Application of Very High Harmonic Fast Waves for Off-Axis Current Drive in the DIII-D and FNSF-AT Tokamaks

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Abstract. Fast waves at frequencies far above the ion cyclotron frequency and approaching the lower hybrid frequency (also called "helicons" or "whistlers") have application to off-axis current drive in tokamaks with high electron beta. The high frequency causes the whistler-like behavior of the wave power nearly following field lines, but with a small radial component, so the waves spiral slowly toward the plasma center. The high frequency also contributes to strong damping. Modeling predicts robust off-axis current drive with good efficiency compared to alternatives in high performance discharges in DIII-D and Fusion Nuclear Science Facility (FNSF) when the electron beta is above about 1.8%. Detailed analysis of ray behavior shows that ray trajectories and damping are deterministic (that is, not strongly affected by plasma profiles or initial ray conditions), unlike the chaotic ray behavior in lower frequency fast wave experiments. Current drive was found to not be sensitive to the launched value of the parallel index of refraction $n_{\|}$, so wave accessibility issues can be reduced. Use of a traveling wave antenna provides a very narrow $n_{\|}$ spectrum, which also helps avoid accessibility problems.

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