Effects of 3D Fields on Fast-Ion Confinement XP 1171

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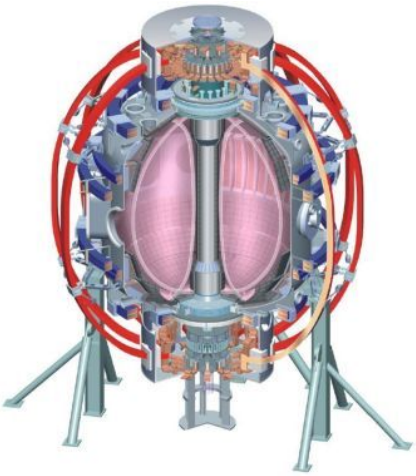


Introduction

Goal: To investigate how externally imposed 3D fields may affect the fast ion population

1. Characterize the perturbed fast ion population
2. Characterize the losses (how large, which particles and where)

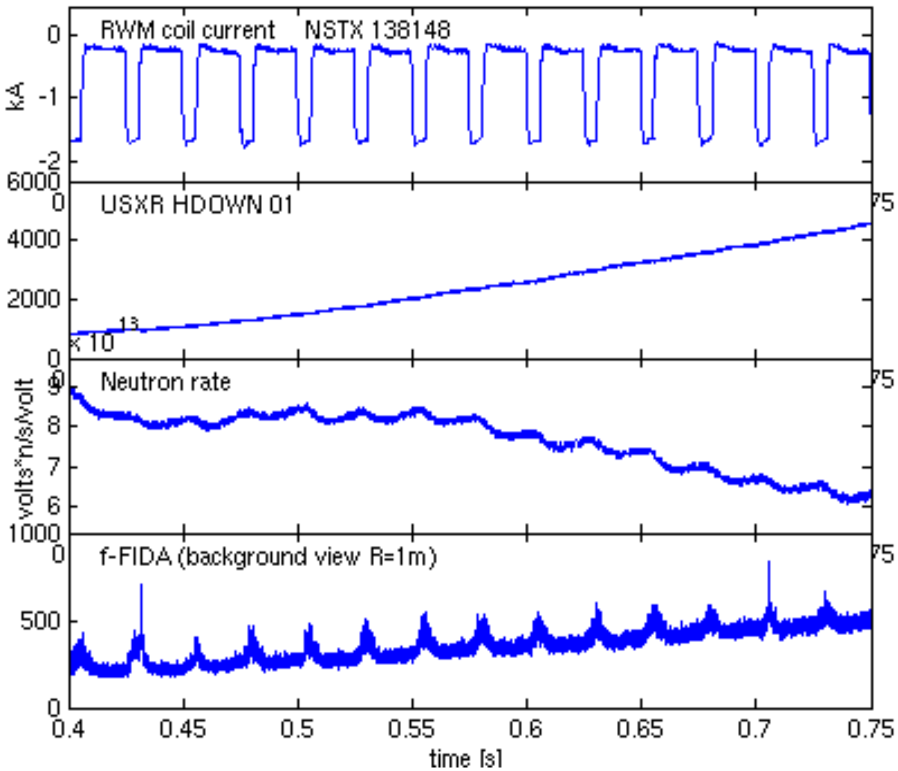
Contributes to **ITPA EP-6**: *Fast ion losses and associated heat load from edge perturbations (ELMs and RMPs)*

Allocated time

- 0.5 days FY11 priority 1 (target scenario and primary objectives)
- 0.5 days FY12 priority 2 (complements and extension)

Experimental Background

- Losses are expected and can be estimated (SPIRAL, ORBIT)
- Resonances between orbits and perturbation determine which particles are affected (energy, pitch, passing, trapped)
- Effect is weak. E.g. no evidence in DIII-D (Heidbrink NF 2000)



- Indirect evidence during FY2010
- Challenging conditions for FIDA
- 3D fields used for ELM triggering/ pacing:
  fast modulation, high density, background light contamination
- Need for a dedicate approach:
  FIDA friendly scenario, low density, MHD/ELM “free”

Experimental tools

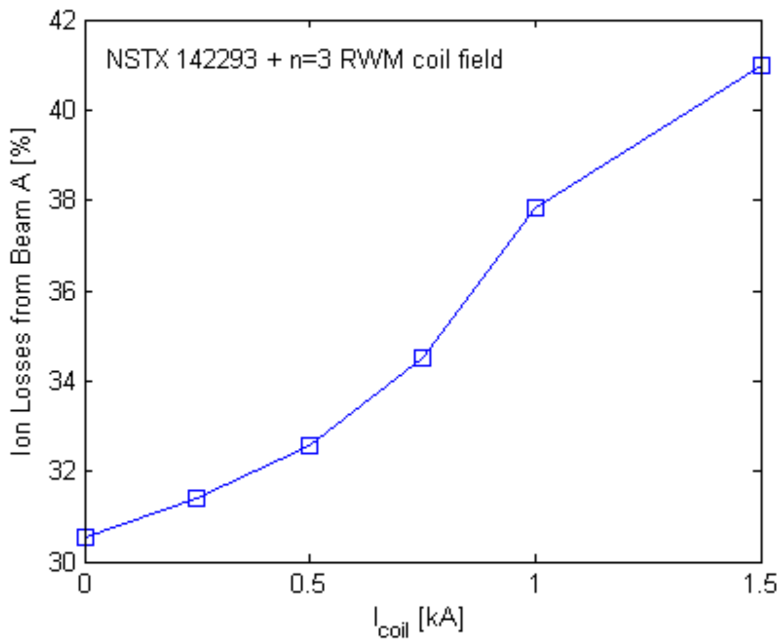
- RWM coils
  - n=3 perturbation
    - static, peripheral
    - destabilize ELMs for I_{RWM}<2 kA
  - n=1 perturbation
    - core penetration, can rotate (up to 120 Hz)
    - may destabilize n=1 kink for I_{RWM}<1 kA
    - affect rotation
  - n=2 perturbation?
  - single coil perturbation?

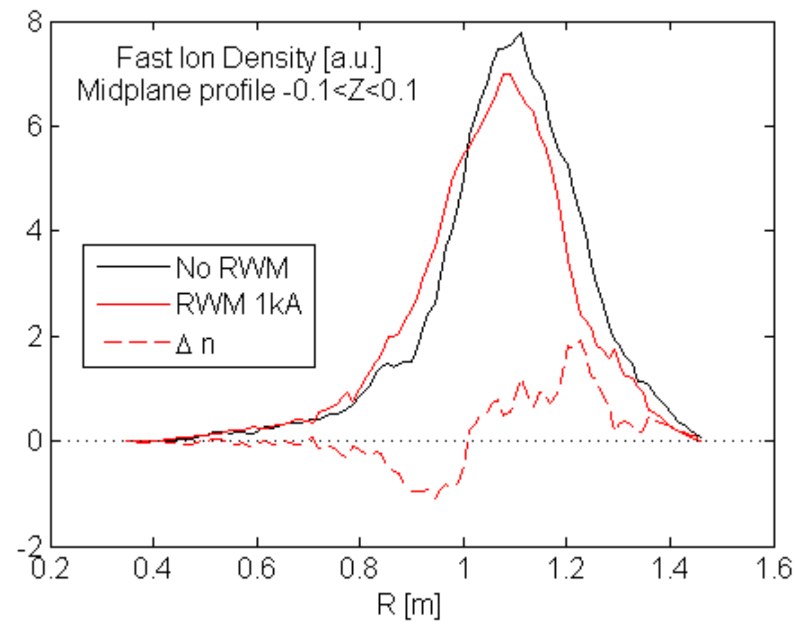
- Fast Ion and Losses diagnostics
  - FIDA set (Fast-Ion core measurement, phase space insight)
  - NPA, ssNPA
  - sFLIP (optimize the n=3 phasing)
  - midplane IR camera (view on the RF antenna)
  - BES (FIDA background contributions form fast-ion in the edge)

SPIRAL predicts finite losses and effect on Fast-Ion density

- Test case NSTX 142293 H-mode 900kA, 0.37T, q_{95}~7 fiducial shape
  - Source A, 90kV (45, 30 included)
  - Static, n=3, I_{RWM}=0-1.5 kA

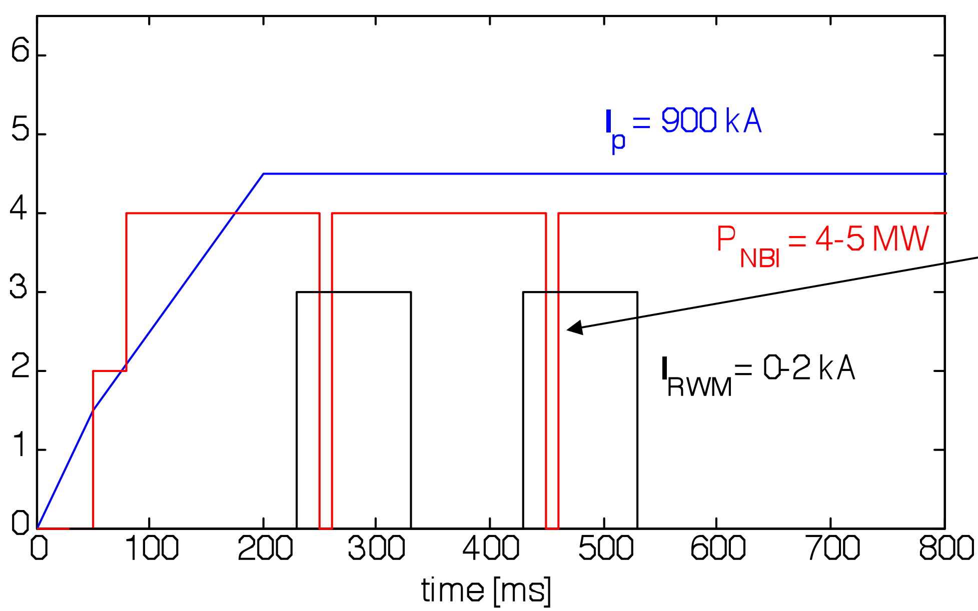
- Global losses due to 3D fields up to 10% of injected particles
- Losses scale with I_{coil}, with saturation for I_{coil}>1kA
- Reduced Fast-Ion density in the plasma core (-20% at R=1.25m)





Reference experimental scenario

- H-mode, 4MW, B_{tor}~0.4 T, I_p=900 kA, ELM-free (NSTX 142293)
- Li ~ 100 mg, for ELM suppression and MHD mitigation
- Lowest achievable density to extend FIDA measurement
- Weak-MHD time window: after I_p flat top, before onset of n=1 kink
  - Adjust NBI waveform, increase q_{edge}, increase density
- RWM coil pulses (50 -100 ms) in MHD free time windows
- NBI notches to for Dα background validation



- Second quiescent phase after n=1 kink dies out
- Possible measurement at high collisionality

Session plan

A. Obtain reference discharge (A,B sources at 90kV)
   - Adjust q evolution to obtain MHD quiescent phase after flat top required for the measurement (~50 ms) [4 shots]

B. Test Static n=3 perturbation
   - Repeat Ref. with 0.5 kA pulses in quiescent phases: optimize timing, reduce B_{tor} to increase relative effect [3 shots]
   - Scan I_{coil} up to ELM destabilization (0.75,1,1.5,2 kA) [6 shots]

C. Test n=1 perturbation (A, B sources at 90kV)
   - Repeat Ref. with 0.5 kA pulses [2 shots]
   - Scan I_{coil} up to kink destabilization [4 shots]

D. Test B,C sources combination (to affect passing/trapped)
   - Repeat Ref. with No RWM [3 shots]
   - Repeat Ref. with 0.5 kA pulses [2 shots]

SPIRAL simulated losses

- NSTX 142293, I_p=900kA B_{tor}=0.37T
- 10000 ions injected, 3000 confined
- Static n=3 I_{coil} = 1 kA
- Losses increse 30→37%
- Toroidally localized where dB_r<0