Princeton Plasma Physics Laboratory
NSTX Experimental Proposal

Title: FIDA Red/Blue Doppler Shift		
OP-XP-917	Revision: **1.0 (1/29/2009)**	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: W. Heidbrink	Date
ATI – ET Group Leader:	Date
RLM - Run Coordinator:	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: FIDA Red/Blue Doppler Shift — No. **OP-XP-917**

AUTHORS: W.W. Heidbrink, M. Podesta — DATE: **1/20/09**

1. Overview of planned experiment

Use modulated neutral-beam injection at low voltage in plasmas with different values of toroidal and poloidal field to confirm a predicted asymmetry between the short and long-wavelength sides of the FIDA spectra.

2. Theoretical/ empirical justification

Calculations indicate that there should be marked differences in the blue and red-shifted FIDA spectra caused by two special features of the ST: large poloidal field and large gyroradius. The large poloidal field causes a large field-line pitch that, for a downward vertical view and co-passing ions in standard NSTX geometry, makes the blue-shifted signals larger than the red-shifted signals outside the magnetic axis (and vice versa inside). In the presence of a gradient in the spatial profile of guiding centers, the large gyroradius causes the blue-shifted profile to shift inward, while the red-shifted spectra shift outward (for the standard clockwise toroidal field). To date, the predicted asymmetries are not observed in the data, casting doubt on the validity of the data (especially the red-shifted spectra). MHD-quiescent plasmas (where the fast-ion distribution function is reasonably well known) with special neutral beam injection patterns are needed to understand this discrepancy.

Note that measurements with either reversed plasma current or reversed toroidal field are also highly desirable.

The purpose of the error field correction shot is to improve the toroidal symmetry of the plasma as a check on the background correction obtained by subtracting the passive signals from the active signals. (Operation of the SPAs do not cause additional noise on the FIDA instrument.)

The bandpass filter scan is to optimize the spectral pass band for subsequent experiments.

3. Experimental run plan

Baseline condition: 0.8 MA, 5.5 kG, 3-4e13 cm-3, deuterium gas (~128742 –exact conditions not crucial). Sources B and C at 65 keV; Source A at 90 keV.

1) **Baseline** Source B at 50% duty cycle (10 ms on/off). Establish baseline. Add 40 ms Source A pulse at beginning and end of time of interest for MSE data. (2-3 shots)

2) **Toroidal Field Scan.** Lower toroidal field to 4.5 kG, then 3.5 kG. (2 shots)

3) **Plasma Current Scan.** At 5.5 kG, lower current to 0.5 MA, then raise current to 1.2 MA (2 shots).

4) **Error Field Correction.** At 5.5 kG and the highest current that runs well, apply "optimized" n=3 error field correction (1 shot).

5) **Source C.** In most interesting condition, substitute Source C for Source B (1 shot).

6) **Filter Scan** Repeat favorite case several times while scanning the angle of the f-FIDA bandpass filter (3 shots).

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

Machine: nothing special. Need fairly clean machine to avoid impurity contamination of FIDA spectra.

Beam: Lower voltage operation than usual & beam modulation.

ICRF: not needed.

Diagnostics: Magnetics to verify quiet plasma; fast-ion (neutrons, NPA, SSNPA, sFLIP) to corroborate FIDA; plasma (Thomson scattering, CHERS) for theoretical fast-ion distribution function, MSE for field-line pitch.

5. Planned analysis

TRANSP analysis to compute expected fast-ion distribution function. This distribution function is input to the FIDA simulation code.

6. Planned publication of results

If we get results that we understand, we will publish a short paper on these novel features of the fast-ion distribution function in an ST.

PHYSICS OPERATIONS REQUEST

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(use additional sheets and attach waveform diagrams if necessary)

Inner wall limited, L-mode, deuterium plasmas with low beam power to avoid fast-ion instabilities.

Experiment can be early in run but cannot tolerate unusually high impurity levels.

Previous shot(s) which can be repeated: 128742 (reference shot), then we will push it into the inner wall.

For the field and current scans, these are recent, fairly similar shots to the desired conditions. However, the shapes are not all identical, so it may be easier and better to modify the previous shot on the fly during the experiment.

Shot	**ITF**	**IP**
128742	64.5	0.8 (reference shot)
130012	64.5	1.0 (want 1.1 if we can)
128673	64.5	0.63 (want 0.5)
130097	52.7	0.8
130092	40.9	0.8

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

I_{TF} (kA): 42-66 Flattop start/stop (s): 0/0.75

I_P (MA): 0.5-1.1 Flattop start/stop (s): 0.25/0.5

Configuration: Inner Wall Limiter (shape not crucial)

Equilibrium Control: rtEFIT

Outer gap (m): 0.04 Inner gap (m): 0 Z position (m): 0

Elongation κ: 1.9 Upper/lower triangularity δ: 0.4

Gas Species: D Injector(s): Fuel from outside to avoid H-mode

NBI Species: **D** Voltage (kV) **A: 90** **B: 65** **C:** 65 Duration (s): Modulate

ICRF Power (MW): 0 Phase between straps (°): Duration (s):

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

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

EFC coils: Off 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		
Dust detector		
EBW radiometers		
Edge deposition monitors		
Edge neutral density diag.		x
Edge pressure gauges		
Edge rotation diagnostic		
Fast ion D_alpha - FIDA	X	
Fast lost ion probes - IFLIP		X
Fast lost ion probes - SFLIP		X
Filterscopes		
FIReTIP		X
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.	X	
Mirnov coils – poloidal array	X	
Mirnov coils – toroidal array	X	
Mirnov coils – 3-axis proto.	X	

Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
MSE		X
NPA – E‖B scanning	X	
NPA – solid state	X	
Neutron measurements	X	
Plasma TV		
Reciprocating probe		
Reflectometer – 65GHz		X
Reflectometer – correlation		
Reflectometer – FM/CW		X
Reflectometer – fixed f		X
Reflectometer – SOL		
RF edge probes		
Spectrometer – SPRED		
Spectrometer – VIPS		
SWIFT – 2D flow		
Thomson scattering	X	
Ultrasoft X-ray arrays		X
Ultrasoft X-rays – bicolor		
Ultrasoft X-rays – TG spectr.		
Visible bremsstrahlung det.		X
X-ray crystal spectrom. - H		
X-ray crystal spectrom. - V		
X-ray fast pinhole camera		
X-ray spectrometer - XEUS		