Plasma response to m/n=3/1 helical perturbation fields generated by the Dynamic Ergodic Divertor (DED) on TEXTOR

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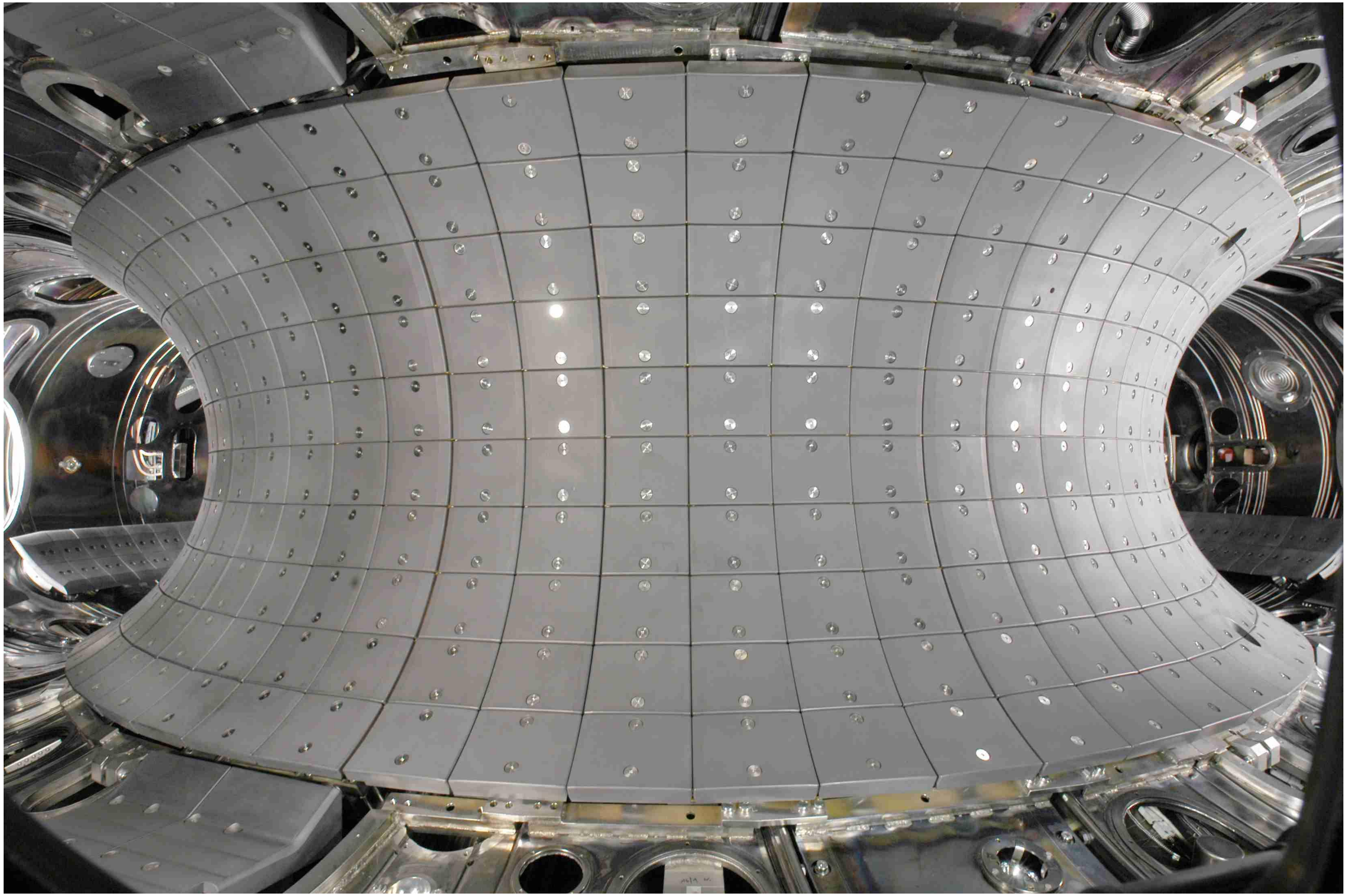
** partners in the Trilateral Euregio Cluster*

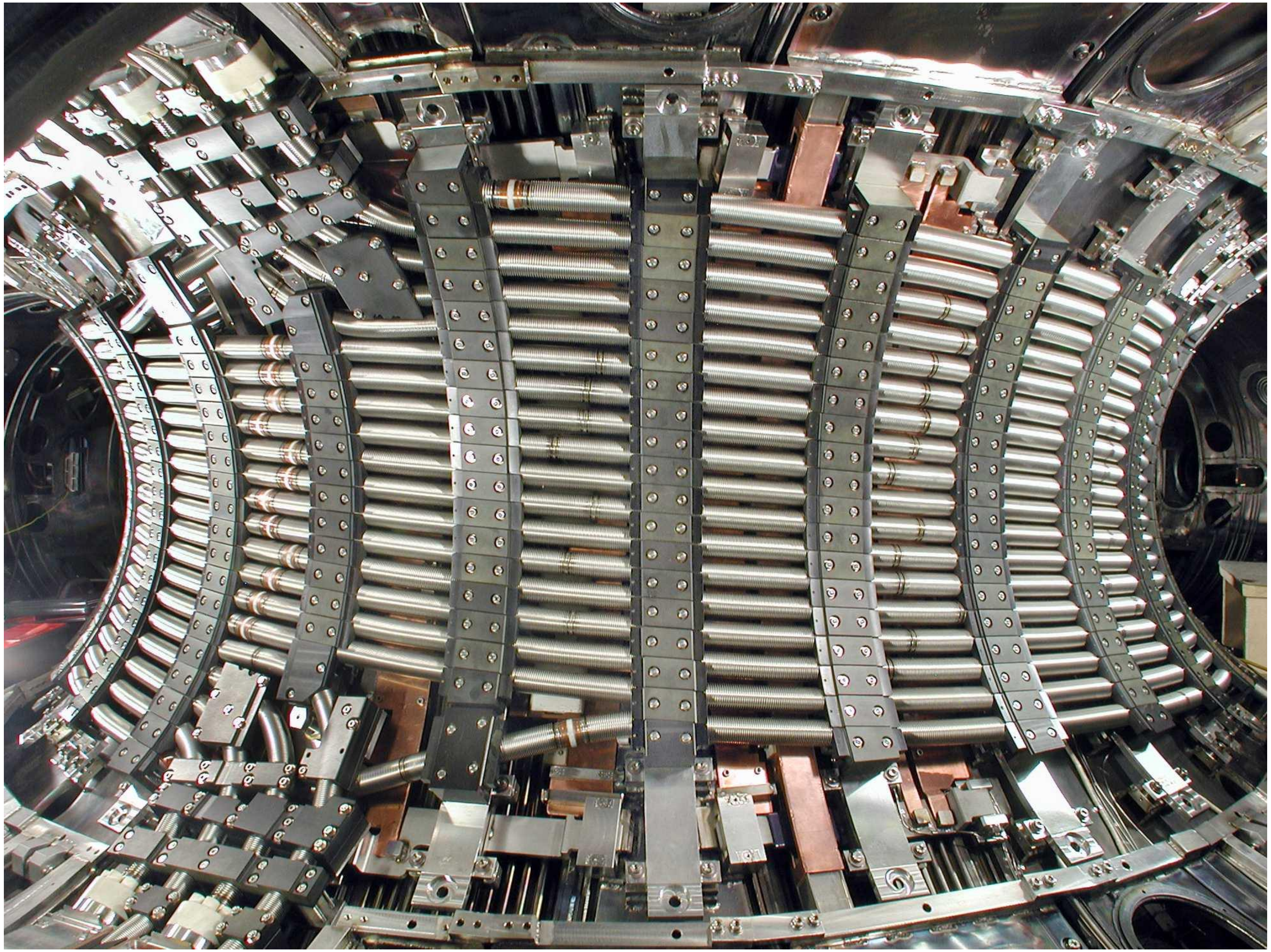
Outline

- Setup of the Dynamic Ergodic Divertor on TEXTOR
- Structure of the m/n=3/1 perturbation field
- Threshold for mode locking
- Drive of toroidal rotation
- Onset scalings of error field induced modes
- Summary and conclusion

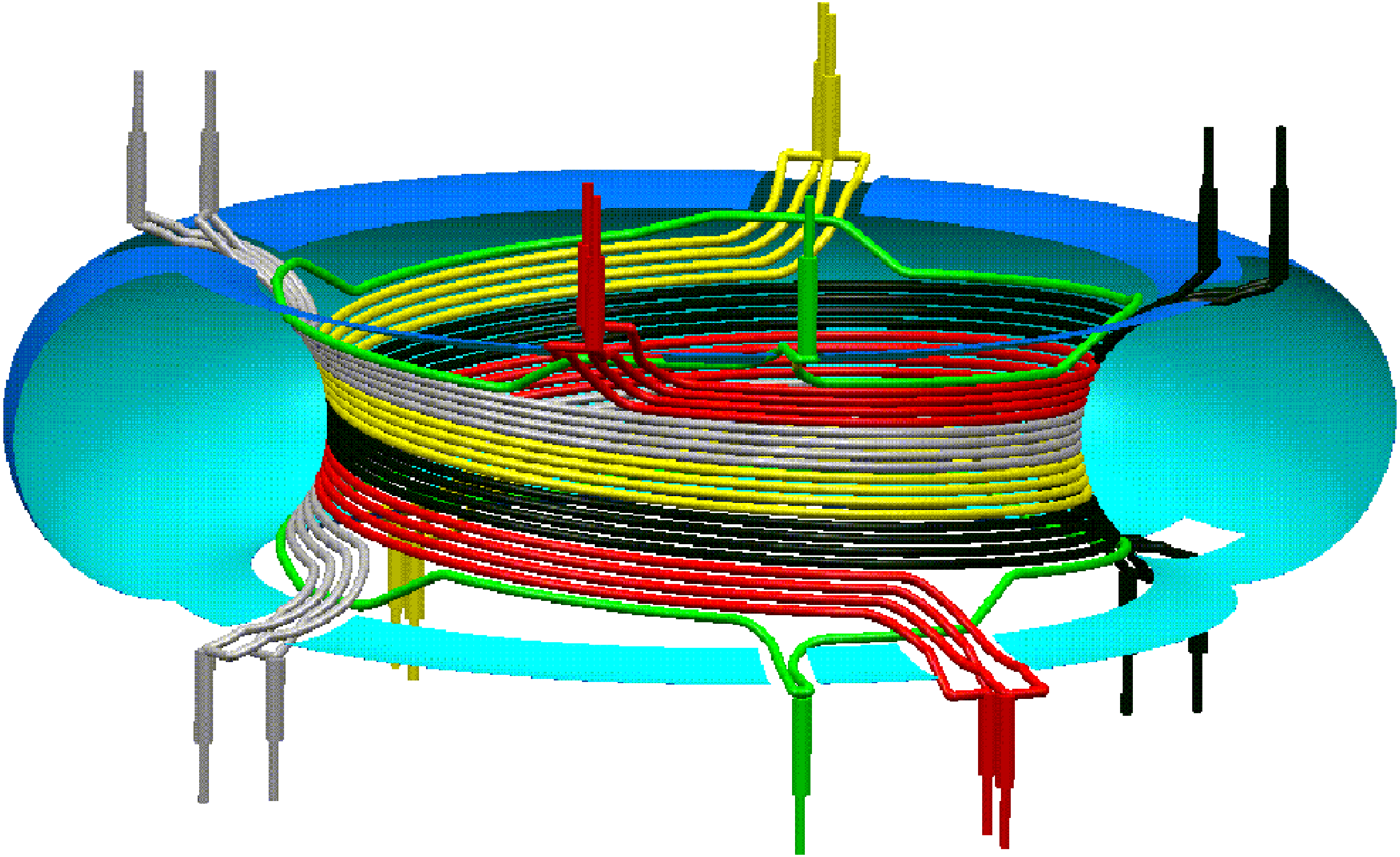
TEXTOR Dynamic Ergodic Divertor (DED) ..



.. consists of 16(+2) helical coils on the HFS



Schematic setup of the DED 3/1 configuration



DED parameters

- 16 coils (+2 compensation coils) mounted on the HFS
- Helical pitch resonant to q=3 field lines
- Configurations
  - 12/4 : PSI studies, divertor properties
  - (6/2)
  - 3/1 : Perturbation field and MHD studies
- Currents
  - up to 15kA/coil
- Frequencies
  - dc
  - low f ac (2Hz), field rotation in co- and counter current direction
  - high f ac (1 .. 10kHz)

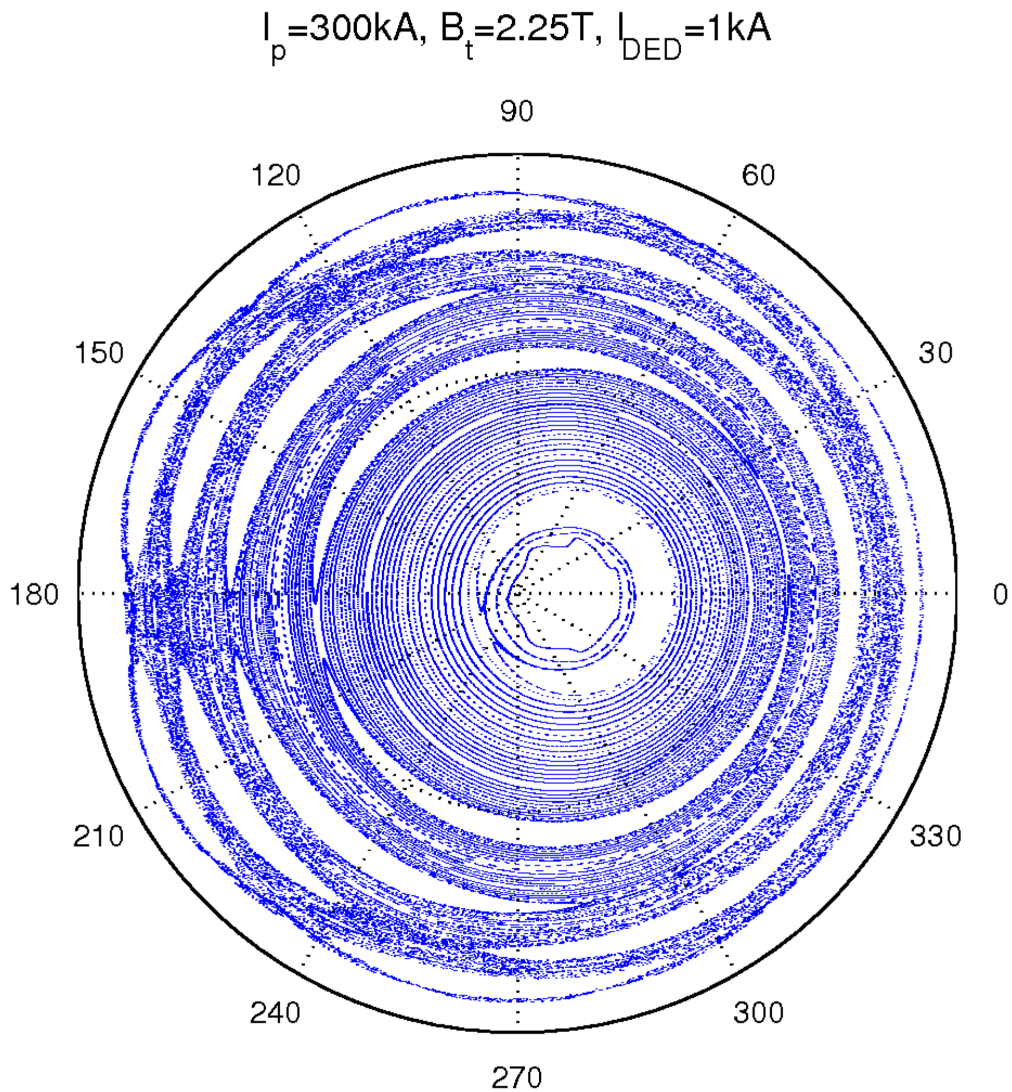
Structure of the perturbation field

standard plasma equilibrium

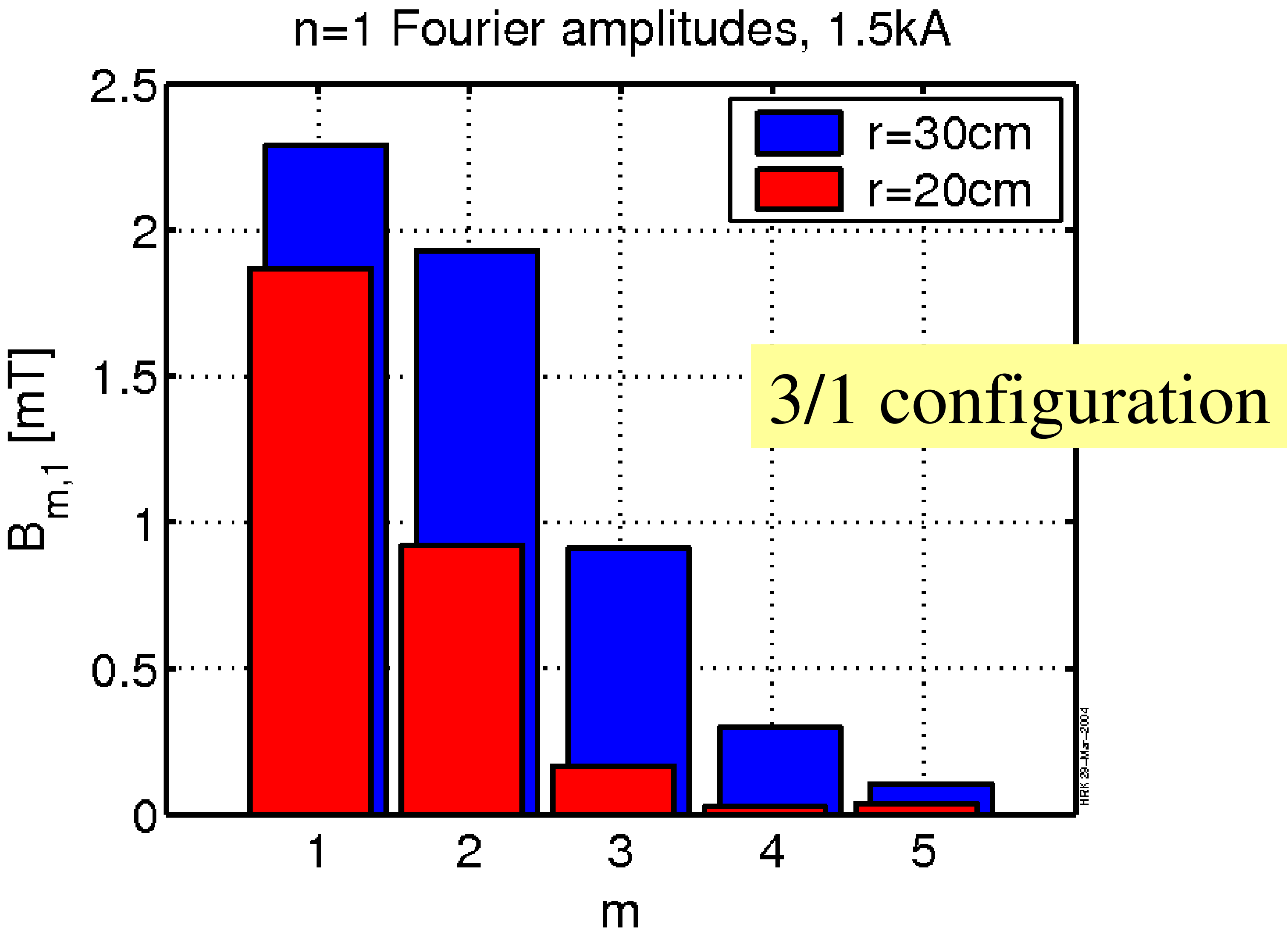
+

vacuum DED field

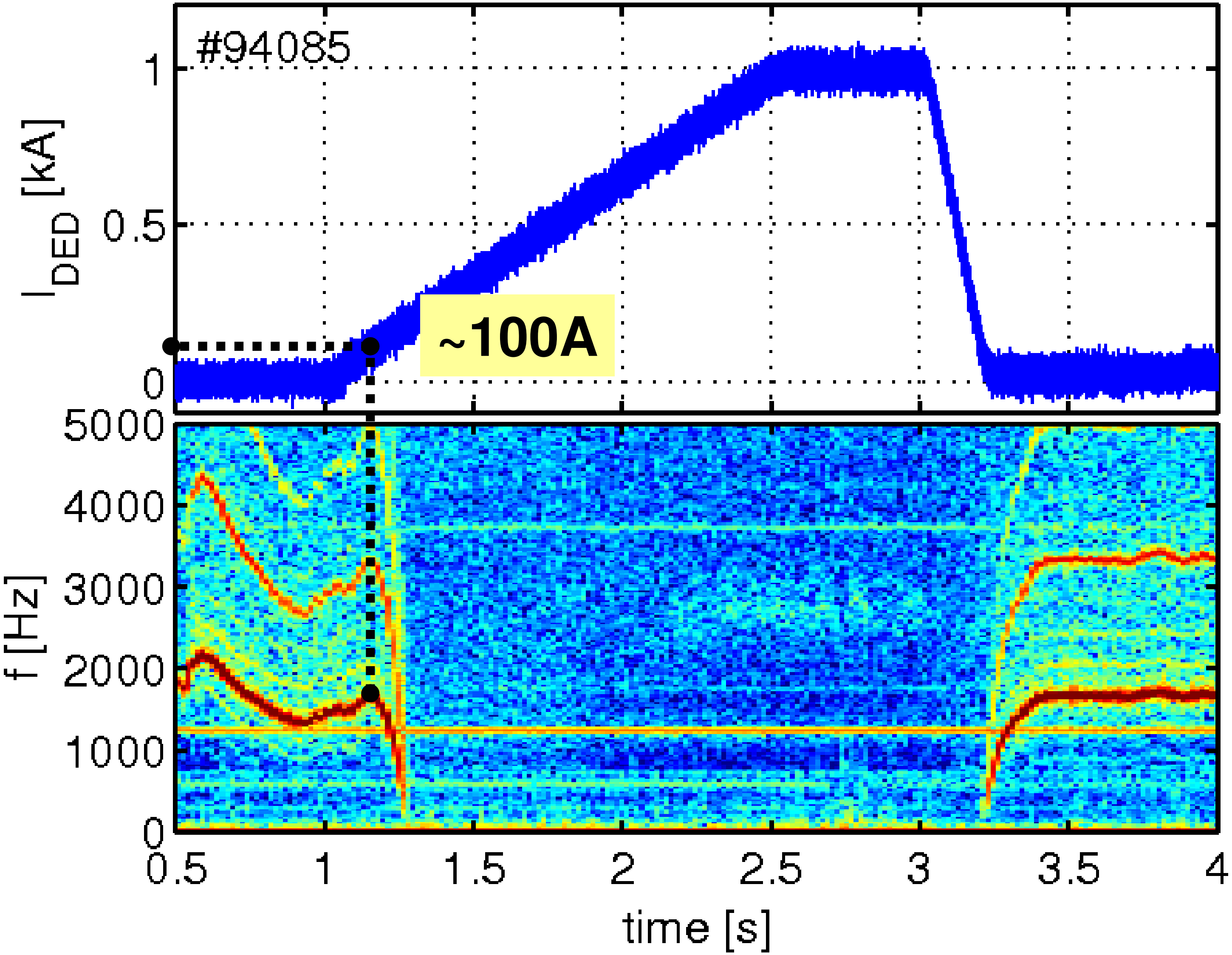
(q_a^{cyl}=4.5)



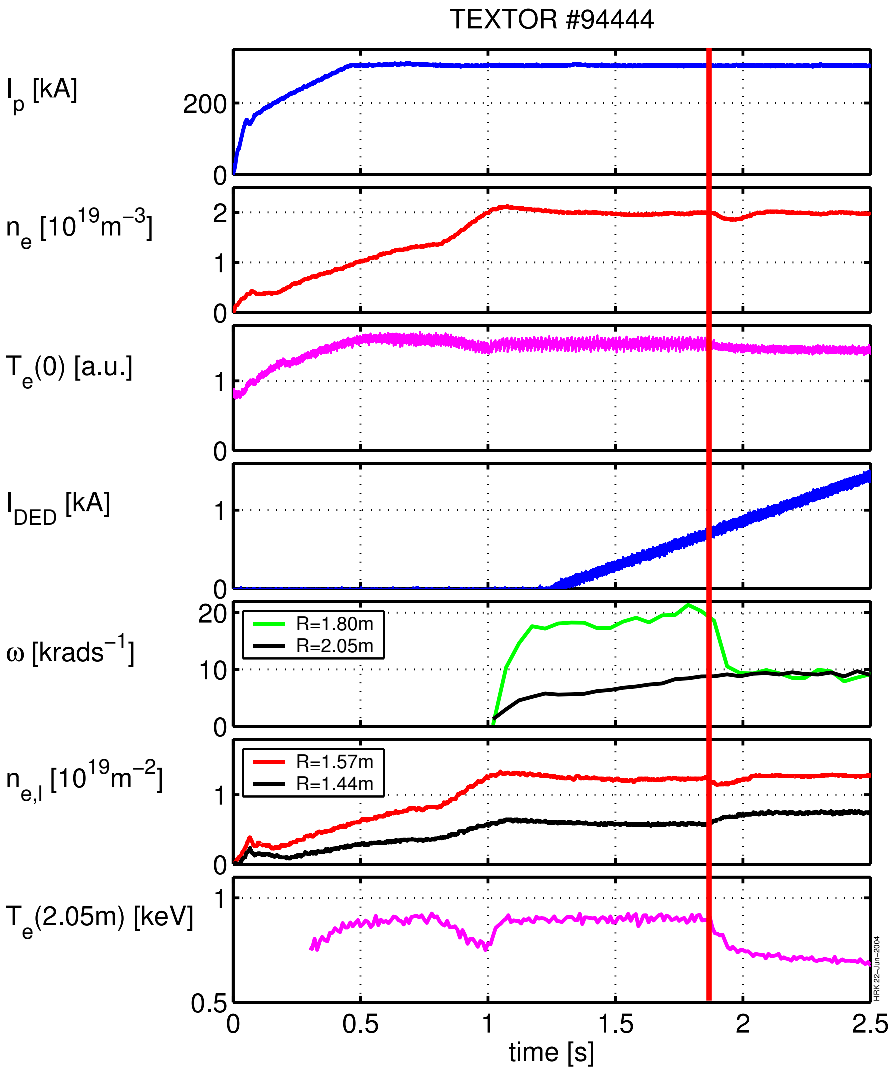
Amplitudes of the *n*=1 Fourier components



Pre-existing m/n=2/1 tearing mode locks

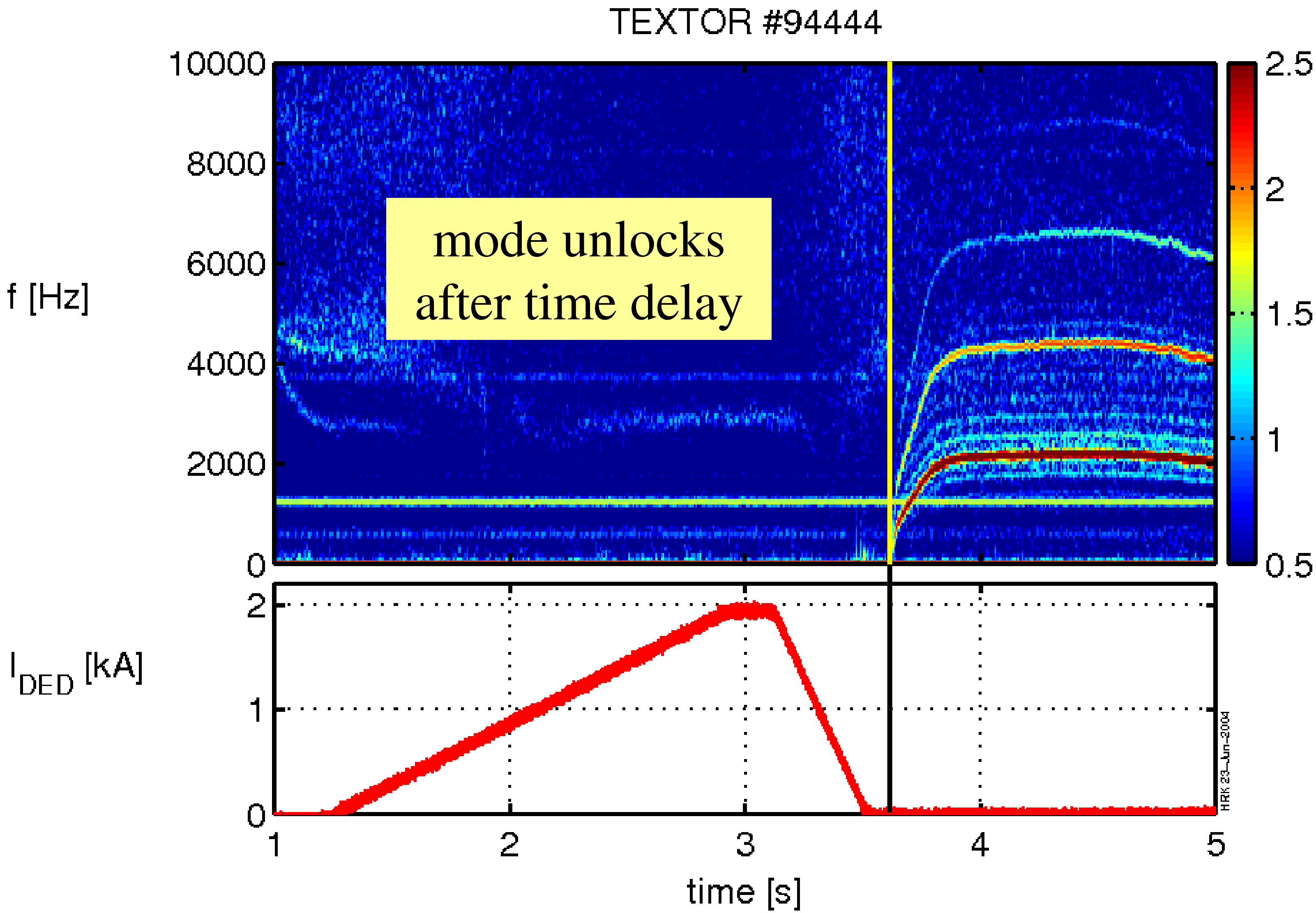


Typical discharge for error field experiments

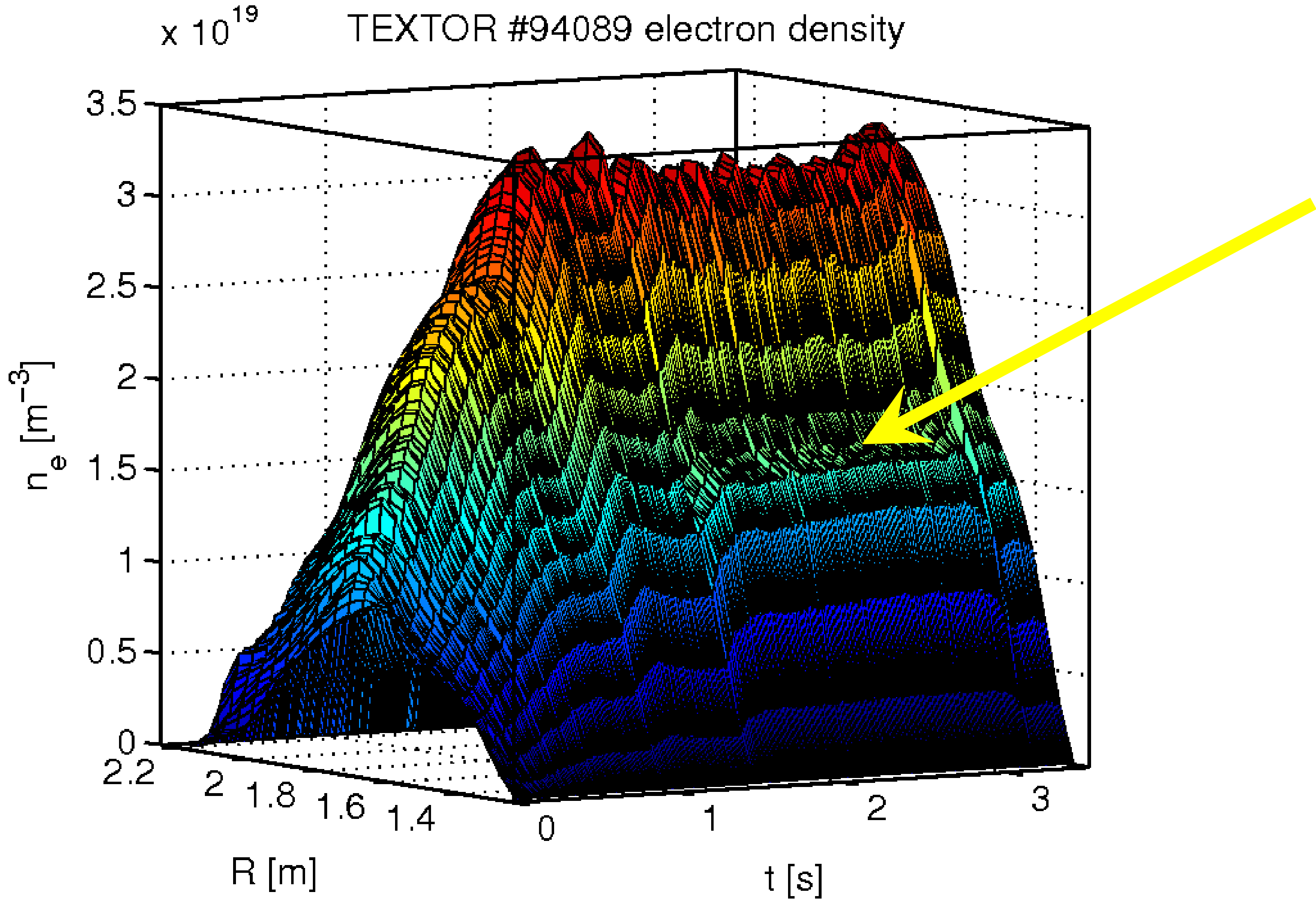


- DED in 3/1 configuration
- B_t=2.25T, I_p=300kA
- $q_{a,cyl}$~4.5
- co-NBI ~ 300kW
- at critical DED current (~0.7kA) a 2/1 tearing mode is excited
- effect is highly reproducible
- dependence on electron density, heating power (beta), and plasma rotation has been studied

Tearing mode is created during DED phase



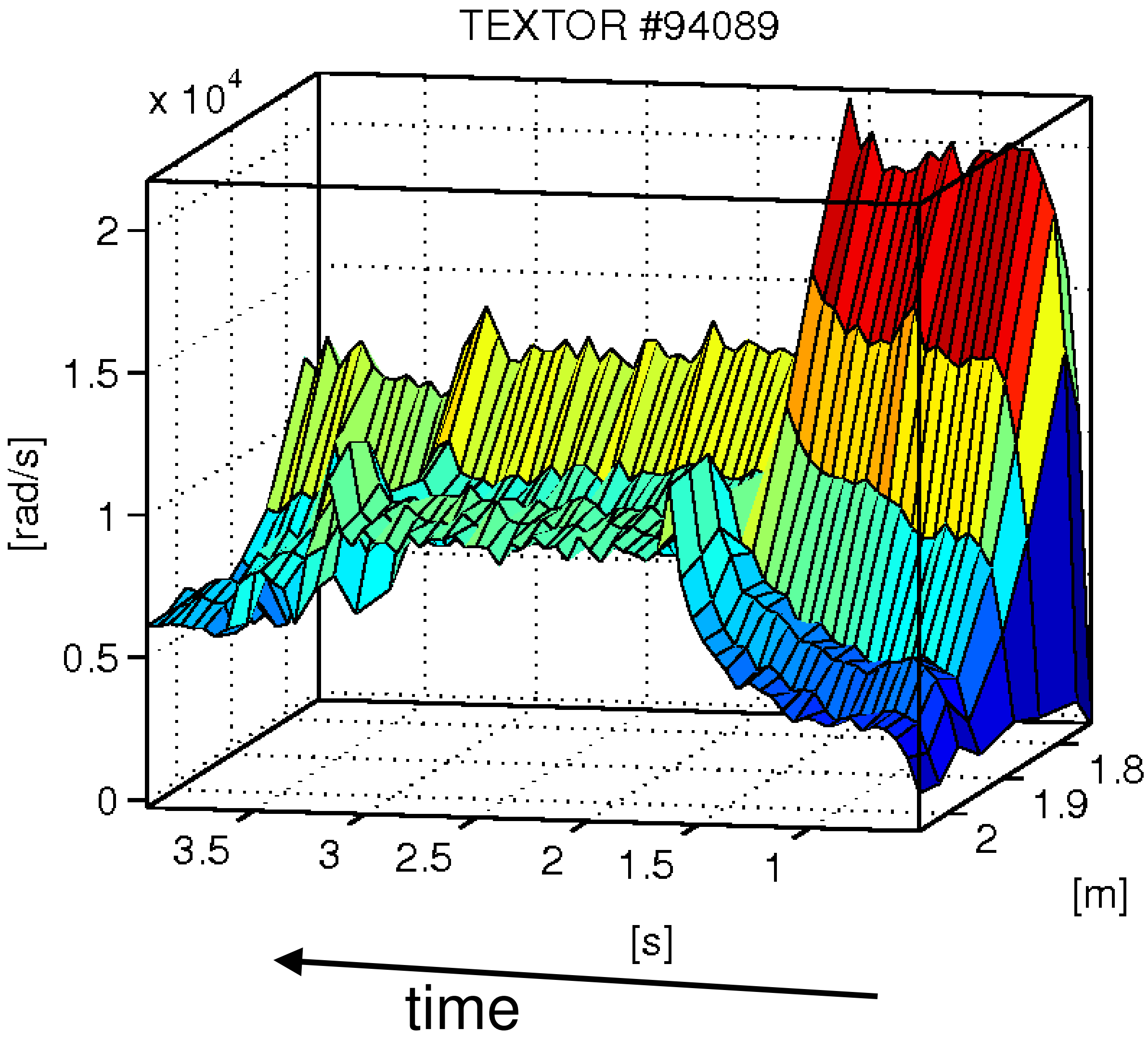
Electron density profile shows locked mode



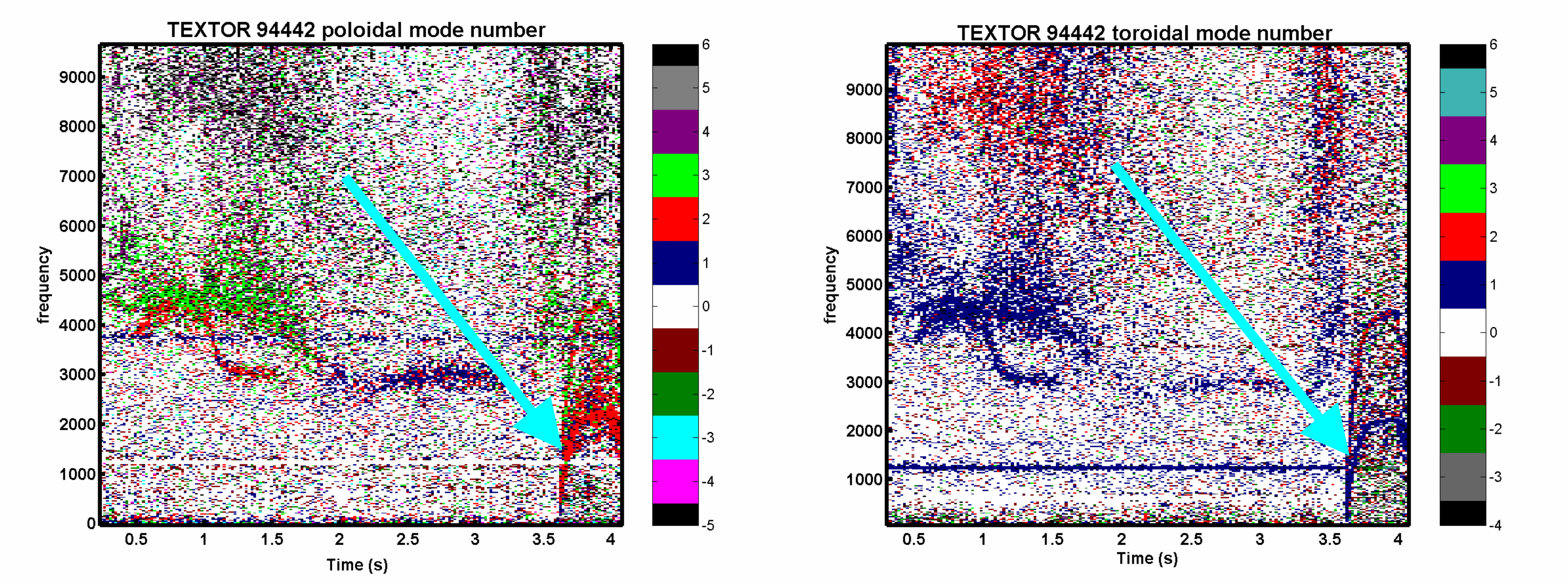
Braking of toroidal rotation

toroidal rotation decreases when mode is created

v_{tor} profile indicates rigid body rotation (between $r_{q=1}$ and $r_{q=2}$)

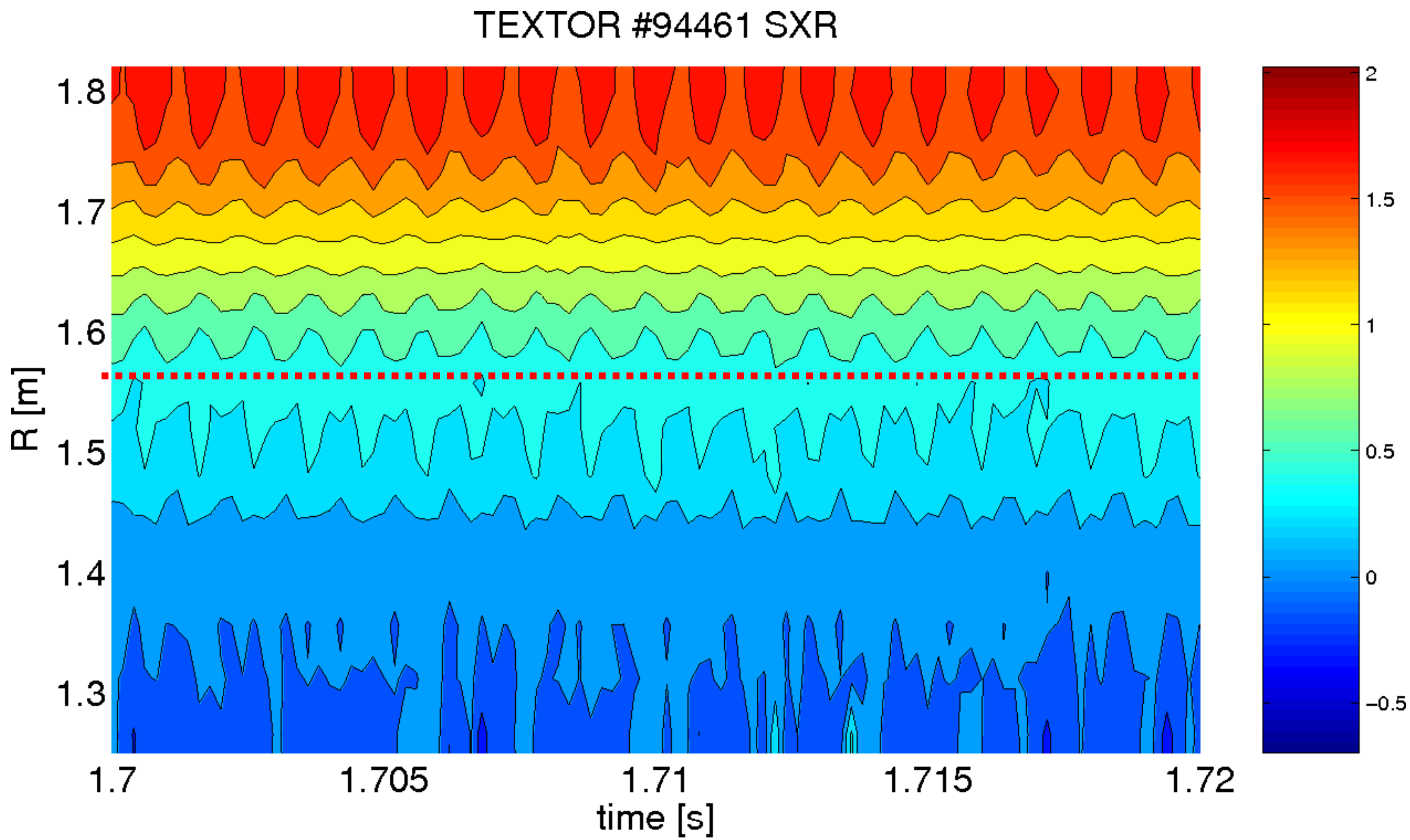


Mode numbers are *m*=2 and *n*=1

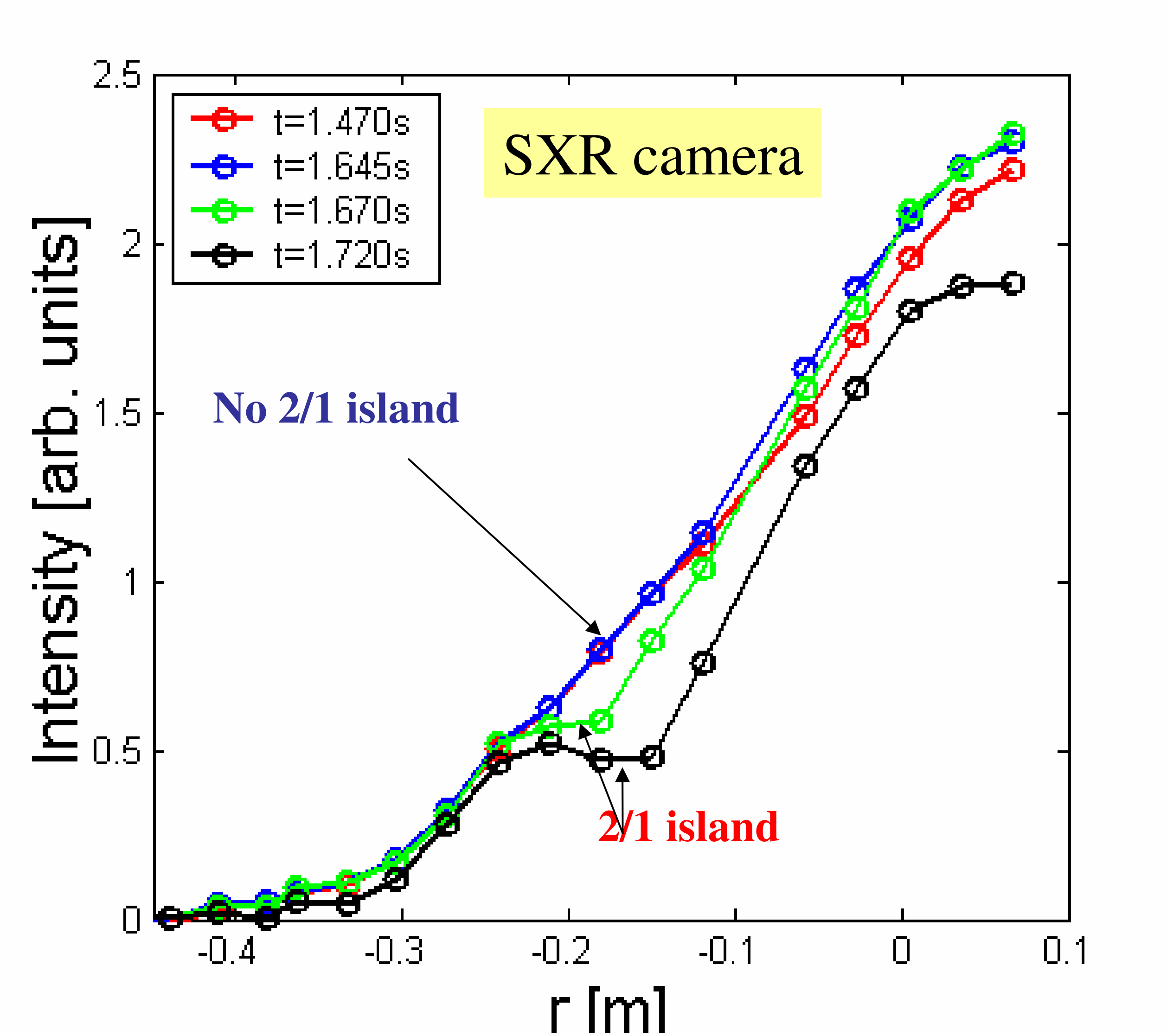


mode numbers analysed with phase comparison method

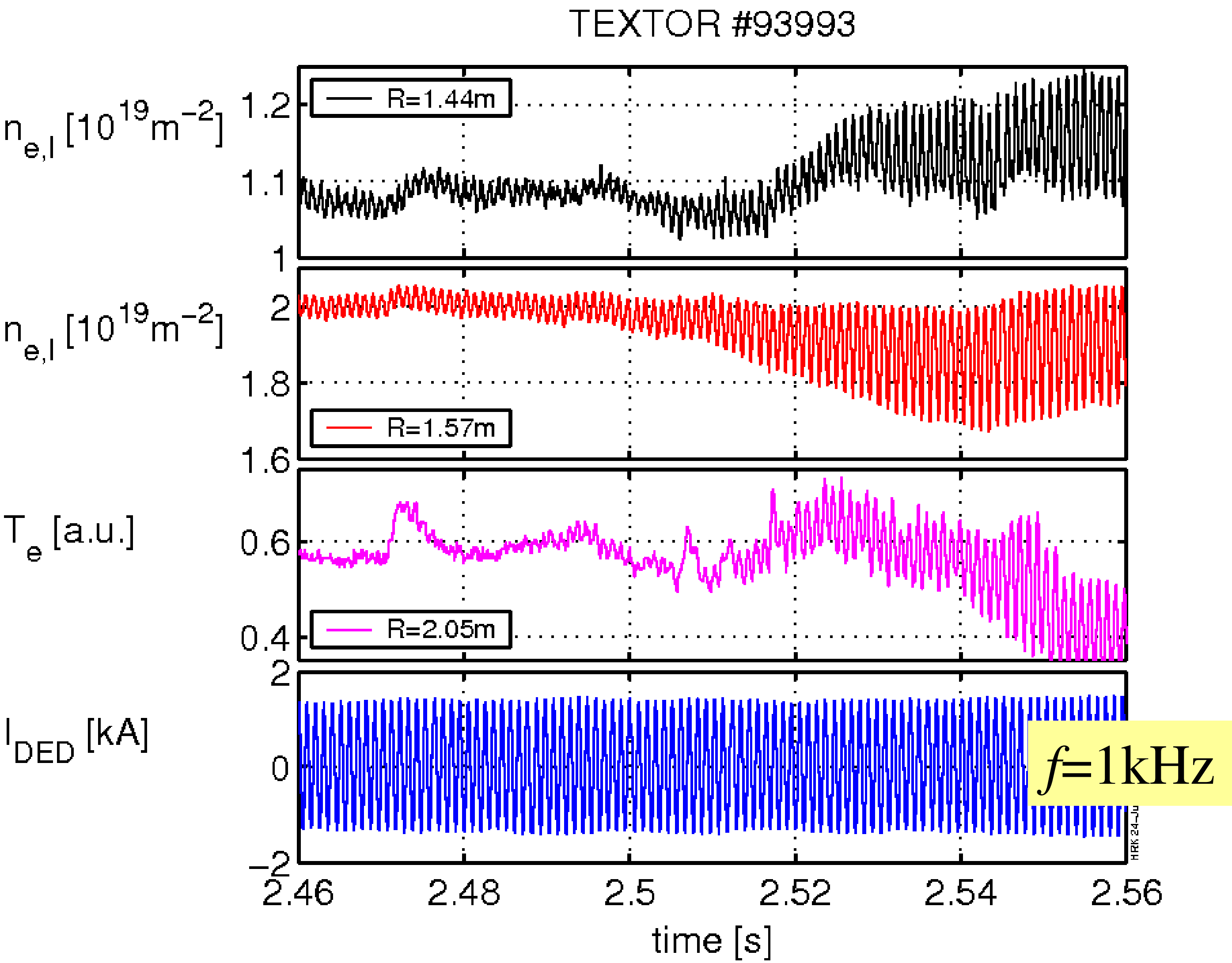
Phase inversion of SXR data indicates tearing mode



Saturated island width up to *20% of minor radius*

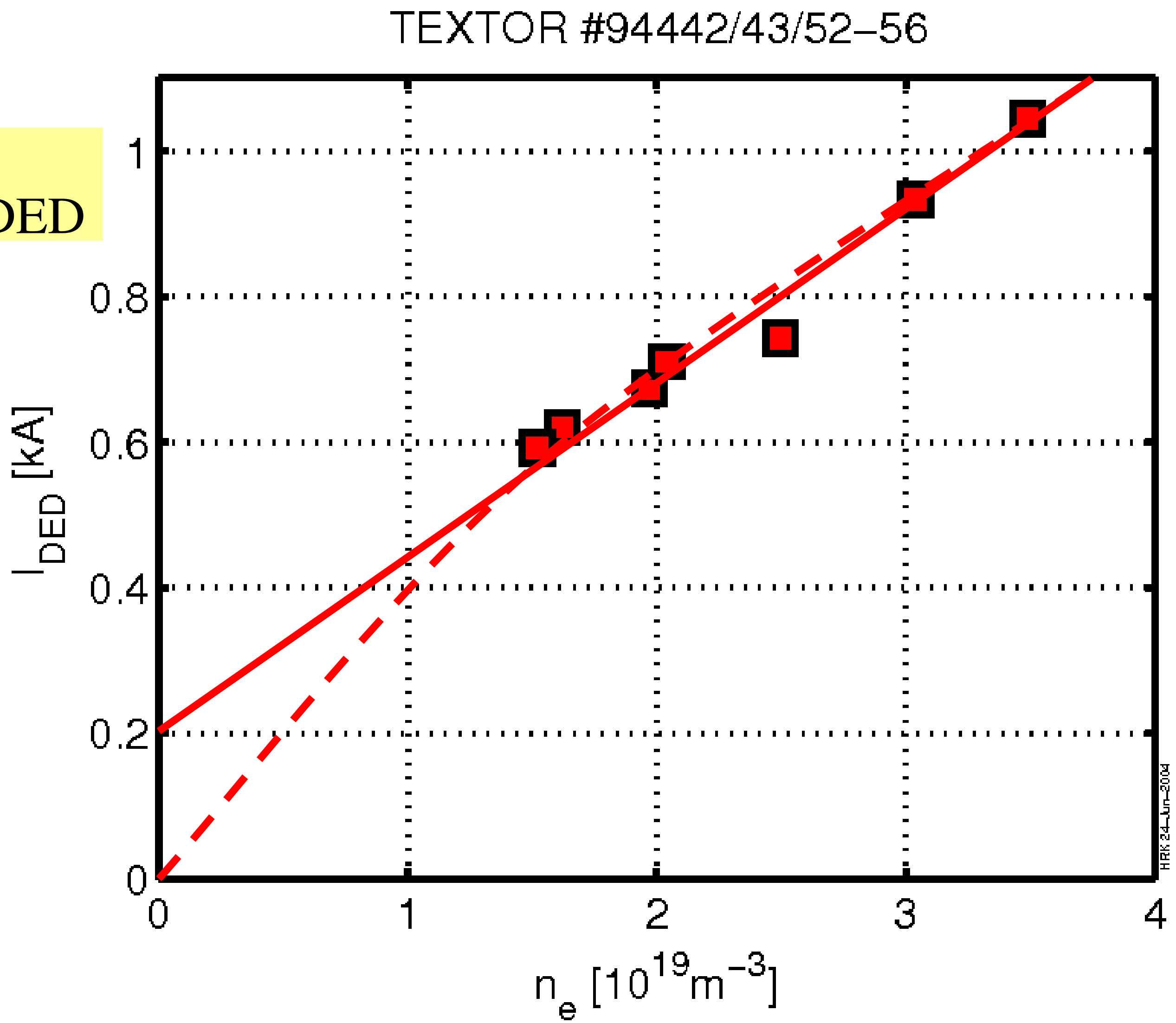


With ac DED mode is “locked” to external perturbation

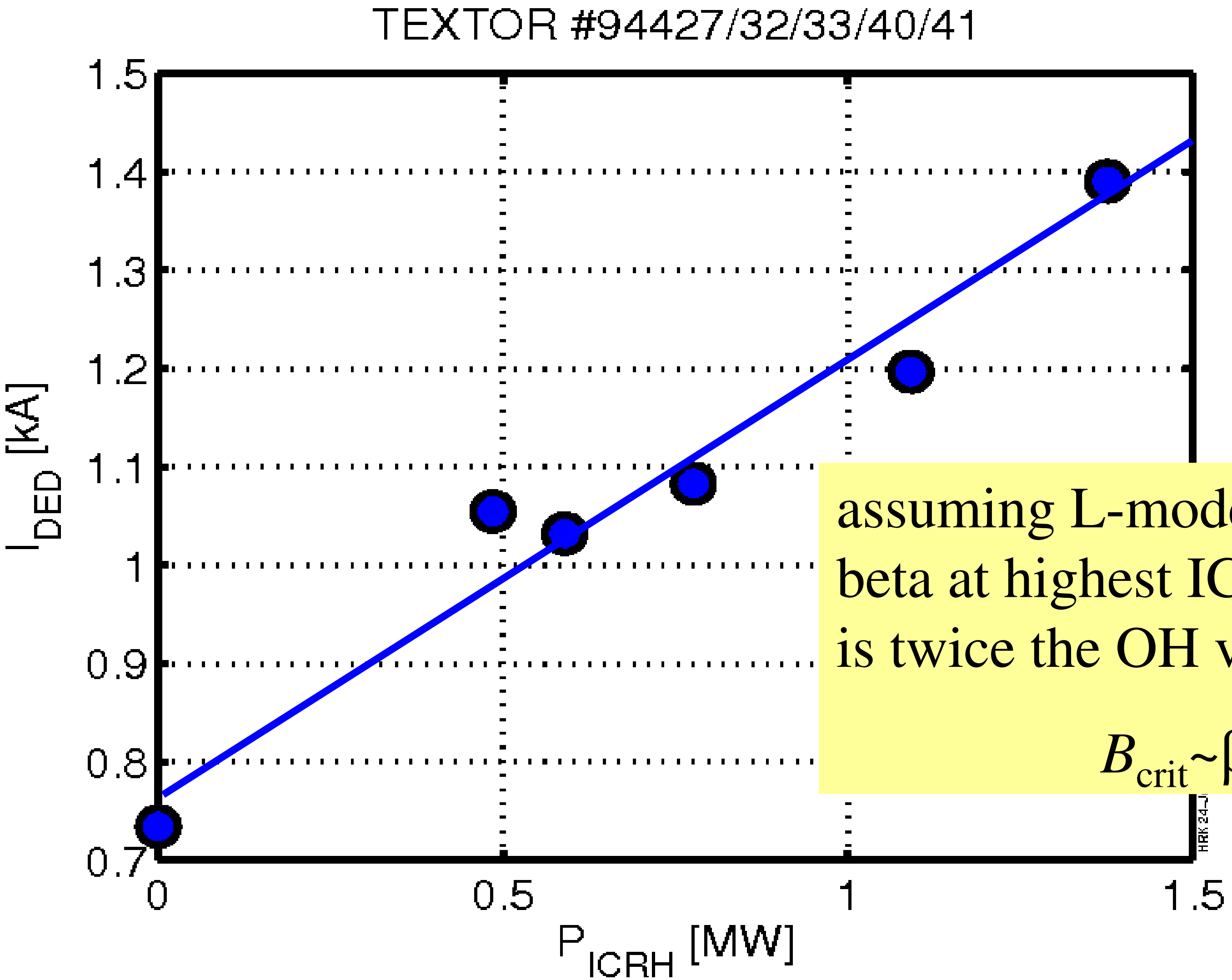


Density scaling of the critical error field

$B_{21} \sim I_{DED}$



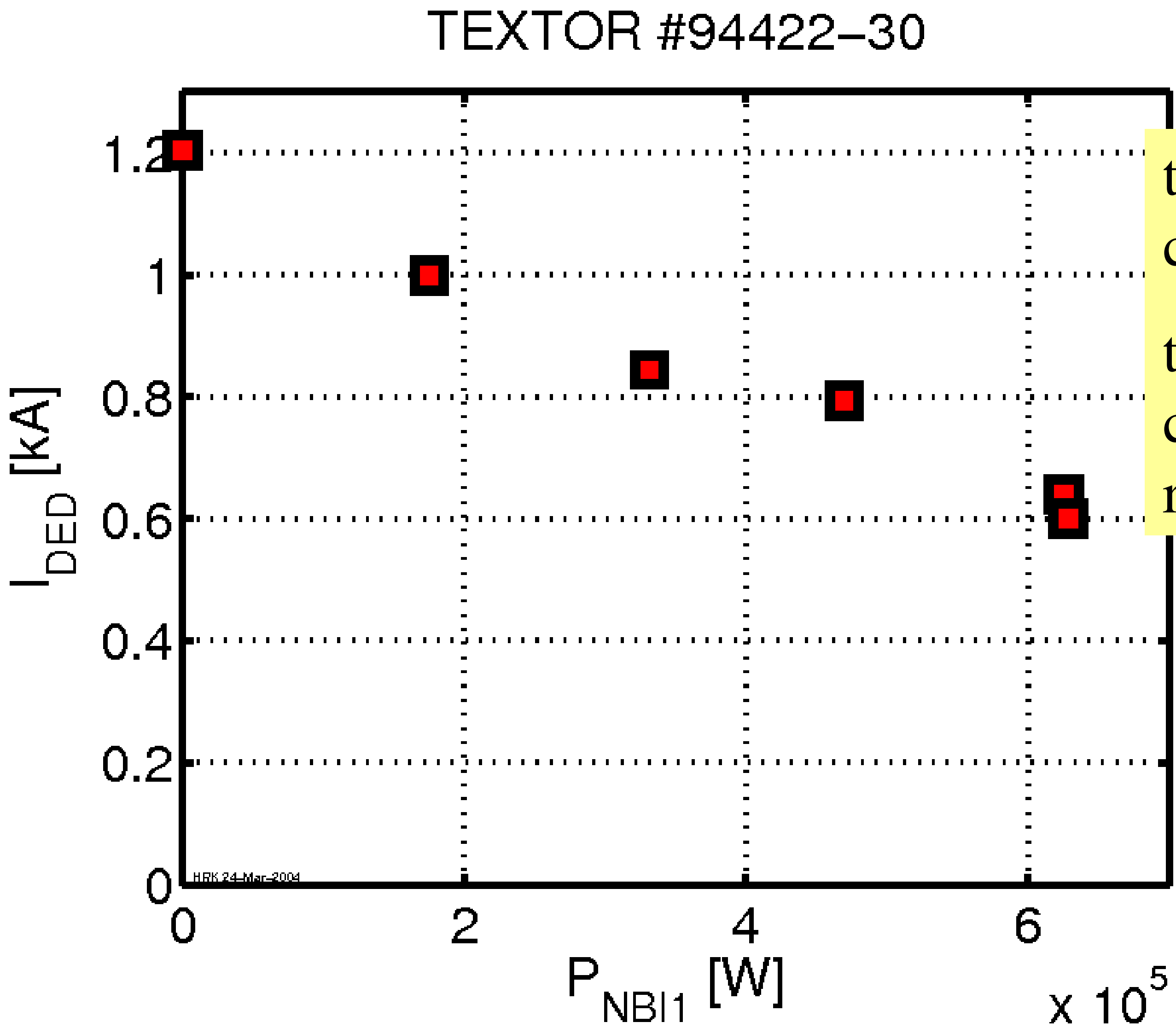
Beta dependence of mode threshold



assuming L-mode scaling
beta at highest ICRH power
is twice the OH value

$B_{crit} \sim \beta$

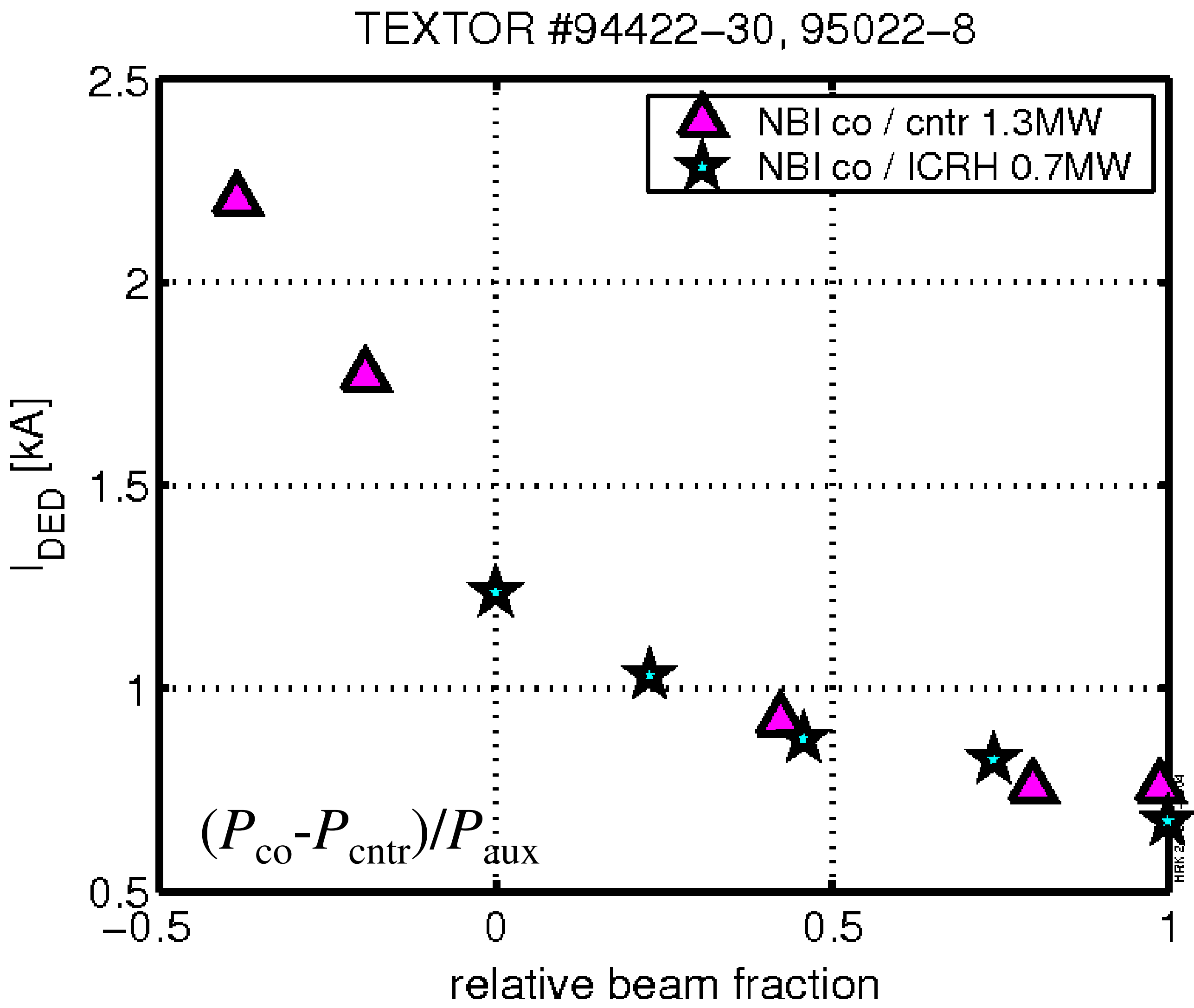
Toroidal plasma rotation <u>decreases</u> mode threshold!?



tangential NBI in co-current direction

total heating power constant (P_{NBI} replaced by P_{ICRH})

Influence of plasma rotation on mode threshold



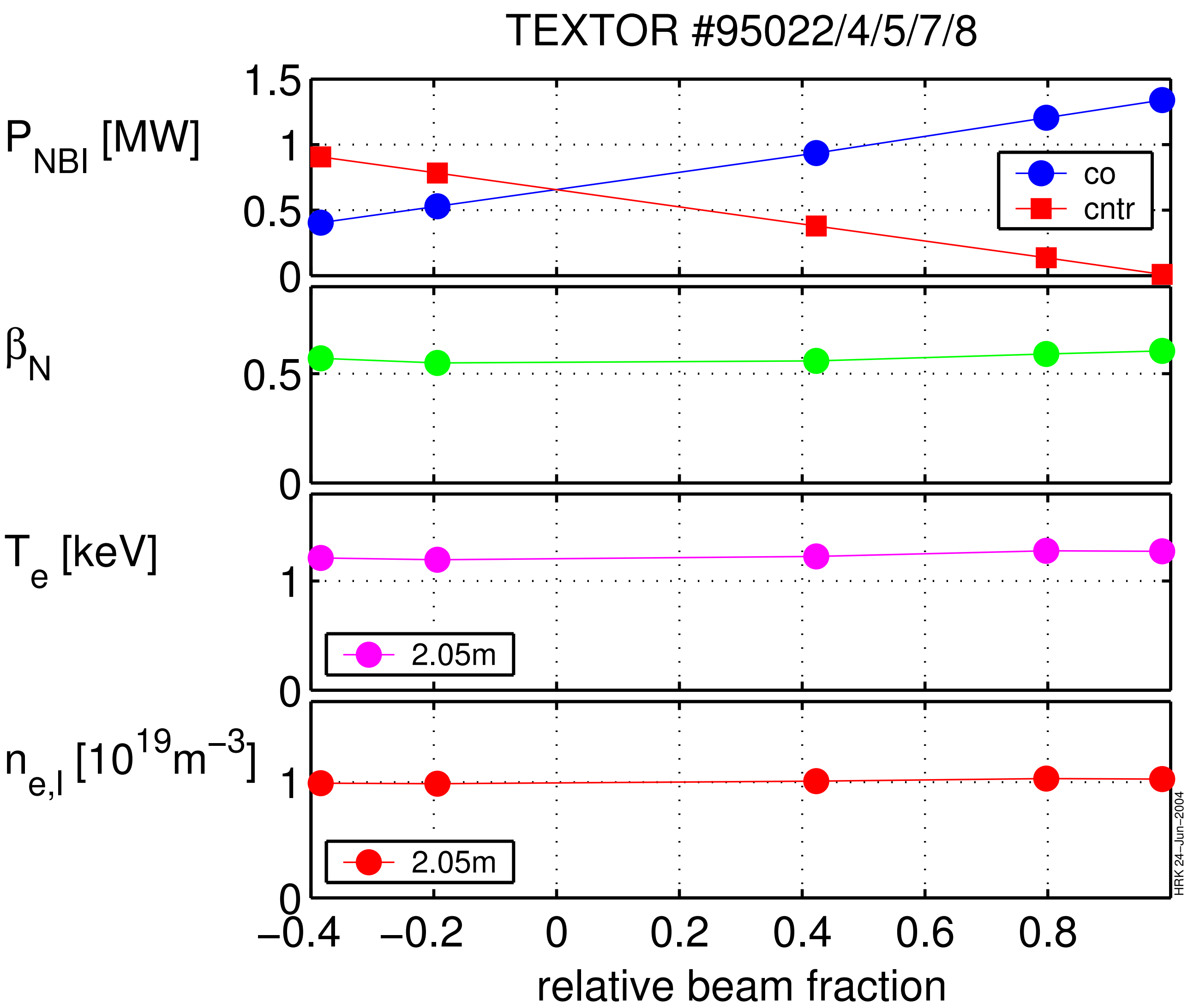
two scans of plasma rotation at constant heating power

- NBI-co + ICRH

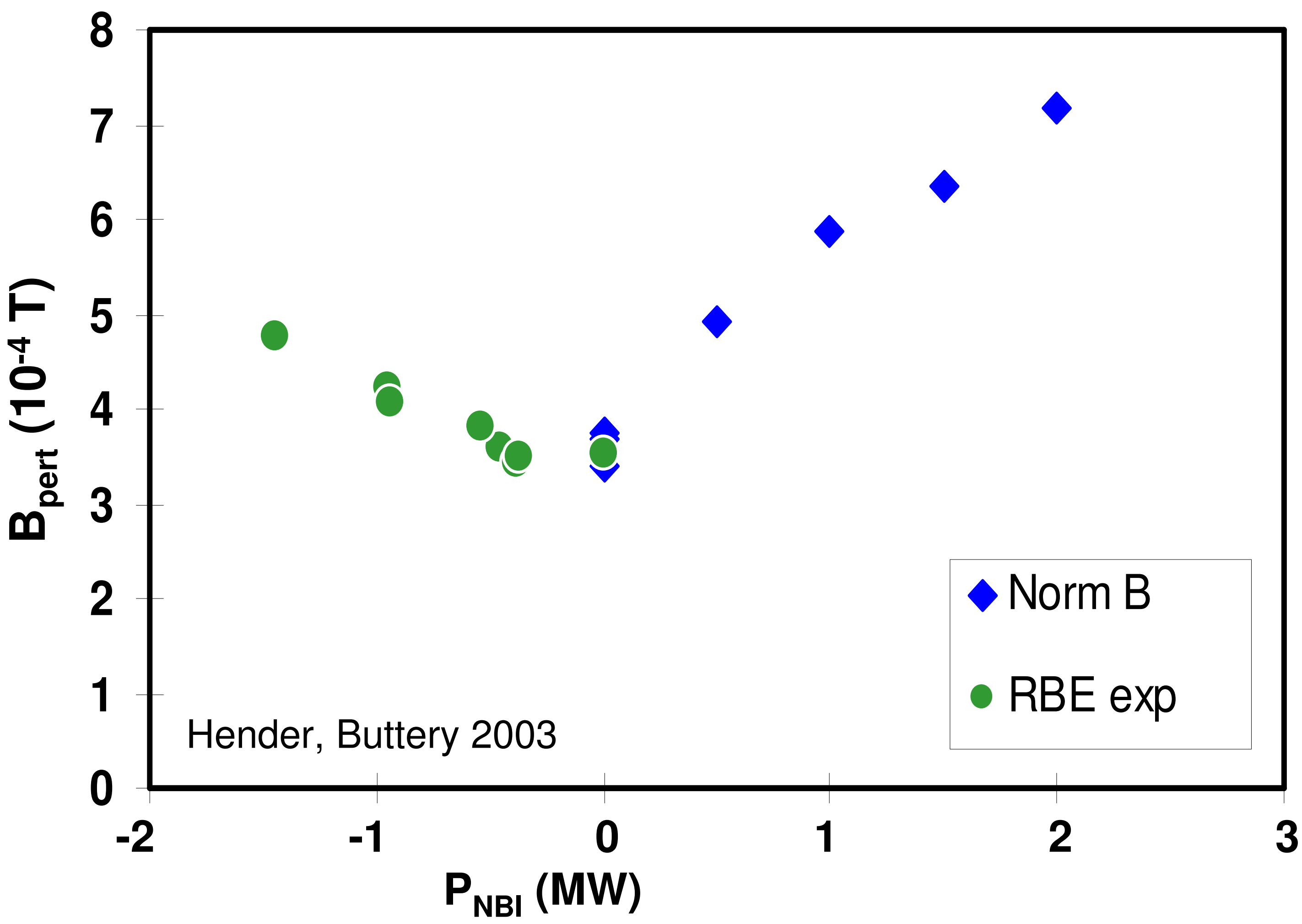
- NBI-co + counter

co-rotation destabilizes, counter-rotation stabilizes 2/1 mode

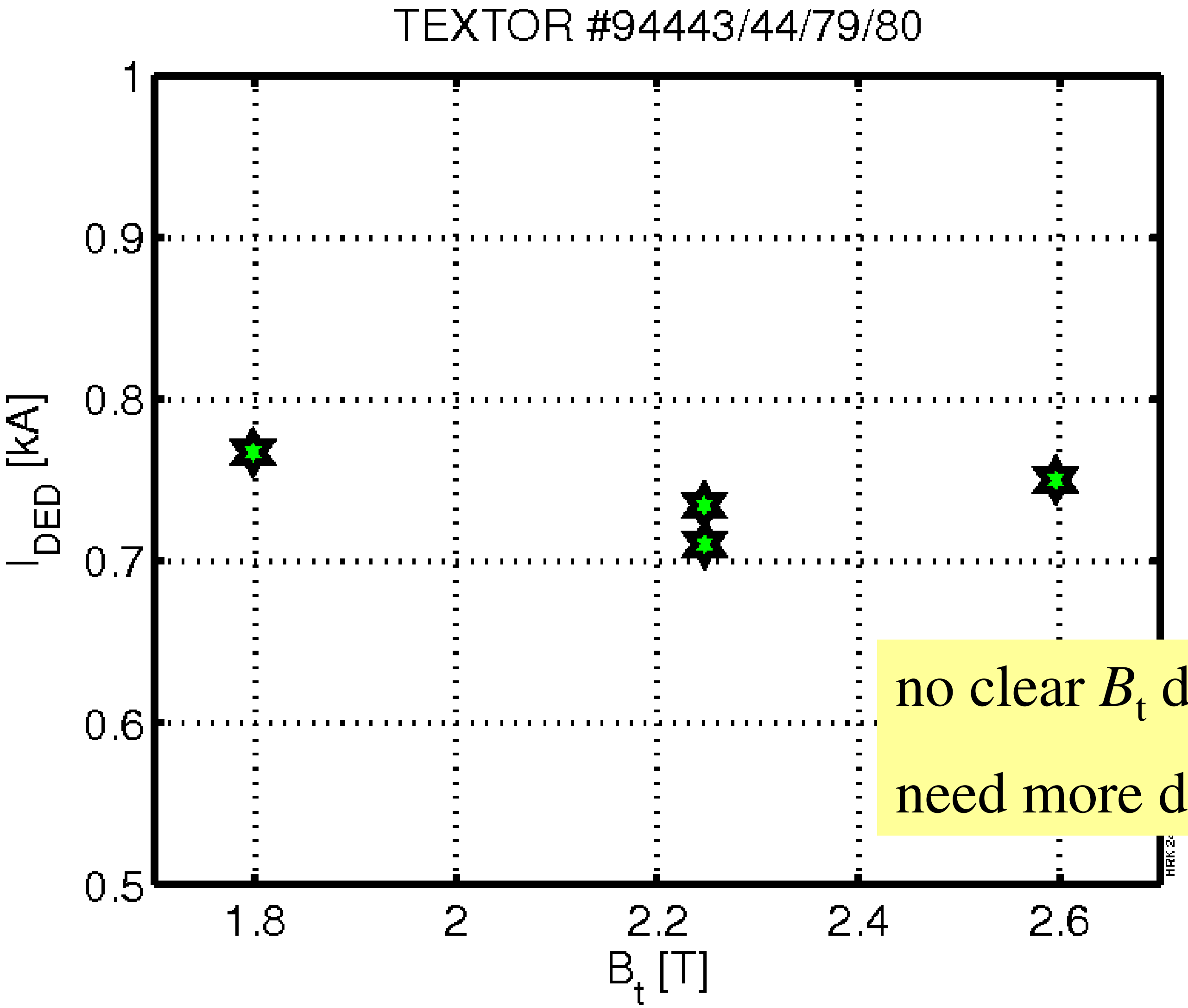
Plasma parameters are constant for rotation scan



Rotation dependence: JET results are different



B_t-scan with q_a=const



no clear B_t dependence

need more data

Summary

- TEXTOR-DED in 3/1 configuration allows to study the onset of error field generated 2/1 tearing modes
- First parameter scans were performed
- Density dependence of locked mode onset threshold agrees with other tokamaks (JET, DIII-D, C-mod)
- No clear B_t dependence of the mode threshold found
- ICRH heating (beta) has a strong stabilizing effect
- Co-NBI is found to destabilize the 2/1 mode, counter-NBI has a strong stabilizing influence
- TEXTOR data does not agree with JET results

Outlook and future work

- Continue detailed investigations of mode onset threshold vs toroidal plasma rotation
- Study B_t dependence of mode onset
- Analyze data with 1kHz ac DED, is there any influence of the rotating field?
- Understand difference to JET experiments
- TEXTOR experiments within the ITPA framework