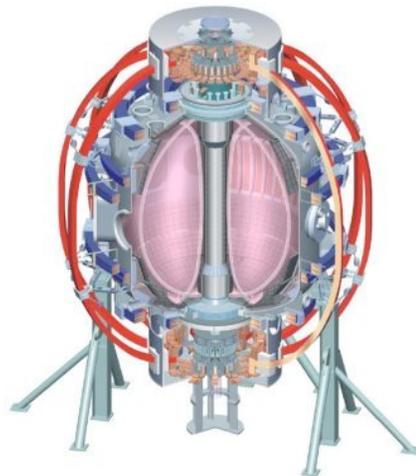


Wave-Particle Interactions TSG Mid-Run Assessment

Gary Taylor

**NSTX Mid-Run Assessment Meeting
June 17, 2009**

College W&M
Colorado Sch Mines
Columbia U
Comp-X
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Maryland
U Rochester
U Washington
U Wisconsin



Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

Overview

- Three EP 1st tier XP's run so far
 - XP-905: “Current Profile Modifications and Fast Ion Loss from BAAEs/EPs” (Darrow)
 - XP-916: “Study of TAE-Induced Fast Ion Transport in L-Mode Plasmas” (Podesta/Crocker/Fu) [Awaiting HHFW to complete]
 - XP-917: “FIDA Blue/Red Checkout” (Heidbrink/Podesta)
- Three HHFW & One EP 1st tier XP's (5 run days) awaiting availability of HHFW System
- Three EP 2nd tier XP's (1.5 run days)

Status of XP Results

XP-905: Current Profile Modifications and Fast Ion Loss from BAAEs/EPMs

Goals:

- Generate BAAE/EPM bursts during steady I_p phase of discharge, widely separated enough in time to allow good MSE measurements of the current profile before and after the bursts
- Measure fast ion loss pitch angle and energy distributions
- Measure effects on confined beam ions
- Measure internal mode structure
- Apply $n=3$ braking to get modes with no flow shear & compare with NOVA modeling

XP-905: BAAEs/EPMs Have No Greater Effect on $j(r)$ than General MHD in NSTX

Results:

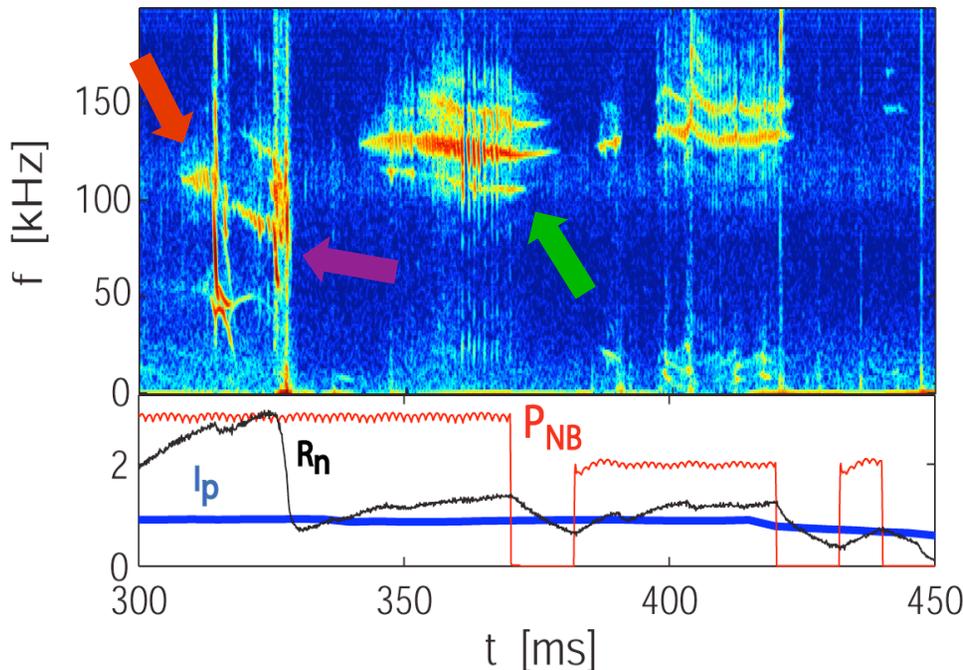
- Modes obtained under 2 conditions
- Good time separation for MSE in 1 case
- Density low enough for good FIDA data in other case
- Good reflectometer data obtained for fitting to NOVA eigenfunctions
- Good fast ion loss data obtained
- $n=3$ braking work incomplete
- Modes have no greater effect on $j(r)$ than general MHD

XP-916: TAEs Studies in L-mode, Center-Stack Limited Deuterium Plasmas - Summary of Day#1

- Good scenario with CS-limited, L-mode plasma achieved
 - $B_{\text{tor}}=5.5\text{kG}$, $I_p=0.9\text{MA}$, $n\sim 3.2\times 10^{19}\text{m}^{-3}$ @ 300ms
 - **TAEs and avalanches successfully reproduced**
 - Good diagnostic coverage
- Time window with $f_{\text{rot}}\approx 0$ through $n=3$ braking, $I_{\text{SPA}}\sim 1\text{kA}$
 - But: concerns about locked-modes. Avoid using SPAs in day#2?
- NB power scan (almost) completed for reference scenario
 - 1-2 shots at very low P_{NB} (sources B&C @65kV) missing
- Toroidal field scan more difficult than expected
 - Hard to avoid low-f modes at 4.5kG, didn't even try $B_{\text{tor}}=3.5\text{kG}$
- Low-density shots missing (problems with glow system)

XP-916: Good Data on TAEs & Associated Fast Ion Transport Collected for a Variety of Conditions

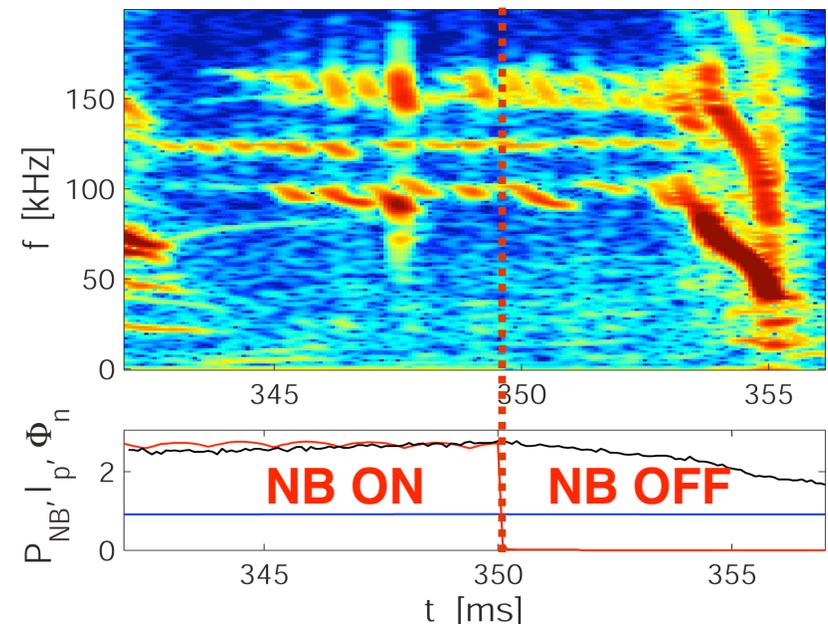
shot# 132764



- Example : shot#132764
- TAEs + avalanches, $t < 330\text{ms}$
- TAEs only, $t > 340\text{ms}$
 - SPAs ON, $n=3$ braking

- Interesting data on TAEs' decay and/or avalanches during NB notch
 - Ex: 132748, 132761, 132764, ...
 - Direct information on TAE damping?

shot# 132748



XP-916: Plan for Day #2

1. Complete missing shots from day#1
 - ✓ NB power scan, very low NB power (2 shots)
 - ✓ Quick NB power scan at low density (~4 shots)
2. Priority to shots for “code validation” & theory-experiment comparison
3. Electron temperature scan (requires HHFW, $P_{RF} \sim 2\text{MW}$)
4. NPA and f-FIDA scan, reference scenario
5. Elongation scan

Extended run day preferred...

XP-917: FIDA Blue/Red Shift

Motivation:

Resolve discrepancy between FIDA & FIDA simulation code in special quiet plasmas so we trust it for instability studies

Goal:

Vary fields to see if predicted spectral asymmetry associated with large gyroradius and large field line pitch is observed

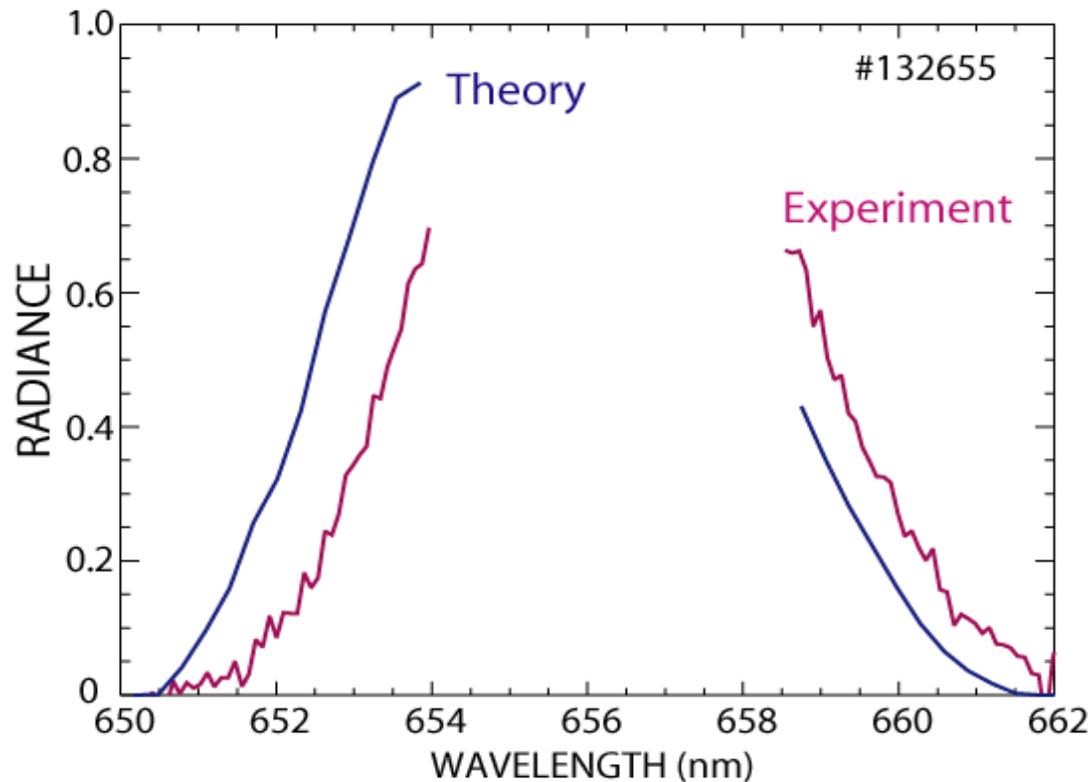
Result:

13 good plasma shots at low beam power at
 $B_T(0) = 3.5, 4.5$ and 5.5 kG & $I_p = 0.5, 0.8,$ and 1.2 MA

Analysis status:

Completed simulations--comparison with data in progress

XP-917: Poor Agreement Still Observed Between Theory and Experiment



- Would greatly benefit from reversed field (B_T and/or I_p) comparison shots!

Remaining 1st & 2nd Tier XPs

Remaining 1st Tier WPI TSG XPs Require 5 Run Days

- XP-944: “ HHFW Heating & Edge Effects in L-Mode” (Ryan/Hosea)
 - Run after 2-4 run days of XMP-26 HHFW plasma conditioning
 - Lithium conditioning at ~ 20 mg/min
 - Requires 1.5 run days
- XP-946: “ HHFW Heating & Edge Effects in H-Mode” (Ryan/Hosea)
 - Lithium conditioning at ~ 20 mg/min
 - Run after XP-944
 - Requires 1.5 run days
- XP-920: “HHFW Heating of Low $T_e(0)$, I_p Plasmas” (Taylor)
 - Lithium conditioning at ~ 20 mg/min
 - Run after XP-944 & XP-946
 - Requires 1 run day
- XP-916: “Study of TAE-Induced Fast Ion Transport in L-Mode Plasmas” (Podesta/Crocker/Fu)
 - Requires 1 (preferably extended) run day & ~ 2 MW of HHFW

2nd Tier WPI TSG XPs Require 1.5 Run Days

- XP-906: “ Development of H-Mode TAE Avalanche Target Plasmas” (Fredrickson)
 - 2008 candidate shots identified, explore parameters for TAE avalanches
 - Requires 0.5 run days
- XP-907: “ Documentation of CAEs & GAEs” (Fredrickson/Gorelenkov)
 - Requires 0.5 run days
 - Attempt to reproduce previous “Angelfish” shots
- XP-947: “HHFW Modification of Rapidly-Chirping Beam-Driven Instabilities” (Heidbrink)
 - Needs > 2 MW, 30 ms pulses of HHFW
 - Start with previous “Angelfish” shots, $B_T(0) \sim 4$ kG L-mode
 - Requires 0.5 run days

XPs Run with Reversed B_T Require 1 Run Day

- XP-944: “HHFW Heating & Edge Effects in L-Mode” (Ryan/Hosea)
 - Antenna phase scan (-150° , -90° , -30° and $+90^\circ$)
 - Current scan from 0.7 to 0.9 MA with -90° phasing
 - Requires 0.5 run days
- XP-917: “FIDA Blue/Red Checkout” (Heidbrink/Podesta)
 - Scan $B_T(0)$ from 3.5 to 5.5 kG & I_p from 0.5 to 1.2 MA
 - Requires 0.5 run days (can limit $B_T(0)$ & I_p scans if less time available)