NSTX

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Tests of fast wave current drive for core q profile control

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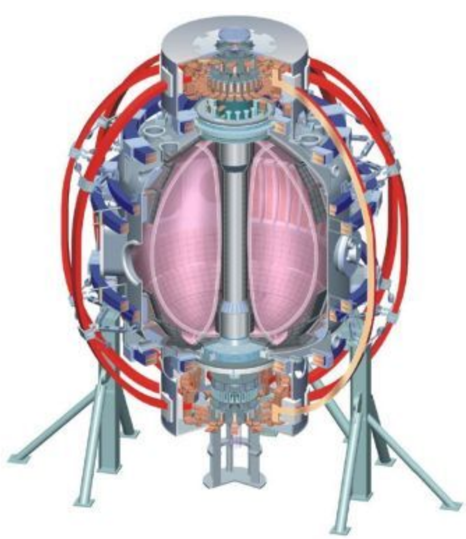

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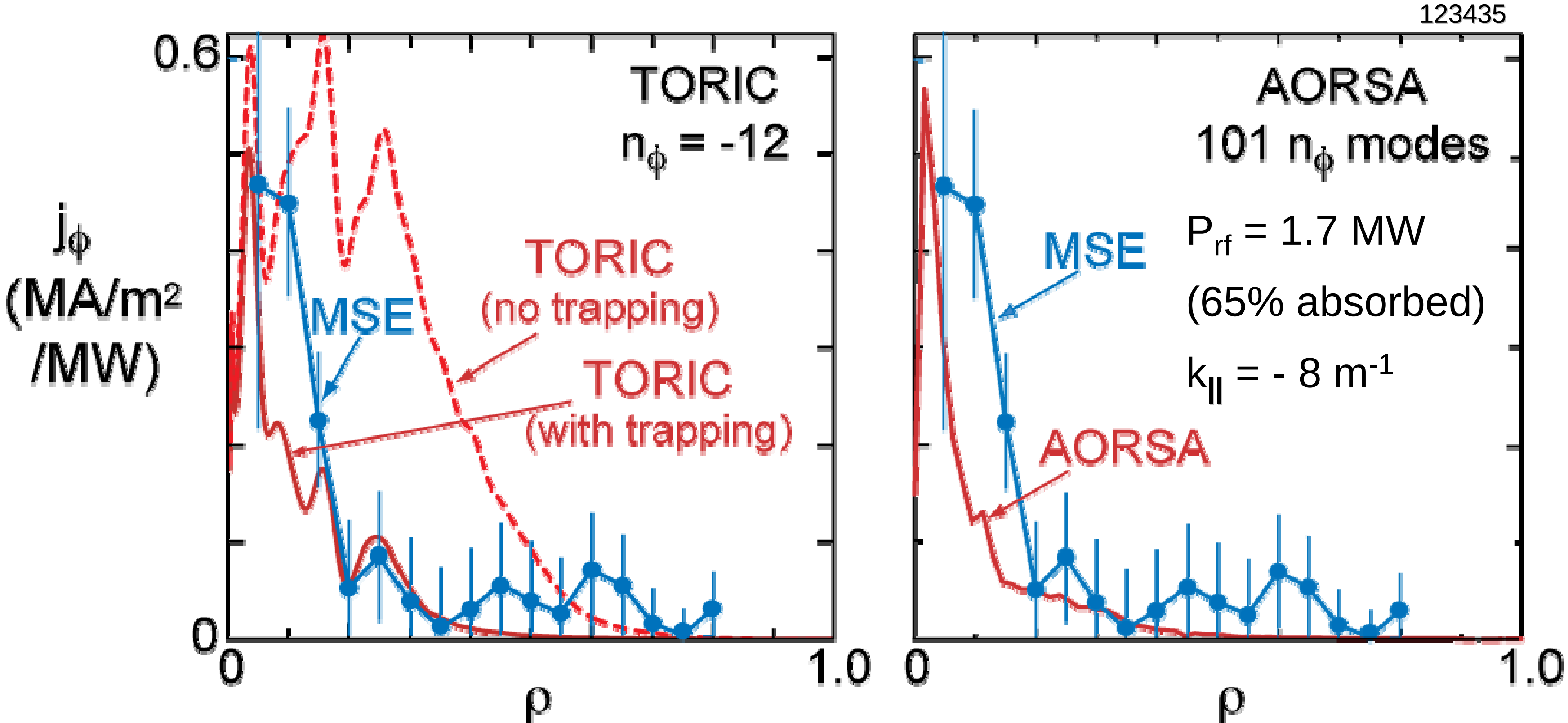
Overview

- **Brief Description:**

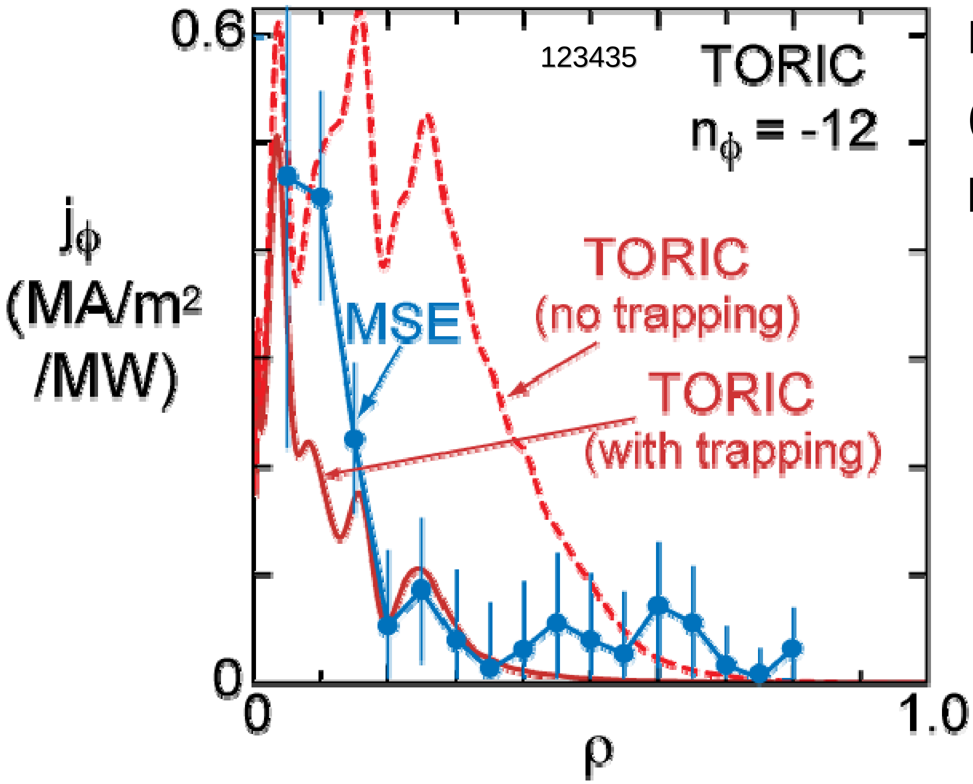
  Assuming successful HHFW coupling and heating of an NBI-heated H-mode plasma, co and counter HHFW CD will be applied to attempt to modify the core q profile and assess changes in transport and MHD instability behavior.
- **Motivation:**
- The core q profile is important for confinement and MHD stability - in particular via transport barrier formation and avoidance of the q=1 surface entering the plasma.
- The HHFW system was upgraded in FY2009 in part to enable higher power and more reliable coupling to high-performance (possibly ELMing) NBI-heated H-modes.
- Aside from modifying plasma evolution via direct electron heating, HHFW CD is projected to be effective near the magnetic axis in driving current and modifying the central q.

From NSTX 5yr plan: Motional Stark Effect (MSE) Measurement of Core HHFW CD in NSTX Plasma



- Measured q(0) decreases from 1.1 to 0.4 with HHFW CD
  - Offers prospect of controlling q(0) in integrated scenarios
- Measured j_ϕ profile consistent with predictions from TORIC & AORSA full-wave codes
  - TORIC predicts electron trapping significantly reduces CD efficiency

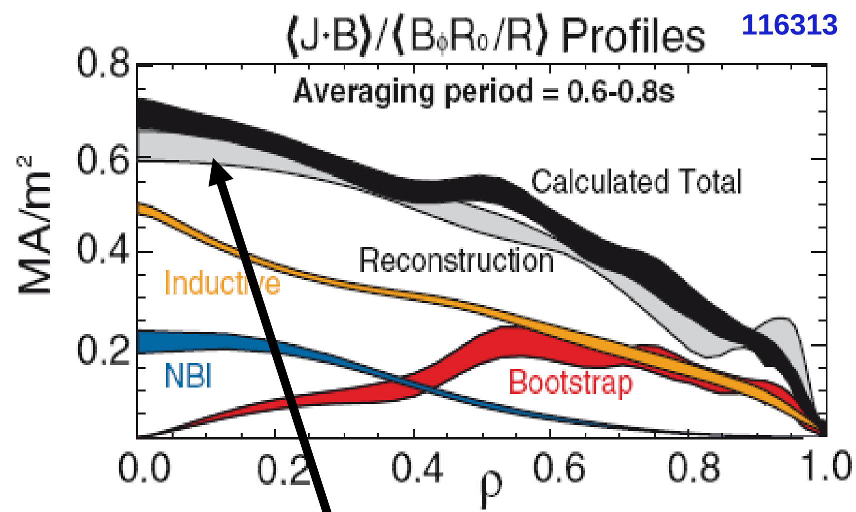
HHFW driven current density is sufficiently high to modify q in high NI-fraction H-mode scenarios



P_{rf} = 1.7 MW

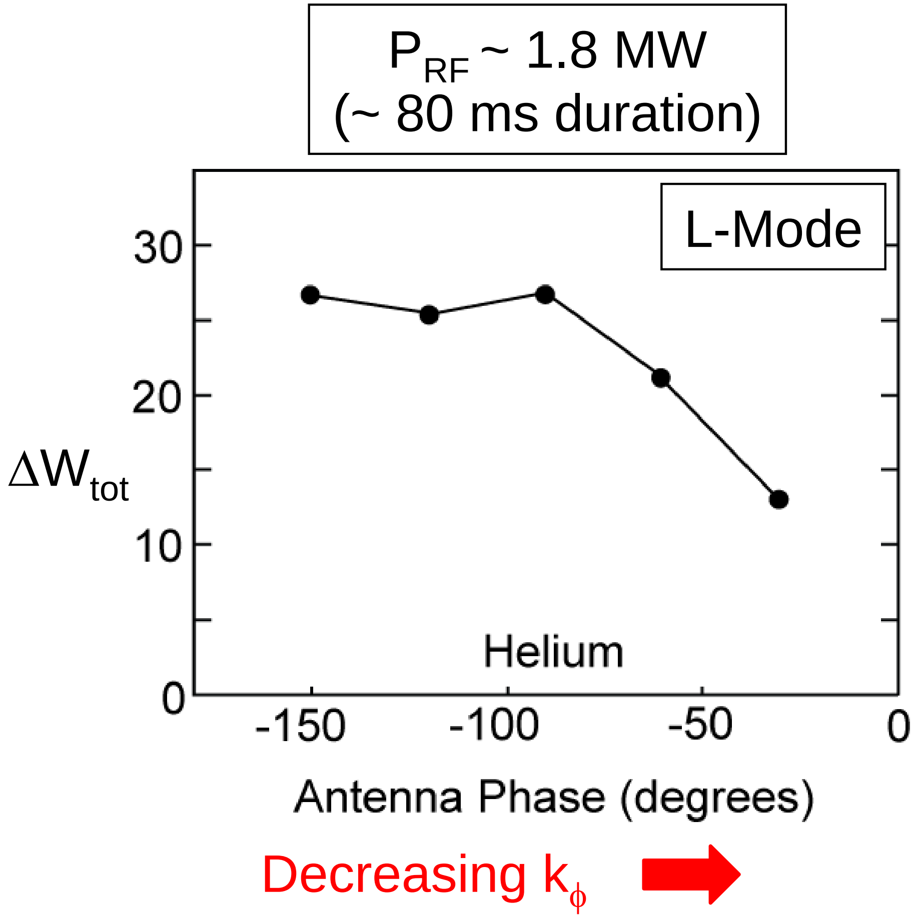
(65% absorbed)

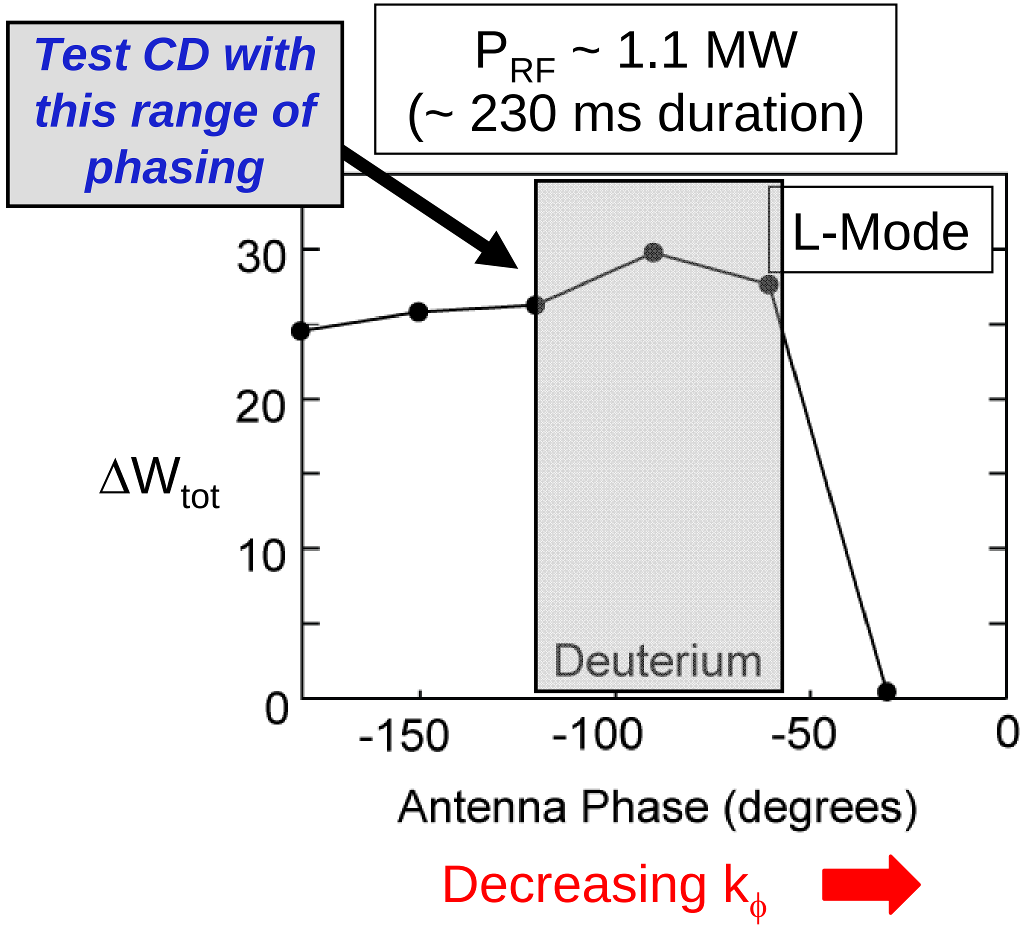
$k_{||}$ = - 8 m^{-1}



- High non-inductive fraction H-mode J_ϕ ~ 0.5-0.7MA/m²
  - H-mode shown has 1.7× lower n_e, 5× higher T_e → η_{RFCD} = 9× lower
  - 6MW RF (source) → 0.2MA/m² → **comparable to NBI-CD near axis**

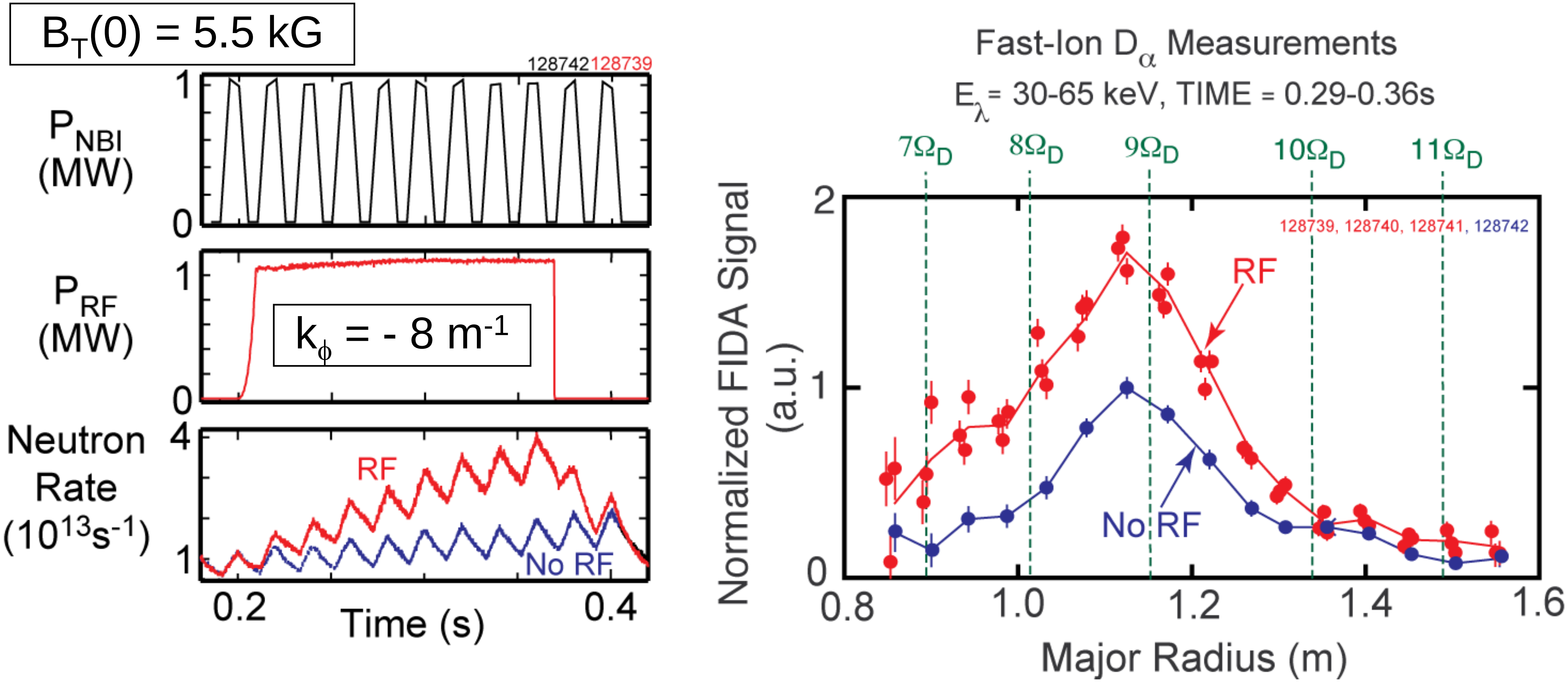
Taylor APS09: Core Heating Efficiency Degrades with Decreasing k_ϕ in L-Mode & H-Mode Plasmas





- Also measure a degradation in core heating efficiency with decreasing k_ϕ In D_2 H-mode:
  - ~ 66% efficiency at k_ϕ = -13 m^{-1}, decreasing to ~40% at k_ϕ = -8 m^{-1}

Taylor APS09: Interaction Between NBI Ions & HHFW Can Be Significant



- Measured acceleration of NBI fast-ions and large increase in neutron rate during HHFW + NBI plasmas
  - ➢ As predicted originally by CQL3D/GENRAY
- Measured significant enhancement & broadening of fast-ion profile when HHFW power is applied

Experimental Approach/Plan:

(1.5 day request, 1 day minimum useful)

- Produce or reproduce NBI-heated H-mode plasma with substantial core Te increase from 2-4MW of HHFW in heating phasing.
- Switch HHFW phasing to drive current in co-Ip direction
- Perform HHFW power scan to find maximum allowable FW power input for range of phasings: 90°, 60°, 120°
  - Assess plasma response: ΔTe(0), and variations in q evolution
- Repeat above for counter CD phasing
- For heating scenarios with largest plasma modification:
  - Scan B_T +/- 5% to change core resonance location, assess FWCD
  - Modify Li conditions and assess changes in heating and CD
    - LITER, LITER + LLD