Construction of a high-granularity scintillating detector prototype for applications in medical physics

The aim of the presented project is construction of a prototype of a detector for medical imaging purposes. The detector will consist of thin and elongated pieces (so called fibers) of a scintillator, ie. a material which emits light under an influence of ionizing radiation. This light can be subsequently detected with specialized sensors called silicon photomultipliers. The proposed detector will consist of several layers of the scintillating fibers coupled with the silicon photomultipliers at both ends. Such a construction will not only ensure high granularity but will also allow for flexibility in the detector geometry. Design of the prototype will be a preparatory stage for construction of the larger, final device intended for proton therapy monitoring in real time. Proton therapy is a type of radiotherapy in which a patient is irradiated with a proton beam. Parameters of the proton beam are selected in such a way, that particles deposit most of their energy in the area of the tumor, and thus cancer cells are destroyed. Because of the specific character of interaction of charged particles with matter this type of radiotherapy can be much more precise than traditional radiotherapy using X rays or gamma radiation. However, due to continuous anatomical changes ongoing in the human body, a shift of the deposited dose in relation to the assumed treatment plan may occur. In order to avoid such situation and take full advantage of the potential of proton therapy the methods of dose distribution monitoring in real time are needed.

As a part of the presented project a series of laboratory test will be conducted in order to examine individual elements of the detector, and thus ensure its best performance. The assembled detector will also be a subject to a series of laboratory experiments using a radioactive source. The aim of those experiments will be an optimization of the device geometry and prepared data analysis algorithms. As a result, the application of the latest advances in nuclear and high energy physics, such as scintillating fibers and silicon photomultipliers, will be demonstrated in the context of medical imaging. Construction of the prototype will be an important step towards the detection setup for monitoring of the dose distribution in proton therapy. It needs to be stressed, that the designed detector and used technological solutions can be applied not only in proton therapy monitoring but also for other types of medical imaging devices, eg. SPECT (Single-Photon Emission Computed Tomography).