Proposed Flight Trigger Configuration: Engines and Scheduler Table

J. Eric Grove
Naval Research Lab
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Purpose

- Intent: Want to run LAT at SLAC with trigger config as much like flight as possible
  - What is flight trigger config? How should it be implemented?
  - Trigger Group and SVAC Group proposal
    - Discussion among Eduardo, Eric, Pat, Anders, Steve, JJ, Mike, Su Dong, etc.

- Want input from C & A group
  - Is this a reasonable first implementation?
  - What needs to be tested now or first?
  - What have we missed?
  - Please estimate some rates identified below…

- First, need to understand capabilities of Trigger
  - Defining document: LAT-TD-01545
    - The GLT Electronics Module, Programming ICD Specification
Trigger Logic

- Specified in “Trigger Engines” from combinations of “Conditions”
  - 8 Trigger Conditions are defined
    - $2^8 = 256$ possible combinations of these Conditions
    - Each can be allowed (or disallowed) to open a trigger window (i.e. start a coincidence)
    - ROI Condition is different (see next page)
      - And be careful not to confuse the ROI Condition with the selection of ACD tiles that make up a Region of Interest (see next page)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Flight setting</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROI (ACD)</td>
<td>Tower-local veto, ~0.3 MIP</td>
<td>Not allowed to open wdw</td>
</tr>
<tr>
<td>TKR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAL-LO</td>
<td>100 MeV single log</td>
<td></td>
</tr>
<tr>
<td>CAL-HI</td>
<td>1 GeV single log</td>
<td></td>
</tr>
<tr>
<td>CNO</td>
<td>~20 MIPs single tile</td>
<td>What is flight threshold?</td>
</tr>
<tr>
<td>Periodic</td>
<td>~1 Hz</td>
<td>Gives pedestals</td>
</tr>
<tr>
<td>Solicited</td>
<td>Special use</td>
<td></td>
</tr>
<tr>
<td>External</td>
<td>Nothing connected!</td>
<td>Not allowed to open wdw</td>
</tr>
</tbody>
</table>
The ROI Trigger Condition is different
- Can be used as trigger source or veto of TKR
  - Globally applied to all Engines, all “Regions of Interest”
    - One or the other, not both
  - We’ve selected TKR-veto mode
    - Thus TKR=False and ROI=True should never occur
      » Forbidden by definition of ROI Condition in GEM

Regions of Interest
- Groupings of ACD tiles to be used as trigger or veto of TKR
  - Also called “tile lists”
- Up to 16 Regions of Interest may be specified at any time
  - Two candidate configs for flight
    - 16 “Tower-local” Regions
      » Corresponding to tiles nearest each Tower (sorta)
    - 1 “Global” Region
      » Single region: all top tiles and first 2 layers of side tiles
- We’ve selected the Tower-local Regions, ok?
More Trigger Logic

• 16 Trigger Engines are available  
  – For each engine  
    • Defined readout mode  
      – Zero suppression on or off  (for ACD and CAL together)  
      – 4-range or 1-range readout  (for CAL)  
    • Programmable pre-scale  
    • User-defined “marker”  
      – 5-bit numerical value to use, e.g., as a label  
      – We haven’t defined any markers, ok?

• Scheduler table  
  – Points each of the 256 combinations of Conditions to a single Engine  
    • No ambiguity

• SVAC and Trigger Group defined Scheduler and Engines  
  – Please review and think about next few slides
## Trigger Scheduler Table

<table>
<thead>
<tr>
<th>Condition Summary</th>
<th>Engine Theme</th>
<th>Readout</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Trigger Scheduler Table</td>
<td>Should never happen</td>
<td>zero suppressed, 1-range</td>
</tr>
<tr>
<td>Solicited</td>
<td>JJ solicited events</td>
<td>zero suppressed, 1-range</td>
</tr>
<tr>
<td>Periodic</td>
<td>Pedestals</td>
<td>unsuppressed, 4-range</td>
</tr>
<tr>
<td>CNO</td>
<td>GCR calibration</td>
<td>zero suppressed, 4-range</td>
</tr>
<tr>
<td>CAL-HI</td>
<td>High energy photons</td>
<td>zero suppressed, 1-range</td>
</tr>
<tr>
<td>CAL-LO</td>
<td>Photons</td>
<td>zero suppressed, 1-range</td>
</tr>
<tr>
<td>TKR</td>
<td>Photons</td>
<td>zero suppressed, 1-range</td>
</tr>
<tr>
<td>ROI</td>
<td>Cal-only photons</td>
<td>zero suppressed, 1-range</td>
</tr>
<tr>
<td>No prescale!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No prescale?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No prescale!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Events with ROI and no TKR are all mapped to the “Should never happen” engine (TKR,ROI) = (z,z) means (0,0), (1,0), and (1,1) but not (0,1)

**Note:** On ground, same map, but always set prescale to unity

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Comments

• Pedestals: Two purposes
  – “Clean” pedestals (only Periodic=True)
  – “Unbiased” sample of typical LAT state (Periodic=True and other stuff True or False)
    • Random sample: Preserve as much info as possible
      – Unsuppressed, 4-range readout
      – No on-board filtering or prescaling

• There are other options for the GCR Calibration Engine
  – GCR calibration
    • Logic: Should we use CNO or throttle with CNO && TKR && CAL-LO?
    • Readout: zero-suppressed, 4-range, with NO prescaling
      – We are assuming that there is no prescaling since rate < 100 Hz
    • CNO events are intended for CAL calibrations
      – Sideways (ACD-TKR-ACD) “not useful”. Discard them.
      – Any uses for sideways CNO?
      – What is the rate of sideways CNO?

• The combination TKR=False and ROI=True should never occur
  – ROI is defined to be coincidence between TKR signal and tower-local veto
    • We’ve put all of these in one engine with minimal readout
More comments

• Trigger efficiency studies are complicated
  – Be careful with prescaling
    • Need to account for missed events
    • Don’t want to miss a rare condition
    • We’ve prescaled only the Deliberate Leakage of particles engine
  – Need some knowledge of effect of filter
    • Leak some events to ground

• TKR trigger efficiency, readout efficiency
  – The obvious TKR efficiency test is a special case and NOT included here.
    • CAL-LO in coincidence with ACD acting as trigger, allowed to open the window
  – Need to use standard data mode for any continuous efficiency study

• Rates
  – What are the rates of each of the Trigger Engines, as defined here?
    • Is no prescaling acceptable? Can we allow FSW filter to do it all?
Appendix: Scheduler in text form

- Eight trigger engine definitions in order of precedence (high to low)
  1. Should never happen (external triggers) (128 entries)
     - Logic: External condition set with anything else
     - Readout: zero-suppressed, 1-range, no prescale
  2. JJ’s special-purpose solicited triggers (63 entries)
     - Logic: Solicited condition set with any of the remainder
     - Readout: zero-suppressed, 1-range, no prescale
  3. Pedestals (31 entries)
     - Logic: Periodic condition set
     - Readout: unsuppressed, 4-range, no prescale
  4. GCR calibration (15 entries)
     - Logic: CNO
     - Readout: zero-suppressed, 4-range, no prescale
  5. High energy photons (7 entries)
     - Logic: CAL-HI
     - Readout: zero-suppressed, 1-range, no prescale
  6. Photons, primary science data (2 entries)
     - Logic: TKR && notROI && (CAL-LO || notCAL-LO)
     - Readout: zero-suppressed, 1-range, no prescale
  7. Photons that don’t convert in TKR (i.e. CAL only) (1 entry)
     - Logic: CAL-LO && notTKR && notROI
     - Readout: zero-suppressed, 1-range, no prescale
  8. Deliberate leakage of protons and He (2 entries)
     - Logic: TKR && ROI && (CAL-LO || notCAL-LO)
     - Readout: zero-suppressed, 1-range, prescaled
     - prescale changes for GND system tests
  1. More Should never happen (7 entries)
     - Logic: notTKR && ROI
     - Readout: zero-suppressed, 1-range, no prescale