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Wall Stabilized Operation in High Beta NSTX Plasmas

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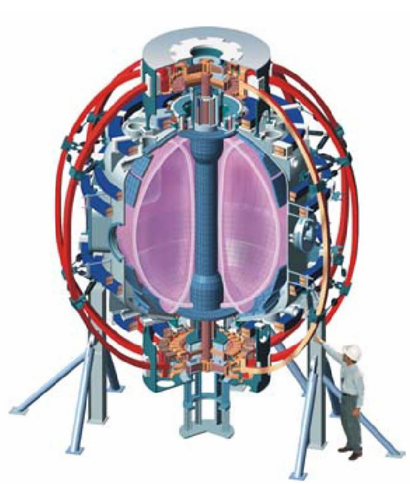

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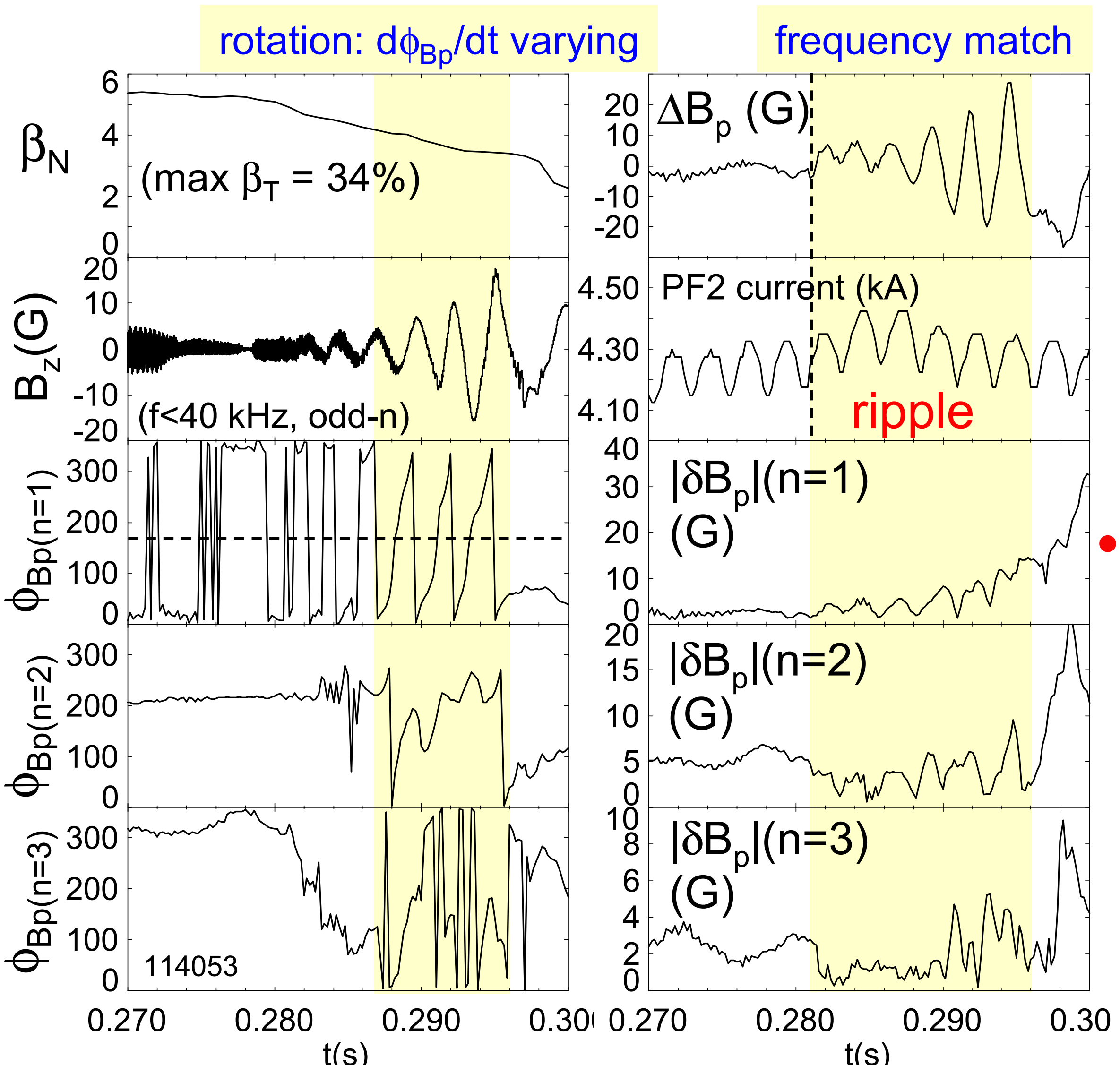
NSTX

Extra slides for poster follow

Evidence for resonance with AC error field observed



F-A modified resonance

$$\left(S_* \nu_* / \left(1+md\right)+1\right)\hat{\omega}_{AC}^2 + \left(s\left(1-md\right)+\Omega_\phi^2\right)=0$$

"static error field" response

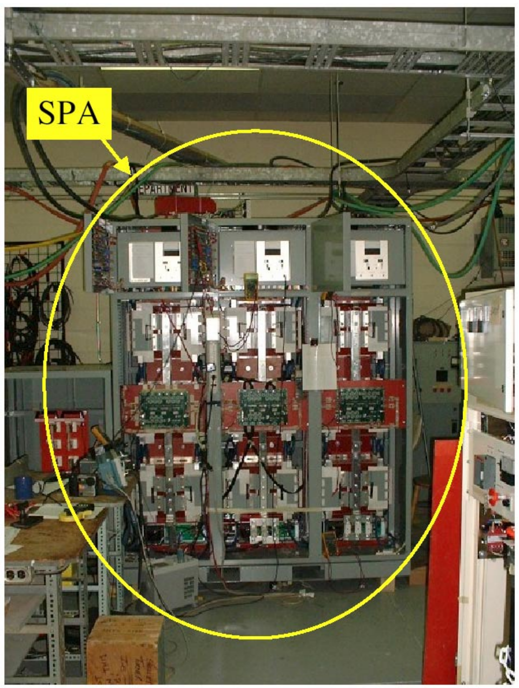
New condition

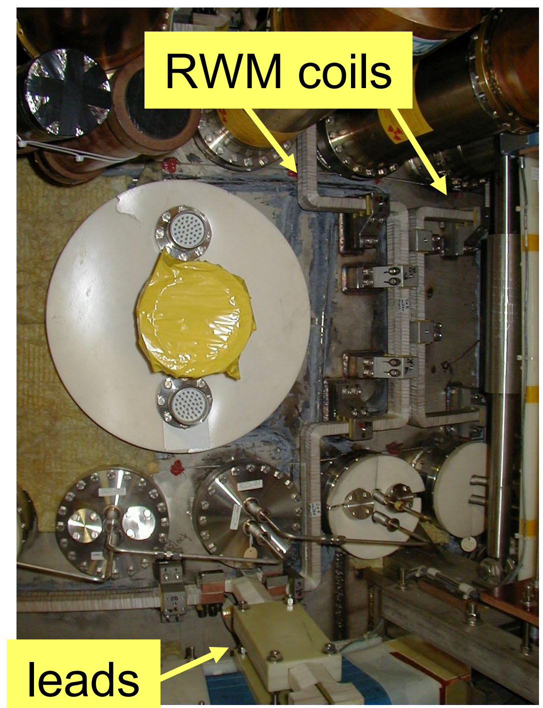
$$\hat{\omega}_{AC}^2 - \nu_*\left(1+md\right)/2S_* = 0$$

- Theory / experiment show
  - AC frequency match may be responsible for mode trigger
  - Mode rotates *counter* to plasma rotation
  - n=1 phase velocity not constant due to error field
  - Estimate of $\omega_{AC}/2\pi$ ~ 350 Hz consistent with PF coil ripple
  - Initial results – quantitative comparison continues

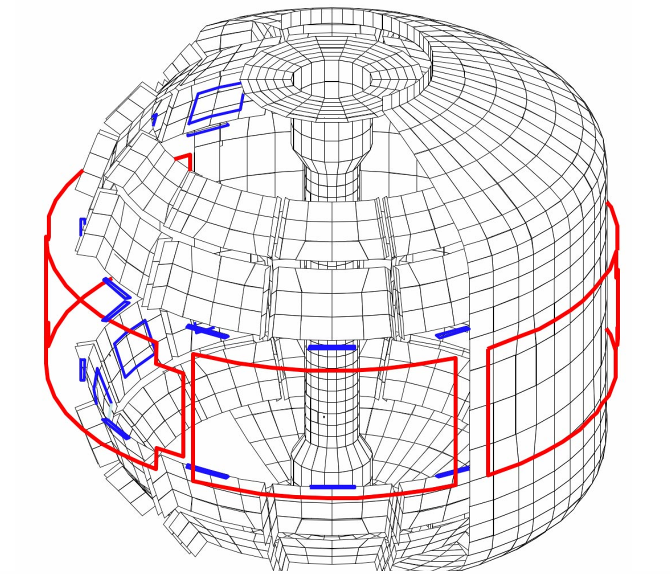
RWM stabilization system being installed for 2005 run

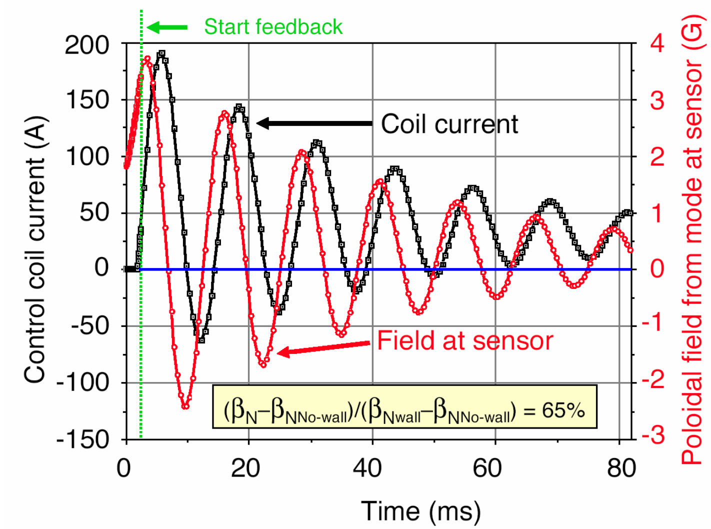
- RWM sensor array used in 2004 experiments
- 6 B_r coils now installed on NSTX
  - Pre-programmed capability in 2005 for RFA suppression / MHD spectroscopy experiments
- 3-channel switching power amplifier (SPA) on-site
- Real-time mode detection and control algorithm development in 2005 for feedback experiments





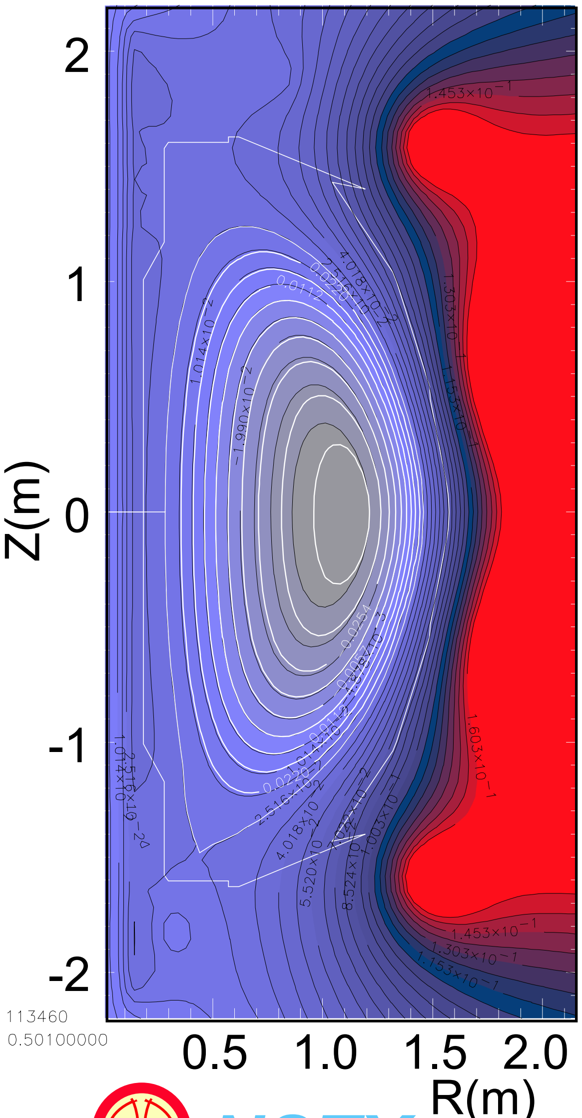
Physics design (VALEN code)

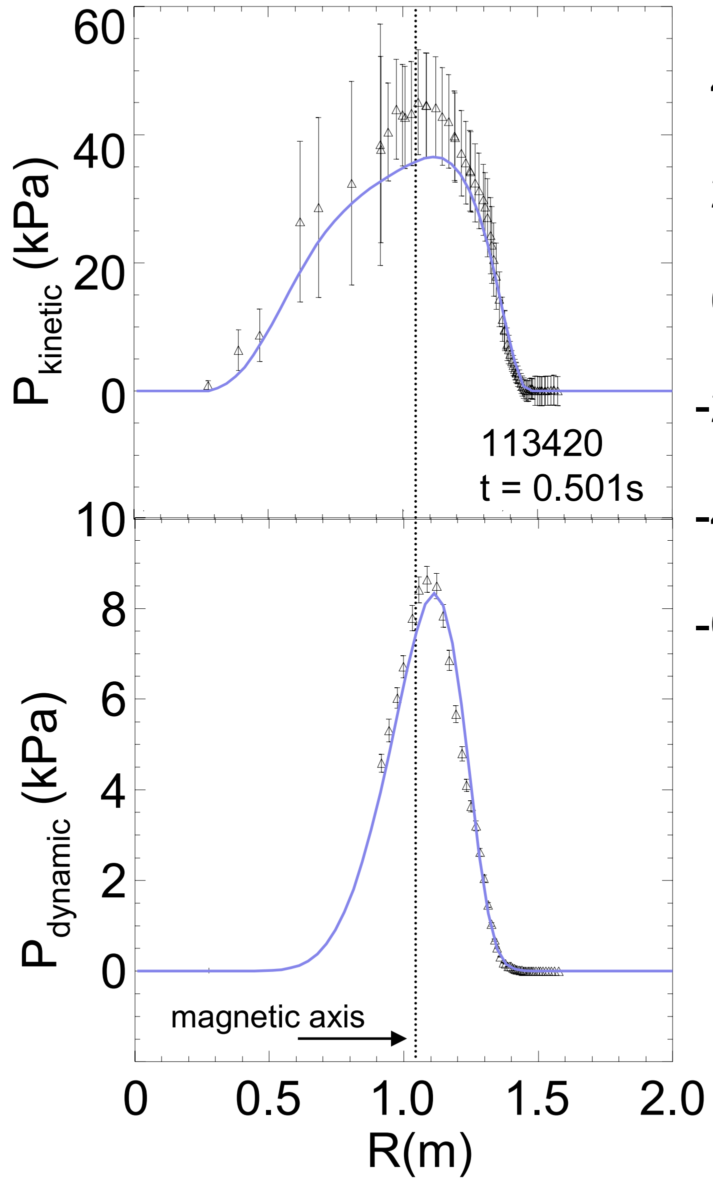


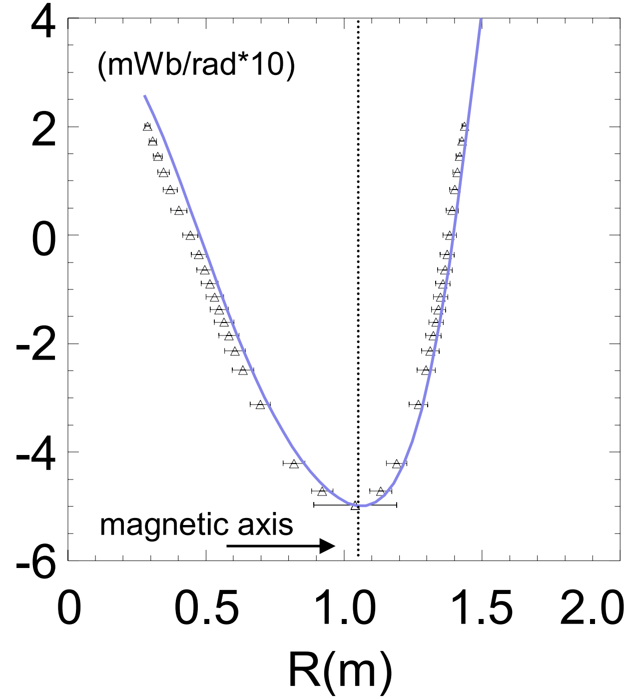


Significant shift of peak pressure off-axis due to rotation

Poloidal flux and pressure







- $(R_{pmax} - R_{axis})/a = 11\%$
- V_ϕ broadens P profile and reduces q_0
- No significant reduction in reconstructed β compared to static case

Toroidal Rotation Damping Torques

- Resonant EM force on island (R. Fitzpatrick, et al.)

~0

$$T_{\varphi EM_{err}} = \frac{r_s}{w\mu_0}\frac{n}{m}\left|\delta B_{r\_island}\right|\left|\delta B_{r\_error\_field}\right| \times Fac_{shielding}$$

$$T_{\varphi EM_{wall}} = \frac{r_s}{w\mu_0}\frac{n}{m}\frac{(\omega\tau_w)\left[1-(r_{s+}/r_w)^{2m}\right]}{1+(\omega\tau_w)^2\left[1-(r_{s+}/r_w)^{2m}\right]^2}\left|\delta B_{r\_island}\right|^2$$

- Neoclassical toroidal viscosity (NTV) theory (K.C. Shaing et al.)

$$T_{NTV} = R\frac{\pi^{1/2}p_i}{v_{t_i}}\left(\Omega_\phi - \Omega_{\mathrm{mode}}\right)\varepsilon^2\sum_{m,n\neq 0}\left(\frac{\delta B_r^{mn}}{B_\phi}\right)^2\frac{1.365n^2q}{1.182+1.365\left|m-nq\right|}$$

dominant m:

$$T_{NTV} = R\frac{\pi^{1/2}p_i}{v_{t_i}}\left(\Omega_\phi - \Omega_{\mathrm{mode}}\right)\varepsilon^2 n^2 q\left(\frac{\delta B_r}{B_\phi}\right)^2$$