
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 Boom TRR Agenda

1:00	Overview	Curtis
1:30	STE-U	Curtis
2:30	MAG	Acuna
3:30	IMPACT Boom	McCauley

Overview

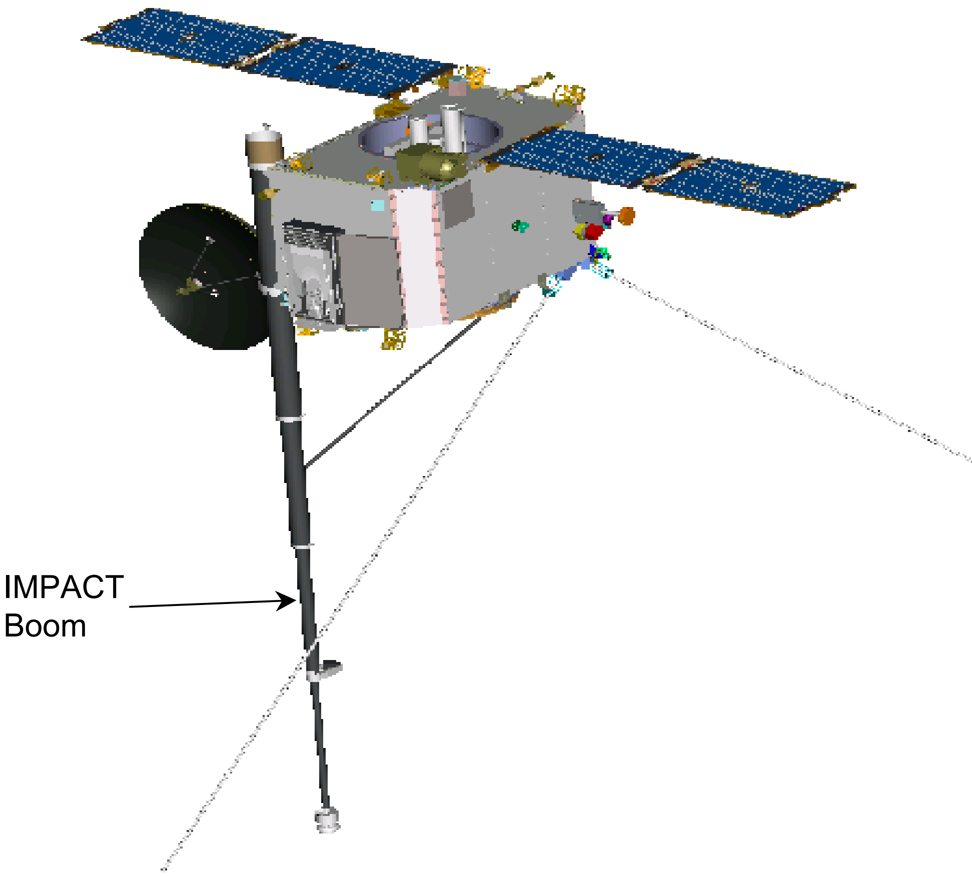
David Curtis (PM), UC Berkeley Space Sciences Lab,
dwc@ssl.berkeley.edu, (510) 642-5998

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

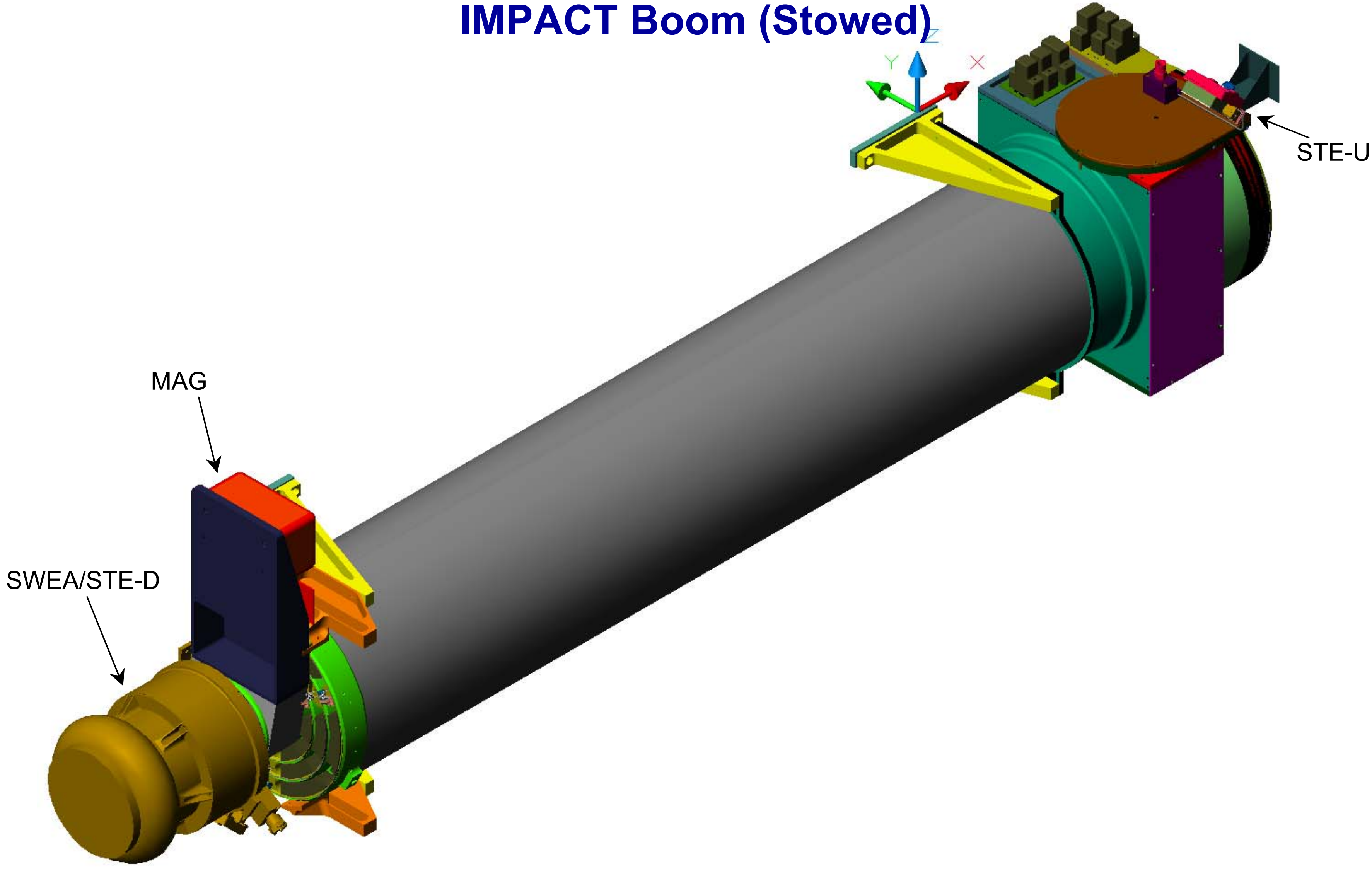
- **Boom Suite:**
  - **Solar Wind Electron Analyzer (SWEA)**
  - **Suprathermal Electron Telescope (STE)**
  - **Magnetometer (MAG)**

- **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)**



IMPACT Boom (Stowed)



TRR Organization

- This TRR covers the Boom structure, plus two of the three instruments assemblies mounted to the boom
  - MAG Sensor
  - STE-U Detector/preamp
- The SWEA/STE-D assembly is not ready for environmental tests yet, and will be tested separately from the boom (as described at the PER)
- Both the MAG sensor and the STE-U have front-end electronics that reside in the IDPU
  - The IDPU will be environmentally tested separately (as described at the PER)
  - An IDPU including the associated flight interface boards will be used for the functional tests during the boom environments (the ETU IDPU LVPS will be used since the flight LVPS is not yet ready)
- EMC will be performed at the Suite level, and will be the subject of a later TRR.
  - IMPACT EMC Test plan has been submitted for review by the EMC committee

Changes Since PER

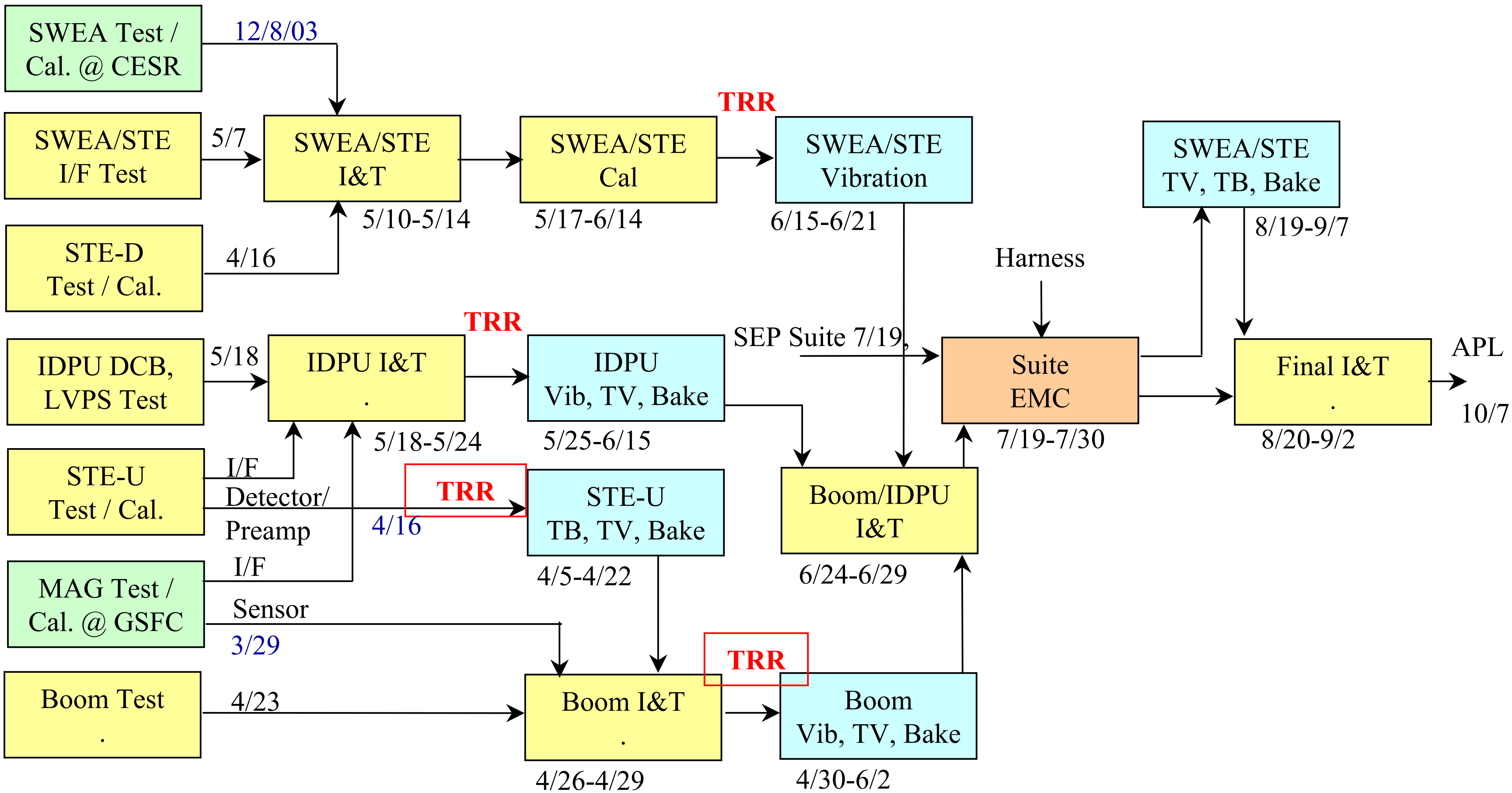
- **STE-U is now being thermal vacuum tested separately from the boom**
  - Contamination concerns from being in vacuum with the detector cold prior to having the boom thoroughly baked out
  - Easier to design a test that will achieve the predicted detector and preamp temperatures without having to include the boom (follows a PER recommendation)
  - STE-U will be mounted to the boom for vibration, as previously planned
- **Bakeouts have been appended to thermal vacuum tests rather than being separate.**
  - Result of a new bakeout plan generated together with Project Contamination Control personnel
  - Logistically easier
  - Boom gets baked out before STE-U attached (except for vibration)
- **Boom, MAG, and STE-U ready to start environmental tests**

Test Matrix Summary

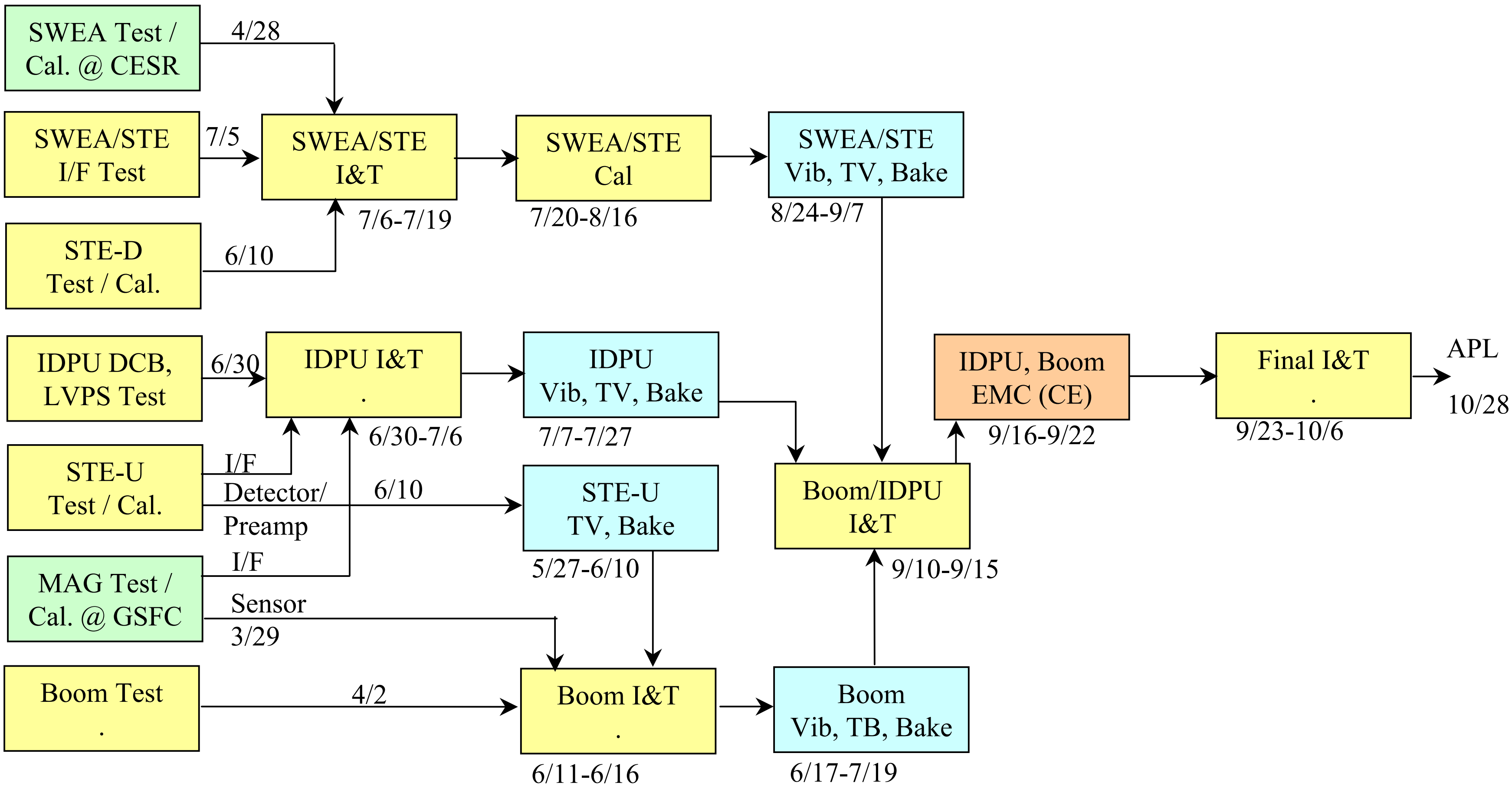
System	EMC	Bakeout	Thermal Vac Cycling (Op/NonOp)	Thermal Balance	Sine Vib	Random Vib	Mass props	Failure Free Hours
SEP		√						
- SEPT-NS	Mag Screening	H	-30 - +40C -40 - +50C	√	√	√	√	24
- SEPT-E	Mag Screening	H	-30 - +40C -40 - +50C	√	√	√	√	24
- SIT	Mag Screening	H	-30 - +30C -35 - +35C	√	√	√	√	24
- HET, LET, Common Elec.	Mag Screening	H	-30 - +35C -40 - +40C	√	√	√	√	24
Boom Assy		√	-33 - +40C -33 - +40 (*)		√ (*)	√ (*)	√	
- Boom	Mag Screening	H	H	√	H	H	Mass	N/A
- SWEA	Mag Screening	√	-25 - +30C -30 - +50C	√	√	√	Mass	24
- STE	Mag Screening	√	-30 - +40 (P) -105- -35 (D) -35 - +45 (P) -110- +40 (D	√	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 plus Mag H = test at higher level of assembly

Boom Suite FM1 Test Flow, Updated 2004-4-12



Boom Suite FM2 Test Flow, Updated 2004-4-12



RFA, Waiver and PFR Status

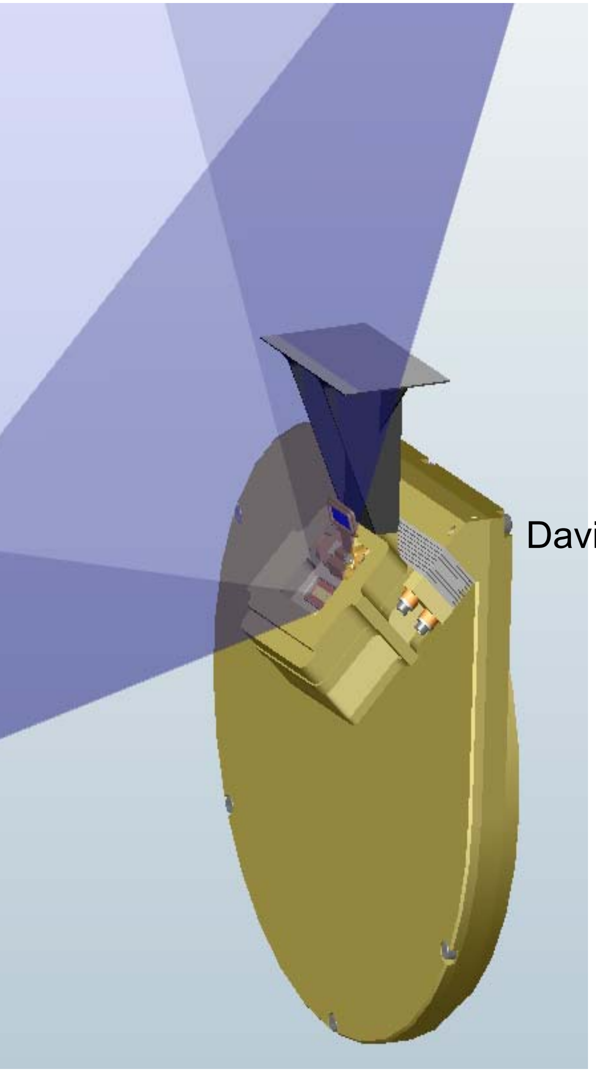
- **All PDR RFAs submitted, approved**
- **29 of 32 CDR RFAs closed**
  - 2 pending final details of SIT door design
  - 1 pending outcome of an analysis of launch aerodynamic heating
- **Responded to 12 of 14 PER RFAs, 5 closed**
  - 2 more waiting Project input
- **21 waivers submitted**
  - 15 approved, 6 open
  - 3 related to environmental tests (next page)
  - Do not expect to have problems getting these approved
- **6 Problem/Failure Reports submitted**
  - 2 closed (PFR 1001, Boom deployment, PFR 6001, SWEA HV part)
  - 3 pending test results (PFR7001, SEPT door, PFR7002, SEPT Detector, PRF7003, SEPT Actuator), do not effect subject of this TRR
  - 1 new (PFR1002, STE-U assembly), discussed in STE-U section below

Environmental Test Waivers

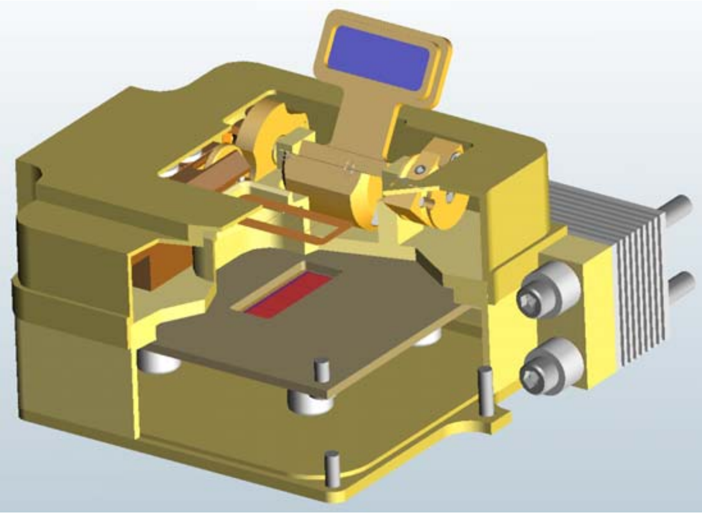
- Thermal Balance
  - We plan thermal balance for one unit only (7381-9003 Env. Test spec says both units)
    - Model differences in environment and in some cases blankets
    - Qual model for the boom, FM1 for the instruments
  - We plan to thermal balance test instruments separately from the boom
    - 7381-9003 calls for them being tested together
  - We do not plan a thermal balance test for the MAG sensor
    - Identical to sensors tested and flown on many missions
- SWEA/STE-D Vibration
  - We plan to vibrate SWEA/STE-D separately from the boom
    - 7381-9003 says instruments are vibrated with the boom
  - We plan to vibrate to levels enveloped from boom vibration testing
    - 7381-9003 says to use 14.1GRMS for instruments vibrated off their "brackets"
- Acoustics
  - We do not plan acoustics for SWEA and STE-D; no sensitive elements (foils, etc)
    - 7381-9003 calls for testing only on sensitive units
    - 7381-9003 also specifically calls for acoustic testing on these units
  - We do not plan for acoustic tests for SEPT
    - There are some fairly robust foils in SEPT
    - We did an acoustic test on the ETU level

Configuration Control

- Change control in effect, including hardware, software and critical GSE, per IMPACT Configuration Control Plan
- All units are serialized and marked
- All test and calibration data shall reference the serial number of the unit under test
- All units have some differences between the Ahead and Behind configuration, and so are not easily interchangeable once configured
  - Thermal coatings
  - FOV orientation
  - Calibrated pairs (MAG sensor and IDPU, STE-U and IDPU)
- It is possible to interchange some units with some rework if necessary, but that is not the baseline plan
  - Nominally units designated for one spacecraft will only test with other units for the same spacecraft
  - Nominally the Ahead spacecraft units will be tested first since they deliver first
  - Should some problem require a swap of units, a review will be performed to ensure that no testing is missed



STE-U



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

STE-U Test Constraints

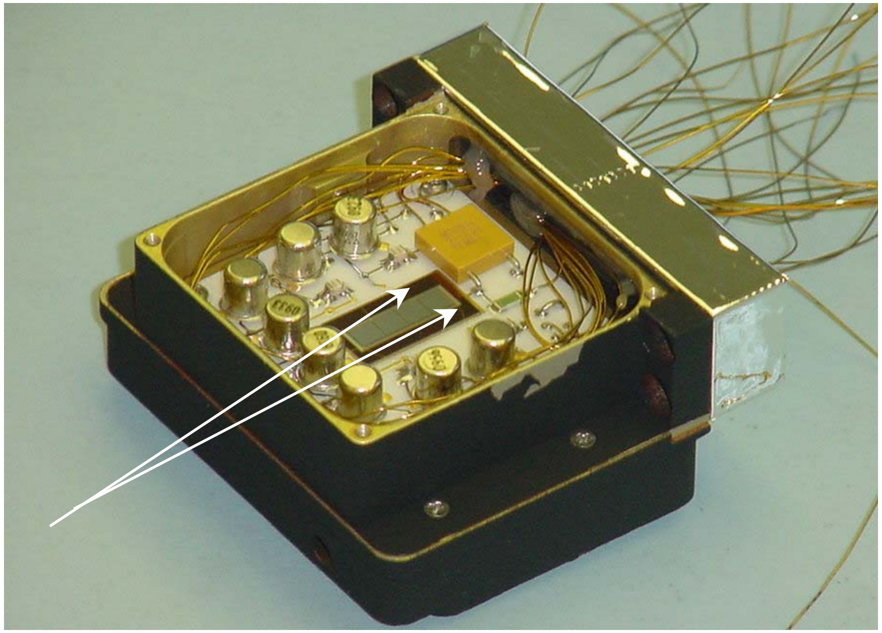
- **STE-U detector is contamination sensitive and hard to clean**
  - The door will be closed and the instrument purged through most of testing.
    - Interruptions in purge can be tolerated
  - The instrument shall be bagged whenever possible
  - The door will only be opened when in a class 10K clean area (class 100K for a short duration opening), or when bagged.
  - The instrument will not be mated to the boom during boom bakeout (change from PER plan)
- **STE-U detector is light-sensitive**
  - During functional tests the instrument must be in the dark or covered with a dark bag
- **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
  - No other source needed for STE CPT

STE-U Pre-Environmental Test Summary

- STE-U ETU door has passed a life test with >10x expected cycles for a 5-year mission
  - Expected operational cycles <500 , tested cycles = 18,000 without incident (ambient)
  - 300 cycle burn-in test performed on the flight door
- Performed thermal vac test on ETU detector to verify detector performance at expected operational temperatures (cold)
- Built 10 detector boards, tested 5 so far, need 4 for flight
  - All 5 met performance requirements, best ones exceed goals.
- Baked out FM1 STE-U preamp board at 70C for 48 hours
- Integrated mechanical and electrical components
- Detector failure after first assembly (bond wire broken in assembly process – PFR1002); see next slide
- Mass = 396g (allocation=320g), Power = 209mW (allocation=200mW)

STE-U Assembly Failure (PFR1002)

- During assembly of STE-U FM1 detector into the housing one of the bond wires was broken
- Detector bond wires were exposed during assembly and routing of wires
- Subsequent assembly will take place with a shield mounted over the detector are to prevent damage.
- Damaged detector board was removed for rework and replaced with a flight spare
- PFR has been submitted
  - not yet closed
- Assembly-level testing delayed
  - Not yet complete



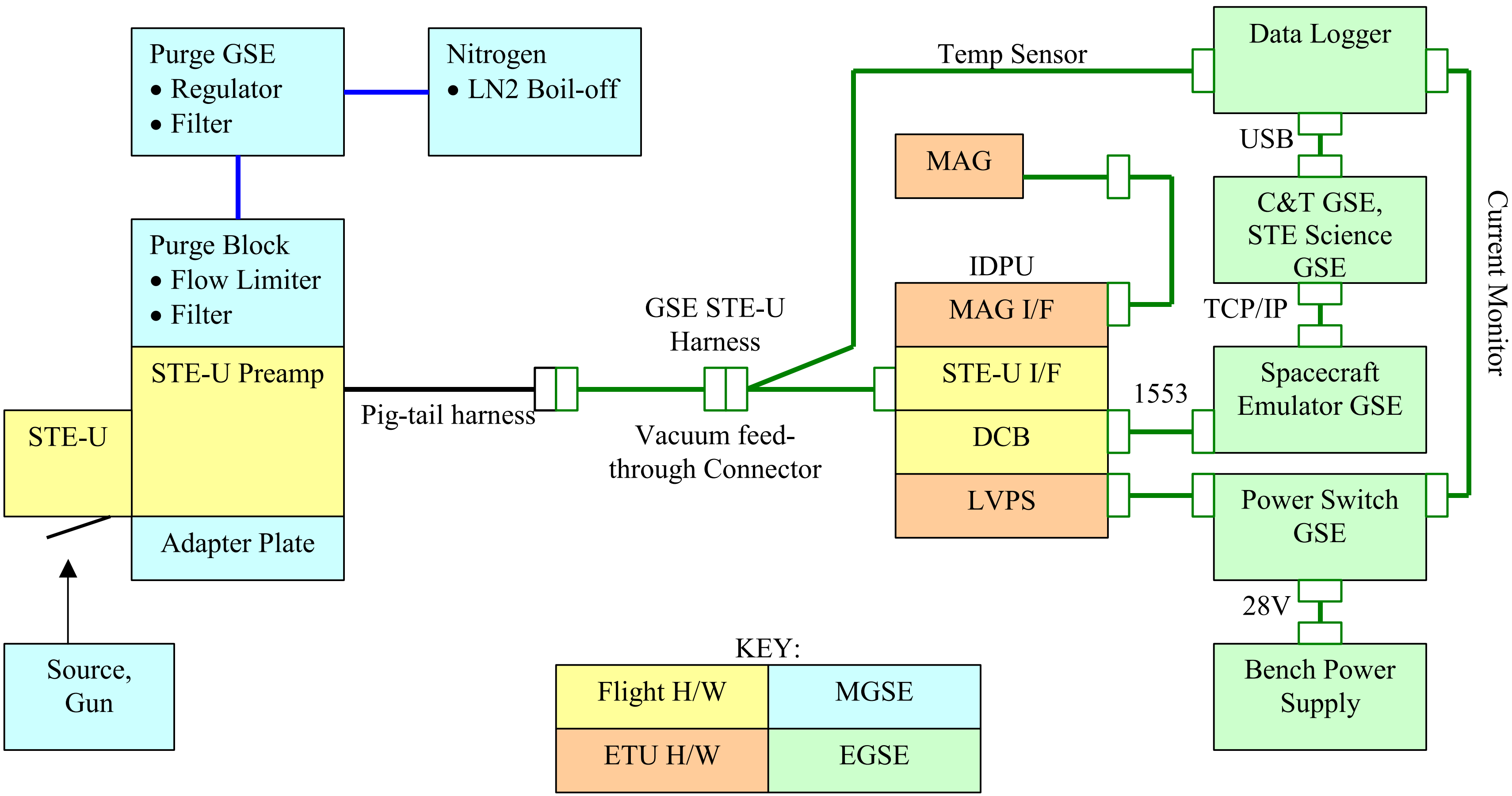
STE-U Pre-Environmental Tests & Calibration Remaining Tasks

- Trim FM1 STE-U interface gain (in IDPU) to match FM1 STE-U detector
- Apply thermal surface finishes to FM1 STE-U housings
- Mount sun-shield
- Verified box bonding requirements and surface conductivity requirements
- Perform bench Comprehensive Performance Test (baseline)
  - For this and following tests used a hybrid IDPU consisting of:
    - FM1 STE-U interface and Data Controller Board
    - ETU LVPS
- Calibrate system with door source and external sources
- System calibration with an electron gun in vacuum (in progress)
  - This test has been performed on the ETU – no surprises expected.
- Collect at least 25 hours of trouble-free operation at STE-U level
- Estimate ~1-2 weeks to completion

STE-U Comprehensive Performance Test

- The STE-U CPT (a subset of the IDPU CPT) includes:
  - 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 gain, resolution, count rate, and thresholds
- CPTs shall be performed before, after, and in some cases (as noted) during environmental tests
- CPT shall be performed together with the Flight IDPU
  - STE-U Interface board in the IDPU is trimmed to the detector
  - The ETU IDPU LVPS may be used for some CPTs when the flight unit is not available
  - IDPU Flight Software complete except for PLASTIC
  - IDPU & GSE software under configuration control
- IDPU/MAG/STE-U CPT under UCB configuration control

STE-U CPT / Calibration Setup



Performance / Calibration Tests Results

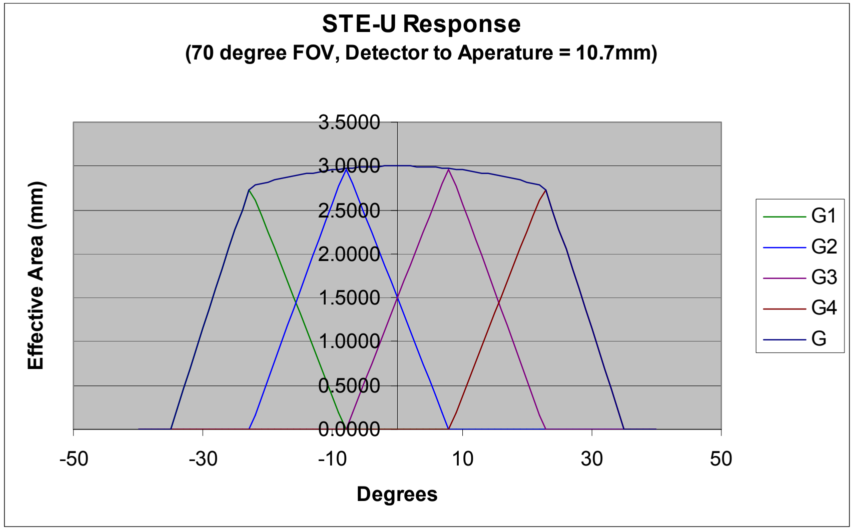
- **First batch of 5 detectors have been tested and meet energy range and resolution requirements, and in some cases meet resolution goals.**
  - **5 more yet to test, 4 required for flight.**
- **One flight detector has been tested cold (down to –100C)**
  - **looking better cold (as expected), and exceeded goals (~1keV threshold)**
- **FM1 ambient performance tests will start this week**
  - **delayed by assembly problem discussed above**

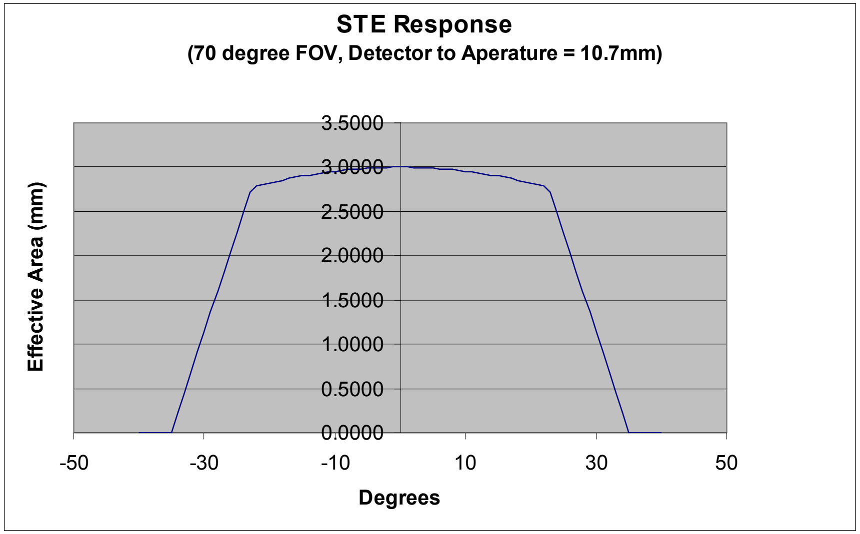
REQUIREMENTS: from IMPACT Performance Requirements Document

Description	Goal	Requirement	Source
FOV	Two opposite 80 x 80 degree	60 x 60 degree	Derived from MRD 4.7(F,G) & solar wind characteristics
Resolution	80 x 20 degrees	60 x 20 degrees	Derived from MRD 4.7(F,G) & solar wind characteristics
Energy	2 - 100 keV	5 – 100 keV	MRD 4.7 (F,G)
Energy Resolution (Telemetry)	35%	100%	Derived from MRD 4.7(F,G) & solar wind characteristics
Energy Resolution (Electronic)	300eV FWHM	2keV	Derived from lower energy and resolution requirements above.
Geometric Factor	0.4 cm^2 ster	0.1 cm^2 ster	Derived from MRD 4.7(F,G) & solar wind characteristics
Background	<1c/s/detector	<30c/s /detector	Derived from MRD 4.7(F,G) & solar wind characteristics
Max Count Rate (per detector)	100,000 counts/sec	10,000 counts/sec	Derived from MRD 4.7(F,G) & solar wind characteristics
Time Resolution	16 seconds 2 seconds (burst)	1 minute	MRD 4.7 (F,G)

STE-U Field of View

- **At least 60 by 60 degree FOV requirement, divided into 4 segments**
- **70 degree by 70 degree FOV by simple analysis of collimator**
  - **Reduced from 80 x 80 goal to provide more margin against scattered light in sunward direction**
  - **STE-D retains desired 80 x 80 degree FOV**
- **To be Measured with electrons in vacuum cal**





STE-U Environmental Test Plan Outline

- Mass properties
  - FM1 STE-U Mass (with ETU blanket): 396g
  - STE-U is sufficiently small that CG and MOI are determined by analysis to the accuracy required
- Magnetics Screening
- Thermal Vac (per documented plan):
  - Preliminary bakeout, up to 48 hours at +40C
  - Thermal Balance
  - Break chamber, configure for thermal vac
  - Thermal vac, 6 op cycles plus one non-op cycle
  - CPT on each operational cycle
  - Qualification bakeout
- Mount to boom (along with MAG sensor), System-level CPT
- Vibration tests
  - See Boom section
- Post-Vibration CPT
- Remove from boom while boom does its thermal vac, bakeout
- Re-attach to boom, System level CPT
- IMPACT Suite EMC test
  - Described at a later TRR

STE-U Test Matrix

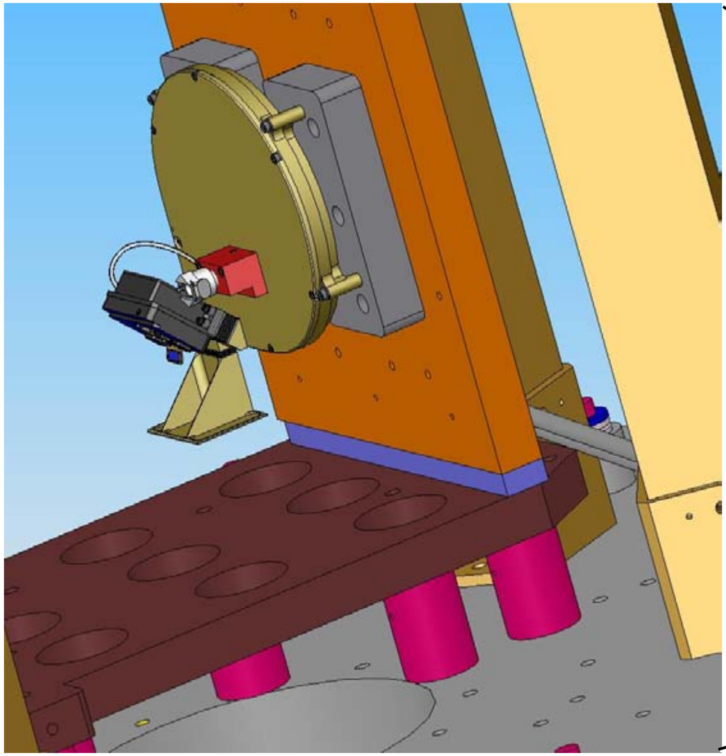
Level of Assembly	Item	Elect. test, rm. Temp	Bench Calibration	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Self Shock	Acoustics	Thermal Vacuum	Voltage margins	Thermal cycle	Thermal balance	Life Test	EMC/EMI	Magnetics	Beam Calibration	Bakeout	Contamination Inspection	Comments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

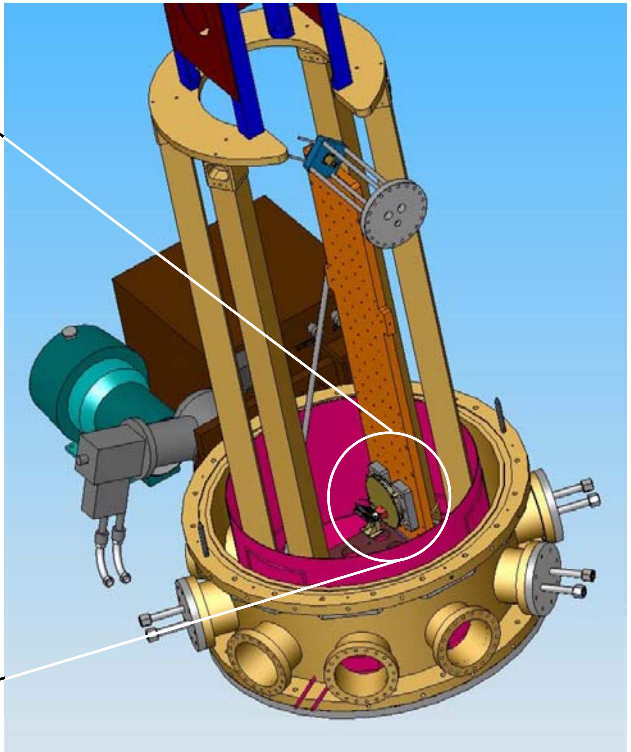
Legend:

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	

Thermal Vacuum Test Conditions

- Preamp thermally coupled to baseplate, representing the boom, blanketed
- Detector mounted to preamp on flight thermal isolators
  - radiatively coupled to shrouds (hard coupled for thermal cycling via strap)
- Control chamber such that STE detector is at least 10C warmer than shroud
  - To avoid contaminating detector





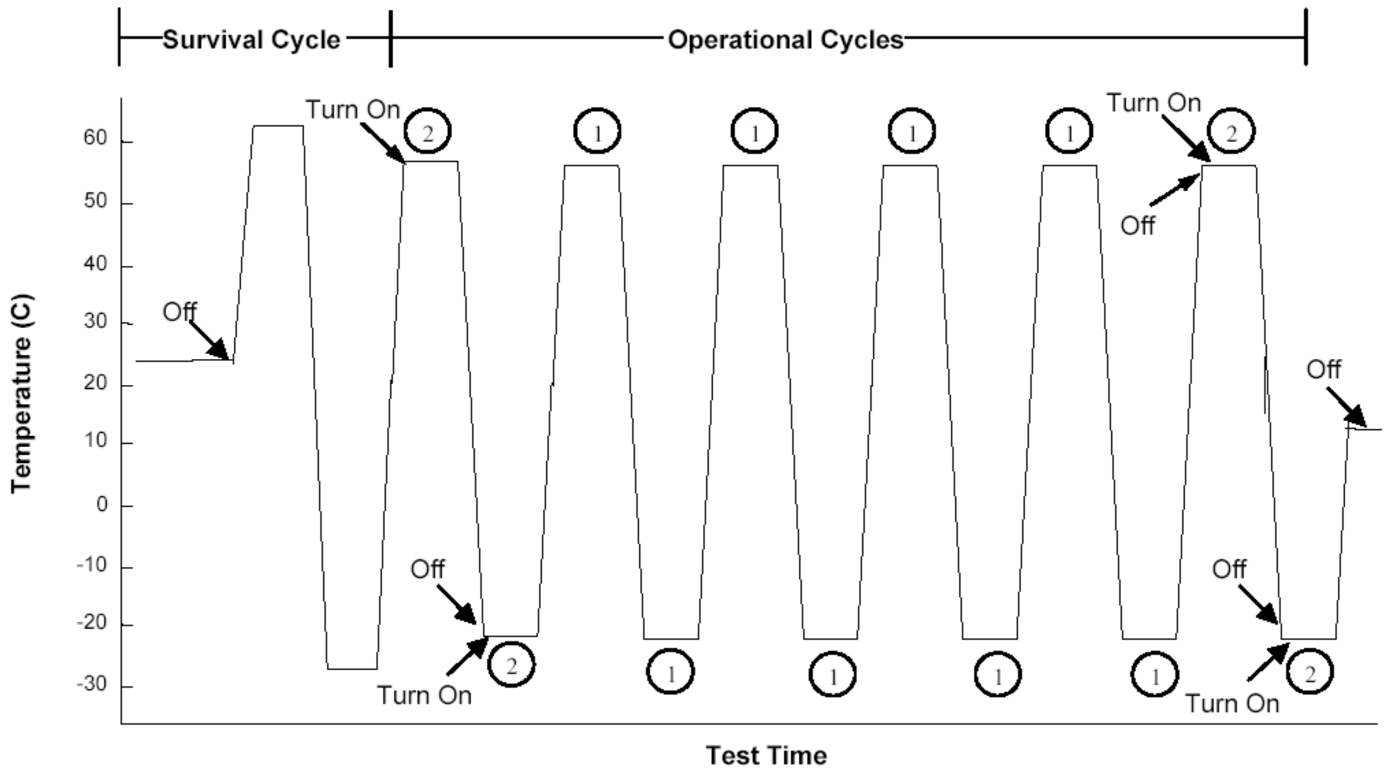
STE-U Mounted in Thermal Vac chamber (upper shroud and chamber walls removed)

STE-U Thermal Balance Test Plan

- Instrument and environment configured as close to flight-like as possible
  - Test designed to verify STE-U thermal model
  - LN2 cooled shroud at <-100C
  - Preamp mounted to baseplate, run at boom predict temperatures
  - Flight-like ETU thermal blankets on preamp/baseplate and sun shade
- Hot and cold cases planned
- Performed with instrument in operational mode
  - Power dissipation in instrument is not significant to thermal model
  - Operational mode allows use of internal temp sensors

Item/Description	Bake-out (°C)	Cold Case 1 (°C)	Hot Case 2 (°C)	Temp Control
Shrouds	20 to 50	<–110	<–110	LN^2 & Test Heaters
Cold Plate (CP)	20 to 50	<–110	<–110	LN^2 & Test Heaters
Chamber Baseplate	40 ± 3°C	–17	+33	LN^2 & Test Heaters
Test Adapter	40 ± 3°C	–17	+33	Via conduction from baseplate
Pre-amp *	40 ± 3°C	–20 (Flight Temp)	+30 (Flight Temp)	Via conduction from adapter
STE-U *	40 ± 3°C	–95 to –80 (Fight Temp)	–70 to –55 (Flight Temp)	Radiation coupling to shrouds

STE-U Thermal Cycling



See Table 2.3-1 for component dependant test temperatures.

Stabilization Criteria: Within 3°C Of Plateau And Changing < 1°C/Hr

See Fig 2.3.3.2-2 and -3 for detailed hot and cold transition definitions, resp.

Six Operational Cycles Required

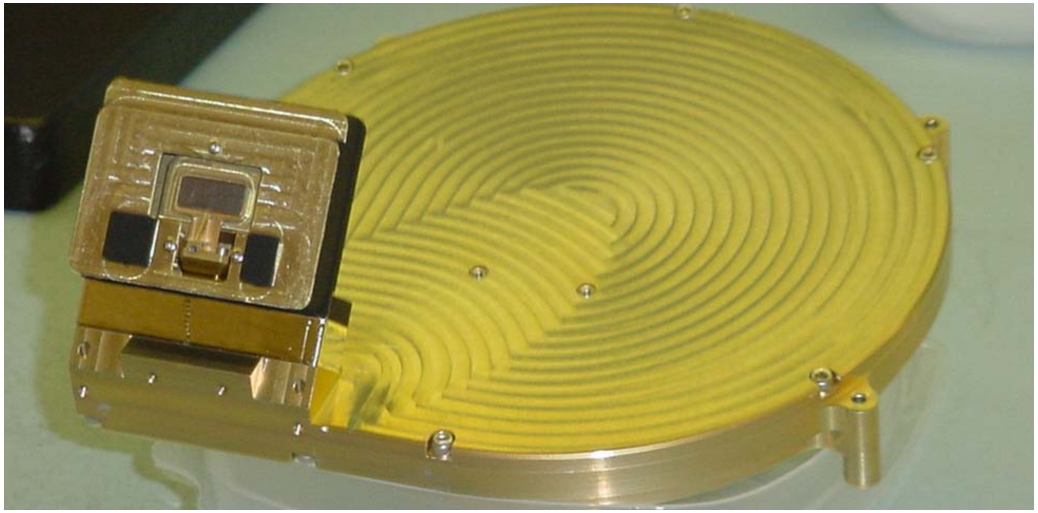
(1) = Stabilize, Print T/C's, Soak 1Hour and Test Concurrently, Print T/C's

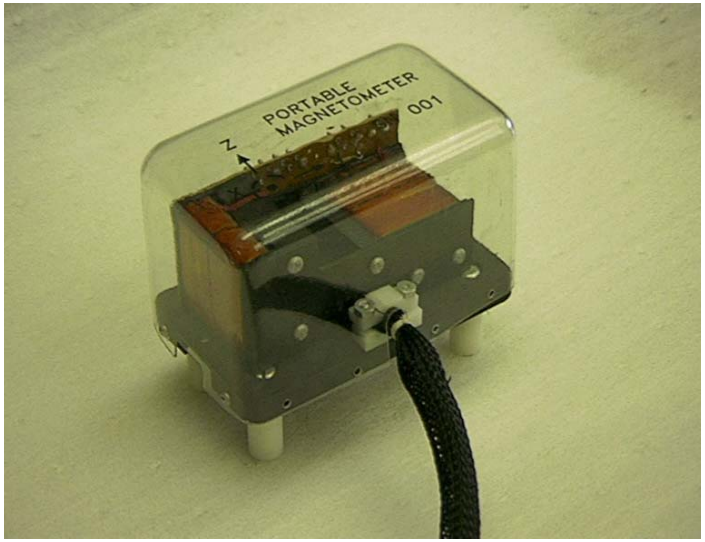
(2) = Stabilize, Turn On, Soak 1Hour and Test Concurrently, Print T/C's at End of Soak

STE-U Status

- **STE-U ready to start environmental tests**
  - Preliminary Ambient tests complete
  - CPT, Bench calibration, Vacuum calibration pending
  - Environmental test plans complete
  - PFR1002 ready to close

Assembled FM1 STE-U





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

Pre-Environmental Performance Test Results

REQUIREMENTS:
from IMPACT Performance Requirements Document

Description	Goal	Requirement	Source
Noise level	0.01 nT	0.05nT	Derived from MRD 4.7(K) and solar wind charateristics
Absolute Accuracy	+/- 0.1 nT	+/-0.1nT	MRD 4.7(K)
Range	+/-512 nT, +/-65536 nT	+/-512 nT	MRD 4.7(K)
Drift	+/-0.2 nT/yr	+/-0.2nT/yr	Derived from Absolute accuracy & MRD 4.6.2.6.1
Time Resolution	1/4 sec. 1/32 sec. (Burst)	1 sec	MRD 4.7(K)

TEST RESULTS (EM, FM1, FM2):

- **SCALE FACTORS (TYPICAL):**
  - **RANGE 0: 0.014 nT/CT or ± 460 nT full scale**
  - **RANGE 1: 1.83 nT/CT or ± 59965 nT full scale**
  - **These ranges were determined by availability of flight-qualified resistors**
- **NOISE LEVEL : preliminary value ~0.015 nT RMS**
  - **Full accuracy requires extended evaluation of test data and noise environment**
- **DRIFT AND ABSOLUTE ACCURACY:**
  - **Cannot be evaluated correctly on the ground**
- **TIME RESOLUTION: 32 samples/sec.**
- **ALIGNMENT (intrinsic):**
  - **within 0.22° of true orthogonality. Knowledge better than 3 arc-min**

MAG Mass & Power

- **Measured Sensor mass: 270g (allocation 310g)**
- **Measured Electronics mass: 293g (allocation 280g)**
- **Measured Power: 631mW (allocation 600mW)**

MAG Comprehensive Performance Test

- After integration with the boom, MAG CPT consisted of:
  - Verify MAG responds to Earth's field
    - Trend noise level, magnitude
    - Also test in a shield can if possible (better noise level measurement)
  - Use In-Flight Calibration system to verify MAG response
    - Trend IFC response (bandwidth)
  - 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
- Tests completed successfully

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
  - Described at a later TRR
- 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, ho	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	**C**	**C**	**C**	**C**	H	H	H		H		**C**	A	H	H		H	H	Sensor thermal balance by heritage
C	Electronics, EM	**C**	**C**	**C**	**C**									**C**					
C	Electronics,F	**C**	**C**	**C**	**C**	H	H	H		H	**C**	**C**		H	H		H	H	

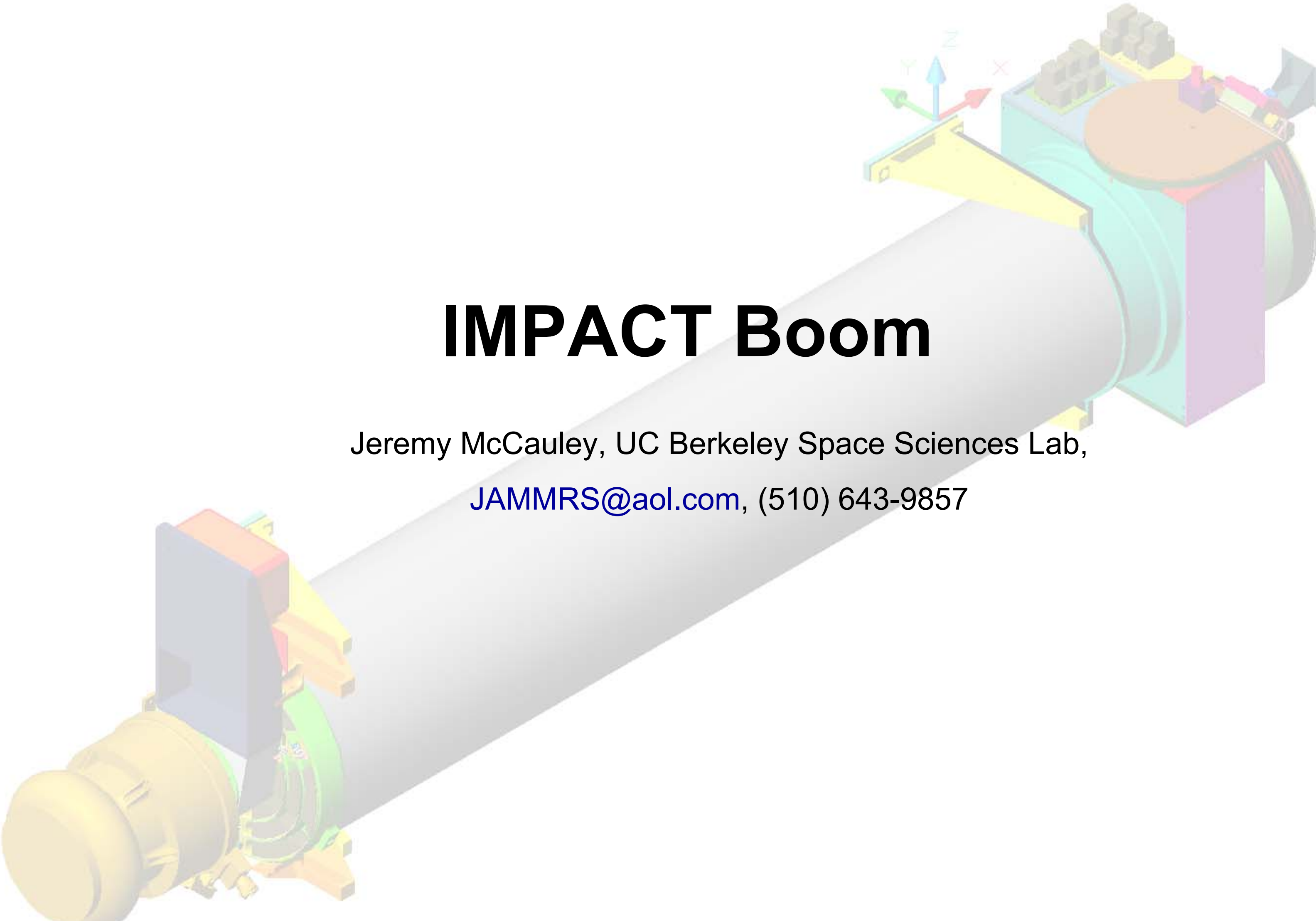
Legend:

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 and FM2 tested and delivered to UCB by April 26**
- **MAG to be integrated to the Boom and Electronics to the IDPU, followed by a system CPT prior to boom environmental tests**

FM1 MAG Electronics and FM2 MAG Sensor



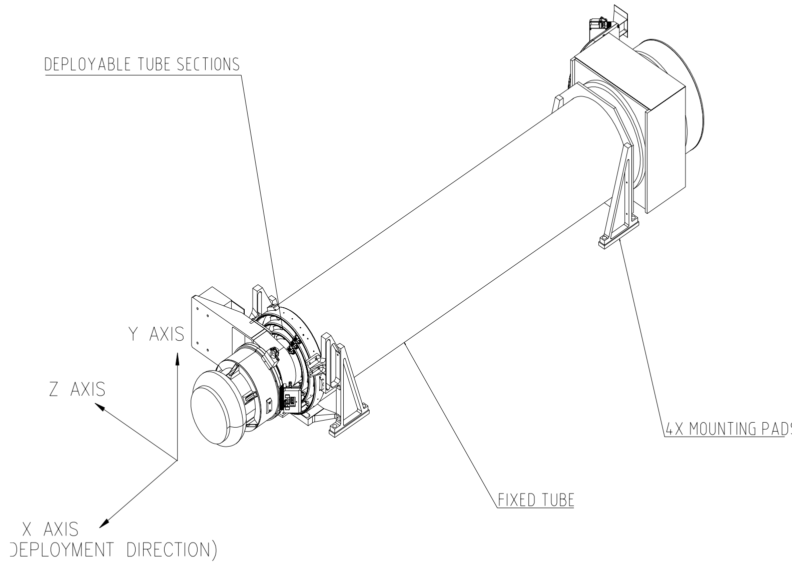
IMPACT Boom

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:
  - Functional, Alignment, Stiffness, Thermal, Vibration, Self-Shock
  - See Boom Test Plan for detailed information



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	Protoflight levels
C	FM2	X		X					X					X		X			X	Protoflight levels
S	FM1		S2		S1	S1	S				S2	S2			S		S2			Protoflight levels
S	FM2		S2		S1	S1	S				S2	S2			S		S2			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
S2 - with MAG	FM1 =	Flight unit #1	**P = Performed**
S = with all instruments	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, Rev. A, IMP-562-DOC (W. Donakowski, 09 April 2004)
- STEREO Boom Thermal Vacuum Cycling Test Procedure, Rev. A, IMP-563-DOC (W. Donakowski, 09 April 2004)
- STEREO/IMPACT Boom Thermal Balance Test Plan (A. Seivold, 29 August 2003)
- STEREO Boom Stowing Procedure, Rev. D, IMP-449-DOC (J. McCauley, 04 March 2004)
- STEREO Boom Deployment Checklist, Rev. E, IMP-451-DOC (J. McCauley, 24 February 2004)
- STEREO Boom Assembly Procedure, Rev. A, IMP-452-DOC (J. McCauley, 23 January 2004)

Boom Functional Test

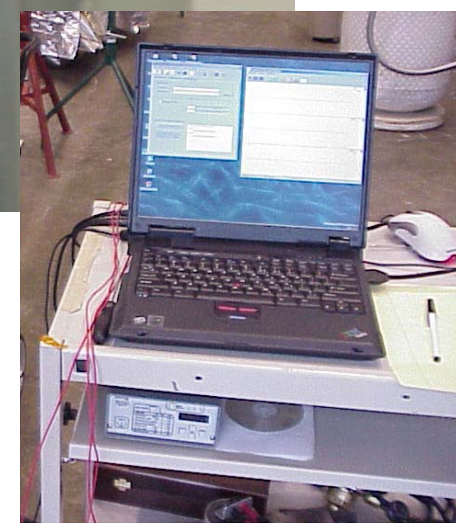
- **Boom functional testing**
  - **Deployments will be performed to ensure proper functionality**
  - **Full deployment is defined as:**
    - **actuation via powering the SMAR (Shape Memory Alloy Release) pin puller,**
    - **Stacer initiation via Deployment Assist Device (DAD),**
    - **full deployment via Stacer,**
    - **extension of all Tubes**
    - **and locking of all Lock Pins**
  - **A total of four (4) full deployments will be made to verify the functionality of the Boom**

Boom Alignment Test

- **Alignment**
  - **Alignment will be verified on Flight Model Booms after each deployment using a digital inclinometer with resolution of 0.01 degree**
  - **Requirement: 52.5 arcmin (0.88 degree)**
    - **PF maximum: 28.8 arcmin (0.48 degree)**

Boom Stiffness Test

- **Stiffness**
  - **Stiffness will be verified for each Flight Model Boom using frequency analysis.**
  - **Requirement: > 0.5 Hz and not coincident with another device (i.e., solar cells, SWAVES antennas)**
  - **Measured by: Endevco 61-A500 Isotron Accel through Model 133 signal conditioner into DAQView**



Boom Environmental Test Plan

- Boom FM1 and FM2 will undergo Vibration with the Magnetometer and STE-U installed
- Boom FM1 and FM2 will undergo Thermal Vacuum Cycling & Bakeout with the Magnetometer installed
- 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 with flight instrument suite prior to FM1 Suite EMC

Boom Environmental Tests

- Thermal Balance
  - Thermal balance was completed for Protoflight and will not be repeated for the Flight Models (Waiver submitted)

- EMC with the suite
  - To be described at a later TRR

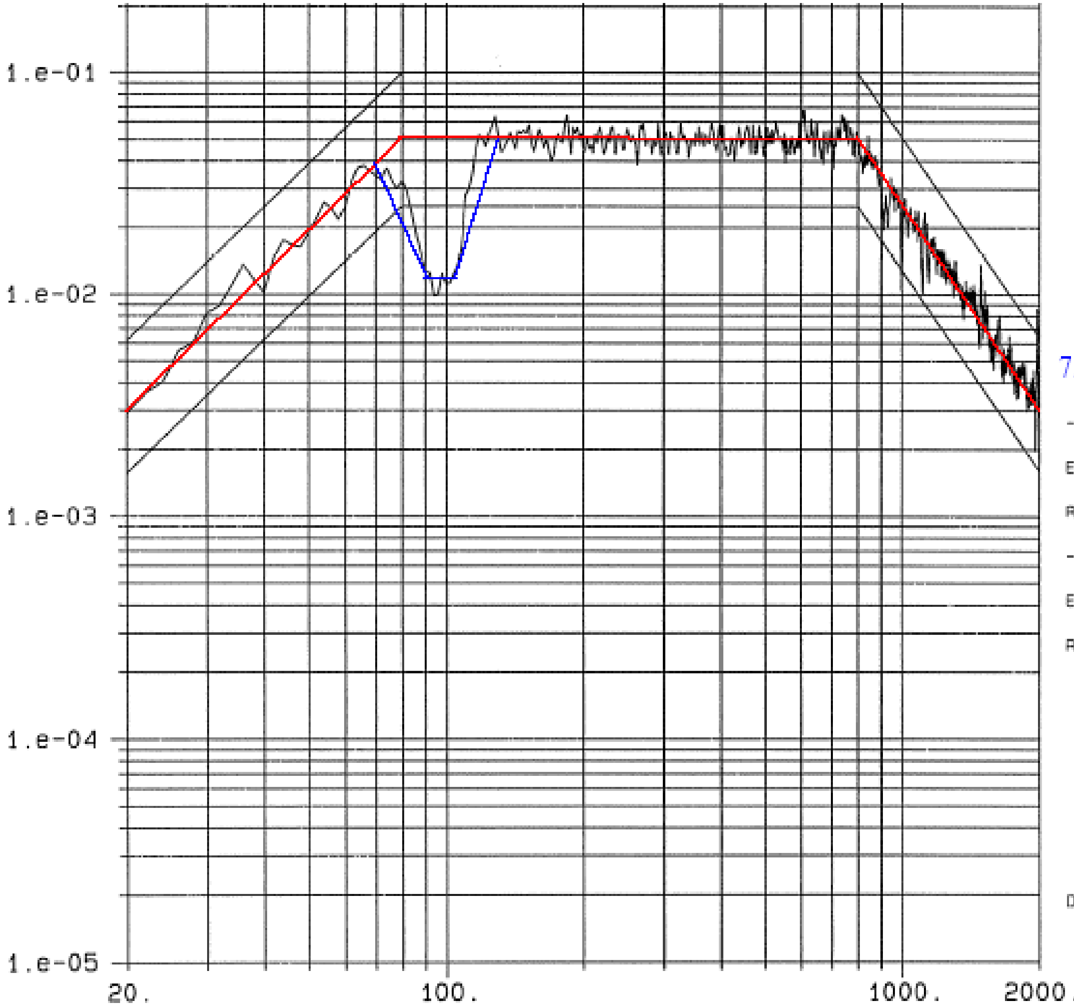
- Acoustic Testing
  - No foils or other acoustic sensitivities
  - Built into the vibration spec (APL 9003)

- Self Shock Test
  - To verify functionality of the complete assembly
  - To verify survivability for attached instruments

Boom Vibration Test Plan

- Vibration
  - Boom will be vibrated to levels specified in Environmental Spec (Sine Sweep, Random) at Wyle Laboratories, Santa Clara, CA
  - Vibration spectra are notched per the PF Control Envelopes (next slides, approved by T. Betenbaugh, 08 March 2004)
  - Boom will be vibrated powered as in launch: survival heaters on
  - An instrument CPT will be performed before and after vibration
  - A harness connectivity test will be conducted before and after vibration
  - A full deployment will be conducted to verify functionality after vibration. This deployment will occur as the hot deployment of thermal vacuum cycling, thus following the “test as you fly” philosophy.

Boom Random Vibration Test, Notched Spectra



PF Random

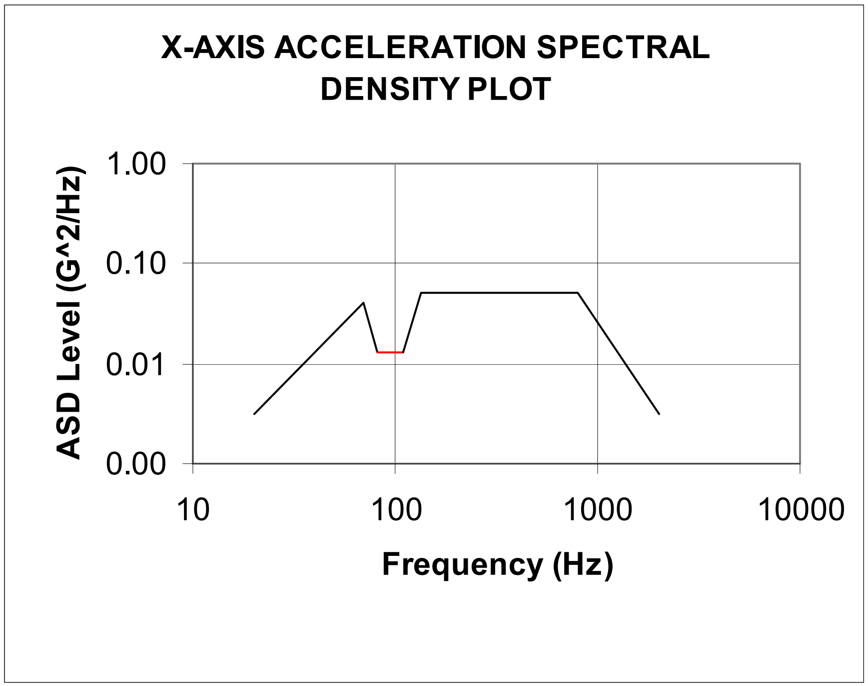
X-Axis Control

7.23Grms

-- Time on act. level --
Elapsed : 0:01:00
Remaining : 0:00:00
--- Time total ---
Elapsed : 0:03:12
Remaining : 0:00:00

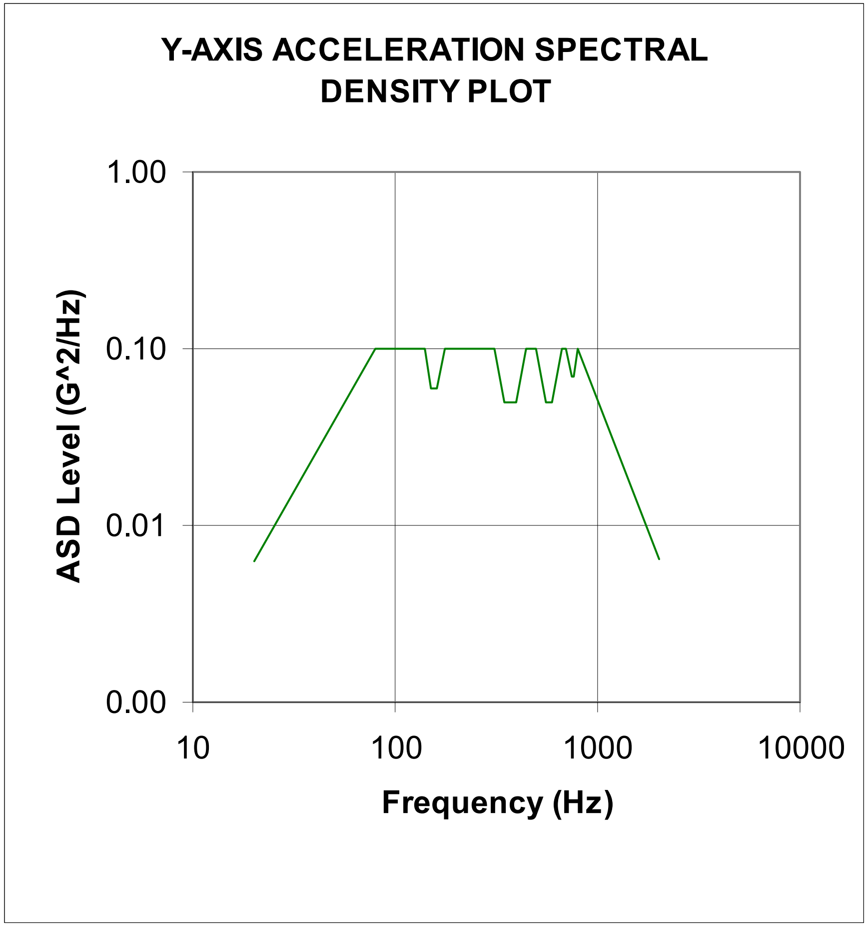
Date : 7/22/2003
9:09:05

Boom Random Vibration Test, X-Axis



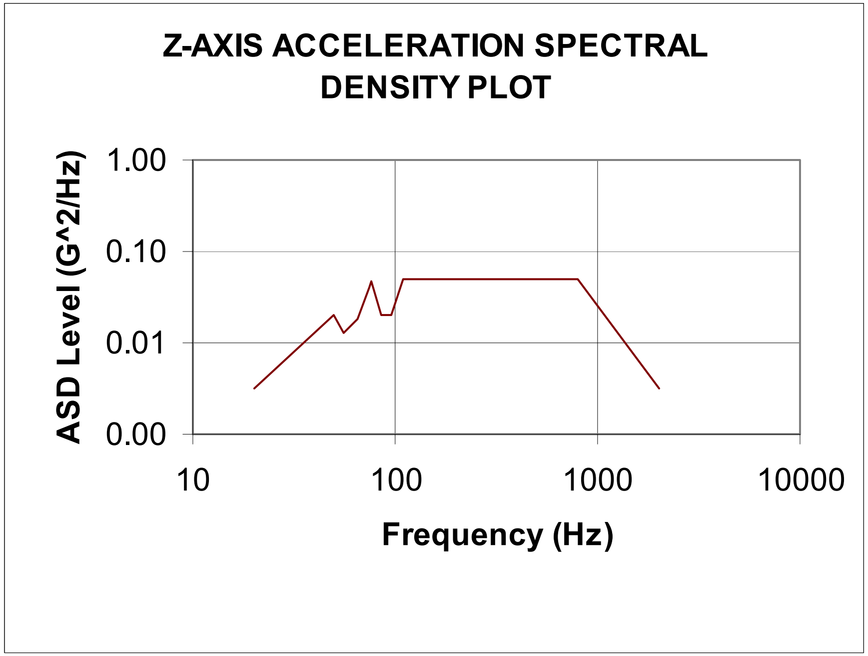
frequency	ASD
(Hz)	(G^2/Hz)
20	0.0031
70	0.0400
81	0.0130
110	0.0130
135	0.0500
800	0.0500
2000	0.0032
Duration: 60 seconds	

Boom Random Vibration Test, Y-Axis



frequency	ASD	frequency	ASD
(Hz)	(G2/Hz)	(Hz)	(G2/Hz)
20	0.0063	440	0.1000
80	0.1000	500	0.1000
140	0.1000	550	0.0500
150	0.0600	600	0.0500
160	0.0600	670	0.1000
175	0.1000	700	0.1000
310	0.1000	740	0.0700
350	0.0500	760	0.0700
400	0.0500	800	0.1000
		2000	0.0065
Duration: 60 seconds			

Boom Random Vibration Test, Z-Axis



frequency (Hz)	ASD (G2/Hz)
20	0.0031
50	0.0200
55	0.0130
65	0.0180
75	0.0400
77	0.0470
86	0.0200
95	0.0200
110	0.0500
800	0.0500
2000	0.0032
Duration: 60 seconds	

Boom Thermal Vac Plan

- 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 predicted by Al Seivold, Thermal Engineer, OSC
    - -33° to +40°C Operational, -33° to +40°C Survival
    - Includes 10° C margin (The in flight predict is -22.5° to +16.5°C.)
  - Bakeout
    - Boom will be baked out to verify outgassing rates as indicated in Contamination Control Plan
    - Goal: TQCM rate not to exceed 165 Hz/hr with Boom at +40°C, TQCM at -20°C and Cold Plate below -100°C

Protoflight Test Results

- The Protoflight Boom has been deployed in excess of 25 times. 18 were full deployments (all subsystems were included)
- 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 28.8 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.
- Details of the Protoflight test results presented at Post-Environmental Review, 03 December 2003.

Pre-Environmental Flight Boom Test Results

- The FM1 Boom is mechanically assembled.
- Preliminary data include:
  - Mass properties:
    - Mass: 10.9 kg (without Instruments, mounting hardware, closeout covers, connectors, or blankets). Allocation is 11.0kg excluding instruments and blankets.
    - MOI: See ICD for analytical numbers
  - Magnetic survey:
    - Part level magnetic survey was conducted for the Boom. The two “hot” items are:
      - Flyweight Brake Mechanism: ~100 nT @ 5” (1.2 m from Magnetometer when stowed, 4.4 m from Magnetometer when deployed resulting in 0.003 nT field at Magnetometer)
      - Preload Spring: ~100 nT @ 5” (1.1 m from Magnetometer when stowed, 4.3 m from Magnetometer when deployed resulting in 0.003 nT field at Magnetometer)

Boom Handling

- **The Flight Model Booms will be stored in a Class 10,000 cleanroom at all times.**
  - **For short durations, the Boom may be exposed to Class 100,000 room during in air deployments and while mounting to and removal from the thermal vacuum chamber.**
  - **The Flight Hardware shall be double-bagged with Llumalloy bagging material or equivalent whenever outside a Class 10,000 clean room following thermal vacuum bakeout.**

- **The Boom Stowing Procedure, IMP-449-DOC, has been designated a hazardous procedure due to physical contact with the stacer.**
  - **Basic precautions are required, i.e., experienced personnel must complete this operation and stowing GSE should be utilized.**

Boom Status

- FM1 is mechanically assembled
- FM1 is awaiting completion of the full harness
- FM1 will be ready for testing by 30 April 2004 (this Friday)
  - This gives one week of contingency before environmental tests can begin following the STE thermal testing
- FM2 is awaiting replacement of 6 Lock Pins, due 23 April 2004

Qual boom ready for thermal balance test