Measurements, modeling, and electron cyclotron heating modification of Alfvén eigenmode activity in DIII-D

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Abstract.

Neutral beam injection into reversed magnetic shear DIII-D plasmas produces a variety of Alfvénic activity including toroidicity and ellipticity induced Alfvén eigenmodes (TAE/EAE, respectively) and reversed shear Alfvén eigenmodes (RSAE) as well as their spatial coupling. These modes are studied during the discharge current ramp phase when incomplete current penetration results in a high central safety factor and strong drive due to multiple higher order resonances. It is found that ideal MHD modeling of eigenmode spectral evolution, coupling, and structure are in excellent agreement with experimental measurements. It is also found that higher radial envelope harmonic RSAEs are clearly observed and agree with modeling. Some discrepancies with modeling such as that due to up/down eigenmode asymmetries are also pointed out. Concomitant with the Alfvénic activity, fast-ion (FIDA) spectroscopy shows large reductions in the central fast ion profile, the degree of which depends on the Alfvén eigenmode amplitude. Interestingly, localized electron cyclotron heating (ECH) near the mode location stabilizes RSAE activity and results in significantly improved fast ion confinement relative to discharges with ECH deposition on axis. In these discharges, RSAE activity is suppressed when ECH is deposited near the radius of the shear reversal point and enhanced with deposition near the axis. The sensitivity of this effect to deposition power and current drive phasing as well as ECH modulation are presented.