Integration, Test, and Calibration

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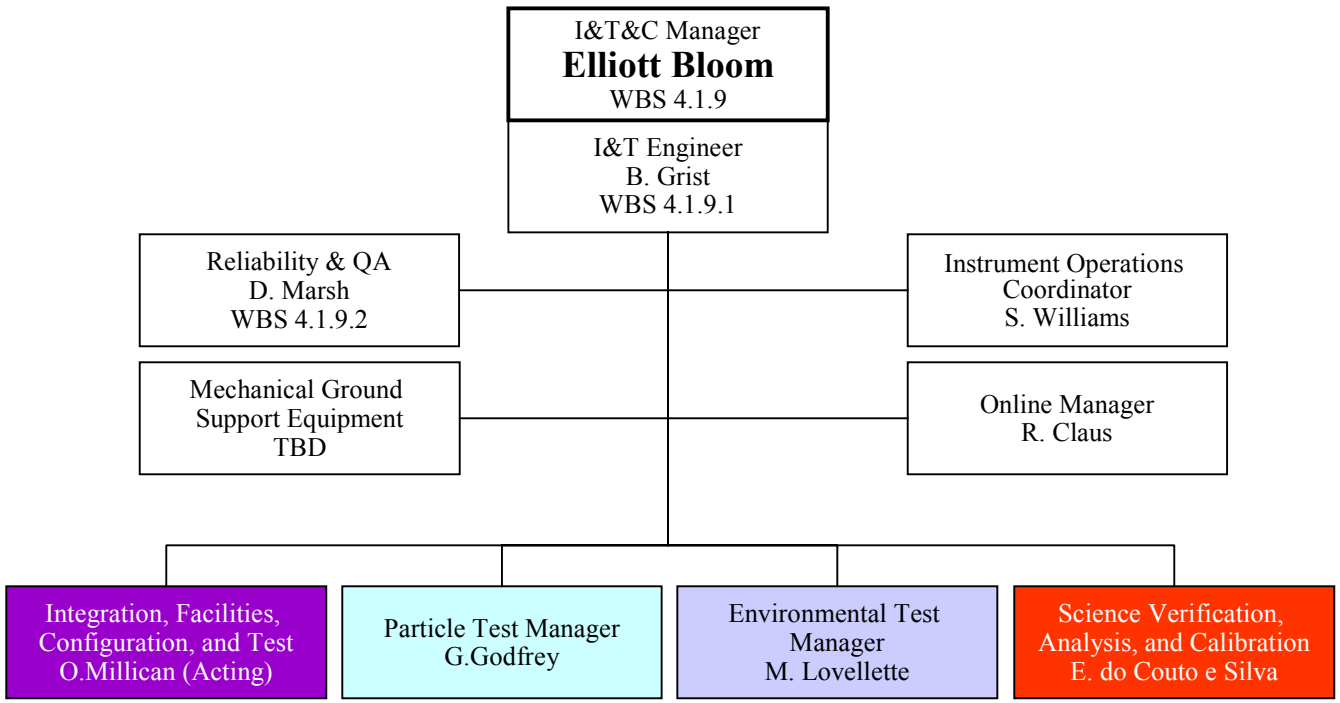
I&T&C Organization Chart



I&T Preparation 4.1.9.3	I&T Preparation 4.1.9.3	I&T Preparation 4.1.9.3	I&T Preparation 4.1.9.3
EM1 Model I&T&C	EM1 Model I&T&C		EM1 Model I&T&C
Calibration Unit I&T 4.1.9.4	Calibration Unit I&T 4.1.9.4		Calibration Unit I&T 4.1.9.4
Flight LAT I&T 4.1.9.6	Flight LAT I&T 4.1.9.6	Flight LAT I&T 4.1.9.6	Flight LAT I&T 4.1.9.6
Mission I&T Support 4.1.9.7	Mission I&T Support 4.1.9.7	Mission I&T Support 4.1.9.7	Mission I&T Support 4.1.9.7

Integration and Test Subsystem Work Breakdown

- 4.1.9.1 I & T Management
  - Coordinate I & T planning
  - Develop LAT I & T plan, to ensure flow of verification test activities
- 4.1.9.2 Reliability and Quality Assurance
  - Collect subsystem verification test results
  - Manage LAT verification test assurance activities
- 4.1.9.3 I & T Preparation - Integration, Facilities, Configuration, and Test, Particle Test, Environmental Test, Science Verification Analysis, & Calibration.
- Prepare LAT I & T facilities
  - Develop calibration equipment
  - Develop Verification matrix and particle test plan
  - Develop environmental test plan
  - Develop Calibration plan

Integration and Test Subsystem Work Breakdown - 2

- **EM1 Model I&T&C-Integration, Facilities, Configuration, and Test, Particle Test, Science Verification Analysis, & Calibration.** (Currently no funding)
  - **Coordinate I&T&C tests with subsystem tests.**
  - **Use subsystem calibration data to tune up I&T&C calibration program.**
  - **Run cosmic rays on "assembled" EM1-EM2 unit at SLAC.**
- **4.1.9.4 Calibration Unit I & T -Integration, Facilities, Configuration, and Test, Particle Test, Science Verification Analysis, & Calibration.**
  - **–Prepare for and integrate Calibration flight modules.**
  - **–Prepare for and test QU with cosmic rays, positron, photon, and hadron beams.**
  - **– Produce LAT calibration products for SAS from QU beam data.**
- **4.1.9.6 Flight LAT I&T- Integration, Facilities, Configuration, and Test, Particle Test, Environmental Test, Science Verification Analysis, & Calibration.**
  - **–Prepare for integration of flight LAT; fabricate and test all mechanical GSE**
  - **–Mechanically integrate flight LAT**
  - **–Plan for and execute environmental verification testing**
  - **–Support planning and execution of Observatory I&T**

Integration and Test Subsystem Work Breakdown - 3

- 4.1.9.7 Mission I&T Support- Integration, Facilities, Configuration, and Test, Particle Test, Environmental Test, Science Verification Analysis, & Calibration.

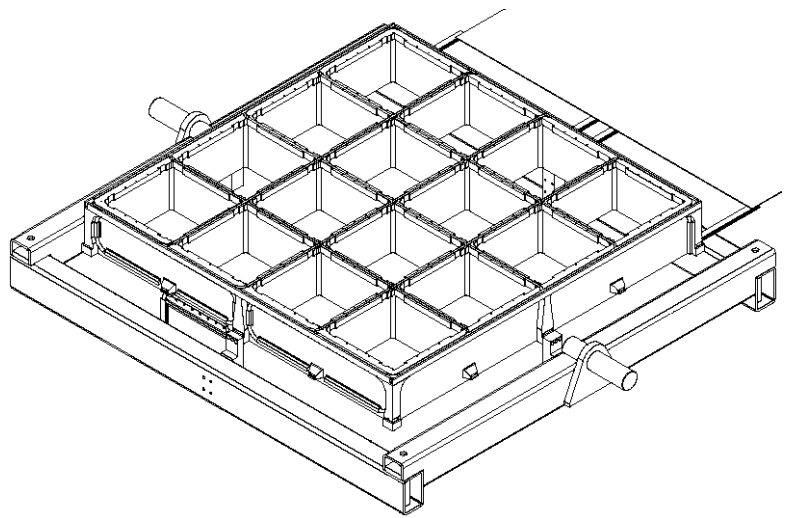
Produce a Working Instrument!

Integration, Test, and Calibration Activities

- I & T "subsystem" is focal point of LAT integration activities
  - I & T & C team plans and manages activities.
  - TKR, CAL, and ACD subsystem teams provide support for Integration & Calibration.
- Total effort involves:
  - I & T & C Subsystem
    - LAT integration planning and management.
    - Mechanical integration and GSE and EGSE development.
    - Plan Environmental tests and Execute.
    - Calibration particle beam and test equipment development.
    - Ground Verification and Calibration of LAT.
    - Commissioning of LAT in orbit.
    - Deliver a Working Instrument to IOC.
  - Mechanical Systems
    - Environmental test support.
    - LAT qualification testing analysis.
  - Electronics and Data Acquisition
    - LAT electrical integration.
    - Performance test planning and execution.
    - Flight software verification testing.
  - IOC Electrical GSE development, including calibration DAQ system
    - LAT performance test planning.
    - EGSE, and GSE operations and support during LAT I & T & C.
  - Science Analysis Software
    - Calibration analysis software development.

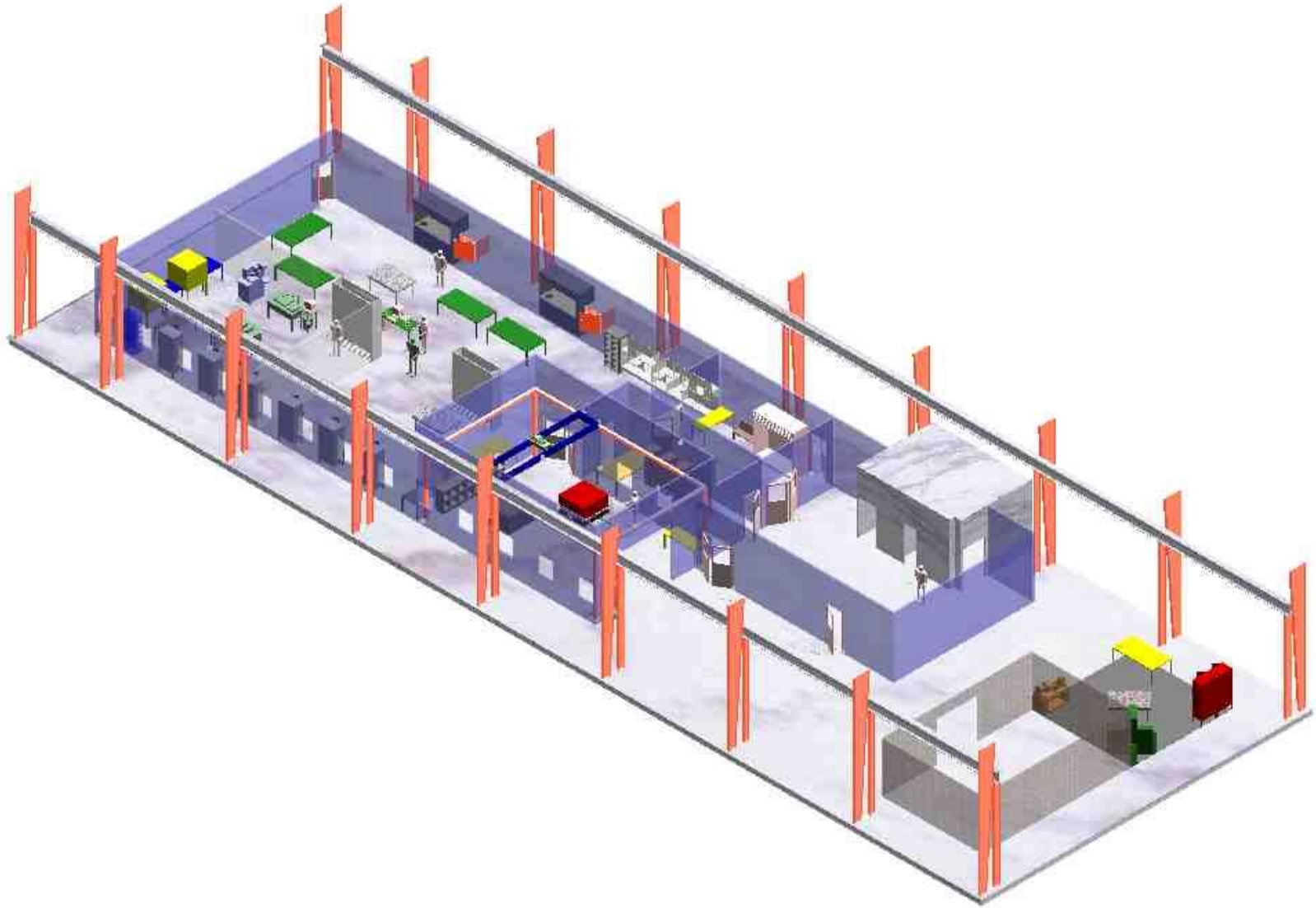
Integration Planning Activities

- **LAT integration planning**
  - Planning for subsystem integration has been included in development of interfaces and LAT design integration
  - Developing concepts for integration EGSE and GSE.
- **LAT integration facilities**
  - New clean room facilities have been built at SLAC for GLAST
  - Facilities include I&T infrastructure
    - Clean room with high bay
    - Storage for flight hardware
- **Environmental Tests**
  - LAT thermal tests at SLAC.
  - Full suite of environmental tests at NRL.
- **Observatory integration support**
  - I&T&C team has been involved with mission in investigating options for observatory integration.
  - LAT and observatory require combined EGSE, GSE and coordinated plans environmental test plans.

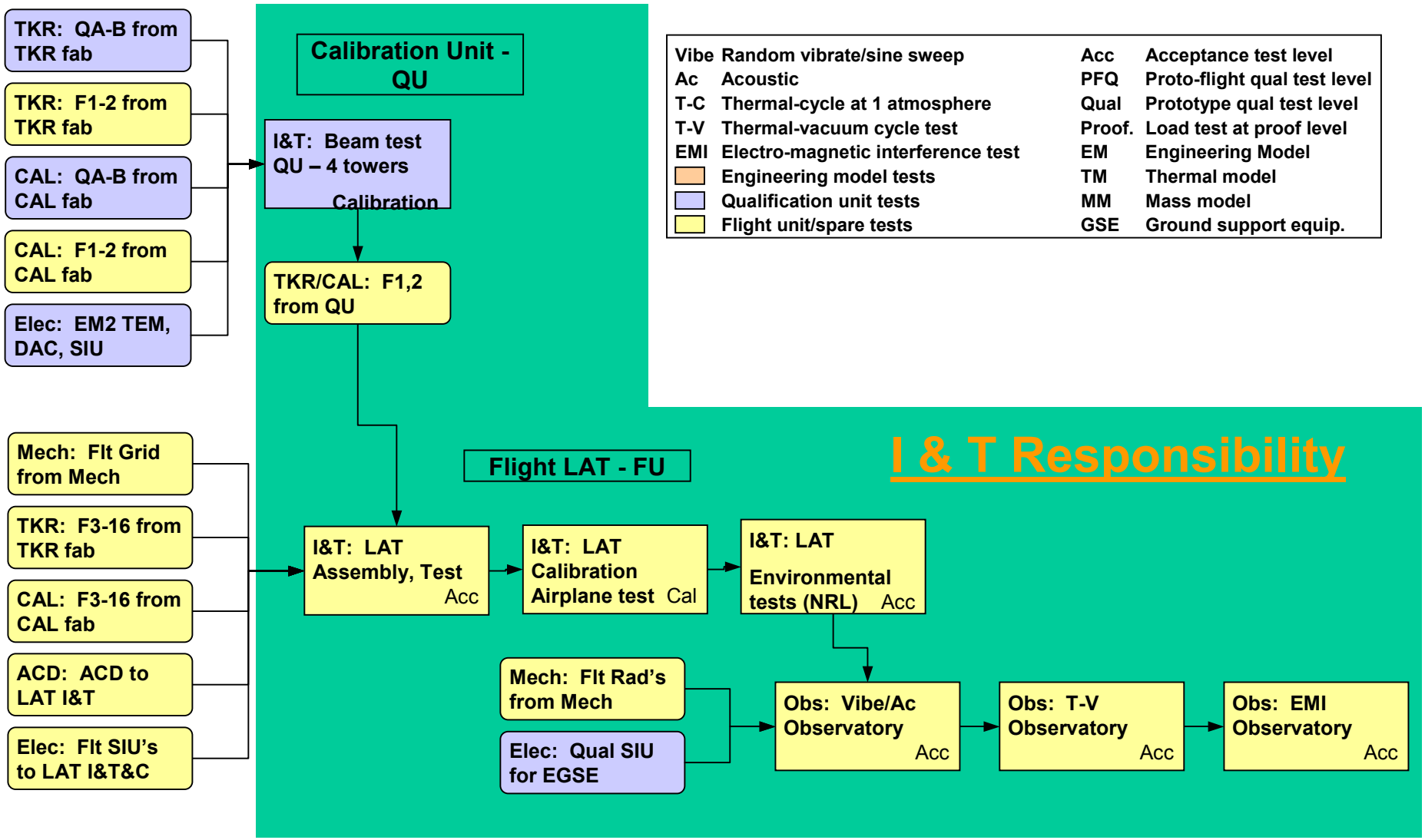


Concept of LAT Integration Frame

Integration and Test Facility at SLAC

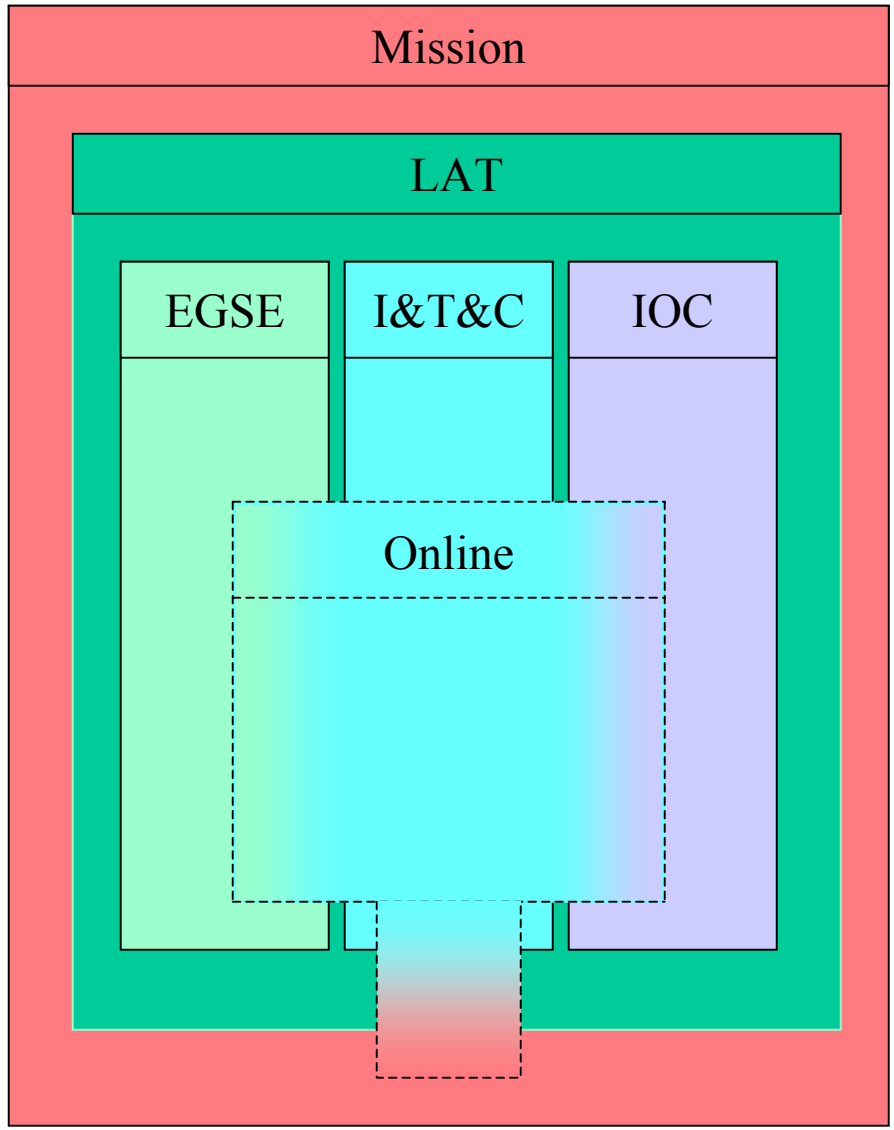


LAT I&T&C Verification and Calibration Flow

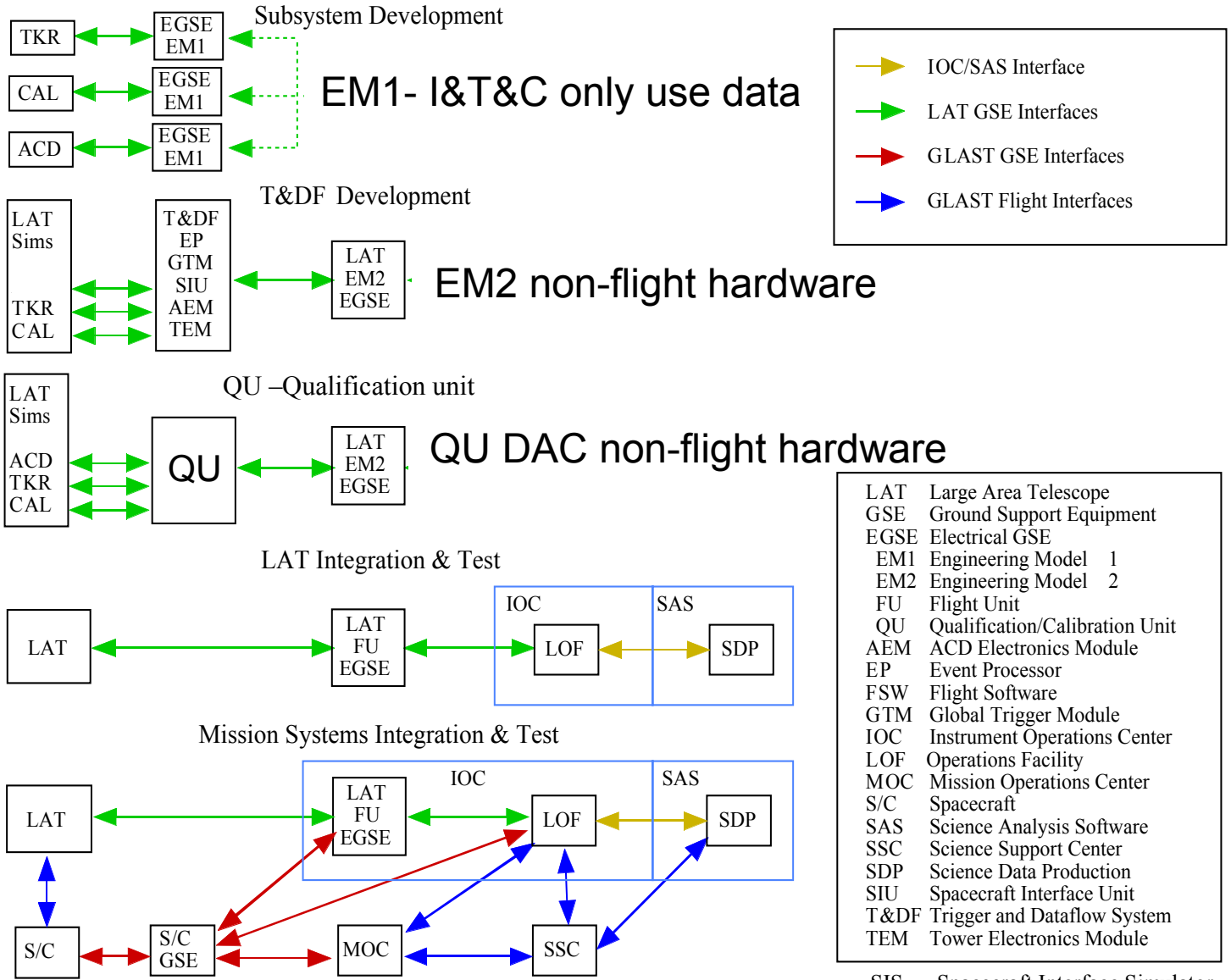


EGSE Areas of Responsibility

- **GLAST Mission**
  - Scott Lambros
- **LAT**
  - Large Area Telescope
    - Peter Michelson
- **EGSE**
  - Electronics Ground Support Equipment
    - Gunther Haller
- **I&T&C**
  - Integration and Test and Calibration
    - Elliott Bloom
- **IOC**
  - Instrument Operation Center
    - Scott Williams

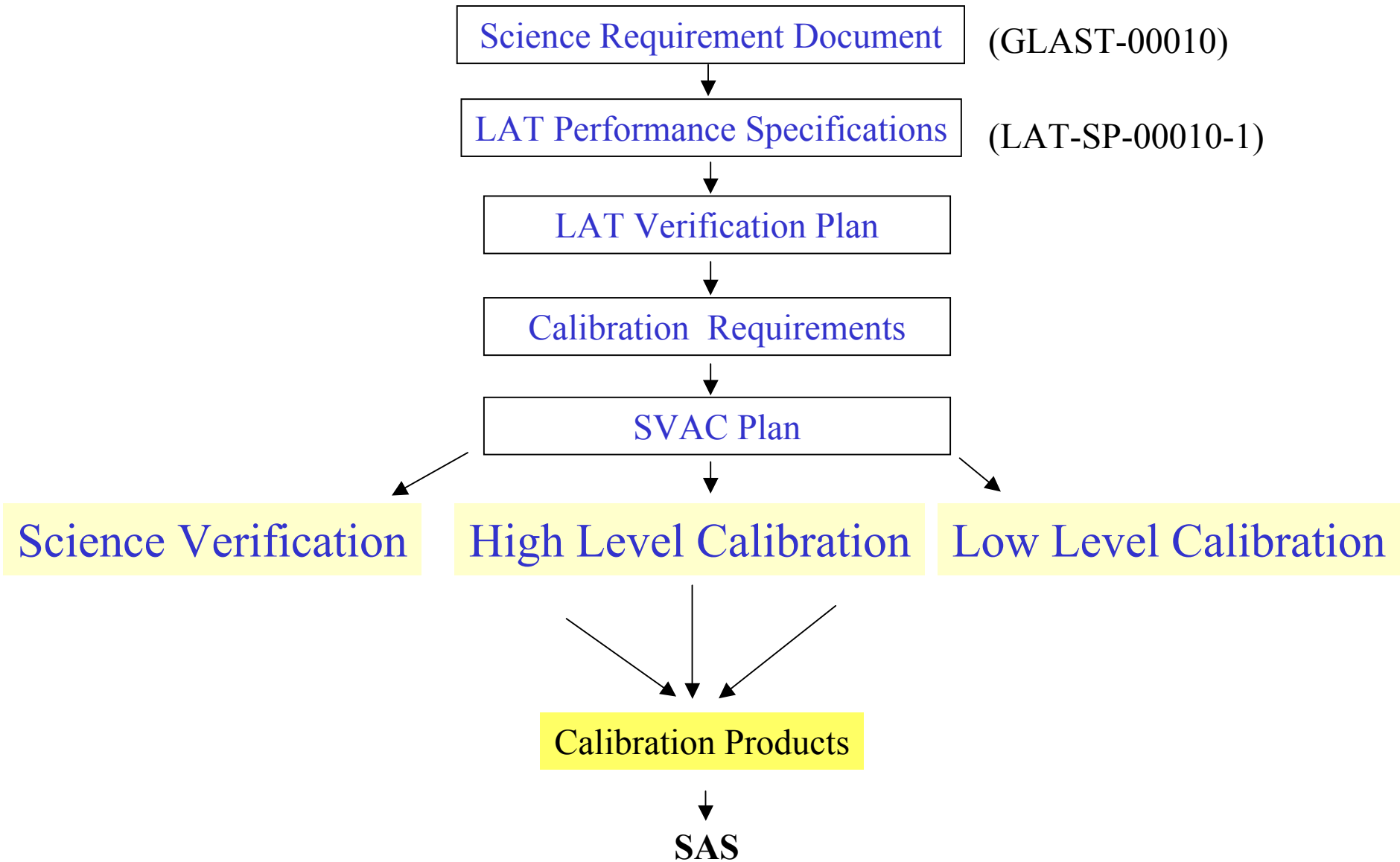


Tests & EGSE Configurations



LAT	Large Area Telescope
GSE	Ground Support Equipment
EGSE	Electrical GSE
EM1	Engineering Model 1
EM2	Engineering Model 2
FU	Flight Unit
QU	Qualification/Calibration Unit
AEM	ACD Electronics Module
EP	Event Processor
FSW	Flight Software
GTM	Global Trigger Module
IOC	Instrument Operations Center
LOF	Operations Facility
MOC	Mission Operations Center
S/C	Spacecraft
SAS	Science Analysis Software
SSC	Science Support Center
SDP	Science Data Production
SIU	Spacecraft Interface Unit
T&DF	Trigger and Dataflow System
TEM	Tower Electronics Module
SIS	Spacecraft Interface Simulator
IPS	Instrument Power Supply

Science Verification, Analysis and Calibration (SVAC) System



SVAC Data

(being reviewed by subsystems)

Science verification

Effective Area
Energy Resolution
Point Spread Function
Field of View
Time Accuracy
Background Rejection
Deadtime
Source Location
Point Source Sensitivity
GRB,AGN location
GRB,AGN notification time

High Level Calibration

Subset of performance calibrations

ACD
- **Detection Efficiency (CT1)**
- **High Threshold detection (CT2)**

TKR
- **Single Tower Alignment (CT4)**
- **Multiple Tower Alignment (CT5)**
- **LAT & Observatory Alignment (CT6)**

CAL
- **PIN Diodes Optical Gain (CT10)**
- **Light Attenuation (CT11)**
- **Light Asymmetry (CT12)**

Low Level Calibration

Subset of baseline calibrations

ACD
- **Pedestals (CT3)**

TKR
- **Noisy Strips (CT7)**
- **Dead Strips (CT8)**
- **Time-Over-Threshold (CT9)**

CAL
- **Pedestals (CT13)**
- **Energy range: Electronic Gain (CT14)**
- **Energy range: Electronic Gain Occupancy (CT15)**
- **Energy range: Integral non linearity (CT16)**
- **Energy range: Differential non linearity (CT17)**

Particle test Verification Matrix

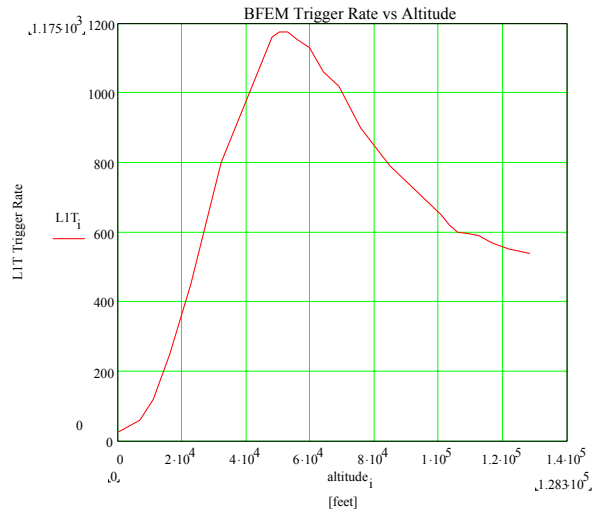
- **Requirements flow down from**
  - **LAT Science Requirements Document – Level II Specification LAT-SS-00010-1 (found in LAT-SS-9.1)**
  - **Summarized by the Instrument Scientist (Steve Ritz)**

Parameter	Constraint	Requirement	Goal	Proposed Verification (all statistics are TBR)	Spec Ref	Beam Tests that do the Verification
A_{eff}	20 MeV	> 300 cm^2	> 1000 cm^2	Sim, BT (>10,000 tagged photon triggers at 20±5 MeV, normal incidence)	5.2.1	1) Chan rad, 20 and 50 Mev γ, norm incid 2) Van de Graf 17.6 Mev γ 3) Brem beam, simultaneously all γ energy bins from 20 Mev to 30 Gev, variety of angles and tranverse positions.
	100 MeV	> 3000 cm^2	> 8000 cm^2	Sim, BT (>5,000 tagged photon triggers at 100±10 MeV, normal incidence)	5.2.1	1) Coherent Brem, .1,.2,.5,1,2,5,10,30 Gev, norm incid 2) Brem beam, simultaneously all γ energy bins from 20 Mev to 30 Gev, variety of angles and tranverse positions.
	1,10 GeV	> 8000 cm^2	> 10,000 cm^2	Sim, BT (>1000 tagged photon triggers at 1±0.1 GeV and 10±1 GeV, normal incidence)	5.2.3	1) Coherent Brem, .1,.2,.5,1,2,5,10,30 Gev, norm incid 2) Brem beam, simultaneously all γ energy bins from 20 Mev to 30 Gev, variety of angles and tranverse positions.
	300 GeV	> 6400 cm^2		Sim, BT (>1000 tagged photon triggers at 10±1 GeV, then extrapolate. Simulations must match measured backsplash rates to better than 10% -- earlier measurements must be reviewed and, if necessary, another set of measurements must be made.)	5.2.1	
	1 TeV		> 9500 cm^2	Sim, as 300 GeV case above.	5.2.1	
A_{eff} knowledge (1σ)	20-50 MeV	< 50 %	< 20 %	Sim (compare the simulation predictions with the measured values for spec refs 5.2.1 and 5.2.3 above. Effective area below 100 MeV is changing rapidly, and this region must be mapped out carefully. Sim in 10 MeV bins)	5.2.4	
	50-300 MeV	< 25 %	< 10 %	Sim (as above)	5.2.4	

Cosmics in Airplane (Psuedo Balloon Flight for Complete Flight Instrument, but Even Better)

- **Full LAT in an airplane (during airplane ride to NRL thermal vac ?)**
- **L1T trigger rate measured in single tower during Balloon Flight**

Altitude [Ft]	BFEM L1T [Hz]	Notes
0	25	Ground
25,000	540	Same rate as in orbit
35,000	900	Airplane flight
50,000	1175	Pfotzer max
127,000	540	~Orbital rate



- **At 25,000 feet verify the flight hardware at orbital L1T rates**
  - **~25 (BFEM size towers) x 540 Hz = 13.5 kHz**
  - **DAQ doesn't crash**
  - **Software filter handles the rate and produces the expected downlink rate**
  - **Livetime is accurately measured**
- **At 35,000 feet test the flight hardware at > orbital L1T rates**
  - **~22 kHz saturates the LAT trigger**
  - **DAQ should not crash**

Environmental Test Matrix

	Fit / Dim Check	Struc Strength	Mass, C.G.	Mass Properties	Sine sweep	Random Vibe	Acoustic	Mechanical shock	Thermal Balance	Thermal Cycling	Thermal-Vacuum	EMC	Alignment	Pressure	Flight Qt'y	Flight Spares
Tracker																
Qual Trays	M	Proof	M		PFQ	PFQ	PFQ			PFQ	PFQ		M			10
Qual Module (TKR #1)	M	Proof	M	M	PFQ	PFQ					PFQ	PFQ	M	Ana		1
Trays	M		M			Acc				Acc			M		304	28+20
Modules (TKR #2-18)	M		M		Acc	Acc					Acc	Acc	M		16	1
Calorimeter																
Qual Module (CAL #1)	M	Proof	M	M	PFQ	PFQ					PFQ	PFQ	M	Ana		1
Modules (CAL #2-18)	M		M		Acc	Acc					Acc	Acc			16	1
Anti-Coincidence Detector																
ACD Flight Unit	M	Proof	M	M	PFQ	PFQ	PFQ				PFQ	PFQ	M	Ana	1	
Mechanical Systems																
Grid Structure	M	Proof	M												1	1
Heat Pipes	M									PFQ				Proof	34	4
Radiators	M	Proof	M		PFQ	PFQ	PFQ			PFQ	PFQ				2	
Qual. Grid Assembly	M	Proof	M		PFQ, MM	PFQ, MM				PFQ, TM						1
Flight Grid Assembly	M	Proof	M												1	
Grid Ass'y w/ Radiators									PFQ, TM		PFQ, TM				1	
Electronic Systems																
TEM, SIU, ACD Units	M		M		PFQ	PFQ					PFQ	PFQ		Ana	20	3
Cable Harness	M		M													
LAT Flight Unit	M		M	**M**		Acc	Acc		Acc	Acc	Acc	Acc	M	Ana	1	
GLAST Observatory			M	M	Acc		Acc	Acc				Acc	M		1	

LAT Modal Survey

Ana:	Analysis	Acc:	Acceptance-level testing	M:	Measure or Inspect
MM:	Test, using Mass Models	PFQ:	Protoflight Qual-level testing	S:	Test sample of total
TM:	Test, using Thermal Models	Qual:	Prototype Qual-level testing	Y:	Yes, this is performed
		Proof:	Test to Proof levels		

Rev date: 1 Oct 01

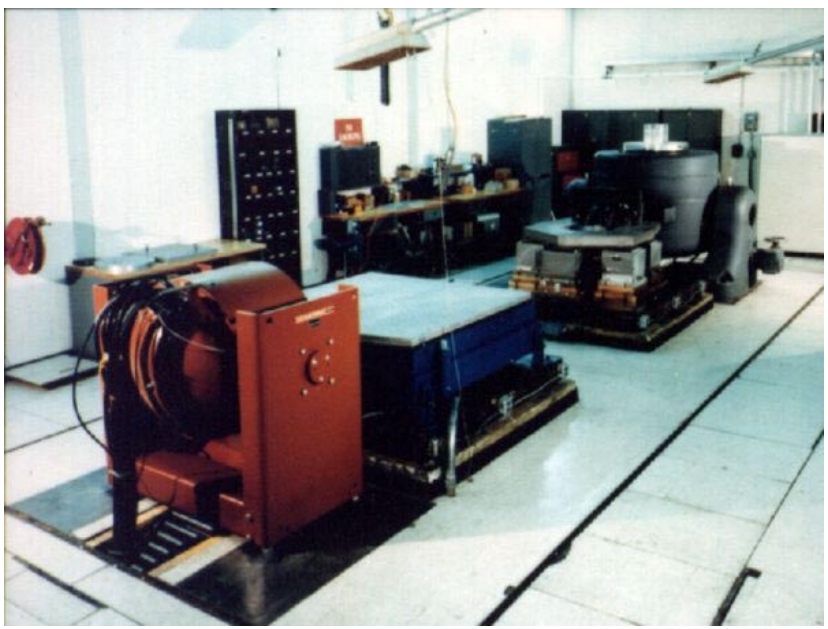
NRL Environmental Test Facility

- **Spacecraft Acoustic Reverberation Chamber**
  - Sound pressure level of 153 dB through a range of 32-10,000 Hz
  - 30,000-lb force electrodynamic vibration exciter

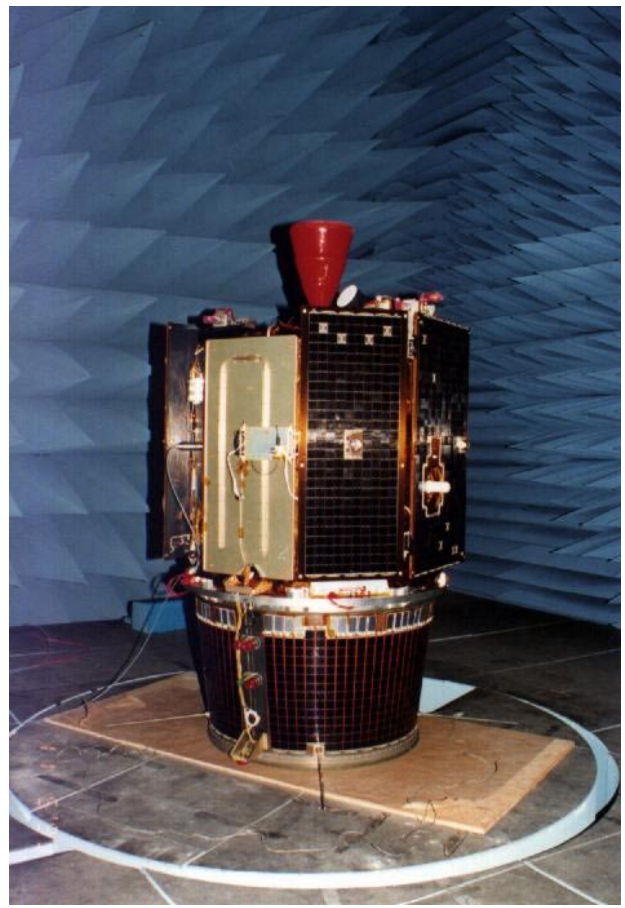
- **Thermal High-Vacuum Chamber Facility**
  - 18 ft diameter x 32 ft in length
  - Pressures below 1×10^{-6} Torr

NRL Environmental Test Facility

- **Spacecraft Vibration Test Facility**
  - Largest table: 35,000-lb Spacecraft Vibration Test Facility
  - Largest table: 35,000-lb continuous sine or rms random vibration output and 105,000-lb peak random vibration
  - Frequency range 5 to 2000 Hz



- **EMI Test Chamber**



prePDR Schedule

9:30 - 9:55 AM		Bloom Intro/Overview
9:55 - 10:10 AM		Grist - Top Level Cost Estimate, Top Level Schedule
10:10 - 10:30 AM		Marsh - QA/Reliability
10:30 - 10:50 AM		Claus - Online
10:50 - 11:10 AM		Williams - IOC Coordination
11:10 - 11:30 AM		Millican - Integration, Facilities, Configuration, and Test
11:30 - 11:40 AM	Break	
11:40 - 12:00 PM		Godfrey - Particle Test
12:00 - 12:20 PM		Lovellette - Environmental Test
12:20 - 12:40 PM		do Couto e Silva - Calibration, Analysis and Science Verification
12:40 - 12:50 PM		Bloom - Summary/Open issues and concerns.
12:50 - 1:30 PM	Discussion	