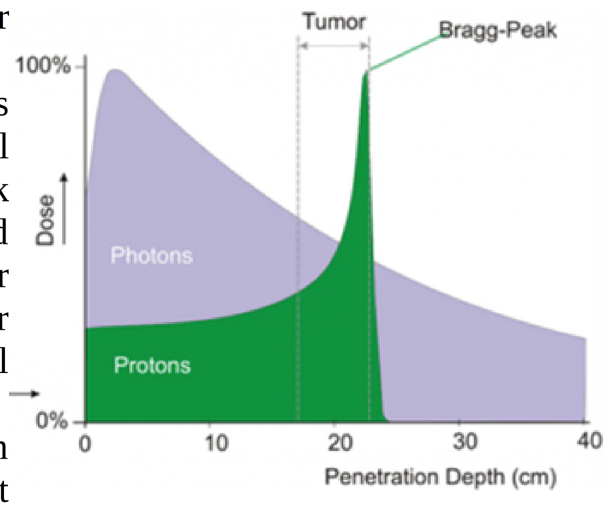
LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Master Thesis

Chair of Medical Physics (LS Parodi), Garching

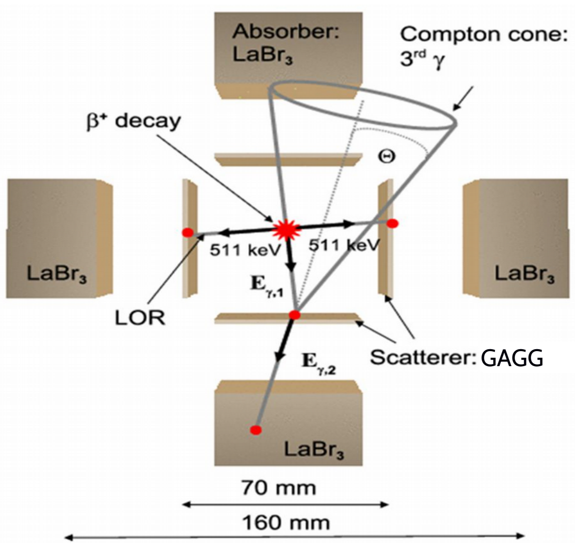
Hybrid Photon Detection System for PET and Prompt Gamma Imaging

Contribution to the EU Marie-Curie project HIPPOCRATE



Overview Proton therapy for cancer treatment is a worldwide rapidly growing treatment option due to its advantageous dose profile compared to conventional photon therapy based on the Bragg peak (see Fig. 1): a high dose can be delivered very localized and conformal to the tumour volume while minimizing side effects for the surrounding healthy tissue (or critical organs).

One of the most essential questions in hadron therapy is therefore the exact position of the Bragg peak inside the patient during the treatment. Due to non-negligible uncertainties during the treatment planning and delivery, there is an urgent demand of novel real-time techniques for the (in-vivo) verification of the proton beam range simultaneously to the dose deposition.



Objective of the thesis project The goal of this thesis project is the setup and characterization of a novel photon detection system, which combines medical imaging modalities of Positron-Emission Tomography (PET) and Prompt-Gamma Imaging for high-precision proton therapy exploiting the Compton scattering kinematics (‘Compton camera’). A 4-arm Compton camera system (Fig. 2) has to be set up in the Garching laboratory, including a detector support structure with flexible positioning capability. Characterization of detector properties and data acquisition will be pursued for Compton and PET imaging of various radioactive photon sources at different positions, and exploring different, relative detector geometries aiming to an optimal imaging setup.

Context of the thesis project The most promising method for in-vivo proton beam range verification relies on the detection of prompt de-excitation photons from nuclear interactions induced by the proton irradiation of the patient. Using a so-called Compton camera, the prompt γ's can be used to visualize the Bragg peak, as there is a direct correlation between the amount of emitted photons and the energy deposit. From the kinematics of Compton scattering, the photon source position can be reconstructed, spanning the so-called Compton cone. Combining four Compton cameras in a rectangular configuration (Fig. 2), one can benefit in addition from the PET signal: β^+-emitters produced by fragmentation processes in the tissue during irradiation (some decaying into an excited daughter that de-excites by an additional third photon) emit positrons that annihilate into two antiparallel gammas (511 keV). Those can be detected by two opposing Compton cameras, allowing for the reconstruction of a line-of-response (LOR). In case of a third photon emission in coincidence to the β^+-decay, the gamma's Compton cone can then be intersected with the PET LOR, thus enhancing the sensitivity, enabling (for specific isotopes) sub-millimeter spatial resolution and opening up the possibility of an almost on-the-fly reconstruction with only few tens of events (compared to thousands in conventional PET) to be processed.

- This Master Thesis project will provide you with a deep insight in the development of modern medical imaging devices starting from basic detector characterizations, to data acquisition and analysis software development and eventually the commissioning phase with benchmark tests.

- We are looking for a highly motivated student with the ability to work independently and conscientiously.

- If you are interested in working in our team, please send your application (motivation letter, CV, transcript of records) including a description of previous experiences in experimental and/or practical work to:

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For further information please refer to:
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