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FTP/1-1: Evaluation of Optimized ICRF and LHRF Antennas in Alcator C-Mod

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Ion cyclotron range of frequency heating (ICRF) and lower hybrid range of frequency current drive (LHCD) are expected to be key heating and current drive actuators for future fusion reactors and devices. However, impurity contamination associated with ICRF antenna operation remains a major challenge, particularly in devices with metallic plasma facing components. For LHCD, maximizing coupled power to the plasma remains a challenge, particularly to maintain low reflection coefficient over range of plasma conditions. Here, we report on an experimental investigation to test whether a field aligned (FA) ICRF antenna can reduce the impurity contamination and SOL modification associated with antenna operation. We also report on results from a new limiter for the LH coupler designed to reduce reflection coefficients across a wider range of plasma conditions.

The unique feature of the so-called FA-antenna is that the current straps and antenna box structure are perpendicular to the total magnetic field. This alignment allows integrated E|| (electric field along a magnetic field line) to be minimized through symmetry. Using finite element method and a cold plasma model, the FA-antenna has been found to have lower integrated E|| relative to the previous antenna geometry.

Initial results indicate that the impurity contamination associated with the FA-antenna is lower relative to our standard ICRF antennas. Configured as a 2-strap antenna, the antenna has lower core impurity contamination and lower impurity source at the antenna at high power density (˜15 MW/m2). An array of core and boundary plasma diagnostics are presently being used to characterize the impurity behavior and impact on the SOL transport and SOL density profiles; the latest results will be presented.

For LHCD, reflection coefficients are very sensitive to the local density and its profile in front of the LHCD coupler. Previously the local LH coupler protection limiter was fixed to the outer wall of the vacuum vessel. The new limiter is mounted on the coupler and protrudes 0.25 mm beyond the coupler for plasma heat flux protection. The protection tiles allow the LH launcher to be moved closer to the plasma than previously possible. Initial high power (Pnet ˜ 700 kW) results show lower reflection coefficients were achieved (Γ2 ˜ 0.1) as compared to the old configuration (Γ2 ˜ 0.2).

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