Development of Over 1 MW and Multi-Frequency Gyrotrons for Present ST and Fusion Experiments in University of Tsukuba

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The development of wide frequency range from 14 to 300 GHz of high power mega-watt gyrotron for fusion is in progress in University of Tsukuba. The strong development activity was carried out in collaboration with JAEA, NIFS, TETD and universities. Over-1 MW dual frequency gyrotron of new frequency range (14 - 35 GHz) has been developed for EC/EBW H&CD for GAMMA 10/PDX, QUEST, NSTX-U and Heliotron J. Output power of 1.25 MW at 28 GHz and estimated oscillation power of 1.2 MW at 35.45 GHz from the same tube have been achieved with the cathode angle improvement and two frequency window. This is the first demonstration of the over 1 MW dual-frequency operations in lower frequency, which contributes to the technology of wide band multi-frequency/multi-MW tube. The output power of 600 kW for 2 s at 28 GHz is also demonstrated. It is applied to the QUEST and has resulted higher EC-driven current than ever. Further development of dual-frequency gyrotron with 2 MW 3 s at 28 GHz, especially designed for G-10/PDX and NSTX, 0.4 MW-CW for QUEST, and power exceeding 1 MW for 3 s at 34.8 GHz for Heliotron J have been started. As for higher frequency range, a new frequency of 154 GHz has been successfully developed, which delivered 1.16 MW for 1 s and the total power of 4.4 MW to LHD plasma with other three 77 GHz tubes, which extended the LHD plasma to high T_e region. All these gyrotron performances are new records in each frequency range. The sub-THz gyrotron development is also just begun in collaboration with JAEA for Demo-Reactor ECH system. In the preliminary experiment, the 520 kW power was obtained at 299.85 GHz.