Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Study of the Parametric Dependence of High-k Turbulence**		
OP-XP-1037	Revision: **0**	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: Yang Ren	Date **07/29/2010**
ATI – ET Group Leader:	Date
RLM - Run Coordinator:	Date
Responsible Division: Experimental Research Operations	

RESTRICTIONS or MINOR MODIFICATIONS

(Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: **Study of the Parametric Dependence of High-k Turbulence** No. **OP-XP-1037**

AUTHORS: **Y. Ren et al.** DATE: **07/29/2010**

1. Overview of planned experiment

The goal of this XP is to investigate the parametric dependence of electron-scale density fluctuations, namely the dependence on collisionality, Bt, Ip by changing these parameters independently. The results from this XP will further our understanding of the mechanism underlining the observed collisionality and Bt scalings and, at the same time, will help us identify the mechanism for electron anomalous energy transport which is a part of the NSTX milestones.

A procedure of collisionality scan has been established in XP 532 by changing Bt and Ip simultaneously to maintain a constant q profile. Bt/Ip scan will also follow that in XP 532 so that comparisons can be made with previously published results.

2. Theoretical/ empirical justification

Previous results from XP 532 by S. Kaye have shown that the confinement time in some H-mode plasmas is strongly dependent on Bt and collisionality but has a weak dependence on Ip. We note that recent scaling results from XP 1048 show different dependences of the confinement time on Bt and Ip. In either case, the underlining mechanisms of these scalings are unclear. Thus a study of the dependence of high-k turbulence on these parameters will provide insight into these scaling. In this XP, we will concentrate on plasmas similar to those in XP 532. The observed collisionality scaling of confinement time could be due to the collisional damping of ETG-mode-driven zonal flow as pointed out in an analytical analysis [E.J. Kim and P.H. Diamond, PRL, 2003]. A similar dependence of ETG turbulence on collisionality has also been observed during PIC gyro-kinetic simulations [S. Parker et al., AIP Conference Proceedings, 2006]. However, this dependence is not seen in numerical simulation using continuous gyro-kinetic code [W. Guttenfelder, private communications]. The effect of collisionality on ETG turbulence remains controversial. Thus studying collisionality dependence of high-k turbulence on NSTX will contribute to the settlement of this issue. The Bt scan carried out in XP 714 was troubled by frequent MHD activities and plasmas similar to those in XP 532 were not obtained. With lithium deposition, long quasi-stationary MHD-free discharges are obtainable and a revisit of the Bt scan of high-k turbulence would provide relevant results for comparison with the Bt scaling of confinement time.

3. Experimental run plan

The first goal in the day is to produce our target plasma those in XP 532: long quasi-stationary MHD-free H-mode plasma with small Elms to reduce impurity accumulation. The reference shot we plan to use is shot 134751. If the desired target plasma is successfully produced, we then proceed with the experimental plan. If not, we will use plasmas similar to those in XP 1048 (shot 138556). The high-k scattering system will be initially configured to collected scattered light from R=135 ($r/a \approx 0.7$). One controlled access will be needed to reconfigure the high-k system to aim at R=117 ($r/a \approx 0.3$).

1. The first scan to be done is the three-point collisionality scan:

(Ip (MA), Bt (T))

(0.9, 0.45) **2 shots+1 contingency**

(1.1, 0.55) **2 shots+1 contingency**

(0.7, 0.35) **2 shots+1 contingency**

The total number of shots for this scan will be **6 shots+3 contingency**. Note that if the **(Ip, Bt)=(0.7,0.35)** plasma has too many MHD modes, we will consider increasing Bt so that **(Ip, Bt)=(0.76,0.38)**. In order to vary ν_{e*} by changing T_e only, it is crucial to maintain a similar line-integrated density for all the shots in this XP. ρ_e and β_T should also be kept constant while changing ν_{e*}, which means that we need to keep $T_e \propto B^2$. Neutral beam power may be varied to achieve this. If $T_e \propto B^2$ is successfully maintained, ν_{e*} scales as B^{-4}.

2. The second scan is the Bt scan with Ip=0.7 MA (use 0.76 MA if (Ip, Bt)=(0.76,0.38) is used in the collisionality scan):

(Ip (MA), Bt (T))

(0.7, 0.45) **2 shots+1 contingency**

(0.7, 0.55) **2 shots+1 contingency**

The total number of shots for this scan will be **4 shots+2 contingency.** This Bt scan in combination with **(Ip, Bt)=(0.7, 0.35)** completes a three-point scan of Bt.

3. The third scan is the Ip scan with Bt=0.55 T. Since we have already obtained two Ips' with Bt=0.55 T in the previous two scans, only one Ip is needed for completing the Ip scan:

(Ip (MA), Bt (T))

(0.9, 0.55) **2 shots+1 contingency**

The three scans can be summarized in the following table:

Bt (T) / Ip (MA)	0.35	0.45	0.55
0.7	**3** (2+1) **Sequence** (number of shots+ number of continguency)	**4** (2+1)	**5** (2+1)
0.9		**1** (2+1)	**6** (2+1)
1.1			**2** (2+1)

After successfully completing the three scans, one controlled access will be needed to configure the high-k system to aim at R=133 (r/a ≈ 0.7). After the control access, the previous three scans will be repeated. **The total number of good shots required to finish the whole experiment is 24.**

OP-XP-1037

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

The development of long quasi-stationary MHD-free plasmas similar to those in XP 532 is essential to this XP. Small ELMs are preferred for impurity control.

5. Planned analysis

LRDFIT, TRANSP, GTS, GS2 and GYRO

6. Planned publication of results

APS and AIP journals

PHYSICS OPERATIONS REQUEST

TITLE: **Study of the Parametric Dependence of High-k Turbulence** No. **OP-XP-1037**

AUTHORS: **Y. Ren et al.** DATE: **07/29/2010**

Brief description of the most important operational plasma conditions required:

1. **Obtain long quasi-stationary MHD-free plasma similar to those in XP 532.**
2. **Keep similar line-integrated density for all the scans.**
3. **Maintain** $T_e \propto B^2$ **while scanning collisionality.**

Previous shot(s) which can be repeated:

Previous shot(s) which can be modified: 134751 (or 138556 if using 134751 is unsuccessful)

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

I_{TF} (kA): **<=65** Flattop start/stop (s):

I_P (MA): **<=1.1** Flattop start/stop (s): **at least 200 ms of flat-top**

Configuration: **LSN**

Equilibrium Control: **Isoflux** (rtEFIT)

Outer gap (m): Inner gap (m): Z position (m): **0**

Elongation: **2.1-2.3** Triangularity (U/L): 0.7-0.75 OSP radius (m):

Gas Species: **D** Injector(s):

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

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

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

LITERs: Total deposition rate (mg/min): **A rate to maintain small ELMs**

LLD: Temperature (°C):

EFC coils: On Configuration: For optimized EF correction and low-n mode control

DIAGNOSTIC CHECKLIST

TITLE: **Study of the Parametric Dependence of High-k Turbulence** No. **OP-XP-1037**

AUTHORS: **Y. Ren et al.** 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		