Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Edge Impurity Transport Measurements with the New MESXR Diagnostic**

OP-XP-1073	Revision: **1.0**	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: D. Clayton	Date
ATI – ET Group Leader: H. Yuh	Date
RLM - Run Coordinator: E. Fredrickson	Date

Responsible Division: Experimental Research Operations

RESTRICTIONS or MINOR MODIFICATIONS

(Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

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AUTHORS: **D. Clayton, K. Tritz** DATE: **10/15/10**

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1. Overview of planned experiment

The goal of this experiment is to measure impurity particle transport in the NSTX pedestal/edge region using small neon gas puffs and the new multi-energy soft-x-ray (MESXR) diagnostic. This will essentially be a repeat of XP 613 (Delgado-Aparicio), which measured impurity transport in the plasma core, but with a new diagnostic optimized for measurements in the edge.

2. Theoretical/ empirical justification

Previous measurements (L. Delgado-Aparicio *et. al.*, Nucl. Fusion, 2009) have shown impurity particle transport to be neoclassical in the NSTX core. X-ray emission from small neon gas puffs was measured with the optical soft-x-ray (OSXR) detectors, a three-color x-ray diagnostic with a full tangential view with a radial resolution of about 5 cm. The MIST impurity transport code was used to find the diffusion coefficients and convective velocities that best fit the measured data. The NCLASS neoclassical transport code predicted similar values for these quantities, indicating that anomalous transport was suppressed in the core. Uncertainty in the edge (r/a > 0.8) measurements, due to poor spatial resolution and a low signal-to-noise ratio from this colder region, was too large to draw any further conclusions.

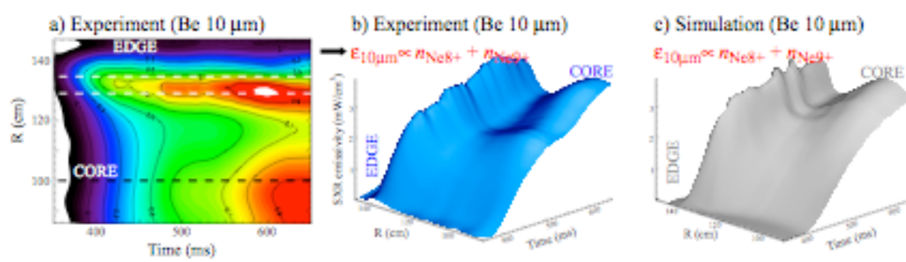

Fig. 1: A sample OSXR measurement of neon x-ray emission and the emission predicted by MIST for transport quantities consistent with neoclassical transport (Delgado-Aparicio).

The newly commissioned MESXR diagnostic consists of five 20-channel photodiode arrays with a tangential view of the plasma edge. Each array has a different filter (and one has no filter), providing a four-color + bolometer radial profile with a spatial resolution of about 1 cm and radial coverage from roughly 130 cm to 150 cm. The high-efficiency photodiodes and thinner filters should provide a much-improved signal-to-noise ratio when measuring the plasma edge compared to the OSXR diagnostic.

Impurity transport in the edge pedestal region is of interest for a variety of reasons. Questions include: How do impurities (particularly carbon) build up in the plasma during ELM-free discharges? How does particle transport vary in space and time throughout the pedestal region? Does the particle transport barrier broaden with lithium deposition?

3. Experimental run plan

The run will begin with tests of the neon gas puffs to determine the appropriate duration and pressure. It will then proceed to a series of parameter scans. Reference shots without neon puffs will also be required at each step.

Neon puff tests (at 0.45 s, 4.5 kG)	2 shots + 2 contingency
B scan (at 0.45 s)	
0.9 MA, 4.5 kG (Ne puff + reference)	2 shots + 1 contingency
1.1 MA, 5.5 kG (Ne puff + reference)	2 shots + 1 contingency
Time Scan (at 4.5 kG)	
0.30 s (Ne puff + reference)	2 shots + 1 contingency
0.60 s (Ne puff + reference)	2 shots + 1 contingency
Total	10 shots + 6 contingency

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

This experiment will require neon gas puffing into quiescent H-mode plasmas (low/no low-frequency MHD, ELMs). LITER evaporation at the beginning of the day and/or the lithium dropper may be needed. 6 MW NBI power will be required, stepped down to 4 MW once H-mode is established (see discharge 141400). Refer to the checklist for diagnostic needs.

5. Planned analysis

EFIT/LRDFIT will be used for equilibrium reconstruction, MIST or an equivalent impurity transport code will be used to find the diffusion coefficient and convective velocities, and NCLASS will be used to calculate the expected neoclassical values for comparison.

6. Planned publication of results

Results will be presented at conferences and published in an appropriate journal (PoP, NF…)

PHYSICS OPERATIONS REQUEST

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Brief description of the most important operational plasma conditions required:

Discharge 141400 will be used as a reference shot. Neon will be puffed into the edge of quiescent plasmas (low/no low-freq MHD, ELMs).

Previous shot(s) which can be repeated: 141400

Previous shot(s) which can be modified:

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

I_{TF} (kA): **4.5 – 5.5 kG** Flattop start/stop (s):

I_P (MA): **1.0 – 1.2 MA** Flattop start/stop (s):

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

Equilibrium Control: **Outer gap / Isoflux** (rtEFIT) **/ Strike-point control** (rtEFIT)

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

Elongation: Triangularity (U/L): OSP radius (m):

Gas Species: **D, Ne** Injector(s): **CS Midplane, Outer Midplane**

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

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

CHI: **<u>Off</u> / On** Bank capacitance (mF):

LITERs: Off / <u>On</u> Total deposition rate (mg/min): **Morning deposition**

LLD: Temperature (°C):

EFC coils: <u>Off</u>/On Configuration: **Odd / Even / Other**

DIAGNOSTIC CHECKLIST

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Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
Beam Emission Spectroscopy		√
Bolometer – divertor		√
Bolometer – midplane array		√
CHERS – poloidal		√
CHERS – toroidal	√	
Dust detector		
Edge deposition monitors		
Edge neutral density diag.		
Edge pressure gauges		
Edge rotation diagnostic		√
Fast cameras – divertor/LLD		
Fast ion D_alpha - FIDA		
Fast lost ion probes - IFLIP		
Fast lost ion probes - SFLIP		
Filterscopes		
FIReTIP		√
Gas puff imaging – divertor		
Gas puff imaging – midplane		
Hα camera - 1D		
High-k scattering		
Infrared cameras		
Interferometer - 1 mm		
Langmuir probes – divertor		
Langmuir probes – LLD		
Langmuir probes – bias tile		
Langmuir probes – RF ant.		
Magnetics – B coils	√	
Magnetics – Diamagnetism	√	
Magnetics – Flux loops	√	
Magnetics – Locked modes		
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 detectors		
Plasma TV		
Reflectometer – 65GHz		
Reflectometer – correlation		
Reflectometer – FM/CW		
Reflectometer – fixed f		
Reflectometer – SOL		
RF edge probes		
Spectrometer – divertor		
Spectrometer – SPRED		√
Spectrometer – VIPS		√
Spectrometer – LOWEUS		√
Spectrometer – XEUS		√
SWIFT – 2D flow		
Thomson scattering	√	
Ultrasoft X-ray – pol. 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 tang. pinhole camera		