Project Purpose and Goals:

Optical Coherence Tomography (OCT) is an imaging technique which has proven to provide high resolution tissue images in a non-invasive, rapid manner. However the method lacks the biochemical specificity required for a more complete evaluation of cancer affected tissues. Raman Spectroscopy – also non-invasive – probes the vibrational modes of molecules, providing the biochemical specificity lacking in OCT. But, Raman scattered signals are intrinsically weak, and whilst acquisitions can take seconds, the method is comparably slower to OCT.

Ideally, combining these two methods could present a synergistic approach - a more holistic method, for the non-invasive diagnosis of skin cancer. In fact, this potential was recently demonstrated by Patil *et al*. with some proof-of-principal *in vivo* tissue testing (Patil 2008). However, the instrument used may not be feasible for routine clinical applications.

At the current time, we possess a state of the art, handheld, compact OCT device primed for clinical trials and testing. We propose to expand upon our previous work in this area (*see reference section*) by presenting results from:

1. Extensive *in vivo* tissue sampling using a variety of commercial Raman bench top systems, encompassing a wide range of excitation wavelengths. This analysis and testing allows us to determine the optimal instrument parameters for a Raman system within a combined, compact device for clinical applications.
2. The exploration of Fluorescence spectroscopy of *in vivo* samples as a possible alternative to Raman spectroscopic measurements.
3. Characterisation of a novel compact, combinatory-OCT system for the rapid clinical evaluation of skin cancer. And finally;
4. Preliminary results using a pilot test study of volunteers.

Equipment used:

Optical Coherence Tomography, OCT

Figure 1 OCS1300SS courtesy of www.Thorlabs.com.

Our OCT instrument measures the magnitude and time delay of reflected light in order to construct depth profiles (A-scans) in the sample being imaged which can be combined to create a 3D image. The design integrates a broadband, high-speed swept laser and a fibre-based Michelson interferometer with a balanced detection scheme.

In a laboratory setting the OCT is placed in a large workspace where a computer screen, microscope, keyboard and mouse may be used. For clinical applications the probe may be simply removed and placed on the exam area.

Raman Spectroscopy

Through collaboration with the Materials and Surface Science Institute (MSSI) and the Facility for Optical Characterisation and Spectroscopy (FOCAS) we have available to us, a range of bench top instruments for our work. These include:

- **Instruments S.A. LabRAM 1B** confocal microscopy system with both Helium-Neon (632.8nm, 11mW) and Argon ion (514.5nm, 50mW) available as sources. Both are polarised, enabling measurement of depolarisation ratios and studies of orientation in materials. Light is imaged to a diffraction limited spot (typically 1 micron) via the objective of an Olympus BX40 microscope. The scattered light is collected by the objective in a confocal geometry, and is dispersed onto an air cooled CCD array by one of two interchangeable gratings, 1800 lines/mm or 600lines/nm, allowing the range from 150cm-1 to 4000cm-1 to be covered in a single image, or with greater resolution in a combination of images.

- **Horiba Jobin Yvon Inverted LabRAM HR800 VIS-NIR**. This instrument offers multiple laser capability, from visible to near IR (specially extended NIR and UV versions) and fast map imaging modes. Available wavelengths include:

    - 785 nm
    - 660 nm
    - 532 nm
    - 473 nm

Keywords: Raman, OCT, Imaging, Biophotonics, Skin Cancer, Diagnosis, Clinical.

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References

- Clancy, NT, MJ Leahy, GE Nilsson, and et al. "Analysis of skin recovery from mechanical indentation using diffuse lighting and digital imaging - art. no. 66291G." *Diffuse Optical Imaging of Tissue*, 2007: G6291-G6291 .
- Enfield, J, J O'Doherty, and MJ Leahy. "Single point and imaging measurements of the optical clearing process - art. no. 66311E." *NOVEL OPTICAL INSTRUMENTATION FOR BIOMEDICAL APPLICATIONS III* 6631 (2007): E6311-E6311 .
- Leahy, MJ, J O'Doherty, P McNamara, and et al. "Diffuse reflection imaging of sub-epidermal tissue haematocrit using a simple RGB camera - art. no. 653503." *Optical Technologies in Biophysics and Medicine VIII* 6535 (2006): 53503-53503.
- O'Doherty, J, J Henricson, C Anderson, and et al. "Sub-epidermal imaging using polarized light spectroscopy for assessment of skin microcirculation." *SKIN RESEARCH AND TECHNOLOGY* 13 (2007): 472 - 484.
- O'Doherty, J, J Henricson, GE Nilsson, and et al. "Real time diffuse reflectance polarisation spectroscopy imaging to evaluate skin microcirculation - art. no. 66310O." *NOVEL OPTICAL INSTRUMENTATION FOR BIOMEDICAL APPLICATIONS III* 6631 (2007): O6310-O6310 .
- Patil, C.A., Bosschaart, N., Nyman, J.S., Faber, D.J., Van Leeuwen, T.G., Mahadevan-Jansen, A. "Development of Combined Raman Spectroscopy - Optical Coherence Tomography (RS-OCT)." *Optics Letters* (Optical Society of America) 33, no. 10 (2008): 1135 - 1137.