

**Princeton Plasma Physics Laboratory
NSTX Experimental Proposal**

Impact of density reduction on long-pulse discharges

OP-XP-838

Revision: **0**

Effective Date: **June 27, 2008**
(Approval date unless otherwise stipulated)

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(2 yrs. unless otherwise stipulated)

PROPOSAL APPROVALS

Responsible Author: Jon Menard

Date March 27, 2008

ATI – ET Group Leader: David Gates

Date

RLM - Run Coordinator: Michael Bell

Date

Responsible Division: Experimental Research Operations

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: Impact of density reduction on long-pulse discharges No. **OP-XP-838**
AUTHORS: **J. Menard, V. Soukhanovskii, D. Gates** DATE: **06/27/2008**

1. Overview of planned experiment

The combination of active suppression of n=1 RFA, n=3 pre-programmed error field correction (EFC), and the after-effects of LITER have produced record pulse-durations. High elongation + EFC + LITER have produced record poloidal beta and record low flux-consumption in NSTX. Further decreases in flux consumption are possible with increased non-inductive fraction and/or increased conductivity. Reduced density could increase the NBI CD efficiency, and if T_e increases at reduced density, density reduction could increase the conductivity and further increase NBI-CD. This experiment will attempt to systematically lower the plasma density by reducing the HFS gas source while avoiding disruptive MHD activity by replacing HFS gas with SGI fueling, optimizing the beam programming to avoid hitting the beta limit, and optimizing early error-field correction to reduce mode locking. These approaches will be applied primarily to long-pulse discharges, but also to high non-inductive fraction discharges.

2. Theoretical/ empirical justification

Reduced density is predicted to increase beam current drive efficiency, and higher T_e at reduced density could further increase NBI-CD efficiency and conductivity – all resulting in increased pulse duration and higher non-inductive fraction plasmas. Higher non-inductive fraction is important for improved operation of NSTX and NSTX-Upgrade and is essential to future ST devices such as NHTX and ST-CTF.

3. Experimental run plan

- A. Reproduce and extend long-pulse discharges (8 shots)
 - 1. Constant evaporation rate = 20mg/min
 - 2. Start from 129125 - scan $I_p = 750\text{kA}, 700\text{kA}, 800\text{kA}$ at $B_T = 0.41$ and 0.375T
- B. For longest duration discharge, perform density scan
 - 1. Reduce HFS fueling rate in 100T increments
 - 2. As plasma density becomes too low and destabilizes locked modes, try:
 - i. Replacing early fueling with SGI fueling to increase density (8 shots)
 - ii. Optimizing beam power and timing to avoid early disruption (4 shots)
 - iii. Earlier EFC to assess impact on early mode locking (4 shots)
 - 3. GOAL: Attempt to completely replace HFS with SGI fueling
- C. At lowest stable operating density, try increased toroidal field and elongation to attempt to increase non-inductive fraction (8 shots)
 - 1. Start from 129986 (record poloidal beta) – scan density with HFS and/or SGI
 - 2. Scan toroidal field from 4.4 kG to 5.2kG in 0.2kG increments

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

The usual diagnostic capabilities are required, NBI voltage on A, B, C = 90, 90, 80kV.

5. Planned analysis

EFIT/LRDFIT, TRANSP, MPTS, CHERS, and RWM/EF sensor analysis will be performed.

6. Planned publication of results

Results will be published in conference proceedings and/or journal such as Nuclear Fusion or Physics of Plasmas within one year of experiment.

PHYSICS OPERATIONS REQUEST

TITLE: Impact of density reduction on long-pulse discharges No. **OP-XP-838**
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Machine conditions (specify ranges as appropriate)

I_{TF} (kA): up to **63kA** Flattop start/stop (s): **0.0, ~2s**

I_P (MA): **0.7, 0.75, 0.8MA** Flattop start/stop (s): **0.2, ~2s**

Configuration: **DN / LSN**

Outer gap (m): **10cm** Inner gap (m): **2-8cm**

Elongation κ : **2.4-2.7** Upper/lower triangularity δ : **0.75 / 0.5**

Z position (m): **0cm**

Gas Species: **D** Injector(s): **CS midplane, outer midplane, SGI**

NBI Species: **D** Sources: **A, B, C** Voltage (kV): **90, 90, 80kV** Duration (s): **2s**

ICRF Power (MW): **0** Phasing: **0** Duration (s): **0**

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

LITER: **On – 20 mg/min (up to 40mg/min may be requested)**

Either: List previous shot numbers for setup: 129125, 129986

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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Note special diagnostic requirements in Sec. 4

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Diagnostic	Need	Want
Bolometer – tangential array		
Bolometer – divertor		
CHERS – toroidal	X	
CHERS – poloidal	X	
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		
H α camera - 1D		
High-k scattering		
Infrared cameras		
Interferometer - 1 mm		
Langmuir probes – divertor		
Langmuir probes – BEaP		
Langmuir probes – RF ant.		
Magnetics – Diamagnetism	X	
Magnetics – Flux loops	X	
Magnetics – Locked modes	X	
Magnetics – Pickup coils	X	
Magnetics – Rogowski coils	X	
Magnetics – Halo currents		
Magnetics – RWM sensors	X	
Mirnov coils – high f.	X	
Mirnov coils – poloidal array	X	
Mirnov coils – toroidal array	X	
Mirnov coils – 3-axis proto.		

Diagnostic	Need	Want
MSE	X	
NPA – ExB scanning		
NPA – solid state		
Neutron measurements	X	
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	X	
Ultrasoft X-ray arrays	X	
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		