NSTX-U

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# Resonant error field threshold with non-resonant braking


*J.-K. Park,*
*J. E. Menard, C. Myer, S. P. Gerhardt, Z. R. Wang,*
*[1]M. Lanctot, R. E. Bell, L. Delgado-Aparicio, …*

*Princeton Plasma Physics Laboratory*
*[1] General Atomics*


**NSTX-U ROF**
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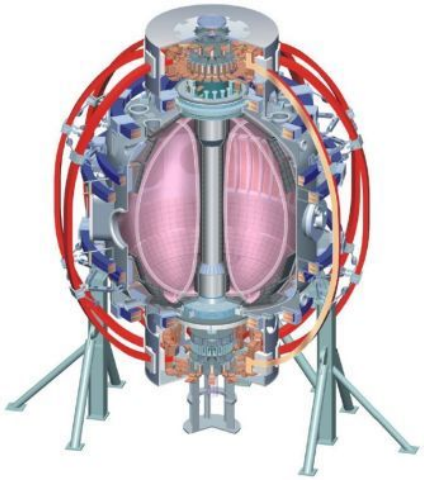

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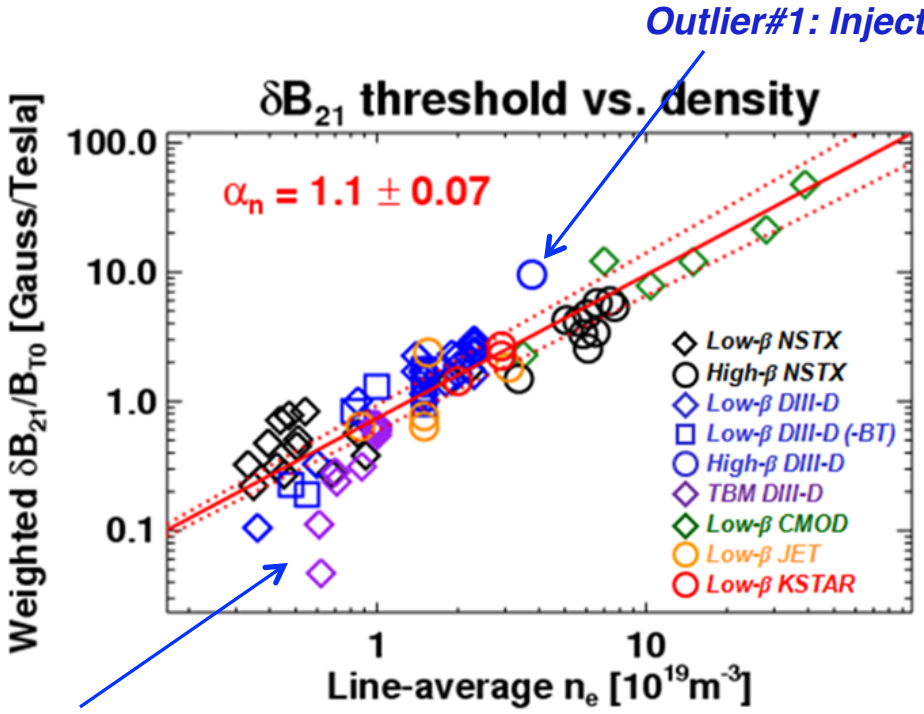
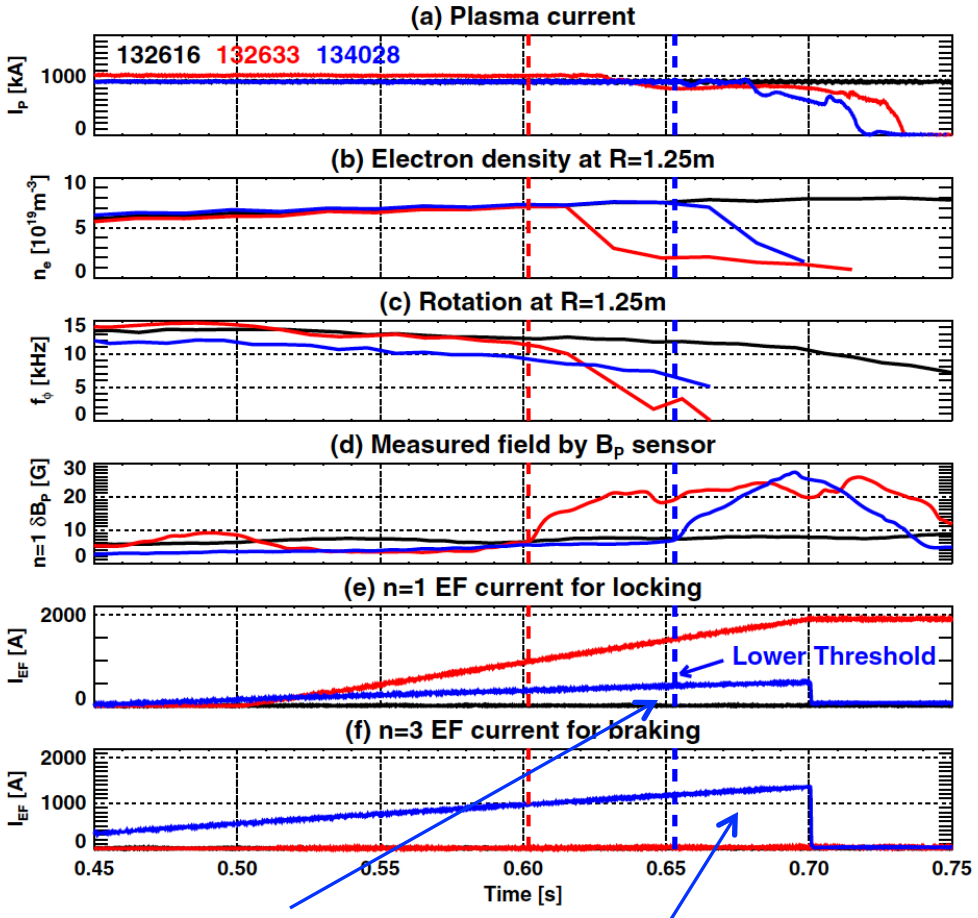
# Error field threshold for locking can be significantly modified in the presence of external torque

- Error field threshold for locking without injection torque (Ohmic scaling) shows fairly robust correlation with density
  - Data from different errors, coils, devices, were successfully combined when the total resonant field driving islands is used to measure error field amplitude
- However, external torque can significantly change error field threshold



# Error field threshold in the presence of non-resonant braking torque needs to be quantified in NSTX-U




*Resonant threshold decreases when non-resonant field is added*

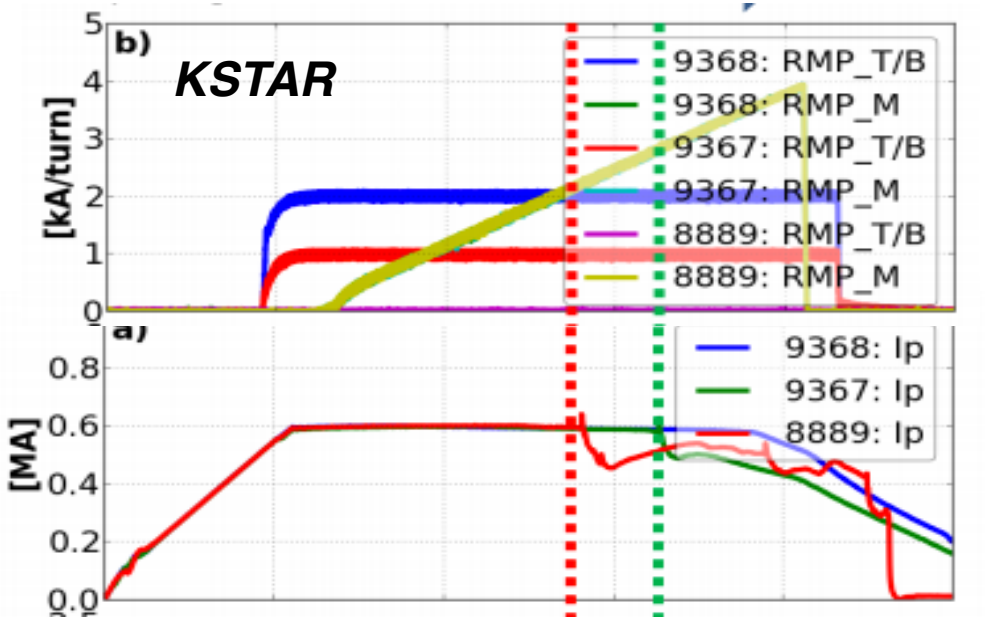
- In H-mode NSTX, n=1 locking threshold decreased significantly by n=3 braking
- Q: How to quantify and predict the effects of braking? Rotation (torque), shear or non-resonant field spectrum (critical to MDC-19)?

$$\left(\frac{\delta B_{21}}{B_{T0}}\right)_{\omega} \cong \left(\frac{\delta B_{21}}{B_{T0}}\right) \times \left(0.22\frac{\omega_\phi}{\omega_D}\right)^{1.46}$$

- Important clue can be obtained if the same level of rotation or rotation shear can be created by n=2 and n=3, with variations in NBIs

# Non-resonant braking effects on error field threshold may or may not be different in Ohmic plasmas

- KSTAR n=1 locking experiments with n=2 braking showed
  - Disruption by locking can be delayed or mitigated by n=2 braking
  - However, earlier locking onset is actually claimed
  - On the other hand, theory predicts locking threshold increase (delayed locking)




$$\left|\frac{b_r^{\mathrm{vac}}}{B_\phi}\right|_{\mathrm{crit,SCi\text{-}HRi},1/\nu} \sim n_e B_\phi^{-13/10} R_0 \tau_V^{-1/2} \sigma_{NR,1/\nu}.$$

$$\sigma_{NR,1/\nu} = \sqrt{\sum_n \sum_{m,m'} n^2 \frac{(b_{nmc} b_{nm'c} + b_{nms} b_{nm's})}{[b_r^{\mathrm{vac}}]^2} B_{\lambda,1/\nu}},$$

***A. Cole***

- Easy to test this in NSTX-U with 6 SPAs

# Shot plan (1 day)

- Ohmic plasmas (0.5 day) in earlier month of operation
  - After n=1 compass scan (Myer)
  - Ramp up n=1 (<1kA/s) until locking
  - Apply 0.5-2kA n=3 and n=2, and ramp up n=1 until locking
  - Try to facilitate passive CHERS
  - Increase density (x2) with gas puffing if possible and repeat the above

- NBI plasmas (0.5 day)
  - Use relatively mild target (1MA, 0.5-0.65T)
  - Measure n=1 threshold
  - Apply 4-step n=3 field and measure rotation and profile
  - Repeat 4-step field with n=2
  - Determine two rotation levels that are producible by both n=3 and n=2, and ramp n=1 until locking to measure threshold