Quantification of Spatially Variant Efficiency in an Orthogonal Strip Detector

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Abstract

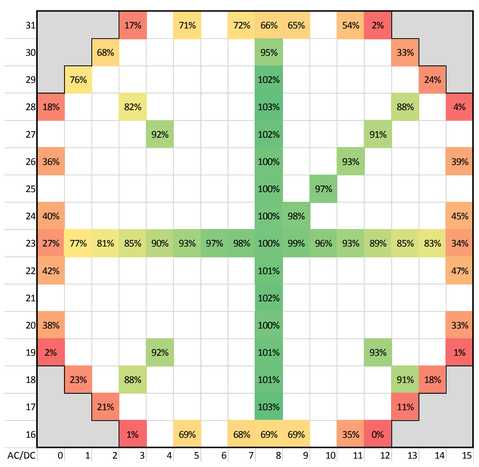
Traditionally, direct gamma-ray imaging has been focused on far-field measurements or used highly collimated pinhole systems. An underutilized method for direct gamma-ray imaging is that of near-field measurements.

Recent work has shown that the relative efficiency of these detectors is dependent on interaction location. This has been less significant for far-field imaging as sources are assumed point-like. When performing near-field measurements, accounting for spatially variant efficiency is important to correctly quantify the source.

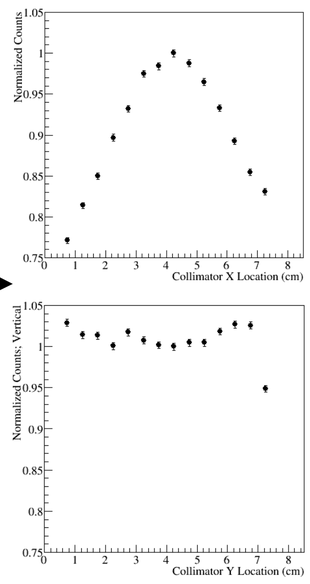
The GeGI detector placed against the collimator

The GeGI detector crystal. There are 16 strips orthogonally on the front and back faces.

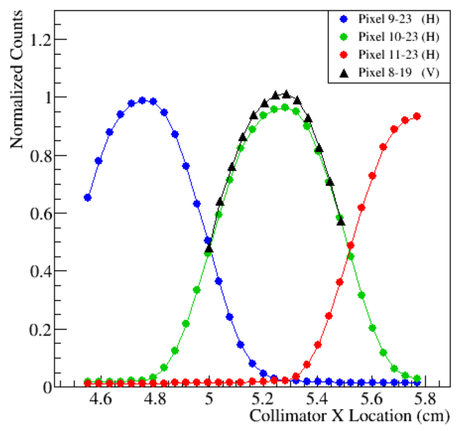
Bulk efficiency variation across the whole crystal



Coarse scans across the whole detector show large efficiency changes horizontally with minimal changes vertically.

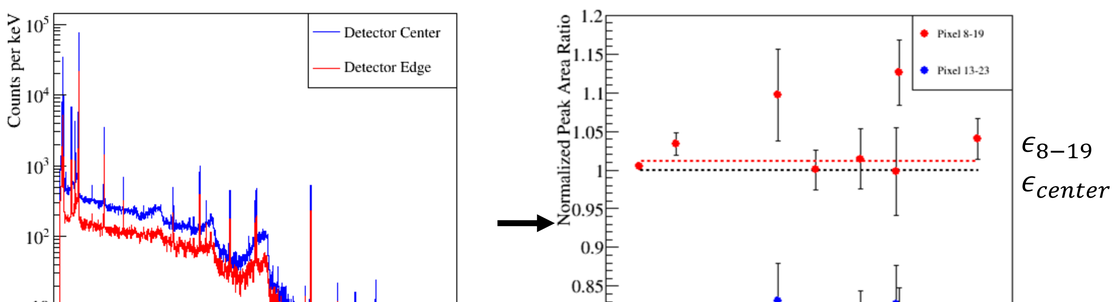


Bulk efficiency variation across individual strips



Fine scans across a single strip show that at the strip edges events are being lost; these events are accounted for in the neighboring strips although there is a net overall loss. This is seen in both horizontal (Blue, Green, Red) and vertical (Black) scans.

Energy dependence of the efficiency variation



Measurements were made at the detectors center, and then with a vertical or horizontal displacement to determine the energy dependent efficiency. The decrease in efficiency is a bulk loss and not an energy dependent loss.

Conclusion

It has been shown that, across the face of the detector, the efficiency varies significantly, such that a singular efficiency calibration is not correct. The non-uniformity in efficiency results in incorrect source quantification in two scenarios: small samples that do not encompass the detector's entire field of view and large samples that are significantly heterogeneous. In either of these cases, by correcting for the changing efficiency, there will be an improvement in the measurement's precision.

ABOUT

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