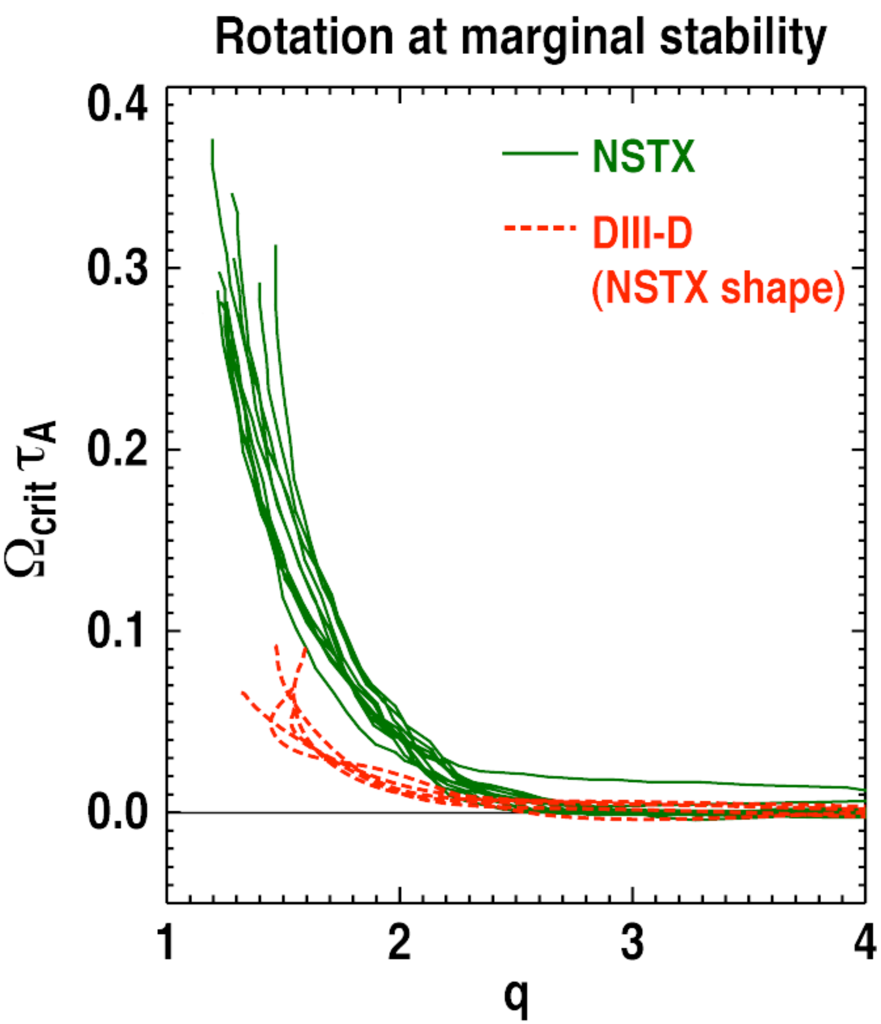
XP 619 Physics of Passive RWM Stabilization

- XP to explore the passive stability physics of the RWM
  - rotation control allows RWM destabilization ‘on-demand’
    - past attempts hindered by high rotation
    - n = 3 rotation control demonstrated on several occasions
- examine parametric dependencies predicted by dissipation models
  - v_A: important parameter in several theories
    - $\omega_\phi \tau_A$ @ q = 2 was previous factor cited for stability determination
    - NSTX data shows increased rotation across entire profile required as compared to DIII-D
      - data at near constant v_A
      - scan v_A independent of v_{ti} when q is fixed
  - ν_{ii}: NTV, neoclassical damping
    - dissipation included in MHD model as modification to parallel viscosity
      - NTV has inverse dependence on ν_{ii}
      - neoclassical parallel viscosity proportional to ν_{ii}

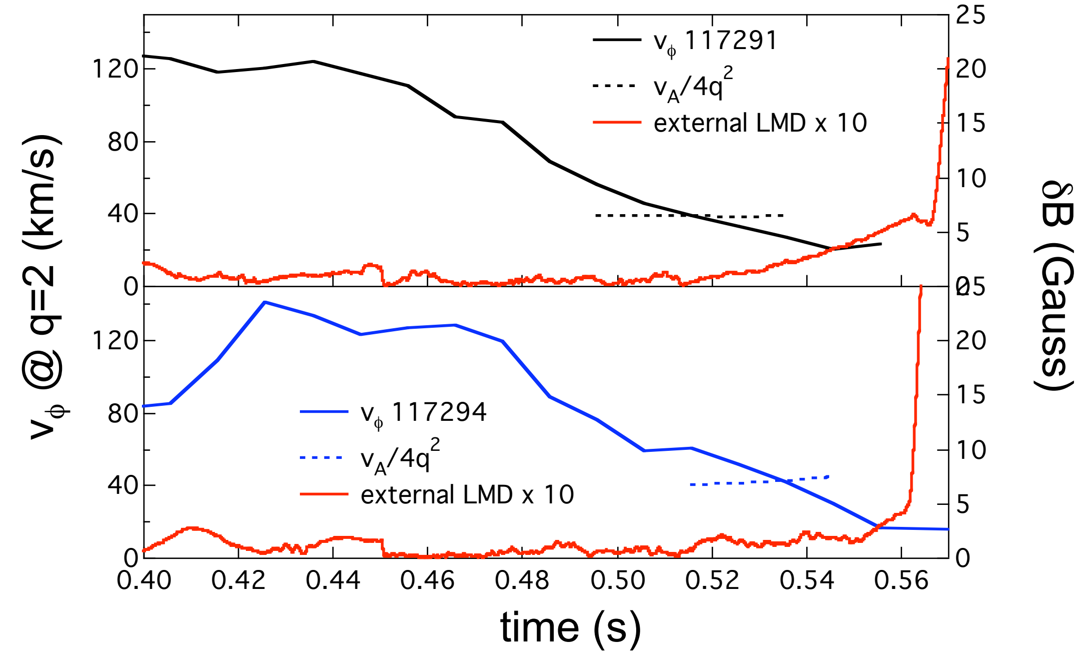
Determining v_A Scaling of RWM Stability Leads to Understanding of Physical Model

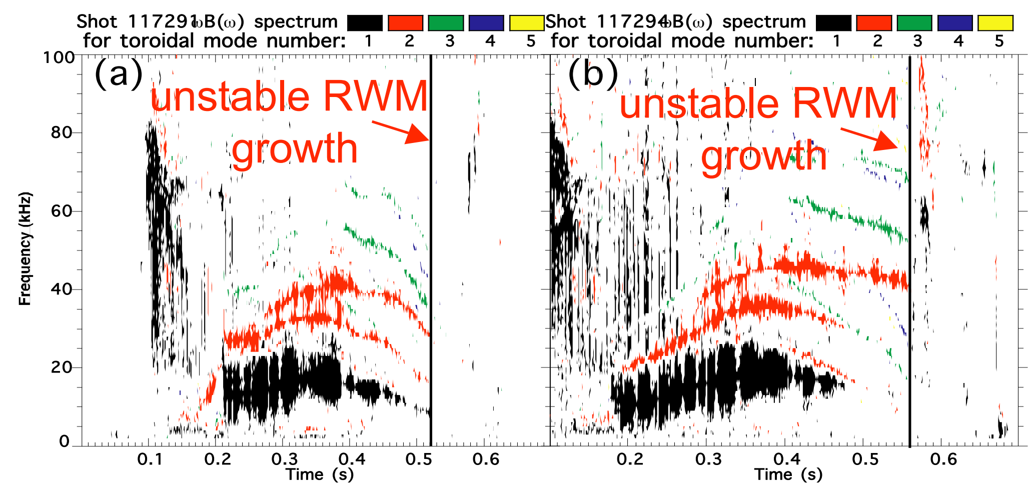
- Alfven speed important in stabilization models
  - coupling to Alfven continuum
  - degree of inertial enhancement
  - has become standard normalization for inter-machine comparison
- NSTX requires higher rotation than DIII-D using v_A normalization
  - aspect ratio dependence or other physics?
  - rotation similar using v_s normalization
- All NSTX Ω_{crit} data obtained at single B_t
  - no large variation in v_A



Rotating MHD Appears to Affect RWM Stability

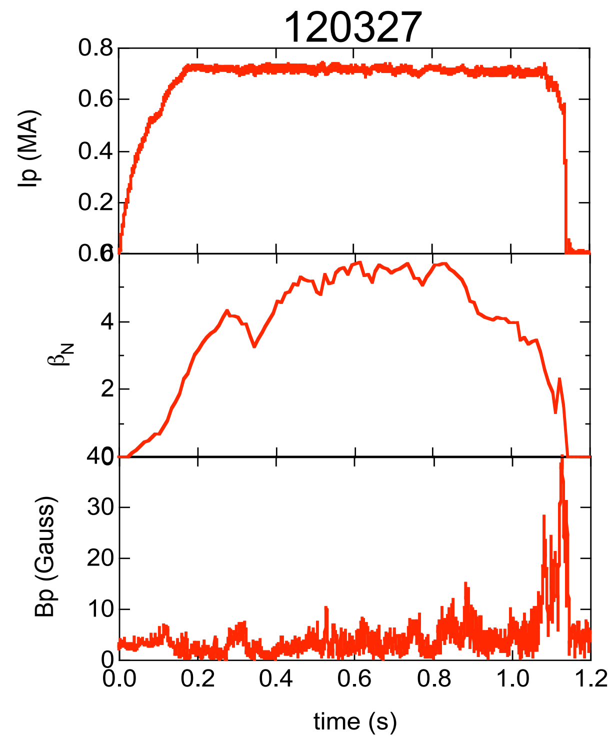
- RWM growth coincides with end of rotating MHD in both cases
- discharge with longer period of n=2 survives with lower rotation at q=2
- faster mode growth with delayed onset
  - DCON δW decreasing with time (becoming more unstable)

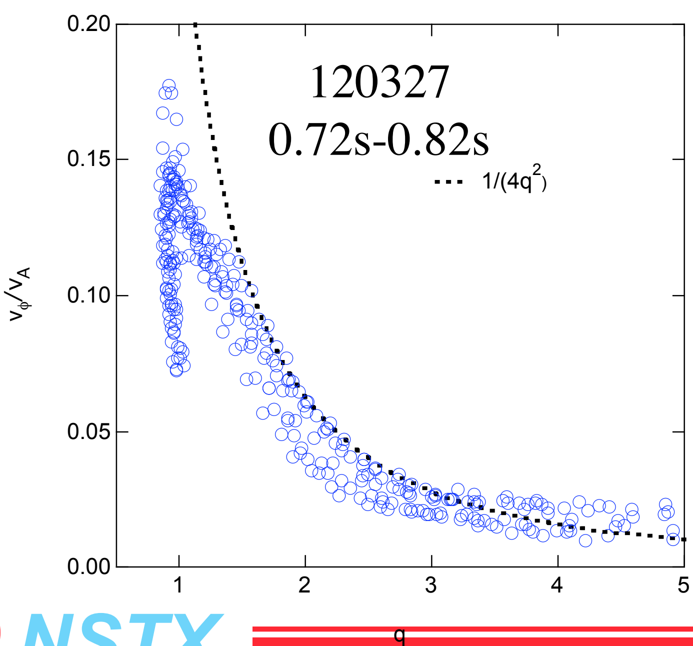


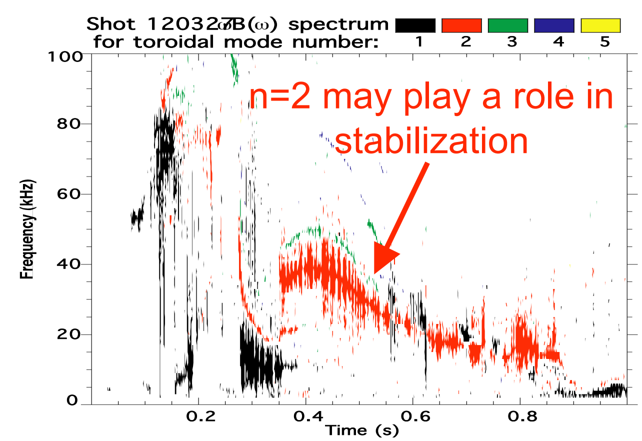


Higher-q Shot Passively Stable at Lower Rotation

- $\beta_N > \beta_N^{\text{no-wall}}$ for several hundred milliseconds with marginal rotation
  - this shot: q_{95} ~ 9
  - 119250 (lower-q target): q_{95} ~ 7
- EFC on throughout shot - no feedback
  - will turn off after 0.5 s in XP
    - avoids RFA
  - use n=3 braking to induce RWM







Parameter Scans

- At fixed q_a scan $B_t \rightarrow$ vary Alfven speed
  - $v_A \sim B/n^{1/2}$ $v_{ti} \sim T_i^{1/2} = n^{-1/2}$
    - ion Landau damping dependent upon v_{ti}
  - vary I_p and B_t simultaneously
    - ~ 25% variation in B_t should be possible
  - lower density at highest I_p
    - avoid Greenwald limit at lower I_p
- Vary collisionality with density scan
  - use SGI and He conditioning to vary density
    - able to vary ion collisionality by a factor of 2 this year
  - natural density rise of ~ 20% during MHD free window
    - vary time of mode onset

Shot List

- Control shot
  - reproduce 119250 — 2
- v_A scan
  - scan at constant q
    - I_p = 1.0 MA B_t = 0.45 T — 2
    - I_p = 0.89 MA B_t = 0.4 T — 8
    - I_p = 1.1 MA B_t = 0.5 T — 8
    - I_p = 0.78 MA B_t = 0.35 T — only if developed in another XP
  - higher q
    - I_p = 0.89 MA B_t = 0.5 T — 3
      - increase TF from 120705 – may need higher density to get rid of n=1
    - I_p = 0.71 MA B_t = 0.4 T — 3
      - 120327 with EFC off @ 0.5s & n=3 braking applied
- Density scan
  - beginning of n=1 free window in low-density discharge — 2
  - end of n=1 free window in high-density discharge — 2

Total: 30

Duration and Required / Desired Diagnostics

- XP could be completed in 1 run day
  - 0.5 T desired for wide range of q at high performance

- Required
  - Magnetics for equilibrium reconstruction
  - Internal RWM sensors
  - CHERS toroidal rotation measurement
  - Thomson scattering
  - Diamagnetic loop

- Desired
  - USXR diagnostic
  - MSE
  - Toroidal Mirnov array