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: xxx	Date
RLM - Run Coordinator: xxx	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: **Effect of Impurities and Wall Conditioning on NTMs** No. **OP-XP-918**

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

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 Argon 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 dynamic EFC (DEFC) 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 DEFC and n=3 EFC. It might also be connected with -and complementary to- 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/impurity drive 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

a) *Establish role of Lithiumization and, more generally, of good wall conditioning and of impurity content, in suppressing/preventing NTMs*

1. Repeat #133025 with 4MW NBI, n=3 EFC, n=1 DEFC, NO Lithium. Requires pre-emptive 1min D2 + 8min He glow discharge cleaning (GDC) . n=1 NTM expected. If not, tweak parameters *(1 good shot).*

2. Repeat after Lithiumization (same evaporation rate as for 129125?). NTM suppression expected. If not, increase Li amount *(1 good shot).*

3. Repeat for different amounts of Li. To avoid cumulative effects, 1min D2-GDC + 10min He-GDC between shots *(3-4 shots).*

4. Repeat best shot over and over, but without re-Lithiumizing every time, until first NTM appears. This is to assess duration of benefits of a single Lithiumization. He-GDC might be required between shots, to avoid disrupting during Ip ramp. *(2-4 shots).*

5. If time, repeat "marginal shot" (i.e., NTM-stabilized shot that required the smallest amount of Li) with reduced n=3 EFC and/or reduced n=1 DEFC gains, to isolate their effects on NTMs (*4-5 shots*).

b) *Deliberately seed impurities. Compared to a), scan of impurity content will be broader and yet partly decoupled from wall conditioning. Also, impurity is different, which is interesting to compare.*

1. Repeat best Lithiumized shot with Argon puffed at the edge. Vary Ar puffing rate (*2-3 shots*).

2. Repeat in non-Lithiumized reference shot *(2-3 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): Flattop start/stop (s):

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

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

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

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

Elongation κ: Upper/lower triangularity δ:

Gas Species: Injector(s):

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

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

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

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

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	√	