The *BABAR* Trigger System

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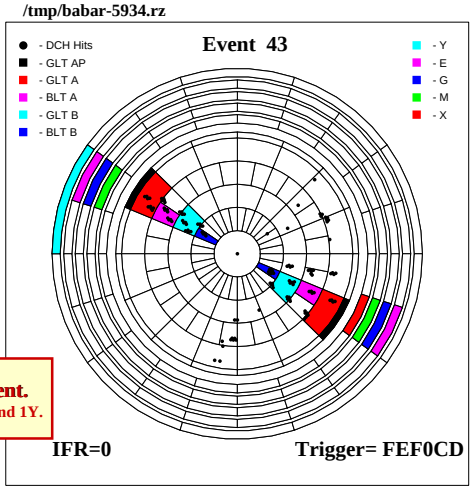
Level 1

The ***BABAR*** Trigger has two levels: a hardware level 1 and a software level 3. The **Level 1** trigger consists of four subsystems:

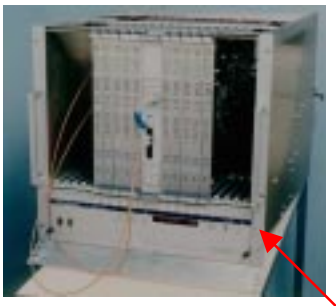
- the track trigger (Drift Chamber Trigger, or **DCT**),
- the energy trigger (Calorimeter Trigger, or **EMT**),
- the cosmic and muon trigger (IFR Trigger, or **IFT**),
- the Global Trigger (**GLT**).

The DCT and EMT receive information from the Drift Chamber and Calorimeter Detectors, process it, and send condensed data to the Global Trigger. The GLT attempts to match the spatial and angular locations of calorimeter clusters and drift chamber tracks. Using these inputs in a flexible programmatic configuration, the GLT is designed to generate Level 1 triggers at no more than **2 kHz** at the design luminosity of $3 \times 10^{33}\ \mathrm{cm}^{-2}\ \mathrm{s}^{-1}$.

GLT Display



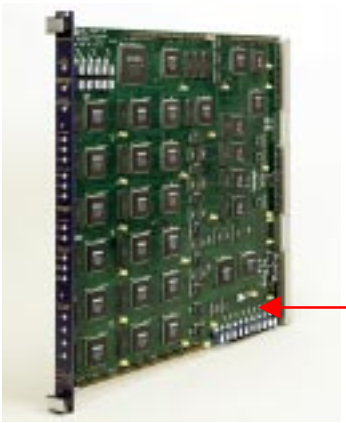
L1 event display of a Bhabha event.
The typical Bhabha trigger signature is 1X and 1Y.

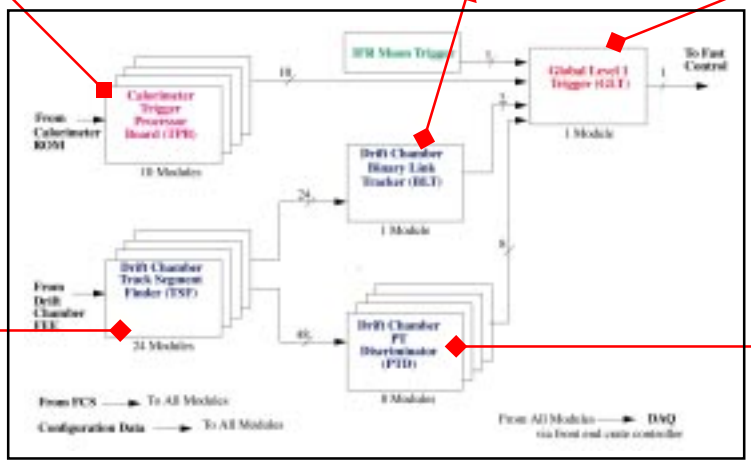


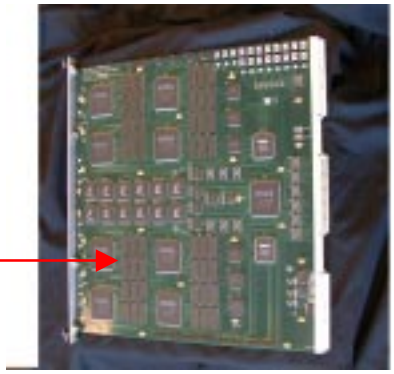
The **EMT** finds ϕ bins of the calorimeter (with a resolution of 1/40 of 2π) that have an energy above a preset value. In total, ϕ maps of five objects (M, G, E, X and Y) are generated. M, G and E objects, corresponding to clusters of increasing energy, are identified over the entire calorimeter, while X represents a cluster in the forward endcap and Y a cluster in the backward region of the barrel.

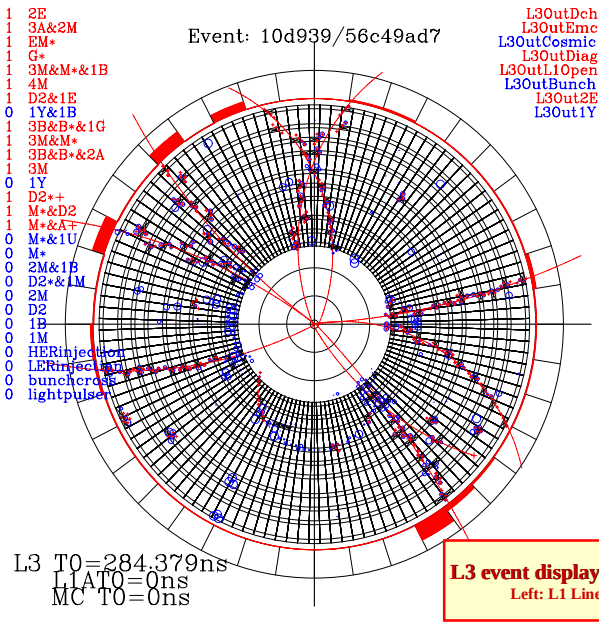
The **DCT** consists of 3 units: the Track Segment Finder (TSF), the Binary Link Tracker (BLT) and the PT Discriminator (PTD). The BLT identifies short (B) and long (A) tracks, the PTD selects high transverse momentum tracks (AP). The angular ϕ resolution is 1/32 of 2π. A 16 bit ϕ map is sent to the GLT.

The **GLT** receives the ϕ maps of the trigger objects found by the DCT and the EMT. From these input data the GLT counts the number of objects and applies simple geometrical cuts such as a back-to-back requirement. The trigger object combinations are compared with pre-defined patterns. As a result the module outputs 24 "raw" trigger lines. The GLT operates at a frequency of 8 MHz. The total L1 latency time is 12.8 µs.









L3 event display of a hadronic event.
Left: L1 Lines, Right: L3 filters.

Level 3

The **Level 3** trigger processes all L1-accepted events at the ***BABAR* on-line farm**. Using the clusters and track segments found by the Level 1 hardware as seeds, fast algorithms are applied to drift chamber and calorimeter data to further reject beam background and to scale high rate processes. The rate at which events are written to archival storage is reduced to less than **100 Hz**, sufficient to accommodate the expected rate of all physics processes at the design luminosity.

Event Filter

The L3 Trigger performs a 3-dimensional track fit and finds the drift chamber start time (T0). The extra information compared with Level 1 is the particle polar angle and the track origin. Several filters select the physics events of interest. Among these are an IPTrackFilter that selects good tracks originating from the IP and an EMC filter algorithm that evaluates the total number of clusters and the energy sum. A Bhabha filter is designed for calibration purposes with the possibility of a θ-dependent scaling factor.

Computing

The events are processed in parallel on 32 Sun Ultra 5 work stations. The processing time is 8 ms / event. The selected events, with detailed filter decisions, are written to disk and queued for full reconstructed. The L3 classifications are also used to select events for on-line monitoring.