

Status of the Trinity Neutrino Observatory

Sofia Stepanoff &
Anthony Brown
for the Trinity Collaboration



Georgia Tech College of Sciences
Center for Relativistic
Astrophysics

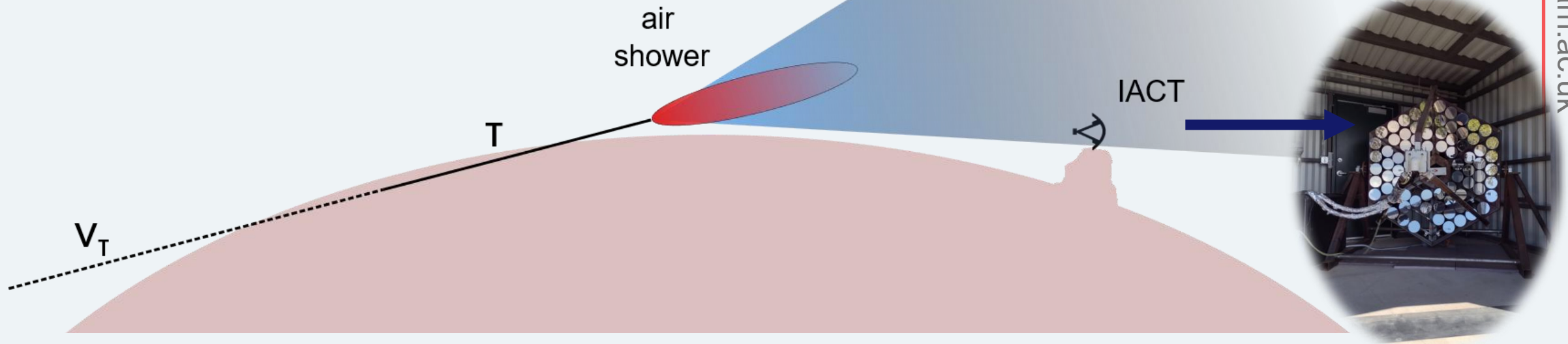


Trinity Detection Concept



Air-shower imaging of Earth-skimming
PeV to EeV tau neutrinos

Essentially an imaging air Cherenkov
telescope pointing at the ground

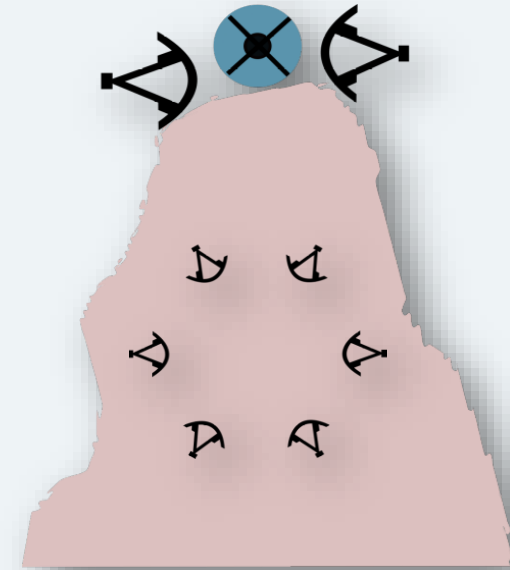
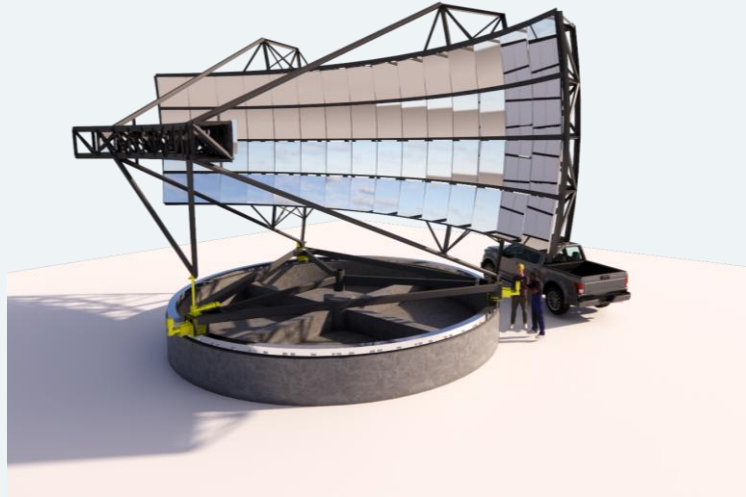


anthony.brown@durham.ac.uk

Trinity Timeline



anthony.brown@durham.ac.uk



Demonstrator Funding

Trinity One
Funding

Trinity Observatory Funding



2021

2023

2026

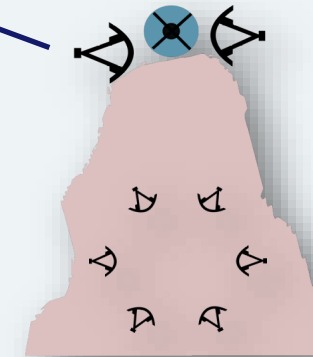
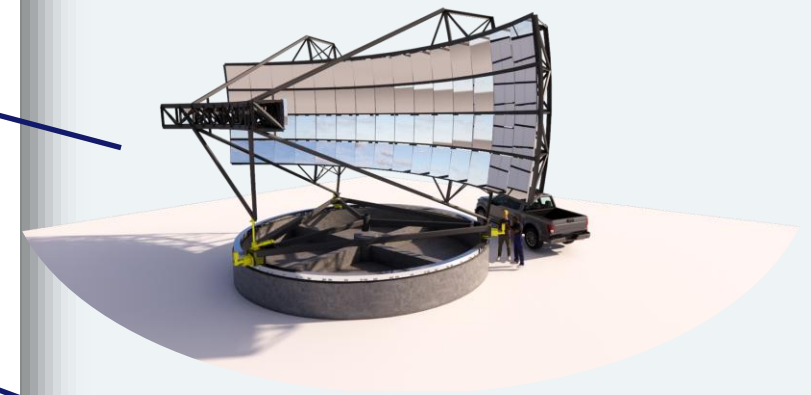
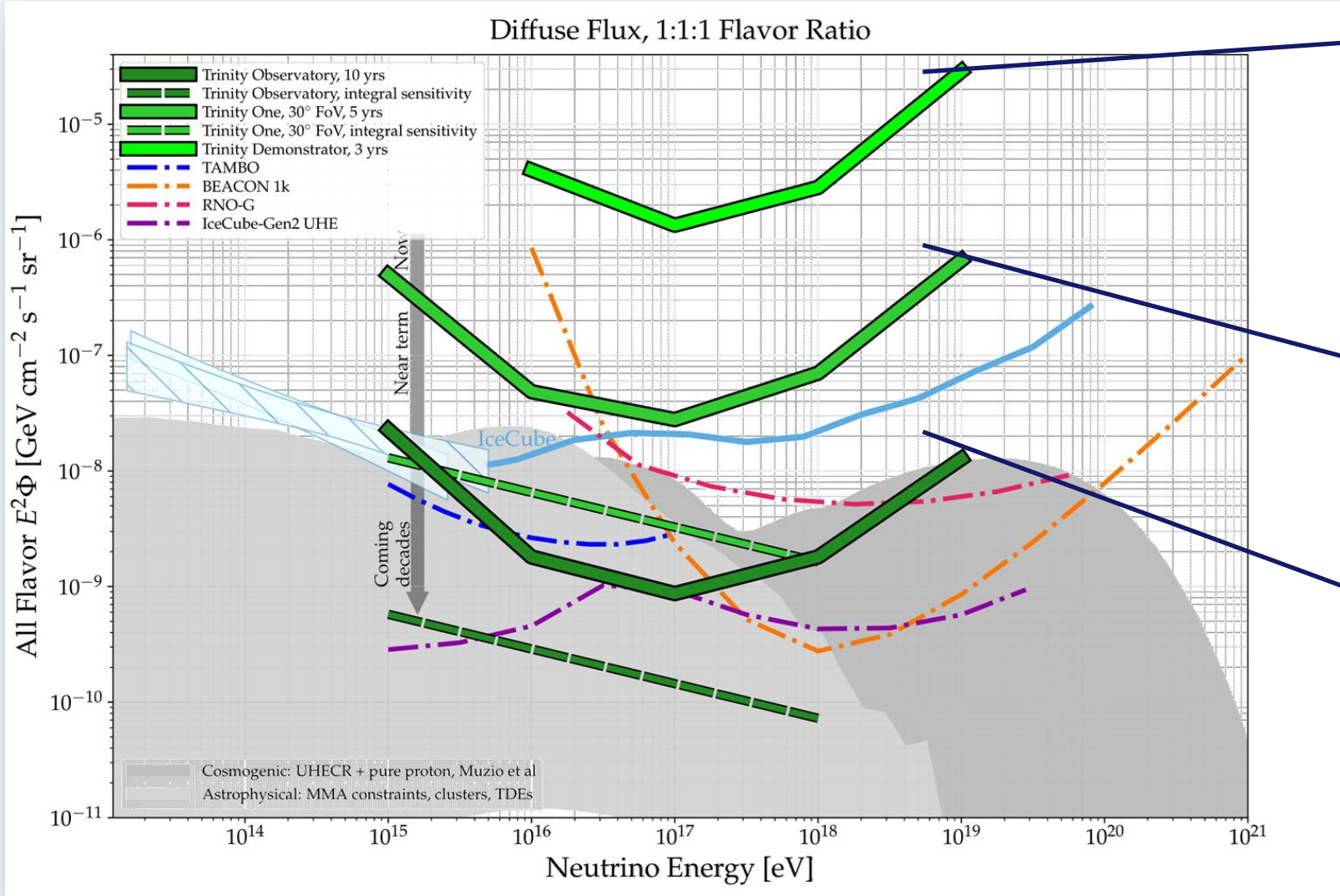
2031

Demonstrator First Light

Trinity Timeline



anthony.brown@durham.ac.uk





anthony.brown@durham.ac.uk

Trinity Demonstrator

- Backgrounds
- Analysis
- Simulation Chain
- Long-term stability
- Remote Operations
- New Techniques

Camera paper: [arXiv:2406.08274]

Commissioning paper: [arXiv:2503.11864]





Trinity Demonstrator

- FOV: $3.8^\circ \times 3.8^\circ$
- Pixels: 256
- Angular Resolution: 0.24°
- Mirror Area: 1.36m^2
- Sampling Speed: 100MS/s

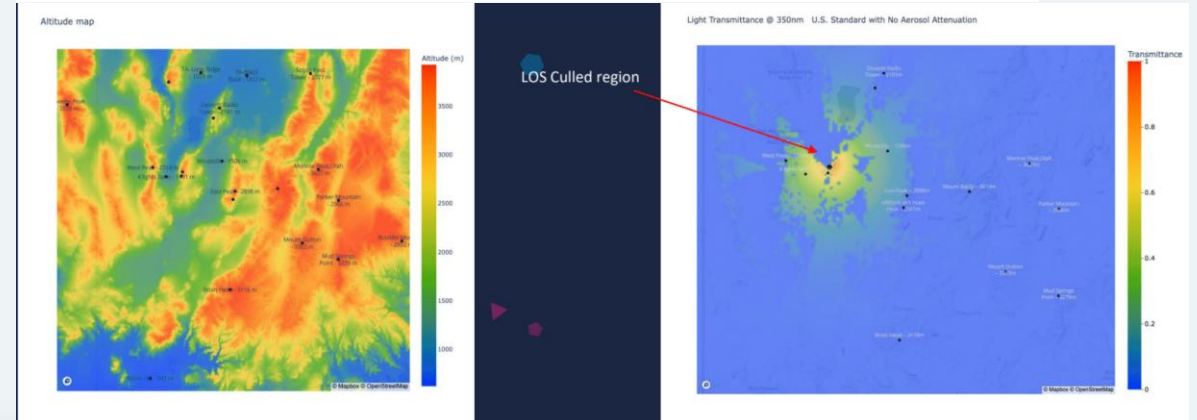
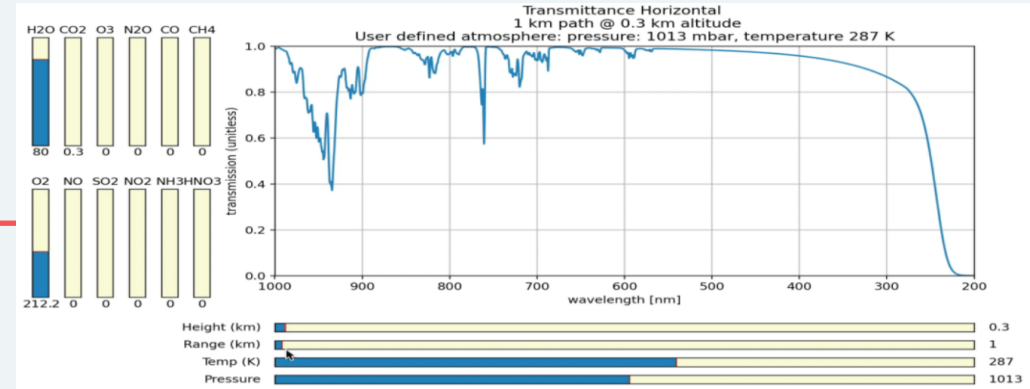
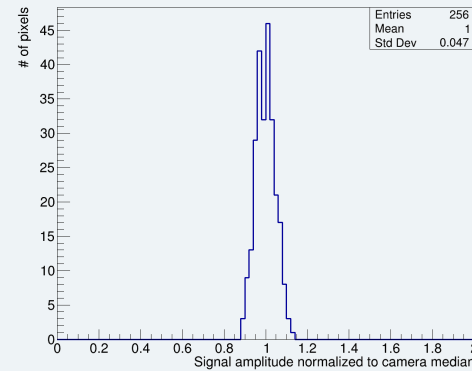
Camera paper: [arXiv:2406.08274]

Commissioning paper: [arXiv:2503.11864]

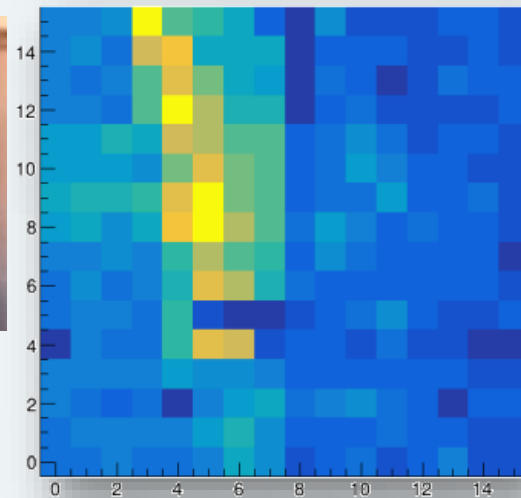


Commissioning

- Aligning optics
- Signal calibration
- Trigger calibration
- Remote operation



Horizon Imaged on SiPMs

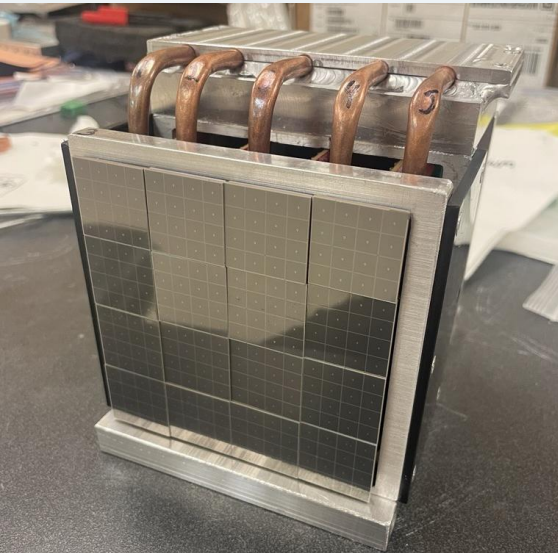


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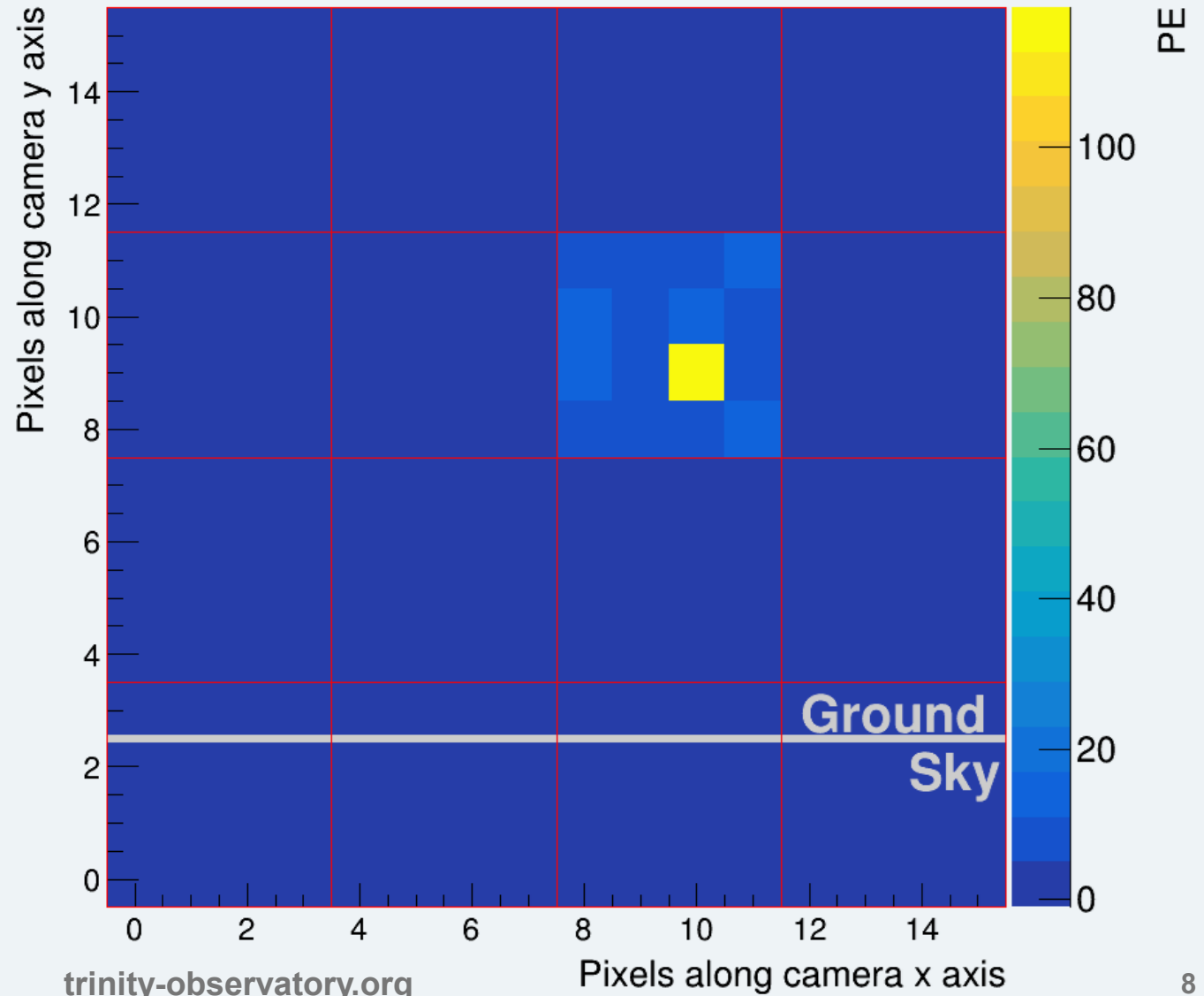


Trigger

- Record any event as soon as the signal in one pixel goes above 20 PE
- Average trigger rate of 0.5 HZ



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anthony.brown@durham.ac.uk

Data Set



Collection Period	October 2024-June 2025
Hours	346
Triggered Events	10 ⁶



anthony.brown@durham.ac.uk

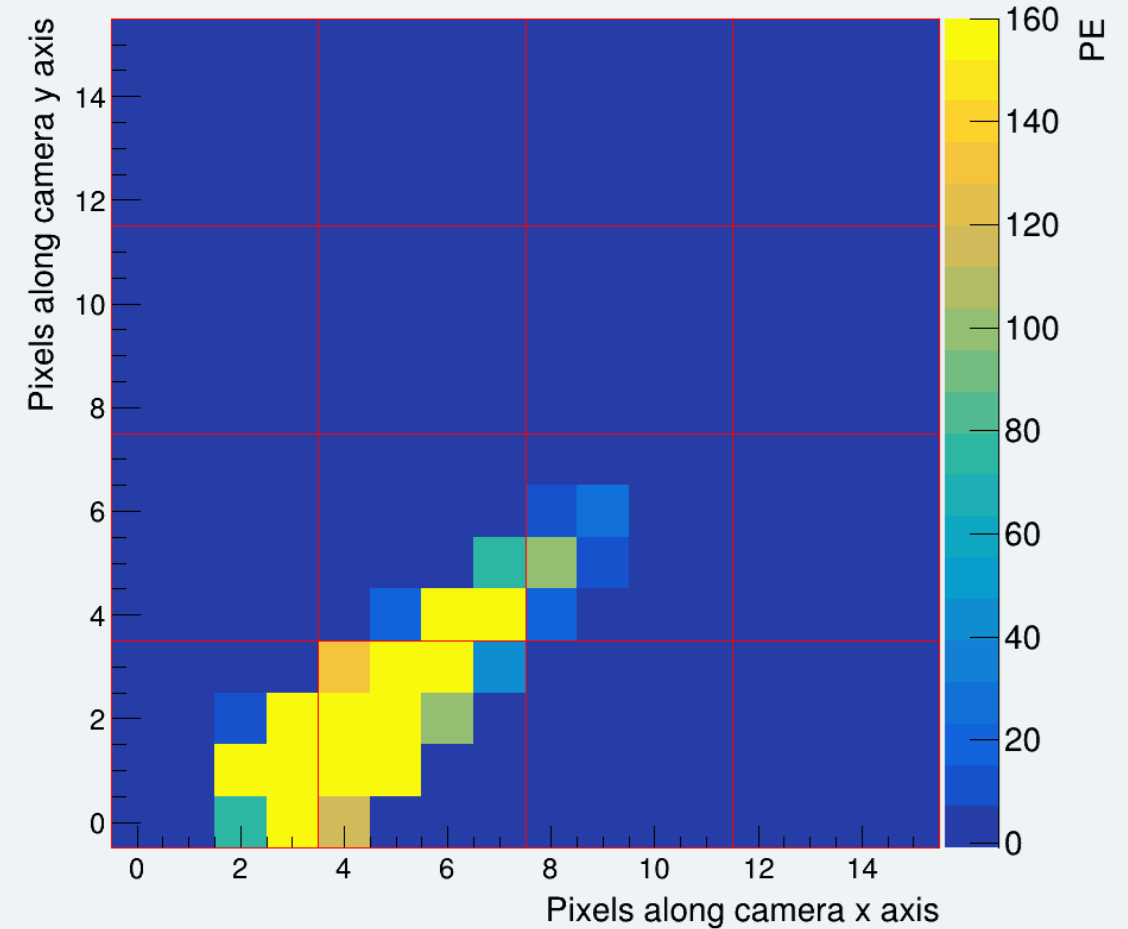
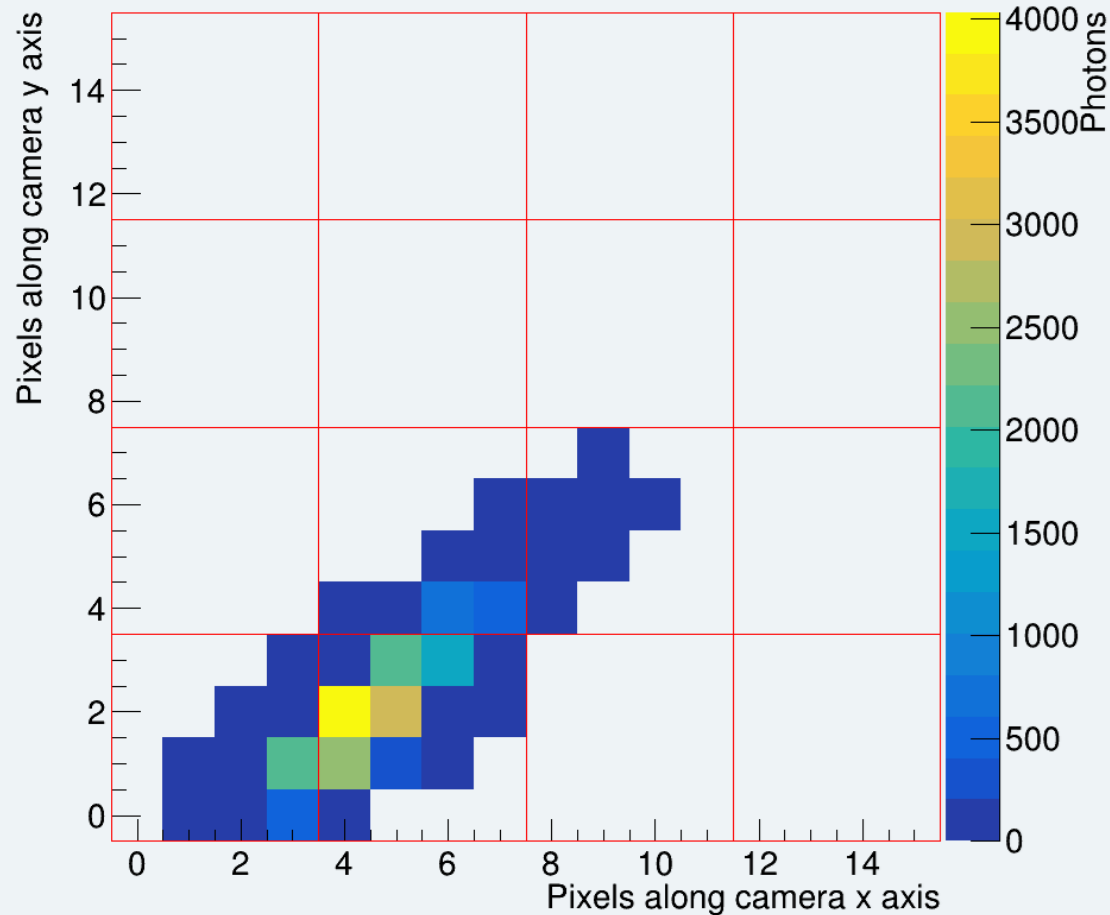
Image Cleaning



Simulated Gold-Plated Event

Energy: 414 PeV, Distance: 170 km, Emergence Angle: 1.75°

Expected Camera Response



anthony.brown@durham.ac.uk

Image Cleaning



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Core Pixel Selection

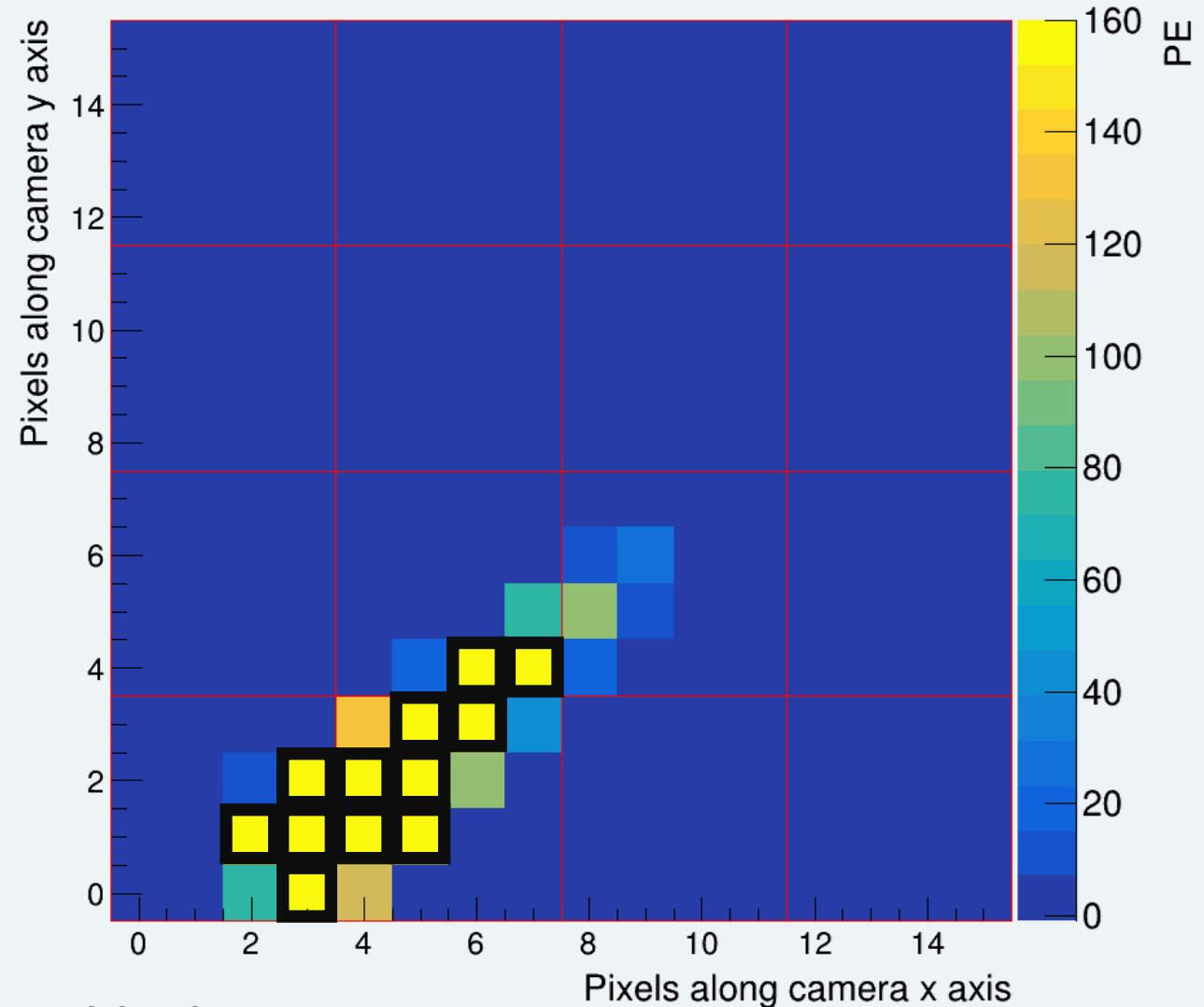


Image Cleaning



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Boundary Pixel Selection

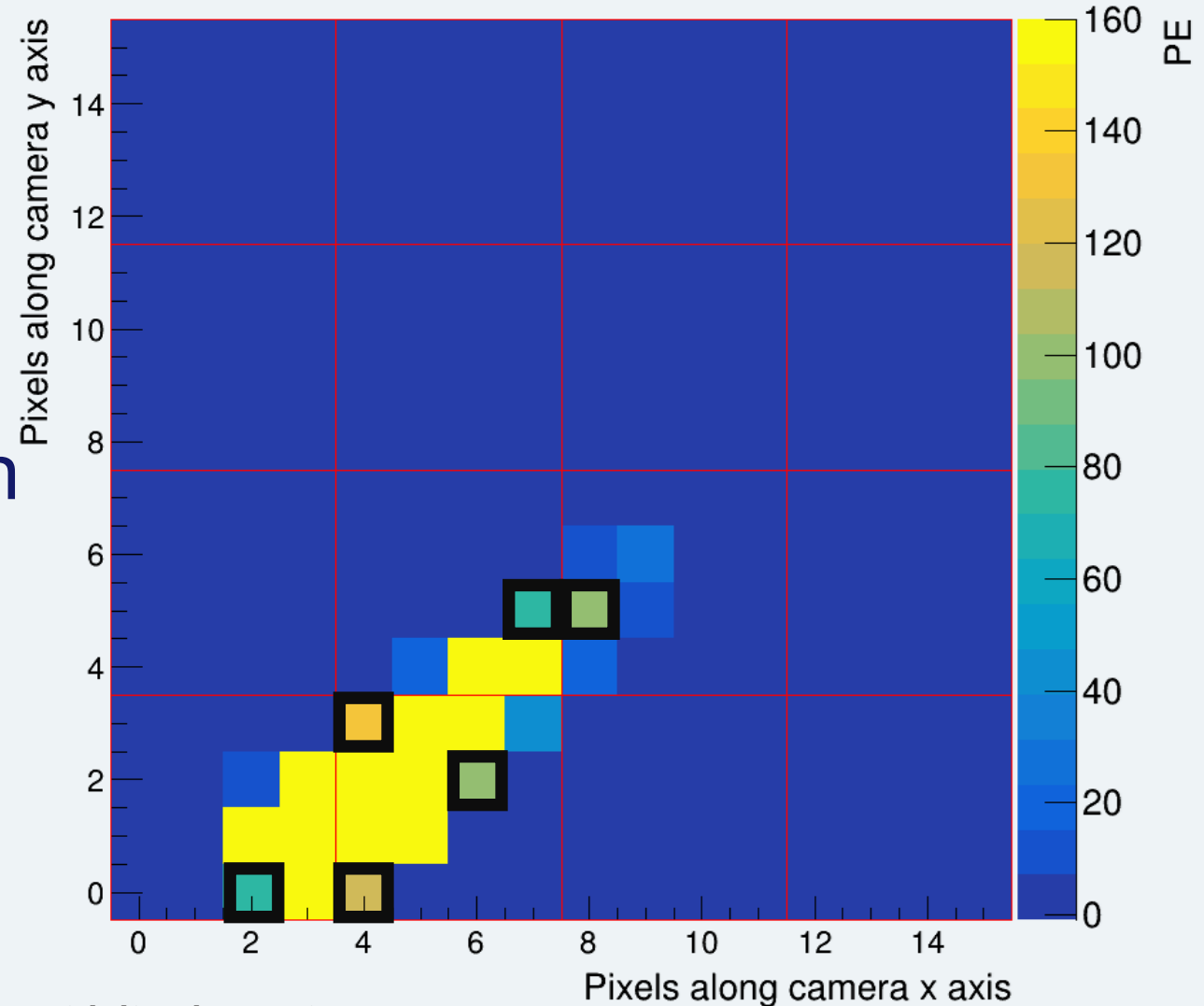
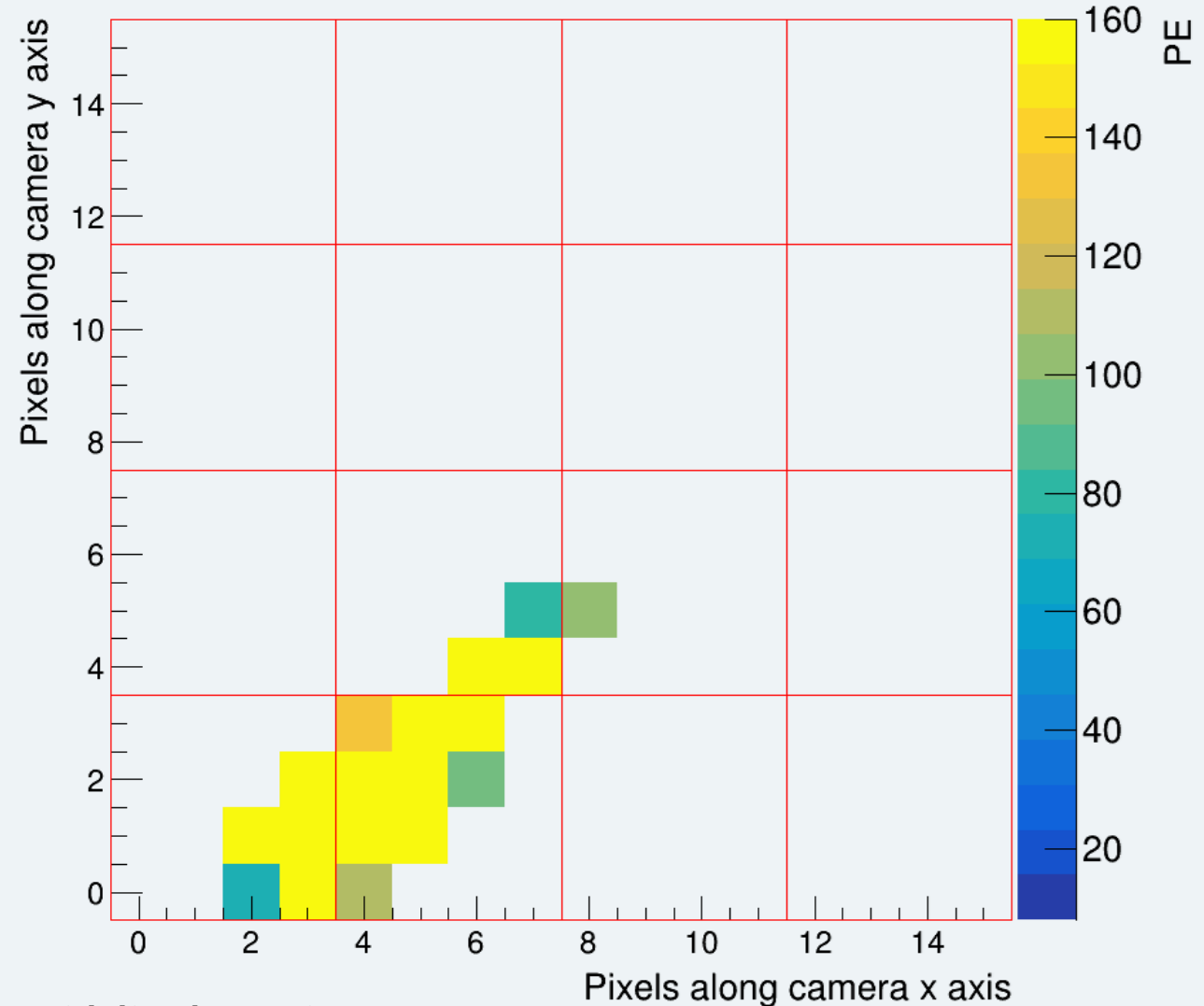


Image Cleaning



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Cleaned Event



Event Selection



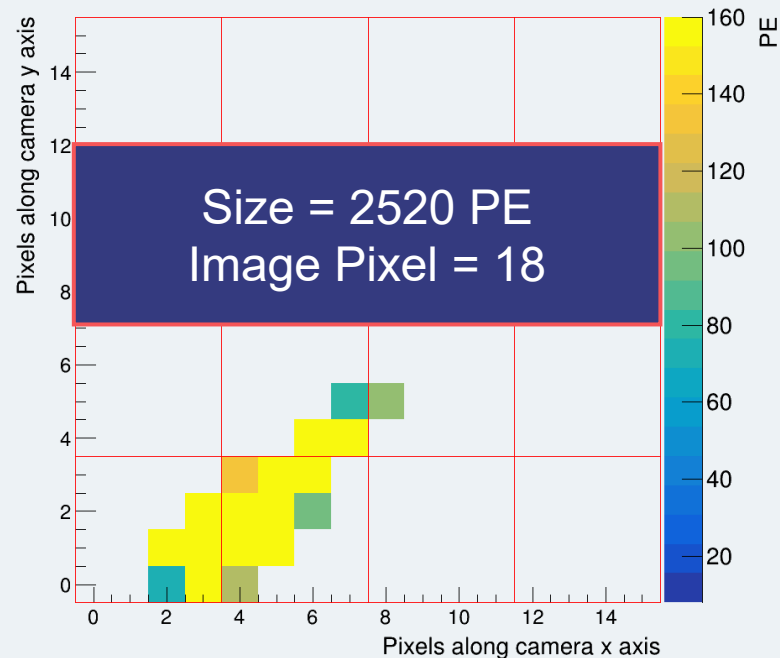
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Size:

Sum signal of all pixels in the cleaned image

Image Pixels:

Pixels in the cleaned image



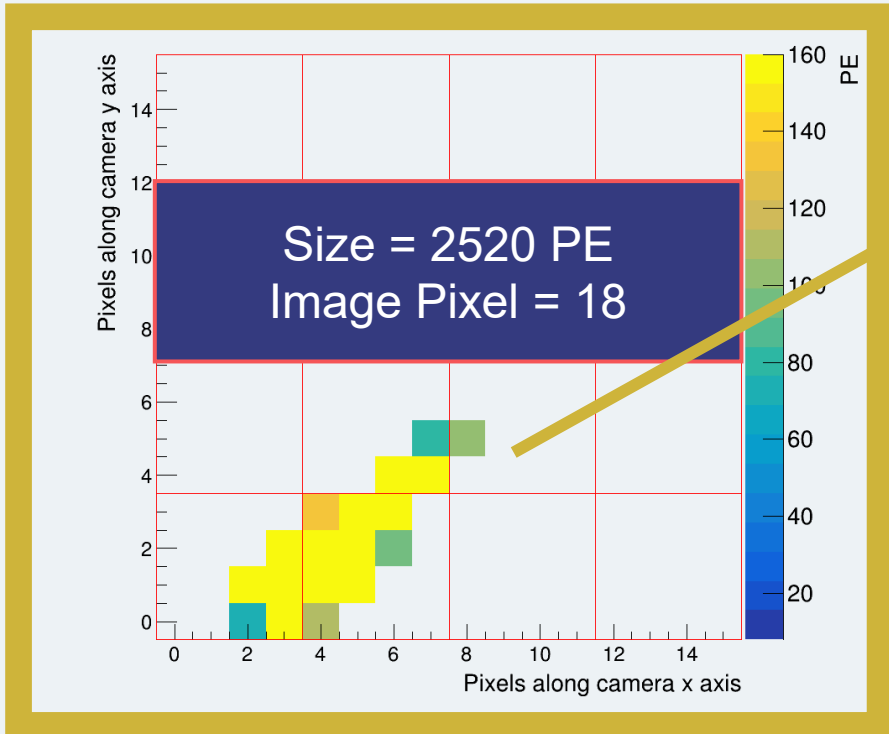
Event Selection

Size:

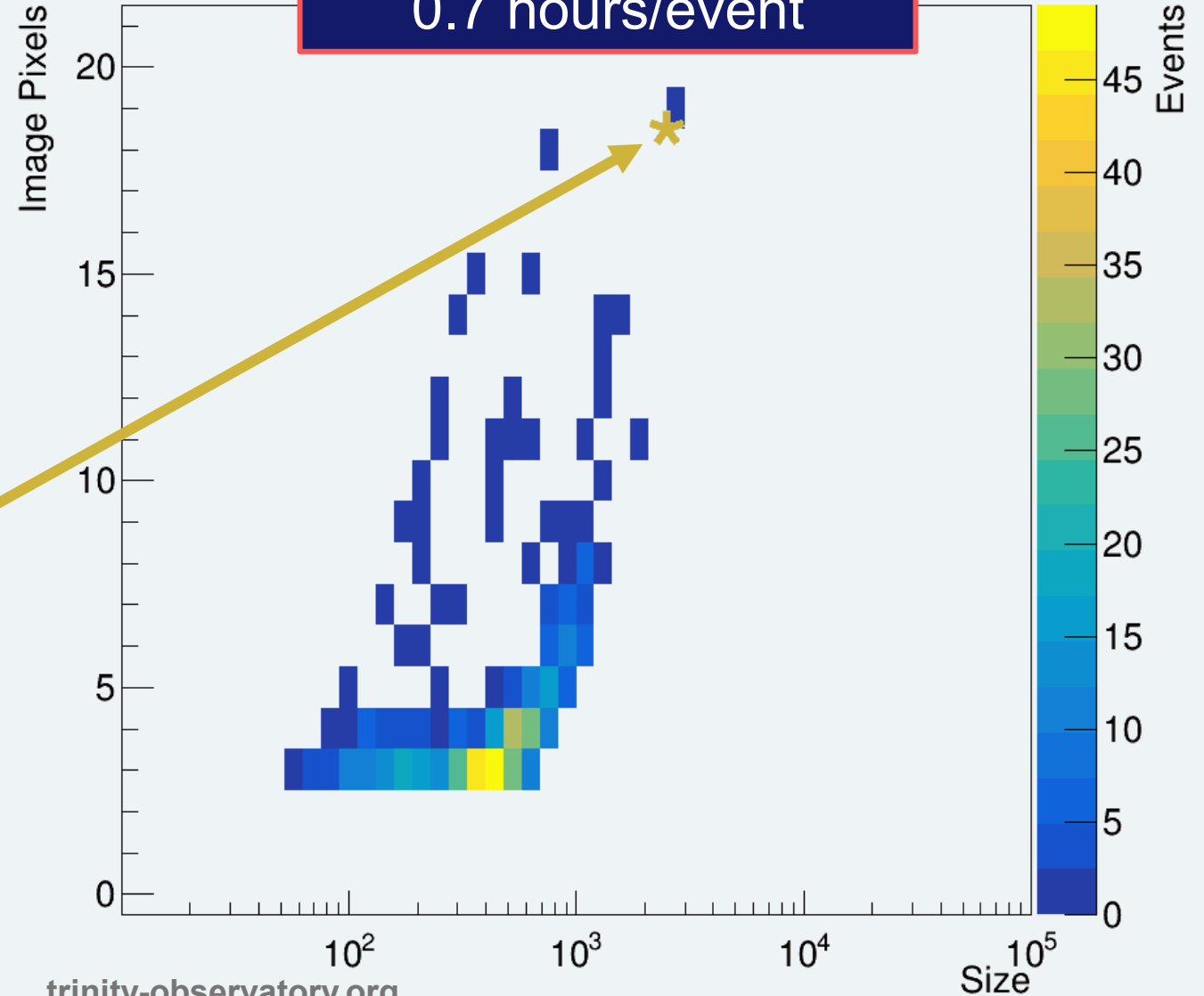
Sum signal of all pixels in the cleaned image

Image Pixels:

Pixels in the cleaned image



497 events
0.7 hours/event

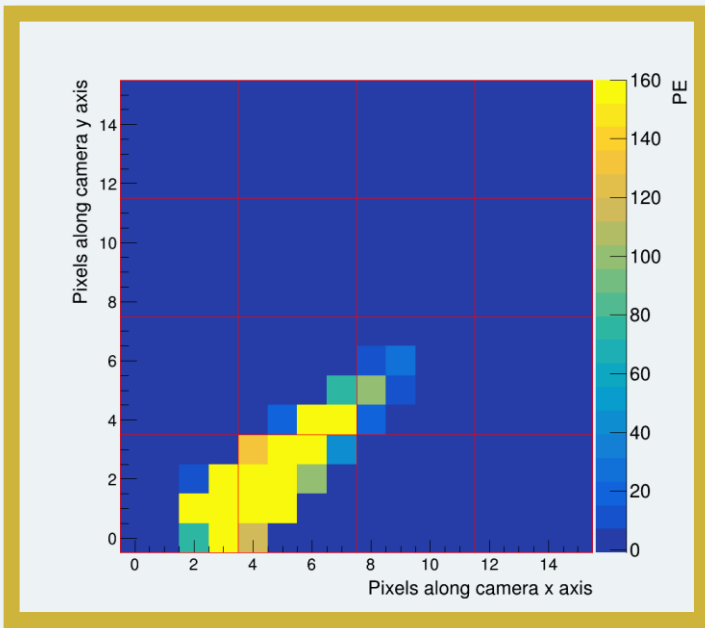


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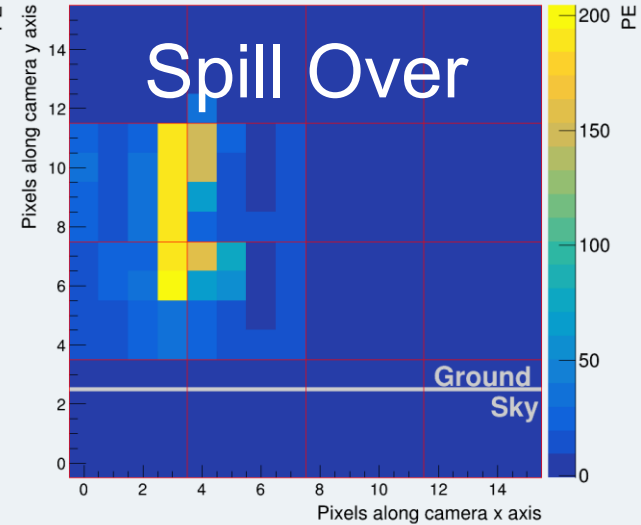
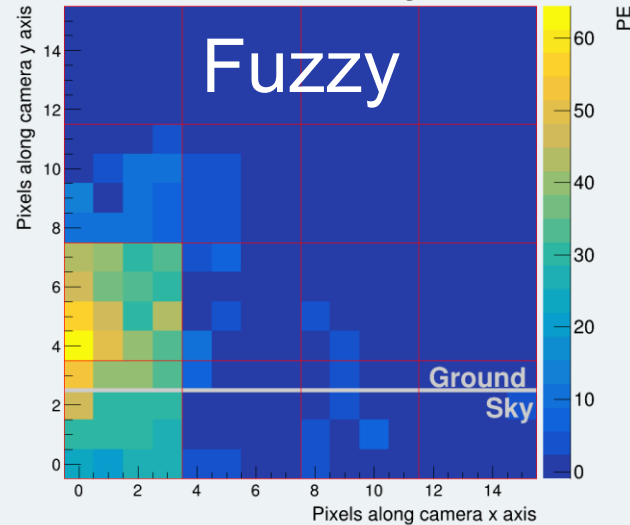
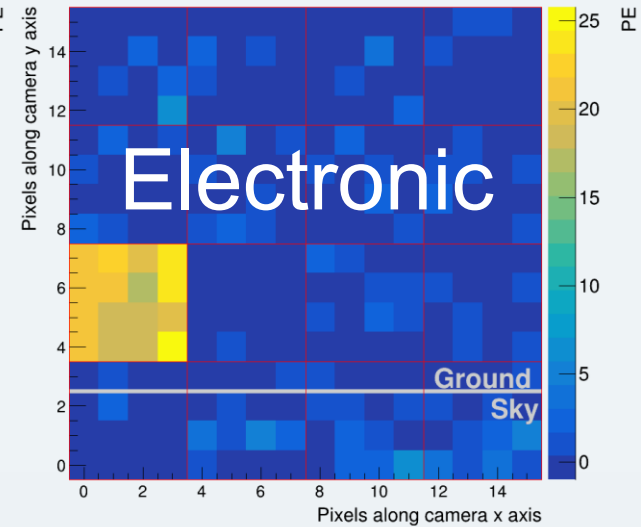
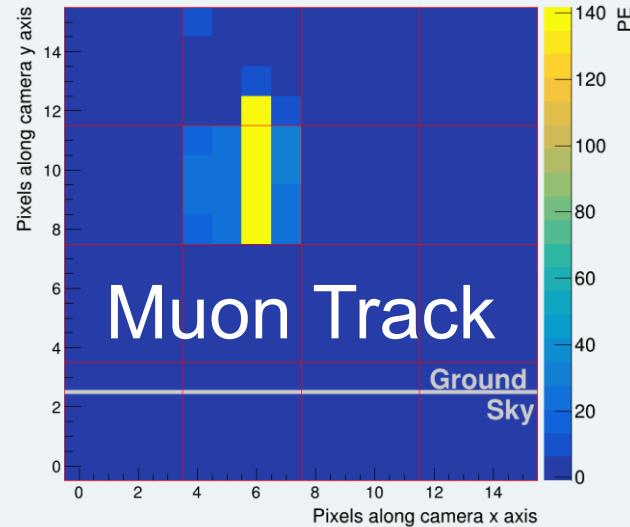
Event Gallery: Types of Events



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Gold Plated Simulation Event

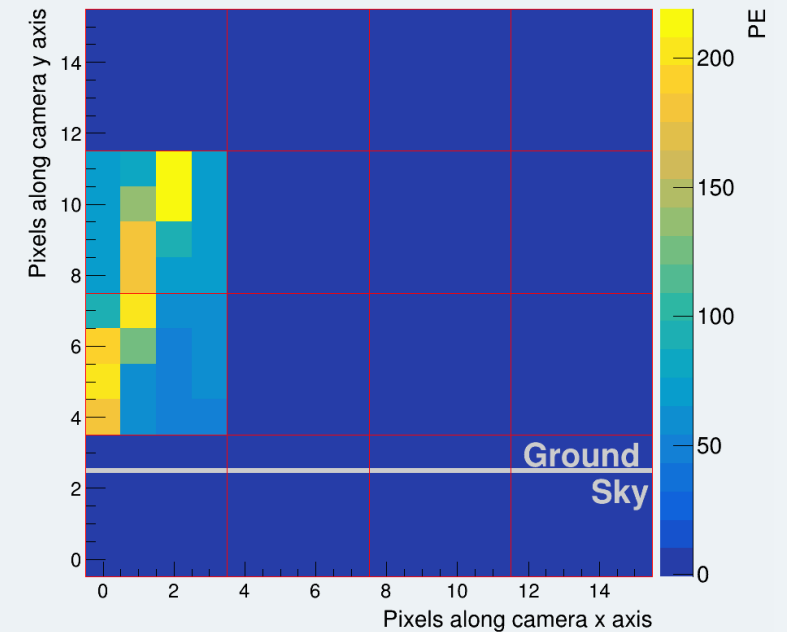
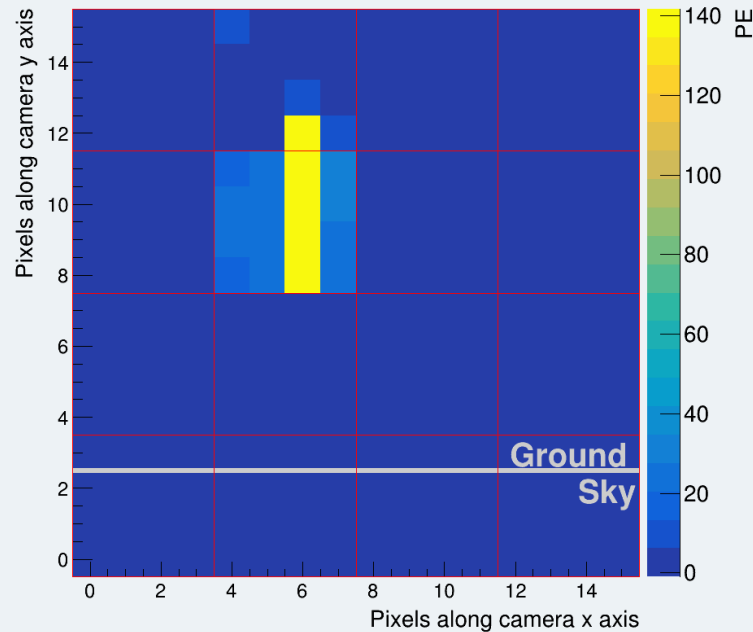
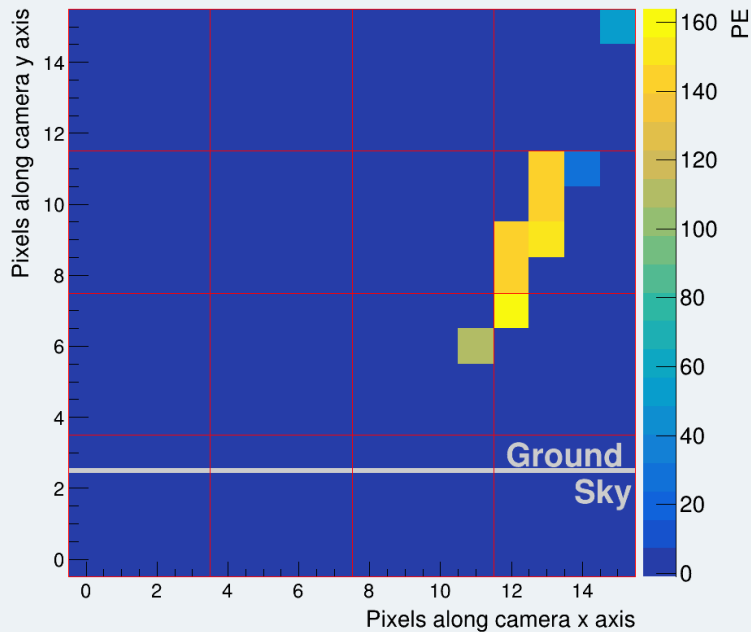
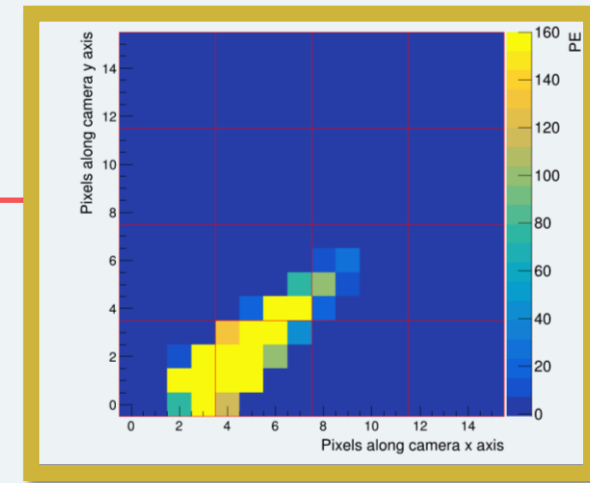


Event Gallery:

461 Muon Tracks Events
0.8 Hours/Event



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Direct Muon Hits

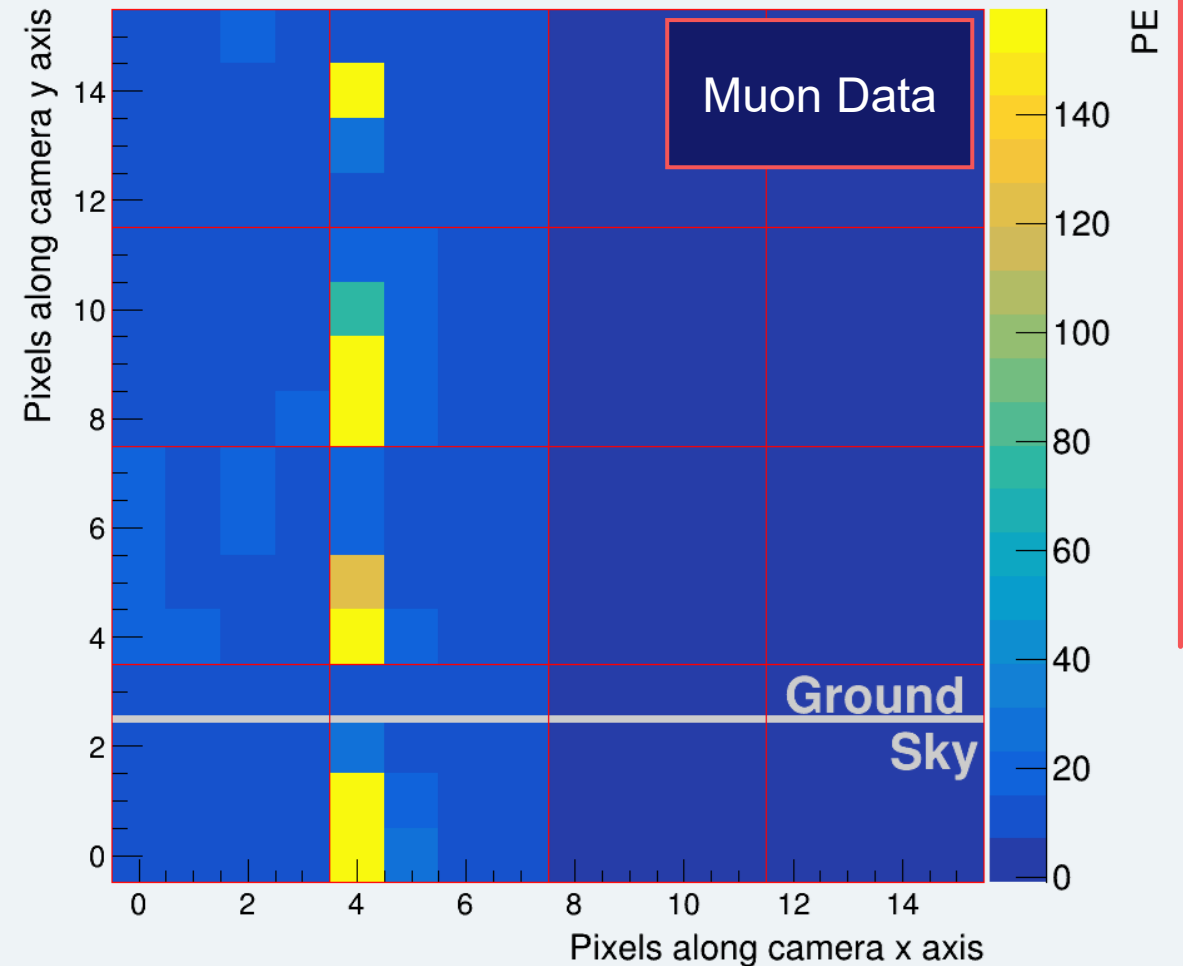
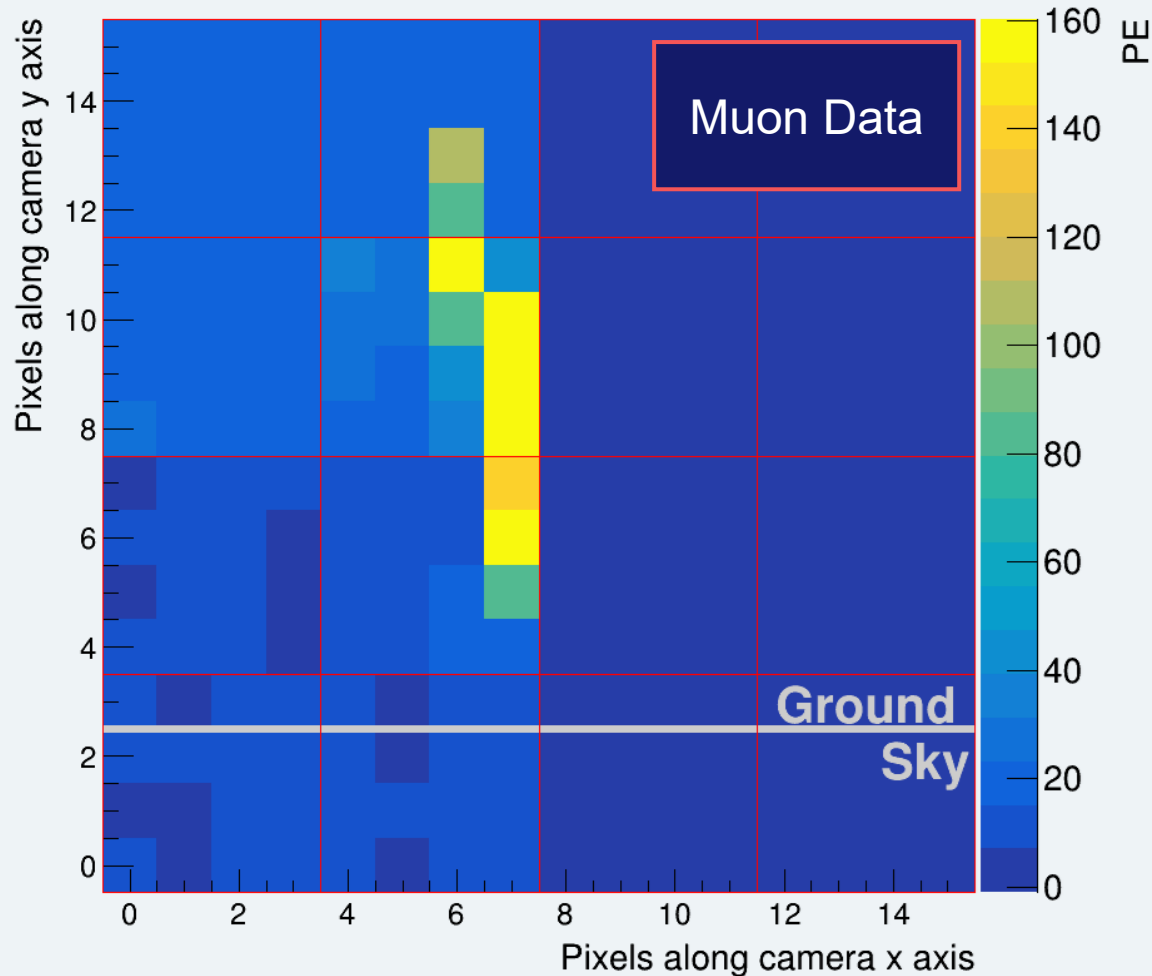


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Plastic Scintillator Detectors



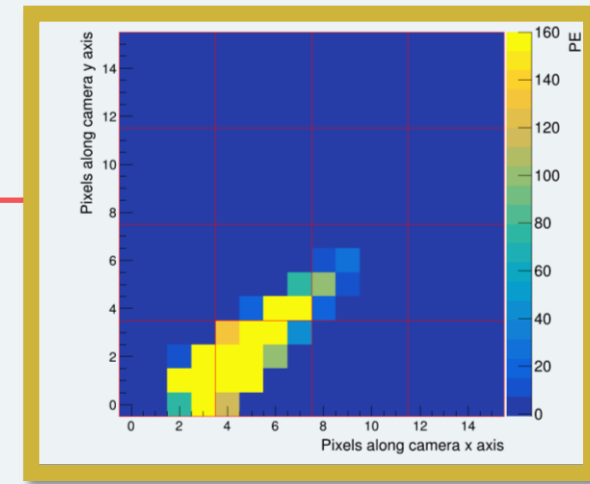
Direct Muon Hits: Sample Events



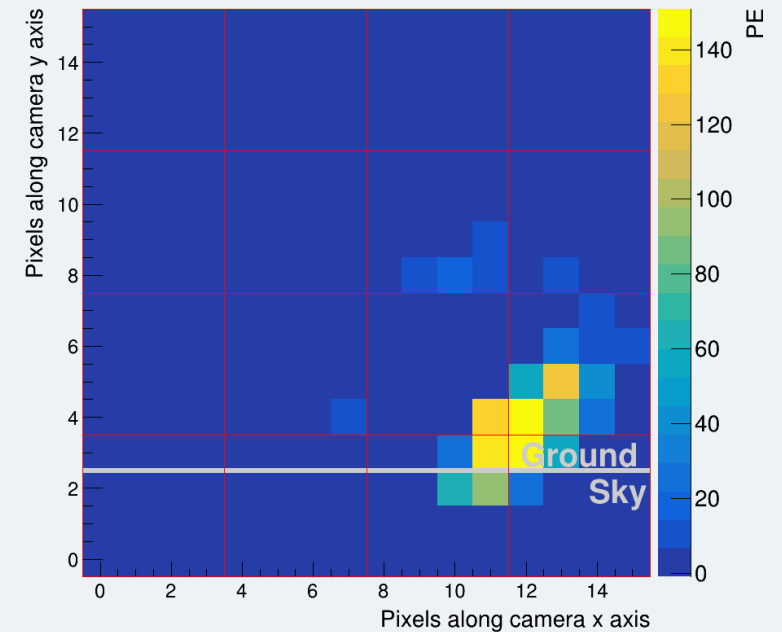
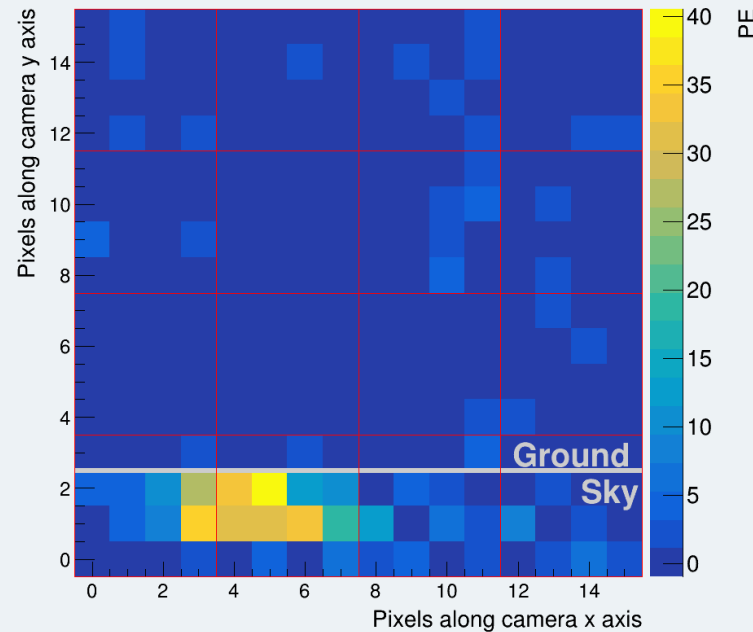
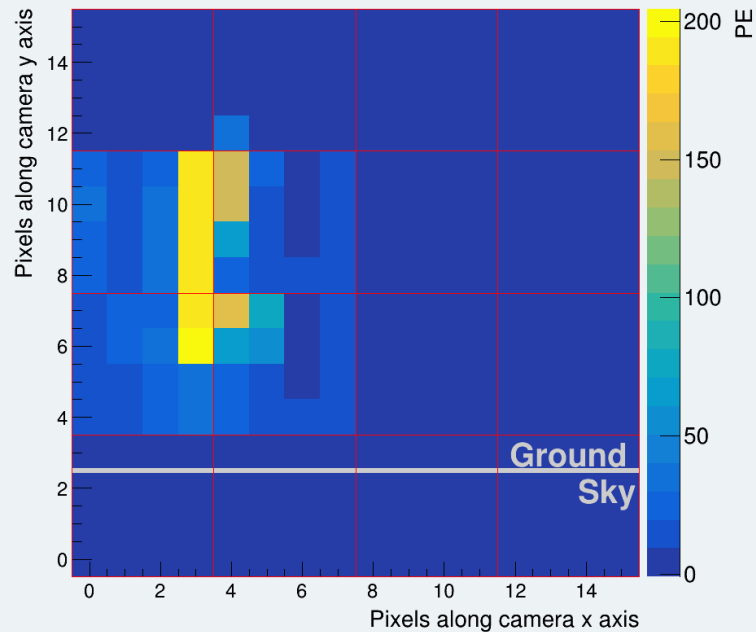
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Event Gallery:

15 Spill Over Events
23 Hours/Events



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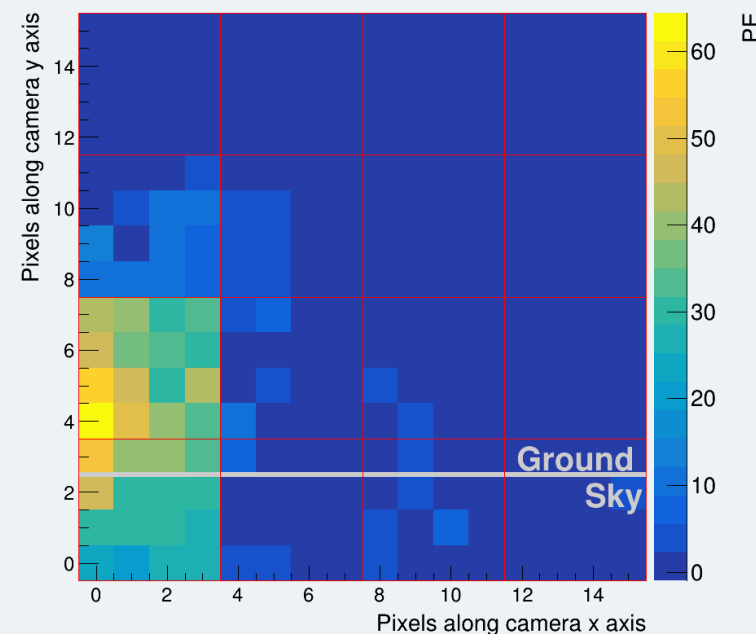
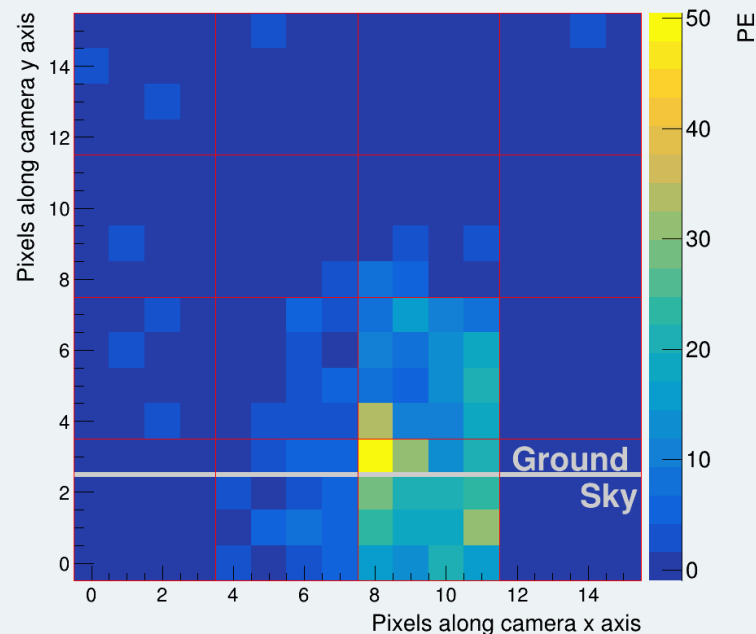
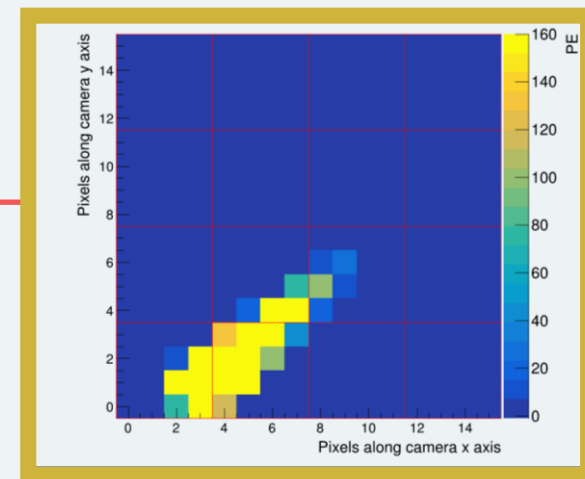


Event Gallery:

2 Fuzzy Events
173 Hours/Event

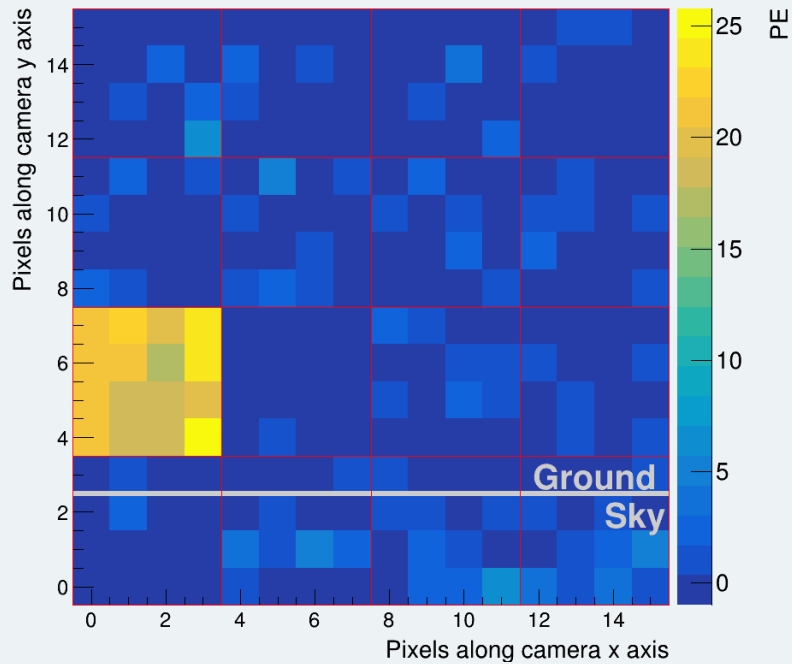


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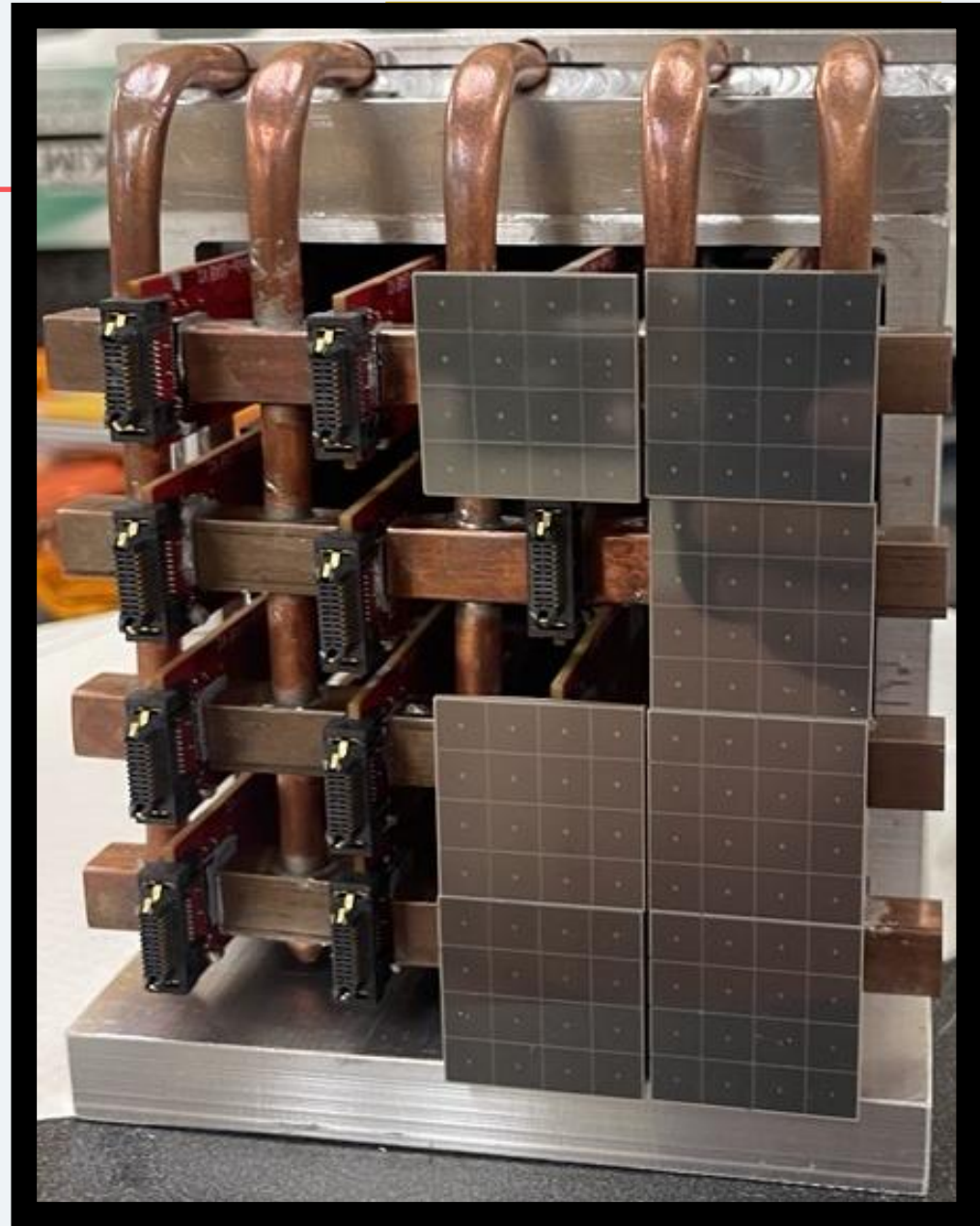


Event Gallery:

19 Electronics Events



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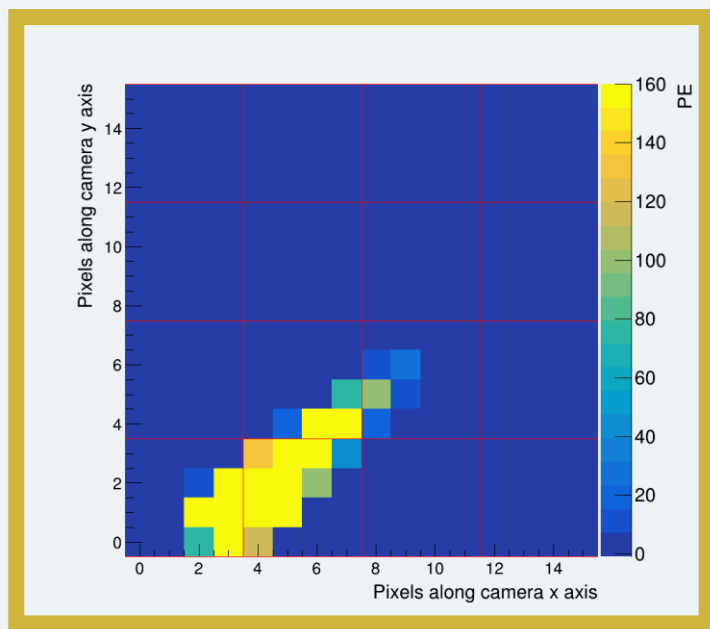


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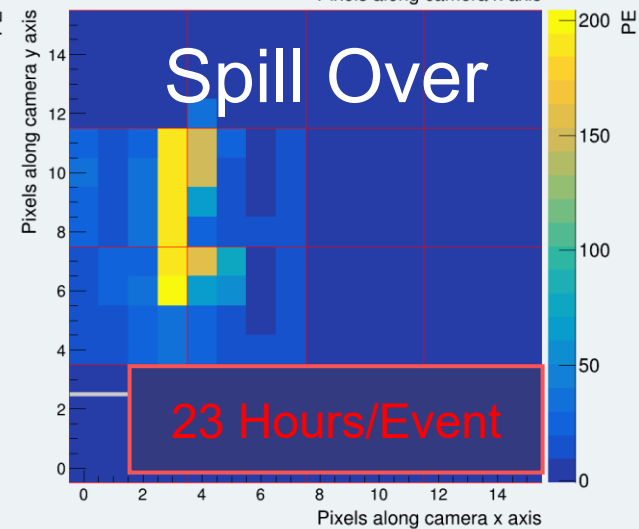
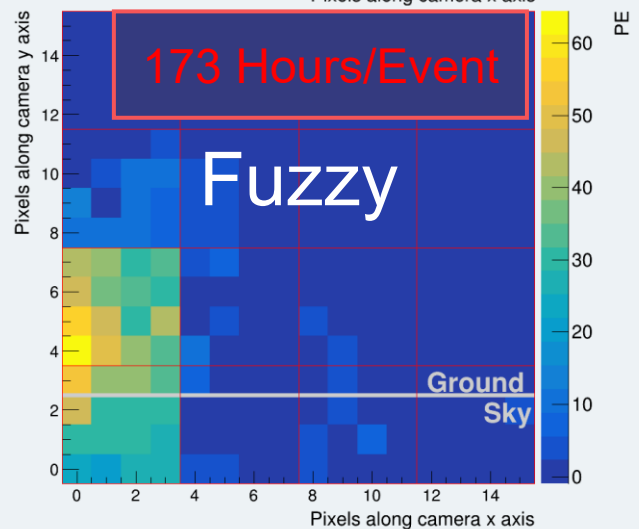
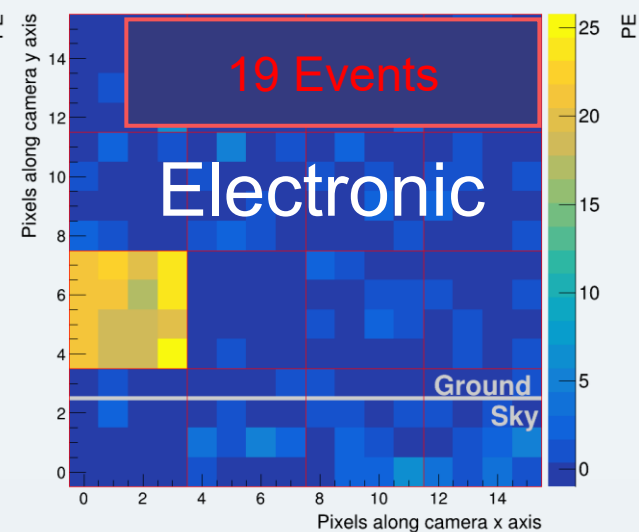
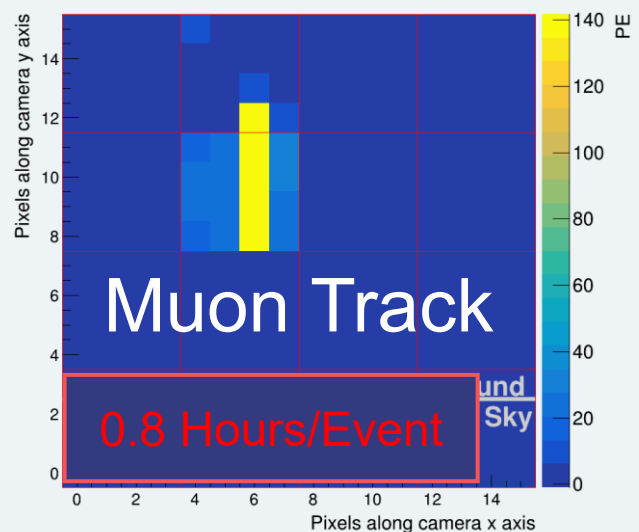
Event Gallery: Types of Events



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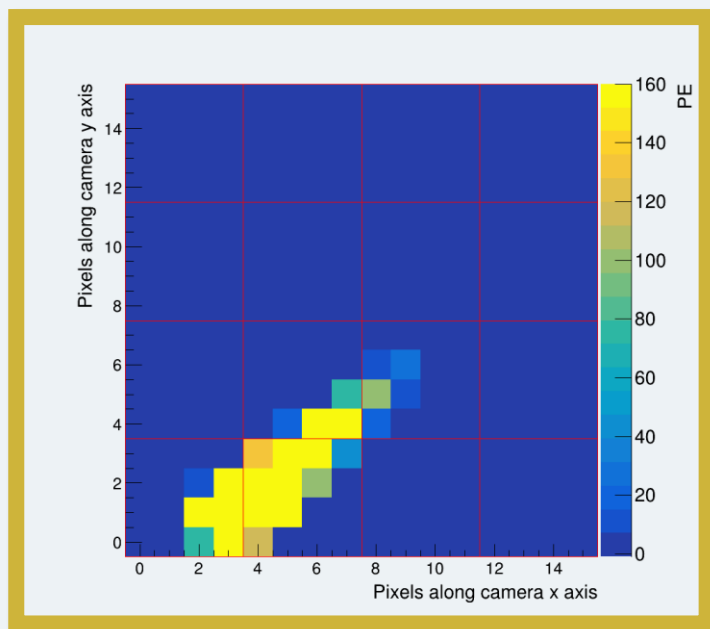
Gold Plated Simulation Event



Event Gallery: Types of Events

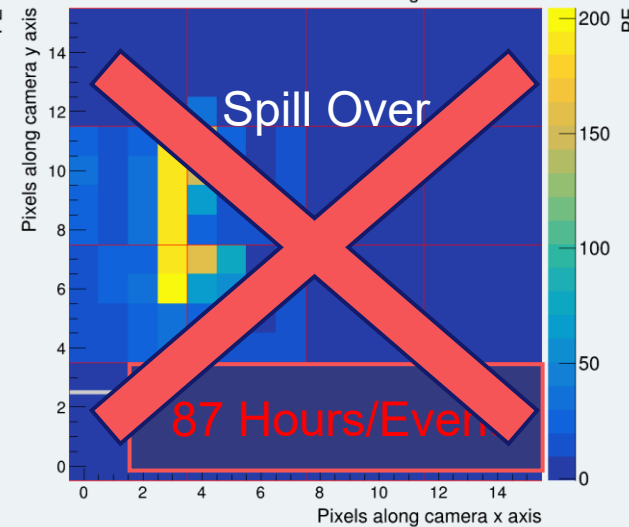
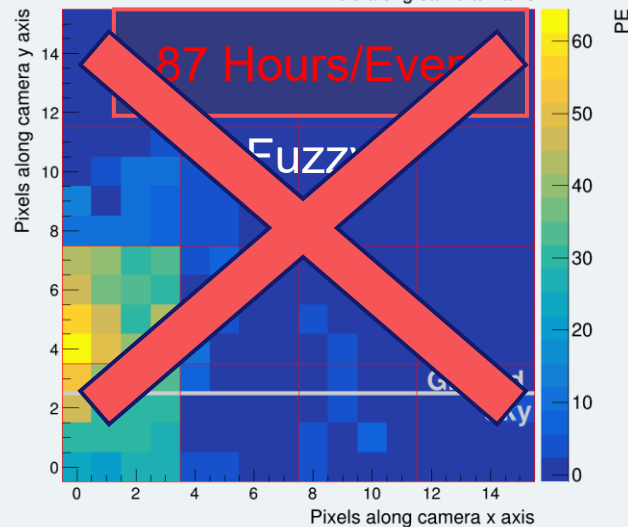
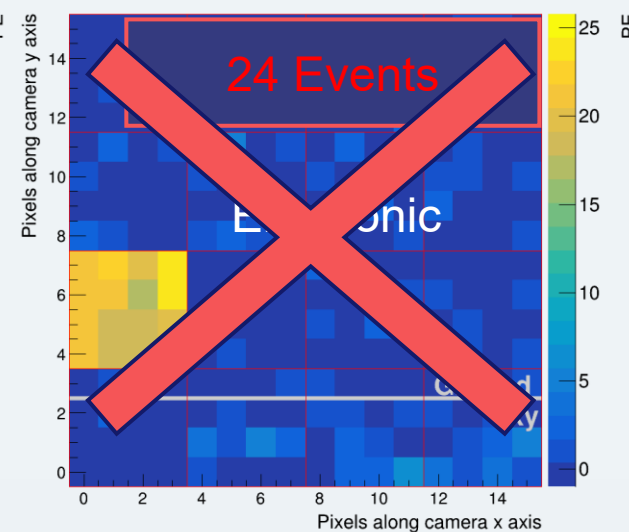
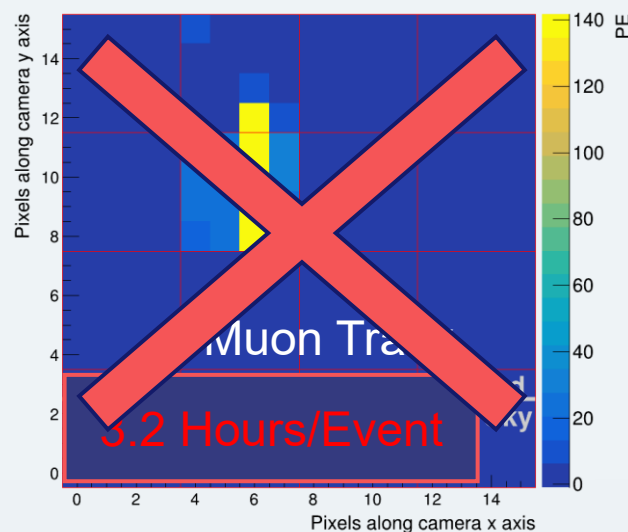


anthony.brown@durham.ac.uk



Gold Plated Simulation Event

No Background Events



Outlook



- Include data affected by weather
- Simulate our acceptance
- Calculate limit on diffuse neutrino flux
- Working on the atmospheric calibration equipment

Camera paper: [arXiv:2406.08274]

**Commissioning paper:
[arXiv:2503.11864]**

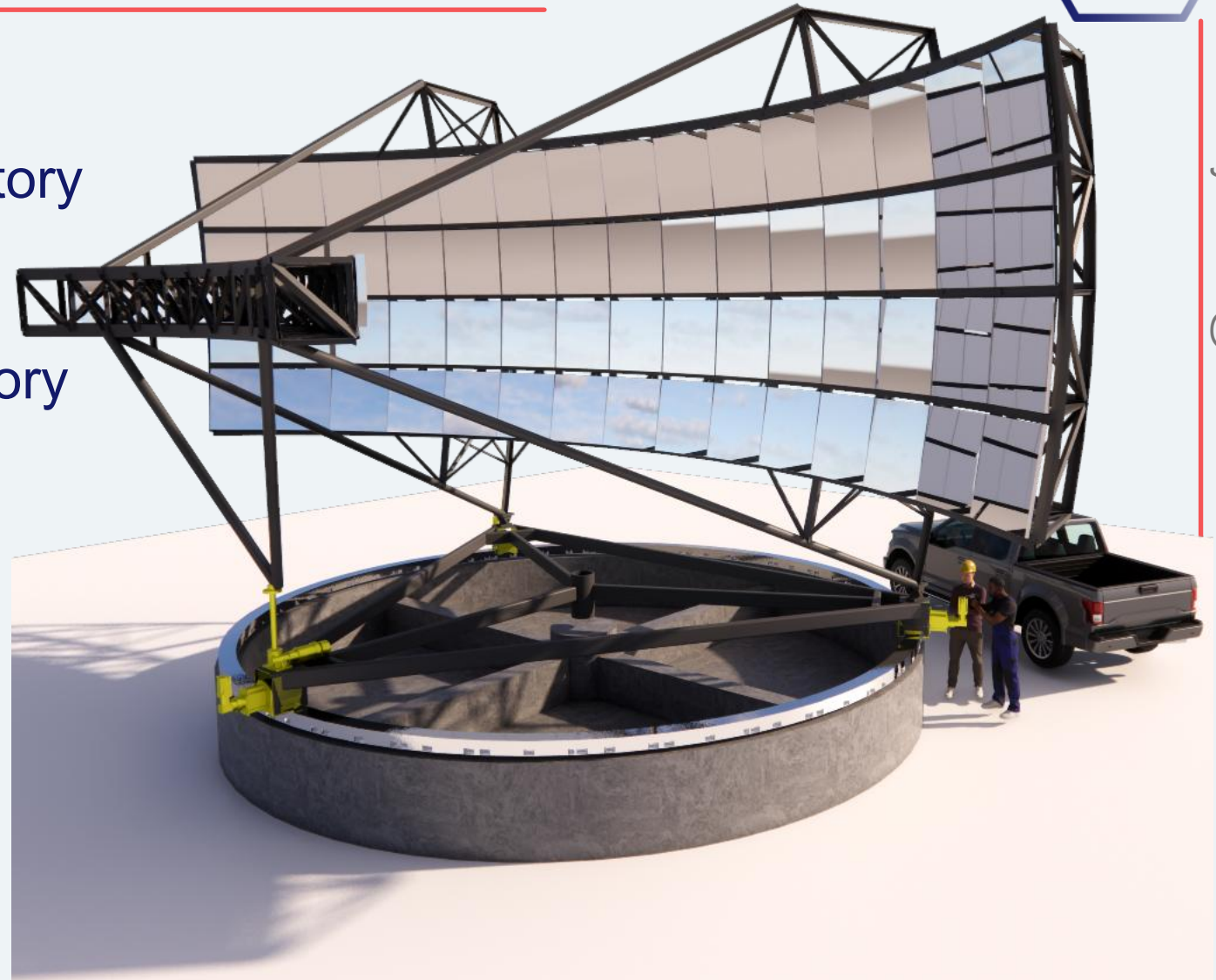


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Outlook: Trinity One



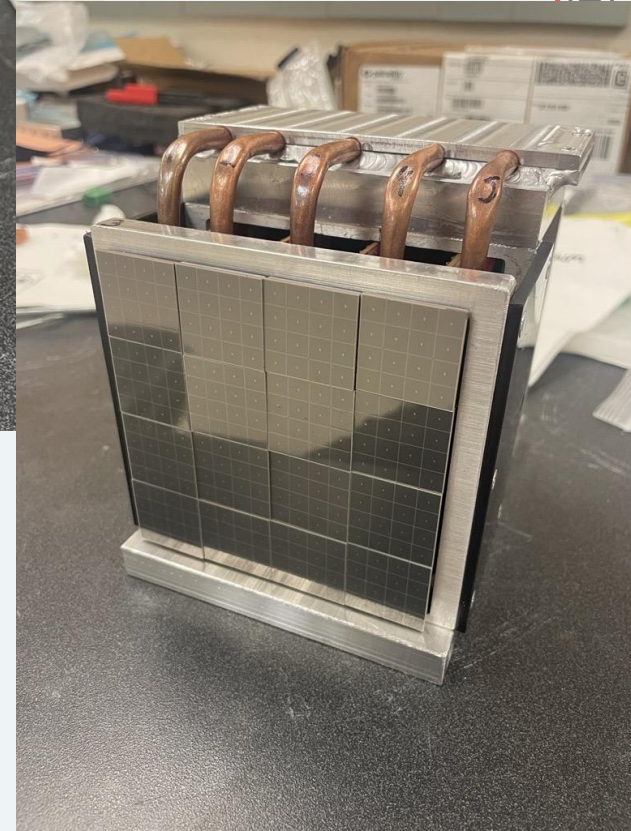
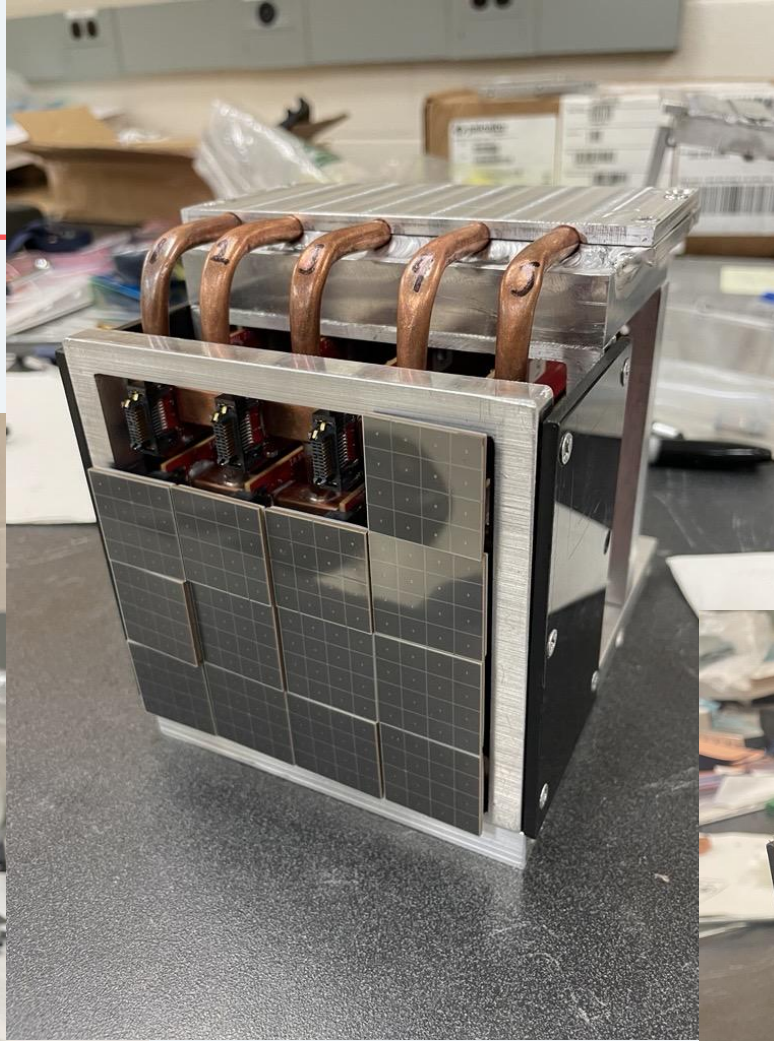
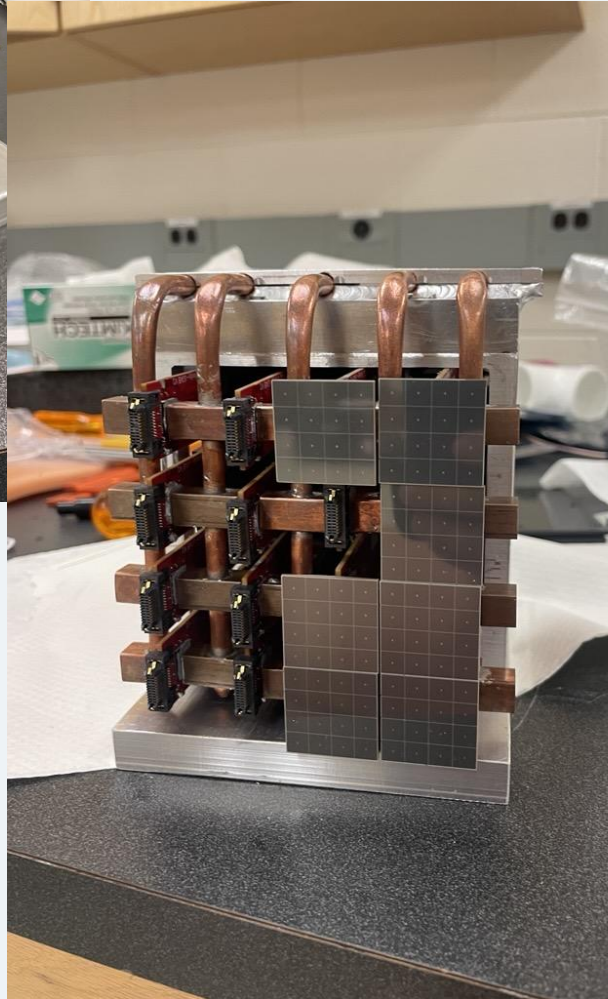
- First telescope of Trinity Observatory
- Rotates in azimuth
- Excellent point source sensitivity
- Planned to be an Open Observatory



anthony.brown@durham.ac.uk



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Optical Alignment

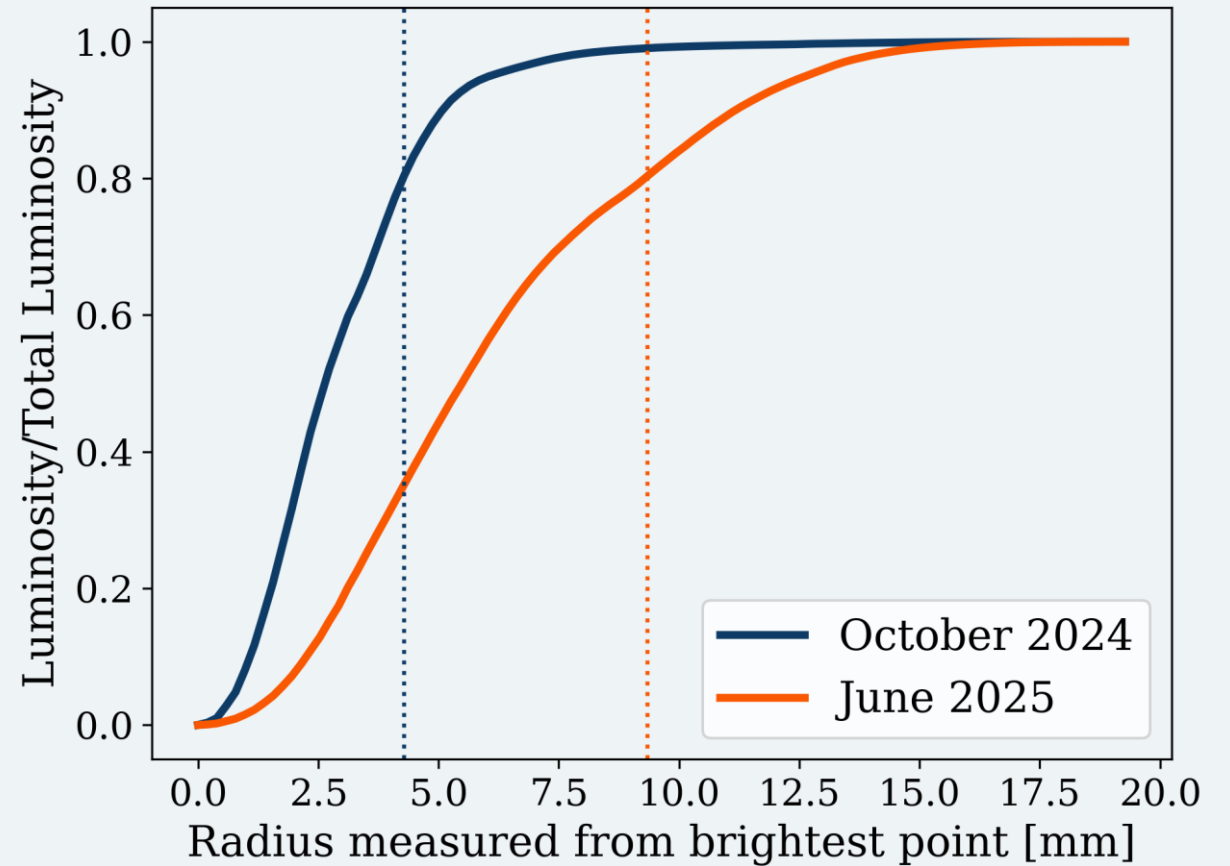


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80% containment radius of 2.1mm



Horizon Imaged on SiPMs

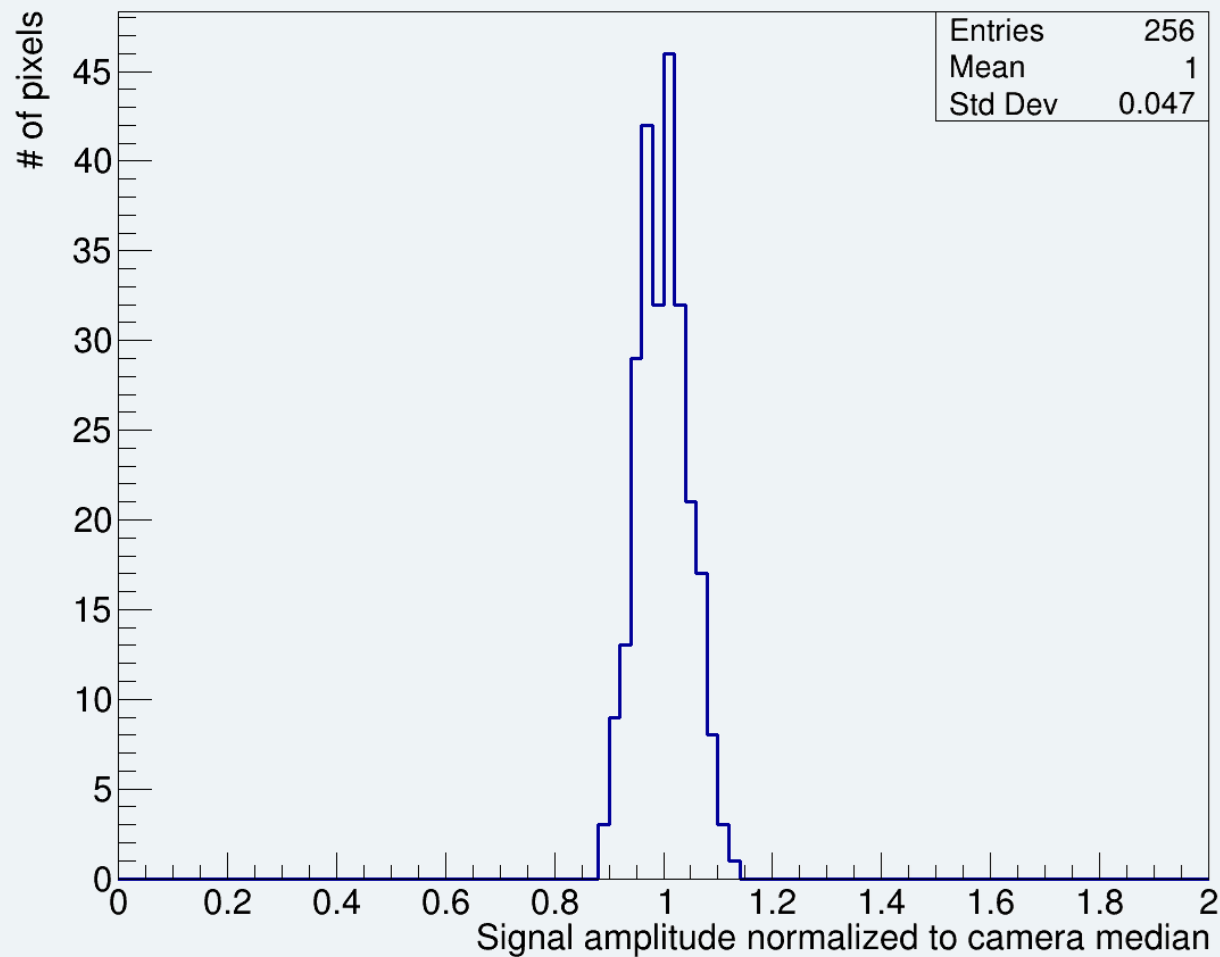


Camera Gain Flat-Fielding



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- HV gain flat-field within 5% std



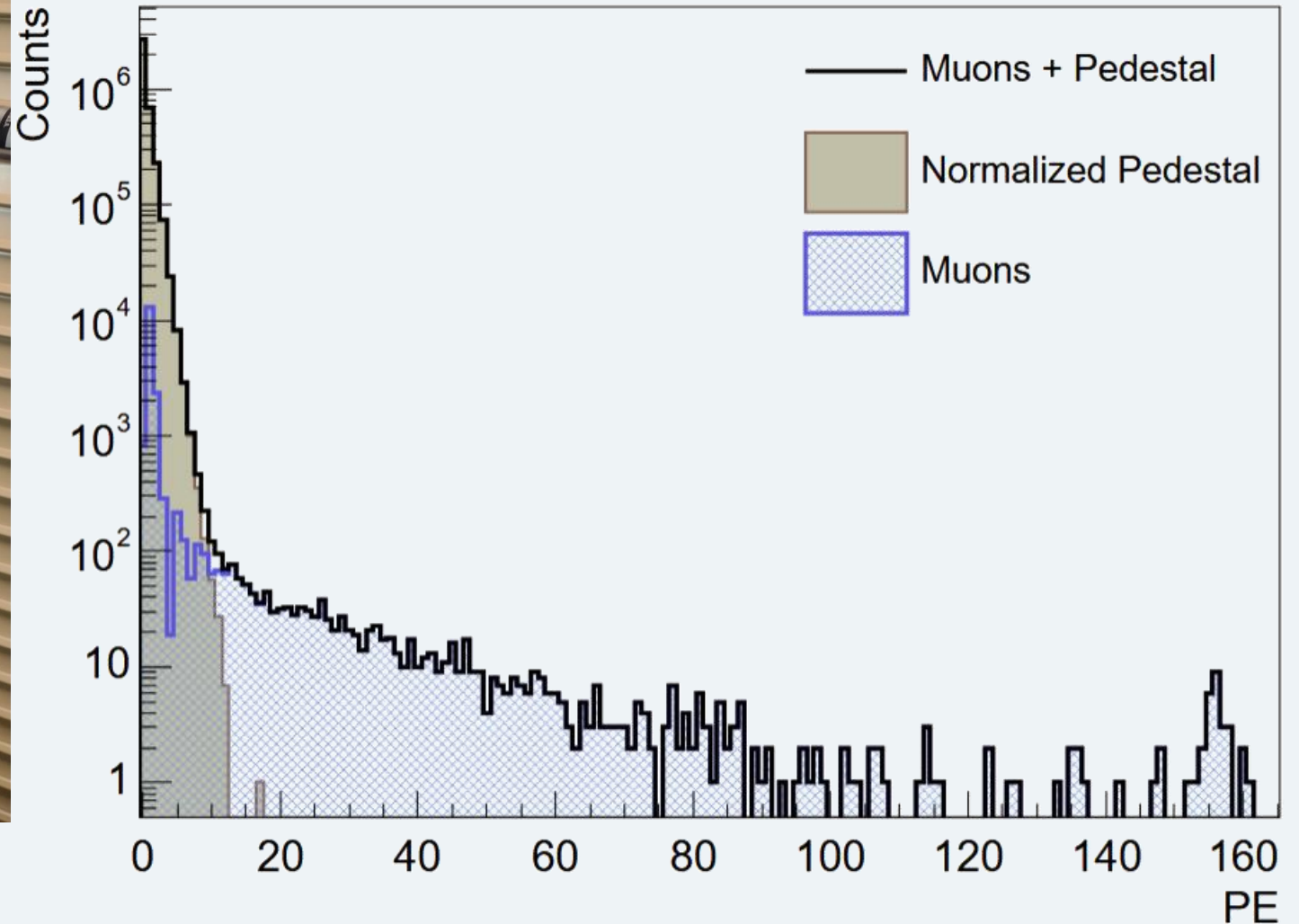
Direct Muon Hits



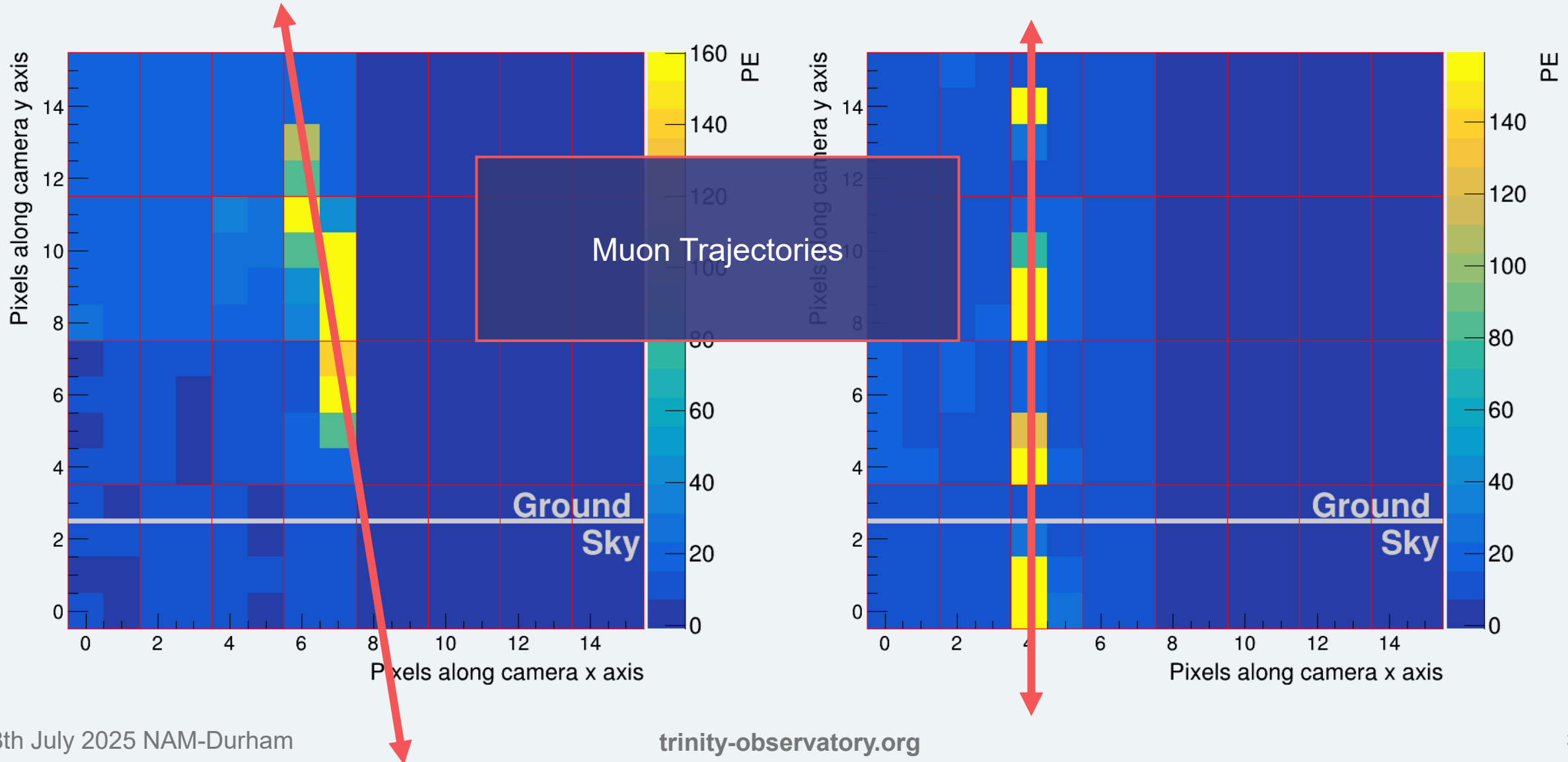
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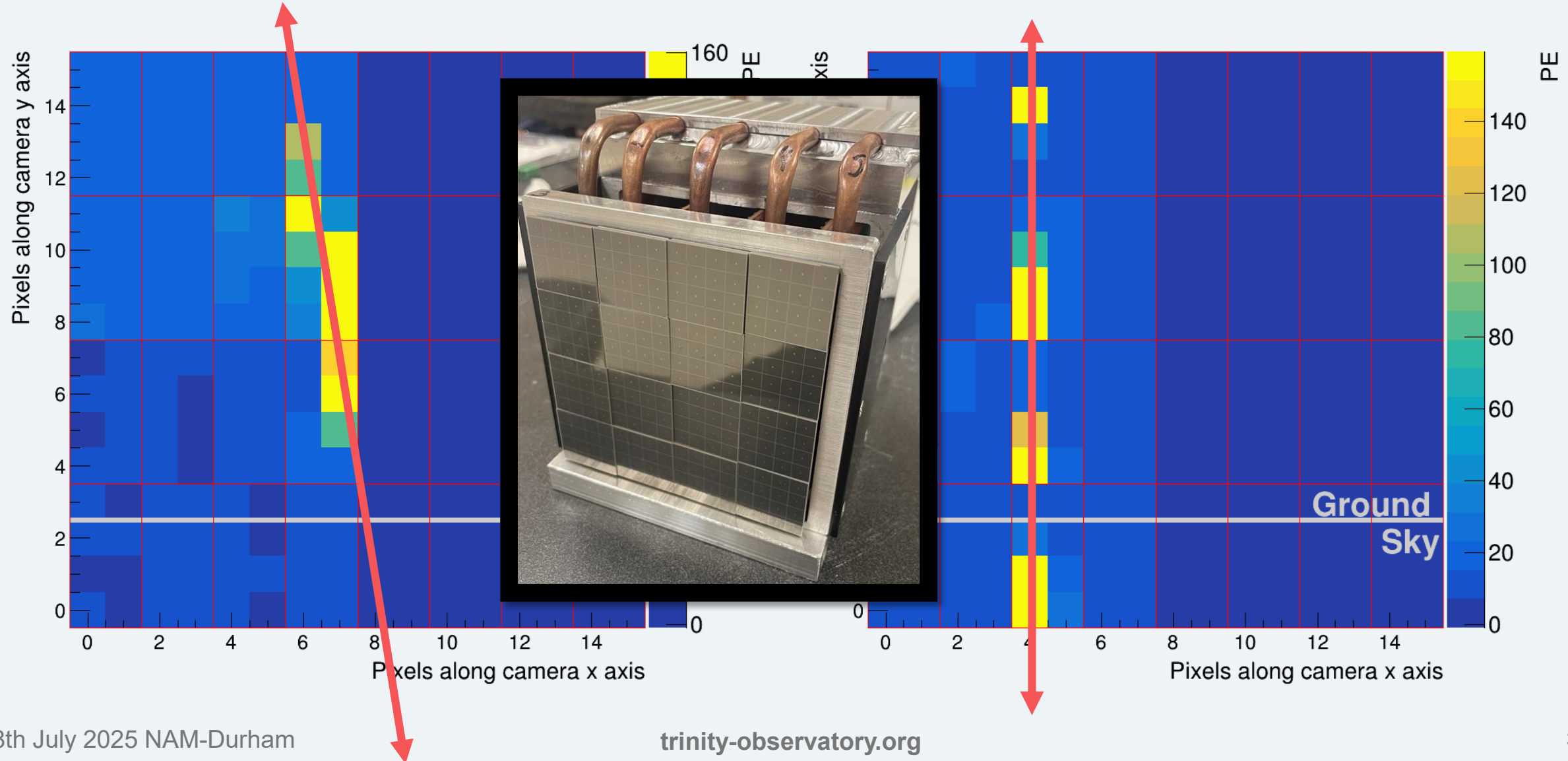
Data Collection for Vertical
Muon Paddles: 2 hours



Background: Sample Events



Background: Sample Events



Background: NSB



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Background: Sub-Showers

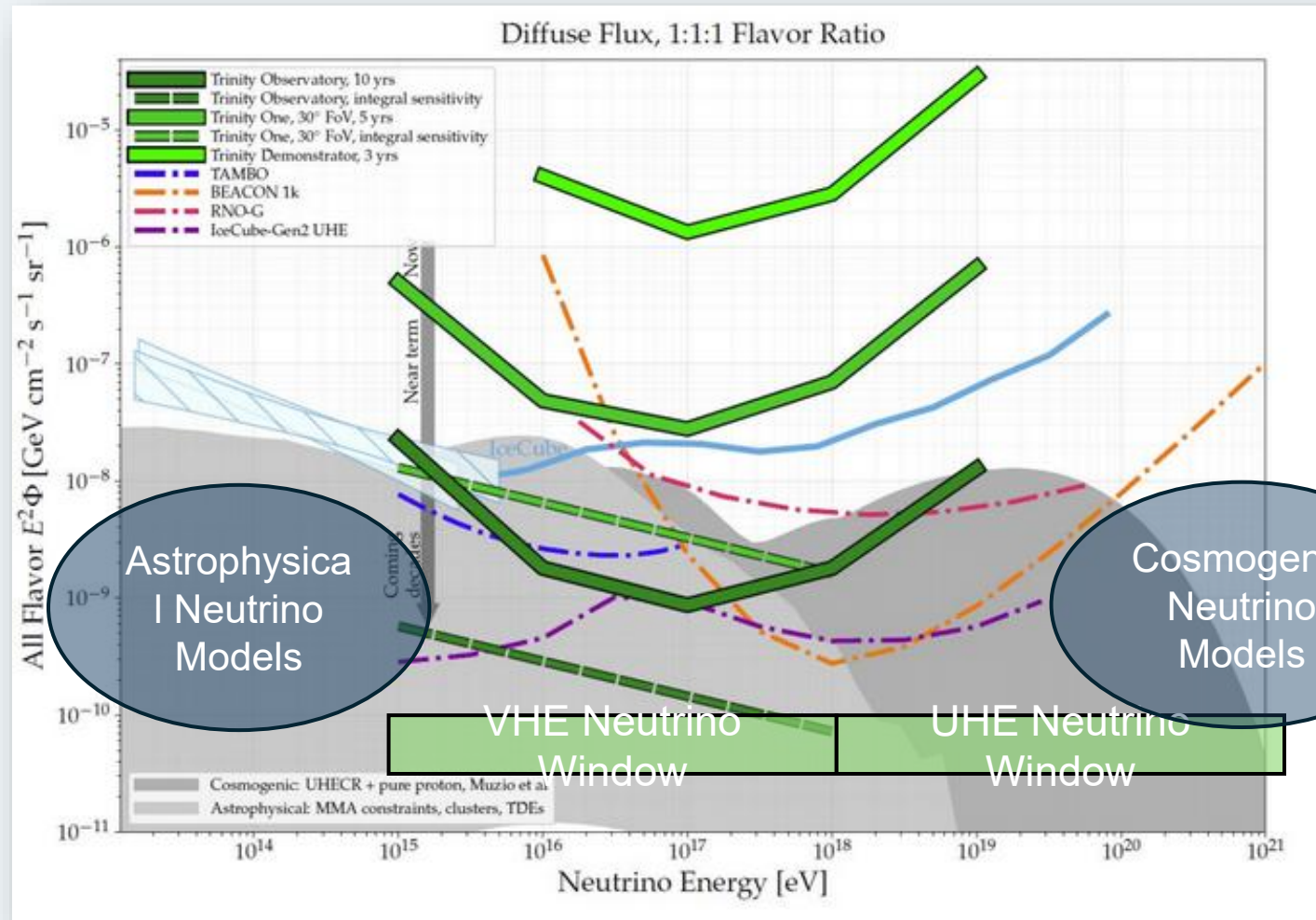


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The VHE/UHE Neutrino Window



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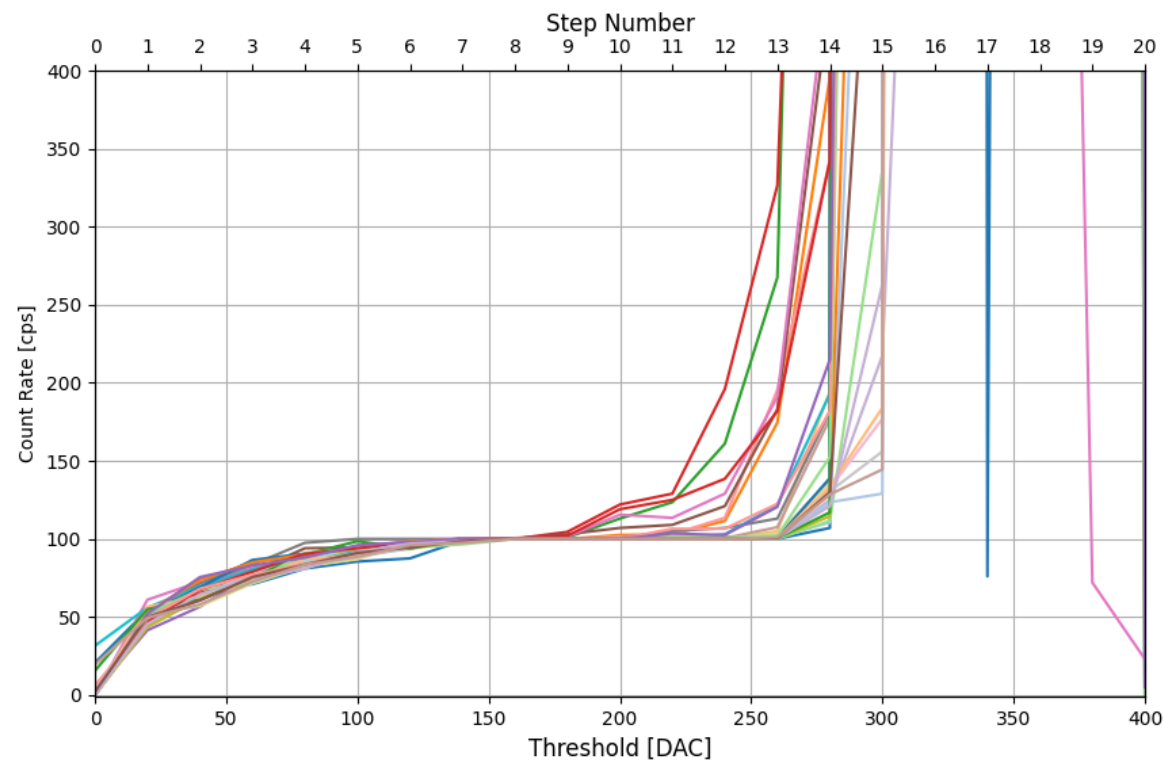
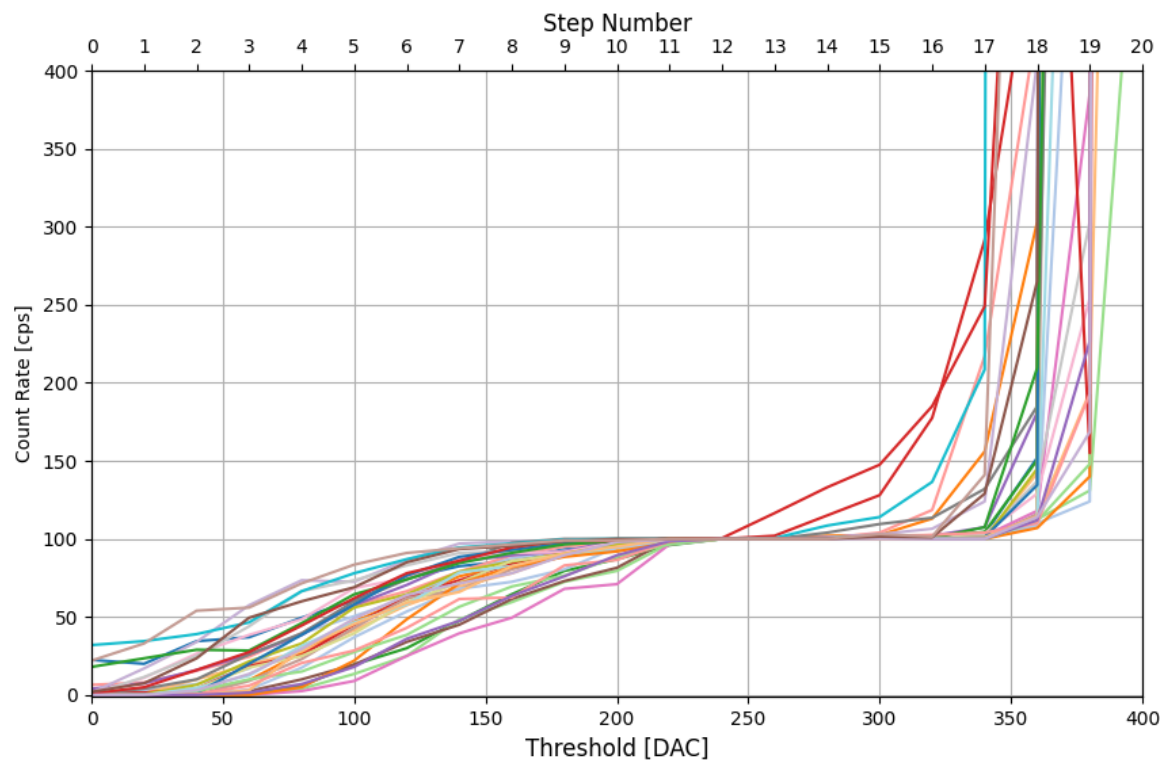
Astrophysical
Neutrino
Models

Cosmogenic
Neutrino
Models

Trigger flat-fielding



- Normal observing conditions:
 - Trigger threshold: 20 PE
 - Trigger rate: < 0.5 Hz

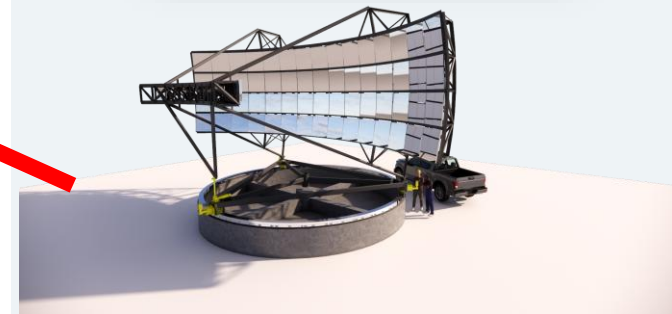
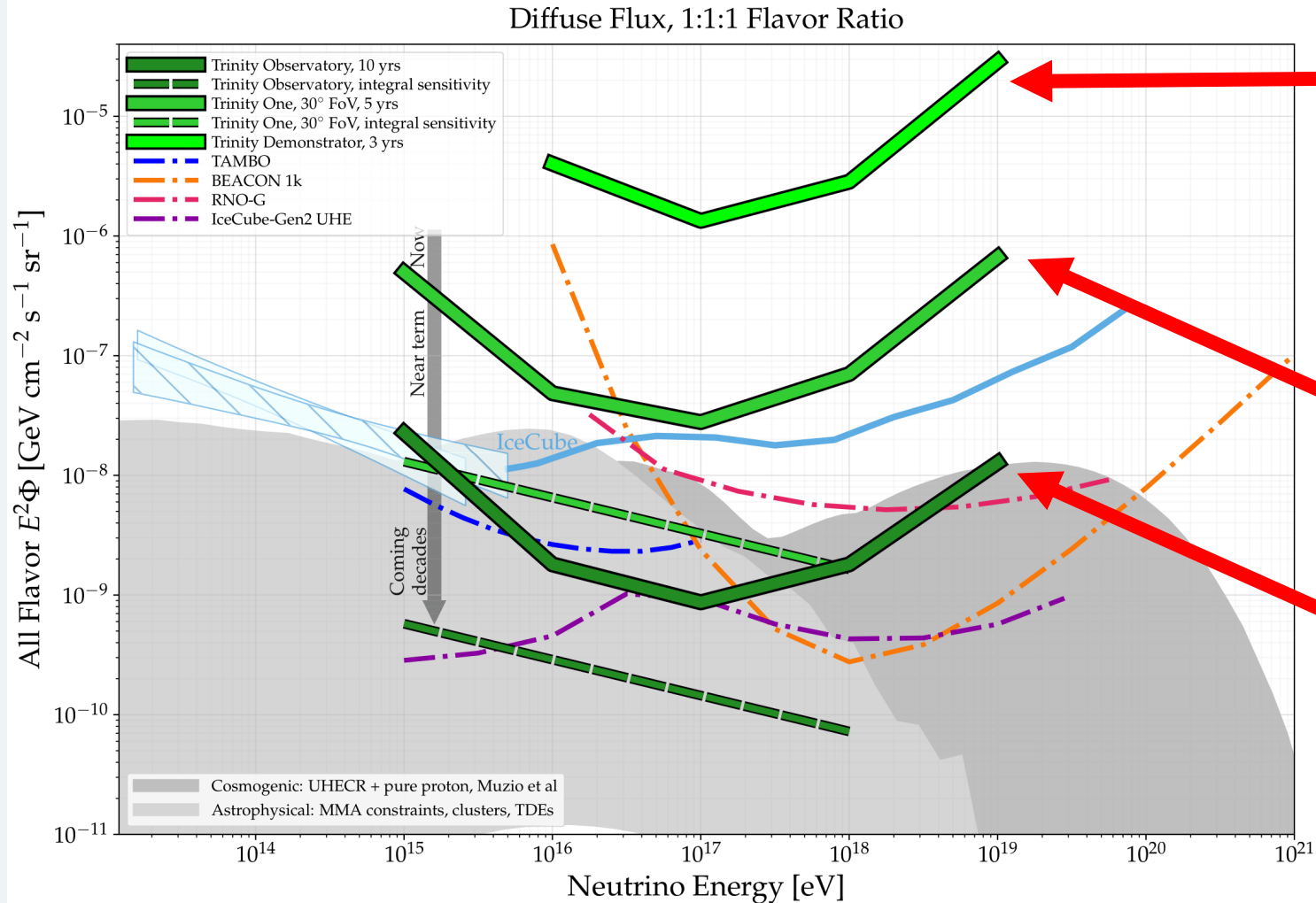


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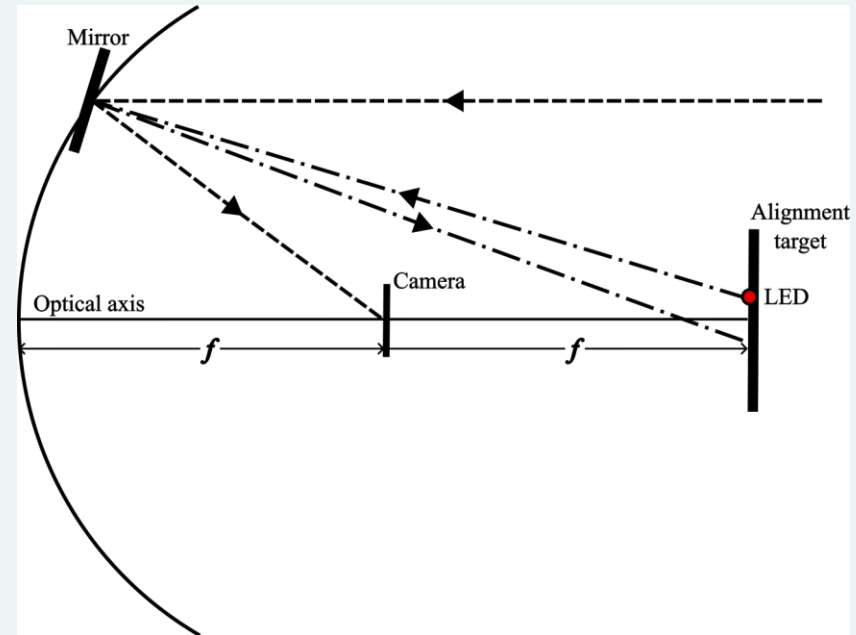
The VHE/UHE Neutrino Window



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Trinity
Observatory

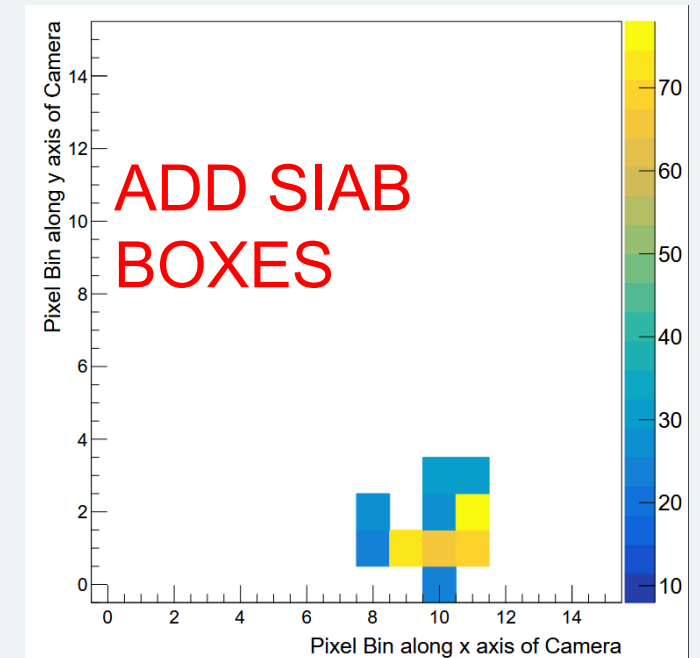
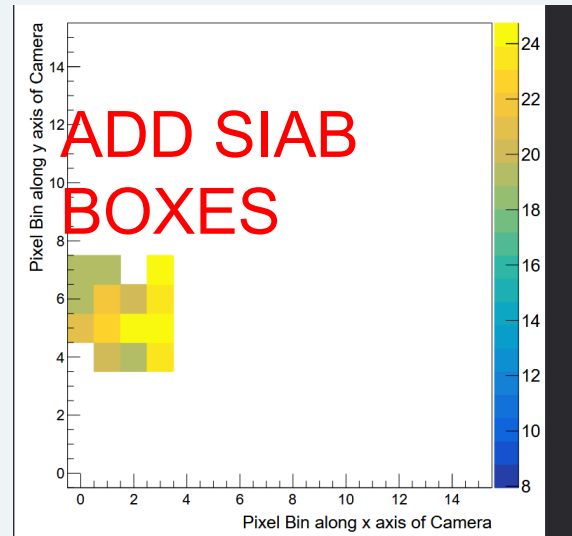
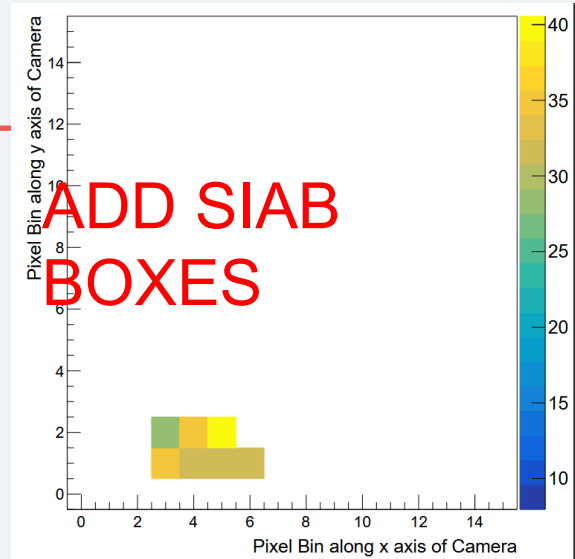
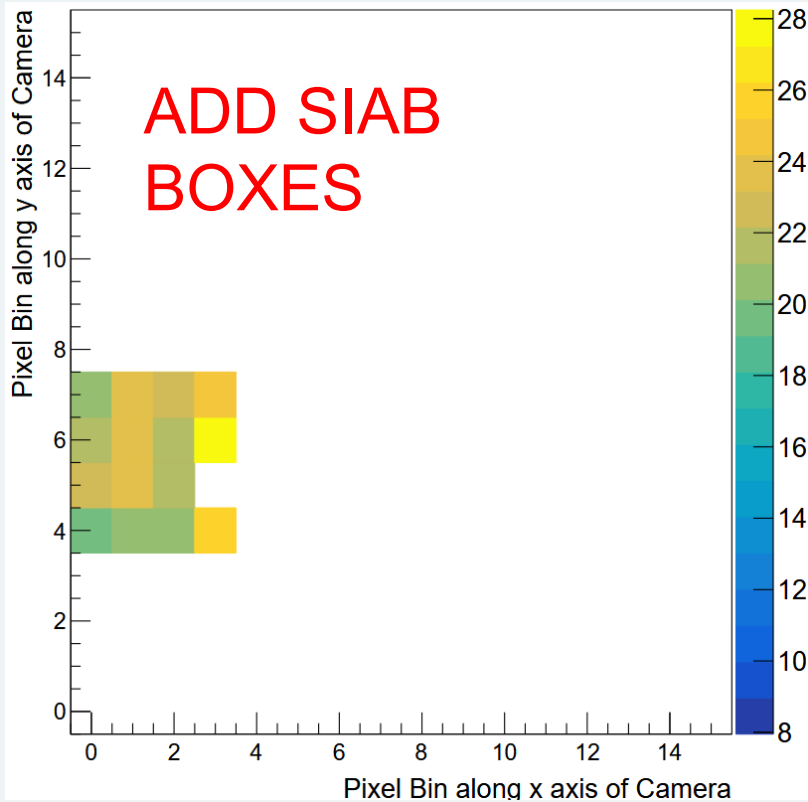


Event Gallery



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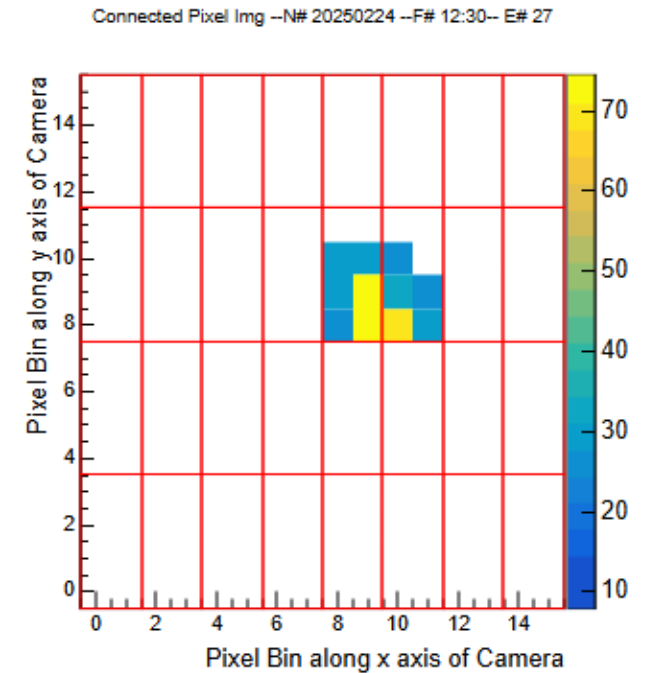
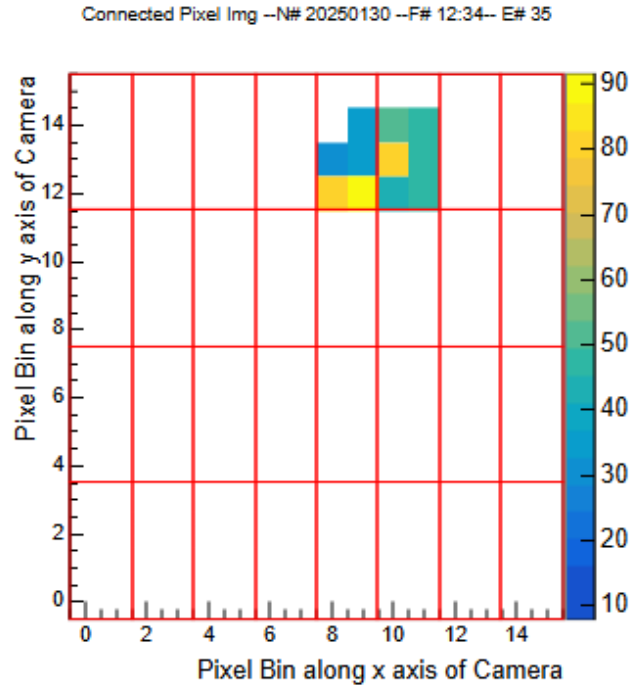
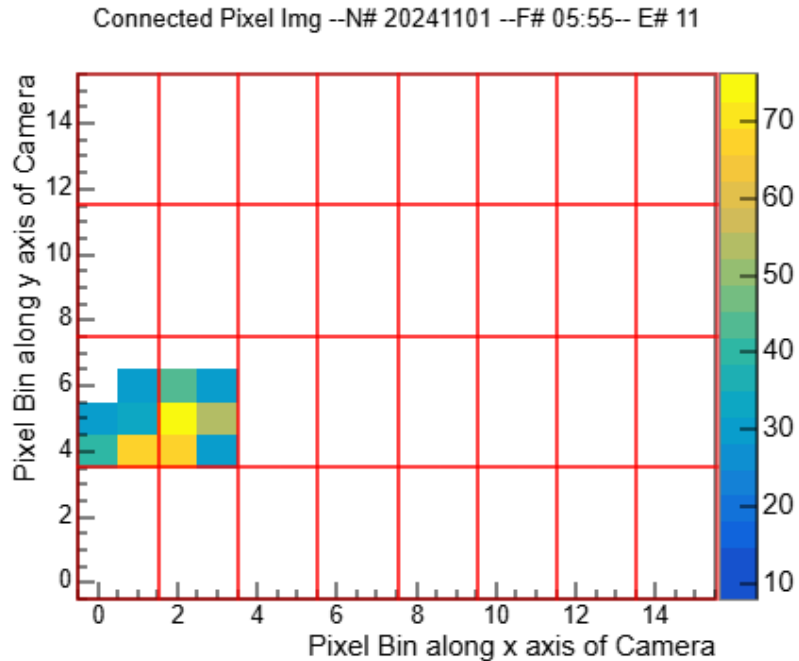
Blob Events



Event Gallery



Bright Cluster with Crosstalk

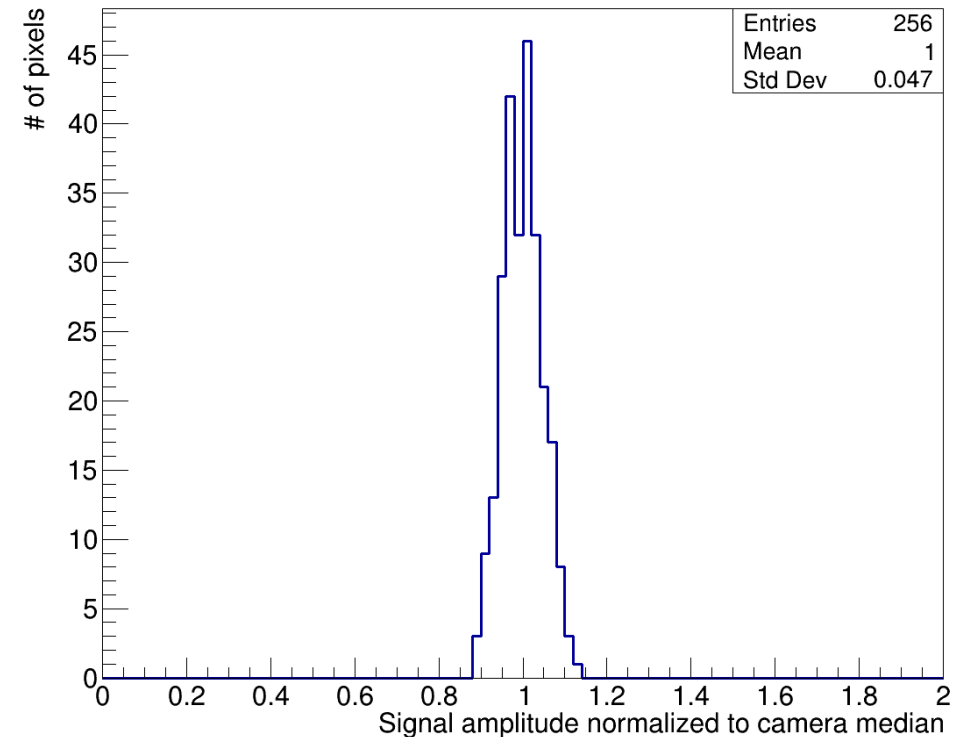
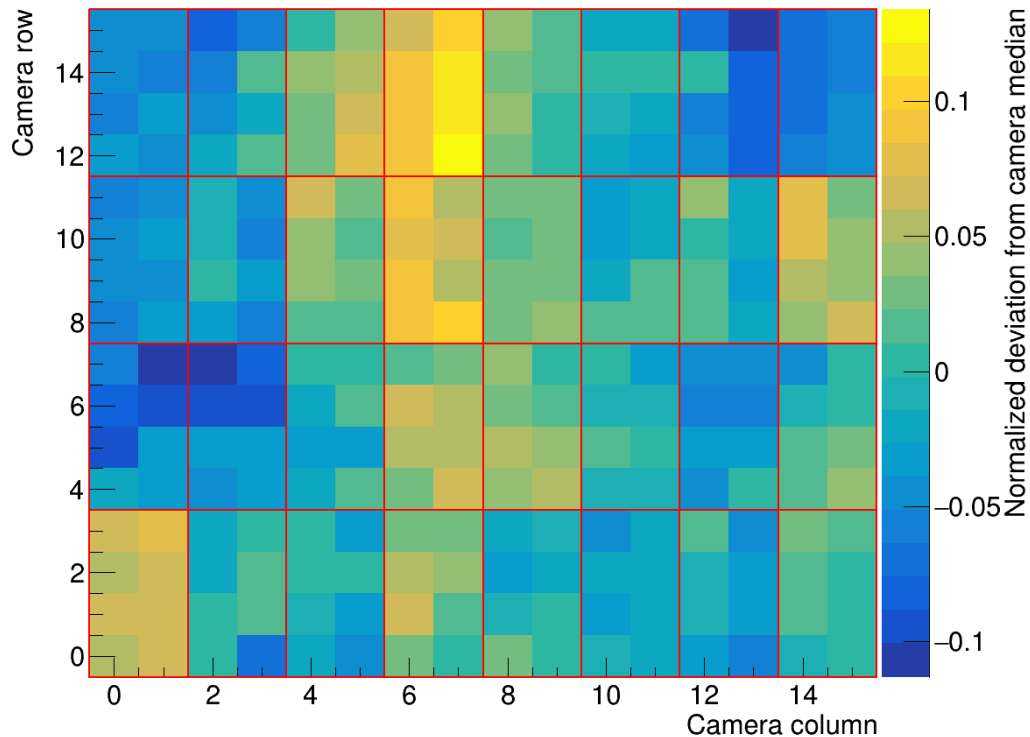


anthony.brown@durham.ac.uk

Camera flat-fielding



- HV gain flat-fielded within 5% std



Event Selection



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Size cut at 5 Image Pixels

Number after event selections
128 events
2.9 Hours/Event

