

# Global Mode Stabilization sensors and control systems

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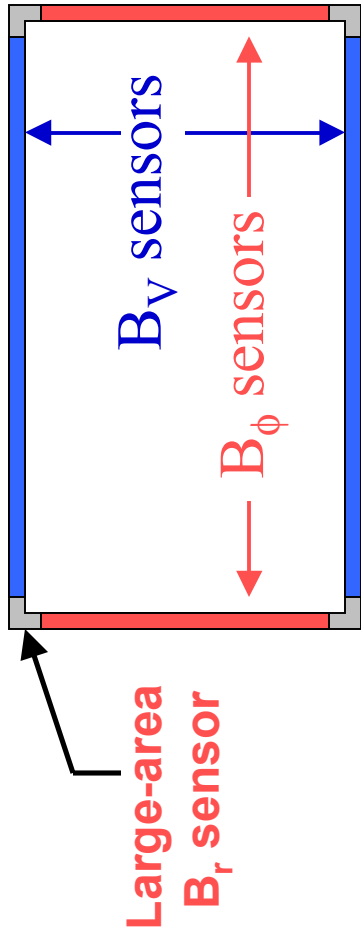
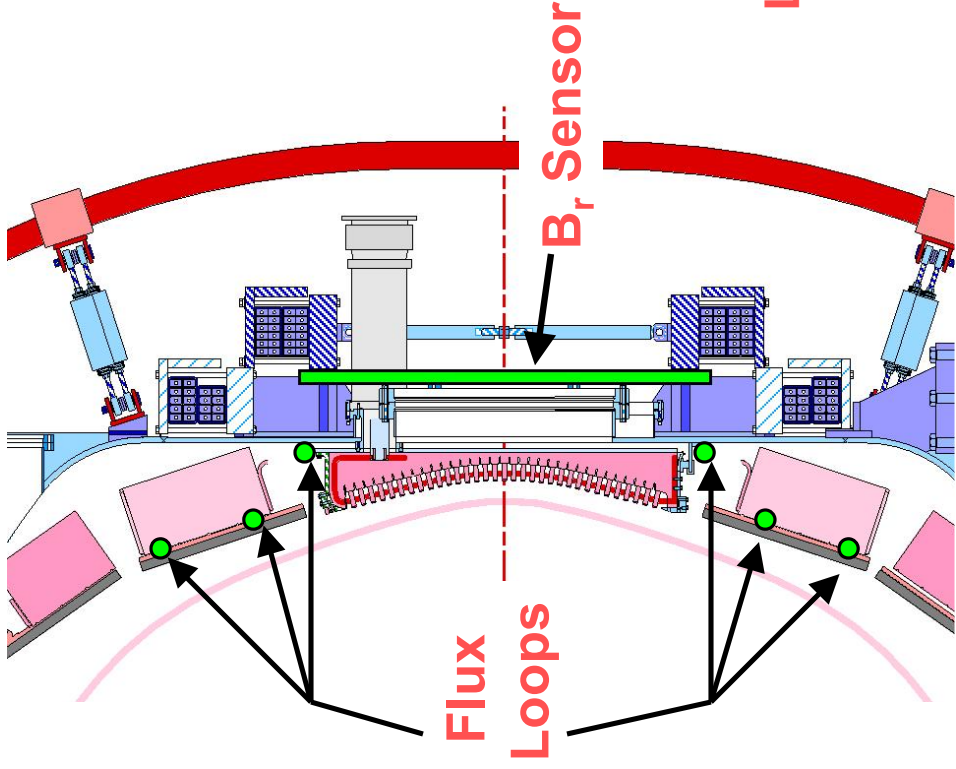
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# External $n=1$ locked-mode sensors invaluable

- Helped identify PF5 error
- Identified preferred  $n=1$  mode locking position
- Measured first RWMs



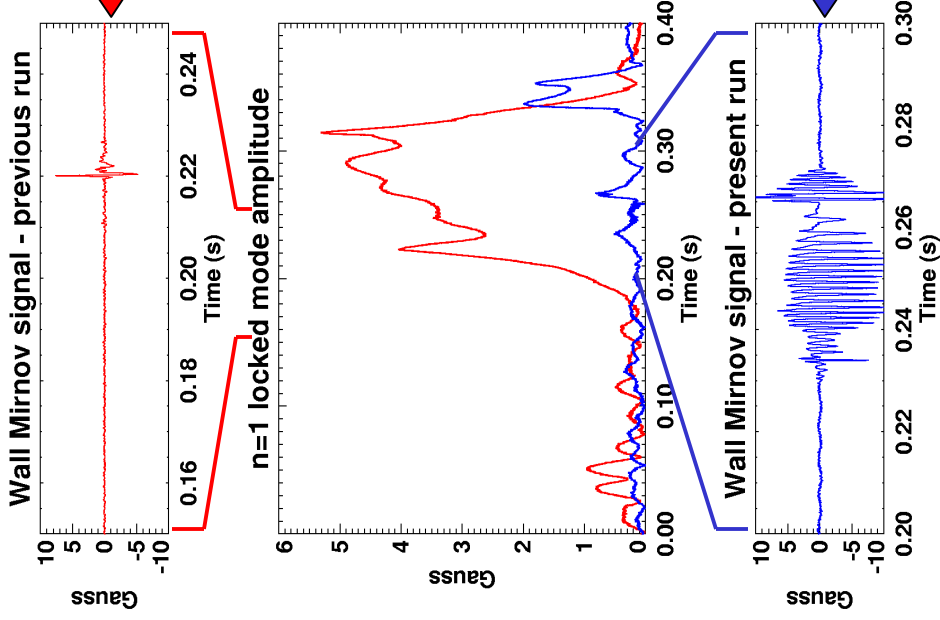
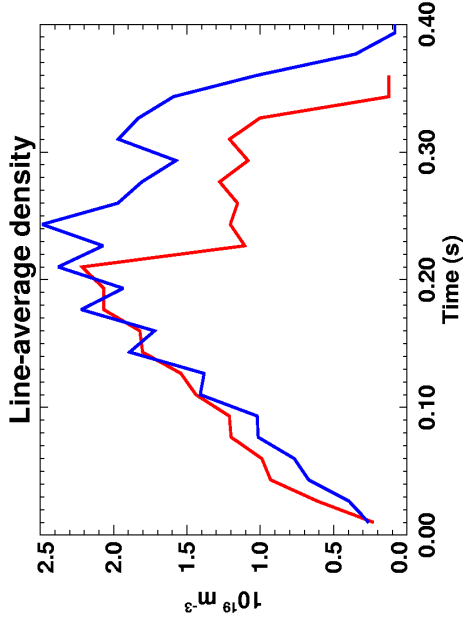
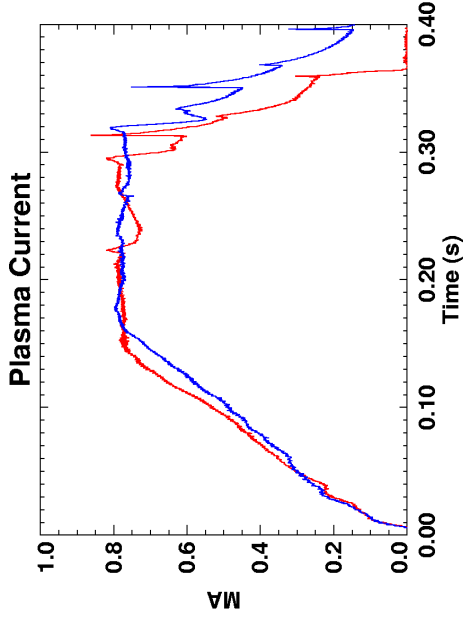
( $B_R$  sensors designed by E. Fredrickson)

# Mode locking has been significantly reduced

Ohmic shots:  $I_p = 800\text{kA}$ ,  $B_t = 4.5\text{kG}$ ,  $\bar{n}_e = 2 \times 10^{19}\text{m}^{-3}$

**Red = previous run (105944)**

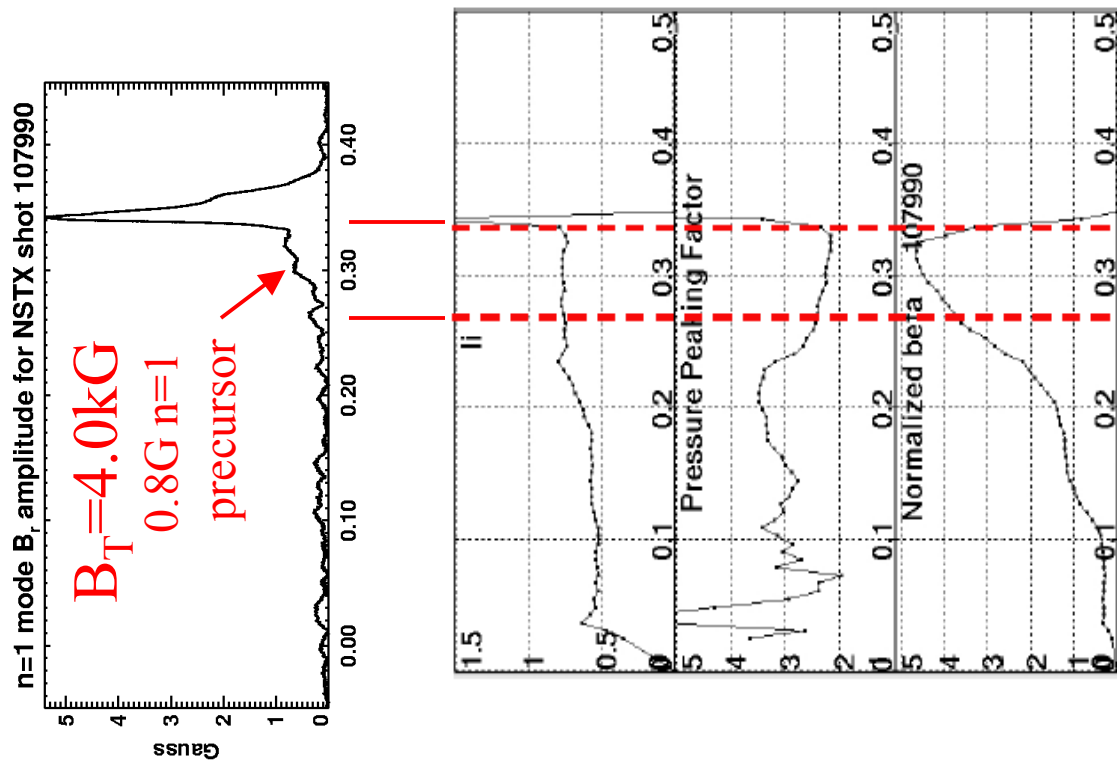
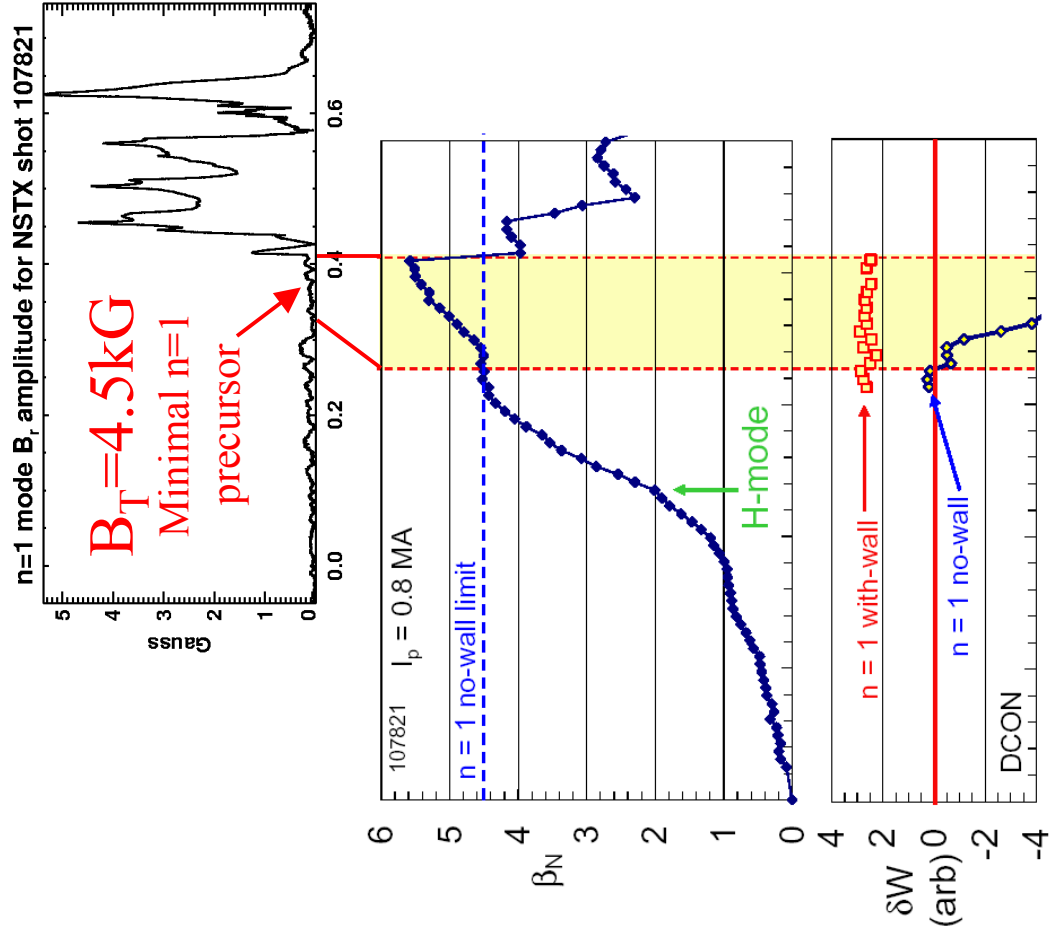
**Blue = present run (106950)**



**Previous run**  $\Rightarrow$   
Tearing modes born early and locked. Plasma current and density significantly disrupted.

**Present run**  $\Rightarrow$   
Modes born later and rotating. Short mode locking period causes minor disruption, then mode decays.

# High $\beta_N$ disruption physics not yet understood



pk-EFIT + DCON analysis by S. Sabbagh

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J.E. Menard – June 25, 2002

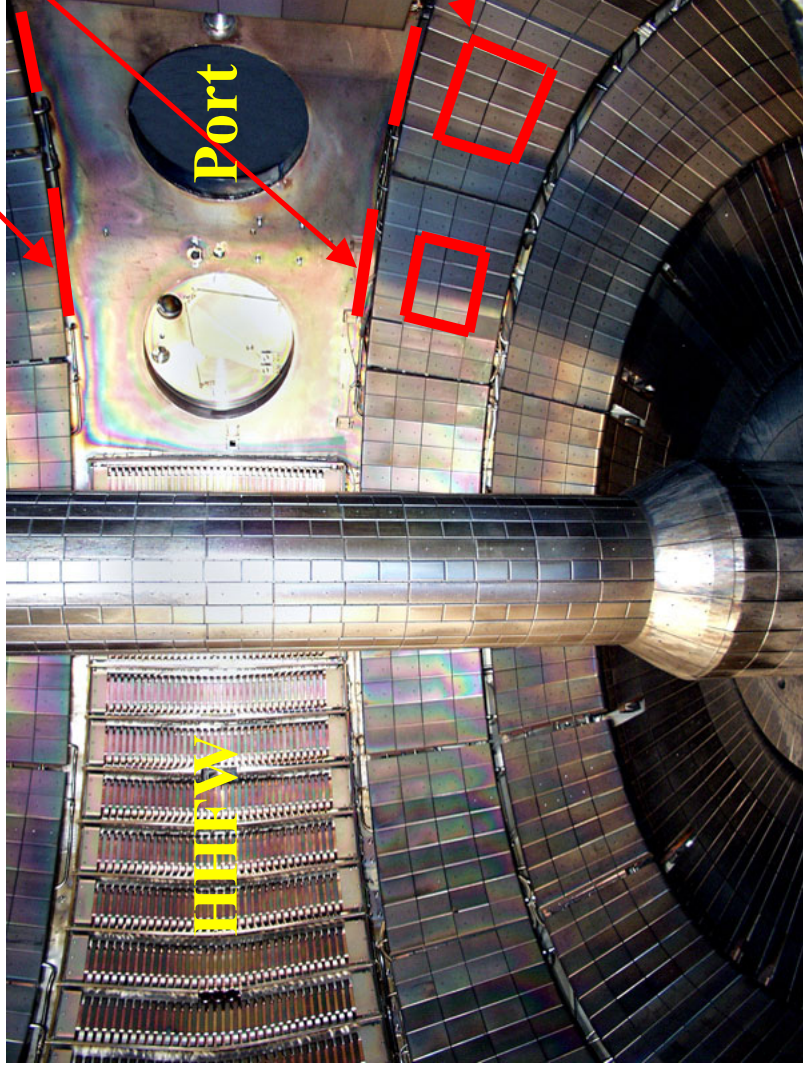


# Measurement goals for new RWM/LM/EF sensors

- Provide first systematic “off-midplane” data
  - Identify possible sources of residual error field
    - PF5 error field significantly reduced, but residual error fields still remain
    - Source is unclear, present locked mode detector insensitive to internal EF
    - We have no in-vessel measurements
  - Measure RWM and locked tearing mode eigenstructure
    - Better understand coupling to plates & coil error fields, braking
    - Allows detailed comparison to codes, benchmarking
- Provide  $n=1$  mode signal to drive feedback system
- Replace/enhance external locked-mode sensor capability
  - May be essential if control coils are mounted externally

# Presently fabricating internal RWM/EF/LM sensors

**Sensors will be much closer to plasma**



- 2  $B_P$  sensors per bay
  - Use average for feedback
  - Use individual for up/down asymmetric mode structure
  - Use individual for EF measurements
- 1  $B_R$  sensor per PPP
  - Optimal place for static EF measurement
    - closer to PF3, PF2, plates
  - Best way to measure slowly growing modes slowed by or locked to passive plates



# Tentative schedule for new GMS sensors

- Install  $\frac{1}{2}$  set during summer 2002
  - 12 B<sub>P</sub>, 12 B<sub>R</sub>
    - 6 toroidal locations, up/down sensors have common toroidal location
  - Integrators
    - Build fall 2002
    - Install and hopefully commission winter 2002
  - Purchase PCS DAQ – fall/winter 2002
    - First data ready for calibration in spring 2003?
- Goals
  - Attempt to measure n=1 RWM and locked modes
  - Initial assessment of error fields from passive plates and coils
- Summer 2003 – install remaining  $\frac{1}{2}$  set of sensors?
  - Measure n=1,2,3 plasma and error-field B-field structure

# Prerequisites for feedback control

- Installation of sensor set during summer 2002
  - Use existing locked-mode sensors if feedback coils are internal?
- Need following systems:
  - Sensors and electronics
    - Internal and external wiring to racks
    - Integrators
    - PCS DAQ
    - Calibration and generation of signal to feedback on
  - Installation of feedback coils – geometry TBD
  - Power supplies – TFTR or purchased audio amps
  - Control algorithms – borrow from DIII-D or home-grown
- Schedule unclear – dependent on coil and supply design
  - Future topics for GMS task group meetings