Heat is radiation that is invisible to the human eye (infrared radiation), which provides the comprehensive information about objects – their position in space, temperature, surface properties, as well as information about the chemical composition of the atmosphere through which the radiation is transmitted. All information carried by the infrared radiation can be red and processed by suitable sensors which transform infrared energy into other forms of energy, easy to direct measurement. In this case, they are infrared detectors. Sir William Herschel, the discoverer of infrared (in 1800), used a thermometer as a detector in which he blackened a cup of mercury. Modern infrared detectors work on completely different principles. They have a different design, sensitivity, speed of response, and hence also application. They can be divided into two basic groups: thermal and photon detectors.

In thermal detectors, incident radiation is absorbed in the material, which increases the temperature of the photosensitive element. The detector output signal is caused by the change of a certain material property, which depends on the temperature. The sensitivity of these detectors is wavelength independent and in most cases they operate at room temperature. The speed of thermal detectors is low, from 10^{-3} to 10^{-1} s.

In photon detectors, incident radiation is absorbed in a semiconductor material by the interaction of photons with electrons. The detector signal is caused by a change in the energy distribution of carriers. Photon detectors show a selective dependence of sensitivity on the wavelength of the incident radiation and, compared to thermal detectors, they are characterized by higher detectivity and faster response rate. Detectors with a long-term sensitivity limit above 3 µm usually need to be cooled to a temperature of liquid nitrogen to reduce thermal processes of generation of charge carriers. Cryogenic cooling creates costly and inconvenience limitations. There is, however, a certain type of photon detectors, so-called High-Operating Temperature (HOT) detectors, which can operate at ambient temperature or be cooled using simple, cheap and convenient thermoelectric coolers. HOT detectors are now a Polish IR branch in the global market.

Devices made in the joint laboratory of the Military University of Technology (WAT) and VIGO System S.A. are characterized by high sensitivity and fast response rates. The ones with the best performances, however, are made of a material that is favored for infrared detectors but is difficult to manufacture, that is mercury cadmium telluride (HgCdTe). In addition, the Restriction of Hazardous Substances (RoHS) Directive limits the utilization of heavy metals such as Hg, Cd and Te in electronic equipment under EU legislation. Hence, there is an urgent need to develop an alternative to HgCdTe. For infrared radiation, group AIIIBV semiconductors such as bulk InAsSb and type-II superlattice (T2SL) are the competitive technologies.

For this reason, this project is aimed at investigating the possibility of making an infrared detector based on semiconductors from the AIIIBV group, achieving a response rate of 1 GHz. The key to success will be a thorough investigation of the physics of photoelectric phenomena in this type of structures and their comprehensive experimental analysis supported by numerical simulations made with computer programs.

The research carried out as part of the project will be of great cognitive importance. They will allow to thoroughly understand and investigate the mechanisms responsible for the speed of operation of devices based on novel semiconductors, which has not been done in any research center so far. In the future, this will allow to increase the competitiveness of the existing production of infrared radiation detectors in Poland and guarantee the maintenance of technological advantage over the competition and meeting the market needs.