Wave-Particle Interaction TSG Mid-Run Assessment

Gary Taylor

NSTX Mid-Run Assessment Meeting

April 16, 2008

Overall Goals & Milestones

NSTX

HHFW:

Understand and improve HHFW coupling, heating & CD in deuterium NBI H-modes & assess effect of Li

Fast Ion MHD:

Assess fast ion transport from TAE avalanches and compare to non-linear TAE simulation

Milestones:

No FY08 milestones

Initial XP Prioritization

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XP #	Title	Authors	Run days assigned	Priority
825	**HHFW Phase Scan & Current Drive in Deuterium L-Mode**	**Ryan & Hosea**	**1**	**1**
	HHFW Phase Scan & Current Drive into NB Deuterium H-Mode	**Hosea & Ryan**	**1.5**	**1**
819	**Fast Ion Transport Induced by Alfvén Avalanches**	**Fredrickson, Podestà, Heidbrink & Darrow**	**2**	**1**
808	**Assess the Affect of Alfvén Cascades on Fast Ion Transport**	**Crocker & Fredrickson**	**1**	**1**
832	Profile of Fast Ions that are Accelerated by HHFW	Heidbrink	0.5	2
807	Vertical NPA Scan w/wo Low f MHD and with High f Only MHD	Medley	0.5	2
	Optimization of EBW Coupling from H-Mode Plasmas	Taylor	0.5	2
	Ramp up in D2 from ECH Target	Hosea, Ryan & Taylor	0.5	2
	Neutral Beam Ion Loss During Energetic Particle Mode Bursts	Darrow	0.5	2
	Angelfish (CAE or GAE hole-clumps) Studies	Fredrickson & Crocker	0.5	2
	Measurement of BAAE and TAE_RSAE Mode Structures with High-k Scattering System	Lee & Gorelenkov	0.5	2

Experiments Run, Initial Results & XP Status

- MP-26 HHFW plasma conditioning ran on 2.5 days,
- MP-54 FIDA checkout ran for half a day on February 21
- So far only ~1.3 days of XP run time with machine available for experiments
- XP-825: "HHFW Heating & CD in D L-Mode" ran only 3 hrs on April 3 with bouncing plasma
- XP-819: "Alfvén Avalanche-Induced Ion Transport" ran only 1 hour on April 4, but had a good run day on April 10

MP-26: HHFW Plasma Conditioning Results

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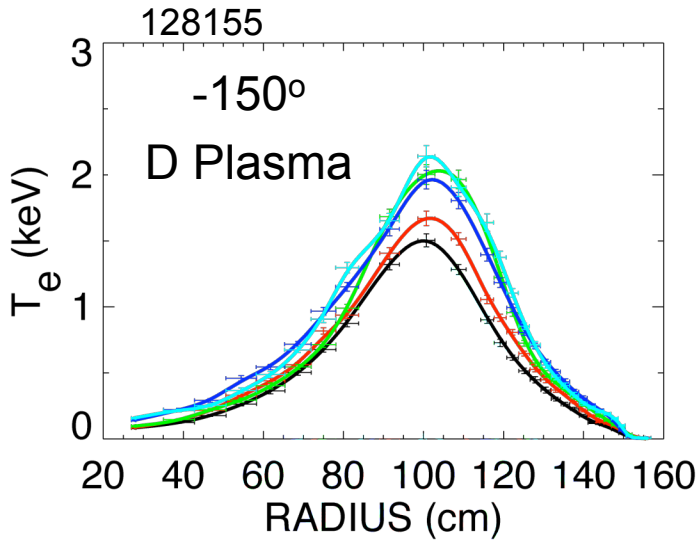
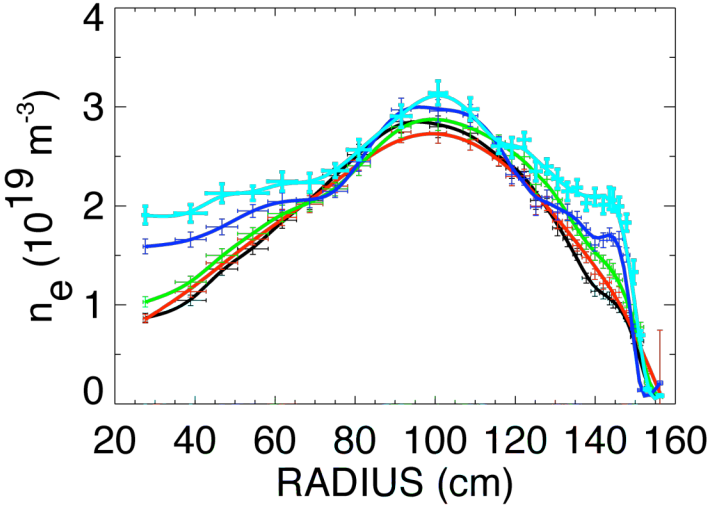
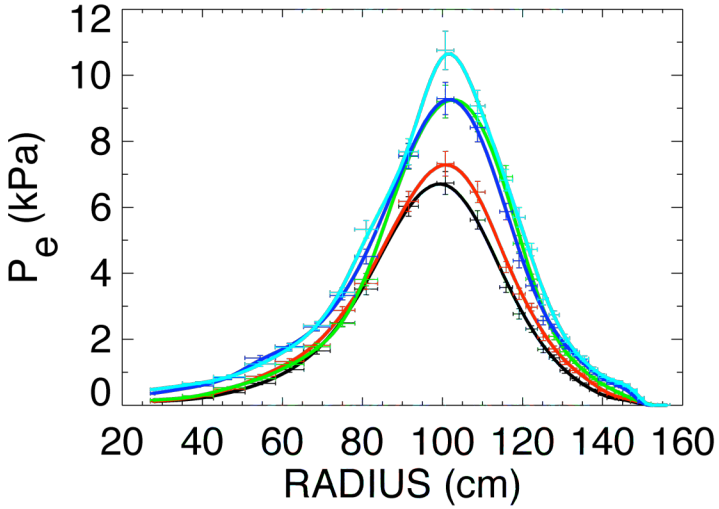
- **February 26 (Full day):**
  - Started in D, 1.1 MW at 180º, -150º, and -90º, 100 ms pulse
  - Switched to He, 1.2 MW at 180º, 1.8 MW at -90º
- **March 5 (Full day):**
  - Started in He, 1.6 MW at 180º, 2.75 MW at -90º, 200 ms pulse
  - A few shots in D, 1.7 MW at 180º
- **April 1 (Half day):**
  - D operation, 300 ms pulses
  - 2.2 MW at -150º, 1.7 MW at -90º, 1.2 MW at +90º
  - Higher than desired edge density (centerstack feed on)
  - MHD instabilities (SPAS helped toward end of afternoon)
  - NBI triggers H-mode for -150º phasing

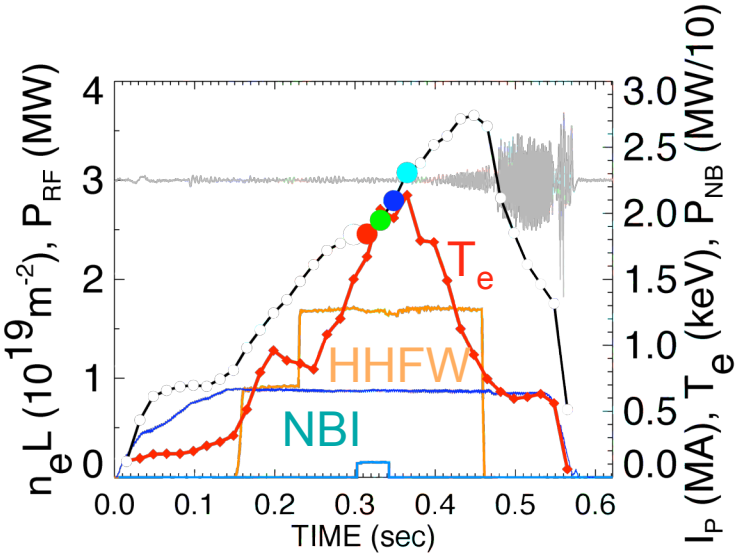
Ryan & Hosea

MP-26: 70 kV NBI in D Plasma Triggers H-mode, HHFW and H-mode Sustained









Ryan & Hosea

XP-821: High k Scattering

- Full day of HHFW (all in He)
- Reached 3.4 MW at -90º (with trips), 1.6 MW at -150º, 1.4 MW at 180º, 300 ms pulses
- Stable operation at 2.9 MW, -90º phasing:
  - $T_e(0)$ reaches 4.3 keV
  - $T_e(0)$, W_{total}, and $W_{electron}$ all drop when MHD activity starts

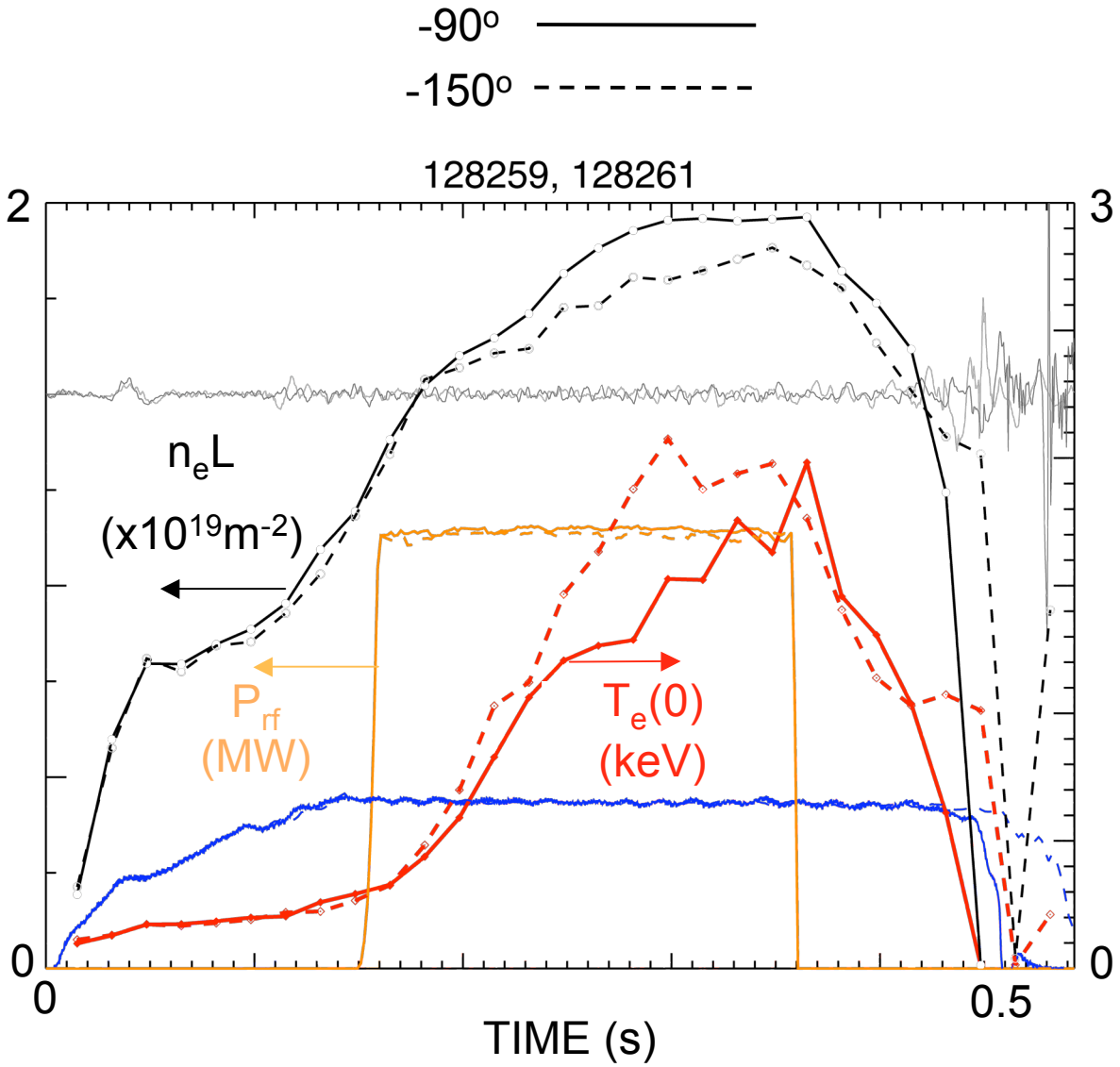
Ryan & Hosea

XP-825: HHFW Heating & CD in D

- No phase scans due to late start & plasma control problems
- 11 RF shots
- No NBI (hence no MSE for current profiles)
- -150º phasing: 7 shots, 1.7 MW, $T_e(0)$ = 3 keV
- -90º phasing: 2 shots,1.2 MW, $T_e(0)$ =1.8 keV
- -30º phasing: 2 shots, 1.2 MW, many breakdowns, little heating
- Generated steep T_e gradients (needed for XP821)
- Turning off centerstack feed and previous day's operation in He helped control edge density rise
- Need better controlled plasmas, higher RF power

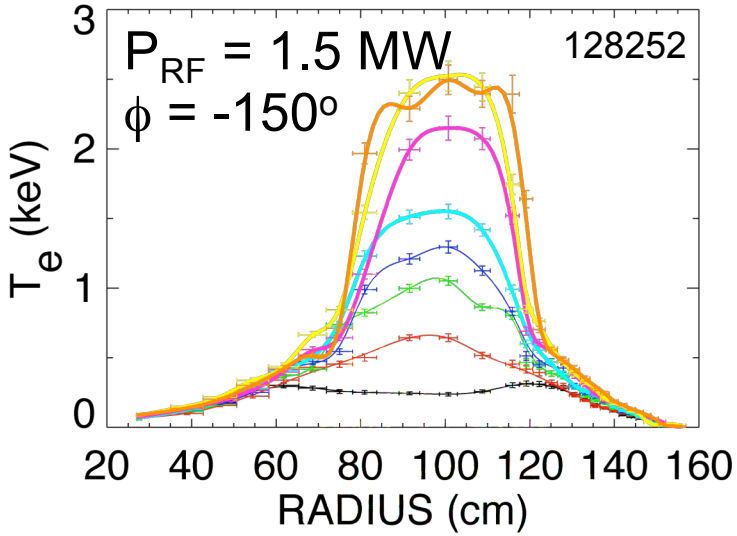
Ryan & Hosea

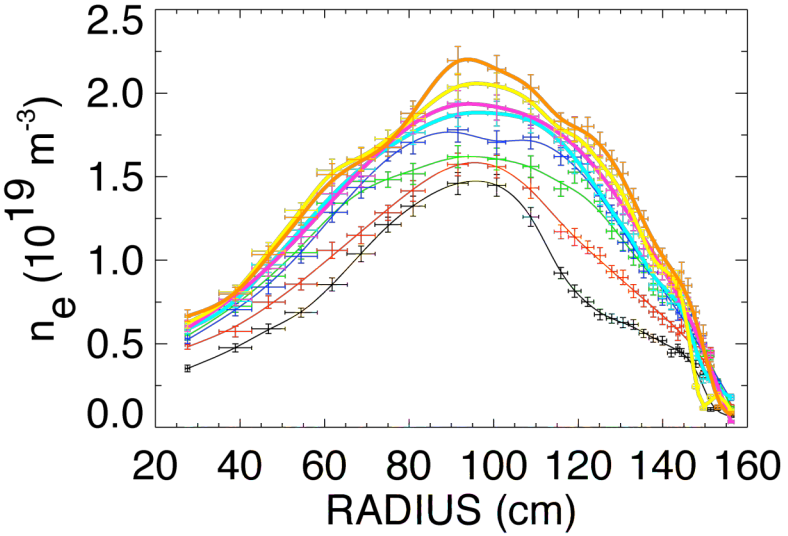
XP-825: Heating at -90° Approaching that at -150°

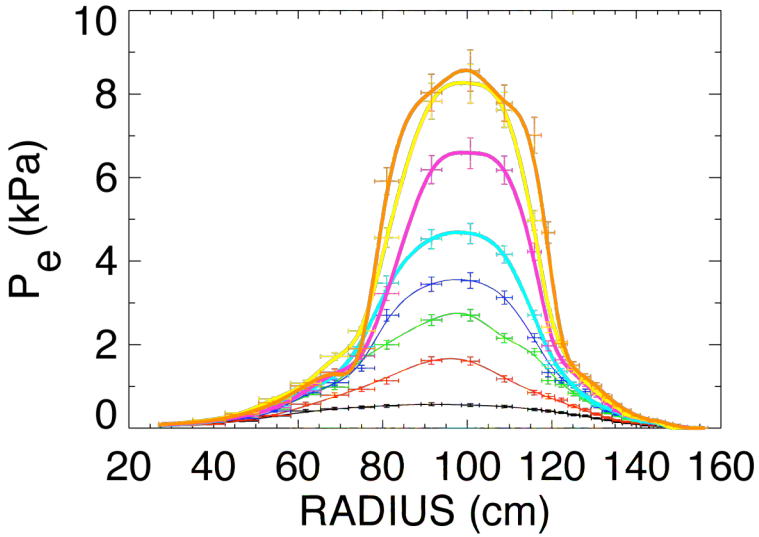


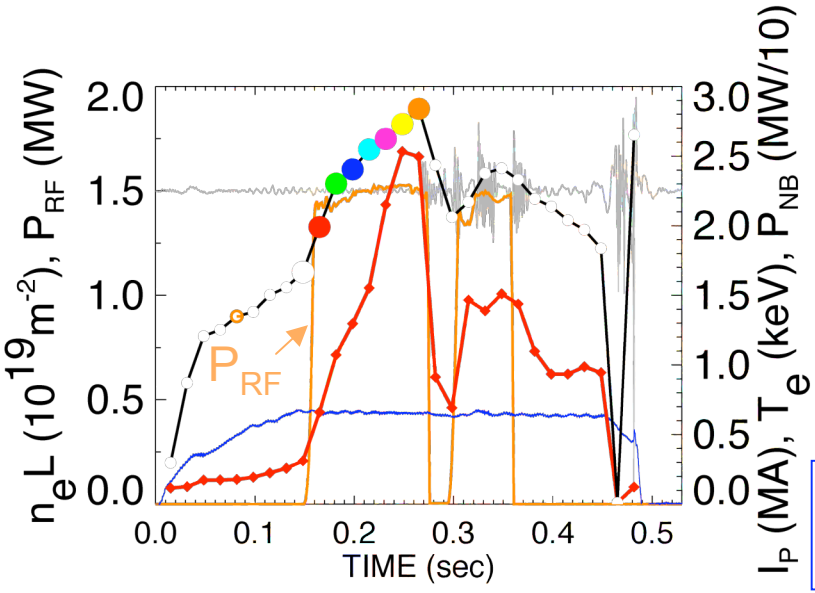
Ryan & Hosea

XP-825: Steep T_e Gradients Produced in Deuterium, but High k Scattering was Misaligned





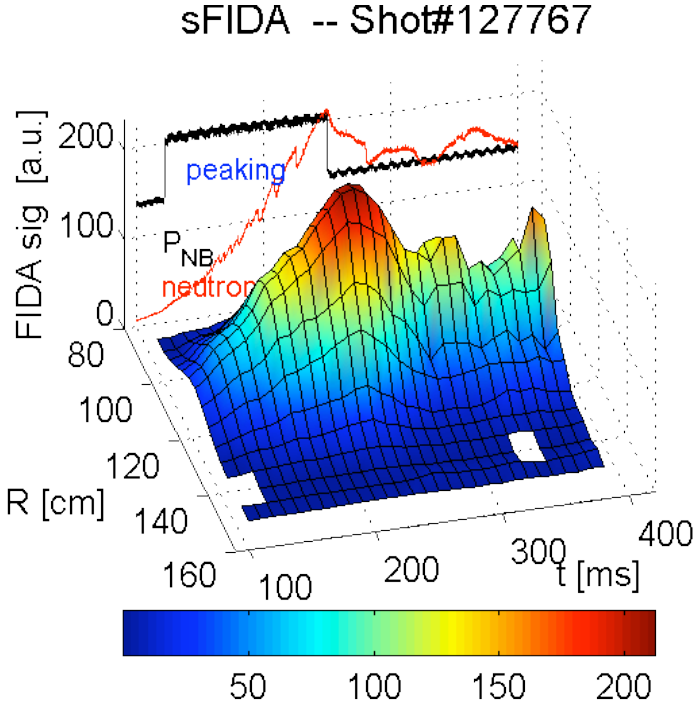


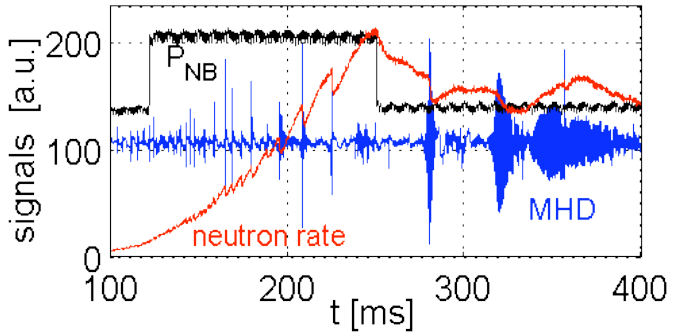


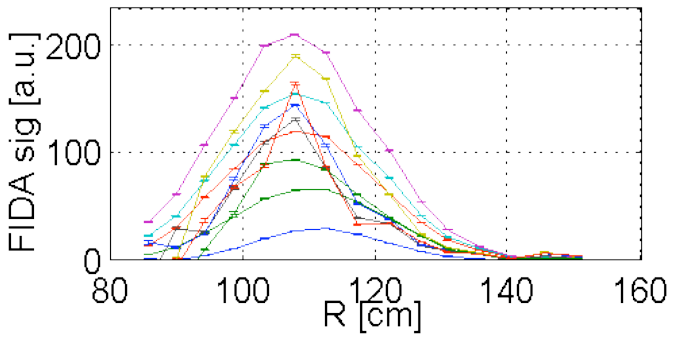
Ryan & Hosea

MP-54: FIDA Commissioning Completed

- Both FIDA systems installed and working:
  - Spectrometer (2x16 radial positions), multi-anode PMT (2x3 radial positions)
  - Fast-ion features observed, got clear response to beam modulation
- FIDA systems routinely operational:
  - Control sofware completed, analysis software underway







Podesta

Status of XP-819: "Fast Ion Transport Induced by Alfvén Avalanches"

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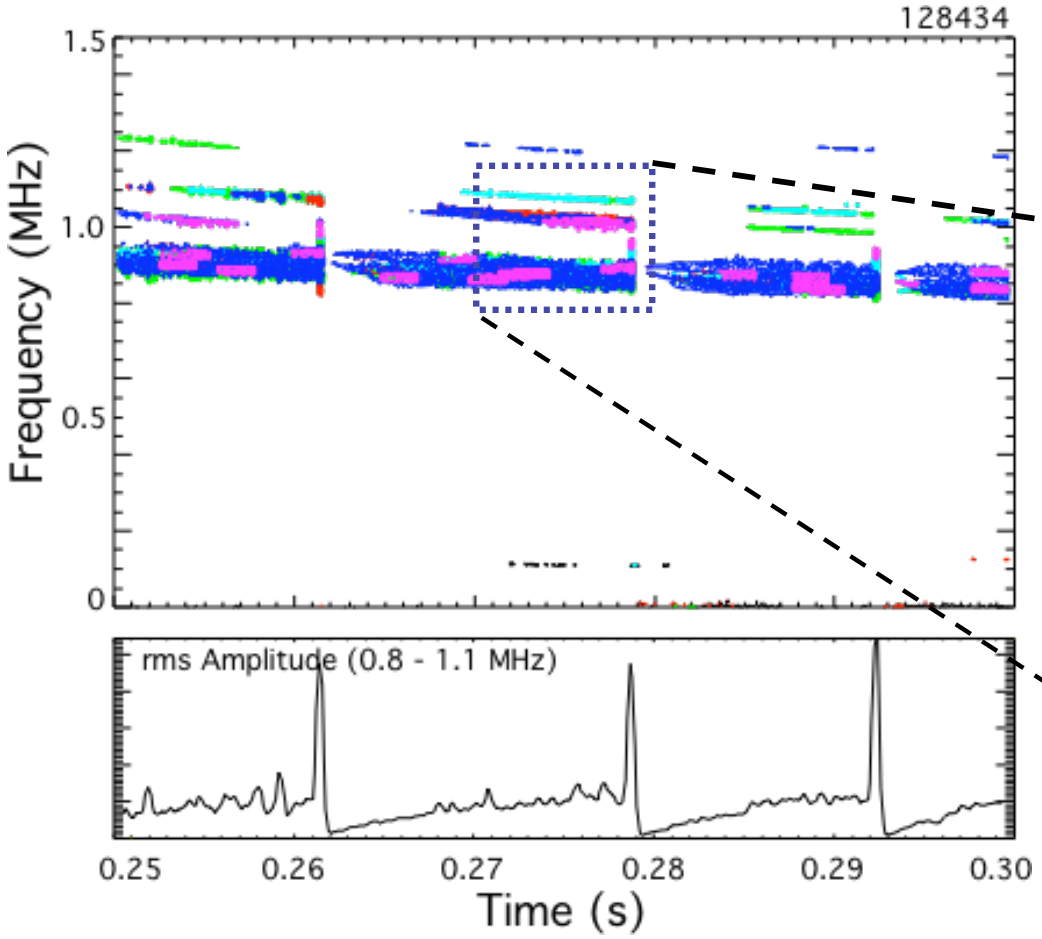
- Beam voltage scan to "avalanche power threshold" found no TAE activity at powers up to 2.3 MW, 95 kV:
  - Power threshold previously identified at 70 kV, 2 sources
  - Neither source A or B produced TAE activity at 95 kV
- TAE avalanches documented under previous conditions; two low voltage sources needed to reach avalanche threshold:
  - Power threshold higher than for 124781; 2.7 MW vs. 2.3 MW
  - Current was higher in these shots 900 kA vs. 800 kA
  - Fast ion transport documented with ssNPA, FIDA
- Threshold for GAE avalanches found; much lower than TAE avalanche threshold:
  - GAE identification suggested by reflectometer data

Fredrickson

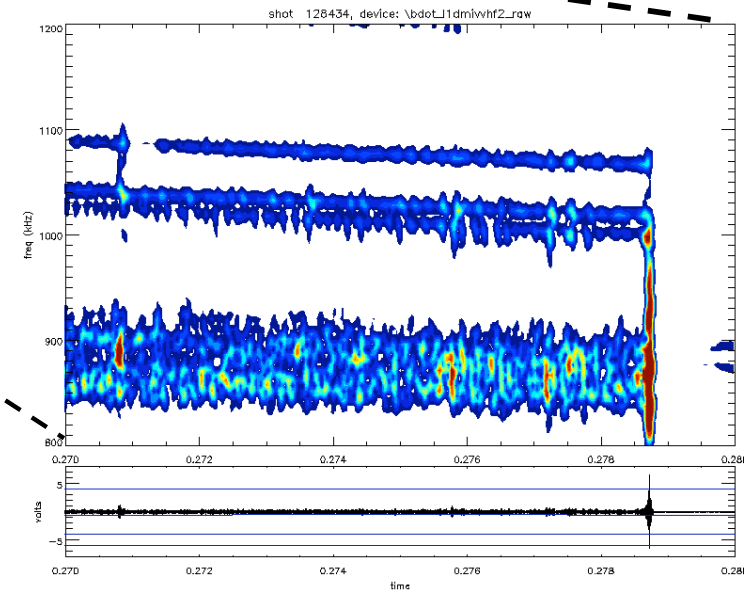
XP-819: GAE Avalanche Threshold Found

- Threshold at 75 kV, 1.5 MW, no low frequency modes
- No correlation with neutron drops, ssNPA so far

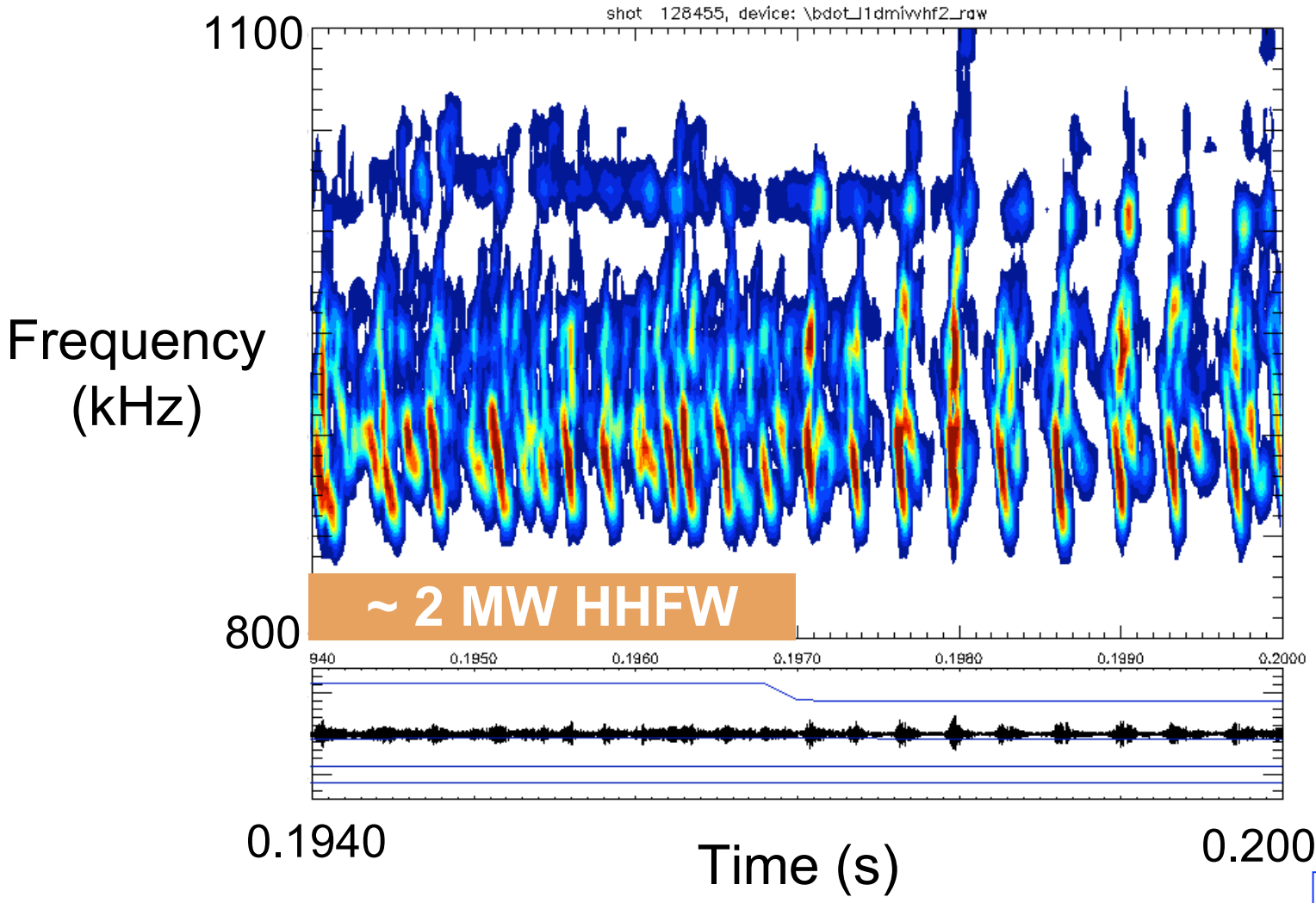


- Multiple modes participate- island overlap

Fredrickson



XP-819: ~2 MW HHFW May Affect Angelfish Burst Period



Fredrickson

- Preliminary result only; effect not present on all shots

XP-819: Remaining Goals

- Need to repeat NPA scan
- Complete q-scan dependence of threshold
  - Move timing of higher power NBI earlier to trigger TAE avalanches at higher q_{min}.
- Toroidal field scan ($V_{Alfvén}$) of threshold
  - Find avalanche threshold at higher (5.5 kG) and lower (3.5 kG) field
- Initial avalanche studies in low density H-modes
  - Find avalanche threshold in low density H-modes; flat density profile changes gap structure
- High-k scattering radial scan
  - Look for coupling to KAW

Fredrickson

Runtime Consumed, Allocated & Needed

NSTX

XP #	Title	Authors	Run Days Assigned	Run Days Initially Allocated	Run Days Consumed	Run Days Needed	Priority
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	Neutral Beam Ion Loss During Energetic Particle Mode Bursts	Darrow	0.5			0	2
	Optimization of EBW Coupling from H-Mode Plasmas	Taylor	0.5			0	2
	Ramp up in D2 from ECH Target	Hosea, Ryan & Taylor	0.5			0	2
		TOTAL RUN DAYS	9	5.5	1.3	7	

Plans for the Rest of the Run

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- No re-prioritization of high priority WPI XPs:
  - D H-mode HHFW expt needs 2 days (originally 1.5 allocated)
  - Still need a day for XP-825 L-mode HHFW expt
  - 1 more day of XP-819, fast ion transport by Alfven avalanches
  - 1 day of XP-808, fast ion transport by Alfven cascades

- Four second priority WPI XPs need 0.5 days each
  (in order of prority):
  - XP-832, HHFW fast ion acceleration (originally combined with XP-825)
  - XP-807, vertical NPA scan
  - BAAE/TAE_RSAE mode structure measurement with high-k (PhD thesis)
  - Angelfish studies