Contribution ID: **164** Type: **Poster**

Plasma Start-up Experiments on the TST-2 Spherical Tokamak

Wednesday, 19 October 2016 14:00 (4h 45m)

Plasma start-up without a large flux swing central solenoid (CS) is one of critical issues in fusion research. In the TST-2 spherical tokamak (ST), non-inductive start-up by waves in the lower-hybrid frequency range (200 MHz) has been studied using three types of antennas. Presently a capacitively-coupled combline (CCC) antenna is used. The maximum sustained plasma current was increased from 16 kA to 25 kA by changing several conditions, such as a higher magnetic field strength and the installation of top and bottom limiters. This demonstrates that lower-hybrid wave (LHW) can be a powerful tool to start-up an ST plasma. Experiments suggested that the wave power is deposited mainly on the peripheral region. In order to improve the wave accessibility and to increase the signal pass absorption, we are preparing for a top-launch CCC antenna, by which a good core power deposition is expected due to the upshift of the n_parallel during the propagation. In addition to the non-inductive start-up experiments, AC Ohmic heating experiments with frequencies up to 10 kHz were performed. This is the first systematic experiments on the AC CS operation in tokamaks, and it can be an option to start-up an ST reactor with a small flux swing. It was demonstrated that it can drive a current with finite DC components (1.9 kA with a |flux swing| < 2 mVs) when the vertical field is applied. The ratio of the DC current to the flux swing is comparable to those in TST-2 standard Ohmic discharges. Furthermore, the plasma current can be ramped-up by superposing the AC Ohmic heating on a plasma sustained by EC wave power alone. The time averaged visible image of the plasma in this phase indicates the formation of an ST configuration. The minimum loop voltage for the breakdown was +/-0.5 V, which corresponds to +/-0.6 V/m at the inboard limiter. This value indicates potential application to superconducting CSs.

Paper Number

EX/P4-48

Country or International Organization

Japan

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Session Classification: Poster 4

Track Classification: EXW - Magnetic Confinement Experiments: Wave–plasma interactions; current drive; heating; energetic particles