High field side LHCD in DIII-D: physics demonstration of reactor relevant current drive

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Calculations show that high field side (HFS) launch of lower hybrid range of frequencies (LHRF) power represents an integrated solution that both improves core wave physics (high current drive efficiency at proper location) and mitigates plasma material interaction (PMI)/coupling issues [1] . To demonstrate the benefits associated with HFS LHCD (wave coupling, propagation, absorption, and current drive efficiency), a conceptual HFS LHCD system has been developed for DIII-D, which represents the first fully developed HFS LHRF system design for an operating tokamak.

Using existing DIII-D discharges, we have identified high performance scenarios with excellent wave penetration, single pass absorption and high off-axis current drive efficiency (r/a~0.6-0.8, FWHM of r/a=0.2 and driven current up to ~0.21 MA/MW). The DIII-D antenna design utilizes proven launching technology (slotted waveguide, multijunction) while remaining within established power density limits. The performance of the antenna was simulated by ALOHA [2] and 3D MFEM [3] and shows low reflected power for a range of plasma conditions.

From an operational perspective, launcher placement on the HFS has potential issues: reduction of inner wall gap and launcher material compatibility. The former was investigated through a scan of the plasma-HFS wall gap. Little or no impact of these plasma shape changes was found on discharge confinement or stability. Data on material compatibility from a molybdenum/carbon mockup antenna installed on the HFS wall of DIII-D will be presented.

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