
STEREO
IMPACT
UCB - NASA/GSFC- Caltech - U of MD - LANL - JPL - UCLA - SAIC - NOAA/SEC
U of MI - JHU/APL - MPAe - U of Kiel - CESR/CNRS - ESA/ESTEC -
DESPA/OBSPM - KFKI/RMKI

IMPACT PER Agenda

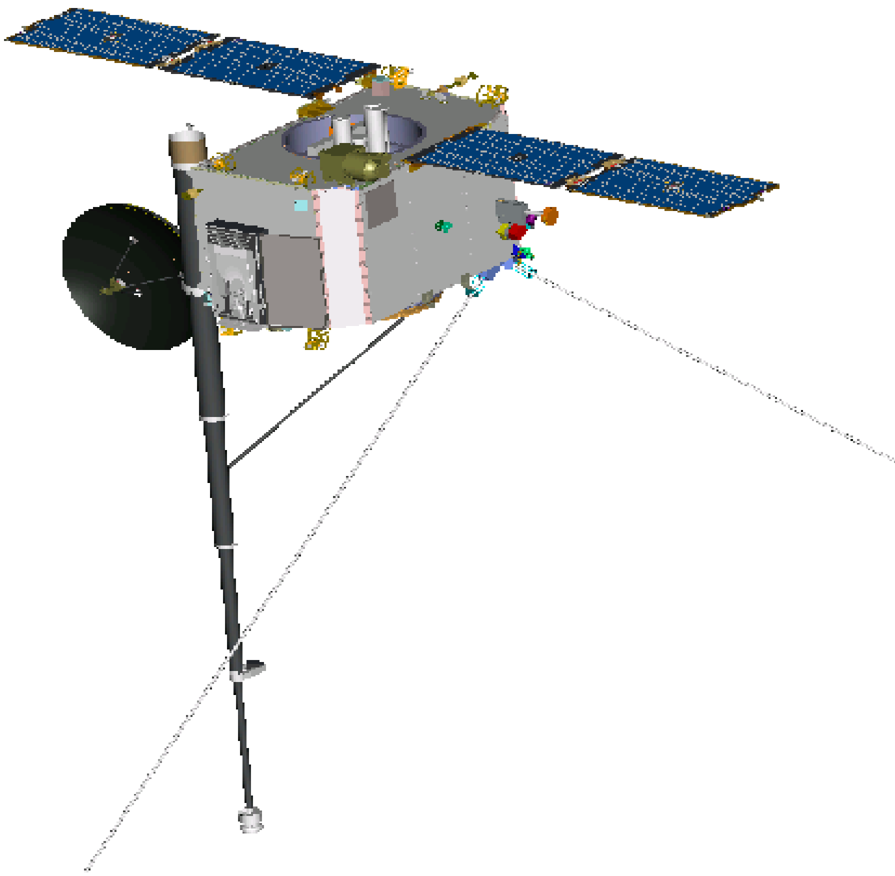
8:00	IMPACT Overview	Curtis
8:30	System Verification Plan	Curtis
9:00	STE-U	Curtis
9:30	SWEA/STE-D	Curtis / Aoustin
10:00	MAG	Curtis / Acuna
10:30	IDPU	Curtis
11:00	IMPACT Boom	McCauley
11:30	IMPACT Suite EMC	Curtis
12:00	Lunch	
1:00	SEP Suite	Cummings
1:30	HET/LET/SEP Central	Cummings / Tycho
2:00	SIT	Walpole
2:30	SEPT (Detailed)	Mueller-Mellin

IMPACT Overview

David Curtis (PM), UC Berkeley Space Sciences Lab,
dwc@ssl.berkeley.edu, (510) 642-5998

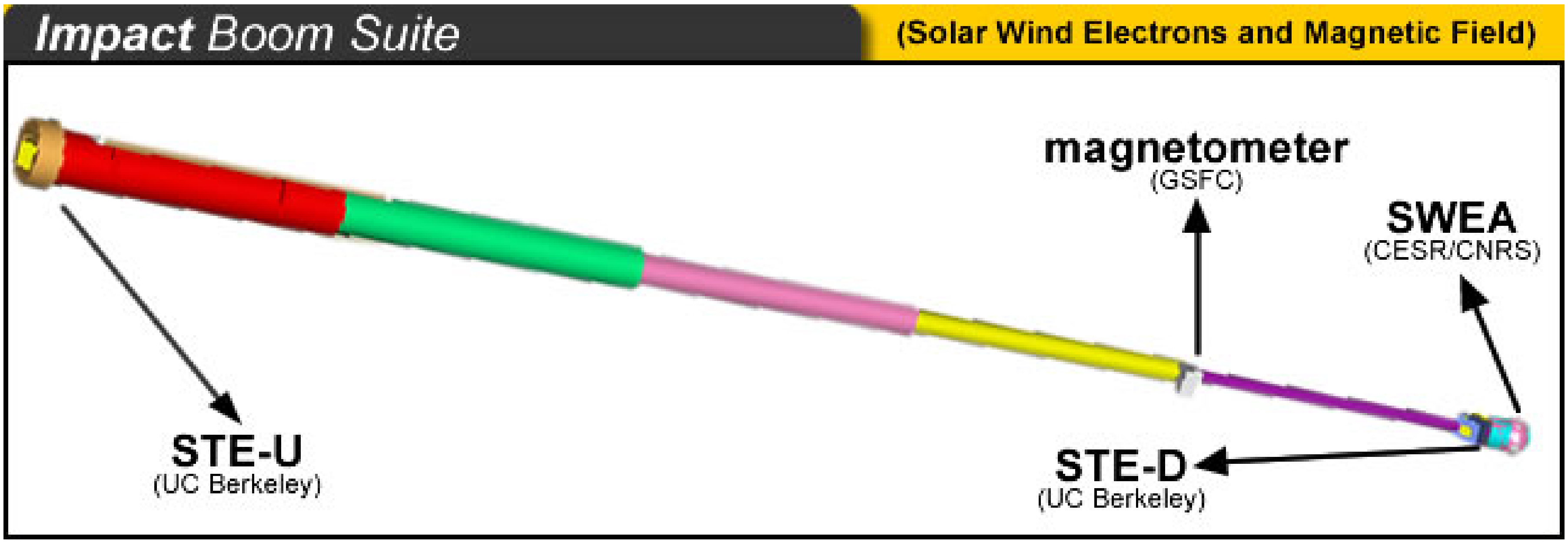
IMPACT (In-situ Measurements of Particles and CME Transients) Instrument Overview

- **Boom Suite:**
  - Solar Wind Electron Analyzer (SWEA)
  - Suprathermal Electron Telescope (STE)
  - Magnetometer (MAG)
- **Solar Energetic Particles Package (SEP)**
  - Suprathermal Ion Telescope (SIT)
  - Solar Electron and Proton Telescope (SEPT)
  - Low Energy Telescope (LET)
  - High Energy Telescope (HET)
- **Support:**
  - IMPACT Boom
  - SEP Central
  - Instrument Data Processing Unit (IDPU)

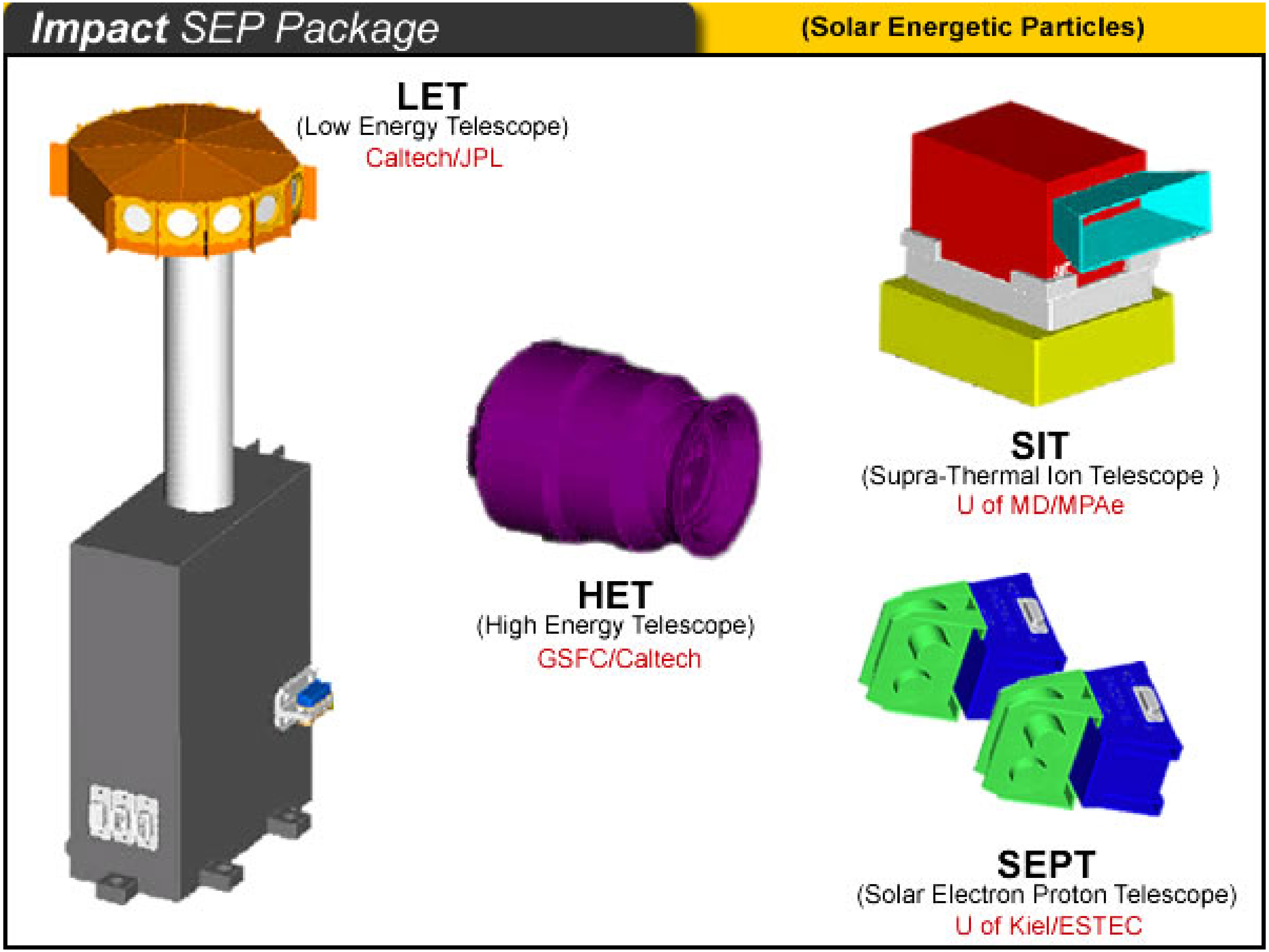


Team Member Institutions and Primary Roles

- **University of California, Berkeley-Space Sciences Laboratory (IMPACT Management,SWEA,STE,IDPU)**
- **NASA Goddard Space Flight Center (MAG,SEP-LET,HET)**
- **California Institute of Technology (SEP-LET,HET)**
- **University of Maryland (SEP-SIT)**
- ***University of Kiel (SEP-SEPT)***
- ***Centre d'Etude Spatiale des Rayonnements CESR (SWEA)***
- **Los Alamos National Laboratory (Science Integration, SEP-SIT)**
- ***Max Planck Institut fur Aeronomie (SEP-SIT)***
- **Jet Propulsion Laboratory (SEP-LET,HET)**
- ***ESTEC-European Space Agency (SEP-SEPT)***
- ***DESPA Observatoire de Paris-Meudon (SWAVES/IMPACT coordination)***
- **University of California, Los Angeles (MAG, IMPACT Data Web)**
- **SAIC-Science Applications International Corporation (IMPACT Modeling)**
- **NOAA Space Environment Center (IMPACT Modeling, Space Weather Applications)**
- **University of Michigan (IMPACT Modeling)**
- ***KFKI-Hungarian Research Institute for Particle and Nuclear Physics (SEP Modeling)***

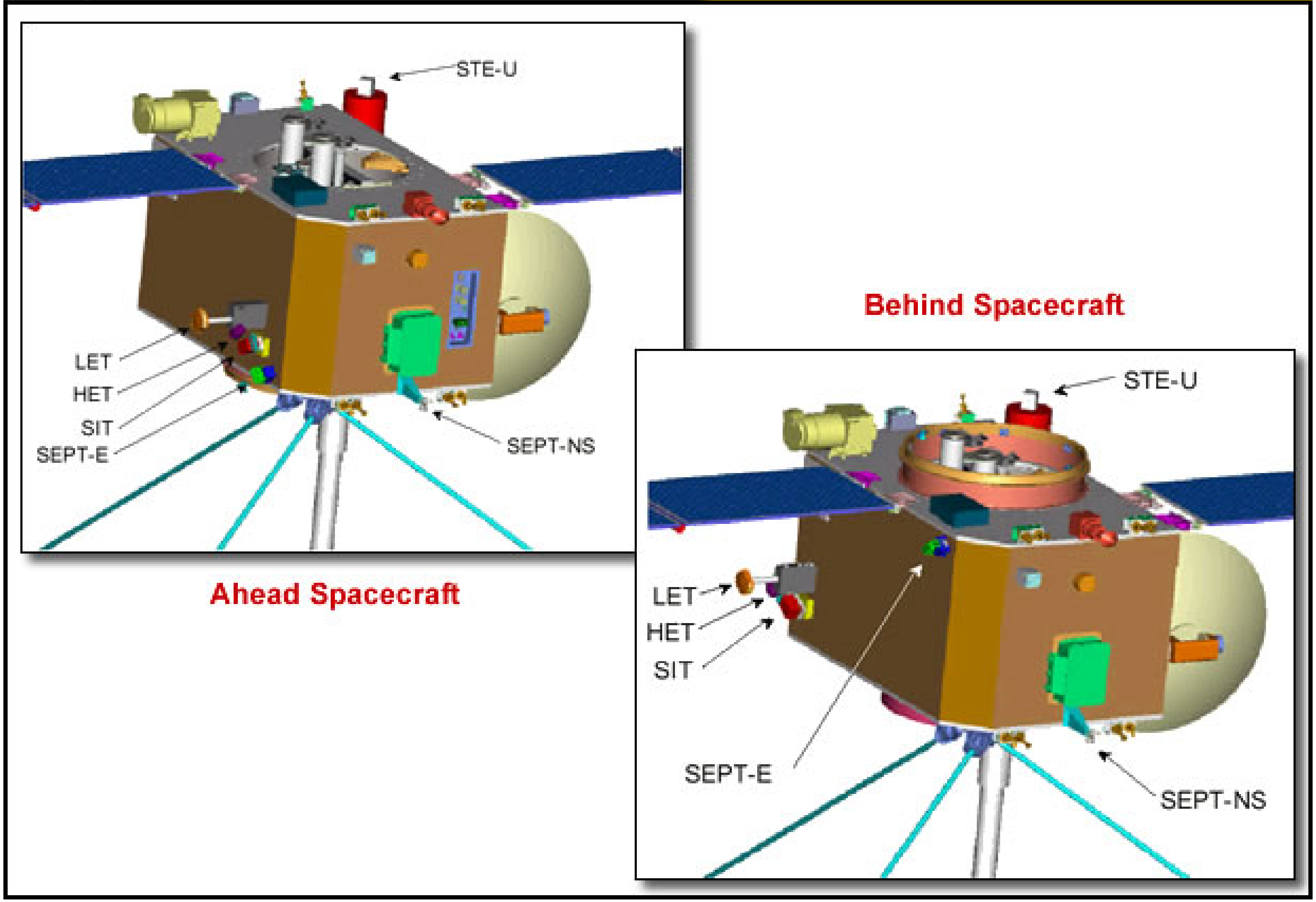


Impact Boom Suite
(Solar Wind Electrons and Magnetic Field)
magnetometer
(GSFC)
SWEA
(CESR/CNRS)
STE-U
(UC Berkeley)
STE-D
(UC Berkeley)


Impact SEP Package
(Solar Energetic Particles)
LET
(Low Energy Telescope)
Caltech/JPL
HET
(High Energy Telescope)
GSFC/Caltech
SIT
(Supra-Thermal Ion Telescope)
U of MD/MPAe
SEPT
(Solar Electron Proton Telescope)
U of Kiel/ESTEC

STEREO IMPACT

Impact Instruments Location (Ahead and Behind Spacecraft)



Design Changes Since CDR

- **No significant design or requirements change since CDR**

System Verification Plan

David Curtis (PM), UC Berkeley Space Sciences Lab,
dwc@ssl.berkeley.edu, (510) 642-5998

Organization of PER

- IMPACT environmental testing starts at the instrument level
- Different instruments are ready to start environmental tests at different times
- PER plan is to have a main PER when the first instrument is ready to test (SEPT). This PER will discuss the overall test plans and the details of the test procedures for the first instrument
  - Emphasis on ensuring that the plans are adequate and complete
- Following Technical Readiness Reviews (TRR) will be held as each subassembly becomes ready to start environmental tests
  - Emphasis on test readiness and test procedures
  - Most TRRs will cover a single instrument and are expected to be done by telecon
  - The SEP Suite TRR will be a somewhat larger meeting at Caltech

Updated Guidelines for the Instrument Pre-Environmental Reviews.

- For IMPACT the PERs will be split into a generic review that will focus on the suite requirements and a series of unique PERs for the individual instruments. The expectation is that the individual reviews will be scheduled after the final acceptance test immediately prior to the start of the environmental test program. The topics to be covered in the reviews is outlined below.

Generic PER

The following gives a list of items, which should be presented at the PER:

- Changes in the design or requirements since the Critical Design Review
- Program status and general test readiness
- Test flow including: calibration, when Comprehensive Performance Tests will be performed, number of T/V cycles, vibration test levels, etc.
- Schedule for the individual instrument tests.
- Product Assurance and Safety requirements
- Final Calibration plans.

Unique PER telecons

- In addition to open items, highlight any significant development issues and resolution.
- Test Plans and procedures addressing:
  - Test objectives/conditions/levels/configuration
  - Test facilities are ready to support the tests and certifications are complete
  - Test fixtures and support equipment are ready & available
  - Instrumentation is ready & available
  - Success/abort/safety criteria are in the procedures as needed.
  - GSE is calibrated and its certification if appropriate.
- Documentation Status, CM status of plans & procedures
- Functional and environmental test history of the hardware
- Present all open and significant closed PFRs. Provide a list or summary of all anomalies, waivers and deviations. Make available at the review test logs, anomaly logs and closure, MRB logs, etc.
- Highlight any non-flight configuration for test, or areas where the test is not representative of flight.
- Provide clear configuration control for the two sets of instruments.
- A summary of requirement compliance should be presented, including significant performance data, highlight margins and non compliances, for individual instruments or subsystems as well as system level as appropriate.
- Open items and plans for close-out
- Final Calibration plans

Verification Plan

- Science Performance Requirements are called out in the IMPACTPerformanceSpec document.
- Other performance requirements levied in Project documents such as the ICD and Environmental Spec
- All requirements have been summarized in a Verification Matrix which identifies where each requirement gets verified
- The IMPACT Environmental Test Plan describes the environmental testing planned for the IMPACT suite prior to spacecraft integration.

Verification Matrix Example

v0.01		2-Jan-03	STEREO/ IMPACT Requirements Verification Matrix												
				Level of Assembly/Ver Method								Completion Date			
Req#	Parameter/ Req Title Section	Requirement	Document	Subassembly	Assembly	Instrument Component	SEP Suite	Boom Suite	IMPACT Suite	Observatory	Verification Description	FM#1	FM#2	Results (Pass/Fail)	Responsible Organization
1.0		**SCIENCE REQUIREMENTS**													
1.1	MAG Science Requirements	Noise Level < 0.05nT	MRD - 4.7(K) and solar wind characteristics. IPF - 3.1			T					Operation in laboratory 4-layer magnetic shield with B<0.25 nT. Computation of noise spectrum from test data				GSFC / Acuna
1.2		Absolute Accuracy < +/- 0.1nT	MRD - 4.7(K) IPF - 3.1			T					Calibration against proton precession standard at GSFC Test Site – Electronics adjustments during electrical testing				GSFC / Acuna
1.3		Range = +/-512nT	MRD - 4.7(K) IPF - 3.1			T					Operation in laboratory coil system and MAG Test Site – Calibration against proton precession standard				GSFC / Acuna
1.4		Drift < +/- 0.2 nT/yr	MRD 4.6.2.6.1 and Absolute Accuracy IPF - 3.1			S,T					Short term test only – analytical verification from prior missions				GSFC / Acuna
1.5		Time Resolution = 1 second	MRD - 4.7(K) IPF - 3.1					T			Boom suite tests shall verify telemetry throughput				UCB / Curtis
1.6	SWEA Science Requirements	FOV = 360 X 60 degrees	MRD - 4.7(H,I,J) IPF - 3.2			T					Calibration with electron gun at CESR				CESR
1.7		Resolution = 45 degrees	MRD - 4.7(H,I,J) IPF - 3.2			T					Calibration with electron gun at CESR				CESR
1.8		Energy = 20 to 1000eV	MRD - 4.7(H,I,J) IPF - 3.2			T, A					Calibration with electron gun at CESR over a limited energy range; extrapolated analytically to lower energies				CESR
1.9		Energy Resolution (Telemetry) < 100%	MRD - 4.7(H,I,J) and solar wind characteristics IPF - 3.2			T					Calibration with electron gun at CESR shall verify instrument resolution (~10%); IDPU software acceptance test shall verify averaging for telemetry into bins with resolution better than 100%				CESR
1.10		Geometric Factor > 0.001 cm^2 ster E(eV)	MRD - 4.7(H,I,J) and solar wind characteristics IPF - 3.2			T					Calibration with electron gun at CESR				CESR
1.11		Max Count Rate (per 22.5 degree sector) > 1E5 counts/sec	MRD - 4.7(H,I,J) and solar wind characteristics IPF - 3.2			T					Calibration with electron gun at CESR				CESR
1.12		Time Resolution = 1 minute	MRD - 4.7(H,I,J)					T			Boom Suite testing shall verify end-to-end throughput				UCB / Curtis

Test Matrix Summary

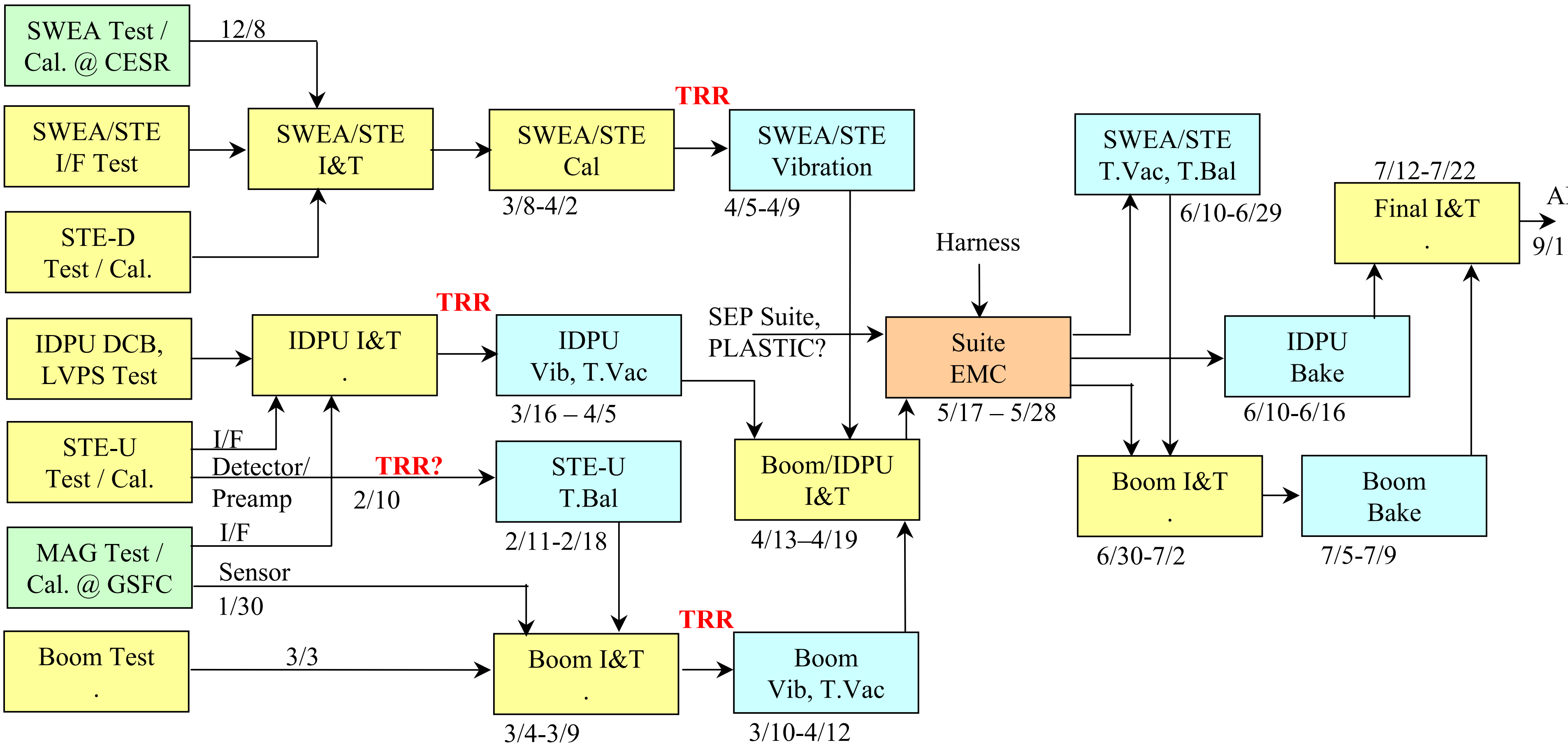
System	EMC	Bakeout	Thermal Vac Cycling (Op/NonOp)	Thermal Balance	Sine Vib	Random Vib	Mass props	Failure Free Hours
SEP		√						
- SEPT-NS	Mag Screening	H	-30 - +40C -40 - +50C	√	√	√	√	24
- SEPT-E	Mag Screening	H	-30 - +40C -40 - +50C	√	√	√	√	24
- SIT	Mag Screening	H	-30 - +30C -35 - +35C	√	√	√	√	24
- HET, LET, Common Elec.	Mag Screening	H	-30 - +35C -40 - +40C	√	√	√	√	24
Boom Assy		√	-33 - +40C -33 - +40C (*)		√ (*)	√ (*)	√	
- Boom	Mag Screening	H	H	√	H	H	Mass	N/A
- SWEA	Mag Screening	H	-25 - +30C -30 - +50C	√	√	√	Mass	24
- STE	Mag Screening	H	H	√	H	H	Mass	24
- Mag Sensor		H	H		H	H	Mass	24
IDPU	Mag Screening	√	-23 - +55C -30 - +60C		√	√	√	24
Flight Harness		√						
IMPACT Suite	RS,RE,CS,CE per EMC Requiurements							100

2004-1-5 DWC (*) = Boom Assy without SWEA H = test at higher level of assembly

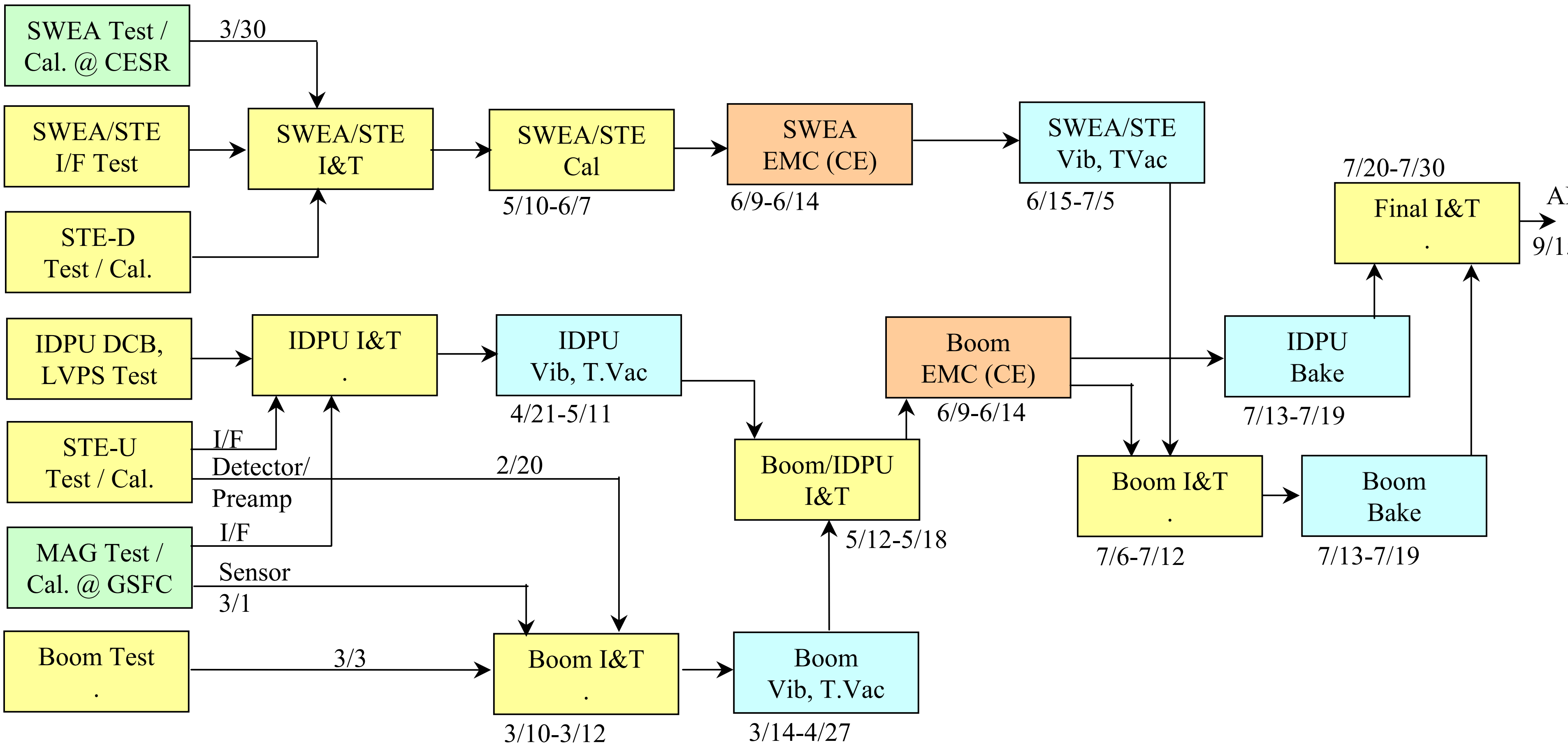
Test Flow

- Minimize risk by starting environmental tests as soon as each instrument is ready rather than waiting for the full suite (where possible)
- The order of the tests shall be adjusted to the availability of flight hardware
  - No reason to believe the order of tests is important except perhaps for the boom
  - Will Vib before Thermal Vac, all other things being equal, but will not delay schedule to meet this criteria
- EMC will be performed as soon as possible
  - Must wait till the full IMPACT suite is ready
- Bakeout shall be performed late in the flow, after EMC.

Boom Suite FM1 Test Flow

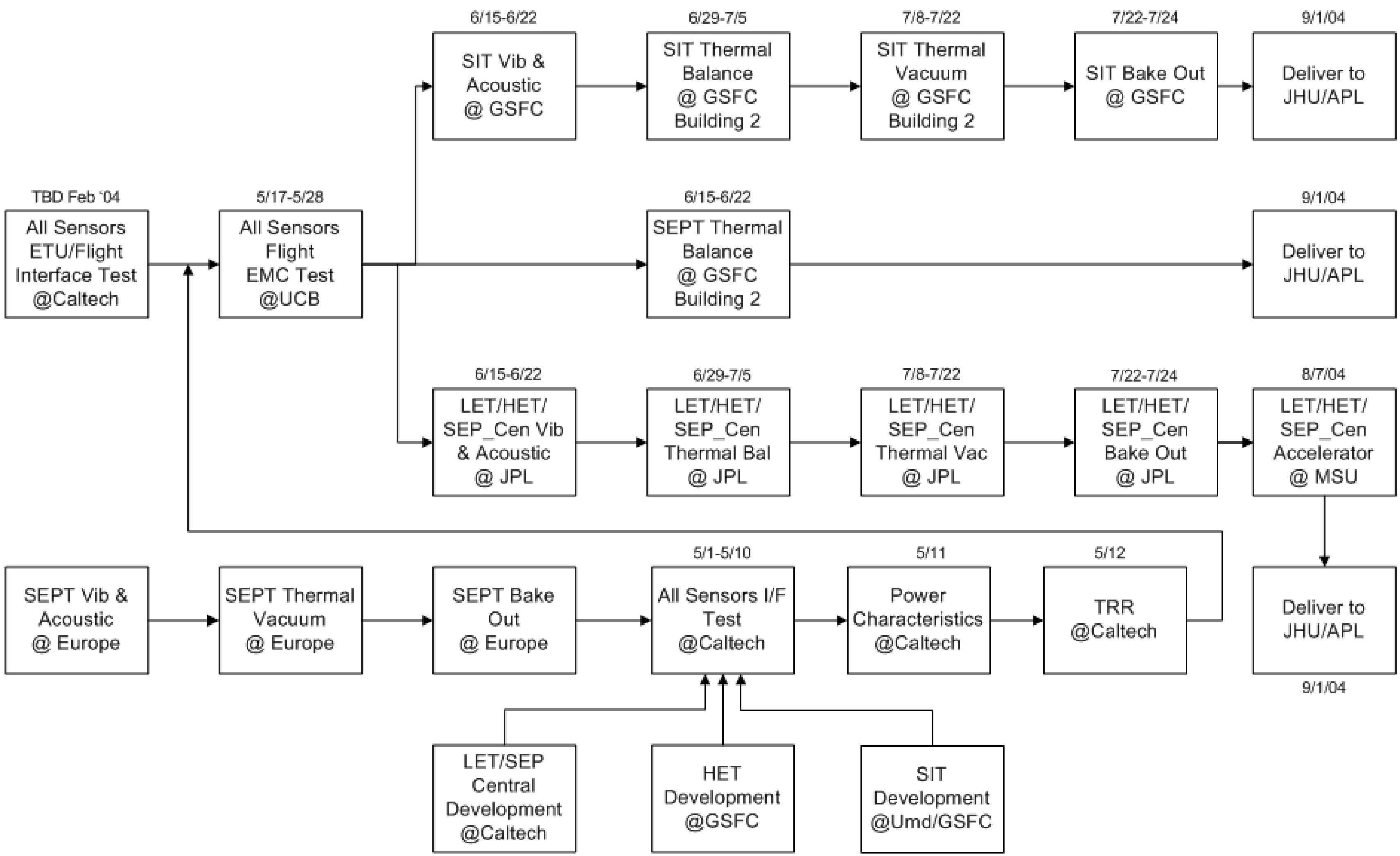


Boom Suite FM2 Test Flow

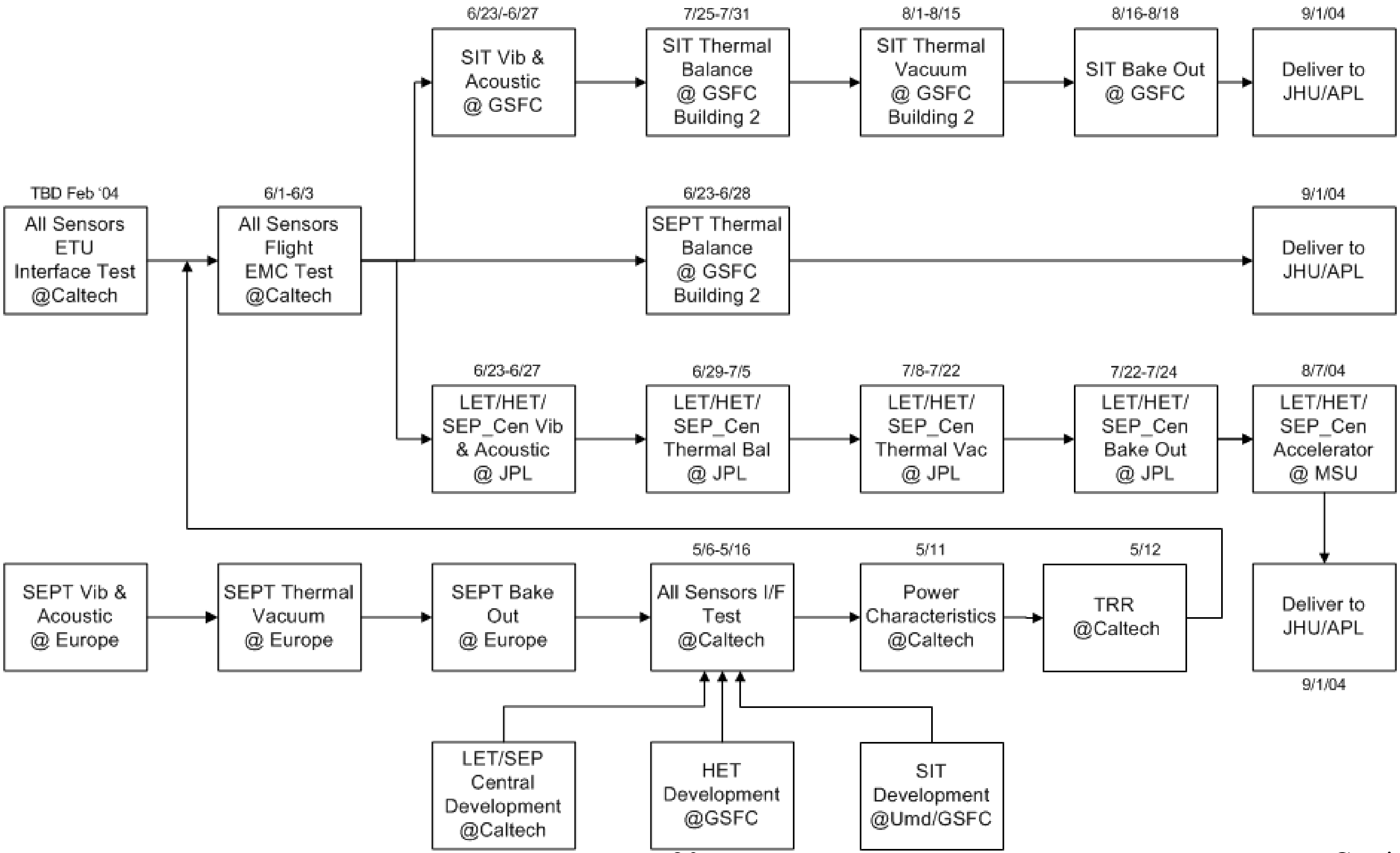


Curtis

SEP Suite FM1 Test Flow (12/16/03)



SEP Suite FM2 Test Flow (12/16/03)



Project Status, Test Readiness

- Instruments are in various states of readiness for test, as described in the instruments sections below
  - SEPT instrument is ready for environments, triggered this review
- Working towards a suite delivery to APL in September 2004
  - Boom and SEP suites deliver separately to APL
  - FM2 delivered ~2 weeks after FM1

PDR, CDR, Waiver, PFR Status

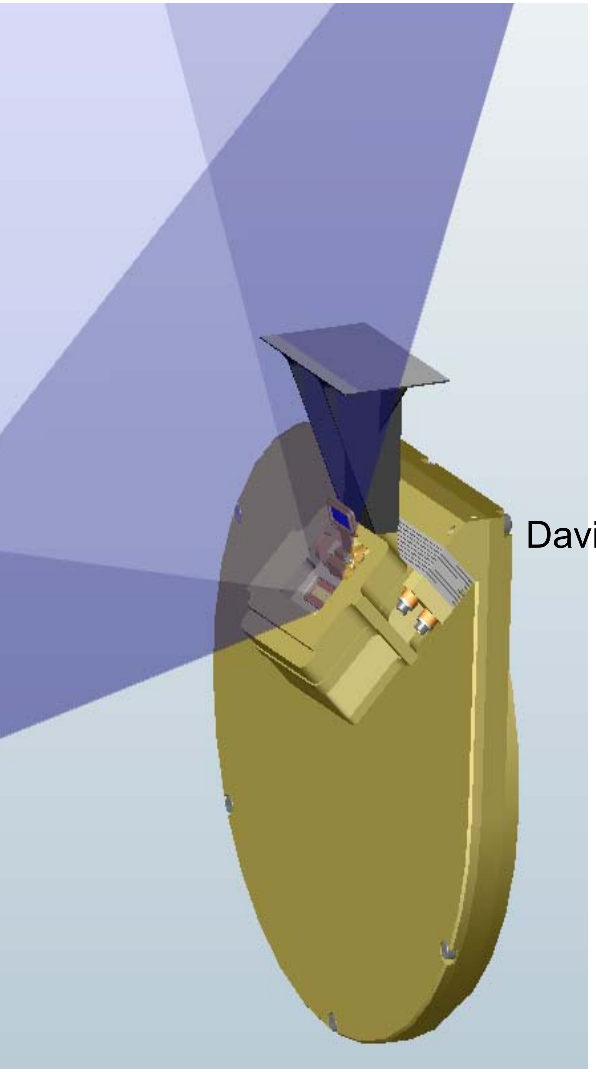
- **All PDR RFAs submitted, approved by reviewer** PDR RFA
  - **1 pending final approval**
- **26 or 32 CDR RFAs closed** CDR RFA
  - **3 pending approval by reviewer**
  - **2 pending final details of SIT door design**
  - **1 pending outcome of an analysis of launch aerodynamic heating**
- **18 waiver submitted** WaiverStatus
  - **14 approved, 4 open**
  - **Do not expect to have problems getting these 4 approved**
- **2 Problem/Failure Reports submitted**
  - **1 closed (PFR 1001)** PFR 1001
  - **1 pending results of part failure analysis (PFR 6001)** PFR 6001

Contamination Control Plan

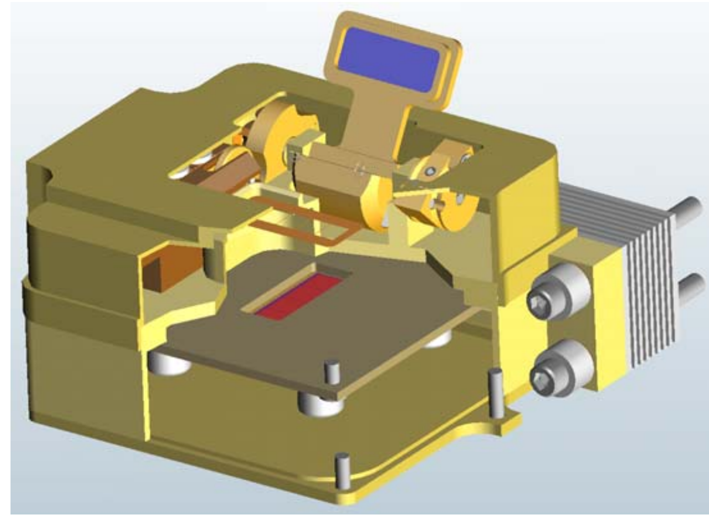
- Contamination requirements and handling plans called out in IMPACT Contamination Control Plan
- Not all test facilities are clean
  - Strategy will be to keep instruments bagged as much as possible when in non-clean environments
  - Contamination sensitive instruments will be bagged and purged al all times when in non-clean environments
- Near the end of the test flow (prior to delivery) instruments will be cleaned and baked out
  - Bakeout will be monitored (TQCM) per the environmental spec to verify outgassing rates

Product Assurance and Safety Requirements

- Verify proof load data
- Verify equipment calibration status
- Verify Contamination and Safety controls
- Conduct daily tail gate meeting to review test activities
- Review and approved all test procedures
- In-process inspections and test monitors
- Final data review and buy off
- Track all problem failure reports



STE-U



David Curtis (PM), UC Berkeley Space Sciences Lab,
dwc@ssl.berkeley.edu, (510) 642-5998

STE-U Test Constraints

- STE-U detector is contamination sensitive.
  - The door will be closed and the instrument purged through most of testing.
    - Interruptions in purge can be tolerated
  - The instrument shall be bagged whenever possible
  - The door will only be opened when in a class 10K clean area (class 100K for a short duration opening), or when bagged.
- STE-U contains a low level (1 µCi) radiation source
  - Source mounted to the door; only exposed when the door is open
  - Proper radiation handling procedures will be used

STE-U Pre-Environmental Tests & Calibration

- **Prior to the start of environmental tests, STE-U will go through a series of performance tests and calibrations to ensure that, at least in ambient conditions, it meets its performance requirements. These tests are similar to those performed on the ETU**
  - **Detector tests before and after mounting**
  - **Integration and test of detector and housing, including door tests**
    - **A life test at >3x expected cycles has been performed on the ETU door**
  - **Preamp electrical tests, conformal coat**
  - **Integration and test of detector and preamp**
  - **Integration and test of STE-U with STE-U interface in IDPU**
  - **Performance tests / calibrations to verify science requirements**
    - **Energy range**
    - **Energy resolution**
    - **Field of View**
    - **Sensitivity (Geometric Factor)**
    - **Background**
    - **Max count rate**
  - **At least 25 hours of continuous trouble free operations shall be obtained prior to the start of environmental tests**
    - **At least 100 hours shall be accumulated prior to delivery**

STE-U Comprehensive Performance Test

- The STE-U CPT will include:
  - Door operation
    - Trend door motion time
  - Electrical performance and resolution using internal test pulser
    - Trend power consumption, gain, and resolution
  - Detector performance using internal calibration source
    - Trend resolution, gain, count rate
- CPTs shall be performed before, after, and in some cases (as noted) during environmental tests

STE-U Environmental Test Plan

- STE-U is expected to be ready for test in February
- Thermal Balance is expected to be completed prior to integration with the boom
- Vib, Thermal Vac, EMC, and bakeout to be completed together with the boom
- No special post-environmental tests required

STE-U Environmental Tests

- Mass properties
  - Flight units shall be weighed in flight configuration (with ETU blankets)
  - STE-U is sufficiently small that CG and MOI can be determined by analysis to the accuracy required
- Thermal Balance
  - STE-U Thermal Balance test (FM1 only) will take place at UCB (separate from the boom)
  - Thermal isolators and blankets will be installed
  - Thermal cases shall be selected and the data analyzed to verify the thermal model
    - Subject to the constraints of the chamber, -100C minimum.
  - The detectors will be closer to their flight temperatures than in thermal vac
    - Detector performance when cold will be monitored
- Vibration
  - STE-U will be vibrated (sine & random) together with the flight boom
    - see boom presentation for details
  - STE-U will be powered off during vibration (off during launch)
  - STE-U will be on the boom for a deployment self-shock test
  - A CPT will be performed before and after vibration
  - No foils or other acoustic concerns, so no acoustic test

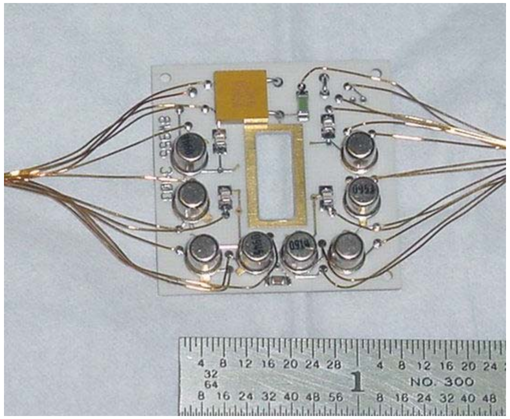
STE-U Environmental Tests, continued

- Thermal Vac
  - STE-U will be cycled together with the boom at UCB
  - 1 survival cycle plus 6 operational cycles per the Environmental Test Spec
    - A CPT will be performed at each dwell
  - STE-U thermal design is complicated – detector is designed to run cold, preamp warm
    - Detector can be operated warm with some decrease in resolution
    - Cycles will be constrained to overlap of the operational ranges
      - -25 to +30C op
      - -30 - +40C non-op
- EMC
  - STE-U will go through EMC with the rest of the suite
    - See EMC presentation below
  - STE-U shall be surveyed magnetically by UCB
- Bakeout
  - STE-U will be baked out together with the rest of the boom late in the flow
    - See boom presentation for details

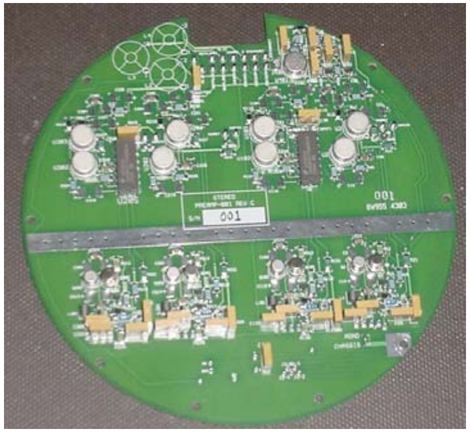
STE-U Status

- **STE-U currently in fabrication**
  - Detector boards built, detectors being installed
  - Preamp boards being loaded
  - Housings fabricated
  - First STE door life test completed
    - Some trouble with limit switches between 1 and 10x expected life
    - Modified design to improve durability; repeat life test expected soon
    - Override for limit switches available if needed in flight

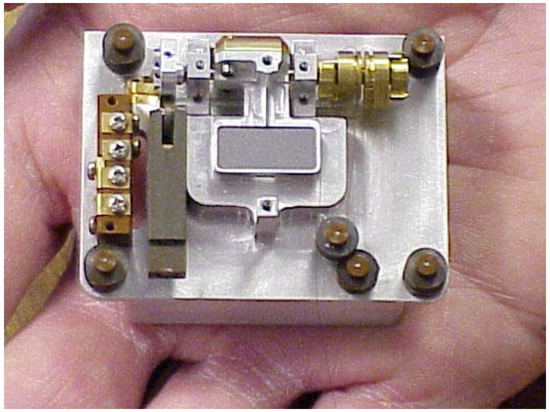
Flight STE Detector Board



Flight STE-U Preamp



ETU STE Housing with Door



STE-U Test Matrix

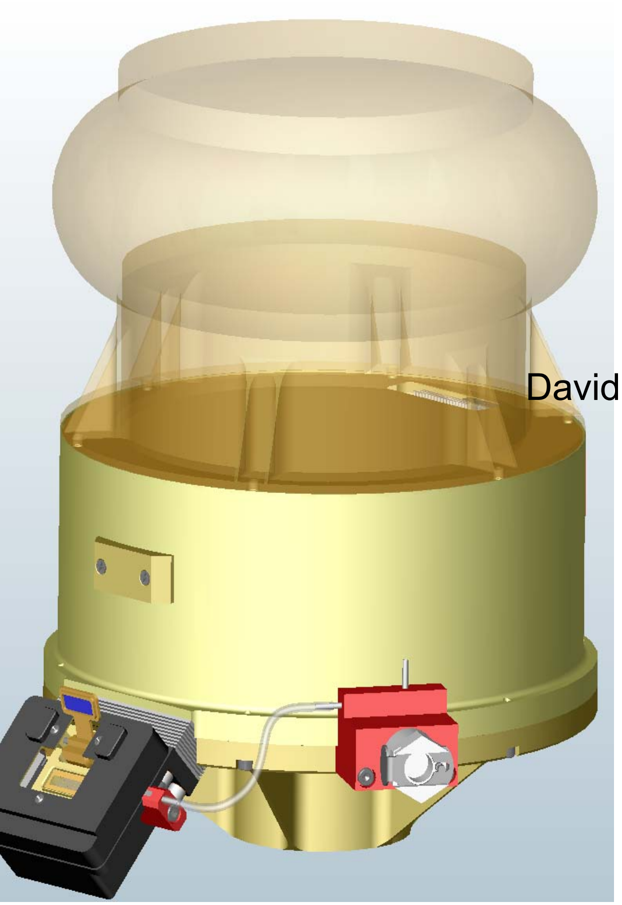
Verification Matrix for STEREO/IMPACT/STE

Revision Date: 11/19/2003
Revision Number: 3

Level of Assembly	Item	Elect. test, rm. Temp	Bench Calibration	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Self Shock	Acoustics	Thermal Vacuum	Voltage margins	Thermal cycle	Thermal balance	Life Test	EMC/EMI	Magnetics	Beam Calibration	Bakeout	Contamination Inspection	Comments
	Hardware Description	**Test**																		
C	Detector, EM	C																		
C	Detector, F	C																	C	
C	Preamp, BB	C	C																	
I	Instrument, ETU	C	C	C	X				A		C						C			
I	Instrument, PF (FM1)	X	X	X	X	H	H	X		X	X		X	X	H	X	X	X	X	
I	Instrument, PF (FM2)	X	X	X	X	H	H	X		X	X			X	H	X	X	X	X	

Legend:

Level of Assembly	Unit Type	
		X = Test required
		A = Analysis
C = Component	BB Breadboard	H = Test at higher level of assembly
I = Instrument	EM Engineering Model	**C = Test Completed**
	PF Protoflight	
	F = Flight	



SWEA/STE-D

David Curtis (PM), UC Berkeley Space Sciences Lab,

dwc@ssl.berkeley.edu, (510) 642-5998

Claude Aoustin, CESR, France

Claude.Aoustin@cesr.fr

SWEA/STE-D I&T

- SWEA is built and calibrated by CESR
- STE-D and the common Pedestal Electronics are built and tested by UCB
  - STE-D is nearly identical to STE-U
  - Pedestal electronics includes:
    - STE-D preamp (same as STE-U)
    - STE-U processing electronics (same as STE-U interface in IDPU)
    - SWEA / STE-D / IDPU interface electronics
    - Common LVPS
- SWEA/STE-D will be integrated and tested at UCB
- SWEA/STE-D will be environmentally tested as a unit

SWEA/STE-D Test Constraints

- **SWEA MCP High Voltage cannot be operated except in vacuum**
  - Accidental operation in air can damage the instrument
  - An enable plug must be installed to run the high voltage. This will normally be out.
  - Electronics can be fully verified with internal test pulsers, but not the detector or MCP HVPS.

- **SWEA Microchannel Plate Detector is contamination sensitive**
  - Detectors are sealed and purged for most ground operations
    - Interruptions in purge can be tolerated
  - The door will only be opened in a class 10K environment or better for short intervals, or if bagged and purged, or in vacuum

- **STE-D has the same constraints as STE-U (see above)**

SWEA Pre-Environmental Tests

- Electrical test performed at board level (HV board, Amplifier board)
- Thermal test done on HV board : -70°C to +50°C
    - Hv calibration curves at different temperature
- Electrical verification after final integration
- Outgassing of the boards done at +60°C during 48 hours
- The full instrument stayed 4 months under vacuum 8 10^{-7} torr during calibration

SWEA Pre-Environmental Calibrations at CESR

- MCP characterization
  - Dead time measurement
  - Gain versus MCP voltage

- Electron beam at 1keV used
  - Azimuth angles 30° to 90° (sectors 14,15,0,1) polar angle 0 to60°
  - Polar angle 50° all azimuths
  - Polar angle 0° all azimuths
  - Polar angle 55° to 67° azimuth 0°
  - Azimuth angles 30° to 90° (sectors 14,15,0,1) polar angle 0 to -60°
  - Polar angle -50° all azimuths
  - Polar angle -55° to -67° azimuth 0°

STE-D and Pedestal Electronics Pre-Environmental Tests & Calibration

- STE-D performance tests are identical to those for STE-U
- Pedestal electronics functionally tested and calibrated on the bench
  - LVPS efficiency, secondary regulation, isolation, thermal, CE tests
  - Analog Housekeeping channels calibrated
  - Analog control signals calibrated
  - IDPU and instrument interfaces tested with ETUs and simulators (end-to-end tests)
  - Voltage margin testing
- SWEA and STE-D instruments integrated
  - System end-to-end bench tests of STE-D
  - System end-to-end vacuum tests/calibrations of SWEA and STE-D
    - Verify system compatibility, noise, throughput
    - Survey of energy/angle response to verify integrated system
    - Verify SWEA dynamic response, energy calibration (sweeping analyzer waveforms)

SWEA/STE-D Comprehensive Performance Test

- The STE-D CPT will be identical to the STE-U CPT
- The SWEA High Voltage and MCP Detector can only run in vacuum
  - For non-vacuum tests, an internal test pulser can be used to stimulate the electronics chain
  - An electron gun or radiation source is required to stimulate detector
    - A small electron gun is planned for thermal vac
- SWEA door can only be opened in a controlled environment, and is a 1-time deployment, requiring a hand re-stow
  - Open once in thermal vac, once in thermal balance
  - Open in a few selected CPT tests with detector bagged and purged.
- SWEA CPT will include
  - Test pulser test to verify instrument commanding and telemetry
  - Door opening test when possible
  - High voltage power-up when in vacuum; verify sweep waveforms
  - Detector test when in vacuum and source available; verify analyzer performance

SWEA/STE-D Environmental Test Plan

- **SWEA/STE-D is expected to be ready for test in April**
  - **Too late for testing with the boom**
  - **Handling risks also indicates separate test from boom**
- **Will be integrated with the boom for EMC and bakeout**
- **Thermal Balance is delayed until after the boom Thermal Vac tests are complete (uses the same chamber), probably after EMC.**

SWEA/STE-D Environmental Tests

- **Mass properties**
  - Flight units shall be weighed in flight configuration (with ETU blankets)
  - SWEA/STE-D is sufficiently small that CG and MOI can be determined by analysis to the accuracy required
- **Vibration**
  - SWEA/STE-D will be vibrated separate from the boom, using vibration levels derived from measured response during boom qual model vibration tests (sine sweep, random)
  - SWEA/STE-D will be vibrated in launch mode, operational power off, heater power on
  - A CPT will be performed before and after vibration
  - No foils or other acoustic concerns, so no acoustic test
- **Thermal Vac**
  - SWEA/STE-D will be cycled separate from the boom
  - 1 survival cycle plus 6 operational cycles per the Environmental Test Spec
    - A CPT will be performed at each dwell
  - STE-D thermal design is complicated – detector is designed to run cold, rest of SWEA/STE-D warm
    - Detector can be operated warm with some decrease in resolution
    - Cycles will be constrained to overlap of the operational ranges
      - -25 to +30C op
      - -30 - +40C non-op

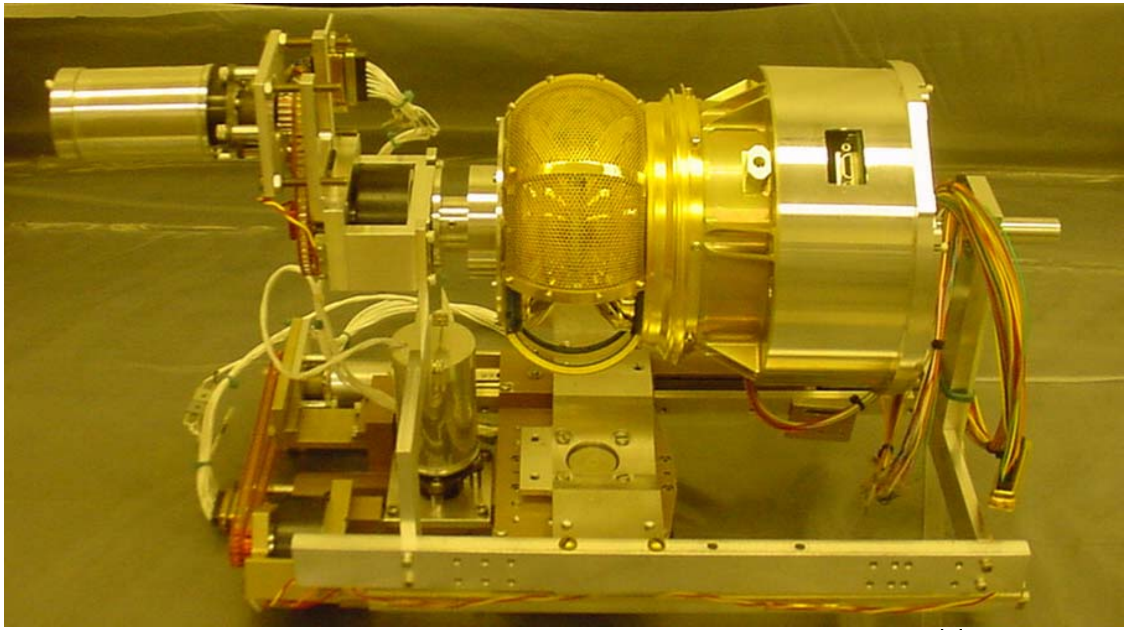
SWEA/STE-D Environmental Tests, continued

- EMC
  - SWEA/STE-D will go through EMC with the rest of the suite
    - See EMC presentation below
  - SWEA/STE-D shall be surveyed for magnetically by UCB
- Thermal Balance
  - SWEA/STE-D Thermal Balance test (FM1 only) will take place at UCB (separate from the boom)
  - Blankets will be installed, and SWEA will be mounted on a prototype 1-segment boom
  - Thermal cases shall be selected and the data analyzed to verify the thermal model
    - Subject to the constraints of the chamber, -100C minimum.
  - The detectors will be closer to their flight temperatures than in thermal vac
    - Detector performance when cold will be monitored
- Bakeout
  - SWEA/STE-D will be baked out together with the rest of the boom late in the flow
    - See boom presentation for details

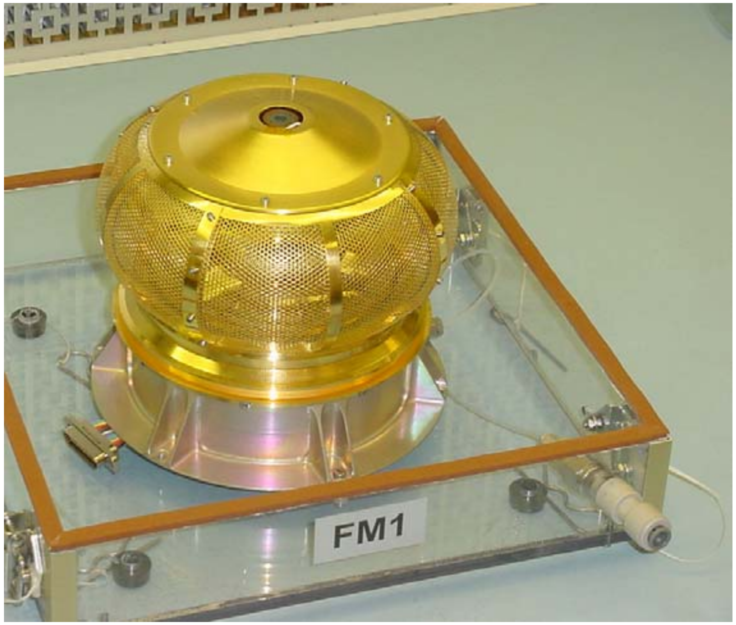
SWEA/STE-D Status

- **FM1 SWEA calibrated and ready for delivery to UCB**
  - One open issue with a part failure
- **FM2 SWEA in calibration at CESR**
- **FM1 STE-D and pedestal electronics in fabrication**
  - LVPS drives the schedule out until April before environmental tests

ETU SWEA/Pedestal/STE-D assembly on manipulator at UCB



FM1 SWEA at UCB



SWEA Test Matrix

Verification Matrix for STEREO/IMPACT/SWEA

Revision Date: 11/26/2003
Revision Number: 3

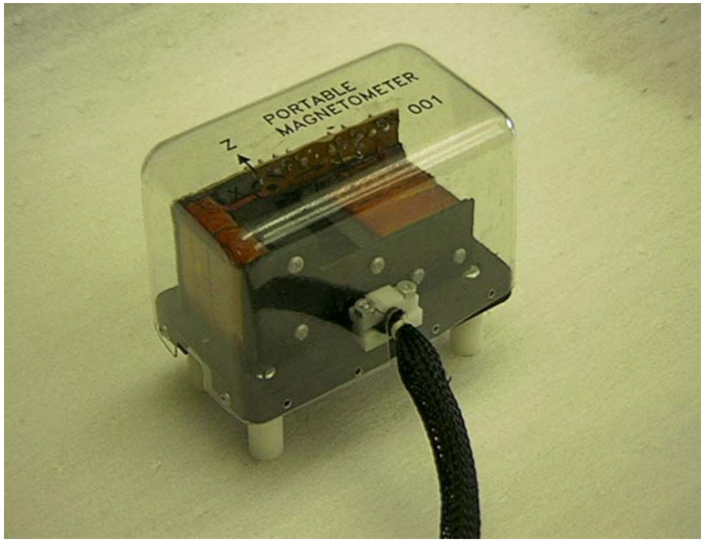
Level of Assembly	Item	Pedestal Interface Test	Elect. test, rm. Temp	Voltage margins	Bench Calibration	Beam Calibration	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Self Shock	Acoustics	Thermal Vacuum	Thermal cycle	Thermal balance	Life Test	EMC/EMI	Magnetics	Bakeout	Contamination Inspection	Comments
C	MCP, F		C			C															
C	Preamp, F		C		C																
C	Optocouplers, F		C		C																
S	Electronics, EM		C	C	C		C	C													
S	Electronics, F		C	C	C		C	C											C		
I	Instrument, EM1	C	C	C		C	H	H										C			UCB test unit
I	Instrument, EM2		C	C		C			X	X		A									CESR test unit
I	Instrument, PF (FM1)	X	C	C		C			H	H	X		X	H	H	X	H	H	H	X	
I	Instrument, PF (FM2)	X	C	C		X			H	H	X		X	H		X	H	H	H	X	
I	Instrument, PF (FS)		X	X																	Spare

Legend:

Level of Assembly	Unit Type		
			X = Test required
			A = Analysis
C = Component	BB =	Breadboard	H = Test at higher level of assembly (at UCB)
S = subsystem	EM =	Engineering Model	**C = Test Completed**
I = Instrument	PF =	Protoflight	
	F =	Flight	

Problems / Failures

- **SWEA FM1 had one part failure during board-level thermal cycling at CESR**
  - **VXI HV multiplier hybrid**
  - **PFR 6001 submitted, still open**
  - **Part failure analysis performed; bad bond**
  - **More parts from lot submitted to analysis**
  - **Part replaced, board thermal cycled, thousands of hours of calibrations**



MAG

David Curtis (PM), UC Berkeley Space Sciences Lab,

dwc@ssl.berkeley.edu, (510) 642-5998

Mario Acuna, GSFC

mario.acuna@gsfc.nasa.gov

MAG Pre-Environmental Tests & Calibration

- **MAG is designed, fabricated, and tested by Mario Acuna's group at GSFC**
- **MAG consists of:**
  - **MAG sensor, to be mounted to the IMPACT boom**
  - **MAG front end electronics, to be mounted in the IDPU**
  - **MAG heater board, also mounted in the IDPU**
- **Calibration and Test performed at GSFC using UCB-supplied IDPU simulator**
- **Test Flow:**
  - **Electrical test, adjustment**
  - **Thermal cycling (air), -35 to +75C**
  - **Preliminary calibration**
  - **Stake/coat boards**
  - **Bakeout**
  - **Final Calibration**
- **Delivery to UCB for integration**
  - **Electronics I&T with IDPU**
  - **Sensor I&T with Boom**

MAG Comprehensive Performance Test

- After integration with the boom, MAG CPT consists of:
  - Verify MAG responds to Earth's field
    - Trend noise level, magnitude
  - Use In-Flight Calibration system to verify MAG response
    - Trend IFC response
  - Verify heater standby power consumption
    - Verify heater active power consumption, operation if cold (~0C)
    - Trend power consumption
  - Verify expected housekeeping
    - MAG temperature
    - Digital status, error indicators

MAG Environmental Test Plan

- After delivery to UCB, MAG will be installed in the IDPU and Boom
- MAG sensor will see vibration, thermal vac, EMC, and bakeout with the IMPACT Boom
  - See boom presentation below
- MAG electronics will see vibration, thermal vac, EMC and bakeout with the IDPU
  - See IDPU presentation below
- No thermal balance is planned for MAG sensor
  - Identical to sensor flown on many previous spacecraft; thermal model well understood

MAG Test Matrix

Verification Matrix for STEREO/IMPACT/MAG

Revision Date: 2004-1-5
Revision Number: 2

Hardware Description		Test																	
Level of Assembly	Item	Elect. test, rm. Temp	Bench Calibration	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Shock	Acoustics	Thermal Vacuum	Voltage margins	Thermal cycle	Thermal balance	>100 hours Operation	EMC/EMI	Magnetics	Bakeout	Contamination	Comments
C	Sensor, EM	C	C																
C	Sensor, F	X	X	X	X	H	H	H		X		X	A	H	H		H	H	Sensor thermal balance by heritage
C	Electronics, EM	C	C	H	H									C					
C	Electronics,F	X	X	X	X	H	H	H		H	X	H		H	H		H	H	

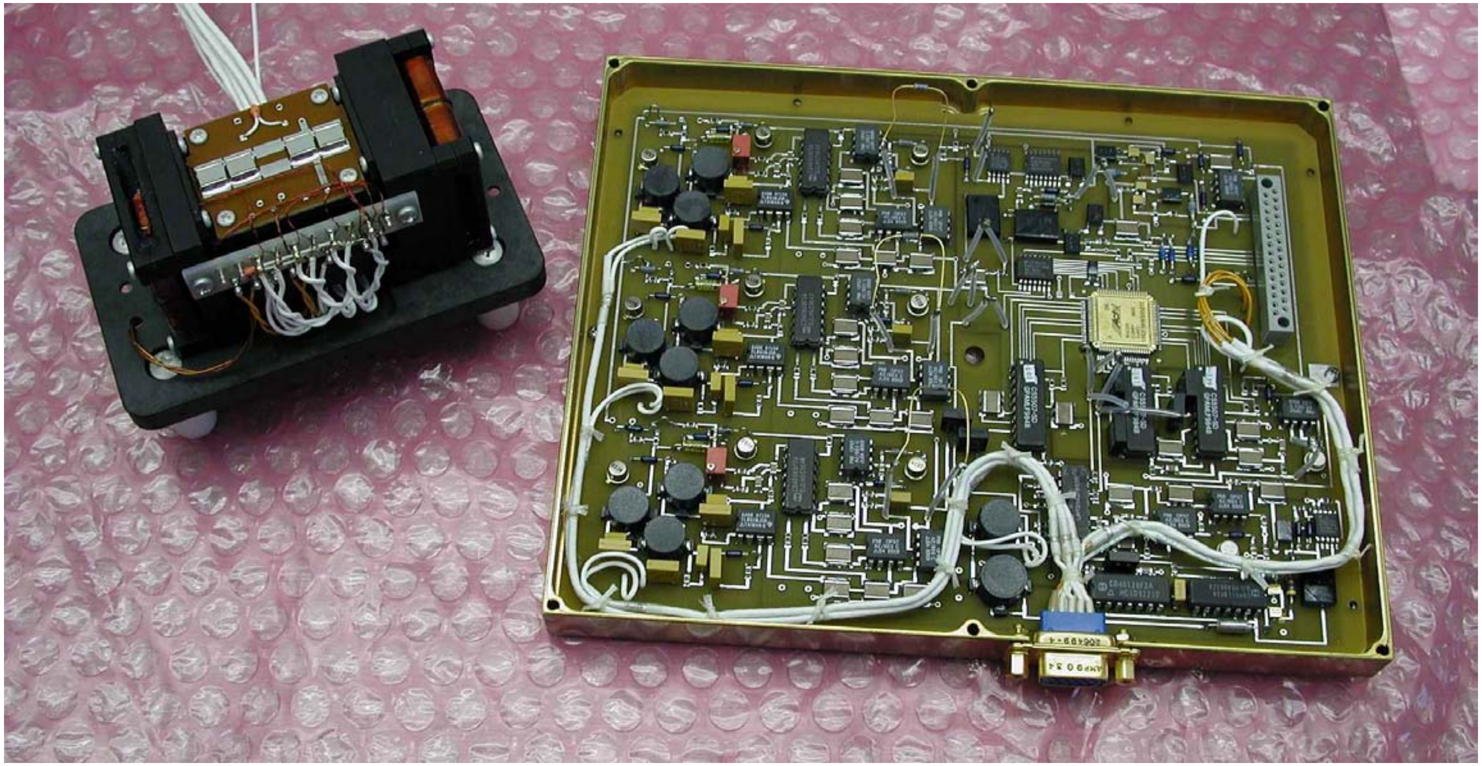
Legend:

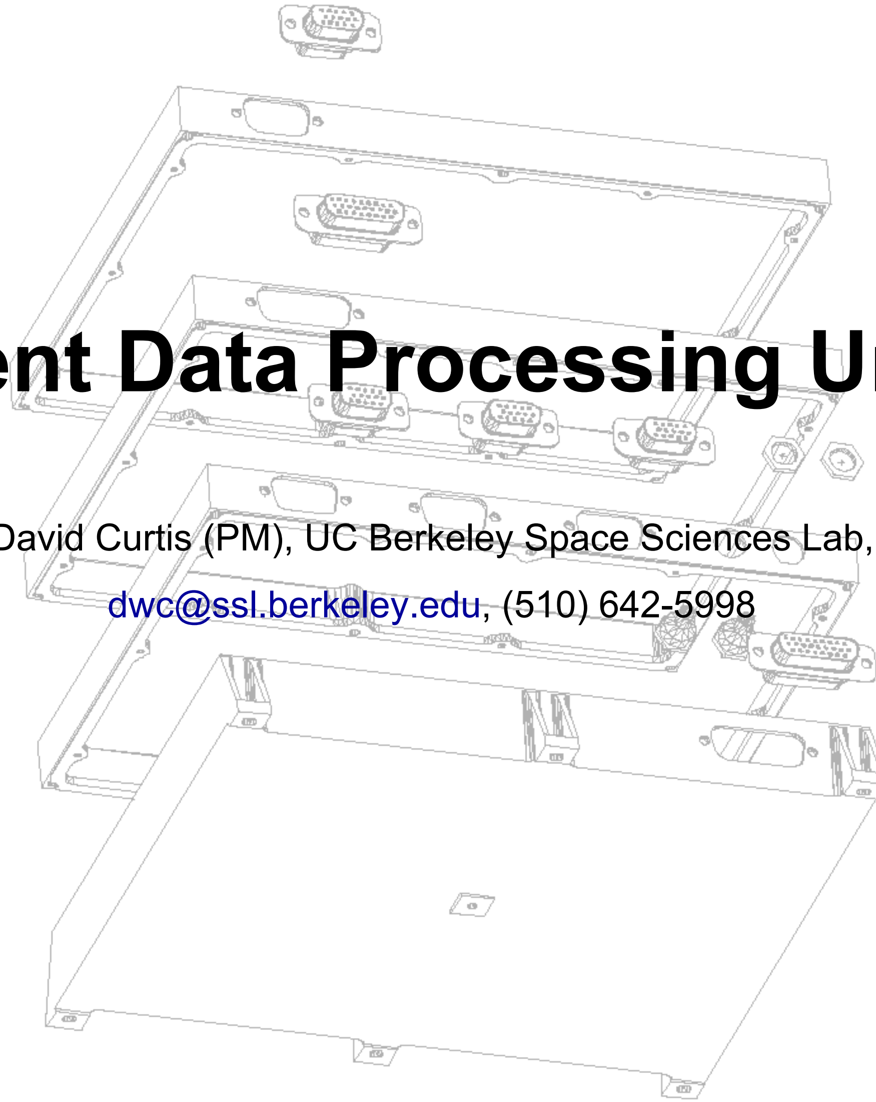
Level of Assembly	Unit Type	
		X = Test required
		A = Analysis
C = Component	BB Breadboard	H = Test at higher level of assembly
I = Instrument	EM Engineering Model	(Boom for sensor, IDPU for electronics)
	PT Prototype	**C = Test Completed**
	PF Protoflight	
	F = Flight	

MAG Status

- **MAG FM1 is complete and tested/calibrated, ready for conformal coat and thermal cycle at GSFC prior to shipping to UCB**
- **MAG FM2 is built and in test at GSFC**

FM1 MAG Electronics and FM2 MAG Sensor





Instrument Data Processing Unit (IDPU)

David Curtis (PM), UC Berkeley Space Sciences Lab,

dwc@ssl.berkeley.edu, (510) 642-5998

IDPU Pre-Environmental Tests

- IDPU consists of:
  - Data Controller Board (DCB) fromUCB; includes flight processor
  - IDPU LVPS from UCB
  - MAG Front End board and MAG heater board from GSFC
  - STE-U Front End board from UCB
- DCB functional testing using special test software
  - Verifies all interfaces, functions, and memories
  - Voltage and temperature margin tests on EM & FM1
  - Voltage margin tests on FM2
  - Flight software PROM acceptance test completed, PROMs programmed, burned-in, and installed
- LVPS testing to include:
  - efficiency, secondary regulation, isolation, thermal, CE
- MAG and STE-U board testing described above
- System tests will be performed using combination of ETUs and simulators

IDPU Comprehensive Performance Test

- **Spacecraft interface testing using the spacecraft emulator**
  - **Verify all message transfer types between spacecraft and IDPU**
- **SEP, SWEA, PLASTIC interface tests using instrument simulators**
  - **Verify IDPU to instrument controls and instrument to IDPU telemetry paths**
- **MAG and STE-U CPTs described above will be performed via the IDPU using ETU detectors**

IDPU Environmental Test Plan

- IDPU will go though Vibration and Thermal Vac early
- Integration and test with flight instrument suites prior to FM1 Suite EMC
- Bakeout after EMC
- No Thermal Balance test planned for IDPU
  - IDPU mounted inside the spacecraft, thermally coupled to deck, no blankets
  - Thermal model can be verified using Thermal Vac data

IDPU Environmental Tests

- Mass properties
  - Flight units shall be weighed in flight configuration
  - IDPU is sufficiently small that CG and MOI can be determined by analysis to the accuracy required
- Vibration
  - IDPU will be vibrated to levels specified in Environmental Spec (Sine Sweep, Random)
  - IDPU will be vibrated in launch mode, powered off with MAG heater powered on
  - A CPT will be performed before and after vibration
  - No foils or other acoustic concerns, so no acoustic test
- Thermal Vac
  - 1 survival cycle plus 6 operational cycles per the Environmental Test Spec
    - A CPT will be performed at each dwell
  - Temperatures as indicated in the Environmental Spec for thermally coupled instruments
    - -23 - +55C Op, -28 - +60 Survival
    - Includes 10C margin

IDPU Environmental Tests, continued

- EMC
  - IDPU will go through EMC with the rest of the suite
    - See EMC presentation below
  - IDPU shall be surveyed for magnetically by UCB

- Bakeout
  - IDPU will be baked out after EMC to verify outgassing rates as indicated in Contamination Control Plan
    - APL to provide conversion from outgassing rate to TQCM rates (after UCB provides chamber configuration data)

IDPU Test Matrix

Verification Matrix for STEREO/IMPACT/IDPU

Revision Date: 11/24/2003
Revision Number: 3

Hardware Description		Test																	
Level of Assembly	Item	Elect. test, rm. Temp	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Shock	Acoustics	Pressure change	Voltage margins	Thermal Vacuum	Thermal balance	>100 hours Operation	EMC/EMI	Magnetics	Leak	Bakeout	Contamination	Comments
C	PWB, EM	**C**	**P**	**C**						**C**			**C**						
I	IDPU EM	**C**	X	X						**C**			**C**	**C**					EMC CE test on EM
C	PWB, F	**C**	**C**	**C**						**C**							X		
I	IDPU, F	X	X	X	X	X			**A**	X	X		X	H	X		X	X	EMC at Suite level

Legend:

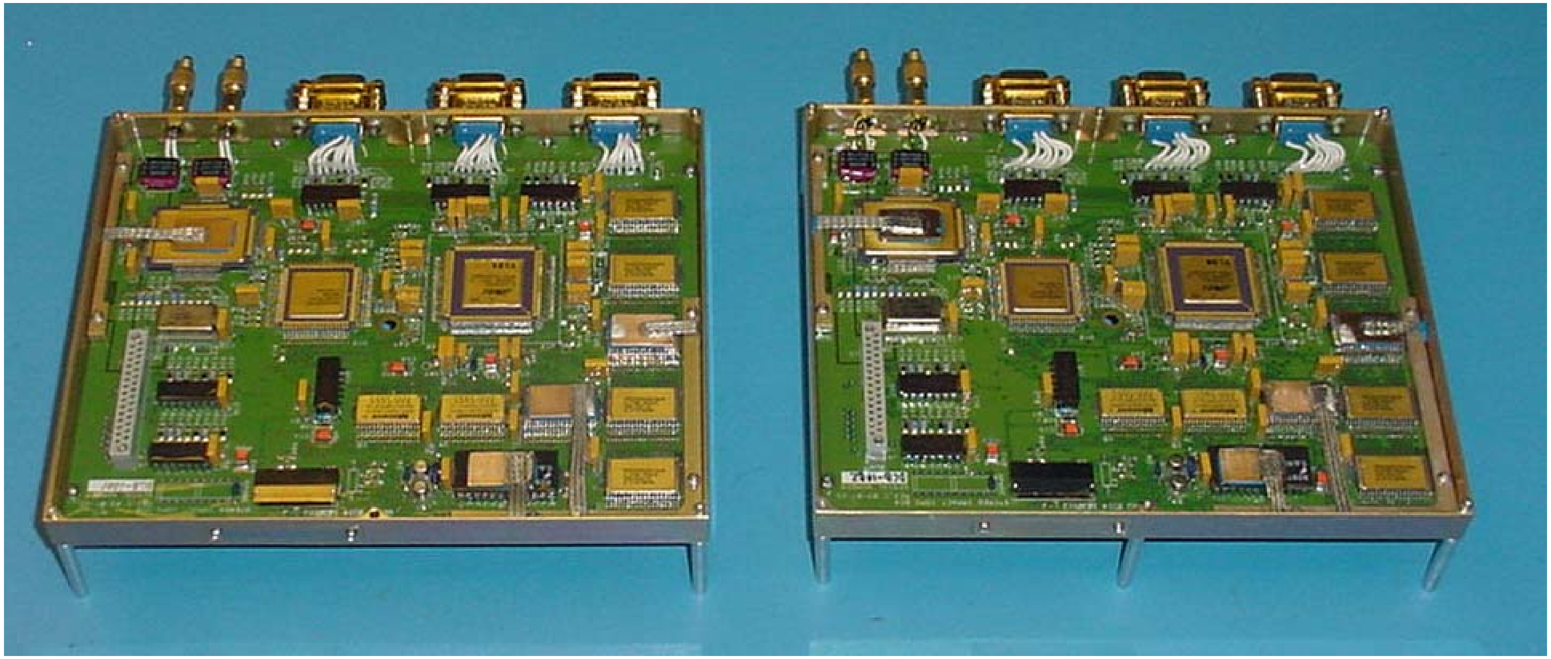
Level of Assembly	Unit Type		Test
			X = Test required
			A = Analysis
C = Component	BB =	Breadboard	H = at higher level of assembly
I = Instrument	EM =	Engineering Model	**C = Test Completed**
	PT =	Prototype	
	PF =	Protoflight	
	F =	Flight	

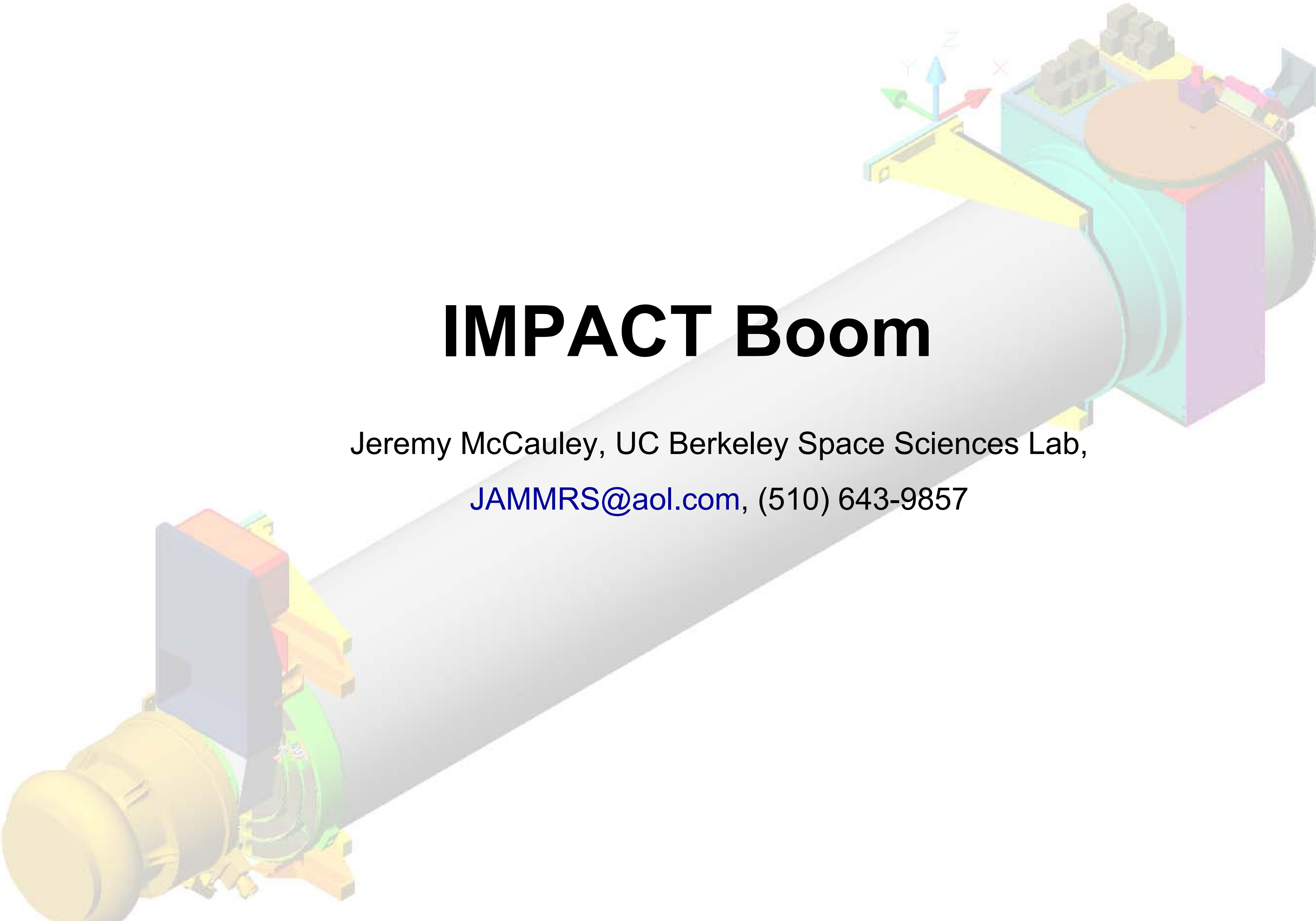
IDPU Status

- ETU IDPU interface tests complete, including spacecraft
- FM1 and FM2 DCB are complete
- FM LVPS PWB in fab
- FM STE-U Interface PWB in fab
- FM1 MAG built, in test at GSFC

- PROM (boot) flight software reviewed, acceptance tested, installed in DCB
- EEPROM (instrument) flight software in Rev 2.5, adequate for system and instrument test (except PLASTIC)
  - Remaining IMPACT functions are "science add-ons" such as Burst triggers; basic measurements can be made without this code
  - Remaining functions not required for instrument environmental tests
  - Rev 3 (final IMPACT software) expected to be complete prior to IDPU environmental tests
  - Current PLASTIC software is adequate for hardware testing
  - Final PLASTIC software required before PLASTIC FM calibrations, ~April 04

IDPU Flight Data Controller Boards





IMPACT Boom

Jeremy McCauley, UC Berkeley Space Sciences Lab,

JAMMRS@aol.com, (510) 643-9857

Boom Performance Test Plan

- **Boom consists of:**
  - The fully assembled Flight Booms (FM1 and FM2), including the Boom Tube Assembly, SMA Pin Puller Release Device, Cables, and mass dummies or instruments as required for the particular test
- **Testing to include:**
  - Thermal, Vibration, Functional, Stiffness, and Alignment verification
  - See Boom Test Plan for detailed information
- **Boom functional testing**
  - Actuated deployments will be performed to ensure functionality

Boom Verification Matrix

Verification Matrix for STEREO/IMPACT/Boom — Revision Date: 1/6/2004 — Revision Number: 5

Hardware Description		Test																		
Level of Assembly	Item	Deploy Test, Room Temperature	Deploy Test, Thermal Vac	Stiffness, Proof Load	Vibration, Sinusoidal	Vibration, Random	Self Shock	Acoustics	Alignment	Force Margin Deployment	Thermal Vacuum	Thermal Cycle	Thermal Balance	End-to-End Conductance Test	EMC/EMI	Magnetics	Bakeout	Deployment Contamination	Contamination Inspection	Comments
C	Proto	P		P																
C	EM	P		P														P		Qual levels
C	PF/FS	P	P	P	P	P	P		P	P	P	P	P	P		P				Protoflight levels
C	FM1	X		X					X			X		X		X			X	Protoflight levels
C	FM2	X		X					X			X		X		X			X	Protoflight levels
S	FM1		S1		S1	S1	S				S1	S1			S		S			Protoflight levels
S	FM2		S1		S1	S1	S				S1	S1					S			Protoflight levels

Legend:

Level of Assembly	Unit Type		Status
C = Component	PT =	Prototype	X = Test required
S1 = with MAG, STE-U	PF/FS =	Protoflight / Flight Spare	A = Analysis
S = with all instruments	FM1 =	Flight unit #1	**P = Performed**
	FM2 =	Flight unit #2	

Boom Test Reference Documentation

- **STEREO/IMPACT Boom Verification Plan, Rev. E (W. Donakowski, 05 July 2003)**
- **STEREO Boom Vibration Test Procedure, IMP-562-DOC (W. Donakowski, 05 July 2003)**
- **STEREO Boom Thermal Vacuum Cycling Test Procedure, IMP-563-DOC (W. Donakowski, 08 August 2003)**
- **STEREO/IMPACT Boom Thermal Balance Test Plan (A. Seivold, 29 August 2003)**
- **STEREO Boom Stowing Procedure, IMP-449-DOC (J. McCauley, 05 August 2003)**
- **STEREO Boom Deployment Checklist, IMP-451-DOC, Rev. C (J. McCauley, 13 November 2003)**

Protoflight Test Results

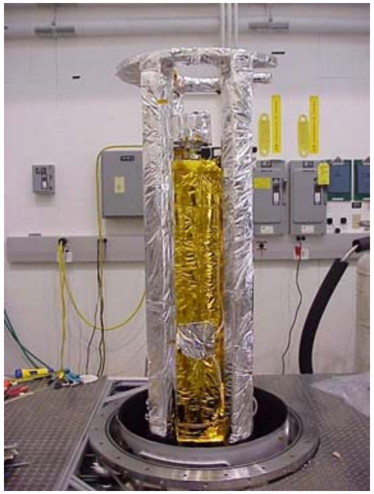
- The Protoflight Boom has been deployed in excess of 25 times.
- The structure has been shown repeatedly to have a first frequency of 1.9 Hz.
- The structure is stable in thermal cycling.
- The actuation and deployment systems function at survival temperatures.
- The structure, actuation and deployment systems function after sinusoidal and random vibration.
- Vibration levels were determined for all attached instruments.
- The Boom has been found to align the Magnetometer to within 25.7 arcmin (root of sum of squares) in the XY and XZ spacecraft planes. (The requirement is 52.5 arcmin.)
- The deployment system functions with adequate force margin.

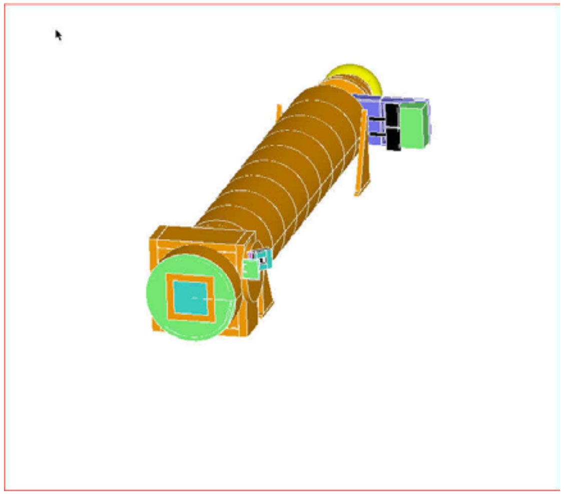
Protoflight Test Results – Thermal Balance

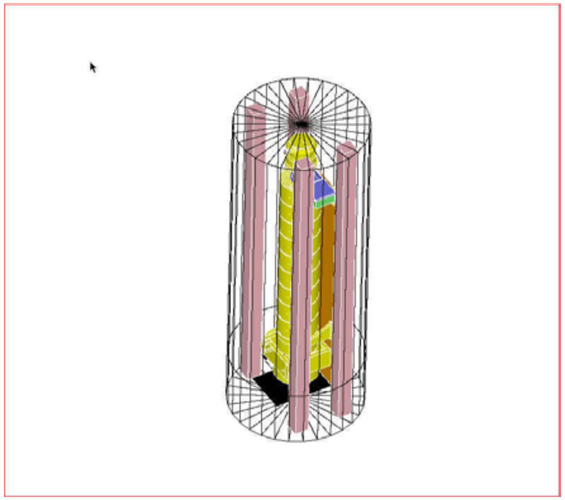
(Protoflight model Boom thermal balance test was conducted September 7-14)

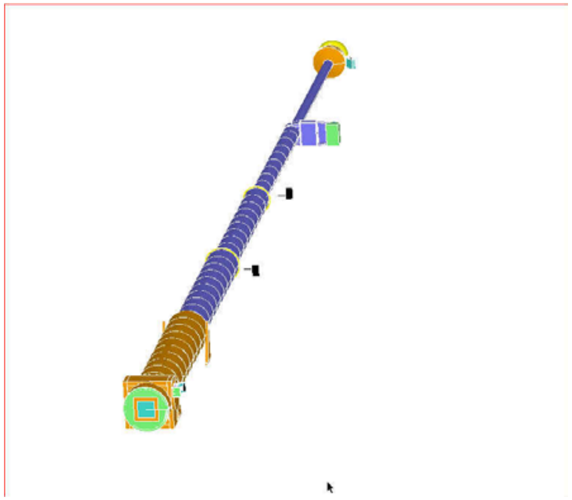
- **Boom thermal design was verified via cold and hot test cases.**
- **Boom to Spacecraft thermal isolation was found to be inadequate; upgraded design meets APL requirements.**
- **Thermal blanket design was determined to be acceptable; effective emittance of the Engineering model blankets was approximately 0.01. Flight blankets will be validated by inspection and during the spacecraft thermal vacuum test.**
- **Thermal model was correlated after minor adjustments; updated flight predictions indicate Boom temperatures and thermal interfaces meet all requirements as specified for the STEREO mission.**
- **Instrument mass models were used in TB test; SWEA and STE thermal designs to be verified in separate thermal balance test in April 04 and validated at spacecraft level TV test.**
- **Magnetometer thermal design has been verified on other programs; thermal interface to be validated at the spacecraft level TV test.**

Protoflight Test Results – Thermal Balance Setup and Model









Protoflight Test Results – Thermal Balance Tables

TABLE 2: IMPACT Boom Stowed Model Flight Predictions				
Location	Worst Cold Cases		Worst Hot Cases	
	AHEAD	BEHIND	AHEAD	BEHIND
Bobbin Cover (10011)	-2.4	-3.9	17.6	14.7
Outer Bobbin (1031)	-12.1	-13.3	7	4.6
Pinpuller (1035)	-14.6	-15.7	4.3	2.1
L. Mt. Ring (1020)	-15.8	-16.8	3	1
Boom Center (1025)	-28.2	-28.5	-11.7	-12.9

TABLE 1: Summary Test Temperatures vs. Model Predictions				
Location	Test	Analysis	Test	Analysis
Bobbin Cover	7.4	7.6	35.5	34.1
Outer Bobbin	-5.8	-7.6	21.2	15.7
STE Pre-Amp MM	-12.1	-12.8	14.2	9.2
Pinpuller	-14.1	-11.2	9.9	11.3
Lower Mount Ring	-11	-13	15	9.3
Boom End	-25.3	-20.9	-1.7	-0.2

TABLE 4: IMPACT Boom Deployed Model Flight Predictions				
Location	Cold BOL Cases		Hot EOL Cases	
	AHEAD	BEHIND	AHEAD	BEHIND
Bobbin Cover (10011)	-6.1	-8.5	40.9	29.2
Outer Bobbin (1031)	-16.4	-18.8	22.9	13.7
Pinpuller (1035)	-19.2	-21.4	18.2	9.5
L. Mt. Ring (1020)	-20.8	-22.8	15.5	7.3
Boom Center (1025)	-50	-51.6	-21.3	-26.4
Boom End (1030)	-68.5	-69.6	-48.5	-50.2

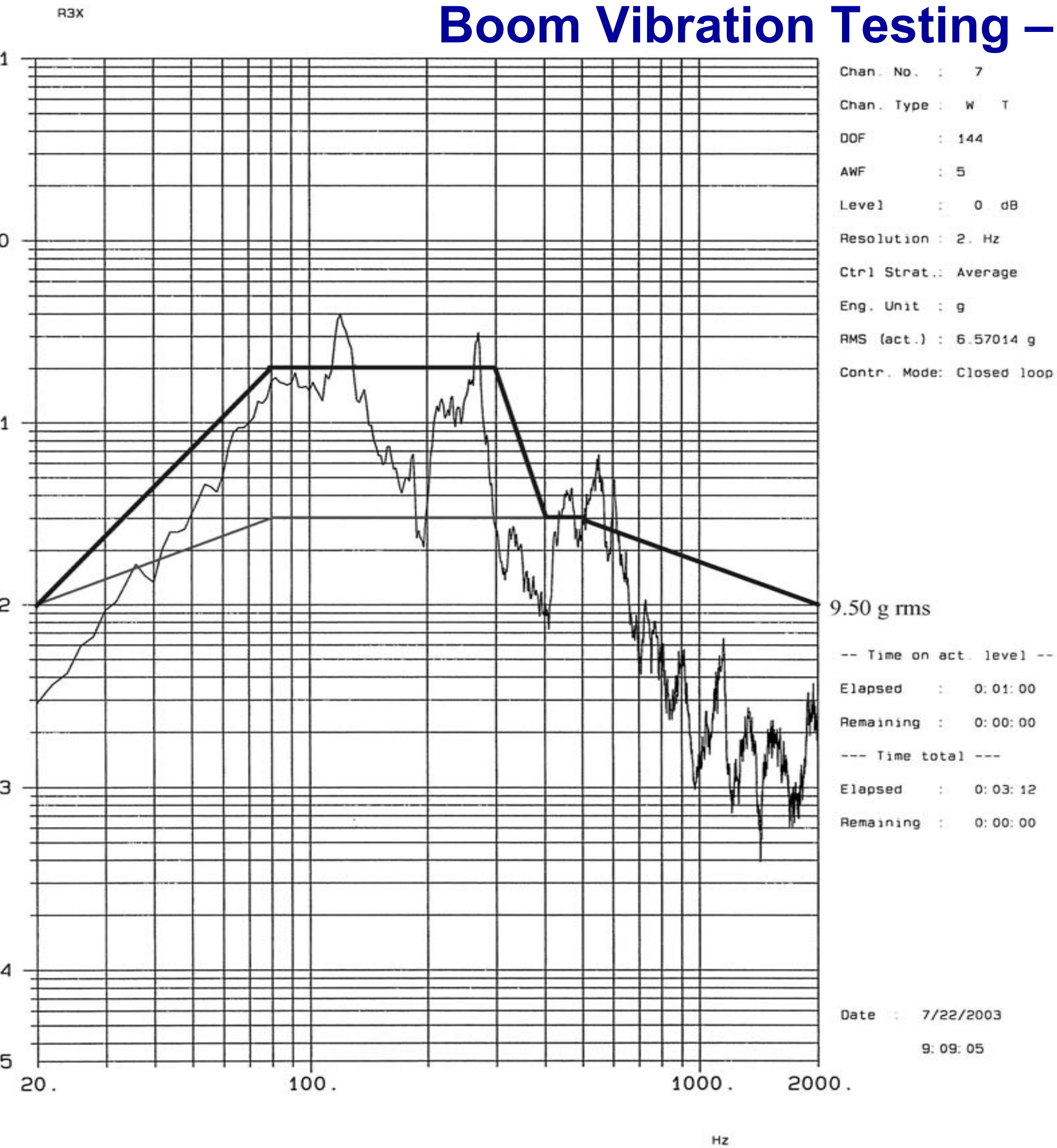
Boom Environmental Test Plan

- Boom FM1 and FM2 will undergo deployment verification after assembly and after Environmental Testing
- Boom FM1 and FM2 will undergo Vibration and Thermal Vac with the Magnetometer and STE-U installed (February – April)
- Boom FM1 and FM2 will undergo one hot and one cold deployment after thermal cycling
- Boom FM1 and FM2 Suites will undergo one fully-configured deployment to verify functionality and self-shock survival
- Integration and test with flight instrument suites prior to FM1 Suite EMC
- Bakeout after EMC

Boom Environmental Tests

- **Mass properties**
  - Flight units shall be weighed in flight configuration
  - CG and MOI shall be measured in flight configurations
- **Vibration**
  - Boom will be vibrated to levels specified in Environmental Spec (Sine Sweep, Random)
  - Boom will be vibrated powered off
  - An instrument CPT will be performed before and after vibration
  - No foils or other acoustic concerns, so no acoustic test
- **Thermal Vac**
  - 1 survival cycle plus 6 operational cycles per the Environmental Test Spec
    - An Instrument CPT will be performed at each dwell
    - Boom FM1 and FM2 will undergo one hot and one cold deployment after thermal cycling
  - Temperatures as indicated in the Environmental Spec for thermally coupled instruments
    - -23 - +30° C Operational, -33 - +40° C Survival
    - Includes 10° C margin

Boom Vibration Testing – SWEA Levels



All instrument vibration envelopes will be verified by FM1 vibration prior to instrument vibration testing

Example:

X AXIS 0dB RANDOM

R3X

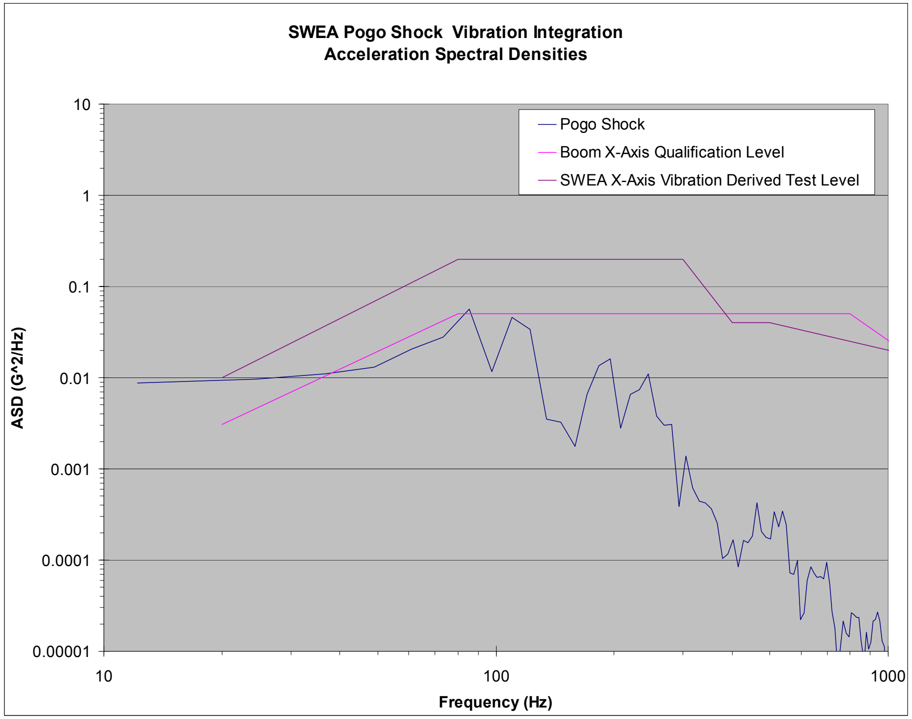
SWEA and STE-D X-axis

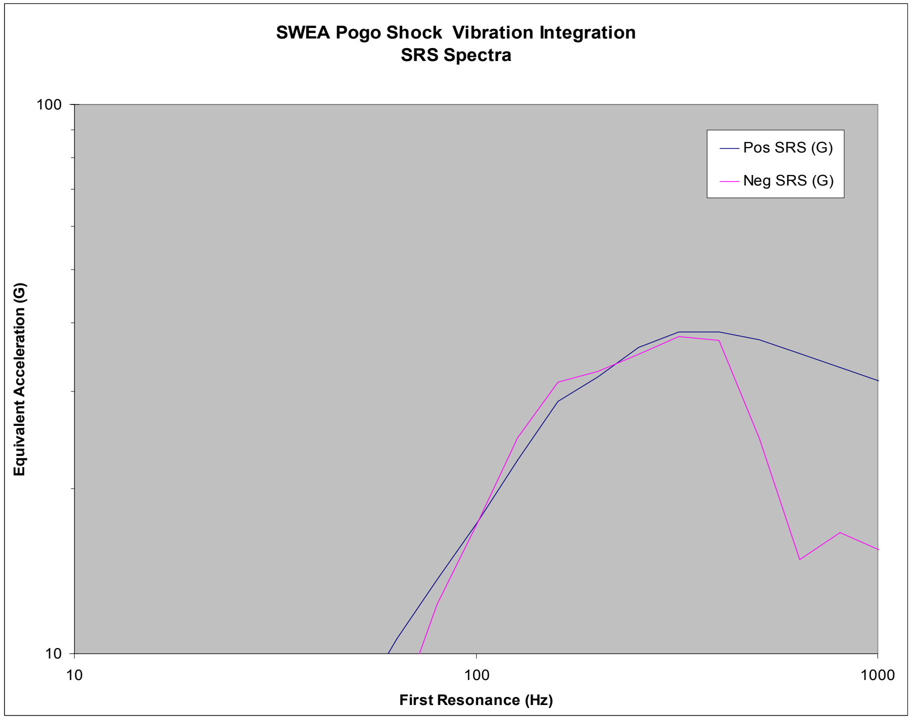
Envelope: 9.50 g rms

- **Created from The FEMCI Book - Creating a Random Vibration Component Test Specification**

Boom Shock Vibration Testing – SWEA Levels

- **SWEA Pogo Shock levels at end of travel are included within the vibration envelopes.**
- **SWEA will be deployed once attached to the Boom for final verification.**





Boom Environmental Tests, continued

- **EMC**
  - Boom will go through EMC with the rest of the suite
    - See EMC presentation below
  - Boom shall be surveyed for magnetic cleanliness at UCB

- **Bakeout**
  - Boom will be baked out after EMC to verify outgassing rates as indicated in Contamination Control Plan
    - APL/GSFC to provide conversion from outgassing rate to TQCM rates

Boom Status

- **FM1 and FM2 tubes are procured and machined**
- **FM1 and FM2 harness assembly parts are fabricated**
- **FM1 and FM2 structure mount assembly parts are fabricated**
- **FM1 and FM2 rings are fabricated**
- **FM1 and FM2 lock pin assemblies are complete**
- **FM1 and FM2 rings and tubes to be glued this month**
- **FM1 and FM2 telescoping assemblies to be constructed in February**

Boom
Deployment Video

Qual boom ready for thermal balance test

IMPACT Suite EMC

David Curtis (PM), UC Berkeley Space Sciences Lab,

dwc@ssl.berkeley.edu, (510) 642-5998

EMC Test Plan

- EMC tests called out in the Project EMC Requirements document
- Only FM1 gets the full suite of EMC tests
  - Bonding & Isolation
  - CE01, CE03, CE07
  - CS01, CS02, CS06
  - RE01, RE02
  - RS03
- FM2 gets a subset of tests
  - CE03
  - Will be performed separately for each separately powered subsystem (IDPU, Boom, SEP)
- IMPACT FM1 Suite shall perform EMC testing together
  - Verifies flight intra-instrument harness noise
  - Verifies sneak current paths between instruments
  - Scheduling difficulty to bring full suite together at one time dictates when test will be done
    - Currently scheduled for May/June
  - PLASTIC plans to test with IMPACT, but IMPACT testing will not be delayed to accommodate PLASTIC
- EMC tests will be arranged by UCB, probably at a facility in the Bay Area
  - Have a ROM from a local EMC house
  - FM2 tests can be performed using UCB-available equipment

EMC Test Levels (From EMC Spec)

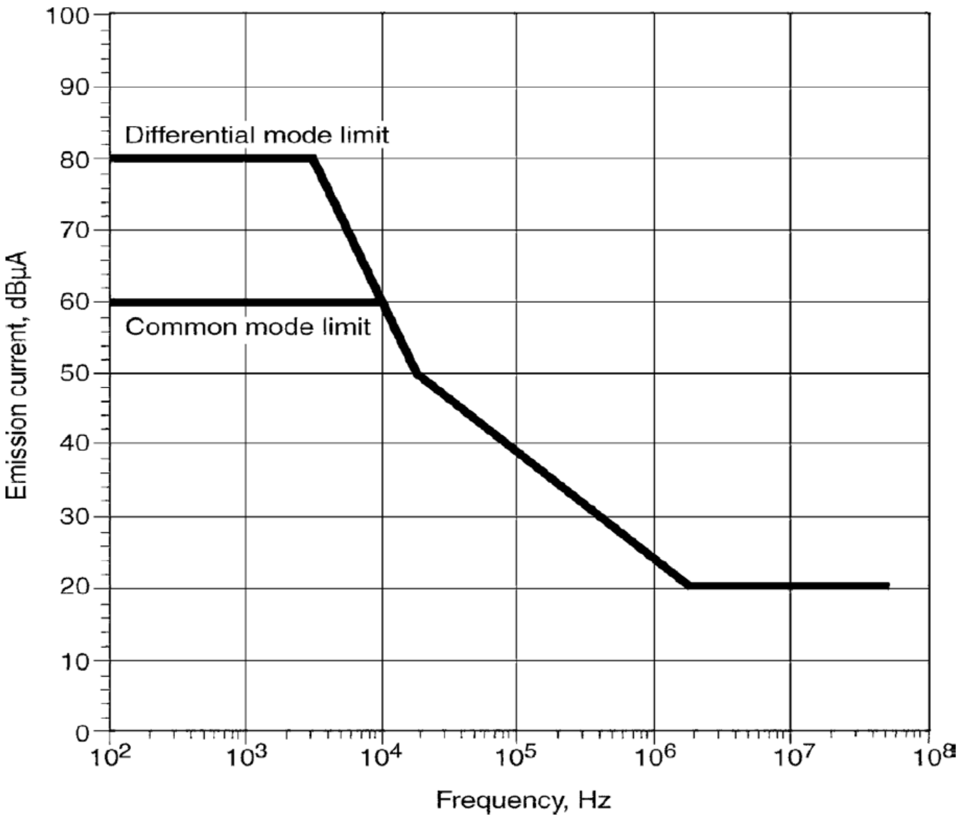


Fig. 1 & 2. CE-01 & CE-03 conducted emissions limits.

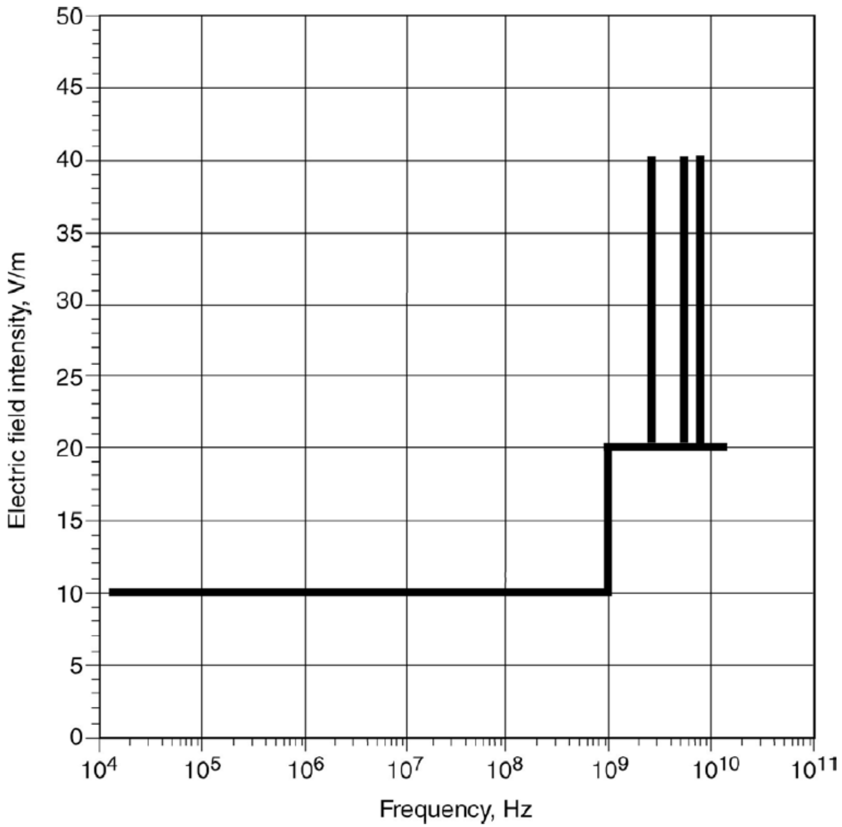


Fig. 4.10. RS-03 Radiated susceptibility levels.

EMC Test Levels (From EMC Spec)

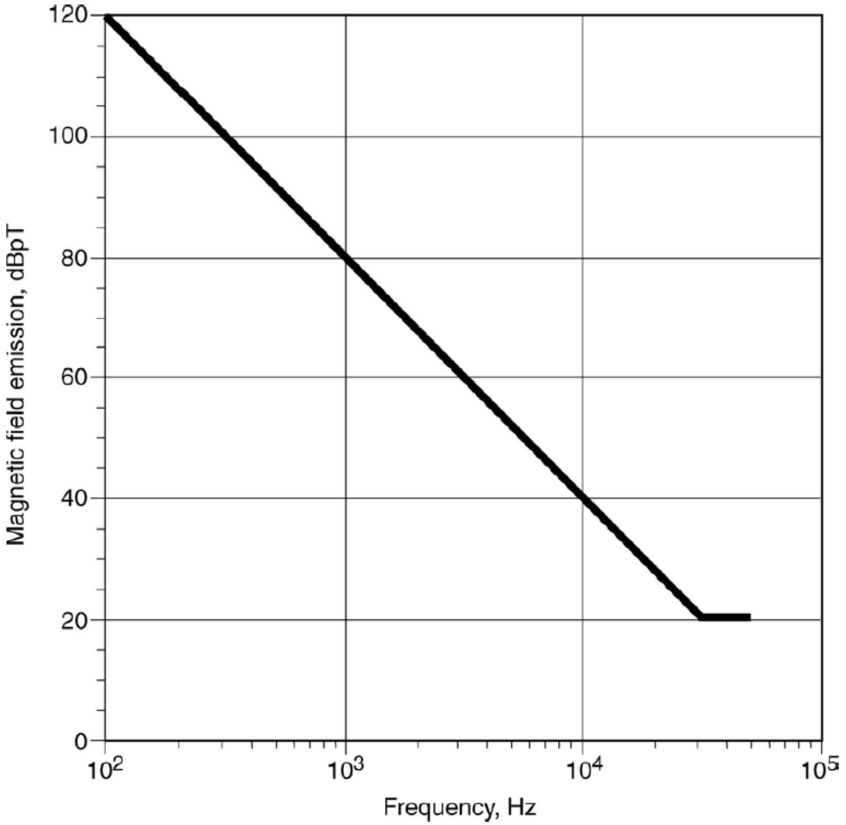


Fig. 4.8. RE-01 Magenetic field emissions limits.

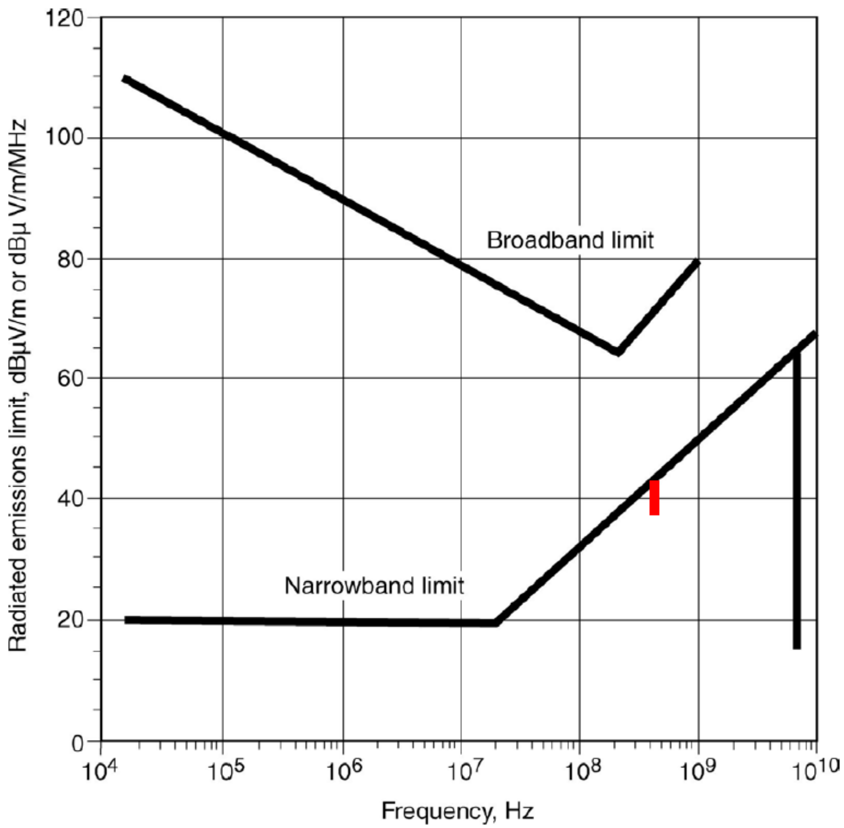


Fig. 4.9. RE-02 Electric field emissions limits.

SEP Suite
Pre Environmental Review

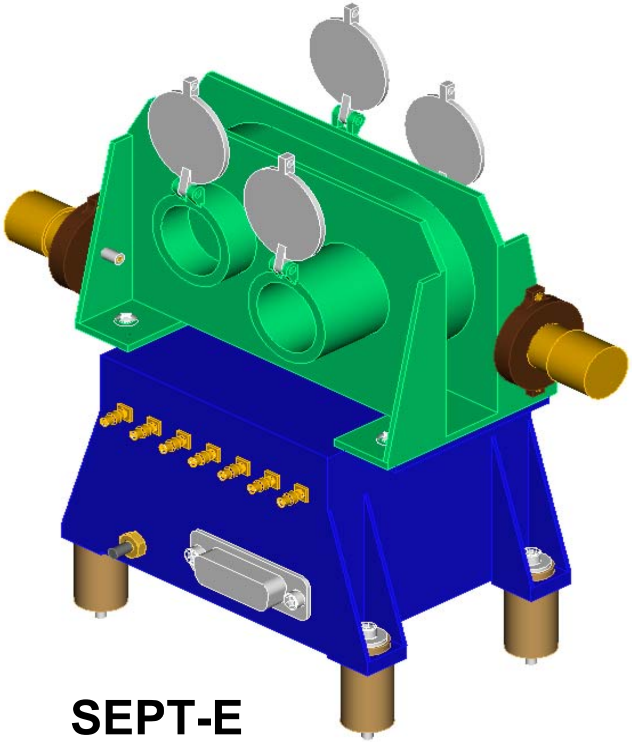
Alan Cummings
ace@srl.caltech.edu
626-395-6708

SEP Sensor Suite

- Low Energy Telescope (LET)
- High Energy Telescope (HET)
- Suprathermal Ion Telecope (SIT)
- Solar Electron and Proton Telescope (SEPT)
- SEP Central Electronics

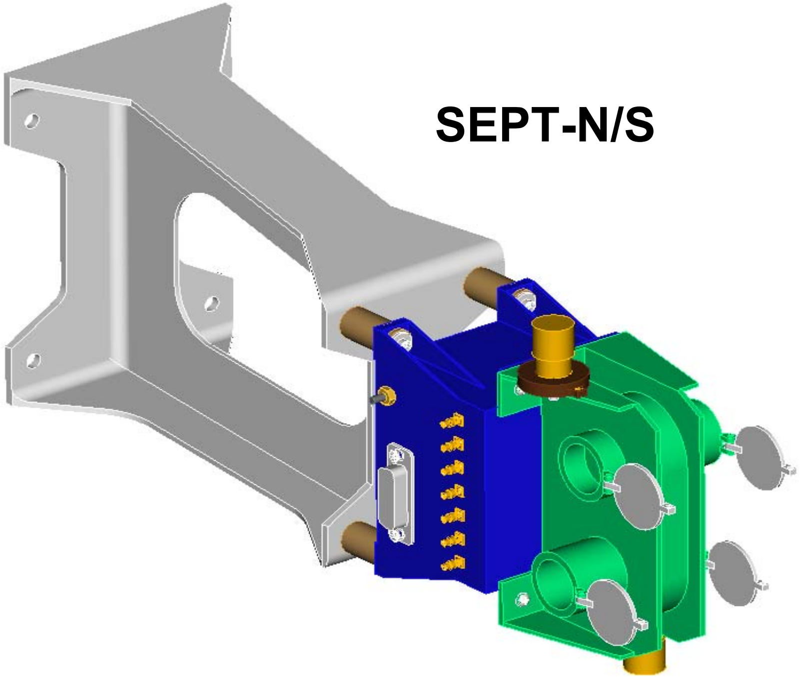
SEPT-Ecliptic and SEPT-North/South

One SEPT-E and one SEPT-N/S are mounted on each spacecraft. They are identical except for thermal hardware and coatings and how and where they are mounted to the spacecraft.

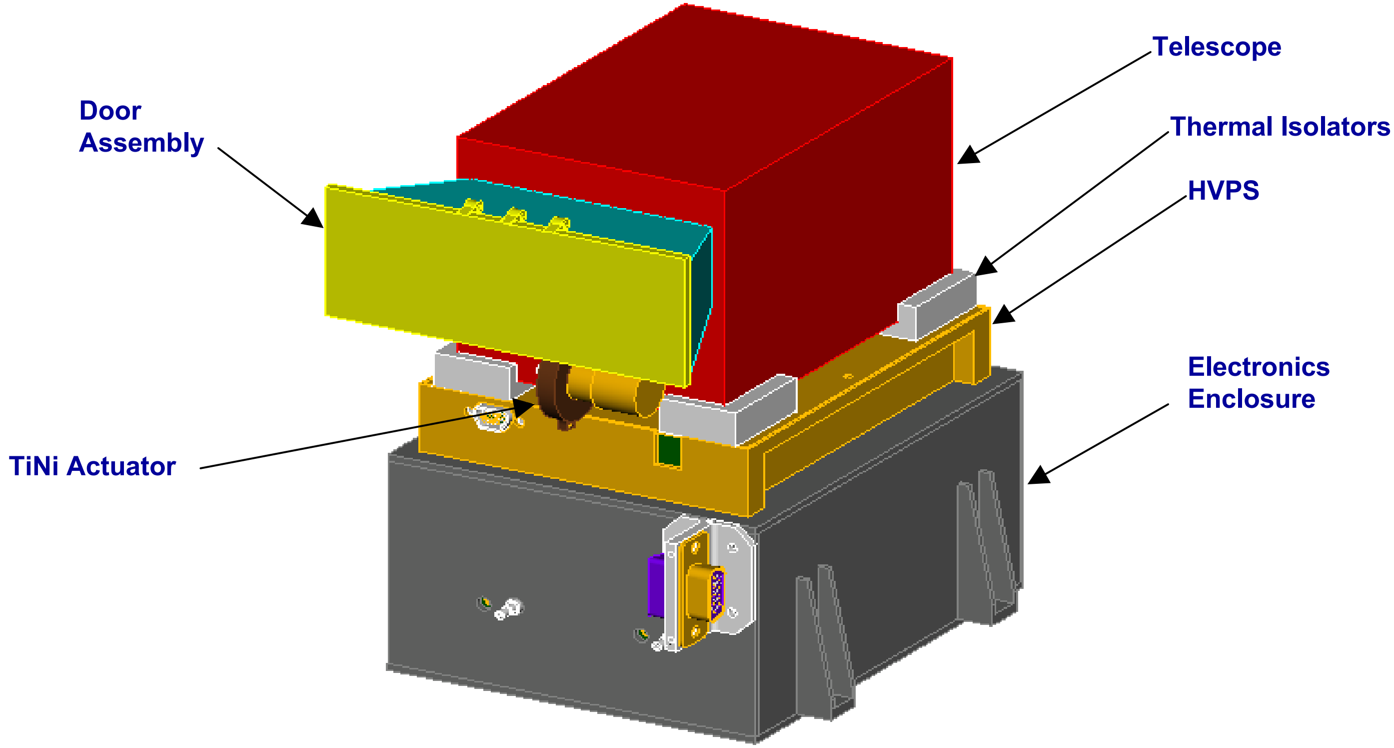


SEPT-E

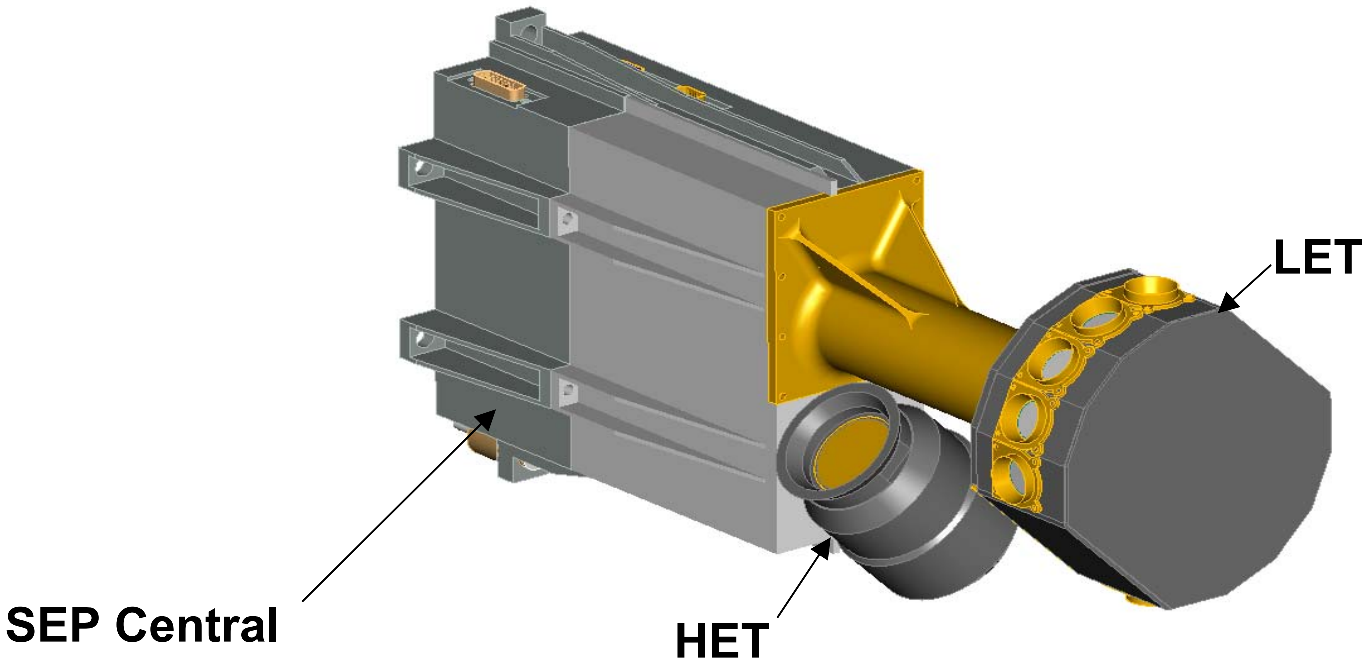
SEPT-N/S



SIT Sensor Assembly



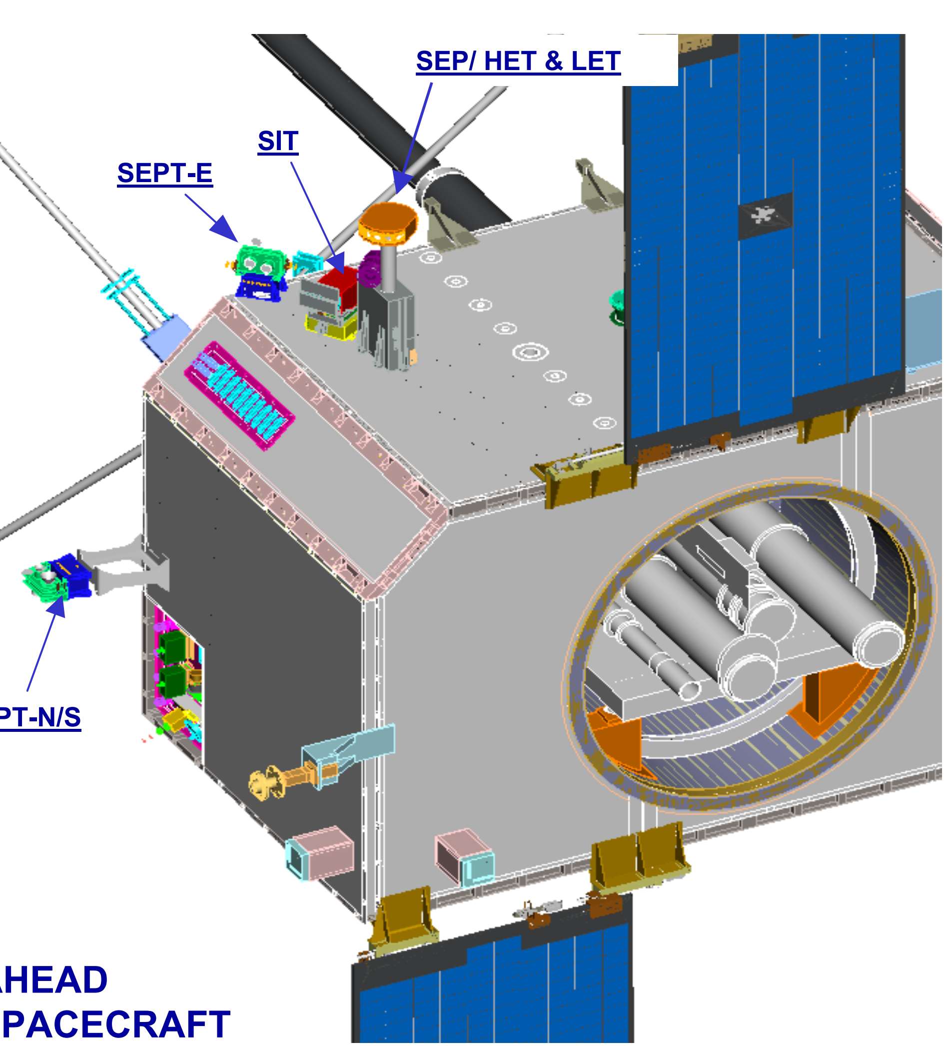
HET/LET/SEP Central

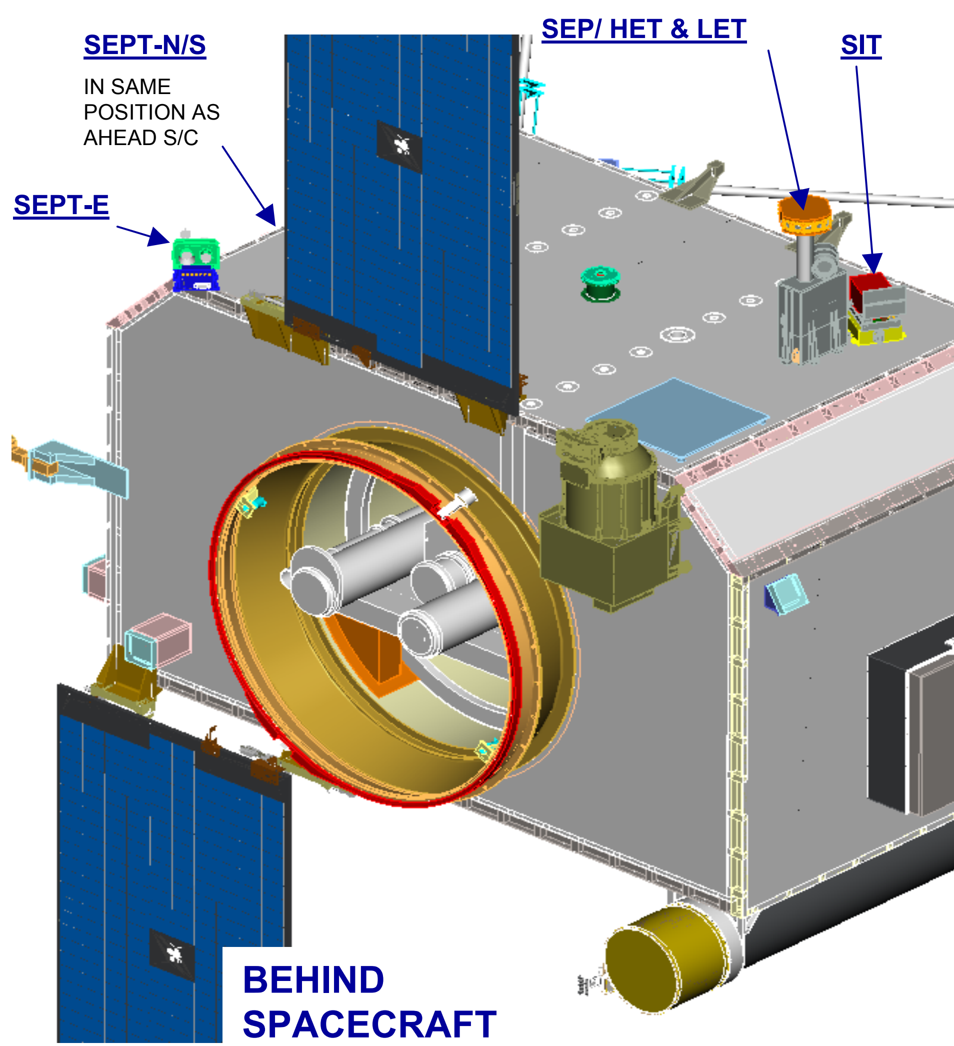


SEP Responsibilities

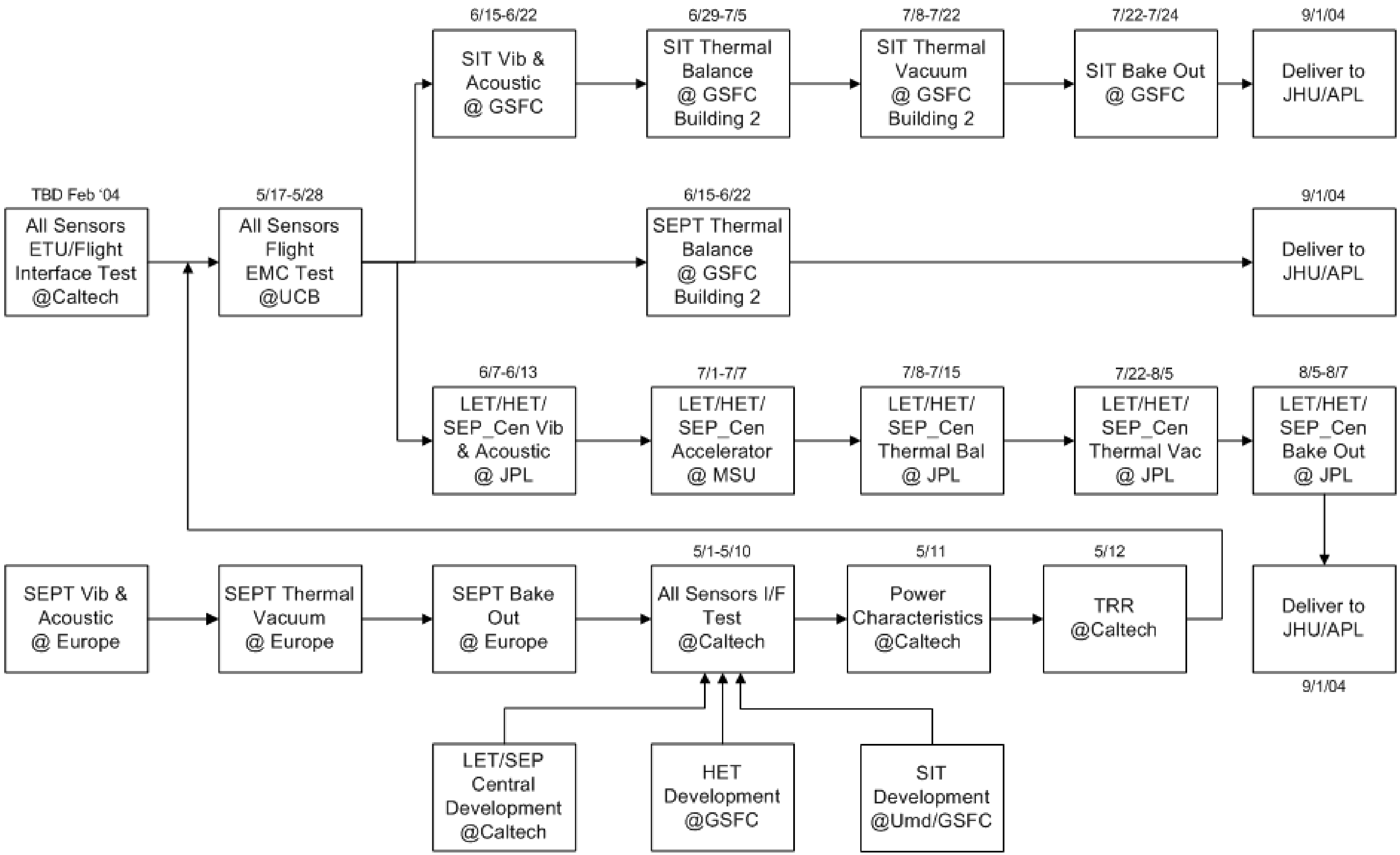
- **University of Kiel** - Design/fabrication/test of SEPT telescopes
- **ESTeC** - Design/fabrication/test of SEPT electronics (except thermal balance)
- **U of MD** - Overall responsibility for design/test of SIT
- **Max Planck/Lindau** - Digital portion of SIT time-of-flight system
- **Caltech**
  - LET development/test; SEP Central electronics (except LVPS), PHA ASIC & MISC development
  - LET, SEP Central, and SEPT software development
  - LET and SEP Central GSE development
  - Overall integration/test of SEP suite
- **JPL**
  - LET/HET detector procurement
  - LET development/test
- **GSFC**
  - HET development/test including software
  - Overall SEP mechanical design and fabrication, excluding SEPT (e.g. detector, telescope, enclosure, and bracket designs)
  - Overall SEP thermal design
  - SIT fabrication/assembly/testing + SIT MISC + SIT software + SIT detector testing
  - Thermal balance of SEPT; thermal vac/balance of SIT
- **UCB** - SEP Central LVPS & SIT HVPS

SEP Sensors on the Spacecraft

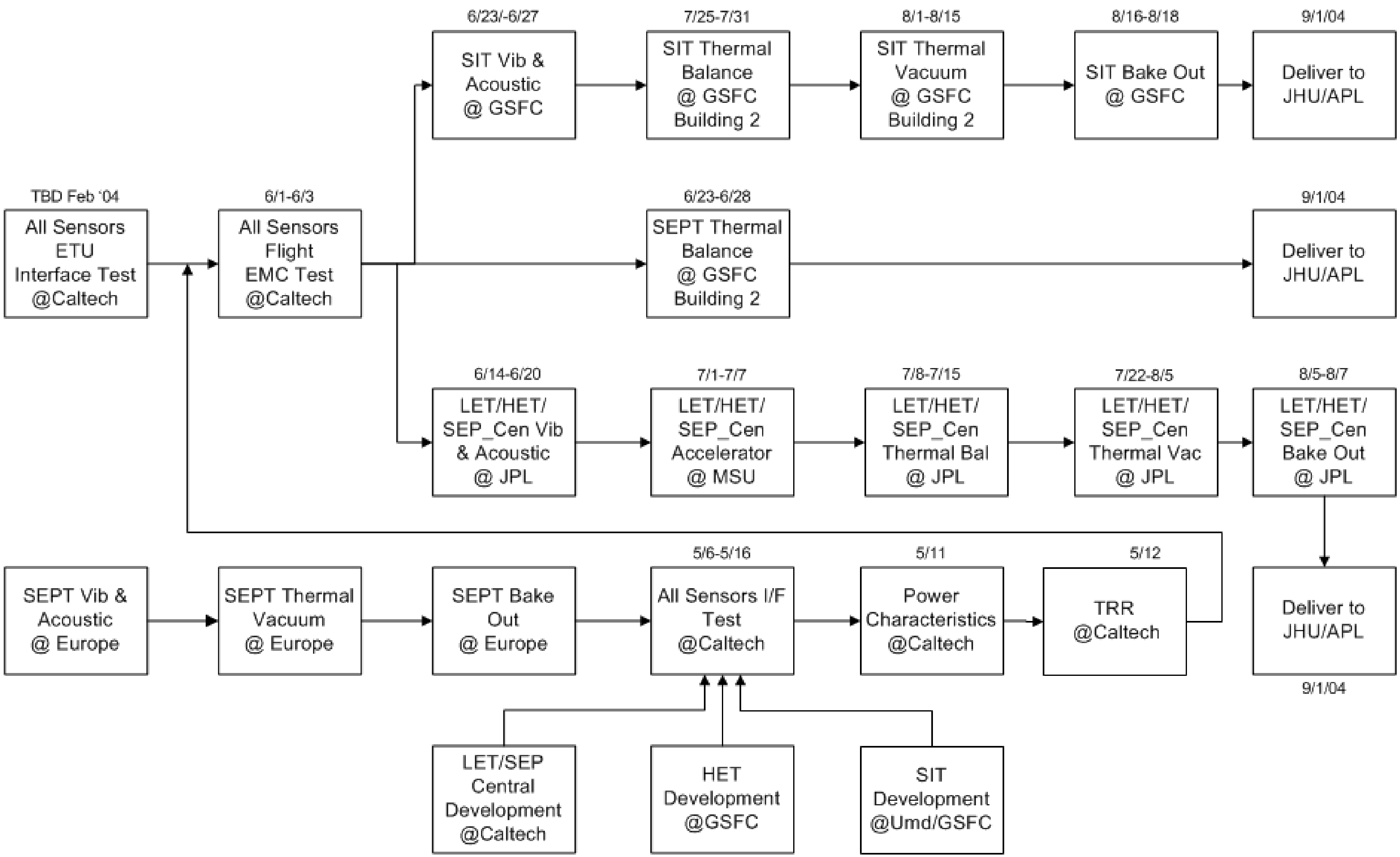




SEP Suite FM1 Test Flow (1/7/04)



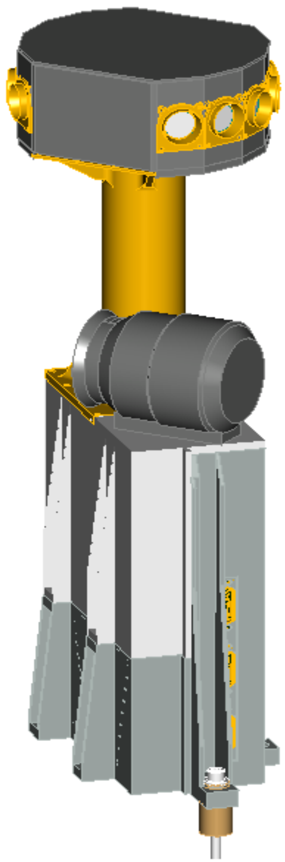
SEP Suite FM2 Test Flow (1/7/04)

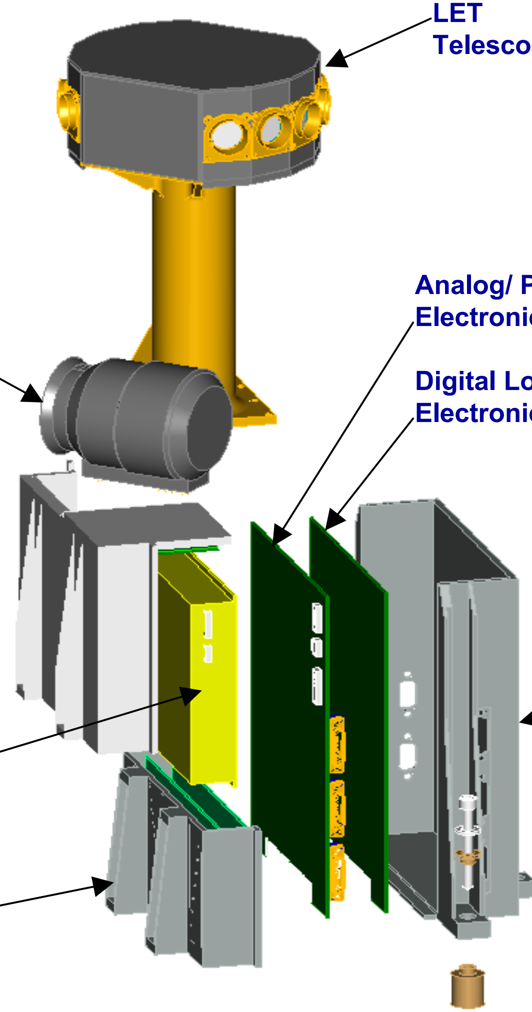


SEP Central/LET/HET Pre Environmental Review

Alan Cummings
ace@srl.caltech.edu
626-395-6708

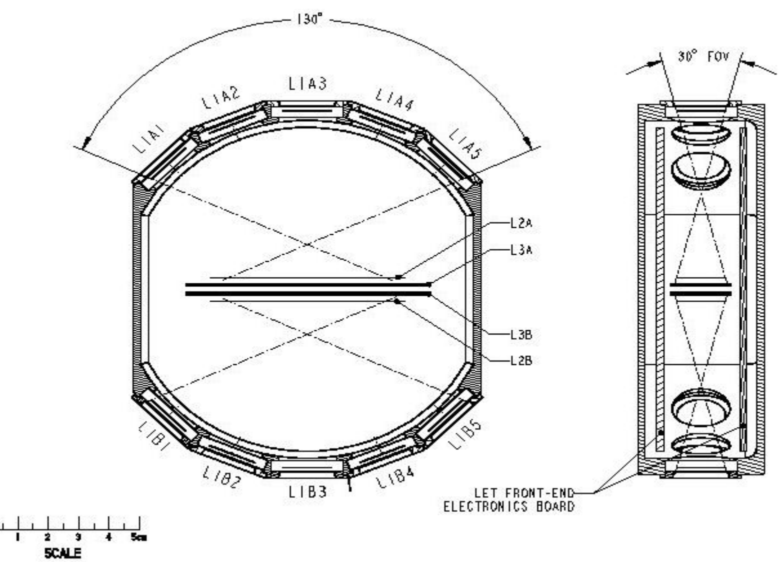
Main SEP Assembly

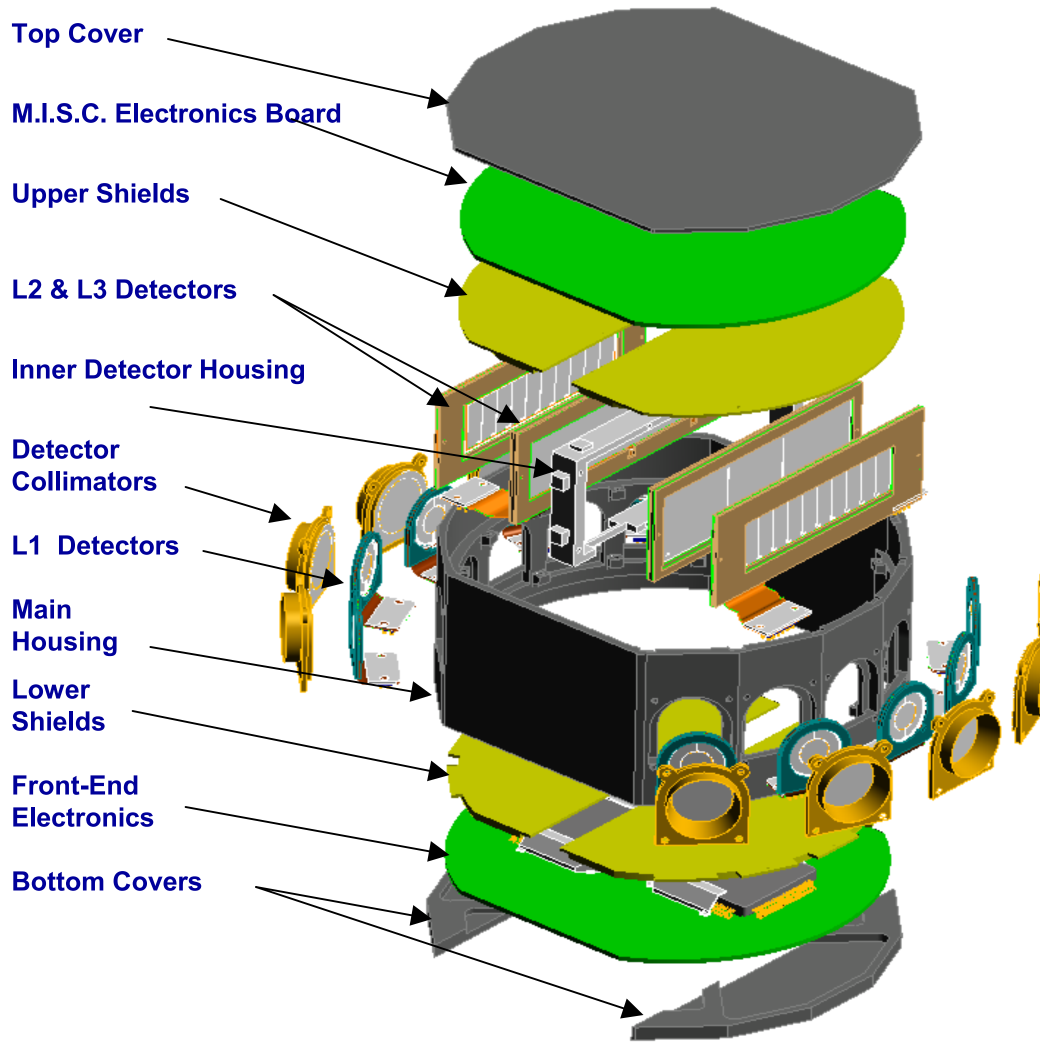




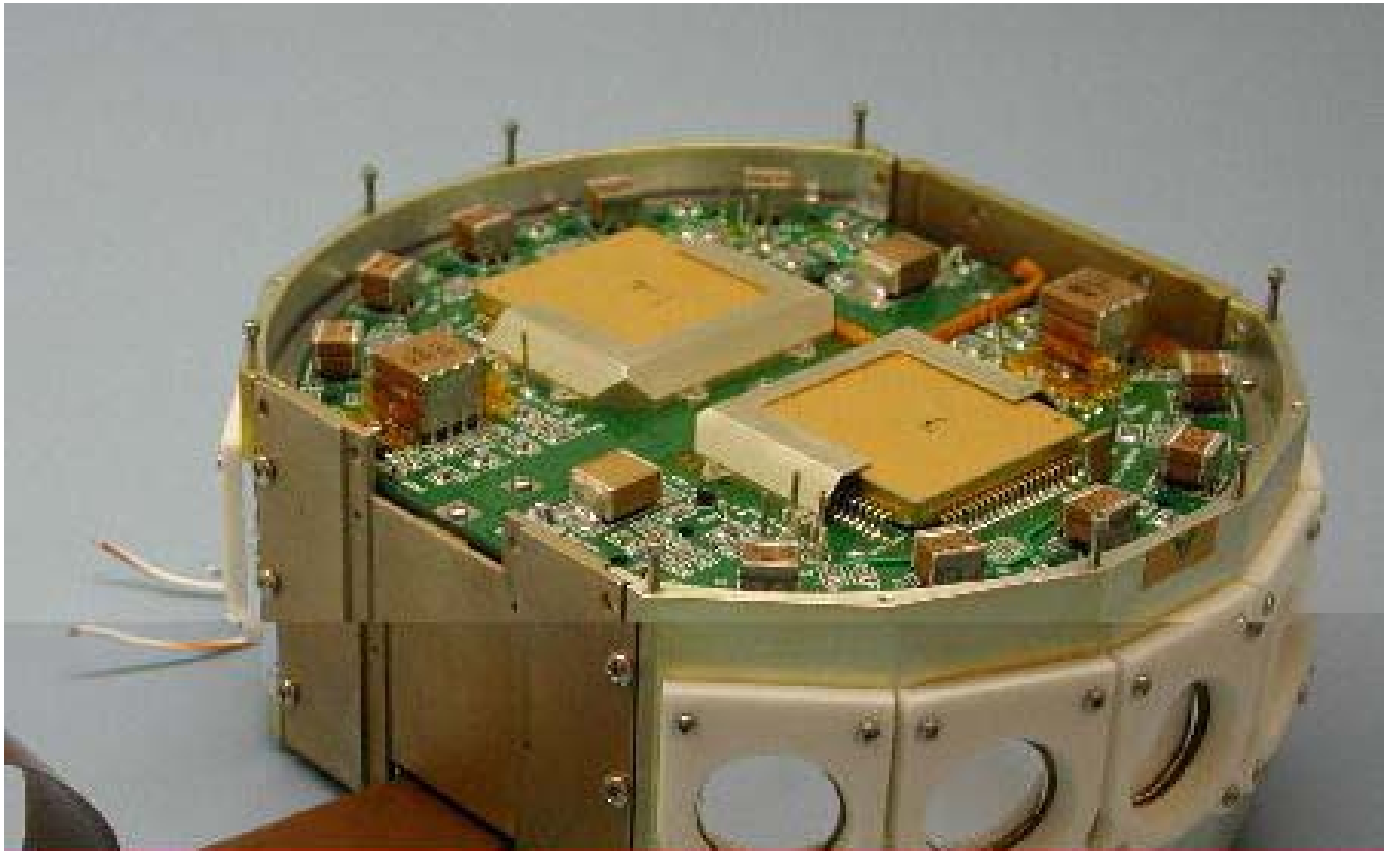
•Behind S/C configuration shown

Low Energy Telescope (LET) Schematic

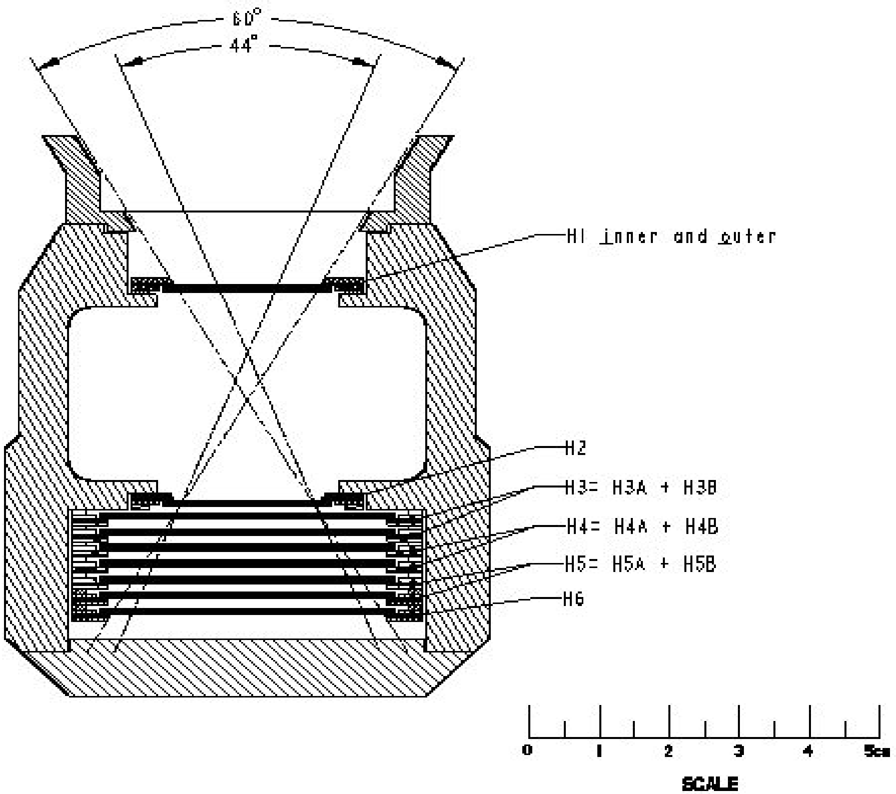


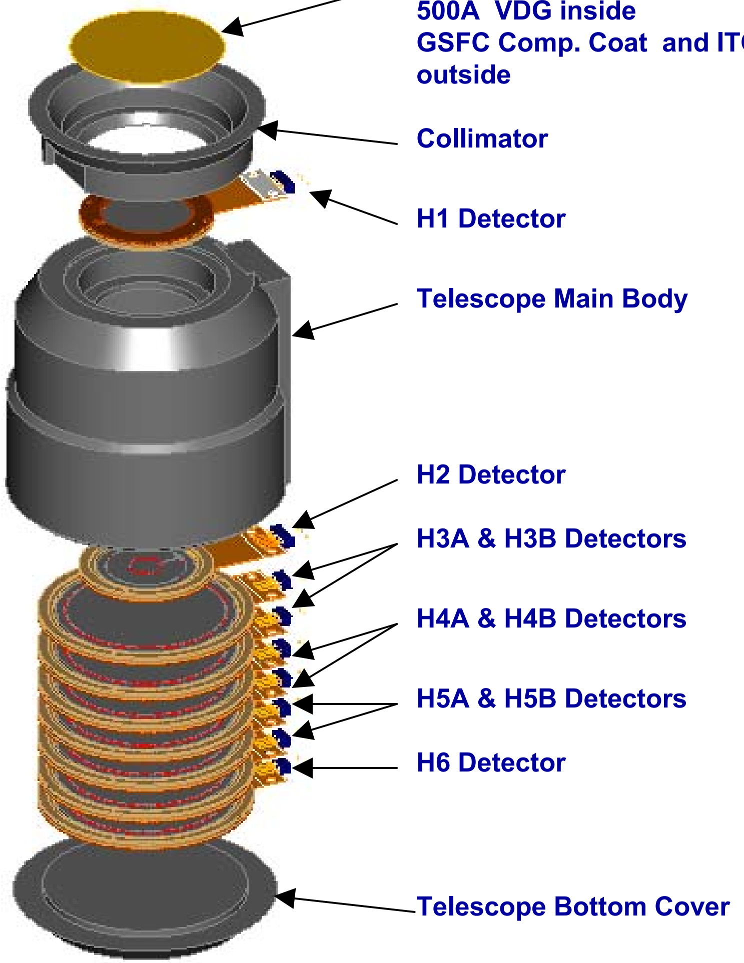


Low Energy Telescope (LET) EM Unit



HET Telescope Schematic





Verification Matrix for STEREO/IMPACT/SEP/LET

Revision Date: 1/8/04
Revision Number: 7

Hardware Description		Tests																					
Level of	Item	Noise & Brkdown	Thermal vacuum	Alphas &/or particle accelerator	Elect. test, rm. Temp	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Shock	Acoustics	Pressure change	Voltage margins	Thermal cycle	Thermal balance	Life Test	EMC/EMI	Magnetics	Radiation	Leak	Bakeout	Contamination	Comments
C	Detectors, PT	C	C	C	C	C	C		C		X			C								X	Acoustics in EM with windows
C	Detectors, F	X	X	X	X	X	X		C					C									
C	Hybrids, PT				C	C	C												X				
C	Hybrids, F				X	X	X									X				X		X	Also standard class H tests
C	LET detector/MISC board, EM			C	C	X	X						X										Alphas done but not req.
C	LET detector/MISC board, F				X																X	X	
C	Connectors, F																					X	
C	Windows, EM								X		X			X									Include L1 detectors for vib & acoustics
I	Instrument, F1		H	X	X	X	X	H	H	A	X	A	X		X	X	H	H			X	X	Protoflight levels for vib; full EMC at suite
I	Instrument, F2		H	X	X	X	X	H	H	A	X	A	X			X	H	H			X	X	Protoflight levels for vib; workmanship for EMC

egend:

Level of Assembly	Unit Type		Tests
			X = Test required
			A = Analysis
C = Component	BB =	Breadboard	H = test at a higher level of assembly
I = Instrument	EM =	Engineering Model	**C = Test Completed**
	PT =	Prototype	
	F =	Flight	
	F1 =	Flight unit #1	
	F2 =	Flight unit #2	

Verification Matrix for STEREO/IMPACT/SEP/SEP Central

Revision Date: 1/8/04
Revision Number: 5

Hardware Description		Tests																				
Level of Assembly	Item	Noise & Brkdown	Thermal vacuum	Alphas	Elect. test, rm. Temp	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Shock	Acoustics	Pressure change	Voltage margins	Thermal cycle	Thermal balance	Life Test	EMC/EMI	Magnetics	Leak	Bakeout	Contamination	Comments
C	LVPS, EM				**C**	X	X						**C**				X					
C	LVPS, F				X												X				X	
C	Analog Post-reg, EM				**C**	**C**	**C**						**C**									
C	Analog Post-reg, F				**C**	**C**	**C**													X	X	hot/cold done but not req.
C	Detector bias supply, EM				**C**	**C**	**C**						**C**									
C	Detector bias supply, F				X	X	X													X	X	new plan to do hot/cold
C	Logic board, EM				**C**	X	X						**C**									
C	Logic board, F				X															X	X	
C	Connectors, F															X					X	
C	Harnesses, F																				X	
I	Instrument, EM				**C**	X	X						X									Electrical EM only
I	Instrument, F1		H		X	X	X	H	H	A		A	X		X	X	H	H		X	X	Protoflight levels for vib; full EMC at suite
I	Instrument, F2		H		X	X	X	H	H	A		A	X			X	H	H		X	X	Protoflight levels for vib; workmanship EMC

Legend:

Level of Assembly	Unit Type			
			X =	Test required
			A =	Analysis
C = Component	BB =	Breadboard	H =	test at a higher level of assembly
I = Instrument	EM =	Engineering Model	**C = Test Completed**	
	PT =	Prototype		
	PF =	Protoflight		
	F =	Flight		
	F1 =	Flight unit #1		
	F2 =	Flight unit #2		

Extraction from STEREO Environment Definition, Observatory, Component and Instrument Test Requirements Document (7381-9003B)

			Reference	How
1	Mechanical Environments		Reference	How
	1.1	Loads	3.4.1.1	Analysis/Test (sine)
	1.2	Stiffness	3.4.1.2	Analysis/Test (sine)
	1.3	Pressure Profile	3.4.1.3	Design
	1.4	Mass Properties	3.4.4	Analysis/Test
	1.5	Sine Survey	3.4.2	Test
	1.6	Sine Sweep	3.4.2.1	Test
	1.7	Random Vibration	3.4.2.2	Test
	1.8	Acoustic	3.4.3	Test
	1.9	Magnetics	3.5	Test
2	Thermal Environments			
	2.1	1 TV Cycle Survival	3.3.2	Test
	2.2	6 TV Cycles Operational	3.3.2	Test
	2.3	Cold Turn-on	3.3.2	Test
	2.4	Hot Turn-on	3.3.2	Test
	2.5	Balance Test	3.3.2	Test
3	Power Characteristics			
	3.1	Turn-on Transients	3.10.2	Test
	3.2	Operating Transients & Ripple	3.10.3	Test
	3.3	Turn-off Transients	3.10.4	Test
	3.4	Under & Over Voltage	3.10.6	Test
	3.5	Power Bus Short Circuit	3.10.7	Test

EMI/EMC covered separately in 7381-9030

Test Considerations

- LET & HET detectors are somewhat contamination sensitive
  - No doors; detectors are protected by thin windows
  - Detector volumes will be purged with dry N2 whenever possible
    - Interruptions in purge can be tolerated
- Exteriors of assemblies must be kept clean
  - Dirty environments are a concern
    - Vibration, acoustics, & thermal vac areas
    - Accelerator test facility
  - Sensor assemblies and SEP Central will be bagged as much as possible when in dirty environments

Performance Tests

- **Prior to the start of environmental tests, LET, HET, and SEP Central will go through a series of performance tests to ensure that they meet their performance requirements at ambient conditions. These tests are similar to those performed on the engineering model.**
  - **Detector tests, including thermal vacuum life test and random vibration**
  - **Tests of printed circuit board assemblies**
  - **Integration and test of detectors and detector boards**
  - **Integration and test of LET & HET sensor assemblies and SEP Central**
  - **Interface LET & HET sensor assemblies with SEP Central and run comprehensive performance tests**
  - **At least 25 hours of continuous trouble free operations shall be obtained prior to the start of environmental tests**
    - **At least 100 hours shall be accumulated prior to delivery**

LET & HET Comprehensive Performance Tests

- Two versions of the CPT, “long” with radiation tests and “short” without
  - Electrical performance and resolution using internal test pulser
    - Trend power consumption, temperature, gains, offsets, and resolutions
  - Event simulations using internal test pulser
    - Trend matrix box counts
  - Particle response using external radiation source (LET) or muons (HET) (long version only)
    - Trend matrix box counts
- CPTs shall be performed before, after, and sometimes during environmental tests
- Radiation tests will not be done in thermal vaccum test

LET/HET/Sep Central Environmental Test Plan

- Fight Unit 1 is expected to be ready for test by 10 May 2004
- Flight Unit 2 ready by 16 May 2004
- EMI/EMC of FM 1 will be done with IMPACT suite at Berkeley; FM 2 at Caltech
- Bakeout will be at the end of thermal vac
- Accelerator end-to-end test tentatively scheduled for July 2004

LET/HET/SEP Central Environmental Tests

- **Mechanical**
  - Testing, except for magnetics, probably will be done at JPL
  - Loads (part of sine test)
  - Stiffness (part of sine test)
  - Pressure profile (by design)
  - Mass properties
    - Flight units shall be weighed to 0.2%
    - CG and MOI will be determined by analysis to the accuracy required
  - Vibration
    - Powered off, except for survival heater
    - Sine survey
    - Sine sweep
    - Random
    - CPTs before and after vibration
  - Acoustic
    - Powered off
    - CPTs before and after
  - Magnetics (GSFC to sniff)

LET/HET/SEP Central Environmental Tests (continued)

- Thermal
  - Probably at JPL
  - Thermal/vac cycling per requirement (7 cycles)
  - Cold turn-on and hot turn-on at appropriate times
  - CPTs (short version) at each plateau
  - Balance test on one flight unit at beginning of thermal vac
    - Thermal isolators and blankets will be installed
    - Thermal cases shall be selected and the data analyzed to verify the thermal model
- Power characteristics
  - Will be done during all-sensors test in May prior to TRR and prior to EMC/EMI
- EMC/EMI
  - FM 1 will go through EMC/EMI with the rest of the IMPACT suite at UCB contractor facility; FM 2 will be done at Caltech
- Bakeout
  - LET/HET/SEP Central will be baked out at the end of thermal vacuum test
  - Subassemblies baked out to higher temperature prior to final bakeout

LET/HET/SEP Central Status

- **SEP Central**
  - Final ETU get-together in January
  - Flight PCBs (except LVPS) are in house and all coupons passed inspection; boards being assembled – expect all to be finished by mid-February
  - LVPS from UCB – expect FM1 board delivered in late Feb
  - Housings are in final design stages – expect flight parts by early March
  - Software ~80% complete
  - Comprehensive Performance Test (CPT) not yet defined
- **LET**
  - Final ETU get-together in January
  - All LET detectors in house; testing underway
  - Hybrids – last two lots are well along; should have all by ~end of Jan
  - Flight PCBs are in house and all coupons passed; expect boards to be assembled by mid-February
  - Housings are in final design stages – expect flight parts by early March
  - Software ~90% complete
  - CPT not defined

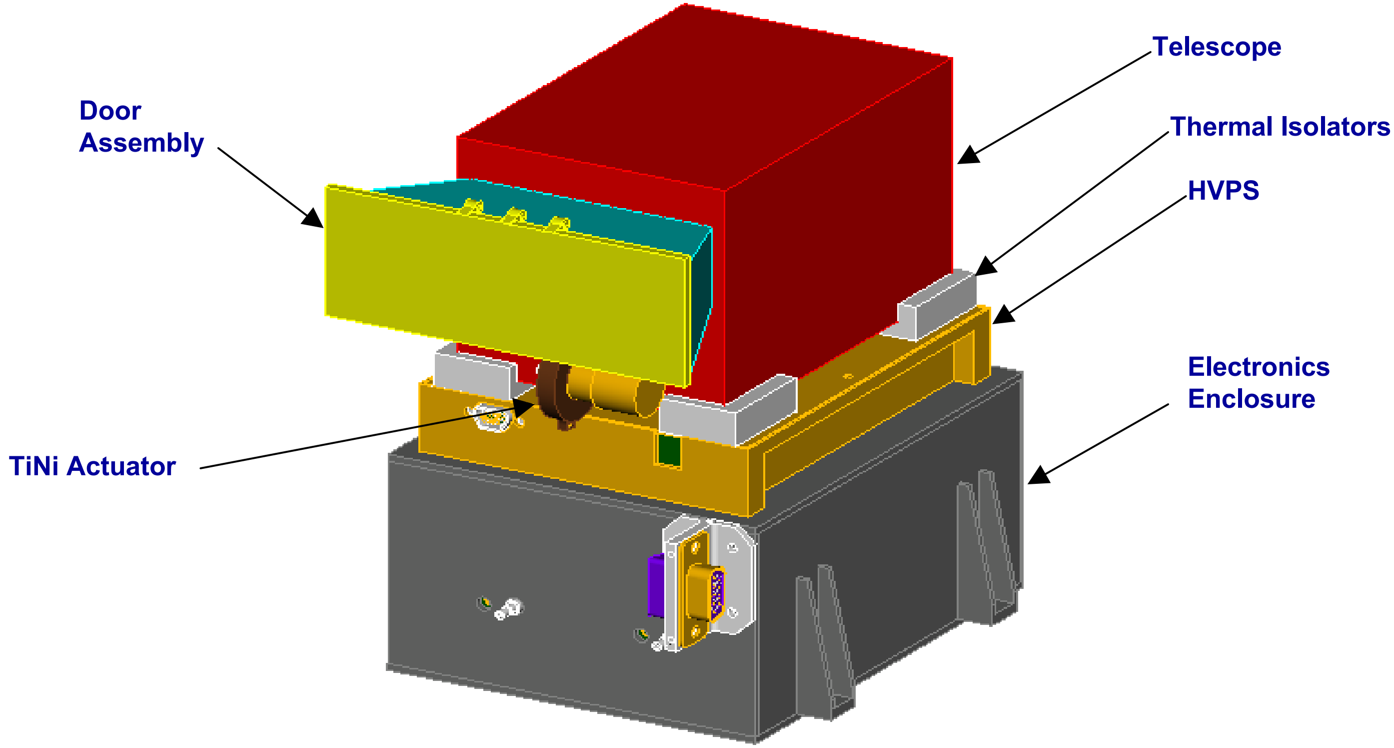
LET/HET/SEP Central Status (continued)

- **HET**
  - Final ETU get-together in January at Caltech to exercise commands, uploads to E2PROM, and uploads to RAM
  - HET detectors: 9 H1 detectors (will fly 4) and 10 H3 detectors (will fly 14) are in house; testing is underway
  - Hybrids: flight PHASICs have all been received
  - Actels: final engineering version is under test now
  - Flight PCBs are in house and all coupons passed; flight boards are fully assembled except for PHASICs and Actels
  - Housings are in final design stage – expect flight parts by mid March
  - Software ~80% complete
  - Comprehensive Performance Test not yet defined

SIT Pre Environmental Review

Peter Walpole
walpole@sampex.umd.edu
301-405-6217

SIT Instrument Assembly



SIT Boxes

- Telescope
  - Thin foil (1000A)
  - Acoustic Cover/Sunshade
  - Cover opening mechanism, TiNi actuator
  - Si surface barrier solid state detector, 500u (1)
  - Microchannel plates (2 sets of chevron plates)
  - High voltages – electron deflection, MCP bias
- HVPS
  - High voltage, settable up to 3000v, nominal ~2800v
  - 10s of uA current
  - Synch from crystal oscillator
  - Test mode 300v limit.
- Electronics
  - Time of flight, energy measurement circuitry
  - Logic/MISC in Actel

SIT Flight Unit Environmental Tests

- **Electronics Bake-out**
- **Vibration**
- **EMC/Magnetics**
- **Acoustic**
- **Thermal Vacuum/ Thermal Balance**
- **Mass Properties**
- **Final Bakeout**

Test Considerations

- SIT detector and microchannel plates are somewhat contamination sensitive
  - Detector volumes will be purged with dry N2 whenever possible
    - Interruptions in purge can be tolerated
  - Sensors will be bagged when in dirty environments
- SIT SSD is Si surface barrier type, limited to <35 degrees C
  - Bakeout of complete instrument limited to protect SSD
  - Initial bakeout of electronics only to higher temperatures for decontamination
- SIT Telescope contains a thin foil
  - An acoustic cover/sunshade opens after launch. Kept closed during all testing except thermal vacuum/balance.
- HVPS and Telescope contain HV when operating.
  - Full HV can be turned on only in hard vacuum (e.g. TV test). Hardware limit to 300v for test mode. HV not accessible to personnel while acoustic cover closed.

Performance Tests

- Prior to the start of environmental tests, SIT will go through a series of performance tests to ensure that it meets its performance requirements at ambient and vacuum conditions. These tests are similar to those performed on the engineering model.
  - Detector tests, including thermal vacuum life test
  - Tests of printed circuit board assemblies
  - Integration and test of flight electronics
  - Integration and test and bench calibration of SIT (telescope, hvps, electronics)
  - Vacuum/alpha source end-to-end test of SIT at UMd
  - Interface SIT with SEP Central and run comprehensive performance tests
  - At least 25 hours of continuous trouble free operations shall be obtained prior to the start of environmental tests
    - At least 100 hours shall be accumulated prior to delivery
  - Particle calibration with accelerator beam
    - Alpha calibration will be performed at UMd before environmental testing and during TV testing
    - Accelerator calibration is desirable but not required. Could occur in Aug while rest of SEP doing beam calibration.

Performance Test - cont

- During and after the environmental test program, two levels of SIT performance test will be performed:

- Vacuum Test
  - End-to-end test – electronics, HVPS, telescope, MISC
  - Instrument stimulated with alpha particles
  - Verifies calibration and resolution of the full instrument and the proper functioning of the logic system.

- Functional Test
  - Performed at ambient. HVPS limited to 300v for safety. Stimulus from external battery-powered test pulser. Verifies function and approximate calibration of electronics.

SIT Environmental Test Plan

- **Ready electronics for environmental test (GSFC and UMd)**
  - **Boards complete and conformal coated**
  - **Unit assembled and vacuum tested**
  - **Telescope removed from unit**
- **Electronics Bakeout – at GSFC**
- **Final assembly**
  - **Vacuum test with alphas**
- **Interface Test with SEP Central – at Caltech**
  - **"Functional Test" during I/F test**
- **EMC Test with SEP suite – UCB**
  - **Instrument functioning during some/all tests. HVPS limited to 300v.**

SIT Environmental Test Plan – (2)

- SIT Acoustic Test - GSFC
  - Functional Test before and after
  - Open acoustic cover after test to verify foil integrity

- Vibration Testing – GSFC
  - Functional Test before testing and between axes
  - Open acoustic cover after test to verify foil integrity

- Thermal Balance/Thermal Vacuum Test – GSFC
  - Functional test before and after test
  - Vacuum test during test
  - Acoustic cover will be open for this test. (Opened after the pre-test functional and closed before the post-test functional, for safety.)

- SIT Final Bakeout - GSFC

- Delivery to JHU/APL
  - Vacuum test at UMd just prior to delivery to verify full operation before it leaves our hands.

SIT Accelerator calibration

- Accelerator end-to-end test tentatively scheduled for August 2004, after end of environmental test program

SIT STATUS

- **SIT Telescope**
  - ETU Telescope at UMd participating in SIT testing
  - Flight Foils at GSFC, MCPs tested at UMd and stored at GSFC
  - Flight SSDs under test at GSFC
- **TOF System**
  - FM1 was downgraded to ETU and is part of the ETU electronics under test at UMd. Work is proceeding at MPAe to generate a new FM1 and FM2.
- **Energy Board**
  - ETU is integrated in the ETU electronics at UMd. Flight units are under construction at GSFC.
- **Logic Board/MISC**
  - The updated ETU logic board and updated motherboard have been integrated with the remaining electronics. Testing is underway at UMd.
- **HVPS**
  - Flight HVPS FM1 is undergoing test at UMd.
- **Flight Software**
  - Version 11/20/03 is installed in the ETU under test at UMd.

SIT Test Matrix

Verification Matrix for STEREO/IMPACT/SEP/SIT

Revision Date: 2002/11/8
Revision Number: 2

Level of Assembly	Item	Vacuum	Alphas	Elect. test, rm. Temp	Bench Calibration	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Self Shock	Acoustics	Thermal Vacuum	Voltage margins	Thermal cycle	Thermal balance	Life Test	EMC/EMI	Magnetics	Beam Calibration	Bakeout	Contamination	Comments
Hardware Description		**Tests**																				
C	Detectors, F		**C**									**C**										
C	Foils PT										X											
C	Telescope PF,F	X	X																		X	
C	Energy board, EM			**C**		**C**	**C**						**C**									
C	Energy board, F			X																	X	
C	TOF Board, EM			**C**		**C**	**C**						**C**									
C	TOF Board, F			X																	X	
C	HVPS EM			**C**		**C**	**C**						**C**									
C	HVPS F			X																	X	
I	Instrument W/O Telescope																			X		
I	Instrument, PF	X	X	X	X	X	X	X	X	X		X	X	X	X	X	H	X	X	X	X	Protoflight levels
I	Instrument, F	X	X	X	X	X	X	X	X	X		X	X	X		X	H	X	X	X	X	Acceptance levels

Legend:

Level of Assembly	Unit Type		
		X =	Test required
		A =	Analysis
C = Component	BB Breadboard	H =	at a higher level
I = Instrument	EM Engineering Model	**C =**	**Test Completed**
	PT Prototype		
	PF Protoflight		
	F = Flight		

SEP SEPT
Pre Environmental Review

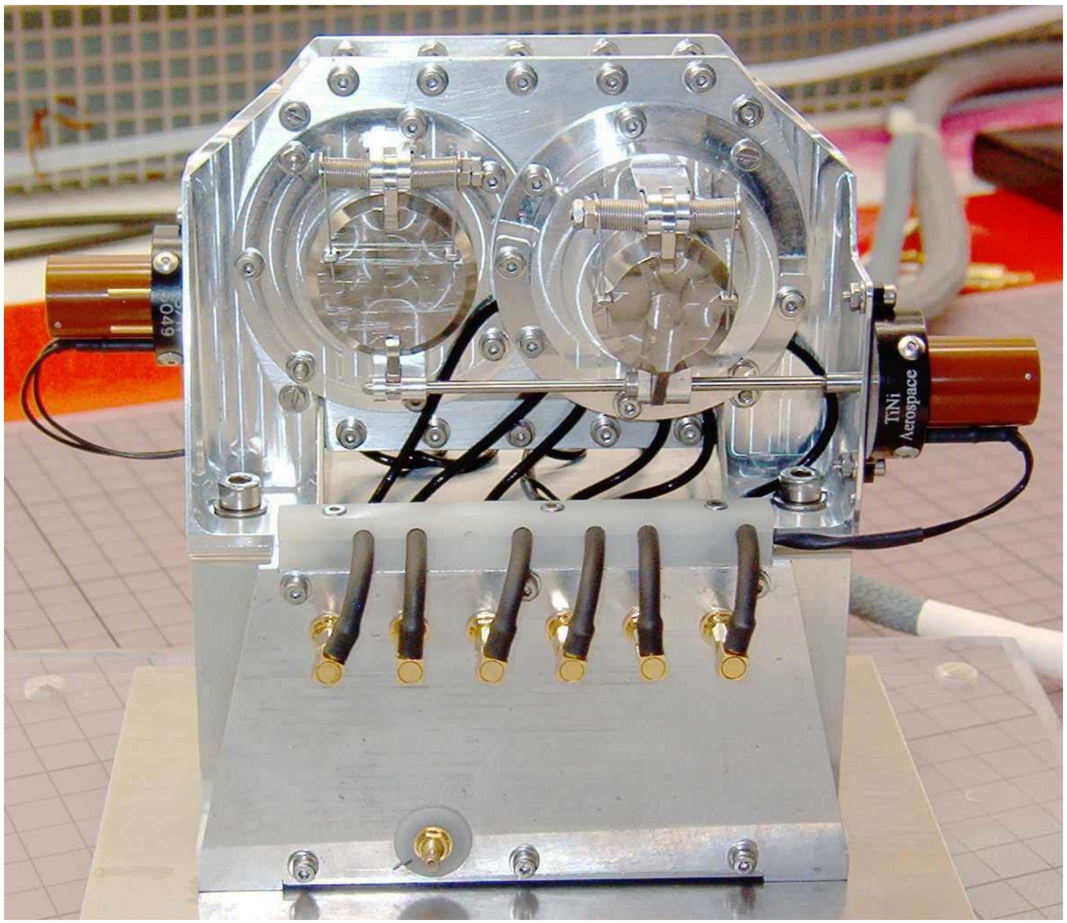
Reinhold Mueller-Mellin

mueller-mellin@physik.uni-kiel.de

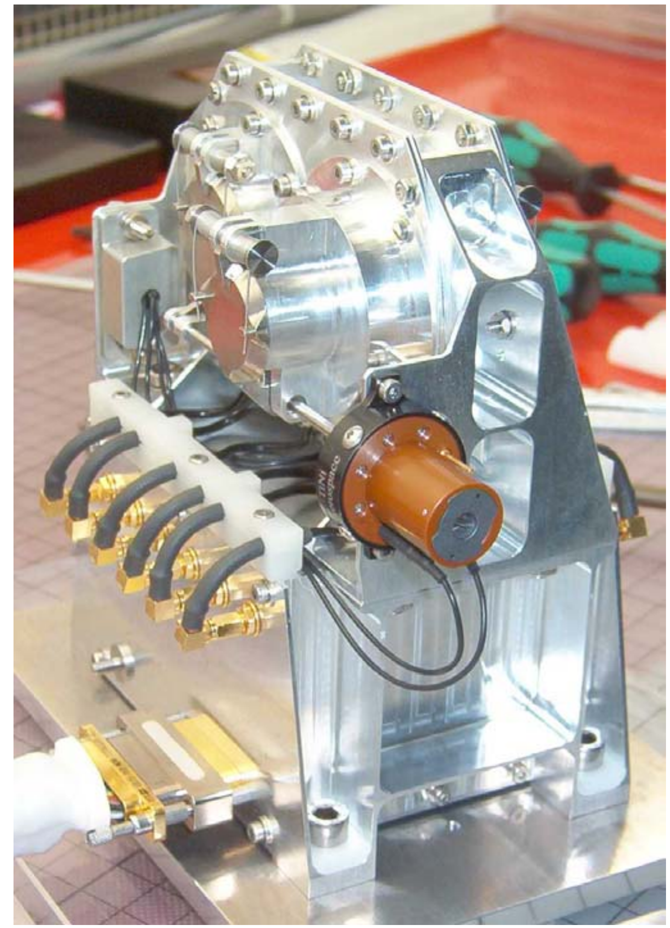
+49-431-880-3227

SEPT

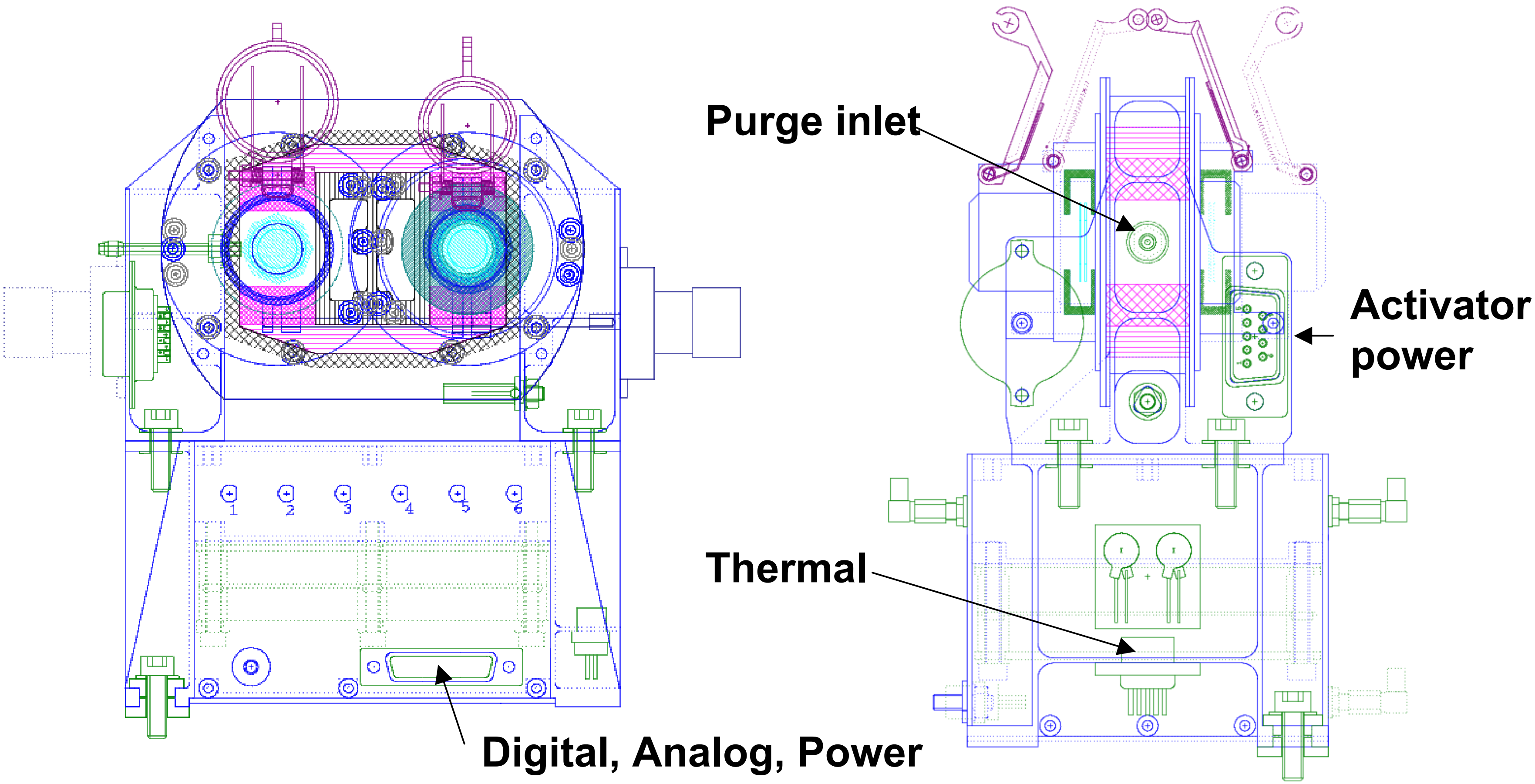
Front View



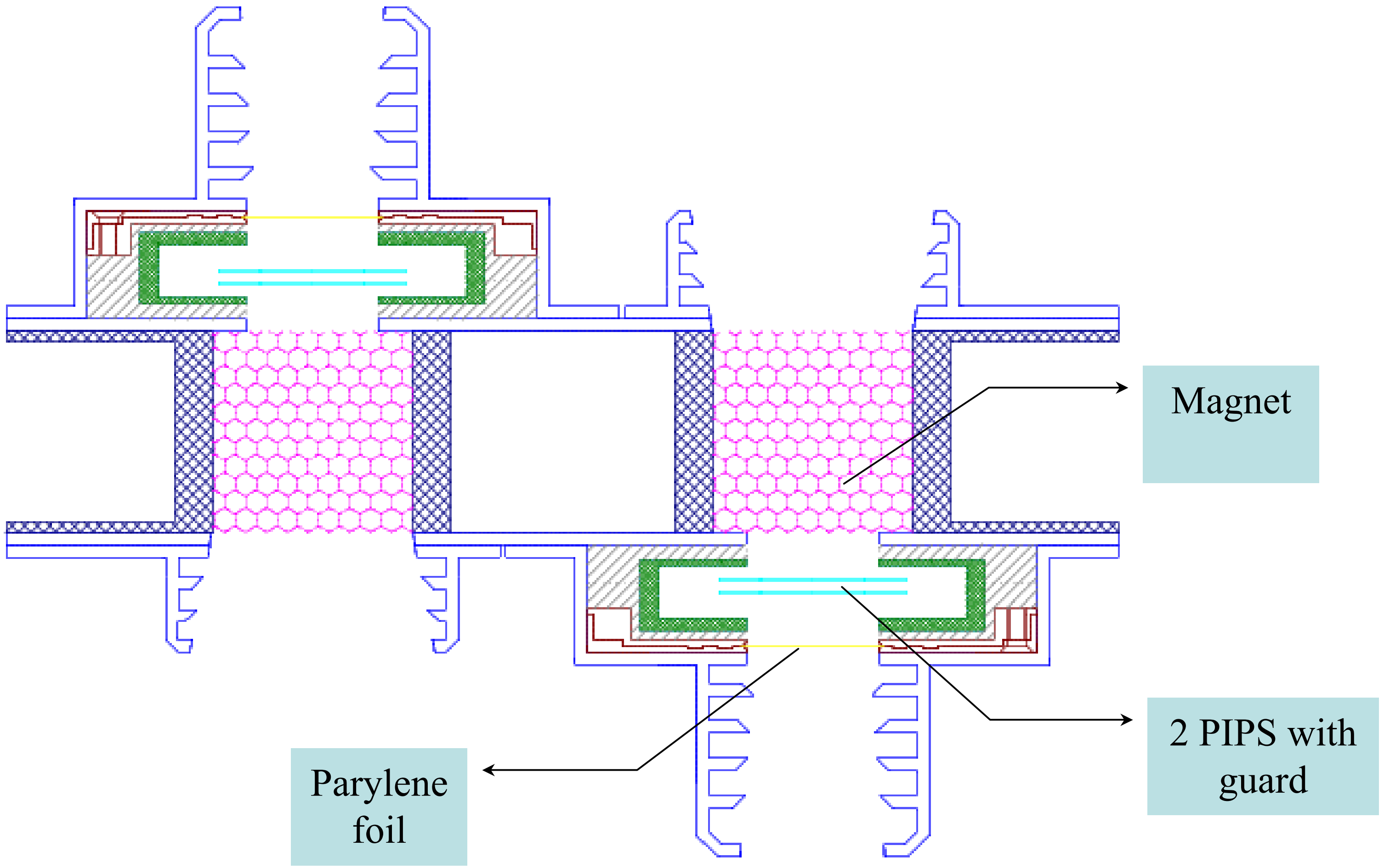
Side View



SEPT design details



SEPT Telescope Schematic



Test Considerations

- SEPT detectors (passivated ion-implanted planar silicon) are somewhat contamination sensitive
  - Doors shall protect from direct sun light during phasing orbit, they are not hermetical seals
  - Detector volumes will be purged with dry N_2 whenever possible, interruptions can be tolerated
  - When not purged and not in class 100,000 clean environment, instrument shall be bagged (e.g. during vibration test)
- There are 4 SEPT telescopes which are identical except for S/C mount and thermal hardware
  - SEPT-E mounted directly, SEPT-NS mounted on bracket
  - 3 different thermal hardware layouts: SEPT-E ahead, SEPT-E behind, SEPT-NS (both ahead and behind)

Test Considerations (continued)

- SEPT-NS will be vibrated with bracket
- Electronics can be fully verified with internal test pulsers, but not the detectors
- ^{60}Co radioactive source (provided by GSFC) will be used to verify detector aliveness (no calibration) during I&T
- Detector calibration with electrons performed prior to integration with radioactive sources (conversion electrons from ^{207}Bi, ^{133}Ba, ^{109}Cd)
- Detector calibration with protons performed with flight spare after delivery of flight units (proton accelerator at HMI/Berlin)

Test Constraints

- Acoustic test performed on Engineering Model only to verify strength of Parylene foil (4 μm thick) and adequate design of foil mount
- Vibration test without thermal hardware due to ongoing procurement of thermostats and operational/survival heaters (waiver granted)
- Thermal balance test after installation of thermal hardware at GSFC using emulator for SEP Central heater control firmware
- Door opening only in TV cold soak, as doors are opened by 1-time actuators requiring manual restow. TV hot soak opening can be exercised on observatory level.
- Engineering model blankets are used for flight model door opening in TV to verify mechanical non-interference

SEPT Pre-Environmental Tests

- Magnets
  - Production of large number (>50) of rare earth permanent magnets
  - Precise determination of magnitude and direction of magnetic remanence
  - Careful selection of 20 magnets to form 5 systems of matched magnets with negligible far field
  - Magnetic field measurement of Engineering Model magnets at GSFC (Mario Acuna) to verify compliance with MAG requirements
  - Monte Carlo simulation of SEPT telescope using data of measured magnetic field to verify that electrons < 400 keV are effectively deflected
  - Radioactive source test (^{207}Bi, conversion electrons of 482 keV, 554 keV, 976 keV, 1048 keV) to confirm Monte Carlo Model

SEPT Pre Environmental Tests (continued)

- Detectors
  - Incoming inspection @ full depletion bias -40 V, monitoring leakage current and noise performance
  - Vacuum test @ overdepletion bias -80 V, monitoring leakage current and noise performance
  - Selection of 10 (out of 15) detector stacks with two detectors each for 4 flight models and 1 flight spare
- Electronics
  - Analog printed circuit board tests using test bed, one temperature cycle
  - Digital printed circuit board tests using test bed, one temperature cycle
  - Assembly tests using SEPT GSE
- Integrated Telescopes
  - Energy calibration with conversion electrons
  - TV tests in laboratory (not to the full temperature range)

SEPT Performance Tests

- Prior to the start of environmental tests, SEPT will go through a series of performance tests to ensure that performance requirements are met at ambient conditions
  - Commandability, operational modes, power consumption, gain, offset, energy resolution, leakage current, background count rate
- SEPT Comprehensive Performance Test
  - Housekeeping monitoring
  - Quiet run (nominal observation mode)
  - Internal test pulser run
  - Commissioning run
  - Radioactive source run (Co60), but not in TV
- At least 24 hours of trouble free operations shall be obtained prior to the start of environmental tests

SEPT Environmental Test Plan

- Flight units 1, 2, 3, and 4 are expected to be ready by 20-JAN-2004
- Spare unit will not undergo environmental tests because of thermal hardware, which is different for 3 units, and it is unknown which unit it might eventually have to replace
- Vibration will be performed in second half of January at ESTEC
- TV and bakeout will be performed in February at ESTEC
- EMC will be performed with SEP suite in May at UoB
- TB will be performed after thermal hardware installation in June at GSFC

SEPT Environmental Tests

- Mass Properties
  - Flight units shall be weighed to 0.2 % (without blankets, thermostats, film heaters)
  - CoG and MoI will be determined by analysis to the accuracy required (goal of 10 %)
- Vibration
  - Powered off
  - Sine survey
  - Sine sweep
  - Random
  - CPTs before, in between axes, and after vibration
  - SEPT-NS on bracket
- Acoustic
  - Powered off, Engineering Model only

SEPT Environmental Tests (continued)

- Magnetics
  - Sniff test at GSFC
- Mechanisms
  - Actuation of cover release performed three times (ambient, instrument TV cold soak, observatory TV hot soak)
- Thermal Vac
  - Without thermal isolators
  - 6 powered operational cycles, 1 survival cycle
  - Cold and hot turn-on at plateaus of first and last operational cycle
  - Actuation of cover release during cold soak with EM blanket
  - CPTs during operational cycles at each plateau
- Thermal Balance
  - Thermal isolators, thermostats, heaters, and blankets installed

SEPT Environmental Tests (continued)

- EMC
  - SEPT will go through EMC/EMI wit the rest of the IMPACT suite
- Bakeout
  - SEPT will be baked out after TV test at ESTEC

SEPT Status

- Final SEP ETU get-together in February 2004 collides with SEPT environmental test programme, SEPT participation not absolutely necessary
- 4 SEPT Flight units (Sensor and Electronics Box) integrated
- Flight spare housing manufactured, electronics boards assembled, but telescope not integrated pending thermal hardware definition
- Flight unit functional tests and energy calibration ongoing
- Commanding performed manually from GSE
- CPT test script for automatic CPT is available

SEPT Problems / Failures

- Tests with SEPT Engineering Model revealed unsatisfactory timing in coincidence/anticoincidence logic
  - Proposed solution: change in FPGA programming
  - But: two FM1 digital boards were manufactured already
  - Hence: old FPGAs unsoldered and replaced by new FPGAs
  - Two FM2 digital boards were populated with correct FPGAs directly
- Epoxy spacers used to mount analog and digital boards in FM1 did not support the standard torque of 1.1 Nm for fasteners M3 V2A
  - New spacers for 4 flight models and 1 flight spare machined from Polyetherketon (PEEK)
- Four (out of 30) detectors did not meet the specifications
  - Resent to manufacturer for diagnosis and rework
  - Sufficient number of detectors available for flight models and flight spare

SEPT Test Matrix

Verification Matrix for STEREO/IMPACT/SEPT

Revision Number 3
Revision Date 2003-11-25

Hardware Description				Tests																				
Level of Assembly	Item	Spacecraft	Quantity	Electrical Function	Electron-, Muon-Cal.	Proton Calibration	Thermal Analysis	Structural Analysis	Vibration, Sinusoidal	Vibration, Random	Self Shock	Acoustics	Mass Properties	Pressure Profile	Mechanical Function	Life Test	EMC/EMI	Magnetics	Leak	Thermal	Thermal Balance	Thermal Vacuum	Bakeout	Comments
C	SEPT (BB)		1	**X**																				Electronics only
I	SEPT (EM)		1	**X**	**X**		**A**	**A**			**X**	**X**		**A**	**X**	**X**		**X**		**X**				Magnetics: Magnet assembly only
I	SEPT-E (F1)	A	1	**X**	X				X	X	X		X		X	**X**	H	H			H	X	X	Test to protoflight level
I	SEPT-E (F2)	B	1	X	X				X	X	X		X		X	**X**	H	H				X	X	Test to protoflight level
I	SEPT-NS (F1)	A	1	**X**	X				X	X	X		X		X	**X**	H	H				X	X	Test to protoflight level
I	SEPT-NS (F2)	B	1	X	X				X	X	X		X		X	**X**	H	H				X	X	Test to protoflight level
I	SEPT (FS)		1	X	X	X										**X**								Thermal hardware determines if -E or -NS

Legend:

Level of assembly	Unit type			
C = Component	BB =	Breadboard	X =	Test required
I = Instrument	EM =	Engineering Model	A =	Analysis
	F1 =	Flight unit #1	H =	Test at higher level of assembly
	F2 =	Flight unit #2	**X =**	**Test completed**
	FS =	Flight Spare		

SEP SEPT
Detailed Test Plan

Reinhold Mueller-Mellin

mueller-mellin@physik.uni-kiel.de

+49-431-880-3227

Acoustic Noise Test

- The SEPT Engineering Model was subjected to an acoustic test program in the 1378 m^3 reverberation chamber of IABG/Munich on 11/12-NOV-2003

Summary

Configuration:	unpowered, doors closed	
Low Level Test:	OASPL = 140.9 dB	34 sec
Protoflight Level Test:	OASPL = 144.2 dB	61 sec
(required	OASPL = 143,6 +3/-1 dB	60 sec)
Post Low Level Test:	OASPL = 140.6 dB	33 sec

- During the tests the structural responses were measured by a total of 8 accelerometers, placed on main body sensor, main body E-Box, outside surface of all 4 covers

Acoustic Noise Test (continued)

- 5 Control microphones were used to record the sound pressure levels. Comparison with specified tolerances (APL document 7381-9003 Section 3.4.3) shows: the test spectrum has been met over the total frequency range, including the OASPL.
- The highest readings of acceleration were:

  Accelerometer A6X: 10 Hz – 2.0 kHz 3.2 g_{rms}
- Visual inspection of foils and functional test did not show any damage
- IABG Test report available (in English, 28 pages plus PSD-plots)

Vibration Test

- Four SEPT Flight Models will be subjected to a vibration test program on the 70 kN Electrodynamic Shaker of the ESTEC Test Centre in week 4 (back-up week 5), 2004
- The shaker is used in vertical configuration for all 3 instrument axes
- To reduce test costs, two SEPT units are vibrated together, resulting in a total of 6 test sequences:

  SEPT-E X-axes FM1 + FM2, SEPT-NS X-axes FM1+ FM2

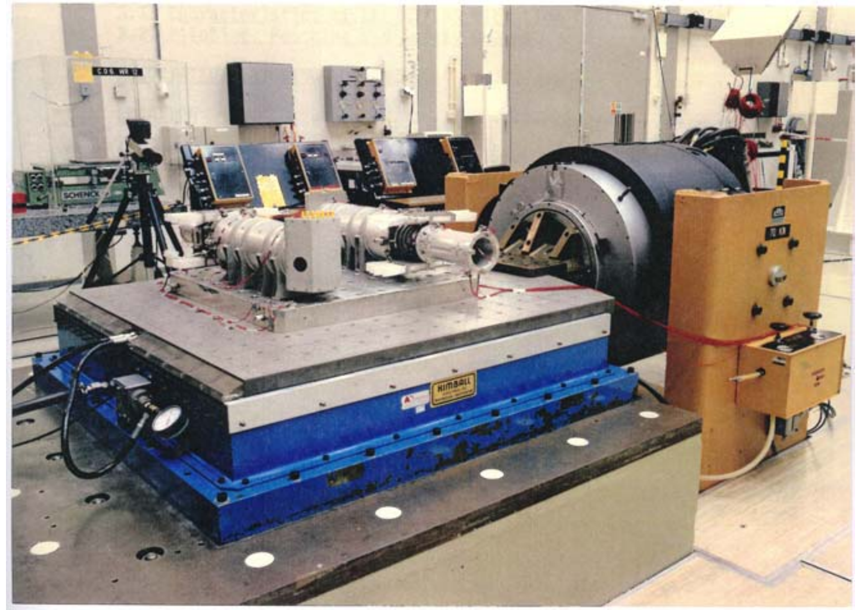
  SEPT-E Y-axes FM1 + FM2, SEPT-NS Y-axes FM1+ FM2

  SEPT-E Z-axes FM1 + FM2, SEPT-NS Z-axes FM1 + FM2
- Each test sequence consists of 5 runs, resulting in a total of 30 runs

  sine low, sine protoflight, sine low, random protoflight, sine low
- SEPT-NS is vibrated on its bracket
- The two units on the shaker will be bagged and continuously purged

Vibration Test (continued)

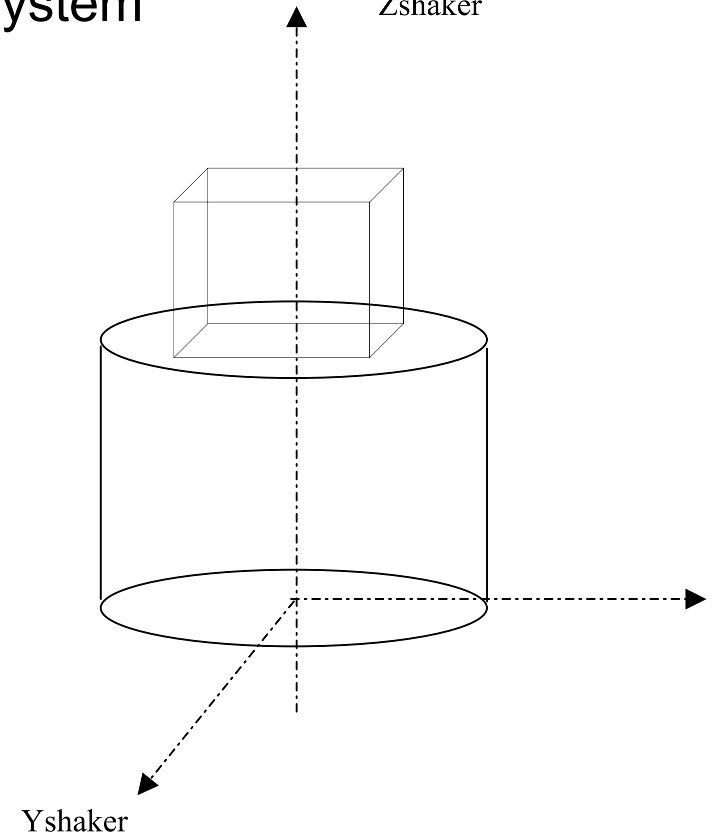
- The 70 kN shaker will be placed in a vertical position (with respect to the position shown in the picture)
- An aluminium cube of ~ 300 mm side length will be used to support two flight units
- By changing the face on which the units are mounted, a different axis will be stimulated each time
- No counterweight is needed



- SEPT-E with Ultem bushings is mounted to the cube with fasteners M4 V2A (torque 2.6 Nm), mass 770g
- SEPT-NS with Ultem bushings is mounted to the bracket which in turn is mounted to the cube with fasteners M5 V2A (torque 5.1 Nm), mass 1110 g

Vibration Test (continued)

- Shaker coordinate System

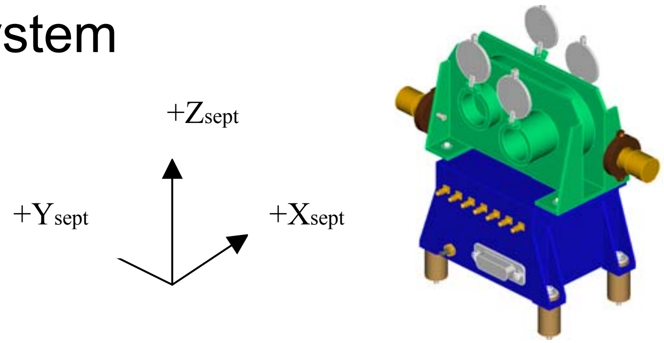


The shaker is stimulated along the Zshaker axis

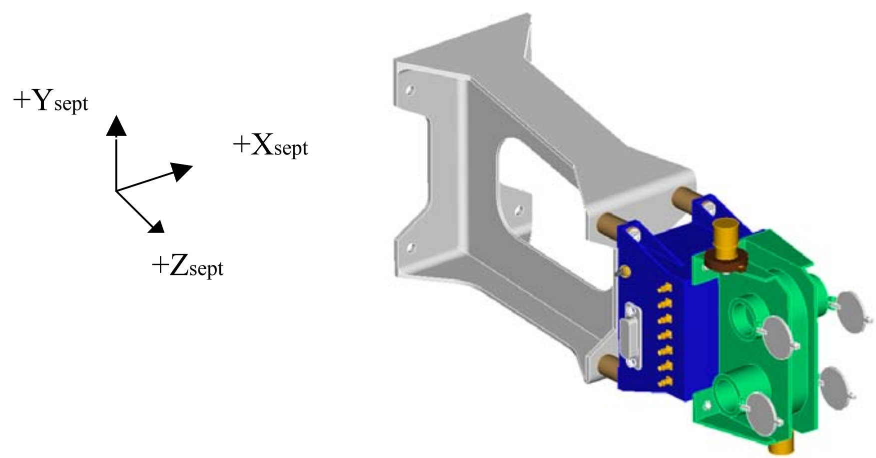
Vibration Test (continued)

- Instrument coordinate system

SEPT-E

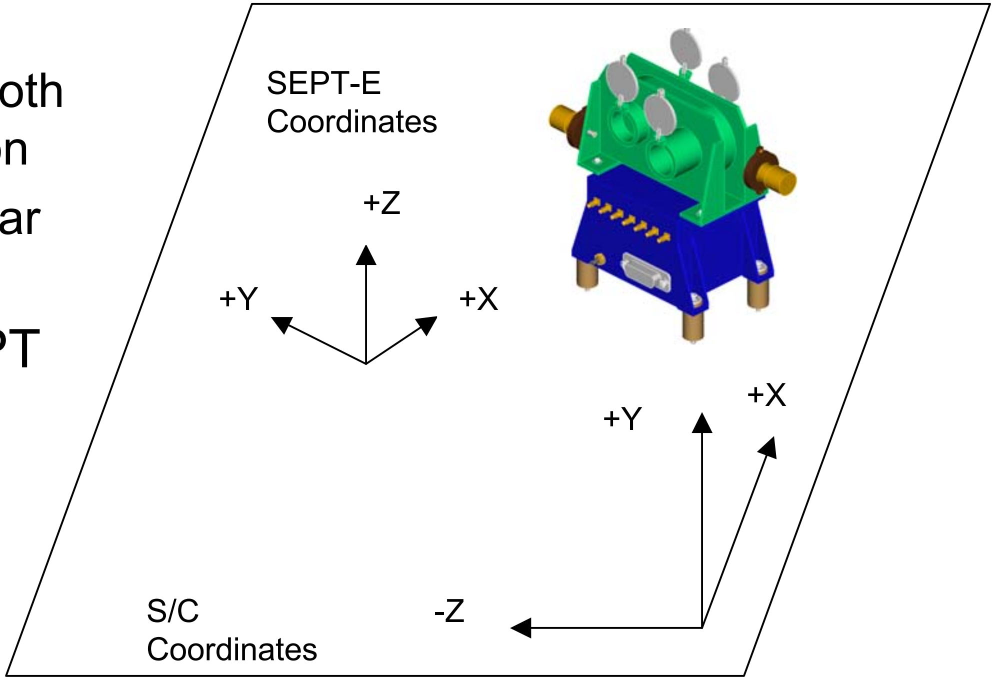


SEPT-NS



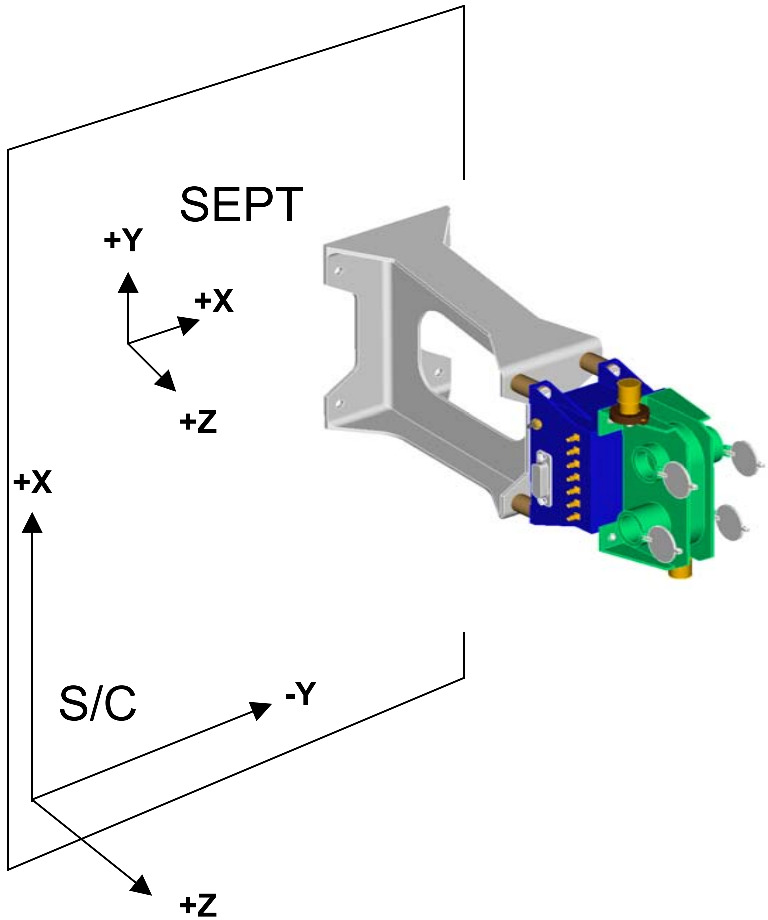
Vibration Test (continued)

- View of Ahead S/C +Y panel
- Thrust in $+X_{S/C}$ direction
  - Apply sine thrust level in both $+X_{SEPT}$ and $+Y_{SEPT}$ direction
  - Apply random perpendicular level in $+Z_{SEPT}$ direction
- For Behind S/C, rotate SEPT by 90° about Z_{SEPT} axis



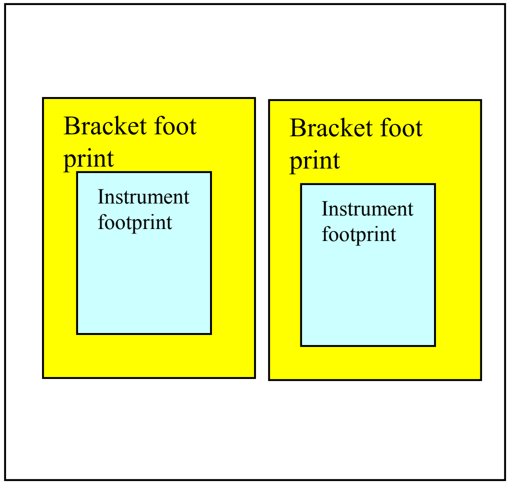
Vibration Test (continued)

- View of Ahead and Behind S/C +Z panel
- Thrust in $+X_{S/C}$ direction
  - Apply sine thrust level in $+Y_{SEPT}$ direction
  - Apply random perpendicular level in $+Z_{SEPT}$ direction



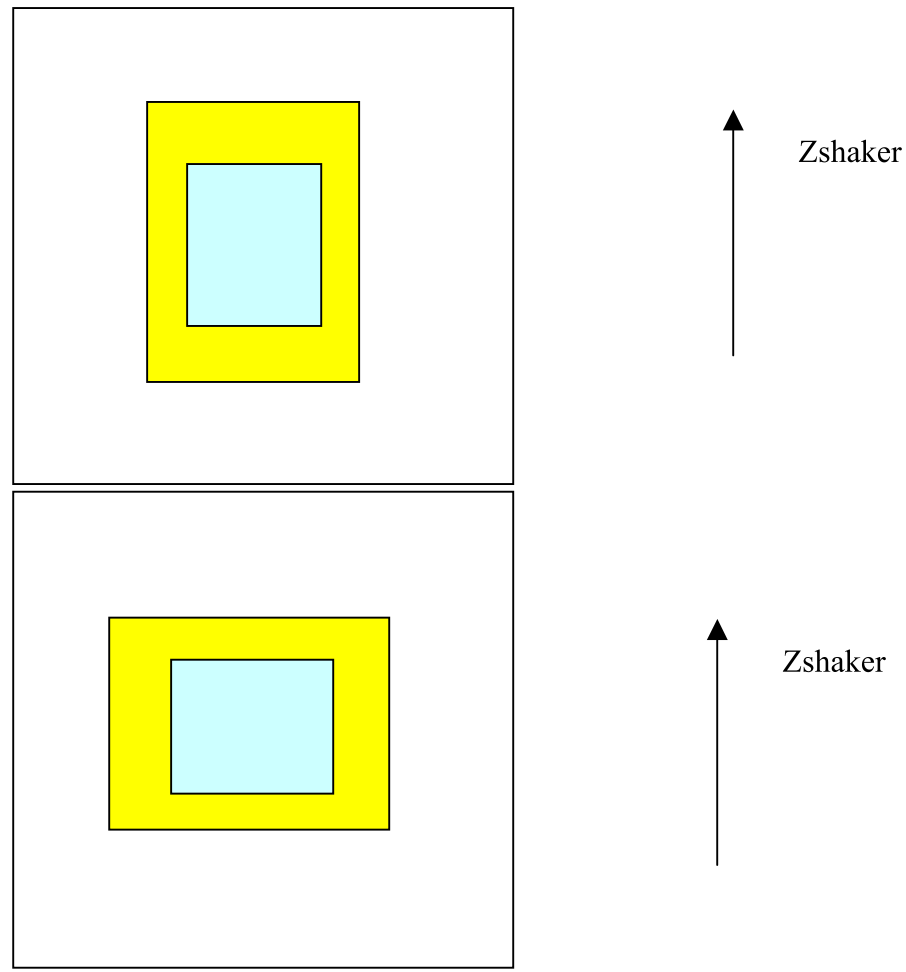
Vibration Test (continued)

- The Z-face of the cube will be used to stimulate simultaneously the Z_{SEPT} axis of two units of the same kind
  (i.e. SEPT-E FM1 and SEPT-E FM2
  or SEPT-NS FM1 and SEPT-NS FM2)
- Minimum distance between footprints: 15 mm



Vibration Test (continued)

- On two opposite lateral faces of the cube, the footprints allow Y-axis vibration
- On the remaining two lateral faces of the cube, the footprints allow Z-axis vibration



Vibration Test (continued)

Run #	Data log name	Level	Unit and axis	Location on cube
1	FM1-E-SL-X-1 FM2-E-SL-X-1	Sine-Low	FM1 SEPT-E Xsept FM2 SEPT-E Xsept	Opposite lateral faces
2	FM1-E-ST-X FM2-E-ST-X	Sine-Thrust	FM1 SEPT-E Xsept FM2 SEPT-E Xsept	Opposite lateral faces
3	FM1-E-SL-X-2 FM2-E-SL-X-2	Sine-Low	FM1 SEPT-E Xsept FM2 SEPT-E Xsept	Opposite lateral faces
4	FM1-E-RPar-X FM2-E-RPar-X	Random-Parallel	FM1 SEPT-E Xsept FM2 SEPT-E Xsept	Opposite lateral faces
5	FM1-E-SL-X-3 FM2-E-SL-X-3	Sine-Low	FM1 SEPT-E Xsept FM2 SEPT-E Xsept	Opposite lateral faces

Vibration Test (continued)

Run #	Data log name	Level	Unit and axis	Location on cube
6	FM1-NS-SL-X-1 FM2-NS-SL-X-1	Sine-Low	FM1 SEPT-NS Xsept FM2 SEPT-NS Xsept	Opposite lateral faces
7	FM1-NS-SLat-X FM2-NS-SLat-X	Sine-Lateral	FM1 SEPT-NS Xsept FM2 SEPT-NS Xsept	Opposite lateral faces
8	FM1-NS-SL-X-2 FM2-NS-SL-X-2	Sine-Low	FM1 SEPT-NS Xsept FM2 SEPT-NS Xsept	Opposite lateral faces
9	FM1-NS-RPar-X FM2-NS-Rpar-X	Random-Parallel	FM1 SEPT-NS Xsept FM2 SEPT-NS Xsept	Opposite lateral faces
10	FM1-NS-SL-X-3 FM2-NS-SL-X-3	Sine-Low	FM1 SEPT-NS Xsept FM2 SEPT-NS Xsept	Opposite lateral faces

Vibration Test (continued)

Run #	Data log name	Level	Unit and axis	Location on cube
11	FM1-E-SL-Y-1 FM2-E-SL-Y-1	Sine-Low	FM1 SEPT-E Ysept FM2 SEPT-E Ysept	Opposite lateral faces
12	FM1-E-ST-Y FM2-E-ST-Y	Sine-Thrust	FM1 SEPT-E Ysept FM2 SEPT-E Ysept	Opposite lateral faces
13	FM1-E-SL-Y-2 FM2-E-SL-Y-2	Sine-Low	FM1 SEPT-E Ysept FM2 SEPT-E Ysept	Opposite lateral faces
14	FM1-E-RPar-Y FM2-E-RPar-Y	Random-Parallel	FM1 SEPT-E Ysept FM2 SEPT-E Ysept	Opposite lateral faces
15	FM1-E-SL-Y-3 FM2-E-SL-Y-3	Sine-Low	FM1 SEPT-E Ysept FM2 SEPT-E Ysept	Opposite lateral faces

Vibration Test (continued)

Run #	Data log name	Level	Unit and axis	Location on cube
16	FM1-NS-SL-Y-1 FM2-NS-SL-Y-1	Sine-Low	FM1 SEPT-NS Ysept FM2 SEPT-NS Ysept	Opposite lateral faces
17	FM1-NS-ST-Y FM2-NS-ST-Y	Sine-Thrust	FM1 SEPT-NS Ysept FM2 SEPT-NS Ysept	Opposite lateral faces
18	FM1-NS-SL-Y-2 FM2-NS-SL-Y-2	Sine-Low	FM1 SEPT-NS Ysept FM2 SEPT-NS Ysept	Opposite lateral faces
19	FM1-NS-RPar-Y FM2-NS-Rpar-Y	Random-Parallel	FM1 SEPT-NS Ysept FM2 SEPT-NS Ysept	Opposite lateral faces
20	FM1-NS-SL-Y-3 FM2-NS-SL-Y-3	Sine-Low	FM1 SEPT-NS Ysept FM2 SEPT-NS Ysept	Opposite lateral faces

Vibration Test (continued)

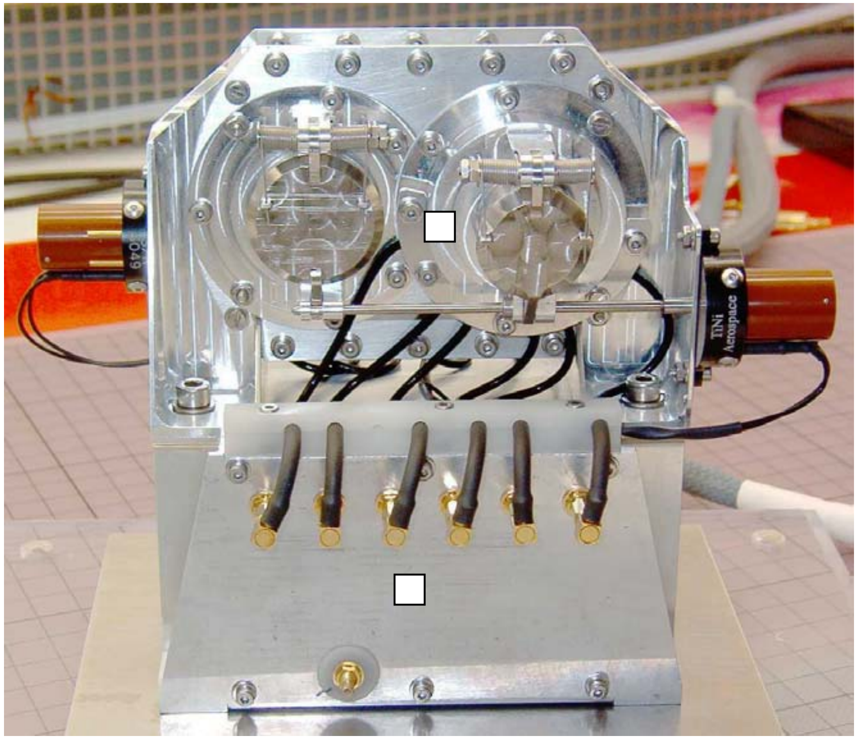
Run #	Data log name	Level	Unit and axis	Location on cube
21	FM1-E-SL-Z-1 FM2-E-SL-Z-1	Sine-Low	FM1 SEPT-E Zsept FM2 SEPT-E Zsept	Both units on top face
22	FM1-E-SLat-Z FM2-E-SLat-Z	Sine-Lateral	FM1 SEPT-E Zsept FM2 SEPT-E Zsept	Both units on top face
23	FM1-E-SL-Z-2 FM2-E-SL-Z-2	Sine-Low	FM1 SEPT-E Zsept FM2 SEPT-E Zsept	Both units on top face
24	FM1-E-RPerp-Z FM2-E-RPerp-Z	Random-Perpendicul.	FM1 SEPT-E Zsept FM2 SEPT-E Zsept	Both units on top face
25	FM1-E-SL-Z-3 FM2-E-SL-Z-3	Sine-Low	FM1 SEPT-E Zsept FM2 SEPT-E Zsept	Both units on top face

Vibration Test (continued)

Run #	Data log name	Level	Unit and axis	Location on cube
26	FM1-NS-SL-Z-1 FM2-NS-SL-Z-1	Sine-Low	FM1 SEPT-NS Zsept FM2 SEPT-NS Zsept	Both units on top face
27	FM1-NS-SLat-Z FM2-NS-SLat-Z	Sine-Lateral	FM1 SEPT-NS Zsept FM2 SEPT-NS Zsept	Both units on top face
28	FM1-NS-SL-Z-2 FM2-NS-SL-Z-2	Sine-Low	FM1 SEPT-NS Zsept FM2 SEPT-NS Zsept	Both units on top face
29	FM1-NS-RPerp-Z FM2-NS-RPerp-Z	Random-Perpendicul.	FM1 SEPT-NS Zsept FM2 SEPT-NS Zsept	Both units on top face
30	FM1-NS-SL-Z-3 FM2-NS-SL-Z-3	Sine-Low	FM1 SEPT-NS Zsept FM2 SEPT-NS Zsept	Both units on top face

Vibration Test (continued)

- **Position and number of accelerometers**
  - 1 cube (9x9x9 mm^3) with 3 accelerometers on sensor
  - 1 cube (9x9x9 mm^3) with 3 accelerometers on E-box
  - 1 cube (9x9x9 mm^3) with 3 accelerometers on bracket
  - No accelerometers can be placed onto the covers because Goddard composite thermal hardware must not be touched



Vibration Test (continued)

Sine-Low	
Frequency (Hz)	Acceleration
5 – 2000	0.25 g
Rate = 4 octaves/min	

Vibration Test (continued)

Sine Sweep			
Thrust		Lateral	
Frequency (Hz)	Acceleration	Frequency (Hz)	Acceleration
5 to 7.4	0.5 inch (double amplitude)	5 to 6.3	0.5 inch (double amplitude)
7.4 to 23	1.4 g	6.3 to 19	1.0 g
25 to 27	16.0 g	21 to 23	12.0 g
29 to 100	1.4 g	25 to 100	1.0 g
Rate = 4 Octaves/min			

Vibration Test (continued)

Random Vibration		
Frequency (Hz)	Perpendicular	Parallel
	PSD Level	PSD Level
20	0.0063 g^2/Hz	0.0031 g^2/Hz
20 to 80	+6 dB/oct	+6 dB/oct
80 to 800	0.1 g^2/Hz	0.05 g^2/Hz
800 to 2000	-9 dB/oct	-9 dB/oct
2000	0.0065 g^2/Hz	0.0032 g^2/Hz
Overall Amplitude	10.4 g_{rms}	7.4 g_{rms}
Duration	60 seconds	60 seconds

Thermal Vacuum Test

- Four SEPT Flight Models will be subjected to a thermal vacuum test program in the Little Vacuum Facility (LIVAF) of the Mechanical Systems Laboratory, ESTEC Test Centre, in week 6 and 7, 2004
- The LIVAF is not equipped with cryo pumps, but with a combination of primary rotary forepump and secondary turbo-molecular pump
- Hence a measurement of the residual gas composition is carried out to establish whether it can be used for TV cycling of SEPT
- To reduce test costs, two SEPT units are TV cycled together, resulting in two test sequences
- SEPT-E and SEPT-NS are mounted without brackets and thermal isolators (Ultem) directly to the temperature controlled cold plate
- One of the four units has the EM blanket installed to verify mechanical non-interference with the door mechanism

Thermal Vacuum Test (continued)

- Residual gas analysis
  - Two temperature cycles performed (+62.5°C, 4.0 10^{-6} mbar to -30°C, 2.4 10^{-7} mbar) with shrouds stabilised at maximum/minimum cycle temperatures
  - Quadrupole mass spectrometer in mass range 1 to 200 amu
  - Identification of 40 major contributors
- Discussion of results
  - Major contributors in hot as well as cold case are H_2O, N_2, and O_2
  - Background level increases with temperature, decreases with duration of cycling
  - Contributors related to pump system (55-57 amu, 68-71 amu) increased
  - TV chamber considered suitable for SEPT TV test
- ESTEC Test report available (in English, 15 pages)

Thermal Vacuum Test (continued)

SEP TV
Test limits
(°C)

Component	Operating	Survival	Qualification
HET			
Detectors	-30to +35	-40 to +40	-40 to +40
Electronics	-30to +35	-40 to +40	-40 to +40
CENTRAL ELEC	-30to +35	-40 to +40	-40 to +40
LET			
Detectors	-30to +35	-40 to +40	-40 to +40
Electronics	-30to +35	-40 to +40	-40 to +40
SIT			
Detectors	-30to +30	-35 to +35	-35 to +35
Electronics	-30to +30	-35 to +35	-35 to +35
SEPT			
Detectors	-30 to +40	-40 to +50	-40 to +50
Electronics	-30 to +40	-40 to +50	-40 to +50
SEPT N/S			
Detectors	-30 to +40	-40 to +50	-40 to +50
Electronics	-30 to +40	-40 to +50	-40 to +50

Thermal Vacuum Test (continued)

- More TBS

Thermal Balance Test

- One SEPT Flight Model will be subjected to a thermal balance test program in Building 2, GSFC in week 25, 2004
- More TBS

SEPT Bakeout

- Four SEPT Flight Models will be subjected to a bakeout program in the Vacuum Test Chamber/Offgassing TOS-QCM of the Materials Physics and Chemistry Section, ESTEC Test Centre, in week 9 (TBC), 2004
  - Not performed in connection with TV test because LIVAF is not equipped with TQCMs
- More TBS