NSTX HHFW Experiments for 2010

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Power Limiting Mechanisms on the HHFW Antenna

- **The new current straps reduce interior voltages while keeping strap/frame currents approximately the same as before – good opportunity to test mechanisms on which antenna designs are based (ITER, DIII-D)**
  - Does reducing internal voltages and E-fields increase antenna power limit?
  - Does internal arcing depend on strap currents (frame currents and sheath voltages)?
  - Does lithium coating on antenna decrease power limit? If so, can antennas be cleaned/conditioned?

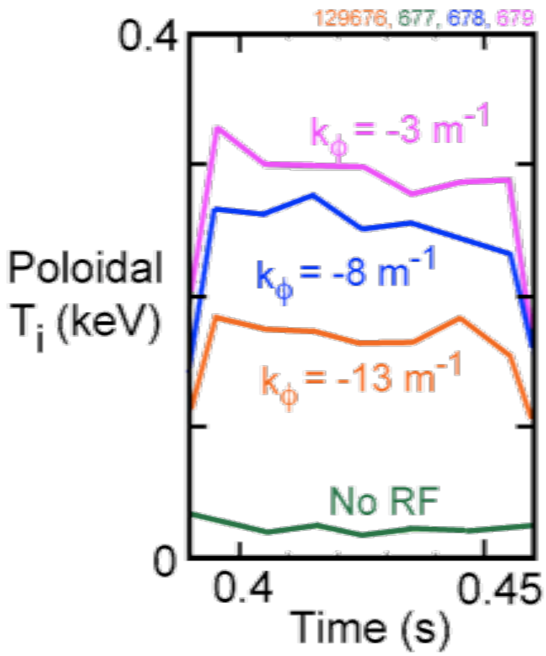
- **Ideal Experiment:**
  - Condition antenna to high power/power limit before operating LITER.

- **Practical Experiment:**
  - Condition antenna early in LLD loading at 20 mg/min evaporation rate, before antenna gets coated with lithium.
  - Protect LLD by using upper single null diverted plasmas, 50 ms RF pulses initially.
  - Gradually extend pulse length to 400 ms.
  - Establish power limits for ±150º, ±90º, ±30º.

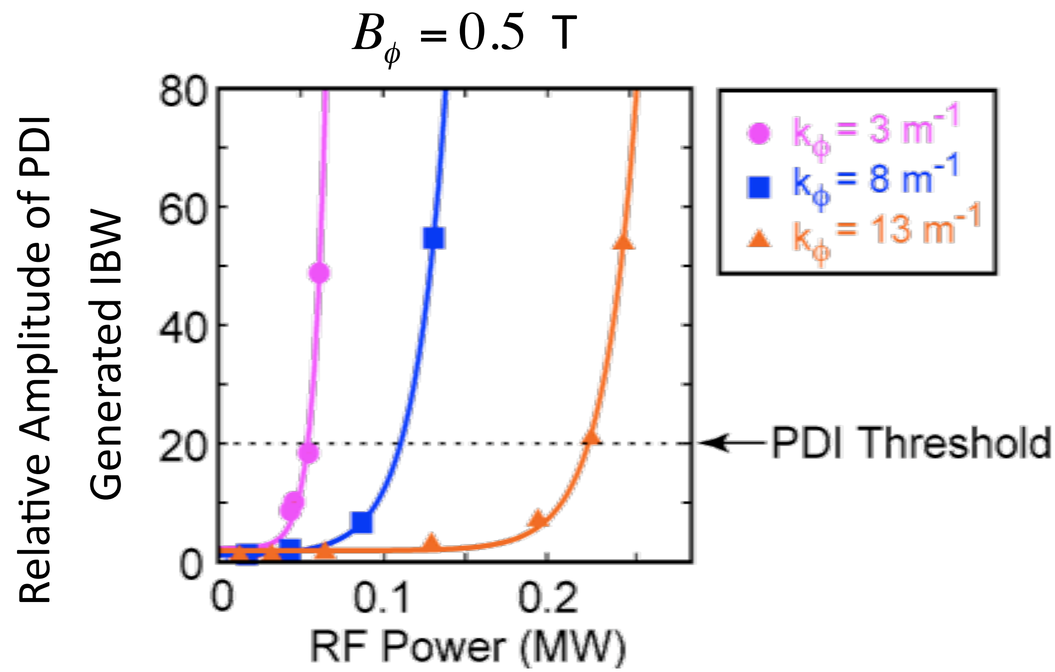
- **Diagnostics:**
  - Fast camera view of antenna
  - IR view of antenna to distinguish temperature/power deposition from light
  - Spectroscopic information (filters on camera, filterscopes)
  - Neutral pressure monitor with fast ion gauge

Theory Support:
  - TOPICA to model charging potential of magnetic field lines.
  - Microwave Studio calculations of frame currents.

PDI k_ϕ Dependence Consistent with Edge Ion Heating Measurements



P_{RF} = 1.2-1.3 MW



- ✓ Predicted power threshold is consistent with previous reflectometer measurements (100 to 300kW), (Wilgen 2005).

HHFW-Generated PDI Study

- **Could be losing substantial power (10-30%) to PDI heating of edge ions.**

- **AORSA 1-D theory is being developed, need data for corroboration.**

- **PDI Power Threshold**
  - Modulate RF power with a slow rise and fall time (~50 ms) to get power threshold for PDI side bands as a function of phase.
  - Reflectometer operates in frequency dwell mode.

- **PDI Interaction Location**
  - For steady RF power, slowly sweep (~10 ms) reflectometer frequency to move the X-mode cutoff through edge plasma to determine location of maximum amplitude of sidebands.
  - Correlate with edge ion temperature profile from ERD.
  - Function of array phase and power.

MSE Measurement of HHFW CD

- Goal: Develop HHFW as central CD profile control tool in D H-mode.
- Previous MSE measurements made at 1.8 MW.
- Need >4 MW for good MSE measurement (and HHFW induced H-mode)
- 400 ms HHFW pulse at ±90º (co/cntr CD)
    - 40 ms beam blip at end of RF to measure HHFW CD efficiency.
    - Increase NBI pulse width by turning beam on earlier.
        - Measure CD time constant early in beam pulse.
        - Measure CD efficiency in presence of NBI late in beam pulse.

General Thoughts on HHFW H-mode XPs

- Need to optimize the relationship between plasma gap, plasma loading, core coupling efficiency, and antenna protection.
- Control edge density – correlate with heating efficiency as a function of phase
- ELMs
  - Determine the effect of RF on ELMs (suppress them or trigger them?)
  - Determine if operation in ELMs can be handled with arc/ELM discriminator (shut off power for arc, leave power on for ELM). First try impedance rise time discriminator.
  - Determine the reflection coefficient characteristics of type I through V ELMs (this could be a low power piggyback experiment).
  - Determine if applying power to ELMs is desirable or not. Monitor power to divertor with fast IR camera while coupling to ELMs. May make use of 3D field triggering of ELMs.
- Investigate coupling to fast ions as a function of HHFW wavelength and ion cyclotron harmonic number. Measure electron heating and ion energy distribution for NBI A, B, and C operation with RF.