Development of lower hybrid current drive actuators for reactor relevant conditions


MIT Plasma Science and Fusion Center, Cambridge, Massachusetts, USA

The high efficiency of lower hybrid current drive (LHCD), \( \eta \equiv n_e I_{LH} R_0 / P_{LH} = \sim 2.5 \times 10^{19} \text{AW}^{-1}\text{m}^{-2} \), makes it an attractive non-inductive current drive source for a steady-state fusion reactor, although unresolved physics and engineering issues must still be addressed. Experiments on Alcator C-Mod and other tokamaks have shown that lower hybrid (LH) waves can be absorbed near the last closed flux surface, rather than the desired mid-radius location, at high density [1]. Experimental and modeling studies at MIT indicate that the deleterious edge absorption is due to weak damping in the multi-pass regime, although other theories point towards prompt absorption in front of the LH antenna.

A new LHCD antenna, installed off the mid-plane to improve quasi-linear absorption of the LH waves when combined with the existing (mid-plane) launcher, will be installed on C-Mod to confirm if stronger single-pass damping will improve LHCD efficiency at high density, as predicted by simulation codes. The addition of a second launcher with more source power will also expand the non-inductive operating range by doubling the available LH power.

The Advanced Divertor Experiment (ADX) is an innovative tokamak proposed for construction at MIT [2]. The conceptual design includes LH antennas on both the low field side (LFS) and high field side (HFS). ADX will verify the predicted benefits of launching LH waves from the HFS in a double null configuration, including a quiescent scrape off layer (SOL) [3] for improved launcher durability, good impurity screening [4], and more direct wave penetration [5] for stronger single pass absorption and higher current drive efficiency at high density.

References