Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: Stability limits at high δ and κ with new PF1A

OP-XP-502	**Revision:**	Effective Date: *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

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ATI – ET Group Leader: S. A. Sabbagh (for D. A. Gates)	Date
RLM - Run Coordinator: J. Menard, S. Sabbagh (Deputy)	Date

Responsible Division: Experimental Research Operations

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

Stability limits at high δ and κ with new PF1A **OP-XP-502**

1. Overview of planned experiment

The goal is to investigate the β limit in high triangularity double null discharges at high elongation using the recently modified PF1A coil. In particular to investigate the impact of increased edge shear and the anticipated higher operating current. The plasma internal inductance will be minimized in an attempt to avoid/delay the onset of the n=1,m=1 internal kink at high current (taking advantage of the increased edge shear.

2. Theoretical/ empirical justification

It has been well documented that shaping can affect the b limit on NSTX (and other machines). A large body of evidence supports this experiments (see e.g. NSTX 5 year plan, D. Gates and the NSTX Research Team, Phys. Plasmas **10** (2003), J. E. Menard, et al. Nuclear Fusion (2002), S. A. Sabbagh, et al., Nucl. Fusion to be published (2005) and others.

3. Experimental run plan

The experiment will benefit greatly from an XMP that investigates the formation of high elongation double null high triangularity plasmas with early divertor formation. The experiment will also attempt to investigate the impact of early H-mode formation on the achievable β.

1. Starting with an existing scenario ramp plasma current to 1.5MA (or as high as possible at a rate of 5.0MA/s. Adjust plasma shaping to avoid contact with plasma facing components. (3-7shots)

2. Vary the current ramp rate between 5.0 and 7.0MA/s in 0.5MA/s steps. Stop if edge MHD activity disrupts the plasma during the ramp. Adjust the plasma shape control to maintain relatively constant shape. Adjust beam timing to heat as early as possible for each ramp rate (10-20 shots, if a promising scenario is observed this section could expand).

3. Add flatspot to Ip in attempt to induce early H-mode. Vary secondary current ramp rate to avoid deleterious MHD. Maximize initial ramp rate, varying from 6 to 10MA/s. If necessary try an imbalance in the PF1A coil to bias the plasma towards lower single null. Vary beam timing to heat as early as possible in each ramp rate (20 shots, if a promising scenario is observed this section could expand).

Note: Section 2 and 3 will be performed alternately on both days of the run to give comparison between H-mode and non-H-mode ramp up scenarios

4. Attempt to extend flattop β to $\sim 2*\tau_E$. If necessary, reduce I_p until successful.

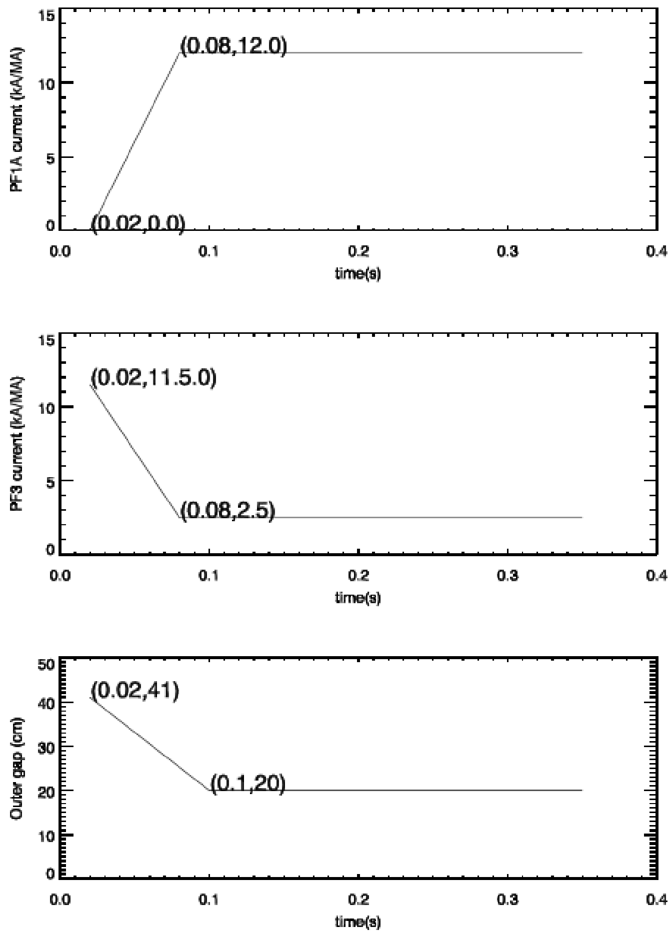

Figure 1: Starting PF waveforms (PF2 is 0.0).

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

Reliable high power NBI is a prerequisite. Thomson is required. CHERS and MSE are highly desirable. A recent boronization is required. It would be best to have investigated the use of the movable glow probe ahead of time. A vessel conditioning regime that is compatible with the high beta scenario is desirable.

5. Planned analysis

EFIT is required. TRANSP will be run on select shots according to data availability. DCON analysis will be useful, particularly if $q(0) > 1$ in some regimes. Eventually, if n=1 internal kinks are observed as in the past, MARS analysis is possible.

6. Planned publication of results

If the anticipated increase in β is realized, the results will be submitted to PRL. There will also be a more detailed Nuclear Fusion and/or a PoP paper as well.

PHYSICS OPERATIONS REQUEST

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Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **36kA** Flattop start/stop (s): **N/A**

I_P (MA): **~1.5MA** Flattop start/stop (s): _____/_____

Configuration: **Inner Wall / Lower Single Null / Upper SN / Double Null**

Outer gap (m): **10cm**, Inner gap (m): **2-4cm**

Elongation κ: **2.5**, Triangularity δ: **0.8**

Z position (m): **0.00**

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

NBI - Species: **D**, Sources: **A/B/C**, Voltage (kV): **90kV**, Duration (s): **400ms**

ICRF – Power (MW): **None**, Phasing: **N/A**, Duration (s): **N/A**

CHI: **Off**

Either: List previous shot numbers for setup: **This is a new experiment.**

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

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Diagnostic	Need	Desire	Instructions
Bolometer – tangential array		4	
Bolometer array - divertor		4	
CHERS		4	
Divertor fast camera		4	
Dust detector		4	
EBW radiometers		4	
Edge deposition monitor		4	
Edge pressure gauges		4	
Edge rotation spectroscopy		4	
Fast lost ion probes - IFLIP		4	
Fast lost ion probes - SFLIP		4	
Filtered 1D cameras		4	
Filterscopes	4		
FIReTIP		4	
Gas puff imaging			
Infrared cameras		4	
Interferometer - 1 mm		4	
Langmuir probe array			
Magnetics - Diamagnetism	4		
Magnetics - Flux loops	4		
Magnetics - Locked modes		4	
Magnetics - Pickup coils	4		
Magnetics - Rogowski coils	4		
Magnetics - RWM sensors		4	
Mirnov coils – high frequency		4	
Mirnov coils – poloidal array		4	
Mirnov coils – toroidal array		4	
MSE		4	
Neutral particle analyzer			
Neutron measurements	4		
Plasma TV	4		
Reciprocating probe			
Reflectometer – core			
Reflectometer - SOL			
RF antenna camera			
RF antenna probe			
SPRED		4	
Thomson scattering	4		
Ultrasoft X-ray arrays		4	
Visible bremsstrahlung det.		4	
Visible spectrometers (VIPS)		4	
X-ray crystal spectrometer - H			
X-ray crystal spectrometer - V			
X-ray PIXCS (GEM) camera			
X-ray pinhole camera			
X-ray TG spectrometer			