Cell cultures (lines) are integral to numerous biological and medical research. Among the best-known cell lines are those derived from dozens of types of malignant tumors stored by the National Cancer Institute. Among them is, e.g., the HeLa cell line, derived from cervical cancer cells taken from a patient in 1951. HeLa cells are capable of infinite divisions and are considered "immortal." The line is used to study the biology of cancer cells, particularly for developing new drugs. On the other hand, cell cultures are also lines, e.g., stem cells, without which the human body could not be formed and function. Their characteristic feature is the ability to transform into other types of cells that build our bodies.

Regardless of the type of cell culture, incubators are commonly used for their maintenance and development. In these devices, there are strictly defined conditions - the right temperature, CO_2 concentration, and humidity. The cells themselves are stored in flat-bottomed dishes, the volume and surface of which can be very diverse - from several dozen to several hundred mL and up to several hundred cm^2. Some culture vessels consist of a stack of flat-bottomed dishes connected together. Cell studies, on the other hand, take place in multi-well dishes. The number of wells on one pan can range from 6 to even 96.

Cell observations during research and routine culture inspections are usually performed using optical microscopes. This involves removing the cell dish from the incubator and placing it under the microscope so that the cell dish is later returned to the incubator. This solution is routine and relatively uncomplicated but has several disadvantages. The culture is not controlled in real time. Removing the cells from the incubator is only possible for a short time not to disturb the culture's life cycle. In addition, during these activities, there is a risk of contamination of the cell culture and the need to repeat the experiment, which generates significant costs.

It should be noted that there are incubators on the market with built-in microscopes. However, these are large and costly solutions. Moreover, they are unsuitable for observing cells placed, e.g., in a pile of dishes, as it happens, among others in stem cell culture. Strict and strictly defined culture conditions, however, make it difficult to use many types of sensors, including electrical ones, to monitor cells.

A simple and inexpensive solution to the cell monitoring problems described above may be using an optical fiber microcavity Mach-Zehnder interferometer (μIMZI). These structures are manufactured by scientists from the Warsaw University of Technology in cooperation with the Institute of Telecommunications and have been successfully used to monitor cells in an incubator. They consist of a circular hole made in a fiber optic using short laser pulses. As a result of the cavity formation, the light guided by the fiber is divided on the wall of the microcavity, where a part of the light is directed towards it. After crossing it, it will meet (interfere) again with the light guided in the fiber's core. Cells present in the picoliter volume of the cavity, depending on their location and nature, interact differently with the light guided in the cavity, which allows detection not only very small changes in the composition of the culture medium but also allows real-time monitoring of the behavior of cells, including those subjected to stimuli from outside. This may be ionizing radiation. Monitoring the effect of ionizing radiation on cells is particularly important in the case of research on cells, e.g., cancerous.

The main goal of this project is to develop a microcavity system for a Mach-Zehnder fiber optic interferometer whose optical response to ionizing radiation will not depend on it. Experiments will be carried out using radiation from different sources and a wide range of doses. For the obtained platform, cell monitoring experiments and analysis of the effect of ionizing radiation on the behavior of these cultures will be carried out. Ionizing radiation includes gamma rays, X-rays, and high-energy particles, which can interact with biological molecules and generate various biological effects. This radiation is essential in medical imaging, sterilization, mutagenesis research, DNA damage research, and cancer treatment. The unique properties of ionizing radiation make it an invaluable tool for understanding cellular processes, diagnosing diseases, and developing innovative therapies. The research and the information obtained from it will allow, e.g., to adjust the dose and type of radiation in the treatment of cancer patients.