Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title:	Long pulse double null development at high κ and δ	
OP-XP-508	**Revision:**	Effective Date: *(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

The goal is to develop and study long pulse plasmas at high elongation and triangularity, taking advantage of the upgraded PF1A coil. The plasma will be shaped as early as feasible and the plasma will be ramped as quickly as possible, so as to minimize internal inductance. The first phase goal is to achieve early H-mode in a double plasma with a high initial ramp rate which will then be fixed at the optimum. Upon completion of the ramp-up phase of the XP, a toroidal field and plasma current scan will be performed, with only the secondary current ramp rate being varied.

2. Theoretical/ empirical justification

This experiment is the most recent in a series of experiments designed to investigate the performance of highly shaped double null plasmas. Both MHD stability calculations and time dependent integrated scenario modeling indicates that the modified PF1A coil, which enables the simultaneous achievement of high elongation and high triangularity, is capable of supporting interesting plasma performance regimes. This experiment directly addresses the goals of the NSTX five year plan.

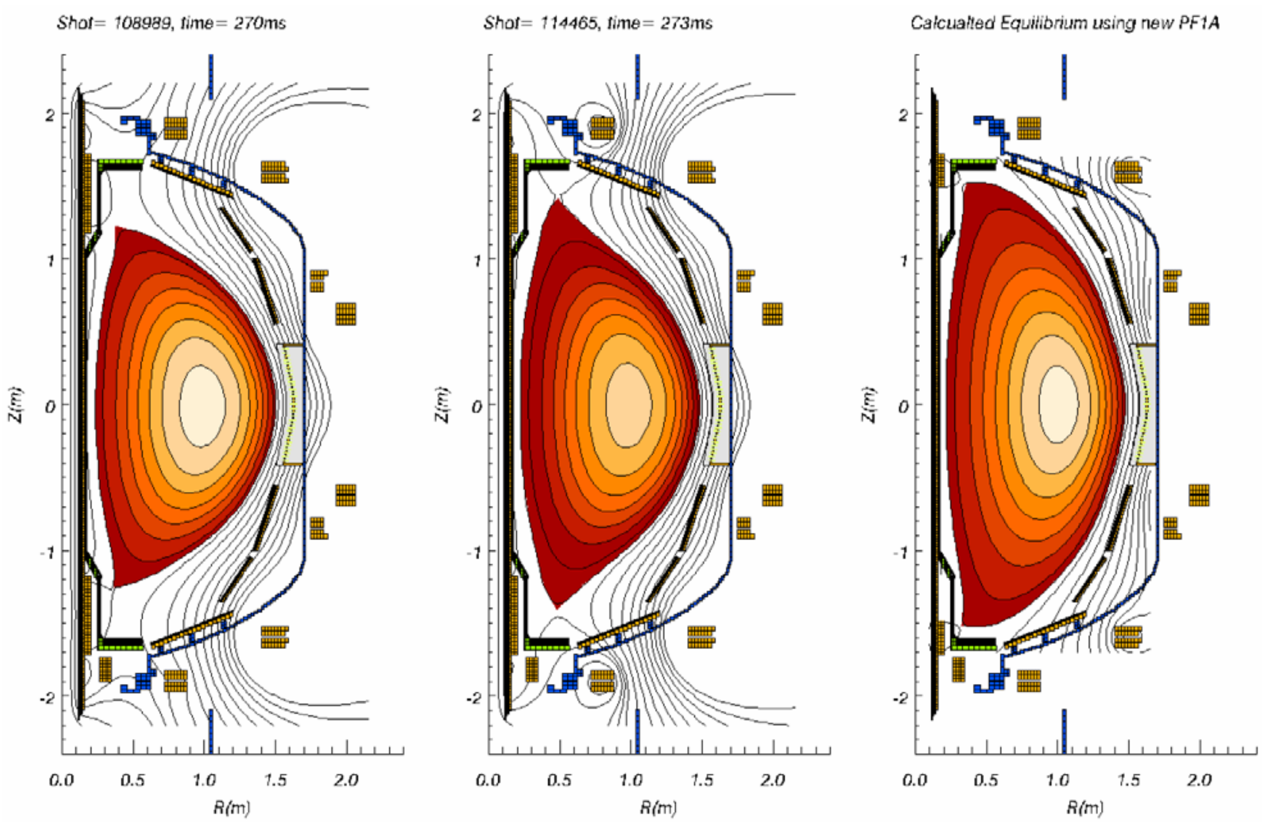

Figure 1: Shape Evolution for NSTX double null plasmas since 2002.

3. Experimental run plan

1. Using the suggested coil currents below, attempt to ramp plasma to full shape as early as possible. Ramp plasma current at rates of 7MA/s through 10MA/s. Use 4.5kGauss. (15 shots)

PF1AU	13.0kA/MA	
PF2U	0	
PF3U	-3.7kA/MA	
PF5	-10.5kA/MA	(feedback controlled)
PF3L	-3.7kA/MA	
PF2L	0	
PF1AL	13.0kA/MA	

2. Vary timing of current flat spot to induce early H-mode, with a target time of t = 0.09s. Bias plasma downwards if necessary to help induce H-mode. Vary beam timing relative to start of transition to optimize Ip flattop and stored energy. Inject source B first a t= 0.05s and vary timing of sources A and C between 0 – 100ms after the start of H-mode. Center stack gas puff should come just after H-mode transition. (15 shots)

3. Vary secondary current ramp rate to avoid MHD. Reduce from 8MA/s in 1MA/s second steps (10 shots).

4. Do Ip scan between 0.8 and 1.2MA. Bt scan between 3.0kGauss and 4.5kGauss. (30 shots)

Case	Bt	Ip
1	4.5kGauss	1MA
2	4.0kGauss	1.2MA
3	3.5kGauss	0.8MA
4	3.0kGauss	1MA
5	4.5kGauss	1.2MA
6	4.5kGauss	0.8MA
7	4.0kGauss	1.2MA
8	3.5kGauss	1.2MA
9	3.0kGauss	1.2MA
10	4.0kGauss	0.8MA
11	3.5kGauss	0.8MA
12	3.0kGauss	0.8MA

5. Do beam power scan for promising cases below to optimize sustained β (criteria to maintain $q(0)>1$ at lowest field possible).

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.

5. Planned analysis

EFIT is required. TRANSP will be run on select shots according to data availability. TSC analysis is a possibility.

6. Planned publication of results

These types of discharges have typically been the subject of our invited talks about long pulse and steady state (Physics of Plasmas, Nucl. Fusion). If performance is as expected, this should be the case again. The usual single null double null comparisons will also be made.

PHYSICS OPERATIONS REQUEST

Long pulse double null development at high κ and δ **OP-XP-508**

Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **36kA-54kA** Flattop start/stop (s): **N/A**

I_P (MA): **0.8 - 1.2MA** Flattop start/stop (s): **200ms/as long as possible**

Configuration: **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 CS gas valve**

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: **See chart above.**

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

Stability limits vs. normalized current at high delta with new PF1A **OP-XP-508**

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			