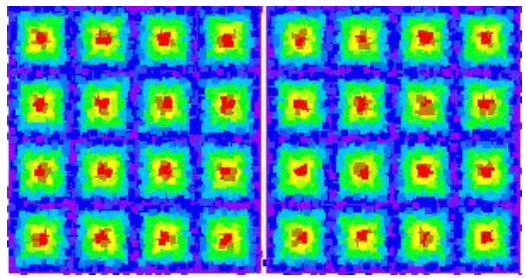
The GLAST Trigger System



Gregg Thayer
SLAC

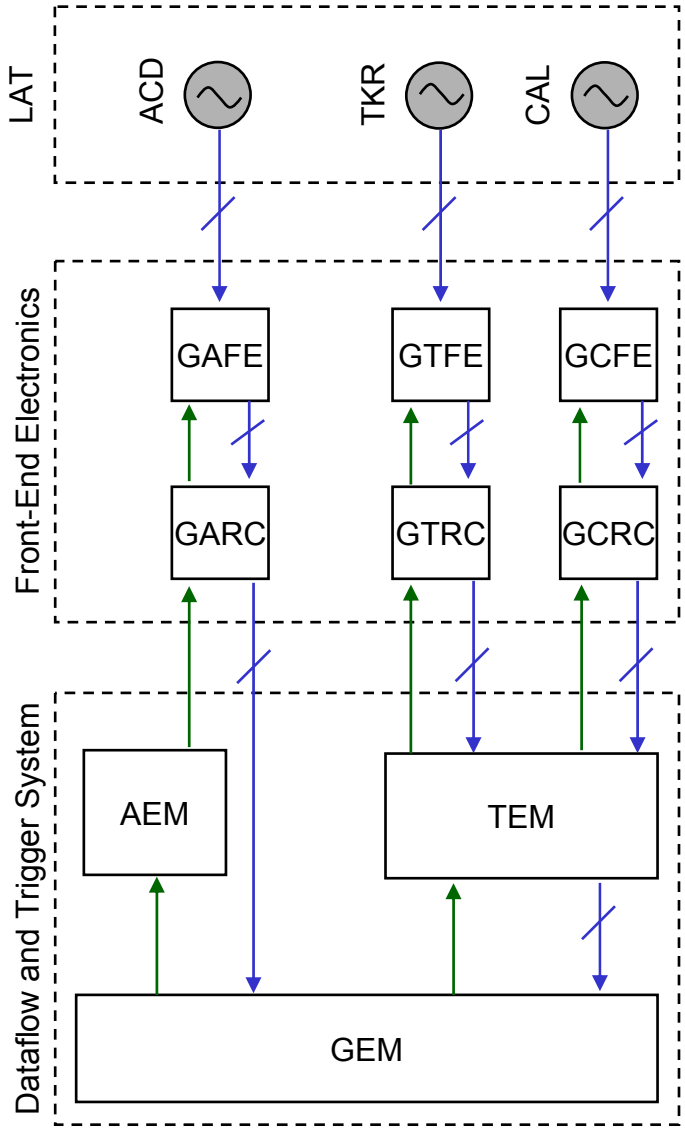
Instrument Analysis Workshop 1
SLAC, June 7, 2004

References

- Trigger
  - LAT-SS-00286 LAT Global Trigger Specification
  - LAT-TD-00560 LAT Global Trigger and ACD Hit Map
  - LAT-TD-01545 GEM Programming ICD
- TEM
  - LAT-TD-00605 TEM Programming ICD
- AEM
  - LAT-TD-00639 AEM Programming ICD

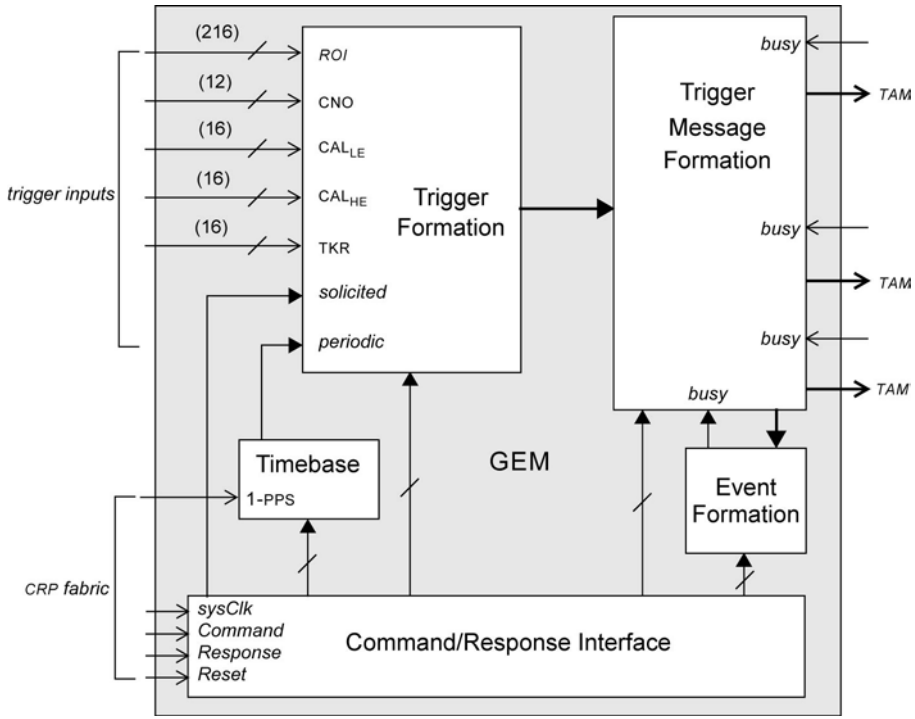
Trigger Overview

- The Trigger monitors the LAT to decide to readout the detector
- Front end electronics digitize and process the signals from the detector
- Signals from the Towers are further processed by the TEMs
- The GEM handles the Trigger Requests and makes a trigger decision
- The TAM instructs the system to initiate readout



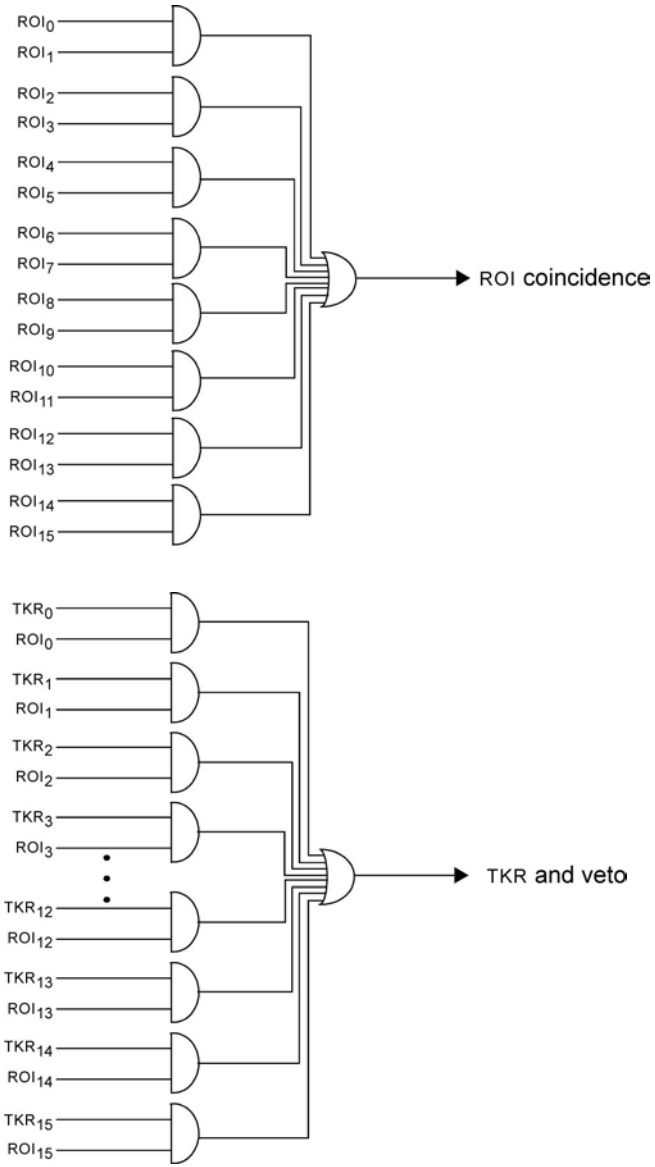
Trigger Primitives

- **ACD**
  - Each FREE board provides a High Level Discriminator signal and 18 Veto signals
  - The HLD signal is used as the CNO trigger
  - The Veto signals are used to form Regions of Interest (ROIs) which can be used as either a trigger or veto
- **CAL**
  - Each tower provides High Energy (HE) and Low Energy (LE) trigger request signals
- **TKR**
  - Each Tower provides a 3-in-a-row signal
- **Internal**
  - The GEM can generate its own triggers either on command or periodically



ACD Regions of Interest

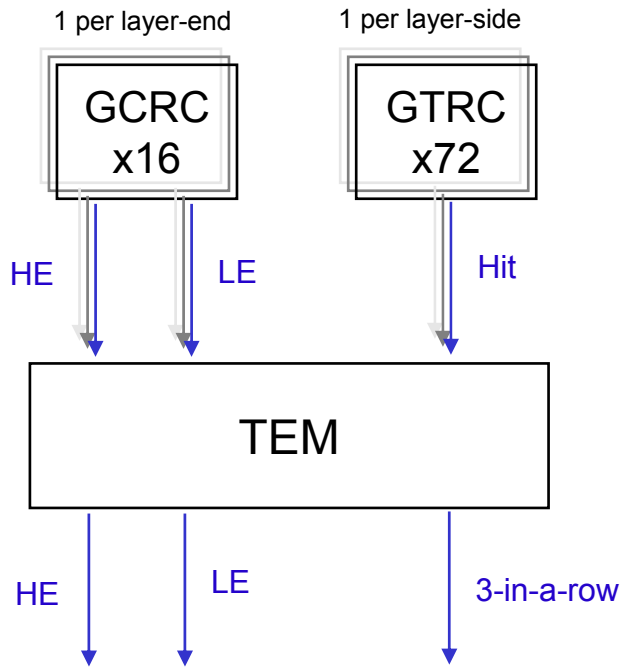
- Each of the 16 ROI is defined as the OR of any of the 108 ACD veto signals and is used either as a trigger or a veto
- When used as a trigger, the ROI are paired, the coincidence of this pair forms the ROI condition
- When used as a veto, each of the 16 ROI are used to negate the trigger request of one of the TKR
- The ROI can only contribute in one of these modes at a time



Tower Trigger Primitives

The TEM Receives trigger signals from CAL and TKR

- **CAL**
  - **Input signals can be delayed 0-800ns**
  - **Each input signal can be masked OFF**
  - **Layer-end signals are OR'd to to produce TEM-wide HE and LE signals**
  - **The width of the output HE and LE signals can be varied from 150-900ns**
- **TKR**
  - **Input signals can be delayed 0-800ns**
  - **Each input signal can be masked off**
  - **Layer-side signals are OR'd to produce layer signals**
  - **Each layer signal can be masked ON**
  - **3-in-a-row logic is applied to layer signals**
  - **Each 3-in-a-row combination can be masked OFF**
  - **All 3-in-a-row combinations are OR'd to produce TEM-wide 3-in-a-row signal**

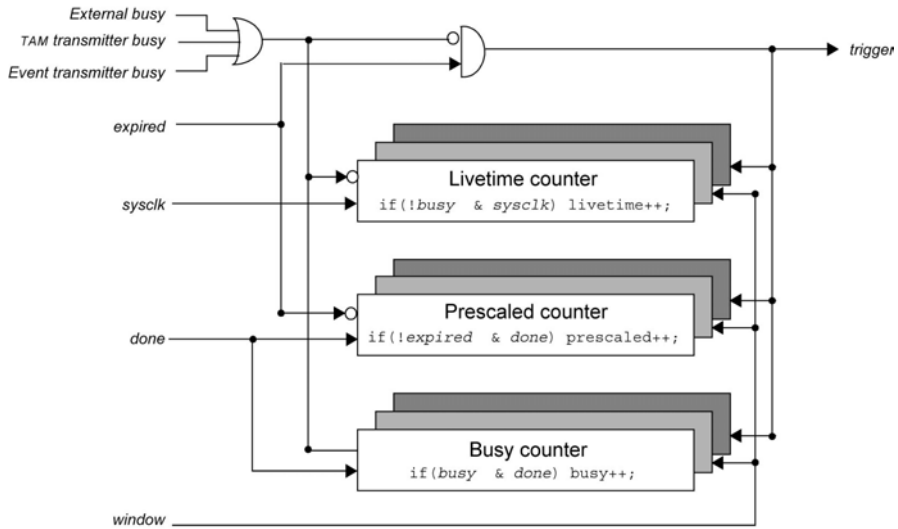


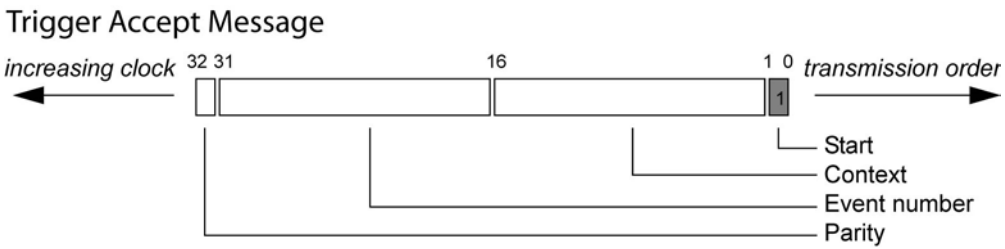
Trigger Window

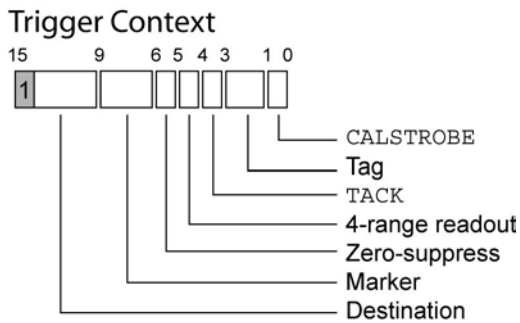
- The trigger window defines the time during which the trigger requests are coincident
- There are 7 trigger conditions which are the OR of the different trigger request signals:
  - ROI
  - CNO
  - CAL (HE)
  - CAL (LE)
  - TKR
  - Periodic
  - Solicited
- Any trigger condition can generate the opening of the trigger window
  - The width of the trigger window is adjustable (~50-1550ns)
  - During a window turn, all trigger requests are latched
- The 7 trigger conditions are used to map each of the 127 possible trigger conditions to one of the 16 Message Engines

Triggering

- The Message Engine is responsible for
  - Prescaling
  - Busy detection
  - Trigger Context portion of the TAM
- If the prescale counter has expired, and the LAT is not busy, a Trigger Accept Message is formed and sent to the TEMs and AEM
- The TEMs and AEM interpret the TAM and send the appropriate commands to the front end to read out the LAT

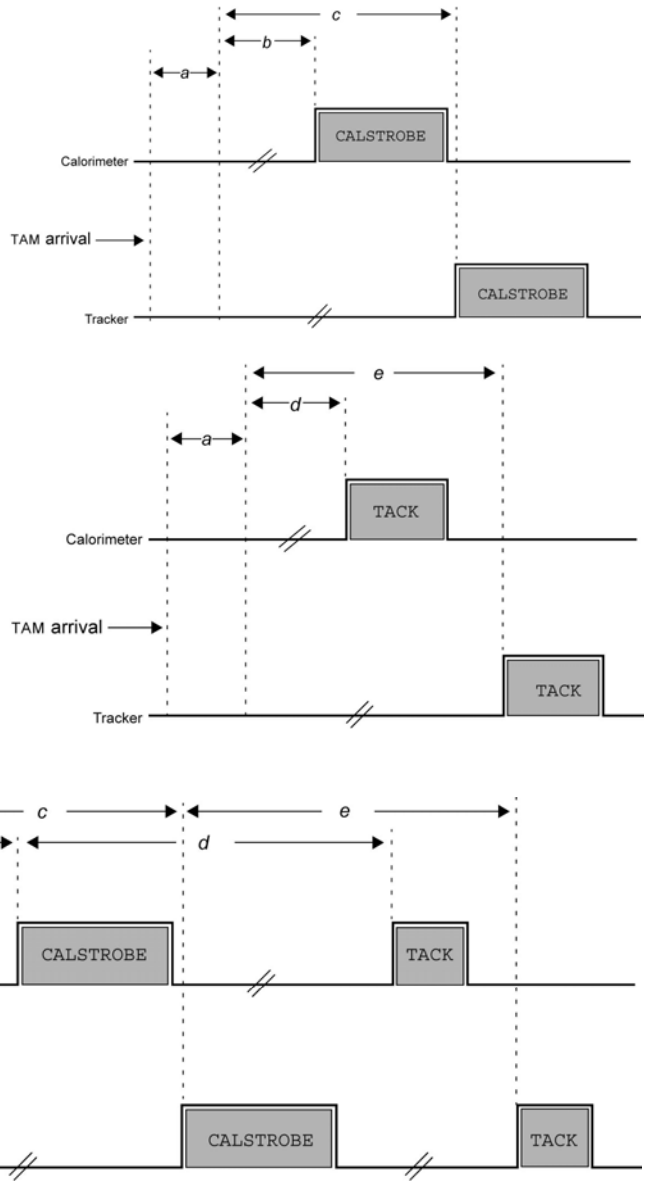






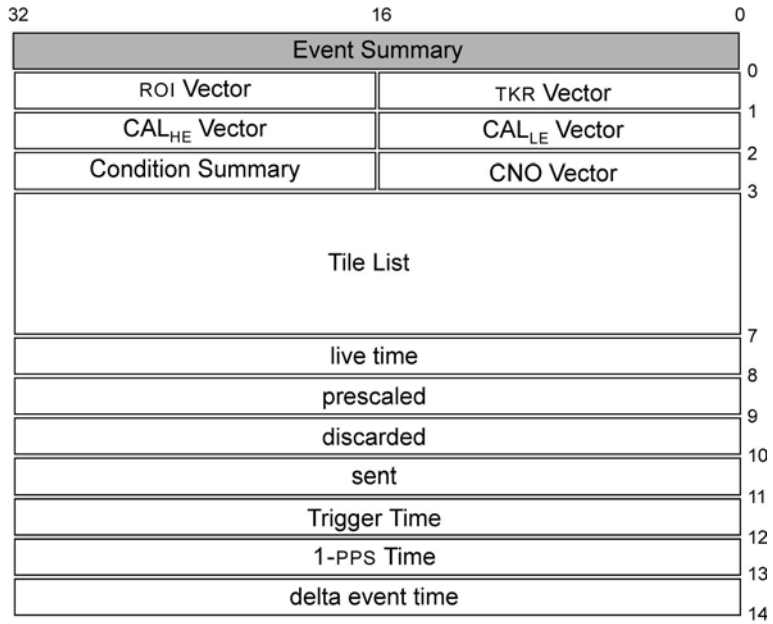
Trigger Sequencing

- The trigger context defines the combination of CALSTROBE and TACK commands sent to the front end
  - Trigger ACKnowledge initiates sample and readout of the detector
  - The CALibration STROBE signal can be used to initiate the injection of charge into the front-end
- There are 3 combinations of these commands
- The delays can be set separately for the AEM and the CAL and TKR on each TEM
  - a) is a fixed ~5 clock delay
  - b) and c) CALSTROBE delay 0-800ns
  - d) and e) TACK delay 12.750μs



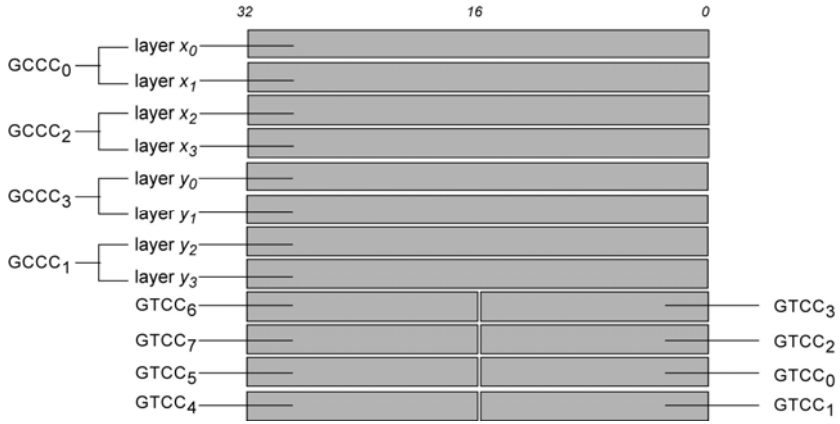
Trigger Data Contribution

- When the GEM sends a TAM it also sends its event contribution to the EBM
- It contains the status of all of the trigger conditions latched during the window turn and the condition summary
- The live time, prescaled, discarded, and sent contributions are sampled from the Message Engine counters
- Trigger Time
  - the GEM timebase sampled at the close of the window
- 1-PPS Time
  - A count of the number of PPS signals received by the GEM and the timebase sampled at the time of the last arrival
- Delta Event Time
  - A count of the number of system clock tics since the last event

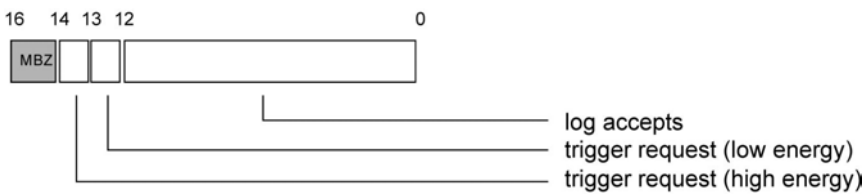


Diagnostic Event Contributions

- The TEM can be configured to include diagnostic information in the event
- Contains the status of all trigger requests
  - GCCC 32 bits, 16 for each layer-end
  - GTCC one for each layer-side



GCCC Contribution



GTCC Contribution