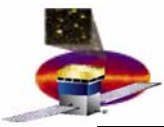


# **Trigger and SVAC Tests During LAT integration**

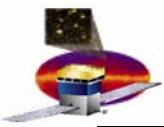
**Su Dong, Eduardo do Couto e Silva and Pat Hascall  
December 7, 2004**



# This Presentation

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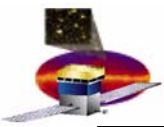
- **Part 1**
  - **Overview of trigger tests**
    - There are 4 tests
      - » FLE scan with muons was added as part of those
  
- **Part 2**
  - **Overview of SVAC tests**
    - There are 17 tests
      - » Merged nomenclature with Gary's table
      - » Addresses ACD tests (for completeness), no 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

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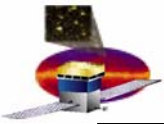
- We do not know if a trigger primitive fired within the trigger window if the TEM diagnostics are disabled
  - In the GEM summary word we only know which tower issue the trigger primitives, but do not know which layer (end) issued the trigger primitives.
- Unbiased sample of triggers only exist with 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



# Trigger Tests (1)

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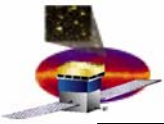
- **1.0 GEM Timing Alignment**
  - **Purpose**
    - To verify the timing alignment and jitter for each GEM trigger input
  - **Duration**
    - 4 hours (EXT AND CAL\_LO)
    - 4 hours (EXT AND TKR)
  - **Configuration**
    - muon data taking configuration.
    - Trigger on EXT trigger (muon telescope) 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.



# Trigger Tests (2)

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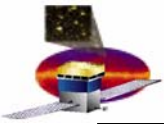
- **2.0 Subsystem TACK Delay Test**
  - **Purpose**
    - To determine the optimal trigger output (TACK) delay for each subsystem.
  - **Duration**
    - 4 hours
  - **Configuration**
    - muon data taking configuration.
    - Trigger on EXT trigger ONLY (muon telescope)
  - **Procedure**
    - Scan 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



# Trigger Tests (3)

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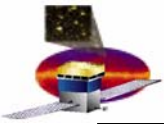
- **3.0 FLE Muon Scan**
  - **Purpose**
    - To determine the optimal setting for the FLE for some of the muon data taking.
  - **Duration**
    - 12 hours
  - **Configuration**
    - muon data taking configuration.
    - Trigger on EXT (muon telescope), TKR and CAL\_LO trigger
  - **Procedure**
    - 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)

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- **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

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- 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 – current implementation

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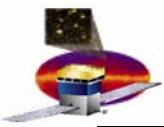
- Trigger window is of fixed time
  - Configurable (250 – ~ 1600 ns)
  - the first trigger type to appear can open the trigger window
    - If the *window open mask* register for that type was enabled
- How do I know a trigger primitive fired?
  - After the window closes it will appear in the GEM condition 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

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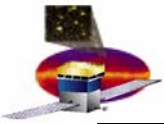
- Single towers outside/inside the flight grid and LAT
  - **Main Register settings**
    - CAL Readout range: **ONE or FOUR?**
    - CAL High energy muon gain: **OFF or ON?**
    - Zero suppression: **ON**
    - TEM trigger diagnostic data: **ON**



# SVAC Tests - Summary

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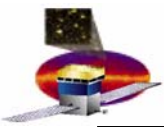
- **Before SVAC tests**
  - **Integrated tower is timed in and nominal settings are known**
- **SVAC tests**
  - **SVAC B1-B3** Flight configuration for LAT
  - **SVAC B4-B5** Main configuration for LAT Calibrations
  - **SVAC B6-B7** FLE trigger on muons for trigger tests
  - **SVAC B8-B9** Main configuration 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

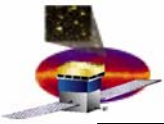
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- To support the SVAC offline calibrations with muons the following charge injection tests will be performed just prior to the muon data taking
  - TKR
    - TE701 – Threshold Dispersion
    - TE601 – Threshold Calibrations
    - TE602 – TOR conversion 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



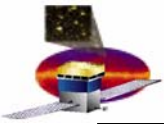
# SVAC Tests – B1 to B3

- 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 **¼ MIP**
      - » CAL\_LO set to **100 MeV**
      - » CAL\_HI set to **1 GeV**
      - » ACD\_HLD set to **1 MIP**



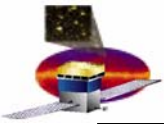
# SVAC Tests – B4-B5

- **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  $\frac{1}{4}$  MIP
      - » CAL\_LO set to **6 MeV (TBD by trigger tests)**
      - » CAL\_HI set to **1 GeV**
      - » ACD\_HLD set to **1 MIP**

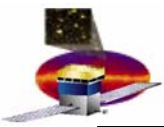


# SVAC Tests – B7

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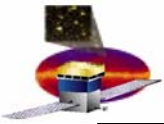
- **SVAC B7 (FLE trigger on muons to support trigger tests)**
  - **Purpose**
    - Record cosmic ray triggers with the **low energy FLE** configuration with TEM diagnostics disabled, to confirm that we only need configuration B6 for the LAT
  - **Duration**
    - Single tower outside the flight grid 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 Tests – B8-B9

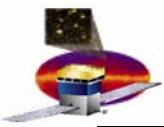
- **SVAC B8-B9 (Main configuration for partially populated LAT)**
  - **Purpose**
    - Record cosmic ray triggers to produce offline calibrations, to evaluate performance and compare with MC simulations with TEM diagnostics enabled
    - This is the **default** and official configuration for **partially 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 **¼ MIP**
      - » CAL\_LO set to **100 MeV**
      - » CAL\_HI set to **1 GeV**
      - » ACD\_HLD set to **1 MIP**



# SVAC Tests – B10

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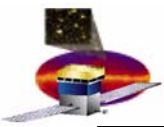
- **SVAC B10 (No zero suppression for partially populated LAT)**
  - **Purpose**
    - Record cosmic ray triggers to produce offline calibrations that require no zero suppression with the TEM diagnostics enabled
  - **Duration**
    - Single tower outside flight grid in vertical orientation: **1 hour**
    - 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 **1/4 MIP**
      - » CAL\_LO set to **100 MeV**
      - » CAL\_HI set to **1 GeV**
      - » ACD\_HLD set to **1 MIP**



# SVAC Tests – B11

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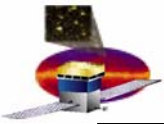
- **SVAC B11 (No zero suppression for LAT)**
  - **Purpose**
    - Record cosmic ray triggers to produce offline calibrations that require no zero suppression with the TEM diagnostics disabled
  - **Duration**
    - LAT in vertical orientation: 1 x 16 hours = **16 hours**
  - **Configuration**
    - 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 **1/4 MIP**
      - » CAL\_LO set to **100 MeV**
      - » CAL\_HI set to **1 GeV**
      - » ACD\_HLD set to **1 MIP**



# SVAC Tests – B12

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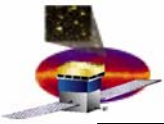
- **SVAC B12 (Main configuration for LAT VDG tests)**
  - **Purpose**
    - Record VDG photons to measure performance
  - **Duration**
    - LAT in horizontal orientation: **16 hours**
  - **Configuration**
    - **CAL**
      - » Auto range: **ON**
      - » Readout range: **ONE**
      - » High energy muon gain: **OFF**
    - **Zero suppression ON**
      - » CAL LAC **1 MeV**
      - » ACD PHA **0.3 MIP**
    - **TEM trigger diagnostics: OFF**
    - **Trigger on**
      - » TKR set to **1/4 MIP**



# SVAC Tests – B13

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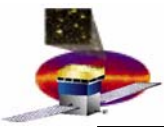
- **SVAC B13 (Main VDG configuration for partially populated LAT)**
  - **Purpose**
    - Record photons to evaluate performance
  - **Duration**
    - Tower A outside grid in horizontal orientation: **16 hour**
    - Tower A and B inside grid in horizontal orientation: **16 hours**
  - **Configuration**
    - 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 **1/4 MIP**



# SVAC Tests – B14

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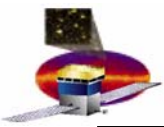
- **SVAC B14 ACD (veto functionality)**
  - **Purpose**
    - Record cosmics for veto functionality
  - **Duration**
    - LAT in vertical orientation: **1-8 hours (TBR)**
  - **Configuration**
    - **CAL**
      - » Auto range: **ON**
      - » Readout range: **ONE**
      - » High energy muon gain: **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

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- **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**

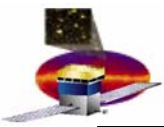


# SVAC Tests – B16

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- **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**

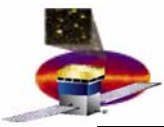




# SVAC Tests – B17

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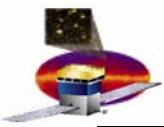
- **SVAC B17 ACD Calibrations**
  - **Purpose**
    - Record cosmics for ROI 3
  - **Duration**
    - LAT in vertical orientation: **6 hours**
  - **Configuration (as in flight for TKR and CAL)**
    - Zero suppression **ON**
      - » CAL LAC **1 MeV**
      - » ACD PHA **0.3 MIP**
    - TEM trigger diagnostics: **OFF**
    - Trigger on ACD
      - » ACD\_veto set to **0.1 MIP**
      - » ACD\_HLD set to **1 MIP**



# Yet To be addressed ...

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- **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

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- 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