High Speed Terahertz Imaging Using Thermosensitive Elements

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Abstract- **We have studied sensitivity, linearity, dynamic range, space and time resolution of three imaging systems for the visualization of high-power radiation from 0.12 to 0.25 μm: an IR-thermograph, a phosphor screen sensitive to thermal quenching of luminescence, and a glass-plate visible-light interferometer.**

I. Introduction

Imaging in the terahertz spectral region is very important in many applications [1]. For high power terahertz sources, like free electron lasers [2], the thermal effect of terahertz radiation can be exploited for the visualization [3]. We compare in this paper main characteristics for three imaging systems.

II. Description of Imaging Systems

A. Infrared thermograph

Infrared thermograph SVIT has a 124×124 martix sensitive to the radiation within 2.5 – 3 μm. Using thin and thick screens of different composition which absorb, at least partially, terahertz radiation, we record images with the repetition rate up to 25 Hz. A "temperature" distribution over the surface of a thick BK7 glass plate exposed with free electron laser (FEL) beam is shown in Fig. 1. A model for the reconstruction of the terahertz radiation power density distribution (PDD) has developed.

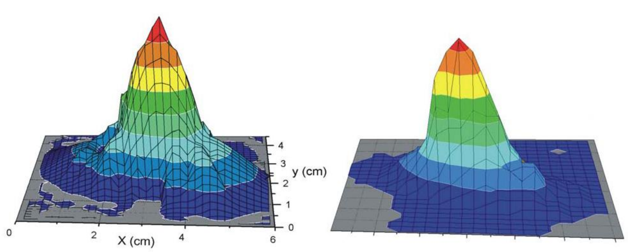

Figure 1. Free electron laser specific power density distribution recorded by the interferometer (left) and the thermograph (right).

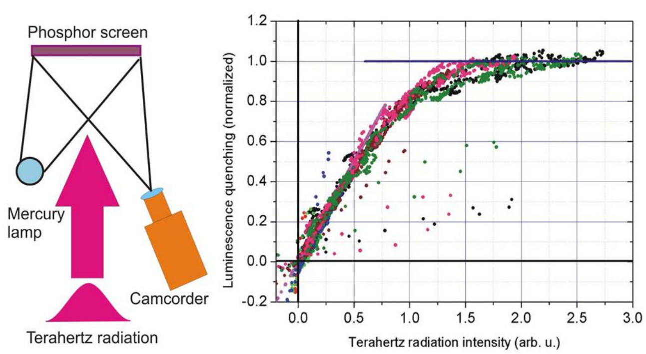

Figure 2. Terahertz radiation visualization with the "thermal image plate" (left). Luminescence quenching vs. THz radiation intensity.

B. Glass-plate interferometer

The glass plate Fizeau interferometer [3] with a semiconductor 0.665 μm laser as a source enables the absolute measurements of PDD for any radiation for which BK7 glass is opaque. Knowing thermo-optical glass characteristics and measuring the reflection coefficient, FEL average power, equal in that experiment to 65 W, has been calculated by integration over the surface PDD shown in Fig. 1.

C. Phosphor screen thermal quenching

Phosphor screens, developed by Macken Instruments Inc. for near- and mid-infrared radiation, were applied for the visualization of terahertz radiation (Fig. 2). Quenching magnitude, determined as $\{I(T_0)-I(T)\}/I(T_0)$, where T_0 is the room temperature, as a function of terahertz radiation power is shown in the plot in Fig. 2 for a screen #8. It grows linearly up to 60% of initial fluorescence intensity. This technique also becomes an absolute one when we complete the measurements of the reflection coefficient tuning FEL radiation within the terahertz spectral range.

Acknowledgments

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References

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