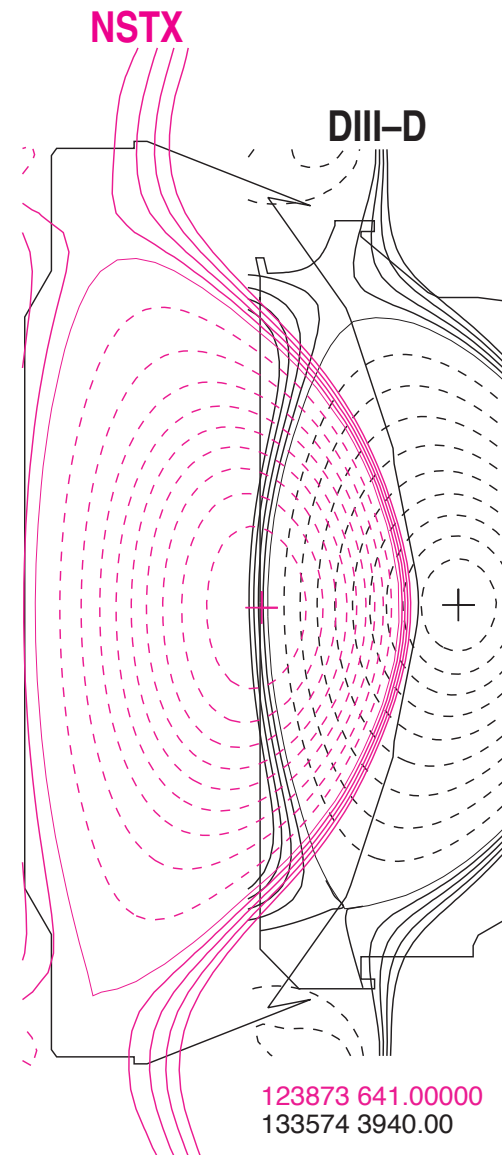


# NSTX and DIII-D Aspect Ratio Comparison of NTM Physics

## XP-914 Review, May 6, 2009

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S. Gerhardt, PPPL  
S. Sabbagh, Columbia

- ELMing H-mode
- Cross-section similar
- Match  $q_{95} \approx 7$
- Aspect ratio varied



# For “Marginal” Magnetic Islands, $dw/dt \leq 0$ for all $w$

- Helically perturbed bootstrap current balanced by negative  $\Delta'$

★ for islands at the “marginal” width,  $\dot{w} \leq 0$  for all  $w$

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

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

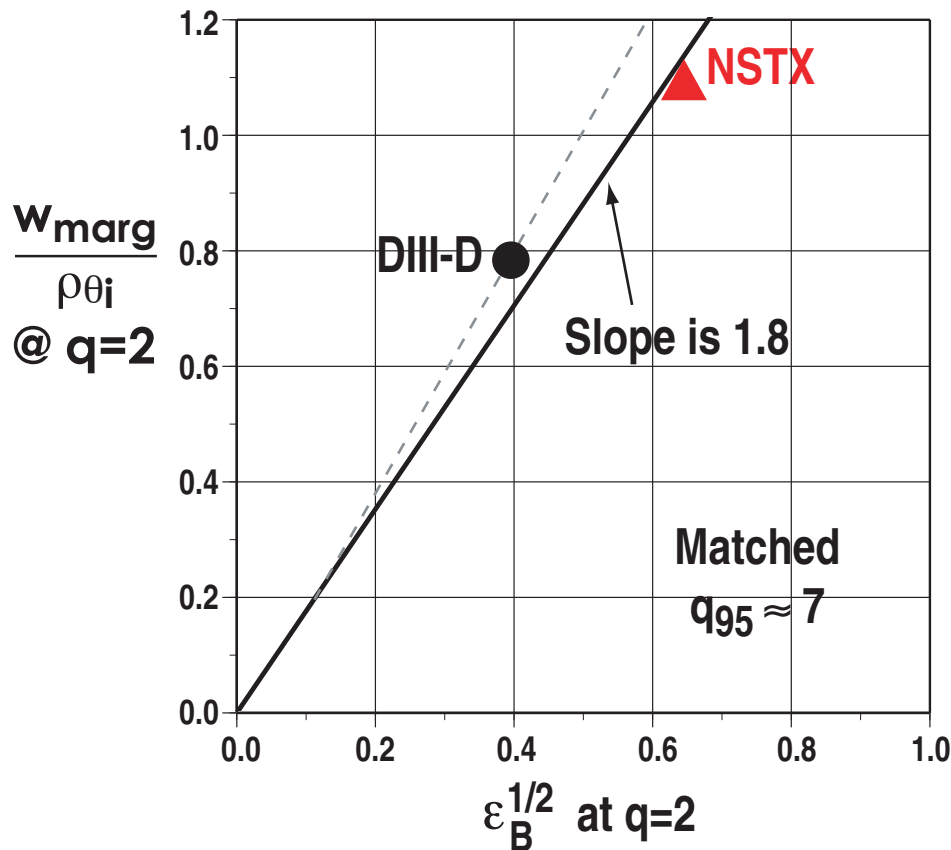
$$- w_{\text{marg}} = w_d$$

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

$$- w_{\text{marg}} = \sqrt{3} w_{\text{pol}}$$

# Preliminary Results on DIII-D and NSTX $m/n = 2/1$ NTM Island Marginal Stability Showed Consistency

- Marginal island width a few times the ion banana width at  $q = 2$
- $\Delta'(w_{\text{marg}})r \approx -1$  noting that  $w$ , flow shear and  $\beta$  are all “small”



- Followup Experiments Need
  - ★ more cases for reproducibility
    - ... probably need full co-rot at marginal point and best  $n=1$  and 3 EFC
      - to avoid locking
  - ★ input for ITPA 2009–2010
    - ... MDC-4 aspect ratio

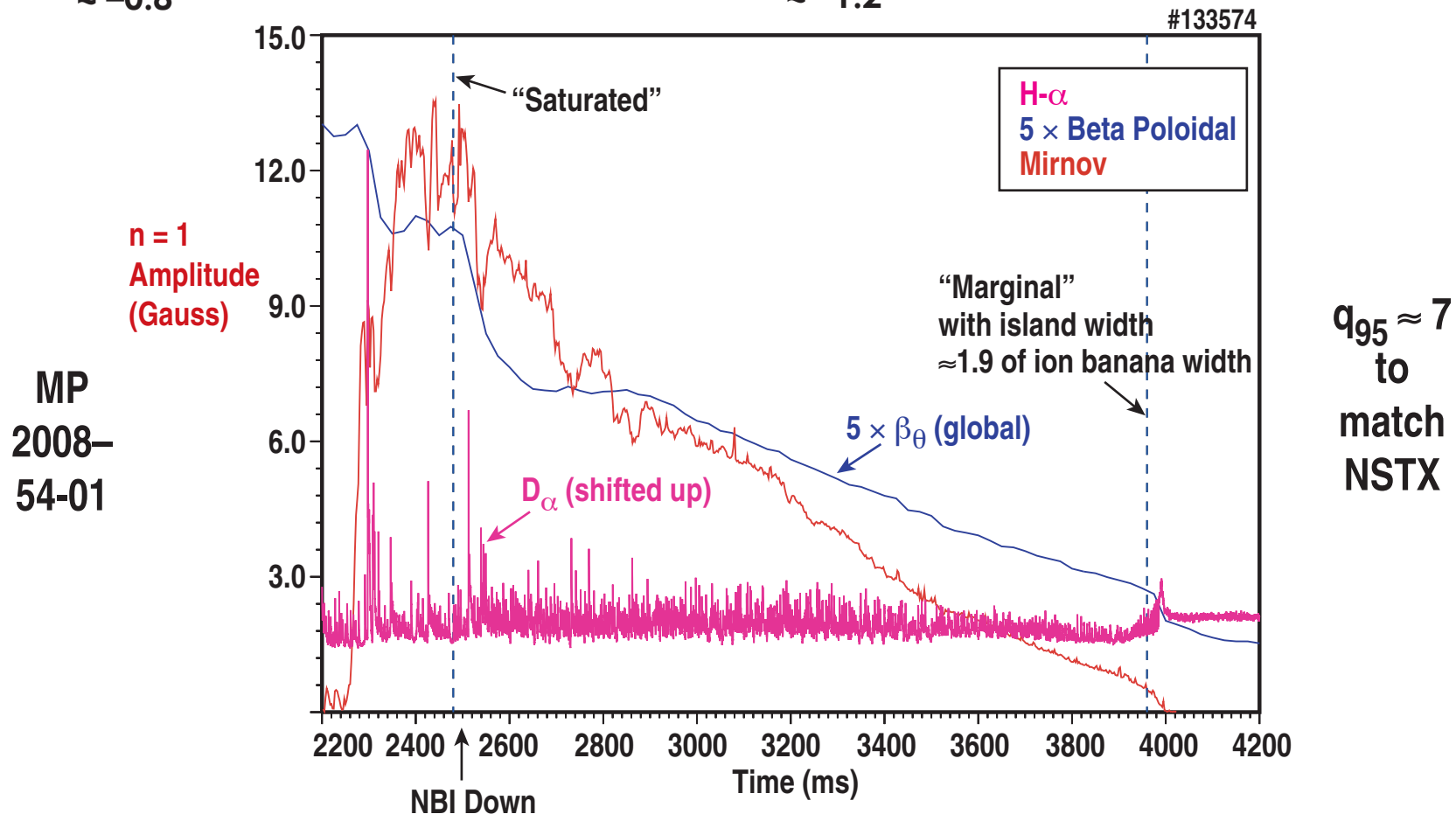
# Appraising Marginal Island Width and $\Delta'$ in DIII-D for $m/n = 2/1$ Neoclassical Tearing Modes

- Helically perturbed bootstrap current balanced by negative  $\Delta'$  in MRE

$$\star \Delta' r \approx -\varepsilon^{1/2} (L_q/L_{pe}) (r/w_{sat}) \beta_{\theta e} \quad \star \Delta' r \approx -(2/3) \varepsilon^{1/2} (L_q/L_{pe}) (r/w_{marg}) \beta_{\theta e}$$

$$\approx -0.42 (0.116/0.323) (0.308/0.074) 0.92 \quad \approx -0.667 * 0.41 (0.165/0.169)(0.282/0.019)0.30$$

$$\approx -0.8 \quad \approx -1.2$$



Report on. . . DIII-D and NSTX Aspect Ratio Comparison of NTM Physics (DIII-D Portion)  
D3DMP No. 2009-54-01 R.J. La Haye, R.J. Buttery, S. Gerhardt, and S. Sabbagh with thanks to Holger Reimerdes for NBI timing  
Run Tuesday AM February 24, 2009 and as contingency Wednesday AM February 25, 2009

### Experimental Shot Plan (This is a 1/2 day experiment). . . Good shots

1. Repeat #133574 with 2/1 destabilized, dudded to NBI power ramp down, H-mode retained, 2/1 mode stabilized without locking. (4 shots)
2. Repeat 2 with more counter-beams in the mix to reduce rotation both at saturation and in ramp down. H-mode retention without locking imperative. The dud trip level may need to be lowered with slower initial rotation. (6 shots)

*135861 and 135869 are good for 2/1, bonus are 135834 and 135837 in which an  $m/n=3/1$  mode is also excited and stabilizes first at higher beta*

3. Repeat 1 but on dud go to NBI beta feedback and slowly vary the mix of beams from predominantly co to balanced. (2 shots)

*135864 and 135863 (smaller dip in rot) are good for 2/1 amp vs rot at beta constant*

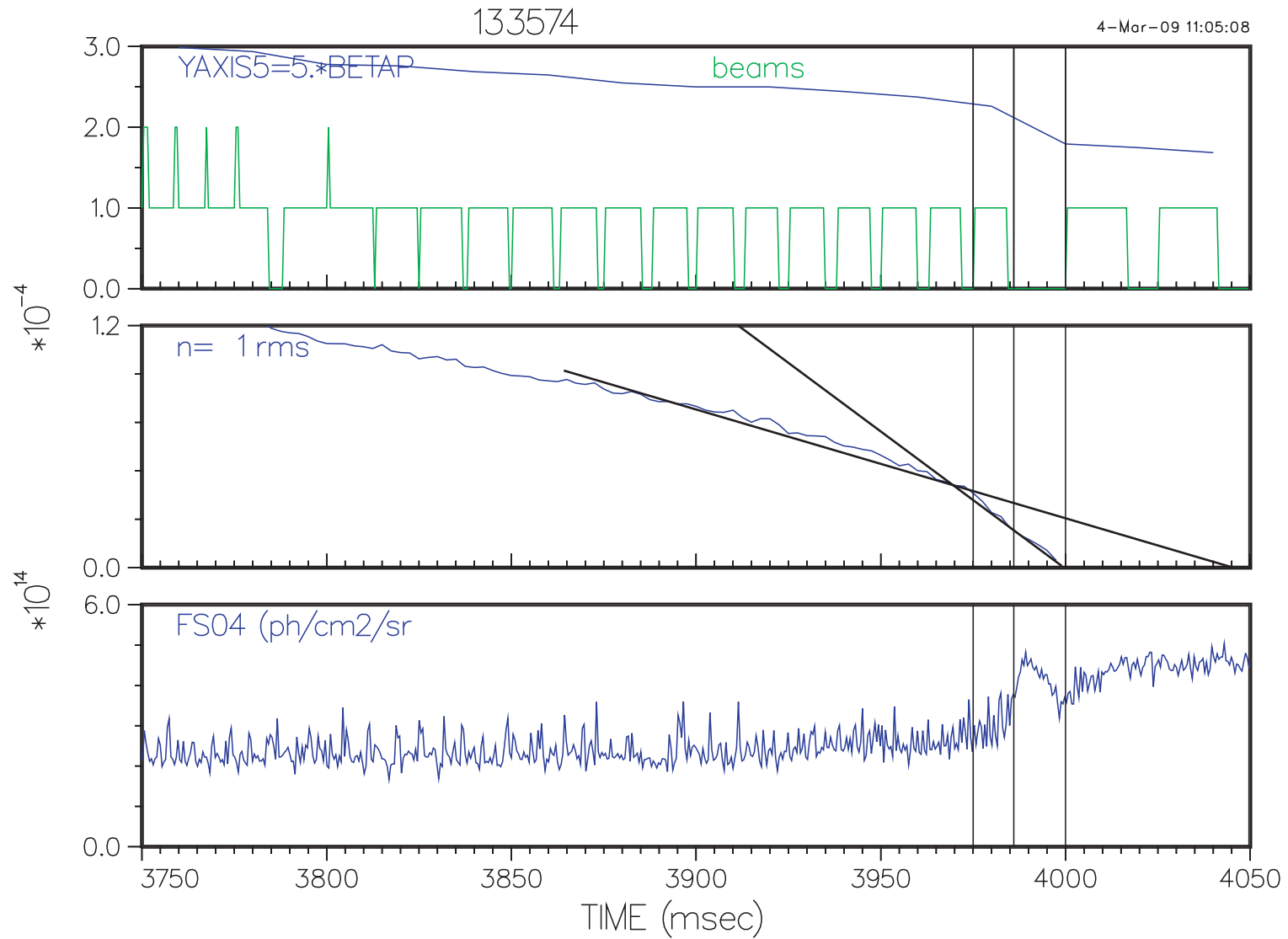
4. Restore 133512, 1.0 MA, -1.6 T, beams etc but keep  $n=1$  EFC on. Sweep NBI torque slowly from predominantly co to balanced with 3/2 mode while avoiding 2/1 onset. (2 shots)

*135867 (for 3/2 amp vs rot at beta constant wo 2/1), 68,66 deeper dip gets 2/1 onset*

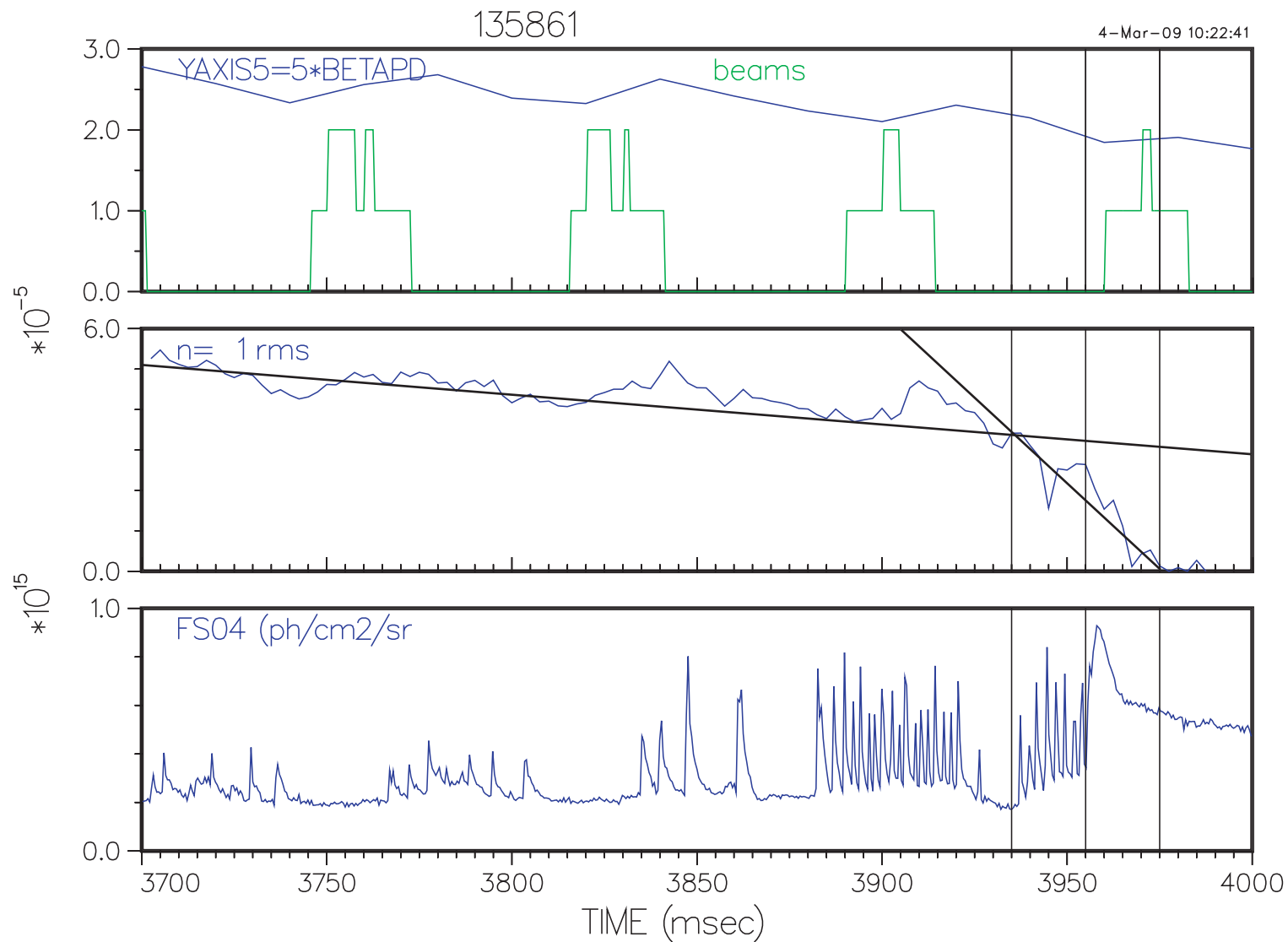
Total (14 shots to be run) with 9 good shots obtained for all aspects plus bonus

NSTX and DIII-D Aspect Ratio Comparison of NTM Physics (NSTX Portion)  
OP-XP-914 R.J. La Haye, R.J. Buttery, S. Gerhardt, and S. Sabbagh  
to be run (0.75 days) after March 30

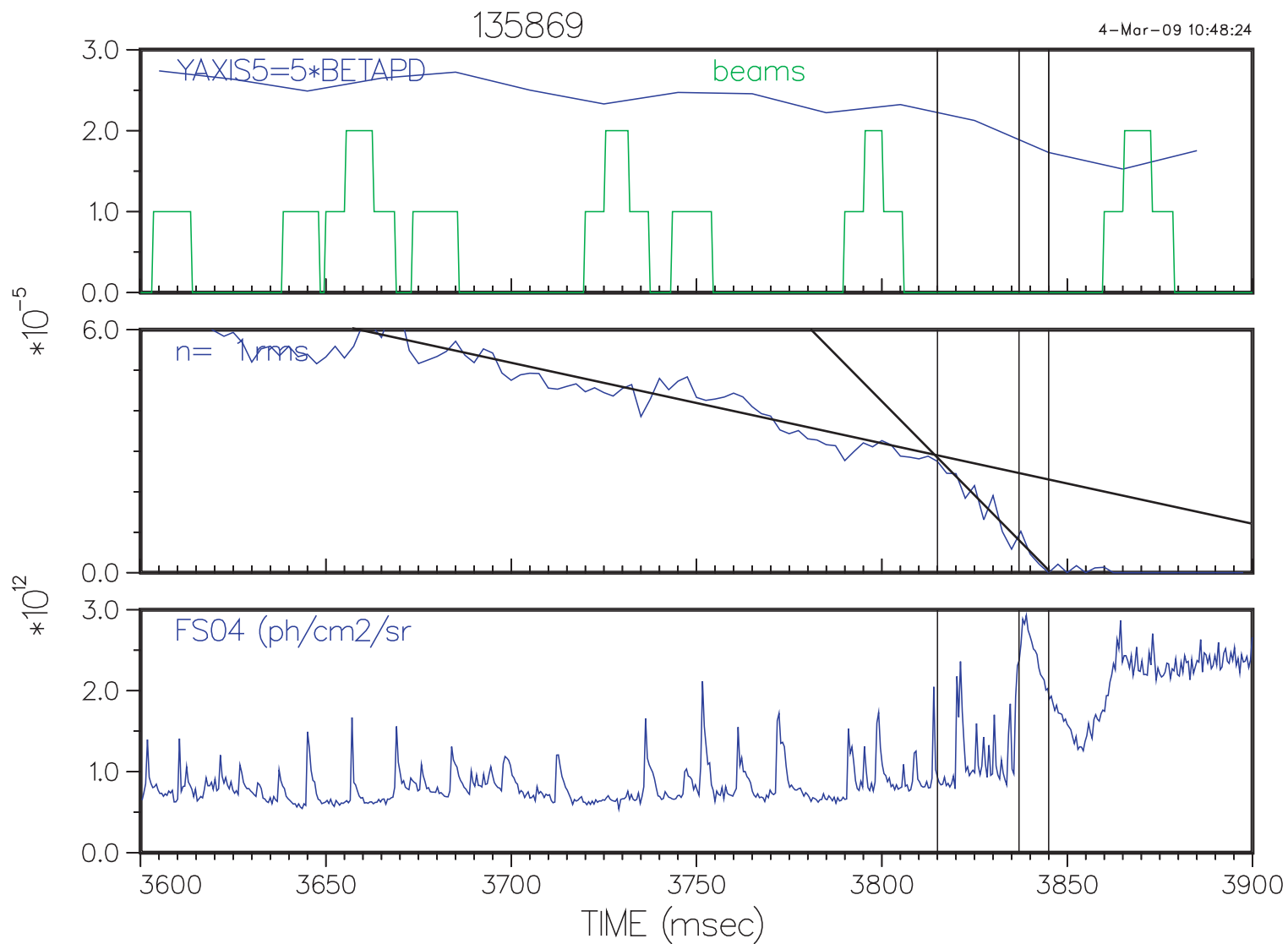
# Only 2/1 Case (in 2008) that Stayed in H-Mode



# New 2/1 Case (1 of 2)



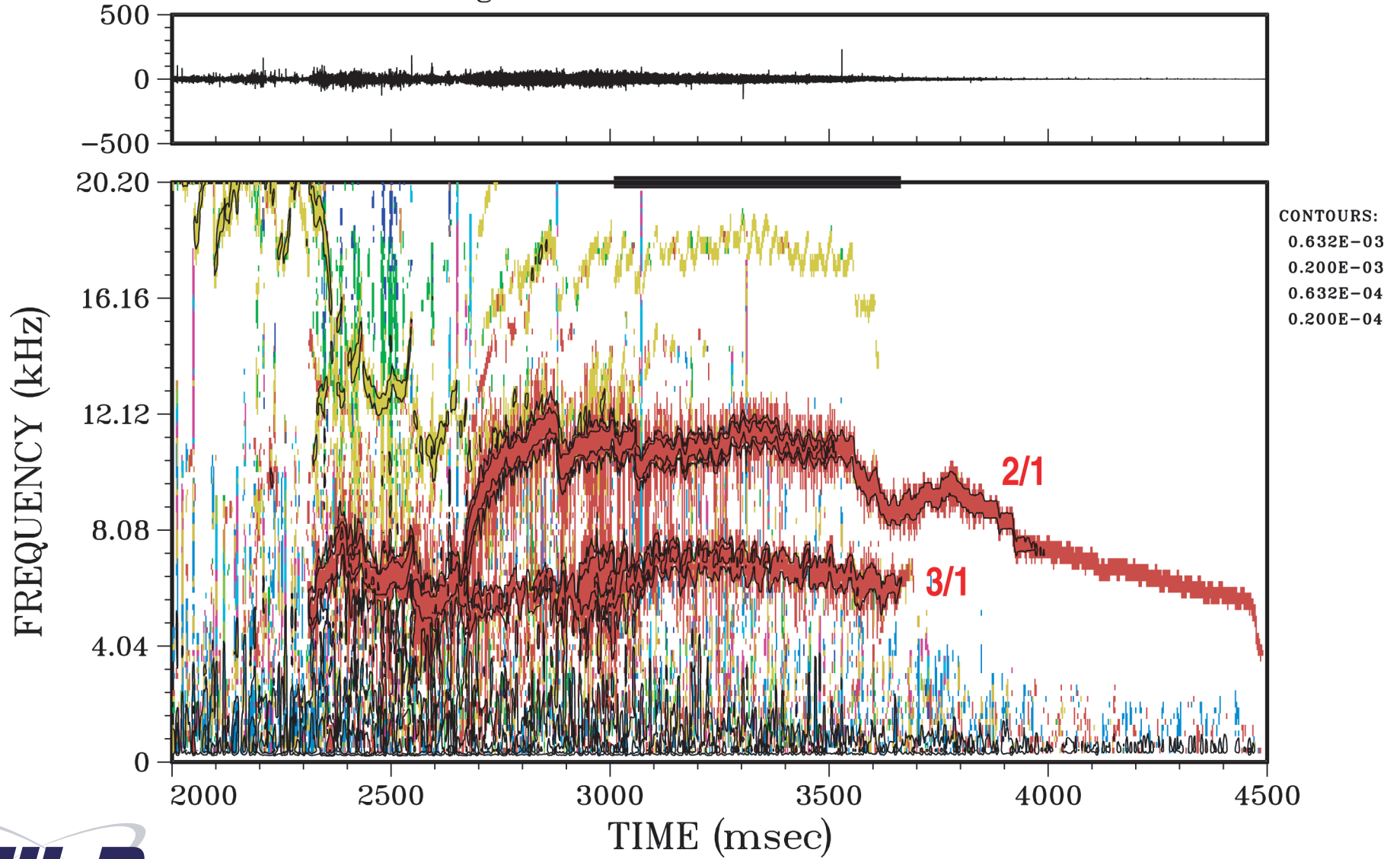
# New 2/1 Case (2 of 2)



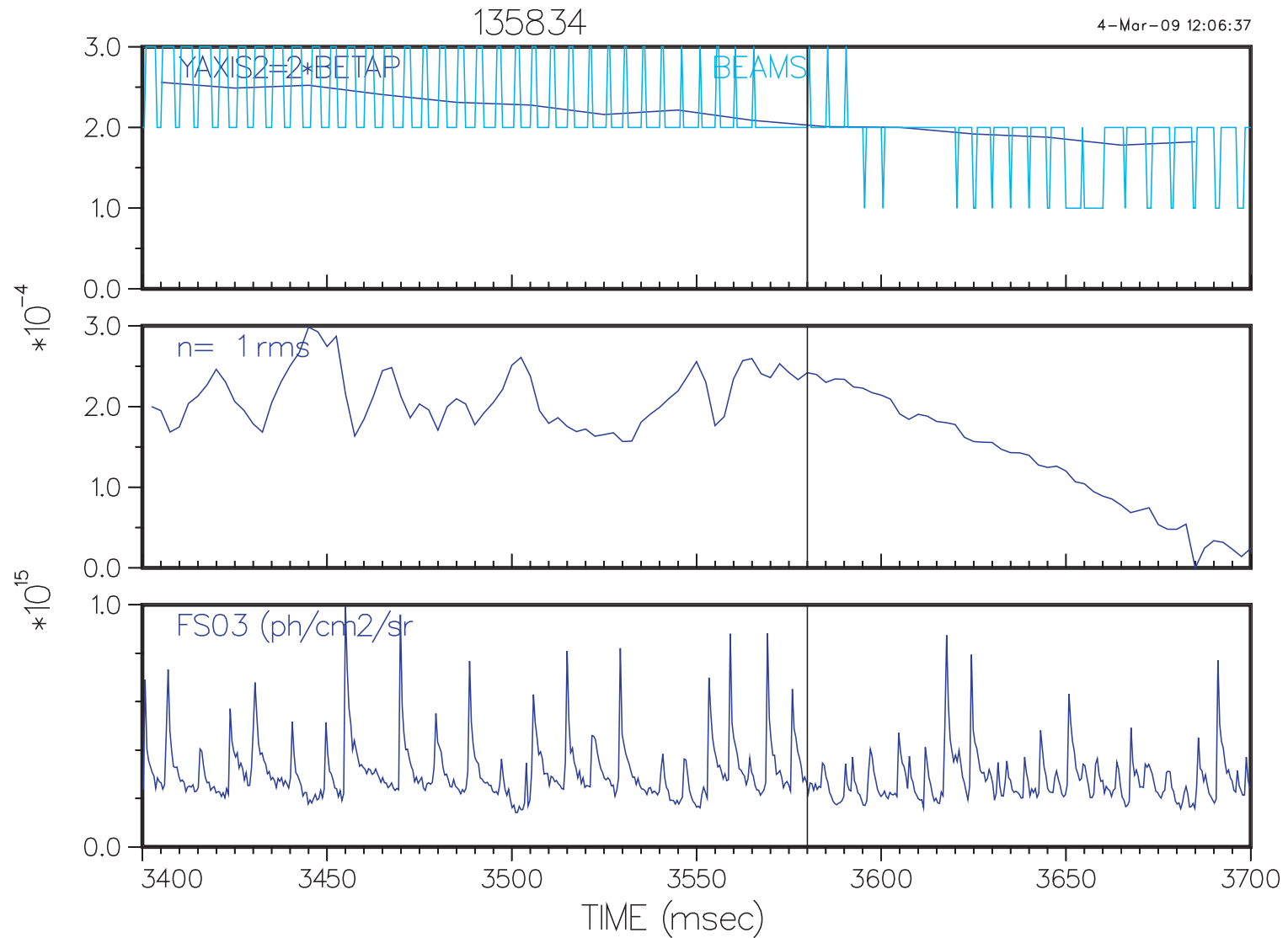


135834

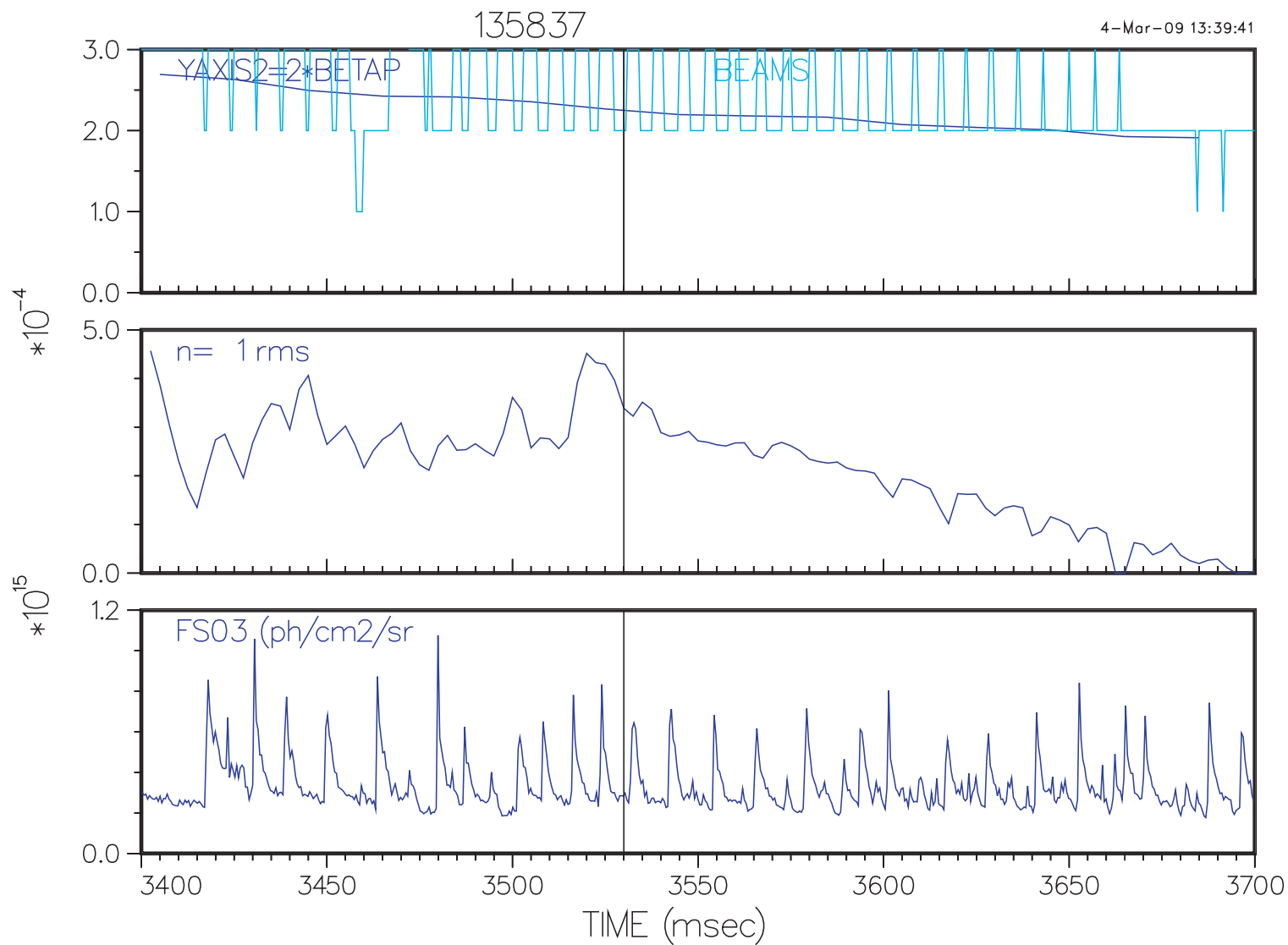
AMPLITUDE SPECTRUM 2000.0 to 4500.0 ms  
0.400 kHz smoothing ( 3 PTS) 5.0 ms intervals  
MPI66M307D -- integrated modes -4 to 5  
MPI66M340D -- integrated -5 -4 -3 -2 -1 0 1 2 3 4 5



# New 3/1 Case (1 of 2)



# New 3/1 Case (2 of 2)



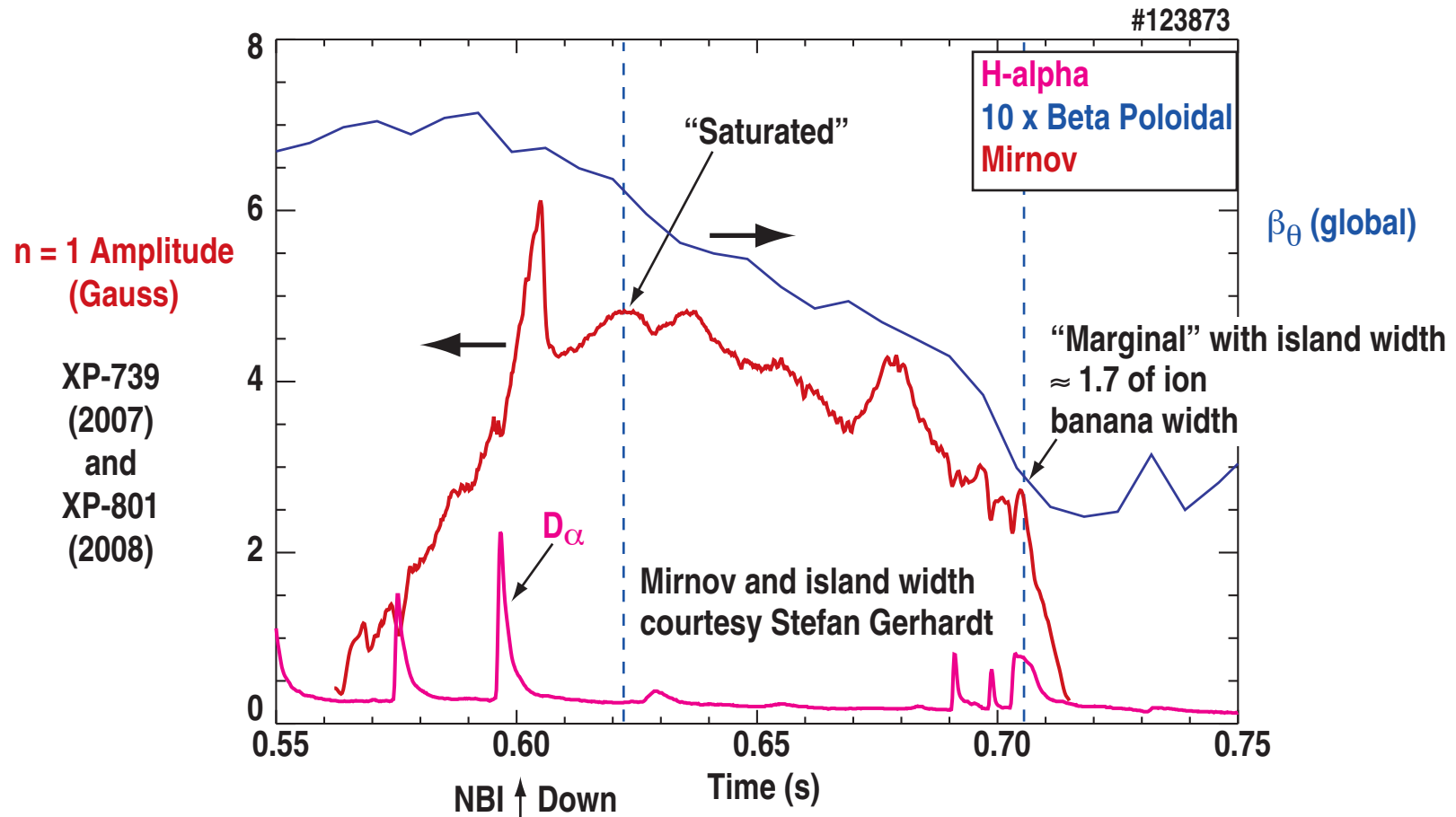
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$$\star \Delta' r \approx -\varepsilon_B^{1/2} (L_q/L_{pe}) (r/w_{sat}) \beta_{\theta e} \quad \star \Delta' r \approx -(2/3) \varepsilon_B^{1/2} (L_q/L_{pe}) (r/w_{marg}) \beta_{\theta e}$$

$$\approx -0.65 (0.083/0.158) (0.447/0.060) 0.22 \quad \approx -0.667 * 0.65 (0.128/0.081)(0.436/0.045)0.135$$

$$\approx -0.6 \quad \approx -0.9$$



# Recent NSTX Case

