EM Calibrations and Data Analysis

EMuardo do Couto e Silva and Xin Chen
Nov 13, 2002
Outline

• EM data taking statistics (summary)
  – CAL Calibration
  – 17.6 MeV Photon Runs
  – Simple comparison between 1 W and 3 W geometry

• EM TOT Studies
  – Energy deposition
  – Calibration
  – Data analysis
Event display of a muon passing through EM

Using GLEAM V3
the official version for EM

Mechanical support structure is not simulated!
### Muon Calibrations

Muon rate from PDG = 1 /cm²/min  
Number of MC events generated with cos²θ distribution = 1,000,000  
Sphere around EM = 60000 cm²  
Area of a CAL Layer = 32 x 32 = 1024 cm²  

CAL needs at least 1000 muons/bin to get 3 mm resolution

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Log Bin size used (cm²)</th>
<th>Normalized Rate</th>
<th># Daily Muons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hz</td>
<td>Hz/cm²</td>
<td>/cm²</td>
</tr>
<tr>
<td>1</td>
<td>TKR trigger</td>
<td>2.7x2.7</td>
<td>0.0152</td>
<td>1310</td>
</tr>
<tr>
<td>2</td>
<td>TKR trigger Number of Tracks &gt; 0</td>
<td>2.7x2.7</td>
<td>0.0136</td>
<td>1177</td>
</tr>
<tr>
<td>3</td>
<td>TKR trigger Number of Tracks &gt; 0 Zdir&lt; 10 deg w.r.t vertical</td>
<td>2.7x2.7</td>
<td>0.0036</td>
<td>312</td>
</tr>
<tr>
<td>4</td>
<td>TKR trigger Number of Tracks &gt; 0 Zdir&lt; 10 deg w.r.t vertical</td>
<td>2.7x0.27</td>
<td>0.0036</td>
<td>312</td>
</tr>
</tbody>
</table>
X and Y Positions of first hit in the TKR assuming 10 degrees with respect to the vertical (corresponds to 20 only minutes of data taking)

27 x 27 mm$^2$ bin
2272 muons/bin/day

27 x 2.7 mm$^2$ bin
227 muons/bin/day

CAL requested 6 days of C.R. data taking
Data Taking Configurations

Photon Run – TKR trigger

[Diagram showing 3 C.R. (Cuts) and a 17.6 MeV γ (Gamma) with CAL (Calorimeter) and TKR (Tracker) sections]
Dir goes from 0 to 180
Muons are symmetric around Y

17.6 MeV $\gamma$

1 foil geometry
17.6 MeV $\gamma$
3 GeV $\mu$

Expected photon rate 0.0127 Hz ~1000 photons a day
1W versus 3 W

After L1T cut

Number of tracks
As expected pattern recognition degrades by adding more W

After all cuts

CAL Energy (MeV)
As expected there is less energy in the CAL when more W layers are added
## SUMMARY

<table>
<thead>
<tr>
<th>Config</th>
<th>Description</th>
<th>Photons (Hz)</th>
<th>Muons (Hz)</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Calibration</td>
<td>N/A</td>
<td>3.7</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Control Sample</td>
<td>N/A</td>
<td>0.4</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Photon Run TKR trigger</td>
<td>0.0127</td>
<td>0.0000*</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Photon Run CAL-LO trigger</td>
<td>1</td>
<td>0.0000*</td>
<td>1</td>
</tr>
</tbody>
</table>

- Analysis is not completely background free since the background consists of a crude approximation to the real spectrum, photon rates depend on VdG performance. Need to work around the clock for 14 days!

**Problem:** Although this allows us to check the VdG operation it relies on a “beam constrained analysis” which is not realistic in orbit

**Next Step:** Let’s investigate a more general analysis that can use the TOT!
Si Energy Deposition (MeV) below top W Conversion Layer (MeV)

17.6 MeV photons
- small tail (up to 2 MeV)

3 GeV muons
- Muons from all directions
- small tail (up to 2.4 MeV)

Cuts: TKR trigger, 1 track and 1 vertex, Si Energy < 1 MeV

MIP ~ 151 keV
Si Energy Deposition below top W Conversion Layer (MeV)

Cuts: TKR trigger, 1 track and 1 vertex, Si Energy < 0.5 MeV

82% of events are 1 hit in = 31% of total

38% of events are 1 hit = 24% of total

By requiring 1 hit and $E > 200$ keV we reject 64% of C.R at the expense of 31% of photons but keeping on the second peak 24% of Photons and 6% of CR. So if we bring the S/N ratio down using other cuts we can use this an extra handle on background rejection.

17.6 MeV γ
3 GeV μ

73% of events are 1 hit = 64% of total

52% of events are 1 hit = 6% of total
TOT “Calibration”

Cuts: TKR trigger, 1 track and 1 vertex

Muons: 1 Mip ~ 33 counts

Landau is not a very good fit, the peak is better described by a Gaussian at 37 counts corresponding to 7.4 microseconds
TOT Distributions

17.6 MeV $\gamma$

3 GeV $\mu$

Cuts: TKR trigger, 1 track and 1 vertex, Si Energy > 0
Cuts applied
• 1 track
• 1 vertex
• 1 or 2 hits in the layer immediately below W where conversion occurred

Suggests we should apply A chi2 cut > 2

17.6 MeV γ
3 GeV μ
After chi2 cut...

Cuts applied
• 1 track
• 1 vertex
• 1 or 2 hits in the layer immediately below W where conversion occurred
• chi2 > 2

TKR Clusters

REC_Surplus_hit_ratio

TOT

Accept (2 sigma away from 1 MIP)

17.6 MeV γ
3 GeV μ
SUMMARY

• Using the TOT we can retain a very pure sample of photons with low efficiency (20% normalized to the triggered rate on TKR triggers) and without beam constrained cuts
• Maybe the TOT can be used as an extra handle on background rejection (beyond the ACD). Lots of work ahead of us…
• We expect 14 days of data taking during EM operations with following caveats
  • assumes 1 Hz rate from VDG
  • Hiro and Xin are modifying the cosmic ray spectrum so that we can have a more realistic estimation of the background rates for the EM and also for CU alignment
• analysis is based on low statistics
• no contingency yet in the plan