Burning Plasma
Bringing a Star to Earth

Final Report of the
Burning Plasma Assessment Committee

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The take-home message

- A burning plasma experiment is critically needed to advance fusion science
  - Join ITER
  - If ITER doesn’t go forward, reassess to move ahead

- An effective burning plasma experiment cannot be done on a flat budget
  - Augmentation of the U.S. program is required

- Priorities must be set for a balanced program
  - Community should focus on realistic opportunities, and identify and prioritize the critical questions
Scope of the committee’s work

• Assess plans for a burning plasma experiment (BPX) program
  – Assess value of and need for BPX
  – Assess scientific and technical readiness
  – Identify plan for optimized results

• Issues outside of scope
  – Inertial confinement fusion
  – How to (best) develop fusion power
  – Fusion-reactor-specific technology
## Committee membership

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<tr>
<th>&quot;Outside&quot; Experts</th>
<th>&quot;Fusion/BPX&quot; Experts</th>
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<td>Raymond Fonck, U Wisconsin, <em>co-chair</em></td>
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Need for a BPX

• Burning plasma experiment is a necessary scientific milestone on the road to the development of fusion power

• BPX is a critical missing element of the current program
Scientific value of a BPX

• Development of fusion energy science
  – Plasma turbulence, transport at large scales
  – Alpha-particle effects on confinement and stability
  – Stability limits in presence of self-heating
  – Behavior and control of self-sustained (burning) plasma

• Basic plasma physics & general scientific interest
  – Laboratory astrophysics, extreme conditions
  – Self-organizing complex systems
Technological value of a BPX

- Will enable
  - Initial study of materials behavior and integrity
  - Tritium processing and inventory control
  - High-heat-flux components
  - Partial study of (breeding) blanket design/testing
  - Remote handling
Readiness for a BPX

- U.S. fusion science program is scientifically and technically ready to undertake a BPX
  - Have confidence in understanding projections and operational boundaries
  - Necessary components can be manufactured and adequate drive technologies exist
Strategically balanced program

- BPX is a necessary but not sufficient step toward fusion energy

- Developing science base for fusion requires both a BPX and concept development and optimization
  - Address the range of primary issues of fusion science

- In context of ITER participation, balance is essential
  - To optimize the scientific output
  - To best understand and exploit the outcomes for the fusion program as a whole
Elements of a balanced program

- Robust program of theory and simulation, coupled with experimental verification

- Direct support of ITER activities
  - Optimize and accelerate ITER benefits

- Concept Optimization Research
  - Portfolio of investigations across related magnetic configurations

- Recruitment, training, and retention of scientific and technical staff
Recommendations: ITER (1)

- The United States should participate in a burning plasma experiment

- The best option is ITER

- If ITER develops, fulfilling the U.S. commitment should be the top priority in a balanced program
Recommendations: ITER (2)

- Level of involvement in ITER should guarantee:
  - Access to all data from ITER
  - Right to propose and carry out experiments
  - Role in producing the high technology components

- If ITER negotiations fail
  - United States should reassess options, but continue to pursue goal of a BPX with international partners
Recommendations: Program Balance

- A strategically balanced fusion program should be developed, including:
  - Participation in ITER
  - Strong domestic fusion science and technology portfolio
  - Integrated theory and simulation program
  - Support for plasma science
Recommendations: Setting Priorities

- Scope, content, and level of U.S. activity in fusion should be defined through prioritized balancing procedure

- OFES and the community will have to make serious priority judgments
  - BPX/ITER and other program elements all have merit, *but* must account for realistic budgetary situations

- Led by OFES, fusion science community should
  - Identify and prioritize critical scientific questions
  - Accept and manage limitations on levels of activity
Budget implications

- Funding trajectory should be developed that
  - Captures the long-term benefits of joining ITER
  - Retains a strong scientific focus on the long-range goal of the program
- Flat budget for OFES with a BPX will degrade the scientific research support in the fusion program
- At the minimum, augmentation of the U.S. program covering all the U.S. ITER construction and operating costs would be required
Conclusion

• A burning plasma experiment is critically needed to advance fusion science
  – Join ITER
  – If ITER doesn’t go forward, reassess to move ahead

• A burning plasma experiment cannot be done on a flat budget
  – Augmentation of the U.S. program is required

• Priorities must be set for a balanced program
  – Community should focus on realistic opportunities, and identify and prioritize the critical questions