EPIC BG working group: 2nd meeting 24/11/05-25/11/05 MPE

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Small new seminar room @ MPE: Basement No. 1.1.18a.
(There will be a beamer, an overhead projector and some
connections for laptops.)

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The EPIC Background: Understand - Reduce - Model

Agenda
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Thurs 24/11/05 14:00-18:00
Fri 25/11/05 10:00-18:00 (Lunch 12:30-13:30?)
(With coffee/tea breaks at appropriate times)
Marcus & I shall try to take the minutes, edit
them and distribute them.

===========

1) - Action Items from meeting #1 (AMR)

2) Progress Reports (Including Actions):

- Overview, Meetings, Apologies, Web Pages, BG Components Synopsis Table (AMR)

- BG Blank Sky Data Analysis (JAC)

- Updates to previous MJF presentation (MJF)
- pn BG Modelling/Subtraction at MPE (MJF)

- Web pages - ESAC (MK)

- Solar wind charge exchange (SS)
- The temporal evolution of the MOS particle background (SS)
(-) SP filtering task (SS)

- Others?

3) New Items/Tools:

- Other BG Tools (AMR)
  - Others ??

- Others ??

4) Final session: 05/11 Afternoon - Summing-up

- AOB
- Next meeting (and/or next progress [teleconf?] meeting).

EPIC-BG Working Group

- At the end of the last UG meeting, and in line with the conclusions from previous UG meetings, it was highlighted that there is a need for EPIC to progress in the description and treatment of the EPIC-BG

- Setting-up (June 05) of EPIC-BG working group:

Andy Read (science chair), Jenny Carter, Wolfgang Pietsch,

Michael Freyberg, Steve Snowden, Matthias Ehle/Marcus Kirsch (SOC)

- Tasks:
- Define requirements of BG material (s/w, templates files) useful for general user
- Place general user BG material (tools, knowledge, files) on SOC web pages
- Organize/monitor necessary work at the PI institutes
- Hold regular BG status meetings
- Liase with other groups working on BG-critical material

EPIC-BG Meeting June/July `05 - Introduction

1) We need to understand the components of the (EPIC) X-ray background
2) We need to reduce as much as we can the (particle/instrumental) components of the X-ray background. This is relevant not just for EPIC, but for future missions also.
3) We need to model as correctly as possible the remaining components of the X-ray background

Understand – Reduce – Model

Meetings

- Report on BGWG at Calibration Meeting (ESAC, 04/10/05)

Apologies

- Silvano Molendi
- Juan Pradas & Juergen Kerp
- Gabriel Pratt

(All would like to remain informed/involved and hope to possibly attend the next meeting)

Actions from 1st meeting (taken from minutes)

AI_EPIC_CAL_14_1: Additional time column wit other 0 point for ODF (RD, MK, MJF)

AI_EPIC_BG_WG_01_01: SS to provide by October 2005 to SOC
- proton screening tool
- use of multiple light curves for screening
- BG tool
- provide list of st. candles for BG analysis comparison with different tools

AI_EPIC_BG_WG_01_02: AMR to provide SOC with scripts for blank sky data by end of August

AI_EPIC_BG_WG_01_03: MK to implement AMR scripts for blank sky data at SOC for standard processing after CAL updates

AI_EPIC_BG_WG_01_04: AMR to invite other BG experts to next meetings and to provide possibly scripts/tasks

AI_EPIC_BG_WG_01_05: MJF to provide link to processed pn closed event files for all modes to MK

AI_EPIC_BG_WG_01_06: MK to provide prototype BG web page by End July

AI_EPIC_BG_WG_01_07: AMR to send up to date link to BG pages at Birmingham

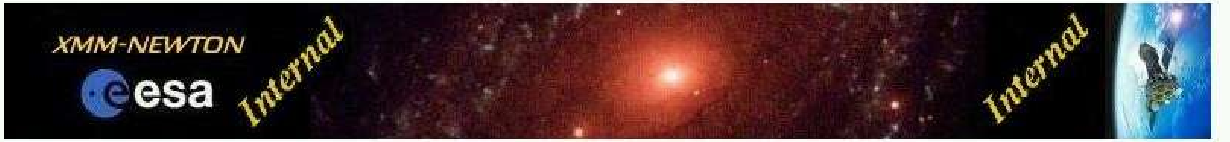
AI_EPIC_BG_WG_01_08: AMR to provide table for BG components to SOC

AI_EPIC_BG_WG_01_09: MJF to summarize the work done currently at MPE on pn BG modelling/subtraction at next meeting

AI_EPIC_BG_WG_01_10: MK to put minutes and AMR to put presentations to Leicester page

AI_EPIC_BG_WG_01_11: WNP to provide SOC with script for "good" image to be turned to a SAS thread

AI_EPIC_BG_WG_01_12: TBD: 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.



EPIC Background

XMM-Newton Revolution 10901050

XMM-Newton Refereed Papers 0891

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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.

There have been various attempts to describe/model the EPIC BG in the past. This page will provide an overview on all sources of BG analysis and modelling pointing out the recommended mainstream for BG treatment by the EPIC consortium.

In 2005 the XMM EPIC BG working group has been founded as a steering and supervising committee to advise and organise the EPIC consortium to provide the user with clear information on the EPIC BG and TBD (SAS)-tools to treat the EPIC BG correctly for various TBD scenarios.

Current progress of the working group can be monitored here

Here, in the in the not to far future, you will find our (EPIC) recomendation for BG treatment.

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

1. Paper: "The XMM-Newton EPIC background: Production of background maps and event files", A.M. Read & T.J. Ponman (University of Birmingham), A&A 409, 395 (2003)
   Web site: Related EPIC background event files, maps, software, analysis techniques etc.
2. Paper: "XMM-Newton EPIC background modelling for extended sources", J. Nevalainen (Helsinki University Observatory) et al., ApJ accepted (2005)
   Web site: Supporting data, background event files etc.
3. Paper: "X-ray background measurements with XMM-Newton EPIC", D.H. Lumb (ESTEC) et al., A&A 389, 93 (2002)
   Web site: Old background files
   Web site: Old explanatory notes (ps.gz)
   Web site: Explanatory notes regarding downloading the EPIC background files.
4. Paper: "The EPIC/MOS view of the 2-8 keV Cosmic X-ray Background Spectrum", A. De Luca & S. Molendi, A&A 419, 837 (2004)
5. Paper: "XMM-Newton Data Processing for Faint Diffuse Emission: Proton Flares, Exposure Maps and Report on EPIC MOS1 Bright CCDs Contamination", J. Pradas & J. Kerp, A&A 443, 721 (2005)

XMM-Newton EPIC Background Components

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

	PARTICLES			PHOTONS	
	SOFT PROTONS	INTERNAL (cosmic-ray induced)	ELECTRONIC NOISE	HARD X-RAYS	SOFT X-RAYS
Source	Few 100 keV solar protons, accelerated by magnetospheric reconnection events. Dominate times of high-BG.	Interaction of High Energy particles (cosmic rays) with detector - associated instrumental fluorescence.	(1) Bright pixels & (parts of) columns. (2) CAMEX readout noise (pn). (3) Artificial Low-E enhancements in MOS1 CCDs 2 & 5 (Also dark current - thought negligible).	X-ray background (AGN etc), single reflections from outside FOV. OOT events (pn)	Local Bubble, Galactic Disk, Galactic Halo, Solar Wind Charge Exchange, single reflections from outside FOV. OOT events (pn)
Variable? (per Observation)	Flares (>1000%). Unpredictable, significant quiescent component (long flares) - survives GTI screening. (Also additional possible 'irreducable' component).	+/-10%. MOS: >2keV continuum unchanged, small changes in fluorescence lines. <1.5keV continuum varies - may be be due to Al redistribution. pn: Difference between continuum and lines (some correlation).	(1) +/-10%. (2) Very constant. (3) Believed constant.	Constant.	Constant. Long obs. may see effect of SWCE.
Variable? (Obs. to Obs.)	Unpredictable. Affect 30%-40% of time. Flaring SP getting worse? Quiescent SP not evolving. More far from apogee. Low-E flares turn on before high-E.	Majority @ +/-15%. Can be x10 higher in high radiation periods. No increase after solar flares. Plus above 'per Observation' variations.	(1) >1000% (pixels come and go, also (micro-)meteorite damage). (2) Mode-dependent (lowest eFF, then FF, LW, highest SW) (3) CCD2: effects 50% of obs. (factor increases with high-BG rate); CCD5: effects 15-20% of obs. (by factor~2).	Constant. OOT events (pn) mode-dependent (LW:0.16%, FF:2.3%, eFF:6.7%)	Variation with RA/Dec (+/-35%). SWCE may affect observations differently. OOT events (pn) mode-dependent (LW:0.16%, FF:2.3%, eFF:6.7%)
Spectral	Variable. Unpredictable. Continuum spectrum (no lines), fitted by unfolded xspec PL model for E>0.5keV (E<0.5keV, less flux is seen). Variable in intensity + shape (the higher the intensity, the flatter the slope).	Flat (MOS index~0.2) + fluorescence + detector noise. MOS: 1.5keV Al-K, 1.7keV Si-K. Det.noise <0.5keV. High-E lines (Cr, Mn, Fe-K, Au). PN: 1.5keV Al-K. No Si (self-absorbed). Cu-Ni-Zn-K (~8keV). MIP noise <0.3keV.	(1) low-E (<300eV), tail may reach higher-E. (2) low-E (<300eV). (3) low-E (<500eV).	1.4 power law. Below 5keV, dominates over internal component.	Thermal with ~<1keV emission lines. Exgal.>0.8keV spatially uniform, index=1.4. Galactic - emission/absorption varies. SWCE very soft, with unusual OVII/OVIII line ratios (plus others).
Spatial - Vignetted?	Yes (scattered) - vignetting is flatter than for photons.	No.	(1,2) No. (3) Yes - evident in vignetting maps. (similar, smaller-magnitude vignetting asymmetries seen in pn).	Yes.	Yes.
Spatial - Structure?	Perhaps, in MOS due to the RGA. No structure seen in pn. SPs observed only inside FOV.	Yes. Detector + construction. MOS: outer CCDs more Al, less Si. CCD edges more Si. Less Si out-FOV. Continuum diff. between out-FOV and in-FOV below Al line (redistribution?). More Au out-FOV. Changes in high-E lines. CCD-to-CCD: line intensity variations, energies/widths stable. PN: Line intensities show large spatial variations from electronic board. Central 'hole' in high-E lines (~8keV). Residual MIP contribution near CAMEX readout (low-E, non-singles, parallel to readout).	Yes. (1) Individual pixels & columns. (Also [pn] sections of columns away from CAMEX, near to FOV centre) (2) Near pn readout (CAMEX), perpendicular to readout. (3) Confined to MOS1 CCDs 2 & 5.	No. Single reflections diffuse flux from 0.4-1.4 deg (out-FOV) is ~7% of in-FOV signal. OOT events (pn) smeared along readout from bright sources of X-rays. (extra BG in pn LW mode due to frame store area).	No, apart from real astronomical objects. Single reflections diffuse flux from 0.4-1.4 deg (out-FOV) is ~7% of in-FOV signal. OOT events (pn) smeared along readout from bright sources of X-rays. (extra BG in pn LW mode due to frame store area).
Patterns	Distribution similar to genuine X-rays.	Distribution different from genuine X-rays.		Genuine X-ray distribution.	Genuine X-ray distribution.

XMM
EPIC
MOS

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University of Leicester

Table 1. Summary of the components within the XMM-Newton EPIC Background; temporal, spatial and spectral properties

	PARTICLES			PHOTONS	
	SOFT PROTONS	INTERNAL (Cosmic-ray induced)	ELECTRONIC NOISE	HARD X-RAYS	SOFT X-RAYS
Source	Few 100 keV solar protons	Interaction of High Energy particles with detector	1) Bright pixels 2) Elec. overshoot near pn readout	X-ray background (AGN etc)	Local Bubble Galactic Disk Galactic Halo
Variable? (per Obs) (Obs to Obs)	Flares ($>$1000%) Unpredictable. More far from apogee. Low-E flares turn on before high-E	±10% ±10% No increase after solar flares	±10% 1) $>$1000% (pixels come and go, also meteor damage)	Constant Constant	Constant Variation with RA/Dec (±35%)
Spatial Vignetted? Structure?	Yes (scattered) Perhaps, unpredictable	No Yes. Detector + construction MOS: outer CCDs more Al, CCD edges more Si PN: Central hole in high-E lines (~8 keV)	No Yes 1) Individual pixels & columns 2) Near pn readout (CAMEX)	Yes No	Yes No, apart from real astronomical objects
Spectral	Variable Unpredictable No correlation between intensity + shape Low-E flares turn on before high-E	Flat + fluorescence + detector noise MOS: 1.5 keV Al-K 1.7 keV Si-K det.noise$<$0.5 keV. High-E – low-intensity lines (Cr, Mn, Fe-K, Au) PN: 1.5 keV Al-K no Si (self-absorbed) Cu-Ni-Zn-K (~8 keV) det.noise$<$0.3 keV	1) low-E ($<$300 eV), tail may reach higher-E 2) low-E ($<$300 eV)	~1.4 power law. Below 5keV, dominates over internal component	Thermal with $\lesssim$1keV emission lines

Read &

Ponman `03

XMM-Newton EPIC
at the University of Leicester

XMM-Newton is currently on its 1056 orbit of the Earth

- Home
- EPIC outreach
- EPIC instrument
- EPIC calibration
- EPIC consortium
- Photo gallery
- Links

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User Resources

Here you will find presentations from calibration meetings, background meetings, software and links to observational data from XMM-Newton.

Attendees' presentations from past calibration meetings. The presentations are available in the following formats: postscript (ps), powerpoint (ppt), or acroread (pdf). Presentations that comprise of several files are tape-archieved (tarred), and often compressed (using gzip).

Calibration Meeting Presentations

- Mallorca, February 2005
- Vilspa, March 2004
- Saclay, September 2003
- Tuebingen, February 2003
- Vilspa, July 2002
- Ringberg, April 2002
- Milan, November 2001
- Leicester, June 2001
- Paris, February 2001
- Leicester, July 2000
- Paris, June 2000

Background WG Meeting Presentations

- ESAC, June 2005
  - **Meeting summary** [pdf]
  - A.Read
    - EPIC-BG Meeting June/July 2005 - Introduction[ppt,pdf]

Background talks are also included in the Calibration Meetings above.

Other BG Items

- BG Flare rejection

- We have recommended in the past, rejection to be made using high-energy (~10-15 keV) lightcurves
- Blank-Sky BG event files use conservative thresholds on emchain-, epchain-produced lightcurves (high-energy)
- Much BG-proficient research now makes use of not only high-energy lightcurves, but lightcurves over the whole spectrum
  - Pratt – 3 sigma clipping using high/full/high/full lightcurves (high/full usually sufficient for normal observations)
  - Temple – 3 sigma clipping using high/full lightcurves
  - Nevalainen – Hard- and soft-band lightcurves
  - Pradas & Kerp – Multi-band (0.2-5, 5-8, 8-12 keV) analysis

Other BG Tools

- BGnearestExp

```
epic4 /work/amr30/BG > BGnearestExp

--------------- BGNEARESTEXP version 1.0 21/11/05 -----------------


Script to find nearest EPIC exposure to that of a particular
user-given event file.

BGnearestExp Evfile Instr Mode Filter ExpTime RevGap Distance Noutput

  Evfile  - Users event file
  Instr   - Required to be same Instrument (Y/N?)
  Mode    - Required to be same Mode (Y/N?)
  Filter  - Required to be same Filter (Y/N?)
  ExpTime - Minimum exposure time [s] (N=ignore)
  RevGap  - Maximum revolution gap (N=ignore)
  Distance- Distance [RA/Dec] offset: [I]gnore, [S]ort by [I/S]
  Noutput - Number of matches to print [N=10]

e.g. BGnearestExp  /mydirectory/myeventfile.fits Y Y Y 70000 100 S 20

---------------------------------------------------------------
```

e.g. > BGnearestExp myeventfile.fits Y Y Y 40000 200 S 20

…same instrument, same mode, same filter, exp>40000sec, within 200 Revs, sorted by angular offset distance …Top 20 matches…

```
--------------- BGNEARESTEXP version 1.0 21/11/05 -----------------

567 0109070201 S001 6.39972358309031E+04 EMOS1 Thin1 PrimeFullWindow 2.07145833000000E+02 2.63686111000000E+01 E1346+266
After instrument selection,     No.of matches : 3947
After mode selection,           No.of matches : 2801
After filter selection,         No.of matches : 1142
After exposure time selection,  No.of matches : 194
After revolution gap selection, No.of matches : 87
Sorting by angular offset distance...
Index tabulated : >0.9998  0.9994-0.9998   0.9962-0.9994   0.9848-0.9962   0.9397-0.9848   0.7071-0.9397
Angular distance: <1 deg      1-2 deg         2-5 deg         5-10 deg        10-20 deg       20-45 deg
Printing first 20 matches...
567 0109070201 S001 6.39972356673777E+04 EMOS1 Thin1 PrimeFullWindow 2.07145833000000E+02 2.63686111000000E+01 E1346+266 1
373 0092850501 S001 4.14211699250638E+04 EMOS1 Thin1 PrimeFullWindow 2.12349333000000E+02 2.63057778000000E+01 PG_1407+265 0.99669
482 0111290601 S001 5.27105030434728E+04 EMOS1 Thin1 PrimeFullWindow 2.16897916500000E+02 2.65372222000000E+01 PG1425+267 0.988412
550 0020540401 S001 4.91666496614814E+04 EMOS1 Thin1 PrimeFullWindow 1.97481666000000E+02 3.23752778000000E+01 RXJ1309.9+3222 0.983771
550 0082990101 S001 4.76092443232834E+04 EMOS1 Thin1 PrimeFullWindow 1.93387500000000E+02 1.57080556000000E+01 3C_277.2 0.957993
584 0145020101 S001 4.17124617615640E+04 EMOS1 Thin1 PrimeFullWindow 2.23633333500000E+02 1.86422222000000E+01 A_1991 0.956014
473 0103660101 S002 4.14965571469963E+04 EMOS1 Thin1 PrimeFullWindow 2.13451251000000E+02 4.40038889000000E+01 PG_1411+442 0.949105
466 0104860501 S001 4.20841611191332E+04 EMOS1 Thin1 PrimeFullWindow 1.85398333500000E+02 2.81038889000000E+01 RX_J122135.6+280613 0.943291
664 0150680101 S001 4.28901727838814E+04 EMOS1 Thin1 PrimeFullWindow 2.29481250000000E+02 3.14630556000000E+01 RDCS1517+3127 0.938714
660 0152940101 S001 6.28558158365190E+04 EMOS1 Thin1 PrimeFullWindow 2.04566250000000E+02 4.54250000000000E+00 NGC_5252 0.927412
656 0141570101 S001 4.24325657290816E+04 EMOS1 Thin1 PrimeFullWindow 1.88915958000000E+02 1.25562500000000E+01 NGC_4552 0.92719
666 0147330201 U002 8.27174816502333E+04 EMOS1 Thin1 PrimeFullWindow 2.10259167000000E+02 2.87777780000000E+00 Abell_1835 0.915803
651 0147610101 U002 4.48687813661397E+04 EMOS1 Thin1 PrimeFullWindow 1.84706500500000E+02 1.44165000000000E+01 NGC_4254 0.912619
459 0084190201 S001 4.79342383812368E+04 EMOS1 Thin1 PrimeFullWindow 2.04171250500000E+02 5.19136111000000E+01 UX_UMa 0.901502
744 0200130101 U002 9.41992137198150E+04 EMOS1 Thin1 PrimeFullWindow 1.87444833000000E+02 7.99997220000000E+00 NGC_4472 0.897114
642 0156360101 S001 5.18836756566167E+04 EMOS1 Thin1 PrimeFullWindow 1.81469166000000E+02 4.44861111000000E+01 rxj1205 0.887302
665 0150350101 S001 4.11377424365878E+04 EMOS1 Thin1 PrimeFullWindow 2.23489999500000E+02 3.54444440000000E+00 NGC5775 0.885562
467 0110980201 S001 5.77857499543428E+04 EMOS1 Thin1 PrimeFullWindow 1.91287083000000E+02 -4.60555600000000E-01 NGC_4666 0.858256
590 0145190101 S001 4.58464026193321E+04 EMOS1 Thin1 PrimeFullWindow 2.28973333500000E+02 5.63288889000000E+01 NGC5907 0.830759
586 0145190201 S001 4.24169668586850E+04 EMOS1 Thin1 PrimeFullWindow 2.28973333500000E+02 5.63288889000000E+01 NGC5907 0.830759
...remaining matches have too large an angular distance offset...
epic4 /work/amr30/BG > []
```

Closed files

- Closed blank-sky (particle) event files also exist (e.g. PM). Where? (I have copies)
- SS ?
- Collect together? Point to via SOC BG-webpage?

Blank-Sky Event files

- Used extensively. Improvements made and ongoing via users' suggestions. (AMR blank sky files very much ' easier to use' than e.g. Nevalainen files).
- Subtle differences in obtained results due to differences in BG cleaning. i.e. due to differences in BG count rate.
- Could make BG Blank-sky event files available also in terms of count rate boundaries, e.g. (c.f. Temple, 0.4-0.6 c/s, 0.2-0.4 c/s, 0.1-0.2 c/s).
- Also in terms of Galactic latitude (e.g. in Galactic plane and out of Galactic plane).