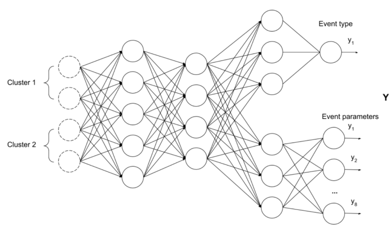
Theses in Bragg Peak Online Monitoring

Ion therapy is a very precise tool in cancer treatment because of its characteristic longitudinal dose profile (Bragg peak). To optimize the precision of ion therapy, a real-time monitoring of the longitudinal Bragg peak position is needed. A promising approach towards online range verification in ion therapy is the analysis of prompt gamma radiation emitted by several nuclear processes. To detect these prompt gammas, we develop in a collaboration with the Jagellonian University in Krakow a **Si**PMs and scintillating **fi**ber-based **C**ompton **C**amera (SiFi-CC).

The SiFi-CC is built of heavy, scintillating crystals shaped into thin fibers and then glued together to two solid blocks. The blocks are the scatterer and the absorber plane of the Compton Camera. If the incoming photons interact first via Compton effect in the scatterer and then are absorbed in a second reaction in the absorber it is possible to confine the direction of the initial photon to a cone surface. By overlaying many of these cones we can reconstruct the distribution of the energy deposition.

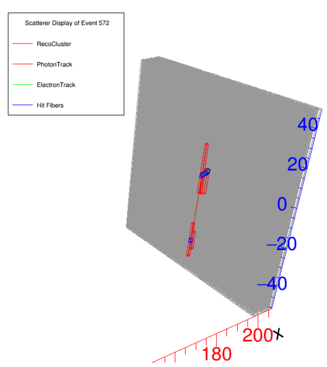
Master's Theses

Improvement of event identification for the SiFi-CC with neural networks



The ideal event to be reconstructed for a Compton camera is an event where the photon interacts via Compton effect in the scatterer and is afterwards absorbed in the absorber via photoelectric effect without any further interactions. In the ideal case both of these interactions happen in a well defined not wide spread area. But since the fraction of events that actually fulfil exactly these criteria is not high enough to reconstruct a Bragg Peak position, events with a different signature need to be used as well. To differentiate between different signatures of Compton events that can be used for the reconstruction and background events, our group developed a neuronal network with a novel design architecture to identify the interaction positions needed for reconstruction. In this thesis it is your task to improve our neural network and introduce new features to perform an optimal event selection. For this thesis programming experience is advantageous.

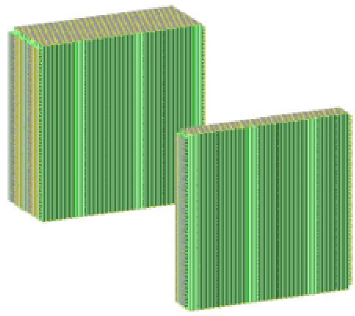
The SiFi-CC used as a Single Plane Compton Camera



A classical Compton Camera as the SiFi-CC depends on interactions of the photon in both, the scatterer and the absorber. All the events where the photon is scattered in one of the modules and interacts again in this module, but not in the other one, can not be used for the reconstruction of a Compton cone. The concept of a Single Plane Camera is based on different energy depositions in two or more detectors that are placed in the same plane with respect to the source but next to each other. Based on this energy distribution, information about the original position of the source can be gained. Since the SiFi-CC modules are build in a very granular way, it is easy to subdivide a single module into sub-parts and so build the needed detectors for a Single Plane Camera. In this thesis, it is your task to use the data from the Geant4 simulation to test the capability of the SiFi-CC setup approach to function as a Single Plane Camera and to determine the extra information that can be gained from this. As Geant4 and Root are run in C++, programming experience is advantageous.

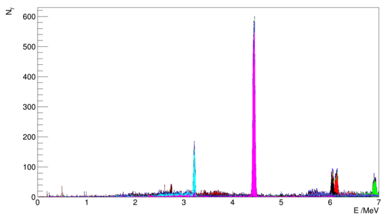
Bachelor's Theses

Simulation of a shielding for the SiFi-CC



For reconstruction of the Compton cone, one needs the photon to interact in both the scatterer and the absorber. There are a lot of events where there is only an interaction in one of the modules or there are events with background interactions from additional particles. To identify particles leaving the camera without interaction an active shielding or veto detector could be build around the setup. To only stop particles from the outside, a passive shielding would be sufficient. In this thesis it is your task to implement a shielding in the Geant4 simulation of our Compton Camera and to evaluate its influence on the cleanliness of our event selection. As Geant4 is run in C++, programming experience is advantageous.

Simulation study of the angular dependence of the energy spectrum



The prompt gamma radiation emitted from the patient has an angular dependency. Depending on the position of the detector relative to the patient and the tumor, the measured energy will therefore change. In this thesis it will be you task to characterize these changes by means of a Geant4 simulation. So the best place for the detector in the treatment room can be found and corrections for measurements from different angles can be calculated. As Geant4 is run in C++, programming experience is advantageous.

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It is possible to work on all topics from home, so there are pandemic-save.

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