Research report for 2010 grant:

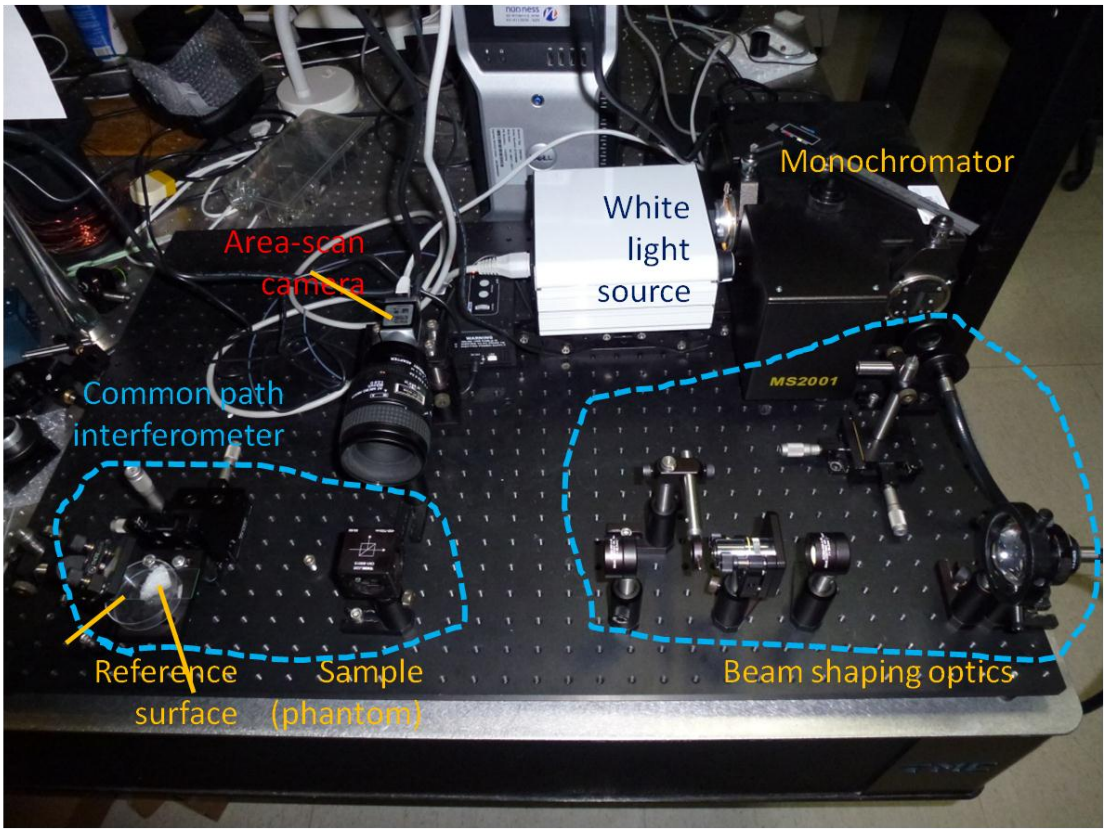
Determining the role inflammation plays in identifying atherosclerotic plaques in vivo using dual infrared thermal imaging - optical coherence tomography probe.

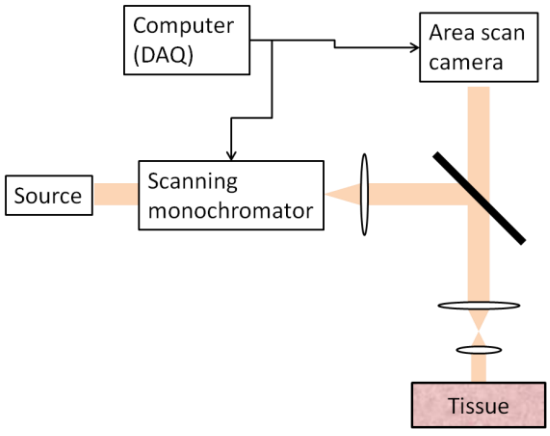
Israel Gannot.

We have built an optical coherence tomography (OCT) in our lab; our system followed a swept-source, full-field, common-path system design (Fig. 1). Here, a white light source (Thorlabs) is coupled to a scanning monochromator (Solart TII). The beam exiting the monochromator output is then reshaped and collimated to a 1 mm diameter. This collimated beam is coupled into a common-path interferometer (in which the reference arm is replaced by a reference surface in the sample arm) and onto the tissue. Light returning from the tissue and reference surface forms an interference patterns on a 1.3 megapixel area-scan camera (Basler). The monochromator scans the wavelength in time, enabling acquisition of 3D data (1280x1024x1024) in under 2 min. The interferogram at each (x, y) position is formed by taking the inverse Fourier transform of the time-varying (wavelength-varying) data at that lateral position.

This specific system configuration was chosen because it has several advantageous features. First, as it is a full-field system, no lateral scanning is required and all the lateral information is acquired in parallel. Because it is a swept-source system, there are no moving parts in the system outside of the monochromator. Omission of the reference arm further simplifies the design. The use of visible light improves the axial resolution to <2 μm; however, the tradeoff is that the penetration depth is limited to 0.5 mm. Note that increased scattering at visible wavelengths degrades image quality at large depths.

Currently, the OCT system is built and acquires 3D data. Currently, there are ongoing studies characterizing the system using light scattering phantoms (polystyrene spheres in agarose gels), as well as imaging of *ex vivo* tissues. Additionally, we are adding a pseudo-focus-tracking capability to the system by integrating a vertical stage; this adapted setup will be used to measure optical scattering properties of the imaged tissues. An image of the buit set-up is shown in fig. 1





(A) (B)

Fig. 1: (A) Schematic and (B) picture of swept-source, full-field, common-path OCT system built in the lab.

The second part of this research was to build and test a thermal imaging bundle. We have developed a bundle for the delivery of thermal images from within body cavities such as blood vessel, GI tract and colon (Fig. 2) . This bundle is made of a coherent set of waveguides internally coated with reflecting layers in the spectral window of 8-12**μm**. We have tested those bundle in a photothermal setting to measure relative quantities of Methylene Blue (MB) and IcG in an agar dish which showed a good correlation with the real relative quantities (within 5%). Fig. 3. We have measured then blood samples with Sodium dithionite, mimicking oxygen saturation levels. Also here we have achieved good accuracy levels above 50% saturation. See table 1.

Real oxygenation level	Estimated oxygenation level
0.50	0.58
0.70	0.64
0.82	*0.85*

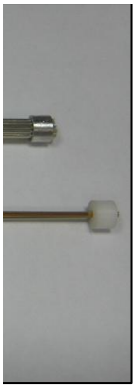


Figure 2: Bundle configurations, the four bundles **Table 1. Blood oxygenation levels measurements.**

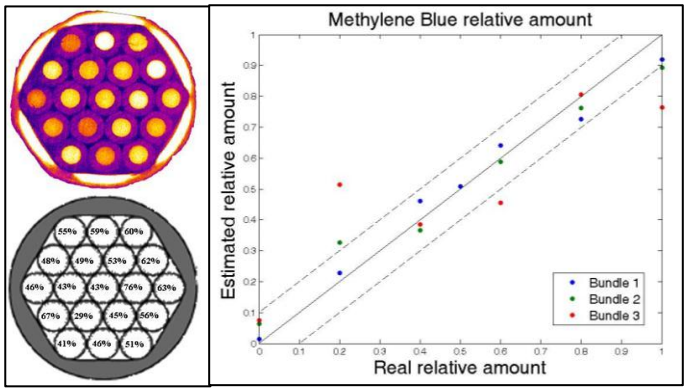


Figure 3: MB estimated relative amount plotted against the real relative amount (right). The IR camera image and the estimated relative amount for the different fibers of the bundle (Left).

Finally we have tested the set-up on a real mouse and found out an excellent correlation measuring 96% oxygen saturation, See fig. 4.

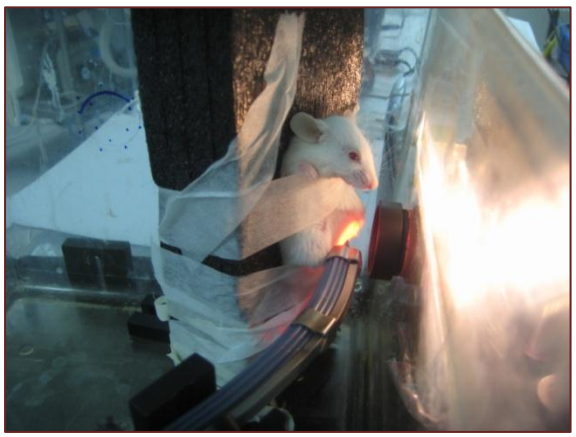


Fig. 4. A measurement of Oxygen saturation on a healthy mouse.

There are still no papers at this stage of the research done under the Sclezak fund. We expect a paper to be submitted during the upcoming year.