SIT Test Readiness Review

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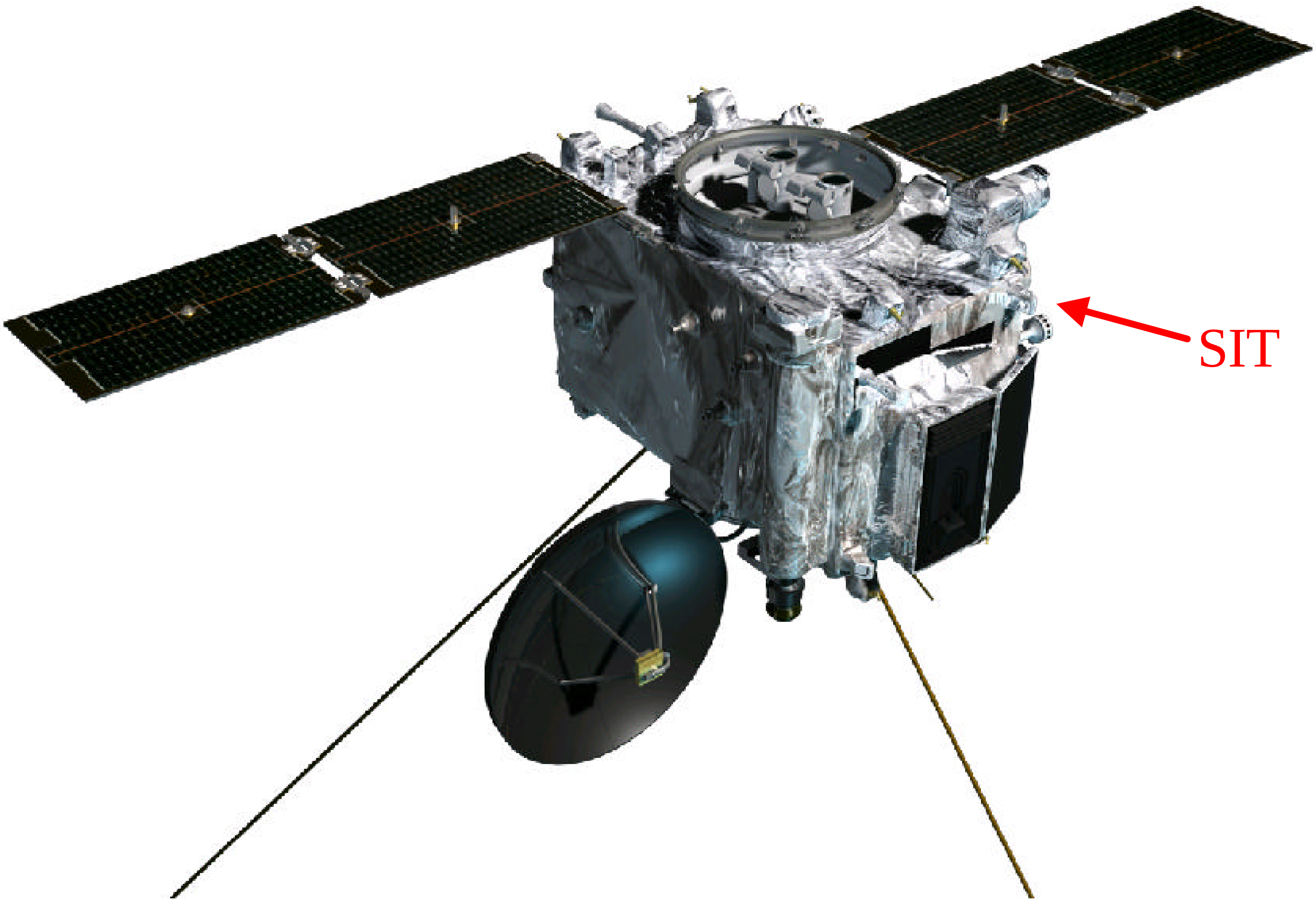
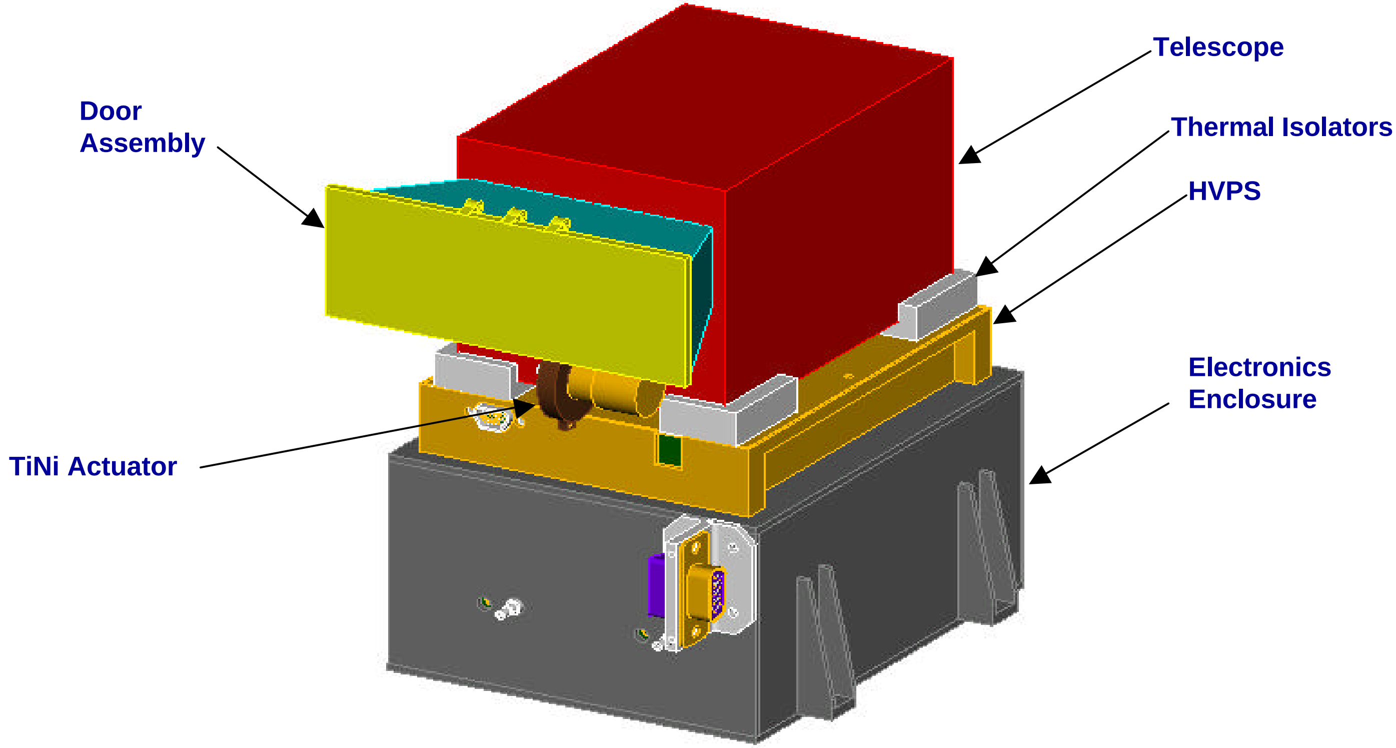
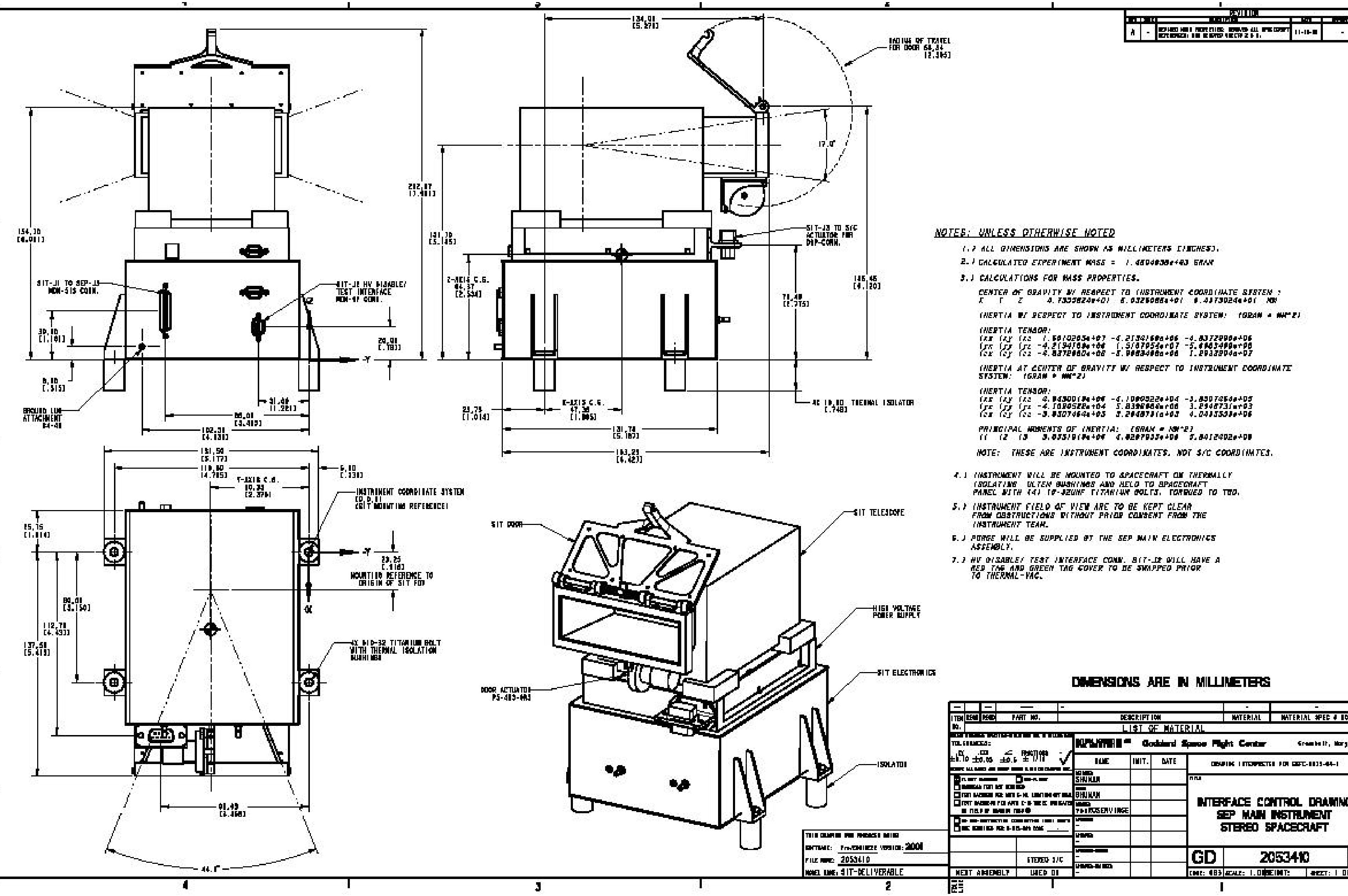
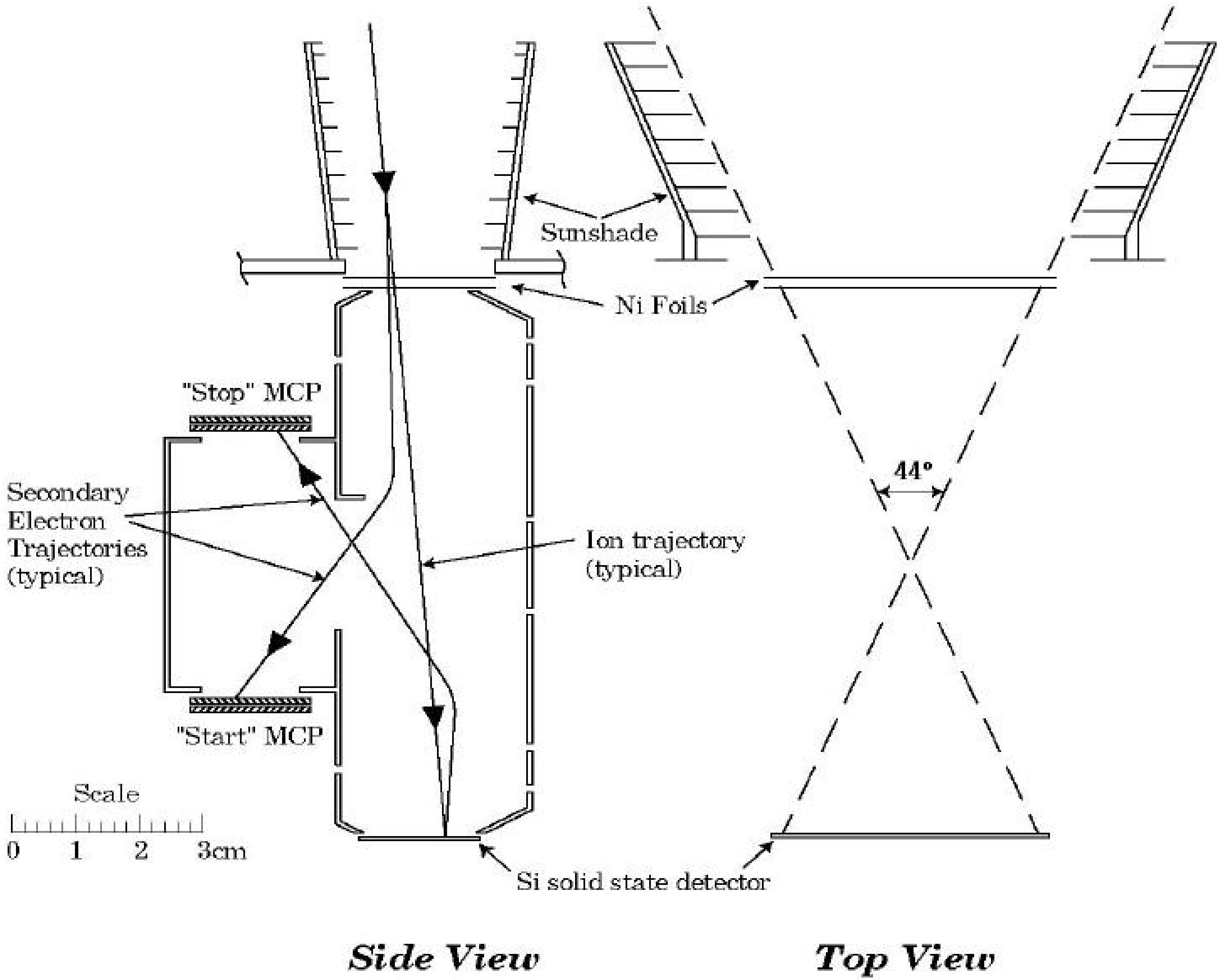

SIT

SIT Instrument Assembly

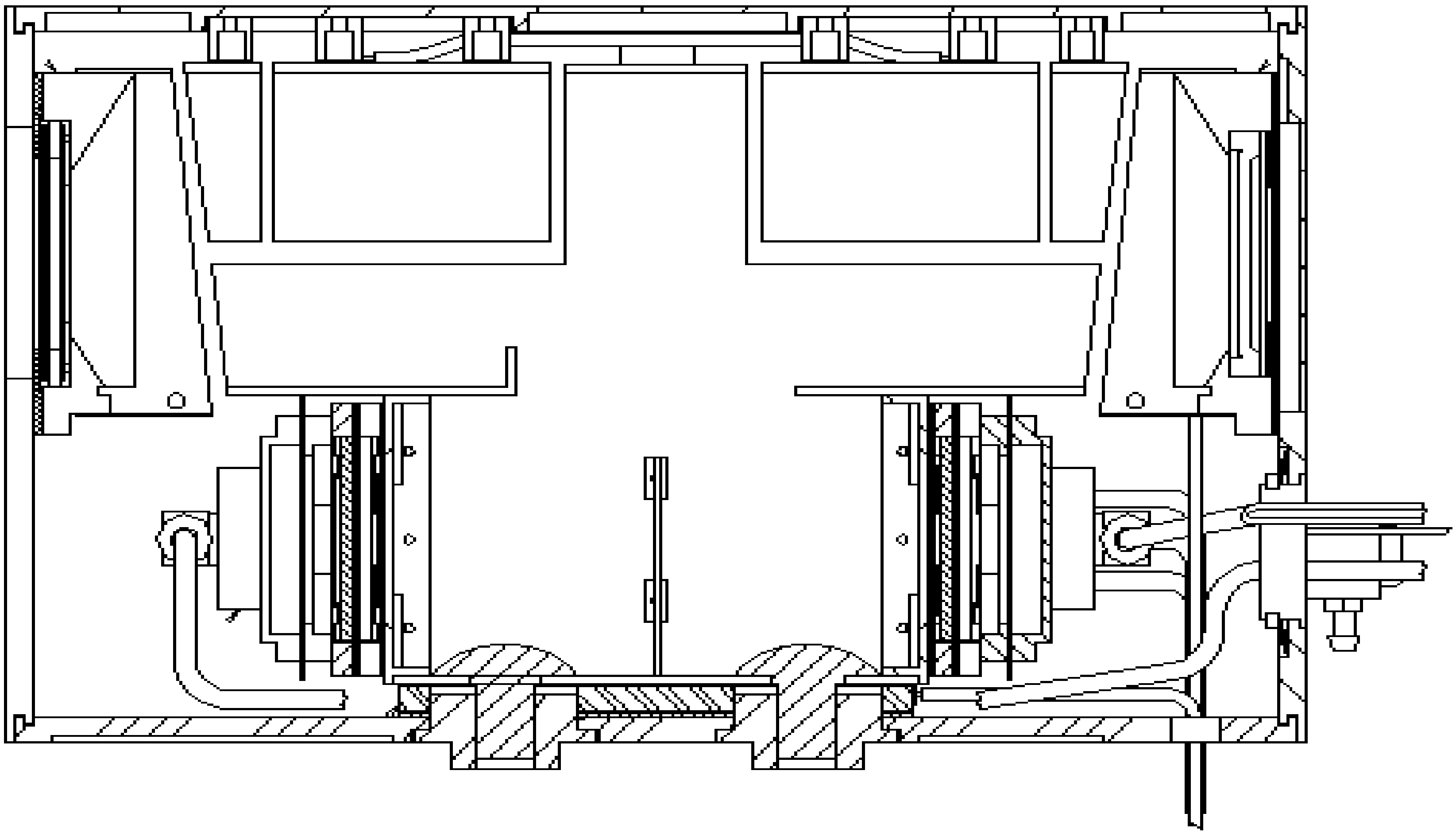



NOTES: UNLESS OTHERWISE NOTED
1.) ALL DIMENSIONS ARE SHOWN AS MILLIMETERS [INCHES].
3.) CALCULATIONS FOR MASS PROPERTIES.
NOTE: THESE ARE INSTRUMENT COORDINATES, NOT S/C COORDINATES.
4.) INSTRUMENT WILL BE MOUNTED TO SPACECRAFT ON THERMALLY ISOLATING ULTEM BUSHINGS AND HELD TO SPACECRAFT PANEL WITH (4) 10-32UNF TITANIUM BOLTS, TORQUED TO TBD.
5.) INSTRUMENT FIELD OF VIEW ARE TO BE KEPT CLEAR FROM OBSTRUCTIONS WITHOUT PRIOR CONSENT FROM THE INSTRUMENT TEAM.
6.) PURGE WILL BE SUPPLIED BY THE SEP MAIN ELECTRONICS ASSEMBLY.
7.) HV DISABLE/ TEST INTERFACE CONN. SIT-J2 WILL HAVE A RED TAG AND GREEN TAG COVER TO BE SWAPPED PRIOR TO THERMAL-VAC.
SIT DOOR
SIT TELESCOPE
HIGH VOLTAGE POWER SUPPLY
SIT ELECTRONICS
DOOR ACTUATOR
ISOLATOR
INSTRUMENT COORDINATE SYSTEM
MOUNTING REFERENCE TO ORIGIN OF SIT FOV
DIMENSIONS ARE IN MILLIMETERS
LIST OF MATERIAL
Goddard Space Flight Center
INTERFACE CONTROL DRAWING
SEP MAIN INSTRUMENT
STEREO SPACECRAFT
GD
2053410
FILE NAME: 2053410
MODEL NAME: SIT-DELIVERABLE
STEREO S/C

Suprathermal Ion Telescope (SIT)



- SIT Telescope Cross Section



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 4000v, nominal ~3000v
  - 10s of uA current
  - Synch from crystal oscillator
  - Test mode 300v limit.
- Electronics
  - Time of flight, energy measurement circuitry
  - Logic/MISC in Actel

Test Considerations

- **SIT detector and microchannel plates are contamination sensitive to volatiles**
  - **Detector volumes will be purged with dry N2 whenever possible**
    - **Interruptions in purge can be tolerated**
- **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.**
- **Exteriors of assemblies must be kept clean**
  - **Instruments will be maintained in a Class 10,000 environment or double bagged**

READINESS STATUS

- FM1 and FM2 Units
- Science Requirements
- Pre-environmental analysis and test
- PFRs and Waivers
- Configuration Control
- Functional Test Procedures
- Acoustic/Vibration, TB and TV Test plans
- Test Harnesses

Flight Units

- Assembled
  - Electronics (9/04, 11/04), nonflight shield board, missing thermal hardware
  - Telescopes (9/04, 11/04) missing sunshade/cover, thermal hardware
  - Final Assembly Complete (1/20/05, 1/21/05)

- Working
  - Accelerator calibration of ETU telescope with FM1 electronics and HVPS (8/04)
  - Successful bench and alpha test of assembled instruments at UMd (11/04, 12/04)

- Software
  - Running version (2004)0903 in both units. (In flight there will be small differences in the software of the two units due to calibration differences)

Science Requirements

3.4. ***SIT Requirements***

Description	Goal	Requirement	Source
FOV	17 x 44 degrees	17 x 44 degrees	Derived from MRD 4.7(F,G) & CME characteristics
Energy	30-2,000 keV/nuc He-Fe	30-2,000 keV/nuc He-Fe	MRD 4.7 (F,G)
Mass Resolution	0.85 AMU (^{16}O at 100keV/nuc)	0.85 AMU (^{4}He at 1MeV/Nuc)	Derived from MRD 4.7(F,G) & CME characteristics
Energy Resolution	20keV FWHM	35keV FWHM @ 22C	Derived from MRD 4.7(F,G) & CME characteristics
Geometric Factor	0.4 cm^2 ster	0.4 cm^2 ster	Derived from MRD 4.7(F,G) & CME characteristics
Background	10^{-2} events/sec in quiet time	10^{-2} events/sec during vac test	Derived from MRD 4.7(F,G) & CME characteristics
Max Event Rate	1000 events/sec	1000 events/sec	Derived from MRD 4.7(F,G) & CME characteristics
Time Resolution	1 Minute	15 Minutes	Derived from MRD 4.7(F,G) & CME characteristics

Summary of SIT Requirements from The IMPACT Performance Specification Version K 4/1/04

Meeting Science Requirements

✓ **FOV: Met by mechanical design, verified by analysis**

✓ **Energy: Si Solid State Detector (SSD) energy threshold raised from 40 to 200 keV Sept 2004 to solve high count rate problem in SSD. Threshold of typical elements He, C, O, Ne, Fe raised from 43, 24, 21, 19, 16 keV/n, respectively, to 81, 41, 35, 30, 20 keV/n. This is within or very close to Level 1 requirement of an *average* of 30 keV/n over the range He-Fe. (ref: e-mail G. Mason to J. Luhmann, Sept 21, 2004).**

✓ **Mass Resolution: typical values of 0.4 AMU (1-sigma) seen in alpha source runs (4He) are much narrower than the requirement of 0.85 AMU (1-sigma) for 4He.**

✓ **Energy Resolution: GSFC lab measurements (Jan 2004) show Solid State Detector noise width <30 keV FWHM, lower than Level-1 requirement of 35 keV FWHM.**

✓ **Geometry Factor: Met by mechanical design, verified by analysis**

Meeting Science Requirements

- ✓ **Background: With no stimulus, < 10 events/hour in vacuum at normal operating HV during testing at UMd, more than meeting the goal of <10^{-2} events/sec. An event is the coincidence of a SSD, START and STOP signal.**

- ✓ **Max Event Rate: Demonstrated ability to handle 4400 Fe events per second during particle accelerator test at BNL (run BNL017, 8/26/04), more than meets the requirement of 1000 events/sec.**

- ✓ **Time Resolution: Rates are read out completely every minute, achieving the goal of 1 minute time resolution.**

Pre-Environment Analysis and Testing

✓ **Detectors – thermal vacuum life test at GSFC**

✓ **Venting – Venting of the telescope was analyzed for its initial design and proved out during the test and launch of WIND/EPACT/STEP**

✓ **Electronics – Done**

- **Board level testing – functional, thermal, voltage**
- **Bench calibration**
- **Conformal coat**
- **Board-level bakeout**

- **Perform CPT on finalized instrument**
  - **Will be accomplished during alpha test to be carried out at UMd prior to Acoustic/Vibration**

Changes in Design Since CDR

- **Telescope**
  - **Modification of SSD mounting to accommodate unexpected buildup of epoxy on SSD frames**
  - **Addition of small pieces of Kapton tape in areas inside telescope where the 1000v electrodes come close to ground to eliminate any possibility of breakdown.**
- **HVPS**
  - **Redesign of the voltage divider circuitry at the output of the supply to achieve tighter control of the subdivided output voltages with respect to load current.**
- **Electronics**
  - **Addition of a shield board between the logic board and the energy board to stop pickup from the memory chips to the energy front end.**
  - **Increasing the time of internal power-on reset from 6 ms to 600 ms**
  - **Increasing compensation capacitance on LM108 opamps to prevent oscillation**

PFRs

- **PR3001 - Failure of PH300RH Amptek hybrid on energy board of FM1**
  - DPA indicated probable ESD
  - Part replaced, no further problems
  - Closed

- **PR3002 – Failure of FM1 ATOF START input circuit during HV testing**
  - DPA indicated HV transient at input to first transistor
  - Cause traced to careless connecting and disconnecting signals during test
  - Replaced part, Modified test procedures
  - Closed

- **PR3003 – Failure of FM2 ATOF START and STOP input circuit in HV testing**
  - Failure of same type as PR3002.
  - We re-analyzed cause of PR3002 and found that the initial analysis was incorrect and the modified test procedures insufficient to prevent HV buildup on the START and STOP telescope outputs. The presence of these HV signals under certain conditions were verified with scope traces.
  - Bleeder circuits were installed to prevent HV buildup and this fix was verified using a fast oscilloscope. The damaged parts were replaced.
  - closed

PFRs

- PR3004 - Failure of FM1 ATOF START and STOP input circuit during BNL testing
  - Similar damage to PR3002 and PR3003 but from different cause.
  - Shielded HV wiring between HVPS and telescope showed sign of corona at connector ends. Poor chamber vacuum (2e-5) coupled with air trapped under shrink tubing allowed conditions conducive to HV breakdown.
  - Connectors fixed, parts replaced. NOTE: these connectors and the making and breaking of connections that contributed to PR3002-4 are features of the test program only and are not present in the assembled flight instrument.
  - Closed
- PR3005 – HV Oscillation in FM2 HVPS during test with ETU electronics
  - When commanded to ramp down to 0, the HV supply begins to oscillate between 0 and maximum HV output.
  - Problem traced to software problem. Fixed.
  - Closed
- PR3006 – Epoxy buildup on Solid State Detector frames interferes with mounting
  - MRB held to allow mounting to be modified to accommodate excess epoxy. Accepted.
  - closed

Waivers

- **Covered in other presentations.**

FM 1 / FM 2 Configuration Control

- **Units differ in way SIT is pointing**
  - **Units uniquely labeled**
  - **FM 1 = Ahead**
  - **FM 2 = Behind**
  - **Important to get this right when mounting to S/C**
  - **Thermal environments different – separate thermal balance tests**
- **Software is slightly different for each unit and the checksum returned on boot up is unique to each unit**
- **Assembly and test records for each unit are maintained separately**

Functional Test Procedures

The following instrument-level functional tests have been written and tested and reviewed internally:

- **Limited Performance Procedure**
  - ~15 minutes (may be interleaved with other tests)
  - Requires no special equipment or conditions
  - Verifies functionality of electronics, has noisy and quiet modes.
- **Comprehensive Performance Test**
  - ~30 minutes (may be interleaved with other tests)
  - Requires use of external battery-powered test pulser
  - Exercises all commands, verifies all S/W functions, provides single calibration point
- **Alpha Test**
  - ~60 minutes (may be interleaved with other tests)
  - Requires moderate vacuum-qualified Am241 radiation source
  - May only be run with instrument in high vacuum for ~12 hours
- **Various short test procedures functioning as segments of the above tests.**

Test Plans

- **Vibration/Acoustic Test Plan**
  - **STEREO IMPACT Suprathermal Ion Telescope (SIT) Acoustics and Vibration Test Plan, 17 December 2004**
  - **Written: Steve Wasserzug**
  - **approved**

- **Thermal Balance/Thermal Vacuum Test Plan**
  - **SEPT/SIT Thermal Balance Test Plan (STEREO-GSFC-002.A)**
  - **(includes Thermal Vacuum test plan)**
  - **Written: R. Harrison**
  - **approved**

Acoustic/Vibe

- **Acoustic Test**
  - Protoflight level acoustic test, 143.6dB, 1 minute
  - CPT and foil inspection at end of test

- **Vibration Test**
  - 0.25 g sine survey (5 – 2000 Hz, 4 oct/min) before and after each vibration run in each axis
  - Protoflight random in each of three axes, 1 min/axis, 7.4grms parallel, 10.4grms perpendicular
  - Protoflight Sin Vibe, 5-100 Hz, 4 octaves/min
  - LPT between axes
  - CPT and foil inspection at end of test
  - Alpha test at UMd

STEREO IMPACT SEPT, SIT TV Test Summary

- **Thermal Vacuum Testing at GSFC using Bldg 4 Bell-Jar Chamber.**
- **Test articles are:**
  - **4 SEPT components: SEPT-E Ahead, SEPT-NS Ahead, SEPT-E Behind and SEPT-NS Behind**
  - **2 SIT components: SIT Ahead and SIT Behind**
- **Testing will consist of a two phase thermal balance followed by thermal cycling with chamber breaks in between**
- **Thermal environment will be controlled by chamber shroud, sun simulating calrod heater array and spacecraft interface simulating cryoplate**

- Test article will be equipped with Flight or Flight-like MLI blankets, cabling, grounding and mounting interfaces
- Balance stability criteria: <0.1°C/hr for at least 1 hour
- 12 hour bakeouts will be performed at beginning of each phase
- All aperture doors will be deployed
  - Sun side SEPT-E doors will be deployed hot
  - All other doors will be deployed cold
- Shroud flooded with LN2 throughout TB tests
- Cold plate will be controlled to predicted spacecraft interface temperatures per ICD.
  - –13°C to +45°C during operational modes
  - –18°C during spacecraft survival mode
- Array of calrod heaters will be used to simulate solar fluxes on Ahead instruments (Phase 1)
- Hardware mounted test heaters will be used.
  - To help bring components to bakeout goals
  - To simulate solar fluxes on SIT Ahead collimator (Phase 1)
- Zero-Q (guard) heaters will used to eliminate heat leakage through instrument T/C bundles

Phase 1 Thermal Balance

- 12 hour bakeout will be performed at beginning of phase
- All aperture doors will be deployed
- Test article will be SEPT-E Ahead, SEPT-E Behind and SIT Ahead
  - Sun side SEPT-E doors will be deployed hot
  - All other doors will be deployed cold
- Heaters will be verified
- Balance Tests
  1. Cold Surv in Sun: Instrument Off, Calrods set to simulate minimum solar flux, Cold plate –18°C, Surv heaters enabled at 25V(adjusted not to cycle)
  2. Cold Op in Sun: Instrument On at 30.5V, Calrods set to simulate minimum solar flux, Cold plate –13°C Op heaters enabled at 30.5V(adjusted not to cycle)
  3. Hot Op in Sun: Instrument On at 30.5V, Calrods set to simulate maximum solar flux, Cold plate +45°C Op heaters disabled

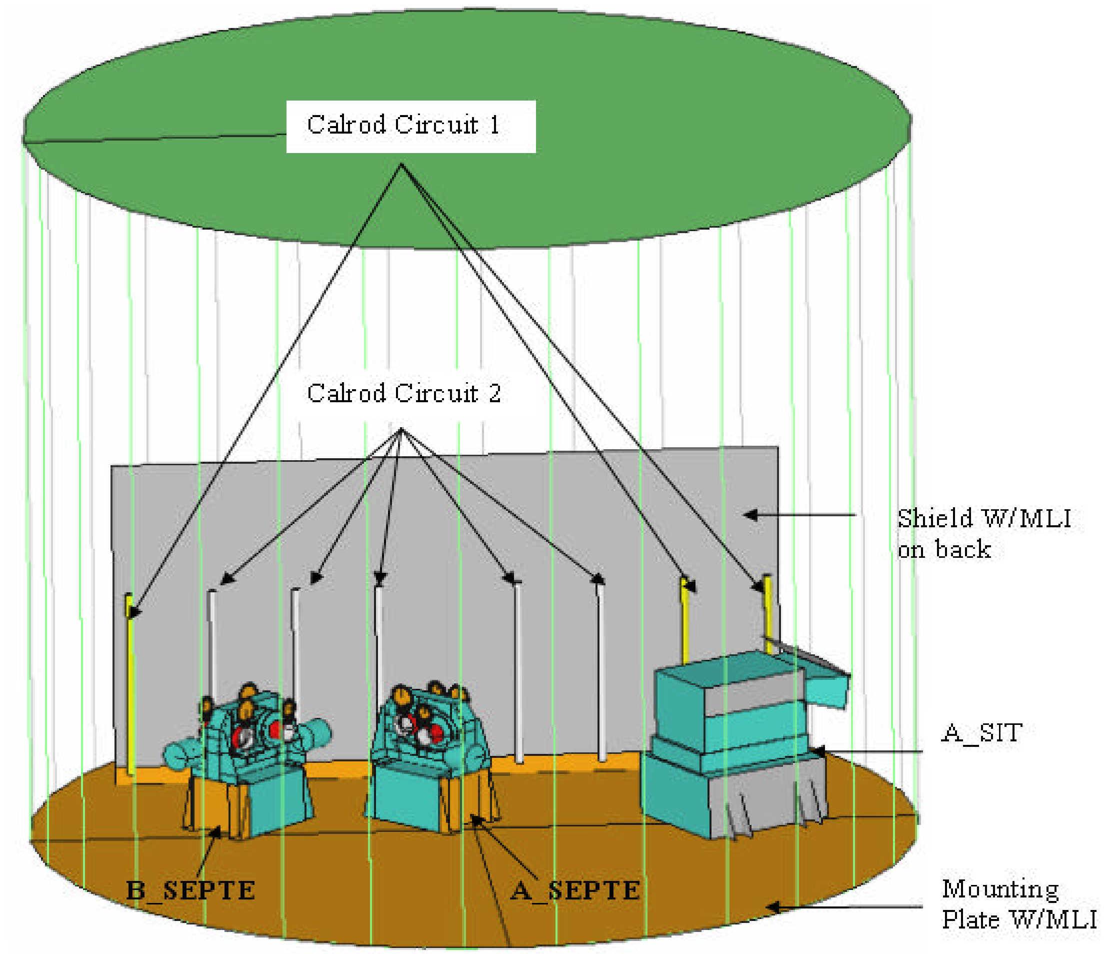
Phase 2 Thermal Balance

- **Test article will be SEPT-NS Ahead, SEPT-NS Behind and SIT Behind**
- **12 hour bakeout will be performed at beginning of phase**
- **All aperture doors will be deployed cold**
- **Heaters will be verified**
- **Balance Tests**
  1. **Cold Surv in Shade: Instrument Off, Calrods off, Cold plate –18°C, Surv heaters enabled at 25V(adjusted not to cycle)**
  2. **Cold Op in Shade: Instrument On at 30.5V, Calrods off, Cold plate –13°C Op heaters enabled at 30.5V(adjusted not to cycle)**
  3. **Hot Op in Shade: Instrument On at 30.5V, Calrods off, Cold plate +45°C Op heaters disabled**

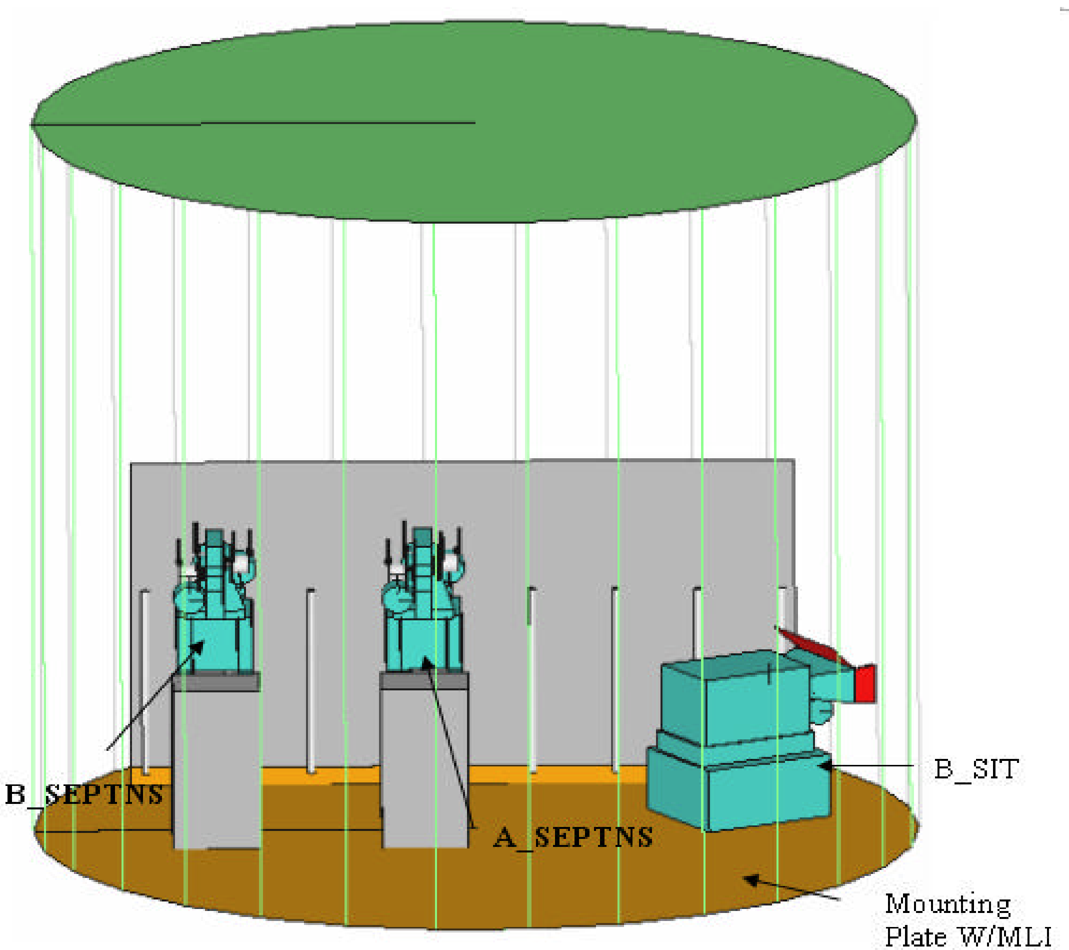
Thermal Cycling

- Test article will be SIT Ahead and SIT Behind
- Test article will be subjected to 6 operational and 1 survival thermal cycles
- Test article will have MLI blankets and mounting isolation removed
- Shroud, cold plate and test heaters will be controlled to achieve desired soak temperatures on test article
- Soak goal temperatures are:
  - Bakeout: +45C SIT Ebox, +35C SIT Telescope
  - Survival: -40 TO +45C SIT Ebox, -40 TO +35C SIT Telescope
  - Operational: -30 TO +40C SIT Ebox, -30 TO +30C SIT Telescope
- Test heaters may be used in thermal cycle test help reach soak goals and for payload safety
- Contamination bakeout to be performed at beginning of test.

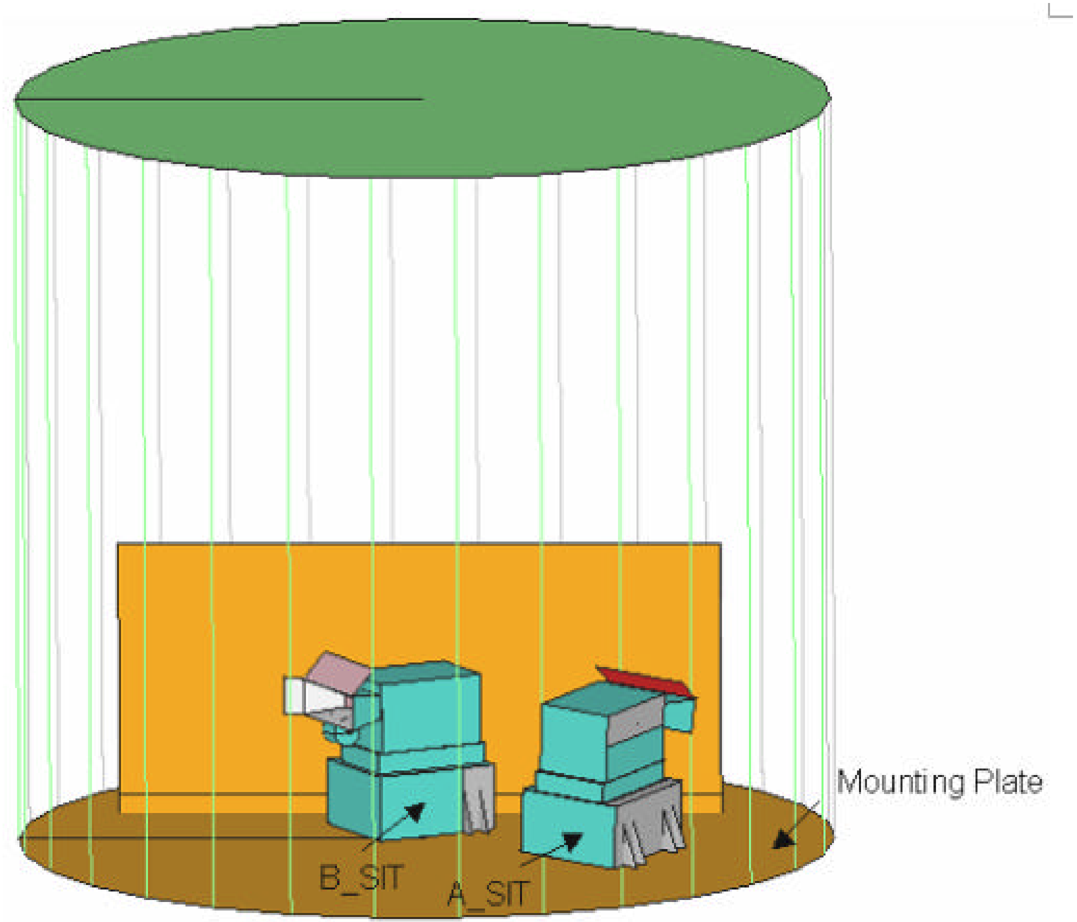
SIT/SEPT Phase 1 TB Test Set-up

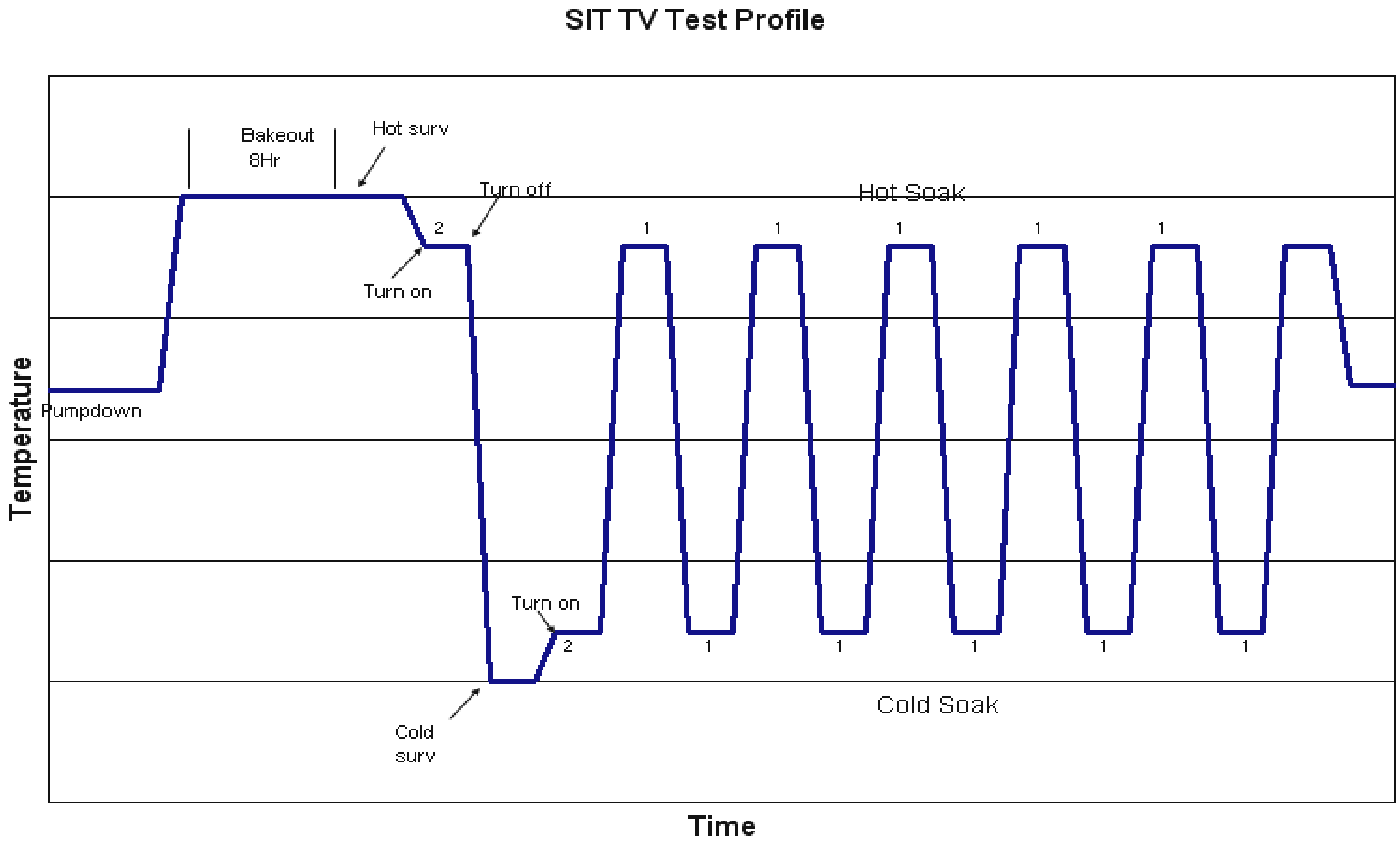


SIT/SEPT Phase 2 TB Test Set-up



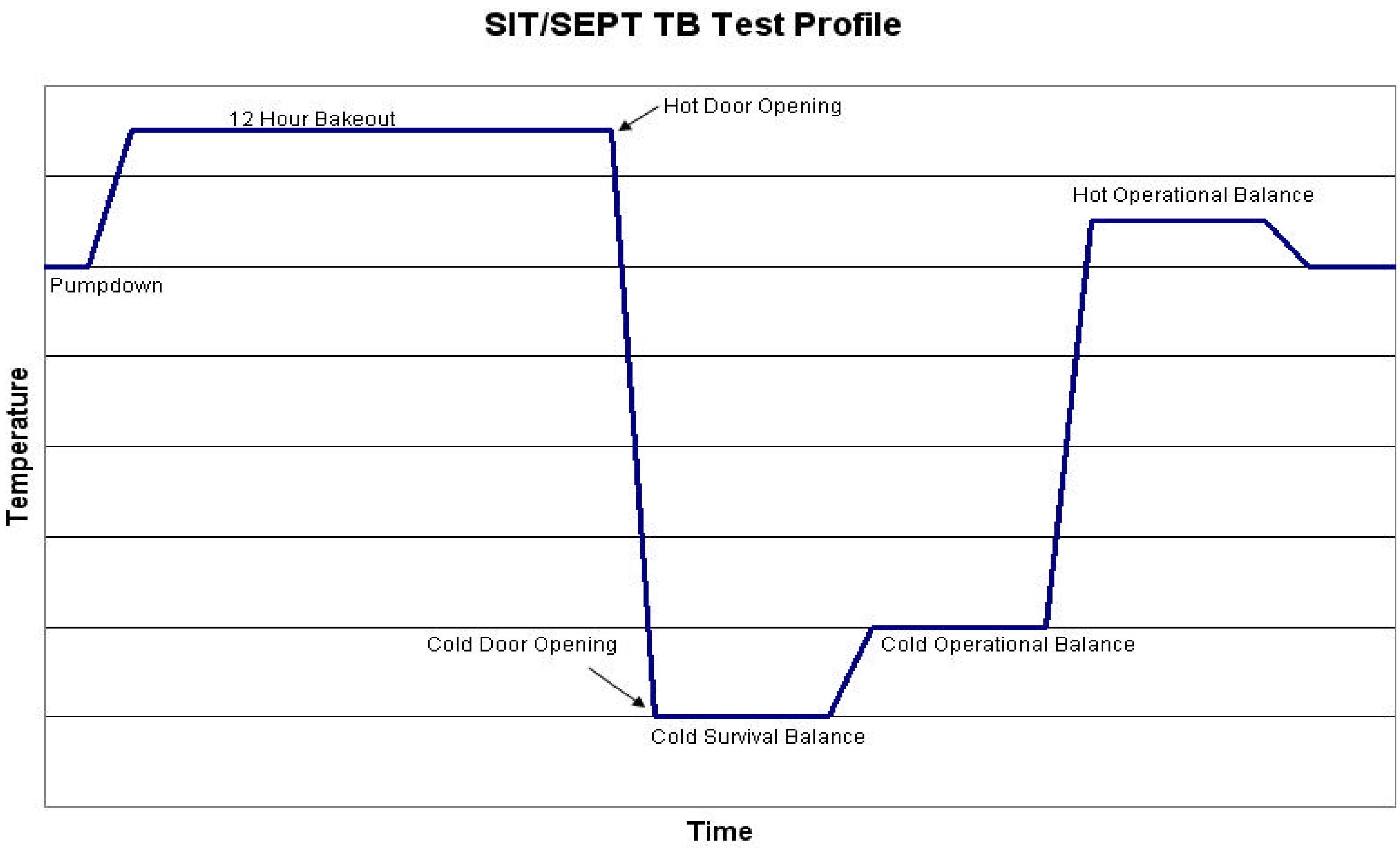
SIT TV Test Set-up





1 = Stabilize, Soak 1Hour and Test Concurrently.
2 = Stabilize, Turn On, Soak 1Hour and Test Concurrently.

SIT/SEPT Thermal Balance Temperature Profile



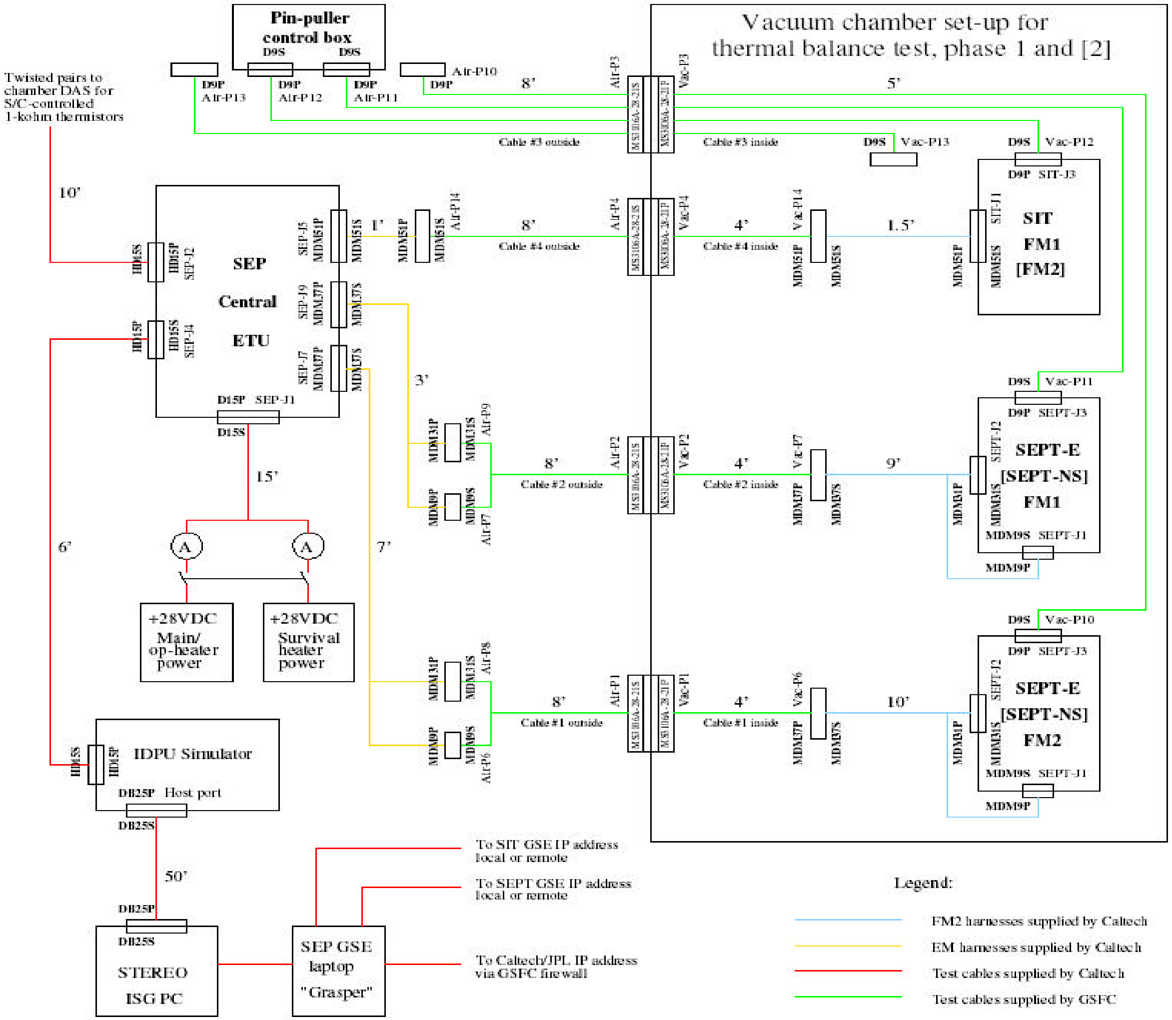
- Balance stability criteria: <0.1°C/hr for at least 1 hour
- Four hour plateaus after stability criteria met

Test Harnesses

Required for thermal balance and thermal vacuum testing

Built and initially tested per drawings

Interface test will be performed prior to connecting SIT



SEPT/SIT Thermal Balance Test Schematic Diagram

BK 12/15/04

SIT Test Matrix

Revision Date: 2005/01/12

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**										Spares still in test
C	Foils										H											Foil acoustic testing to be done at instrument level
C	Telescope PF,F	**C**	**C**																		**C**	
C	Energy board, EM			**C**		**C**	**C**						**C**									
C	Energy board, F			**C**		**C+**	**C+**						**C+**						**C+**		**C**	
C	TOF Board, EM			**C**		**C**	**C**						**C**									
C	TOF Board, F			**C**		**C+**	**C+**						**C+**						**C+**		**C**	
C	HVPS EM			**C**		X	X						**C**									
C	HVPS F			**C**		**C+**	**C+**												**C+**		**C**	
I	Instrument W/O Telescope																			**C**		
I	Instrument, FM1	**C**	**C**	**C**	**C**	X	X	X	X	X	X+	X	H	X	X	X	**C**	H	X	X	X	Protoflight levels for vib and acoustics, full EMC at suite
I	Instrument, FM2	**C**	**C**	**C**	**C**	X	X	X	X	X	X+	X	H	X	X+	X	H	H	X	X	X	Protoflight levels for vib and acoust., wrkmanship EMC

Legend:

Level of Assembly	Unit Type		
C = Component	BB Breadboard	X = Test required	Note: TB test needed for FM2 from differing thermal designs designs on A and B S/C
I = Instrument	EM Engineering Model	A = Analysis	Note: Magnetics now being done at suite level.
	PT Prototype	H = at a higher level	Note: Beam calibration at instrument level
	PF Protoflight	**C = Test Completed**	
	F = Flight	X+ = new test required	
		C+ = new test completed	
		X (shaded) planned test that will not be performed	

SIT Test Matrix Comments

- **Acoustics**
  - We originally planned to do an acoustic test only on the thin SIT foils, mounted in the flight telescope behind the acoustic cover. The telescope and cover however have only recently become available so we have changed the test to perform it at the instrument level, on both flight units.

- **Electronics Testing: Hot, Cold and Voltage Margin**
  - We originally showed doing this only on the EM units. We have expanded this to checking the flight units as well for some of the electronics.

- **Accelerator Calibration**
  - Originally we had hoped to do a beam calibration on both flight units. Last August however we took the ETU telescope with the FM1 electronics and HVPS and successfully performed a test. The results of this test proved:
    - The instrument performs as expected over the energy and species range
    - The logic handles several times our required event rate and the software functions well
  - We conclude that separate calibrations for the flight units are not warranted

SIT Flight Unit Environmental Tests

- **Electronics Bake-out**
  - **Done**
- **EMC/Magnetics**
  - **Suite-level EMC of FM1 complete**
  - **Reduced testing of FM2 – to be done**
  - **Magnetics – suite-level test at GSFC after environments**
- **Acoustic**
- **Vibration**
- **Thermal Vacuum/ Thermal Balance**
- **Final Bakeout**
  - **During TV/TB**

SIT Environment Test Flow Plan