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NSTX 2005 Experimental Proposals: RWM Dissipation & DIII-D Similarity

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for the

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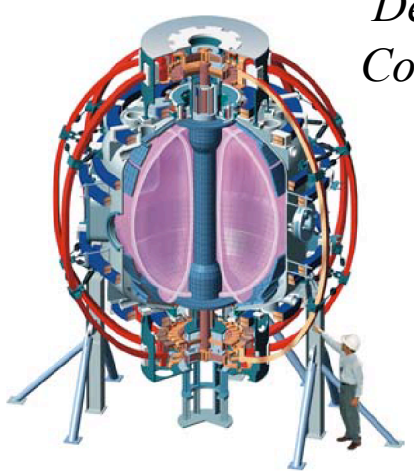

NSTX Research Forum
September 22 - 24, 2004
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XP Proposals: Completion of 2004 RWM XPs

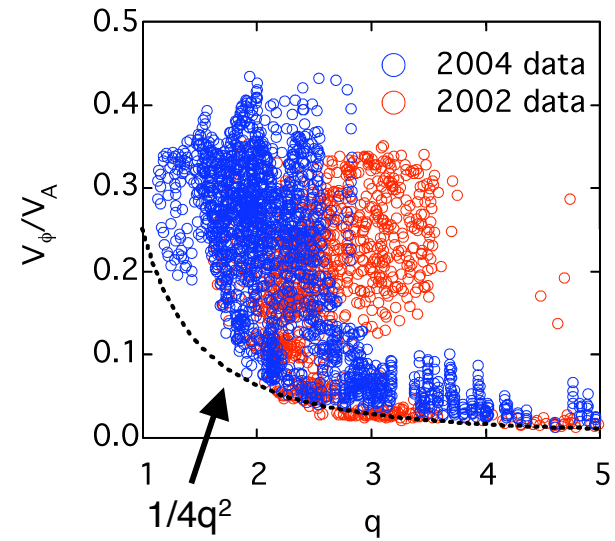
- XP 428: Dissipation and Stability Physics of the RWM
  - Examine the strength and relative importance of various RWM energy dissipation mechanisms
  - Determine q dependence of RWM stability
  - Completion of XP 428 from CY2004 run
  - New machine/diagnostic capabilities will increase run efficiency
    - internal sensors for RWM identification
    - active coil to control rotation & induce mode onset
- XP 453: DIII-D/NSTX RWM Similarity
  - Compare RWM stability parameters in similar discharges at different aspect ratios
  - Resolve differences in Ω_{crit} scaling
  - Completion of XP 453 from CY2004 run
  - DIII-D run time will follow successful NSTX run $\Rightarrow$ suggest early run slot

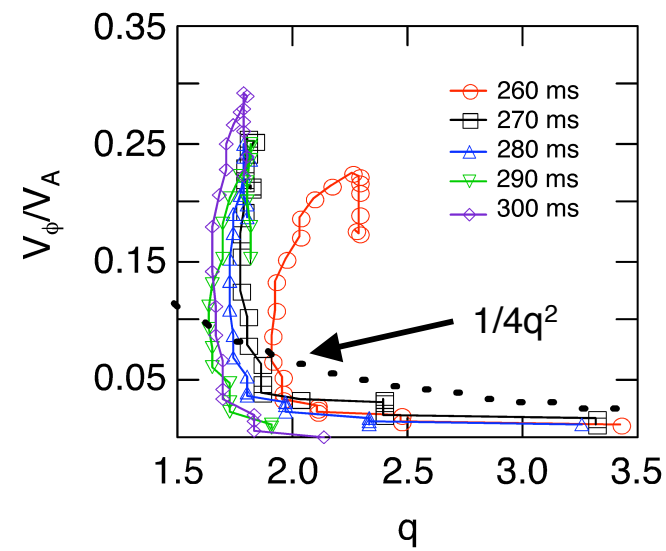
XP 428: RWM Dissipation and Stability Physics

- Motivation
  - RWM stability when $\beta_N > \beta_{N\ no\text{-}wall}$ is allowed through a combination of toroidal rotation and energy dissipation
  - RWM energy dissipation mechanism(s) which allow stability above no-wall beta limit is (are) presently uncertain
- Goals
  - Examine q dependence of RWM stability boundary
    - $\omega_\phi/\omega_A > 1/4q^2$ observed as necessary condition in 2002 NSTX data
    - toroidal inertial enhancement limit from drift-kinetic energy principle
    - DIII-D observes $\Omega_{crit} \propto q^\alpha$ ($\alpha > 0$) dependence
  - Evaluate strength of dissipation mechanisms
    - sound wave dissipation $\propto k_{||} v_{ti} \rho$
    - ion Landau damping significant if $\omega_\phi > \varepsilon^{1/2} v_{ti}/qR$
    - numerical calculations → MARS-F
    - analytic theory → Fitzpatrick-Aydemir model
  - Determine relative importance of dissipation and inertia

Inertial Enhancement Model Describes Observed Ω_{crit} Boundary in NSTX

- Shots with sufficient rotation survive for several τ_{wall}
  - several thousand shot*time*radius points from 2002 & 2004
  - β_N > 5 for all points
    - no-wall limit computed for 2004 data
  - all have β_N > 5 for at least 10 τ_{wall}
- Shots with insufficient rotation experience RWM collapse
  - usually in ~ 3 τ_{wall}
  - shot 114036 experiences RWM
    - growth after ~ 4 τ_{wall}
- $1/q^2$ dependence is contrary to observations on DIII-D



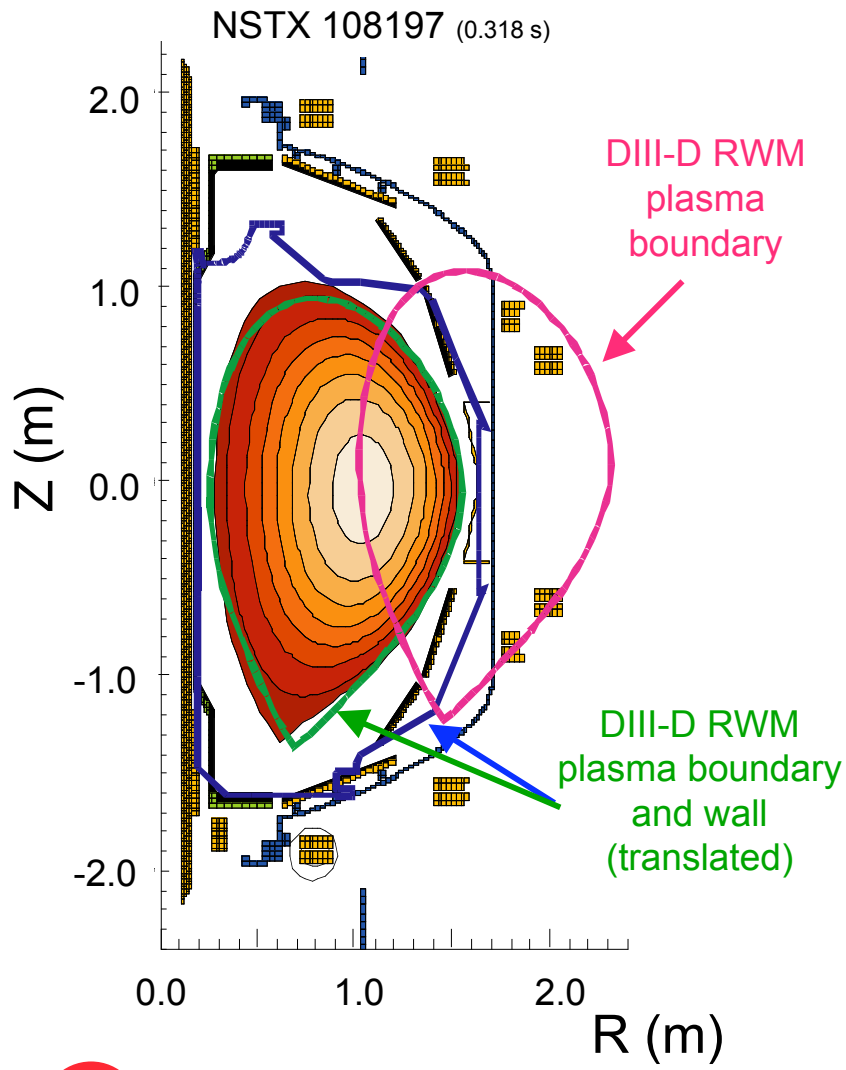


XP 453: DIII-D/NSTX RWM Similarity XP

- Motivation
  - Compare RWM physics between low and moderate A devices
    - Basic RWM observation similar in devices, but some key details differ
- Goals
  - Create similar discharges with different aspect ratios
    - Match poloidal cross-section and proximity to no-wall limit
  - Compare RWM physics at different aspect ratio
    - Rotation damping rate / critical rotation frequency / RWM growth rate
    - Radial variation of mode amplitude (rotation damping profile)
    - Trapped particle effects (Hu and Betti: explicit A dependence)
    - Resonant field amplification / MHD spectroscopy
    - Magnetic braking (test neoclassical toroidal viscosity theory)
  - Test present RWM stability theory
    - Compare MARS results to test stabilization / dissipation theories

DIII-D / NSTX Boundary already well matched

(Sontag, Reimerdes, Garofalo, Sabbagh, Strait, LaHaye, Okabayashi, etc.)



- Approach
  - More closely match RWM generation
  - Utilize active control coil for rotation control/RFA studies
  - Complementary experiment to be submitted to DIII-D Research Opportunities Forum
- Address discrepancy between NSTX & DIII-D Ω_{crit} observations
  - DIII-D observes $q^{+\alpha}$ scaling
  - NSTX observes $q^{-\alpha}$ scaling
- History
  - XP was delayed due to high MHD at B_t = 0.3 kG in DIII-D shape during 2004 run

Duration and Required / Desired Diagnostics

- Each XP could be completed in 1.5 run days
- Required
  - EFIT with flux iso-surface constraint (reduced error on q profile)
  - CHERS toroidal rotation measurement
  - Internal RWM sensors
  - Thomson scattering
  - Diamagnetic loop
  - USXR
- Desired
  - MSE
  - Advanced USXR diagnostics
  - Toroidal Mirnov array
  - Fast camera