Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **Investigation of Ion Transport with Beam Modulation**		
OP-XP-831	Revision:	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: P.Ross	Date
ATI – ET Group Leader: S.Kaye	Date
RLM - Run Coordinator: M.Bell	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: Investigation of Ion Transport with Beam Modulation — No. **OP-XP-831**

AUTHORS: **P.Ross** — DATE:

1. Overview of planned experiment

The goals of this Experimental Proposal are to investigate the ion power balance by determining effects of beam modulation on the fast ion distribution and then the effects of longer beam modulation on the thermal ion population. The fast ion population comes from beam-plasma charge exchange and represents a source term in the ion power balance equation, so this will be studied first. To study the fast ion population, the beam power will be modulated under plasma conditions which have no large MHD modes. The fast ion distribution will be measured using the NPA, incorporating the Edge Neutral Density Diagnostic which will measure the neutral density profile in the edge of the plasma.

Beam modulation will also be used to affect the thermal ion population. The secondary goal is to establish regions of anomalously high ion temperatures, where the ion temperature is greater than is estimated assuming neoclassical diffusion.

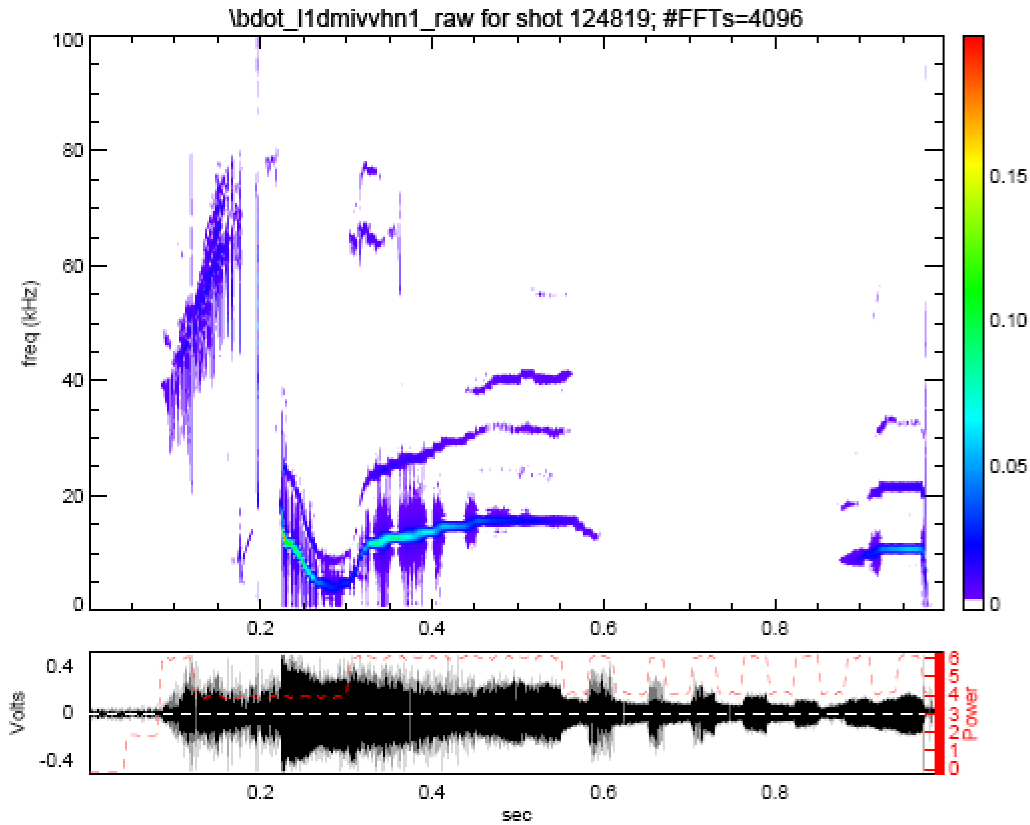
2. Theoretical/ empirical justification

The investigation of ion power balance was begun with XP 737. However, during XP 737, the neutral particle analyzer was positioned to view at a tangency radius of 80, 100, 120 cm. It was assumed that the modulations from source B would be visible at these tangency radii.

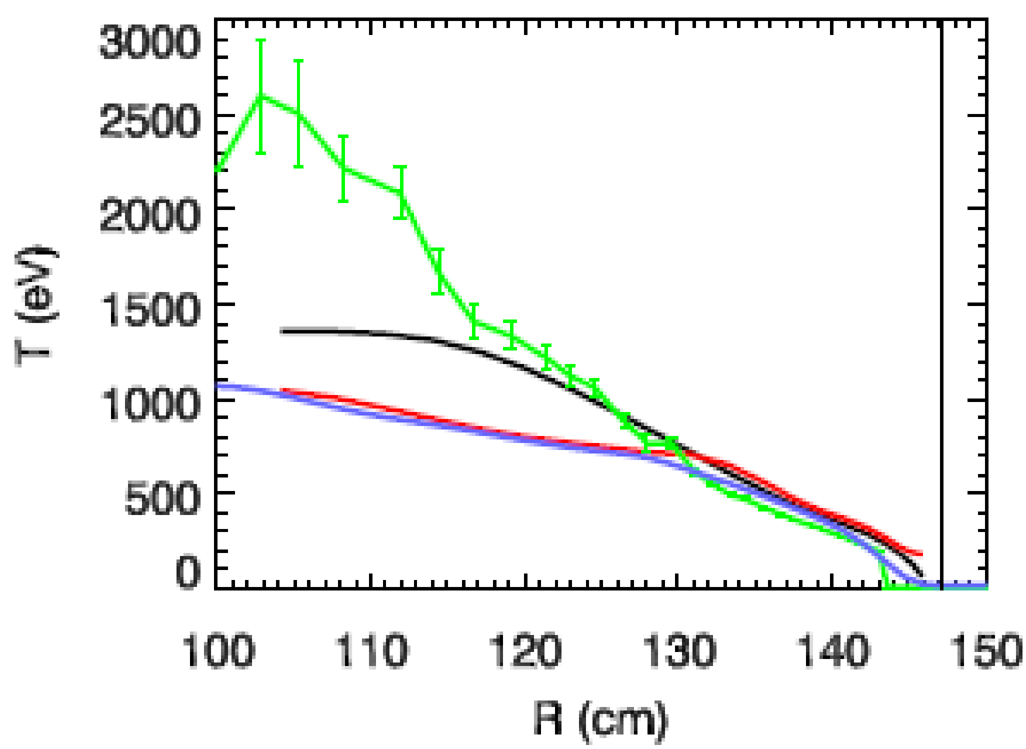
This turned out not to be the case. Preliminary TRANSP simulations of shot 125332 using an MSE constrained q-profile show that with the NPA aligned on a tangency radius of 80 cm, the NPA would barely catch the edge of the beam deposition profile. At larger radii, the NPA completely missed the beam deposition area. As a result, XP 737 failed to show a significant effect of the beam modulations on the fast ion distribution. The final calculations will be finished before the XP runs. When the intersection of the NPA sightline and the fast ion distribution function is calculated, we will perform a fine scan of the NPA in that region.

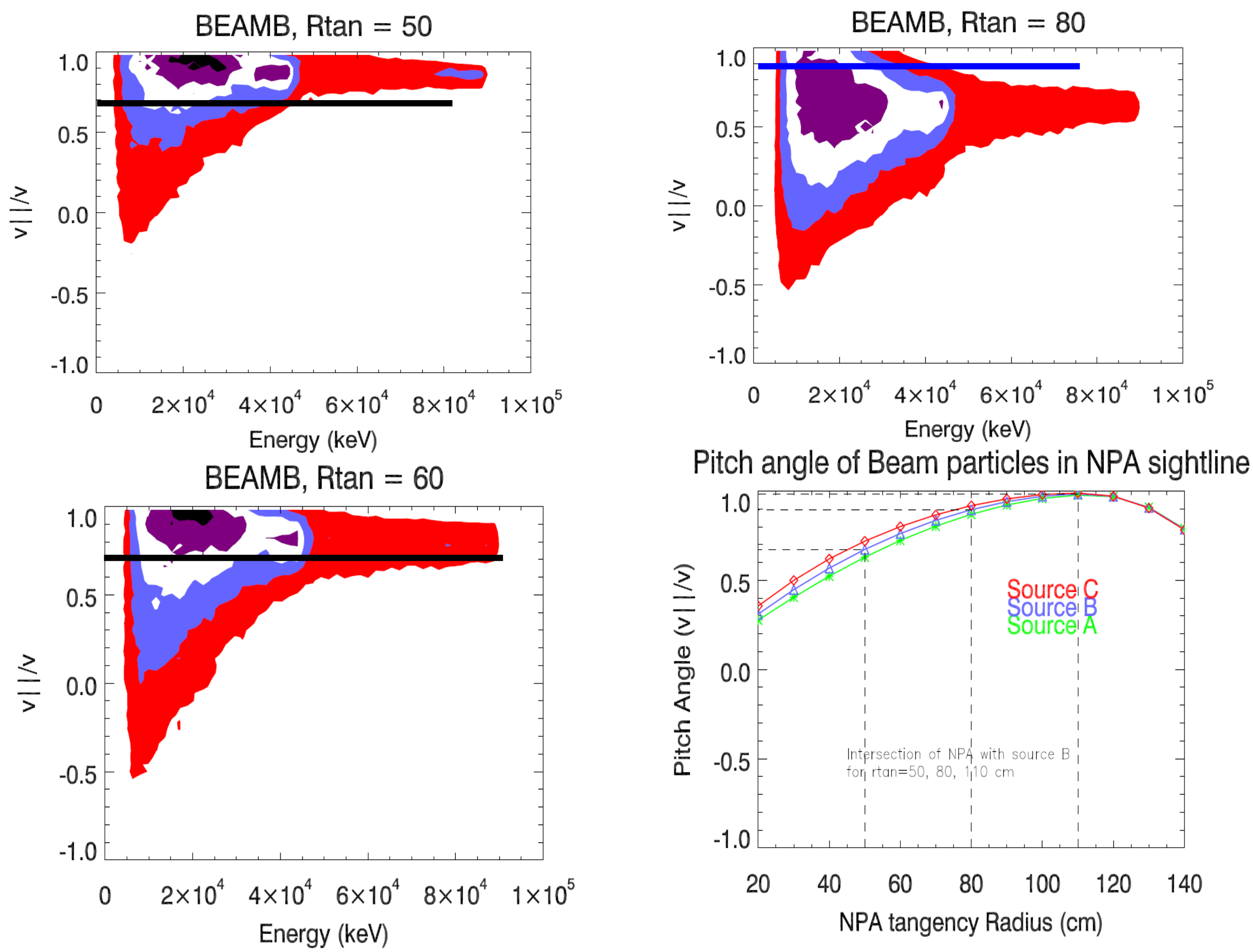
However, XP 737 demonstrated the feasibility of reproducing shots with a long period that was free from large amplitude, low frequency MHD activity. This is critical in mitigating any fast ion redistribution in order to more accurately measure the fast ion population with the NPA. This will be important for the TRANSP analysis.

High ion temperatures have been observed during the 2008 run campaign. While it is unclear yet whether these measurements are valid, they raise interesting questions about the ion power balance. TRANSP analysis shows that if these temperatures are accurate, they represent an anomalously high ion temperature. This XP hopes to reproduce those high ion temperatures and analyze the heating mechanism.



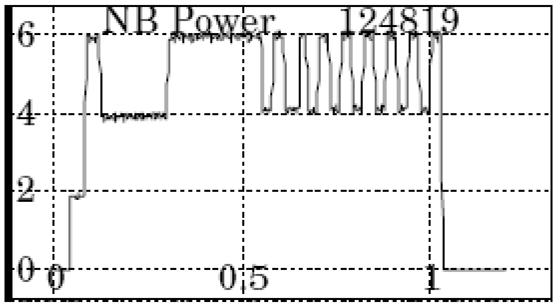
Ion and electron Temperatures, shot 127953




BEAMB, Rtan = 50
v||/v
Energy (keV)
BEAMB, Rtan = 80
v||/v
Energy (keV)
BEAMB, Rtan = 60
v||/v
Energy (keV)
Pitch angle of Beam particles in NPA sightline
Pitch Angle (v||/v)
NPA tangency Radius (cm)
Source C
Source B
Source A
Intersection of NPA with source B
for rtan=50, 80, 110 cm

3. Experimental run plan

The base shot for this XP is 124819. As in XP 737, the beams will be modulated starting at 550 ms to correspond with the beginning of the MHD free time period. Minimal shot development should be required.



Shot List:

All shots will be run with beam modulations of 30 and 50 ms.

NPA Rtan	NPA Vertical angle (°)
40	0
45	0
50	0,4,8
55	0
60	0,4,8
65	0
70	0,4,8

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

See the attached diagnostic requirement worksheet.

5. Planned analysis

Data analysis will largely focus on the NPA and CHERS data. These two diagnostics will be complimented by the addition of the Edge Neutral Diagnostic, which will measure the profile of the edge neutral particles.

The shots will be simulated in TRANSP to analyze the beam neutrals and study the ion power balance. Specifically, the discharges will be examined to study the fast ion population and the thermal ion diffusion and heat transfer to the electrons

6. Planned publication of results

The results will be published in a PPPL report, as well as reported at the DPP07 conference. These results are also an integral part of P. Ross's dissertation.

PHYSICS OPERATIONS REQUEST

TITLE: No. **OP-XP-831**
AUTHORS: DATE:

Machine conditions (specify ranges as appropriate)

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

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

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

Outer gap (m): Inner gap (m):

Elongation κ: Upper/lower triangularity δ:

Z position (m):

Gas Species: Injector(s):

NBI Species: **D** Sources: Voltage (kV): Duration (s):

ICRF Power (MW): Phasing: Duration (s):

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

LITER: On / Off

Either: List previous shot numbers for setup:

Or: Sketch the desired time profiles, including inner and outer gaps, κ, δ, heating, fuelling, etc. as appropriate. Accurately label the sketch with times and values.

DIAGNOSTIC CHECKLIST

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

Note special diagnostic requirements in Sec. 4

Diagnostic	**Need**	**Want**
Bolometer – tangential array		**X**
Bolometer – divertor		**X**
CHERS – toroidal	**X**	
CHERS – poloidal	**X**	
Divertor fast camera		**X**
Dust detector		**X**
EBW radiometers		**X**
Edge deposition monitors		**X**
Edge neutral density diag.	**X**	
Edge pressure gauges	**X**	
Edge rotation diagnostic	**X**	
Fast ion D_alpha - FIDA	**X**	
Fast lost ion probes - IFLIP		**X**
Fast lost ion probes - SFLIP	**X**	
Filterscopes		**X**
FIReTIP		**X**
Gas puff imaging	**X**	
Hα camera - 1D		**X**
High-k scattering		**X**
Infrared cameras		**X**
Interferometer - 1 mm		**X**
Langmuir probes – divertor		**X**
Langmuir probes – BEaP		**X**
Langmuir probes – RF ant.		**X**
Magnetics – Diamagnetism		**X**
Magnetics – Flux loops	√	
Magnetics – Locked modes		**X**
Magnetics – Pickup coils	√	
Magnetics – Rogowski coils	√	
Magnetics – Halo currents		**X**
Magnetics – RWM sensors		**X**
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 – ExB scanning	**X**	
NPA – solid state	**X**	
Neutron measurements	**X**	
Plasma TV		**X**
Reciprocating probe		
Reflectometer – 65GHz		**X**
Reflectometer – correlation		**X**
Reflectometer – FM/CW		**X**
Reflectometer – fixed f		**X**
Reflectometer – SOL		**X**
RF edge probes		**X**
Spectrometer – SPRED		**X**
Spectrometer – VIPS		**X**
SWIFT – 2D flow		**X**
Thomson scattering	**X**	
Ultrasoft X-ray arrays		**X**
Ultrasoft X-rays – bicolor		**X**
Ultrasoft X-rays – TG spectr.		**X**
Visible bremsstrahlung det.		**X**
X-ray crystal spectrom. - H		**X**
X-ray crystal spectrom. - V		**X**
X-ray fast pinhole camera		**X**
X-ray spectrometer - XEUS		**X**