SCHOOL OF ENGINEERING

VANDERBILT UNIVERSITY

Distribution of Proton-Induced Transients in Silicon Focal Plane Arrays

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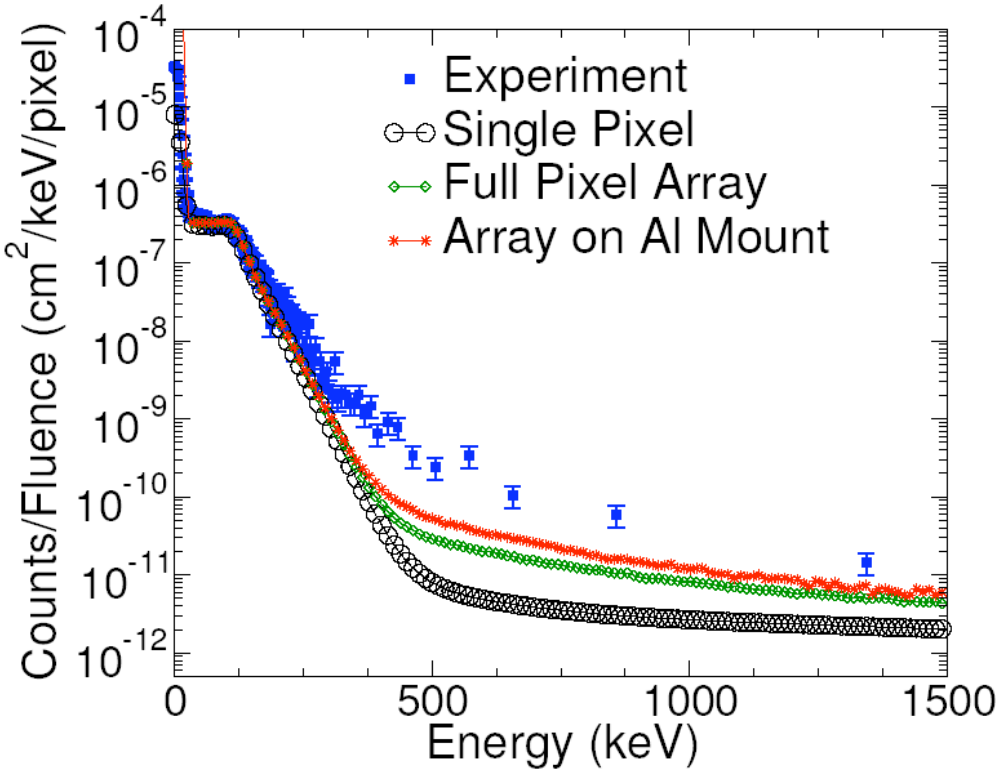
Outline

- Motivation
- Background
- Previous Results
- Results
  - Materials below pixels play important role in single event response
  - Mounting which focal plane array sits on during experiment can increase response of device
- Conclusions



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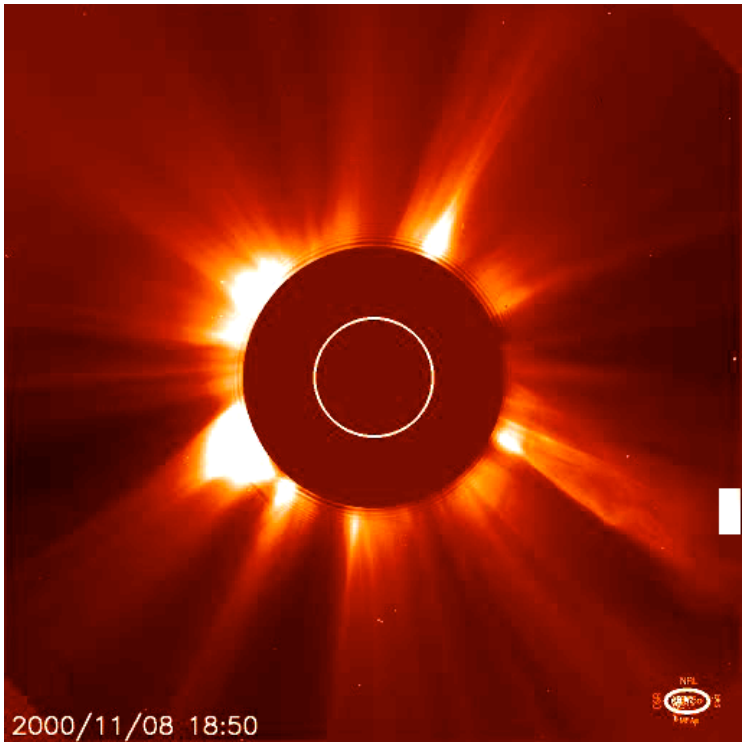
Motivation

- Proton events contribute to device noise floor
- Better understanding of how radiation-induced energy deposition occurs will improve prediction techniques
- Accurate modeling helps predict on-orbit response



http://sohowww.nascom.nasa.gov/gallery/Movies/flares.html

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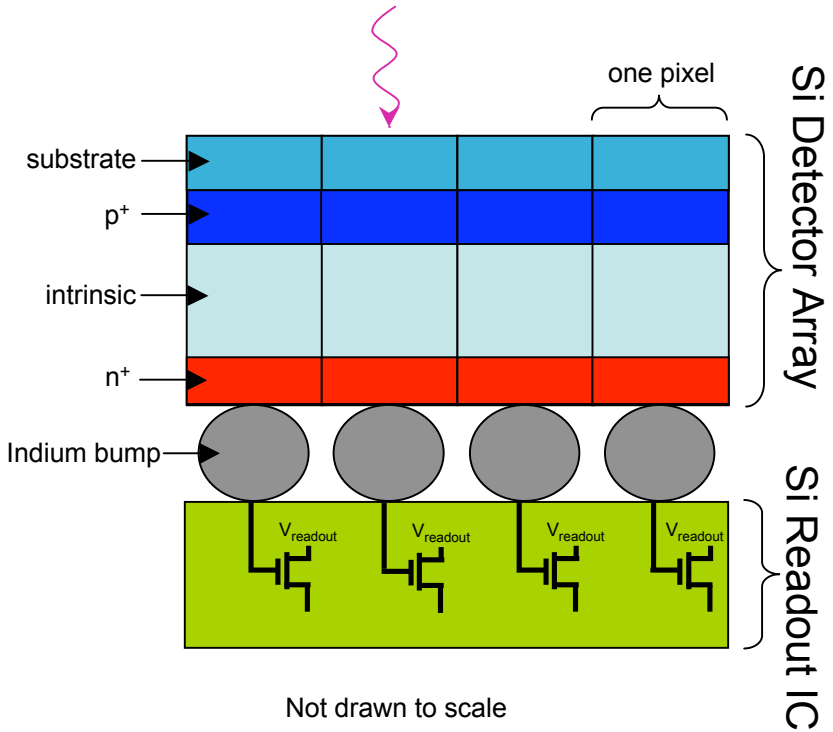
Background

Experiment

- Back side hybrid FPA
- Silicon p-i-n 128 × 128 detector array
- Irradiated with 63 MeV protons at 45°
- Biased to 15V resulting in full depletion
- Exposed at 233 K

Basic Hybrid P-i-N FPA



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Previous Work

Experiment

- Back side hybrid FPA
- Silicon p-i-n 128 × 128 detector array
- Irradiated with 63 MeV protons at 45°
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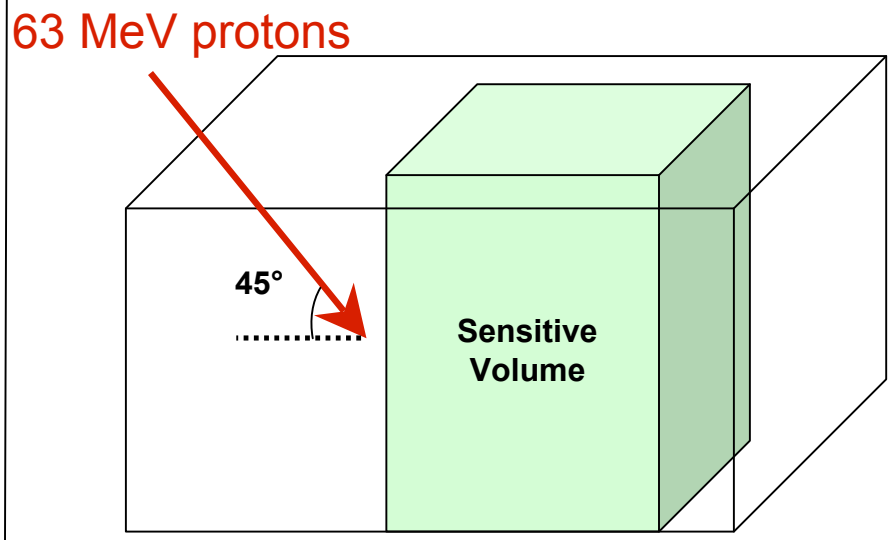
Simulation - MRED

- Sensitive volume equal in size to one pixel



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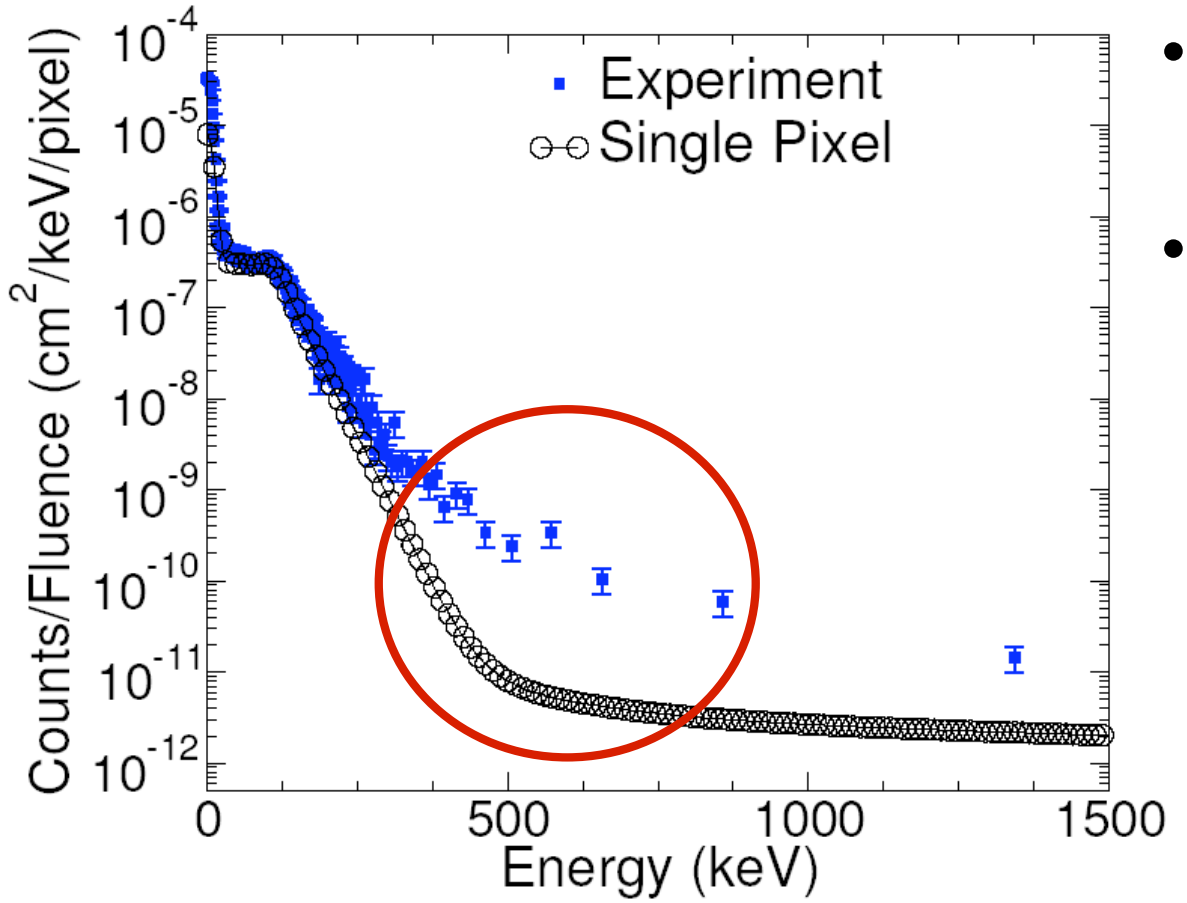
Previous Work



- Good agreement below 300 keV
- Differences past 300 keV due to
  - Known error in nuclear reaction models
  - Charge collection
  - Simplification of structure

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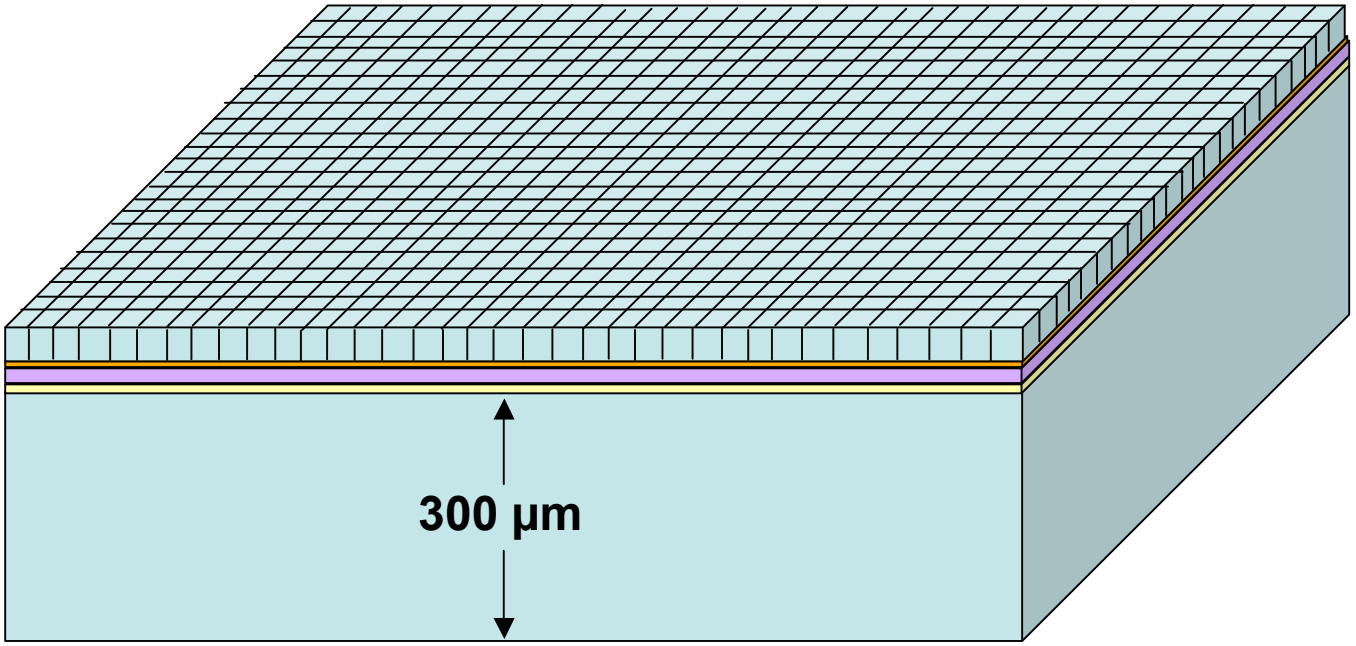
FPA Structure



Silicon

Sub-Pixel Materials

Indium

Metal Stack

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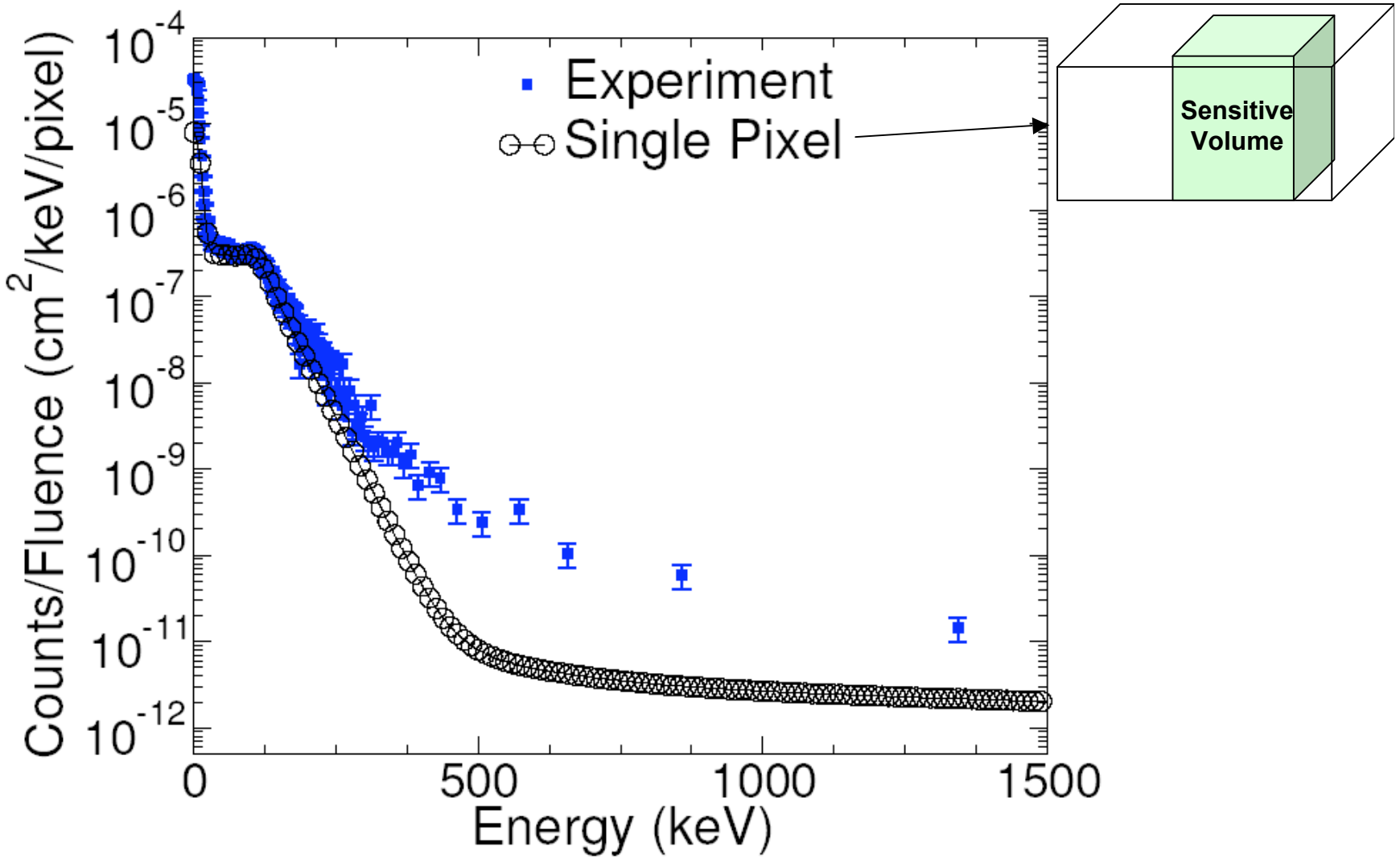
Full Array Simulation Results



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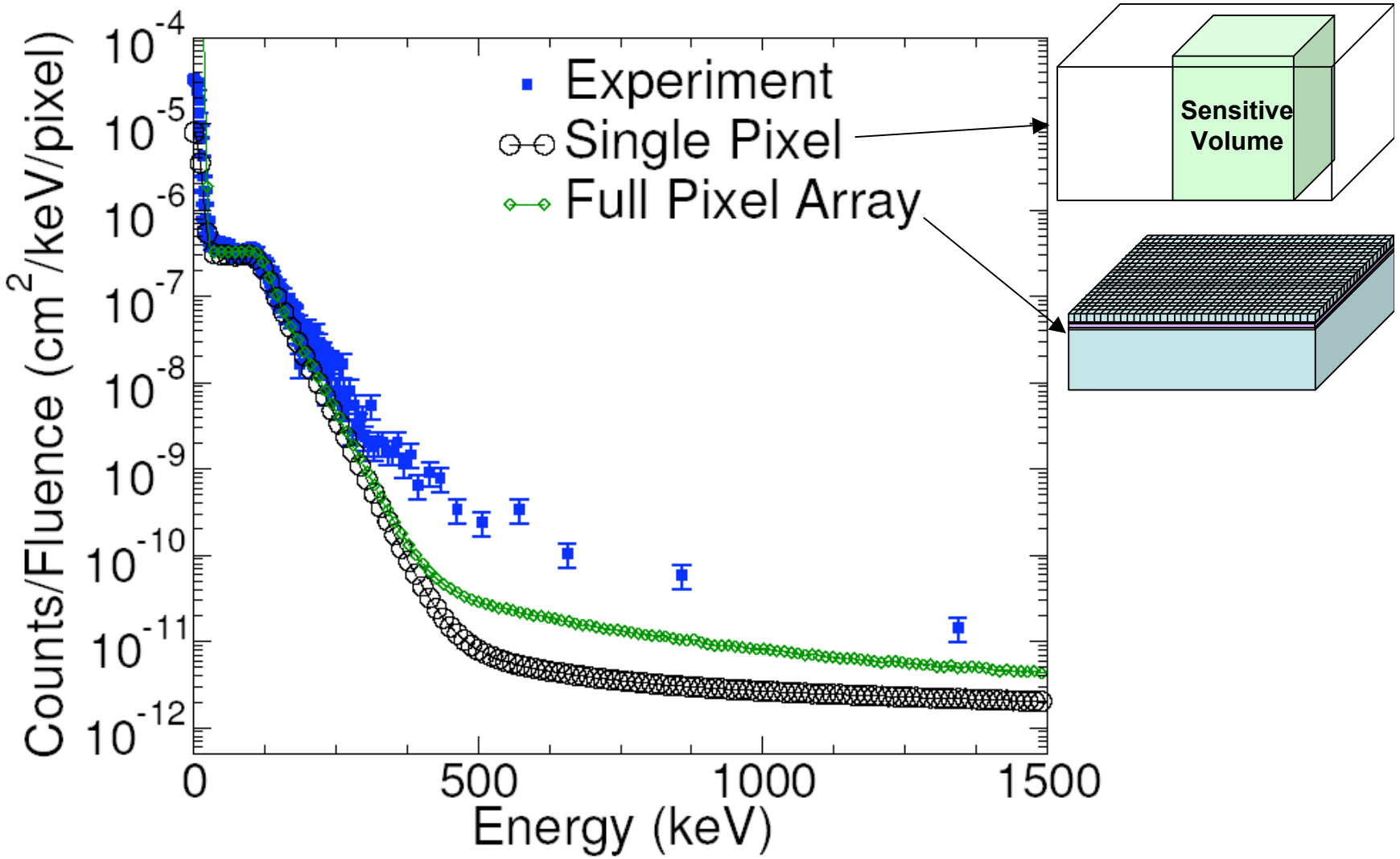
Full Array Simulation Results



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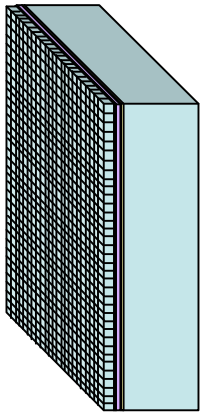
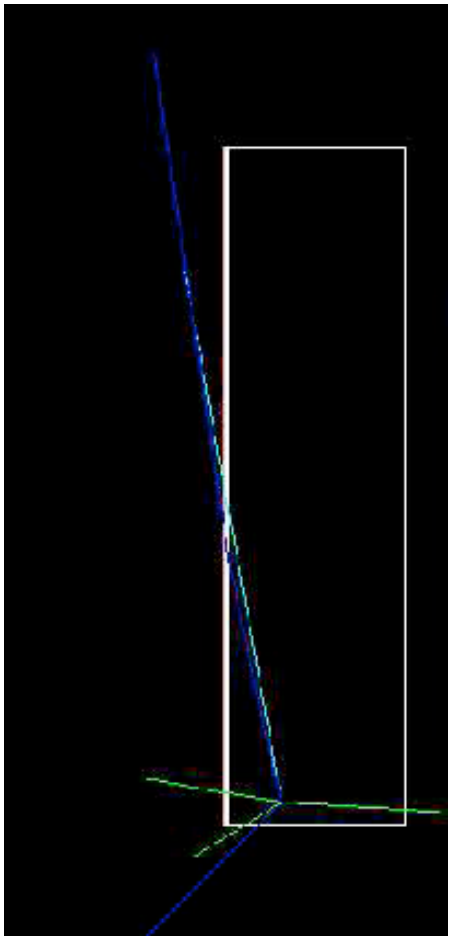
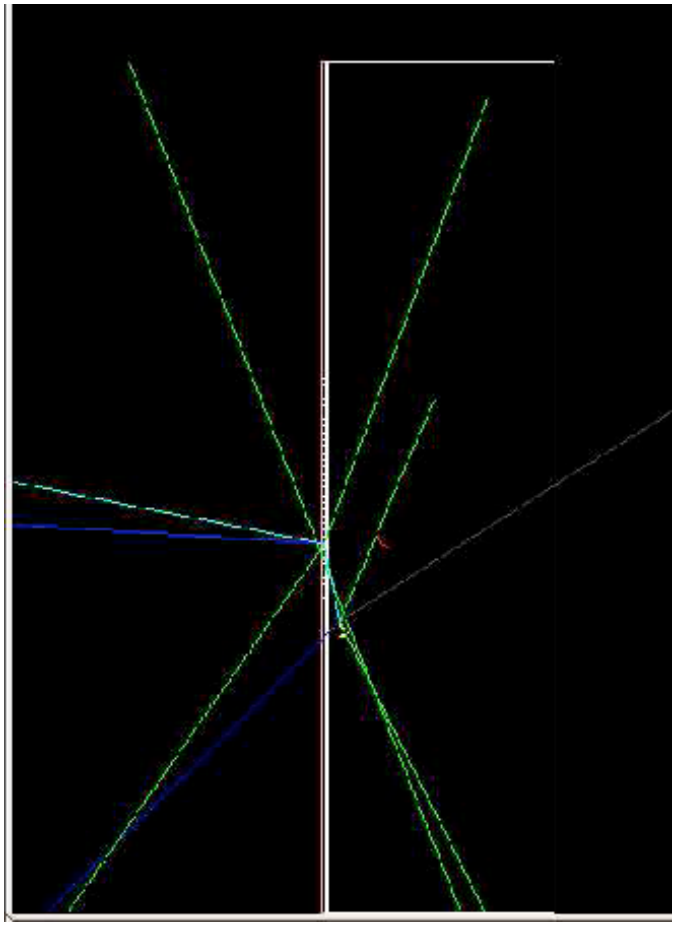
Event Images







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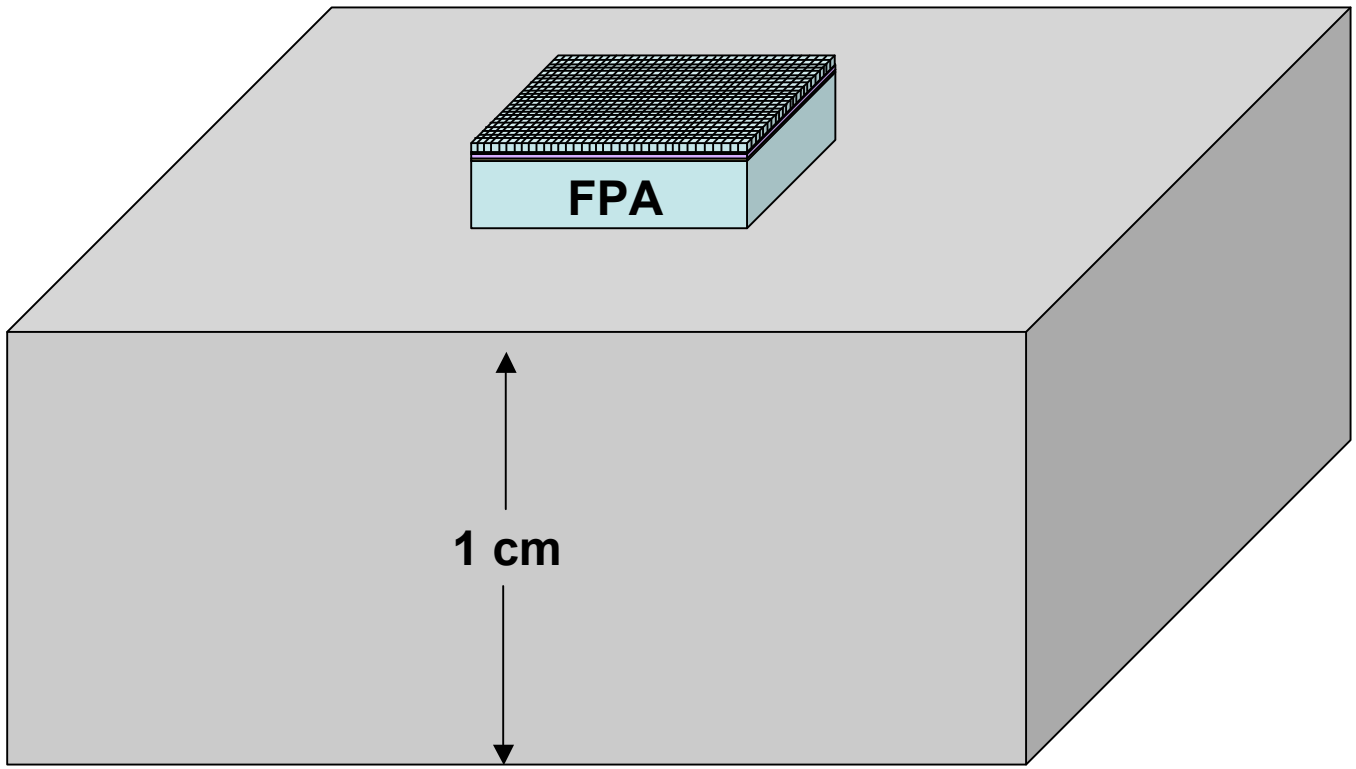
FPA Structure on Mounting



Silicon

Sub-Pixel Materials

Indium

Metal Stack

Mounting

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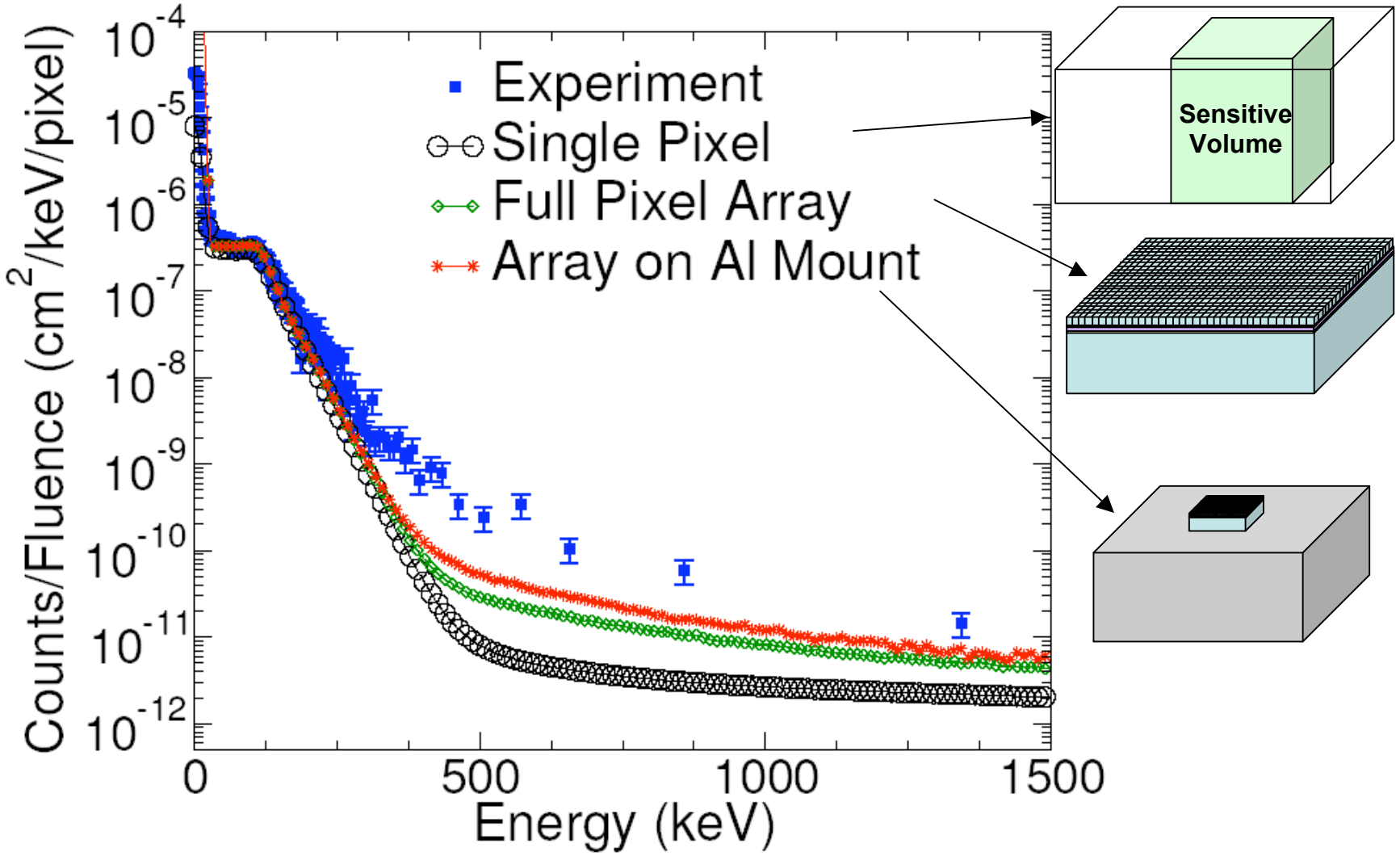
Full Array on Aluminum Mounting



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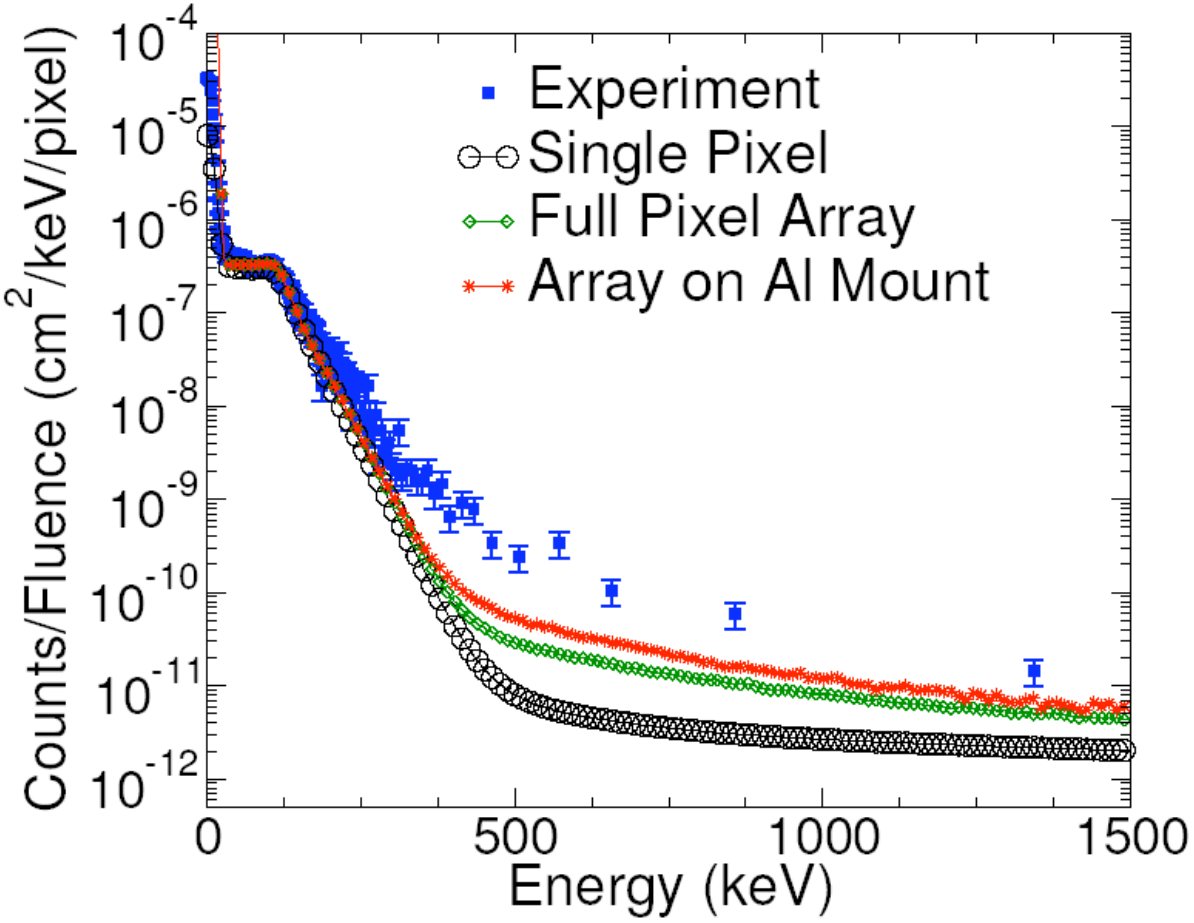
Full Array on Various Mountings



- Other Mountings Simulated
  - Ceramic
  - Beryllium
  - Copper
  - Tantalum
- Results similar to aluminum

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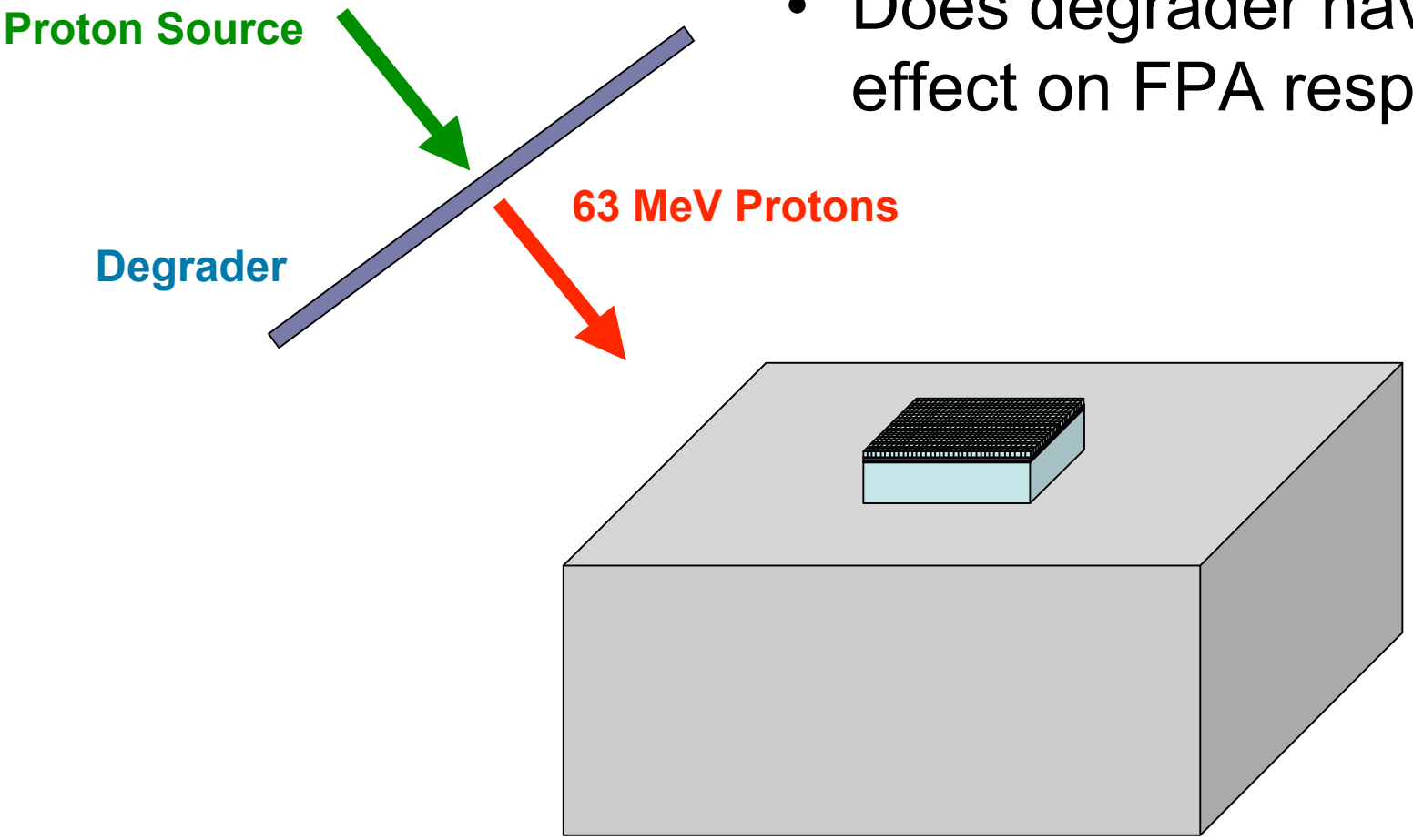
Proton Beam in Experiment



- Does degrader have an effect on FPA response?

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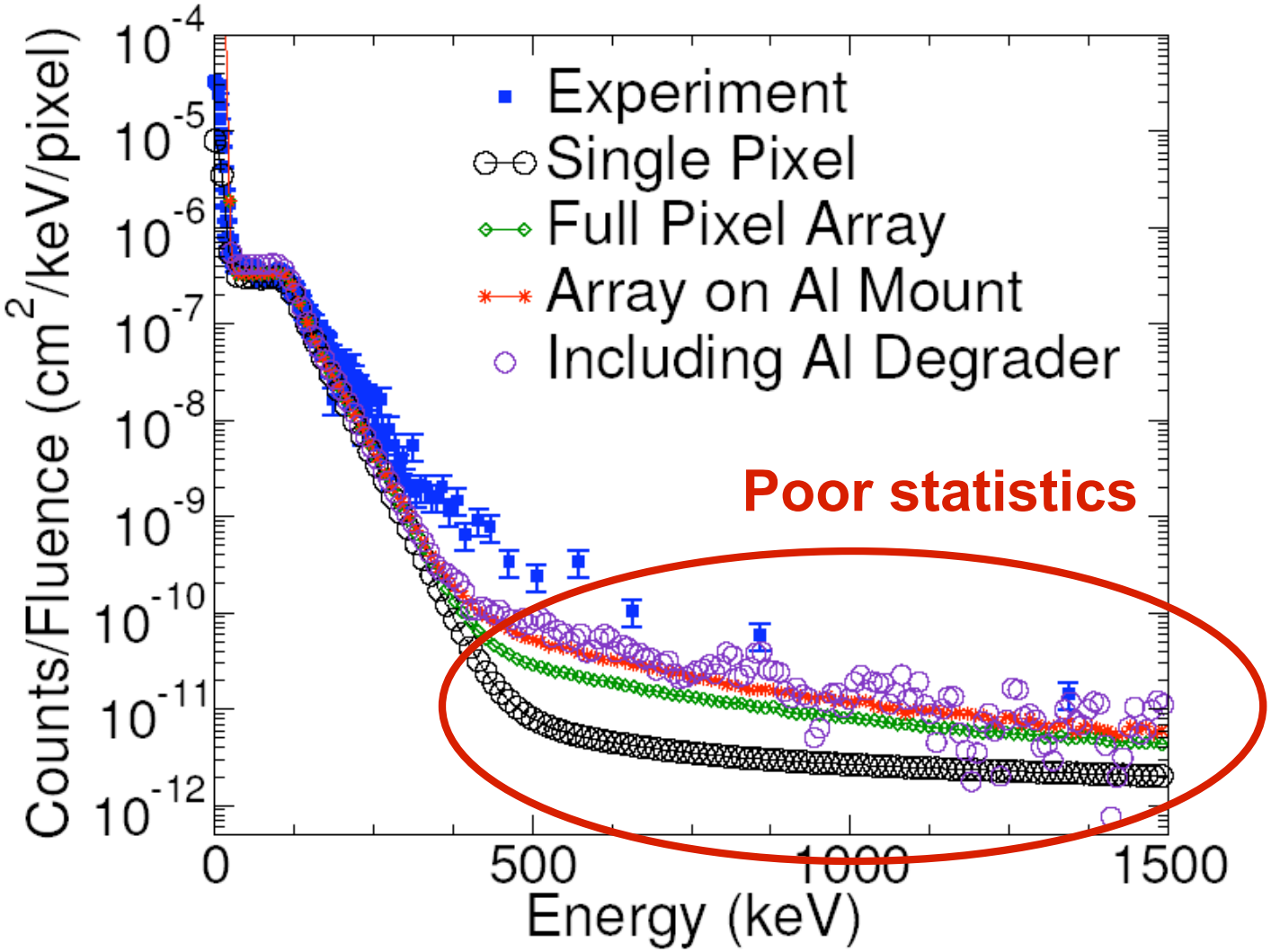
Aluminum Degrader in Beam Path



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Conclusions

- Materials located beneath focal plane array have impact on amount of energy deposited
- The mounting FPA is set on has impact on cross section
- Degrader between beam line and FPA can cause increase in cross section
- Considering materials placed above and below a device must be considered

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