Agenda:

EPIC BG working group: 6th meeting: 05/11/07 - Mallorca

Location: http://www.hoteltora.com/ [Minutes - ME]

14:30 - 18:00 (tea/coffee at ~16:15)

Introduction and action items from last meeting [AMR]

BG report from the June XMM-Newton UG meeting [ME]

The status of XMM-ESAS [SS]

The status of the Blank Sky files and software [JAC]

EPIC PN background spectra for low surface brightness sources [WNP]

Discussion: Web Pages, BG Components, FWC data, new scripts/tools, long-term BG trends etc. [AMR + all]

Summing-up - AOB - Plans for the next period - Next meeting

[AMR]
Apologies:

None
1.0 Action Items from last meetings (AR)

**AL_EPIC_BG_WG_01_01**: SS to provide by October 2005 to SOC
- Proton screening tool
- Use of multiple light curves for screening
- Provide list of st. candles for BG analysis comparison with different tools
  - By end of December 2005 a SAS task version will be available for DT, aiming release for SAS 7.0 – **OVERDUE** (SAS task by B. Perry for DT; there was a problem with Perl numerical recipes & PGP key for upload) – see new(265,954),(976,999)
  - list of BG candles - **ONGOING**

**AL_EPIC_BG_WG_01_04**: AR to invite other BG experts to next meetings and to provide possibly scripts/tasks - **ONGOING**

**AL_EPIC_BG_WG_01_12**: MF: Once any BG or Closed fits files had been obtained, the user can change their CCF_PATH etc. setup so that a new cifbuild would incorporate these extra files. This enables the BG/Closed events files (e.g. the ones used in SS’s task) to be used in the SAS, without them having to be included in the CCF files. – **ONGOING, no news from MF** - Interface TBD (MF & RS)

**AL_EPIC_BG_WG_02_01**: MK to ask RGS if RGS BG light curve could help EPIC screening
**OPEN**: MK shortly discussed with A. Pollock; **no news from MK**, A. Pollock should be involved later (invite him for one of the next meeting)

**AL_EPIC_BG_WG_02_03**: ME to test and transfer WPs script of 01_11 to SOC thread **ONGOING**, to be used/tested by SAS-WS participants;
AI is now part of the project of a Young Graduate Trainee (YGT) working with ME at ESAC, see Section 2.5 below.

**AL_EPIC_BG_WG_03_02**: On all: provide AR with additional links & more papers for BG component table - **ONGOING**
AI_EPIC_BG_WG_03_07: on ME: test soft proton screening s/w SAS tool “espfit”
    OPEN – v0.7 is available in SAS development track now: 1st test on A1795
MOS data looks OK, pn check still TBD

AI_EPIC_BG_WG_03_08: on MF: UHB update section 3.2.4: outside FoV eff. Area (up to
70 arcmin). Undate of CCF (currently not supported; calview 15 arcmin.
TBC) OPEN, no news from MF

AI_EPIC_BG_WG_03_10: on SM: provide BGWG with script on bkg treatment in spectral analysis
(after publication of related paper) – OPEN ⇒ see talk by AL, section 2.4

AI_EPIC_BG_WG_03_11: on AR: check HK parameters for anomalous MOS FWC data OPEN

AI_EPIC_RG_WG_04_02: on SS/K. Kuntz: try to extend MOS tools such that they also work for EPIC-pn
by about June 2007 – ONGOING

AI_EPIC_BG_WG_04_05: on JC/ME: test if location selection tool for blank-sky fields can be installed
at ESAC – ONGOING

AI_EPIC_BG_WG_04_06: on JC/AR: check if ‘ghosting’ script can be made available to all users via
the BGWG script page – ONGOING

AI_EPIC_BG_WG_04_07: on AR: trigger the generation of full field-of-view FWC MOS data by K.
Kuntz (standard mode), and make them available to ME for an update of the
FWC web page and related Newsletter announcement – ONGOING

AI_EPIC_BG_WG_04_08: on AR: trigger the generation of smaller sub-sets of EPIC-pn FWC data
(with M. Freyberg) ⇒ update of FWC web page needed - OPEN

AI_EPIC_BG_WG_04_10: on SS: ask K. Kuntz to include a figure on the dependence of the flaring MOS
background on the orbital position of XMM-Newton in the planned paper
- ONGOING
New Action Items resulting from this meeting:

AL_EPIC_BG_WG_05_01: on ME: continue testing of espfilt task with the goal of a first public release in SASv7.1

AL_EPIC_BG_WG_05_05: on SS: try to extend functionality of ESAS for pn and deliver a progress report for the next BGWG meeting
AL_EPIC_BG_WG_05_06: on AR/SS/ME: formulate request for more FWC calibration data

Possible future AI (on R. Saxton+student)?
Use SciSim to simulate cluster & bkg and test different analysis methods on it (also for Chandra simulator).
Background Analysis

This page gives information on the background analysis of all XMM-Newton instruments (EPIC, RGS, OM) in order that a proper data reduction may be undertaken.

| EPIC Background | RGS Background | OM Background | XMM-Newton Background |

EPIC

Introduction

The XMM-Newton observatory provides unrivalled capabilities for detecting low surface brightness emission features from extended and diffuse galactic and extragalactic sources, by virtue of the large field of view of the X-ray telescopes and the high throughput yielded by the heavily nested telescope mirrors. In order to exploit the excellent EPIC data from extended objects, the EPIC background, now known to be higher than estimated pre-launch, needs to be understood thoroughly.

There are several different components to the EPIC background:

1. Photons:
   - The astrophysical background, dominated by thermal emission at lower energies (E<1 keV) and a power law at higher energies (primarily from unresolved cosmological sources). This background varies over the sky at lower energies.
   - Solar wind charge exchange.
   - Single reflections from outside the field of view, out-of-time events etc.

2. Particles:
   - Soft proton flares with spectral variations from flare to flare. For weak sources the only option is to select quiet time periods from the data stream for analysis.
   - Internal (cosmic-ray induced) background, created directly by particles penetrating the CCDs and indirectly by the fluorescence of satellite material to which the detectors are exposed.

3. Electronic Noise:
   - Bright pixels, columns etc., readout noise etc.

A table summarizing the temporal, spectral and spatial properties of these EPIC background components is available here.
### XMM-Newton EPIC Background Components

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

<table>
<thead>
<tr>
<th>Source</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOFT PROTONS</strong></td>
<td><strong>INTERNAL</strong></td>
<td><strong>ELECTRONIC NOISE</strong></td>
<td><strong>PHOTONS</strong></td>
<td><strong>SOFT X-RAYS</strong></td>
</tr>
<tr>
<td><strong>PARTICLES</strong></td>
<td><strong>(cosmic-ray induced)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable? (per Observation)</td>
<td>MOS: &gt;2 keV continuum unresolved, small changes in fluorescence lines.</td>
<td>(2) CAMEX readout noise (pre).</td>
<td>Single Reflections from outside FOV. Quasi-time (QOT) events.</td>
<td></td>
</tr>
<tr>
<td>Flaring SP increasing? Quiescent SP not evolving. More SPs from apogee. More SPs in winter than in summer. Low-E transients turn on before high-E.</td>
<td>MOS: 0.05-1.0 keV, &lt;0.5 Obs-HK.</td>
<td>(3) Artificial lower limits for MOS.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable? (Obs. to Obs.)</td>
<td>Majority @ &gt;1.1 keV. Can be x10 higher in high-flux periods. No increase after solar flares.</td>
<td>MOS: &lt;0.8 keV. High-E lines.</td>
<td>Variation with RA/Dec. (4.35%).</td>
<td></td>
</tr>
<tr>
<td>Spectral</td>
<td>Flat MOS index 0.2+5 fluorescence noise + direct noise.</td>
<td>(4) Low-E (&lt;1 keV).</td>
<td>SWCX may affect observations differently.</td>
<td></td>
</tr>
<tr>
<td>Spatial-Vignetted?</td>
<td>No (seem better).</td>
<td>No flux in FOV.</td>
<td>OOT events (pro mode-dependent (LW0.1%, FF8.3%, EFF 2.3%)).</td>
<td></td>
</tr>
<tr>
<td>Patterns</td>
<td>Distribution similar to genuine X-rays.</td>
<td>Distribution different from genuine X-rays.</td>
<td>Partially ionized objects. X-rays 1-8 keV spatially uniform.</td>
<td></td>
</tr>
</tbody>
</table>

*Malaga, Spain 05/11/07*
Products

- **XMM-Newton Extended Source Analysis Software package, XMM-ESAS**
  Released in March 2006 by the EPIC Background Working Group allowing the user to model the quiescent particle background both spectrally and spatially for the EPIC MOS detectors.

- **New XMM-Newton 'blank sky' background events files**
  Released in May 2006 by the EPIC Background Working Group for the 3 EPIC instruments in each of their different instrument/mode/filter combinations, and constructed using superpositions of pipeline product data from the 2XMM reprocessing of many pointed observations.

- **Filter Wheel Closed data**
  Released in September 2006 by the EPIC Background Working Group the stacked collections of Filter Wheel Closed (FWC) data are available for the MOS and pn cameras.

- **Further EPIC Background Scripts**

Other Useful Information

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

   Web site: Related EPIC background event files, maps, software, analysis techniques etc.
   Web site: Supporting data, background event files etc.
   Web site: Related background files and explanatory notes
   [An older version of the background files is still available: Web site: Old background files and old explanatory notes]
This page contains the following scripts:

- Estimation of the residual Soft Proton flare contamination
- The "images" Script: a tool to create attractive XMM-Newton images

**Estimation of the residual Soft Proton flare contamination**

A shell script to perform the Fin/Fout ratio calculation developed by Silvano Molendi, Andrea De Luca & Alberto Leccardi (2004, A&A 419, 837) on EPIC event files (MOS1, MOS2 and/or pn), to estimate the amount of residual Soft Proton flare contamination is available.

The script can be run on any EPIC event files (MOS1, MOS2 and/or pn), to estimate the amount of "residual" Soft Proton (SP) flare contamination, i.e. it should only be used "after" attempts have been made to clean the event files for SPs using GTI filtering.

The script compares area-corrected count rates in the in-FOV (beyond 10 arcminutes) and out-of-FOV regions of the detector. The higher the in-FOV to out-of-FOV ratio, the more the file is contaminated by SPs:

- Ratio < 1.15 : File is not contaminated by SPs.
- Ratio 1.15-1.3 : File is slightly contaminated by SPs.
- Ratio 1.3-1.5 : File is very contaminated by SPs.
- Ratio > 1.5 : File is extremely contaminated by SPs.

For point source analysis, and especially for bright point sources, a rigorously correct treatment of the background is not critical, and even extremely SP contaminated files may be analysed safely in the usual manner.

For extended source analysis however, even a moderate amount of residual SP contamination may lead to corrupted science results, especially e.g. in the estimated temperature. Here the user may wish to, depending on what they are trying to do, use another (cleaner) observation (of the same or a different target). Or they may attempt to remove the residual SPs using more complex data screening (some descriptions of various techniques are given in the Other Useful Information section of the main ESAC-XMM Background Analysis page). If the data allow, the user could also attempt to include the SP contamination as an extra model component, when modelling the data (e.g. in spectral fitting).

Note finally that for observations where an extended source fills the entire field of view (FOV), e.g. the Coma cluster, then the Fin_over_Fout script does not yield a reliable measurement of the SP contamination. Care should be taken in such situations.

The script may be downloaded here.
Fin_over_Fout       [New – Available]

Warnings put in regarding use of the MOS1 algorithm with post Rev-961 MOS1 CCD6 loss
[have requested input from SM/AL]

```
> amr30@epic6 /work/amr30/M101/OBS1/ > ../../Scripts/Fin_over_Fout r1_EvM1_f.fits r1_EvM2_f.fits r1_EvPN_f.fits N N N N
-------- FIN_OVER_FOUT version 1.1 05/10/07 --------
Creating clean event files and spectra...
Using recommended default Energy ranges...
Analysing MOS1 file...
Warning: MOS1 observation made after the Rev 961 MOS1 CCD6 loss...
        MOS1 result may not be entirely accurate (to ~10% in RATIO) ...
Analysing MOS2 file...
Analysing PN file...
Removing intermediate files...

   COUNTS   EXP TIME   F(IN)/F(OUT)
        IN     OUT     IN     OUT     RATIO     ERR
M1   9417   2423   37.4   37.4   1.719   0.047
M2   8908   2687   38.3   38.3   1.584   0.042
PN  18267  1822   23.3   23.3   1.331   0.037

File is extremely contaminated by Soft Protons
File is extremely contaminated by Soft Protons
File is very contaminated by Soft Protons
```

Andy Read (amr30@star.le.ac.uk)
6th EPIC BG WG Meeting
Mallorca, Spain 05/11/07
XMM-Newton Further EPIC Background Scripts

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The script may be downloaded here.
Script to perform image creation + cleaning + exposure correcting + smoothing + …

- Runs cifbuild, odfingest, epchain, emchain, (omichain)
- Performs gti file preparation, gti cleaning, cleans bad pixels and columns, subtracts ooT events (pn)
- Makes images, exposure maps, masks, smoothes images, makes combined exposure map and mask
- Weighs pn against MOS cameras in each band
- Use images, exposure maps, masks and weights to combine images from all cameras

(M. Ehle, R. Willatt, W. Pietsch, M. Bauer)

SN2004dj in NGC 2403

XMM
EPIC
MOS

Andy Read (amr30@star.le.ac.uk)
6th EPIC BG WG Meeting
Mallorca, Spain 05/11/07

University of Leicester
BGrebinimage2SKY [New – Available]

Now can rebin and reproject any DETX/DETY image of any binning onto the sky to the spatial scale and sky X/Y position of a user-input image

**BGrebinimage2SKY**

Projection of Sky maps: A script to rebin and reproject exposure maps (or any DETX/DETY image of any binning) onto the sky to the spatial scale and sky position of a user-input image. This is useful when wanting to work in sky coordinates and to a different spatial scale than e.g. the 4 arcsecond scale used in the production of the exposure maps. This script is a wrapper for a fortran executable and is dependent on the user’s operating system.

The shell script (BGrebinimage2SKY) and the fortran executable (either BGrebinimage2SKY_interp_solaris or BGrebinimage2SKY_interp_linux, depending on your system - this must be renamed to 'BGrebinimage2SKY_interp') can again be obtained from the main download script site.

Typing the name of the shell script wrapper BGrebinimage2SKY gives help on usage.

Use:
```
BGrebinimage2SKY Input_exposure_map template_image eventfile Interpolation_radius outimage scaling
```

Example call:
```
BGrebinimage2SKY EXPm.fits myimage.fits evfile.fits 0.15 outexp.fits 0
```
M. Bauer et al.: The diffuse X-ray emission in the starburst galaxy NGC 253

\[
B(E) = S_{\text{out-of-time}}^{\text{OCT}}(E) \times f + S_{\text{det}}(E) \frac{R_{\text{obs}}}{R_{\text{det}}} \frac{t_{\text{obs}}}{t_{\text{det}}} - S_{\text{det}}^{\text{OCT}}(E) \frac{R_{\text{obs}}}{R_{\text{det}}} \frac{t_{\text{obs}}}{t_{\text{det}}} \times f + \\
+ V(E, \theta_s) A_s \frac{V(E, \theta_B) A_B}{\text{sky background}} \times \left( B_{\text{obs}}(E) - B_{\text{out-of-time}}^{\text{OCT}}(E) \times f - B_{\text{det}}(E) \frac{R_{\text{obs}}}{R_{\text{det}}} \frac{t_{\text{obs}}}{t_{\text{det}}} + B_{\text{det}}^{\text{OCT}}(E) \frac{R_{\text{obs}}}{R_{\text{det}}} \frac{t_{\text{obs}}}{t_{\text{det}}} \times f \right)
\]
This page contains details on the XMM-Newton EPIC cameras, including health monitoring, and presentations from calibration meetings and background meetings. Attendees' presentations from past meetings are available in the following formats: postscript (.ps), powerpoint (.ppt), or acrobat (.pdf). Presentations that comprise of several files are tape-archived (taped), and often compressed (using gzip). All the health monitoring plots are in PostScript format, unless otherwise stated.

Plots showing the health of the EPIC MOS instrument can be found on our Instrument Health Monitoring page.

**Instrument Monitoring**

**Calibration Meeting Presentations**

- Expand all meetings (closing meeting)
- Palermo, April 2007
- Mallorca, October 2006
- Iceland, June 2006
- MPE, May 2006
- ESAC, October 2005
- Mallorca, February 2005
- Veld, March 2004
- Saclay, September 2003
- Tiembgen, February 2003
- Veld, July 2002
- Ringberg, April 2002
- Mann, November 2001
- Leicester, June 2001
- Paris, February 2001
- Leicester, July 2000
- Paris, June 2000

**Background WG Meeting Presentations**

- Palermo, April 2007
- Mallorca, October 2006
- MPE, May 2006
- MPE, November 2005
- ESAO, June 2005

Background talks are also included in the Calibration Meetings above.
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### EPIC

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There are several different components to the EPIC background:

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---

Andy Read (amr30@star.le.ac.uk)
6th EPIC BG WG Meeting
Mallorca, Spain 05/11/07
The Behaviour of the XMM–Newton Background:
From the beginning of the mission until August 2006

XMM-SOC-USR-TN-0014
issue 1.0

P.M. Rodríguez–Pascual and R. González–Riestra
XMM–SOC User Support Group
January 22, 2007

1 Introduction

In their Meeting of May 2006, the XMM–Newton Users Group recommended “to reassess the EPIC background loading for a 1 year sample in order to investigate a seasonal dependence” (rec. 2006-05-19/34). There was a second recommendation “to study the possibility to define a new type of proposal whose scientific objectives can be achieved with short observations performed in high background conditions at the last science time of the revolution” (rec. 2006-05-19/35). The present report is aimed to study the two above points. For this purpose we have examined the background in RGS1 and EPIC–pn science observations taken until the end of July 2006.
- EPIC-pn data more scarce & RGS on longer time at end of rev
- Conclusions based mainly on RGS – within scatter, no difference between instruments
Evolution of the BG (years)

- Instruments generally agree
- No clear trend in evolution of BG
- Largest changes seen at end of rev – peaks of BG increase from 2000 to 2003-2005 and then decline

30@star.le.ac.uk)
WG Meeting
pain 05/11/07
Evolution of the BG (months)

- Seasonal dependence due to asymmetry of the Earth’s magnetic field along the sun-antisun line.
- Beginning: Strong seasonal effect – high Feb-Aug – lower for rest of year – min in Dec & Jan – variation factor can be ~8
- Apogee: Similar – marked minimum in Dec & Jan – variation only <3 (only <1.5 in Mar-Oct)
- End: Highest levels and strongest variations – Max in Apr (~8x Aug-Sep) – plus yearly effect
Evolution of the XMM BG (Years)
Evolution of the XMM BG (Months)
Some Other Open Issues

• espfilt?

• Any new tools, files?
• MJF – new pn CLOSED stacked sets – SAS 7.1

• Scripts? Link from Other scripts page to ‘other scripts’ – e.g. ghostholes, BGrebinimage2SKY

• Plans for future versions of the ESAS s/w package?
• Convert ESAS into pn tool?

• Papers – KK/SS – MOS BG paper (astro-ph?) (BGWG-link?)

• What to present to CAL tomorrow?
OOT events – removal on an event-by-event basis?

To remove OOT events on a statistical basis from pn event files.

- shell-script? SAS-task?

- Takes (clean) pn event file as input, obtains mode, hence knows fraction of events that are OOT events (e.g. 6.3% for PP mode [2.3% for ePP]).

- Per CCD

  - Per RAWX (if stats allow - can be checked first - if not [low stats] can go to groups of columns e.g. 2/4/8/16 RAWX...)

  - Analyse events in particular RAWX column - Select 6.3(PP)% of the events such that:
    1) They are uniformly distributed (flat) in RAWY
    2) Anything else? e.g. spectral considerations...

  - Remove these events to a separate (OOT) file

- Next RAWX

- Next CCD

- Updates header values - e.g. such that one is unable to do the same procedure again (only want to do this once to a file).

=================================================================