Goddard Space Flight Center, Greenbelt

SOHO
Monthly Trending Report
November 2012

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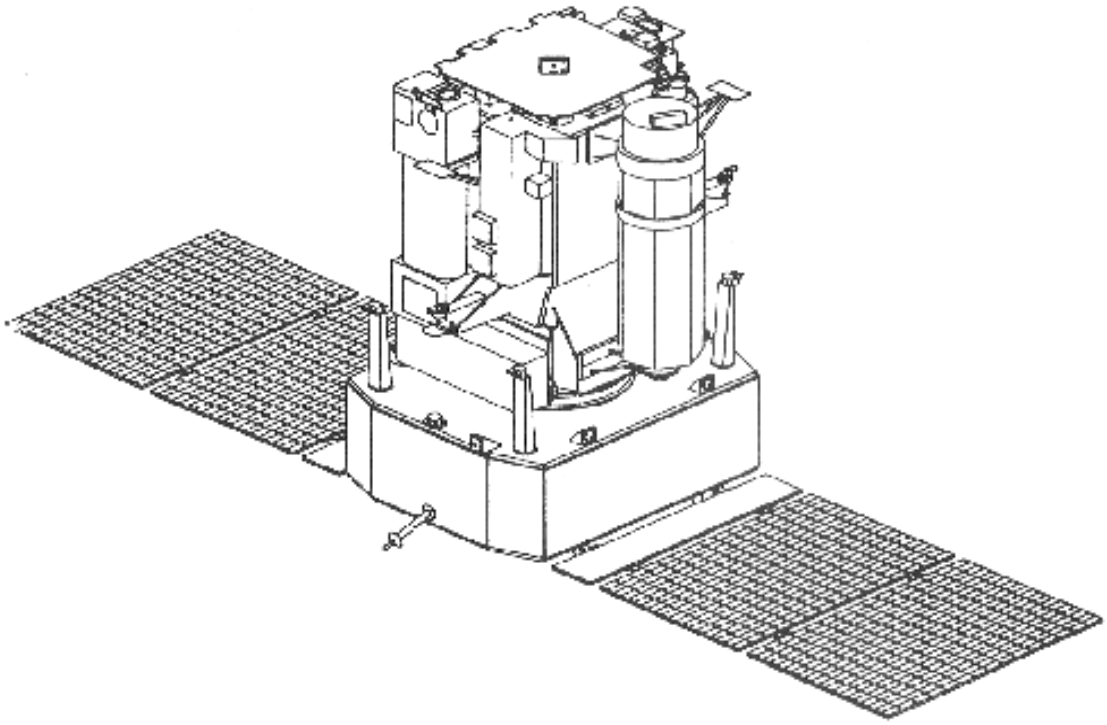

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1 SOHO Spacecraft Status Synthesis

General	Science data collection was nominal. Since Oct 9 spacecraft is at a constant 180-degree roll angle	
Power	Solar array degradation	22.50% after 204 months of flight, equivalent to 1.32% per year.
DHSS	SSR	SEF's: average of 0.76 evt/min
	Tape Recorder	Not used this month
	OBT drift	Average of 4.5 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	SSU-A works fine.
Propulsion	Fuel	Remaining fuel: about 114kg
	Thruster branch A	Used for SK and MM
	Thruster branch B	Not used
Maneuvers	Station Keeping	None this month
	Momentum Management	None this month
	Roll	None this month
Thermal	Overall temperatures	on expected trend
	SVM Equipment	FPSS plate temperature at 47.6C
	PLM status	All experiments ON with: - SUMER : since March 23, detector is ON (hence SH OFF) - GOLF sensor Substitution Heater ON (circuit 68 at 30%) - since Jan 6 2011, VIRGO uses its redundant power supply (VIPWB) - since Mar 23 2011, CTOF is OFF with its Substitution Heater ON (circuit 64 at 60%),
S/C Hardware failures:	Loss of fast loop of receiver 1 on April 23, 1997 Loss of all 3 gyros; September & December 1998 Loss of battery 1; March 7, 2002 HGA antenna Z motor stuck; May 2003 (still possible to move the antenna around Z axis with dual winding activation) Loss of FSPAAD on Apr 21, 2004 Loss of CSPAAD (ESR-27 on May 3 2012)	

2 Detailed Trending Analysis

2.1 Power Sub-system

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

Since June 2012, several experiment LCL status toggled OFF and ON, reporting erroneous values.
Between October 21 and Nov 27 (included), no LCL toggling was observed.
On Nov 28 , one LCL toggling was reported in TM for PLM PDU1.
On Nov 30 it occurred for 13 times, also for PLM PDU1.
The reason for the sudden increase is the OBT frequency adjustment performed on Nov 30. The master oscillator drives not only the on-board time (managed by the CDMU) but also (via dividers) the timing of the interrupt driving the high priority and low priority processes in the COBS.
However the CPU clock frequency does not change (internal clock in the processor).
A slight change in the external interrupt frequency causes the LCL toggling in telemetry effect to occur more frequently. Since this phenomenon only affects LCL status reporting for just one format (the actual LCL is NOT toggling), there is no effect on-board.

For more details on “LCL toggling” see technical note SOHO/PRG/TN/748.

Solar Array degradation:
The degradation this month was -0.08% (based on TSI value provided by VIRGO).

Total degradation after 204 months of flight is 22.50%, which corresponds to 1.32% per year (refer to plot in Annex 5.1.1).

On Nov 12, the solar cells voltage of –Y wing (2 reference cells in open circuit, PUGS1B TM) decreased from 0.96V and violated its Yellow Low limit set at 0.85V (lowest value at 0.82V)(S/C anomaly S12-0041). After a 10-minute excursion, the cells voltage came back to its normal value. All other solar arrays parameters were steady (including the cells voltage on the other SA wing). After discussion with power experts, it looks like this excursion is likely due to a shadowing effect of a “debris” or “flake from the spacecraft”.
Comparable excursions were observed twice in 2005 and periodically LASCO instrument observes such debris.

Current Margin:
The present current margin (seasonally changing), based on the minimum value of shunt current (PISW2, for section 8) and the main bus peak current, as reported in TM (34A), is 7.6A (see plot in Annex 5.1.2).

The monthly highest values recorded by the onboard min/MAX monitoring of the main bus current was 33A; the lowest was 27.2A (see plot in Annex 5.1.3).

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 was 4.5ms with a maximum delta of 5.2 ms.
The last OBT frequency adjustment was done on November 30 2012 and had a side effect on the number of “LCL toggling events” (see remark in §2.1). However there is nothing than can be done to reduce this phenomenon and it has no impact on-board.

This month single bit errors have been reported in CDMU RAM memory (when using nominal processor) without any operational impact (always at the same address as observed since Sept 2008).

Solid State Recorder:

The SEF count, at 0.758 evt/min, is average for the period (see plot in Annex 5.2.1 and Annex 5.2.2 (daily average of SEF counts plotted since 2009)).

Transponder:

Good performances of transponders and High Power Amplifiers.

HGA/APME:

High Gain Antenna nominally pointed around Y-axis; Z-axis at -16.7 degrees.

Tape Recorder:

Not used this month.

2.3 Attitude and Orbit Control Sub-system

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

Star tracker

There was no star swap this month.
The background level is stable at 688mV (for gain 4).

FPSS

The FPSS outputs are well within limits (see plot in Annex 5.3.1).

Reaction Wheels

The reaction wheels' friction torques are given well within trend (see plots of speeds vs torques in Annex 5.3.2 to 5.3.4).

CSPAAD replacement

Since June 2012, CSPAAD is replaced by new on-board monitorings of SAS1-B.
For additional robustness it was decided to use also the status ("shunt" or "on bus") of solar array section 2 to confirm a sun off-pointing during routine operations. The new monitoring of SA section 2 status is currently running (with no corrective action in order to check in-flight behavior). It is foreseen to use the final strategy in April 2013.

2.4 Propulsion Sub-system

2.4.1 Thruster Maneuvers

None this month.

2.4.2 Remaining fuel (PVT analysis)

According to PVT estimate, there are about 113.9 kg of fuel remaining (with an uncertainty of about 3 kg) (see Annex 5.4.1).

No fuel used this month.

2.5 Thermal sub-system and thermoelasticity

All temperatures are within limits.

The plots of the sun shield temperatures since launch are given in Annex 5.5.1.

Note this month the high temperature of CEPAC (QTHI1A at 41.3°C, average daily value for Nov 30 2012), which could create conditions for triggering of spacecraft monitorings of CEPAC current and temperature (as observed last year during the warm season).

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3 Status of Anomalies

Anomalies during the reporting month:

Anomaly	Date	Title	Origin	Close-out reference
S12-0040	2012-11-01	CDMU SEU Counter Increase	SVM	CDMU single bit errors at the same location 0xDF9F.
S12-0041	2012-11-05	CEPAC Yellow High limit violations	CEPAC	
S12-0041	2012-11-12	Solar array cell voltage (PUGS1B) YL for 8 minutes	SVM	likely due to a dust particle in front of one cell

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: - patch 2 (gyroless functions) - patches of Sub-Formats 5 and 6 - patch for Intermittent recording V3 - patch for TCM in macros - patch for RW speed limits updating - patch to correct Scheduler Bug - patch for UVCS safing (thermally more robust in case of ESR or off-pointing) - patch to increase the number of Standard Monitorings - patch to fix intermittent recording to avoid a warm startup during RTU reconfiguration
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, 15, 16 V2 and 17
Star Tracker	FM-5.0 with SSU patch 2A
Solid State Recorder	Version 2.03.0. (= Version 2.02 + SEF/DEF and IT2 patch)

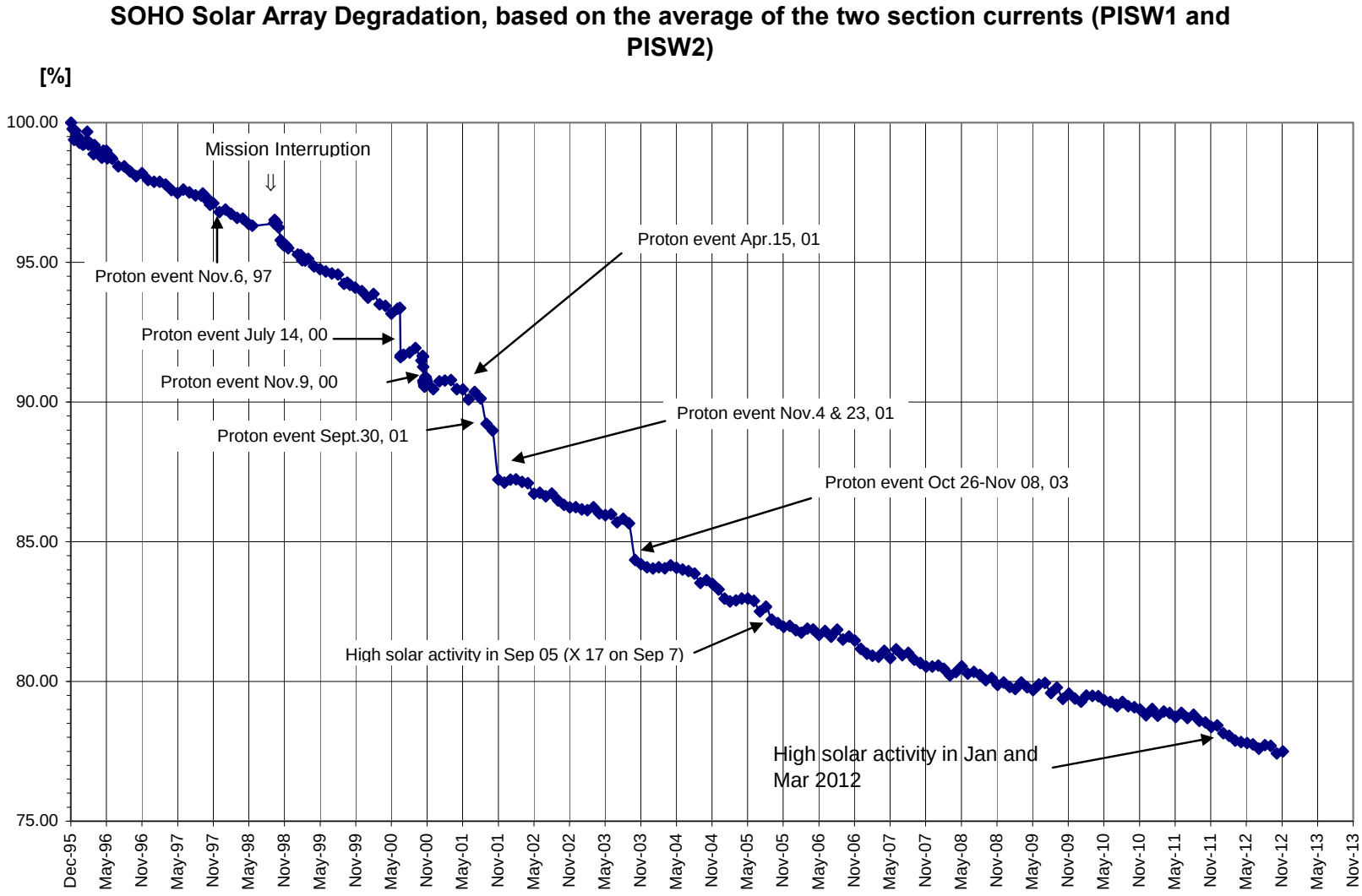
4.2 Recent Changes (OCD's and UB's)

2385	5-May-09	HPA thermal limits
2387	12-May-09	SSU-B test
2389	1-Jun-09	Ground limits (tuned for a list of SVM parameters)
2392	6-Jun-09	If needed switch ON CDS electronics substitution heaters (not executed)
2406	14-Aug-09	Move HGA Z-axis +197 steps to -16.7 degrees (dual coil) to reduce Keyholes
2417	6-Oct-09	GOLF thermal limits and electronics substitution heater set at 90%
2418	6-Oct-09	APME-B switched OFF
2420	19-Oct-09	Enable PLM circuits already at 0%
2421	19-Oct-09	Battery 2 thermal threshold
2423	22-Oct-09	Upload ACU patch 16
2424	22-Oct-09	Tank and RWL heaters put in mode 2
2429	5-Nov-09	PLM heaters tuning (-7.6W)
2430	5-Nov-09	APMM Temperature limits
2431	2-Nov-09	SWAN thermal settings
2435	16-Nov-09	ATPTA-B Temperature limits
2443	23-Jan-10	SSR Memory Unit 9 switched back ON
2448	3-Feb-10	Upload COBS UVCS safing patch (SMILE CSEC018)
2453	8-Mar-10	VIPWA-B YLL and RLL decreased
2468	2-Aug-10	ATLVA-B YLL decreased from 12C to 11C
2478	29-Oct-10	PLM heaters reduction for Bogart (-12.5W)
2479	1-Nov-10	Widen ground limits for gyros outputs (ASFD55L, AXFD11, AXFD12)
2480	9-Nov-10	Upload COBS patch for more standard monitoring channels
2481	9-Nov-10	Test of COBS patch for more standard monitoring channels
2493	18-Jan-11	Switch back ON SSR Memory Unit number 10
2494	25-Jan-11	Upload ACU patch 16 V2 (clear mapping buffer spread over 16 slots)
2503	22-Apr-11	Upload ACU patch 17 (RSL processing changes for Bogart mission)
2504	22-Apr-11	Reduce CTOF nominal substitution heater from 80% to 60%
UB57	21-Jul-11	Update of COBS and ACU Gyroless SW (COBS patch for more St Mon and for UVCS; ACU patches 16 and 17). Updates of Applications SW UM, St Mon and Macros for Bogart.
2509	4-Jan-12	Upload new on-board monitorings for CEPAC/ERNE (HIPWA and QTHI1A)
2516	30-Jan-12	Reduce CELIAS **redundant** substitution heater for circ 64, 65 and 66 (from 90% to 80%)
2520	14-May-12	Do Not Enable CSPAAD
2525	11-Jun-12	CSPAAD replaced by SAS1-B
2526	18-Jun-12	PLM heaters phase tuning (PPDU1)
2527	6-Jul-12	PSSSW2 mon no CA – TR mon in Th circ 99
2528	18-Sep-12	Upload Intermittent recording fix patch
2529	18-Sep-12	New monitoring to be used during CDS switch ON
2530	9-Oct-12	Reduced filter of Shunt status 2 Monitor to 2
2531	9-Oct-12	Decreased upper threshold of SSR Standard Monitoring to 47°C

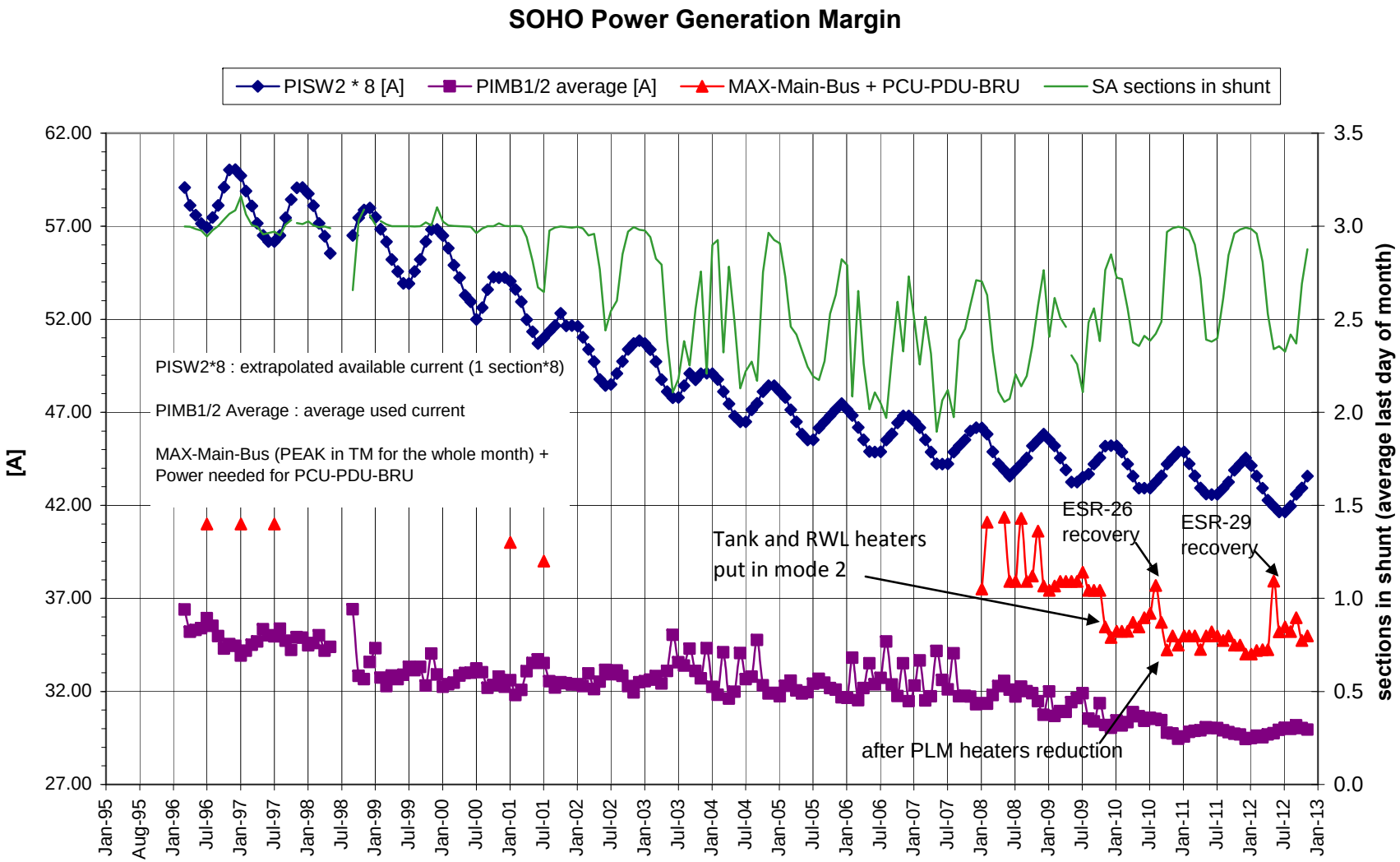
5 ANNEX

5.1 Power plots

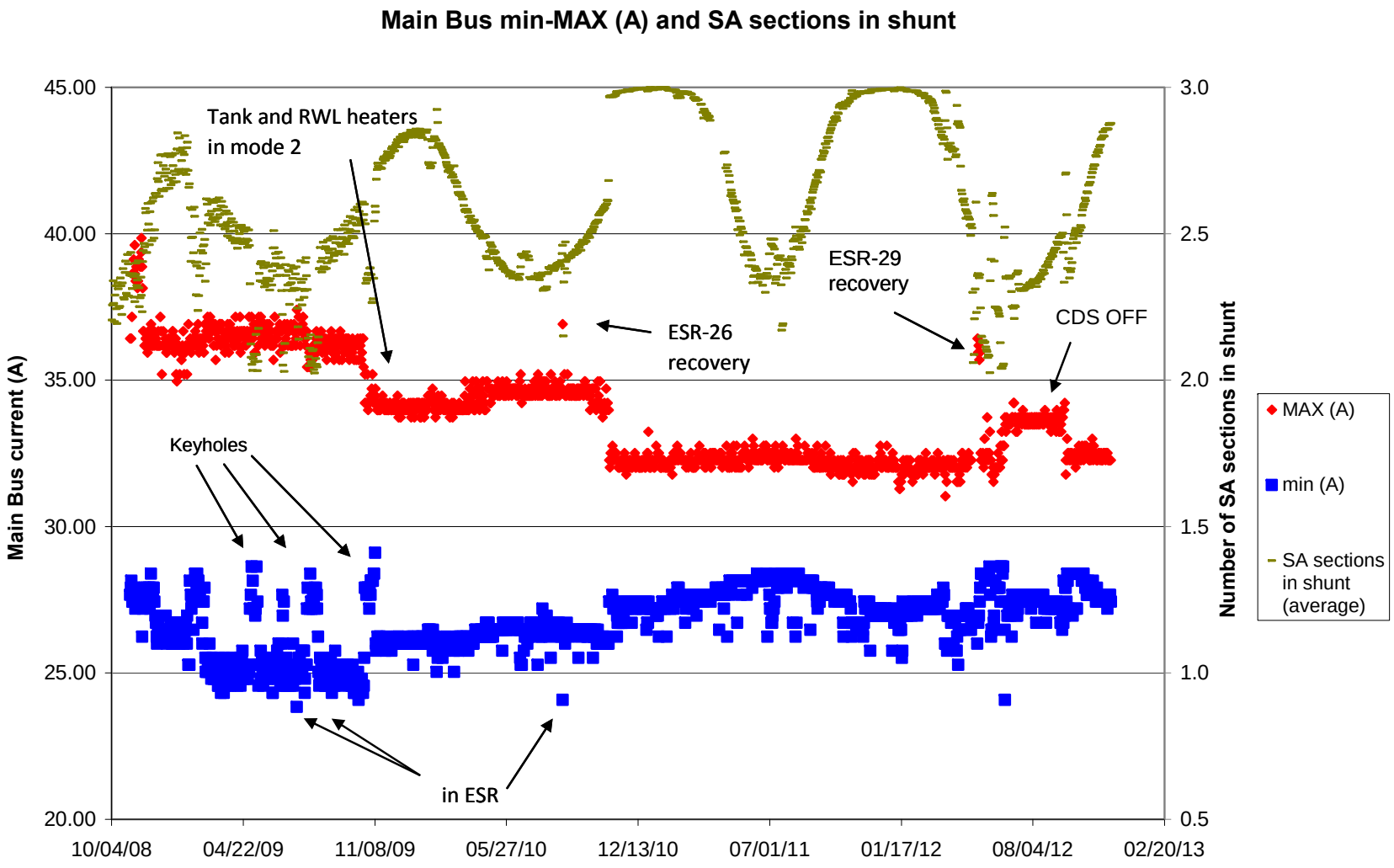
5.1.1 Solar array degradation



5.1.2 Power margin

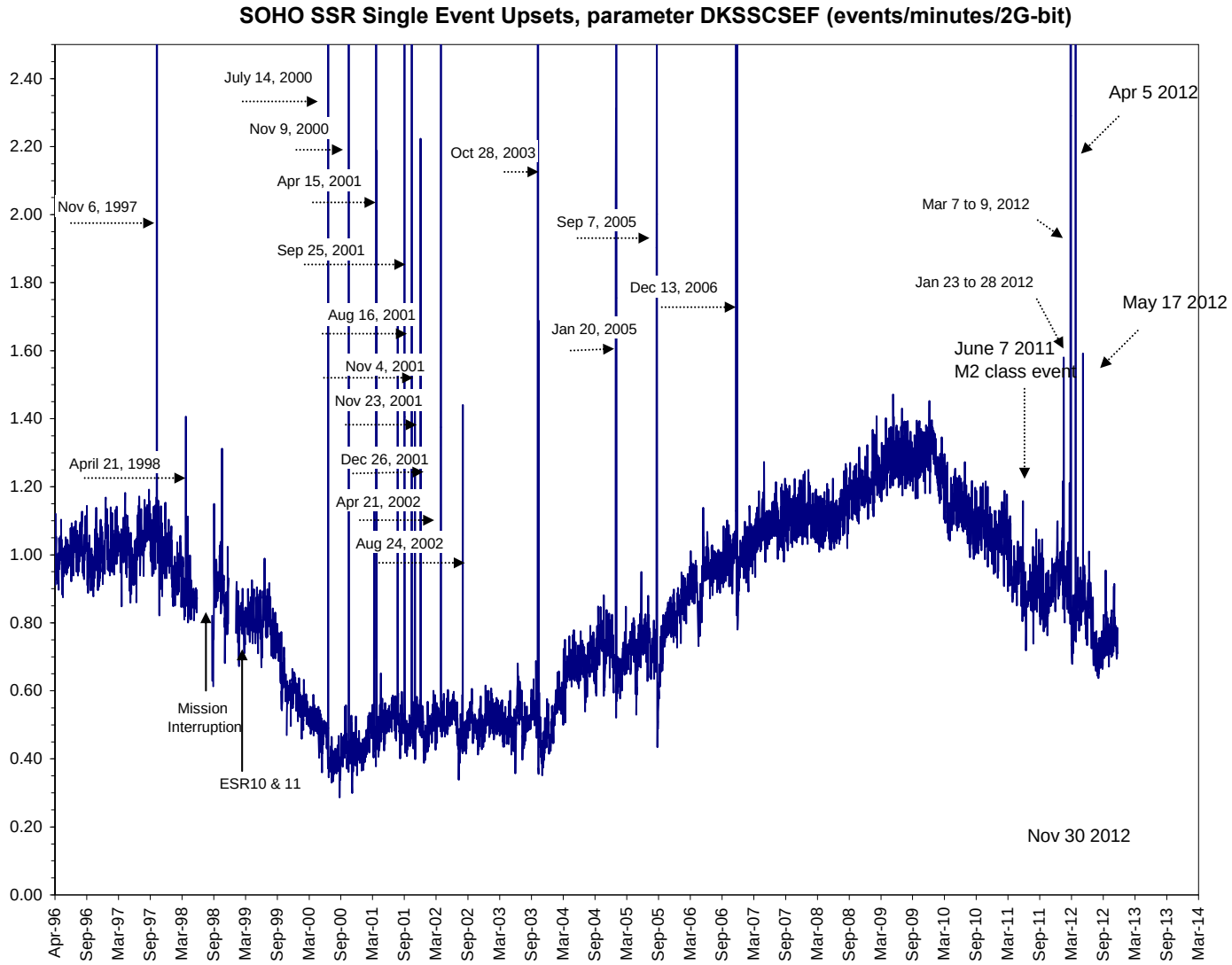


5.1.3 Main Bus Current daily min-MAX and Number of SA sections in shunt

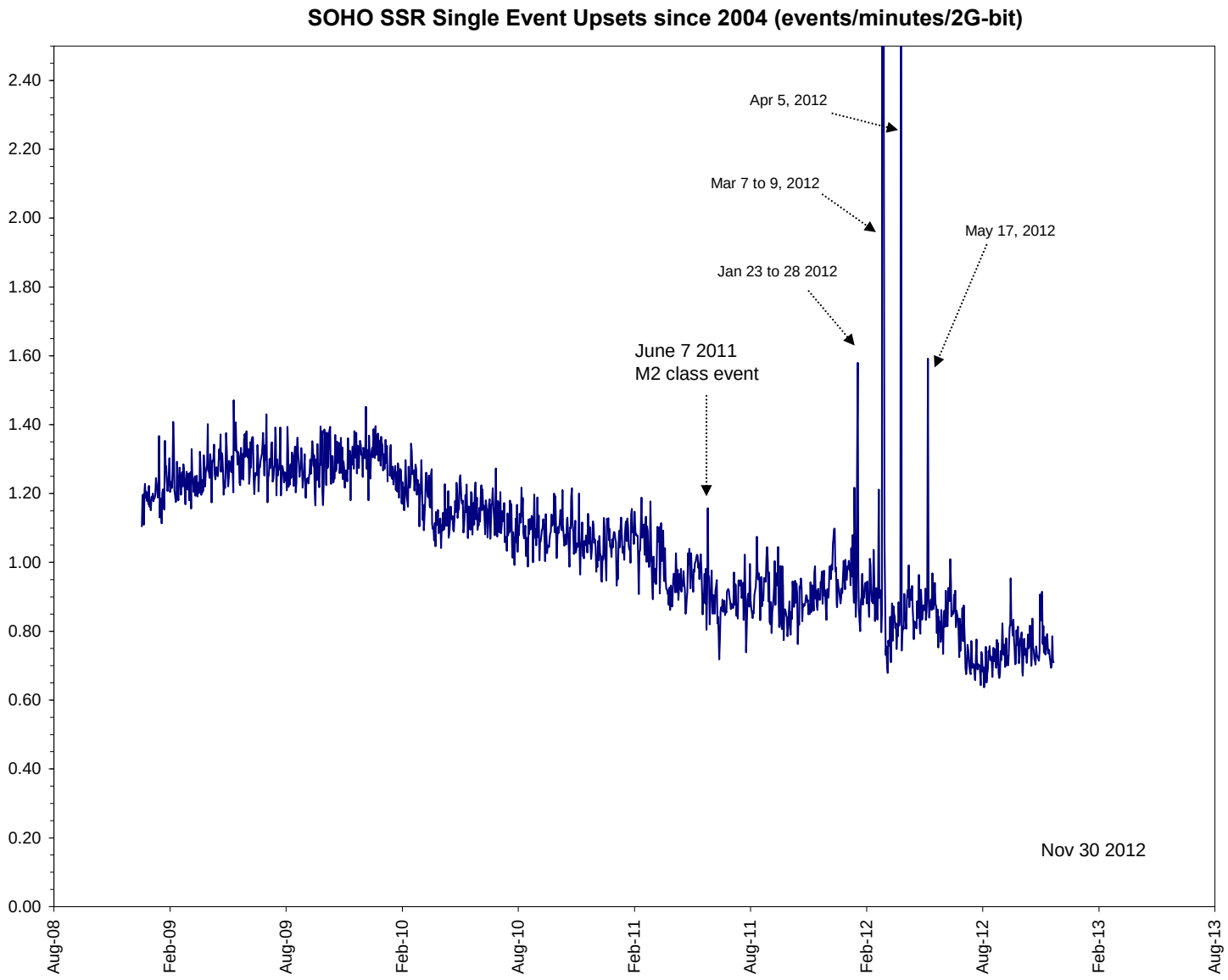


5.2 SSR / SEU Rate

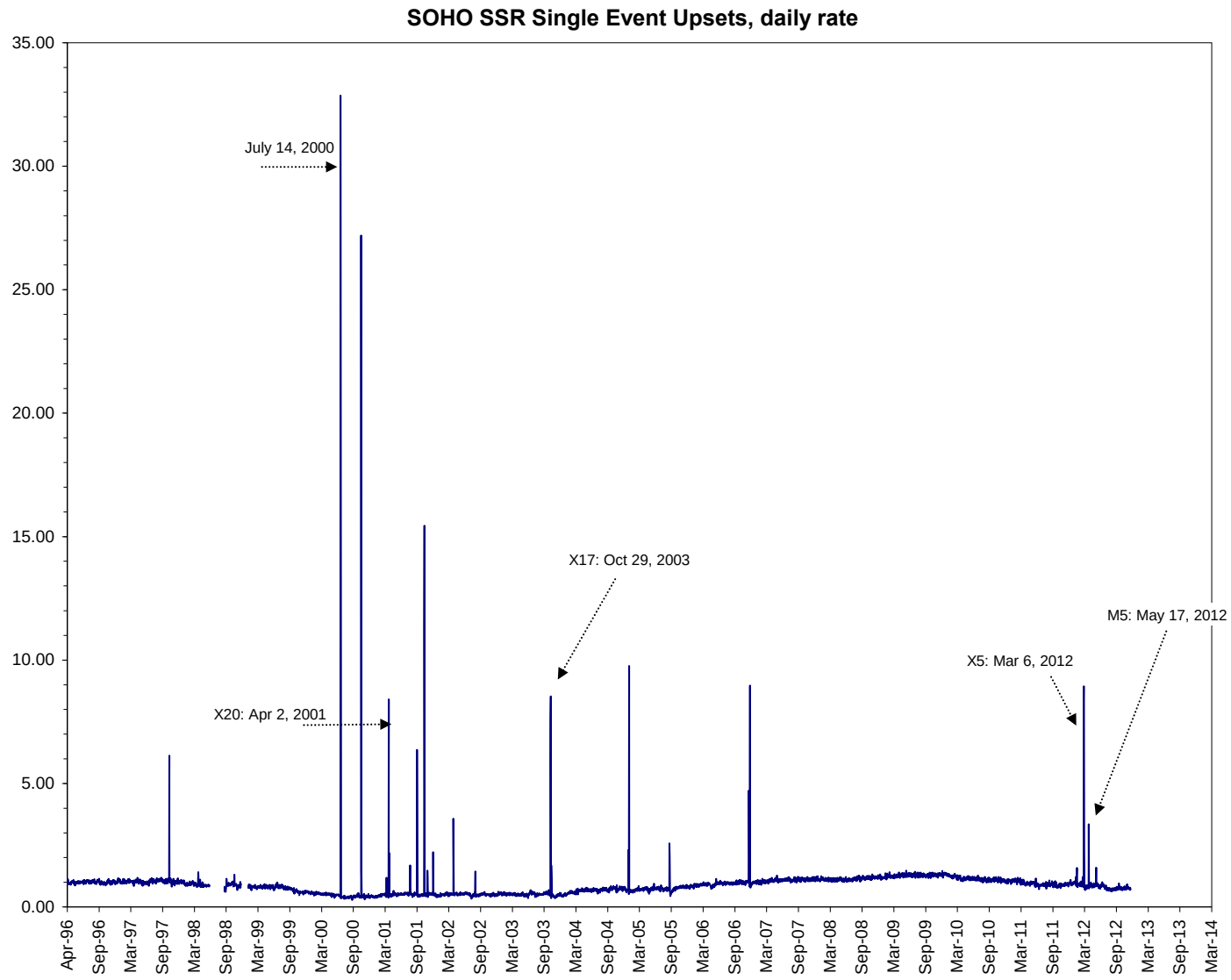
5.2.1 Since Launch



5.2.2 Since 2009

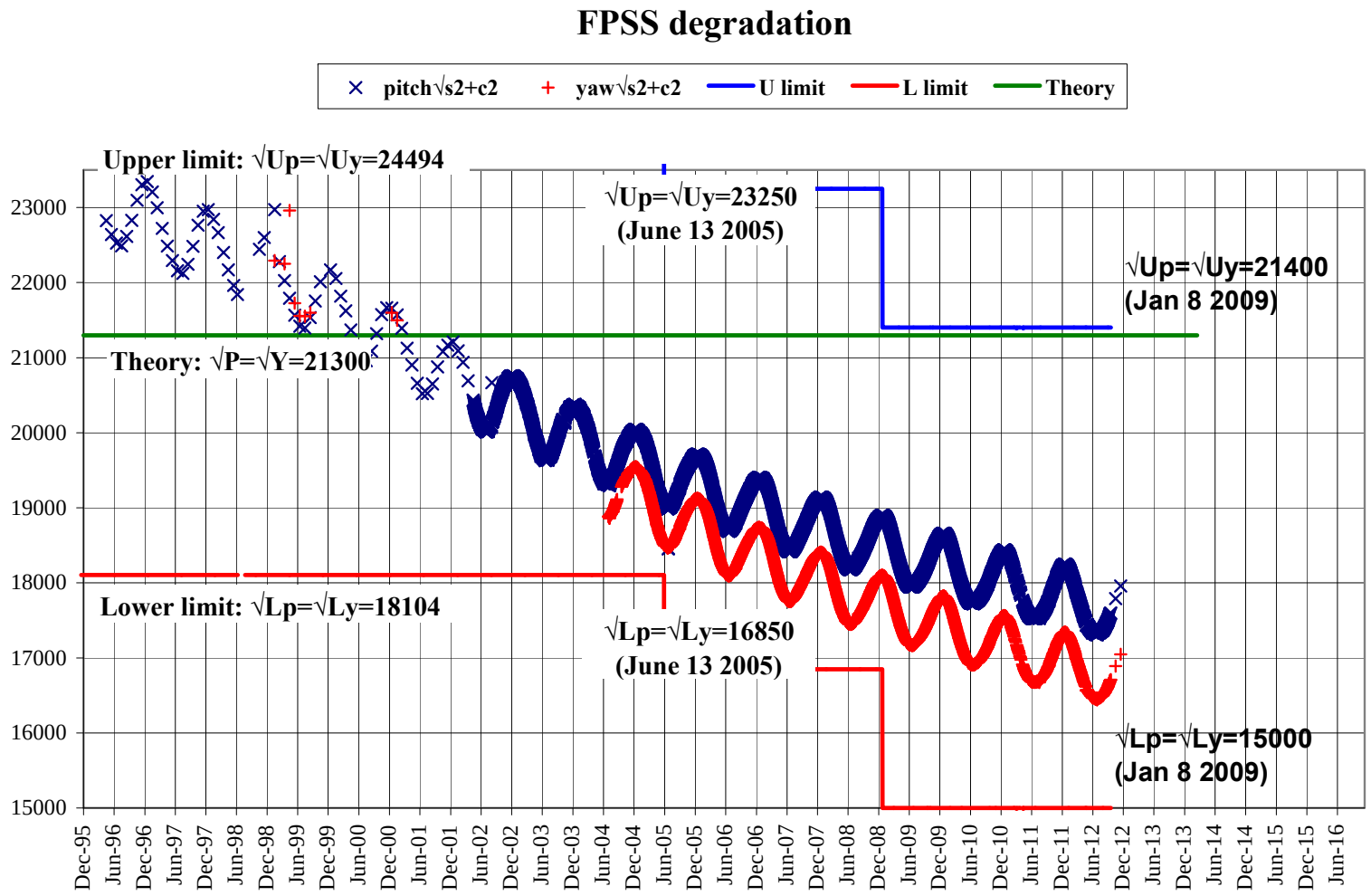


5.2.3 Large scale

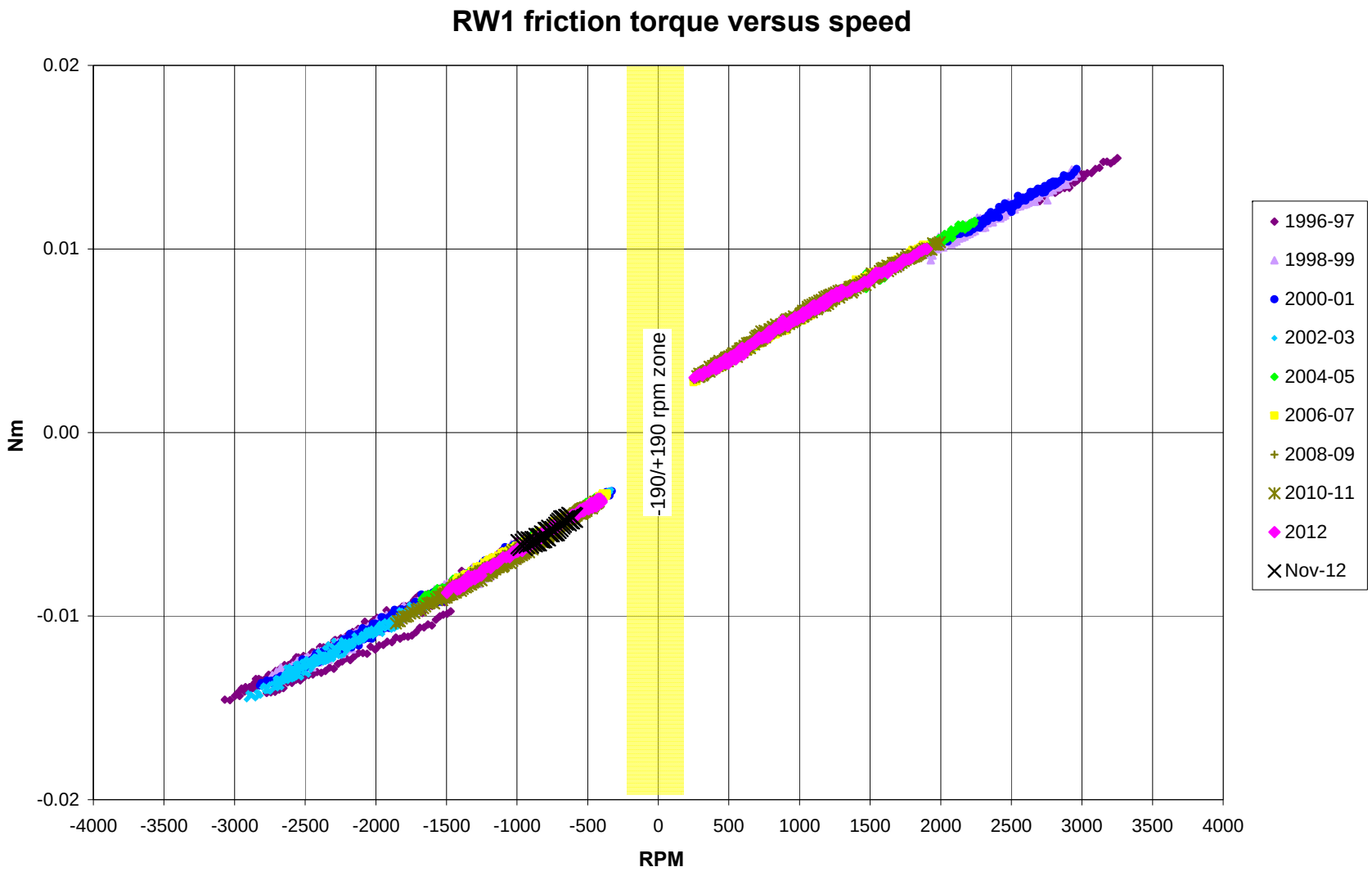


5.3 AOCS plots

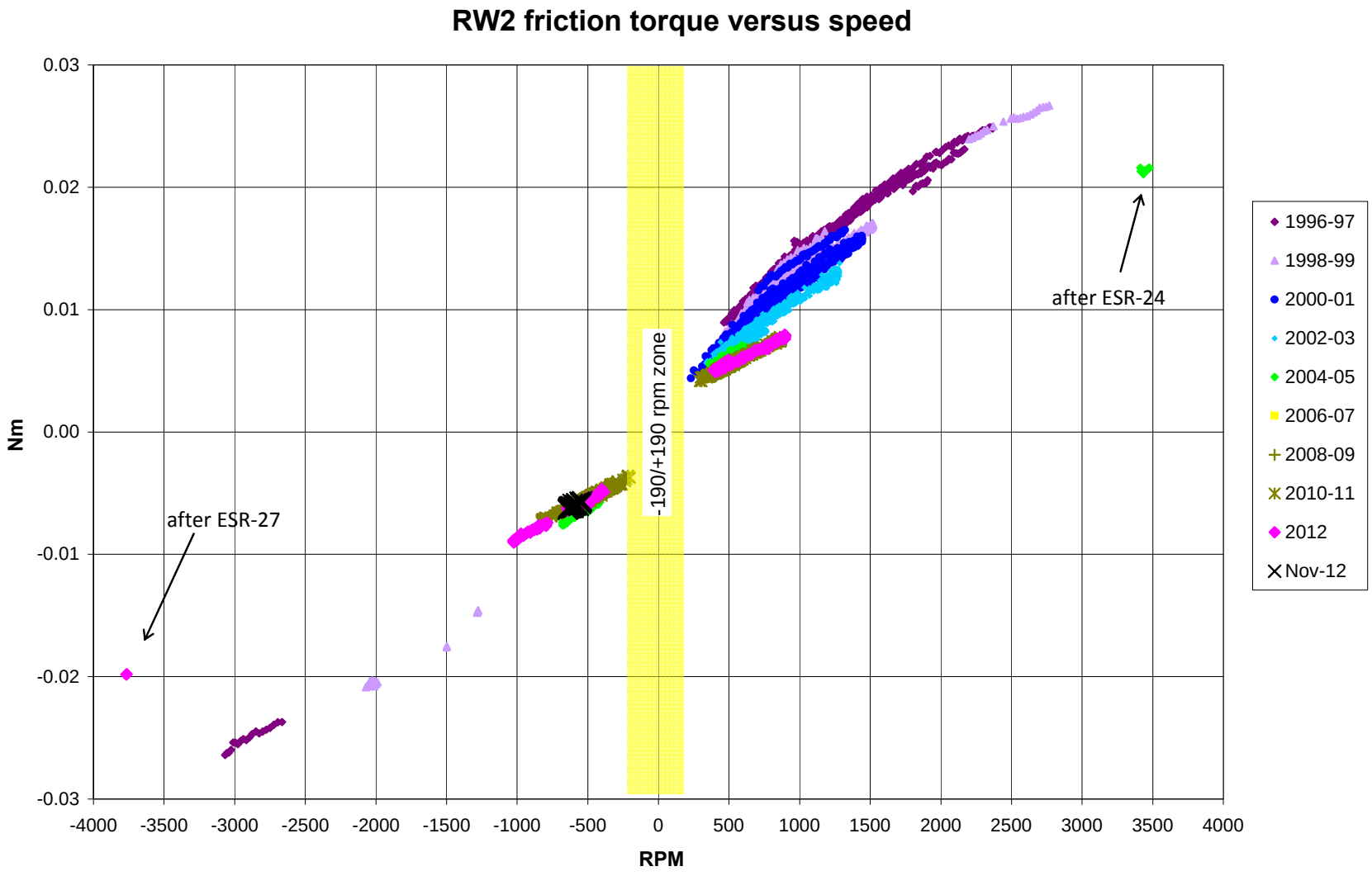
5.3.1 FPSS degradation



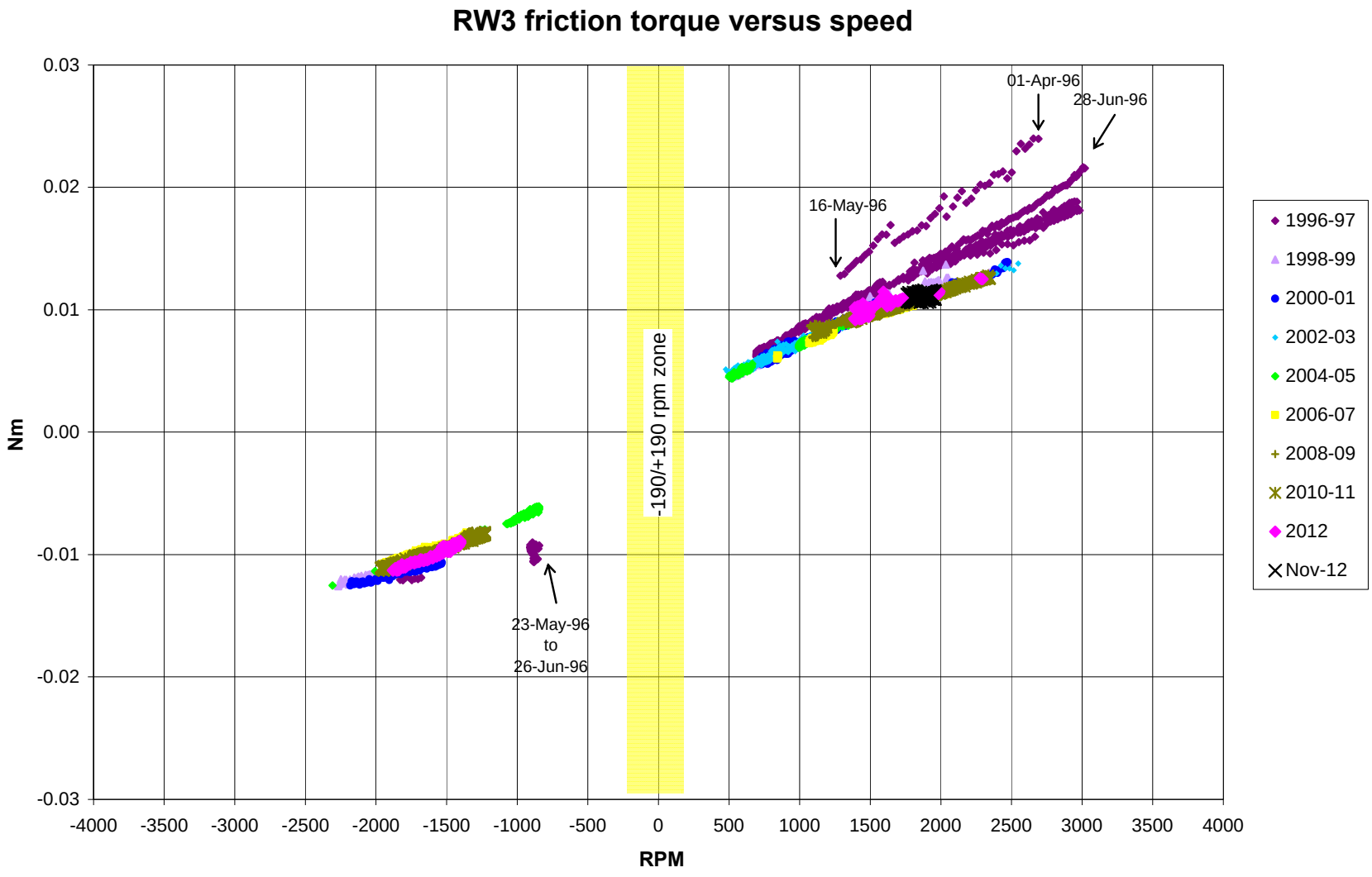
5.3.2 Reaction Wheel 1 friction



5.3.3 Reaction Wheel 2 friction

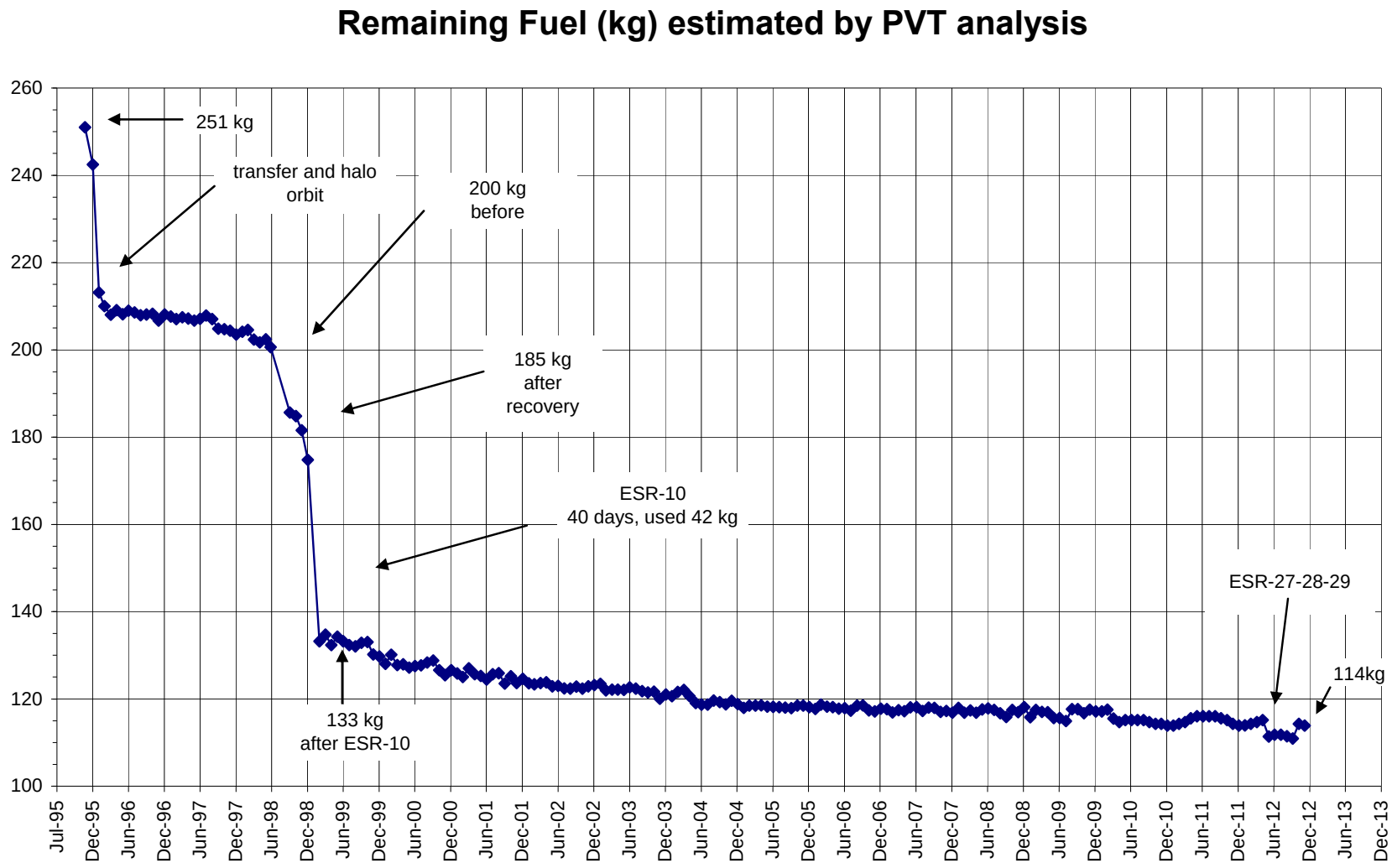


5.3.4 Reaction Wheel 3 friction



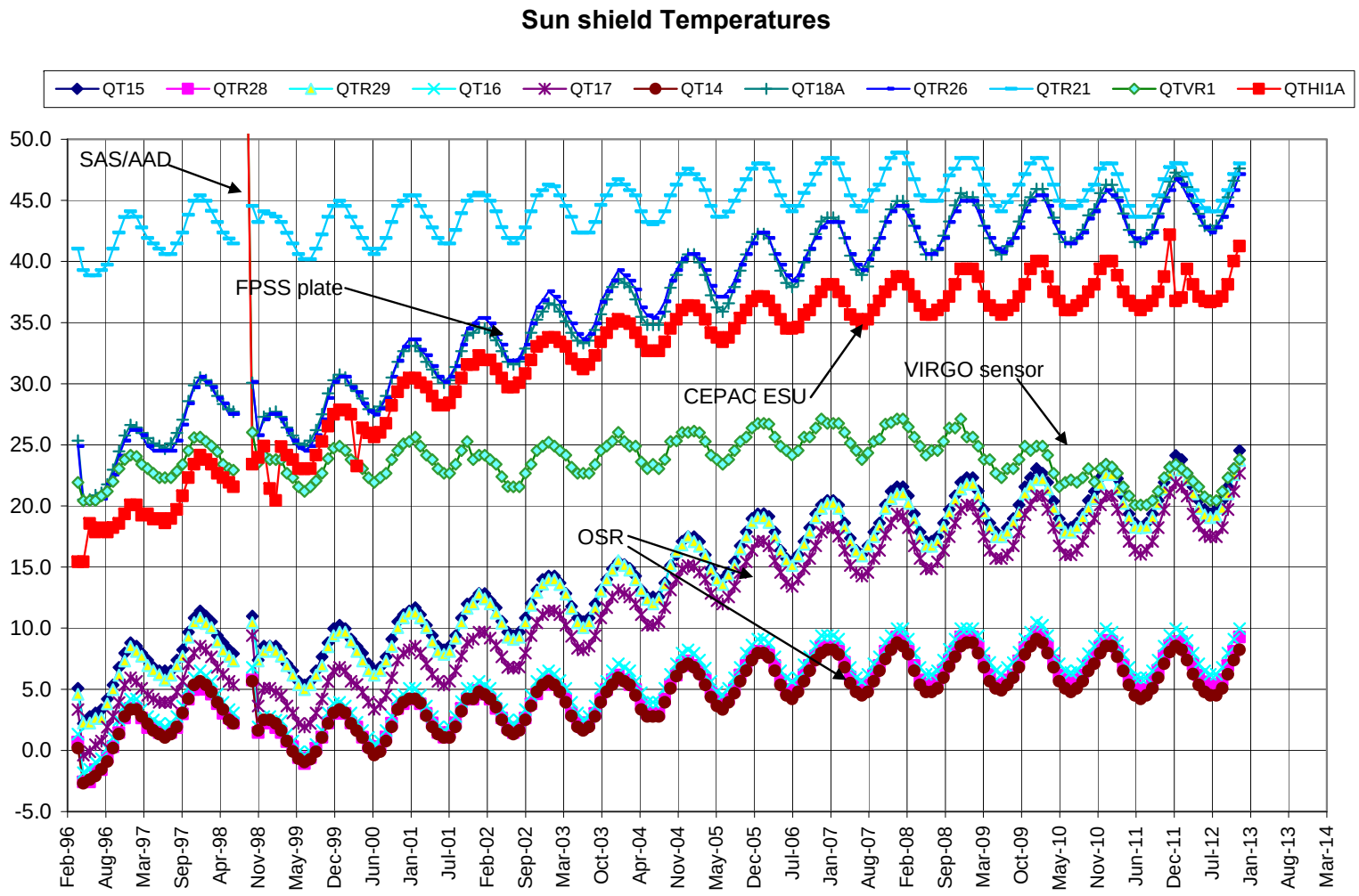
5.4 Propulsion plots

5.4.1 Remaining amount of fuel



5.5 Plots of temperatures

5.5.1 Top panel



5.6 SOHO Event List

Month	Day	Year	1995-12-02	Affected	Day of Year	Flight Day	Time (UTC)	Event
JAN	3	2012		Spacecraft	3	5877		***Beginning of keyhole period for D27***
JAN	5	2012		CEPAC	5	5879		CEPAC ESU switched ON (with new COBS monitorings of HIPWA and QTHI1A)
JAN	6	2012		Spacecraft	6	5880	21:40	Transponder Swap (1->2)
JAN	13	2012		Spacecraft	13	5887	17:25	SK-76: jets 1,2 ; dV -0.007m/s. Wheels at -1435/ -642/ 2004 rpm
JAN	13	2012		Spacecraft	13	5887	18:05	Momentum Management 3 segments (jets 5A, 4A and 2A). Final wheels speeds: -976 / -380 / 2270 rpm
JAN	17	2012		Spacecraft	17	5891	17:49	180° Roll, satellite in 0-degree position. Final wheels speeds: 1914 / 409 / -1407 rpm
JAN	17	2012		Spacecraft	17	5891	20:50	Transponder Swap (2->1)
JAN	20	2012		Spacecraft	20	5894		***End of keyhole period for D27***
MAR	23	2012	2012-03-30	SUMER	83	5957		SUMER campaign
APR	3	2012		Spacecraft	94	5968		***Beginning of keyhole period for D27***
APR	5	2012		Spacecraft	96	5970	15:22	Transponder Swap (1->2)
APR	11	2012		Spacecraft	102	5976	16:20	SK-77: jets 1,2 ; dV -0.015m/s. Wheels at 243/ 873/ -1517rpm
APR	11	2012		Spacecraft	102	5976	17:15	Momentum Management 3 segments (jets 5A, 1A and 4A). Final wheels speeds: 900 / 492 / -880 rpm
APR	11	2012		Spacecraft	102	5976	19:40	180° Roll, satellite in 180-degree position. Final wheels speeds: -395/ -491/ 1383 rpm
APR	11	2012		Spacecraft	102	5976	21:40	Transponder Swap (2->1)
APR	14	2012		Spacecraft	105	5979		***End of keyhole period for D27***
MAY	3	2012		Spacecraft	124	5998	22:25	**ESR-27** triggered by CSPAAD (false trigger)
MAY	8	2012		Spacecraft	129	6003		Roll maneuvers (+10°; -36°and then -57.32°).Roll angle at 180°.
MAY	8	2012		Spacecraft	129	6003	20:34	**ESR-28** triggered by CSPAAD (false trigger) and warm start-up
MAY	9	2012		Spacecraft	130	6004	13:10	Roll maneuvers (+4.2°).Roll angle at 180°.
MAY	9	2012		Spacecraft	130	6004	16:05	**ESR-29** triggered by CSPAAD (false trigger)
MAY	10	2012		Spacecraft	131	6005	18:20	SK-78 (first segment) delta-V -0.3 m/s. Wheels at 1705 / -3693 / 1606 rpm
MAY	10	2012		Spacecraft	131	6005	19:15	SK-78 (second segment, aborted) delta-V -0.13 m/s. Wheels at 1809 / -3913 / 1637 rpm
MAY	10	2012		Spacecraft	131	6005	20:20	Momentum Management 2 segments (jets 4A and 2A). Final wheels speeds: -705 / -855 / 1055 rpm
MAY	10	2012		Spacecraft	131	6005	22:45	SK-78 (third segment) delta-V -0.152 m/s. Wheels at 1364 / -1237 / -558 rpm
MAY	10	2012		Spacecraft	131	6005	23:35	Momentum Management 3 segments (jets 5A, 1A and 4A). Final wheels speeds: 1566 / -1066 / -306 rpm
MAY	11	2012		Spacecraft	132	6006		Spacecraft rolled to 180° angle.
MAY	30	2012		Spacecraft	151	6025	11:56	SK-79 (delta-V -0.33 m/s. Wheels at -703 / -1031 / 1629 rpm
JUN	22	2012		Spacecraft	174	6048	9:06	Spacecraft thermal reconfiguration caused by CDS instrument getting too cold
JUN	28	2012		Spacecraft	180	6054		***Beginning of keyhole period for D27***
JUL	2	2012		Spacecraft	184	6058		Transponder Swap (1->2)
JUL	6	2012		Spacecraft	188	6062	16:50	SK-80: jets 1,2 ; dV -0.024m/s. Wheels at -1526/ -775/ 1422rpm
JUL	6	2012		Spacecraft	188	6062	17:20	Momentum Management 3 segments (jets 5A, 3A and 2A). Final wheels speeds: -1331 / -505 / 1775 rpm
JUL	12	2012		Spacecraft	194	6068	18:05	180° Roll, satellite in 0-degree position. Final wheels speeds: 1317/ 484/ -1885 rpm
JUL	12	2012		Spacecraft	194	6068	21:10	Transponder Swap (2->1)
JUL	17	2012		Spacecraft	199	6073		***End of keyhole period for D27***
SEP	19	2012	2011-09-28	CDS	263	6137		CDS switched back ON
OCT	1	2012		Spacecraft	275	6149		***Beginning of keyhole period for D27***
OCT	3	2012		Spacecraft	277	6151	14:59	Transponder Swap (1->2)
OCT	9	2012		Spacecraft	283	6157	17:40	SK-81: jets 1A/2A; dV -0.0627m/s. Wheels at 405 / 372 / -1425 rpm
OCT	9	2012		Spacecraft	283	6157	18:15	Momentum Management 3 segments (jets 5A, 4A and 2A). Final wheels speeds: 1209 / 406 / -799 rpm
OCT	9	2012		Spacecraft	283	6157	19:52	+180° Roll, satellite in 180-degree position. Final wheels speeds: -396 / -405 / 1605 rpm
OCT	9	2012		Spacecraft	283	6157	23:00	Transponder Swap (2->1)
OCT	12	2012		Spacecraft	286	6160		***End of keyhole period for D27***

5.7 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 April 96 daily average of power parameters for the last day of each month
	P_ESA_MM_1B.xls	Daily value of onboard min/MAX of main bus current since Nov 2008
DHSS	DHS Trend Long.xls	Since April 96 daily average of DHSS parameters for the last day of each month
	SEF Overall.xls	Daily rate of Single Event Failure on the Solid State Recorder (since launch)
	Tape Recorder.xls	Tape recorder parameters (when used)
RF	RF Trend Long_NEW.xls	With the automation, measurements not input anymore by console operator. This file is not maintained, its content has been included in RF Trend Long_fromITPS.xls
	RF Trend Long_fromITPS.xls	Uses ITPS to automatically get ground stations measurements for RF trending. Previous values since launch are also recorded in this file.
AOCS and Propulsion	Wheels Friction Long.xls	Wheel speeds and torques (daily average) + estimation of external disturbance torques since April 96
	Wheels Spikes.xls	Listing of all the spikes on Wheel speeds TM (follow up on the wheel speed TM anomaly).
	AOCS HK PVT Analysis.xls	AOCS housekeeping parameters with also the remaining amount of fuel (PVT analysis) and the SSU background level.
	PROS-thrusterOnTime.xls	Branch A thrusters firing times since launch.
	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
	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 March 2000
Thermal	Temp SVM.xls	SVM temperatures since April 96
	Temp PLM.xls	PLM temperatures since April 96

6 Distribution List

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