Apparatus for Spectroscopic Diagnosis of Biological Tissue

As we all know, cancer is a global issue, it respects no borders and affects us all, directly or indirectly. According to the World Health Organization of Public services (WHO), nowadays there are about 25 million patients sick of a cancer in the world and every year 6.7 million people die from the disease.

This case, along with already existing technologies of diagnostics and treatment needs modern methods to be created, while conventional ones do not provide accurate diagnosis in the disease's early stages on the one hand, and on the other hand practically excluded real time wide area surveillance (monitoring), including surgical treatment. That's why the special attention is given to the creation of the new technology of early and effective diagnostics and treatment primarily focused on a patient. The necessity of modern technologies is very high all over the world. For the period 2002-2006 only the European Union allocated about 475 million euro to this.

All in all based on conventional methods we have following "inconveniences":

- **At present the injury, invasive biopsy predominates**
- **Difficulties of early malignancy diagnose by low inter-observer agreement**
- **Presently there are no "instantaneous" methods of determination of cancerous cells**

The corresponding response on the above mentioned challenges are different optical spectroscopic methods. These methods reveal information about the composition of matter at different scales, from the microscopic to the macroscopic. Indeed, the chain from atoms to organisms: *atom – molecule – biomolecule – system – cell – organism* (*human body*), consists of a number of clearly distinguishable systems. Thus, when spectroscopy is used as a tool to examine human tissues, one may acquire information from the atom or molecular to the tissue level, depending on the specific method that is employed. Since the development of disease is a complex process that typically involves changes in several aspects of tissue physiology and morphology, it is reasonable to expect that the combination of multiple modalities providing complementary information on tissue status will enhance our capability to detect disease at an early and any stage of progress.

Laser induced fluorescence spectroscopy, diffuse reflectance spectroscopy and light scattering spectroscopy can be implemented simultaneously in a clinical setting. Powerful light sources and sensitive detectors enable data acquisition at time scales that are fast enough so that motion artifacts can be avoided. Data analysis can be performed in real-time, allowing the use of these techniques ultimately as an independent diagnostic tool (free of injury biopsy) used for patient monitoring and for guiding treatment decisions. Spectroscopic imaging modalities can be developed based on initial point spectroscopic measurements, so that a large tissue area can be screened for the presence or absence of suspicious lesions. Since all three techniques may provide information about subtle changes that occur before any macroscopically visible changes, it is possible that their use will not only improve our ability to detect early lesions, but it will also enhance our understanding of the basic biochemical and morphological events involved in the progression, for example, from normal epithelium trough dysplasia to cancer. This, in turn, could lead to the development of improved therapeutic interventions.

In our laboratory several optical techniques have been explored for obtaining structural and functional information from glandular tissues. Mainly it was laser induced fluorescence spectroscopy of thyroid gland. It has been shown that the fluorescence spectra provide the information about the biochemical composition of tissue and unambiguously detect adenoma, papillary and follicular carcinomas, goiter and allow to define the abnormality degree of the thyroid tissue.

As we know glandular tissue is a part of the larger tissue category known as epithelial. On the other hand, it is well known, that carcinomas, which comprise almost 90% of all human cancers, arise in the epithelium, the superficial layer lining the surfaces of organs and tissues. So the investigation of glandular tissues gives the opportunity to obtain the main features of monitoring the progression of disease of about 90% of all human cancers as well. In such formulation it is evident that the spectroscopy of glandular tissue seems to be very important application of optical/laser spectroscopy in medicine.

Based on worldwide experience and the results of our investigations, we have built the apparatus for laser induced fluorescence diagnosis – Laser Canceroscope, which can be also easily modified by other spectroscopic modalities as diffuse reflectance and light scattering diagnoses. The combination of three spectroscopic modalities provide biochemical, structural, and morphological information on tissue state simultaneously.