Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Develop H-mode avalanche target plasma**		
OP-XP-1011	Revision:	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: E. D. Fredrickson	Date Feb. 08, 2010
ATI – ET Group Leader: G. Taylor	Date
RLM - Run Coordinator: E. Fredrickson	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: Develop H-mode avalanche target No. **OP-XP-1011**

AUTHORS: E. D. Fredrickson, et al. DATE: **Feb 8, 2010**

1. Overview of planned experiment

The goal of this experiment is to develop a reliable, reproducible target plasma with TAE avalanches. If such a plasma is found, the remainder of the experimental time will be to explore the range of parameters for which TAE avalanches are still found. A possible starting point would be shots like 135430-135447. Nominally a 700 kA, 4 kG plasma. Of the 16 shots with these parameters attempted, those with density at 0.3 s of about $3x10^{13}/cm^3$ had TAE activity; shots with higher density had no TAE. A similar set of shots at 900 kA showed similar behavior, so target currents of 700 to 900 kA are likely possible. The shots typically had sources A and B at 90kV and source C at 70 kV. It's not clear if the lower voltage source was necessary for the TAE.Unless a more promising target is identified before this XP runs, this will be the target.

2. Theoretical/ empirical justification

Studies of TAE avalanches in L-mode plasmas are becoming mature. Nearly complete data sets on equilibrium parameters, mode amplitudes, internal measurements of mode profiles have been made. In 2010, the new BES diagnostic will allow the extension of the L-mode studies to H-mode plasmas. The density profile is much broader in H-modes, changing the shape of the gap structure and possibly affecting the coupling of poloidal harmonics. This will be the first attempt to explore operational range of H-mode avalanches.

3. Experimental run plan

A small number of H-mode shots with TAE avalanches were identified during the 2008 and 2009 campaigns. These shots are the basis for developing the target plasma. If a more promising target plasma shot is identified before this XP is run, it will, of course, be substituted.

The experiment will begin by trying to reproduce as closely as possible the conditions in shot 135437. Reproducing the conditions should result in similar TAE avalanches. All needed diagnostic data should be acquired in a single shot, so no more than two shots at any condition should be needed (for redundancy). Beyond documenting fast ion transport in an H-mode TAE avalanche, the avalanching dependence on density, plasma current and beam voltage/power could be explored.

Run Plan

1. Reproduce conditions of shot 135437 (3 shots)

2. Small density scan to optimize TAE avalanches (4 shots), down, then up.

3. Drop source C (and condition up to 80 kV) at best density. Then add source C at 80 kV (2-4 shots).

4. Current scan at 'best' density, 0.8MA and 0.9MA, if no avalanches, raise or lower density (4 shots).

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

Describe any prerequisite conditions, development, XPs or XMPs needed.
Attach completed Physics Operations Request and Diagnostic Checklist.

Three beam sources, LITER, SPAs, BES, MSE, FIDA, fast Mirnov.

5. Planned analysis

What analysis of the data will be required: EFIT, TRANSP, etc.?

LRDFIT w/MSE, TRANSP, NOVA, ORBIT.

6. Planned publication of results

What will be the final disposition of the results; where will results be published and when?

Results will be published, assuming that good avalanches are produced and full data sets are acquired.

PHYSICS OPERATIONS REQUEST

TITLE: TAE Avalanches in H-modes — No. **OP-XP-1011**

AUTHORS: **E Fredrickson, et al** — DATE: **Feb. 8, 2010**

(use additional sheets and attach waveform diagrams if necessary)

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

Making the density approximately 3 x $10^{13}/cm^3$ by 0.3s is probably the most important condition required for this experiment.

Previous shot(s) which can be repeated: 135437

Previous shot(s) which can be modified:

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

I_{TF} (kA): **48** Flattop start/stop (s): **0.15s**

I_P (MA): **0.7 to 0.9** Flattop start/stop (s):

Configuration: **DN?**

Equilibrium Control: **rtEFIT(?**)

Outer gap (m): **0.13** Inner gap (m): **0.06** Z position (m): **0**

Elongation κ: **2.4** Upper/lower triangularity δ: **0.5/0.8**

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

NBI Species: **D** Voltage (kV) **A: 90** **B: 90** **C: 70-80** Duration (s): **0.5**

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

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

LITERs: On Total deposition rate (mg/min):

EFC coils: On Configuration: **Odd**

DIAGNOSTIC CHECKLIST

TITLE: **H-mode avalanche** No. **OP-XP-906**

AUTHORS: **E D Fredrickson** DATE:

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		