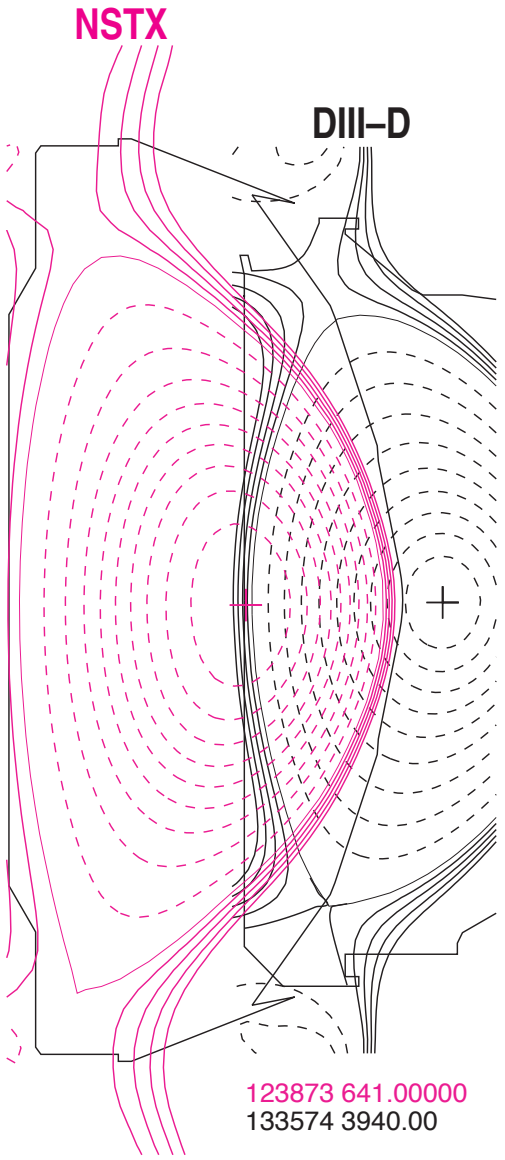
NSTX/DIII-D Aspect Ratio Comparison of 2/1 NTM Physics

R.J. La Haye, General Atomics
R.J. Buttery, UKAEA Culham (Now GA)
S. Gerhardt, PPPL
S. Sabbagh, Columbia University

Report on XP914 and 2009-54-01

at the NSTX Results/Theory Review

September 15–16, 2009



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NSTX

168-09/RJL/rs

For "Marginal" Magnetic Islands, dw/dt ≤ 0 for all w

- **Helically perturbed bootstrap current balanced by negative Δ'**
  - ★ **for islands at the "marginal" width, $\dot{w} \leq 0$ for all w**

$$0 \approx \Delta' + \varepsilon^{1/2} \frac{L_q}{L_{pe}} \frac{\beta_{\theta e}}{w_{marg}} \left[\frac{w_{marg}^2}{w_{marg}^2 + w_d^2} - \frac{w_{pol}^2}{w_{marg}^2} \right]$$

$$\cdots 0 \approx \Delta' + \frac{1}{2} \varepsilon^{1/2} \frac{L_q}{L_{pe}} \frac{\beta_{\theta e}}{w_{marg}} \quad \text{for } w_{pol}^2 << w_d^2$$

$$- w_{marg} = w_d$$

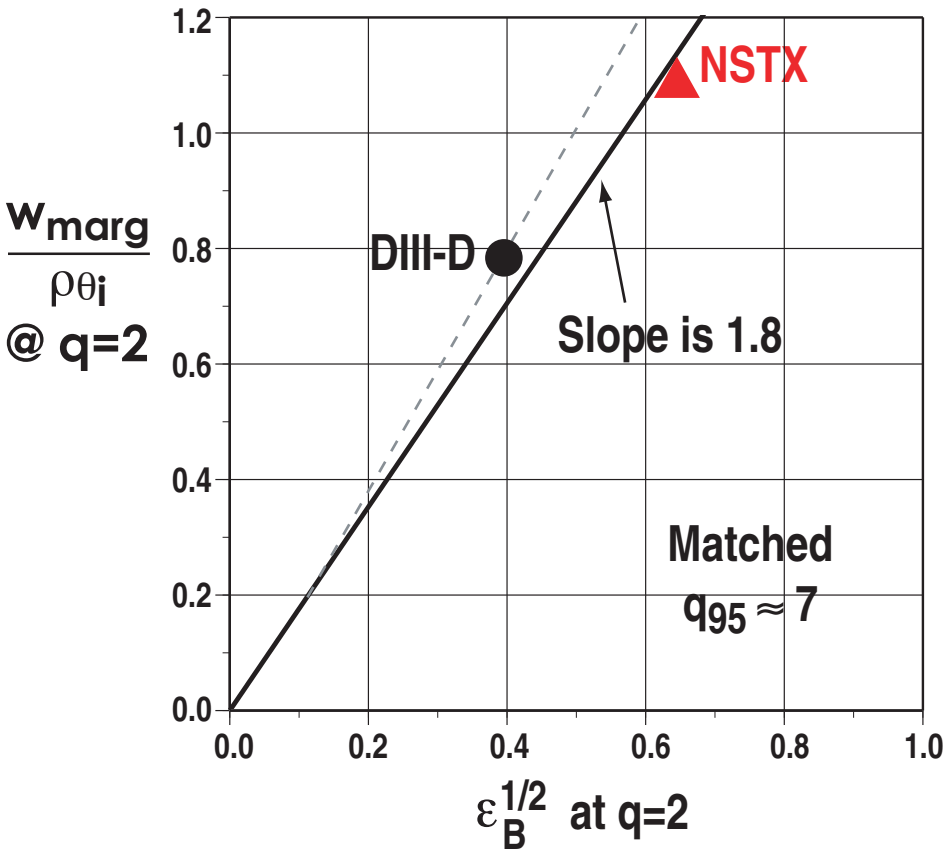
$$\cdots 0 \approx \Delta' + \frac{2}{3} \varepsilon^{1/2} \frac{L_q}{L_{pe}} \frac{\beta_{\theta e}}{w_{marg}} \quad \text{for } w_d^2 << w_{pol}^2$$

$$- w_{marg} = \sqrt{3}\,(w_{pol}^2 + w_d^2)^{1/2}$$

  - ★ **note GGJ curvature term "D_R" neglected here**
    - **··· important for NSTX?**

Preliminary Results Before 2009 on DIII–D and NSTX m/n = 2/1 NTM Island Marginal Stability Showed Consistency

- Marginal island width several times the ion banana width at q = 2



- Followup experiments needed
  - ★ more cases for reproducibility
    - … probably need full co-rot at marginal point and best n=1 and 3 EFC in NSTX
      - – to avoid locking
  - ★ input for ITPA 2009–2010
    - … MDC-4 aspect ratio

with $\varepsilon_B = (B_{IN} - B_{OUT})/(B_{IN} + B_{OUT})/2$

$\approx r/R_0$ for DIII-D only

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NSTX

Experiments Collected Good Data Sets on Restabilization in 2009

Method: In both DIII-D and NSTX

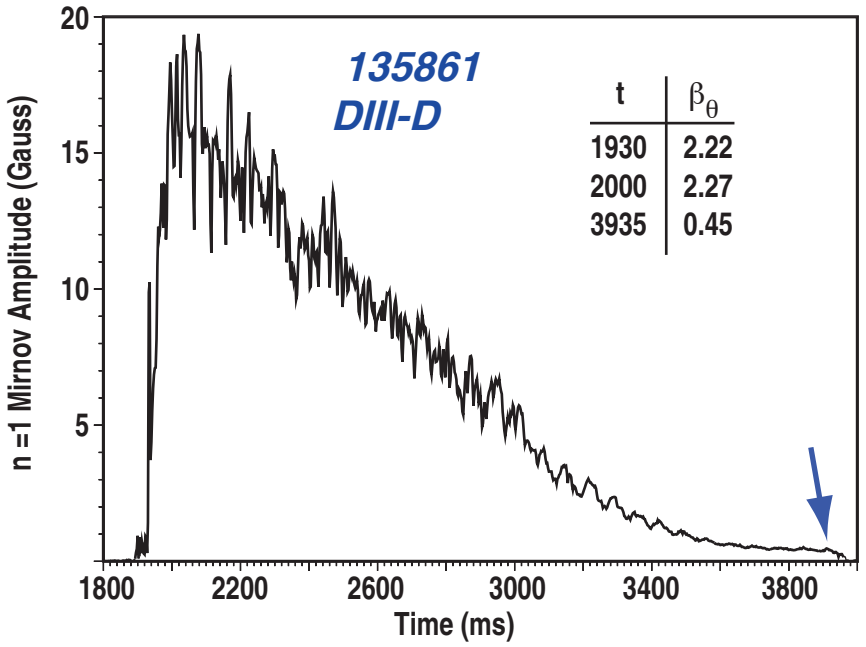
- Strike 2/1 mode in NBI heated ELMy H-mode discharge
- Ramp-down β_θ by reducing the beam power
- Determine the marginal island width (island width at the value of β_θ just sufficient to support an NTM)
- Marginal island width contains critical information about the small-island physics

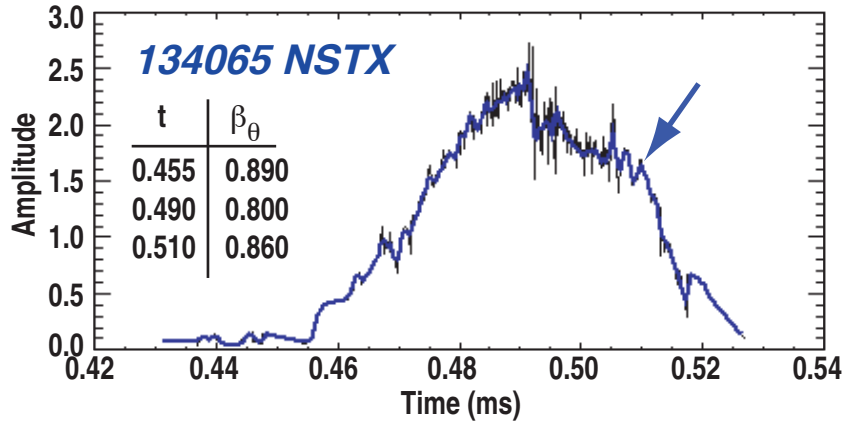
Result: DIII-D

- Used gas puff to stay in H-mode
- 5 good 2/1 (and 2 good 3/1) cases
- Analysis complete

Result: NSTX

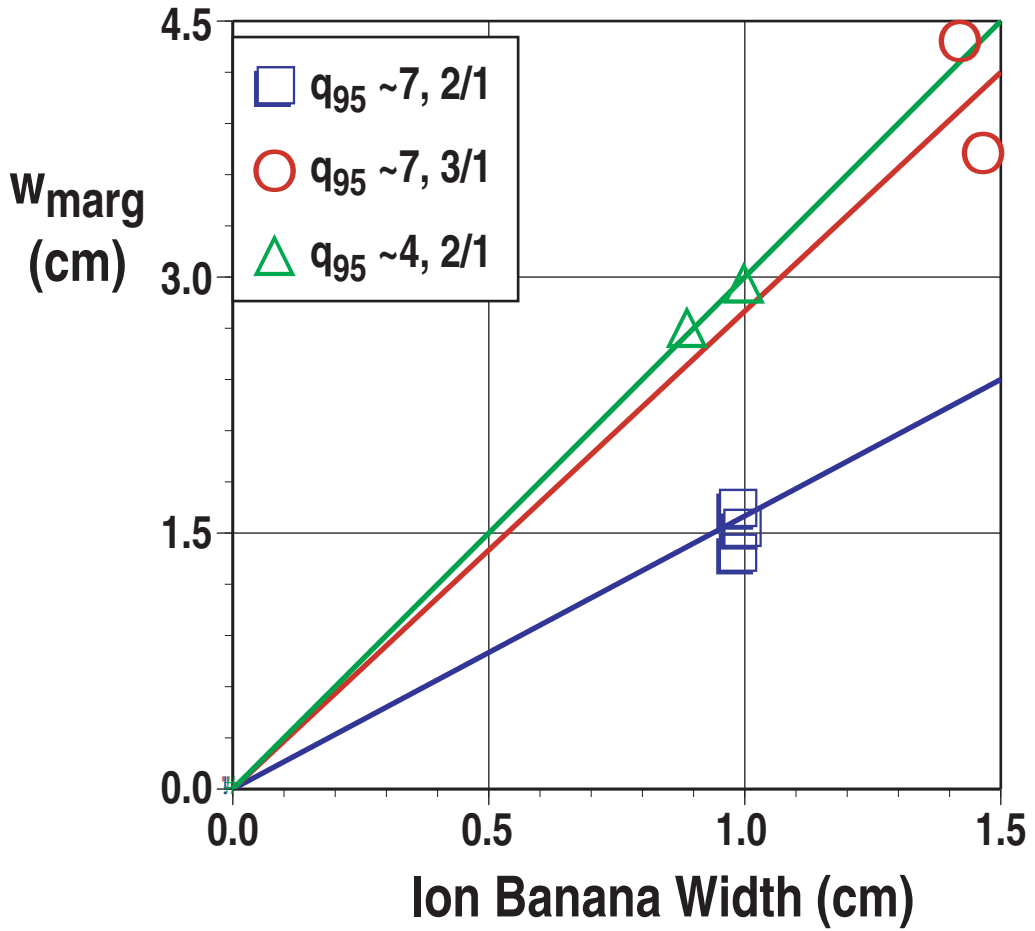
- Achieved a reproducible onset condition using modest Li evaporation
- Up to 9 good cases, 8 collected this year
- Analysis to be done





As Expected, the Marginal Island Width is Several Times the Ion Banana Width

- These results from DIII-D will be compared to NSTX data to determine aspect ratio dependence (and curvature effect ?)



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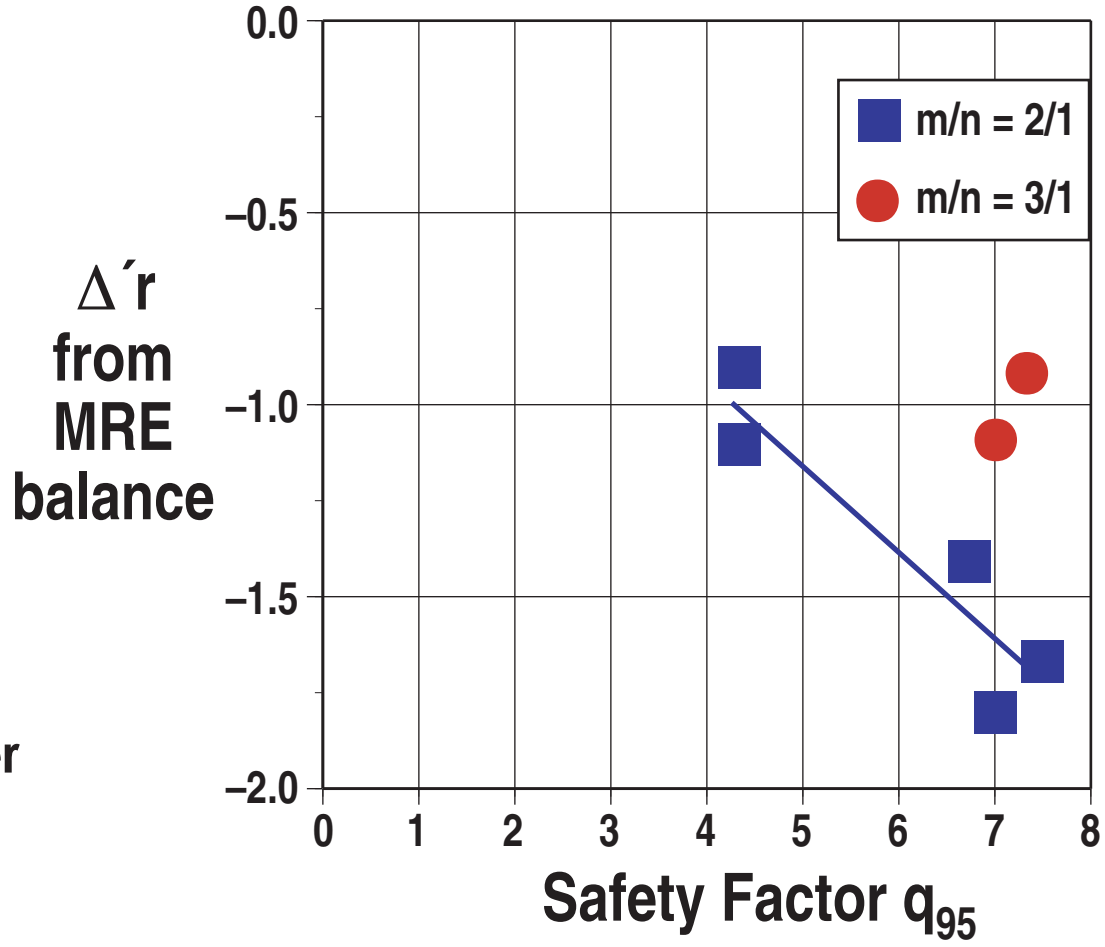
Tearing Stability Index Decreases With Smaller q_{95}, as Expected Since $q_{95} \lesssim 3$ is Classically Unstable

- Surprising result is that 3/1 mode less classically stable than 2/1 mode
  - ★ but 3/1 stabilizes at higher beta (β_θ = 0.94 vs 0.45) and lower ℓ_i (0.86 vs 1.06)



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