Princeton Plasma Physics Laboratory **NSTX Experimental Proposal**		
Title: Comparison of Small ELM regimes on C-Mod, MAST, and NSTX		
OP-XP-721	**Revision: 2**	Effective Date: **Feb 27, 2008** *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS	
Responsible Author: R. Maingi	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)

Original proposal has been updated with revised plan for scans, more recent reference shots and updated diagnostic list.

NSTX EXPERIMENTAL PROPOSAL

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AUTHORS: **A. Hubbard, R. Maingi, H. Meyer** DATE: **2/27/08**

1. Overview of planned experiment

The primary aim is to match, to the extent possible, the shape (except R/a) and key dimensionless parameters of small ELM regimes on Alcator C-Mod, MAST and NSTX. The Enhanced D_α H-Mode and higher power ELMy H-Mode in C-Mod will be compared with the Type V ELMy H-Mode and mixed Type I/V ELMy H-Modes in NSTX and MAST. We will compare access conditions and fluctuation properties of these ELM regimes in each device, to improve our understanding of the relationships between these regimes, including the possible role of aspect ratio.

2. Theoretical/ empirical justification

While the “Type I” ELMy H-Mode regime is currently the baseline scenario for ITER, it is recognized that operation with large ELMs has serious disadvantages; extrapolation from present experiments indicates divertor erosion will be a serious issue. Development of regimes with high confinement but with smaller or no ELMs is thus a high priority on all tokamaks. A variety of small ELM regimes on various devices have been reported such as grassy ELMs (JT-60U, JET), type-II ELMs (JET, AUG, DIII-D, C-Mod), HRS-Mode (JFT-2M, C-Mod), EDA (C-Mod), and type-V ELMs (NSTX) mostly at high collisionality $\nu_{e,ped}^* > 0.5$. The physics leading to these different regimes and, hence, the scalability towards ITER is not fully understood.

A recent ITPA-sponsored dimensionless comparison between C-Mod and the higher aspect ratio JFT-2M (PEP-12) showed much commonality between EDA H-Mode and the HRS-Mode. It is of interest to find out whether the new “type-V” ELM regime in NSTX, and possibly also observed in MAST, has the same physical mechanism as HRS/EDA or type-II; some properties appear similar, although the details seem to be different. A similar comparison between C-Mod, NSTX and MAST would help to understand the differences and commonalities of these regimes, and improve the reliability of extrapolations to ITER. They should also help establish such operation more routinely on MAST. The difference in field line pitch between small and large aspect ratio would highlight the role of q_{95} for the instabilities. This experiment (PEP-16) was proposed as a high priority activity by the Pedestal ITPA group at its meeting in Lisbon (Nov 2004), and accepted by the representatives of MAST, NSTX and C-Mod at the IAE Program Leaders’ meeting in Culham, Dec 2004. A similar proposal has been submitted to MAST.

A common cross-sectional shape has been produced in each of the 3 machines: a lower-single null with elongation ~ 1.7 and triangularity ~ 0.5. Small ELMs were obtained in C-Mod, MAST, and NSTX in experiments in 2007, although the type V ELMs in NSTX were only obtained in this shape at high q95.

3. Experimental run plan (1/2 day)

Here we propose to finish the NSTX portion of the experiment at low q95. This was not possible in 2007 because H-mode access was restricted at low q95 at the end of this particular run day. We propose to avoid this problem by using longer HeGDC of 9 minutes between shots, followed by 6 minutes of pump-out to make sure residual Helium in the discharges is minimized. This will lead to a 15 minute shot cycle. We also require source C at 1 MW.

I. Reproduce **124657** (0.6 MA, 0.45 T): previous NSTX H-mode at high q95 (3 shots)

II. Increase I_p by 0.15 MA increments while making sure that H-mode access is maintained for target q95=5.5, which requires 0.9 MA (5 shots)

III. Decision point: if time permits, drop B_t by 0.05 T to get lower q95 (2 shots)

IV. Perform 5 point NBI scan in 3 shots to determine ELM stability threshold, as in 124656-58 (5 shots)

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

This XP requires an operational NBI system with source C derated in voltage to deliver 1MW. The capability of performing a detailed δ_r^{sep} scan with rtEFIT is essential. We desire HeGDC between shots of ~ 6.5-7.5 minutes for a 12.5 minute repetition rate.

5. Planned analysis

Accurate EFIT reconstructions suitable for mapping pedestal diagnostics will be required. The pedestal profiles will be fitted with the widely accepted tanh function for comparison between machines. Edge stability calculations will be done with a number of codes, including PEST, DCON, and ELITE, and possibly MARS.

6. Planned publication of results

Results will first be presented and discussed at the next Pedestal ITPA meeting, and will then be published at the IAEA meeting.

PHYSICS OPERATIONS REQUEST

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Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **52-64** Flattop start/stop (s): _____/_____

I_P (MA): **0.8-1.0** Flattop start/stop (s): **0.15/1.5 (max)**

Configuration: **Lower Single Null**

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

Elongation κ: **1.7** Triangularity δ: **0.45**

Z position (m): **0.00**

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

NBI - Species: **D**, Sources: **A/B/C**, Voltage (kV): **90/90/80** Duration (s): **<1.5 sec**

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

CHI: **Off**

Shot numbers for setup: **124657**

DIAGNOSTIC CHECKLIST

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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	✔	

Diagnostic	Need	Want
Magnetics - RWM sensors	✔	
Mirnov coils – high f.	✔	
Mirnov coils – poloidal array	✔	
Mirnov coils – toroidal array	✔	
Mirnov coils – 3-axis proto.		
MSE	✔	
NPA – ExB 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'r - H		
X-ray crystal spectrom'r - V		
X-ray fast pinhole camera		✔
X-ray spectrometer - XEUS		✔