Effects of toroidal rotation on TAE dynamics and TAE radial phase variation

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½ Run Day allocated in FY12, priority 1

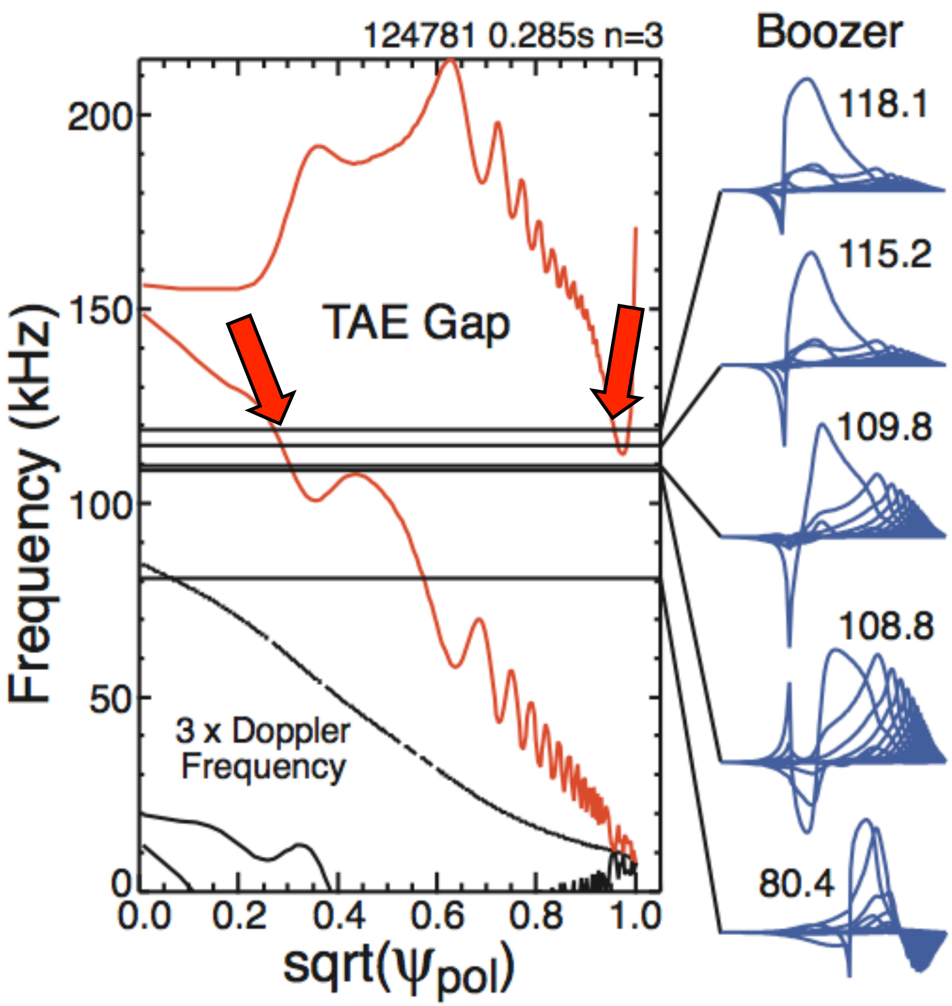
Motivation and goals

- Study of TAEs in L-mode made good progress in FY10
  - Collected data for detailed comparison theory/experiments
  - “Rotation” is an important element
- NSTX (low aspect ratio) has large rotation frequency
  - Rotation comparable with TAE frequency (plasma frame)
  - Stability and structure of TAE modes may change as TAE gap varies for different rotation profiles
- Reflectometers measured large ($\sim\pi/2$) radial phase variation for TAEs in FY10 – ideal MHD predicts constant phase
  - Instrumental effect?
  - Coupling to fast ions, and other non-ideal effects?
- Goal: explore dependence of TAE dynamics on rotation profile; compare results with predictions from codes such as NOVA-K, M3D-K
  - Include detailed study of radial variations of TAE phase

Example#1: *continuum damping* is sensitive to gap structure; large contribution to total damping on NSTX

NOVA calculations, Lab frame

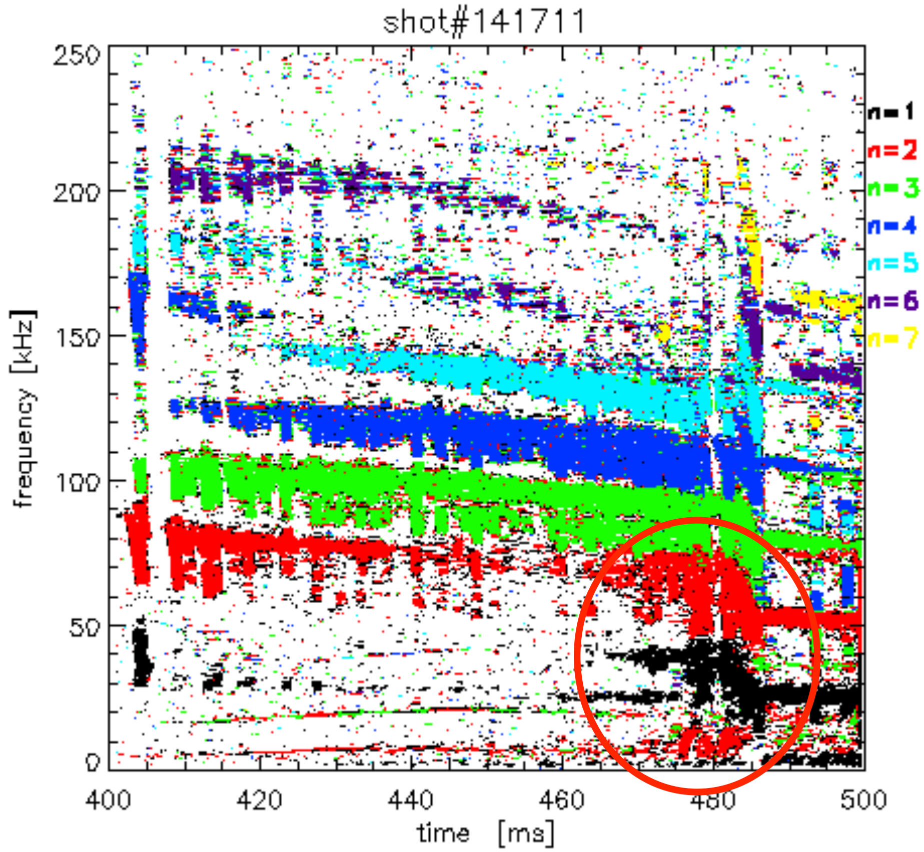
[E. Fredrickson et al., PoP 16 (2009)]



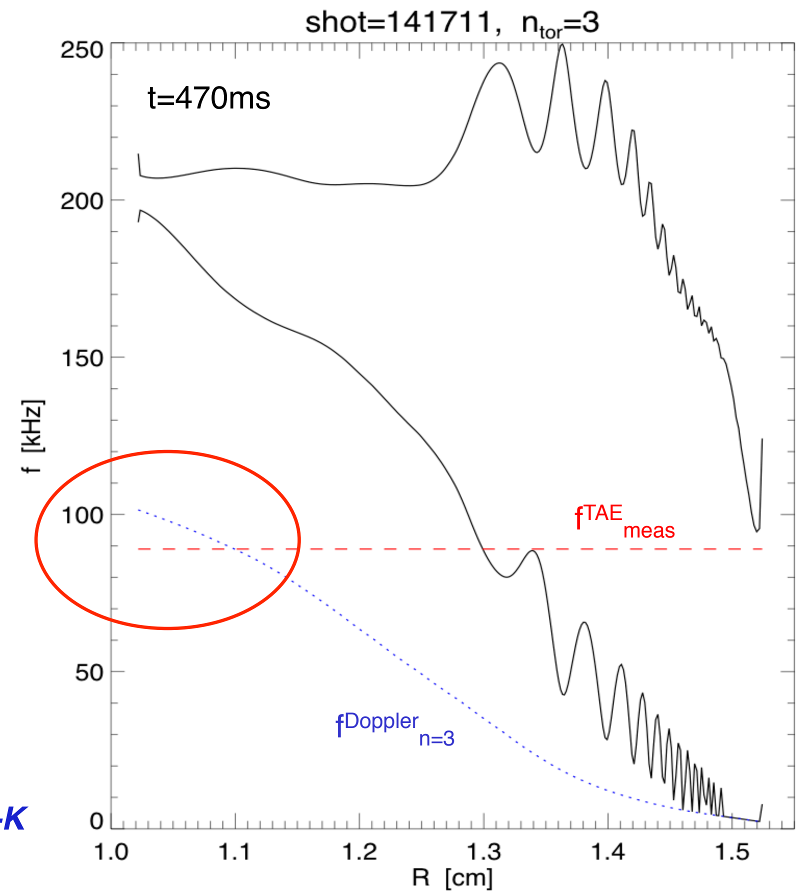
- As *rotation* and *q-profile* evolve, modes can experience strong interaction with continuum

- Can we separate the different effects experimentally?

Example#2: coupling of TAEs with kinks/ fishbones favored when $n_{tor} \times f_{rot}$ on axis ~ f^{TAE} ?



- Strong burst of TAEs at t~485ms
- Kink-like modes destabilized afterward
- Reconstructed $f_0^{TAE} \longrightarrow 0$
- TAE mode structure ~maintained



TAE continuum from NOVA-K

Run plan – ½ day experiment

- Target: "best shot" from 2010: shot no 141711 2 shots
  - Target B_{tor}=5.5kG, I_p=900kA, center-stack limited plasma
  - Backup: similar shots from XP-1015 (2010)
  - Position edge (Q-band) reflectometers at midplane
- Optimize scenario for reduced TAE bursts/chirps 6 shots
  - Modifying NB power and timing as needed (e.g. to avoid early kinks, etc.)
- Introduce n=3 braking as early as possible
  - Start ramp as early as ~200 ms, flat-top at 250-280 ms
  - Consider using n=2 instead, based on new results from FY11
- Scan of n=3 braking 6+ shots
  - Start with 1 kA; increase/decrease shot-by-shot between ~200A and ~1.5kA (or whenever bad things happen: plasma locks, ...)
  - Introduce small vertical jogs (~2cm) later in discharge – timing t.b.d. –, measure local k_{pol} with reflectometers & local k_{vert} with BES
- If time permits: revisit scenario with frequent bursts 6 shots
  - Second NB phase starts earlier, increase P_{NB} if needed
  - Repeat n=3 braking scan
- If time permits – even more: *H-mode* scenario >4 shots
  - Chose best case from XP-1011, perform n=3 braking scan

Required machine and diagnostic capabilities

- Run after XP-1011, test of new SPAs, etc.
- Usual profile diagnostics
  - MPTS, CHERS, RTV, (pCHERS)
- Need MSE (NB source A) for q-profile data
- Need all fast ion diagnostics
  - FIDA's, NPA, ssNPA, sFLIP, neutrons
- Mode structure measurements are crucial:
  - Reflectometers
  - BES w/ good radial coverage plus vertical array
  - Soft-X rays (but SNR might be too low)
- Plan to use one/two NB sources at de-rated voltage
- Moderate/low lithium evaporation rate (~5mg/min)