Overview of KIT activities on high power, high frequency gyrotron development and the role of the new FULGOR teststand at KIT

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Abstract: For a future DEMOnstration fusion power plant two challenging trends with respect to gyrotron features are recognized: (a) the operating frequency will be above 200 GHz and (b) the requested total efficiency of the gyrotron should be as high as possible.

ECRH systems for future plants (DEMO) or Fusion Power Plants (FPP) will most probably require multi-megawatt and continuous wave gyrotrons which are able to oscillate at a frequency significantly above 200 GHz. The coaxial cavity technology which is under investigation and development at KIT since several years, seems to have the optimum properties to fulfill the requirements towards sub-THz operation in the MW output power regime. To benefit from these advantages and to profit from the existing experience on this technology the modular 2 MW 170 GHz gyrotron has been taken as a starting point for a 170/204/238 GHz multi-frequency gyrotron design study. Recent activities for improvement of the performance of this gyrotron and preparations for long pulse operation will be shown. In a first step we aim at ~ 100 ms operation, in a second step, with the tube being equipped with an improved cooling system, 1 s operation is envisaged.

KIT is currently constructing a new gyrotron teststand, FULGOR, having specific features, such as: 10 MW electrical input power in CW, magnetic field up to 10.5 T with 261 mm warm bore hole of the SCM and several voltage taps from the high-voltage DC power supply. The CW HV Power supply (120 kV, 130 A) has already been delivered and accepted, a dry superconducting magnet will be delivered in 2019.

For the first time it will be possible with FULGOR to test Multistage Depressed Collector (MDC) gyrotrons which are supposed to increase the overall efficiency from 50 % (state of the art) to 60 % or even higher. There are two concepts for gyrotron MDC: a axisymmetric concept, which relies on the demagnetization combined with non-adiabatic magnetic transitions and a concept based on E×B drifts to sort electrons. First considerations of a proof-of-principle design for the ExB drift concept will be shown.

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