Wave-Particle Interaction ET Midyear Assessment

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Prioritization of Wave-Particle XPs and Allocation of Run Days (as of Jan 06)

NSTX 2006 Run Wave-Particle ET XPs

XP#	Lead Author(s)	XP Title	ET Review	Allocated Days	Priority	Early/Mid/Late Run
608	E. Fredrickson & C. Petty	TAE/EPM impact on fast ion transport (JNBI) & Displacement of NB ions by MHD	1/12/06	1	1	E/M
607	W. Heidbrink, E. Fredrickson & N. Crocker	Fast-ion Transport by Fishbone instabilities & Documentation of TAE/EPM fast ion losses	1/12/06	1	1	E/M (4/21/06)
	E. Fredrickson	Direct Launch of CAE/GAE with RF antenna	1/26/06	piggyback	2	M/L
	E. Fredrickson	Parameter scaling of 'Angelfish' instability	1/26/06	0.5	2	E/M
625	S. Diem & G. Taylor	Thermal EBW emission and oblique O-mode coupling efficiency in L and H-mode plasmas	2/2/06	0.5+0.5	1	M & L (4/27/06)
	S. Bernabei	Search for RF missing power	1/19/06	1	1	E
617	J. Hosea	HHFW power deposition vs phase and wavelength through power modulation	2/9/06	0.5+0.5	1	E & L (4/26/06)
	S. Bernabei	Reverse Bt and Btheta fields	1/19/06	0.5+0.5	1	M
	J. Hosea	Magnetic field direction effect on HHFW coupling	2/9/06	1	2	E & L
	R. Pinsker	Absorption of HHFW on Beam Ions in NSTX	2/2/06	1	2	E & L
	B. LeBlanc	HHFW into Reversed Shear Plasmas	2/23/06	1	2	M
	B. LeBlanc	High Te Plasma Scenarios with HHFW-Heating	2/23/06	1	2	L
			Total:	10.5		

XPs Already Run

- **XMP 026: HHFW Antenna Conditioning**
  - **Feb 28 (1/2 day), conditioned to ~ 1 MW**
  - **April 20 (3/4 day), conditioned to ~ 2.3 MW, 5 shots at 5 kG**
- **XP 607: Fast ion transport by fishbone instabilities and Documentation of TAE/EMP Fast Ion Losses**
  - **April 21 (1 day)**
- **XP 617: HHFW power balance vs B at approximately constant q.**
  - **April 26 (1 day)**
- **XP 625: Thermal EBW Conversion to O-Mode at 8-40 GHz**
  - **April 27 (1/2 day)**

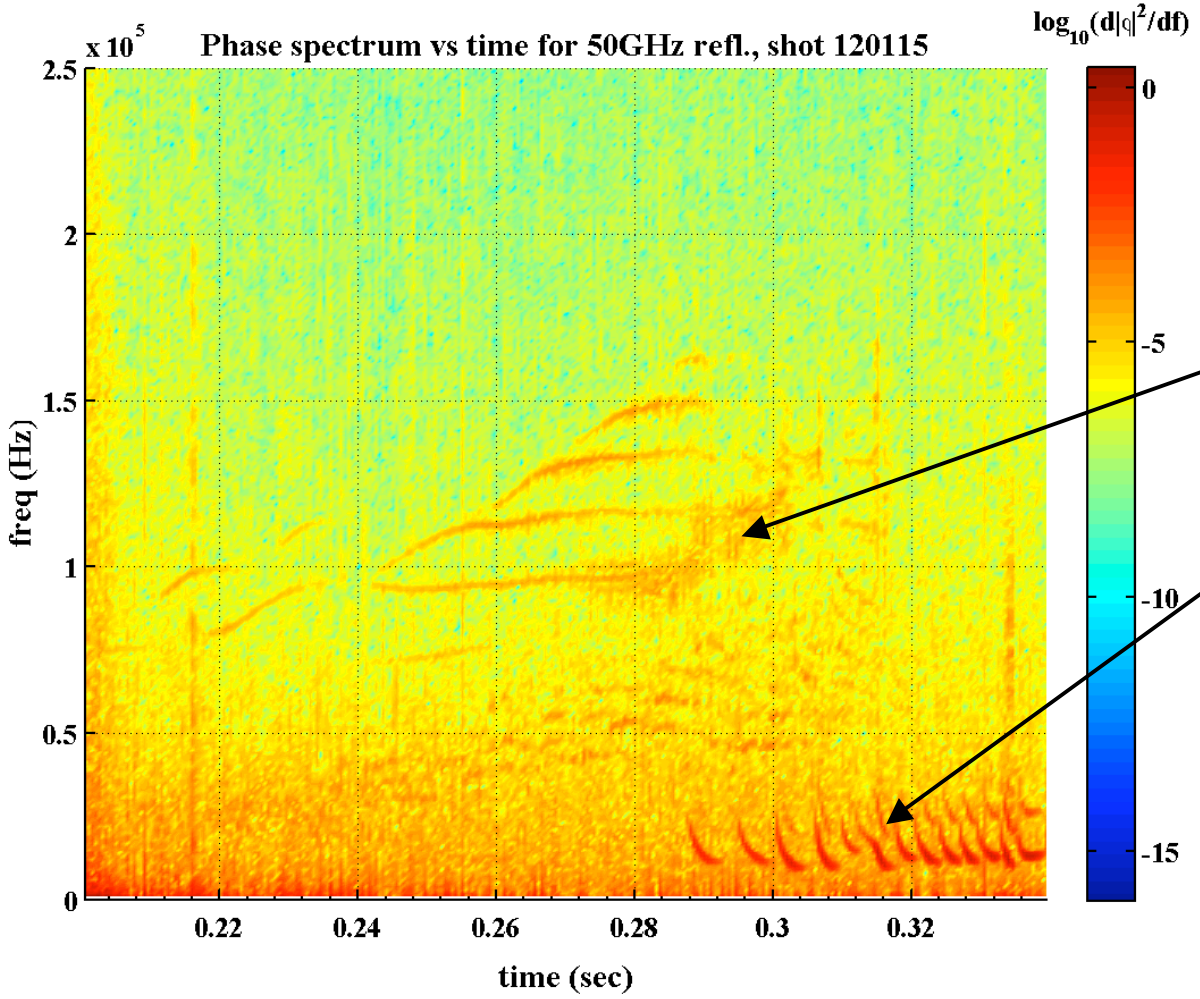
XP 607: Transport of Fast Ions by Fishbones and TAEs

- Run April 21 (1 day)
- Goal was to measure simultaneously the internal structure and fluctuation amplitude of both TAEs and fishbone instabilities and the fast ion transport they cause.
- He L-mode plasma.
- Diagnostics (including MSE) worked well.
- Instabilities were measured by soft x-rays, reflectometers, and magnetic coils.
- Fast ions were measured by the E||B neutral particle diagnostic, the solid state neutral particle analyzer array, neutrons, and loss probes.

Three different beam conditions with different instability behavior were fully documented

- First condition used Source C at 90 keV, and showed TAE activity (~100 kHz) from 200-290 ms, with strong frequency chirping associated with with fishbones (~20 kHz) dominating after 290 ms.
- Second condition used Source A at 90 keV and had strong frequency chirping in the TAE band rather than the more gradual evolution seen in the first case.
- Third condition used Source C at 70 keV and had weaker activity in both phases of the discharge.
- Data analysis will be deferred until after the run and should enable a quantitative comparison of the observed fast-ion transport with theory.

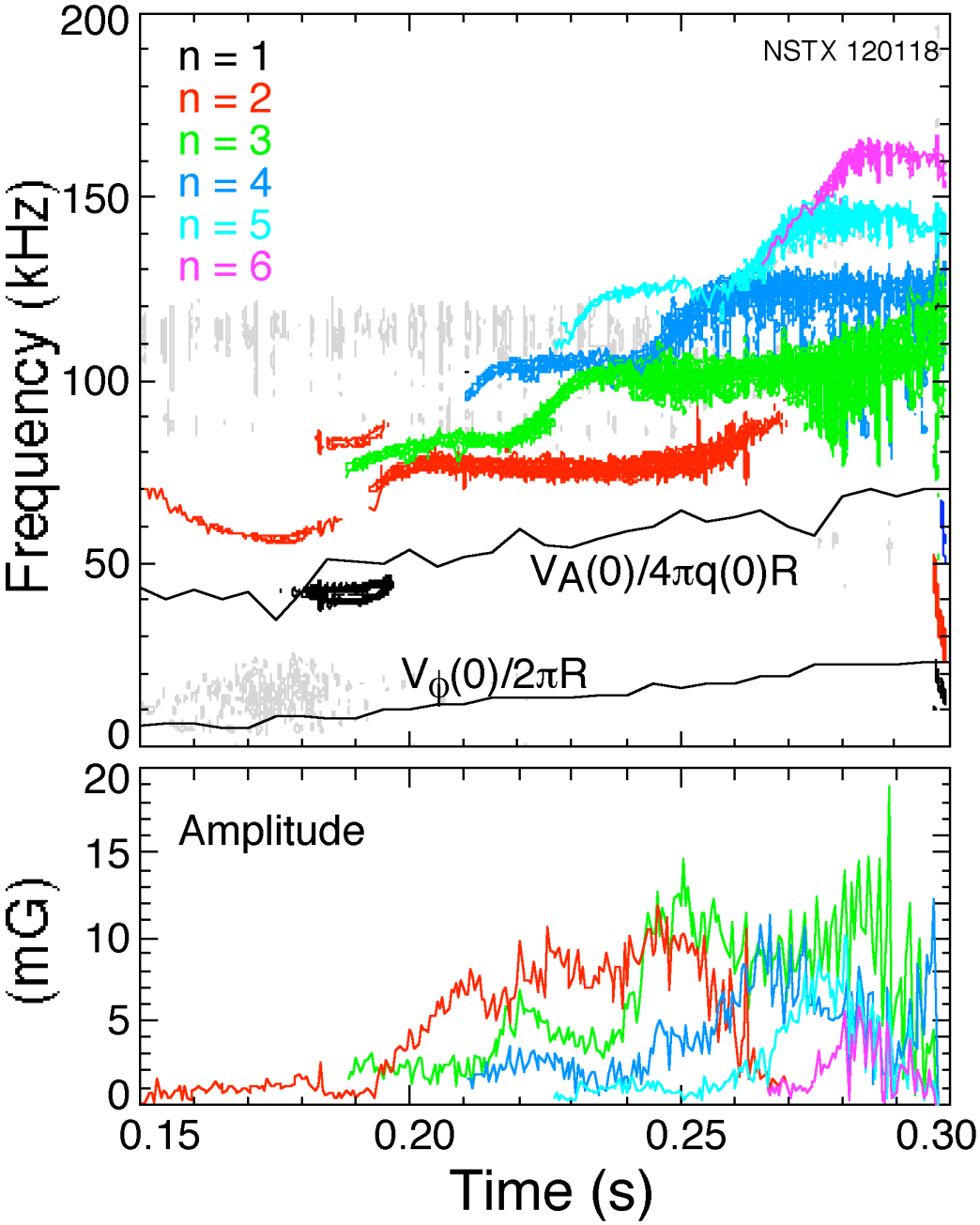
Example of coherent oscillations from the plasma core, measured by 50 GHz reflectometer



- Source C at 90 keV (1st condition)
- TAE activity from 200-290 ms.
- Frequency chirping from fishbones after 290 ms.

TAE evolution at low density needs documentation

- TAE show one or two slowish upward frequency chirps.
- Upward frequency chirps for different n's occur at different times - not like cascades.



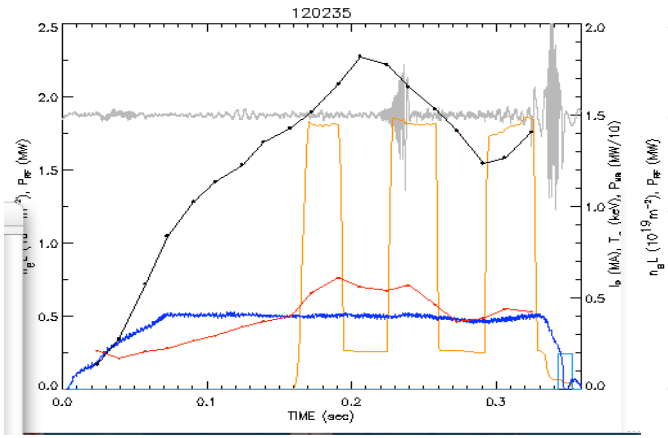
XP617: HHFW power balance vs B at approximately constant q.

- First scheduled run for HHFW experimental proposal XP# 617 was performed on April 26 to investigate scaling of surface power loss with magnetic field.
- Much of the data desired for this experiment was obtained but some additional shots at high and low field will be needed to complete this XP.
- Several shots were not good due to NSTX system problems and the run at 5.5 kG was cut short due to over temperature FCPC faults. Also, due to the restart of experimental computer systems, magnetic MHD measurements are not available for the lower field scans except for -7 m^{-1}.
- Nevertheless, sufficient data was obtained to permit a first analysis of the field effect on power balance. A preliminary look at the possible effects of increasing the magnetic field suggests that higher field is beneficial for core heating at both -7 m^{-1} and ±14 m^{-1}.

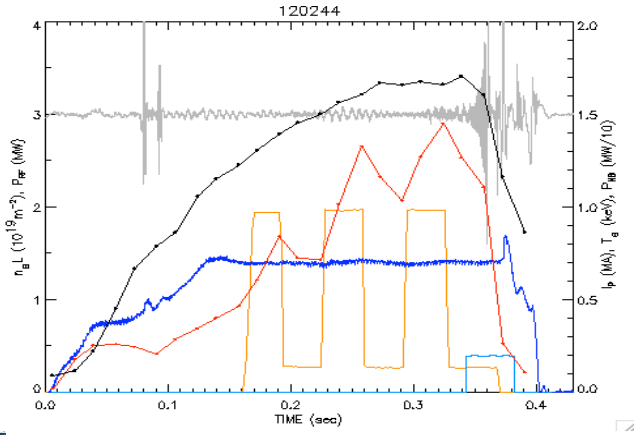
XP617 Scans Performed at 2 MW (modulated)

shots	B	Ip	k
120224-226	4.5 kG	600 kA	±14 m^{-1}
120227-230	3.0 kG	450 kA	±14 m^{-1}
120231-234	3.0 kG	450 kA	±7 m^{-1}
120235-238	3.0 kG	450 kA	-7 m^{-1}
120239-244	5.0 kG	700 kA	-7 m^{-1}
120245-250	5.5 kG	B-field test shots	
120251-256	5.5 kG	700 kA	±14 m^{-1}
120257	5.5 kG	700 kA	-7 m^{-1}

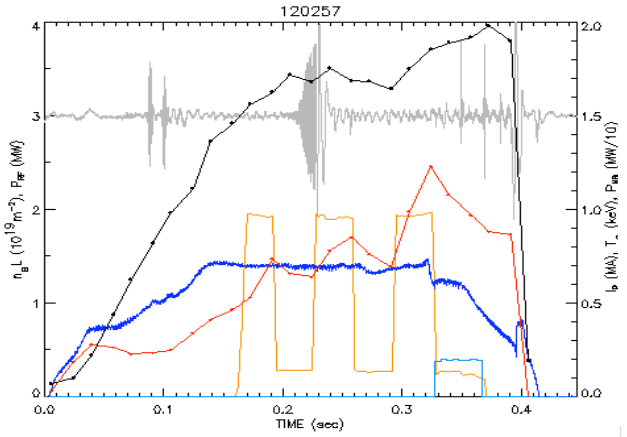
Preliminary summary for XP617 (April 26, 2006)



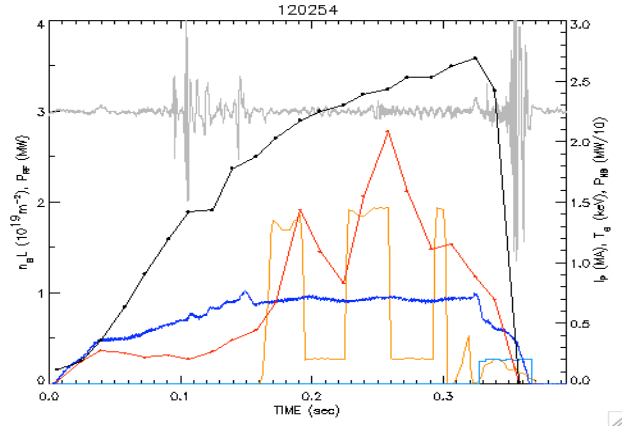
B = 3 kG, - 7 m^{-1}



B = 5 kG, - 7 m^{-1}



B = 5.5 kG, - 7 m^{-1}

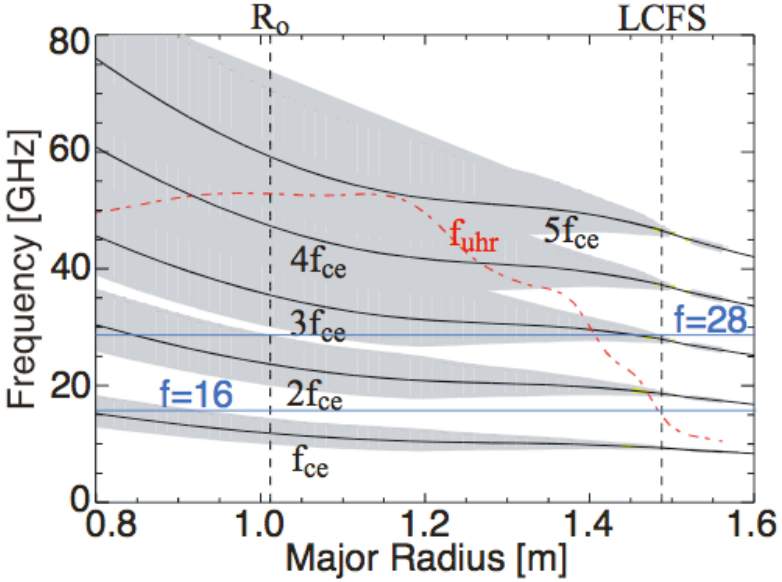


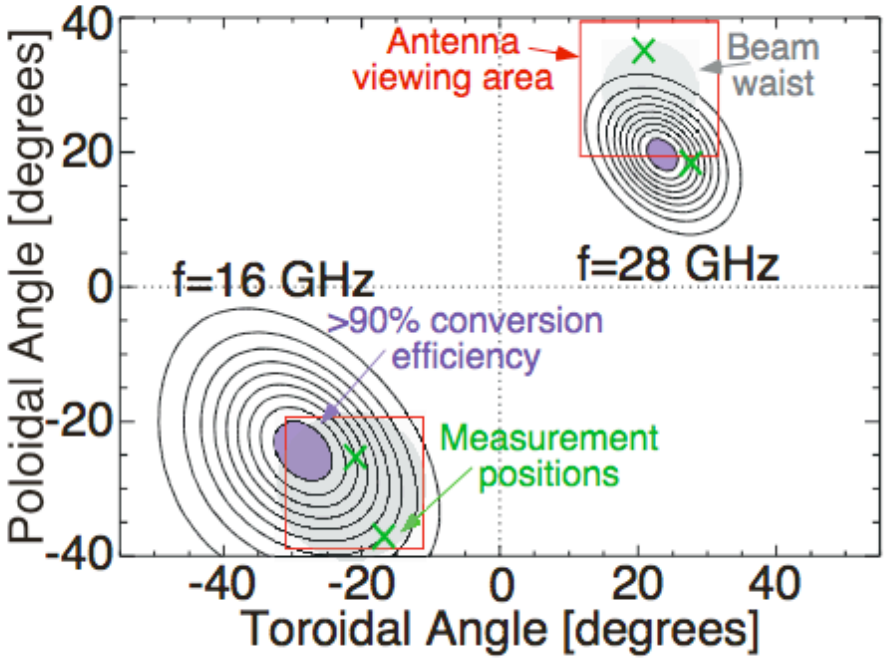
B = 5.5 kG, ±14 m^{-1}

- ±14 m^{-1} phasing gives greater $T_e(0)$ increment than -7 m^{-1}.
- Higher field improves -7 m^{-1} heating.
- MHD affects heating - comparisons need to be made in stable regions.
- Analysis of τ_E with increments of stored energy will determine effect of B on power deposition.

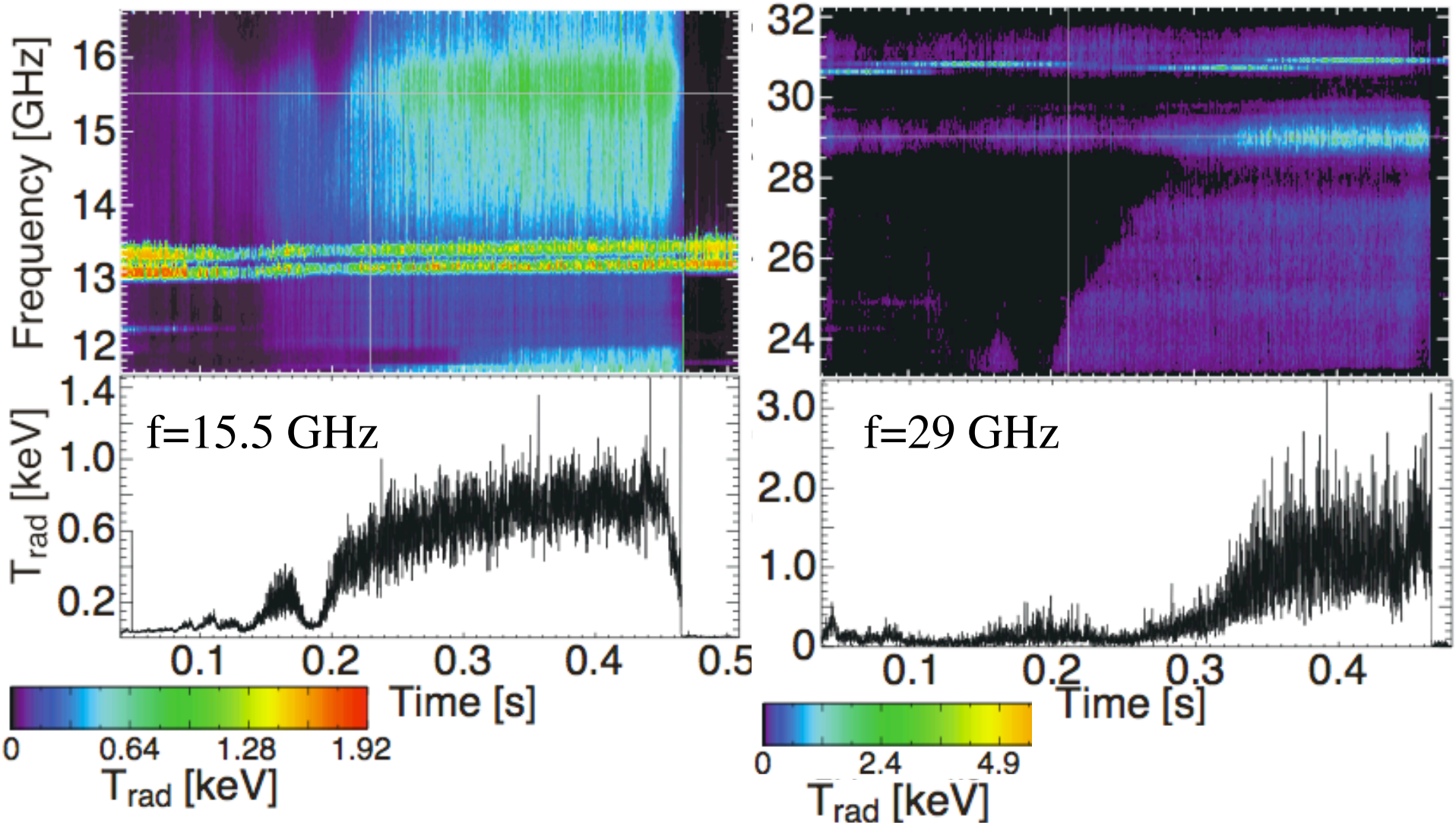
XP 625: Thermal EBW Conversion to O-Mode at 8-40 GHz

- Part 1: Map coupling efficiency of He, L-mode, I_p=800 kA, B_t=4.5kG discharge
  - 12 pointing directions investigated
  - Experimental variation in emission levels correspond to theory
  - Part 2 of XP to map coupling efficiency of H-mode plasmas should be completed by the end of May





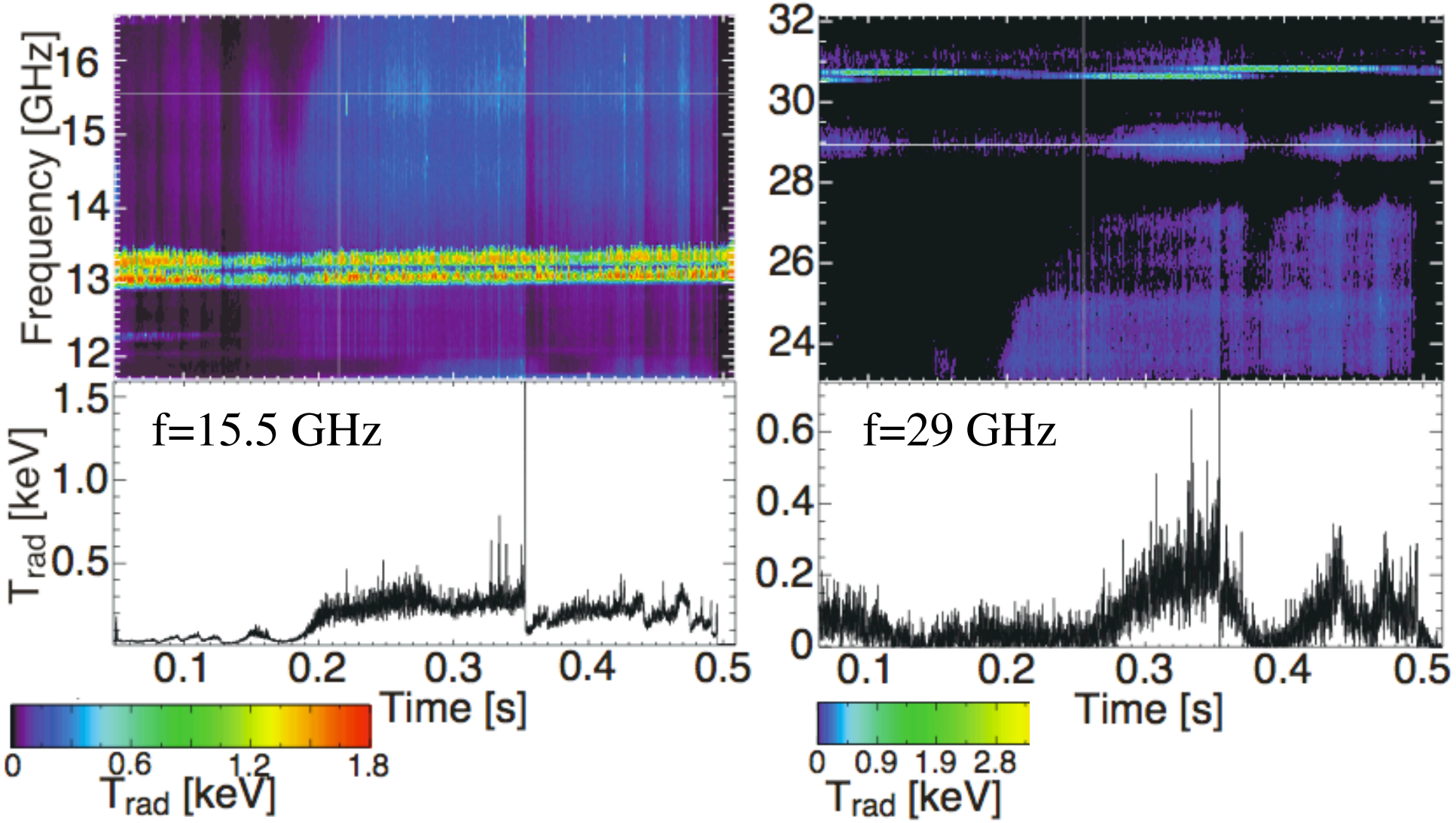
Maximum Emission Correlates to Theoretical Prediction



Preliminary T_{rad} does not include ~10-20% window loss

NSTX

Low Emission When Pointing Direction Not Optimized



Preliminary T_{rad} does not include ~10-20% window loss

NSTX

Wave-Particle Interaction Effort For Remainder of 2006 (Priority One Items)

- **XP 608** - TAE/EPM Impact on Fast Ion Transport and Displacement of NB ions by MHD (Fredrickson/Petty)
  - supports ITER/ITPA, XP has been approved and is ready to run
  - 1 day at high B_T (> 5 kG)
- **XP 607** - Fast ion transport by fishbones & TAE/EMP Fast Ion Losses (Heidbrink/Fredrickson)
  - Need to document bursting TAE conditions with MSE, NPA scans
  - Need to document conditions for slow chirping TAE
- **XP 625** - Thermal EBW Emission (Diem/Taylor)
  - Completed L-mode (1/2 day), need H-mode
  - Completing H-mode scan may need more than 1/2 day
- **XP 617** - HHFW power balance vs B (Hosea)
  - Scans not yet completed (~1/2 day)
  - Repeat selected scans to obtain missing MHD (magnetic) data
- Search for Missing HHFW Power (gap, power scan) (Bernabei)
  - 1 day (after RF probe installed)

Wave-Particle Interaction Effort Remainder of 2006 (Second Level Priority)

- HHFW with reversed B_T (Bernabei/Hosea/Ryan)
  - high priority ONLY IF there are other XPs to reverse B_T
  - 1 day (after RF probe installed)
- Absorption of HHFW on Fast Beam Ions (Pinsker)
  - 1 day
- HHFW into Reversed Shear Plasmas (LeBlanc)
  - 1 day
- High Te Plasma Scenarios with HHFW Heating (LeBlanc)
  - 1 day
  - May depend on successful power coupling experiments
- Parameter Scaling of “Angelfish” Instability (Fredrickson)
  - 1/2 day

HHFW Support of Other ETs

- XP627 - Non-solenoidal I_P Ramp Up With HHFW (Kessel)
  - Integrated scenario ET
  - Need to survive L-H mode transition
- XP606 - Transient CHI (Raman)
  - Solenoid-free Plasma Start Up ET
  - Heating/current drive at 7 m^{-1}