Status of the Gyrotron Multistage Depressed Collector Development at Karlsruhe Institute of Technology

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ABSTRACT

Gyrotrons are the high-power RF sources used for Electron Cyclotron Resonance Heating (ECRH) and Current Drive (ECCD) in fusion plasma experiments and future power plants. For example ten 140 GHz, 1 MW continuous wave (CW) gyrotrons are employed as the only heating sources in the Wendelstein 7-X stellarator [1], while 170 GHz, 1 MW, CW gyrotrons [2] are developed for the ITER project. The future DEMOnstration power plant requires advanced gyrotrons with even higher frequency and power. For DEMO, gyrotron efficiency is vital. Nowadays gyrotrons with single-stage depressed collector have approximately 50 % overall efficiency. The DEMO power plant requires gyrotron efficiency of much higher than 60 %. Therefore, a Multistage Depressed Collector (MDC) is the key component for the improvement of gyrotron efficiency.

However, there is no MDC for gyrotrons yet in the world. The MDC schemes for other kinds of microwave tubes are not applicable in gyrotrons, because gyrotrons have a relatively strong magnetic field in the collector, where the field confines the annular spent electron beam. There are two concepts for gyrotron MDCs. The first is the axisymmetric concept, which relies on demagnetization combined with non-adiabatic magnetic transitions [3]. The second concept uses the E×B drift to sort electrons [4]. Both have been systematically investigated via simulations at KIT. Compared to the axisymmetric concept, the E×B concept is more efficient and theoretically more reliable, while less sensible to various perturbations [5]. There are many variants to create an E×B drift. The most promising approach is to produce an azimuthal electric field using helical electrodes [6].

In this talk, the status of the MDC research at KIT will be presented. The most important results of the comprehensive investigations will be discussed. A very preliminary mechanical design of the most promising approach will be proposed.

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