Level-3 Trigger

David Lawrence  JLab

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Level-3 Overview

• L3 farm is required for high luminosity running
  – $10^8$ tagged $\gamma/s$
• L3 farm is not part of 12GeV project
  – except for L3 farm infrastructure (lines 1532010)
• Plan is to implement L3 infrastructure using monitoring farm
  – All events pass through monitoring farm nodes before being written to disk
  – Basic framework for L3 will be in place and we will have experience operating in that mode prior to needed L3
Software Level-1 Event filter

Event is kept if either L1a_fired or L1b_fired is true

38% of events discarded by software L1 trigger
(original L1 study rejected ~53%)

0.1% of events in coherent peak region discarded by L1 trigger

13.3% of L1 accept events in coherent peak region

Trigger implemented in TRIGGER library (DMCTrigger objects)

Nominal goal for L3 is to discard 90% of L1-accepted events

A. Somov  GlueX-doc-1043

Beam Photon Energy

February 12, 2013 DL bgen + L1 event filter

Nominal goal for L3 is to discard 90% of L1-accepted events

L3 trigger
Method

- List below provides inputs that could be used to determine the accept/reject state of the L3 trigger:
  - Definitely accept
  - Definitely reject
  - Default accept

- Some values take much more CPU to obtain
  - Quick decisions will be tested first and expensive ones only if they fail to provide a definitive answer

- For current study, all values are calculated indicating worst-case scenario for CPU requirement

```c
// Add data members here. For example:
int Ntagger; // Number of reconstructed tagger hits
int Nstart_counter; // Number of start counter hits
int Ntof; // Number of TOF hits
int Ncdc_layers; // Number of different CDC layers hit
int Nfdc_planes; // Number of different FDC planes hit
int Nfdc; // Number of FDC hits (cathode + anode)
int Nfdc_pseudo; // Number of FDC pseudo hits
int Ncdc;
int Ntrack_candidates; // Number of track candidates
int Ntrack_wb; // Number of wire-based tracks
float Ptot_tracks_wb; // Scaler sum of total momentum from wire-based tracks
int Nbcal_clusters; // Number of BCAL clusters
int Nfcal_clusters; // Number of FCAL clusters
float Ebcal; // Total energy in BCAL (rough estimate)
float Efcal; // Total energy in FCAL
bool L3good; // true if event passes L3 trigger
```
Input Distributions

- \( \Sigma \) BCAL fADC hits (both sides)

Systematically high, but not by more than 20%

- \( \Sigma \) FCAL hits

- \textit{bggen} generated events (~26k)

- Distribution of each parameter is recorded
  - 15 parameters
  - Red = all events
  - Blue = “keepers” (i.e. inside coherent peak)

- Events we wish to keep have parameters stored in separate histograms (blue)
  - The ratio of these are probability distributions
Log likelihood

\[ \log(FOM) = \sum_i \log \phi(p_i) \]

Nominal goal:
Reject 90%

Current study:
Reject 72%
\textit{(includes 10\% loss of signal events)}

\textit{n.b. For this data set and software L1 trigger, 86.7\% are from outside coherent peak}

18\% of “bad” events accepted
Most expensive algorithms

52% Wire-based tracks
36% Track Candidates
11% FDC Pseudo

based on 16.6k pythia-generated, L1-filtered events with high luminosity EM background

L3 trigger
FOM without Wire-based tracking

If wire-based tracking is not done:

- L3 algorithm runs ~2 times faster
- ~2% more bad events accepted

20% of "bad" events accepted

18% of "bad" events accepted
Results Summary

• Simple algorithm rejects 80% of background while rejecting 10% of signal
• L1 trigger simulation needs to be reviewed
• Analysis of CPU usage to discriminating power will allow some speedup of code, but by how much is unknown
• Combining quantities (e.g. Ebcal + Efcal) may provide metrics with better discriminating ability
Backups
Results Summary

• Single core processing rate: 22Hz per core  
  – (106Hz per 5 cores)

• Without wire-based tracking rate is 3x higher

• To handle 20kHz low-luminosity trigger rate we would need ~910 cores (20kHz/22Hz)  
  – 29 boxes with 32 cores  
  or  
  – 15 boxes with 64 cores

• Without wire-based tracking we would need only ~303 cores  
  – 10 boxes with 32 cores  
  or  
  – 5 boxes with 64 cores

• Project has $39k for L3 farm equipment infrastructure
### Rejection Rate calculation

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Coherent Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 filtered</td>
<td>16529</td>
<td>2195</td>
</tr>
<tr>
<td>No L1 filter</td>
<td>26607</td>
<td>2198</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
N_{\text{good}} &= 2195 \\
N_{\text{total}} &= 16529 \\
N_{\text{bad}} &= N_{\text{total}} - N_{\text{good}} = 14334
\end{align*}
\]

Acceptance rate for bad events: \( R_{\text{bad}} = 18\% \)
Acceptance rate for good events: \( R_{\text{good}} = 90\% \)

Total events accepted:
\[
N_{\text{accepted}} = R_{\text{bad}} \times N_{\text{bad}} + R_{\text{good}} \times N_{\text{good}} = 4556
\]

\[
R_{\text{reject}} = 1 - \frac{N_{\text{accepted}}}{N_{\text{total}}} = 1 - \frac{4556}{16529} = 72\%
\]