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

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High field side (HFS) launch of RF power in the ion cyclotron range of frequencies (ICRF) and the lower hybrid range of frequencies (LHRF) in double null configurations in reactor grade plasmas is studied and found to represent an integrated solution that both mitigates PMI / coupling problems and at the same time opens up the possibilities of greatly improved core wave physics

Power exhaust in a tokamak tends to send heat and particles to the low field side (LFS) scrape off layer (SOL) of the tokamak forcing RF launchers to be placed farther away from the plasma on the LFS, which reduces wave coupling and increases the probability of parasitic absorption in the SOL. In contrast, the quiescent nature of the HFS SOL in double null configurations encourages placement of RF launchers closer to the plasma on the HFS making it possible to utilize a small antenna-plasma gap with good coupling. The HFS SOL also has been found to strongly screen impurities thus mitigating adverse effects of PMI on the core plasma that might arise from near and far field RF sheaths associated with ICRF launchers. In addition lower electron densities measured in the HFS SOL relative to the low field side, combined with a more quiescent SOL may help to reduce parasitic losses of LHRF power due to parametric decay instability, collisional losses, and scattering of LH waves from density fluctuations and blobs.

Significant improvements in core wave physics are also achievable with HFS launch of LHRF and ICRF power. Higher toroidal magnetic field on the HFS combined with careful poloidal positioning of the LH launcher makes it possible to couple faster LH waves resulting in improved core wave penetration and higher LH current drive efficiency. High field side launch of ICRF waves in a deuterium majority plasma with high minority hydrogen concentration (> 10%) makes it possible to couple fast waves directly to ion Bernstein waves (IBW) which damp strongly on bulk plasma electrons, thus avoiding the generation of fast ion tails and concomitant tail losses that can occur with the LFS minority ICRF absorption scheme.

Theoretical studies with advanced ray tracing, full-wave, and Fokker Planck simulation tools (GENRAY, TORIC, TORLH, and CQL3D) will be presented for a range of configurations.

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