

Power combiners and fast switches for high-power ECRH systems

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Combination of the power of two (or more) gyrotrons is an attractive feature for large ECRH systems, e.g. for ITER. Fast switching of the power from continuously operating gyrotrons between two antennas synchronous to the rotation of the magnetic islands in tokamaks maximizes the efficiency for stabilization of neoclassical tearing modes (NTMs). In general, fast switches allow sharing of the installed power between different types of launchers or different applications depending on priority.

The key component for these tasks is the high-power four-port diplexer. The power combination is performed using small frequency differences of the sources. The switching between two output channels can be controlled electronically without moving parts by a small frequency-shift keying of the gyrotron (some tens of MHz).

In the paper, diplexer designs compatible with high-power ECRH systems are discussed. A summary of numerical and experimental results obtained up to now is presented, including high-power switching and combination experiments using gyrotrons of the ECRH system for the stellarator W7-X.

Concepts for the application of high-power diplexers for the ECRH system on ITER are presented. This includes conventional (slow) switching of the power between two launchers without the need to stop the gyrotron during switching, fast switching between upper and mid-plane launcher synchronously with the rotation of the NTMs, and power combination of two gyrotrons into one line. Issues of integration and system operation with conventional gyrotrons are discussed. Future possibilities offered by phase-controlled gyrotrons like multi-beam combining and controlled scanning of the combined beam are highlighted.

At present, the development of high-power diplexers for ECRH is carried out in the frame of the virtual institute "Advanced ECRH for ITER" (collaboration between IPP Garching and Greifswald, FZK Karlsruhe, IHE Karlsruhe, IPF Stuttgart, IAP Nizhny Novgorod, and IFP Milano), which is supported by the Helmholtz-Gemeinschaft deutscher Forschungszentren. A possible collaboration with other parties is to be discussed on the workshop.