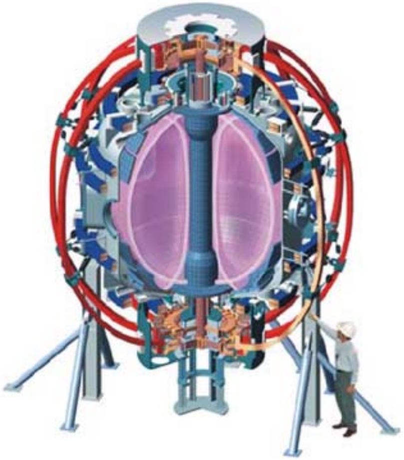
Supported by

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…



NSTX MHD SFG Meeting

December 11 2007

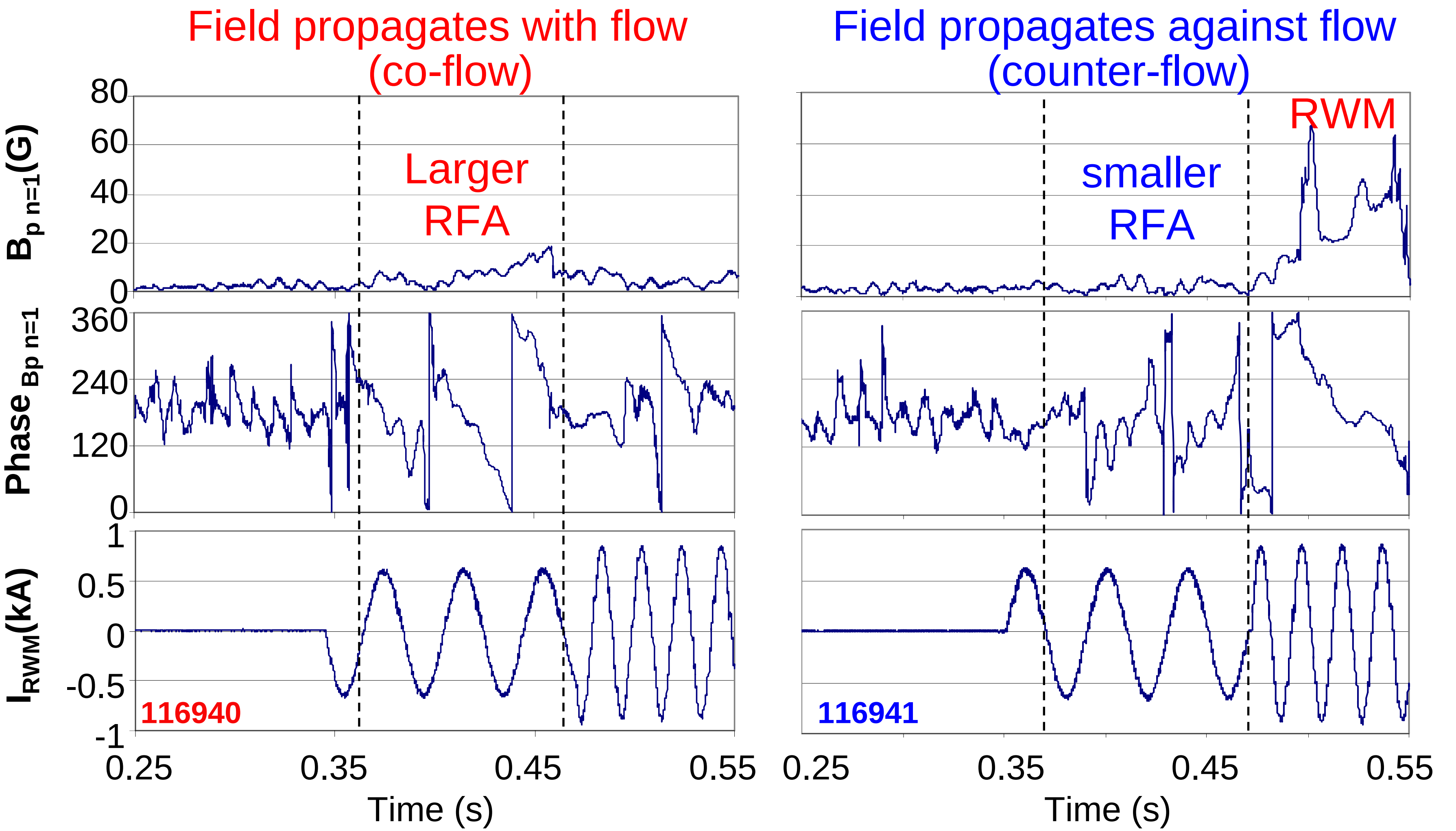
Princeton Plasma Physics Laboratory

Columbia U
Comp-X
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
NYU
ORNL
PPPL
PSI
SNL
UC Davis
UC Irvine
UCLA
UCSD
U Maryland
U New Mexico
U Rochester
U Washington
U Wisconsin
Culham Sci Ctr
Hiroshima U
HIST
Kyushu Tokai U
Niigata U
Tsukuba U
U Tokyo
JAERI
Ioffe Inst
TRINITI
KBSI
KAIST
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
U Quebec

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

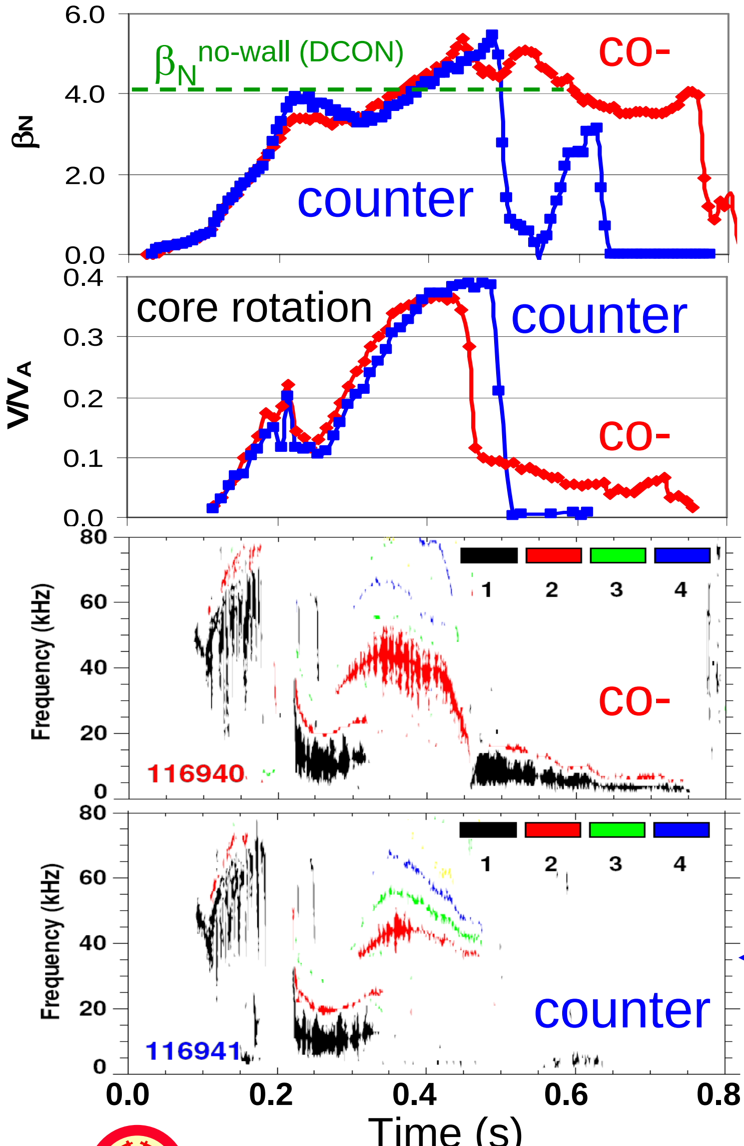
- Goal
  - Demonstration of ELM mitigation with NSTX midplane RWM coil set
- Approach (complementary to other proposed plans)
  - Application of broader n spectrum of DC fields
    - Non-standard coil configs: (i) turn off one coil, (ii) turn off 5 coils, (iii) turn off every other coil, (iv) slow pre-programmed 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, no n = 1

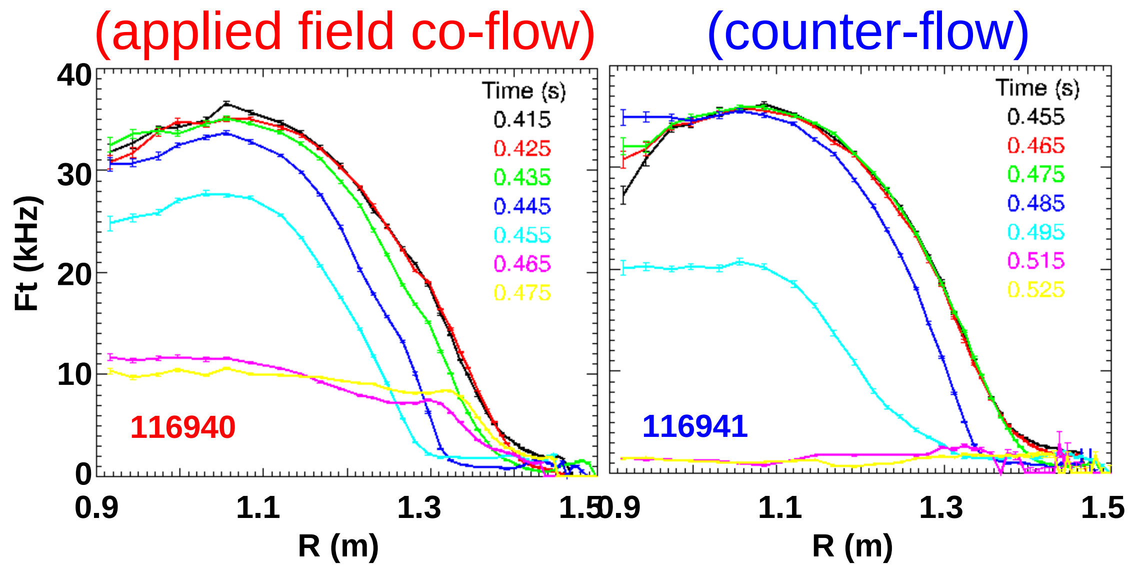
Direction of applied n=1 traveling wave alters RWM stability



- 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

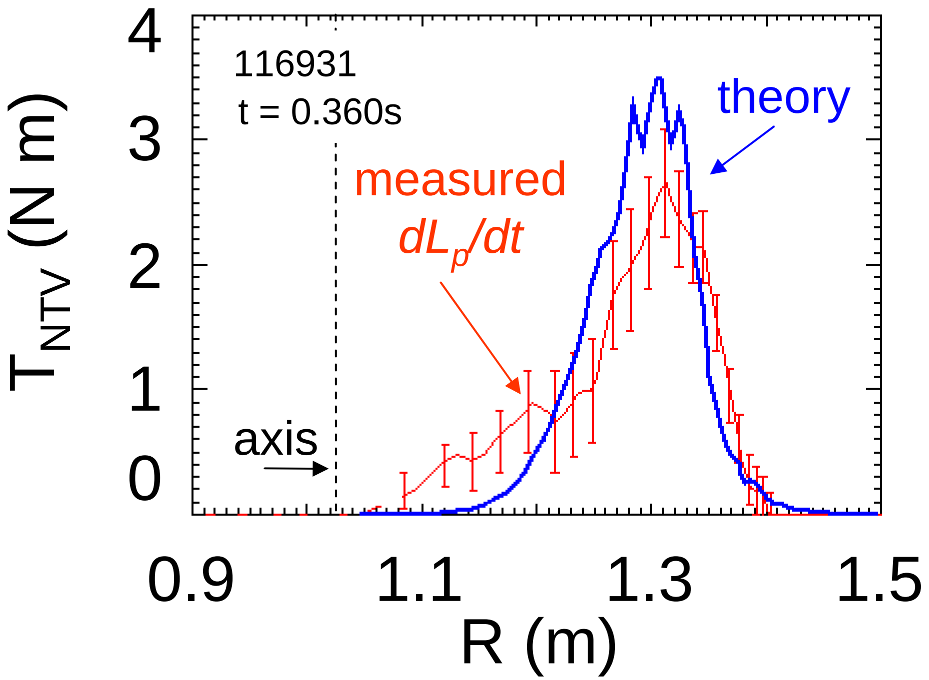




- Applied field in the direction of plasma flow:
  - RFA increases and rotation damps
  - n=1 internal mode triggered
  - Rigid rotor rotation profile; beta recovers
- Applied field against the plasma flow:
  - RWM grows
  - Rapid, complete rotation and beta collapse

Observed rotation decrease follows NTV theory

<u>*n* = 3 applied field configuration</u>



(Zhu, et al., PRL **96** (2006) 225002.)

- Further test NTV theory; compare to other devices
  - Trapped particle effects, 3-D field spectrum important for quantitative agreement
  - Scales as $\delta B^2(p_i/\nu_i)(1/A)^{1.5}$
  - Low collisionality, ν_i, ITER plasmas expected to have higher rotation damping
  - Saturation of $1/\nu_i$ scaling expected by theory, can it be found?
- Approach
  - Use n = 2 field to slow ω_ϕ, compare to other devices
  - Vary collisionality (as in past XPs) to produce ~ at least a factor of 2 variation in NSTX
- Request 1 run day (*<u>separate</u>* 2008 NSTX XP proposal

NSTX