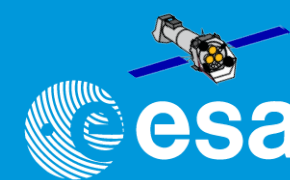


# Introduction to the XMM-Newton Science Analysis System

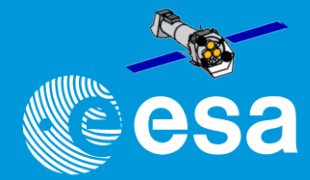
Aitor IBARRA & Carlos GABRIEL (+ almost the whole... at least a lot of the)  
XMM-Newton Science Operations Center - ESA

- What is the SAS?
- SAS installation and setup
- SAS data reduction scheme
- Getting started I: the Observation Data File (ODF) + odfbrowser
- Getting started II: the Calibration Current File (CCF) and the Calibration Index File (CIF)
- Getting started III: the common first steps
- Running SAS: GUI or command line
- PPS or “SAS has already reduced these data”
- Retrieving XMM-Newton data
- SAS as web services → "RISA" → XSA to reprocess data
- SAS & Jupyter notebooks & DataLabs Initiative: Shaping the future

# What is the SAS?

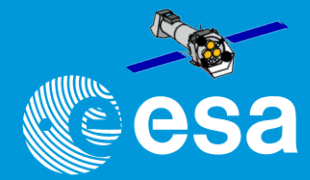


# What is the SAS?



- The XMM-Newton Scientific Analysis System is a suite of programs (“tasks”) for dealing with data from all XMM-Newton Instruments
- It is written basically in C++ and Fortran 90/95. Perl and shell scripts constitute “metatasks”. It makes use of public libraries / programs like cfitsio, xmgrace, ds9
- It has been developed by ~ 30 programmers, working in 6 different countries along many, many years.....
- A subset of the SAS is used as the core of the official Pipeline Processing System (PPS) for reducing the data to calibrated event lists, images, spectra, source lists (and much more)

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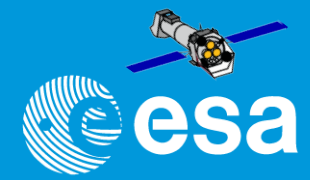


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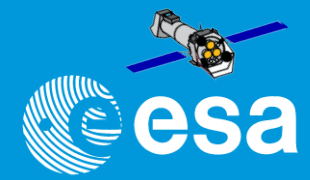
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New SAS v21.0 to be released on April 2023

- Binary distributions of SAS are available **only** for 64bit:
  - Linux Centos 7.3, Ubuntu 20.04 and RHEL8.6
  - Mac OS X - 64bit
    - + 11.07 - *Big Sur* and 12.07 - *Monterrey*
  - *Virtual Machine running Ubuntu 20.04 64bit (Windows, Linux and MacOSX).*
  - *Docker version since SAS v20.0*
- >> “official” supported platforms which can be used by other OSs
- Objectives:
  - make it easy to install: untar and go
  - provide all libraries required, also external ones (like cfitsio) -  
(however, need to be installed: ds9 / FTOOLS / GRACE / Perl)



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- *Docker version since SAS v20.0*

## Mac Note:

- Apple M1 is based on ARM architecture
- Intel binaries can be executed thanks to Rosetta emulator
- Currently working on a SAS native M1 build

>> “official” supported platforms which can be used by other OSs

- Objectives:

- make it easy to install: untar and go

- provide all libraries required, also external ones (like cfitsio) -  
(however, need to be installed: ds9 / FTOOLS / GRACE / Perl)

All SAS installations are binary (no support for building from source code)

```
tar xzf sas_20.0.0-[OS].tgz
```

```
./install.sh (will check everything is in place, download and install a Miniconda if  
necessary and finally install SAS)
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directory with all contents
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directory with all contents
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Everytime you want to run SAS:

```
> ./setsas.sh (bash) or > source ./setsas.csh (csh) in that directory
```

or

```
> . <top-dir>/xmmsas_20211130_0941/setsas.sh
```

```
> source <top-dir>/xmmsas_20211130_0941/setsas.csh
```

X-ray detectors are **photon-counting** → two main consequences:

- X-ray astronomy is an **intrinsic Poissonian science**
  - Scientific products can have a few or even zero events in large ranges of their parameter spaces
- The “king” in the X-ray realm is the **event**, characterised by:
  - **position (X-Y) on the detector**
  - “**pulse height**”, which is related to the X-ray **energy (E)** of the incoming photon in a complex and generally non-linear way
  - **arrival time (t) at the spacecraft**
  - event “**shape**” (used to separate X-ray events from particles’ signatures)
  - other secondary attributes (you don’t generally have to worry about)

**When?**

**Where?**

**Who?**

**What?**

	<input type="checkbox"/> TIME D s	<input type="checkbox"/> X J 0.05 ARCSECONDS	<input type="checkbox"/> Y J 0.05 ARCSECONDS	<input type="checkbox"/> PHA I CHAN	<input type="checkbox"/> PI I CHAN	<input type="checkbox"/> PATTERN B	<input type="checkbox"/> CCDNR B
1	9.506202266412E+07	23743	21330	423	1447	2	1
2	9.506202266412E+07	28728	21990	25	98	0	1
3	9.506202527717E+07	28176	31623	25	97	0	1
4	9.506202527717E+07	29829	30841	327	1131	0	1
5	9.506202527717E+07	23686	19319	541	1854	0	1
6	9.506203046611E+07	25510	32711	1810	6171	0	1
7	9.506203566620E+07	29814	28823	102	360	0	1
8	9.506203826626E+07	26635	30601	2062	7028	0	1
9	9.506204346625E+07	26429	20314	443	1519	4	1
10	9.506204606629E+07	20691	28728	1608	5471	3	1
11	9.506204606629E+07	27989	29777	202	700	0	1
12	9.506204606629E+07	21937	25667	117	402	2	1
13	9.506204866632E+07	28132	32491	462	1589	0	1
14	9.506204866632E+07	27204	29741	904	3095	0	1
15	9.506205126638E+07	22124	20257	290	994	0	1
16	9.506205906643E+07	23193	18795	1398	4771	0	1
17	9.506206166646E+07	23224	19326	276	950	0	1
18	9.506206946653E+07	27755	28979	183	637	0	1
19	9.506207206939E+07	22533	29563	33	118	0	1

The X-ray scientific products can be seen as ***projections*** onto the sub-spaces defined by the event physical quantities

- By collapsing time and space, one gets an energy distribution function (***spectrum***) in units of ***counts per energy bin***
- By collapsing time and energy, one gets a 2-D ***image*** in units of ***counts per pixel***
- By collapsing space and energy, one gets an intensity ***time series*** in units of ***counts per time bin***

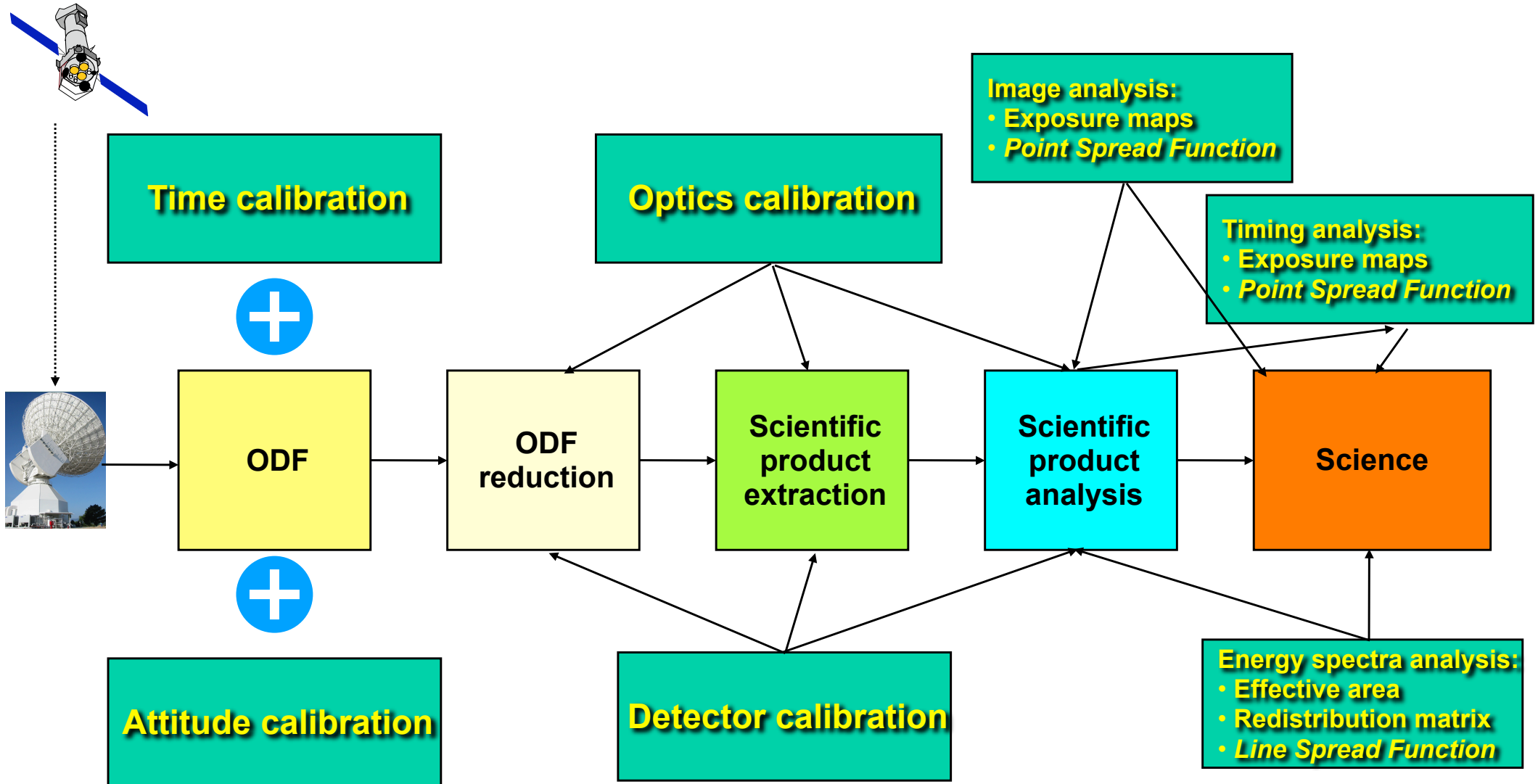
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**These scientific products are expressed in units that are *indirectly* related to the intrinsic properties of celestial sources**

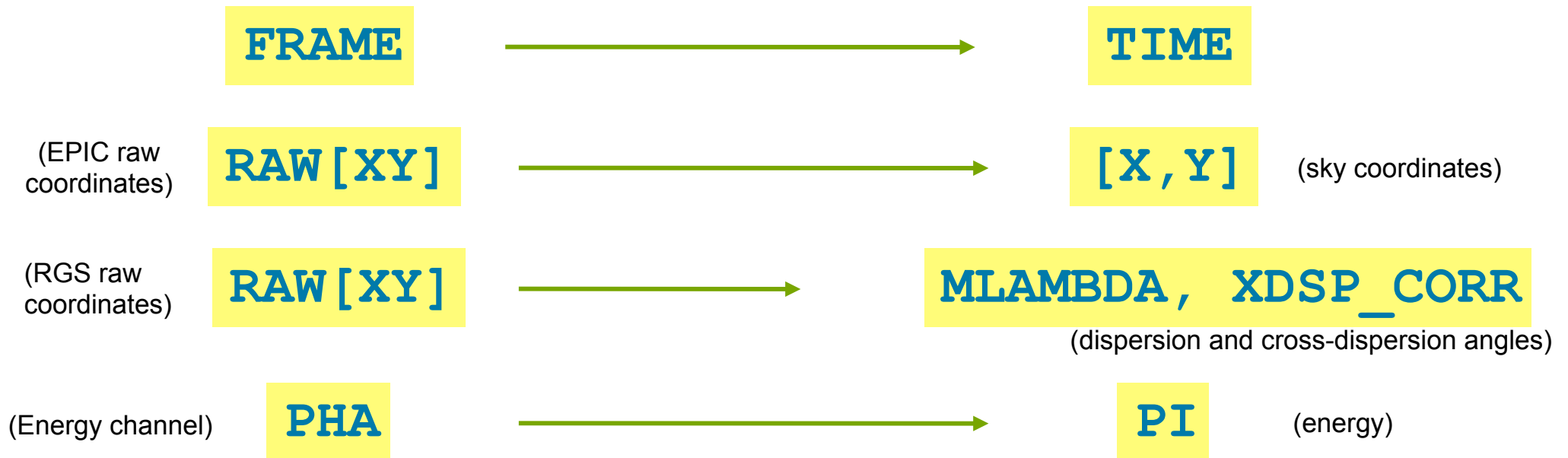


# Data reduction = calibration



SAS does two things (to XMM data), that no other tool does:

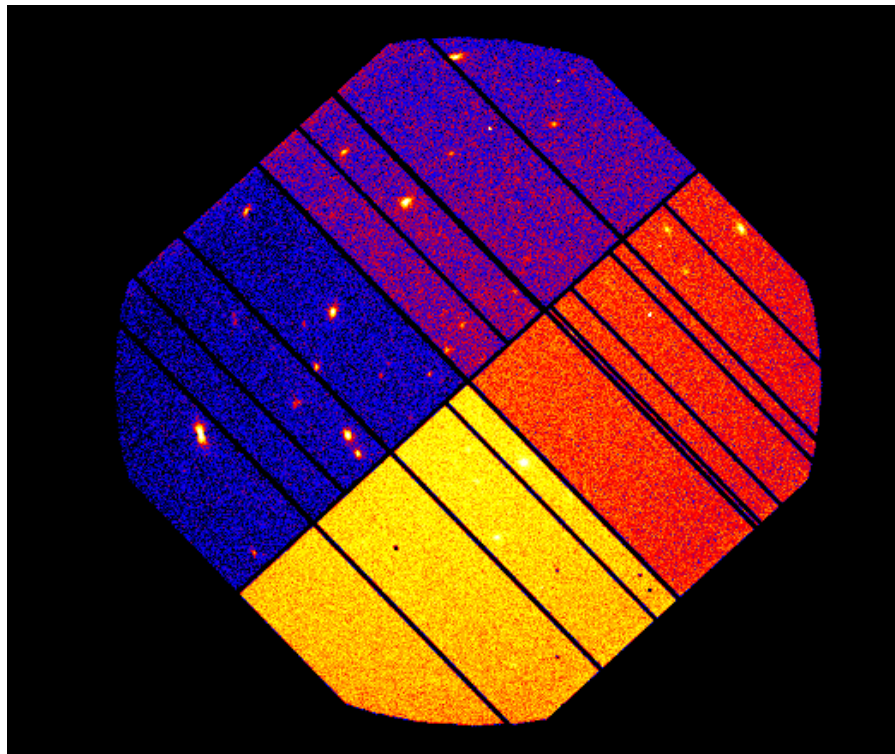
- applies **calibrations** to raw data



- optimally **screen / filter** your data

SAS does two things (to XMM data), that no other tool does:

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**TIME**

**[X, Y]**

(sky coordinates)

**MLAMBDA, XDSP\_CORR**

(dispersion and cross-dispersion angles)

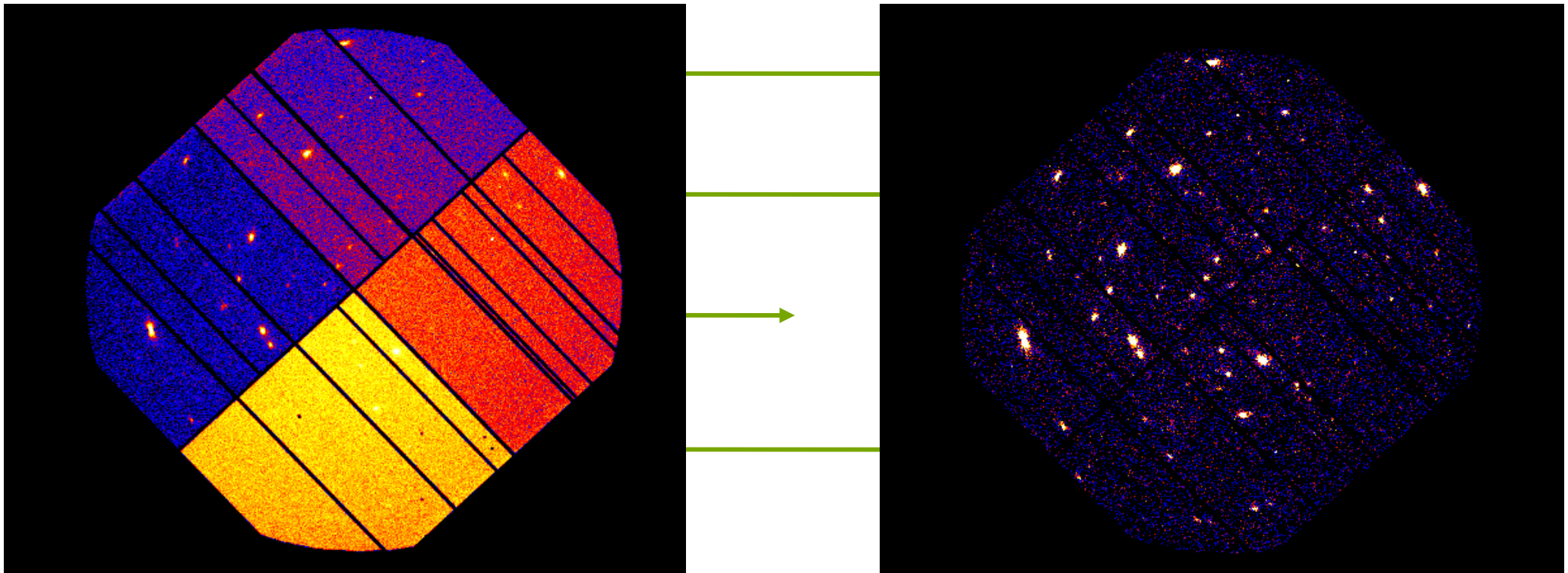
**PI**

(energy)

- optimally **screen / filter** your data

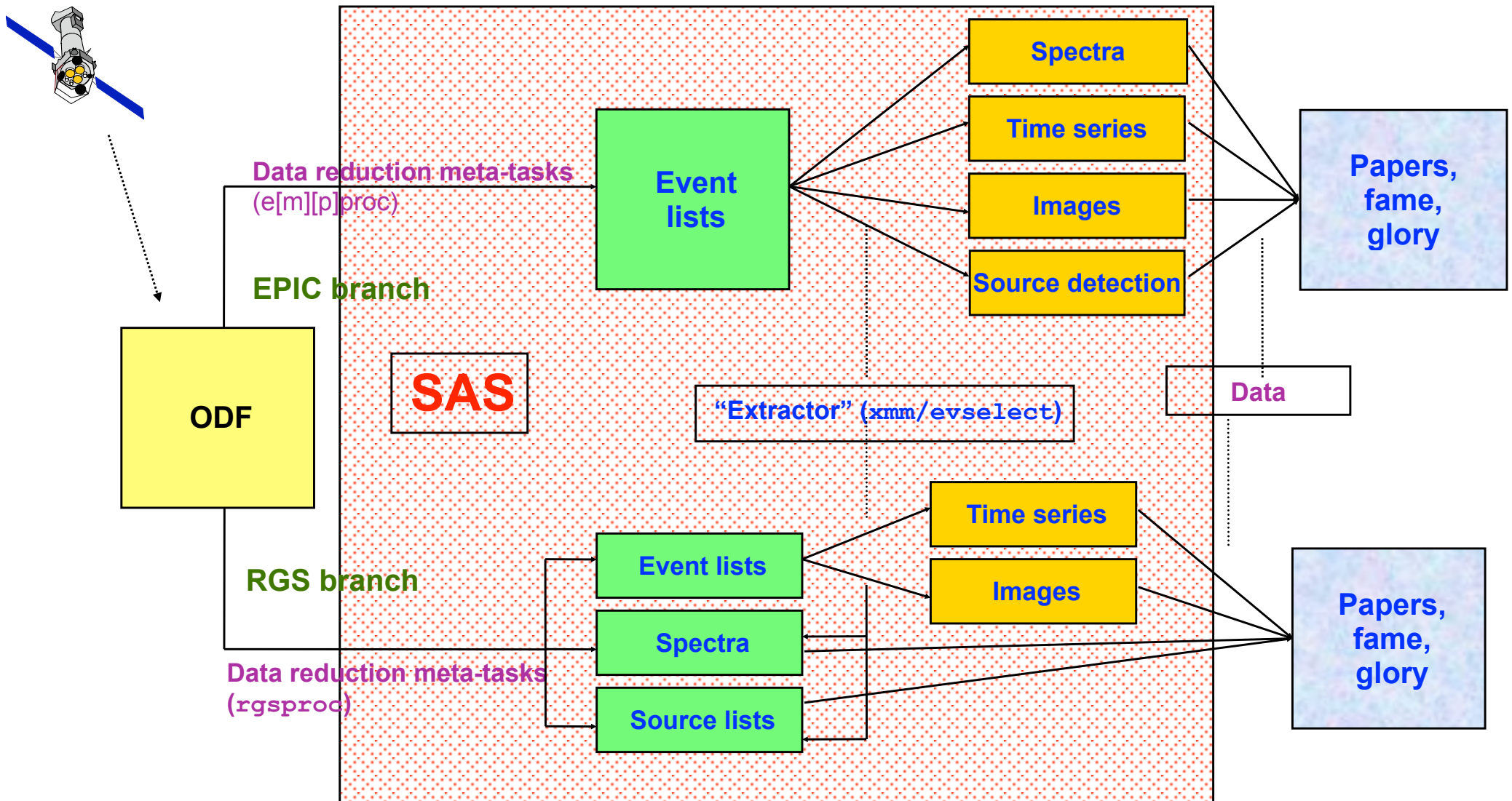
SAS does two things (to XMM data), that no other tool does:

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# SAS Grand-Scheme



A yellow square with a black border containing the text 'ODF' in blue.

ODF

- CCD-based event lists, containing uncalibrated quantities
- Auxiliary and Housekeeping files, pn/RGS diagnostic images
- Spacecraft housekeeping
- Spacecraft attitude showing the satellite star tracker pointing
- Time correlation file (onboard time and frame counter versus UTC)
- ODF summary file

ODF

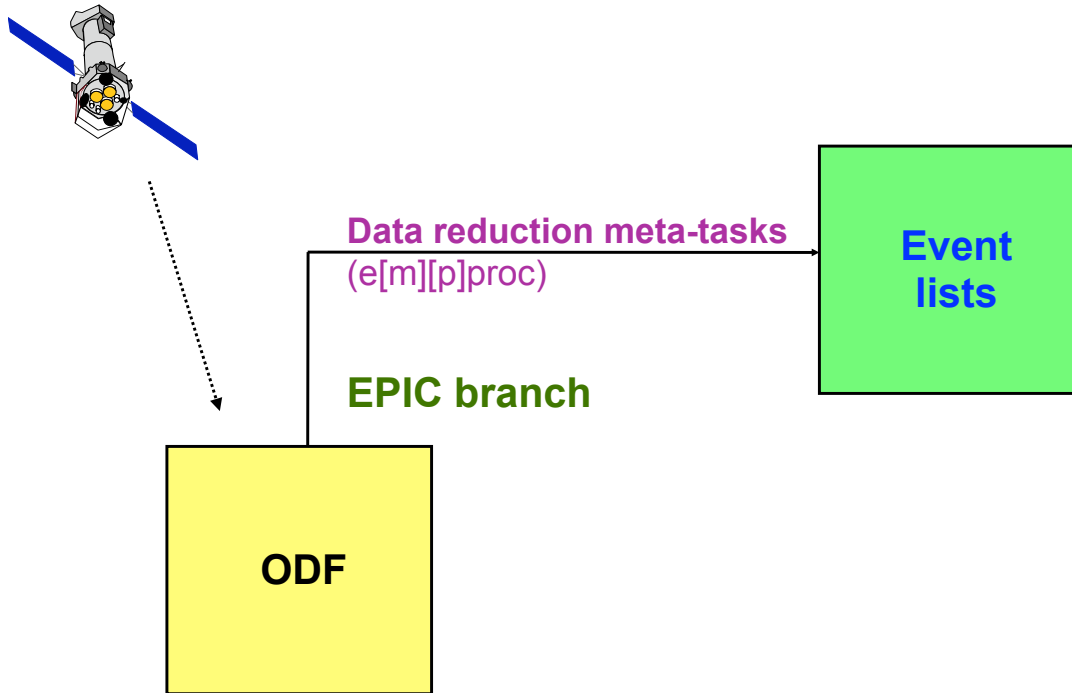
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ODF

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- **ODF summary file** **ASCII**

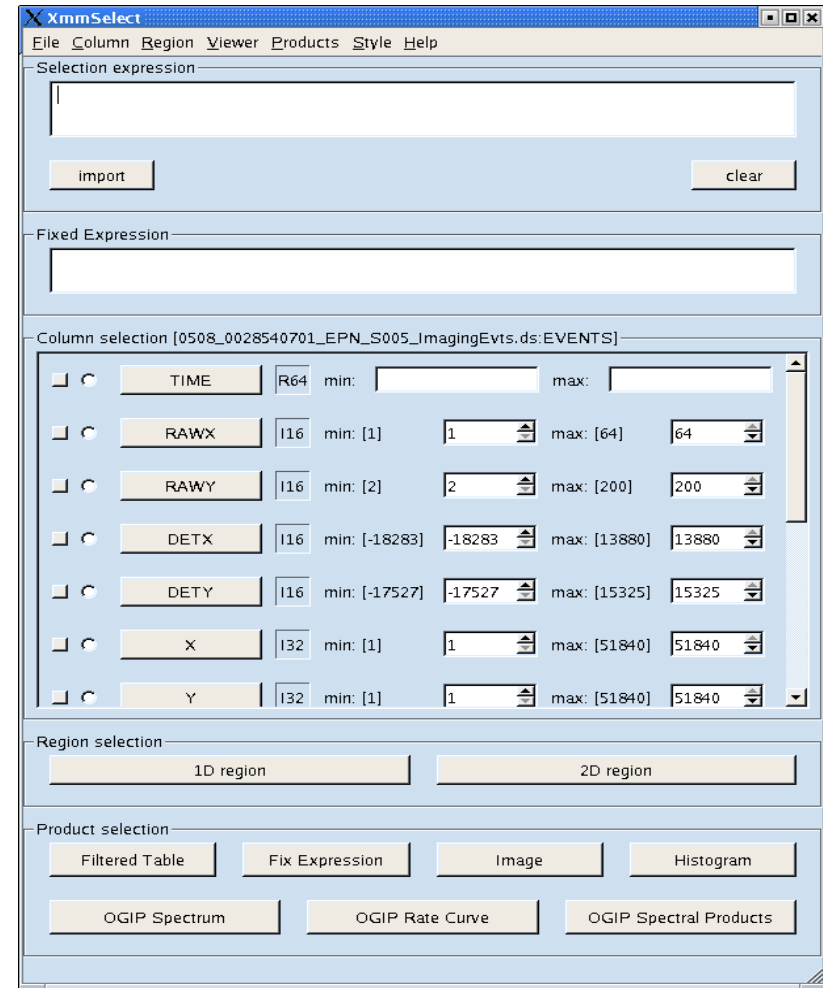
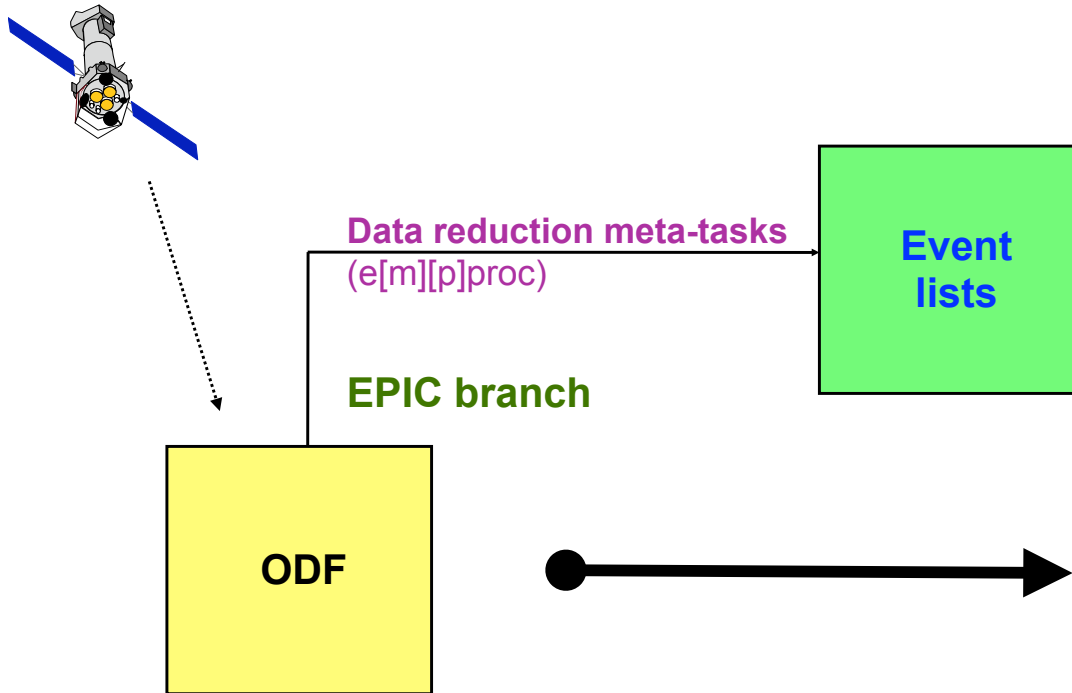


# epicproc = e[m][p]proc



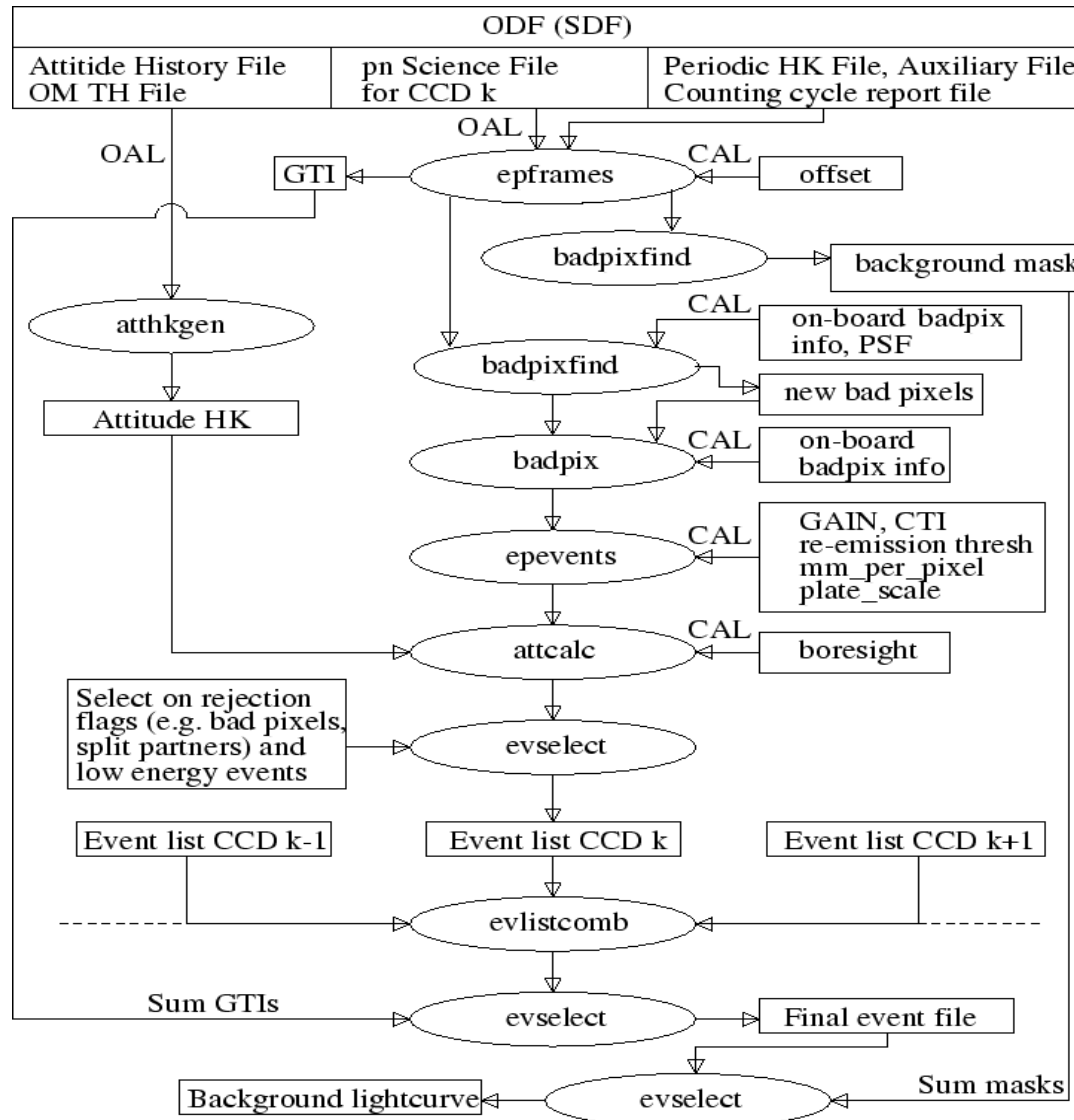
- metatasks to process MOS or pn data
- generate calibrated, filtered event lists
- leave user in control of GTI and filter expressions

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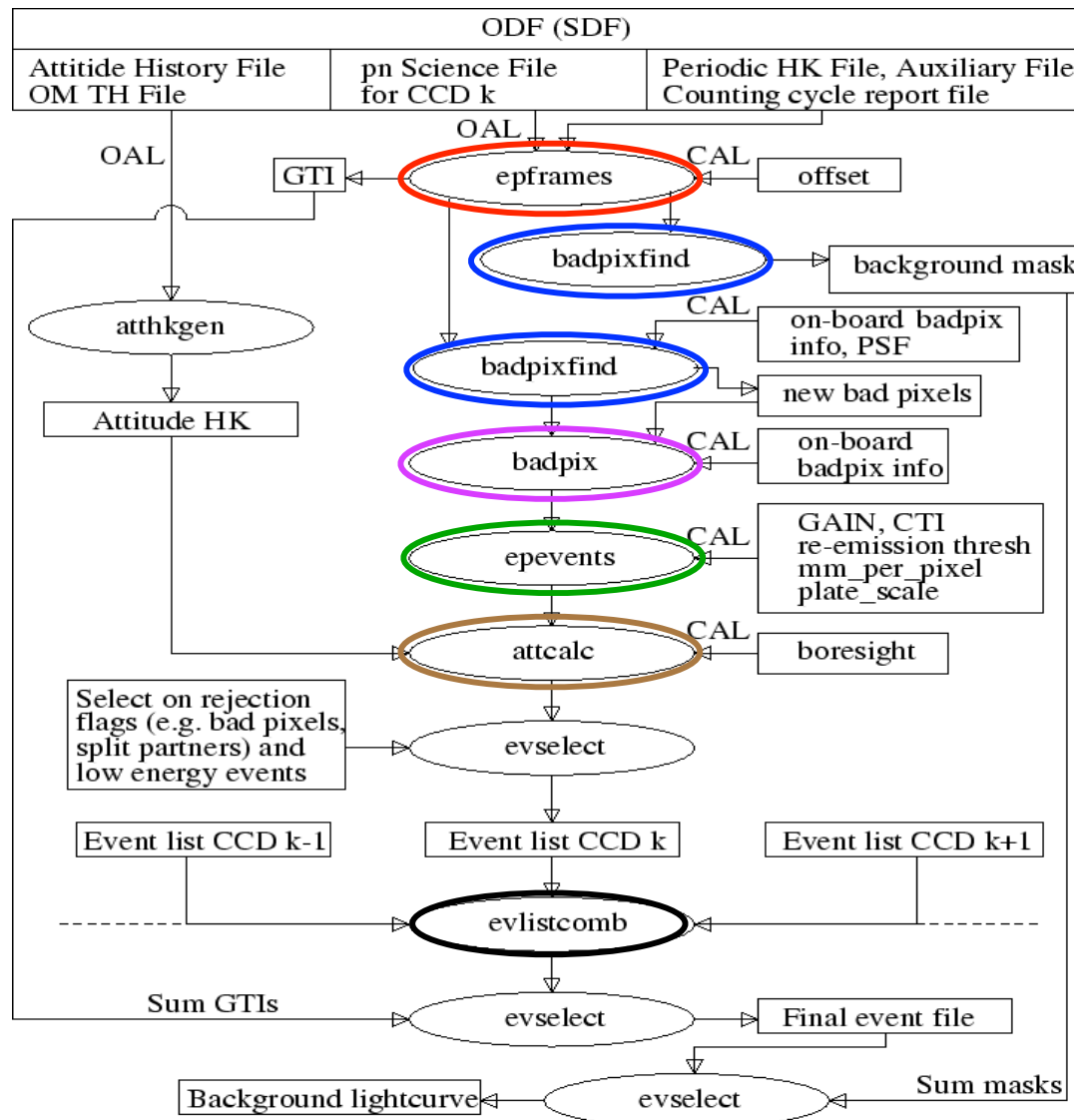
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# eproc reduction scheme



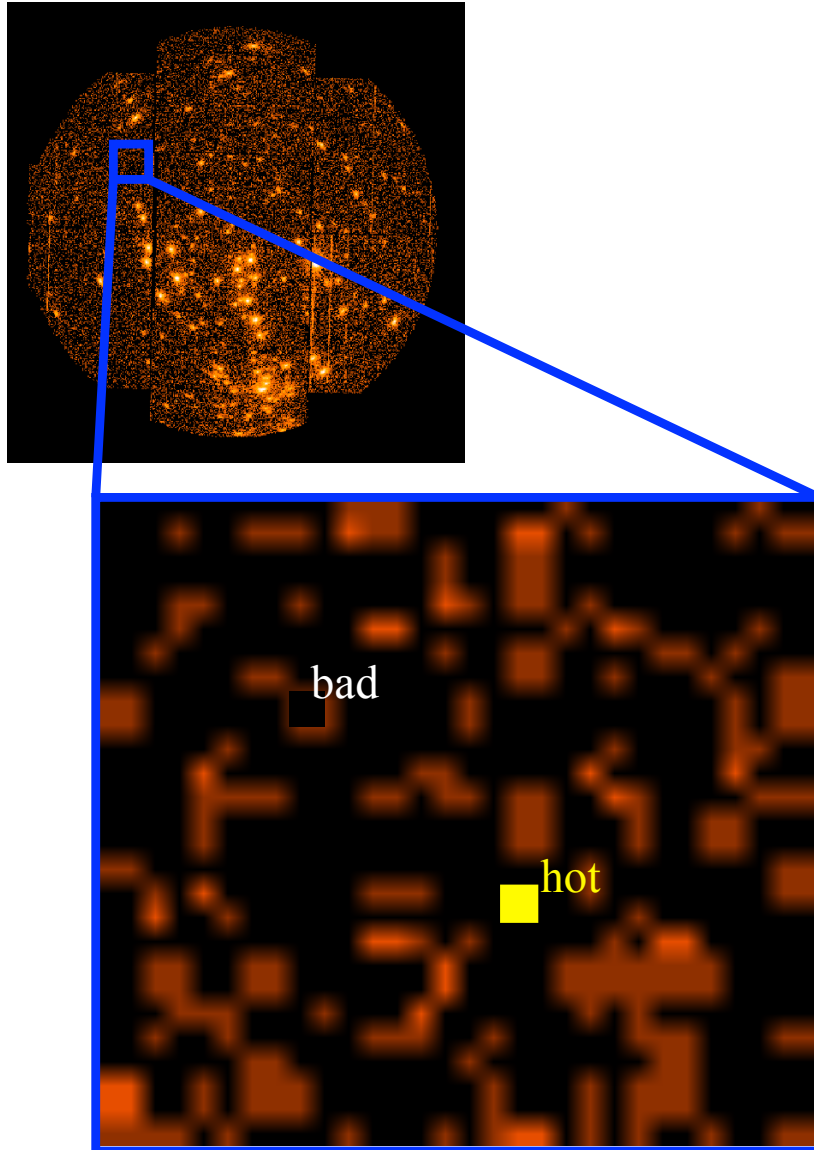
- **epframes** to process a CCD, exposure and datamode specific ODF file, creating the output raw event list and GTI data set
- **badpixfind** to find new bad pixels
- **badpix** to process the raw event list, adding the BADPIX extension
- **epevents** to process the event list file, flagging trailing events, performing split events pattern recognition, CTI and gain correction to create the calibrated event list
- **attcalc** to calculate the X and Y sky coordinates.
- **evlistcomb**, the CCD specific data sets are merged into a single event list.

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- In the EPIC pn imaging mode, the EVENTS table of the calibrated event list files contain 14 columns i.e :
  - TIME --> **when** did my photon arrive
  - RAWX RAWY --> **where** on the CCD
  - DETX DETY --> **where** on the detector
  - X Y --> **where** from the sky
  - PHA PI --> **which** energy did my photon have
  - FLAG --> did it hit the detector at a critical place
  - PATTERN --> was it a single/double.....
  - CCDNR --> on which CCD did it hit the detector



- dead pixel: no events are detected
- hot pixel: pixel “produces” ghost events very often
- by default epicproc will try to detect bad pixels for any imaging exposure.
- the new bad pixels are then used in the data reduction together with any other known (via the calibration files) bad pixels

- by default the event lists are filtered, and the filtered events are removed
- the filter expression can be controlled by the user
  - `flagfilteredevents == true`:  
In this case all events will be retained, and a flag column will be set to indicate what events would have been removed.

Fundamental final product of `epicproc` is the event list:

`*[Imaging-Timing]Evts.ds` (eg. `0193_0112570601_EMOS1_S001_ImagingEvts.ds` )

+ BadPixel tables produced by `(em)badpixfind`

Once we have the event files.... It is time to “xmmselect” to filter the data and produce images, spectra or light curves....

```
#> xmmselect table=<PNorMOS_event_file>
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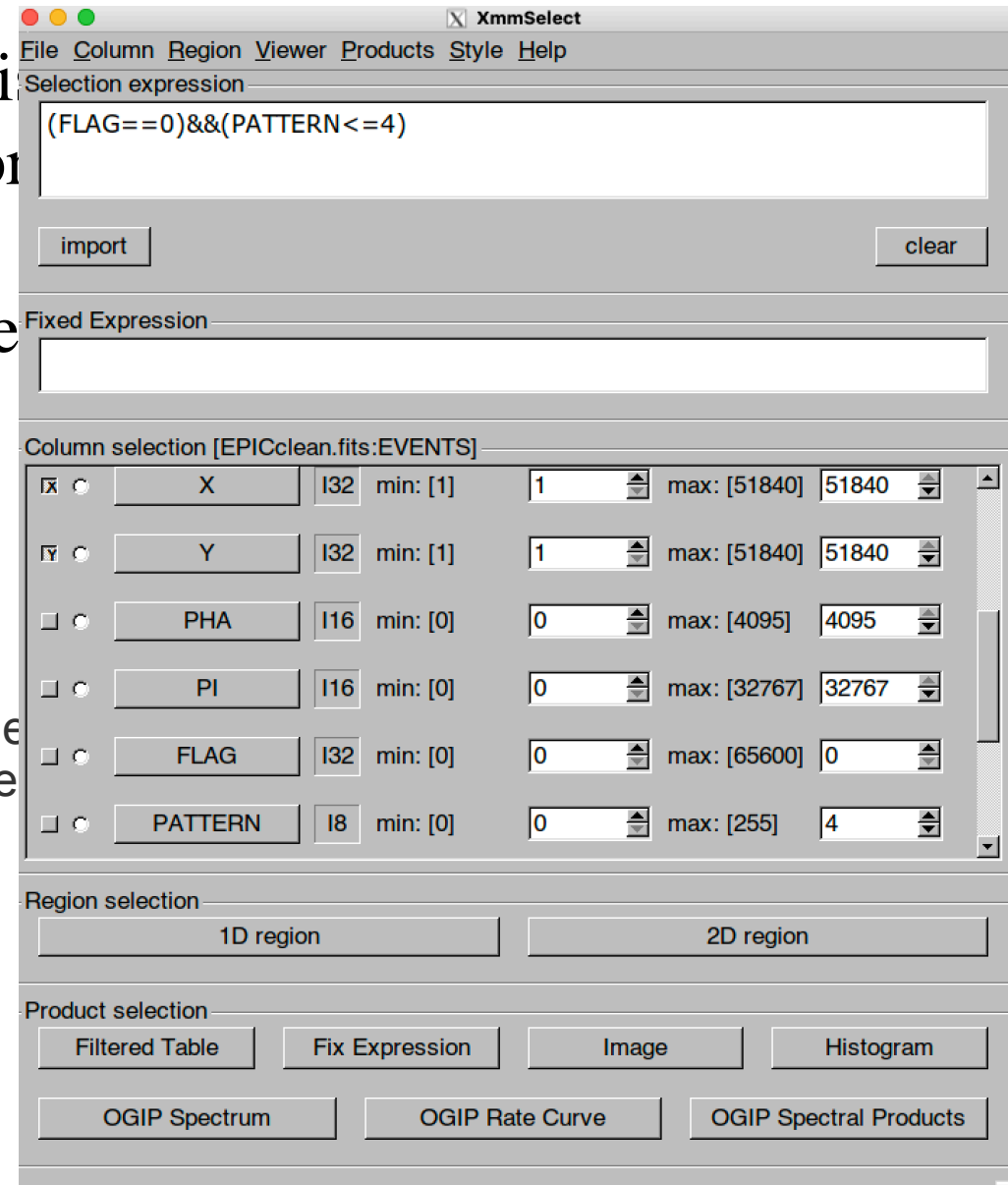
- How to filter EPIC event lists for flaring particle background
- Extraction of pn spectra from point-like sources

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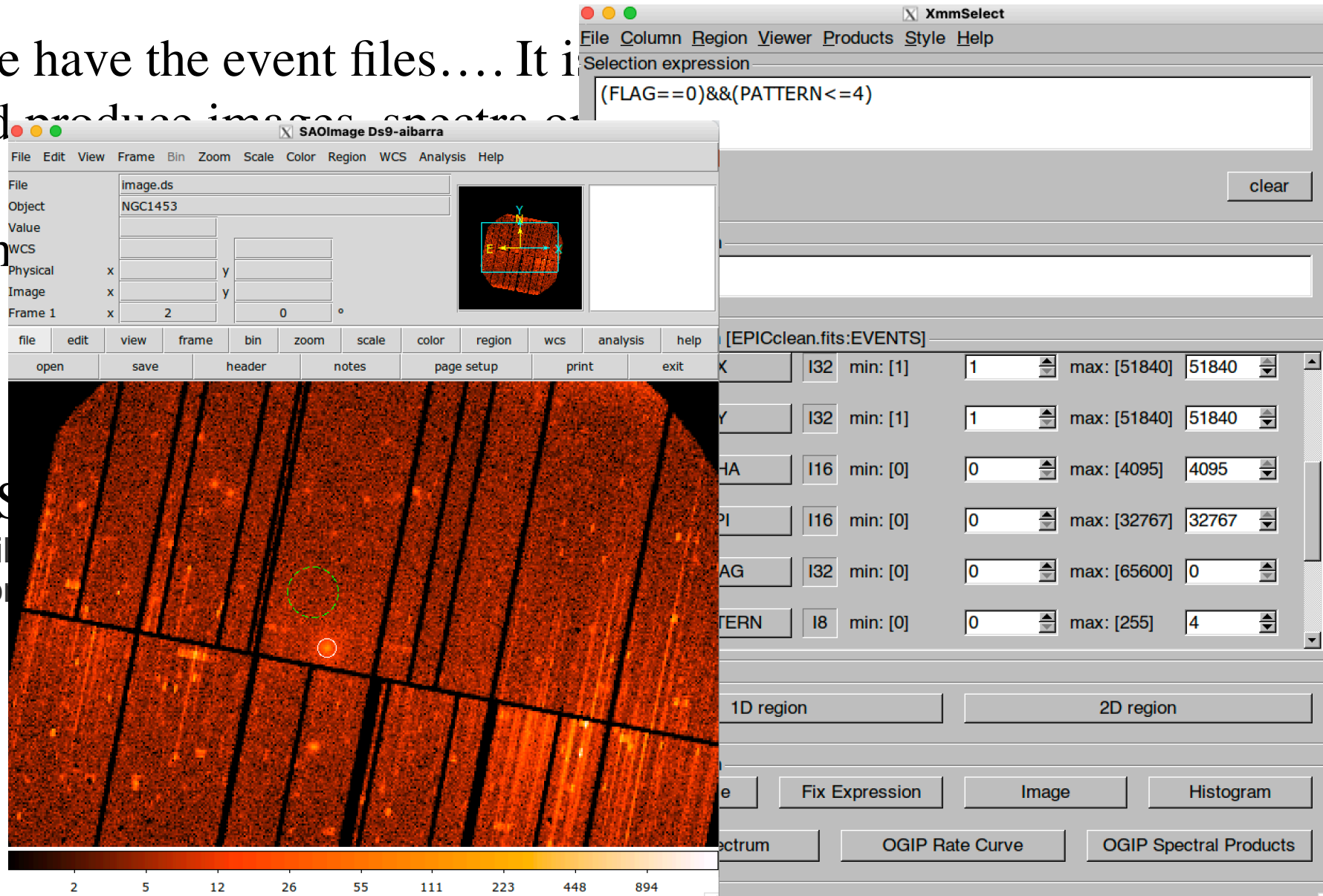


Once we have the event files.... It is  
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#> xmm

Follow S

- How to fit
- Extraction

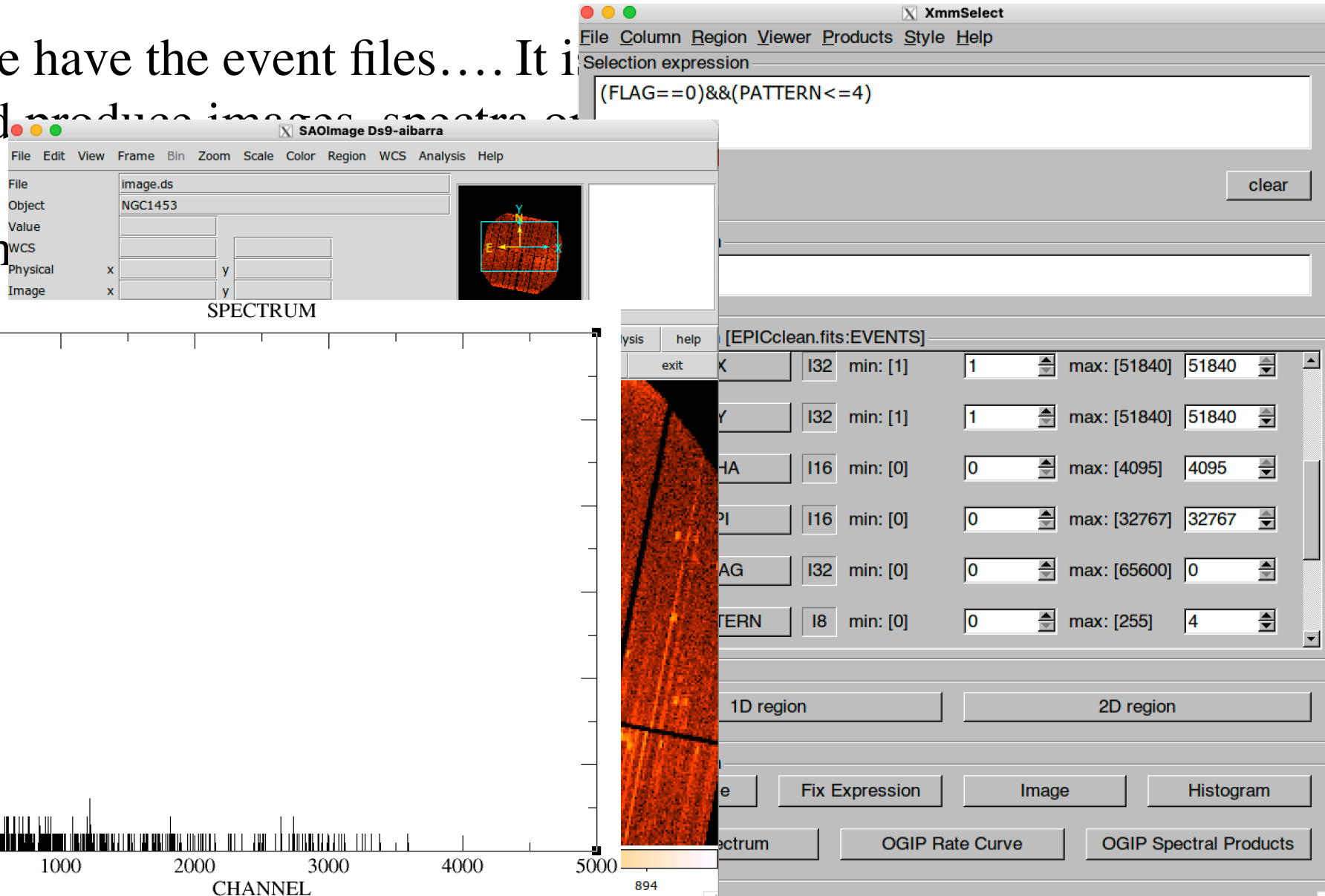


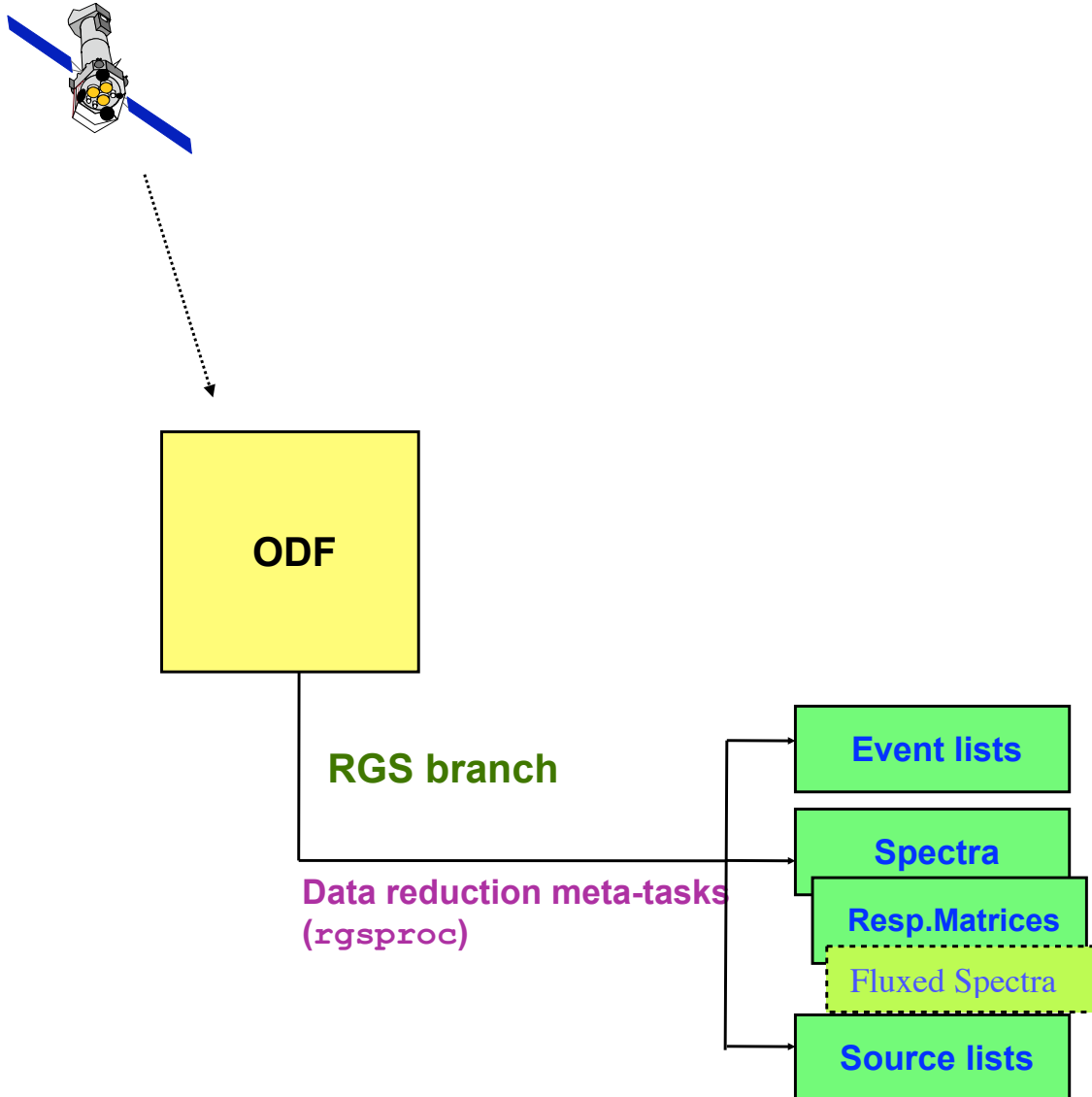
The screenshot displays the XmmSelect software interface. The main window shows a large image of a detector with a color scale at the bottom ranging from 2 to 894. A green circle highlights a region of interest, and a red circle highlights a specific event. The XmmSelect window is open, showing a selection expression:  $(FLAG=0)\&\&(PATTERN\leq 4)$ . The interface includes various panels and buttons for event selection and analysis.

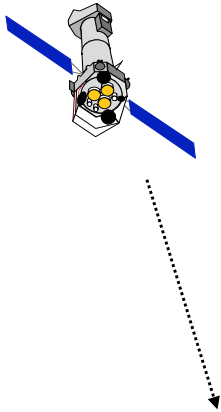
Parameter	Value	Min	Max	Current
X	132	min: [1]	max: [51840]	51840
Y	132	min: [1]	max: [51840]	51840
HA	116	min: [0]	max: [4095]	4095
PI	116	min: [0]	max: [32767]	32767
AG	132	min: [0]	max: [65600]	0
PATTERN	18	min: [0]	max: [255]	4

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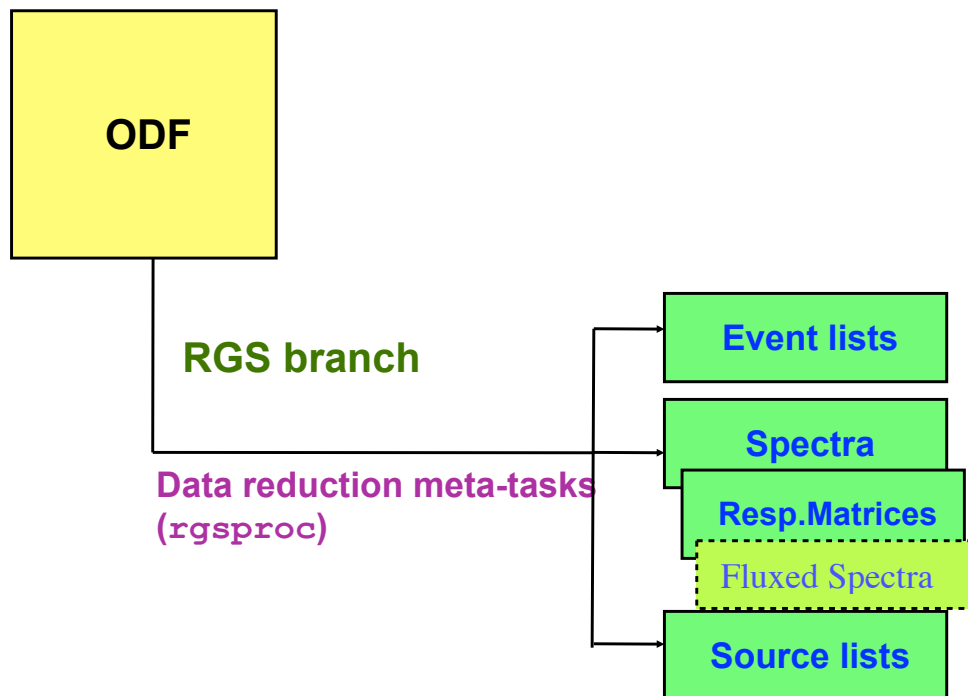
#> xmm

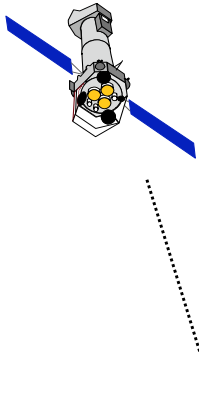






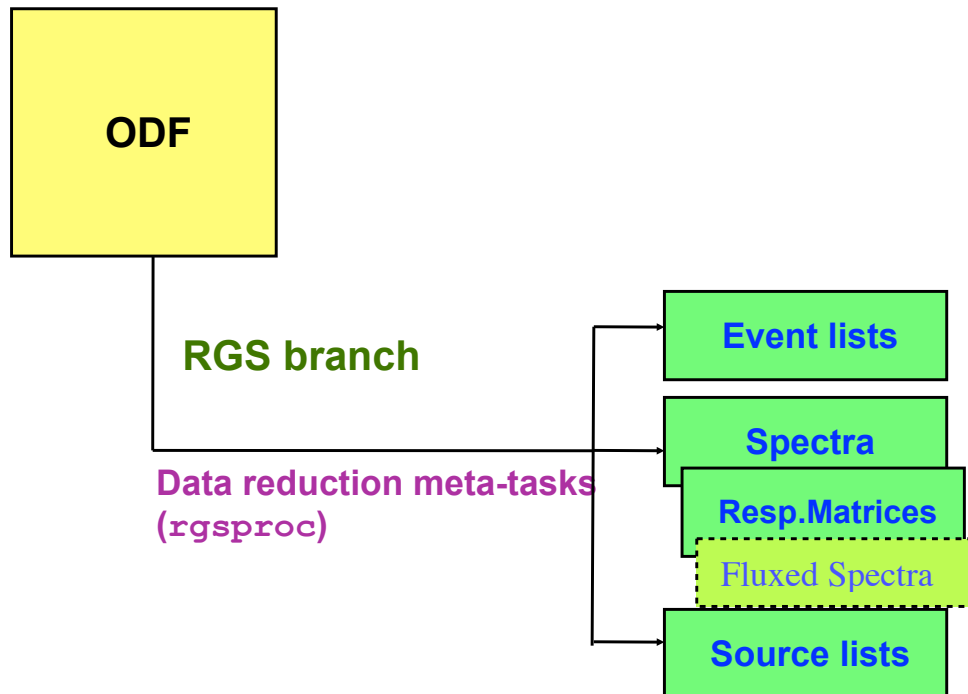
- meta-task: interface to 17 SAS tasks (that can also be run separately)
- controlled by  $\approx 80$  parameter switches
- five entry and final points (“processing stages”) >>
- produces filtered event lists, spectra and matrices
- **the quality of the results depends critically on the source coordinates**

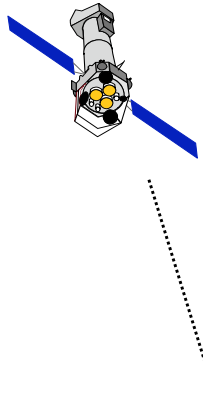




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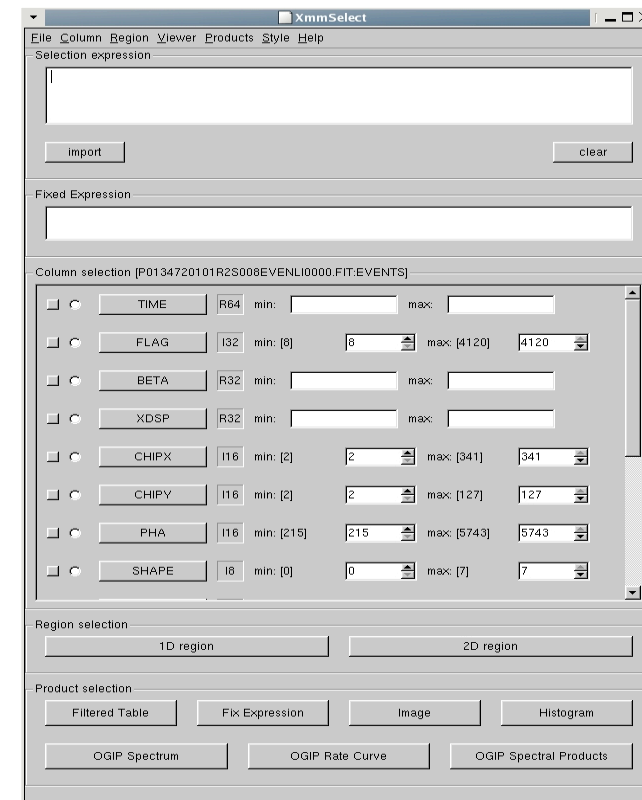
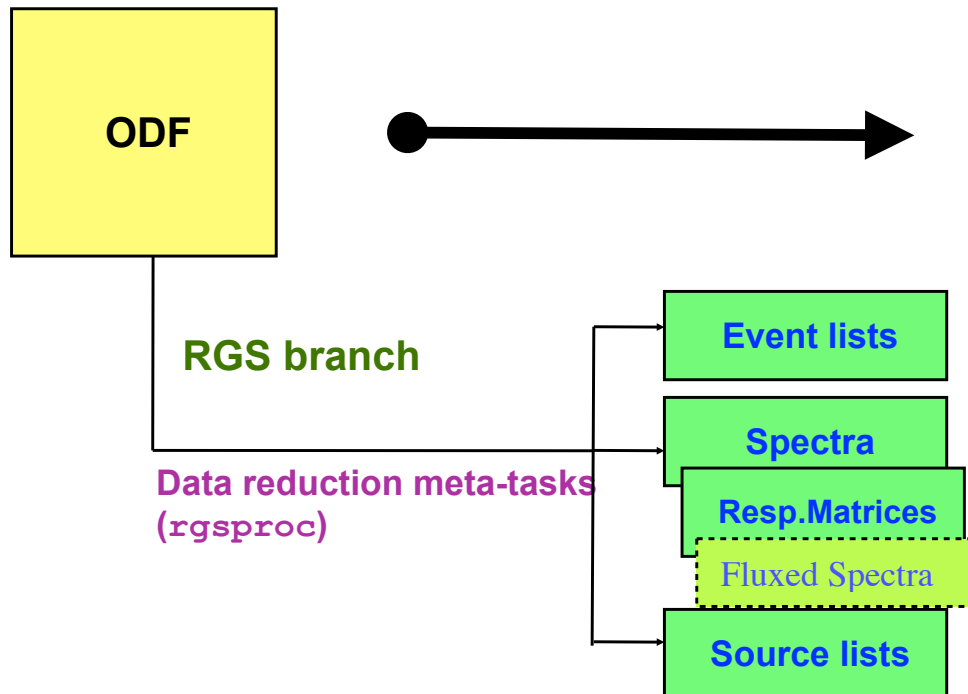
events  
angles  
filter  
spectra  
fluxing





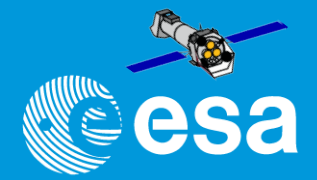
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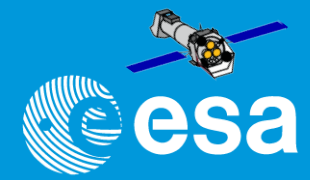


# Simplified scheme of the RGS FOV

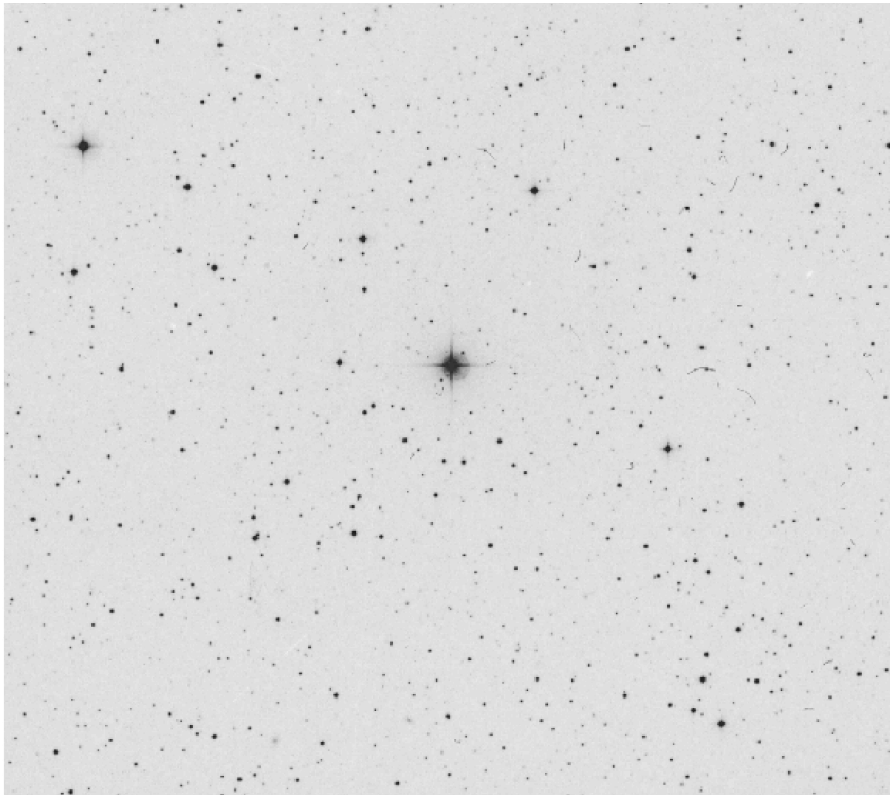


why the coordinates are so important!:

# Simplified scheme of the RGS FOV

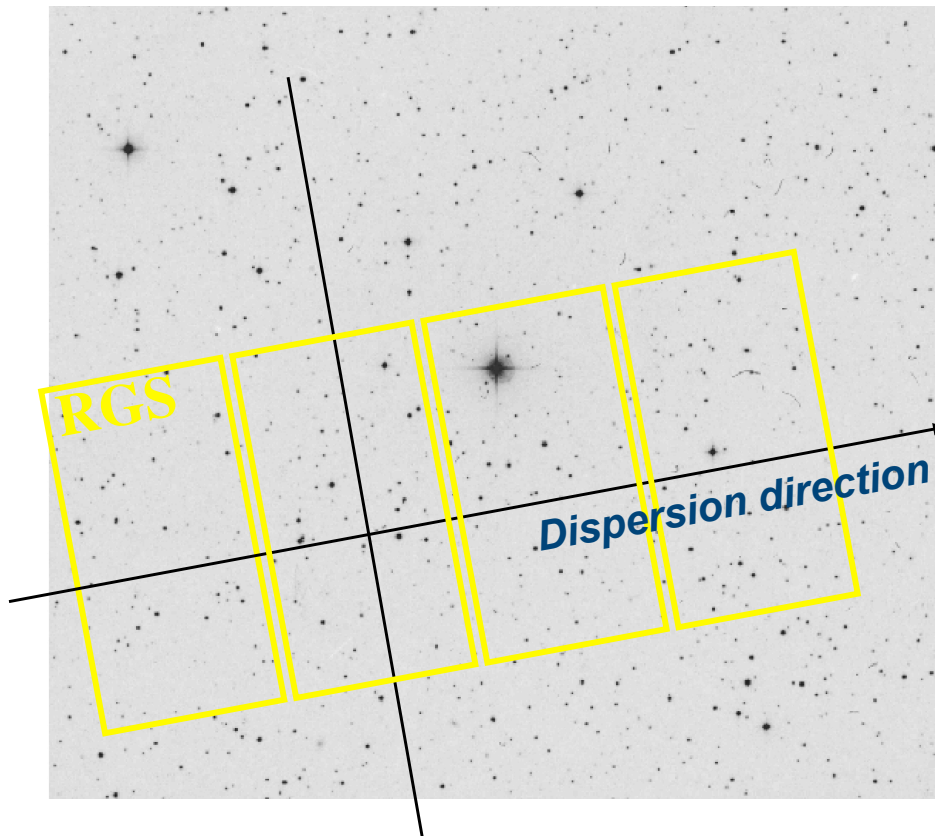


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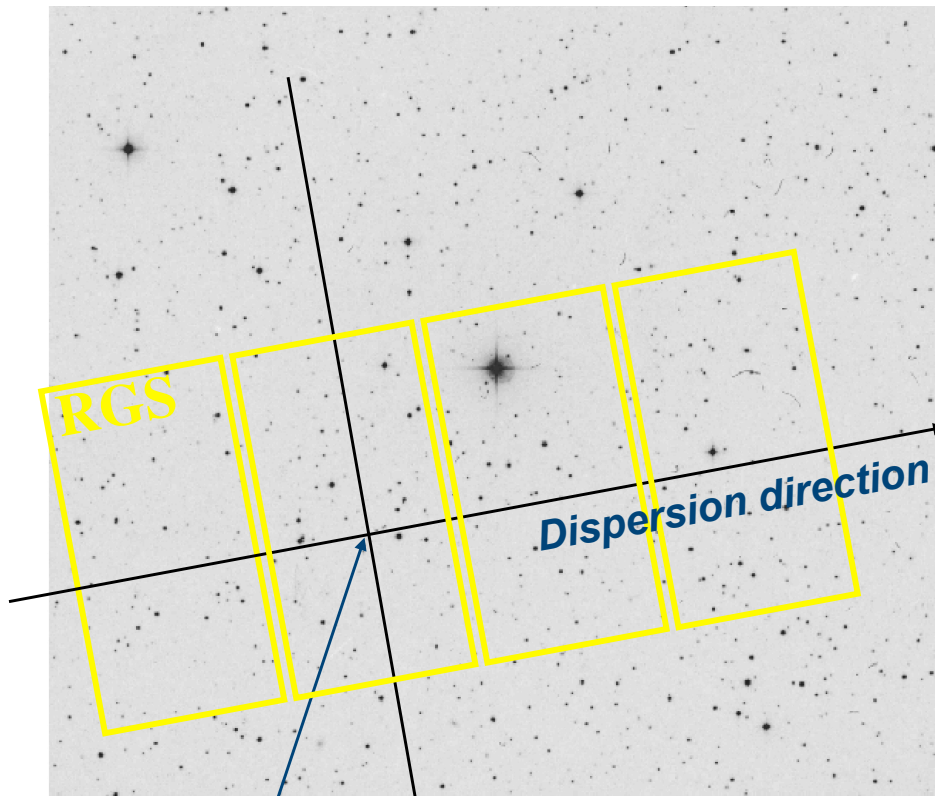
# Simplified scheme of the RGS FOV

why the coordinates are so important!:



# Simplified scheme of the RGS FOV

why the coordinates are so important!:



S/C pointing:  $RA_0, dec_0$   
 $\alpha_0$ : incidence angle at centre of FOV

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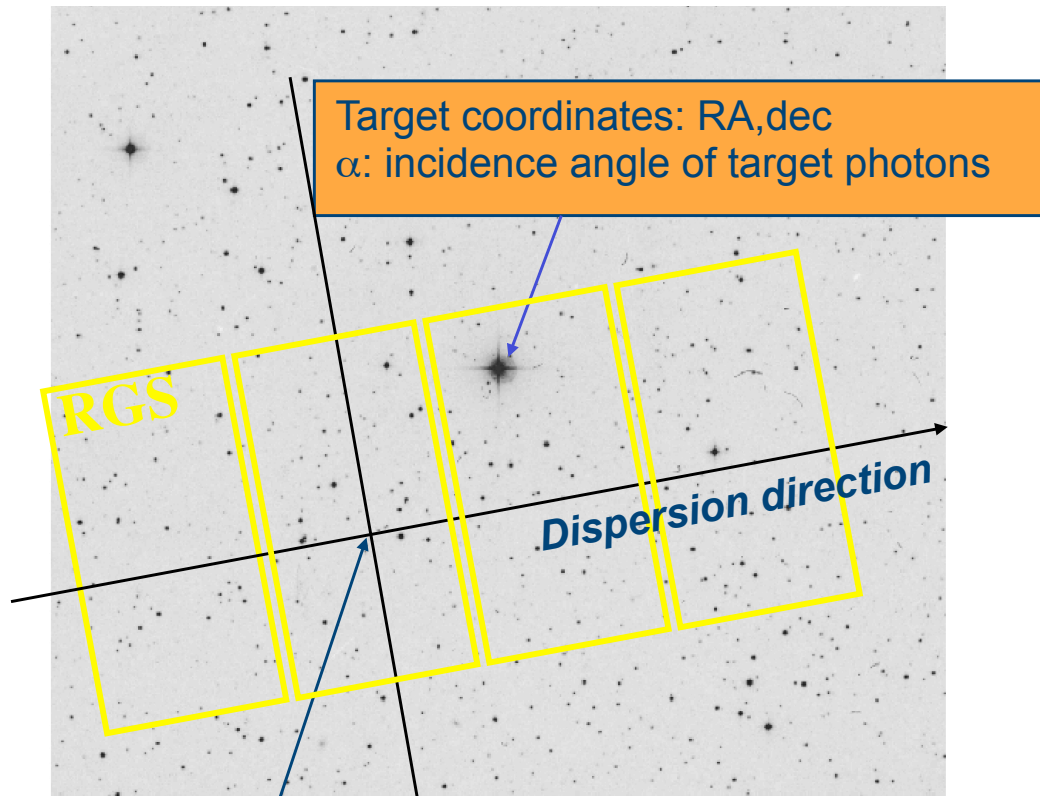


Target coordinates: RA,dec  
 $\alpha$ : incidence angle of target photons

S/C pointing:  $RA_0, dec_0$   
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# Simplified scheme of the RGS FOV

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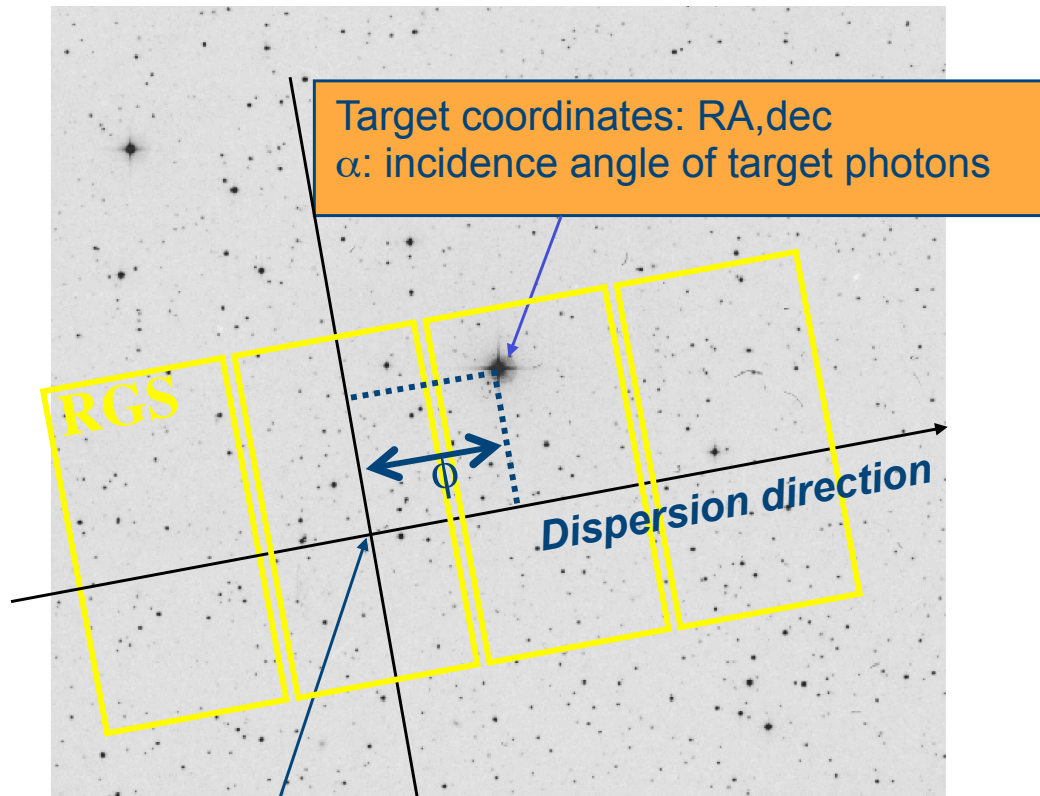
According to the grating equation

$$\lambda = (\cos \beta - \cos \alpha) d / m$$

being  $\alpha = \alpha_0 + \phi F/L$

# Simplified scheme of the RGS FOV

why the coordinates are so important!:



Target coordinates: RA,dec  
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S/C pointing:  $RA_0, dec_0$   
 $\alpha_0$ : incidence angle at centre of FOV

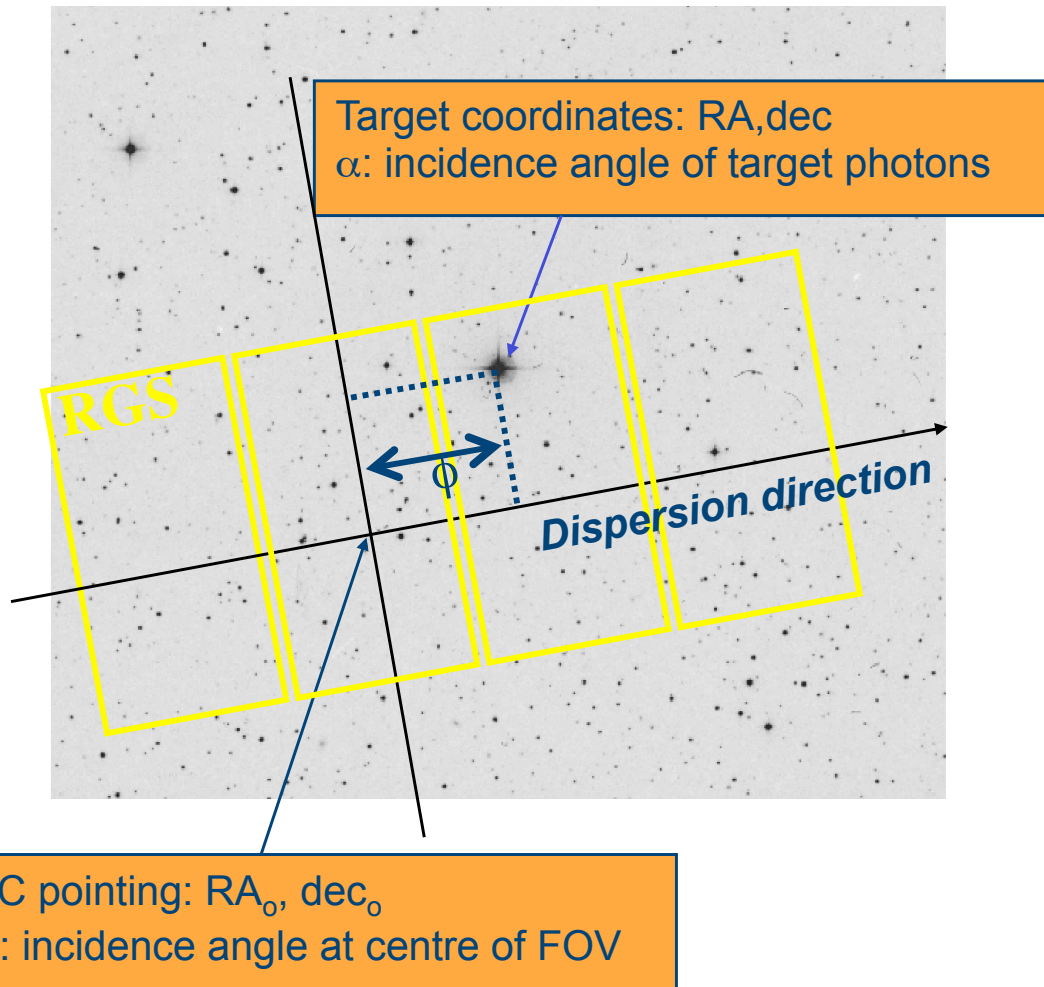
According to the grating equation

$$\lambda = (\cos \beta - \cos \alpha) d / m$$

being  $\alpha = \alpha_0 + \phi F/L$

# Simplified scheme of the RGS FOV

why the coordinates are so important!:



According to the grating equation

$$\lambda = (\cos \beta - \cos \alpha) d / m$$

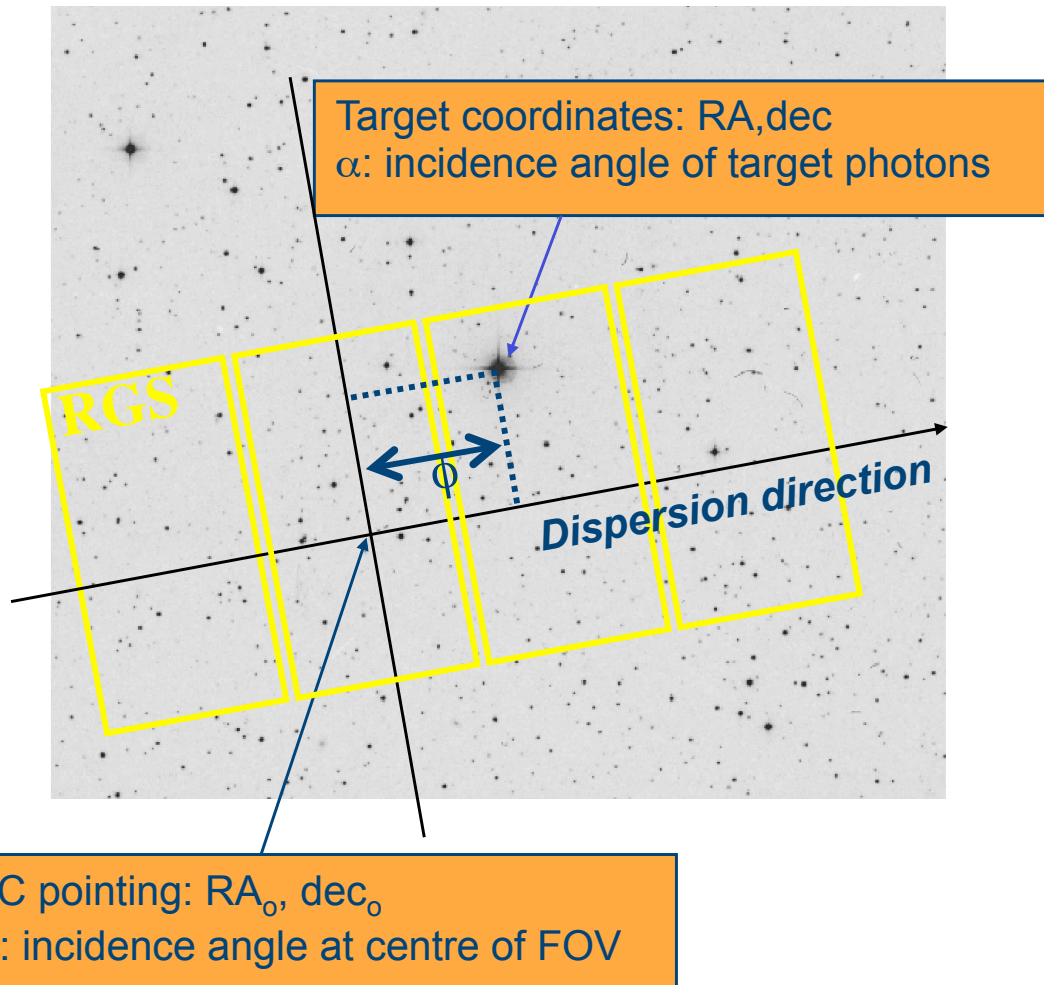
being  $\alpha = \alpha_0 + \phi F/L$

$$\phi = f (RA - RA_0, dec - dec_0, P.A.)$$



# Simplified scheme of the RGS FOV

why the coordinates are so important!:



According to the grating equation

$$\lambda = (\cos \beta - \cos \alpha) d / m$$

being  $\alpha = \alpha_0 + \phi F/L$

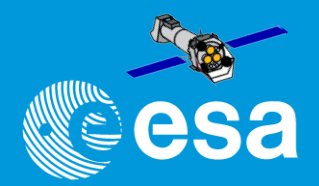
$$\phi = f (RA - RA_0, dec - dec_0, P.A.)$$



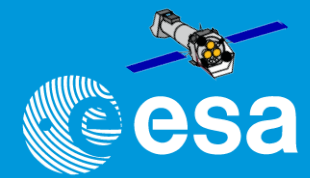
the wavelength scale and the effective area depend on the position of the source in the FOV

$$1 \text{ arcsec} \approx 2.3 \text{ m}\text{\AA} \text{ (45 km/s at } 15 \text{ \AA)}$$

# rgsproc: what does it do?

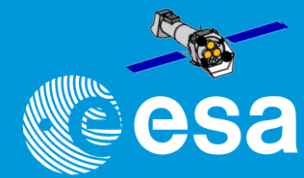


# rgsproc: what does it do?



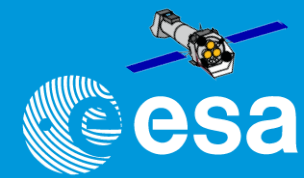
<b>Stage</b>	<b>Task</b>	<b>Purpose</b>	<b>Output</b>
<b>Events</b>	atthkgen	generates attitude file	Source list + intermediate combined event list
	attfilter	filters the attitude file	
	hkgtigen	generates housekeeping GTIs	
	rgsoffsetcalc	uses the diagnostic mode data for offset calculation	
	rgssources	creates the list of sources to processed	
	rgsframes	flags bad frames, convert RAW[XY] to readout node reference system ([XY]CORR), creates GTI for telemetry drops, calculates dead time	
	rgsenergy	performs energy calibrations, i.e. creates the PI column	
	rgsbadpix	flags bad pixels (CCF known + own analysis)	
	rgsevents	event reconstruction: total energy (ENERGY), "pattern" (GRADE/SHAPE), coordinates (CHIP[XY],BETA,XDSP)	
	evlistcomb	event list concatenation	

# rgsproc: what does it do?



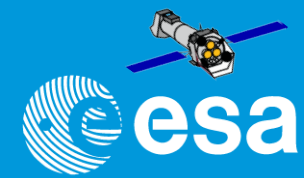
<b>Stage</b>	<b>Task</b>	<b>Purpose</b>	<b>Output</b>
<b>Events</b>	atthkgen	generates attitude file	Source list + intermediate combined event list
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	rgsevents	event reconstruction: total energy (ENERGY), "pattern" (GRADE/SHAPE), coordinates (CHIP[XY],BETA,XDSP)	
	evlistcomb	event list concatenation	
<b>Angles</b>	rgsangles	aspect correction (BETA_CORR, XDSP_CORR)	Aspect correction
<b>Filter</b>	rgsfilter	creates filtered event list, removing unwanted frames and events and adding exposure maps	Final event list
<b>Spectra</b>	rgsregions	computes background and source extraction regions foreach source	Source and background spectra
	rgsspectrum	extracts source and background spectra	
	rgsbkgmodel	generates model background (optional)	
<b>Fluxing</b>	rgsrmfgen	creates a response matrix	Response matrices and combined spectrum in physical units
	rgsfluxer	combines a collection of RGS spectra into one "fluxed" spectrum	

# rgsproc: what does it do?



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<b>Events</b>	atthkgen	generates attitude file	Source list + intermediate combined event list
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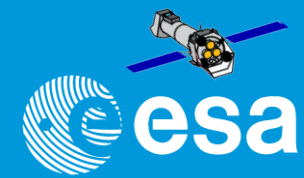
# rgsproc: what does it do?



Stage	Task	Purpose	Output
<b>Events</b>	atthkgen	generates attitude file	Source list + intermediate combined event list
	attfilter	filters the attitude file	
	hkgtigen	generates housekeeping GTIs	
	rgsoffsetcalc	uses the diagnostic mode data for offset calculation	
	rgssources	creates the list of sources to processed	
	rgsframes	flags bad frames, convert RAW[XY] to readout node reference system ([XY]CORR), creates GTI for telemetry drops, calculates dead time	
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	rgsbadpix	flags bad pixels (CCF known + own analysis)	
	rgsevents	event reconstruction: total energy (ENERGY), "pattern" (GRADE/SHAPE), coordinates (CHIP[XY],BETA,XDSP)	
	evlistcomb	event list concatenation	
<b>Angles</b>	rgsangles	aspect correction (BETA_CORR, XDSP_CORR)	Aspect correction
<b>Filter</b>	rgsfilter	creates filtered event list, removing unwanted frames and events and adding exposure maps	Final event list
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Source dependent

# rgsproc: what does it do?



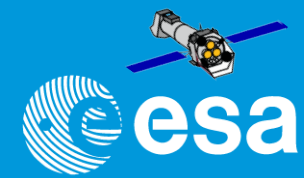
Stage	Task	Purpose	Output
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	attfilter	filters the attitude file	
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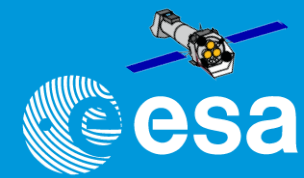
Source independent

<b>Angles</b>	rgsangles	aspect correction (BETA_CORR, XDSP_CORR)	Aspect correction
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Source dependent



# rgsproc: what does it do?



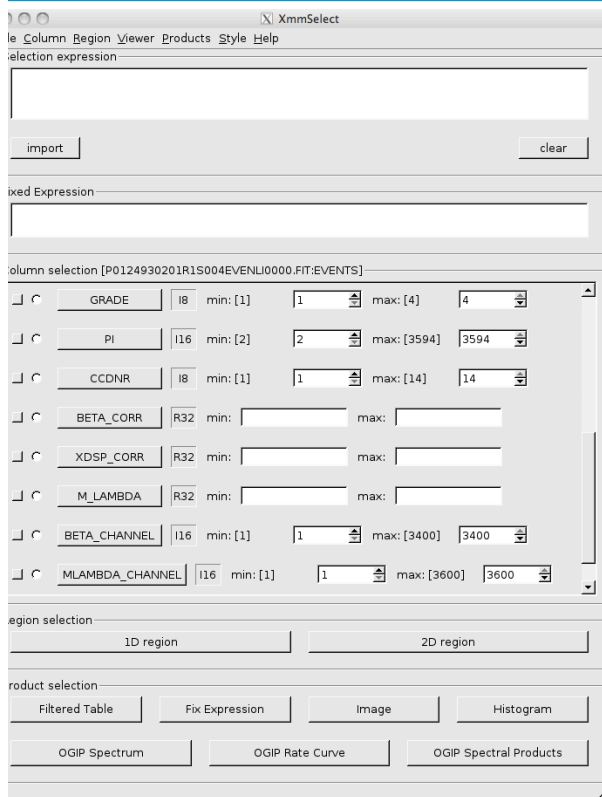
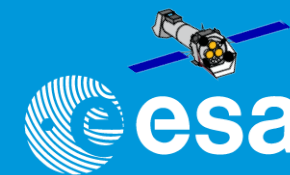
Stage	Task	Purpose	Output
<b>Events</b>	atthkgen	generates attitude file	Source list + intermediate combined event list
	attfilter	filters the attitude file	
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	rgsframes	flags bad frames, convert RAW[XY] to readout node reference system ([XY]CORR), creates GTI for telemetry drops, calculates dead time	
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	evlistcomb	event list concatenation	

Source independent

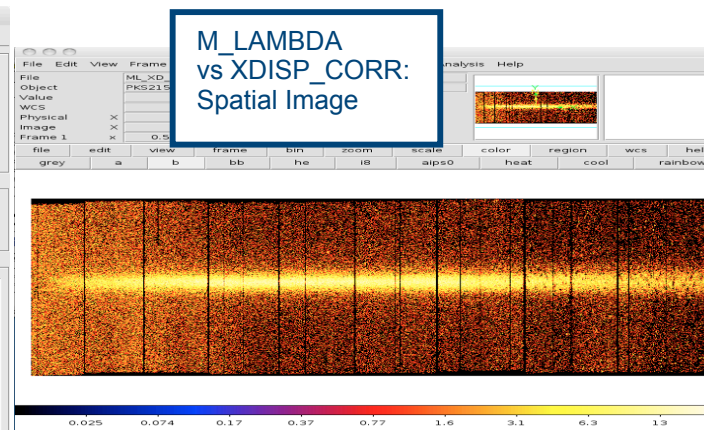
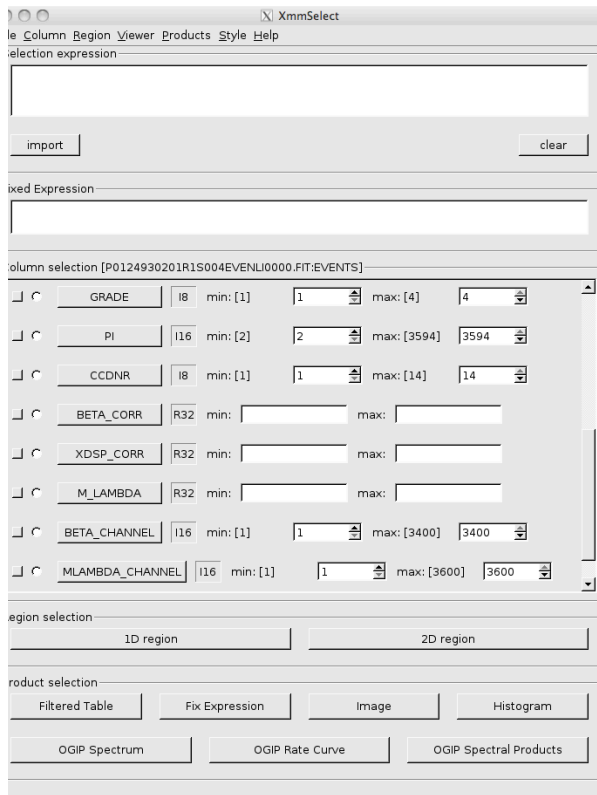
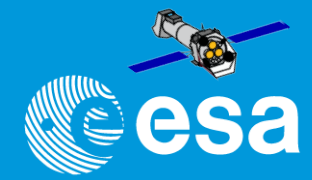
<b>Angles</b>	rgsangles	aspect correction (M_LAMBDA, XDSP_CORR)	Aspect correction
<b>Filter</b>	rgsfilter	creates filtered event list, removing unwanted frames and events and adding exposure maps	Final event list
<b>Spectra</b>	rgsregions	computes background and source extraction regions for each source	Source and background spectra
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<b>Fluxing</b>	rgsrmfgen	creates a response matrix	Response matrices and combined spectrum in physical units
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Source dependent

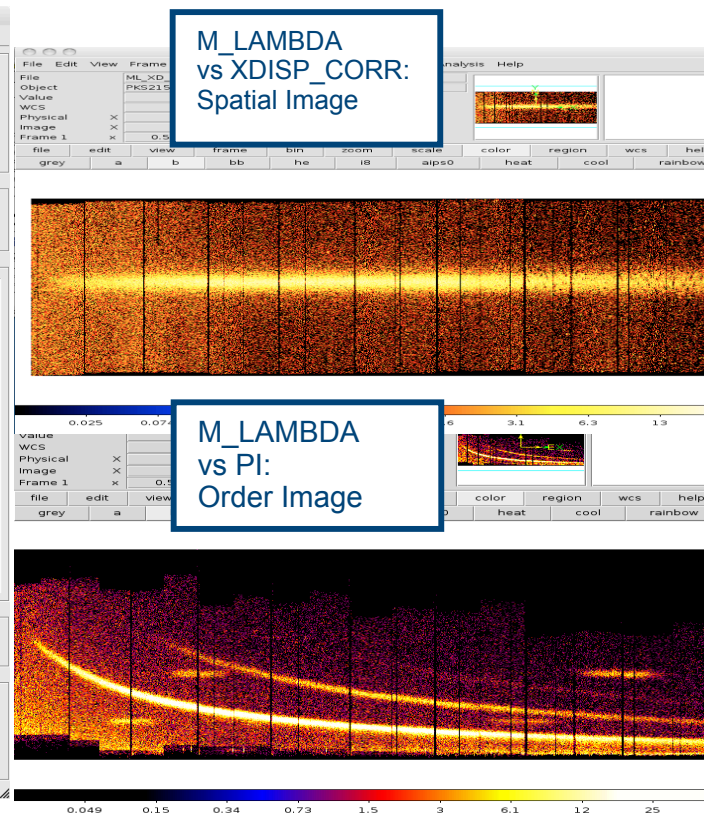
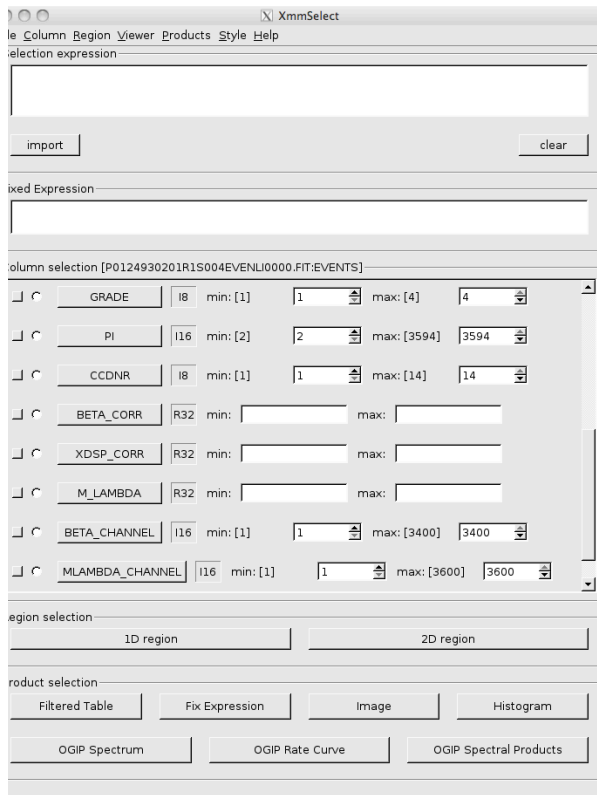
# rgsproc does a lot



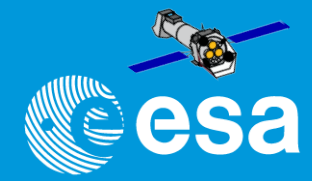
# rgsproc does a lot



# rgsproc does a lot



# rgsproc does a lot



XmmSelect

File Column Region Viewer Products Style Help

selection expression

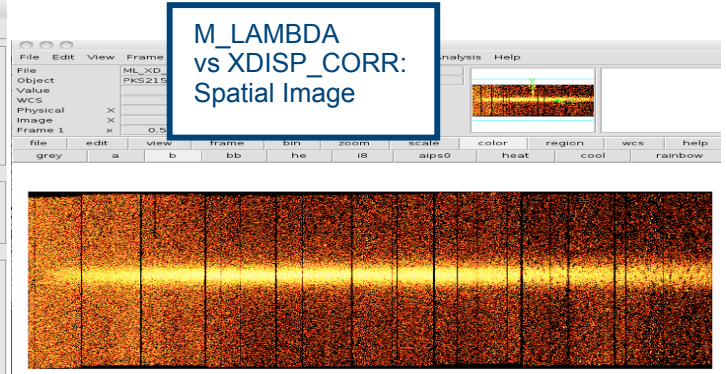
import clear

Fixed Expression

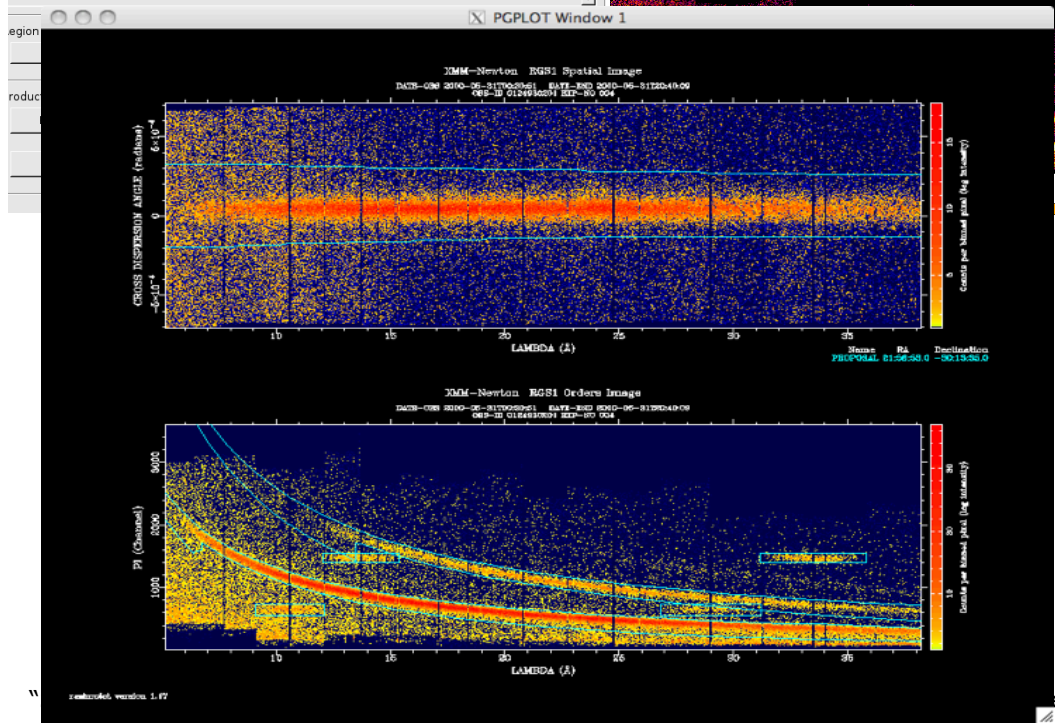
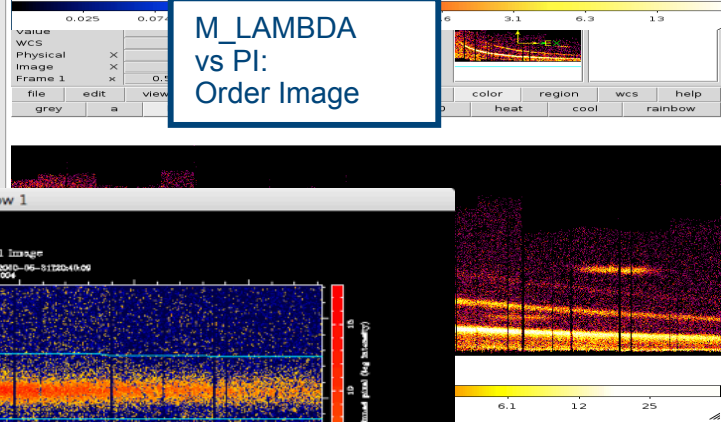
Column selection [P0124930201R1S004EVENL0000.FIT:EVENTS]

- GRADE | i8 | min: [1] | 1 | max: [4] | 4
- PI | i16 | min: [2] | 2 | max: [3594] | 3594
- CCDNR | i8 | min: [1] | 1 | max: [14] | 14
- BETA\_CORR | R32 | min: | max: |
- XDISP\_CORR | R32 | min: | max: |
- M\_LAMBDA | R32 | min: | max: |
- BETA\_CHANNEL | i16 | min: [1] | 1 | max: [3400] | 3400
- MLAMBDA\_CHANNEL | i16 | min: [1] | 1 | max: [3600] | 3600

M\_LAMBDA vs XDISP\_CORR: Spatial Image



M\_LAMBDA vs PI: Order Image



# rgsproc does a lot



XmmSelect

File Column Region Viewer Products Style Help

selection expression

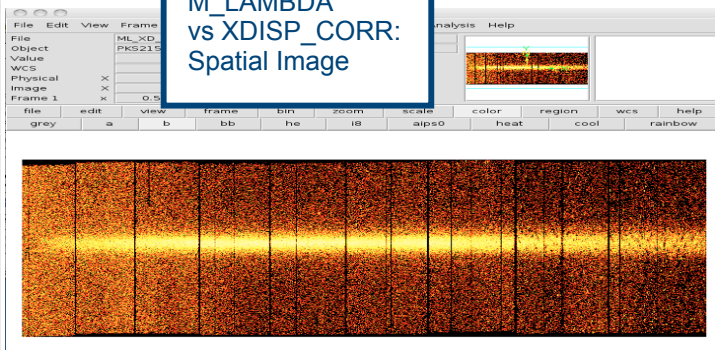
import clear

Fixed Expression

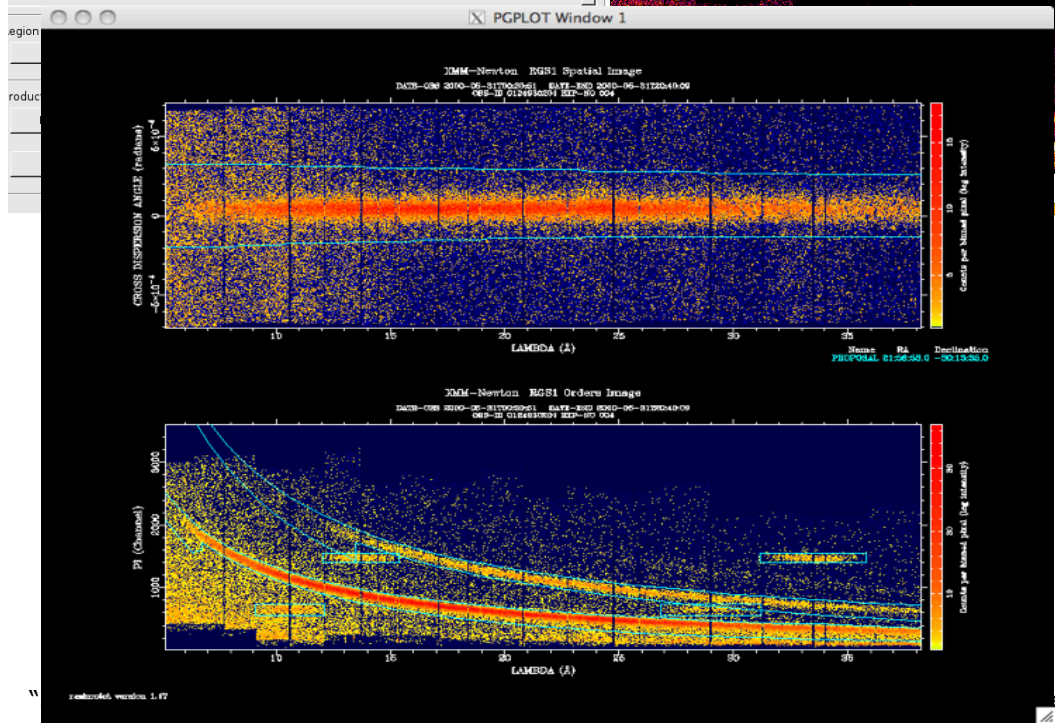
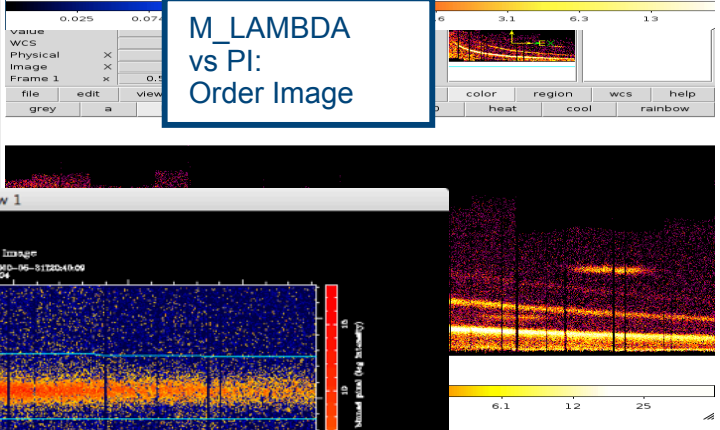
Column selection [P0124930201R1S004EVENL0000.FIT:EVENTS]

- GRADE | i8 | min: [1] | 1 | max: [4] | 4
- PI | i16 | min: [2] | 2 | max: [3594] | 3594
- CCDNR | i8 | min: [1] | 1 | max: [14] | 14
- BETA\_CORR | R32 | min: | max: |
- XDSP\_CORR | R32 | min: | max: |
- M\_LAMBDA | R32 | min: | max: |
- BETA\_CHANNEL | i16 | min: [1] | 1 | max: [3400] | 3400
- MLAMBDA\_CHANNEL | i16 | min: [1] | 1 | max: [3600] | 3600

M\_LAMBDA vs XDISP\_CORR: Spatial Image

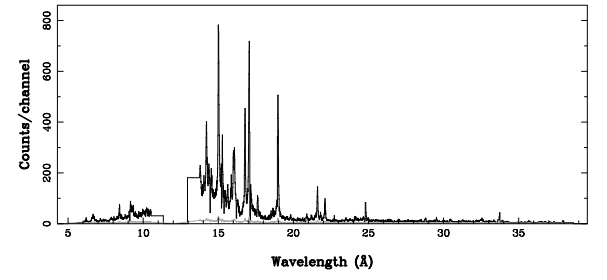


M\_LAMBDA vs PI: Order Image

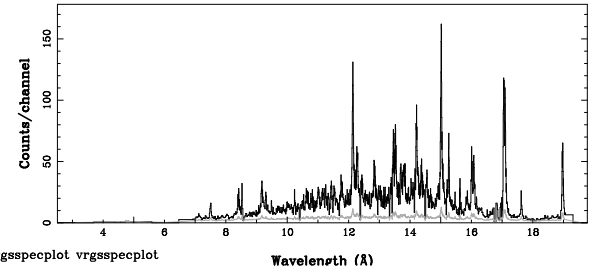


XMM - RGS1 - OBJECT: Capella - RA: 76.17350 - DEC: 45.99633 DATE-OBS 2016-09-10T00:09:21  
 OBS-ID: 0791090301 - EXP-ID: Indef - Exp. Time: 25580.37106375 DATE-END 2016-09-10T07:17:04  
 Key: - data

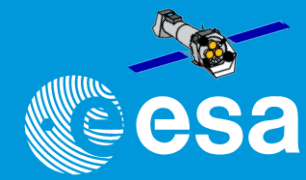
SOURCE ID: 87 - SPECTRUM ORDER: 1 SRC+BKG SPECTRUM, Min. cts/bin = 20  
 WHOLE\_FIELD



SOURCE ID: 87 - SPECTRUM ORDER: 2 SRC+BKG SPECTRUM, Min. cts/bin = 20  
 WHOLE\_FIELD



# rgsproc does a lot



**XmmSelect**  
File Column Region Viewer Products Style Help

Selection expression

Fixed Expression

Column selection [0508\_0028540701\_EPN\_S005\_ImagingEvts.ds: EVENTS]

<input type="checkbox"/>	<input type="radio"/>	TIME	R64	min:		max:	
<input type="checkbox"/>	<input type="radio"/>	RAWX	I16	min:	[1]	max:	[64] [64]
<input type="checkbox"/>	<input type="radio"/>	RAWY	I16	min:	[2]	max:	[200] [200]
<input type="checkbox"/>	<input type="radio"/>	DETX	I16	min:	[-18283]	max:	[13880] [13880]
<input type="checkbox"/>	<input type="radio"/>	DETY	I16	min:	[-17527]	max:	[15325] [15325]
<input type="checkbox"/>	<input type="radio"/>	X	I32	min:	[1]	max:	[51840] [51840]
<input type="checkbox"/>	<input type="radio"/>	Y	I32	min:	[1]	max:	[51840] [51840]

Region selection

1D region      2D region

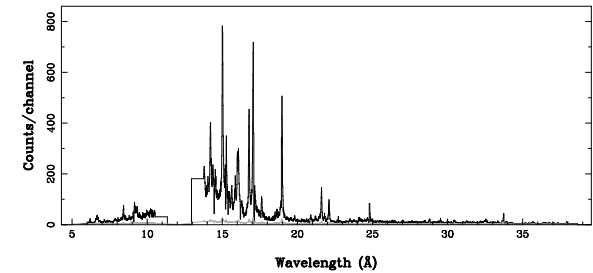
Product selection

Filtered Table    Fix Expression    Image    Histogram

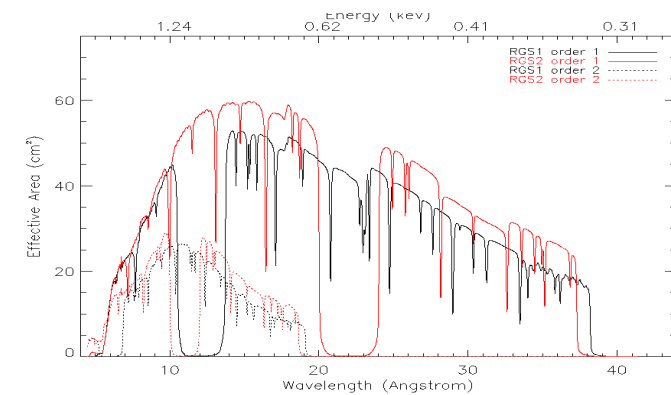
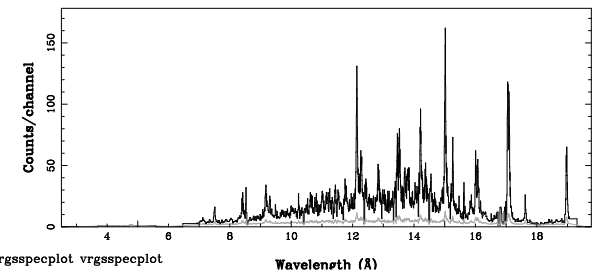
OGIP Spectrum    OGIP Rate Curve    OGIP Spectral Products

XMM - RGS1 - OBJECT: Capella - RA: 76.17850 - DEC: 45.99633      DATE-OBS 2016-09-10T00:09:21  
 OBS-ID: 0791090301 - EXP-ID: Indef - Exp. Time: 25580.37106375      DATE-END 2016-09-10T07:17:04  
 Key: - data

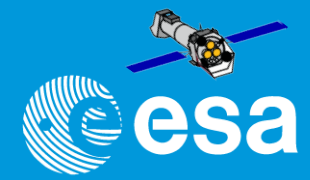
SOURCE ID: 87 - SPECTRUM ORDER: 1      SRC+BKG SPECTRUM, Min. cts/bin = 20  
 WHOLE\_FIELD



SOURCE ID: 87 - SPECTRUM ORDER: 2      SRC+BKG SPECTRUM, Min. cts/bin = 20  
 WHOLE\_FIELD



# What do I get after processing?



## For each RGS and exposure:

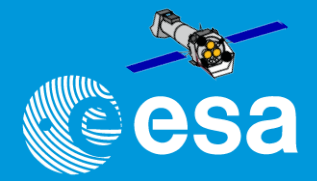
<i>File</i>	<i>Content</i>	<i>rgsproc (default)</i>	<i>PPS</i>
P0123456701R1S004EVENLI0000.FIT	Filtered Event List	Y	Y
P0123456701R1S004SRCLI_0000.FIT	Source List	Y (coord from proposal)	Y (coord from EPIC src list)
P0123456701R1S004BGSPEC1001.FIT P0123456701R1S004BGSPEC2001.FIT	Background Spectra (1 <sup>st</sup> and 2 <sup>nd</sup> order)	Y	Y
P0123456701R1S004SRSPEC1001.FIT P0123456701R1S004SRSPEC2001.FIT	Source Spectra (1 <sup>st</sup> and 2 <sup>nd</sup> order)	Y	Y
P0123456701R1S004SBSPEC1001.FIT P0123456701R1S004SBSPEC2001.FIT	Source+Bkg Spectra (1 <sup>st</sup> and 2 <sup>nd</sup> order)	Y	Y
P0123456701R1S004RSPMAT1001.FIT P0123456701R1S004RSPMAT2001.FIT	Response Matrices (1 <sup>st</sup> and 2 <sup>nd</sup> order)	Y	only for 1 <sup>st</sup> order
P0123456701R1S004R[SR,BG]TSR1001.FIT P0123456701R1S004R[SR,BG]TSR2001.FIT	Time Series (1 <sup>st</sup> and 2 <sup>nd</sup> order) Source and Background	Y	Y
P0123456701R1S004IMAGE_0000.FIT P0123456701R1S004IMAGE_0000.PNG	Dispersion-CrossDispersion Image	N	Y
P0123456701R1S004ORDIMG0000.FIT P0123456701R1S004ORDIMG0000.PNG	Dispersion-Energy Image	N	Y
P0123456701R1S004EXPMAP0000.FIT	Exposure Map	Y	Y
P0123456701R1S004FBKTSR0000.FIT	Flare Background Timeseries	N	Y
P0123456701R1S004SRSPEC0001.PDF	Source Spectra (PDF)	N	Y

## For each observation:

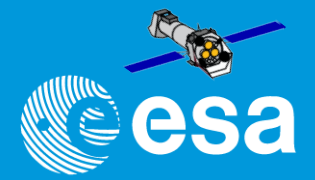
<i>File</i>	<i>Content</i>	<i>rgsproc (default)</i>	<i>PPS</i>
P0123456701OBX000fluxed1000.FIT P0123456701OBX000fluxed2000.FIT	Source Fluxed Spectra (1 <sup>st</sup> and 2 <sup>nd</sup> order)	Y	Y



# Getting started with SAS I: the ODF

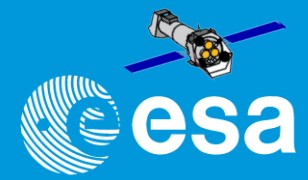


# Getting started with SAS I: the ODF



SAS needs for processing the ODF an Advanced Summary File (SUM.SAS), produced by [odfingest](#), extending an original summary file with data extracted from HK + calibration files

# Getting started with SAS I: the ODF



SAS needs for processing the ODF an Advanced Summary File (SUM.SAS), produced by [odfingest](#), extending an original summary file with data extracted from HK + calibration files

[odfingest](#) operates on the ODF directory \$SAS\_ODF

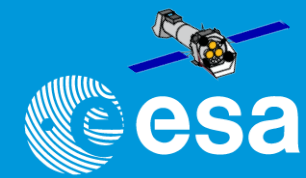
```
#> setenv SAS_ODF <odf_dir>
```

```
#> export SAS_ODF <odf_dir>
```

Command: > [odfingest](#) odmdir=\$SAS\_ODF

will produce a Summary file <SUM> = RRRR\_OOOOOOOOOO\_SCX00000SUM.SAS  
in the working directory

# Getting started with SAS I: the ODF



SAS needs for processing the ODF an Advanced Summary File (SUM.SAS), produced by `odfingest`, extending an original summary file with data extracted from HK + calibration files

`odfingest` operates on the ODF directory `$SAS_ODF`

```
#> setenv SAS_ODF <odf_dir>
```

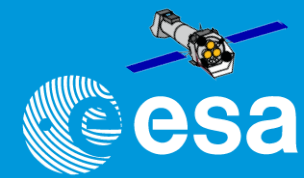
```
#> export SAS_ODF <odf_dir>
```

Command: `> odfingest odmdir=$SAS_ODF`

will produce a Summary file `<SUM> = RRRR_OOOOOOOOOO_SCX00000SUM.SAS`  
in the working directory

```
May 28, 01 15:11      0072_0123720201_SCX00000SUM.SAS      Page 1/252
//-----
// XMM-Newton Science Analysis System
//-----
//
// ODF Summary File
// By: odfingest(odfingest-2.2) [xmmsas_20010517_1900-no-aka-no-aka] on 2001-05-
28T15:00:18.000
//
//
// Directory where the ODF constituents were found. This may have to be edited t
o match the local file system structure.
//
PATH /xvsas05/sasval/data/rawdata/ODS11/ABDor/
//
// Observation Record
//
OBSERVATION
0123720201 / Observation Identifier
0072 / Revolution Identifier
2000-05-01T02:30:21.000 / Observation Start Time
2000-05-01T19:46:33.000 / Observation End Time
//
// Number of files in the Observation Summary File, and their names
//
FILES
203 / Number of Files
0072_0123720201_M1S00300AUX.FIT / ODF Constituent
0072_0123720201_M1S00310IME.FIT / ODF Constituent
0072_0123720201_M1S00320IME.FIT / ODF Constituent
0072_0123720201_M1S00330IME.FIT / ODF Constituent
0072_0123720201_M1S00340IME.FIT / ODF Constituent
```

# Getting started with SAS I: the ODF



SAS needs for processing the ODF an Advanced Summary File (SUM.SAS), produced by `odfingest`, extending an original summary file with data extracted from HK + calibration files

`odfingest` operates on the ODF directory `$SAS_ODF`

```
#> setenv SAS_ODF <odf_dir>
```

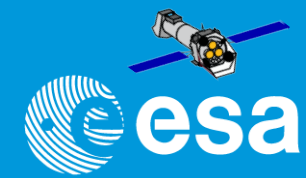
```
#> export SAS_ODF <odf_dir>
```

Command: `> odfingest odmdir=$SAS_ODF`

will produce a Summary file `<SUM> = RRRR_OOOOOOOOOO_SCX00000SUM.SAS`  
in the working directory

```
May 28, 01 15:11      0072_0123720201_SCX00000SUM.SAS      Page 1/252
//-----
// XMM-Newton Science Analysis System
//-----
// ODF Summary File
// By: odfingest(odfingest-2.2) [xmmsas_20010517_1900-no-aka-no-aka] on 2001-05-
28T15:00:18.000
//
// Directory where the ODF constituents were found. This may have to be edited t
o match the local file system structure.
//-----
0072_0123720201_scx00000TCS.FIT / ODF Constituent
//
// Instrument Record
//
INSTRUMENT
M1
Y / Is this instrument active?
16 / Number of exposures for this instrument
//
// Exposure Record
// Observation Level Exposure Index = 1
// Instrument [M1] Level Exposure Identifier = 5003
// Instrument [M1] Level Exposure Index = 1
//
EXPOSURE
003 / Exposure Identifier [also 5003]
Y / Is this a scheduled exposure?
SCIENCE / Exposure Type
0123720201M1S003 / Commanded Exposure Identifier
0123720201M1S003 / Proposal Exposure Identifier
```

# Getting started with SAS I: the ODF



SAS needs for processing the ODF an Advanced Summary File (SUM.SAS), produced by [odfingest](#), extending an original summary file with data extracted from HK + calibration files

[odfingest](#) operates on the ODF directory \$SAS\_ODF

```
#> setenv SAS_ODF <odf_dir>
```

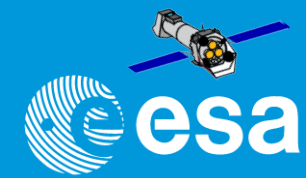
```
#> export SAS_ODF <odf_dir>
```

Command: > [odfingest](#) odmdir=\$SAS\_ODF

will produce a Summary file <SUM> = RRRR\_0000000000\_SCX00000SUM.SAS  
in the working directory

```
May 28, 01 15:11      0072_0123720201_SCX00000SUM.SAS      Page 1/252
// -----
2000-05-01T10:45:05.000 / Actual End Time
//
// Configuration Record for M1
//
CONFIGURATION EPIC MOS
77 / Number of configuration parameters available
MODE = PrimeFullWindow / Instrument configuration
CALIBRATION_MODE_1 = PrimeFullWindow / Mode used to calibrate events from CCD 1
CALIBRATION_MODE_2 = PrimeFullWindow / Mode used to calibrate events from CCD 2
CALIBRATION_MODE_3 = PrimeFullWindow / Mode used to calibrate events from CCD 3
CALIBRATION_MODE_4 = PrimeFullWindow / Mode used to calibrate events from CCD 4
CALIBRATION_MODE_5 = PrimeFullWindow / Mode used to calibrate events from CCD 5
CALIBRATION_MODE_6 = PrimeFullWindow / Mode used to calibrate events from CCD 6
CALIBRATION_MODE_7 = PrimeFullWindow / Mode used to calibrate events from CCD 7
DATA_MODE_1 = Imaging / Data mode for CCD 1
DATA_MODE_2 = Imaging / Data mode for CCD 2
DATA_MODE_3 = Imaging / Data mode for CCD 3
DATA_MODE_4 = Imaging / Data mode for CCD 4
DATA_MODE_5 = Imaging / Data mode for CCD 5
DATA_MODE_6 = Imaging / Data mode for CCD 6
DATA_MODE_7 = Imaging / Data mode for CCD 7
FILTER_WHEEL = NOT VALID CS // Name of filter wheel position
FILTER_WHEEL_POSITION = 1580 // Hardware filter wheel position
FILTER = Calclosed // Filter
CLOCK_RESET_TIME_COARSE = 3826099 // Coarse component of the clock reset time
003 / Exposure Identifier [also S003]
Y / Is this a scheduled exposure?
SCIENCE / Exposure Type
0123720201M1S003 / Commanded Exposure Identifier
0123720201M1S003 / Proposal Exposure Identifier
```

# Getting started with SAS I: the ODF



SAS needs for processing the ODF an Advanced Summary File (SUM.SAS), produced by [odfingest](#), extending an original summary file with data extracted from HK + calibration files

[odfingest](#) operates on the ODF directory \$SAS\_ODF

```
#> setenv SAS_ODF <odf_dir>
```

```
#> export SAS_ODF <odf_dir>
```

Command: > [odfingest](#) odmdir=\$SAS\_ODF

will produce a Summary file <SUM> = RRRR\_0000000000\_SCX00000SUM.SAS  
in the working directory

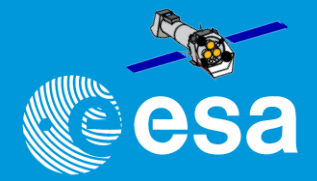
After the Summary file has been produced:

```
#> setenv SAS_ODF <SUM>
```

```
#> export SAS_ODF=<SUM>
```

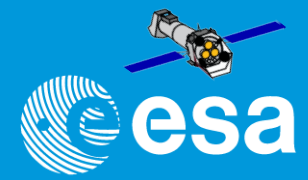
```
May 28, 01 15:11 0072_0123720201_SCX00000SUM.SAS Page 1/252
// -----
2000-05-01T10:45:05.000 / Actual End Time
//
// Configuration Record for M1
//
CONFIGURATION EPIC MOS
77 / Number of configuration parameters available
MODE = PrimeFullWindow / Instrument configuration
CALIBRATION_MODE_1 = PrimeFullWindow / Mode used to calibrate events from CCD 1
CALIBRATION_MODE_2 = PrimeFullWindow / Mode used to calibrate events from CCD 2
CALIBRATION_MODE_3 = PrimeFullWindow / Mode used to calibrate events from CCD 3
CALIBRATION_MODE_4 = PrimeFullWindow / Mode used to calibrate events from CCD 4
CALIBRATION_MODE_5 = PrimeFullWindow / Mode used to calibrate events from CCD 5
CALIBRATION_MODE_6 = PrimeFullWindow / Mode used to calibrate events from CCD 6
CALIBRATION_MODE_7 = PrimeFullWindow / Mode used to calibrate events from CCD 7
DATA_MODE_1 = Imaging / Data mode for CCD 1
DATA_MODE_2 = Imaging / Data mode for CCD 2
DATA_MODE_3 = Imaging / Data mode for CCD 3
DATA_MODE_4 = Imaging / Data mode for CCD 4
DATA_MODE_5 = Imaging / Data mode for CCD 5
DATA_MODE_6 = Imaging / Data mode for CCD 6
DATA_MODE_7 = Imaging / Data mode for CCD 7
FILTER_WHEEL = NOT VALID CS // Name of filter wheel position
FILTER_WHEEL_POSITION = 1580 // Hardware filter wheel position
FILTER = Calclosed // Filter
CLOCK_RESET_TIME_COARSE = 3826099 // Coarse component of the clock reset time
003 / Exposure Identifier [also S003]
Y / Is this a scheduled exposure?
SCIENCE / Exposure Type
0123720201M1S003 / Commanded Exposure Identifier
0123720201M1S003 / Proposal Exposure Identifier
```

# Getting started with SAS II: the CCF





# Getting started with SAS II: the CCF



XMM-Newton calibration data is contained in Current Calibration File (CCF)

CCF = the collection of all the XMM-Newton calibration files ever made public (= hundreds!)  
Note: the calibration files are updated continuously >>> NO CCF version number

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CCF = the collection of all the XMM-Newton calibration files ever made public (= hundreds!)  
Note: the calibration files are updated continuously >>> NO CCF version number

Calibration Index File (CIF) necessary for data analysis, pointing to the relevant files, according to:

- observation date
- analysis date

`cifbuild` operates on the calibration directory `$SAS_CCFFPATH`

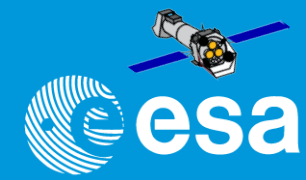
```
#> export SAS_CCFFPATH=<ccf_dir>
```

```
#> setenv SAS_CCFFPATH <ccf_dir>
```

Command: > `cifbuild`

produces a FITS file `ccf.cif` with extension `CALINDEX` >

# Getting started with SAS II: the CCF



XMM-Newton calibration data is contained in Current Calibration File (CCF)

CCF = the collection of all the XMM-Newton calibration files ever made public (= hundreds!)  
Note: the calibration files are updated continuously >>> NO CCF version number

Calibration Index File (CIF) necessary for data analysis, pointing to the relevant files, according to:

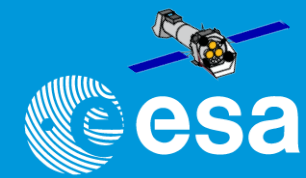
- observation date
- analysis date

`cifbuild` operates on the calibration directory `$SAS_CCFPATH`  
#> export SAS\_CCFPATH=<ccf\_dir>  
#> setenv SAS\_CCFPATH <ccf\_dir>

Command: > `cifbuild`  
produces a FITS file `ccf.cif` with extension `CALINDEX` >

File Edit Tools					
	TELESCOP	SCOPE	TYPEID	ISSUE	VALDATE
	4A	6A	32A	1	19A
					yyyy:dd:mmZhh:mm:ss
40	XMM	EPN	LINCOORD	9	1998-01-01T00:00:00
41	XMM	EPN	MODEPARAM	3	1999-01-01T00:00:00
42	XMM	EPN	PATTERNLIB	1	1998-01-01T00:00:00
43	XMM	EPN	QUANTUMEF	8	2000-01-01T00:00:00
44	XMM	EPN	REDIST	5	1998-01-01T00:00:00
45	XMM	EPN	TIMECORR	4	1998-01-01T00:00:00
46	XMM	OM	ASTROMET	8	1998-01-01T00:00:00
47	XMM	OM	BADPIX	2	1998-01-01T00:00:00
48	XMM	OM	COLORTRANS	5	1998-01-01T00:00:00
49	XMM	OM	DARKFRAME	3	1998-01-01T00:00:00
50	XMM	OM	DIFFUSEGALA	1	1998-01-01T00:00:00
51	XMM	OM	HKPARMINT	3	1999-01-01T00:00:00
52	XMM	OM	LARGESCALESENS	2	1998-01-01T00:00:00
53	XMM	OM	LINCOORD	1	1998-01-01T00:00:00
54	XMM	OM	PHOTONAT	3	1998-01-01T00:00:00
55	XMM	OM	PIXTOPXSENS	3	1998-01-01T00:00:00
56	XMM	OM	PSFLDRB	4	1998-01-01T00:00:00
57	XMM	OM	QUICKMAG	2	1998-01-01T00:00:00
58	XMM	OM	ZODIACAL	1	1998-01-01T00:00:00
59	XMM	RGS1	ADUCONV	5	2000-02-06T16:49:60
60	XMM	RGS1	BACKGROUN	1	1998-01-01T00:00:00
61	XMM	RGS1	BADPIX	5	2000-02-06T16:49:60
62	XMM	RGS1	CALSOURCEDATA	1	1998-01-01T00:00:00
63	XMM	RGS1	CLOCKPATTERNS	1	1998-01-01T00:00:00
64	XMM	RGS1	CROSSPSF	2	2000-01-01T00:00:00
65	XMM	RGS1	CTI	2	2000-02-06T16:49:60
66	XMM	RGS1	DARKFRAME	4	1998-01-01T00:00:00
67	XMM	RGS1	HKPARMINT	6	1999-01-01T00:00:00
68	XMM	RGS1	LINCOORD	7	1998-01-01T00:00:00
69	XMM	RGS1	LINESPREADFUNC	3	1999-01-01T00:00:00

# Getting started with SAS II: the CCF



XMM-Newton calibration data is contained in Current Calibration File (CCF)

CCF = the collection of all the XMM-Newton calibration files ever made public (= hundreds!)

Note: the calibration files are updated continuously >>> NO CCF version number

Calibration Index File (CIF) necessary for data analysis, pointing to the relevant files, according to:

- observation date
- analysis date

`cifbuild` operates on the calibration directory `$SAS_CCFPATH`

```
#> export SAS_CCFPATH=<ccf_dir>
```

```
#> setenv SAS_CCFPATH <ccf_dir>
```

Command: `> cifbuild`

produces a FITS file `ccf.cif` with extension `CALINDEX` >

After the Calibration Index file has been produced:

```
#> export SAS_CCF=absolute_path/ccf.cif
```

```
#> setenv SAS_CCF absolute_path/ccf.cif
```

**NOTICE: any file with extension CALINDEX is valid as SAS\_CCF**

File Edit Tools					
	TELESCOP	SCOPE	TYPEID	ISSUE	VALIDATE
	4A	6A	32A	1	19A
	yyyy:dd:mmZhh:mm:ss				
40	XMM	EPN	LINCOORD	9	1998-01-01T00:00:00
41	XMM	EPN	MODEPARAM	3	1999-01-01T00:00:00
42	XMM	EPN	PATTERNLIB	1	1998-01-01T00:00:00
43	XMM	EPN	QUANTUMEF	8	2000-01-01T00:00:00
44	XMM	EPN	REDIST	5	1998-01-01T00:00:00
45	XMM	EPN	TIMECORR	4	1998-01-01T00:00:00
46	XMM	OM	ASTROMET	8	1998-01-01T00:00:00
47	XMM	OM	BADPIX	2	1998-01-01T00:00:00
48	XMM	OM	COLORTRANS	5	1998-01-01T00:00:00
49	XMM	OM	DARKFRAME	3	1998-01-01T00:00:00
50	XMM	OM	DIFFUSEGALA	1	1998-01-01T00:00:00
51	XMM	OM	HKPARMINT	3	1999-01-01T00:00:00
52	XMM	OM	LARGESCALESENS	2	1998-01-01T00:00:00
53	XMM	OM	LINCOORD	1	1998-01-01T00:00:00
54	XMM	OM	PHOTONAT	3	1998-01-01T00:00:00
55	XMM	OM	PIXTOPXSENS	3	1998-01-01T00:00:00
56	XMM	OM	PSFLDRB	4	1998-01-01T00:00:00
57	XMM	OM	QUICKMAG	2	1998-01-01T00:00:00
58	XMM	OM	ZODIACAL	1	1998-01-01T00:00:00
59	XMM	RGS1	ADUCONV	5	2000-02-06T16:49:60
60	XMM	RGS1	BACKGROUND	1	1998-01-01T00:00:00
61	XMM	RGS1	BADPIX	5	2000-02-06T16:49:60
62	XMM	RGS1	CALSOURCEDATA	1	1998-01-01T00:00:00
63	XMM	RGS1	CLOCKPATTERNS	1	1998-01-01T00:00:00
64	XMM	RGS1	CROSSPSF	2	2000-01-01T00:00:00
65	XMM	RGS1	CTI	2	2000-02-06T16:49:60
66	XMM	RGS1	DARKFRAME	4	1998-01-01T00:00:00
67	XMM	RGS1	HKPARMINT	6	1999-01-01T00:00:00
68	XMM	RGS1	LINCOORD	7	1998-01-01T00:00:00
69	XMM	RGS1	LINESPREADFUNC	3	1999-01-01T00:00:00

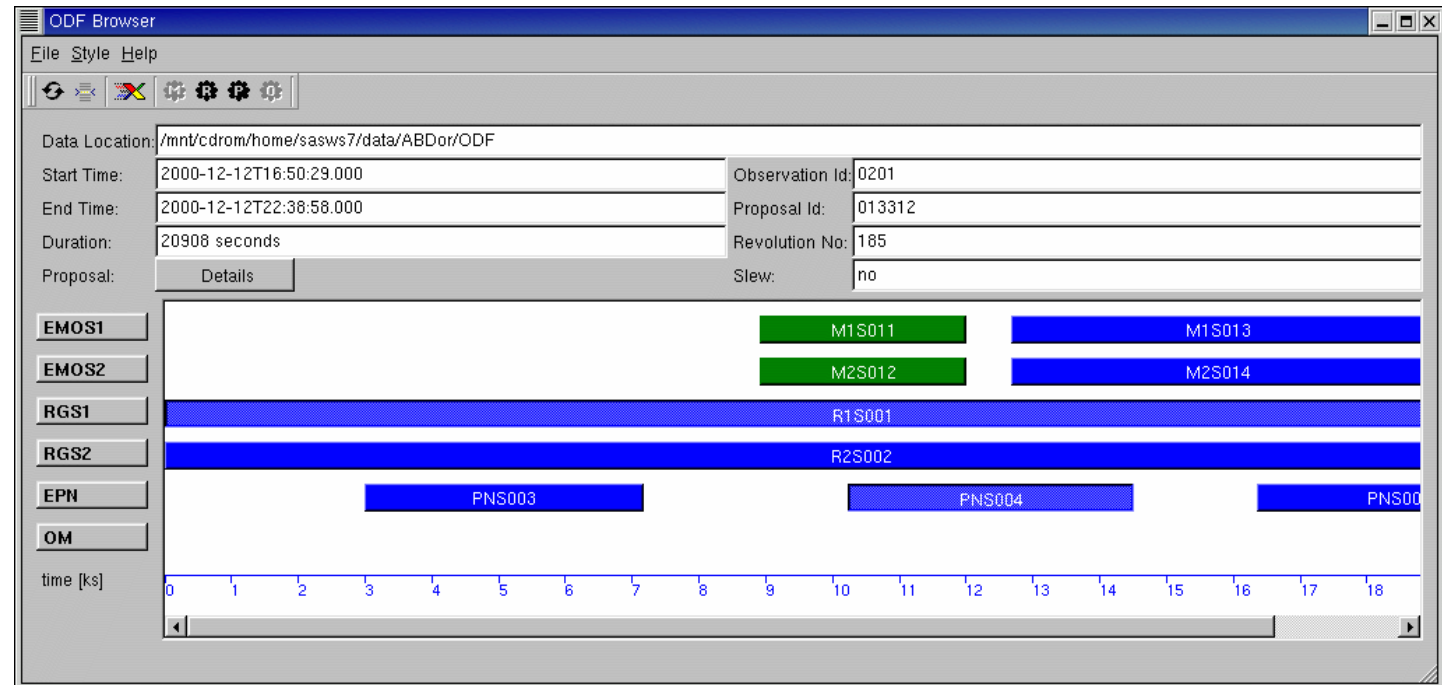


A task to view the contents of the ODF and more ...

An ODF is constituted in the rule by hundreds of files. [odfbrowser](#) displays graphical summaries of an observation, allowing the user to select any number of exposures and launch the metatasks [\[em\]](#)[\[ep\]](#)[\[rgs\]proc](#)

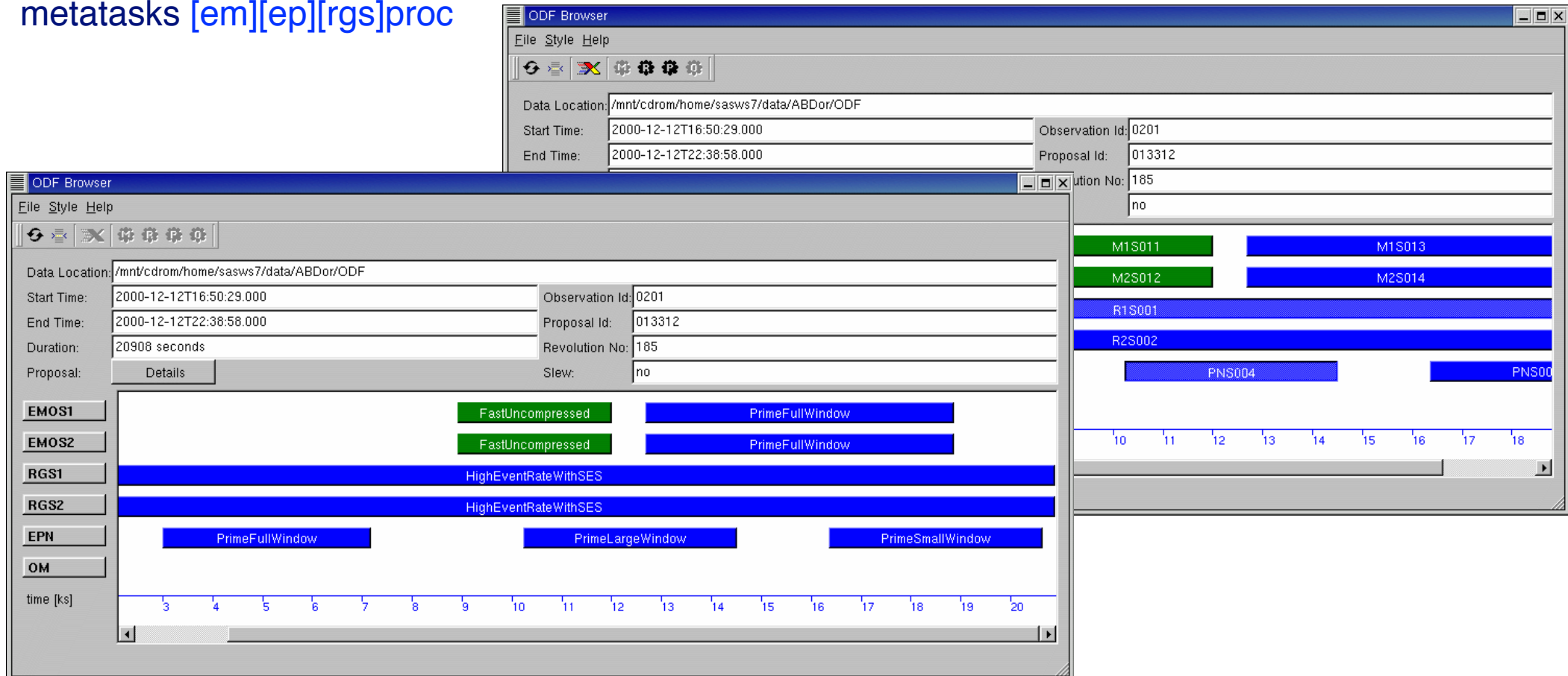
A task to view the contents of the ODF and more ...

An ODF is constituted in the rule by hundreds of files. **odfbrowser** displays graphical summaries of an observation, allowing the user to select any number of exposures and launch the metatasks `[em][ep][rgs]proc`



A task to view the contents of the ODF and more ...

An ODF is constituted in the rule by hundreds of files. **odfbrowser** displays graphical summaries of an observation, allowing the user to select any number of exposures and launch the metatasks `[em][ep][rgs]proc`







**cifbuild** uses single CCF keywords:

- VALDATE as start of calibration validity period
- EVALDATE as end of validity period
- DATE as analysis validity period

cifbuild uses single CCF keywords:

- VALDATE as start of calibration validity period
- EVALDATE as end of validity period
- DATE as analysis validity period

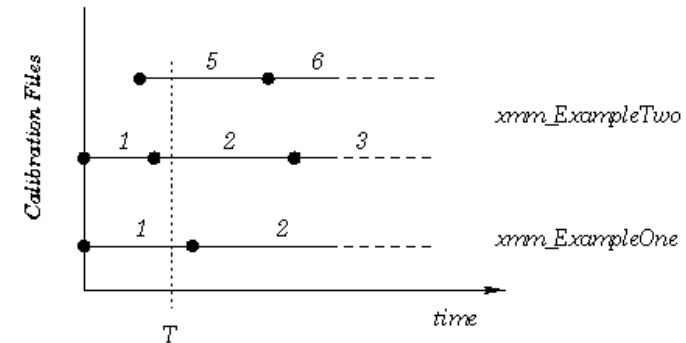


Figure 2: Current calibration file with two files: update. At the time  $T$  the current calibration file consists of *xmm\_ExampleOne\_0001.ccf* and *xmm\_ExampleTwo\_0005.ccf*

cifbuild uses single CCF keywords:

- VALDATE as start of calibration validity period
- EVALDATE as end of validity period
- DATE as analysis validity period

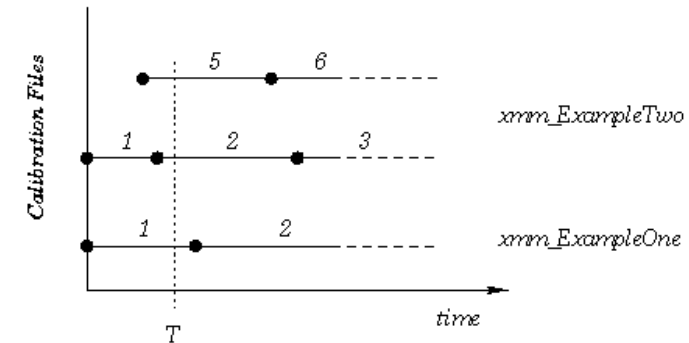


Figure 2: Current calibration file with two files: update. At the time  $T$  the current calibration file consists of *xmm\_ExampleOne\_0001.ccf* and *xmm\_ExampleTwo\_0005.ccf*

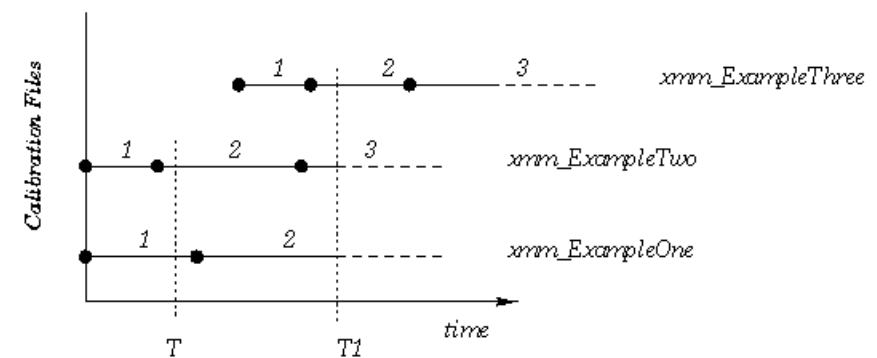


Figure 3: Current calibration file with three files. At the time  $T1$  the current calibration file consists of *xmm\_ExampleOne\_0002.ccf* and *xmm\_ExampleTwo\_0009.ccf* and *xmm\_ExampleThree\_0002.ccf*

cifbuild uses single CCF keywords:

- VALDATE as start of calibration validity period
- EVALDATE as end of validity period
- DATE as analysis validity period

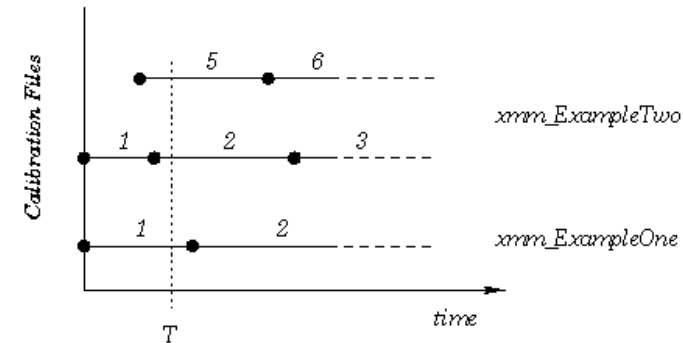


Figure 2: Current calibration file with two files: update. At the time  $T$  the current calibration file consists of *xmm\_ExampleOne\_0001.ccf* and *xmm\_ExampleTwo\_0005.ccf*

Rule: out of all the CCF calibration files take the highest issue with VALDATE lower AND EVALDATE higher than observation date AND DATE lower than analysis date.

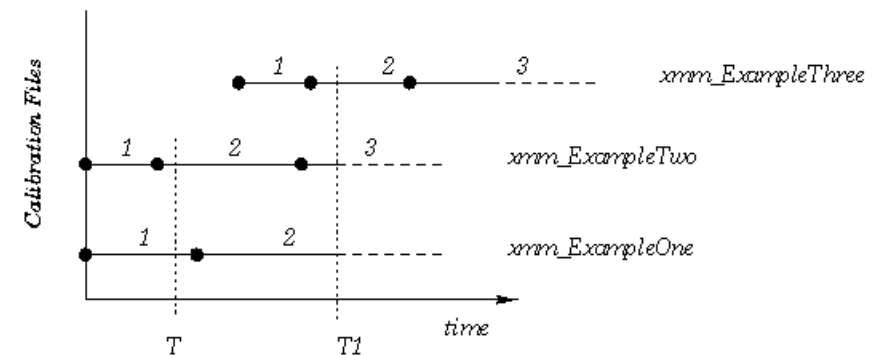
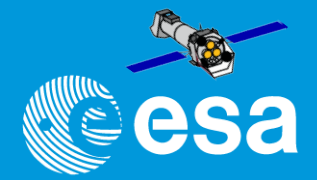


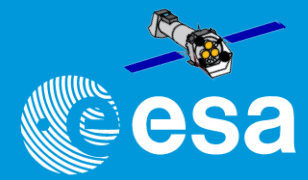
Figure 3: Current calibration file with three files. At the time  $T1$  the current calibration file consists of *xmm\_ExampleOne\_0002.ccf* and *xmm\_ExampleTwo\_0009.ccf* and *xmm\_ExampleThree\_0002.ccf*

- On the XMM-Newton calibration web pages:
  - updated cif can be generated on-line and compared to the one you generate
  - required (missing) CCF constituents can also be downloaded
  - local CCF library can be mirrored from XMM web site via the **rsync** or **mirror** commands (see doc web pages)
  - there is a “valid” CCF library (**1.1 GB instead of > 6 GB**)  
*(if you don't have it yet you can get it from me...)*
- CCF release notes shall be consulted, at least periodically.
  - Subscribing to the CCF mailing list is also useful, to get the RNs only when there is something new.

# Getting started with SAS III: the basic steps



# Getting started with SAS III: the basic steps



Summary of basic steps to start using SAS:  
(csh / tcsh version)

```
source <SAS-DIR>/setsas.csh
```

```
setenv SAS_ODF <ODF-DIR>
```

```
setenv SAS_CCFPATH <Calibration Files-DIR>
```

```
cifbuild
```

```
setenv SAS_CCF ccf.cif
```

```
odfingest
```

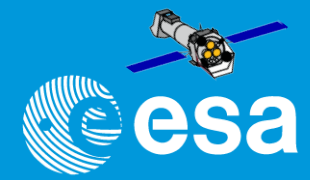
```
set sumfile=`ls -1 *SUM.SAS`
```

```
setenv SAS_ODF $sumfile
```

>> ready to start working on the ODF data  
located in <ODF-DIR>



# Getting started with SAS III: the basic steps



Summary of basic steps to start using SAS:  
(csh / tcsh version)

```
source <SAS-DIR>/setsas.csh
```



```
setenv SAS_ODF <ODF-DIR>
```

```
setenv SAS_CCFPATH <Calibration Files-DIR>
```

```
cifbuild
```

```
setenv SAS_CCF ccf.cif
```

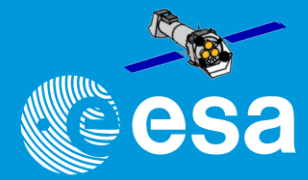
```
odfingest
```

```
set sumfile=`ls -1 *SUM.SAS`
```

```
setenv SAS_ODF $sumfile
```

>> ready to start working on the ODF data  
located in <ODF-DIR>

# Getting started with SAS III: the basic steps



Summary of basic steps to start using SAS:  
(csh / tcsh version)

```
source <SAS-DIR>/setsas.csh
```



```
setenv SAS_ODF <ODF-DIR>
```

```
setenv SAS_CCFPATH <Calibration Files-DIR>
```

```
cifbuild
```

```
setenv SAS_CCF ccf.cif
```

```
odfingest
```

```
set sumfile=`ls -1 *SUM.SAS`
```

```
setenv SAS_ODF $sumfile
```

>> ready to start working on the ODF data  
located in <ODF-DIR>

# Getting started with SAS III: the basic steps



Summary of basic steps to start using SAS:  
(csh / tcsh version)

```
source <SAS-DIR>/setsas.csh
```

```
setenv SAS_ODF <ODF-DIR>
```

```
setenv SAS_CCFPATH <Calibration Files-DIR>
```

```
cifbuild
```

```
setenv SAS_CCF ccf.cif
```

```
odfingest
```

```
set sumfile=`ls -1 *SUM.SAS`
```

```
setenv SAS_ODF $sumfile
```

>> ready to start working on the ODF data  
located in <ODF-DIR>

```
|sasbld03n:~> source setsas.csh

sasversion:- Executing (routine): sasversion -w 1 -V 4
sasversion:- sasversion (sasversion-1.3) [xmmsas_20211130_0941-20.0.0] started: 2023-02-06T22:30:32.000
sasversion:- XMM-Newton SAS release and build information:

SAS release: xmmsas_20211130_0941-20.0.0
Compiled on: Tue Nov 30 09:49:16 CET 2021
Compiled by: sasbuild@sasbld03n
Platform : Ubuntu18.04

SAS-related environment variables that are set:

SAS_DIR = /sas/Linux/Ubuntu18.04/64/xmmsas_20211130_0941
SAS_PATH = /sas/Linux/Ubuntu18.04/64/xmmsas_20211130_0941
SAS_CCFPATH = /ccf/valid

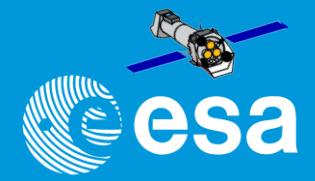
sasversion:- sasversion (sasversion-1.3) [xmmsas_20211130_0941-20.0.0] ended: 2023-02-06T22:30:32.000

Do not forget to define SAS_CCFPATH, SAS_CCF and SAS_ODF

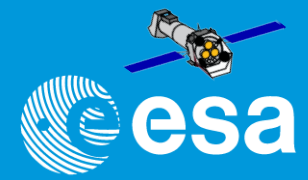
SAS 20.0.0 ready !

|sasbld03n:~> █
```

# Getting started with SAS III: the basic steps



# Getting started with SAS III: the basic steps



OR, if you use the **bash / sh / ksh**:

```
. <SAS-DIR>/setsas.csh
```

```
export SAS_ODF=<ODF-DIR>
```

```
export SAS_CCFPATH=<Calibration Files-DIR>
```

```
cifbuild
```

```
export SAS_CCF=cif.cif
```

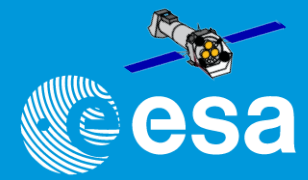
```
odfingest
```

```
export sumfile=`ls -1 *SUM.SAS`
```

```
export SAS_ODF=$sumfile
```

>> ready to start working on the ODF data  
located in <ODF-DIR>

# Getting started with SAS III: the basic steps



OR, if you use the **bash / sh / ksh**:

```
. <SAS-DIR>/setsas.csh
```



```
export SAS_ODF=<ODF-DIR>
```

```
export SAS_CCFPATH=<Calibration Files-DIR>
```

```
cifbuild
```

```
export SAS_CCF=ccf.cif
```

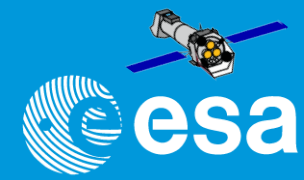
```
odfingest
```

```
export sumfile=`ls -1 *SUM.SAS`
```

```
export SAS_ODF=$sumfile
```

>> ready to start working on the ODF data  
located in <ODF-DIR>

# Getting started with SAS III: the basic steps



OR, if you use the **bash / sh / ksh**:

**. <SAS-DIR>/setsas.csh**



**export SAS\_ODF=<ODF-DIR>**

**export SAS\_CCFPATH=<Calibration Files-DIR>**

**cifbuild**

**export SAS\_CCF=ccf.cif**

**odfingest**

**export sumfile=`ls -1 \*SUM.SAS`**

**export SAS\_ODF=\$sumfile**

>> ready to start working on the ODF data  
located in <ODF-DIR>

```
aibarra@sasbld03n:~$ ./setsas.sh

sasversion:- Executing (routine): sasversion -w 1 -V 4
sasversion:- sasversion (sasversion-1.3) [xmmsas_20211130_0941-20.0.0] started: 2023-02-06T22:26:33.000
sasversion:- XMM-Newton SAS release and build information:

SAS release: xmmsas_20211130_0941-20.0.0
Compiled on: Tue Nov 30 09:49:16 CET 2021
Compiled by: sasbuild@sasbld03n
Platform   : Ubuntu18.04

SAS-related environment variables that are set:

SAS_DIR = /sas/Linux/Ubuntu18.04/64/xmmsas_20211130_0941
SAS_PATH = /sas/Linux/Ubuntu18.04/64/xmmsas_20211130_0941
SAS_CCFPATH = /ccf/valid

sasversion:- sasversion (sasversion-1.3) [xmmsas_20211130_0941-20.0.0] ended: 2023-02-06T22:26:33.000

Do not forget to define SAS_CCFPATH, SAS_CCF and SAS_ODF

SAS 20.0.0 ready !
```

# Getting started with SAS III: the basic steps



OR, if you use the **bash / sh / ksh**:

**. <SAS-DIR>/setsas.csh**



**export SAS\_ODF=<ODF-DIR>**

**export SAS\_CCFPATH=<Calibration Files-DIR>**

**cifbuild**

**export SAS\_CCF=ccf.cif**

**odfingest**

**export sumfile=`ls -1 \*SUM.SAS`**

**export SAS\_ODF=\$sumfile**

>> ready to start working on the ODF data  
located in <ODF-DIR>

```
aibarra@sasbld03n:~$ ./setsas.sh

sasversion:- Executing (routine): sasversion -w 1 -V 4
sasversion:- sasversion (sasversion-1.3) [xmmsas_20211130_0941-20.0.0] started: 2023-02-06T22:26:33.000
sasversion:- XMM-Newton SAS release and build information:

SAS release: xmmsas_20211130_0941-20.0.0
Compiled on: Tue Nov 30 09:49:16 CET 2021
Compiled by: sasbuild@sasbld03n
Platform   : Ubuntu18.04

SAS-related environment variables that are set:

SAS_DIR = /sas/Linux/Ubuntu18.04/64/xmmsas_20211130_0941
SAS_PATH = /sas/Linux/Ubuntu18.04/64/xmmsas_20211130_0941
SAS_CCFPATH = /ccf/valid

sasversion:- sasversion (sasversion-1.3) [xmmsas_20211130_0941-20.0.0] ended: 2023-02-06T22:26:33.000

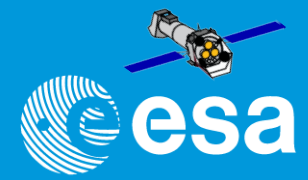
Do not forget to define SAS_CCFPATH, SAS_CCF and SAS_ODF

SAS 20.0.0 ready !
```

You can locate all these commands  
into (c)sh command files

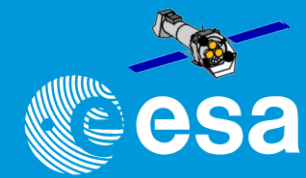


# Getting started with SAS IV: all the information



- SAS public web page: <https://www.cosmos.esa.int/web/xmm-newton/sas> (download, installation, information, etc)
- ...How to use SAS

# Getting started with SAS IV: all the information



- SAS public web page: <https://www.cosmos.esa.int/web/xmm-newton/sas> (download, installation, information, etc)
- ...How to use SAS

xmm-newton

SCIENCE MISSIONS SCIENCE & TECHNOLOGY EUROPEAN SPACE AGENCY

XMM-Newton » Data Analysis

Home / Latest News

Conferences & Meetings

News

General User Support

Proposers Info

Observers Info

Data Analysis

Archive, Pipeline & Catalogues

Calibration & Background

SOC Info

About XMM-Newton

Image Gallery

Publications

Other Links

### XMM-NEWTON DATA ANALYSIS

**SAS NEWS**  
News, special information...

**WHAT IS THE SCIENTIFIC ANALYSIS SYSTEM (SAS)?**  
A comprehensive approach

**HOW TO USE SAS**  
Guides, manuals, on-line documentation, background analysis, watchout items

**XMM-NEWTON SAS WORKSHOPS**  
Presentations from the latest Workshop, Information about the next SAS Workshop

**SAS VERSION CHANGES**  
SAS version history, release notes, validation

**DOWNLOAD AND INSTALL SAS**  
How to download and how to install SAS, which are the software requirements

**XMM-NEWTON SCIENCE SIMULATOR**  
SciSim software to generate simulated XMM-Newton data

↓

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# Getting started with SAS IV: all the information



- SAS public web page: <https://www.cosmos.esa.int/web/xmm-newton/sas> (download, installation, information, etc)
- ...How to use SAS

**HOW TO USE SAS**

**DATA ANALYSIS THREADS**  
Data reduction examples for (almost) every purpose

**USERS GUIDE TO THE XMM-NEWTON SAS**  
The official XMM-Newton SAS User Guide [on-line](#), [PDF version](#) and [Postscript version](#)

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

**SAS ON-LINE DOCUMENTATION**  
Documentation of all single SAS packages

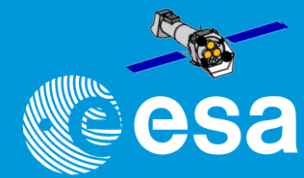
**SAS COOKBOOK**  
An introduction to XMM-Newton data analysis - from NASA XMM-GOF

**BACKGROUND ANALYSIS**  
XMM-Newton pages dedicated to background analysis of all XMM-Newton instruments

**ESAS COOKBOOK**  
Cookbook for data analysis of extended sources using ESAS in SAS, ([on-line](#) and [PDF](#)) from NASA XMM-GOF.  
[ESAS warnings and watchouts](#) from NASA XMM-GOF.

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

# Getting started with SAS IV: all the information



- SAS public web page: <https://www.cosmos.esa.int/web/xmm-newton/sas> (download, installation, information, etc)

- ...How to use SAS

The screenshot shows the 'HOW TO USE SAS' webpage with a navigation menu at the top containing 'SCIENCE MISSIONS', 'SCIENCE & TECHNOLOGY', and 'EUROPEAN SPACE AGENCY'. The main content area is divided into two columns of boxes:

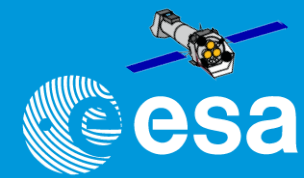
- DATA ANALYSIS THREADS**: Data reduction examples for (almost) every purpose. An arrow points from the text 'Analysis recipes' to this box.
- USERS GUIDE TO THE XMM-NEWTON SAS**: The official XMM-Newton SAS User Guide on-line, PDF version and Postscript version. An arrow points from this box to the text 'General guide'.
- SAS WATCHOUT PAGE**: Issues concerning SAS and data analysis, recommended workarounds/solutions, useful tricks and tips. An arrow points from the text 'Problems??' to this box.
- SAS ON-LINE DOCUMENTATION**: Documentation of all single SAS packages.
- SAS COOKBOOK**: An introduction to XMM-Newton data analysis - from NASA XMM-GOF.
- BACKGROUND ANALYSIS**: XMM-Newton pages dedicated to background analysis of all XMM-Newton instruments.
- ESAS COOKBOOK**: Cookbook for data analysis of extended sources using ESAS in SAS, (on-line and PDF) from NASA XMM-GOF. Includes a link to 'ESAS warnings and watchouts from NASA XMM-GOF'.
- SAS INVERSE INDEX**: The SAS Inverse Index has been designed to provide the list of SAS tasks needed to be executed in order to perform a given scientific analysis job.

Analysis recipes

General guide

Problems??

# Getting started with SAS IV: all the information



- SAS public web page: <https://www.cosmos.esa.int/web/xmm-newton/sas> (download, installation, information, etc)

## ...How to use SAS

The screenshot shows the 'HOW TO USE SAS' webpage with a navigation menu at the top: SCIENCE MISSIONS, SCIENCE & TECHNOLOGY, and EUROPEAN SPACE AGENCY. The main content is organized into two columns of boxes:

- Left Column:**
  - DATA ANALYSIS THREADS**: Data reduction examples for (almost) every purpose
  - SAS WATCHOUT PAGE**: Issues concerning SAS and data analysis, recommended workarounds/solutions, useful tricks and tips
  - SAS COOKBOOK**: An introduction to XMM-Newton data analysis - from NASA XMM-GOF
  - ESAS COOKBOOK**: Cookbook for data analysis of extended sources using ESAS in SAS, (on-line and PDF) from NASA XMM-GOF. ESAS warnings and watchouts from NASA XMM-GOF.
- Right Column:**
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Analysis recipes

Problems??

ABC guide

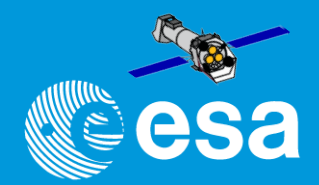
Extended sources

### HOW TO USE SAS

General guide

Task by task info

# The SAS threads



- Home / Latest News
- Conferences & Meetings ▶
- News ▶
- General User Support ▶
- Proposers Info ▶
- Observers Info ▶
- Data Analysis ▶
- Archive, Pipeline & Catalogues ▶
- Calibration & Background ▶
- SOC Info ▶
- About XMM-Newton ▶
- Image Gallery
- Publications ▶
- Other Links ▶

## HOW TO USE SAS

### DATA ANALYSIS THREADS

Data reduction examples for (almost) every purpose

### USERS GUIDE TO THE XMM-NEWTON SAS

The official XMM-Newton SAS User Guide [on-line](#), [PDF version](#) and [Postscript version](#)

### SAS WATCHOUT PAGE

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### SAS INVERSE INDEX

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

## xmm-newton



[XMM-Newton](#) » [Data Analysis](#) » [How to use SAS](#) » [Data Analysis Threads](#)

- [Home / Latest News](#)
- [Conferences & Meetings](#)
- [News](#)
- [General User Support](#)
- [Proposers Info](#)
- [Observers Info](#)
- [Data Analysis](#)
- [Archive, Pipeline & Catalogues](#)
- [Calibration &](#)

## SAS THREADS

### JUPYTER NOTEBOOK THREADS

With the infrastructure of Python introduced in SAS 19, three experimental threads have been released under Jupyter Notebooks. These threads are not intended to be complete but to serve the purpose of illustrating how to use the Python interface to run SAS from a Jupyter Notebook

SAS Start-up and event list manipulation		
- SAS start-up thread in Python	<a href="#">Jupyter Notebook</a>	<a href="#">html</a>
- How to reprocess ODFs to generate calibrated and concatenated EPIC event lists	<a href="#">Jupyter Notebook</a>	<a href="#">html</a>
- How to filter EPIC event lists for flaring particle background	<a href="#">Jupyter Notebook</a>	<a href="#">html</a>



## xmm-newton



### XM EPIC RELATED THREADS

Home	<b>All in one go: from raw data (ODF) to science products</b>		
	- Analysis chain for point-like sources: <a href="#">xmmextractor</a>	<a href="#">command line</a>	
Conf	<b>Step-by-Step</b>		
	Event list generation:		
	- How to reprocess ODFs to generate calibrated and concatenated EPIC event lists	<a href="#">command line</a>	
News	Filtering against high background:		
	- How to filter EPIC event lists for flaring particle background	<a href="#">command line &amp; GUI version</a>	
Gene	Light curve generation:		
	- Extraction of a light curve for a point-like source (EPIC and RGS)	<a href="#">command line</a>	<a href="#">GUI version</a>
Prop	Spectrum extraction:		
	- Extraction of MOS spectra from point-like sources	<a href="#">command line</a>	<a href="#">GUI version</a>
	- Extraction of MOS spectra from point-like sources taken in timing mode	<a href="#">command line</a>	
Obse	- Extraction of pn spectra from point-like sources	<a href="#">command line</a>	<a href="#">GUI version</a>
	- Extraction of pn spectra from point-like sources taken in timing mode	<a href="#">command line</a>	
Data	- Extraction of spectra in a few clicks: <a href="#">especget</a>		<a href="#">GUI version</a>
	- Combining the spectra of the 3 EPIC cameras	<a href="#">command line</a>	
Archi	- Overlapping EPIC data treatment: <a href="#">multixmmselect</a>		<a href="#">GUI version</a>
Catal	Point Spread Function (PSF) generation:		
	- 2-D PSF à la carte	<a href="#">command line</a>	
Calib	<b>More complex analysis for bright sources</b>		
	- Dealing with EPIC Out-of-Time (OOT) events	<a href="#">command line</a>	
	- How to evaluate and test pile-up in an EPIC source	<a href="#">command line</a>	
	<b>Handling of EPIC background</b>		
	- How to use EPIC instrumental background files	<a href="#">command line</a>	
	ESAS:		
	- Creation of EPIC background subtracted, exposure corrected images	<a href="#">command line</a>	
	- Creation of EPIC merged background subtracted and exposure corrected images	<a href="#">command line</a>	
	- Creation of EPIC spectral analysis files for a cluster radial profile	<a href="#">command line</a>	
	Images:		
	- A shell script to create attractive EPIC-pn & MOS combined images	<a href="#">dedicated Web page</a>	
	- How to Generate Vignetting-corrected Background-subtracted EPIC Images	<a href="#">command line</a>	
	<b>Source detection</b>		
	- EPIC source finding thread in one go: <a href="#">edetect_chain</a>	<a href="#">command line</a>	
	- EPIC source finding thread: step-by-step	<a href="#">command line</a>	
	- EPIC source finding in overlapping exposures	<a href="#">command line</a>	
	<b>Slew data processing</b>		
	- How to process EPIC slew data	<a href="#">command line</a>	

### SAS THREADS

, three experimental threads have been released under Jupyter Notebooks. These have the purpose of illustrating how to use the Python interface to run SAS from a Jupyter

	<a href="#">Jupyter Notebook</a>	<a href="#">html</a>
<a href="#">Concatenated EPIC</a>	<a href="#">Jupyter Notebook</a>	<a href="#">html</a>
<a href="#">Background</a>	<a href="#">Jupyter Notebook</a>	<a href="#">html</a>

## xmm-newton



### XM EPIC RELATED THREADS

Home	<b>All in one go: from raw data (ODF) to science products</b>		
	- Analysis chain for point-like sources: <a href="#">xmmextractor</a>	command line	
Conf	<b>Step-by-Step</b>		
	Event list generation:		
News	- How to reprocess ODFs to generate calibrated and concatenated EPIC event lists	command line	
	Filtering against high background:		
Gene	- How to filter EPIC event lists for flaring particle background	command line & GUI version	
	Light curve generation:		
Prop	- Extraction of a light curve for a point-like source (EPIC and RGS)	command line	GUI version
	Spectrum extraction:		
Obse	- Extraction of MOS spectra from point-like sources	command line	GUI version
	- Extraction of MOS spectra from point-like sources taken in timing mode	command line	
Data	- Extraction of pn spectra from point-like sources	command line	GUI version
	- Extraction of pn spectra from point-like sources taken in timing mode	command line	
Archi	- Extraction of spectra in a few clicks: <a href="#">especget</a>		GUI version
Catal	- Combining the spectra of the 3 EPIC cameras	command line	
Calib	- Overlapping EPIC data treatment: <a href="#">multixmmselect</a>		GUI version
	Point Spread Function (PSF) generation:		
	- 2-D PSF à la carte	command line	
	<b>More complex analysis for bright sources</b>		
	- Dealing with EPIC Out-of-Time (OOT) events	command line	
	- How to evaluate and test pile-up in an EPIC source	command line	
	<b>Handling of EPIC background</b>		
	- How to use EPIC instrumental background files	command line	
	ESAS:		
	- Creation of EPIC background subtracted, exposure corrected images	command line	
	- Creation of EPIC merged background subtracted and exposure corrected images	command line	
	- Creation of EPIC spectral analysis files for a cluster radial profile	command line	
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	- How to Generate Vignetting-corrected Background-subtracted EPIC Images	command line	
	<b>Source detection</b>		
	- EPIC source finding thread in one go: <a href="#">edetect_chain</a>	command line	
	- EPIC source finding thread: step-by-step	command line	
	- EPIC source finding in overlapping exposures	command line	
	<b>Slew data processing</b>		
	- How to process EPIC slew data	command line	

### SAS THREADS

, three experimental threads have been released under Jupyter Notebooks. These he purpose of illustrating how to use the Python interface to run SAS from a Jupyter

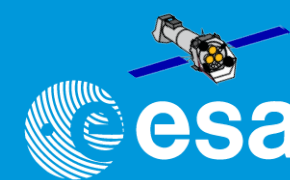
#### - RGS RELATED THREADS

	<b>All in one go: from raw data (ODF) to science products</b>		
	- Analysis chain for point-like sources: <a href="#">xmmextractor</a>	command line	
	<b>Step-by-Step</b>		
»	- How to reduce RGS data and extract spectra of point-like sources	command line	
	- <a href="#">rgsproc</a> , coordinates and masks	command line	
	Light curve generation:		
?	- Extraction of a light curve for a point-like source (EPIC and RGS)	command line	GUI version
	<b>More complex analysis for the very bright sources</b>		
	- Pile-up in the RGS: how to prevent it, evaluate its existence and make corrections	command line	

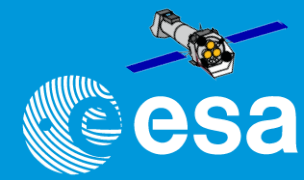
#### OM RELATED THREADS

	<b>All in one go: from raw data (ODF) to science products</b>		
	- Analysis chain for point-like sources: <a href="#">xmmextractor</a>	command line	
	<b>Step-by-Step</b>		
	- OM image mode data processing chain	processing chain	command line
	- OM fast mode data processing chain	processing chain	command line
	- OM Grism processing chain	processing chain	command line
	- Interactive OM photometry	command line	
	- Converting OM data to OGIP II format (use in <a href="#">xspect</a> )	command line	

# A SAS thread (Jupyter Notebook)



# A SAS thread (Jupyter Notebook)



jupyter sas-startup (unsaved changes) Python 3 (ipykernel) Logout

File Edit View Insert Cell Kernel Widgets Help Not Trusted Python 3 (ipykernel)

Run

## SAS Startup Thread in Python

### Introduction

The SAS Start-up thread provides a detailed explanation on how to get started with SAS. In particular it shows how to initialize SAS, how to point SAS to the calibration files needed for a given XMM-Newton Observation, and how to get the data ready to be processed by any SAS task. With SAS 19, we are introducing a new infrastructure for Python which allows one to run Python tasks from the command line, as any other non Python SAS task, and to access the same code from a Jupyter Notebook. Besides that, SAS 19 includes several new Python tasks, among them, two which can help us to start working with SAS: [startsas](#) and [sasver](#).

### Expected Outcome

The ability to process any XMM-Newton observation with any SAS task.

### SAS Tasks to be Used

- [sasver](#)
- [startsas](#)
- [cifbuild](#)
- [odfingest](#)

### Prerequisites

It is assumed that SAS has been installed properly, according to the explanations given in the [current SAS installation pages](#). Before SAS is initialized, the HEASOFT software must be already initialized as well (see [SAS Watchout](#)).

### Useful Links

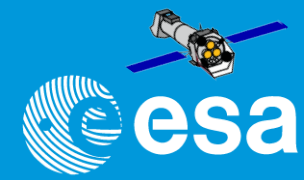
- [pysas](#)
- [SAS web pages](#)
- [SAS download page](#)
- [SAS external software requirements](#)
- [Latest SAS on-line documentation](#)
- [SAS Threads](#)

### Caveats

**Last Reviewed: 30 November 2021, for SAS v20.0**

**Last Updated: 15 March 2021**

# A SAS thread (Jupyter Notebook)



jupyter sas-startup (unsaved changes)



Logout

File Edit



## Running sasver

You may try now to run your first SAS Python task: [sasver](#). This task provides a sort of \*about SAS\* and also, a test of SAS \*readiness\*. If such task is able to run successfully, the whole SAS is ready to be used.

The purpose of [sasver](#) is to show the \*identity\* card of the SAS version you are running. Besides, it shows all SAS shell environment variables defined so far.

The task [sasver](#) can be run either from the command line or from a notebook. Most Python SAS tasks will behave this way. To run it from the command line, you simply have to invoke it as you would do any other SAS command,

```
sasver
```

which will produce in the terminal several output lines.

However, to run this task from a Jupyter Notebook, we need to employ a different method. Given that such method can be used to run any other SAS task, either Python or non Python, we are going to explain it by using the SAS task [sasver](#) as an example.

## Invoking SAS Python tasks from notebooks

To work with any specific Python component included in SAS, we need to import the corresponding package from the Python core package for SAS. Such package is named `pysas`.

To execute any SAS task within a Notebook, we need to import from `pysas` a component known as `Wrapper`. The following cell shows how to do that,

```
In [ ]: from pysas.wrapper import Wrapper as w
```

Any SAS task accepts arguments which can be either specific options, e.g. `--version`, which shows the task's version, or parameters with format `param=value`. When the task is invoked from the command line, these arguments follow the name of the task. However, in Notebooks we have to pass them to the task in a different way. This is done using a Python list, whose name you are free to choose. Let the name of such list be `inargs`.

To pass the option `--version` to the task to be executed, we must define `inargs` as,

# A SAS thread (Not Jupyter Notebook)

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## Expected Outcome

Corrected light curves of XMM-Newton EPIC and RGS instruments.

## SAS Tasks to be Used

- `evselect`
- `epiclccorr`
- `rgslccorr`
- `barycen`

## Prerequisites

- SAS Start-up Thread
- How to reprocess ODFs to generate calibrated and concatenated EPIC event lists Thread
- How to reduce RGS data and extract spectra of point-like sources Thread

## Useful Links

- How to evaluate the pile-up fraction thread

## Caveats

Last Reviewed: 29 May 2013, for SAS v13.0

Last Updated: 29 May 2013

## Procedure

### EPIC

As an example case, we will consider the extraction of a light curve from a pn event list (`PN_evt.fits`). The same recipe applies for MOS.

1. Set up your SAS environment (see **Prerequisites** for this thread at the top of the page).
2. Be aware: if you are interested in very short time periods, such as they appear in pulsars or cataclysmic variables, you have to perform a barycentric correction. This means that the arrival time of a photon is shifted as is it would have been detected at the barycentre of the solar system (the centre of mass) instead at the position of the satellite. In this way, the data are comparable. The SAS task `barycen` performs this correction. As `barycen` overwrites the `TIME` column entries, it is advisable first to copy the original event list.

```
cp PN_evt.fits PN_evt_barcen.fits
barycen table=PN_evt_barcen.fits:EVENTS
```

3. Extract an image (in sky coordinates in this example; extraction in detector - `DET[XY]` - coordinates is possible as well)

```
evselect table=PN_evt.fits imagebinning=binSize imageset=PNimage.img withimageset=yes \
xcolumn=X ycolumn=Y ximagebinsize=80 yimagebinsize=80
```

4. Display the image

```
imgdisplay withimagefile=true imagefile=PNimage.img
```

5. Select the region, from which the light curve shall be accumulated, using the `Region/Circle` in `ds9` (see Fig.1)

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```
cp PN_evt.fits PN_evt_barc
barycen table=PN_evt_barc
```

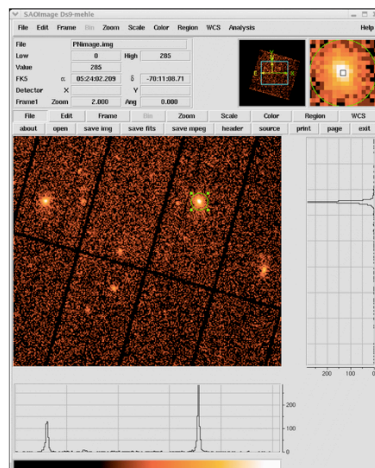
3. Extract an image (in sky coordin

```
evselect table=PN_evt.fits
xcolumn=X ycolumn=Y xim
```

4. Display the image

```
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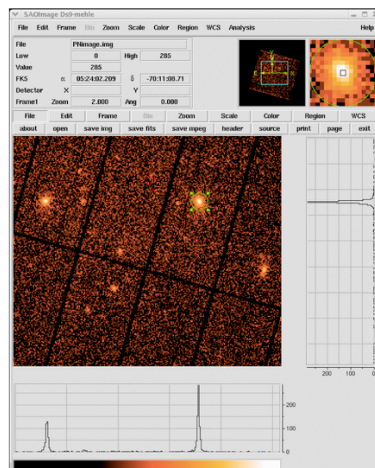
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6. Double-click with the cursor on the defined region. A window pops up, showing the properties of the region (Fig.2). Write down the coordinates of the Centre (25910.5, 25870.5) and the Radius(400).

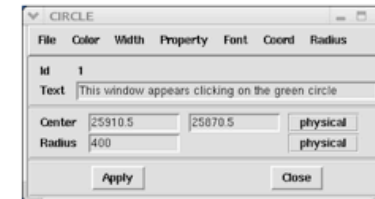


Fig.2: Selection region properties window, popped-up by double-clicking on the region in the main `ds9` window

Units of sky coordinates (X,Y) are 0.05 arcsec, hence the radius in our example is 20 arcsec.

7. Now you can extract a source+background light curve, using all the selection region and including a quality selection appropriate for a light curve extraction. For PN, taking good events, singles and doubles with an energy range between 200 and 10000 eV (`#XMMEA_EP && (PATTERN<=4) && (PI in [200:10000])`). For MOS, taking good events, singles, doubles, triples and quadruples with an energy range between 200 and 10000 eV (`#XMMEA_EM && (PATTERN<=12) && (PI in [200:10000])`). In the example, the bin size is 100 seconds.

```
evselect table=PN_evt.fits energycolumn=PI expression='#XMMEA_EP&&(PATTERN<=4)&& \
((X,Y) IN circle(25910.5,25870.5,400))&&(PI in [200:10000])' \
withrateset=yes rateset='PN_source_lightcurve_raw.lc' timebinsize=100 \
maketimecolumn=yes makeratecolumn=yes
```

The parameter `makeratecolumn=yes` produces a light curve in count rates (with errors). Otherwise the light curve is produced in counts (with errors).

8. Repeat steps #4 to #6 above to determine the region, from which the background light curve is to be extracted. We will assume in the following that the extraction region corresponds to an annulus, centered in (25910.5,25870.5) and with inner and outer radii 1000 and 2000 pixels, respectively.
9. Extract a background light curve, using all the selection expressions defined so far, and the same bin size (100 seconds) and energy range as for the source+background light curve

```
evselect table=PN_evt.fits energycolumn=PI expression='#XMMEA_EP&&(PATTERN<=4)&& \
((X,Y) IN annulus(25910.5,25870.5,1000,2000))&&(PI in [200:10000])' \
withrateset=yes \
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maketimecolumn=yes makeratecolumn=yes
```

The light curves are OGIP-compliant, and therefore can be processed by standard XRONOS-like LHEASOFT packages.

10. However, light curves obtained in such a way should be corrected for various effects affecting the detection efficiency, such as vignetting, bad pixels, PSF variation and quantum efficiency, as well as for variations affecting the stability of the detection within the exposure, like dead time and GTIs. Since all these effects can affect in a different manner source and background light curves, the background subtraction has to be done accordingly. A SAS task, `epiclocorr`, performs all of these corrections at once. It requires as input both light curves (which are used to establish the binning of the final corrected background subtracted light curve) and the event file. A simple command line call:

```
epiclocorr srcalist=PN_source_lightcurve_raw.lc eventlist=PN_evt.fits outset=PN_locorr.lc \
bkgalist=PN_light_curve_background_raw.lc withbkgset=yes applyabsolutecorrections=yes
```

11. Plot the resulting light curves, e.g.

```
dsplot table=PN_locorr.lc withx=yes x=TIME withy=yes y=RATE
```

This command will launch the following `xmgspace` window



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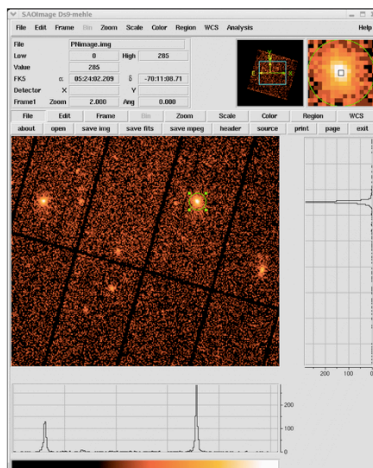
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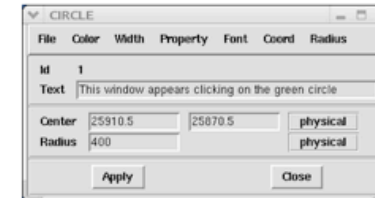


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11. Plot the resulting light curves, e.g.

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```

This command will launch the following `xmgrace` window

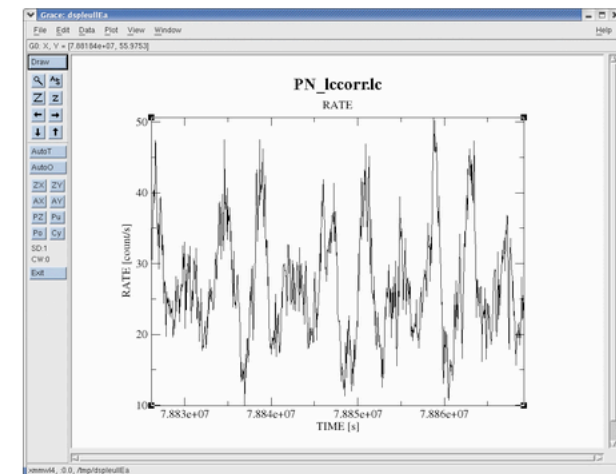
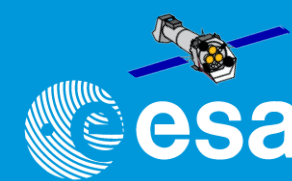
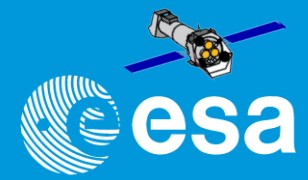


Fig.3: `xmgrace` window, containing the background-subtracted exposure-corrected light curve

# The main GUI

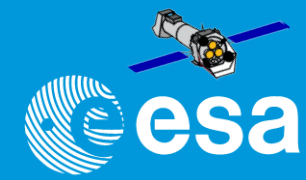


# The main GUI



- Access to all tasks (GUI call) and descriptions
- Setting general defaults
- Access to help pages
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The screenshot shows the SAS GUI window with a menu bar (File, Task, Custom, Style, Help) and a toolbar. The main area displays a table of tasks with columns for task name, group, history, and description. Below the table is a log window showing system information and configuration settings.

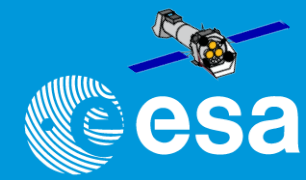
task	group	history	description
obt2met	utility		Convert On-Board-Time to MET
odfbrowser	utility		Interactive ODF browser; allows the procs to run on a selection of e
odfexpand	utility		Display the name of an ODF constituent matching a specific instrum
odffix	utility		Make additions to a PMS or scisim ODF so that it can be used with
odfingest	pipeline		Prepare an ODF for processing
omatt	om		Convert a source list from OM detector to sky coordinates, and proc
omcomb	om		Combines the four non-overlapping OM science windows from a
omcosflag	pipeline		Applies the OM tracking to a bad pixel map
omdetect	om		Uses an extractor like algorithm with modification to detect sources i
omdrifhist	om		Provides graphical and statistical information on the OM tracking his
omfastflat	om		Applies in-orbit and modulo-8 spatial fixed-pattern noise calibrations
omfastshift	om		Corrects FAST mode event list coordinates for spacecraft drift.
omchain	om		This package contains a PERL script which takes a set of fast mode
omflatfield	om		Creates a tracking shifted flatfield and applies it to an OM OSW ima
omflatgen	om		Combines a number of individual slew images into a full window fla
omgchain	om		This package contains a PERL script which takes a set of grism mod
omgprep	om		Convert a source list from OM detector to sky coordinates, and proc
omgrism	pipeline		This task constructs the PPS product OM OSW FITS source timeser
omgrismplot	timing		Plots EPIC or OM net source and background time series and perfo

XMM Science Analysis System - GUI version 1.52.8  
Started on Sat Jan 19 19:21:05 2008

```
@@ SAS_SUPPRESS_WARNING=1; export SAS_SUPPRESS_WARNING
@@ SAS_CCF=.; export SAS_CCF
@@ SAS_CCFPATH=.; export SAS_CCFPATH
@@ cd /sas
@@ HOME=/Users/cgabriel; export HOME
@@ SAS_MEMORY_MODEL=high; export SAS_MEMORY_MODEL
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omfastshift	om		
omchain	om		
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omflatgen	om		
omgchain	om		
omgprep	om		
omgrism	pipeline		
omgrismplot	timing		

A configuration dialog box is open, showing settings for the 'odf' task:

- odf: 0112570601\_SCX00000SUM.SAS
- ccf: /Users/cgabriel/WORK/0112570601/wrk/ccf.cif
- home: /Users/cgabriel
- current: /sas
- ccfpath: /CCF
- usetabs: yes
- SuppressWarning: 1
- verbosity: 1
- memory: high

Buttons: OK, Cancel, Save, Defaults

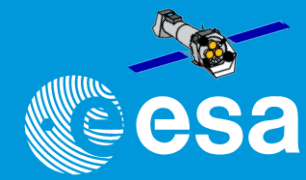
Log output (sas\_log):

```
XMM Science Analysis System - GUI version 1.52.8
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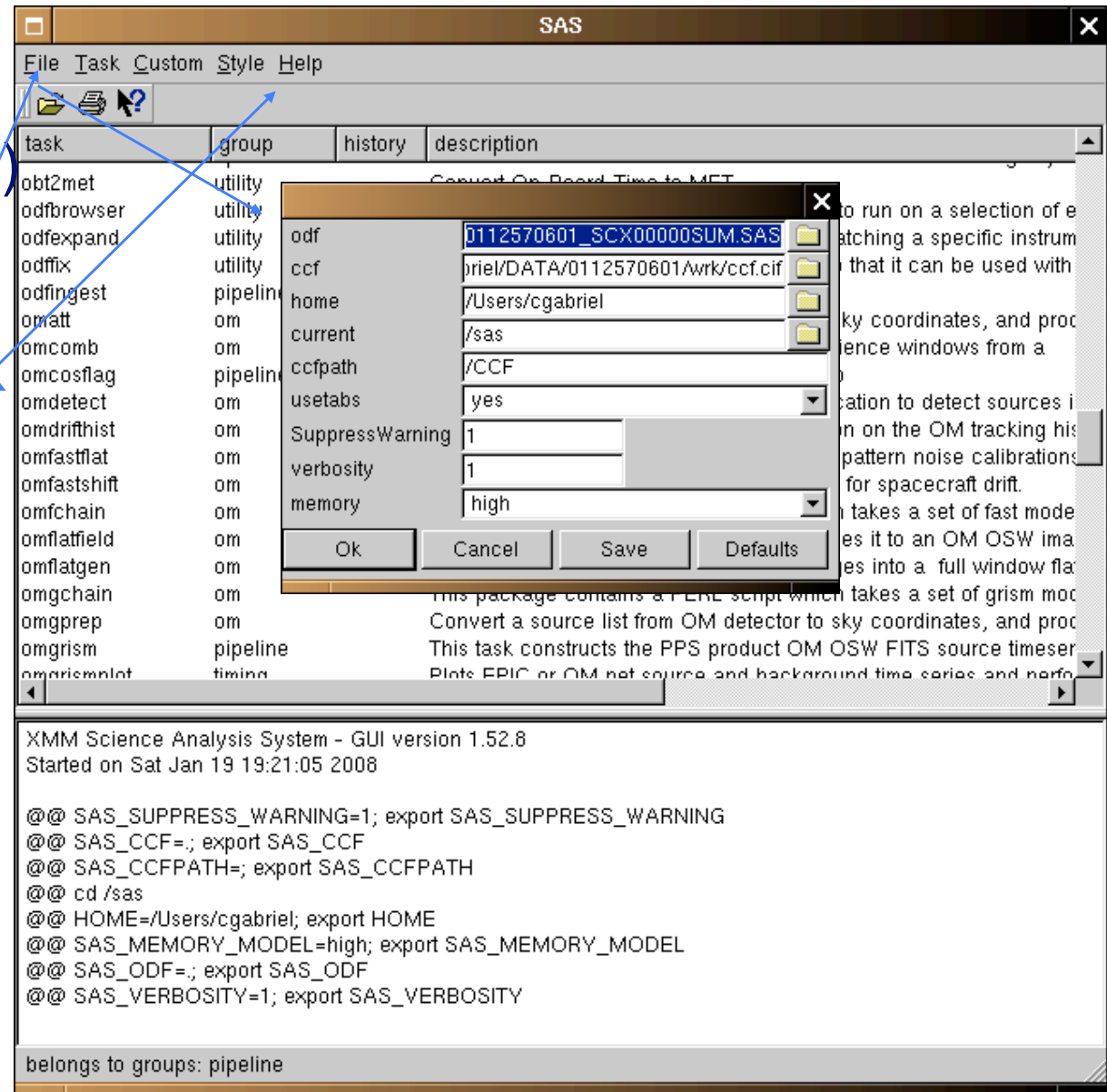
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omgrism	pipeline		
omgrismplot	timing		

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- ccf: /Users/cgabriel/WORK/0112570601/wrk/ccf.cif
- home: /Users/cgabriel
- current: /sas
- ccfpath: /CCF
- usetabs: yes
- SuppressWarning: 1
- verbosity: 1
- memory: high

The dialog box has buttons for OK, Cancel, Save, and Defaults. Below the dialog box, the SAS log window shows the following output:

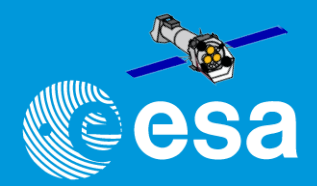
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# GUI or command line?



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GUIs are very useful for beginners

Every SAS task has its own GUI - they can be called by other (main) GUI or directly from the command line by `#> <task> -d`:

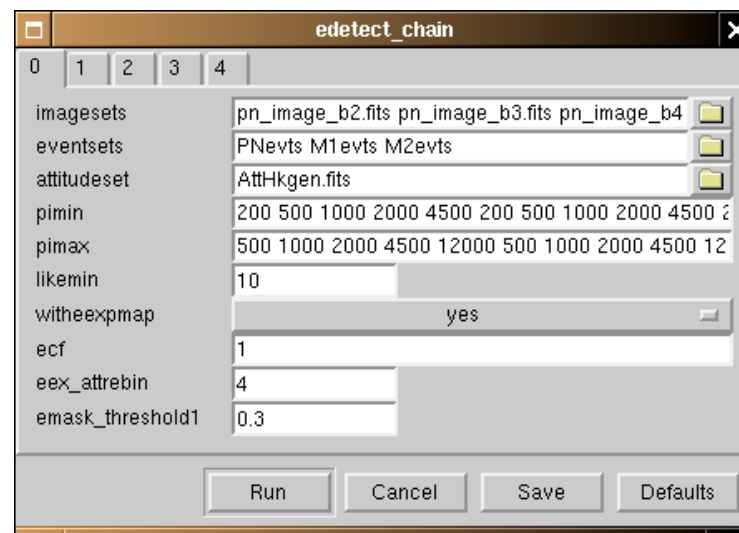
```
edetect_chain -d
```

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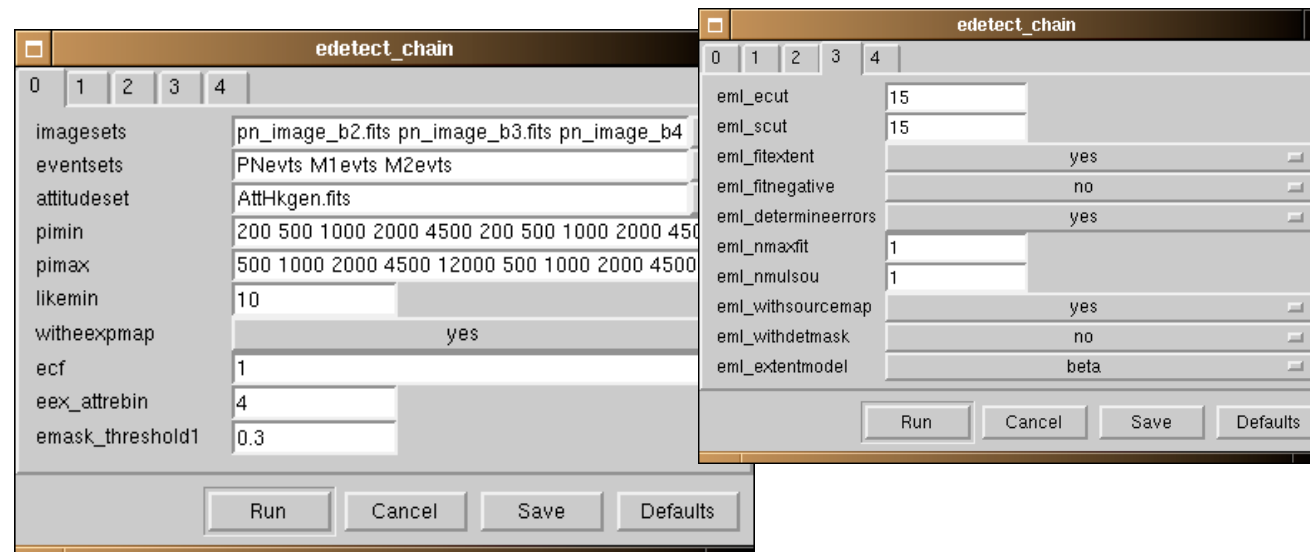


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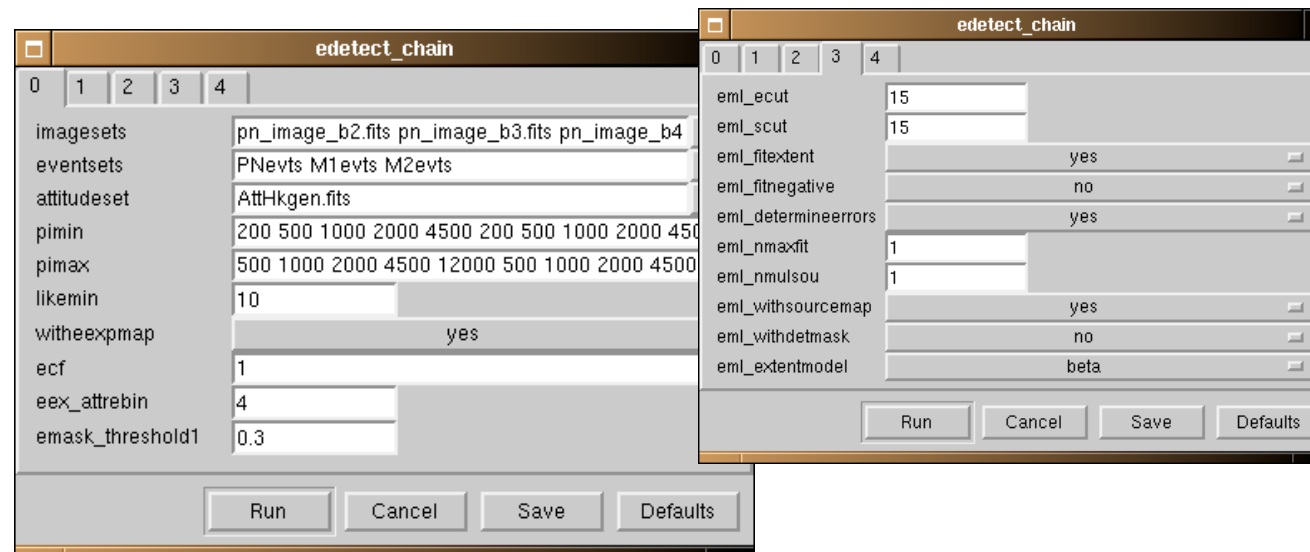


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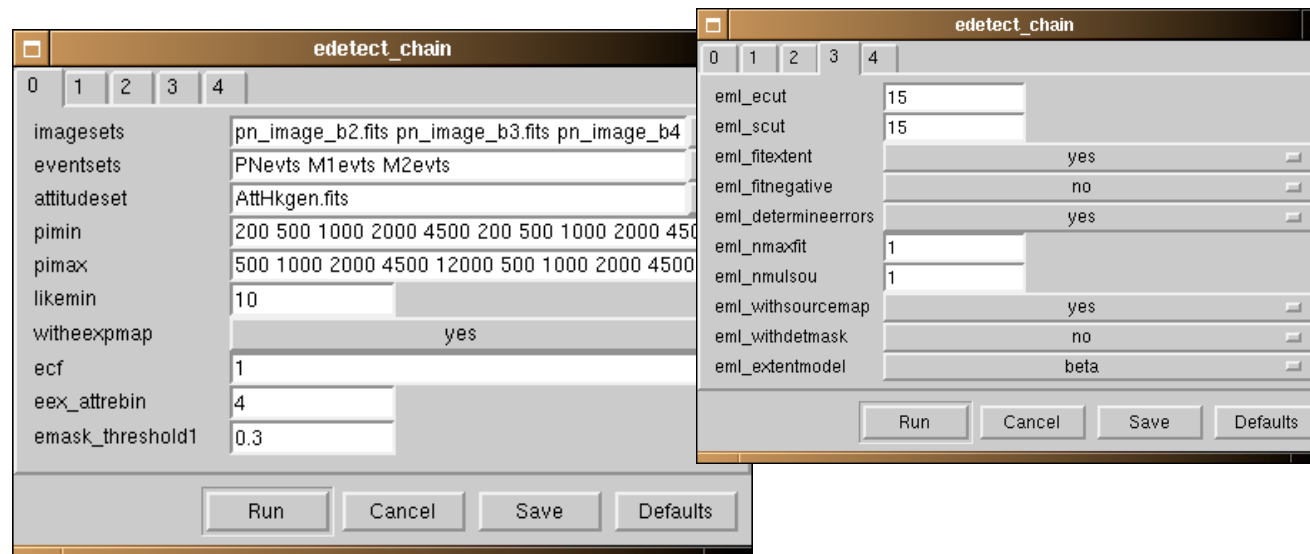
source list

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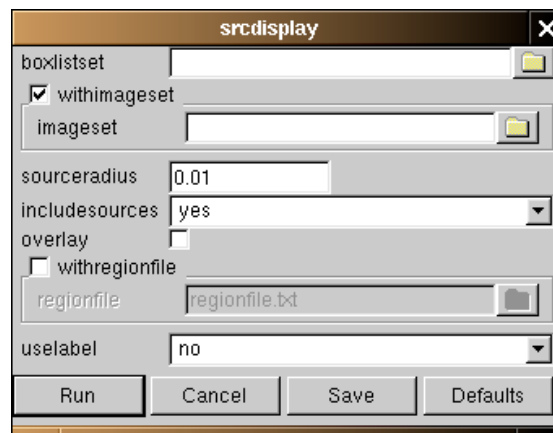
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`srcdisplay -d`

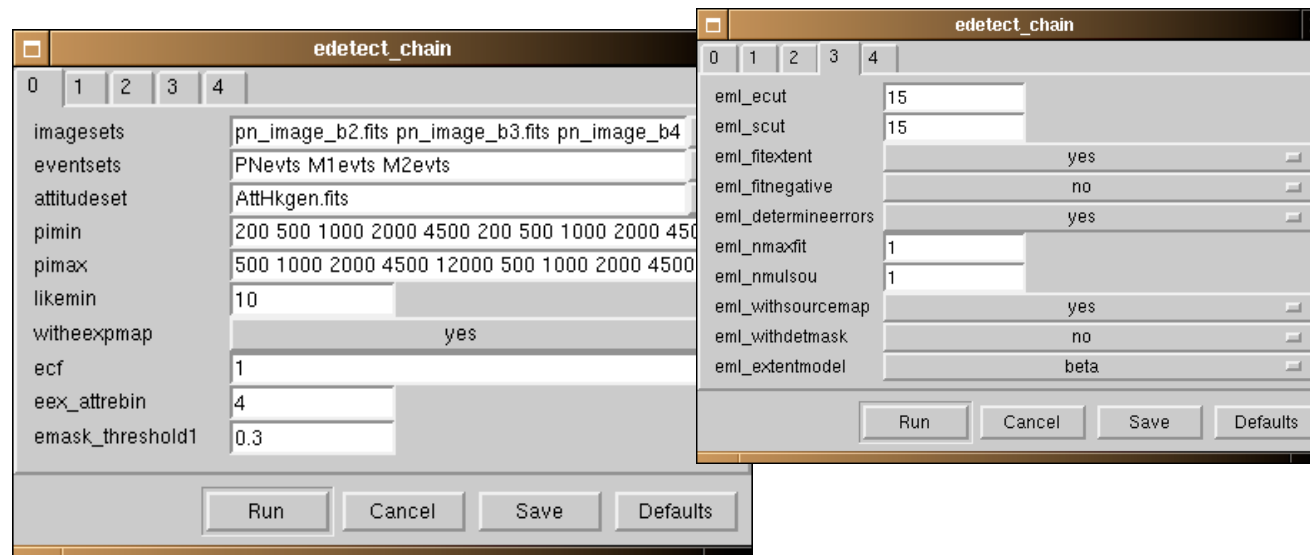


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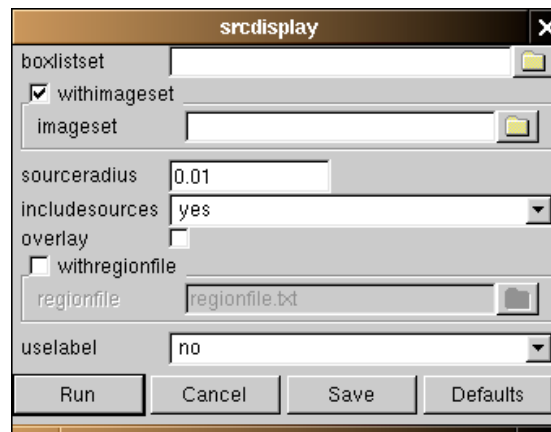
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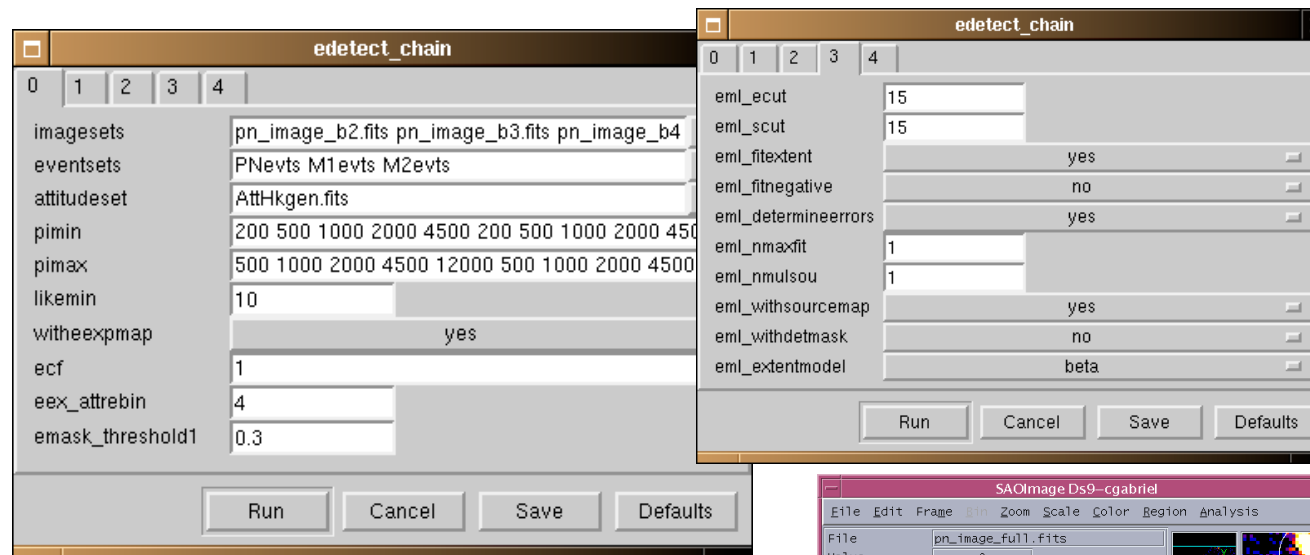


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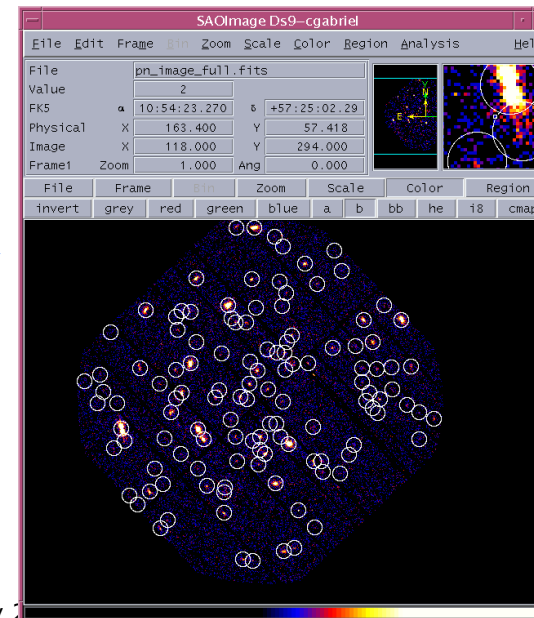
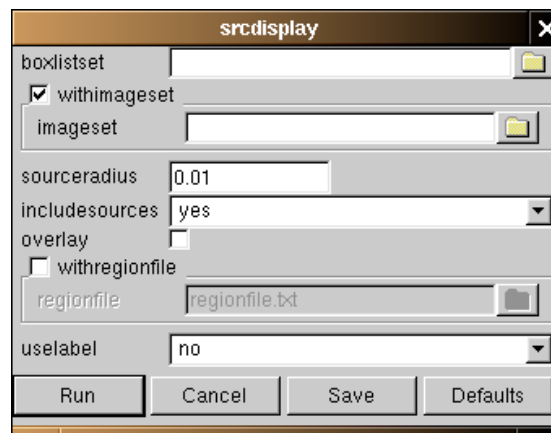
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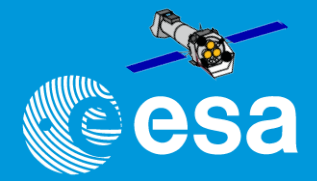
source list

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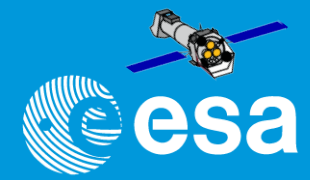




**GUI or command line? BOTH**

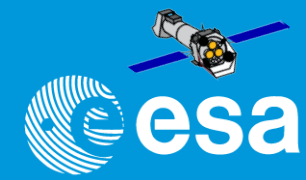


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```
det_script - /Users/cgabriel/DATA/0112570601/wrk/srcdet/
File Edit Search Preferences Shell Macro Windows Help

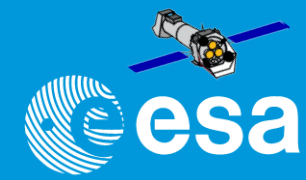
evselect table=MOS1evt:EVENTS expression='#XMMEA_EM&&(PI>10000)&&(PATTERN==0)' rateset="m1_back_lightc.fits" timebinsize=10
withrateset=yes maketimecolumn=yes makeratecolumn=yes
evselect table=MOS2evt:EVENTS expression='#XMMEA_EM&&(PI>10000)&&(PATTERN==0)' rateset="m2_back_lightc.fits" timebinsize=10
withrateset=yes maketimecolumn=yes makeratecolumn=yes
evselect table=PNevt:EVENTS expression='#XMMEA_EP&&(PI>10000)&&(PATTERN==0)' rateset="pn_back_lightc.fits" timebinsize=10
withrateset=yes maketimecolumn=yes makeratecolumn=yes

dsplot table=m1_back_lightc.fits x=TIME y=RATE &
dsplot table=m2_back_lightc.fits x=TIME y=RATE &
dsplot table=pn_back_lightc.fits x=TIME y=RATE &

tabgtigen table=m1_back_lightc.fits expression="RATE < 0.35" gtiset=m1_back_gti.fits
tabgtigen table=m2_back_lightc.fits expression="RATE < 0.35" gtiset=m2_back_gti.fits
tabgtigen table=pn_back_lightc.fits expression="RATE < 1.00" gtiset=pn_back_gti.fits

evselect table=MOS1evt:EVENTS imagebinning='binSize' imageset='m1_image_full.fits' withimageset=yes xcolumn='X' ycolumn='Y'
ximagebinsize=40 yimagebinsize=40 expression='#XMMEA_EM&&(PI in [200:12000])&&(PATTERN in [0:12])&&(FLAG==0) &&
gti(m1_back_gti.fits,TIME)'
evselect table=MOS1evt:EVENTS imagebinning='binSize' imageset='m1_image_b1.fits' withimageset=yes xcolumn='X' ycolumn='Y'
ximagebinsize=40 yimagebinsize=40 expression='#XMMEA_EM&&(PI in [200:500])&&(PATTERN in [0:12])&&(FLAG==0) &&
gti(m1_back_gti.fits,TIME)'
evselect table=MOS1evt:EVENTS imagebinning='binSize' imageset='m1_image_b2.fits' withimageset=yes xcolumn='X' ycolumn='Y'
ximagebinsize=40 yimagebinsize=40 expression='#XMMEA_EM&&(PI in [500:1000])&&(PATTERN in [0:12])&&(FLAG==0) &&
gti(m1_back_gti.fits,TIME)'
evselect table=MOS1evt:EVENTS imagebinning='binSize' imageset='m1_image_b3.fits' withimageset=yes xcolumn='X' ycolumn='Y'
ximagebinsize=40 yimagebinsize=40 expression='#XMMEA_EM&&(PI in [1000:2000])&&(PATTERN in [0:12])&&(FLAG==0) &&
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det_script - /Users/cgabriel/DATA/0112570601/wrk/srcdet/
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evselect table=MOS1evt:EVENTS expression='#XMMEA_EM&&(PI>10000)&&(PATTERN==0)' rateset="m1_back_lightc.fits" timebinsize=10
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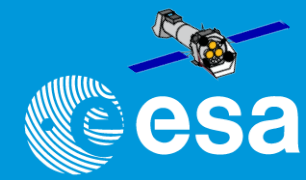
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ximagebinsize=40 yimagebinsize=40 expression='#XMMEA_EM&&(PI in [500:1000])&&(PATTERN in [0:12])&&(FLAG==0) &&
gti(m1_back_gti.fits, TIME)'
evselect table=MOS1evt:EVENTS imagebinning='binSize' imageset='m1_image_b3.fits' withimageset=yes xcolumn='X' ycolumn='Y'
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My answer: GUI & command line

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withrateset=yes maketimecolumn=yes makeratecolumn=yes
evselect table=PNevt:EVENTS expression='#XMMEA_EP&&(PI>10000)&&(PATTERN==0)' rateset="pn_back_lightc.fits" timebinsize=10
withrateset=yes maketimecolumn=yes makeratecolumn=yes

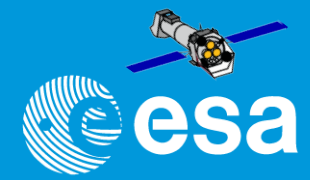
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ximagebinsize=40 yimagebinsize=40 expression='#XMMEA_EM&&(PI in [500:1000])&&(PATTERN in [0:12])&&(FLAG==0) &&
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evselect table=MOS1evt:EVENTS imagebinning='binSize' imageset='m1_image_b3.fits' withimageset=yes xcolumn='X' ycolumn='Y'
ximagebinsize=40 yimagebinsize=40 expression='#XMMEA_EM&&(PI in [1000:2000])&&(PATTERN in [0:12])&&(FLAG==0) &&
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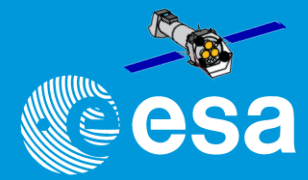
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# PPS or “proc” products? BOTH



All data  already reduced by PPS (SAS subset with default parameters)

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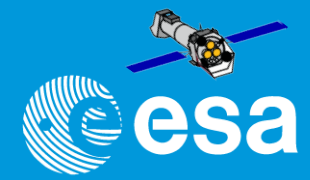


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Why reprocessing then (epproc, emproc, rgsproc, om?chain) ?

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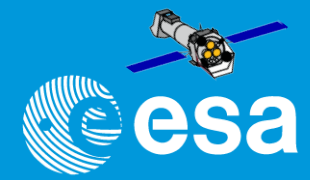
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During 2019 general reprocessing (third time in 19 years)

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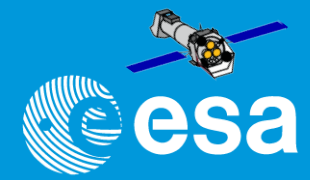
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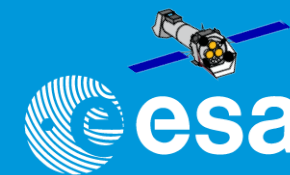
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**Bulk reprocessing will take place in ...**

Even if you reduce yourself the data it is important to get a look into the PPS data beforehand, in ALL cases they will give a good impression about the contents

# Where is the XMM-Newton data? In XSA



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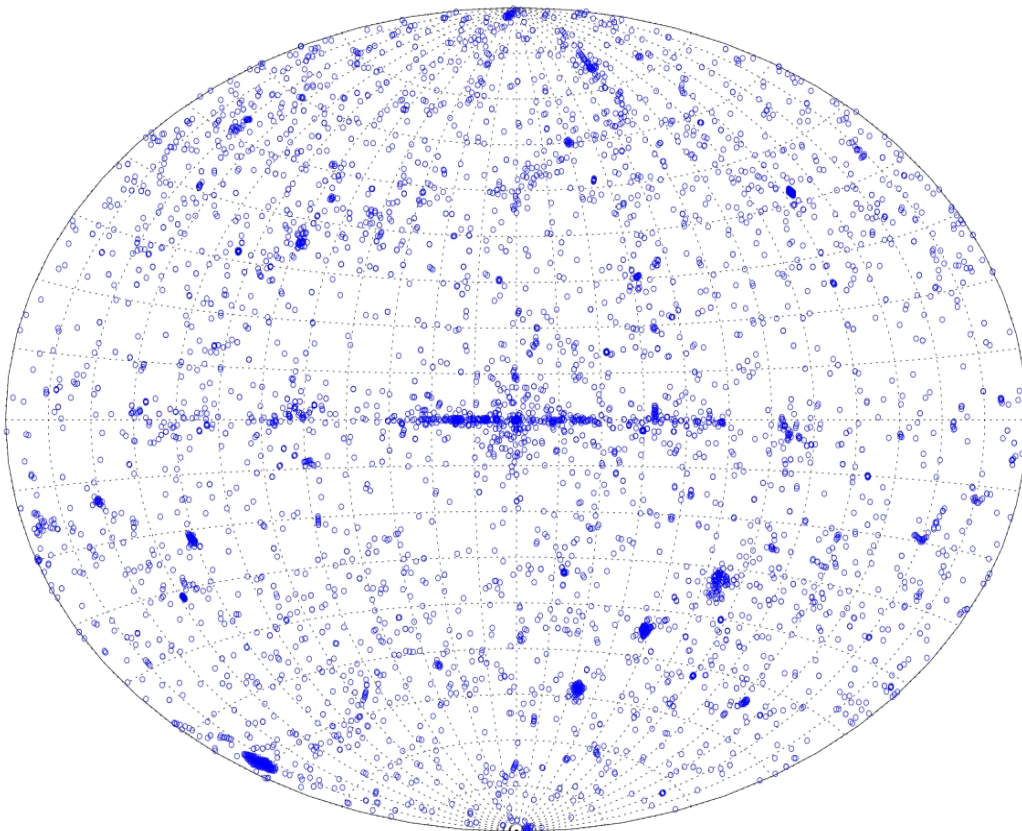
## Contents of the XSA:

- ODF/PPS of ~ 17000 pointed observations
- SDF of ~ 5,000 slew observations
- SDF of ~ 200,000 Slew Survey sub-exposures
- 939.270 detections (4XMM-DR12 catalogue) / 630.347 unique sources
- 8,863,922 OM sources (XMMOM SUSS 5 catalogue)
- 72352 Slew Survey sources (XMMSL2)

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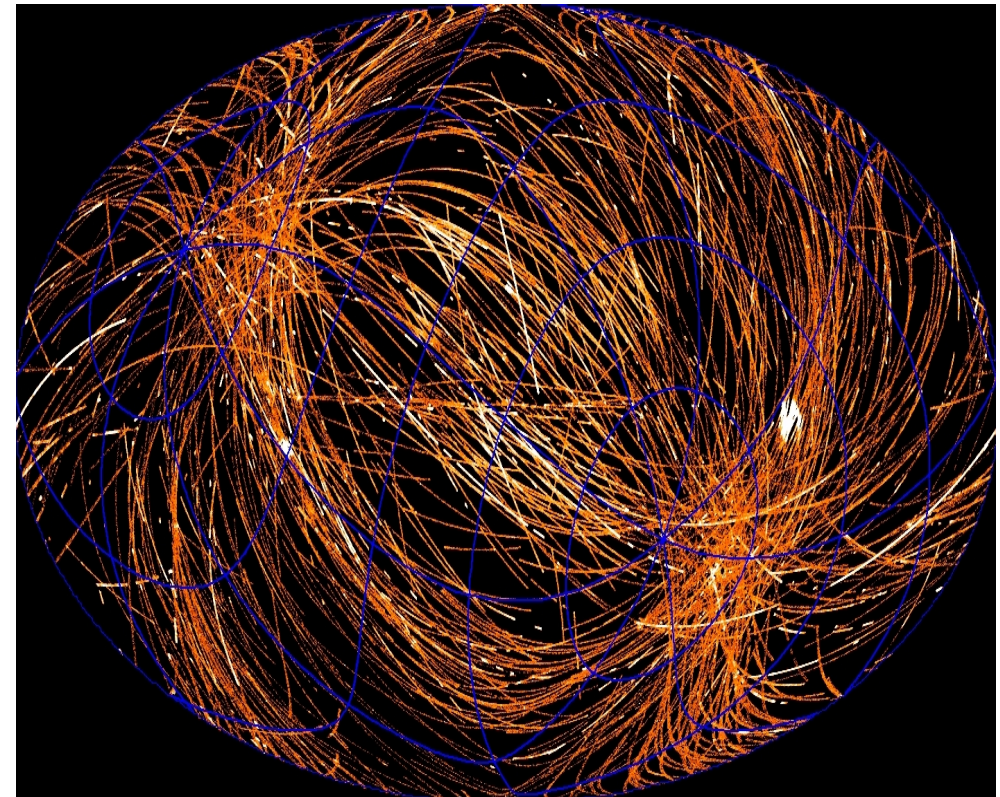
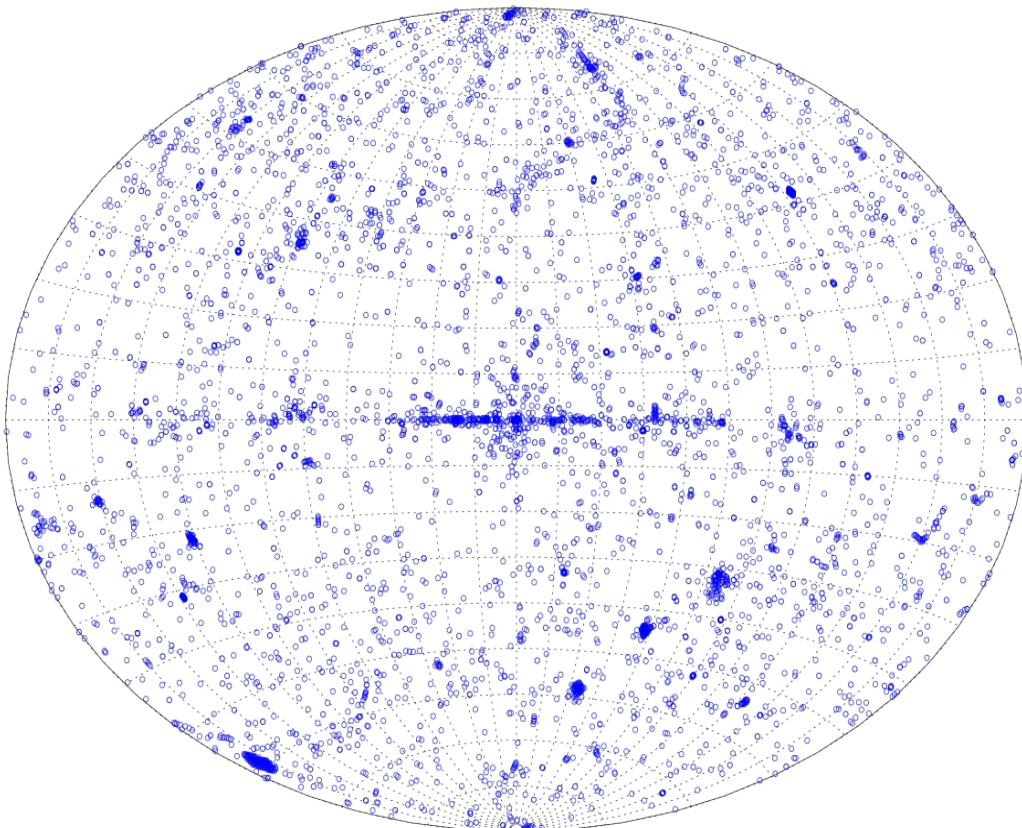
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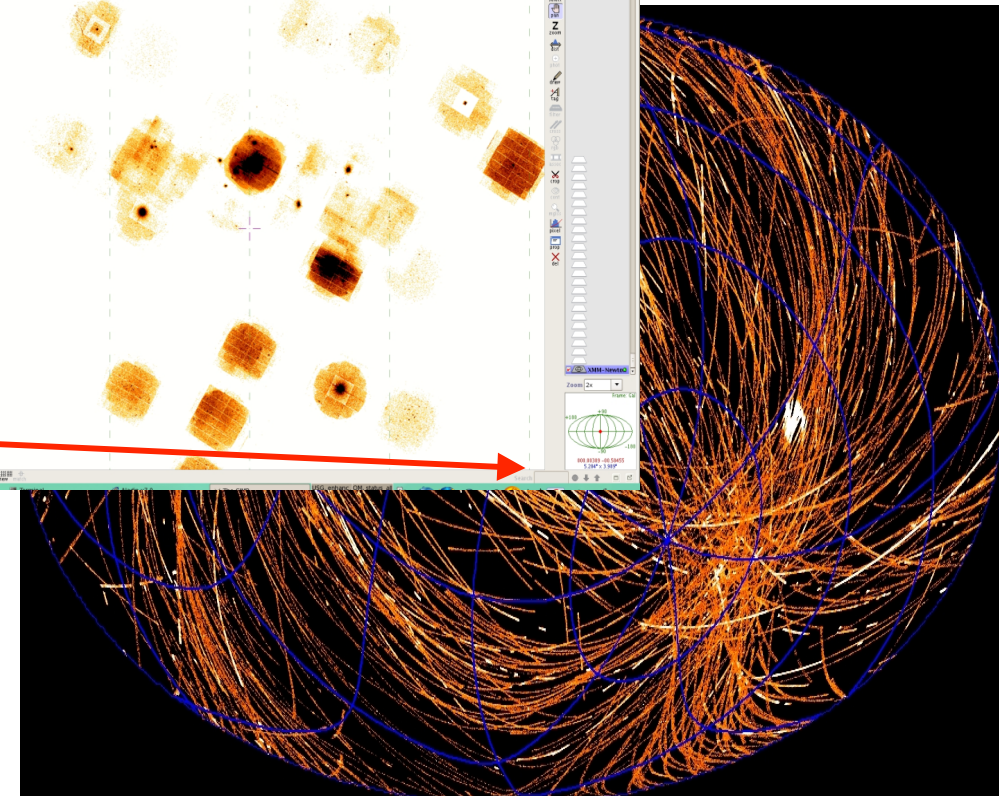
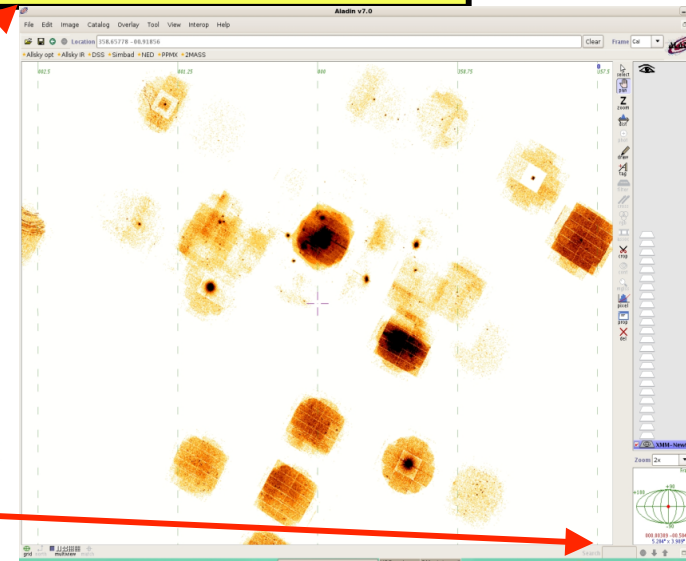
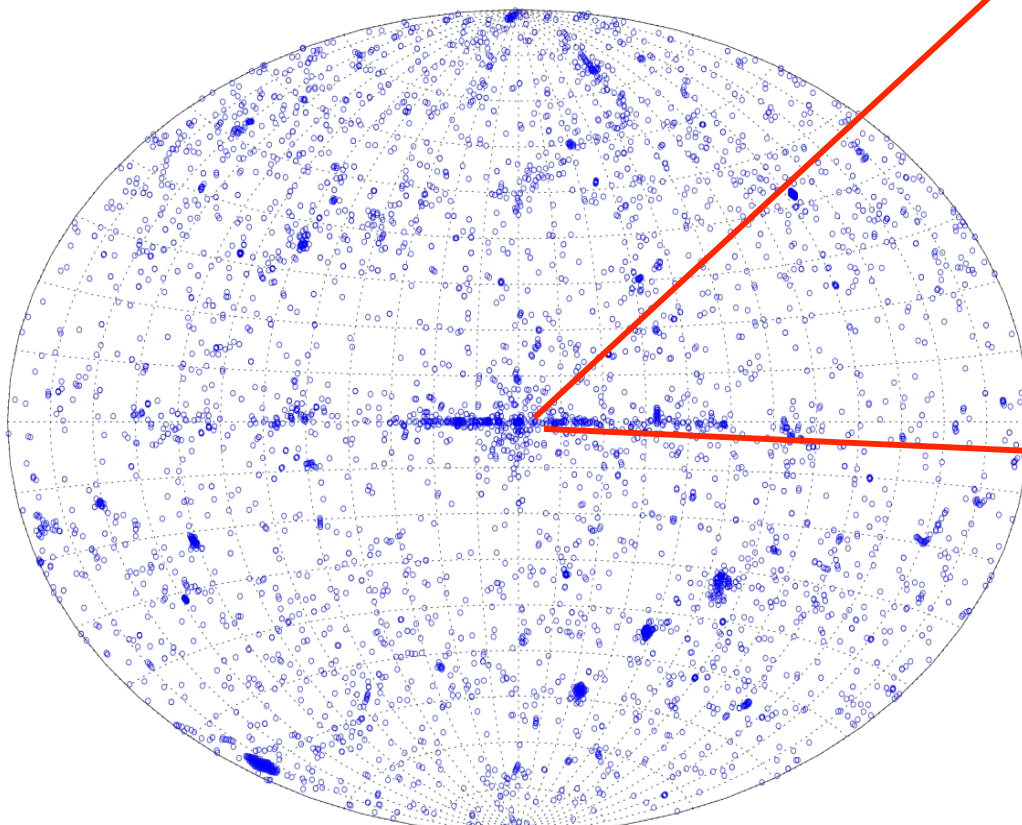
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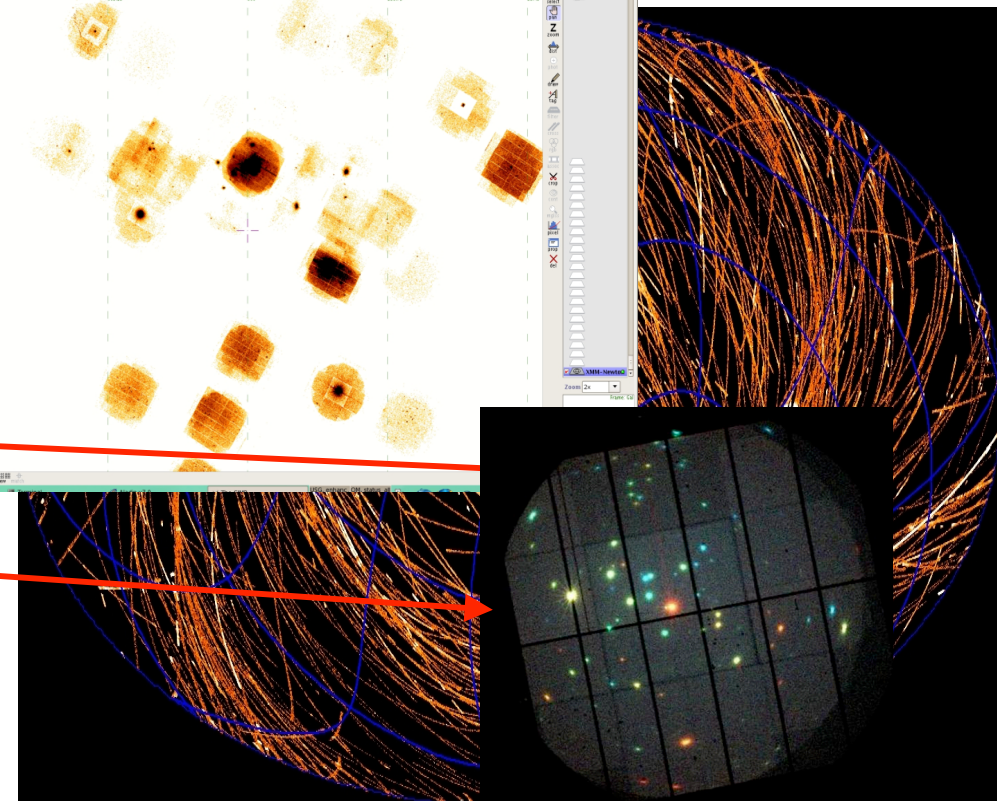
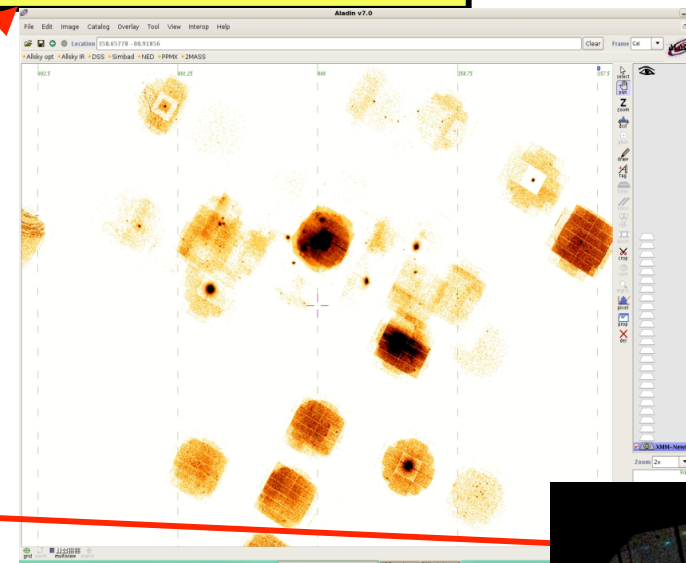
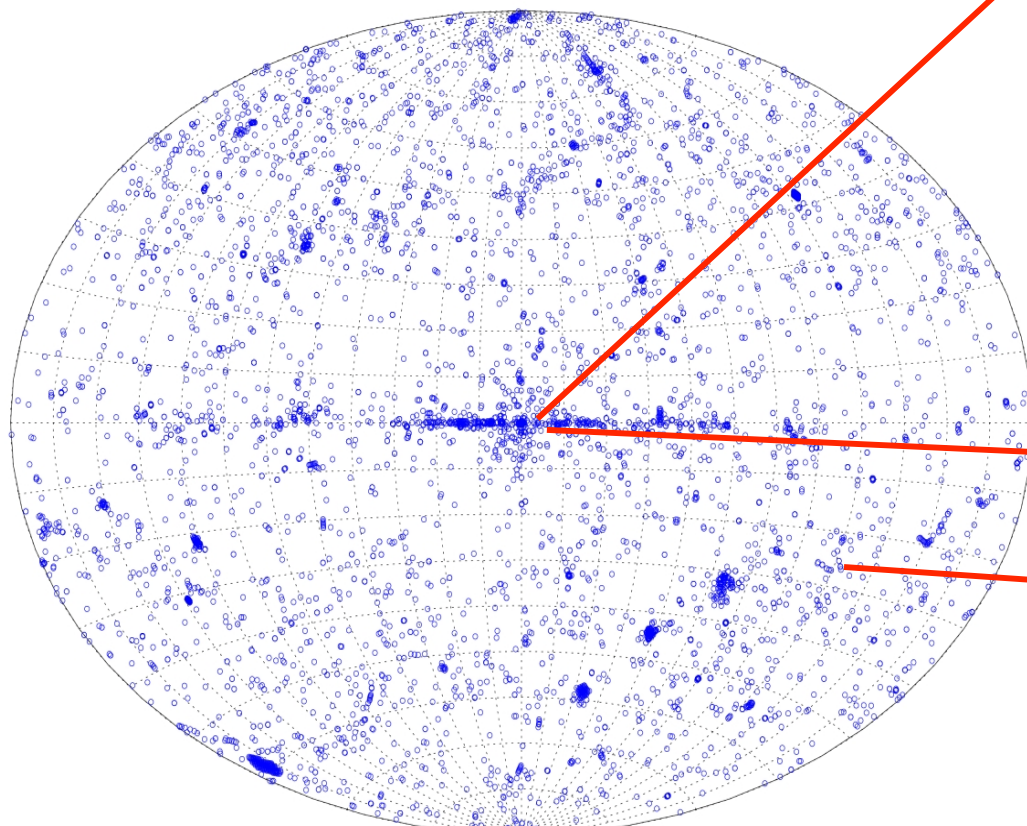
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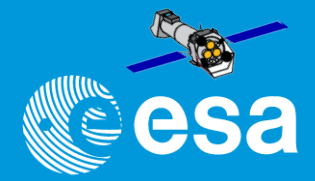
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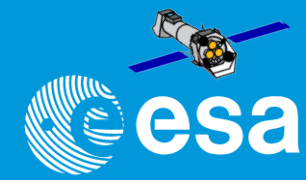




# How to get XMM-Newton data? The XSA



# How to get XMM-Newton data? The XSA



## XMM-Newton Science Archive

Go to Results



### XMM-Newton Science Archive Search

Single Object Search Multi-Object Search Search Clear

Name  Equatorial  Galactic

Target in  Field Of View  Circle  Box

Name   Resolve  Given by Proposer

M51 resolved by Sesame

**Filters for Observation, Proposal and Catalogue Searches**

**Observation**

Observation ID  List of Observation IDs  No file chosen

Revolution  Start Date between  and  Duration

Availability Any Status Any  Non-standard ODF  PPS with no science

[\[Instrument Configuration\]](#)

**Proposal**

Target Type  Proposal ID  PI Name  String in Abstract

[\[Advanced Proposal Options\]](#)

**Catalogue**

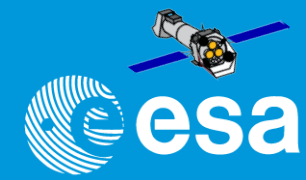
4XMM-DR12 Catalogue 4XMM-DR12s Catalogue OM Source Catalogue Slew Survey Source Catalogue

Detection Likelihood  Total Flux  Source Quality Flag Multiple

**Display options**

Observations	PPS Sources	Slew Observations	Catalogues/Upper Limits
<input checked="" type="checkbox"/> Pointed Observations <input type="checkbox"/> Exposures <input type="checkbox"/> EPIC Exposures <input type="checkbox"/> OM Exposures	<input type="checkbox"/> EPIC PPS Sources <input type="checkbox"/> OM PPS Sources <input type="checkbox"/> Slew PPS Sources	<input type="checkbox"/> Slew Observations <input type="checkbox"/> Slew Obs. Segments <input type="checkbox"/> Slew Publications	<input type="checkbox"/> 4XMM-DR12 Filtered Catalogue <input type="checkbox"/> 4XMM-DR12s Filtered Stack Cat <input type="checkbox"/> OM Source Catalogue <input type="checkbox"/> Slew Survey Clean Catalogue

# How to get XMM-Newton data? The XSA



## XMM-Newton Science Archive

## XMM-Newton Science Archive

Back to Search Close all

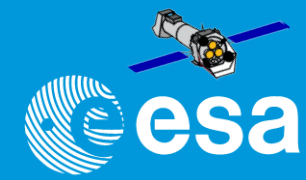
Results #2 Results #4

OBSERVATIONS (16)

Columns Column units Display selected Add to Basket Save table as Send table to Reprocess RGS Spectra

			Obs.ID	EPIC	RGS	BKGD	ESASky	Target	RA	DEC	Rev	Distance	Start Date	End Date	Dur.	Target Type	PI name	Prop. Program	Public Date	PPS ver	Co
<input type="checkbox"/>			0112840201					M51	13h 29m 52.40s	+47d 11' 53.8"	568	0.19	2003-01-15 13:12:55	2003-01-15 19:01:31	20916	SPIRAL GALAXY	GRIFFITHS, RICHARD	GO	Public data	17.56_20190403_1200	
<input checked="" type="checkbox"/>			0212480801					SN2005cs	13h 29m 52.76s	+47d 10' 35.7"	1018	1.12	2005-07-01 06:38:00	2005-07-01 20:18:14	49214	SUPERNOVA	SCHARTEL (PS), NORBERT	TOO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0303420101					M51	13h 29m 51.89s	+47d 10' 32.2"	1180	1.19	2006-05-20 06:31:01	2006-05-20 21:32:55	54114	SPIRAL GALAXY	Dewangan, Gulab	GO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0303420201					M51	13h 29m 51.89s	+47d 10' 32.2"	1182	1.19	2006-05-24 11:12:05	2006-05-24 21:25:34	36809	SPIRAL GALAXY	Dewangan, Gulab	GO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0852030101					M 51	13h 29m 55.99s	+47d 14' 03.4"	3587	2.35	2019-07-11 10:47:26	2019-07-12 08:10:46	77000	ULTRA-LUMINOUS X-RAY SOURCE (JLX)	Brightman, Murray	GO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0830191401					M 51	13h 30m 00.89s	+47d 13' 44.0"	3381	2.45	2018-05-25 20:26:58	2018-05-26 23:40:18	98000	GALAXY	SCHARTEL (PS), NORBERT	TOO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0830191501					M 51	13h 30m 00.89s	+47d 13' 44.0"	3390	2.45	2018-06-13 01:39:03	2018-06-13 19:09:03	63000	GALAXY	SCHARTEL (PS), NORBERT	TOO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0830191601					M 51	13h 30m 00.89s	+47d 13' 44.0"	3391	2.45	2018-06-15 01:24:21	2018-06-15 18:54:21	63000	GALAXY	SCHARTEL (PS), NORBERT	TOO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0824450901					M51	13h 30m 00.92s	+47d 13' 44.0"	3375	2.45	2018-05-13 21:18:47	2018-05-14 18:58:47	78000	ULTRA-LUMINOUS X-RAY SOURCE (JLX)	Israel, Gian Luca	GO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0883550101					M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4021	2.46	2021-11-22 08:47:58	2021-11-23 21:01:18	130400	ULTRA-LUMINOUS X-RAY SOURCE (JLX)	Israel, Gian Luca	GO	Public data	19.16_20210326_1200	
<input type="checkbox"/>			0883550201					M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4022	2.46	2021-11-24 08:40:38	2021-11-25 20:50:38	130200	ULTRA-LUMINOUS X-RAY SOURCE (JLX)	Israel, Gian Luca	GO	Public data	19.16_20210326_1200	
<input type="checkbox"/>			0883550301					M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4044	2.46	2022-01-07 05:21:21	2022-01-08 17:51:21	131400	ULTRA-LUMINOUS X-RAY SOURCE (JLX)	Israel, Gian Luca	GO	Public data	19.16_20210326_1200	
<input type="checkbox"/>			0883550401	N/A	N/A	N/A		M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4021	2.46	2021-11-22 06:39:08	2021-11-22 08:47:58	7730	ULTRA-LUMINOUS X-RAY SOURCE (JLX)	Israel, Gian Luca	GO	Public data	19.16_20210326_1200	
<input type="checkbox"/>			0883550501	N/A	N/A	N/A		M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4022	2.46	2021-11-24 06:31:56	2021-11-24 08:40:38	7722	ULTRA-LUMINOUS X-RAY SOURCE (JLX)	Israel, Gian Luca	GO	Public data	19.16_20210326_1200	
<input type="checkbox"/>			0677980701					SN2011dh	13h 30m 05.11s	+47d 10' 11.3"	2105	2.6	2011-06-07 04:56:49	2011-06-07 08:38:48	13319	SNR FILLED-CENTER TYPE II	SCHARTEL (PS), NORBERT	TOO	Public data	17.56_20190403_1200	
<input type="checkbox"/>			0677980801					SN2011dh	13h 30m 05.11s	+47d 10' 11.3"	2107	2.6	2011-06-11 04:41:57	2011-06-11 08:23:54	13317	SNR FILLED-CENTER TYPE II	SCHARTEL (PS), NORBERT	TOO	Public data	17.56_20190403_1200	

# How to get XMM-Newton data? The XSA



## XMM-Newton Science Archive

## XMM-Newton Science Archive

Back to Search Close all

Results #2 Results #4

OBSERVATIONS (16)

Columns Column units Display

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Obs.ID	EPIC	RGS	BKGD
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0112840201			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0212480801			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0303420101			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0303420201			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0852030101			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0830191401			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0830191501			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0830191601			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0824450901			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0883550101			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0883550201			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0883550301			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0883550401	N/A	N/A	N/A
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0883550501	N/A	N/A	N/A
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0677980701			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0677980801			

Plot controls

Redshift: 0

Show error:  Line  Bar

Wavelength/Energy:

X range: 6 38  X Log scale

Y range:

Spectral lines:  Main  Other

<input type="checkbox"/>	Obs Id	Src	RA	DEC
<input type="checkbox"/>	0212480801	004	13h29m52.27s	+47d11'46.5"

Plot average Plot all Units Sexagesimal

Data Analysis

RGS Spectrum – Obs: 0212480801 Source #004 (Ra=202.46782, Dec=47.196)

Wavelength (Angstroms)

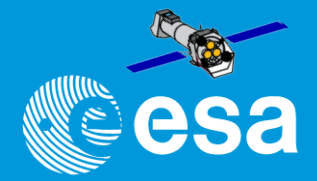
am	Public Date	PPS ver	Co
	Public data	17.56_20190403_1200	
	Public data	17.56_20190403_1200	
	Public data	17.56_20190403_1200	
	Public data	17.56_20190403_1200	
	Public data	17.56_20190403_1200	
	Public data	17.56_20190403_1200	
	Public data	17.56_20190403_1200	
	Public data	19.16_20210326_1200	
	Public data	19.16_20210326_1200	
	Public data	19.16_20210326_1200	
	Public data	19.16_20210326_1200	
	Public data	17.56_20190403_1200	
	Public data	17.56_20190403_1200	

1 of 1 Page size: 100

Displaying 1-16 of 16



# Processing from XSA (using RISA)



- Reprocessing

# Processing from XSA (using RISA)



- Reprocessing

The screenshot shows the XMM-Newton Science Archive interface. At the top, there are navigation links for HOME, SEARCH, COMMAND & URL ACCESS, INTERACTIVE ANALYSIS, TAP QUERIES, and ASTROQUERY. The main content area displays a table of observations with columns for Obs.ID, EPIC, RGS, BKGD, ESASky, Target, RA, DEC, Rev, and Start. A dialog box titled "Instrument (task) | Products" is open, showing a list of processing options with checkboxes. The "RGS1" and "RGS2" options are checked. To the right, a "Details for Observation 0112840201" panel shows an EPIC Image and an RGS fluxed spectrum plot. Below the plot, there is a "Proposal Abstract" section with the text: "STUDIES OF COMPLEX FE-LINE EMISSION IN LLAGN AND LINERS. GT - We propose to determine whether complex, possibly ionized Fe-K emission is present in M81, NGC4579 and M51 as suggested by examination of ASCA data. We will constrain the energy of the line centroid and thus resolve whether the line-emitting gas is ionized. The line E.W. will be used as a diagnostic to discriminate between various models for the origin of the Fe-K lines. Constraints on the line profiles will be used to indicate the extent of any relativistic line broadening or line complexity."

Obs.ID	EPIC	RGS	BKGD	ESASky	Target	RA	DEC	Rev	Start
0112840201					M51	13h 29m 52.40s	+47d 11' 53.8"	568	2003-01-1

**Instrument (task) | Products**

- PN (runs epproc) | Event lists
- MOS1 (runs emproc) | Event lists
- MOS2 (runs emproc) | Event lists
- RGS1 (runs rgsproc) | Fluxed spec / Light curve
- RGS2 (runs rgsproc) | Fluxed spec / Light curve
- OM (runs omchain) | OM Source products

Select All Clear OK

**Details for Observation 0112840201**

EPIC Image RGS fluxed spectrum

Summary Science Exposures Publications

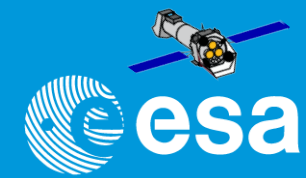
Obs. ID 0112840201  
Revolution 568  
Target M51  
Exposures 3 EPIC, 5 OM, 2 RGS

**Proposal Abstract**  
**STUDIES OF COMPLEX FE-LINE EMISSION IN LLAGN AND LINERS**  
GT - We propose to determine whether complex, possibly ionized Fe-K emission is present in M81, NGC4579 and M51 as suggested by examination of ASCA data. We will constrain the energy of the line centroid and thus resolve whether the line-emitting gas is ionized. The line E.W. will be used as a diagnostic to discriminate between various models for the origin of the Fe-K lines. Constraints on the line profiles will be used to indicate the extent of any relativistic line broadening or line complexity.

Show Quality Report



# Processing from XSA (using RISA)



- Reprocessing
- EPIC Image, spectra or light curve

The screenshot shows the XMM-Newton Science Archive interface. A reprocessing dialog box is open, listing instrument and product options. The 'Details for Observation 0112840201' panel is also visible, showing an EPIC image and an RGS fluxed spectrum.

**Instrument (task) | Products**

- PN (runs epproc) | Event lists
- MOS1 (runs emproc) | Event lists
- MOS2 (runs emproc) | Event lists
- RGS1 (runs rgsproc) | Fluxed spec / Light curve
- RGS2 (runs rgsproc) | Fluxed spec / Light curve
- OM (runs omchain) | OM Source products

Select All Clear OK

**Details for Observation 0112840201**

EPIC Image RGS fluxed spectrum

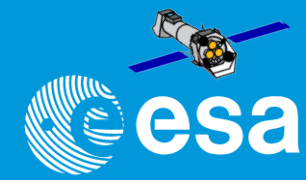
Summary Science Exposures Publications

Obs. ID 0112840201  
Revolution 568  
Target M51  
Exposures 3 EPIC, 5 OM, 2 RGS

**Proposal Abstract**  
**STUDIES OF COMPLEX FE-LINE EMISSION IN LLAGN AND LINERS**  
GT - We propose to determine whether complex, possibly ionized Fe-K emission is present in M81, NGC4579 and M51 as suggested by examination of ASCA data. We will constrain the energy of the line centroid and thus resolve whether the line-emitting gas is ionized. The line E.W. will be used as a diagnostic to discriminate between various models for the origin of the Fe-K lines. Constraints on the line profiles will be used to indicate the extent of any relativistic line broadening or line complexity.

Show Quality Report

# Processing from XSA (using RISA)



### Postcard Preview

Interactive Analysis Save/Open as Send Image to

P0112840201EPX0003COLIM8000.FIT

Instrument: EMOS2 EMOS1 EPN  
Filter: Thin1 Thin1 Thin1  
Exposure (sec): 20665 20665 19047  
Object: M51  
Observer: Prof RICHARD GRIFFITHS  
DATE-OBS: 2003-01-15T13:42  
Image size: pixels (82:525, 99:561)

EUROPEAN SPACE AGENCY

## XMM

HOME

Back to S

Res

OE

Col

AIBARRAI

Data Analysis Basket

### Details for Observation 0112840201

EPIC Image RGS fluxed spectrum

Science Exposures Publications

Observation ID	0112840201
Exposure (sec)	568
Filter	M51
Instruments	3 EPIC, 5 OM, 2 RGS

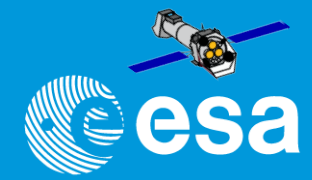
**Proposal Abstract**

**STUDIES OF COMPLEX FE-LINE EMISSION IN LLAGN AND LINERS**

*We propose to determine whether complex, possibly ionized Fe-K emission is present in M51 and M51 as suggested by examination of ASCA data. We will constrain the line centroid and thus resolve whether the line-emitting gas is ionized. The line will be used as a diagnostic to discriminate between various models for the origin of the Fe emission. Constraints on the line profiles will be used to indicate the extent of any relativistic broadening or line complexity.*

Show Quality Report

# Processing from XSA (using RISA)



The screenshot displays the XMM-Newton Science Archive interface. At the top, the navigation bar includes 'HOME', 'SEARCH', 'COMMAND & URL ACCESS', 'INTERACTIVE ANALYSIS', 'TAP QUERIES', and 'ASTROQUERY'. The 'Data Analysis' section is active, featuring a 'Data Analysis' logo and a menu with options like 'File', 'Edit', 'View', 'Zoom', 'Scale', 'Color', 'Regions', 'WCS', 'Analysis', and 'Help'. The main content area is titled 'RGS - Spectra Visualization' and shows the 'EPIC Exposures' section with the following details:

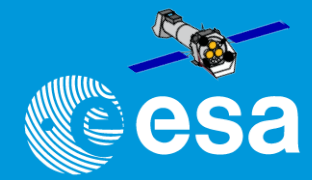
- Obs Id: 0112840201
- Instrument: EPN
- Exposure: S002
- View background flaring: Plot

The 'RISA analysis of EPIC Exposures' section includes:

- Flag: --
- Pattern: --
- PI (eV): -
- Product Type: Spectra
- Centre & optimize src region:
- Buttons: 'Get JS9 Source' and 'Edit source region'
- Dropdown menu options: Spectra, Light Curve, Image, Events

On the left, a 'Postcard Preview' shows a spectral plot with 'Declination' on the y-axis (00' to 25') and '13h' on the x-axis. A secondary interface on the far left shows 'EUROPEAN SPACE AGENCY' and 'XMM-Newton' branding with navigation buttons like 'HOME', 'Back to Search', 'Res', 'OE', and 'Col'.

# Processing from XSA (using RISA)



**XMM-Newton Science Archive**

HOME SEARCH COMMAND & URL ACCESS INTERACTIVE ANALYSIS TAP QUERIES ASTROQUERY

Postcard Preview [Back to Search](#)

Open images with JS9 EPIC Exposures Add SRC regions

**EPIC Exposures**

Obs Id: 0112840201  
Instrument: EPN  
Exposure: S002  
View background flaring: Plot

**RISA analysis of EPIC Exposures**

Flag: 0  
Pattern: <=4  
PI (eV): 500 - 2000  
Product Type: Spectra  
Centre & optimize src region:

Get JS9 Source: circle(23800.00, 28600.00, 940.00)  
Get JS9 Background: circle(22040.00, 30920.00, 1259.99)

[Reset Form](#)

Submit

File Edit View Zoom Scale Color Regions WCS Analysis Help

sqrt asinh sinh squared inc/excl src/bkg remove open infobox magnifier panner

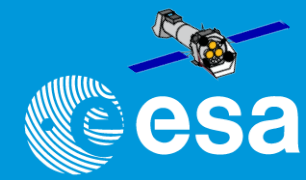
000 13:31:41.586 +47:10:42.39 (FK5) 2840.000 22600.000 (physical)

analysis Help

m- zoom1 histeq power

infobox magnifier panner

# Processing from XSA (using RISA)



**XMM-Newton Science Archive**

HOME SEARCH COMMAND & URL ACCESS INTERACTIVE ANALYSIS TAP QUERIES ASTROQUERY

Postcard Preview Back to Search

Open images with JS9 EPIC Exposures Add SRC regions

**EPIC Exposures**

Obs Id: 0112840201

Instrument: EPN

Exposure: S002

View background flaring: Plot

**RISA analysis of EPIC Exposures**

Flag: 0

Pattern: <=4

PI (eV): 500 - 2000

Product Type: Spectra

Centre & optimize src region:

Get JS9 Source: circle(23800.00, 28600.00, 940.00)

Get JS9 Background: circle(22040.00, 30920.00, 1259.99)

Reset Form

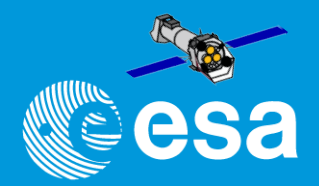
Submit

**RISA**

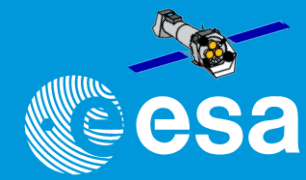
Your RISA Request is being processed with ID20231516263. You will receive an email once the data are available for download

Close

# All the individual sources detected



# All the individual sources detected



## XMM-Newton Science Archive

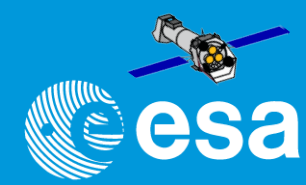


Back to Search Close all

Results #1 Results #2

OBSERVATIONS (16) 4XMM-DR12 CAT (1383)																	
Columns	Column units	Display selected	Add to Basket	Save table as	Send table to	Reprocess	RGS Spectra										
<input type="checkbox"/>		Obs.ID	EPIC	RGS	BKGD	ESASky	Target	RA	DEC	Rev	Distance	Start Date	End Date	Dur.	Target Type	PI name	Prop.
<input type="checkbox"/>		0112840201					M51	13h 29m 52.40s	+47d 11' 53.8"	568	0.19	2003-01-15 13:12:55	2003-01-15 19:01:31	20916	SPIRAL GALAXY	GRIFFITHS, RICHARD	
<input type="checkbox"/>		0212480801					SN2005cs	13h 29m 52.76s	+47d 10' 35.7"	1018	1.12	2005-07-01 06:38:00	2005-07-01 20:18:14	49214	SUPERNOVA	SCHARTEL (PS), NORBERT	
<input type="checkbox"/>		0303420101					M51	13h 29m 51.89s	+47d 10' 32.2"	1180	1.19	2006-05-20 06:31:01	2006-05-20 21:32:55	54114	SPIRAL GALAXY	Dewangan, Gulab	
<input type="checkbox"/>		0303420201					M51	13h 29m 51.89s	+47d 10' 32.2"	1182	1.19	2006-05-24 11:12:05	2006-05-24 21:25:34	36809	SPIRAL GALAXY	Dewangan, Gulab	
<input checked="" type="checkbox"/>		0852030101					M 51	13h 29m 55.99s	+47d 14' 03.4"	3587	2.35	2019-07-11 10:47:26	2019-07-12 08:10:46	77000	ULTRA-LUMINOUS X-RAY SOURCE (ULX)	Brightman, Murray	
<input type="checkbox"/>		0830191401					M 51	13h 30m 00.89s	+47d 13' 44.0"	3381	2.45	2018-05-25 20:26:58	2018-05-26 23:40:18	98000	GALAXY	SCHARTEL (PS), NORBERT	
<input type="checkbox"/>		0830191501					M 51	13h 30m 00.89s	+47d 13' 44.0"	3390	2.45	2018-06-13 01:39:03	2018-06-13 19:09:03	63000	GALAXY	SCHARTEL (PS), NORBERT	
<input type="checkbox"/>		0830191601					M 51	13h 30m 00.89s	+47d 13' 44.0"	3391	2.45	2018-06-15 01:24:21	2018-06-15 18:54:21	63000	GALAXY	SCHARTEL (PS), NORBERT	
<input type="checkbox"/>		0824450901					M51	13h 30m 00.92s	+47d 13' 44.0"	3375	2.45	2018-05-13 21:18:47	2018-05-14 18:58:47	78000	ULTRA-LUMINOUS X-RAY SOURCE (ULX)	Israel, Gian Luca	
<input type="checkbox"/>		0883550101					M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4021	2.46	2021-11-22 08:47:58	2021-11-23 21:01:18	130400	ULTRA-LUMINOUS X-RAY SOURCE (ULX)	Israel, GianLuca	
<input type="checkbox"/>		0883550201					M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4022	2.46	2021-11-24 08:40:38	2021-11-25 20:50:38	130200	ULTRA-LUMINOUS X-RAY SOURCE (ULX)	Israel, GianLuca	
<input type="checkbox"/>		0883550301					M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4044	2.46	2022-01-07 05:21:21	2022-01-08 17:51:21	131400	ULTRA-LUMINOUS X-RAY SOURCE (ULX)	Israel, GianLuca	
<input type="checkbox"/>		0883550401	N/A	N/A	N/A		M51 ULX-7	13h 30m 00.89s	+47d 13' 44.4"	4021	2.46	2021-11-22 06:39:08	2021-11-22 08:47:58	7730	ULTRA-LUMINOUS X-RAY SOURCE (ULX)	Israel, GianLuca	

# All the individual sources detected



## XMM-Newton Science Archive

[Back to Search](#) [Close all](#)

## XMM-Newton Science Archive

[Back to Search](#) [Close all](#)

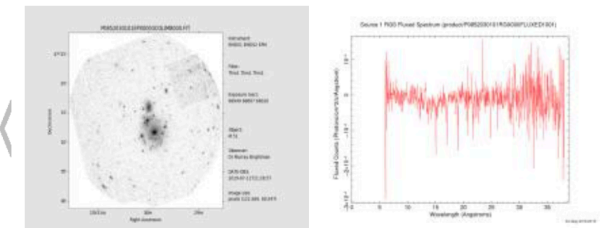
Results #1 Results #2

OBSERVATIONS (1)	EXPOSURES (19)	EPIC PPS SOURCES (226)	OM PPS SOURCES (1000)	4XMM-DR12 CAT (226)	OM SOURCE CAT (0)	PUBLICATIONS (0)							
Columns	Column units	Display selected	Add to Basket	Save table as	Send table to	Source Reproc.							
<input type="checkbox"/>	Dwnld.	ObsID	Src Nu	RA	DEC	Pos.Err	Det ML	Img	FC	LC	Spec	ESASky	Total Flux
<input type="checkbox"/>		0852030101	1	13h 29m 52.78s	+47d 11' 43.9"	0.1	215793						1.81E-12
<input type="checkbox"/>		0852030101	2	13h 30m 01.15s	+47d 13' 43.2"	0.1	75011						9.76E-13
<input type="checkbox"/>		0852030101	3	13h 30m 07.69s	+47d 11' 05.8"	0.1	27319						3.53E-13
<input type="checkbox"/>		0852030101	4	13h 29m 59.34s	+47d 15' 56.5"	0.2	37963						7.55E-13
<input type="checkbox"/>		0852030101	5	13h 29m 39.81s	+47d 12' 40.5"	0.1	11767						1.51E-13
<input type="checkbox"/>		0852030101	6	13h 29m 43.45s	+47d 11' 34.4"	0.2	3533						5.38E-14
<input type="checkbox"/>		0852030101	7	13h 29m 44.06s	+47d 11' 27.7"	0.2	2920						9.27E-13
<input type="checkbox"/>		0852030101	8	13h 29m 53.83s	+47d 14' 35.0"	0.2	5087						1.40E-13
<input type="checkbox"/>		0852030101	9	13h 29m 38.73s	+47d 18' 53.1"	0.2	6261						1.20E-13
<input type="checkbox"/>		0852030101	10	13h 30m 04.45s	+47d 13' 20.4"	0.2	1407						9.67E-14
<input type="checkbox"/>		0852030101	11	13h 30m 02.47s	+47d 13' 02.8"	0.3	4023						2.62E-13

1 of 3 Page size: 100

Displaying 1-100 of 226

### Details for Observation 0852030101



EPIC Image

RGS fluxed spectrum

Summary Science Exposures Publications

Obs. ID	0852030101
Revolution	3587
Target	M 51
Exposures	3 EPIC, 14 OM, 2 RGS

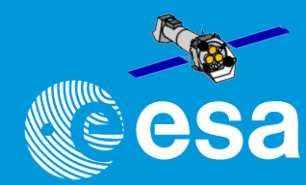
#### Proposal Abstract

##### A Broadband X-ray Spectral Study of two NS-Powered ULX Sources in M51

We propose joint observations with NuSTAR and XMM-Newton of the M51 galaxies that will provide the best simultaneous, high-time resolution, and sensitive broadband X-ray spectral dataset on the sources within them yet. The joint dataset will yield the first high-quality broadband spectrum of at least one neutron-star-powered ultraluminous X-ray source in the galaxy, possibly two. This will allow a detailed spectral decomposition and sensitive searches for cyclotron lines. The timing resolution of XMM-Newton will allow us to detect pulsations, yielding an improved orbital solution for one ULX, and perhaps detecting them for the first time in one of the many others in the galaxies.



# All the individual sources detected



## XMM-Newton Science Archive

## XMM-Newton Science Archive

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Results #1 Results #2

OBSERVATIONS (1) EXPOSURES (19) EPIC PPS SOURCES (226) OM PPS SOURCES (1000) 4XMM-DR12 CAT (226) OM SOURCE CAT (0) PUBLICATIONS (5) PROPOSALS (1)

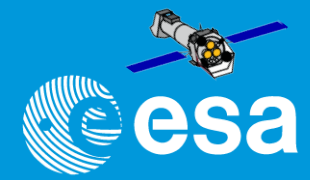
Columns Column units Display selected Save table as Send table to

<input type="checkbox"/>	Dwnld.	Obs.ID	IAU name	RA	DEC	PosErr	OFFAXIS_PN	EP_8 Det ML	QUALITY FLAG	In-	Thick	FC	LC	CS	ESAsky	SED 0	SED 1	SED 2	EP_8 Rate	EP_8 Rate Err
<input type="checkbox"/>		0852030101	4XMM J132952.6+471144	13h 29m 52.63s	+47d 11' 44.3"	0.3	2.1	215793	Suspect parameters										1.48E00	5.80E-03
<input type="checkbox"/>		0852030101	4XMM J133000.9+471343	13h 30m 01.00s	+47d 13' 43.6"	0.3	2.0	75011	Suspect parameters										5.11E-01	3.29E-03
<input type="checkbox"/>		0852030101	4XMM J133007.5+471106	13h 30m 07.54s	+47d 11' 06.2"	0.3	4.1	27319	Suspect parameters										2.14E-01	2.24E-03
<input type="checkbox"/>		0852030101	4XMM J132959.2+471557	13h 29m 59.19s	+47d 15' 56.9"	0.3	2.8	37963	Suspect parameters										5.43E-01	4.17E-03
<input type="checkbox"/>		0852030101	4XMM J132939.7+471239	13h 29m 39.66s	+47d 12' 40.9"	0.3	2.0	11767	Suspect parameters										1.12E-01	1.64E-03
<input type="checkbox"/>		0852030101	4XMM J132943.2+471134	13h 29m 43.30s	+47d 11' 34.8"	0.3	2.4	3533	Suspect parameters										6.49E-02	1.68E-03
<input type="checkbox"/>		0852030101	4XMM J132943.9+471128	13h 29m 43.90s	+47d 11' 28.1"	0.3	2.5	2920	In suspect area										7.35E-01	2.55E-02
<input type="checkbox"/>		0852030101	4XMM J132953.6+471435	13h 29m 53.68s	+47d 14' 35.4"	0.3	1.1	5087	Suspect parameters										6.93E-02	1.41E-03
<input type="checkbox"/>		0852030101	4XMM J132938.5+471854	13h 29m 38.57s	+47d 18' 53.5"	0.4	5.4	6261	Good										7.66E-02	1.49E-03
<input type="checkbox"/>		0852030101	4XMM J133004.2+471320	13h 30m 04.30s	+47d 13' 20.8"	0.4	2.6	1407	Suspect parameters										3.46E-02	1.13E-03
<input type="checkbox"/>		0852030101	4XMM J133002.1+471304	13h 30m 02.32s	+47d 13' 03.2"	0.4	2.3	4023	Suspect parameters										2.83E-01	4.91E-03
<input type="checkbox"/>		0852030101	4XMM J132950.8+471031	13h 29m 50.89s	+47d 10' 31.4"	0.4	3.3	1067	Suspect parameters										3.05E-02	1.12E-03
<input type="checkbox"/>		0852030101	4XMM J132950.4+470956	13h 29m 50.40s	+47d 09' 56.1"	0.4	3.9	1222	In suspect area										5.45E-01	1.85E-02

1 of 3 Page size: 100

Displaying 1-100 of 226

# How to find files in the XMM-Newton data forest



## EPIC:

\*MIEVLI\* / \*PIEVLI\* files are the event list files in PPS

\*[Imaging-Timing]\*Evts.ds files are the corresponding ones in PROC

\*IMAGE\_8000\*.FTZ are the FITS compressed whole camera images in PPS

The only EPIC products from e[m-p]proc are the event list files and Bad Pixel tables

## RGS:

\*R1\*EVENTLI\* / \*R2\*EVENTLI\* are the event list files in PPS and PROC

\*R1\*SRCLI\* / \*R2\*SRCLI\* are the source list files in PPS and PROC

\*SRSPEC\* are the source subtracted spectra in PPS and PROC

Response matrices are products in PROC (\*Matrix\*), as well as fluxed spectra (\*fluxed\*)

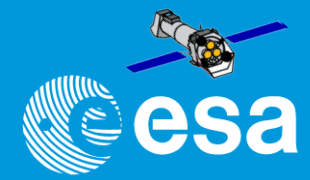
Intermediate RGS products are only kept in PROC (not in PPS), therefore RGS analysis starting on intermediate point only possible with PROC products

## OM:

Whole analysis done by pipeline – Check source detections (using eg. implot, ds9, ftools)  
If necessary, re-start analysis at intermediate steps (omdetect in [om\[i-f\]thread.html](#))

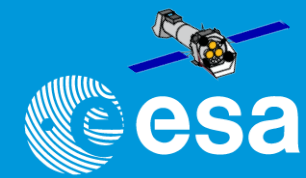
**PPS Index Summary can help a lot to recognize correspondence FileType <-> FileName**

# How to find files in the XMM-Newton data forest



**PPS Index Summary can help a lot to recognize correspondence FileType <-> FileName  
... but also to find everything produced by PPS (and that's a lot!)**

# How to find files in the XMM-Newton data forest



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[OBS Summary](#)   [PPS Summary](#)   [EPIC Summary](#)   [OM Summary](#)   [RGS Summary](#)   [Catalogue Summary](#)

## 0303420201 Observation Data Summary File

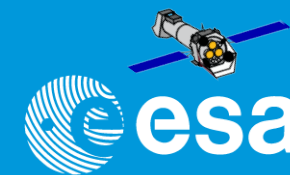
Revolution	Target	Scheduled Length	Observer
1182	M51	36809	Dr Gulab Dewangan

[Guest Observer Information](#)   [Proposal Target Information](#)   [Observation Record Instrument Information](#)  
[Exposure and Configuration Information](#)

### Guest Observer Information

Dr Gulab Dewangan  
Carnegie Mellon University  
Department of Physics  
5000 Forbes Avenue  
Pittsburgh  
PA  
UNITED STATES  
15213  
gulabd@cmu.edu

# How to find files in the XMM-Newton data forest



PPS Index Summary can help a lot to recognize correspondence FileType <-> FileName  
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 [PPS Summary](#)  
 [EPIC Summary](#)  
 [OM Summary](#)  
 [RGS Summary](#)  
 [Catalogue Summary](#)

## 0303420201 PPS Processing Summary

Revolution	Target	Scheduled Length	Observer
1182	M51	36809	Dr Gulab Dewangan

[EPIC Exposures Processed](#)  
 [OM Exposures Processed](#)  
 [RGS Exposures Processed](#)  
[Generic Products](#)

### EPIC Exposures processed by PPS

Inst.	Exp. Id	Sched	Mode	Datamode	Filter	Position	Duration	Exposure	SrcDet	SSP	Flare Scrn	Actual Start	Actual End
EMOS1	<a href="#">S001</a>	Y	PrimeFullWindow	Imaging	THIN1	FILTER_A	36574	25015	Y	Y	Y	2006-05-24T11:12:42	2006-05-24T21:22:16
EMOS2	<a href="#">S002</a>	Y	PrimeFullWindow	Imaging	THIN1	FILTER_A	36578	25412	Y	Y	Y	2006-05-24T11:12:43	2006-05-24T21:22:21
EPN	<a href="#">S003</a>	Y	PrimeFullWindow	Imaging	THIN1		34997	22545	Y	Y	Y	2006-05-24T11:35:02	2006-05-24T21:18:19

### OM Exposures processed by PPS

Inst	ExpID	Sched	Detector	Mode	Data Mode	Filter	Duration	Actual Start	Actual End
OM	<a href="#">S006</a>	Y	REDUNDANT	Image	Engineering4	UVW1	3400	2006-05-24T11:35:40	2006-05-24T12:32:20
OM	<a href="#">S007</a>	Y	REDUNDANT	Image	Engineering4	UVW2	3398	2006-05-24T15:20:22	2006-05-24T16:17:00
OM	<a href="#">S008</a>	Y	REDUNDANT	Image	Engineering4	UVW2	3375	2006-05-24T18:35:00	2006-05-24T19:31:15

### RGS Exposures processed by PPS

Inst.	Exp. Id	Sched	Mode	Datamode	Event Filtering	Duration	Actual Start	Actual End
RGS1	<a href="#">S004</a>	Y	HighEventRateWithSES	Spectroscopy	rejflags,att&TI,bk&TI	36806	2006-05-24T11:12:05	2006-05-24T21:25:31
RGS2	<a href="#">S005</a>	Y	HighEventRateWithSES	Spectroscopy	rejflags,att&TI,bk&TI	36809	2006-05-24T11:12:05	2006-05-24T21:25:34

# How to find files in the XMM-Newton data forest



**PPS Index Summary can help a lot to recognize correspondence FileType <-> FileName  
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[OBS Summary](#)   [PPS Summary](#)   [EPIC Summary](#)   [OM Summary](#)   [RGS Summary](#)   [Catalogue](#)

## 0303420201 EPIC Processing Summary

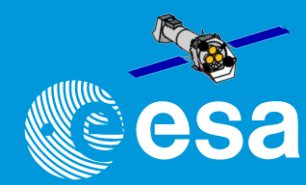
Revolution	Target	Scheduled Length	Observer
1182	M51	36809	Dr Gulab Dewangan

Multi-Exposure Products	Exposures processed by PPS	Sources processed by PPS
-------------------------	----------------------------	--------------------------

### Multi-Exposure Products

Filename	Content	Band
P0303420201EPX0000BKGMP8000.FT2	EPIC OBSERVATION BACKGROUND MAP	0.2 - 12.0
P0303420201EPX0000BKGMP8000.PNG	EPIC OBSERVATION BACKGROUND MAP	0.2 - 12.0
P0303420201EPX0000BLSLI0000.FT2	EPIC OBSERVATION BOX-LOCAL SOURCE LIST	
P0303420201EPX0000BMSLI0000.FT2	EPIC OBSERVATION BOX-MAP SOURCE LIST	
P0303420201EPX0000BSMLI0000.FT2	EPIC SUMMARY SOURCE LIST	
P0303420201EPX0000BSMLI0000.HTM	EPIC SUMMARY SOURCE LIST	
P0303420201EPX0000EXPMP8000.FT2	EPIC OBSERVATION EXPOSURE MAP	0.2 - 12.0
P0303420201EPX0000EXPMP8000.PNG	EPIC OBSERVATION EXPOSURE MAP	0.2 - 12.0
P0303420201EPX0000IMAGE8000.FT2	EPIC OBSERVATION IMAGE	0.2 - 12.0
P0303420201EPX0000IMAGE8000.PNG	EPIC OBSERVATION IMAGE	0.2 - 12.0
P0303420201EPX0000MSRLI0000.FT2	EPIC OBSERVATION ML SOURCE LIST	
P0303420201EPX0000SNSMP8000.FT2	EPIC OBSERVATION SENSITIVITY MAP	0.2 - 12.0
P0303420201EPX0000REGION0000.ASC	EPIC SOURCE DS9 REGIONS	
P0303420201M1X0000BKGMAP1000.FT2	EPIC MERGED BACKGROUND MAP	0.2 - 0.5
P0303420201M1X0000BKGMAP2000.FT2	EPIC MERGED BACKGROUND MAP	0.5 - 1.0
P0303420201M1X0000BKGMAP3000.FT2	EPIC MERGED BACKGROUND MAP	1.0 - 2.0
P0303420201M1X0000BKGMAP4000.FT2	EPIC MERGED BACKGROUND MAP	2.0 - 4.5
P0303420201M1X0000BKGMAP5000.FT2	EPIC MERGED BACKGROUND MAP	4.5 - 12.0
P0303420201M1X0000DETMASK1000.FT2	EPIC DETECTION MASK	0.2 - 0.5
P0303420201M1X0000DETMASK2000.FT2	EPIC DETECTION MASK	0.5 - 1.0

# How to find files in the XMM-Newton data forest



PPS Index Summary can help a lot to recognize correspondence FileType <-> FileName  
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[OBS Summary](#)   [PPS Summary](#)   [EPIC Summary](#)   [OM Summary](#)   [RGS Summary](#)   [Catalogue](#)

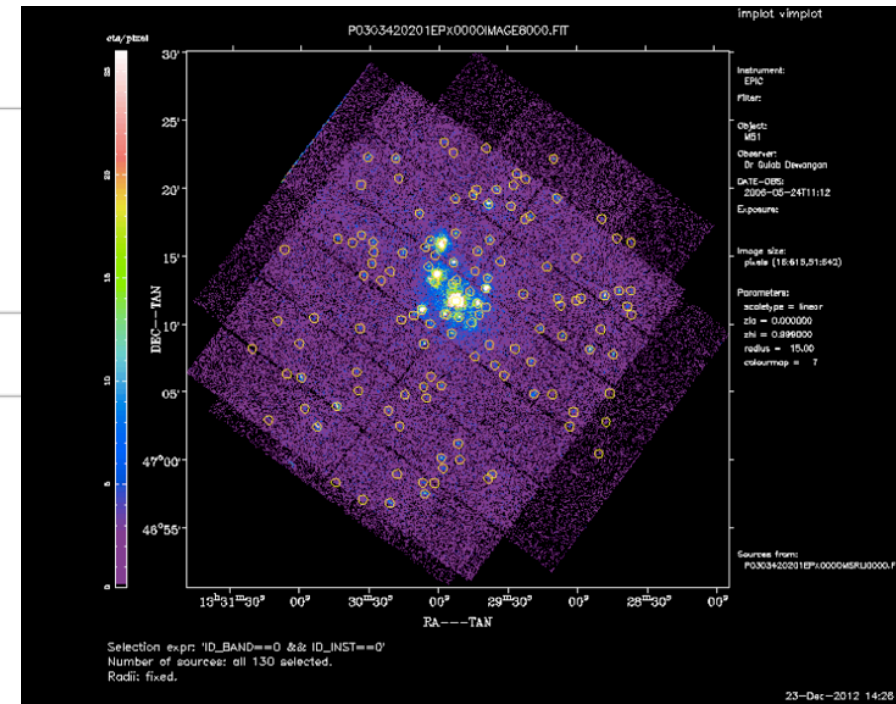
## 0303420201 EPIC Processing Summary

Revolution	Target	Scheduled Length	Observer
1182	M51	36809	Dr Gulab Dewangan

[Multi-Exposure Products](#)   [Exposures processed by PPS](#)   [Sources processed by PPS](#)

### Multi-Exposure Products

Filename	Content	Band
<a href="#">P0303420201EPX0000BKGMPS8000.FT2</a>	EPIC OBSERVATION BACKGROUND MAP	0.2 - 12.0
<a href="#">P0303420201EPX0000BKGMPS8000.PNG</a>	EPIC OBSERVATION BACKGROUND MAP	0.2 - 12.0
<a href="#">P0303420201EPX0000BLSLI0000.FT2</a>	EPIC OBSERVATION BOX-LOCAL SOURCE LIST	
<a href="#">P0303420201EPX0000BMSLI0000.FT2</a>	EPIC OBSERVATION BOX-MAP SOURCE LIST	
<a href="#">P0303420201EPX0000BSMLI0000.FT2</a>	EPIC SUMMARY SOURCE LIST	
<a href="#">P0303420201EPX0000BSMLI0000.HTM</a>	EPIC SUMMARY SOURCE LIST	
<a href="#">P0303420201EPX0000EXPMP8000.FT2</a>	EPIC OBSERVATION EXPOSURE MAP	0.2 - 12.0
<a href="#">P0303420201EPX0000EXPMP8000.PNG</a>	EPIC OBSERVATION EXPOSURE MAP	0.2 - 12.0
<a href="#">P0303420201EPX0000IMAGE8000.FT2</a>	EPIC OBSERVATION IMAGE	0.2 - 12.0
<a href="#">P0303420201EPX0000IMAGE8000.PNG</a>	EPIC OBSERVATION IMAGE	0.2 - 12.0
<a href="#">P0303420201EPX0000MSRLI0000.FT2</a>	EPIC OBSERVATION ML SOURCE LIST	
<a href="#">P0303420201EPX0000SNSMP8000.FT2</a>	EPIC OBSERVATION SENSITIVITY MAP	0.2 - 12.0
<a href="#">P0303420201EPX0000REGION0000.ASC</a>	EPIC SOURCE DS9 REGIONS	
<a href="#">P0303420201M1X0000BKGMAP1000.FT2</a>	EPIC MERGED BACKGROUND MAP	0.2 - 0.5
<a href="#">P0303420201M1X0000BKGMAP2000.FT2</a>	EPIC MERGED BACKGROUND MAP	0.5 - 1.0
<a href="#">P0303420201M1X0000BKGMAP3000.FT2</a>	EPIC MERGED BACKGROUND MAP	1.0 - 2.0
<a href="#">P0303420201M1X0000BKGMAP4000.FT2</a>	EPIC MERGED BACKGROUND MAP	2.0 - 4.5
<a href="#">P0303420201M1X0000BKGMAP5000.FT2</a>	EPIC MERGED BACKGROUND MAP	4.5 - 12.0
<a href="#">P0303420201M1X0000DETMASK1000.FT2</a>	EPIC DETECTION MASK	0.2 - 0.5
<a href="#">P0303420201M1X0000DETMASK2000.FT2</a>	EPIC DETECTION MASK	0.5 - 1.0



# How to find files in the XMM-Newton data forest



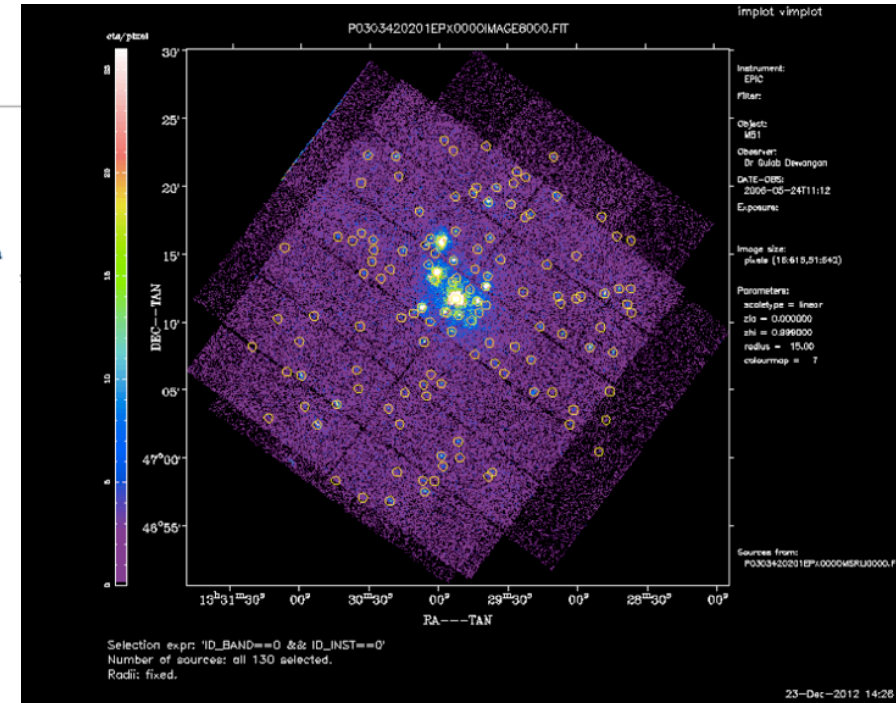
PPS Index Summary can help a lot to recognize correspondence FileType <-> FileName  
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[OBS Summary](#)   [PPS Summary](#)   [EPIC Summary](#)   [OM Summary](#)   [RGS Summary](#)   [Catalogue](#)

## 0303420201 EPIC Processing Summary

Inst.	Exp. Id	Sched	Mode	Datamode	Filter	Position	Duration	Exposure	SrcDet	SSP	Flare	Scrn
EPH	S003	Y	PrimeFullWindow	Imaging	THIN1		34997	22545	Y	Y		Y
Filename	Content		Band									
P0303420201PNS003PIEVL10000.FTZ	EPIC PN IMAGING MODE EVENT LIST											
P0303420201PNS003FBKTSR0000.FTZ	EPIC FLARE BACKGROUND TIMESERIES											
P0303420201PNS003FBKTSR0000.PDF	EPIC FLARE BACKGROUND TIMESERIES											
P0303420201PNS003EXPMAP1000.FTZ	EPIC EXPOSURE MAP		0.2 - 0.5									
P0303420201PNS003IMAGE_1000.FTZ	EPIC IMAGE		0.2 - 0.5									
P0303420201PNS003EXPMAP2000.FTZ	EPIC EXPOSURE MAP		0.5 - 1.0									
P0303420201PNS003IMAGE_2000.FTZ	EPIC IMAGE		0.5 - 1.0									
P0303420201PNS003EXPMAP3000.FTZ	EPIC EXPOSURE MAP		1.0 - 2.0									
P0303420201PNS003IMAGE_3000.FTZ	EPIC IMAGE		1.0 - 2.0									
P0303420201PNS003EXPMAP4000.FTZ	EPIC EXPOSURE MAP		2.0 - 4.5									
P0303420201PNS003IMAGE_4000.FTZ	EPIC IMAGE		2.0 - 4.5									
P0303420201PNS003EXPMAP5000.FTZ	EPIC EXPOSURE MAP		4.5 - 12.0									
P0303420201PNS003IMAGE_5000.FTZ	EPIC IMAGE		4.5 - 12.0									
P0303420201PNS003EXPMAP8000.FTZ	EPIC EXPOSURE MAP		0.2 - 12.0									
P0303420201PNS003EXPMAP8000.PNG	EPIC EXPOSURE MAP		0.2 - 12.0									
P0303420201PNS003IMAGE_8000.FTZ	EPIC IMAGE		0.2 - 12.0									
P0303420201PNS003IMAGE_8000.PNG	EPIC IMAGE		0.2 - 12.0									

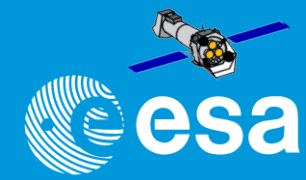


### Sources processed by PPS

Source	Inst.	Exp. Id	RA	Dec	RA Dec Err	Count	Band 8 Flux	EPIC Det ML	Inst. Det ML	Ontime	EPIC Extent	EPIC Flags	Srcdet
Dec (Hex)			[hms]	[° ' "]	["]		[erg/s/cm <sup>2</sup> ]			[s]	[image pixels]		
1 (001)	EMOS1	S001	13 29 52.54	47 11 44.6	0.2	6105.9 ±90.4	1.87e-12 ±5.13e-14	50374	14744	25012	2 ±0	FFFFFFFFFFFF	Y
1 (001)	EMOS2	S002	13 29 52.54	47 11 44.6	0.2	5649.5 ±87.6	1.86e-12 ±5.39e-14	50374	13048	25389	2 ±0	FFFFFFFFFFFF	Y
1 (001)	EPN	S003	13 29 52.54	47 11 44.6	0.2	12549.8 ±138.9	1.5e-12 ±3.32e-14	50374	22575	22545	2 ±0	FFFFFFFFFFFF	Y
2 (002)	EMOS1	S001	13 30 0.93	47 13 43.6	0.1	1932.0 ±49.0	1.19e-12 ±5.36e-14	21364	5121	25012	0	FFFFFFFFFFFF	Y
2 (002)	EMOS2	S002	13 30 0.93	47 13 43.6	0.1	1823.2 ±47.3	1.16e-12 ±5.52e-14	21364	4692	25389	0	FFFFFFFFFFFF	Y
2 (002)	EPN	S003	13 30 0.93	47 13 43.6	0.1	5078.1 ±79.9	1e-12 ±2.8e-14	21364	11555	22545	0	FFFFFFFFFFFF	Y
3 (003)	EMOS1	S001	13 30 7.48	47 11 6.4	0.2	667.9 ±29.5	3.13e-13 ±2.58e-14	6922	1367	25012	0	FFFFFFFFFFFF	Y



# How to find files in the XMM-Newton data forest



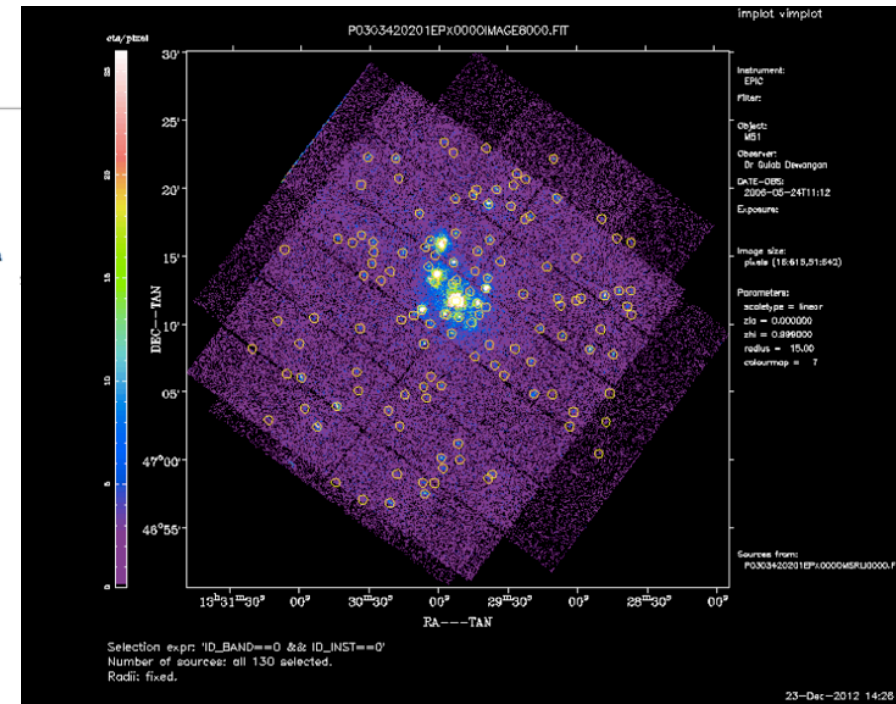
PPS Index Summary can help a lot to recognize correspondence FileType <-> FileName  
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[OBS Summary](#)   [PPS Summary](#)   [EPIC Summary](#)   [OM Summary](#)   [RGS Summary](#)   [Catalogue](#)

## 0303420201 EPIC Processing Summary

Inst.	Exp. Id	Sched	Mode	Datamode	Filter	Position	Duration	Exposure	SrcDet	SSP	Flare	Scrn
EPN	S003	Y	PrimeFullWindow	Imaging	THIN1		34997	22545	Y	Y		Y
Filename	Content		Band									
P0303420201PNS003PIEVL10000.FTZ	EPIC PN IMAGING MODE EVENT LIST											
P0303420201PNS003FBKTSR0000.FTZ	EPIC FLARE BACKGROUND TIMESERIES											
P0303420201PNS003FBKTSR0000.PDF	EPIC FLARE BACKGROUND TIMESERIES											
P0303420201PNS003EXPMAP1000.FTZ	EPIC EXPOSURE MAP		0.2 - 0.5									
P0303420201PNS003IMAGE_1000.FTZ	EPIC IMAGE		0.2 - 0.5									
P0303420201PNS003EXPMAP2000.FTZ	EPIC EXPOSURE MAP		0.5 - 1.0									
P0303420201PNS003IMAGE_2000.FTZ	EPIC IMAGE		0.5 - 1.0									
P0303420201PNS003EXPMAP3000.FTZ	EPIC EXPOSURE MAP		1.0 - 2.0									
P0303420201PNS003IMAGE_3000.FTZ	EPIC IMAGE		1.0 - 2.0									
P0303420201PNS003EXPMAP4000.FTZ	EPIC EXPOSURE MAP		2.0 - 4.5									
P0303420201PNS003IMAGE_4000.FTZ	EPIC IMAGE		2.0 - 4.5									
P0303420201PNS003EXPMAP5000.FTZ	EPIC EXPOSURE MAP		4.5 - 12.0									
P0303420201PNS003IMAGE_5000.FTZ	EPIC IMAGE		4.5 - 12.0									
P0303420201PNS003EXPMAP8000.FTZ	EPIC EXPOSURE MAP		0.2 - 12.0									
P0303420201PNS003EXPMAP8000.PNG	EPIC EXPOSURE MAP		0.2 - 12.0									



Source	Inst.	Exp. Id	RA	Dec	RADec Err	Count	Band 8 Flux	EPIC Det ML	Inst. Det ML	Ontime	EPIC Extent	EPIC Flags	Srcdet
1 (001)	EPN	S003	13 29 52.54	47 11 44.6	0.2	12549.8 ±138.9	1.5e-12 ±3.32e-14	50374	22575	22545	2 ±0	FFFFFFFFFFFF	Y
Filename	Content		Band										
P0303420201PNS003SRSPEC0001.FTZ	EPIC SOURCE SPECTRUM												
P0303420201PNS003BGSPEC0001.FTZ	EPIC SOURCE BACKGROUND SPECTRUM												
P0303420201PNS003SPCPLT0001.PDF	EPIC SOURCE SPECTRUM PLOT												
P0303420201PNS003SRCTSR8001.FTZ	EPIC SOURCE TIMESERIES		0.2 - 12.0										
P0303420201PNS003STSPLT0001.PDF	EPIC SOURCE TIMESERIES PLOT												
P0303420201PNS003SRCREG0001.ASC	EPIC SOURCE DS9 REGION												
P0303420201PNS003SRCARF0001.FTZ	EPIC ANCILLARY RESPONSE FUNCTION												



## xmm-newton



XMM-Newton » Data Analysis

- Home / Latest News
- Conferences & Meetings ▶
- News ▶
- General User Support ▶
- Proposers Info ▶
- Observers Info ▶
- Data Analysis ▶
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- Calibration & Background ▶
- SOC Info ▶
- About XMM-Newton ▶
- Image Gallery
- Publications ▶
- Other Links ▶

### XMM-NEWTON DATA ANALYSIS

#### SAS NEWS

News, special information...

#### WHAT IS THE SCIENTIFIC ANALYSIS SYSTEM (SAS)?

A comprehensive approach

#### HOW TO USE SAS

Guides, manuals, on-line documentation, background analysis, watchout items

#### XMM-NEWTON SAS WORKSHOPS

Presentations from the latest Workshop, Information about the next SAS Workshop

#### SAS VERSION CHANGES

SAS version history, release notes, validation

#### DOWNLOAD AND INSTALL SAS

How to download and how to install SAS, which are the software requirements

#### XMM-NEWTON SCIENCE SIMULATOR

SciSim software to generate simulated XMM-Newton data

XMM-Newton » Data Analysis » What is SAS

- Home / Latest News
- Conferences & Meetings ▶
- XMM-Newton News ▶
- Home General User Support ▶
- Conf Proposers Info ▶
- News Observers Info ▶
- General Data Analysis ▶
- Prop Catalogues Archive, Pipeline & ▶
- Obs Calibration & Background ▶
- Data SOC Info ▶
- Arch About XMM-Newton ▶
- Catal Image Gallery ▶
- Calib Publications ▶
- Back Other Links ▶
- SOC
- About
- Image
- Publ
- Othe

## INTRODUCTION TO SAS

### BY THE WAY: WHAT IS ALL THAT ABOUT?

The [Science Analysis System \(SAS\)](#) is a collection of tasks, scripts and libraries, specifically designed to reduce and analyze data collected by the [XMM-Newton observatory](#).

### WHY DO I NEED IT?

XMM-Newton data are available in two formats:

- *Observation Data Files (ODF)*, i.e. reformatted telemetry in FITS format. They contain un-calibrated quantities on a chip-by-chip or science window basis for the X-ray cameras and Optical Monitor, respectively
- *Pipeline Processing System (PPS)* products, a collection of validated, top-level scientific products including event and source lists, multiwavelength images and cross-correlation products, generated at the [Survey Science Center \(SSC\)](#).

Even if one starts the analysis of an XMM-Newton datasets with the PPS products, the SAS is necessary to extract standard (spectra, light curves) and/or customized science products. Moreover, SAS allows the users to reproduce the reduction pipelines run to get the PPS products (or, at least, a substantial part of them) from the ODFs files. This step is advisable, whenever substantial changes in the software and/or instrument calibrations occurred from the time when the ODF were processed by the SSC.

### ... SO ALL MY FTOOLS/LHEASOFT OR SPEX KNOWLEDGE IS NOT USEFUL?

Don't jump too early to this pessimistic conclusion! Whenever relevant, XMM-Newton data files are FITS (or compressed FITS). When appropriate, data files produced by the SAS tasks (e.g.: images, spectra, time series) have been designed to be OGIP-compliant. They provide therefore full compatibility with the most commonly used analysis packages, such as: FTOOLS (FITS file manipulation), XANADU (timing and spectral analysis), SPEX (spectral analysis) SAOIMAGE, SAOTNG, DS9 (image display and analysis). However, you do not *need* to know the FTOOLS/LHEASOFT package to work with XMM-Newton data. SAS includes a powerful and extensive suite of FITS file manipulation packages, based on the [Data Access Layer](#) library.

On the other hand, SAS does **not** include tools for spectral, timing or image analysis (although being able to generate all files - spectra, light curve, response matrices, exposure maps - which are required for the scientific analysis).

XMM-Newton » Data Analysis » How to use SAS

Home / Latest News
Conferences & Meetings ▶
News ▶
General User Support ▶
Proposers Info ▶
Observers Info ▶
Data Analysis ▶
Archive, Pipeline & Catalogues ▶
Calibration & Background ▶
SOC Info ▶
About XMM-Newton ▶
Image Gallery
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Other Links ▶

## HOW TO USE SAS

### DATA ANALYSIS THREADS

Data reduction examples for (almost) every purpose

### USERS GUIDE TO THE XMM-NEWTON SAS

The official XMM-Newton SAS User Guide [on-line](#), [PDF version](#) and [Postscript version](#)

### SAS WATCHOUT PAGE

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

### SAS ON-LINE DOCUMENTATION

Documentation of all single SAS packages

### SAS COOKBOOK

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

### BACKGROUND ANALYSIS

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

### ESAS COOKBOOK

Cookbook for data analysis of extended sources using ESAS in SAS, ([on-line](#) and [PDF](#)) from NASA XMM-GOF. [ESAS warnings](#) and [watchouts](#) from NASA XMM-GOF.

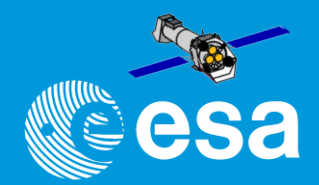
### SAS INVERSE INDEX

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

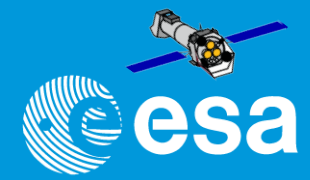
... before starting to analyse data of an XMM-Newton observation:

1. Verify the quality of the pre-processed scientific products (PPS), produced by the automatic Pipeline processing
2. Check the expected accuracy of the XMM-Newton calibrations, through:
  - Instrument calibration status reports
  - SAS Science Validation Reports
  - Current Calibration File (CCF) Release Notes
3. Compare your own set of calibration files with the latest available
  - Reduce the data again if a calibration file has changed, which may affect your scientific conclusions. Always stay on the safe side!
4. Once you have installed SAS, your job is not finished ...
  - Check the SAS “watchout and evergreen” SAS pages, which contain known caveats or bugs
  - Subscribe to the calibration mailing list
  - Install an automatic mirror of the calibration files
  - Make use of the threads, would you like to learn something new

# SAS as a web service: RISA



# SAS as a web service: RISA



So far, SAS runs locally on user's machine:

Integration on several different platforms + distribution

Large maintenance due to need of compatibility with new libraries in new versions

SAS download + installation + setup necessary

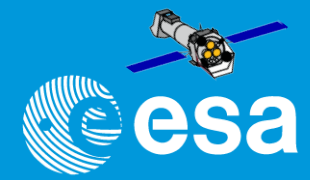
Data + Calibration DB download

SOC

User



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## Running SAS through Web Services?

reduction of maintenance due to the limitation to few platforms (1 ?)

easy to be fully "frozen" from a certain point in time

neither SAS installation nor data download needs by single user

automatic access to large H/W and S/W resources (ESAC Grid + VO tools)

full data access (processing close to XSA and central CCF repository)

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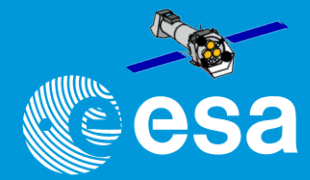
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but

- ... FTOOLS could be added
- ... other "certified" S/W

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## Further Advantages:

- processing in semi-batch mode large amounts of data
- data combination
- complement for archive >> on-the-fly reprocessing
- size-able according to needs - scalability

>> complemented with VM (based on same OS)

+ longer cycles / possibility of freezing for long periods

+ allowing for larger control of analysis, scripting + mixing with other tools (IDL, etc)

## Disadvantage:

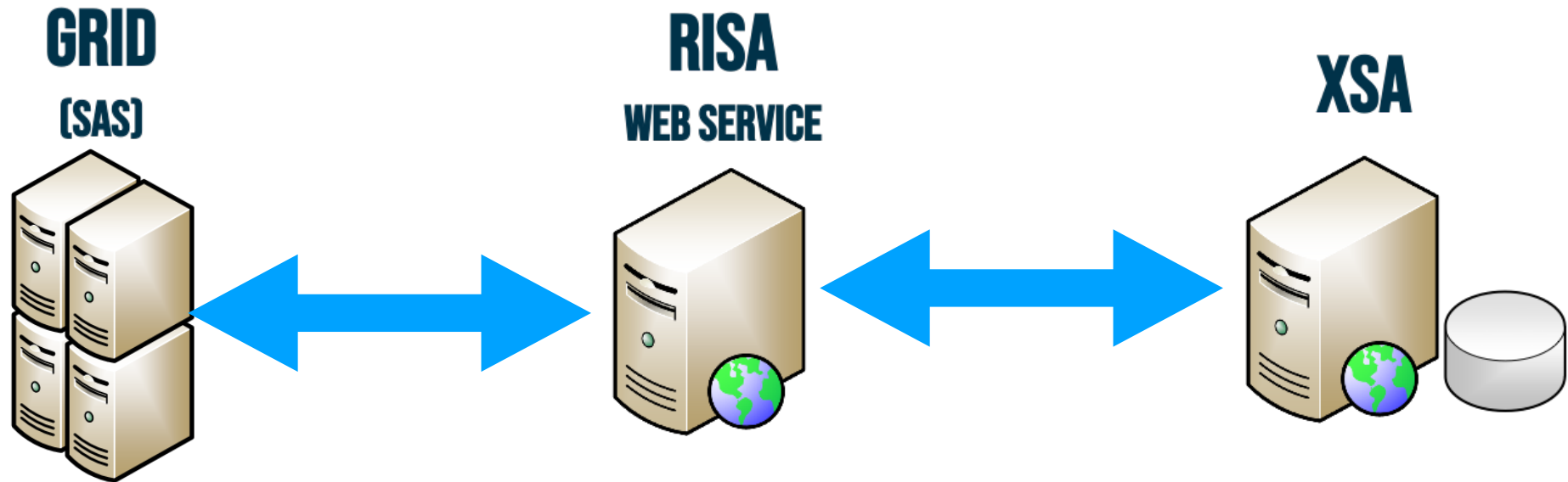
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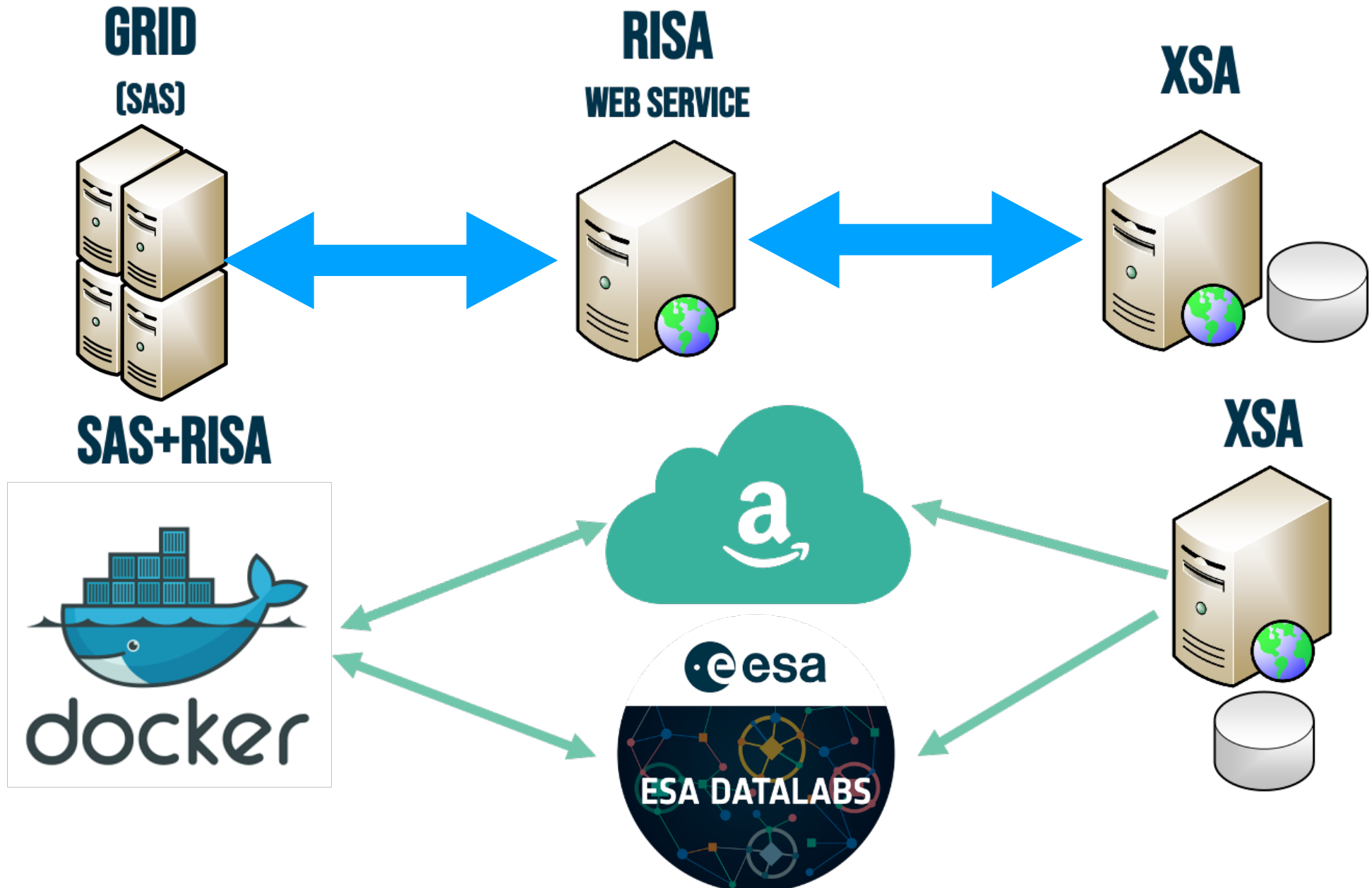
... FTOOLS could be added

... other "certified" S/W

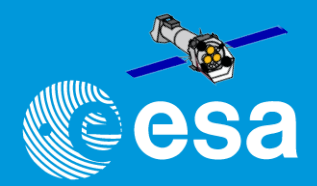
# RISA evolution to AWS



# RISA evolution to AWS

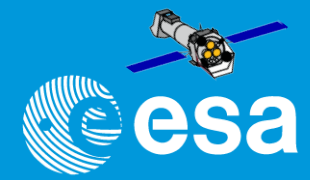


# Shaping the SAS future: DataLabs





# Shaping the SAS future: DataLabs



→ THE EUROPEAN SPACE AGENCY



ESA Datalabs [0.5.0-43-G2FD0FF1C]



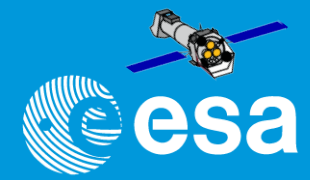
## Datalabs

Manage your running datalabs

+ Launch new

 <b>sas thread</b> jl-xmm-sas	
 <b>SAS</b> x-xmm-sas	

# Shaping the SAS future: DataLabs





→ THE EUROPEAN SPACE AGENCY esa

ESA Datalabs [0.5.0-43-G2FD0FF1C] 🧪 🔄 📁 🔔 👤

## Datalabs

Manage your running datalabs + Launch new

**sas thread**  
jl-xmm-sas🔌 Delete

**SAS**  
x-xmm-sas🔌 Delete

## Data Volume Catalog

Domain  
 Space Science (1)

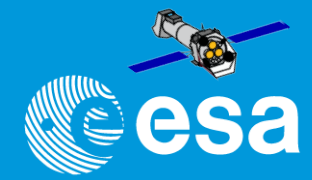
xmm



### XMM-Newton CCFs

Data Volume for XMM-Newton Calibration CCFs repository. Data volume made available by XMM-Newton mission.

# Shaping the SAS future: DataLabs



→ THE EUROPEAN SPACE AGENCY esa

ESA Datalabs [0.5.0-43-G2FD0FF1C] 🧪 🔄 📁 🔔 👤

### Datalabs

Manage your running datalabs + Launch new

sas thread  
jupyter xmm-sasDelete

SASDelete

---

### Data Volume Catalog

**Domain** ▼

Space Science (1)

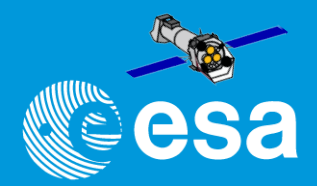
🔍 ⚙️

**XMM-Newton CCFs**

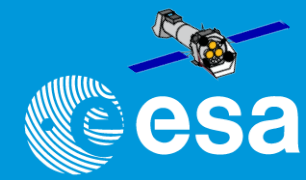
Data Volume for XMM-Newton Calibration CCFs repository. Data volume made available by XMM-Newton mission.

NOT YET IN THE OPERATIONAL DATALABS!!!  
WORKING ON USE CASES

# Shaping the SAS future: DataLabs



# Shaping the SAS future: DataLabs



The screenshot shows the ESA DataLabs interface. On the left, a file explorer shows a workspace with several Jupyter Notebook files. The main area displays the 'sas-startup.ipynb' notebook, which contains the following content:

## SAS Startup Thread in Python

### Introduction

The SAS Start-up thread provides a detailed explanation on how to get started with SAS. In particular it shows how to initialize SAS, how to point SAS to the calibration files needed for a given XMM-Newton Observation, and how to get the data ready to be processed by any SAS task. With SAS 19, we are introducing a new infrastructure for Python which allows one to run Python tasks from the command line, as any other non Python SAS task, and to access the same code from a Jupyter Notebook. Besides that, SAS 19 includes several new Python tasks, among them, two which can help us to start working with SAS: [startsas](#) and [sasver](#).

### Expected Outcome

The ability to process any XMM-Newton observation with any SAS task.

### SAS Tasks to be Used

- [sasver](#)
- [startsas](#)
- [cifbuild](#)
- [odfingest](#)

### Prerequisites

It is assumed that SAS has been installed properly, according to the explanations given in the [current SAS installation pages](#). Before SAS is initialized, the HEASOFT software must be already initialized as well (see [SAS Watchout](#)).

### Useful Links

- [pysas](#)
- [SAS web pages](#)
- [SAS download page](#)
- [SAS external software requirements](#)
- [Latest SAS on-line documentation](#)
- [SAS Threads](#)

### Caveats

Last Reviewed: *30 November 2021, for SAS v20.0*  
Last Updated: *15 March 2021*

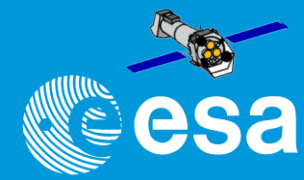
---

## Procedure

Lets begin by asking four questions:

1. Where in my system have I installed the SAS software?
2. Where in my system have I stored the Calibration files?

# Shaping the SAS future: DataLabs



```
ESA Datalabs [0.5.0-43-G2FDDFF1C]
File Edit View
+ / my_workspac
Filter files by name
Name
epic-bkgfilteri
epic-reproces
SAS_image_vi
sas-startup.jp
startsas.log

sas-startup.ipynb
Python 3 (ipykernel)

[11]: inargs=['odfid=0780860901','workdir=/media/home/my_workspace/my_ODFs/0780860901/']

[12]: w('startsas', inargs).run()

startsas - WARNING - Executing /usr/local/SAS/xmmsas_20211130_0941/lib/python/pysas/startsas/startsas.py {'odfid':
'0780860901', 'workdir': '/media/home/my_workspace/my_ODFs/0780860901/', 'sasfiles': 'no', 'sas_ccf': '', 'sas_odf
': '', 'level': 'ODF', 'cifbuild_opts': '', 'odfingest_opts': ''}

Starting SAS session

Working directory = /media/home/my_workspace/my_ODFs/0780860901/

Requesting odfid = 0780860901 to XMM-Newton Science Archive

Downloading 0780860901, level ODF. Please wait ...

Downloading URL http://nxs.esac.esa.int/nxs-servlet/data-action-ai?obsno=0780860901&level=ODF to 0780860901.t
ar.gz ... [Done]

Creating directory 0780860901 ...

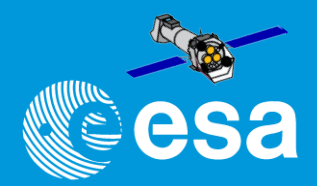
Unpacking 0780860901.tar.gz ...

Unpacking 3115_0780860901.TAR ...

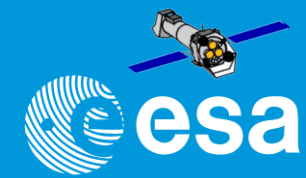
Setting SAS_ODF = /media/user/my_ODFs/0780860901/0780860901

2. Where in my system have I stored the Calibration files?
```

# Shaping the SAS future: DataLabs



# Shaping the SAS future: DataLabs



```
sas-startup.ipynb
Python 3 (ipykernel)

How to continue from here?

This depends on the type of products you have requested.

If you requested the Pipeline products (level=PPS), you may begin exploring these products directly. Among them, you will find the Observation Event Files for the different instruments and a lot of information ready to be used.

If you simply requested the ODF (level=ODF), the first step is to run the proper SAS tasks to get the Observation Event Files for each instrument. Then, you may have a look to other Threads to get familiar with specific processing tasks for each instrument.

In the next cells we show how to run from here four typical SAS tasks, three `procs` and one `chain` to process exposures taken with the EPIC PN and MOS instruments, RGS and OM.

Given that the execution of these tasks produces a lot of output, we have not run them within the notebook.

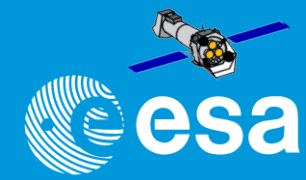
We leave this up to you!

[79]: os.chdir(work_dir)

[16]: w('epproc', []).run()
epproc:- Selected CCD: 7
epproc:- Selected CCD: 8
epproc:- Selected CCD: 9
epproc:- Selected CCD: 10
epproc:- Selected CCD: 11
epproc:- Selected CCD: 12
epproc:- 0 [Imaging] -> 1
epproc:- 1 [Timing] -> 0
epproc:- Considering one of the 1 exposures for mode 0 [Imaging]
epproc:- Considering exposure PNS003[index=0]
epproc:- Considering one of the 0 exposures for mode 1 [Timing]
epproc:- Selected exposure: 3 mode 0 [Imaging]
epproc:- Executing (invoked): atthkgen atthkset=../3115_0780860901_Atthk.ds timestep=1 timebegin=0 timeend=0 withtimeranges=no withpreqgti=no preqgtifile=pointings.fit -w 1 -V 4
epproc:- atthkgen (atthkgen-1.22.1) [xmmas_20211130_0941-20.0.0] started: 2022-11-18T18:36:43.000
epproc:atthkgen:- Executing (routine): atthkgen atthkset=../3115_0780860901_Atthk.ds timestep=1 timebegin=0 timeend=0 withtimeranges=no withpreqgti=no preqgtifile=pointings.fit -w 1 -V 4
epproc:atthkgen:- atthkgen (atthkgen-1.22.1) [xmmas_20211130_0941-20.0.0] started: 2022-11-18T18:36:43.000
epproc:atthkaen:- 20 % completed of 1st run (AHF/OM)
```



# Shaping the SAS future: DataLabs



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epproc:- Considering one of the 1 exposures for mode 0 [Imaging]
epproc:- Considering exposure PNS003[index=0]
epproc:- Considering one of the 0 exposures for mode 1 [Timing]
epproc:- Selected exposure: 3 mode 0 [Imaging]
epproc:- Executing (invoked): atthkgen atthkset=../3115_0780860901_Atth
-w 1 -V 4
epproc:- atthkgen (atthkgen-1.22.1) [xmmsas_20211130_0941-20.0.0] star
epproc:atthkgen:- Executing (routine): atthkgen atthkset=../3115_07808
ntings.fit -w 1 -V 4
epproc:atthkgen:- atthkgen (atthkgen-1.22.1) [xmmsas_20211130_0941-20.0.0] started: 2022-11-18T18:36:43.000
epproc:atthkaen:- 20 % completed of 1st run (AHF/OM)
```

```
WARNING: FITSFIXEDWARNING: 'MATRIX' made the change 'Set MJD-OBS to 57733.434931 from DATE-OBS.
Set MJD-END to 57733.647940 from DATE-END'. [astropy.wcs.wcs]
```

```
[128]: %matplotlib inline
fig = plt.figure(figsize=(10,10))
ax = fig.add_subplot(111,projection=wcs)
ra=ax.coords[0]
dec=ax.coords[1]
ra.set_major_formatter('d.ddd')
dec.set_major_formatter('d.ddd')
ax.coords[0].set_axislabel('RA')
ax.coords[1].set_axislabel('DEC')
ax.imshow(image_data,cmap='hot',norm=LogNorm())
```

[128]: <matplotlib.image.AxesImage at 0x7f765f875970>

```
ointsings.fit
:qgtifile=poi
```

Mode: Command Ln 1, Col 1 sas-startup.ipynb