

XMM-Newton Status and Extended Operations



XMM-Newton: The Next Decade, 4-6 June 2007

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Mission Extended Operation Review

What is the expected mission status in the next decade?

ESA has just conducted independent reviews of XMM-Newton (and Integral) Extended Operations. Triggered by realization that both missions will be operating beyond their design lifetimes. Reviews examined:

- Scientific interests in the missions
- Capability of the flight and ground segments
- Funding and cost saving

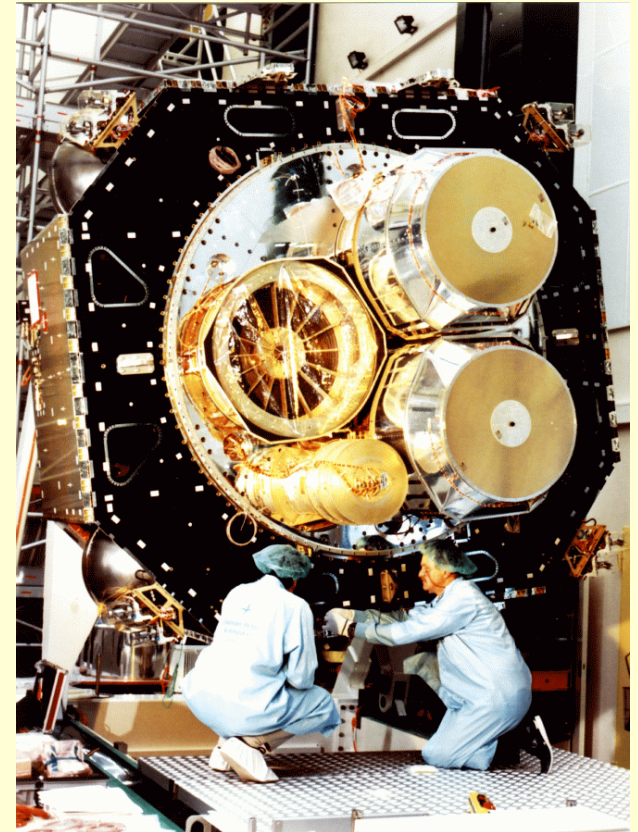
Two phase review consisting of two Review Teams (ESA experts from other projects and external scientists) who made recommendations to a Review Board of ESA managers.



XMM-Newton Science Case

- Nearly 1500 refereed papers - one of the most successful ESA science missions ever.
- Publication rate currently 300 refereed papers per year, many of which are highly cited
- Highly active community of >1500 scientists.
- Very high over-subscription of available observing time by factor of 7.
- High attendance at this workshop evidence of continued interest in the mission.

The scientific interest in extending the mission is very high and likely to remain so for the foreseeable future.



Spacecraft Health

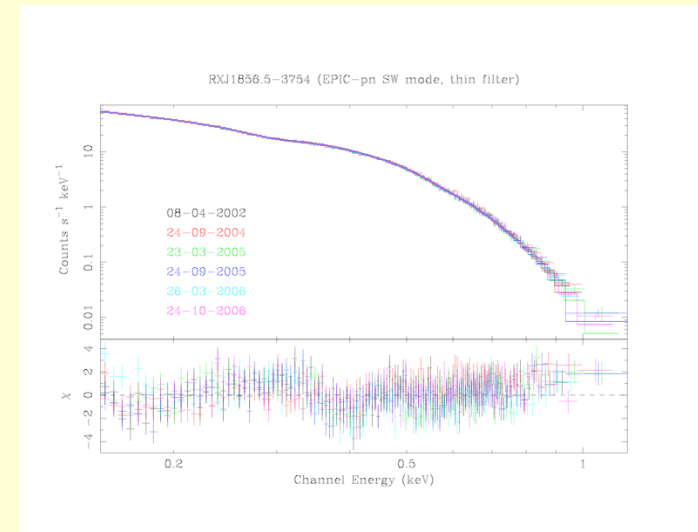
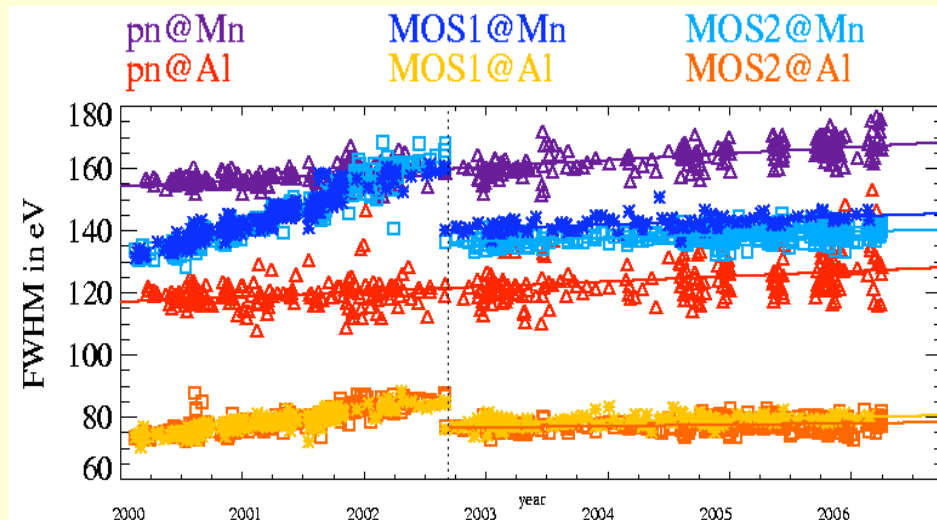
| Overview of consumables and limited life items | | |
|--|---|-----------------------------|
| Fuel: | remaining estimated usage per year “mileage” left | 95 kg 8.6 kg 11 years |
| Solar array power output | maximum required current margin margin at end-of-2012 | 1350 W 520 W 360 W |
| Battery lifetime | according to user handbook | 15 y |
| Gyros | usage | < 15% |
| Reaction wheels | usage | < 15% |
| RF switches | usage | 20% main 0% redundant |

The radiation design reference will be approached at the end of 2011. Therefore no radiation damage is expected before 2012. Design margins should allow a much longer operation, it is reasonable to assume a design margin of 50%.

Instrument Health

XMM-Newton: EPIC

- The Nov 2002 reduction in EPIC MOS (and RGS) operating T resulted in far fewer hot pixels, and decreased energy resolution degradation rates. Predicted energy resolutions given in table below
- 4 micrometeoroid impact events in 7 yrs have resulted in the loss of 1 in 14 of the MOS CCDs – a 5% reduction in the EPIC active area.
- No effects of contamination visible.

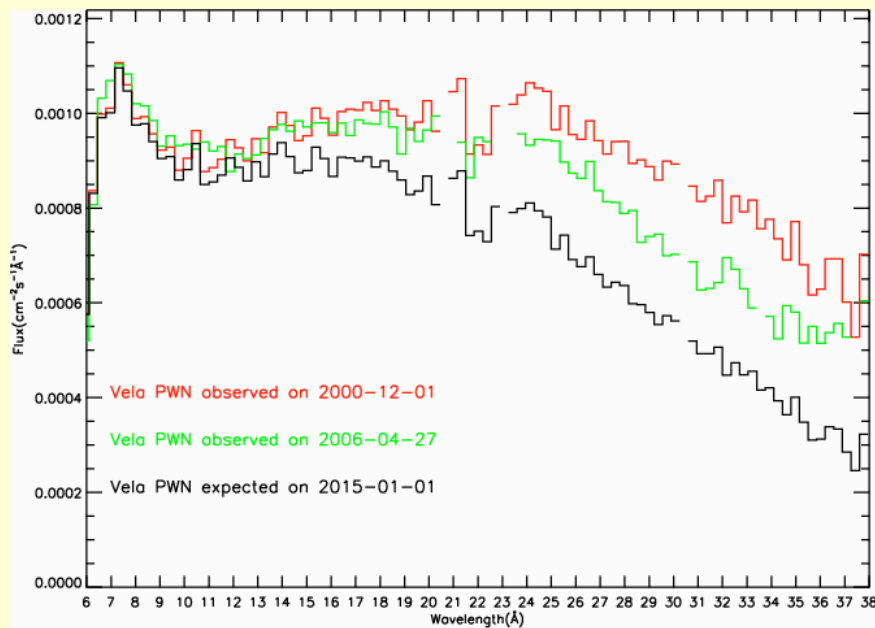


| CAMERA | FWHM @ MN AFTER LAUNCH | FWHM @ MN AFTER COOLING | FWHM @ MN IN 2015 | FWHM @ AL AFTER LAUNCH | FWHM @ AL AFTER COOLING | FWHM @ AL IN 2015 |
|--------|------------------------|-------------------------|-------------------|------------------------|-------------------------|-------------------|
| MOS1 | 135 | 140 | 156 | 75 | 75 | 86 |
| MOS2 | 135 | 135 | 148 | 77 | 77 | 82 |
| pn | 155 | NA | 185 | 120 | NA | 141 |

Instrument Health

XMM-Newton: RGS

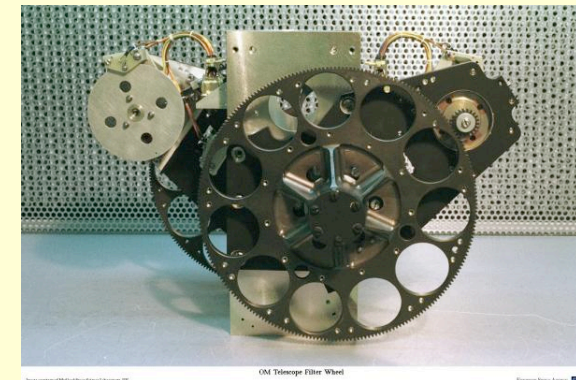
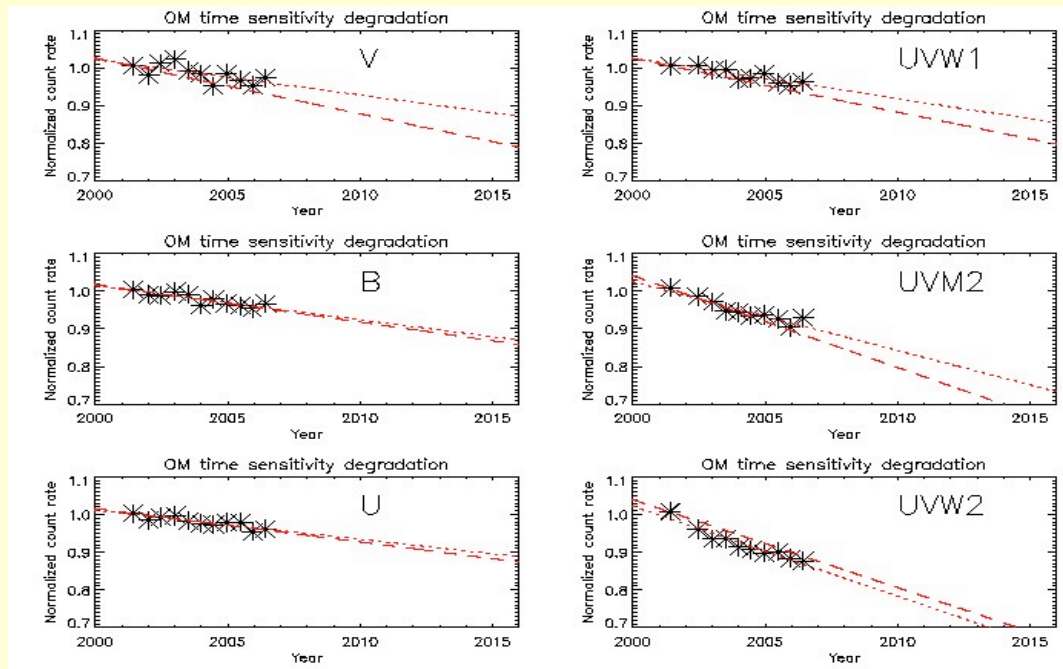
- Two (out of 18) CCD chips failed early in the mission. No loss of wavelength coverage due to redundancy. No other loss of redundancy.
- Contamination is reducing the effective area at long wavelengths. Estimated to be a 50% reduction in effective area at 30 Å in 2015, compared to launch.



Instrument Health

XMM-Newton: OM

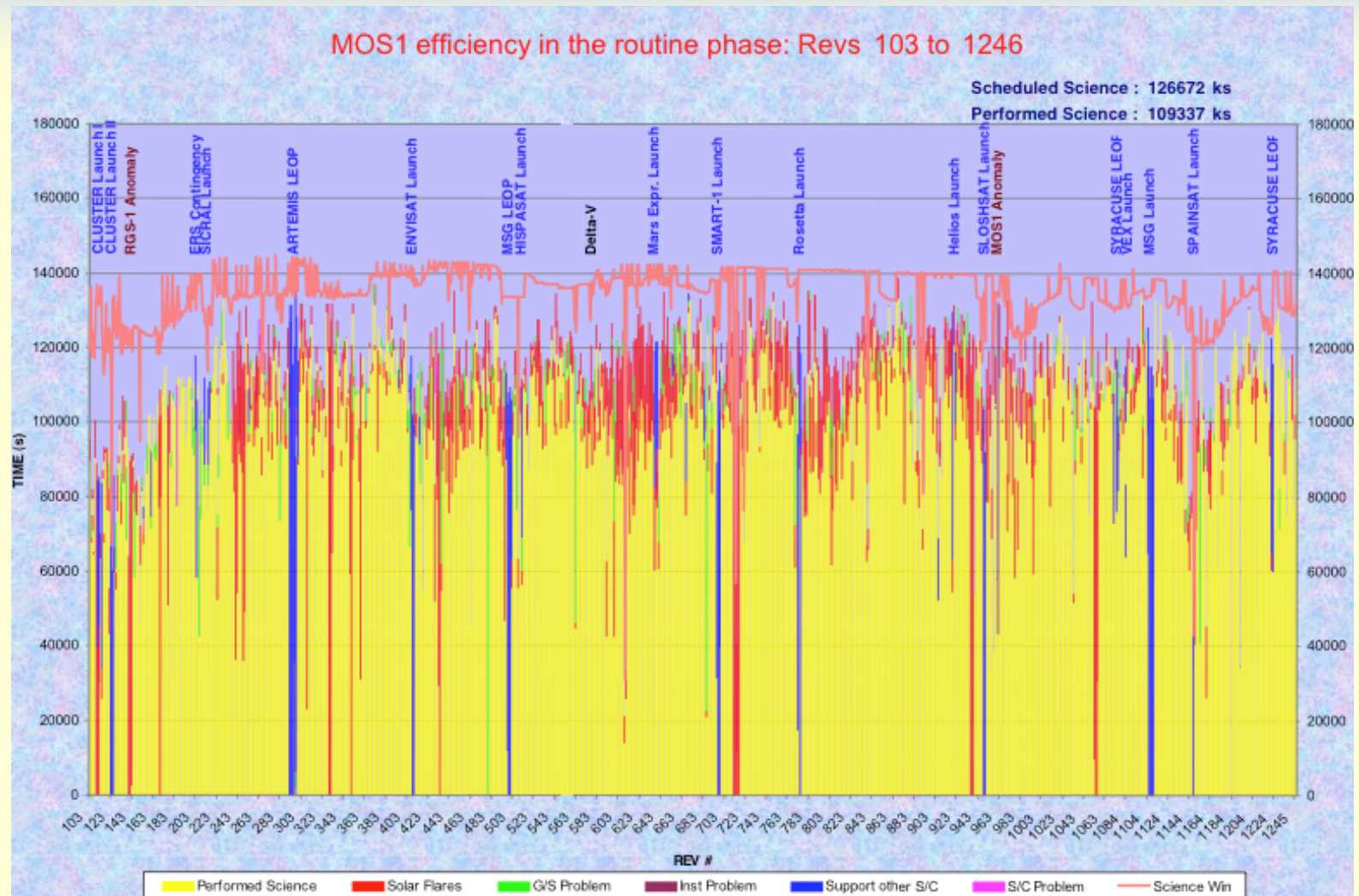
- Wavelength dependent sensitivity reduction, probably due to a degradation of the detector photocathode. Fully redundant detectors, filter wheel and electronics chains.



- By 2015, The predicted sensitivities in the optical filters (U, B, V) will have decreased by <20%. In the UV filters (UVW1, UVM2, UVW2) the loss of sensitivity will be 20-40%.

Observing Efficiency

- Plot shows the MOS1 time lost due to solar flares in red. Worst interval is between rev 600 and 1000 - on the falling edge of the previous solar max.
- Indicates that next solar maximum is not expected to have a large effect on the XMM observing efficiency.



2000

2003

2006



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Space Segment Summary

- After 7 years in orbit, the spacecraft has not had a major anomaly requiring the use of a redundant sub-system.
- Future orbital evolution small and not deemed to cause any problems.
- All mission elements are stable and trouble free with sufficient consumables and life limited items to allow operation of the mission up to at least 2018.

XMM-Newton Ground Segment

- MOC Mission Operations Centre
- SOC Science Operations Centre
- SSC Survey Science Centre

All centres are stable and trouble free and do not need major investments beyond normal maintenance

The SSC is funded by national agencies from D, ES, F, I, and UK at a level of 13 Full Time Equivalents (FTEs). Funding beyond 2010 can be expected at the same level.

Funding: ESA

Background:

- ESA Council appointed the Science Programme Review Team (SPRT) to perform a high-level external review of the management of the Science Programme.
- SPRT recommended that expenditures on mission extensions be given special attention.
- In order to have the first new mission in the Cosmic Vision 2015 plan before 2020, SPRT recommended that the planned spending in the Science Directorate to 2015 be reduced by 200 M€.
- It has been decided that 60 M€ of these savings will come from reductions in planned mission extensions.

Funding: ESA

In the Science Programme future planning there was provision for:

- 4-year extension for XMM-Newton beyond March 2010 (70.3 M€)
- 2-year extension for Integral beyond Dec 2010 (17.4 M€)
- MEX extension (15.3 M€)
- VEX extension (8.2 M€)

=> Annual running costs: 17.6 M€ (XMM-Newton) and 8.7 M€ (Integral).

All missions needing extensions will “suffer” equally so the share of additional CaC allocated to XMM-Newton and Integral is **40.0 M€**.

Funding: ESA

| Apr 00 Mar 01 | Apr 01 Mar 02 | Apr 02 Mar 03 | Apr 03 Mar 04 | Apr 04 Mar 05 | Apr 05 Mar 06 | Apr 06 Mar 07 | Apr 07 Mar 08 | Apr 08 Mar 09 | Apr 09 Mar 10 | Apr 10 Mar 11 | Apr 11 Mar 12 | Apr 12 Mar 13 |
|------------------|------------------|--|------------------|--|------------------|--|------------------|--------------------------|------------------|------------------|------------------|------------------|
| Year 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Nominal Mission | | | | | | | | | | | | |
| | | Approval and CaC 1 st Extension | | | | | | | | | | |
| | | | | Approval and CaC 2 nd Extension | | | | | | | | |
| | | | | | | Approval and CaC 3 rd Extension | | | | | | |
| | | | | | | | | Approval and CaC Request | | | | |

- Both XMM-Newton and Integral have 4-year rolling extensions.
- “Rolling” as each extension extends the approval to operate for the first 2-year interval of the extension and approves an increase in the CaC necessary for the 2nd 2-year interval.
- Mission extension requests are planned for 2007 November SPC and prior Advisory Structure meetings.
- However 2-year extensions at these costs: $2 \times (17.6 + 8.7) \text{ M€} = 52.6 \text{ M€}$ are no longer affordable. Therefore we started looking at a number of cost cutting measures....

XMM-Newton Cost Reduction Options (1/2)

| No | Element | How | Impacts & Risks | Comment | Savings | Science Impact |
|----|---|--|---|--|---------|----------------|
| X1 | No ToO support outside working hrs | On-call support comp by leave. Saves 0.2 FTEs | Chance of being too late for highly interesting ToO | | - | Moderate |
| X2 | No AOs - XMM operated in sky-scan mode with data immediately public | Saves TAC costs. More complicated mission planning. Saves 1 FTE | Less community interest. Science strongly affected More complicated mission planning | Scanning mode still being developed. One for the future? | Small | Severe |
| X3 | Reduction in SAS maintenance | Reduce SAS team from 3 to 2 FTEs | Analysis improvements may not be implemented for community | >2009 due to Frame Contract | Small | Minor |
| X4 | Reduced calibration and instrument health monitoring | IDT reduced from 7 to 6 FTEs | Retains 1 calibration FTE per instrument, 1 X-Cal, 1 overall instrument engineer and 1 FTE of flexible response to contingencies or trends | >2009 due to Frame Contract. Keeping a minimum of only 3 FTEs would remove almost all capacity to react to unforeseen changes in calibration | Small | Minor |
| X5 | Bare minimum SOC operations | This is an additional saving of 14 FTEs to be applied together with options X3, X4, X6, X7 and X8. | No community support, No SAS evolution, minimum calibration updates, no proposal enhancement, no conf/workshop support, no ToOs, minimum support for instrument anomaly recovery, new observing modes | >2009 due to Frame Contract | Large | Severe |
| X6 | Minimal further archive development | Archive team reduced from 2 to 1 FTE. | Less science exploitation due to reduced archive capabilities | VO activities not affected | Small | Minor |

XMM-Newton Cost Reduction Options (2/2)

| No | Element | How | Impacts & Risks | Comment | Savings | Science Impact |
|-----|--|---|--|---|---------|----------------|
| X7 | Reduce Comm/MP Support | Reduce community support team from 7 to 6 FTEs. | Reduced community support, cuts in helpdesk, enhancement or conf. support | >2009 due to Frame Contract. UG not in favour | Small | Moderate |
| X8 | Removal of RT operations support from ESAC | Transfer INSCON RT activities to MOC, ops. support team reduced from 4 to 2 FTEs and S/W supp team reduced from 6 to 5 FTEs | Small increased risk of soft proton damage and increased SPACON workload | Reduction in ESAC manpower inconsistent with ESA plans to expand ESAC. Risks still being assessed | Large | Moderate |
| X9 | Reduce GS coverage to 75% of current | Only take data during 75% of each revolution | Science return reduced by ~40% for 25% reduction in observing time. | Perth covers apogee - time with the lowest bg | Large | Severe |
| X10 | Go to 8hr/d operations 5d/ week | Reduce SPACON and engineering teams strongly together with smaller SOC | Science return reduced to 25% | | Large | Severe |
| X11 | Share SPACONs with Integral | Reduce SPACONs from 6 to 3 per mission. X-training | Increased SPACON workload. Lengthened recovery times from solar flares and anomalies | Only if Integral in operation | Med | Moderate |
| X12 | Share MOC eng team with Integral | Reduce MOC eng team from 7 to 3.5 FTEs | Reduced capability to perform onboard S/W maintenance, Longer instrument recovery during nights and weekends. Longer timeline recovery during nights and weekends for significant problems | Only if Integral in operation | Med | Moderate |

Cost Reduction Options - Analysis

- Clear that not all the options provide acceptable reductions in scientific return for their likely cost savings and only the following options were further considered:
 - X3 – Reduced SAS development
 - X4 – Reduced calibration and instrument health monitoring
 - X6 – Reduced XMM-Newton archive development
 - X8 – Removal of RT operations support from ESAC
 - X11/I6 – Share SPACONs between the 2 missions
 - X12/I7 – Share (smaller) MOC engineering teams between the 2 missions
- The main savings come from X8 (removing RT operations from ESAC) and by combining MOC SPACON and engineering teams (X11/I6 and X12/I7).
- This is the "revised operations concept" which ties Integral and XMM-Newton operations together. Concept designed not to increase risk, but will reduce performance - ie recovery times following anomalies will be longer.

Funding: ESA

Status of revised operations concept:

- XUG (Jan 2007) cautiously endorsed proposed savings and requested a thorough risk assessment. (IUG also cautiously approved proposed savings)
- AWG recommendation supporting the implementation of the revised concept and noting that no decision should be now that precludes further extensions
- SSAC (Jan 2007) endorsed and SPC (Feb 2007) noted the AWG recommendation.
- XMM-Newton PIs also cautiously endorsed proposed savings at a meeting on 27 Feb 2007.
- Detailed risk assessment made available (XMM-SOC-OPS-TN-005).
- MEOR Review Team fully endorsed the revised operational concept and its implementation was given the go-ahead at the MEOR Review Board meeting by ESA management on 22 May 2007.
- Board recommended that the extension request end dates be aligned.



Conclusions

- The revised operational concept allows a further 2-year extension for both XMM-Newton and Integral to be requested as funding now sufficient to operate both missions until mid-2013.
- Requests for the 2010-2012 XMM-Newton and Integral extensions are planned for the Sept to Nov 2007 advisory and SPC meetings (as originally foreseen), but using the lower costs obtained by adopting the revised operational concept.
- Implementation plan now being put into place. Cross training of the two MOC and the XMM-Newton SOC teams has already started with a view to implementing the revised operational concept by the end of the year.
- In addition, we continue to search for additional efficiency savings (and funds!) so as to be able to continue operations for as long as possible.