Modulation Transfer Function measurements of terahertz camera

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***Abstract*-The interest towards submillimetre-wave (or THz) imaging systems arises from their ability to detect concealed weapons and explosives at a stand-off range up to ~25 meters. The authors have previously reported on the demonstration of a passive 640 GHz camera that acquires passive THz videos up to 10 frames/second [2,3]. Our present efforts are focused on the development of a new prototype with improved image sampling, angular resolution and footprint. In this paper we summarize our efforts regarding the characterization of the optical system of the demonstrator with respect to its modulation transfer function measurements.**

I. Introduction

Modulation Transfer Function (MTF) is a fundamental figure-of-merit of all image forming systems.

The MTF describes how the system can reproduce differences in contrast i.e. the spatial frequency response of the system. This means that MTF is also closely related to more commonly used Point Spread function which tells you the systems optical impulse response.

Modulation Transfer Function is a normalized Fourier transform of the line spread function (LSF) of the system [1]:

$$MTF = \frac{\left| \int_{-\infty}^{\infty} F_l(x) e^{-i\omega x} dx \right|}{\int_{-\infty}^{\infty} F_l(x) dx} \tag{1}$$

Direct measurements of the system's line spread function is very hard and in order to get reproducible results with a good signal-to-noise ratio an indirect method must be used. The line spread function can be obtained from the system's Edge Spread Function [4]. The Edge spread function itself contains information about the cameras frequency response and the center frequency of the bolometers used as detectors. When the physical size of the edge and distances to detectors are know, the diffraction from the edge is proportional to the center frequency and bandwidth of our system. Thus, the width of the edge spread can be used to infer the effective centre frequency of our nominally extremely broad band system (200 GHz – 1 THz).

The system involved in the measurements is a cryocooled linear array bolometer camera with superconducting NbN air-bridge bolometers. System is described in more detail in [2-3].

In the paper we will report our results on the ESF measurement campaign, which is under way at the time of writing of this abstract.

The Edge Spread Function will be measured by scanning a bright point source within the camera's field of view. We will utilize a blackbody source (a SiC heater element, a.k.a. "glo-bar") with a 5 mm diameter aperture. The point source will be attached to a XY-scanner stage and moved across the field-of-view. The line spread function will then obtained by numerically differentiating the edge spread function.

$$F_l = \frac{d}{dx} F_e(x) \tag{2}$$

References

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