ECAL Background Rates using Hall D Generator

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Trigger Thresholds from DIS Gen.

- Cluster thresholds generated from electron signals (DIS weighted generator)
- The trigger threshold is the DIS threshold in the shower.
  - Shower 6+1 Thresholds: \{617.9, 531.0, 460.0, 389.8, 331.0, 287.6, 271.9, 272.0\} MeV
  - Shower 2+1 Thresholds: \{501.5, 471.9, 412.8, 340.5, 291.9, 255.3, 243.7, 244.0\} MeV
- No threshold is applied to Pre-Shower clusters
ECAL Analysis with Trigger Windows

- Backgrounds are generated using cross section weighted events from hall D generator
- Combined Pions: $\pi^-$, $\pi^+$, $\pi^0$
  - Events are uniformly separated in time according to the background rates
- Tracks incident on the ECAL can then be separated to 30 ns time windows (trigger window is 30 ns)
- Each sector (12 deg) of ECAL is treated independently
- Total time in simulation is 35070 ns or 1169 background trigger windows
- Photon blocker included in the simulation
Trigger Definition

- Select 6+1 max energy cluster for each window in each sector
- If above the threshold, trigger the sector
- Trigger condition applied based on radial dependence cluster thresholds
Tracks Incident on ECAL

Total no. of tracks incident on the ECAL sector are categorized into:
- Pions (+/-)
- Pi0 Photons
- All other photons
Tracks Incident on ECAL After 6+1 Trigger

Total no. of tracks incident on the ECAL sector are categorized in to,

- Pions (+/-)
- Pi0 Photons
- All other photons
ECAL : Wiser Background Rate

- Total background rates before and after applying the trigger
- With the photon blocker
- Photons are separated into two groups
  - From Pi0 and all other secondary photons
  - No high energy gammas after photon blocker
  - Photon rate is mostly dominated by very low energy tracks

<table>
<thead>
<tr>
<th>All Mom.</th>
<th>Before Trigger</th>
<th>After 6+1 Trigger</th>
<th>After 2+1 Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MHz</td>
<td>MHz</td>
<td>MHz</td>
</tr>
<tr>
<td>Bkg. e±</td>
<td>1308.2</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td>π±</td>
<td>842.5</td>
<td>5.3</td>
<td>2.0</td>
</tr>
<tr>
<td>γ(π0)</td>
<td>55346.5</td>
<td>49.9</td>
<td>14.3</td>
</tr>
<tr>
<td>all other γ</td>
<td>9104.3</td>
<td>11.4</td>
<td>3.7</td>
</tr>
</tbody>
</table>

P > 1 GeV

| Bkg. e± | 0.0          | 0.0              | 0.0              |
| π±      | 140.1        | 4.3              | 1.0              |
| γ(π0)   | 0.3          | 0.0              | 0.0              |
| all other γ | 0.0    | 0.0              | 0.0              |

P < 1 GeV

| Bkg. e± | 1308.2        | 0.9              | 0.4              |
| π±      | 702.4         | 1.0              | 1.0              |
| γ(π0)   | 55346.2       | 49.9             | 14.3             |
| all other γ | 9104.3 | 11.4             | 3.7              |
ECAL : Hall D Gen. Background Rate

- Total background rates before and after applying the trigger
- With the photon blocker
- Photons are separated into two groups
  - From Pi0 and all other secondary photons
  - No high energy gammas after photon blocker
  - Photon rate is mostly dominated by very low energy tracks

<table>
<thead>
<tr>
<th>All Mom.</th>
<th>Before Trigger 396.9 MHz</th>
<th>After 6+1 Trigger 0.3 MHz</th>
<th>After 2+1 Trigger 0.0 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bkg. e±</td>
<td>433.2 MHz</td>
<td>3.8 MHz</td>
<td>0.5 MHz</td>
</tr>
<tr>
<td>γ(π0)</td>
<td>23010.9 MHz</td>
<td>14.2 MHz</td>
<td>2.5 MHz</td>
</tr>
<tr>
<td>all other γ</td>
<td>4581.4 MHz</td>
<td>3.0 MHz</td>
<td>0.7 MHz</td>
</tr>
<tr>
<td>P &gt; 1 GeV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bkg. e±</td>
<td>0.1 MHz</td>
<td>0.0 MHz</td>
<td>0.0 MHz</td>
</tr>
<tr>
<td>π±</td>
<td>97.3 MHz</td>
<td>3.1 MHz</td>
<td>0.5 MHz</td>
</tr>
<tr>
<td>γ(π0)</td>
<td>0.2 MHz</td>
<td>0.0 MHz</td>
<td>0.0 MHz</td>
</tr>
<tr>
<td>all other γ</td>
<td>0.2 MHz</td>
<td>0.0 MHz</td>
<td>0.0 MHz</td>
</tr>
<tr>
<td>P &lt; 1 GeV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bkg. e±</td>
<td>396.7 MHz</td>
<td>0.3 MHz</td>
<td>0.0 MHz</td>
</tr>
<tr>
<td>π±</td>
<td>335.8 MHz</td>
<td>0.7 MHz</td>
<td>0.1 MHz</td>
</tr>
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<td>γ(π0)</td>
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</tr>
</tbody>
</table>
Trigger Rate Estimation
ECAL Shower Energy Deposit

Trigger threshold _______

1. Sh. S+1 energy deposit in 30 μs (R: 1.1 - 1.3 m, No. Trig)
   - Mean: 0.02 ± 0.594
   - RMS: 72.54

2. Sh. S+1 energy deposit in 30 μs (R: 1.3 - 1.5 m, No. Trig)
   - Mean: 0.02 ± 0.7987
   - RMS: 75.63

3. Sh. S+1 energy deposit in 30 μs (R: 1.5 - 1.7 m, No. Trig)
   - Mean: 0.02 ± 0.8953
   - RMS: 78.54

4. Sh. S+1 energy deposit in 30 μs (R: 1.7 - 1.9 m, No. Trig)
   - Mean: 0.033
   - RMS: 82.64

5. Sh. S+1 energy deposit in 30 μs (R: 1.9 - 2.1 m, No. Trig)
   - Mean: 0.02 ± 1.063
   - RMS: 86.18

6. Sh. S+1 energy deposit in 30 μs (R: 2.1 - 2.3 m, No. Trig)
   - Mean: 0.02 ± 1.115
   - RMS: 88.64

7. Sh. S+1 energy deposit in 30 μs (R: 2.3 - 2.5 m, No. Trig)
   - Mean: 0.02 ± 1.213
   - RMS: 92.74

8. Sh. S+1 energy deposit in 30 μs (R: 2.5 - 2.7 m, No. Trig)
   - Mean: 0.02 ± 2.064
   - RMS: 94.28

9. Sh. S+1 energy deposit in 30 μs (R: 2.7 - 2.9 m, No. Trig)
   - Mean: 0.02 ± 2.064
   - RMS: 94.28

10. Sh. S+1 energy deposit in 30 μs (R: 1.1 - 1.3 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28

11. Sh. S+1 energy deposit in 30 μs (R: 1.3 - 1.5 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28

12. Sh. S+1 energy deposit in 30 μs (R: 1.5 - 1.7 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28

13. Sh. S+1 energy deposit in 30 μs (R: 1.7 - 1.9 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28

14. Sh. S+1 energy deposit in 30 μs (R: 1.9 - 2.1 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28

15. Sh. S+1 energy deposit in 30 μs (R: 2.1 - 2.3 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28

16. Sh. S+1 energy deposit in 30 μs (R: 2.3 - 2.5 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28

17. Sh. S+1 energy deposit in 30 μs (R: 2.5 - 2.7 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28

18. Sh. S+1 energy deposit in 30 μs (R: 2.7 - 2.9 m, No. Trig)
    - Mean: 0.02 ± 2.064
    - RMS: 94.28
ECAL Pre-Shower Energy Deposit
Trigger Rate Estimation

• Total time windows 1169
  – In each window there are 30 individual sectors → 1169*30

• Maximum trigger rate is 1/30 ns → 33.33 MHz
  – This is when all time windows are triggered

• Total time windows after applying the trigger 162

• Total trigger rate only from pion bkg. 4.612 MHz
  – 154 kHz per sector

• This estimation does not include EM background
Trigger Rate Estimation with Wiser

- Total time windows 233
  - In each window there are 30 individual sectors → 233*30
- Maximum trigger rate is 1/30 ns → 33.33 MHz
  - This is when all time windows are triggered
- Total time windows after applying the trigger 53
- Total trigger rate only from pion bkg. 7.58 MHz
  - 253 kHz per sector
- This estimation does not include EM background
Trigger Rate Estimation in preCDR

<table>
<thead>
<tr>
<th>region</th>
<th>full</th>
<th>high</th>
<th>low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rate entering the EC (kHz)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$e^-$</td>
<td>413</td>
<td>148</td>
<td>265</td>
</tr>
<tr>
<td>$\pi^-$</td>
<td>$5.1 \times 10^5$</td>
<td>$2.7 \times 10^5$</td>
<td>$2.4 \times 10^5$</td>
</tr>
<tr>
<td>$\pi^+$</td>
<td>$2.1 \times 10^5$</td>
<td>$1.0 \times 10^5$</td>
<td>$1.2 \times 10^5$</td>
</tr>
<tr>
<td>$\gamma(\pi^0)$</td>
<td>$8.4 \times 10^7$</td>
<td>$4.2 \times 10^7$</td>
<td>$4.3 \times 10^7$</td>
</tr>
<tr>
<td>$p$</td>
<td>$5.5 \times 10^4$</td>
<td>$2.4 \times 10^4$</td>
<td>$3.1 \times 10^4$</td>
</tr>
<tr>
<td>sum</td>
<td>$8.5 \times 10^7$</td>
<td>$4.2 \times 10^7$</td>
<td>$4.3 \times 10^7$</td>
</tr>
</tbody>
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<table>
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<th>trigger rate for $p &gt; 1$ GeV (kHz)</th>
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<tr>
<td>$e^-$</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>$\gamma(\pi^0)$</td>
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</tr>
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</thead>
<tbody>
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<td>sum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total trigger rate (kHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>total</td>
</tr>
</tbody>
</table>

- Total trigger rate 8.7 MHz
  - 290 kHz per sector