PPPL,NFRI

U.S. DEPARTMENT OF ENERGY | Office of Science

Study of Error Field and 3D Plasma Response in KSTAR

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In collaboration with
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PPPL-NFRI Collaboration Meeting
B318, PPPL
October 21, 2013

Outline

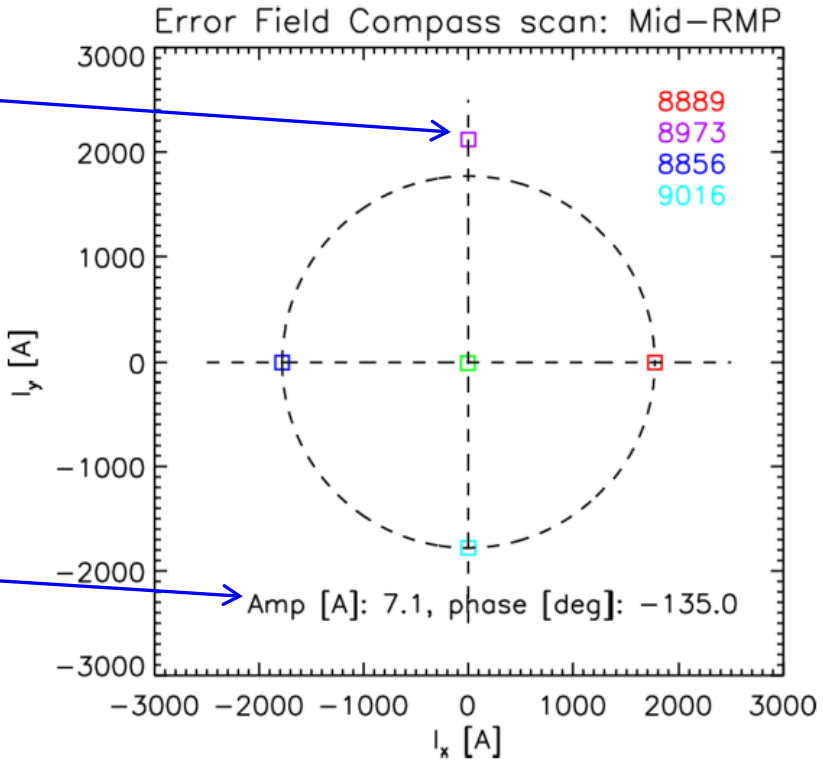
- Intrinsic error field investigation and correction
  - Investigation of source : n=1 compass scan
  - Error field threshold : IPEC application
  - Plans for collaboration
- Magnetic braking and toroidal rotation control
  - Test of magnetic braking
  - Study of NTV physics and rotation control
  - Plans for collaboration
- 3D plasma response and ELM control
  - Plasma response analysis in RMP ELM experiments
  - Plans for collaboration

Toroidal compass scan has been used to find any intrinsic non-axisymmetry in KSTAR

- Compass scan is to rotate a fixed non-axisymmetric magnetic field toroidally and to see difference in plasma response such as locking
- 2011~2013 results: Not yet clear indication of intrinsic error field

Locking threshold in RMP coil currents

Inferred error field in RMP coil currents

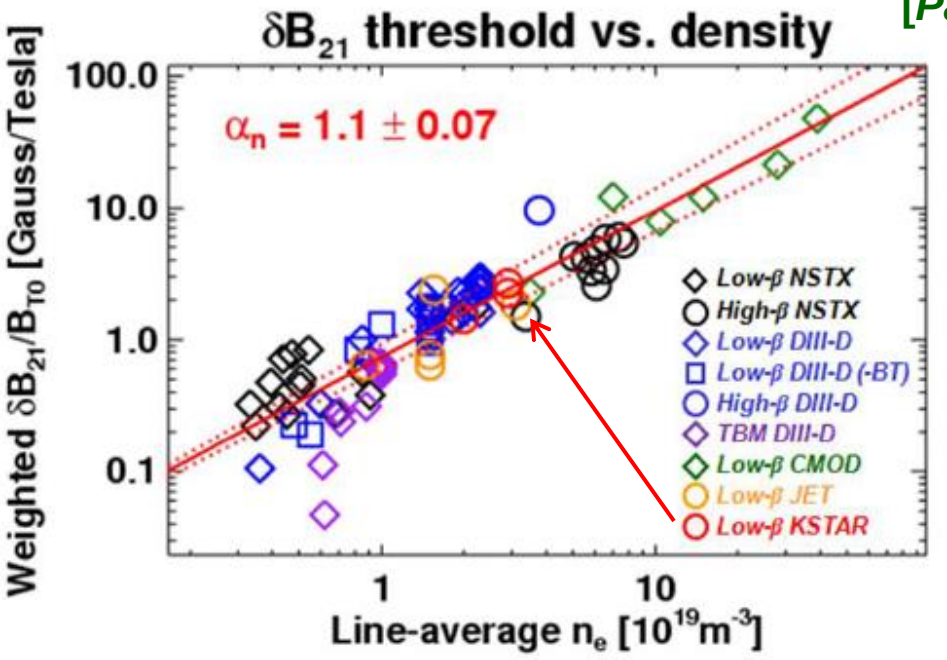


2013 results
In courtesy of Y. In

Error field threshold estimated by IPEC has been included in locking threshold scaling database

- IPEC has been applied to estimate error field threshold from experiments and to include KSTAR in locking scaling database

[*Park, IAEA (2012)*]



- 2013: n=1+2 applications showed inverse correlation between NTV and locking threshold: will be analyzed in IPEC and POCA

Can be a good test for Cole's theory (PRL, 2008)

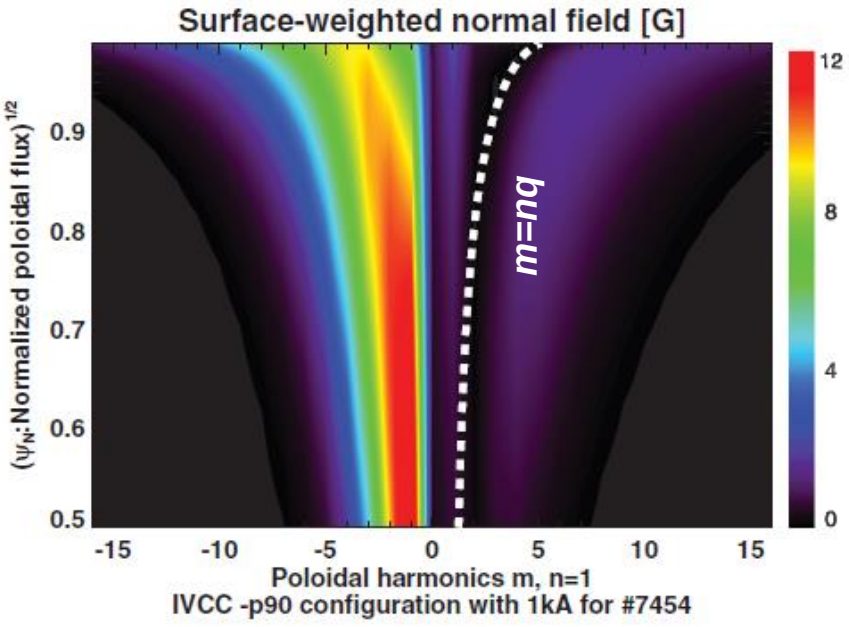
Plans for collaboration on error field study

- Error field investigation by compass scan
  - With Y. In and Y. M. Jeon (NFRI)
  - Complete compass scan using top-alone and bottom-alone coils
- Error field threshold study
  - With J. H. Kim (NFRI)
  - Analyze locking threshold with non-resonant magnetic braking and propose experiments in H-mode
- Error field correction if needed (depending on compass scan)
  - Apply optimized correction to measure lower-bound of locking density
  - Study error field correction in H-modes and optimize correction to minimize NTV damping
  - Find error field source and develop error field model

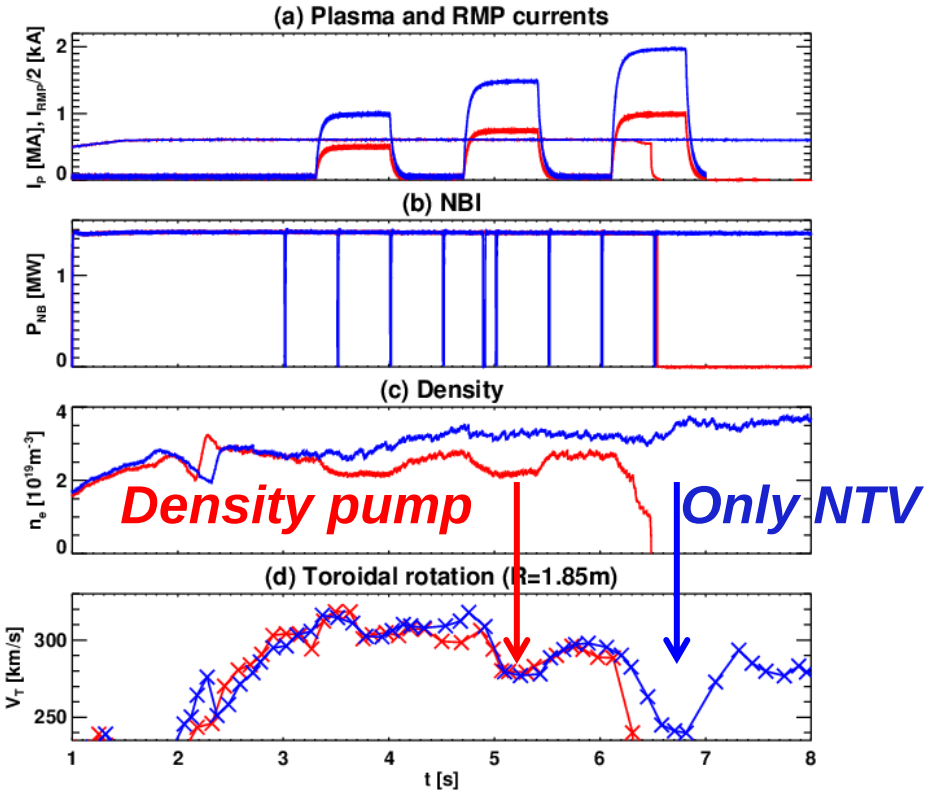
Highly non-resonant n=1 magnetic braking has been successfully tested for the first time

- 3 rows of internal coils in KSTAR can uniquely produce back-winding helical field and highly non-resonant n=1 magnetic braking

-90 phasing

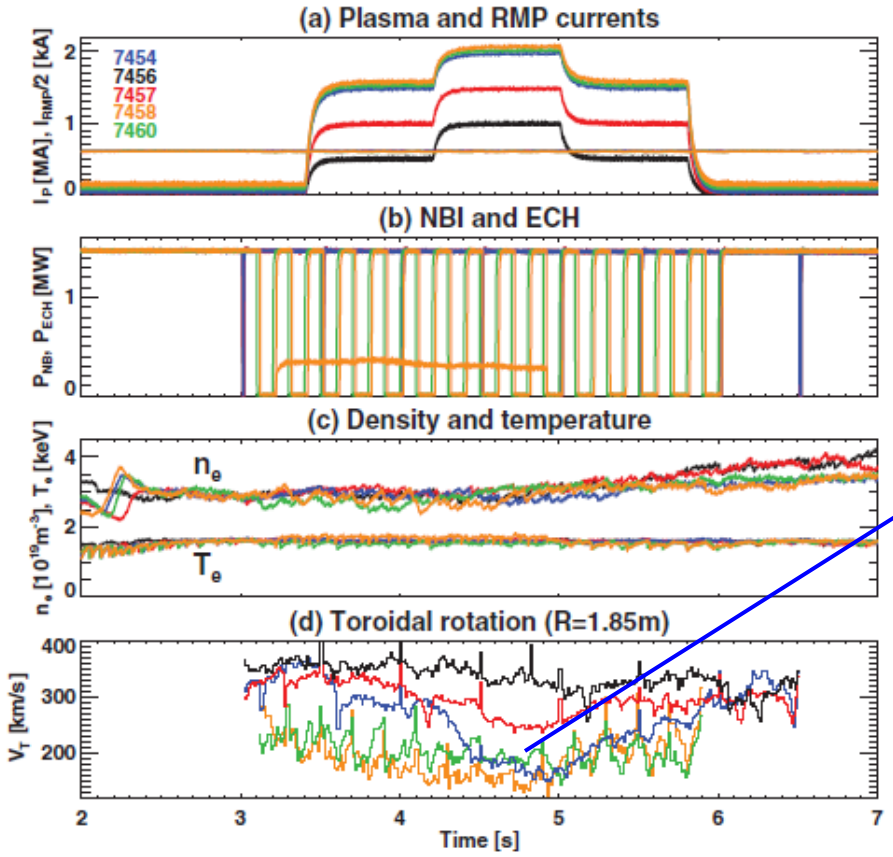


-90 phasing
+90 phasing

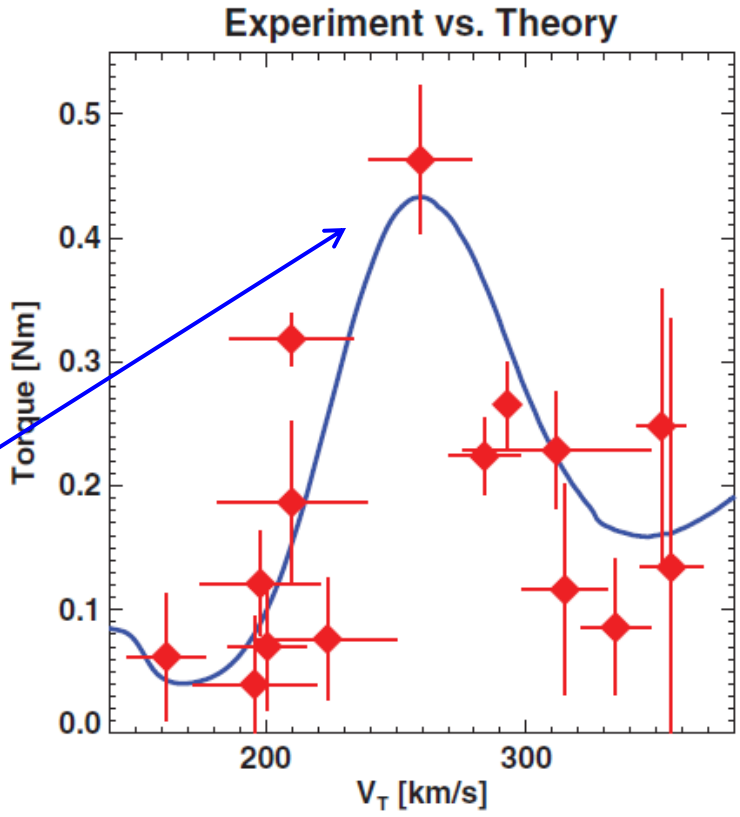


n=1 non-resonant braking led to observation of bounce-harmonic rotational resonance

- n=1 can best separate rotational resonances: $l\omega_b$-$n\omega_P$~0
- Strong resonance was identified as bounce-harmonic resonance



[*Park, PRL (2013)*]



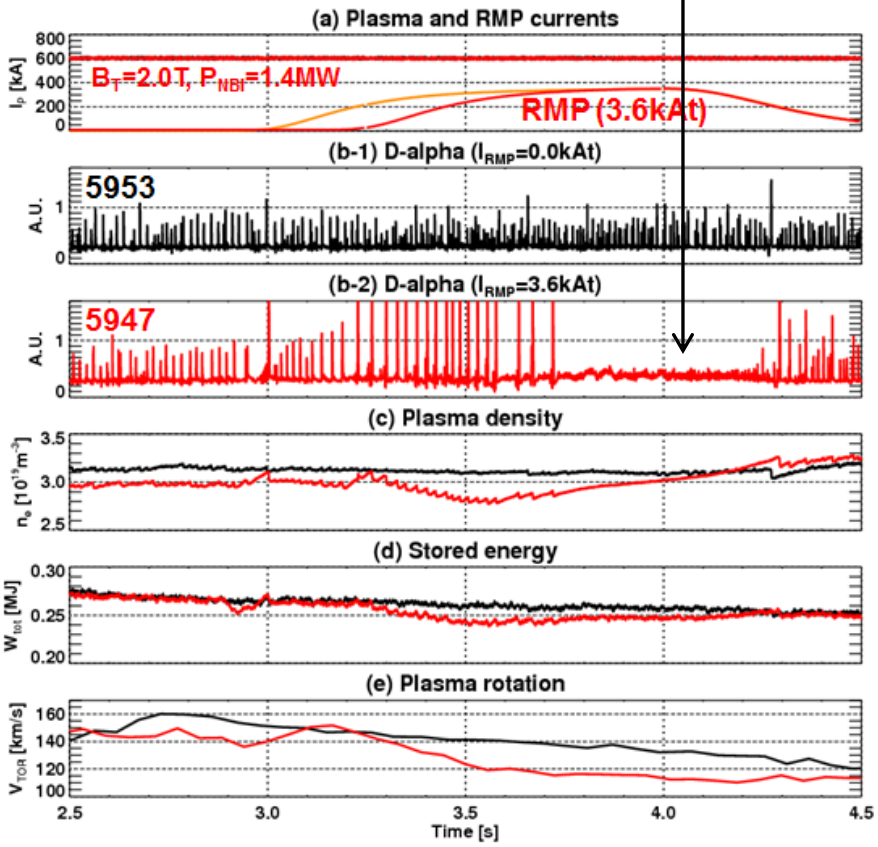
Plans for collaboration

- Test of magnetic braking
  - With Y. M. Jeon and H. H. Lee (NFRI)
  - n=2 magnetic braking to reach superbanana-plateau regime
- Rotation control
  - With Y. M. Jeon and W. H. Ko (NFRI)
  - Use rotational resonances to establish stable rotational equilibrium and scenarios
- NTV physics study
  - With K. Kim, Z. Wang (PPPL), S. Satake (NIFS)
  - Use advanced NTV modeling in various levels (IPEC-PENT, MARSK, MARSQ, POCA, FORTEC-3D codes)

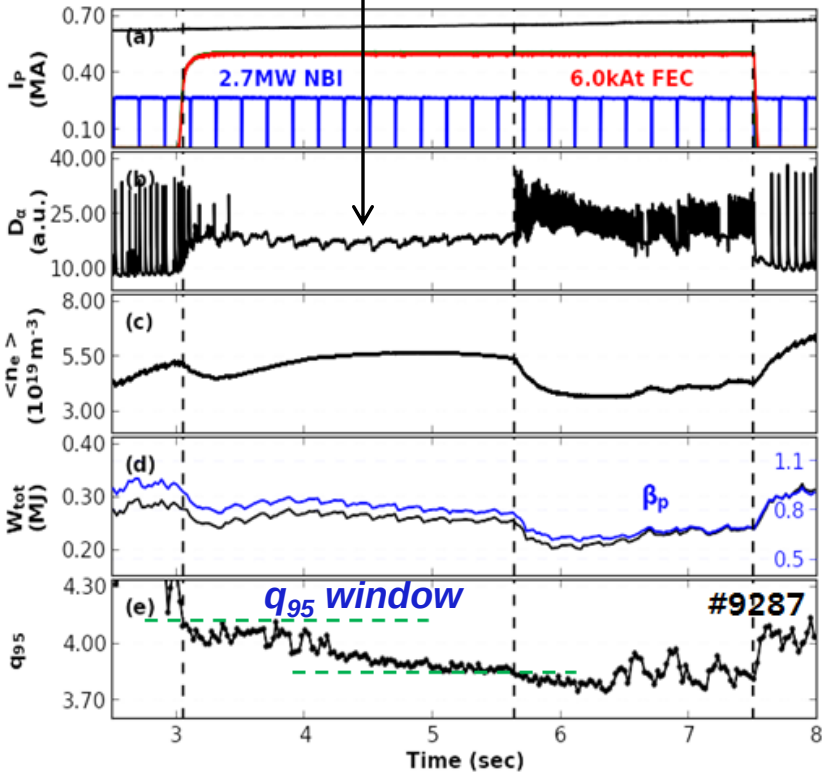
PPPL-NFRI collaboration has been synergetic for RMP ELM mitigation/suppression studies

- 2011: n=1 ELM suppression

[*Jeon, PRL (2012)*]

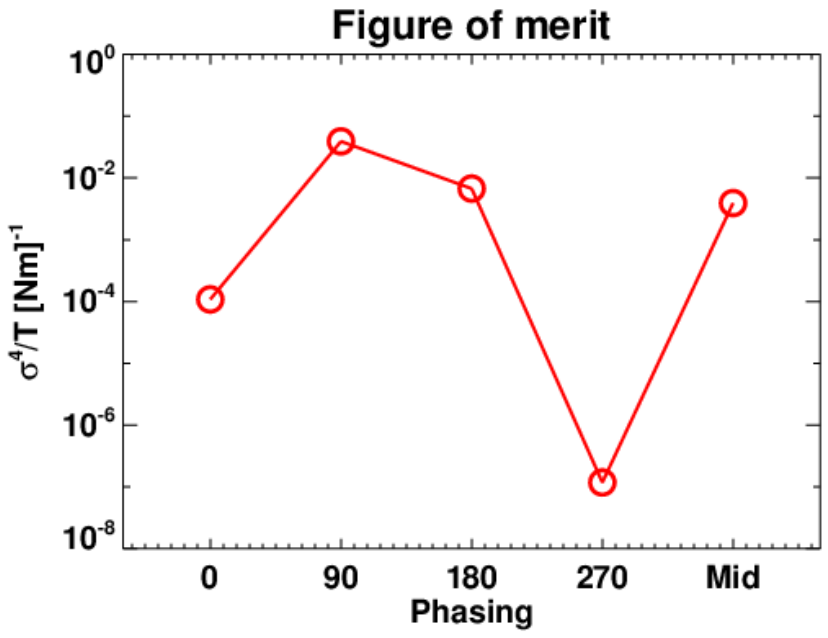


- 2012-2013: n=2 ELM suppression

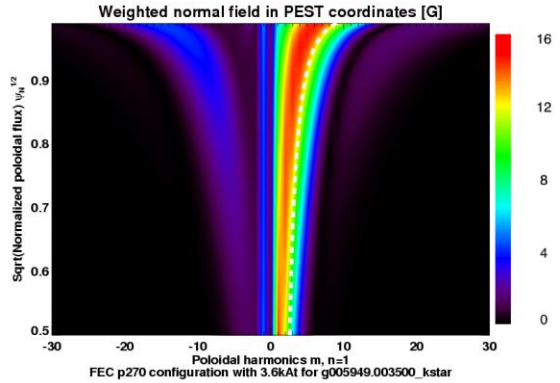


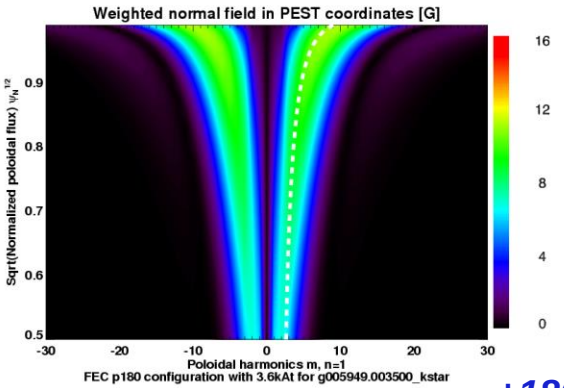
n=1 RMP configurations for ELM control have been optimized through collaboration

- n=1 +90 phasing can maximize Chirikov overlap while minimizing NTV : ELM suppressed
- n=1 +180 phasing can produce Kink-response : Locking occured
- This subtle balance can vary as a function of q-profile



+90 phasing





+180 phasing

Plans for collaboration

- Understand n=1 ELM suppression window
  - With Y. M. Jeon (NFRI), T. E. Evans (GA)
  - Q95~6.0, but plasma density or may also important parameters
- Study n=1 RMP physics
  - With Z. Wang (PPPL), T. E. Evans (GA)
  - Apply various plasma response models (GPEC, MARSK, M3D-C1) to provide consistent understanding of n=1 RMP physics
- Collaboration on RMP ELM suppression experiments
  - With Y. M. Jeon, S. W. Yoon (NFRI)
  - Propose and cooperate on ELM mitigation/suppression experiments