Mallorca, March 29th 2011

Summary of SOC Activities

Ignacio de la Calle

The Working Group EPIC Background

Motivation

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.

Members

LUX: Andy Read (chair), Jenny Carter
GSFC GOF: Steve Snowden, Kip Kuntz
MPE: Wolfgang Pietsch, Michael Freyberg
INAF: Silvano Molendi
ESA: Ignacio de la Calle (co-ord.), Matthias Ehle, Carlos Gabriel
IAAT: Christoph Tenzer
Guests: Steve Sembay, …

Outcome of the Latest Users Group Meeting

The latest Users Group (UG) meeting took place at ESAC on the 12th-13th of May 2010. For this meeting, no specific talk was requested regarding BGWG activities.

The issues raised at the latest UG meeting concerning the activities of the BGWG have to do with:

1. **ESAS**
   - Incorporation of ESAS-pn
2. **Filter Wheel Close Data and Repository**
   - Study of the evolution with time
   - Tool to allow a selection of data with time from the repository

Next UG Meeting: 19th-20th of May 2011 at ESAC

For this coming meeting, Matteo G. will include a slide in his *EPIC Calibration Status* presentation summarising last year's BGWG activities.

Outcome of the Latest Users Group Meeting

Endorsement 2009-05-07/01: UG endorses the new approach for the collection of EPIC filter wheel closed (FWC) data, as recommended by the BGWG and EPIC-Cal team: **Implemented & Closed**

Recommendation 2006-05-19/33: As far as possible, the UG recommends regular updates of 2XMM catalogue in an incremental fashion plus periodic reprocessing of the archive: **On-going**, see M. Watson presentation.

Recommendation 2008-05-07/04: The new 2D PSF model should be described in a technical document such that derived model parameters (that will be stored in a calibration file), can be understood and interpreted without the need of using SAS: **Closed**: CCF release note & public SAS thread "2-D PSF a la carte" available.

Recommendation 2008-05-07/05: XMM-ESAS should allow the analysis of all extended sources, i.e. it should also accept pn data as input. If possible, XMM-ESAS should also be made easier or simplified, especially wrt the fitting process: **On-going**

Recommendation 2008-05-07/09: RISA should be evaluated some time after the first public release: **Open**

Recommendation 2009-05-07/01: Although the idea of having a dedicated repository for high level XMM-Newton data products (á la MAST) is interesting, XMM-Newton SOC should not take the lead in such initiatives. **Closed**

Recommendation 2009-05-07/02: UG recommends that LPs should be considered as coherent entities that should not be cut in time – but the final decision certainly remains with OTAC panels. **Closed**

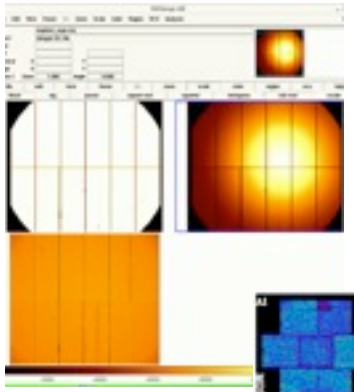
Recommendation 2009-05-07/03: The BGWG should continue their study of the evolution of the FWC data with time: **Open:** No news wrt study of evolution

Recommendation 2009-05-07/04: The BGWG should provide the community with a tool that allows to select FWC data from the repository based on the time when the data was collected. **On-going**: maintenance of data repository is becoming SOC activity.

Activities of the BGWG

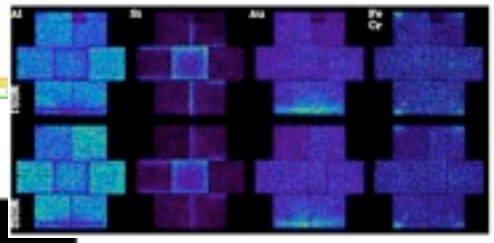
I. Blank Sky Background Event Files

Developed and maintain at LUX by the EPIC Blank Sky team based on the work of J. Carter and A. Read (A&A 464, p1155, 2007)



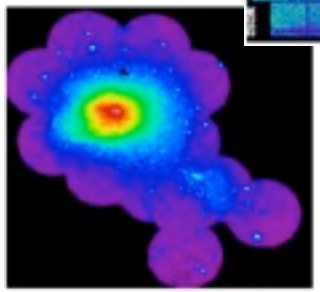
II. Filter Wheel Close Data (FWC)

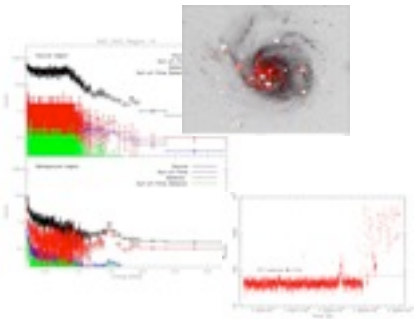
Repository of FWC Data provided by K. Kuntz (EPIC-MOS) and M. Freyberg (EPIC-pn)



III. XMM-Newton Extended Source Analysis Software (XMM-ESAS)

Developed by S.Sembay at the NASA/GSFC XMM-Newton Guest Observer Facility (GOF) in cooperation with the XMM-Newton SOC and the Background Working Group.





IV. Background treatment Scripts

Collection of analysis Scripts developed by several teams as part of PhD Theses, Trainee Projects, Research work .....

Products of the BGWG: I. Blank Sky Files

SAS Threads

The thread dealing with Blank Sky files was updated (J. Carter) in April 2010.

The thread now deals with the analysis of both MOS and pn blank field files. The release, together with other thread updates, was announced in the XMM-Newton-NEWS #113 (30-Sep-2010).

How to use EPIC background blank field files

Changes to Blank Sky Web Pages at the SOC

J. Carter implemented some changes in Aug 2010 to reflect the processing of the blank sky event files using SAS 9.0 (revolutions included up to 1789).

Products of the BGWG: II. FWC

Filter wheel closed (FWC) data

- Data gathered from calibration observations with filter wheel in closed position
- Released in September 2006: stacked collections of FWC data available for MOS and pn
- Dedicated EPIC FWC calibration observation:
  - NRCO#70 in 2007
  - Rout. Cal. 10 ksec /month
  - New approach implemented in the Routine Calibration Plan as of **summer 2009**
    - 2 x 10 ksec RCO; CLOSED FF (10 ksec/semester)
    - Should there be evidence of response inhomogeneities, this can be increased via NRCOs
    - Additionally, during all the slews in every 4th revolution, the MOS cameras can be set to CLOSED FF (pn slews are used for science)

Products of the BGWG: II. FWC

- The repository was updated in August 2010, and included data up to January 2010. The release was announced in the XMM-Newton-NEWS #113 (30-Sep-2010)

- The repository has been updated again in March 2011, and includes data up to January 2011. The data is not yet public, but will be soon.

- The idea is to update the repository once per year (*maybe 2*), just before the BGWG, or UG, meeting (*before the AO opening*).

  - Under the new implementation (10 ksec/semester), FWC routine calibration observations have been performed in:

    January 3rd 2010
    July 3rd 2010
    January 3rd 2011

    EPIC-pn & EPIC-MOS FF CLOSED 10 ksec observations

    The MOS slew data (every 4th revolution) has not been analyzed

Products of the BGWG: II. FWC

- Apart from the dedicated routine calibration observations, other observations have been performed during 2010/2011

EPIC-pn

EFF	(Nov09)	May10
LW	(Apr05)	Sep10
SW	(Aug05)	Sep10
TI	(Aug06)	----
BU	(Oct03)	----

EPIC-MOS

FF Aug10 (only FF data is included in the repository, although other modes are available)

Products of the BGWG: II. FWC

Updates to Web Pages

- Information has been added and the structure of the pages has been rearranged
- Introduce features to comply with the UG recommendations

UG Recommendations

Recommendation 2009-05-07/04: The BGWG should provide the community with a tool that allows to select FWC data from the repository based on the time when the data was collected. **On-going**: maintenance of data repository is becoming SOC activity.

Recommendation 2009-05-07/03: The BGWG should continue their study of the evolution of the FWC data with time: **Open:** No news wrt study of evolution

Products of the BGWG: II. FWC

EPIC-pn Full Frame

Full Frame (FF) mode

This page provides links to several event files: On the one hand, a link to the merged event file containing the sum of all the MOS1 Filter Wheel Closed observations available in the XMM-Newton archive up to a given date; on the other, links to the individual event files that make up themerged event file. A given user may want to use only a specific selection of events to produce tailor made Filter Wheel Closed data. This can be done in either of two ways: by filtering the merged event file and, by combining individual event files.

How to Filter the Merged Event List

Any column in the merged event list can be used for filtering. A column (`Rev`) containing the revolution number corresponding to each event has been added to the merged event list. This makes filtering the merged event list for given periods of time easier. For example, if only a particular subset of revolutions of the merged filter wheel closed event list is wanted, the SAS task `evselect` can be used in the following way:

- If only data from a given revolution range wants to be used:

```
evselect table=mos1_closed_FF.fits expression="(Rev>=780 && Rev<=970)" withfilteredset=yes filteredset=filtered.fits
```

- If a given revolution wants to be excluded:

```
evselect table=mos1_closed_FF.fits expression="(Rev!=780)" withfilteredset=yes filteredset=filtered.fits
```

- Nevertheless, if filtering based on `TIME` is required, the following expression will select only a given time period:

```
evselect table=mos1_closed_FF.fits expression="TIME>=2.1803e+08 && TIME<=2.4070e+08" withfilteredset=yes filteredset=filtered.fits
```

The `TIME` is expressed in terms of number of seconds since the reference time (1998-01-01T00:00:00)

In each case, the file `filtered.fits` will contain only those events that fulfill the `expression`.
Information on how to write or combine filter expressions can be found in the documentation of `selectlib`.

Warning: Filtering the merged event list requires a large amount of memory usage. Users experiencing `OutOfMemory` problems may want to choose the low-memory-model within SAS (set the SAS environment variable `SAS_MEMORY_MODEL` to `low`; see the SAS documentation for more details).

How to Merge Individual Event List

Several individual Filter Wheel Closed event lists can be merged using the SAS task `merge`. For example, to merge data corresponding to two given revolutions, the `merge` command would look like this:

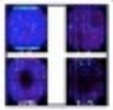
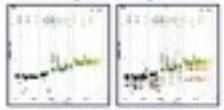
```
merge set1=file_1 set2=file_2 outset=merged_1.fits
```

The file `merged_1.fits` will contain the merge event lists corresponding to the two revolutions. More revolutions can be added simply be merging the corresponding revolution file and the file `merged_1.fits`. For instance:

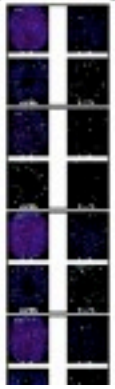
```
merge set1=file_3 set2=merged_1.fits outset=merged_2.fits
```

The file `merged_2.fits` will contaiint events corresponding to *file_1*, *file_2* and *file_3*.
Information on additional functionality when merging event files can be found in the documentation of the SAS task `merge`.

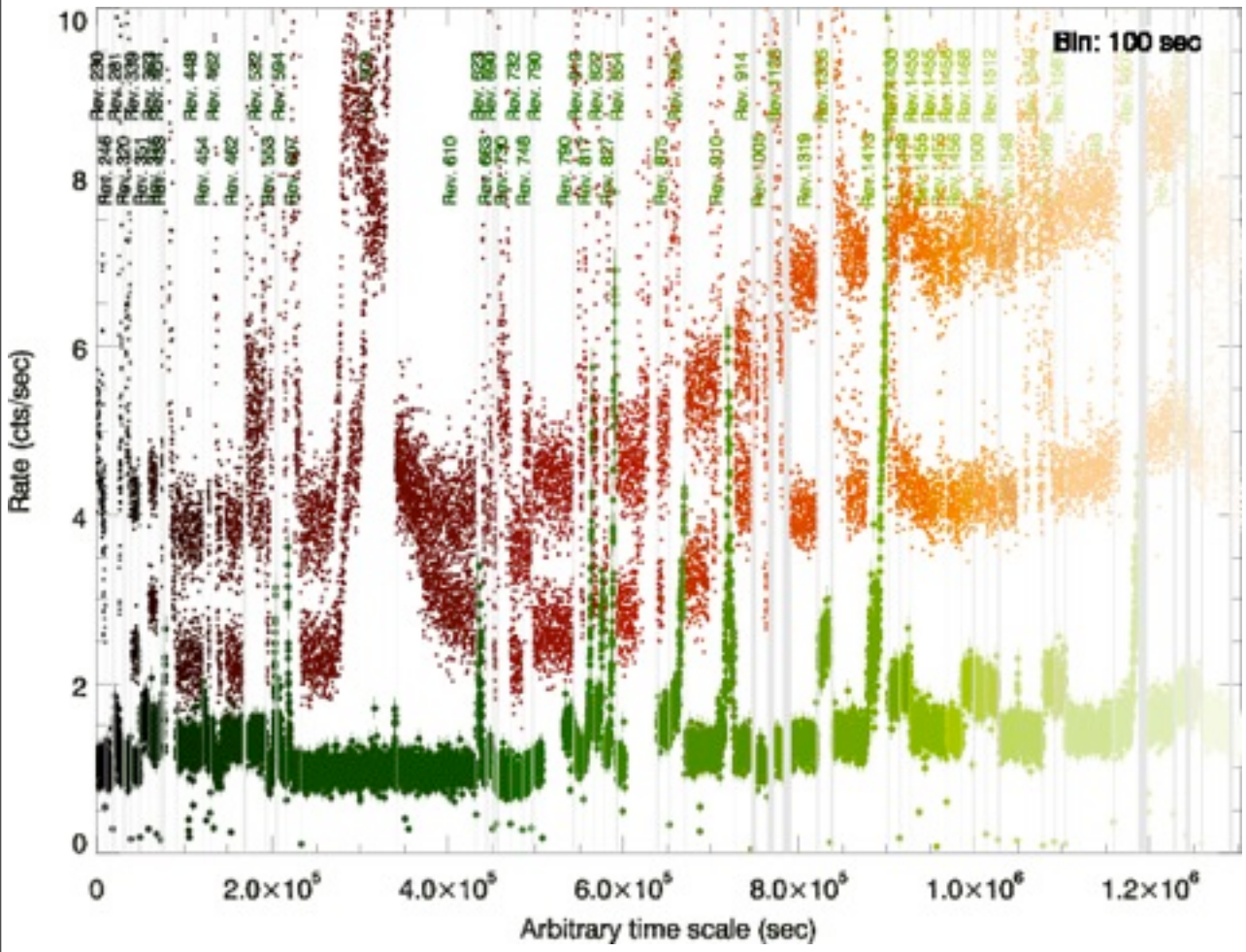
Products of the BGWG: II. FWC

Merged Event List (Rev.266 - Rev.1844)	File Size [Mb]	Total Time [ks]	Image [DETX/DETY]	Light Curve [cts/sec]	Radiation Monitor [cts/sec]
Merged Event File	715	421.1	 (ps file)	 (ps file) (ps file)	 (ps file)

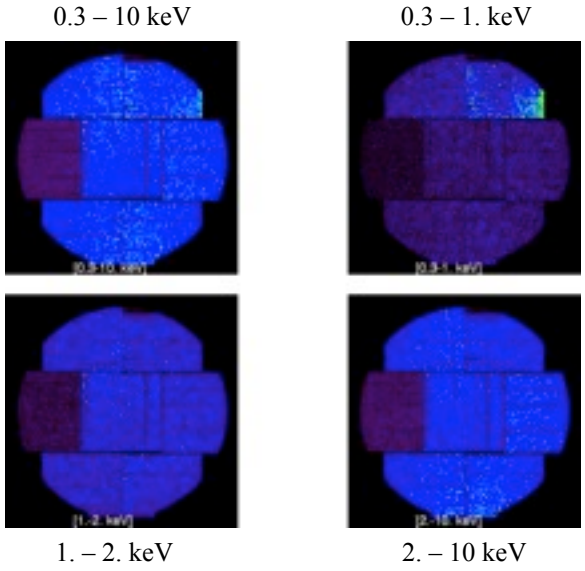
Merged Event List: Merged Filter Wheel Closed event list. No filtering expression has been applied during the generation of the event lists. A column with the revolution number has been added to the event list. The individual event lists that make up the merged file are listed below.
File Size[Mb]: Size of the Merged Filter Wheel Closed event list in units of megabyte.
Total Time[ks]: Duration of the merged Filter Wheel Closed exposures in units of kilosecond.
Image: Combined Filter Wheel Closed filtered image in detector coordinates (DETX, DETY). The filter expression used to create these images is (FLAG==0 && PATTERN <= 4). Four images are shown corresponding to different energy ranges: *Top Left*, energy range 0.2-10 keV; *Top Right*, energy range 1-2 keV; *Bottom Left*, energy range 7.8-8.2 keV; *Bottom Right*, energy range 7.3-7.6 keV. These energy ranges have been chosen to highlight known instrumental spectral features (see the *EPIC background* section of the XMM-Newton User Handbook for more details).
Light Curve: Combined Filter Wheel Closed filtered 100 seconds bin light curves (*green*). The filter expression used to create these light curves is (FLAG==0 && PATTERN <= 4). No energy cut has been applied. The right figure shows the same but includes the light curves corresponding to the high and low energy Radiation Monitor (*red*).
Radiation Monitor: Radiation Monitor 100 seconds bin light curves for high (*red*) and low (*green*) energy over the corresponding revolution. Overimposed is the light curve of the corresponding Filter Wheel Closed observation (*black*).

Individual Event List	Time [ks]	Observation Start [UTC Date]	Image [DETX/DETY]	Light Curve [cts/sec]	Radiation Monitor [cts/sec]
0266_0136750301_EPN_U002	28.1	2001-05-22T06:06:51.0			
0363_0112830701_EPN_S005	6.1	2001-12-01T19:37:07.0			
0448_0153750701_EPN_S008	30.5	2002-05-20T19:59:40.0			
0462_0134521601_EPN_S005	23.2	2002-06-18T09:53:21.0			

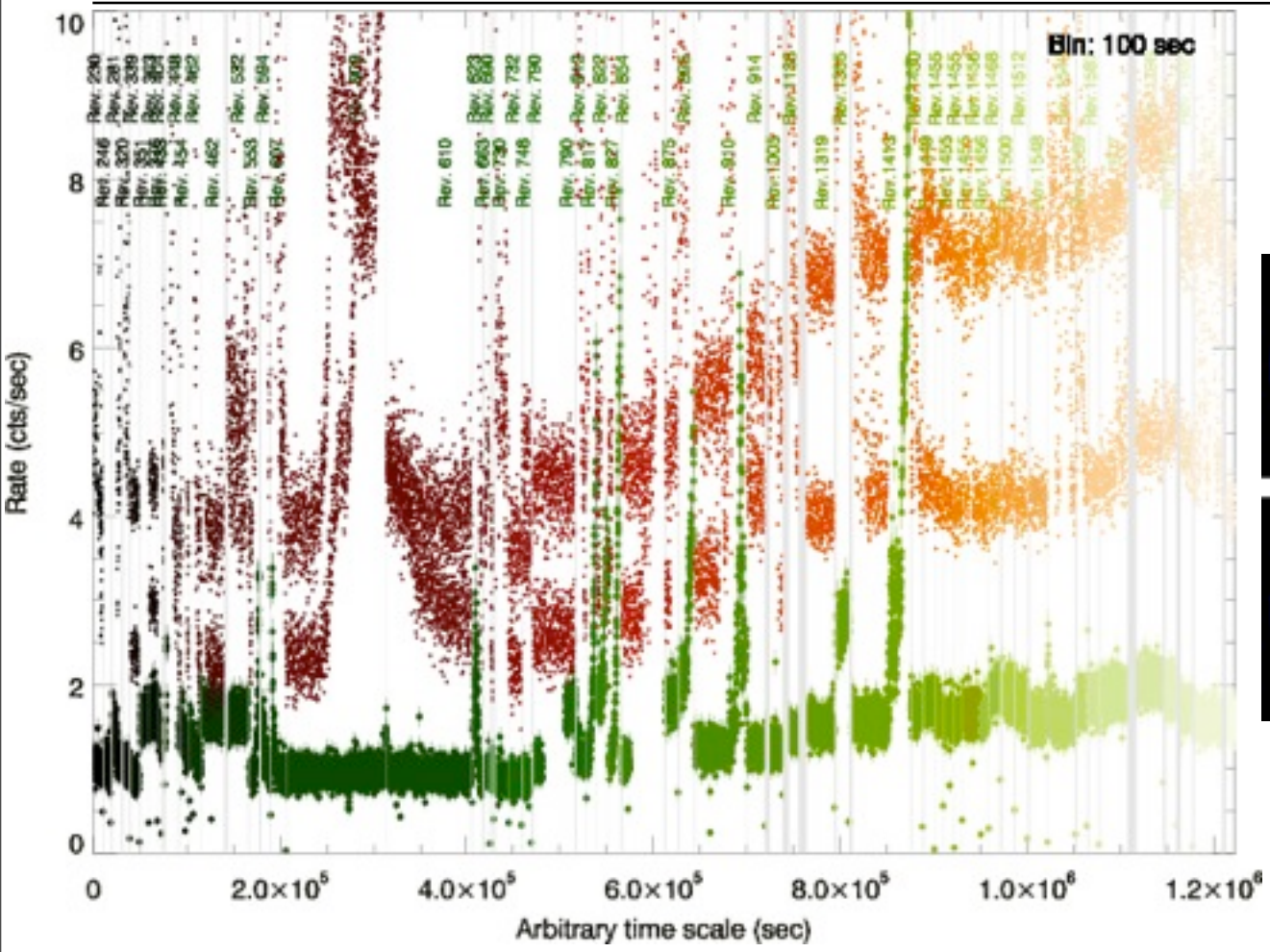
Products of the BGWG: II. FWC



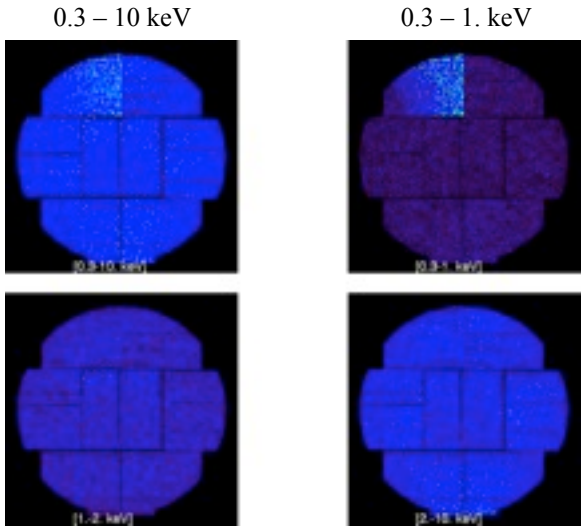
MOS1 Full Frame



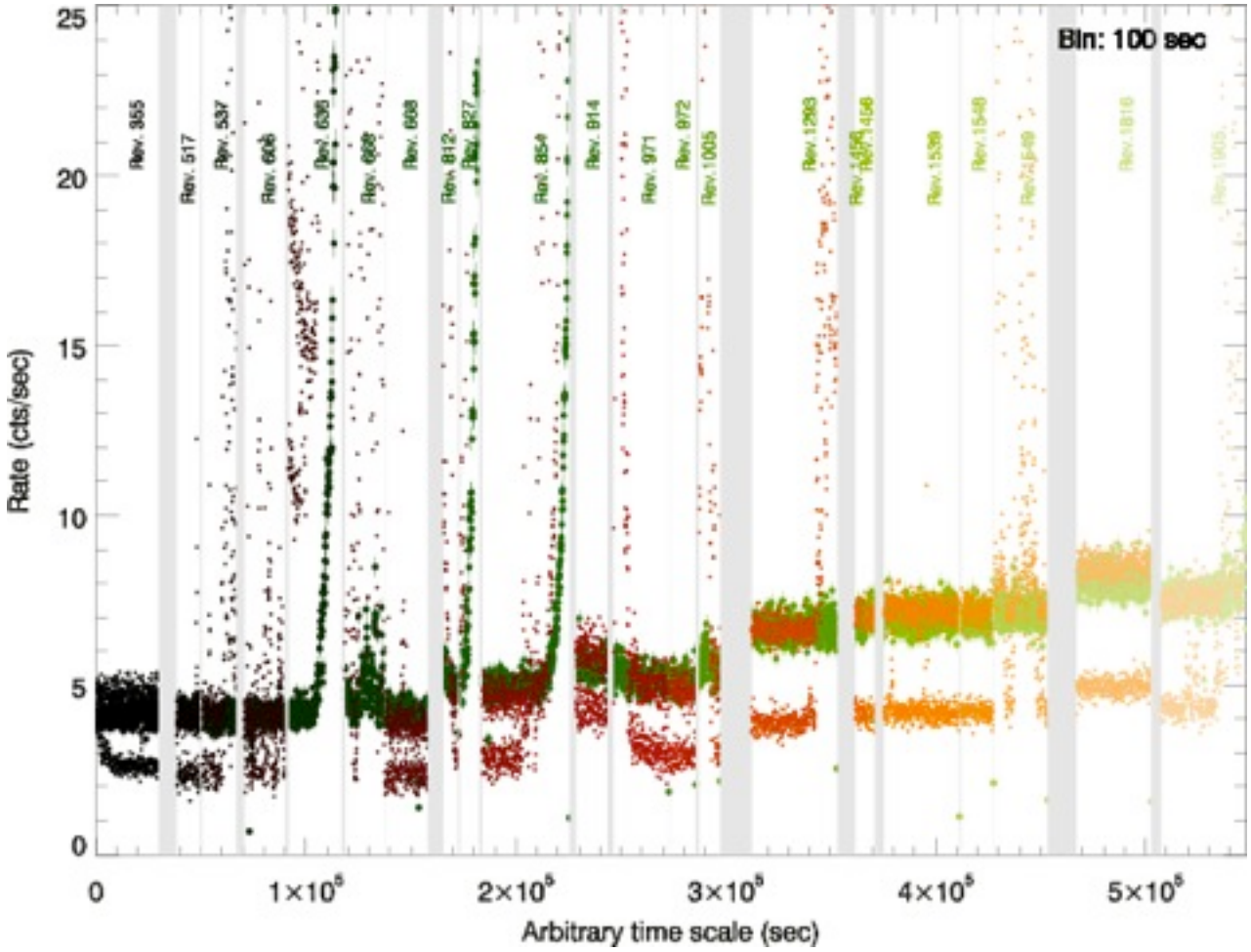
Products of the BGWG: II. FWC



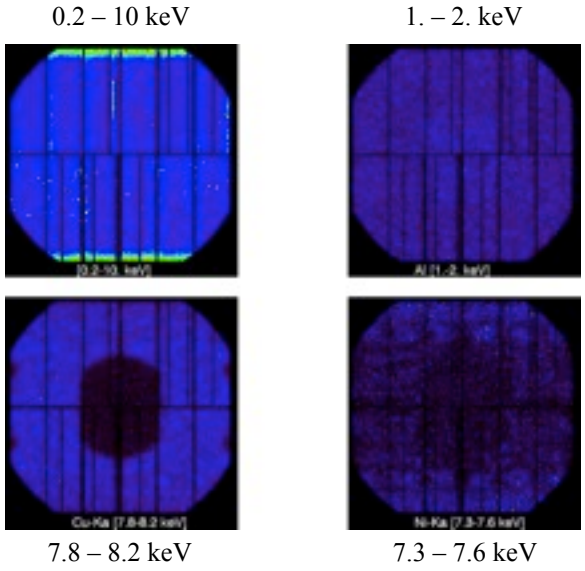
MOS2 Full Frame



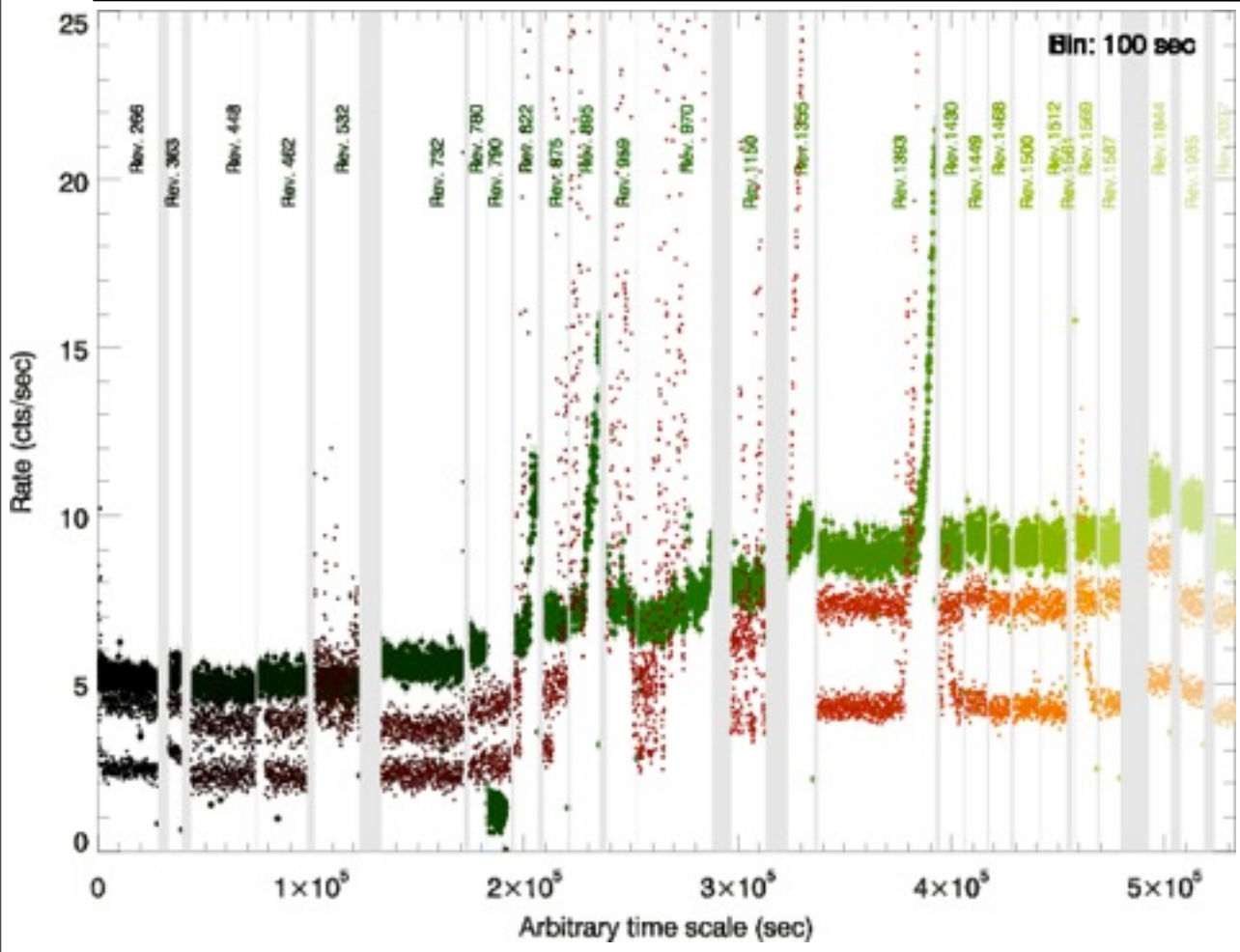
Products of the BGWG: II. FWC



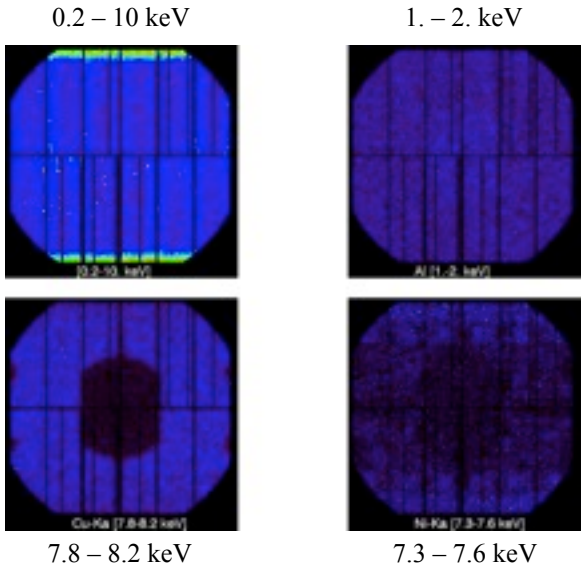
PN Extended Full Frame



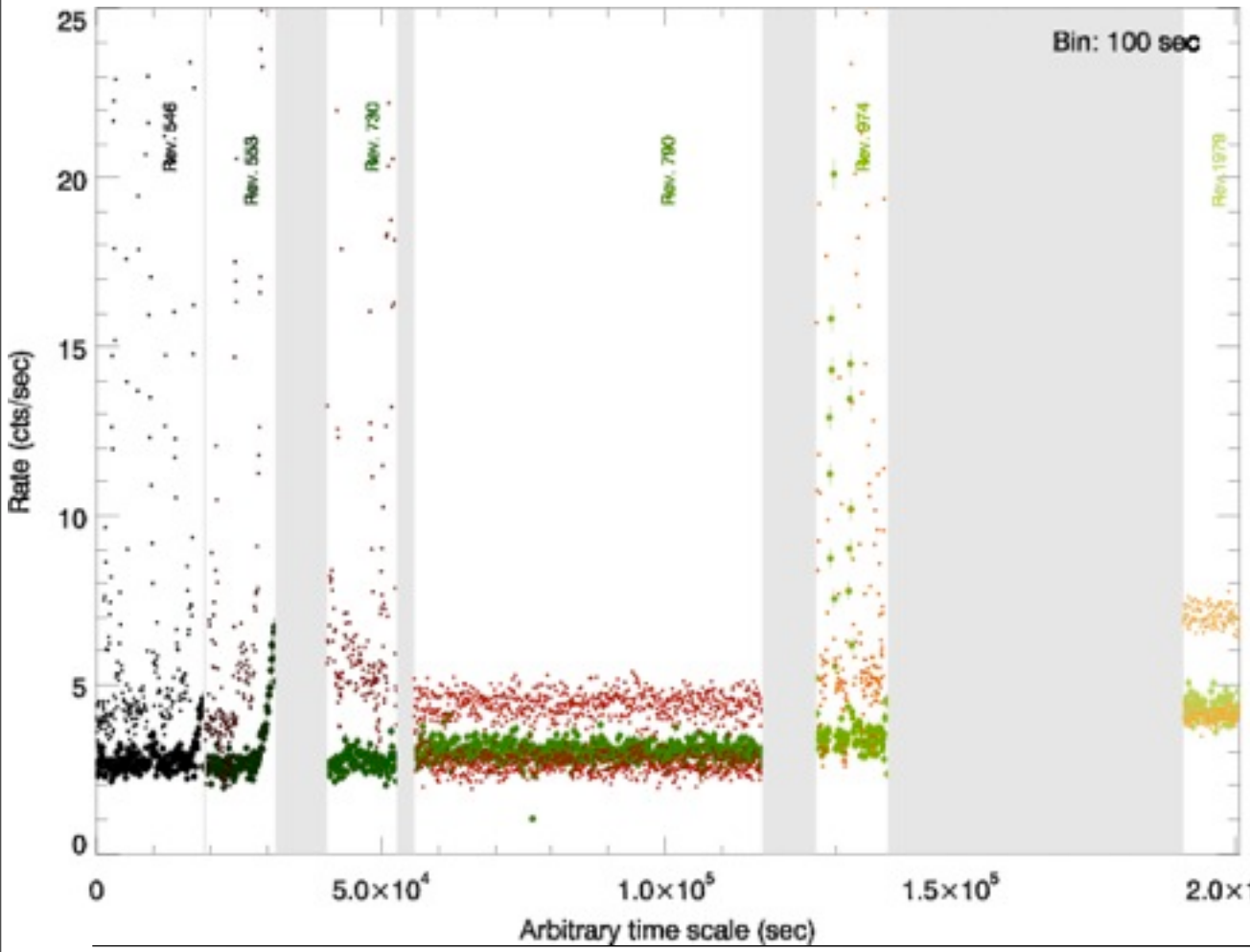
Products of the BGWG: II. FWC



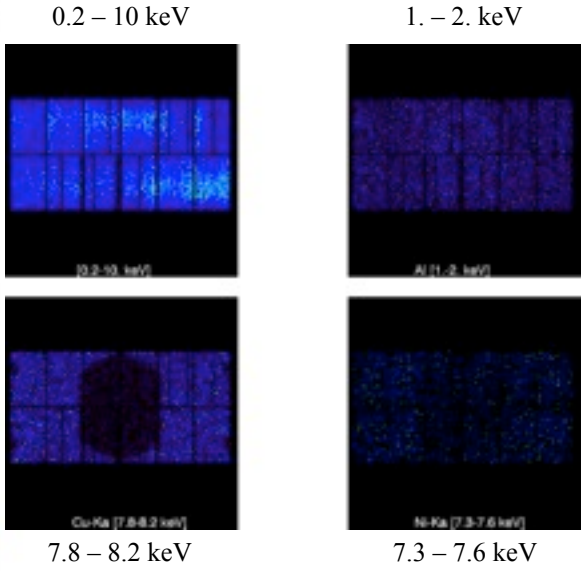
PN Full Frame



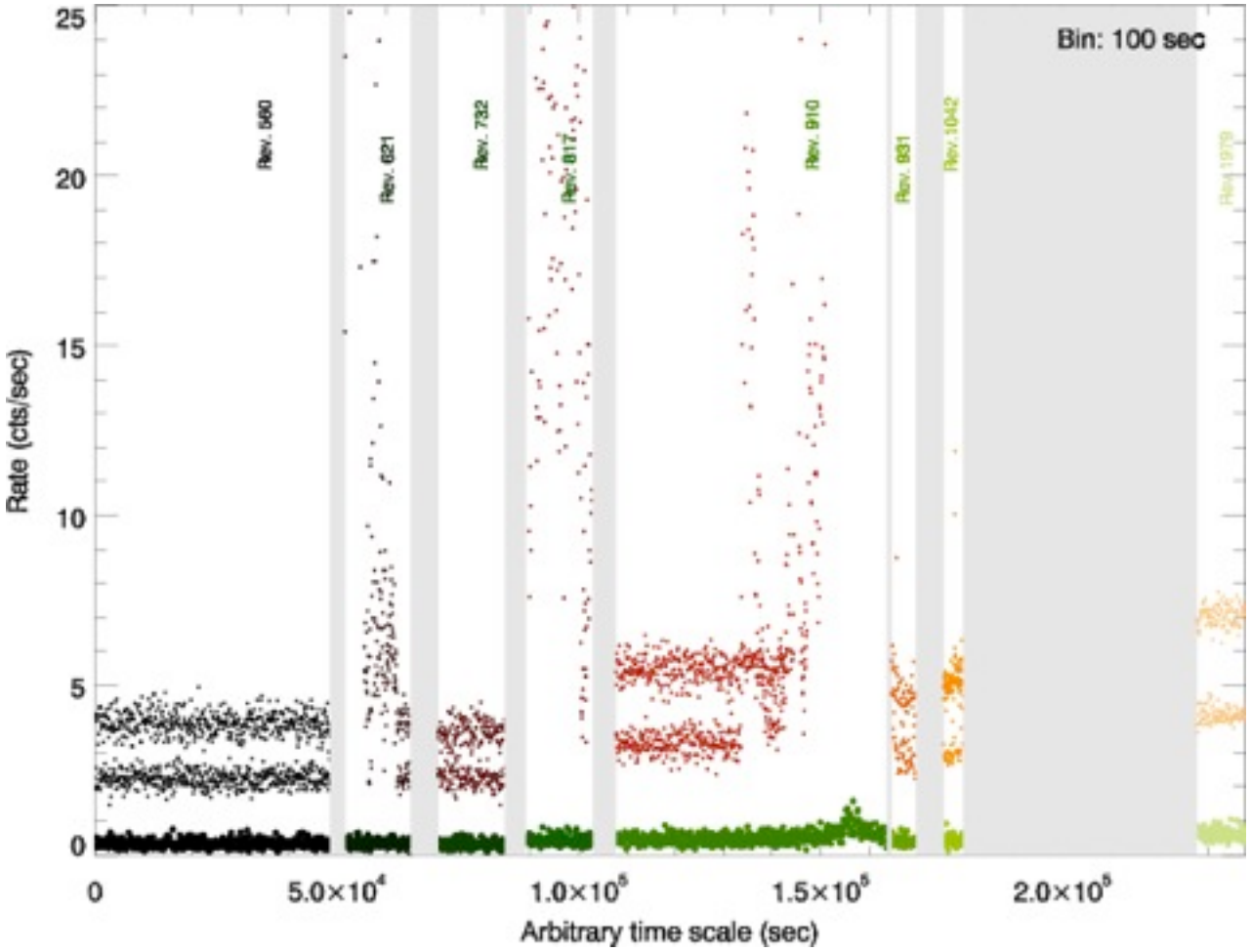
Products of the BGWG: II. FWC



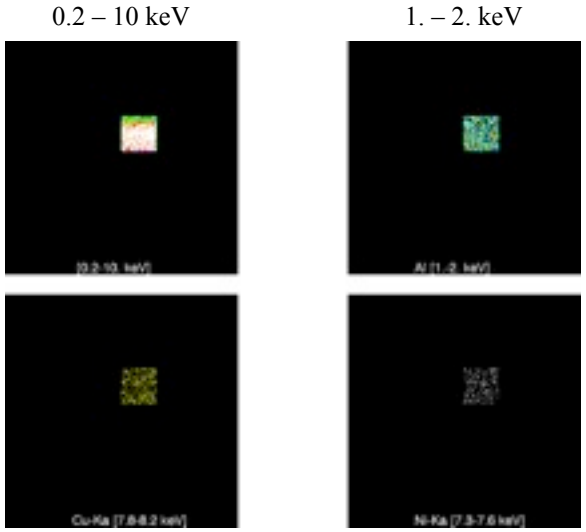
PN Large Window



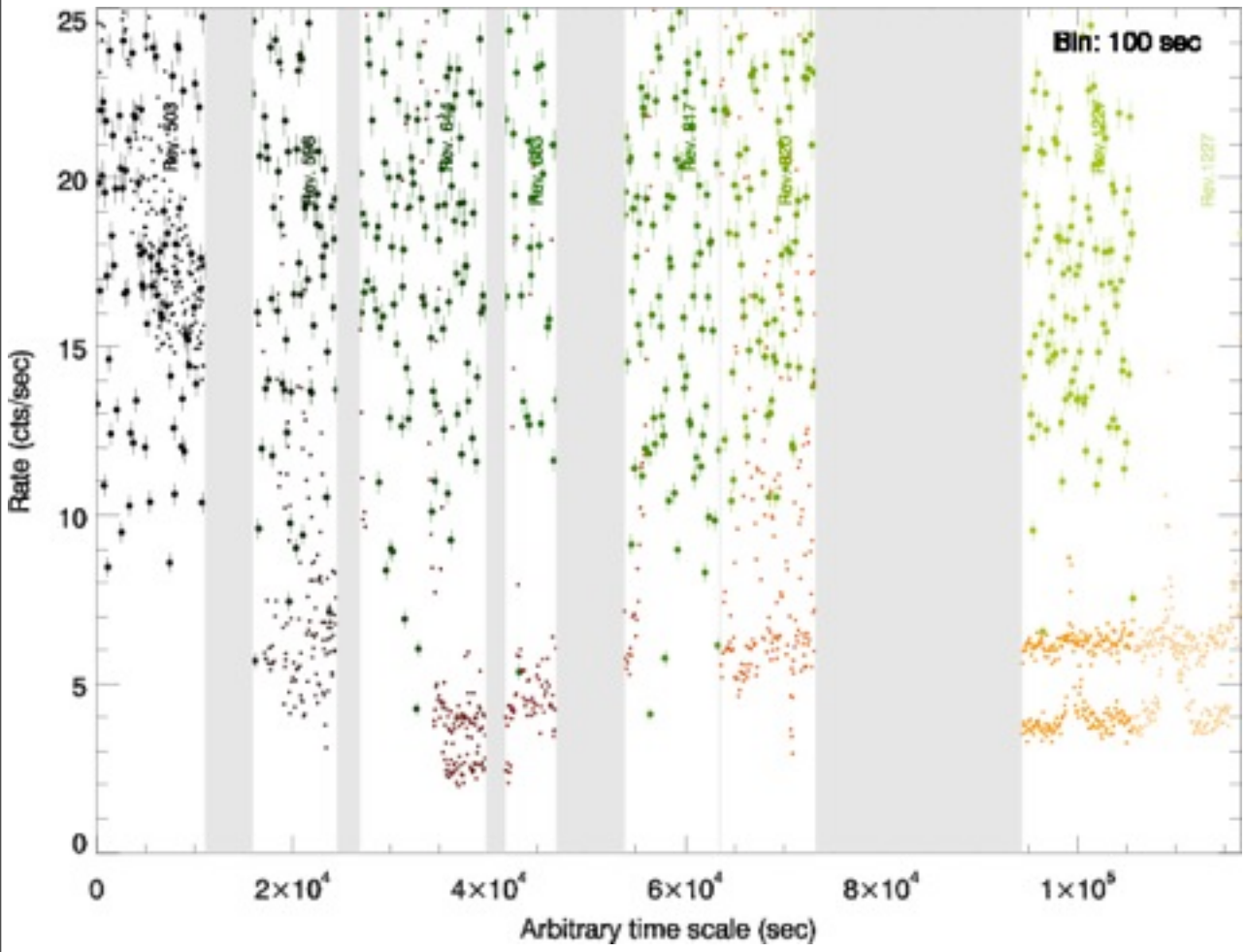
Products of the BGWG: II. FWC



PN Small Window



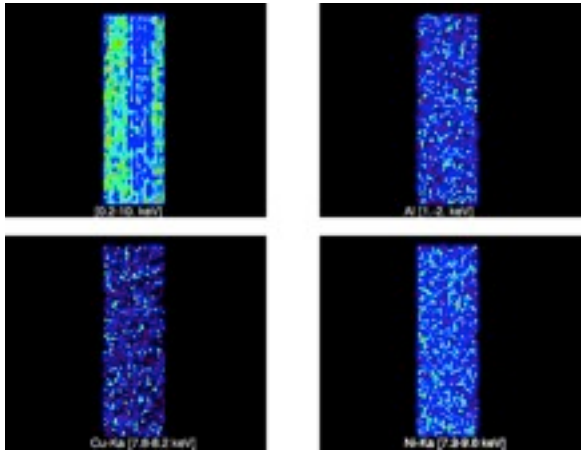
Products of the BGWG: II. FWC



PN Timing

0.2 – 10 keV

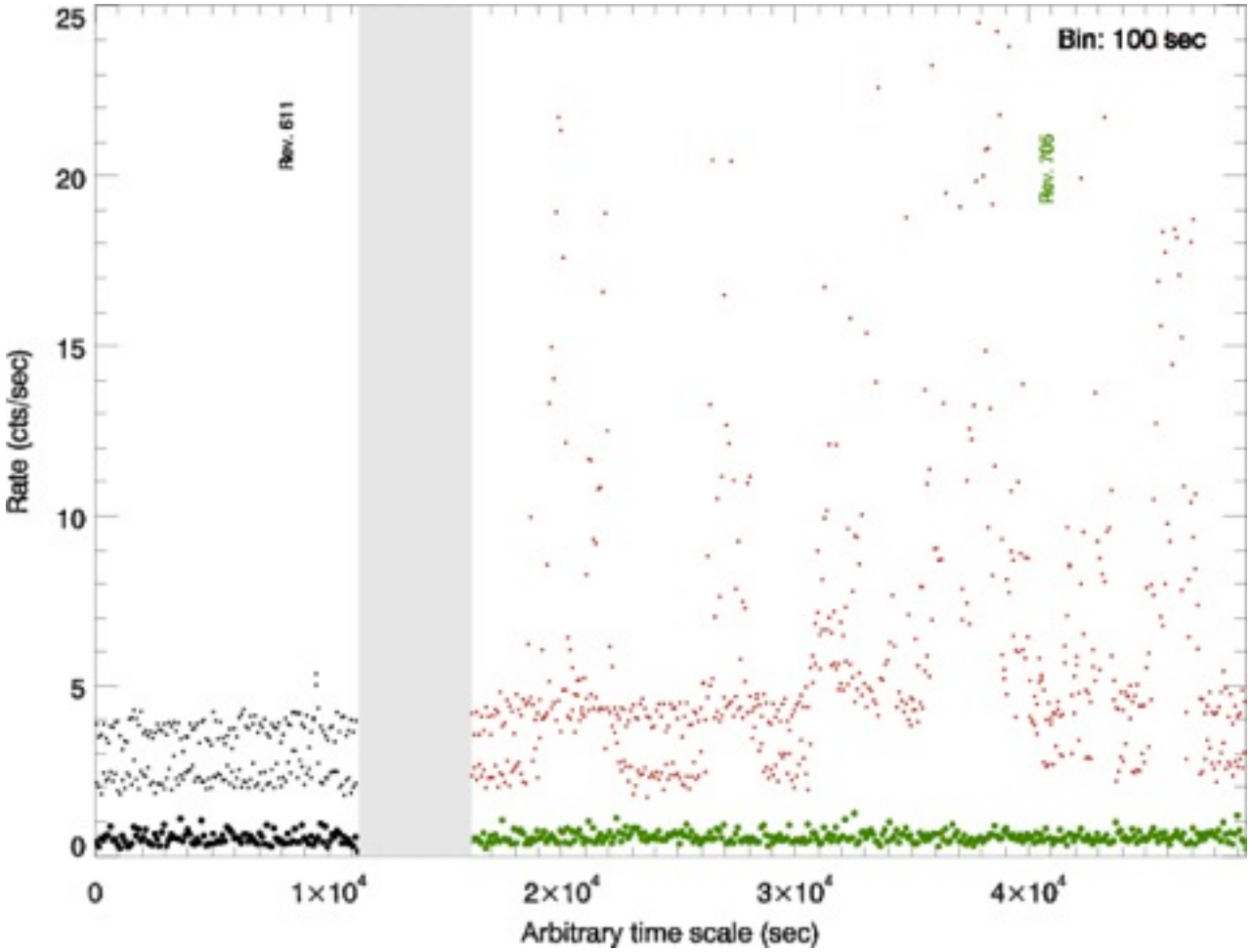
1. – 2. keV



7.8 – 8.2 keV

7.3 – 7.6 keV

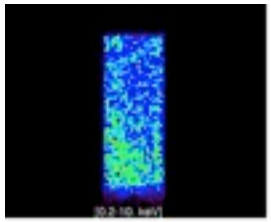
Products of the BGWG: II. FWC

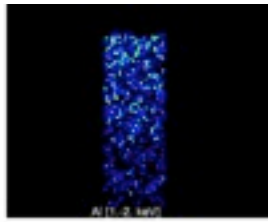


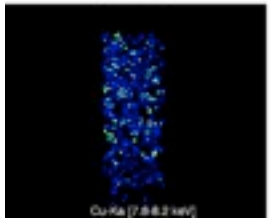
PN Burst

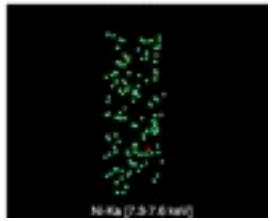
0.2 – 10 keV

1. – 2. keV









7.8 – 8.2 keV

7.3 – 7.6 keV

Products of the BGWG: III. ESAS

1. **XMM-Newton Extended Source Analysis Software Package (ESAS)**
   - Released in March 2006 for EPIC MOS detectors.
     - Create model quiescent particle background spectra for user defined regions within the FOV of the detectors.
     - Create bkg subtracted & exposure corrected images.
   - Based on software described in Snowden, Collier & Kuntz (*2004, ApJ 610, 1182*) and updated & applied to a catalog of cluster observations in Snowden, Mushotzky, Kuntz, Davis (*2008, A&A 478, 615*).

2. **PERL scripts (calling SAS tasks) & stand-alone Fortran 77 programs + FITS Calibration files**
   - Version 2 released, 31 May 2007.
   - *"If problems arise or results look odd, please contact the XMM-Newton Helpdesk".* Suggestions for improving the software or documentation welcome.

3. **Principal ideas originally presented at the Documentation**
   - Cookbook: incl. example data & recipe of spectral & image data processing

4. **Ideas originally introduce at the UG meeting in 2007 and 2008**

Products of the BGWG: III. ESAS

What is new ?

- As of SAS v9.0 (June 2009) the ESAS code is integrated (A. Ibarra, SOC) in SAS. Only the analysis concerning MOS was included in this version.
- As of SAS v11.0 (March 2011) ESAS includes the analysis of pn data.
- The ESAS code will be maintained by S. Snowden (XMM-Newton Guest Observer Facility, NASA/GSFC).
  - There will no longer be a stand-alone version of ESAS
- At the XMM-Newton Helpdesk a new folder has been created to hold questions specific to ESAS. So far, the folder contains 25 messages. S. Snowden is contacted frequently to help solve this questions.

Products of the BGWG: III. ESAS

The **ESAS Cookbook** is regularly updated (NASA/GSFC). The current version is version v4.3, released on the 6th March 2011 to be in line with SAS v11.0 and includes the analysis of pn and MOS data.

Version 4.3: 6 March 2011

COOKBOOK FOR ANALYSIS PROCEDURES FOR *XMM-NEWTON* EPIC MOS OBSERVATIONS OF EXTENDED OBJECTS AND THE DIFFUSE BACKGROUND

S. L. SNOWDEN
Code 662, NASA/Goddard Space Flight Center, Greenbelt, MD 20771
Steven.L.Snowden@nasa.gov

AND

K. D. KUNTZ
Johns Hopkins University, Baltimore, MD
kuntz@pha.jhu.edu

SAS	Task	Change
V10.5	*pn_back*	Additional diagnostic output
–	*espfilt*	Improve the output plotting
–	CalDB files	Extensive reformatting of files requiring changes in multiple tasks
–	*pn_back*	New release – still under development
–	*cheese-bands*	New release
–	*proton_scale*	Parameter and input file changes for `mode=2`
–	*mos_back*	Bug fix affecting Mac users
–	*proton*	Combined CCF flare files
–	*comb*	Updated scale factors for merging data from different filters – assumed hardness now selectable
–	*merge_comp_xmm*	Same as *comb*
–	*swcx*	Cast SWCX background images
V11.0	CalDB	Updated QPB and FWC files – NEW DOWNLOAD REQUIRED
–	*mos_back*	Check for MOS1 CCD#6 status
–	*mos-spectra*	Check for MOS1 CCD#6 status
–	*proton*	Check for MOS1 CCD#6 status
–	*swcx*	Check for MOS1 CCD#6 status
–	*bin_image*	Implement SWCX processing
–	*bin_image_merge*	Implement SWCX processing
–	*adapt_2000*	Implement SWCX processing
–	*merge_comp_xmm*	Implement SWCX processing
–	*conv-region*	Simplify region description for multiple observations
V11.?[a]	CalDB	Updated QPB and FWC files – NEW DOWNLOAD REQUIRED
–	*mos_back*	Fix ObsID misidentification in **-spec.qdp*
–	–	Add additional diagnostic information in **-aug.qdp*
–	–	Fixes required for updated QPB files
–	*mos-filter*	Diagnostic output added to check for anomalous states
–	*cheese*	Fixes required by changed file format for *emask* output
–	*mos_back*	Fixes required by changed file format for *emask* output
–	*make_mask_merge*	Fixes required by changed file format for *emask* output
–	–	Modify so that it will run with just the output from cheese

Products of the BGWG: III. ESAS

How to use SAS

SAS User Guide
The official XMM-Newton SAS User Guide on-line, PDF version and Postscript version

SAS watchout page
Issues concerning SAS and data analysis, recommended workarounds/solutions, useful tricks and tips

SAS 11.0.0 on-line documentation
Documentation of all single SAS packages

SAS Cookbook
An introduction to XMM-Newton data analysis - from NASA XMM-GOF

Data analysis threads
Data reduction examples for (almost) every purpose

Data Analysis Cookbook
XMM-Newton Data Analysis Cookbook - from MPE

Background analysis
XMM-Newton pages dedicated to background analysis of all XMM-Newton instruments

ESAS Cookbook
Cookbook for data analysis of extended sources using ESAS in SAS - from NASA XMM-GOF.
ESAS warnings and watchouts page - from NASA XMM-GOF.

SAS Inverse Index
The SAS Inverse Index has been designed to provide the list of SAS tasks needed to be executed in order to perform a given scientific analysis job.

http://xmm.esac.esa.int/sas/current/howtousesas.shtml

Products of the BGWG: III. ESAS

Future plans for ESAS

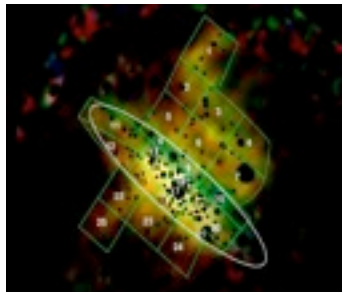
- Simplify the way ESAS treats calibration files (CalDB), for example, treat them in the same way as CCFs
- Development of an ESAS analysis thread (S. Snowden) to be included with the rest of the SAS threads available to users

Products of the BGWG: IV. Scripts

The group holds a repository of scripts for background treatment.

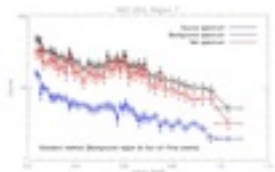
- SOC support is given on a best-effort basis
- The long term aim is to incorporate useful/validated scripts as SAS tasks

- Estimation of the residual Soft Proton Flare contamination
  (Developed by Silvano Molendi, Andrea De Luca & Alberto Leccardi (2004, A&A 419, 837), and coded by A. Read, for EPIC event files, to estimate the amount of residual Soft Proton flare contamination)

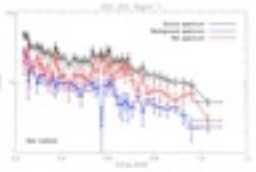


- The 'images' script: a tool to create attractive XMM-Newton Images
  (Developed at the XMM-Newton SOC as part of a trainee project to create attractive multi-energy band images using and merging data from the three EPIC cameras)

- Background correction for faint extended EPIC-pn emission
  (Method developed by M. Bauer (MPE) to use a local estimate of the sky background to correct for faint extended emission in EPIC-PN data; Bauer, M. et al 2007, astro-ph/0711.3182)



Standard Method



New Method

Products of the BGWG: IV. Scripts

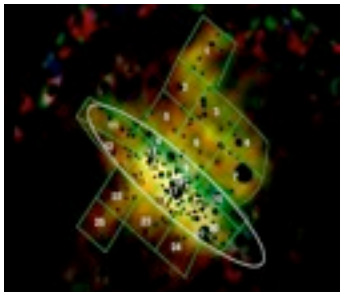
The group holds a repository of scripts for background treatment.

- SOC support is given on a best-effort basis
- The long term aim is to incorporate useful/validated scripts as SAS tasks

- Estimation of the residual Soft Proton Flare contamination
  (Developed by Silvano Molendi, Andrea De Luca & Alberto Leccardi (2004, A&A 419, 837), and coded by A. Read, for EPIC event files, to estimate the amount of residual Soft Proton flare contamination)

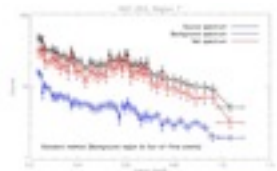
- The 'images' script: a tool to create attractive XMM-Newton Images
  (Developed at the XMM-Newton SOC as part of a trainee project to create attractive multi-energy band images using and merging data from the three EPIC cameras)

Removed

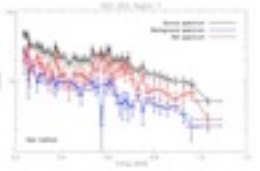


- Background correction for faint extended EPIC-pn emission
  (Method developed by M. Bauer (MPE) to use a local estimate of the sky background to correct for faint extended emission in EPIC-PN data; Bauer, M. et al 2007, astro-ph/0711.3182)

We state that support is no longer provided



Standard Method



New Method

Summary

Blank Sky Files

Update SAS threads to include the analysis of MOS and pn data
Update some information at SOC Web Pages

Filter Wheel Close Observations

Update web pages
Update of repository in March 2011
Added information to merge and select FWC data according to TIME
Added plot to track the time evolution of the FWC data

XMM-ESAS

As of SAS as of v.11.0 ESAS includes the analysis of pn data
Creation of a dedicates folder to address ESAS questions on the XMM-Newton helpdesk
Warning and watchout section available and maintained by S. Snowden
A thread dealing with data analysis with ESAS will be made available soon

Scripts

Remove some scripts or state that support is no longer provided