III. Physikalisches Institut B | RWTH AACHEN UNIVERSITY

Theses in Bragg Peak Online Monitoring

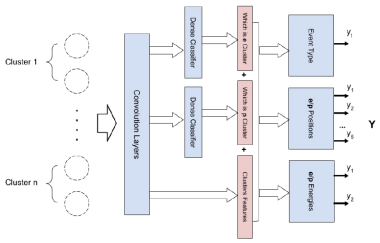
Ion therapy is a very precise tool in cancer treatment because of its characteristic longitudinal dose profile (Bragg peak). To optimize the precision of ion therapy, a real-time monitoring of the longitudinal Bragg peak position is needed. A promising approach towards online range verification in ion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

SiFi-CC

The SiFi-CC is built of thin fibers made of heavy, scintillating crystals which are arranged into two solid blocks. The blocks are the scatterer and the absorber plane of the Compton Camera. If the incoming gamma 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 photons to a cone surface. By overlaying many of these cones the distribution of the energy deposition can be reconstructed.

Master's Theses

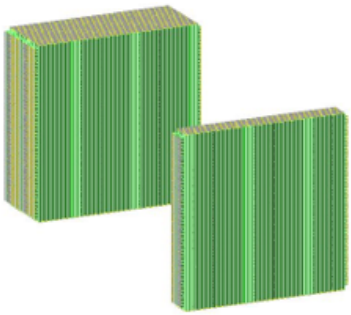
Improvement of event identification for the SiFi-CC with neural networks



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 fulfill exactly these criteria is not high enough to reconstruct a Bragg Peak position, events with a different signature need to be considered 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 test different network architectures. For example, a Bayesian neural network can be set up to investigate the uncertainties of the predictions. For this thesis programming experience is advantageous.

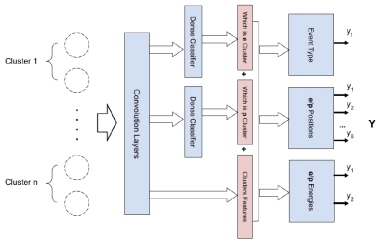
Bachelor's Theses

Simulation studies to optimize a veto detector for the SiFi-CC



Corresponding to the principle of a Compton camera, the measured positions and energies of the scattered photon and the electron from the first Compton interaction are used to reconstruct the Compton cones. For correct reconstruction, the measured deposited energy needs to be equal to the energy of the primary photon. If the scattered photon deposits only a part of its energy in the SiFi-CC volume and leaves the detector afterwards, the reconstruction gets incorrect. To register the events, where the energy is not fully deposited in the SiFi-CC volume, a veto detector can be applied. In this thesis, it is your task to optimize a veto detector in the Geant4 simulation of our Compton Camera and to evaluate its influence on the accuracy of our event selection. As Geant4 is run in C++, programming experience is advantageous.

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 fulfill 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 neural network with a novel design architecture to identify the interaction positions needed for reconstruction.
Topics related to the neural network are, for example, the improvement and evaluation of the network using different datasets or creating a network which can be used for an intermediate reconstruction step.
For this thesis programming experience is advantageous.

Contact

Dr. Ronja Hetzel	hetzel@physik.rwth-aachen.de	26C203
Mareike Profe	profe@physik.rwth-aachen.de	26C203

In general, it is also possible to work on slightly different topics. Please contact us if you are interested in this. You can work on all topics either in the institute or from home, so they are pandemic-save.

Later this year, topics related to the hardware development of the SiFi-CC project can probably also be offered.

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