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XP 1017_ext: RF heating at divertor/SOL regions

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J.C. Hosea, PPPL

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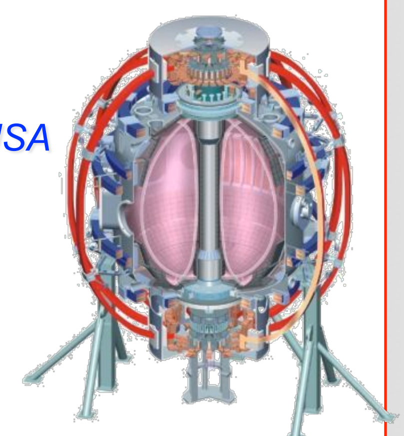

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XP Review
March, 2011

XP 1017: RF heating at divertor/SOL regions

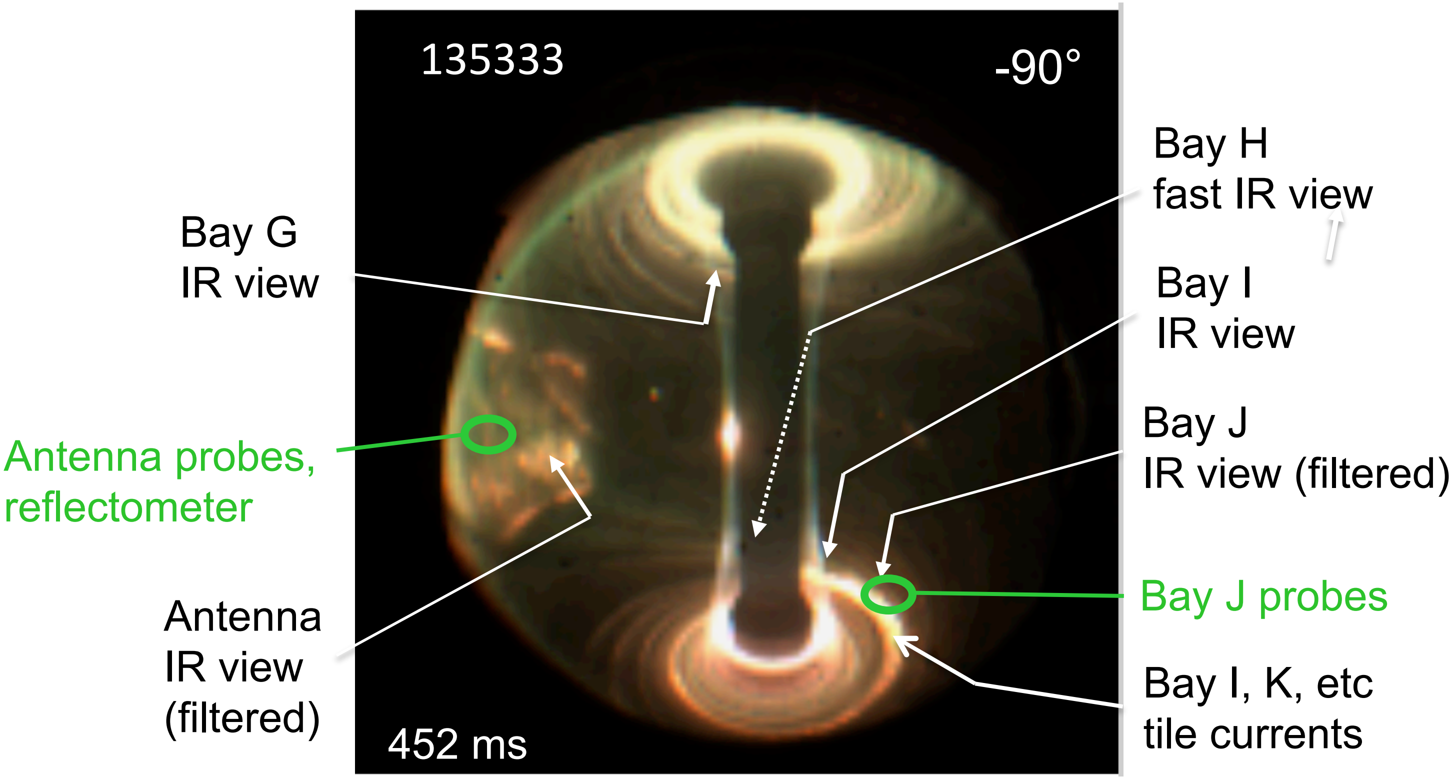
Goals:

- Understand the characteristics of the HHFW edge heating that has been observed in "hot" zones on the outer divertor plates
- Help benchmark edge heating effects in advanced RF heating codes

Objectives:

- Probe divertor and antenna hot zones and investigate heating characteristics and processes
  - ➢ Divertor hot zones
  - Characterize divertor hot zones with visible and IR cameras, as well as with probes
  - Enhance exploration of hot zone with scans in magnetic field pitch, gapout, and antenna phase
  - ➢ Antenna hot zones
  - Characterize antenna hot zones with visible and IR cameras, as well as with probes, reflectometer
- Many additional diagnostics needed to investigate edge heating properties
  - ERD, TS, CHERS, etc.

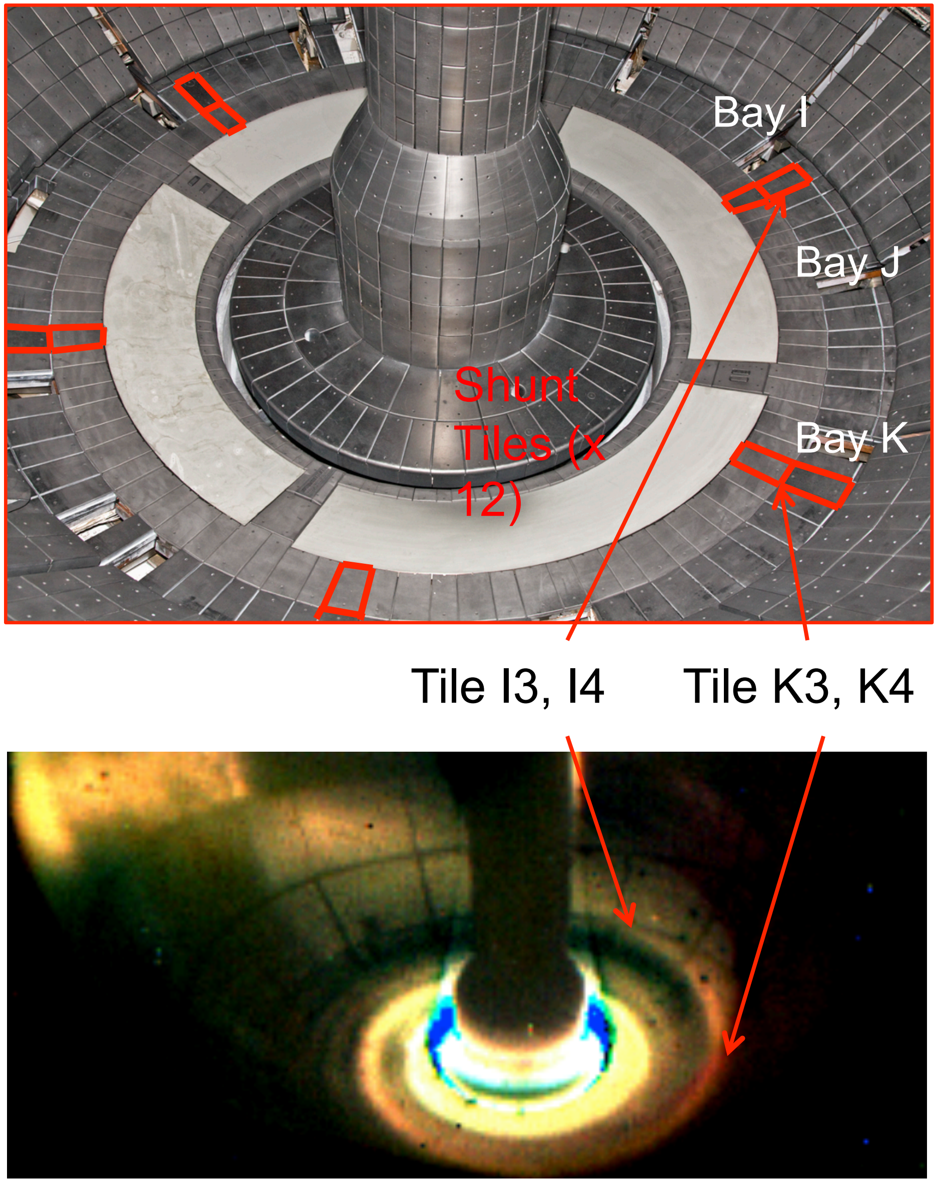
IR cameras and probes are critical for documenting edge heating



B_ϕ = 4.5 kG, I_P = 0.8 MA

- New IR views of Bay J bottom and of antenna are needed for power deposition measurements
- Field pitch can be varied to pass hot zone over probe at Bay J bottom
- Higher field pitch will permit view of hot zone by fast IR at Bay H

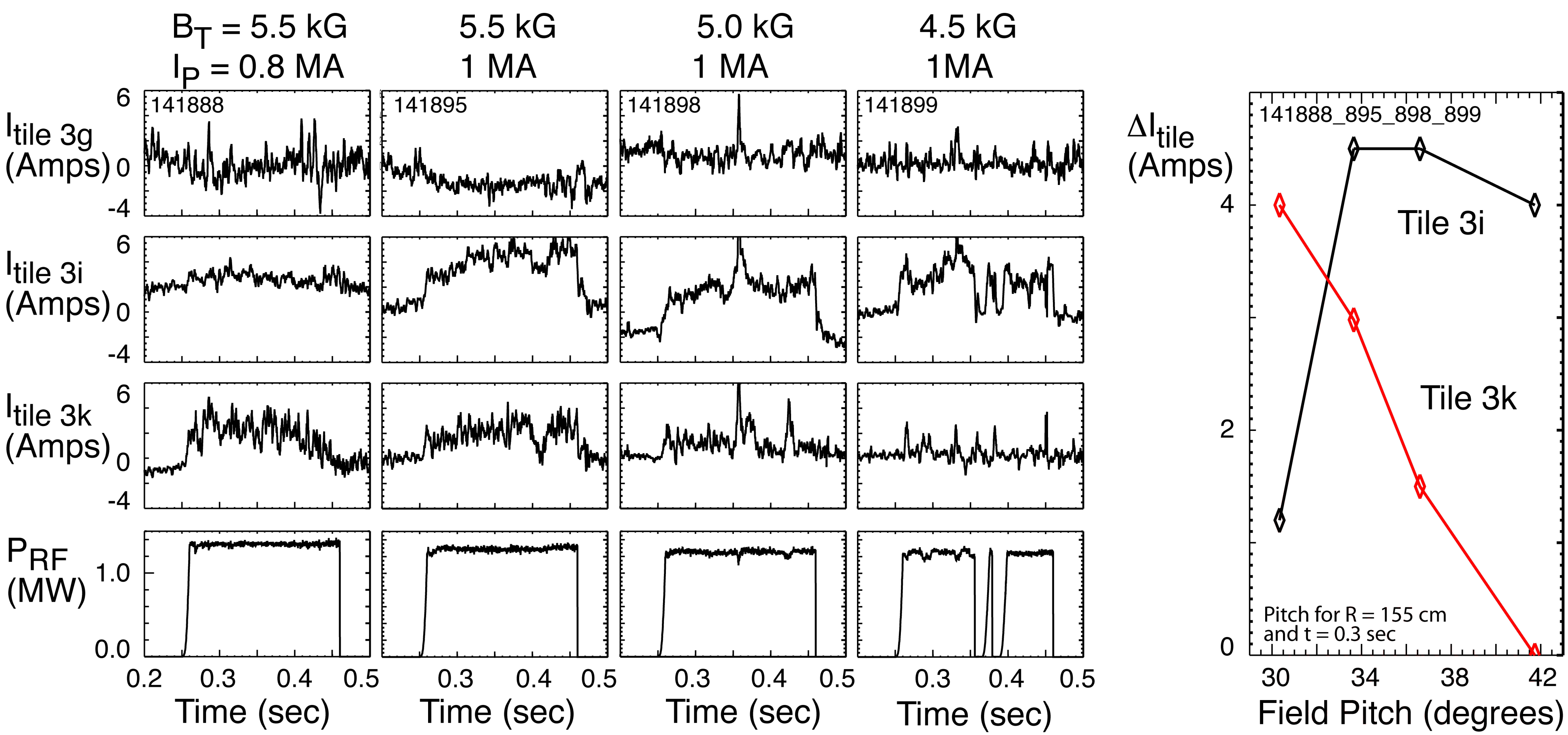
Experimental studies began in 2010 to determine the properties of the RF interaction at the “hot” zone



- Divertor tile currents can be used to indicate RF surface wave effects
- Tiles in row 3 and 4 of divertor plate are instrumented with Rogowski sensors
- Bay I and K tiles are in line with “hot” zone for RF edge deposition
- IR cameras were used to locate the heat deposition radially

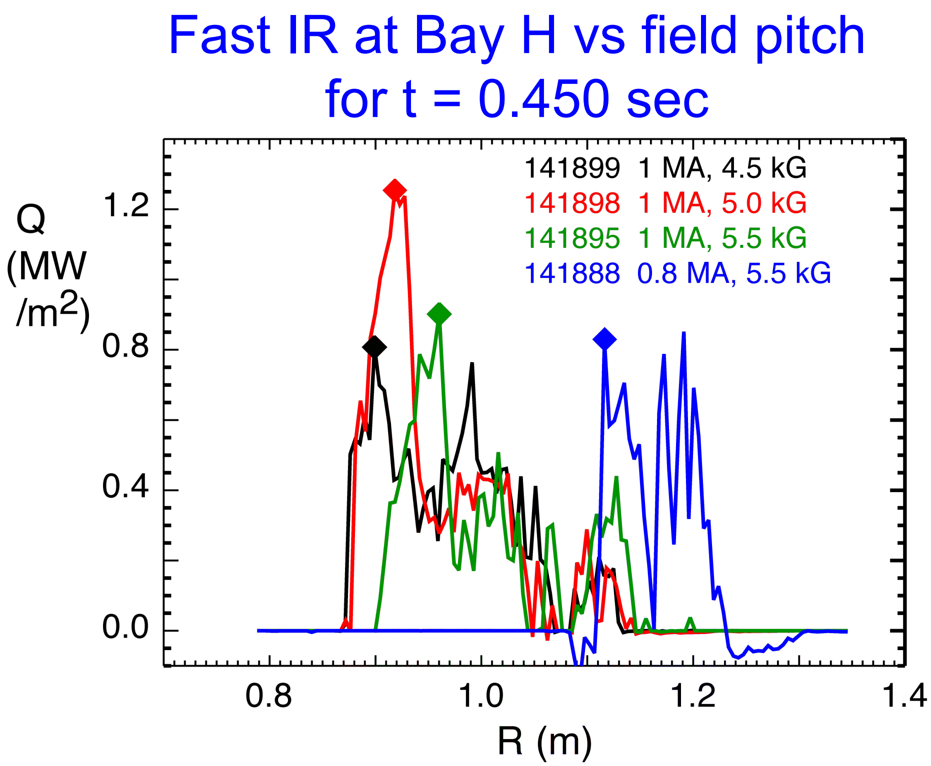
P_{RF} ~ 1.4 MW

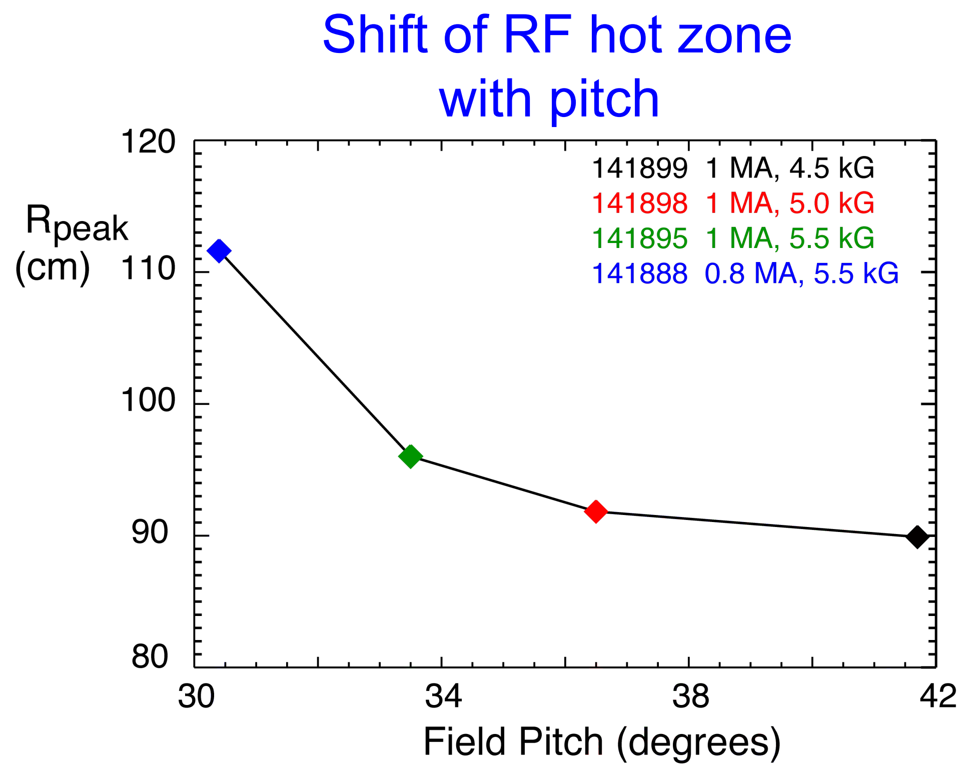
Divertor tile currents in row 3 show movement of RF hot zone across tiles as magnetic field pitch is increased



- $\Delta I_{tile\ 3k}$ decreases and $\Delta I_{tile\ 3i}$ increases as magnetic field pitch increases and RF spiral hot zone moves toward the center stack

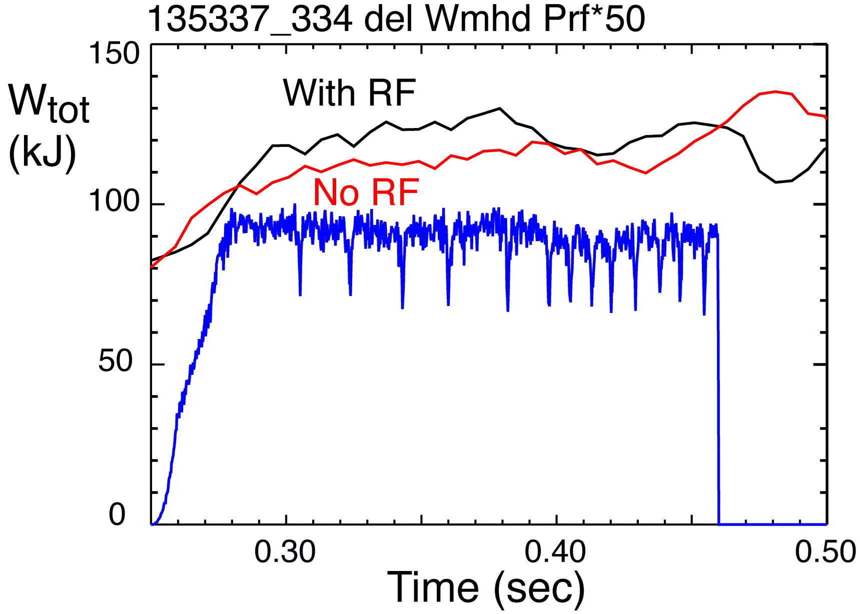
Tile currents in row 3 are consistent with RF hot zone movement measured with the fast IR camera at Bay H



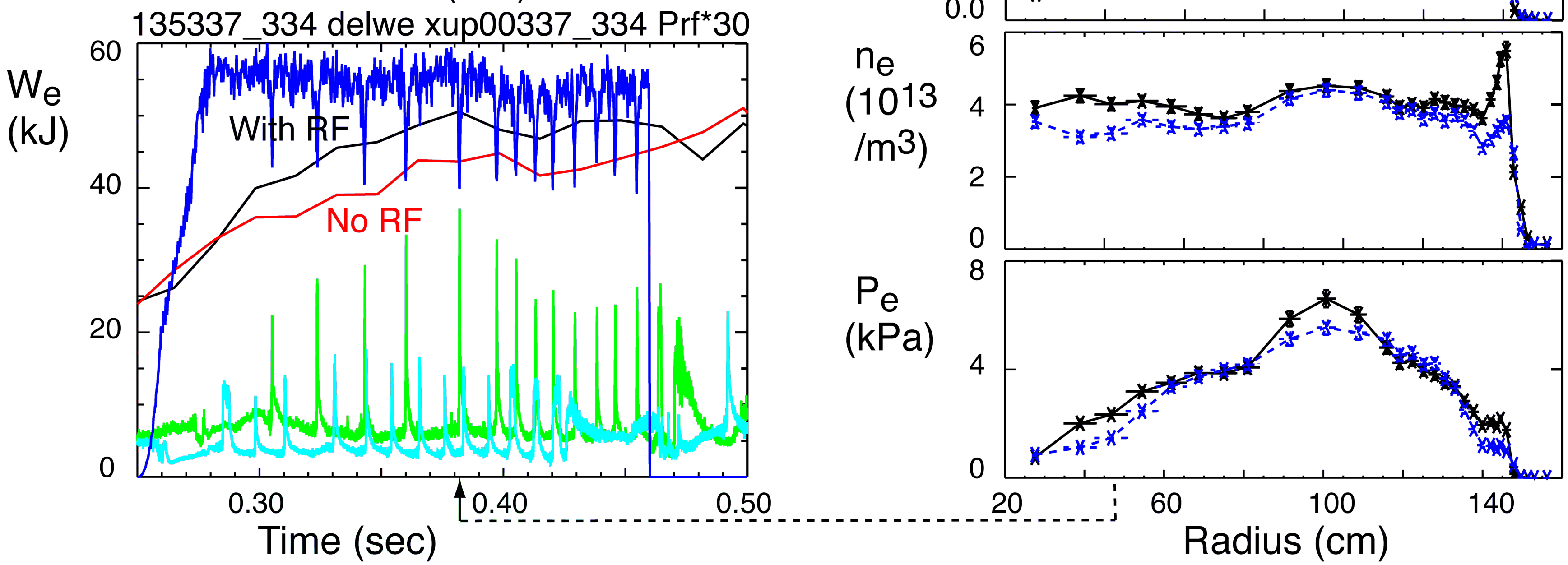


- Movement of RF hot zone with magnetic field pitch is relatively fast in the lower pitch range but slows considerably in the higher pitch range

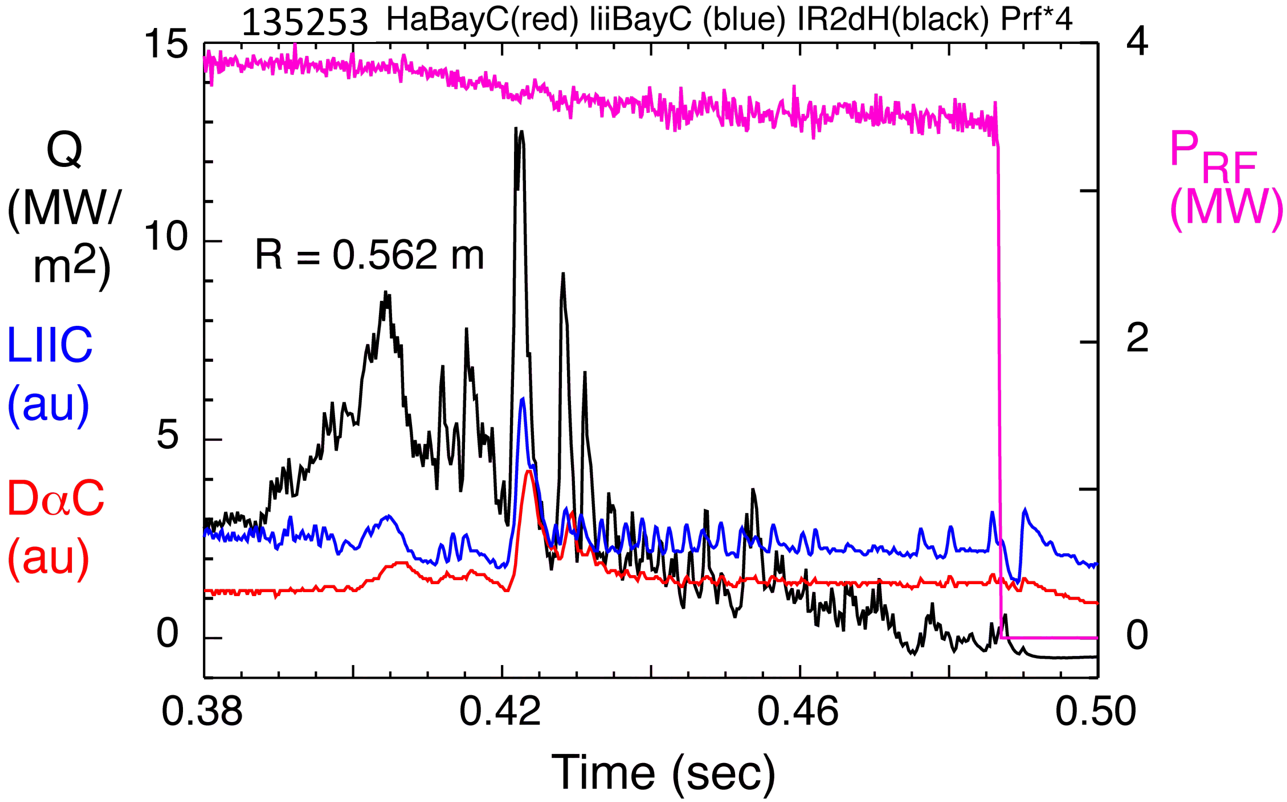
Power coupled to core is affected by ELMs and/or by higher edge density/steeper density gradient



ΔW_{tot} and ΔW_e for shot 135337 with ELMs are reduced by ~ 50% relative to shot 130608 ELM free case



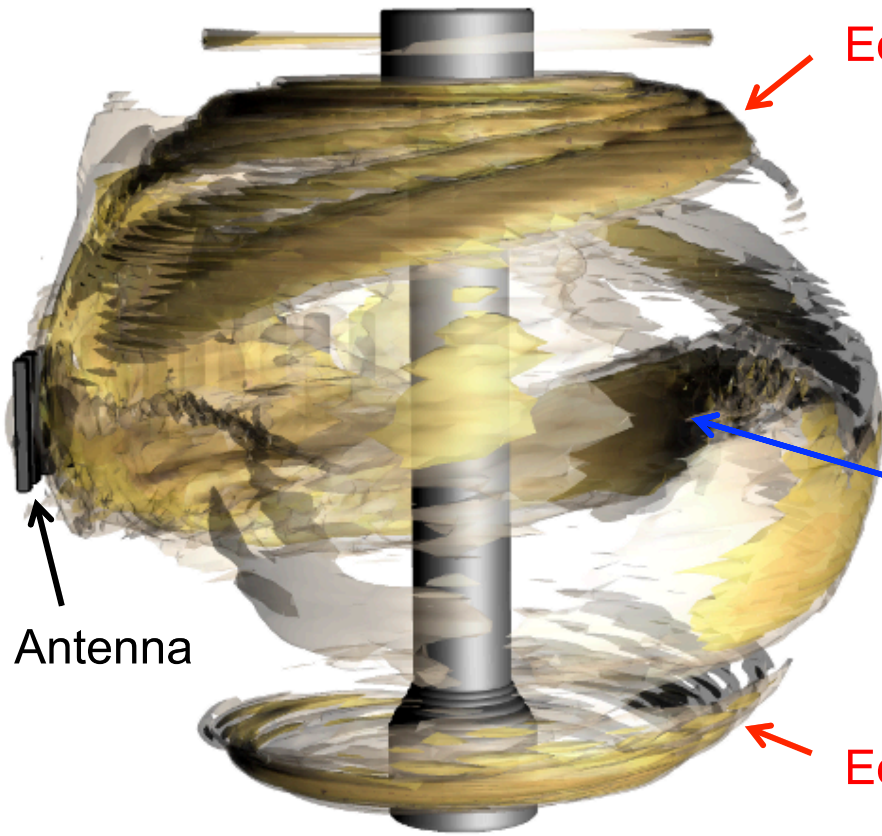
ELM heat deposition at the outer strike radius is very large but effect on density in plasma edge is small



- The Bay H fast IR heat deposition measurement, Q, clearly shows the ELM heat deposition on the lower divertor plate at R = 0.562 m (divertor strike radius)
- Small effect of largest ELM is barely evident on the net RF power
  - ELMs are located away from the antenna
  - Gives opportunity to evaluate RF edge loss without edge density increase during ELMs

AORSA extended to open field lines in the SOL gives edge RF fields – can be benchmarked in HHFW H-mode case

Co-current drive,
-90° antenna phasing,
$k_\phi = -8m^{-1}$



- Initial results suggest edge modes could be cause of RF hot zone.
- Direct link is not yet established and AORSA edge modeling by D. Green et al. is continuing
- Higher current HHFW H-mode case will place RF hot zone in Fast IR camera view