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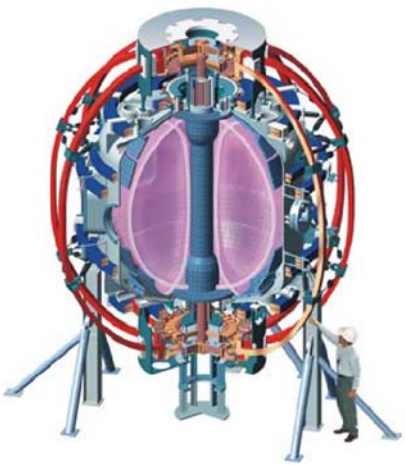
# Joint Experiment on ELM Mitigation with Midplane Control Coils

S. A. Sabbagh, T. Evans, D. Gates, R. Maingi, J.E. Menard, J.K. Park, many others…



**Joint ELM Mitigation XP Meeting**

January 28, 2008

Princeton Plasma Physics Laboratory

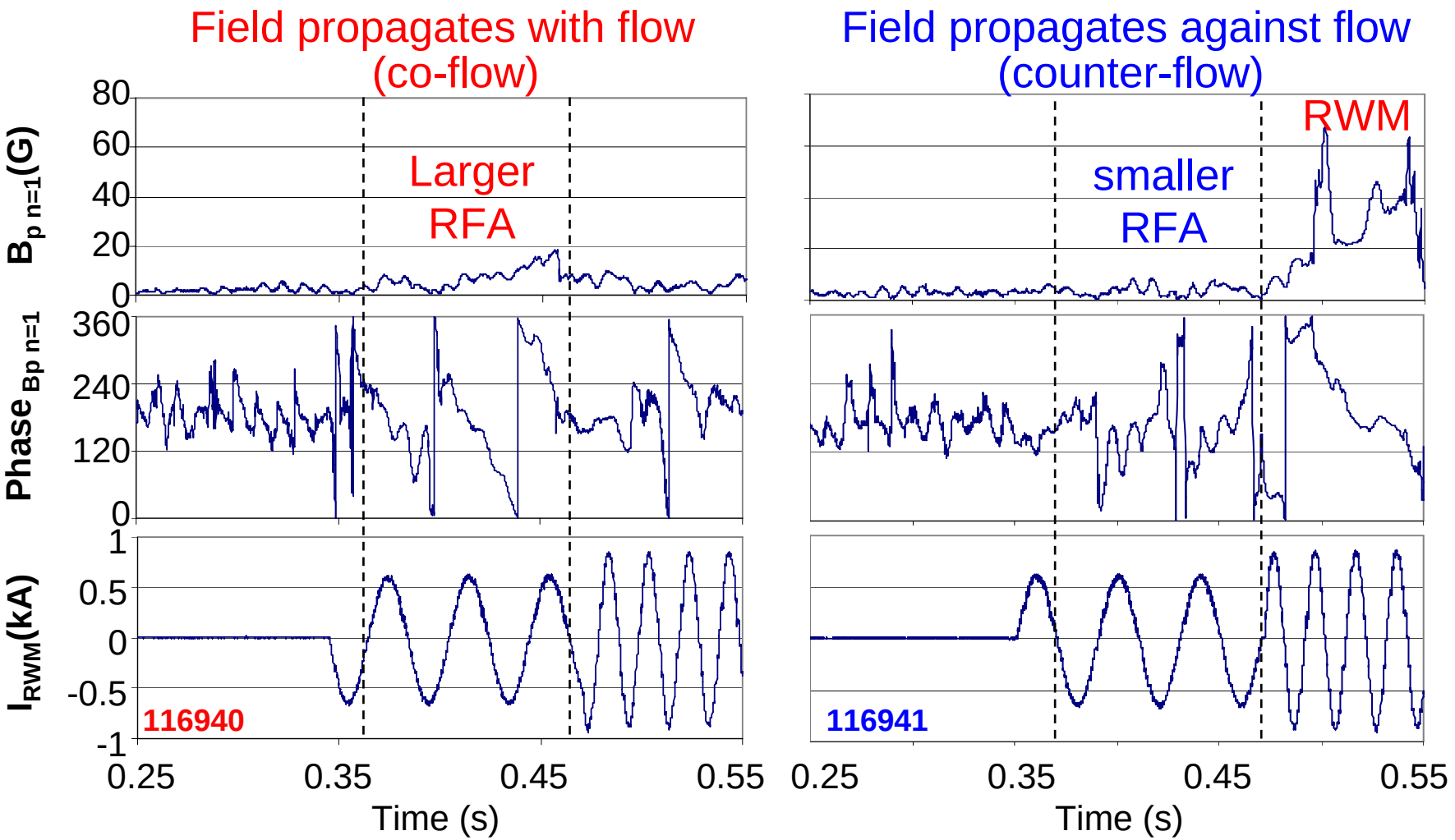
# Exploratory approach to finding ELM mitigation solution with midplane non-axisymmetric coils

- Goal
  - Demonstration of ELM mitigation with NSTX midplane RWM coil set
- Approach (complementary to other proposed plans)
  - Application of broader n spectrum of DC fields
    - Non-standard coil configs: (i) turn off one coil, (ii) turn off 5 coils, (iii) turn off every other coil, (iv) slow pre-programmed toroidal propagation of setup (iii)
    - New “n = 2” applied field capability for 2008, vary phase
    - Perturbations away from “n = 1” control currents (which have n = 1,5 dominant), superposition of n = 1 – 3, higher n
    - Bonus: Can get NTV rotation braking data piggyback!
  - Application of AC fields
    - Pre-programmed toroidal propagation of several DC setups mentioned above
      - Might stimulate ELM to allow to transform large ELMs into smaller (acceptable) ELMs
      - Now examining existing ELM mitigation evidence from past RWM, NTV experiments
    - N = 1 feedback
      - Can best feedback configuration from 2007 alter ELM dynamics?
  - Take best approach above and run in closest ITER shape w/ELMS

# Experimental Configurations discussed to date

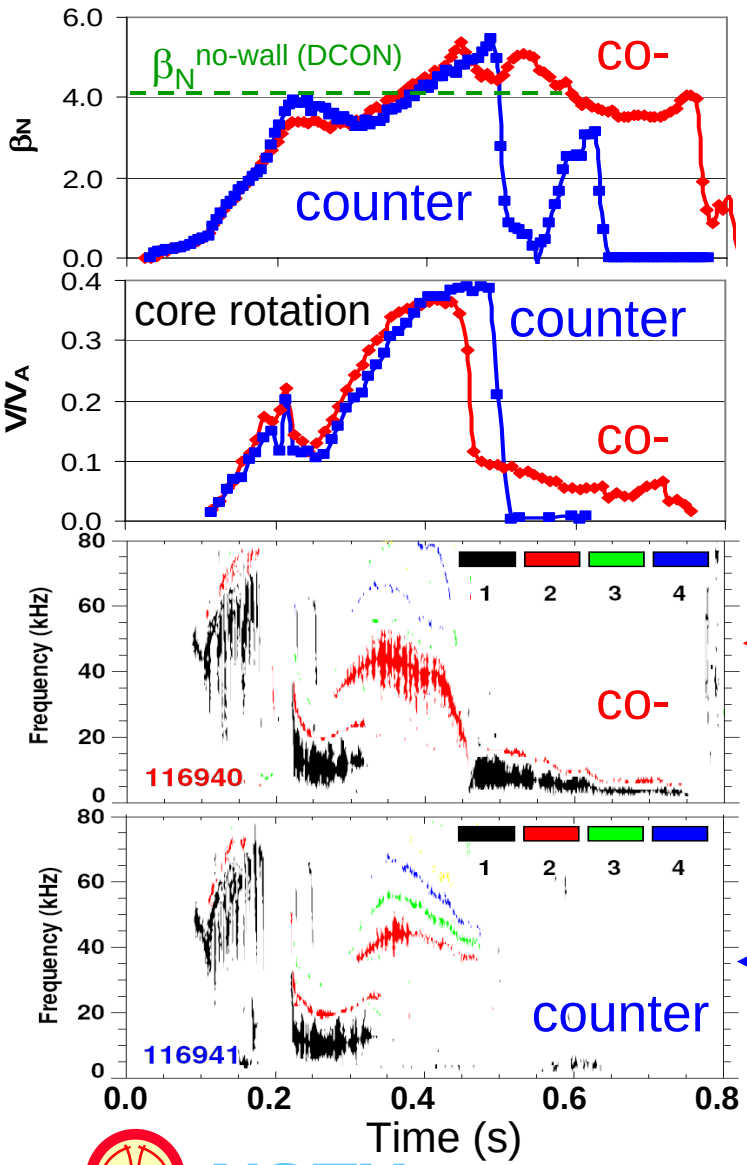
- Discussion / analysis delayed for several reasons – still underway
  - Plan to bring together strawman run plan this week for comment
- Configurations discussed to date
  - Application of broader n spectrum of DC fields
    - Combination of n = 2 and n = 3 fields
    - Application of n = 6 field (primary is n = 0 field)
    - Suggestion of n = 1 and n = 2 fields of high enough amplitude to bring $V_\phi = 0$
    - n = 3 ELM destabilization shots with NBI torque scan (examine $V_\phi$ effect)
  - Application of AC fields
    - Pre-programmed fields
      - n = 2, 3 non-rotating field configurations, AC variation of amplitude to cyclically affect rotation; combined field and rotation variation to affect ELMs (changes to grad(P), J)
      - n = 1 rotating fields – both co- and counter propagating; n = 2 time-varying phase
    - N = 1 feedback
      - Few ms rise time ok for feedback, but amplitude, mode number is going to be key (e.g. shot 123474 ELMs too small amplitude to be detected; needs strong n = 1 component)
      - "Giant" ELMs show n = 1 $\Delta B_r$ rise (also n = 2 and n = 3), $\Delta B_p$ responds to ELM crash – possibly feedback on $\Delta B_r$

# Direction of applied n=1 traveling wave alters RWM stability

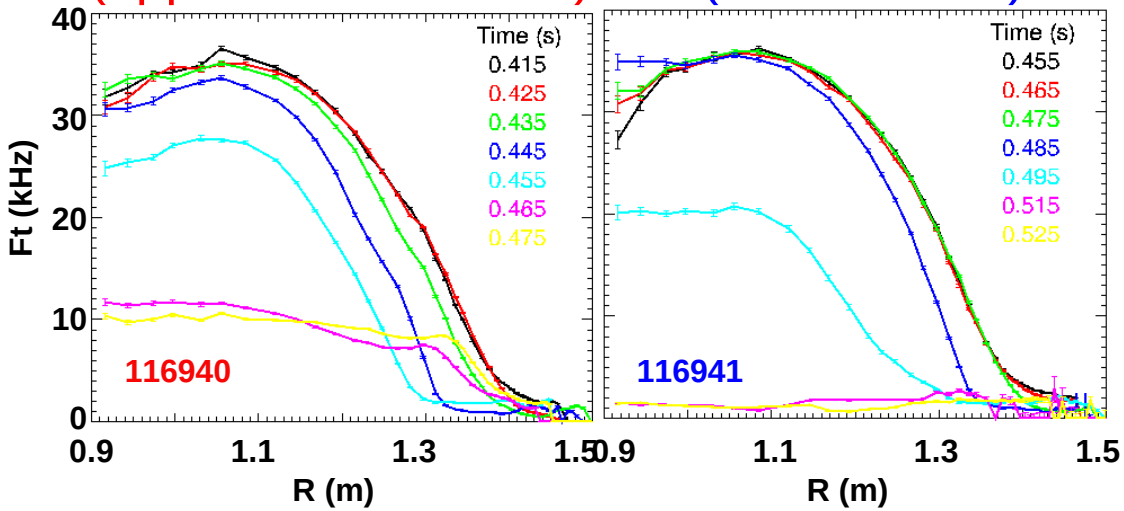



- Stronger RFA with co-flow field
- RWM not destabilized
- Weaker RFA with counter-flow field
- Unstable RWM

# Unstable RWM avoided with rapidly rotating n = 1




(applied field co-flow) (counter-flow)




- Applied field in the direction of plasma flow:
  - RFA increases and rotation damps
  - n=1 internal mode triggered
  - Rigid rotor rotation profile; beta recovers
- Applied field against the plasma flow:
  - RWM grows
  - Rapid, complete rotation and beta collapse