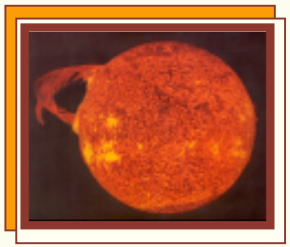
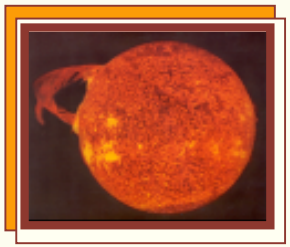


Overview of the Report of the 2005 FESAC Facilities Panel

Volume 1: **Characteristics and Contributions of the Three Major United States Toroidal Magnetic Fusion Facilities**

& Volume 2: **Requested Information Provided by the Three Major United States Toroidal Magnetic Fusion Facilities**



5 April 2005 FESAC Charge

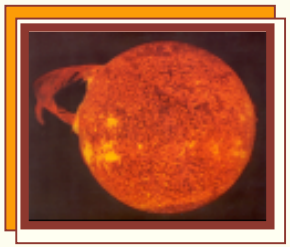
Dear Professor Hazeltine:

Funding U.S. participation in the ITER project will place considerable pressure on the Office of Science budget in future years. I am committed to a strong base fusion research program during ITER construction but want to be sure that the program is cost-effective. In particular, I do not believe that we should continue running existing facilities just because we can do more research on them but because we can do unique and important research on them. Accordingly, I would like you to assess characteristics of the three major U.S. toroidal magnetic fusion facilities in the context of the international fusion programs and determine what contributions they can make to fusion science and the fundamental vitality of the U.S. Fusion Program during the next five years.

I would like you to consider the following issues in your assessment:

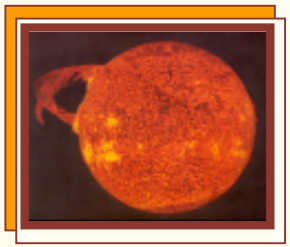
1. What are the unique and complementary characteristics of each of the major U.S. fusion facilities?
2. How do the characteristics of each of the three U.S. fusion facilities make the U.S. toroidal research program unique as a whole in the international program?
3. How well do we cooperate with the international community in coordinating research on our major facilities and how have we exploited the special features of U.S. facilities in contributing to international fusion research, in general, and to the ITER design specifically?
4. How do these three facilities contribute to fusion science and the vitality of the U.S. Fusion program? What research opportunities would be lost by shutting down one of the major facilities?

Sincerely, Raymond L. Orbach, Director, Office of Science



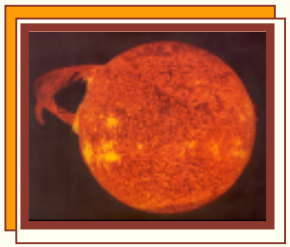
Facilities Panel 2005 Time Line

April 5:	Charge Letter is issued to FESAC
April 19:	Panel membership is determined
April 28:	Panel requests information from the three facilities
May 28:	Panel receives requested input from the three facilities [Volume 2]
June 2:	Panel receives unsolicited joint facilities document [Appendix 4]
June 13-17:	Panel holds review meeting
July 11:	Panel provides final report to FESAC
July 19:	Panel briefs FESAC per report contents



Panel Membership

JILL DAHLBURG, Naval Research Laboratory (Chair)
STEVEN L. ALLEN, Lawrence Livermore National Laboratory (Vice-Chair)
RICCARDO BETTI, University of Rochester
STEPHEN KNOWLTON, Auburn University
RAJESH MAINGI, Oak Ridge National Laboratory
GERALD A. NAVRATIL, Columbia University
STEVEN A. SABBAGH, Columbia University
JOHN SHEFFIELD, University of Tennessee
JAMES W. VAN DAM, University of Texas at Austin
DENNIS WHYTE, University of Wisconsin at Madison



May 28, 2005

Input from the Community

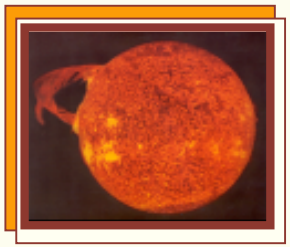
Volume 2:

Requested Information Provided by the Three Major U.S. Toroidal Magnetic Fusion Facilities

On April 28, 2005, the FESAC Facilities Panel requested input from each of the three major U.S. toroidal magnetic fusion facilities. The request included an invitation to each facility program director to provide a docu ment (30 pages maximum length) that addressed in detail the panel charge as provided in Appendix 2 of this report Volume 1. The three '30-page' documents that were received by the Facilities Panel in response to this request are here reproduced as background to report Volume 1.

The Facilities Panel wishes to express its sincere gratitude to the program directors of the three major facilities, and to their staffs, for the thoughtful and detailed input provided during the panel activity.

and ...



June 2, 2005

Input from the Community

Volume 1 Appendix 4:
The Three Facilities Joint Document

Dear Dr. Dahlburg:

The undersigned three Directors of the Alcator C-Mod, DIII-D, and NSTX Programs hereby submit to the FESAC Facilities Panel the attached unsolicited document to assist in the Panel's deliberations. This document seeks to describe for the Panel those unique research roles for the United States in the world fusion program enabled by the combined contributions of the three U.S. Facilities: Alcator C-Mod, DIII-D, and NSTX.

This document was jointly written by the three Program Directors undersigned, in consultation with our teams. This document reflects our mutual view that the United States fusion program and the world fusion program derive great benefit from the continued operation of all three facilities.

We hope this submission is of value to the Panel.

Sincerely yours,

Earl S. Marmar

Earl Marmar (Alcator C-Mod)

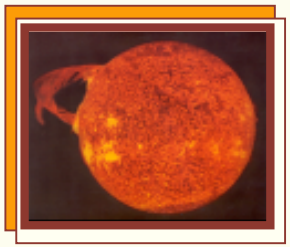
Ron Stambaugh

Ronald Stambaugh (DIII-D)

Martin Peng

Martin Peng (NSTX)

and ...



June 13-15, 2005

Input from the Community

FESAC Facilities Panel June Meeting at the U.S. Naval Research Laboratory (June 13-17, 2005)

All members of the FESAC Facilities Panel (see page 2 of this report) met for five days to hear testimony from representatives of each of the three major U.S. toroidal magnetic fusion facilities, and to deliberate about panel findings and responses. The meeting agenda is reproduced in A4.1 below. The list of meeting attendees is provided in A4.2.

A4.1. FESAC Facilities Panel Meeting Presentations

Monday, June 13:
- Executive Session [08:45 – 09:45]
- Alcator C-Mod Presentations, and Q&A [10:15 – 18:00]
  - Introduction, *E. Marmar*
  - ITER/ Burning Plasma Supporting Research, *M. Greenwald*
  - Wave-Plasma and Advanced Tokamak, *A. Hubbard*
  - Transport, *M. Greenwald*
  - Plasma Boundary, *B. Lipschultz*
  - Macroscopic Stability, *E. Marmar*
  - Facility Capabilities, *E. Marmar*
  - Summary, *E. Marmar*

Tuesday, June 14:
- Executive Session [08:45 – 09:45]
- DIII-D Presentations, and Q&A [10:15 – 18:30]
  - DIII-D Program, Staff and Facility, *R. Stambaugh*
  - University Research Using DIII-D, *E. Doyle*
  - Advanced Tokamak and ITER Research, *M. Wade*
  - Transport Research, *K. Burrell*
  - Stability Research, *E. Strait*
  - Alfven Mode Research, *R. Nazikian*
  - Pedestal and Divertor Research, *M. Fenstermacher*
  - Answers to the [Charge] Questions – Summary, *T. Taylor*

Wednesday, June 15:
- Executive Session [08:45 – 09:45]
- NSTX Presentations, and Q&A [10:00 – 15:15]
  - Macroscopic Plasma Physics and Solenoid-free Start-up + HHFW and EBW, *J. Menard*
  - Multi-scale Transport Physics, *S. Kaye*
  - Energetic Particles, *D. Gates / N. Gorelenkov*
  - Plasma Boundary Interfaces, *J. Boedo*
  - Long-term Vision of ST as an Option for CTF, *M. Peng*
- General Discussion [15:15 – 15:45]
- NSTX Presentations, and Q&A, continued [15:45 – 18:30]
  - Science Overview, *E. Synakowski*
  - Facility Diagnostic Capabilities, *M. Ono*

Thursday, June 16: Executive Session [08:45 – 18:00]

Friday, June 17: Executive Session [08:45 – 18:00]

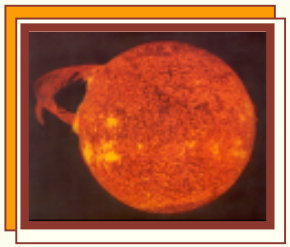
A4.2. FESAC Facilities Panel Meeting Attendees

U.S. Department of Energy Attendees:
- Erol Oktay, DOE (June 13-15)
- Stephen Eckstrand, DOE (June 13-15)
- Adam Rosenberg, DOE (June 13-15)

Alcator C-Mod Attendees:
- Earl Marmar, MIT (June 13-15)
- Martin Greenwald, MIT (June 13-15)
- Miklos Porkolab, MIT (June 13-15)
- Ronald Parker, MIT (June 13)
- Amanda Hubbard, MIT (June 13)
- Steven Scott, PPPL (June 13)
- Robert Granetz, MIT (June 13)
- Paul Bonoli, MIT (June 13)
- Steven Wukitch, MIT (June 13)
- Bruce Lipschultz, MIT (June 13)

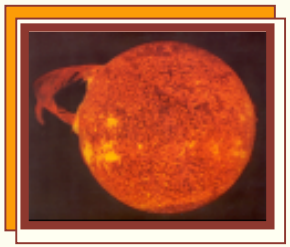
DIII-D Attendees:
- David Baldwin, GA (June 13-15)
- Ronald Stambaugh, GA (June 13-15)
- Tony Taylor, GA (June 13-15)
- Vincent Chan, GA (June 14)
- Mickey Wade, GA (June 14)
- Keith Burrell, GA (June 14)
- Edward Strait, GA (June 14)
- Max Fenstermacher, GA (June 14)
- Raffi Nazikian, PPPL (June 14)
- Edward Doyle, UCLA (June 14)

NSTX Attendees:
- Rob Goldston, PPPL (June 13-15)
- Richard Hawryluk, PPPL (June 15)
- Edmund Synakowski, PPPL (June 13-15)
- Martin Peng, ORNL (June 13-15)
- Masayuki Ono, PPPL (June 15)
- Stan Kaye, PPPL (June 15)
- Jon Menard, PPPL (June 15)
- Jose Boedo, UCSD (June 15)
- David Gates, PPPL (June 15)
- Stewart Zweben, PPPL (June 15)



The Charge addresses the three major U.S. toroidal fusion facilities.

The three major toroidal fusion research facilities in the U.S. have diverse and complementary characteristics, which were developed on the basis of evolving U.S. innovation in fusion energy sciences. Taken together these three facilities provide the U.S. with a very effective presence in the world program of fusion research. Their success has enabled the U.S. to have substantial impact on the direction and progress of the field, including world leadership in understanding fundamental transport processes in magnetically confined plasmas, and optimization of the magnetic configuration for confinement of high pressure plasmas.



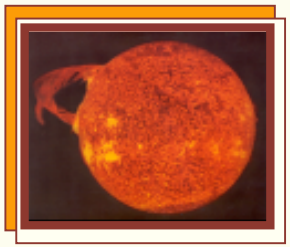
Unique and complementary characteristics

The characteristics that make each of these toroidal facilities unique in research capability stem from their initial research motivations:

C-Mod to understand plasma behavior at very high magnetic field with the plasma pressure and field appropriate for sustaining a burning plasma for energy production.

DIII-D to understand and improve plasma confinement and stability as a function of plasma shape and magnetic field distribution in a collisionless plasma.

NSTX (the most recently commissioned, in 1999) to apply advances in understanding of magnetic field configuration to optimize both plasma stability and confinement in a proof-of-principle, low aspect ratio toroidal experiment (the spherical torus).



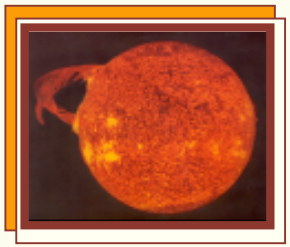
Today, each facility is a leading element of the world program in magnetic fusion research.

C-Mod has the world's highest tokamak magnetic field and is the only facility capable of studying plasma/ wall interactions and radio frequency heating and current drive in ITER-like geometry with magnetic field and plasma pressure characteristic of a burning plasma.

DIII-D, with its unparalleled plasma transport diagnostics and world-leading capability for plasma shaping and control of major instabilities limiting high pressure plasmas, has established itself as the center for developing long-pulse, high performance advanced tokamak operation.

NSTX is the world's most capable spherical torus, exploring high-β plasma stability and confinement at extreme toroidicity (low aspect ratio) and is the major US experiment for concept innovation in magnetic confinement now in operation.

While these three facilities are clearly distinct, they also have a degree of commonality that makes them highly effective as a group.



The report addresses the charge questions *[#1, #2 & #4i]* from the perspective of ...

.. the most important frontier areas in fusion energy sciences research, recently described in detail in the April 2005 FESAC Program Priorities Report:

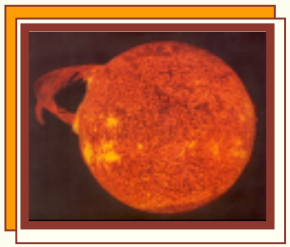
Macroscopic plasma physics: Understand the role of magnetic structure on plasma confinement and the limits to plasma pressure in sustained magnetic configurations;

Multi-scale transport physics: Understand and control the physical processes that govern the confinement of heat, momentum, and particles in plasmas;

Plasma boundary interfaces: Learn to control the interface between the 100-million-degree-C plasma and its room temperature surroundings;

Waves and energetic particles: Learn to use waves and energetic particles to sustain and control high temperature plasmas;

Fusion engineering science: Understand the fundamental properties of materials, and the engineering science of the harsh fusion environment.

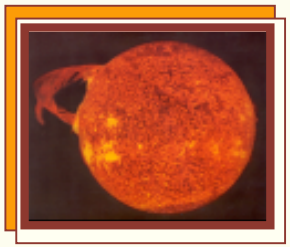


Report Volume 1 Outline

Qs #1, 2, 4i

Q #3

Q #4ii



Next six talks:

[10:10]	2. Macroscopic Plasma Physics	*(S. Sabbagh)*
[10:22]	3. Multiscale Transport Physics	*(J. Van Dam)*
[10:34]	4. Plasma Boundary Interfaces	*(D. Whyte)*
[10:46]	5. Waves & Energetic Particles	*(S. Knowlton)*
[10:58]	6. Fusion Engineering Science	*(J. Sheffield)*
[11:10]	7. Contributions to & Cooperation with the International Community	*(S. Allen)*