Early detection of cancers is an important issue in oncology. However, the potential of contemporary screening methods does not cover the need. According to National Cancer Registry the necessity is evaluated for more than 11 million of examinations per year in Poland. The limits follow from expensive and time consuming measuring procedures.

It was stated that in breath of the cancer sick peoples, specific chemical compounds (biomarkers) occur. Investigation of the exhaled human air is conducted since tens of years, mainly using the gas chromatography. As far as single chromatographic measurement last about 1.5 hour, such approach cannot be used for screening. Recent progress in optoelectronics provides an opportunity to construct relatively simple biomarker sensors based on absorption laser spectroscopy. Performance of the investigation providing the opportunity to elaborate optoelectronic sensors for screening based on detection of cancer biomarkers in breath with laser spectroscopy techniques is the main goal of the project.

Principle of operation of such sensors is simple: it is based on measurement of light attenuation by the breath sample contained in a cell. There is a necessity that the light wavelength is precisely tuned to the absorption band of the compound of interest. As far as the attenuation depends on the compound concentration it allows the compound density determination.

Formaldehyde, acetaldehyde as well as various other volatile organic compounds (VOC) like acetone, benzene, butane, decane, ethane, ethylene, heptanal, heksanal, isoprene, pentane, toluene as well as xylene and its isomers are considered as cancer biomarkers (breast, lungs, prostate and the other ones) occurring in the air exhaled from human lungs. The absorption spectra of such compounds are located in infrared domain.

As far as the typical mixing ratios of these biomarkers in breath are in the range of tens of parts per billion only, the expected values of the absorption coefficients are low. Therefore the ultrasensitive methods of laser absorption spectroscopy will be applied. Roughly speaking they consist in using of the experimental cells equipped with mirrors. The laser beam is reflected many times among the mirrors. That leads to lengthening of the light path in gas sample and to an increase of measurement sensitivity. Moreover, proper selection of the detection wavelength reduces the influence of the interferences on the measurement process. These interferences are caused by the compounds that are present in breath with high density (like water and carbon dioxide molecules).

Recent progress in optoelectronics and constant decrease of optoelectronic element prices provide the opportunity to construct relatively cheap, small, easy to maintain sensors that will be useful for screening. We expect that in the future the sensors elaborated within this project could be installed even in ordinary medical consulting rooms. Proposed solutions will reduce the examination costs and will significantly shorten their time to single minutes. In addition, the applied procedures will be simple, non-invasive (like a spirometry), painless and possible to perform during a regular medical visit. That will increase the psychological comfort of the patient and his family.

The team of the project is very well prepared for its realization. The team consists of scientists from University of Warsaw and Military University of Technology, collaborating in the field of trace matter detection in gases since almost 10 years. Within this time the team has realized about 7 scientific grants. Recent works concerned the detection of the breath biomarkers of bowel and liver diseases (methane, CO), lung diseases (NO) and the other ones. Team members are well experienced in various optical and laser techniques in all spectral ranges. Their laboratories are well equipped with modern optical apparatus and the electronics for signal detection below the noise level.

Important aspect of the project will also consist in an impact on Polish medical and optoelectronic industry. The elaborated sensors could be implemented by Polish enterprises in the future. Our team collaborates with the group from the Institute of Electron Technology (where the QCL’s are elaborated) and with VIGO Systems S.A.- the manufacturer of worldwide known IR photodetectors. Results of our investigation would play a role of an indicator about market demand on laser and photodetector types.