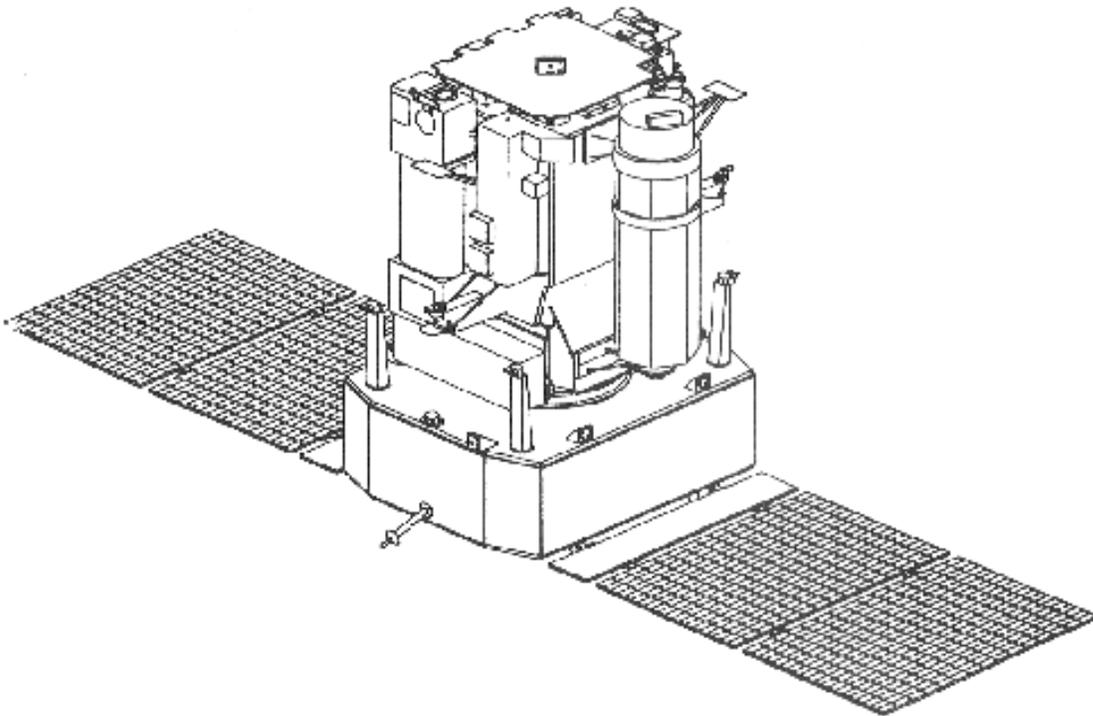




Goddard Space Flight Center, Greenbelt

SOHO Monthly Trending Report July 2005

Ref: SOHO/PRG/TR/613 2005 Aug 30



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1 SOHO Spacecraft Status Synthesis

General	Science data collection was nominal Spacecraft has been in inverted roll position since June 17, 2005	
Power	Solar array degradation	17.50% after 116 months of flight, equivalent to 1.81% per year.
DHSS	SSR	SEF's: average of 0.75 evt/min
	OBT drift	-0.21 ms for the period
RF	Transponders/Antennae	Nominal
AOCS	Reaction Wheels	RW 1, 2 and 3: work fine RW 4 was not used this month
	Fine Sun Sensor	FPSS A works fine
	Star Tracker	Nominal
Propulsion	Fuel	Remaining fuel: about 118 kg
	Thruster branch A	Not used this month
	Thruster branch B	Not used this month
Maneuvers	Station Keeping	None this month
	Momentum Management	None this month
	Roll	None this month
Thermal	Temperatures	Within limits
S/C Hardware failures:	Loss of fast loop of receiver 1 on Apr.23, 1997 Loss of all 3 gyros; Sept./Dec. 1998 Loss of battery 1; March 7, 2002 HGA antenna Z motor stuck; May 2003 (still possible to move the antenna along Z axis with dual winding activation) Loss of FSPAAD on Apr 21, 2004.	

2 Detailed Trending Analysis

2.1 Power Sub-system

The performance of the power system is nominal. All housekeeping parameters are within limits.

Solar Array degradation:

The degradation this month was 0.37%.

Total degradation after 116 months of flight is 17.50%, which corresponds to 1.81% per year (refer to plot in Annex 5.1).

Current Margin:

The present current margin (seasonally changing), based on the value of the PISW2 and the main bus peak current (37 A), is 8.53 A.

2.2 Data Handling Sub-system

The performance of the Data Handling Subsystem is nominal.

The housekeeping parameters were stable.

CDMU:

The average onboard time drift in March was -0.21 ms with a maximum delta of 0.56 ms.

There was one DMA error this month.

Solid State Recorder:

The SEF count, at 0.75 evt/min, is average for the period.

Transponder: nominal.

High Gain Antenna: nominal

Tape Recorder Maintenance:

No Tape Recorder Maintenance performed this month.

2.3 Attitude and Orbit Control Sub-system

The status of AOCS subsystem is nominal; all housekeeping parameters are within limits.

Note: S/C has been in inverted roll position since June 17, 2005.

Star tracker

The background level is stable at 687.7 mV.

Reaction Wheels

No evolution can be noticed in the reaction wheels' friction torques this month (see Annex 5.3 to 5.5).

The external disturbance torques are stable:

$T_x = 4.34 \text{ e-7 Nm}$, $T_y = -8.06 \text{ e-8 Nm}$, $T_z = -1.35 \text{ e-6 Nm}$.

FPSS

Due to ageing, FPSS limits have been changed (OCD #2037).

A check that these new limits are also suitable for the redundant channel (FPSS B) was performed on July 12 (OCD #2045).

This test was the opportunity to compare FPSS A (ON since launch) and FPSS B (OFF since launch) characteristics.

FPSS B works fine and seems to age the same way as FPSS A.

The result report (SOHO/PRG/MEM/614-2) is attached as an extra appendix at the end of this document.

2.4 Propulsion Sub-system

Maneuvers

None this month

Remaining fuel (PVT analysis)

According to PVT estimate, there are about 118 kg of fuel remaining (see Annex 5.6).

2.5 Thermal Sub-System and Thermoelasticity

All temperatures are within limits. The plots of the OSR and FPSS temperatures since launch are given in Annex 5.7.

3 Status of Anomalies

Anomalies during the reporting month:

Anomaly	Date	Title	Origin	Close-out reference
S05-0048	04-Jul-2005	CEPAC ESU Data Request Error	CEPAC	OCD 1207;ESU Patch PSR003
S05-0049	04-Jul-2005	CDS CIEG+5V Limit Flagging	CDS	GIS lookup table calculation (e-mail R. Yurow May 6)
S05-0050	07-Jul-2005	One Single DMA Failure Over 1 Format	SVM	PL/174/PS/371 Comm.Rep.
S05-0051	08-Jul-2005	CEPAC ESU Data Request Error	CEPAC	OCD 1207;ESU Patch PSR003
S05-0052	15-Jul-2005	CDS CIVMCP Yellow High Limit Violations	CDS	
S05-0053	25-Jul-2005	VIPWA Flagged Delta Red	VIRGO	

The anomaly spreadsheet (see trend files in the annex) lists the status of all spacecraft anomalies since launch.

4 Configuration

4.1 Flight Software Configuration

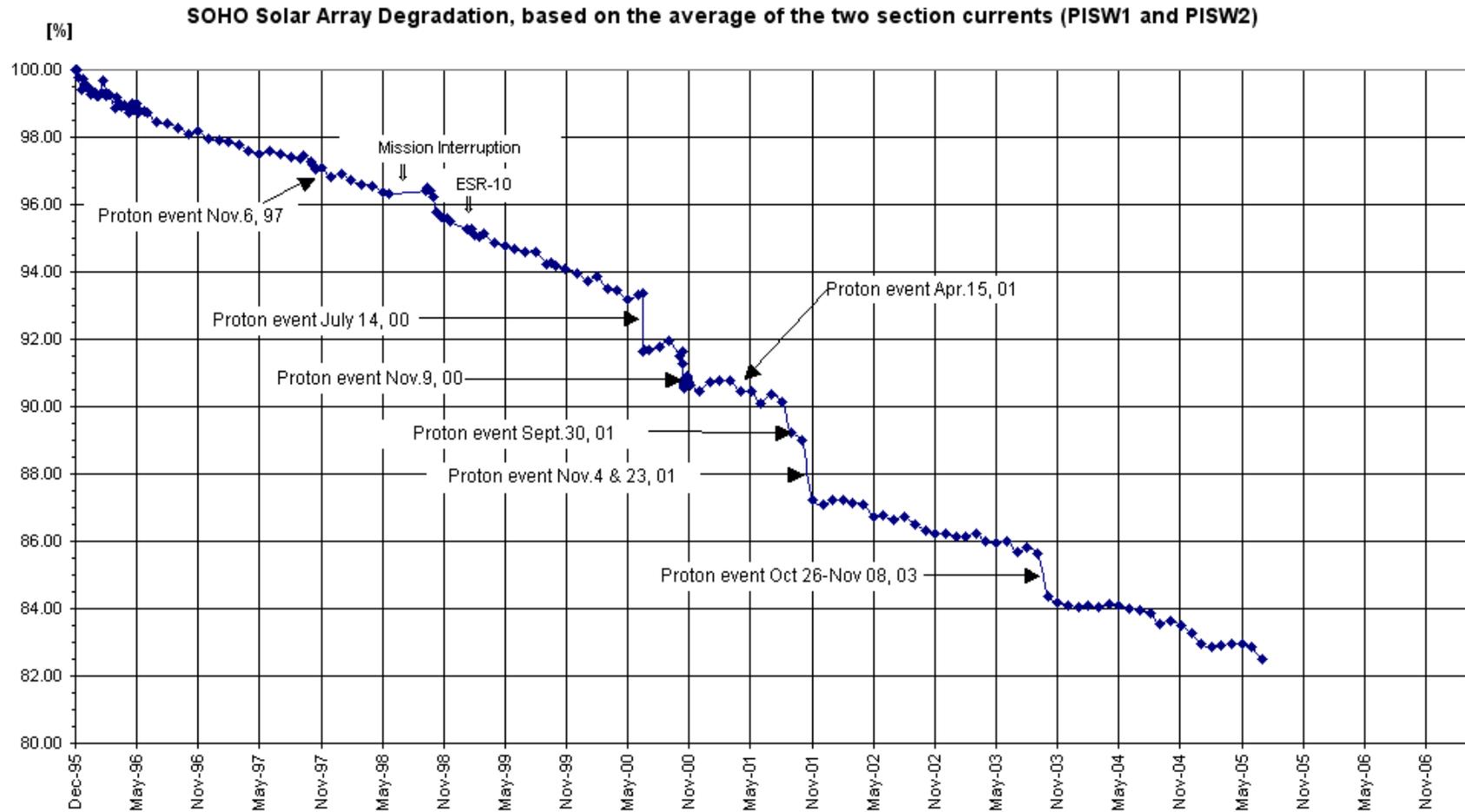
Central On Board Software	V14 with: <ul style="list-style-type: none"> - patch 2 (gyroless functions) - patches of SubFormats 5 and 6 - patch for Intermittent recording V3
Attitude Control Unit	FM_3_0 (i.e. FM_2_3A in PROM + ACU patch 8 for gyroless) + ACU patches 9, 10, 12, 13, 14 and 15
Star Tracker	FM-5.0 with SSU patch 2B
Solid State Recorder	No patch.

4.2 Recent Changes (OCD's and UB's)

1811	25-Jun-03	Raise APMM Temperature
1812	26-Jun-03	Try HGA Z Motor
1813	29-Jun-03	Test of MR/HR via LGA Using 70-M Antenna
1815	29-Jun-03	Try HGA Z Motor
1817	01-Jul-03	UVCS changes circuit 84: T3 from -5°C to 8.24°C; ground limits are RL=9, YL=12°C
1821	07-Jul-03	Restore Nominal Thermal Settings for APMM (control circuit 22, T1=0°, T2=10°)
1823	08-Jul-03	Switch to Medium Rate Telemetry to get attitude packets
1828	10-Jul-03	Synchronize Nominal and Redundant APMEs and Repoint Y Axis
1829	10-Jul-03	Try to Acquire MR then HR on HGA
1830	14-Jul-03	Move HGA Z Axis +30, -30, -6, steps single coil and -30 steps double coil.
1841	06-Aug-03	Move HGA Z-axis double coil -30 steps, then +30 Steps to known position
1851	16-Sep-03	Increase TC Watchdog and RWS Limits for Isabel Hurricane
1855	06-Oct-03	Disable HGA Nominal Control Function and Delete Entries
1858	21-Oct-03	Increase Ground Limits for QTR26
1860	27-Oct-03	APME Z-Axis improvement tests
1865	12-Nov-03	Test in single winding on APME Z
1866	14-Nov-03	Change Onboard and Ground Limits for FPSS Monitoring: onboard 45 deg C; QTR26 and QTR 27: YH = 43, RH = 44
1869	21-Nov-03	Modify FPSS Ground Limits: QT18A and QT18B: YH = 43, RH = 44; QT1920A and QT1920B: YH = 35, RH = 40
1873	01-Dec-03	APME Z-Axis Improvement tests
1875	11-Dec-03	Test in single winding on APME Z
1877	18-Dec-03	Test to Operate SSR & TR
1881	22-Dec-03	Authorization for Simultaneous Operation of Tape Recorder and Solid State Recorder
1883	16-Jan-04	Restore Pitch and Yaw Offsets by Memory Write Command
1892	24-Mar-04	Skip WS Daily Adjustment and Set TC Watchdog to 72 Hours (Keyhole Operations)
1903	22-Apr-04	Clear Anomaly Latches while in ESR
1907	23-Apr-04	Set Up Standard Monitoring using FPSS Sun Presence
1914	10-Jun-04	Send FSPAAD Latch Clear Weekly
1947	22-Sep-04	Change "wheel spk.txt" monthly trend item
1948	22-Sep-04	Upload and test COBS Intermittent Record Patch
1951	30-Sep-04	Test of subset 3ATT (intermittent recording) during last keyhole gap
1956	04-Nov-04	SSR in record mode during predicted RFI
1962	08-Dec-04	Disable CSPAAD until further notice (ESR 24 recovery)
1994	24-Jan-05	Switch on Memory Unit #11 of the SSR
2020	11-Apr-05	Move HGA -70 steps (Z axis)
2028	17-May-05	Disable HGA nominal function
2031	26-May-05	Turn APME A On
2032	1-June-05	HGA Y negative move using APME A
2037	8-June-05	Change FPSS Limits
2038	8-June-05	Confirm Fine Pulse position vs step counter
2041	14-June-05	Upload SSU Patch 2B (aka "one word patch")
2045	8-July-05	FPSS A-B Comparison

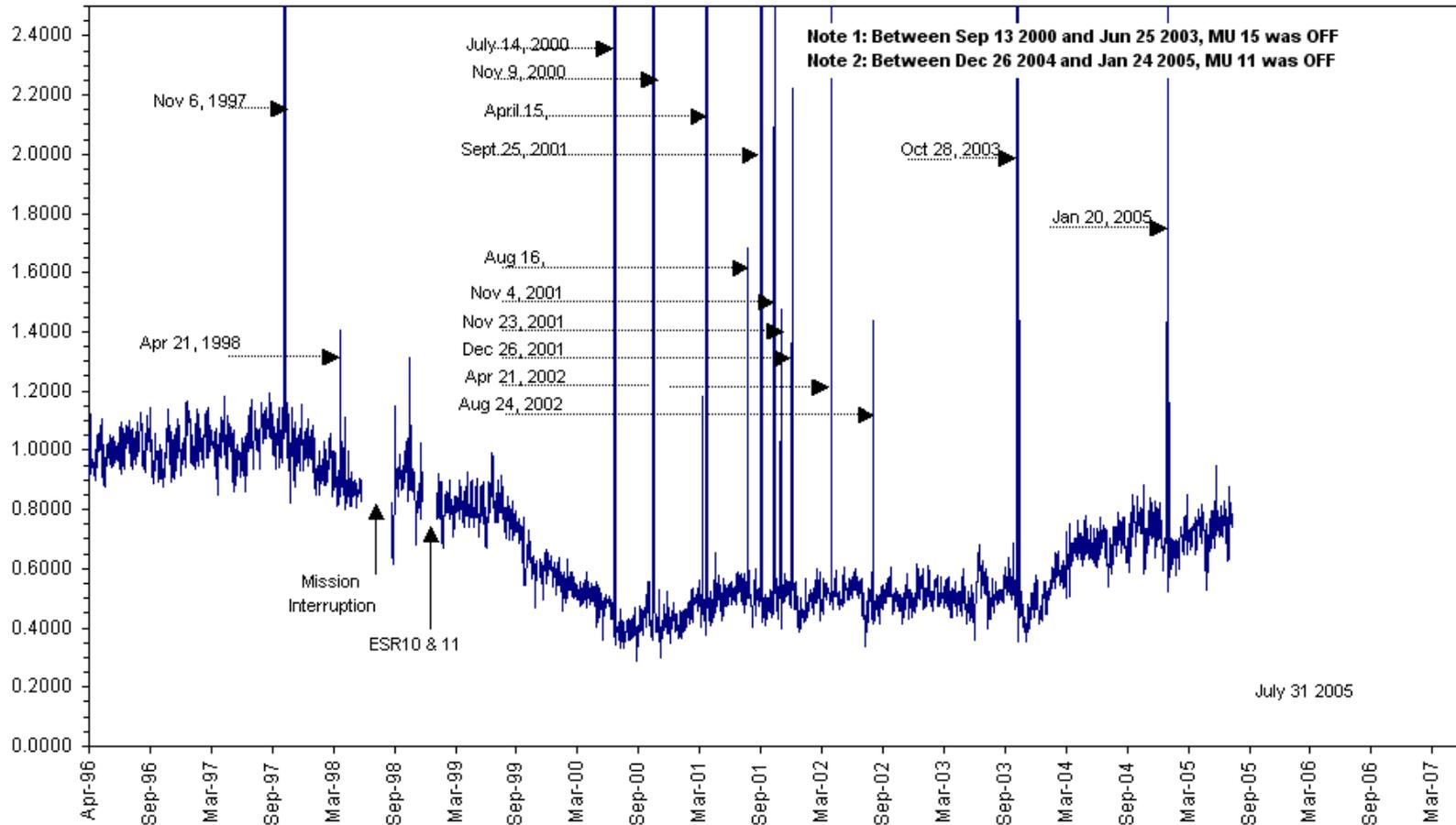
5 ANNEX

5.1 Solar array degradation

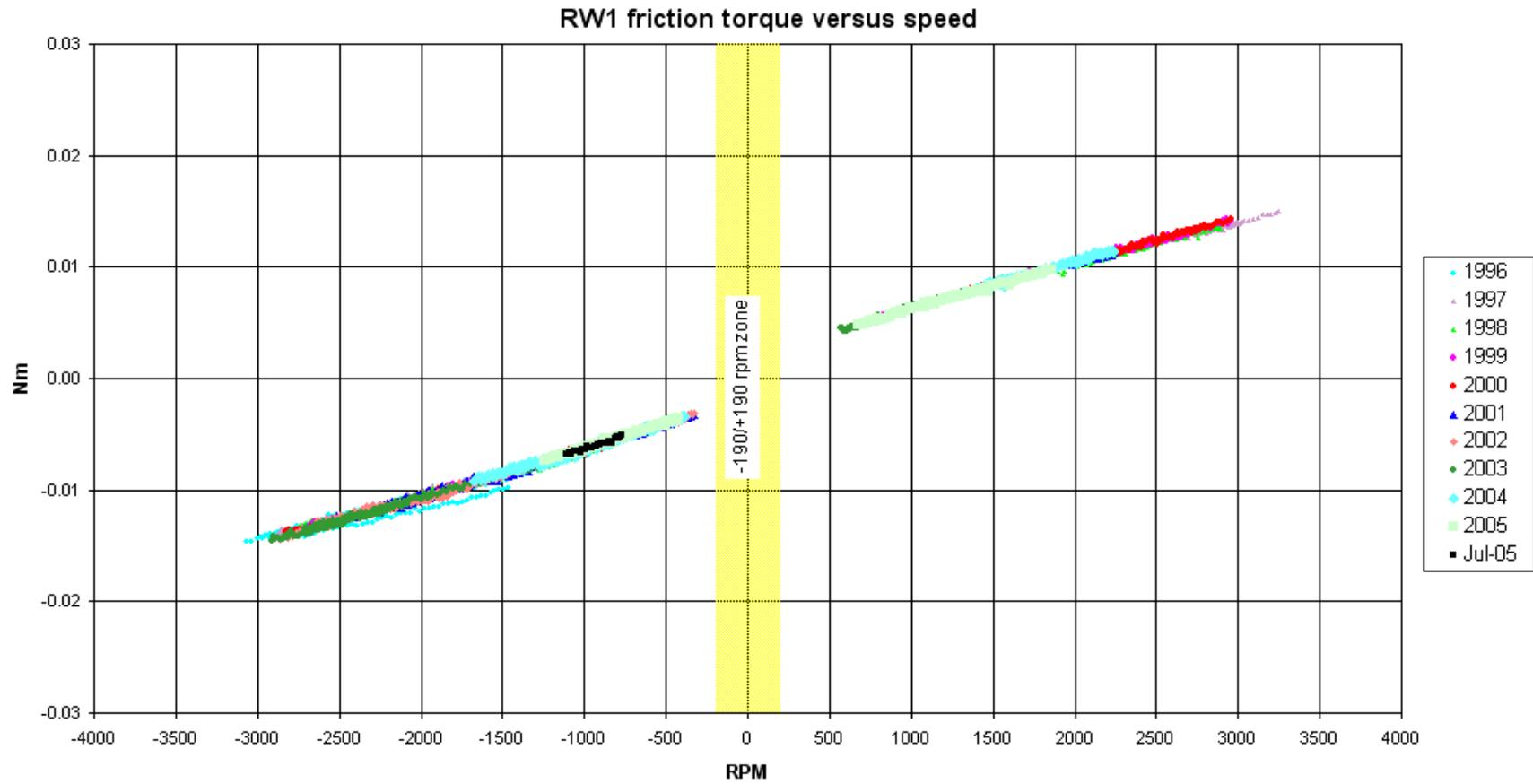


5.2 SSR / SEU Rate

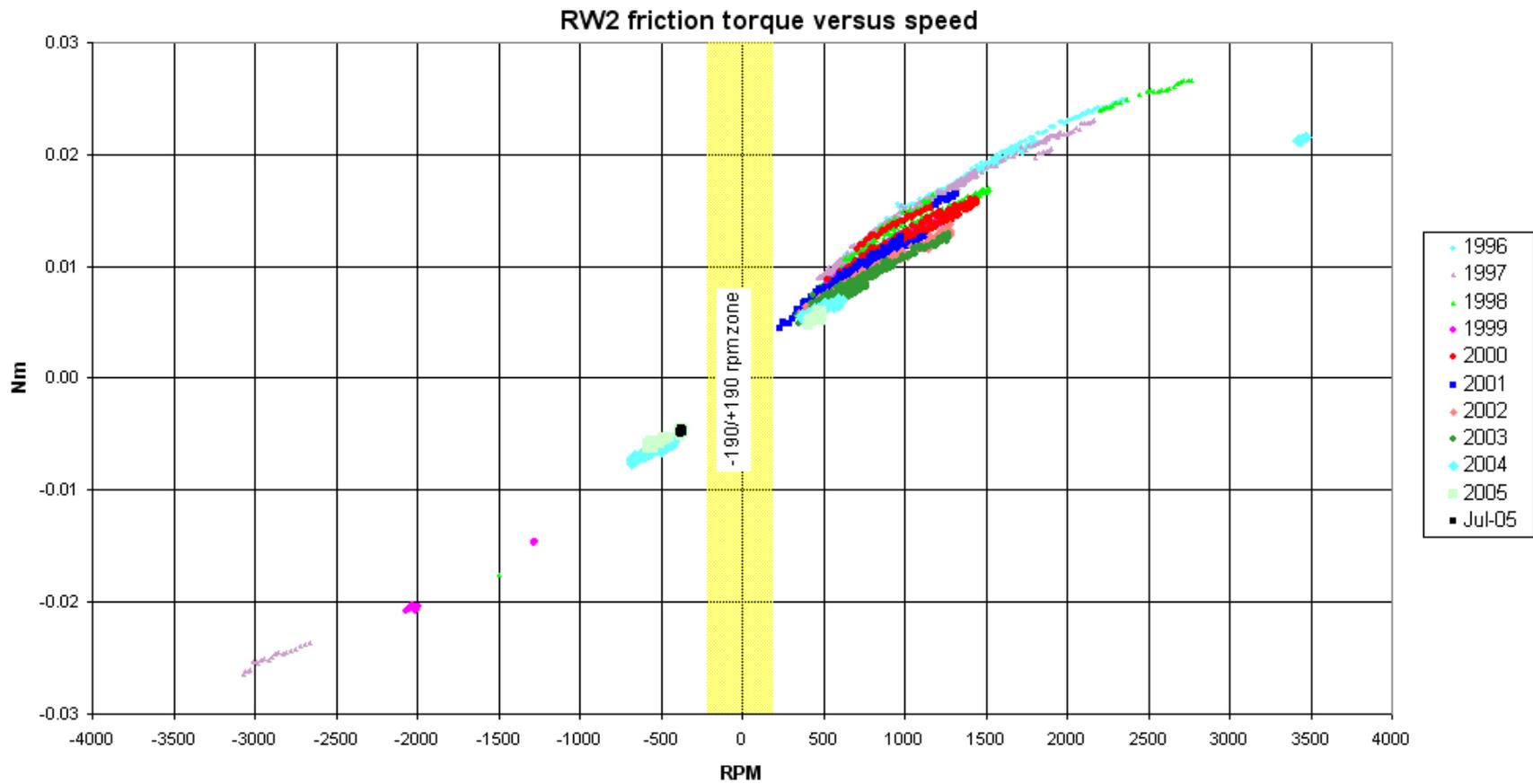
SOHO SSR Single Event Upsets, parameter DKSSCSEF (events/minutes/2G-bit)



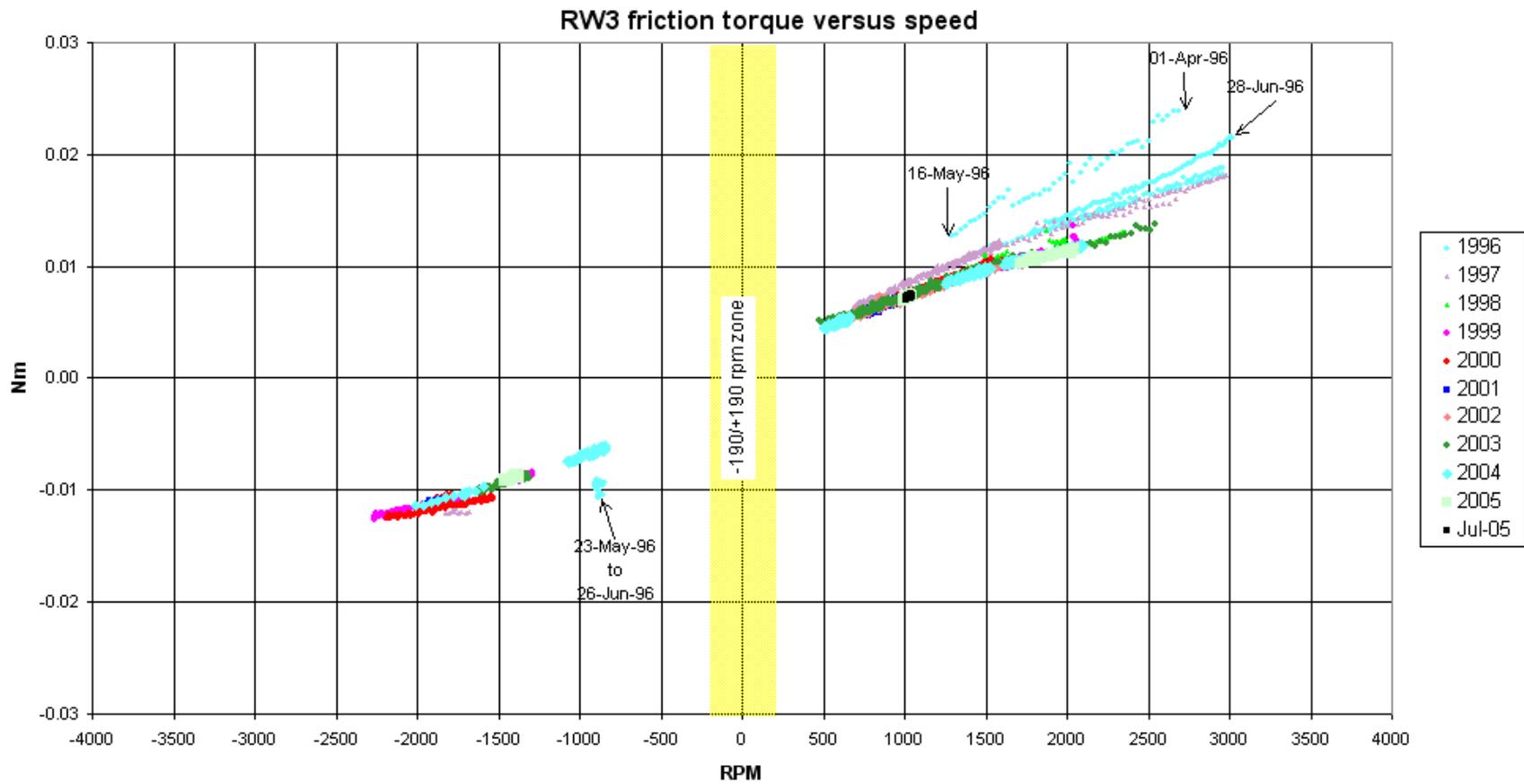
5.3 Reaction Wheel 1 friction



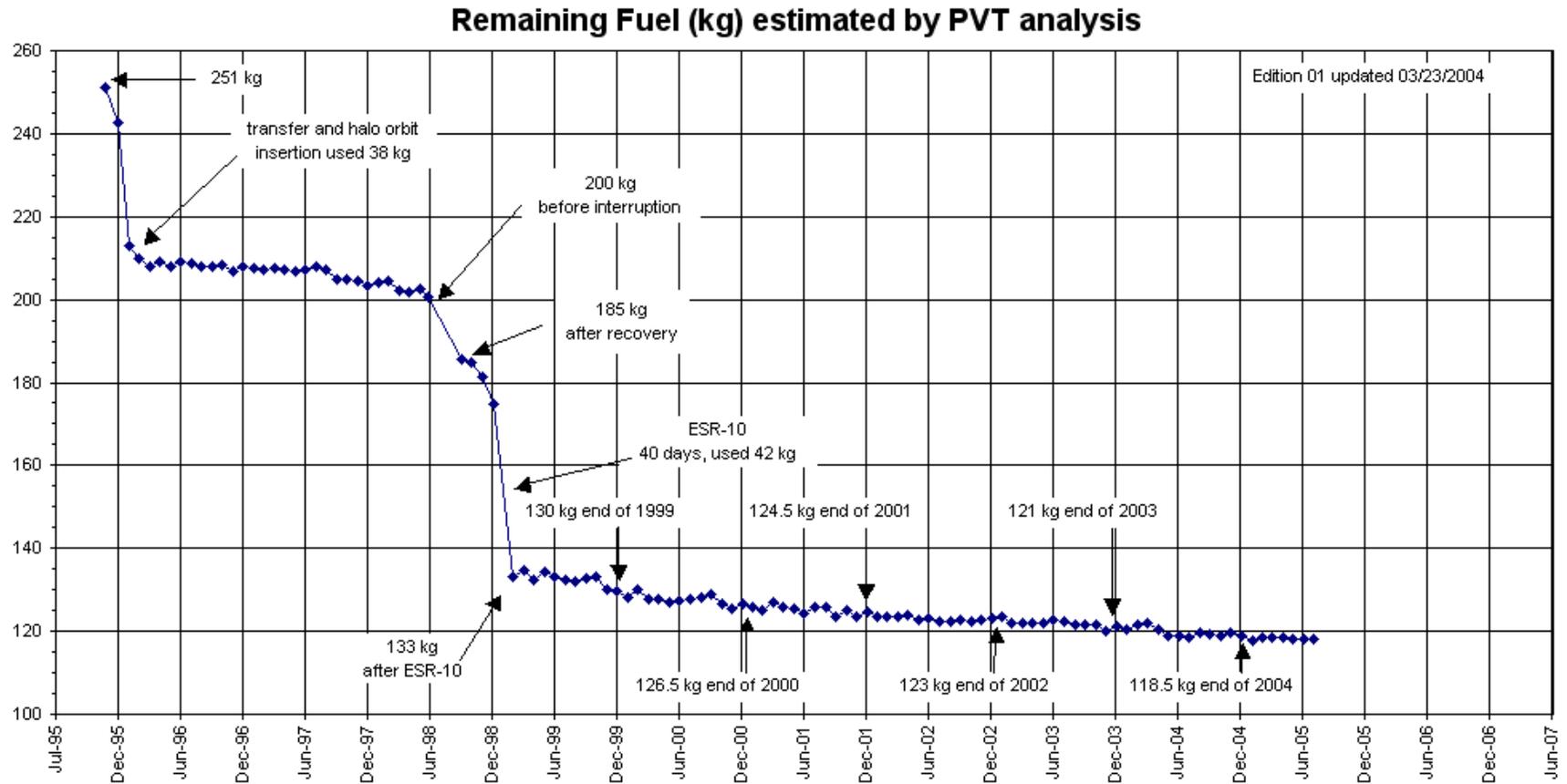
5.4 Reaction Wheel 2 friction



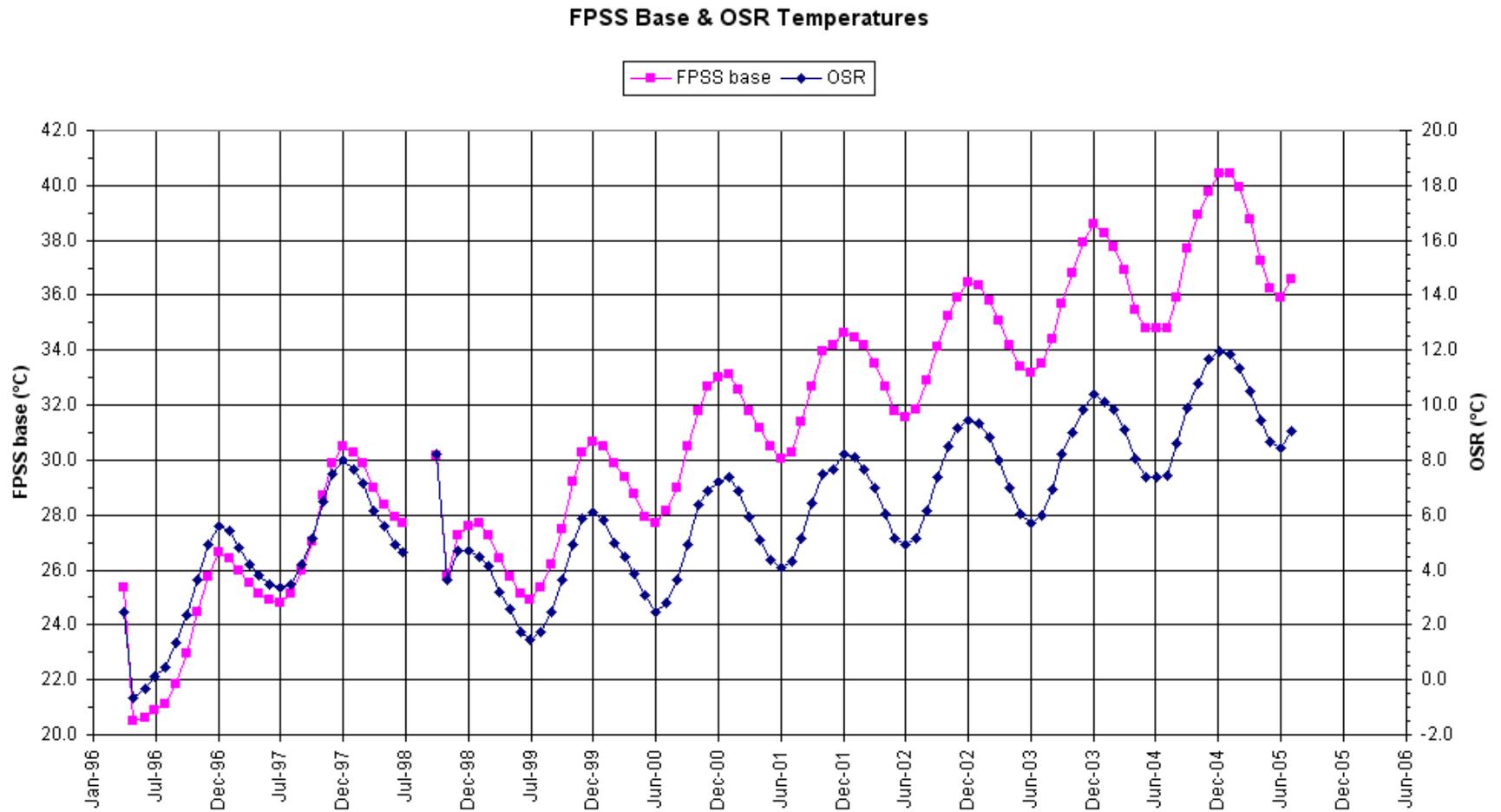
5.5 Reaction Wheel 3 friction



5.6 Plot of remaining amount of fuel



5.7 Plots of OSR and FPSS temperatures



5.8 SOHO Event List

Month	Day	Year	Day of Year	Flight Day	Time (UT)	Event
DEC	21	2004	356	3308	12:00	SK-45: jets 1,2,4,6; dV: 0.3358 m/s
DEC	21	2004	356	3308	13:15	Momentum Management 3 segments. Final speeds: 1165/455/--835 rpm
DEC	21	2004	356	3308	16:09	180° Roll, satellite in inverted position. Final speeds: --380/--455/1615 rpm
DEC	26	2004	361	3313	20:00	SSR Memory Unit #11 switched off by itself
DEC	30	2004	365	3317		End of December keyhole period
JAN	20	2005	25	3343		Major flare (18-21 Jan). Led to many anomalies, in particular multiple star swaps on Jan 20.
JAN	24	2005	24	3342	19:15	SSR Memory Unit #11 switched back ON
FEB	3	2005	34	3352		MDI 4-Day Continuous until February 6
FEB	18	2005	49	3367		FSPAAD state indicated "detected"
MAR	3	2005	62	3380		Beginning of March keyhole period
MAR	22	2005	81	3399		SK-46: jets 2,3,4; dV: 0.1137 m/s
MAR	22	2005	81	3399		Momentum Management 3 segments. Final speeds: --974/--400/2272 rpm
MAR	22	2005	81	3399		180 ° Roll, satellite back to regular position. Final speeds: 1885/400/--1370 rpm
MAR	31	2005	90	3408		End of March keyhole period
MAR	31	2005	90	3408		MDI 5-Day Continuous until April 4
APR	8 & 9	2005	98	3416		GOLF polarizer and quarter wave electronics turned off, substitution heaters (68+69) to 30%
APR	20	2005	110	3428	14:14 14:26	HGA moved around Z axis by -70 steps (dual coil) to -18.553 deg to eliminate mini-keyholes
APR	27	2005	117	3435		MDI 6-Day Continuous until May 2
MAY	16	2005	136	3454		MEDOC Campaign #15, until June 05
MAY	16	2005	136	3454	22:27	APME A Switched OFF
MAY	26	2005	146	3464	18:58	APME A Switched back ON
JUN	2	2005	153	3471	15:00	HGA moved thru APME A around Y axis by -35 steps to get a fine pulse (whole APME A loop control)
JUN	5	2005	156	3474		Beginning of June keyhole period
JUN	9	2005	160	3478		Transponder Swap (1->2)
JUN	17	2005	168	3486		SK-47: jets 2,3,4; dV: 0.030 m/s
JUN	17	2005	168	3486		Momentum Management 3 segments. Final speeds: 610/390/--1000 rpm
JUN	17	2005	168	3486		180 ° Roll, satellite in inverted position. Final speeds: --615/--385/990 rpm
JUN	17	2005	168	3486		Upload of SSU Patch 2B (One Word Patch)
JUN	17	2005	168	3486		Determine exact fine pulse position vs step counter + move antenna (Y axis) to -4.06875 deg (June 20 16:00)
JUN	18	2005	169	3487	7:54	Star swap from star 1 to star 2
JUN	20	2005	171	3489		Transponder Swap (2->1)
JUN	25	2005	176	3494		End of June keyhole period
JUN	26	2005	177	3495		MDI 60-Day Continuous period until August 28
JUL	12	2005	193	3511	14:30	FPSS-B comparison with FPSS-A (OCD # 2045)

5.9 Trend Files

The table hereafter gives the names and contents of the trend files, which are available on request from the authors of this document.

Topic	File name	Description
General	SOHO Events.xls	Log file of all the major SOHO events since launch
	Anomalies.xls	List of all the spacecraft anomalies with their closure reference
Power	SA Degradation.xls	Solar arrays data and degradation
	Power Trend Long.xls	Since Apr.96 daily average for the last day of each month of power parameters
DHSS	DHS Trend Long.xls	Since April 96 daily average for the last day of each month of DHSS parameters
	SEF Overall.xls	Daily rate of Single Event Failure on the Solid State Recorder (since launch)
	Tape Recorder.xls	Tape recorder parameters for each maintenance
RF	RF Trend Long.xls	Since launch daily average for the last day of each month of RF parameters
	HGA Moves.xls	Cumulated number of HGA movements between March 1999 and May 2003 (not updated since HGA problem)
AOCS	Wheels Friction Long.xls	Wheel speeds and torques (daily average) + estimation of external disturbance torques since Apr 96
	Wheels Spikes.xls	Listing of all the spikes on Wheel speeds TM (follow up on the wheel speed TM anomaly).
	AOCS HK Long.xls	AOCS housekeeping parameters since January 97
	SSU Back Ground Trend.xls	SSU background level since April 96
	SSU SEU Stat.xls	Guide star and SEU information for each day of the month
	SSU SEU Log File Sum Up.xls	Guide star losses and star swaps since launch
Propulsion	AOCS Counters.xls	Statistics on AOCS timers (AKNBSCH and AKTIMERB) counts per format over 1/2 hour on the last day of each month, since Mar.2000
	PVT Analysis 2.xls	Remaining fuel estimated by PVT analysis.
Thermal	Temp SVM.xls	SVM temperatures since April 96
	Temp PLM.xls	PLM temperatures since April 96

6 Distribution List

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7 Appendix: Result report of FPSS-B Comparison with FPSS-A

Rev 1 on 2005-07-13: Change point 3 of conclusion

Rev 2 on 2005-07-27: Add calculation of FPSS-B offset from FPSS-A.
Modify conclusion accordingly.

FPSS-B Comparison with FPSS-A

Subject:

After the FPSS limits have been modified (OCD #2037), a check that these limits can also be used for FPSS B had to be performed.

This test was run on Tuesday, July 12 2005 according to OCD # 2045.

OCD 2045 description

The steps unfolded during the test were the following ones:

- Memory dump of FPSS A data area to obtain a reference value set
- Switch ON FPSS B
- Initialize FPSS B MACS bus head
- Set memory dump to FPSS B area
- Perform a first dump
- Perform a second dump for confirmation
- Switch OFF FPSS B

Results

The telemetry values recorded are:

- FPSS SINE Y (Pitch)
- FPSS COSINE Y (Pitch)
- FPSS SINE Z (Yaw)
- FPSS COSINE Z (Yaw)
- FPSS COARSE (Pitch and Yaw)

The table hereafter gives the values obtained:

	FPSS-A		FPSS-B1 st try		FPSS-B 2 nd try	
	Hx Val	Dec Val	Hx Val	Dec Val	Hx Val	Dec Val
Sine Y (SY)	E6DC	-6436	FD91	-623	FD92	-622
Cosine Y (CY)	45D3	17875	4BCF	19407	4BD3	19411
Sine Z (SZ)	FFFF	-1	206	518	207	519
Cosine Z (CZ)	482D	18477	498E	18830	4992	18834
Coarse Y/Z	55	85	55	85	55	85
Pitch: SQRT (SY*SY+CY*CY)		18998		19417		19421
Yaw*: SQRT (SZ*SZ+CZ*CZ)		18477		18837		18841
	FPSS A		FPSS B		DELTA (B-A)	
Average Pitch	18998		19419		421	
Average Yaw	18477		18839		362	

*: For FPSS-A, as spacecraft is perfectly pointed, Yaw = CZ

- FPSS A and FPSS B values are quite similar
- As for FPSS A, FPSS B pitch value is greater than yaw value
- Both pitch and yaw values are greater for FPSS B than for FPSS A (+2.22% in Pitch and +1.96% in Yaw)
- The differences between FPSS A and FPSS B are of the same order for pitch and yaw

The measured pitch and yaw angles can be computed as:

$$\text{Pitch angle} = \text{atan2}(\text{SY}, \text{CY})/360$$

$$\text{Yaw Angle} = \text{atan2}(\text{SZ}, \text{CZ})/360$$

This gives the following table:

	FPSS-A	FPSS-B1 st try	FPSS-B 2 nd try
Pitch angle (rad)	-9.60015E-4	-8.91411E-5	-8.89798E-5
Pirch angle (arcsec)	-198.02	-18.39	-18.35
Yaw angle (rad)	-1.50337E-7	7.63954E-5	7.65266E-5
Yaw angle (arcsec)	0	15.76	15.78

Conclusion

The test was a full success.

What can be pointed out:

- FPSS B seems to work fine
- As FPSS A values are smaller than FPSS B values, the new limits set for FPSS A are also valid for FPSS B
- The differences between FPSS A and FPSS B are small, meaning the particles have a similar effect on FPSS ageing whether it is turned ON or not.
As no comparison between FPSS A and FPSS B was performed during commissioning (see foreword section SSA7 in the Final Spacecraft Commissioning Report Ref PL/100/FV/750/ms), no other point is available and consequently this hypothesis cannot be confirmed yet.
- If FPSS B has to be used, a calibration with the instruments is required to re-establish the optimal sun pointing attitude. As a first approximation a pitch offset of -18 arcsec and a yaw offset of 16 arcsec could be used.