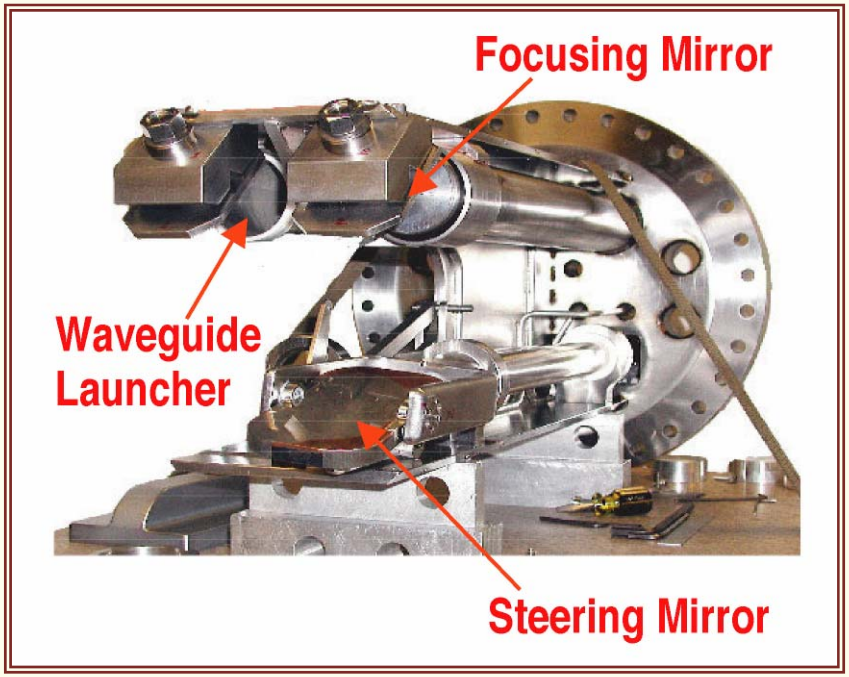
Fusion Engineering Science

- 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.

Wave Heating Schemes

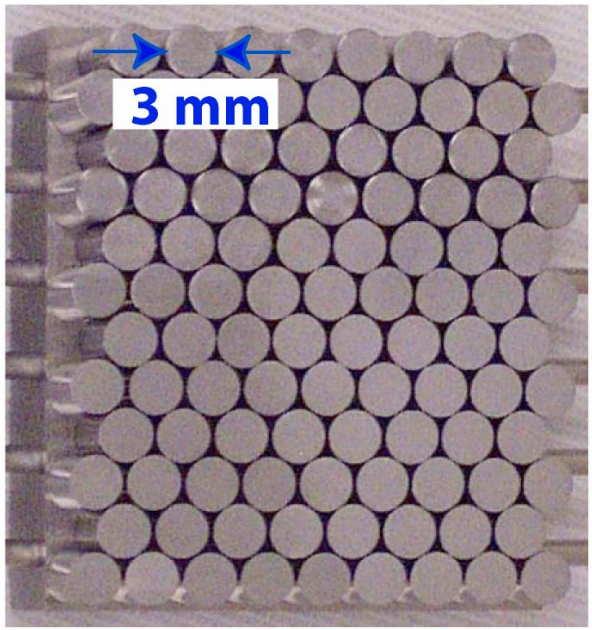
- The wide range of complementary heating schemes used in the U.S. facilities, are important for both profile and instability control.
  - C-Mod with Ion Cyclotron and Lower Hybrid.
  - DIII-D with Electron Cyclotron and Fast Wave
  - NSTX with Electron Bernstein and High Harmonic Fast Wave.
- NSTX is studying Coaxial Helicity Injection to enable solenoid-free start-up.



Steerable Launcher for Electron Cyclotron Waves On DIII-D (built by PPPL)

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.