Abstract

Proton radiotherapy can provide an addition to cancer treatment as the delivered dose in the patient can be deposited accurately. Since the path to the tumour is determined by Computed Tomography and Magnetic Resonance Imaging, a calibration between proton stopping power and photon mass attenuation coefficient needs to be made. As this translation is complex due to the difference in interaction mechanisms, it is necessary to increase the margins around the tumour location. More tissue is irradiated as a consequence, reducing the benefit of proton radiotherapy. This problem would be resolved when protons are used for imaging purposes, which introduces the field of proton radiography. As protons scatter significantly, they must be tracked individually before and after traversing the patient. A radiograph of the different densities in the body follows from the measured energy loss along the reconstructed path. The requirements of measuring the particle's position and energy deposition lead to a distinct detector design.

A prototype consisting of two Time Projection Chambers and a BaF_2 calorimeter (ProPix I) was constructed in previous studies. The data collected in 2015 at the proton beam of KVI, Groningen, is used to further characterise said configuration. Several improvements on the acquisition software are performed and a data analysis is presented afterwards: the energy deposit radiograph is shown to possess a 2.5% density resolution and the scattering radiograph is constructed for the first time. Additionally, the combination of both parameters is shown to provide an excellent method of separating materials. As ProPix I is limited in its data-acquisition rate, a second generation design (ProPix II) - fully based on pixel detectors - is proposed. After simulations show the promising features of said configuration, some characterisation is performed with a radioactive source. By the collection of results on spatial resolution, density resolution and data-acquisition rate, it is shown that the proposed design has properties close to those required for clinical application.