Princeton Plasma Physics Laboratory **NSTX Experimental Proposal**		
Title: **Comparison of H-mode fueling with supersonic gas injector and conventional gas injector**		
OP-XP-912	Revision:	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS	
Responsible Author: V. A. Soukhanovskii	Date 02/04/2009
ATI – ET Group Leader:	Date
RLM - Run Coordinator:	Date
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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1. Overview of planned experiment

The goal of the experiment is to study H-mode fueling with the supersonic gas injector (SGI). The following points are to be addressed through a comparative analysis of fueling by the SGI and a conventional low field side (LFS) gas injector (CGI):

- Fueling efficiency
- Pedestal characteristics and pedestal fueling
- Response of wall and divertor recycling source to gas injection
- Formation of X-point MARFE

2. Theoretical/ empirical justification

Previous SGI experiments in NSTX demonstrated the possibility of high-efficiency H-mode fueling with the SGI. We are seeking to compare it to a LFS CGI at identical plasma and machine conditions, to quantify the fueling efficiency estimates, particle balance, and to study wall and divertor response to the gas injection. Another objective is to study the H-mode pedestal fueling. Substantial experimental and theoretical work performed in large aspect ratio tokamaks implied that the H-mode density pedestal width and height are determined by neutral penetration length. We would like to document SGI and CGI fueled pedestal conditions so that analytical models of neutral penetration can be applied.

3. Experimental run plan

1. H-mode fueling with SGI and reduced CGI during density ramp-up

- Obtain a reference H-mode discharge with reduced HFS fueling (up to 3 shots)
  - Use the fiducial (0.8-0.9 MA, 6 MW) discharge, keep outer gap 10 cm
  - Start with HFS plenum pressure 300-500 Torr and SGI
  - SGI setup: R=1.56 - 1.58 m, Plenum pressure 5000 Torr, Timing to match the HFS fueling profile
- Adjust SGI timing to optimize H-mode discharge (1-2 shots)
- Repeat with LFS injector (Injector # 2) at identical rate and timing
- Use MPTS relative laser timing to get the “gas on – gas off” conditions
- Use several gas flow rates with both SGI and LFS injector, e.g., 50, 100, 150 Torr l /s

2. **Comparison of SGI and CGI in discharge front-end (optional)**
    - Run the fiducial discharge. Note the Injector # 2 time history and rate in the front-end of the discharge (first 150 ms).
    - Replace the LFS injector with an identical or as similar as possible SGI pulse.
    - The SGI will be operated at R=1.56 - 1.58 m.
    - SGI setup: plenum pressure P_0=2000-5000 Torr.
    - Adjust SGI pulse duration or pressure as needed

3. **Fueling optimization for LLD experiments (optional)**
    - Obtain a reference LLD experiment configuration – the medium elongation and triangularity discharge
    - Reduce HFS fueling in steps to 100-500 Torr in HFS plenum pressure and add SGI with injection rate and timing as in 1.
    - Adjust SGI pressure and timing to achieve required plasma density

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

1. SGI XMP results available - need to know SGI injection rate calibration
2. SGI plenum pressure up to 5000 Torr
3. Wall / impurity conditions to allow reliable H-mode access and long pulse

5. Planned analysis

What analysis of the data will be required: LRDFIT, BFIT, possibly TRANSP.

6. Planned publication of results

Results will be used to complete a manuscript summarizing SGI fueling on NSTX. It is planned to submit the manuscript to a major fusion journal in FY 2008.

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:

Standard fiducial discharge

- unbalanced double null configuration, κ= 2.15-2.25, δ=0.7 -0.75, Outer gap ~ 10 cm, Drsep=-6-10 mm
- 0.8-0.9 MA, 6 MW
- HFS, Injector 2, SGI gas systems with D_2

Previous shot(s) which can be repeated: 123931 (2007)

Previous shot(s) which can be modified: 128797 (1 MA)

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

I_{TF} (kA): -53 kA Flattop start/stop (s):

I_P (MA): 0.80 MA Flattop start/stop (s):

Configuration: **LSN**

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

Outer gap (m): **0.09-0.10** Inner gap (m): **0.06-0.07** Z position (m): **0.0**

Elongation κ: 2.15-2.25 Upper/lower triangularity δ: 0.70-0.75

Gas Species: **D2** Injector(s): SGI, HFS, Inj. 2

NBI Species: **D** Voltage (kV) **A: 90** **B: 90** **C:** 90 Duration (s): 1 s

ICRF Power (MW): 0 Phase between straps (°): Duration (s):

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

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

EFC coils: Off 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		