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A.P. Biddle and J.C. Sprott

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High Power Heating and Propagation Using Fast Magnetosonic Waves in the Wisconsin Tokapole II.*

A.P. BIDDLE and J.C. SPROTT, University of Wisconsin, Madison, WI, USA.

Tokapole II is a toroidal octupole with a major radius of 50 cm, a 44 cm square cross section, and a 4 kG toroidal field. The resulting topology is that of a tokamak with four poloidal divertors. The ohmic heating current of 40 kA with central density 10^{13} cm^{-3} has a pulse length ~4 ms. The current channel is approximately square with a uniform plasma density which falls rapidly outside the channel.

The pulsed rf source is a two tube modified tuned-plate tuned-grid push-pull self excited oscillator with 1.1 ms square pulse length. It is capable of driving very low impedance loads at 2 MW levels. The tank circuit is the frequency determining element. The intrim launching structure is one turn loop located outside the vacuum tank which views the plasma through a 9 cm diameter 1.3 cm thick Macor port. This coil also is the tank circuit inductor, which eliminates losses and detuning of matching circuits. It also allows the oscillator frequency to shift over a limited range, ~5%, to follow both bulk plasma reactance and eigenmode changes, giving a limited tracking capability.

The normal experiment is run at the 250 kW level in hydrogen with a 5% doping of helium to enable ion temperature measurements from Doppler broadening of the 4686 Angstrom line. The $\omega=2\omega_{ci}$ used for the fast wave generation coincides with the machines magnetic axis. Doubling of the ion temperature has been achieved with the ions accounting for ~15% of the rf input power deposited in the plasma. The remainder is evidently refracted by the thick evanescent region to the walls. A sharp increase in impurity radiation which scales with rf power roughly accounts for the balance of the rf power. The ion temperature decays after the rf pulse ends to the unperturbed level in a time roughly that of the energy confinement time, though impurity radiation persists much longer. No significant changes occur in the gross parameters of the discharge, suggesting it is limited by factors other than impurities. No strong dependence has been observed on the exciting frequency.

Rf spatial field measurements with an inserted probe have been made. They are in good agreement with a two step density profile in which a sharp edge separates a uniform core density sufficient for propagation from that of an evanescent region, similar in concept to a dielectric waveguide.

A new antenna which will have a continuously variable spacing from the plasma and a 2 MW capability is being installed to increase core coupling and decrease impurity radiation. The increase in ion temperature is expected to be ultimately limited by the low poloidal flux available.

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