HHFW/RF Breakout Summary

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PPPL

Presentations and Discussion to outline experimental plan for FY 2002 run

- Electron Heating
- Ion Interaction
- Current Drive
- EBW Research

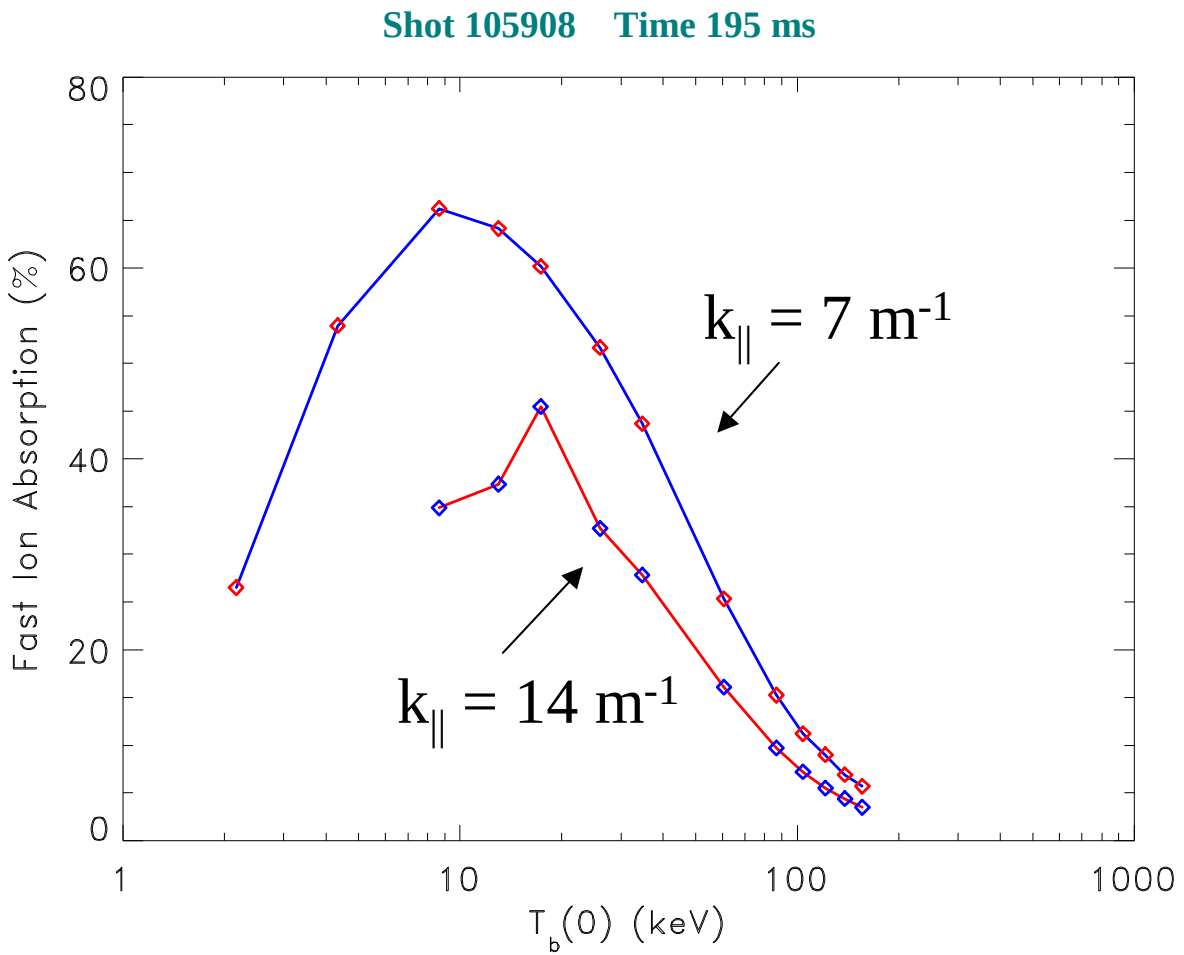
Electron Heating

- Goals
  - Raising density
  - Heating at high Ip without IRE
  - Electron heating in the presence of NBI
  - Heating in various configurations
  - Power deposition profile
- Start be reproducing previous conditions
  - Have machine conditions changed?
    - Has field error correction changed behavior of IRE?
    - Has bake-out changed behavior of edge conditions
    - Does Center Stack gas puffing change recycling
- The answers to these questions affects what to try next (It may be that answering these questions is the experimental plan in this area)

Ion Interaction studies

- HHFW interaction with the beam ions has been observed
- Need to quantify observations
  - Vary NBI injection energy
  - Vary density and field to change k_{perp} ρ_i
  - Scan B across multiple resonances
  - Scan NPA to get radial and pitch angle profile to compare with modeling
- Look for thermal ion interaction
  - H minority (may require H puffing)

Absorption vs. $k_{||}$, Fast Ion Temp

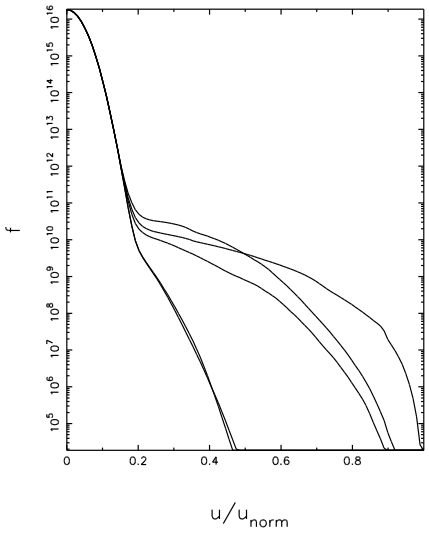


- Fast ion absorption larger for lower $k_{||}$, peaks at lower $T_b(0)$
- Absorption still small near 140 keV

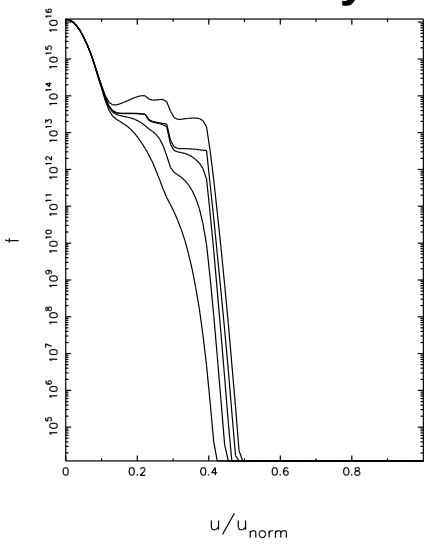
Ion Distribution Functions with: RF, NBI, RF+NBI,. no−banana losses

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

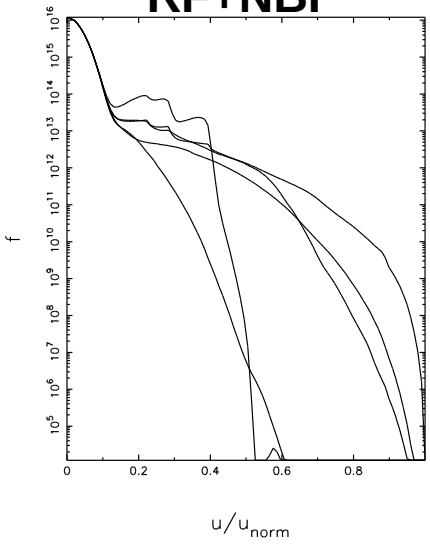
RF only



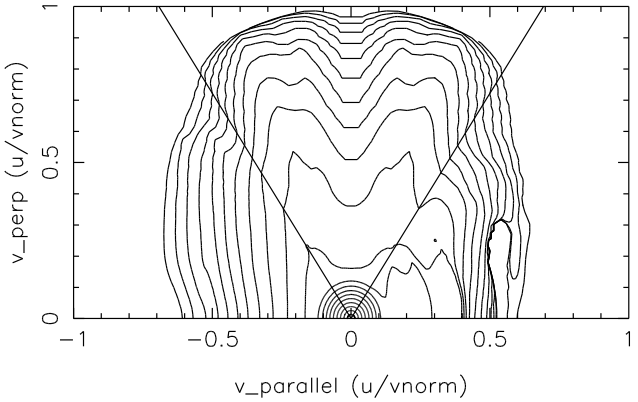
NBI only



RF+NBI



RF+NBI

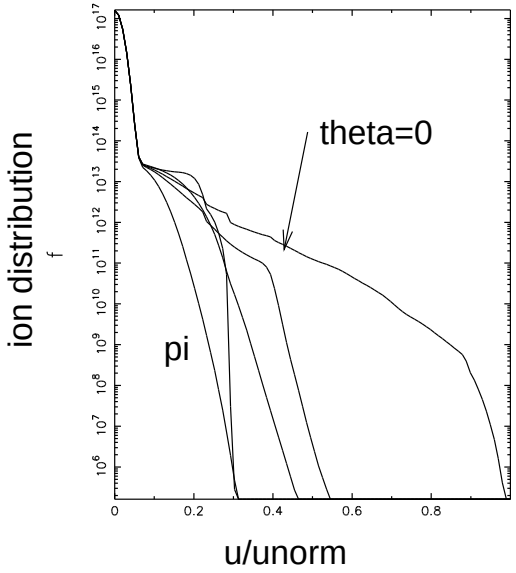


CompX

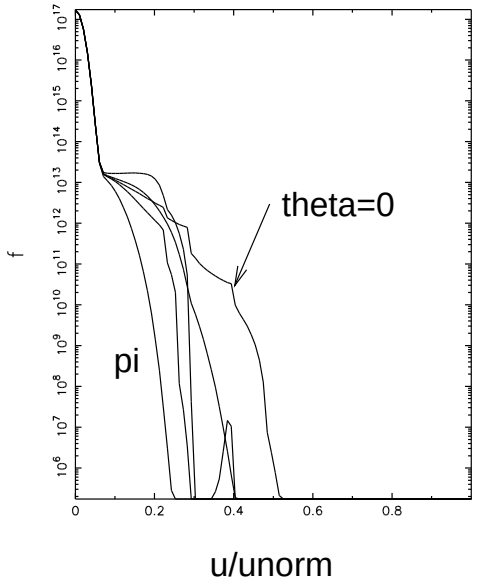
Comparison of NBI+FW Ion Distribution Functions with/without Banana Losses

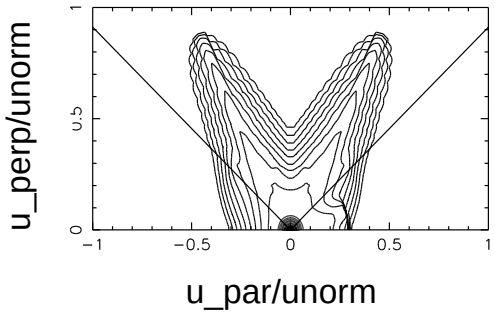
(Cuts through f(v,theta) at cnst theta, and 2D distn, at rho =0.5a)
(unorm corresponds to 500 keV.)

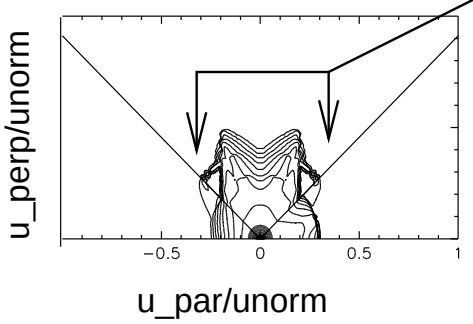
No banana loss



With banana loss







Fast ion banana loss for rho_banana > (a−r).

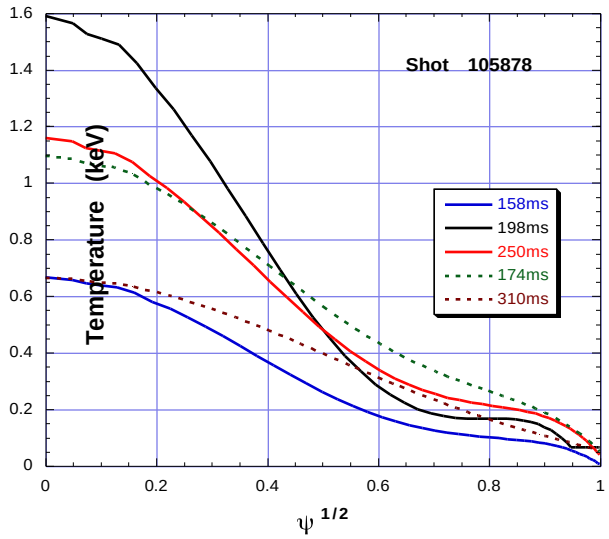
CompX

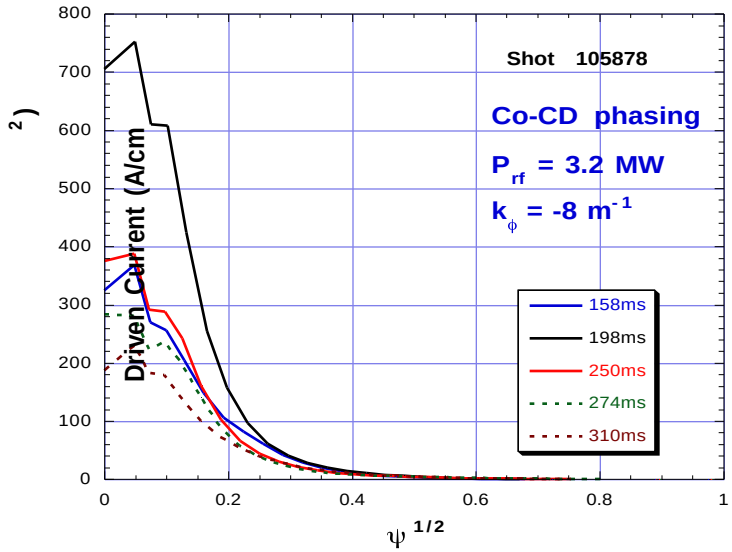
Current drive studies

- Need
  - High power (as much as possible)
  - Long pulse steady conditions
  - Phase control
- What scenario makes best sense to observe driven current with only magnetics to show the way?
  - Plasma Configuration
    - LSN or CS limited
  - Current mode of operation
    - Open circuited OH
    - Current clamped
    - Voltage clamped
    - What to do about voltage from PF
  - Phasing: fixed or alternating?

Status of CURRAY Modeling of HHFW CD

- Driven current profiles calculated for a number of time slices in a discharge, using reconstructed EFIT equilibrium and measured n, T profiles :





- Self-adjoint technique invoked in evaluating local CD efficiency. 25 - 110 rays used to simulate launched CD spectrum, P (θ,n,m).

- For experimental analysis, this calculation process needs to be automated and incorporated with TRANSP.

Improved Modeling in Support of Experiments

- Status of interface to TRANSP:
  - CURRAY as an NTCC module is an on-going effort; about half done
  - Direct coupling to TRANSP, an alternative solution
- Make code run faster with parallelization of ray tracing.
- Quasilinear diffusion effect on electron velocity distribution:
  - Cardinali calculated higher CD efficiency with QL effects
  - Need detailed benchmarking between his code and CURRAY that uses linear model
- Electric field effect on CD efficiency:
  - In CURRAY, $j/p \longrightarrow j/p \times [1 - C(Z_{eff},w_{te})(T_e/n_e)E_{loop}/(j/p)_o]$ where $w_{te} = v_{||}/v_{te}$, $(j/p)_o$ is CD efficiency w/o neoclassical effects. Need to re-establish validity of this correction factor
- Benchmark with CQL3D QL Fokker Planck code (Harvey).

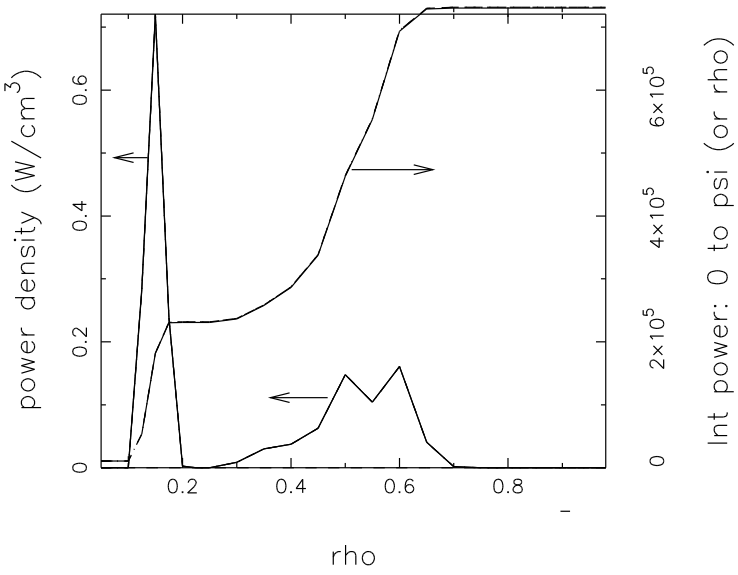
EBW Feasibility Studies

- Limited to emission measurements this run
  - Use new fast reciprocating probe to measure density profile at present receiver location
  - Move receiver to spare tube in the HHFW antenna
    - May have sharper scrape-off length
- Need to establish a desired EBW scenario for NSTX to guide which emission measurements to do next run
  - Poloidal location and frequency depend on what role EBW is expected to perform

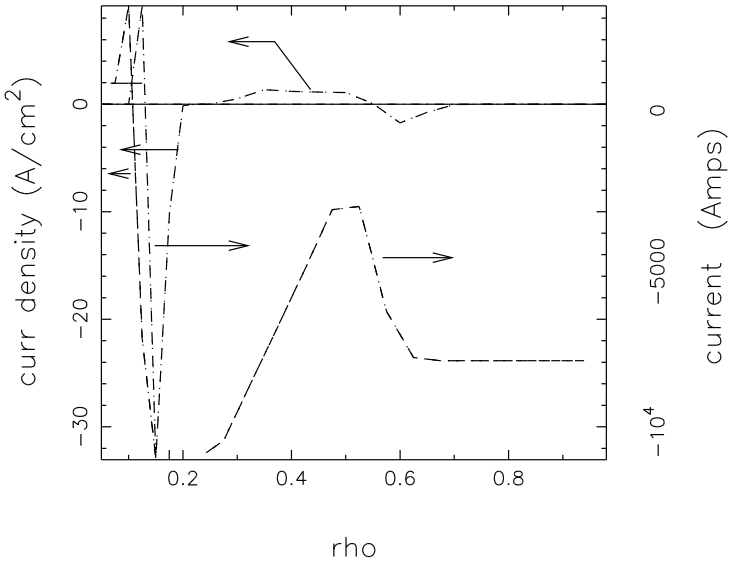
EBW Power Deposition and Driven Current

***Above midplane launch case.**
***Current is driven near the axis in negative dirn and at intermediate radii in the positive dirn, due to n_par variation.**
***CD efficiency near the axis is 0.07 A/W, giving efficiency eta=0.04 (not optimized).**

Power Density (Watts/cc) and
Integrated Power (Watts)



Current Density (A/cm**2) and
Integrated Current Density (Amps)



Tentative run time allocation

- Heating 2 days
- Ion interaction 3 days
- Current drive 3 days
- In reserve 1 day

- EBW may require some dedicated shots with plasma run against HHFW antenna