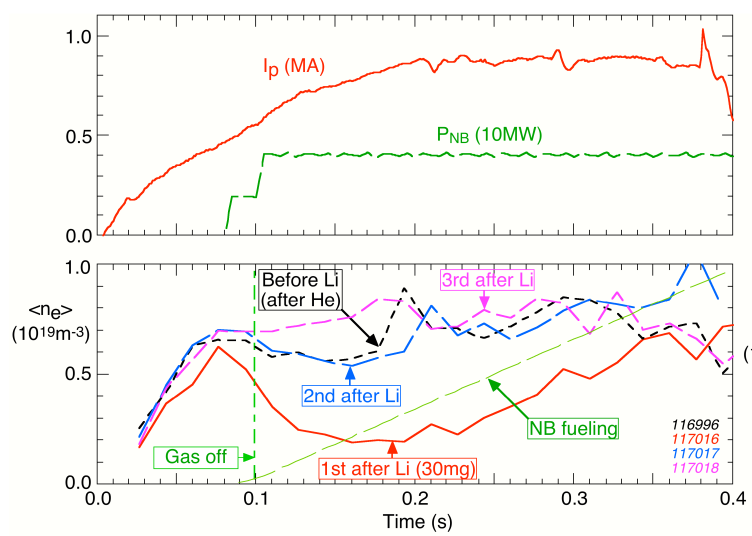
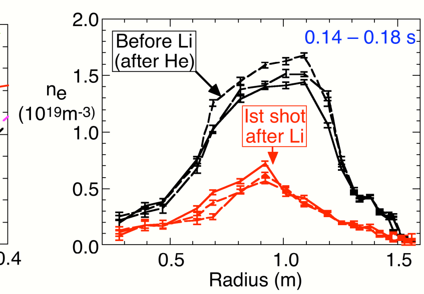
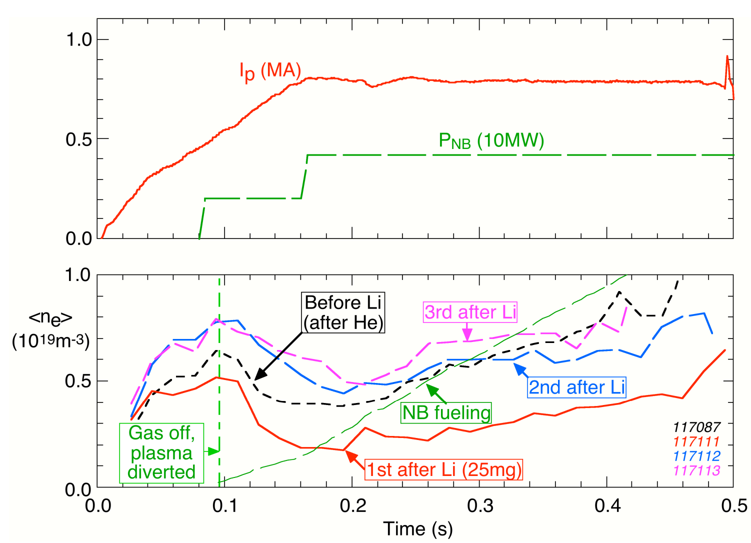
XP601: Effect of Evaporated Lithium PFC Coatings on Density Control, H.W. Kugel, et al

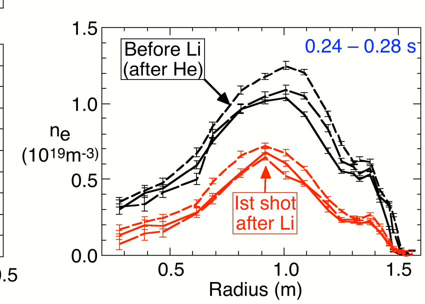
- **Goal**
  1. LPI-range thin coatings – L-mode (day 1)
  2. thin coatings – H-mode, same shape as above (day 2)
  3. thick coatings – H-mode, same shape as above (day 2)
  4. thin or thick coatings – long pulse, LSN H-mode with pf1B (day 3)
  5. thin or thick coatings – L-mode for transport and turbulence experiments (day 3)





Center-stack limiter discharges, 0.9 MA, 0.45T, D_2 gas fueling 3.5mg





Lower single-null divertor discharges, 0.45T, D_2 gas fueled 3.5mg

Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: Effect of Evaporated Lithium PFC Coatings on Density Control

OP-XP-601	**Revision:**	Effective Date: 1/31/06 *(Ref. OP-AD-97)* Expiration Date: 1/31/08 *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Author H.W. Kugel, et al.	Date
ATI – ET Group Leader: R. Maingi	Date
RLM - Run Coordinator: R. Raman	Date

Responsible Division: Experimental Research Operations

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

Effect of Evaporated Lithium PFC Coatings on Density Control

1. Overview of planned experiment

This three day XP will investigate the effects of evaporated lithium coatings on density control prior to its application in other XP's. First, this XP will make contact with the LPI thin coating results, and then proceed to thicker coatings and long pulses. The basic procedure will follow:

1. LPI-range thin coatings – L-mode (day 1)
2. thin coatings – H-mode, same shape as above (day 2)
3. thick coatings – H-mode, same shape as above (day 2)
4. thin or thick coatings – long pulse, LSN H-mode with pf1B (day 3)
5. thin or thick coatings – L-mode for transport and turbulence experiments (day 3)

2. Theoretical/ empirical justification

• NSTX Phase I (Li Pellet Injection) experiments demonstrated that surfaces *pre-coated with lithium*, edge pumped a diverted plasma and exhibited an increased peaking of the density profile.

• These results motivated preparations for Phase II installation of a LIThium EvaporatoR (LITER-1) for performing routine thick lithium coating depositions over a significant fraction of the plasma facing surfaces.

3. Experimental Plan Day #1: Thin Coatings, LPI Discharges

3.1 Document initial conditions using baseline L-mode LSN discharge with no center stack gas fueling (117087). [1 discharge]

3.2 Apply about 6 He LSN Ohmic discharges (116991) to obtain the same wall conditions for a comparison with previous LPI results. [8 discharges]

3.3 Compare the density control provided by a thin evaporated coating of 30-90 mg (2-6 nm) with the similar deposition using LPI into LSN Helium discharges.
Run 3-5 baseline discharges to see duration of effect: LPI showed the effect wearing off after 2 discharges,

1. Deposit 30-90 mg Li before running LSN baseline 117087
3. HeGDC for 9 minutes.
4. Repeat 117087
5. HeGDC for 9 minutes.
6. Repeat 117087 … [3-5 discharges]

3.4 How do lithium wall conditions change if no He LSN Ohmic discharges used for pre-conditioning?

1. HeGDC for 9 minutes.
2. Deposit 30-90 mg Li
3. Apply LSN baseline 117087
4. HeGDC, for 9 minutes.
5. Repeat 117087
6. HeGDC, for 9 minutes.
7. Repeat 117087 … [3-5 discharges] [15-19 discharges]

3.5 **How do lithium wall conditions change if no HeGDC used between discharges?**

1. No HeGDC
2. Deposit 30-90 mg Li
3. Apply LSN baseline 117087
4. No HeGDC
5. Repeat 117087
6. No HeGDC
7. Repeat 117087 … [3-5 discharges] [15-19 discharges]

4. Day #2: Thick Coatings, Thin coatings between shots, H-mode

4.1 Induce H-mode in reference L-mode discharge and gauge H-mode access and density control. Use 9- 11.5 minutes HeGDC between discharges, as determined by wall conditions.

1. Deposit 30-90 mg Li and repeat 117087 with center stack gas fueling at 1000 torr.
2. Vary center stack gas fueling pressures [1100, 1200, 900, 800] to test H-mode access; use HeGDC and deposit Li between every shot, if needed and determined by above.
3. If fueling still too low, add in center stack shoulder fueling at 600 torr, and vary as needed for H-mode access. [10-20 discharges]

4.2 Increase lithium thickness and restore density flattop during H-mode pulse.

1. Deposit 200 mg Li and rerun H-mode discharge above with increased LFS fueling or private region fueling during flattop
2. Repeat Li deposition and continue increasing fueling until density reaches a flattop during Li pumping
3. If not successful repeat by increasing HFS fueling

[10 discharges]

4.3 Once density flattop is achieved, perform density scan at longest pulse length achievable. Try for 2-3 density values.

[5-10 discharges]

[Total =25-40 discharges]

5. *Day #3: Thin or thick Coatings, long pulse LSN H-mode and L-mode targets*

5.1 Long-pulse H-mode with pf1B shape

1. Deposit 30mg of Lithium or optimum between shot amount as determined from first two days
2. Run long pulse pf1bB H-mode discharges e.g. #116313, #116318, #117147 (w0/RWM coils) or best available after increasing early fueling to insure H-mode success. Probably will have to iterate on best early fueling rate to avoid locked modes; add in shoulder injector or branch 5 injector if necessary [5-8 discharges]
3. Increase to higher lithium coating, as determined from first two days, and optimize fueling to control density during long pulse. [5-8 discharges]

5.2 Reversed shear L-mode development for transport studies

1. Restore #117783 with no Lithium deposited before shot [2 shots]
2. Deposit minimum lithium before shot try to reproduce at slightly lower density; increase low-field side fueling slowly if locked modes appear [2-6 shots]
3. Increase lithium coating between shots in slow increments to find minimum density before locked modes, as well as to try to maintain density during discharge flattop. [4-8 shots]

5.3 How does systematically changing edge neutral density effect the RF breakdown voltage.

1. Apply an RF-blip during all of the above flattops.

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

Prerequisites: Boronization, low recycling walls.
Required Configuration: Machine, NBI, and RF-blip conditions for LSN (117087)
Required Diagnostics: Standard.
Required Run Time: 40-60 discharges (2 days)

PHYSICS OPERATIONS REQUEST

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Machine conditions (specify ranges as appropriate) DLSN 117087 and DLSN (117087)

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

I_P (MA): ______ Flattop start/stop (s): _____/_____

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 / He**, Injector: **Midplane / Inner wall / Lower Dome**

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

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

CHI: **On / Off**

Either: List previous shot numbers for setup: ______________________________

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	X		
Bolometer array - divertor	X		
CHERS	X		
Divertor fast camera	X		
Dust detector			
EBW radiometers			
Edge deposition monitor	X		
Edge pressure gauges	X		
Edge rotation spectroscopy		X	
Fast lost ion probes - IFLIP		X	
Fast lost ion probes - SFLIP		X	
Fast X-ray pinhole camera		X	
Filtered 1D cameras	X		
Filterscopes	X		
FIReTIP	X		
Gas puff imaging	X		
Infrared cameras	X		
Interferometer - 1 mm		X	
Langmuir probe array	X		
Magnetics - Diamagnetism	X		
Magnetics - Flux loops	X		
Magnetics - Locked modes	X		
Magnetics - Pickup coils	X		
Magnetics - Rogowski coils	X		
Magnetics - RWM sensors		X	
Mirnov coils – high frequency	X		
Mirnov coils – poloidal array	X		
Mirnov coils – toroidal array	X		
MSE			
Neutral particle analyzer	X		
Neutron measurements	X		
Optical X-ray		X	
Plasma TV	X		
Reciprocating probe		X	
Reflectometer – core		X	
Reflectometer - SOL		X	
RF antenna camera			
RF antenna probe			
SPRED	X		
Thomson scattering	X		
Ultrasoft X-ray arrays	X		
Visible bremsstrahlung det.	X		
Visible spectrometer (VIPS)	X		
X-ray crystal spectrometer - H	X		
X-ray crystal spectrometer - V	X		