

Design of an optical system with off-axis parabolic mirrors for THz system

Friday, November 8, 2024 12:20 PM (15 minutes)

A terahertz (THz) range of an electromagnetic spectrum is considered to be used for the 6G wireless network. The important task of such networks is to design a collimated beam to increase the working distance between a source and a THz detector. One of the methods for rapid and targeted data transfer is applied directional beamforming technologies using interference of several antennas. Here for such purpose the possibility of off-axis parabolic (OAP) mirrors usage was studied.

An optical system with two OAP mirrors for collimation and focusing 140THz radiation on the pyroelectric detector surface is considered.

A Gaussian type of the radiation beam based on experimental data was generated with Ansys Zemax Optic-Studio software. As an optical system high-reflectivity OAP mirrors of aluminum with a protective coating with a diameter 50.8mm and reflected focal length 101.6mm were used. For a 140GHz source with a total power of 22mW, Gaussian initial beam profile in the emitter plane and divergence angle of 22° at 1/e² level with peak radiant intensity 0, 3W/sr, collimated beam has been received with divergence angle less than 3° and peak radiant intensity 94, 3W/sr.

The divergence angle $\theta = 2 \times d \cdot 3^\circ$ caused by diffraction was calculated by equation $d = \lambda/w[\text{rad}]$, where wavelength $\lambda = 2.14\text{mm}$ corresponds to the 140GHz frequency and $w = 25\text{mm}$ is an average mirror semidiameter. The diffraction angle value is comparable to that determined in geometric optics approximation.

This work was supported by the Volkswagen Foundation Partnerships-Cooperation Project 97738.

Type of presence

Presence online

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Session Classification: Advanced Optical Systems: From Design to Construction