Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: Study of Transport with Reversed Shear in NSTX		
OP-XP-610	**Revision: 1**	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)

NSTX EXPERIMENTAL PROPOSAL OP-XP-610

1. Overview of planned experiment

The plan of this experiment is to continue development of reversed shear q-profiles and study the thermal and particle transport properties of the ions and electrons. We will have available the MSE diagnostic and EFIT for between shot analysis. This will provide the needed guidance to develop the appropriate q-profile. The presence of MHD of various forms is the major impediment to achieving a high q(0) and strongly reversed shear q-profile. Last year we ran XP522 in NSTX which successfully obtained a reversed shear q-profile. The results indicated a correlation of improved ion and electron transport with a reversed shear q-profile in an L-mode plasma. We plan to continue to pursue these studies with the aim of varying the shear and documenting the transport with L-mode. We obtained some variation of shear last year, but would like to extend this to a monotonic q-profile to obtain a wider range of parameters and also operate experiment at higher magnetic field if possible. The other part of the experimental plan is to repeat the L-mode case, but have the plasma transition into an H-mode by moving it off the center stack. This was attempted last year, but very little time was spent on it. We did manage to get an H-mode transition that lasted a short amount of time. We would like to extend the period of the H-mode phase to determine the thermal and particle transport properties.

2. Theoretical/ empirical justification

Many theoretical based models for stability and transport depend on the q-profile and in particular on the magnetic shear. Experimental observations of the effect of magnetic shear on transport and stability have been documented in several tokamaks, such as TFTR and DIII-D. In this XP we propose to explore the stability and transport effects in the ST with reversed shear.

3. Experimental run plan

The conditions for this XP should be run at 4.5 kG, or higher if possible, with NB-A and NB-B at 90 kV. In order to slow the current penetration to the plasma core we want to elevate the electron temperature as much as possible and produce as large a plasma as possible. The plasma current will be at 1 MA. If we run out of OH too early then drop the plasma current to 900 or 800 kA.

1. <u>Reversed shear with L-mode at 4.5 kG:</u>
    a. Reproduce 116960.
    b. Repeat 115821.

c. Develop monotonic q-profile: Vary NB-A timing. Start NB-A at 0.04, 0.25, and 0.275 seconds.

d. If (c) does not work then add NB-B at 0.04, 0.08, .120 seconds for 50-100 ms to try to induce an early magnetic reconnection.

e. Slow current ramp and delay NB-A to allow current penetration; Ip flattop at 0.275 seconds, NB-A at .295 seconds.

f. Start up with smaller geometric center and slowly grow plasma to reach 85 cm at 0.2 seconds. Normally plasma starts at 65 cm at 50 ms. Try starting plasma at 45 cm and grow to 85 cm by 0.2 seconds. If 45 cm is successful, then try growing plasma from 30 cm.

Utilize GDC between shots.

This scenario development will take about 15 shots.

2. Reversed shear with L-mode up to 5.5 kG:

   a. Reproduce 116960 like conditions at 5.0 kG. May require some retuning of NB-A timing to avoid MHD problems.

   b. If (a) improves Te and looks promising then try 5.5 kG.

   c. Repeat 1b above at 5.0 or 5.5 kG, but with retuning if necessary.

   d. Repeat most successful approach of 1c-1f.

This development will take about 8 shots.

3. Develop reversed shear with H-mode:

In contrast to L-mode plasmas, higher density H-mode offers a regime with a different collisionality and high pressure gradient at the edge. This will change the NBCD and bootstrap current profile. The approach for development would be to take our condition in section 1 or 2 above and pull the plasma off the center stack(CS) after the reversed shear high Te mode has developed and add CS gas for a transition into H-mode. This approach was begun last year, but was not completed. One shot (116982) was successful in forming an H-mode but disrupted early. The goal here is to continue with that approach and extend the length of the H-mode phase.

   a. H-mode scan: Move inner gap about 2 cm off CS at 0.2 seconds. Use CS gas injector to induce H-mode(116982).

   b. Lower plasma position (drsep by 5 mm).

   c. Vary timing (0.2-0.25 seconds) of inner gap movement.

   d. Add NB-B at 0.3 s.

This section will take about 15 shots.

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

Well conditioned operation at 1.0 MA and 4.5 kG or higher. NB-A at 90 kV. NB-B and NB-C available.

5. Planned analysis

LRDFIT and EFIT for equilibrium reconstruction. Transp for transport analysis. Possible analysis of microstability with GS2, GYRO, or other codes.

6. Planned publication of results

APS meeting and refereed journals.

PHYSICS OPERATIONS REQUEST

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Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **53** Flattop start/stop (s): _____/_____

I_P (MA): **1.0** Flattop start/stop (s): **.14-.33/ > .5**

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

Outer gap (m): _____, Inner gap (m): _____

Elongation κ: _____, Triangularity δ: _____

Z position (m): **0.00**

Gas Species: **D** Injector: **Midplane / Inner wall / Lower Dome**

NBI - Species: **D**, Sources: **A/B/C**, Voltage (kV): **90**, Duration (s): **.7**

ICRF – Power (MW): ____, Phasing: **Heating / CD**, Duration (s): _____

CHI: **Off**

Either: List previous shot numbers for setup: **116960, 115821**

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			
Bolometer array - divertor			
CHERS	x		
Divertor fast camera		x	
Dust detector			
EBW radiometers			
Edge deposition monitor			
Edge pressure gauges			
Edge rotation spectroscopy		x	
Fast lost ion probes – IFLIP			
Fast lost ion probes – SFLIP			
Filtered 1D cameras			
Filterscopes		x	
FIReTIP		x	
Gas puff imaging		x	
High-k scattering	x		
Infrared cameras			
Interferometer – 1 mm			
Langmuir probes - PFC tiles			
Langmuir probes - RF antenna			
Magnetics – Diamagnetism	x		
Magnetics – Flux loops	x		
Magnetics – Locked modes	x		
Magnetics – Pickup coils	x		
Magnetics - Rogowski coils	x		
Magnetics - RWM sensors			
Mirnov coils – high frequency	x		
Mirnov coils – poloidal array	x		
Mirnov coils – toroidal array	x		
MSE	x		
Neutral particle analyzer		x	
Neutron Rate (2 fission, 4 scint)			
Neutron collimator			
Plasma TV		x	
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	x		
Thomson scattering - 30 channel		x	
Ultrasoft X-ray arrays	x		
Ultrasoft X-ray arrays - 2 color	x		
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			
X-ray TG spectrometer			