Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: Comparative Study of the scattered spectra between L and H mode confinement regime on NSTX.

OP-XP-629	**Revision: 1**	Effective Date: 6 June 06 *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Author: H. Park, D. Smith, E. Mazzucato, K.C. Lee, R. Maingi	Date
ATI – ET Group Leader: M. Bell, K. Tritz (T&T)	Date
RLM - Run Coordinator: R. Raman	Date

Responsible Division: Experimental Research Operations

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

Comparative Study of the scattered spectra between L and H mode confinement regime on NSTX. **OP-XP-629**

1. Overview of planned experiment

During the initial operation of the high-k scattering system on NSTX, the observed scattered power spectra during the H-mode phase was significantly different from the L-mode phase at the edge of the plasma. Monotonically decreasing power spectra as function of wave-numbers during the L-mode phase is changed into a non-monotonic shape. A growth of the power spectrum at the highest k was noted as the power spectra of intermediate wave-numbers remained clamped. The observed phenomenon is new and requires a systematic study near the edge region and the measurement will be compared with other fluctuation measurement and timing of the transition. The objective of this XP is to measure the scattered spectra at a few different edge radial positions (143 cm. 140 cm and 137 cm) so that the detailed comparison could be made with other fluctuation diagnostics and variations of the transition characteristics at different tangencies could be investigated as the pressure gradient rapidly changes.

2. Theoretical/ empirical justification

1) The newly observed variations in the scattered spectra from L-mode to the H-mode phase transition warrant a detailed experiment to improve understanding of the relationship between confinement and the behavior of the turbulence at high wave-numbers.

2) The observed momentum bifurcation from one wave-number to another may require more experiments to build new theoretical models.

3) Understanding of the spatial delay time of the changes in the power spectra at different wave-numbers during L to H transition is critical to build a model. Therefore, comparison studies of the transition timing and variation in the scattered spectra as function of tangencies with other fast fluctuation diagnostics is necessary. Especially fluctuation data from the FIReTIP edge channel #7 will be extremely useful for comparison with the scattered spectra from lowest wave-numbers. The transition time changes can be compared with the D_α signals, Mirnov coil signals, etc.

3. Experimental run plan

Sample scattering raw signals from the edge of the OH and NBI heated discharges are illustrated in Fig. 1 and Fig. 2, respectively. In an OH discharge, the scattered power is monotonically decreasing as function of wave-numbers within the present experimental error bars. The trend in L-mode discharge of the NBI heated plasmas is not much different from that of the OH discharges as shown in early and later stages of the discharge in Fig. 2. During the H-mode phase, changes in the scattered spectra are significantly different from those of the L-mode phase as illustrated in this figure. As the transition is occurring, a sudden drop of the scattered power in lower wave-numbers is clearly seen. However, the recovery of the scattered power in the lowest wave-number is noted while the power spectra in the intermediate wave-numbers are clamped for the duration of the H–mode. Notable growth of power spectra is observed at the highest wave-number. This new observation certainly warrants more experiment to clarify the physics of high-k spectra behavior during H-mode phase on NSTX. The model discharge is shot #119284, where L to H mode transition is clear and the scattering system was tested and changes in scattered spectra during L to H mode phase was made.

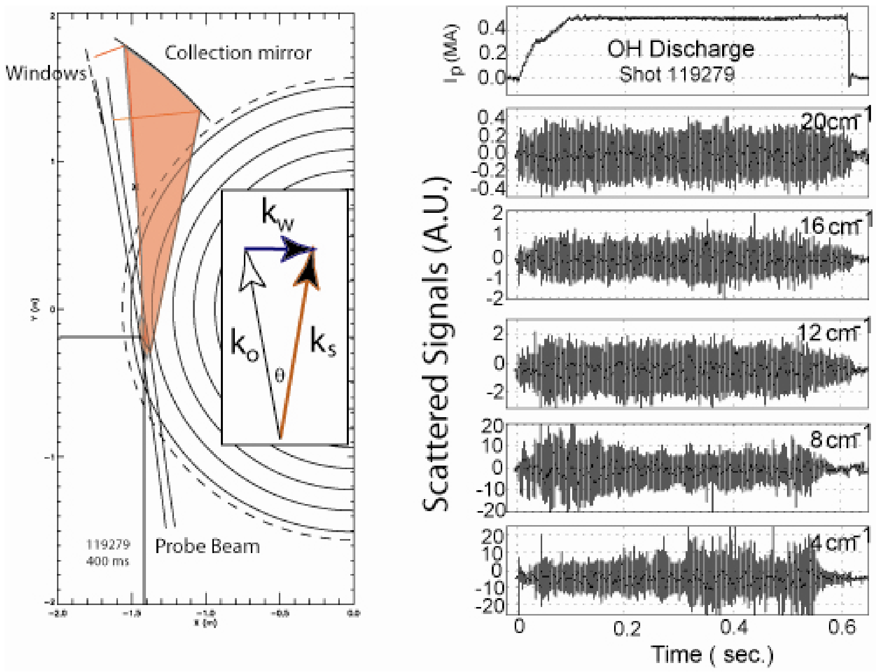

Fig. 1. Scattered geometry and raw scattered signals at five different wavenumbers of the OH discharge.

a) Start with the Standard DN H-mode scenario (NBI~4 MW, Ip~0.9 -1.0 MA: Shot 120157 or a more recent shot with CS gas at 900Torr, NBI SRC A starting at 60ms, B starting at 80ms and C starting at 145ms) with last closed flux surface at Rt = 145 cm. If a drop in fluctuation level is seen during the H-mode phase, on subsequent shots the beams would be turned off before the shot ends to recover comparisons with the L-mode phase. If we do not observe the previously observed behavior, the back-up plan is to return to the conditions of the shot #119284.

b) Stear the launching beam at the Rt =142 cm and adjust the five collection mirrors accordingly. Scan the plasma + 3cm and -3 cm from the nominal Rt =145 cm.

c) Stear the launching beam at the Rt = 135 cm and adjust the five collection mirror position accordingly. Scan the plasma + 3cm and -3 cm from the nominal Rt =145 cm.

d) For the condition in which a clear reduction in the fluctuation level is seen the shot would be repeated after a He plasma conditioning shot to lower the H-mode pedestal density by about 20%.

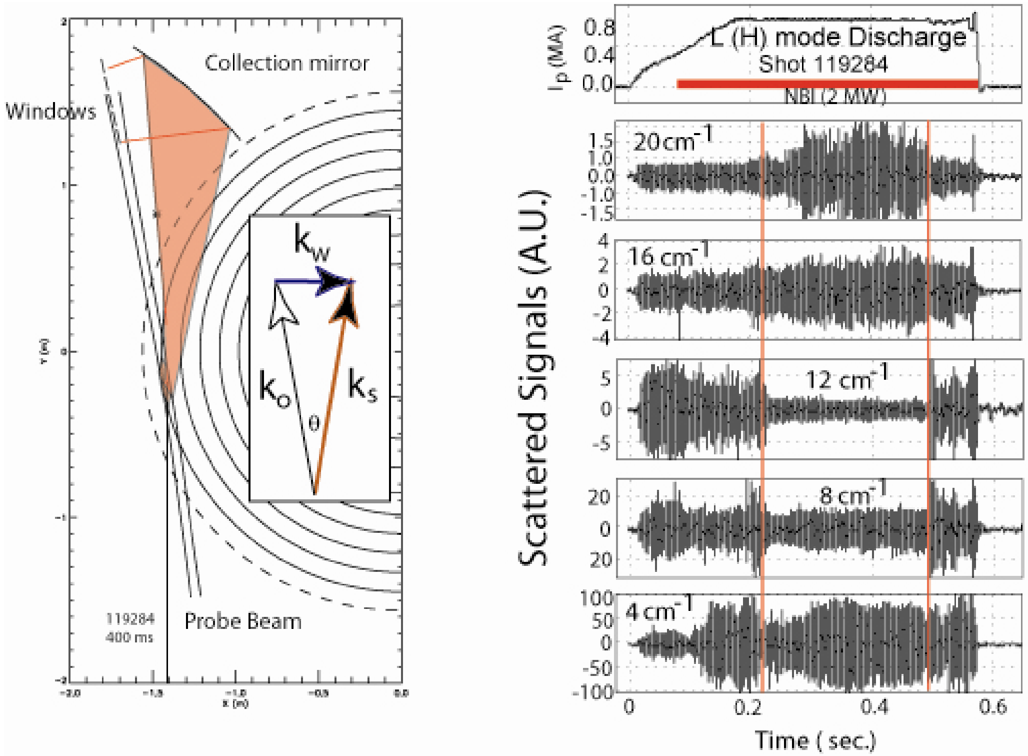

Fig. 2. Scattered raw signal at five different wave-numbers from NBI heated plasmas where L/H transition and corresponding changes in scattered power spectra are clear.

4. Required machine, NBI, RF, CHI and diagnostic capabilities

NBI ~6 MW is required with the source combination for the Ti measurement (source A mandatory for Ti measurement). Reflectometry, probe, GPI and other fluctuation diagnostics systems are required, if possible.

5. Planned analysis

a) Scattered signals will be calibrated with the attenuators (optical and electrical) and theoretical numbers for the scattering geometry such as interaction length will be folded to plot scattered power as function of wave-numbers. FFT analysis will provide frequency spectra information.

b) EFIT and TRANSP will be required for the flux surface check and transport analysis (χ_I, χ_e and other transport related plasma parameters)

6. Planned publication of results

With the system calibration after the run and TRANSP analysis, the result will be aimed to be published in PRL.

PHYSICS OPERATIONS REQUEST

Comparative Study of the scattered spectra between L and H mode confinement regime on NSTX. **OP-XP-629**

Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **-55 kA** Flattop start/stop (s): **0.0/0.8**

I_P (MA): **800 kA – 1MA** Flattop start/stop (s): **0.15/0.6**

Configuration: **Inner Wall / Lower Single Null / Upper SN / Double Null**

Outer gap (m): _____, Inner gap (m): _____

Elongation κ: _____, Triangularity δ: _____

Z position (m): **0.00** **SAME CONFIGURATION with #119284**

Gas Species: **D**, Injector: **Midplane / Inner wall / Lower Dome**

NBI - Species: **D**, Sources: **A/C**, Voltage (kV): **80kV**, Duration (s): **01/0.55**

ICRF – Power (MW): ____, Phasing: **Heating / CD**, Duration (s): _____

CHI: **On / Off**

Either: List previous shot numbers for setup: **#119284**

Or: Sketch the desired time profiles, including inner and outer gaps, κ, δ, heating, fuelling, etc. as appropriate. Accurately label the sketch with times and values.

DIAGNOSTIC CHECKLIST

Comp. Study of the scatt. spectra between L/H mode conf. regime on NSTX.

Diagnostic	Need	Desire	Instructions
Bolometer – tangential array	x		
Bolometer array - divertor			
CHERS	x		
Divertor fast camera			
EBW radiometer			
Edge pressure gauges			
Edge rotation spectroscopy	x		
Fast lost ion probes			
Filterscopes			
FIReTIP	x		
Gas puff imaging	x		
H□ camera - 1D			
Infrared cameras			
Interferometer - 1 mm			
Langmuir probe array	x		
Magnetics - Diamagnetism	x		
Magnetics - Flux loops	✔		
Magnetics - Locked modes			
Magnetics - Pickup coils	✔		
Magnetics - Rogowski coils	✔		
Magnetics - RWM sensors			
Mirnov coils – high frequency			
MSE	x		
Neutral particle analyzer			
Neutron measurements			
Plasma TV	✔		
Reciprocating probe	x		
Reflectometer – core			
Reflectometer - SOL	x		
SPRED	x		
Thomson scattering	x		
Ultrasoft X-ray arrays	x		
Visible bremsstrahlung det.	x		
Visible spectrometer (VIPS)	x		
X-ray crystal spectrometer - H	x		
X-ray crystal spectrometer - V	x		
X-ray GEM camera			
X-ray pinhole camera			

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