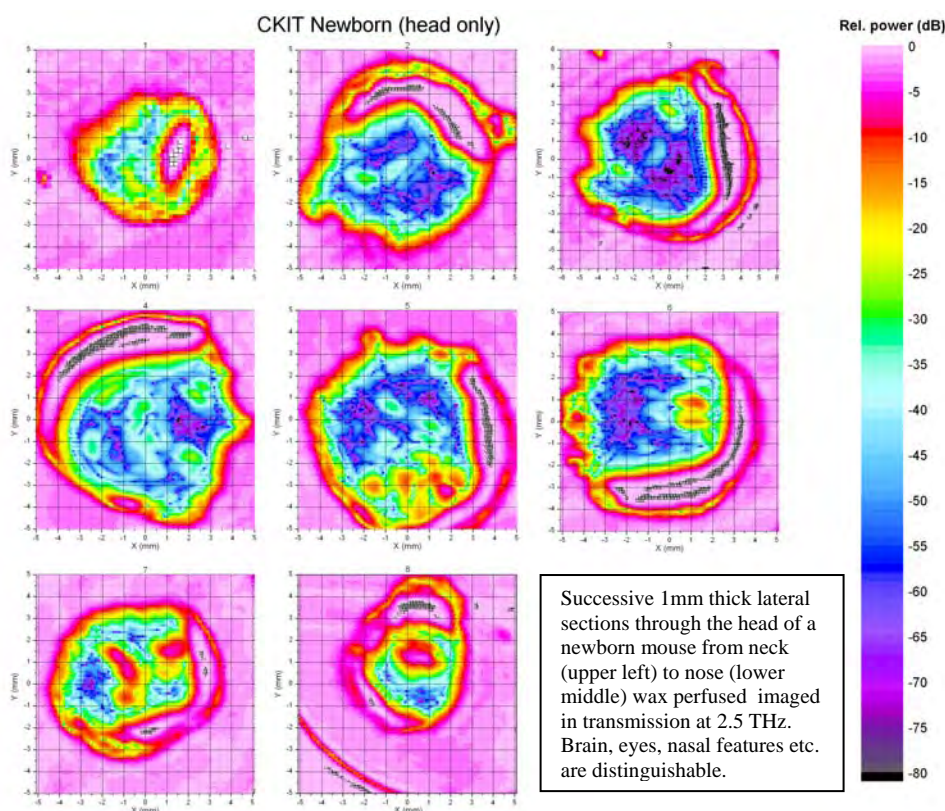


Terahertz Applications Beyond Space Science

Peter H. Siegel, Caltech/JPL

Abstract:

After more than 30 years of focused applications in the space sciences area, Terahertz Technology is experiencing a true Renaissance. While major strides continue to be made in submillimeter wave astronomy and spectroscopy, the past few years have seen an unprecedented expansion of terahertz applications, components and instruments targeted *outside* of the space sciences. Broad popular interest in this unique frequency domain has emerged for the first time¹, spanning applications as diverse as biohazard detection and tumor recognition. Already there are groups around the world who have applied specialized Terahertz techniques to disease diagnostics², recognition of protein structural states³, monitoring of receptor binding⁴, performing label-free DNA sequencing⁵ and visualizing contrast in otherwise uniform tissue⁶. A commercial terahertz imaging system has recently started tests in a hospital environment and new high sensitivity imagers with much deeper penetration into tissue have begun to emerge⁷. Solicitations for more sophisticated instruments and enabling terahertz components have filtered into US agency proposal calls from DoD and NASA, to NSF and NIH, and many new research groups have sprung up, both in the US and in Europe and Asia. This talk will broadly survey terahertz applications that may be less familiar, but equally interesting to a space scientist, with the hope of stimulating some crossover into Earth-based life sciences.



¹ P.H. Siegel, "Terahertz Technology in Biology and Medicine," IEEE Trans. MTT, vol. 52, no. 10, Oct. 2004, pp. 2438-2448.

² R.M. Woodward, V.P. Wallace, R.J. Pye, B.E. Cole, D.D. Arnone, E.H. Linfield and M. Pepper, "Terahertz Pulse Imaging of ex vivo Basal Cell Carcinoma," J. of Inv. Dermatology, vol. 120, no. 1, Jan. 2003, pp. 72-78.

³ A. Markelz, S. Whitmore, J. Hillebrecht and R. Birge, "THz time domain spectroscopy of bimolecular conformational modes," Physics in Medicine and Biology, vol. 47, no. 21, 7 Nov. 2002, pp.3797-3805.

⁴ S.P. Mickan, A. Menikhu, H. Liu, C.A. Mannella, R. MacColl, D. Abbott, J. Munch and X-C Zhang, "Label-free bioaffinity detection using terahertz technology," Physics in Medicine and Biology, vol. 47, no. 21, 7 Nov. 2002, pp.3789-3795.

⁵ P. Haring Bolivar, M. Brucherseifer, M. Nagel, H. Kurz, A. Bosserhoff and R. Buttner, "Label-free probing of genes by time domain terahertz sensing," Physics in Medicine and Biology, vol. 47, no. 21, 7 Nov. 2002, pp.3815-3821.

⁶ K.J. Seibert, T. Löffler, H. Quast, M. Thomson, T. Bauer, R. Leonhardt, S. Czasch and H.G. Roskos, "All-optoelectronic continuous wave THz imaging for biomedical applications," Physics in Medicine and Biology, vol. 47, no. 21, 7 Nov. 2002, pp.3743-3748.

⁷ P.H. Siegel and R.J. Dengler, "Terahertz Heterodyne Imager for Biomedical Applications," SPIE Conf. on THz and GHz Electronics and Photonics III, vol. 5354, San Jose, CA, Jan 25-26, 2004.