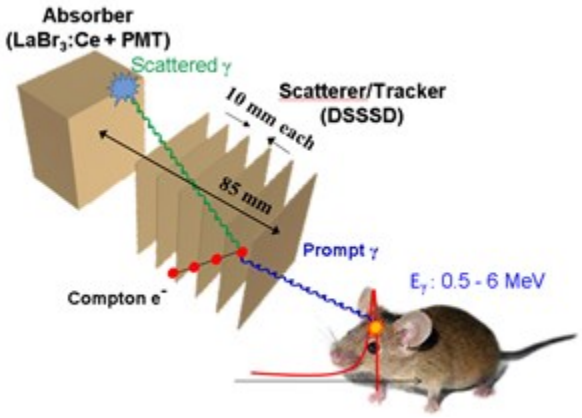
LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Range Verification in Hadron Therapy – Prompt Gamma Imaging

Master Thesis: Prompt-Gamma Imaging with a Compton Camera

Overview Hadron therapy, i.e treating cancer by irradiating tumor cells with particles like protons or ions, offers distinct advantages compared to conventional radiation therapy with photons. One of the central issues in hadron therapy is the exact stopping position of the beam particles ("Bragg peak") inside the patient during treatment. Here the dominant amount of the therapeutic dose is planned to be deposited in the tumor volume. Thus the tumor can (in principle) be targeted very precisely, while surrounding healthy tissue can be spared. However, various beam range uncertainties force to apply safety margins around the tumor volume that compromise the initial precision of the method. It is the goal of our project to develop a diagnostic tool that ultimately allows to reduce these safety margins.



Schematic of our Compton camera prototype consisting of a monolithic scintillator as absorber and 6 layers of double-sided silicon strip detectors as scatterer.

Context of the thesis During the irradiation with hadrons, nuclei contained in the tissue target (e.g. ^{16}O, ^{12}C) are excited due to nuclear reactions and de-excite promptly under the emission of photons. These so-called prompt gamma rays can be used to visualize the Bragg peak, as there is a direct correlation between the amount of emitted photons and the energy deposit.

In our group, we develop a "Compton camera" for the localization of the Bragg-peak position. This Compton camera is a double-stage photon detector, consisting of a scatter and an absorber component (see figure) and allows for the reconstruction of the origin of photons by exploiting the kinematics of Compton scattering.

Our setup Our detector prototype consists of a $LaBr_3$:Ce scintillator, read out by a 64-fold photomultiplier tube (PMT) as absorber detector. The scatterer is composed of 6 layers of double-sided silicon strip detectors, allowing not only for the detection of photons, but also of the Compton-scattered electrons. Furthermore, we are currently investigating an alternative scintillation crystal ($CeBr_3$) as absorber, silicon photomultipliers (SiPM) as alternative photo-sensors with corresponding highly integrated readout electronics and a scintillator-based scatterer.

Scope of the Thesis Project: We are looking for a highly motivated student for a Master Thesis project located at the Chair of Medical Physics (LS Parodi) in Garching to work with us on the further development of the Compton camera detector system. The project tasks will comprise characterization measurements of new detector components, participation in a beamtime at the MLL Tandem particle accelerator for online tests of the full Compton camera prototype and the analysis of data obtained during previous beamtimes.
Experience in laboratory work and python coding is advantageous but not mandatory.

If you are interested and like high-tech labwork as well as computer-based data analysis, then you should contact us to make an appointment for a personal visit for further details on the project and a tour of the labs:

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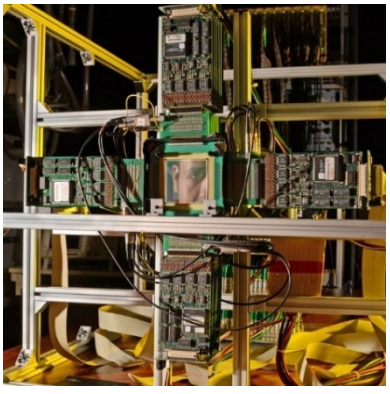

Scatter part of the Compton camera: Double-sided silicon strip detectors with their readout electronics

For further information please refer to:
https://www.med.physik.uni-muenchen.de/research/range-verification/promptgamma/index.html