Status Report
FESAC Panel on Priorities

For further information, please access FESAC Priorities Panel website at:
http://www.mfescience.org/fesac/index.html
FESAC Charge on Priorities
from Dr. Ray Orbach

• focus the program in a more complete and fundamental way than we have done before.

• Identify the major science and technology, ....recommend how to organize campaigns to address those issues, and recommend the priority order for these campaigns.

• take account of fusion programs abroad and that includes ITER as an integrated part of the whole.

• Assume that funding for ITER construction is provided in addition to (base program) funds.

• Include Inertial Fusion and relevant aspects of High Energy Density Physics...

• Look at the program through 2014, the year ITER operation is expected to begin.
**Panel Work Plan**

- **Step 1** - Develop overarching themes, topical scientific and technical questions, and decision criteria.  
  *Initial step completed—community feedback received.*

- **Step 2** - Develop research approach/thrusts for each question.  
  *Underway. Six working groups established. First drafts done. Next meetings of the panel: June 17-19*

  **Interim Report—July, 2004**

- **Step 3** - Develop campaigns and priorities  
  *Panel discussing basic approach and process. Interact with community*

  **Final Report—December, 2004**
01. Understand the dynamics of matter and fields in the high-temperature plasma state.

02. Create and understand a controlled, self-heated, burning starfire on earth.

03. Make fusion power practical.
Theme: Macroscopic Plasma Behavior
T1. How does magnetic field structure affect plasma confinement?
T2. What limits the maximum pressure that can be achieved in laboratory plasmas?
T3. How much external control versus self-organization will a fusion plasma require?

Theme: Multi-scale Transport Behavior
T4. How does turbulence cause heat, particles, and momentum to escape from plasmas?
T5. How are large-scale electromagnetic fields and mass flows generated in plasmas?
T6. How do magnetic fields in plasmas rearrange and dissipate their energy?

Theme: High-energy Density Implosion Physics
T7. How can high energy density fusion plasmas be assembled and ignited in the laboratory?
T8. How do hydrodynamic plasma instabilities affect implosions to high energy density?
Topical Questions (cont’d)

**Theme: Plasma Boundary Interfaces**

T9. How can we interface a 100 million degree burning plasma to its room temperature surroundings?

**Theme: Waves and Energetic Particles**

T10. How can heavy ion beams be compressed to the high intensities required for creating high energy density matter?
T11. How do electromagnetic waves interact with plasma?
T12. How do high energy particles interact with plasma?

**Theme: Fusion Engineering Science**

T13. How does the challenging fusion environment affect plasma chamber systems?
T14. What are the ultimate limits for materials in the harsh fusion environment?
T15. How can systems be engineered to heat, fuel, pump and confine steady-state or repetitively pulsed burning plasmas?
Present Activity

• Research approaches formulated by working groups

• Assessed at June 17 - 19 panel meeting
<table>
<thead>
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The Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas (CMSO)

An NSF Physics Frontier Center, established in partnership with DOE
**Purpose:**
To understand major plasma physics problems critical to laboratory and astrophysical plasmas

**Unites**
Laboratory and astrophysical scientists
Experiments, theory, and computation
• Initiated Sept, 04

• Funded for five years
Physics Topics

- Dynamo
- Magnetic reconnection
- Angular momentum transport
- Ion heating
- Magnetic chaos and transport
- Magnetic helicity conservation and transport

Spans plasma phenomena in solar wind, sun, accretion disks, galactic clusters...
Center Members

- 24 initial members, 6 institutions (plus some 20 postdocs and students)
- Equal amounts of lab physicists and astrophysicists
- Experimenters, theorists, computational physicists
Institutions

The University of Wisconsin
Princeton University
The University of Chicago
Science Applications International Corp
Swarthmore College
Lawrence Livermore National Laboratory

Includes experiments:
MST (UW), MRX (PPPL), SSX (Swarthmore), SSPX (LLNL)
Core Center Tasks

1. Compare astrophysical and lab phenomena
2. Compare results from different experiments
3. Perform joint experiments and develop joint diagnostics
4. Apply theoretical and computational tools developed in one venue to other situations

Hopefully generate new ideas for astrophysical phenomena
Relation to DOE MST Work

- Strongly complementary and cross-fertilizing
- Enhances progress in fusion goals
- Enlarges scientific impact of MST results
- Great fusion outreach
The Center is a partnership between NSF and OFES

• Overlapping scientific goals

• OFES supports all facilities, prior code development