Proposal Submission for NSTX Research Forum 2001

Title	Liquid Surface Module for Particle Control
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Liquid Surface Module for Particle Control

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There is a growing body of evidence that particle control is important even in short pulse devices. One of the papers at the APS meeting was a presentation from DIII-D on improvements in plasma performance (ELM free H-mode plasmas and higher edge temperatures) when pumping was performed in a closed upper divertor. Experiments on Tore Supra have shown that the particle inventory in the walls of a tokamak can take a very long time to remove at the low particle pumping rate available on Tore Supra. Since NSTX has added neutral beam heating and coaxial helicity injection, and is planning to add pellet fueling, all of which are strong particle sources, it seems wise to try to add particle control to the list of tools that are available on the device. Research on liquid surfaces for fusion applications have shown that flowing surface offer the possibility for both power and particle removal from fusion devices. We propose to design and construct a limiter or divertor module for NSTX that will provide the ability to remove H and D particles from the edge plasma region and alter the particle recycling on NSTX.

We will conduct a design study to determine the best location for the module (outboard mid-plane as a limiter, in the divertor region, or other locations). The module must be designed to remove the heat flux associated with the particle flux needed to alter the particle inventory in the machine. The leading edges of the module must be recessed from the contact surface to prevent overheating of the edges. The design will be coordinated with existing and planned diagnostics, the configuration of the machine, and be constructed so that comparisons can be made with and without the module functioning. The design will include an assessment of the particle pumping to be expected, the heat removal capability, MHD effects on the flowing liquid surface, an assessment of the ES&H issues associated with the module and external systems needed to flow the liquid, and an assessment of the potential risks associated with the module. Funding for the project will be provided from the Technology Program.

We will present options for a limiter module at the outboard mid-plane and a divertor module. The limiter module will be designed to be retracted beyond the outer passive plates to allow comparison of the particle removal with and without the module. The flowing surface will be accomplished either by using flow over a backing plate or free flowing streams. The flow will be active only during plasma pulses. MHD effects on the flowing streams have shown the need for insulating side walls on the backing plate. ES&H issues related to the flow will be discussed.

We have used the UEDGE code to estimate the properties of the plasma scrape-off layer (SOL). The predicted heat and particle flux to the limiter are 6-12 MW/m^2 and ~5 x $10^{18}/cm^2/s$. The scrape-off lengths are 1-5 mm. Using these characteristics of the plasma edge, the TMAP code has been used to calculate hydrogen retention in the flowing streams. For a flow velocity of 10 m/s, the estimated particle removal rate is 5 x $10^{20}/s$. These estimates show that the pumping is sufficient to alter the particle recycling in NSTX.