UNDERWATER NEAR INFRARED SPECTROSCOPY – UNIRS
Coordinator: Prof. Giuseppe Conte

Abstract This project aims at developing a novel, wearable, biometric device to assess in real-time changes in concentrations of oxygenated hemoglobin and deoxygenated hemoglobin in human tissues of divers during the dive. These two parameters define the oxygen saturation index StO2 of the tissue and they give indication about the hematic flux which flows through it.
The technique to be employed by the device is the so-called near infrared spectroscopy, or NIRS. NIRS is a noninvasive analysis technology that is based on the interaction of biological tissues and blood components with light radiation in the near infra-red region of the electromagnetic spectrum (from about 700 nm to 950 nm). A large number of NIR photons emitted by a source in contact with a biological tissue's surface are reflected outside, along a trajectory that curves backward, after entering deeply into the tissue. NIR probes consist of a light source and a series of sensors that capture the light after it has crossed the tissue at variable depth and it comes back to the surface. Oxygenated hemoglobin and deoxygenated hemoglobin have different adsorption spectra and this make possible, by the analysis of the reflected radiation, to assess the oxygen saturation index StO2 of the tissue. In particular, placing the probe on the forehead, NIRS is used for non-invasive assessment of StO2 in the cerebral.
Continuous monitoring of StO2 in the front cerebral area during the dive can provide useful information for early detection of dangerous levels of hypoxia or hyperoxia, so to activate suitable safety and rescue measures to protect the diver's life. In addition, recorded data can be used for studying specific phenomena in the physiology of diving, as those concerning oxygenation of tissues or neural activity in response to definite stimuli in the underwater environment and/or the effects on the nervous system and on the brain's activity of saturation diving, as well as those of breathing (mixtures of) gases (e.g. nitrox, trimix) that can prolong beyond actual limits the duration of the dive.
The objective of the project can be summarized as follows.

1. To assess viability and to evaluate potential of NIRS techniques in measuring StO2 of biological tissues and hematic flows in the underwater environment up to 50m depth.
2. To design, to develop and to construct a prototypal novel, automatic, wearable, biometric device for NIRS that can work in the underwater environment up to 50m depth.
3. To characterize physiological situations of interest, in particular related to risks of hypoxia or hyperoxia, on the basis of NIRS data.
4. To develop automatic information extraction procedures that can detect the physiological situations of interest mentioned above.
5. To develop standard safety procedure for divers on the basis of NIRS data analysis.