Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: Effect of Evaporated Lithium PFC Coatings on Density Control		
OP-XP-601	**Revision:**	Effective Date: 4/7/06 *(Ref. OP-AD-97)* Expiration Date: 4/7/08 *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

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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)

Note:

1. In 119665, LFS gas ends at 80ms. CS gas comes in at 98ms. Consider reducing this time difference to <10ms for the first two shots.

2. Exercise gas injectors to verify they are injecting at the correct time prior to running first shot after Li deposition.

Effect of Evaporated Lithium PFC Coatings on Density Control

1. Overview of planned experiment

This two 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. The basic procedure will follow:

a. thin coatings – long pulse, high power H-mode (day 1)
b. thick coatings – long pulse, high power H-mode (day 2)

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 long-pulse H-mode DN discharge with center stack gas fueling (119665). [1 discharge]

3.2 Apply about 6 He LSN Ohmic discharges (116991 or equivalent) to prepare the wall as done previously for LPI. [8 discharges]

3.3 Evaluate the density control provided by a thin evaporated coating of ~ 100 mg (~7 nm) on long pulse discharges, with HeGDC between shots. Since we anticipate that the lithium will be consumed in a small number of shots (<5), the wall conditions will be changing. Avoid changing the external fueling unless runaways are observed and/or H-mode access becomes problematic.

1. Evaporate 100 mg Li
2. Run #119665 with a shortened pulse, i.e. ramp down starting at 250ms (beyond where H-mode transition should occur), to determine if there is sufficient fueling to avoid runaways. If density is too low, repeat target discharge to determine if Lithium was wearing out. (2 discharges)
3. If density is still too low on second discharge and/or H-mode cannot be achieved, increase fueling in the order below: (3-5 discharges)
   (a) early LFS fueling
   (b) CS fueling
   (c) Add shoulder fueling
   (d) Add SGI fueling

4. If there are obvious signs of lithium saturation at any stage, evaporate another 100mg.
5. When density is sufficiently high, extend the pulse length to 500msec and repeat with same fueling. If density too low at 500 msec, repeat above discharge to determine if Lithium is saturating. (2 discharges)
6. If density is still too low, repeat target discharge with increased fueling in order of:
    a) CS gas
    b) SGI gas
    c) shoulder gas
    d) LFS gas injector.
    e) If fueling still too low, to controlled access to increase size of fueling plenums. (3-5 discharges)
7. Extend discharges to 1 sec. Pulse length and repeat until standard high recycling discharge is re-established. [3-5 discharges]

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

1. Evaporate 100 mg Lithium.
2. Repeat steps in 3.3. Hopefully no fueling adjustment will be needed, since we learned from 3.3. [5-10 discharges]

3.5 ***Time permitting on the first day or on a subsequent day*****: How do lithium wall conditions change if no HeGDC used between discharges?**

1. Evaporate 100 mg Lithium.
2. Repeat steps in 3.3 without HeGDC. If discharges become irreproducible and ratty, apply a single standard HeGDC to demonstrate the need for it, otherwise continue until the Lithium becomes saturated. [5-10 discharges]

--- decision point ---

a. If the 100 mg of lithium evaporation enables density control but wears out too quickly, move on to the evaluation of thick coatings (~ 500 mg), by repeating step 3.3 above. The previous day's run will be used to guide if Helium pre-conditioning discharges and/or between shot HeGDC are needed. Here the fueling will be adjusted to get the long-pulse H-modes with density control. (10-20 shots)
b. If the 100 mg of lithium evaporation lasts a long time (~15-30 discharges), then evaporate between 20 and 50mg to determine if stable conditions can be achieved with a lower deposition by repeating step 3.3. (10-20 shots)
c. If the lithium is not effective at pumping the H-modes because of very long particle confinement time, then repeat step 3.3 with L-mode target discharges as in the LPI work for a direct 1:1 comparison, i.e. target #117087 with no center stack gas fueling. This will require 8 He pre-conditioning shots (10-20 shots + pre-conditioning shots)

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

1. Apply an RF-blip during some of the above flattops, provided it remains non-perturbatve.

4. 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): **-53** Flattop start/stop (s): **-0.02/1.1**

I_P (MA): **1** Flattop start/stop (s): **0.2/1.0**

Configuration: **Double Null**

Outer gap (m): **0.1**, Inner gap (m): **0.03**

Elongation κ: **2.2**, Triangularity δ: **0.5**

Z position (m): **0.00**

Gas Species: **D**, Injector: MidPlane/CenterStack/SGI

NBI - Species: **D**, Sources: **A/B/C**, Voltage (kV): **90**, Duration (s): **<0.9s**

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

CHI: **OFF**

Either: List previous shot numbers for setup: **#119665 (H-mode), #117087 (L-mode)**

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	X		
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	

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• Goals

1. Thin coatings for H-mode density control

2. Thick Coatings for H-mode density control and/or L-modes for direct comparison with LPI results.