One of the high-risk anthropogenic threats are radioisotopes. The released radionuclides to the environment during nuclear plant accidents like Fukushima Daiichi or Chernobyl but also in satellite accidents (e.g. SNAP-9 burn-on) together with nuclear weapon tests have spread all over the world. Radioisotope decay, through the emission of high energy particles, interacts with matter by ionizing it. High radiation doses are lethal to the organisms due to structural changes in organic compounds including DNA. The disintegrations of the DNA result in the malfunction of transcriptions whereby organisms are dying due to broad metabolic dysfunctions. However, such high doses do not occur widely in the natural environment. The effects of very high ionizing radiation on organisms are well understood, while less is known about how organisms respond to lower chronic exposure. In recent years, high concentrations of artificial radionuclides compared to other terrestrial ecosystems have been found on glaciers. The glacial ecosystem is also characterized by a relatively simple trophic network and the patchy distribution of organisms in the so-called cryoconite holes. Therefore, glaciers are a suitable model to study the effects of chronic ionizing radiation on organisms in the natural environment. The main aim of this project is to understand whether chronic environmental ionizing radiation on glaciers influences organisms functioning.

The project combines the high efficiency of laboratory experiments with environmental samples analysis. This will allow understanding of whether relationships between ionizing radiation and organisms functioning observed in the laboratories around the world are directly reflected in the natural environment where other factors also act. The radioactivity of the glacial sediments will be measured along with the activity of genes related to the defense of organisms against the effects of ionizing radiation. Moreover, the experimental part will validate the results obtained as part of the in situ approach, using one species of cyanobacteria living on glaciers. High-energy molecules emitted during the decay of nuclei by ionization of cellular water cause the formation of reactive oxygen species that interact with cellular structures in a wide range. Organisms, on the other hand, activate enzymes that neutralize them in response. Since water is the main substance in the cell, the first signs of an organism's defense should be observable in the form of increased activity of oxidative stress genes. On the other side, indirectly and directly, ionizing radiation might cause breaks in DNA strand. Because such events are very dangerous for the cell functionality, mechanisms like SOS response are activated which directly increase the ability of organisms to act against DNA breaks. If high-energy ionizing radiation occurring in the environment interacts with organisms, changes should be observed in such basic cell systems.

This project raises the challenge of combining effective and controlled laboratory research with an understanding of processes in the natural environment. As nuclear energy potentially becomes the major source of electricity for our planet, it is important to understand in detail its environmental impacts not only on zone closely related to nuclear accidents but also on the global ecosystem.