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Advance in heating and current drive by RF waves towards long-pulse operation on EAST

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There are two lower hybrid current drive (LHCD) systems in EAST with the operating frequencies at 2.45 GHz (source power of 4 MW) and 4.6 GHz (source power of 6 MW), which is the main electron heating and current drive (H&CD) tool. Hot spots issue and anomalous loss of LHCD efficiency at high density are the big challenges in long-pulse and high betap operation with high LH power. By upgrading the guard limiters, the power handling capability of LH systems are improved and the 4.6 GHz LH system can operate with power > 2.5 MW routinely. With lithium wall conditioning and favourable magnetic field, the interactions of the LH waves with the scrape off layer (SOL) plasmas are mitigated, indicated by the frequency spectral measurements. As a result, good LHCD efficiency ˜ 0.9 *10ˆ19 A/W/m2 is obtained even when density increased to 5.4 * 10ˆ19 /m3 in H-mode plasmas (the Greenwald density fraction ne / nG ˜ 0.75). In order to decrease the interactions of LH antenna with SOL plasmas, a new passive-active-multijunction (PAM) launcher has been developed for the 2.45 GHz system, and good coupling with reflection coefficient ˜ 3% has been demonstrated with the plasma-antenna distance up to 11 cm. High electron temperature Te >12 keV plasmas measured by Thomson scattering is produced by injecting 1.4 MW electron cyclotron (EC) waves into the centre of plasmas sustained by 2.3 MW LH waves. With these improvement, significant advance has been achieved with RF waves, including long-pulse H-mode operation up to 312 s with 1.8 MW 4.6 GHz LH power, 1.6 MW EC power and 1.2 MW ion cyclotron (IC) power, long-pulse I-mode operation up to 1056 s sustained by moderate 4.6 GHz power ˜ 1.05 MW and EC power ˜ 0.55 MW. In order to enhance the H&CD capability, the 2.45 GHz system will be replaced by a new 4.6 GHz / 4 MW system with a PAM launcher, which is under construction.

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