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Error Field Threshold Study in high-β plasmas with reduced input torques (XP1018)

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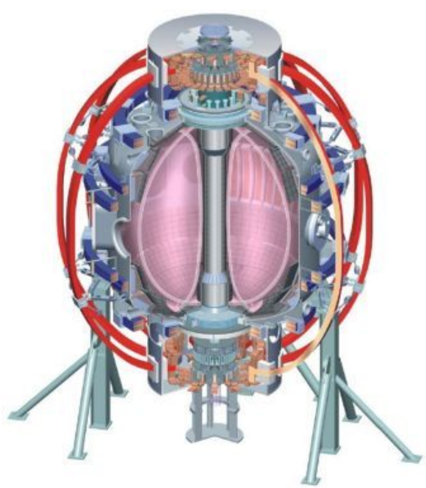
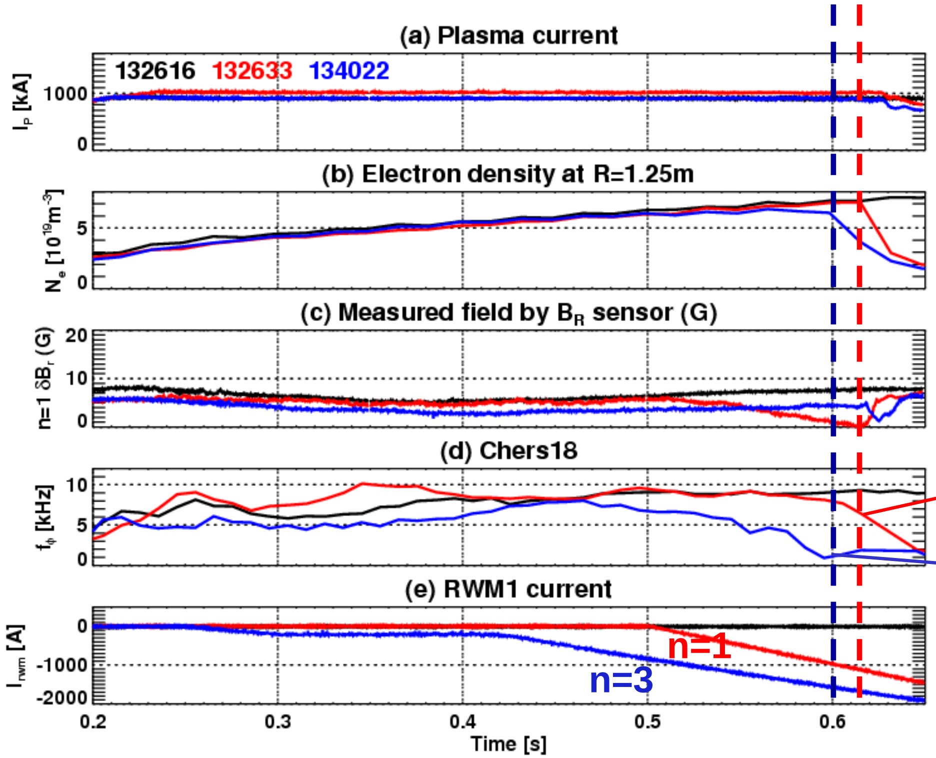


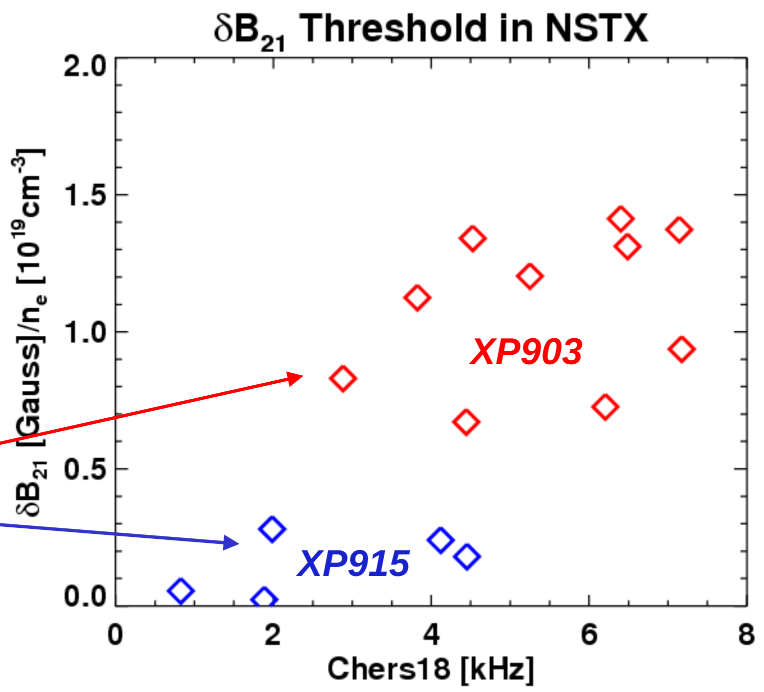
Motivation of XP1018

- Plasma can be more sensitive to error fields at higher-β regime, due to amplifications by plasma response
- Reliable error field threshold scaling in high-β, or H-mode plasmas is required for ITER, etc
- XP903, XP915 investigated error field threshold in high-β, and with reduced rotations by n=3 magnetic braking
- There are three XPs this year to extend the study
  - J. Menard : Intermediate regime across L-H
  - R. Buttery (XP1032) : H-mode regime with various different parameters
  - **J. Park (XP1018) : H-mode regime with HHFW, to reduce input torques**

Rotation is the key to error field threshold in H-mode

- The n=1 threshold becomes smaller when rotation is reduced by n=3 braking (XP915, R. J. Buttery)
  - Rotation (torque) is the key parameter when input torques exist

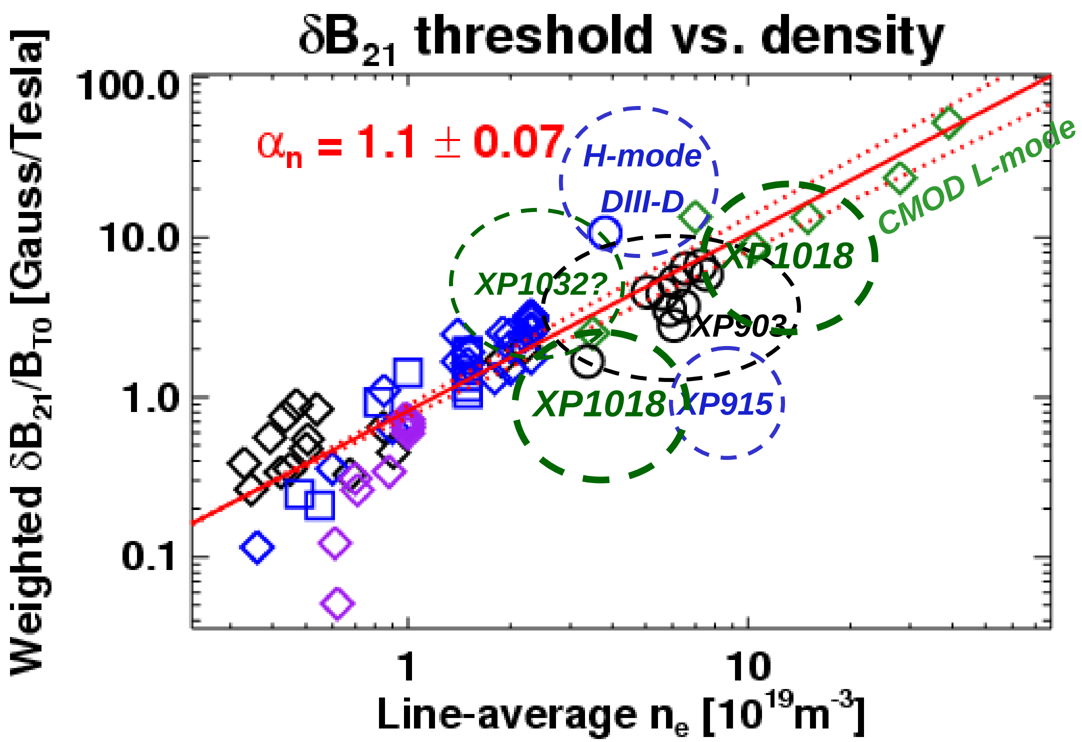




Error field threshold scaling should include rotations in H-mode

- The best parametric scaling with total resonant field:

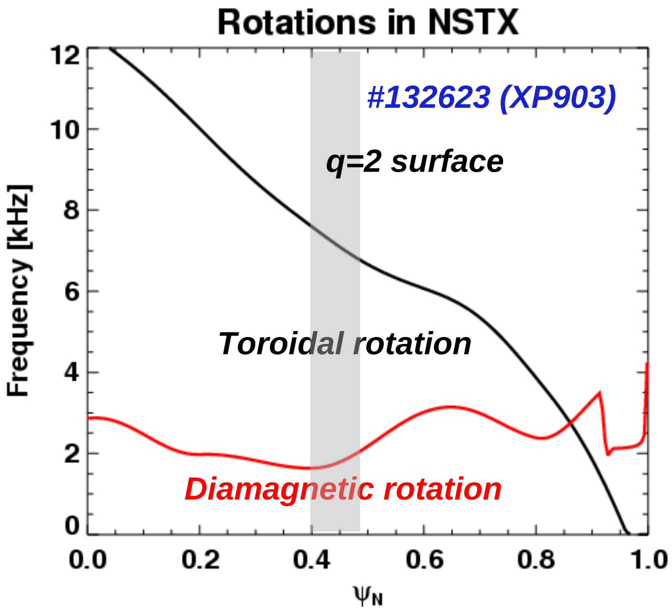
$$\frac{\delta B_{21}}{B_{T0}} \leq 0.9\times10^{-4}\left(n[10^{19}m^{-3}]\right)^{1.1}\left(B_{T0}[T]\right)^{-1.4}\left(R_0[m]\right)^{0.61}$$



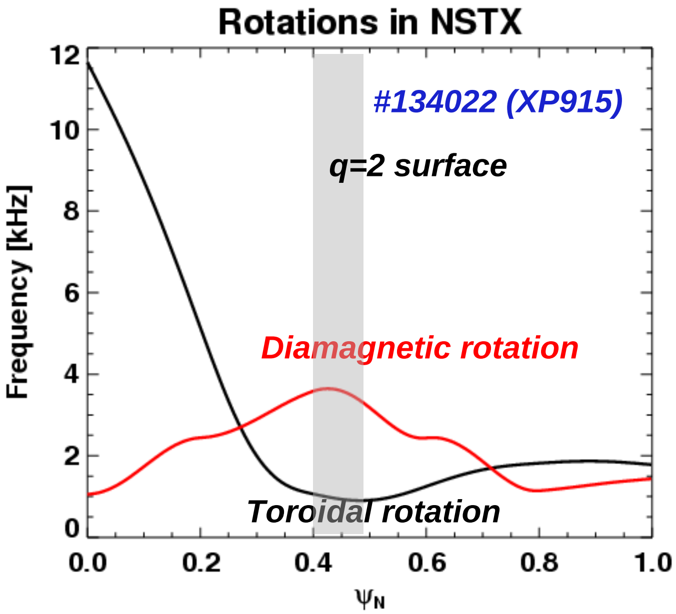
Effects by rotation on thresholds are not yet reliably quantified across parameters

- Rotation helps shielding of magnetic perturbations, and thus increases thresholds, but its effects are not yet quantified
  - What level of rotations would keep the linear density scaling from L-mode?
  - How do the thresholds scale with rotations? $(\omega_\varphi/\omega_D)^\alpha$?

The case which follows the linear density scaling from L-mode

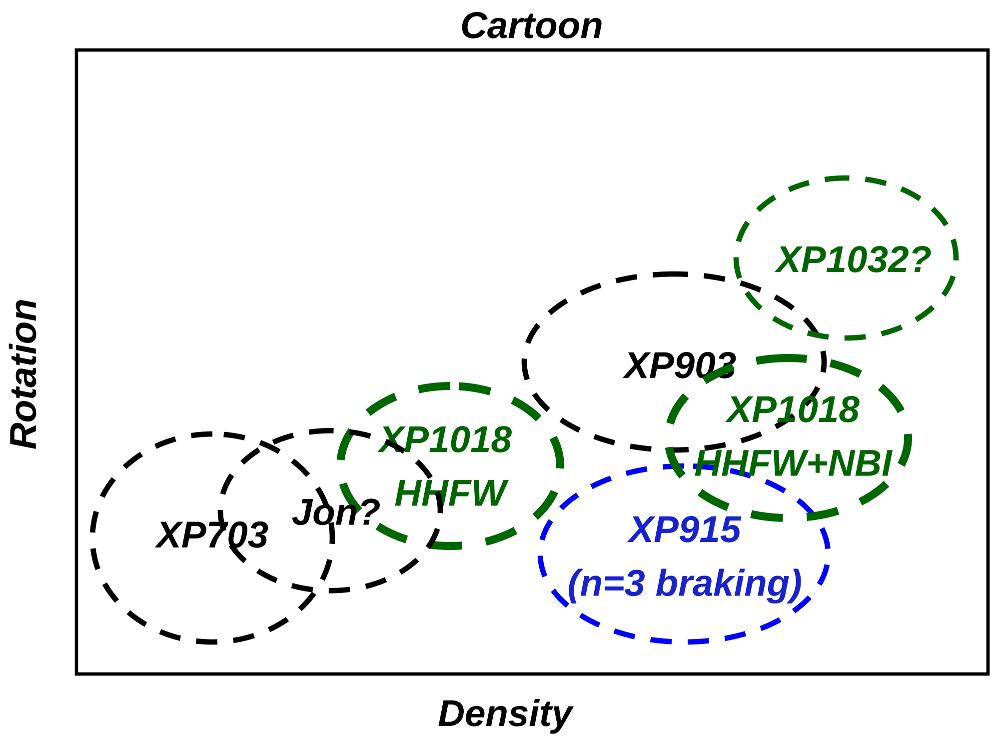


The case which is largely below the linear density scaling from L-mode



XP1018 will focus on HHFW and NBI 2MW plasmas instead of n=3 magnetic braking

- NBI 2~3 MW (XP903) : ω_φ~ 10kHz (Ch.18), n_e ~ 4~6e19 m^{-3}
- HHFW on NBI 2MW : Similar or lower ω_φ + higher n_e
- Only HHFW heating : lower ω_φ + lower n_e



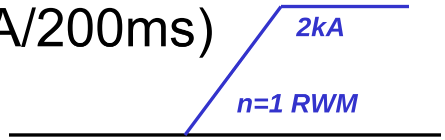
XP1018 step (0.5 day)

- Reproduce XP903 with NBI 2MW (Baseline, with or without LITER)
  - Develop targets (132623, IP=900kA) (2 shots)
  - Apply n=1 currents by SPA (2 shots)

- Apply HHFW on NBI 2MW
  - Add HHFW ~1.5MW, ~3MW (3 shots)
  - Apply n=1 currents by SPA at 50ms after HHFW (3 shots)

- Apply only HHFW
  - Apply only HHFW ~1.5MW, ~3MW (3 shots)
  - Apply n=1 currents by SPA (3 shots)
  - Apply NBI A after HHFW heating for diagnostics (2 shots)

* SPA wave forms (SPA1-,SPA2+,2kA/200ms)



Other considerations

- HHFW XPs will be very helpful
  - H-mode coupling experiments, etc
  - Density and rotation vs. HHFW will be important

- LITER may be used (if it is better in terms of parametric space)
  - Stability, shot duration, density vs. LITER will be important

- Diagnostics
  - All magnetics including Mirnov arrays
  - CHERS (toroidal and poloidal)
  - TS, FIReTIP
  - Edge rotation diagnostic
  - Fast cameras - divertor