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Development of the Proton Computed Tomography (pCT) prototype

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Proton computed tomography (pCT) is a novel three-dimensional medical imaging technique proposed for the pre-treatment diagnosis of patients undergoing proton therapy. The two main components of our pCT prototype are a proton tracker and a calorimeter. A proton tracker allows precise tracking of proton trajectories, while a proton calorimeter provides accurate measurement of their energies. For our design, we use a specific monolithic active pixel sensor (MAPS) called ALPIDE as an essential part of both a proton tracker and a proton calorimeter. Our pCT prototype has been tested with the Varian ProBeam Compact Proton Therapy System at King Chulalongkorn Memorial Hospital (KCMH), Bangkok, Thailand. The integrated trigger system was also developed to synchronize between the proton beam and the pCT components. The trigger signals are transmitted to activate the rotational stage, produce detection events for the ALPIDE chips, and regulate the proton gating. With this setup, we have studied the possibility of reconstructing proton tracks from activated pixels in a two-sigma region of a Gaussian profile. This study focused primarily on the proton beam, which had the lowest energy of 70 MeV, and the transmission beam used for pCT imaging, which carried an energy of 200 MeV. For both energies, almost 70% of the tracks could be effectively reconstructed from every layer of the ALPIDE chips. The testing results of the pCT prototype run under our trigger system confirm that the ALPIDE chips can be used as integral components for both a tracker and a proton calorimeter.

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