STEREO

IMPACT

FM2 STE-U Thermal Vacuum Test Report

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Document Revision Record

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Distribution List

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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 FM2 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 FM1 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

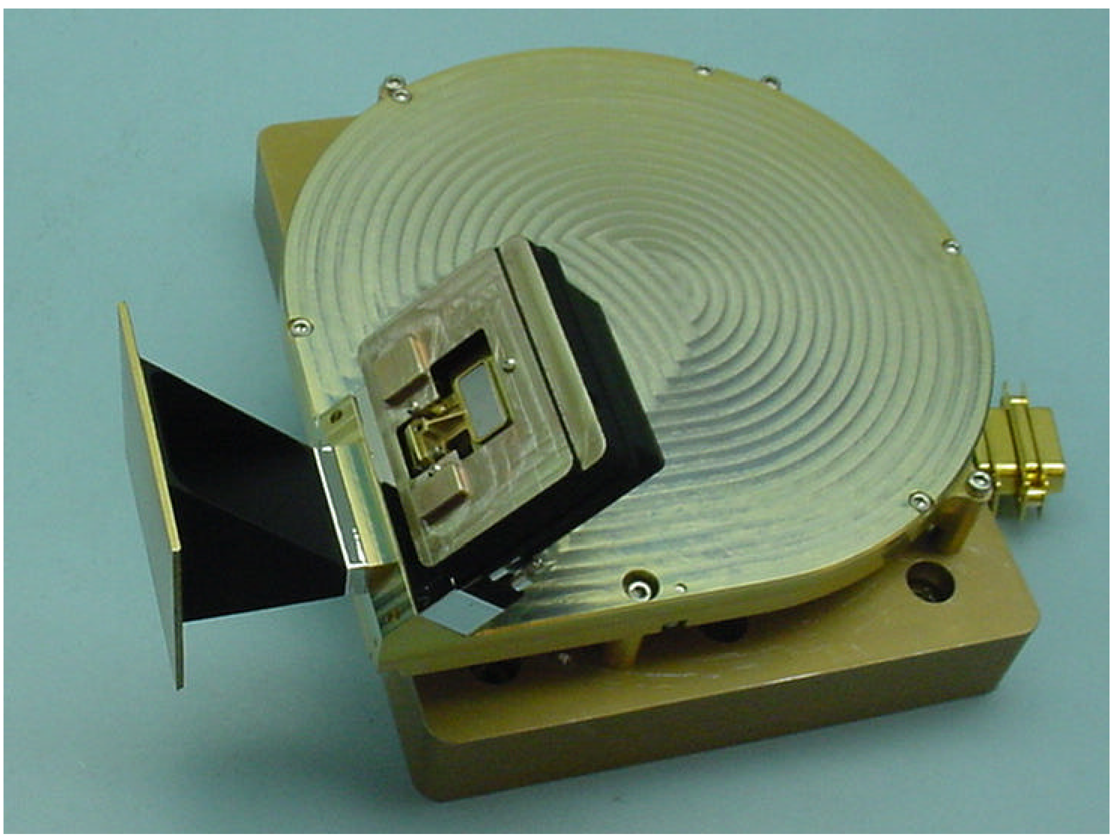


Fig 1. FM2 STE-U Unit

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 FM2 IDPU with the exception that the ETU LVPS was used (since the FM2 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. 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-July-21. Following a long weekend 60 hour +40C bakeout / non op hot cycle, the instrument was transitioned to non-op cold. The first 3 and a half cycles proceeded uneventfully, but on cycle 4 hot the STE door status switch failed (see IMPACT PFR1013). The testing was discontinued and the unit was warmed up, removed and diagnosed. The door switch was adjusted and testing continued. Since the adjustment was minor, it was decided (together with the Project IM) to continue where we left off, at cycle 4, but starting with a door cycle test to verify reliability.

3.2. ***Second Run***

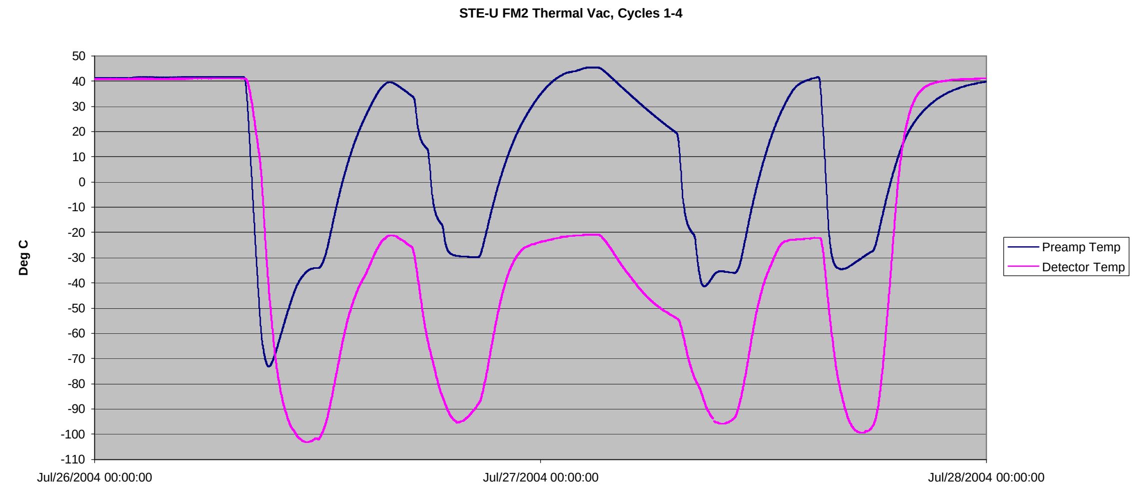
The unit was cooled down to cold soak and door cycling was attempted. Preliminary door motions looked fine, but automated door cycling caused the door to fail. The chamber was warmed up, and the instrument removed and diagnosed. It was determined that the automated door cycling left insufficient time for the actuator to cool off between actuations, which resulted in an actuator wire overheating and failing (see IMPACT PFR 1014). The door actuator wire was replaced. In addition, the flight software was modified to prevent attempts to actuate the door too close together. After discussions together with the Project IM it was determined that we would again continue from where we had left off, with the addition of some door cycles at the first cold soak to verify reliability.

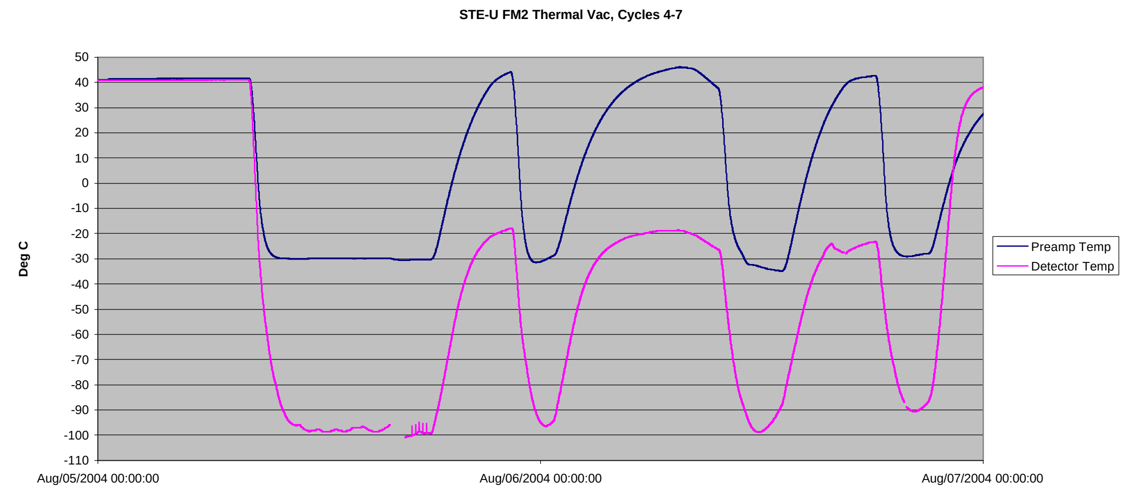
3.3. ***Third Run***

The unit was returned to the chamber and once again returned to cold soak cycle 4. The door was cycled 20 times (slowly, with 2 minutes between actuations) to verify door reliability, which went successfully. Cycling then continued uneventfully. In addition to the CPTs at each soak, a test of light sensitivity and bias voltage sensitivity were added to cold soak and hot soak number 6.

Following cycling the unit was returned to +40C and TQCM data was collected for several hours – see below.

4. Temperature Profile





5. Trending Data

STE-U FM2 Performance Trend

												Test Pulser					Door Source							Long Integration Door Source (Door LUT)						
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	Acc Time (sec)	Offset (keV)	Gain (keV/Bin)	Curv. (1/keV)	6keV c/s	22keV c/s	88keV c/s	FWHM
July 21 2004	0407211325.tlm	Pre thermal vac ambient (in chamber)	23.9	26.3	33.3	16.8	0.38 / 0.38	0.25 / 0.38	7/14/2004	0	10	-0.06	0.3857	1.09E-04	13.4135	1.034	-0.05	0.3810	6e-5 (F)	44.97	26.34	1.081		-0.03	0.3807	6.14E-05	42.90	24.09	1.65E-02	1.067
										1	9	-0.02	0.3848	1.29E-04	12.7075	0.884	-0.04	0.3769	6e-5 (F)	48.73	26.08	0.932		-0.04	0.3769	6e-5 (F)	45.46	23.60	9.31E-03	0.925
										2	10	-0.04	0.3853	1.21E-04	12.9227	0.933	-0.05	0.3765	6e-5 (F)	37.86	24.92	0.974		-0.03	0.3759	6e-5 (F)	36.57	21.83	1.57E-02	0.948
										3	10	-0.09	0.3856	1.11E-04	13.4180	1.008	-0.12	0.3823	6e-5 (F)	36.99	24.83	1.069	1530	-0.10	0.3821	4.48E-05	35.01	22.31	1.52E-02	1.028
July 26 2004	0407260000.tlm	Thermal Vac Hot Soak #2 (cold start)	-21.8	38.6	35.7	16.2	0.38 / 0.38	0.38 / 0.38	7/14/2004	0	9	-0.04	0.3853	1.13E-04	13.3622	0.904	-0.01	0.3825	6e-5 (F)	48.02	26.06	0.991	540	-0.01	0.3828	5.20E-05	44.43	25.18	1.38E-02	0.993
										1	8	0.01	0.3846	1.31E-04	12.6501	0.753	-0.01	0.3788	6e-5 (F)	51.61	27.01	0.860		0.00	0.3785	7.27E-05	46.79	24.36	1.74E-02	0.848
										2	8	0.01	0.3849	1.26E-04	12.8286	0.778	-0.01	0.3783	6e-5 (F)	40.51	23.90	0.887		-0.02	0.3784	6e-5 (F)	38.07	22.50	1.16E-02	0.879
										3	9	-0.04	0.3852	1.15E-04	13.3710	0.877	-0.04	0.3829	6e-5 (F)	38.64	24.98	0.963		-0.03	0.3827	5.88E-05	37.06	22.94	2.81E-02	0.978
July 26 2004	0407260000.tlm	Thermal Vac Cold Soak #2	-94.7	-29.1	36.4	16.05	0.50 / 0.50	0.50 / 0.50	7/14/2004	0	7	-0.06	0.3857	1.11E-04	13.2480	0.713	-0.02	0.3858	6e-5 (F)	47.89	26.38	0.821	1080	-0.01	0.3853	6.08E-05	44.75	24.38	2.09E-02	0.816
										1	6	0.01	0.3851	1.33E-04	12.5321	0.576	0.00	0.3818	6e-5 (F)	50.16	25.60	0.687		0.00	0.3816	6.45E-05	47.02	23.65	2.18E-02	0.683
										2	6	0.01	0.3851	1.31E-04	12.6466	0.615	0.01	0.3811	8.28E-05	39.92	23.38	0.695		-0.01	0.3822	5.13E-05	37.75	22.35	8.19E-03	0.706
										3	7	-0.05	0.3851	1.16E-04	13.2630	0.683	0.04	0.3855	7.47E-05	40.63	25.41	0.786		-0.04	0.3857	5.61E-05	37.29	23.27	1.28E-02	0.786
July 27 2004	0407270000.tlm	Thermal Vac Hot Soak #3	-23.3	36.5	33.1	18.3	0.38 / 0.38	0.38 / 0.38	7/14/2004	0	8	-0.06	0.3855	1.07E-04	13.3556	0.891	-0.01	0.3822	6e-5 (F)	47.89	26.41	0.903	7200	-0.01	0.3821	6.59E-05	44.52	24.63	1.69E-02	0.912
										1	7	0.01	0.3847	1.31E-04	12.6527	0.745	0.00	0.3784	6e-5 (F)	51.39	26.04	0.780		-0.01	0.3784	7.02E-05	47.28	23.96	1.50E-02	0.792
										2	7	-0.01	0.3848	1.25E-04	12.8316	0.768	-0.02	0.3782	6e-5 (F)	41.38	24.07	0.809		-0.01	0.3780	6e-5 (F)	37.93	22.27	1.02E-02	0.811
										3	8	-0.06	0.3851	1.13E-04	13.3710	0.862	-0.03	0.3824	6e-5 (F)	39.95	23.84	0.872		-0.04	0.3827	5.55E-05	37.16	23.10	1.43E-02	0.889
July 27 2004	0407270000.tlm, 0407270937.tlm	Thermal Vac Cold Soak #3 (cold start)	-94.8	-37	31	18.5	0.50 / 0.50	0.50 / 0.50	7/14/2004	0	7	-0.05	0.3851	1.12E-04	13.2577	0.715	-0.01	0.3854	6e-5 (F)	47.49	25.36	0.787	320	-0.02	0.3857	5.54E-05	45.71	24.82	1.45E-02	0.811
										1	6	0.00	0.3849	1.29E-04	12.5329	0.578	0.00	0.3820	6e-5 (F)	50.67	25.74	0.688		0.01	0.3813	8.62E-05	46.49	23.97	1.19E-02	0.673
										2	6	0.01	0.3850	1.30E-04	12.6485	0.603	-0.01	0.3823	6e-5 (F)	41.62	24.56	0.698		-0.01	0.3823	5.24E-05	37.99	22.79	1.38E-02	0.704
										3	7	-0.05	0.3857	1.14E-04	13.2986	0.676	-0.04	0.3857	6e-5 (F)	40.80	24.98	0.785		-0.04	0.3853	7.64E-05	37.38	23.07	1.82E-02	0.780
July 27 2004	0407270937.tlm	Thermal Vac Hot Soak #4	-22.7	38.6	32.7	16.4	0.38 / 0.38	0.38 / 0.38	7/14/2004	0	8	-0.04	0.3855	1.11E-04	13.3596	0.839	0.00	0.3821	6e-5 (F)	47.49	26.53	0.907	530	-0.02	0.3825	6e-5 (F)	44.32	24.33	1.42E-03	0.913
										1	7	0.01	0.3850	1.31E-04	12.6501	0.702	-0.02	0.3787	6e-5 (F)	50.54	25.67	0.794		0.00	0.3784	6e-5 (F)	47.00	23.91	1.80E-02	0.794
										2	8	0.01	0.3848	1.27E-04	12.8241	0.726	0.01	0.3776	6e-5 (F)	41.57	25.18	0.812		-0.01	0.3780	6e-5 (F)	37.72	22.58	8.75E-03	0.810
										3	8	-0.03	0.3852	1.15E-04	13.3662	0.809	-0.02	0.3822	6e-5 (F)	39.46	25.10	0.889		-0.04	0.3821	7.62E-05	38.92	23.26	2.12E-02	0.888
Aug 5 2004	0408051114.tlm	Thermal Vac Cold Soak #4	-97.7	-30	32.4	18.5	0.50 / 0.50	0.38 / 0.50	8/5/2004	0	8	-0.04	0.3852	1.12E-04	13.2599	0.874	-0.02	0.3863	6e-5 (F)	48.50	26.19	0.947	800	-0.02	0.3868	6.14E-05	45.53	24.25	1.44E-02	0.933
										1	7	-0.01	0.3846	1.27E-04	12.7653	0.715	-0.01	0.3821	6e-5 (F)	49.77	25.45	0.784		-0.02	0.3816	7.79E-05	46.20	23.43	1.24E-02	0.798
										2	7	-0.01	0.3850	1.23E-04	13.0427	0.744	-0.01	0.3820	6e-5 (F)	40.15	23.45	0.803		-0.01	0.3817	6.38E-05	37.44	22.14	1.38E-02	0.821
										3	8	-0.03	0.3845	1.21E-04	13.2715	0.862	-0.04	0.3876	6e-5 (F)	38.37	23.63	1.043		-0.05	0.3875	5.27E-05	35.37	21.84	1.68E-02	0.934
Aug 5 2004	0408051114.tlm, 0408052157.tlm	Thermal Vac Hot Soak #5	-20.7	39.6	33.8	16.3	0.38 / 0.38	0.25 / 0.38	8/5/2004	0	10	-0.05	0.3857	1.12E-04	13.4084	1.031	-0.04	0.3835	6e-5 (F)	44.93	25.00	1.071	300	-0.03	0.3831	6.50E-05	44.41	24.68	2.00E-02	1.067
										1	8	0.00	0.3846	1.28E-04	12.9322	0.867	-0.01	0.3779	6e-5 (F)	49.57	25.26	0.927		-0.01	0.3776	6e-5 (F)	46.61	24.14	0.00E+00	0.943
										2	9	-0.01	0.3848	1.21E-04	13.2138	0.901	-0.02	0.3774	6e-5 (F)	39.74	24.91	0.964		-0.03	0.3775	6e-5 (F)	37.01	22.13	1.12E-02	0.958
										3	10	-0.05	0.3857	1.14E-04	13.4175	1.019	-0.06	0.3844	6e-5 (F)	38.68	24.70	1.095		-0.05	0.3841	6e-5 (F)	38.27	23.17	8.74E-03	1.087
Aug 5 2004	0408052157.tlm, 0408060000.tlm	Thermal Vac Cold Soak #5	-90	-31.4	32.1	18.5	0.50 / 0.50	0.38 / 0.50	8/5/2004	0	11	-0.05	0.3859	1.13E-04	13.2966	0.911	-0.02	0.3868	6e-5 (F)	48.33	26.04	0.958	840	-0.01	0.3863	6.59E-05	44.99	24.34	2.73E-02	0.885
										1	9	0.00	0.3846	1.28E-04	12.7779	0.743	-0.01	0.3822	6e-5 (F)	50.47	25.42	0.825		0.00	0.3813	6.95E-06	46.18	23.61	1.45E-02	0.750
										2	10	-0.01	0.3849	1.23E-04	13.0482	0.764	-0.01	0.3815	6e-5 (F)	40.54	24.09	0.850		-0.03	0.3818	5.88E-05	37.15	22.15	1.11E-02	0.774
										3	11	-0.06	0.3857	1.13E-04	13.2957	0.882	-0.06	0.3876	6e-5 (F)	39.35	24.13	0.949		-0.05	0.3872	6.30E-05	36.74	22.67	1.13E-02	0.875
Aug 6 2004	0408060000.tlm	Thermal Vac Hot Soak #6	-20.7	45	31.7	18.3	0.38 / 0.38	0.38 / 0.38	8/5/2004	0	10	-0.05	0.3858	1.12E-04	13.4080	1.034	-0.03	0.3830	6e-5 (F)	47.91	26.75	1.070	350	-0.03	0.3833	6e-5 (F)	44.94	24.40	3.56E-03	1.079
										1	8	0.00	0.3849	1.27E-04	12.9280	0.872	-0.02	0.3784	6e-5 (F)	50.04	25.48	0.942		-0.01	0.3781	6e-5 (F)	47.19	24.14	3.32E-03	0.941
										2	9	0.00	0.3850	1.21E-04	13.2165	0.901	-0.02	0.3777	6e-5 (F)	41.62	24.20	0.977		-0.02	0.3779	6e-5 (F)	37.00	22.82	1.21E-02	0.953
										3	10	-0.06	0.3858	1.13E-04	13.4147	1.021	-0.04	0.3842	6e-5 (F)	37.40	24.63	1.040		-0.06	0.3847	6e-5 (F)	38.40	23.25	1.06E-02	1.077
Aug 6 2004	0408060000.tlm	Thermal Vac Cold Soak #6	-95.4	-32.3	32.3	18.3	0.50 / 0.50	0.38 / 0.50	8/5/2004	0	9	-0.07	0.3854	1.10E-04	13.2513	0.891	-0.04	0.3874	6e-5 (F)	47.78	26.66	0.957	630	-0.02	0.3868	5.83E-05	44.64	24.19	2.80E-02	0.969
										1	8	-0.01	0.3850	1.26E-04	12.7677	0.728	-0.02	0.3823	6e-5 (F)	48.41	25.48	0.813		-0.02	0.3821	5.70E-06	46.43	23.28	9.95E-03	0.817
										2	8	-0.02	0.3851	1.21E-04	13.0313	0.757	-0.04	0.3825	6e-5 (F)	41.05	24.24	0.850		-0.01	0.3817	6e-5 (F)	36.55	22.26	1.42E-02	0.842
										3	9	-0.06	0.3850	1.13E-04	13.2024	0.880	-0.05	0.3876	6e-5 (F)	38.41	25.30	0.963		-0.05	0.3873	5.96E-05	36.66	22.52	1.07E-02	0.946
Aug 6 2004	0408060000.tlm, 0408061733.tlm	Thermal Vac Hot Soak #7	-27.5	39.1	34	16.2	0.38 / 0.38	0.38 / 0.38	8/5/2004	0	9	-0.04	0.3853	1.13E-04	13.3631	0.983	-0.02	0.3835	6e-5 (F)	45.48	24.54	1.043	810	-0.02	0.3837	5.26E-05	44.79	24.49	1.56E-02	1.043
										1	8	-0.01	0.3846	1.25E-04	12.8840	0.825	0.00	0.3780	6e-5 (F)	49.68	25.45	0.916		-0.01	0.3783	6e-5 (F)	46.65	23.67	8.86E-03	0.899
										2	8	-0.01	0.3854	1.20E-04	13.1941	0.854	-0.01	0.3778	6e-5 (F)	39.67	24.67	0.915		-0.02	0.3778	6e-5 (F)	37.09	22.41	1.94E-02	0.927
										3	9	-0.05	0.3852	1.15E-04	13.3698	0.975	-0.05	0.3844	6e-5 (F)	38.89	24.28	1.044		-0.05	0.3846	5.04E-05	38.30	22.91	1.53E-02	1.039
Aug 6 2004	0408061733.tlm	Thermal Vac Cold Soak #7	-89.1	-29.2	34.5	16.3	0.50 / 0.50	0.38 / 0.50	8/5/2004	0	8	-0.04	0.3850	1.14E-04	13.2631	0.892	-0.02	0.3866	6e-5 (F)	48.27	25.64	0.943	810	-0.03	0.3869	5.02E-05	45.68	24.72	9.55E-03	0.986
										1	7	0.00	0.3846	1.29E-04	12.7789	0.732	0.02	0.3820	6e-5 (F)	50.52	25.89	0.823		-0.02	0.3817	6e-5 (F)	46.29	23.82	1.34E-02	0.819
										2	8	-0.10	0.3850	1.22E-04	13.0497	0.761	-0.02	0.3817	6e-5 (F)	41.19	23.64	0.817		-0.02	0.3815	6e-5 (F)	37.47	22.58	5.33E-03	0.847
										3	9	-0.07	0.3857	1.14E-04	13.2977	0.879	-0.06	0.3875	6e-5 (F)	39.53	24.31	0.940		-0.04	0.3867	7.85E-05	36.40	23.15	1.43E-02	0.964

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 ~140eV 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 47 Hz/hour was reached monitoring a -20C TQCM at 5.0 minute intervals for 30 hours with the chamber shrouds, baseplate, and coldplate set to 40C (non-op hot). 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.

Note also the correlation of TQCM rate with room temperature. This run was done during a relatively hot spell; data taken earlier, at the end of the first run, when the room temperature was a bit cooler, achieved rates of ~30Hz/hour.

6.1. *STE-U FM2 TQCM Data*