

XP818: Exploratory approach to finding ELM mitigation solution with midplane non-axisymmetric coils

- Goal

- Demonstration of ELM mitigation with NSTX midplane RWM coil set

- Approach

- Target development

- (i) low $q_{95} < 6$; (ii) swept q_{95} to insure mitigation not missed due to resonance ; (iii) high $q_{95} > 8$

- Application of DC fields (broader n spectrum, new 2008 capabilities)

- Past odd parity fields ($n = 3, 1+3$) operating on low q_{95} target
- New even parity field ($n = 2$ (strong $n = 4$), 6) capability for 2008
- New combined odd/even parity (present favorite $n = 2 + 3$)

- Application of AC fields

- Using either/both odd and even parity fields; co/ctr propagation
 - ELM mitigation through effects on edge plasma profiles
- Feedback on $n = 1$

- May be useful for giant ELMs, buildup detected by RWM B_r sensors

- Repeat techniques showing most potential in low recycling (post-LITER)



XP818 ELM Mitigation run on two days last week

Shots taken (Mon. + Fri.)

Task	Number of Shots
1) Create target plasmas	
A) Create $q_{95} < 6$ target: (generate at least 10 ELMs with approximately even spacing) ($q_{95} \sim 5.5$ is adequate)	
- Use shot 124349 as setup shot, ($I_p = 0.8$ MA, $B_t = 0.5$ T), change NBI source C to 1 MW unmodulated	2
- Raise I_p to 0.9 MA; change B_t to 0.45T, then 0.40T	3
- If $q_{95} > 6$ and insufficient ELMs, perform startup optimizations as per J. Menard to raise q_{min} .	(8)
B) Create q_{95} ramp target	
- Start from low q_{95} target created in step (1A), I_p flat-top to 0.7 MA, ramping up to 1.0 MA; adjust eventual I_p flat-top if needed to create steady ELMs.	4
- if plasma drops out of H-mode, start I_p ramp from 1.0 MA ramping to 0.7 MA	(2)
- vary B_t to change range of q ramp (optional)	(2)
C) Create $q_{95} > 8$ target	
- Use shot 124349 as setup shot, ($I_p = 0.8$ MA, $B_t = 0.5$ T), change NBI source C to 1 MW unmodulated	
- Drop I_p to 0.7 MA; tweak to 0.75 MA if desired	2
2) Attempt ELM mitigation with non-axisymmetric fields under normal recycling conditions	
- <u>DC fields</u> :	
A) Apply $n = 3$ field configuration; vary amplitude from 1.5 kA	4
B) Apply $n = 3 + 1$ field configuration; vary amplitude from 1.0 kA, 0.5 kA	4
C) Apply $n = 2 + 3$ field configuration (start from RWM (1-4) 0.5kA, RWM (2,6) 0.5kA, RWM (3,5) 1.5 kA)	4
D) Apply $n = 2$ field configuration; vary amplitude from 1.5 kA	4
E) Apply $n = 6$ field configuration (primary field is $n = 0$); vary amplitude from 2.5 kA	3
- <u>AC fields (pre-programmed)</u> :	
F) Apply $n = 3$; vary f above/below ELM frequency; vary amplitude from 2.0 kA	4
G) Apply $n = 1$ (co-propagating); vary f above/below ELM frequency; vary amplitude	4
H) Apply $n = 1$ (ctr-propagating); vary f above/below ELM frequency; vary amplitude	4
- <u>AC fields ($n = 1$ feedback)</u> :	
I) $n = 1$ B_r feedback: giant ELM target (e.g. 125271), vary (i) gain (ii) phase	6
3) Attempt ELM mitigation with non-axisymmetric fields under reduced recycling conditions	16
Total (optional): 64 (12)	

XP818 successful so far in changing ELM frequency

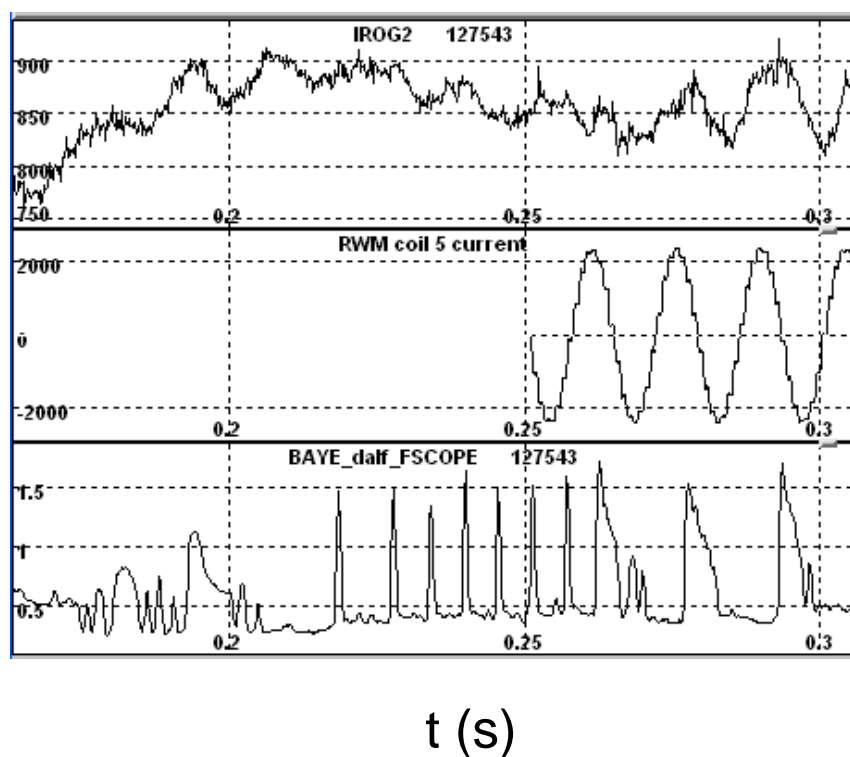
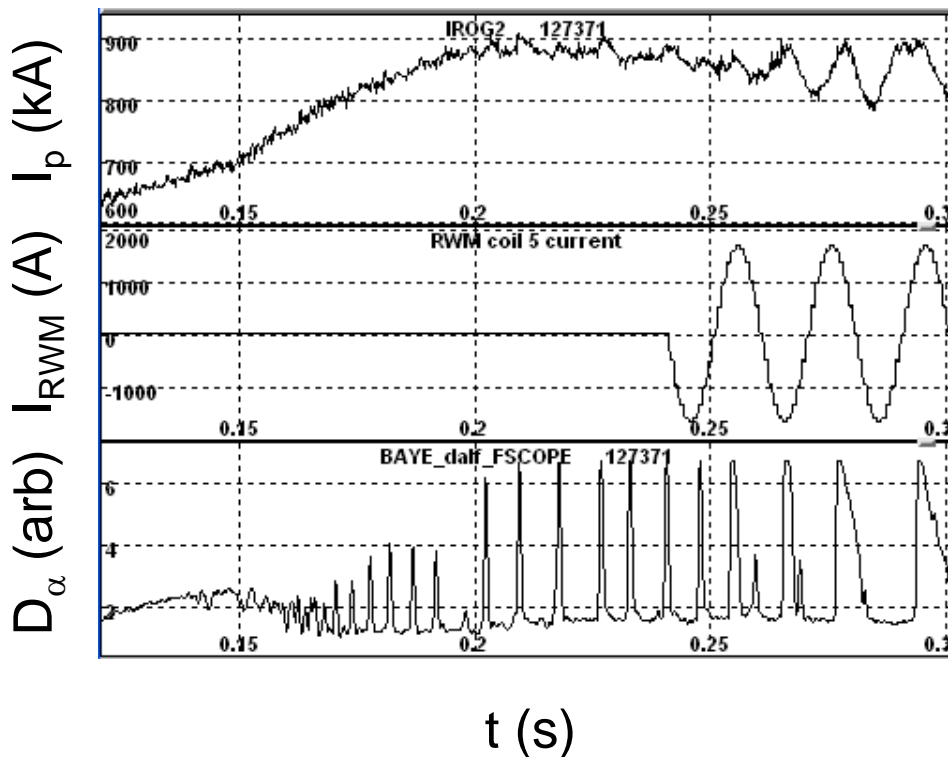
- ELM frequency initially reduced with application of AC fields
 - First shown with $n = 3$ AC standing wave, then $n = 2$ AC
 - AC fields allow application of greater peak RWM coil current before plasma rotation damping becomes too severe
 - Also shown with DC fields
 - Jokingly named: “Pulsed High Amplitude Transient” – PHAT ELMs
 - Longer duration (multi-filament), lower frequency than Type I
- Key to now understand the effect - aim for mitigation
 - Effect is not restricted to a narrow range of q_{95} – a good thing!
 - Mitigation in DIII-D shown to be sensitive to q_{95}
 - Effect is apparently not highly sensitive to applied field
 - Clear dependence on field amplitude
 - Dependence on field configuration ($n = \text{odd, even}$) and application (AC, DC) not yet concluded
 - Frequency $\sim 50\text{Hz}$ largely independent of applied field
 - Variation of plasma quantity is affecting ELM



Reduced ELM frequency observed in several applied field configurations

[n = 3 AC field, 70 Hz, 3.8 kA peak-to-peak](#)

[n = 2 AC field, 70 Hz, 5.5 kA peak-to-peak](#)



- Timing of PHAT ELMs correlated to timing of applied field in dedicated shots

