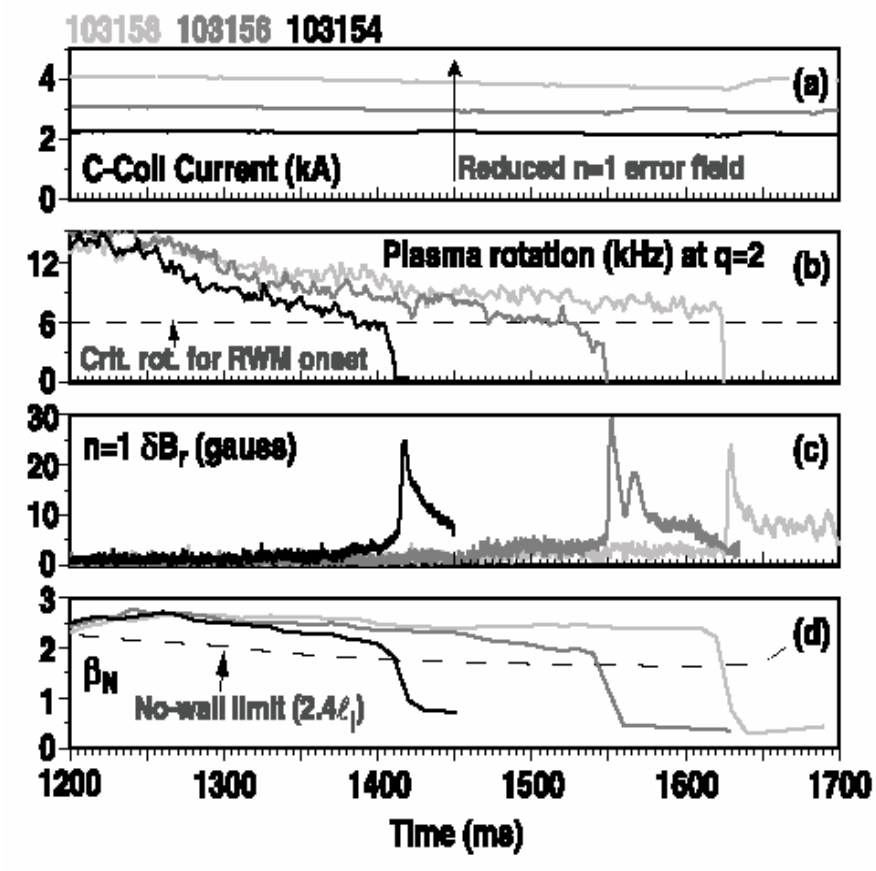
XP452: RWM physics with initial global mode stabilization coil operation

- Goals
  - Alter toroidal rotation / examine critical rotation frequency
    - Examine effect of applied DC error field
    - Greater control in timing to reach critical rotation frequency
  - Examine resonant field amplification (RFA)
    - Determine RFA amplitude / phase vs. $\beta_N/\beta_{Nno\text{-}wall}$
    - Determine stable RWM mode damping
  - Investigate MHD spectroscopy / possible dynamic stabilization
    - Determine RFA amplitude / phase dependence on frequency
    - Compute RWM damping rate and mode rotation frequency
    - Apply modulation at $1/\tau_{wall}$ ~ 50 – 100 Hz to attempt stabilization

Initial GMS coil XP targets have analogs in DIII-D MPs

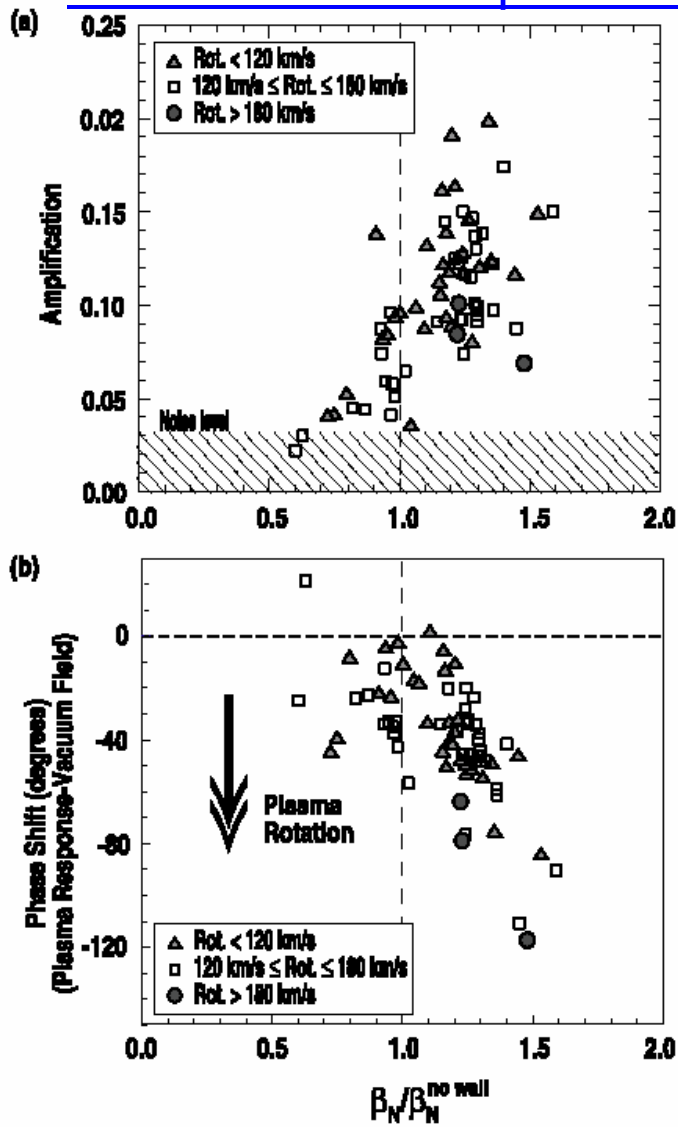
Critical rotation frequency



A.M. Garofalo, *et al.*, *Nucl. Fusion* **42 (2002) 1335.**

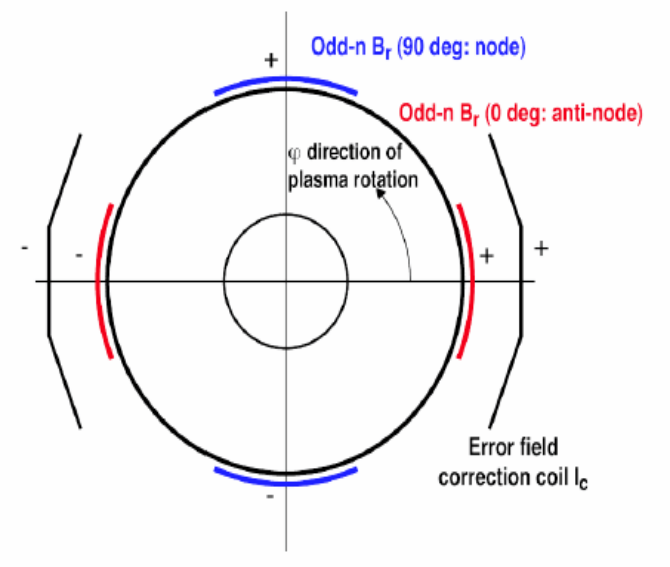
A.M. Garofalo, *et al.*, *Phys. Plasmas* **9 (2002) 1997.**

Resonant field amplification

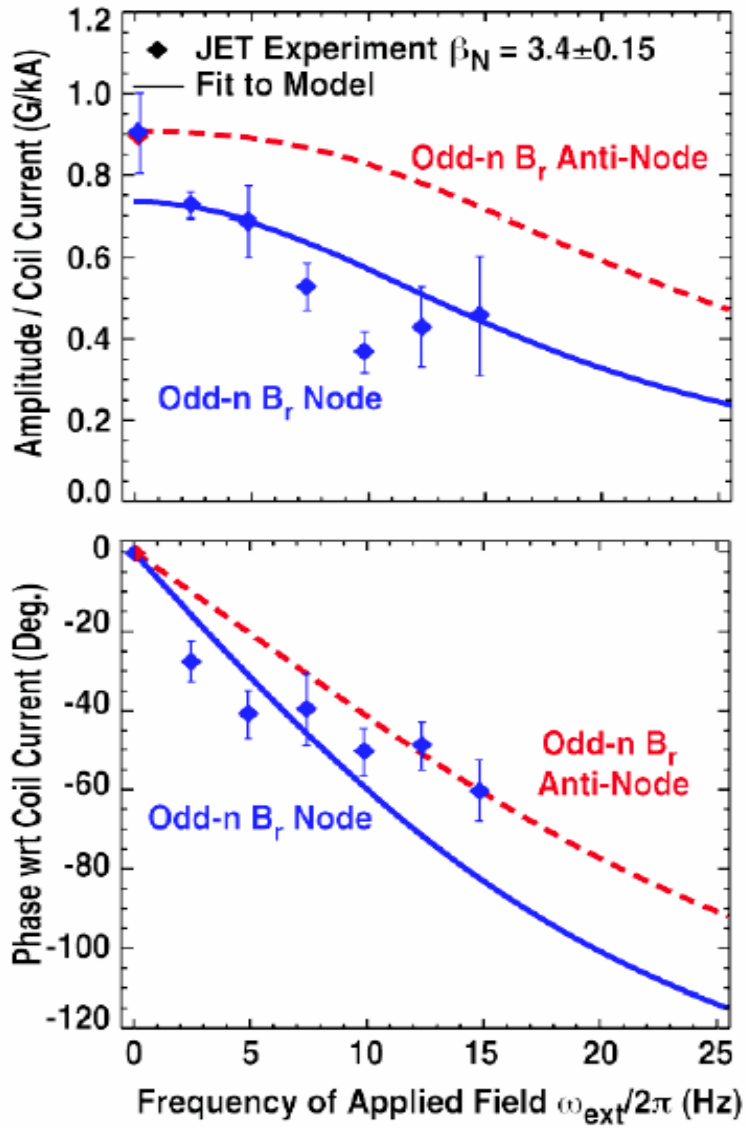


DIII-D/JET RFA Similiarity XP recently conducted

JET (error field coil and sensors)



- Coil similar to NSTX
- RFA data yields
  - amplitude / phase
  - stable RWM damping rate
  - mode rotation frequency



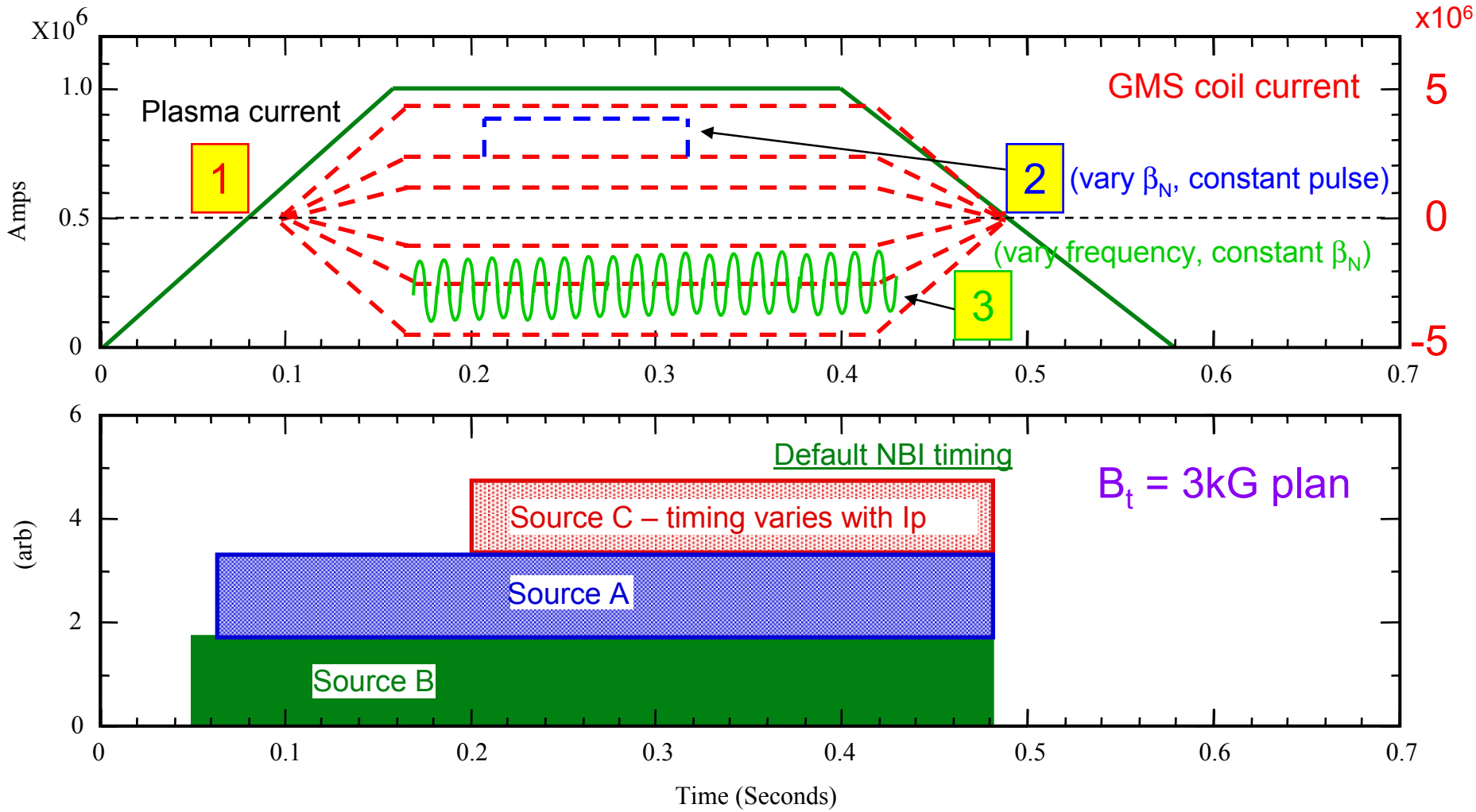
H. Reimerdes, *et al.*, *EPS Meeting 2004*.

XP452: RWM Physics with initial GMS coil - Run plan

Task	Number of Shots	
1) Critical rotation study / toroidal rotation alteration		
A) Vary DC applied current, phase 0 degrees:		
(i) 2.5 or 3 NBI sources, longest possible pulse with $\beta_N / \beta_{Nno\text{-}wall} > 1$	1	
(ii) Apply GMS coil current in four steps up to maximum allowed	4	
(iii) 1or 2 NBI sources ($\beta_N / \beta_{Nno\text{-}wall} < 1$) in above with high V_ϕ damping	1	sub
B) Repeat above with phase 180 degrees	5	(11)
2) RFA study		
A) Vary β_N, GMS DC coil current minimizing Vf damping + GMS coil current pulse:		
(Apply 0.1s pulse during a period of approximately constant β_N)		
(i) Vary β_N by using 1.5, 2, 2.5, 3 NBI sources	4	
(apply two GMS coil pulses per shot if discharge duration is long enough)		
(ii) Repeat with one other GMS DC coil current conditions to vary V_ϕ	4	
(iii) Vacuum field shots (to eliminate eddy current effects of pulse)	4	(12)
3) MHD spectroscopy / dynamic stabilization		
A) Vary applied field modulation over DC GMS coil current minimizing V_ϕ damping:		
(Apply modulation early ($\beta_N / \beta_{Nno\text{-}wall} < 1$) through planned end of discharge)		
(i) 3 NBI sources, vary applied field frequency 40, 30, 20, 12, 7 Hz	5	
(ii) 2 NBI sources, vary applied field frequency	3	
B) 1 NBI source at GMS frequency that produced maximum RFA amplitude	1	
C) Apply modulation to DC offset that destabilizes RWM: three frequencies	3	
D) Vacuum field shots for each frequency used (if necessary)	5	(17)
4) (Optional) repeat the most successful trials above with an even parity perturbation	(optional 20)	

Total: 40

Schematic Waveforms for GMS coil – XP452



- Aspect ratio in 110184 increased in time – vary A in similar way

Duration and Required / Desired Diagnostics

- XP could be completed in 1.5 run days
  - Overlap with DIII-D/NSTX RWM Similarity experiment
- Required
  - Magnetics for equilibrium reconstruction
  - Internal RWM sensors
  - CHERS toroidal rotation measurement
  - Thomson scattering
  - Diamagnetic loop
- Desired
  - USXR diagnostic at two toroidal positions
  - Toroidal Mirnov array
  - MSE