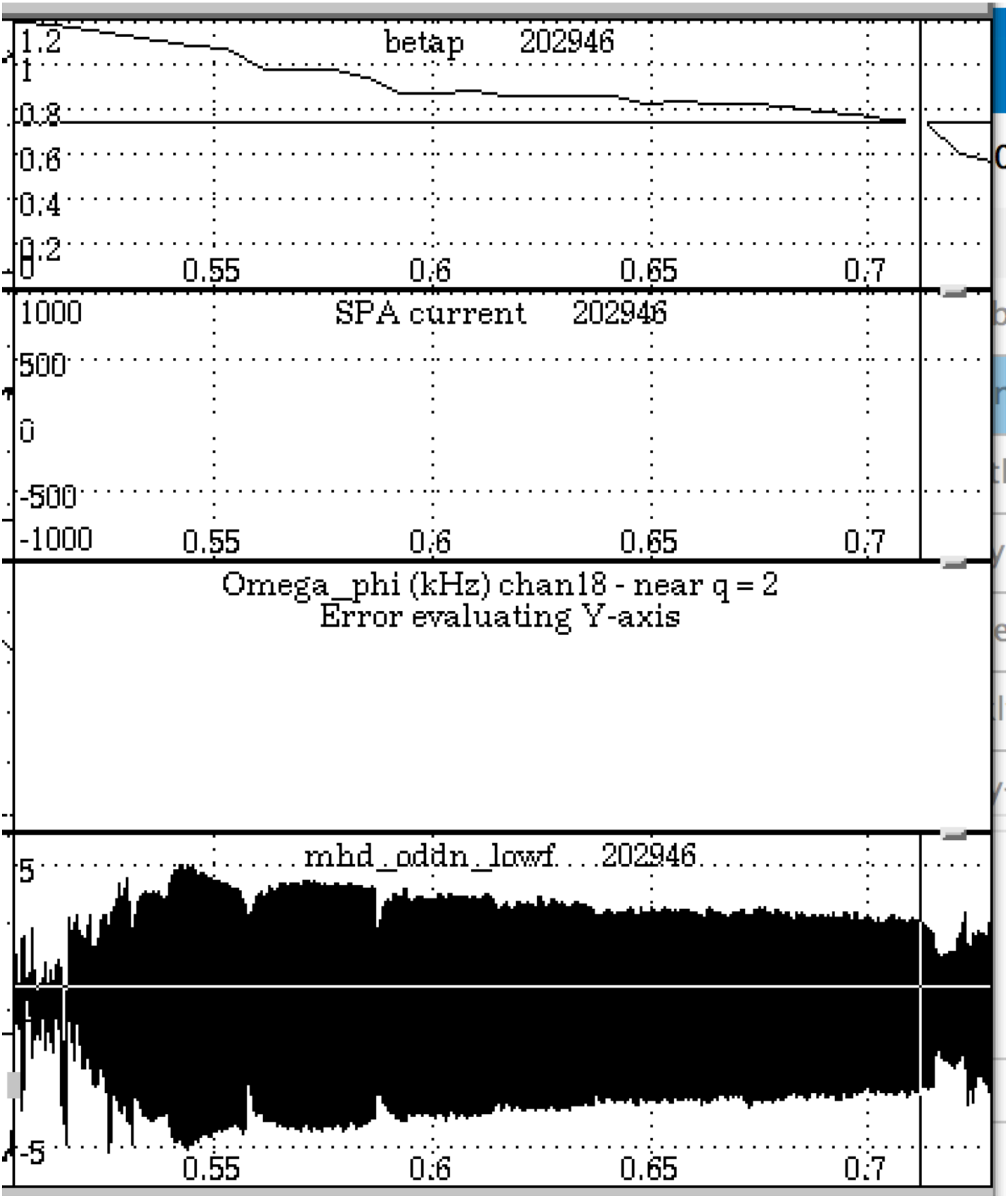
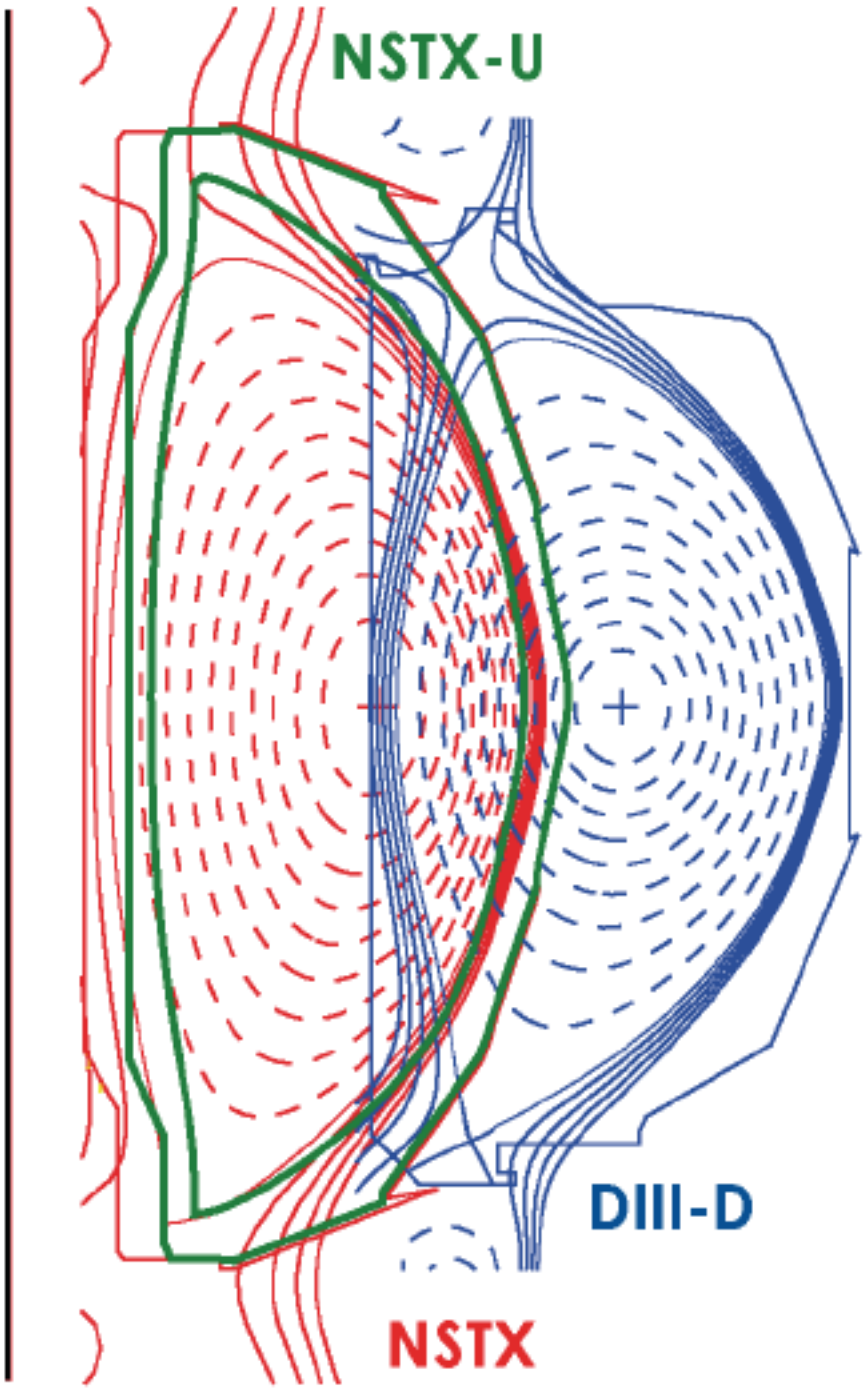
Sta Bil Ity
Words (mostly) and Music by Woody Guthrie

Oh, if you ain't got the **sta-bil-ity**, folks, you ain't got the **sta-bil-ity**,
Why, you better go back to beautiful Texas, Oklahoma, Kansas, Georgia, Tennessee.
California is a garden of Eden, a paradise to live in or see;
But believe it or not, ***you won't find it so hot***
If you ain't got the **sta-bil-ity**.


betap 202946
1.2
1
0.8
0.6
0.4
0.2
0
0.55
0.6
0.65
0.7
SPA current 202946
1000
500
0
-500
-1000
0.55
0.6
0.65
0.7
Omega_phi (kHz) chan18 - near q = 2
Error evaluating Y-axis
mhd_oddn_lowf... 202946
5
-5
0.55
0.6
0.65
0.7



Aspect Ratio R/a = 1.4, 1.7, 2.7

DIII-D/NSTX COLLABORATIONS ON 2/1 TEARING

[1] S.P. Gerhardt, D.P. Brennan, R. Buttery, R.J. La Haye, S. Sabbagh, E. Strait et al., "Relationship between onset thresholds, trigger types and rotation shear for the m/n=2/1 neoclassical tearing mode in a high-beta spherical torus"
Nucl. Fusion 49, 032003 (2009)

[2] R.J. Buttery, S. Gerhardt, R.J. La Haye, Y.Q. Liu, H. Reimerdes, et al.,
"The impact of 3D fields on tearing mode stability of H-modes"
Nucl. Fusion 51, 073016 (2011)

[3] R.J. La Haye, R.J. Buttery, S.P. Gerhardt, S.A. Sabbagh, and D.P. Brennan,
"Aspect ratio effects on neoclassical tearing modes from comparison between DIII-D and NSTX"
PHYSICS OF PLASMAS 19, 062506 (2012)

RELEVANT DIII-D WORK

[4] R.J. La Haye, B.W. Rice, E.J. Strait,
"Increasing the beta limit due to neoclassical tearing modes by raising the axial safety factor q(0)>1"
Nuclear Fusion 40, 53 (2000)

(5) J. A. Ferron et al. PoP 2005 12 056126

[6] C.T. Holcomb, J.R. Ferron, T.C. Luce, T.W. Petrie, J.M. Park, F. Turco, M.A. Van Zeeland, M. Okabayashi, C.T. Lasnier, J.M. Hanson, P.A. Politzter, Y. In, A.W. Hyatt, R.J. La Haye and M.J. Lanctot,
"Steady state scenario development with elevated minimum safety factor on DIII-D"
Nucl. Fusion 54, 093009 (2014)

XPs to MSG on n=1 Tearing Progress from Contact with NSTX to Natural q Evolution to Use of Off-axis NBI

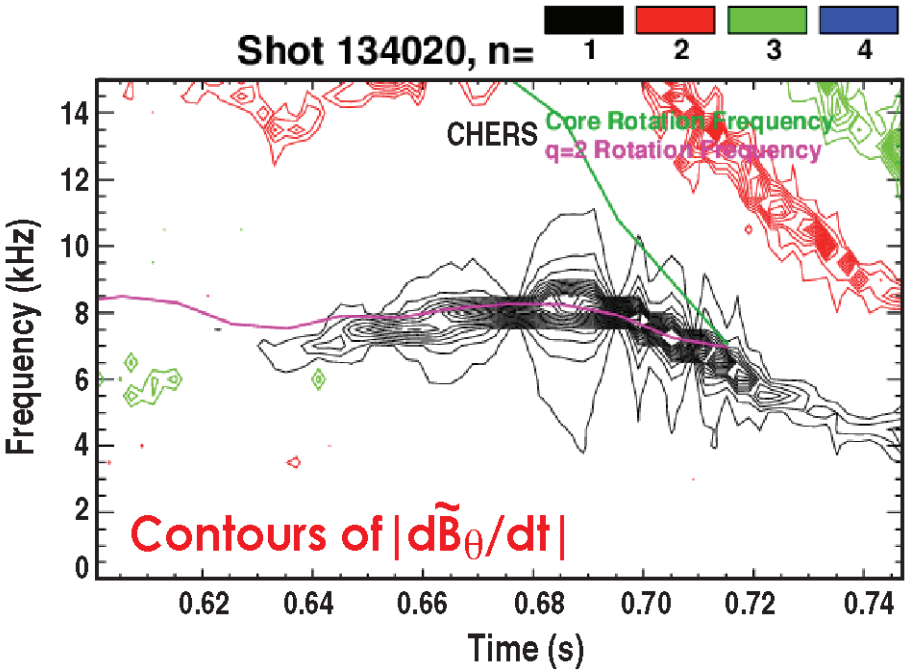
- **XP10: make contact with NSTX for n=1 tearing stability (La Haye)**
- **XP47: assess β_N and qmin n=1 tearing stability limits at the increased aspect ratio of NSTX-U (La Haye)**
- **XP93: compare benefits of off-axis NBI & coordinate with DIII-D (Ferron)**
  - FY 2015 JRT: "Conduct experiments and analysis to quantify the impact of broadened current and pressure profiles on tokamak plasma confinement and stability"

Larger Aspect Ratio in NSTX-U May Reduce Stabilizing Curvature for m/n=2/1 Tearing Stability From That in NSTX (Connection with NSTX Could be Done in Weeks 1–4, More Later)

- **Previous related NSTX XPs include**
  - 739 Marginal island width of NTMs
  - 740 NTM threshold at low rotation
  - 801 Further study of 2/1 NTMs
  - 915 Influence of rotation and error fields on tearing mode beta limits

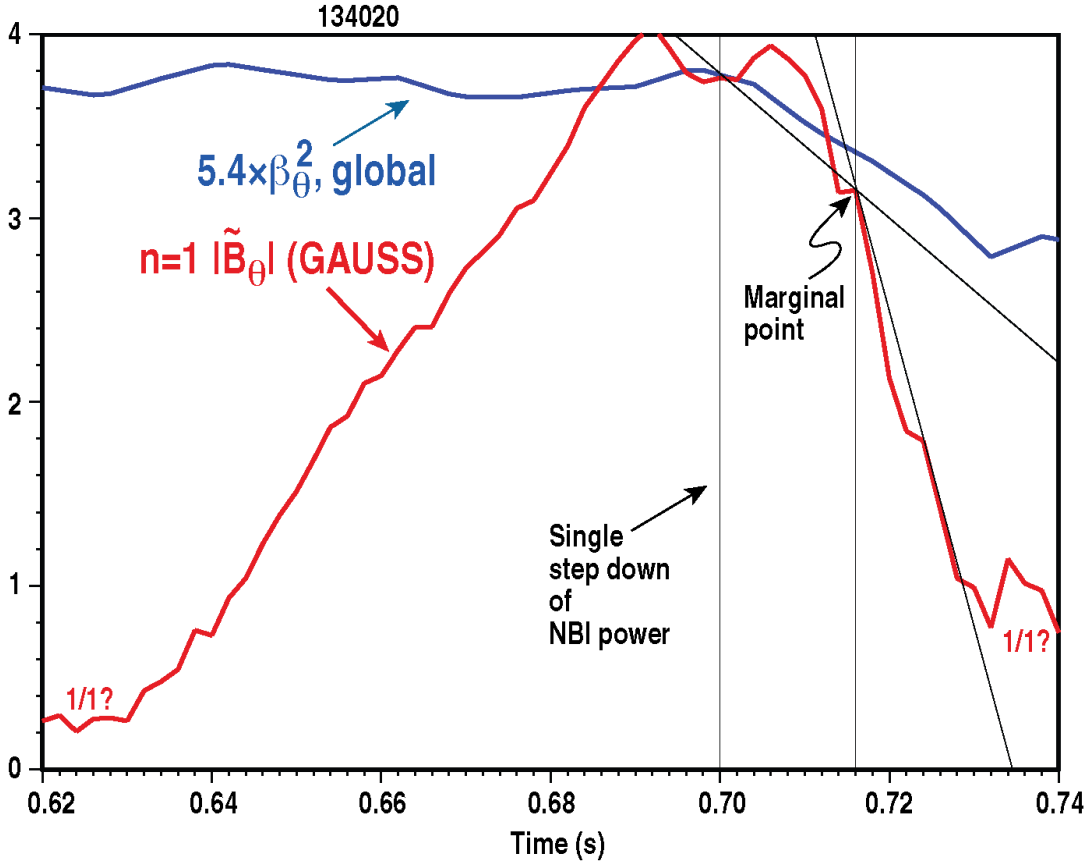
- **Publications include**
  - S.P. Gerhardt et al, NF 49, 032003 (2005)
  - R.J. Buttery et al, NF 51, 073016 (2011)
  - R.J. La Haye et al, PoP 19, 062506 (2012)

NSTX: Reproducible onset condition using modest L_i evaporation, and mode locking avoided by n=1 and n=3 error field correction (IP = 0.9 MA, BT = 0.44 T, "fixed" q_{95})



NSTX Exhibits Little Hysteresis in Beta Between n=1 NTM Excitation and Self-Stabilization ("Marginal Point")

- **NBI power stepped down after m=2, n=1 mode saturates**
  - mode wanes, then stabilizes

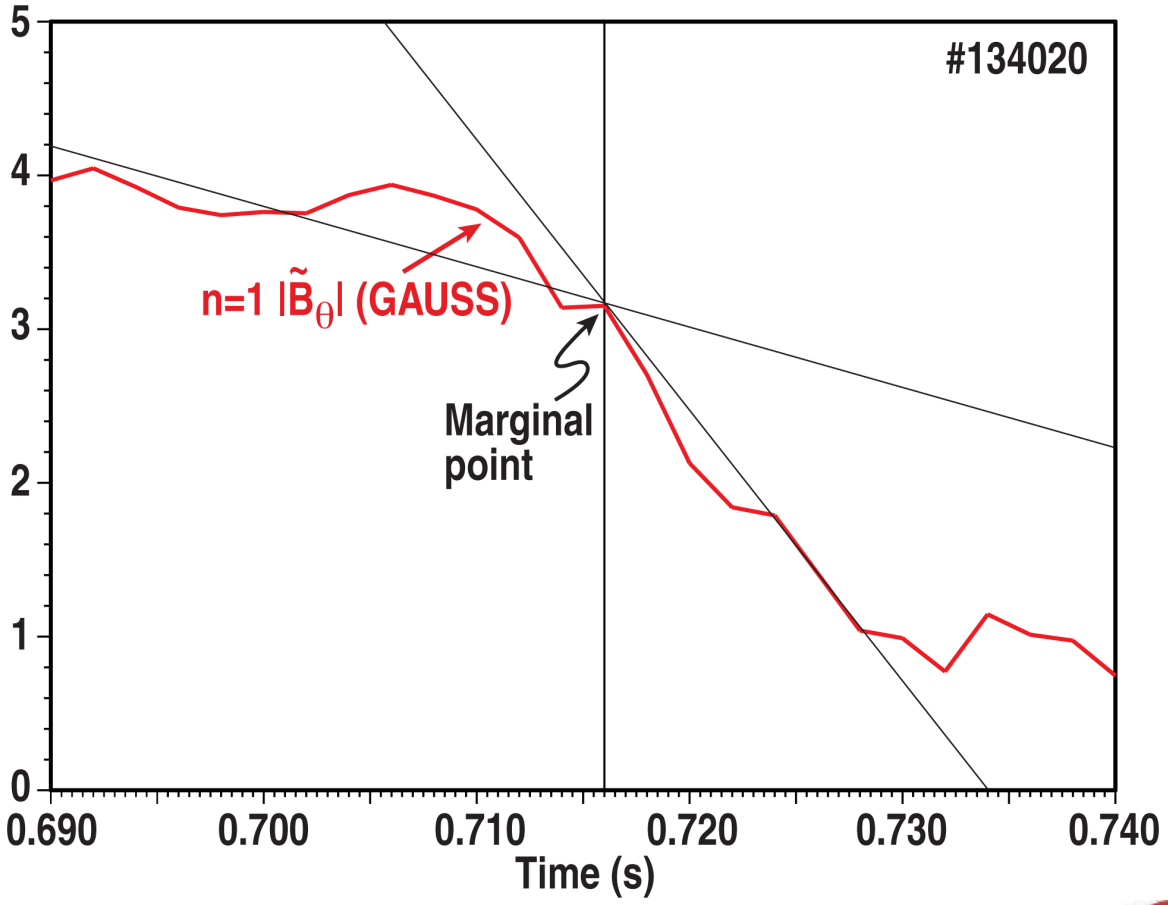


- **Classical tearing stability index $\Delta' \approx 0$ inferred**
  - curvature D_R balanced by neoclassical bootstrap drive D_{nc}
    - thus little hysteresis
  - advantage for low aspect ratio

- **$D_R/D_{nc} \approx -1.2\,(a/R)^2$**
  - NSTX → NSTX-U
    - $(a/R)^2$ x 2/3
      - less stable?

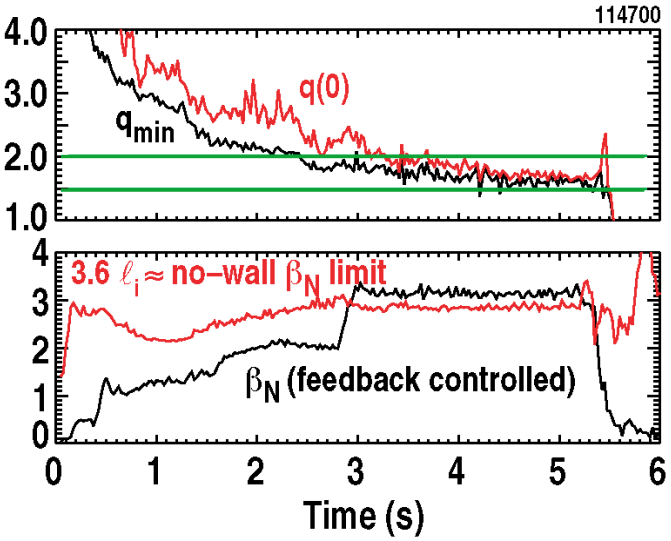
Marginal Point is Determined from Change in Slope of Mode Amplitude with Time (NSTX Example Shown)

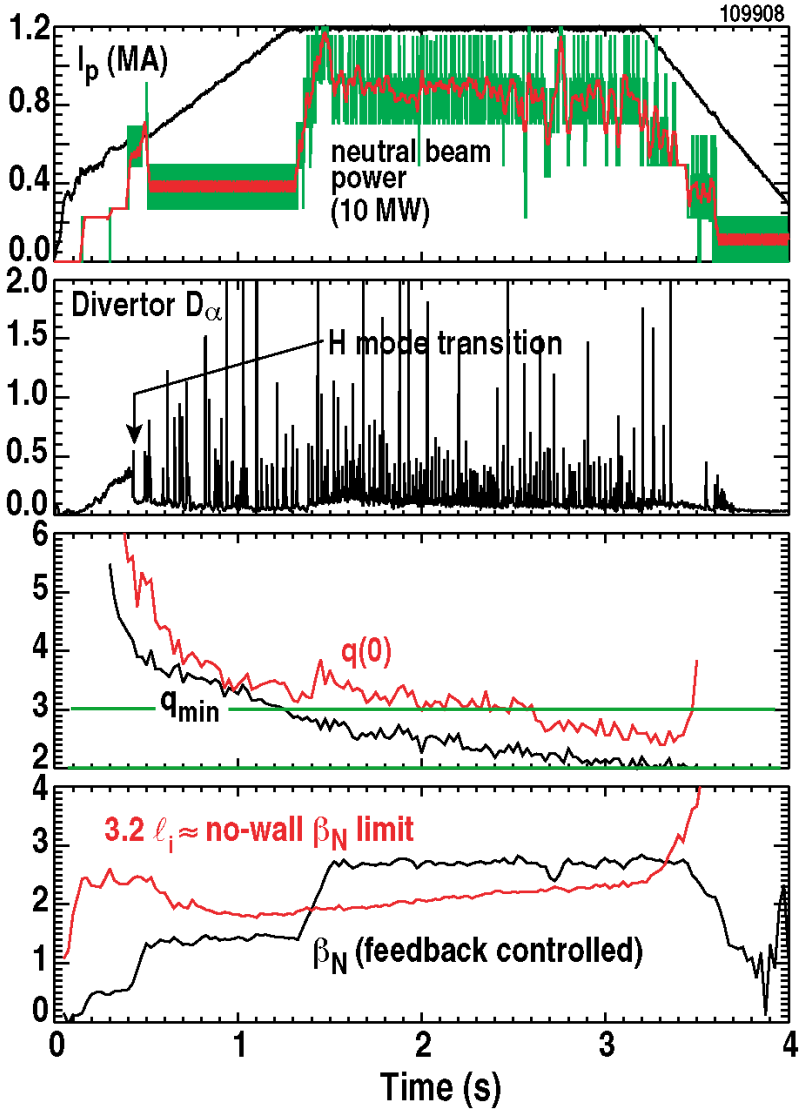
- **Slow decrease in beta (not shown) causes mode to get smaller**
  - mode wanes, then stabilizes



The q Profile Timing is Varied in DIII-D by Modifying the Discharge Formation or Delaying the High Beta Phase

- Increased T_e in H-mode slows rate of current penetration
- $1.5 < q_{min} < 3$, $q_{95} \approx 5$
- Two examples, $q_{min} \approx 2.5$, $\beta_N = 2.7$ and $q_{min} \approx 1.7$, $\beta_N = 3.2$ run without significant MHD for discharge duration
  - sweetspots for n=1 stability





DIII-D NATIONAL FUSION FACILITY SAN DIEGO

J. Ferron, etal., PoP 12, 056126120051

017-15/RJL/jy