

Advances in High-Harmonic Fast Wave Physics in NSTX

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**APS-DPP Invited Talk Outline
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Key Results & Conclusions

- Significant improvements in HHFW core heating achieved when fast wave propagation begins away from the launcher and wall:
 - Li conditioning improves core heating by reducing n_{edge} in front of antenna
 - First observation of HHFW core heating at $k_{\phi} = 3 \text{ m}^{-1}$ in D
 - NSTX record $T_e(0) = 5 \text{ keV}$ with $P_{\text{rf}} = 3 \text{ MW}$ at $k_{\phi} = 14 \text{ m}^{-1}$ in He & D
 - First significant core electron heating of NBI-driven D H-mode with $k_{\phi} = 14 \text{ m}^{-1}$ and 8 m^{-1} heating
 - $k_{\phi} = 8 \text{ m}^{-1}$ heating during start-up & ramp-up with Li conditioning shows core electron heating, even at $n_e(0) \sim 4 \times 10^{18} \text{ m}^{-3}$
- Fast camera pictures supportive of surface fast waves depositing considerable RF energy on the outside divertor plate, especially at smaller k_{ϕ}
- FIDA data clearly show significant broadening of fast-ion profile when HHFW power is applied to NBI-heated plasmas:
 - CQL3D Fokker-Planck code predicts much more narrow profile than observed, points to need for full orbit treatment
- PDI production of energetic ions near plasma edge may contribute to significant edge RF loss and clamp edge rotation

Theory/Modeling Needs

- GENRAY analysis for H-mode case shows much more power being deposited off axis than for the L-mode case
 - Increase in off-axis electron temperature and pressure observed in some cases is consistent with the modeling
- GENRAY analysis can now include propagation & absorption outside the LCFS:
 - New capability already successfully applied to LH studies on C-Mod
 - Can model collisional edge heating associated with edge propagation
 - See whether waves launched outside LCFS propagate in common flux region down to divertor
- New GENRAY simulations needed with ray bundles, simulating wave fields launched with spectrum of poloidal modes:
 - New modeling being performed in collaboration with Bob Harvey (CompX)
 - Simulations will include a model of the internal surfaces of the NSTX vessel
 - These new GENRAY results will be included in APS talk