Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: **Long-wavelength turbulence characterization in L- and H-mode discharges**

OP-XP-1038	Revision:	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: D. Smith	Date
ATI – ET Group Leader: H. Yuh (T&T)	Date
RLM - Run Coordinator:	Date

Responsible Division: Experimental Research Operations

RESTRICTIONS or MINOR MODIFICATIONS
(Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: **Turbulence characterization in L- and H-mode** No. **OP-XP-1038**

AUTHORS: **D. Smith, S. Kubota, G. McKee, R. Fonck, I. Uzun-Kaymak** DATE:

---

1. Overview of planned experiment

Briefly describe the scientific goals of the experiment.

This XP will employ the new BES system to investigate the dynamics of LH transitions and HL back-transitions and to characterize the long-wavelength turbulence properties of L- and H-mode plasmas. The primary objective is to obtain LH and HL transitions at a range of densities by adjusting the timing of transitions. As a byproduct, the XP will document turbulence properties in L- and H-mode phases. To control the timing of the LH transition, δ_r^{sep} will swing from positive to negative (start in USN and swing to LSN). To control HL back-transitions, step-downs in NB power will be employed. To investigate the poloidal dynamics (velocity, zonal flows/GAMs) of fluctuations in the pedestal, RMIDOUT scans will move the pedestal across a BES poloidal array. Finally, obtain radial correlation lengths from BES and reflectometers in L-mode phase for comparison.

2. Theoretical/ empirical justification

Brief justification of activity, including supporting calculations as appropriate. Describe *briefly* any previous or related experiments.

Turbulent transport is thought to dominate transport of particles, energy and momentum in L-mode and lower-density H-mode ST plasmas. This XP tests this idea by quantifying long-wavelength turbulence parameters (spectra, amplitude, correlation lengths and decorrelation times) in L-mode and H-mode plasmas as a function of density/collisionality. In addition, this XP examines turbulence suppression and flow dynamics across the transition from the edge/pedestal region into the mid-radius. Also, this XP examines turbulence flow variation in the edge as the DRSEP parameter is varied to change equilibrium from upper-single-null (high L-H power threshold) to lower-single-null (low L-H power threshold).

3. Experimental run plan

Describe experiment in detail, concentrating on specifying scans, decision points and processes.

1. Establish baseline discharge for LH timing scan: 800 kA, 4 kG discharge with fiducial shape and 3 MW NB (Sources A, B, and C at 1 MW each). Used modified version of 141143 with 3 MW NB SS and drsep>0. Maintain L-mode into Ip flattop with positive δ_r^{sep}. Induce LH transition early in Ip flattop by swinging δ_r^{sep} negative. Deposit Li at low rate (~150 mg/shot) to maximize the LH power threshold difference between USN and LSN. Attempt to eliminate ELMs, AEs, and core modes. (Start shot development for (4) by adding step-downs in NB power late in discharge to induce HL back-transition.) **[1 shot + shot development]**

2. Obtain LH transitions at higher densities by postponing the δ_r^{sep} swing, but retain enough flux to maintain H-mode phase for at least 50 ms. Attempt LH transition at 2 higher densities relative to baseline discharge.

[2 shots + contingency]

3. Using LH scenario with the least ELM/AE/core mode activity, scan RMIDOUT in 2 cm steps to move pedestal relative to a BES poloidal array.
[2-3 shots + contingency]

4. Establish baseline discharge for HL timing scan: fiducial-like with 800 kA, 4 kG, and 3 MW NBI. Late in discharge, induce HL back-transition by stepping down NB one source at a time. Negative δ_r^{sep} with early LH transition is acceptable, but raise δ_r^{sep} as needed to achieve HL back-transition. Attempt to eliminate ELMs, AE, and core modes, but ELMs may be needed to reduce impurity radiation.
[1 shot + shot development]

5. Obtain HL back-transitions at lower densities by moving NB steps earlier. Attempt HL transition at 2 lower densities relative to baseline discharge.
[2 shots + contingency]

6. Using HL scenario with the least ELM/AE/core mode activity, scan RMIDOUT in 2 cm steps to move pedestal relative to a BES poloidal array.
[2-3 shots + contingency]

Total: 10-12 shots + shot development + contingency

Run time: 1/2 day

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

Describe any prerequisite conditions, development, XPs or XMPs needed.
(you must also complete the Physics Operations Request and Diagnostic Checklist)

BES, 3 NB sources, Bay K LITER, reflectometers

5. Planned analysis

What analysis of the data will be required: EFIT, TRANSP, specialized diagnostic analysis, modeling with impurity, edge transport or gyro-kinetic codes etc.?

Pursue comparison to edge simulation codes such as XGC or SOLT.

6. Planned publication of results

What will be the final disposition of the results; where will results be published and when?

Aim for NF paper and invited talks within 18 months.

PHYSICS OPERATIONS REQUEST

TITLE: **Turbulence characterization in L- and H-mode** No. **OP-XP-1038**

AUTHORS: **D. Smith, S. Kubota, G. McKee, R. Fonck, I. Uzun-Kaymak** DATE:

(use additional sheets and attach waveform diagrams if necessary)

Brief description of the most important operational plasma conditions required:

Previous shot(s) which can be repeated:

Previous shot(s) which can be modified: 141143 w/ 3 MW NB SS and drsep>0

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

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

I_P (MA): **0.8** Flattop start/stop (s):

Configuration: **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** Injector(s):

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

LITERs: On Total deposition rate (mg/min): **10-20**

EFC coils: On Configuration: **Odd / Even / Other** *(attach detailed sheet)*

DIAGNOSTIC CHECKLIST

TITLE: **Turbulence characterization in L- and H-mode** No. **OP-XP-1038**

AUTHORS: **D. Smith, S. Kubota, G. McKee, R. Fonck, I. Uzun-Kaymak** DATE:

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		