DESIGN AND SIMULATION ANALYSIS OF OUTPUT SYSTEM FOR TRI-FREQUENCY GYROTRON

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ABSTRACT

The design and optimization of a comprehensive output system for tri-frequency conventional cavity gyrotron, operating at 42 GHz ($TE_{6,2}$ mode), 84 GHz ($TE_{10,4}$ mode), and 95 GHz ($TE_{12,4}$ mode), is explored in this study [1]. The design of essential components such as the nonlinear taper (NLT), quasi-optical launcher (QOL), sapphire Brewster window, and matching optics unit (MOU) are carried out. The NLT and QOL designs tailored to support each frequency are developed using our in-house code Gyrotron Design Suite (GDS-2018), ensuring precise optimization [2]. A pivotal aspect of the system is the efficient conversion of the higher-order mode RF wave into a near-Gaussian profile suitable for propagation [3]. To achieve this, a dimpled-wall QOL design is employed, and optimized using a combination of GDS-2018 and commercial code package of Launcher Optimization Tool (LOT) [2], [4]. The Gaussian content factors exceeding 99.68%, 99.85%, and 99.91% for the tri-frequency gyrotron operating at 42 GHz, 84 GHz, and 95 GHz, respectively, are obtained by simulations. Further, a common sapphire Brewster window for the tri-frequency gyrotrons, strategically designed to facilitate the efficient transport of the near-Gaussian beam towards the tokamak core [3]. The final output component comprises an MOU (consisting of two beam shaping mirrors) system post-RF window to employ synthetic Gaussian beam to ensure optimal beam quality and efficient coupling to the corrugated waveguide [5], [6]. Parameters such as beam ellipticity and astigmatism are evaluated to estimate effective beam propagation while maintaining beam quality.

References

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