Theory and Modeling of HHFW Heating and Current Drive

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Status of HHFW Modeling with Ray Tracing

- CURRAY uses rays based on full antenna spectrum.
- CURRAY, HPRT ray tracing codes and AORSA full-wave code have been benchmarked for beam ion absorption in NSTX discharges. (APS/DPP01)
- CURRAY and PICES full wave code results agree well for selected time slices in CD discharges using co-CD, counter-CD and symmetric antenna phasing, and with simple 1-D model (ORNL).
- Preliminary benchmarking between CURRAY and GENRAY shows general agreement in wave propagation and absorption for thermal plasmas. Further work is in progress.
- Detailed comparison with experimental results has not yet been done.

Plans for HHFW Ray Tracing Modeling

- **Current Drive Efficiency Models**:

  - Adjoint model in CURRAY generally agrees with Ehst-Karney model for CD discharges to date, where central CD is expected.
  - Adjoint model gives ~20% higher CD in some time slices; investigation is on-going.
  - Will the models still agree at higher beta dischargers?

- **Incorporation of CURRAY into TRANSP analysis**:

  - Work is on-going.
  - Conversion to F90 platform and portability were achieved with Wiley (UT-Austin) as an NTCC activity.
  - Plan 1-2 weeks' visit to PPPL in August to complete work, with UT-Austin and PPPL coordination; preparatory work ahead of visit.

Kinetic Modeling of HHFW Interaction with Ions

- Use ORBIT-RF code with modifications, in collaboration with GA.
- Modify RF-induced energy kick for ion passing through closely-spaced successive harmonic cyclotron resonances.
- Status: Just started running and familiarization with ORBIT-RF.
- Near-term plans:
  - Coupling to calculated free-boundary equilibria
  - First investigate low-harmonic ion heating (APS02) using simple model of wave fields
- Long-term plans:
  - Combine with full wave code
  - Benchmark with CQL3D/GENRAY

Time Dependent Discharge Analysis

- Parallelization of ray tracing equations

- How much can be done without coupling full wave/Fokker Planck combination to TRANSP?

  Must address the following issues:
  - Is modified resistivity model adequate for CD evaluation in presence of d.c. electric field?
  - Will an ion tail of the majority species be generated at projected power levels? How do we model ion tail and its effects adequately?
  - Will a linear electron CD model be adequate at steady state?