XMM-Newton

Specifications for Individual SSC Data Products

Issue 4.6
Prepared by the XMM-Newton Science Operations Centre
and the Science Survey Center Teams

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Revision History

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Issue 4.6	12.04.2021	P. Rodríguez (Editor)	Revision related to upgrade to SAS19.0
Issue 4.5	27.11.2018	P. Rodríguez (Editor)	Revision related to upgrade to SAS17.0
Issue 4.4	15.01.2018	P. Rodríguez (Editor)	Revision related to upgrade to SAS16.1 and some changes in EPIC spectral products
Issue 4.3	31.01.2017	P. Rodríguez (Editor)	Revision related to upgrade to SAS16.0 and inclusion of source detection in slew exposures
Issue 4.2	21.04.2015	P. Rodríguez (Editor)	Revision related to upgrade to SAS15.0
Issue 4.1	17.12.2014	P. Rodríguez (Editor)	Minor revision related to upgrade to SAS14.0
Issue 4.0	2.07.2013	S. Rosen (Editor)	Significant revision related to the bulk reprocessing for the 3XMM catalogue
Issue 3.0	06.04.2011	S. Rosen (Editor)	Significant revision to include slew observation products and modest pipeline upgrades
Issue 2.1	10.08.2010	S. Rosen (Editor)	Minor revision relating to detection masks (not officially released)
Issue 2.0	18.12.2009	S. Rosen (Editor)	Major revision to bring document up to date with current pipeline products
Issue 1.1	21.12.2000	J. Osborne (Editor)	Brought up to date for public release
Issue 1.0	29.02.2000	J. Osborne (Editor)	Consists of XMM-SOC-ICD-0006-SSC issue 1.1 plus DCPs 1-73, and made consistent with XMM-SOC-ICD-0006-SSC issue 2.0

Contents

1 Preface

This is the reference document describing the individual XMM-Newton Survey Science Centre (SSC) data product files. It is intended to be of use to software developers, archive administrators and to scientists analysing XMM-Newton data. Please see the SSC Data Products Interface Control Document (XMM-SOC-GEN-ICD-0006-SSC, issue 4.0) for a description of the product group files and other related files that are sent to the XSA

This version (4.6) includes changes related to the upgrade to SAS19.0 in the processing pipeline originally developped in 2018 to uniformly process all the XMM data at that time, from which the 4XMM catalogue was derived. In addition to the changes associated to SAS19.0, new EPIC-pn spectral products are now generated for bright sources pontentially affected by pile-up (6.5.5.1) and PHA compliant spectrum files are created for OM sources whose sky location is statistically compatible with some EPIC source for which EPIC spectra are produced (6.4.6).

This document will continue to evolve through subsequent issues, under indirect control from the SAS and SSC Configuration Control Boards.

This document is the result of the work of many people. Contributors have included:

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2 Acronym List

AMS	Archive Management Subsystem
ASCII	American Standard Code for Information Interchange
AHF	(ODF) Attitide History File
ASU	Astronomical Server URL
BSM	Baseline Spectroscopy Mode
CCD	Charge Coupled Device
CCW	Counter ClockWise
CD-ROM	Compact Disk - Read-Only Memory
CDS	Centre de Données astronomiques de Strasbourg
CGS	Centimetre Gramme Second
DCP	Document Change Proposal
DEC	Declination
EDU	Event detection unit
EPIC	European Photon Imaging Camera
ERMS	EPIC Radiation Monitor System
FITS	Flexible Image Transport System
FOV	Field Of View
FWHM	Full Width at Half Maximum
GB	GigaBytes
GIF	Graphics Interchange Format
GO	Guest Observer
GSFC	Goddard Space Flight Center
GTI	Good Time Interval
HDU	Header Data Unit
HK	House-Keeping
HST	Hubble Space Telescope
HTML	Hyper-Text Markup Language
ICD	Interface Control Document
ID	IDentifier
KB	KiloBytes
MB	MegaBytes
MCP	Micro-Channel Plate
MIP	Minimum Ionising Particle
MJD	Modified Julian Date
ML	Maximum Likelihood
MOS	Metal Oxide Semiconductor
OAL	Observation Access Layer
ODF	Observation Data File
ODS	Observation Datafile Subsystem
OGIP	Office for Guest Investigator Programs
OM	Optical Monitor

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OSW	OM Science Window
PHA	Pulse Height Analyser
PI	Position Invariant
P-N	Positive-Negative
PNG	Portable Network Graphics
PPS	Pipeline Processing System
PSF	Point Source Function
RA	Right Ascension
RGS	Reflection Grating Spectrometer
SAS	Science Analysis System
SIMBAD	Set of Identifications, Measurements, and Bibliography for Astronomical Data
SDF	Slew Data File
SOC	Science Operation Centre
SSC	Survey Science Centre
SSO	Solar System Object
TBD	To Be Decided
TT	Terrestial Time
URL	Uniform Resource Locator
USNO B1	United States Naval Observatory catalogue of Astronomical standards V2.0
UTC	Universal Time, Coordinated
WWW	World Wide Web
XID	X-ray IDentification programme
XMM	X-ray Multi-Mirror
XSA	XMM Science Archive

3 Reference Documents

- **R-1:** Interface Control Document: Observation and Slew Data Files - Issue 2.13
- **R-2:** SAS Packages
- **R-3:** Data Products Interface Control Document - Issue 4.0

4 Introduction

One of the main roles of the SSC within the XMM-Newton project is the creation of a variety of data products from the XMM-Newton observations.

There are 3 major classes of SSC data products:

- PPS Products
- The XMM-Newton Catalogues
- XID Products

The PPS products are the results of pipeline processing of individual pointed observation data file sets (ODFs). Many of the higher-level products are manually screened as part of a quality control process. The PPS products include summary information, calibrated cleaned event lists, the positions and brightnesses of detected sources, high-level data products (e.g. images, spectra and timeseries), catalogue cross-correlation information, quality information and an executable log file. XMM-Newton also acquires data during slews between pointed observations. As of 2010-11-08 these slew data sets (SDFs), which are scientifically valuable, are processed by a separate branch of the SSC pipeline. Up to 1st March 2012, all pipeline processing was performed by the SSC at the University of Leicester. From that date, responsibility for all routine processing of XMM-Newton pointed data and slew data was transferred to the XMM-Newton SOC.

The XMM-Newton catalogues collate and list the primary characteristics of all sources detected by XMM-Newton up to the cut-off date of the relevant catalogue. Catalogues are made, separately, for the pointed mode data and for the slew data. Responsibility for the former lies with the SSC while the slew catalogues are produced by a team at the XMM-Newton SOC. Both XMM-Newton pointed and slew data catalogues are re-issued at intervals to account for the continuously increasing sky area covered by XMM-Newton in orbit and improvements in processing and calibration. In December 2019 SSC released a completely new version of both the catalogue of detections, 4XMM-DR9, and the stacked catalogue, 4XMM-DR9s. Both catalogues were further updated in December 2020 (4XMM-DR10 and 4XMM-DR10s).

Access to the catalogues and catalogue documentation is available from the SSC pages,

- http://xmmssc.irap.omp.eu/
- https://xmmssc.aip.de/cms/catalogues/index.html

Other sites hosting the catalogue and/or associated products include,

- LUX (http://xmmssc-www.star.le.ac.uk/Catalogue),
- LEDAS (http://www.ledas.ac.uk/),
- XSA (http://www.cosmos.esa.int/web/xmm-newton/xsa) - through searchable interface,
- OAS (http://xcatdb.unistra.fr/3xmmdr8/index.html),

- GSFC (http://heasarc.gsfc.nasa.gov/W3Browse/xmm-newton/xmmssc.html) and
- Vizier at CDS (http://vizier.u-strasbg.fr/).

Non-proprietary data, as processed by PPS tools (and subsequently screened by the SSC), are used to create the XMM-Newton catalogue.

After the release of the first version of XMM-Newton Slew Catalogue in 2006 and a number of incremental releases in subsequent years, the last version of the catalogue was released in 2017, following a major revision of the processing pipeline.

The current slew catalogue and information about its contents and construction can be found at,

- http://www.cosmos.esa.int/web/xmm-newton/xmmsl2-ug/

The slew catalogue and documentation can also be downloaded from the XMM-Newton Science Archive,

- http://www.cosmos.esa.int/web/xmm-newton/xsa

it is searchable through the XSA interface.

In earlier versions of this document (1.1), intended XMM-Newton XID programme products were also described. However, in 2008 the XID project took the decision to release it's programme products through a dedicated public XID programme results database. Initial datasets started to become available through this XID results database in July 2010. Access to these data is through,

- http://xcatdb.u-strasbg.fr/xidresult/

Details and product descriptions for this are also available there or will be added in the near future.

This document focuses only on the specifications of the PPS processed products.

The PPS product files are grouped into `tar` files before being transferred to the XMM-Newton archive. The PPS to XSA interface is defined in [R-3]. PPS products are made available to XSA within 30 working days of receipt of the ODF/SDF in normal circumstances (generally within 14 days).

The PPS data products derived from pointed mode observations are subject to quality control before delivery to the SOC. Slew data products are not screened at the current time due to manpower limitations. Slew data that enter the XMM-Newton slew catalogue are subject to manual screening procedures by the team that produce the slew catalogue. PPS products may be flagged if there are doubts about their validity. Products that cannot be made reliably are not delivered. Thus, while this document describes the set of all possible PPS data products, the pipeline processing of individual observations may not generate the full set of products described here.

Access to the data products described here is the responsibility of the SOC and is provided via the XSA for both XMM-Newton principal guest observers and, after the proprietary period has

elapsed, archival researchers from the whole scientific community. The XSA contents can be browsed using a web interface, allowing SSC product group files or individual product files to be downloaded via the internet. The XSA contents can also be directly accessed through the Archive Inter-Operability System that can be used, for instance, to retrieve data from the XSA through a batch script. CD-ROM media were delivered at the beginning of the mission but are no longer used except in exceptional circumstances.

Useful reference material about,

- XMM-Newton UHB
- XMM-Newton Data File Handbook
- SAS

can be found at,

- http://www.cosmos.esa.int/web/xmm-newton/documentation

Information about, and access to, the XSA can be found at,

- http://www.cosmos.esa.int/web/xmm-newton/xsa

5 The PPS Products

5.1 PPS product formats

Each PPS product is contained within a single file. The following file formats will be used:

5.1.1 FITS

FITS is the format used for bulk data destined for further analysis (e.g. event lists, images, source lists, etc). FITS files are OGIP compliant where possible. For FITS files where OGIP FITS standards are not applicable or available, new standards closely following the OGIP approach are used. Extensions to the OGIP FITS standards adopted by other projects have been carefully considered. Our aim is to ensure that the usage of FITS for PPS data products conforms to a coherent standard in order to provide maximal compatibility with a range of existing analysis systems. All but one of the FITS files are supplied compressed by Unix GNU `gzip`.

5.1.2 PDF

Intrinsically compressed PDF files used for the display of line graphics. When these files are derived from product files in FITS format the PDF file is significantly smaller than the FITS file, and/or contains annotations providing a user-friendly summary of the FITS file.

5.1.3 PNG

PNG is used for the display of pixel images. Like the GIF format it was intended to replace, PNG is an intrinsically compressed format capable of being included as in-lined images in WWW pages. In some cases, these graphics files are derived, at least in part, from product files in FITS format. In these cases the PNG files are significantly smaller than their FITS counterparts and/or contain annotations providing a user-friendly summary of the FITS file.

5.1.4 HTML

HTML is the standard format for files which provide overview or summary-type text information. Important PPS results are not presented only in HTML files, and thus some information may be found in more than one type of file.

5.1.5 ASCII

ASCII files are used to present script, region and some tabular information.

5.2 The use of URLs

HTML files offer the possibility to provide structure to the collected PPS products of an observation through the use of hyperlinks.

5.2.1 External URLs

Links within the PPS products point to external services to provide added value. Due to security issues, URLs to external sites are limited to links to the SIMBAD family of servers only (for which CDS will ensure support throughout the life of the SSC). These links provide reference data only, they do not provide access to bulk data. Thus the XMM-Newton archive of PPS products is self-contained.

The use of external URLs not only provides ancillary information (such as original references) at the click of a button, but also allows the information to be updated. Indeed, the provision of catalogue links via the ASU protocol allows users to re-perform their source cross-correlations at a later date, accessing the more recent catalogue data that would then exist.

5.2.2 Internal URLs

The use of internal links (i.e. those pointing to PPS products within the XMM-Newton archive) can provide a quick and user-friendly mechanism for navigating around a product set. For example, it is clearly very useful for a user to be able to click on a source ID in a list of detected sources to retrieve other products relating to that source (e.g. a spectrum or a timeseries). This function is particularly useful in the cross-correlation PPS products. Such internal links are provided in HTML PPS products.

Within a PPS observation product set (i.e. those belonging to a single ODF) HTML links are self-contained, that is there are no link to destinations outside of the product set, apart from the external URLs already described.

5.3 Access to PPS products

General user access to PPS products is via the XSA. The XSA provides querying capabilities via keyword value searches and has a web user-interface allowing archive browsing and requests for download delivery of datasets.

All but one of the individual PPS product file types are aggregated (using Unix `tar`) into groups for transmission to the XSA at the SOC. The product groups, their associated keywords and the mechanism for transmitting them to the SOC are defined in reference [R-3]. The XSA stores the products in these groups. Some graphical items are unpacked on the XSA server to allow on-line browsing of individual products within the group.

6 Description of Individual Products

The products of the pipeline processing of XMM-Newton observations are described in this section. Here, and in section 9.2, typical product file sizes are given. In general, file size estimates are average values derived from the combination of many files. Other file size values reflect representative example cases.

6.1 The Division of the Data: Observations and Exposures

The PPS treats every ODF, produced at the XMM-Newton SOC, in isolation. An ODF will contain data from a single observation only, and the PPS makes no attempt to combine data across ODF boundaries. An observation is taken to be the EPIC, RGS, OM, housekeeping and ancillary data collected within a fixed continous period of time under a unique identifier. This identifier is formed with ten digits: six from the proposal identifier (1-6), two from the observation identifier (7-8) and two more from the extended observation identifier (9-10). In the vast majority of cases an observation corresponds to a single pointing on the sky, but there is a number of single observations that include several nearby pointing attitudes. These are referred to as Mosaic observations and their original ODFs are splitted into as many sub-ODFs as pointing attitudes within the observation. The last two ditigs of the sub-ODFs identifiers are replaced by a pointing sequence number starting in 31. An ODF contains data from all operational instruments; the data from the various instruments, to some small extent, may be analysed together (e.g. RGS processing may depend on EPIC or OM data). The PPS does not wait for data apparently missing from an ODF. PPS products relate to data from single observations only.

The same general considerations apply to the slew data in SDFs: an SDF contains data from a single maneuver from one pointed observation to another and the PPS treats these SDFs separately using a separate processing branch of the pipeline. At present, scientifically useful data during slews are taken only with the EPIC-pn camera. The EPIC-pn data are always taken using the medium filter and may be acquired in the extended full frame (frame time 199 ms), full frame (frame time 73 ms) or large window (frame time 48 ms) modes, where the short frame times result in minimal along-track blurring from the satellite's 90 degree/hour slew speed. During slews, the EPIC-MOS cameras are active but have the CAL-CLOSED filter in place while the OM has the blocked filter inserted.

An observation consists of a sequence of exposures for each instrument. For an individual instrument (e.g. EPIC-MOS 1), exposures form a non-temporally-overlapping sequence. The exposures of different instruments start and end independently, and thus partially overlap in time. During an exposure, the commanded state of the individual instrument is unchanged, no important hardware or data acquisition mode changes occur, and the data thus have a fixed format. An exposure is thus something which occurs in a single individual instrument. It is the task of the ODS (which makes the ODFs) to divide the XMM-Newton instrument telemetry into files of single exposures.

For most purposes, the PPS treats individual exposures separately; most PPS products will be derived from data taken during a single exposure. However, in the later stages of the processing of EPIC, RGS and OM data separate exposures within an instrument observation are combined. The primary example of this is the EPIC source detection stage of the PPS, where suitable data are combined to achieve greater sensitivity.

EPIC observations can include a number of calibration-type exposures such as offset maps. Such exposures are analysed by the PPS and the results applied to the science exposures as appropriate. However, they do not, in themselves, yield PPS products.

ERMS data are not processed by the PPS for its scientific content and there are no ERMS products.

Slew data comprise a single exposure (for just the EPIC-pn at the current time). The slew branch of the pipeline however, fragments the resulting event data into a series of distinct, spatially non-overlapping, steps along the slew path; the resulting image from each step is approximately 1^o x 1^o in size. The number of steps varies with the length of the slew (typically ∼100 steps). The processing software uses the spacecraft attitude information to correct for the slew motion of the satellite, providing 'true' sky coordinates for each event, within the spatial precision afforded by the finite frame time.

6.2 Common FITS Headers and Extensions

6.2.1 Standard primary header keywords

The primary header of every FITS file produced as part of the products contains the following mandatory keywords (values shown for the keywords are example values).

Name	Value/Type	Description
SIMPLE	T	file does conform to FITS standard
BITPIX	32	number of bits per data pixel
NAXIS	2	number of data axes
EXTEND	T	FITS dataset may contain extensions
TELESCOP	'XMM '	Telescope (mission) name
INSTRUME	'EPN '	Instrument name
DETNAM	'REDUNDANT'	PRIME or REDUNDANT
DATAMODE	'IMAGING '	Instrument mode (IMAGING, TIMING, BURST, etc.)
FILTER	'Thin1 '	Filter ID
OBS_MODE	'POINTING'	Observation mode (pointing or slew)
OBS_ID	'0406610101'	Observation identifier
EXP_ID	'0406610101008'	Exposure identifier
CONTENT	'EPIC IMAGE'	Contents of file
ORIGIN	'Leicester&SSC'	Origin of FITS file
DATE	'2006-12-11T13:33:29.000'	creation date
REVOLUT	'1265 '	Satellite Revolution Number
OBJECT	'HS 1036+4008'	Name of observed object (sub-image identifier for slew data *)
MJDREF	5.08140000000000E+04	[d] 1998-01-01T00:00:00 (TT) expressed in MJD
CREATOR	'evselect (evselect-3.58.7) [xmmsas_20061026_1802-6.6.0]'	name of co
DATE-OBS	'2006-11-05T19:27:25'	Start Time (UTC) of exposure
DATE-END	'2006-11-05T22:16:22'	End Time (UTC) of exposure
OBSERVER	'N.E. Body'	Name of PI (XMM-Newton for slew data)
RA_PNT	1.59890958333333E+02	[deg] Actual (mean) pointing RA of the optical
DEC_PNT	3.99108333333333E+01	[deg] Actual (mean) pointing Dec of the optical
PA_PNT	1.21305374145508E+02	[deg] Actual (mean) measured position angle of
RADECSYS	'FK5 '	World coord. system for this file
EQUINOX	2.00000000000000E+03	Equinox for sky coordinate x&y axes
EXPOSURE	9.72541258776188E+03	max of ONTIMEnn values
SEQ_ID	'035890 '	Pipeline sequence
PROCDATE	'2006-12-11T13:21:02'	Processing date
PROCREV	'1 '	Processing revision
PPSVERS	'06000518_20061025.152514'	PPS configuration
SASVERS	'xmmsas_20061026_1802-6.6.0'	SAS version
ODSVER	'16.911 '	ODS version
ODFVER	'001 '	ODF_VERSION
MTFLAG	T	Moving Target Flag; T if it is a moving target

* The OBJECT identifier for slew data is set to P<obsid>_<imagenumber> where imagenumber is the decimal value representing the step number in the sequence of image steps along the slew path.

The DETNAM keyword is only present in files where there is a choice, e.g. for OM this keyword can take the value PRIME or REDUNDANT. Additional keywords specific to each instrument or each

product may also be defined in the primary header.

The _PNT keywords are present in many files, including some merged-exposure products and auxiliary reponse files. In EPIC files they give the mean/median Spacecraft Attitude (≡Star Tracker Boresight) but in RGS and OM files they are the mean/mean Instrument Boresight. The spacecraft pointing coordinates are provided in OM files via the RA_SCX, DEC_SCX and PA keywords.

The primary header also describes all selection expressions and manipulation procedures applied to the data contained in the file through the XPROC* keywords and CONTINUE lines. These list the processing task calls and associated parameter specifications used in producing the file.

For EPIC products extracted on a source-by-source basis (spectra, time-series, etc.) an additional keyword, SRCNUM, is always present in the data extension header (for RGS source-specific products, the source number is conveyed by the SOURCEID keyword).

6.2.2 Good-time interval (GTI) extension

- This extension lists time intervals during which valid data are present in a data file.
- With one exception (EPIC source-specific timeseries files, where they are absent), the extension header contains the following keywords to identify the extension:

```
EXTNAME = 'STDGTI  '           / name of this binary table extension
HDUCLASS= 'OGIP    '           / File conforms to OGIP/GSFC conventions
HDUCLAS1= 'GTI     '           / File contains Good Time Intervals
HDUCLAS2= 'STANDARD'           / File contains Good Time Intervals
```

- Note that the EXTNAME keyword value, in the example above STDGTI, may also contain values of the form GTI<number>.
- The extension contains a binary table with the following columns:

Name	Type	Description
START	8-byte REAL	Start time (seconds)
STOP	8-byte REAL	Stop time (seconds)

- Times in the GTI extension are specified in seconds after a reference time given in a header keyword (MJDREF) which, for XMM-Newton, is set to the MJD (in days in TT), corresponding to 1998-01-01T00:00:00. The time reference system is given in header keywords TIMESYS and TIMEREF.

6.3 Observation Summary Products

6.3.1 PRODUCT: HTML Observation summary (SUMMAR)

- This summary file lists details of the observation, e.g. name of the GO, target name, start and end time of the observation, pointing position, etc.
- For each instrument, the summary contains details of the individual exposures in the observation, including the start and end time, filter wheel position, instrument mode and important instrument mode parameters.
- For slew data, some items in this file contain dummy contents because they are not meaningful for slew data and/or are not present in the summary file in the SDF (for pointed data much of this information is contained in the equivalent ODF summary file). All necessary information is available in the ODF headers. Also for slew data, only the observation summary, PPS summary and EPIC summary data pages contain useful data as the OM and RGS instruments are not used for science data during slews. As source detection on slew data is not currently performed in the PPS, no source details or cross-correlations with external catalogues are present.
- The observation summary is delivered in HTML.
- The summary does not contain PPS results. However, access to many key product files is available via links from the HTML pages.
- This is a product of class PPSOBS.
- There is one observation summary per observation. File size is ∼30KB.

6.3.2 PRODUCT: FITS Attitude time series (ATTTSR)

- This product re-presents the data from the ODF Spacecraft Attitude History and OM Tracking History Data files in the form of attitude values (as supplied by the OAL), and attitude differences, in uniform time steps.
- These files are identified using the keyword

  ```
  CONTENT = 'ATTITUDE TIME SERIES'
  ```

  in the primary header.
- For slew data, the ATT_SRC keyword in the primary header is always set to RAF
- This is a product of class PPSOBS.
- The ATTHK extension is a binary table with the following columns:

Name	Type	Description
TIME	8-byte REAL	Time (seconds)
AHFRA	8-byte REAL	AHF Right Ascension (degrees)
AHFDEC	8-byte REAL	AHF Declination(degrees)
AHFPA	8-byte REAL	AHF position angle (degrees)
OMRA	8-byte REAL	OM Right Ascension(degrees)
OMDEC	8-byte REAL	OM Declination (degrees)
OMPA	8-byte REAL	OM position angle (degrees)
DAHFPNT	8-byte REAL	Pointing difference AHF-PNT (degrees)
DOMPNT	8-byte REAL	Pointing difference OM-PNT (degrees)
DAHFOM	8-byte REAL	Pointing difference AHF-OM (degrees)

- This is a science product, it is used by SAS tasks which need access to the XMM-Newton attitude.
- There is one file per observation. The product is supplied in FITS format. A typical file is $\sim$ 2.4 MB uncompressed for pointed data. Uncompressed slew files are typically $\sim$ 0.3 MB

6.3.3 PRODUCT: FITS Spacecraft Position time series (ORBTSR)

- This product re-presents the data from the ODF Spacecraft Orbit Position History in the form of spacecraft coordinates (as supplied by the OAL), in differente reference systems, in uniform time steps.
- These files are identified using the keyword

  `CONTENT = 'SPACECRAFT ORBIT'`

  in the primary header.
- This is a product of class PPSOBS.
- The ORBIT extension is a binary table with the following columns:

Name	Type	Description
TIME	8-byte REAL	Time (seconds)
GEI_X	8-byte REAL	GEI X-axis position vector (km)
GEI_Y	8-byte REAL	GEI Y-axis position vector (km)
GEI_Z	8-byte REAL	GEI Z-axis position vector (km)
GSE_X	8-byte REAL	GSE X-axis position vector (km)
GSE_Y	8-byte REAL	GSE Y-axis position vector (km)
GSE_Z	8-byte REAL	GSE Z-axis position vector (km)
VX	8-byte REAL	GEI X-axis velocity vector (km/s)
VY	8-byte REAL	GEI Y-axis velocity vector (km/s)
VZ	8-byte REAL	GEI Z-axis velocity vector (km/s)

- There is one file per observation. The product is supplied in FITS format. A typical file is $\sim$ 4 MB uncompressed for pointed data. Uncompressed slew files are typically $\sim$ 1MB

6.3.4 PRODUCT: FITS Observation reference catalogue extract (REFCAT)

- This product provides extracts of the USNO (currently USNO-B1.0), 2MASS and, where available, SDSS (currently DR9) catalogues, covering the EPIC field.
- Each catalogue extract is contained in its own extension
- This file is used as the reference catalogue in the cross-correlation with both EPIC and OM source lists during the astrometric rectification process (only the USNO data is used for the OM).
- These files are identified using the keyword

  `CONTENT = 'REFERENCE CATALOGUE'`

  in the primary header.
- This is a product of class `PPSOBS`.
- The `USNO, 2MASS and SDSS` extensions are binary tables with the following columns:

Name	Type	Description
CAT_RA	8-byte REAL	Right Ascension (degrees)
CAT_DEC	8-byte REAL	Declination(degrees)
CAT_RADEC_ERR	4-byte REAL	Catalogue position error (degrees)
BMAG	4-byte REAL	B magnitude (USNO), not set (0.0) (2MASS) u' band (SDSS)
RMAG	4-byte REAL	R magnitude K band magnitude (2MASS) r' band (SDSS)
PMRA	4-byte INTEGER	Proper motion in RA (mas/yr)
PMDEC	4-byte INTEGER	Proper motion in DEC (mas/yr)

- This is a science product that is used in the PPS but can also be used by users to replicate the PPS rectification process.
- There is one file per observation. The product is supplied in FITS format. A typical file is $\sim$ 1 MB uncompressed.

6.4 OM Products

This section describes the OM pipeline products derived from XMM-Newton OM pointed data. The OM does not view the sky during slews but calibration observations, particularly dark frames and flat-field exposures, are made during these periods. In the past, data from these were combined into observation-specific PPS products but this is no longer the case since they are not used in OM data reduction.

OM PPS products include files used to quantify star-tracking information, FITS and PNG images, object region files and source lists. Source time-series and grism spectra are included for data are taken in `FAST` mode or with the grism filter respectively.

Note that in this document, the grism products are described, separately, in section 6.4.5. This is because although most grism product types are similar to those for `IMAGE` and `FAST` mode, there are differences in the nature of the products which leads to them being grouped together for coherence.

6.4.1 OM general FITS product header

The primary header of all OM FITS products contains the mandatory FITS keywords defined in section 6.2.1. The `DETNAM` keyword in the primary header assumes the values `PRIME` or `REDUNDANT` (to date, only the latter), and the `DATAMODE` keyword is `IMAGE` or `FAST` or `TRACKING` (for tracking star products).

As the OM is an optical instrument, the OGIP FITS standards are not strictly applicable (being defined for use with data from high-energy astrophysics experiments). The products defined here follow the spirit of the OGIP conventions as closely as possible, and `HDUCLAS`n keywords are included where the OM product is thought sufficiently similar to its OGIP analogue.

6.4.2 OM image products

This section describes OM image data products generated for pointed observations. The science products comprise both detector coordinate images and images transformed to sky coordinates for `IMAGE` and `FAST` modes. This is done to facilitate comparison with other data such as EPIC images and/or external images (e.g. the Digital Sky Survey). Further sky coordinate images may be generated, which are superpositions (mosaics) of multiple exposures, where exposures from the same observation are available in the same filter. For grism data, only grism-aligned image products are made; this product is described, separately, in section 6.4.5.1.

For OM OSW FITS image products the following instrument specific header keywords are present (values shown are examples):

```
BINBPE   = T                          / BPE binning enabled
BINAX1   = 1                          / DPU x-axis binning 2**N
BINAX2   = 1                          / DPU y-axis binning 2**M
OSW_ID   = '1'                        / Identifier for current OSW
FRAMTIME = '5.62200007358626E+00'     / [millisecs] CCD frame time
DEADFRAC = '3.09498406042415E-02'     / CCD dead fraction
```

Note that the BINAX1 and BINAX2 values refer to the indices, N and M, not the result of the binning expression, so when BINAX1 = BINAX2 = 1, the binning factor is 2.

OM IMAGE mode data are taken in 4 configurations. These are:

- Default format: The whole field, ultimately, is covered using 5 distinct, sequential exposures which (mostly) cover different parts of the detector. Each exposure comprises two windows, a small one of size 2' x 2', always at the centre of the field and with a resolution of 0.5"/image-pixel, and a larger one, of lower resolution (1"/image-pixel) that covers the central part of the field in one exposure and side strips surrounding it in the other four exposures. Note that this format is also sometimes referred to as "Rudi-5" configuration.
- Full Frame low resolution (ENG2): A single exposure of the whole field at 1"/image-pixel (1024 x 1024 pixels).
- Full Frame high resolution (ENG4): A single exposure of the whole field at 0.5"/image-pixel (2048 x 2048 pixels).
- User defined: A window of size and location defined by the user, subject to instrument constraints on the total number of pixels in the window(s).

Grism data are taken in normal imaging mode, in any of the above configurations.

In addition, FAST mode acquires data as event lists from up to 2 windows per exposure, each window being 22x23 pixels (10.5" x 11"). Images are made from these small windows.

It should be noted that there is no operational difference between the windows defined in the default "Rudi-5" configuration and those defined by the user, they just *may* have different size or location but the operation mode of the instrument is exactly the same.

6.4.2.1 PRODUCT: OM OSW FITS image (IMAGE_, FIMAG_, IMAGEF)

- Each OM exposure may have up to five science windows or OSWs, although there are typically only 2 per exposure. Each OSW is stored as a pair of arrays. The image itself is stored as the primary data array while the quality array is stored as the IMAGE extension EXTNAME = 'QUALITY'. A third extension (EXTNAME = 'MODES') contains a binary table holding information about the image window.
- Although FAST data are acquired in the form of an events stream, the SSC pipeline generates an image (IMAGEF) from the whole FAST event file.
- These files are identified using the keyword,

```
CONTENT = 'OM OSW IMAGE'   (IMAGE_)
for default and User configurations
```

or

```
CONTENT = 'OM FULL-FRAME IMAGE'   (FIMAG_)
for low and high resolution full-frame configurations
```

or

```
CONTENT = 'OM FAST MODE OSW IMAGE'  (IMAGEF)
for FAST mode.
```

in the primary header.

- The OGIP filetype is defined by the keywords,

```
HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
```

in the primary header.

- The MODES extension is a binary table with the following columns:

Name	Type	Description
MODE	4-byte INTEGER	Mode identifier (Imaging=0, FAST=1)
WINDOWX0	4-byte INTEGER	X location of lower left window corner
WINDOWY0	4-byte INTEGER	Y location of lower left window corner
WINDOWDX	4-byte INTEGER	X dimension of window
WINDOWDY	4-byte INTEGER	Y dimension of window

- This is a product of class OMSW.
- This is a science product containing the primary scientific data from the OM. It is suitable for use in further data analysis.
- The IMAGE_ files are typically ∼690 kB uncompressed while the FIMAG_ files are, on average, 5.2MB in size, uncompressed. The IMAGEF produced in FAST mode are much smaller, with an average uncompressed size of ∼24KB.

6.4.2.2 PRODUCT: OM OSW ASCII source region file (SWSREG, SFSREG)

- This is an ascii file that provides a ds9-compatible list of source regions, derived from the OSW source list (SWSRLI) file for normal imaging or SFSRLI for FAST data - see section 6.4.4.
- This is a product of class OMSW.
- This is used to facilitate the overlaying of source positions when displaying the unrotated OSW image. For FAST data there is typically just one entry.
- There is one file per OSW per exposure. Each SWSREG file is around 15KB while the SFSREG files are around 100 Bytes only.

6.4.2.3 PRODUCT: OM OSW FITS sky image (SIMAGE, SIMAGF, FSIMAG)

- The FITS format OM OSW images are rotated and rebinned to North-aligned sky coordinates.
- The files are identified using the keyword

  ```
  CONTENT = 'OM OSW SKY IMAGE'  (SIMAGE)
  for default and User configurations
  ```

  or

  ```
  CONTENT = 'OM FULL-FRAME SKY IMAGE'  (FSIMAG)
  for low and high resolution full-frame configurations
  ```

  or

  ```
  CONTENT = 'OM FAST MODE OSW SKY IMAGE'  (SIMAGF)
  for FAST mode window
  ```

- This is a product of class OMSW.
- These images may be rectified against the USNO-B1 catalogue in which case keywords RA_OFF, DEC_OFF and POSCOROK are added to the header.
- This product is used for comparison between optical and X-ray images (also in sky coordinates). It is used in the production of OM OSW PNG images.
- There is one OM OSW FITS sky image for each OM OSW FITS image, and each file, on average, occupies ∼1.2MB uncompressed while the FAST mode image is typically 14KB uncompressed. For the full frame images the size is typically 22MB uncompressed.

6.4.2.4 PRODUCT: OM OSW PNG sky image plots (SIMAGE, SIMAGF, FSIMAG)

- This is a PNG preview product showing the OSW sky image
- The plot is derived from the FITS OSW sky image including the small FAST mode window (SIMAGF) files.
- This is a product of class OMSW.
- This is a preview product suitable for use in an online browser. There is one file per OSW sky image with a size of approximately 60KB. For the full frame sky image, the size is 100KB.

6.4.2.5 PRODUCT: OM OSW flatfield (FLAFLD)

This product is no longer made by the pipeline. A scientifically meaningful flatfield image can not readily be constructed from onboard flat-field images. A unit flatfield is considered to be adequate and so the creation of this product was dropped from the processing.

6.4.2.6 PRODUCT: OM Observation FITS sky image (RSIMAG, HSIMAG, LSIMAG, USIMAG)

- Where more than 1 FITS format OM OSW sky image exists for the same filter, they are combined in to a mosaiced, North-aligned observation sky image for that filter.
- The files are identified using the keyword,

  `CONTENT = 'OM DEFAULT-format SKY IMAGE MOSAIC'  (RSIMAG)`

  or

  `CONTENT = 'OM FULL-FRAME HIRES SKY IMAGE MOSAIC'  (HSIMAG)`

  or

  `CONTENT = 'OM FULL-FRAME LORES SKY IMAGE MOSAIC'  (LSIMAG)`

  or

  `CONTENT = 'OM USER WINDOWS SKY IMAGE MOSAIC'  (USIMAG)`

  depending on the imaging configuration from which it is made.
- This is a product of class OMOBS.
- This product is used for comparison between optical and X-ray images (also in sky coordinates). It is used in the production of OM mosaic PNG images.
- There is one OM FITS sky mosaic image for each filter for each imaging mode, even if only a single OSW image in that filter exists . After pipeline based on SAS15 all windowed exposures are combined in the mosaic image, independently on whether they come from the default configuration ("Rudi-5") or defined by the user. A typical file occupies $\sim$ 7MB uncompressed.

6.4.2.7 PRODUCT: OM Observation PNG sky image plots (HSIMAG, LSIMAG, RSIMAG, USIMAG)

- This is a PNG preview product showing the Observation sky image
- The plot is derived from the FITS Observation sky image.
- This is a product of class OMOBS.
- This is a preview product suitable for use in an online browser. There is one file per Observation sky image. Each file is approximately 90 KB.

6.4.3 OM Timeseries products

This section describes timeseries (lightcurve) data products to be generated from pointed observations.

6.4.3.1 General conventions

- Where FITS is defined as the file format, the OGIP standard defined by OGIP/93-003 is followed as closely as possible. A FITS file has the following basic structure:

  1. Primary header with null primary array.
  2. A "Rate" extension (`EXTNAME = 'RATE' or 'RATES'`), containing the timeseries.

- The primary header also contains the start and end times of the exposure. These are in UTC date format (yyyy-mm-ddThh:mm:ss). It also contains keywords, `TIMESYS` defining the time system - for XMM-Newton this is Terrestial time (TT), `TIMEREF` indicating to where the timing is referenced and `MJDREF`, the reference time, which for XMM-Newton is set to the (TT) MJD, in days, corresponding to 1998-01-01T00:00:00.

- The `RATE` extension header contains the exposure start and stop times specified in seconds relative to the reference time.

6.4.3.2 PRODUCT: OM OSW FITS source timeseries (`TIMESR`)

- OM source timeseries are only produced for OSWs in `FAST` mode.

- There is one timeseries per detected source for each OSW in an exposure.

- The OM pipeline nominally produces timeseries with bins evenly spaced at the same intervals as the `FAST` mode time-slices.

- These files are identified using the keyword,

  ```
  CONTENT = 'OM OSW SOURCE TIMESERIES'
  ```

  in the primary header.

- This is a product of class `OMSRC`.

- The OGIP filetype is defined by the keywords

  ```
  HDUCLASS= 'OGIP'                / Format conforms to OGIP/GSFC conventions
  HDUCLAS1= 'LIGHTCURVE'          / Light curve series
  HDUCLAS2= 'NET'                 / Background subtracted
  HDUCLAS3= 'RATE'                / Exposure corrected (ie.  count rate)
  ```

  in the header of the `RATE` extension.

- The `RATE` extension is a binary table with the following columns:

Name	Type	Description
TIME	8-byte REAL	Spacecraft time (s) relative to reference epoch
RATE	4-byte REAL	Count rate (count/s)
ERROR	4-byte REAL	Error (count/s)
BACKV	4-byte REAL	Background count rate (count/s) (note 1)
BACKE	4-byte REAL	Background rate error (count/s) (note 1)

note 1: In data processed after pipeline based on SAS14.0, the background for OM light curves are estimated in the associated imaging window. Therefore, it is constant along the time series.

- This is a science product.
- There is one OSW FITS timeseries per detected source per FAST OSW per exposure. Usuaully there is just one source in the small FAST window so generally there is one source timeseries file per window. A typical file is 28KB uncompressed.

6.4.3.3 PRODUCT: OM OSW PDF source timeseries (TIMESR)

- This is a PDF preview product containing the source and background timeseries for selected sources.
- The plot is derived from the FITS source timeseries. The timeseries is binned before plotting to reduce the product size.
- This is a product of class OMSRC.
- This is a preview product suitable for use in an online browser. There is one file per detected source per OSW per exposure. Each file is approximately 65KB.

6.4.3.4 PRODUCT: OM FITS source timeseries (TIMESR)

The OM sources detected in individual FAST mode exposures are cross-correlated with the sources detected in imaging windows. First with the source list from the IMAGING window in the same exposure. If the cross-match fails, a second attempt is made with the OM observations source list (OBSMLI 6.4.4.4).

- All timeseries files for the same source are merged into a single file with 4 more columns aimed to help the identification of the origin of the record. The extra columns are FILTER, EXPID, OSWID and SRCNO and uniquely identify the origin of the record. In addition, a column MJD with the Modified Julian Day (MJD = 2400000.5)
- These files are identified using the keyword,

  ```
  CONTENT = 'OM SOURCE TIMESERIES'
  ```

  in the primary header.
- This is a product of class OMSRC.
- The OGIP filetype is defined by the keywords

```
HDUCLASS= 'OGIP'                / Format conforms to OGIP/GSFC conventions
HDUCLAS1= 'LIGHTCURVE'          / Light curve series
HDUCLAS2= 'NET'                 / Background subtracted
HDUCLAS3= 'RATE'                / Exposure corrected (ie.  count rate)
```

in the header of the RATE extension.

- The RATE extension is a binary table with the following columns:

Name	Type	Description
TIME	8-byte REAL	Spacecraft time (s) relative to reference epoch
RATE	4-byte REAL	Count rate (count/s)
ERROR	4-byte REAL	Error (count/s)
BACKV	4-byte REAL	Background count rate (count/s)
BACKE	4-byte REAL	Background rate error (count/s)
MJD	8-byte REAL	Modified Julian Day
FILTER	CHARACTER	OM filter for this record
EXPID	CHARACTER*4	Exposure Id from which this record comes from
OSWID	CHARACTER*1	OSW Id
SRCNO	CHARACTER	Source id in the original OM OSW Fast Source lists (SFSRLI

- This is a science product.
- There is one FITS timeseries per detected source per observation. Usuaully there is just one source in the small FAST window so generally there is one source timeseries file per window. A typical file is 28KB uncompressed.

6.4.3.5 PRODUCT: OM PNG source timeseries (TIMESR)

- This is a PNG preview product containing the source timeseries for selected sources along the whole observation.
- All filters are mixed in the same plot and identified by a different color
- The plot is derived from the FITS source timeseries. The timeseries is binned before plotting to reduce the product size.
- This is a product of class OMSRC.
- This is a preview product suitable for use in an online browser. There is one file per detected source per observation. Each file is approximately 65KB.

6.4.3.6 PRODUCT: OM OSW FITS tracking star timeseries (TSTRTS)

- The tracking star timeseries are produced from the OM tracking star data.
- Each file contains one binary table extension which contains the timeseries for all of the tracking stars (upto a maximum of 10).
- There are no background timeseries as this information is not available for tracking stars.

- Tracking star timeseries are produced for the default configuration of OM `IMAGE` mode, user-defined mode and for `FAST` mode. They are not created for the low- and hi- resolution full frame modes or for grism data.
- The OM tracking star timeseries give serendipitous information on tracking star variability.
- These files are identified using the keyword,

  ```
  CONTENT = 'OM TRACKING STAR TIMESERIES'
  ```

  in the primary header.
- This is a product of class `OMEXP`.
- The OGIP filetype is defined by the keywords,

  ```
  HDUCLASS= 'OGIP'                / Format conforms to OGIP/GSFC conventions
  HDUCLAS1= 'LIGHTCURVE'          / File contains a time-series
  HDUCLAS2= 'TOTAL'               / Not background subtracted
  HDUCLAS3= 'RATE'                / Exposure corrected (ie.  counts/bin)
  ```

  in the header of the `RATES` extension.
- The `RATES` extension is a binary table with the following columns. There is one column per tracking star, and up to 10 tracking stars in total:

Name	Type	Description
`RATE1`	4-byte REAL	Counts/s
`RATE2`	4-byte REAL	Counts/s
...	...	"
`RATEn`	4-byte REAL	Counts/s

- There is 1 FITS files per exposure, each file is typically 17KB uncompressed.

6.4.4 OM Source list products

This section describes the OM source list products to be generated from pointed observations.

6.4.4.1 PRODUCT: OM OSW FITS source list (SWSRLI, SFSRLI)

The OM pipeline produces a source list for each OSW it processes.

Note that the event data in FAST mode OSWs are summed into single images (one per OSW) from which the source list is produced.

The grism products are described in section 6.4.5.

- The source detection list is supplied in FITS format.
- These files are identified using the keyword,

  ```
  CONTENT = 'OM OSW SOURCE LIST'  (SWSRLI)
  ```

  or

  ```
  CONTENT = 'OM OSW FAST SOURCE LIST'    (SFSRLI)
  ```

  in the primary header.
- This is a product of class OMSW.
- The OGIP filetype is defined by the keywords,

  ```
  HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1= 'SRCLIST '           / File contains a source list
  ```

  in the primary header.
- The PPS computes the 5-σ limiting magnitude for the OSW and writes it as a keyword (MAGLIMIT) in the FITS header (excluding grism source lists).
- The data extension (EXTNAME = 'SRCLIST') contains a binary table with the following columns:

Name	Type	Description
SRCNUM	4-byte INTEGER	Source number
XPOS	4-byte REAL	X-pixel position
YPOS	4-byte REAL	Y-pixel position
POSERR	4-byte REAL	Positional error (pixels)
RA	8-byte REAL	Source Right Ascension
DEC	8-byte REAL	Source Declination
LII	8-byte REAL	Source Galactic longitude
BII	8-byte REAL	Source Galactic lattitude
RA_CORR	8-byte REAL	Right Ascension rectified to USNO
DEC_CORR	8-byte REAL	Declination rectified to USNO
RATE	4-byte REAL	Net source count rate
RATE_ERR	4-byte REAL	Net source count rate error
BACKGROUND_RATE	4-byte REAL	Background rate in source region
SIGNIFICANCE	4-byte REAL	Source significance
CORR_RATE	4-byte REAL	Corrected net source rate
CORR_RATE_ERR	4-byte REAL	Corrected net source rate error
CORR_BACKGROUND_RATE	4-byte REAL	Corrected background rate
PSF1_CORR	4-byte REAL	% PSF corrn. to default aperture
PSF2_CORR	4-byte REAL	% PSF corrn. for wings
SPB_COILOSS	4-byte REAL	Coincidence loss corrn. in source+background
BK_COILOSS	4-byte REAL	Coincidence loss corrn. in background
MAG	4-byte REAL	Magnitude
MAGERR	4-byte REAL	Error on magnitude
NOPIXELS	4-byte INTEGER	Numer of pixels in extended source
APERTURE	4-byte REAL	Aperture radius used
FWHM_MAJ	4-byte REAL	Source FWHM (ellipse major axis)
FWHM_MAJ_ERR	4-byte REAL	Source FWHM (major axis) error
FWHM_MIN	4-byte REAL	Source FWHM (ellipse minor axis)
FWHM_MIN_ERR	4-byte REAL	Source FWHM (minor axis) error
PA	4-byte REAL	Position angle of ellipse major axis
PA_ERR	4-byte REAL	Position angle error
QFLAG	16-bit INTEGER	Quality flag
CFLAG	8-bit INTEGER	Confusion flag
EFLAG	8-bit INTEGER	Extension flag
SRC_ID	4-byte INTEGER	Source number in observation source list

- This is a science product. The OM OSW source list is the first stage analysis of the OSW.
- In the case of the FAST mode source list (SFSRLI), the SRCLIST extension table has the same columns as the normal imaging OSW source list (above), except for the following columns which are absent: RA_CORR, DEC_CORR and SRC_ID.
- Where the corrected rate exceeds 1000 counts/s, the significance is set to a negative value to indicate issues with excessively bright sources.
- There is one file per OSW per exposure. Each file is typically 90KB uncompressed (much smaller for the FAST mode list, averaging 23KB).

6.4.4.2 PRODUCT: OM mosaiced FITS source lists (RSISWS, HSISWS, LSISWS, USISWS)

OM source detection procedures are run on each mosaiced image per mode and filter (see 6.4.2.6).

- The source detection list is supplied in FITS format.
- The files are identified using the keyword,

  `CONTENT = 'OM RUDI-5 SOURCE LIST MOSAIC'  (RSISWS)`

  or

  `CONTENT = 'OM FULL-FRAME HIRES SOURCE LIST MOSAIC'  (HSISWS)`

  or

  `CONTENT = 'OM FULL-FRAME LORES SOURCE LIST MOSAIC'  (LSISWS)`

  or

  `CONTENT = 'OM USER WINDOWS SOURCE LIST MOSAIC'  (USISWS)`

  depending on the imaging configuration from which it is made.
- This is a product of class OMOBS.
- There is one OM FITS mosaic source file for each filter and imaging mode.
- The OGIP filetype is defined by the keywords,

```
HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1= 'SRCLIST '           / File contains a source list
```

  in the primary header.
- The PPS computes the 5-σ limiting magnitude for the mosaiced image and writes it as a keyword (MAGLIMIT) in the FITS header (excluding grism source lists).
- The data extension (EXTNAME = 'SRCLIST') contains a binary table with the same columns as described in 6.4.4.

6.4.4.3 PRODUCT: OM mosaic ASCII source region file (RSISWS, HSISWS, LSISWS, USISWS)

- This is an ascii file that provides a ds9-compatible list of source regions, derived from the mosaic source lists (RSISWS, HSISWS, LSISWS, USISWS).
- This is a product of class OMOBS.
- This is used to facilitate the overlaying of source positions on mosaic images.
- There is one file per filter and mode.

6.4.4.4 PRODUCT: OM observation FITS source lists (OBSMOS, OBSMLI)

The whole-observation source list is the result of merging the information in the OM OSW and mosaiced source lists (see section 6.4.4.1 and 6.4.4.2) but it does not include FAST mode source lists. Weighted source position and position error are derived from the detections in various filters (if present). Various photometric measures (weighted values where multiple same-filter measurements exist) are provided for each available filter and, where possible, colours are computed. Quality, confusion and extension flags are given for all filters used. The background count rates are omitted, as are the source detector coordinate positions (these are available in the OSW source lists). The header of the SRCLIST extension contains zero-points and conversion factors and quantities derived during the astrometric rectification of the field against the USNO-B1 catalogue.

The combination of all the individual source lists from OSW and mosaiced images is done in two steps: first OSW source lists and mosaiced source lists are combined separately to produce two combined lists, one for OSW exposures and one for mosaiced images (OBSMOS). Then, these two combined lists are further merged to produced the final OM source list for the whole observation (OBSMLI) that contains all sources detected, no matter whether in individual exposures or in mosaiced images.

- These files are identified using the keyword,

  ```
  CONTENT = 'OM OBSERVATION SOURCE LIST MOSAIC' (OBSMOS)
  ```

  and

  ```
  CONTENT = 'OM OBSERVATION SOURCE LIST' (OBSMLI)
  ```

  in the primary header.

- This is a product of class OMOBS.

- The OGIP filetype is defined by the keywords,

  ```
  HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1= 'SRCLIST '           / File contains a source list
  ```

  in the header of the primary extension.

- The source list is contained in a binary table extension EXTNAME='SRCLIST'. The number of columns in the table depends on the number of filters used during an observation.

- There is one row in the table for each merged source - all filter-dependent information contained within the row.

Name	Type	Description
SRCID	4-byte INTEGER	Source number in field
RA	8-byte REAL	Source Right Ascension
DEC	8-byte REAL	Source Declination
RA_CORR	8-byte REAL	Source Right Ascension rectified to USNO
DEC_CORR	8-byte REAL	Ssource Declination rectified to USNO
POSERR	4-byte REAL	Positional error (arcsec)
LII	8-byte REAL	Source Galactic longitude
BII	8-byte REAL	Source Galactic lattitude
*x*_SIGNIFICANCE	4-byte REAL	Source significance for filter *x*
⋮	⋮	⋮
*x*_CORR_RATE	4-byte REAL	Corrected source count rate
*x*_CORR_RATE_ERR	4-byte REAL	Corrected source count rate error
⋮	⋮	⋮
*x*_INS_MAG	4-byte REAL	Instrumental magnitude
*x*_INS_MAG_ERR	4-byte REAL	Instrumental magnitude error
*x*_*y*_INS	4-byte REAL	Instrumental colour for filters *x* and *y*
x-*y*_INS_ERR	4-byte REAL	Instrumental colour error
⋮	⋮	⋮
*x*_STD(*x*-*y*)	4-byte REAL	Standard magnitude (optical filters only) for filter *x*, derived from filters *x* and *y*
*x*_STD_ERR(*x*-*y*)	4-byte REAL	Standard magnitude error
x-*y*_STD_COL	4-byte REAL	Standard colour
x-*y*_STD_COL_ERR	4-byte REAL	Standard colour error
⋮	⋮	⋮
*x*_AB_FLUX	4-byte REAL	AB flux
*x*_AB_FLUX_ERR	4-byte REAL	AB flux error
⋮	⋮	⋮
*x*_AB_MAG	4-byte REAL	AB magnitude
*x*_AB_MAG_ERR	4-byte REAL	AB magnitude error
⋮	⋮	⋮
*x*_MAJOR	4-byte REAL	Source FWHM (ellipse major axis)
MEAN_MAJOR_AXIS	4-byte REAL	Mean source FWHM (major axis)
*x*_MINOR	4-byte REAL	Source FWHM (ellipse minor axis)
MEAN_MINOR_AXIS	4-byte REAL	Mean source FWHM (minor axis)
*x*_POSANG	4-byte REAL	Position angle of major axis
MEAN_POSANG	4-byte REAL	Mean position angle of major axis
⋮	⋮	⋮
*x*_QUALITY_FLAG	16-bit INTEGER	Quality flag
QUALITY_FLAG_COMB	16-bit INTEGER	Worst-case quality flag, over all filters
*x*_CONFUSION_FLAG	8-bit INTEGER	Confusion flag
CONFUSION_FLAG_MAX	8-bit INTEGER	Worst-case confusion flag, over all filters
*x*_EXTENDED_FLAG	8-bit INTEGER	Extension flag
EXTENDED_FLAG_MAX	8-bit INTEGER	Worst-case extension flag, over all filters

- Columns only in OBSMLI:

Name	Type	Description
SRCMOS	4-byte INTEGER	Source number in mosaic combined source list
*x*_SKY_IMAGE	CHARACTER	*x* filter data comes from mosaiced image
SPECTRA	CHARACTER	Source identification in the PHASPE file name (set to NULL if file not available)
TSERIES	CHARACTER	Source identification in the merged TIMESR file name (set to NULL if file not available)

- The column names containing *x* and/or *y* are quantities for a given filter or pair of filters, where the *x, y* are replaced by the appropriate OM filter ID (S for UVW2, M for UVM2, L for UVW1, U, B, V or W for WHITE).
- This is a science product. It represents the summation of knowledge of source properties derived from all the imaging exposures available within the observation.
- There is one file per observation, supplied in FITS format. The file is typically ∼250KB uncompressed.

6.4.4.5 PRODUCT: OM observation ASCII source region file (OBSMLI)

- This is an ascii file that provides a ds9-compatible list of source regions, derived from the observation source list (OBSMLI) file.
- This is a product of class OMOBS.
- This is used to facilitate the overlaying of source positions.
- There is just one file per observation.
- This is a science product suitable for use in further data analysis.

6.4.5 OM grism products

OM grism data are acquired using the grism filters (optical or UV) and one of the normal imaging modes. The resulting images contain both zeroth order features which map to celestial objects on the sky and the first-order dispersed spectra associated with them. Zeroth order features and the associated spectra are detected, from which source lists are created. In principle, spectra can be extracted for all objects which have a zeroth *and* first-order detection in the source list but at the current time, the SSC pipeline only extracts a spectrum for the target. It is extracted based on the nominal target position if there is no detection of the target zeroth order feature in the data.

6.4.5.1 PRODUCT: OM OSW FITS grism-aligned image (GIMAGE)

- The ODF raw grism image is rotated and rebinned to align the spectra along the Y direction.
- The files are identified using the keyword,

  ```
  CONTENT = 'OM GRISM-ALIGNED IMAGE'
  ```

- This is a product of class OMSW.
- This product is the basis for the extraction of OM grism spectra.
- There is one OM OSW FITS grism-aligned image per OSW per exposure and each file, on average, occupies ∼3.7MB uncompressed.

6.4.5.2 PRODUCT: OM OSW FITS grism source list (SGSRLI)

The source list for a grism exposure represents a list of detections of all the zeroth order and/or first-order spectrum features in the OSW image.

- The source detection list is supplied in FITS format.
- These files are identified using the keyword,

  ```
  CONTENT = 'OM OSW GRISM SOURCE LIST'
  ```

  in the primary header.
- This is a product of class OMSW.
- The OGIP filetype is defined by the keywords,

  ```
  HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1= 'SRCLIST '           / File contains a source list
  ```

  in the primary header.
- The data extension (EXTNAME = 'SRCLIST') contains a binary table with the following columns:

Name	Type	Description
SRCNUM	4-byte INTEGER	Source number
XPOS	4-byte REAL	X-pixel position
YPOS	4-byte REAL	Y-pixel position
POSERR	4-byte REAL	Positional error (pixels)
SPB_COILOSS	4-byte REAL	Coincidence loss correction in source+background
BK_COILOSS	4-byte REAL	Coincidence loss correction in background
FWHM_MAJ	4-byte REAL	Source FWHM (ellipse major axis)
FWHM_MAJ_ERR	4-byte REAL	Source FWHM (major axis) error
FWHM_MIN	4-byte REAL	Source FWHM (ellipse minor axis)
FWHM_MIN_ERR	4-byte REAL	Source FWHM (minor axis) error
PA	4-byte REAL	Position angle of ellipse major axis
PA_ERR	4-byte REAL	Source position angle error
QFLAG	16-bit INTEGER	Quality flag
CFLAG	8-bit INTEGER	Confusion flag
EFLAG	8-bit INTEGER	Extension flag
SPECTR_ID	4-byte INTEGER	Spectrum identifier
REL2SRCNUM	4-byte INTEGER	Identifies related spectrum and zeroth order feature entries

- This is a science product. The OM OSW source list is the first stage analysis of the OSW for grism data.
- The grism source list is different from the standard imaging and FAST source lists because many entries correspond to the detections of the spectra themselves and not just the zeroth order features that map the objects in the sky. At present, the SSC pipeline does not insert celestial coordinates (RA and DEC) in the file, though this is expected to change in a future pipeline release. The ellipse parameters of the detections largely reflect dispersion in the spectrum and zeroth order features, rather than the intrinsic extension of the object in the sky.
- There is one file per OSW per exposure. Each file is typically 24KB uncompressed.

6.4.5.3 PRODUCT: OM OSW FITS grism spectra list (SPECLI)

The grism OSW source list (SGSRLI), above, represents a list of *all* the zeroth order and/or first-order spectral features detected in the OSW image. Not all zeroth order features have an associated first-order spectrum visible in the image and vice versa (due to brightness or location in the window). The spectra list conveys the set of *related pairs* of zero- and first-order spectral features (in the case when the extraction of all of the field spectra was requested). Currently, in the SSC pipeline the request is for the extraction of the target spectrum only so the grism OSW spectra list contains a single spectrum entry.

- The spectra list is supplied in FITS format.
- These files are identified using the keyword,

  CONTENT = 'OM GRISM SPECTRA LIST'

  in the primary header.

- This is a product of class OMSW.
- The OGIP filetype is defined by the keywords

```
HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1= 'SRCLIST '           / File contains a source list
```

  in the primary header.

- The data extension (EXTNAME = 'SRCLIST') contains a binary table with the following columns:

Name	Type	Description
SPECTR_ID	4-byte INTEGER	Spectrum number
X0	4-byte REAL	X-pixel position of zeroth order
Y0	4-byte REAL	Y-pixel position of zeroth order
X1	4-byte REAL	X-pixel position of first order
Y1	4-byte REAL	Y-pixel position of first order
OBJ_TYPE	CHARACTER	TARGET or FIELD object

- This is a science product.
- This product is derived from the grism source list (SGSRLI).
- The OBJ_TYPE distinguishes whether the spectrum is for the designated target of the observation or detected field objects. Currently, the pipeline only extracts the target so there should only be one entry in SSC products.
- There is one file per OSW per exposure. Each file is typically 12KB uncompressed.

6.4.5.4 PRODUCT: OM OSW ASCII grism region file (SGSREG)

- This is an ascii file that provides a ds9-compatible list of regions, derived from the OSW grism source list (SGSRLI).
- This is a product of class OMSW.
- This is used to facilitate the overlaying of source positions when displaying the grism-aligned OSW image (GIMAGE). It includes both zeroth order features and the first-order spectra.
- There is one file per OSW per exposure. Each file is around 10KB in size.

6.4.5.5 PRODUCT: OM OSW ASCII grism spectra region file (SPCREG)

- This is an ascii file that provides a ds9-compatible list of regions, derived from the OSW grism source list (SPECLI).
- This is a product of class OMSW.

- This is used to facilitate the overlaying of the extracted source spectra when displaying the grism-aligned OSW image (GIMAGE). It includes both the zeroth order feature and the first-order spectra regions. For the SSC pipeline, this file contains regions for just the target of the observation.
- Where the target spectrum is faint or undetected, there may be no corresponding region in the OM grism OSW ASCII region (SGSREG) file. The target spectrum is displayed in red.
- There is one file per OSW per exposure. Each file is 0.2KB in size.

6.4.5.6 PRODUCT: OM OSW FITS grism spectrum (SPECTR)

- A separate spectrum is generated for each object having an entry in the grism spectra source list (SPECLI)). Currently only the target object is present in that file so only one PPS spectrum is extracted per grism OSW.
- The spectrum is supplied in FITS format.
- These files are identified using the keyword,

  ```
  CONTENT = 'OM GRISM SOURCE SPECTRUM'
  ```

  in the primary header.
- This is a product of class OMSW
- The OGIP filetype is defined by the keywords,

  ```
  HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1= 'SPECTRUM '          / File contains spectral data
  ```

  in the primary header.
- The data extension (EXTNAME = 'RATE<nnn>' where <nnn> is a source number) contains a binary table with the following columns:

Name	Type	Description
WAVELENGTH	4-byte REAL	Wavelength of bin in Angstroms
RATE	4-byte REAL	Background-subtracted source count rate/Å in spectral bin
ERROR	4-byte REAL	Error on RATE in spectral bin
BACKV	4-byte REAL	Background rate in source region in spectral bin
BACKE	4-byte REAL	Error on BACKV
FLUX	4-byte REAL	Flux in spectral bin (erg/s/cm^2/Å)
FLUX_ERR	4-byte REAL	Flux error in spectral bin

- Keywords in the header of the RATE<nnn> extension convey the widths and offsets of the source and background extraction regions used.

- The OGIP filetype is defined in the `RATE<nnn>` extension by the keywords

```
HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1= 'SPECTRUM '          / File contains spectral data
HDUCLAS2= 'NET     '           / Background subtracted
HDUCLAS3= 'RATE    '           / Exposure corrected
```

- There is one spectrum per selected source (only the target, currently) per grism OSW. Each file is typically ∼70KB compressed.

6.4.5.7 PRODUCT: OM OSW PDF grism spectrum plot (SPECTR)

- This is a PDF preview product containing the source and background spectra for selected sources.
- The plot is derived from the FITS source spectrum.
- This is a product of class OMSW.
- This is a preview product suitable for use in an online browser.
- There is one spectrum per selected source (only the target, currently) per grism OSW. Each file is approximately 100KB.

6.4.6 OM spectral products

6.4.6.1 PRODUCT: OM PHA Source spectrum (PHASPE)

- A spectrum is generated for each OM source listed in the EPIC summary source list (OBSMLI 6.5.6.7) as suitable counterpart.
- Unlike source products for EPIC camera the last three characters in the file name do not correspond to the source identificator (SRCID) in the source list (OBSMLI 6.4.4.4) in hexadecimal format. The reason is that there are many observations where SRCID exceeds the limit a 3-character hexadecimal format (4096).
- The keyword SRCID in the header of the SPECTRUM extension of PHASPE is the value of the column SRCID in the OM Observation Source list (OBSMLI 6.4.4.4) whose rates have been used to create the PHA spectrum file.
- The keywords EPICSRCn in the SPECTRUM extension refer to the value in the SRC_NUM column of the EPIC summary source list (OBSMLI 6.5.6.7) for which the OM source has been identified as possible optical counterpart according to their measured positions and estimated uncertainties.

  Since it is not intended to cross-match uniquely EPIC and OM sources, there may be several possible OM counterparts for a single EPIC source and several possible EPIC counterparts for a single OM source.
- The spectrum is created with SAS task om2pha as an "OGIP TYPE:II" file that contains the spectrum for each OM filter on a separate row.
- These files are identified using the keyword

  ```
  CONTENT = 'OM PHA SOURCE SPECTRUM'
  ```

  in the primary header.
- This is a product of class OMSRC.
- The OGIP filetype is defined by the keywords

  ```
  HDUCLASS= 'OGIP    '
  HDUCLAS1= 'SPECTRUM'
  HDUCLAS2= 'TOTAL   '
  HDUCLAS3= 'RATE    '
  HDUCLAS4= 'TYPE:II '
  ```

  in the header of the SPECTRUM extension.
- This is a product of class OMSRC
- The SPECTRUM extension contains a binary table (one row per OM filter) with the following columns:

Name	Type	Despription
SPEC_NUM	2-byte INTEGER	Reference number of the spectrum stored in this row
CHANNEL	2-byte INTEGER	Channel numbers for the spectra in the RATE*
RATE	4-byte REAL	Counts per second observed in the filter*
STAT_ERR	4-byte INTEGER	Statistical error RATE column*
RESPFILE	CHARACTER*31	Name of ancillary response file, including effective area
ROWID	CHARACTER	Name of OM filter for the data in this row

* These column have the format of a vector but with just one element

- Each file is approximately 2 MB uncompressed.

6.4.6.2 PRODUCT: OM Response Matrix (RSPMAT)

- There is one response matrix file per OM filter in PHASPE files. Since such response matrix only depends on OM filter it is the same for all sources and, therefore, there is one of these files per observation per filter.
- These files are identified using the keyword

  ```
  CONTENT = 'OM RESPONSE MATRIX FUNCTION'
  ```

  in the primary header.
- This is a product of class OMSRC.
- Each file contains 3 extensions: a primary header (with NULL image), a SPECTRESPMATRIX extension and a EBOUNDS extension.
- The following keywords are relevant in the SPECTRESPMATRIX extension to identify the file:

  ```
  HDUCLASS= 'OGIP    '
  HDUCLAS1= 'RESPONSE'
  HDUCLAS2= 'RSP_MATRIX'
  ```

- The SPECTRESPMATRIX extension contains a binary table (one row per chanel) with the following columns:

Name	Type	Description
ENERG_LO	4-byte REAL	Lower energy bound of the energy bin (keV)
ENERG_HI	4-byte REAL	Upper energy bound of the energy bin (keV)
N_GRP	2-byte INTEGER	Number of channel subsets in the energy bin
F_CHAN	2-byte INTEGER	First channel number of each subset (vector column)
N_CHAN	2-byte INTEGER	Number of channels in each subset (vector column)
MATRIX	4-byte REAL	Response matrix for the energy bin (vector column)

- In the case of OM repsonse matrix, N_GRP, F_CHAN and _CHAN are always set to value 1

- A keyword, LO_THRES, in the SPECTRESPMATRIX extension conveys the response threshold below which it is considered to be zero. Such data are not included in the file to minimize storage requirements.
- The following keywords are relevant in the EBOUNDS extension to identify the file:

```
HDUCLASS= 'OGIP    '
HDUCLAS1= 'RESPONSE'
HDUCLAS2= 'EBOUNDS'
```

- The EBOUNDS extension contains a binary table with a three columns:

Name	Type	Description
CHANNEL	2-byte INTEGER	channel number
E_MIN	4-byte REAL	Lower energy bound of channel
E_MAX	4-byte REAL	Upper energy bound of channel

- Each file is approximately 10 MB uncompressed.

6.4.7 OM PPS summary and miscellaneous products

6.4.7.1 PRODUCT: OM OSW PDF tracking history plot (TSHPLT)

- The tracking history plot is a vector diagram summarising the jitter detected by the OM over the course of the observation.
- Included on the plot (in PDF) are statistics which characterise the motion, e.g. average drift, characteristic width and percentage of excursions beyond a specified number of arc-sseconds.
- This is a product of class OMEXP.
- There is one file per exposure, approximately 150KB.

6.4.7.2 PRODUCT: OM HTML summary page (SUMMAR)

- A summary of all OM products is provided in HTML.
- The preview frames in PNG format are viewable using these HTML pages, as are all products in PDF.
- This is a product of class OMOBS.
- There is 1 summary page per observation. File size is $\sim$30 KB.

6.5 EPIC Products

EPIC PPS products include calibrated event lists, FITS and PNG images, background and exposure maps, lists of detected source and, for sufficiently bright objects, source spectra and time-series. For slew data, at present, sky images, exposure maps, filtered and unfiltered event lists are produced. Source detection is not performed on slew data in the PPS, so no source lists or source-specific products are extracted.

References in this section to `IMAGING` and `TIMING` modes shall be taken to include `REDUCED IMAGING` (EPIC MOS), and `COMPRESSED TIMING` (EPIC MOS) and `BURST` (EPIC pn) modes respectively.

6.5.1 EPIC general products header

The primary header of all EPIC products contains the mandatory FITS keywords defined in section 6.2.1. The `DATAMODE` keyword assumes the values `IMAGING` or `TIMING`.

6.5.2 EPIC Image data products

This section describes the image data products to be generated from pointed observations. e

6.5.2.1 General conventions

- Where FITS is specified as a file format, the OGIP guidelines are adopted when appropriate.
- Zero or more good time interval extensions (6.2.2) may be present.
- Detector information and processing history details are provided via keywords in the primary header.
- All images are presented in tangent plane projection of equatorial sky coordinates, centred on the nominal pointing position. The second (Y) axis is aligned to local Celestial North at the image centre.
- For pointed data, the images have a pixel size of 4×4 arcseconds (compared to an on-axis PSF FWHM of 4-6"). The image size is adjusted to encompass the entire EPIC field-of-view including some spacecraft jitter and telescope boresight errors. As in most cases a single pointing attitude is maintained during the whole observation, the image size is typically $\sim$ 42.7 arcminutes on each side (or 640×640 pixels)

  For slew data, the image size varies from step to step along the slew path, depending on the direction of the path at that point.
- Images are produced in a number of energy bands, covering the full energy range ("total band") and narrower bands. These energy bands are defined by pulse-invariant (PI) channels which have a fixed channel-energy relation throughout the life of the mission. There are 6 values of `BAND` for general images:

Band no.	Energy range (keV)	Used in
1	0.2-0.5	images
2	0.5-1.0	images
3	1.0-2.0	images
4	2.0-4.5	images
5	4.5-12.0	images
8	0.2-12.0	images, timeseries, other products

Three additional bands are defined (band 6 (soft): 0.2-2.0 keV; band 7 (hard): 2.0-12 keV; band 9 (XID band): 0.5-4.5 keV). Pointed mode image products are made in bands 1-5 and 8 while slew data image products are generated for bands 6, 7 and 8.

- EPIC source lists refer to a BAND of 0 to denote information relating to all analysed bands combined
- EPIC source lists include hardness ratios which are ratios of count rates in the energy bands defined above. The hardness ratios used are:

Hardness ratio	Range	Definition
HR1	soft	(band 2 - band 1)/(band 2 + band 1)
HR2	mid	(band 3 - band 2)/(band 3 + band 2)
HR3	hard	(band 4 - band 3)/(band 4 + band 3)
HR4	hard	(band 5 - band 4)/(band 5 + band 4)

6.5.2.2 PRODUCT: EPIC exposure FITS image (`IMAGE_`)

- The raw (i.e. not exposure corrected) images are produced by accumulating all valid events in an exposure from all camera CCDs operating in `IMAGING` mode. Events collected in other instrument modes (eg. `TIMING` mode) are not used.
- A set of raw images are produced for each EPIC camera (2 MOS and 1 pn). In the case of slew data, only pn data are available.
- These images are accumulated from intervals of low particle background, i.e. when the global background is below a certain threshold determined for every exposure according to a signal-to-noise optimization algorithm (see section 6.5.3.4).

  For slew observations, the current background screening procedure is more conservative; if the mean pn count rate in the 7.5 - 12 keV energy range over the duration of the slew observation exceeds 5.5 counts/s, the observation is not processed at all.
- The physical unit of the pixel data are counts.
- These images are science products suitable for use in data analysis.
- The raw images are supplied in FITS format. The image data array is fixed as 32-bit integers for pointed data. In the case of slew image products, the files may be 8- or 16- bit integers.
- These files are identified via the primary header keyword,

```
CONTENT = 'EPIC IMAGE'
```

for pointed data or,

```
CONTENT = 'SLEW STEP IMAGE'
```

for slew data.

- This is a product of class EPICEXP.
- The OGIP filetype is defined by the keywords,

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'IMAGE   '           / File contains an image
HDUCLAS2 = 'TOTAL   '           / Total counts
```

in the primary header.

- For each exposure there is one image per imaging energy band listed in section 6.5.2.1 for pointed data. For slew data, there is one image in each of bands 6, 7 and 8 for every step along the path.
- Each FITS image is typically 1.4-1.8MB uncompressed for pointed data and $\sim$ 0.3MB uncompressed for slew data images.

6.5.2.3 PRODUCT: EPIC exposure PNG image (IMAGE_)

- Annotated raw images are supplied in PNG format. These images are derived from the FITS format raw photon images, annotated with a sky grid and text to identify the observation, exposure ID, camera and energy band.
- These images are preview products suitable for use in an online browser.
- For each exposure in pointed observations there is one image made for the total band (band 8) only. For slew observations there is one image for every energy band (bands 6, 7 and 8)
- Each image is $\sim$ 45KB for pointed observations, $\sim$ 20KB for slew observations

6.5.2.4 PRODUCT: EPIC unfiltered FITS image (slew only) (UNFDAT)

- These are made only for data taken during slew observations. They are similar to the raw sky (IMAGE_) images also made for slew data but no filtering of the events by pattern or flag is applied.
- Only pn data are available.
- The physical unit of the pixel data are counts.
- These images are intended, principally, for diagnostic purposes.

- The images are supplied in FITS format. The image data arrays are generally 16-bit integers but occasionally they may be 8-bit integers.
- These files are identified via the primary header keyword,

  ```
  CONTENT = 'UNFILTERED SLEW STEP IMAGE'
  ```

- This is a product of class `EPICEXP`.
- The OGIP filetype is defined by the keywords,

  ```
  HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1 = 'IMAGE   '           / File contains an image
  HDUCLAS2 = 'TOTAL   '           / Total counts
  ```

  in the primary header.
- There is one unfiltered image per step along the slew path and it is for band 8.
- Each FITS image is typically 1.5MB uncompressed.

6.5.2.5 PRODUCT: EPIC observation FITS image (`OIMAGE`)

- This image is made from all IMAGING mode data taken during an observation. These are not made for slew data.
- There is one image which includes data from all EPIC cameras which operated in IMAGING mode.
- The image is made for the total-band only (i.e. band 8, listed in section 6.5.2.1).
- The physical unit of the pixel data is counts.
- The image is supplied in FITS format, with the image data stored as 32-bit integer values in the primary HDU.
- The files are identified by the keyword,

  ```
  CONTENT = 'EPIC OBSERVATION IMAGE'
  ```

- This is a product of class `EPICOBS`.
- The OGIP filetype should be defined by the keywords,

  ```
  HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1 = 'IMAGE   '           / File contains an image
  HDUCLAS2 = 'TOTAL   '
  ```

  in the primary header. *At present, these are not, however, propagated into the output file.*
- There is one file per observation.
- Each FITS image is approximately 1.7MB uncompressed.

6.5.2.6 PRODUCT: EPIC observation PNG image (OIMAGE)

- The EPIC FITS observation image is used as a basis for this PNG format image. It is annotated with sky coordinate information and text to identify the observation. These are not made for slew data.
- This image is a preview product suitable for use in an online browser.
- There is one PNG image which includes data from all EPIC cameras operated in IMAGING mode, for the total band only.
- This is a product of class EPICOBS
- There is one file per observation, being approximately 60 KB.

6.5.2.7 PRODUCT: EPIC observation FITS three colour image (3COLIM)

- This image is made from all IMAGING mode data taken during an observation. These are not made for slew data.
- There is one image which includes data from all EPIC cameras which operated in IMAGING mode.
- The image is made for the total-band only (i.e. band 8, listed in section 6.5.2.1). The image has three channels corresponding to energy bands 0.3-0.7keV, 0.7-1.2keV and 1.2-7.0keV. In the creation of the image, events are weighted by their corresponding vignetting correction and the livetime, so that final image is corrected for vignetting and exposure time. In addition, events from MOS1/2 cameras get weights 5.41/4.64/2.96 in red/green/blue channels with respect to EPIC pn. Estimates of minimum instrument background and out-of-time events in the pn camera are subtracted from the raw image. This raw image is provided as extension RAWIMAGE.
- The minimum instrumental background is estimated from the repository of Filter Wheel Closed data as provided by the SAS task evqpb. The image subtracted is stored in the extension FWCIMAGE and the actual scaling factor is saved as the keyword FWCSCAL in the primary extension.
- The estimates of out-of-time events in the EPIC pn camera are stored in the extension OOTIMAGE and the scaling factor is given as the keyword OOTSCAL in the header of the primary image.
- The physical unit of the pixel data is counts per second.
- The image is supplied in FITS format, with the image data stored as 32-bit real values in the primary HDU.
- The files are identified using the keyword,

```
CONTENT = 'EPIC THREECOLOUR IMAGE'
```

- This is a product of class EPICOBS
- The OGIP filetype should be defined by the keywords,

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'IMAGE   '           / File contains an image
HDUCLAS2 = 'TOTAL   '
```

in the primary header.

- There is one file per observation.
- Each FITS image is approximately 4.8MB uncompressed.

6.5.2.8 PRODUCT: EPIC observation PNG three colour image (3COLIM)

- The EPIC FITS observation three colour image is used as a basis for this PNG format image. It is annotated with sky coordinate information and text to identify the observation. Red, green and blue channels in the PNG image correspond to low (0.3-0.7keV), mid (0.7-1.2keV) and high (1.7-7keV) energy channels in FITS file, scaled logarithmically between 2.25 and 674 counts/ks/arcmin^2. These are not made for slew data.
- This image is a preview product suitable for use in an online browser.
- There is one PNG image which includes data from all EPICs operated in IMAGING mode, for the total band only.
- This is a product of class EPICOBS
- There is one file per observation, being approximately 60 KB.

6.5.2.9 PRODUCT: EPIC FITS exposure map (EXPMAP)

- Exposure maps are produced which reflect spatial variations in quantum efficiency of the detectors, bad pixels, inter-CCD gaps and the mirror vignetting.
- These maps are science products suitable for use in data analysis. They may be used to "flat field" the corresponding FITS format raw photon images.
- A set of exposure maps are produced for each EPIC camera (2 MOS and 1 pn) for each exposure. For slew data only pn data are available.
- For pointed data, exposure maps are generated for the energy bands defined in section 6.5.2.1 For slew data they are made for bands 6, 7 and 8.
- The physical unit of the pixel data is seconds.
- The exposure maps are supplied in FITS format.
- These files are identified using the primary header keyword

```
CONTENT = 'EPIC EXPOSURE MAP'
```

for pointed data and

```
CONTENT = 'SLEW STEP EXPOSURE MAP'
```

for slew data.

- This is a product of class EPICEXP.
- The OGIP filetype should be defined by the keywords

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'IMAGE   '           / File contains an image
HDUCLAS2 = 'EXPOSURE'           / Exposure map
```

  in the primary header. *At the current time, these are not, however, propagated into the output file.*
- Each FITS image is approximately 1.8 MB uncompressed for pointed data and is typically around 0.6MB for slew data.

6.5.2.10 PRODUCT: EPIC exposure PNG exposure map (EXPMAP)

- The total-band EPIC FITS exposure maps are used to generate these PNG format images. It is annotated with sky coordinate information and text to identify the observation. These are not made for slew data.
- This image is a preview product suitable for use in an online browser.
- There is one total-band (band-8) PNG image made for each exposure of each instrument.
- This is a product of class EPICEXP
- There is one file per observation, about 65KB in size.

6.5.2.11 PRODUCT: EPIC observation FITS exposure map (OEXPMP)

- An EPIC total-band exposure map is generated by mosaicing together the band-8 exposure maps of all MOS and pn exposures used. These are not made for slew data.
- The physical unit of the pixel data is seconds.
- The exposure maps are supplied in FITS format.
- These files are identified using the keyword

```
CONTENT = 'EPIC OBSERVATION EXPOSURE MAP'
```

  in the primary header.
- This is a product of class EPICOBS.
- The OGIP filetype should be defined by the keywords

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'IMAGE   '           / File contains an image
HDUCLAS2 = 'EXPOSURE'           / Exposure map
```

in the primary header. *At the current time, these are not, however, propagated into the output file.*

- Each FITS image is approximately 1.7MB uncompressed.

6.5.2.12 PRODUCT: EPIC observation PNG exposure map (OEXPMP)

- Annotated observation exposure maps are supplied in PNG format. These are derived from the FITS format observation exposure maps, annotated with a sky grid and text to identify the observation. Detected source positions are shown in overlay. These are not made for slew data.
- These images are preview products suitable for use in an online browser.
- For each observation there is one image made for the total band (band 8) only.
- Each image is approximately 90KB in size.

6.5.2.13 PRODUCT: EPIC observation ASC footprint region(OFTPRT)

- Observation footprint computed as the countours enclosing positive values in the observation EPIC exposure map (OEXPMP) described above.
- It is provided as a ds9 regions file.
- There is one file produced per observation, if EPIC imaging science data are avaiable.
- This is a product of class EPICOBS.
- Each ASC file is approximately 15KB uncompressed.

6.5.2.14 PRODUCT: EPIC exposure-merged FITS background map (BKGMAP)

- A smooth background map is modelled by an adaptive smoothing technique described in detail in Traulsen, I., Schwope, A. D., Lamer, G., et al. 2019, A&A, 624, A77 applied to source-excised images after a first round of detection and subsequent masking of detected sources. The sky image used is made by merging, per instrument, any exposures taken using the same mode and filter. These are not currently made for slew data.
- There is one map made for each of the energy bands 1-5, per instrument per merged image set.
- The physical unit of the pixel data is counts.
- These images are science products suitable for use in data analysis.
- The background maps are supplied in FITS format. The image data array is 32-bit reals since the image is a smoothed representation of the background.
- The OGIP filetype should be defined by the keywords

```
CONTENT = 'EPIC MERGED BACKGROUND MAP'
```

in the primary header.

- This is a product of class EPICOBS.
- Each FITS image is approximately 1.7MB uncompressed.

6.5.2.15 PRODUCT: EPIC exposure-merged FITS exposure map (MEXPMP)

- An exposure map that reflects the exposure from one or more exposures that were merged. Where only one exposure is present, the map is equivalent to the per exposure EXPMAP file. A primary motive for producing this file was to reflect the case where one or more MOS CCDs affected by low-energy noise were removed. This step has been dropped from pipeline processing so this product currently shows the entire merged exposure map but is retained as MOS noisy CCD filtering may be applied at some stage.
- There is one map made for each of energy bands 1-5, per instrument per exposure-merged image set.
- The physical unit of the pixel data is seconds.
- These images are science products suitable for use in data analysis.
- The merged exposure maps are supplied in FITS format.
- The OGIP filetype should be defined by the keywords

  ```
  CONTENT = 'EPIC MERGED EXPOSURE MAP'
  ```

  in the primary header.
- This is a product of class EPICOBS.
- Each FITS image is approximately 1.7MB uncompressed.

6.5.2.16 PRODUCT: EPIC exposure-merged FITS detection mask (DETMSK)

- An image is made which represents the parts of the sky image that are to be used in source detection. The map is an array of 1's (use) and 0's (don't use) and masks bad pixels, bad columns, chip gaps etc. Currently, these are not made for slew data.
- It is made from the corresponding band un-vignetted exposure map.
- These masks are science products suitable for use in data analysis.
- The masks are supplied in FITS format. The data array is 32-bit integers.
- After the bulk reprocessing for the 3XMM catalogue, the mask image appears in a separate MASK extension.
- These files are identified using the keyword

  ```
  CONTENT = 'EPIC DETECTION MASK'
  ```

in the primary header.

- This is a product of class EPICOBS.
- The OGIP filetype is defined by the keywords

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'IMAGE   '           / File contains an image
HDUCLAS2 = 'MASK    '           / Detection mask
```

in the primary header.

- Each FITS image is approximately 1.7MB uncompressed.

6.5.2.17 PRODUCT: EPIC observation FITS background map (OBKGMP)

- An EPIC total-band (band-8) background map is generated by summing together the band 1-5 merged background maps. These are not made for slew data.
- The physical unit of the pixel data is counts.
- The background maps are supplied in FITS format. The image data array is 32-bit reals.
- These files are identified using the keyword

```
CONTENT = 'EPIC OBSERVATION EXPOSURE MAP'
```

in the primary header.

- This is a product of class EPICOBS.
- Each FITS image is approximately 1.7 MB uncompressed.

6.5.2.18 PRODUCT: EPIC observation PNG background map (OBKGMP)

- Annotated observation background maps are supplied in PNG format. These are derived from the FITS format observation background maps, annotated with a sky grid and text to identify the observation. Detected source positions are shown in overlay. These are not made for slew data.
- These images are preview products suitable for use in an online browser.
- For each observation there is one image made for the total band (band 8) only.
- Each image is approximately 55 KB in size.

6.5.2.19 PRODUCT: EPIC observation FITS sensitivity map (OSNSMP)

- This image is a map of the minimum source flux (count rate) detectable by the point source detection task eboxdetect when analysing all EPIC imaging mode exposures. This flux limit is governed by the likelihood value used in source detection. The sensitivity value is zero for regions for which there is no sensitivity. These are not made for slew data.
- These maps are science products and may be used to estimate approximate upper-limit fluxes on undetected sources within the FOV and for the calculation of coverage correction curves.
- The product contains sensitivity values relating to the combination of all EPIC image mode exposures in an observation that are used in source detection.
- The sensitivity map is produced for the total energy band only.
- The unit of the pixel data are counts per second.
- The product is supplied in FITS format.
- These files are identified using the keyword

  ```
  CONTENT = 'EPIC OBSERVATION SENSITIVITY MAP'
  ```

  in the primary header.
- This is a product of class EPICOBS.
- The OGIP filetype is defined by the keywords

  ```
  HDUCLASS = 'OGIP   '     / Format conforms to OGIP/GSFC conventions
  HDUCLAS1 = 'IMAGE  '     / File contains an image
  HDUCLAS2 = 'GENERIC'     / Sensitivity map
  ```

  in the primary header.
- There is one EPIC sensitivity map per observation.
- Each product is approximately 1.7 MB uncompressed.

6.5.3 EPIC Time-series and timing analysis products

This section describes time-series (lightcurve) data products to be generated from pointed observations. No time-series products are currently made from slew observations.

6.5.3.1 General conventions

- Where FITS is defined as the file format, the OGIP standard defined by OGIP/93-003 is to be followed. A FITS file has the following basic structure:
  1. Primary header with null primary array.
  2. A "Rate" extension (`EXTNAME = 'RATE'`), containing the time-series.
  3. Good time interval extension(s) (6.2.2, where the `EXTNAME` value string contains at least the text "GTI"). These are present where appropriate good time intervals are applicable.
- The primary header also contains the start and end times of the exposure. These are in UTC date format (yyyy-mm-ddThh:mm:ss).
- The `RATE` extension header contains keywords, TIMESYS defining the time system - for XMM-Newton this is Terrestial time (TT), TIMEREF indicating to where the timing is referenced and MJDREF, the reference time, which for XMM-Newton is set to the (TT) MJD, in days, corresponding to 1998-01-01T00:00:00. It also contains the exposure start and stop times specified in seconds relative to the reference time.
- Products are produced for the total band (band-8) only for source timeseries.

6.5.3.2 PRODUCT: EPIC FITS source time-series(`SRCTSR`)

- In the case of `IMAGING` modes, time-series are considered for extraction for point sources in the EPIC field where the EPIC band-8 count rate is > 100 cts/s - where the detection comes from only one or two of the cameras, this initial filtering is by equivalent EPIC counts, which are derived adopting a PN to MOS count ratio of 3.5:1. Timeseries (and spectra) are subsequently delivered where the extracted spectrum has > 100 "good" (in XSPEC terminology) counts.

  Spatial information is restricted basically to only one direction (CCD RAWX coordinate) when EPIC CCDs are operated in `TIMING` or `BURST` modes. Then, sources cannot be searched for using the same algorithms as in `IMAGING` modes. Only for PN camera, the extraction of "source" time-series and spectrum is attempted; a histogram on RAWX coordinate is created with "good" events in the energy range $0.5 - 7.0$keV. If there are more than 100 of these "good" events and the peak of the histogram is found within RAWX $[12, 52]$, both time-series and spectra are extracted. The source extraction region is selected as 19 columns in RAWX direction, centered on the location of the histogram maximum, and all valid RAWY rows (200 in `TIMING` and 180 in `BURST`).
- A source time-series is accumulated by use of a spatial filter (a circular aperture whose radius is defined by a S/N optimisation algorithm) on valid events in an exposure from CCDs operating in `IMAGING` mode.

- A source time-series file contains the exposure corrected, background subtracted intensity and associated error of the detected EPIC source and the fraction of effective exposure time of each time bin. It also contains the background timeseries.
- The time-series follow a regular binning scheme (i.e. equispaced time bins).
- The width of the time bins is determined from the mean count rate with the aim of ensuring good average photon statistics in the total flux band, with a minimum of 10 counts required in each bin and a minimum bin size of 10s. For the EPIC pn cameras the size of the time bin is fixed to 20 times the frametime, therefore, it is mode dependent. For `TIMING` and `BURST` modes the time bin sizes are 0.12 and 0.08 seconds, respectively
- In accordance with FITS conventions, gaps in the time-series are denoted by inserting the IEEE NaN constant in the relevant time bin.
- Source time-series are delivered in FITS format.
- These files are science products which may be used in further data analysis.
- These files are identified using the keyword

  ```
  CONTENT = 'EPIC SOURCE TIMESERIES'
  ```

  in the primary header.
- This is a product of class `EPICSRC`.
- The OGIP filetype are defined by the keywords

  ```
  HDUCLASS = 'OGIP        '     / Format conforms to OGIP/GSFC conventions
  HDUCLAS1 = 'LIGHTCURVE  '     / File contains a time-series
  HDUCLAS2 = 'NET         '     / Background has been subtracted from source counts
  HDUCLAS3 = 'RATE        '     / Data are in the form of counts per sec
  ```

  in the header of the `RATE` extension.
- The `RATE` extension is a binary table with the following columns for light curves corresponding to a single EPIC exposure:

Name	Type	Description
`TIME`	8-byte REAL	Time since reference time (s)
`FRACEXP`	4-byte REAL	Fractional effective exposure in time bin
`RATE`	4-byte REAL	Net count rate (count/s)
`ERROR`	4-byte REAL	Error (count/s)
`BACKV`	4-byte REAL	Background count rate (count/s)
`BACKE`	4-byte REAL	Background error (count/s)

  In the files corresponding to a EPIC camera for the whole observation, the table also includes lightcurves in different energy bands (1-5 for imaging modes, 2-4 for timing modes)

Name	Type	Description
TIME	8-byte REAL	Time since reference time (s)
FRACEXP	4-byte REAL	Fractional effective exposure in time bin
RATE	4-byte REAL	Net count rate (count/s)
ERROR	4-byte REAL	Error (count/s)
BACKV	4-byte REAL	Background count rate (count/s)
BACKE	4-byte REAL	Background error (count/s)
RATE1	4-byte REAL	Net count rate (count/s) in band 1
RATE1_ERR	4-byte REAL	Error (count/s) in band 1
BACK1V	4-byte REAL	Background count rate in band 1 (count/s)
BACK1E	4-byte REAL	Background error in band 1(count/s)
RATE2	4-byte REAL	Net count rate (count/s) in band 2
RATE2_ERR	4-byte REAL	Error (count/s) in band 2
BACK2V	4-byte REAL	Background count rate in band 2 (count/s)
BACK2E	4-byte REAL	Background error in band 2(count/s)
RATE3	4-byte REAL	Net count rate (count/s) in band 3
RATE3_ERR	4-byte REAL	Error (count/s) in band 3
BACK3V	4-byte REAL	Background count rate in band 3 (count/s)
BACK3E	4-byte REAL	Background error in band 3 (count/s)
RATE4	4-byte REAL	Net count rate (count/s) in band 4
RATE4_ERR	4-byte REAL	Error (count/s) in band 4
BACK4V	4-byte REAL	Background count rate in band 4 (count/s)
BACK4E	4-byte REAL	Background error in band 4 (count/s)
RATE5	4-byte REAL	Net count rate (count/s) in band 5
RATE5_ERR	4-byte REAL	Error (count/s) in band 5
BACK5V	4-byte REAL	Background count rate in band 5 (count/s)
BACK5E	4-byte REAL	Background error in band 5 (count/s)
EXP_ID	CHARACTER*4	Exposure ID
TIMEDEL	8-byte REAL	Time bin (s)

The column EXP_ID contains the exposure id from which the record is coming from and the column TIMEDEL is the time bin size for each record. For the most common case of a single exposure per camera all the values in these two column are the same along the table.

- Source (SRC_GTIS) and background (BKG_GTIS) GTI extensions are also present. Both are binary tables with the following columns:

Name	Type	Description
START	8-byte REAL	GTI start time since reference time (s)
STOP	8-byte REAL	GTI stop time since reference time (s)

- For each candidate source, one time-series file is produced for each EPIC camera for each exposure in the total band (8) only.
- For an exposure of ∼15 ksec with 30 second time bins a time-series file is approximately 70KB uncompressed.

6.5.3.3 PRODUCT: EPIC PDF source time-series (STSPLT)

- This product is produced from the FITS format source time series. The background subtracted source time series and background time series are plotted, along with the GTI intervals and the fractional exposure values.
- The data from the FITS timeseries may be further binned to provide good signal-to-noise in each data point and to ensure the plotted points are clearly displayed.
- This is a preview product suitable for use in an online browser.
- This is a product of class EPICSRC.
- The product is supplied in PDF format.
- There is one file per selected source per exposure. Each file is typically 50KB.
- There is also a file per source, camera and observation where the lightcurves for different energy bands and for the whole observation are combined
- There is also a file per selected source per observation where all the light curves available from the different EPIC and RGS exposures are combined.

6.5.3.4 PRODUCT: EPIC FITS global background time-series (FBKTSR)

- This product is a time-series that was previously constructed from high energy events (7keV $<$ E $<$ 15keV) for the pn and from GATTI-flagged events above 14keV for MOS. Since the bulk reprocessing for 3XMM-DR4 catalogue, it is produced as a light curve from the in-FOV events, covering the 0.5-7.5 keV band, after prominent sources are excised.
- The flare background light curve is now exposure corrected.
- This is a science product, which is useful for the characterisation of instrumental background in the EPIC cameras and is used, for example, by the SSC pipeline in determining periods of high background to be excluded when making EPIC images. The pipeline applies a signal-to-noise optimisation algorithm to the flare background light curve to determine a rate-cut threshold for generating GTIs that excise flaring activity. The signal-to-noise information is provided in the file.
- The files are provided in FITS format.
- These files are identified using the keyword

  ```
  CONTENT = 'EPIC FLARE BACKGROUND TIMESERIES'
  ```

  in the primary header.
- This is a product of class EPICEXP.
- The OGIP filetype is defined by the keywords

```
HDUCLASS = 'OGIP      '  / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'LIGHTCURVE'  / File contains a time-series
HDUCLAS2 = 'NET       '  / File contains gross rates
HDUCLAS3 = 'RATE      '  / Light curve stored as rates
```

in the header of the RATE extension.

- The RATE extension is a binary table with the following columns:

Name	Type	Description
TIME	8-byte REAL	Time since reference time(s)
RATE	4-byte REAL	Count rate (count/s)
ERROR	4-byte REAL	Count rate error (count/s)
FRACEXP	4-byte REAL	Fractional exposure in the bin
T_ELAPSED	8-byte REAL	Elapsed time since start of light curve (s)

Each file contains STDGTI extensions (one per CCD) as described in 6.5.7.5.

- A single REGION extension contains a binary table showing the source regions excluded during extraction of the background light curve, and contains the following columns:

Name	Type	Description
SHAPE	16-byte character	Region shape (CIRCLE)
X	4-byte REAL	X position of circle
Y	4-byte REAL	Y position of circle
R	4-byte REAL	Radius of the circle
COMPONENT	BYTE	component identifier

- For the pn instrument, mask extensions are also present. The MASK extensions are 1-byte images (containing 1s or 0s) showing the usable pixels from the pn event processing stage.
- There is one mask per CCD.
- The first mask extension is labelled MASK. Thereafter, they are labelled as BLK<nnnnn> where the first 3 digits of <nnnnn> refer to the CCD number.
- The SN_TO_BKGCUT extension is a binary table containing the signal-to-noise values as a function of the background rate-cut threshold. It contains the following columns:

Name	Type	Description
BKGRATECUT	4-byte REAL	Background rate cut threshold (cts/s)
BKGRAWCUT	4-byte REAL	Background cut threshold in original data units
BKGRATE	4-byte REAL	Exact background value
SN_RATIO	4-byte REAL	Signal to noise ratio for this cut threshold
N_BIN	4-byte INTEGER	Number of active bins used

- The header of this extension contains (with arbitrary example values) the following keywords that relate to optimum rate cut threshold determination.

```
BGOPTCUT  = 1.62109603881836E+01 / Optimum threshold of the BKG by bkgoptrate
FRACTLFT  = 1.00000000000000E+00 / Fraction of time bins used if BGOPTCUT applied
NBINOPT   =                 4004 / Number of bins if BGOPTCUT applied
NBINAFTF  =                 4004 / Number of bins after filtering is applied
NBINORIG  =                 4005 / Number of original bins
```

- When there are more than one FBKTSR FITS file for a given camera they are merged into a single file to produce a background time series file per camera and observation. BACKSCAL keyword in individual files are taken into consideration to homogenize count rates from different exposures.
- The algorithm to find the threshold count rate that optimizes the signal-to-noise for source detection is applied again to the merged lightcurve. This new value is then used for GTI filtering in the creation of images used in source detection process.
- There is one FITS file per exposure and one FITS file per camera and observation if more than one exposure suitable for source detection is found for an EPIC camera within the observation. A typical time-series file is approximately 45 kB compressed.

6.5.3.5 PRODUCT: EPIC graphics global background timeseries (FBKTSR)

- This product is produced from the FITS format global background timeseries.
- It is a preview product suitable for use in an online browser.
- It contains two graphic entries: 1) A plot of the exposure-corrected flare background light curve with a marker indicating the optimized rate cut threshold; 2) the signal-to-noise v rate-cut threshold curve, with a similar threshold marker.
- This is a product of class EPICEXP.
- The product is supplied in PDF and PNG format.
- There are one PDF and PNG files per exposure. If there is any FBKTSR FITS file as the result of merging from several exposures, PDF and PNG files are produced also for this merged FBKTSR files. Each PDF file is typically 35KB while PNG typical size is $\sim$100KB.

6.5.4 EPIC spectral products

This section describes the spectral data products generated from pointed observations. Spectral products are not currently generated for slew data.

Source and background spectra are supplied. Spectral redistribution matrices are not supplied - these can be made by the user or, alternatively, canned response matrices can be used, as indicated by the information contained in the spectrum file header. An ancillary response file is provided. *No spectral fitting products are produced by the PPS*. Note that since the response is a strong function of detector position, it is important that the best canned response matrix is used. This is indicated by the `RESPFILE` keyword in the product headers. Canned response matrices can be obtained from http://www.cosmos.esa.int/web/xmm-newton/epic-response-files.

6.5.4.1 General conventions

- Where FITS is specified as a file format, the OGIP standards defined by OGIP/92-007 (and amended by OGIP-92/007a) is followed where appropriate. Such a FITS file has the basic structure:
  1. Primary header with null primary array.
  2. Data extension (`EXTNAME = 'SPECTRUM'`).
  3. Region extension (`EXTNAME = 'REGION'`).
  4. Good time interval extensions (`EXTNAME = 'GTI<xxxxx>'`) (6.2.2).
- GTI extensions are present for each CCD and `<xxxxx>` is a number related to the CCD number.
- The spectral channels in these files are of the PI (position invariant) type. The corresponding keyword is set in the FITS header (`CHANTYPE = 'PI'`).
- pn spectra contain 4096 channels, MOS spectra, 2400 channels.
- Source spectra are not background-subtracted.

6.5.4.2 PRODUCT: EPIC FITS source spectrum (`SRSPEC`)

- A source spectrum is generated for each EPIC source which is found to be sufficiently bright to yield a useful spectrum. As for the production of source timeseries, spectra are considered for extraction for point sources in the EPIC field where the EPIC band-8 count rate is > 100 cts/s - where the detection comes from only one or two of the cameras, this initial filtering is by equivalent EPIC counts, which are derived adopting a PN to MOS count ratio of 3.5:1. Spectra are subsequently delivered where the extracted spectrum has > 100 "good" (in XSPEC terminology) counts.
- A source spectrum is accumulated by use of a spatial filter (a circular aperture whose radius is determined by a S/N optimisation algorithm) on valid events in an exposure from CCDs operating in `IMAGING` mode. For the EPIC pn camera in `TIMING` mode the spectrum is extracted from a box 19 pixels wide centered on the `RAWX` column where the emission is peaked.

- The spectrum is extracted using GTIs that filter out flaring background periods that significantly degrade the total signal-to-noise. These GTIs are obtained from the source time series (6.5.3.2) using the method described in Piconcelli et al. (2004, MNRAS, 351,161-168)
- For each candidate source a spectrum is produced for each EPIC camera (2 MOS and 1 pn), where available.
- No systematic error is included in the spectrum file. The statistical error is defined by Poisson errors on the counts in the channel (ie. the keyword `POISSERR=T` in the spectrum extension header). Quality and grouping information are included in the file.
- The data are stored as counts, not count rate. The exposure time is stored in a separate keyword in the header (`EXPOSURE`).
- The source spectrum is supplied in FITS format.
- This is a science product suitable for use in further data analysis.
- These files are identified using the keyword

  ```
  CONTENT = 'EPIC SOURCE SPECTRUM'
  ```

  in the primary header.
- This is a product of class `EPICSRC`.
- The OGIP filetype is defined by the keywords

  ```
  HDUCLASS = 'OGIP    ' / Format conforms to OGIP/GSFC conventions
  HDUCLAS1 = 'SPECTRUM' / PHA dataset (OGIP memo OGIP-92-007)
  HDUCLAS2 = 'TOTAL   ' / Gross PHA spectrum (source + bkg)
  HDUCLAS3 = 'COUNT   ' / PHA data stored as counts (not cts/s)
  ```

  in the header of the `SPECTRUM` extension.
- The appropriate canned response matrix to be used is provided by the `RESPFILE` keyword in the `SPECTRUM` extension.
- Several numbers for pile-up diagnostics are recorded as keywords in the `SPECTRUM` extension:

Name	Description
`PILEFRAC`	Pile-up fraction estimate according to recipes in Jethwa et al. (A& A, 2015, 581,A104) for different cameras and modes
`SNGL_OTM` `ESGL_OTM`	observed-to-model pattern fraction for single events and its associated 1σ error from `epatplot`
`DBLE_OTM` `EDBL_OTM`	observed-to-model pattern fraction for double events and its associated 1σ error from `epatplot`

- The SPECTRUM extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
CHANNEL	2-byte INTEGER	Detector channel number
COUNTS	4-byte INTEGER	Observed counts
QUALITY	2-byte INTEGER	Quality information
GROUPING	2-byte INTEGER	Grouping information

- The header contains keywords that define the ancillary response file (ANCRFILE) and the background file (BACKFILE) associated with the source spectrum.

- The REGION extension currently defines a circular region (this may change to an elliptical aperture at some future date in pipeline processing). It contains a binary table with, currently, the following columns:

Name	Type	Description
SHAPE	16-byte character	Region shape (CIRCLE)
X	4-byte REAL	X position of circle
Y	4-byte REAL	Y position of circle
R	4-byte REAL	Radius of the circle

- The X, Y, R columns are vector columns in the REGION extension though, for the default circular region, only the first element of each is filled. X, Y and R are expressed in x/y pixel units (0.05 arcseconds).

- GTI extensions are also provided for each detector CCD. These are binary tables with the following columns:

Name	Type	Description
START	8-byte REAL	GTI start time since reference time (s)
STOP	8-byte REAL	GTI stop time since reference time (s)

- For each exposure there is one source spectrum file per selected source in the EPIC field. The average file size is 90 KB, uncompressed.

6.5.4.3 PRODUCT: EPIC FITS source background spectrum (BGSPEC)

- A background spectrum is generated for each detected EPIC source for which a source spectrum is generated.

- The background spectrum is generated by accumulation of detected events from a source-free region of the field-of-view (contaminating source regions having been masked out in the process).

- For each candidate source a background spectrum is produced for each EPIC camera (2 MOS and 1 pn) where available.

- No systematic error is included in the spectrum file. The statistical error is defined by Poisson errors on the counts in the channel (ie. the keyword `POISSERR=T` in the spectrum extension header).
- The data are stored as counts, not count rate.
- Background spectra are supplied in FITS format.
- These files are identified using the keyword

  ```
  CONTENT = 'EPIC SOURCE BACKGROUND SPECTRUM'
  ```

  in the primary header.
- This is a product of class `EPICSRC`.
- The OGIP filetype is defined by the keywords

  ```
  HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1 = 'SPECTRUM'           / Extension contains an spectrum
  HDUCLAS2 = 'TOTAL   '           / File contains gross counts
  HDUCLAS3 = 'COUNT   '           / Data stored as counts
  HDUVERS1 = '1.1.0   '           / Version number of the format
  ```

  in the header of the `SPECTRUM` extension.
- The `SPECTRUM` extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
`CHANNEL`	2-byte INTEGER	Detector channel number
`COUNTS`	4-byte INTEGER	Observed counts

- The `REGION` extension currently defines a circular region, offset from the source except for sources in the central CCD of MOS cameras in windowed modes where the region is an annulus co-centered with the source and extending into the peripheral CCDs. The extension contains a binary table with the following columns:

Name	Type	Description
`SHAPE`	16-byte character	Region shape (CIRCLE)
`X`	4-byte REAL	X position of circle
`Y`	4-byte REAL	Y position of circle
`R`	4-byte REAL	Radius of the circle

- The `X, Y,` and `R` columns are vector columns in the `REGION` extension.
- The background region can have circular regions masked out where contaminant sources are known to exist. These are defined by `SHAPE` entries set to `!CIRCLE`, one row per masked region. `X, Y` and `R` are expressed in x/y pixel units (0.05 arcseconds).

- GTI extensions are also provided for each detector CCD. These are binary tables with the following columns:

Name	Type	Description
START	8-byte REAL	GTI start time since reference time (s)
STOP	8-byte REAL	GTI stop time since reference time (s)

- For each exposure there is one background spectrum file per selected source in the EPIC field. The files are typically 85 KB in size, uncompressed.

6.5.4.4 PRODUCT: EPIC PNG source extraction regions (SRSPEC)

- This product is produced from the FITS format source and background spectra. The extraction regions in the REGION extension of the FITS file are overlaid onto the Band 8 image of the corresponding EPIC exposure. Source and background extraction regions are plotted in white colour as solid and dashed lines, respectively. Exclusion regions due to other field sources are plotted in red colour.
- This is a preview product suitable for use in an online browser.
- This is a product of class EPICSRC.
- The product is supplied in PNG format.
- There is one file per selected source per exposure. Each file is typically 5 KB.

6.5.4.5 PRODUCT: EPIC PDF source spectrum plot (SPCPLT)

- This product is an annotated plot of the background subtracted, exposure corrected source spectrum. The data are grouped to ensure good statistics in each data point before plotting. The plot shows flux (normalised counts/s/keV) versus energy (keV).
- The background spectrum is not plotted in this product.
- This is a preview product suitable for use in an online browser. It is supplied in PDF format.
- This is a product of class EPICSRC.
- There is a single file per selected source per exposure. Each file is approximately 14 KB.

6.5.4.6 PRODUCT: EPIC-OM PNG spectrum plot (SEDPLT)

- For EPIC sources having OM sources within their position error circle, a plot is created with the EPIC fluxes in the 5 standard energy bands and the fluxes of the OM sources through the available filters.
- The file with the plot also includes OM images of the EPIC source error circle in all available OM filters as well as the corresponding EPIC 3-colour image (6.5.2.7)

- This is a preview product suitable for use in an online browser. It is supplied in PNG format.
- This is a product of class `EPICSRC`.
- There is a single file per selected source. Each file is approximately 350 KB.

6.5.5 EPIC-pn spectral products for pile-up analysis

This section describes the spectral products generated for bright EPIC sources suitable of being affected by pile-up. These products are generated only for sources for which a pn standard spectrum has been produced from an exposure with CCDs operating in `IMAGING` mode and whose measured total count rate is larger than 0.3 times the count rate quoted in Table 3 of the XMM-Newton Users handbook (https://xmm-tools.cosmos.esa.int/external/xmm_user_support/documentation/uhb/epi as maximum to avoid deteriorated response due to photon pile-up.

A number of spectra are generated with different pattern and region selection criteria:

- Only single events from the same circular region as standard spectrum (6.5.4.2)
- Only double events from the same circular region as standard spectrum item
- Single and double events from annular extraction regions with outer radius as in the circular region in standard spectrum but with inner radius 60, 90, 125, 160, 200, 250, 330 and 480 (in units of 0.05 arcsec).

Response matrix, effective area and background estimate files are produced for these spectra.

In order to facilitate the use of these spectra related to pile-up analysis they all are combined into a single file `OGIP TYPE:II`.

6.5.5.1 PRODUCT: EPIC source combined spectra (`SCOMSP`)

- The source spectrum is supplied in FITS format
- These files are identified using the keyword

  `CONTENT = EPIC SOURCE COMBINED SPECTRA`

  in the primary header
- This is a product of class EPICSRC
- The OGIP file is TYPE II defined by the keywords in the `SPECTRUM` extension

```
HDUCLASS= 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1= 'SPECTRUM'           / File contains a spectrum
HDUCLAS2= 'TOTAL   '           / File contains gross counts
HDUCLAS3= 'COUNT   '           / Spectrum is stored as counts
HDUCLAS4= 'TYPE:II '
HDUVERS1= '1.2.1   '           / Version of format
```

- the `SPECTRUM` extension contains a binary table (one row per spectrum) with following columns:

SPEC_NUM	2-byte INTEGER	reference number of the spectrum stored in this row
CHANNEL	4-byte INTEGER	array containing the channel numbers
COUNTS	4-byte INTEGER	array containing the number of counts observed
QUALITY	2-byte INTEGER	array giving the data quality flag
GROUPING	2-byte INTEGER	array giving the data data grouping flag
ROWID	CHARACTER	unique identifier for each spectrum
EXPOSURE	4-byte FLOAT	the exposure time for each spectrum
BACKFILE	CHARACTER	the name of the background file (if any) associated with the dataset contained in COUNTS
BACKSC	4-BYTE FLOAT	the scaling factor to be applied to BACKFILE
RESPFILE	CHARACTER	name of the redistribution matrix file (RMF) associated with the dataset
ANCRFILE	CHARACTER	name and ROWID of the OGIP Type II file with the effective area associated to the data in COUNTS

- First record in the table corresponds to a circular extraction region of the same radius as the standard spectrum with same GTI and FLAG selection criteria but containing only single pattern events.
- Second record is for the double pattern events.
- Following records are for single and doubles events extracted from an annular region with the same outer radius as in standard spectrum (and first and second rows) and inner radius in the sequence 60, 90, 125, 160, 200, 250, 330 and 480 as far as this inner radius is smaller than the outer radius.
- There are up to 10 extensions with names REG000nn with nn from 01 to 10. They contain a binary table with following columns:

Name	Type	Description
SHAPE	16-byte character	Region shape (CIRCLE in REG00001 and REG00002 or ANNULUS in the rest)
X	4-byte REAL	X position of circle/annulus
Y	4-byte REAL	Y position of circle/annulus
R	4-byte REAL	Radius of the circle or 2-element array with inner and outer radii of the annulus
COMPONENT	BYTE	component identifier (always 0)

- The X, Y, R columns are expressed in x/y pixel units (0.05 arcsec). X, Y and the last element of R array have the same value in all extensions.
- This is a product of class EPICSRC.
- For each exposure there is one spectrum file per selected source in the EPIC field fulfilling the rate criteria described in 6.5.5 The average file size is 100KB, compressed

6.5.5.2 PRODUCT: EPIC background spectra for pn pile-up analysis (BGP0SP, BGPDSP, BGP4SP)

- Three background spectrum files are generated per source spectrum for pileup analysis: a background spectrum for single pattern events (BGP0SP), another for double pattern events BGPDSP) and another with single and double pattern events (BGP4SP).
- These background spectra are extracted with the same FLAG, REGION and GTI selection criteria as the standard background spectrum (BGSPEC in 6.5.4.3).
- The characterstics of the files described in 6.5.4.3 apply to these files, except those explicitly described here.
- The files are identified using the keyword

```
EPIC SOURCE BACKGROUND PATTERN0 SINGLES SPECTRUM (BGP0SP)
for only single pattern events spectrum
or
EPIC SOURCE BACKGROUND PATTERND DOUBLES SPECTRUM (BGPDSP)
for only double pattern events spectrum
or
EPIC SOURCE BACKGROUND PATTERN4 SPECTRUM  (BGP4SP)
for single and double events spectrum
```

- These are products of class EPICSRC.
- For each exposure there are these three spectrum files per selected source in the EPIC field fulfilling the rate criteria described in 6.5.5.1. The average file size is 20KB, compressed

6.5.6 EPIC source list and image analysis products

This section describes the EPIC source list and image analysis products.

The PPS uses two tasks to detect sources: `eboxdetect` and `emldetect`. The `eboxdetect` source detection task is run twice while the `emldetect` task only once, per observation, making products with different names. Specifically, when each detection task is executed it runs simultaneously on a single set of (non energy-overlapping) multi-band images from each instrument, i.e. up to 5 bands from 3 instruments in pointed observations, and up 2 bands from EPIC pn in slew observations The input images may be from separate exposures or merges of more than one exposure in each instrument where more than one usable exposure was taken in the same mode. The decision of which exposures are used for these merged images is based on factors such as the exposure length and mode, with the aim of maximizing depth and sky area covered. The task, `eboxdetect`, can run in 'local' or 'map' mode. In a first pass, `eboxdetect` uses 'local' mode, determining a background estimate at the source position from a region local to the source box. Detected objects from this 'local' map stage are masked from the image and a smooth global background map is determined by an adaptive smoothing technique to the remaining data. A second `eboxdetect` pass then uses this map to detect sources with greater sensitivity. Finally, this list of sources forms the input to `emldetect` where Maximum-Likelihood PSF fitting is employed. Until a proper treatment of PSF fitting in multipointing observations is determined, `emldetect` is not run on full sky view images from Mosaic observations; it is run on sub-ODFs associated to single pointing intervals. In the case of slew observations the source detection process is done after dividing the whole data set in intervals of 45 seconds, which roughly corresponds to 1 degree long in the direction of the slew motion.

The output file format of the two tasks is similar (regardless of the mode used when running `eboxdetect`). Where source detection is performed, there may be up to 3 primary source detection product file types per observation (see sections 6.5.6.2 to 6.5.6.4). The products give only total-band source positions, while other measured parameters are band-specific. The `emldetect` source lists also include one result set for the core-XID band (0.5-4.5keV).

The `emldetect` primary source detection products for pointed observations are summarised, internally cross-correlated and, where possible, position-rectified in the final observation summary source list. Position rectification is a process of varying the ensemble of raw source positions until position residuals with respect to an astrometric catalogue are minimised; this may not be possible for all observations. Also added are information on related OM sources, columns for information on EPIC source variability (though these are not currently filled) and whether sources have spectral or timeseries products. There are 2 such observation summary source list products per observation (described in sections 6.5.6.7 and 6.5.6.6).

6.5.6.1 General conventions

- Where FITS is specified, the file has the basic structure:
  1. Primary header with null primary array.
  2. Data table (BINTABLE extension)
- The following keywords are present in the primary header to identify the file type:

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'SRCLIST '           / File contains a source list
```

6.5.6.2 PRODUCT: EPIC FITS observation box-local source list (OBLSLI)

- This file contains the full information on all source detections from the eboxdetect pipeline analysis task, run in 'local' mode, on the input list of images.
- The product provides a single position for each source detected in the combined image set. It contains other measured source parameters on an energy band-specific basis.
- The product is supplied in FITS format.
- The product is identified using the keyword,

  `CONTENT = 'EPIC OBSERVATION BOX-LOCAL SOURCE LIST'`

  in the primary header.
- This is a product of class `EPICOBS`.
- The mode in which the `eboxdetect` task was runs is specified by the keyword in the binary table extension,

  `BOXMODE = 'LOCAL'`
- The single binary table data extension has the name,

  `EXTNAME = 'SRCLIST'`
- The following columns make up the binary table extension:

Name	Type	Description
BOX_ID_SRC	4-byte INTEGER	eboxdetect source number
ID_INST	4-byte INTEGER	ID of instrument (e.g.,0: all, 1:pn, 2: MOS1, 3: MOS2)
ID_BAND	4-byte INTEGER	ID of energy band (0...N, 0: all bands, 1: lowest band)
SCTS	4-byte REAL	PSF-corrected net source counts per band
SCTS_ERR	4-byte REAL	source counts error
BOX_CTS	4-byte REAL	Counts in box
X_IMA	4-byte REAL	X source position (image pixels)
X_IMA_ERR	4-byte REAL	X position error
Y_IMA	4-byte REAL	Y source position (image pixels)
Y_IMA_ERR	4-byte REAL	Y position error
LIKE	4-byte REAL	Likelihood of detection
BG_MAP	4-byte REAL	value of background estimated at source location
BG_RAW	4-byte REAL	Mean raw background from bk region
EXP_MAP	4-byte REAL	value of exposure map at source location
FLUX	4-byte REAL	flux in erg/cm^2/s using ECF from parameter file
FLUX_ERR	4-byte REAL	flux error
RATE	4-byte REAL	vignetting corrected source count rate (count/s)
RATE_ERR	4-byte REAL	rate error
RA	8-byte REAL	right ascension of source position (deg)
DEC	8-byte REAL	declination of source position (deg)
RADEC_ERR	4-byte REAL	1 sigma position error (arcsec) - no systematic included
LII	8-byte REAL	Galactic lattitude of source (deg)
BII	8-byte REAL	Galactic longitude of source (deg)
HR1	4-byte REAL	hardness ratio 1 (only for ID_BAND=0)
HR1_ERR	4-byte REAL	1σ error in hardness ratio 1
HR2	4-byte REAL	hardness ratio 2 (only for ID_BAND=0)
HR2_ERR	4-byte REAL	1σ error in hardness ratio 2
HR3	4-byte REAL	hardness ratio 3 (only for ID_BAND=0)
HR3_ERR	4-byte REAL	1σ error in hardness ratio 3
VIGNETTING	4-byte REAL	Vignetting value at source location
BOX_SIZE	4-byte REAL	detection box size (image pixels)
EEF	4-byte REAL	Fraction of source PSF in box (encircled energy fraction)
DIST_NN	4-byte REAL	distance from nearest neighbour (arcsec)

- There is one row for each detection of a source in an energy band (or combined band) for each camera. For 5 independent energy band images input to the eboxdetect task there are 6 rows per detected 'real' source (1 per band and 1 for the total band) per camera.

- There is one additional row per source summarising some values over all cameras present. Thus there may be a total of up to 19 entries (rows) per detected source in the file (6 energy bands from 3 cameras and one row over all cameras).

- There is one product per observation where eboxdetect is run in 'local' mode. The size of the file depends on the number of sources detected and the number of cameras used. For $\sim$100 sources and 19 rows per detected 'real' source (i.e. with 3 cameras present and one row summarising all cameras), the product is typically $\sim$300 KB uncompressed.

6.5.6.3 PRODUCT: EPIC FITS observation box-map source list (OBMSLI)

- This file contains the full information on all source detections from the eboxdetect pipeline analysis task, run in 'map' mode, on the input list of images.
- The product provides a single position for each source detected in the combined image set. It contains other measured source parameters on an energy band-specific basis.
- The product is supplied in FITS format.
- The product is identified using the keyword,

  `CONTENT = 'EPIC OBSERVATION BOX-MAP SOURCE LIST'`

  in the primary header.
- This is a product of class `EPICOBS`.
- The mode in which the eboxdetect task was run is specified by the keyword in the binary table extension.

  `BOXMODE = 'MAP'`
- The single binary table data extension has the name,

  `EXTNAME = 'SRCLIST'`
- The following columns make up the binary table extension:

Name	Type	Description
BOX_ID_SRC	4-byte INTEGER	eboxdetect source number
ID_INST	4-byte INTEGER	ID of instrument (e.g.,0: all, 1:pn, 2: MOS1, 3: MOS2)
ID_BAND	4-byte INTEGER	ID of energy band (0...N, 0: all bands, 1: lowest band)
SCTS	4-byte REAL	PSF-corrected net source counts per band
SCTS_ERR	4-byte REAL	source counts error
BOX_CTS	4-byte REAL	Counts in box
X_IMA	4-byte REAL	X source position (image pixels)
X_IMA_ERR	4-byte REAL	X position error
Y_IMA	4-byte REAL	Y source position (image pixels)
Y_IMA_ERR	4-byte REAL	Y position error
LIKE	4-byte REAL	Likelihood of detection
BG_MAP	4-byte REAL	value of background estimated at source location
BG_RAW	4-byte REAL	Mean raw background from bk region
EXP_MAP	4-byte REAL	value of exposure map at source location
FLUX	4-byte REAL	flux in erg/cm^2/s using ECF from parameter file
FLUX_ERR	4-byte REAL	flux error
RATE	4-byte REAL	vignetting corrected source count rate (count/s)
RATE_ERR	4-byte REAL	rate error
RA	8-byte REAL	right ascension of source position (deg)
DEC	8-byte REAL	declination of source position (deg)
RADEC_ERR	4-byte REAL	1 sigma position error (arcsec) - no systematic included
LII	8-byte REAL	Galactic lattitude of source (deg)
BII	8-byte REAL	Galactic longitude of source (deg)
HR1	4-byte REAL	hardness ratio 1 (only for ID_BAND=0)
HR1_ERR	4-byte REAL	1σ error in hardness ratio 1
HR2	4-byte REAL	hardness ratio 2 (only for ID_BAND=0)
HR2_ERR	4-byte REAL	1σ error in hardness ratio 2
HR3	4-byte REAL	hardness ratio 3 (only for ID_BAND=0)
HR3_ERR	4-byte REAL	1σ error in hardness ratio 3
VIGNETTING	4-byte REAL	Vignetting value at source location
BOX_SIZE	4-byte REAL	detection box size (image pixels)
EEF	4-byte REAL	Fraction of source PSF in box (encircled energy fraction)
DIST_NN	4-byte REAL	distance from nearest neighbour (arcsec)

- There is one row for each detection of a source in an energy band (or combined band) for each camera. For 5 independent energy band images input to the eboxdetect task there are 6 rows per detected 'real' source (1 per band and 1 for the total band) per camera.
- There is one additional row per source summarising some values over all cameras present. Thus there may be a total of up to 19 entries (rows) per detected source in the file (6 energy bands from 3 cameras and one row over all cameras).
- There is one product per observation if eboxdetect is run in 'map' mode. The size of the file depends on the number of sources detected and the number of cameras used. For $\sim$100 sources and 19 rows per detected source (i.e. with 3 cameras present and one row summarising all cameras), the product is typically $\sim$300 KB uncompressed.

6.5.6.4 PRODUCT: EPIC FITS observation ml source list (OMSRLI)

- This file contains the full information on all source detections from the emldetect pipeline analysis task, run on the input image list.
- The product provides a single position for each source detected in the combined image set. It contains other measured source parameters on an energy band-specific basis.
- In the case of slew observations, there is one file per energy band.
- The product is supplied in FITS format.
- The product is identified using the keyword,

  `CONTENT = 'EPIC OBSERVATION ML SOURCE LIST'`

  in the primary header.
- This is a product of class `EPICOBS`.
- The single binary table data extension has the name,

  `EXTNAME = 'SRCLIST'`

- The following columns make up the binary table extension:

Name	Type	Description
ML_ID_SRC	4-byte INTEGER	emldetect source number
BOX_ID_SRC	4-byte INTEGER	eboxdetect source number
ID_INST	4-byte INTEGER	ID of instrument (e.g., 0: all; 1: pn, 2: MOS1, 3: MOS2)
ID_BAND	4-byte INTEGER	ID of energy band (1...N, 0: all bands, 1: lowest band)
ID_CLUSTER	4-byte INTEGER	cluster ID (same for sources fit simultaneously)
SCTS	4-byte REAL	PSF-corrected net source counts per band
SCTS_ERR	4-byte REAL	1σ source counts error
X_IMA	4-byte REAL	X source position (image pixels)
X_IMA_ERR	4-byte REAL	1σ X position error
Y_IMA	4-byte REAL	Y source position (image pixels)
Y_IMA_ERR	4-byte REAL	1σ Y position error
EXT	4-byte REAL	extent (image pixels)
EXT_ERR	4-byte REAL	1σ error of extent
DET_ML	4-byte REAL	detection likelihood in band
EXT_ML	4-byte REAL	likelihood of extent in band
BG_MAP	4-byte REAL	value of background map at source location
EXP_MAP	4-byte REAL	value of exposure map at source location
FLUX	4-byte REAL	flux in 10^{-15} erg/cm^2/s using ECF from parameter file
FLUX_ERR	4-byte REAL	1σ flux error
RATE	4-byte REAL	vignetting corrected source count rate (count/s)
RATE_ERR	4-byte REAL	1σ rate error
RA	8-byte REAL	right ascension of source position (deg)
DEC	8-byte REAL	declination of source position (deg)
RADEC_ERR	4-byte REAL	1σ position error (arcsec) - no systematic included
LII	8-byte REAL	Galactic lattitude of source
BII	8-byte REAL	Galactic longitude of source
RAWX	4-byte INTEGER	X raw pixel position of source in image
RAWY	4-byte INTEGER	Y raw pixel position of source in image
OFFAX	4-byte REAL	Off-axis distance of source (arcmin)
CCDNR	4-byte INTEGER	Detector CCD number in which source lies
HR1	4-byte REAL	hardness ratio 1 (only for ID_BAND=0)
HR1_ERR	4-byte REAL	1σ error in hardness ratio 1
HR2	4-byte REAL	hardness ratio 2 (only for ID_BAND=0)
HR2_ERR	4-byte REAL	1σ error in hardness ratio 2
HR3	4-byte REAL	hardness ratio 3 (only for ID_BAND=0)
HR3_ERR	4-byte REAL	1σ error in hardness ratio 3
HR4	4-byte REAL	hardness ratio 4 (only for ID_BAND=0)
HR4_ERR	4-byte REAL	1σ error in hardness ratio 4
CUTRAD	4-byte REAL	cut out radius for events used in PSF fit
MASKFRAC	4-byte REAL	Fraction of source available for fitting (not masked)
EEF	4-byte REAL	Encircled energy fraction of source used in fitting
VIGNETTING	4-byte REAL	Vignetting value at source location
ONTIME	4-byte REAL	Sum of GTI intervals for source location
DIST_NN	4-byte REAL	distance to nearest neighbour (arcsec)
FLAG	12-byte CHARACTER	Source flags (components relating to automatic flags may be set)
XIMNAME	40-byte CHARACTER	Image where the source is found (only for slew data)

- There is one row for each detection of a source in an energy band (or combined band) for each camera. For 5 independent energy band images input to the eboxdetect task there are 6 rows per detected 'real' source (1 per band and 1 for the total band) per camera.
- There is one additional row per source summarising some values over all cameras present. Thus there may be a total of up to 19 entries (rows) per detected source in the file (6 energy bands from 3 cameras and one row over all cameras).
- The size of the file depends on the number of sources detected and the number of energy bands used. For ∼100 sources and 19 rows per detected source, the product is ∼420 KB uncompressed.

6.5.6.5 PRODUCT: EPIC FITS summary source list (OBSMLI)

- This file contains summarised information from the previously described primary EPIC ml source lists. Detections of the same physical source are combined on the basis of position coincidence, so that there is a single entry per source.
- Source parameters are derived from the primary EPIC ml source lists. They include references back to the entries in those source lists, and, where possible, improved celestial positions based on a best match of the source positions to the positions of objects in an astrometric catalogue. A wide range of parameters are provided for separate instruments (and all-EPIC in some cases), relating to count rates, fluxes (including for the XID band), likelihood, vignetting and exposure map values and hardness ratios. In addition, information on the nearest OM counterpart sources and the creation of EPIC spectral and timeseries products is included.
- The product is supplied in FITS format.
- The file is identified using the keyword,

  `CONTENT = 'EPIC SUMMARY SOURCE LIST'`

  in the primary header.
- This is a product of class `EPICOBS`.
- The single binary table extension has the name,

  `EXTNAME = 'SRCLIST'`

- There is a single row for each distinct celestial source.
- The following 242 columns make up the binary table extension:

Name	Type	Description
SRC_NUM	4-byte INTEGER	source number
EP_1_ML_ID	4-byte INTEGER	EPIC ML source list source ID - all-band analysis
EP_1_BOX_ID	4-byte INTEGER	EPIC box source list source ID 1 - all-band analysis
EP_2_ML_ID	4-byte INTEGER	EPIC ML source list source ID 2 - XID-band analysis
EP_2_BOX_ID	4-byte INTEGER	EPIC box source list source ID 2 - XID-band analysis
RA	8-byte REAL	RA (2000) of source (deg)
DEC	8-byte REAL	DEC (2000) of source (deg)
RADEC_ERR	4-byte REAL	source position error (arcsec)
LII	8-byte REAL	Galactic longitude of RA,DEC (deg)
BII	8-byte REAL	Galactic latitude of RA,DEC (deg)
PN_CTS	4-byte REAL	pn total band counts
PN_CTS_ERR	4-byte REAL	
M1_CTS	4-byte REAL	mos 1 total band counts
M1_CTS_ERR	4-byte REAL	
M2_CTS	4-byte REAL	mos 2 total band counts
M2_CTS_ERR	4-byte REAL	
PN_TOT_FLUX	4-byte REAL	pn total band flux (ergs/s/cm^2)
ERR_PN_TOT_FLUX	4-byte REAL	
M1_TOT_FLUX	4-byte REAL	M1 total band flux (ergs/s/cm^2)
ERR_M1_TOT_FLUX	4-byte REAL	
M2_TOT_FLUX	4-byte REAL	M2 total band flux (ergs/s/cm^2)
ERR_M2_TOT_FLUX	4-byte REAL	
EP_TOT_FLUX	4-byte REAL	EPIC total band flux (ergs/s/cm^2)
ERR_EP_TOT_FLUX	4-byte REAL	
PN_x_FLUX	4-byte REAL	pn band x flux (x=1 to 5)
ERR_PN_x_FLUX	4-byte REAL	
M1_x_FLUX	4-byte REAL	M1 band x flux (x=1 to 5)
ERR_M1_x_FLUX	4-byte REAL	
M2_x_FLUX	4-byte REAL	M2 band x flux (x=1 to 5)
ERR_M2_x_FLUX	4-byte REAL	
EP_x_FLUX	4-byte REAL	EPIC band x flux (x=1 to 5)
ERR_EP_x_FLUX	4-byte REAL	
PN_XID_FLUX	4-byte REAL	pn XID band flux
ERR_PN_XID_FLUX	4-byte REAL	
M1_XID_FLUX	4-byte REAL	M1 XID band flux
ERR_M1_XID_FLUX	4-byte REAL	
M2_XID_FLUX	4-byte REAL	M2 XID band flux
ERR_M2_XID_FLUX	4-byte REAL	
EP_XID_FLUX	4-byte REAL	EPIC XID band flux
ERR_EP_XID_FLUX	4-byte REAL	
PN_TOT	4-byte REAL	pn total band count rate

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Name	Type	Description
PN_TOT_ERR	4-byte REAL	
M1_TOT	4-byte REAL	M1 total band count rate
M1_TOT_ERR	4-byte REAL	
M2_TOT	4-byte REAL	M2 total band count rate
M2_TOT_ERR	4-byte REAL	
EP_TOT	4-byte REAL	EPIC total band count rate
EP_TOT_ERR	4-byte REAL	
PN_x	4-byte REAL	pn count rate for band x (x=1 to 5) (cts/s)
PN_x_ERR	4-byte REAL	error on pn band x count rate
M1_x	4-byte REAL	M1 count rate for band x (x=1 to 5) (cts/s)
M1_x_ERR	4-byte REAL	error on M1 band x count rate
M2_x	4-byte REAL	M2 count rate for band x (x=1 to 5) (cts/s
M2_x_ERR	4-byte REAL	error on M2 band x count rate
PN_XID	4-byte REAL	pn count rate for XID band (cts/s)
PN_XID_ERR	4-byte REAL	error on pn XID band count rate
M1_XID	4-byte REAL	M1 count rate for XID band (cts/s)
M1_XID_ERR	4-byte REAL	error on M1 XID band count rate
M2_XID	4-byte REAL	M2 count rate for XID band (cts/s)
M2_XID_ERR	4-byte REAL	error on M2 XID band count rate
EP_XID	4-byte REAL	EPIC count rate for XID band (cts/s)
EP_XID_ERR	4-byte REAL	error on EPIC XID band count rate
PN_DET_ML	4-byte REAL	pn total-band detection max likelihood
M1_DET_ML	4-byte REAL	M1 total-band detection max likelihood
M2_DET_ML	4-byte REAL	M2 total-band detection max likelihood
EP_DET_ML	4-byte REAL	EPIC total-band detection max likelihood
PN_XID_ML	4-byte REAL	pn XID-band detection max likelihood
M1_XID_ML	4-byte REAL	M1 XID-band detection max likelihood
M2_XID_ML	4-byte REAL	M2 XID-band detection max likelihood
EP_XID_ML	4-byte REAL	EPIC XID-band detection max likelihood
PN_x_ML	4-byte REAL	pn band-x detection max likelihood (x= 1 to 5)
M1_x_ML	4-byte REAL	M1 band-x detection max likelihood (x= 1 to 5)
M2_x_ML	4-byte REAL	M2 band-x detection max likelihood (x= 1 to 5)
EP_EXTENT	4-byte REAL	EPIC source extent (image pixels)
EP_EXT_ERR	4-byte REAL	
EP_EXT_ML	4-byte REAL	EPIC source extent max likelihood
PN_x_EXP	4-byte REAL	pn band-x eff. exposure time at source location (x= 1 to 5) (secs)
PN_x_VIG	4-byte REAL	pn band-x vign. at source location (x= 1 to 5)
M1_x_EXP	4-byte REAL	M1 band-x eff. exposure time at source location (x= 1 to 5) (secs)
M1_x_VIG	4-byte REAL	M1 band-x vign. at source location (x= 1 to 5)
M2_x_EXP	4-byte REAL	M2 band-x eff. exposure time at source location (x= 1 to 5) (secs)

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Name	Type	Description
M2_x_VIG	4-byte REAL	M2 band-x vign. at source location (x= 1 to 5)
PN_ONTIME	4-byte REAL	pn total ON-time (secs)
M1_ONTIME	4-byte REAL	M1 total ON-time (secs)
M2_ONTIME	4-byte REAL	M2 total ON-time (secs)
PN_MASKFRAC	4-byte REAL	pn mask fraction for source (PSF-weighted mean detector coverage)
M1_MASKFRAC	4-byte REAL	M1 mask fraction for source
M2_MASKFRAC	4-byte REAL	M2 mask fraction for source
PN_OFFAX	4-byte REAL	pn source off-axis distance (arcmins)
M1_OFFAX	4-byte REAL	M1 source off-axis distance (arcmins)
M2_OFFAX	4-byte REAL	M2 source off-axis distance (arcmins)
PN_HR1	4-byte REAL	pn hardness ratio #1
PN_HR1_ERR	4-byte REAL	
PN_HR2	4-byte REAL	pn hardness ratio #2
PN_HR2_ERR	4-byte REAL	
PN_HR3	4-byte REAL	pn hardness ratio #3
PN_HR3_ERR	4-byte REAL	
PN_HR4	4-byte REAL	pn hardness ratio #4
PN_HR4_ERR	4-byte REAL	
M1_HR1	4-byte REAL	M1 hardness ratio #1
M1_HR1_ERR	4-byte REAL	
M1_HR2	4-byte REAL	M1 hardness ratio #2
M1_HR2_ERR	4-byte REAL	
M1_HR3	4-byte REAL	M1 hardness ratio #3
M1_HR3_ERR	4-byte REAL	
M1_HR4	4-byte REAL	M1 hardness ratio #4
M1_HR4_ERR	4-byte REAL	
M2_HR1	4-byte REAL	M2 hardness ratio #1
M2_HR1_ERR	4-byte REAL	
M2_HR2	4-byte REAL	M2 hardness ratio #2
M2_HR2_ERR	4-byte REAL	
M2_HR3	4-byte REAL	M2 hardness ratio #3
M2_HR3_ERR	4-byte REAL	
M2_HR4	4-byte REAL	M2 hardness ratio #4
M2_HR4_ERR	4-byte REAL	
EP_HR1	4-byte REAL	EPIC hardness ratio #1
EP_HR1_ERR	4-byte REAL	
EP_HR2	4-byte REAL	EPIC hardness ratio #2
EP_HR2_ERR	4-byte REAL	
EP_HR3	4-byte REAL	EPIC hardness ratio #3
EP_HR3_ERR	4-byte REAL	

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Name	Type	Description
EP_HR4	4-byte REAL	EPIC hardness ratio #4
EP_HR4_ERR	4-byte REAL	
VAR_STAT	4-byte REAL	value of the variability statistic
N_BINS	4-byte INTEGER	number of bins in the lightcurve
P_VAR	4-byte REAL	probability of variability statistic
VAR_EXP_NO	4-byte INTEGER	exposure no of originating lightcurve
OM_ID1	4-byte INTEGER	OM ID of nearest OM counterpart
OM_ID1_DIST	4-byte REAL	OM-EPIC source distance (arcsecs) to cpt 1
OM_ID2	4-byte INTEGER	OM ID of 2nd nearest OM counterpartt
OM_ID2_DIST	4-byte REAL	OM-EPIC source distance (arcsecs) to cpt 2
OM_ID3	4-byte INTEGER	OM ID of 3rd nearest OM counterpartt
OM_ID3_DIST	4-byte REAL	OM-EPIC source distance (arcsecs) to cpt 3
OM_ID4	4-byte INTEGER	OM ID of 4th nearest OM counterpartt
OM_ID4_DIST	4-byte REAL	OM-EPIC source distance (arcsecs) to cpt 4
OM_ID5	4-byte INTEGER	OM ID of 5th nearest OM counterpartt
OM_ID5_DIST	4-byte REAL	OM-EPIC source distance (arcsecs) to cpt 5
N_OPT_CO	4-byte INTEGER	number of OM counterparts
OMFLAG	CHARACTER*10	OM data availability
SPECTRA	LOGICAL	one or more EPIC spectra made
TSERIES	LOGICAL	one or more EPIC timeseries made
PN_FLAG	12-byte CHAR	pn validation flags (first 9 automatically set)
M1_FLAG	12-byte CHAR	M1 validation flags (first 9 automatically set)
M2_FLAG	12-byte CHAR	M2 validation flags (first 9 automatically set)
EP_FLAG	12-byte CHAR	EPIC validation flags (summary of worst instrument cases)
RA_CORR	8-byte REAL	RA corrected by cat X-corr
DEC_CORR	8-byte REAL	DEC corrected by cat X-corr
LII_CORR	8-byte REAL	Gal. longitude of RA_CORR,DEC_CORR
BII_CORR	8-byte REAL	Gal. latitude of RA_CORR,DEC_CORR
SYSERRCC	4-byte REAL	Error on astrometric correction

- An attempt is made to rectify the source positions through a cross-correlation with an external (currently USNO-B1.0, 2MASS or SDSS-DR9) catalogue. Parameters of the cross-correlation (e.g. the number of matches, RA, DEC and rotation offset corrections determined and likelihood of the process) are conveyed in keywords in the source list extension header. Where deemed successful, the keyword, POSCOROK is set to true. In this case, the RA_CORR and DEC_CORR columns are adjusted to include these offsets and rotation, otherwise they are the same as the RA and DEC columns. The column, SYSERRCC, in the SRCLIST table conveys the error associated with the rectification process. It is a column rather than a fixed keyword because it includes a rotational component that renders the error a function of off-axis angle (i.e. source position).

- There is one product per observation. Assuming 100 sources, the file is ∼190 KB uncompressed.

6.5.6.6 PRODUCT: EPIC HTML summary source list (OBSMLI)

- This product is derived from the EPIC FITS summary source list, and takes the form of an HTML table.
- It contains a subset of 17 columns relating to the source ID information, its coordinates, EPIC and XID-band count rates and detection maximum likelihoods, EPIC extent information, validation flags and the availability of OM objects.
- This is a products of class EPICOBS.
- There is one product per observation. Assuming 100 sources, the file is 21 KB.

6.5.6.7 PRODUCT: EPIC FITS summary source list for slew data (OBSSLI)

- This file contains summarised information from the EPIC ml source lists from slew data . Detections of the same physical source are combined on the basis of position coincidence, so that there is a single entry per source.
- Source parameters are derived from the primary EPIC ml source lists. They include references back to the entries in those source lists. A range of parameters are provided, relating to count rates, fluxes, likelihood and exposure map values.
- The product is supplied in FITS format.
- The file is identified using the keyword,

  ```
  CONTENT = 'EPIC SUMMARY SOURCE LIST FOR SLEW DATA'
  ```

  in the primary header.
- This is a product of class EPICOBS.
- The single binary table extension has the name,

  ```
  EXTNAME = 'SRCLIST'
  ```

- There is a single row for each distinct celestial source.
- The following columns make up the binary table extension:

Name	Type	Description
SRCNAME	40-byte CHAR	Source name
RA	8-byte REAL	RA (2000) of source (deg)
DEC	8-byte REAL	DEC (2000) of source (deg)
RADEC_ERR	8-byte REAL	source position error (arcsec)
SCTS_x	4-byte REAL	PSF-corrected net source counts in band x (x=B6,B7,B8)
SCTS_x_ERR	4-byte REAL	1σ source counts error in band x
EXT_x	4-byte REAL	extent (image pixels)
EXT_x_ERR	4-byte REAL	1σ error of extent
DET_ML_x	4-byte REAL	detection likelihood in band
BG_MAP_x	4-byte REAL	value of background map at source location
RATE_x	4-byte REAL	vignetting corrected source count rate (count/s)
RATE_x_ERR	4-byte REAL	1σ rate error
FLUX_x	4-byte REAL	flux in 10^{-15}erg/cm^2/s using ECF
FLUX_x_ERR	4-byte REAL	1σ rate error
XIMNAME	4-byte REAL	Name of image were source has been detected

- There is one product per observation.

6.5.7 EPIC calibrated event list

6.5.7.1 General conventions

- Event lists are delivered in FITS format. The OGIP guidelines for defining event lists are followed (OGIP/94-003).
- These event lists are science products suitable for use in further data analysis.
- Each event list contains events from one EPIC camera only. For pointed observations, for each EPIC camera there is a single file containing filtered events from all CCDs operating in `IMAGING` modes, and a single file containing events from the CCD operating in a `TIMING` mode (where appropriate). Imaging modes are: Full Frame, Extended Full Frame (pn only) and Partial Window. Timing modes are: `TIMING` and, for EPIC pn only, `BURST`. For slew observations there is a single event list spanning the entire exposure and also a set of separate event lists, one for each step along the slew path - see sec. 6.1.
- The structure of the FITS file is:
  1. Primary header with null primary array.
  2. A single binary table extension containing the event data (`EXTNAME='EVENTS'`).
  3. A single binary table extension containing the list of bad offsets data (`EXTNAME='OFFSETS'`).
  4. Binary table extensions containing exposure data (`EXTNAME='EXPOSUnn'`).
  5. Binary table extensions containing bad pixel data (`EXTNAME='BADPIXnn'`).
  6. Binary table extensions containing good-time interval (GTI) data (`EXTNAME='STDGTInn'`).
  7. Binary table extension containing a copy of the Calibration Index File (CIF) information (`EXTNAME='CALINDEX'`).
- For each of the extension types, `EXPOSUnn`, `BADPIXnn` and `STDGTInn`, there is one binary table extension per active CCD (per active CCD node for EPIC MOS). The values of `nn` is the CCD number (for the EPIC MOS the first digit is the node number). These multiple extensions have the same table format for both EPIC MOS and EPIC pn.
- Event times are specified in seconds after a reference time specified in a header keyword.
- Intervals of high particle background are not removed from these calibrated event lists.

6.5.7.2 Format of the OFFSETS extension

- In pn event lists this extension contains the CCD columns to which an additional offset is applied to reduce noise (the offset is later subtracted again by the SAS). In the MOS event lists this extension currently defines columns outside the sensitive CCD window, to which formal very high values of the offset are associated. These columns are discarded by the data processing.
- For MOS imaging mode event lists this extension contains the following columns:

Name	Type	Description
RAWX	2-byte INTEGER	Row or column of the bad offset
OFFSETX	2-byte INTEGER	amplitude of additional column offset (0 for row offset)
OFFSETY	2-byte INTEGER	amplitude of additional row offset (0 for column offset)
CCDNR	1-byte	CCD where the offset occurs

- For MOS timing mode event lists this extension contains the following columns:

Name	Type	Description
RAWX	2-byte INTEGER	Row or column of the bad offset
OFFSETX	2-byte INTEGER	amplitude of additional column offset
CCDNR	1-byte	CCD where the offset occurs

- For pn imaging mode event lists this extension contains the following columns:

Name	Type	Description
RAWX	2-byte INTEGER	Row of the bad offset
OFFSETX	2-byte INTEGER	amplitude of additional column offset
CCDNR	1-byte	CCD where the offset occurs

- For pn timing mode event lists this extension contains the following columns:

Name	Type	Description
RAWX	2-byte INTEGER	Row of the bad offset
OFFSETX	2-byte INTEGER	amplitude of additional column offset
CCDNR	1-byte	CCD where the offset occurs

- Note that currently, the offset table is always empty and only the CCDNR column is present and it is unfilled. This may change in the future.

6.5.7.3 Format of the EXPOSUnn extensions

- This extension contains the exposed fraction of each frame per CCD (in the pn the frame time is constant, and is therefore not included in this extension).
- There is one extension per CCD in the relevant mode (IMAGING or TIMING) during the exposure.
- The following keywords are present in all cases (example values shown):

```
CCDID    =                    1 / CCD Identifier
FRMTIME  =                 2600 / Nominal frame integration time
WINDOWX0 =                    1 / X coordinate of bottom left corner of window
WINDOWY0 =                    1 / Y coordinate of bottom left corner of window
WINDOWDX =                  600 / Size, along x-axis, of window
WINDOWDY =                  600 / Size, along y-axis, of window
```

- In addition, the following keywords are present in EPIC pn EXPOSUnn extensions:

```
QUADRANT =                    0 / Quadrant Identifier
QUADMODE =                    0 / Quadrant mode
CCDMODE  =                    0 / CCD mode
SINGLES  =               588287 / number of single events
DOUBLES  =                67309 / number of double events
TRIPLES  =                 2920 / number of triple events
QUADRUPL =                 4607 / number of quadruple events
NOTRECEV =                 3958 / number of not recognized events
NOTRECPA =               171641 / number of not recognized patterns
MAXPAT   =                  263 / maximum pattern size
MIPS     =                    3 / number of MIPs found
RECPHOTO =               664123 / number of recognized photons
ANALYSED =               924737 / number of analysed events
```

- For both imaging and timing mode MOS event lists this extension contains the following columns:

Name	Type	Description
TIME	8-byte REAL	Frame start time (seconds since reference time)
TIMEDEL	4-byte REAL	Duration of frame time (seconds)
FRACEXP	4-byte REAL	Fractional exposure of frame

- For both imaging and timing mode pn event lists this extension contains the following columns:

Name	Type	Description
TIME	8-byte REAL	Frame start time (seconds since reference time)
FRACEXP	4-byte REAL	Fractional exposure of frame

6.5.7.4 Format of the BADPIXnn extensions

- This extension gives the pixels identified as bad in the event list.
- There is one extension per CCD in the relevant mode (IMAGING or TIMING) during the exposure.
- For EPIC pn BADPIXnn extensions the following keywords are present:

```
CCDID   =                     1 / ccd in use
QUADRANT=                     1 / quadrant in use
```

- For EPIC MOS BADPIXnn extensions the following keywords are present:

```
CCDID   =                     1 / ccd in use
CCDNODE =                     1 / CCD node in use
```

- This extension for imaging and timing mode of both MOS and pn contains the following columns:

Name	Type	Description
RAWX	2-byte INTEGER	Raw X coordinate
RAWY	2-byte INTEGER	Raw Y coordinate
TYPE	2-byte INTEGER	Bad pixel type
YEXTENT	2-byte INTEGER	Y-direction extent
BADFLAG	2-byte INTEGER	bad pixel flag

6.5.7.5 Format of the STDGTInn extensions

- This extension gives the good time intervals for the event list.
- There is one extension per CCD in the relevant mode (IMAGING or TIMING) during the exposure.
- The following keywords are present:

```
HDUCLASS = 'OGIP    '           / format conforms to OGIP standard
HDUCLAS1 = 'GTI     '           / table contains Good Time Intervals
HDUCLAS2 = 'STANDARD'           / standard Good Time Interval table
```

- This extension contains the following columns:

Name	Type	Description
START	8-byte REAL	seconds (since reference time)
STOP	8-byte REAL	seconds (since reference time)

6.5.7.6 Format of the DLIMAPnn extensions

- This extension is *only* present in pn event files. It gives the number of rejections of each column (discarded lines) of CCD nn over the course of the exposure.
- There is one extension per CCD in the relevant mode (IMAGING or TIMING) during the exposure.
- This extension contains the following columns:

Name	Type	Description
DLIODF	4-byte INTEGER	Number of rejections by onboard MIP algorithm
DLISAS	4-byte INTEGER	Number of subsequent rejections by the SAS

- Each row corresponds to a column.

6.5.7.7 Format of the HKAUXnn extensions

- This extension is *only* present in pn event files. It gives the number of discarded lines of CCD nn as a function of time. It is used to correct the dependency of the gain correction on the particle background.
- There is one extension per CCD in the relevant mode (IMAGING) during the exposure. Note that the values in DSLIN column are zero for Small Window mode.

- This extension contains the following columns:

Name	Type	Description
TIME	8-byte REAL	seconds (since reference time)
DSLIN	4-byte REAL	Number of rejections by onboard MIP algorithm

- Each row corresponds to a time.

6.5.7.8 Format of the CALINDEX extension

This is described in section 6.8.6.

6.5.7.9 PRODUCT: EPIC FITS MOS IMAGING mode event list (MIEVLI)

- For MOS camera CCDs operating in IMAGING and REDUCED IMAGING modes the EVENTS extension contains a binary table (one row per event) with the following columns:

Name	Type	Description
TIME	8-byte REAL	Event time (seconds) since reference time
RAWX	2-byte INTEGER	Raw CCD pixel of event (X axis)
RAWY	2-byte INTEGER	Raw CCD pixel of event (Y axis)
DETX	2-byte INTEGER	Linearised camera coordinate of
DETY	2-byte INTEGER	event. Units of 0.05″.
X	4-byte INTEGER	Projected sky coordinates of event, relative
Y	4-byte INTEGER	to nominal pointing position. Units of 0.05″.
PHA	2-byte INTEGER	Uncorrected event energy
PI	2-byte INTEGER	Corrected event energy
FLAG	4-byte INTEGER	Event quality flag
PATTERN	1-byte INTEGER	Event pattern ID
CCDNR	1-byte INTEGER	CCD ID number

  The "pattern" reflects the distribution of charge occurring in CCD pixels around the centroid of a photon event (see Turner et al., 2001, A&A, 365, L27-35 or http://xmm-tools.cosmos.esa.int/external/sas/current/doc/emevents/index.html for the MOS and http://xmm-tools.cosmos.esa.int/external/sas/current/doc/epevents/index.html for the pn, for more details)

- There are also EXPOSUnn, BADPIXnn, and STDGTI extensions as described above. nn is the CCD number (for EPIC MOS the first digit is the node number).

- These files are identified using the keyword

  CONTENT = 'EPIC MOS IMAGING MODE EVENT LIST'

  in the primary header.

- This is a product of class EPICEXP.

- There is one EPIC MOS image mode events file per EPIC MOS IMAGING mode exposure. The file is typically 16 MB uncompressed.

6.5.7.10 PRODUCT: EPIC FITS pn IMAGING mode event lists (PIEVLI, SLEVLI)

- For pointed observations, a single file is made per exposure (PIEVLI). For slew observations, a file is made covering the entire exposure (SLEVLI) but the events are also divided into separate files, one per step along the slew path (PIEVLI) - see sec. 6.1. The latter event lists have an identifier in the file name that distinguishes the step number. The formats of the FITS files are essentially the same.

- For pn CCDs operating in IMAGING mode the EVENTS extension contains a binary table (one row per event) with the following columns:

Name	Type	Description
TIME	8-byte REAL	Event time (seconds)
RAWX	2-byte INTEGER	Raw CCD pixel of event (X axis)
RAWY	2-byte INTEGER	Raw CCD pixel of event (Y axis)
DETX	2-byte INTEGER	Linearised camera coordinate of
DETY	2-byte INTEGER	event. Units of 0.05″.
X	4-byte INTEGER	Projected sky coordinates of event, relative
Y	4-byte INTEGER	to nominal pointing position. Units of 0.05″.
PHA	2-byte INTEGER	Uncorrected event energy
PI	2-byte INTEGER	Corrected event energy
FLAG	4-byte INTEGER	Event quality flag
PATTERN	1-byte INTEGER	Combined pattern info 2
PAT_ID	2-byte INTEGER	Combined pattern info 1
PAT_SEQ	1-byte INTEGER	Pattern sequence
CCDNR	1-byte INTEGER	CCD number
TIME_RAW	8-byte REAL	Raw event time (seconds)

- There are also EXPOSUnn, BADPIXnn, STDGTI and DLIMAP extensions as described above.

- These files are identified using the primary header keyword

  CONTENT = 'EPIC PN IMAGING MODE EVENT LIST'

  for pointed data (PIEVLI),

  CONTENT = 'SLEW FILTERED EVENTS PER STEP'

  for the event lists from each step along the slew path (PIEVLI) and

  CONTENT = 'SLEW SINGLE RAW EVENT LIST'

  for the total slew data event list (SLEVLI).

- These are products of class EPICEXP.

- For pointed data there is one EPIC pn image mode events file per EPIC pn IMAGING mode exposure. The file size is typically 130 MB uncompressed. For slew data, the event lists from each step along the slew path have an average size ∼7 MB while the slew total event file size is typically ∼10 MB.

6.5.7.11 PRODUCT: EPIC FITS MOS TIMING mode event list (TIEVLI)

- For MOS camera CCDs operating in TIMING and COMPRESSED TIMING modes, the EVENTS extension contains a binary table (one row per event) with the following columns:

Name	Type	Description
TIME	8-byte REAL	Event time (seconds)
RAWX	2-byte INTEGER	Raw CCD pixel of event (X axis)
PHA	2-byte INTEGER	Uncorrected event energy
PI	2-byte INTEGER	Corrected event energy
FLAG	4-byte INTEGER	Event quality flag
PATTERN	1-byte INTEGER	Event pattern ID
CCDNR	1-byte INTEGER	Overall CCD number

- These files are identified using the keyword

  CONTENT = 'EPIC TIMING MODE EVENT LIST'

  in the primary header.

- This is a product of class EPICEXP.

- There is one timing mode events file per TIMING mode exposure. The file size is, on average, 125 MB uncompressed.

6.5.7.12 PRODUCT: EPIC FITS pn TIMING mode event list (TIEVLI)

- For pn CCDs operating in TIMING and BURST modes the EVENTS extension contains a binary table (one row per event) with the following columns:

Name	Type	Description
TIME	8-byte REAL	Event time (seconds)
RAWX	2-byte INTEGER	Raw CCD pixel of event (X axis)
RAWY	2-byte INTEGER	Raw CCD pixel of event (Y axis)
DETX[1]	2-byte INTEGER	Linearised camera coordinate of
DETY[1]	2-byte INTEGER	event. Units of 0.05″.
X[1]	4-byte INTEGER	Projected sky coordinates of event, relative
Y[1]	4-byte INTEGER	to nominal pointing position. Units of 0.05″.
PHA	2-byte INTEGER	Uncorrected event energy
PI	2-byte INTEGER	Corrected event energy
FLAG	4-byte INTEGER	Event quality flag
PATTERN	1-byte INTEGER	Combined pattern info 2
PAT_ID	2-byte INTEGER	Combined pattern info 1
PAT_SEQ	1-byte INTEGER	Pattern sequence
CCDNR	1-byte INTEGER	CCD number

[1] Values in these columns are meaningless in Timing/Burst modes

- These files are identified using the keyword

```
CONTENT = 'EPIC TIMING MODE EVENT LIST'
```

in the primary header.

- This is a product of class `EPICEXP`.
- There is one timing mode events file per `TIMING` mode exposure. The file size is around 240 MB uncompressed.

6.5.8 EPIC region and ancillary products

6.5.8.1 PRODUCT: EPIC ASCII ML source region file (REGION)

These products, currently, are only made for pointed observation data, except the EPIC PPS summary product which is also made for slew observations.

- This is an ascii file describing the all-EPIC source regions.
- It is suitable for use with the image-display/overlay task, ds9.
- It is derived from the merged maximum likelihood source list file OMSRLI.
- This is a product of class EPICOBS.
- There is 1 file per observation. The file size is, on average, 5 KB.

6.5.8.2 PRODUCT: EPIC ASCII source specific region file (SRCREG)

- This is an ascii file providing ds9-like source and background regions used for the extraction of the timeseries and spectral products of a specific source. All other detected source regions are also present in the file, being distinguished by a different colour code for overlay on an image.
- It is derived by merging separate intermediate product ascii files for each of the regions mentioned above.
- This is a product of class EPICSRC.
- There is 1 file per source per exposure for which spectral and timeseries products were extracted. The file size is, on average, 4 KB.

6.5.8.3 PRODUCT: EPIC FITS Ancillary response function file (SRCARF, SCOARF)

- This is a FITS format file providing the effective area of the instrument as a function of energy (channel).
- A file SRCARF is produced for each source and exposure for which spectral products have been extracted and is for use with those spectral products.
- It is suitable for use with XSPEC and other X-ray spectral fitting software packages.
- The file comprises two extensions; a primary header with a null image array and and binary data table SPECRESP.
- The SPECRESP extension contains the following columns:

Name	Type	Description
ENERG_LO	4-byte REAL	Energy (keV) of the lower bound of the channel
ENERG_HI	4-byte REAL	Energy (keV) of the upper bound of the channel
SPECRESP	4-byte REAL	Instrumental effective area (cm^2) in the channel
ARF_NUM [1]	2-byte INTEGER	reference number of the arf stored in this roe
ROWID [1]	CHARACTER	unique identifier for each spectrum/arf

[1] These columns are only in TYPE:II files.

- A file SCOARF is produced for each source and EPIC-pn exposure for which spectral products for pileup analysis (6.5.5) have been extracted and is for use with those spectral products.
- These files are identified using the keyword

  ```
  CONTENT = 'EPIC ANCILLARY RESPONSE FUNCTION'
  for OGIP TYPE:I files
  or
  CONTENT = 'EPIC ANCILLARY RESPONSE COMBINED FUNCTIONS'
  for OGIP TYPE:II files
  ```

  in the primary header.
- This is a product of class EPICSRC.
- The OGIP filetype is defined by the keywords

  ```
  HDUCLASS = 'OGIP    '           / Format conforms to OGIP standard
  HDUCLAS1 = 'RESPONSE'           / dataset relates to spectral response
  HDUCLAS2 = 'SPECRESP'           / dataset is a spectral response matrix
  and
  HDUCLAS4 = 'TYPE:II '
  for multiple spectra within a single file .
  ```

  in the header of the SPECRESP extension.
- There is one file per EPIC spectrum file . The file size is 18 KB compressed for TYPE:I files and ∼80 KB for TYPE:II.

6.5.8.4 PRODUCT: EPIC FITS Ancillary redistribution matrix file (SP0RMF, SPDRMF, SP4RMF)

- This is a FITS format file providing the redistribution matrix of the instrument from input photon energy into detector energy channels.
- Files SP0RMF, SPDRMF, SP4RMF are produced for each source and exposure for which spectral products have been extracted for pn pile-up analysis and is for use with those spectral products.
- It is suitable for use with XSPEC and other X-ray spectral fitting software packages.
- These files are identified using the keyword

  ```
  CONTENT = 'EPIC RESPONSE MATRIX PATTERN0 SINGLES FUNCTION'
  for spectra from only single events
  or
  CONTENT = 'EPIC RESPONSE MATRIX PATTERND DOUBLES FUNCTION'
  for spectra from only double events
  or
  CONTENT = 'EPIC RESPONSE MATRIX PATTERN4 FUNCTION'
  for spectra from single and double events
  ```

in the primary header.

- This is a product of class EPICSRC.
- The OGIP filetype is defined by the keywords

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP standard
HDUCLAS1 = 'RESPONSE'           / dataset relates to spectral response
HDUCLAS2 = 'RSP_MATRIX'         / dataset is a spectral response matrix
HDUCLAS3 = 'REDIST  '           / photon redistribution matrix
```

in the header of the MATRIX extension.

- The file comprises three extensions; a primary header with a null image array, a binary data table MATRIX and a binary table EBOUNDS.
- The MATRIX extension contains the following columns:

Name	Type	Description
ENERG_LO	4-byte REAL	Lower energy bound of the energy bin (keV)
ENERG_HI	4-byte REAL	Upper energy bound of the energy bin (keV)
N_GRP	2-byte INTEGER	Number of channel subsets in the energy bin
F_CHAN	2-byte INTEGER	First channel number of each subset (vector column)
N_CHAN	2-byte INTEGER	Number of channels in each subset (vector column)
MATRIX	4-byte REAL	Response matrix for the energy bin (vector column)

- A keyword, LO_THRES, in the MATRIX extension conveys the response threshold below which it is considered to be zero. Such data are not included in the file to minimize storage requirements.
- The following keywords are relevant in the EBOUNDS extension to identify the file:

```
HDUCLASS= 'OGIP    '
HDUCLAS1= 'RESPONSE'
HDUCLAS2= 'EBOUNDS'
HDUVERS = '1.2.0   '
```

- The EBOUNDS extension contains a binary table with a single column:

Name	Type	Description
CHANNEL	2-byte INTEGER	channel number
E_MIN	4-byte REAL	Lower energy bound of channel
E_MAX	4-byte REAL	Upper energy bound of channel

- Each file is approximately 4 MB compressed.

6.5.9 EPIC PPS summary products

6.5.9.1 PRODUCT: EPIC HTML summary page (SUMMAR)

- A summary of all EPIC products is provided in HTML.
- The preview frames in PNG format are viewable using these HTML pages, as are all products in PDF.
- This is a product of class EPICOBS.
- There is 1 summary page per observation. File size is, on average, 110 KB.

6.6 RGS Products

Three named modes of operation are available for the RGS instrument, i.e. `Spectroscopy` mode, High Count Rate (HCR) mode and Small Window mode. `Spectroscopy` mode is used for standard scientific exposures and HCR mode is used occasionally for very bright sources. However, in essence, these two modes are the same, the only difference being that diagnostic images that are provided in `Spectroscopy` mode are not generated in HCR mode due to the reduced available telemetry bandwidth. Small window mode is similar to HCR but only the central quarter of the CCD rows in the cross-dispersion direction are used. This reduces pile-up effects from bright sources because the readout time is faster than Spectroscopy mode.

RGS products include FITS and graphics images formed in aspect-corrected dispersion vs cross-dispersion and CCD energy vs dispersion spaces, a calibrated event list and aspect-corrected exposure map, a list of sources and spectra and spectral plots for selected sources and for the whole field.

A maximum of three sources are extracted by the pipeline. Generally, the proposal position is extracted and, if the brightest EPIC source (above some rate threshold) is not positionally consistent with the proposal position, it is also extracted. A spectrum may be extracted from the on-axis position as well.

6.6.1 RGS general products header

The primary header of all RGS products contains the mandatory FITS keywords defined in section 6.2.1.

6.6.2 RGS image products

6.6.2.1 PRODUCT: RGS FITS image (`IMAGE_`)

- An image in aspect-corrected wavelength spectral-order product (`M_LAMBDA`) vs cross-dispersion angle.
- These files are identified using the keyword,

  ```
  CONTENT = 'RGS IMAGE'
  ```

  in the primary header.
- This is a product of class `RGSEXP`.
- The OGIP type of the file is defined by the keywords,

  ```
  HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1 = 'IMAGE   '           / File contains an image
  HDUCLAS2 = 'TOTAL   '           / Gross Image
  HDUVERS1 = '1.1.0   '           / Version of format
  ```

- This is a science product suitable for use in further data analysis. Potential uses include the overlaying of EPIC detections to locate any weak spectra and verifying the placement of the extraction regions.

- There is one file per exposure. Each file is, on average, 5 MB uncompressed.

6.6.2.2 PRODUCT: RGS PNG image (IMAGE_)

- Annotated RGS images, supplied in PNG format. Annotations identify the observation, exposure ID, etc., and show the extraction regions used in making the RGS source spectra.
- These images are preview products suitable for use in an online browser.
- This is a product of class RGSEXP.
- There is one file per exposure. Each file is typically 45 KB.

6.6.2.3 PRODUCT: RGS FITS energy-dispersion image (ORDIMG)

- An image in aspect-corrected CCD PI energy channel vs wavelength spectral-order product. Bright sources appear as hyperbola-like curves, with higher orders displaced vertically. Bright regions due to the calibration sources may also be visible.
- These files are identified using the keyword,

  ```
  CONTENT = 'RGS ENERGY-DISPERSION IMAGE'
  ```

  in the primary header.
- This is a product of class RGSEXP.
- The OGIP type of the file is defined by the keywords,

  ```
  HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
  HDUCLAS1 = 'IMAGE   '           / Extension contains an image
  HDUCLAS2 = 'TOTAL   '           / Gross Image
  HDUVERS1 = '1.1.0   '           / Version of format
  ```

- This is a science product suitable for use in further data analysis. Potential uses include the overlaying of EPIC detections to locate any weak spectra.
- There is one file per exposure. Each file is typically 1.5 MB uncompressed.

6.6.2.4 PRODUCT: RGS PNG energy-dispersion image (ORDIMG)

- Annotated RGS energy-dispersion images, supplied in PNG format. Annotations identify the observation, exposure ID, etc., and show the extraction regions used in making the RGS source spectra.
- These images are preview products suitable for use in an online browser.
- This is a product of class RGSEXP.
- There is one file per exposure, each file being around 38 KB.

6.6.2.5 PRODUCT: RGS FITS exposure map (EXPMAP)

- A FITS image wavelength spectral-order product vs cross-dispersion coordinates giving the total active time per pixel over an entire RGS CCD array.
- These files are identified using the keyword,

  ```
  CONTENT = 'RGS EXPOSURE MAP'
  ```

  in the primary header.
- This is a product of class RGSEXP.
- This is a science product suitable for use in further data analysis.
- There is one FITS file per exposure. Each file is 2.2 MB uncompressed, typically.

6.6.3 RGS spectral products

This section describes the spectral data products to be generated from pointed observations.

Source and background region spectra and a background-subtracted source spectrum are supplied for the brightest point sources in the RGS (in nearly all cases this is just one source). Spectral response matrices are also supplied.

6.6.3.1 General conventions

- Where FITS is specified as a file format, the OGIP standards defined by OGIP/92-007 (and amended by OGIP-92/007a) are followed as far as is appropriate. Such a FITS file has the basic structure:
  1. Primary header with null primary array.
  2. Data extension (EXTNAME = 'SPECTRUM').
- The spectra are binned into a set of wavelength bins, these being determined by the off-axis angle of the source in the FOV. The width of the bins is constant in terms of wavelength, and thus a continuous function of energy. The number of bins is 3600.

6.6.3.2 PRODUCT: RGS FITS source region spectrum (SBSPEC)

- For each RGS instrument and for each source, two spectrum files are created, one for each of the first and second dispersion orders.
- The spectra represent the counts recorded from the source plus background measured in the source extraction region.
- The spectra are integrated over the entire exposure.
- These files are identified using the keyword,

  ```
  CONTENT = 'RGS FITS SOURCE+BACKGROUND SPECTRUM' / Contents of file
  ```

- The following keywords are relevant in the SPECTRUM extension to identify the file:

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'SPECTRUM'           / OGIP Memo OGIP/92-007
HDUCLAS2 = 'TOTAL     '         / what combination of source and background
HDUCLAS3 = 'COUNT   '           / which data representation
HDUVERS  = '1.2.0   '           / Version number of the format
```

- This is a product of class RGSSRC.
- The SPECTRUM extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
CHANNEL	2-byte INTEGER	Dispersion channel
COUNTS	4-byte INTEGER	Photon detection count
QUALITY	2-byte INTEGER	Quality flag
AREASCAL	4-byte REAL	Area scaling factor
BACKSCAL	4-byte REAL	Background area scaling factor

- The order and source of the spectrum is identified by the following keywords in the SPECTRUM extension:

```
SOURCEID =                    3
RFLORDER =                    1 / RGS order number (1 or 2)
```

- This is a science product suitable for use in further data analysis.
- There are two FITS files per source (one for each order). Each file is approximately 65 KB uncompressed.

6.6.3.3 PRODUCT: RGS FITS background spectrum (BGSPEC)

- For each RGS instrument and each source, two spectrum files are created, one for each of the first and second dispersion orders. These are *not* created for RGS Small Window mode.
- The spectra represent the counts recorded from the background extraction region.
- The spectra are integrated over the entire exposure.
- These files are identified using the keyword,

```
CONTENT = 'RGS SOURCE BACKGROUND SPECTRUM' / Contents of file
```

- The following keywords are relevant in the SPECTRUM extension to identify the file:

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'SPECTRUM'           / OGIP Memo OGIP/92-007
HDUCLAS2 = 'BKG     '           / what combination of source and background
HDUCLAS3 = 'COUNT   '           / which data representation
HDUVERS  = '1.2.0   '           / Version number of the format
```

- This is a product of class RGSSRC.
- The SPECTRUM extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
CHANNEL	2-byte INTEGER	Dispersion channel
COUNTS	4-byte INTEGER	Photon detection count
QUALITY	2-byte INTEGER	Quality flag
AREASCAL	4-byte REAL	Area scaling factor
BACKSCAL	4-byte REAL	Background area scaling factor

- The order and source of the spectrum is identified by the following keywords in the SPECTRUM extension:

```
SOURCEID =                    3
RFLORDER =                    1 / RGS order number (1 or 2)
```

- This is a science product suitable for use in further data analysis.
- There are two FITS files per source (one for each order). Each file is approximately 65 KB uncompressed.

6.6.3.4 PRODUCT: RGS FITS source spectrum (SRSPEC)

- For each RGS instrument, for each source, two spectrum files are created, one for each of the first and second dispersion orders.
- The spectra are background subtracted after channel-by-channel exposure correction of source and background. In Small window mode, which is only processed in pipelines from prod8.4 onwards, background subtraction is not performed.
- The spectra are integrated over the entire exposure.
- These files are identified using the keyword,

```
CONTENT = 'RGS SOURCE SPECTRUM' / File content
```

- The following keywords are relevant in the SPECTRUM extension to identify the file:

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'SPECTRUM'           / OGIP Memo OGIP/92-007
HDUCLAS2 = 'NET     '           / what combination of source and background
HDUCLAS3 = 'COUNT   '           / which data representation
HDUVERS  = '1.2.0   '           / Version number of the format
```

- This is a product of class RGSSRC.
- The SPECTRUM extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
CHANNEL	2-byte INTEGER	Dispersion channel
COUNTS	4-byte INTEGER	Photon detection count
STAT_ERR	4-byte REAL	Statistical error
QUALITY	2-byte INTEGER	Quality flag
AREASCAL	4-byte REAL	Area scaling factor

- The order and source of the spectrum is identified by the following keywords in the SPECTRUM extension:

```
SOURCEID =                    3
RFLORDER =                    1 / RGS order number (1 or 2)
```

- This is a science product suitable for use in further data analysis.
- There are two FITS files per source (one for each order). Each file will be approximately 60 KB uncompressed.

6.6.3.5 PRODUCT: RGS PDF source spectrum (SRSPEC)

- This product comprises a pair of plots of the source spectrum in first and second order. From 2011 (pipeline prod8.4) the spectra are presented in wavelength (Angstroms) space. Earlier products were plotted in beta channel space with additional axes overlaid showing energy and wavelength scales.
- The source spectrum in this product is background subtracted.
- This is a summary product supplied in PDF format.
- These files are preview products suitable for use in an online browser.
- This is a product of class RGSSRC.
- There is one file per source per RGS instrument. File size is approximately 110 KB.

6.6.3.6 PRODUCT: RGS FITS whole-field spectrum (WFSPEC)

- For each RGS instrument, for each exposure, two spectrum files are created, one for each of the first and second dispersion orders.
- These spectra are accumulated from the whole field.
- No background subtraction is performed.
- The spectra are integrated over the entire exposure.
- These files are identified using the keyword

```
CONTENT = 'RGS WHOLE FIELD SRC+BKG SPECTRUM' / Contents of file
```

- The following keywords are relevant in the SPECTRUM extension to identify the file:

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'SPECTRUM'           / OGIP Memo OGIP/92-007
HDUCLAS2 = 'TOTAL   '           / what combination of source and background
HDUCLAS3 = 'COUNT   '           / which data representation
HDUVERS  = '1.2.0   '           / Version number of the format
```

- This is a product of class RGSEXP.
- The SPECTRUM extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
CHANNEL	2-byte INTEGER	Dispersion channel
COUNTS	4-byte INTEGER	Photon detection count
QUALITY	2-byte INTEGER	Quality flag
AREASCAL	4-byte REAL	Area scaling factor
BACKSCAL	4-byte REAL	Background area scaling factor

- The order and source of the spectrum is identified by the following keywords in the SPECTRUM extension:

```
SOURCEID =                   95
RFLORDER =                    1 / RGS order number (1 or 2)
```

- The SOURCEID keyword represents a pseudo-source number allocated to the whole field 'object' and is one greater than the highest numbered EPIC source in the RGS source list.
- This is a science product that is suitable for use in further analysis. However, it is not background subtracted and suitable rmfs would need to be created to perform serious scientific analysis.
- There are two FITS files per source (one for each order). Each file will be approximately 60 KB uncompressed.

6.6.3.7 PRODUCT: RGS PDF whole-field spectrum (WFSPEC)

- This product comprises a pair of plots of the spectrum from the whole field in first and second order. From 2011 (pipeline prod8.4) the spectra are presented in wavelength (Angstroms) space. Earlier products were plotted in beta channel space with additional axes overlaid showing energy and wavelength scales
- The spectrum in this product is not background subtracted.
- This is a summary product supplied in PDF format.
- These files are preview products suitable for use in an online browser.
- This is a product of class RGSEXP.
- There is one file per exposure per RGS instrument. File size is approximately 90 KB.

6.6.3.8 PRODUCT: RGS FITS fluxed source spectrum (FLUXED)

- A combined spectrum is produced for each source from the first-order fits source spectra (SRSPEC) from the two RGS instruments.
- The spectrum is corrected for the effective area of the instruments.
- These files are identified using the keyword,

```
CONTENT = 'RGS FLUXED SPECTRUM' / Contents of file
```

- This is a product of class RGSOBS.
- The SPECTRUM extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
CHANNEL	4-byte REAL	channel (Angstroms)
FLUX	4-byte REAL	Flux (s^{-1} cm^{-2} $Å^{-1}$))
ERROR	4-byte REAL	Error on Flux

- This is a product intended for initial visualisation of the RGS spectra, in particular, because it generally eliminates the presence of gaps arising from the absence of specific CCDs in the separate instrument spectra. It does not take account of the redistribution of monochromatic photons so is not strictly suitable for further scientific use.
- There is one FITS files per source. Each file will be approximately 22 KB uncompressed.

6.6.3.9 PRODUCT: RGS PDF fluxed source spectrum (FLUXED)

- This product comprises a plot of the RGS first order fluxed source spectrum. The X axis is in wavelength, the Y axis, fluxed counts
- This is a summary product supplied in PDF format.
- These files are preview products suitable for use in an online browser.
- This is a product of class RGSOBS.
- There is one file per source. The file size is approximately 24 KB.

6.6.3.10 PRODUCT: RGS FITS background model spectrum (BGMODL)

- For each RGS instrument and exposure, two model background spectrum files are created, one for each of the first and second dispersion orders. These are *not* created for RGS Small Window mode.
- The model background is not further used in PPS processing but is made for usage in XSPEC by the user.
- The spectra are integrated over the entire exposure.
- These files are identified using the keyword,

```
CONTENT = 'RGS BACKGROUND MODEL' / Contents of file
```

- This is a product of class RGSEXP.
- Each file contains 3 extensions: A primary header (with NULL image), a SPECTRUM extension and a FACTORS extension.
- The following keywords are relevant in the SPECTRUM extension to identify the file:

```
HDUCLASS = 'OGIP    '           / Format conforms to OGIP/GSFC conventions
HDUCLAS1 = 'SPECTRUM'           / OGIP Memo OGIP/92-007
HDUCLAS2 = 'BKG     '           / what combination of source and background
HDUCLAS3 = 'RATE    '           / which data representation
HDUVERS  = '1.2.0   '           / Version number of the format
```

- The SPECTRUM extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
CHANNEL	2-byte INTEGER	Dispersion channel
RATE	4-byte INTEGER	Model rate (cts/s)
STAT_ERR	4-byte REAL	Statistical error
QUALITY	2-byte INTEGER	Quality flag
AREASCAL	4-byte REAL	Area scaling factor
BACKSCAL	4-byte REAL	Background scaling factor

- The order and source of the spectrum is identified by the following keywords in the SPECTRUM extension:

```
SOURCEID =                    2
RFLORDER =                    1 / RGS order number (1 or 2)
```

- The SOURCEID keyword value is always 2 for the background model spectrum, i.e. it is based on the ONAXIS position.
- The FACTORS extension contains a binary table with a single column:

Name	Type	Description
Factors	8-byte REAL	weighting factor

- The process uses template spectra that sample a range of background levels (divided into 16 ranges). The factors are those used to weight the template spectra based on the observed background level during the observation, derived from the off-axis region of CCD9.
- Each file will be approximately 85 KB uncompressed.

6.6.4 RGS spectral response matrix products

The SSC pipeline makes two types of spectral response file product for the RGS. These are response matrix files (one per source) for individual sources extracted during RGS processing and a response matrix file for the whole field.

These are generated for use in spectral analysis packages such as XSPEC.

6.6.4.1 PRODUCT: RGS FITS source response matrix (RSPMAT)

- For each RGS instrument and exposure, a spectral response matrix is created for a given source.
- These files are identified using the keyword,

```
CONTENT = 'RGS RESPONSE MATRIX' / Contents of file
```

- This is a product of class RGSSRC.
- Each file contains 3 extensions: A primary header (with NULL image), a MATRIX extension and an EBOUNDS extension.
- The following keywords are relevant in the MATRIX extension to identify the file:

```
HDUCLASS = 'OGIP    '
HDUCLAS1 = 'RESPONSE'
HDUCLAS2 = 'RSP_MATRIX'         / NET response
HDUCLAS3 = 'FULL    '           / all effects included
HDUVERS  = '1.3.0   '
```

- The MATRIX extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
ENERG_LO	4-byte REAL	Lower energy bound of the energy bin (keV)
ENERG_HI	4-byte REAL	Upper energy bound of the energy bin (keV)
N_GRP	2-byte INTEGER	Number of channel subsets in the energy bin
F_CHAN	2-byte INTEGER	First channel number of each subset (vector column)
N_CHAN	2-byte INTEGER	Number of channels in each subset (vector column)
MATRIX	4-byte REAL	Response matrix for the energy bin (vector column)

- A keyword, LO_THRES, in the MATRIX extension conveys the response threshold below which it is considered to be zero. Such data are not included in the file to minimize storage requirements.
- The following keywords are relevant in the EBOUNDS extension to identify the file:

```
HDUCLASS= 'OGIP    '
HDUCLAS1= 'RESPONSE'
HDUCLAS2= 'EBOUNDS'
HDUVERS = '1.2.0   '
```

- The EBOUNDS extension contains a binary table with a single column:

Name	Type	Description
CHANNEL	2-byte INTEGER	channel number
E_MIN	4-byte REAL	Lower energy bound of channel
E_MAX	4-byte REAL	Upper energy bound of channel

- Each file is approximately 30 MB uncompressed for 1st order spectra, 14 MB for 2nd order.

6.6.4.2 PRODUCT: RGS FITS whole-field response matrix (WREMAT)

- For each RGS instrument and exposure, a spectral response matrix is created for the whole field.
- This file is an approximation to a true response for the whole field and should not be used for detailed scientific analysis.
- These files are identified using the keyword,

```
CONTENT = 'RGS WHOLE FIELD RESPONSE MATRIX' / Contents of file
```

- This is a product of class RGSEXP.

- Each file contains 3 extensions: A primary header (with NULL image), a MATRIX extension and an EBOUNDS extension.
- The following keywords are relevant in the MATRIX extension to identify the file:

```
HDUCLASS = 'OGIP    '
HDUCLAS1 = 'RESPONSE'
HDUCLAS2 = 'RSP_MATRIX'          / TOTAL response
HDUCLAS3 = 'FULL    '            / all effects included
HDUVERS  = '1.3.0   '
```

- The MATRIX extension contains a binary table (one row per channel) with the following columns:

Name	Type	Description
ENERG_LO	4-byte REAL	Lower energy bound of the energy bin (keV)
ENERG_HI	4-byte REAL	Upper energy bound of the energy bin (keV)
N_GRP	2-byte INTEGER	Number of channel subsets in the energy bin
F_CHAN	2-byte INTEGER	First channel number of each subset (vector column)
N_CHAN	2-byte INTEGER	Number of channels in each subset (vector column)
MATRIX	4-byte REAL	Response matrix for the energy bin (vector column)

- A keyword, LO_THRES, in the MATRIX extension conveys the response threshold below which it is considered to be zero. Such data are not included in the file to minimize storage requirements.
- In the MATRIX extension for whole-field response file, the N_GRP column values are zero and the F_CHAN,N_CHAN and MATRIX columns are empty.
- The following keywords are relevant in the EBOUNDS extension to identify the file:

```
HDUCLASS = 'OGIP    '
HDUCLAS1 = 'RESPONSE'
HDUCLAS2 = 'EBOUNDS'
HDUVERS  = '1.2.0   '
```

- The EBOUNDS extension contains a binary table with a single column:

Name	Type	Description
CHANNEL	2-byte INTEGER	channel number
E_MIN	4-byte REAL	Lower energy bound of channel
E_MAX	4-byte REAL	Upper energy bound of channel

- Each file is approximately 30 MB uncompressed for 1st order spectra, 14 MB for 2nd order.

6.6.5 RGS source timeseries products

This section describes the RGS timeseries data products generated for individual sources in pointed observations.

6.6.5.1 PRODUCT: RGS FITS background-subtracted source timeseries (SRCTSR)

- For sources for which spectra are extracted, background-subtracted timeseries are also generated.
- A source time-series is accumulated by use of a set of spatial filters defined in the RGS source list (see section 6.6.6.2).
- A source time-series file contains the exposure corrected, background subtracted intensity and associated error of the RGS source and the fraction of effective exposure time of each time bin. In the case of data taken in RGS Small Window mode, background subtraction is not performed.
- A separate background timeseries FITs file is created (see 6.6.5.3).
- The time-series follow a regular binning scheme (i.e. equispaced time bins) and is currently fixed at 1000s.
- The data are extracted from both orders and over the full energy range (4-40 Å).
- In accordance with FITS conventions, gaps in the time-series are denoted by inserting the IEEE NaN constant in the relevant time bin.
- Source time-series are delivered in FITS format.
- These files are science products which may be used in further data analysis.
- These files are identified using the keyword,

  ```
  CONTENT = 'RGS SOURCE TIMESERIES'
  ```

  in the primary header.
- This is a product of class RGSSRC.
- The OGIP filetype are defined by the keywords,

  ```
  HDUCLASS= 'OGIP'                / Format conforms to OGIP/GSFC conventions
  HDUCLAS1= 'LIGHTCURVE'          / File contains a time-series
  HDUCLAS2= 'NET '                / Background subtracted
  HDUCLAS3= 'RATE'                / data are in the form of counts per sec.
  ```

  in the header of the RATE extension.
- The RATE extension is a binary table with the following columns:

Name	Type	Description
TIME	8-byte REAL	Time since reference time (s)
RATE	8-byte REAL	Net count rate (count/s)
ERROR	8-byte REAL	Net count rate error (count/s)
COUNTS	8-byte REAL	Total Counts
ERRCTS	8-byte REAL	Error on counts
FRACEXP	8-byte REAL	Fractional effective exposure in time bin

- A timeseries is made for each source in the RGS source list, for each RGS instrument and for each exposure.
- A typical time-series file is approximately 64 KB uncompressed.

6.6.5.2 PRODUCT: RGS PDF background-subtracted source timeseries (STSPLT)

- This product is produced from the FITS format source time series. The background subtracted source time series and background time series are plotted, along with the GTI intervals and the fractional exposure values.
- The data from the FITS timeseries may be further binned to provide good signal-to-noise in each data point and to ensure the plotted points are clearly displayed.
- This is a preview product suitable for use in an online browser.
- This is a product of class RGSSRC.
- The product is supplied in PDF format.
- There is one file per selected source per exposure. Each file is typically 50 KB.

6.6.5.3 PRODUCT: RGS FITS source background timeseries (SRBTSR)

- A background timeseries is accumulated by use of a set of spatial filters defined in the RGS source list (see section 6.6.6.2) It is not created for RGS in Small Window mode.
- This file is associated with a source timeseries file (see 6.6.5.1)
- The time-series follow a regular binning scheme (i.e. equispaced time bins) and is currently fixed at 1000s.
- The data are extracted from both orders and over the full energy range (4-40 Å).
- In accordance with FITS conventions, gaps in the time-series are denoted by inserting the IEEE NaN constant in the relevant time bin.
- Background time-series are delivered in FITS format.
- These files are science products which may be used in further data analysis.
- These files are identified using the keyword,

```
CONTENT = 'RGS SOURCE BACKGROUND TIMESERIES'
```

in the primary header.

- This is a product of class RGSSRC.
- The OGIP filetype are defined by the keywords,

```
HDUCLASS= 'OGIP'                / Format conforms to OGIP/GSFC conventions
HDUCLAS1= 'LIGHTCURVE'          / File contains a timeseries
HDUCLAS2= 'TOTAL '              / File contains gross rates
HDUCLAS3= 'RATE'                / data are in the form of counts per sec.
```

in the header of the RATE extension.

- The RATE extension is a binary table with the following columns:

Name	Type	Description
TIME	8-byte REAL	Time since reference time (s)
RATE	8-byte REAL	Count rate (count/s)
ERROR	8-byte REAL	Count rate error (count/s)
COUNTS	8-byte REAL	Counts
ERRCTS	8-byte REAL	Error on counts
FRACEXP	8-byte REAL	Fractional effective exposure in time bin

- A timeseries is made for each source in the RGS source list, for each RGS instrument and for each exposure, except for RGS Small Window mode.
- A typical time-series file is approximately 64 kB uncompressed.

6.6.6 RGS event list, background timeseries, source list & cross-dispersion histogram products

6.6.6.1 PRODUCT: RGS FITS event list (EVENLI)

- For each RGS detector there is a single file containing filtered events from all CCDs.
- The structure of the FITS file is:

1. Primary header with null primary array.
2. A binary table extension containing event data (EXTNAME='EVENTS').
3. Per CCD (m =1-9) a standard GTI extension (STDGTI0m).
4. Per CCD (m) and per CCD readout node (n=0-1), a bad pixel extension (BADPIXnm).
5. Per CCD (m) and per CCD readout node (n), a rejected pixel extension (REJPIXnm).
6. Per CCD (m) an exposure extension (EXPOSU0m).
7. Per CCD (m) and per readout node (n), an exposure map extension EXPMAPnm.

- These files are identified using the keyword,

  `CONTENT = 'RGS EVENT LIST'`

  in the primary header.

- This is a product of class `RGSEXP`.

- The `EVENTS` extension comprises a binary table extension with the following columns:

Name	Type	Description
`TIME`	8-byte REAL	Frame timestamp
`FLAG`	4-byte INTEGER	Event attribute flags
`BETA`	4-byte REAL	Uncorrected dispersion angle
`XDSP`	4-byte REAL	Uncorrected cross-dispersion angle
`CHIPX`	2-byte INTEGER	Chip X coordinate (pixel)
`CHIPY`	2-byte INTEGER	Chip Y coordinate (pixel)
`PHA`	2-byte INTEGER	Total telemetered energy
`SHAPE`	BYTE	Event shape identifier
`GRADE`	BYTE	Total number of pixels
`PI`	2-byte INTEGER	Total corrected CCD event energy
`CCDNR`	BYTE	CCD ID number
`BETA_CORR`	4-byte REAL	Attitude corrected dispersion angle (radians)
`XDSP_CORR`	4-byte REAL	Attitude corrected cross-disp angle (radians)
`M_LAMBDA`	4-byte REAL	Wavelength spectral-order product
`BETA_CHANNEL`	2-byte INTEGER	BETA_CORR channel
`MLAMBDA_CHANNEL`	2-byte INTEGER	M_LAMBDA channel
`XDSP_CHANNEL`	2-byte INTEGER	XDISP_CORR channel

- Event times are specified in seconds after a reference time specified in a header keyword (`MJDREF`).

- The `STDGTI0m` extension comprises a binary table extension with the following columns:

Name	Type	Description
`START`	8-byte REAL	GTI start time (s) since reference epoch
`STOP`	8-byte REAL	GTI end time (s) since reference epoch

- The `BADPIXnm` extension contains a binary table extension with the following columns:

Name	Type	Description
`CHIPX`	2-byte INTEGER	Chip X coordinate (pixel)
`CHIPY`	2-byte INTEGER	Chip Y coordinate (pixel)
`YEXTENT`	2-byte INTEGER	Extent of badness in Y (pixel)
`TYPE`	2-byte INTEGER	Type of badness
`BADFLAG`	2-byte INTEGER	Data source flag

- The REJPIXnm extension contains a binary table extension with the following columns:

Name	Type	Description
FRAME	4-byte INTEGER	Frame identifier
FLAG	4-byte INTEGER	Event attribute flags
CHIPX	2-byte INTEGER	Chip X coordinate (pixel)
CHIPY	2-byte INTEGER	Chip Y coordinate (pixel)

- The EXPOSU0m extension contains a binary table extension with the following columns:

Name	Type	Description
FRAME	4-byte INTEGER	Frame identifier
NLOSTEVT	2-byte INTEGER	Number of lost events in frame
ABORTFLG	2-byte INTEGER	Abort frame flag
FLAG	4-byte INTEGER	Frame attributes
TIMEDEL	4-byte REAL	Frame integration time (s)
TIME	8-byte REAL	Seconds since MJDREF
FRACEXP0	4-byte REAL	Exposure fraction node 0
FRACEXP1	4-byte REAL	Exposure fraction node 1
ASPCDSP	4-byte REAL	Aspect correction applied to BETA (radians)
ASPCXDSP	4-byte REAL	Aspect correction applied to XDSP (radians)

- The EXPMAPnm extension is an image extension containing the exposure map for CCD m, node n.
- This is a science product suitable for use in further data analysis.
- There will be a single event file per exposure. The event lists will typically be 10 MB uncompressed

6.6.6.2 PRODUCT: RGS FITS source list (SRCLI_)

- This product lists bright sources detected by EPIC which fall in the RGS field of view. It also includes the entries for the proposal position and the on-axis location. EPIC and RGS positions are given, as well as RGS spatial and energy-dispersion angle extraction regions for the sources and a background region.
- These files are identified using the keyword,

  ```
  CONTENT = 'RGS SOURCE LIST' / File content
  ```

  in the primary header.
- There are two binary table extensions (SRCLIST and RGSn_BACKGROUND), plus a further three binary table extensions per source (RGSn_SRCm_SPATIAL, RGSn_SRCm_ORDER_1 and RGSn_SRCm_ORDER_2, where n is the number of the RGS (1 or 2) and m is the number of the source.
- The SRCLIST extension has the following columns:

Name	Type	Description
INDEX	2-byte INTEGER	Source index number starting from 1
LABEL	CHARACTER string	Label for the source (e.g. proposal/on-axis/epic)
RA	4-byte REAL	Right Ascension (degrees)
DEC	4-byte REAL	Declination (degrees)
RATE	4-byte REAL	Counts per sec from PEIC source list
DELTA_DISP	4-byte REAL	Offset from pointing: dispersion direction.
DELTA_XDSP	4-byte REAL	ffset from pointing: cross-dispersion direction
FOV_PHI	4-byte REAL	Polar coord of source in FOV
FOV_R	4-byte REAL	Polar coord of source in FOV
CONFUSION	4-byte REAL	'Fraction giving a measure of the confusion between each source and the prime source
PROCESS	LOGICAL	True means a spectrum extraction region should be constructed for this source
BKG_EXCLUDE	LOGICAL	True means this source should be excluded from the background spectrum extraction region
FIXED_ON_SKY	LOGICAL	True for sources whose positions were initially entered as ra and dec
EPIC_FILE	4-byte INTEGER	Key to identify the appropriate EPICFILEn and EPICBANDn attributes
FLAG	4-byte INTEGER	Quality flag

- A keyword in the extension header, PRIMESRC, conveys the source number considered as the prime object for extraction
- The RGSn_BACKGROUND extension contains a region specification for an uncontaminated background region.
- The following keywords are relevant to the RGSn_BACKGROUND extension,

```
HDUCLASS = 'ASC     '
HDUCLAS1 = 'REGION  '
HDUCLAS2 = 'STANDARD'
```

- The RGSn_BACKGROUND extension has the following columns:

Name	Type	Description
SHAPE	CHARACTER string	(e.g. polygon)
LAMBDA	4-byte REAL vector	Wavelength spectral-order product (Å)
XDSP_CORR	4-byte REAL vector	Attitude-corrected cross-dispersion angle (rad)
COMPONENT	BYTE	Polygon parameter, usually one per CCD (but can be more)

- The component identifier indicates component parts of the whole selection region. For example, a selection region that spans multiple CCDs will have at least one different component number for each CCD covered.
- The structure of the three binary table extensions created per source (RGSn_SRCm_SPATIAL, RGSn_SRCm_ORDER_1 and RGSn_SRCm_ORDER_2) are almost identical.

- These extensions are ASC region specifications for source number m. Respectively, they are the spatial (dispersion vs cross-dispersion), order 1 (energy vs dispersion) and order 2 (energy vs dispersion) extraction regions.
- The HDUCLASn keyword set is the same as for the RGSn_BACKGROUND extension.
- These extensions have the following columns:

Name	Type	Description
SHAPE	CHARACTER string	(e.g. polygon)
LAMBDA	4-byte REAL vector	Wavelength spectral-order product (Å)
PI	4-byte REAL vector	Total corrected CCD event energy
COMPONENT	BYTE	Component number to which shape belongs

- For the RGSn_SRCm_SPATIAL extension, the PI column is replaced by a XDSP_CORR column.
- This is a product of class RGSEXP.
- This is a science product suitable for use in further data analysis.
- There is one FITS file per source exposure. Each file is, on average, approximately 50 KB uncompressed.

6.6.6.3 PRODUCT: RGS FITS flare background timeseries (FBKTSR)

- For each RGS detector a flare background timeseries file is produced. This is made from events in a designated background area measured from CCD9.
- The structure of the FITS file is:
- Primary header with null primary array.
- A binary table extension containing the timeseries (EXTNAME='RATE').
- These files are identified using the keyword,

  CONTENT = 'RGS FLARE BACKGROUND TIMESERIES'

  in the primary header.
- This is a product of class RGSEXP.
- The RATE extension comprises a binary table with the following columns:

Name	Type	Description
TIME	8-byte REAL	Frame timestamp
RATE	8-byte REAL	
ERROR	8-byte REAL	

- Timestamps are specified in seconds after a reference time specified in a header keyword (MJDREF).
- There is one FITS file per exposure. Each file is typically 25 KB uncompressed.

6.6.6.4 PRODUCT: RGS FITS cross-dispersion histogram (DSPHIS)

- For each RGS detector and extracted source, a histogram is made in the cross-dispersion direction. It is restricted to the extraction region of the specific source.
- The structure of the FITS file is:
- Primary header with null primary array.
- A binary table extension containing the histogram (EXTNAME='HISTO')
- A binary table extension containing the region from which the histogram was extracted (EXTNAME='RGSn_SRCm_ORDER_1') for RGS instrument n and source m.
- These files are identified using the keyword,

  CONTENT = 'RGS CROSS-DISPERSION HISTOGRAM'

  in the primary header.
- This is a product of class RGSSRC.
- The HISTO extension contains a binary table with the following columns:

Name	Type	Description
XDSP_CORR	8-byte REAL	Attitude corrected cross-disp angle (radians)
COUNTS	8-byte REAL	Counts in this cross-dispersion bin

- The following keywords are relevant to the RGSn_SRCm_ORDER_1 extension,

```
HDUCLASS = 'ASC     '
HDUCLAS1 = 'REGION  '
HDUCLAS2 = 'STANDARD'
```

- The RGSn_SRCm_ORDER_1 extension contains a binary table with the following columns:

Name	Type	Description
SHAPE	CHARACTER string	(e.g. polygon)
BETA_CORR	4-byte REAL vector	Attitude corrected dispersion angle (radians)
PI	4-byte REAL vector	Total corrected CCD event energy
COMPONENT	BYTE	Component number to which shape belongs

- There is one FITS file per exposure per source. Each file is typically 20 KB uncompressed.

6.6.7 RGS PPS summary products

6.6.7.1 PRODUCT: RGS HTML summary page (SUMMAR)

- A summary of all RGS products is provided in HTML.
- The graphics products are viewable using these HTML pages.
- This is a product of class RGSOBS.
- There is 1 file per observation. On average, the file size is about 21 KB.

6.7 Catalogue and Archive Products

6.7.1 Introduction

This section describes the content and format of PPS data products created by the cross-correlation of EPIC source positions with archival data. Archival material includes both catalogues of objects and sky pixels. There is no cross-correlation of OM sources in the PPS. Also, at present, source detection is not performed on slew observation data, so no catalogue cross-correlation products are generated for slew observations.

6.7.2 The cross-correlation process

Two distinct cross-correlation processes are used in the pipeline for different purposes. In the first, raw EPIC source positions are correlated against an astrometric catalogue with a large number of stellar entries. The purpose is to provide a measure of, and correct where possible, any residual offset and rotation of the observation (spacecraft) frame with respect to an absolute astrometric frame defined by the reference catalogue. This may not always be possible, especially in crowded or complex fields. The second usage correlates EPIC source positions (ideally corrected by the first procedure) against a large collection of archival data (catalogues and pixel data) to make the bulk of the source-specific cross-correlation products. The objective here is to provide lists of potential astrophysical counterparts for each EPIC-detected object from a range of multiwavelength archival material. This stage is performed remotely for the PPS by the Archival Catalogue and Database Subsystem (ACDS) at the Observatoire Astronomique de Strasbourg (OAS). All FITS cross-correlation products specify whether corrected or uncorrected EPIC source positions were used.

The latter cross-correlation process answers two distinct questions: 1) Is there an object in the error circle which could be the counterpart of the X-ray source? 2) Are there objects which could have been detected by EPIC but were not?

For the purpose of visual inspection and/or follow-up observations, optical images (finding charts) of the area of sky around EPIC sources are also provided.

6.7.2.1 Search around raw EPIC positions: for rectification

The raw EPIC source positions are correlated against subsets of objects within the XMM-Newton field of view, extracted from large astrometric reference catalogues; currently the catalogues used are i) the USNO B1 catalogue, ii) the 2MASS catalogue and iii) the SDSS (DR9) catalogue and the object subsets from each are stored in a PPS product (see 6.3.4). The EPIC source position offsets from counterparts in whichever of the above mentioned catalogues yields the 'best' results, are then used to derive field-level coordinate corrections (average offsets in RA, DEC and position angle) which are then applied to the positions of all the EPIC sources. These corrected EPIC source positions are subsequently used in making the other source-specific cross-correlation products.

6.7.2.2 Search around EPIC positions: for identifications

The number of catalogues systematically searched for positional coincidence with each EPIC source is of the order of two hundred and changes with time as new catalogues become available. Potential counterparts of each XMM-Newton source are listed out to a maximum separation of

3.4σ (99.73% confidence) where σ is a quadratic combination of the positional uncertainties of the XMM-Newton and catalogue objects. Assuming a 1σ position error of 5 arcsec, and a search radius of about 17 arcsec implies a search area of 0.25 arcmin^2 per source or $\sim$18 arcmin^2 for a typical 70 sources per EPIC observation. This is less than 3% of the total nominal EPIC FOV.

The PPS products provide, for each EPIC source, the list of entries contained in the catalogues scanned, together with their measurements, sorted by increasing distance to the best X-ray position up to a given confidence radius.

6.7.2.3 Search in the whole EPIC field of view

Considering the larger area involved, the number of catalogues queried for the whole EPIC field of view has to be restricted to those containing the highest level of information on the astronomical content of the EPIC field of view and those containing known X-ray sources. The minimum set of catalogues for which a whole field search is performed comprises major X-ray catalogues (including ROSAT all-sky survey and pointings), SIMBAD and NED.

The corresponding PPS products consist of a list of all entries (summary and all catalogue measurements) together with some graphical representation of their location on the sky. Catalogued X-ray sources not detected by EPIC are highlighted.

6.7.3 Format of the PPS cross-correlation products

The need to provide both human and machine readable information implies the delivery of products in different formats as no one format readily fulfills both requirements. FITS is considered the best machine readable format for most tables and image cross-correlation data products. Graphical products are provided in PDF format. For products which need to be human readable, the PPS provides data mainly in HTML format as the simplest way to organize rather complex information into an easily browsable structure.

6.7.4 General cross-correlation products

These PPS cross-correlation products list the names of all catalogues searched (both around each EPIC position and in the whole EPIC field) and describe the format of their output.

6.7.4.1 PRODUCT: HTML main cross-correlation page (`XCORRE`)

- This HTML product is a front page to the other cross-correlation HTML and graphics pages, providing links to these products.
- There is one file per observation.
- This is a product of class `CATOBS`.
- File size: typically 5 KB.

6.7.4.2 PRODUCT: FITS searched catalogues page (`SRCHD_`)

- This FITS product is a summary of all catalogues searched.
  The extension name will be `EXTNAME` = '`SRCHD_`'.
  This product will be identified by the FITS header keyword,

CONTENT = 'SEARCHED CATALOGUES'

- The SRCHD_ extension contains a binary table with the following columns:

Name	Type	Description
CAT_TITLE	CHARACTER	full catalogue title
FOV	CHARACTER	F for FOV and Source checked
ACRONYM	CHARACTER	Catalogue acronym
CATID	CHARACTER	Identifier label (xxxxa)
N_IN_FOV	4-byte INTEGER	Sources in FOV from this catalogue
N_MATCH	4-byte INTEGER	Number with matches to XMM sources
COLNAME1	CHARACTER	Entry name (first choice)
COLNAME2	CHARACTER	Entry name (second choice)
FSTAT	4-byte REAL	Error scale used in catalogue
TAB_DESCR	CHARACTER	

- This is a product of class CATOBS.
- There is one file per observation.
- File size: typically 45 KB.

6.7.4.3 PRODUCT: HTML searched catalogues page (SRCHD_)

- This HTML product is a summary of all catalogues searched.
- A character flag (F) at the beginning of each line will indicate if the catalogue was also searched in the whole EPIC field of view.
- There is one file per observation.
- This is a product of class CATOBS.
- File size: typically 35 KB.

6.7.4.4 PRODUCT: HTML catalogue description pages (Dxxxxa)

- A detailed description is only made for those catalogues having a match in the current observation.
- Each catalogue has a numerical/character xxxxa identifier embedded in the file name, following the D character. The character, a will be T if relating to results drawn from a table or A, B, C, etc, for real catalogue numbers.
- A comprehensive description of the content of each column/measurement and notes is required for easy reading. The catalogue description and format is an HTML version of the human readable ASCII standard catalogue description.
- This product contains the main catalogue title, general description, date, file summary, byte-by-byte description of the file, notes, history, etc.
- This HTML product may contain external URLs.

- There is one file per matching catalogue in the observation.
- This is a product of class `CATCAT`.
- File size: average is $\sim$ 20 KB.

6.7.5 Cross-correlation products associated with EPIC source detections

6.7.5.1 PRODUCT: FITS EPIC source cross-correlation results (`Sxxxxa`)

- This product gathers, in a single file, all entries in a searched catalogue which match raw EPIC source positions.
- Each file relates to a specific catalogue and has a numerical/character `xxxxa` identifier embedded in the file name, following the `S` character.
- The FITS file contains a binary table extension. The format of this table will depend on the catalogue from which the data are drawn, and so is not specified here.
- The extension name is `EXTNAME` = 'SRCRES'.
- This products is identified by the FITS header keyword,

  `CONTENT = 'EPIC SOURCE CROSS-CORRELATION RESULTS'`

- This is a product of class `CATOBS`.
- There is one file per observation (relating to a single catalogue). The size is typically 45 KB.

6.7.5.2 PRODUCT: HTML EPIC sources cross-correlation results (`SRCRES`)

- This is a HTML product which gathers together, in one file, the results from the separate FITS EPIC source cross-correlation results files.
- The basic layout of the HTML page is that of CDS Vizier extractions, i.e. each catalogue block contains a first line of description followed by catalogues measurements. Each row corresponds to an XMM-Newton source.
- Each row contains: The XMM-Newton source number and finding chart (both are URL links), the catalogue object name, followed by various catalogue measurements.
- URLs:
  - Catalogue name to catalogue descriptions.
  - Column labels to specific explanations in catalogue descriptions.
  - EPIC source number to EPIC summary.
  - Textual link to finding charts.
- There is one file per observation.
- This is a product of class `CATOBS`.
- File size: average $\sim$450 KB.

6.7.5.3 PRODUCT: HTML EPIC source cross-correlation summary (SRCSUM)

- This product presents an overview of the cross-correlation results of each EPIC source.
- For each EPIC source, a summary of the X-ray data, including position, 1 sigma error radius, count rate , extent information and a selection of hardness ratios, is provided.
- The EPIC source summary is followed by the group of all entries found in the catalogues searched, sorted by increasing distance to the best EPIC position.
- For each catalogue entry matching the EPIC position, information is presented on: catalogue name, full entry name, position, error on entry position, distance to EPIC position, a 'standard' catalogue measurement (e.g. V magnitude) in two columns, nature and value and the object entry number in the catalogue.
- URLs:
  - EPIC source number to EPIC summary.
  - Catalogue name to catalogue descriptions.
  - Catalogue entry name to HTML EPIC source catalogue measurement.
  - SIMBAD name to ASU formatted real time query (external URL).
  - Textual link to finding charts.
- There is one file per observation.
- This is a product of class CATOBS.
- The file size is ∼290 KB.

6.7.5.4 PRODUCT: FITS EPIC source cross-correlation summary (SRCSUM)

- This summary product holds an overview of the cross-correlation results.
- It is similar in content to the product HTML EPIC source cross-correlation summary, but does not contain URLs nor the detailed EPIC information.
- This product is identified by the FITS header keyword,

  ```
  CONTENT = 'EPIC SOURCE CROSS-CORRELATION SUMMARY'
  ```

- The file is FITS format.
- The table extension is SRCSUM. This contains a binary table with the following columns:

Name	Type	Description
SRC_NUM	4-byte INTEGER	Source number
RA	8-byte REAL	Source right ascension (deg)
DEC	8-byte REAL	Source declination (deg)
RADEC_ERR	4-byte REAL	Source 1σ position error (arcsec)
CAT_NAME	CHARACTER string	Catalogue name
CAT_ENTRY	CHARACTER string	Full entry name
CAT_RA	8-byte REAL	Entry right ascension (deg)
CAT_DEC	8-byte REAL	Entry declination (deg)
CAT_RADEC_ERR	4-byte REAL	1σ position error (arcsec) on entry
D_EPIC_CAT	4-byte REAL	Distance to EPIC position (arcsec)
CAT_MEAS	CHARACTER string	Catalogue measurement description
CAT_VAL	8-byte REAL	Catalogue measurement value
CAT_NUM	4-byte INTEGER	Unique catalogue entry number

- There is one file per observation.
- This is a product of class CATOBS.
- The file size will be approx. 120 KB uncompressed.

6.7.5.5 PRODUCT: PDF finding chart (FCHART)

Finding charts (i.e. optical images of small areas of the sky) are a valuable scientific add-on to the XMM-Newton PPS products. This is because one can not be completely confident that the systematic object search and extraction processes by which catalogues are made do not miss objects which are faint, extended or have complex shapes. The finding chart can also give clues to the complexity of the field near a source.

- While the provision of small finding charts (a few arcminutes centred on each EPIC source) is less efficient than the provision of 1 large file, the more direct applicability and smaller individual size of such files is the main motive behind their provision.
- 2×2 arcminute finding charts with 0.75 arcsecond pixels are provided for each EPIC source.
- The finding chart is a grey-scale image.
- The file is supplied in PDF format.
- EPIC flux contours or source position error circles are overlaid on the sky image.
- The image legend shows the PI, target, observation ID and source number, XMM-Newton coordinates, image centre coordinates and plate details and the 90% confidence X-ray error circle size. Orientation axes (N, E) are shown on the image.
- This is a product of class CATSRC.
- There is one chart per EPIC source.
- File size is equal to 125 KB.

6.7.6 Cross-correlation products associated with the whole EPIC field of view

6.7.6.1 PRODUCT: FITS EPIC field of view cross-correlation results (Fxxxxa)

- These FITS products gather together all the catalogue sources in the EPIC FOV from a subset of the catalogues.
- The data from each catalogue are provided in separate, catalogue-specific files, i.e. there is one file per catalogue.
- These files are identified using the keyword,

  `CONTENT = 'EPIC FOV CROSS-CORRELATION RESULTS'`

  in the primary header.
- The extension name is `EXTNAME` = '`FOVRES`'.
- There is one file per observation per catalogue from the subset used.
- This is a product of class `CATCAT`.
- File size: average ∼55 KB uncompressed.

6.7.6.2 PRODUCT: HTML EPIC field of view cross-correlation results (FOVRES)

- This single file product is an HTML representation of the information contained in the separate catalogue-specific FITS field of view cross-correlation results files.
- The basic layout of the HTML page is that of CDS Vizier extractions, i.e. each catalogue block contains a first line of description followed by catalogues measurements.
- Possibly matching EPIC source numbers are in the first column.
- URLs:
  - Catalogue name to detailed catalogue descriptions.
  - Column labels to specific explanations in catalogue descriptions.
  - EPIC source number to EPIC summary (in case of EPIC source match).
  - Textual link to finding charts (in case of EPIC source match).
- There is one file per observation.
- This is a product of class `CATCAT`.
- File size: average, ∼100 KB.

6.7.6.3 PRODUCT: HTML EPIC field of view summary (FOVSUM)

- This is a summary product listing all SIMBAD and X-ray catalogued objects present in the EPIC field of view, independently of their detection in X-rays in the current observation.
- The catalogues considered in this case are a subset of those searched around each EPIC source.
- Catalogue entries are sorted by right ascension.
- This product allows the astronomer to get an overview of the astronomical content of the EPIC field. It is also a means to find previously known X-ray sources which are not detected in the XMM-Newton observation.
- For each catalogue entry with a position in the EPIC field of view the page lists the: catalogue name, full entry name, position, error on entry position, a 'standard' catalogue measurement (e.g. V magnitude in two columns; nature and value) and when possible the number of a matching EPIC source.
- URLs:
  - Catalogue name to catalogue descriptions.
  - Entry name to HTML EPIC field of view catalogue measurement.
  - SIMBAD name to ASU real time query (external URL).
  - Where applicable, EPIC source number to EPIC summary.
- There is one file per observation.
- This is a product of class CATOBS.
- File size: averages ∼60 KB.

6.7.6.4 PRODUCT: FITS EPIC field of view summary (FOVSUM)

- This product contains similar information to that in the product HTML EPIC field of view summary, but in machine readable FITS format.
- These files are identified using the keyword,

  CONTENT = 'EPIC FOV CROSS-CORRELATION SUMMARY'

  in the primary header.
- The extension name is EXTNAME = 'FOVSUM'.
- The binary table of the FITS file contains the following columns:

Name	Type	Description
SRC_NUM	4-byte INTEGER	Source number
CAT_NAME	20-byte Character string	Catalogue name
CAT_ENTRY	30-byte Character string	Full entry name
CAT_RA	8-byte REAL	Source right ascension(deg)
CAT_DEC	8-byte REAL	Source declination (deg)
CAT_RADEC_ERR	4-byte REAL	1 sigma catalogue posn error (arcsec)
CAT_MEAS	10-byte Character string	Catalogue measurement description
CAT_VAL	8-byte REAL	Catalogue measurement value
CAT_NUM	4-byte INTEGER	Unique catalogue entry number

- There is one file per observation.
- This is a product of class CATOBS.
- File size: average 115 KB uncompressed.

6.7.6.5 PRODUCT: PDF EPIC catalogue plot (CATPLT)

- This is a graphic representation of whole field of view catalogue extractions overlaid on the EPIC image. It is intended to allow a good visualization of the content of the EPIC full field of view measurements product.
- The image legend shows the PI, target, observation ID, XMM-Newton image centre coordinates and EPIC instrument exposure times. A coordinate grid is overlaid.
- There is one PDF format file per observation.
- This is a product of class CATOBS.
- File size: average 270 KB.

6.7.6.6 PRODUCT: PDF XMM-Rosat image (ROSIMG)

- This product provides a graphic comparison between the EPIC and ROSAT images in order to better assess potential non-detected X-ray sources and large scale extended sources.
- EPIC source positions and flux contours are overlaid on a ROSAT image.
- The image legend shows the PI, target, observation ID, XMM-Newton image centre coordinates and EPIC instrument exposure times. It also indicate the contour levels plotted and provides basic information on the Rosat image.
- There is one PDF file per observation.
- This is a product of class CATOBS.
- File size: average 275 KB.

6.8 PPS Run Products

6.8.1 PRODUCT: ASCII PPS script log (SCRLOG)

- This file contains the log of the PPS run, i.e. every executable invocation are listed, together with important output information (e.g. error messages).
- Non-executable lines are prefixed by #.
- This file identifies the version(s) of each PPS task module used in the processing of the data, including the version(s) of the PPS control software.
- It lists the date and time of pipeline execution.
- It contains the parameter file data used by PPS tasks during the PPS run.
- This product is of class PPSOBS.
- This product is delivered in ASCII format.
- There will be one file per observation. File size will be ∼15 MB.

6.8.2 PRODUCT: ASCII PPS run message (PPSMSG)

- This file contains a text description of the PPS run. It acts as the basis for an e-mail message to be sent to the proposing observer when the PPS products are accepted into the XMM-Newton archive.
- This is the one product that is not included in a product group.
- This product is of class PPSOBS.
- This product is delivered in ASCII format.
- There is one file per PPS run. File size is typically ∼23 KB. Files generated for ODFs during a bulk reprocessing may contained specific lists of the calibration files used in that reprocessing in which case the PPS run message file is larger (∼54 KB). The file also contains, appended to the end, the summary screening report generated from manual screening by SSC staff.

6.8.3 PRODUCT: HTML PPS run summary (PPSSUM)

- This file acts as a home page for the products created in the PPS run. It provides links to the top level pages of the various types of products (e.g. OM HTML summary page).
- This product is of class PPSOBS.
- This product is delivered in HTML format.
- There is one file per PPS run. File size is, on average, 15 KB.

6.8.4 PRODUCT: HTML PPS index

- PPS HTML index files include links, with brief explanations, to every file within the product group in which they sit (see section 8). There are no links to files external to the product group.
- The names of these files begin with the string `PP`.
- The product is delivered in HTML format.
- This is the only PPS product not listed in the PPS product index product. It thus does not have a product class.
- There is one file per product group. For a product group with 49 data products the file size will be ∼6 KB.

6.8.5 PRODUCT: PPS FITS product index (`PINDEX`)

- The PPS product index lists every product created in the pipeline analysis of the observation (including itself, but excluding the PPS HTML index files, the PPS script log and PPS messages).
- The product is delivered in FITS format.
- There is one FITS extension per product class (see section below). Each contains a binary table listing all the PPS products which fall in that class. The extension names are those of the product classes. The names and formats of the data columns vary from class to class. Extensions may be absent if no products of the relevant class have been produced.
- In each class extension there is one row per product. The columns list database keyword values associated with the product.
- There is one additional extension, named `INSTSUMM`, which gives brief details of the structure of the observation (eg number of exposures in each instrument). This extension has one row per instrument, ie 6 rows.
- This file is identified using the keyword,

  ```
  CONTENT = 'PPS PRODUCT INDEX'
  ```

  in the primary header.
- This product is of class `PPSOBS`.
- There is one file per observation. File size is typically ∼350 KB uncompressed. This is the only fits file that is delivered in uncompressed form.
- The data products are divided into the following product classes:

Product class	*Product description* Product name
CATCAT	*Catalogue products at the catalogue level* HTML Catalogue descriptions FITS EPIC field-of-view cross-correlation results HTML EPIC field-of-view cross-correlation results
CATOBS	*Catalogue (cross-correlation) products at the observation level* HTML Searched catalogues FITS Searched catalogues HTML EPIC source cross-correlation summary FITS EPIC source cross-correlation summary HTML EPIC source cross-correlation results FITS EPIC source cross-correlation results HTML Main cross-correlation page HTML EPIC field-of-view summary FITS EPIC field-of-view summary PDF catalogue plot PDF XMM-ROSAT image
CATSRC	*Catalogue products at the individual source level* Finding chart
EPICEXP	*EPIC products at the exposure level* EPIC MOS/pn FITS image (pointed and slew) EPIC MOS/pn FITS unfiltered image (*slew only*) EPIC MOS/pn PNG image EPIC MOS/pn FITS exposure map (pointed and slew) EPIC MOS/pn PNG exposure map EPIC MOS/pn FITS global background time-series EPIC MOS/pn PDF global background time-series EPIC MOS/pn IMAGING mode event list (pointed and slew) EPIC TIMING mode event list
EPICOBS	*EPIC products at the observation level* EPIC MOS/pn FITS exposure-merged detector mask EPIC MOS/pn FITS exposure-merged background map EPIC MOS/pn FITS exposure-merged exposure map EPIC MOS/pn FITS observation image EPIC MOS/pn PNG observation image EPIC MOS/pn FITS observation three colour image EPIC MOS/pn PNG observation three colour image EPIC FITS observation exposure map EPIC PNG observation exposure map EPIC ASC footprint region EPIC FITS observation background map

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Product class	*Product description* Product name
	EPIC PNG observation background map
	EPIC sensitivity map
	EPIC observation box-local source list
	EPIC observation box-map source list
	EPIC observation ml source list
	EPIC FITS summary source list
	EPIC HTML summary source list
EPICSRC	*EPIC products at the individual source level*
	EPIC FITS source time-series
	EPIC PDF source time-series
	EPIC PDF source FFT plot
	EPIC FITS source spectrum
	EPIC FITS source background spectrum
	EPIC FITS source background spectrum
	EPIC FITS source ancillary response file
	EPIC PDF source spectrum plot
	EPIC FITS source combined spectra
	EPIC FITS source background combined spectrum
	EPIC FITS source background pattern0 singles spectrum
	EPIC FITS source background pattern4 spectrum
	EPIC FITS source background patternd doubles spectrum
	EPIC FITS ancillary response combined functions
	EPIC FITS response matrix pattern0 singles function
	EPIC FITS response matrix patternd doubles function
	EPIC FITS response matrix pattern4 function
	EPIC-OM PNG source sed plot
	EPIC ASCII source region
OMEXP	*OM products at the exposure level*
	OM FITS tracking star timeseries
	OM PDF tracking star timeseries
	OM tracking history plot
OMOBS	*OM products at the observation level*
	OM FITS observation source list
	OM FITS observation mosaic image
	OM FITS observation source list mosaic
	OM PNG observation mosaic image
OMSW	*OM products at the OSW level*
	OM OSW FITS sky image
	OM OSW PNG sky image
	OM OSW FITS image
	OM OSW FITS source list
	OM OSW ASCII source regions

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Product class	*Product description* Product name
	OM OSW FITS grism aligned image OM ASCII grism regions OM FITS grism source list OM ASCII grism spectrum region OM FITS grism spectra list OM FITS grism spectrum OM PDF grism spectrum
OMSRC	*OM products at the individual source level* OM OSW FITS source time-series OM OSW PDF source time-series OM FITS source time-series OM PNG source time-series OM PHA Source spectrum OM Response Matrix
RGSEXP	*RGS products at the exposure level* RGS FITS image RGS PNG image RGS FITS energy-dispersion image RGS PNG energy-dispersion image RGS FITS exposure map RGS FITS event list RGS FITS source list RGS FITS background model RGS FITS whole field spectrum RGS PDF whole field spectrum RGS FITS whole field response matrix RGS FITS flare background timeseries
RGSOBS	*RGS products at the observation level* RGS FITS fluxed spectrum RGS PDF fluxed spectrum
RGSSRC	*RGS products at the individual source level* RGS FITS source+background spectrum RGS FITS background spectrum RGS FITS source spectrum RGS PDF source spectrum RGS FITS source response matrix RGS FITS cross-dispersion histogram RGS FITS background-subtracted source timeseries RGS PDF background-subtracted source timeseries RGS FITS source background timeseries
PPSOBS	*Miscellaneous PPS products at the observation level* Calibration index

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Product class	*Product description* Product name
	Attitude time series Reference catalogue SSC logo 1 SSC logo 2 CDS logo 1 CDS logo 2 CDS logo 3 PPS product index

6.8.5.1 CATCAT extension

Column name	Format	Fixed	Rest.Opt	Description
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
CATNAME	CHAR*40			Catalogue name
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.2 CATOBS extension

Column name	Format	Fixed	Rest.Opt	Description
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.3 CATSRC extension

Column name	Format	Fixed	Rest.Opt	Description
OBS_MODE	CHAR*8		Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
PLATE_RA	REAL			Finding chart plate centre RA
PLATE_DEC	REAL			Finding chart plate centre declination
PLATE_FILTER	CHAR*20			Finding chart plate filter
PLATE_ID	CHAR*20			Finding chart plate identifier
PLATE_ORIGIN	CHAR*32			Finding chart plate origin
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.4 EPICEXP extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5		Y	Instrument name
EXP_ID	CHAR*4			Exposure ID within observation
MODE	CHAR*20		Y	Instrument mode
DATAMODE	CHAR*20		Y	Instrument data mode
EP_FILTER	CHAR*16		Y	EPIC filter
OBS_MODE	CHAR*8	Y	Y	Observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
EXP_START	CHAR*24	Y		Date and time of exposure start (UTC)
EXP_STOP	CHAR*24	Y		Date and time of exposure end (UTC)
EXP_DURATION	REAL			Duration of exposure (sec)
BAND	INTEGER			Energy band (0-8, 0=NULL)
EXPOSURE	REAL			Exposure time
SRCDET	LOGICAL			Source detection performed
SSP	LOGICAL			Source specific products made
FLARESCREENED	LOGICAL			Flare screening performed
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

- The tables in the following sections describe the columns for each extension:

6.8.5.5 EPICOBS extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5		Y	Instrument name
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.6 EPICSRC extension

Column name	Format	Fixed	Rest. Opt.	Description
INSTRUMENT	CHAR*5		Y	Instrument name
EXP_ID	CHAR*4			Exposure ID within observation
SRC_NUM	INTEGER			Source number (from observation source list)
BAND	INTEGER			Energy band (0-8, 0=NULL)
MODE	CHAR*20		Y	Instrument mode
DATAMODE	CHAR*20		Y	Instrument data mode
EP_FILTER	CHAR*16		Y	EPIC filter
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
EXP_START	CHAR*24	Y		Date and time of exposure start (UTC)
EXP_STOP	CHAR*24	Y		Date and time of exposure end (UTC)
EXP_DURATION	REAL			Duration of exposure (sec)
RA_OBJ	DOUBLE			RA of source (2000.0)
DEC_OBJ	DOUBLE			Declination of source (2000.0)
RADEC_ERR	REAL			Error on position in arcsecs
LII_OBJ	DOUBLE			Galactic longitude of source
BII_OBJ	DOUBLE			Galactic latitude of source
PN_CTS	REAL			pn counts
PN_CTS_ERR	REAL			error
M1_CTS	REAL			M1 counts
M1_CTS_ERR	REAL			error
M2_CTS	REAL			M2 counts
M2_CTS_ERR	REAL			error
PN_TOT_FLUX	REAL			pn total band flux
PN_TOT_FLUX_ERR	REAL			error

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Column name	Format	Fixed	Rest. Opt.	Description
M1_TOT_FLUX	REAL			M1 total band flux
M1_TOT_FLUX_ERR	REAL			error
M2_TOT_FLUX	REAL			M2 total band flux
M2_TOT_FLUX_ERR	REAL			error
PN_TOT	REAL			pn total band rate
PN_TOT_ERR	REAL			error
M1_TOT	REAL			M1 total band rate
M1_TOT_ERR	REAL			error
M2_TOT	REAL			M2 total band rate
M2_TOT_ERR	REAL			error
EP_TOT	REAL			EPIC total band rate
EP_TOT_ERR	REAL			error
PN_DET_ML	REAL			pn detection likelihood
M1_DET_ML	REAL			M1 detection likelihood
M2_DET_ML	REAL			M2 detection likelihood
EP_DET_ML	REAL			EPIC detection likelihood
EP_EXTENT	REAL			extent
EP_EXTENT_ERR	REAL			error
PN_ONTIME	REAL			pn ontime
M1_ONTIME	REAL			M1 ontime
M2_ONTIME	REAL			M2 ontime
EP_HR1	REAL			All-EPIC hardness ratio 1
EP_HR1_ERR	REAL			Error on EPIC hardness ratio 1
EP_HR2	REAL			All-EPIC hardness ratio 2
EP_HR2_ERR	REAL			Error on EPIC hardness ratio 2
EP_HR3	REAL			All-EPIC hardness ratio 3
EP_HR3_ERR	REAL			Error on EPIC hardness ratio 3
EP_HR4	REAL			All-EPIC hardness ratio 4
EP_HR4_ERR	REAL			Error on EPIC hardness ratio 4
SRCDET	LOGICAL			Source detected
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
EP_FLAG	CHAR*16			EPIC flags
M1_FLAG	CHAR*16			M1 flags
M2_FLAG	CHAR*16			M2 flags
PN_FLAG	CHAR*16			pn flags
VVFLAGS	CHAR*8			EPIC Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format

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Column name	Format	Fixed	Rest. Opt.	Description
NAME	CHAR*31			File name

6.8.5.7 OMEXP extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5	Y	Y	Instrument name
DETECTOR	CHAR*10	Y	Y	Detector name
OM_FILTER	CHAR*16		Y	OM filter
MODE	CHAR*20		Y	Instrument mode
DATAMODE	CHAR*20		Y	Instrument data mode
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
EXP_ID	CHAR*4			Exposure number within observation
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
EXP_START	CHAR*24	Y		Date and time of exposure start (UTC)
EXP_STOP	CHAR*24	Y		Date and time of exposure end (UTC)
EXP_DURATION	REAL			Duration of exposure (sec)
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.8 OMOBS extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5	Y	Y	Instrument name
DETECTOR	CHAR*10	Y	Y	Detector name
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.9 OMSRC extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5	Y	Y	Instrument name
DETECTOR	CHAR*10	Y	Y	Detector name
MODE	CHAR*20		Y	Instrument mode
DATAMODE	CHAR*20		Y	Instrument data mode
OM_FILTER	CHAR*16		Y	OM filter
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
EXP_ID	CHAR*4			Exposure ID within observation
OSW_ID	CHAR*8			OSW number within exposure
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
EXP_START	CHAR*24	Y		Date and time of exposure start (UTC)
EXP_STOP	CHAR*24	Y		Date and time of exposure end (UTC)
EXP_DURATION	REAL			Duration of exposure (sec)
SRC_NUM	INTEGER			Source number (from observation source list)
RA_OBJ	DOUBLE			RA of source (2000.0)
DEC_OBJ	DOUBLE			Declination of source (2000.0)
LII_OBJ	DOUBLE			Galactic longitude of source
BII_OBJ	DOUBLE			Galactic latitude of source
MAGNITUDE	REAL			Source magnitude
VARSTAT	REAL			Source variability statistic
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.10 OMSW extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5	Y	Y	Instrument name
DETECTOR	CHAR*10	Y	Y	Detector name
OM_FILTER	CHAR*16		Y	OM filter
MODE	CHAR*20		Y	Instrument mode
DATAMODE	CHAR*20		Y	Instrument data mode
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
EXP_ID	CHAR*4			Exposure ID within observation
OSW_ID	CHAR*8			OSW number within exposure
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
EXP_START	CHAR*24	Y		Date and time of exposure start (UTC)
EXP_STOP	CHAR*24	Y		Date and time of exposure end (UTC)
EXP_DURATION	REAL			Duration of exposure (sec)
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.11 RGSEXP extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5		Y	Instrument name
MODE	CHAR*20		Y	Instrument mode
DATAMODE	CHAR*20		Y	Instrument data mode
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
EXP_ID	CHAR*4			Exposure ID within observation
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
EXP_START	CHAR*24	Y		Date and time of exposure start (UTC)
EXP_STOP	CHAR*24	Y		Date and time of exposure end (UTC)
EXP_DURATION	REAL			Duration of exposure (sec)
FILTGRPS	INTEGER			Code number of group of pre-defined rejection criteria
OCB	INTEGER			On-chip binning factor
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.12 RGSOBS extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5		Y	Instrument name
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.13 RGSSRC extension

Column name	Format	Fixed	Rest.Opt	Description
INSTRUMENT	CHAR*5		Y	Instrument name
MODE	CHAR*20		Y	Instrument mode
DATAMODE	CHAR*20		Y	Instrument data mode
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
EXP_ID	CHAR*4			Exposure ID within observation
OCB	INTEGER			On-chip binning factor
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
EXP_START	CHAR*24	Y		Date and time of exposure start (UTC)
EXP_STOP	CHAR*24	Y		Date and time of exposure end (UTC)
EXP_DURATION	REAL			Duration of exposure (sec)
FILTGRPS	INTEGER			Code number of group of pre-defined rejection criteria
RGSORDER	INTEGER			Dispersion order
SRC_NUM	INTEGER			Source number (from observation source list)
RA_OBJ	DOUBLE			RA of source (2000.0)
DEC_OBJ	DOUBLE			Declination of source (2000.0)
LII_OBJ	DOUBLE			Galactic longitude of source
BII_OBJ	DOUBLE			Galactic latitude of source
EP_TOT	REAL			EPIC total band source count rate
EP_TOT_ERR	REAL			Error on EPIC source count rate
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.14 PPSOBS extension

Column name	Format	Fixed	Rest.Opt	Description
OBS_MODE	CHAR*8	Y	Y	XMM observation mode
OBS_ID	CHAR*10	Y		XMM observation ID
OBS_START	CHAR*24	Y		Date and time of observation start (UTC)
OBS_STOP	CHAR*24	Y		Date and time of observation end (UTC)
OBS_DURATION	REAL	Y		Duration of observation (sec)
CONTENT	CHAR*40		Y	Description of file content
RA_PNT	DOUBLE	Y		RA of XMM pointing (J2000.0)
DEC_PNT	DOUBLE	Y		Dec. of XMM pointing (J2000.0)
PA_PNT	DOUBLE	Y		Position angle of XMM (CCW from North)
LII_PNT	DOUBLE	Y		Galactic longitude of XMM pointing
BII_PNT	DOUBLE	Y		Galactic latitude of XMM pointing
OBSERVER	CHAR*40	Y		Name of PI
OBJECT	CHAR*40	Y		Name of target object
VVFLAGS	CHAR*8			Validation & verification flags
PROCREVISION	CHAR*8	Y		Processing revision
PROCDATE	CHAR*24	Y		Processing date (UTC)
SASVERSION	CHAR*20	Y		SAS version identifier
PPSVERSION	CHAR*24	Y		PPS configuration version identifier
FORMAT	CHAR*4		Y	File format
NAME	CHAR*31			File name

6.8.5.15 INSTSUMM extension

Column name	Format	Rest.Opt	Description
INSTRUMENT	CHAR*5	Y	Instrument name
ACTIVE	LOGICAL		Instrument active flag
NEXPOSURES	INTEGER		Number of exposures from the instrument
PRIORITY	INTEGER		Instrument priority

6.8.5.16 Restricted option data types

Keyword:	INSTRUMENT
Values:	EMOS1, EMOS2, EPN, RGS1, RGS2, OM

Keyword:	OBS_MODE
Values:	POINTED, SLEW

Keyword:	FORMAT
Values:	FITS, HTML, PDF, PNG, ASCI

Keyword:	DATAMODE
Values:	Imaging, Timing, Burst, Spectroscopy, Imaging, Fast

Keyword:	DETECTOR
Values:	PRIME, REDUNDANT

Keyword:	EPIC_FILTER
Values:	CLOSED, THICK, MEDIUM, THIN1, THIN2, OPEN

Keyword:	OM_FILTER
Values:	BLOCKED, UVW2, UVM2, UVW1, U, B, V, WHITE, MAGNI, GRISM1, GRSIM2, BARRED_U

Keyword:	CONTENT
Values:	OM OSW SKY IMAGE
	OM OSW IMAGE
	OM OSW SOURCE TIMESERIES
	OM SOURCE TIMESERIES
	OM TRACKING STAR TIMESERIES
	OM OSW SOURCE LIST
	OM OSW GRISM SOURCE LIST
	OM OSW FAST SOURCE LIST
	OM OSW FAST REGION FILE
	OM OSW REGION FILE
	OM OBSERVATION SOURCE LIST
	OM TRACKING HISTORY PLOT
	OM OBSERVATION SUMMARY
	OM FULL-FRAME IMAGE
	OM FULL-FRAME SKY IMAGE
	OM RUDI-5 SKY IMAGE MOSAIC [1]
	OM FULL-FRAME HIRES SKY IMAGE MOSAIC
	OM FULL-FRAME LORES SKY IMAGE MOSAIC
	OM USER WINDOWS SKY IMAGE MOSAIC
	OM FULL-FRAME SKY IMAGE
	OM RUDI-5 SOURCE LIST MOSAIC [1]
	OM FULL-FRAME HIRES SOURCE LIST MOSAIC
	OM FULL-FRAME LORES SOURCE LIST MOSAIC
	OM USER WINDOWS SOURCE LIST MOSAIC
	OM FAST MODE OSW IMAGE
	OM FAST MODE OSW SKY IMAGE
	OM GRISM DS9 REGIONS
	OM GRISM-ALIGNED IMAGE
	OM GRISM DS9 SPECTRUM REGIONS
	OM GRISM SPECTRA LIST
	OM GRISM SOURCE SPECTRUM
	OM PHA SOURCE SPECTRUM
	OM RESPONSE MATRIX
	EPIC DETECTION MASK
	EPIC IMAGE
	SLEW STEP IMAGE (*slew only*)
	UNFILTERED SLEW STEP IMAGE (*slew only*)

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Keyword:	CONTENT
	EPIC SUMMARY SOURCE LIST FOR SLEW DATA (*slew only*)
	EPIC OBSERVATION IMAGE
	EPIC THREECOLOUR IMAGE
	EPIC OBSERVATION EXPOSURE MAP
	EPIC OBSERVATION FOOTPRINT
	EPIC EXPOSURE MAP
	SLEW STEP EXPOSURE MAP (*slew only*))
	EPIC OBSERVATION BACKGROUND MAP
	EPIC MERGED BACKGROUND MAP
	EPIC EXPOSURE-MERGED EXPOSURE MAP
	EPIC OBSERVATION SENSITIVITY MAP
	EPIC SOURCE DS9 REGION
	EPIC SOURCE DS9 REGIONS
	EPIC SOURCE TIMESERIES
	EPIC SOURCE TIMESERIES PLOT
	EPIC SOURCE FFT PLOT
	EPIC GLOBAL BACKGROUND TIMESERIES
	EPIC SOURCE SPECTRUM
	EPIC SOURCE SPECTRUM PLOT
	EPIC SOURCE BACKGROUND SPECTRUM
	EPIC ANCILLARY RESPONSE FUNCTION
	EPIC OBSERVATION BOX-LOCAL SOURCE LIST
	EPIC OBSERVATION BOX-MAP SOURCE LIST
	EPIC OBSERVATION ML SOURCE LIST
	EPIC SUMMARY SOURCE LIST
	EPIC MOS IMAGING MODE EVENT LIST
	EPIC pn IMAGING MODE EVENT LIST
	SLEW STEP FILTERED EVENT LIST (*slew only*)
	SLEW SINGLE RAW EVENT LIST (*slew only*)
	EPIC TIMING MODE EVENT LIST
	EPIC OBSERVATION SUMMARY
	RGS IMAGE
	RGS FLARE BACKGROUND TIMESERIES
	RGS SOURCE SPECTRUM
	RGS FLUXED SPECTRUM
	RGS SOURCE TIMESERIES
	RGS SOURCE BACKGROUND TIMESERIES
	RGS BACKGROUND MODEL
	RGS SOURCE BACKGROUND SPECTRUM
	RGS EVENT LIST
	RGS OBSERVATION SUMMARY
	RGS SOURCE LIST

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Keyword:	CONTENT
	RGS ENERGY-DISPERSION IMAGE
	RGS EXPOSURE MAP
	RGS FITS SOURCE+BACKGROUND SPECTRUM
	RGS RESPONSE MATRIX
	RGS WHOLE FIELD SRC+BKG SPECTRUM
	RGS WHOLE FIELD RESPONSE MATRIX
	RGS CROSS-DISPERSION HISTOGRAM
	SEARCHED CATALOGUES
	CATALOGUE DESCRIPTIONS
	EPIC SOURCE CROSS-CORRELATION SUMMARY
	EPIC SOURCE CROSS-CORRELATION RESULTS
	FINDING CHART
	EPIC FOV CROSS-CORRELATION SUMMARY
	EPIC FOV CROSS-CORRELATION RESULTS
	EPIC CATALOGUE PLOT
	XMM-ROSAT IMAGE
	MAIN CROSS CORRELATION PAGE
	PPS OBSERVATION SUMMARY
	PPS SCRIPT LOG
	PPS RUN MESSAGE
	PPS RUN SUMMARY
	SSC LOGO 1
	SSC LOGO 2
	CDS LOGO 1
	CDS LOGO 2
	CDS LOGO 3
	PPS PRODUCT INDEX
	CALIBRATION INDEX FILE
	ATTITUDE TIME SERIES
	REFERENCE CATALOGUE

[1] The term, Rudi-5, is sometimes used, interchangably, for the "default mode" of image taking with the OM. A Rudi-5 (default mode) set of images comprises 5 sets of exposures, each exposure containing a pair of windows in which data are acquired. Each pair consists of one small, high resolution (0.5") window which always covers the centre of the field and one larger, lower resolution (1") window whose location changes with each exposure such that, together, the 5 low resolution windows from the 5 exposures cover the whole OM field of view. See the description of the OM default configurations in the XMM-Newton UHB.

6.8.6 PRODUCT: Calibration Index File (CALIND)

- This file consists of the calibration index file used in the PPS run to make the products, with added primary header keywords.
- The file is identified using the keyword,

  CONTENT = 'CALIBRATION INDEX FILE'

in the primary header.

- This product is of class PPSOBS.
- This product is delivered in FITS format, having one bintable extension with extension name CALINDEX. The table columns are,

TTYPE	TFORM	TUNIT	DESCRIPTION
TELESCOP	4A		Telescope
SCOPE	6A		Calibration scope
TYPEID	32A		Calibration data type
ISSUE	I		Constituent issue number
VALDATE	19A	yyyy:dd:mmZhh:mm:ss	Start of validity
VALDATE-END	19A	yyyy:dd:mmZhh:mm:ss	End of validity
FNAME	256A		Constituent file path
DATE	19A	yyyy:dd:mmZhh:mm:ss	Creation date
FSIZE	J	byte	Constituent size
SUBDATE	19A	yyyy:dd:mmZhh:mm:ss	Submission date
EXTSEQU	32A		Extension sequence
EXTSEQID	256A		Extension sequence identifiers
MD5	32A		MD5 digital signature
CREATOR	64A		File creator

- There is one file per PPS run. File size is typically 100 KB uncompressed.

6.8.7 PRODUCT: SSC logo 1 (SSCLG1)

- This file contains a schematic image of the XMM-Newton telescope front end.
- This is a product of class PPSOBS.
- The product is delivered in PNG format.
- There is one file per observation. File size is 3 KB.

6.8.8 PRODUCT: SSC logo 2 (SSCLG2)

- This file contains a graphic with the words 'XMM-Newton survey science centre'.
- This is a product of class PPSOBS.
- The product is delivered in PNG format.
- There is one file per observation. File size is 3 KB.

6.8.9 PRODUCT: CDS logo 1 (CDSLG1)

- This file contains a graphic with the word 'NED'.
- This is a product of class PPSOBS.
- The product is delivered in PNG format.
- There is one file per observation. File size is 1 KB.

6.8.10 PRODUCT: CDS logo 2 (CDSLG2)

- This file contains a graphic with the words 'Vizier'.
- This is a product of class PPSOBS.
- The product delivered in PNG format.
- There is one file per observation. File size is 5 KB.

6.8.11 PRODUCT: CDS logo 3 (CDSLG3)

- This file contains a graphic with the words 'Simbad'.
- This is a product of class PPSOBS.
- The product is delivered in PNG format.
- There is one file per observation. File size is 6 KB.

7 File Names

SSC product file names include sufficient information to determine at least the following:

- product type
- file type
- XMM-Newton observation identifier

The form of the XMM-Newton observation/slew identifier has been defined in the ODF ICD [R-1]. PPS data products use this in making the product filename.

7.1 File name conventions

SSC product filenames comply with ISO 9660 level 2, and are subject to additional constraints also.

- Filenames are up to 27 characters, followed by a dot, followed by 3 characters.
- All filename characters are upper case.
- Where a fixed number of digits is specified, leading zeros are present if the field would not otherwise be filled.
- Allowed characters include only A-Z, 0-9 and the underscore character (_).

7.2 PPS product file names

PPS data product filenames take the 27.3 character form: `POOOOOOOOOODDUEEETTTTTTSXXX.FFF`

P	The character `P`, to identify the files as a PPS product file
OOOOOOOOOO	Observation identifier (10 characters = `ppppppooll` in [R-1], section 5.3.1.1) (note 1)
DD	Data source identifier (2 characters)
U	Exposure flag (1 character = S (sched), U (unsched), X (not applicable))
EEE	Exposure number within the instrument observation (3 digits)
TTTTTT	Product type (6 characters)
S	0 or data subset number/character (1 character, differentiates energy bands, OSWs, filters, orders etc.)
XXX	Source number or slew step number (3 characters, hexadecimal) (note 2). It is set to 000 in source products from EPIC-pn Timing mode
FFF	File format (3 characters)

The allowed values of the data source and format fields are shown below, as is the source keyword of the data subset number.

DD Value	Meaning
OM	OM
R1	RGS 1
R2	RGS 2
RG	both RGSs combined
M1	EPIC MOS 1
M2	EPIC MOS 2
PN	EPIC PN
EP	all EPICs combined
CA	Catalogue cross-correlation
OB	Observation
FFF Value	Meaning
PNG	PNG file
FIT	FITS file
FTZ	Gzipped FITS file
HTM	HTML file
PDF	PDF file
ASZ	Gzipped ASCII file
ASC	ASCII file

The individual product filenames are listed in section 9.1, where the associated DD, TTTTTT and FFF field values are given.

Product class	Source of S value
OMSW	OSW_ID
OMSRC	OSW_ID
OMOBS	FILTER
EPICOBS	BAND
EPICEXP	BAND
EPICSRC	BAND
RGSEXP	RGSORDER
RGSSRC	RGSORDER
RGSOBS	RGSORDER

8 Product Groups

With one exception, the individual PPS product files are grouped into Unix `tar` product group files before they are sent to the SOC. The exception is the PPS run message product file. The product group names, but not the product group constituents, are defined in [R-3]. The group constituents are specified here.

Groups include all specified files for the entire observation. The one exception is the EPIC source-specific group, which includes all files for a specific X-ray source; thus there may be more than one of these groups in an observation product set.

All product group files include at least one file: the PPS HTML index file. These files include links to all the other files in their group.

8.1 Constituents of the pipeline product group files

The data product files which are included in the pipeline product group files are listed here. The format and the expected number of file instances in the group are also given. In some cases, this number is quite uncertain. This is especially true for EPIC source-specific products where it depends on the number of sources meeting the extraction criteria, for slew observations where the number of step images depends on the length of the slew and for OM data where, for example, the number of images depend on the number of exposures requested and the mode used for the exposure. For the OM fast mode and for grism data, the number of products shown relate to cases where such data are taken. FITS format files are individually compressed with GNU `gzip`.

Product group	Constituent files	Format	Typical number
EPIC event list group	EPIC MOS imaging mode event list	FITS	2
	EPIC pn imaging mode event list	FITS	1
	SLEW single raw event list (*slew only*)	FITS	1
	SLEW step filtered event list (*slew only*)	FITS	70
	EPIC timing mode event list	FITS	0
	PPS HTML index	HTML	1
EPIC sky image group	EPIC image	FITS	18
	SLEW step image (*slew only*)	FITS	210
	Unfiltered SLEW step image (*slew only*)	FITS	70
	EPIC observation image	FITS	1
	EPIC observation three colour image	FITS	1
	EPIC observation exposure map	FITS	1
	EPIC observation footprint region	ASCII	1
	PPS HTML index	HTML	1
EPIC ancillary group	EPIC camera exposure map	FITS	18
	EPIC exposure-merged exposure map	FITS	15
	SLEW step exposure map (*slew only*)	FITS	210
	EPIC camera background map	FITS	18

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Product group	Constituent files	Format	Typical nr.
	EPIC camera detector mask	FITS	15
	EPIC camera global background time-series	FITS	3
	EPIC observation sensitivity map	FITS	1
	EPIC observation background map	FITS	1
	EPIC observation region file	ASCII	1
	PPS HTML index	HTML	1
EPIC source list group	EPIC obs box-local source list	FITS	1
	EPIC obs box-map source list	FITS	1
	EPIC obs ml source list	FITS	1
	EPIC FITS summary source list	FITS	1
	EPIC FITS summary source list	HTML	1
	PPS HTML index	HTML	1
EPIC source-specific group	EPIC FITS source timeseries	FITS	30
	EPIC FITS source spectrum	FITS	30
	EPIC FITS source bkground spectrum	FITS	30
	EPIC FITS ancillary response file	FITS	30
	EPIC source region	ASCII	30
	EPIC pn source combined spectrum	FITS	1
	EPIC pn background combined spectrum	FITS	1
	EPIC pn background spectrum with singles/doubles	FITS	1
	EPIC pn response matrix for singles/doubles spectrum	FITS	1
	EPIC ancillary response file for combined pn spectrum	FITS	1
	EPIC-OM source SED plot	PNG	5
	PPS HTML index	HTML	1
OM images	OM OSW FITS image	FITS	20
	OM OSW FITS sky image	FITS	20
	OM observation FITS sky image	FITS	2
	OM OSW FITS Grism-aligned image	FITS	3
	OM OSW FITS Grism spectra list	FITS	3
	OM OSW FITS Grism spectrum	FITS	3
	PPS HTML index	HTML	1
OM source lists group	OM OSW source list	FITS	20
	OM observation source list	FITS	1
	OM OSW FITS grism source list	FITS	3
	PPS HTML index	HTML	1
OM timeseries group	OM OSW FITS source timeseries	FITS	10
	OM OSW source timeseries	PDF	10
	OM source timeseries	FITS	10

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Product group	Constituent files	Format	Typical nr.
	OM source timeseries	PNG	10
	OM FITS tracking star timeseries	FITS	8
	PPS HTML index	HTML	1
OM spectral productss	OM PHA source spectrum	FITS	10
	OM Response Matrix	FITS	3
OM ancillary group	OM OSW ASCII region	ASCII	20
	PPS HTML index	HTML	1
RGS event list group	RGS event list	FITS	2
	RGS source list	FITS	2
	PPS HTML index	HTML	1
RGS exposure group	RGS exposure map	FITS	2
	PPS HTML index	HTML	1
RGS image group	RGS FITS image	FITS	2
	RGS FITS energy-dispersion image	FITS	2
	PPS HTML index	HTML	1
RGS spectrum group	RGS FITS source spectrum	FITS	4
	RGS FITS source region spectrum	FITS	4
	RGS FITS background spectrum	FITS	4
	RGS FITS background model spectrum	FITS	4
	RGS FITS source response matrix	FITS	2
	RGS FITS whole field spectrum	FITS	4
	RGS FITS whole field response matrix	FITS	2
	RGS FITS fluxed spectrum	FITS	1
	RGS FITS flare background timeseries	FITS	2
	RGS FITS cross-dispersion histogram	FITS	2
	RGS FITS background-subtracted source timeseries	FITS	4
	RGS FITS source background timeseries	FITS	4
	PPS HTML index	HTML	1
Cross-correlation group	FITS source cross-corr summary	FITS/HTML	2
	FITS source cross-corr results	FITS	20
	FITS FOV cross-corr summary	FITS/HTML	1
	FITS FOV cross-corr results	FITS	10
	Finding chart plot	PDF	80
	Cross-corr searched catalogues	FITS/HTML	2
	Cross-corr catalogue descriptions	HTML	20
	XMM-rosat image plot	PDF	1
	XMM catalogue plot	PDF	1
	Main cross-corr page	HTML	1
	PPS HTML index	HTML	1
PPS data group	PPS product index	FITS	1
	Calibration index file	FITS	1

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Product group	Constituent files	Format	Typical nr.
	Attitude time series	FITS	1
	Spacecraft orbit	FITS	1
	Reference catalogue	FITS	1
	PPS script log	ASCII	1
	PPS HTML index	HTML	1
PPS graphics group	EPIC PNG image	PNG	3
	EPIC PNG exposure map	PNG	3
	EPIC PNG background map	PNG	3
	EPIC PDF global background timeseries	PDF	3
	EPIC PNG observation image	PNG	1
	EPIC PNG three-colour image	PNG	1
	EPIC PNG observation exposure map	PNG	1
	EPIC PNG observation background map	PNG	1
	EPIC PNG source extraction image	PNG	1
	EPIC PDF source timeseries plot	PDF	30
	EPIC PDF source FFT plot	PDF	30
	EPIC PDF source spectrum plot	PDF	30
	EPIC HTML summary page	HTML	1
	OM PDF tracking history plot	PDF	10
	OM PNG sky image	PNG	20
	OM PNG observation sky image	PNG	2
	OM PDF grism spectrum plot	PDF	3
	OM HTML summary page	HTML	1
	RGS image plot	PNG	2
	RGS energy-dispersion image plot	PNG	2
	RGS source spectrum plot	PDF	2
	RGS whole field spectrum plot	PDF	2
	RGS fluxed source spectrum plot	PDF	1
	RGS HTML summary page	HTML	1
	HTML source cross-corr summary	HTML	1
	HTML source cross-corr results	HTML	1
	HTML FOV cross-corr summary	HTML	1
	HTML FOV cross-corr results	HTML	1
	Observation summary	HTML	1
	SSC logo1	PNG	1
	SSC logo2	PNG	1
	CDS logo1	PNG	1
	CDS logo2	PNG	1
	CDS logo3	PNG	1
	PPS summary	HTML	1
	PPS HTML index	HTML	1

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Product group	Constituent files	Format	Typical nr.

9 Summary PPS Product Information

9.1 PPS products and their filenames

This section relates PPS product names to the names of the files containing the products by listing the characters that make up fields of the file name (see section 7). Each file is one product and each product is one file.

9.1.1 OM product filenames

Product name	File name field		
	DD	TTTTTT	FFF
OM OSW FITS image	OM	IMAGE_	FTZ
(Full Frame)	OM	FIMAG_	FTZ
(FAST mode)	OM	IMAGEF	FTZ
OM OSW FITS grism-aligned image	OM	GIMAGE	FTZ
OM OSW FITS sky image	OM	SIMAGE	FTZ
(Full Frame mode)	OM	FSIMAG	FTZ
(FAST mode)	OM	SIMAGF	FTZ
OM OSW PNG sky image	OM	SIMAGE	PNG
(Full Frame mode)	OM	FSIMAG	PNG
OM OSW ASCII source regions	OM	SWSREG	ASC
(FAST mode)	OM	SFSREG	ASC
OM Observation FITS sky image (Default)	OM	RSIMAG	FTZ
(Full Frame low res)	OM	LSIMAG	FTZ
(Full Frame hi res)	OM	HSIMAG	FTZ
(User defined)	OM	USIMAG	FTZ
OM Observation PNG sky image (Default)	OM	RSIMAG	PNG
(Full Frame low res)	OM	LSIMAG	PNG
(Full Frame hi res)	OM	HSIMAG	PNG
(User defined)	OM	USIMAG	PNG
OM OSW FITS source timeseries	OM	TIMESR	FTZ
OM OSW PDF source timeseries	OM	TIMESR	PDF
OM FITS tracking star timeseries	OM	TSTRTS	FTZ
OM OSW source list file	OM	SWSRLI	FTZ
(FAST mode)	OM	SFSRLI	FTZ
OM observation source list file	OM	OBSMLI	FTZ
OM grism OSW FITS source list file	OM	SGSRLI	FTZ
OM grism OSW FITS spectra list file	OM	SPECLI	FTZ
OM grism OSW ASCII region	OM	SGSREG	ASC
OM grism OSW ASCII spectra region	OM	SPCREG	ASC
OM grism FITS spectrum	OM	SPECTR	FTZ
OM grism PDF spectrum plot	OM	SPECTR	PDF
OM tracking history plot	OM	TSHPLT	PDF
OM products HTML summary page	OM	SUMMAR	HTM

9.1.2 EPIC product filenames

Product name	File name field		
	DD	TTTTTT	FFF
EPIC FITS image	(note 1)	IMAGE_	FTZ
SLEW step FITS image (*slew only*)	(note 3)	IMAGE_	FTZ
Unfiltered slew step FITS image (*slew only*)	(note 3)	UNFDAT	FTZ
EPIC PNG image	(note 1)	IMAGE_	PNG
EPIC FITS observation image	(note 2)	OIMAGE	FTZ
EPIC PNG observation image	(note 2)	OIMAGE	PNG
EPIC FITS three-colour image	(note 2)	3COLIM	FTZ
EPIC PNG three-colour image	(note 2)	3COLIM	PNG
EPIC FITS exposure map	(note 1)	EXPMAP	FTZ
SLEW step FITS exposure map (*slew only*)	(note 3)	EXPMAP	FTZ
EPIC PNG exposure map	(note 1)	EXPMAP	PNG
EPIC FITS exposure-merged exposure map	(note 1)	MEXPMP	FTZ
EPIC FITS observation exposure map	(note 2)	OEXPMP	FTZ
EPIC PNG observation exposure map	(note 2)	OEXPMP	PNG
EPIC ASC footprint region	(note 2)	OFTPRT	ASC
EPIC FITS merged background map	(note 1)	BKGMAP	FTZ
EPIC FITS observation background map	(note 2)	OBKGMP	FTZ
EPIC PNG observation background map	(note 2)	OBKGMP	PNG
EPIC FITS detection mask	(note 1)	DETMSK	FTZ
EPIC FITS observation sensitivity map	(note 1)	OSNSMP	FTZ
EPIC FITs source timeseries	(note 1)	SRCTSR	FTZ
EPIC PDF source timeseries plot	(note 4)	STSPLT	PDF
EPIC PDF source FFT plot	(note 1)	SFFTPL	PDF
EPIC FITS global background timeseries	(note 1)	FBKTSR	FTZ
EPIC PDF global background timeseries	(note 1)	FBKTSR	PDF
EPIC source spectrum	(note 1)	SRSPEC	FTZ
EPIC source extraction region	(note 1)	SRSPEC	PNG
EPIC source background spectrum	(note 1)	BGSPEC	FTZ
EPIC source spectrum plot	(note 1)	SPCPLT	PDF
EPIC-OM spectral energy distribution plot	(note 2)	SEDPLT	PNG
EPIC-pn source combined spectra	(note 3)	SCOMSP	FTZ
EPIC-pn background combined spectra	(note 3)	BCOMSP	FTZ
EPIC-pn background single spectra	(note 3)	BGP0SP	FTZ
EPIC-pn background double spectra	(note 3)	BGP4SP	FTZ
EPIC-pn single and double bkgd spectra	(note 3)	BGPDSP	FTZ
EPIC observation box-local source list file	(note 2)	OBLSLI	FTZ
EPIC observation box-map source list file	(note 2)	OBMSLI	FTZ
EPIC observation ml source list file	(note 2)	OMSRLI	FTZ
EPIC FITS summary source list file	(note 2)	OBSMLI	FTZ

(continued on next page)

(continued from previous page)			
EPIC HTML summary source list file	(note 2)	OBSMLI	HTM
EPIC FITS summary source list file for slew data	(note 3)	OMSSLI	FTZ
EPIC MOS IMAGING mode event list file	(note 1)	MIEVLI	FTZ
EPIC pn IMAGING mode event list file	(note 1)	PIEVLI	FTZ
SLEW single raw event list file (*slew only*)	(note 3)	PIEVLI	FTZ
SLEW step event list file (*slew only*)	(note 3)	SLEVLI	FTZ
EPIC TIMING mode event list file	(note 1)	TIEVLI	FTZ
EPIC ML source region file	(note 2)	REGION	ASC
EPIC source region file	(note 1)	SRCREG	ASC
EPIC ancillary response file	(note 1)	SRCARF	FTZ
EPIC-pn response matrix for singles spectra	(note 3)	SPORMF	FTZ
EPIC-pn response matrix for doubles spectra	(note 3)	SPDRMF	FTZ
EPIC-pn response matrix for singles and doubles spectra	(note 3)	SP4RMF	FTZ
EPIC-pn response matrix for singles spectra	(note 3)	SPORMF	FTZ
EPIC-pn ancillary response combined functions	(note 3)	SCOARF	FTZ
EPIC HTML summary page	(note 2)	SUMMAR	HTM

Notes

1) DD may take the values M1, M2, PN.

2) DD takes the value EP (all EPICs combined).

3) DD takes the values PN.

4) DD may take the values M1, M2, PN, EP (all EPICs combined)

9.1.3 RGS product filenames

Product name	File name field		
	DD	TTTTTT	FFF
RGS FITS image	(note 1)	IMAGE_	FTZ
RGS PNG image	(note 1)	IMAGE_	PNG
RGS FITS energy-dispersion image	(note 1)	ORDIMG	FTZ
RGS PNG energy-dipersion image	(note 1)	ORDIMG	PNG
RGS FITS exposure map	(note 1)	EXPMAP	FTZ
RGS FITS source region spectrum	(note 1)	SBSPEC	FTZ
RGS FITS background spectrum	(note 1)	BGSPEC	FTZ
RGS FITS source spectrum	(note 1)	SRSPEC	FTZ
RGS PDF source spectrum plot	(note 1)	SRSPEC	PDF
RGS FITS background model spectrum	(note 1)	BGMODL	FTZ
RGS FITS whole field spectrum	(note 1)	WFSPEC	FTZ
RGS PDF whole field spectrum	(note 1)	WFSPEC	PDF
RGS FITS fluxed source spectrum	(note 2)	FLUXED	FTZ
RGS PDF fluxed source spectrum	(note 2)	FLUXED	PDF
RGS FITS source response matrix	(note 1)	RSPMAT	FTZ
RGS FITS whole field response matrix	(note 1)	WREMAT	FTZ
RGS FITS background-subtracted source timeseries	(note 1)	SRCTSR	FTZ
RGS FITS source background timeseries	(note 1)	SRBTSR	FTZ
RGS FITS event list file	(note 1)	EVENLI	FTZ
RGS FITS source list file	(note 1)	SRCLI_	FTZ
RGS FITS flare background timeseries	(note 1)	FBKTSR	FTZ
RGS FITS cross-dispersion histogram	(note 1)	DSPHIS	FTZ
RGS HTML summary page	(note 2)	SUMMAR	HTM

9.1.4 Catalogue product filenames

Product name	File name field		
	DD	TTTTTT	FFF
HTML Main cross-correlation page	CA	XCORRE	HTM
FITS Searched catalogues	CA	SRCHD_	FTZ
HTML Searched catalogues	CA	SRCHD_	HTM
HTML Catalogue descriptions	CA	D*xxxxa*†	HTM
FITS EPIC source cross-correlation results	CA	S*xxxxa*†	FTZ
HTML EPIC source cross-correlation results	CA	SRCRES	HTM
HTML EPIC source cross-correlation summary	CA	SRCSUM	HTM
FITS EPIC source cross-correlation summary	CA	SRCSUM	FTZ
PDF Finding chart	CA	FCHART	PDF
FITS EPIC FOV cross-correlation results	CA	F*xxxxa*†	FTZ
HTML EPIC FOV cross-correlation results	CA	FOVRES	HTM
HTML EPIC FOV cross-correlation summary	CA	FOVSUM	HTM
FITS EPIC FOV cross-correlation summary	CA	FOVSUM	FTZ
PDF EPIC catalogue plot	CA	CATPLT	PDF
PDF XMM-Rosat image	CA	ROSIMG	PDF

† In the above table, *xxxx* will take different values according to the names of the catalogues searched. *a* will take the value T where results are drawn from a table, and the values A,B,C etc. to represent real catalogue numbers.

9.1.5 Observation summary and PPS run product filenames

Product name	File name field		
	DD	TTTTTT	FFF
Observation summary	OB	SUMMAR	HTM
Attitude time series	OB	ATTTSR	FTZ
Spacecraft Orbit	OB	ORBTSR	FTZ
Reference catalogue	OB	REFCAT	FTZ
PPS script log	OB	SCRLOG	ASC
PPS run message	OB	PPSMSG	ASC
PPS run summary	OB	PPSSUM	HTM
PPS HTML index	-	see below	HTM
PPS product index	OB	PINDEX	FTZ
Calibration index file	OB	CALIND	FTZ
SSC logo 1	OB	SSCLG1	PNG
SSC logo 2	OB	SSCLG2	PNG
CDS logo 1	OB	CDSLG1	PNG
CDS logo 2	OB	CDSLG2	PNG
CDS logo 3	OB	CDSLG3	PNG

The TTTTTT field values for the PPS HTML index products are the values of the same field of the product group filename for the product group in which they sit. Group membership is specified in section 8. These files have files names of the form,

PPOOOOOOOOOOTTTTTTyyy_0.HTM

where yyy is usually 000 unless, in the case of EPIC, they relate to specific sources in which case it is the hexadecimal equivalent of the decimal source number. The product group filenames are defined in [R-3], and are repeated here:

TTTTTT	Product group name
CRSCOR	Cross-correlation group
EANCIL	EPIC ancillary group
EEVLIS	EPIC event list files group
ESKYIM	EPIC sky images group
ESOURC	EPIC source-specific group
ESRLIS	EPIC source list files group
OIMAGE	OM images group
OMSLIS	OM source list files group
OMSRTS	OM timeseries group
OANCIL	OM ancillary group
REVLIS	RGS event list files group
REXPIM	RGS exposure images group
RIMAGE	RGS images group
RSPECT	RGS spectrum group
PPSDAT	PPS data group
PPSGRA	PPS graphics group

9.2 The size and frequency of PPS products

This section presents a representative measure of the number of times that the various product files will occur during a single observation. Approximate data volumes are also given - these are estimates for the total volume of each given file type per observation. FITS files and some ASCII files are delivered compressed, so compressed sizes are presented here for these files. Uncompressed file sizes are given in the sections describing the individual products.

Estimates of the size and frequency of data product files are drawn from a real observation and are presented in the following tables (based on data processed by the 3XMM pipeline, for pointed data). However, it should be noted, that data volumes can vary markedly, even when similar numbers of files are involved. For example, OM UV-filter images have in general much smaller volumes, by factors of 2-3, than optical band filter images due to the lower count rates. Similarly, source list file sizes depend on the number of detected sources and event list file volumes broadly scale with total count rate and observation length. The estimates that follow for pointed data are based on an observation with the following characteristics:

1. An observation lasting 33ksec, comprising single science exposures in EPIC and RGS. The EPIC instruments are in full frame and the RGS operating in spectroscopy mode.
2. Two OSWs per exposure and 10 exposures (two sets in default format, one in a UV filter and one in an optical filter) for the OM.

3. There is an OM fast mode window accompanying each imaging exposure (i.e. 10 fast mode exposures). Timeseries are extracted for one source in each fast mode exposure.

4. Time-series and spectra are extracted for 10 EPIC sources (a total of 19 timeseries and spectra)

5. Around 110 EPIC detections in the EPIC field-of-view.

6. Around 2000 OM detections in total.

For an example of slew data, an observation with 71 image steps along the slew path is adopted.

9.2.1 OM product rates and sizes

Product	Frequency (per observation)	Volume per observation (compressed, MB)
OM OSW FITS image	20	11.00
OM OSW FITS image (fast)	10	0.20
OM OSW FITS sky image	20	12.50
OM OSW FITS sky image (fast)	10	0.24
OM OSW PNG sky image	20	2.71
OM FITS observation sky image	2	8.16
OM PNG observation sky image	2	0.33
OM ASCII source region	20	0.78
OM ASCII source region (fast)	10	0.16
OM OSW FITS source timeseries	10	0.25
OM OSW PDF source timeseries	10	1.55
OM FITS tracking star timeseries	5	0.12
OM OSW source list file	20	0.98
OM OSW source list file (fast)	10	0.24
OM observation source list file	1	0.27
OM tracking history plot	5	1.28
OM HTML summary page	1	0.14

9.2.2 EPIC product rates and sizes

Product	Frequency (per observation)	Volume per observation (compressed, MB)
EPIC FITS image	18	2.1
EPIC PNG image	3	0.35
EPIC FITS exposure map	18	9.94
EPIC PNG exposure map	3	0.47
EPIC FITS merged exposure map	15	8.28
EPIC FITS background map	15	8.25
EPIC FITS observation image	1	0.20
EPIC PNG observation image	1	0.16
EPIC FITS three-colour image	1	0.72
EPIC PNG three-colour image	1	0.36
EPIC FITS observation exposure map	1	0.74
EPIC PNG observation exposure map	1	0.18
EPIC ASC footprint region	1	0.02
EPIC FITS observation background map	1	0.73
EPIC PNG observation background map	1	0.11
EPIC FITS detection mask	15	0.98
EPIC FITS observation sensitivity map	1	0.72
EPIC FITS source time-series	30	1.13
EPIC PDF source time-series plot	30	3.76
EPIC FITS global background timeseries	3	0.37
EPIC PDF global background timeseries	3	0.43
EPIC FITS source spectrum	30	1.18
EPIC FITS source background spectrum	30	1.18
EPIC PNG source extraction region image	30	0.5
EPIC PDF source spectrum plot	30	1.08
EPIC FITS ancillary response file	30	1.39
EPIC observation box-local source list file	1	0.42
EPIC observation box-map source list file	1	0.27
EPIC observation ml source list file	1	0.20
EPIC FITS summary source list file	1	0.17
EPIC HTML summary source list file	1	0.06
EPIC MOS IMAGING mode event list file	2	11.62
EPIC pn IMAGING mode event list file	1	48.29
EPIC TIMING mode event list file (note 1)	1	6.71
EPIC ASCII source region	1	0.02
EPIC ASCII source-specific region	30	0.46
EPIC HTML summary page	1	0.22

9.2.3 SLEW observation product rates and sizes

Product	Frequency (per observation)	Volume per observation (compressed, MB)
SLEW step FITS image	213	1.6
Unfiltered slew step FITS image	71	1.1
SLEW step FITS exposure map	213	268
EPIC observation ml source list file	3	0.06
EPIC FITS summary source list	1	0.05
SLEW single raw event list file	1	3.6
SLEW step event list file	71	165
EPIC HTML summary page	1	0.11

9.2.4 RGS product rates and sizes

Product	Frequency (per observation)	Volume per observation (compressed, MB)
RGS FITS image	2	0.20
RGS PNG image	2	0.18
RGS FITS energy-dispersion image	2	0.21
RGS PNG energy-dispersion image	2	0.16
RGS FITS exposure map	2	0.44
RGS FITS source region spectrum	4	0.22
RGS FITS background spectrum	4	0.22
RGS FITS source spectrum	4	0.17
RGS PDF spectrum	2	0.30
RGS FITS background model	4	0.38
RGS FITS whole field spectrum	4	0.22
RGS PDF whole field spectrum	2	0.31
RGS FITS source response matrix	2	63.60
RGS FITS whole field response matrix	2	64.36
RGS FITS fluxed source spectrum	1	0.04
RGS PDF fluxed source spectrum	1	0.04
RGS FITS background-subtracted source timeseries	2	0.03
RGS FITS source background timeseries	2	0.03
RGS FITS event list file	2	6.37
RGS FITS source list file	2	0.06
RGS FITS flare background timeseries	2	0.05
RGS FITS cross-dispersion histogram	2	0.05
RGS HTML summary page	1	0.06

9.2.5 Catalogue product rates and sizes

Product	Frequency (per observation)	Volume per observation (compressed, MB)
HTML Main cross-correlation page	1	0.02
FITS Searched catalogues	1	0.04
HTML Searched catalogues	1	0.14
Catalogue descriptions	22	1.01
HTML EPIC source cross-correlation summary	1	0.34
FITS EPIC source cross-correlation summary	1	0.06
HTML EPIC source cross-correlation results	1	0.39
FITS EPIC source cross-correlation results	20	0.56
Finding chart	115	15.87
HTML EPIC FOV cross-correlation summary	1	0.04
FITS EPIC FOV cross-correlation summary	1	0.02
HTML EPIC FOV cross-correlation results	1	0.06
FITS EPIC FOV cross-correlation results	6	0.14
PDF EPIC catalogue plot	1	0.17
XMM-rosat image	1	0.22

9.2.6 Observation summary and PPS run product rates and sizes

Product	Frequency (per observation)	Volume per observation (compressed, MB)
Observation summary	1	0.09
Attitude time series	1	0.17
Spacecraft orbit	1	2.00
Reference Catalogue	1	0.34
PPS script log	1	18.70
PPS run message (note 1)	1	0.02
PPS run summary	1	0.05
PPS HTML index	34	0.62
PPS product index	1	0.60
Calibration index file	1	0.32
SSC logo 1	1	0.02
SSC logo 2	1	0.06
CDS logo 1	1	0.02
CDS logo 2	1	0.02
CDS logo 3	1	0.02

9.2.7 Total PPS products data volume

Below is an estimate of the total compressed volume of the PPS data products for a single observation. This estimate is, for obvious reasons, just an example. Please note the assumptions of section 9.2 and that the EPIC timing event file(s) are not included in the total estimate.

Product type	Volume per observation (compressed, MB)
OM	30
EPIC	160
RGS	120
Catalogue	10
Obs. sum. &PPS run	10
TOTAL	330

For a slew observation,

Product type	Volume per observation (compressed, MB)
EPIC	439
Obs. sum. &PPS run	2.6
TOTAL	442

10 Appendix A

10.1 PPS product creation tasks

This section identifies the PPS task(s), mostly from the list of SAS and ftool tasks in [R-2], responsible for the creation of each PPS product. Here creation does not necessarily mean initial creation, nor does the table necessarily list the last task to interact with a product. Rather, the table lists the tasks that make the major contribution to the creation of the products.

The origin of the data which are input to the creating tasks is listed as one of: ODF – only ODF files are used; PPS – intermediate PPS output files are used; data product name – only a deliverable data product is used.

10.1.1 OM product creation tasks

Product	Creation task(s)	Origin of data
OM OSW FITS image	`ommodmap or omfastflat`	PPS
OM OSW FITS sky image	`omatt`	PPS
OM observation FITS sky image	`ommosaic`	PPS
OM ASCII source region	`omdetect`	PPS
OM OSW FITS source timeseries	`omlcbuild`	PPS
OM OSW PDF source timeseries	`lcplot`	OM OSW FITS source timeseries
OM FITS tracking star timeseries	`omthconv`	ODF
OM OSW FITS source list	`omdetect,ommag`	PPS
OM FITS observation source list	`omsrclistcomb, ommergelists`	PPS
OM FITS grism-aligned image	`omgprep`	PPS
OM FITS grism source list	`omdetect`	PPS
OM FITS grism spectra list	`omgrism`	PPS
OM FITS grism source spectrum	`omgrism`	PPS
OM PDF grism spectrum plot	`omgrismplot`	PPS
OM ASCII grism region	`omdetect`	PPS
OM ASCII grism spectra region	`omgrism`	PPS
OM PHA source spectrum	`ompha`	PPS
OM PDF tracking history plot	`omdrifthist`	ODF
OM products HTML summary page	`psssumm`	PPS

10.1.2 EPIC product creation tasks

Product	Creation task(s)	Origin of data
EPIC FITS image	`evselect`	EPIC event list
SLEW step FITS image	`eslewchain, evselect`	EPIC event list
Unfiltered slew step FITS image	`eslewchain, evselect`	EPIC event list
EPIC PNG image	`implot`	EPIC event list
EPIC FITS exposure map	`eexpmap`	EPIC event list
SLEW step FITS exposure map	`eslewchain, eexpmap`	EPIC event list
EPIC PNG exposure map	`implot`	EPIC FITS exposure map
EPIC FITS background map	`esplinemap`	PPS
EPIC FITS observation image	`mosaic`	EPIC FITS images, exposure map
EPIC PNG observation image	`implot`	EPIC FITS observation image
EPIC FITS three-colour image	`etruecolor`	EPIC FITS images
EPIC PNG three-colour image	`implotrgb`	EPIC FITS observation image
EPIC FITS observation exposure map	`emosaic`	EPIC FITS exposure maps
EPIC PNG observation exposure map	`implot`	EPIC FITS observation exposure map
EPIC FITS exposure-merged exposure map	`imweightadd`	EPIC FITS exposure maps
EPIC FITS observation background map	`emosaic`	EPIC FITS background maps
EPIC PNG observation background map	`implot`	EPIC FITS observation background map
EPIC observation sensitivity map	`esensmap`	Exposure, background & detection maps
EPIC FITS detection mask	`emask`	PPS
EPIC FITS source time-series	`evselect,epiclccorr`	PPS
EPIC PDF source time-series plot	`elcplot`	EPIC FITS source time-series
EPIC PDF source FFT plot	`efftplot`	EPIC FITS source time-series
EPIC FITS global background time-series	`evselect`	PPS
EPIC PDF global background time-series	`fplot`	PPS
EPIC FITS source spectrum	`evselect, especget`	PPS
EPIC FITS source background spectrum	`evselect, especget, ebkgreg`	PPS
EPIC source extraction region image	`implotregions`	EPIC FITS source (and background) spectra
EPIC source spectrum plot	`XSPEC`	EPIC FITS source (and background) spectra
EPIC FITS ancillary response file	`arfgen`	PPS
EPIC FITS resdistribution response file	`rmfgen`	PPS
EPIC observation box-local source list	`eboxdetect`	EPIC FITS images
EPIC observation box-map source list	`eboxdetect`	EPIC FITS images
EPIC observation ml source list	`emldetect`	EPIC FITS images
EPIC FITS summary source list	`srcmatch`	EPIC ml source lists
EPIC HTML summary source list	`srcmatch`	EPIC summary source list

Product	Creation task(s)	Origin of data
EPIC MOS IMAGING mode event list	`evselect`	ODF
SLEW single raw event list	`eslewchain, evselect`	ODF
SLEW step event list	`eslewchain, evselect`	ODF
SLEW FITS summary source list	`eslewsearch`	PPS
EPIC pn IMAGING mode event list	`evselect`	ODF
EPIC TIMING mode event list	`evselect`	PPS
EPIC ASCII source region	`slconv`	EPIC FITS observation ml source list
EPIC ASCII source-specific region	`slconv`	PPS
EPIC HTML summary page	`ppssumm (pointed), ppsslewsum (slew)`	PPS

10.1.3 RGS product creation tasks

Product	Creation task(s)	Origin of data
RGS FITS image	`evselect`	RGS event list
RGS PNG image	`rgsimplot`	RGS FITS image
RGS FITS energy-dispersion image	`evselect`	RGS event list
RGS PNG energy-dispersion image	`rgsimplot`	RGS FITS energy-dispersion image
RGS exposure map	`rgsfilter`	RGS event list
RGS FITS source region spectrum	`rgsspectrum`	PPS, rgs source list, event list
RGS FITS background spectrum	`rgsspectrum`	PPS, rgs source list, event list
RGS FITS source spectrum	`rgsspectrum`	PPS, rgs source list
RGS PDF source spectrum plot	`rgsspecplot`	RGS FITS source & background spectra
RGS FITS background model spectrum	`rgsbkgmodel`	PPS
RGS FITS whole field spectrum	`rgsspectrum`	PPS, rgs source list, event list
RGS PDF whole field spectrum plot	`rgsspecplot`	RGS FITS whole field spectrum
RGS FITS source response matrix	`rgsrmfgen`	PPS, RGS FITS source list, RGS FITS source spectrum
RGS FITS whole field response matrix	`rgsrmfgen`	PPS, RGS FITS source list, RGS FITS whole field spectrum
RGS FITS fluxed source spectrum	`rgsfluxer`	RGS FITS source spectrum
RGS PDF fluxed source spectrum	`fplot`	RGS FITS source spectrum
RGS FITS background-subtracted source timeseries	`rgslccorr`	PPS, rgs source list
RGS PDF background-subtracted source timeseries	`elcplot`	PPS, rgs source list
RGS FITS source background timeseries	`rgslccorr`	PPS, rgs source list
RGS FITS event list	`rgsfilter`	PPS
RGS FITS source list	`rgssources`	EPIC ML source list
RGS FITS flare background timeseries	`evselect`	RGS FITS event list
RGS FITS cross-dispersion histogram	`evselect`	RGS FITS event list
RGS HTML summary page	`ppssumm`	PPS

10.1.4 Catalogue product creation tasks

Product	Creation task(s)	Origin of data
Main cross-correlation page	ACDS	catalogue HTML & graphics products
FITS Searched catalogues	ACDS	ACDS catalogues
HTML Searched catalogues	ACDS	FITS searched catalogues
HTML Catalogue descriptions	ACDS	ACDS catalogues
HTML EPIC source cross-correlation summary	ACDS	equivalent FITS product
FITS EPIC source cross-correlation summary	ACDS	equivalent FITS results product
HTML EPIC source cross-correlation results	ACDS	equivalent FITS product
FITS EPIC source cross-correlation results	ACDS	ACDS catalogues, EPIC summary source list
Finding chart	ACDS	ACDS archival data
HTML EPIC FOV cross-correlation summary	ACDS	equivalent FITS product
FITS EPIC FOV cross-correlation summary	ACDS	equivalent FITS results product
HTML EPIC FOV cross-correlation results	ACDS	equivalent FITS product
FITS EPIC FOV cross-correlation results	ACDS	ACDS catalogues, EPIC summary source list
PDF catalogue plot	ACDS	ACDS catalogues
PDF XMM-Rosat image	ACDS	EPIC observation image & ACDS archival data

10.1.5 Observation summary and PPS run product creation tasks

Product	Creation task(s)	Origin of data
Observation summary	obssumm	ODF
Attitude time series	atthkgen	ODF
Reference catalogue	imcat	USNO
PPS script log	PPS control s/w	PPS
PPS run message	PPS control s/w	PPS
PPS run summary	ppssumm	PPS
PPS HTML index	PCMS	PPS
PPS product index	PCMS	PPS-DB
Calibration index file	cifbuild	CCF
SSC logo 1	–	library file
SSC logo 2	–	library file
CDS logo 1	–	library file
CDS logo 2	–	library file
CDS logo 3	–	library file