## Princeton Plasma Physics Laboratory
# NSTX Experimental Proposal

Title: **Lithium effects on transport in the edge/SOL**

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|---|---|---|
| **OP-XP-1072** | Revision: | Effective Date:<br>*(Approval date unless otherwise stipulated)*<br>Expiration Date:<br>*(2 yrs. unless otherwise stipulated)* |

## PROPOSAL APPROVALS

| | |
|---|---|
| **Responsible Author: Jose Boedo** | Date |
| **ATI – ET Group Leader: V. Soukhanovskii** | Date |
| **RLM - Run Coordinator:** | Date |

**Responsible Division: Experimental Research Operations**

## RESTRICTIONS or MINOR MODIFICATIONS
(Approved by Experimental Research Operations)

# NSTX EXPERIMENTAL PROPOSAL

TITLE: **Lithium effects on transport in the edge/SOL** No. **OP-XP-1072**
AUTHORS: **J. Boedo, V. Soukhanovskii, R. Maingi, et al.** DATE: **10/11/2010**

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## 1. Overview of planned experiment

The experiment will obtain high spatial resolution profiles of $N_e$, $T_e$ and potentials in the midplane edge and SOL and also radial turbulent transport measurements as the content of lithium in the boundary is varied with all other plasma and shape parameters constant. The objective will be to observe profile and transport changes as the amount of lithium changes and to get basic information as to what affects plasma performance, for example, a particle pinch. We will starve the plasma of lithium for a few shots until ELMS start coming back while measuring the aforementioned profiles. If possible, a large amount of lithium will then be evaporated for a few more shots while measurements are performed.

## 2. Theoretical/ empirical justification

NSTX is pioneering the use of lithium surfaces that increase plasma performance and help control density. There are many features of these discharges that are unknown, why ELMs are eliminated, how impurities accumulate, etc. A first attempt to this experiment was done during shots 140148-140152 by keeping the plasma conditions constant as lithium quantity was varied and edge measurements were made. The first results were encouraging but the outer gap kept increasing, preventing the measurements form reaching the core. We will repeat but with an eye on outer gap control and probe penetration into the core. The first results showed that the SOL is essentially unmodified as the lithium quantity is varied but that the pedestal location moves inward as the lithium amount is increased.

## 3. Experimental run plan

We will repeat shot series 140148-140152 although with a smaller (2 cm smaller) outer gap and better gap control. We will measure with the fast reciprocating probe $T_e$ and $N_e$ profiles and fluctuations and transport to see changes, in particular, to search for an inward particle pinch. Since this experiment will be run while between-shots lithium deposition is not possible, it will rely on lithium deposition of 1 – 2 g at the start of the run day to produce the initial ELM-free discharges then allow the depletion of the lithium coating to produce a return to ELMing H-mode discharges.

Experimental sequence:

1) At end of previous day: take reference shot with inactive lithium to verify plasma and probe operations;

2) Start of main day: deposit ~ 1g lithium then cool down LITER;

3) When LITER has cooled enough to allow MPTS shutter to open, run shots with fast reciprocating probe and full diagnostics;

4) Repeat until lithium becomes inactive and ELMs return, possibly waiting until the end of the day, after another experiment has been run, to complete the measurements in ELMing conditions.

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

We will require a LSN discharge at 0.8 MA and -0.44 T with a flat top from 0.2 s to 0.77 s while injecting low power NBI at 1 MW. The NBI programming should be reproduced from the reference shots 140148-152. The outer gap MUST be reduced by 2 cm.

## 5. Planned analysis

$T_e$, $N_e$ profile analysis will be done with a double probe code.

Fluctuations analysis will be done with various statistical and metric codes to calculate skewness, kurtosis, rms levels, etc.

Radial turbulent transport will be done with a specialized code that filters the data properly to eliminate low-f and MHD contamination.

Conditional averaging will also be done to quantify the behaviour of blobs.

We will seek to do edge simulations by using OEDGE and also the Lodestar turbulence code.

## 6. Planned publication of results

We will aim to publish the experimental results first, possibly in PoP and the more complete work with simulations later on, possibly PoP or NF

# PHYSICS OPERATIONS REQUEST

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**Brief description of the most important operational plasma conditions required:**

Reproduce any of the shots 140148-140152. This is a LSN, low power (1 MW) H-mode discharge with a current of 0.8 MA and $B_T$ of -0.44, an elongation of 2.30 and Z-centered.

**Note: the outer gap MUST be reduced from 0.09 to 0.07 m and kept constant so the probe can have a steady target.**

Reproduce NBI programming exactly, which involves a source stack to about 5MW, reducing to 3MW at 0.161 s and then to 1 MW at 0.202 s, then staying constant for the duration of the plateau to 0.77 s

Since this experiment will be run while between-shots lithium deposition is not possible, it will rely on lithium deposition of 1 – 2 g at the start of the run day to produce the initial ELM-free discharges.

**Previous shot(s) which can be repeated:**

**Previous shot(s) which can be modified: 140148, 140149, 140150, 140151**

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

$I_{TF}$ (kA): **-0.44 T** Flattop start/stop (s): **0.20**

$I_P$ (MA): **0.820** Flattop start/stop (s): **0.77**

Configuration: **LSN**

Equilibrium Control: **rtEFIT (with outer gap programmed to meet needs)**

Outer gap (m): **0.07** Inner gap (m): **0.08** Z position (m): **-0.02**

Elongation: **2.3** Triangularity (U/L): **0.373/0.711** OSP radius (m): **0.66**

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

**NBI** Species: **D** Voltage (kV) **A: 90** **B: 90** **C: 67** Duration (s): **0.8**

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

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

**LITERs: On** Total deposition rate (mg/min): **1 – 2 g evaporated at outset**

**LLD:** Temperature (°C): **20**

**EFC coils: Off** Configuration: **Odd / Even / Other**

# DIAGNOSTIC CHECKLIST

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*Note special diagnostic requirements in Sec. 4*

| **Diagnostic** | **Need** | **Want** |
|---|---|---|
| Beam Emission Spectroscopy | | √ |
| Bolometer – divertor | | √ |
| Bolometer – midplane array | √ | |
| CHERS – poloidal | | √ |
| CHERS – toroidal | √ | |
| Dust detector | | |
| Edge deposition monitors | | |
| Edge neutral density diag. | | |
| Edge pressure gauges | | √ |
| Edge rotation diagnostic | | √ |
| Fast cameras – divertor/LLD | √ | |
| Fast ion D_alpha - FIDA | | |
| Fast lost ion probes - IFLIP | | |
| Fast lost ion probes - SFLIP | | |
| Filterscopes | √ | |
| FIReTIP | √ | |
| Gas puff imaging – divertor | | |
| Gas puff imaging – midplane | | √ |
| H$\alpha$ camera - 1D | √ | |
| High-k scattering | | |
| Infrared cameras | | √ |
| Interferometer - 1 mm | | |
| Langmuir probes – divertor | | √ |
| Langmuir probes – LLD | | |
| Langmuir probes – bias tile | | |
| Langmuir probes – RF ant. | | |
| Magnetics – B coils | √ | |
| Magnetics – Diamagnetism | √ | |
| Magnetics – Flux loops | √ | |
| Magnetics – Locked modes | | √ |
| 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 detectors | | |
| Plasma TV | | √ |
| Reflectometer – 65GHz | | |
| Reflectometer – correlation | | |
| Reflectometer – FM/CW | | |
| Reflectometer – fixed f | | |
| Reflectometer – SOL | | √ |
| RF edge probes | | |
| Spectrometer – divertor | | √ |
| Spectrometer – SPRED | √ | √ |
| Spectrometer – VIPS | √ | |
| Spectrometer – LOWEUS | | |
| Spectrometer – XEUS | | |
| SWIFT – 2D flow | | |
| Thomson scattering | √ | |
| Ultrasoft X-ray – pol. 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 tang. pinhole camera | | √ |