AbstractID: 9435 Title: A Design of Compton Cameras for Imaging Gamma Emission in Proton therapy

Purpose: To design a Compton camera to image gamma-ray emission during the treatment of proton therapy as a possible method to verify dose delivering.

Method and Material: The pixilated $LaBr_3$ (Ce) crystal was investigated as both scattering and absorbing detectors. In this design each $LaBr_3$ crystal module used in front layer has the size of 2.5cm x 2.5cm x 0.5cm that was segmented into 4mm x 4mm x 2mm on its top to enhance the spatial resolution based on the differential response of PSPMT that receives scintillation light. Each detector in the rear layer has the size of 2.5cm x 2.5cm x 3.0cm and was segmented into 4mm x 4mm x 10mm. The position resolution in locating interaction is about 2mm laterally and 2.5mm vertically in the front detectors while the resolutions are 2mm and 15 mm in the rear detectors. The efficiency and angular uncertainty of this Compton camera was investigated based on numerical calculation. The geometry of the detectors and distance between detectors were optimized to achieve high efficiency or high angular resolution.

Results: Angular uncertainty of ~0.1 radians was the low limit for us to image 511 keV gamma rays because of the Doppler broadening. However, the angular uncertainty below 0.05 radians was achievable by observing the scattered photons at about 25^o-60^o scattering angle for 10 cm distance between detectors.

Conclusions: Based on numerical calculation, we proposed a Compton camera with two layers. The potential angular resolution in imaging 511 keV gamma rays was about 0.3 radians while it was 0.05 radians or less from gamma rays above 2 MeV. The angular uncertainty is relevant to resolution, but higher resolution can potentially be achieved with proper image reconstruction algorithms that will be developed and evaluated in future.