC solutions***
- Improve the readiness of **liquid metal** plasma facing materials and test slow-flow and/or fast-flow PFC concepts on confinement facilities
- In coordination with FST-PR-A (FPP design activity), advance the integration of full-physics and reduced material **models** and edge/divertor plasma models to permit validated prediction of PFC performance under FPP conditions
- Develop and deploy **in-situ and ex-situ materials characterization tools** in both off-line test stands and plasma simulators as well as in confinement experiments to permit more rapid evaluation of PFC system performance and behaviors

FST SO-B: *Determine the structural and functional materials that will survive under fusion reactor conditions (1 Major New Facility)*

- **Expand program to develop structural and functional materials** that will survive in a fusion reactor
- Design, construct and operate a **Fusion Prototypic Neutron Source (FPNS)**
- Carry out in-pile **Fission irradiation testing**
- Develop **high temperature nuclear structural design criteria**
- Strategy for **cryogenic neutron irradiation** experiment for magnet materials
- **Integrate fusion pilot plant design** with materials and remote maintenance

*** Red denotes proposed major new facilities**

FST SO-C: *Develop the science and technology necessary to breed, extract, and safely manage large quantities of tritium (2 Major New Facilities)*

- Initiate small scale test stands for functional breeder materials to advance blanket designs
- Test compatibility between breeder and structural materials
- Construct bench scale experiments for tritium extraction and transport
- Develop models and multi-physics simulations capability for blanket design
- Design, construct and operate a **Blanket Component Test Facility (BCTF)** (non-nuclear)
- Identify strategy for **volumetric neutron source (VNS)** for component scale irradiations
- Bench-scale tests of plasma exhaust pumping and handling (DIR)
- Advance pellet injection technology, fueling and disruption mitigation
- Support other innovation in tritium processing to reduce cost, size and tritium inventory
- Innovate tritium measurements
- Tritium permeation barriers and capture technologies
- Develop a plan for to provide start-up tritium inventory

FST SO-D: *Advance the tokamak physics basis sufficiently to design a low-cost fusion pilot plant (1 Major New Facility)*

- Leverage all opportunities to access, prepare for, and study burning plasma physics for validated extrapolations to FPP

- Establish the capability to test tokamak divertor solutions at conditions typical of an FPP that can also be integrated with FPP operating scenarios by designing and constructing a **New Tokamak User Facility (NTUF)** with community defined capabilities and justification (See Appendix B)

    - Flexible divertor solutions, including long legged concepts
    - Ability to demonstrate integration of high performance core with edge solution

- Develop the scientific basis for candidate scenarios that project to high average power on the FPP, utilizing domestic and foreign facilities, transitioning to NTUF and ITER

- Advance multiple methods for disruption handling, inform FPP decision making

- Test tokamak-specific integration of new PFC materials to reduce extrapolation uncertainties

FST SO-E: *Advance the stellarator physics basis sufficiently to design a low-cost fusion pilot plant (1 (or more) Major New Facility)*

- Expand and sustain an integration, design, and optimization effort to identify candidate stellarator configurations that scale to an FPP

- Design, construct and operate one or more stellarators to validate optimization projections, demonstrate performance that projects to a FPP

- Validate core physics and investigate steady-state divertor and plasma exhaust solutions in long-pulse, high-performance optimized stellarators

FST SO-F: *Innovate the magnet, heating, and current drive technology needed to reduce the pilot plant capital cost (1 Major New Facility)*

- Establish the experimental capabilities required to develop and test high field magnets and cables, coordinating with industry and other DOE/SC offices
- Integrate achievable magnet technologies into the FPP Multiphysics design tools
- Continue to develop and test high current, high field cable technologies in FPP conceptual design phase
- Establish new **RF test facility** to develop and test RF launcher concepts
- Establish new RF source R&D center to develop the RF technology needed for a FPP
- Support the development of reactor-relevant H/CD scenarios through experiments and support model development and validation on both current and future devices

FST SO-G: *Develop the balance of plant technology, remote handling and maintenance approach, and licensing framework necessary to ensure safe and reliable operation of the fusion pilot plant*

- Start a working group to develop a licensing framework for fusion
- Establish a technical basis for fusion reactor safety and licensing
- Develop new and specialized sensors and diagnostics for in and ex-vessel survey
- Establish strategies for remote calibration, alignment, maintenance, and replacement of components
- Carry out conceptual design and small-scale tests of BOP equipment

FST SO-H: *Develop alternative approaches to fusion that could lead to a lower cost fusion pilot plant, utilizing partnerships with private industry and interagency collaboration*

- Establish a program that can pursue requirements for **Inertial Fusion Energy (IFE)**
- Advance technologies relating to the driver, target fabrication, diagnostics and modeling that could make IFE an attractive source of clean energy
- Establish a staged, three-tier program to develop promising **alternative magnetic fusion energy configurations**
- Leverage private industry and interagency investments (DOE ARPA-E) in alternative fusion approaches through collaborations in theory, modeling, measurement capabilities, and technology transfer

FST PR-A: *Establish a multi-institutional, interdisciplinary program to develop fusion pilot plant concepts.*

- Initiate and sustain a **multi-institutional, FPP design program** that brings together experts from across the **public fusion program with industry**
- Expand the integration of predictive plasma modeling and material modeling capabilities with industry-standard engineering tools to incorporate costing and innovation
- Establish and engage appropriate expertise in **techno-economic analysis** of potential FPP concepts
- Conduct **FPP mission scoping engaging with public and private stakeholders** to identify an optimal set of deliverables for the fusion pilot plant

FST PR-B: *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.*

- Fulfill commitments to ITER construction and operation
- Prepare US workforce to participate fully in ITER operations
- Utilize existing facilities and funding models to support ITER readiness through start of Pre-Fusion Power Operations (PFPO)
- Leverage ITER involvement to inform decisions for FPP
    - Scenario development
    - Tritium handling, safety
    - Diagnostics in nuclear environments

FST PR-C: *Deploy various models of public-private partnerships to develop technology at a lower cost and move towards fusion commercialization*

- Develop, utilize and expand programs for private-public partnerships that leverage lessons learned from DOE and other areas of the federal government
    - Expand INFUSE, coordinate with ARPA-E, Establish possible NASA COTS-like (cost sharing) models
- Dialogue should be fostered between government researchers and experts in the private sector, the private sector should be recognized as a stakeholder for developing goals for FES programs

FST PR-D: *Develop and utilize a hierarchy of validated models for predictive integrated modeling, by continuing the partnership between FES and ASCR, expanding capacity computing infrastructure, and utilizing advances in computational architecture and capability.*

- Support advancing fundamental scientific understanding through theory and computational exploration
- Develop hierarchies of validated models suitable for timely design and optimization of future devices
- Develop physically rigorous and computationally robust model integration methods for whole-facility modeling of a FPP
- Invest in computational infrastructure and software engineering need to enable optimal use of high performance computing
- Support expanded verification, validation and uncertainty quantification activities

FST PR-E: *Establish a program for developing diagnostics, measurement, and control techniques that can be used in a reactor environment.*

- Develop critical in-situ and combined effect diagnostics for fusion materials research and plasma science needed to validate models
- Initiate the R&D needed to solve diagnostic survivability challenges imposed by nuclear conditions in a FPP
- Develop nuclear environment compatible plasma diagnostics and engineering instrumentation needed for control and safe operation of a FPP, and benchmark these on available facilities
- Develop advanced control techniques to maintain high performance burning plasmas without disruptions or other major excursions

Main Findings and Recommendations: FST

The FST Community Embraces a Mission-Driven Program

Vision Statement

Our vision is for fusion energy to be a major source of safe, economical, and environmentally sustainable energy in time to address critical energy and security needs of the U.S. and the world.

Mission Statement

Establish the basis for the commercialization of fusion energy in the U.S. by developing the innovative science and technology needed to accelerate the construction of a fusion pilot plant at low capital cost.

- Echoes key recommendation of National Academies report
- Will benefit from FES partnering with private industry and other offices
- Recognition in the community that progressive diverting resources from existing facilities may be necessary to start new facilities.
- The resources and research programs of existing facilities should immediately evolve to reflect the priorities of the CPP plan.

Fusion Pilot Plant (FPP)

- Goal is to demonstrate technical feasibility while also projecting to commercial viability
- Three deliverables were considered to define an FPP
  - Produce net electricity from fusion
  - Establish the capability of high average power output
  - Demonstrate the safe production and handling of the tritium, as well as the feasibility of a closed fuel cycle
- Tokamak is the leading concept. However, optimized stellarators, inertial fusion, and other alternate concepts could ultimately lead to an attractive FPP.

Burning Plasmas

- ITER is currently the best opportunity to participate in burning plasma experiment at the scale of a reactor. The U.S. should remain a full participant.
- Existing facilities (DIII-D, NSTX-U, international collaborations), and theory and modeling, are important to help us prepare for and extrapolate to burning physics regimes.
- Private ventures may also provide opportunities to access burning plasmas. We should support these endeavors and leverage these opportunities.
- A new tokamak facility (NTUF) is needed that is capable of handling power exhaust at conditions typical of an FPP while simultaneously demonstrating the necessary plasma performance.
    - Conceptual design should be started immediately and operations should begin in 2020s

Fusion Materials

- Need to rapidly expand research in fusion materials and technology
  - Required for nearly any plausible pilot plant design, and likely set the timescale on which any FPP could be successful
- Immediately begin design and construction of a Fusion Prototypic Neutron Source (FPNS)
  - Generate world-leading data on the degradation of materials when exposed to neutrons from fusion
- Expand program for the development of structural and functional materials for fusion
- Targeted investments should be made in fusion blanket and plasma facing component (PFC) programs

Embrace Innovation

- Research should focus on developing solutions to well-known challenges in fusion energy development by emphasizing exploration and utilization of new, potentially transformative science and technologies.
  - There are many examples in the report of areas where a relatively small investment could yield significant or transformational progress.
- There should be multi-institutional, multi-disciplinary FPP design studies. This will help identify cost drivers and inform research priorities accordingly.
  - We need additional innovation to achieve a commercially viable design. Program needs to be flexible and shouldn't lock in a design at this point.
- Program must closely partner with private industry to drive innovative technologies for a commercially competitive product.

How We Did Prioritization

- Discussion of prioritization began during the CPP Knoxville workshop and at CPP-Houston the attendees applied Prioritization Assessment Criteria (PACs) to the FST program.
- PACs, were derived from the 2017 Austin workshop values, discussed at CPP Knoxville, finalized by the MFE+FM&T PC, presented and discussed at CPP Houston, and ranked in their importance by the Houston attendees

1. ***Importance to FPP Mission***
2. ***Urgency***
3. ***Impact of Investment***
4. ***Using Innovation to Lower Cost***
5. ***U.S. Leadership and Uniqueness***

See Appendix A for the definition of PACs presented at Houston and results of this prioritization

Appendix A Describes the Application of the PACs to the FST Program

Table A1. Houston Attendee Polling of FST Program Elements by Prioritization Assessment Criteria (PACs)

A	B	C	D	E	F	G	H
		Mission	Urgency	Impact of Invest	Innovation	US Leadership	Ave. of Col C-G
Fusion Prototypic Neutron Source	FST-SO-B.2						
Blankets Sci & Tech Program	FST-SO-C.1,2,4						
Tokamak Disruptions Program	FST-SO-D.4						
Burning Plasmas	FST-SO-D.1						
Materials Development Program	FST-SO-B.1,3,4,5						
Magnets	FST-SO-F.1,2,3						
New Tokamak User Facility (NTUF)	FST-SO-D.2						
PFC Material Integration Program	FST-SO-D.5						
Solid PFC Program	FST-SO-A.1,3,4						
Tritium Fueling & Exhaust Program	FST-SO-C.3,7,10,11,12						
Tokamak Scenarios Program	FST-SO-D.3						
PPP and Intragency MFE Alternates	FST-SO-H.4						
Liquid PFC Program	FST-SO-A.2,3,4						
QS stellarator	FST-SO-E.2						
QS Stell Opt +international collab	FST-SO-E.1,3						
Blanket Component Test Facility	FST-SO-C.5						
ITER Team	FST-PR-B.2,3						
Three Tier MFE Alternatives Program	FST-SO-H.3						
RF Test Stand + Scenarios	FST-SO-F.4,5,6						
Volumetric Neutron Source	FST-SO-C.6						
RAMI and Balance of Plant	FST-SO-G.3,4,5						
Licensing	FST-SO-G.1,2						
Inertial Fusion Energy (IFE)	FST-SO-H.1.2	Polling Data Not Presented Due to Parallel Development of IFE in HEDP Topical Area (See Main Text)					
Max Value		**4.73**	**4.57**	**4.46**	**4.39**	**4.40**	**4.35**
Min Value		**2.81**	**2.82**	**2.94**	**2.25**	**2.52**	**2.94**

Provide a measure of the communities priorities/views for the FESAC subcommittee to use in constrained budget scenarios

The results from this analysis were qualitatively consistent with discussion and polling from the Knoxville workshop

FST/DPS Prioritization Was Not Attempted By the CPP

- Although the CPP made a lot of progress, there is still a lot of work to be done.
- Although prioritization information was collected in FST and some prioritization occurred in DPS, no cross-FES prioritization was attempted
- ***Overall program balance remains a major issue that was not addressed during the CPP process***
    - The FESAC subcommittee is currently trying to tackle this problem

Summary

- There is community consensus to pursue *all* recommendations in the report in the long-range strategic plan, in a blue-sky scenario
    - No attempt was made at constrained budgets ; prioritization information was collected
- FST: focus on science and technology that leads to the construction of a Fusion Pilot Plant
- DPS: realize the potential of plasma science to deepen our understanding of nature and provide the scientific underpinning for plasma-based technologies that benefit society
- Report contains many recommendations that can be enacted in the near term, by FES and with partners, and focuses on activities within a 10 year horizon
- Community planning should be repeated every 5–7 years to adjust plan as necessary and to maintain community involvement.

Final Remarks

- More information including the slides presented to FESAC are on he APS-DPP-CPP website here: https://sites.google.com/pppl.gov/dpp-cpp
- The full CPP Report is on the front page of the website
- The plan is long (199 pages).
- While you should read the entire plan, if you want a good sense of the outcomes in FST, consider reading the Executive Summary (4 pages proceeded in the numbered pages) and the FST Intro (pgs 44-46)
- Please also consider endorsing the final CPP report from the main webpage
    - Approximately 500 signatures already collected

Thanks For Your Attention

Backup