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#6-122 Single-plane readout Compton camera - laboratory performance evaluation

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In the evolving landscape of radiation imaging for applications in astrophysics, medical imaging, and homeland security, the Compton gamma camera has proven to be a highly advantageous and versatile tool for imaging and localizing gamma radiation sources. Compton cameras take advantage of Compton scattering kinematics to reconstruct the direction of the incoming gamma rays and hence to localize the source. The scintillator-based Compton gamma cameras, read out by silicon photomultipliers, offer a compromise between angular resolution, efficiency and compactness, which are crucial to build lightweight and portable devices. Most scintillator-based Compton gamma cameras comprise at least two separate readout planes, necessary to accurately determine the locations of the scattering and of the absorption of an incoming gamma ray. We developed a novel single-plane Compton gamma camera, based on segmented scintillators read out only on a single side by silicon photomultipliers. The detector features an 8x8 matrix, where each element consists of two 3x3x3 mm^3 GAGG:Ce scintillator crystals optically coupled on both sides of a 3x3x20 mm^3 plexiglass light guide, forming two separate but optically coupled layers of crystals. The front layer functions as the scatterer and the back layer as the absorber, while both are read-out by a single SiPM array placed on the back of the matrix. This novel configuration reduces the number of read-out channels by half compared to dual-plane readout, maintaining compactness and portability. We performed in-depth laboratory characterization of our novel Compton gamma camera, by measuring its energy resolution and angular resolution across a range of gamma energies, including 511 keV and 662 keV, and by imaging radioactive sources at different positions within the field-of-view. In addition to measurements, we performed GEANT4 simulations to help us identify the noise sources, attributed to specific light interactions, aiding in refining the dataset for improved image reconstruction fidelity. The camera's energy resolution measured at 662 keV, is 8.9 ± 1.9% for the front layer and 10.8 ± 1.6% for the back layer. In the preliminary imaging tests with Cs-137 or Na-22 source placed 100 mm in front of the module, we clearly reconstructed the source image, with angular resolution measure of 14.0° (FWHM) for 662 keV and 14.2° (FWHM) for 511 keV gammas, respectively. We will also compare reconstructed images obtained using Simple Back Projection and Maximum Likelihood Expectation Maximization algorithms, demonstrating sensitivity for imaging off-axis sources within the field of view. This study underscores the capability of the novel Single-plane readout Compton camera to image gamma sources, with promising applications as a compact device in environmental gamma-ray detection and homeland security monitoring.

Primary author: DASH, Om Prakash (University of Zagreb Faculty of Science, Department of Physics)

Co-authors: Prof. BOSNAR, Damir (University of Zagreb Faculty of Science, Department of Physics); Prof. MAKEK, Mihael (University of Zagreb Faculty of Science, Department of Physics); BOKULIĆ, Tomislav (University of Zagreb Faculty of Science, Department of Physics)

Presenter: DASH, Om Prakash (University of Zagreb Faculty of Science, Department of Physics)

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