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24 GHz Microwave Mode Converter Optimized for Superconducting ECR Ion Source SECRAL

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Over-sized round waveguide with a diameter about Ø33.0 mm excited in the TE_{01} mode has been widely adopted for microwave transmission and coupling to the ECR (Electron Cyclotron Resonance) plasma with the superconducting ECR ion sources operate at 24 or 28 GHz, such as SECRAL and VENUS. In order to study the impact of different microwave modes on ECRH efficiency and especially the production of highly charged ions, a set of compact and efficient TE_{01}-HE_{11} mode conversion and coupling system applicable to 24 GHz SECRAL whose overall length is 330 mm has been designed, fabricated and tested. In this paper, a TE_{01}-HE_{11} mode conversion system is analyzed, which includes a TE_{01} round waveguide taper, a TE_{01}-TE_{11} mode converter and a TE_{11}-HE_{11} mode converter. Numerical simulation on the basis of the mode coupling theory for the purpose of structure design optimization is done by relevant MATLAB code-written and all the calculations are verified by the commercial CST Microwave Studio software. Good agreements between offline tests and calculation results have been achieved, which indicates the TE_{01}-HE_{11} converter meets the application design. The detailed results of the optimized coupling system will be presented in the paper.