Princeton Plasma Physics Laboratory **NSTX Experimental Proposal**		
Title: **Effect of Impurities and Wall Conditioning on NTMs**		
OP-XP-918	Revision: **0**	Effective Date: **6/1/09** *(Approval date unless otherwise stipulated)* Expiration Date: **6/1/11** *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS	
Responsible Author: Francesco Volpe	Date 05/29/09
ATI – ET Group Leader: Steve Sabbagh	Date 06/01/09
RLM - Run Coordinator: Roger Raman	Date 06/01/09
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

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AUTHORS: **F. Volpe, S. Gerhardt, S. Sabbagh** DATE: **05/29/09**

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1. Overview of planned experiment

Lithiumization data at NSTX suggest that good wall conditioning might help avoiding NTMs. Post-disruption data at DIII-D also suggest an effect of impurities on NTM stability.

We propose to systematically characterize these effects for the first time, by operating otherwise NTM-unstable discharges under controlled plasma and wall conditions. In particular, NTM stability will be characterized as a function of the Li amount and of time since the last Lithiumization. Puffing Neon will give an additional tool to scan the impurity content on a broader range and with a different impurity. Finally, error field correction (EFC) and feedback (FB) will be reduced, to assess their effect on NTMs and isolate how much of NTM stabilization was due to Li and how much to the other two, as well as to identify possible synergies.

2. Theoretical/ empirical justification

The empirical justification for this experiment is the past observation of NTM suppression in Lithiumized NSTX discharges with n=1 FB and n=3 EFC. These data are related but somehow in contradiction with the observations that (i) increased impurity content makes DIII-D more prone to 2/1 NTMs and (ii) enhanced radiation destabilized classical tearing modes in the RTP tokomak prior to disruptions [Salzedas *et al*., PRL 2002].

Several theoretical explanations were conjectured by S. Gerhardt and F. Volpe. Some invoked direct suppression of NTMs through resistivity, radiative drives or sinks in the modified Rutherford equation, slowed current evolution, modified pressure profile and thus modified bootstrap current and/or classical stability (Δ'), rotation and/or magnetic shear and their effect on Δ'. Indirect NTM suppression was also hypothesized, via stabilization of some NTM trigger, probably ELMs, or the coupling between the NTM and its trigger might have changed, e.g. due to increased rotation shear.

It is believed that systematic scans will help discriminating among these hypotheses by identifying trends and dependencies and by providing input for modeling.

Finally, the experiment is relevant to ITER, where one might want to wait for good wall conditioning before trying high β, if this poses a risk for NTMs and thus possibly mode locking and disruptions, and it is relevant to power plants, where the liquid Lithium divertor might prevent NTMs.

3. Experimental run plan

1. 1min D2-GDC +10min He-GDC +5min pump-out. Then repeat #133025 with 4MW NBI, n=3 EFC, n=1 FB, NO Lithium. Repeat with 6MW NBI. These will be the two “no Li, NTM” reference shots. (2 good shots)
2. Add Li until NTM is mitigated (50, 100, 200mg). 4MW NBI. If needed, go to 6MW. (1-4 shots)
3. Repeat to check reproducibility (1-2 shots)
4. Add Ne from injector 3 (bay J upper), to change profile near q=2. Scan one or more of the following: Injection rate: 1-5 Torr-l/s, Injector pressure: 140-170 Torr, Injection duration: pulses of 20-200 ms. (3-4 shots)

5a. Repeat best shot with reduced or turned off n=3 EFC. (1-2 shots)

5b. Repeat best shot without n=1 FB. (1 shot)

5c. If time and if thought useful, repeat w/o n=1 FB AND w/o n=3 EFC (or with EFC reduced) (1 shot)

6. Lithiumize once, with minimum amount sufficient for stabilization (see step 2), then repeat best shot over and over, but without re-Lithiumizing every time, until first NTM appears. This is to assess duration of benefits of single Lithiumization. He-GDC might be required between shots, to avoid disrupting during Ip ramp. (>3 shots)

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

No special capability required

5. Planned analysis

Standard EFIT equilibria.

Possible TRANSP, UEDGE, DCON, PEST-III, NIMRAD (NIMROD+Bremsstrahlung).

6. Planned publication of results

Poster at APS?

Contributed talk at MHD Control Workshop at PPPL in Nov.09.

Potential PPCF paper (regular paper, not as an invited in the special issue dedicated to the workshop).

PHYSICS OPERATIONS REQUEST

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(use additional sheets and attach waveform diagrams if necessary)

Describe briefly the most important plasma conditions required for the experiment:

Previous shot(s) which can be repeated: 133025

Previous shot(s) which can be modified:

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

I_{TF} (kA): 4-4.5kG Flattop start/stop (s):

I_P (MA): 0.8-1.0 Flattop start/stop (s): 0.2/1.3

Configuration: ~~**Limiter**~~ **/ DN / LSN /** ~~**USN**~~

Equilibrium Control: **Outer gap / Isoflux** (rtEFIT)

Outer gap (m): Inner gap (m): Z position (m):

Elongation κ: 2-2.5 Upper/lower triangularity δ:

Gas Species: Injector(s):

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

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

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

LITERs: ~~**Off**~~ **/ On** Total deposition rate (mg/min): **12.5**

EFC coils: ~~**Off**~~**/On** Configuration: **Odd** ~~**/ Even / Other**~~ *(attach detailed sheet*

DIAGNOSTIC CHECKLIST

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Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
Bolometer – tangential array		√
Bolometer – divertor		√
CHERS – toroidal	√	
CHERS – poloidal		√
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		√
Hα camera - 1D		√
High-k scattering		
Infrared cameras		√
Interferometer - 1 mm		√
Langmuir probes – divertor		√
Langmuir probes – BEaP		
Langmuir probes – RF ant.		
Magnetics – Diamagnetism	√	
Magnetics – Flux loops	√	
Magnetics – Locked modes	√	
Magnetics – Pickup coils	√	
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 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	√	
Ultrasoft X-ray 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 fast pinhole camera		
X-ray spectrometer - XEUS		√