Princeton Plasma Physics Laboratory **NSTX Experimental Proposal**		
Title: **Further Study of the m/n=2/1 NTM on self-stabilization during beta ramp down**		
OP-XP-801	Revision: **01/28/2008**	Effective Date: **02/18/2008** Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS	
Responsible Author: R.J. La Haye	Date 01/28/08
ATI – ET Group Leader: S.A. Sabbagh	Date
RLM - Run Coordinator: M. Bell	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: **Further Study of the m/n=2/1 NTM on self-stabilization during beta ramp down** No. **OP-XP-801**

AUTHORS: **R. J. La Haye, R. J. Buttery, E. J. Strait** DATE: **01/28/08**

1. Overview of planned experiment

It is planned to destabilize an m/n=2/1 neoclassical tearing mode in each discharge during the rise in beta and switch phases to beta ramp down. While information on the beta for destabilization is useful, the key point here is the conditions for the marginal point at which self-stabilization occurs. The marginal island width and the marginal beta in the low aspect ratio NSTX can be compared to data in the large aspect ratio DIII-D (to be acquired in 2008) and in JET (in hand). This will help check the physics of the small-island stabilizing effects, important both for destabilization, and for stabilization by radio frequency current drive. The effect of rotation on the marginal condition will be obtained by varying the rotation with n=3 magnetic braking; the effect of resonant n=1 error field will also be investigated.

2. Theoretical/ empirical justification

Small island stabilizing effects (transport, polarization current, etc.) set the marginal beta above which neoclassical tearing modes (NTMs) can be excited. The marginal full island width is the value of w at which growth is largest. This island size plays an important role in determining the electron cyclotron current drive (ECCD) requirements for stabilization in ITER. In “high” aspect ratio devices (ASDEX-Upgrade, DIII-D, JET and JT-60U), the marginal island width for m/n=3/2 is found to be about twice the ion banana width. [R.J. La Haye, R. Prater, R.J. Buttery, N. Hayashi, A. Isayama, M.E. Maraschek, L. Urso and H. Zohm, "Cross-machine benchmarking for ITER of neoclassical tearing mode stabilization by electron cyclotron current drive", Nuclear Fusion 46, 451 (2006).]

The purpose of this experiment, in NSTX, is to investigate if this scaling occurs at low aspect ratio. As n=2 is difficult to routinely produce in NSTX, the m/n=2/1 mode will be studied in conjunction with new experiments on DIII-D and JET (and perhaps AUG). XP-739 in May 2007 got two good shots of which #123873 was analyzed; the polarization threshold fitted better than the transport threshold, and the ratio of 2/1 marginal island width to ion banana width was about 2, as in the 3/2 high aspect ratio data base. More cases, particularly with different rotation, are desirable in NSTX for analysis and confirmation.

3. Experimental run plan

This is a one day experiment. Follow up would be in an experiment (TBD) to concentrate on the NTM destabilization and add more ramp down data as possible depending on, but not counting on, no locking or disruption in the excitation. Here in XP-801 some data for the complementary XP would be obtained as well but locking and disruption must be avoided so as to reach the ramp down phase in ELMing H-mode, and stay in it.

1. Reproduce #123873, no n=3 braking in the ramp down phase. This plasma had "deshaped" fiducials (elongation reduced), stayed in ELMing H-mode to past the 2/1 stabilization (at ~4 kHz rotation at q=2 by CHERS). 2 shots

2. Adjust shape to reduce core 1/1 mode during 2/1 ramp down, which makes the n=1 Mirnov analysis awkward. An increase of kappa from 2.03 to 2.22 at the same minor radius keeps the 1 cm SOL safely off the vessel. Trying 2.12 first, and more (up to 2.22) if not adequate, would be the approach. 4 shots

3. Use best of step 2 and vary n=3 magnetic braking in beta ramp down (step at t=0.6 sec as in 123873) with two shots each at n=3 currents in ramp down of 0, 530 A, 750 A, 1061 A, as possible such as to avoid n=1 locking and stay in ELMing H-mode through 2/1 stabilization. 8 shots

4. Repeat the n=3 current turned off in ramp down in step 3, but with n=1 error field correction less than optimum during ramp down to investigate effect of resonant error field on both rotation and on marginal island. No correction in ramp down would be tried first and if locking occurred half correction. 4 shots

5. Repeat 3 with no n=3 braking but at reduced Ip of 0.85 MA (same BT of 4.4 kG so q95 increased from 7.5 to 8.9) to change betap, i.e. the NTM drive) for checking competing effects in self-stabilization. 4 shots

Total 22 shots.

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

Toroidal Field: B_T=-4.4 kG

Plasma Current : I_P=0.85 ~ 1.0 MA

Shape: NSTX 123873 with variation to higher elongation

Beams: Enough power to excite 2/1 mode. 2 needed but 3 desirable for finer tuning of power ramp down.

Essential Diagnostics: Magnetics (fast and slow), RWM detectors
CHERS for core Ti and rotation
Thomson scattering
SXR for island width

5. Planned analysis

In each case of a "break" in the n=1 Mirnov amplitude to self-stabilization, the island width and the "bootstrap drive" (ε**0.5*betape*Lq/Lpe) at this marginal point, the ratio of ion banana width to rs, collisionality, rotation, etc to add to a data base from large aspect ratio tokamaks. Time-dependent modeling will be done for some key shots with either or both the polarization and the transport threshold models.

6. Planned publication of results

Results would be most valuable in combination with new data (on the 2/1 mode) in large aspect ratio tokamaks, for publication as a paper in Nuclear Fusion, for example.

PHYSICS OPERATIONS REQUEST

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Machine conditions (specify ranges as appropriate)

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

I_P (MA): 1.0 Flattop start/stop (s):

Configuration: **DN as in 123873 with adjustments**

Outer gap (m): Inner gap (m):

Elongation κ: Upper/lower triangularity δ:

Z position (m):

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

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

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

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

LITER: Off

List previous shot numbers for setup: Shot **123873** for shape and timing will be the start.

DIAGNOSTIC CHECKLIST

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Diagnostic	Need	Want
Bolometer – tangential array		X
Bolometer – divertor		X
CHERS – toroidal	X	
CHERS – poloidal		X
Divertor fast camera		X
Dust detector		X
EBW radiometers		X
Edge deposition monitors		X
Edge neutral density diag.		X
Edge pressure gauges		X
Edge rotation diagnostic		X
Fast ion D_alpha - FIDA		X
Fast lost ion probes - IFLIP		X
Fast lost ion probes - SFLIP		X
Filterscopes	X	
FIReTIP		X
Gas puff imaging		X
$H\alpha$ camera - 1D		X
High-k scattering		X
Infrared cameras		X
Interferometer - 1 mm		X
Langmuir probes - divertor		X
Langmuir probes – RF ant.		X
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
Mirnov coils – high f.	X	
Mirnov coils – poloidal array	X	
Mirnov coils – toroidal array	X	
MSE	X	
NPA – ExB scanning		X
NPA – solid state		X
Neutron measurements		X
Plasma TV		X
Reciprocating probe		X
Reflectometer – 65GHz		X
Reflectometer – correlation		X
Reflectometer – FM/CW		X
Reflectometer – fixed f		X
Reflectometer – SOL		X
RF edge probes		X
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
X-ray crystal spectrom'r - V		X
X-ray fast pinhole camera		X
X-ray spectrometer - XEUS		X