Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: Stability of Different ELM Types on NSTX

OP-XP-530	**Revision:**	Effective Date: 07/25/2005 *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

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ATI – ET Group Leader: R. Kaita	Date
RLM - Run Coordinator: J. Menard (S. Sabbagh)	Date 7/26/2005
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

1. Overview of planned experiment

The primary goal of this experiment is to measure the edge plasma profiles just before and after different types of ELMs to facilitate an assessment of the edge stability characteristics. Discharges with different ELM types will be optimized for measurement with the higher resolution edge Thomson channels, although the main focus will be on large Type I ELMs. A secondary goal is to image the ELM structures simultaneously with and the new fast camera from Nova Photonics (divertor) and the Hiroshima camera (midplane fisheye view).

2. Theoretical/ empirical justification

Many different types of ELMs have been observed in NSTX, categorized by the impact on stored energy, dependence on heating power, etc. Several of these ELM types are shown in Figure 1. Until now, edge stability calculations have been inconclusive because the edge plasma gradients were not sufficiently resolved, and the current density profile was not measured. With the recent addition of the new edge Thomson channels and the commissioning of the MSE system, more reliable edge stability calculations will be facilitated for comparison with the edge profiles just before and after an ELM.

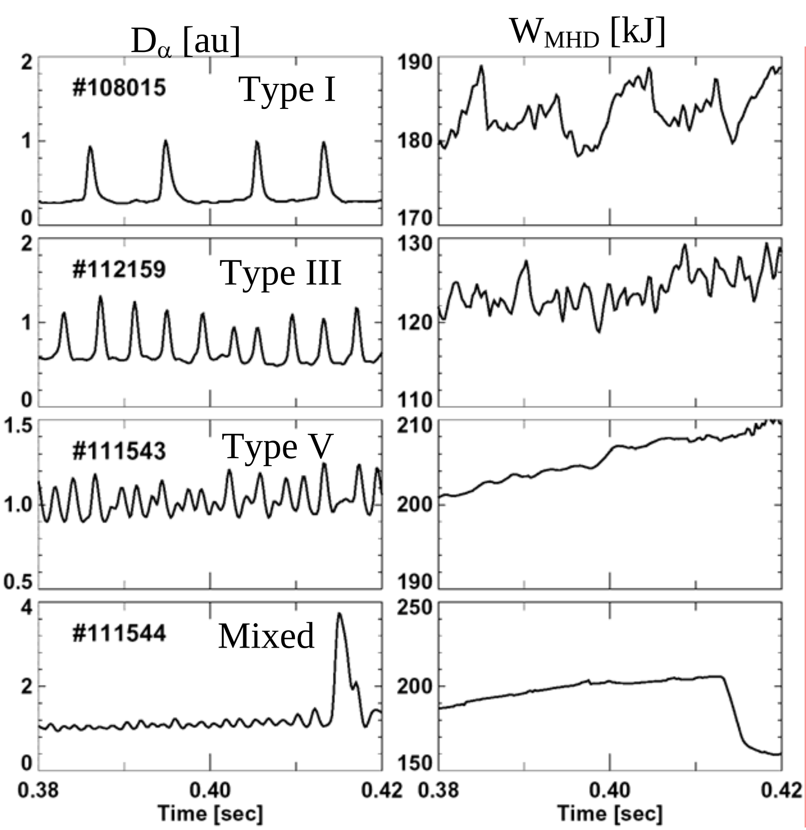

Fig. 1 – Various ELM Types Observed in NSTX (Maingi, EPS 2004)

Several other diagnostics will be used to characterize the ELMs. The Johns Hopkins USXR system will be run mainly in two-color mode with the BayG upward-looking array using the thicker Be100 filter and the Bay-G lower-looking array using mainly the Be10 filter, to facilitate the reconstruction of T_e(R,t). On specific discharges, the arrays will be switched to the Ti filter to look for oscillations near the separatrix which may correspond to the pre-cursors observed in the magnetics data. In addition, the UCLA reflectometer system will be run in fast profile mode to allow rapid reconstruction of the edge $n_e(R,t)$. Finally the ERD diagnostic is needed to allow the investigation of the effect of rotation on edge stability.

3. Experimental run plan (1 day, prioritized list below)

I. Reproduce 117054 – a discharge with mostly Type V ELMs and a few large Type I ELMs. (3 shots)

II. Optimize the outer gap for edge Thomson resolution of the edge gradients – this should occur for outer gap in the range of 6-8 cm. *Use rtEFIT if needed or desired.* (3 shots)

III. Vary the Thomson laser timing to try to optimize edge profile measurement just before a large ELM, i.e. within 5 msec. *This means spacing the lasers 5-10 msec apart, instead of the normal 16.7 msec.* (max. 8 shots)

IV. Reproduce a high δ DN (#115864) to make Type I ELMs without Type V ELMs. (3 shots)

V. Optimize the outer gap for edge Thomson resolution of the edge gradients – this should occur for outer gap in the range of 6-8 cm. (6 shots)

VI. Time permitting – drop the power in the DN to see effect on ELMs and document. (5 shots)

VII. Return to step II and make the discharge up/down symmetric by copying PF2L waveform into PF2U, etc., to make Type III ELMs. *Note that this may not give a symmetric DN – may need to bias slightly downward to get drsep = 0 if desired for low magnetic shear.* (2 shots)

VIII. Time permitting – make a shape between the DN and LSN to see when the Type III ELMs disappear and Type V ELMs appear, and document profiles. (5 shots)

IX. Reproduce a high δ LSN with pf1B (#116313) to make Type ? ELMs. (3 shots)

X. Optimize the outer gap for edge Thomson resolution of the edge gradients – this should occur for outer gap in the range of 6-8 cm. (3 shots)

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

This XP requires an operational NBI system, as well as the capability of generating lower-single null, upper-single null, and double-null diverted discharges with the plasma control system. We desire HeGDC between shots of ~ 11 minutes for a 15 minute repetition rate.

5. Planned analysis

Edge stability calculations will be done with a number of codes, including PEST, DCON, and ELITE, and possibly MARS.

6. Planned publication of results

Data and analysis will be published at the APS meeting in 2005 and the PSI meeting in 2006.

PHYSICS OPERATIONS REQUEST

Stability of Different ELM Types on NSTX **OP-XP-530**

Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **52** Flattop start/stop (s): _____/_____

I_P (MA): **0.7-1.0** Flattop start/stop (s): **0.15/1.5 (max)**

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

Outer gap (m): **5-15cm**, Inner gap (m): **2-10cm**

Elongation κ: **1.8-2.3**, Triangularity δ: **0.3-0.8**

Z position (m): **0.00**

Gas Species: **D**, Injector: **Inner wall Midplane**

NBI - Species: **D**, Sources: **A/B/C**, Voltage (kV): **80-95**, Duration (s): **<1 sec**

ICRF – Power (MW): ____, Phasing: , Duration (s): _____

CHI: **Off**

Either: List previous shot numbers for setup: **117054, 115864, 116313**

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

Stability of Different ELM Types on NSTX **OP-XP-530**

Diagnostic	Need	Desire	Instructions
Bolometer - tangential array		✓	
Bolometer array - divertor		✓	
CHERS	✓		
Divertor fast cameras		✓	Highly desired
Dust detector			
EBW radiometers			
Edge deposition monitor			
Edge pressure gauges		✓	
Edge rotation spectroscopy		✓	
Fast lost ion probes – IFLIP		✓	
Fast lost ion probes – SFLIP		✓	
Filtered 1D cameras		✓	
Filterscopes	✓		
FIReTIP	✓		
Gas puff imaging		✓	
High-k scattering			
Infrared cameras		✓	
Interferometer – 1 mm			
Langmuir probes - PFC tiles		✓	
Langmuir probes - RF antenna			
Magnetics – Diamagnetism	✓		
Magnetics – Flux loops	✓		
Magnetics – Locked modes	✓		
Magnetics – Pickup coils	✓		
Magnetics - Rogowski coils	✓		
Magnetics - RWM sensors	✓		
Mirnov coils – high frequency	✓		
Mirnov coils – poloidal array	✓		
Mirnov coils – toroidal array	✓		
MSE	✓		
Neutral particle analyzer			
Neutron Rate (2 fission, 4 scint)			
Neutron collimator			
Plasma TV	✓		Nova Photonics camera requested
Reciprocating probe		✓	
Reflectometer - FM/CW		✓	
Reflectometer - fixed frequency homodyne		✓	
Reflectometer - homodyne correlation		✓	
Reflectometer - HHFW/SOL		✓	
RF antenna camera			
RF antenna probe			
Solid State NPA			
SPRED		✓	
Thomson scattering - 20 channel	✓		
Thomson scattering - 30 channel	✓		
Ultrasoft X-ray arrays	✓		
Ultrasoft X-ray arrays - 2 color		✓	
Visible bremsstrahlung det.		✓	
Visible spectrometers (VIPS)			
X-ray crystal spectrometer - H			
X-ray crystal spectrometer - V			
X-ray PIXCS (GEM) camera			
X-ray pinhole camera			