Investigation of Parametric Decay during HHFW

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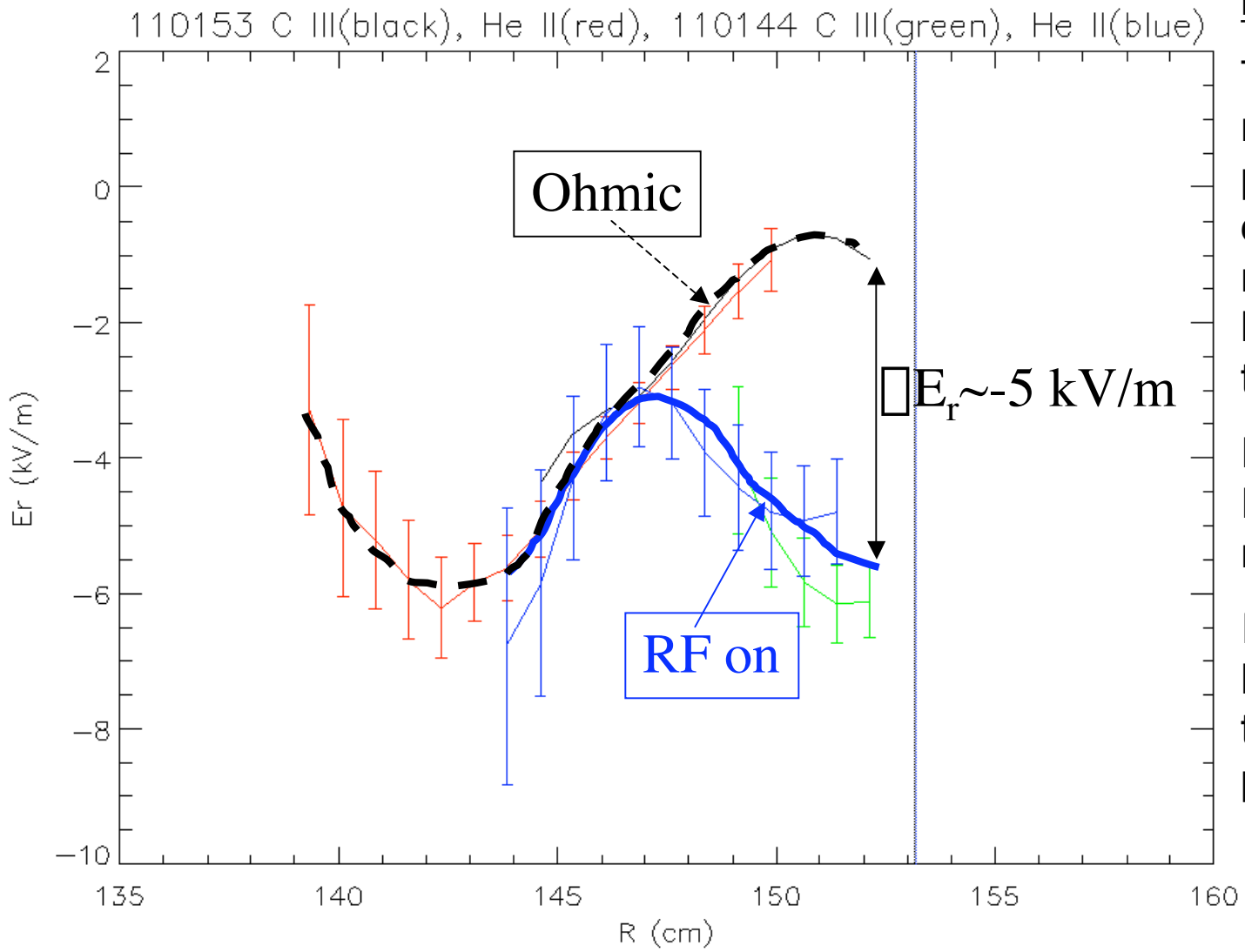
Circumstantial Evidence for Parametric Decay has been observed

- Edge ion heating and rotation
  - In outer 10 cm
  - $T_{perp} > T_{par}$
- Energy Balance
  - Inconsistencies between kinetic and magnetic stored energies

E_r from He II and C III (cold)



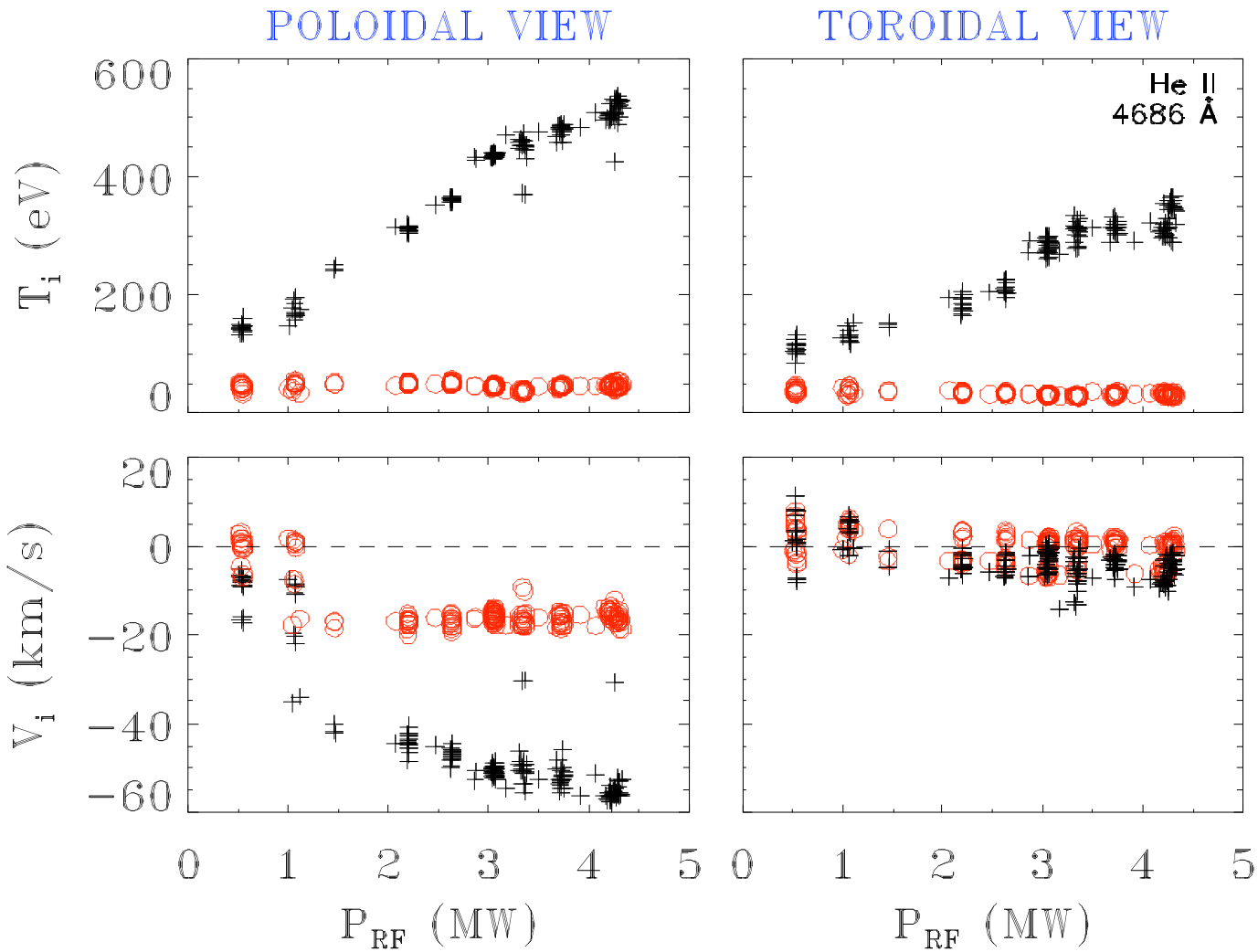
Ohmic v. RF heated

The E_r at the edge most region of the plasma (R>146 cm) is more negative during RF heated plasmas than during Ohmic.

For R<146 cm the E_r is similar (for the region measured)

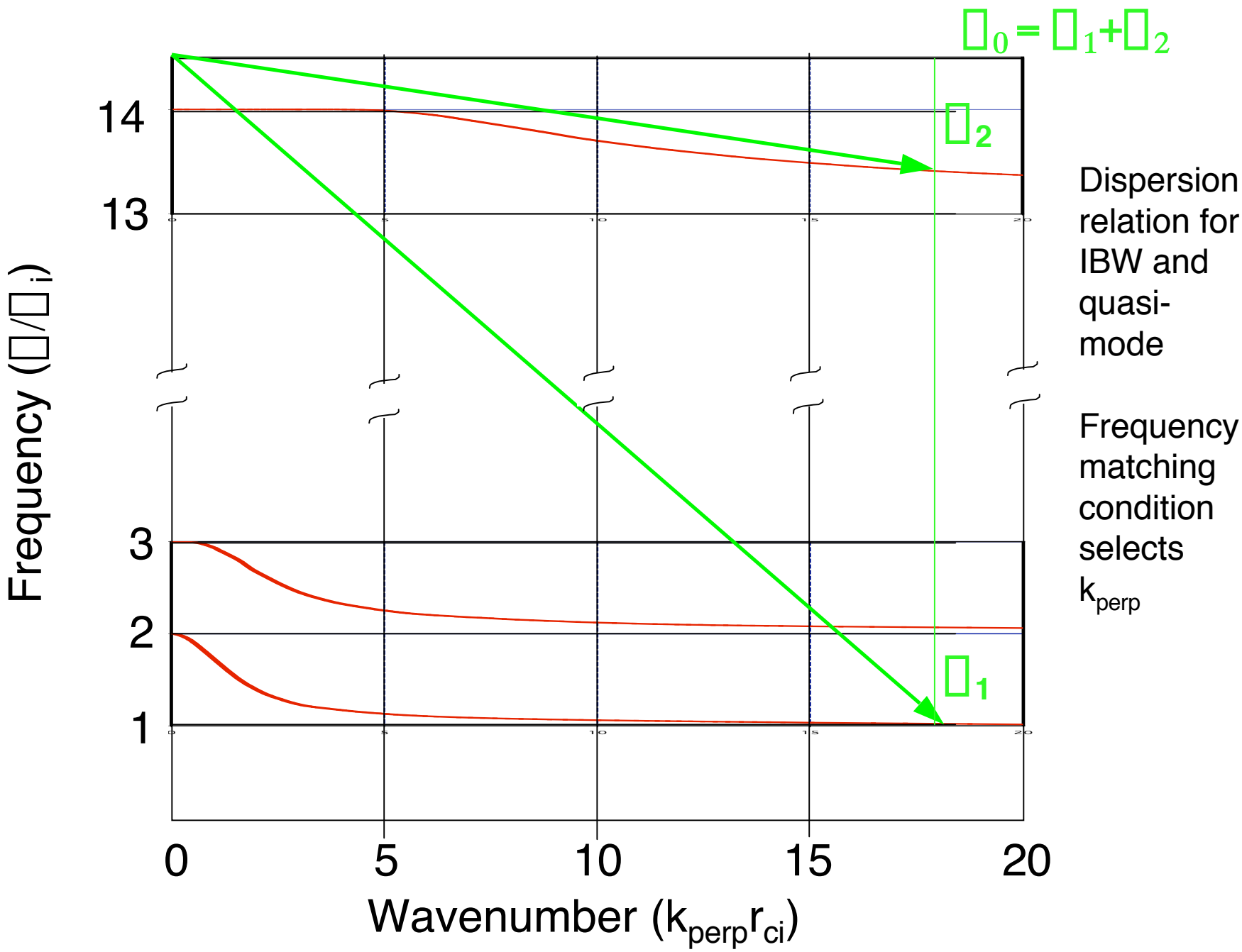
Implies that RF leads to ion loss at the edge of the plasma.

More power leads to more heating

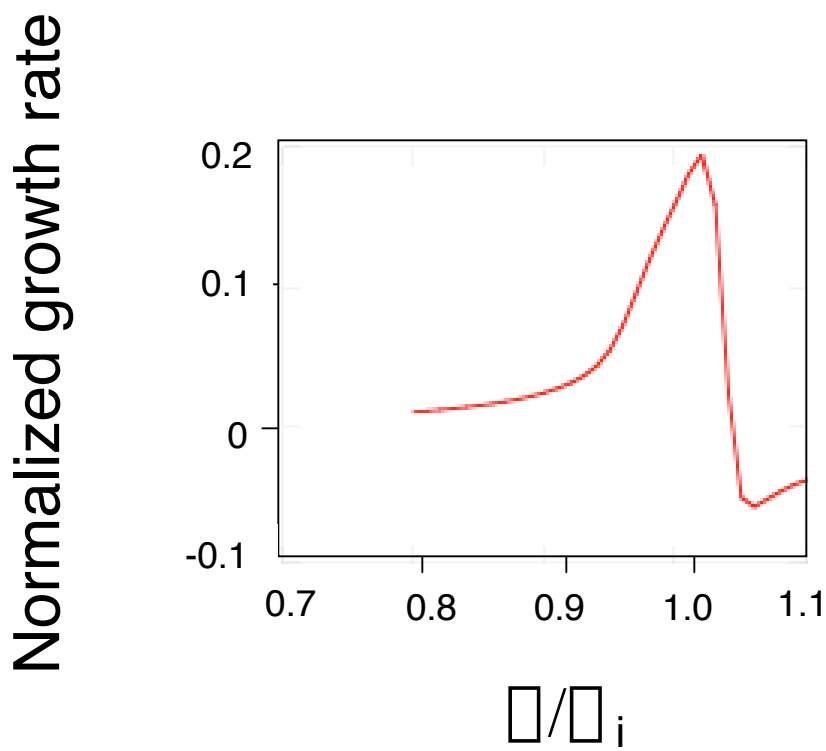


Negative poloidal velocity is upwards on the outboard midplane.
Negative toroidal velocity is opposite to the direction of I_p.

From NSTX Shot 110133 to 110145 the applied RF power was increased.
Empirically, T_i increases as $P_{RF}^{0.47}$.


$\omega_0 = \omega_1 + \omega_2$
ω_2
ω_1
14
13
3
2
1
0
5
10
15
20
Frequency (ω/ω_i)
Wavenumber ($k_{perp} r_{ci}$)
Dispersion relation for IBW and quasi-mode
Frequency matching condition selects k_{perp}

Numerically calculating the normalized growth rate for ω ω_i yields



T_e , T_i = 50 eV
$n_e = 2 \times 10^{18}$
B = 2.3 kG

Growth rate maximizes for $k_{||} = \omega_i/0.7v_{te}$

Growth rate is found to decrease with increasing edge temperature and increase with increasing edge density

Where does the coupled power go?

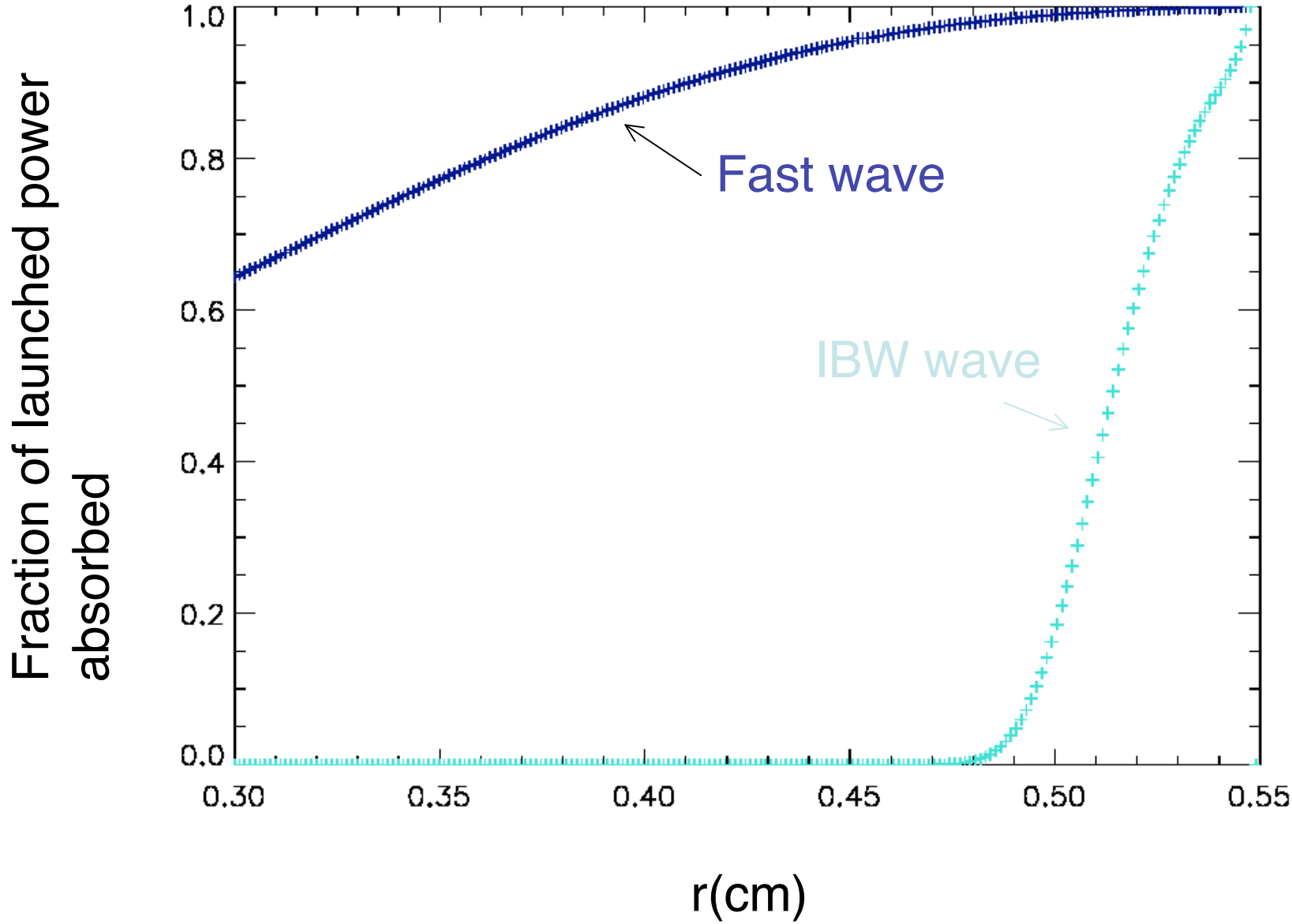
Both the ion Bernstein wave and the ion quasi-mode should deposit their energy into the majority ions

The quasi-mode does not propagate and deposits its energy locally but because of its low frequency it can not contain much energy

The Bernstein wave will propagate until it reaches the next cyclotron harmonic - for NSTX this is within about 10 cm of the edge

So all the parametrically coupled power should damp within 10 cm of the edge

Power absorption for edge launched fast wave and IBW



Campaign

- Passively look for evidence of decay during HHFW experiments
  - Continue edge measurements
  - Use probes to look for decay waves
- Possible dedicated experiments to check detailed predictions
  - Is there a threshold?
  - Density edge temperature dependence
  - Small variations in B