**STSM report**

**STSM Application number:** COST-STSM-BM1205-33097

**STSM Grantee:** Prof. Igor Meglinski

**STSM title:** The new optical diagnostic modality – the role of nuclear size in cell differentiation.

**Home Institution:** University of Oulu, Finland

**Host Institution:** Weizmann Institute of Science, Israel

**STSM period:** 07.03.2016 to 21.03.2016

**STSM purpose:** To try and test a new optical modality and to prepare a joint scientific publication.

**Description of the work carried out during the STSM:**
In Optoelectronics and Measurement Techniques Laboratory of the University of Oulu a new method for non-invasive diagnostic of cancerous and non-cancerous tissue samples by using circularly polarized light has been introduced. An alternative approach of state-of-the-art optical imaging modalities for tissue diagnosis and cancer detection are available in Dr. Viacheslav Kalchenko's Unit at the Weizmann Institute of Science (Israel).

Igor Meglinski visited the Weizmann Institute of Science and jointly with Dr. Kalchenko worked on the validation of the polarization based technique and its testing to measure the nuclear size of cells with cancer, pre-cancer and non-cancer. In addition Prof. Meglinski and Dr Kalchenko developed a new technique for high quality perfusion imaging (in terms of WG1 activities).

Based on the results of collaboration a joint publication will be prepared prepared and published shortly. The results of the joint collaboration will be also presented at the upcoming conferences and COST 1205 meetings.

**Mutual benefits for the Home and Host institutions:**

Both Host and Home institutions agree to continue collaboration. More tissue samples will be tested in Oulu and will be mesured independently by two different experimental systems in the Weizmann Institute of Science. Based on these studies we expect a development of a new experimental system that will be able to predict the changes of in cancerous and non-cancerous tissues based on the changes of the nuclear size in the cells. Potentially a new diagnostic modality is very likely can be developed.

I confirm that the information above is correct and that this STSM has set the basis of a profitable collaboration between the two groups involved in this research.

Figure 1 shows the experimental setup. Circular polarized light is produced using a 635 *nm* laser diode (Thorlabs, Inc., USA) and focused onto the surface of the sample. Scattered light is collected at a distance ($d$ = 1 *mm*) away from the point of incidence and is then passed through an analyzer to measure its state of polarization. The source-detector separation $d$ plays an important role in the observation of circular polarization. With $d = 0$, the detected signal is likely to be saturated by light in the cross-polarized state. This is due to an overwhelming percentage of single backscattering at the sub-surface area. The contribution of the co-polarized component grows with the increase of $d$. In order to reduce the uncertainty in the source-detector separation $d$ and to avoid surface refections, two standard microscope objectives have been used to deliver incident laser radiation and detect scattering light respectively. These objectives have been implemented into the setup at angles 45° ± 2° and 10° ± 2° (see Fig.1) which are chosen intentionally, as the physical size of the objectives forbids them from maintaining a normal angle to the surface of the scattering medium. The effective path-lengths distribution of the photons migrated from source to detector within the medium, shown in Fig.1, has been simulated by Monte Carlo method, developed by Prof. Meglinski, for the actual parameters of the experimental system.

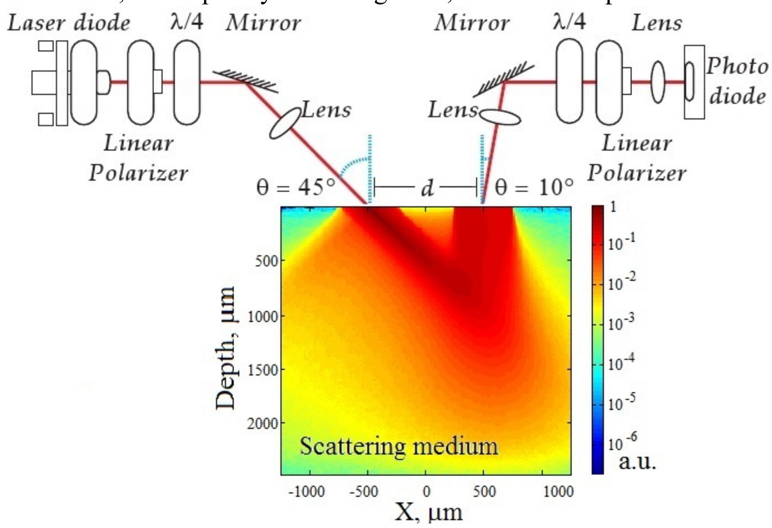


Figure 1. Schematic presentation of the experimental setup. The circular polarized light is focused onto the sample surface. Back-scattered light is collected at distance $d$ away from the point of incidence, then its state of polarization is analyzed.

All the experiments have been conducted using tissue samples with the confirmed nuclear size of cells, including cancerous, pre-cancerous and non-cancerous. The results of the polarization of the back-scattered light observed for each sample are presented below.

Figure 2 presents the intensity of circular polarized laser light backscattered from the cells cultures. The results clearly demonstrate a shift of the detected intensity of the circular polarized optical radiation backscattered from the the different cells caltures. It is also clearly seen that with the increasing nuclear size the polarization state of backscattered light eventually changes its helicity, as this corresponds to the relative positions of the minima.

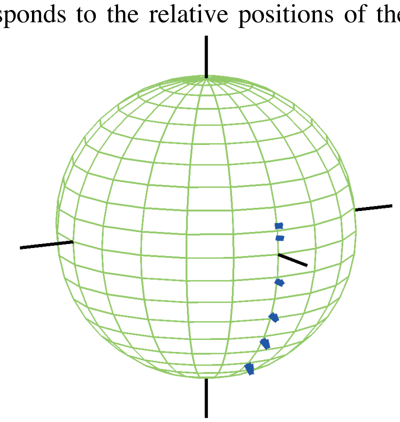

Fig.2. Poincaré sphere plots the positions of the polarization vectors corresponding to the increase of nuclear size.

To conclude: the developed system is capable of detecting small changes in the scattering anisotropy of scattering particles, such as nuclear of the cells. This should have obvious applications in the cancer diagnosis, e.g. as the detection of nuclear size increase at the pre-cancerous stage.

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## STSM REPORT (Cont'd)

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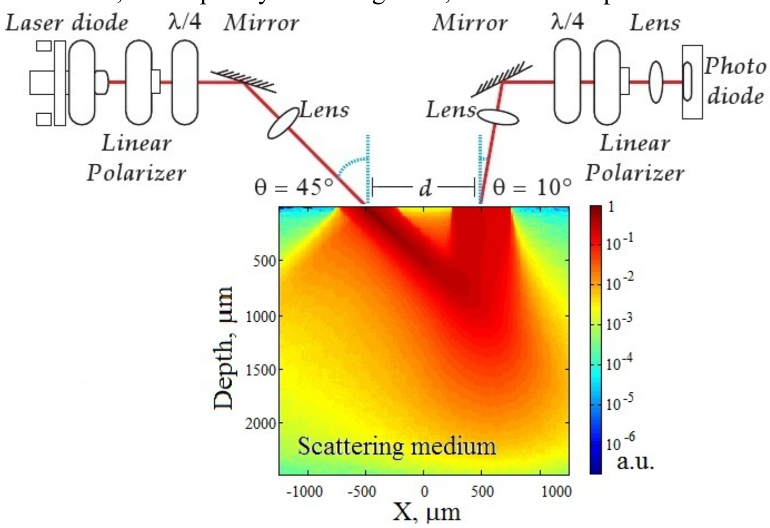


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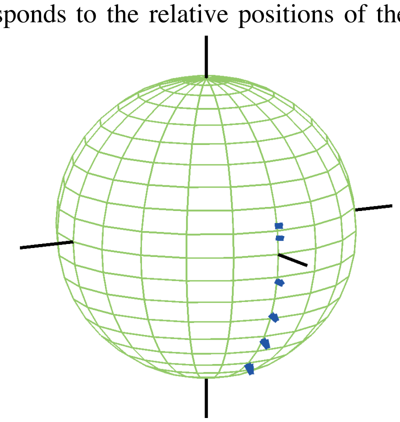

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