Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Extending reversed shear scenarios**

OP-XP-1040	Revision:	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: H. Yuh	Date
ATI – ET Group Leader: H. Yuh	Date
RLM - Run Coordinator: E. Fredrickson	Date

Responsible Division: Experimental Research Operations

Chit Review Board (designated by Run Coordinator)

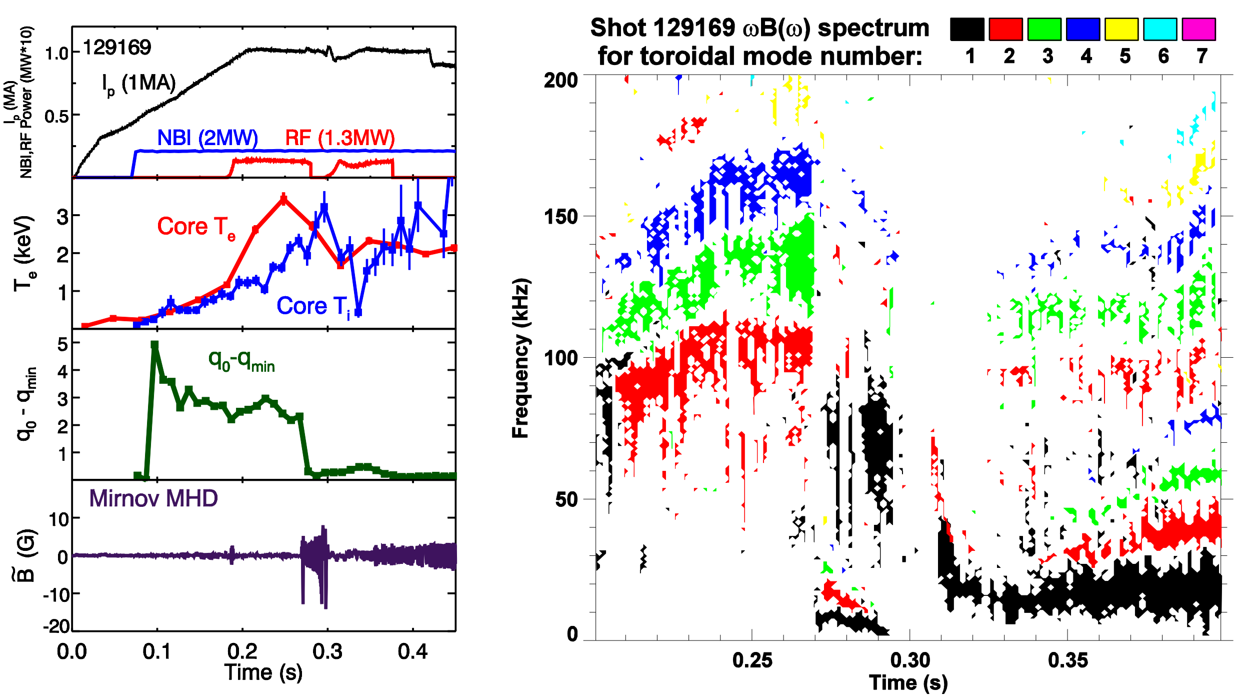
MINOR MODIFICATIONS (Approved by Experimental Research Operations)

1. Overview of planned experiment

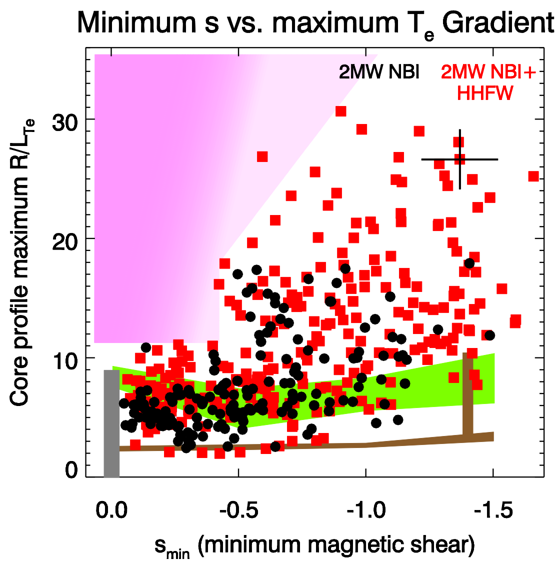
This experiment seeks to extend the L-mode reversed shear discharges to a full current relaxation time by avoiding the MHD induced current redistribution by limiting the heating of the e-ITB. The XP further seeks to transition into H-mode while maintaining a reversed shear q-profile.

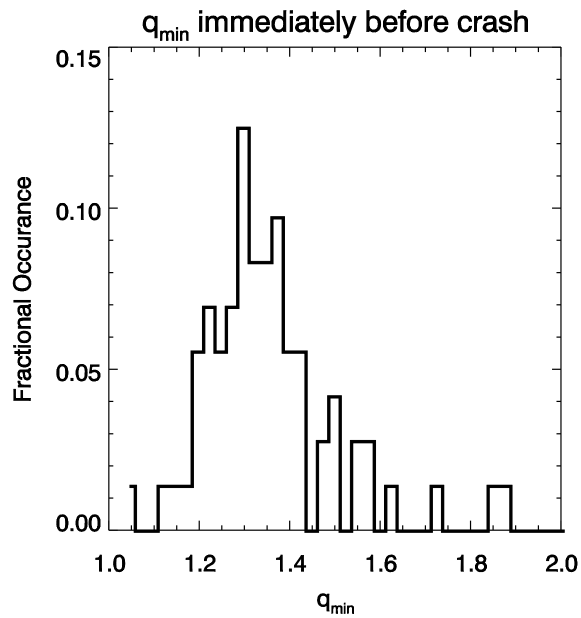
2. Theoretical/ empirical justification

Although high confinement ITBs have been observed in previous XPs, using NBI, NBI+RF (XP829), or RF only (XP821), a rapid influx of current to the core as fast or faster than the MSE time resolution (10ms) is routinely observed (see q_0-q_{min} in third panel). This rapid change in q-profile ends the period of improved internal transport. While the primary goals of the XP in the past campaigns have been to document the q-profile and turbulence behavior during the RS phase, this XP will focus on two phases



1. T&T - Avoiding the rapid redistribution of current to the core and characterizing turbulence through a current relaxation time. Observe evolution of ETG through current relaxation (hopefully a magnetic shear scan in time). Apply additional power during intermediate RS profiles to assess maximum accessible gradient.
2. ASC – Maintaining the RS q-profile with the ITB through an H-mode transition has been discussed for years. It will be attempted in earnest in this XP.





3. Experimental run plan

The XP will focus on trying to sustain the RS scenario so that it does not result in a transition to a monotonic q-profile via anomalous current redistribution.

1. Recover conditions similar to 129169. This involves lithium evaporation at a moderate rate, 10-15 mg/min. Due to sensitivity of early current profile to density, it usually takes at least **5 shots** to achieve this. Use this time to start coupling RF at 200ms, adjusting outer gap to optimize RF coupling as requested.
2. Current (ramp) scan - Determine if 1.1 or 1.2MA improves RS conditions. Adjust I_p ramp rate to flatop ±20ms to observe effect on current redistribution.

Best condition from Step 1, change to 1.1MA	1 shot
Best condition from Step 1, change to 0.9MA	1 shot
Change early (first stage) ramp point by ±50kA for effect	2 shots
Change second stage ramp rate ±20ms of best current condition	2 shots

3. Select most sucessful I_p and ramp rate to try and sustain the RS for as long as possible. Use RWM coils if locked modes are present.

Substitute Src A@90kV with B@65kV at 200ms, try producing RS w/B only	2 shots
Turn off A at 200ms, inject RF only at 1, 2, 3MW	4 shots
With NBI off, switch RF to Co/Counter/Heating phase to affect core current density	4 shots
If non-Src A heating is used successfully, document current profile with Src A blips at times of interest.	3 shots

4. Select a sustained ITB shot and try to induce a L-H transition.

Increase inner gap and center stack gas.	3 shots
Use ramping RF power to drive discharge into H-mode	6 shots
Document H-mode using Src A. Add	4 shots

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

The RF XMP must have been completed RF will be required.

Lithium evaporation required at a moderate rate 10-15mg/min. Using LLD to reach low collisionality may be KEY to preventing tearing modes that cause current redistribution.

NBI Src A @ 90kV and B&C @ 65kV will be required.

MSE, high-k, and BES diagnostics required.

RWM coils should be used in error field correction, and later in feedback mode if necessary.

Attach completed Physics Operations Request and Diagnostic Checklist.

5. Planned analysis

LRDFIT with MSE, TRANSP, gyrokinetic codes GS2 and/or GYRO, MHD stability codes will be used.

6. Planned publication of results

If results are of publication quality, they will be published in the appropriate journals.

PHYSICS OPERATIONS REQUEST

TITLE: No. **OP-XP-**
AUTHORS: DATE:

(use additional sheets and attach waveform diagrams if necessary)

Describe briefly the most important plasma conditions required for the experiment:

Start with model 129169

Reversed shear L-mode to begin.

Lithium.

Previous shot(s) which can be repeated:

Previous shot(s) which can be modified:

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

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

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

Configuration: **Limiter / DN / LSN / USN**

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 / On** Bank capacitance (mF):

LITERs: Off / On Total deposition rate (mg/min):

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

DIAGNOSTIC CHECKLIST

TITLE: No. **OP-XP-**

AUTHORS: DATE:

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 – E||B 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		