Princeton Plasma Physics Laboratory **NSTX Experimental Proposal**		
Title: **ELM Destabilization by RMP**		
OP-XP-809	Revision:	Effective Date: Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS	
Responsible Author:	Date
ATI – ET Group Leader:	Date
RLM - Run Coordinator:	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: **ELM Destabilization by RMP** No. **OP-XP-809**

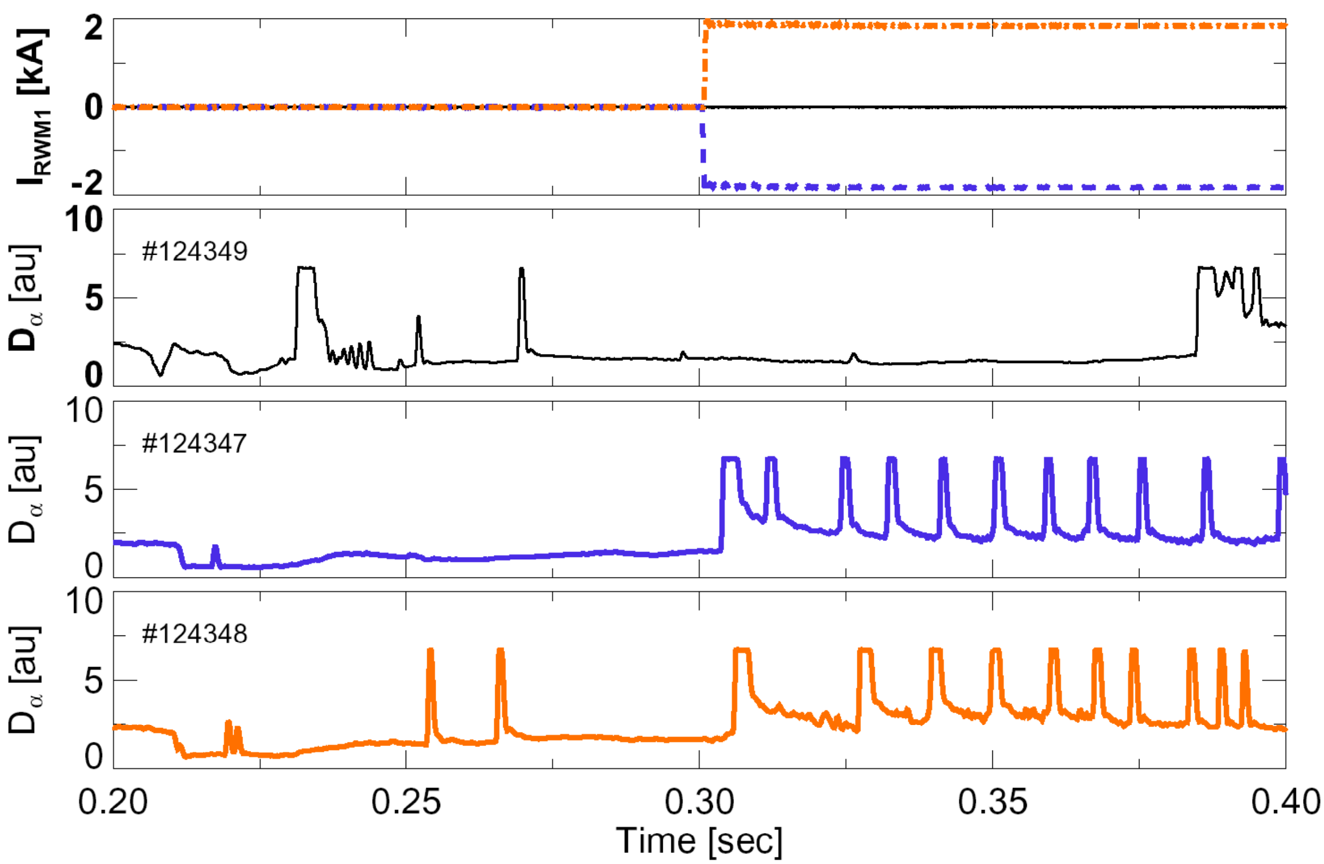
AUTHORS: **J. Canik, T. Evans, S. Kaye, R. Maingi, E. Unterberg** DATE: **Feb 15, 2008**

1. Overview of planned experiment

The goal of this experiment is to investigate the effects of Resonant Magnetic Perturbations (RMP) on ELM stability. This proposal builds on the results of XP 730 in 2007, in which the application of RMPs using the EF/RWM caused the triggering of ELMs. The characteristics of the ELM-triggering will be explored in more detail by varying the magnitude of the applied RMP to determine the threshold for destabilization. Detailed edge profile measurements will be used to investigate the edge stability changes at the ELM destabilization threshold. .

2. Theoretical/ empirical justification

ELM suppression by RMP has been demonstrated in several machines, with extensive studies performed at DIII-D. This technique acts by replacing the large, transient transport caused by Type I ELMs with a lower level of continuous transport due to a stochastic layer at the plasma edge. ELM suppression with RMPs is expected to be an important tool for reducing the risk of wall damage posed by ELMs in large machines. Experiments on NSTX have been performed using the EF/RWM coils to produce a stochastic magnetic field at the edge. Initial experiments (XP525 in 2005) showed brief windows of ELM suppression; however, the interpretation of these results was complicated by changes in wall conditions and recycling. Further experiments were performed (XP730 in 2007) which showed that, rather than



suppressing ELMs, applying the RMP triggered ELMs in an otherwise quiescent discharge (see Figure). While it is has been demonstrated that the edge stability can be altered by the application of RMPs with the NSTX external midplane coils, it is important to understand what causes the destabilization of ELMs in these plasmas.

3. Experimental run plan

The discharges of XP730 (in an ITER-like shape) provide a starting point for this proposal. A low triangularity discharge with a long period with irregular ELMs will be used as a reference point (c.f. NSTX discharge 124349 or 123876). It is critical that the reference discharge is achieved before this XP is run. RMP will then be applied using the EF/RWM coils in an n=3 configuration, from t=0.300 to 0.600 s. The first step in this experiment is to vary the current in the EF/RWM coils to determine the threshold at which the applied RMP causes ELMs to be destabilized. Several discharges will then be taken alternating with the RMP on and off, so that the effect of the RMP can be separated from the effects of changing wall conditions and recycling. To obtain high-quality edge profiles, several discharges will then be performed, with the outer gap varied to increase the radial resolution of the measurements.

I. Reproduce reference discharge #124349 with B=0.5 T, Ip = 800 kA, gapout = 10cm, P_{NBI} = 5 MW, RMP current = 0 A. (1-2 shots)

Sequence #	Comment	Parameter	RMP Current
I,1-2	Reference (124349)		0

II. EF/RWM current scan B=0.5 T, Ip = 800 kA, gapout = 10cm, P_{NBI} = 5. Begin by starting at 1 kA, incrementing current by 0.5 kA, up to 2 kA. When ELM-triggering is observed, take a shot with no RMP current, then repeat at the triggering current to verify reproducibility. Then take additional shot at a current based on ELM-triggering seen so far, to increase resolution at near-threshold current. (6 shots)

Sequence #	Comment	Parameter	RMP Current
II, 1	RMP scan	B=0.5 T, Ip=800 kW, P=5 MW, gapout = 10cm	1.0 kA
II, 2			1.5 kA
II, 3			2.0 kA
II, 4	Reproducibility check		0
II, 5			Triggering value from II, 1-3
II ,6	Additional shot near threshold EF/RWM current		Between above and below ELM-triggering threshold from II,1-3

III. Alternating RMP on/off with B=0.5 T, RMP current just above threshold as determined in sequence II. (5 shots). During one discharge, the time for which the RMP is applied will be reduced to just enough to trigger ELMs, to check if the ELMs stop when RMP ends

Sequence #	Comment	Parameter	RMP Current
III, 1,3	RMP off	B=0.5 T, Ip=800 kW, P=5 MW, gapout = 10 cm	0
III, 2,4	RMP on		Near threshold from sequence II
III, 5	RMP applied for short time duration.		Same current, time shortened to only enough to trigger ELMs from seqs. II and III

IV. Outer gap scan with B=0.5 T, Ip = 800 kA, PNBI = 5 MW, RMP current above threshold from sequence II (4 shots)

Sequence #	Comment	Parameter	RMP Current
IV, 1	Outer gap scan	gapout = 10cm	Near threshold from sequence II
IV, 2		gapout = 9.5cm	
IV, 3		gapout = 10.5cm	
IV, 4		gapout = 9 or 11cm	

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

This XP requires a fully operational NBI system. We desire HeGDC between shots of ~6.5 minutes for a 12.5 minute repetition rate.

5. Planned analysis

ELM destabilization will be correlated with the edge stochastic layer as calculated with RMP spectral modeling and magnetic field line tracing. Pedestal profile analysis will be performed using the high resolution diagnostic data; this will then be used to assess the peeling-ballooning stability of the discharges. Theoretical stability to ELMs will be calculated for discharges just above and below the triggering threshold in RMP current.

6. Planned publication of results

Results will be presented at various conferences and published in a refereed journal when the analysis is complete.

PHYSICS OPERATIONS REQUEST

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Machine conditions (specify ranges as appropriate)

I_{TF} (kA):58kA Flattop start/stop (s): 0/1

I_P (MA):0.8 Flattop start/stop (s): .15/1.0

Configuration: **DN**

Outer gap (m): **10cm** Inner gap (m): **~5cm**

Elongation κ: **1.8** Upper/lower triangularity δ: 0.5

Z position (m): **0.0**

Gas Species: **D** Injector(s): Inner Wall Midplane

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

ICRF Power (MW): 0 Phasing: Duration (s):

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

LITER: Off

Either: List previous shot numbers for setup: **124349**

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

TITLE: **ELM Destabilization by RMP** No. **OP-XP-810**

AUTHORS: **J. Canik, T. Evans, S. Kaye, R. Maingi, E. Unterberg** DATE: **Feb 15, 2008**

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

Diagnostic	Need	Want	Conditions
Mirnov coils – high f.	x		
Mirnov coils – poloidal array	x		
Mirnov coils – toroidal array	x		
MSE	x		
NPA – ExB scanning			
NPA – solid state			
Neutron measurements			
Plasma TV	x		
Reciprocating probe			
Reflectometer – 65GHz		x	
Reflectometer – correlation		x	
Reflectometer – FM/CW		x	
Reflectometer – fixed f		x	
Reflectometer – SOL		x	
RF edge probes			
Spectrometer – SPRED		x	
Spectrometer – VIPS		x	
SWIFT – 2D flow		x	
Thomson scattering	x		
Ultrasoft X-ray arrays	x		
Ultrasoft X-rays – bicolor		x	
Ultrasoft X-rays – TG spectr.		x	
Visible bremsstrahlung det.		x	
X-ray crystal spectrom'r - H			
X-ray crystal spectrom'r - V			
X-ray fast pinhole camera			
X-ray spectrometer - XEUS			