STEREO
IMPACT

FM1 STE-U Thermal Vacuum Test Report

IMPACT-STEU-FM1-TVac-ReportB.doc
Version B – 2005-Mar-25

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Document Revision Record

Rev.	Date	Description of Change	Approved By
A	2004-Jul-9	Preliminary Draft	-
B	2005-03-25	Add retest cycle after PFR1011 door fix	-

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1. Overview

1.1. *Introduction*

STE-U is part of the STEREO IMPACT instrument suite. It resides at the sunny end of the IMPACT boom.

This document describes the results of the thermal vacuum testing performed on the FM1 STE-U unit. This testing was performed at U.C. Berkeley following the test procedure called out in reference 1. This report only covers the thermal cycling part of that test procedure. The thermal balance test results are discussed in a separate report.

1.2. *Applicable Documents*

The following documents are closely interrelated with this specification. All documents can be found on the Berkeley STEREO/IMPACT FTP site unless otherwise indicated:

http://sprg.ssl.berkeley.edu/impact/dwc/

1. IMPACT STE-U TVAC TEST PLAN
2. APL Document APL 7381-9003 Rev A – STEREO Environment Definition, Observatory and Instrument (on APL web site)
3. IMACT-IDPU-CPT

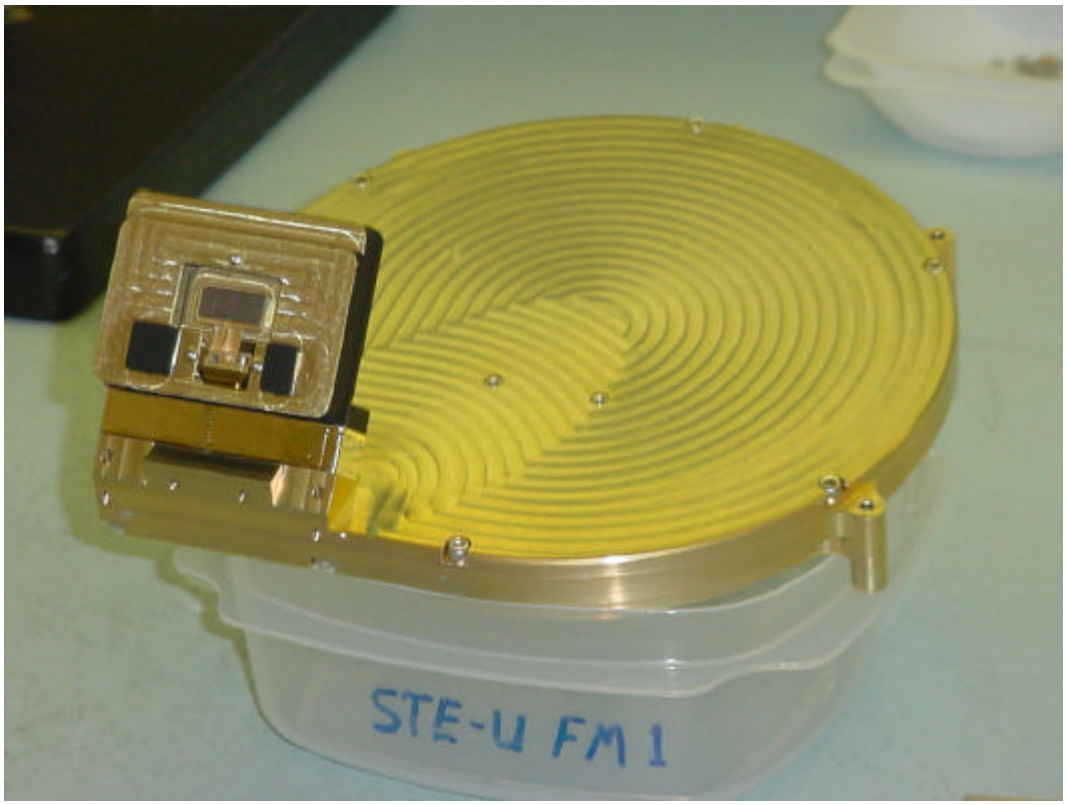


Fig 1. FM1 STE-U Unit

2. Test Setup

The "Jeffrey" thermal vacuum chamber at U.C. Berkeley was used. This is the chamber built for the IMPACT Boom thermal vacuum tests. It was used because it was the only chamber available at the time that could get cold enough.

STE-U thermal vacuum tests is complicated by the fact that the preamp portion has a significantly different temperature range from the detector portion. To accommodate this the preamp is hard-mounted to the baseplate and then covered with a thermal blanket (the same blanket that was used for STE-U thermal balance tests). The detector protrudes from this blanket so it can view the shrouds that were run cold. Radiation is insufficient to get the detector cold enough, so a heat strap was attached from the chamber cold plate to the detector. This allowed us to control the detector temperature more directly. Running the chamber with these gradients in it (rather than the usual isothermal thermal vac test) involved a learning curve. It was difficult to hit the correct temperature for both units. In some cases the temperature is somewhat beyond the required qualification level. Nothing was over-stressed during the test.

The IDPU was setup outside the chamber. This was the FM1 IDPU with the exception that the ETU LVPS was used (since the FM1 IDPU LVPS was not yet available). This plus GSE as described in the test procedure allowed us to test the instrument and monitor its internal temperatures.

In addition to chamber monitoring TCs (on the baseplate, cold plate, and shrouds), chamber TCs were attached to the instrument and GSE as called out in the test procedure. We were unable to get a TC to attach reliably to the STE detector without compromising the surface properties so TC11 was attached to the heat strap near the detector instead (for the second run). The internal instrument TC was relied upon to measure the detector temperature. This temperature was found to be consistent with the heat strap temperature during soaks, less a few degrees lost across the joint between the heat strap and the detector.

3. Test History

3.1. *First Run*

This test was first attempted starting on 2004-May-06. Following a 12 hour +40C bakeout / non op hot cycle, the instrument was transitioned to non-op cold. Since the door had not been tested in cold vacuum, and because the non-op cold is not significantly colder than the operational cold level, and after determining that the door should operate at the non-op cold level, it was decided to attempt to open the door at this point. The door failed to open. Repeated attempts were made to open the door as the temperature was slowly increased over the next several hours, including some attempts using up to the maximum door time-out value, with no success. The test was aborted, the unit was removed, and a PFR was written and forwarded to Project (IMPACT PFR-1008). The

cause for the problem was determined and fixed, and the PFR was closed out with Project concurrence.

3.2. *Second Run*

The fixed instrument was re-installed in the chamber and testing proceeded according to the test procedure starting on 2004-June-4.

We were unable to reach the –100C non-op cold case – the coldest we could get was –96C. This appears to have been due to poor conduction to the heat strap, which was later fixed, and –100C was achieved during cycle 6.

Instrument CPT tests proceeded successfully at each operational plateau using the STE portion of the IDPU CPT (reference 3), but there we saw two sources of intermittent noise. One was easily correlated to acoustic noise generated when LN2 first started to flow into the system after being off for a while. The pipes would "sing" quite loudly for a minute or so, and the resulting vibrations would cause noise in the STE-U unit. This is not uncommon for these sensitive systems, and is not a problem (if the STEREO spacecraft vibrates that much SECCHI will have a problem before we do).

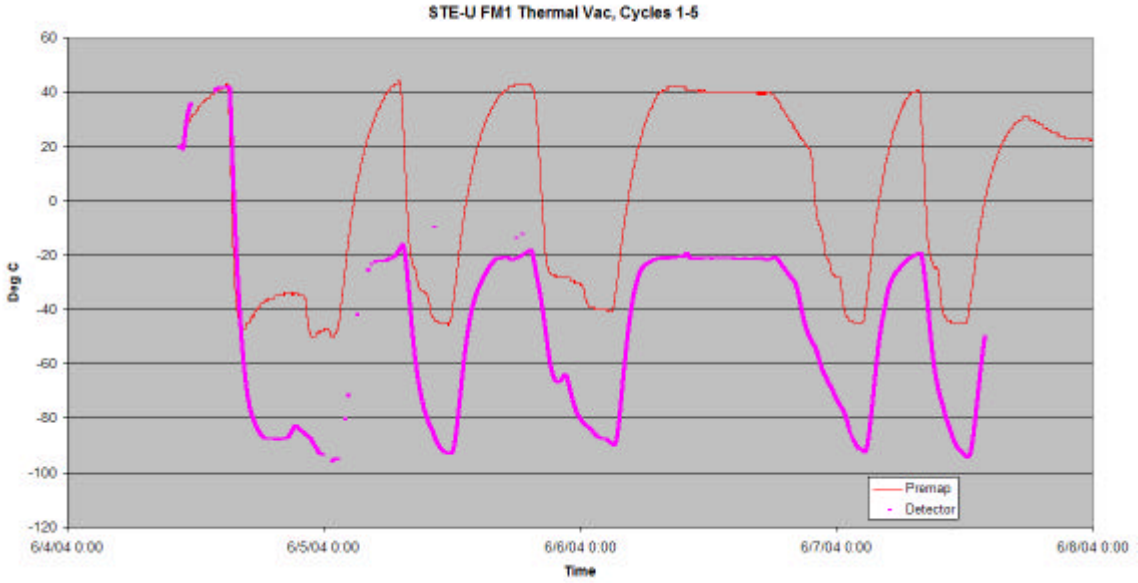
The second source of noise was tracked down to an intermittent oscillation in the preamp that could get stimulated by various events in the chamber (such as heaters and valves). It was decided that we should pause the testing to adjust the compensation capacitors on the preamp to suppress this oscillation. A PFR was written and submitted (IMPACT PFR1009). The test was put on hold and chamber was broken after cycle 5. The unit was removed, adjusted, re-tested, and re-installed in the chamber. No oscillation was observed in the last two cycles, verifying the fix.

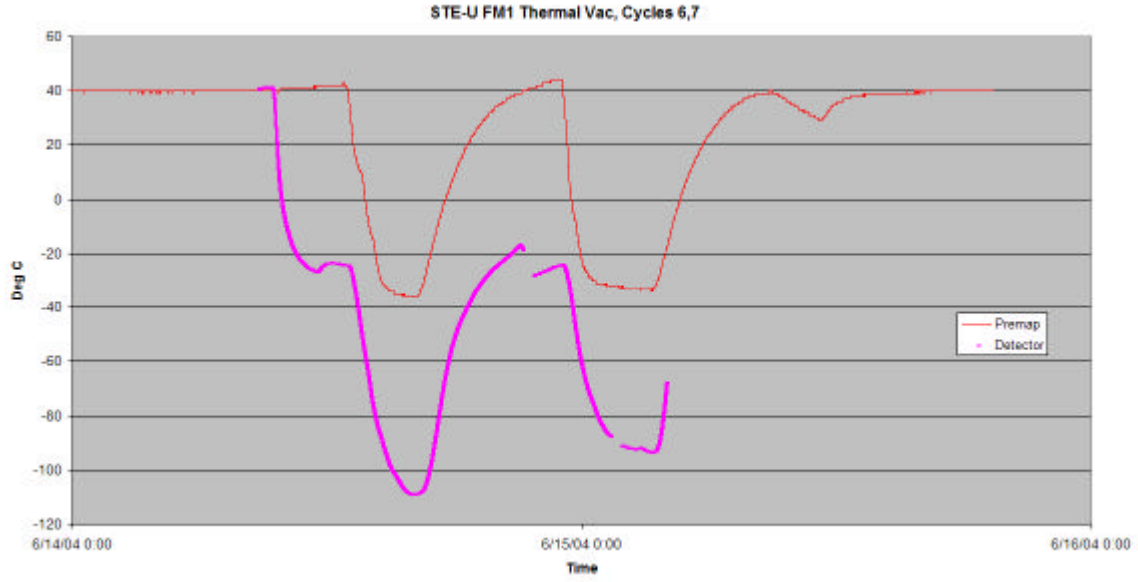
Finally the chamber was broken briefly to disconnect the heat strap (so the cold plate could be used as a cold plate independent of the detector temperature), and the bakeout certification was performed successfully.

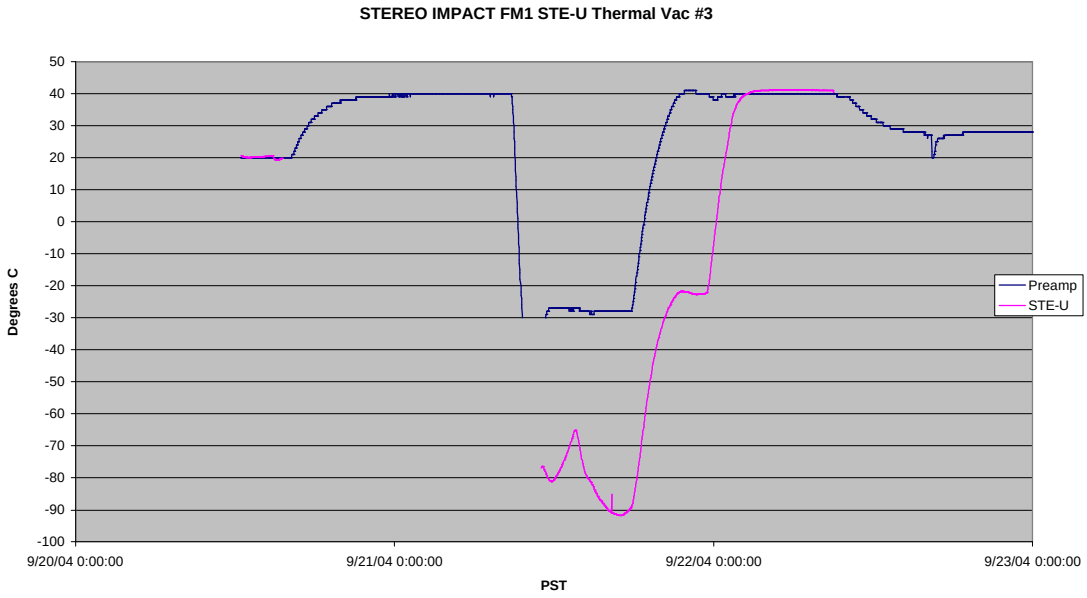
3.3. *Third Run*

The STE-U door failed after vibration (PFR1011). After fixing the door a workmansip vibration and 1-cycle thermal vac was performed to verify the fix works over temperature.

4. Temperature Profile






STEREO IMPACT FM1 STE-U Thermal Vac #3
Degrees C
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
9/20/04 0:00:00
9/21/04 0:00:00
9/22/04 0:00:00
9/23/04 0:00:00
PST
Preamp
STE-U

5. Trending Data

STE-U FM1 Performance Trend

												Test Pulser					Door Source					
Date	File	Test	STE-U Temp	Preamp Temp	IDPU Temp	ISTEUCur (mA)	Door Open (sec)	Door Close (sec)	Fit Rev	Det.	Thresh.	Offset (keV)	Gain (keV/Bin)	Curv. (1/keV)	Test Gain	FWHM (keV)	Offset (keV)	Gain (keV/Bin)	Curv. (1/keV)	6keV c/s	22keV c/s	FWHM
May 4 2004	0405030000.tlm	Thermal Balance	-62	25	30	20			6/10/2004	0		-0.03	0.3842	1.36E-04	13.4025	0.927	0.00	0.3901	7.55E-05	35.68	22.70	0.974
										1		0.04	0.3838	1.57E-04	12.7275	0.582	0.01	0.3864	9.54E-05	41.18	24.40	0.687
										2		0.04	0.3829	1.61E-04	12.5861	0.621	-0.02	0.3926	6e-5 (F)	36.49	21.72	0.772
										3		-0.01	0.3844	1.40E-04	13.1720	0.762	-0.03	0.3972	6e-5 (F)	19.73	14.03	0.891
June 2 2004	0406022043.tlm	Pre-Tvac #2 ambient (10MHz noise suppression caps installed on I/F)	28.5	Ambient	36	17	0.38 / 0.62	0.25 / 0.38	6/10/2004	0	9	-0.03	0.3845	1.29E-04	13.8357	0.848	-0.03	0.3838	1.29E-4(F)	43.82	28.18	0.928
										1	10	0.00	0.3834	1.52E-04	13.0995	0.833	-0.03	0.3790	1.52E-4(F)	42.49	27.89	0.871
										2	9	-0.03	0.3841	1.52E-04	12.6275	0.822	-0.08	0.3894	1.52E-4(F)	37.91	24.80	0.917
										3	9	-0.04	0.3845	1.35E-04	13.5003	0.821	-0.02	0.3927	1.35E-4(F)	36.35	24.78	0.901
June 5 2004	0406050000.tlm	Tvac #2 Hot#2	-22	38	19	17.6	0.38 / 0.38	0.38 / 0.38	6/10/2004	0	8	-0.01	0.3845	1.34E-04	13.4473	0.810	-0.03	0.3892	4.50E-05	49.19	30.14	0.901
										1	7	0.03	0.3837	1.58E-04	12.7517	0.677	-0.01	0.3885	1.49E-05	46.50	28.88	0.753
										2	7	0.01	0.3842	1.58E-04	12.4575	0.741	-0.03	0.3914	6E-5(F)	40.74	27.73	0.839
										3	7	0.00	0.3835	1.43E-04	13.1913	0.774	-0.02	0.3948	4.97E-05	41.49	27.45	0.883
June 5 2004	0406050000.tlm	Tvac #2 Cold #2	-91	-47	27	19.26	0.50 / 0.50	0.38 / 0.50	6/10/2004	0	7	-0.01	0.3844	1.34E-04	13.4022	0.695	-0.02	0.3922	6E-5(F)	48.31	30.00	0.805
										1	6	0.05	0.3835	1.62E-04	12.6837	0.549	-0.02	0.3892	7.70E-05	47.24	30.31	0.663
										2	6	0.03	0.3845	1.64E-04	12.3859	0.612	-0.04	0.3954	6E-5(F)	39.65	28.13	0.710
										3	7	-0.04	0.3852	1.18E-04	13.0327	0.987	-0.02	0.4003	6E-5(F)	42.21	26.83	0.802
June 5 2004	0406050000.tlm	Tvac #2 Hot #3	-21	41	35	17.7	0.38 / 0.38	0.38 / 0.38	6/10/2004	0	8	0.04	0.3838	1.42E-04	13.4153	0.818	-0.03	0.3893	4.33E-05	49.36	29.65	0.911
										1	7	0.06	0.3837	1.64E-04	12.7505	0.677	0.02	0.3852	6e-5 (F)	36.39	25.54	0.787
										2	8	0.03	0.3834	1.62E-04	12.4268	0.736	-0.02	0.3912	6e-5 (F)	40.08	26.11	0.876
										3	8	0.01	0.3842	1.42E-04	13.1854	0.775	0.00	0.3945	6e-5 (F)	39.99	25.85	0.879
June 6 2004	0406060000.tlm, 0406060220.tlm	Tvac #2 Cold #3	-87	-41.6	25.3	18.7	0.50 / 0.50	0.38 / 0.50	6/10/2004	0	7	-0.03	0.3843	1.30E-04	13.4045	0.702	-0.03	0.3916	6e-5 (F)	45.71	28.23	0.808
										1	6	0.02	0.3836	1.55E-04	12.6822	0.558	-0.02	0.3887	6e-5 (F)	47.95	28.79	0.646
										2	6	-0.01	0.3860	1.25E-4(F	12.3402	0.622	-0.03	0.3951	6e-5 (F)	41.31	26.49	0.722
										3	6	-0.06	0.3843	1.27E-04	13.0591	0.782	-0.03	0.3995	6e-5 (F)	41.11	26.87	0.794
June 6 2004	0406060220.tlm	Tvac #2 Hot #4	-21	39.9	29.1	18.4	0.38 / 0.38	0.38 / 0.38	6/10/2004	0	7	0.02	0.3838	1.36E-04	13.4756	0.811	0.00	0.3876	8.68E-05	47.46	29.57	0.889
										1	7	0.05	0.3839	1.60E-04	12.8044	0.680	-0.01	0.3849	7.60E-05	48.16	27.84	0.748
										2	7	0.03	0.3838	1.61E-04	12.4702	0.733	-0.03	0.3915	6E-5 (F)	41.49	27.54	0.841
										3	7	0.02	0.3840	1.42E-04	13.2478	0.771	-0.02	0.3951	5.12E-05	40.69	25.87	0.884
June 7 2004	0406070138.tlm	Tvac #2 Cold #4	-87.2	-46.5	27	19.2	0.50 / 0.50	0.38 / 0.50	6/10/2004	0	7	0.01	0.3840	1.35E-04	13.4076	0.699	-0.03	0.3921	6E-5 (F)	48.30	29.50	0.794
										1	5	0.04	0.3835	1.60E-04	12.6856	0.557	-0.02	0.3893	6E-5 (F)	46.99	28.61	0.661
										2	6	0.02	0.3845	1.60E-04	12.3869	0.615	-0.04	0.3954	6E-5 (F)	41.99	26.16	0.741
										3	6	0.01	0.3843	1.44E-04	13.0685	0.754	-0.02	0.4002	6E-5 (F)	41.76	27.19	0.810
June 7 2004	0406070138.tlm	Tvac #2 Hot #5 (BOB in)	-21.1	37.7	29	18.6	0.38 / 0.38	0.25 / 0.38	6/10/2004	0	9	-0.02	0.3840	1.32E-04	13.4123	0.956	-0.02	0.3881	7.92E-05	48.95	30.12	1.025
										1	7	0.05	0.3837	1.60E-04	12.7493	0.766	-0.03	0.3858	6E-5 (F)	47.57	29.66	0.821
										2	8	0.04	0.3839	1.65E-04	12.4858	0.840	-0.01	0.3903	8.14E-05	40.94	27.09	0.927
										3	9	0.01	0.3837	1.48E-04	13.1473	0.957	-0.02	0.3959	6E-5 (F)	41.33	26.48	0.990
June 7 2004	0406070138.tlm	Tvac #2 Cold #5	-90.6	-47.3	24	19	0.50 / 0.50	0.38 / 0.50	6/10/2004	0	6	-0.03	0.3845	1.29E-04	13.3993	0.689	-0.01	0.3911	9.56E-05	48.87	31.14	0.817
										1	6	0.02	0.3837	1.57E-04	12.6786	0.548	-0.03	0.3904	1.58E-05	46.35	27.22	0.661
										2	6	0.00	0.3847	1.56E-04	12.3780	0.611	0.05	0.3959	6e-5 (F)	41.43	26.88	0.748
										3	6	-0.12	0.3858	1.05E-04	13.0659	0.757	-0.02	0.4002	6E-5 (F)	41.35	26.72	0.795
June 11 2004	0406110000.tlm	Ambient test, after compensation caps increased	21	21	27	18.3			6/10/2004	0												
										1												
										2												
										3												
June 14 2004	0406140839.tlm	Tvac #2 Hot #6	-26	41	33.6	18	0.38 / 0.38	0.38 / 0.38	6/10/2004	0	8	0.03	0.3843	1.37E-04	13.5076	0.812	-0.01	0.3890	4.80E-05	48.06	29.65	0.887
										1	7	0.06	0.3834	1.62E-04	12.8147	0.683	0.02	0.3843	1.02E-04	46.61	28.51	0.762
										2	7	0.03	0.3842	1.61E-04	12.5141	0.738	-0.02	0.3916	4.76E-05	39.76	29.96	0.848
										3	8	0.01	0.3846	1.40E-04	13.2296	0.775	0.00	0.3948	6e-5 (F)	40.58	26.37	0.870
June 14 2004	0406140839.tlm	Tvac #2 Cold #6	-99.3		32.7	17.5	0.50 / 0.50	0.50 / 0.50	6/10/2004	0	7	0.02	0.3846	1.37E-04	13.3941	0.687	0.00	0.3912	9.70E-05	49.16	29.26	0.808
										1	6	0.07	0.3830	1.64E-04	12.6424	0.554	0.00	0.3902	6e-5 (F)	46.48	28.42	0.654
										2	6	0.04	0.3846	1.67E-04	12.3823	0.618	-0.03	0.3964	6e-5 (F)	40.55	26.37	0.734
										3	6	0.03	0.3840	1.49E-04	13.0719	0.662	-0.02	0.3996	6e-5 (F)	41.78	27.05	0.768
June 15 2004	0406140839.tlm	Tvac #2 Hot #7	-27.6		33.4	18	0.38 / 0.38	0.38 / 0.38	6/10/2004	0	8	0.03	0.3843	1.37E-04	13.5087	0.802	0.00	0.3886	5.24E-05	48.41	29.51	0.895
										1	7	0.07	0.3834	1.62E-04	12.8177	0.678	0.00	0.3857	6e-5 (F)	46.15	28.22	0.773
										2	7	0.04	0.3840	1.63E-04	12.5178	0.736	-0.02	0.3914	6e-5 (F)	40.29	25.70	0.851
										3	7	0.04	0.3840	1.48E-04	13.2343	0.761	-0.03	0.3954	6e-5 (F)	40.14	26.52	0.853
June 15 2004	0406150000.tlm, 0406150252.tlm	Tvac #2 Cold #7	-91	-34.5	29.6	18.5	0.50 / 0.50	0.38 / 0.50	6/10/2004	0	7	0.02	0.3839	1.37E-04	13.4193	0.709	0.00	0.3903	1.11E-04	46.58	29.10	0.807
										1	6	0.05	0.3832	1.61E-04	12.6940	0.566	0.02	0.3879	9.27E-05	47.26	28.54	0.673
										2	6	0.02	0.3841	1.62E-04	12.4014	0.629	-0.04	0.3955	6e-5 (F)	40.75	26.47	0.753
										3	6	-0.08	0.3853	1.23e-4 (F	13.0929	0.688	0.01	0.3971	1e-4 (F)	40.40	25.93	0.783

STE-U FM1 Performance Trend

													Test Pulser					Door Source					
Date	File	Test	STE-U Temp	Premap Temp	IDPU Temp	ISTEUCur (mA)	Door Open (sec)	Door Close (sec)	Bias	Fit Rev	Det.	Thresh.	Offset (keV)	Gain (keV/Bin)	Curv. (1/keV)	Test Gain	FWHM (keV)	Offset (keV)	Gain (keV/Bin)	Curv. (1/keV)	6keV c/s	22keV c/s	FWHM
14-Sep-04	0409141837.tlm	Bech test after actuator repair	23.3	Ambient	27.5	19.8	0.38 / 0.38	0.25 / 0.38	20	8/5/2004	0	11	-0.05	0.3847	1.31E-04	13.8966	1.005	-0.05	0.3892	1.04E-04	40.72	24.68	0.979
											1	9	-0.04	0.3837	1.52E-04	13.1918	0.892	-0.09	0.3853	6e-5 (F)	39.61	23.43	0.947
											2	8	-0.04	0.3838	1.52E-04	12.8059	0.797	-0.09	0.3917	6e-5 (F)	35.24	21.91	0.916
											3	10	-0.06	0.3846	1.33E-04	13.6664	0.830	-0.04	0.3952	6e-5 (F)	34.78	21.34	0.870
20-Sep-04	0409201225.tlm	Post-workmanship-vib CPT, in Tvac chamber, Ambient	20.3	21.7	32.7	18.7	0.38 / 0.50	0.38 / 0.50	20	8/5/2004	0	13	-0.02	0.3841	1.30E-04	13.6841	1.354	-0.01	0.3897	4.15E-05	38.93	24.85	1.314
											1	10	0.02	0.3837	1.55E-04	13.0251	0.981	-0.05	0.3853	6e-5 (F)	40.28	24.69	1.034
											2	8	0.03	0.3834	1.63E-04	12.5800	0.820	-0.06	0.3913	6e-5 (F)	35.95	22.23	0.957
											3	12	0.01	0.3833	1.44E-04	13.4806	1.212	-0.02	0.3949	6e-5 (F)	33.96	22.44	1.241
21-Sep-04	0409211057.tlm	Thermal Vac #3 cold	-91.3	-29.1	36.6	17.7	0.50 / 0.50	0.38 / 0.50	20	8/5/2004	0	9	0.01	0.3837	1.39E-04	13.4826	0.931	0.10	0.3923	6e-5 (F)	40.54	25.05	1.054
											1	7	0.05	0.3837	1.64E-04	12.7514	0.675	0.06	0.3896	6e-5 (F)	40.68	24.31	0.784
											2	6	0.03	0.3837	1.66E-04	12.4017	0.606	-0.02	0.3962	6e-5 (F)	38.23	22.84	0.736
											3	9	-0.02	0.3843	1.42E-04	13.2415	0.927	0.01	0.3999	6e-5 (F)	38.60	22.57	1.024
21-Sep-04	0409211057.tlm	Thermal Vac #3 cold, bias DAC=100	-91.3	-29.1	36.6	17.7			20	8/5/2004	0	8											
											1	6											
											2	6											
											3	8											
21-Sep-04	0409211057.tlm	Thermal Vac #3 HOT, bias DAC=100	-22.2	40.9	36.5	17.8	0.38 / 0.38	0.38 / 0.38	20	8/5/2004	0	9	0.02	0.3838	1.48E-04	12.7506	0.963	-0.04	0.3917	6e-5 (F)	45.45	26.80	1.036
											1	7	0.07	0.3853	1.70E-04	12.3629	0.677	-0.03	0.3873	6e-5 (F)	46.31	24.96	0.764
											2	7	0.05	0.3866	1.69E-04	12.3258	0.723	-0.07	0.3835	6e-5 (F)	38.66	23.06	0.808
											3	9	0.03	0.3836	1.58E-04	12.6350	0.908	-0.05	0.3970	6e-5 (F)	39.12	24.40	0.980
21-Sep-04	0409211057.tlm	Thermal Vac #3 HOT, bias DAC=20 (default)	-22.2	40.9	36.5	17.8			20	8/5/2004	0												
											1												
											2												
											3												

5.1. *Trending Data Explanation*

The trending data on the previous page is extracted from the trending file for this instrument. It is composed of vales measured during the CPT, either directly, or from a post-processing fitting function which evaluates the data collected.

- The Door Open and Door Close columns show two times; from application of power to the time when the door comes off the first switch (starts moving), and the time from the application of power to the time when the door reaches the destination switch.
- Threshold values are DAC levels, corresponding to ~100eV per step. Requirement is <5keV.
- The test pulser fit data measures the electronic performance. Of particular interest is the FWHM, which measures the electronic noise in the system. Other values can be used to look for thermal drift and other trends in energy gain and offset.
- The "door source" fit data measures the calibration source on the STE door, and so is a end-to-end measurement (albeit using mostly photons rather than electrons). Again the FWHM is of interest (requirement < 2keV).

6. TQCM Data

A final TQCM value of approximately 52 Hz was reached monitoring a -20C TQCM at 15.0 minute intervals for 8 hours with the chamber shrouds and baseplate set to 40C (non-op hot) and the cold plate set at -100C. This TQCM value indicates only the background levels of contamination from the chamber are present, as was expected from such a small instrument in a large chamber. The TQCM data follows.

6.1. ***STE-U FM1 TQCM Data***

STE-U FM1 TQCM Qualification Data

Time	Hertz	Rate
Timelapse 10		
6/16/2004 9:11	3546	
6/16/2004 9:26	3577	124
6/16/2004 9:41	3606	116
6/16/2004 9:56	3634	112
6/16/2004 10:11	3659	100
6/16/2004 10:26	3685	104
Timelapse 11		
6/16/2004 10:45	3715	
6/16/2004 11:00	3738	92
6/16/2004 11:15	3760	88
6/16/2004 11:30	3780	80
6/16/2004 11:45	3800	80
6/16/2004 12:00	3819	76
6/16/2004 12:15	3838	76
6/16/2004 12:30	3857	76
6/16/2004 12:45	3874	68
6/16/2004 13:00	3891	68
6/16/2004 13:15	3907	64
6/16/2004 13:30	3924	68
6/16/2004 13:45	3940	64
6/16/2004 14:00	3956	64
6/16/2004 14:15	3971	60
6/16/2004 14:30	3986	60
6/16/2004 14:45	4001	60
6/16/2004 15:00	4016	60
6/16/2004 15:15	4030	56
6/16/2004 15:30	4045	60
6/16/2004 15:45	4058	52
6/16/2004 16:00	4072	56
6/16/2004 16:15	4085	52