Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: The role of internal and external components in kink modes

OP-XP-216	**Revision:**	Effective Date: *(Ref. OP-AD-97)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

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ATI - Task Force Leader: J. Menard	Date 5/6/2002
RLM - Run Coordinator:	Date

Responsible Division: Experimental Research Operations

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

The role of internal and external components in current driven kinks

1. Overview of planned experiment

This experiment is intended to build on the results of XP-28 and in particular to clarify the role of internal and external components in current-driven ideal external kink instabilities in NSTX. The effect of qaxis and wall-proximity will be investigated. Additional goals are to investigate the impact of the reduced error field on the instability and to start an investigation of the transition from current-driven to pressure-driven kinks.

2. Theoretical/ empirical justification

The analysis of XP-28 indicates that in a subset of shots, 106004,106005,106009 and 105993 we were able to obtain clear evidence of an external kink. The analysis also showed that in many discharges including this sub-set there was a clear role for internal modes as well as locked modes. The early beam heating intended to delay the fall of qaxis below unity, nevertheless promoted coupling to the m=1 through pressure effects. In addition the experiments were conducted at a time when the error field was significant. As a result many discharges were dominated by either the internal modes or by locked modes. This made the analysis of the external kink ambiguous but it also provided a window into the role of the internal, external and locked modes. In addition, diagnostic difficulties made it difficult to get rotation data and measure plasma perturbations near the plasma boundary. Even with the limited data several observations can be made: a) an external current driven kink was clearly observed; b) theoretical analysis of shots with external kinks show within acceptable error bars that the mode appears to be an ideal kink; c) the kink led to a beta-collapse, however there was no correlation with locked modes and d) locked modes were seen when there was a strong internal component to the perturbation or when there was no obvious precursor.

3. Experimental run plan

The first set of shots are intended to re-establish the conditions where a clean external kink is observed. The goal is to get a current pedestal similar to that obtained in 106004. We may need to adjust the density to match the edge Te obtained in 106004. After we obtain a clean ext. kink the next set will explore the coupling of the external mode to internal components by reducing qaxis. The next set of discharges will use faster current ramp-rates to induce the instability well before qaxis reaches unity. Once we achieve a reliable scenario with qaxis > 1, the goal is qaxis > 1.2, then we will vary the wall distance to assess the impact of the plasma-wall gap. In the last set of discharges we will vary the beta to explore the relative contributions of the current and pressure drive of the instability.

1. Reproduce conditions similar to those of XP-28: center-stack limited discharges with up-down symmetry, TF=0.35 T (42 kA), 800 kA plasma current reaching a flat top at 0.15s. The initial toroidal field is 3.5 kG and starting at 0.124 s. is ramped down at -213 kA/s. The density reaches 3 10^15 at the start of the flat-top The 'B' source is set to inject at 0.06 secs at 80keV. We may need to adjust the density to match the edge Te (≈100 eV at edge) obtained in 106004. (Note: These conditions are similar to the wave forms of 106004) (**4-5** shots)

2. Once we obtain the clean external kink, we then systematically increase the internal mode component by delaying the start of the TF ramp down in 30 ms increments. (**4-5** shots)

3. This sequence of shots is intended to establish a new baseline with qaxis >1.2. This may be achieved by raising the initial TF to 4.5 KG and adjusting the TF ramp rate. The starting point could use 107811 as a reference discharge. The TF ramp rate would be adjusted to reach the same TF at 0.17s. This requires starting at 53 kA and starting at 0.124 s. to ramp down at -463 kA/s.(**4-5** shots)

4. Select the best case with high qaxis and external kink signature and using this as a base case vary the plasma-wall distance, three gaps, to see the effect on the external kink (10,6 and 3 cm)(**6** shots)

5. Select the conditions with qaxis ~ 1.2 and vary the beta; 1 shot with reduced beta, achieved by switching to source A at lower energy, 65 keV**;** Then restore source B to have both sources In this scenario if the disruption is too early then we can reduce the current drive by reducing the Ip ramp rate. (**3** shots)

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

This XP requires an operational NBI system. Power will be used as required to have a clean ramp-up and satisfactory q(0) evolution. The high-n Mirnov array should be functional as well as the locked mode detector. Analysis of the results, beyond simple empirical scalings, will require detailed profile data, thus Thompson scattering, CHERS are essential. It is important that one of the USXR filters be set to look at the lower-temperature edge fluctuations.

5. Planned analysis

Initial empirical scaling studies will require EFIT analysis. Higher level analysis, if sufficient data were available, would require TRANSP to feed parameters to codes such as PEST, DCON etc.

6. Planned publication of results

The results would be suitable for Journal Articles on kink modes as well as locking phenomena. As more data is gathered, further articles could be written.

PHYSICS OPERATIONS REQUEST

Title: Internal/External components in Kinks XP No.:216

Machine conditions (specify ranges as appropriate)

I_{TF} (kA): **41-53** Flattop start/stop (s): _____/_____

I_P (MA): **0.8** Flattop start/stop (s): **0.15**

Configuration: **Inner Wall / Double Null**

Outer gap (m): _____, Inner gap (m): _____

Elongation κ: _____, Triangularity δ: _____

Z position (m): **0.00**

Gas Species: **D / He**, Injector: **Midplane / Inner wall / Lower Dome**

NBI - Species: **D**, Sources: **A/B/C**, Voltage (kV): **80/65**, Duration (s): **0.24**

ICRF – Power (MW): ____, Phasing: **Heating / CD**, Duration (s): _____

CHI: **Off**

If shots are new and unique, sketch desired time profiles and shapes. Accurately label the sketch so there is no confusion about times or values. Attach additional sheets as required.

DIAGNOSTIC CHECKLIST

Title: Internal/External components in Kinks XP No.: 216

Diagnostic system	Need	Desire	**Requirements** (timing, view, etc.)
Magnetics	✔		
Fast visible camera		✔	
VIPS-1		✔	
VIPS-2		✔	
SPRED		✔	
GRITS		✔	
Visible filterscopes		✔	
VB detector		✔	
Midplane bolometer		✔	
Diamagnetic flux		✔	
Density interferometer (1mm)		✔	
FIReTIP interferometer/polarimeter		✔	
Thomson scattering	✔		
CHERS	✔		Between shot analysis would be desirable-not essential. After XP analysis is essential.
NPA		✔	
X-ray crystal spectrometer			
X-ray PHA			
EBW radiometer			
Mirnov arrays	✔		
Locked-mode detectors	✔		
USXR arrays	✔		Top array uses Ti05 filter and Horizontal arrays to use Be-05
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 camera (2-D)			
Divertor bolometer (4 ch.)			
IR cameras (2)			
Tile thermocouples			
SOL reflectometer			