XP514: Thermal Electron Bernstein Wave Emission & Coupling on NSTX

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NSTX Results Review
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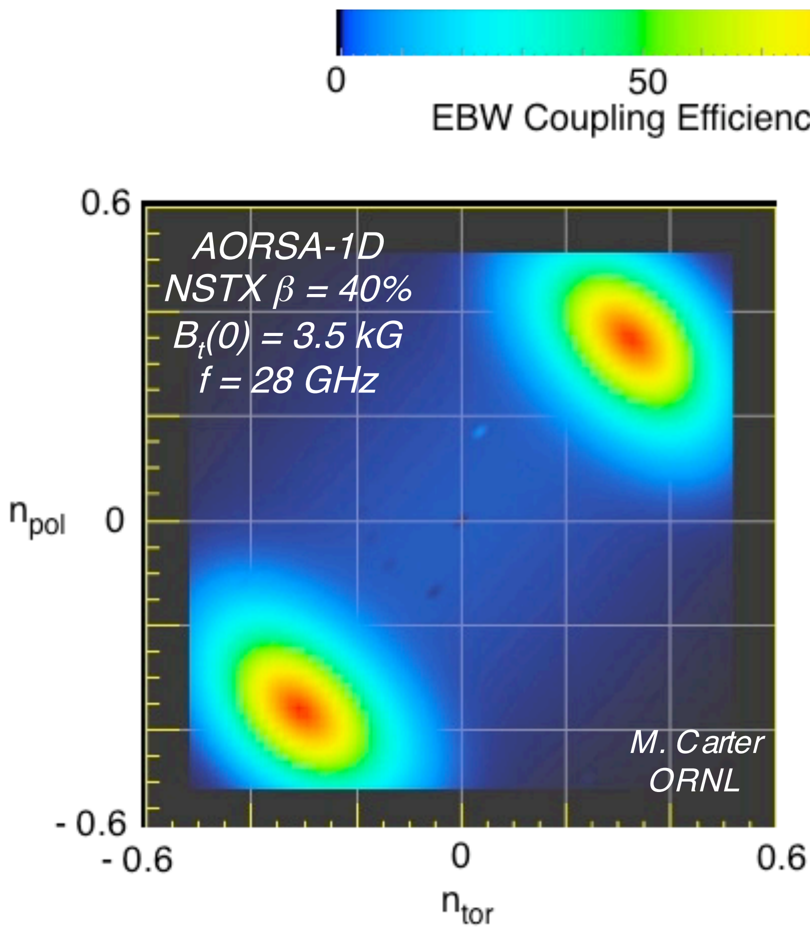
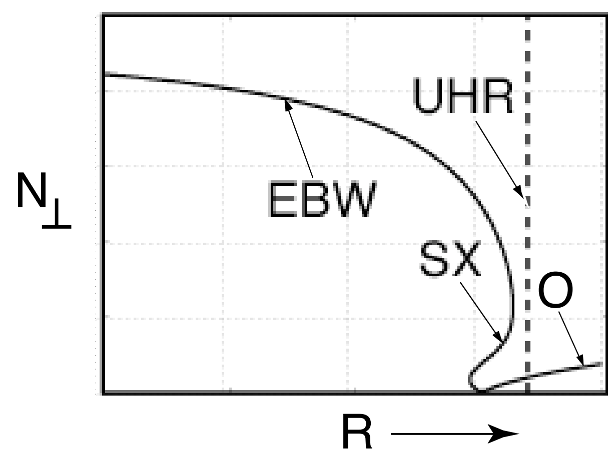
EBW Emission & Coupling Physics Important for $T_e(R)$ Diagnostic Development & EBWCD System Design



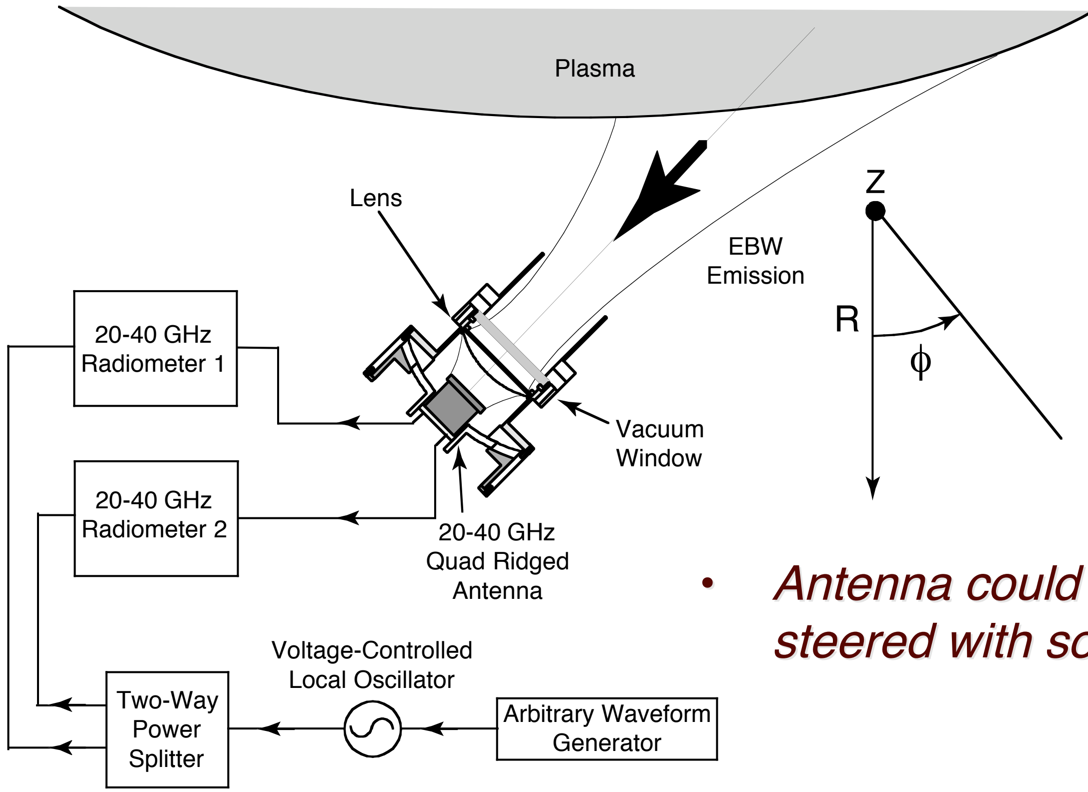
- Need resilient EBW coupling for EBWCD & $T_e(R)$ diagnostic
- XP514 studied oblique O-mode 2nd harmonic EBW coupling



$$T(N_\perp, N_{//}) = \exp\left\{-\pi k_o L_n \sqrt{(Y/2)}\left[2(1+Y)(N_{//,opt} - N_{//})^2 + N_\perp{}^2\right]\right\}$$

Where: $Y = \omega_{ce}/\omega$

Dual-Channel 20-40 GHz Radiometer & Quad-Ridged Horn Provides Orthogonal Polarization Measurements



- *Antenna could be manually steered with some difficulty*

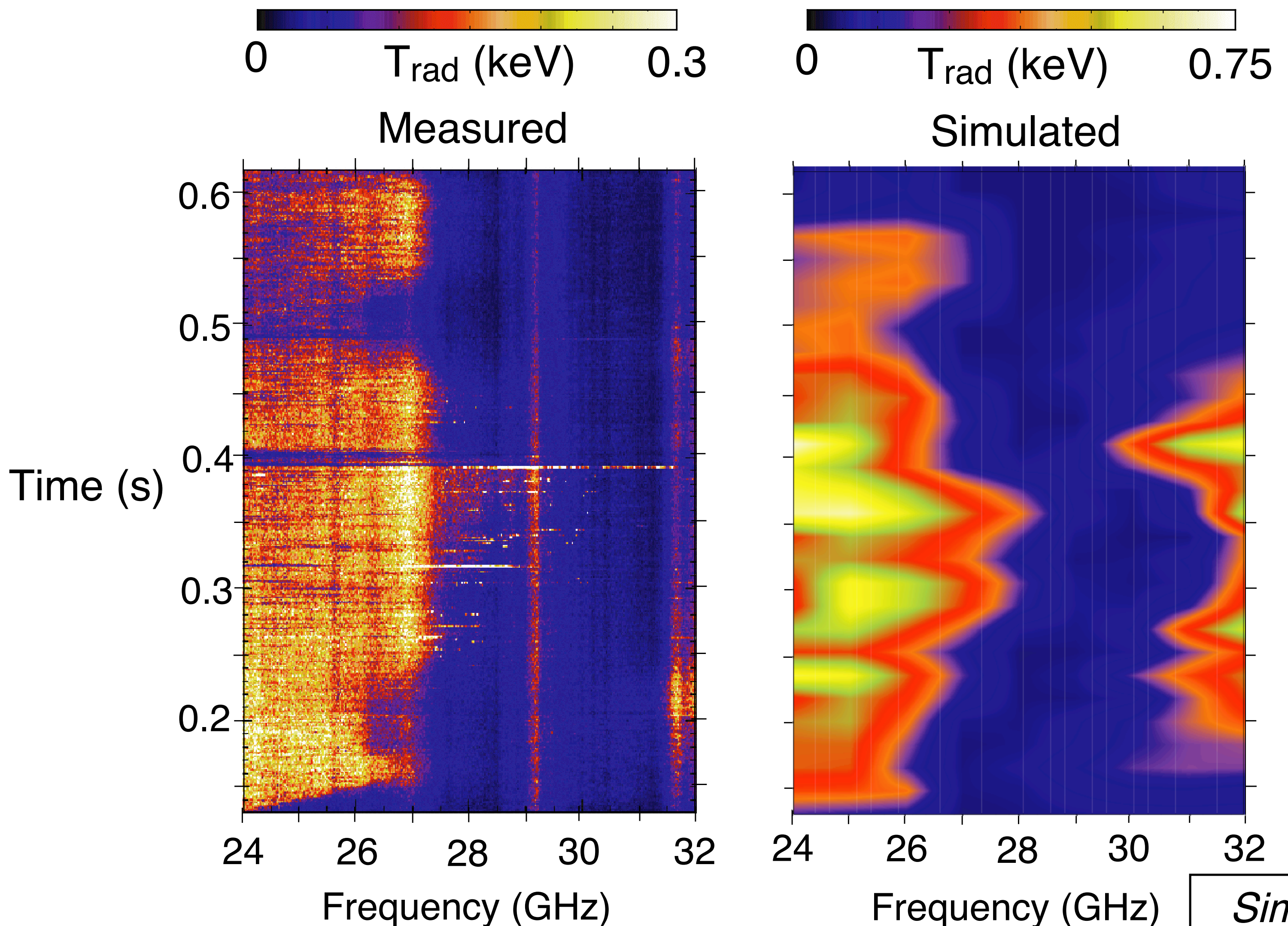
Experiment Goals:

- *Measure $T_e(R,t)$ via thermal EBW emission*
- *Analyze polarization of thermal EBW emission*
- *Demonstrate > 80% coupling of thermal EBWs at ~ 28 GHz*

Obtained Good EBW Emission, T_e, n_e & EFIT Data to Compare to Modeling, Despite Locked Modes

- NBI-heated H-mode target plasma; measured EBW emission between 24 & 32 GHz during dedicated half-day
- Acquired data at I_p = 0.8 & 0.9 MA, early termination at I_p = 1 MA due to locked mode
- Ran frequency scan at I_p = 0.8 MA, but conditioning/fueling changed & developed locked modes during scan
- Emission bursting events, particularly immediately prior to locked modes
- Compared experimental results to full wave mode conversion & 3-D ray tracing codes

Evolution of Measured 24-32 GHz EBW Emission from H-Mode had T_{rad} ~ 2-4 Times Smaller than Simulation

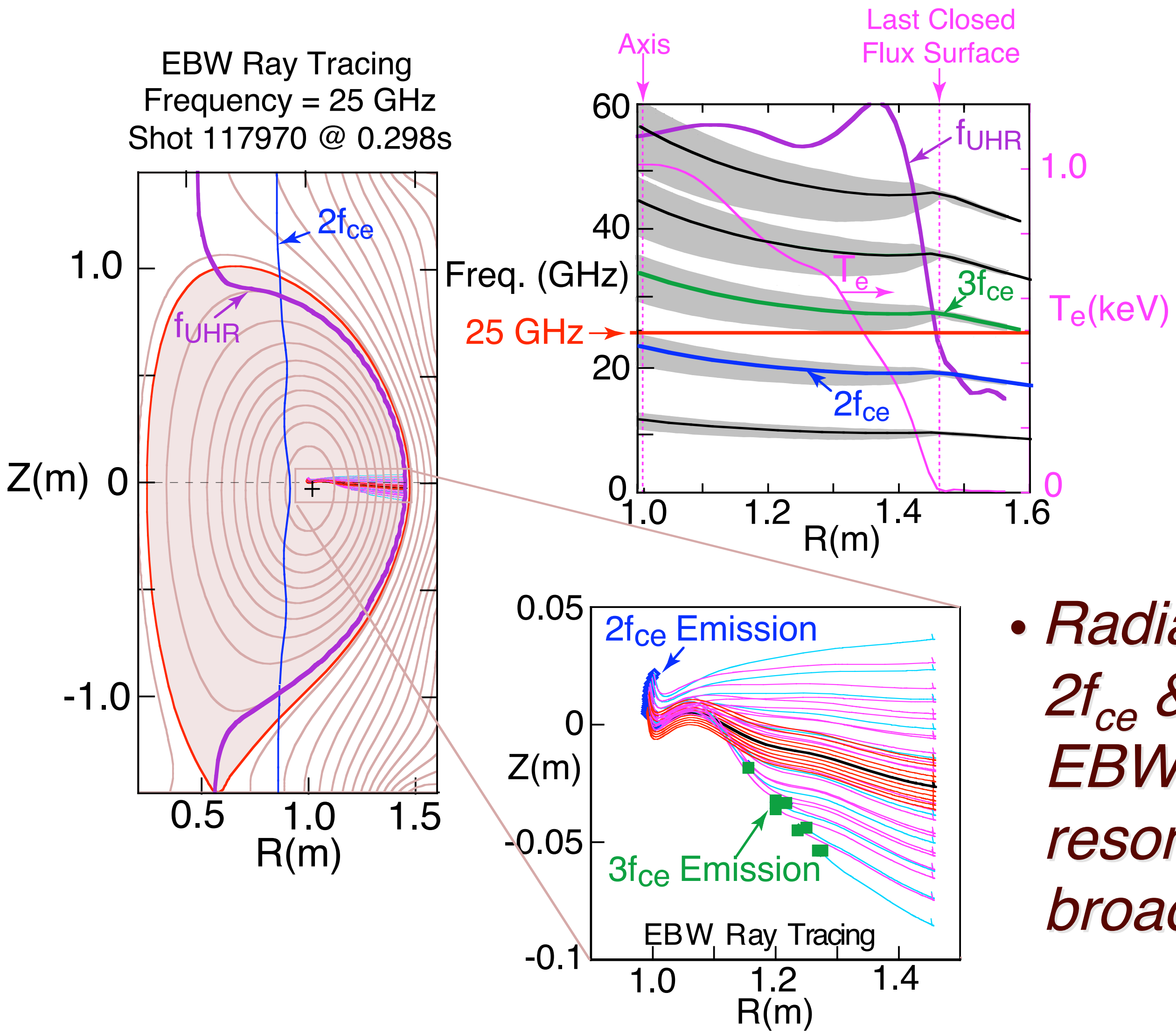


Shot 117970

$B_t(0)$ = 4.5 kG

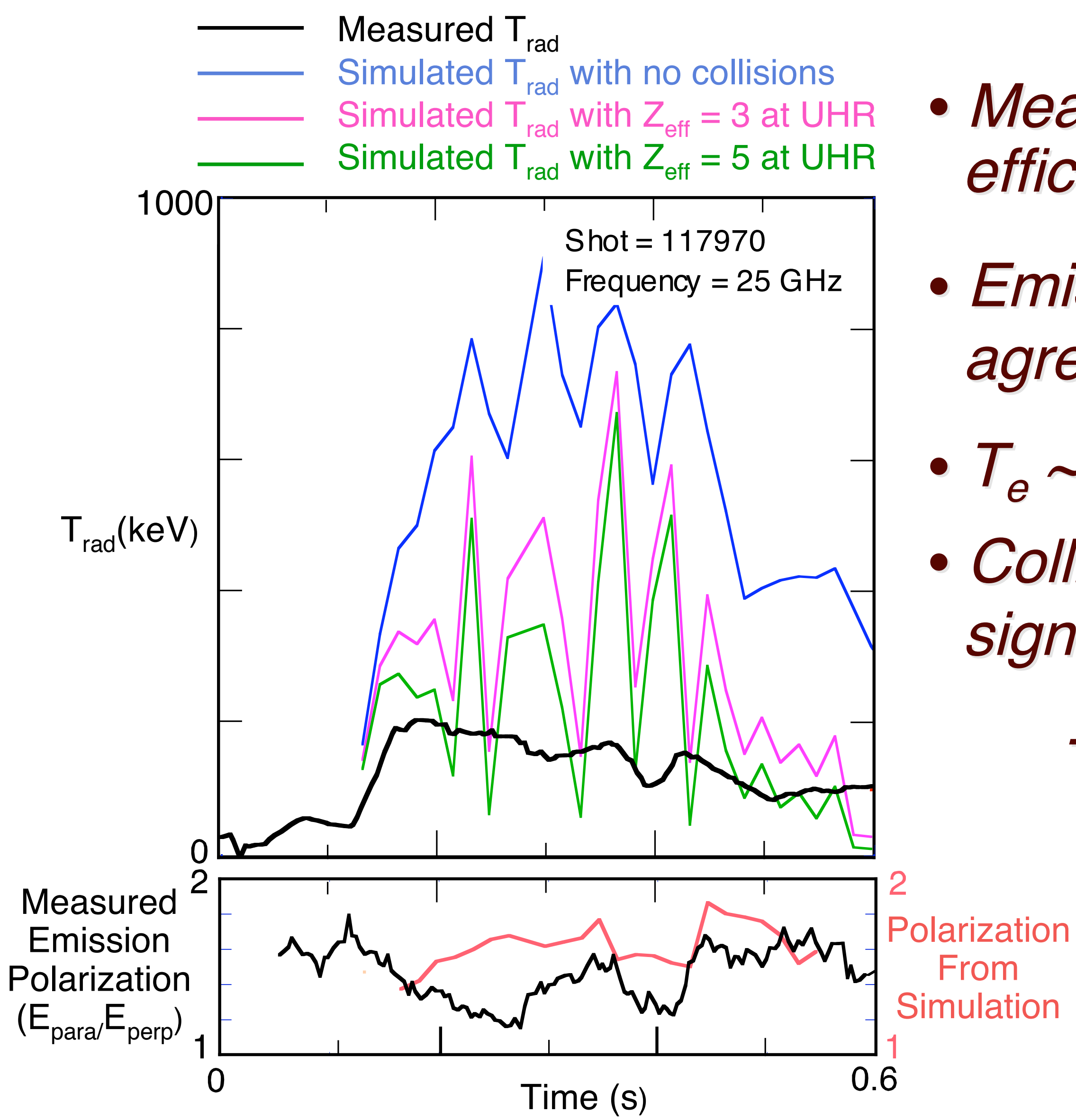
Simulation used Z_{eff} = 1.36 at UHR

Measured T_{rad} at 25 GHz from $2f_{ce}$ On-Axis, & $3f_{ce}$ Off-axis; Harmonic Mix Sensitive to EBW $n_{//}$



- *Radial access between $2f_{ce}$ & $3f_{ce}$ sensitive to EBW $n_{//}$ due to EC resonance Doppler broadening*

Collisional Loss at Upper Hybrid Resonance (UHR) May Explain Low Measured EBW T_{rad}



- *Measured EBW coupling efficiency (T_{rad}/T_e) ~ 20%*
- *Emission polarization agrees with simulation*
- *T_e ~ 10-30 eV near UHR*
- *Collisional losses can be significant for T_e < 30 eV:*
  - *EBW conversion efficiency sensitive to Z_{eff} at low T_e*

XP514 Summary

- *Completed first measurements of 2nd harmonic EBW coupling to O-mode from H-mode NSTX plasmas*
- *Coupling efficiency only ~ 20%:*
  - *modeling indicates low T_e & Z_{eff} ~ 3 at UHR can cause significant EBW collision loss at UHR*
  - *~ 80% fundamental EBW coupling from L-mode NSTX plasmas last year; higher T_e at UHR*
  - *still analyzing EBW emission data obtained during other experiments during 2005 run*
- *Detailed 8-40 GHz thermal EBW emission coupling study on NSTX in 2006-7 with two remotely-steered antennas*