Topical Area: A.1

RF Start-up and Sustainment Experiments on TST-2@K

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Because of the tight space on the inboard side of the torus, central solenoidless plasma start-up and sustainment are crucial issues for a spherical tokamak reactor. Two scenarios have been studied on TST-2@K (TST-2 at Kyushu Univ.). The first is utilization of loop voltage induced by time-varying vertical field, and the second is utilization of spontaneous current generation under high power RF injection. The TST-2 device was moved to Kyushu Univ. temporarily, and plasma heating and current drive experiments were carried out using high power RF sources (8.2 GHz /200 kW), which are normally used for LHCD experiments on TRIAM 1-M. The wave was launched from 8 horn antennas located on the low field side of the torus. The polarization was nearly X-mode, and the launched power was in the range 100-170 kW. In the first scenario, plasma currents of up to 10 kA were generated. It was found that the plasma current starts even when the vertical field is negative (opposite to that required for equilibrium), so a field null is not necessary for discharge initiation in the presence of intense RF power. In the second scenario, steady state discharges with a plasma current of 4 kA were achieved. The line integrated density was $3x10^{17}$ m^{-2}. The discharge duration (up to 0.3 sec) was limited by the toroidal field, and the plasma disappeared when the fundamental resonance layer moved out of the vacuum vessel. An electron temperature of 160 eV was derived from soft X-ray pulse height analysis, and the soft X-ray flux was consistent with bremsstrahlung emission from the bulk plasma. Magnetic analysis revealed that the current centroid is located near the outboard limiter, with a significant fraction of the current flowing in the open field region. Discharges were insensitive to the vertical field or RF power ramp-up (or ramp-down), but in some cases plasma showed spontaneous transitions. Possible mechanisms of current sustainment were investigated, but not resolved. Bootstrap current and negative Pfirsch-Schlüter current have significant contributions, while ECCD probably do not. Although experimental results suggest no or small mode conversion efficiency for EBW, we cannot exclude EBWCD effect because of the large injected power.