# Imaging Scintillation Events via a Lens

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## Abstract:

Gamma ray detectors measure the position and energy deposition of interactions from incident gamma rays. This information is used to determine the direction to the radiation source, with applications in nuclear security, medical imaging, and astronomy. A scintillator detector emits visible light from a gamma ray interaction's location, which is termed as a "scintillation event". Previous methods use silicon photomultipliers (SiPM) coupled to the scintillator's surface to capture the light and measure interactions. However, two separate interactions in one monolithic scintillator cannot be distinguished due to the spread of light overlapping on the SiPM. Measuring two interactions from one gamma ray is needed to perform Compton backprojection to determine the direction to the radiation source.

We address this problem via hardware and propose to measure interactions by imaging a monolithic scintillator with a lens and a single photon avalanche diode (SPAD) array. SPAD arrays detect single photons of light and have high spatial and temporal resolution needed to measure scintillation events. By employing a lens, light from two separate interactions is prevented from overlapping on the SPAD array, thus retaining the information needed to measure two separate interactions in a monolithic scintillator. An interaction can be considered a point source of light. Therefore, an image of an interaction should contain a cluster of photons whose diameter depends on the distance from the focal plane due to defocus blur.

We report experimental images of scintillation events taken with different lenses. Many images containing clusters of photons are captured when the gamma ray source is present. Clusters with different diameters are captured, indicating that defocus blur based on interaction location is being observed. Few clusters are captured when no source is present due to noise from dark counts or background radiation.