Fast Wave Antenna Loading in Advanced Tokamak Plasmas in DIII-D*

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DIII-D is equipped with three fast wave current drive (FWCD) systems, one of which is capable of generating up to 2.0 MW at 60 MHz and the other two being capable of operation in a range of frequencies from 60–120 MHz (1.0 MW from each transmitter at 120 MHz). Each transmitter drives a four-element phased array antenna.

Previous work has shown that the FWCD systems drive current consistent with theory in ELMing H-mode plasmas [1,2] even under conditions of low single-pass absorption, provided that the edge density profile satisfies certain conditions. The same edge conditions that maximize the current drive efficiency tend to minimize the resistive loading on the antennas (maximize the antenna voltage for a given power level.) This means that the best regimes for current drive tend to have the lowest antenna power limits. The goal of the present work is to measure the antenna loading in regimes of Advanced Tokamak (AT) interest to estimate the maximum power that may be coupled reliably to those discharges with the present antennas. Previous work indicated that the power limit in ELMing H-modes was due to a maximum electric field in the antenna structures. The power limit may therefore be increased by raising the resistive antenna loading, if this can be achieved without lowering the limiting electric field value. This can be done on the higher frequency arrays by increasing the rf frequency from the 83 MHz used previously to near 120 MHz, because the current straps on those antennas are self-resonant near 120 MHz. The present experiments are designed to verify the improved loading near 120 MHz by comparing the loading on the 60 MHz and 117.6 MHz antennas in plasmas of AT interest. The resistive antenna loading was measured on both arrays as a function of the separatrix/antenna distance (the "outer gap"). The loading presented to the feedlines was effectively about twice as high on the 117.6 MHz antenna as that of the 60 MHz antenna. The exponential decay of the resistive loading as the gap is increased compares well with a simple model. Experiments extending the coupled power on the 117.6 MHz antenna towards the present transmitter limit of 1.0 MW are planned to quantify the improvement.

[1] R.I. Pinsker, *et al.*, Proc. of 25th Euro. Conf. on Controlled Fusion and Plasma Phys., Prague, 1998 (European Physical Society) Vol. **22C**, p. 1406.
[2] C.C. Petty, *et al.*, Nucl. Fusion **39**, 1421 (1999).

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*Work supported by the U.S. Department of Energy under Contracts DE-FC02-04ER54698, DE-AC05-00OR22725, and DE-AC02-76CH03073.