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Development of Compton Camera System for Unmanned Helicopter

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Abstract: To localize the radiation source in the contaminated areas in Fukushima is essential and urgent. Based on this purpose, we are developing a Compton camera with radiation localization capability which could be mounted on an unmanned helicopter to scan the contaminated areas. The Compton camera is composed of two arrays of GAGG scintillators coupled with photo detectors and uses dynamic time-over-threshold (dToT) electronics for multi-channel spectra acquisition. The being developed system has two imaging modes, one is gamma-camera mode which maps the measured count rate with energy selection using the scanning flight and the other is Compton-camera mode which maps the Compton image using the hovering flight. Here the initial performance of the being developed camera is reported.

Keywords: Gamma Camera, Compton Camera, Unmanned helicopter, Hot spot

1. Introduction

To localize the radioactive materials in the contaminated areas is essential and urgent for the evaluation of decontamination in Fukushima. We are now developing a Compton camera with radiation localization capability. In this research, we employed an unmanned helicopter which can carry the Compton camera to scan the contaminated areas. The figure below shows the schematic of the being developed system.

This Compton camera consists of two arrays of scintillator detectors. Each array has 4×4 detectors. GAGG, coupled to a 4×4 array of Silicon Photomultiplier (SiPM) as the scatter and 4×4 array of Avalanche Photo Diode (APD) as the absorber, is employed as the scintillator. GAGG is a new scintillator with energy resolution of 4.3 % @ 662 keV, light output of 60000 photons/MeV, 88ns decay time and low self-background radiation. The size of the crystals for scatter is 10×10×5(mm), while that for absorber 10×10×10(mm). The detectors are connected to dToT ASICs to convert the charge signal into the digital signal which was processed with a FPGA for the coincidence detection. The coincidence events are recorded with the position data of the camera from a GPS mounted on the helicopter and transferred to the ground PC using Wi-Fi communication modules.

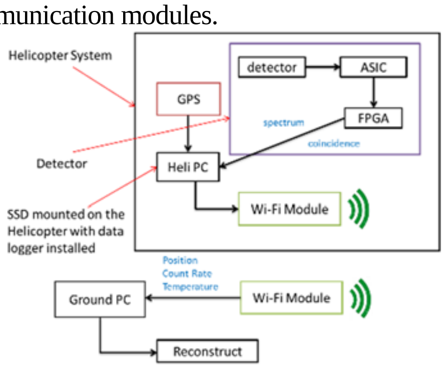

Fig. 1: The schematic of the whole system

2. Experiment and Results

We did some lab experiments to characterize the performance of the detector. Figure 2 shows the setup of the experiment. We got an angular resolution as high as 14degree and an efficiency as high as 1.6%. Figure 3 shows the reconstructed image when the source was put at the center position. The image was reconstructed with Filtered Back Projection (FBP) based on Legendre series.

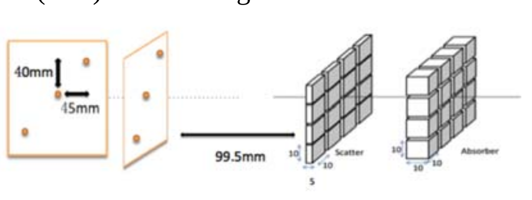

Fig. 2: Setup of point source image experiment

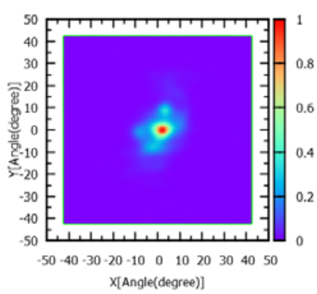

Fig. 3: Image when the source was put at the center

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