§64. Wall Conditioning for Long Discharges in ATF

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The ATF is a 12-field-period torsatron with a major radius of 2.1m and an average minor radius of 0.27m. The coil system has been designed to have the capability for steady-state operation at 1T. However, operation with long pulses is limited to low magnetic field because of uncooled components in the bus work. This dictated the use of second harmonic electron cyclotron heating (ECH) at 28 GHz or 35 GHz, which correspond to an operating field of 0.5 T and 0.63 T, respectively. Each ECH system is rated at 200 kW steady state. The maximum plasma density was determined by the cut-off condition for X-mode ($< 4.8 \times 10^{18}$ m^{-3} for 28 GHz and 7.5×10^{18} m^{-3} for 35 GHz). Helium was the usual working gas since recycling control is easier than with hydrogen.

Although wall conditioning is a prerequisite for obtaining hot plasmas, the conditioning usually performed in the interval between shots does not seem to be well adapted for the long-pulse discharge. Real-time boronization was attempted using a solid target of boron-doped carbon. The 20% boron-doped (by weight) carbon-composite head had dimension of 30 mm diameter x 30 mm. This solid target is expected to be small enough not to act as a substantial limiter. Isotropic graphite is connected to the boron-doped head for protection of the metal support structure. This system was set on the top of the torus and the operated magnetic field was directed clockwise during this experimental campaign.

Solid-target boronization was attempted in 30 to 60-second discharges. Figure 1 shows impurity line emission for three cases with different positions of the solid target. The positions Z = 33 cm and 23 cm correspond to target positions of r = 0.95 and r = 0.7, respectively, where r is the normalized minor radius. The line density was kept constant in this scan. Some reduction of oxygen is seen and deep insertion causes a small increase in carbon radiation. However, no substantial effect was obtained since the input energy to the target was insufficient to heat the surface to the 1500°C temperature that is necessary for evaporation of boron. Although the effect of real-time boronization was obscure during this experimental campaign, the long-pulse discharge itself provided very effective wall conditioning. Long-pulse operation, consisting typically of 20 60s-long shots a day, reduced the impurity-gas levels within a few days after an opening to the lowest level that had been achieved with extensive gettering.

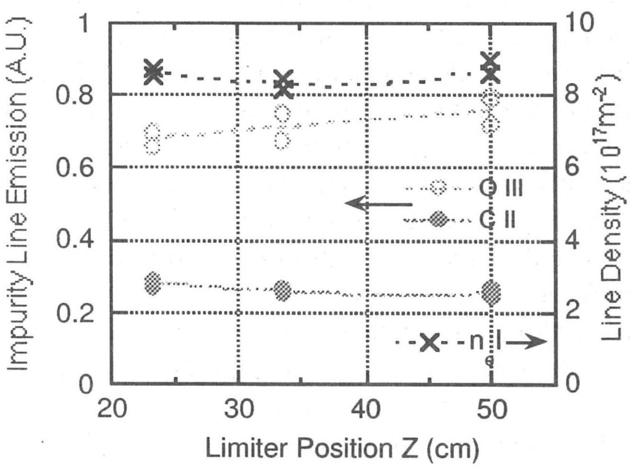

Fig.1 Dependence of impurity line emission on the position of the boron-doped solid target. The last closed flux surface is located at Z = 38 cm.