Real Time Gamma-Ray Reconstruction For the pSCT

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Topics

• Background
  – VHE Gamma-Ray Sources
  – Gamma-Ray Shower
  – Cherenkov Telescope Array
  – Prototype Schwarzschild-Couder Telescope
• Motivation For this Research
  – Quicklook
• Gamma Reconstruction Steps
  – Integrating Pulses
  – Subtracting the Pedestal
  – Cleaning the image
  – Moments Parameters
  – Hadron/Gamma-Ray Separation
• Conclusion
TeV Gamma-Ray Sources

- AGN
- PWN
- SNR
- Star Burst
- Gamma Binary or Pulsars
The Different Particle Showers
Cherenkov Telescope Array

- Ten-fold sensitivity of current instruments
- 4 decades of energy coverage: tens of GeV to >100 TeV
- Improved angular resolution
- Two asymmetric arrays (North/South)
prototype Schwarzschild-Couder Telescope (pSCT)

100 GeV – 10 TeV

Silicon Photo Multiplier (SiPM) Camera
Fred Lawrence Whipple Observatory

pSCT
The Camera Interface

Subfield Backplane
(5×5 Camera Modules)
Camera Interface

- 11,328 Pixels
- Each pixel is 0.067 Degrees
- 6.5 x 6.5 mm^2
- 2.55 x 2.55 mm
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Motivation

• Real Time analysis of Showers
• Create a Quicklook Component for pSCT
  – Always Running
  – Results Available in Real Time for Active and Past Runs for an Individual to view
  – Also change configuration settings like, cuts and thresholds
• **Gamma Reconstruction Steps**
  – Integrating Pulses
  – Subtracting the Pedestal
  – Cleaning the image
  – Moments Parameters
  – Hadron/Gamma-Ray Ray Separation
Calculating the area under the pulse

The area under the curve represents the charge of each pixel

Important to be able to see and access only the charge associated with each pixel to recreate the camera image accurately
Create integration window that applies to every pixel to speed up analysis.
Example Pulse

To acquire Area under the curve for the charge.
Subtracting the Pedestal

- The hardware can create noise that affects the charge value of each pixel
  - Noise various from pixel to pixel
- Pedestal Value is a set value
- So eliminating them both is essential
Pedestal Value

- Discern Pedestal Value
Using a histogram to acquire pedestal value

Add all the pixels to a single histogram in order to see the accumulated wave form.

Histogram describes the values and the number of times they occurred.
Once this is done you can plot or check histogram for two maximums the first being the pedestal which we want.

dc/pe ratio is used as input to the simulations; eventdisplay is working everywhere in units of [dc]

(not part of the package)
Histogram Form

Number of Events

Pulse Count
Cleaning the Image

Cut of 500

Cut of 600

Cut of 950

Cut of 750

Cut of 850
Apply a Method to remove isolated Pixels

• Removing isolated pixels is essential
• Use a method of checking whether each active pixel’s neighbor has a charge
• Use two Pixel widths
  – 1 Pixel width is 2.5 mm
• If it has no pixels around it that are active remove it
• Else leave it alone
Image After the Method is Applied
Image parameter calculation

VImageParameterCalculation::calcParameters
VImageParameter

- most important:
  - size
  - width
  - length
  - phi
  - loss (next page)
  - FUI

Parameters written to output file:
Tel_x/tpars

Centre of field of view
Calculated Parameters

Phi – Angle relative to Center
-57.03 Degrees

size=410779.0 mm^2

length=90.84 mm^2
9.53mm

width=19.96 mm^2
4.467 mm
Cosmic Ray Shower vs Gamma-Ray Shower

- Hadron Showers tend to be more circular or spread out and random compared to a gamma-ray shower.
In Closing

• The Next Steps
  – Recreating the direction of the shower
  – Create Sky Maps
  – Creating diagnostic Histograms
  – Creating GUI and or Web Displays

• Real Time Analysis of the Showers

• Create Diagnostics for User in a Quicklook Manner

• Use the Gamma-Ray Reconstructing Steps to Accomplish this
Thank You

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