Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: Physics of Ohmically Heated H-mode Plasmas		
OP-XP-506	Revision: **2 (2008)**	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author:	Date
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

TITLE: **Physics of Ohmically Heated H-mode Plasmas** No. **OP-XP-506**

AUTHORS: **C.E. Bush, S. Kubota, R. Bell, S. Zweben, R. Maqueda, B. LeBlanc, K.C. Lee, L. Roquemore, K. Tritz, R. Raman, S. Kaye**

DATE: **June 2, 2008**

1. Overview of planned experiment

This is a continuation of XP506 of the 2005 run. The goal of this experiment is to study H-modes in which core and edge turbulence can be measured. Also a second goal is to study an H-mode with no external fast particle or momentum input in order to understand the fundamental physics of the L-H transition and the H-mode.

2. Theoretical/ empirical justification

A detailed justification for OH H-mode experiments can be found in the original XP506. However, since the original proposal, technical advances, completion of publications, and updated ITER research needs are new justification. These include:

1. Reflectometer modifications and improvements.
2. The original XP required density fluctuation and profile measurements for which run time was never allocated.
3. Writing of a PRL and one other paper were stopped when it was decided that more data should be taken to support the apparent unique result of decreased core correlation length across the L- to H-mode transition in Ohmic plasmas.
4. Recent 10^{th} Transport Physics and CDBM TG Meeting held at PPPL April 24-27, 2006

The new reflectometer capabilities include 1) simultaneous measurements using the correlation and profile reflectometers and 2) quadrature detection in both channels of the correlation system. The profile reflectometer data is important for tracking fast density profile changes at the L-H transition; this data is crucial for all estimates made with the other reflectometers. Previously the correlation system needed to be decoupled to make these measurements. The second upgrade allows the possibility of both the radial wavenumber spectrum and density fluctuation level using the correlation reflectometer signals. Recent simulations using modeled turbulence and the 2-D full-wave code FWR2D have shown that these quantities are crucial in determining the instrument response of the correlation reflectometer. Finally, this upgrade also allows the poloidal correlation of turbulence for poloidal velocity measurements. Measurements made in 2005 indicated the possibility of radial decorrelation of turbulence. This additional data will allow investigation of the ExB flow shear as a possible mechanism for these observations.

At the April ITPA meeting a “Special Session on Rotation and Momentum Transport” was held. There it was reiterated that the 2003 ITPA Coordinating Committee had identified plasma rotation and momentum transport as an area requiring enhanced attention. At the April meeting it was emphasized that both the intrinsic rotation of OH H-modes and beam induced are important for understanding H-mode physics especially for making predictions for ITER. (Reference: See ITPA April 2006 Princeton, Special Summary by E.J. Doyle)

3. Experimental run plan

Plan: Do experiment in a well conditioned machine with 7 min glow between shots.

(1). Re-establish ohmic H-mode shot. Use shot 117256. **4 shots**

— Want H-phase of duration > 80 ms

(2). Take correlation and density profile measurements simultaneously. **6 shots**

The upgraded correlation reflectometer will also provide a measure of the fluctuation level.

— Also make other important measurements – ERD, Thomson, GPI, high-k

(3). Controlled access to reconfigure reflectometer for poloidal **requires access after 5:00pm**

velocity measurements. The two correlation reflectometer channels will be decoupled. These channels will be connected to poloidally separated sets of horns. Requires an evening after run to be ready for next morning.

(4). Take documentation shots (as in (2) above) in this alternate configuration. **4 shots**

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

A clean, well conditioned chamber with low recycling walls is necessary, and running of the XP shortly after a boronization would be desirable. Best techniques for maintaining these conditions (such as alternate high power helium conditioning discharges) should be available if needed. RF and CHI are not required. The diagnostics to be emphasized for this XP are the ERD (edge rotation diagnostic), newly upgraded reflectometry (Peebles, Kubota), 30 point MPTS, GPI (Fast camera and array), FIReTIP, CHERS, ultra-soft X-ray arrays, and the reciprocating probe. Although NBI heating would not be required for most shots, it would be good to have beam blips for CHERS measurements in case time allows for 3 or 4 additional shots. However, we must make sure the beam blips do not affect the transition. For higher spatial resolution the 30 point MPTS, FIReTIP and other diagnostics.

5. Planned analysis

Plasma analysis using EFIT and TRANSP (with NCLASS).

6. Planned publication of results

Resulting data would allow completion of a PRL which is in preparation. The plasma is to be well documented allowing the main physics issues to be addressed. An additional 2 papers are also possible. Results would also be reported to the appropriate working group of the ITPA.

PHYSICS OPERATIONS REQUEST

TITLE: **Physics of Ohmically Heated H-mode Plasmas** No. **OP-XP-506**

AUTHORS: **C.E. Bush, S. Kubota, R. Bell, S. Zweben, R. Maqueda, B. LeBlanc, K.C. Lee, L. Roquemore, K. Tritz, R. Raman, S. Kaye** DATE: **June 2, 2008**

Machine conditions (specify ranges as appropriate) **Model Shot 117256** (but no blips)

I_{TF} (kA): **53 kA** Flattop start/stop (s): **0.0/0.6**

I_P (MA): **600 – 900 kA** Flattop start/stop (s): **0.2/0.6**

Configuration: **Lower Single Null (LSN)**

Outer gap (m): Inner gap (m):

Elongation κ: Upper/lower triangularity δ:

Z position (m): **0.00**

Gas Species: **D / He** Injector(s): **Midplane / Inner wall / Lower Dome**

NBI Species: **D / H** Sources: Voltage (kV): Duration (s):

ICRF Power (MW): Phasing: Duration (s):

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

LITER: On / Off

Previous shot numbers for setup: **117256 (a very good model shot)**

DIAGNOSTIC CHECKLIST

TITLE: **Physics of Ohmically Heated H-mode Plasmas** No. **OP-XP-506**

AUTHORS: **C.E. Bush, S. Kubota, R. Bell, S. Zweben, R. Maqueda, B. LeBlanc, K.C. Lee, L. Roquemore, K. Tritz, R. Raman, S. Kaye** DATE: **June 2, 2008**

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 – ExB 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		