Trigger and SVAC Tests During LAT integration

Su Dong, Eduardo do Couto e Silva and Pat Hascall

December 7, 2004
This Presentation

- **Part 1**
  - **Overview of trigger tests**
    - There are 4 tests
      » FLE scan with muons was added as part of those

- **Part 2**
  - **Overview of SVAC tests**
    - There are 17 tests
      » Merged nomenclature with Gary’s table
      » Addresses ACD tests (for completeness), no need to talk about them today

- **What do we expect to achieve today?**
  - **Agreement on the definition of these tests**
  - **Define action items for issues we may raise**
To be Addressed Today

- We do not know if a trigger primitive fired within the trigger window if the TEM diagnostics are disabled
  - In the GEM summary word we only know which tower issued the trigger primitives, but do not know which layer (end) issued the trigger primitives.
- Unbiased sample of triggers only exist with muon telescope
  - we can not analyze data with multiple trigger lines enabled (needed for efficiency studies)
- Can not test CAL FHE with muon spectrum
  - not enough high energy events
- Testing CAL FLE with muons requires lowering the on-orbit settings
  - Need to determine optimal operation point
    - beware of retriggering
1.0 GEM Timing Alignment

- Purpose
  - To verify the timing alignment and jitter for each GEM trigger input

- Duration
  - 4 hours (EXT AND CAL_LO)
  - 4 hours (EXT AND TKR)

- Configuration
  - muon data taking configuration.
  - Trigger on EXT trigger (muon telescope) AND TKR or CAL (only one trigger input under test each time)

- Procedure
  - Scan TREQ delay for the trigger test (across the allowable range)
  - Take 5000 events for each of the 16 allowed points.
  - Compute the coincidence of external trigger and trigger under test at each step
  - Compute center time and jitter.
2.0 Subsystem TACK Delay Test

- **Purpose**
  - To determine the optimal trigger output (TACK) delay for each subsystem.

- **Duration**
  - 4 hours

- **Configuration**
  - muon data taking configuration.
  - Trigger on EXT trigger ONLY (muon telescope)

- **Procedure**
  - Scan TACK delays for the TKR and CAL over the applicable range simultaneously
  - Record 5000 events for each of the 8 steps
  - Determine the optimal TACK delay will by analysis
    - Use pulse heights for the CAL and hit multiplicity for the TKR
3.0 FLE Muon Scan

- **Purpose**
  - To determine the optimal setting for the FLE for some of the muon data taking.

- **Duration**
  - 12 hours

- **Configuration**
  - muon data taking configuration.
  - Trigger on EXT (muon telescope), TKR and CAL_LO trigger

- **Procedure**
  - Use procedure from CAL as baseline LAT-MD-04187-01
  - Alternative proposal
    » Scan FLE DAC setting for the CAL over the applicable range
    » Record 5000 (TBR) EXT triggered events for each of the 3 steps (TBR)
    » Determined the optimal FLE by analysis
Trigger Tests (4)

- 4.0 Trigger efficiency
  - **Purpose**
    - To determine the trigger efficiency
  - **Duration**
    - 4 hours
  - **Configuration**
    - muon data taking configuration.
    - Can be combined with the SVAC test B4
    - Trigger on EXT (muon telescope), TKR and CAL_LO trigger
  - **Procedure**
    - Analysis offline
Trigger Primitives

• Available when TEM diagnostics are enabled
  - Allows one to know which layer (end) issued a trigger request
• The GEM summary words tell which trigger occurred in a particular tower/ACD
  - TKR, CAL_LO, CAL_HI, CNO, ROI, EXT, Periodic, Solicited
• Default on orbit
  - TEM diagnostics OFF
• Default for SVAC tests for full LAT
  - TEM diagnostics OFF
• Default for SVAC tests of partially populated LAT and tests outside flight grid and trigger tests
  - TEM diagnostics ON
• Trigger window is of fixed time
  – Configurable (250 – ~ 1600 ns)
  – the first trigger type to appear can open the trigger window
    – If the window open mask register for that type was enabled
• How do I know a trigger primitive fired?
  – After the window closes it will appear in the GEM condition summary word, from which the L1 trigger is formed, only if
    – a trigger type signal was HIGH during the time the window was open
• What if the window open mask register for a given type was disabled but the signal was HIGH?
  – It will be in the GEM condition summary word
    – Provided some other trigger will open the window at a compatible time!
Muon Data Taking for Trigger Tests

- Single towers outside/inside the flight grid and LAT
  - **Main Register settings**
    - CAL Readout range: **ONE** or **FOUR**?
    - CAL High energy muon gain: **OFF** or **ON**?
    - Zero suppression: **ON**
    - TEM trigger diagnostic data: **ON**
SVAC Tests - Summary

- Before SVAC tests
  - Integrated tower is timed in and nominal settings are known

- SVAC tests
  - SVAC B1-B3 Flight configuration for LAT
  - SVAC B4-B5 Main configuration for LAT Calibrations
  - SVAC B6-B7 FLE trigger on muons for trigger tests
  - SVAC B8-B9 Main configuration for partially populated LAT
  - SVAC B10 No zero suppression for partially populated LAT
  - SVAC B11 No zero suppression for LAT
  - SVAC B12 Main configuration for LAT VDG tests
  - SVAC B13 Main VDG configuration for partially populated LAT
  - SVAC B14 ACD Veto functionality
  - SVAC B15-B17 ACD Calibrations

- Trade-off between fast throughput in data processing and convenience for users suggested that the
  - SVAC Data Taking scripts should be limited to 100-200 MB runs
    - Implies in ~30 min runs for 1 tower
SVAC tests – Charge Injection

• To support the SVAC offline calibrations with muons the following charge injection tests will be performed just prior to the muon data taking
  – TKR
    – TE701 – Threshold Dispersion
    – TE601 – Threshold Calibrations
    – TE602 – TOR conversion parameter calibrations
  – CAL
    – Name? – FLE/FHE characterization charge injection
• To “calibrate out the cross talk” effect from the FLE (using SAS calibGenCAL v3), the following trigger test is needed
  – Name? – FLE characterization with muons
SVAC Tests – B1 to B3

SVAC B1-B3 (Flight configuration for LAT)

- **Purpose**
  - Record cosmic ray triggers to compare offline calibrations and performance with results from default ground muon configuration (B2).
  - This is the default flight configuration for the LAT

- **Test/Duration**
  - B1: Single tower outside the flight grid (Towers A and B only): 2 hours
  - B1: Each single tower once it is installed inside the flight grid: 4 hours
  - B1: LAT in vertical orientation: 5 x 24 hours = 120 hours
  - B2: LAT in horizontal orientation (prior to VDG tests): 3 hours
  - B3: LAT in horizontal orientation: 5 x 24 hours = 120 hours

- **Configuration**
  - CAL
    - Auto range: ON
    - Readout range: ONE
    - High energy muon gain: OFF
  - Zero suppression ON
    - CAL LAC 1 MeV
    - ACD PHA 0.3 MIP
  - TEM trigger diagnostics: OFF
  - Trigger on logical OR
    - EXT trigger (muon telescope) if accessible
    - TKR set to \( \frac{1}{4} \) MIP
    - CAL_LO set to 100 MeV
    - CAL_HI set to 1 GeV
    - ACD_HLD set to 1 MIP
SVAC Tests – B4-B5

• SVAC B4-B5 (Main configuration for LAT Calibrations)
  – Purpose
    – Record cosmic ray triggers to produce offline calibrations, to evaluate performance and compare with MC simulations.
    – This is the default and official configuration for LAT calibrations and includes measurement of response of both CAL PIN diodes.
  – Test/Duration
    – B4: LAT in vertical orientation: 6 x 24 hours = 144 hours
    – B5: LAT in horizontal orientation for baseline prior to Environmental Tests= 16 hours
  – Configuration
    – CAL
      » Auto range: ON
      » Readout range: FOUR
      » High energy muon gain: ON
    – Zero suppression ON
      » CAL LAC 1 MeV
      » ACD PHA 0.3 MIP
    – TEM trigger diagnostics: OFF
    – Trigger on logical OR
      » EXT trigger (muon telescope) if accessible
      » TKR set to ¼ MIP
      » CAL_LO set to 100 MeV
      » CAL_HI set to 1 GeV
      » ACD_HLD set to 1 MIP
SVAC Tests – B6

• SVAC B6 (FLE trigger on muons to support trigger tests)
  – Purpose
    – Record cosmic ray triggers to verify performance
    – Trigger efficiency tests for trigger group
    – This is the low energy FLE configuration for the LAT
  – Duration
    – Single tower outside the flight grid vertical orientation (tower A and B only): 1 hour
    – Single tower inside the flight grid vertical orientation (TBR depends on first two tower tests)
    – LAT in vertical orientation: 8 hours (TBR depends on first two tower tests)
  – Configuration
    – CAL
      » Auto range: ON
      » Readout range: ONE
      » High energy muon gain: OFF
    – Zero suppression ON
      » CAL LAC 1 MeV
      » ACD PHA 0.3 MIP
    – TEM trigger diagnostics: ON
    – Trigger on logical OR
      » EXT trigger (muon telescope) if accessible
      » TKR set to ¼ MIP
      » CAL_LO set to 6 MeV (TBD by trigger tests)
      » CAL_HI set to 1 GeV
      » ACD_HLD set to 1 MIP
SVAC Tests – B7

- **SVAC B7 (FLE trigger on muons to support trigger tests)**
  - **Purpose**
    - Record cosmic ray triggers with the low energy FLE configuration with TEM diagnostics disabled, to confirm that we only need configuration B6 for the LAT
  - **Duration**
    - Single tower outside the flight grid vertical orientation (tower A and B only): 1 hour
    - Single tower inside the flight grid (TBR depends on first two tower tests)
  - **Configuration**
    - CAL
      - Auto range: ON
      - Readout range: ONE
      - High energy muon gain: OFF
    - Zero suppression ON
      - CAL LAC 1 MeV
      - ACD PHA 0.3 MIP
    - TEM trigger diagnostics: OFF
    - Trigger on logical OR
      - EXT trigger (muon telescope) if accessible
      - TKR set to ¼ MIP
      - CAL_LO set to 6 MeV (TBD by trigger tests)
      - CAL_HI set to 1 GeV
      - ACD_HLD set to 1 MIP
SVAC B8-B9 (Main configuration for partially populated LAT)

- **Purpose**
  - Record cosmic ray triggers to produce offline calibrations, to evaluate performance and compare with MC simulations with TEM diagnostics enabled
  - This is the default and official configuration for partially populated LAT calibrations and includes measurement of response of both CAL PIN diodes.

- **Duration**
  - B8: Single tower outside grid vertical orientation (Towers A and B only): 2 hours
  - B8: Partially populated LAT inside flight grid vertical orientation: 15 hours
  - B9: Two-Towers (A,B) inside grid in horizontal orientation (prior to VDG tests): 3 hours

- **Configuration**
  - CAL
    - Auto range: ON
    - Readout range: FOUR
    - High energy muon gain: ON
  - Zero suppression ON
    - CAL LAC 1 MeV
    - ACD PHA 0.3 MIP
  - TEM trigger diagnostics: ON
  - Trigger on logical OR
    - EXT trigger (muon telescope) if accessible
    - TKR set to $\frac{1}{4}$ MIP
    - CAL_LO set to 100 MeV
    - CAL_HI set to 1 GeV
    - ACD_HLD set to 1 MIP
SVAC B10 (No zero suppression for partially populated LAT)

- **Purpose**
  - Record cosmic ray triggers to produce offline calibrations that require no zero suppression with the TEM diagnostics enabled

- **Duration**
  - Single tower outside flight grid in vertical orientation: 1 hour
  - Partially populated LAT and/or Single tower inside flight grid in vertical orientation: 1 hour

- **Configuration**
  - CAL
    - Auto range: **ON**
    - Readout range: **FOUR**
    - High energy muon gain: **ON**
  - Zero suppression **OFF**
  - TEM trigger diagnostics: **ON**
  - Trigger on logical OR
    - EXT trigger (muon telescope) if accessible
    - TKR set to ¼ MIP
    - CAL_LO set to 100 MeV
    - CAL_HI set to 1 GeV
    - ACD_HLD set to 1 MIP
SVAC Tests – B11

• SVAC B11 (No zero suppression for LAT)
  – Purpose
    – Record cosmic ray triggers to produce offline calibrations that require no zero suppression with the TEM diagnostics disabled
  – Duration
    – LAT in vertical orientation: 1 x 16 hours = 16 hours
  – Configuration
    – CAL
      » Auto range: ON
      » Readout range: FOUR
      » High energy muon gain: ON
    – Zero suppression OFF
    – TEM trigger diagnostics: OFF
    – Trigger on logical OR
      » TKR set to ¼ MIP
      » CAL_LO set to 100 MeV
      » CAL_HI set to 1 GeV
      » ACD_HLD set to 1 MIP
SVAC Tests – B12

• SVAC B12 (Main configuration for LAT VDG tests)
  – Purpose
    – Record VDG photons to measure performance
  – Duration
    – LAT in horizontal orientation: 16 hours
  – Configuration
    – CAL
      » Auto range: ON
      » Readout range: ONE
      » High energy muon gain: OFF
    – Zero suppression ON
      » CAL LAC 1 MeV
      » ACD PHA 0.3 MIP
    – TEM trigger diagnostics: OFF
    – Trigger on
      » TKR set to ¼ MIP
SVAC Tests – B13

• SVAC B13 (Main VDG configuration for partially populated LAT)
  – **Purpose**
    – Record photons to evaluate performance
  – **Duration**
    – Tower A outside grid in horizontal orientation: **16 hour**
    – Tower A and B inside grid in horizontal orientation: **16 hours**
  – **Configuration**
    – CAL
      » Auto range: **ON**
      » Readout range: **FOUR**
      » High energy muon gain: **ON**
    – Zero suppression **ON**
      » CAL LAC **1 MeV**
      » ACD PHA **0.3 MIP**
    – TEM trigger diagnostics: **ON**
    – Trigger on
      » TKR set to **¼ MIP**
SVAC Tests – B14

- SVAC B14 ACD (veto functionality)
  - **Purpose**
    - Record cosmics for veto functionality
  - **Duration**
    - LAT in vertical orientation: 1-8 hours (TBR)
  - **Configuration**
    - CAL
      » Auto range: ON
      » Readout range: ONE
      » High energy muon gain: OFF
    - Zero suppression ON
      » CAL LAC 1 MeV
      » ACD PHA 0.3 MIP
    - TEM trigger diagnostics: OFF
    - Trigger on logical OR
      » EXT trigger (muon telescope) if accessible
      » TKR set to ¼ MIP
      » CAL_LO set to 100 MeV
      » CAL_HI set to 1 GeV
      » ACD_HLD set to 1 MIP
SVAC Tests – B15

- SVAC B15 ACD Calibrations
  - **Purpose**
    - Record cosmics for ROI 1
  - **Duration**
    - LAT in vertical orientation: 6 hours
  - **Configuration (as in flight for TKR and CAL)**
    - Zero suppression ON
      - CAL LAC 1 MeV
      - ACD PHA 0.3 MIP
    - TEM trigger diagnostics: OFF
    - Trigger on ACD
      - ACD_veto set to 0.1 MIP
      - ACD_HLD set to 1 MIP
SVAC Tests – B16

• SVAC B16 ACD Calibrations
  – Purpose
    – Record cosmics for RO2 2
  – Duration
    – LAT in vertical orientation: 6 hours
  – Configuration (as in flight for TKR and CAL)
    – Zero suppression ON
      » CAL LAC 1 MeV
      » ACD PHA 0.3 MIP
    – TEM trigger diagnostics: OFF
    – Trigger on ACD
      » ACD_veto set to 0.1 MIP
      » ACD_HLD set to 1 MIP
SVAC Tests – B17

• SVAC B17 ACD Calibrations
  – Purpose
    – Record cosmics for ROI 3
  – Duration
    – LAT in vertical orientation: 6 hours
  – Configuration (as in flight for TKR and CAL)
    – Zero suppression ON
      » CAL LAC 1 MeV
      » ACD PHA 0.3 MIP
    – TEM trigger diagnostics: OFF
    – Trigger on ACD
      » ACD_veto set to 0.1 MIP
      » ACD_HLD set to 1 MIP
Yet To be addressed …

• External trigger efficiency ~ 1 to 4 Hz
  – This needs to be understood before data taking time is finalized

• Testing STRETCH_OR in the GTRC needs to be added to the TKR tests
  – This needs to be understood before data taking time is finalized

• Redundancy between sides A and B of ELX boxes needs to be added
  – This needs to be understood before data taking time is finalized
**Trigger window – proposal**

- The trigger primitive information should always flow into the GEM condition summary word
  - irrespective of the status of the window open register

- Benefits
  - Add flexibility to the system for on-orbit operations
    - **Case 1**
      - Disallow CAL_HI to open the window (in case it has a significant trigger time slew which is energy dependent)
      - CAL_HI APPEARS in the GEM event summary word as long as TKR or CAL_LO opens the window
    - **Case 2**
      - Disallow CAL_LO to open the window (in case retriggering is an issue)
      - CAL_LO APPEARS in the GEM event summary word as long as TKR opens the window
      - Rely on TKR for low energy spectrum
        - » Not good situation and need careful study of systematics