Proposal Submission for NSTX Research Forum 2001

Title	**Flexible Fueling System for NSTX High Density Operation**
First Name and Initial(s)	Larry R.
Last Name	Baylor
Email address	BaylorLR@ornl.gov
Mailing address	ORNL Box 2009, Oak Ridge, TN 37831-8071
Phone number	865-574-1164
Institution	ORNL
Co-authors	M. Gouge, G. Schmidt, R. Maingi, S. Combs
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Flexible Fueling System for NSTX High Density Operation

This proposal is for a flexible pellet fueling system to be installed on NSTX for use in studies of high density operation and density profile control. Pellet injection will enable the extension of the NSTX operating regime to higher density than has thus far been achieved, which is limited by fueling capability. Pellet experiments on START were able to achieve a central density of $5x10^{20}$ m^{-3}, which corresponded to a Greenwald factor (nGW) of 1.6. 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.

Pellet injection in NSTX will also 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 without 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. The NSTX pellet fueling system will 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.

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 and will be initially used on MST at U.Wisconsin. It has 4 independent barrels that can each produce a single cylindrical pellet. The simplified advanced design of PIS utilizes a self contained LHe refrigerator (cryo-cooler) to freeze the pellets in-situ in the barrels and thus liquid helium 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 ($9x10^{20}$ 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 factor of 2 in possible penetration range.

The START pellet experiments used vertical 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 launch with the use of curved guide tubes. Injection through curved guide tubes will require slow pellets (<500 m/s) to insure survival of intact pellets. Slow pellets in PIS are achieved with the use of a mechanical punch to accelerate the pellets with minimal propellant gas.