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Microwave Spherical Torus Experiment in the LATE Device

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The main objective of the Low Aspect ratio Torus Experiments (LATE) device at Kyoto University is to demonstrate the formation of Spherical Torus (ST) plasma by microwave power at electron cyclotron frequency range without the center solenoid. The solenoid-free startup is considered to be crucial for the future ST plant since ST has only a limited space in the center column of the device to keep the advantage of low aspect ratio geometry. ECH/ECCD by microwave injection from a small launcher remote from the plasma is quite attractive from the technical point of view for the start-up in future fusion grade devices.

The vacuum vessel of the LATE device is a cylinder with a diameter of 1m and a height of 1m. Experiments are carried out with three 2.45GHz long pulse magnetrons (two 5kW CW magnetrons and a 20kW 2-second magnetron), and a 5GHz-130kW-70ms Klystron.

By injecting a 5GHz microwave power of 130kW, breakdown takes place near the fundamental EC resonance layer and an initial plasma current starts to flow. The initial closed flux surface is produced via a current jump, in which the plasma current is spontaneously increased to 5 kA under a steady vertical field of Bv = 50 G (at R = 25cm). Subsequently, the plasma current is ramped up with the increase of equilibrium vertical field strength, and reaches up to 15 kA at Bv = 160 G.

During the plasma current ramp-up, bremsstrahlung hard X-ray spectra show that a current carrying electron tail up to ~ 100 keV is being developed. On the other hand, magnetic measurements show that a reverse voltage is exerted on the plasma center due to the self-induction of plasma current. The electron tail is developed against this reverse voltage. The current ramp-up may be ascribed to ECCD by high-N// electron Bernstein waves which can provide a large parallel momentum to resonant electrons enough to develop the current carrying electron tail even in the reverse electric field.