Novel high power co-axial FEM based on a 2D-1D Bragg cavity

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Abstract

First measurements of microwave radiation from a coaxial Free-Electron Maser (FEM) based on a two-mirror cavity formed by a 2D Bragg (input mirror) and 1D Bragg structure (output mirror) is presented. The use of a 1D Bragg structure as an output mirror reduces the cavity Q-factor, improves the RF field profiles inside the cavity and increases the output power as compared to FEM's based solely on 2D Bragg structures. The two-mirror cavity of length 81 cm (input 2D Bragg mirror 10.4 cm, output 1D Bragg mirror 10 cm) was located inside the transmission line along the uniform part of the undulator. To drive the FEM a high current accelerator based on a magnetically insulated explosive emission carbon cathode was used. The driving electron beam voltage of 450 kV and pulse duration of ~200ns was applied and a thin (0.2cm) annular electron beam of current ~1500A and mean diameter of 7.0 cm was generated. To measure the output radiation a Ka-band receiving horn with 60dB of attenuation and calibrated microwave detectors were located at a distance of 1.5m from the output window. The total power was measured and calculated to be 60 (±10) MW corresponding to an efficiency of ~10%. Using the cut-off filters the location of the operating frequency was found to lie between 35 GHz and 39 GHz, which is in good agreement with theoretically predicted frequency of 37.3 GHz. Detailed study of the frequency spectrum and susceptibility experiments are currently under progress.