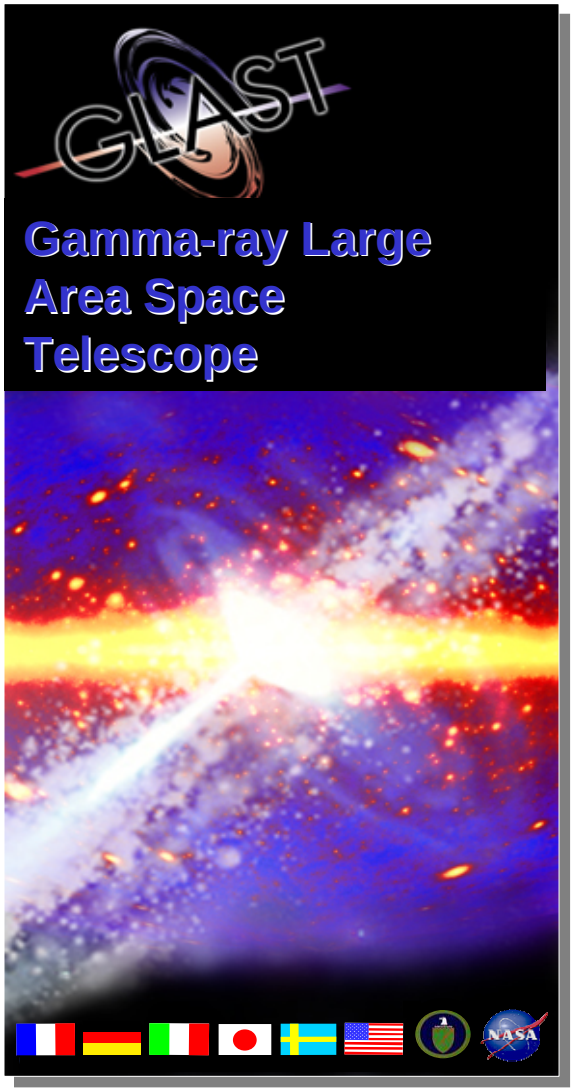

GLAST Large Area Telescope

Pre-Environmental Test Review

EMI/EMC

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NRL

Purpose / Contents

- Demonstrate readiness to proceed with EMI/EMC testing of the integrated flight instrument, i.e. the LAT:
  - Test requirements are complete
  - LAT has been appropriately tested at lower levels of assembly
  - Passes comprehensive systems test
  - EMI/EMC test plans and procedures complete
  - Facilities readiness and certification verified
  - STE and MGSE complete, fabricated, and ready for use
  - Manpower is sufficient to cover all planned for activities

Requirements complete

- All flight system design analyses and unit testing have been successfully completed
  - Mission System Spec → 433-SPEC-0005
    - EMI Environments
  - LAT Environmental Requirements Spec → LAT-SS-00778
    - EMI Environments
  - LAT Performance Verification Plan → LAT-MD-00408-04c
    - Verification test definition
  - EMI Test Plan → LAT-MD-02726-01

- LAT EMI-specific operating modes have been defined
  - LICOS scripts and supporting displays are identified and in development

Subsystem EMI/EMC Test Summary

		RE101	RE102	CE101	CECM	CS102	CS06	RS101	RS103	St. Mag	
TKR											
	ProtoFlight	X	X	X	X	X	X	X	X	X	0
	Flight (Acpt)			X		X					0
CAL											
	ProtoFlight	X	X	X	X	X	X	X	X	X	0
	Flight (Acpt)			X		X					0
ACD											
	Qual BEA	X	X	X	X	X	X	X	X	X	
	ProtoFlight										(a)
T&DF											
	Qual	X	X	X	X	X	X	X	X	X	3(b)
	Flight (Acpt)			X		X					0
Mech (Radiators)											
	ProtoFlight		X								(c)

(a) ACD Subsystem EMI testing Waivered - LAT-XR-06733

(b) Qual TEM/TPS, GASU exceeded radiated emissions spec (RE102) in S band, GPS notch; HCB exceeded CECM spec

(c) Radiator subsystem test of VCHP heater power source deferred to LAT level configuration

Radiator Subsystem EMI/EMC Issue

- **VCHP heater Radiated Emissions testing**
  - **S/C power source for LAT VCHP heaters is an unfiltered DC-DC converter.**
  - **Concern is the conducted noise for this power source will become radiated emission issue for LAT system test.**
  - **This issue shall be resolved by special subsystem (Radiator) test – RE102 – using simulated S/C power source.**
  - **The test will be performed just prior to LAT system EMI/EMC test.**
  - **Preliminary testing of this at SLAC gives reasonable confidence that there is no significant issue here.**

LAT EMI Test

LAT test levels derived from LAT-SS-0778

- **Test Suite:**
  - CE102 Conducted Emissions, Power Leads, 10 kHz to 10 MHz, MIL-STD-462, CE03
  - CECM & CEDM Conducted Emissions, Time Domain, 150 MHz Bandwidth
  - CS102 Conducted Susceptibility, Power Leads, 10 kHz to 10 MHz, MIL-STD-462, CS02
  - CSCM Conducted Susceptibility, Common Mode, 30 Hz to 150 MHz, MIL-STD-462, CS02
  - CS06 Conducted Susceptibility, Spike, Power Leads, MIL-STD-462
  - RE101 Radiated Emissions, Magnetic Field, 20 Hz to 50 kHz
  - RE102 Radiated Emissions, Electric Field, 10 kHz to 18 GHz, MIL-STD-461E
  - RS101 Radiated Susceptibility, Magnetic Field, 20 Hz to 50 kHz
  - RS103 Radiated Susceptibility, Electric Field, 30 MHz to 18 GHz
- **Verify by Analysis:**
  - RS103 Radiated Susceptibility, Electric Field, 18 GHz to 40 GHz
  - Static Magnetic Field

LAT Power Interfaces

- **SC-LAT Power Interfaces**
  - SC PRU (P) - LAT PDU
  - SC PRU (R) - LAT PDU
  - SC PRU (P) - LAT SIU (P)
  - SC PRU (R) - LAT SIU (R)
  - SC PRU (P) - LAT VCHP +Y Heaters
  - SC PRU (P) - LAT VCHP –Y Heaters
  - SC PRU (R) - LAT VCHP +Y Heaters
  - SC PRU (R) - LAT VCHP –Y Heaters
  - SC PDU (P) - LAT Makeup Heaters (Survival)
  - SC PDU (R) - LAT Makeup Heaters (Survival)

Heater circuit power interfaces are not tested.

Test Limitations

- RS103 upper limit of 18GHz (40GHz)
  - 18 – 40 GHz addressed by analysis.
- Limited area of RS101 test
  - Requires scanning each 10cm x 10cm area, ~16min/scan
  - ~1450 scans for the LAT, another ~1200 for the radiators (~29 days)
  - Scan selected locations around connectors, PMTs, BEA
- Redundant side testing limited to Conducted Emissions (CE102) and Conducted Susceptibility (CS102)

Test Sequence

- Radiator EMI test
- Radiated Emissions
- Radiated Susceptibility
  - Allows maximum time to evaluate data off line before EMI complete
- Primary side Conducted Emissions and Susceptibility
  - Organized to minimize required LAT power cycles
- Redundant side Conducted Emissions and Susceptibility
  - Organized to minimize required LAT power cycles
- Time for power cycle is important
  - Non-optimized CE/CS testing requires 32 LAT power on/off cycles

CE & CS Tests

Test	System	Primary	Red.	Bands	Power cycles
CE102	SIU	+28, Ret.	+28, Ret.	1	4
CE102	DAQ	+28, Ret.	+28, Ret.	1	4
CECM	SIU	+28-Ret.		1	1
CECM	DAQ	+28-Ret.		1	1
CEDM	SIU	+28-Ret.		1	1
CEDM	DAQ	+28-Ret.		1	1
CS102	SIU	+28, Ret.	+28, Ret.	2	8
CS102	DAQ	+28, Ret.	+28, Ret.	2	8
CS06	SIU	+28-Ret.		1	1
CS06	DAQ	+28-Ret.		1	1
CSCM	SIU	+28-Ret.		1	1
CSCM	DAQ	+28-Ret.		1	1
Total		16	8		32

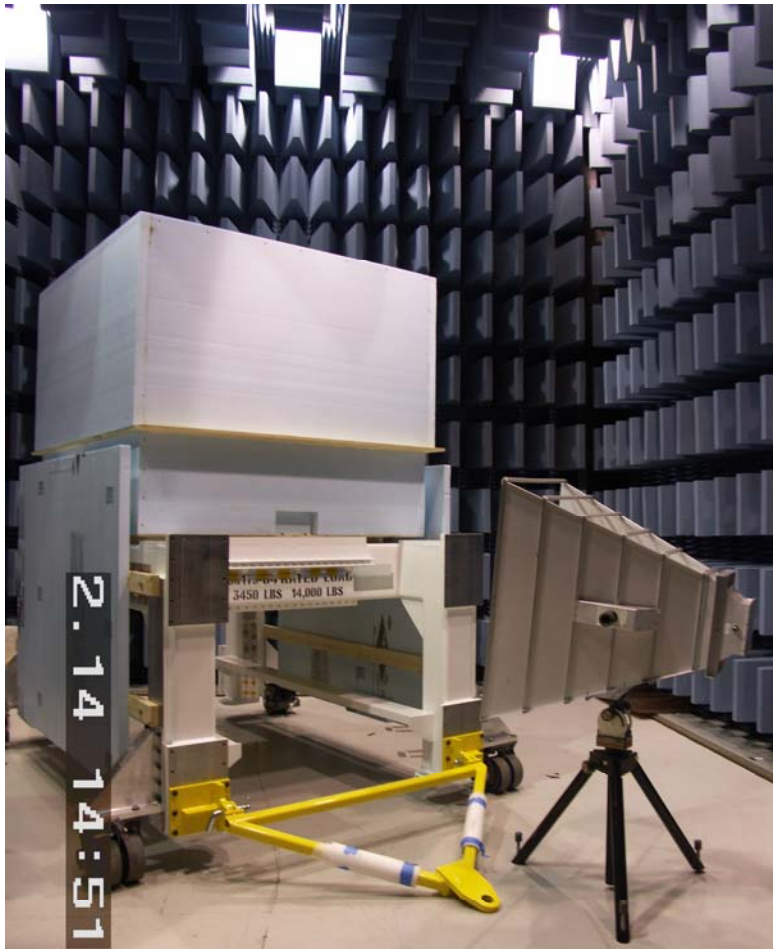
Test Durations

- Times include test time includes EMI facility set up and calibration, overhead for LAT ops is estimated separately
  - Schedule allows 11 days or 132 hours

Test	Duration (hrs)	# of cable configs.	LAT overhead	Total test time (hrs)
CE102	6	2	25% + 0.5	19
CECM	6	1	“	7
CEDM	6	1	“	7
CS102	8	2	50% + 0.5 h	32
CSCM	6	1	“	10
CS06	6	1	“	10
RE101& 103	6	1	25% + 0.5 h	8
RS101& 103	16	1	50% + 0.5 h	24
Rad Test	12	1	0%	12
Total				129

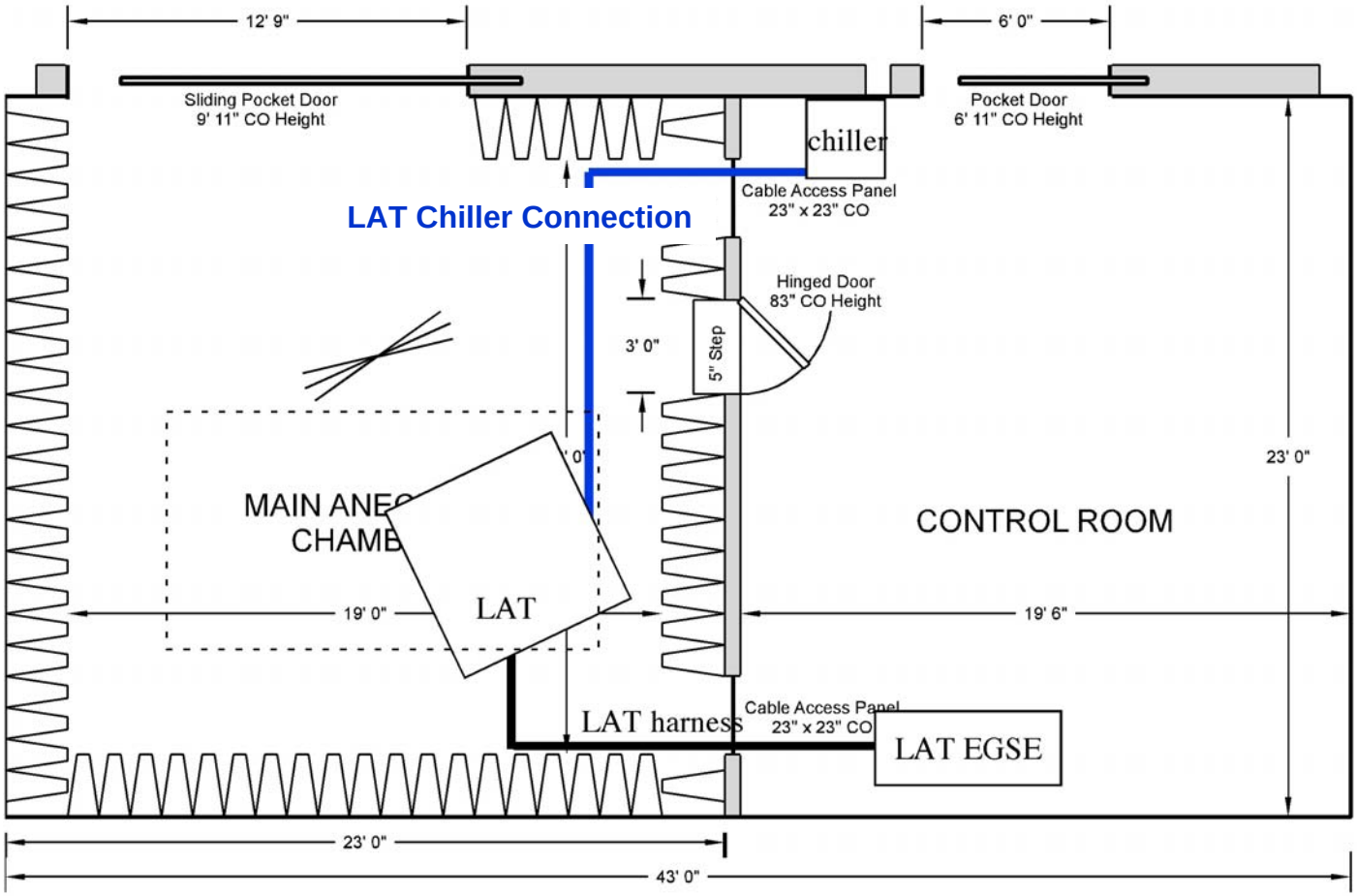
EMI Test Configuration

- Performed in NRL anechoic chamber
  - ESD coverings will be removed from sides during active radiated testing. Bags in place for conducted tests, transport and inactive periods. The top of the LAT will remain covered at all times.
  - GN2 purge to control humidity
  - Active cooling w/ LAT chiller system



Path finder of LAT instrument on the test stand in NRL's anechoic chamber

Test Layout


12' 9"
6' 0"
Sliding Pocket Door
9' 11" CO Height
Pocket Door
6' 11" CO Height
chiller
Cable Access Panel
23" x 23" CO
LAT Chiller Connection
Hinged Door
83" CO Height
3' 0"
5" Step
23' 0"
MAIN ANE
CHAME
CONTROL ROOM
19' 0"
LAT
19' 6"
LAT harness
Cable Access Panel
23" x 23" CO
LAT EGSE
23' 0"
43' 0"

Conducted Test Considerations

- Fully test Primary:
  - SC PRU (P) - LAT PDU (P)
  - SC PRU (P) - LAT SIU (P)
- Limited test of Redundant: (CE102, CS102)
  - SC PRU (R) - LAT PDU (R)
  - SC PRU (R) - LAT SIU (R)
- No plan to test PDU - LAT Survival Heaters
  - Thermostatic control, open circuit at LAT operating temp
  - Not active with LAT operating in Mission
- No plan to test PRU - VCHP Heaters

Test Harnesses

- Radiated testing will used nominal EGSE cables
  - Harness is fully shielded
    - Includes all connector savers
    - All test ports are closed out
  - Fly away test harnesses are shielded
    - Accelerometers
    - TCs & thermistors

- Breakout cables required for conducted emissions testing
  - LAT-DS-06531 LSC to RF shield, SIU power
  - LAT-DS-06530 BPU PNL to LSC, SIU power
  - LAT-DS-06528 BPU PNL to LSC, LSC to DAQ, DAQ power

Test Software

- **Emissions Testing – Script # LAT-171**
  - **LAT configured to collect muons with additional periodic trigger to appropriately populate the T&DF data flow and science data stream to the VSC.**
- **Susceptibility Testing – Script # LAT-181:**
  - **LAT configured to collect muons with CAL triggers (flight level) and ACD vetos enabled.**
  - **Susceptibility monitoring**
    - **TKR event occupancy**
    - **CAL pedestal widths (noise) and trigger rates**
    - **ACD pedestal widths (noise) and veto rates**
    - **T&DF commanding and data flow errors**
  - **Real time monitoring**
    - **Strip chart of LAT trigger rate and deadtime**
    - **Diagnostic error messages**
  - **Post processing**
    - **Global TKR occupancy vs time**
    - **Global CAL, ACD pedestal widths vs time**
    - **Correlate post processing events with log of frequency vs time**

Personnel

- EMI/EMC Test Director - Michael Lovellette
- EMI/EMC Facility Operations
  - Mike Obara - Test Conductor
  - Tony Grey - Test Conductor

- LAT Instrument Operations
  - Brian Grist – Operations Lead
  - Standard LAT I&T Operators and Online analysis support
  - Anders Borgland – Offline instrument analysis lead
  - Elliott Bloom – LAT181 analysis lead

EMI/EMC Test Summary

- **Ready to test**
  - **Facility ready to support test**
  - **No outstanding issues with subsystem testing except completion of radiator VCHP heater CS / RE verification**
  - **Supporting analyses for static magnetic field have been accepted by Blanchette for GLAST project**
  - **Supporting analysis for RS103 18 – 40 GHz performance is in progress.**
    - **All subsystems except ACD are complete.**