Background Working Group (BGWG)

The EPIC Background working group was founded in 2005 to provide users with clear information on the EPIC Background and (SAS)-Tools to treat the EPIC Background correctly for various scenarios.

• Blank Sky (BS) Files (all-EPIC imaging mode, and pn timing mode)
• Solar Wind Charge Exchange (SWCX) contamination
• Filter Wheel Closed (FWC) data
• Extended Source Analysis Software (ESAS)
• MOS CCD Noise
• + User resources (files, tasks, scripts, info, advice, papers)

UG: ‘The UG congratulates the SOC, Instrument Teams, Background Working Group (BGWG), SAS developers also from SSC for the tremendous work done on the different aspects of the calibration, background analysis and SAS development.’
# XMM-Newton EPIC Background Components

Table summarizing the components within the XMM-Newton EPIC Background; temporal, spectral and spatial properties.

Count rate plots, giving an estimate of the to-be-expected EPIC background in low background periods, both in-FOV (photon+particles) and out-FOV (particles), are available [here](#).

<table>
<thead>
<tr>
<th>PARTICLES</th>
<th>INTERNAL (cosmic-ray induced)</th>
<th>ELECTRONIC NOISE</th>
<th>HARD X-RAYS</th>
<th>PHOTONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOFT PROTONS</td>
<td>Interaction of High Energy particles (cosmic rays) with detector - associated instrumental fluorescence.</td>
<td>Bright pixels &amp; (parts) of columns.</td>
<td>X-ray background (AGN etc), Single Reflections from outside FOV, Out-of-time (OOT) events (pn)</td>
<td>Local Bubble, Galactic Disk, Galactic Halo, Solar Wind Charge Exchange (SWCX), Single Reflections from outside FOV, Out-of-time (OOT) events (pn)</td>
</tr>
</tbody>
</table>
| Source | Few x 100 keV solar protons, accelerated by magnetospheric reconnection events. Dominate times of high-BG. | 110%.
MOS1-MOS2 >2keV continuum unchanged, small changes in fluorescence lines. 1.5keV continuum - may be due to Al redistribution. | 110%.
| Variable? (per Observation) | Flares (up to 1000%). Unpredictable. Significant quiescent component (long flares) - survive GTI screening. (Also additional possible irreducible component) | 110% constant. | Constant. |
| Variable? (Obs. to Obs.) | Unpredictable. Affect 30%-40% of time. Flaring SP increasing? Quiescent SP not evolving. More SPS far from apogee. More SPS in winter than in summer. Low-E flares turn on before high-E. | Majority ±15%. Can be 10 higher in high radiation periods. No increase after solar flares. | Constant. |
| Spectral | Variable Unpredictable. Continuum spectrum (no lines), fitted by unfolded spex.pl [double-exponential or broken power law (break energy stable ~2 keV) model for 30-50 keV (0.1-50 keV, less flux is seen) Variance in intensity, shape (higher the intensity, flatter the slope). | (1) 100% pixels come and go, also [micrometeorite damage]. Mode-dependent lowest eff, then FF, LW, highest SW. | Variation with RA/Dec (±35%). |
| Spatial - Vignetted? | Yes (scattered) - Vignetting is flatter than for photons - low-E SPS extremely flat, higher-E SPS steeper (MOS2 - pn shows more constant vignetting with energy). | Flat (MOS index=0.2) + fluorescence + detector noise. | SWCX two modes: SWCX, SWCX very soft, with unusual Ovi/Nv line ratios (plus others) - Strong Ovi & MgII |
| Spatial - Structure? | Perhaps, in MOS due to the RGA. No structure seen in pn. SP feature seen in MOS1-CCD2 at low-E. SPS observed only inside FOV. | Yes, Detector + construction. MOS1-CCDs more Al, low Si. Less Si out-FOV. Continuum diff between out-FOV and in-FOV below Al line (redistribution?). More Al out-FOV. Changes in high-E lines, CCD to CCD. Line intensity variations, energies/strength stable. | No, apart from real astronomical objects. Exgals 0.8 keV spatially uniform. |
| Patterns | Distribution similar to genuine X-rays. | Distribution different from genuine X-rays. | Genuine X-ray distribution. |

This page is maintained by Andy Read, and was last updated on 03/02/2012 15:10:11.
XMM-Newton Extended Source Analysis Software package, XMM-ESAS
As of SAS version 9.0, the XMM-ESAS package is integrated in SAS. XMM-ESAS allows the user to model the quiescent particle background for both spectral and spatial analysis of EPIC pn and EPIC MOS observations.

XMM-Newton 'blank sky' background event files
XMM-Newton EPIC blank sky user facility released in August 2010 following a processing of the XMM-Newton archive (up to revolution 1789) using SAS 9.0. Users within the community are invited to request blank sky files specifically catered for, and precisely tuned to their own particular needs.

Filter Wheel Closed data
Updated in April 2011 by the EPIC Background Working Group the stacked collections of Filter Wheel Closed (FWC) data are available for the MOS and pn cameras.

Exospheric solar wind charge exchange affected observations
Lines-of-sight to XMM-Newton targets sometimes traverse regions of X-ray emission in the vicinity of the Earth. This emission results from a charge transfer process between ions in the solar wind and neutral gas (primarily hydrogen) close to the Earth, and can exhibit temporal signatures that make it possible to identify affected observations.

Further EPIC Background Scripts
- Estimation of the residual Soft Proton flare contamination
- Background correction for faint extended EPIC PN emission
- Specific scripts to be used with Blank Sky event files

Other Useful Information
The following sources of information (including historical collections of background blank sky fields) are also available:

Web site: XMM-Newton EPIC 'Blank Sky' Background
Web site: Related EPIC background event files, maps, software, analysis techniques etc.
Web site: Supporting data, background event files etc.
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Web site: Supporting data, background event files etc.
Web site: Table of temporally-variable SWCX-affected observations
Blank Sky Files – All-EPIC Imaging

- Very popular - 500+ requests processed, 100 individual users
- Link to table of all requests now available – users can obtain previous BS files
- Future possibility of selecting on observations with/without noisy MOS CCDs
- Blank Sky threads and improved scripts on BGWG web pages
Blank Sky Files – pn Timing

• Scanned whole dataset of timing mode observations
• Checked if they are really blank (~30 observations ‘non-strict’, ~16 ‘strict’)
• Found source contamination and subtracted it
• PN TI Blank Sky BG seen to scale with instrumental BG (RGS)
• Aim to:
  • Create templates for different BG conditions, to extract the PN TI BG
  • Normalization of the templates with the 12-15 keV continuum or with help of the copper line intensity
  • Testing on a sample of obscured XRBs
• SWCX - Solar Wind Charge eXchange
• Almost whole mission analysed (MOS - FF)
• Variable SWCX-affected observations (~3% of all obs.) linked to from EPIC BGWG main pages
• Links to individual spectra and lightcurves
• Link to info for all observations used in the study
Filter Wheel Closed (FWC) Files

- Stacked collections of data in FWC available for MOS (FF) and pn (all modes)
- Repository updated once per year, before BGWG/BOC/UG (updated February 2012, including data up to December 2011)
- Light curve of EPIC-pn TI mode has been fixed by placing a cut on PI>300eV
- New events, files and plots added to web pages

0.2 – 10 keV
1. – 2. keV
7.8 – 8.2 keV
7.3 – 7.6 keV
ESAS in SAS

• ESAS – Extended Source Analysis System (SSn/KK)
• Now fully working in SAS on MOS and pn
• Now no stand-alone version of ESAS
• Need to make ESAS more conforming to the SAS:
  • To be rewritten in F90/C++,
  • with CAL-DB moving to normal CCFs (large effort – 125->25 files)
• For next release:
  • MOS processing uses 5eV binning
  • Adaptive smoothing for additional info
MOS CCD Noise

• ‘Switchpoints’ between noise states occur predominantly at times of high radiation
• All tests to ‘switch’ CCD noise state (sequencer restarts, high-radiation) failed
• No clues to why particular high-rad observations ‘switch’ – huge range in accumulated radiation dose between switches
• Technical Note written
• M2C5 still noisy/clean, after switch to secondary electronics mode, but noisy less often (last ~500 rev) – other chips different
Sco X-1

- Slew (pn)
- Source ~3deg across
- Useful for stray light analysis
End