Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: **Basic Operation with Reversed TF**		
OP-XP-955	Revision: **0**	Effective Date: **8/4/09** *(Approval date unless otherwise stipulated)* Expiration Date: **8/4/11** *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: D. Mueller	Date 8/4/09
ATI – ET Group Leader:	Date 8/4/09
RLM - Run Coordinator: R. Raman	Date 8/4/09
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 toroidal field direction on NSTX will be changed from its normal, *i.e.* clockwise viewed from above, to the reversed, *i.e.* counter-clockwise viewed from above, direction. The goals of this experiment are to:

1) Establish standard plasma operation with reversed TF;
2) Compare the NB-heated LSN fiducial plasma with reversed TF to that with normal TF;
3) Compare this fiducial plasma with the sign of the EFIT control parameter DRSEP changed to move the dominant divertor from the bottom to the top of NSTX;
4) Perform USN, LSN and DN discharges and assess their performance, including differences in H-Mode power threshold, ELMs and MHD activity.

2. Theoretical/empirical justification

This work is a prerequisite for other physics investigations planned to exploit reversed-TF operation.

3. Experimental run plan

	Shots	Total
1) Run recent LSN fiducial shot with reversed TF with both 4 and 6 MW NBI, repeating as necessary to optimize the startup and gas puffing, outer gap = 10cm. Check for signs of increased fast ion losses (increased Prad, and TV pictures), increase outer gap and/or delay beams as is appropriate.	4	4
2) Change sign of DRSEP after start-up phase and run shots with 4 and 6 MW NBI Use RWM feedback from negative B_T for only the last shot Decision point, skip to steps 9 and 10 when new matrix is ready.	4	8
3) Run LSN shot 117747 repeating as necessary to optimize the startup and gas puffing	2	10
4) Perform power scan 4.5, 3.5, 3, 2 MW to get H-Mode threshold for LSN	6	16
5) Run USN shot 117750 repeating as necessary to optimize the startup and gas puffing	2	18
6) Perform power scan 4.5, 3.5, 3, 2 MW to get H-Mode threshold for USN	6	24
7) Run DN shot 117745 repeating as necessary to optimize the startup and gas puffing	2	26
8) Perform power scan 4.5, 3.5, 3, 2 MW to get H-Mode threshold for DN	6	32
9) If β_N >4.5 in steps 1) or 2), using the plasma with highest β_N, perform an n=3 error field correction scan using Table 1 below.	6	38
10) Using the “best” value of n=3 correction from 9), perform a scan of the phase of the n=1 feedback in 45° steps. using the standard gains from 134808 with the new matrix.	8	44

11) Fine tune scans in 4), 6) and 8) to get threshold power more accurately as time allows		6	50
12) Add lithium powder at 30 mg/min starting before t=0 and continuing through the shot for the best conditions established for the USN discharges		4	54
13) Add lithium powder at 30 mg/min starting before t=0 and continuing through the shot for the best conditions established for a complementary LSN discharges		2	56
14) Using the best performing shot from 10), perform an outer gap scan (10 , 7, 13, 16, 19 cm), taking care to increase the early outer gap to match the flattop value.		7	63

TABLE 1.

SPA1 (A)	SPA2 (A)	SPA3 (A)	Shot No.
0	0	0	
-250	250	250	
250	250	-250	
-500	-500	500	
500	500	-500	
-750	-750	750	

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

TF reversed and ISTP for operating with it completed.

NBI A @2 MW, B @1.5 MW, C @1 MW with possible changes in voltage, including 6 MW total power

Apply lithium evaporation at a rate of 200 mg/shot and run on a 10 min shot cycle.

One lithium powder dropper, preferably both, is required for steps 10) and 11).

Prior to TF reversal, run the following:	Shots
1) LSN from 117747, but increase Ip to better confine fast ions (aim for 900 kA)	4
2) Perform a power scan to find the H-Mode power threshold to about 0.5 MW	6
3) Perform an USN shot from 117750 at Ip in 1) at moderate power (2 or 4 MW).	2
4) Use Li dropper before and during shot at 30 mg/min and assess performance improvement with the Li powder.	6
Total	18

Note: The plasma current and plasma control scheme from above will be used whenever the shots 117745-50 are called for in the main XP.

5. Planned analysis

EFIT and TRANSP

6. Planned publication of results

These results will intrinsically contribute to NSTX publications and inform other experiments.

PHYSICS OPERATIONS REQUEST

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(use additional sheets and attach waveform diagrams if necessary)

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

Reversed TF

Previous shot(s) which can be repeated: **117745 (DN), 117747 (LSN), 117750 (USN)**
Previous shot(s) which can be modified: **133808 for DRSEP scan**

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

I_{TF} (kA): **53** Flattop start/stop (s): **-0.02/1.4**

I_P (MA): **0.6–0.8** Flattop start/stop (s):

Configuration: **USN, LSN and DN**

Equilibrium Control: **Outer gap / Isoflux** (rtEFIT)

Outer gap (m): **0.1** Inner gap (m): **0.01** Z position (m): **variable**

Elongation κ: **2.0-2.4** Upper/lower triangularity δ: **0.4**

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

NBI Species: **D** Voltage (kV) **A: 90** **B: 90** **C: 90** Duration (s): **1.4**

ICRF Power (MW): **0** Phase between straps (°): Duration (s):

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

LITERs: On Total deposition rate (mg/min): **10**

EFC coils: On Configuration: **Odd**

DIAGNOSTIC CHECKLIST

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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		√