Fusion Engineering Science

The FESAC Priorities Panel report describes this area as, “Understand the fundamental properties of materials and the engineering science in the harsh fusion environment.”

This section is brief because much of this area is outside the scope of the three experiments, and various aspects are discussed elsewhere in the report.

In this talk a brief review is given of contributions to plasma technologies for heating and current drive, fueling and plasma-facing materials. In addition there is the goal of supporting the safe operation of ITER, including disruption mitigation.
The wide range of complementary heating schemes used in the U.S. facilities, are important for both profile and instability control.

- C-Mod with Ion Cyclotron and Lower Hybrid.
- DIII-D with Electron Cyclotron and Fast Wave
- NSTX with Electron Bernstein and High Harmonic Fast Wave.

NSTX is studying Coaxial Helicity Injection to enable solenoid-free start-up.
Plasma Facing Materials

An issue for ITER which plans Beryllium main walls, Carbon fiber composites and Tungsten brushes for the divertor.

- C-Mod has all-metal, molybdenum walls, and is testing tungsten brushes built by Sandia – see figure.

- DIII-D uses all carbon and may test hydrogen recovery with oxygen baking.

- NSTX uses carbon and is testing lithium for pumping and as a divertor target.

- C-Mod and NSTX target plates have ITER-level divertor power density.

Tungsten “brush” tile built by Sandia is being tested in C-Mod
Pumping, Fueling, Disruptions

- DIII-D uses cryo-pumping for density control in H-Modes.
- C-Mod operates at ITER scrape-off layer power density and opacity, and plans cryo-pumping with neutrals in the fluid regime.
- A variety of fueling systems is in use, including pellet injection, and a compact torus injector will be installed on NSTX.
- C-Mod and DIII-D have installed disruption detection, avoidance, and mitigation systems which will be necessary for ITER operation.
Integrated Operational Scenarios

- Significant contributions have been made and will continue to be made in demonstrating operational scenarios that maximize performance – beta, transport, impurity minimization, “steady state” - while minimizing undesirable wall and divertor interactions.

- In DIII-D, the MIMO – dynamical control system – uses inputs from profiles and instability mode behavior. This work is very important for ITER.

- The MDSplus data management system, developed at C-Mod, is now used at 30 sites internationally, as well as for ITER databases and for remote access to JET.