

RESCUING AN UPSET INTEGRAL



On 22 September, one of three active 'reaction wheels' onboard ESA's Integral spacecraft turned off without warning and stopped spinning, causing a ripple effect that meant the satellite itself began to rotate.

As its momentum was being lost, the Sun, the primary source of the satellite's energy, was left to save the mission.

Mission Status Report

INTEGRAL User's Group meeting #26, December 01+02, 2021



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European Space Agency

Agenda



Status Summary

- Further details in the Centre Reports from MOC, ISOC
- Science covered by Project Scientist

Missions Extension

Outlook: Ongoing Processes

INTEGRAL: Status Summary (since last IUG Nov 2020)



Reminder: Use of Propulsion system stopped; change of operations: “Z-flip” to control angular momentum without thrusters (no thruster commanding since 17 Jul 2020)

We had a rough ride and a near-death experience...

- 12 Sep 2021: anomaly experienced when switching between the two on-board low gain antennas; possible degradation of radio switch → workaround (a la XMM-Newton) for risk mitigation: switching transponders (avoiding the radio switch)
- 22/23 Sep 2021: Reaction Wheel#3 switch off (SEU) triggered ESAM#9, which failed to stabilize the spacecraft (thruster underperformance): MOC/Industry experts managed to catch a spinning INTEGRAL (twice)!

[for full details see Anomaly Report, ISOC News & POM; outreach activities: ESA web story, Infographics, Space Rocks, ...]

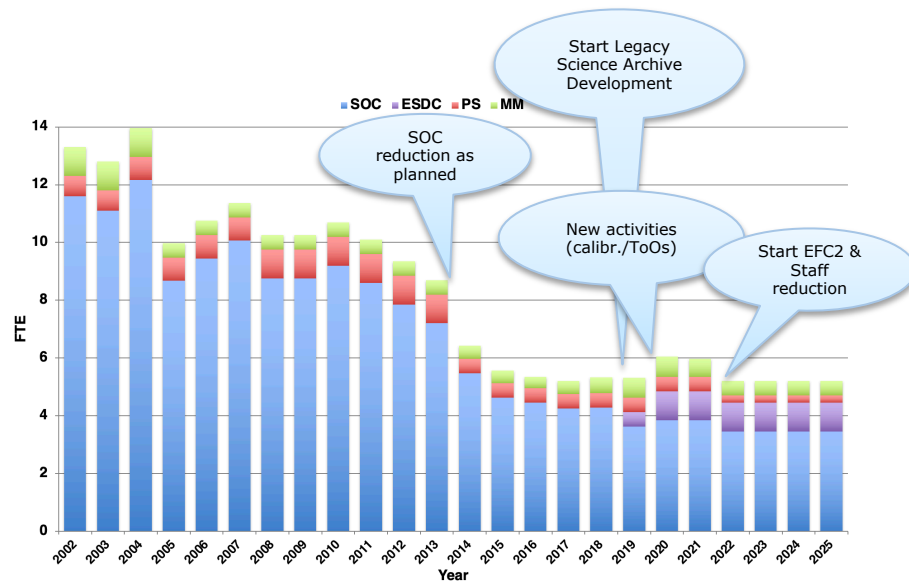
⇒ back to science 1 Oct; fastest ever joint ToO on 14 Oct (4.7 hrs from trigger to start of observations)

... but we came back quickly. Efficiency unchanged. Safer & faster (ToO) than before.

People matters: ISOC changes



- G. Belanger: ISOC coordinator (~0.5 FTE) & Archive Scientist (0.25 FTE); reduction due to contributions to M5 SciOps Study finished in mid 2021; involved now also in division-wide study on AI/ML
- J.-U. Ness (0.5 FTE) & E. Kuulkers (0.3 FTE) **stopped end 2020 as SciOps Scientists** (ESA staff & contractor rules)
- Old service contract: 2 Ops Scientists & 2 S/W Engineers shared with XMM-Newton/Solar Orbiter & 1 full Ops Scientist
- **New Frame Contract (EFC2) since July 2021 without negative impact: ISOC kept expertise & consortium is involving more people (risk mitigation)**
- **Legacy Science Archive development by ESAC Science Data Centre (ESDC) continues at ~1 STE.**



Mission Extension: Reminder



Status: 1 Oct 2020 SPC#164:

The SPC was invited to:

1. approve the operations of Cluster, ExoMars-TGO*, Gaia, Hinode*, HST* , **INTEGRAL**, IRIS*, Mars Express, SOHO* and XMM-Newton **from 1 January 2021 to 31 December 2022**, as foreseen by SPC in 2018 (ESA/SPC(2018)22 and ESA/SPC/MIN/158, rev.1 (Final)) ✓
2. approve **indicative extensions** to the operations of Gaia, Hinode*, HST*, IRIS*, SOHO* and XMM-Newton from 1 January 2023 to 31 December 2025, subject to a mid-term review and subsequent SPC confirmation in 2022 ✓

An `*' indicates an ESA Science Programme contribution to a mission operated by a partner

Decision for INTEGRAL: extension for **2021-22 confirmed** & **no further indicative extension**

→ prepare, throughout 2021-2022, end of operations by Dec 2022, and start of (2 years) post-operations in January 2023.

Mission Extension: Update



3+4 Nov 2021 SPC#168: ESA Executive briefly presented new plan = baselined assumption:

- Step 1 of Extension: **Evaluation of Science Merit** by Jun 2022 SPC
(preceded by recommendations from Advisory Structure (working groups & SSAC))
- Step 2 of Extension: **Decision on Programmatic Content** by Feb 2023 SPC
 - + : Clarity on financial situation in Science directorate
 - : this is after the end of currently approved operations!

→ plan is to **continue all missions** (in the extension process) **by 6 months, i.e. Jun 2023.**

Early decision by SPC (and possibly Council) needed soon, i.e. either Feb or Jun 2022

Periods under discussion: Extension 2023-2025, Indicative Extension 2026-2028

Mission Extension: Preparations



All missions going through **Mission Extensions Operations Review (MEOR)**

- Presentations & Review Board meeting took place @ESOC 22+23 Nov 2021
 - Mission Manager, Project Scientist, Spacecraft Operations Manager
 - PIs as observers
- Assessment of technical status:
 1. Are there any items that have degraded since the last MEOR? Impact on Science return?
 2. What are the main life-time limiting items and drivers?
 3. Any changes to operations concept or ground systems and their impact on science performance, cost and risk.
 4. Operations support needed from nationally-funded agencies for instrument teams and data processing consortia.
 5. Suitability of proposed method of spacecraft disposal (including compliance with space debris measures), for all relevant cases of mission termination (end 2022 if extension is not granted, end 2025 or later/natural end of mission).

Mission Extension: Next steps



MEOR Board Report to be finalised, signed and distributed in Dec. 2021:

- Findings, summary of conclusions / recommendations and any actions.
- Report will be submitted to D/SCI to guide Executive's decision on which extension cases to be pursued.

Any changes in technical status after MEOR will be monitored and injected into the decision making process.

All (successful) **missions** going then through ESA's Science Advisory Structure (AWG, SSAC):

- Science Case (7-pager) by Mar/Apr 2022
- Result: Recommendations

Reminder:

- Continuation until mid 2023 is assumption & ESA's Executive understanding of recent discussions with SPC
- Step 1 of Extension: **Evaluation of Science Merit** by Jun 2022 SPC
- Step 2 of Extension: **Decision on Programmatic Content** by Feb 2023 SPC

If INTEGRAL is considered for Extension is still TBC; Doing preparatory work; No Guarantee!

INTEGRAL: Outlook / Ongoing Processes



- Making use of Gyro slew (long slews: no need to split, no dummy obs)
- Ultra Fast ToOs (1-2 hours from approval to start of obs; also for Earth obs?)
- 'Safe mode on wheels' MOC procedure in place; to be automated (by ~end 2021). On-board implementation planned by end 2022
- Further improvements on Z-flip tools & process (gravity torque maps; optimizations; pushing the boundaries)
- Extension Process: Science case - next stop: Science Advisory Committees
- INTEGRAL Science Legacy Archive (ISLA)
- Planning of INTEGRAL 20 years in space conference & outreach activities