

Experimental Results of a PLL-stabilized MW-Class 140 GHz Gyrotron at W7-X

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ABSTRACT

At Wendelstein 7-X (W7-X), one of the MW-class Electron Cyclotron Resonance Heating (ECRH) gyrotrons is used for the Collective Thomson Scattering (CTS) diagnostic [1]. To improve the CTS diagnostic, a frequency stabilization system for MW-class gyrotrons with diode-type electron gun will be implemented. Furthermore, such a frequency stabilization would also allow exploring the possibility to directly heat ions in the fusion plasma with beat waves generated from two gyrotrons.

Continuing the work from [2], a new digital PLL system was designed and implemented at W7-X for a 140 GHz gyrotron from manufacturer CPI [3]. The gyrotron output frequency can be controlled with the accelerating voltage, which is applied between the anode and cathode of the gyrotron diode-type Magnetron Injection Gun. For the PLL system, the accelerating voltage is varied through the body voltage power supply [4]. Experiments at different pulse lengths and operating points were conducted with the new PLL system at 140 GHz.

The measurements from the experiments show a significant improvement of the gyrotron frequency stability. While for the free-running case, no clear peak was present at a specific frequency in the frequency spectrum, the experiments with the PLL system showed a clear peak at the desired frequency and a full -20 dB linewidth of below 20 kHz was measured. The most significant sidebands appear at harmonics of 3.2 kHz and 135 kHz from the main peak. These frequencies are introduced by the noise of the semiconductor PSM cathode power supply, where they were also measured. Future investigations will be conducted to reduce the noise of the cathode power supply on the accelerating voltage.

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References

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