Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Dust mobilization from ITER-scale castellations**		
OP-XP-938	Revision: **0**	Effective Date: **7/24/09** *(Approval date unless otherwise stipulated)* Expiration Date: **7/24/11** *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: C H Skinner	Date 7/24/09
ATI – ET Group Leader: V Soukhanovskii	Date 8/12/09
RLM - Run Coordinator: Roger Raman	Date 8/12/09
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: Dust mobilization from ITER-scale castellations — No. **OP-XP-938**

AUTHORS: C H Skinner, S Gerhardt and L Roquemore — DATE: **7/24/09**

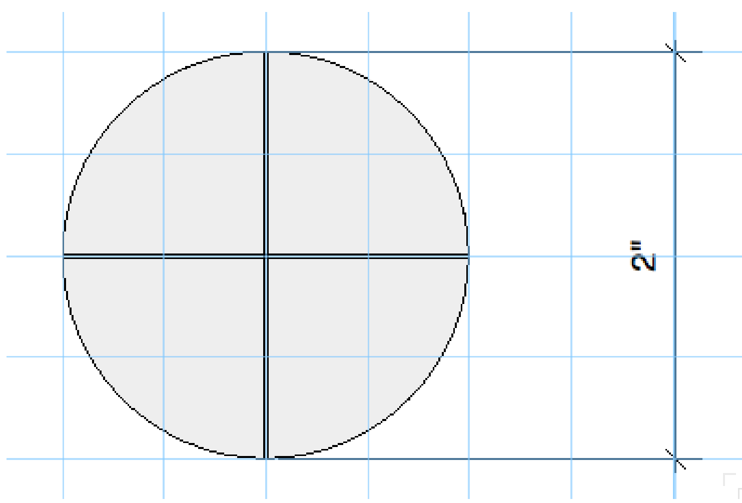
1. Overview of planned experiment

Dust is likely to accumulate in gaps between tile castellations in ITER. The ability of dust to be ejected from these castellations by off-normal events is unknown. This XP plans to obtain the first experimental data on the mobilization of dust from ITER-scale castellations.

A boron nitride mockup with the exact geometry of the ITER castellation gaps (Fig. 1) will be loaded with a pre-weighed quantity of carbon or tungsten dust and mounted on the sample probe. The probe will be inserted into NSTX and subject to discharges that end with planned vertical displacement events that land close to the probe. Afterwards the probe will be withdrawn and the amount of dust left in the gaps will be weighed. Fast camera and spectroscopic measurements of dust will also be made.

2. Theoretical/ empirical justification

Dust will be generated by plasma-wall interactions on ITER. The total quantity of dust in ITER is limited for safety reasons. The quantity of dust on hot surfaces is also limited to assure the integrity of the vacuum vessel in accident conditions. Dust may also transport impurities into the core plasma limiting the performance. Finally dust may coat diagnostic mirrors. Thus it is important to obtain data on the mobilization of dust from castellation gaps. There is also interest in obtaining ITER-relevant tungsten spectra with the XEUS and LOWEUS spectrometers (P. Beiersdorfer).

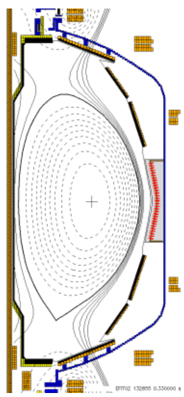


View of top of sample probe with 0.5 mm wide gaps in 'castellations' at depth of gap 15 mm 'carbon' and 8 mm tungsten

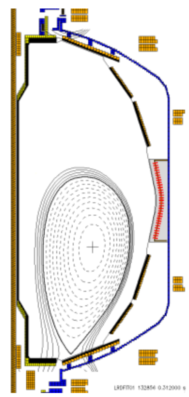
3. Experimental run plan

A preliminary experiment, run piggy back, will insert the loaded sample probe to a position >10 cm below the tiles for exposure to several hours of plasma shots. The weight of the dust will be measured before and after exposure. Any change in dust weight will establish how much dust is lost due to loading/unloading and machine vibration due to pulsing the PF and TF coils. Since the probe surface will be > 10 cm below the tile surface there will be no plasma exposure in this step. Plasma exposure will occur in the following steps:

Step 1: Reload shot 132855. This is a combined PF-2/PF-1a shot. Convert from He to D_2, and inject Scr. A from 100 msec till 1 sec. Example LFS D2 waveform can be found in shot 129512, though be careful that this is from 2008.



132855 during
the flat top



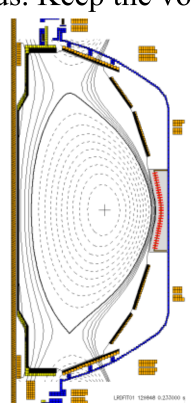
Repeat of 132856
At the end of the VDE

Step 2: Repeat, with vertical control freeze. Freeze the PF-3 voltage from 260-360, and apply a 40 V offset. The discharge should develop a downward VDE.

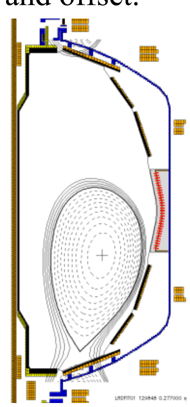
Step 3: Repeat with Src. B at 0.14 sec, for a total of 4MW

Step 4: Repeat once the best shot from Steps 2 or 3.

Step 5: Reload shape category from shot 129848. This is a similar L-mode shot to what is used above, but with more current in the PF-2 coils, so that the triangularity is reduced. This tends to move the VDE impact point to larger radius. Keep the voltage freeze and offset.



129848 during
the flat top



129848 just before
vessel contact

If this discharge has issues, try once to fix it.

Step 6: Repeat twice more the best discharge taken from those above.

If He-GDC is used a separate trial to determine if GDC mobilizes dust will be done.

Experiments are planned with carbon and then with tungsten dust. In the case of tungsten the dust influx into the plasma could be identified spectoscopically.

The probe head will be fabricated from boron nitride (an insulator) to avoid issues with induced JXB forces.

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

Shots have already been developed (for normal TF).
A fast camera at Bay J top will view the probe to detect dust ejected.
The IR camera will be used to assess the temperature excursion.
Langmuir probe data will be taken without bias scan to improve time resolution.

5. Planned analysis

Depending on the results we will compare the dust mobilization to that expected from ITER off-normal events.

6. Planned publication of results

A potential venue is the International Conference on Plasma Surface Interactions PSI19 next May in San Diego.

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:

See sect. 3.

Previous shot(s) which can be repeated: 132855, 129848

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	√	