Benefits of a Domestic Burning Plasma Experiment

Professor Michael Mauel
Columbia University

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Benefits of a Domestic BPX

- Any BPX should be built as part of an overall, international fusion energy development plan, consisting of
  - Study and understanding of burning plasmas (BPX)
  - Development of attractive, low-activation, fusion energy components
  - Broad physics and technology research to establish the knowledge base for an optimal power system: steady-state, high beta, at an appropriate size and cost

- A domestic BPX must be part of a modular approach to fusion development.
  - Together with the BPX, separate and medium-scale modules/programs develop
    - Fusion components
    - Optimized steady-state confinement configurations, and
    - Physics and simulation tools.
  - Similar to the IFE roadmaps: faster, smaller steps each "meeting specific science and technology goals before going on to the next step." The integration step "establishes a technical and cost basis for commercial power."

Our Political "Perceptions"

- **The U.S. will only accelerate fusion if we participate in ITER.**
- **U.S. fusion can never hope to get a ~ $1B facility.**

- Our political judgments may be wrong.
- (In my opinion,) our geo-political track record is poor.
- National and international politics can change quickly.

My recommendation:

- Our government depends on U.S. fusion scientists for our technical judgments of fusion energy development options.
- If we don't second guess our own technical judgments, then there ***will be no losers and world-wide fusion wins.***

➲ Let's try to evaluate the benefits of a **domestic** BPX within an **international** modular program without political prejudice.

Visualization Exercise

- Imagine our government really wants to accelerate fusion energy research because fusion is an **important, environmentally-sustainable energy source**.

  …and not just because George likes Tony Blair.

- Imagine that we have no idea what ITER-FEAT really costs.

  …and we have to use our own common sense to judge ITER's cost and schedule

- Imagine that we really can **double** the U.S. fusion budget if we propose a **compelling plan** for fusion energy development that builds on our **outstanding scientific and technical progress.**

  …and not just because of political opportunity.

- Imagine that the U.S. is not **always a steady international partner** and new Presidents may change past policies.

  …even if we do have an international agreement.

Some Evidence of this "Alternate Reality" Exists

- Other fields of U.S. science successfully do build >$1B scale experiments.
  - Astronomy —> Hubble, VLBA, NGST (2010)
  - Astrophysics —> Chandra
  - DOE/Basic energy sciences —> SNS, APS
  - HEP (with FERMI + D0, RHIC, SLAC, and LHC) proposes a U.S. NLC this year.
- The U.S. does change it's mind quickly (even with international agreements).
  - Japanese "Kibo" module (~ $1B) delayed/cancelled from ISS due to cost overrun
  - U.S. decides international Kyoto accord really isn't such a good plan after all
  - (ITER-FEAT construction would require the support of 4 administrations!)
- Fusion energy science has re-established its credibility
  - NRC calls fusion science "easily on par" with any other field of science
  - New center for plasma physics established by NSF
  - Growing awareness/advocacy by those outside fusion for faster-paced fusion R&D

"Develop a compelling Fusion Program Plan
and the funding will follow."

Hermann Grunder
Fusion Snowmass 1999

Benefits of a Domestic Burning Plasma Experiment

(given our "alternate reality")

- Adapted from the HEPAP (Jan 2002) Long Range Plan:
  - The **BPX** will be one of the greatest scientific projects of our time, at the frontier of science and advanced technology.
  - By hosting the **BPX**, the U.S. would be at the center of scientific and technical activity for a great international project and this important field of science.
  - A healthy worldwide **fusion** program requires a distribution of major facilities around the globe. It is appropriate for the next large new facility to be in the U.S.
  - By offering to host the **BPX**, the U.S. would send a message of leadership and responsibility.
  - Past investments in **fusion** experiments have enormously enriched society. Economic benefits have been documented.
  - Locating a **BPX** in the United States would allow a greater portion of our economic investment to be recaptured through jobs and technological benefits.
  - ➲ Strengthen the science and technology infrastructure for **fusion energy** development.

- Congress would be able to see a real hardware during domestic site visits (instead of wall posters and web sites).
- There would be greater opportunities for U.S. scientific, education, and outreach for fusion energy and plasma physics.
- *(It would be "OK" to include contingency in our cost estimates.)*

Impact on World Fusion of a U.S. BPX

- Burning plasma experiments would begin sooner with less risk.
- The world would see a BP research step that requires < 30 g T on site and does *not* produce 30,000 tonnes of rad-waste.
- Three options for EU and Japan (There are no losers!):
  - EU & JA see a vigorous, expanding U.S. program, and they decide to construct ITER-FEAT without U.S. participation. **Fusion wins!** (Big time.)
  - EU & JA denounce the U.S. as unreliable, rethink their MFE programs, and join a multiple-machine strategy with a VNS and a SC AT research device. **Fusion wins!**
  - EU & JA denounce the U.S. as unreliable, eliminate their MFE programs, and restructure their HED Laser Programs into a fast-track IFE program. **Fusion wins!**
- In each case, fusion continues as a very strong and vigorous **international** R&D program—containing a **domestic** BPX.

Back to Reality…

- The U.S. will only accelerate fusion if we participate in ITER.
- U.S. fusion can never get a ~ $1B facility.

So let's take the ITER plunge…

♦♦♦ Experts Only

(Steep slopes, Sharp curves, Use Extreme Caution)

Back to Reality…

- **The U.S. will only accelerate fusion if we participate in ITER.**
- **U.S. fusion can never get a ~ $1B facility.**

While ITER-FEAT is a mature (and beautiful!) design and ITER would move us quickly to the size-scale of a future power-plant, there still exists serious risks…

Worst case scenario:

- **ITER-FEAT proves significantly more costly. Construction drags on and on, preventing any other large experiment. Development of low-activation fusion components delayed. Green's see ITER as a radioactive menace.**
- **Responding to delays & cost overruns, Congress withdraws U.S. from ITER, discrediting fusion, and committing all funds to CO_2 sequestration!**

…and Congress indicts Jerry Navratil for knowing all along that ITER would exceed cost and schedule estimates and not speaking out loudly enough!

Summary Thoughts

- **Fusion significantly benefits from a domestic BPX.**
- **We should not get distracted by international "what ifs". I (we?) really don't know and can not predict the evolution of fusion geo-politics.**
- **We should try to keep focused on the "Snowmass mission": the scientific and technical assessment of BPX options.**
- **We must be clear about what we know (and don't know) about the steps required for fusion energy development. Our nation depends upon our technical judgments.**

Attend the FESAC/Prager Panel open house: tonight 8:00pm.