Plasma Current Start-up by ECH on LATE

H.Tanaka, K.Katsuura, M.Konno, K.Higaki, T.Yoshinaga,
H.Igami, M.Uchida, T.Maekawa

Graduate School of Energy Science, Kyoto University,
Sakyo-ku, Kitashirakawa Oiwake-cho, Kyoto 606-8502, Japan

Experiments on start-up and formation of spherical tokamak (ST) plasmas without Ohmic heating (OH) have been carried out by injecting the microwave power in the electron cyclotron range of frequency in the LATE device. The vacuum chamber is a SUS cylinder with an inner diameter of 100 cm and a height of 100 cm. The diameter of the center stack is 11.4 cm and there is no central solenoid for OH. Toroidal coil current can be served up to 180 kAT for more than 0.1 s by a regulated power supply. There are 3 sets of vertical field coils whose currents are controlled by preprogramming. Two microwave power sources, a magnetron (2.45 GHz, $\leq$ 5 kW, CW) and a klystron (2 GHz, $\leq$ 350 kW, $\leq$ 0.1 s), are used respectively. The microwaves are injected obliquely to the toroidal field from the outboard side such as the electric field vector is on the equatorial plane. The plasma current is estimated from the 15 flux loop coils.

The initial plasma is produced by the fundamental electron cyclotron resonance with a weak vertical field (5 $\sim$ 10 G at R $\sim$ 20 cm). As increasing the strength of the vertical field gradually over the time duration $\sim$ 0.06 s and keeping it at a constant value, the plasma current increases and becomes in a steady state. So far, a plasma current of 5 kA is generated by injecting the microwave power of 45 kW at 2 GHz. The figure is the contour map of the poloidal flux in such a discharge reconstructed from the magnetic measurements and shows that the closed flux surfaces are produced. The outer most flux surface has the aspect ratio $\sim$ 1.4 and the elongation $\sim$ 1.2. The electron density estimated by a 70 GHz microwave interferometer along the vertical cord at R = 27 cm is $\sim 10^{11}$ cm^{-3}, which is about twice the cutoff density. This fact suggests that the electron Bernstein waves may be mode converted by the O-X-B process, heat the plasma and drive the plasma current. The plasma current increases as the microwave power and the strength of the vertical field are increased. The plasma current is proportional linearly to the vertical field strength and the relation is roughly consistent with a simple ST equilibrium model.