NSTX

Supported by

U.S. DEPARTMENT OF ENERGY | Office of Science

XP-903

Error Field Threshold Study in High-β_N Plasmas

J.-K. Park, J. E. Menard,
and the NSTX research team

MHD group review
Jan. 22, 2009

College W&M
Colorado Sch Mines
Columbia U
Comp-X
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Maryland
U Rochester
U Washington
U Wisconsin

Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

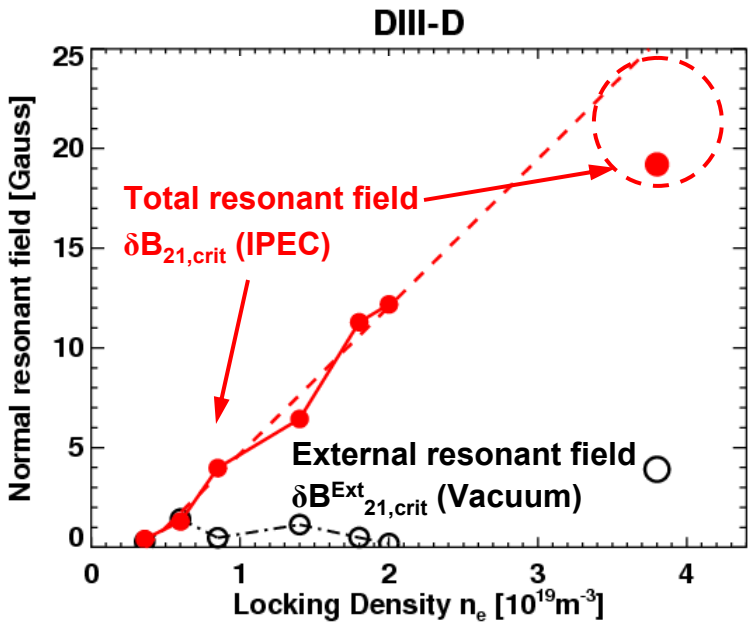
Background

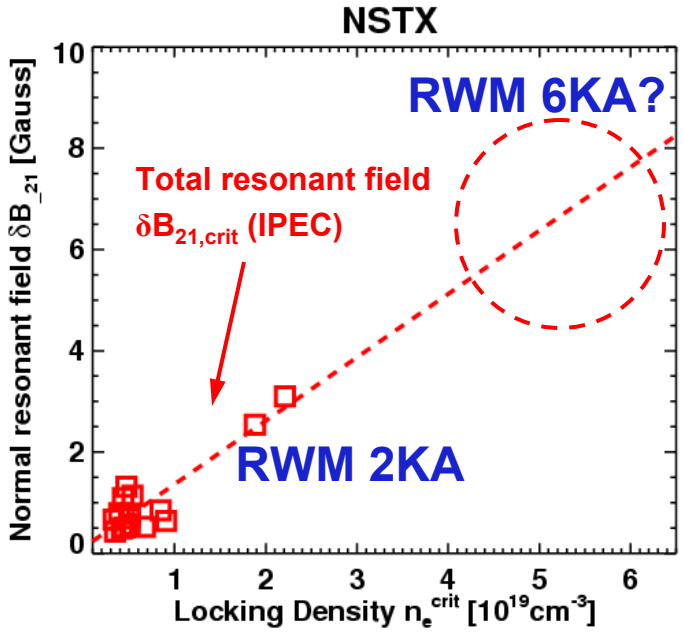
- Locking is a sudden opening of a magnetic island (at q=2?) when non-axisymmetric field is beyond a threshold
- Theory and experiment demonstrated linear correlation between critical resonant field and locking density
- IPEC gives more precise measure of (total) resonant field compared to (external) resonant field in vacuum
- 3 US tokamaks' data are mostly for low-β_N plasmas, but β_N is not so low in ITER inductive operations

➡ **Need to know error field threshold in high-β_N plasmas**

Explicit goal is to find out a "locking" in NSTX high-β_N and to increase parameter space for scaling

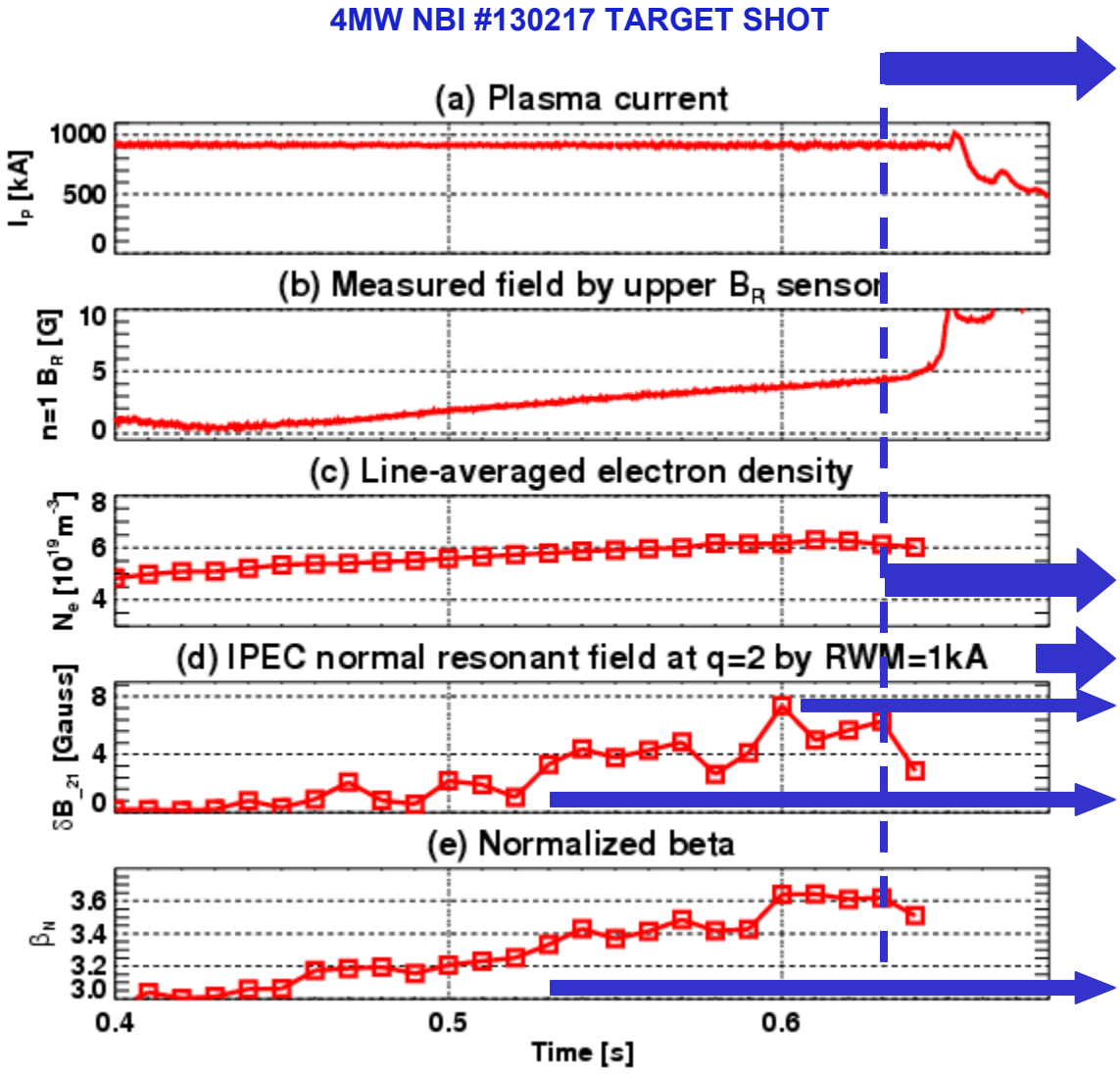
- Demonstration of the linear correlation for stable high-β_N in NSTX plasmas





- Need ~8G total resonant field for density 6x$10^{19}m^{-3}$
- 8G is possible by **RWM 6kA**, without plasma response

Feasibility can be found by XP2008 shots (or experience) and by plasma amplifications



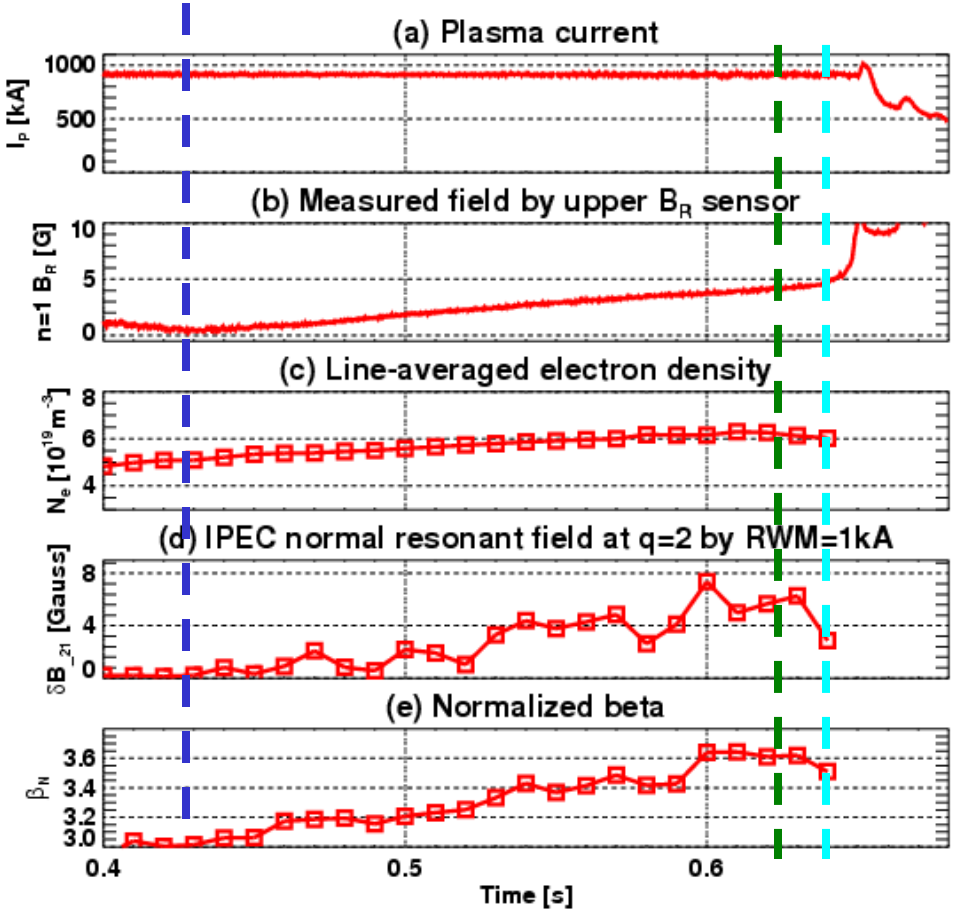
Locking, not by RWM since plasma is stable (DCON) and β_N < 4.0

Locking Density 6x10^{19} &
Locking Field ~8 Gauss &
RWM is only 1kA
#130217 is locked at 1kA

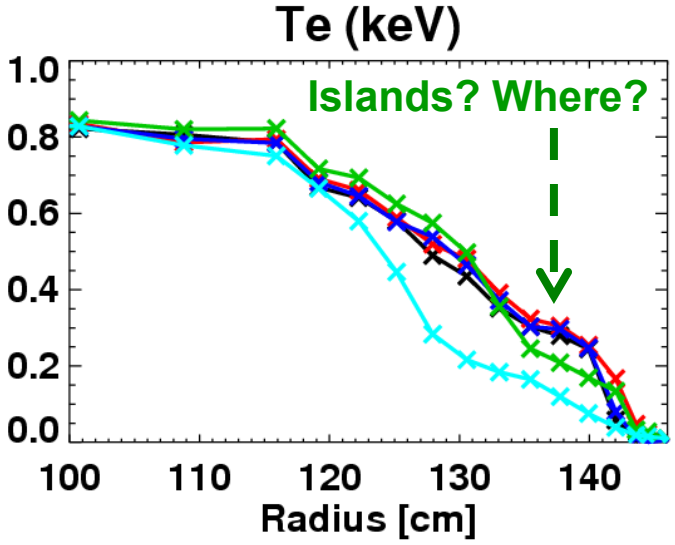
Moderate change of plasma β_N (closely to marginal point) can produce rapid increase of the resonant field

Implicit goal is to understand the role of plasma response, in high β and in locking physics

- Fast swiping of RWM currents can make a locking in relatively low β_N?
- How does the critical RWM vary as a function of β_N? Sensitivity?



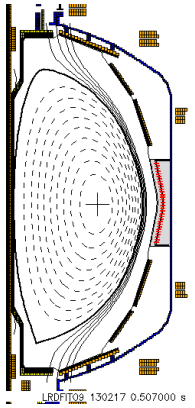
- Can we measure magnetic islands when a locking seemingly occurs?



USXR mapping?

Run Plan (0.5 day)

- One (or two) target shot may be sufficient (#130217~221)
  - Need to have sufficient β_N changes during shots
  - Start with NBI<4MW, and varies power **: 4 shots**



- Fast swiping of RWM n=1 (#122660) at different times
  - Apply RWM n=1 **(0→3kA in 40ms and stay)** when β_N is as low as possible in flat top
  - If locked when RWM=3kA, start with that β_N at that time **: 2 shots**
  - Apply RWM n=1 (0→3kA) to different β_N at different times **: 8 shots**
- When time permitting, **: 6 shots**
  1) If insufficient β_N scan, increase NBI power and thus β_N
  2) If sufficient β_N scan, increase elongation (#124440) *(better coupling to n=1 is expected if q95 is similar)* and repeat RWM n=1 (0→3kA) at different times