Status of Activities on the Theory Program Review Charge

John Sheffield.
2.27.01. FESAC Meeting

Panel members.
Tom Antonsen, Lee Berry, Michael Brown, Jill Dahlburg, Ron Davidson, Martin Greenwald, Chris Hegna, Bill McCurdy, David Newman, Claudio pellegrini, Cynthia Phillips, Doug Post, Marshall Rosenbluth, John Sheffield, Tom Simonen, and Jim Van Dam.

The Panel has set up two meetings to hear from the community:

- UCLA January 31 – February 1,
  Western US.

- PPPL March 29 – 30,
  Eastern US.

In addition, the Panel has received written input.

UCLA Meeting Agenda:

09.00 am Panel only.

10.00 am Input to Panel. S.Eckstrand, R.Taylor, J.Cary, D.Schnack, V.Chan.

12.30 pm Lunch.

01.30 pm Input to Panel. A.Glasser, R.Cohen, A.Friedman, J-N LeBoeuf,

03.45 pm. Input to Panel. M.Tabak, Van Dam, Aamodt vus, Other input.

06.00 pm Adjourn.

February 1. Panel only.

08.30 am to 12.00 noon.

Some Input Received.

The total Theory/Computing (T/C) effort is about 100 FTEs + 20-30 FTEs supported by experimental programs. This about 13 to 15 % of the OFES budget.

Overall, the presentations and written material did not show any great unhappiness with the T/C program content. However, a number of points of concern were raised.

1. Consistency (or lack of it) in the evaluation of programs from different kinds of institutions. In the discussions it was pointed out that OFES has made changes in the reviews. There needs to be an understanding of the legal constraints on the system.

The Panel has asked for more information.

2. Concerns that the category descriptors for the program elements were inadequate (misleading) and unnecessarily restrictive. In discussions it appeared that this could readily be rectified by using a range of types of descriptors and the use of more than one e.g., Magnetic Reconnection, RFP, rather than just Alternate.

The support of T/C in the experimental programs is not systematic. There are concerns about the limited support for the smaller experimental programs (mainly alternates in the MFE program but also small tokamaks and basic science experiments).

1. In preparation of proposals for new experiments.
2. In the optimization and operation of experiments.

Should there be some guidelines for T/CX support for each experimental program? The funding to be spent wherever the best expertise can be found?

Not surprisingly, there was a concern that the total funding for T/C was inadequate to meet the expectations of the program. In discussions, the point was made that the same comment could be made for all of the OFES program e.g., each experiment was supported to less than the optimum level; leading to a low percentage of operating time and/or unfortunate trade-offs between diagnostics, heating/fueling, and T/C.

3. This is not a new problem and arises in part from the persistent assumption and hope that the budget should and would increase. From the T/C perspective, it will be important to first study the issue of efficiency of resource use e.g, is there unnecessary duplication in aspects of the work?

5. There was a discussion of how program goals are set in the T/C program. It is clear that there is a lot of input that provides the background in which decisions are made, but it seems that priorities may be set to some extent by the quality of proposals to do work. Input is received from:

- FESAC (see below).
- IPPA process (see below).
- TTF.
- Theory Committee.
- PSIDAC.
- Compilation of funding proposals.
- Other ?

There seems to be a feeling that there is insufficient analysis of the details of goals for deliberate decision making on priorities. At the same time there is a concern to not inhibit innovation.

- How could this be improved without adding more management layers?
- How can the community take more responsibility for prioritizing the program to ensure a more effective attack on the problems?

6. We agreed that we needed a better understanding of what was happening in the code development, maintenance, availability areas. We have asked for a compilation of the more widely used codes.

- Is there unnecessary duplication?
- What do we want to do with legacy codes?
- How do we make codes more available and user-friendly; particularly for smaller groups?
- How can we attract first rate computer/computer experts?
- What types of computers do we need for different applications/
- Role of NERSC, clusters, work stations, institutional computers?
- How can we best ensure that code developers are properly recognized, are told about bugs in their programs, and modifications to them?
- How do we ensure funds are available to make codes portable?

7. There were discussions about whether support for the program components was too fragmented. In our desire to show collaboration, were we forcing it and ending up with numbers of small fractions of FTEs (e.g., 20 x 0.1 FTEs) rather than having a few contributors spend more time (e.g., 4 x 0.5 FTEs). It was also commented that it could be more effective for a program element to have everybody on one site, bite the bullet and have people employed by the host organization e.g., for an experiment.
- How are such things decided?
- Is there any data on this?

There are some obvious questions:

- Do the individuals in a fragmented situation or individual performers have an association with a group that is strong in some aspect of T/C, or bring special skills?
- Do they couple to other areas of plasma science?
- What is the time-scale of the program element?
- Is co-location a critical issue?

8. There was a concern that the T/C program is not exciting enough, or explained in an exciting manner to attract bright new people. This problem is seen at universities particularly, and in some skill areas e.g., computing/computing. A corollary question is, how do we connect reward to performance?

The FESAC Knoxville report said:

• “The dramatic advances in the predictive power of modern theory and simulation make these tools essential elements of a cost-effective program.”

• “ Strengthen theory and computation as very cost effective means to advance fusion and plasma science, taking advantage of advances in computation science and technology.”

The Integrated Program Planning Activity (IPPA) lists the main goals for the OFES program:

The central elements of these plans are represented by four MFE and two IFE programmatic goals.

These goals are:

MFE PROGRAM GOALS

1. Advance the fundamental understanding of plasma, the fourth state of matter, and enhance predictive capabilities, through the comparison of well-diagnosed experiments, theory and simulation.

2. Resolve outstanding scientific issues and establish reduced-cost paths to more attractive fusion energy systems by investigating a broad range of innovative magnetic confinement configurations.

3. Advance understanding and innovation in high-performance plasmas, optimizing for projected power-plant requirements, and participate in a burning plasma experiment.

4. Develop enabling technologies to advance fusion science; pursue innovative technologies and materials to improve the vision for fusion energy; and apply systems analysis to optimize fusion development.

IFE PROGRAM GOALS

1. Advance the fundamental understanding and predictability of high energy density plasmas for IFE, leveraging from the ICF target physics work sponsored by the National Nuclear Security Agency's Office of Defense Programs.

2. Develop the science and technology of attractive rep-rated IFE power systems, again leveraging from the work sponsored by DOE in the DP ICF Program. The knowledge base for next step decisions in the development of fusion energy will be based upon these six key program goals. These goals are the guiding basis for the Integrated Program.

Table 3.1 The Program Goals and Objectives.

Goals	5-Year Objectives	10-Year Objectives	15-Year Objectives
Goal 1. Advance understanding of plasma, the fourth state of matter, and enhance predictive capabilities, through comparison of well-diagnosed experiments, theory and simulation	**1.1 Turbulence and Transport** Advance scientific understanding of turbulent transport forming the basis for a reliable predictive capability in externally controlled systems. **1.2 Macroscopic Stability** Develop detailed predictive capability for macroscopic stability, including resistive and kinetic effects. **1.3 Wave Particle Interactions** Develop predictive capability for plasma heating, flow, and current drive, as well as energetic particle driven instabilities, in a variety of magnetic confinement configurations and especially for reactor-relevant regimes. **1.4 Multiphase Interfaces** Advance the capability to predict detailed multi-phase plasma-wall interfaces at very high power-and particle-fluxes. **1.5 General Science** Advance the forefront of non-fusion plasma science and plasma technology across a broad frontier, synergistically with the development of fusion science in both MFE and IFE.	**Develop fully integrated capability** for predicting the performance of externally-controlled systems including turbulent transport, macroscopic stability, wave particle physics and multi-phase interfaces. **Develop qualitative predictive capability** for transport and stability in self-organized systems. **Advance the forefront of non-fusion plasma science and technology** across a broad frontier, synergistically with the development of fusion science.	**Develop a fully validated comprehensive simulation capability** applicable to the broad range of magnetic confinement configurations. **Advance the forefront of non-fusion plasma science and technology** across a broad frontier, synergistically with the development of fusion science.

Goals	5-Year Objectives	Medium Term to 20 Years
Goal 5: Advance the fundamental understanding and predictability of high energy density (HED) plasmas for IFE, leveraging from the ICF target physics work sponsored by the National Nuclear Security Agency's Office of Defense Programs.	**5.1 Beam Target Interaction and Coupling** Advance the understanding of driver interaction and coupling in IFE targets to a level sufficient to determine tradeoffs among driver beam focusing, absorption, x-ray production, beam-plasma instability, and target preheat. **5.2 Energy Transport and Symmetry** Advance the understanding of energy transport to a level sufficient to determine the tradeoffs between the number of beams and chamber geometry, beam spatial profile, beam pointing accuracy and beam power balance, as well as hohlraum geometry for indirect drive. **5.3 Implosion Dynamics and Equations of State (EOS) of Materials** Advance the understanding of implosion dynamics and EOS of fusion materials to a level sufficient to determine the pulse shape and timing requirements for IFE targets. **5.4 Hydrodynamic Instability and Mix** Advance the understanding of hydrodynamic instability and mix sufficient to determine the tradeoffs between techniques to optimize ablation stabilization as well as other approaches to reducing instability growth, and the driver requirements on intensity, spatial uniformity and pulse shaping. **5.5 Ignition and Burn Propagation** Advance the integrated understanding of coupling, symmetry, pulse shaping, and instability sufficient to specify the optimal assembly of fuel for ignition and burn propagation subject to tradeoffs in driver, chamber and target fabrication specifications.	Develop optimized target designs based on information from the IRE and NIF and other intertial fusion programs.