Third Report of the Informal National Compact Stellarator Experiment
Program Advisory Committee
3-4 June 1999

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The Informal National Compact Stellarator Experiment (NCSX) Program Advisory Committee (PAC) met on June 3 and 4, 1999 to advise the director of the Princeton Plasma Physics Laboratory, Robert Goldston, on whether the appropriate: (1) machine characteristics are being designed so as to economically address the highest priority physics issues and (2) physics and engineering analyses are being performed to evaluate machine capabilities. The Committee also had broader comments on the development of the design work.

The PAC found substantial progress had been made in both the physics and engineering design of NCSX since the December 1998 meeting. The NCSX team presented a design that has an interesting plasma configuration, a set of coils that can produce it, and a construction scenario based on the reuse of the PBX site and coils. The success at building a national design team is impressive.

Near term priorities are being set by the desire for a Physics Validation Review (PVR) in the fall of 1999 as well as the July 1999 Snowmass meeting on the fusion program. The PAC makes four observations relative to the near term priorities. (1) The critical path to a PVR is set by the need to conduct device flexibility studies. The flexibility of the coil set is critical for accommodating different current and pressure profiles and magnitudes as well as studying the physics of varying the plasma shape. In particular, the coils must be consistent with a start-up scenario. (2) By the PVR, the team must show magnetic surfaces exist in the primary plasma configurations and must have a plausible scenario for maintaining surfaces in other configurations. (3) The NCSX design team needs a clearer statement of the achievable physics program versus the technical capabilities of a proposed device. In particular, the attainability and the effect of pulse length, magnetic field strength, heating power, and diagnostic access on the physics program needs better definition. Without such studies trade-offs can not be optimally made. (4) Confinement enhancement techniques need to be explored, especially those that might affect machine design. Existing studies indicate the available neutral beam power of 6 MW is marginal for achieving a plasma beta of 4% at a field of 1.2 T. The implied confinement is comparable to the best obtained in stellarators of similar size but at lower values of beta, about 1.6 Times L-mode and 2.3 Times ISS95.

Plasma access and magnetic surface maintenance issues must be definitively addressed in a Conceptual Design Review (CDR) and affect nearer term design activities. Studies of plasma access for heating and diagnostics has received limited attention and the space allocated for ports in the preconceptual design is inadequate. The diagnostic and heating capabilities of the device will be largely determined by the available port space, and the requirement for access will constrain the design of coils. An optimal strategy for obtaining good magnetic surfaces over a broad range of NCSX configurations may require significant time to develop and will be required before the CDR.

Although the NCSX team must focus resources to complete the studies required for a PVR, lower priority items should be addressed. For example, the coil group should

explore ideas for additional reductions in the current density, which would extend the pulse length, while producing a broad range of interesting configurations. The physics group should search for configurations with higher beta, greater than 4%, such as plasmas with additional axisymmetric elongation or plasmas with pressure profiles that are marginal to the ballooning mode across the radial profile. Theoretical analyses to resolve the uncertainties in the bootstrap current should be continued. However, the uncertainties affect the reactor vision for quasi-axisymmetric stellarators rather than the design of the experiment. Preliminary studies of high harmonic fast wave (HHFW) heating at 350 MHz were presented. Wave heating options should be explored further.

In summary, the answer to the question whether the appropriate machine characteristics are being designed so as to economically address the highest priority physics issues is: Major progress has been made in finding an appropriate design point. However, the flexibility of the machine to produce a variety of interesting plasmas must be addressed before the PVR. The physics goals versus technical capabilities of a device should be better defined. The attainment of the design beta, 4%, will require confinement comparable to the best obtained in stellarators of similar size. Confinement enhancement techniques and their implications for the machine design need to be studied. The answer to the question whether the appropriate physics and engineering analyses are being performed to evaluate machine capabilities is: The best available tools are being used. However, these tools may require refinement to address the issues of flexibility and magnetic surface existence.