

# Using terahertz pulsed imaging (TPI) to identify colonic pathology.

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**Abstract**—Terahertz Pulsed Imaging (TPI) is a non-ionizing and non-destructive technique. Image contrast has been seen between normal and diseased tissues in *ex vivo* measurements. In this study, terahertz images of excised colon tissue show contrast between regions of tumor and normal tissue. Averaged waveforms from within tumor and normal regions are different. A number of parameters from the data have been identified that show statistically significant differences ( $p < 0.01$ ) between data from tumor and normal regions.

## I. INTRODUCTION AND BACKGROUND

Colon cancer is the third most common cancer in both men and women and the third leading cause of cancer-related mortality in both men and women in the United States. Eighty three percent of cases arise in people who are 60 years or older. As with most cancers, early detection is essential for improved survival rates, but symptoms only tend to present at advanced stages of the disease. Screening through fecal occult blood tests and subsequent colonoscopy for positive tests has enhanced detection rates, but there remains a problem in detecting flat adenomas, dysplasia and their differentiation from inflammatory atypia.

Advances in biomedical optics have been applied in an attempt to overcome sensitivity and specificity limitations for detecting dysplasia and invasive cancer of the colon. The terahertz techniques remain under utilised in medical imaging. However, the development of a practical method of generating and detecting broadband pulses at this frequency contained within a portable system suitable for clinical studies has lead to novel techniques for detection of neoplasia in skin [1] and breast tissues [2]. The aim of this study was to determine the feasibility of using terahertz pulsed imaging (TPI) to identify colonic pathology.

## II. MATERIALS AND METHOD

**Methods:** Patients undergoing elective large bowel resection at a single centre (St Mary's Hospital, London) were recruited to the study from January to September 2007. The study was approved by the local research ethics committee, and informed consent was obtained from all patients. Samples of normal mucosa, polyps and cancer were taken from the resection specimens and scanned with the TPI Imaga1000™ (TeraView Ltd, Cambridge, UK). Scanned specimens then underwent histological examination.

## III. RESULTS

Eighty three biopsy samples were retrieved from 28 patients: 16 male and 12 female, mean age, 63.2 (range, 29-87 years). Twenty one patients had malignant disease, of the remaining 7 patients, 3 had ulcerative colitis, 3 had Crohn's disease and 1 had diverticular disease.

Histological examination of the samples revealed invasive cancer in 23 samples, dysplasia in 21 samples and reactive changes in 8 samples. The remaining samples were classified as normal mucosa. Figure 1 show a THz image of colon tissue. The upper section of tissue is cancerous, the lower section is normal good contrast is seen between the two regions. Averaged waveforms from within tumor and normal regions are different. Several parameters extracted from the THz data were selected for study. Significant variation was noted between normal mucosa, invasive cancer and dysplasia. These differences were less marked between normal mucosa and reactive changes.

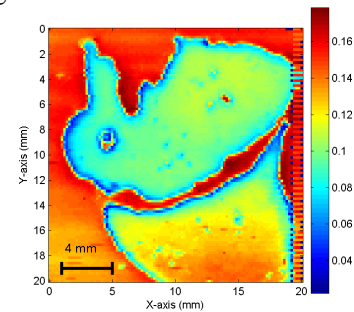


Fig. 1. THz image of diseased colon (upper) and adjacent normal tissue (lower).

In conclusion, the findings of this study demonstrate the potential of TPI to identify colonic dysplasia and invasive cancer under controlled conditions. These findings provide the basis for the development of *in vivo* imaging techniques.

## REFERENCES

1. Wallace, V.P., et al., *Terahertz Pulsed Imaging of BCC ex Vivo And in Vivo*. Brit J. Derm., 2004. **151**(2): P. 424-432.
2. Fitzgerald, A.J., et al., *Terahertz Pulsed Imaging of Human Breast Tumors*. Radiology, 2006. **239**(2): P. 533-540.