n=3 Braking With Optimal n=1 Error Field Correction

Presented by:
Andrea M. Garofalo, *Columbia University*

Summary of XP 729

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Columbia University

Purpose of Experiment

- **Investigate the effects of n=3 magnetic braking of the toroidal rotation in a plasma with beta above the n=1 no-wall stability limit, and with optimized correction of the n=1 error field.**
- **In particular, study**
  - the dependence of the RWM rotation threshold on the magnitude of uncorrected n=1 error field
  - the dependence of the n=3 braking effect on the plasma rotation

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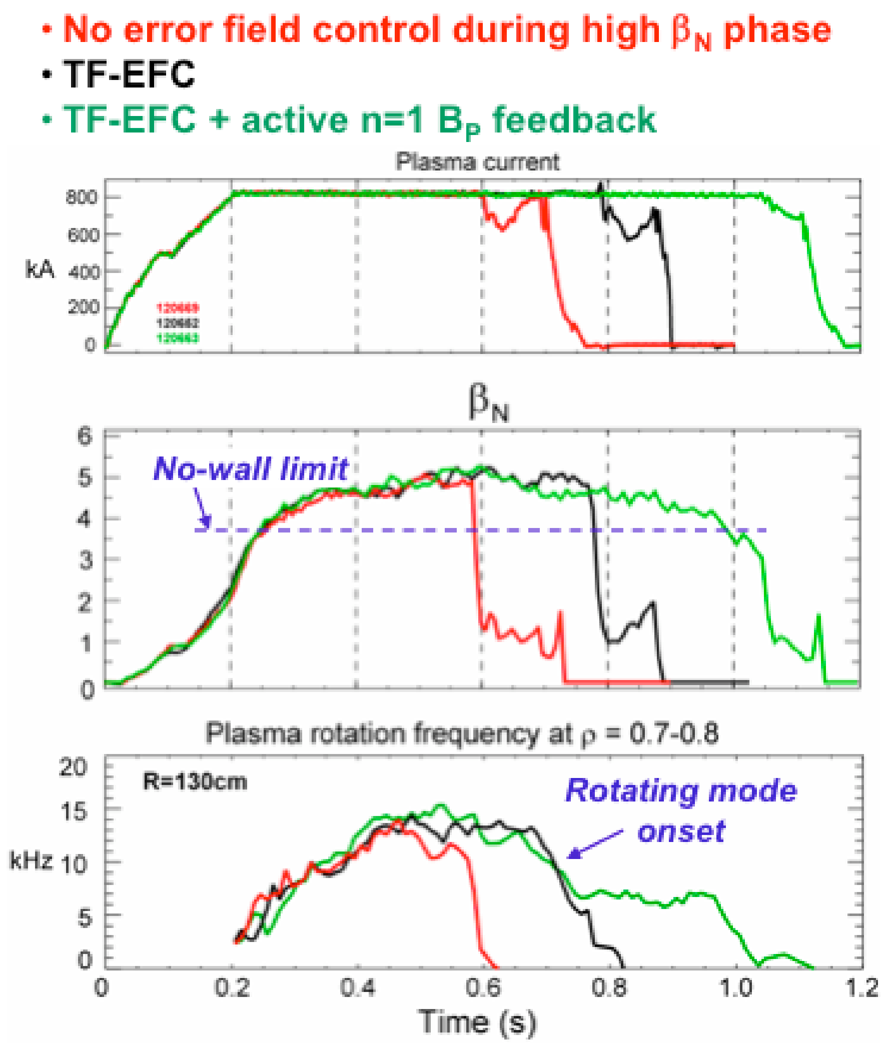
Background and Motivation

- **Menard's 2005-06 NSTX experiments on error field identification and control showed that Dynamic Error Field Correction (i.e. EFC using RWM feedback) increases the toroidal rotation and optimizes performance of plasmas with beta above the no-wall limit.**
  - This result implies that previous n=3 experiments on NSTX, conducted without dynamic error field correction, had residual, uncorrected n=1 error fields



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Background and Motivation (cont.)

- **On DIII-D, n=3 braking can lead to RWM growth, in presence of an uncorrected n=1 error field**
  - n=1 error field leads to effective RWM threshold much higher than true linear-stability threshold [A.M. Garofalo, et al., IAEA 2006]
- **With optimal n=1 error field correction, non-resonant n=3 braking in DIII-D does not lead to unstable RWM**
  - Non-resonant braking effect is observed to decrease with lower toroidal rotation. Braking becomes ~zero at an "offset" rotation, which is above the rotation threshold for RWM stabilization [G. Jackson, et al., EPS 2006]
  - "Offset" rotation predicted by a neoclassical toroidal viscosity (NTV) model of momentum dissipation [K.C. Shaing, et al., Phys. Fluids 1986]

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Experimental Approach

- **Establish target discharge with beta above the n=1 no-wall stability limit, and with correction of the n=1 error field optimized using the RWM feedback system**
  - Plan to start from previously developed discharge with optimized EFC
- **Add n=3 braking currents to the currents for optimal correction of the n=1 error field. Vary the n=3 amplitude**
- **If n=3 braking alone <u>IS NOT</u> sufficient to destabilize an RWM:**
  - Vary q95, look for change on braking effect
  - Reduce the n=1 correction currents until the RWM onset is observed
- **If n=3 braking <u>IS</u> sufficient to destabilize an RWM**
  - Vary NBI energy, look for changes in rotation threshold

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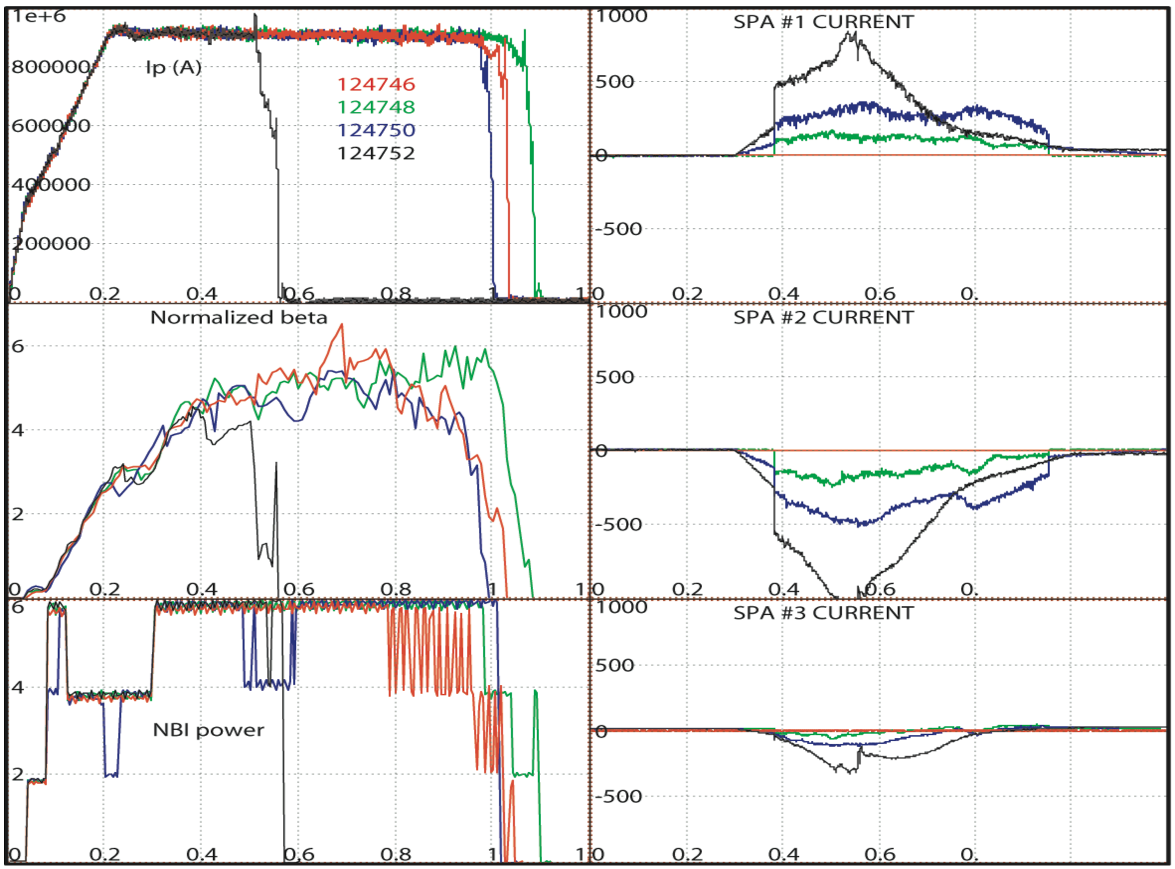
Determination of the optimal n=1 EFC using RWM feedback (DEFC) - Bru Sensors

- Started from recent discharge with MODEID feedback using Bru sensors
- Used feedback-driven currents (time-averaged) as preprogrammed offset currents in following discharge with MODEID feedback
- Continued updating offset currents based on new feedback requests
- Iterations diverged quickly



- Results suggest there may be contamination of n=1 sensor signal

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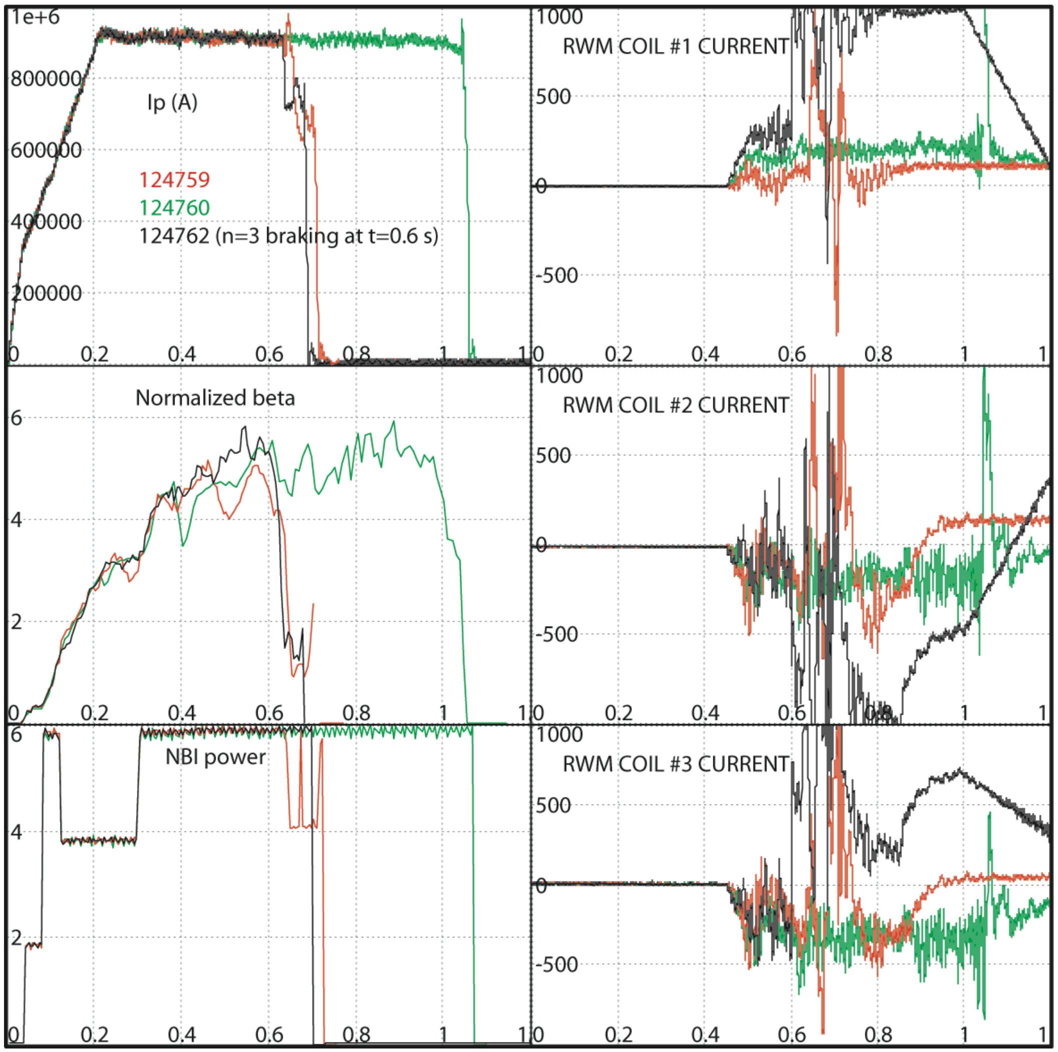
Determination of the optimal n=1 EFC using RWM feedback (DEFC) - Bpu Sensors

- **Started from recent discharge with MODEID feedback using Bpu sensors**
- **Iterations did not diverge**



- **Possible convergency of feedback currents and higher beta (up to 0.6 s) suggest procedure was working**

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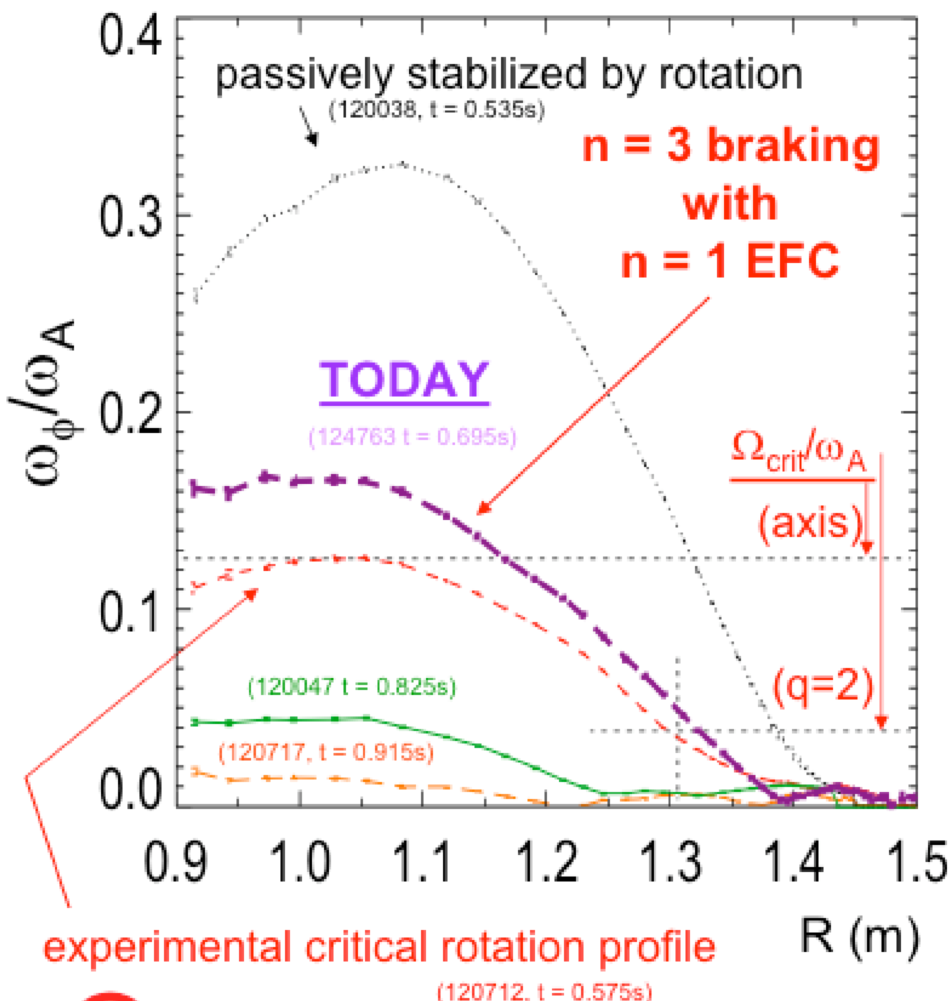
n=3 Braking Applied in Last Few Discharges



- Goal was to investigate whether applying n=3 magnetic braking without an n=1 error field yields a lower rotation threshold for RWM stabilization than observed with an n=1 error field
- Loss of H-mode and/or locked tearing modes observed before rotation profile could be reduced below established "critical" rotation profile for RWM stabilization