HHFW Phased Array Operation For Current Drive Experiments

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and all other NSTX collaborators
both national and international

HHFW CD experiments were performed in 2002 and 2003

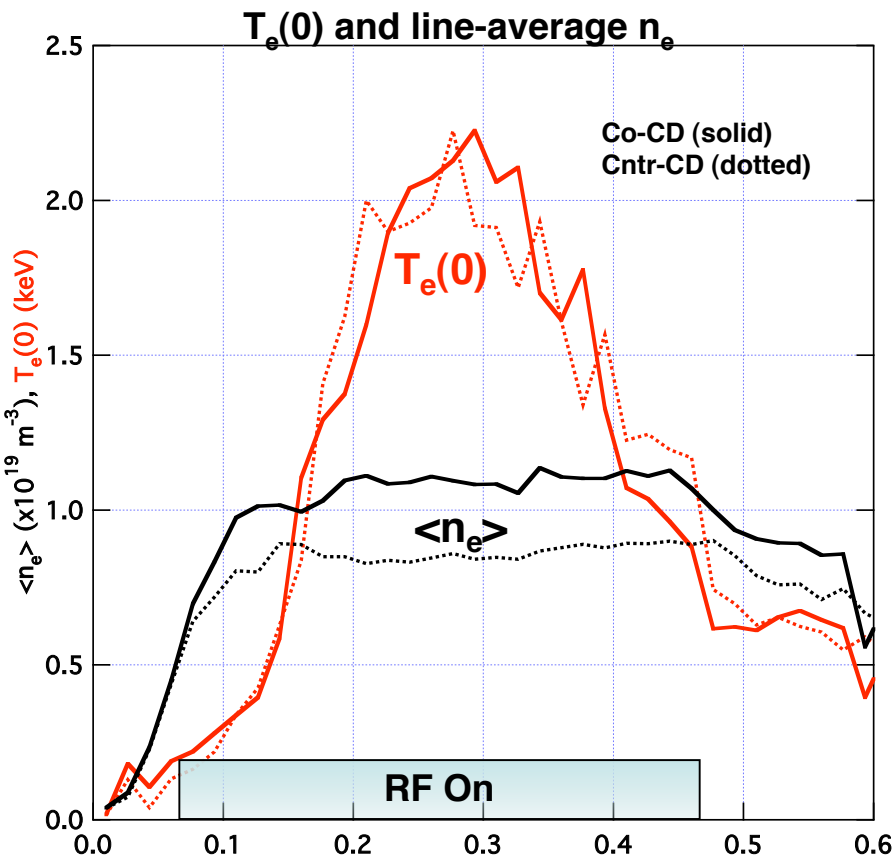
- Lower single-null diverted plasmas
- Experiments tried to maximize the detection of driven current
  - $B_0 \sim 0.45$ T
  - $I_p \sim 0.5$ MA
  - $\langle n_e \rangle \leq 1e19\ m^{-3}$
- MOST experiments were performed with $k_z = 7.6\ m^{-1}$
- Deliverable rf power increased from < 2.5 MW (2002) to > 4 MW (2003)
- Analysis of current drive relied on changes in loop voltage for similar plasma conditions as array phasing was changed from co-CD to counter-CD.
- Both deuterium (2002) and helium (2003) gave similar CD efficiencies.
- CD efficiencies are on the low end of agreement with theoretical predictions (assuming 100% power coupling).

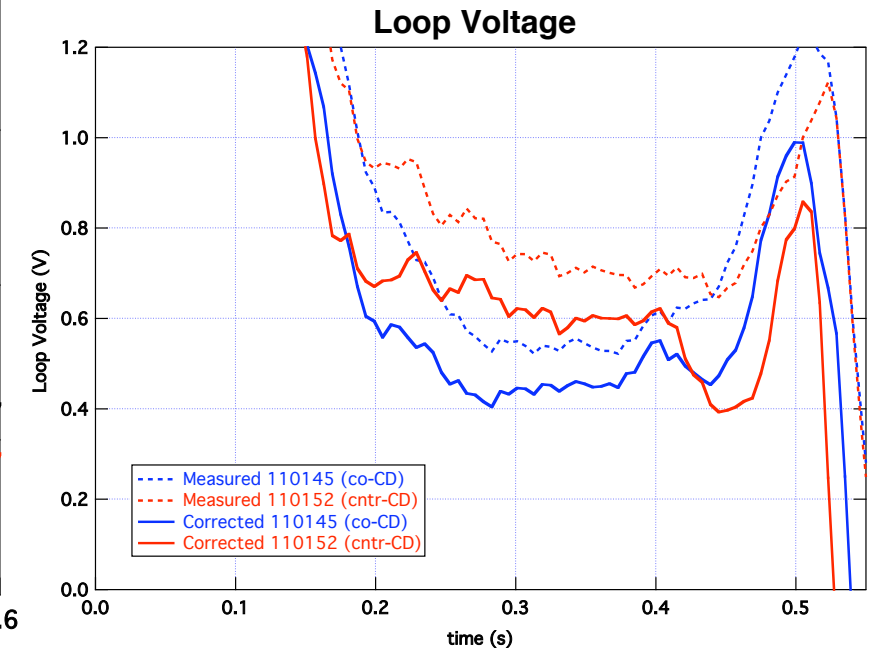
He operation in 2003

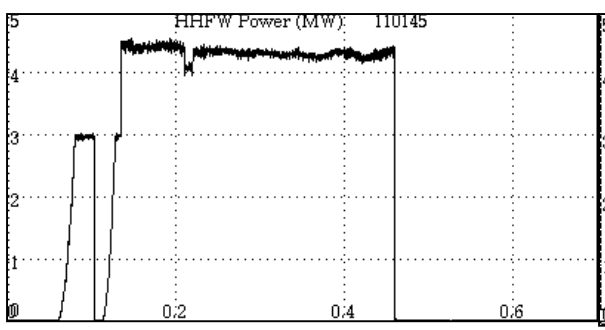
$k_z = \pm 7.6\ m^{-1}$

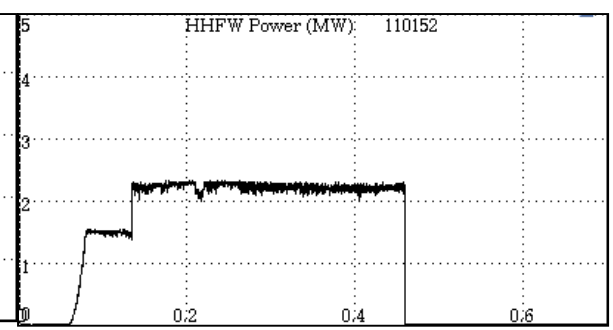
$I_p = 0.5$ MA

$B_0 = 0.45$ T



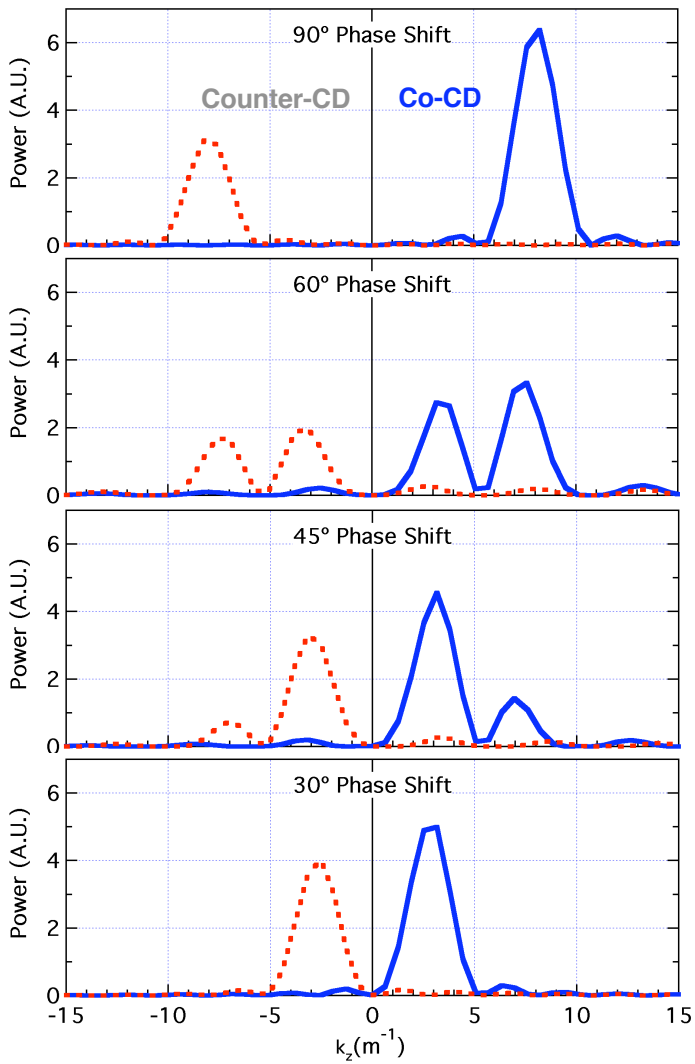






There is limited experimental operation at other array phasings

Calculated Spectra From RANT3D



In 2002, some operation at □□ = ±45°

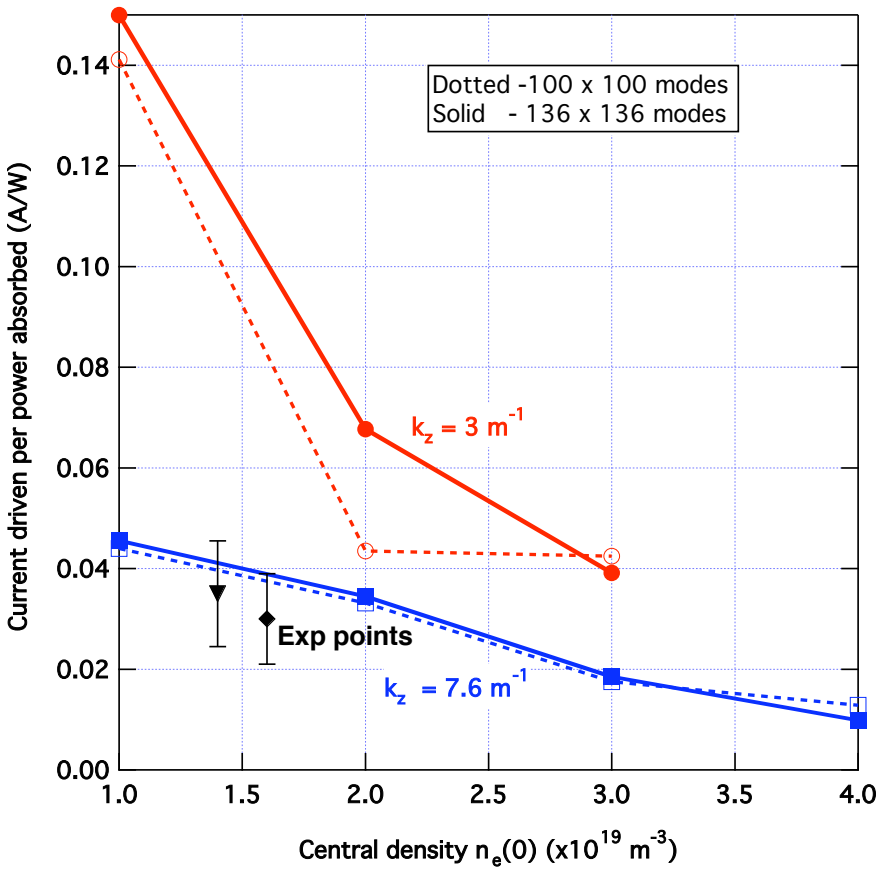
- Primarily k_z = 3 m^{-1}
- limited in power due to somewhat lower loading, increased rf noise pickup.
- □slightly improved over ±90°.

In 2003, some operation at □□ = ±60°

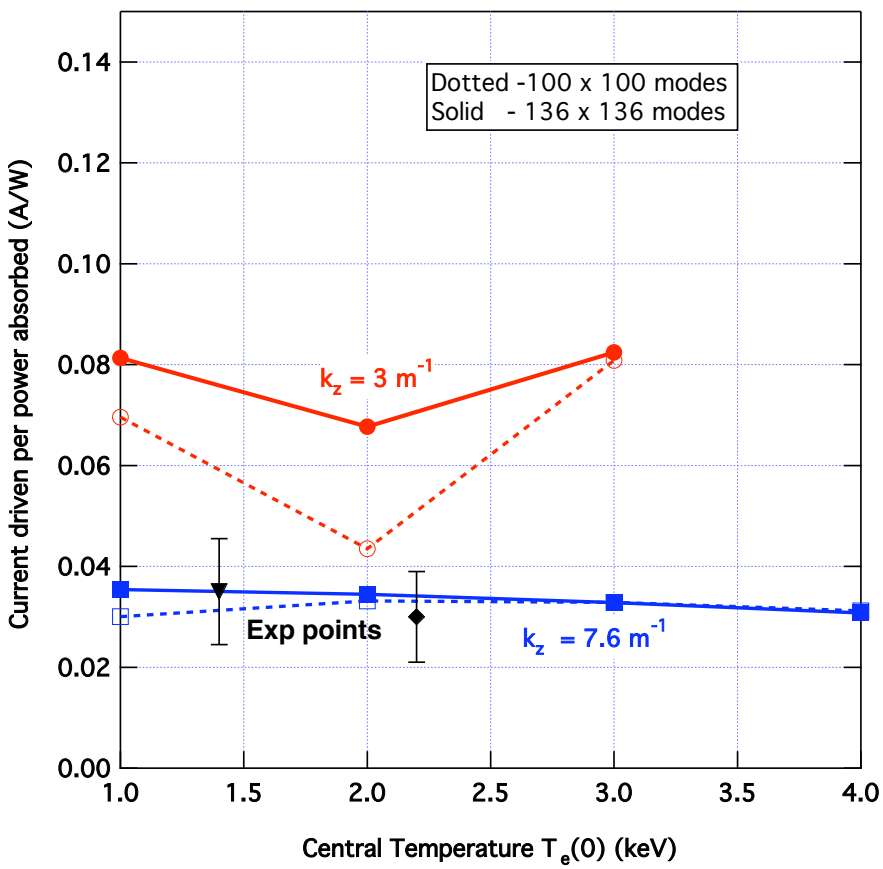
- Power split between k_z = 7.6 and 3 m^{-1}
- no change compared to ±90°.

Full-wave code calculations predict better CD efficiency for 3 m^{-1}

Density scan at constant temperature
($T_e(0)$ = 2 keV)



Temperature scan at constant density
($n_e(0)$ = 2e19 m^{-3})



AORSA runs (Jaeger)

Expected experimental difficulties operating at 3 m^{-1}

Slow central heating of electrons at 3 m^{-1}

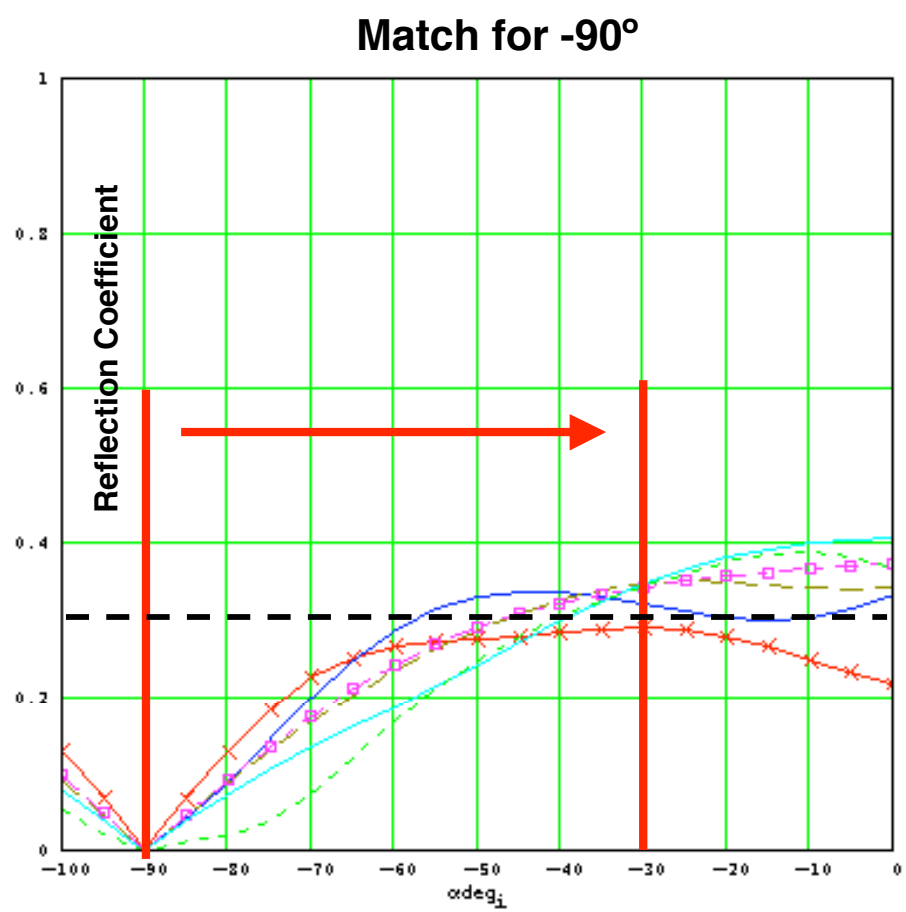
- Heat at -90º (7.6 m^{-1}) or 180º (14 m^{-1}), switch to -30º (3 m^{-1}) during pulse.
- Need to maintain acceptable match at transformers.

Increased noise generation at low phase shifts

- Better shielding and filtering has lessened this problem.

Lower loading may limit deliverable power

- Feedback control of plasma position may help.



CURRENT DRIVE EXPERIMENTS IN THE ABSENCE OF MSE

1. Comparison of 3 m^{-1} operation to previous 7.6 m^{-1} operation (1 day)
   - Similar plasma conditions to last year's experiment
   - Increase power
   - Compare loop voltage for co/counter-CD phasing

2. H-mode, high bootstrap, low loop voltage, non-inductive operation (1 day)
   - Will not perform co/counter-CD comparison.
   - Develop XP with the integrated scenario development group.

3. IF MSE BECOMES AVAILABLE AT THE END OF THE RUN PERIOD
   - Measure and compare current profiles for 3 and 7.6 m^{-1} operation