

Fast Ion Distribution and Losses Due to HHFW/NBI Interactions

R.W. Harvey and A.P. Smirnov, CompX

NSTX Research Forum, Nov. 28-30, 2001

- High harmonic fast waves interact strongly with NB injected fast ions in NSTX.
- The resulting fast ion distributions can be calculated with the GEN-RAY/CQL3D ray tracing and Fokker- Planck codes.
(Future SciDAC work will include coupling to AORSA and TORIC full wave codes).
- The 3D FP calculations include banana orbit losses (although the code uses a zero banana assumption in lowest order). and provide a model for the FW induced fast ion losses to the plasma periphery.
- For comparison with the experiment, this provides a 3D ($u_{\parallel}, u_{\perp}, \rho$) model for:
 - (1) Absorption of FW self- consistent with the NBI and RF quasilinear distortion of the ion distribution.
 - (2) Effect of banana losses on the fast ion power to the bulk plasma.
 - (3) Fast ion fluxes to the the plasma periphery.

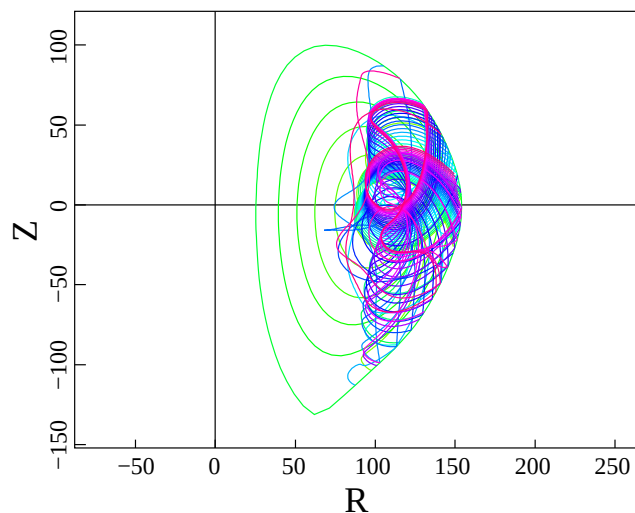
CQL3D/GENRAY Modeling of NSTX FW with/without NBI

(105830_0193 test case)

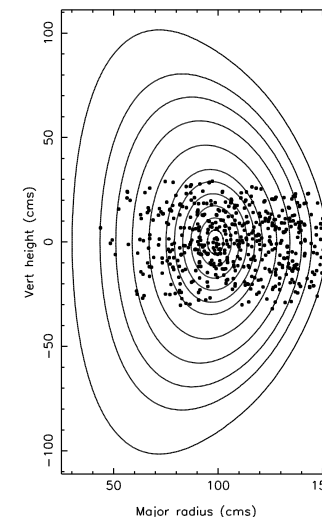
Features:

- *GENRAY rays are cold (or optionally hot).
- *CQL3D uses ray data to calculate 2-velocity/1-radius collisional/quasilinear electron and ion distributions.
- *Ray absorption is iterated to be self-consistent with the ql distortion of the distributions.
- *RF interaction with NB injected fast ions included.
- *Primary limitation of model: –CQL3D is zero-banana width model, but fast ion loss regions included.
–Full-wave effects to be included within next year.

Rays

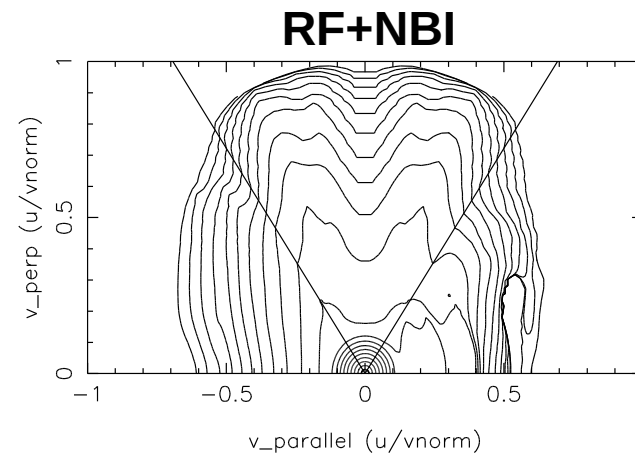
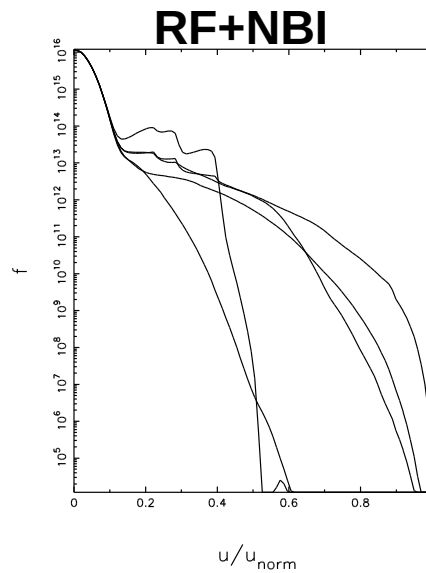
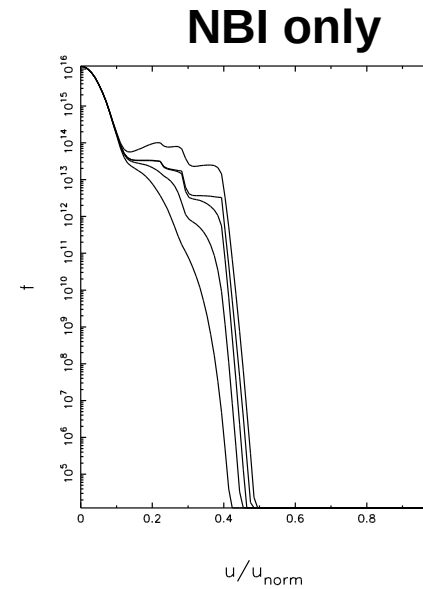
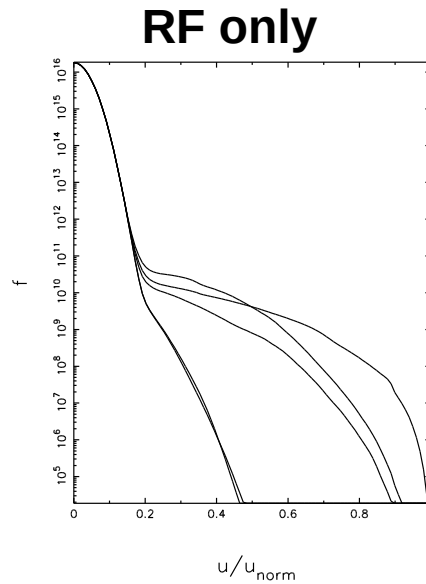


NBI



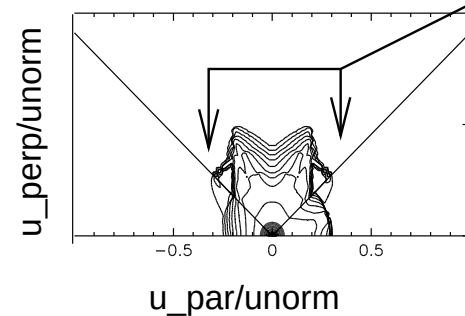
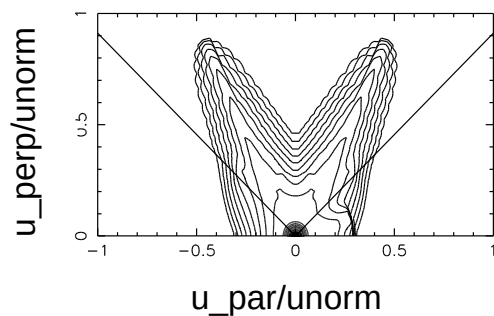
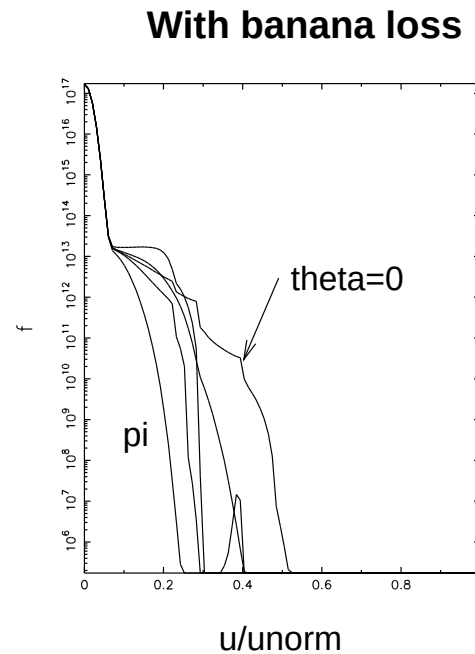
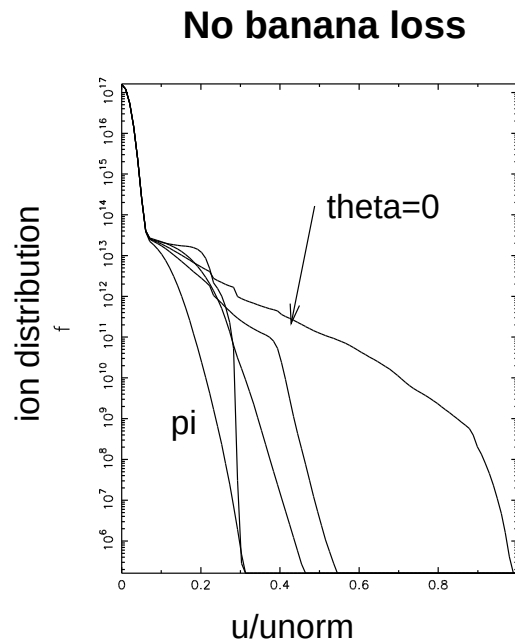
Ion Distribution Functions with: RF, NBI, RF+NBI,. no-banana losses

(Cuts through $f(v, \theta)$ at cnst θ , and 2D distn, at $\rho = 0.25a$)
(unorm corresponds to 500 keV.)



Comparison of NBI+FW Ion Distribution Functions with/without Banana Losses

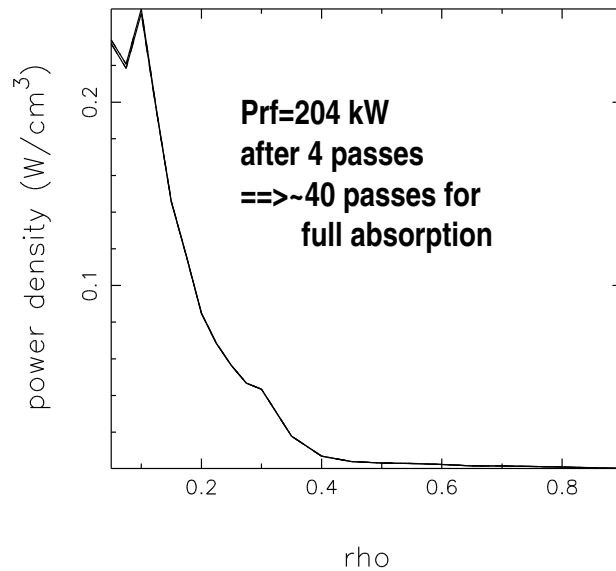
(Cuts through $f(v, \theta)$ at $\text{cnst } \theta$, and 2D distn, at $\rho = 0.5a$)
(unorm corresponds to 500 keV.)



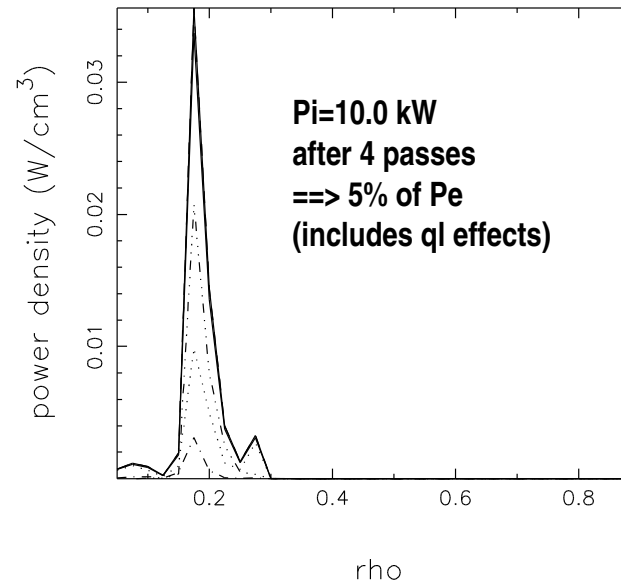
RF Power Deposition Profiles, and Conclusions

(2.4 MW FW Power)

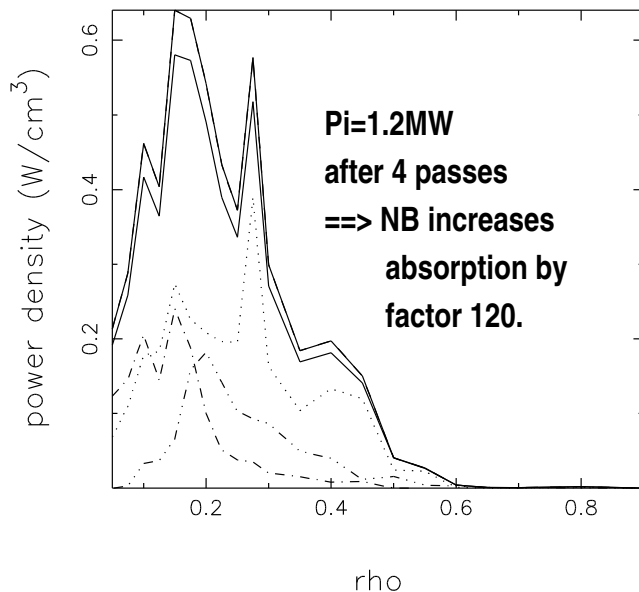
FW Deposition on Electrons



FW Deposition on Ions (No NBI)



FW Deposition on Ions (with NBI)



- Conclusions (for #105830):**
(FW ray tracing benchmarking in progress.)
- *Ion deposition is 5% of electron deposition including QL effects, no NBI.
 - *Ion deposition is 6X electron deposition including NBI.
 - *QL induced fast ion fluxes are calculable in CQL3D.