The XMM 20 year reunion – random thoughts for the panel discussion.

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With twenty years of operational life for XMM-Newton – so far, one can be amazed at the longevity of space science missions now compared with the early years of space research.
At the beginning of ESRO/ESA in the 1960's, a mission's budget would be determined, typically, by fitting within the fairing of a launcher, with the goal of surviving for a year in space and with up-front funding for a two-year operational lifetime.

Needless to say technological advances, particularly in miniaturization, reduction of power demand, computing etc., have been rapid in the decades since. For example, I was project scientist for ESRO/ESA's third satellite HEOS-1, launched in 1968, whose aim was to study the solar wind, interplanetary magnetic fields and cosmic rays. It was placed in a 4.5 day period orbit with a total downlink data rate of 12bps. The instruments were either on or off – no mode switching or adjustments so rather straightforward operationally.

The early missions were widely different, meaning no standard spacecraft bus or systems, though HEOS 2 was the exception carrying similar instruments, but into a high-inclination, near-polar orbit.

Given the many disciplines and the expanding space science community, the ESRO/ESA science budget was sub-critical and the programme needed to include joint missions e.g. with NASA for IUE and ISEE. Conversely it was interesting to note the transatlantic pressure when ESA chose to fly the stand-alone ISO mission in advance of a comparable NASA mission.

The scene changed in 1984/85 with the adoption and implementation of the 'Horizon 2000' long- term plan instigated by the then Director of Science, Roger Bonnet, and chair of the Space Science Advisory Committee, Johan Bleeker. This plan was based on four flagship, ESA-led, 'Cornerstone Missions', all of which would require long term technological development with regard to spacecraft systems, instrumentation and operations. The second of these was to be XMM-Newton. These cornerstones were to be complemented by medium and small (cost-wise) missions selected by the time-honoured, competitive process initiated by 'calls for ideas'. The key to Horizon 2000 was to secure a real increase of 5% per year in the funding for the ESA science program.

As an aside, it is interesting to note that, without the development of the XMM bus there might not have been INTEGRAL, similarly the Rosetta bus enabled Mars Express and Venus Express as 'medium missions'.

Turning to 'Early X-ray Astrophysics', X-ray astronomy lost out, within ESRO/ESA to gamma-ray astronomy (COS-B) in the early '70s. However from that, the HELOS (Highly Eccentric Lunar Occultation Satellite) mission, to more precisely locate the position and identification of X-ray sources, was envisaged. HELOS morphed into the EXOSAT mission, launched in 1983. EXOSAT was ESA's first 3-axis stabilized platform with ~arcsec pointing ability and stability, the first with star trackers and the first with an on-board computer.

In the year before the launch of EXOSAT, the thoughts of the European X-ray astronomy groups turned to a successor mission for 'High Throughput X-ray Spectroscopy' (ultimately XXM-Newton) which would be complementary to Riccardo Giacconi's 1.5m telescope planned within the NASA programme (ultimately AXAF-Chandra). 'A Proposal to ESA for an X-Ray Multi-Mirror Astronomy Mission' was submitted in 1982 in response to a 'call for ideas.'

Briefly, the proposal featured seven high energy telescopes, going to 10keV with 30" HEW and 0.5m^2 and twenty low energy telescopes going to 5keV with 10" HEW and 1m^2. The mirror technologies encompassed foils, diamond turning and replication. Every conceivable form of back-end detector was envisaged: PSCPs, GSCPs, MCPs, CCDs, together with crystal spectrometers, transmission and reflection gratings etc.

There then followed five years of detailed to study to find the optimum approach to the fabrication of the mirror optics, the selection of the spectroscopy regime, and to determine the most appropriate detector technology to deliver the mission objectives as defined in the Mission Science Report of 1988. This report also defined the science management plan which, interalia, identified all instruments to be supplied by PI-led teams and the X-ray mirrors and telescope assemblies supplied by ESA.

Through the 1980's advances were made in the development of solid state detectors such as X-ray sensitive CCDs (as first flown on ASTRO-D/ASCA in 1993) to the extent that CCDs were the focal plane detectors of choice for XMM, obviating the use of position sensitive gas-filled detectors as used on e.g. EXOSAT, ROSAT and SAX. The development of X-ray CCDs by e2V was supported through ESA's Technological Research Programme.

Given the experience of EXOSAT, XMM would be placed in an eccentric, 48 hour period orbit for long, uninterrupted observations and ease of operation and the X-ray telescopes would be complemented with an Optical Monitor for simultaneous uv/optical coverage. The X-ray mirrors would follow the EXOSAT replication manufacturing method but using carbon fibre carriers in place of beryllium. However it was found that the required surface figure and smoothness to meet the mission objectives could not be achieved due to 'print through' and nickel carriers, with their mass penalty, were substituted. This in turn led to the replacement of Ariane 4 with the Ariane 5 launcher.

It should be noted here that EXOSAT was the first ESA mission with a 'Post Operations and Archive Phase' (PO/AP hereinafter) which ran from 1986 to 1990 and which, interalia, led to the institution of XMM's Survey Science Centre.

On a personnal note, I was not closely involved with XMM during the development phase of the project since, in 1985, through a streamlining within the then Space Science Department, I 'inherited' astronomy missions including IUE, operated at Villafranca until 1996 and thereafter its PO/AP, HST and ISO. In fact I was 'up to my neck' in ISO activities up to its launch in 1995 and beyond to the end of its mission in 1998. However XMM had two very capable Project Scientists in the shape, initially, of Tony Peacock then later Fred Jansen. It's right and proper here to thank them for their excellent work on the project.

I might also recall here the return to ESA of Robert Lainé to take up the position of XMM Project Manager. Robert worked with me within the EXOSAT payload team and he was also instrumental in redesigning that spacecraft, already in the hands of industry, to properly accommodate the imaging telescopes and attitude measurement system. He was certainly the right guy to have in place to solve the XMM mirror problem!

There was a long gap between EXOSAT and XMM operational phases however many of the persons who worked on IUE and ISO brought their knowledge, expertise and experience directly to XMM science operations in the most efficient manner. Many of them would have met me first on the opposite side of the interview table – and some of them have been here these last two days. One was Norbert Schartel who worked originally on IUE – many thanks to him for his part in the arrangements for this reunion.

There existed a reluctance to acknowledge the need for a PO/AP for missions and for each project it was an uphill struggle to obtain the resources to do a good job. Of course, initially, a PO/AP was only considered for astrophysics missions where ultimately all observational data could be made available to the scientific community through the archives. For the classical PI mission, this was not the case – certainly in my time in ESA. However I have to say the establishment of ESAC and the inclusion of mission products from all disiplines to make them broadly available has been most welcome and impressive. When I first came here in the 1980's Villafranca comprised a castle, a couple of satellite communication dishes and the 'IUE building'. The transformation here has also been truly amazing!

Amazing too, and not before time, is the intended ~ 10% increase in ESA's Science Programme funding, the first major increase in some 25 years, following from the recent ESA Council at Ministerial Level. This bodes well for the timely implememtation of XMM's successor Athena together with Lisa the gravitational wave detection mission. Congratulations therefore to the current Director of Science, Günther Hasinger, who spent part of his early life as an X-ray astronomer interpreting EXOSAT data.