Response to Liquid Surface Module at NSTX 5-Year Plan Ideas Forum

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Outline

- IPPA Boundary Physics Goals on Spherical Torus
- IPPA Goals on Boundary Physics - heat flux and impurities
- Summary of Liquid Surface Module Presentation at NSTX 5-Year Plan Forum
- Liquid Surface Module Issues Raised at NSTX 5-Year Plan Forum

IPPA Boundary Physics Goals on Spherical Torus

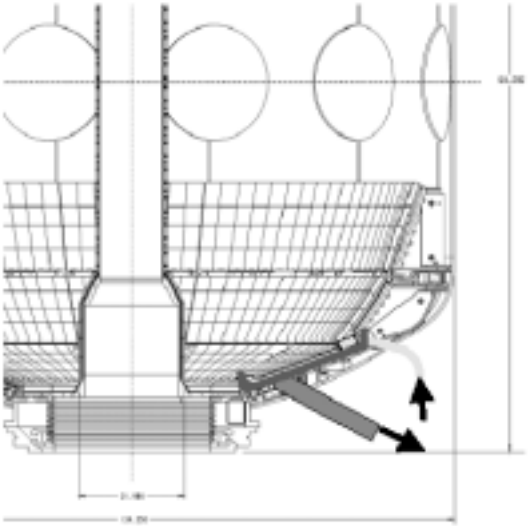
- 5-Year Objective: Make preliminary determination of the attractiveness of the spherical torus (ST), by bootstrap operation and acceptable divertor heat flux, for pulse lengths much greater than energy confinement times.

- Implementing Approaches:
  - 3.2.1.5 Disperse Edge Heat Flux at Acceptable Levels:Study the dispersion of edge heat flux over a range of externally controllable parameters and estimate the plasma facing component requirements under high heating power in the spherical torus magnetic geometry. Determine the ability for managing intense energy and particle fluxes in the edge geometry and for increasing pulse durations significantly beyond the energy confinement time. Most elements of the physics on the edge open field lines are shared between the ST and the tokamak, while the ST introduces stronger variations of the magnetic field strength along the field lines that are closer to the magnetic mirror. The “toroidal mirror” configuration also tends to have large flux expansion in the divertor region, likely extending the physics research into new parameter regimes.

IPPA Goals on Boundary Physics - heat flux and impurities

- 3.1.4.3 Plasma-wall Interaction: Understand the conditions under which the heat flux from the plasma core can be more broadly distributed on vessel walls an divertor. Develop fundamental understanding of conditions for detachment of flowing plasma from the divertor plate. Use materials-physics data to determine level of tritium retention in walls. Refine understanding of atomic and plasma physical processes in sheath regions near confining walls.

Summary of Liquid Surface Module Presentation at NSTX 5-Yr Plan Forum



- Liquid surface module designed to remove 10^{23} particles/ shot
  - Can also help with power handling capability
- Lithium surface area ~ 1 m^2 , 10 m/s flow velocity
- Proposed liquid surface module has the potential of addressing particle control needs in the 5 year plan.
- Several R& D issues have been resolved over the past 15 months
- The key remaining issue is MHD effects on the flowing liquid metal
- Experiments are beginning to provide the data needed to validate the MHD modeling
- MHD modeling is progressing with key issues about boundary conditions and computational schemes being optimized.
- We anticipate making a decision to implement a flowing liquid surface in a fusion device in Fall 2003.

Liquid Surface Module Issues Raised at NSTX 5-Year Plan Forum

- Accepted as possible solution for particle control but also recognized that much work is still needed.
- Effectiveness for helium pumping should be studied (cf IPPA Goal 3.1.4.3).
- Concern raised about what happens to liquid surface module during ELM's.
- Requirements for major machine modifications an issue.
  - Tight space may eliminate possibility for midplane module.
  - Divertor module may be more practical.
    - » Experience in removal and modification of lower divertor plate this NSTX opening may be useful.