# Monte Carlo Simulation and Analysis Framework for a CdZnTe-based Spherical Coded Aperture and Compton Gamma-ray Imager

NE 255 - Numerical Simulation in Radiation Transport
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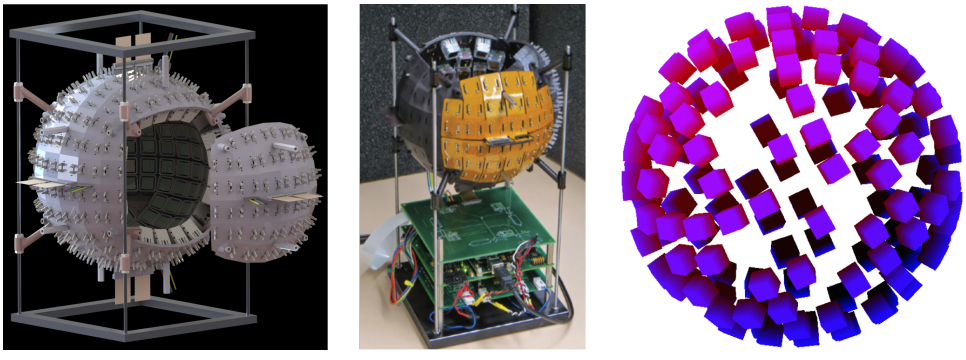
## I Introduction

The goal of this project is to improve a Geant4 [1] Monte Carlo simulation for the Portable Radiation Imaging Spectroscopy and Mapping (PRISM) detector system under development at Lawrence Berkeley National Laboratory (LBNL) (see Fig. 1a-b) and to develop a small suite of analysis tools. The PRISM system consists of $cm^3$ CdZnTe (CZT) coplanar grid (CPG) gamma-ray detectors arranged on the inner surface of a 14 cm diameter sphere. There are 192 available detector locations on the sphere, but an active coded arrangement, or a pattern of occupied and empty locations (see Fig. 1c), of the detectors allows for gamma-ray imaging in $4\pi$ using both coded aperture (low energy) and Compton imaging (high energy) modalities. The purpose of the simulation is to determine the response of the system to radioactive sources of varying energies, intensities, and spatial distributions in the entire $4\pi$ field-of-view (FOV). The simulated response can then be used as a tool to inform prototype design, for characterization, and for image reconstruction.

The original simulation was developed in order to generate a simple approximation of the coded aperture response in the far-field limit (parallel rays at infinity). The simulation essentially functioned as a ray-tracer (i.e. no scattering, no secondary electron tracking), however some physics was included to account for the depth-of-interaction (DOI) in each detector. This project aims to restructure and upgraded the original simulation to include more functionality such as scattering physics, secondary electron production and tracking, multi-site events, geometry modification, and near-field sources with varying strengths and distributions. In addition to the simulation, analysis tools used for event sequencing, data preprocessing, and 2D/3D image reconstruction will be developed. The ultimate objective of this project is to develop a high-fidelity, robust, flexible, well-documented, and easy to use simulation and analysis framework that can be used to answer a variety of research questions for the novel concept of a spherical coded aperture and Compton imaging system.



(a) (b) (c)

Fig. 1. (a) Modular design of PRISM. (b) PRISM prototype system currently under development at LBNL. (c) Example coded arrangement of detectors.

Outline the rest of the report here...

## II Mathematics

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## III Algorithms

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## IV Plans for Completion

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## References

[1] S. Agostinelli *et al.*, (GEANT4 Collaboration), Nucl. Instrum. Methods A **506**, 250 (2003).