NEW BIOMEDICAL OPTICS TEST BED FACILITY ABOUT TO LAUNCH AT THE CSIR NATIONAL LASER CENTRE

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Applications of optically based techniques in surgery and medicine continue to increase rapidly. This is mainly due to the fact that such techniques hold a series of inherent advantageous properties compared to more conventional medical techniques. For instance, by applying optical techniques, treatments and diagnostic procedures can be done non-invasively which reduces the inconvenience for the patients as well as the risk of spreading infectious diseases. Furthermore, optically based medical equipment is typically relatively inexpensive and can also be made transportable which allows for outpatient treatment and early diagnostics at first level patient care. This is of substantial importance in the South African context, specifically in terms of deployment of medical diagnostic and therapeutic equipment in remote/rural areas.

Examples of optically based medical applications are:

- Phototherapy (i.e. photodynamic cancer therapy (PDT) and low-level laser therapy (LLLT)).
- Laser surgery (in ophthalmology, dermatology, oncology, cardiology, etc).
- Optical biopsy (i.e. cancer diagnostics, tissue glucose measurements, and hemodynamic monitoring).
- Optical tomography (i.e. optical coherence-, photo-acoustic-, fluorescence-, and time-resolved transmittance tomography).

Currently, the Biophotonics Group at the CSIR National Laser Centre (NLC) is involved in projects on both PDT and LLLT. To facilitate these and future projects the group is in the process of completing a generic in-house platform for pre-clinical testing of novel optically based medical applications. As illustrated in the figure, this so-called Biomedical Optics Test Bed (BioBed) platform consists of four core technologies, i.e.:

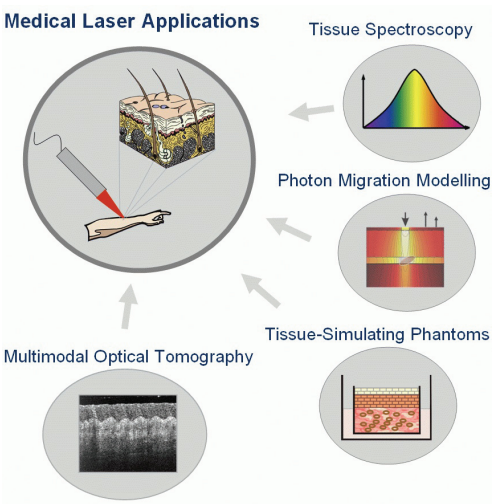
Tissue spectroscopy:
Fundamental optical characterisation of biological media, i.e. determination of absorption and scattering properties of human tissue, and body fluids.

Photon migration modeling and analysis:
Mathematical modeling and computer simulations of light propagation in human tissue as well as multivariate data analysis.

Tissue-simulating phantoms:
Manufacture and assembly of liquid and molded solid phantoms for reference and control as well as artificial (living) human tissue equivalents for preclinical testing.

Multimodal optical tomography:
Non-invasive (and non-ionizing) imaging/morphological analysis of human tissue in order to monitor and quantify the structural effects of optically based therapeutic modalities applied, and to aid in the development of novel medical diagnostic techniques.

To implement the BioBed platform at the CSIR, a biological cell culture laboratory has been established and closely integrated with adjacent optical laboratories. This enables the biophotonics research group to manufacture synthetic three-dimensional (3D) tissue models from human cell samples, which can be induced with various forms of lesions, e.g. cancer. Consequently, these 3D tissue models constitutes a very convenient, cost-effective, and realistic but risk-free environment for preclinical testing and optimization of novel medical laser applications. To monitor and quantify the effects of various optically based medical therapeutic modalities, a so-called Optical Coherence Tomography (OCT) system has also been acquired. This OCT system allows researchers to perform non-invasive in vivo cross-sectional real-time imaging of living tissue. In the case of skin tissue (as shown in the figure), the OCT system will provide images with a resolution of ~ 20 µm down to a depth of ~ 2 mm.



The BioBed R&D platform – CSIR National Laser Centre

As implied above, the field of Biomedical Optics is highly multidisciplinary. Therefore, to succeed, collaboration between various disciplines, e.g. physics, medicine, biology, and engineering is crucial. Accordingly, one of the key drivers for establishing the BioBed platform at the CSIR was to facilitate such multidisciplinary biomedical optics collaboration in South Africa, and as also implied, a number of such projects has already been launched.

Yet, the CSIR National Laser Centre would like to strongly encourage any interested companies, research institutions or students with ideas on other new potential collaboration projects, to contact the organisation for further discussions and exploration.

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