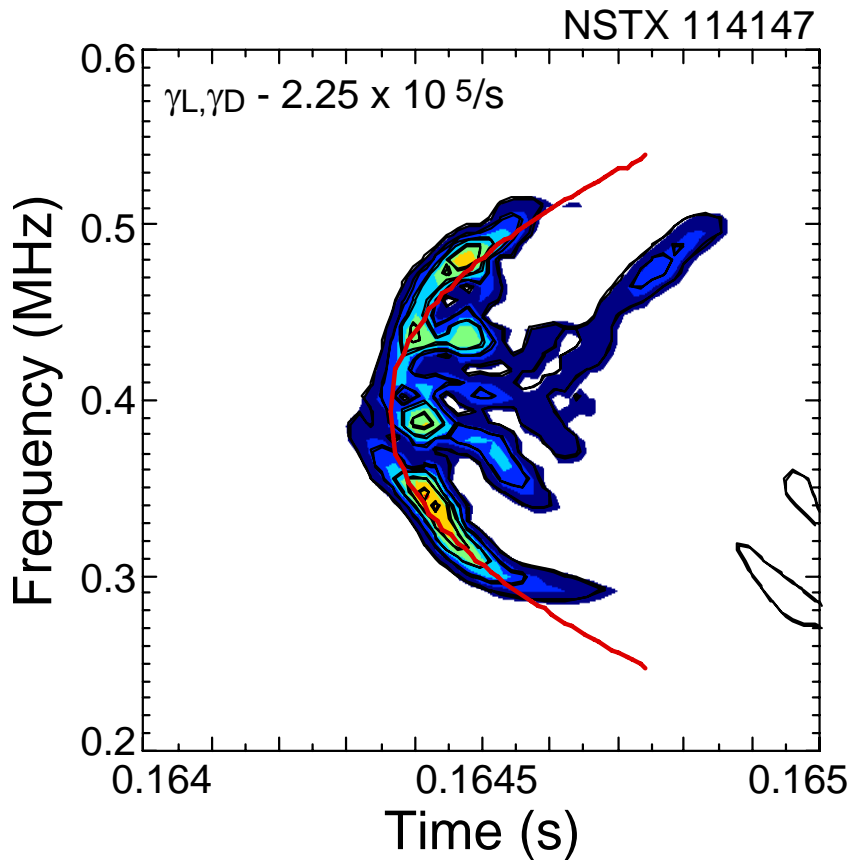# Nonlinear Evolution of Angelfish

XP Goals

- Thoroughly document Angelfish with new diagnostics (especially reflectometers & FIDA)

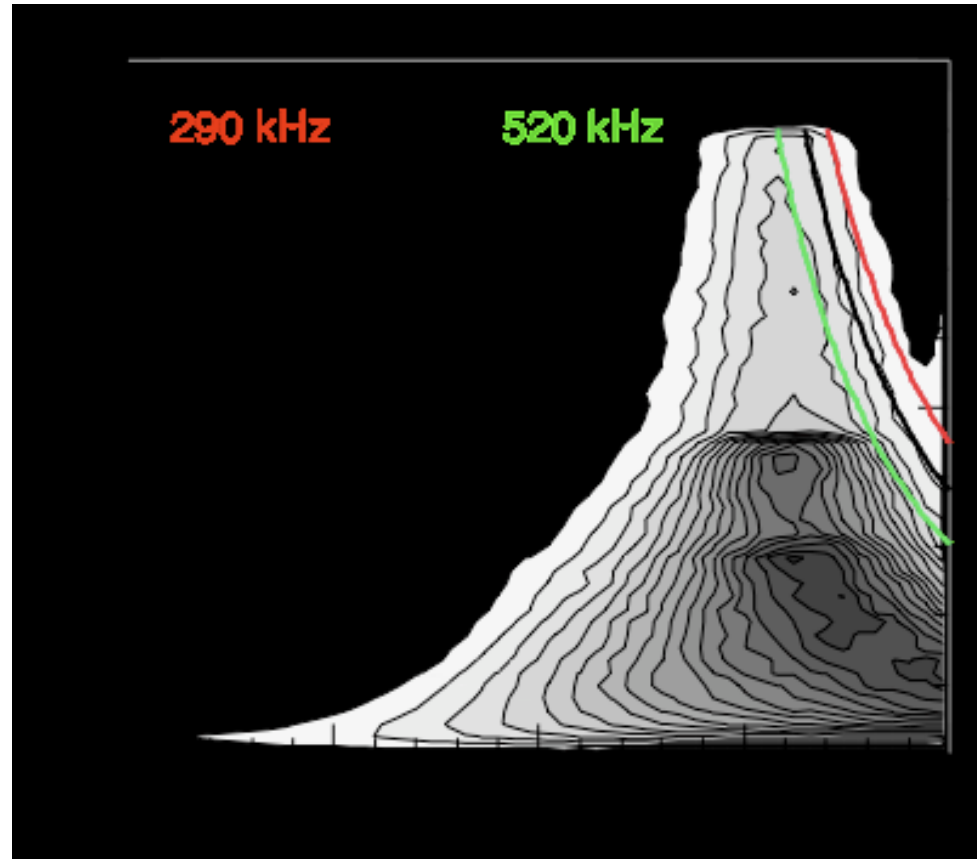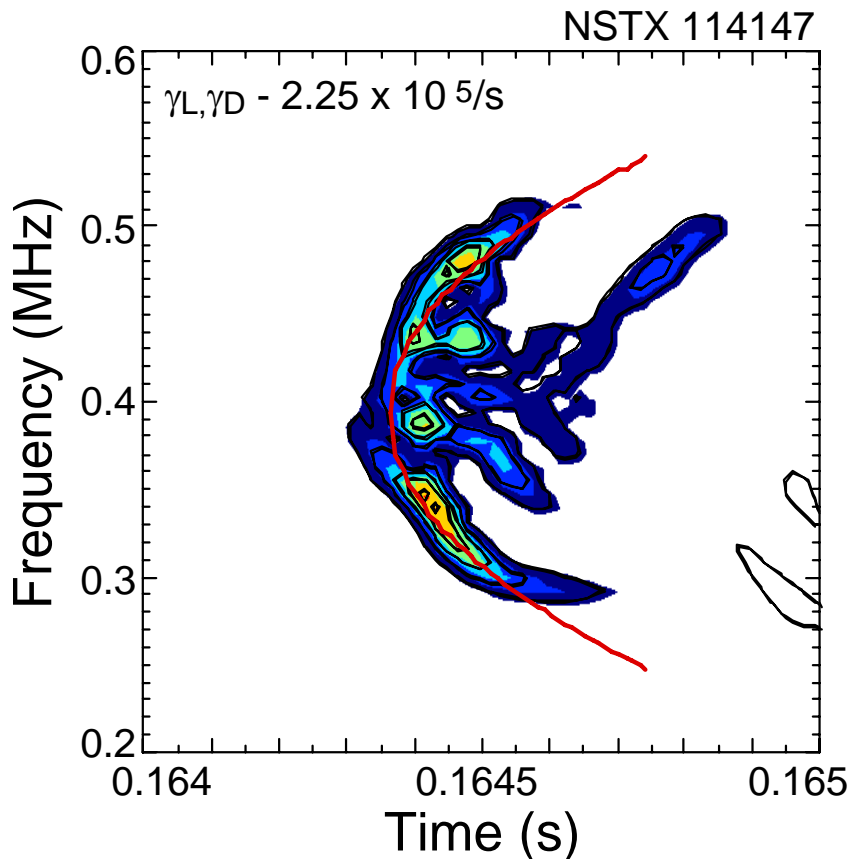- Apply HHFW to alter frequency chirping

Dispersion relation:

$$\omega_{lab} = \omega_{GAE} - k_\parallel V_{tor} = k_\parallel V_{Alfvén} - k_\parallel V_{tor}$$

Resonance condition:

$$\omega_{ci} - k_\parallel V_{b\parallel} + k_\parallel V_{tor} = \omega_{GAE}$$

NSTX 114147

$\gamma_L, \gamma_D - 2.25 \times 10^5 /s$

Frequency (MHz) vs Time (s)

290 kHz   520 kHz

# Frequency Chirping may be explained by the Berk-Breizman model

- Chirping is caused by holes & clumps that propagate in phase space--resonant ions are trapped in the instability wave field
- Increased pitch-angle scattering knocks ions out of resonance, suppressing chirping.
- Berk-Breizman model consistent with several experiments

Plasma Phys. Cont. Fusion 48 (2006) 1347.
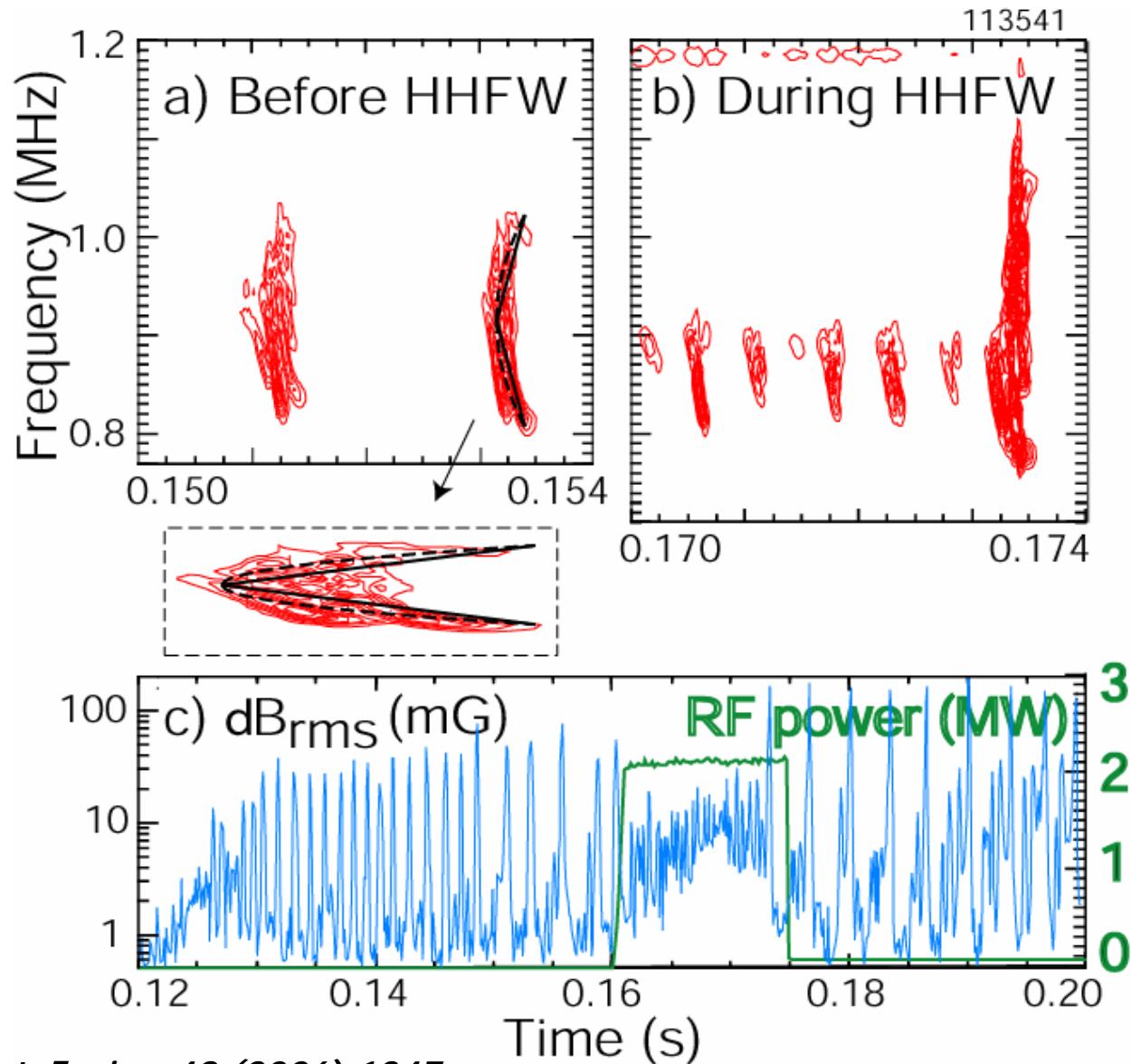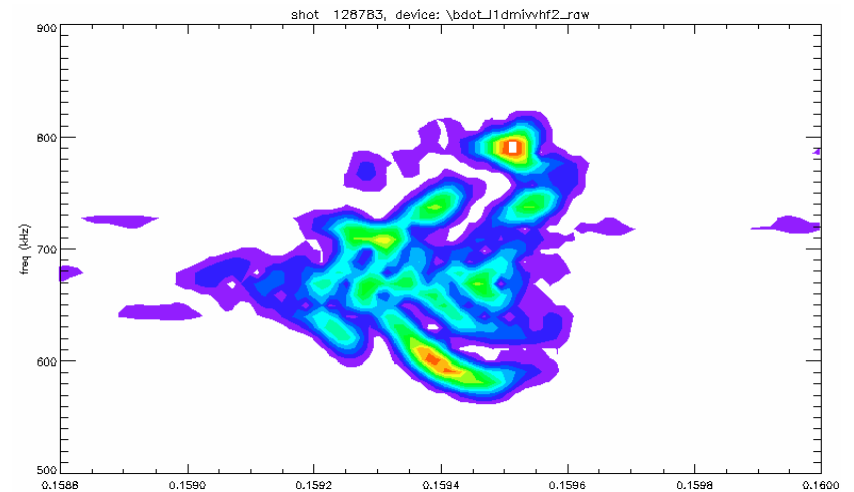
Most Angelfish Observations are at Low Toroidal Field

Old database (Fredrickson)
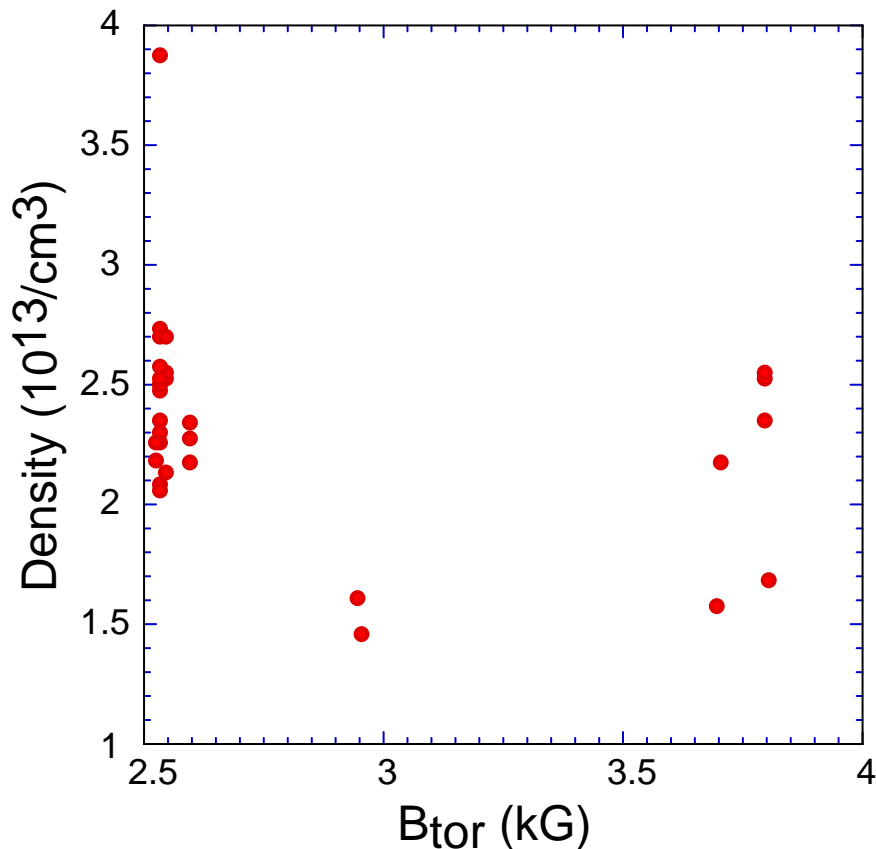
Tentative* Reference Shot: 128783 (700 kA, 3.5 kG)

*Will switch if better case observed in 2010 campaign

Experiment Outline:

1.   Reproduce good Angelfish shot

1a. If no Angelfish, try different beam sources. If still no Angelfish, lower toroidal field.

1b. If Angelfish only occur briefly, flat-top plasma current earlier.

2. Adjust density for optimal reflectometer data (as necessary).

3. Apply 30 ms HHFW pulses during Angelfish.

3a. If effect on neutron rate is small, change HHFW phasing.

4. If HHFW has an effect on the Angelfish, run several repeat shots with and without RF to confirm reproducibility.

5. Beam notches in best cases to check FIDA/NPA data.

6. If HHFW has an effect, lower HHFW power to find the threshold for suppressed frequency chirping.