Level-3 Trigger

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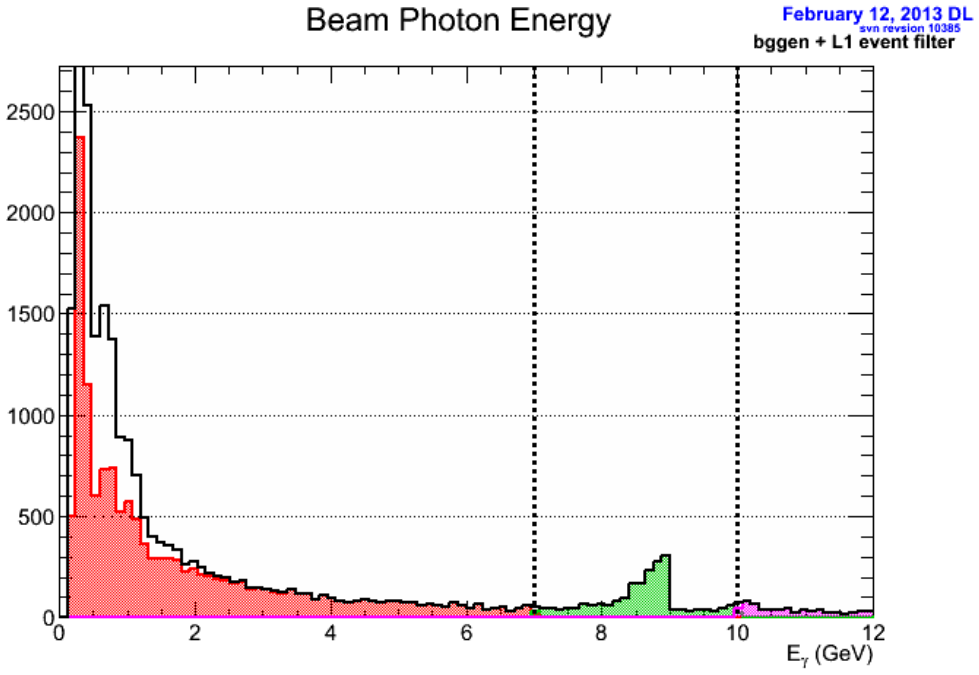
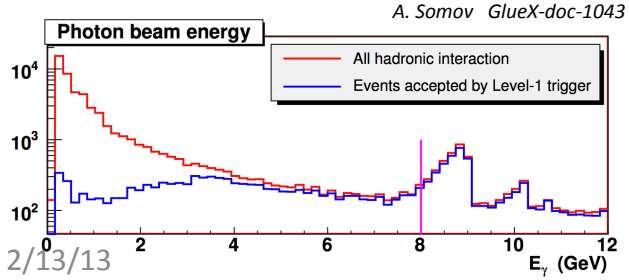
Level-3 Overview

- L3 farm is required for high luminosity running
  - 10^8 tagged γ/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

```
// BCAL and FCAL
bool sum_cut = (Ebcal + 4.0*Efcal)>=2.0;
trig->L1a_fired = sum_cut && Ebcal>0.200 && Efcal>0.030;
trig->L1b_fired = sum_cut && Ebcal>0.030 && Efcal>0.030 && Nschits>0;
```





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

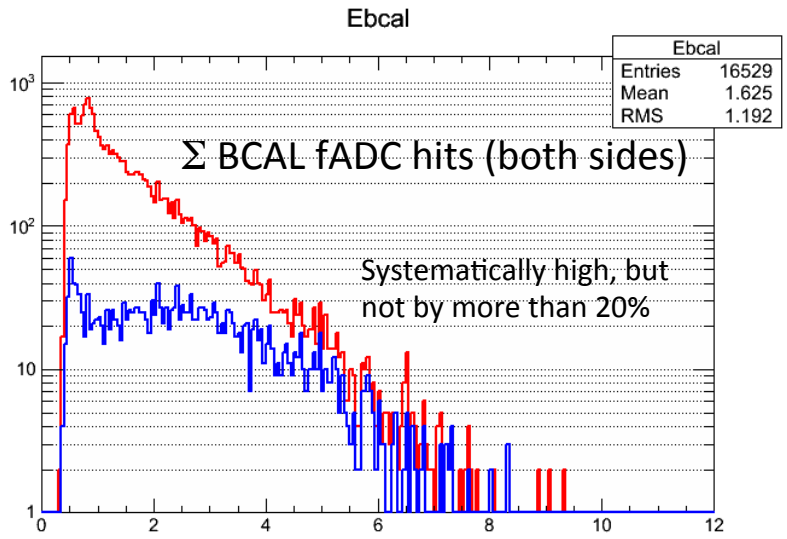
- Event is kept if either L1a_fired or L1b_fired is true
- 38% of events discarded by software L1 trigger
  (original L1 study rejected ~53%)
- 0.1% of events in coherent peak region discarded by L1 trigger
- 13.3% of L1 accept events in coherent peak region
- Trigger implemented in TRIGGER library (DMCTrigger objects)
  — *hd_eventfilter*

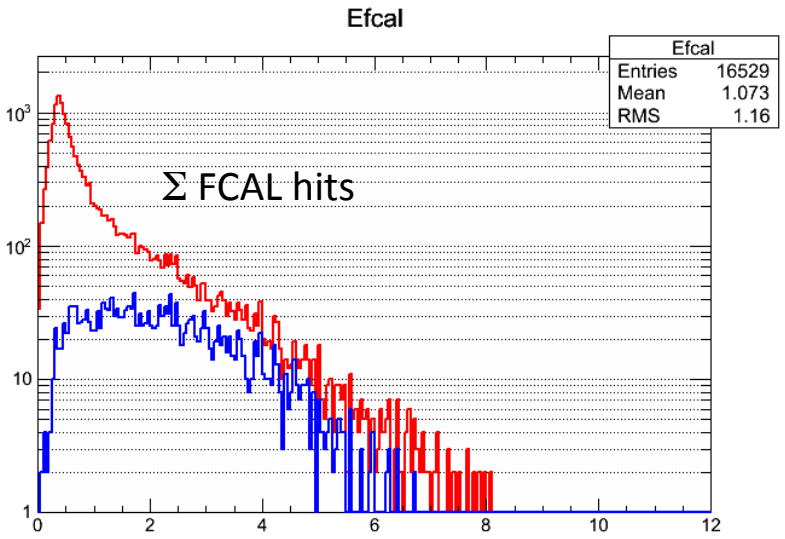
Method

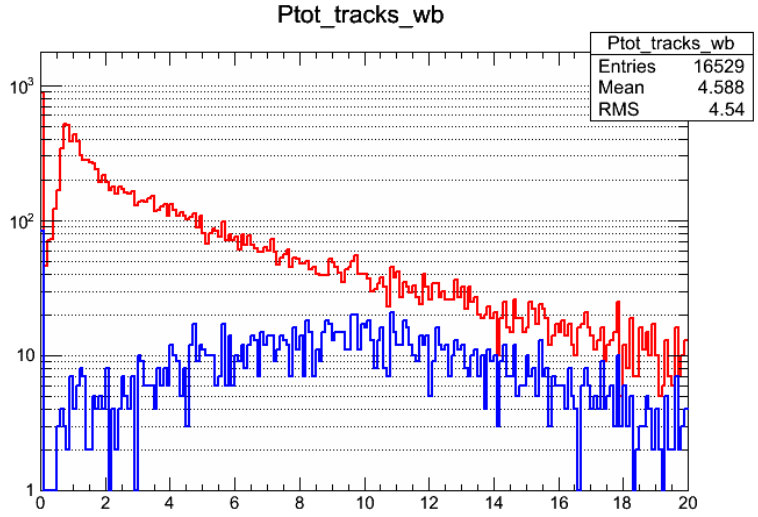
- List below provides inputs that could be used to determine the accept/ reject state of the L3 trigger:
  - Definitely accept
  - Definitely reject
  - Default accept
- Some values take much more CPU to obtain
  - Quick decisions will be tested first and expensive ones only if they fail to provide a definitive answer
- For current study, all values are calculated indicating worst-case scenario for CPU requirement

```
// 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;                 // Number of CDC hits
  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

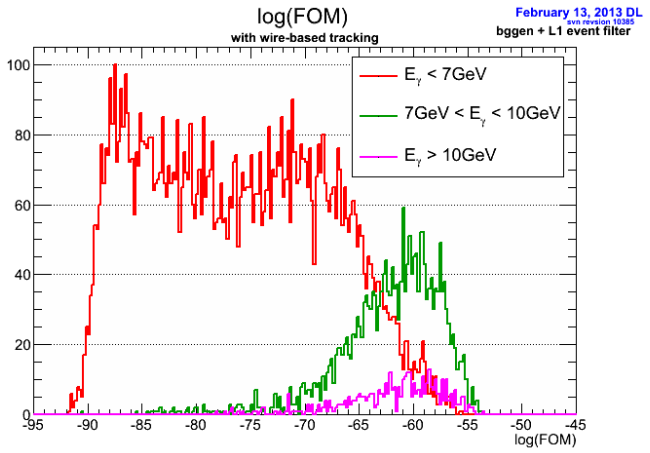






- *bggen* generated events (~26k)
- Distribution of each parameter is recorded
  - 15 parameters
  - Red = all events
  - Blue = "keepers" (i.e. inside coherent peak)
- Events we wish to keep have parameters stored in separate histograms (blue)
  - The ratio of these are probability distributions

Log liklihood

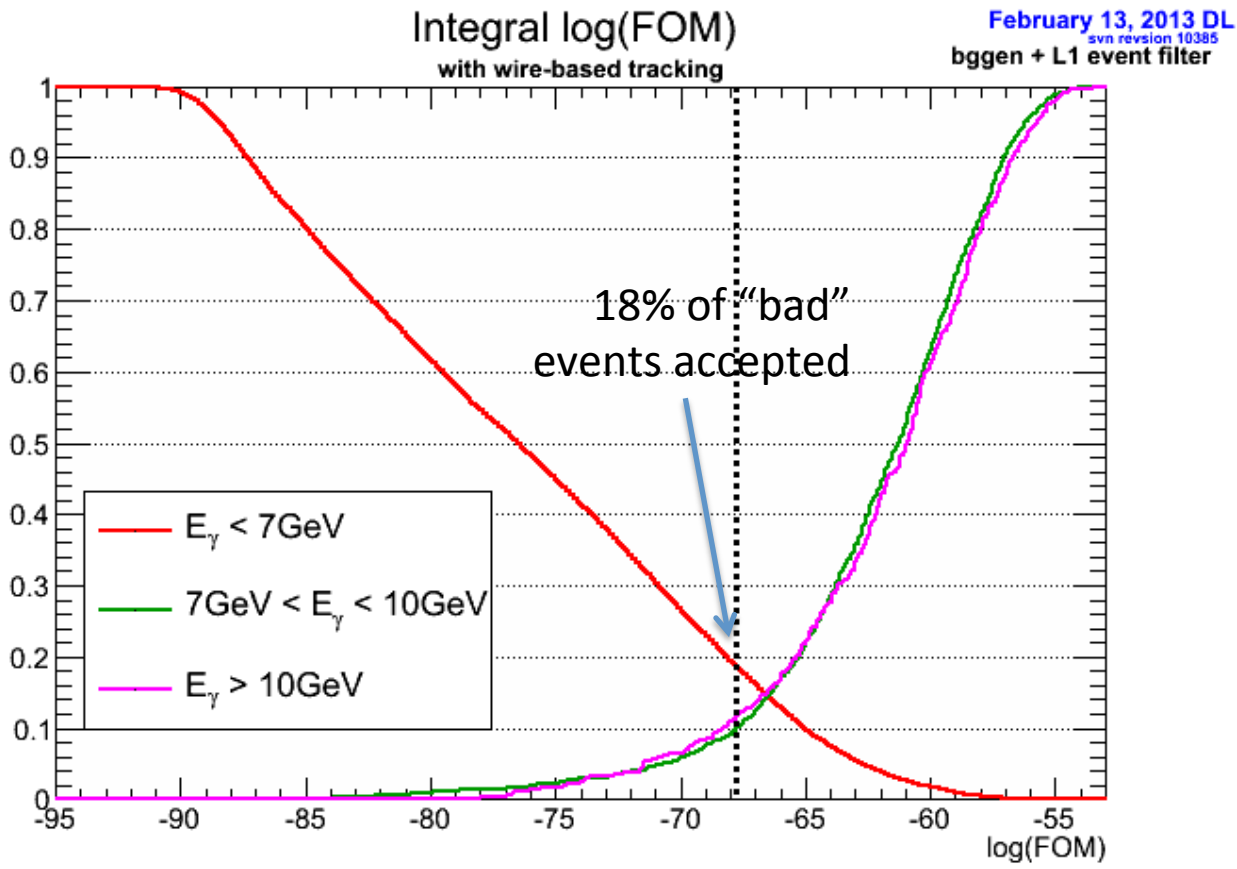


$$log(FOM) = \sum_i \log \wp(p_i)$$

Nominal goal:
Reject 90%

Current study:
Reject 72%
(includes 10% loss of signal events)

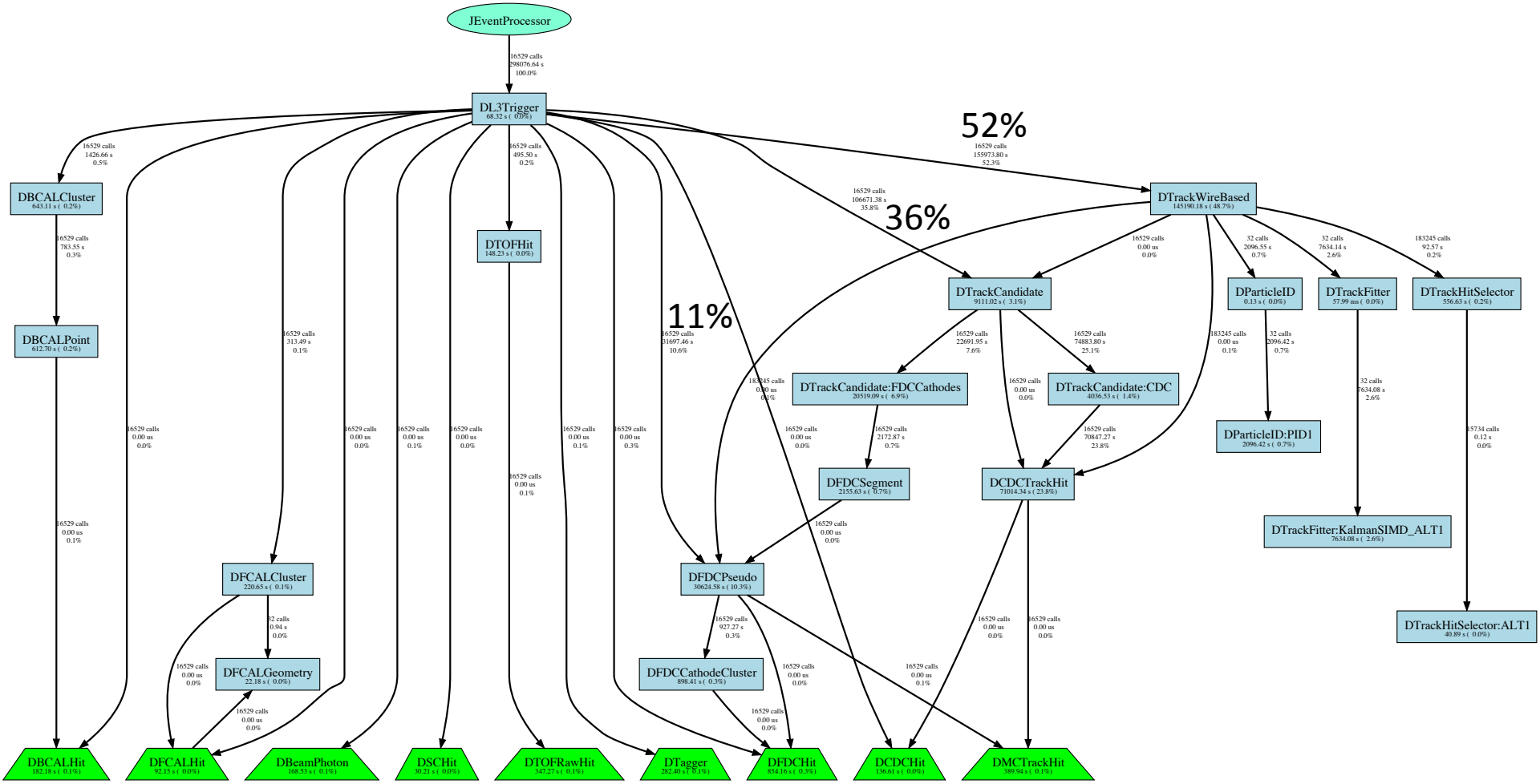
n.b. For this data set and software L1 trigger, 86.7% are from outside coherent peak



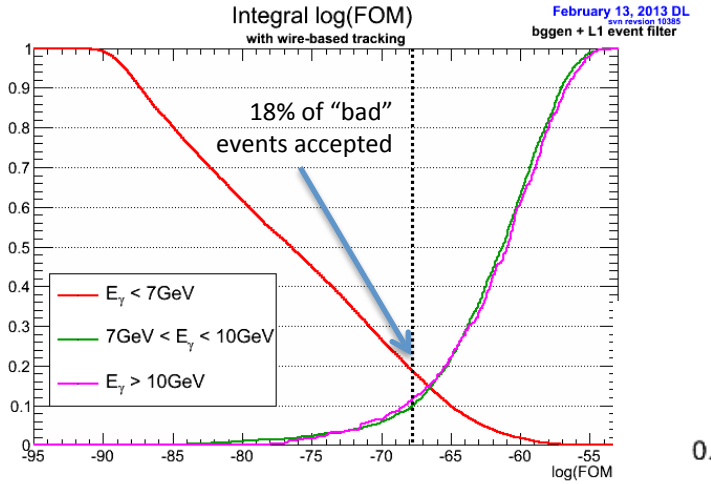
Most expensive algorithms

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

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

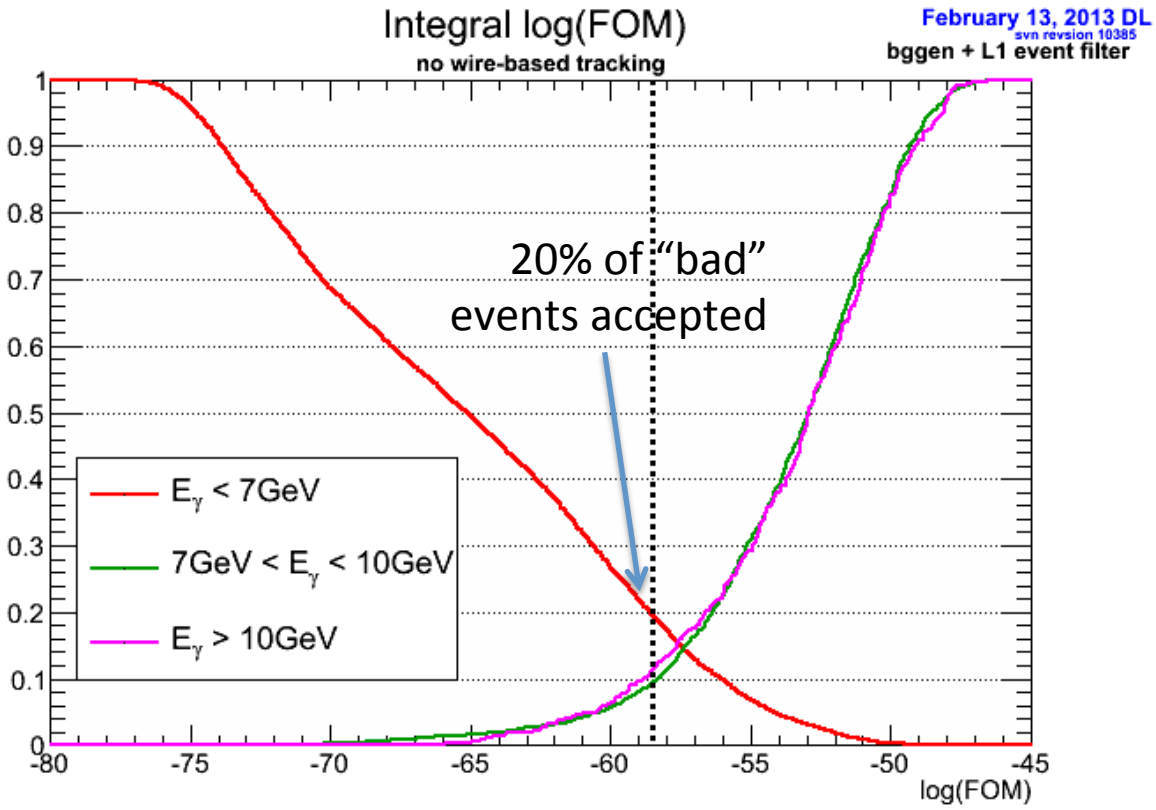


FOM without Wire-based tracking



If wire-based tracking is not done:

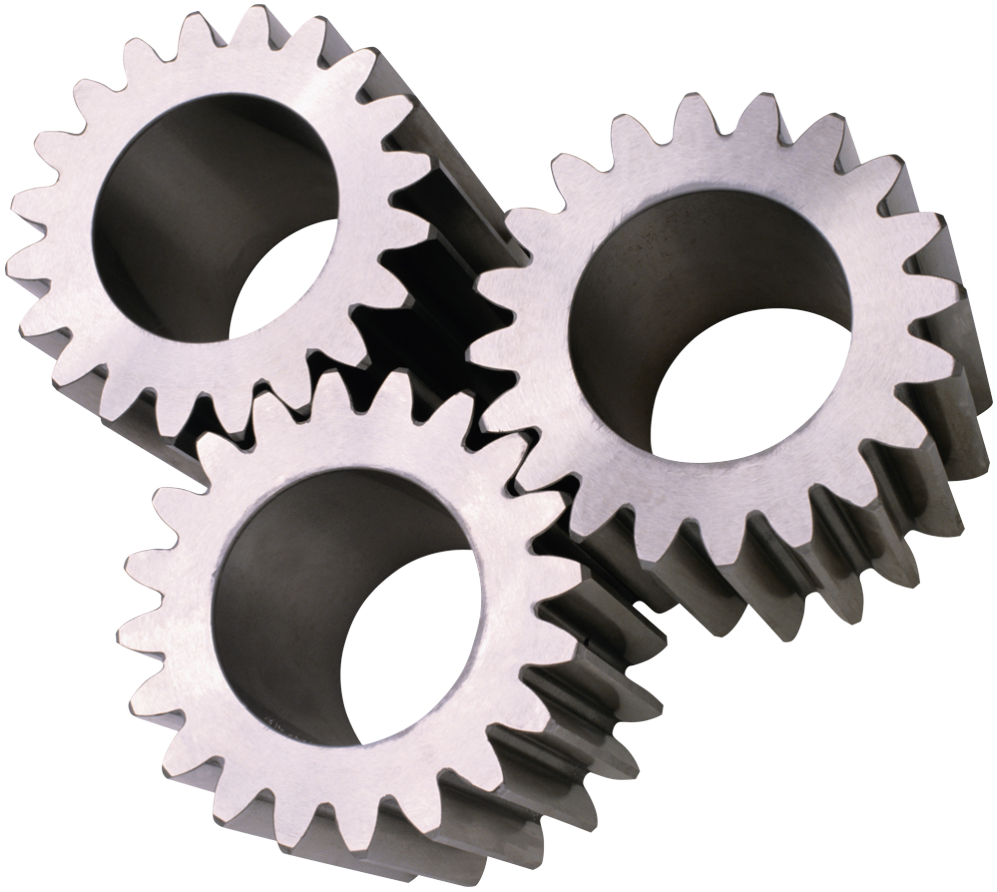
- L3 algorithm runs ~2 times faster
- ~2% more bad events accepted



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 5cores)
- 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

	Total	Coherent Peak
L1 filtered	16529	2195
No L1 filter	26607	2198

$$N_{good} = 2195$$
$$N_{total} = 16529$$
$$N_{bad} = N_{total} - Ngood = 14334$$

Acceptance rate for bad events: $R_{bad} = 18\%$

Acceptance rate for good events: $R_{good} = 90\%$

Total events accepted: $N_{accepted} = R_{bad} * N_{bad} + R_{good} * N_{good} = 4556$

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