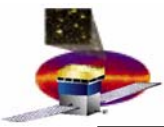


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**Trigger Engine Configuration  
and  
Phase 1 and 2  
SVAC, E2E Tests  
(hereafter LAT 70X, 80X)**

**Eduardo, Eric Grove and Pat  
(after discussions with Steve, JJ and Anders)**



# Overview of this talk

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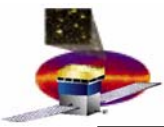
- **Original Goal**
  - **Define Phase 2 Systems Tests using cosmic rays**
    - Consolidate information from the following plans
      - » SVAC Plan for LAT Integration: LAT-MD-00575
      - » Recommendation from Committee on E2E testing: LAT-MD- 03489
      - » Trigger Test Plan: LAT-MD- 07604
- **Outcome of the process**
  - **Proposal for a configuration of the trigger engines for on-orbit operations**
    - To be used as starting point for Systems tests in Phase 1 and 2
    - Will be adapted to reflect pre-launch test program
  - **List of recommended cosmic ray tests for Phases 1 and 2**
    - Includes configuration and duration
    - Number of tests was reduced with the definition of a multiple trigger engine configuration



# Overview of Trigger Engine Configuration

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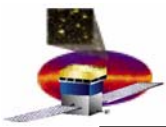
- **Goals**
  - **Define a Trigger Engine Configuration for operations in orbit**
    - Lots of flexibility
      - » Thanks to FSW
    - Definition is not unique and we will probably iterate many times on this
      - » This talk should be viewed as a initial draft
  - **Define a Trigger Engine Configuration to be used for ground system tests**
    - Derived from the one used for operations on orbit
    - Caveats for ground testing
      - » Particle spectrum is not the same as in orbit
      - » Trigger rates and allowed trigger types are not the same as in orbit
- **Outcome**
  - **Configured 8 engines based on discussions between**
    - Instrument Scientist (Steve)
    - SVAC, ISOC PVO (Eduardo, Anders)
    - FSW (JJ)
    - System Engineering (Pat)
    - Trigger, ISOC PVO (Eric)



# Trigger Windows

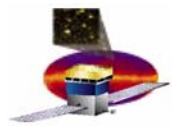
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- On-orbit configuration includes which trigger type is allowed to open the trigger window
- Allowed in orbit
  - Cal Hi
  - Cal Lo
  - CNO
  - TKR
  - Solicited triggers
    - used as sweep events
  - Periodic triggers
    - used to read out an empty instrument to measure pedestals
- Not allowed in orbit (allowed for GND system tests)
  - External
  - ROI



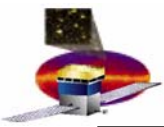
# Trigger Engine Mapping

- Trigger engine definitions in order of precedence (high to low)
  - Sweep events and other JJ specials (128 entries)
    - Logic: Solicited condition set
    - Readout: zero-suppressed, 1-range
  - Pedestals (2 entries)
    - Logic: Periodic condition set
    - Readout: unsuppressed, 4-range
  - GCR calibration (64 entries)
    - Logic: CNO
    - Readout: zero-suppressed, 4-range
  - HE photons with splashback (32 entries)
    - Logic: CAL-HI
    - Readout: zero-suppressed, 1-range
  - Photons, primary science data (8 entries) changes for GND system tests
    - Logic: TKR && notROI && (CAL-LO || notCAL-LO)
    - Readout: zero-suppressed, 1-range
  - Photons that don't convert in TKR (8 entries)
    - Logic: CAL-LO && notTKR && (ROI || notROI)
    - Readout: zero-suppressed, 1-range
  - Deliberate leakage of protons and He (8 entries)
    - Logic: TKR && ROI && (CAL-LO || notCAL-LO)
    - Readout: zero-suppressed, 1-range, prescaled
  - Should never happen (6 entries) changes for GND system tests
    - Logic: notTKR && notCAL-LO && ROI; Ext only; nothing
    - Readout: Null engine 0, no readout



# Trigger Engine Mapping Table

Condition Summary								Theme	Readout
External	Solicited	Periodic	CNO	Cal Hi	Cal Lo	TKR	ROI		
x	1	x	x	x	x	x	x	Sweep Events	zero suppressed, 1-range
x	0	1	0	0	0	0	0	Pedestals	unsuppressed, 4-range
x	0	x	1	x	x	x	x	GCR calibration	zero suppressed, 4-range
x	0	x	0	1	x	x	x	High Energy photons	zero suppressed, 1-range
x	0	x	0	0	0	1	0	Photons	zero suppressed, 1-range
x	0	x	0	0	1	1	0	Photons	zero suppressed, 1-range
x	0	x	0	0	1	0	0	Cal only photons	zero suppressed, 1-range
x	0	x	0	0	1	0	1	Cal only photons	zero suppressed, 1-range
x	0	x	0	0	0	1	1	Deliberate leakage	zero suppressed, 1-range, prescaled
x	0	x	0	0	1	1	1	Deliberate leakage	zero suppressed, 1-range, prescaled
x	0	x	0	0	0	0	1	Should never happen	N/A
0	0	0	0	0	0	0	0	Should never happen	N/A
1	0	0	0	0	0	0	0	Should never happen	N/A



# Noteworthy

---

- **External condition**
  - **not allowed to open a window, so this condition should never occur!**
    - Offline software on the ground will monitor GEM Condition Summary word for such anomalies
- **One condition summary leads to Null action and is mapped to**
  - **ROI only**
    - not allowed to open a window, so this condition should never occur!
    - These are mostly particles clipping edges of ACD
  - **No conditions**
- **There are other options for the GCR Calibration Engine**
  - **GCR calibration**
    - Logic: CNO or **CNO && TKR && CAL\_LO?**
    - Readout: zero-suppressed, 4-range
    - **We do not care so much about side entering particles since we want CNO for CAL calibrations**
      - » **What is the rate of these?**

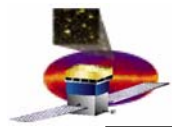


# Overview of Cosmic Ray Tests

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- **Goals**
  - **Verify quality and contents of science data for different configurations**
    - Parameter space is huge
      - » This talk proposes to limit the parameter space
  - **Characterize LAT Performance and refine calibrations**
    - Caveats for ground testing
      - » Particle spectrum is not the same as in orbit
      - » Trigger rates and allowed types are not the same as in orbit
- **Ground Rules**
  - **Minimize and/or eliminate repetition of cosmic ray data taking**
    - Consolidate, to the best of our knowledge, existing data taking plans
- **Current Assumptions**
  - **Trigger and Data flow functionality has already been tested**
    - Includes verification of science data quality for redundant side of GASU
  - **Validated calibration constants from Phase 2 are available prior to tests**
    - used as input for SVAC and E2E data taking
- **Outcome**
  - **Number of tests: 14**
    - Phase 1 : 8
    - Phase 2 : 8
      - » 3 are already part of trigger plan – we request more muons
      - » 1 is already part of ACD CPT - we request longer data taking
      - » 1 is already part of Ops test Plan but has no muons
  - **Duration : 104 hours**
    - Phase 1 : 8 h
    - Phase 2 : 96 h
      - » Possible reduction to 84 hours
    - Does not include overhead for setting up and performing data taking
  - **Data Analysis Results**
    - The goal is to present results on Instrument Analysis Workshop 6
      - » First week of March 2006 @ SLAC



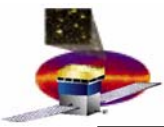


# Trigger Engine Mapping – LAT GND System Tests

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Needs to be revised after Monday meeting

- Trigger engine definitions in order of precedence (high to low)
  - Sweep events and other JJ specials
    - Logic: Solicited condition set
    - Readout: zero-suppressed, 1-range
  - Pedestals
    - Logic: Periodic condition set
    - Readout: unsuppressed, 4-range
  - GCR calibration
    - Logic: CNO
    - Readout: zero-suppressed, 4-range
  - HE photons with splashback
    - Logic: CAL-HI
    - Readout: zero-suppressed, 1-range
  - Photons, primary science data becomes GND cosmic rays
    - Logic: TKR
    - Readout: zero-suppressed, 1-range
  - Photons that don't convert in TKR
    - Logic: CAL-LO && notTKR && (ROI || notROI)
    - Readout: zero-suppressed, 1-range
  - Deliberate leakage of protons and He
    - Logic: TKR && ROI && (CAL-LO || notCAL-LO)
    - Readout: zero-suppressed, 1-range, prescaled
  - Should never happen
    - Logic: notTKR && notCAL-LO && ROI; nothing
    - Readout: Null engine 0, no readout



# System Tests : Phase 2 (1 of 3)

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- **LAT 701: Flight configuration - primary side of GASU 48 hours**
  - **Performance verification (largest statistical sample for LAT)**
    - Map LAT with cosmic rays
      - » Driven by ACD: 100,000 hits/tile
    - Verify detector alignment
    - Measure efficiencies using combinations of TKR, CAL and ACD
  - **Unbiased trigger sample**
    - Measure noise occupancies
  - **Unsupressed data**
    - Calculate pedestals
    - Recommendation from Committee on E2E testing (2.1.1-7 in LAT-MD- 03489) – Baseline CR Data Volume
- **LAT 702: Flight configuration - redundant side of GASU 8 hours**
  - verify data quality from the redundant side of GASU prior to this test
    - » Request short run (30 min) of LAT 701 and 702 for Phase 1
  - **Engine configuration is the same as in LAT 701**
- **LAT 711: Muon Calibration - primary side of GASU 16 hours**
  - **Compare with results from LAT701**
  - **Calibrate energy scales**
    - Measure muon peaks
    - Correlate data between diodes and sides
  - **Unbiased trigger sample**
    - Measure noise occupancies during calibrations
  - **Unsupressed data**
    - Calculate pedestals with muon gains
  - **Engine configuration is the same as in LAT 701 but CAL front-ends set to muon gain**

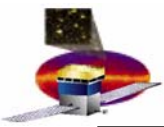
# System Tests : Phase 2 (2 of 3)

- LAT 721: ACD calibrations using ACD only: **16 hours**
  - **Calibrate all tiles and efficiency measurements**
  - **Single Engine Test: TKR and CAL Flight settings**
    - Set in coincidence TOP tiles and sides tiles (S1 to S4)
    - ROI allowed to open trigger window
      - » (TOP && (S1 || S2 || S3 || S4) || (S1 && S3) || (S2 && S3) || (S2 && S4) || (S3 && S4))
    - Expected about 20k events for the peak of the muon distribution for (assuming ROI triggers @ 100 Hz)
    - 16 tower rates is ~ 500 Hz so one expects similar rates from ROI
      - » Under investigation (Alex Moiseev)
      - » Potentially this test could be reduced to 4 hours.
      - » This test is currently part of ACD CPT (triggerOps), should it remain there or be moved to SVAC runs?
- LAT 731: Data Transport Errors **1 hour**
  - **Verify data quality after inducing parity errors in the system**
    - Verify that error rate is not a function of the event size
    - Demonstrate that we can analyze events with and without errors offline and search for correlations between them
  - **Unbiased trigger sample**
    - Measure noise occupancies
  - **Use same Engine configuration described in LAT 701**
  - **Currently part of LAT 660 (Operation and Test Plan LAT-MD- 02730) –**
    - Requested System Engineering to provide 1 hour of muons for this test
  - **Recommendation from Committee on E2E testing (2.1.1-10 in LAT-MD- 03489) - T&DF Data Transport Errors**

# System Tests : Phase 2 (3 of 3)

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- LAT 741 : GEM self-Integrity test (Data taken during Trigger Tests) **4 hours?**
  - **Verify effects from false triggers:**
    - Galloping trigger rate;
      - » Search for “trigger bursts”
    - Adjacent event trigger pattern similarity
    - Non-Poisson's distribution for Cosmic Rays.
      - » Search for unusually short interval between events
  - **Engine configuration described in Trigger test plan**
  - **Currently part of LAT 211 (2.2.5 in Trigger Test Plan LAT-MD- 07604) – GEM self-Integrity test**
  - **Recommendation from Committee on E2E testing (2.1.2-4 in LAT-MD- 03489) - T&DF False Triggers**
- LAT 751 : GEM Trigger engines (Data taken during Trigger Tests) **3 hours**
  - **Demonstrate that science data is analyzable for all trigger engines**
    - Characterize performance for a subset of engines
  - **Validate data analysis chain from telemetry to offline**
    - Demonstrate that we can analyze events with and without errors offline and study possible correlations
  - **Engine configuration described in Trigger test plan**
  - **Currently part of LAT 211 (2.2.8 in Trigger Test Plan LAT-MD- 07604) – GEM Trigger Engine test**
    - Cycle periodic triggers though all engines
    - Requested trigger group to add 10 min of muons cycled through all engines
- LAT 761 : L1 Veto Efficiency (Data taken during Trigger Tests) **2 hours**
  - **Demonstrate that science data is consistent with expectations with ground cosmic ray spectrum**
    - Verify rates
    - Verify data quality of unvetoed data
  - **Engine configuration described in Trigger test plan**
  - **Currently part of LAT 211 (2.2.5 in Trigger Test Plan LAT-MD- 07604) – VETO Efficiency test**
    - Requested trigger group to ensure min of 2 hours of cosmic ray data taking



# System Tests : Phase 1

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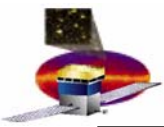
- **Phase 1 tests : mitigation risk for Phase 2**
  - **Derived from**
    - Recommendation from Ad-hoc Committee on E2E testing (LAT-MD- 03489)
    - **Phase 1 tests are not part of verification sell-off**
- **There are constraints for the usage of external pulser in Phase 2**
  - **IRD para 3.2.4.6:**
    - "The SC or LAT may elect to use test points to provide external access to internal circuitry via Ground Support Equipment (GSE). Use of test points shall meet the following requirements."
  - **IRD para 3.2.4.6.1:**
    - "Test points shall not be used during SC integration and test, except as expressly approved and documented in formal procedures."
  - **IRD para 3.2.4.6.2:**
    - "Data collected to verify acceptance or qualification of performance requirements shall be acquired through flight interfaces and not through test point interfaces."



# LAT System Tests : Phase 1

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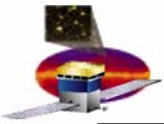
- LAT 701: Flight configuration - primary side of GASU 1 hour
- LAT 702: Flight configuration - redundant side of GASU 1 hour
  - Verify integrity of data prior to Phase 2 tests
- LAT 8XX tests
  - Data Analysis Goals
    - Compare results from Phase 1 baseline test LAT 701
      - » Compare distributions from several engines after muon selection cuts
      - » Calculate pedestals
      - » Measure noise occupancy
  - Trigger Engine Configuration
    - same as in LAT 701
- Power Supply only tests
  - Verify ability to operate at voltage margins:
    - Set power supply either to 27 or 29 V
- LAT 801 : Unregulated Power Supply set to 27V 1 hour
- LAT 811 : Unregulated Power Supply set to 29V 1 hour
  - 2.1.1-2 – Condition Scan CR Test in LAT-MD- 03489
- Orbital Max Rate Tests
  - Verify ability to trigger at high rates:
    - External pulser is allowed to open trigger window: rate of 15 KHz
- LAT 821 : Orbital Max Rate Cosmic Ray Test 1 hour
  - 2.1.1-4 – Nominal Rate CR Test in LAT-MD- 03489
- LAT 831: Orbital max rate Cosmic Ray Test in muon gain : 1 hour
  - 2.1.1-8– Nominal Rate CR Data Volume Test in LAT-MD- 03489
- LAT 841 : Unregulated Power Supply set to 27V at orbital max rates 1 hour
- LAT 851 : Unregulated Power Supply set to 29V at orbital max rates 1 hour
  - 2.1.1-5 – Nominal Rate Condition Scan CR Test in LAT-MD- 03489



# Comments/Questions

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- **Trigger Tests that SVAC is not planning to analyze**
  - **ETE 2.2.1-3 (Baseline CR Trigger Test)**
    - Tests of Individual triggers
      - » Will be analyzed by trigger group
  - **ETE 2.2.1-6 (CAL Nominal Rate CR Test)**
    - Lower thresholds in CAL.
      - » Will be analyzed by trigger group
- **NRL Tests**
  - **E2E 2.2.1-2 (Condition Scan CR Test)**
    - **Need to test system clock vs Temperature @ NRL**
      - » **Should we develop a script and test it in Phase 1 as part of mitigation risk?**



# The path forward...

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- **Implement suggestions from today's discussion**
  - to on-orbit configuration of trigger engines
  - to cosmic ray data taking runs
    - Decide on rate for external pulser tests for Phase 1
    - Decide on durations of tests for Phases 1 and 2
      - » LAT 721 (needs ACD input)
- **Define matrix for GND tests**
  - Need to evaluate statistics and prescaling used for tests
  - Need to evaluate data volume
- **Work on implementation details**
  - **SVAC/online to decide how to retrieve these tests from runs database**
    - For data analysis we need to give LAT Collaboration unique IDs
    - Do not know online constraints yet
  - **SVAC/SAS/online to devise how offline user knows from which trigger engine an event comes from**
- **Present an update next Monday (Nov 28)**
  - **Goal is to get an agreement on list of tests and configurations so that we can**
    - write a document to capture all this information
    - Initiate preparations for data analysis
    - Evaluate impact on schedule and online development