Isotope impact on Alfvén eigenmodes and fast ion transport in DIII-D

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Measurements of beam driven Alfvén Eigenmode (AE) activity in matched deuterium (D) and hydrogen (H) DIII-D plasmas are found to exhibit a dramatic difference in unstable mode activity and fast ion transport for a given injected beam power[1]. The dependence of the unstable AE spectrum in reversed magnetic shear plasmas on beam and thermal species is investigated in the current ramp by varying beam power in a sequence of discharges for fixed thermal and beam species at fixed density (See Figure 1). In general, a spectrum of Reversed Shear Alfvén Eigenmodes (RSAEs) and Toroidal Alfvén Eigenmodes (TAEs) are driven unstable with sub-Alfvénic D beam injection while primarily only RSAEs are driven unstable for the H beam cases investigated. Further, for a given beam power, the driven AE amplitude is always reduced with H beams relative to D and for H thermal plasma relative to pure D or mixed D/H plasmas. Estimates of the fast ion stored energy combined with modeling using the hybrid kinetic-MHD code MEGA indicate that the dominant mechanism contributing to the difference between H and D beam drive is the faster classical slowing down of H beam ions relative to D and the resultant lower beam ion pressure. Additionally, predictions of the expected outcome were made before the experiment took place (so-called “predict first”), using the reduced critical gradient model TGLFEP, and calculations of the AE induced stored energy deficits show quantitative agreement with the observed dependencies on injected power, isotope and minimum safety factor.

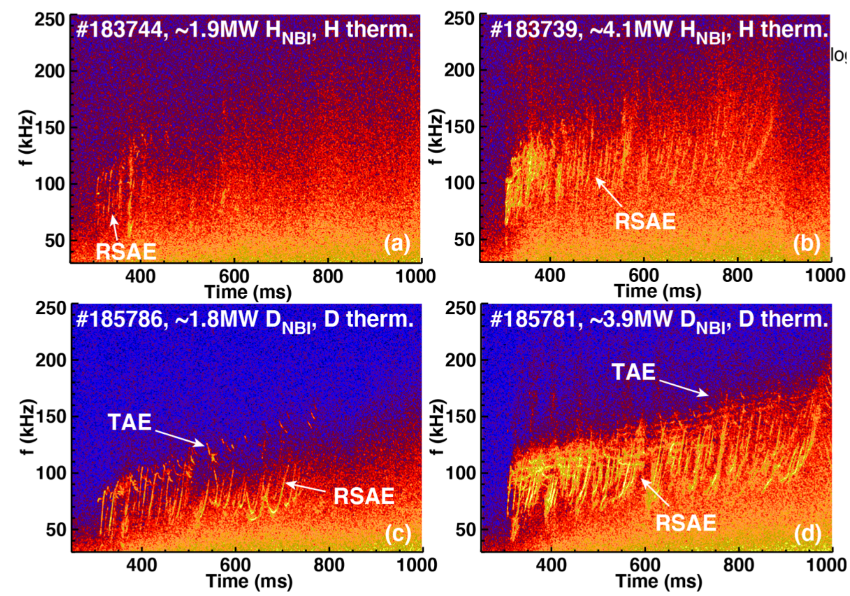

Figure 1. CO2 interferometer crosspower spectrograms for (a)-(b) HNBI, Htherm and (c)-(d) DNBI, Dtherm power scan respectively.

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