Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Characterization of magnetically triggered ELMs in lithium conditioned discharges**		
OP-XP-926	Revision: **0**	Effective Date: **7/20/09** *(Approval date unless otherwise stipulated)* Expiration Date: **7/20/11** *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: J.M. Canik	Date 7/20/09
ATI – ET Group Leader: V. Soukhanovskii	Date 7/20/09
RLM - Run Coordinator: R. Raman	Date 7/20/09
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: J.M. Canik No. **OP-XP-926**
AUTHORS: Characterization of magnetically triggered ELMs in lithium conditioned discharges DATE: **7/16/09**

1. Overview of planned experiment

The goal of the experiment is to characterize the features of the magnetic triggering of ELMs in lithium-enhanced ELM free H-modes. The following characteristics will be measured: change in pedestal density, temperature and rotation during n=3 application; threshold perturbation for ELM triggering; radial structure of ELM loss as a function of plasma shape, and the impact of toroidal phase and waveform of the n=3 field on ELM triggering.

2. Theoretical/ empirical justification

Previous experiments using 3D magnetic perturbations in NSTX have shown that the application of these fields can destabilize large ELMs in discharges exhibiting small Type-V ELMs, as well as in ELM-free H-modes enabled by lithium conditioning. Measurements of several features of the triggering phenomena have been made in non-lithium plasmas; in particular the threshold perturbation for triggering was found, and changes to the pedestal structure were measured after the 3D field application. The ELM triggering effect was used in lithium enhanced ELM-free H-mode as an ELM pace-making technique, and was shown to successfully decrease the impurity content of the plasma. However, the impact of the 3D field on the edge pedestal during lithium-enhanced plasmas has not been measured, nor has the effect of varying perturbation strength on the triggering speed and efficacy. The goal of the present experiment is to provide thorough documentation of these effects in lithium discharges.

3. Experimental run plan

1. Produce reference discharge (2 shots)

Reload of 133816: κ=2.4, δ=0.7, P_{NBI}=4MW, LITER at ~250mg, no SPA

Adjust Li deposition rate as necessary for reliable ELM-free operation

2. SPA current scan to find triggering threshold using DC SPA waveform (4 shots)

SPA currents: 300-1200 A in increments of 300 A (4)

3. Pedestal profile measurements throughout ELM cycle, n=3 square wave (10 shots)

Decision point: SPA current chosen to give ELM triggering time of ~20-30 ms, if possible, based on results of step 2. If this is achieved, pulse frequency will be set to 15 Hz; if triggering time is ~10 ms (as in 130670), frequency will be set to 30 Hz to synchronize with TS lasers

1st Thomson laser fired at beginning of SPA pulses, and

2nd laser fired at ~1/3 of the period between n=3 field on and ELM times (2 shots)

2nd laser fired ~2/3 of the period between n=3 field on and ELM times (2 shots)

2^{nd} laser fired just before (few ms) ELM (2)

2^{nd} laser fired just before second ELM (2)

1^{st} laser just before first ELM, and second during ELM (2)

4. Profile measurements at lower elongation (7 shots)

Reduce κ to 2.0 (e.g. reload 130652), SPA waveform from series 3 (1)

Lower frequency of n=3 pulses if necessary to ensure reliable triggering (1)

1^{st} Thomson laser fired at beginning of SPA pulses, and

2^{nd} laser fired just before (few ms) ELM (3)

1^{st} laser just before first ELM, and second during ELM (2 shots)

5. Test effect of n=3 toroidal phase, waveform shape on triggering (4 shots)

Reload high κ shape of series 3, and apply n=3 field as in 3 but with toroidal phase shifted 60. TS laser timing is 1: at SPA turn-on, 2: just before ELM onset (2 shots)

Apply n=3 as a sinusoidal waveform with same amplitude and frequency as series 3 (1)

Double frequency of n=3 to test impact on ELM frequency (1)

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

This XP requires a fully operational NBI system. We desire LITER operating at an evaporation rate of 40 mg/min with a 10 minute shot cycle.

5. Planned analysis

EFIT/LRFDIT; pedestal profile analysis to use in kinetic BFIT; stability calculations with PEST and ELITE; spectral analysis using vacuum approximation and IPEC

6. Planned publication of results

The results of this experiment will be presented during an invited talk at the APS 09 meeting if the nomination is accepted, and will be published in the corresponding Physics of Plasmas issue.

PHYSICS OPERATIONS REQUEST

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(use additional sheets and attach waveform diagrams if necessary)

Describe briefly the most important plasma conditions required for the experiment:

Reliable ELM-free operation with lithium conditioning is required.

Previous shot(s) which can be repeated: 130669,130652

Previous shot(s) which can be modified:

Machine conditions *(specify ranges as appropriate, strike out inapplicable cases)*

I_{TF} (kA): 53 Flattop start/stop (s): 0/1

I_P (MA): 0.8 Flattop start/stop (s): .15/1

Configuration: **Limiter / DN / LSN / USN**

Equilibrium Control: **Outer gap / Isoflux** (rtEFIT)

Outer gap (m): **0.1** Inner gap (m): **0.05** Z position (m):

Elongation κ: 2.4/2.0 Upper/lower triangularity δ: 0.7

Gas Species: **D** Injector(s):

NBI Species: **D** Voltage (kV) **A: 90** **B: 60** **C:** 90 Duration (s): 1

ICRF Power (MW): Phase between straps (°): Duration (s):

CHI: **Off / On** Bank capacitance (mF):

LITERs: Off / On Total deposition rate (mg/min): **40**

EFC coils: Off/On Configuration: **Odd / Even / Other** *(attach detailed sheet*

DIAGNOSTIC CHECKLIST

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Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
Bolometer – tangential array	√	
Bolometer – divertor		√
CHERS – toroidal	√	
CHERS – poloidal	√	
Divertor fast camera		√
Dust detector		
EBW radiometers		
Edge deposition monitors		
Edge neutral density diag.		√
Edge pressure gauges		√
Edge rotation diagnostic	√	
Fast ion D_alpha - FIDA		
Fast lost ion probes - IFLIP		
Fast lost ion probes - SFLIP		
Filterscopes	√	
FIReTIP		√
Gas puff imaging		√
Hα camera - 1D	√	
High-k scattering		
Infrared cameras	√	
Interferometer - 1 mm		
Langmuir probes – divertor	√	
Langmuir probes – BEaP		
Langmuir probes – RF ant.		
Magnetics – Diamagnetism	√	
Magnetics – Flux loops	√	
Magnetics – Locked modes	√	
Magnetics – Pickup coils	√	
Magnetics – Rogowski coils	√	
Magnetics – Halo currents	√	
Magnetics – RWM sensors	√	
Mirnov coils – high f.		√
Mirnov coils – poloidal array		√
Mirnov coils – toroidal array		√
Mirnov coils – 3-axis proto.		

Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
MSE		√
NPA – E||B scanning		
NPA – solid state		
Neutron measurements		√
Plasma TV		√
Reciprocating probe		
Reflectometer – 65GHz		√
Reflectometer – correlation		√
Reflectometer – FM/CW		
Reflectometer – fixed f		
Reflectometer – SOL		√
RF edge probes		
Spectrometer – SPRED		√
Spectrometer – VIPS		√
SWIFT – 2D flow		
Thomson scattering	√	
Ultrasoft X-ray arrays	√	
Ultrasoft X-rays – bicolor		√
Ultrasoft X-rays – TG spectr.		√
Visible bremsstrahlung det.		√
X-ray crystal spectrom. - H		
X-ray crystal spectrom. - V		
X-ray fast pinhole camera		
X-ray spectrometer - XEUS		