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Recent progress of the ECRH system and related physics experiments on J-TEXT

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As an attractive auxiliary heating method, electron cyclotron resonance heating (ECRH) has been widely used in the present magnetic confinement fusion devices and will be one of the major heating methods for the future devices such as ITER, etc.

J-TEXT is a middle size tokamak with a major radius of 1.05m and a minor radius of 0.25~0.29m. The toroidal field, the plasma current and the plasma density for normal discharge are ~2T, ~200kA and (1~10) × $10^{19}$$m^{-3}$, respectively.[1] The J-TEXT tokamak obtained its first plasma in 2006. However, it had been operated only with the ohmic heating for a long time. This greatly limits the operation range of J-TEXT, and also the related physics experimental research.

To improve the plasma parameters of J-TEXT, we started to develop a 105GHz/500kW/1s ECRH system for the J-TEXT tokamak since 2017. Considering the toroidal field of the J-TEXT tokamak, this system mainly works at the second extraordinary mode. In 2019, the first plasma heating experiment with the ECRH system has been successfully carried out on J-TEXT. Currently, it has been used as a regular auxiliary heating system on J-TEXT and the power of more than 400kW has been successfully injected into the plasma, increasing the core electron temperature from 0.9keV to around 1.5keV. Figure 1 gives the layout of the ECRH system and the heating effect of a typical discharge with 350kW ECRH power injected into the plasma.

Up to now, several physics experiments such as plasma heating, assisted start-up, current drive, plasma disruption, magnetohydrodynamic (MHD) instabilities control and electron thermal transport have been carried out with this system. [2-5] In addition, another 500kW ECRH system has been under development since 2021, and the commissioning of the new system will be finished in 2022. In this condition, the operation range of J-TEXT will be further extended. [6]

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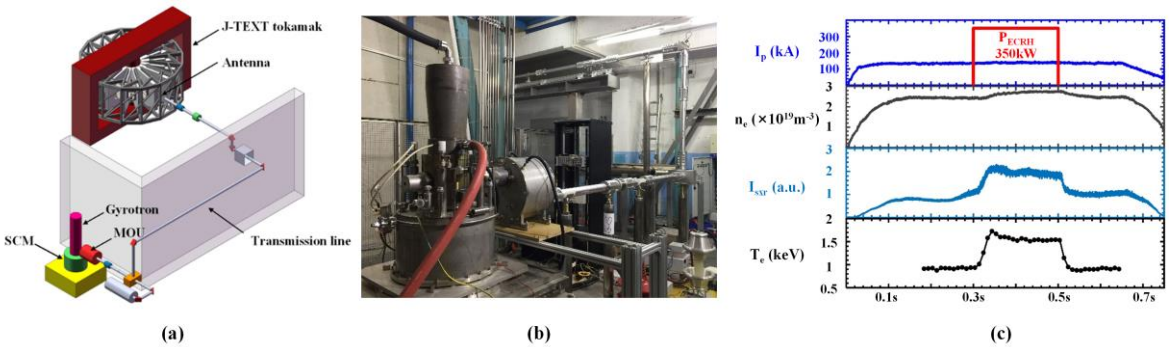

Figure 1. (*a*) Layout of the 105GHz/500kW/1s ECRH system on J-TEXT. (*b*) Photo of the gyrotron and part of the transmission line of the ECRH system. (*c*) A typical discharge with 350kW ECRH power.