Near-infrared spectroscopy is an optical technique that, when used in medical diagnostics, allows the estimation of tissue oxygenation parameters. The idea of the technique is based on measurement of attenuation of light penetrating a tissue. Using 2 wavelengths and knowing the corresponding extinction coefficients for the oxygenated and deoxygenated hemoglobin, one can determine changes in their concentrations. In its simplest and most frequently used form, the analysis of measurement results assumes that the tissue is a homogeneous medium. In case of measurements on a head in search of brain oxygenation, this assumption is extremely important, because it can lead to significant errors in the estimation of changes in hemoglobin in the brain.

The aim of this project is to develop a method that allows invasive measurements using near-infrared spectroscopy. The advantage of invasive measurements is potentially to reduce the influence of extracerebral layers on the measurement results and thus, to more accurately estimate physiological parameters of the brain. Due to the invasive nature of the measurement, these tests can only be carried out in an intensive care unit, where invasive probes are used to monitor intracranial pressure or partial oxygen pressure (PtiO2). The measurement of oxygen partial pressure is an invasive method, that utilizes a photochemical process, so the measuring probe consists, among other things, of an optical fiber.

The measurement method proposed in this project assumes the use of the PtiO2 probe as the detection optical fiber for the NIRS system in order to evaluate physiological parameters of the brain directly. The PtiO2 probe is approved for clinical trials, and therefore has the necessary approvals and permits. Within the project, changes in the concentration of oxygenated and deoxygenated hemoglobin and cerebral autoregulation will be determined. Moreover, we propose a method for assessment of critical-intracranial pressure, i.e. the intracranial pressure above which the cerebral blood flow ceases. In order to verify the measurement method, physiological parameters determined based on invasive and non-invasive measurements will be compared. On this basis, the influence of extracerebral layers on the results of the NIRS measurements will be estimated. In addition, this project will answer the question of whether invasive NIRS measurements are possible using an existing, certified measuring probe for use in intensive care unit and whether there is an advantage of using the invasive NIRS method for patients in severe condition.