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High-power and long-pulse operation of ICRH system in EAST tokamak

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Ion cyclotron resonance heating (ICRH) has been a dependable tool for sturdy and long pulse plasma heating with high RF power of several megawatts. However, low ICRH antenna coupling efficiency, high temperature of antenna limiter and Faraday Screen (FS) and MHD instabilities have limited high-power and long-pulse operation of the system. To increase ICRH antenna coupling efficiency and decrease the voltage in transmission line, a new kind of ICRH antenna with smaller k_(//) had been designed and operated[1]. The coupling loading of the new ICRH antenna is ~2–3 times greater than old ICRH antenna and the efficient ion and electron heating had been achieved. To operate the ICRH antenna in a better heating state and produce relatively low impurities, the antenna strap probe based diagnostic system had been designed to monitor antenna phasing, and the power and phase feedback control system had been used to control antenna phasing[2, 3]. To decrease the heat load in the front face of the ICRH antenna, new kind of antenna limiter had been designed with CFC material, which has better water cooling as the thickness of the antenna limiter with CFC material is thinner than before. And this limiter design allows the antenna straps closer to the plasma, which also could improve the antenna coupling efficiency. New kind of FS with optimized cooling channels had been designed and used, which could make the temperature of ICRH antenna FS lower than 400° in the pulse of 200 s and the power of 1 MW operation [4]. In order to make the ICRH system working sturdy during the confined mode transition and edge localized modes activity, the load tolerant matching network have been designed and operated. By keeping a low reflection ratio in the network for a wide range of resistance, this matching network could allow sturdy high-power and long-pulse operations without fast impedance matching [5, 6]. For long-pulse and high-power operation, we had achieved 1.5 MW/41 s and 1.1 MW/61 s with one ICRH antenna in the high poloidal beta plasma discharge. ICRH power up to 1.8 MW is routinely coupled to the plasma for pulse lengths up to 21 s and 0.6 MW for 300 seconds.

References

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Primary author: LIU, Lunan (ASIPP)

Co-authors: ZHANG, Xinjun (Institute of Plasma Physics Chinese Academy of Sciences (ASIPP)); Ms QIN, Chengming (ASIPP); Mr ZHANG, Wei (ASIPP)

Presenter: LIU, Lunan (ASIPP)

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