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New trends of gyrotron development at KIT: An overview on recent investigations

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Electron-Cyclotron-Resonance Heating and Current Drive (ECRH&CD) is one of the preferable auxiliary heating systems for magnetically confined nuclear fusion plasmas. ECRH&CD is widely used in tokamaks and helical machines for start-up and plasma control.

Since many years KIT is strongly involved in the development of high power gyrotrons for use in ECRH. KIT is pursuing two development lines: (i) the conventional, hollow cavity gyrotron and (ii) the coaxial cavity gyrotron. In the frequency range up to 170 GHz the conventional 1 MW gyrotron is the state-of-the-art for CW operation.

KIT is also pushing conventional cavity gyrotrons from 1 MW to 1.5 MW in a common project with IPP Greifswald. In this contribution we will report on first investigations towards a 1.5 MW, 140 GHz gyrotron.

Coaxial cavity technology has the advantage of higher power capability, in particular at higher frequency.

A short-pulse modular 170 GHz, 2 MW coaxial cavity gyrotron is being upgraded to allow pulse extension up to approximately 100 ms and up to 1 s in a second step. For this purpose the cooling performance of the main sub-components such as beam tunnel, cavity, coaxial insert and launcher has been developed and substantially improved. The design of the magnetron injection gun (MIG) has been significantly revised. In parallel an inverse MIG has been designed and manufactured. Both MIG designs satisfy the criteria for the suppression of the electron trapping mechanisms.

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. KIT is addressing these requirements by investigating both technologies for its performance at a frequency well above 200 GHz and we started careful analysis of multi-staged-depressed collectors.

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