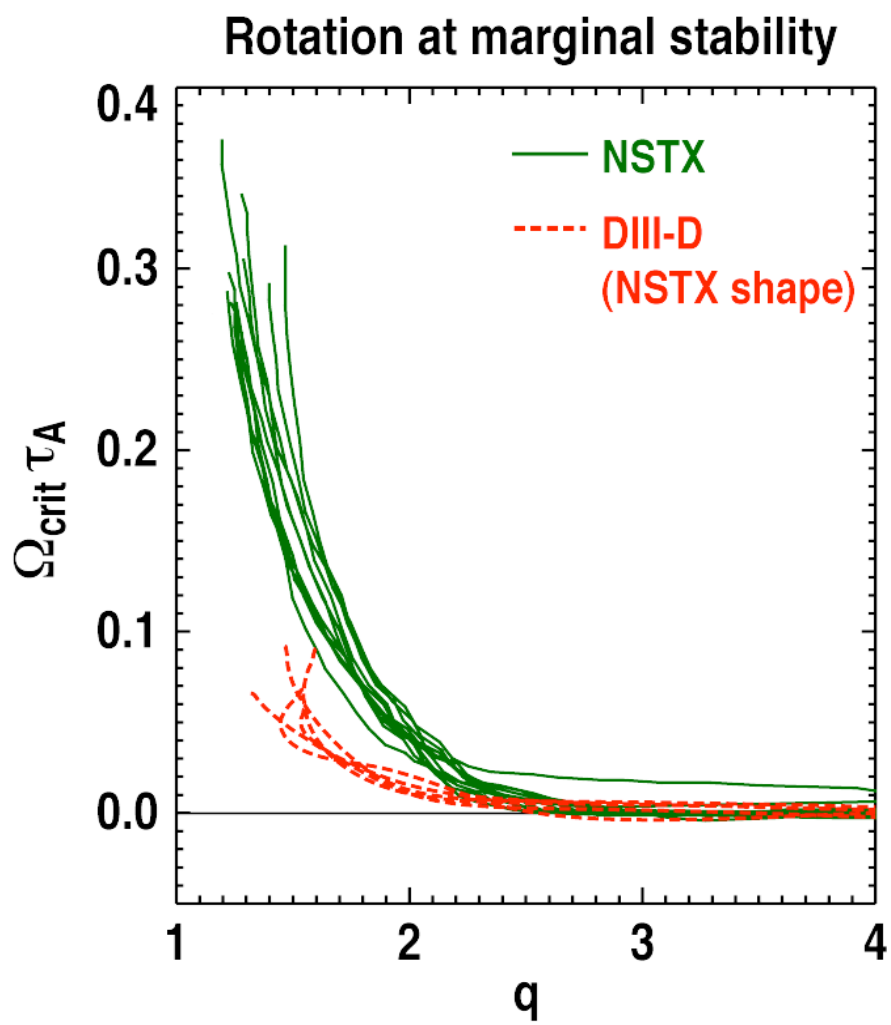
# XP 619 Physics of Passive RWM Stabilization

- 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
  - $\nu_{ii}$: NTV, neoclassical damping
    - dissipation included in MHD model as modification to parallel viscosity
      - NTV has inverse dependence on $\nu_{ii}$
      - neoclassical parallel viscosity proportional to $\nu_{ii}$
  - MHD amplitude: alteration of RWM stability
    - alteration of drive or dissipation?

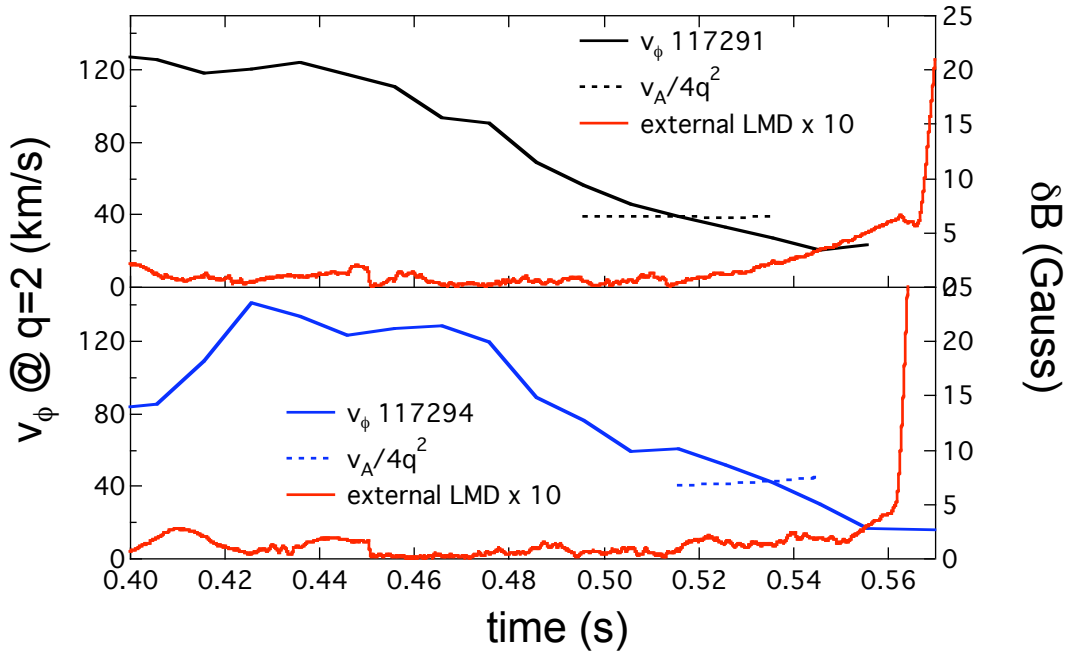
# Determining $v_A$ Scaling of RWM Stability Leads to Understanding of Physical Model

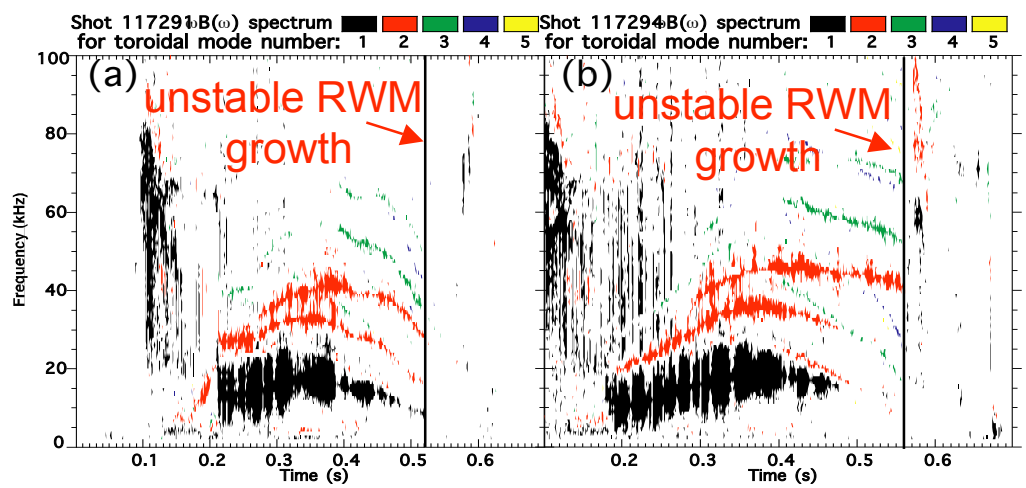
- Alfven speed important in stabilization models
  - coupling to Alfven continuum
  - degree of inertial enhancement
  - has become standard normalization for inter-machine comparison
- NSTX requires higher rotation than DIII-D using $v_A$ normalization
  - aspect ratio dependence or other physics?
  - rotation similar using $v_s$ normalization
- All NSTX $\Omega_{crit}$ 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)



# Parameter Scans

- At fixed $q_a$ scan $B_t$ → vary Alfven speed
  - $v_A \sim B/n^{1/2}$ $\quad v_{ti} \sim T_i^{1/2} = n^{-1/2}$
    - ion Landau damping dependent upon $v_{ti}$
  - vary $I_p$ and $B_t$ simultaneously
- Vary collisionality with density scan
  - vary time of mode onset
  - natural density rise of ~ 20% during MHD free window
- Vary MHD at time of mode onset
  - brake rotation earlier or later to move before/after n=1 free window

# Shot List

- Control shot
  - reproduce 119250 — 2
- $v_A$ scan
  - baseline scan at first q value
    - $I_p$ = 1.0 MA $B_t$ = 0.45 T — 2
    - $I_p$ = 0.89 MA $B_t$ = 0.4 T — 3
    - $I_p$ = 1.1 MA $B_t$ = 0.5 T — 3
    - $I_p$ = 0.78 MA $B_t$ = 0.35 T — 3
  - higher q
    - $I_p$ = 0.89 MA $B_t$ = 0.5 T — 3
    - $I_p$ = 0.71 MA $B_t$ = 0.4 T — 3
  - lower q
    - $I_p$ = 1.1 MA $B_t$ = 0.35 T — 3

# Shot List

- Density scan
  - beginning of n=1 free window – 0.5 s ($n_e\ell$ ~ $8.7e^{15}$) 2
  - middle of n=1 free window – 0.6 s ($n_e\ell$ ~ $9.5e^{15}$) 2
  - end of n=1 free window – 0.7 s ($n_e\ell$ ~ $10.5e^{15}$) 2
- MHD scan
  - just before n = 1 free window 2
  - just after n = 1 free window 2

Total: 32

# 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