Finding "Hot" CAL FLE and FHE Discriminators

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Rationale for finding hot discriminators

- What's a "hot" discriminator?
  - "Hot" means "causing high trigger rates"
    - Regardless of whether that's due to noise, crosstalk, or any other random or systematic process

- Why do we care?
  - Need to time-in CAL-LO
    - Trigger group aims for FLE ~1/4 to ~1/2 MIP
      - 3-6 MeV is just too low for some GCFEs
      - Note that there is no need to time-in every single channel!
  - Need to understand headroom ("footroom"??) for FHE
    - FHE flight setting is determined by need for
      - self-veto prevention
      - on-board filter for bkg rejection
    - Current plan is FHE = 1 GeV
      - But how low can we set it?
        - » My guess is that some GCFEs will run away ~ 0.5 GeV
  - Parallel muTrg is hard to run
    - CAL-LO trigger rates at "8 MeV" are quite high
    - Work-around to try: use TKR triggers instead

Basis for test plan

- Test plan to find hot FLE and FHE
  - Two purposes
    - For FLE, identify GCFEs with high, out-of-family minimum useful settings so they can be excluded from timing-in
    - For FHE, measure the headroom between the minimum useful setting and the flight setting
  - Basis and constraints
    - Minimum useful setting varies from channel to channel
      - Known hot FLE include FM105, board X-, row 0, col 10.
        - » See appendix for full list
    - Event readout is cause for retrigger
      - Not event content, not trigger source
      - Use external pulser to give predictable, high rate
        - » Prescale logging-to-disk of pulser triggers to minimize data volume
    - Event counter matters
      - "Need" to accumulate >128k events in each config
    - Rely on trigger diagnostics
      - Need to be sure to latch at right time for FLE and FHE

Proposed FHE test plan

- **FHE test sequence**
  1. **Set FHE to flight nominal, enable all GCFEs, all Towers in parallel**
     - **Trigger mask**
       - **Enable: all FHEs in all layer-ends**
  2. **Collect data with trigger on pulser || CAL-HI. Analyze.**
     - **Trigger mask as defined by step 1 for first pass, step 5 for next passes**
     - **Analysis**
       - **Calculate rate of FHE=true for each layer-end based on diagnostic bits. Find outliers**
  3. **Collect data, disabling hot layer-ends to verify. Analyze.**
     - **Trigger mask**
       - **Enable: all FHEs in nominal layer-ends**
       - **Disable: all FHEs in each hot layer-end**
  4. **Collect data, enabling individual GCFEs within hot layer-ends in sequence to find hot channels. Analyze.**
     - **Trigger mask**
       - **Enable: all FHEs in nominal layer-ends, one FHE in each hot layer-end**
       - **Disable: all-but-one FHE in each hot layer-end**
     - **Loop 12 times, once for each GCFE in sequence**
  5. **Disable all hot GCFEs, set FHE to lower value, and start again at step 2. Analyze.**
     - **Trigger mask**
       - **Enable: all FHEs except known hot**
       - **Disable: all known hot FHEs**

FHE test configuration

- **CAL and Trig configuration**

Tower enable	**All, parallel acquisition**
Gain	**LE = 5, HE = 15**
Readout	**1-range, auto-range, zero-suppressed**
Zero-suppression threshold	**LAC = 2 MeV, enabled**
Trigger source	**Ext || CAL-HI** **TKR, CAL-LO, ACD disabled**
Ext pulser	**1 kHz periodic**
CAL-LO, HI thresholds	**FLE = 100 MeV, disabled** **FHE = 1000 MeV, 500 MeV, 300 MeV, 200 MeV in sequence**
TEM diagnostics	**Enabled**
Data logging	**Prescale pulser trig by 1024 (just to ensure some output)** **Do not prescale CAL-HI**
Run time	**3 minutes, each config**

Proposed FLE test plan

- For FLE test, do entirely analogous procedure
  - Sorta substitute FLE for all FHE, CAL-LO for all CAL-HI
  - Enable CAL-LO
    - Use FLE = 20 MeV, 15 MeV, 10 MeV, and 5 MeV in sequence
  - Disable CAL-HI
    - Set FHE = 1000 MeV (flight setting)
  - Analysis unchanged
    - FLE will be triggering on muons, but hot FLEs will still be outliers in rate of FLE=true
    - Can confirm that events are retriggers with muon imaging and with gemDeltaEventTime

- Be willing to stop before minimum FLE or FHE in list if rate is unacceptable
  - Stopping early is ***not*** failure

Software needs

- Online
  - Need tool to generate FLE and FHE trigger masks
    - Code exists within calf_mu_optical in CAL_NRL environment
      - We used this e.g. for FM105 and FM117
      - Presents GUI and writes temporary trg.xml table
    - Code could be resurrected for v3 SLAC environment
- Analysis
  - NRL has tools to find trigger efficiency using diagnostic data
    - Exist in ROOT (e.g. as part of muTrg analysis) and IDL
      - Need tweaks to follow this test plan
    - Could be offline or rewritten to Python for online

Appendix: Known hot FLEs

- **Known hot FLEs**
  - **ATDP website contains Exceptions List XML files**
    - http://heseweb.nrl.navy.mil/glast/CAL_ATDP/index.html
    - **Includes hot FLE list from Module Assy & Test**
      - **In this case, "hot" means min setting ~ muon peak**

Module	Board	Row	Column
FM105	X-	0	10
FM117	Y+ Y- Y-	2 0 3	1 5 4