Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: **Characterization of turbulence in the NSTX boundary**		
OP-XP-437	**Revision: 1**	Effective Date: *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS	
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Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

0.0 Overview of the Planned Experiments

A basic characterization of the properties of turbulence in the NSTX edge is required to develop an elementary knowledge of the cross-field transport, benchmark NSTX against other devices and eventually, advance basic understanding by comparing measurements to BOUT predictions. Further experiments will eventually allow a systematic survey of the dependence of turbulence on heating power, shape, and density. We will start with L-mode since the signal/noise ratio is higher. The GPI camera and the edge reciprocating probe were repositioned during the last vacuum opening and are now set for a 30-35° pitch angle. Consequently, the experiments should be performed at ~800-900 kA plasma current and a ~4.5 kG toroidal field, conditions that also have been shown to have long duration H-modes.

A density scan will be first priority since the edge turbulence is predicted to depend crucially on a combination of Ballooning/Resistive X-point interplay as can be seen in Fig. 1. The simulations indicate that as the density is increased (at constant pressure), the turbulence peaks more strongly on the LFS midplane and its intensity increase. Although NSTX does not have poloidally resolved turbulence diagnostics yet, the changes in turbulence intensity should be clearly observable. Further data will be obtained in H-mode, where the predictions hold, although at lower intensity levels due to the stabilization of turbulence by velocity shear. The key diagnostics for this XP will be:

- Fast Probe for edge fluctuations and profiles
- Reflectometers
- GPI edge camera for edge fluctuations
- H_α/D_α cameras and diodes particle inventory/transport analysis
- Divertor Langmuir probes for divertor electron density, temperature, and particle flux

The basic L-mode experiments should be performed with fairly low NBI power or strong gas puff to keep the plasma in L-mode. For true LSN, (800 kA, 0.45 T) the L-H transition power threshold should be ~650 kW unless LFS fueling is used. The plasma should be run so that ~4 density values ranging from 1.5 to ~4.5×10^{13} cm^{-3} (high density values may be too high for low power conditions) can be achieved. Particular attention will be paid to detecting MARFEs and the effects of plasma detachment. The diagnostics can take data at various times during the discharge to have the desired density.

The power levels will be obtained by using derated NBI sources, instead of modulated, to avoid separatrix oscillations. The higher power discharges can be kept in L-mode if desired by strong outboard gas fueling:

- Run with higher power sources (de-rated ~ 60 kV) or 750 kW per source and add sources for total power levels of 750, 1500 and 2250 kW.

The experiments can start with the lowest power set (~750 kW) and fuel the plasma on the LFS so that it is kept in L-mode and the lowest desired density is achieved. The density increase in NSTX will naturally provide higher densities. The gas puff can be increased to achieve higher densities if needed.

After the first density scan, the power should be increased to the next step and if possible, kept in L-mode by gas puffing and the density scan repeated. A third power point at (~2250 kW) will follow, obtaining H-mode, and a density scan will be performed. If short for time, sacrifice the mid power series.

The second data set concentrates on comparing the LSN configuration to a double null diverted (DND) plasma at two NBI power levels conducing to L and H-mode. The physics basis for this comparison is the addition of a second X-point and the corresponding resistive mode. The expectation is that a second X-point not only would increase the source but also pin down the existing mode and thus the fluctuation levels should increase on the LFS

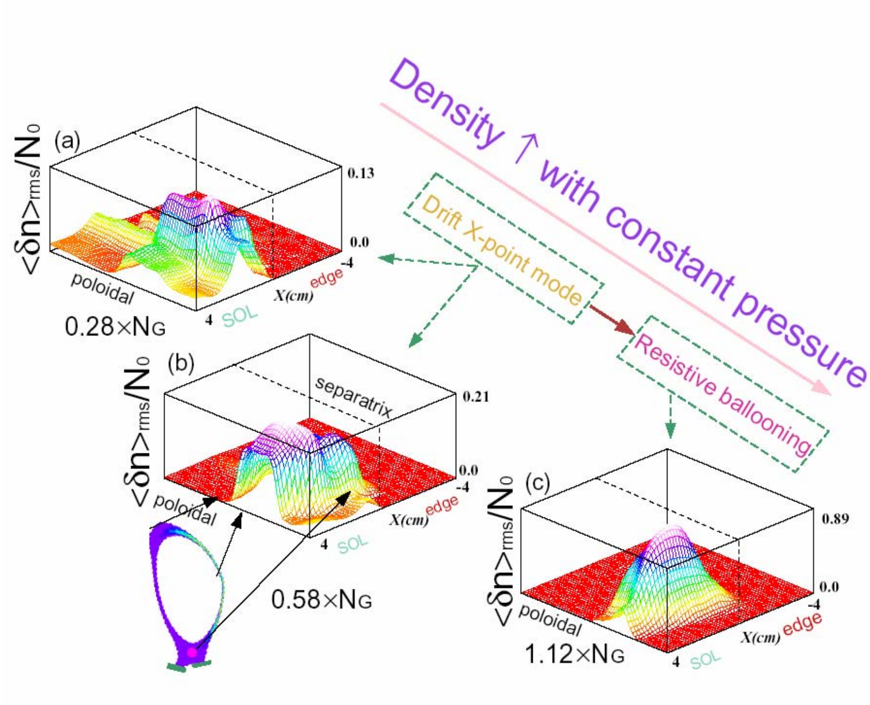

Figure 1. BOUT-predicted poloidal/radial variation of normalized density fluctuations with Greenwald factor (DIII-D simulation).

. Another BOUT prediction is that the ExB velocity shear levels will change substantially when the configuration is shifted from LSN to DN. An example of changes induced by modifying the grad-B direction (or the location of the X-point) is shown in Fig. 2, where the turbulent radial particle flux varies by factors of ~2 inside the LCFS.

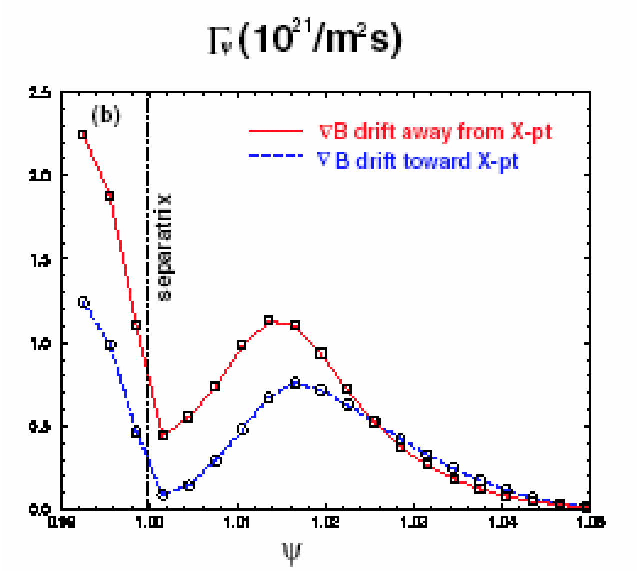

Figure 2. BOUT-predicted variation of the surfaced-averaged particle flux with change in the direction of the Grad-B drift. Factors of ~2 at the LCFS.

2.0 Conditions and Requirements

The main mode of operation is in lower single null divertor geometry, with some shots in DN for comparison. Operations are design to be a compromise between having enough flux-swing to maintain a 200-300 msec current flat-top and running in H-mode with I_p~ 800 kA and B_t = 4.5 kG. Note that ELM free H-mode are to be avoided because they are transient in nature. H-modes with continuous ELM's are acceptable, especially if shots with and without transitions can be taken for comparison. A shots such as 110194, 111543 and 111902 are a good reference.

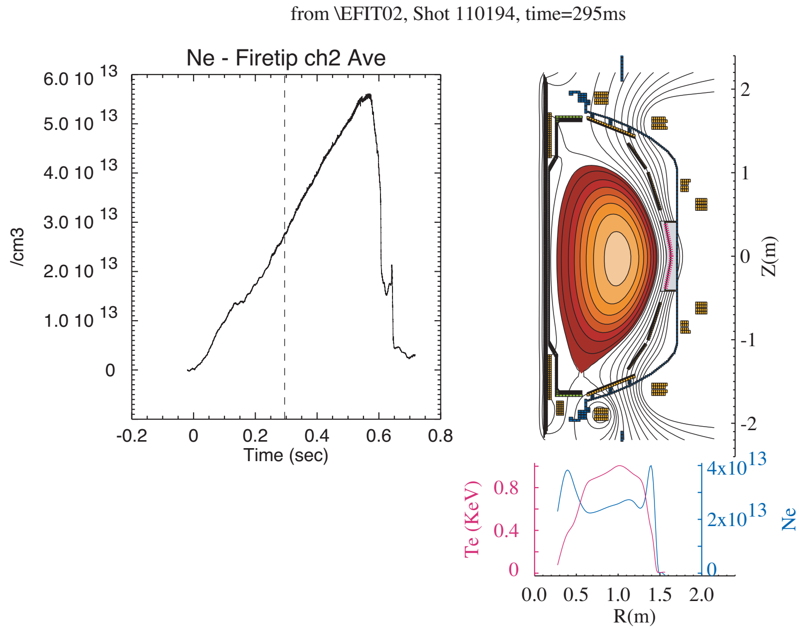

Figure 3. Configuration for reference shot 110194 (other references 111543 and 111902).