XMM-Newton Operations & Rejuvenation

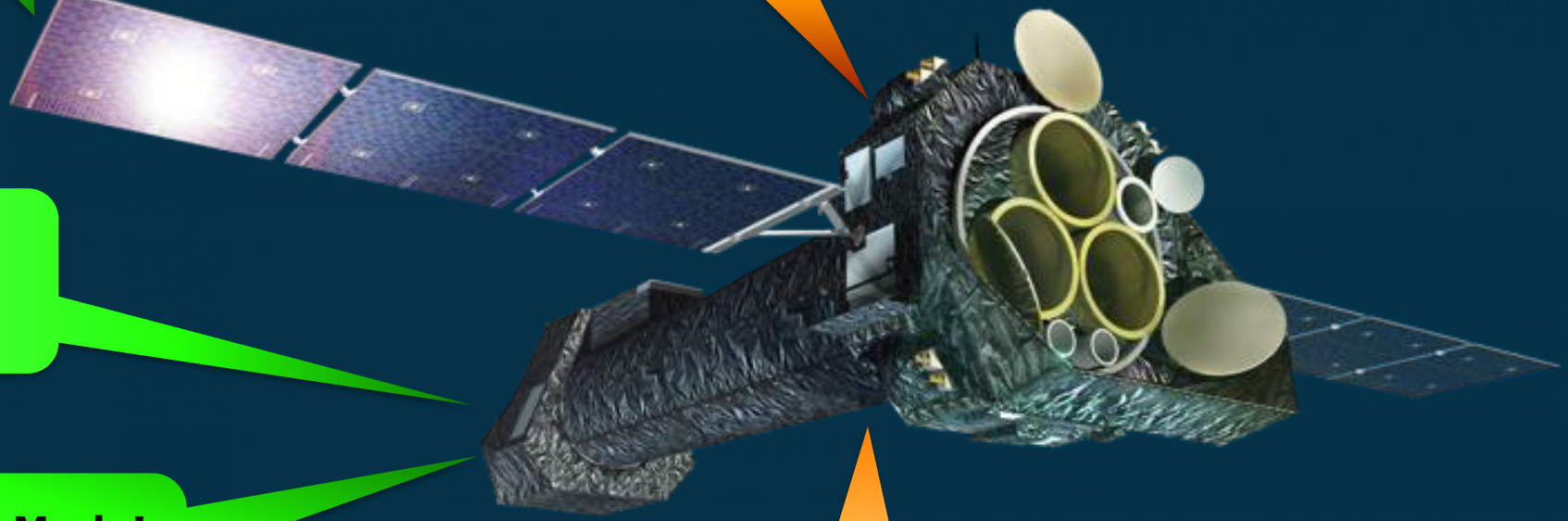
Felix Meeker-Fuerst

18th IACHEC meeting (Pelham) -- 21/04/2026

XMM-Newton: slowly evolving, still in very good shape

Solar panels not limiting lifetime

Attitude Anomaly Detector acting up early – disabled



Propellant well beyond 2032

New Safe Mode! Adding also new abilities

Reaction wheels & opto-couplers fine

One battery clearly aging, but no imminent worry

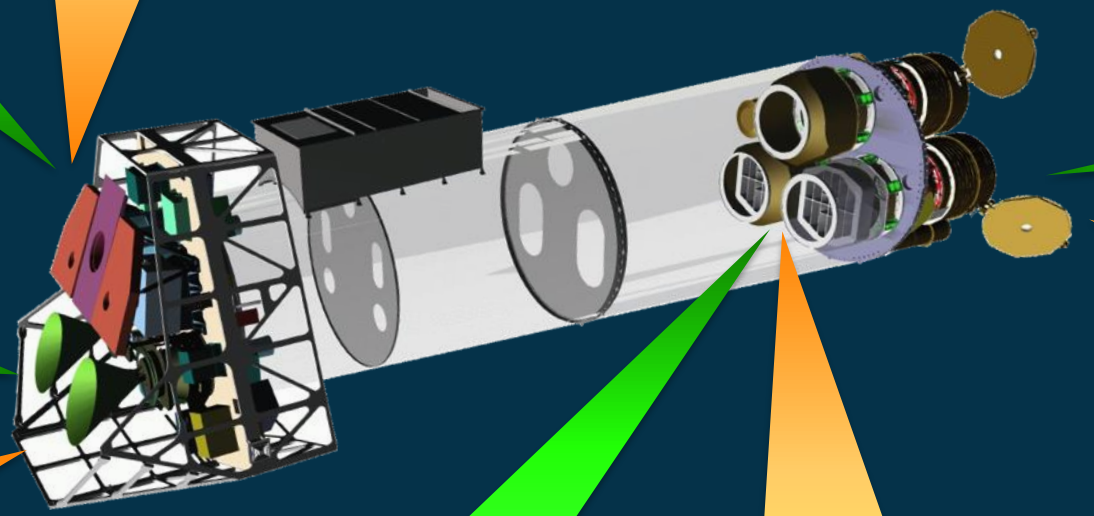
XMM-Newton: slowly evolving, still in very good shape

EPIC pn:
nominal operations,
stable bad pixels,
stable energy scale,
stable effective area

EPIC pn:
Slowly decreasing
Charge Transfer
Efficiency (CTE)
➠ corrections

= monitoring and calibration effort

More details in the other talks



OM: nominal operations

EPIC MOS:
nominal operations,
stable bad pixels, stable
eff. area (MOS1)

OM:
Slow degradation
of CCD
➠ corrections

EPIC MOS:
Slowly decreasing CTE
Decreasing energy
scale & eff. area
➠ corrections

RGS:
nominal operations,
stable wave-length
scale

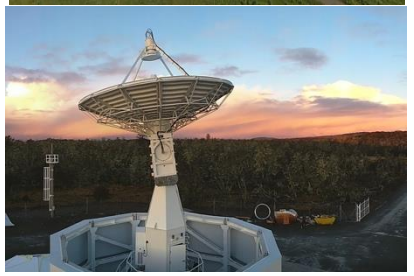
RGS:
Slowly decreasing
CTE and effective
area ➠ corrections

XMM-Newton Orbit – fully covered

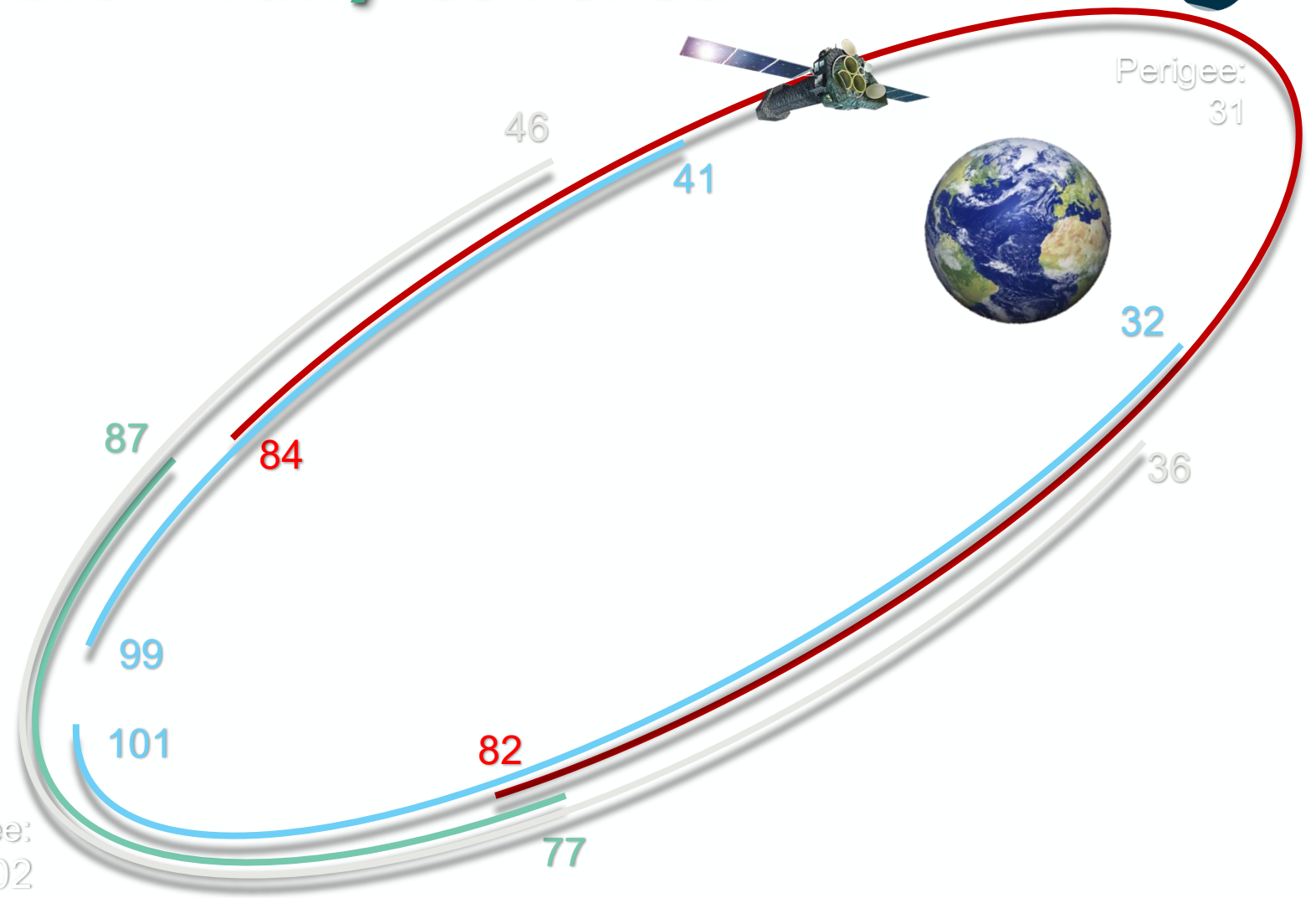
Kourou (ESTRACK)

Yatharagga (SSC)

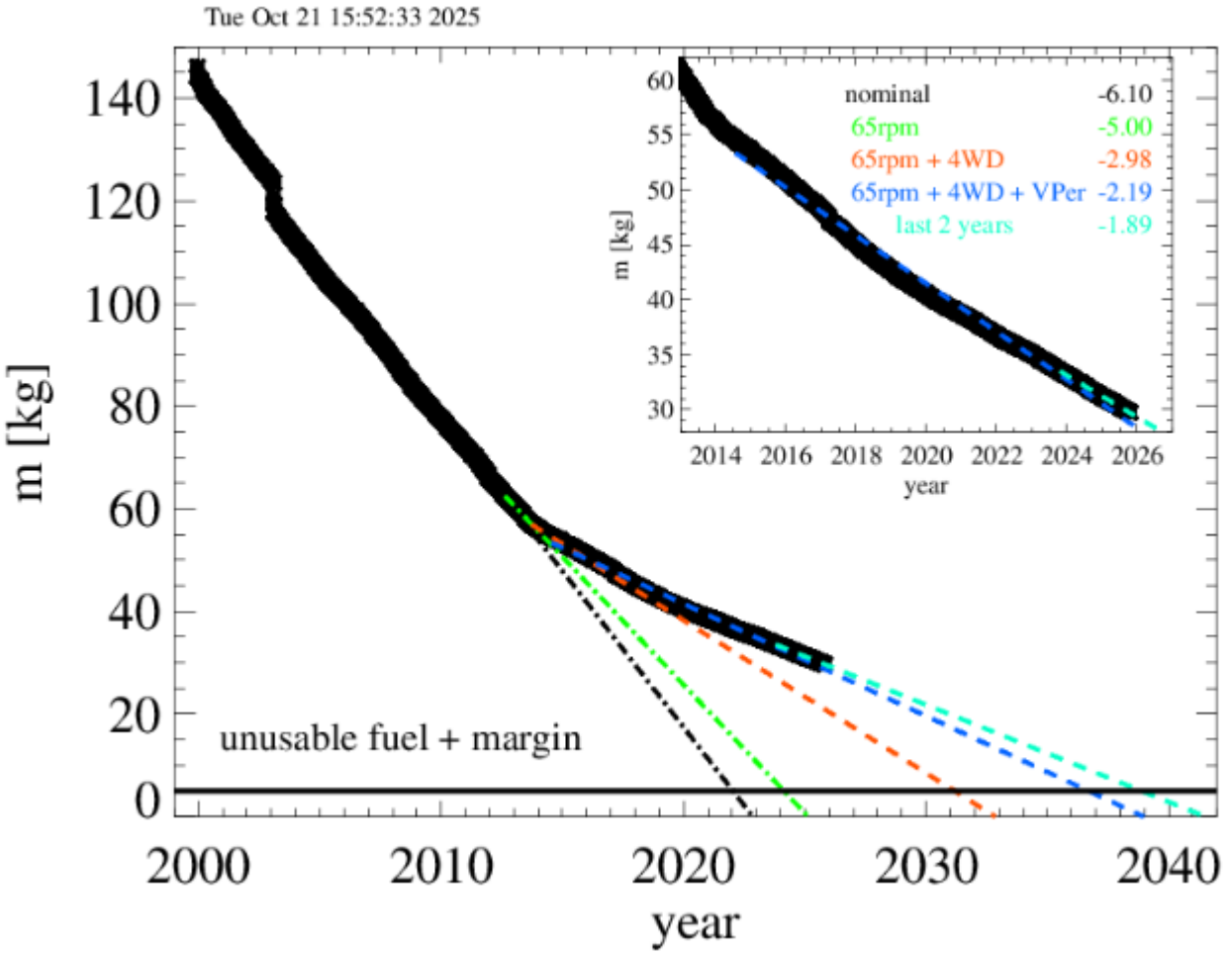
Santiago (SSC)



Tolhuin (KSAT/ CONAE)



Attitude and Orbit Control System: stable - fuel estimates give life time > 2034+



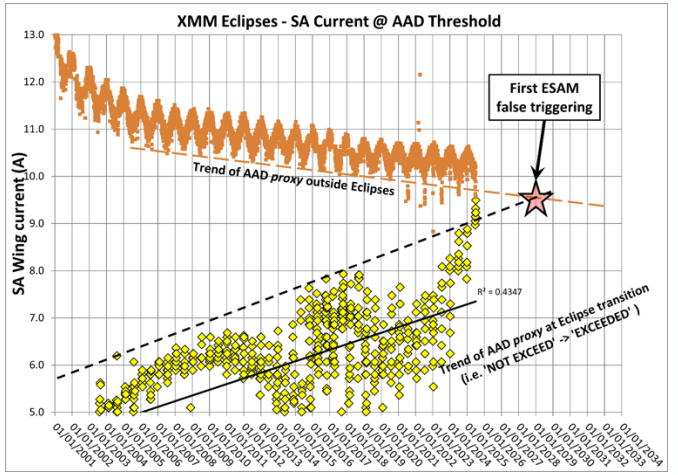
Reaction wheels primary actuators for attitude control.

Thrusters only used for wheel unloading.

Since 2013 use 4 reaction wheels instead of 3

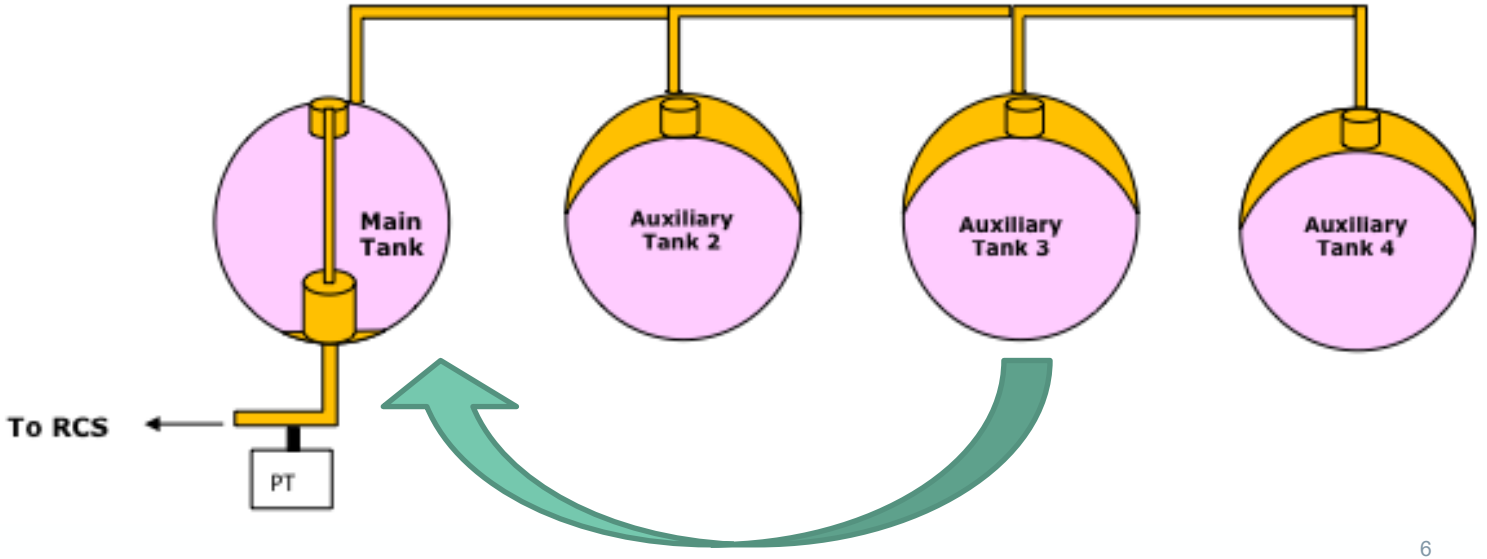
- reduced fuel consumption by more than a factor of 2
- wheels in low speed regime → no significant caging detected anymore

Since 2025 Attitude Anomaly Detector unreliable
→ replaced by ground automation



replenishment - main tank is refilled annually

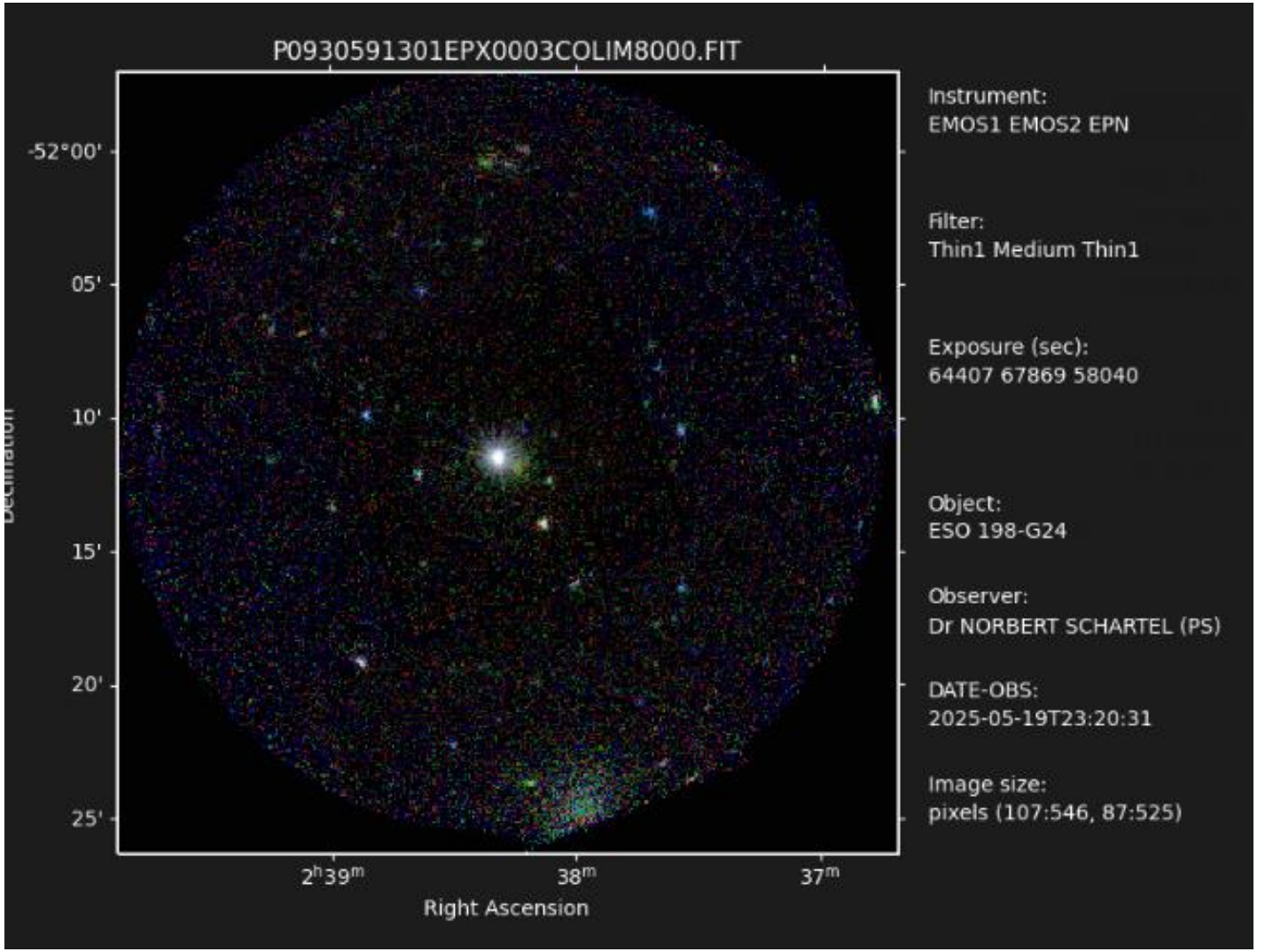
- need thermal excursions to move the remaining propellant inside the Auxiliary Tanks and to replenish the Main Tank
- command thermal excursions to mop up the remaining propellant inside the Auxiliary Tanks and to replenish the Main Tank
- migration phase: 2017-2020 (thermo-dynamical fuel balance)
- replenishment phase (2020+) (thermo-dynamical fuel and gas exchange)
- close control of the tank heater loops is required meanwhile provided by an elegant solution via open and closed loop temperature control via CDMU
- 5 replenishment activities successfully performed



replenishment - main tank is refilled annually

- Stable attitude is required for two full revolutions (96h) for the activity
- We always try to look for a suitable science target during this time
- In 2025 ESO 198-G24

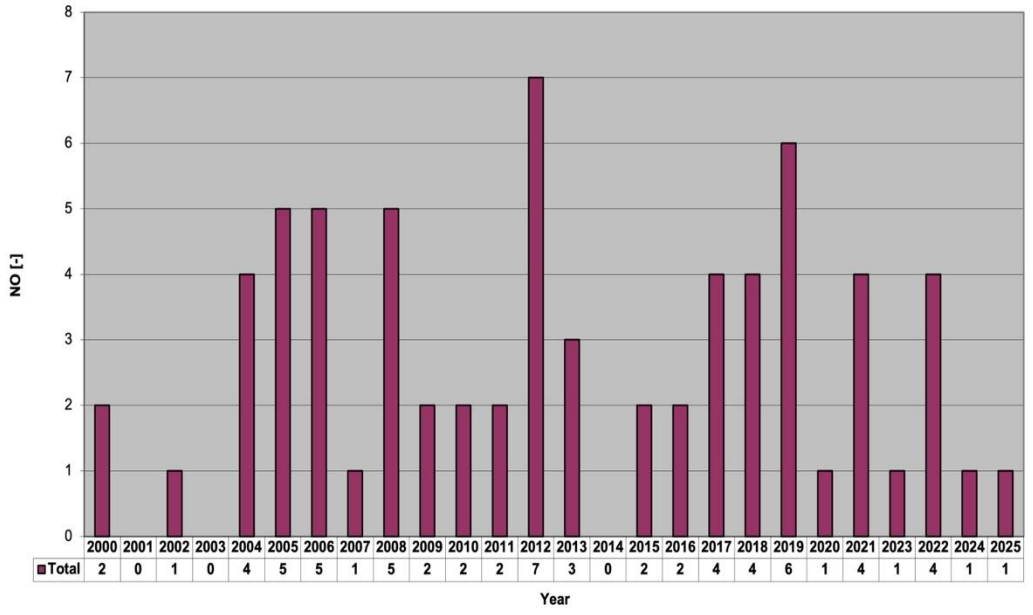
- Data are immediately public

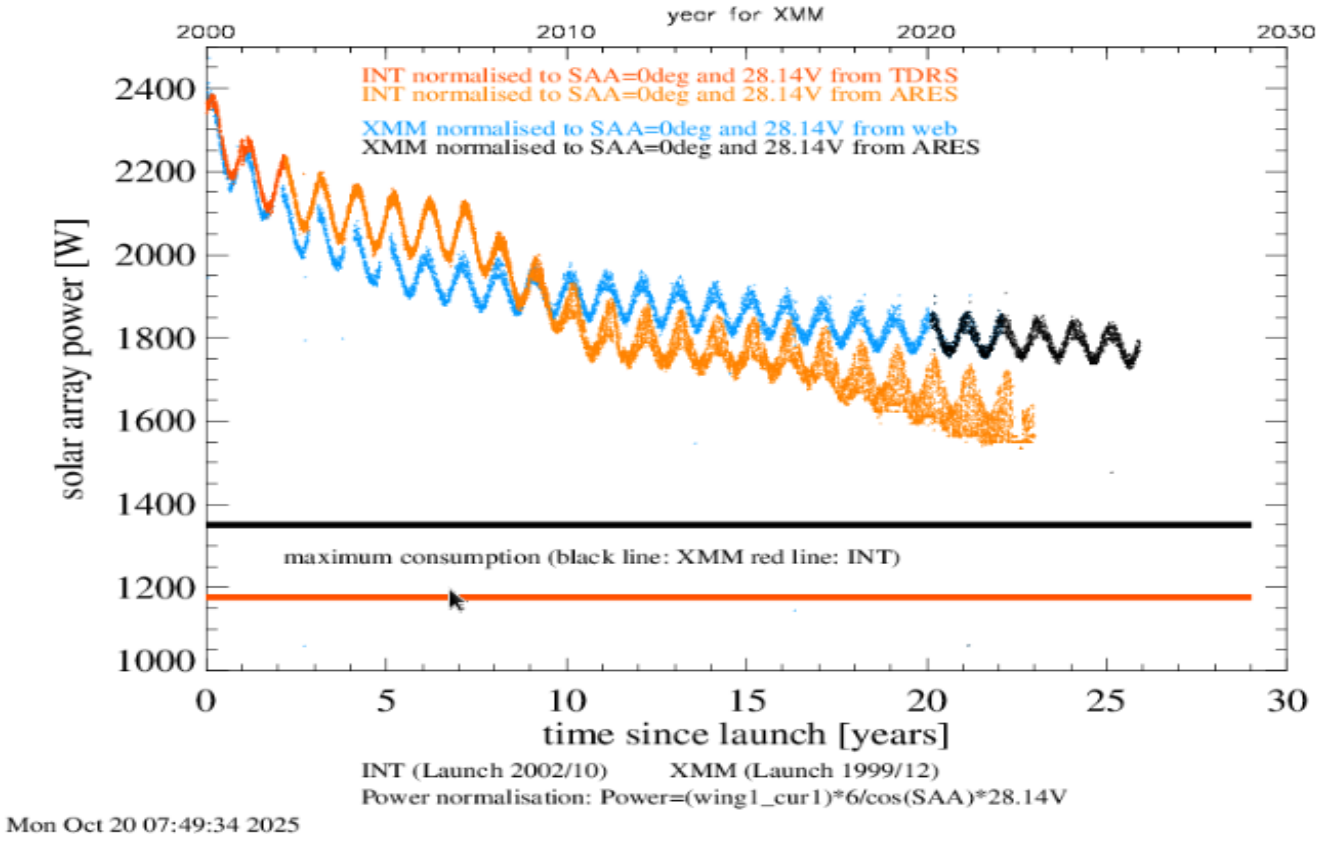


power system – no change

- running flawlessly on nominal units
- all voltages and currents remain in their operational range
- solar cell power has sufficient margin
- Usual small number of Latching Current Limiter trips

Latching Current Limiters trips





On Board Data Handling – stable – new fuel less safe mode added

2025 New Safe Mode: fuel less safe mode improving safety and further instrument monitoring via mini On Board Control Procedures (OBCP)

on board and could be used in case of no fuel or thruster failure

started using the new mini-OBCP functionality (Reaction Wheel SEU)

further applications in 2026 (instrument, batteries, …)

18th International Conference on Space Operations, Montreal, Canada, 26 - 30 May 2025.

SpaceOps-2025, ID # 248

XMM-Newton Reaction Wheel-Based Attitude Safe Mode

Greta De Marco[a]*, Jim Martin[b], Liviu Toma[c], Timothy Finn[d], Marcus G. F. Kirsch[e]

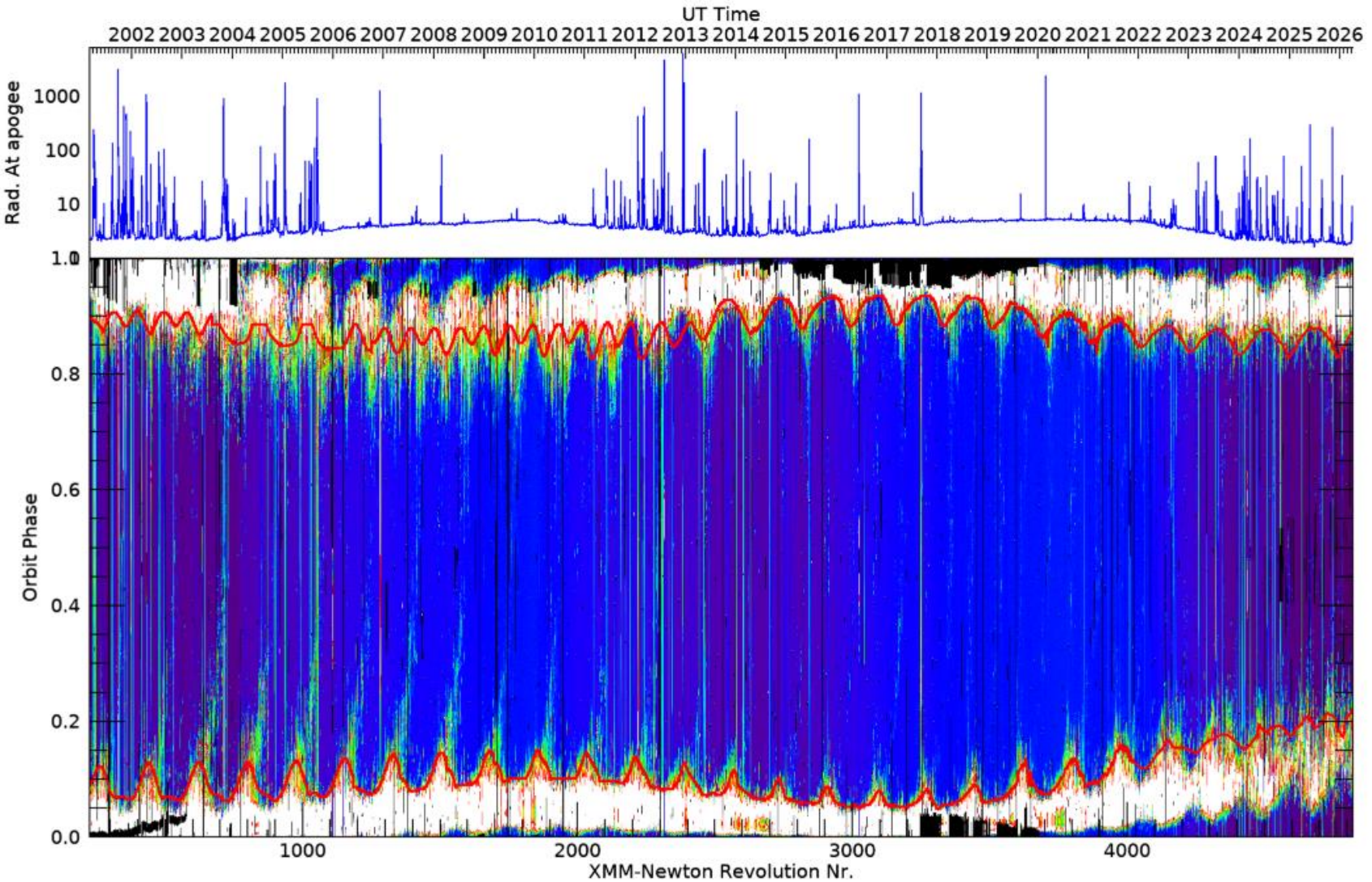
Radiation environment

Evolving orbit and solar activity means changing radiation environment for XMM-Newton.

Idea: ground automation can keep instruments save

➔ System checks on radiation level and turns instruments on/off

Problem: repeated on/off switches during exit of perigee.

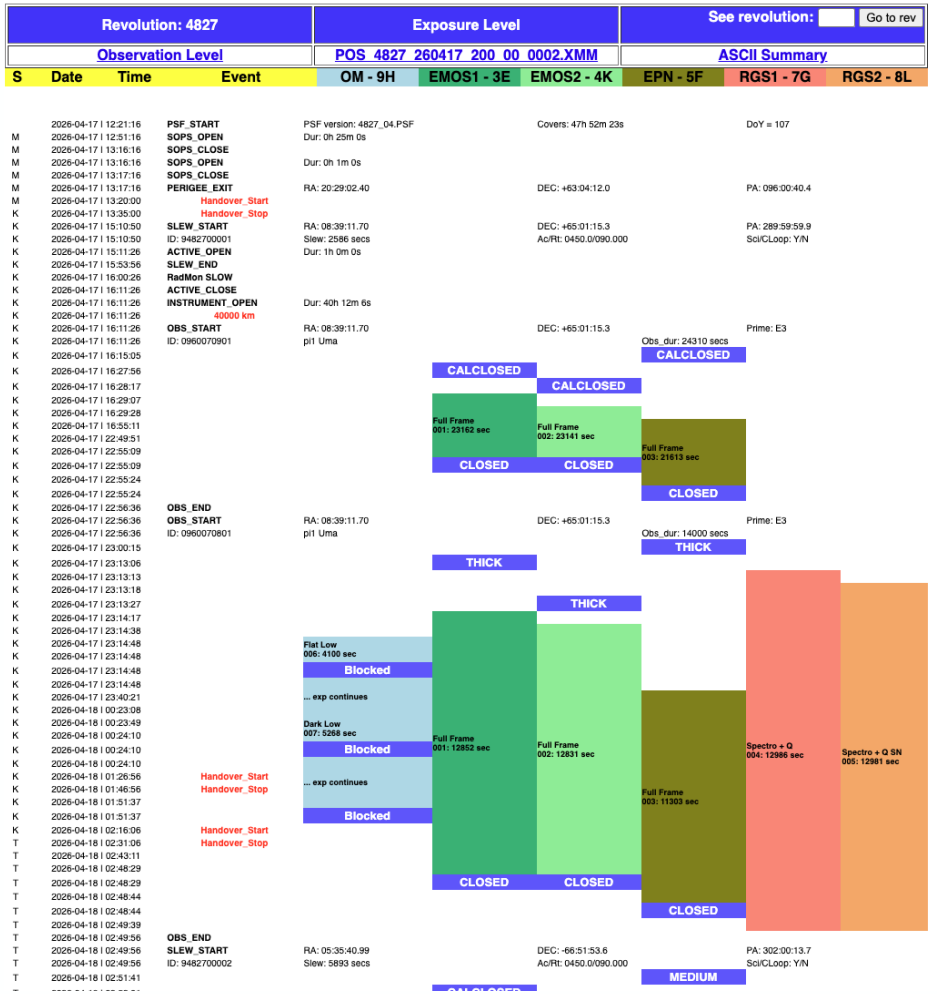


Radiation environment

Scheduling CALCLOSED observations at the beginning of every revolution, while model predicts radiation will still high.

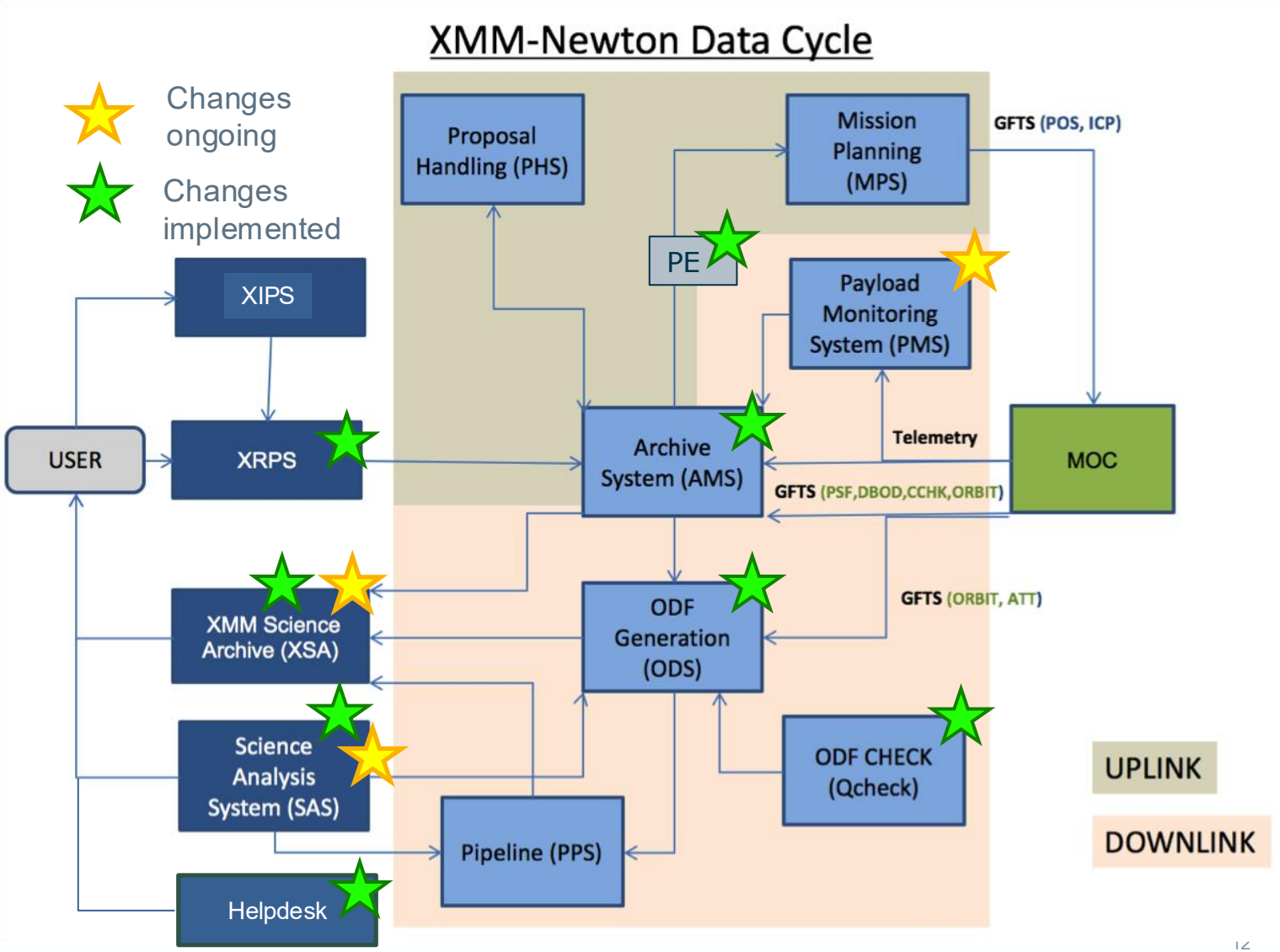
INSTRUMENT_OPEN lowered to allow extra time for these CALCLOSED observations.

Overall impact: reduction of available science time (but time would be lost anyway to high radiation).



SOC system evolution since MEOR 2021

- Continued replacement of older servers. Critical replacements finalised; ready for operations
- Database now interfacing with DABYS.
- Low-level data processing automated.
- Trend monitoring making use of ARES system. Including use of AI/ML methods.
- Science Analysis Software now built using CI/CD system in S2E2.
- SAS available via ESA Datalabs and advertised to community. Source code release ready except for ESLB approval.
- Helpdesk moved to Atlassian.
- SOC Cosmos pages overhauled.
- Automated catalogue ingestion for Archive. Migration to Angular to be done by mid 2026.

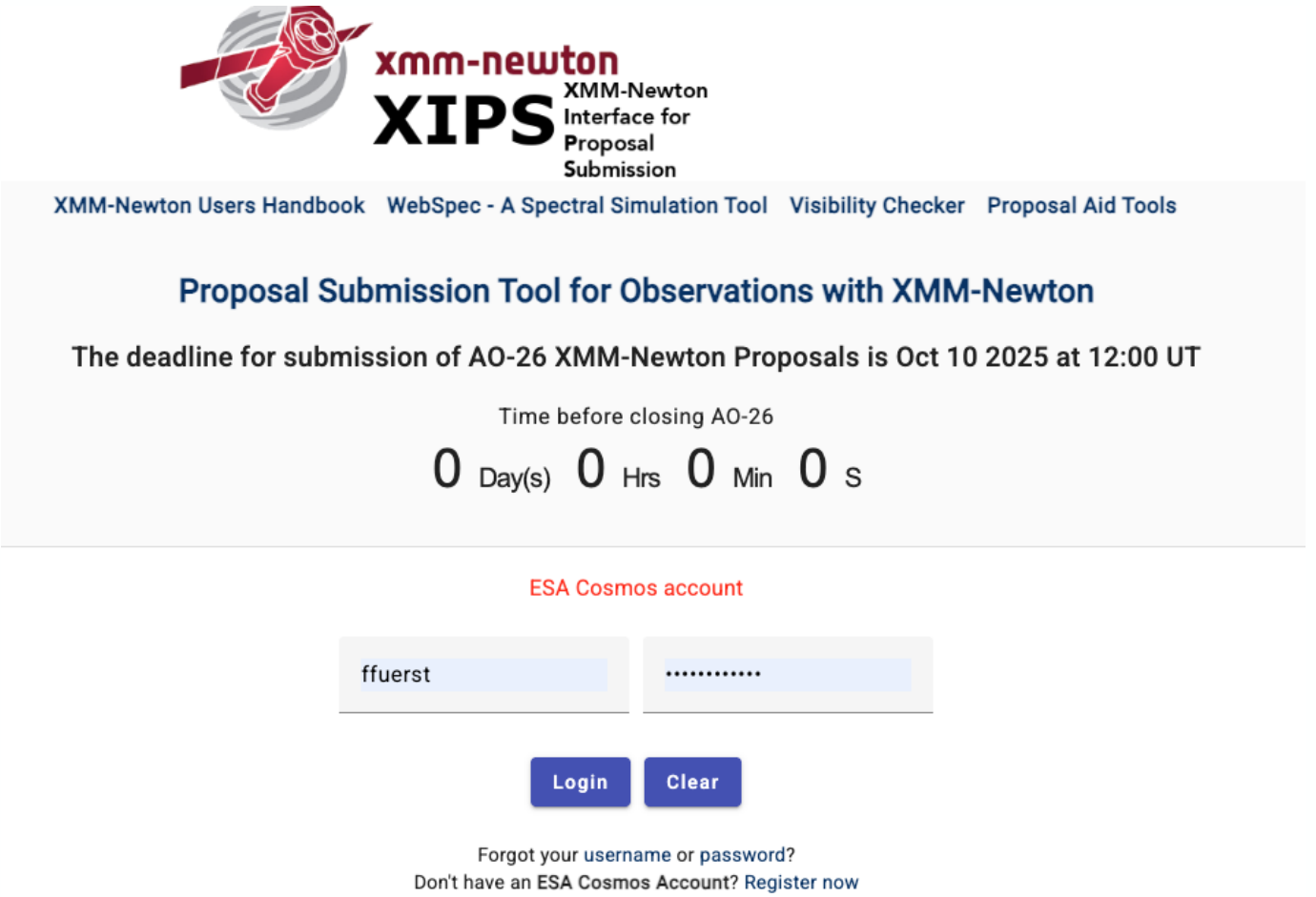


Proposal Handling Software (XIPS)

- New tool based on angular frontend
- In place since 2021
- Much nicer UI and much easier to maintain
- Allows easily to add new fields like other coordinated observations or similar.

Next steps:

Use a similar system for XRPS and Proposal Editor.



Science Analysis Software (SAS)

Current version: **SAS v22.1**

Next version: **SAS v23**
- First SAS in years with the source code released
- Difficult process to remove all copyright protected code
- No feature change compared to SAS v22.1

Then: **SAS v24**
- Source code will also be released
- Some small updates and alignment of SAS with pipeline software

SAS DOWNLOAD

CODING LANGUAGES

The **SAS** is coded in C++, Fortran 95, Perl and Python. **SAS 22.1** was built on **GNU C/C++/Fortran 13.3.0** on 64-bit Intel CPUs, both Linux and macOS, regardless of the compiler version provided natively with the Operating System.

SAS Perl tasks were built on Perl 5.34.1 which required the installation of some additional modules not included in the Perl 5.34.1 source code (for more details look at the requirements page).

SAS Python tasks were built on Python 3.12.4 together with some additional Python packages (for a list of these packages and full details on the SAS Python environment, please look at the requirements page).

For the time being, the **SAS** is distributed only in binary form. We do not provide yet any support on building the **SAS** from source code.

Calibration Updates:

Regularly published, mostly independent of SAS version changes.

(Exception for example upcoming OM flat fielding change)

SAS in ESA Datalabs

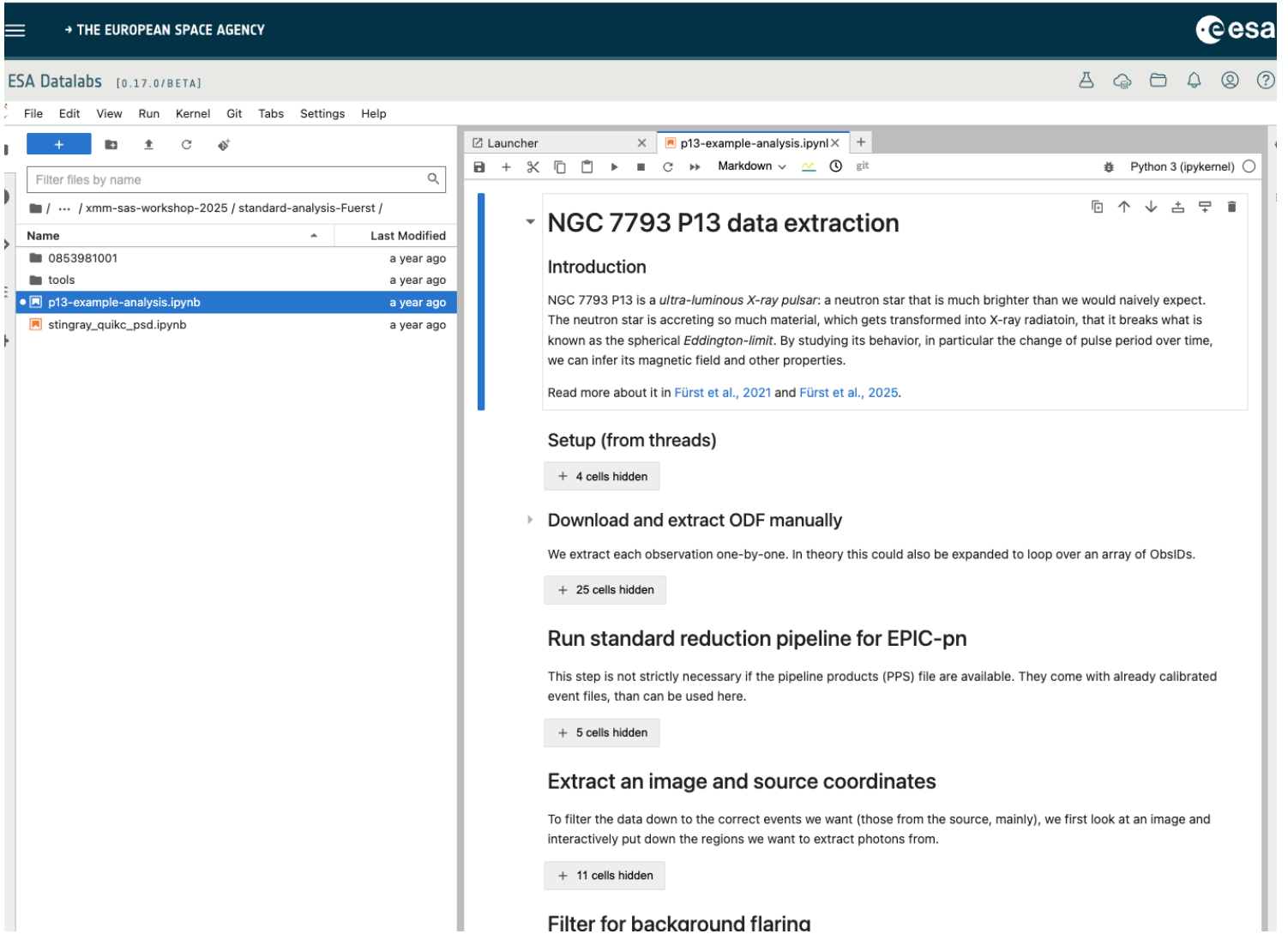
We are now providing SAS in the ESA Datalabs Cloud computing platform:

https://datalabs.esa.int/

Usually Jupyter notebook environment, but terminal can also be used.

Similar setup to NASA's SciServer / Fornax.

All future SAS releases will be available on Datalabs.



SAS in Datalabs Workshop

Last year (April 2025) we held an online workshop together with our NASA colleagues (XMM-Newton GOF) to demonstrated Datalabs and SciServer.

Recordings of the workshop are online:

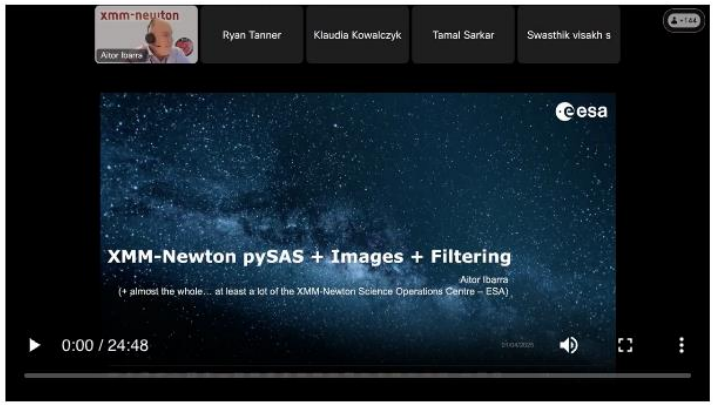
https://www.cosmos.esa.int/web/xmm-newton/sas-video-tutorials

And

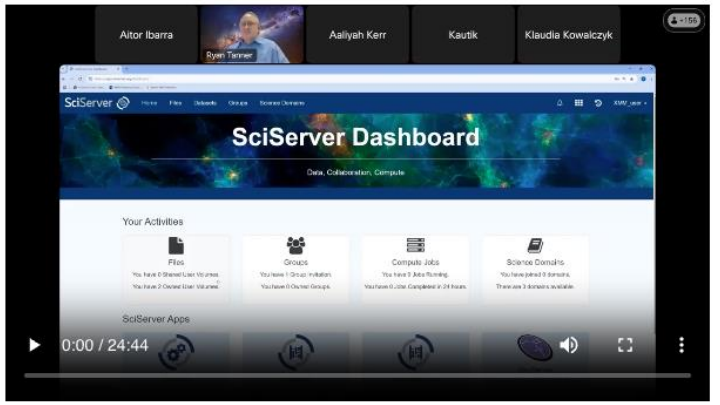
https://heasarc.gsfc.nasa.gov/docs/xmm/tutorial_videos.html#sciserver

DAY 1 SESSIONS

Intro to pySAS: Images and Filters, Aitor Ibarra



Intro to SAS in SciServer, Ryan Tanner



Summary

- XMM-Newton still operating smoothly at only 26 years young
- Operations should continue in this way until at least 2035.
- After that, we will need to get more creative…

- Software and hardware systems are either already modernized or in the process of being updated.
- Improve user experience and maintainability
- Should be good for another 10 years now

- SAS is available in the cloud