High quality beams of MV/cm THz pulses generated from DSTMS

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***Abstract*—A beam characterization of a THz beam generated from the organic crystal DSTMS is presented. The simple, collinear phase-matching geometry for this crystal results in an M^2 factor below 1.5, resulting in a focused field strength of more than 4 MV/cm.**

I. INTRODUCTION

THE recent development of THz sources has led to studies of nonlinear effects induced by intense THz pulses [1]. Organic crystals such as DSTMS have been demonstrated to produce very high pulse energies of more than 100 µJ, which, with the advantage of a collinear phase matching geometry, easily can be focused to achieve tens of MV/cm [2]. For most experiments within spectroscopy, imaging and z-scan techniques, the beam profile of the incident beam plays an important role. For visible and NIR beams this is typically characterized by a beam scan where a CCD or CMOS camera is scanned through the focal plane and the beam shape and radius is measured as function of z distance. However, due to the limited availability of cameras sensitive to THz radiation, the number of full beam characterizations in the THz range has been limited [3]. Now, the recent development of THz cameras [4] has opened the possibilities for beam characterization in the same way as what is typically performed with visible and NIR beams. Here, a characterization of a THz beam profile generated from a DSTMS crystal is presented, where a M^2 values less than 1.5 are achieved.

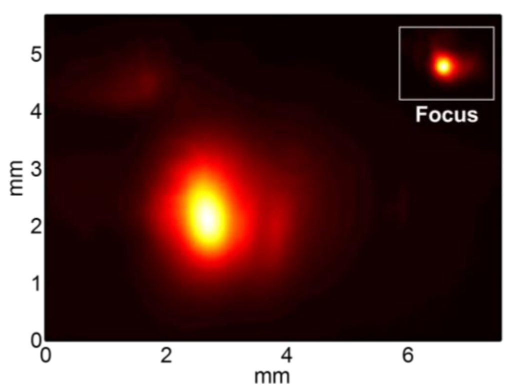

Fig. 1. Unfocused and focused THz beam from DSTMS

II. RESULTS

A THz beam is generated from a 460 µm thick DSTMS with a diameter of 3 mm. The crystal is pumped by laser pulses centered at 1300 nm and with a pulse energy of 1 mJ, generated from an OPA system pumped by a table-top amplified Ti:Sapphire laser system. The generated THz spectrum is measured to span from 1 to 5 THz, and the field strength in focus of a 2” off-axis parabolic mirror is measured to be more than 4 MV/cm, using a pyro-electric detector (QMC instruments) for energy calibration. A THz camera (NEC) is scanned through the focal plane of the 2” off-axis parabolic mirror, where an intensity image of the beam is recorded at each step. Figure 1 shows an example of the unfocused beam, with the focused beam shown in the inset. The shades to the rights of and above the beam spot originate from reflections from silicon wafers used to attenuate the beam. All measured profiles have a Gaussian shape. The FWHM of the beam recorded at each z-position of the camera are shown in Fig. 2 for the horizontal and vertical axis together with fits of the FWHM for a Gaussian. From this, the M^2 values were extracted according to the ISO 11146 standard, and for all frequencies within the bandwidth to be below 1.5. This is similar to the beam of the amplified laser beam specified to be lower than 1.45. For comparison a beam profile has also been measured from a $LiNbO_3$ system, where the M^2 value on average was found to be larger than 2. This is likely to be caused by the much more complex phase-matching geometry used for $LiNbO_3$ systems [5]. Simple phase-matching geometry resulting in high-quality beams of intense pulses generated from DSTMS are promising for nonlinear spectroscopy or imaging experiments where an optimum beam profile is crucial.

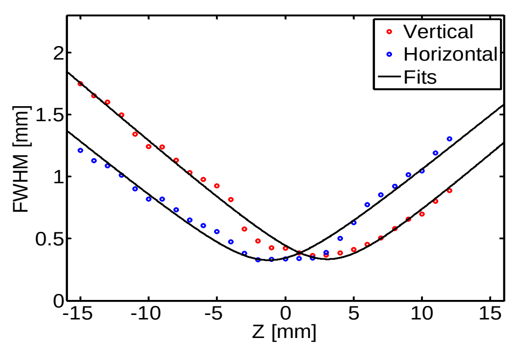

Fig. 2. FWHM measured for the DSTMS in horizontal and vertical direction.

III. SUMMARY

In summary, beam profiles with an M^2 lower than 1.5 have been measured on an intense THz beam generated from DSTMS. This is comparable to the quality of the laser beam used for THz generation.

REFERENCES

[1] Jewariya *et al.*, Phys. Rev. Lett., **105** 203003 (2010).
[2] Shalaby, and Hauri, Nat. Commun. **6**, 5976 (2015).
[3]. P. Klarskov *et al.*, New J. Phys. **15**, 075012 (2013).
[4] N. Oda, C. R. Physique **11**, 496 (2010).
[5] Hebling *et al.*, J. Opt. Soc. Am. B 25, B6 (2008).