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Taming the ICRF Antenna - Plasma Edge Interaction using Novel Field-Aligned ICRF Antenna on Alcator C-Mod[1]

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For ICRF antenna utilization in future fusion reactors, taming the antenna-plasma edge interaction while robustly coupling RF power is a critical challenge. Using a novel field-aligned (FA) ICRF antenna where the antenna straps are perpendicular to the total magnetic field, we have shown dramatically improved ICRF antenna performance. The FA antenna has significantly reduced antenna impurity sources, core impurity contamination and radiated power compared to conventional toroidally aligned antennas. The FA antenna also has load tolerance to plasma transients and significantly reduced RF-enhanced heat flux. The emerging physics picture is that the FA antenna minimizes generation of slow wave fields (E//B polarization). This reduction in slow wave lowers the local RF sheath around the ICRF antenna, and thus lowers the impurity source at local antenna structure. Simplified antenna simulations show a strong reduction in slow wave fields. The reduction of the slow wave field also impacts the antenna load tolerance. With the slow wave present, the antenna impedance is strongly modified by the slow wave coupling between antenna straps and this coupling is dependent upon the local density. With reduced slow wave coupling, the antenna reactive impedance is defined by the strap geometry and independent of the plasma whereas the real impedance is determined by the fast wave coupling. Experimentally we have found that the FA antenna loading has similar trends versus plasma current and densities to TA antennas, but the FA antenna reflection coefficient has significantly reduced variation, particularly during L-H and H-L transitions, and ELMs. Further comparisons of the FA and TA antennas are underway with an extensive array of diagnostics to characterize the RF plasma edge interaction and the latest results will be presented.

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