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Novel Reactor Relevant RF Actuator Schemes for the Lower Hybrid and the Ion Cyclotron Range of Frequencies[1]

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This paper presents a fresh physics perspective on the onerous problem of coupling and successfully utilizing ion cyclotron range of frequencies (ICRF) and lower hybrid range of frequencies (LHRF) actuators in the harsh environment of a nuclear fusion reactor. The ICRF and LH launchers are essentially first wall components in a fusion reactor and as such will be subjected to high heat fluxes. The high field side (HFS) of the plasma offers a region of reduced heat flux together with a quiescent scrape off layer (SOL). Placement of the ICRF and LHRF launchers on the tokamak HFS also offers distinct physics advantages: The higher toroidal magnetic field makes it possible to couple faster phase velocity LH waves that can penetrate farther into the plasma core and be absorbed by higher energy electrons, thereby increasing the current drive efficiency. In addition, re-location of the LH launcher off the mid-plane (i.e., poloidal "steering") allows further control of the deposition location. Also ICRF waves coupled from the HFS couple strongly to mode converted ion Bernstein waves and ion cyclotron waves waves as the minority density is increased, thus opening the possibility of using this scheme for flow drive and pressure control. Finally the quiescent nature of the HFS scrape off layer should minimize the effects of RF wave scattering from density fluctuations. Ray tracing / Fokker Planck simulations will be presented for LHRF applications in devices such as the proposed Advanced Divertor Experiment (ADX) and extending to ITER and beyond. Full-wave simulations will also be presented which demonstrate the possible combinations of electron and ion heating via ICRF mode conversion.

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