Princeton Plasma Physics Laboratory **NSTX Experimental Proposal**		
Title: Dependence of the H-mode Pedestal Structure on Aspect Ratio		
OP-XP-529	**Revision: a**	Effective Date: 07/28/2005 *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS	
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Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

1. Overview of planned experiment

We propose to study the dependence of pedestal structure (heights, widths, and gradients) on aspect ratio. The basic idea is to match certain dimensionless parameters (ρ_*, ν_*^e, and certain shape parameters) between DIII-D, NSTX and MAST to determine if the pedestal structure, i.e. height, width and gradient, is dependent on the aspect ratio. More specifically we hope to resolve the dependence of the T_e width and the pressure pedestal height on aspect ratio.

In addition, a component of this experiment is to perform shape development for a similar set of experiments on small ELM regimes between NSTX, C-MOD, and MAST. Here we propose to do the shape development as preparation for a more detailed experiment.

2. Theoretical/ empirical justification

Previous scaling studies of the H-mode T_e pedestal width between DIII-D and JT-60U have shown the possibility [1] of an aspect ratio dependence, namely $\Delta_{Te} \sim \varepsilon^{0.5}$, where ε = a/R. Such a strong dependence, if present in the entire international database, could complicate interpretation of multi-machine experiments at different aspect ratios. NSTX and MAST provide a low aspect ratio comparison with $0.66 < \varepsilon < 0.8$, as compared with the typical DIII-D $\varepsilon \sim 0.38$. While NSTX has plasma-facing component proximity and a divertor shape closer to DIII-D, MAST provides better edge diagnostics and the opportunity to determine if differences in ratio of plasma to vacuum vessel volume affect the pedestal parameters. Hence we propose to use all three machines in this study.

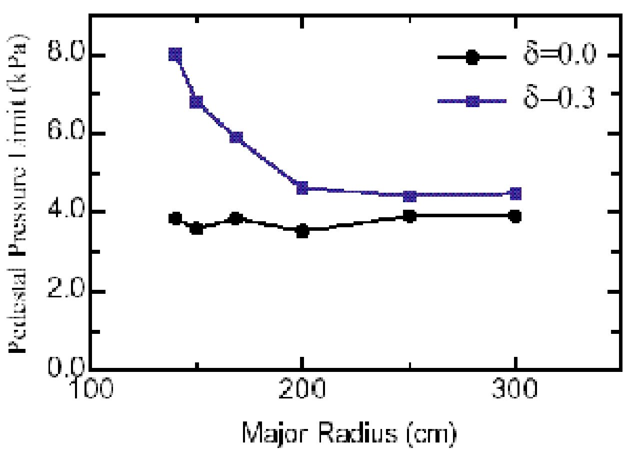

Fig. 1. Dependence of pedestal pressure limit in major radius at fixed minor radius, i.e. an aspect ratio scan, from Ref. [2].

Stability calculations with the ELITE code [2] rather robustly showed that the pedestal pressure was expected to increase with decreasing major radius at moderate shaping, i.e. $\delta \sim 0.3$-0.4. Note that the calculation was done assuming a fixed pedestal width, so that the prediction is actually of the critical pedestal gradient. Also, the minor radius was held constant, such that the aspect ratio increased with decreasing major radius. Thus the prediction equates to an increase of the pedestal pressure gradient with inverse aspect ratio, although we note that the actual NSTX and MAST aspect ratio lies to the right of the x-axis.

The DIII-D part of this experiment was run in Jan. and March 2005, and the MAST part will be run later this year.

In addition, a similar set of experiments to compare small ELM regims was recently initiated between NSTX, C-MOD, and MAST. Here the prescription is similar to the one detailed above for the NSTX/DIII-D/MAST experiment, in that the pedestal quantities will be matched under conditions where small ELMs are observed in all three machines. Here we propose to develop the shape used in C-MOD, shown in Fig. 2 below, which has $\kappa \sim 1.7$ and $\delta_l \sim 0.5$, with target $\beta_{ped} \sim 1.5\%$, $\rho^*_{ped} \sim .01$, and $\nu^*_{e,ped} \sim 1$. This will mean running NSTX with low NBI power ~ 1.5-2 MW (just above the L-H threshold) and at the highest field available.

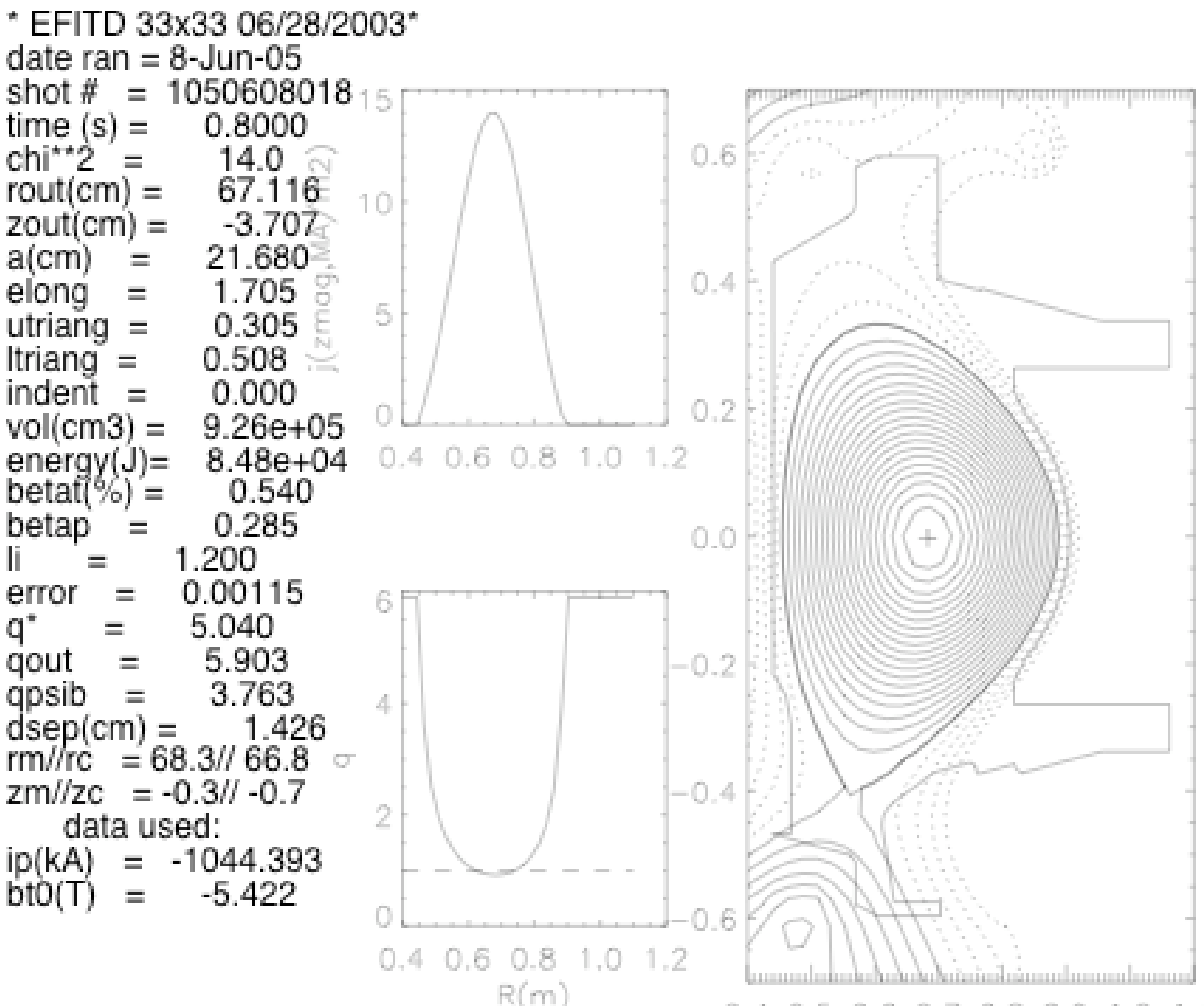

Fig. 2 – C-MOD Equilibrium plot for target discharge shape

3. Experimental run plan (1 day, prioritized list below)

I. Reproduce the "higher" squareness shape from D3D shot #121504, with NSTX parameters I_p=800 kA, B_t=0.45 T, P_{NBI} = 2-4 MW (whatever needed for H-mode access), under rtEFIT control. The outer gap must be adjusted to ~ 9-10 cm to provide optimal Thomson profile resolution. A good starting point may be NSTX #111378, except with early NBI changed so that src. B starts at 80ms and src. A at 200 ms. (5-10 shots)

II. Vary the NBI heating power from 2-6 MW to match the edge ρ* at the top of the pedestal ~ 0.011, and as much as possible, vary the HFS fueling rate to match the edge ν* at the top of the pedestal from 0.4-1. (5-10 shots)

III. Increase NBI power to determine the pedestal β limit. May have to change I_p to match ρ* and vary density slightly to match ν*. (5-10 shots)

IV. Time permitting: repeat steps I-III with lower squareness shape (D3D #121516), which is a better match to the MAST shape. (5-10 shots)

V. Time permitting: do shape development for C-MOD target shape #1050608018 with 1 NBI source at 800 kA and perform NBI power scan from 1-3 sources.

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

This XP requires an operational NBI system, as well as the capability of generating lower-single null, upper-single null, and double-null diverted discharges with the plasma control system. We desire HeGDC between shots of ~ 9 minutes for a 15 minute repetition rate. *The plasma will be controlled with rtEFIT.*

5. Planned analysis

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

Data and analysis will be published at the PSI and IAEA meetings in 2006.

7. References

[1] T. Hatae, et al., Plasma Physics Controlled Fusion **42**, A283 (2000).

[2] P.B. Snyder, et al., Phys. Plasmas **9**, 2037 (2002).

PHYSICS OPERATIONS REQUEST

Dependence of the H-mode Pedestal Structure on Aspect Ratio **OP-XP-529**

Machine conditions (specify ranges as appropriate)

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

I_P (MA): **0.6-1.0** Flattop start/stop (s): **0.15/1.0 (max)**

Configuration: **Double Null**

Outer gap (m): **8-10cm**, Inner gap (m): **2-10cm**

Elongation κ: **1.7-1.9** Triangularity δ: **0.45-0.6**

Z position (m): **0.00**

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

NBI - Species: **D**, Sources: **A/B/C**, Voltage (kV): **70-95**, Duration (s): **<1 sec**

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

CHI: **Off**

Either: List previous shot numbers for setup: **121504, 121516 D3D; 111378 NSTX, 1050608018 (C-MOD) for part V**

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

Dependence of the H-mode Pedestal Structure on Aspect Ratio **OP-XP-529**

Diagnostic	Need	Desire	Instructions
Bolometer - tangential array		✓	
Bolometer array - divertor		✓	
CHERS	✓		
Divertor fast cameras		✓	Nova Photonics camera requested
Dust detector			
EBW radiometers			
Edge deposition monitor			
Edge pressure gauges		✓	
Edge rotation spectroscopy		✓	
Fast lost ion probes – IFLIP		✓	
Fast lost ion probes – SFLIP		✓	
Filtered 1D cameras		✓	
Filterscopes	✓		
FIReTIP	✓		
Gas puff imaging		✓	
High-k scattering			
Infrared cameras		✓	
Interferometer – 1 mm			
Langmuir probes - PFC tiles		✓	
Langmuir probes - RF antenna			
Magnetics – Diamagnetism	✓		
Magnetics – Flux loops	✓		
Magnetics – Locked modes	✓		
Magnetics – Pickup coils	✓		
Magnetics - Rogowski coils	✓		
Magnetics - RWM sensors	✓		
Mirnov coils – high frequency	✓		
Mirnov coils – poloidal array	✓		
Mirnov coils – toroidal array	✓		
MSE	✓		
Neutral particle analyzer			
Neutron Rate (2 fission, 4 scint)			
Neutron collimator			
Plasma TV	✓		Request Hiroshima U. camera
Reciprocating probe		✓	
Reflectometer - FM/CW		✓	
Reflectometer - fixed frequency homodyne		✓	
Reflectometer - homodyne correlation		✓	
Reflectometer - HHFW/SOL		✓	
RF antenna camera			
RF antenna probe			
Solid State NPA			
SPRED		✓	
Thomson scattering - 20 channel	✓		
Thomson scattering - 30 channel	✓		
Ultrasoft X-ray arrays	✓		
Ultrasoft X-ray arrays - 2 color		✓	
Visible bremsstrahlung det.		✓	
Visible spectrometers (VIPS)			
X-ray crystal spectrometer - H			
X-ray crystal spectrometer - V			
X-ray PIXCS (GEM) camera			
X-ray pinhole camera			