Princeton Plasma Physics Laboratory

NSTX Machine Proposal

Title: **NSTX Start-up Commissioning and Evaluation**

OP-XMP-48	Revision**: 0**	Effective Date: Feb 13, 2008 *(Ref. OP-AD-97)* Expiration Date: Feb 13, 2010 *(2 yrs. unless otherwise stipulated)*

Procedure Approvals

Responsible author: **D. Mueller**	Date
ATI (NSTX Physics Ops): **D. Mueller**	Date
RLM (NSTX Experimental Research Ops): **M.G. Bell**	Date

Responsible Division: **Experimental Research Operations**

MINOR MODIFICATIONS

3. I-III Change reference shot from 121563 to 123893 700 kA LSN He shot for the RF conditioning setup

If XP802, Bias probe XP is to be run and RF is not going to be ready for a couple weeks, use 124688, a 600 kA 3.5 kG D2 ohmic shot instead.

3. IV Use 125329 as the reference shot for the NB part (this is 900 kA and uses the SPAs with n=3 configuration and feedback to minimize error fields after 400 ms). Note, this is a low li, long pulse sho; if it does not work, instead try the 1 MA fiducial from the 2007 run 125320; if that also does not work try 122318, an 800 kA LSN setup that worked at higher li.

Skip 3. VII

3. VIII compare 119083 with 122332, the "best" shot early in the 2007 run before the second boronization and 122374 after the second boron (It was decided to boronize after that due to the poor performance and short discharge duration, and subsequent to the boronization (122373), things improved). See shot log from 122300 to 122400 for comments. 122374 was good enough that the run began in earnest after that.

Skip 3. IX if RF is not ready

REVIEWERS (designated by RLM)	
ATI	D. Mueller
Test Director	D. Mueller
Independent Reviewer	n/a
D-Site Shift Supervisor	n/a
NSTX	n/a
TFTR Caretaking	n/a
Vacuum	n/a
Computer	n/a
Tritium	n/a
QA/QC	n/a
AC Power	n/a
FED	n/a
ECS/MG	n/a
FED	n/a
ERWM	n/a
Water	n/a
NB	n/a
RF	n/a
Diagnostics	n/a

TRAINING (designated by RLM)

Training required: No ■ Yes ☐ Instructor _____

Personnel (group, job title or individual name)	Read Only	Instruction	Hands-On

Training Rep. _____

RLM _____

NSTX MACHINE PROPOSAL

TITLE: **NSTX Start-up Commissioning and Evaluation** No. **OP-XMP48**

AUTHOR: **D. Mueller** DATE: **Feb. 13, 2007**

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1. Overview:

This experiment will establish high plasma current NBI heated plasmas with controlled spatial trajectories for comparison with previous discharges. A shot to help calibrate MPTS is included and plasmas for RF conditioning are included since it is hoped the RF will be ready early in the run. Inner wall limited (as part of the normal start-up), single null diverted, and double null diverted discharges will be used. This task involves four basic steps: plasma breakdown optimization, plasma control gain optimization (if needed) and plasma shape programming, use of rt-EFIT-isoflux control is planned.

2. Justification:

These plasma scenarios will be the basis for many of the NBI experiments in the run.

3. Plan:

I. Establish common startup phase using preprogrammed poloidal field coil current control with a preprogrammed prefill of deuterium from an outer midplane gas injector and He puffing to maintain density. Verify that the plasma current, vessel current, and magnetic field and flux measurements used in the real time control system are being sampled and scaled appropriately in the real time the data acquisition system. Reference shot 121563, this is a 700 kA He RF conditioning target. See Phys Ops. Request Form. Perform steps II-III as needed.

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Shot numbers

II. Establish feedback control of the plasma using the discharge shape algorithm using the restored discharge as a starting point by setting all system waveforms to zero.

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Shot numbers

III. Use rtEFIT -isoflux control to maintain control during flattop.

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Shot numbers

IV. Establish a NBI heated, long pulse, high triangularity, DN shot using PF1A. Reference shot 119991. See Phys Ops. Request Form. Begin with 1 NB source (B).

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Shot numbers

V. Increase NB power by adding sources as needed.

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Shot numbers

VI. Repeat steps III-V for lower single null configuration starting from reference shot 120640, a long-pulse, NB-heated LSN shot using PF1B from XP614. See Phys. Ops. Request Form.

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Shot numbers

VII. Using 120640 and 1 NB source, modify the outer gap request to move plasma to within 3 cm of the RF antennas for a couple shots for MPTS calibration.

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Shot numbers

VIII. Produce a LSN discharge based on 119083 for comparison with shots from early in the 2006 run

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Shot numbers

IX. Perform RF conditioning using shot 121563, a 700 kA, He discharge as the target plasma. Increase RF power as it conditions.

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Shot numbers

4. Required machine, beam, ICRF and diagnostic capabilities:

I. Gas injection system operational and calibrated.

II. Completion of ISTP-001 using the PSRTC control software.

III. Plasma Control System (PCS) operational with real-time data acquisition providing necessary input data for the control algorithms.

IV. NB sources conditioned to at least 85 kA.

V. For the following magnetic diagnostic systems, calibrated, integrated (where appropriate) signals with offset, drift and stray-field pickup removed, must be digitized, archived and accessible through MDSplus. (Note: Signals in control system will be compared to standard data acquisition system.)

a) Coil current measurements,
b) Flux loops,
c) Loop voltages,

d) Mirnov coils,
e) Plasma current Rogowski,
f) Vessel current measurements.

VI. Plasma TV operational with view of plasma cross-section

VII. EFIT reconstruction code capable of analyzing equilibrium using calibrated data from the MDSplus tree, with current geometrical data for sensor positions. The analysis should include the measured vessel current distribution determined using the measured loop voltage distribution and use the plasma current measurement as a constraint. Will be compared to rt-EFIT analysis before using rt-EFIT isoflux control.

VIII. A measurement of plasma density is desirable.

IX. RF vacuum conditioning completed.

5. Sign off at run time:

5.1 Permission to Proceed: _____

Physics Operations Head

5.2 Documentation of results:

Documentation of the results completed, attached to proposal and sent to Ops. Center with copies to Cognizant Physicist and Head of Physics Operations.

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Cognizant Physicist/Test Director

PHYSICS OPERATIONS REQUEST

NSTX Plasma Control System Commissioning **OP-XMP-48**

Machine conditions

I_{TF} (kA): **53.5** Flattop start/stop (s): **-0.010 – 1.5**

I_P (MA): **1.0, 0.8** Flattop start/stop (s): **0.2 – 0.3 to 1.4s**

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

Z (m): **0.00**

Elongation κ: **~2.4, 2.4**

Triangularity δ: **~0.7. 0.6**

Gas Species: **D, He for HHFW conditioning shots**

NBI: **6 MW**

ICRF: **up to 2MW possibly**

CHI: **n/a**

List of previous shot numbers for setup:

119991 – for development common startup and high-δ DN divertor prototype. For first attempts do not use rtEFIT (keep all system waveforms zero) and ramp I_p down at ~0.3s

119083 – LSN prototype

120640 – for MPTS system checkout and calibration

121563 – for HHFW antenna conditioning

DIAGNOSTIC CHECKLIST

NSTX Plasma Control System Commissioning OP-XMP-48

Diagnostic	Need	Desire	Instructions
Bolometer – tangential array		✓	
Bolometer array - divertor		✓	
CHERS – toroidal		✓	
CHERS - poloidal			
Divertor fast camera			
Dust detector			
EBW radiometers			
Edge deposition monitors			
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 – 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			
NPA – ExB 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	✓		**For later shots**
Ultrasoft X-ray arrays		✓	
Ultrasoft X-ray arrays – bicolor		✓	
Ultrasoft X-rays – TG spectr.		✓	
Visible bremsstrahlung det.		✓	
X-ray crystal spectrometer - H			
X-ray crystal spectrometer - V			
X-ray fast pinhole camera			