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XP: HHFW absorption in Neutral-Beam heated plasmas

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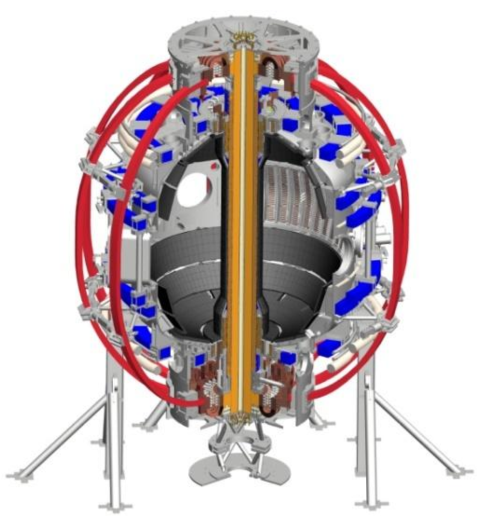

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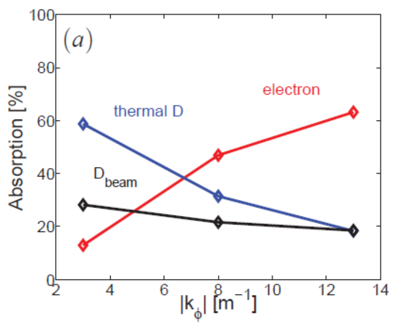
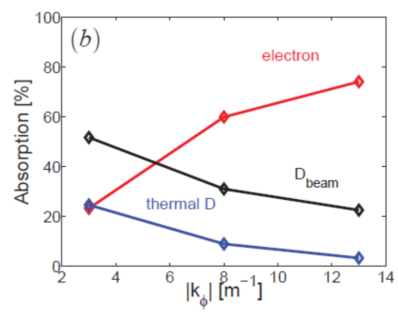
Significant fraction of HHFW power can be absorbed by fast ions during NBI

- Combine RF and NBI has been challenging
- Little data available on how much RF power is absorbed by fast vs. thermal ions
- For NSTX-U:
  - ion acceleration to loss orbits can constitute a loss of FW and fast-ion power, and can cause detrimental heat loads on PFCs (i.e. the HHFW antenna limiter)
  - the increased magnetic field will reduce the harmonic number of the FW system and potentially enhance ion absorption
- RF simulations show significant RF power absorption by fast ions in many cases and also large thermal ion absorption when $T_i \geq T_e$
  - additional absorption dependence on the HHFW antenna phase

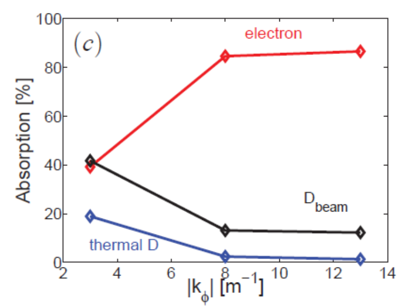
Ti = 2.86 keV, Te = 1.22 keV



Ti = 1.43 keV, Te = 1.22 keV



Ti = 1.43 keV, Te = 2.44 keV



AORSA results on NSTX-U [Bertelli et al, AIP Conf. Proc. 2014]

Goals

- Characterize RF absorption as a function of RF phasing, outer gap, magnetic field
  - Fist start with L-mode plasma for a "basic characterization" then move to H-mode plasma

- Benchmark RF codes, such as GENRAY/CQL3D (with ion orbit effects), TORIC (stand-alone and in TRANSP framework), AORSA, AORSA+CQL3D, and ORBIT-RF

- Benchmark synthetic diagnostics (FIDASIM) & compare with experiments

- Determine to what degree poor HHFW performance in beam-heated discharges is due to fast-ion absorption vs. other mechanisms (e.g. SOL losses of FW power)
  - See R16-3 milestone ("assess FW SOL losses, core thermal and fast ion interactions at increased B_T, I_P")
  - ITPA: high interest to study interaction between RF waves and fast ions

- Assess changes in radial intrinsic impurity transport (F. Scotti, et al.)
  - See also XP by J. Menard ("Scoping study for core impurity reduction using HHFW")

Starting with a basic characterization in L-Mode plasma and then move up to H-Mode plasma

L-mode plasma

- Establish baseline scenario: start with discharges similar to 2008 FIDA experiments
- NBI power 1-1.5 MW (NBI 1 only) and RF power 1-1.5 MW
- No lithium (suitable at the beginning of NSTX-U FY2015 campaign?)
- RF antenna phase scan: 13 m^{-1}, 8 m^{-1}, 3 m^{-1}
- B_{tor} scan: 0.55 T, 0.65 T, 0.75 T

H-mode plasma

- Optimize the outer gap for best antenna coupling (for each value of outer gap, take a NO RF reference shot)
- RF power scan: 2-4 MW
- NB injection voltage scan (NBI 1 only, NBI 2 only , NBI 1+2)
- RF antenna phase and B_{tor} scan as done in L-Mode plasma
- Need moderate lithium evaporation, small/no ELMs (perhaps suitable later in NSTX-U FY2015 campaign?)

Requested diagnostics: all fast-ion diagnostics, Thomson scattering, CHERS, HHFW-antenna IR camera

Desired diagnostics: SOL reflectometer and other IR cameras