GLAST Large Area Telescope:

TKR Calibrations

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TKR

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TKR Parameters to be Calibrated

- Bad channels.
  - Noisy channels.
    - Masked online to reduce excess data rate.
  - Dead/disconnected channels.
    - Not used for mask.
    - Used in offline analysis to account for missing hits.
- GTFE DACs
  - Calibration DAC (One DAC per GTFE)
    - Charge scale needs to be calibrated for each GTFE.
    - Channel level dispersion is expected to be small.
  - Threshold DAC (One DAC per GTFE)
    - Tuning of DAC to nominal threshold (1.4 fC ~ 0.27 MIP)
- TOT
  - TOT as a function of input charge (calibration DAC)
Noisy Strips

- High noise occupancy strips need to be identified and masked.
  - Specification
    - Trigger: $< 5 \times 10^{-5}$ (strip average)
    - Data: $< 10^{-4}$ (strip average)
- Noise occupancy $< 10^{-2}$ will be sufficiently quite for offline analysis.
- For now, limit is set conservatively.
  - Any strip above $10^{-4}$ is masked.
- On orbit, noisy channel should be determined based on average GTRC data rate.
  - Retain as many strips as possible for offline use.
  - No fixed threshold

![Graph showing noise occupancy for layer Y3]
Dead Channels

- Dead channels are dead amplifier channels.
  - No data from charge injection.
  - Shows up as zero gain channels in gain measurement.
Disconnected Strips

- Disconnected strips are due to broken connection between amplifier and silicon strip.
  - Shows up as very low noise channels.
  - Noise < 500 electrons.

Channel Noise for layer Y14
Partially Disconnected Strips (Noise)

- Partially disconnected strips are due to broken connection between SSDs.
  - Shows up as intermediate noise channels.
- Not to easy to distinguish them from quite GTFEs.

Channel Noise for layer X5

Partially disconnected strips
Partially Disconnected Strips (Occupancy)

- It is easier to identify partially disconnected strips from strip occupancies.
  - Use track information to determine the associated SSD.
  - Occupancy drops to 0 if connection is broken.
  - Important to keep track of history.
Intermittently Disconnected Strips

- Intermittently disconnected strips make life more interesting.

<table>
<thead>
<tr>
<th>Layer</th>
<th>strip #</th>
<th>Occupancies</th>
<th></th>
<th>Occupancy deficit at the edges of top and bottom 2 layers</th>
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<tbody>
<tr>
<td>SSD0</td>
<td>SSD1</td>
<td>SSD2</td>
<td>SSD3</td>
<td></td>
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<tr>
<td>X2</td>
<td>1441</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>1446</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1447</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Y3</td>
<td>863</td>
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<td>0</td>
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<tr>
<td></td>
<td>870</td>
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<tr>
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<td>875</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>X16</td>
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<td>19</td>
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<tr>
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<tr>
<td></td>
<td>35</td>
<td>8</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

- Occupancy is not sufficient to reliably identify intermittent strips.
- Efficiency is complimentary to occupancy
- Still work in progress
Intermittently Partially Disconnected Strips

- Intermittently partially disconnected strips are slightly easier to identify. (although hard to pronounce…)
  - Occupancies in strips closer to amplifier can be used as references.

<table>
<thead>
<tr>
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<th>Occupancies</th>
</tr>
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<tr>
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<tr>
<td></td>
<td>556</td>
<td>34</td>
</tr>
</tbody>
</table>

\[
FOM = \log \left( \frac{f_p(occ, \mu)}{f_p(int(\mu), \mu)} \right)
\]

\(f_p\): Poisson probability function
DAC/TOT Calibrations Overview

• DAC/TOT calibration sequence
  – TOT-charge calibration.
    • Measure TOT vs. input charge and fit.
    • Pretend input charge (calibration DAC scale) is known.
    • Factor out channel dependence.
  – Charge scale calibration.
    • Muon MIP peak to calibrate input charge (calibration DAC) scale.
  – Threshold DAC calibration.
  – Second iteration of TOT-charge calibration.
    • TOT depends on threshold.
**TOT-Charge Calibration**

- Charge injection test.
  - Measure TOT as a function of input charge.
  - Fit to second order polynomial.
    - Charge = $p_0 + p_1 \times \text{TOT} + p_2 \times \text{TOT}^2$
  - Large dispersion of conversion parameters within GTFE.
    - Due to shaper circuitry limitation.

![Graphs showing TOT parameter vs. strip# and TOT vs. Calibration DAC]
Charge Scale Calibration

- Fit muon charge distribution for each GTFE.
  - Gaussian convolved Landau distribution.

Raw TOT Distributions

Charge Distributions (channel dependence factored out)

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Threshold DAC Calibration

- Scan threshold DAC for a given input charge (1.4 fC ~ 0.27 MIP)

BEFORE charge scale calibration

AFTER charge scale calibration

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• Effective data threshold is higher than the trigger threshold.
  – Trigger threshold: charge required to trigger at pulse peak.
  – Data threshold: charge required for data capture at TACK.
• TACK: ~1 µs after the trigger request.
Conclusions

• Bad strips
  – Identification of noisy, dead, disconnected strips is well understood.
  – Identification of partially disconnected strips is in a good shape.
  – Identification of intermittently disconnect strips (partial or not) is a challenge.
    • Reasonable solution exists.

• DAC/TOT calibrations.
  – Procedure in place.
  – Appear to be working as expected.
  – Needs more studies to understand the effect.
  – Data threshold dispersion is large.