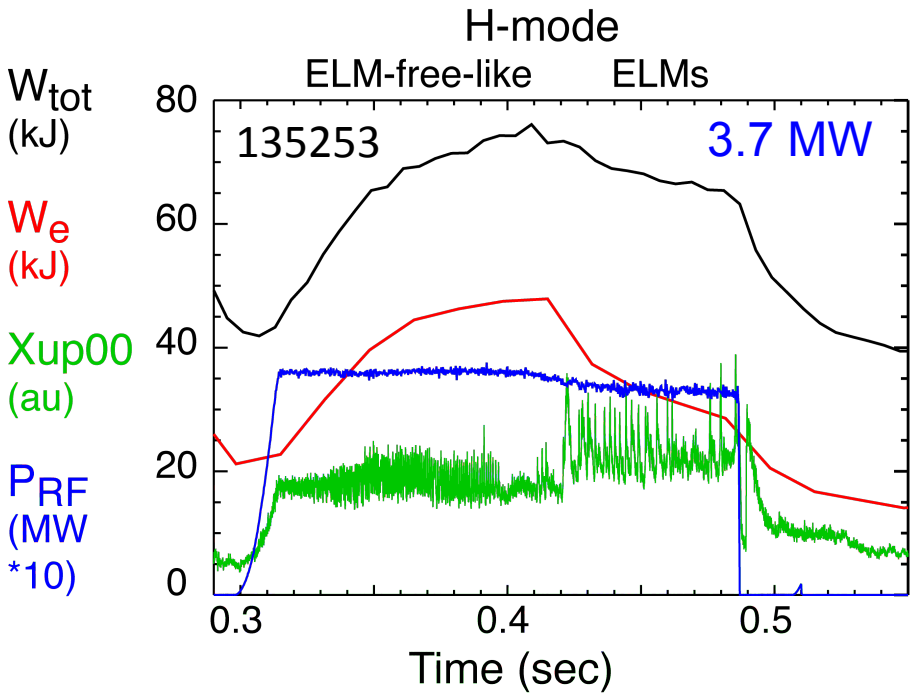
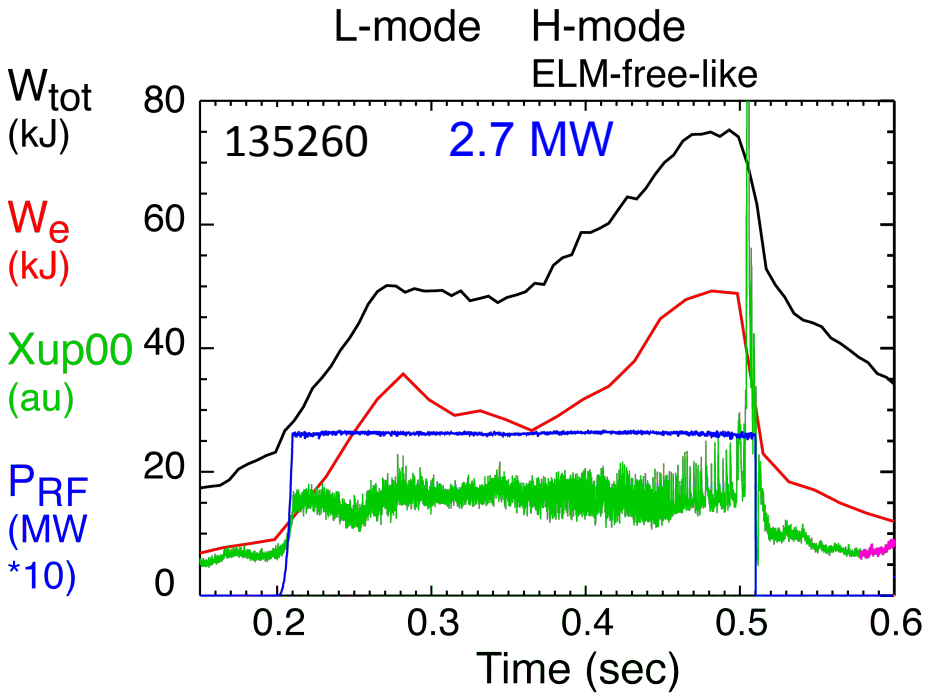
XP 1: Turbulence characteristics for HHFW H-mode saturated stored energy versus HHFW power

J. Hosea, Yang Ren, Ernesto Mazzucato, David Smith, et al.

- Maximum stored energy during the ELM-free-like phase of the HHFW electron heating generated H-mode appears to be independent of P_{RF} down to a low P_{RF} value
- Initial high-k scattering measurements suggest micro-turbulence increases substantially with P_{RF}
- Would like to investigate high-k profile measurements as a function of P_{RF} with fall off of P_{RF} during the ELM-free-like phase of the HHFW H-mode
  - Would like to measure high-k scattering spectra vs P_{RF} to discern turbulence level required to maintain critical temperature gradient conditions during the same shot conditions
    - All high-k channels for maximum $k_{\perp}\rho_s$ range
    - 4 radial positions for kigh-k measurements for large radial range
  - Can ETG turbulence be measured into the linear range with drop off in power and eventual loss of critical temperature gradient?

Stored energy in ELM-free-like HHFW H-mode saturates at same level when P_{RF} is reduced from 3.7 MW to 2.7MW

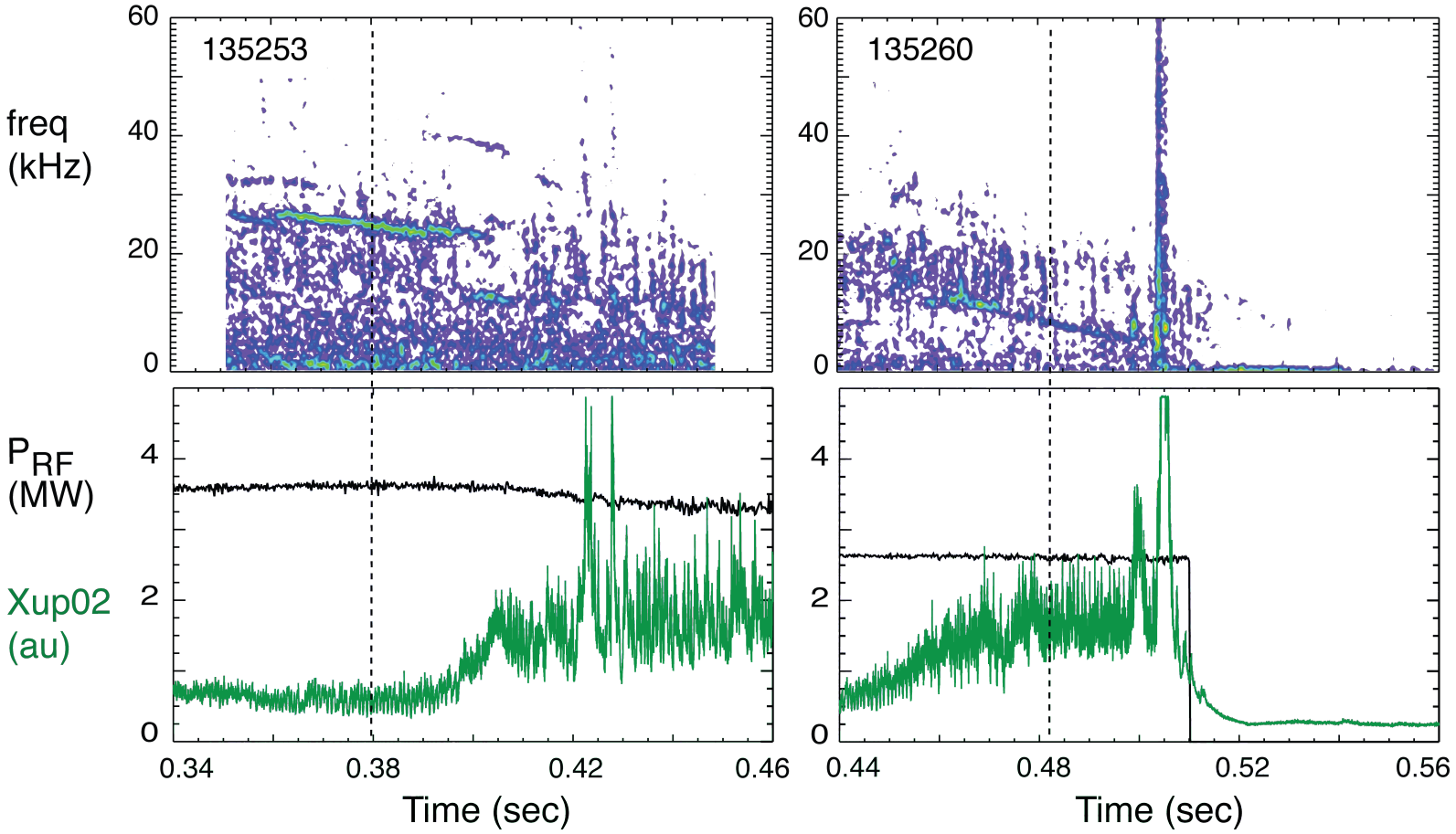




- Stored electron electron and total energies reach similar values prior to onset of large ELMs
- MHD shows no Alfven eigenmodes and Mirnov MHD is only present for frequencies below ~ 50 kHz
- Suggests that micro-turbulence increases with P_{RF} leading to an increase in transport

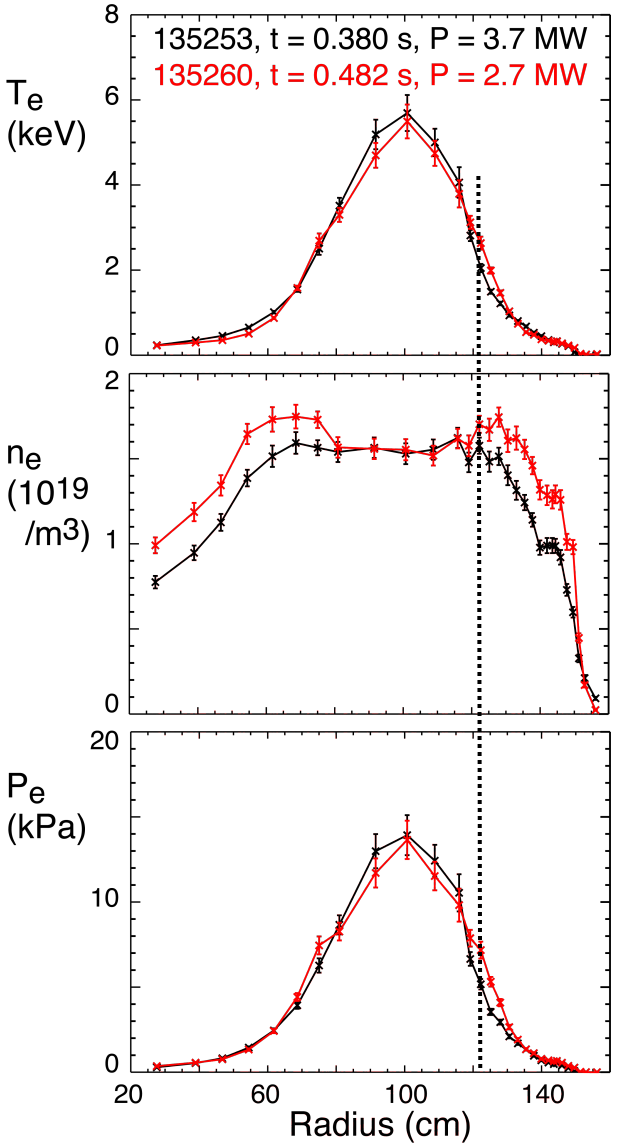
MHD is reduced at frequencies < ~ 50 kHz when P_{RF} is reduced from 3.7 MW to 2.7MW

Comparison of MHD spectra for 135253 t = 0.38 s, 135260 t = 0.482 s

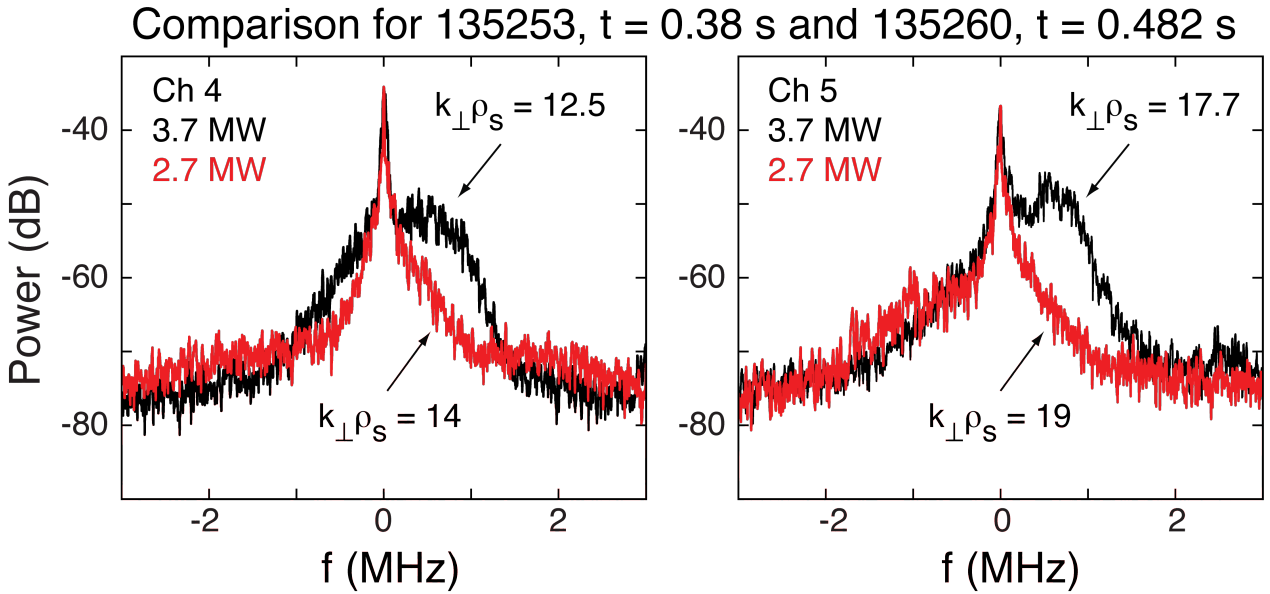


- MHD shows no Alfven eigenmodes and Mirnov MHD is only present for frequencies below ~ 50 kHz
- Turbulent spectra is indicated without large coherent modes

Initial high-k scattering measurements indicate that ETG turbulence increases with RF power

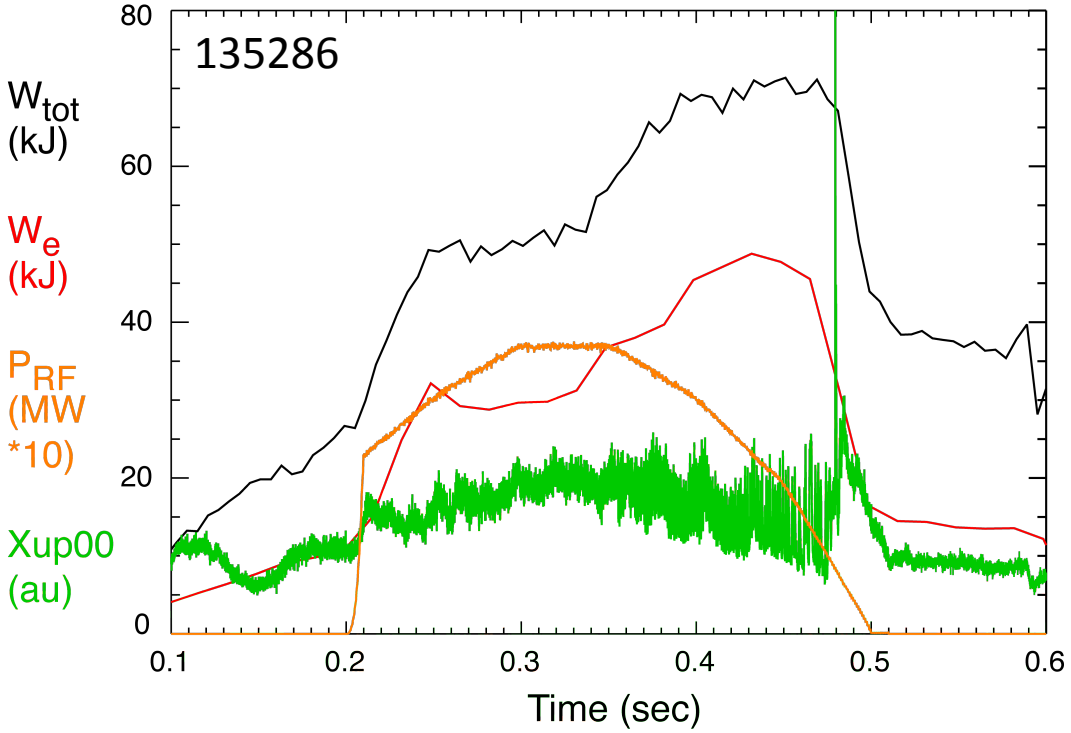


High-k scattering spectra vs RF power



- Increase in high-k turbulence may cause the observed saturation of stored energy with increasing RF power
- Critical T_e gradient is in the range measured for L-mode plasmas (H. Yuh et al., PRL 106 Feb. 11) with monotonic q profile

Stored energy saturates during the fall of P_{RF} in ELM-free-like H-mode period



- Both W_{tot} and W_e stored energies attain values during the RF power ramp down comparable to the previous levels shown for 3.7 MW and 2.7 MW flat RF power pulses
- A strong change in radial transport is indicated vs P_{RF}
- Measurements of high-k scattering should help elucidate the quantitative role of ETG turbulence relative to transport if spectral levels follow P_{RF} and τ_{eff}, especially if levels can be measured for the T_e gradient falling below the critical value

Experimental run plan

- Begin with helium HHFW H-mode
  - Repeat conditions of shot 135286: P_{RF} 3.4 MW with relatively slow fall off during Elm-free-like H-mode, B_T = 5.5 kG, I_P = 0.65 MA, high-k at ~ 123 cm
  - Establish similar discharge conditions with B_T/I_P = 5.5 kG/1 MA or 4.5 kG/0.8 MA (if possible) to allow IR camera coverage of RF "hot" zone as well as outer divertor region
  - For best condition, make high-k measurements for 110 cm and then 136 cm
    - Measure heat flux to divertor and "hot" zone to the extent possible vs time
- Change to deuterium HHFW H-mode for best condition (still 136cm high-k)
  - Measure if high-k spectra increases with decrease in Z_{eff} as predicted by Ernesto Mazzucato
    - Measure if heat flux to divertor increases overall for deduced power to core plasma
  - Make high-k measurements for 123 cm and 110 cm

❖ 1 day desired. With ½ day perform helium case only