HIGH EFFICIENCY OFF-AXIS CURRENT DRIVE BY HIGH FREQUENCY FAST WAVES

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Recent modeling work at the Kurchatov Institute has indicated that current drive (CD) can be done off-axis with high efficiency by using very high harmonic fast waves ("helicons" or "whistlers"), in the frequency range around 500 MHz for DIII-D. The modeling, corroborated and extended by calculations at General Atomics, indicates that plasmas with high electron beta are needed in order for the CD to take place off-axis, making DIII-D a highly suitable test vehicle for this process because of the availability of large electron heating power by the electron cyclotron heating system. This CD would contribute to the DIII-D program by providing greater flexibility in the control of the current profile for high performance Advanced Tokamak discharges. Further calculations show that this CD technique could also provide a means to support the desired current profile in the Fusion Nuclear Science Facility (FNSF). In FNSF the higher efficiency could help to alleviate the tension between high density operation, to improve the divertor performance, and low density operation, to reduce the recirculating power by increasing the CD effectiveness.

The calculations show that the driven current is not very sensitive to the launched value of $n_{||}$, and this can be understood from examination of the evolution of $n_{||}$ as the waves propagate in the plasma. Because of this insensitivity, relatively large values (~3) of $n_{||}$ can be launched, thereby avoiding some of the problems with mode conversion in the boundary found in some previous experiments. Use of a traveling wave antenna provides a very narrow spectrum, which also helps avoid mode conversion, and this antenna technology is well suited to the relatively weak coupling in an H-mode scenario with a large gap between the plasma and the antenna. We anticipate installing a traveling wave antenna and a 500 MHz 1 MW klystron and testing this concept in DIII-D in 2016.

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