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ITR/1-4Ra: Development in Russia of Megawatt Power Gyrotrons for Fusion

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During last years several new gyrotrons were designed and tested in Russia. Main efforts were spent for development 170GHz/1MW/50%/CW gyrotron for ITER and multifrequency gyrotrons. Additionally other new gyrotrons were shipped and installed at running plasma installations. The industrial production prototypes of the ITER gyrotron were tested at power 1.0 MW in 400...500 second pulses and 0.8-0.9 MW in 1000 second pulses. For 1 MW power regime the gyrotron efficiency is 55%. The last gyrotron versions operate in LHe-free magnet. It is important that two last gyrotrons (V-10 and V-11) demonstrate very similar output parameters. Time traces for the main gyrotron parameters are stable and confirm possibility of the gyrotron operation even in longer pulses. Detail analysis of the test results showed that a slightly modified ITER gyrotron prototype is capable to operate at power 1.2 MW. First tests of the modified tube are rather encouraging: microwave power 1.2 MW at MOU output was demonstrated in 100 second pulses with efficiency of 53%. Additionally two gyrotron models with TE_{28,12} operating mode were tested in short-pulse experiments.

The use of step-tunable gyrotrons can greatly enhance performance of ECRH/ECCD systems due to larger accessible radial range, possible replacement of steerable antennas, higher CD efficiency for NTM stabilization. The main problems in development of multifrequency gyrotrons are to provide: efficient gyrotron operation at different modes, efficient conversion of the modes into a Gaussian beam, reliable operation of broadband or tuneable window. Considering this three key problems one can say that first two of them are solved, but realization of a CVD diamond window for a megawatt power level multi-frequency gyrotron met real difficulties. Now a new tuneable window concept is under consideration.

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