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Prototype of a module of a Compton camera for online beam range monitoring in proton therapy

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The main advantage of proton therapy over conventional radiotherapy is the scheme of dose deposition: unlike X-rays, protons are fully stopped in patient's tissues with a distinct maximum at the end of their range: the Bragg peak. Such a distribution allows for a precise coverage of a tumor volume while sparing the nearby healthy tissues. However, accurate control of the proton beam range is still considered a challenge. The SiFi-CC (SiPM and scintillation Fiber based Compton Camera) project aims to develop a method of in vivo proton range monitoring with the use of a Compton camera. Such a detector exploits the Compton effect and can register prompt gamma rays produced when protons interact with the nuclei of the tissues. We propose a design which is a trade-off between the camera performance and its cost, dependent on the number of channels. In our approach, both detector modules (scatterer and absorber) will consist of multiple layers of scintillation fibers with dual readout via silicone photomultipliers. The scintillation material and fiber coating were chosen based on an extensive study of the fiber properties [1]. Our simulation studies have shown that such a solution is feasible and appropriate for online range monitoring in proton therapy [2].
I am going to present the idea and overview of the SiFi-CC project and elaborate on the single module prototype of a Compton camera that is already assembled and examined. I will present the results of the prototype performance tests: a comparison of different types of optical coupling, crosstalk effect, position- and energy resolution, along with conclusions for the construction of a full two-module Compton camera detector.

[1] K. Rusiecka et al., JINST 16 (2021) P11006
[2] J. Kasper et al., Phys. Med. 76 (2020) 317

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