MISSION AND NEED FOR A FUSION NUCLEAR SCIENCE FACILITY

Mission *Gerald Navratil*
Need *Mohamed Abdou*
The Spherical Torus Option *Y-K Martin Peng*
The Advanced Tokamak Option *Ron Stambaugh*
Magnetic Fusion Pilot Plant Studies *Jon Menard*
The Stellarator Option *Mike Zarnstorff*

Fusion Power Associates
31st Annual Meeting and Symposium
1-2 December 2010

FUSION NUCLEAR SCIENCE FACILITY:

COMMENTS ON MISSION

Gerald A. Navratil
Columbia University

Fusion Power Associates
31st Annual Meeting and Symposium
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FNSF: SOME HISTORICAL CONTEXT

Recall FPA Annual Meeting of 2000:

MFE: US out of ITER by Congressional Directive

ICF: NIF re-baselining and design reviews underway

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Community/DOE Response in MFE:

UFA Burning Plasma Workshops 2000 set stage
DOE sponsors Snowmass 2002 Meeting on Burning Plasmas
FESAC Austin Meeting used Snowmass 2002 input for ITER plan
NAS Review of MFE Plan for Burning Plasma Step
2003 Presidential Announcement of US Joining ITER Effort

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Here we are 10 years later:

ICF/IFE: NIF complete and on verge of first ignition experiments
MFE: ITER construction has started in the EU

The critical physics experiments on burning plasmas are being addressed for both MFE and ICF/IFE…

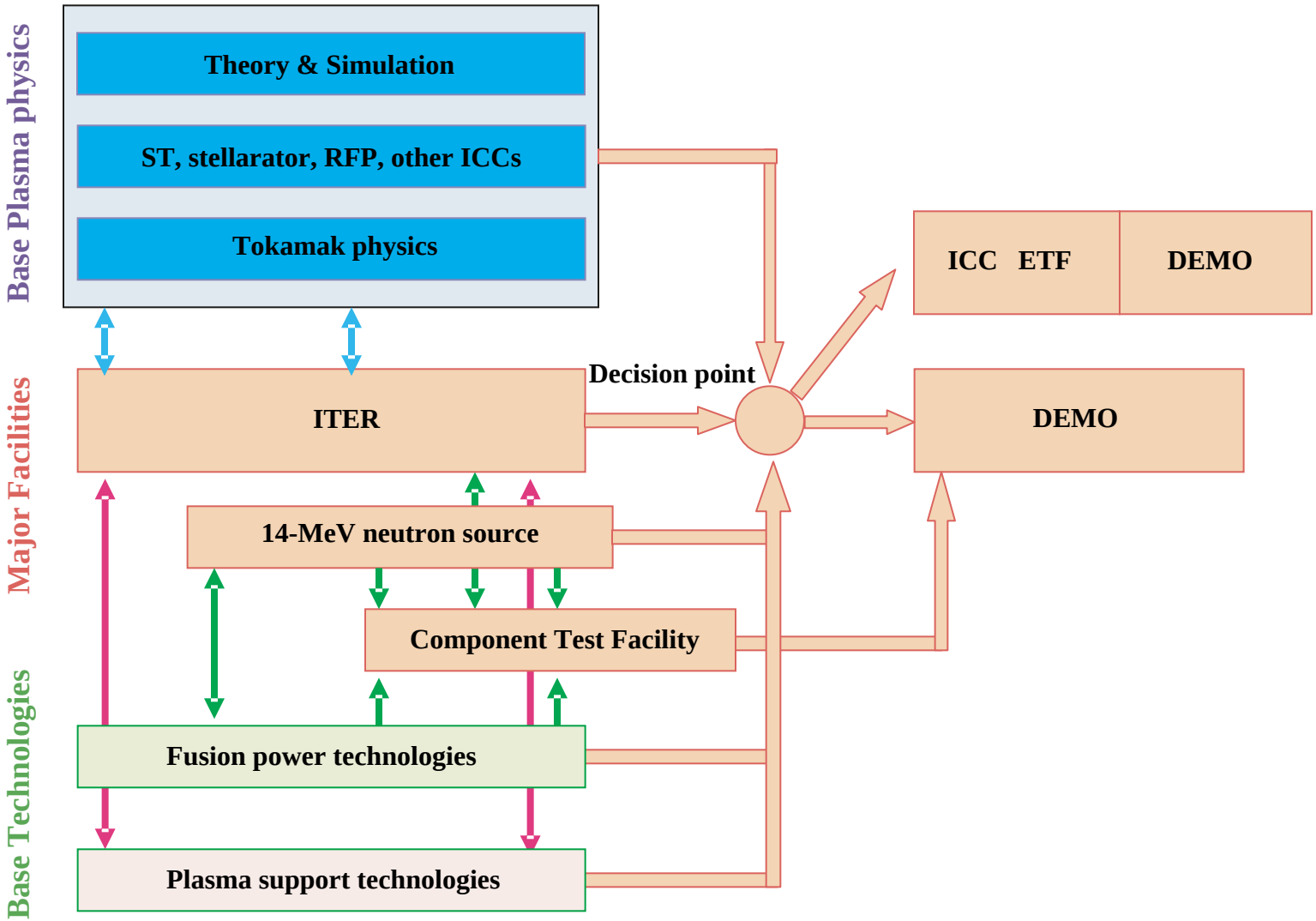
FNSF: Some Historical Context

It was well recognized at Snowmass 2002 that while the study of burning plasma physics was a critical step in fusion energy development for both MFE and IFE…

- **There were also critical materials and technology issues that needed to be addressed in order to apply the knowledge we gained about burning plasma state**

To answer these questions at that time IFE looked towards establishing an IRE and MFE envisioned a future CTF step and on the critical path to a practical energy source.

FESAC/Snowmass Report: ITER-Based Development Path



FUSION NUCLEAR SCIENCE PROGRAM

For MFE the FESAC Greenwald Report in 2007 identified and quantified the “gaps” in our program to develop a practical MFE power system assuming success with ITER

This was further refined in the ReNeW report of 2009 where mission elements for a ‘Fusion Nuclear Science Facility’ were proposed

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WE ARE STILL QUITE EARLY IN DEFINING THE TECHNICAL APPROACH AND MISSION OF THIS FACILITY AND THE PROGRAM THAT IT WILL BE A PART OF…

FNSF STEERING GROUP LOOKED AT MISSION – WILL SUMMARIZE HERE

DOE HAS RECENTLY LAUNCHED A FUSION NUCLEAR SCIENCE PATHWAYS ACTIVITY

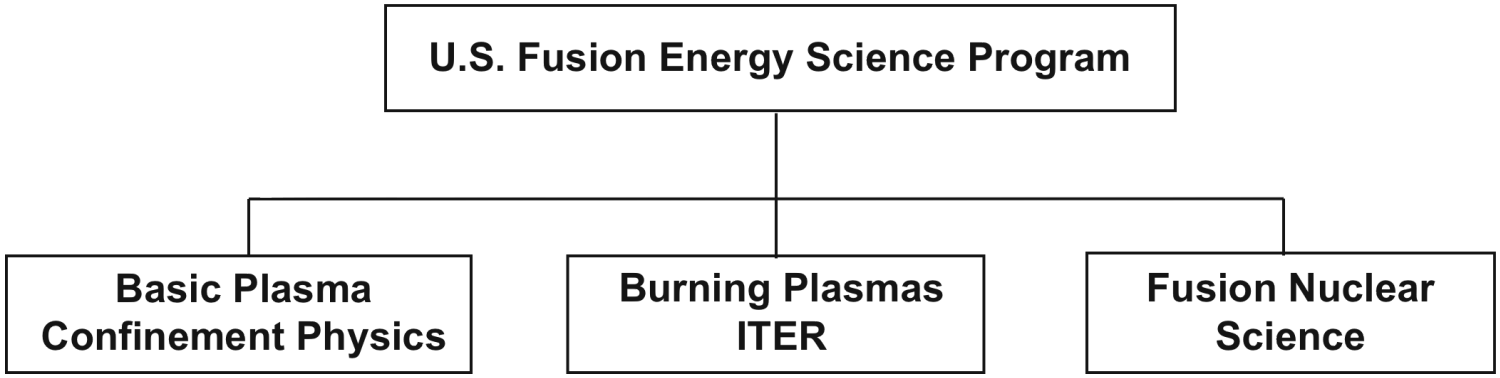
PPPL PLANNING 2011 WORKSHOP ON FUSION DEVELOPMENT PATHS

FNSF STEERING GROUP MEMBERSHIP

Gerald Navratil (Chair, Columbia University)
Martin Peng (Deputy Chair, Oak Ridge National Laboratory)
Ron Stambaugh (Deputy Chair, General Atomics)
Mohamed Abdou (University of California – Los Angeles)
Vincent Chan (General Atomics)
Ray Fonck (University of Wisconsin)
Dave Hill (Lawrence Livermore National Laboratory)
Rick Kurtz (Pacific Northwest National Laboratory)
Dale Meade (Fusion Innovation Research and Energy)
Jon Menard (Princeton Plasma Physics Laboratory)
Stan Milora (Oak Ridge National Laboratory)
Richard Nygren (Sandia National Laboratory)
Ron Parker (Massachusetts Institute of Technology)
Miklos Porkolab (Massachusetts Institute of Technology)
Stewart Prager (Princeton Plasma Physics Laboratory)
James Rushton (Oak Ridge National Laboratory)
Ned Sauthoff (Oak Ridge National Laboratory)
George Tynan (University of California – San Diego)
James Van Dam (University of Texas – Austin)
Scott Willms (Los Alamos National Laboratory)

FUSION NUCLEAR SCIENCE PROGRAM

– A WHITE PAPER –



Historically the core of the program has been the basic plasma confinement physics research…focused on understanding the high-temperature plasma properties in the hot central core region of the magnetically confined plasmas.

Progress in understanding the basic plasma confinement physics of the tokamak configuration has been great enough … to move to the frontier of burning plasma physics, as embodied in the ITER Project…(that) … is now the centerpiece of the U.S Fusion Program.

The U.S. and world fusion program now has in place strong Basic Plasma Confinement Physics and Burning Plasma Physics program elements. However, the U.S. has allocated relatively few resources in the past decade to the third major area of effort – Fusion Nuclear Science. **In order for the U.S. to be positioned to take advantage of success in ITER, support for Fusion Nuclear Science should be dramatically increased in the coming decade.**

FUSION NUCLEAR SCIENCE PROGRAM

– A WHITE PAPER –

DEVELOPING A STRATEGY FOR THE US FUSION PROGRAM

The **US has an opportunity to maintain world leadership by aggressively pursuing a Fusion Nuclear Science Program** that would focus on … the science challenges of plasma-wall interactions, materials, and harnessing fusion energy. Solving these problems will require fundamental advances in several important sub-fields of science that include: plasma, atomic, and molecular physics; material sciences; neutron sciences; fluid-flow and heat-transfer; and associated engineering challenges.

When ignition is demonstrated in NIF, there naturally will be increased interest in the IFE approach to fusion as an energy source…and many of the materials and nuclear science **issues to be addressed in the FNSP are common to both MFE and IFE** and the FNSP supply critical nuclear science advances for both approaches.

Executing this program and eventually deploying a FNSF, would vault the U.S. program into leadership of critical areas of the overall fusion challenge. This **transition can be executed over the next decade or so, concurrent with the construction and initial operation of ITER.**

The research activities on **ITER and this FNSP would define the centers of gravity of fusion science and engineering development,** and will expedite the decision on proceeding to the development of a demonstration fusion power plant.

FUSION NUCLEAR SCIENCE PROGRAM

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ELEMENTS OF THE FUSION NUCLEAR SCIENCE PROGRAM

A spectrum of mission elements is required for a successful Fusion Nuclear Science Program. At a minimum, these top-level objectives must include:

Overall Goal

Show that fusion can make energy and its own fuel in a practical system.

Objectives

- Produce and extract significant fusion power (hundreds of MW) for long operating times
- Demonstrate fusion fuel self-sufficiency
- Show fusion can produce high-grade process heat that can generate electricity and/or hydrogen.
- Develop, characterize, and qualify radiation resistant materials and the blankets and plasma-facing components that will utilize them
- Enable plasma science research on high performance, steady-state, burning plasmas in preparation for a demonstration fusion power plant (DEMO).
- Obtain first data on integrated fusion system operation, fuel management, reliability, availability, and maintainability to guide future fusion energy development.