XP804: Comparison of neoclassical toroidal viscosity (NTV) among tokamaks (n = 2 fields, ν_i scaling)

- Goals
  - Compare NTV results/analysis on NSTX to other devices
    - n = 2 data available JET, C-MOD, initial results in MAST (writing MAST 08 XP)
  - Test NTV theory for n = 2 applied field configuration
    - n = 2 may be best for comparison to other devices (n = 1 strongest resonant rotation damping, n = 3 weak in some devices, many machines run n = 2)
    - Examine possible RFA effects by varying proximity to no-wall limit
  - Investigate damping over widest possible range of ion collisionality to determine affect on rotation damping and compare to theory
    - Key for ITER, comparison to other devices important
  - Supplement past published NSTX results (XP524) using n = 1, 3 fields

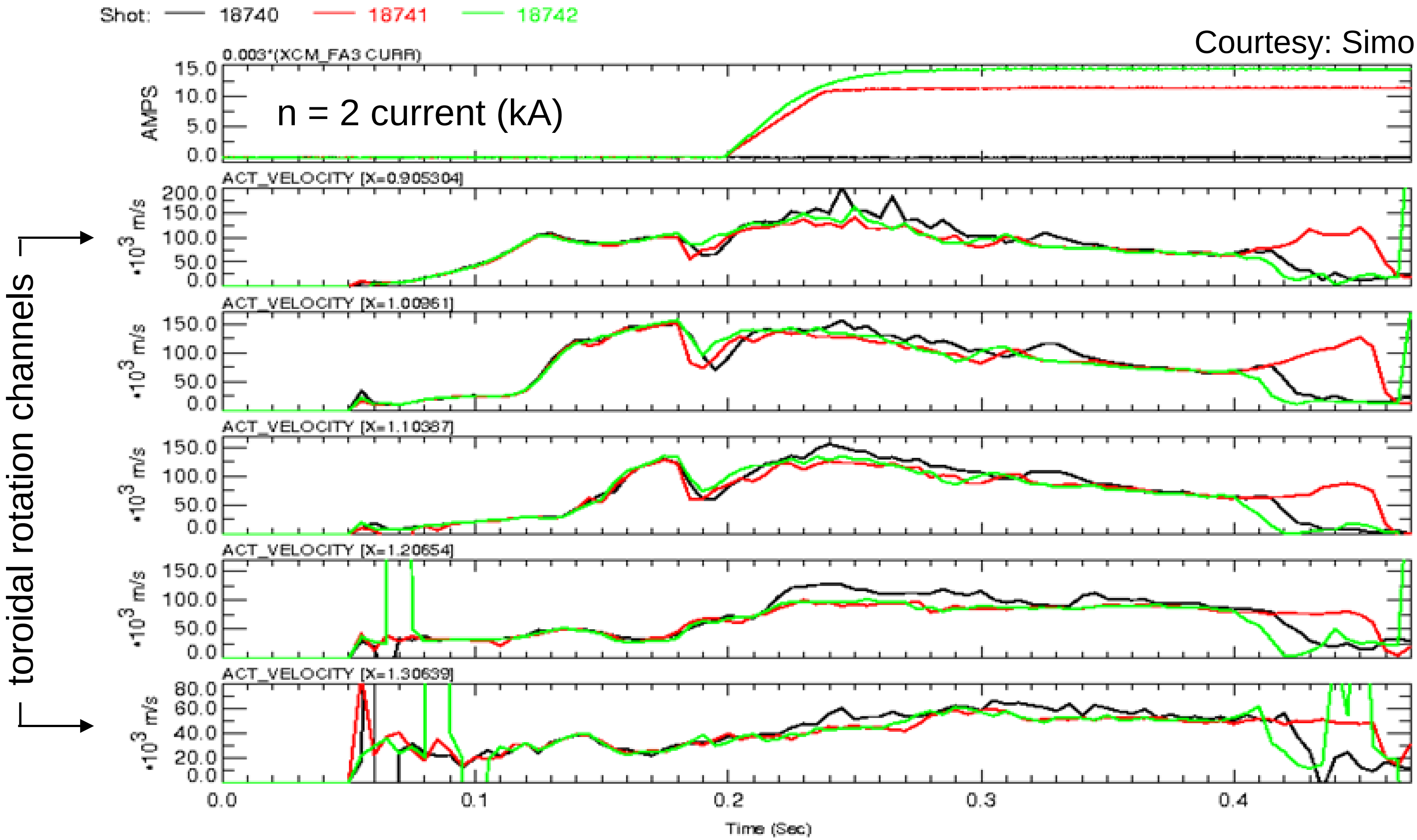
- Addresses
  - Joule milestone, leverages ST geometry
  - ITER support (RWM coil design), ITPA joint experiment MDC-12

XP804: NTV n = 2 and ν_i - Run plan 3/6/08

Shots taken

Task	Number of Shots
1) Create targets (i) below, but near and (ii) above ideal no-wall beta limit (control shots)	
(use 124606 as setup shot, 2 or 3 NBI sources, relatively high κ ~ 2.4 to avoid rotating modes)	
A) No n = 2 applied field; 3, then 2 NBI sources	2
2) Apply n = 2,6 field: (Use shot 127395 to set up n = 2 waveforms)	
A) Step up n = 2 currents during discharge in four 75ms steps, 500A/step, 3 NBI	2
B) Step up n = 2 currents during discharge in four 75ms steps, 500A/step (A + B)	2
C) n = 2 DC pulse at steady ω_ϕ, measure spin down, pulse off to measure ω_ϕ spin-up, 3 NBI	3
D) n = 2 DC pulse at steady ω_ϕ, measure spin down, pulse off to measure ω_ϕ spin-up, 1 or 2 NBI	3
E) n = 6 DC pulse at steady ω_ϕ, measure spin down, pulse off to measure ω_ϕ spin-up, 3 NBI	3
3) Ion collisionality variation	
A) Vary ν_i at constant *q*, apply n = 2 field during period free of strong rotating modes	8
B) Increase n = 2 field for shots with collisionality that yields the weakest damping	3
4) Reversed I_p scans	
A) Repeat scans 1 and 2 above in reversed I_p	13
Total (standard I_p; reversed I_p):	26 ; 13

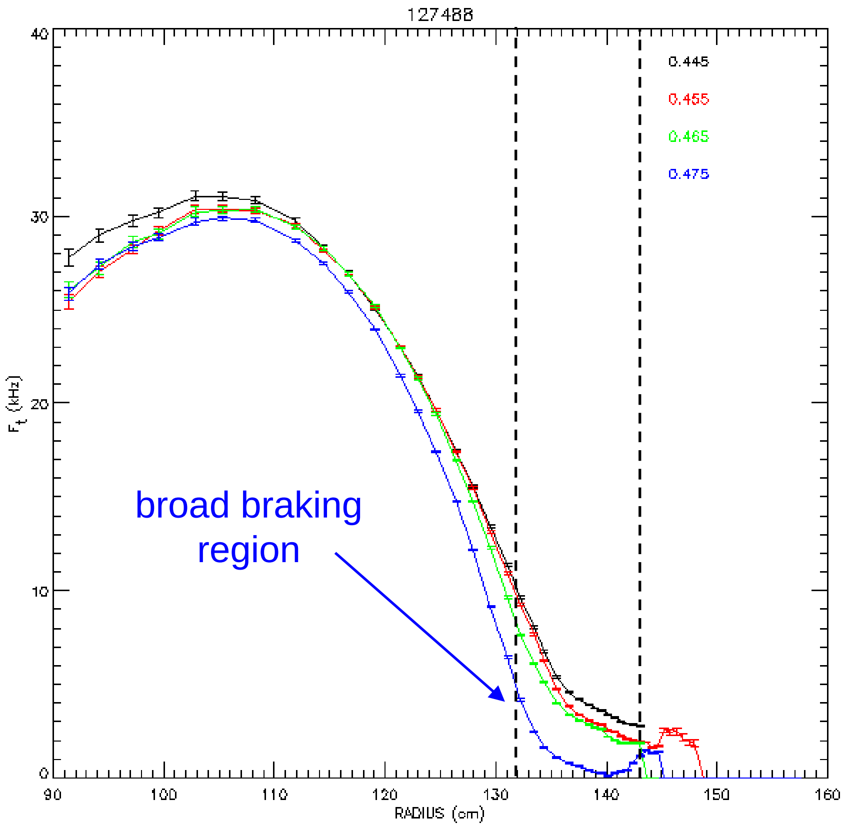
MAST first n=2 NTV experiment shows little effect



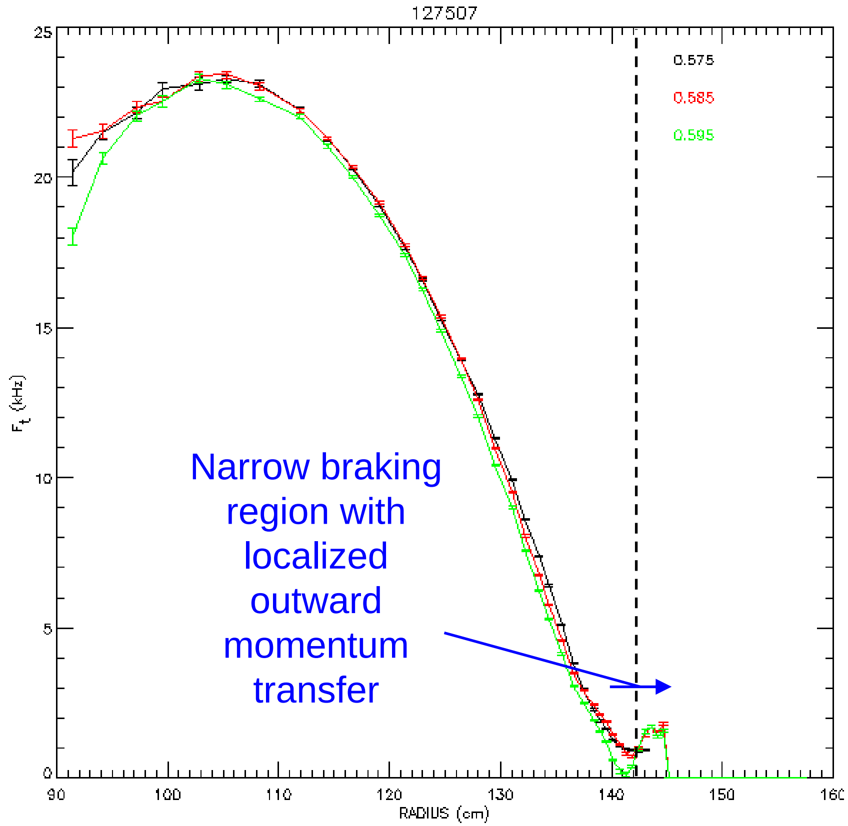
- MAST first results show an initial drop in rotation when the n = 2 field is switched on, but rotation the same in all three shots at a later time.
- BUT - JET n = 2 experiment showed clear braking effect!

Clear braking effect observed on NSTX, n=2 field

Rotation evolution during n = 2 braking



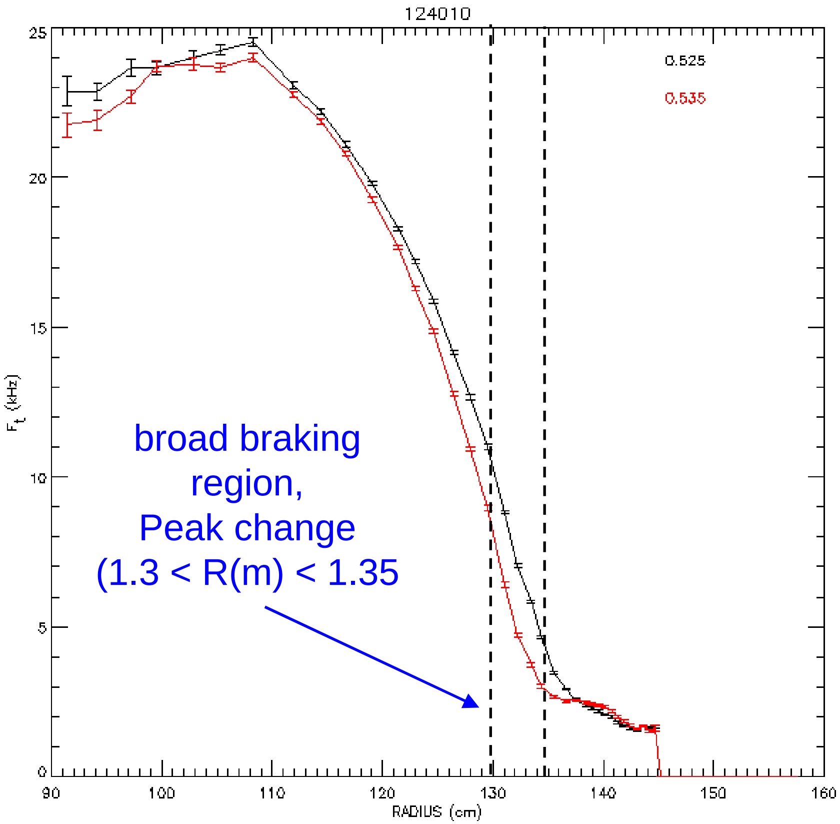
EXAMPLE: Apparent resonant surface braking



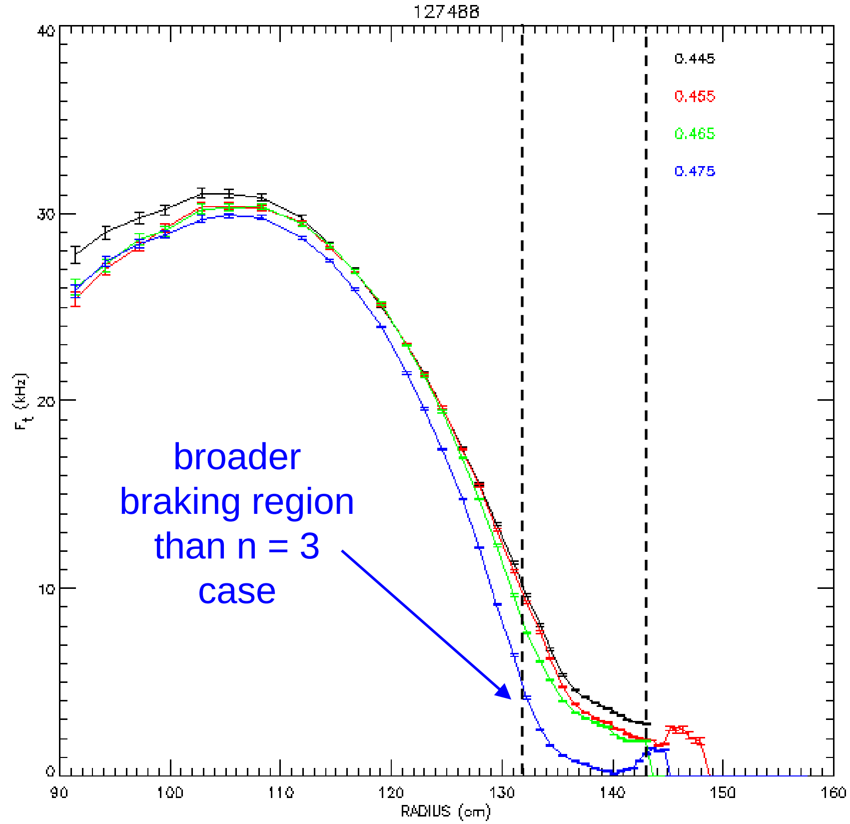
- Braking profile different from “resonant surface” braking sometimes observed
  - Does a key resonant surface still play a role?

Braking profile from n=2 field different than from n=3

Rotation evolution during n = 3 braking



Rotation evolution during n = 2 braking



- Broad region with greater effect at large R (field spectrum?)
- Next step – analyze non-resonant NTV profile
  - Strong enough to explain experiment? Compare to MAST, JET.