

SOHO Mission Update

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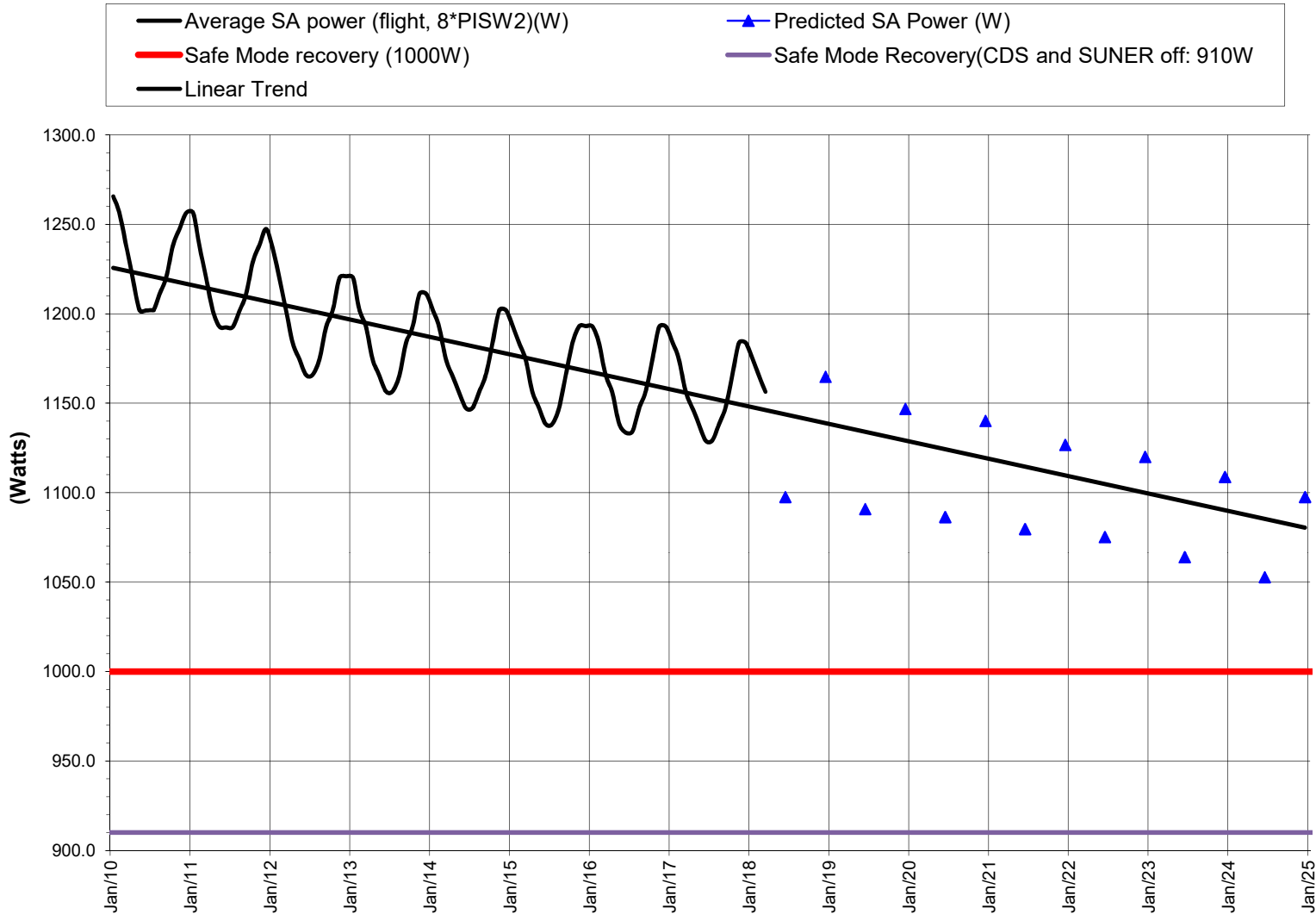
- Spacecraft status
- Payload status
- Ground system status
- System maintainability and funding
- Summary

- Spacecraft and instruments are “nominal” and there are no known technical limitations which should prevent SOHO from operating for several more years
- Solar array degradation study performed at NASA/GSFC in Nov 2017:
 - **Sufficient power reserves until at least end of 2025**
- On 14 November ESA’s Science Programme Committee (SPC) approved another mission extension for SOHO through the end of 2022 (subject to confirmation in 2020).

Sufficient power reserves until at least 2025



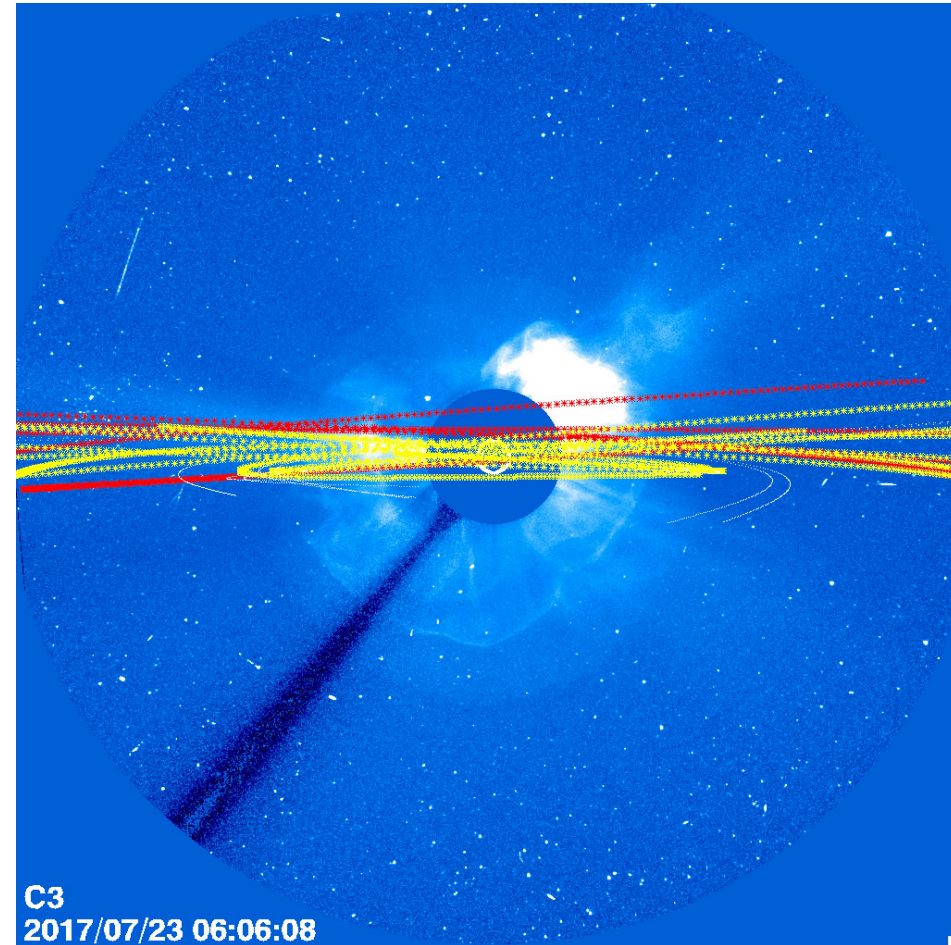
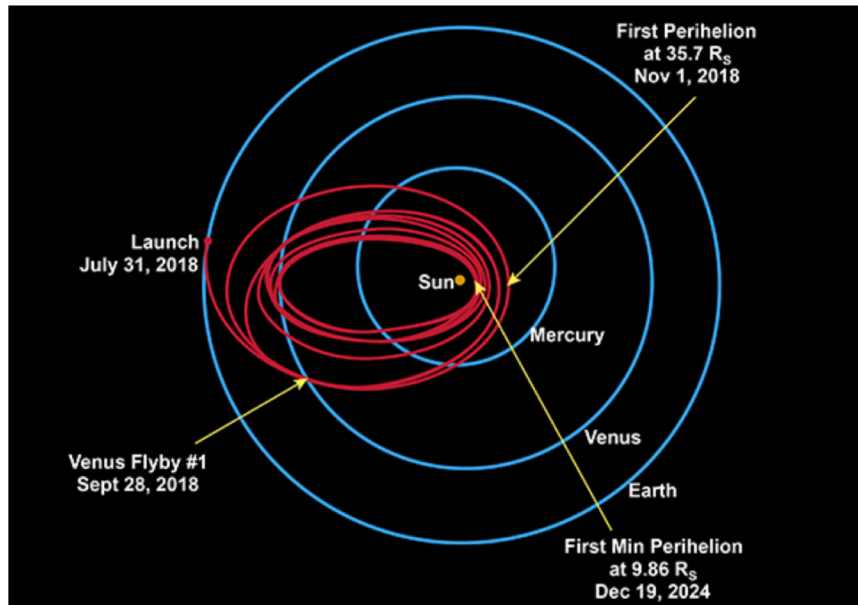
SOHO Solar Arrays Power (W)



- Spacecraft and instruments are “nominal”
- Solar array degradation study performed at NASA/GSFC in Nov 2017:
 - Sufficient power reserves until at least end of 2025
- On 14 November ESA’s Science Programme Committee (SPC) approved another mission extension for SOHO through the end of 2022 (subject to confirmation in 2020).

New science opportunities with Parker Solar Probe

- Parker Solar Probe (PSP) launched on 12 Aug
- PSP will fly through the solar corona down to $10 R_{\odot}$
- LASCO C3 field-of-view extends to $30 R_{\odot}$
- LASCO C3 will be the only remote sensing instrument on Earth-Sun line that will be able to see what structures PSP will fly through



Publications in refereed literature



➤ > 5570 papers total

➤ > 3500 authors

➤ > 250 theses

(lost count)

➤ First authors

- 39% Europe

- 38% US

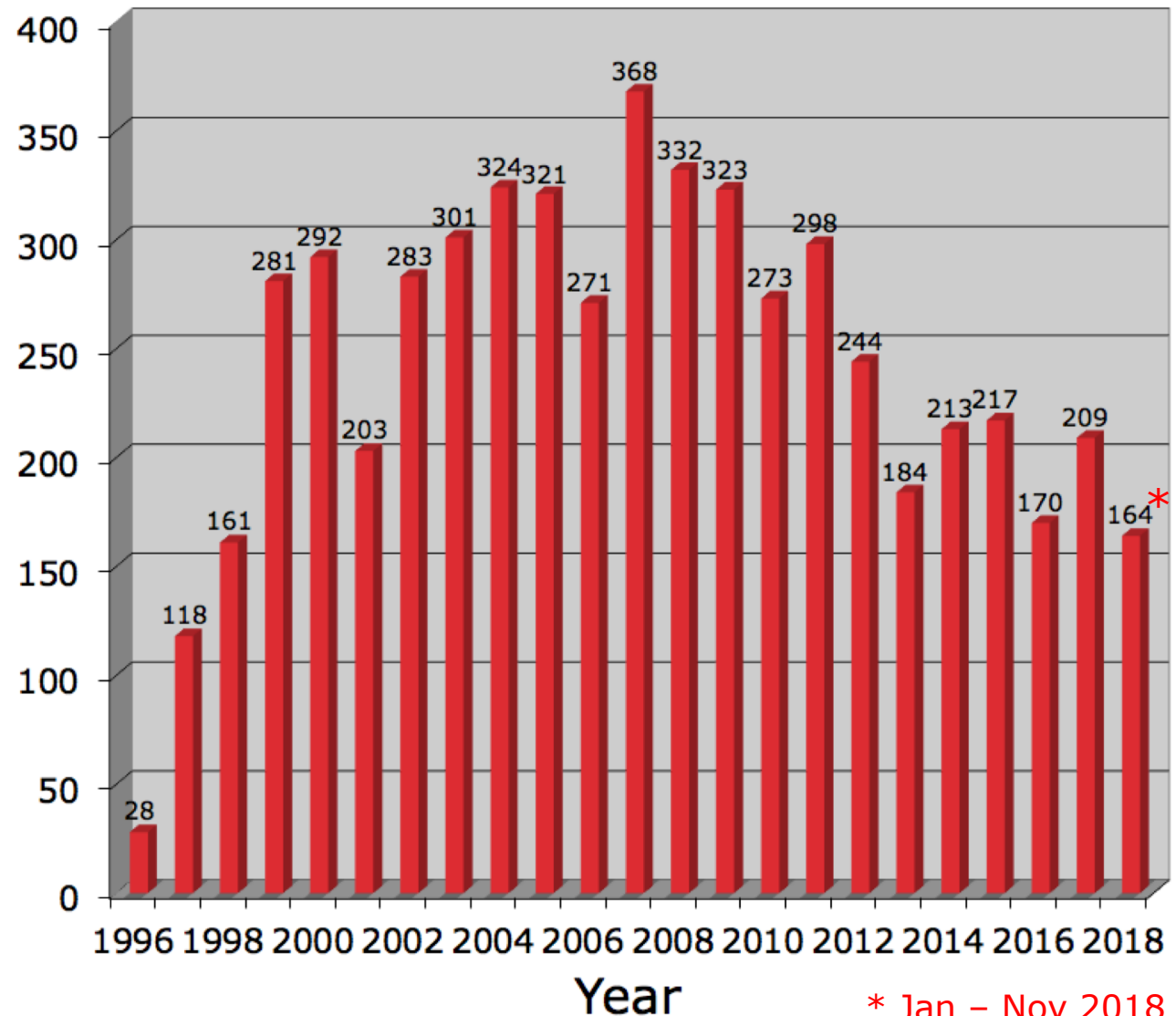
- 8% China

- 4% India

- 4% Russia

- 7% rest of world

(Japan, Korea, Brazil, Argentina, Mexico, ...)

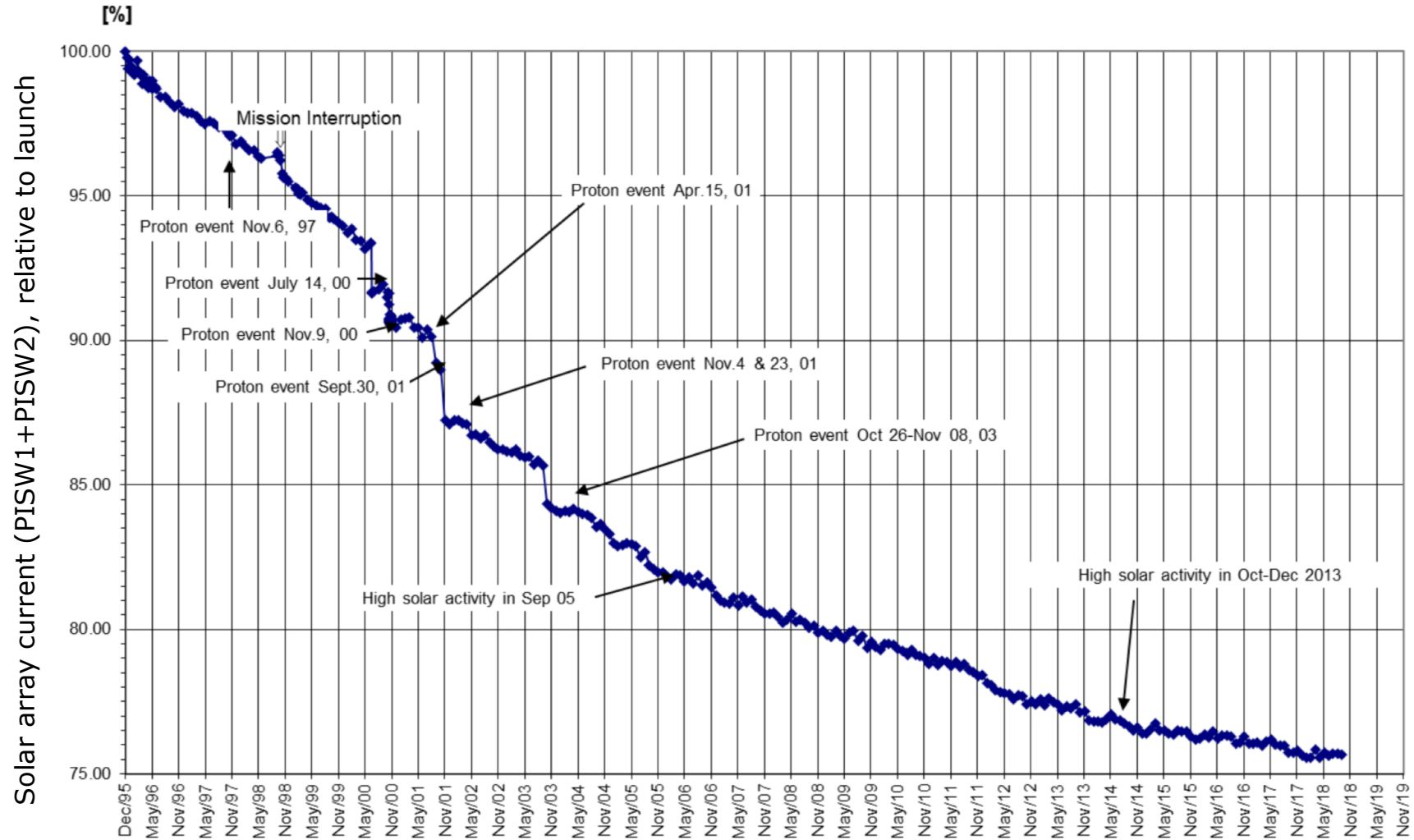


* Jan - Nov 2018

➤ **S/C is healthy and performs within specifications**

- **Hardware Failures (none with significant impact on science)**
 - 1997 April 23: Loss of fast loop of receiver 1 (but still being used in slow sweep mode)
 - 1998 Sep/Dec: Loss of all 3 gyros
 - 2002 March 7: Loss of battery 1 (battery 2 still in trickle charge, but probably low capacity)
 - 2003 May: High gain antenna Z motor stuck (now parked in both axes)
 - causes telemetry "keyholes" every 3 months, but manageable with on-board patch for intermittent recording of selected packets and extra DSN support
 - 2004 April 21: Loss of Fine Sun Pointing Attitude Anomaly Detector (FSPAAD)
 - 2012 May 9: Loss of Coarse Sun Pointing Attitude Anomaly Detector (CSPAAD)
- **Reserves**
 - Remaining fuel: 113 ± 3 kg (usage during last 10 years: ~ 5 kg)
 - Solar array degradation after 274 months (nearly 23 years): 24.35% (equivalent to 1.07% / year; budget was 4% / year)
 - > 150 W power reserves
 - Redundant subsystems

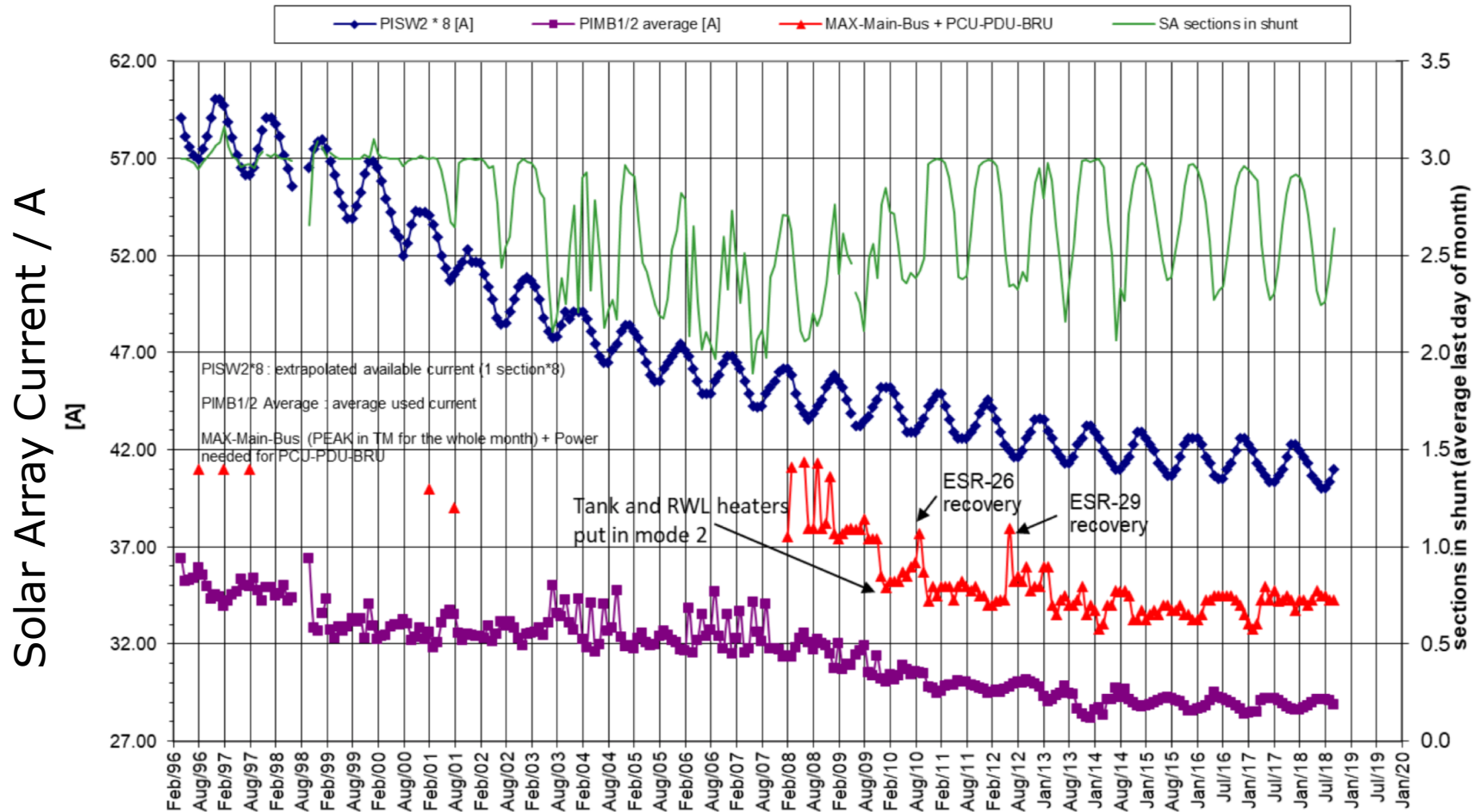
Solar array degradation



Power generation margin



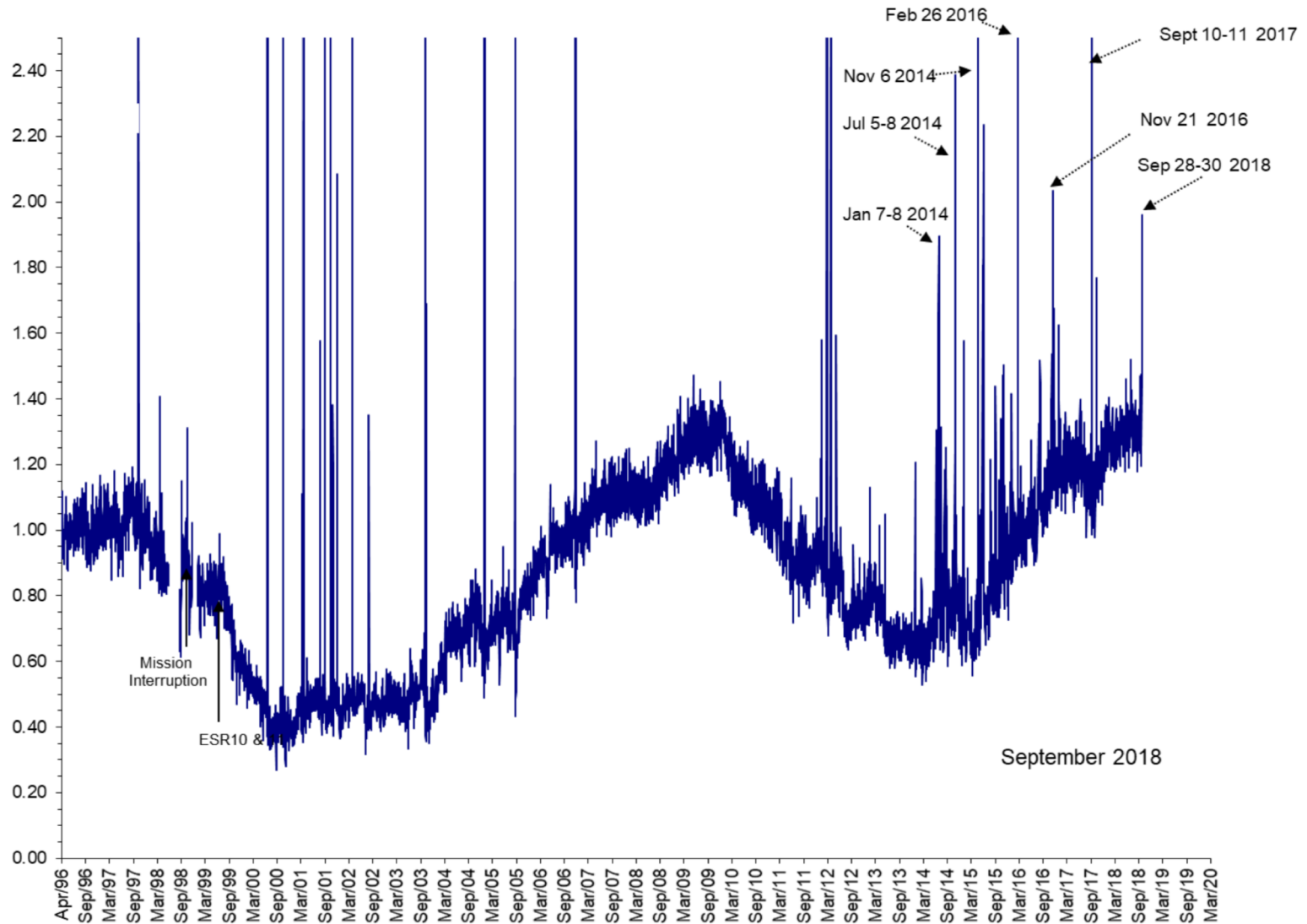
SOHO Power Generation Margin / September 2018



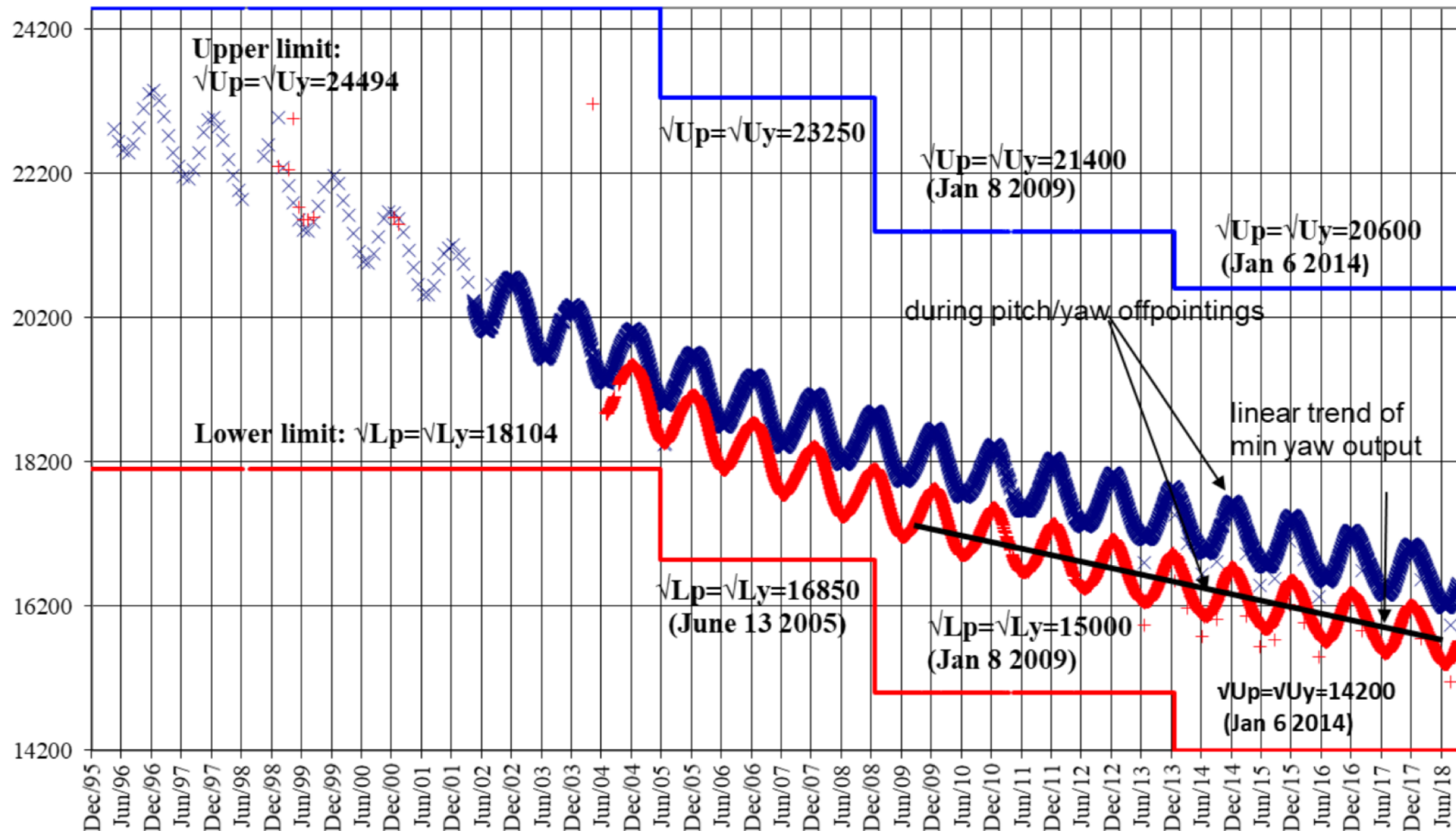
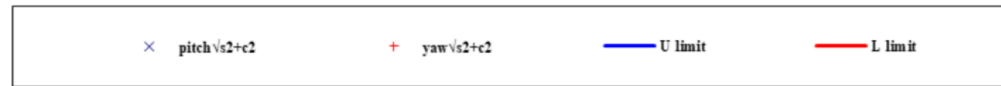
Solid state recorder single event upset rate



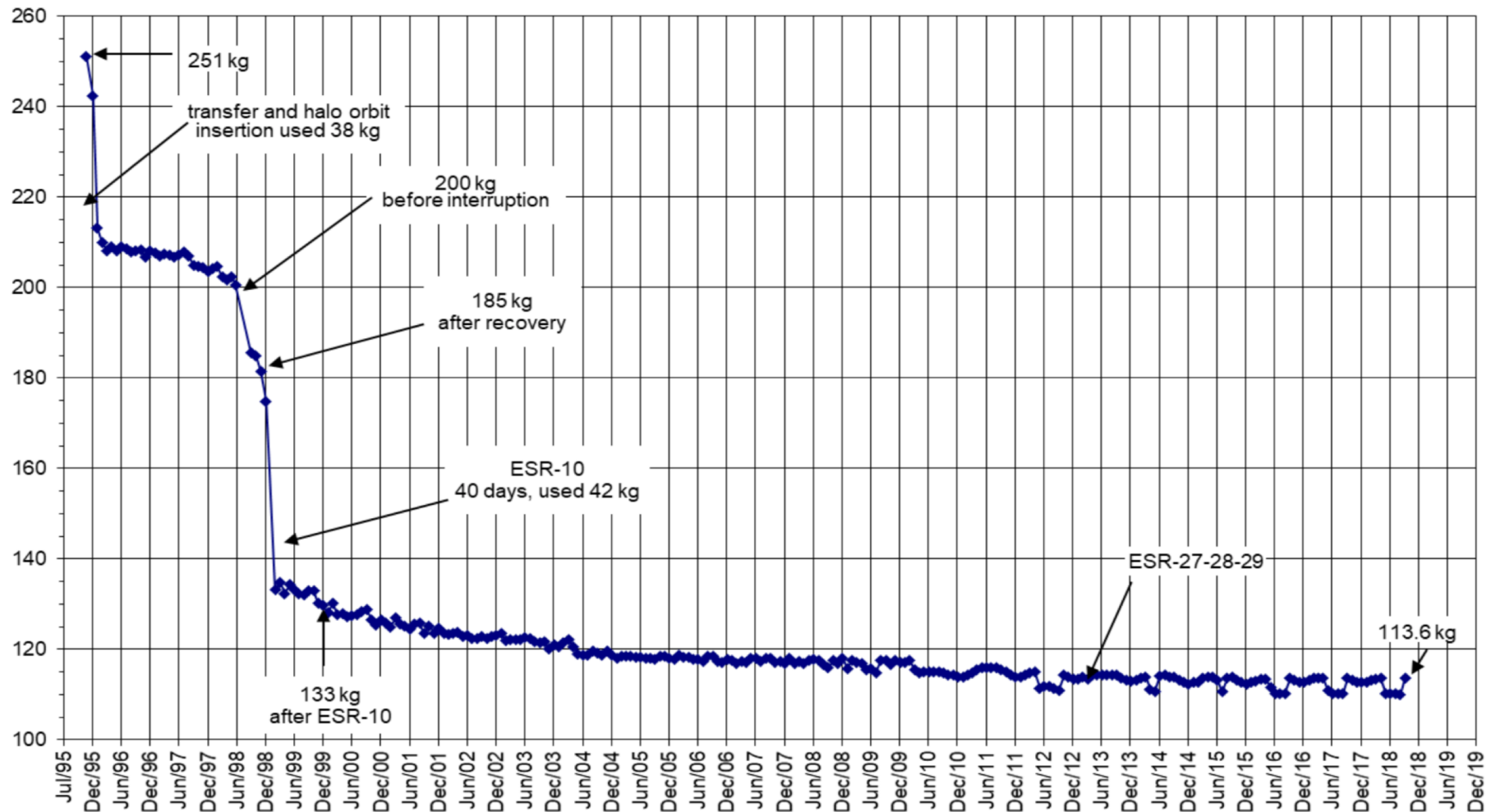
SOHO SSR SEUs with data from (MU3,MB0), parameter DKSSCSEF (events/minutes/2G-bit)



FPSS degradation / September 2018



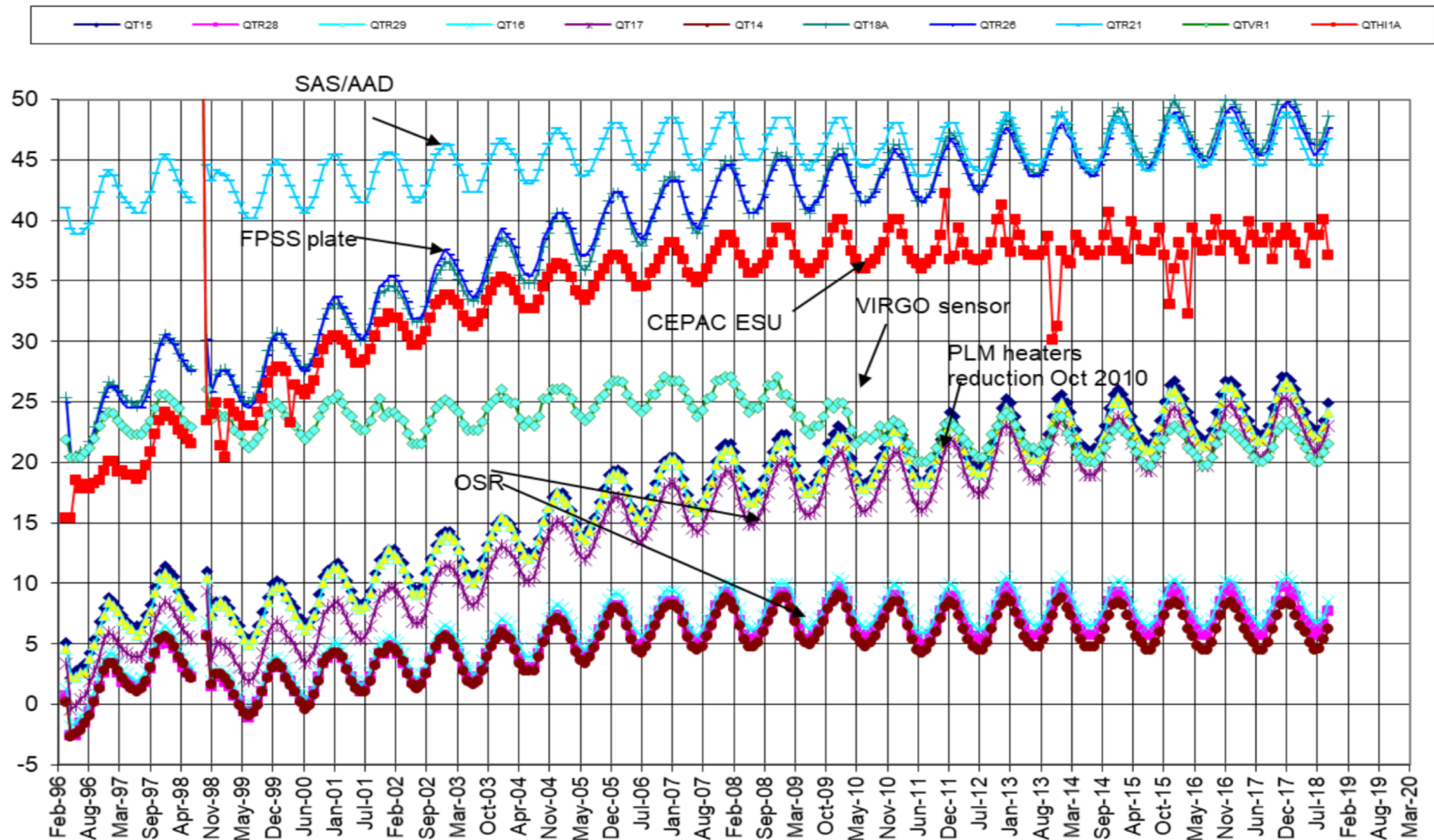
Remaining Fuel (kg) estimated by PVT analysis / September 2018



Top panel temperatures

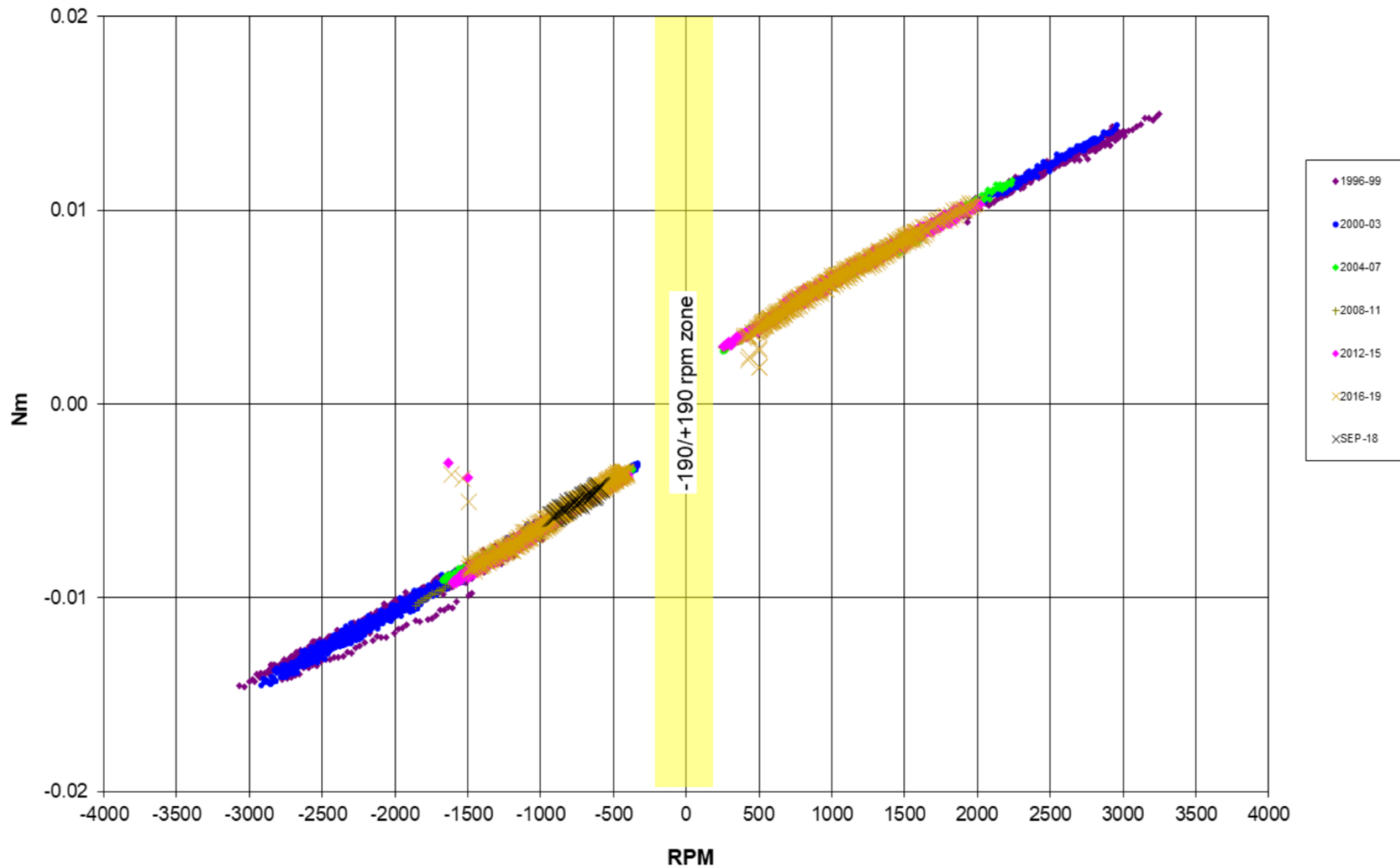


Sun shield Temperatures / September 2018



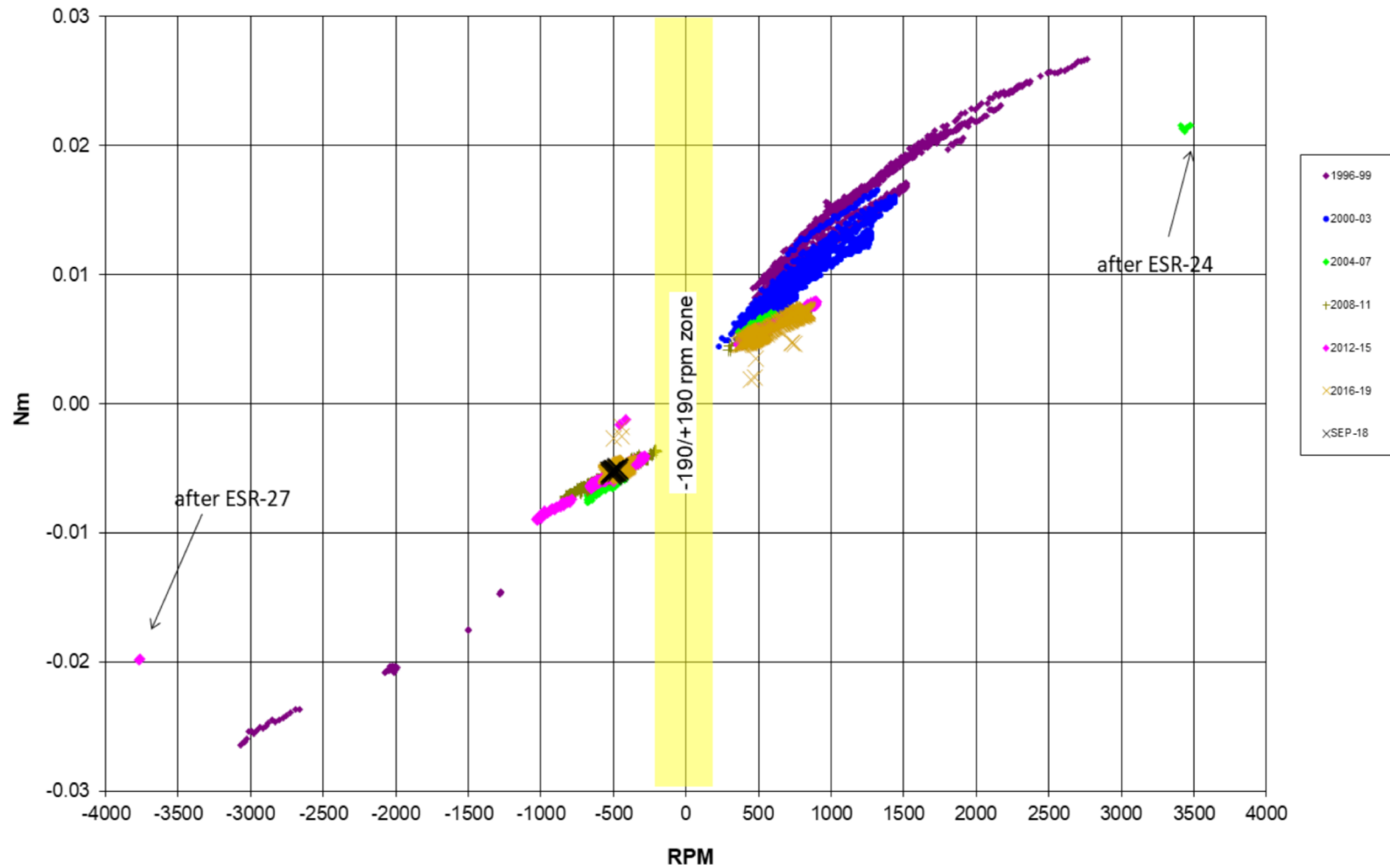
Reaction wheel 1 performance

RW1 "daily average of commanded torque" versus speed



Reaction wheel 2 performance

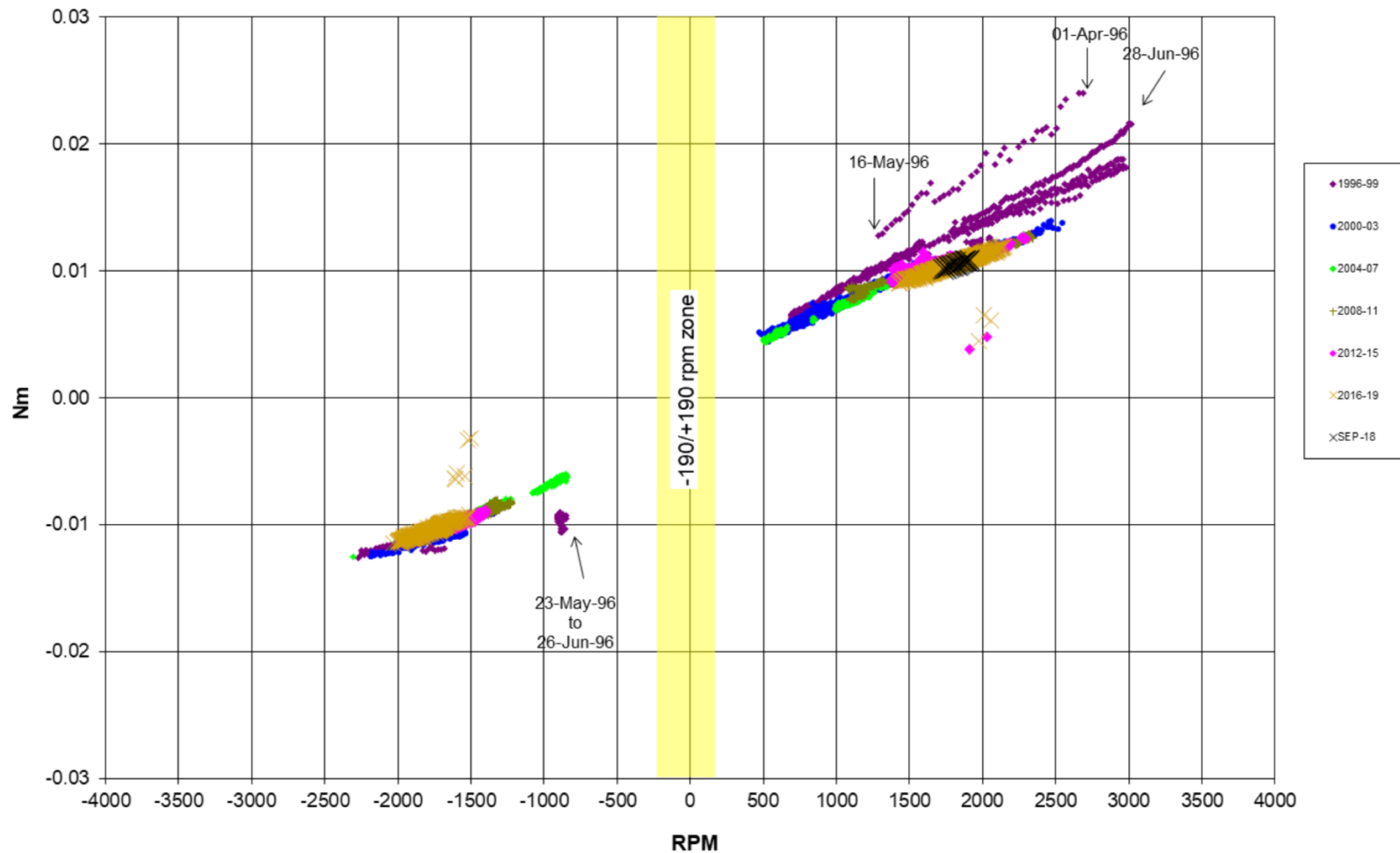
RW2 "daily average of commanded torque" versus speed



Reaction wheel 3 performance



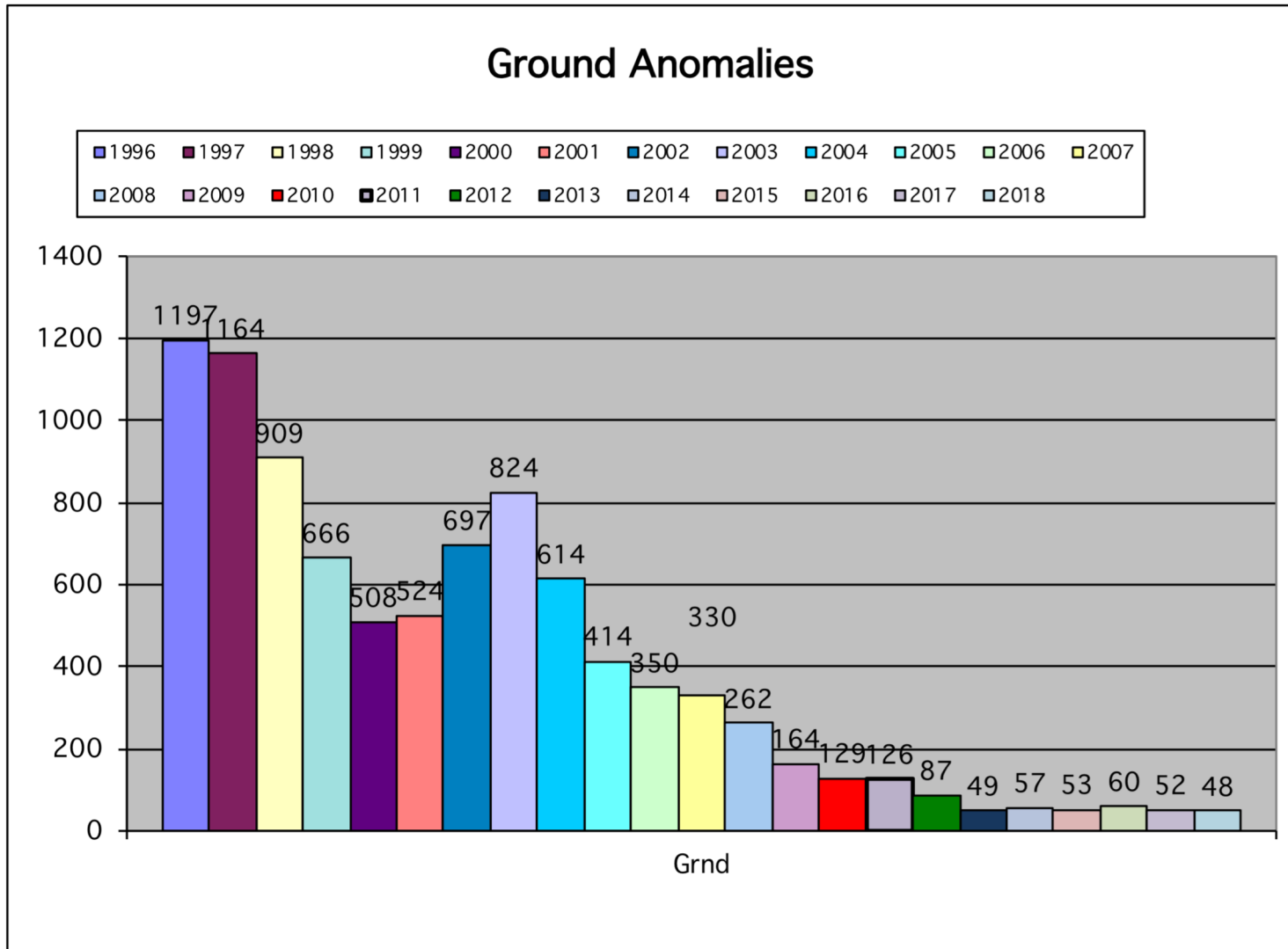
RW3 "daily average of commanded torque" versus speed



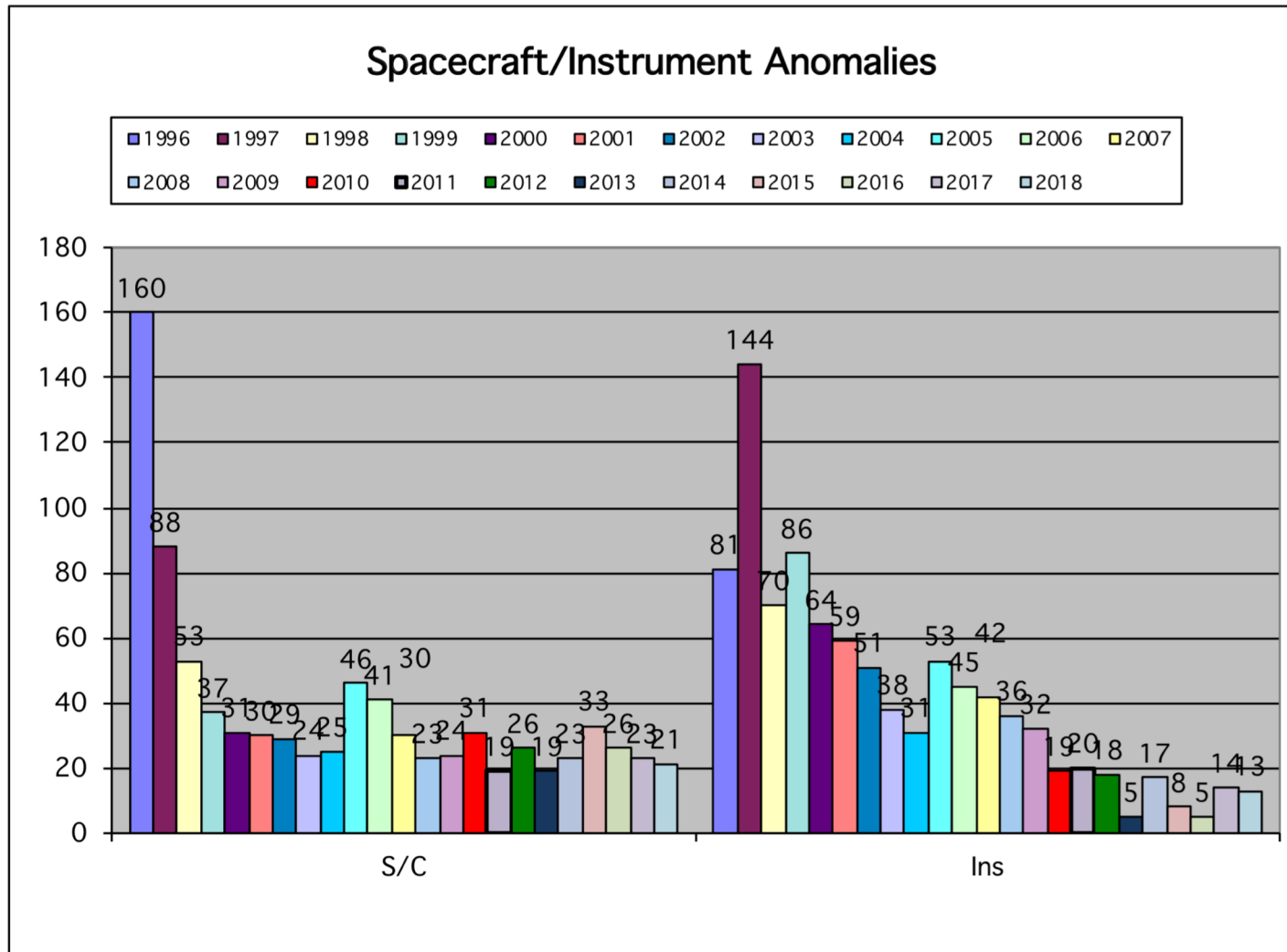
- Spacecraft Status
- **Payload Status**
- Ground System Status
- Mission Operations Changes
- System Maintainability and Funding
- Disposal Strategy
- Summary

- No fundamental changes in the past 4 years:
 - GOLF: nominal
 - VIRGO: nominal
 - MDI: stopped taking science data on 11 April 2011 (but restarted for Mercury transit)
 - SUMER: hibernated on 8 August 2014
 - CDS: hibernated on 5 September 2014
 - EIT: nominal (only taking 2 synoptic sets per day)
 - LASCO:
 - C2 & C3 nominal
 - Very stable: decrease in sensitivity < 0.4% per year
 - C1 lost in 1998 (FPI damaged during deep freeze)
 - UVCS: off since 19 January 2013
 - SWAN: nominal
 - CELIAS
 - MTOF, STOF, SEM nominal
 - CTOF impaired since October 1996 (HV power supply hardware failure)
 - COSTEP
 - EPHIN nominal
 - LION impaired since shortly after launch, with increased noise
 - ERNE: nominal (can only operate one of the 2 detectors during hot season)

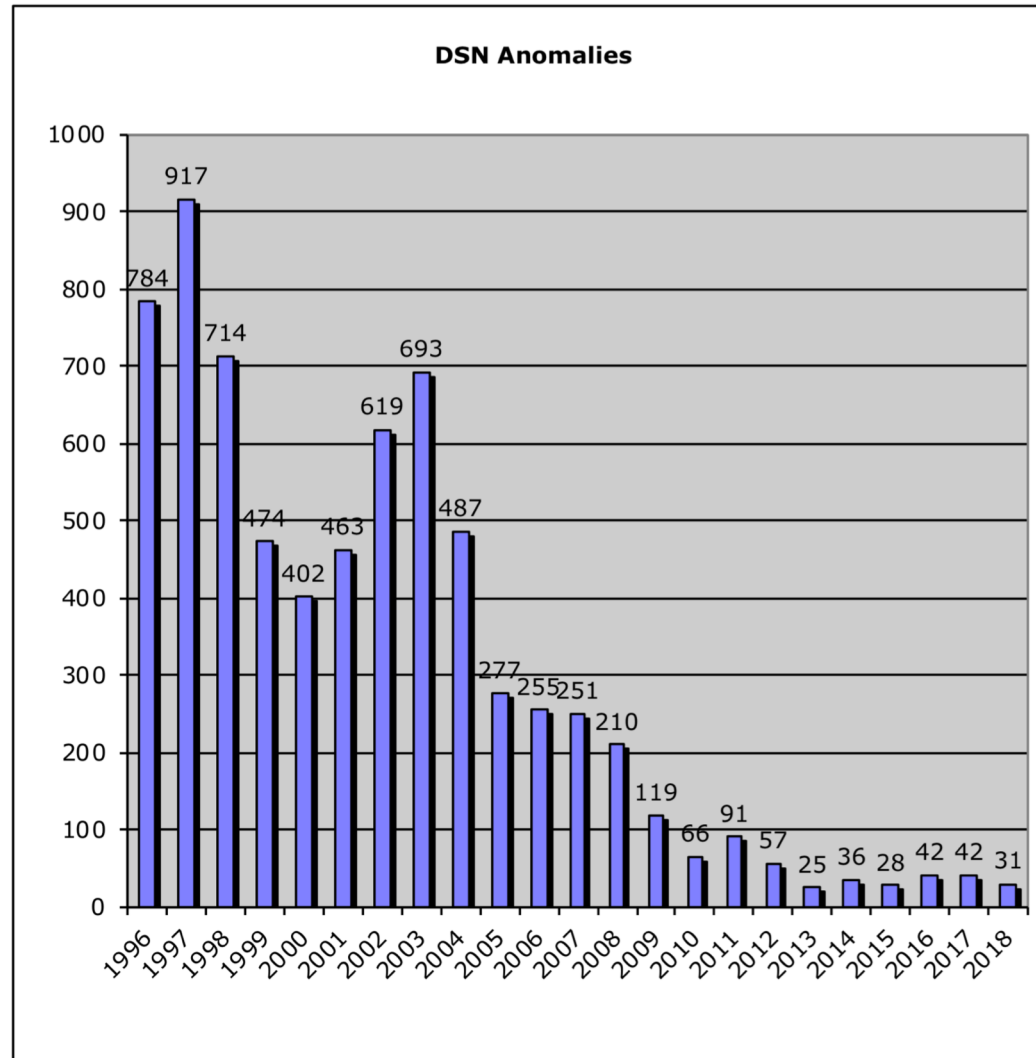
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- Payload Status
- **Ground System Status**
- SOC Science & Instrument Support
- Mission Operations Changes
- System Maintainability and Funding
- Cost
- Disposal Strategy
- Summary



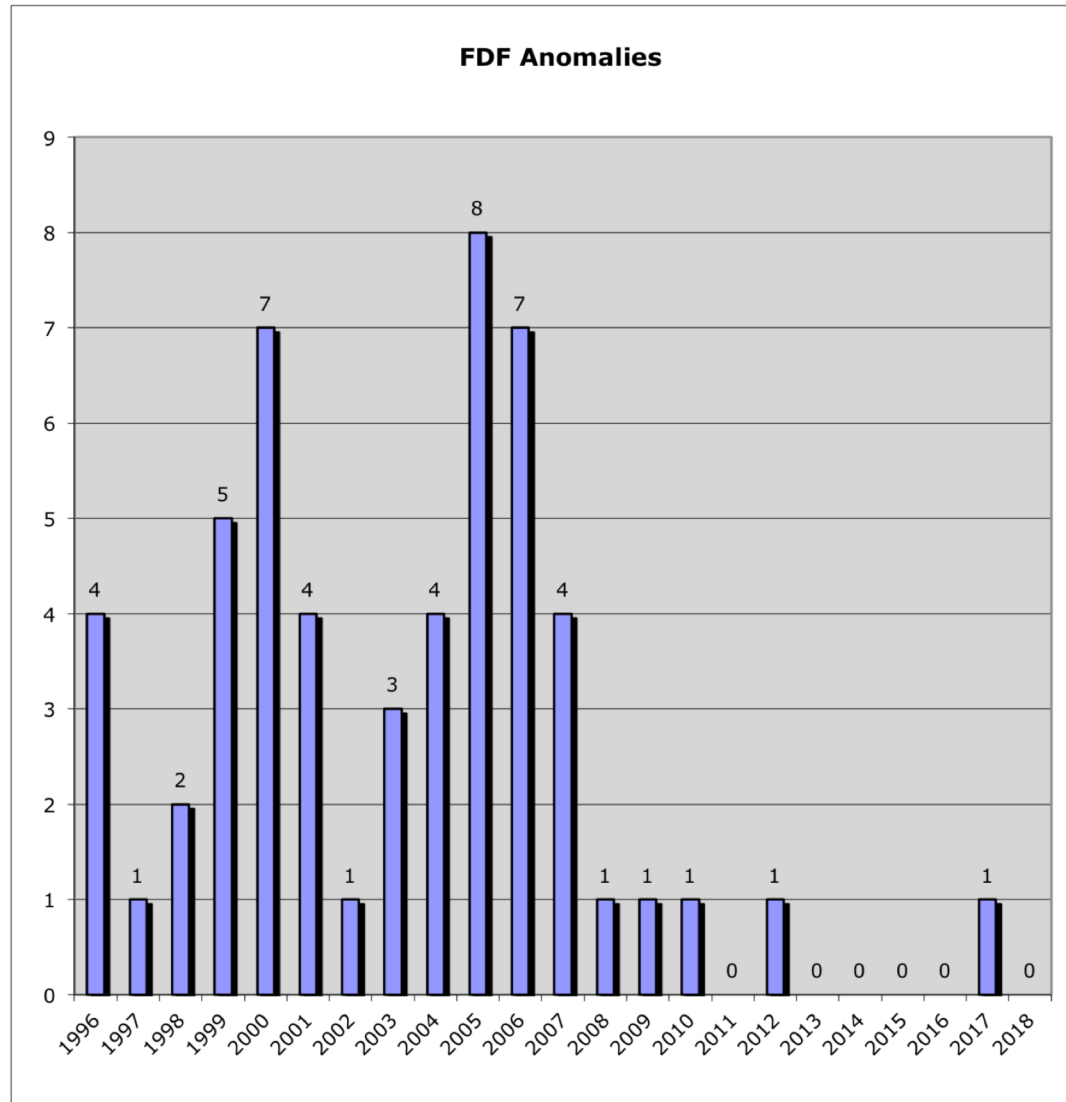
2018 data is projected



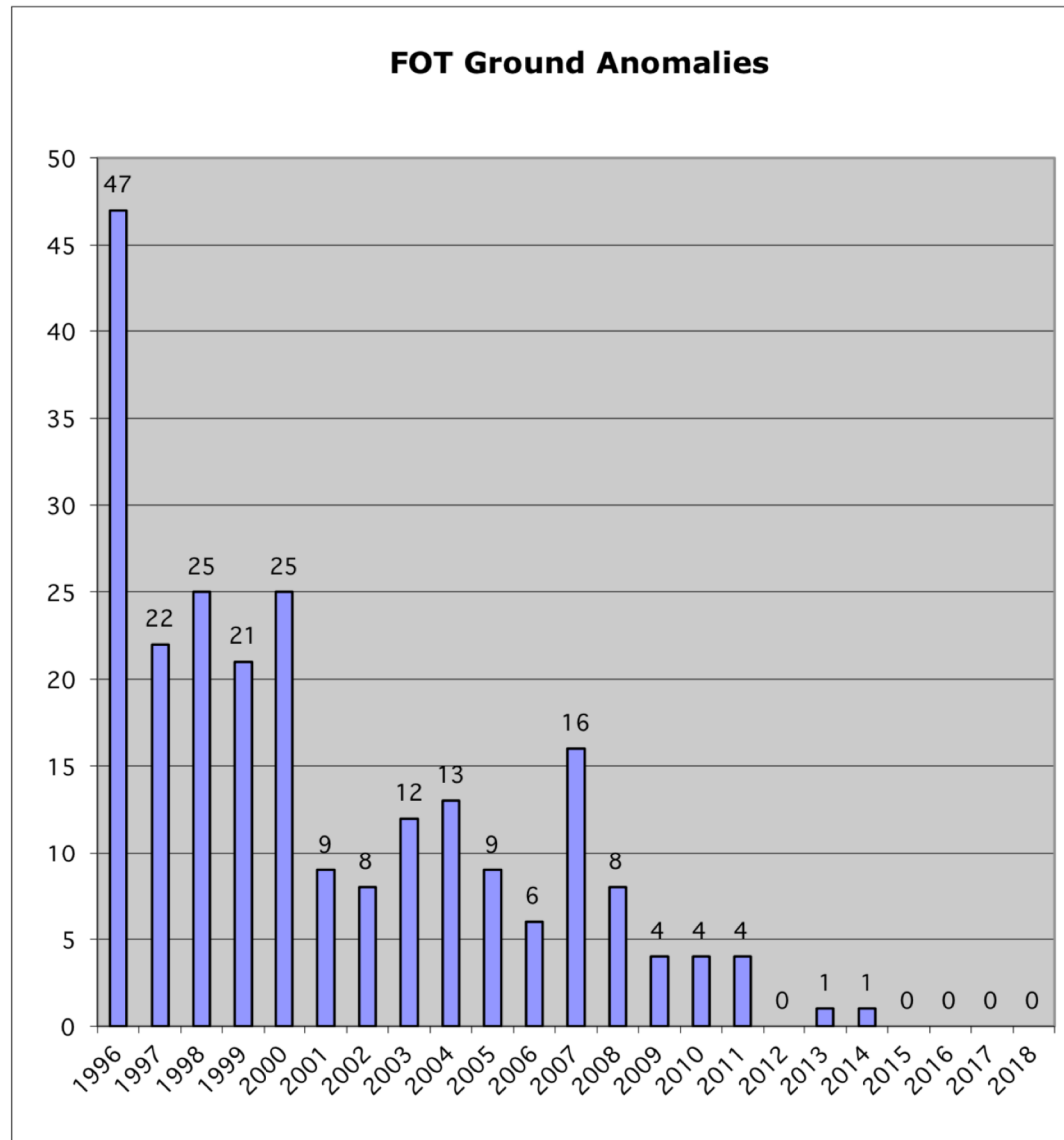
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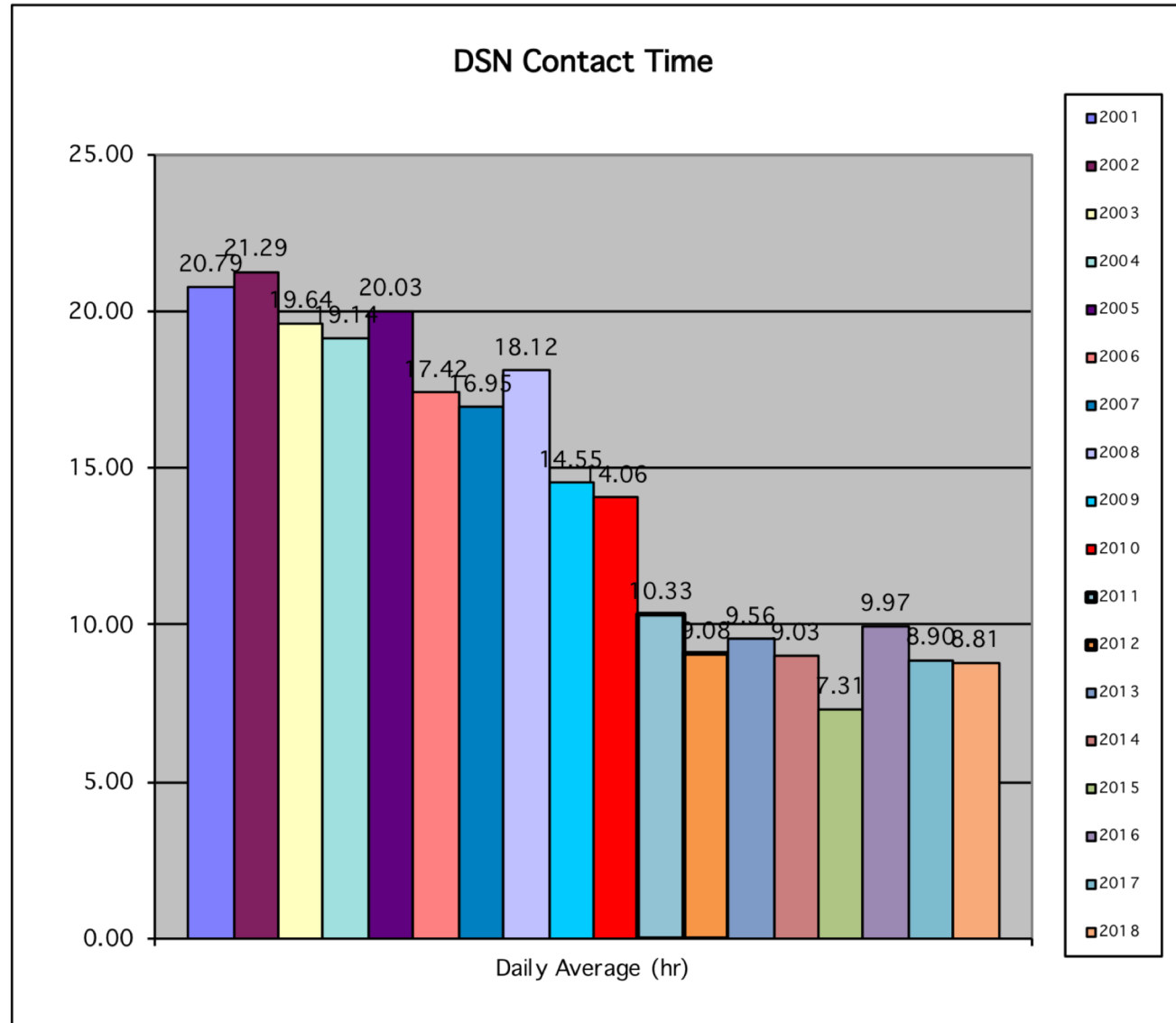


2018 data is projected

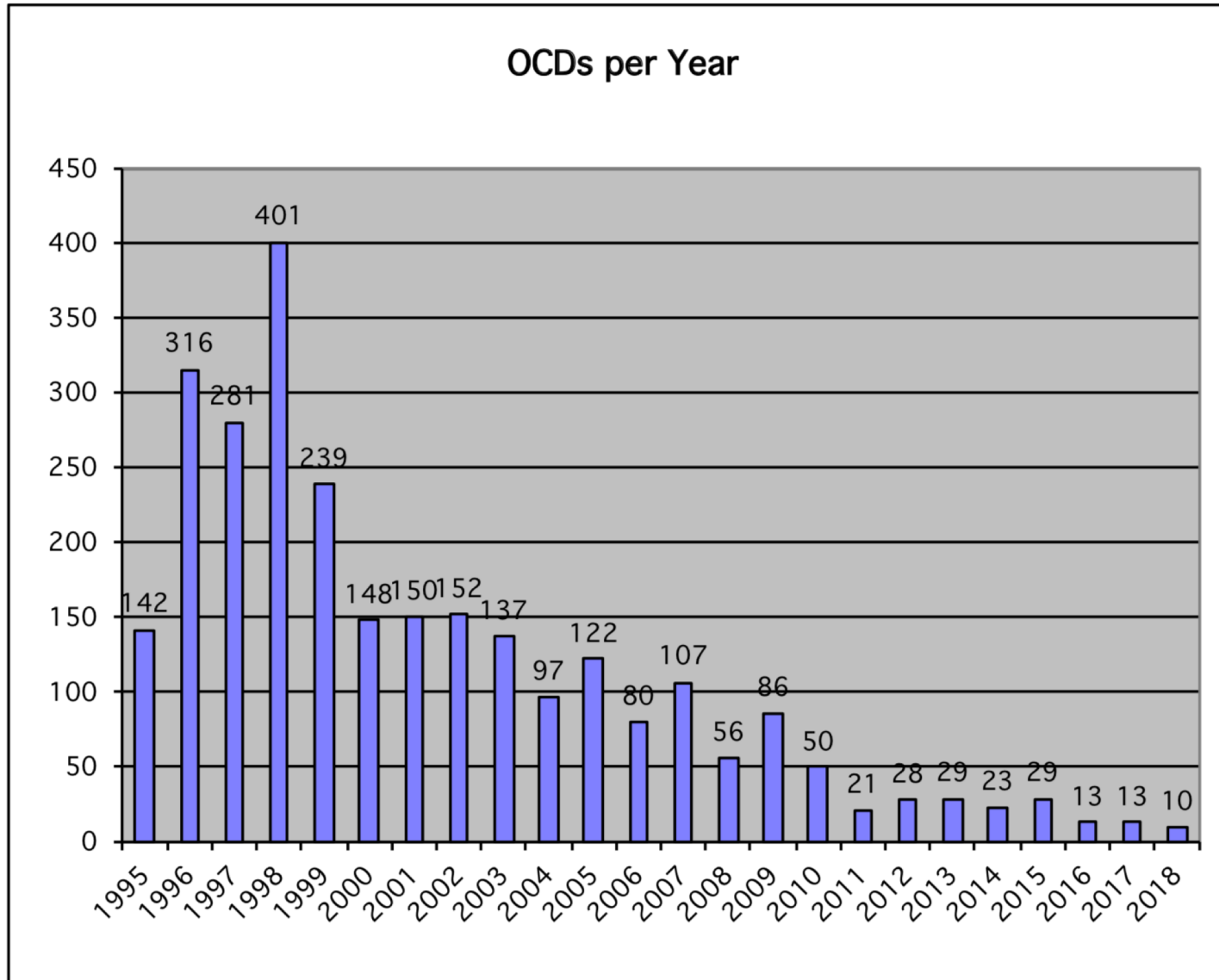


2018 data is projected





Operations Change Directives (OCDs)



- Spacecraft Status
- Payload Status
- Ground System Status
- SOC Science & Instrument Support
- Mission Operations Changes
- **System Maintainability and Funding**
- Cost
- Disposal Strategy
- Summary

- SOHO is a “mature” mission: maintenance of computing infrastructure challenging
- 2010: upgrade of EOF Core System (used for T&C) to Linux (from AIX)
- 2011: upgrade of ESA SOHO server (used, among other tasks, for ancillary data and real-time image generation) to Linux
- 2012: upgrade of ESA SCOS stations from Sun Sparc 10 running Solaris 2.6 to Linux
- 2012: upgrade of Data Processing System (DPS) to Linux
- 2016: upgrade of MOC operational strings (machines used for S/C operations)
- SOHO Simulator
 - running on Sun Sparc under Solaris 2.6
 - keeping several old Sun Sparc workstations as spare
 - however, because of SOHO/LASCO’s critical role in the US space weather architecture, NASA started software port to sustainable platform
- To mitigate risk of aging ops team, NASA also considering move of SOHO MOC into the Virtualized Multi Mission Operations Center (VMMOC)

- SOHO does *not* have to participate in NASA Senior Reviews
 - Recognition of critical importance of LASCO observations “to the Nation’s space weather architecture”
 - SOHO considered “infrastructure” that must be maintained
- Space Weather Research and Forecasting Act
 - Passed US Senate on 2 May 2017:
 - “In order to sustain current space-based observational capabilities, NASA shall:
 - in cooperation with the European Space Agency, maintain operations of the Solar and Heliospheric Observatory/Large Angle and Spectrometric Coronagraph (SOHO/LASCO) for as long as it continues to deliver quality observations, and
 - prioritize the reception of LASCO data.”
- President’s FY19 NASA budget request for SOHO: 2.3 M\$ FY19 - FY23

<https://www.congress.gov/bill/115th-congress/senate-bill/141>

- Biennial mission extension review for all ESA missions
- 2+2 cycle:
 - Next 2 years (in this case 2019-2020) confirmation
 - Additional 2 years extension (in this case 2021-2022)
- 3 parts:
 - Technical: Mission Extension Operations Review (MEOR): 5-6 June
 - Proposal to ESA's advisory structure (SSEWG, AWG, SSAC): early Sept.
 - Presentation to ESA's advisory structure: 10 October
- Positive recommendations by Working Groups and SSAC
- Science Programme Committee (SPC) approval (unanimous): 14 Nov
 - Confirmation of 2019-2020 extension
 - New extension 2021-2022 (subject to confirmation in 2020)

- Spacecraft and instruments are healthy
- There are no known technical limitations which should prevent SOHO from operating through the end of 2022
- Funding at ESA and NASA secured for the coming years
- SOHO scientifically still very productive and will continue to make unique and critically important contributions to the “Heliophysics System Observatory”