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## FTP/P1-20: Development of MW Gyrotrons for Fusion Devices by University of Tsukuba

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Over-1 MW power gyrotrons for ECH have been developed in the joint program of NIFS and University of Tsukuba. The obtained maximum outputs are 1.9 MW for 0.1 s on the 77 GHz LHD tube and 1.0 MW for 1 ms on the 28 GHz one, which are the new records in these frequency ranges. In long pulse operation, 300 kW for 40 min at 77 GHz and 540 kW for 2 s at 28 GHz were achieved. Three 77 GHz gyrotrons have already been installed and operated stably in LHD. More than 3.4 MW has been injected into LHD plasma contributing to producing the electron temperature  $T_e$  of 20 keV. A new program of 154 GHz 1 MW development has started for high density plasma heating in LHD and the first tube has been fabricated. A 28 GHz gyrotron is also required at QUEST in Kyushu University, where 0.4 MW continuous wave (CW) one is needed. A few sec. with multi-MW gyrotron is useful for novel Electron Bernstein Wave (EBW) heating system of NSTX in PPPL. Based on the first 28 GHz 1 MW tube results, the design of the new 28 GHz tube has progressed, which satisfies both requirements. These lower frequency tubes like 77 GHz or 28 GHz one are also important for advanced magnetic fusion devices, which use the EBW heating / current drive.

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