Proposal and Attendance Form for NSTX Research Forum 2001

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Please write in the boxes below a one-page abstract of your proposal to be presented:

Title: Local transport diagnostic for NSTX using USXR imaging of Tracer Encapsulated Solid Pellet Injection

We propose to implement on NSTX a novel transport diagnostic, which combines the Tracer Encapsulated Solid Pellet Injection (TESPEL) technique recently developed at LHD [1], with the Ultrasoft X-ray Telescope now being developed by our group [2].

TESPEL consists in injecting a tracer impurity pellet (typically lithium hydride) embedded in a plastic shell. The pellet travels though the plasma without causing any significant perturbation, except for a weak fueling effect. At a radial location controllable through the pellet launch velocity, the tracer is released and ionized, producing a narrow (1-2 cm width) shell of fully stripped Li ions. The shell is made visible through charge exchange (CX) reactions at the locations where it crosses the neutral heating beam. By following the radial spread of this internal, localized source it is then possible to directly determine the local particle transport coefficients.

The visible light CX emission from TESPEL is very faint however, due to the low density of Li ions achievable ($\leq$ 1% N_e) and to the rapid decrease in CX cross sections with increasing quantum number. Most of the power due to CX reactions is emitted in the 135 Å, $\Delta n=1-2$ resonance line.

We therefore propose to image the TESPEL ultrasoft X-ray light using a multilayer mirror telescope. In addition to mapping with good spatial resolution (< 1 cm) the distribution of Li ions, when used in conjunction with a fast 2-D detector (see e.g., D. Pacella's talk) such an instrument could also image turbulent fluctuations in the Li III shell. The proposed diagnostic would then simultaneously assess the local transport and fluctuations, enabling a direct correlation between the two. As in BES, imaging of the turbulent structures would require viewing the beam along the magnetic field lines.

In addition, we identify other exciting diagnostic possibilities using TESPEL and USXR imaging. For example, one could image the bright plume of collisionally excited Li III ions transiently produced at the pellet location, for a measurement of the magnetic field pitch angle. Also, using a higher-Z tracer (e.g., Al) one could 'illuminate' a narrow range of flux surfaces with bright, longer-lasting He-like and H-like SXR line emission and use this light to image flux surface deformations arising from ideal MHD modes.

Finally, we note that TESPEL has excellent potential for 'cold pulse' propagation experiments. For example, injection of an Al pellet at mid-radius in NSTX would produce a brief, localized, but strong cooling effect propagating both inward and outward.

A collaboration with the LHD diagnostic team towards the development of imaging instruments for TESPEL and its possible application on NSTX has already been initiated.

1. S. Sudo et al., Proc. 17th IAEA Fusion Energy Conference, Yokohama, Japan, 1998
2. D. Stutman et al., in print, Rev. Sci. Instrum., January 2001

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