Research on *higher operating temperature* (HOT) infrared (IR) detectors operating without cryogenic cooling should be considered to be the Polish specialty well recognized all over the world, however many IR applications require operation above room temperature, $T \geq 300$ K. The proposed project continues and develops this research, particularly HOT detection and time response. Among new trends of IR detectors' development, *type-II superlattices* (T2SLs) InAs/GaSb are one of the most widely investigated. The development of T2SLs (InAs, GaSb, AlSb, e.g. InAs/GaSb, InAs/AlSb, Ga-free InAs/InAsSb) heterostructures technology enables a design of IR structures achieving nearly background limited photodetector (BLIP) condition. Theoretical analysis shows, that the inherent material parameters of T2SLs InAs/GaSb detectors might be considerably improved by introducing appropriate design changes in the photosensitive elements. This possibility is offered by structures with multi-stage active layer (cascade structure) and barrier layers. Those architectures increase quantum efficiency and limit the flow of charge carriers. In this case, the signal to noise ratio and the detectivity will continue to increase with multiple discrete absorbers resulting in improved device performance at elevated temperatures. That is why the main goal of the proposed project is research on effects related to the time response, designing, numerical modeling, growth by *molecular beam epitaxy* (MBE) cascade infrared detectors with T2SLs InAs/GaSb active layers with short time constant, operating above room temperature, $T \geq 300$ K. It will be also essential to research on the mechanisms of the carrier transport and generation-recombination processes in multi-stage T2SLs InAs/GaSb structures. Moreover, proposed project is also focused on research on determination of the structure (number of cascades, width of single cascade) and development of the technology of multi-stageT2SLs InAs/GaSb detectors grown on GaAs substrates, operating at $T \geq 300$ K exhibiting high frequency response without impeding detectivity. Our preliminary simulation and experimental results indicate that simple multi-stage structures with T2SLs InAs/GaSb active layers and barrier layers InAs/AlSb SLs grown on GaSb substrates reach time response, $\tau_s \approx 1\text{–}2$ ns (for $V = 400$ mV); detectivity $D^* \sim 10^9$ cmHz$^{1/2}$/W (unbiased structure), peak wavelength, $\lambda_{Peak} \sim 3.5$ μm, and $T \sim 300$ K. It is believed that GaAs substrate implementation may improve D^* by up to 10 times giving flexibility in terms of time frequency response optimization. We assume that within confines of the project we will reach $D^* \sim 10^{10}$ cmHz$^{1/2}$/W and time response, $\tau_s \leq 1$ ns for MWIR range and $T \geq 300$ K for structures grown on GaAs substrates.

The tasks essential to fulfill proposed project are as follows:

1) device numerical modeling using commercially available simulation platform APSYS (T2SLs library);
2) cascade structures growth on GaAs substrates, using MBE - RIBER Compact 21 DZ - MUT/VIGO Systems epitaxy lab);
3) material characterization, e.g. X-ray diffraction, transmission and photoluminescence;
4) detector *processing*, e.g. mesa etching, formation of metal contacts;
5) detector characterization: *I-V*, *C-V*, spectral response, responsivity, time response - optical parametric oscillator (OPO).

The main goal of proposed project is to maintain or strengthen of the Polish specialty in global scale (what we have been doing for nearly 20 years with mercury cadmium telluride, HgCdTe) in terms of designing and fabrication of HOT IR detectors ($T \geq 300$ K). This goal could be met only by introduction and implementation of the new material with better physical parameters in comparison to the HgCdTe being the most explored compound in IR detectors' technology. The proposed project fully uses internal research potential and what is most important it offers further step ahead in terms of development of the new type of IR detectors. The proposed project takes up the subject of the growth of the cascade IR detectors consisting of T2SLs InAs/GaSb active layers on GaAs substrates to form immersion lens which in turn increases detectivity. What is more the project deals with HOT detectors with completely unique energy band structure. The successful realization of the proposed project will have a significant influence on the level of the knowledge in proposed subject. Our main effort will be to increase operating temperature and increasing the time response and/or detectivity at the same time. It requires high technology and numerical modeling capability of the effects related to detection of IR. Advanced simulation of the barrier detectors should lead to optimal architectures and should reduce the cost of fabrication. This allows to increase the range of potential applications in science medicine, environment protection, in particular where cooling is difficult to realize. Proposed detectors structures could be used for detection of explosives, which gets further attention due to increase of the possible terrorist attacks. Tasks planned to be undertaken in this research project are new in comparison to the present state of the art. The lack of the detailed theoretical analysis of cascade IR detectors on GaAs substrates (problems with the growth on GaAs) based barrier detector in terms of time response, no available comparison with conventional detectors, and novel implementation of optimal design solutions underline the innovative character of the project. The proposed subject of research will be of great importance in development of both, the theory and technology of new type of IR detectors exhibiting high frequency response without influencing detectivity. The progress in this project will enable a better understanding of the charge carriers transport effects as well as the sources and mechanisms responsible for detector's time response. Also, it will significantly contribute to a development of the optimal design and technology of MWIR cascade IR detectors ($T \geq 300$ K).