

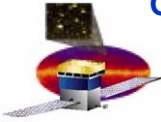
GLAST Large Area Telescope

Systems Engineering

Test Status, NCRs and Verification Status

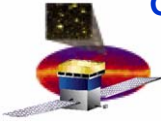
Pat Hascall
Systems Engineering
Joe Cullinan
Quality

Stanford Linear Accelerator Center



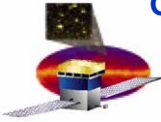
LAT Test Status

- **EMI**
 - Updated flag status in next chart, EMI break of config charts follow
- **End to end test (Systems perspective)**
 - Identified several minor issues which can be easily resolved
 - Method of operation was a distinct improvement over the first instrument sim
 - The LAT engineering team was able to focus on the instrument with Elizabeth calling the procs
 - Telemetry display pages continuing to improve and provide data relevant to a proc on a single or small number of pages
 - Working on several proposals to speed power up
 - Cal and tracker bias as one command each rather than 16 commands each
 - Option to not use dwell if we have the high rate downlink
 - If there is enough power margin, powering the LAT fully when the grid heaters are still drawing power would simplify and potentially shorten the LAT power up sequence
- **FSW upload/regression test**
 - File upload hampered by command failures
 - Hardline and RF, Spacecraft A and B sides
 - Scripts were robust (kudos to On-Line) and minimized the impact of the dropped commands
 - Uploads were completed, continuing on to the regression tests on Side 1



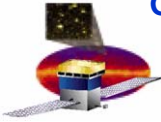
EMI Flag Status

- 35 flags were LAT related (LAT team assessment)
 - 23 flags closed
 - 6 closed to QARs
 - EMI susceptibility in calorimeter (Waiver generation in process)
 - EMI susceptibility in temp sensors (Waiver generation in process)
 - XLHP temp sensor
 - 3 QARs against GD EGSE
 - 12 remain open
 - 3 document tlm issues (dropped and glitchy)
 - Kurt working through our lists with Tim to look for unexpected dropouts
 - 6 were science data related (none during EMI susceptibility sweeps)
 - Rich and Bryson continuing review and feeding information back to GD
 - » We can locate potentials for SSR-UDL dropped frame issues, but do not have all the information to confirm the 4000 frame symptom
 - » We have seen additional cases where the RE test operations resulted in SSR files that confused the pipeline ingest process
 - 2 document commanding issues (not during sweep)
 - GD working, these 2 attributed to the TURFTS rack
 - 1 documents LAT response to GBM (GBM power up triggered LAT response, not EMI related)
 - Reviewing earlier cases



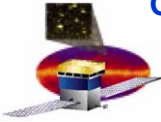
EMI Overview

- **LAT EMI testing showed no significant susceptibilities**
 - **Two susceptibilities detected which will not impact on-orbit operations**
- **A significant volume of data was collected and has all been reviewed**
 - **There were 331 runs during the EMI testing**
 - **Those runs collected over 100 million events**
- **Non EMI related items are in work with the Spacecraft team**



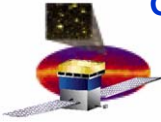
Review Process

- The LAT data review is a three tiered process, with email feedback to monitor completion of the discipline expert data review
- Samples of data reviewed at end of presentation
- Tier 1 – Test Engineers
 - Monitor pass/fail, limits and any error/warning messages
 - For EMI, added low rate science counters to check for increased event activity due to EMI
- Tier 2 – Systems Engineers
 - Review every run
 - Test report if applicable
 - Message logs
 - Science data reports (Digi report)
 - Review housekeeping telemetry daily
 - Developed tools to monitor GPS lock and telemetry dropouts
- Tier 3 – Discipline Experts
 - Monitor data flow through the offline processing
 - Monitor subsystem performance



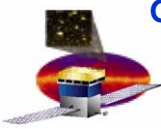
EMI Issues

- **Known susceptibilities (based on the LAT level EMI test)**
 - **Tracker susceptibility at 100 MHz**
 - **Minor temp sensor susceptibility at 30MHz to 100MHz**
- **Observed susceptibilities**
 - **Calorimeter susceptibility at 280MHz**
 - **Minor temperature susceptibility at 30MHz to 100MHz**
 - **Tracker susceptibility at 100MHz was not seen**



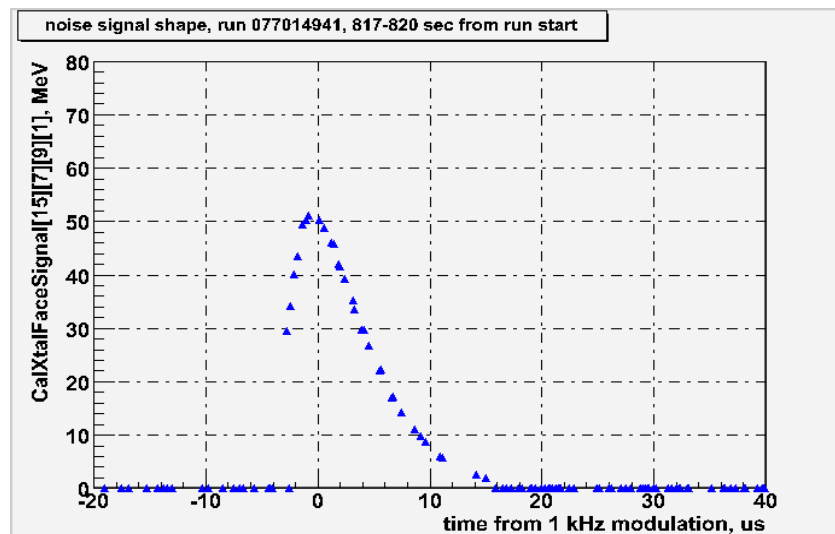
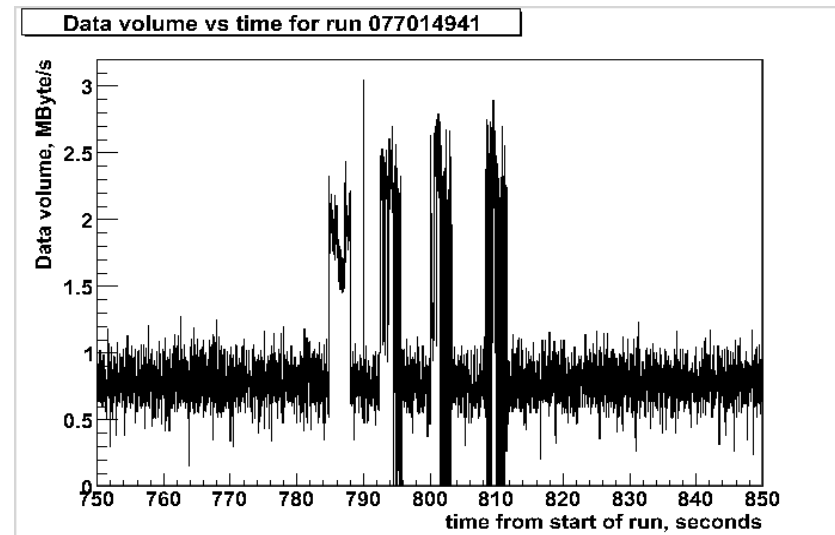
Calorimeter Susceptibility

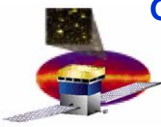
- Symptoms of susceptibility observed near 280 MHz, both polarizations
 - Excess CAL triggers and occupancy in phase with 1 kHz pulse modulation of RF test equipment
 - Predominantly in 4 towers near (+X,+Y) corner
 - Excesses seen only within ~10 us of leading edge of RF pulse
 - Transmitter uses 1 kHz pulse modulation with 50% duty cycle
 - Absolute phase isn't yet known. Maybe we're seeing trailing edge of pulse
 - No trigger or occupancy excess observed during the body of the RF pulse
 - No sustained effects are visible in CAL
 - Datagrams dropped (not sent from CPU to SSR), CPU load rises to 100%
 - Error messages from LAT dataflow system indicate backpressure asserted
 - High data volume from additional 1 kHz of large events (relative to flight)
 - CPUs are running in "write-through" cache mode (reboot holdover), decreasing computing capacity by a factor of 3 – 5, exacerbating the problem
 - » CPU load (write-through) is 45% with ~600 Hz of cosmics
 - » CPU load (nominal) is 15% with ~600 Hz of cosmics
 - Event communications fabric is shared by instrument data and CPU-to-CPU communications.
 - Large event volumes can disrupt CPU message transmission and delivery
- Speculation:
 - Affected towers are near one of two rise-to-altitude vents on +X face of EMI skirt
 - Perhaps this particular vent is source of RF leakage
- No on-orbit issue, no emitters at this frequency, waiver in process



Calorimeter Susceptibility

- Upper panel: Large LAT data volume
 - Four episodes of high volume
 - Correspond to 4 freq steps near 280 MHz
 - Each freq step = 3 sec RF on, ~4 sec RF off
 - Data dropped during last 3 freq steps when:
 - CPU load rises to 100%
 - error messages seen in Diagnostic stream
- Lower panel: Profile of signal induced in CAL
 - Observation: Excess CALLO triggers are precisely periodic at 1 kHz
 - Use that periodicity to look for CAL signals
 - Measure duration and strength of signal in CAL
 - CAL pulse height has been phase-aligned with 1 kHz spike of CALLO triggers
 - TKR-triggered muons (one per blue dot)
 - Trace out excess signal in CAL
 - Consistent with very fast spike through 3.5 us shaper
 - Absence of signal beyond 10 us from time of 1 kHz spike means that this is not a sustained effect in CAL
 - Trigger and data excess is associated with leading (or trailing) edge of RF pulse

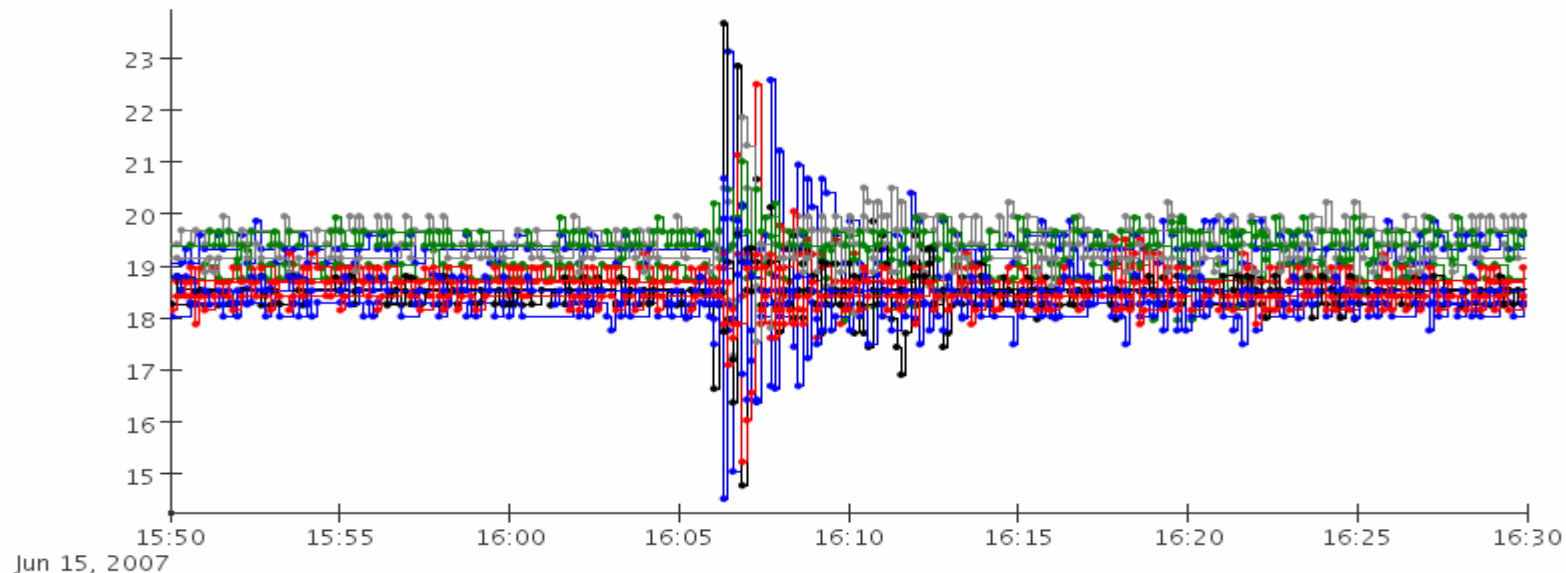


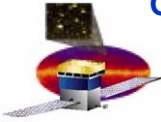


RTD Susceptibility

- **Observatory RS103 testing reconfirmed a known susceptibility between 30 – 100 MHz of certain RTDs.**
 - Radiator
 - VCHP Reservoir
 - ACD Shell
- **An example of the susceptibility**

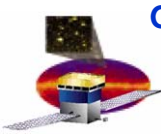
LHKP0RAD0T, LHKP0RAD10T, LHKP0RAD11T, LHKP0RAD1T, LHKP0RAD2T, LHKP0RAD3T, LHKP0RAD4T, LHKP0RAD5T, LHKP0RAD6T, LHKP0RAD7T, LHKP0RAD8T, LHKP0RAD9T





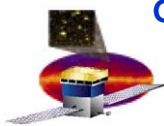
RTD Susceptibility Status

- **Flag #102 written to document the susceptibility**
 - **Originally documented in NCR 939**
- **The susceptibility is consistent with what was found at LAT-level testing.**
- **Waiver to be submitted**

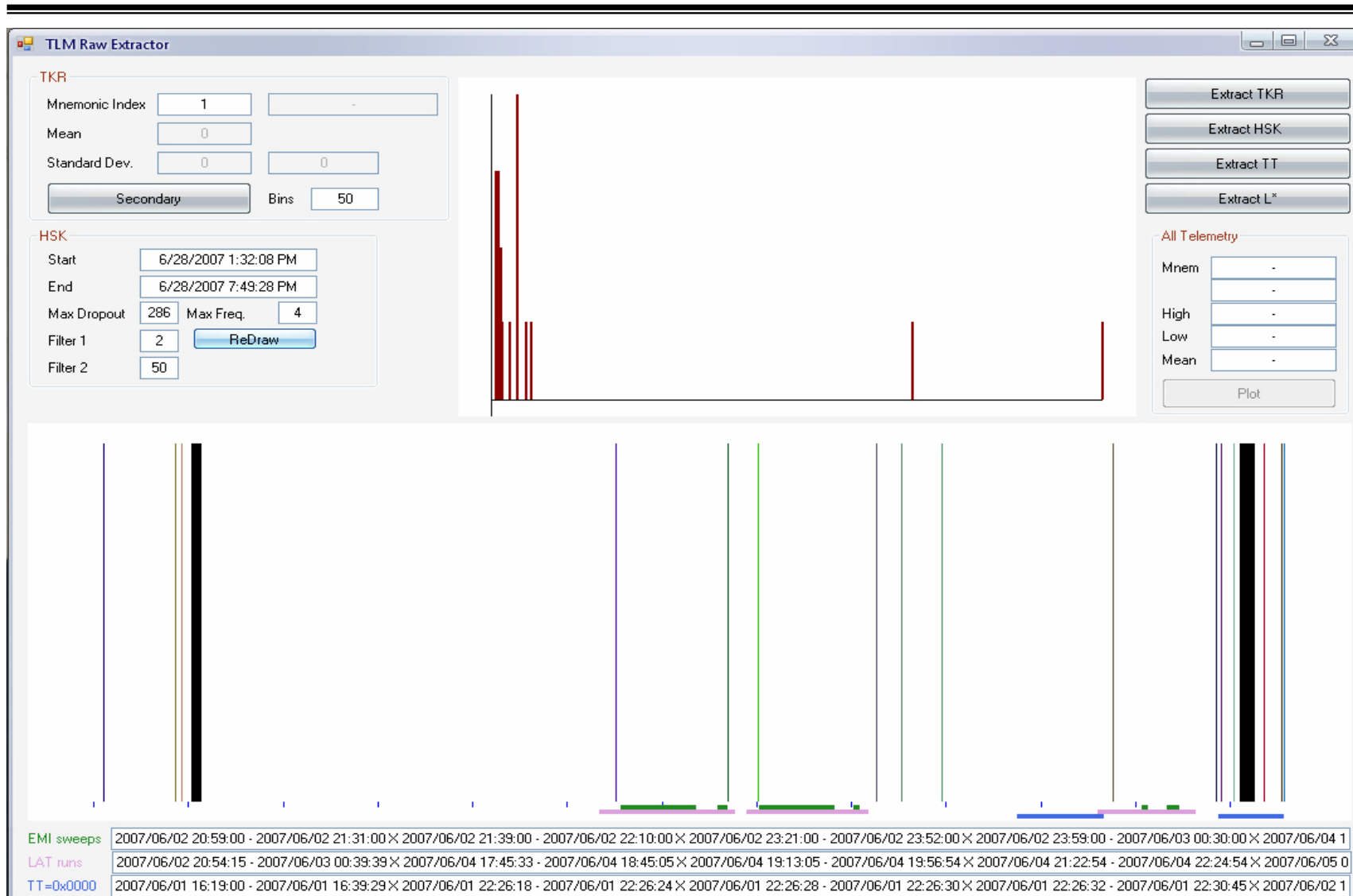


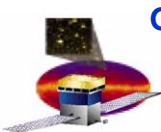
Other Observed Issues

- **VCHP-XLHP Temperature Sensor anomaly (see next slide)**
- **Details of the following set of observed issues in the Spacecraft presentation**
 - **Housekeeping telemetry dropouts and glitches**
 - **Instances of dropped telemetry packets or corrupted data**
 - **Typically correlated to changes in telemetry rate or downlink**
 - **See next slide for typical frequency**
 - **Science data dropouts**
 - **Instances of dropped packets or potentially corrupted packets**
 - **Non-contiguous SSR dumps**
 - **SSR/UDL dropped frame**
 - **Corrupt sync pattern**
 - **None occurred during susceptibility testing and thus are not EMI related**
 - **GPS lock dropouts**
 - **GPS lock flags showed many instances of lost GPS lock**
 - **See Spacecraft presentation**



Telemetry and GPS Dropouts

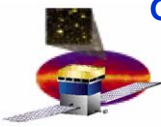




VCHP-XLHP Temperature Sensor Anomaly

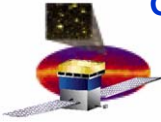
- Telemetry glitches were found for the +Y VCHP-XLHP heatpipe #4 primary thermistor.





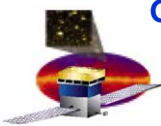
VCHP-XLHP Temperature Sensor Status

- The glitches were first noticed during self-compatibility
- Review of the telemetry history reveals glitches during LAT pre-TV CPT
 - Magnitude of the glitches range from ~3 DegC to ~9 DegC
 - Duration is on the order of minutes
- Glitches are occurring more frequently since the start of EMI testing
 - Magnitude is much larger, duration is longer in many cases
 - We do not believe the glitches are EMI test related
 - Glitches found during LAT pre-TVAC
 - Some instances occurred during LAT power on in preparation for EMI testing or in between EMI tests
- LAT recommendation for troubleshooting after the radiators discussed in FRB, potentially to be performed on Monday.
 - Inspecting the interface connector pins, wires and sensors
 - With a Ohm-meter connected at the interface connector via BoB, apply hand pressure along wire routing to see if a change in resistance occurs.
- May need to change LAT TCS to read the VCHP-DSHP interface sensor instead if the cause of the glitches cannot be fixed



Digi Report Data Samples

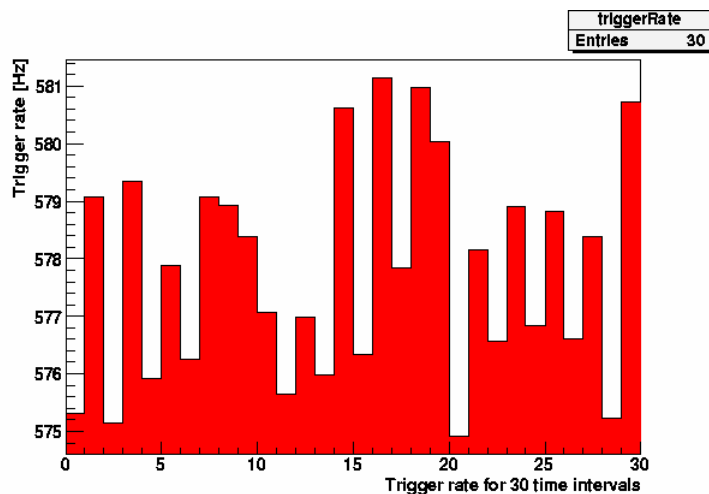
- The following charts show 4 of the 64 plots for each Digi report
 - **Compares run 77014940 (100MHz to 180MHz) to run 77014941 (180MHz to 1GHz)**
 - **Plots selected to show calorimeter susceptibility effects**
- **Trigger rates for 30 time intervals showed the spike in events**
- **Number of CAL LO triggers per tower showed that the triggers all came from tower 15**
- **Time interval between adjacent events in milliseconds showed that the interference had a 1 msec periodicity**
- **Average number of crystal hits in a particular CAL layer showed that the effect covered more than tower 15**



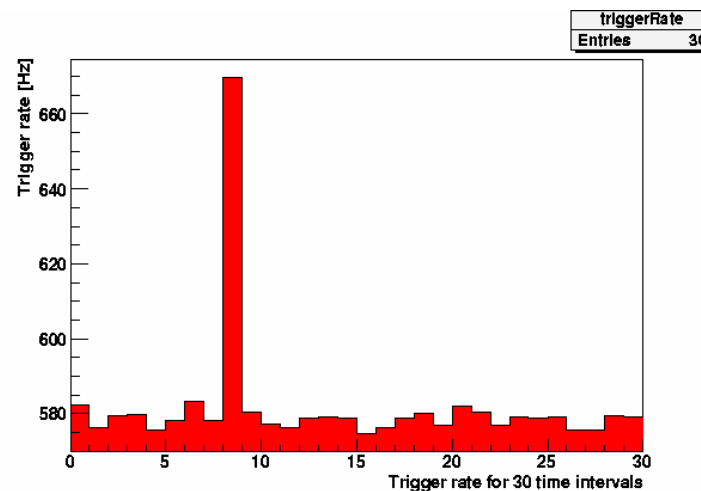
Digi Data Samples (Continued)

Trigger rate vs time

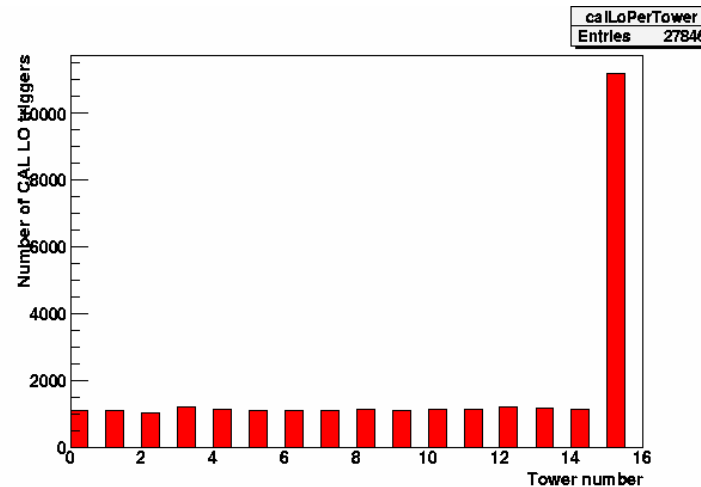
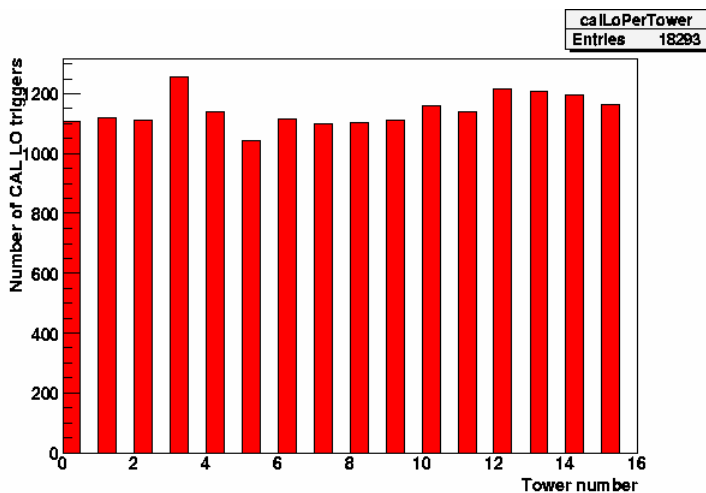
Run 77014940

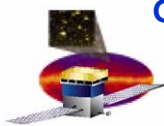


Run 77014941



Triggers vs tower

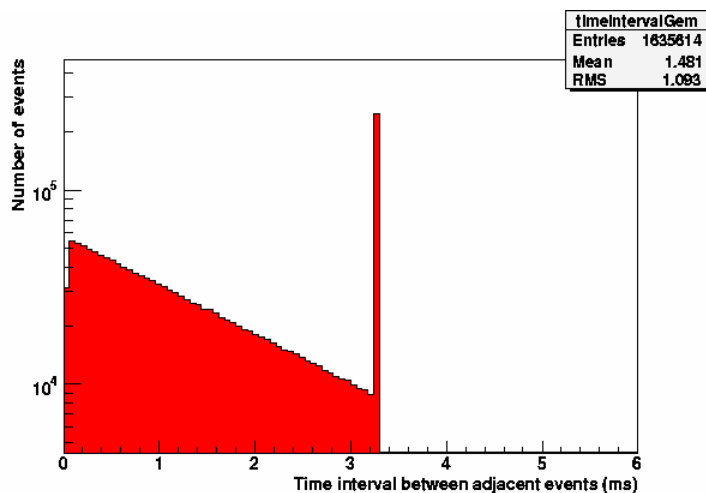




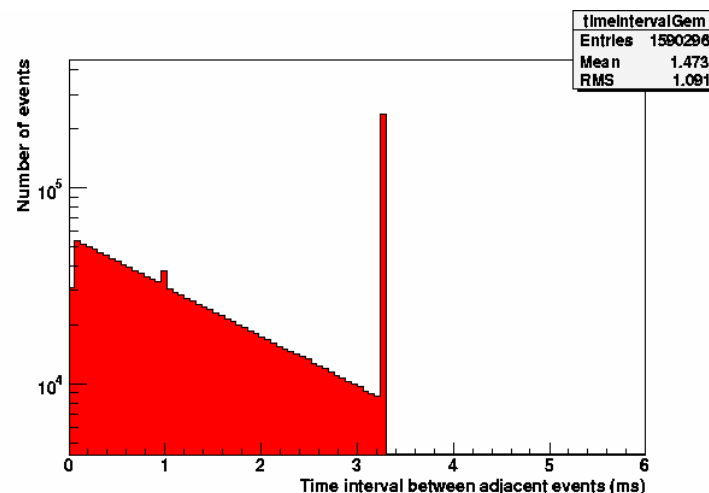
Digi Data Samples (Continued)

Time between adjacent events

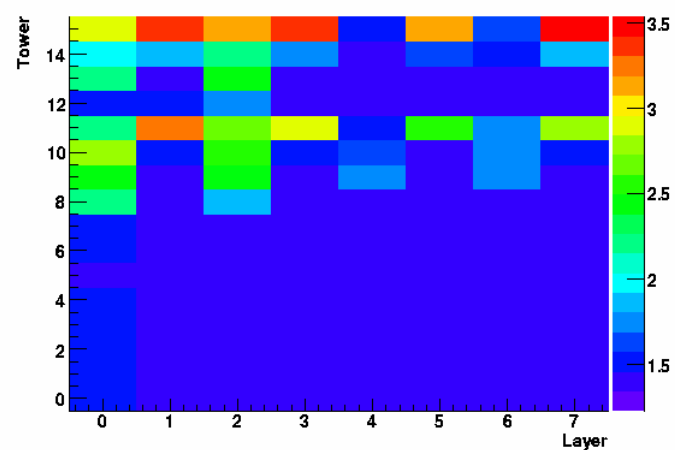
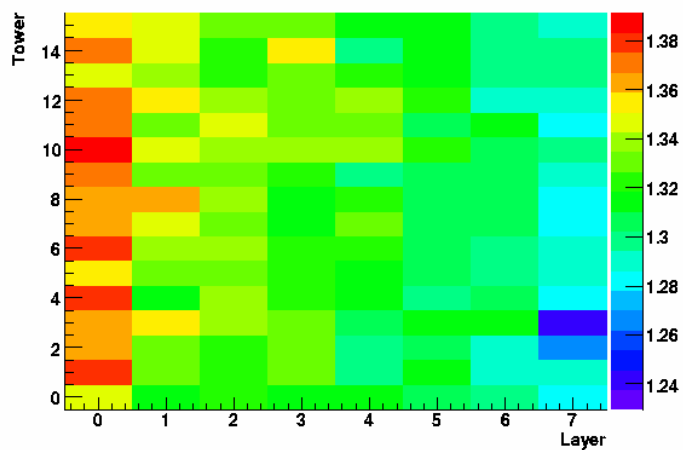
Run 77014940



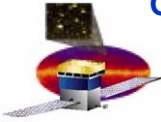
Run 77014941



Average number of hits per layer

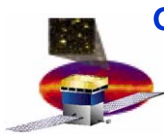


NCRs and waivers



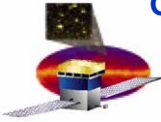
Summary

- **LAT data review is complete**
- **Two acceptable EMI susceptibilities were detected and documented**
- **Several other non EMI related issues were documented**
- **OK to break configuration**



NCR Summary Status

Closure Plan	Definition	Count
Work continuing		
QAR	CND or other issue transferred to a QAR	9



LAT Level Verification Status

Category	Verification Method					Totals	
	Test	Demo	Analysis	Inspection	Children	Complete	% Comp
	# Comp	# Comp	# Comp	# Comp	# Comp		
Requirement Identified	120	73	206	37	22	458	100.0%
Flow Down Complete	120	73	206	37	22	458	100.0%
Draft Verification Plans	120	73	206	37	22	458	100.0%
Final Verification Plans	120	73	206	37	22	458	100.0%
Verification Plans Executed	102	63	194	35	16	410	89.5%
Verification Reports Submitted	102	63	194	35	16	410	89.5%
Requirements Sold	100	63	191	35	16	405	88.4%
Expect Compliance	0	0	0	0	0	0	0.0%
Verifications Plan Deferred	18	10	12	2	6	48	10.5%
Requirements Issues	0	0	0	0	0	0	0.0%
Total VPs	120	73	206	37	22	458	

- **Progress this month**
 - All 458 VPs are Final
 - All VPs planned for execution to this point have been performed
 - 410 VPs have been executed to date
 - 405 VPs approved and 5 VPs conditionally approved by GSFC
 - Two reopened to add details, closure plan in place
- **Status**
 - VCRM version 25 released
 - All deferred GRB reqts will be sold post FSW B1.0 installation

NCRs and Waivers