EPIC BG working group: 5th meeting 11/04/07 - Palermo

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Agenda

Location : http://www.grandhotelfedericoii.it/ [Minutes - ME]

9:30 - 12:00 (coffee served at 11:00)

•Introduction and action items from last meeting [AMR]

•An XMM-Newton XMM-ESAS software update [SS]

•Kip's view of soft proton flaring [SS]

•Update on Blank Sky work plus soft proton flaring analysis [JAC]

•Analysis of low surface brightness sources with EPIC [AL]

•New version of image generation script [ME]

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

•Final item: - Summing-up - AOB - Plans for the next period – Next meeting (and/or next progress [teleconf?] meeting).

Apologies:

MJF, (MK), KK, SM, GP, WNP

Actions from last meeting (taken from minutes) 1/3

1.0 Action Items from last meetings (AMR)

AI_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)

AI_EPIC_BG_WG_02_03: ME to test and transfer WNPs 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

AI_EPIC_BG_WG_02_10: all to provide proposal to AMR to link relevant papers to the BG component table – ONGOING (also see AI_EPIC_BG_WG_03_02)

AI_EPIC_BG_WG_02_11: ME to check with mission planning if criterion can be added for SWCX avoidance – ONGOING (offline between mission planning & SS)
An AO5 observation (100ks) in June should help to constrain model
First Results reported by SS: A beautiful data set without any high radiation nor SWXC signatures! ⇒ upper limits only will be extracted

AI_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 AI_EPIC_BG_WG_03_07
- list of BG candles - ONGOING

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

AI_EPIC_BG_WG_01_12: MJF: 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 MJF** - Interface TBD (MJF & RS)

On all: provide AMR with additional links & more papers - **ONGOING**

AI_EPIC_BG_WG_03_03: on AMR/JAC: to explain on blank sky web page when to use filled and/or unfilled data sets (recommendations) - **OPEN**

AI_EPIC_BG_WG_03_05: on AMR: to test if sky-recast tool is working correctly on specific data set (i.e a cluster) – **half CLOSED**

AI_EPIC_BG_WG_03_07: on ME: test soft proton screening s/w SAS tool (in dev. track?, TBC) **OPEN – waiting for task delivery**

AI_EPIC_BG_WG_03_08: on MJF: UHB update section 3.2.4: outside FoV eff. Area (up to 80 arcmin), Update of CCF (currently not supported, calview, 15 arcmin, TBC) **OPEN, no news from MJF**

AI_EPIC_BG_WG_03_10: on SM: provide BGWG with script on bkg treatment in spectral analysis (after publication of related paper) - **OPEN**

AI_EPIC_BG_WG_03_11: on AMR: check HK parameters for anomalous MOS FWC data - **OPEN**

New Action Items resulting from this meeting:

AI_EPIC_BG_WG_04_00: on all: send presentations to AMR

AI_EPIC_BG_WG_04_01: on SS/K. Kuntz: delivery of tools for MOS to merge data and for improved soft proton handling by March 2007

AI_EPIC_BG_WG_04_02: on SS/K. Kuntz: try to extend MOS tools such that they also work for EPIC-pn by about June 2007

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

AI_EPIC_BG_WG_04_06: on JAC/AMR: check if 'ghosting' script can be made available to all users via the BGWG script page

AI_EPIC_BG_WG_04_07: on AMR: 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

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

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

AI_EPIC_BG_WG_04_11: on ME: discuss with MS problem of undetected high energy noisy hot pixels and see if they can be detected in badpixfind or if SAS thread for background removal needs modifications

AI_EPIC_BG_WG_04_12: on SS to trigger on B. Perry that espfilt avoids the hot flickering pixel in pn CCD 11, column 63 (and eventually other bad regions of detectors)

Possible future AI (with 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

EPIC

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.

	PARTICLES			PHOTONS	
	SOFT PROTONS	INTERNAL (cosmic-ray induced)	ELECTRONIC NOISE	HARD X-RAYS	SOFT X-RAYS
Source	Few x 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) (4) Artificial Low-E enhancements in outer MOS CCDs (Also dark current - thought negligible).	X-ray background (AGN etc), Single Reflections from outside FOV, Out-of-time (OOT) events (pn)	Local Bubble, Galactic Disk, Galactic Halo, Solar Wind Charge Exchange (SWCX), Single Reflections from outside FOV, Out-of-time (OOT) events (pn)
Variable? (per Observation)	Flares (up to >1000%). Unpredictable. Significant quiescent component (long flares) - survive 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) (4) Believed constant.	Constant.	Constant. Long obs. may see effect of SWCX (e.g. variations at 0.5-1.2 keV [OVII/MgXI], but not at 2-4 keV).
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 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) effects 5-20+% of obs. (4) effects 20-50% of obs. (factor increases with high-BG rate)	Constant. OOT events (pn) mode-dependent (LW:0.16%, FF:6.3%, eFF:2.3%)	Variation with RA/Dec (+/-35%). SWCX may affect observations differently. OOT events (pn) mode-dependent (LW:0.16%, FF:6.3%, eFF:2.3%)
Spectral	Variable. Unpredictable. Continuum spectrum (no lines), fitted by unfolded xspec PL (double-exponential or broken power law [break energy stable ~3.2 keV]) model for E>0.5keV (E<0.5keV, less flux is seen). Variable in intensity + shape (higher the intensity, 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) (4) low-E (<500eV) (3) High-rate plus soft excess.	1.4 power law. Below 5keV, dominates over internal component. Above 5keV, internal component component dominates (in times of low-BG).	Thermal with ~<1keV emission lines. Extragalactic @>0.8keV, index=1.4. Galactic - emission/absorption varies. SWCX very soft, with unusual OVIII/OVII line ratios (plus others) - Strong OVIII & MgXI
Spatial - Vignetted?	Yes (scattered) - Vignetting is flatter than for photons - low-E SPs extremely flat, higher-E SPs steeper	No - flat (see below).	(1,2) No. (3) No/unclear (out-FOV) (see below) (4) Yes - evident in vignetting maps (in-FOV). (similar, smaller-magintude vignetting asymmetries seen in pn).	Yes.	Yes.
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. 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) MOS1 CCDs 4 & 5, MOS2 CCDs 2 & 5 - unusual in- & out-FOV differences (esp. MOS1 CCD4) and spatial inhomogeneities. (4) MOS1 CCDs 2 & 5.	No. Single reflections: Diffuse flux from 0.4-1.4 deg (out-FOV) is ~7% of in-FOV signal. Effective area of 1 telescope ~3 sq.cm at 20-80 arcmintes off-axis. 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. Exgal.>0.8keV spatially uniform. SWCX over whole FOV. Single reflections: Diffuse flux from 0.4-1.4 deg (out-FOV) is ~7% of in-FOV signal. Effective area of 1 telescope ~3 sq.cm at 20-80 arcmintes off-axis. 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.	Distribution different from genuine X-rays.	Genuine X-ray distribution.	Genuine X-ray distribution.

XMM
EPIC
MOS

Andy Read (amr30@star.le.ac.uk)
5th EPIC BG WG Meeting
Palermo, Sicily 11/04/07

University of Leicester

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:

1. Paper: "The XMM-Newton EPIC background: Production of background maps and event files", A.M. Read & T.J. Ponman, 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, M. Markevitch & D. Lumb, ApJ 629, 172 (2005)
   Web site: Supporting data, background event files etc.
3. Paper: "X-ray background measurements with XMM-Newton EPIC", D. Lumb, R.S. Warwick, M. Page & A. De Luca, A&A 389, 93 (2002)
   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].
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)

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.

After downloading the file, the script will need to be made executable:

```
chmod 755 Fin_over_Fout
```

For details on how the script works, type:

```
./Fin_over_Fout
```

Script use:

```
./Fin_over_Fout m1ev m2ev pnev elo ehi keepfiles outfile
```

Where:

```
m1ev      - MOS1 event file (N = ignore)
m2ev      - MOS2 event file (N = ignore)
pnev      - pn event file   (N = ignore)
elo       - low-energy threshold  [eV] (N = use recommended default values)
ehi       - high-energy threshold [eV] (N = use recommended default values)
keepfiles - keep intermediate files (Y/N)
outfile   - ouput file name (N = just output to screen)
```

Example call:

```
./Fin_over_Fout myM1ev.fits myM2ev.fits N 7000 12000 Y MyFinFout.dat
```

XMM-Newton EPIC
at the University of Leicester

XMM-Newton has orbited the Earth
1337
times

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User Resources

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 acroread (pdf). Presentations that comprise of several files are tape-archieved (tarred), and often compressed (using gzip). All the health monitoring plots are in PostScript format, unless otherwise stated.

Instrument Monitoring

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

Calibration Meeting Presentations

- Expand all meetings (allowing searching)
- Mallorca, October 2006
- Iceland, June 2006
- MPE, May 2006
- ESAC, October 2005
- 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

- Mallorca, October 2006
- MPE, May 2006
- MPE, November 2005
- ESAC, June 2005

Background talks are also included in the Calibration Meetings above.

•- Should we put these tables in the XMM-Newton background Analysis pages on our web? (with of course the proper reference to your work). Otherwise they are quite difficult to find ...

•We could even think on including them in the XMM-Newton UHB, again provided you agree (maybe a link will do).

•- It would be good to have explicitly said in the table header that these mean count rates take into account only 'low background‘ periods (i.e. after filtering out events with 10-15keV flux higher than 1c/s (0.35c/s) for pn (MOS), right?)

•- Would it make sense to give median values as well ?

•- Histograms like the one in Fig.10 of the paper could also be useful, for all instrument/modes. However we are not sure if it is worth to do this in case of too much work. If available, they could as well go to the UHB

•- Could we provide estimates of the instrument/mode/filter combinations commonly used that are not included in the table? Maybe: large and small window modes, and ff with thick filter. The thick filter could be especially interesting to check whether it might be worth to use it to reduce the background if the source is known to be hard or the column density is high (so that no much soft X-ray emission is expected). We don't need a table for this, as we understand it can be much beyond the work you do, but could we provide some hints like: (if true) for epic-pn SW mode the mean count rates are simply reduced by the 30 % loss of live time?

•Timing modes count rates would also be useful, but we guess this is much more difficult to estimate. Can one provide rough estimates?

•- In our web, the reference to the 'table summarizing the temporal, spectral and spatial properties of the EPIC background components' should be made much more easy to be seen in our 'background analysis' web page. It was difficult to find even for Maria who knew it was there.

•- Last, what is your feeling about how representative is the fraction of science data 'lost' (or thrown away) due to high background (i.e. 10-15 keV flux above the threshold). In case you have no 'feeling', just the rate of science time you threw away would be a 'measure'. You give some numbers: only 72 out of 116 were 'clean' enough, besides, table 3 gives fraction of pn exposure 'clean' of flares.

Table 5. Mean count rates for the *photon* background maps (over the central 16′×16′), for the different instrument, mode and filter combinations, and for each of the six (five plus total) standard energy bands.

Instr.	Mode/ filter	N_{obs}	Mean Count Rate (ct ks^{-1} arcmin^{-2}) (+ standard deviation)					
			Band 0: 200–12 000 eV	**Band 1:** 200–500 eV	**Band 2:** 500–2000 eV	**Band 3:** 2000–4500 eV	**Band 4:** 4500–7500 eV	**Band 5:** 7500–12 000 eV
MOS1	ft	49	2.10 (1.36)	0.37 (0.18)	0.78 (0.46)	0.49 (0.37)	0.35 (0.22)	0.31 (0.18)
MOS1	fm	21	2.00 (1.06)	0.32 (0.12)	0.80 (0.38)	0.48 (0.27)	0.33 (0.16)	0.29 (0.14)
MOS2	ft	46	2.23 (1.40)	0.39 (0.19)	0.84 (0.50)	0.53 (0.39)	0.37 (0.22)	0.32 (0.18)
MOS2	fm	26	1.81 (1.07)	0.31 (0.12)	0.76 (0.39)	0.42 (0.27)	0.29 (0.16)	0.27 (0.13)
PN	ft	18	6.50 (3.89)	1.90 (1.02)	2.46 (1.28)	0.93 (0.71)	0.69 (0.43)	0.61 (0.24)
PN	fm	12	4.31 (2.24)	1.13 (0.50)	2.04 (0.94)	0.72 (0.33)	0.64 (0.36)	0.68 (0.48)
PN	et	32	5.19 (4.38)	1.87 (2.06)	1.71 (1.01)	0.86 (0.68)	0.72 (0.52)	0.79 (0.55)
PN	em	8	5.41 (2.66)	1.94 (0.77)	1.90 (0.47)	0.90 (0.60)	0.76 (0.50)	0.74 (0.40)

Table 6. Mean count rates for the *particle* background maps for the different instrument, mode and filter combinations, and for each of the six (five plus total) standard energy bands.

Instr.	Mode/ filter	N_{obs}	Mean Count Rate (ct ks^{-1} arcmin^{-2}) (+ standard deviation)					
			Band 0: 200–12 000 eV	**Band 1:** 200–500 eV	**Band 2:** 500–2000 eV	**Band 3:** 2000–4500 eV	**Band 4:** 4500–7500 eV	**Band 5:** 7500–12 000 eV
MOS1	ft	49	1.40 (0.11)	0.12 (0.03)	0.44 (0.04)	0.24 (0.02)	0.26 (0.02)	0.34 (0.03)
MOS1	fm	21	1.43 (0.11)	0.13 (0.03)	0.45 (0.04)	0.24 (0.02)	0.26 (0.02)	0.34 (0.02)
MOS2	ft	46	1.34 (0.09)	0.14 (0.02)	0.42 (0.03)	0.23 (0.02)	0.24 (0.02)	0.32 (0.02)
MOS2	fm	26	1.31 (0.09)	0.13 (0.02)	0.42 (0.04)	0.23 (0.02)	0.24 (0.02)	0.31 (0.02)
PN	ft	18	8.37 (2.29)	2.13 (0.43)	1.95 (1.36)	1.50 (0.86)	1.13 (0.31)	2.05 (0.21)
PN	fm	12	8.16 (1.60)	2.23 (0.31)	1.55 (0.77)	1.32 (0.47)	1.11 (0.20)	2.08 (0.25)
PN	et	32	7.96 (1.52)	2.10 (0.29)	1.61 (0.86)	1.32 (0.58)	1.15 (0.32)	2.01 (0.20)
PN	em	8	8.22 (2.72)	2.27 (0.87)	1.58 (0.81)	1.31 (0.64)	1.12 (0.31)	2.05 (0.26)

XMM-Newton EPIC Background Components

Table giving in-FOV and out-FOV count rates (ct/ksec/sq.arcmin) of the quiescent EPIC Background for the various instrument-mode-filter combinations. Pattern 0 and pattern<=4 (pn) and pattern<=12 (MOS) countrates are given. b1=0.2-0.5 keV, b2=0.5-1 keV, b3=1-2 keV, b4=2-4.5 keV, b5=4.5-12 keV.

Instr.	mode	filter	I/O--FOV	b1		b2		b3		b4		b5		b8	
				P0	P12/4	P0	P12/4	P0	P12/4	P0	P12/4	P0	P12/4	P0	P12/4
M1	FF	T	IN-FOV	0.347	0.408	0.361	0.429	0.586	0.740	0.500	0.684	0.685	1.098	2.479	3.358
M1	FF	T	OUT-FOV	0.075	0.117	0.070	0.095	0.323	0.415	0.216	0.308	0.475	0.796	1.161	1.734
M1	FF	M	IN-FOV	0.335	0.396	0.405	0.479	0.683	0.860	0.611	0.832	0.793	1.260	2.827	3.826
M1	FF	M	OUT-FOV	0.075	0.119	0.071	0.095	0.332	0.425	0.226	0.321	0.486	0.812	1.191	1.773
M1	FF	K	IN-FOV	0.166	0.214	0.302	0.359	0.461	0.584	0.293	0.409	0.486	0.798	1.708	2.364
M1	FF	K	OUT-FOV	0.067	0.109	0.066	0.088	0.324	0.414	0.213	0.304	0.480	0.811	1.152	1.729
M2	FF	T	IN-FOV	0.355	0.414	0.389	0.453	0.608	0.758	0.521	0.702	0.699	1.099	2.572	3.427
M2	FF	T	OUT-FOV	0.079	0.131	0.081	0.101	0.362	0.457	0.229	0.324	0.513	0.846	1.265	1.859
M2	FF	M	IN-FOV	0.328	0.385	0.415	0.482	0.686	0.853	0.595	0.798	0.766	1.197	2.789	3.715
M2	FF	M	OUT-FOV	0.077	0.129	0.083	0.103	0.372	0.468	0.233	0.328	0.520	0.860	1.286	1.888
M2	FF	K	IN-FOV	0.169	0.216	0.309	0.359	0.470	0.587	0.294	0.401	0.485	0.784	1.727	2.347
M2	FF	K	OUT-FOV	0.077	0.130	0.080	0.101	0.374	0.473	0.232	0.322	0.528	0.874	1.292	1.902
PN	EF	T	IN-FOV	2.131	3.262	2.193	2.902	2.327	3.321	3.214	4.929	4.960	8.258	14.76	22.59
PN	EF	T	OUT-FOV	0.604	1.813	0.834	1.079	1.301	1.798	1.773	2.652	3.074	4.953	7.563	12.26
PN	EF	M	IN-FOV	3.037	4.248	3.474	4.577	3.936	5.626	5.447	8.365	7.545	12.65	23.34	35.34
PN	EF	M	OUT-FOV	0.888	2.203	1.314	1.702	1.976	2.763	2.763	4.151	4.122	6.696	11.02	17.46
PN	EF	K	IN-FOV	1.193	1.944	1.937	2.546	1.273	1.802	1.436	2.175	2.969	4.873	8.771	13.28
PN	EF	K	OUT-FOV	0.326	1.418	0.433	0.567	0.730	0.994	0.974	1.432	2.486	3.917	4.939	8.315
PN	FF	T	IN-FOV	3.496	5.900	4.829	6.304	5.805	8.223	7.982	12.18	11.00	18.19	32.98	50.61
PN	FF	T	OUT-FOV	1.822	4.569	2.617	3.374	3.889	5.425	5.278	7.936	7.695	12.43	21.22	33.63
PN	FF	M	IN-FOV	3.219	5.767	4.679	6.102	6.179	8.748	9.109	13.91	13.77	22.89	36.82	57.24
PN	FF	M	OUT-FOV	1.850	4.832	2.696	3.466	4.075	5.678	5.799	8.712	8.910	14.54	23.25	37.12
PN	FF	K	IN-FOV	1.257	2.063	1.899	2.480	1.911	2.723	2.625	4.005	4.740	7.868	12.38	19.07
PN	FF	K	OUT-FOV	0.526	1.893	0.725	0.932	1.125	1.549	1.614	2.385	3.278	5.262	7.248	11.99

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.

Other Useful Information

The following sources of information (including historical collections of background 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, 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, M. Markevitch & D. Lumb, ApJ 629, 172 (2005)
   Web site: Supporting data, background event files etc.
3. Paper: "X-ray background measurements with XMM-Newton EPIC", D. Lumb, R.S. Warwick, M. Page & A. De Luca, A&A 389, 93 (2002)
   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].
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)

pn Filter Wheel Closed Data

Files Too Big?

General remarks

The EPIC-pn CCD camera is - like the EPIC MOS - equipped with a filter wheel system and 6 different filter setups, seperated by angular distance of 60 degrees. These are:

- Closed (1.05 mm Al)
- Thin1 (40 nm Al + 160 nm polyimide)
- Thin2 (40 nm Al + 160 nm polyimide)
- Medium (80 nm Al + 160 nm polyimide)
- Thick (45 nm Sn + 55 nm Al + 330 nm polypropylene + 55 nm Al)
- Open

The individual layers are given from the telescope toward the detector. By turning the filter wheel from any of the abovementioned positions by a few degrees a radioactive Fe-55 source (decay into an excited state of Mn) can (additionally) illuminate the CCD (Cal positions, e.g. CalClosed, CalThin1).

The Closed filter exposures can be used to model and subtract the internal camera background. This is composed by:

- electronic readout noise (at lowest energies)
- high energy particles producing charge directly in CCD and Camex
- Particle induced X-rays (continuum and fluorescent lines), generated inside the camera
- thermal CCD noise is negligible

These components are distributed non-homogeneously, and are differently subject to Out-of-Time Events. Also line widths and pattern fractions are slightly different for each of the EPIC-pn readout modes. It is highly recommended not to combine event files from different submodes.

The following links provide further information on mode-specific issues related to Closed filter exposures. Furthermore, these pages contain links to the corresponding merged Closed filter event file, the list of exposures (along with start and end times and background level indicators) used in the merge.

- Imaging Modes:
  - Full-Frame Mode (FF)
  - Extended Full-Frame Mode (eFF)
  - Large-Window Mode (LW)
  - Small-Window Mode (SW)
- Fast Modes
  - Timing Mode (TI)
  - Burst Mode (BU)

Below you can find relevant reports and proceedings about EPIC-pn Closed filter exposures, such as spatial, temporal, and spectral properties of the internal background.

- EPIC-pn: spatial properties
- EPIC-pn: spectral and temporal properties
- EPIC-pn: background calibration

A much more complete description of EPIC background can be found at:

- ESAC Background Analysis pages
- EPIC Background synopsis table
- XMM-Newton User's Handbook, especially the sections on EPIC and background

[General][FF][eFF][LW][SW][TI][BU]

University *of* Leicester

MOS Filter Wheel Closed Data

MOS Filter Wheel Closed (FWC) Data

The ftp directory linked below contains all of the FWC observations in the public archive. Each file contains the data for a single CCD.

The data for each CCD was extracted from each ObsId using the filter (CCDNR==n)&&((FLAG & 0x766a0f63)==0)&&(PATTERN<=12). The data from all ObsIds contributing to a given CCD were combined using the SAS task "merge".

The data files can be accessed via our ftp server.

Index of ftp://xmm.esac.esa.int/pub/ccf/

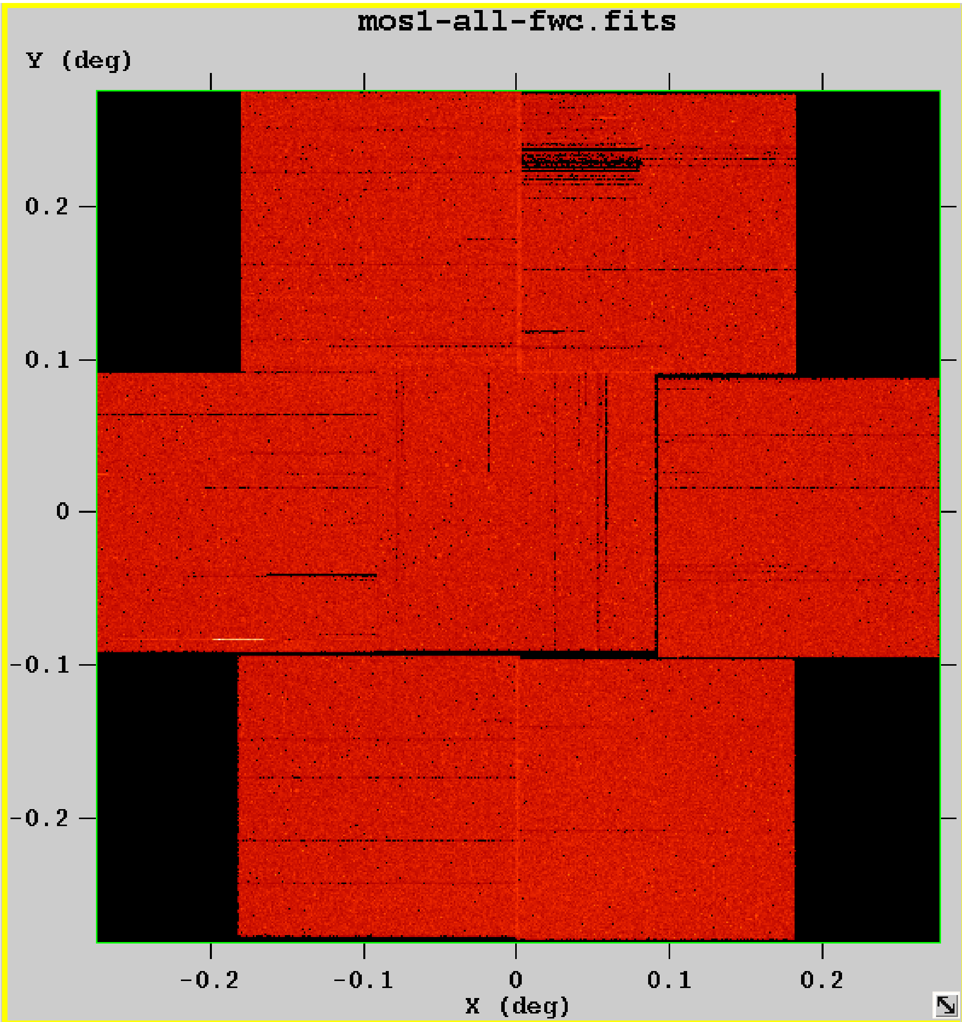
Up to higher level directory

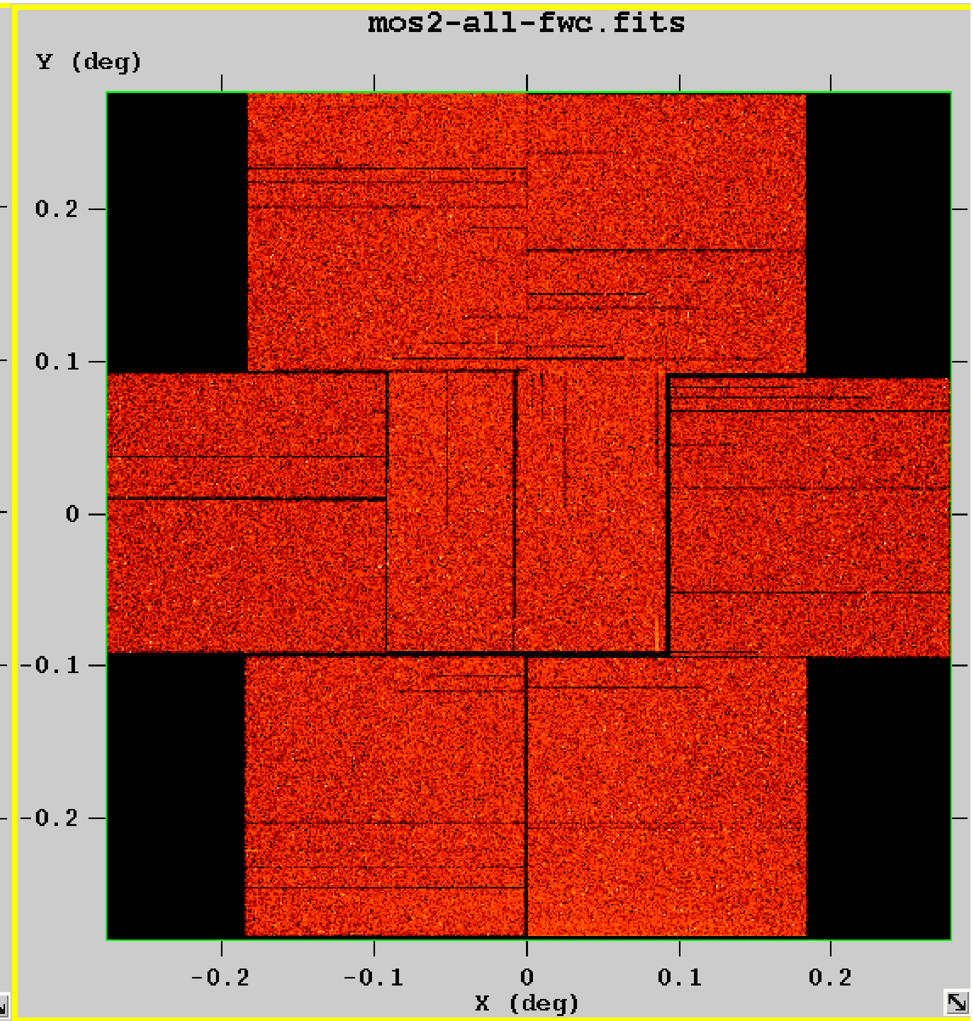
mos1-1S-fwc.fits.gz	8624 KB	14/04/06	18:27:00
mos1-2S-fwc.fits.gz	9285 KB	14/04/06	18:52:00
mos1-3S-fwc.fits.gz	8712 KB	14/04/06	19:00:00
mos1-4S-fwc.fits.gz	6266 KB	23/04/06	01:59:00
mos1-5S-fwc.fits.gz	8262 KB	14/04/06	19:55:00
mos1-6S-fwc.fits.gz	7886 KB	14/04/06	21:23:00
mos1-7S-fwc.fits.gz	8809 KB	14/04/06	22:21:00
mos2-1S-fwc.fits.gz	8887 KB	14/04/06	22:44:00
mos2-2S-fwc.fits.gz	8354 KB	14/04/06	22:53:00
mos2-3S-fwc.fits.gz	8415 KB	14/04/06	23:02:00
mos2-4S-fwc.fits.gz	8691 KB	14/04/06	23:12:00
mos2-5S-fwc.fits.gz	5982 KB	14/04/06	23:17:00
mos2-6S-fwc.fits.gz	8512 KB	14/04/06	23:27:00
mos2-7S-fwc.fits.gz	9050 KB	14/04/06	23:36:00

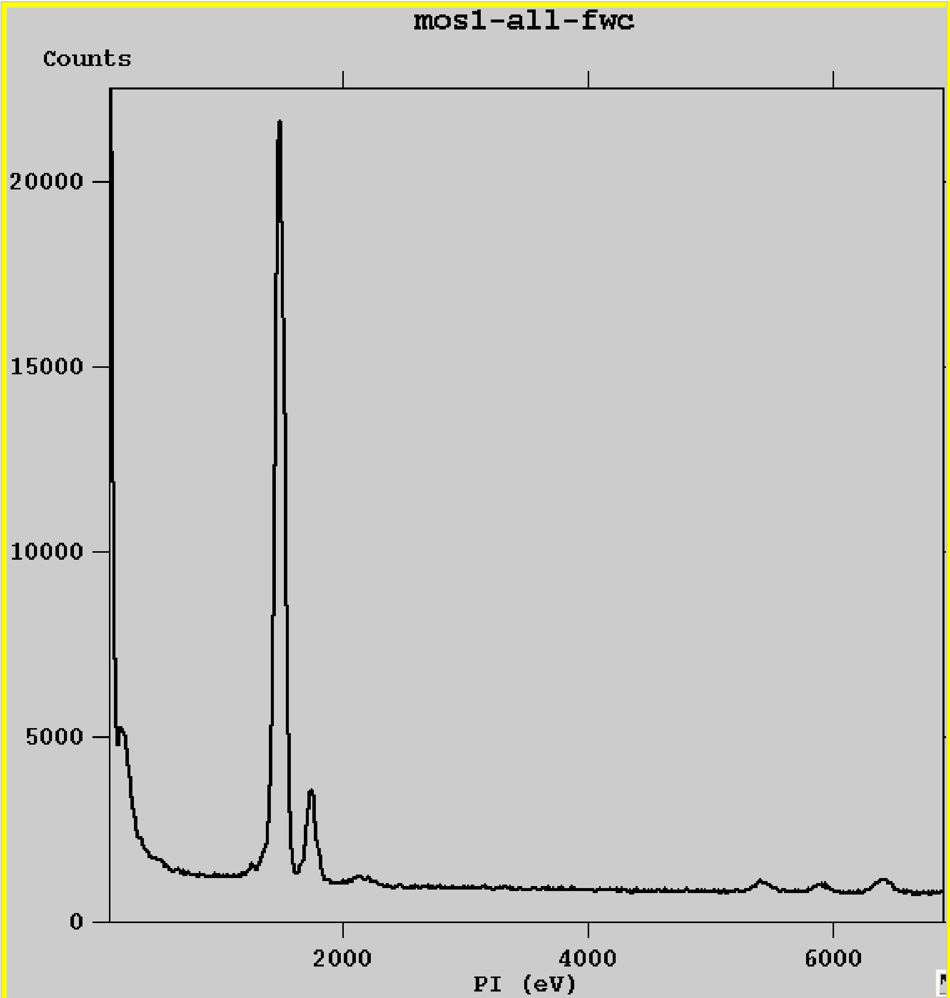
- Only S=standard state files released for now – good.
- Why only on a per-CCD basis?
- Can we combine these into full FOV datasets? (Users have requested this)

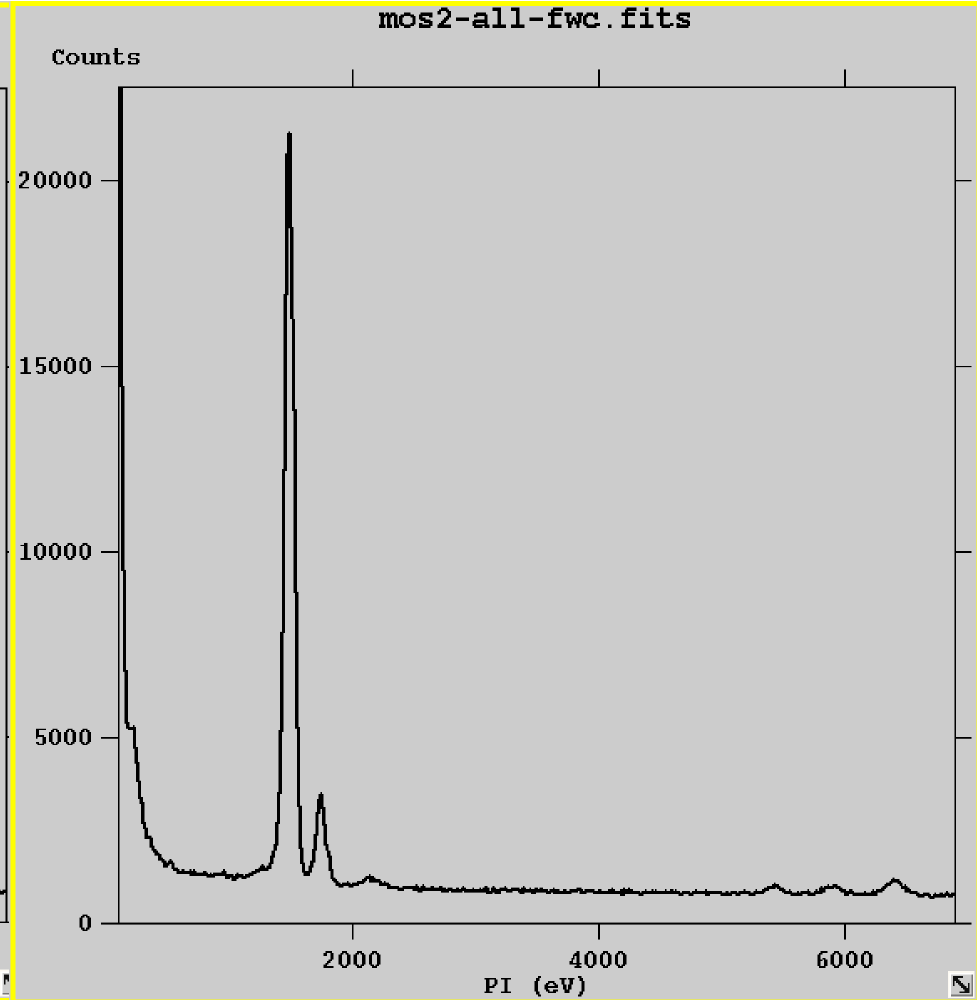
New MOS FWC files (each ~65MB) created from all of the FWC data for which:

- All chips were on in full imaging mode
- All chips were in their "normal" state









Can create images, spectra and time-series using XMM-SAS

Some Other Open Issues (old)

• espfilt: Brendan tried to upload package - failed with getting a pgp access key. Should be OK now?

• f_in/f_out script: Onto BGWG page? Scripts page? … with e.g. ‘ghostholes’ + …

• FWC data: Full FOV issues. + A section for the next newsletter needs to be prepared...

• Any new tools, files?
• Vadim Burwitz (for MJF): "EPIC-pn Timing-Mode Closed Filter Background" - New files?
• Also “Simulation of particle induced EPIC-pn background with Geant4”: Chris Tenzer

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

• Recent Nevalainen paper (astro-ph/0610461) – low energy (<0.5 keV) cal problems pn and/or MOS ?

• What to present to CAL tomorrow?

XMM-Newton EPIC 'Blank Sky' Background

New XMM-Newton background 'blank sky' events files for the 3 EPIC instruments in their different instrument mode/filter combinations have been constructed using a superposition of many pointed observations of pipeline product data from the 2XMM reprocessing (Second XMM-Newton Serendipitous Source Catalogue) and have been processed with the latest version of the SAS, SAS 6.5. Exposure maps in the different instrument/mode/filter combinations have also been produced. A link to the paper by Carter and Read (in preparation) will appear here shortly. On these web pages, details can be found on how to obtain these background products together with related software.

Contents:

Latest Updates

- Aug-2006: GTI extensions revised for all event lists. Modified BlankSky.tgz
- Jun-2006: TSTART and TSTOP keywords added to EXPOSURE extensions of unfilled event lists
- May-2006: Initial web site

F_{in}_over_F_{out}

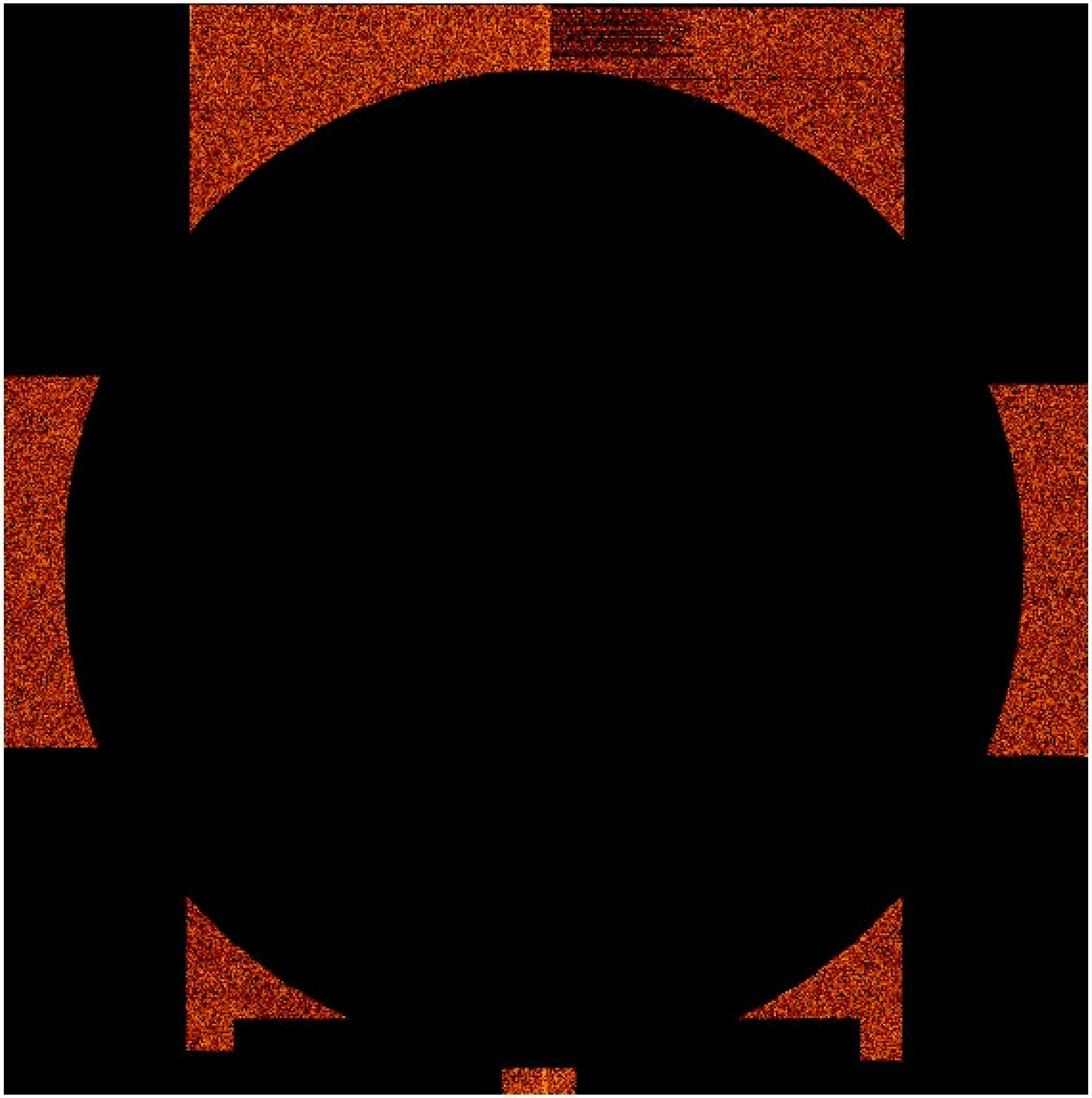
Script to perform the F_{in}/F_{out} ratio calculation of Molendi et al.

Delivered to BGWG web

```
amr30@epic6 /home/work/amr30/BG/SM/ > /work/amr30/Scripts/Fin_over_Fout

-------- FIN_OVER_FOUT version 1.0 06/10/06 --------


Script to perform the Fin/Fout ratio calculation developed by Silvano
Molendi, Andrea De Luca & Alberto Leccardi (A&A, 419, 837) on any EPIC
event files (MOS1, MOS2 and/or pn), to estimate the amount of residual
Soft Proton flare contamination. The script has to be used after
attempts have been made to clean the event files for Soft Proton
flares using a GTI filtering. The script compares count rates in the
in-FOV (beyond 10 arcminutes) and out-of-FOV regions of the detector,
and hence the event files need to have been processed in such a manner
as to retain the out-of-FOV events (i.e. the selection expression in
evselect needs to include the #XMMEA_16 flag - [evselect table=... ...
expression=(... && #XMMEA_16) ...]. By default, the count rates are
compared in the energy bands 6-12 keV (for MOS) and 5-7.3 keV plus
10-14 keV (for pn). A user-input energy band can be used instead if
required (via the parameters elo and ehi); User-input energy bands
should be broad (for better statistics) if the source is negligible in
the outer region of the FOV beyond 10 arcminutes. If however the
source fills the whole FOV, the band should be reduced at the soft
end. Output can be set to a file or to the screen (via the parameter
outfile), and the intermediate files can be kept (via the parameter
keepfiles).

Use: ./Fin_over_Fout m1ev m2ev pnev elo ehi keepfiles outfile

  m1ev      - MOS1 event file (N = ignore)
  m2ev      - MOS2 event file (N = ignore)
  pnev      - pn event file (N = ignore)
  elo       - low-energy threshold [eV] (N = use recommended default values)
  ehi       - high-energy threshold [eV] (N = use recommended default values)
  keepfiles - keep intermediate files (Y/N?)
  outfile   - ouput file name (N = just output to screen)

e.g. ./Fin_over_Fout myM1ev.fits myM2ev.fits N 7000 12000 Y MyFinFout.dat
```

Complicated selection area used for MOS to avoid calibration ‘holes’

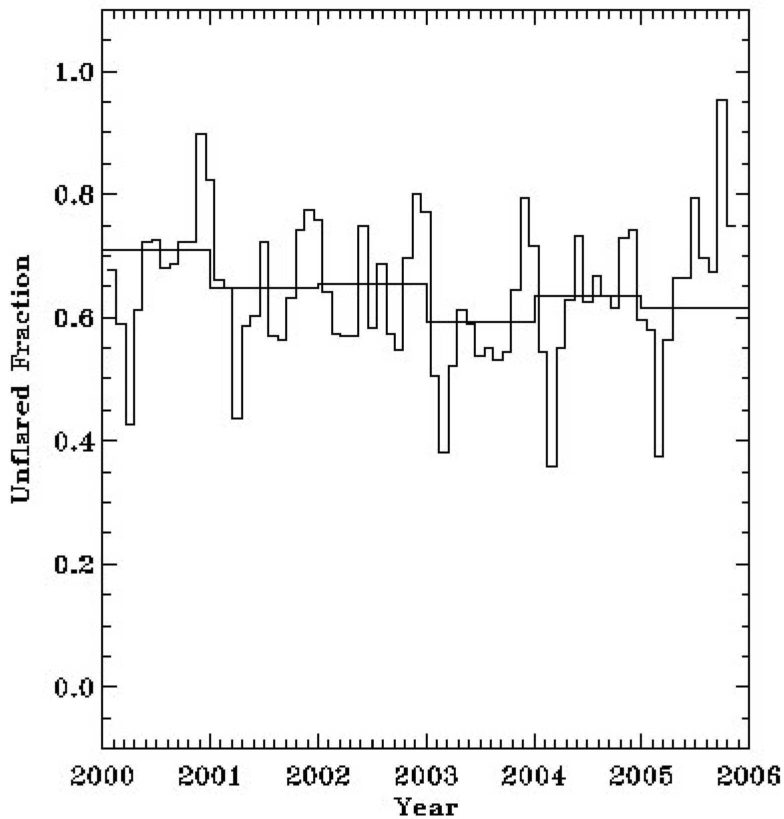
PN uses simple circular selection area



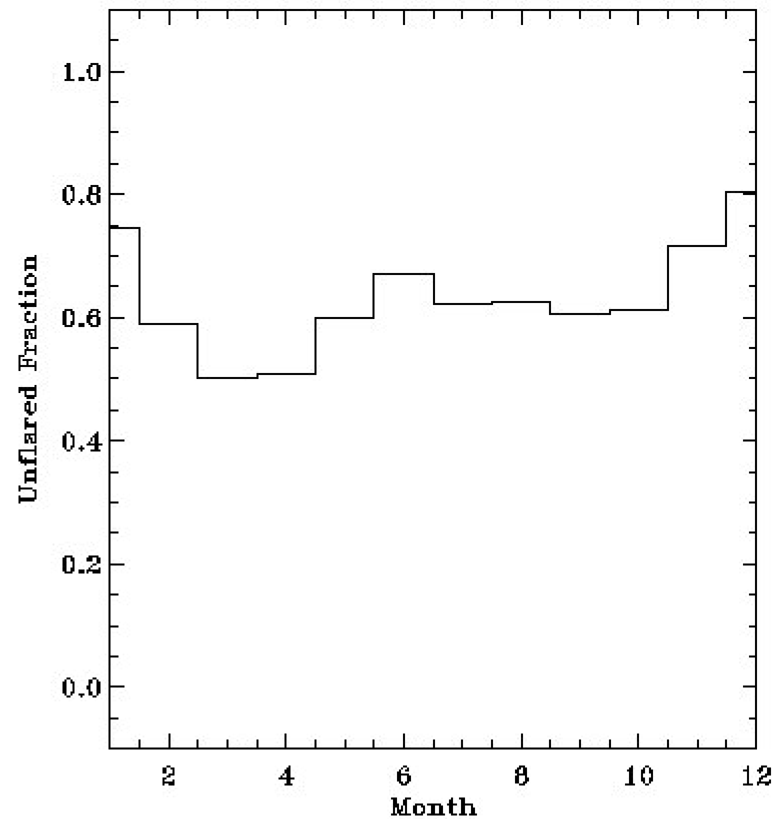
In use…

```
amr30@epic6 /home/work/amr30/BG/SM/ > /work/amr30/Scripts/Fin_over_Fout m1_cleansp.evt m2_cleansp.evt pn_cleansp.evt N N N N

-------- FIN_OVER_FOUT version 1.0 06/10/06 --------

Creating clean event files and spectra...
Using recommended default Energy ranges...
Analysing MOS1 file...
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    File is extremely contaminated by Soft Protons
M2     8908    2687    38.3   38.3    1.584   0.042    File is extremely contaminated by Soft Protons
PN    18267    1822    23.3   23.3    1.331   0.037    File is very contaminated by Soft Protons
```

Ratio < 1.15	: File is not contaminated by soft protons
1.15 < Ratio < 1.30	: File is slightly contaminated by soft protons
1.30 < Ratio < 1.50	: File is very contaminated by soft protons
Ratio > 1.50	: File is extremely contaminated by soft protons



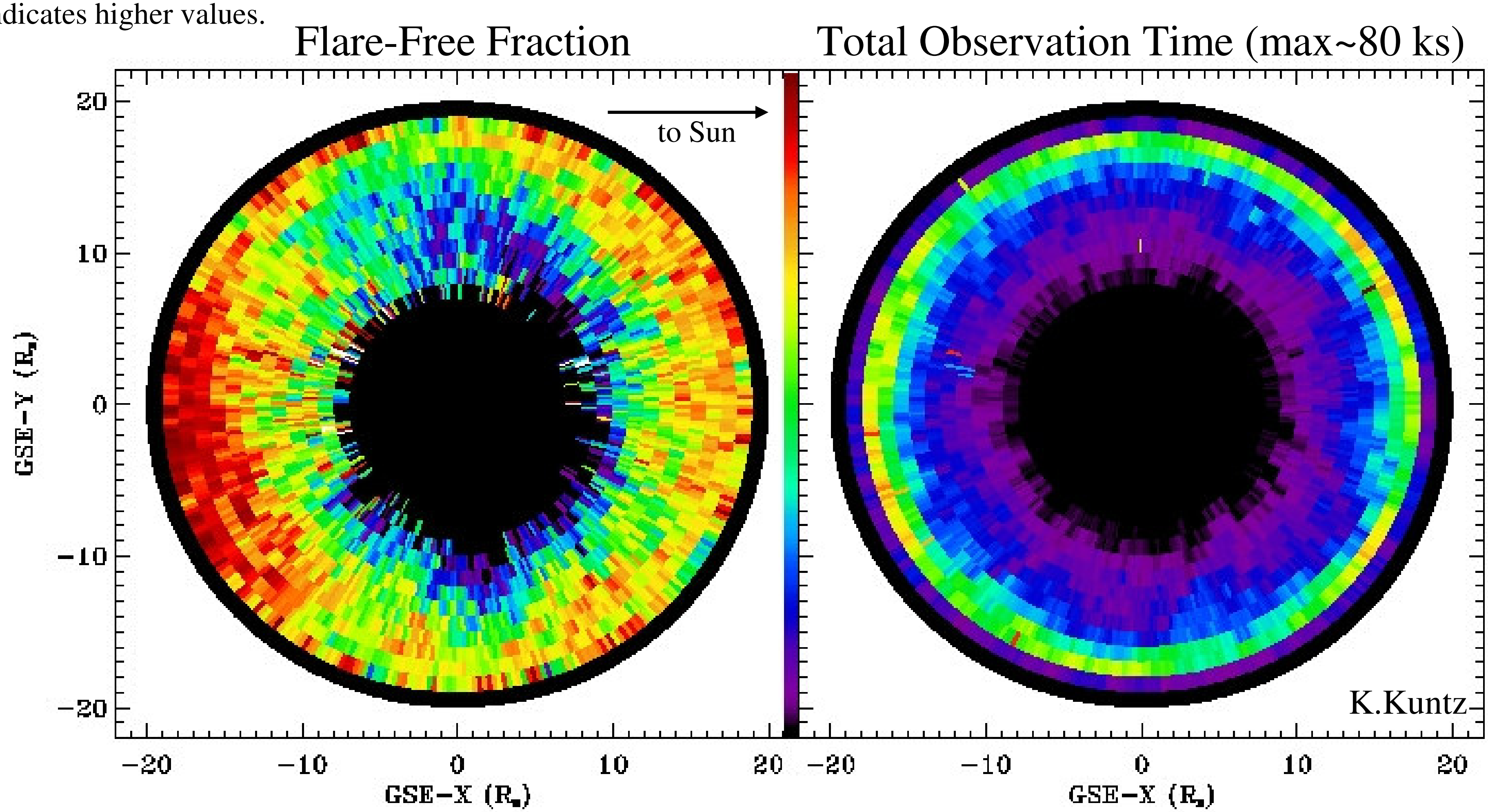
1.0
0.8
0.6
0.4
0.2
0.0
Unflared Fraction
2000
2001
2002
2003
2004
2005
2006
Year



1.0
0.8
0.6
0.4
0.2
0.0
Unflared Fraction
2
4
6
8
10
12
Month

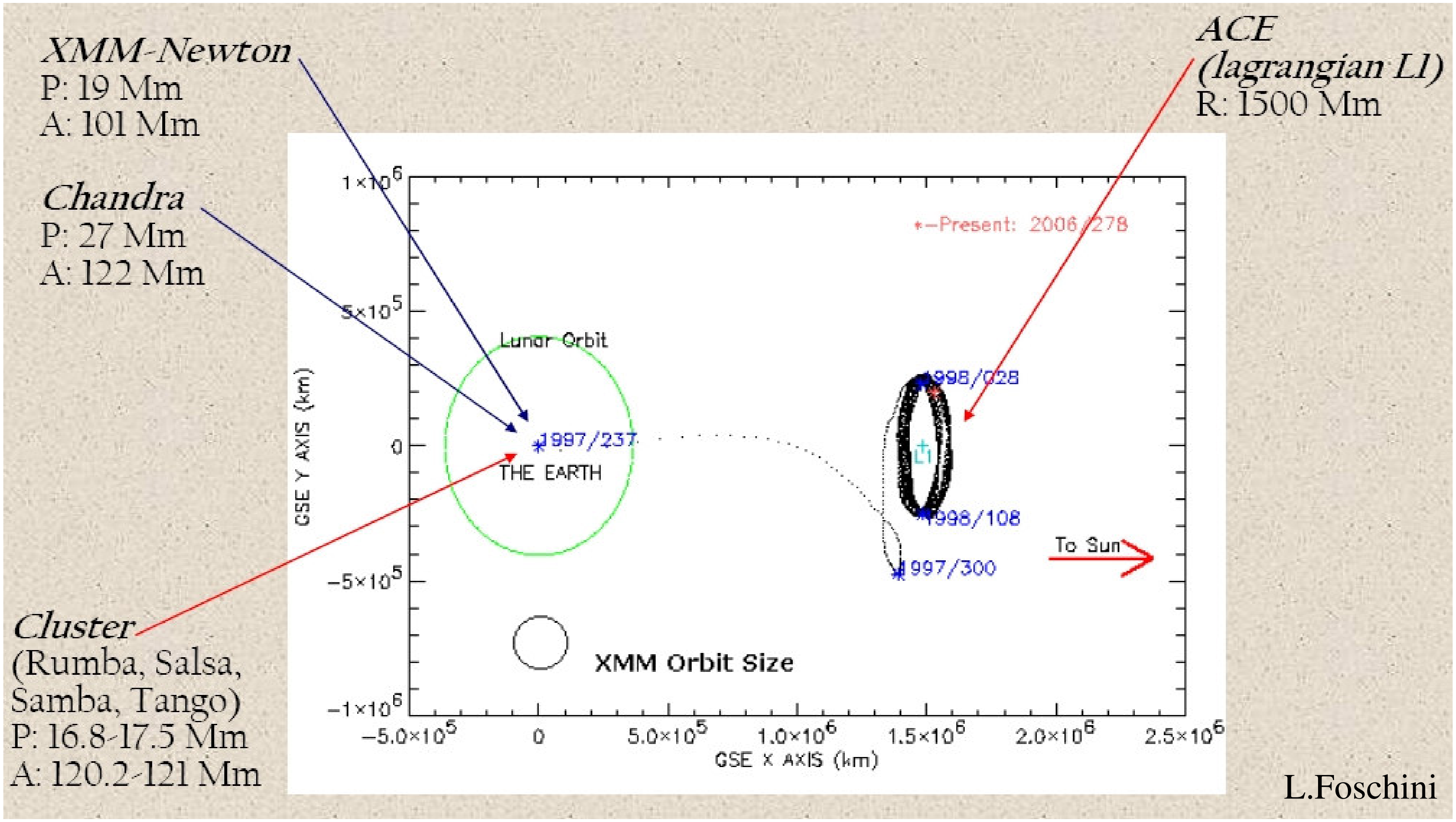
Flare-Free Fraction as a function of orbital position (using ~entire EPIC dataset)

GSE-X points towards the sun. GSE-X-GSE-Y plane is the plane of the ecliptic. GSE-Z is towards the north pole. Red indicates higher values.



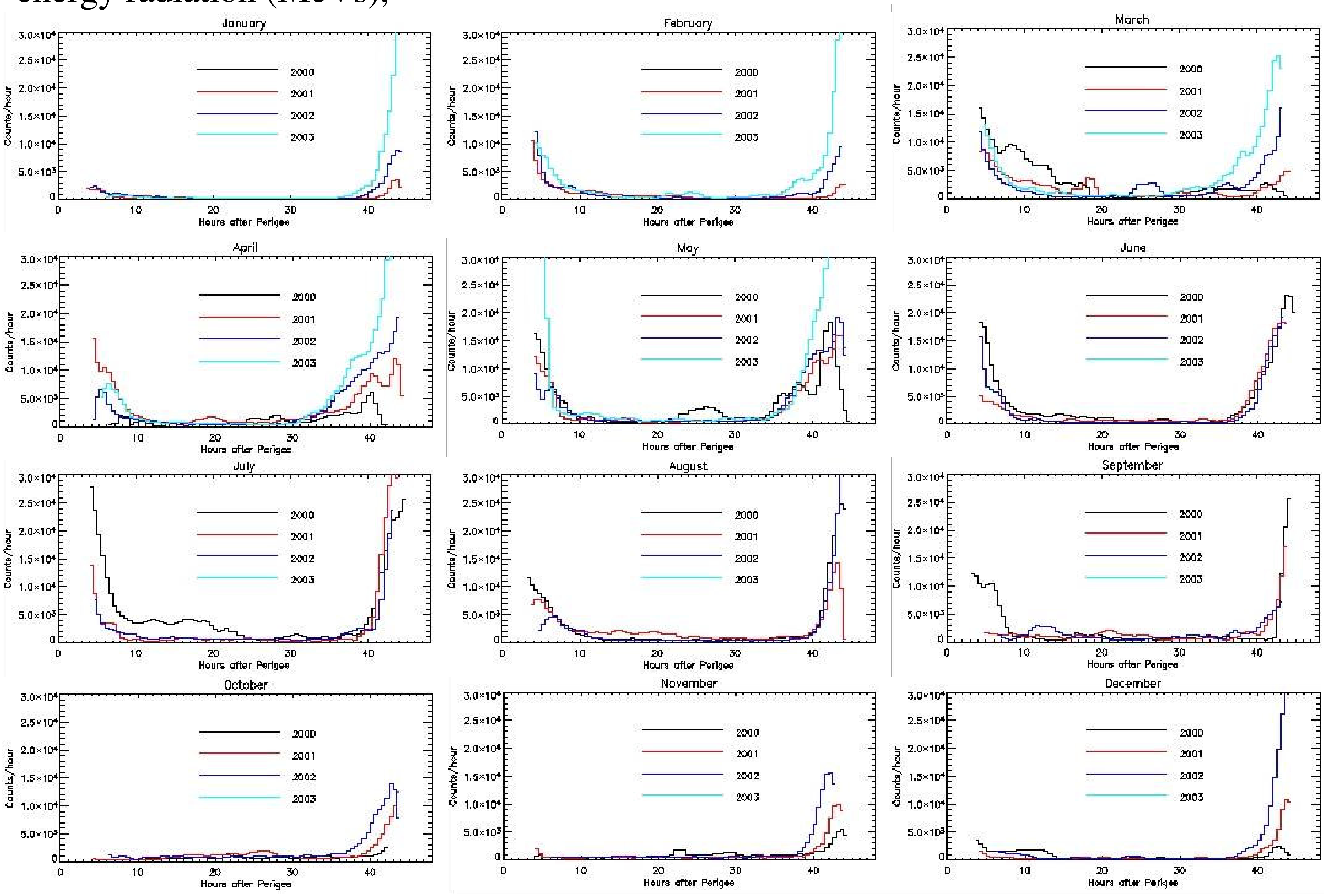
The best observations are made:

- When the spacecraft is as far from the earth as possible
- and at 180 degrees from the sun.
- Towards the sun seems to be better than 90 degrees from the sun.
- Given the orbit, the best observations will be done in Winter.

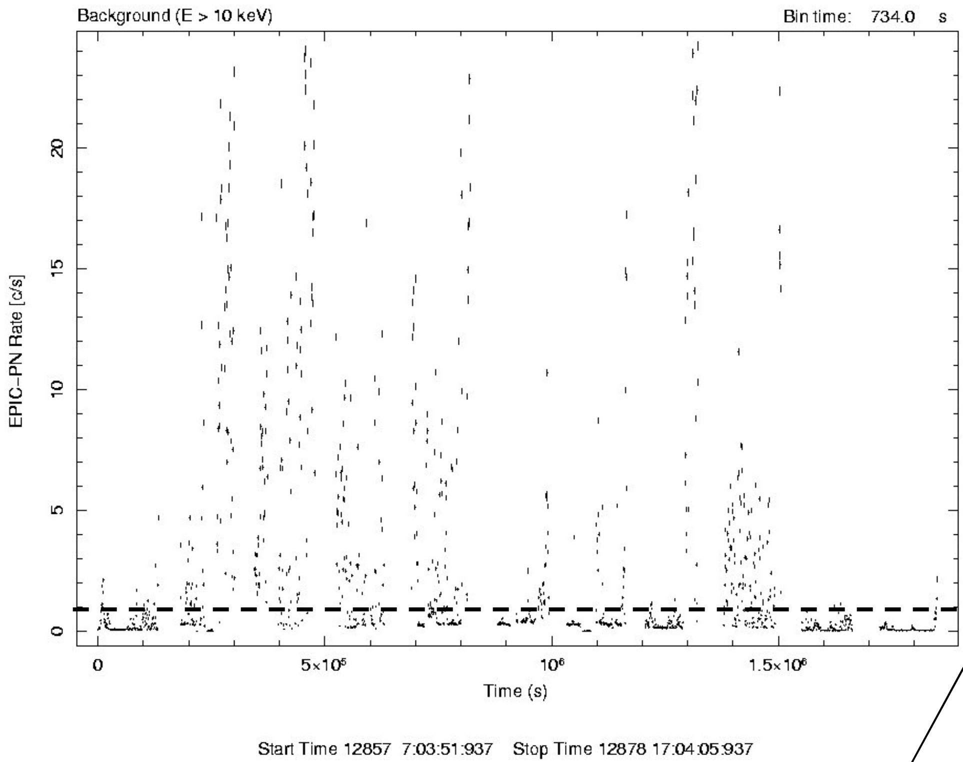


XMM-Newton
P: 19 Mm
A: 101 Mm
Chandra
P: 27 Mm
A: 122 Mm
Cluster
(Rumba, Salsa, Samba, Tango)
P: 16.8-17.5 Mm
A: 120.2-121 Mm
ACE
(lagrangian L1)
R: 1500 Mm
*—Present: 2006/278
Lunar Orbit
1997/237
THE EARTH
1998/028
L1
1998/108
1997/300
To Sun
XMM Orbit Size
GSE Y AXIS (km)
GSE X AXIS (km)
1×10^6
5×10^5
0
−5×10^5
−1×10^6
−5.0×10^5
0
5.0×10^5
1.0×10^6
1.5×10^6
2.0×10^6
2.5×10^6
L.Foschini

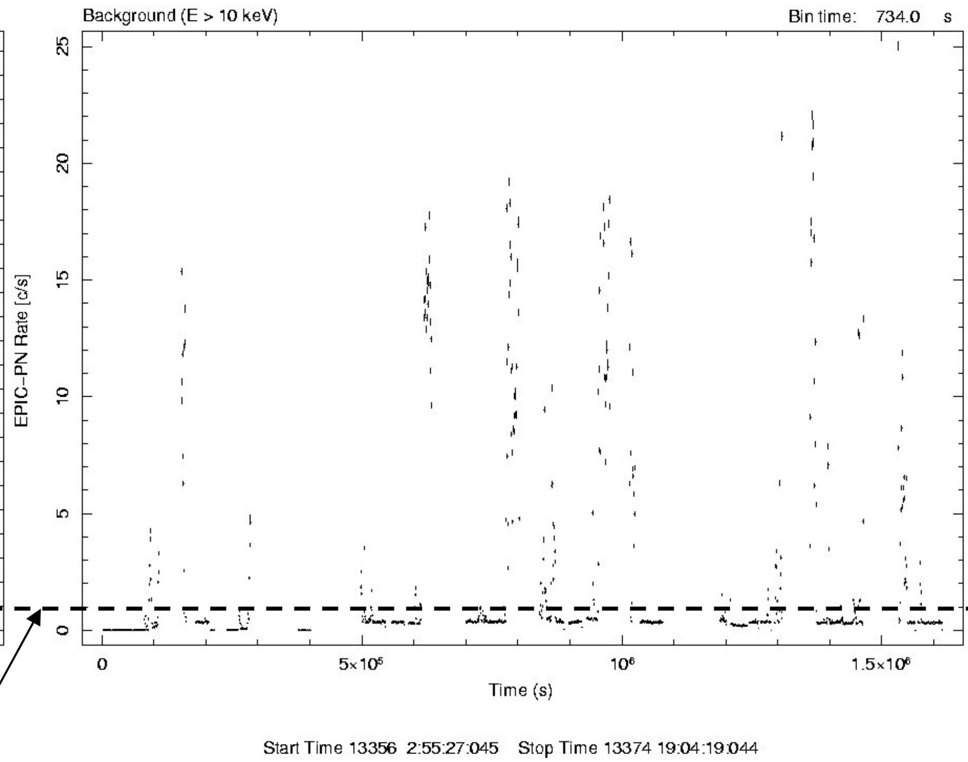
RGS background count rate - sensitive to both soft protons (few 100s keV) plus higher energy radiation (MeVs),



Summer (Aug 2003)



Winter (Dec 2004 – Jan 2005)

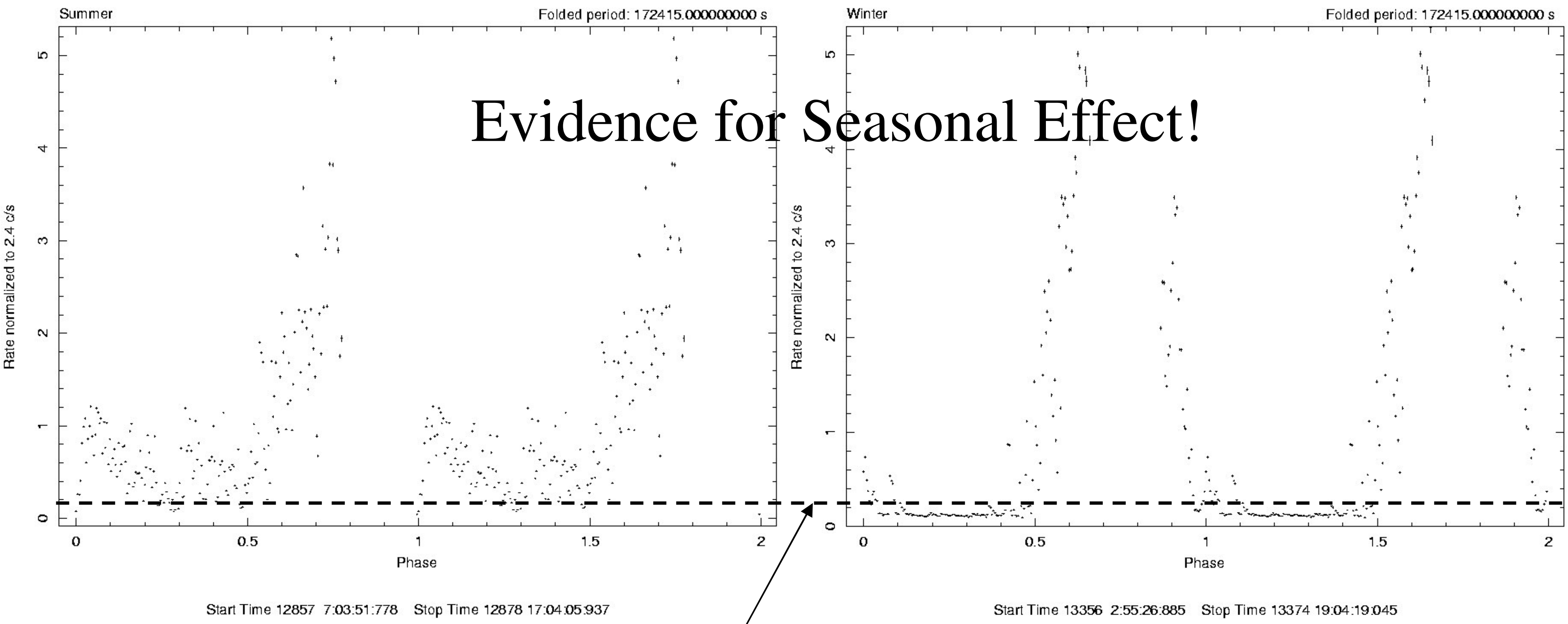


‘Acceptable level’ ~ 1 ct/s @ E>10 keV

V.Fioretti & L.Foschini

Folded on Orbit Period (48 hours)

Summer (Aug 2003) Winter (Dec 2004 – Jan 2005)



Evidence for Seasonal Effect!

'Acceptable level' ~ 1 ct/s @ E>10 keV

V.Fioretti & L.Foschini

OOT events – removal on an event-by-event basis?

```
============
AMR - 020206
============
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 FF mode [2.3%
  for eFF]).

- 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(FF)% 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).

==================================================================
```