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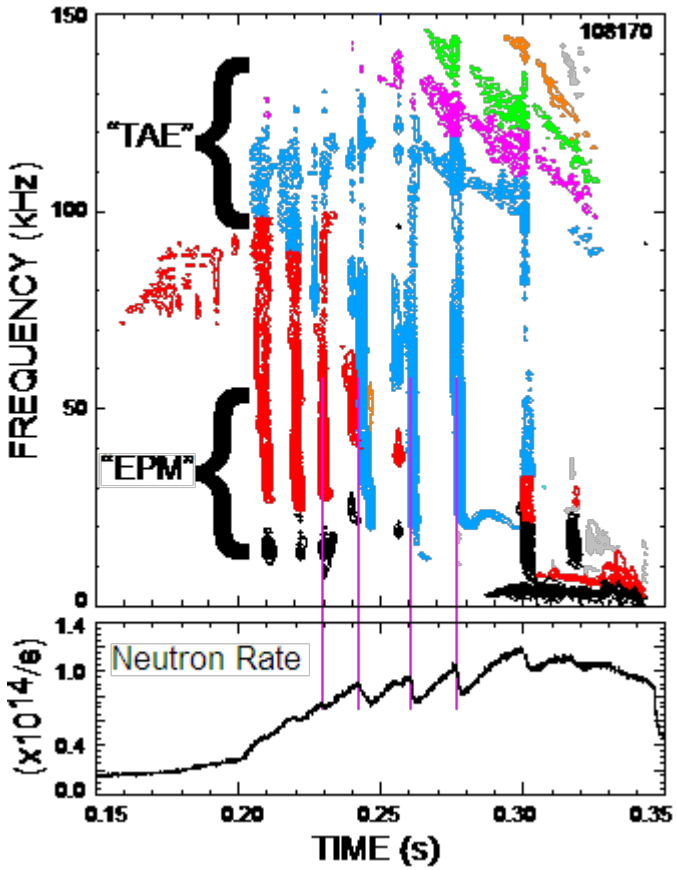
Areas of collaboration on EP-driven mode studies

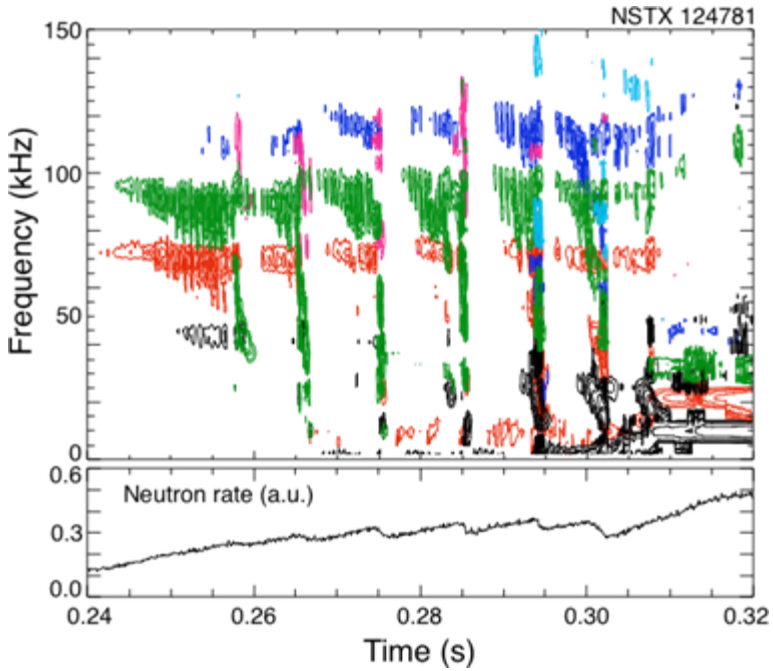
- Non-linear physics of energetic particle driven modes
  - Saturation amplitude and multi-mode interactions of TAE
  - Chirping and transport from TAE and EPMs
- Multi-mode transport in phase space of fast ions
  - Redistribution of fast ions by EPMs and TAE
  - Impact on heating profile, beam driven currents
- "Phase-space engineering" of fast ion distributions
  - Using HHFW/ICRF to change fast-ion phase-space parameters

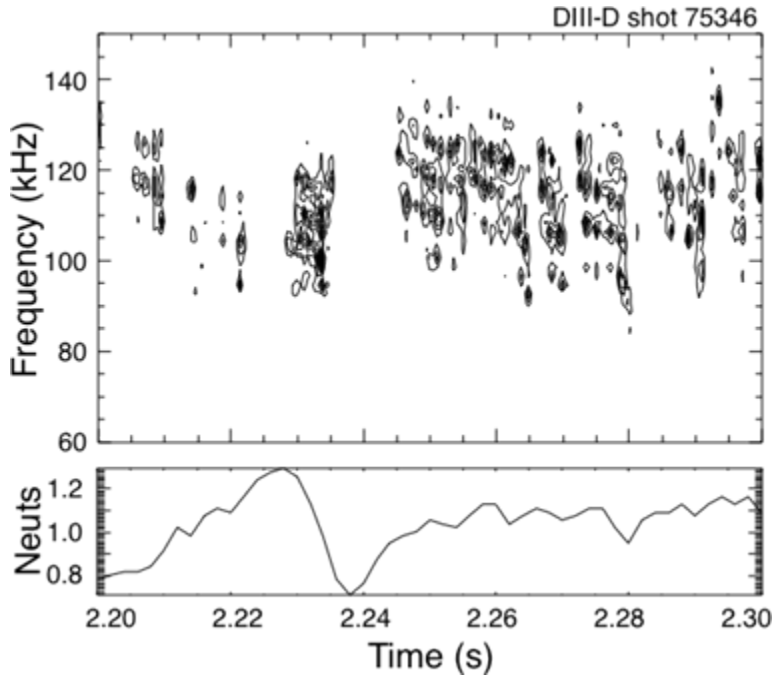
Understanding non-linear dynamics key to fast ion transport modeling

- Why/when do TAE and EPM chirp?
  - More prevalent on NSTX? Low A?
  - How does chirp affect fast ion transport?
- Need measurement of mode amplitude, radial profile
  - DIII-D has ECE/BES/PCI
  - NSTX has reflectometers, interferometers and BES(?)
- Need measurement of fast ion distribution, change
  - DIII-D has FIDA/fast neutrons
  - NSTX has FIDA, NPAs, FLIP and fast neutrons



Significant transport of fast ions in small ρ* machines possible through multi-mode interactions

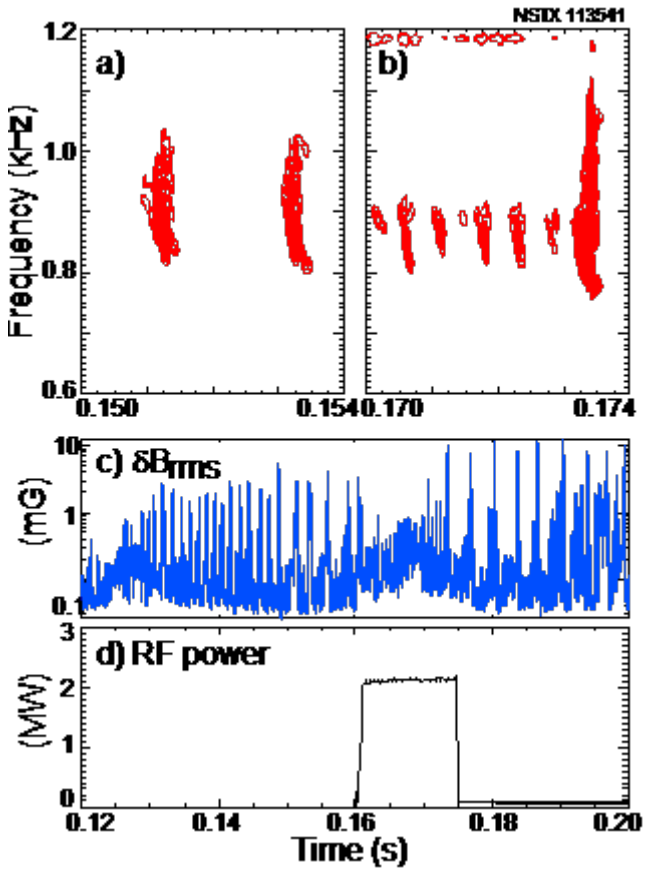




- Secondary modes destabilized through direct non-linear coupling or through fast-ion phase space coupling.
- Coupling can greatly enhance fast ion interaction with modes, transport.
- Detailed measurements of each mode, coupled with measurements of fast ion distribution changes needed to model coupling.
- Benchmark M3D-k, Nova/Orbit

"Phase-space engineering" of fast ion distributions

- HHFW or other RF heating of fast ions is a tool for "phase-space" engineering.
- NSTX can use HHFW (see figure at right) and DIII-D can use ICRH to control EP-driven modes.
- The affect has only been seen on CAE/GAE range of frequency chirping modes, future experiments might extend this to TAE or fishbone frequency modes.
- NSTX can use NPA to measure the affect on fast ion population, FIDA might also be used on NSTX/DIII-D



Summary

- DIII-D and NSTX provide aspect ratio scaling at otherwise similar parameters ($V_{fastion}/V_{Alfvén}$, $\beta_{fast}/\beta_{thermal}$, ρ^*).
- DIII-D and NSTX have complementary fast ion diagnostics:
  - NSTX: NPA, FLIP, FIDA, and fast neutrons.
  - DIII-D: FIDA and fast neutrons.
- Goals for future experiments are to understand:
  - Non-linear saturations of EP driven modes
  - Chirping of EP driven modes
  - Non-linear coupling of EP driven modes
  - Transport of fast ions by EP driven modes
- "Phase-space engineering" provides a potential path for control of EP driven modes.