

# SOHO spacecraft operations

Spacecraft status

Keyholes operations

Solid State Recorder Single Events Upsets

Conclusion

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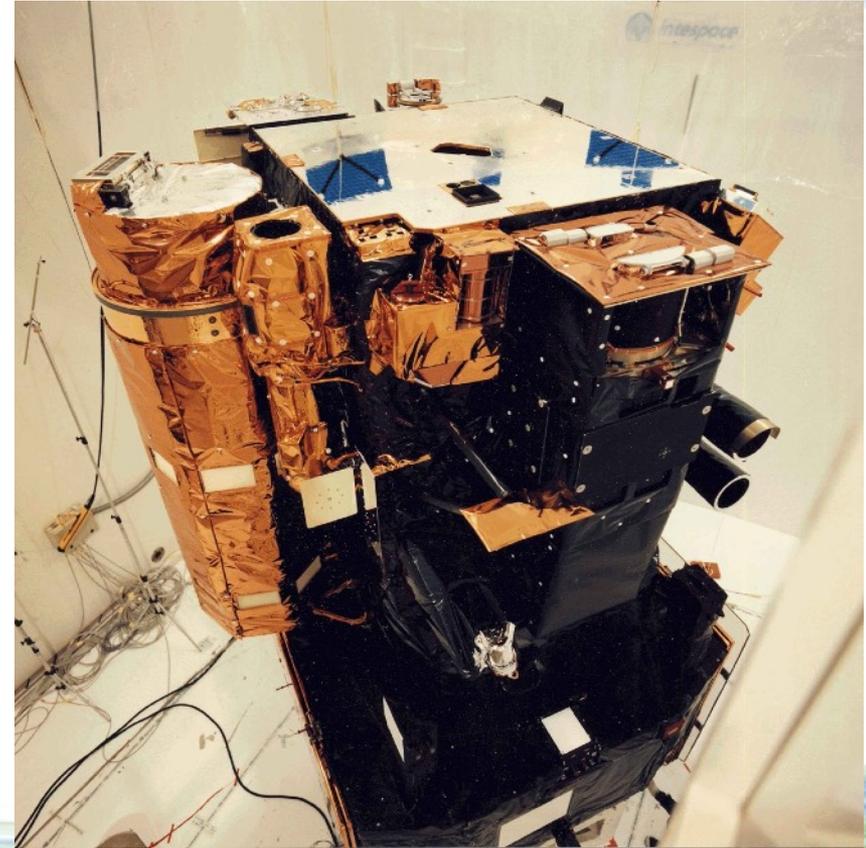
# SOHO : spacecraft status in October 2025

## Service Module:

- Solar Array degradation: 26.4% (less than 0.9% per year)
- Using all nominal equipment for gyroless operations
- Remaining fuel : 111 kgs
- S-band receiver 1 has to be swept slowly to lock on uplink RF signal
- 3 gyros declared failed in 1998; battery 1 disconnected in 2002;
- Sun pointing anomaly detectors failed (replaced by onboard SW monitorings)
- HGA antenna Z motor stuck in 2003 => keyholes operations.

## Instruments:

- CTOF, UVCS, SUMER and CDS have been switched OFF
- VIRGO uses its redundant power supply
- LASCO is crucial for space weather predictions



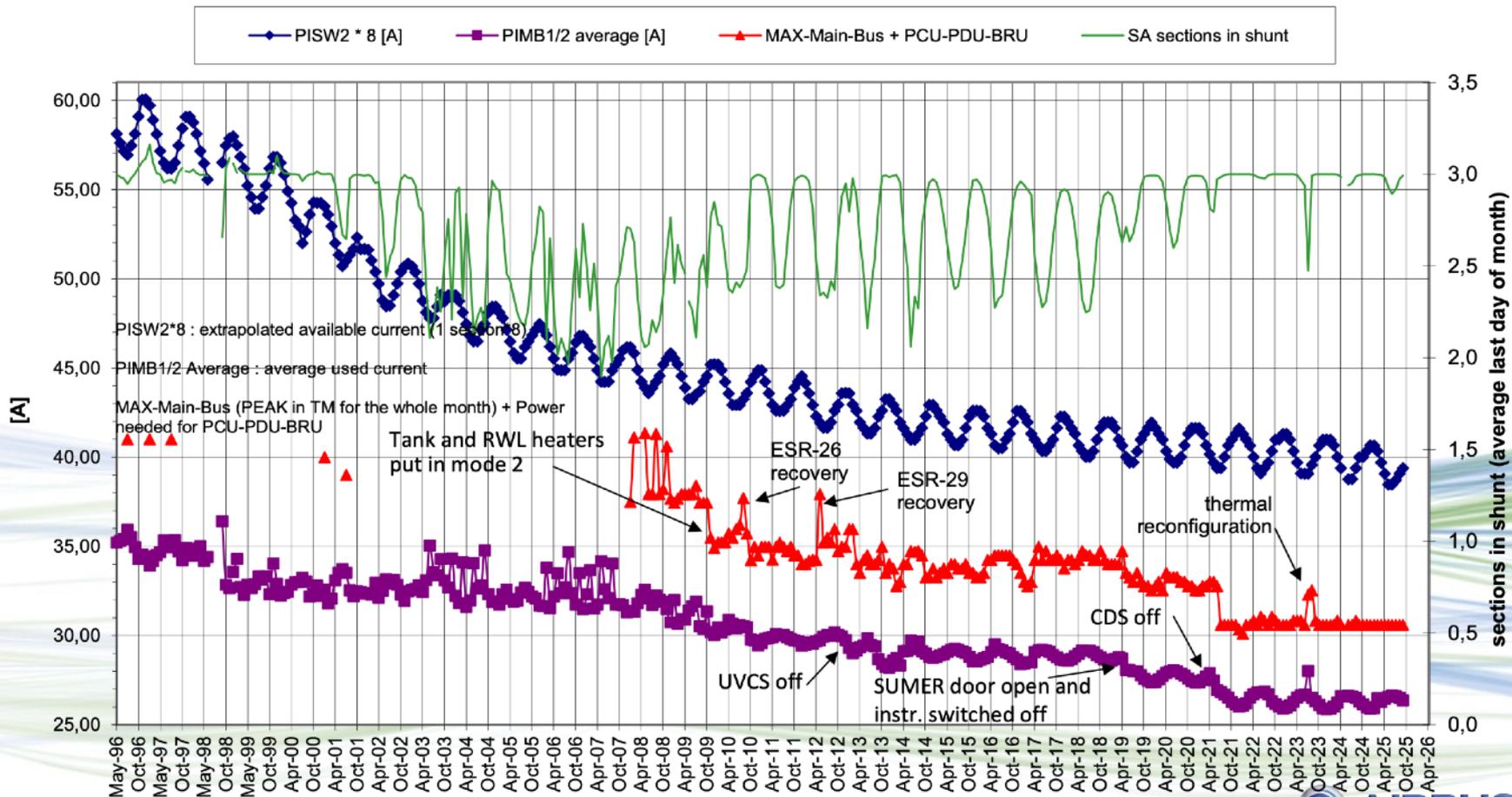
# SOHO: Power margin

## Changes in Payload configuration:

-Instruments switched OFF and substitution heater reduced to 0% for optical parts (UVCS, SUMER and CDS). SUMER door is OPEN.

-Payload heating power reduced

### SOHO Power Generation Margin



# SOHO: HGA pointing anomaly

## Chronology:

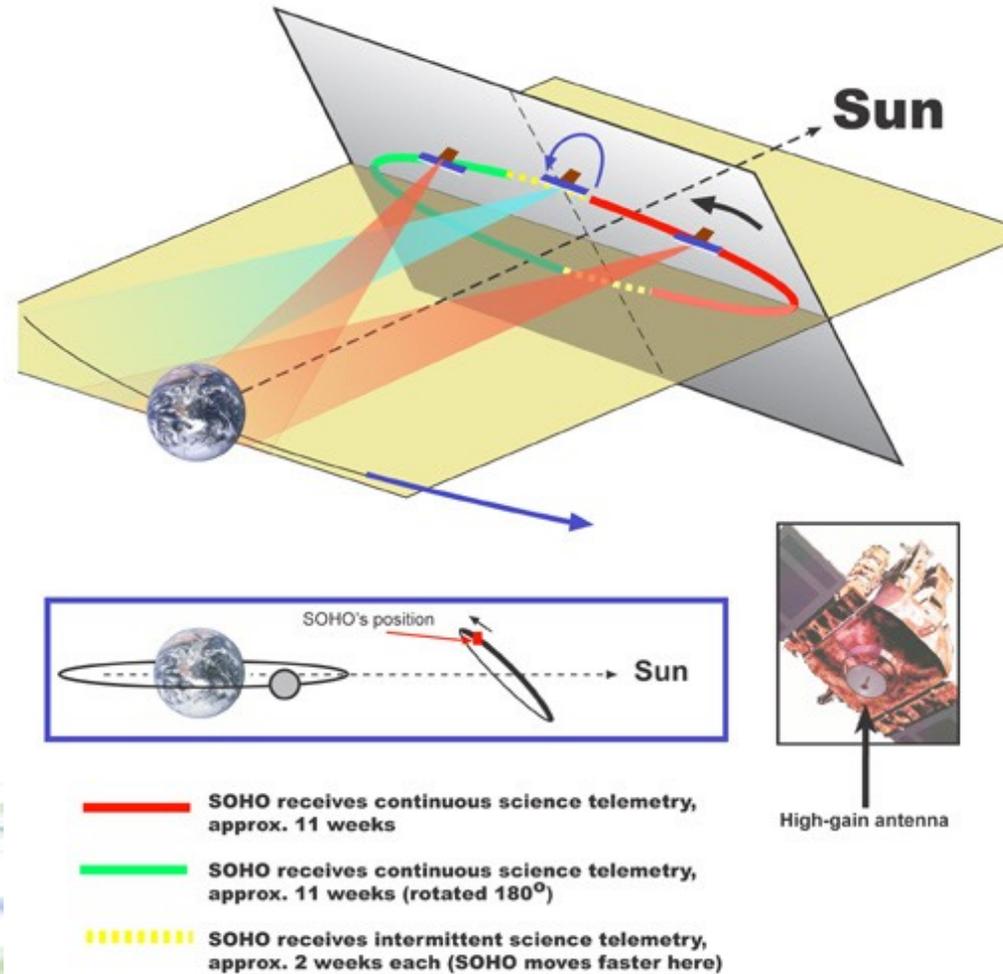
-5 Mai 2003: HGA stuck on E-W axis,

## Solutions :

-HGA parked half way on E-W axis (-15.2 degrees) and at 0 degree on N-S axis

-Every 3 months, SOHO S/C is rolled by 180 degrees

-During Keyholes only crucial science data are stored onboard (using CSW intermittent recording capability)



# SOHO: Solid State Recorder (SSR)

## Description:

- 2-Gbit memory stack made of 16 128-Mbit Memory Units (Texas Instrument SMJ44100 Dynamic RAM) using Hamming code single errors are autonomously corrected by scrubbing (each 16-word data is read every 29 minutes)
- Each memory Unit is divided into two 64-Mbit memory bank
- Each memory bank is divided into 128 512-Kbit memory pages (so 256 memory pages per Memory Unit)
- Record data rate 56 Kbit/s . Dump data rate 160 Kbit/s
- Used as a “Tape Recorder” : LIFO

## Observations :

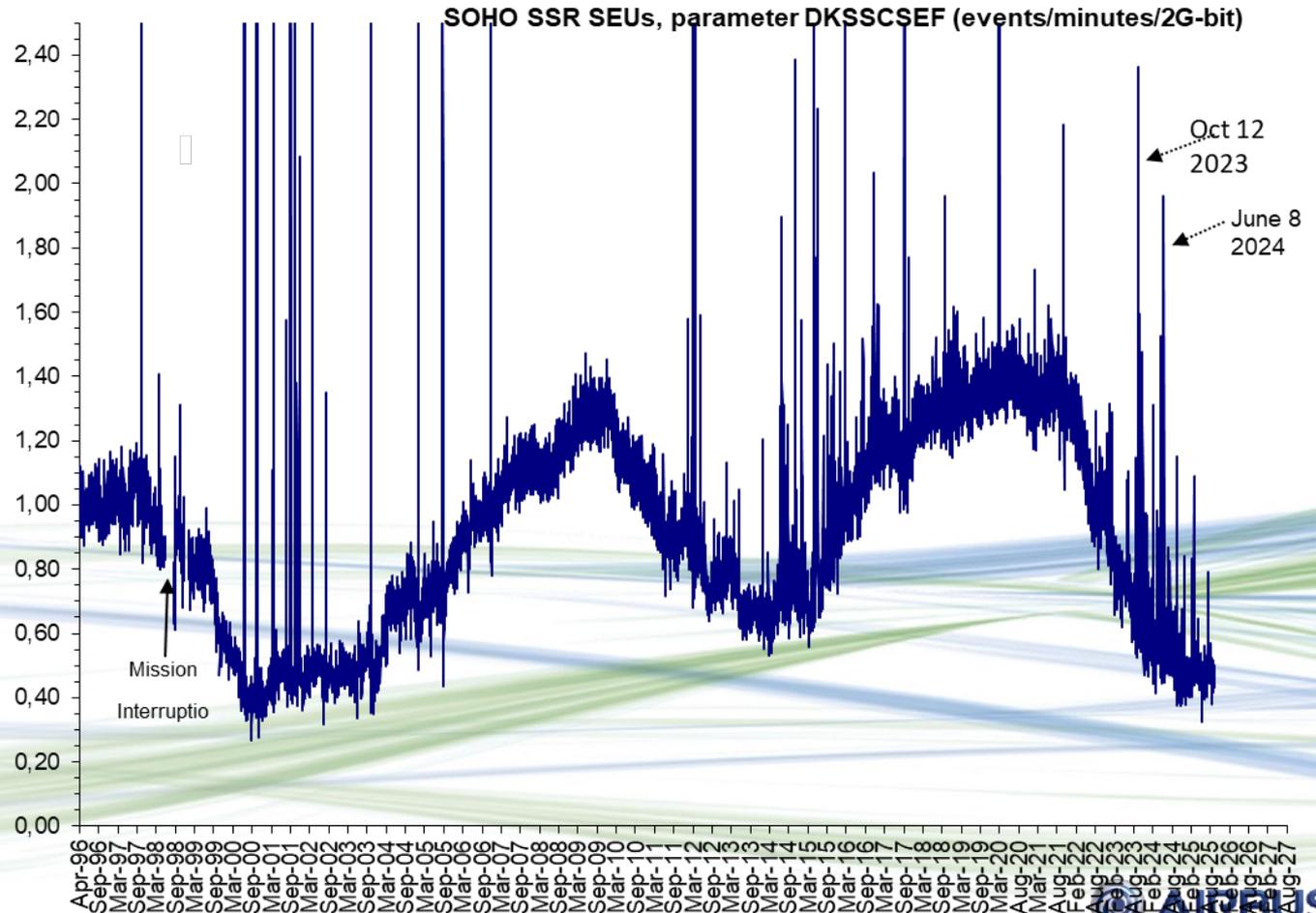
- Counter of number of Single Event Upsets is reported in TM every 15 seconds
- Average between 1.4 and 0.5 SEUs/minute for the whole SSR  
(only 2 double errors since launch (in 2020 and 1997))

# SOHO: Solid State Recorder

## SSR SEUs since launch:

-Solar cycle: the more the sun is active , the less the cosmic rays can penetrate the solar system and therefore the less SEUs are reported in average

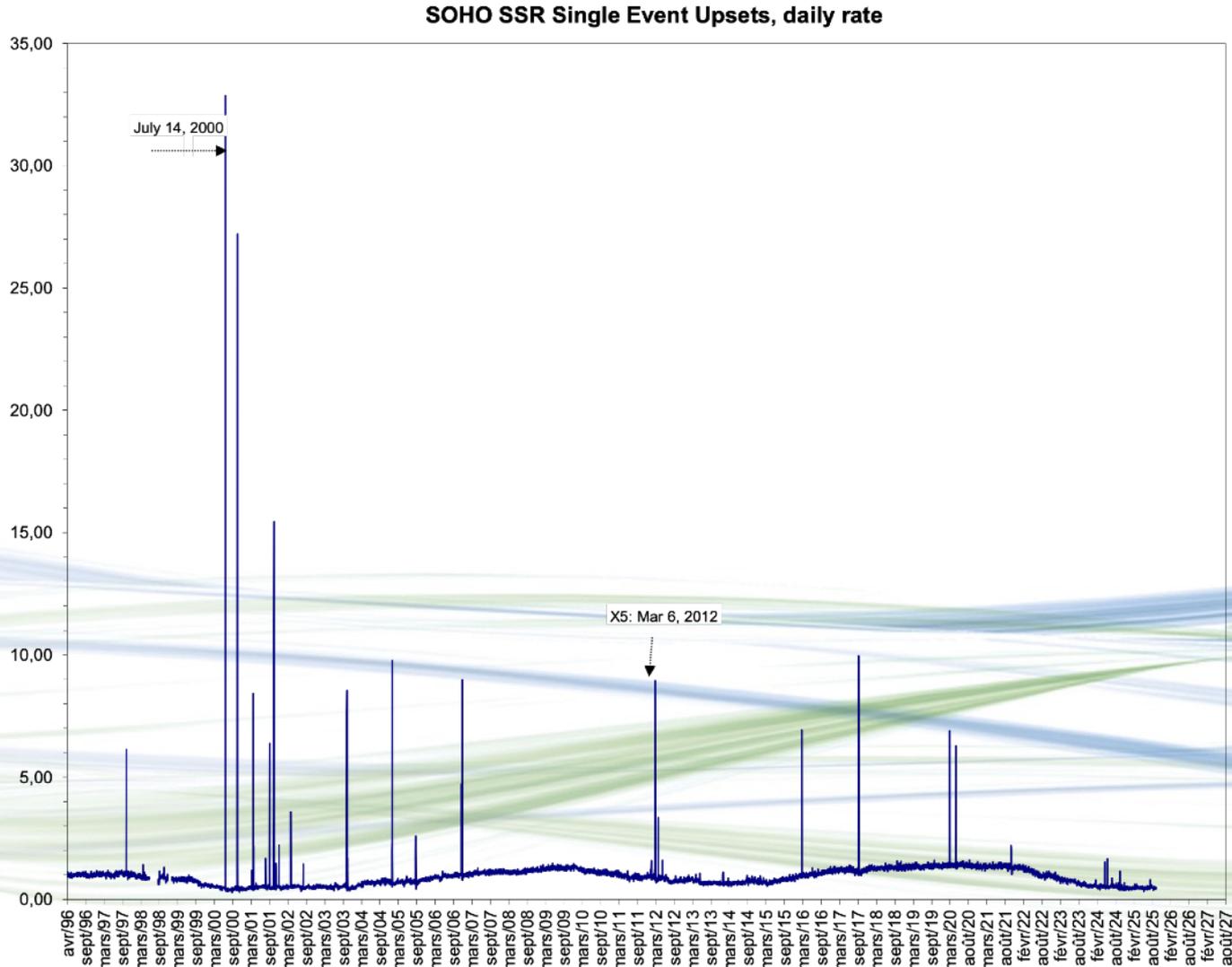
-Solar eruptions



# SOHO: Solid State Recorder

## SSR SEUs during solar storms:

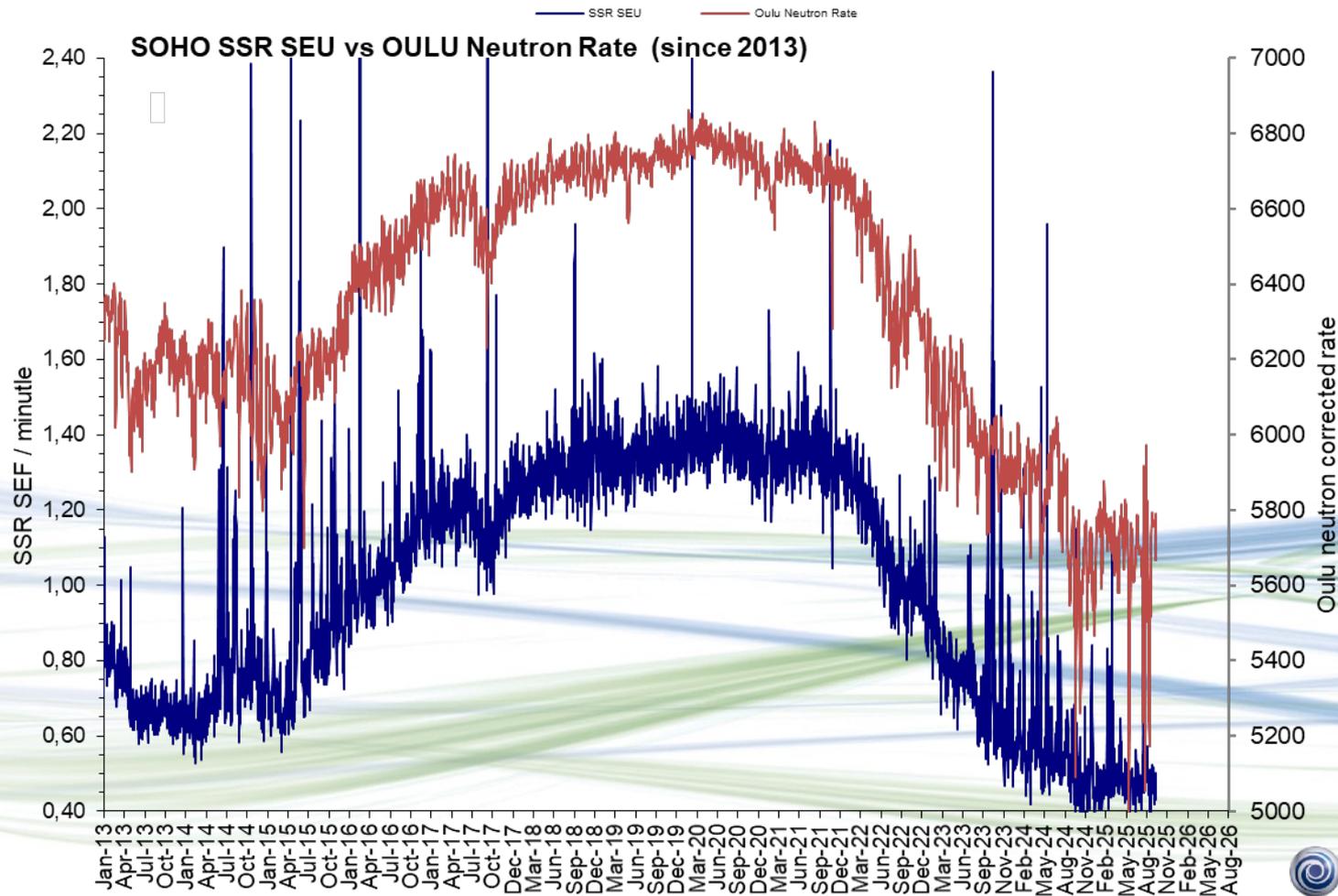
- Solar flares & CMEs do have huge impact in terms of SSR SEUs peaks



# SOHO: Solid State Recorder

## SSR SEUs compared to OULU neutron rate:

Oulu station provides Neutron count rate (practically quantity of cosmic rays) which correlates with SOHO SSR SEUs level



# Conclusion

## Success of both keyhole operations and automated routine operations

- Reduced Flight OPS team since automation in 2007
- Thruster maneuvers are planned months in advance
- Proactive international cooperation: ESA, NASA and FOT, Airbus and scientists

## SOHO spacecraft is resilient:

- Still using nominal equipment
- Critical resource is the people



**SOHO scientists**

