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Power Balance Measurements in Tokapole II Discharges.* R.J. GROEBNER, R.N. DEXTER, and J.C. SPROTT, University of Wisconsin, Madison, WI, USA.

We present the results of the initial power balance studies of Tokapole II discharges. Tokapole II is an octupole with a strong toroidal field and ohmic heating. The magnetic configuration of toroidal plasma discharges in this device is that of a tokamak with a four-null poloidal divertor. Typical discharge characteristics are $B_T \simeq 4kG$, $R=50cm$, $I_p \simeq 40kA$, $n_e \simeq 8\times10^{12}$ cm^{-3}, $T_e \simeq 100eV$, $T_i \simeq 20eV$, $\beta \simeq 0.2\%$, $Z_{eff} \simeq 1.5-2.5$. The ohmic heating voltage pulse shape is a quarter sine wave with a duration of 2.8 msec.

For the data presented, the plasma current was measured with a Rogowskii coil and the toroidal electric field with an electric field probe. The latter is a one turn loop, inserted in the plasma, which measures the time rate of change of the poloidal magnetic flux. Detailed spatial measurements of the ohmic input power can be and are being made on Tokapole II discharges. The ohmic input power increases rapidly to about 400kW at 1.5 msec and then drops rapidly. At the peak of the input power, the plasma current has started to decrease and the inductive voltage from the decaying current actually provides most of the toroidal electric field at this time. A 40 GHz microwave interferometer shows that the line-averaged electron density rises quickly to about 8×10^{12} cm^{-3} and is relatively constant during most of the discharge.

An absolutely calibrated 1-meter Seya-Namioka vacuum ultraviolet monochromator is used to observe the time history of resonance lines of oxygen III through VI. We have used a computer code in which $T_e(t)$ is one of the input parameters to simulate the ionization of the oxygen ions; by comparing the times of the ionization peaks in the code to the observed times, we infer that T_e reaches 80-100eV. T_i was obtained from the Doppler broadening of He II λ4686 Å, after a small amount of helium was added to the plasma.

A 1/2-meter Seya, equipped with a microchannel plate, simultaneously displays all lines in the 500-1250 Å region of the VUV spectrum. The anode current of the microchannel plate is roughly proportional to the power radiated in this spectral region. This signal has been calibrated by comparing it to power measurements performed with the 1-m Seya in the same region. The 1/2-m Seya indicates that the radiated power is about 60kW during most of the discharge. Transmitting filters, with passbands in various regions of the VUV and SXR spectral domains, have also been used with a channeltron detector to gain coarse information on the spectral distribution of radiated power. These filters can also be used to provide spatial information on the radiated power.

Using the definition $\tau_E = U/(P_{in} - dU/dt)$ where P_{in} is the ohmic input power and $U = 3/2k\,(n_e T_e + n_i T_i)$ is the plasma stored energy, we find that τ_E is about 300 μsec. Within the margins of error, the radiated power is about 15-25% of the input power and is not sufficient to account for the power loss. Further analysis of the effects of the impurities will be presented.

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