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## **Background Working Group Meeting**

*Leicester, March 6<sup>th</sup> 2012*

# **Summary of SOC Activities**

**Ignacio de la Calle**



# The Working Group EPIC Background

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## 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

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The latest Users Group (UG) meeting took place at **ESAC** on the **19<sup>th</sup>-20<sup>th</sup> of May 2011**. For this meeting, no specific talk was requested regarding BGWG activities.

No further issues were raised at the latest UG meeting concerning the activities of the BGWG. The AI we had coming out of UG meetings are all closed.

## **Next UG Meeting: 19<sup>th</sup>-20<sup>th</sup> of April 2012 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

**CLOSED**

**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.

**CLOSED**

**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 (à 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**

**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

**CLOSED**

**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.





# Products of the BGWG: I. Blank Sky Files

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## Blank Sky SAS Threads

One thread available dealing with both EPIC-pn and EPIC-MOS analysis.

*How to use EPIC background blank field files*

No changes or updates in 2011

## Changes to Blank Sky Web Pages at the SOC

J. Carter provided a new version of the Skycast script in August 2011. The pages were changed accordingly to reflect this update.





# Products of the BGWG: II. SWCX

## Products

- [XMM-Newton Extended Source Analysis Software package](#), [XMM-ESAS](#)  
As of SAS version 9.0, the XMM-ESAS package is integrated in SAS. XMM-ESAS allows the user to model the quiescent particle background for both spectral and spatial analysis of EPIC pn and EPIC MOS observations.
- [XMM-Newton 'blank sky' background event files](#)  
XMM-Newton EPIC blank sky user facility released in August 2010 following a processing of the XMM-Newton archive (up to revolution 1789) using SAS 9.0. Users within the community are invited to request blank sky files specifically catered for, and precisely tuned to their own particular needs.
- [Filter Wheel Closed data](#)  
Updated in April 2011 by the EPIC Background Working Group the stacked collections of Filter Wheel Closed (FWC) data are available for the MOS and pn cameras.

## [Exospheric solar wind charge exchange affected observations](#)

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

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

## XMM-Newton EPIC-MOS observations affected by Solar Wind Charge Exchange occurring in the exosphere of the Earth

This table details the set of EPIC-MOS observations affected by exospheric Solar Wind Charge Exchange (SWCX, Carter et al. 2011). We quote the EPIC MOS1 and MOS2 exposure identifier for each case. The column "Diagnostic plots" contains links to two types of plots. The first shows low energy (0.5 - 0.7 keV, black) and high energy (2.5 - 5.0 keV, red) lightcurves for the observation in question, with the solar proton flux as measured by ACE (blue) when available. The vertical dot-dashed line separate the SWCX-affected and SWCX-unaffected periods (as described in the paper). The SWCX-affected period occurs when an enhancement is seen in the low-energy lightcurve that is not observed in the high-energy lightcurve. The second plot shows a resultant spectrum for the SWCX-affected period, with a basic SWCX model fit to the data (solid line), using the SWCX-unaffected period as the background in each case. This spectrum is of the SWCX component only (see paper). If your analysis involves data taken by the EPIC-pn during one of the observations listed below, please check carefully whether your observation overlaps with the EPIC-MOS exposures. A list of all 3012 observations analysed in this study, detailing the exposure identifiers and filters used in the exposures, can be found [here](#).

Index	Revn.	Obsn.	Date	Expn MOS1	Expn MOS2	Xu	Rx	Diagnostic plots
1	0342	0085150301	2001-10-21T21:20:41	U003	U003	27.2	10.3	<a href="#">lightcurve &amp; spectrum</a>
2	0209	0093552701	2001-01-28T15:09:09	S001	S002	23.0	4.0	<a href="#">lightcurve &amp; spectrum</a>



# Products of the BGWG: III. FWC

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## 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 4<sup>th</sup> revolution, the MOS cameras can be set to CLOSED FF (pn slews are used for science)





# Products of the BGWG: III. FWC

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- The idea is to update the repository once per year, just before the BGWG, or UG, meeting (*before the AO opening*).
- The repository was updated in February 2012, and included data up to December 2011. The release will be announced in a XMM-Newton-NEWS letter as in other years.
  - Under the new implementation (10 ksec/semester), FWC routine calibration observations have been performed in:

<i>January</i>	<i>3<sup>rd</sup></i>	<i>2011</i>
July	27 <sup>th</sup>	2011
December	31 <sup>st</sup>	2011

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

The MOS slew data (every 4<sup>th</sup> revolution) **has not been analyzed**



# Products of the BGWG: III. FWC

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- Apart from the dedicated routine calibration observations, other observations have been performed during 2011 in FWC

## EPIC-pn

EFF	(May10)	Apr11
LW	(Sep10)	----
SW	(Sep10)	----
TI	(Aug06)	----
BU	(Oct03)	----

( ) ≡ *previous existing observation*

## EPIC-MOS

FF Oct11 (only FF data is included in the repository, although other modes are available)



# Products of the BGWG: III. FWC

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## Updates to Web Pages

- Add new event files and update plots
- AL\_EPIC\_BG\_WG\_10\_06 on IdIC
- *Check the FWC timing mode data: remove the lower 0.2 keV for timing and make it 0.3 keV.*

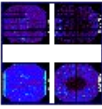
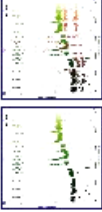
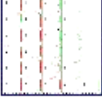
**DONE, problem fixed.**

## UG Recommendations

- None this year



# Products of the BGWG: III. 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]
<a href="#">Merged Event File</a>	715	421.1	 <a href="#">[ps file]</a>	 <a href="#">[ps file]</a>	 <a href="#">[ps file]</a>

**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.

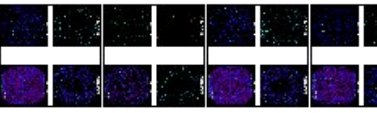


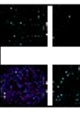


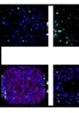


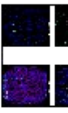
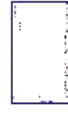

**File Size[Mb]:** Size of the Merged Filter Wheel Closed event list in units of megabyte.

**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).

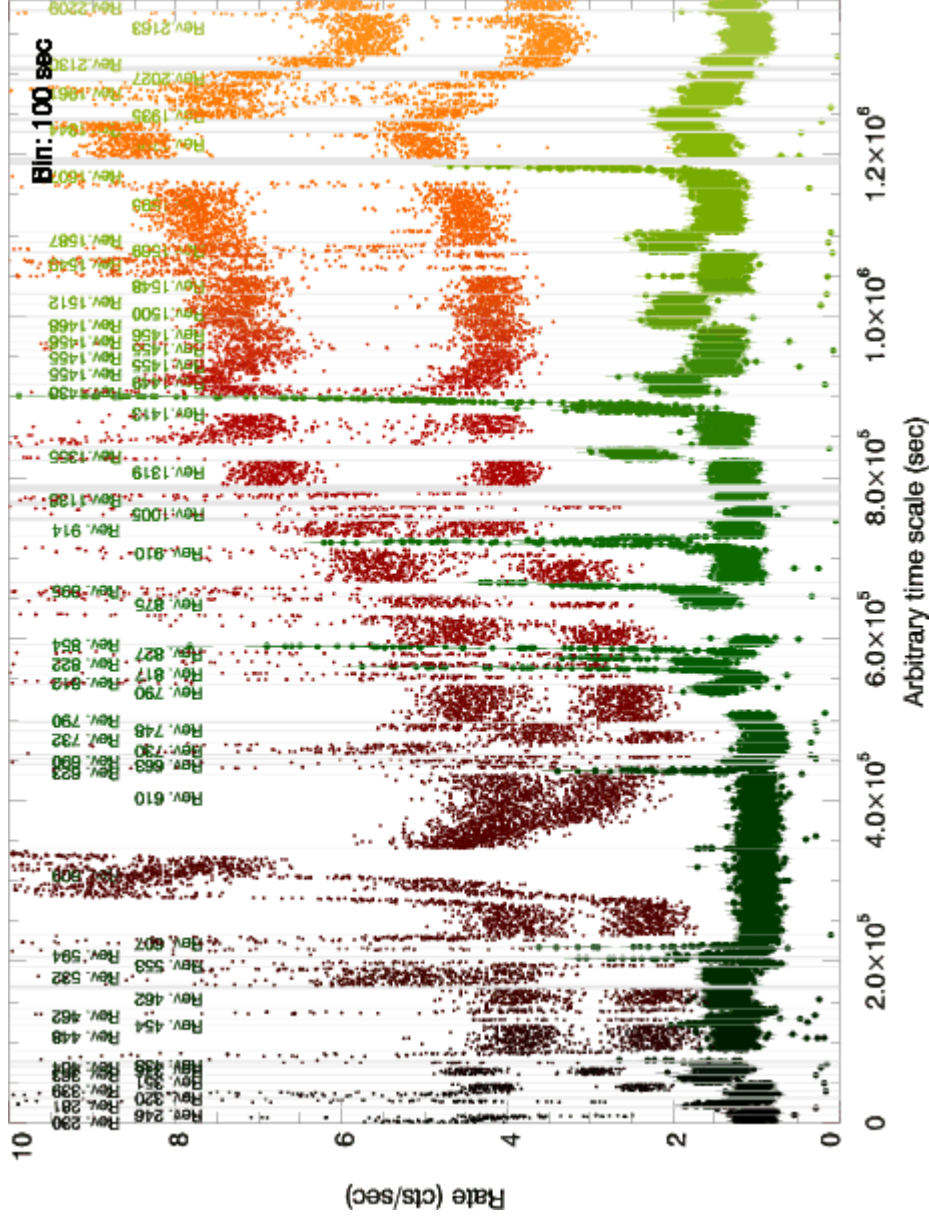
**Light Curve:** Combined Filter Wheel Closed filtered 100 seconds bin light curves (green). The filter expression used to create these light curves is (FLAG==0 && PATTERN <= 4). No energy cut has been applied. The right figure shows the same but includes the light curves corresponding to the high and 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).

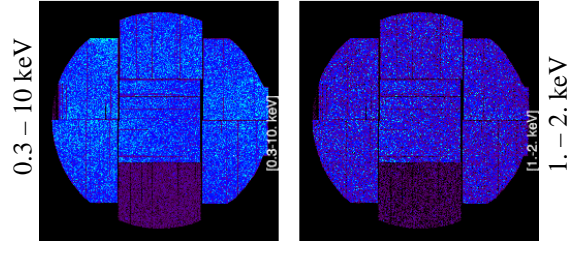
Individual Event List	Time [ks]	Observation Start [UTC Date]	Image [DETX/DETY]	Light Curve [cts/sec]	Radiation Monitor [cts/sec]
<a href="#">0266_0136750301_EPN_U002</a>	28.1	2001-05-22T06:06:51.0			
<a href="#">0363_0112830701_EPN_S003</a>	6.1	2001-12-01T19:37:07.0			
<a href="#">0448_0153750701_EPN_S008</a>	30.5	2002-05-20T19:59:40.0			
<a href="#">0462_0134521501_EPN_S003</a>	23.2	2002-06-18T09:53:21.0			



# Products of the BGWG: III. FWC



## MOS1 Full Frame

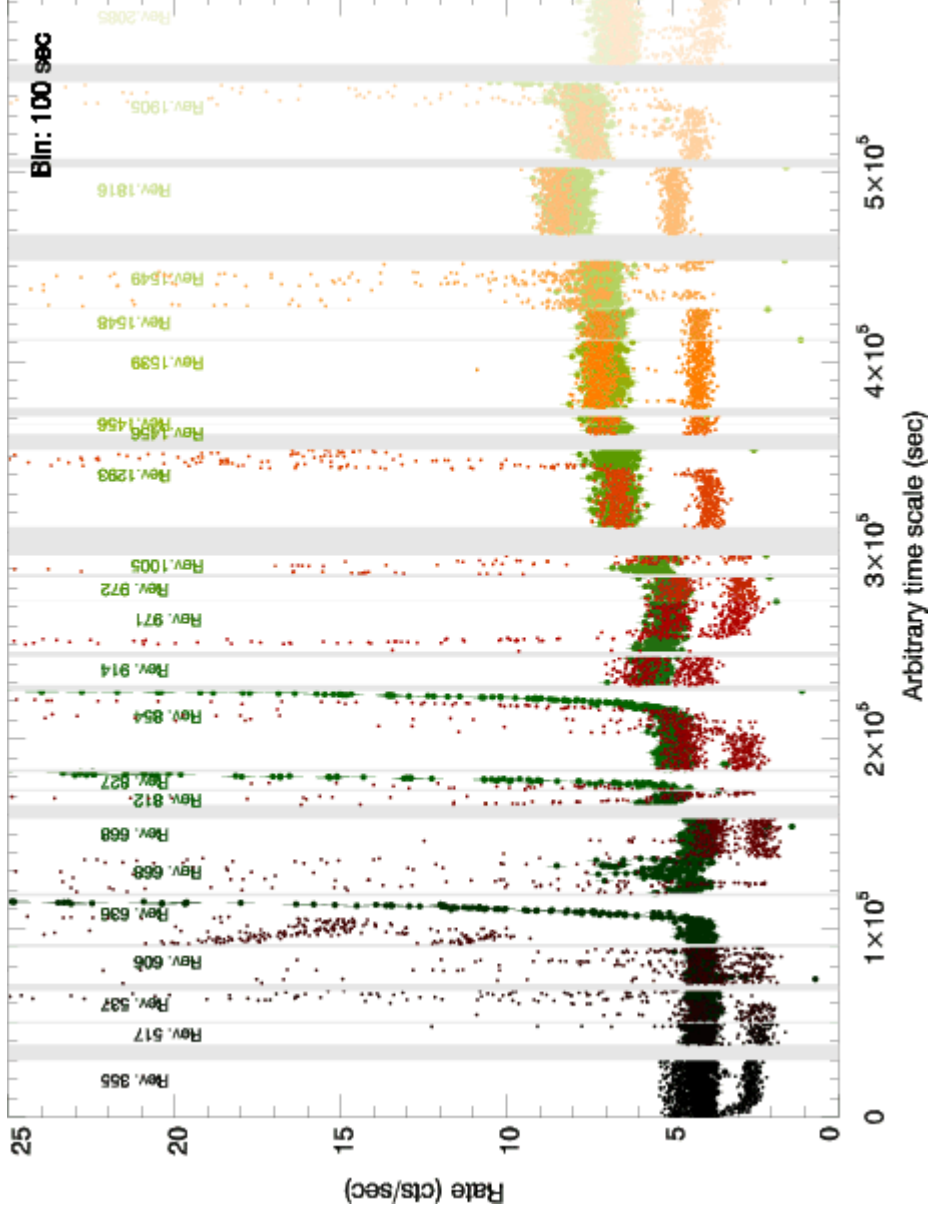




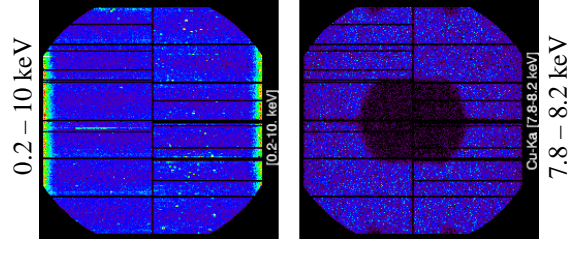




# Products of the BGWG: III. FWC

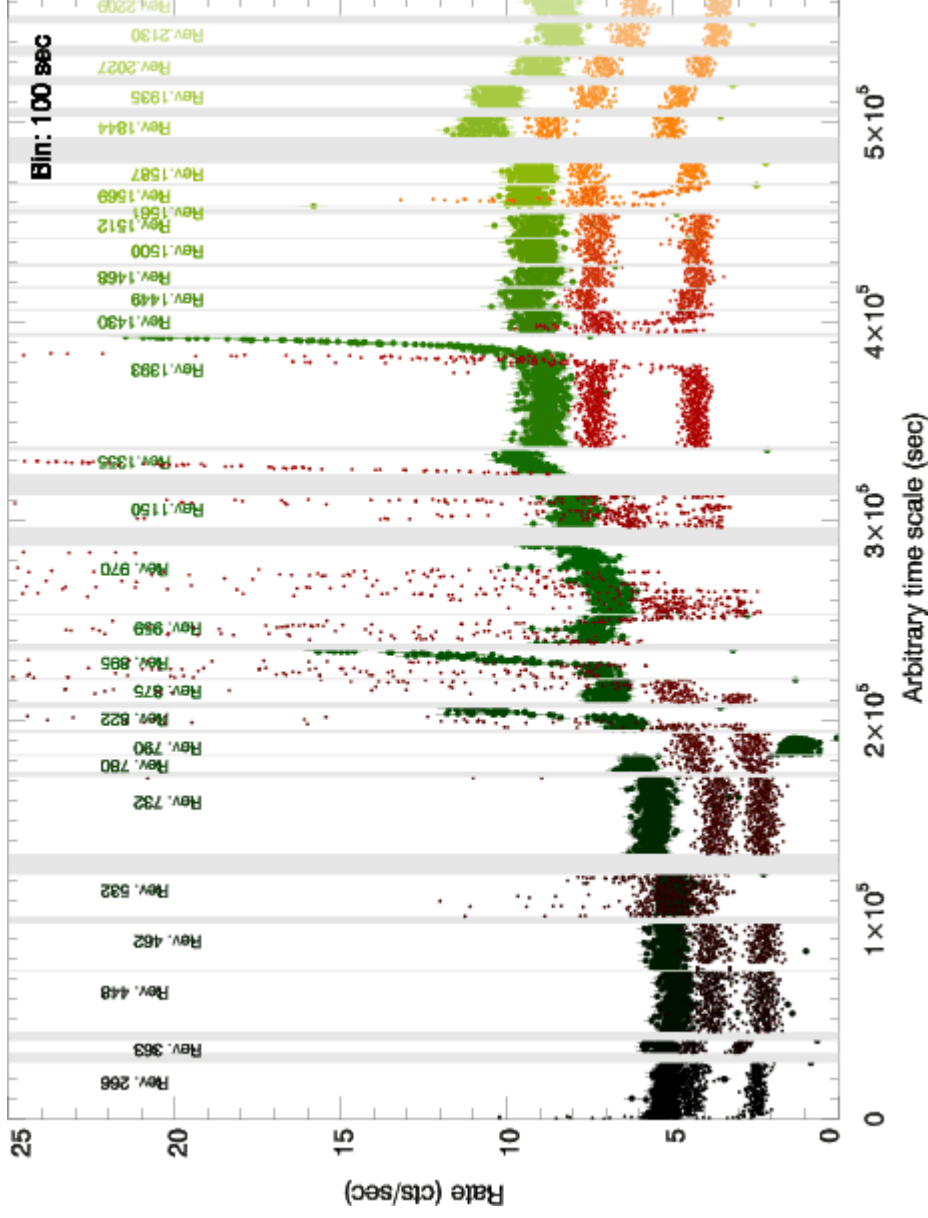


## PN Extended Full Frame

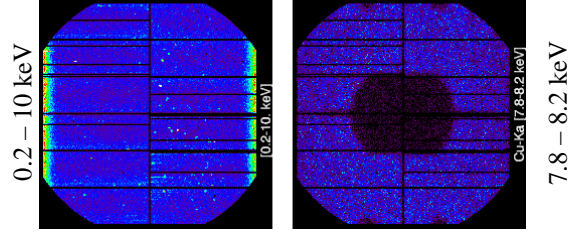


xmm-newton

# Products of the BGWG: III. FWC

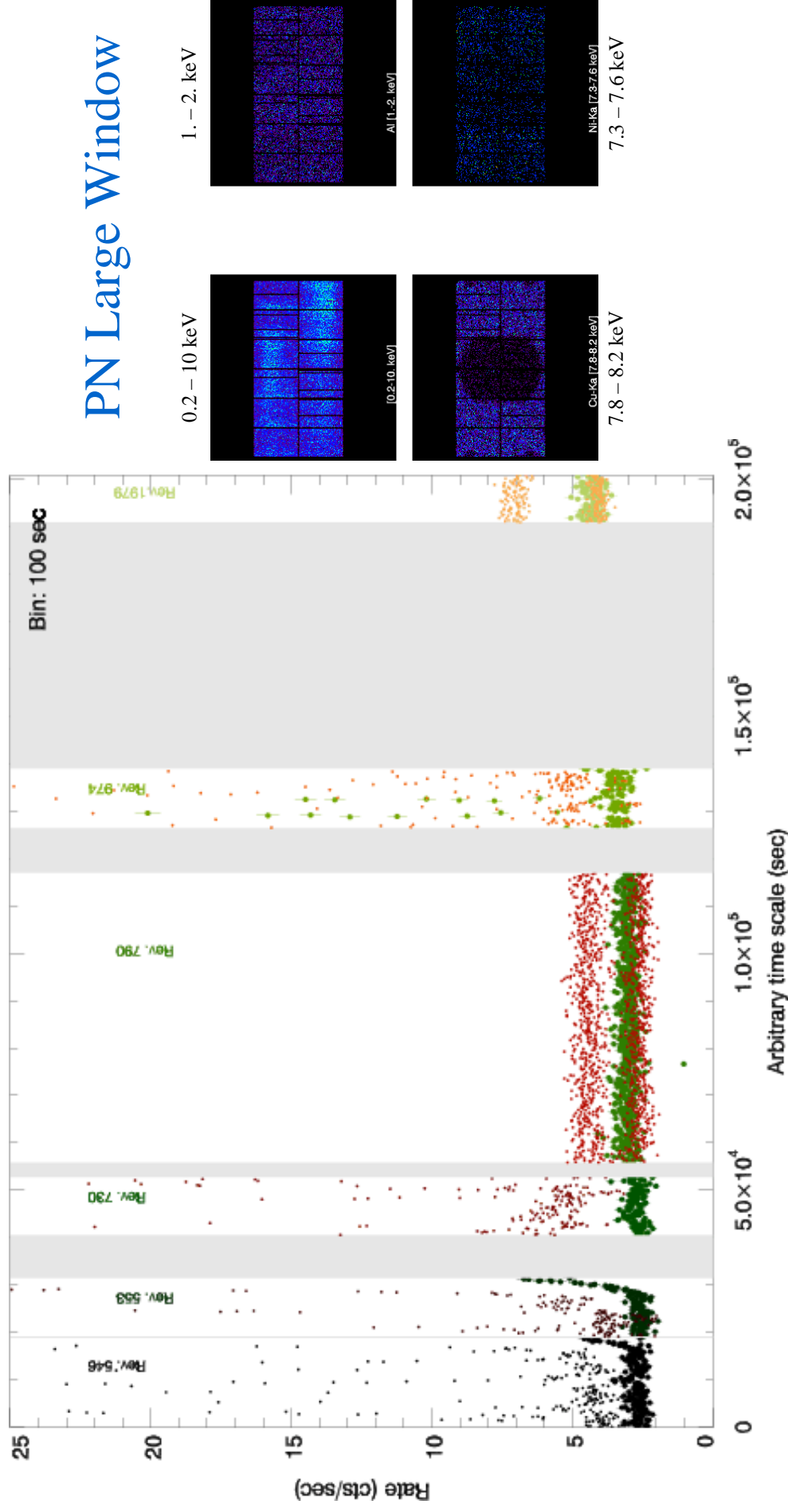


## PN Full Frame

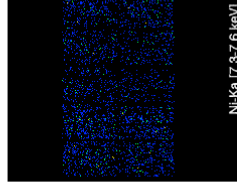
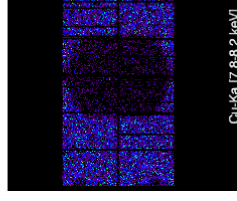
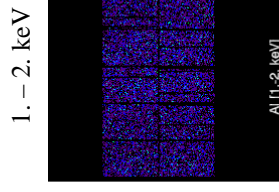
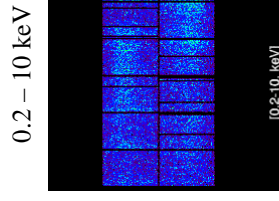


xmm-newton

# Products of the BGWG: III. FWC

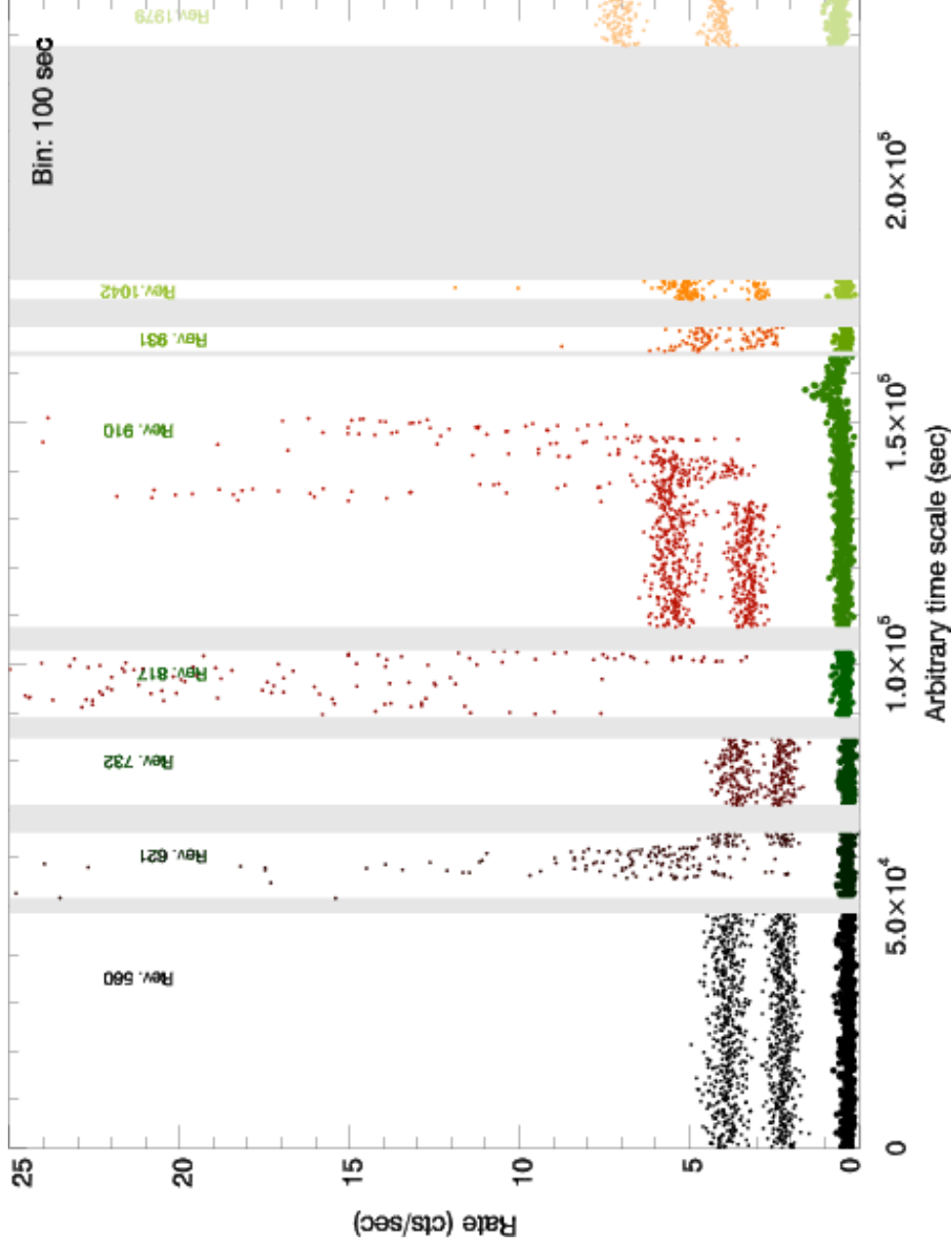


## PN Large Window



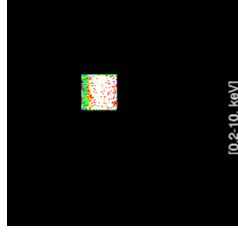
xmm-newton

# Products of the BGWG: III. FWC



## PN Small Window

0.2 – 10 keV



0.2-10. keV

1. – 2. keV



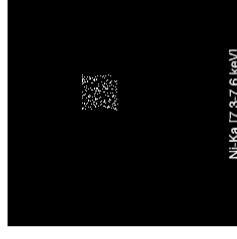
Al (1.2. keV)

7.8 – 8.2 keV



Cu-Ka (7.8-8.2 keV)

7.3 – 7.6 keV

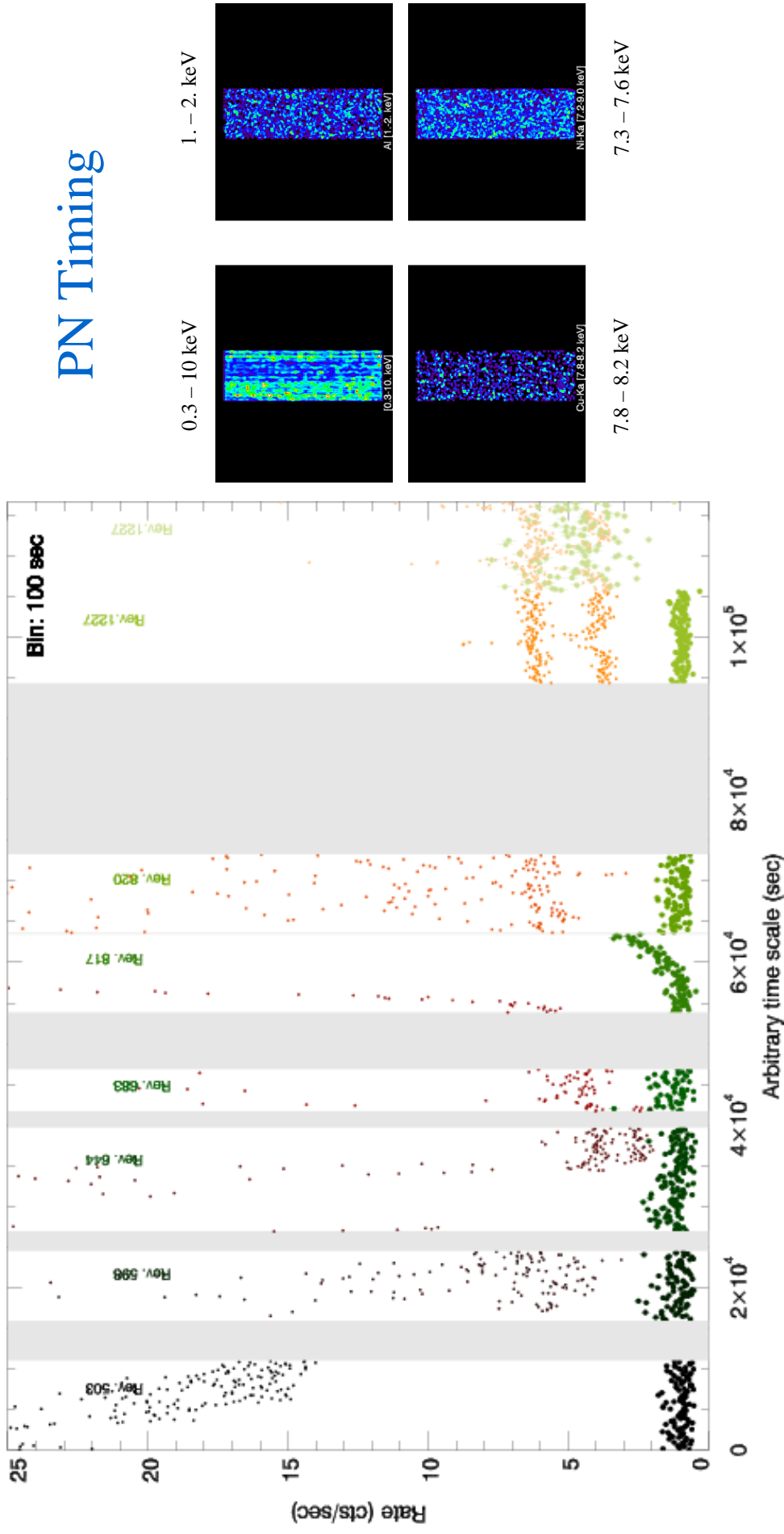


Ni-Ka (7.5-7.6 keV)



xmm-newton

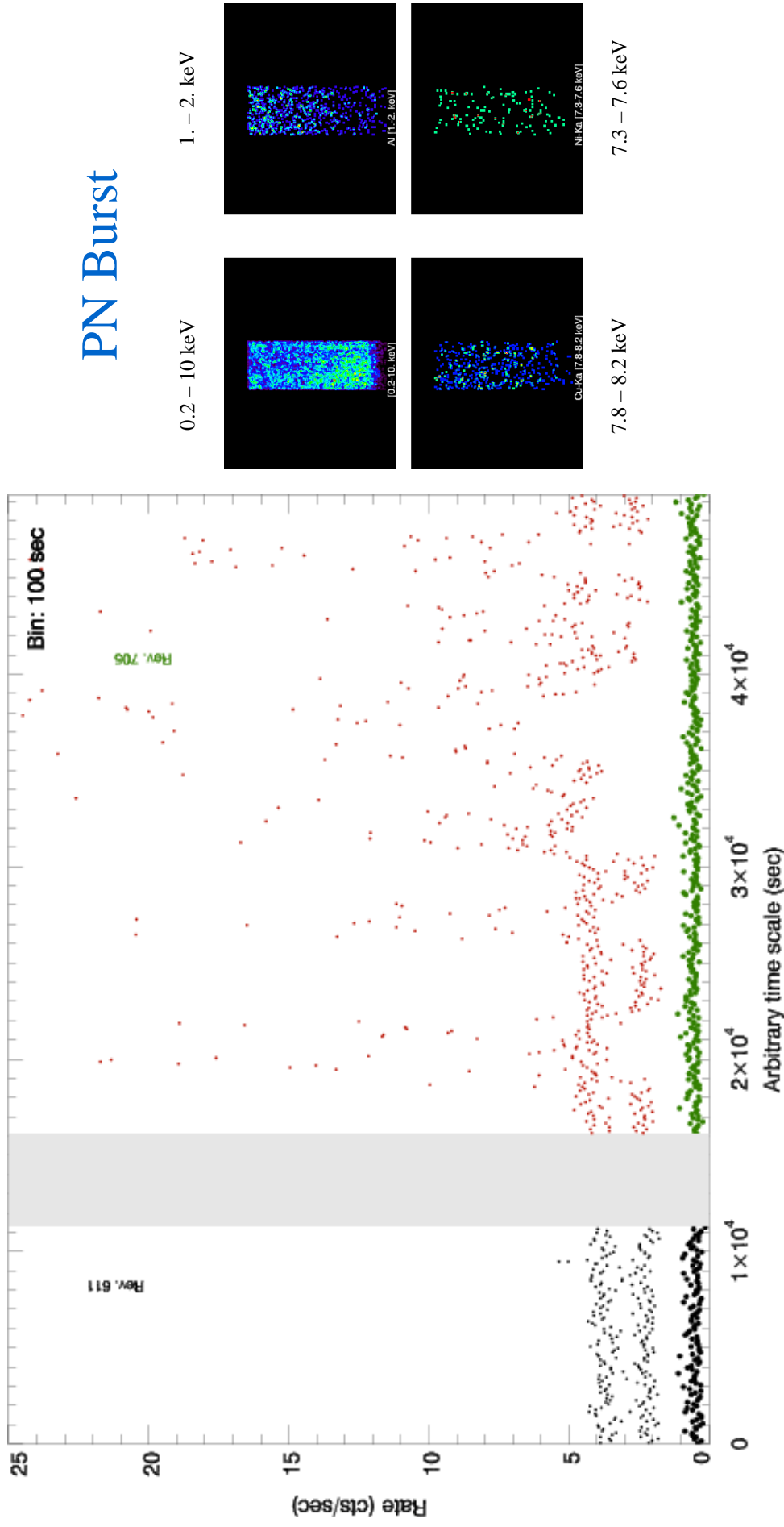
# Products of the BGWG: III. FWC



xmm-newton



# Products of the BGWG: III. FWC





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# Products of the BGWG: IV. 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: IV. ESAS

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## Summary of implementations

- 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.
- As of June 2011 we have and maintain two ESAS analysis threads (written by S. Snowden).



# Products of the BGWG: IV. ESAS

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## How to use SAS

### Users Guide to the XMM-Newton SAS

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

### SAS 11.0.0 on-line documentation

Documentation of all single SAS packages

### Data analysis threads

Data reduction examples for (almost) every purpose

### 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 watchout page

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

### SAS Cookbook

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

### Background analysis

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

### 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: IV. ESAS

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

SAS	Task	Change
V10.5	<i>pn_back</i>	Additional diagnostic output
-	<i>esppfit</i>	Improve the output plotting
-	CalDB files	Extensive reformatting of files requiring changes in multiple tasks
-	<i>pn_back</i>	New release – still under development
-	<i>cheese-bands</i>	New release
-	<i>proton_scale</i>	Parameter and input file changes for mode=2
-	<i>mos_back</i>	Bug fix affecting Mac users
-	<i>proton</i>	Combined CCF flare files
-	<i>comb</i>	Updated scale factors for merging data from different filters – assumed hardness now selectable
-	<i>merge_comp_rmm</i>	Same as <i>comb</i>
-	<i>swcx</i>	Cast SWCX background images
V11.0	CalDB	Updated QPB and FWC files – NEW DOWNLOAD REQUIRED
-	<i>mos_back</i>	Check for MOS1 CCD#6 status
-	<i>mos_spectra</i>	Check for MOS1 CCD#6 status
-	<i>proton</i>	Check for MOS1 CCD#6 status
-	<i>swcx</i>	Check for MOS1 CCD#6 status
-	<i>bin_image</i>	Implement SWCX processing
-	<i>bin_image_merge</i>	Implement SWCX processing
-	<i>adapt_2000</i>	Implement SWCX processing
-	<i>merge_comp_rmm</i>	Implement SWCX processing
-	<i>cont-region</i>	Simplify region description for multiple observations
V11.7 <sup>a</sup>	CalDB	Updated QPB and FWC files – NEW DOWNLOAD REQUIRED
-	<i>mos_back</i>	Fix ObsID misidentification in <i>*-spec.qdp</i>
-	-	Add additional diagnostic information in <i>*-aug.qdp</i>
-	-	Fixes required for updated QPB files
-	<i>mos-filter</i>	Diagnostic output added to check for anomalous states
-	<i>cheese</i>	Fixes required by changed file format for <i>emask</i> output
-	<i>mos_back</i>	Fixes required by changed file format for <i>emask</i> output
-	<i>make_mask_merge</i>	Fixes required by changed file format for <i>emask</i> output
-	-	Modify so that it will run with just the output from cheese

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  
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AND

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Johns Hopkins University, Baltimore, MD  
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# Products of the BGWG: IV. ESAS

## Creation of EPIC ESAS spectral analysis files for a cluster radial profile

### Introduction

This thread describes how to create EPIC spectral and response files for a complicated multi-region analysis combining data from the three instruments.

This thread uses data from the observation of Abell 1795, ObsID 0097820101, which is also used as the Spectral Analysis example where a script and output files are provided.

### Expected Outcome

The final outcome of this thread is the spectral analysis of the radial profile of the cluster of galaxies Abell 1795 with ten annuli.

### SAS Tasks to be Used

- `cifbuild`
- `odfingest`
- `epchain`
- `emchain`
- `pn-filter`
- `mos-filter`
- `cheese`
- `mos-spectra`
- `pn-spectra`
- `pn_back`
- `pn_back`
- `rot-im-det-sky`
- `comb`
- `adapt_900`
- `arfgem`
- `evselect`
- `specgroup`

### Prerequisites

- SAS Startup Thread

### Useful Links

- SAS Startup Thread

### Useful Links

- This thread makes use of the image display software `asa` and the spectral fitting tool `l3spec`.
- A full guide to the use of the ESAS software in SAS can be found [here](#) or [here](#)

### Caveats

### Creation of EPIC background subtracted, exposure corrected images

#### Introduction

This thread describes how to create EPIC background subtracted, exposure corrected images combining data from the three instruments.

#### Expected Outcome

The final outcome of this thread are adaptively smoothed images in two spectral bands. In the process of creating the images full field of view and outer annulus spectral products (source and model background spectra, RMFs, and ARFs) are produced as well as count, exposure, and background count images.

#### SAS Tasks to be Used

- `cifbuild`
- `odfingest`
- `epchain`
- `emchain`
- `pn-filter`
- `mos-filter`
- `cheese`
- `mos-spectra`
- `pn-spectra`
- `pn_back`
- `pn_back`
- `rot-im-det-sky`
- `proton_scale`
- `proton`
- `comb`
- `adapt_900`
- `arfgem`
- `specgroup`

#### Prerequisites

- SAS Startup Thread

#### Useful Links

- This thread makes use of the image display software `asa` and the spectral fitting tool `l3spec`.
- A full guide to the use of the ESAS software in SAS can be found [here](#) or [here](#)

#### Caveats

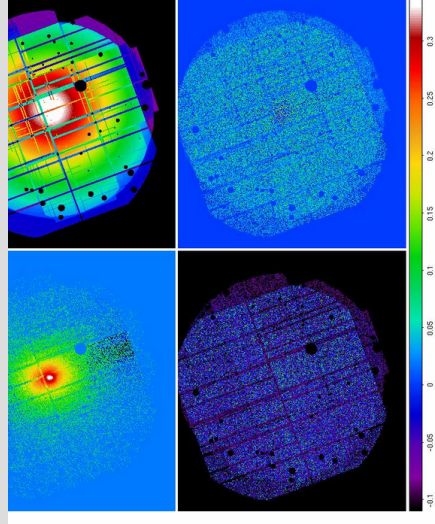


Figure 7: Merged image components with the count image (upper left), exposure image (upper right), QFB image (lower left), and soft proton image (lower right). The negative counts in the count image



# Products of the BGWG: IV. ESAS

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## Future plans for ESAS

- Simplify the way ESAS treats calibration files (CalDB), for example, treat them in the same way as CCFs

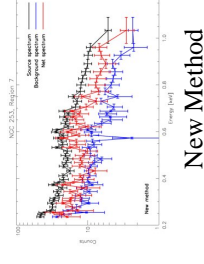
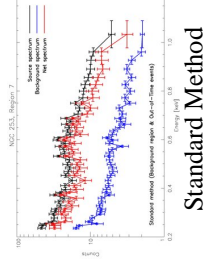
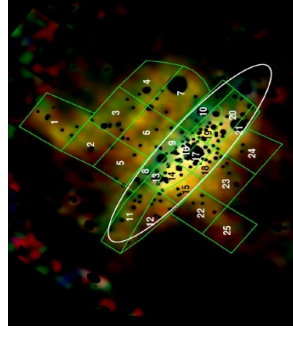


# Products of the BGWG: V. Scripts

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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 and placed under Threads**
- 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**



# Summary of BGWG Activities

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## **Solar Wind Charge Exchange**

New product available. Table providing details about the set of EPIC-MOS observations affected by exospheric Solar Wind Charge Exchange

## **Blank Sky Files**

Update Skycast script

## **Filter Wheel Close Observations**

Repository regularly updated. The last update was February 2012, including data up to December 2011

The light curve of EPIC-pn Timing mode data has been fixed by placing a cut on  $PI > 300$  eV

## **XMM-ESAS**

Two ESAS threads dealing with data analysis with ESAS are now provided in the Threads section of the SAS Home page

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