Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: Improved H-mode density control with the shoulder injector		**XP#409**
OP-XP-409	**Revision:**	Effective Date: 12/22/03 *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Author: R. Maingi, D. Mueller	Date
ATI - Task Force Leader: J. Menard	Date
RLM - Run Coordinator: S. Kaye	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

Improved H-mode density control with the shoulder injector

R. Maingi (ORNL), D. Mueller

1. Overview of planned experiment

The goal of this experiment is to 1) determine the shape configurations in which the center stack shoulder injector allows long pulse H-mode access, and 2) to evaluate the quality of the resulting H-modes, including density control, pulse length, and confinement. The desired end product is a long pulse H-mode with reduced density rise rate.

2. Theoretical/ empirical justification

The center stack shoulder injector was installed at the beginning of FY 2003 to reduce the

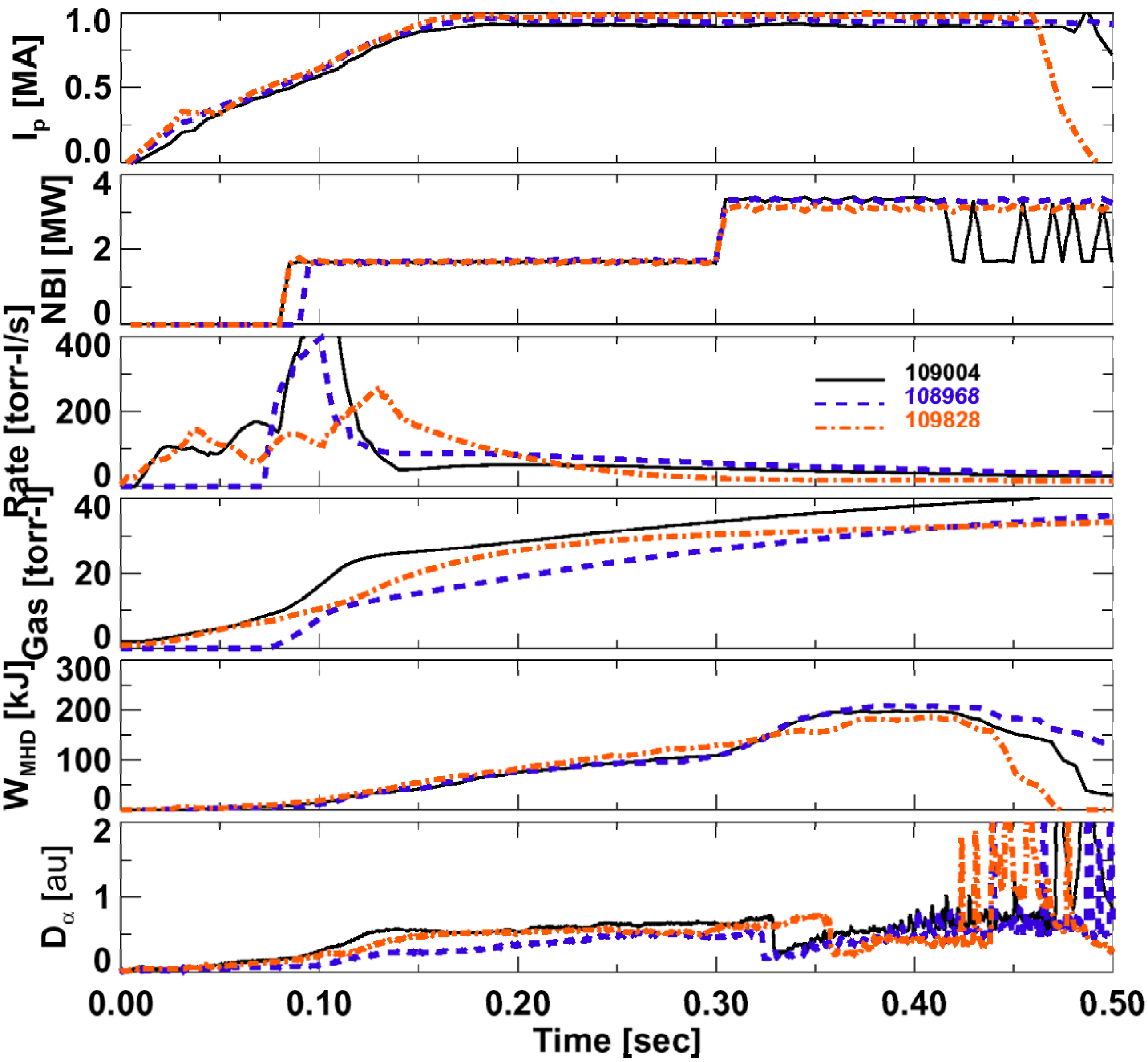

Fig. 1 – Comparison of center stack midplane (#108968, #109004) and center stack shoulder (#109828) fueled discharges from the last two run periods in DN configuration. It is evident that H-mode access was similar. In LSN configuration, H-modes could not be readily obtained with the shoulder injector.

time decay rate of the leakage gas from the center stack midplane injector, to improve source control. Vacuum measurements showed that the dribble rate e-folding time scale was indeed reduced from about 500ms to 200ms. In early FY 2003, the injector failed to allow H-mode access in lower-single null (LSN) configuration, despite ready access with the midplane injector. It was noted that the power threshold was running higher than normal by about a factor of two with the center stack midplane; thus, the shoulder injector may simply have had a higher power threshold in LSN.

The shoulder injector was successfully used in double-null (DN) configuration to access H-mode in early FY 2003 (Fig. 1). The overall characteristics were similar to discharges from the late FY 2002 experiments.

Visible camera pictures with the plasma TV showed that the recycling light in LSN expanded to a broad region near the top of the vessel with shoulder fueling. Thus it was speculated that neutrals were not trapped but free to move toward the outer midplane, where they would cause significant toroidal drag and possible higher power threshold. The plasma TV pictures also showed that that the shoulder gas recycling light did not extend to the outboard side in DN, i.e the gas was better trapped because of the second divertor in the vicinity of the injector. This simple argument suggests that upper-single null may effectively capture the gas also, hence the rationale for comparing the efficacy of the shoulder injector as a function of discharge shape.

3. Experimental run plan

This experiment should only be run when long pulse H-modes have already been re-obtained with the center stack midplane injector. The capability to switch between injectors without a controlled access is a requirement.

1. Restore long pulse DN center stack midplane fueled discharge, e.g. #109004 (I_p = 1 MA, B_t = 0.45 T). A more recent one is #109828, which actually had center stack shoulder fuel (2 shots)
2. Change injector to center stack midplane, and scan plenum pressure from 600-1500 torr in 3-4 steps (5 shots)
3. Switch to center stack shoulder fueling, and scan plenum pressure from 300-800 (8 shots)
4. Using the "best" fueling rate from above, perform drsep scan to +/- 1 cm in 0.5cm increments to determine if neutral trapping is different in the three configurations (6 shots)
5. Repeat above with a lower fueling rate and a higher fueling rate (12 shots)

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

This XP requires an operational NBI system, as well as the capability of generating lower-single null an double-null diverted discharges with the plasma control system. No RF or CHI will be used during this experiment.

5. Planned analysis

Confinement analysis requires EFIT. More detailed analysis will be done if data are clear.

6. Planned publication of results

The results will help us better characterize the shoulder injector and plan future experiments.

PHYSICS OPERATIONS REQUEST

Improved H-mode density control with the shoulder injector **XP #409**

Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **52** Flattop start/stop (s): _____/_____

I_P (MA): **0.5-1.0** Flattop start/stop (s):**0.15/0.5**

Configuration: **Lower Single Null**

Outer gap (m): **__5-10cm_** Inner gap (m): **_~2-3cm__**

Elongation κ: **_1.8_** Triangularity δ: **__0.44___**

Z position (m): **0.00**

Gas Species: **D_2** Injector: **CS midplane, CS shoulder**

NBI - Species: **D**, Sources: **A/B/C** Voltage (kV): **80** Duration (s):<**0.3s**

ICRF – Power (MW): **0**, Phasing: **N/A** Duration (s): _____

CHI: **Off**

Either: List previous shot numbers for setup: **109828 (DND)**
Or: Sketch the desired time profiles, including inner and outer gaps, κ, δ, heating, fuelling, etc. as appropriate. Accurately label the sketch with times and values.

DIAGNOSTIC CHECKLIST

Title: Improved H-mode density control with the shoulder injector **No. 409**

Diagnostic system	**Need**	**Desire**	**Requirements** (timing, view, etc.)
Magnetics	✔		
Fast visible camera	✔		
VIPS-1		✔	
VIPS-2		✔	
SPRED		✔	(highly desired)
GRITS		✔	
Visible filterscopes	✔		
VB detector		✔	
Midplane bolometer		✔	
Diamagnetic flux	✔		
Density interferometer (1mm)		✔	
FIReTIP interf'r/polarimeter	✔		
Thomson scattering	✔		
CHERS		✔	
NPA		✔	
X-ray crystal spectrometer		✔	
X-ray PHA		✔	
EBW radiometer		✔	
Mirnov arrays	✔		
Locked-mode detectors	✔		
USXR arrays		✔	
2-D x-ray detector (GEM)		✔	
X-ray tangential camera		✔	
Reflectometer (4 ch.)		✔	
Neutron detectors		✔	
Neutron fluctuations		✔	
Fast ion loss probe		✔	
Reciprocating edge probe			
Tile Langmuir probes		✔	
Edge fluctuation imaging		✔	
H-alpha cameras (1-D)		✔	
Divertor fast camera (2-D)		✔	(D_α filter)
Divertor bolometer (4 ch.)		✔	
IR cameras (2)		✔	
Tile thermocouples		✔	

SOL reflectometer		✔	
Poloidal and toroidal rotation		✔	

PPPL EXPERIMENTAL PROPOSAL REVIEW CHIT Chit No. ________

XP TITLE: Improved H-mode density control with the shoulder injector XP No. 409

PROPOSER: R. Maingi/D. Mueller DATE OF REVIEW: 12/19/03

COMMENT / CONCERN / RECOMMENDATION

Name ____________________________

REVIEW BOARD COMMENT / RECOMMENDATION

❑ REQUIRES ACTION / ❑ NO ACTION REQUIRED / ❑ OTHER ______________________

Run Coordinator ______________________ Date _________

PROPOSER'S RESPONSE

Proposer ______________________ Date _________

RUN COORDINATOR REVIEW OF RESPONSE

❑ APPROVE / ❑ DISAPPROVE RESPONSE

Run Coordinator ______________________ Date _________