U.S. Department of Energy's

Office of Science

Fusion Energy Sciences Program Update

Fusion Energy Sciences Advisory Committee

Office of Fusion Energy Sciences

Excellent Science Attractive Energy

www.ofes.fusion.doe.gov

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July 26, 2004

Topics

- Budget
- ITER
- Solicitations
- Reports/Reviews
- Goals/Metrics/Milestones/Targets

Status of OFES FY 2005 Budget

- Congressional Request $264.1 M
- House Mark $276.1 M
  - Increase use of small and large experiments
  - Further work on inertial fusion energy technology
  - Take advantage of opportunities in HEDP
  - Take advantage of opportunities in large-scale computing
  - Provide cost-effective construction of compact stellarators
  - Reduce ITER due to delay in site selection
- Awaiting Senate action
- Long-term continuing resolution or omnibus is possible

Distribution of FY 2004 Funds from GA Tax Refund and Prior Contract Adjustment

- A total of $2,554,000 became available this year from GA tax refund and close-out of a prior contract
- These funds were distributed in FY 2004 as follows:
  - $1,050 K to GA to initiate planned hardware modification projects (such as beam redirection and divertor modification) and reduce potential manpower impacts in FY 2005
  - $1,060 K to PPPL to extend NSTX operations by 2 weeks and to implement planned FY 2005 hardware modifications (reducing FY 2005 manpower impacts)
  - $150 K for the NSF Partnership on Plasma Science
  - $111 K to ORNL for computer simulation work and for ITPA Topical Group Chair activities
  - $183 K to resolve funding issues at INEEL, U. of Wisconsin, and the U. of Rochester

Training for FWPs Submitted via ePME*

- ePME is a DOE-wide electronic system that allows for beginning-to-end R&D program management across the Department.
- Provides for on-line submittal, review, and award; and portfolio tracking and reporting.
- Deploys September 30.
- Allows receipt of FY05 funding proposals out-of-cycle and FY07 budget proposals (CFO Field Budget Call) in February 2005.
- 2-hour on-line training class will be available for end users in Nov/Dec.

*e-Portfolio Management Environment

Site Selection Negotiations Continue

Rokkasho, Japan (northern Japan)

Cadarache, France, EU (southern France)

- **On June 18th, 2004, the Third Preparatory (Negotiations) Meeting for ITER Decision Making was held at Ray Orbach's level. All six ITER Parties were present.**

Common Message from 3rd Preparatory Meeting for ITER Decision Making

(IAEA Vienna, 18th June 2004)

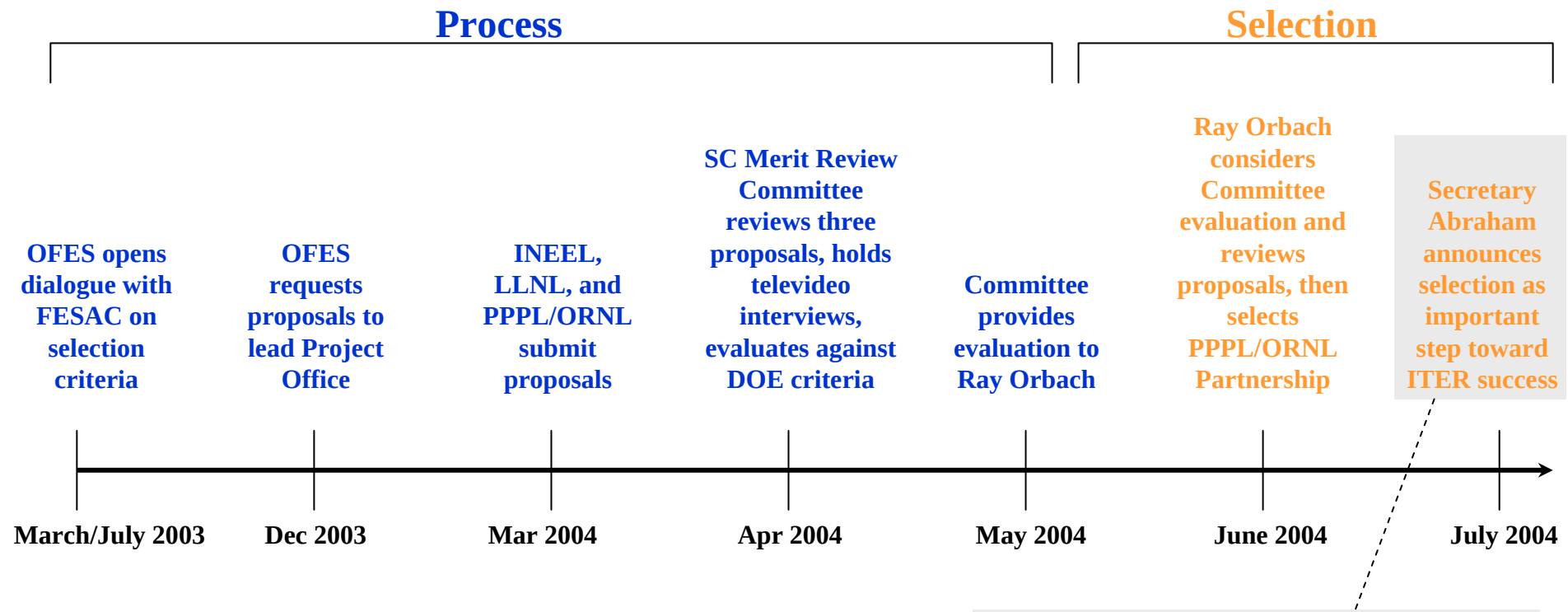
Delegations from China, European Union, Japan, the Republic of Korea, the Russian Federation, and the United States met at the IAEA headquarters in Vienna on 18th June 2004 to advance the ITER negotiations.

The two potential Host Parties, European Union and Japan, presented their positions, taking account of recent bilateral discussions on a broader approach to realising fusion energy. The parties noted that the contents of these offers were essentially symmetrical and showed a readiness of each of the potential Host Parties to contribute significantly to the realisation of elements of the Broader Approach other than ITER in addition to their contributions to ITER itself.

All Parties stressed the urgency of reaching a rapid resolution of the siting issue so as to move forward to implementation of ITER in a framework of international collaboration.

- **Resolution continues to be largely in the hands of the EU and JA.**

Path to Selection of US ITER Project Office



Next Steps:

- Define project organization
- US ITER Project Office, under leadership of Ned Sauthoff, works with community to select key personnel
- Consider, define and organize the US ITER/Burning Plasma Program

"I am confident that our partners in the ITER negotiations will recognize our choice of PPPL/ORNL to manage the U.S. participation in ITER for what it is: the clearest possible indication that our Nation takes ITER – and our role in ITER – very seriously."

Secretary Abraham
July 13, 2004

DOE's Announcement of the US ITER Project Office

DOE NEWS

U.S. DEPARTMENT OF ENERGY • OFFICE OF PUBLIC AFFAIRS • WASHINGTON, DC 20585

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FOR IMMEDIATE RELEASE
Tuesday, July 13, 2004

U.S. ITER Project Office will be Located at Princeton Plasma Physics Laboratory

WASHINGTON, DC – The U.S. Department of Energy announced today that the U.S. project office for ITER, a major international fusion experiment, will be located at Princeton Plasma Physics Laboratory (PPPL). PPPL is located on Princeton University's James Forrestal Campus in Plainsboro, NJ, and is charged with developing the scientific understanding and key innovations that will lead to an attractive fusion energy source.

PPPL, in partnership with DOE's Oak Ridge National Laboratory (ORNL), will be responsible for overseeing the U.S. ITER Project Office and providing it with the requisite staffing and facilities.

"The United States and our international partners are in talks to launch ITER, a critically important experiment to test the feasibility of nuclear fusion as a source of electricity and hydrogen," Secretary of Energy Spencer Abraham said.

"Throughout its history, Princeton Plasma Physics Laboratory has earned a reputation for the highest-quality science and top-flight management," Secretary Abraham said. "Ever since fusion research began at Princeton University in 1951, our nation and the world have looked to this facility's researchers for scientific and engineering insights that will enable mankind to realize the benefits of fusion, the energy that powers the stars and the sun."

"That is why I am pleased to announce that, after careful review, we have selected the Princeton Plasma Physics Laboratory/Oak Ridge National Laboratory partnership to run the U.S. ITER Project Office," Secretary Abraham said. "I am confident that our partners in the ITER negotiations will recognize our choice of PPPL/ORNL to manage the U.S. participation in ITER for what it is: the clearest possible indication that our Nation takes ITER – and our role in ITER – very seriously."

The U.S. ITER Project Office at PPPL will be responsible for project management of U.S. activities to support construction of this international research facility. These will include securing technical assistance from the U.S. fusion community; procuring and shipping U.S. hardware contributions; arranging for U.S. personnel to work abroad at the ITER site; representing the U.S. with the international ITER organization on construction and preparation for ITER operations; and coordinating and integrating the U.S. fusion community's ITER project activities with the international ITER project.

R-04-146 (MORE)

The PPPL/ORNL proposal was one of three proposals submitted by DOE national laboratories to lead the Project Office. The two other proposals were from Lawrence Livermore National Laboratory and Idaho National Engineering and Environmental Laboratory. The applications were reviewed by a merit review committee, which was appointed on April 12 by Dr. Raymond L. Orbach, Director of the Office of Science. The committee was comprised of six members – five current senior DOE federal officials and one retiree, who were selected for their experience overseeing complex projects. The panel included legal advice. The review panel conducted a rigorous, objective and fair review of the three proposals and forwarded their evaluations to Dr. Orbach, who made the final selection.

On January 30, 2003, President Bush announced that the U.S. was joining the negotiations for the construction and operation of the international magnetic fusion experiment ITER. There are two competing sites to host the $5 billion test bed for harnessing nuclear fusion to generate electricity. The European Union has selected Cadarache, France, as its candidate site; Japan's contender is Rokkasho. The U.S. supports the Japanese site.

The ITER international fusion experiment was priority one in *Facilities for the Future of Science: A Twenty-Year Outlook*, a proposed portfolio of 28 new facilities and upgrades of current facilities that Secretary Abraham released in November 2003 to serve as a roadmap for future scientific facilities to support DOE's basic science and research mission and to help the Department plan its future scientific investments.

A fusion power plant would produce no greenhouse gas emissions, use abundant and widely distributed sources of fuel, shut down easily, require no fissionable materials, operate in a continuous mode to meet demand, and produce manageable radioactive waste.

Princeton Plasma Physics Laboratory is a collaborative national center for plasma and fusion science. PPPL is managed by Princeton University for the U.S. Department of Energy, Office of Science. The lab's web site address is www.pppl.gov.

Oak Ridge National Laboratory is the Department of Energy's largest science and energy laboratory. It is an international leader in a range of scientific areas that support DOE's mission in the Office of Science, and it manages a major fusion energy sciences program. ORNL is managed by a partnership of the University of Tennessee and Battelle, and is located in Oak Ridge, TN. The lab's web site address is www.ornl.gov.

The Office of Fusion Energy Sciences in DOE's Office of Science conducts the Nation's basic research program to broaden our understanding of fusion energy science and to harness this energy source for the production of hydrogen and electricity.

DOE's Office of Science is the single largest supporter of basic research in the physical sciences in the Nation, manages 10 world-class national laboratories and builds and operates some of the Nation's most advanced R&D user facilities. More information about the office is available at www.science.doe.gov.

R-04-146 -DOE-

International Tokamak Physics Activity (ITPA) and ITER Physics

- 5th ITPA Coordinating Committee meeting held in Shanghai on June 10-11, 2004:
  - Korea joined ITPA.
  - Ron Stambaugh is selected as the new Chair of the committee.
  - Topical Physics Groups are working on the Tokamak Physics Basis update for submission to Nuclear Fusion In December 2004.
- Technical work in ITPA is progressing well:
  - Joint experiments among the world tokamaks, coordinated through ITPA and IEA Agreements, are productive.
  - Next series of Topical Group meetings will be held in Lisbon after the IAEA Fusion Energy Conference.
- We need to improve interaction with the International Team on ITER Physics Tasks:
  - ITER relevant experiments and modeling studies should be developed into ITER Physics tasks.

FY 2004 SciDAC Renewal Process

- In January 2004, the Office of Fusion Energy Sciences issued both an announcement and a notice for fusion SciDAC proposals to laboratory groups and non-laboratory groups respectively
- OFES recruited a total of thirty-two reviewers, who carried out a total of 52 reviews of the seven proposals we received. There were three types of reviews:
  - Review of the physics and fusion science content
  - Review of the relevance of the proposed research for burning plasma
  - Review of the computer science and applied math content for those proposals that requested Scientific Application Partnership Program (SAPP) funding from OASCR
- The two highest rated proposals were selected for funding
  - *Center for Extended Magnetohydrodynamic Modeling*, Stephen Jardin PI
  - *Center for Gyrokinetic Particle Simulation of Turbulent Transport in Burning Plasmas*, W. Lee, PI
- The remainder of the funds ($1M) were set aside to begin work on the SciDAC Fusion Simulation Project (FSP) in collaboration with OASCR, which would provide matching funds

Fusion Simulation Project Status

- The Fusion Simulation Project (FSP) will unify and accelerate progress on a complete, integrated simulation and modeling capability for ITER-class burning plasma

- Creating this capability entails integrating physics that heretofore has largely been considered in isolation

- In FY 2005, OFES and OASCR are planning to begin the first phase of the FSP by soliciting proposals for the initial integration efforts called “Focused Integration Initiatives” in the FESAC Report

- From 1-3 projects would be started in FY 2005 depending on the FY 2006 budget outlook

Status of 2005 Solicitations

Theory and ICC

- 20 theory proposals submitted -- 9 renewals, 11 new – about $3.8 available
- 18 non-lab and 8 lab ICC proposals submitted for a total of about $4.5M from renewals (7 renewals overall)
- Theory reviews are now completed, ICC underway
- Theory selection by August 2, and ICC selection is targeted for August 25

NSTX

- Notice to be published about August 15 (based on peer reviewed 5-year plan)
- Updated program letter available on NSTX web site on September 15 (based on PAC input)
- Proposals due October 15, 2004/funding decisions made early January

Fusion Science Centers

- 13 pre-applications received, 7 invited to submit full applications
- 2 centers funded for 5 years, with the possibility a renewal for an additional 5 years
  - University of Maryland/UCLA
  - University of Rochester
- University of Maryland and UCLA Center will focus on Multiscale Plasma Dynamics using facilities at both of the schools
  - Total funding of $6.4 million over five years
  - Other institutions involved are Princeton University, the Massachusetts Institute of Technology (MIT), and the University of Michigan
  - More information available at: http://cmpd.umd.edu/
- The University of Rochester Center will study Extreme States of Matter and Fast Ignition Physics
  - Total funding of $5.5 million over five years
  - Partners include MIT, General Atomics, University of California at San Diego, Ohio State University, UCLA and the University of Texas at Austin
  - Collaboration with the National Nuclear Security Administration programs at Rochester and Lawrence Livermore National Laboratory
  - For more information see: http://fsc.lle.rochester.edu/

FRONTIERS FOR DISCOVERY IN HIGH ENERGY DENSITY PHYSICS

Prepared for

Office of Science and Technology Policy
National Science and Technology Council
Interagency Working Group on the
Physics of the Universe

Prepared by

National Task Force
on High Energy Density Physics

July 20, 2004

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Four Major HEDP Research Areas

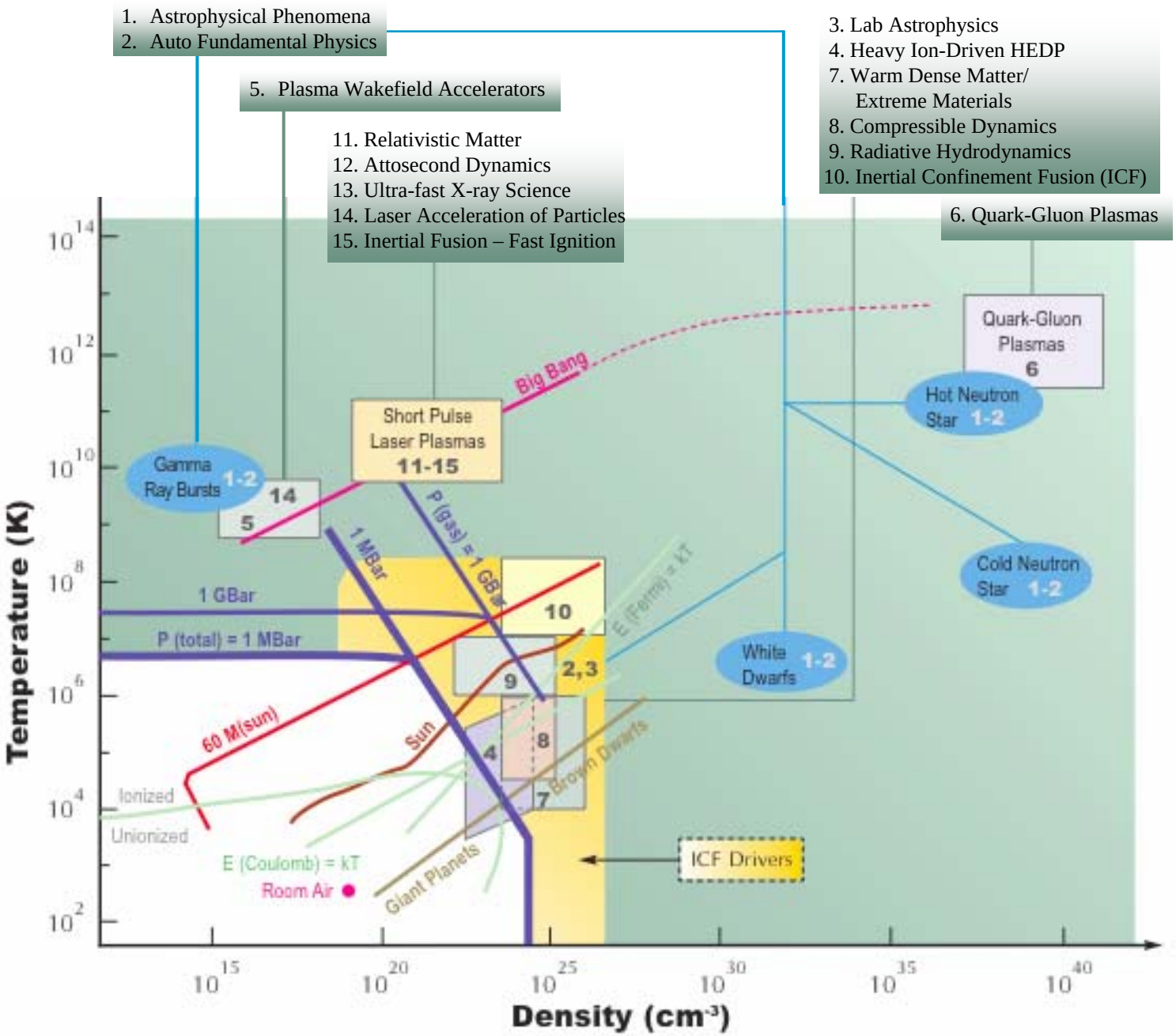
1. High energy density physics in astrophysical systems;

2. Beam-induced high energy density physics (Relativistic Heavy Ion Collider, heavy ion fusion, high-intensity accelerators, etc.);

3. High energy density physics in Stockpile Stewardship facilities (Omega, Z/ZR, National Ignition Facility, etc); and

4. Ultrafast, Ultraintense Laser Science

Four Major HEDP Research Areas



Map of the HED Universe

International Workshop on Advanced Computational Materials Science: Application to Fusion and Generation IV Fission Reactors

March 31 – April 2, 2004
(organized by ORNL at the request of BES)

- Select international scientific committee convened to determine whether increased effort on modeling and simulation could bridge gap between data needed for design of advanced nuclear technologies and data from existing experiments

- Discussion focused on fusion (where the "gap" is larger)

- Clear consensus that IFMIF-like irradiation facility is needed, but no agreement that IFMIF was the best approach

- Aggressive theory and modeling effort could reduce the time and experimental investment required for materials development

- Complete report available at: http://www.csm.ornl.gov/meetings/SCNEworkshop/DC-index.html

Review of Low Energy Nuclear Reactions

(Cold Fusion)

- Office of Science review coordinated by NP and BES
- Based on document prepared by researchers in the field
- Two parts
  - Mail review with individual comments from reviewers
  - Panel review with oral presentation and individual comments from reviewers
- DOE staff will summarize review comments for the Office of Science

Ten Year Goals for Fusion Energy Sciences

- Demonstrate progress in developing a predictive capability for key aspects of burning plasmas using advances in theory and simulation benchmarked against a comprehensive experimental database of stability, transport, wave-particle interaction, and edge effects. **(2015)**

- Demonstrate progress in developing the fundamental understanding and predictability of high energy density plasma physics, including potential energy producing applications. **(2015)**

- Demonstrate enhanced fundamental understanding of magnetic confinement and in improving the basis for future burning plasma experiments through research on magnetic confinement configuration optimization. **(2015)**

Program Plan for Fusion Energy Sciences: Roadmap of Objectives and Performance Targets

2006 | 2008 | 2010 | 2012 | 2014 | 2016

Burning Plasma

- The Department's role in the ITER is established **(2005)** INTL
- Initiate experiments on the National Ignition Facility (NIF) to study ignition and burn propagation in IFE relevant fuel pellets **(2012)** NNSA
- ⬡ Demonstrate progress in developing a predictive capability for key aspects of burning plasmas using advances in theory and simulation benchmarked against a comprehensive experimental database of stability, transport, wave-particle interaction, and edge effects. **(2015)**

Fundamental Understanding

- Achieve a fundamental understanding of tokamak transport and stability in pre-ITER plasma experiments **(2009)**
- Major aspects relevant to burning plasma behavior observed in experiments prior to full operation of ITER are predicted with high accuracy and are understood **(2015)**
- Evaluate the process affecting the transport of petawatt laser energy in dense plasmas **(2009)** NNSA
- Create and measure properties of high energy density plasmas using intense ion beams, dense plasma beams and lasers **(2012)**
- ⬡ Demonstrate progress in developing the fundamental understanding and predictability of high energy density plasma physics, including potential energy producing applications. **(2015)** NNSA

Configuration Optimization

- Evaluate the ability of the compact stellarator configuration to confine a high temperature plasma **(2012)**
- ⬡ Demonstrate enhanced fundamental understanding of magnetic confinement and in improving the basis for future burning plasma experiments through research on magnetic confinement configuration optimization. **(2015)**
- Achieve long-duration, high-pressure, well-confined plasmas in a spherical torus sufficient to design and build fusion power-producing Next-Step Spherical Torus **(2008)**
- Demonstrate use of active plasma controls and self-generated plasma current to achieve high-pressure/well-confined steady-state operation for ITER **(2008)**
- ⬢ Advance plasma science and computer modeling to obtain a comprehensive, and fully validated, plasma configuration simulation capability. **(2020)**

and here

Materials, Components, & Technologies

- Start production of superconducting wire needed for ITER magnets **(2006)**
- Deliver to ITER for testing the blanket test modules needed to demonstrate t feasibility of extracting high temperature heat from burning plasmas and for self-sufficient fuel cycle **(2013)** BES

Future Facilities

(Cross cut and support multiple objectives and targets):

- **ITER:** construction begins for this international collaboration to build the first fusion burning plasma experiment capable of a self-sustaining fusion reaction. **(2006)** INTL
- **ITER:** operation begins. **(2014)** INTL
- **Next-Step Spherical Torus (NSST) Experiment:** construction begins to test the spherical torus, an innovative concept for magnetically confining a fusion reaction. **(2010)**
- **NSST:** operation begins (2016)
- **Integrated Beam Experiment (IBX):** Begin construction of an intermediate-scale experiment to understand how to generate and transmit the focused, high energy ion beam needed to power an IFE reaction **(2013)**

Interdependencies:

(Descriptions)

*Broadly with **ASCR** on computational developments, both hardware and software, affecting all facets of basic research and advanced instrumentation.*

INTL *=with international community on ITER*

BES *=with BES on nano-designed materials*

NNSA *=with NNSA*

⬢ =Key Intermediate Objective from DOE Strategic Plan
⬡ =Long Term Success Measure from PART

This timeline is for planning purposes only and does not constitute financial or contractual commitments by the Federal Government.

Annual Measure 1 (Proposed)

- Percentage of agreed upon scientific milestones for the combined major national fusion facilities that are accomplished within the given fiscal year
  - How will progress be measured: Progress will be tracked quarterly through the Department of Energy's tracking system – JOULE. Results will be reported in the Department's Performance and Accountability report that is published soon after the end of each fiscal year.

Targets	Achieved
2001 - > 85%	83%
2002 - > 85%	98%
2003 - > 85%	98%
2004 - > 85%	
2005 - > 85%	

Annual Measure 2

- Average achieved operation time of the major national fusion facilities as a percentage of the total planned operation time. (*Efficiency measure*)
  - How will progress be measured: Progress will be tracked quarterly through the Department of Energy's tracking system – JOULE. Results will be reported in the Department's Performance and Accountability report that is published soon after the end of each fiscal year

Targets	Achieved
2001 - > 90%	100%
2002 - > 90%	94%
2003 - > 90%	81%

(*NSTX operated only 4 weeks because of a magnet coil failure*)

2004 - > 90%

2005 - > 90%

Annual Measure 3

- Cost-weighted mean percent variance from established cost and schedule baselines for major construction, upgrade, or equipment procurement projects

  - How will progress be measured: Progress will be tracked quarterly through the Department of Energy's tracking system – JOULE. Results will be reported in the Department's Performance and Accountability report that is published soon after the end of each fiscal year

Targets	Achieved
2001 - > 10%, <10%	-6%, -6%
2002 - > 10%, < 10%	+5%, +0%
2003 - > 10%, <10%	+0%, +0%
2004 - > 10%, <10%	
2005 - > 10%, <10%	