Proposal Submission for NSTX Research Forum 2001

Title	**Flexible Fueling System for NSTX Transport Studies**
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Flexible Fueling System for NSTX Transport Studies

This proposal is for a flexible pellet fueling system to be installed on NSTX to be used in studies of density profile control and transport barrier formation. Pellet injection in NSTX will provide a potential advanced confinement regime trigger as has been observed on DIII-D. Pellets on DIII-D have been used to induce H-mode operation at 30% lower power than was obtained with the pellet trigger. Strongly peaked density profiles have also been obtained on DIII-D with multiple pellet injection leading to PEP-mode internal transport barriers with Te ~ Ti. The NSTX pellet fueling system will also provide a tool for core particle transport studies. Density perturbations from deep and shallow penetrating pellets can be used to investigate the transport of majority ion species in the core plasma. Impurity doped pellets can be produced for impurity transport studies.

Pellet injection will enable the extension of the NSTX operating regime to higher density than has thus far been achieved. The use of pellet injection to increase the density on NSTX may also have the benefit of leading to improved confinement above the presently observed Ohmic saturation density of about $4x10^{19}$ m^{-3}. A number of tokamak experiments such as Alcator-C have seen improved Ohmic confinement at high density with pellet injection, presumably due to stabilization of ITG turbulence with peaked density profiles.

The pellet injector proposed for use on NSTX is a small portable device known as a “pellet injector in a suitcase (PIS)”. PIS is being developed in the OFES fueling technology program. It has 4 independent barrels that can each produce a single cylindrical pellet. The simplified advanced design of PIS utilizes a self contained liquid helium (LHe) refrigerator (cryo-cooler) to freeze the pellets in-situ in the barrels and thus LHe is not required for this injector.

The NSTX machine size and target plasmas are well matched to this simplified pellet injection system. The range of pellet sizes are from 1mm diameter ($5x10^{19}$ atoms) to 2.7mm diameter ($9 x10^{20}$ atoms). The range of pellet speeds using a single stage hydrogen propellant driver are 200 - 1500 m/sec speed. Penetration depth scales as pellet velocity to the 1/3 power thus leading to a penetration range of a factor of 2.
The START experiments used vertical pellet injection aimed toward the inner column. The initial application on NSTX would most likely be outside midplane launch, but could easily be changed to vertical and off-axis launch with the use of curved guide tubes. Several injection trajectories can be used to investigate different NSTX physics objectives:

- Outside midplane - ITB formation, density limit, transport, B ablatant drift
- Off axis - ITB formation with off axis shear in rotation
- Vertical – high field side fueling, transport

For NSTX, B is inward on the low field side in high beta cases, which may yield inward drift of pellet ablatant instead of outward drift as seen in tokamaks.