Real-time measurement of MHD stability using active MHD spectroscopy

By
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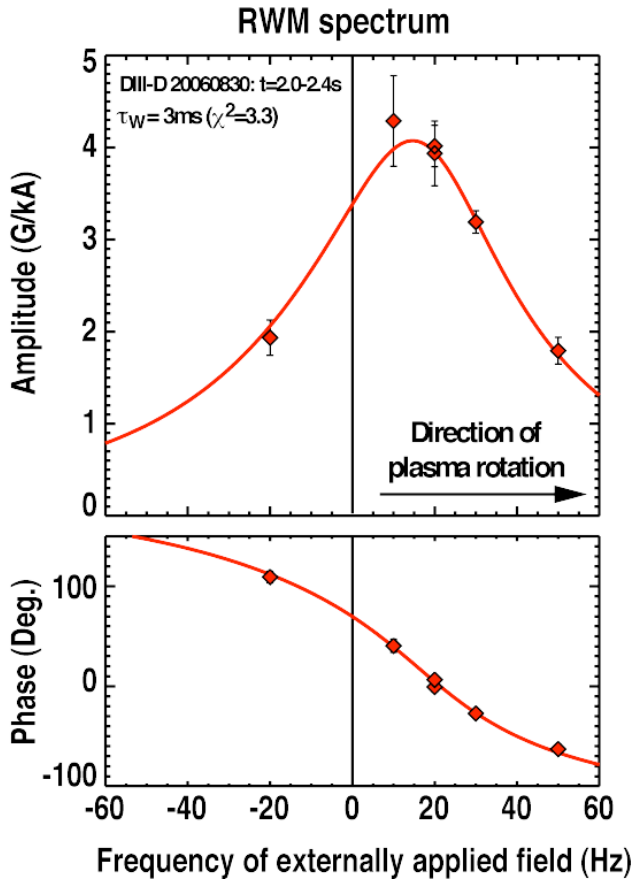

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Disruption avoidance preferable to disruption mitigation

- **In a reactor disruptions should NOT be caused be operating the machine into a stability limit**
  - If causes of disruptions could be limited to (catastrophic) hardware failures, more drastic mitigation techniques with more severe side-effects would be acceptable

- **Real-time measurement of *n*=1 kink stability provides PCS with information on when stabilizing measures are required**
  - Complement with real-time stability predictions, e.g. by using DCON

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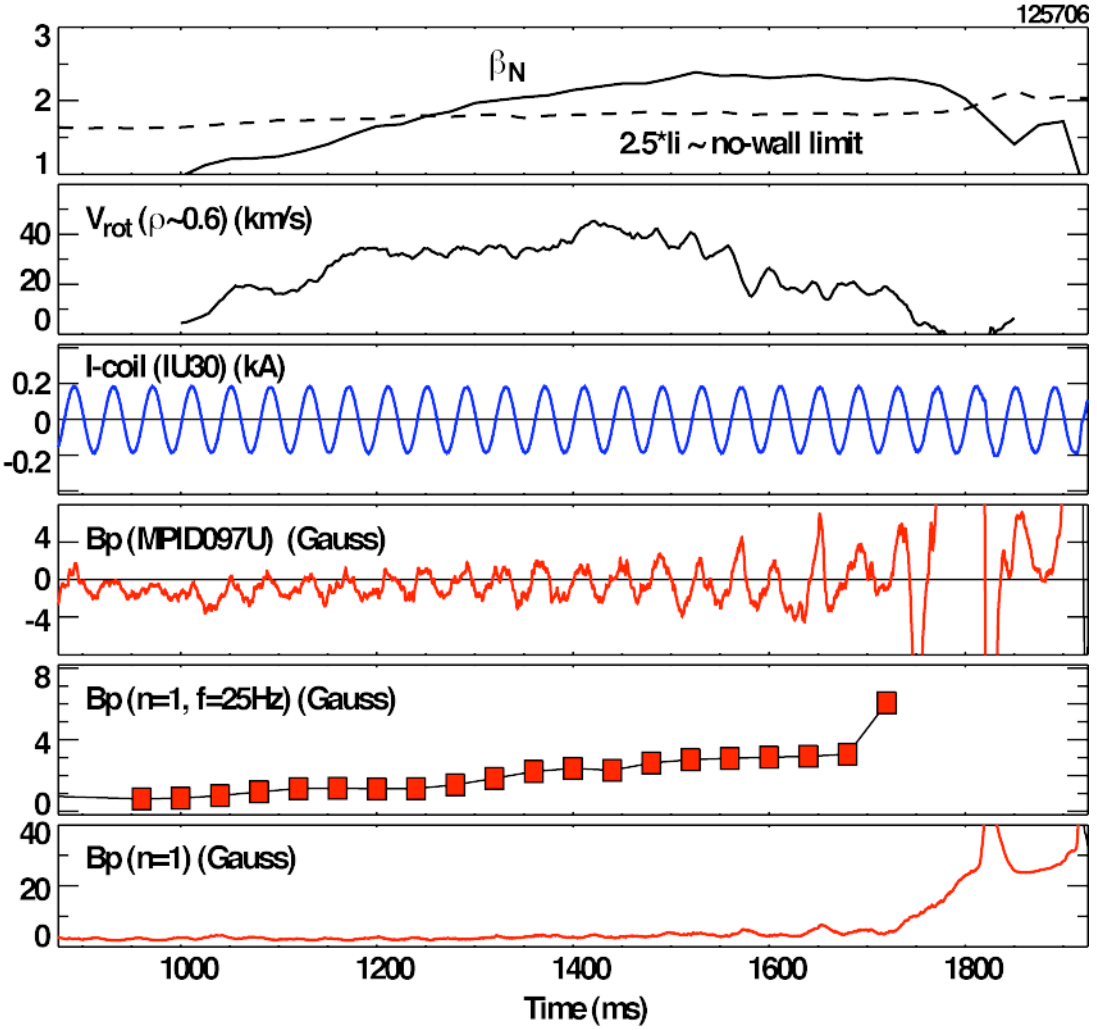
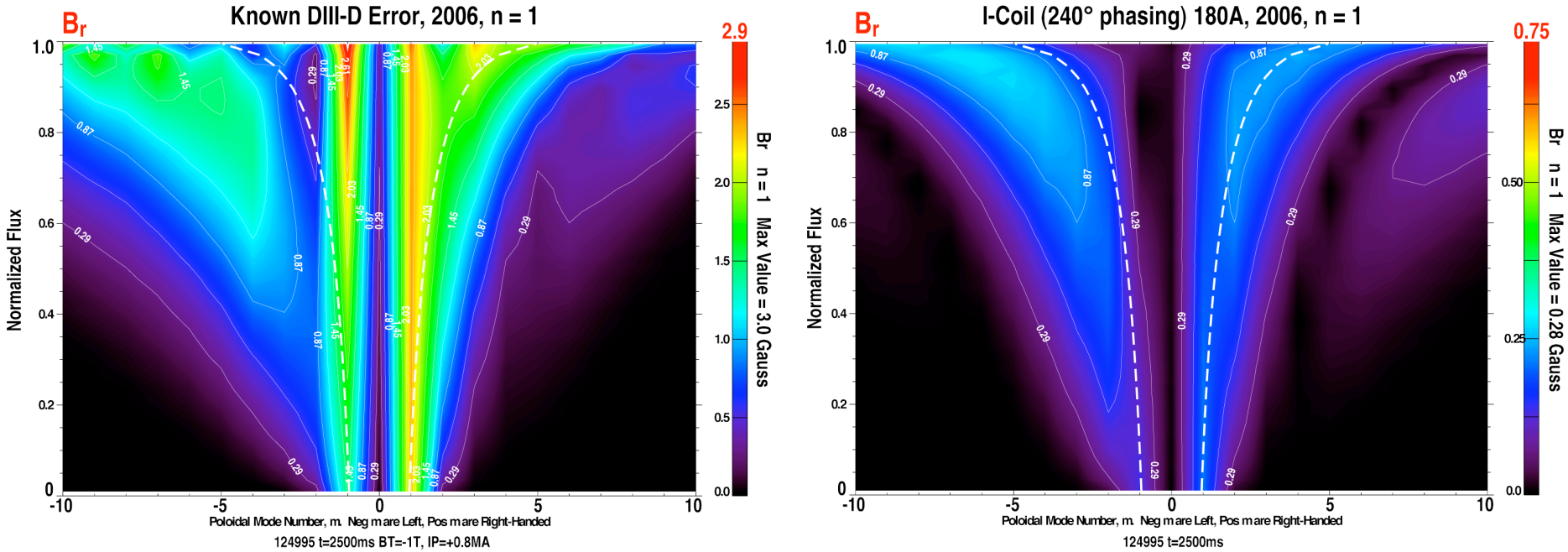
Apply slowly rotating, low amplitude *n*=1 I-coil currents and measure coherent plasma response in real-time

- **Actuator (I-coil)**
  - Frequency close to RWM resonance (10-50Hz) limits time resolution
  - Low amplitude <200A minimizes perturbation
- **Detector (magnetic probes)**
  - Increase number of probes to suppress noise
  - Use internal measurements
    - + Application for toroidally distributed ECE measurements



Applied field is small compared to the intrinsic *n*=1 error field



Courtesy of Mike Schaffer

- **Applied perturbation is an order of magnitude smaller than empirically determined I-coil error field correction (127838: B_T=-2.0T, I_P=1.2MA)**

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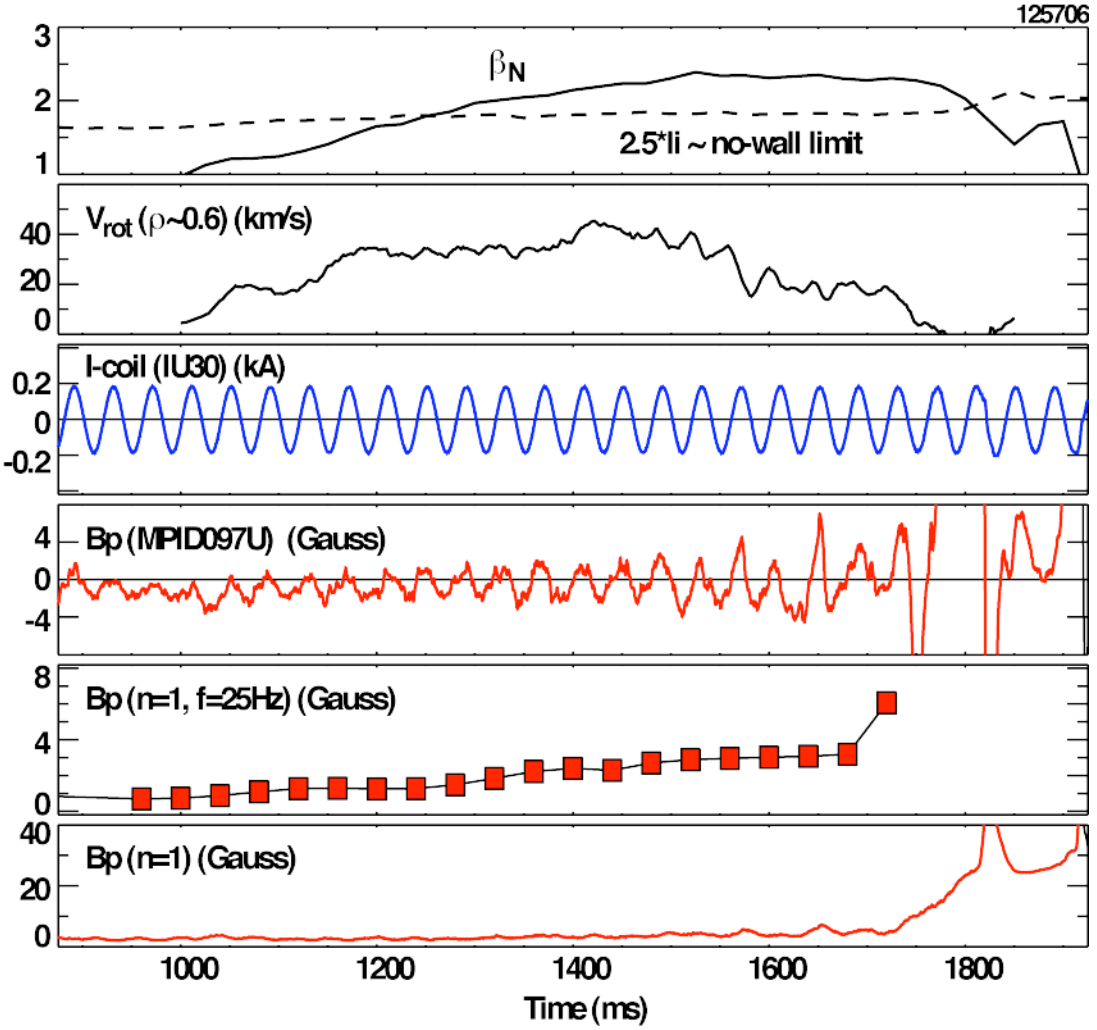
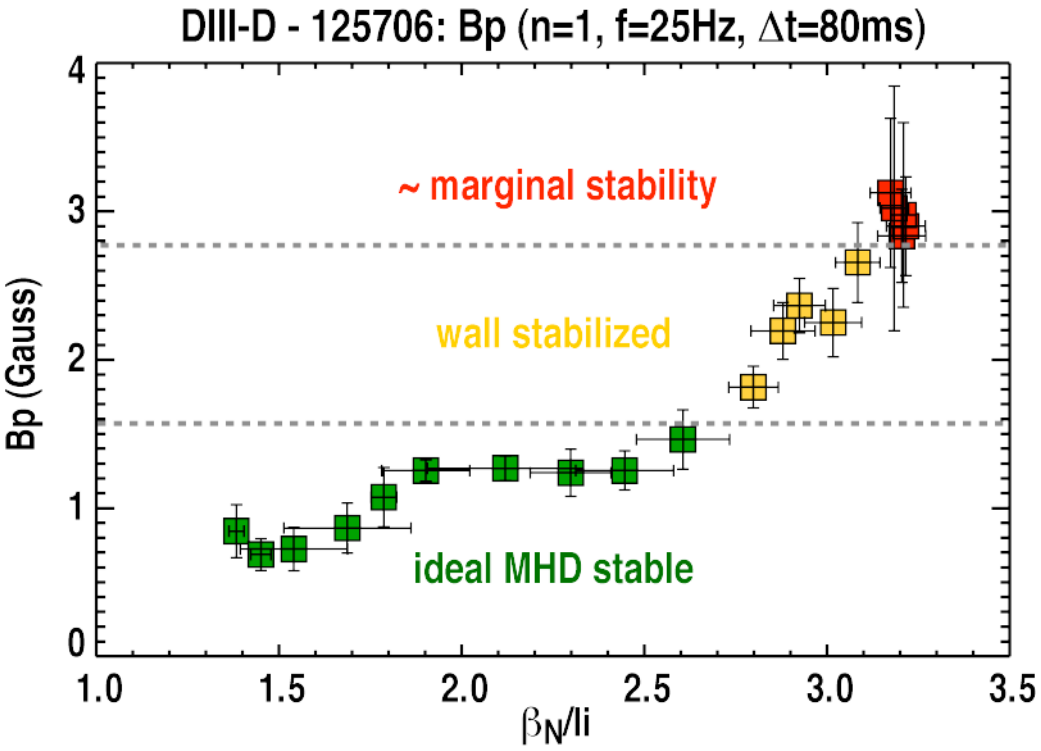


Amplitude of perturbed field indicative for global ideal MHD stability



- **No increase over vacuum: plasma ideal MHD stable**
  - No action
- **Increased plasma response: kink mode wall stabilized**
  - Activate dynamic error field correction or active RWM feedback control
- **Further increase of plasma response: stability limit imminent**
  - Modify current profile, increase rotation or decrease beta/safe shut-down

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Summary

Objectives:

- **Demonstrate the feasibility of real-time active stability measurements**
- **Demonstrate disruption-free operation in the wall stabilized regime**
  - Also requires simultaneous tearing mode control

Hardware/software improvements:

- **Implement real-time measurement of plasma response in PCS**
- **Improve signal-to-noise ratio using more/different sensors**
  - Investigate use of internal measurements (requires diagnostic upgrades)

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