XMM-Newton ready for the next decade?!!!!

Chandra calibration meeting
25 October 2007

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European Space Agency (ESA)
• health status of XMM
  – funding
  – spacecraft
  – instruments
  – calibration

• Cross Calibration
  – cross calibration archive
  – Chandra
  – Integral
  – Suzaku
  – Swift
  – IACHEC
• launched December 1999
• high elliptic orbit today rev: 1442
• published papers by today 1623
• AO7 closed
• ODFs in archive ~ 7500
• mission life --> pending SPC approval until END 2012
    ---> further extension targeted
No radiation damage expected before 2012. Design margins should allow a much longer operation (reasonable design margin 50%).
Instruments: healthy and clean - what does it mean?

• Instrument performance is unchanged or change is understood and can be modeled

• Health risks:
  – micro-meteoroids
  – Soft protons funneled by mirrors
  – Hard particles

  Reduction of Charge Transfer Efficiency and energy resolution

• Instruments show no contamination
  - Particulate contamination
  - Molecular contamination
  - Contamination risk: Out-gassing material

  Reduction of effective area and creation of edges in spectra
4 impacts so far in the mission
Last one in rev 961 (March 05) caused the loss of MOS1 CCD6 and a new hot column passing very close to the MOS1 boresight.
After a sudden optical flash, bright hot pixels appear
Interpreted as a dust micro-meteoroid scattered off the mirror surface under grazing incidence and reaching the focal plane detector.
Typical size ~< 1 micron
Interplanetary (or interstellar) dust but not linked to meteor shower (higher sizes/masses)
• at high energies EPIC-MOS energy resolution was degrading up to the cooling of the EPIC-MOS cameras --> after cooling nearly back to launch values
• no major effects are anticipated during the next solar cycle
• resolution @2015 is still near to launch values
  – factor FWHM@Mn: M1:1.16, M2: 1.10, pn: 1.20
**EPIC-MOS patch**

- small patch on each detector has been discovered using all archived 1ES0102 observation and performing in addition a raster scan to identify position and time variability.
- patch has degraded over time.
- broadens the redistribution function at energies around 0.5 keV
- coincident with the nominal position of sources when placed at EPIC-pn and RGS boresights, i.e.: the peak in received photon dose of the detectors
- causes a significant change in the low energy redistribution characteristics of the EPIC-MOS cameras, which is spatially and temporarily dependent
- the situation seems to have stabilised
- **no evidence for contaminant**
- Epoch & spatial dependent Response Matrices
- **detailed spatial re-analysis planned**
isolated neutron star RXJ1856-3754 is used as a target to monitor contamination on the EPIC cameras

very soft spectrum \(\rightarrow\) well suited to measure possible contamination, which would affect the low energy regime most strongly

observations can be used to derive upper limits for contamination for carbon and oxygen

SNRs N132D and 1ES0102 are used to measure contamination and stability of the energy calibration of the EPIC cameras.

This analysis showed that the EPIC-MOS cameras have changed in their redistribution characteristics but not in a way consistent with contamination.

<table>
<thead>
<tr>
<th>CAMERA</th>
<th>CARBON</th>
<th>OXYGEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPIC-pn</td>
<td>(&lt; 2.7 \cdot 10^{-7}\text{gcm}^{-2})</td>
<td>(&lt; 2.5 \cdot 10^{-6}\text{gcm}^{-2})</td>
</tr>
<tr>
<td>EPIC-MOS</td>
<td>(&lt; 7.2 \cdot 10^{-7}\text{gcm}^{-2})</td>
<td>(&lt; 1.3 \cdot 10^{-5}\text{gcm}^{-2})</td>
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</tbody>
</table>
- no further problems of CCD failure after revolution 135 early in the mission
- RGS2 single-node readout
  - recurring set-up electronics problems
  - operating since 2007 August 18 in single-node readout
  - initial re-calibration CCFs in place
  - requires SAS v7.1
  - pile-up considerations

- flux deficit due to carbon absorption --> linear build up model in calibration
- New RGS effective area CCFs based on linear increase with time of pure carbon contamination layer
- Fixed polynomial blazar power-law correction
- Improved Crab nebula model
- corrected RGS flux constant within ± 5 %
• Laboratory measurements of all Optical Monitor components allowed to predict the throughput of the OM system

• after launch in-flight throughput measured by observing standard stars was found to be lower than expected (in particular in the UV filters)

• deficit observed in the in-flight throughput, as low as 16 % at 212 nm, is independent from the time sensitivity degradation of the OM detector, which is much smaller.

**Sensitivity loss by 2015**

- U, B, V, UVW1 : < 15 %
- UVM2, UVW2 : < 30 %
• **EPIC:**
  - loss of 5% EA (at the outer FOV)
  - rock solid super clean pn instrument
  - controlled MOS redistribution changes
  - CTI changes as expected
  - no contamination

• **RGS:**
  - loss of 2/18 CCDs shortly after launch (however redundant)
  - controlled contamination
    (by 2015: 50% EA reduction at 30 Å)

• **OM:**
  - wavelength dependent sensitivity reduction by 2015: 20% (optical), 20-30% (UV)
cross calibration archive

- data processing
- spectral extraction
- data fitting

XMM
Cross Cal data archive

Chandra
Cross Cal data archive

ESAC grid
fully automated + version control

AJAX based web applications

- data processing
- spectral extraction
- data fitting

XSA
ESAC grid

AJAX based web applications
• to go public by end 2007

• Current content:
  – ~ 250 observations
  – ~ 150 checked in for automated processing (XMM only)
  – ~ 20 checked in for automated processing (XMM-Chandra)
  – all will be checked in by end 2007 (definition of extraction region/times and check for pile up needs to be checked and iterated ONCE manually)

• Using ESAC grid:
  – 10 nodes so far, each node has 2 CPUs Intel(R) Xeon(TM) 3.00GHz with 6GB of memory

  ➡ process and fit 150 Observations /24 hours
calibration - example H1426+428

EPIC-pn MOS1 MOS2 RGS1 RGS2

SAS 6.1 (December '04)

SAS 6.5 (August '05)

SAS 7.1 + new RGS EA
September 2007
PKS2155-304
XMM rev. 0362
Good agreement above 1 keV
ACIS/LETG has higher normalisation than the EPICs below 1 keV
Above ~2 keV, ACIS/LETG agrees with MOS
• 1. HRCS-LETG deficit below 1 keV (as e.g. the Beuermann et al. 2006 results comparing with ROSAT), and excess above 1.5 keV (HRC LETG flux derived from combining orders 1 to 5)

• 2. ACISS-LETG deficit similar to that of HRCS-LETG in 0.33-0.54 keV band

• 3. Overall, where EPIC diverge, ACISS-HETG follows MOS rather than PN
Cygnus X-1
- XMM rev. 0907
- pn modified timing mode
- Unique BH model
- Joint fit with norm. constants
- Data by courtesy of S. Fritz, IAAT
XMM-Newton versus Suzaku/Swift

RXJ1856.6-3754

PKS2155-304: 22.04.2007

XIS rmf/arf of 2006

Work in progress
International Astronomical Consortium for High Energy Calibration (IACHEC)
XMM-Newton, Chandra, Suzaku, INTEGRAL, Swift, RXTE, BeppoSax, Rosat, Einstein, (Astrosat, Symbol-X, E-Rosita)

Goals:

• supervise cross calibration efforts
• paper on X-ray calibration standard candles
• paper on X-ray calibration targets for standard calibration issues
• XMM-Newton is ready to perform high-end observation until at least 2018
• funding most probably until end 2012
• all mission elements are stable and trouble free
• outstanding publication rate of ~300 papers/year
• half of all XMM-Newton papers are in the top 10 % of cited astrophysical papers
• calibration under control and in good shape
• A07 involvement: over-subscription factor ~7

• keep on making rock an’ roll