Princeton Plasma Physics Laboratory **NSTX Experimental Proposal**		
Title: **Ultra-high speed GPI measurements of the L-H transition**		
OP-XP-929	Revision: **0**	Effective Date: **7 / 7 /09** *(Approval date unless otherwise stipulated)* Expiration Date: **7 / 7/ 11** *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS	
Responsible Author: Stewart Zweben	Date 7/1/09
ATI – ET Group Leader: V. Soukhanovskii	Date 7/7/09
RLM - Run Coordinator: R. Raman	Date 7/7/09
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: **Ultra-high speed GPI measurements of the L-H transition** No. **OP-XP-929**

AUTHORS: S.J. Zweben, R.J. Maqueda, S. Kubota, T. Munsat, S. Kaye, R. Maingi et al DATE: **7/1/09**

1. Overview of planned experiment

This experiment will use the maximum possible capability of the GPI system to diagnose the turbulence changes associated with the L-H transition. Two Phantom 7.3 cameras will view exactly the same region in order to make 2-D images of the edge turbulence at ~300,000 frames/sec, which twice as fast the existing Phantom images of the transition. A single type of L-H transition will be diagnosed to get a sample of ~5-10 transitions in order to obtain a clear picture of the phenomenology.

In addition to this GPI imaging data, we will try to take as much additional turbulence data as possible using other fast imaging views, reflectometry, high-k scattering, FIR interferometry, etc. We will also try to obtain as much edge plasma data as possible using CHERS, EDR, Thomson, USXR arrays, etc.

2. Theoretical/ empirical justification

According to conventional theory, the L-H transition is caused by edge turbulence suppression due to shear flows, zonal flows, or possibly GAMs. However, very little direct evidence for the connection between these flows and the onset of the transition exists, mainly due to limited information on the space vs. time structure of the turbulence and of the local flows. This experiment will obtain perhaps the best-ever data on edge turbulence and local flows during the L-H transition. This is possible by combining two Phantom 7.3 cameras to make 64 x 64 pixel movies at 300,000 frames/sec. These images will be analyzed using the “HOP-V” turbulence velocity analysis code of T. Munsat, the wave-wave coupling codes of F. Poli, and the existing turbulence analysis codes at PPPL. Using these analysis tools it should be possible to measure the local 2-D turbulence structure and 2-D velocity fields vs. time before, during, and after the transition, and so directly check the theoretical models of the transition.

Previous images of the L-H transition were made using one Phantom camera at 150,000 frames/sec, but the framing rate was not quite high enough to analyze the velocity of the turbulence. In 2004, images were made using the PSI-5 camera at 250,000 frames/sec, but only 300 frames could be captured on each shot (~ 1.2 msec), so very few good transitions were “caught”, and any longer-duration “precursors” to these transition were not accessible. With the two Phantom 7.3’s in this experiment, we will be able to capture ~50-100 msec of good GPI data before, during, and after the transition in each shot.

Assessing turbulence before and through the L-H transition is an important ITPA topic.

3. Experimental run plan

The plan is simply to reproduce a shot for which there was a sharp (i.e. not dithering) L-H transition during the flat-top of the current ~ 0.2-0.25 sec. We will repeat this condition, with some possible variations in GPI gas puff, until ~ 5-10 good shots with L-H transitions caught by GPI are obtained.

The shots should have B=4.5 kG and I=0.8-0.95 MA for proper field line angle for GPI. The level of NBI power should be enough to make a sharp L-H transition, but as low as possible to increase the sensitivity of the reflectometer to edge fluctuations.

Candidate shots which had good GPI data with a single Phantom camera at 150,000 frames/sec.

#132959: at L-H transition at 0.252 sec, B=4.5 T, I=0.92 MA, P=1.2 MW
#132967: at L-H transition at 0.255 sec, B=4.5 T, I=0.92 MA, P=3.75 MW
#134079: at L-H transition at 0.216 sec, B=4.5 T, I=0.92 MA, P=4 MW

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

Repeat one of the shots above with to 4 MW from 0.2-0.3 sec in order to access the H-mode.

5. Planned analysis

Turbulence structure and correlation analysis using existing codes, HOP-V turbulence velocity analysis, bicoherence and other wave-wave coupling analysis. We will also try to compare the results with any theoretical analysis (e.g. for the effect of shearing on the turbulence correlation lengths), or simulations of the L-H transition, e.g. with XGC-1.

6. Planned publication of results

At least one PoP-type paper can come out of this. Detailed analysis of the data from the HOP-V code and the wave-coupling code could become separate papers.

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:

Set up shot like #132959, with late H-mode transition (during the current flat-top).

Previous shot(s) which can be repeated: #132959

Previous shot(s) which can be modified:

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

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

I_P (MA): 0.9 MA Flattop start/stop (s): 0.2

Configuration: **LSN**

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** Bank capacitance (mF):

LITERs: 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		x
CHERS – poloidal		x
Divertor fast camera		x
Dust detector		
EBW radiometers		
Edge deposition monitors		
Edge neutral density diag.		
Edge pressure gauges		x
Edge rotation diagnostic		x
Fast ion D_alpha - FIDA		
Fast lost ion probes - IFLIP		
Fast lost ion probes - SFLIP		
Filterscopes		x
FIReTIP		x
Gas puff imaging	x	
Hα camera - 1D		x
High-k scattering		x
Infrared cameras		
Interferometer - 1 mm		
Langmuir probes – divertor		x
Langmuir probes – BEaP		x
Langmuir probes – RF ant.		
Magnetics – Diamagnetism		x
Magnetics – Flux loops	√	
Magnetics – Locked modes		x
Magnetics – Pickup coils	√	
Magnetics – Rogowski coils	√	
Magnetics – Halo currents		
Magnetics – RWM sensors		
Mirnov coils – high f.		x
Mirnov coils – poloidal array		x
Mirnov coils – toroidal array		x
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		x
Reciprocating probe		
Reflectometer – 65GHz		
Reflectometer – correlation		x
Reflectometer – FM/CW		x
Reflectometer – fixed f		x
Reflectometer – SOL		x
RF edge probes		
Spectrometer – SPRED		
Spectrometer – VIPS		
SWIFT – 2D flow		x
Thomson scattering	x	
Ultrasoft X-ray arrays		x
Ultrasoft X-rays – bicolor		x
Ultrasoft X-rays – TG spectr.		x
Visible bremsstrahlung det.		
X-ray crystal spectrom. - H		
X-ray crystal spectrom. - V		
X-ray fast pinhole camera		
X-ray spectrometer - XEUS		