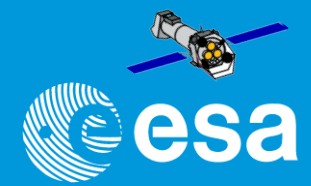


Introduction to the XMM-Newton Science Analysis System

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”
- XSA can reprocess the data (RISA)
- Retrieving XMM-Newton data
- SAS >> web services - shaping the future

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
- A subset of the SAS is used as the core of the official pipeline (PPS) for reducing the data to calibrated event lists, images, spectra, source lists (and much more)

Actual SAS version: SAS 17 – released on June 22, 2018

- Binary distributions of SAS are available **only** for 64bit:
 - Linux RedHat 6.8, Ubuntu 16.04
 - Mac OS X - 64bit
 - + 10.12.6 - Sierra, can be used with 10.11 - El Capitan or 10.13 High Sierra (not fully tested yet with Mojave, but seems to work)
 - *Virtual Machine running Ubuntu 18.04 64bit (Windows, Linux and MacOSX)...*
- >> “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_17.0.0-[OS].tgz
```

```
./install.sh (will check everything is in place, download and install a Miniconda if  
necessary and finally install SAS)
```

```
>> xmmsas_20180620_1731  
directory with all contents
```

Everytime you want to run SAS:

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

or

```
> . <top-dir>/xmmsas_20180620_1731/setsas.sh  
> source <top-dir>/xmmsas_20180620_1731/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?

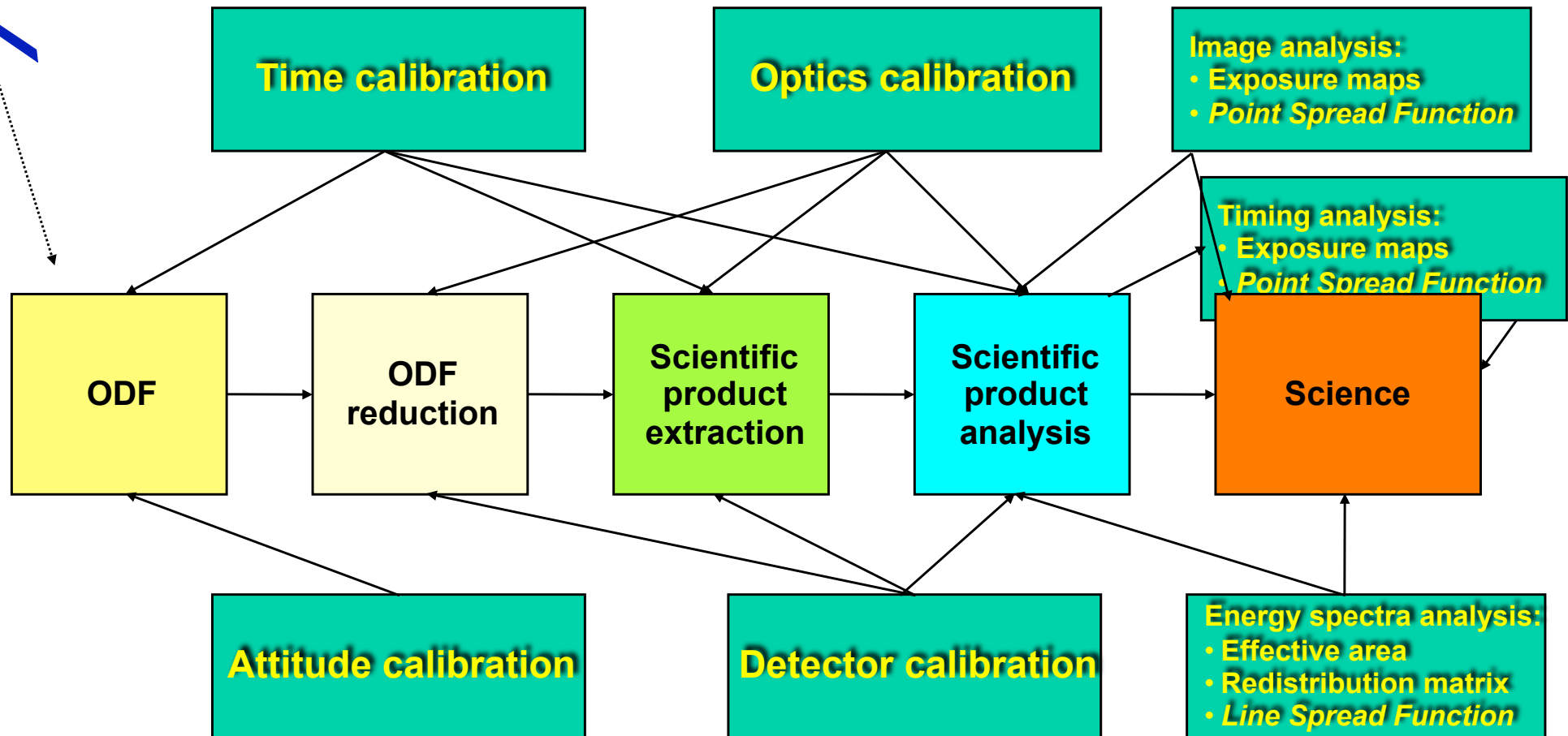
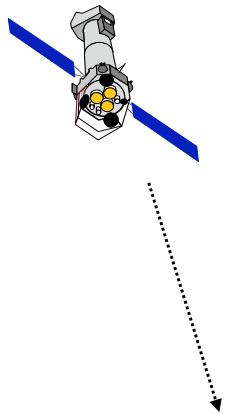
	<input type="checkbox"/> TIME D s	<input type="checkbox"/> X J 0.05 ARCSECONDS	<input type="checkbox"/> Y J 0.05 ARCSECONDS	<input type="checkbox"/> PHA I CHAN	<input type="checkbox"/> PI I CHAN	<input type="checkbox"/> PATTERN B	<input type="checkbox"/> CCDNR B
1	9.506202266412E+07	23743	21330	423	1447	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***

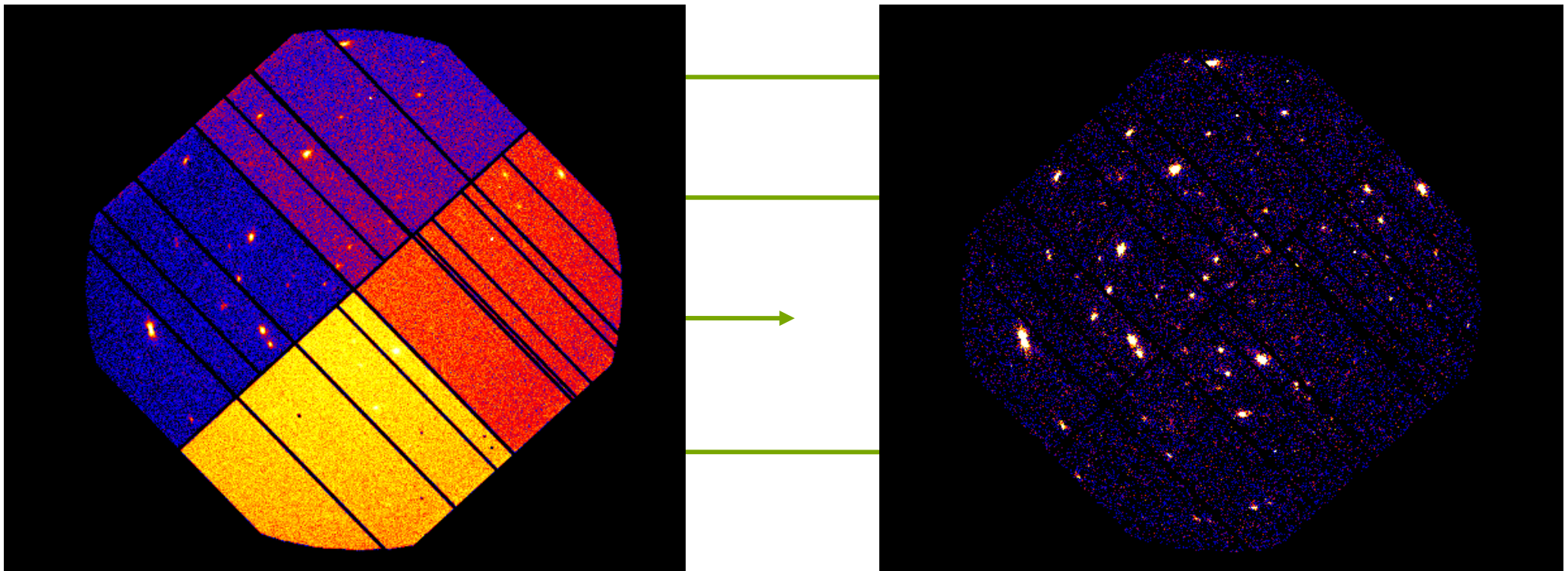
These scientific products are expressed in units that are indirectly related to the intrinsic properties of celestial sources

Data reduction = calibration



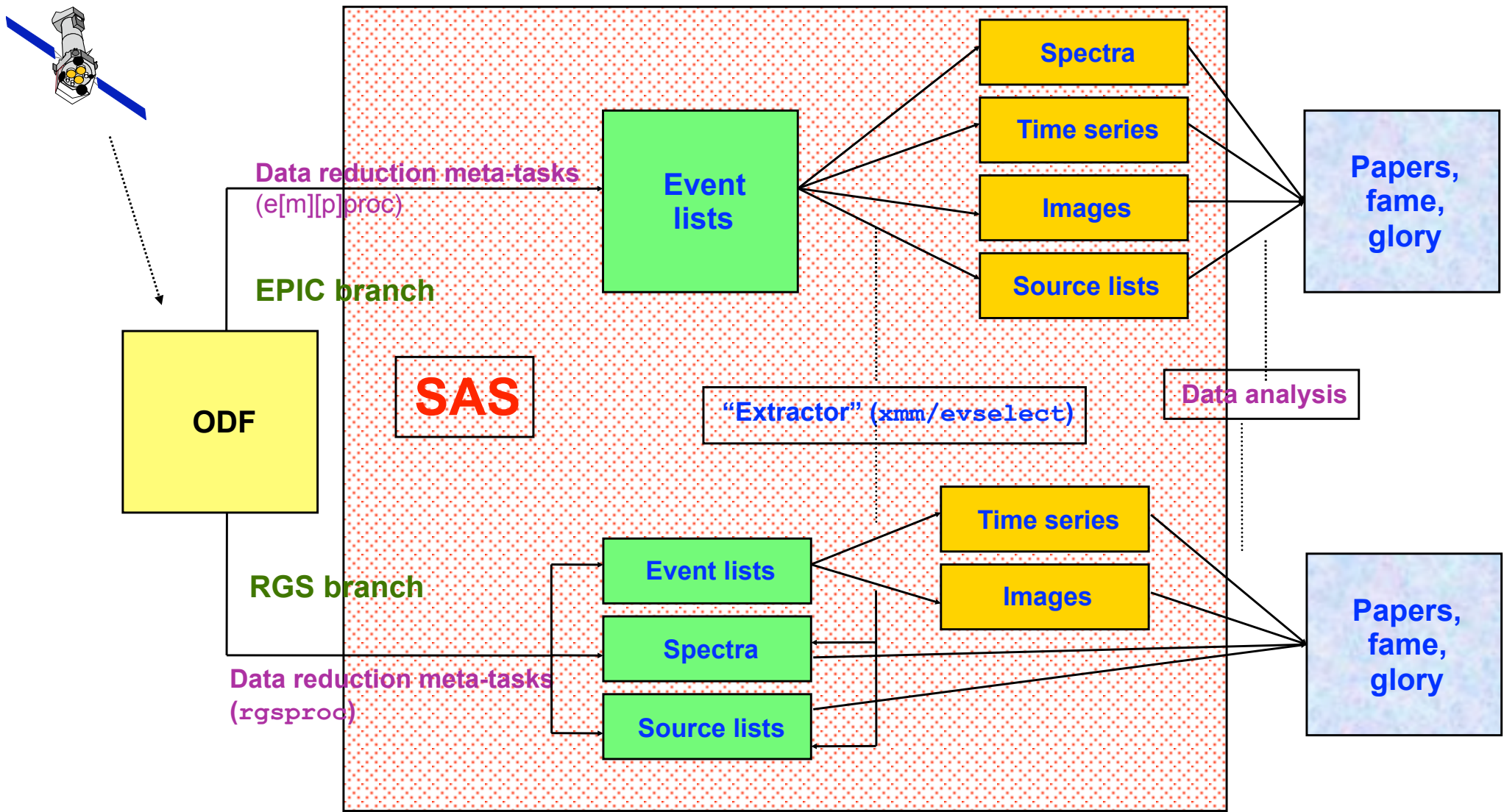
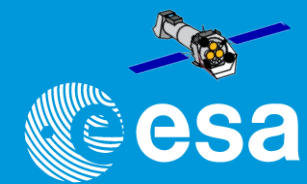
SAS does two things (to XMM data), that no other tool does:

- applies **calibrations** to raw data



- optimally **screen / filter** your data

SAS Grand-Scheme

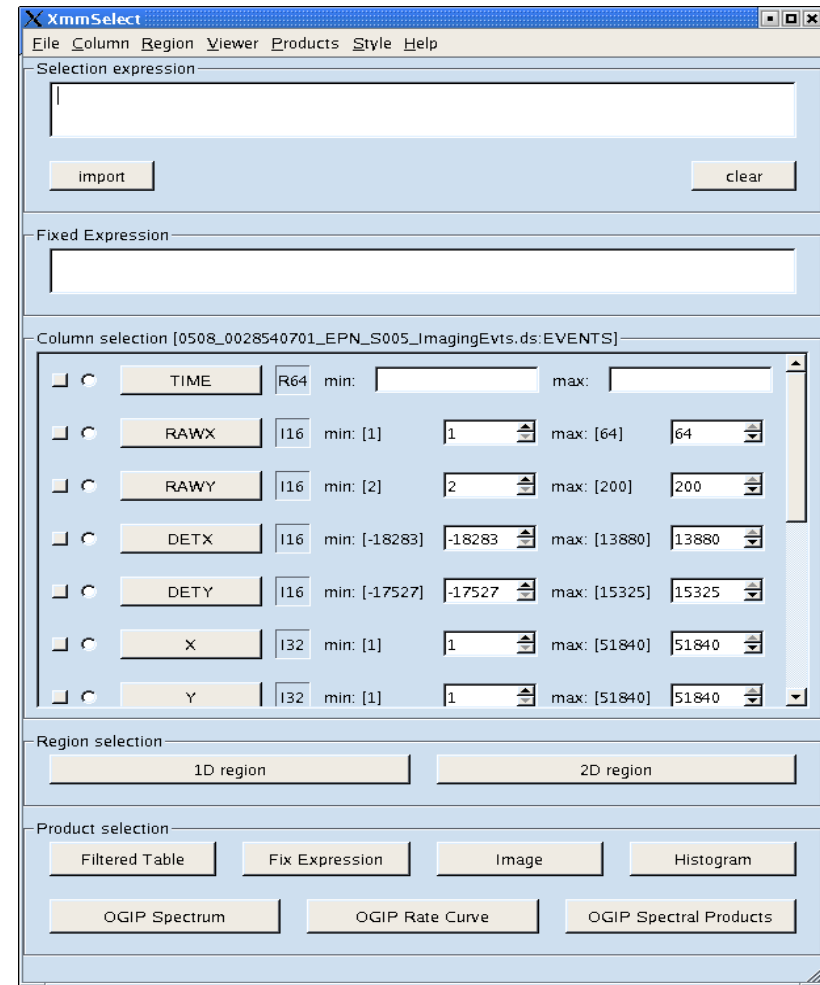
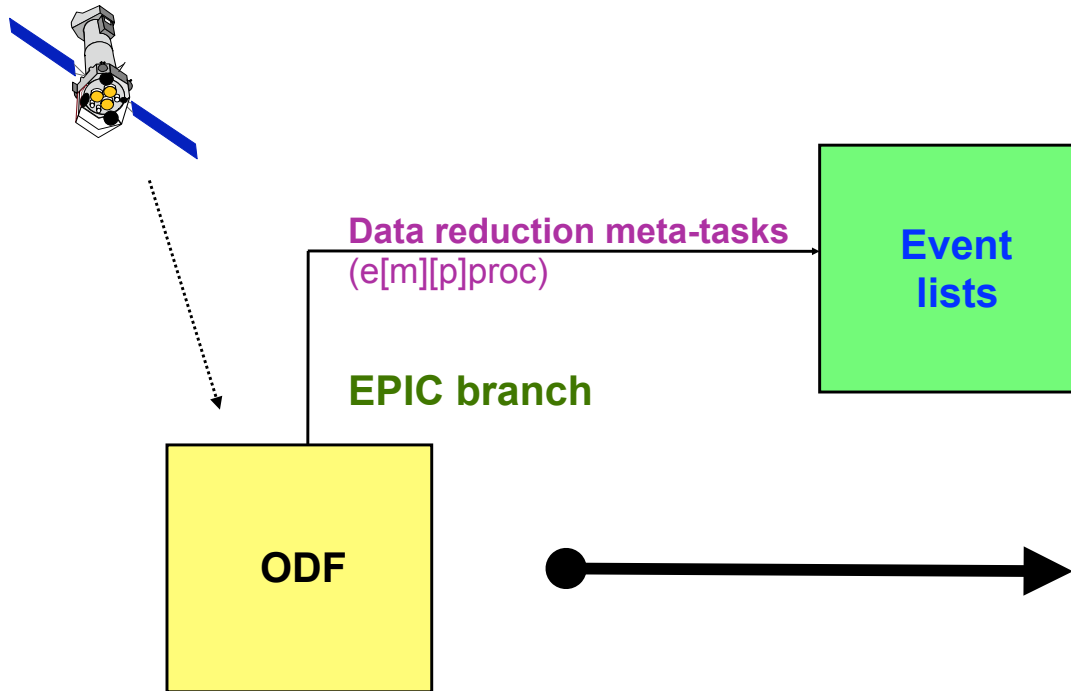




ODF

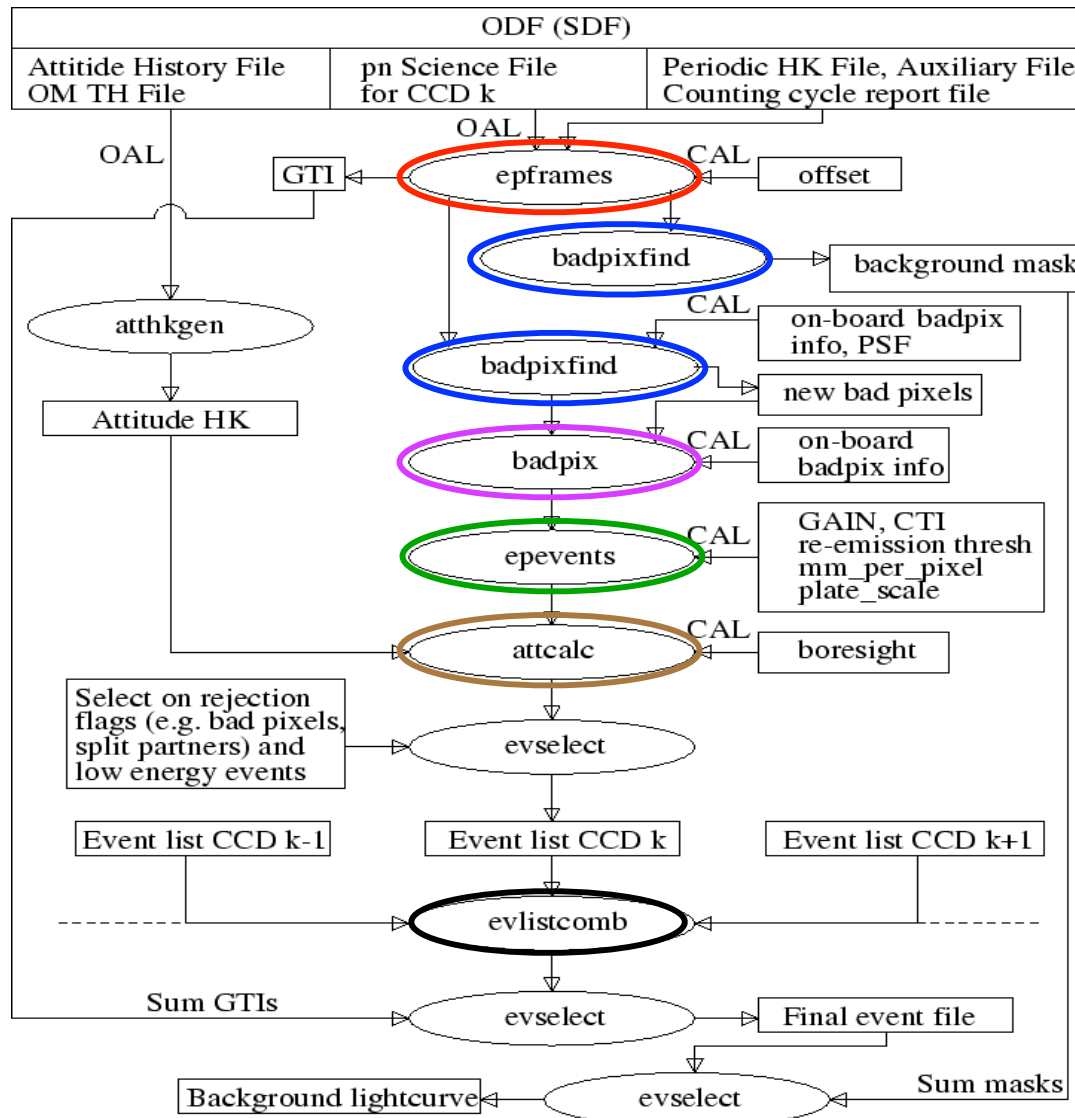
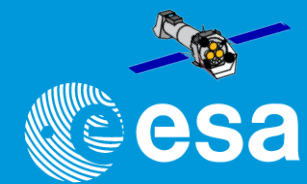
- CCD-based event lists, containing uncalibrated quantities
- Auxiliary and Housekeeping files, pn/RGS diagnostic images
- Spacecraft housekeeping **FITS**
- Spacecraft attitude showing the satellite star tracker pointing
- Time correlation file (onboard time and frame counter versus UTC)
- ODF summary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

epicproc = e[m][p]proc



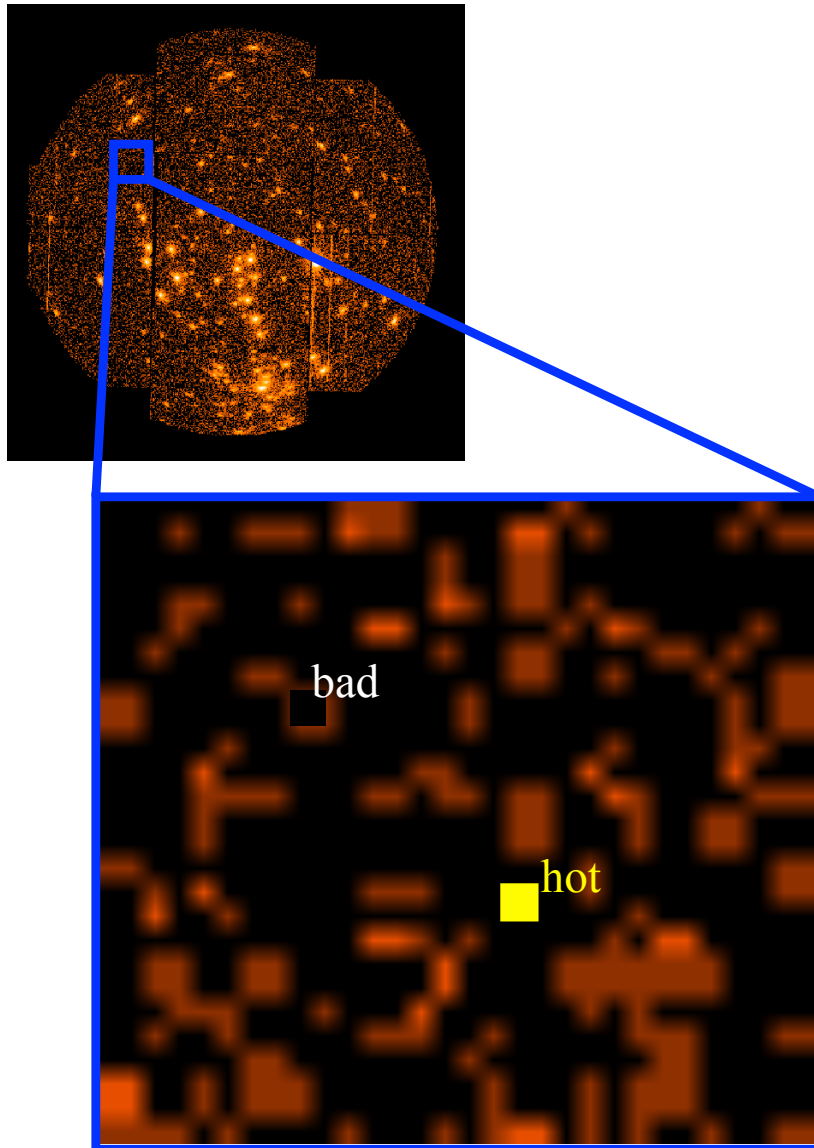
- metatasks to process MOS or pn data
- generate calibrated, filtered event lists
- leave user in control of GTI and filter expressions

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.

- 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

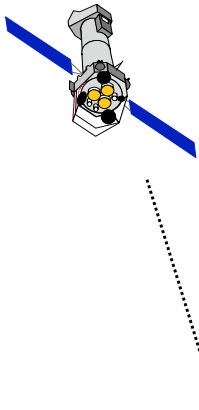
- by default the event lists are filtered, and the filtered events are removed
- the filter expression can be controlled by the user
 - `flagfilteredevents == true`:
In this case all events will be retained, and a flag column will be set to indicate what events would have been removed.

Fundamental final product of epicproc is the event list:

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

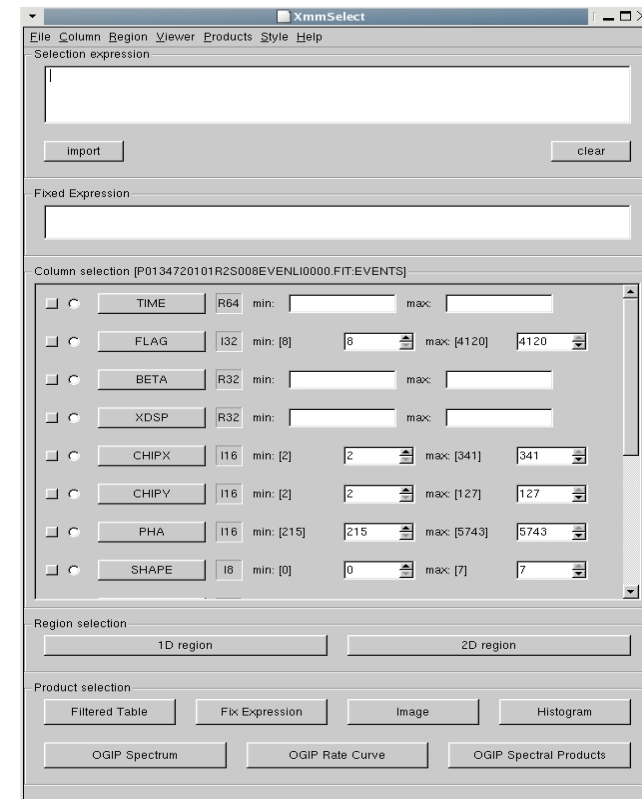
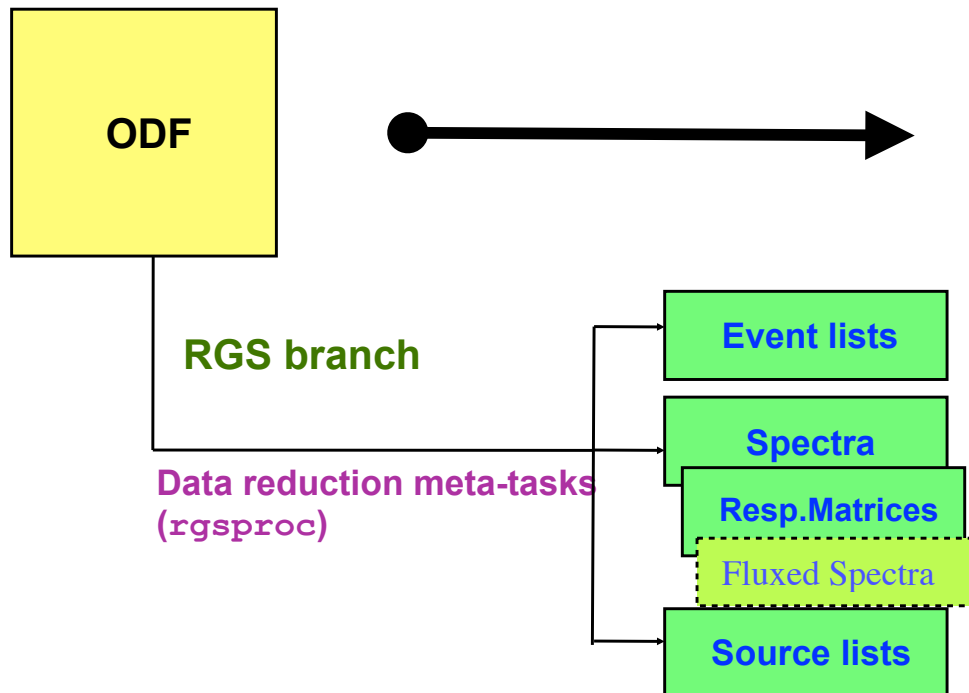
+ BadPixel tables produced by `(em)badpixfind`

>> further scientific analysis based on work with event files [see Matteo's talk]



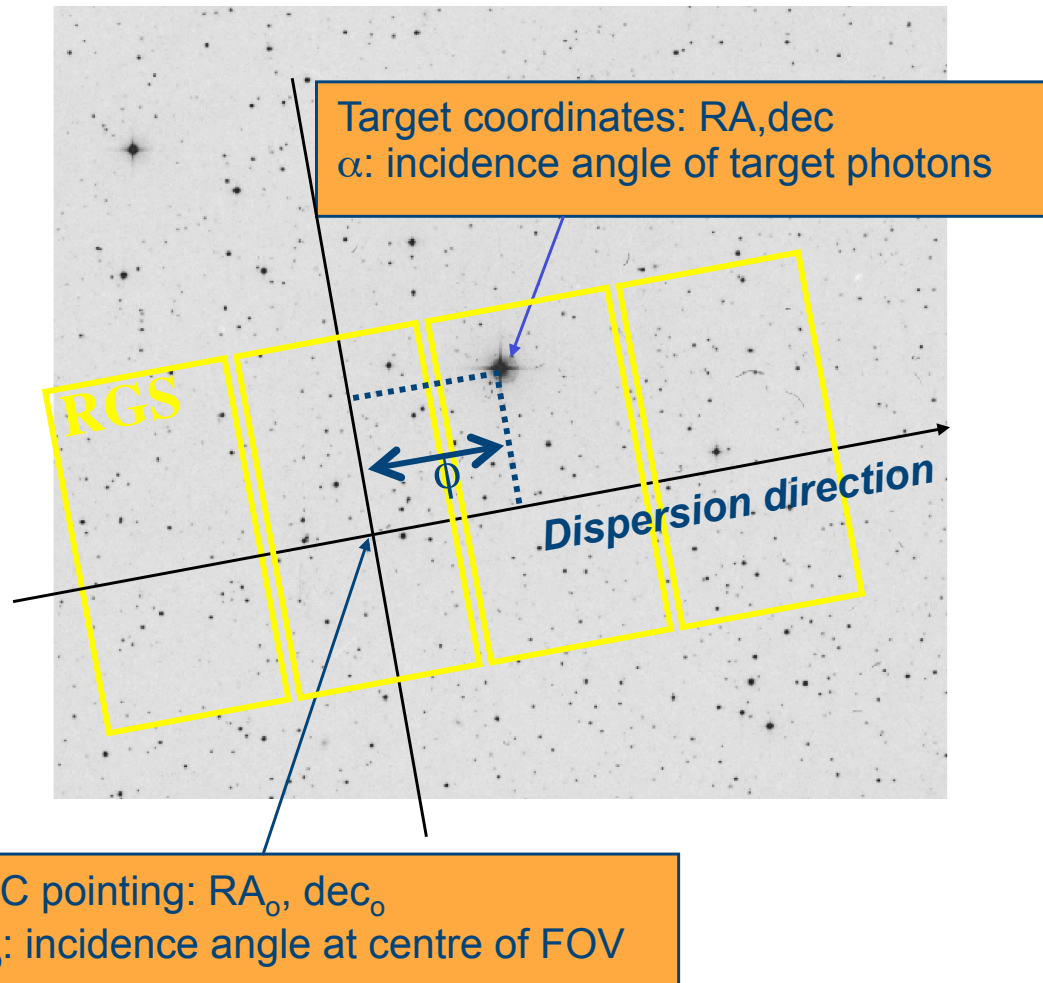
- meta-task: interface to 17 SAS tasks (that can also be run separately)
- controlled by \approx 80 parameter switches
- five entry and final points (“processing stages”) >>
- produces filtered event lists, spectra and matrices
- **the quality of the results depends critically on the source coordinates**

events
angles
filter
spectra
fluxing



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

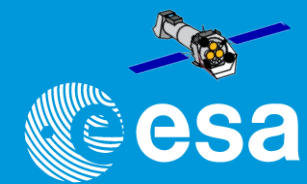
$$\phi = f (RA - RA_0, dec - dec_0, P.A.)$$



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

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

rgsproc: what does it do?



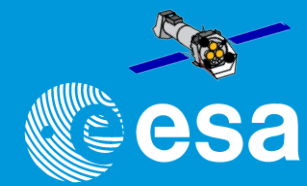
Stage	Task	Purpose	Output
Events	atthkgen	generates attitude file	Source list + intermediate combined event list
	attfilter	filters the attitude file	
	hkgtigen	generates housekeeping GTIs	
	rgsoffsetcalc	uses the diagnostic mode data for offset calculation	
	rgssources	creates the list of sources to 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	

Source independent

Angles	rgsangles	aspect correction (M_LAMBDA, XDSP_CORR)	Aspect correction
Filter	rgsfilter	creates filtered event list, removing unwanted frames and events and adding exposure maps	Final event list
Spectra	rgsregions	computes background and source extraction regions for each source	Source and background spectra
	rgsspectrum	extracts source and background spectra	
	rgsbkgmodel	generates model background (optional)	
Fluxing	rgsrmfgen	creates a response matrix	Response matrices and combined spectrum in physical units
	rgsfluxer	combines a collection of RGS spectra into one "fluxed" spectrum	

Source dependent

rgsproc does a lot



File Edit View Frame Analysis Help

Object Value ML_XD_1 PK5215

WCS Physical Image Frame 1

File edit view

color region wcs help

grey a view

heat cool rainbow

M_LAMBDA vs XDISP_CORR: Spatial Image

Import clear

Linked Expression

Column selection [P0124930201R1S004EVENLI0000.FIT:EVENTS]

GRADE | 8 min: [1] 1 max: [4] 4

PI | 16 min: [2] 2 max: [3594] 3594

CCDNR | 8 min: [1] 1 max: [14] 14

BETA_CORR | R32 min: max:

XDSP_CORR | R32 min: max:

M_LAMBDA | R32 min: max:

BETA_CHANNEL | 16 min: [1] 1 max: [3400] 3400

MLAMBDA_CHANNEL

Region selection

1D region

Product selection

Filtered Table

OGIP Spectrum

PGPLOT Window 1

File Object Value Lam_F PK5215

WCS Physical Image Frame 1

File edit view

color region wcs help

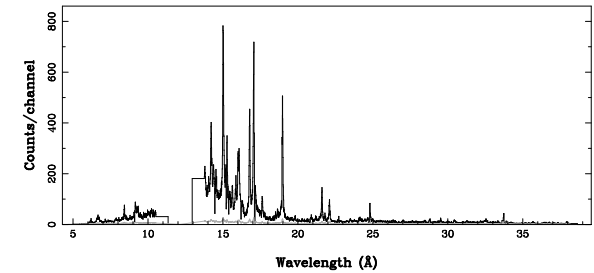
grey a view

heat cool rainbow

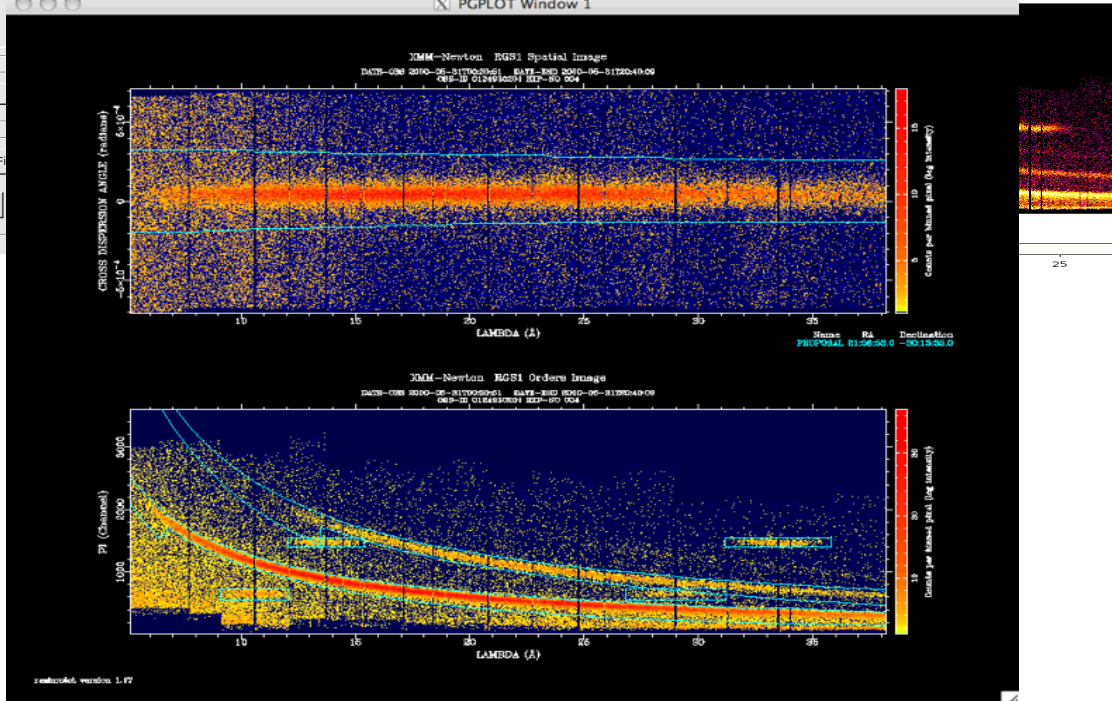
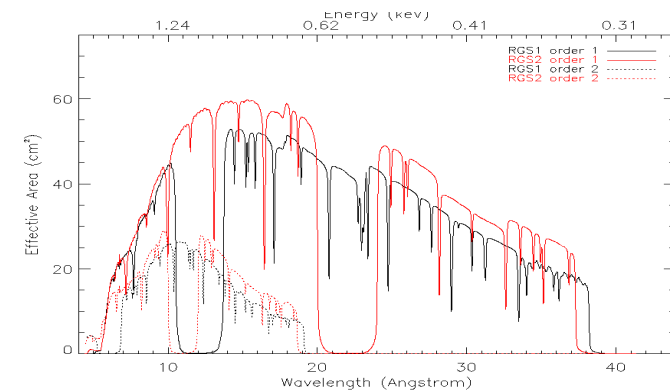
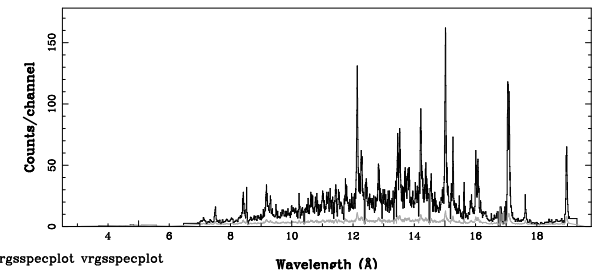
M_LAMBDA vs PI: Order Image

XMM - RGS1 - OBJECT: Capella - RA: 79.17850 - DEC: 45.99633 DATE-OBS 2016-09-10T00:09:21
 OBS-ID: 0791980301 - EXP-ID: Indef - Exp. Time: 25660.37106375 DATE-END 2016-09-10T07:17:04
 Key: - data

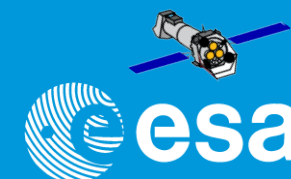
SOURCE ID: 87 - SPECTRUM ORDER: 1 SRC+BKG SPECTRUM, Min. cts/bin = 20
 WHOLE_FIELD



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:

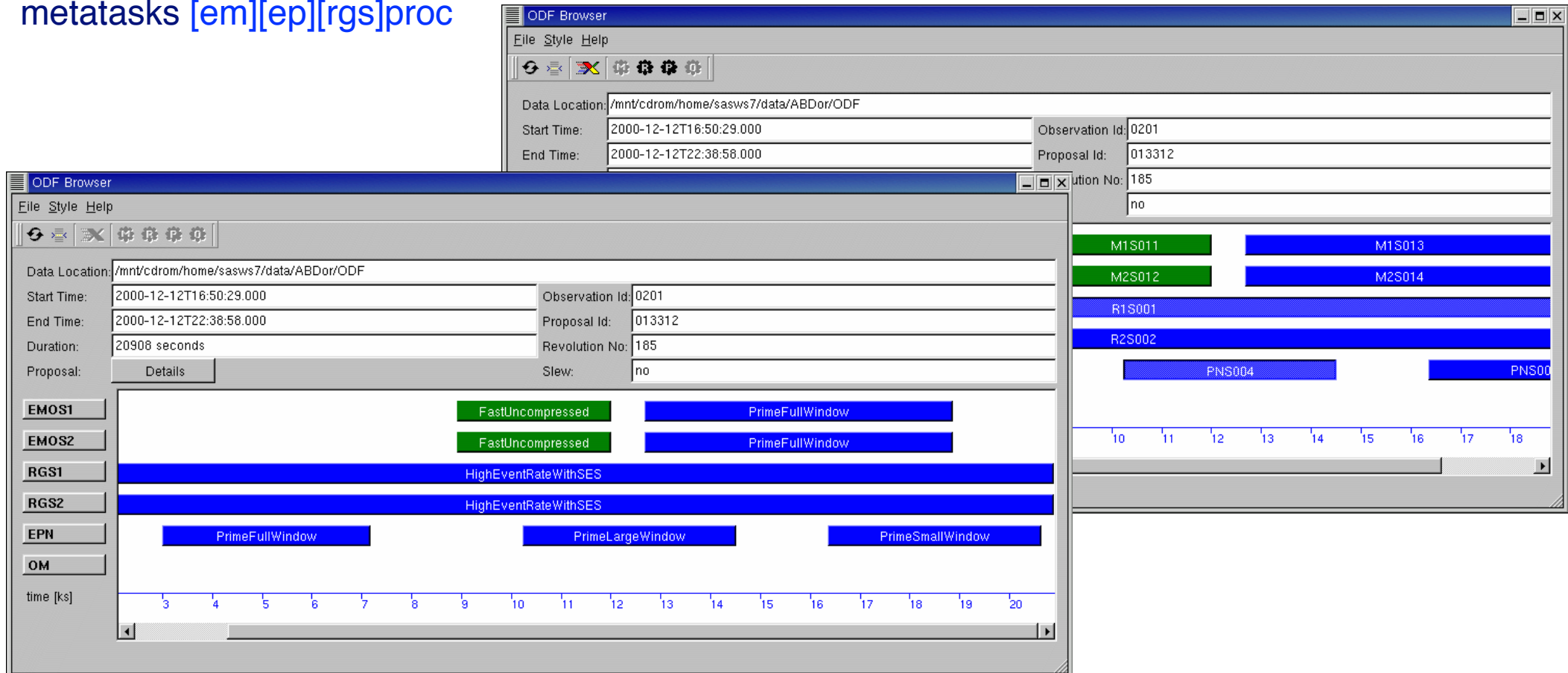
<i>File</i>	<i>Content</i>	<i>rgsproc (default)</i>	<i>PPS</i>
P0123456701R1S004EVENLI0000.FIT	Filtered Event List	Y	Y
P0123456701R1S004SRCLI_0000.FIT	Source List	Y (coord from proposal)	Y (coord from EPIC src list)
P0123456701R1S004BGSPEC1001.FIT P0123456701R1S004BGSPEC2001.FIT	Background Spectra (1 st and 2 nd order)	Y	Y
P0123456701R1S004SRSPEC1001.FIT P0123456701R1S004SRSPEC2001.FIT	Source Spectra (1 st and 2 nd order)	N	Y
P0123456701R1S004SBSPEC1001.FIT P0123456701R1S004SBSPEC2001.FIT	Source+Bkg Spectra (1 st and 2 nd order)	Y	Y
P0123456701R1S004RSPMAT1001.FIT P0123456701R1S004RSPMAT2001.FIT	Response Matrices (1 st and 2 nd order)	Y	only for 1 st order
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:

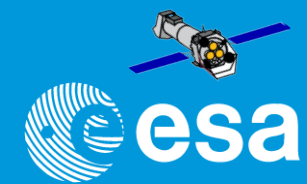
<i>File</i>	<i>Content</i>	<i>rgsproc (default)</i>	<i>PPS</i>
P0123456701OBX000fluxed1000.FIT P0123456701OBX000fluxed2000.FIT	Source Fluxed Spectra (1 st and 2 nd order)	Y	Y

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`



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` `setenv SAS_CCFPATH <ccf_dir>`

Command: `> cifbuild`

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

After the Calibration Index file has been produced:

`setenv SAS_CCF ccf.cif`

File Edit Tools					
	TELESCOP	SCOPE	TYPEID	ISSUE	VALIDATE
	4A	6A	32A	I	19A
	yyyy:ddmmZhh: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	DIFUSEGALA	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	PHOTTONAT	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	CROSSSPF	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

NOTICE: any file with extension `CALINDEX` is valid as `SAS_CCF`

cifbuild uses single CCF keywords:

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

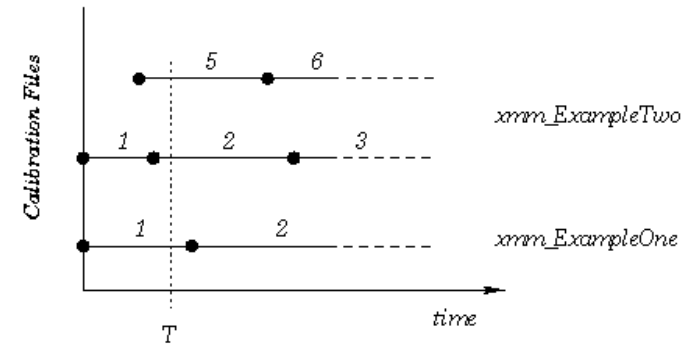


Figure 2: Current calibration file with two files: update. At the time T the current calibration file consists of *xmm_ExampleOne_0001.ccf* and *xmm_ExampleTwo_0005.ccf*

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.

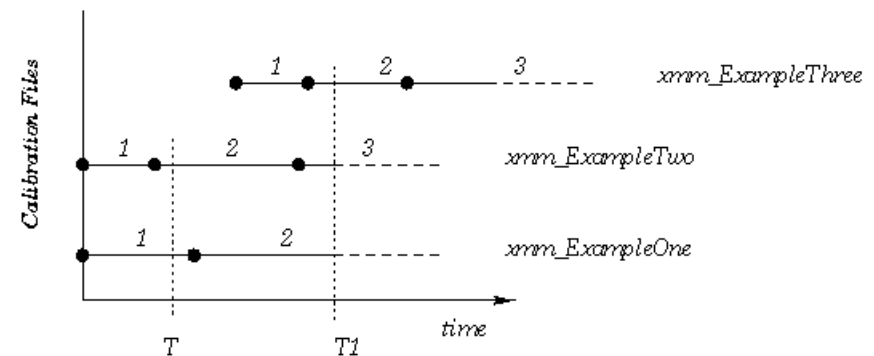
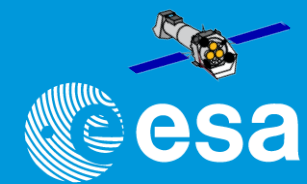


Figure 3: Current calibration file with three files. At the time $T1$ the current calibration file consists of *xmm_ExampleOne_0002.ccf* and *xmm_ExampleTwo_0009.ccf* and *xmm_ExampleThree_0002.ccf*

- 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



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>



```
wrk — tcsh — 80x24
[xcgabriel:~/data/0124711401/wrk] cgabriel1% source ~/sas/actual/setsas.csh

sasversion:- Executing (routine): sasversion -w 1 -V 4
sasversion:- sasversion (sasversion-1.2) [xrmsas_20141104_1833-14.0.0] started:
  2014-11-15T20:18:54.000
sasversion:- XMM-Newton SAS release and build information:

SAS release: xrmsas_20141104_1833-14.0.0
Compiled on: Tue Nov  4 19:01:46 UTC 2014
Compiled by: sasbuild@xmac02.esac.esa.int
Platform   : Darwin-12.5.0 64

SAS-related environment variables that are set:

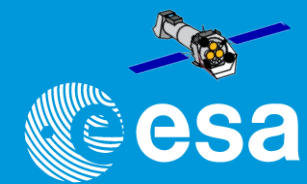
SAS_DIR = /Users/cgabriel1/sas/xrmsas_20141104_1833
SAS_PATH = /Users/cgabriel1/sas/xrmsas_20141104_1833
SAS_CCFPATH = /CCF

sasversion:- sasversion (sasversion-1.2) [xrmsas_20141104_1833-14.0.0] ended:
  2014-11-15T20:18:54.000

Do not forget to define SAS_CCFPATH, SAS_CCF and SAS_ODF

[xcgabriel:~/data/0124711401/wrk] cgabriel1% □
```


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>

```
bash-3.2$ . ~/sas/actual/setsas.sh

sasversion:- Executing (routine): sasversion -w 1 -V 4
sasversion:- sasversion (sasversion-1.2) [xmmsas_20141104_1833-14,0,0] started:
 2014-11-15T20:32:22,000
sasversion:- XMM-Newton SAS release and build information:

SAS release: xmmsas_20141104_1833-14,0,0
Compiled on: Tue Nov  4 19:01:46 UTC 2014
Compiled by: sasbuild@xmac02.esac.esa.int
Platform   : Darwin-12.5.0 64

SAS-related environment variables that are set:

SAS_DIR = /Users/cgabriel1/sas/xmmsas_20141104_1833
SAS_PATH = /Users/cgabriel1/sas/xmmsas_20141104_1833
SAS_CCFPATH = /CCF

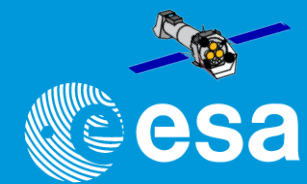
sasversion:- sasversion (sasversion-1.2) [xmmsas_20141104_1833-14,0,0] ended:
 2014-11-15T20:32:22,000

Do not forget to define SAS_CCFPATH, SAS_CCF and SAS_ODF

bash-3.2$
```

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

General guide

Task by task info

Analysis recipes

The screenshot shows the XMM-Newton SAS website. At the top, there are navigation links for 'SCIENCE MISSIONS', 'SCIENCE & TECHNOLOGY', and 'EUROPEAN SPACE AGENCY', along with a 'SIGN IN' button. The main header features the 'xmm-newton' logo and the ESA logo. A left-hand navigation menu lists various categories: 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, and Other Links. The main content area is titled 'HOW TO USE SAS' and contains several resource boxes: 'USERS GUIDE TO THE XMM-NEWTON SAS' (with sub-links for on-line, PDF, and Postscript versions), 'SAS WATCHOUT PAGE' (for issues and workarounds), 'SAS ON-LINE DOCUMENTATION' (for SAS packages), 'SAS COOKBOOK' (introduction to data analysis), 'DATA ANALYSIS THREADS' (circled in red, for data reduction examples), 'BACKGROUND ANALYSIS' (for background analysis of instruments), 'ESAS COOKBOOK' (for extended sources), and 'SAS INVERSE INDEX' (for task lists). The footer contains the copyright notice: 'COPYRIGHT 2017 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED.'

xmm-newton



XMM-Newton » Data Analysis » How to use SAS » Data Analysis Threads

Home / Latest News

Conferences & Meetings ▶

News

General

Proposed

Observation

Data Analysis

Archive

Catalog

...

EPIC RELATED THREADS

All in one go: from raw data (ODF) to science products			
- Analysis chain for point-like sources: xmmextractor	command line		
Step-by-Step			
Event list generation:			
- How to reprocess ODFs to generate calibrated and concatenated EPIC event lists	command line		
Filtering against high background:			
- How to filter EPIC event lists for flaring particle background	command line & GUI version		
Light curve generation:			
- Extraction of a light curve for a point-like source (EPIC and RGS)	command line	GUI version	
Spectrum extraction:			
- 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		
- 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		
- Extraction of spectra in a few clicks: especget		GUI version	
- Combining the spectra of the 3 EPIC cameras	command line		
- Overlapping EPIC data treatment: multixmmselect		GUI version	
Point Spread Function (PSF) generation:			
- 2-D PSF à la carte	command line		
More complex analysis for bright sources			
- Dealing with EPIC Out-of-Time (OOT) events	command line		
- How to evaluate and test pile-up in an EPIC source	command line		
Handling of EPIC background			
- 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		
Images:			
- A shell script to create attractive EPIC-pn & MOS combined images		dedicated Web page	
- How to Generate Vignetting-corrected Background-subtracted EPIC Images	command line		
Source detection			
- EPIC source finding thread in one go: edetect_chain	command line		
- EPIC source finding thread: step-by-step	command line		
- EPIC source finding in overlapping exposures	command line		
Slew data processing			
- How to process EPIC slew data	command line		

SAS THREADS

command line	
command line	
command line	
command line	

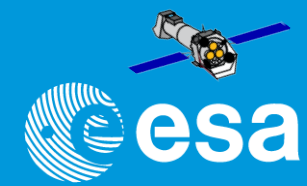
RGS RELATED THREADS

All in one go: from raw data (ODF) to science products		
- Analysis chain for point-like sources: xmmextractor	command line	
Step-by-Step		
- How to reduce RGS data and extract spectra of point-like sources		
- rgsproc , 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
More complex analysis for the very bright sources		
- Pile-up in the RGS: how to prevent it, evaluate its existence and make corrections	command line	

OM RELATED THREADS

All in one go: from raw data (ODF) to science products		
- Analysis chain for point-like sources: xmmextractor	command line	
Step-by-Step		
- 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 xspect)	command line	

A SAS thread



This thread contains a step-by-step recipe to extract light curves of a point-like source for all the X-ray cameras, sub

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 re

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 variable arrival time of a photon is shifted as is it would have been detected at the barycentre of the solar system (the c the data are comparable. The SAS task `barycen` performs this correction. As `barycen` overwrites the `TIME` column

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

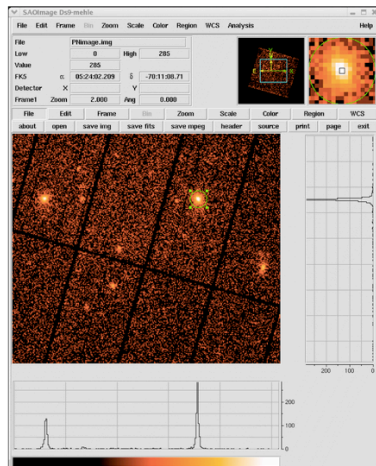
3. Extract an image (in sky coordin

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

4. Display the image

```
imgdisplay withimagefile=t
```

5. Select the region, from which th



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).

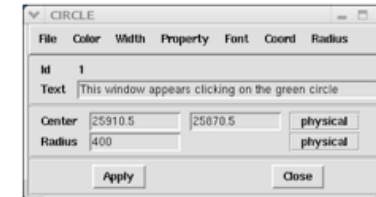


Fig.2: Selection region properties window, popped-up by double-clicking on the region in the main `ds9` window

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 (`#XOGEA_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 (`#XOGEA_EM && (PATTERN<=12) && (PI in [200:10000])`). In the example, the bin size is 100 seconds.

```
evselect table=PN_evt.fits energycolumn=PI expression='#XOGEA_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='#XOGEA_EP&&(PATTERN<=4)&& \
{((X,Y) IN annulus(25910.5,25870.5,1000,2000))}&&(PI in [200:10000])' withrateset=yes \
rateset='PN_light_curve_background_raw.lc' timebinsize=100 \
maketime
```

The light cur

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

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

This command will launch the following `xmgrace` window

11. Plot the resul

```
dsplot tab
```

This comman

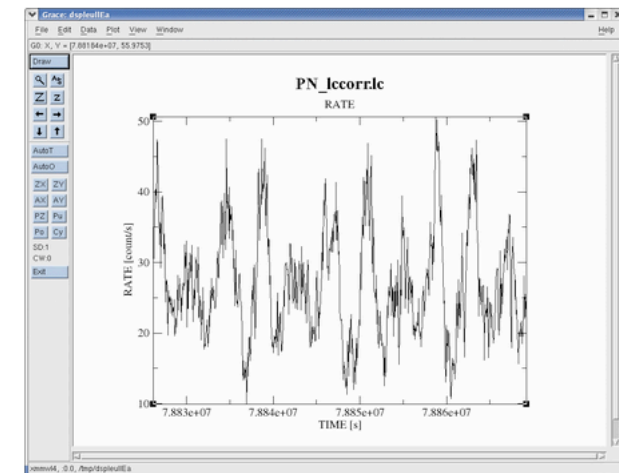
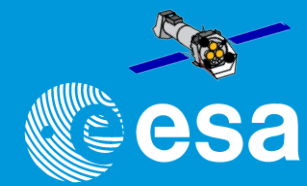


Fig.3: `xmgrace` window, containing the background-subtracted exposure-corrected light curve

The main GUI



- Access to all tasks (GUI call) and descriptions
- Setting general defaults
- Access to help pages
- Writing log into window and file (sas_log)

The screenshot shows the SAS GUI with a task list on the left, a configuration dialog box in the center, and a log window at the bottom. The task list includes columns for task name, group, history, and description. The configuration dialog box is titled 'Convert On Board Time to MET' and contains fields for 'odf', 'ccf', 'home', 'current', 'ccfpath', 'usetabs', 'SuppressWarning', 'verbosity', and 'memory'. The log window displays the following text:

```
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
@@ SAS_ODF=.; export SAS_ODF
@@ SAS_VERBOSITY=1; export SAS_VERBOSITY

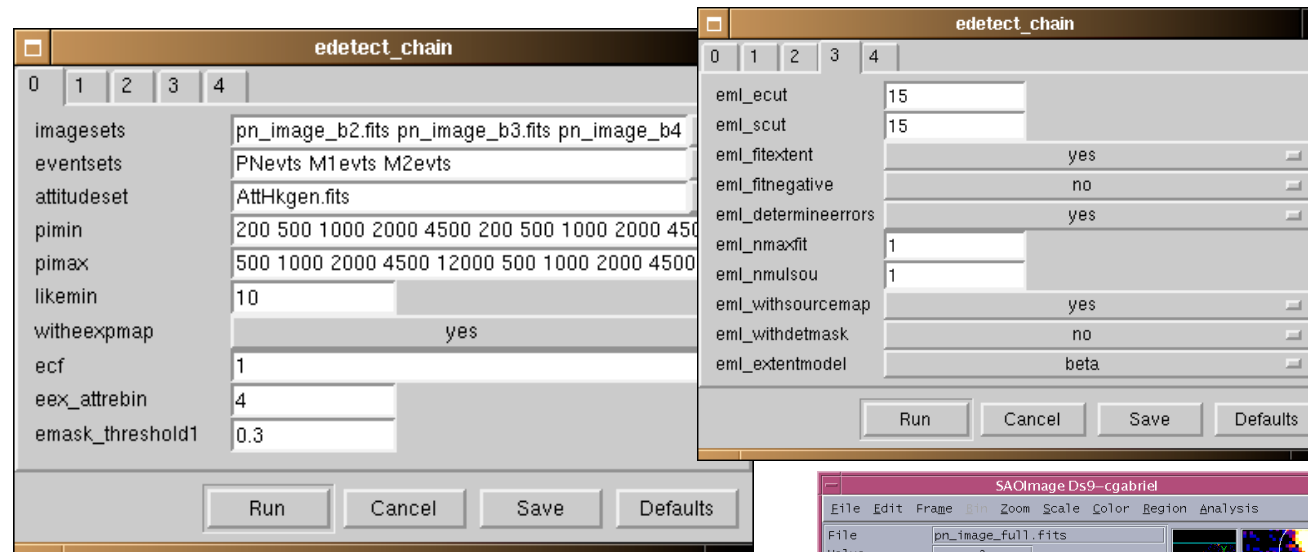
belongs to groups: pipeline
```

GUI or command line?

GUIs are very useful for beginners

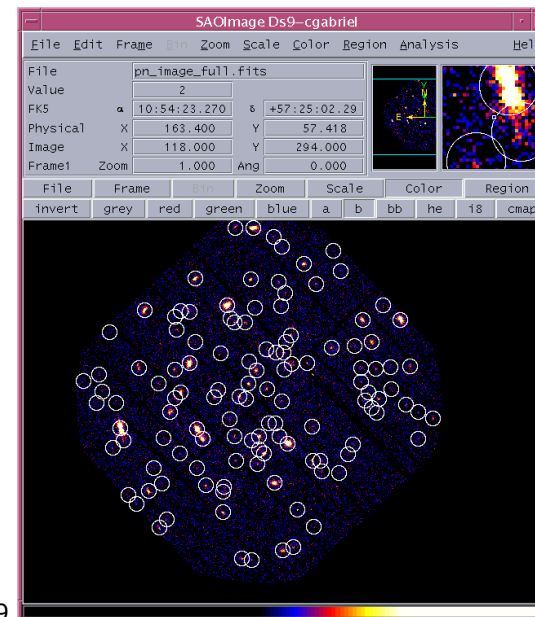
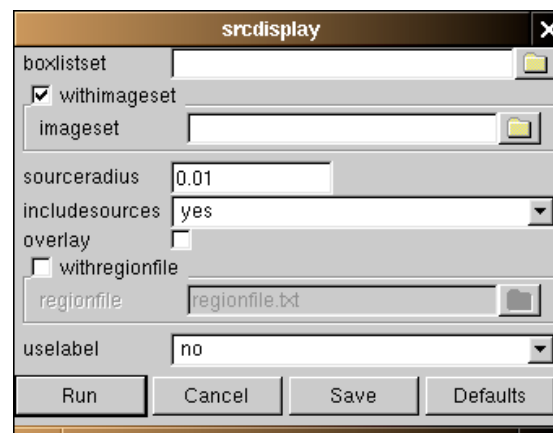
Every SAS task has its own GUI - they can be called by other (main) GUI or directly from the command line by `> <task> -d`:

`edetect_chain -d`

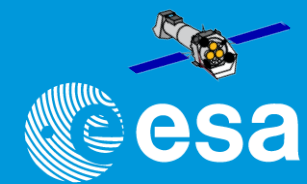


source list

`srcdisplay -d`



GUI or command line? BOTH



Line commands are, if you know them, faster in execution, and you learn how to concatenate them, so that ...

eventually,
you can
produce your
own scripts

```
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

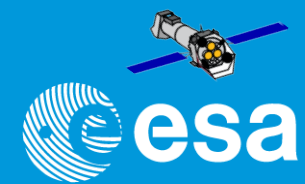
dsplot table=m1_back_lightc.fits x=TIME y=RATE &
dsplot table=m2_back_lightc.fits x=TIME y=RATE &
dsplot table=pn_back_lightc.fits x=TIME y=RATE &

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) &&
```

My answer: GUI & command line >> scripts

PPS or “proc” products? BOTH



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

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

- ❖ old SAS/PPS used for that data
- ❖ newer (probably more accurate) calibration than the one used by PPS
- ❖ special needs for using non-default parameters

During 2012 general reprocessing (second time in 12 years)

- >> XMM Science Archive repopulated with s/w and calibration as 2012 knowledge
- + source specific products: spectra and light curves
- + 3XMM - the largest X-ray sources catalogue

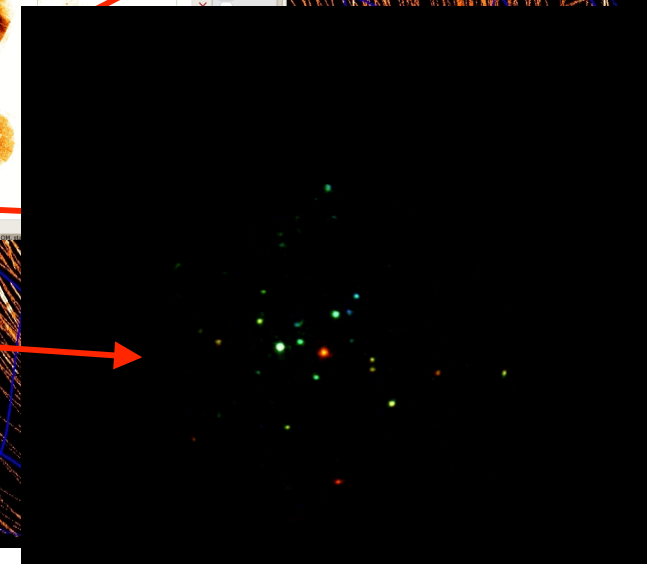
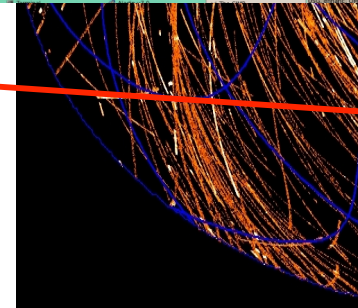
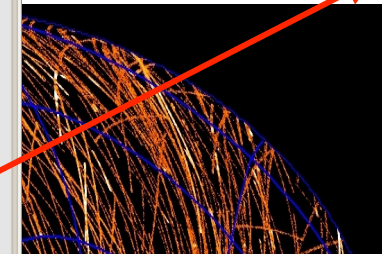
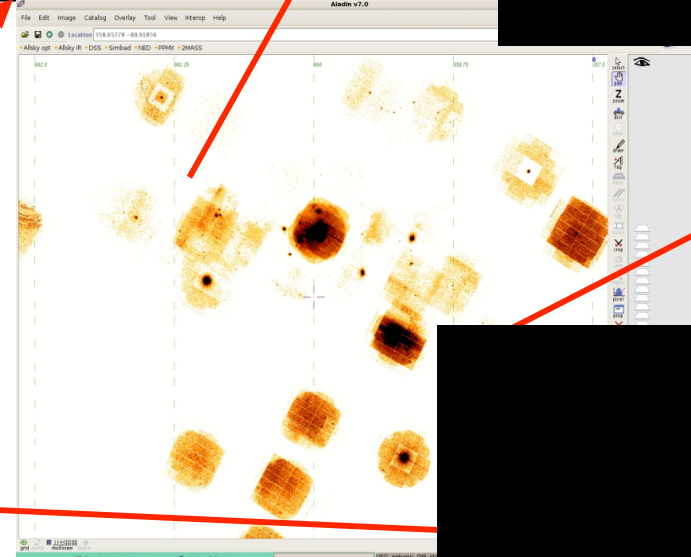
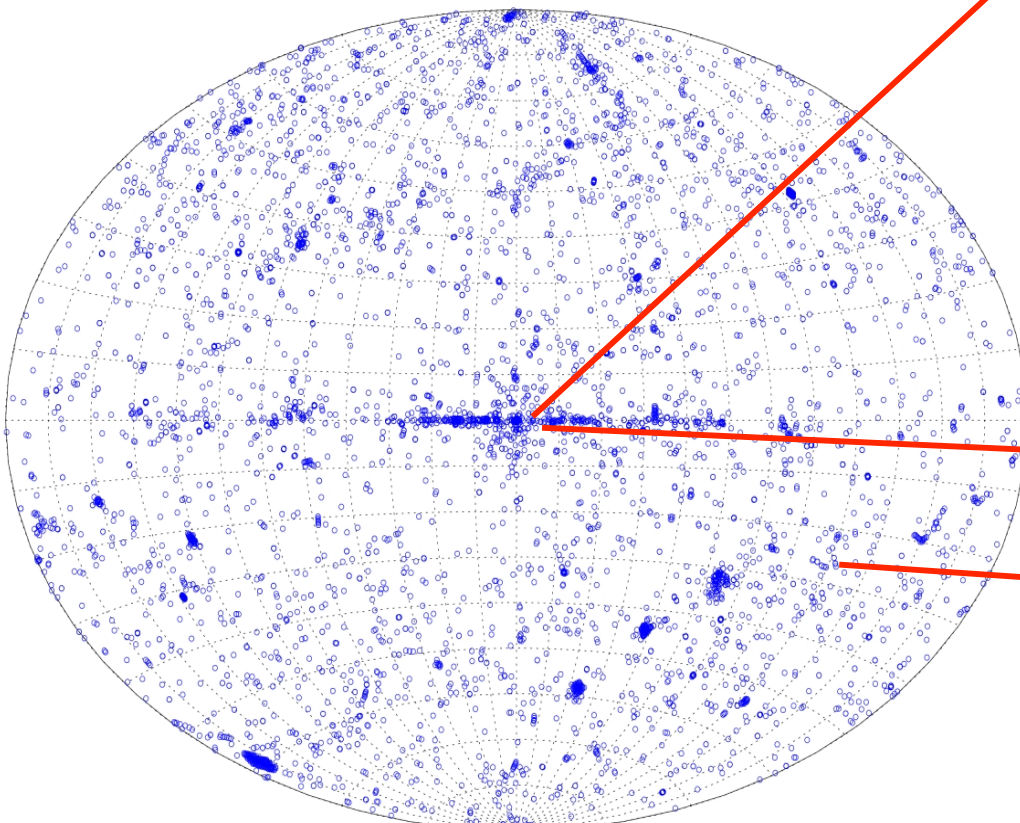
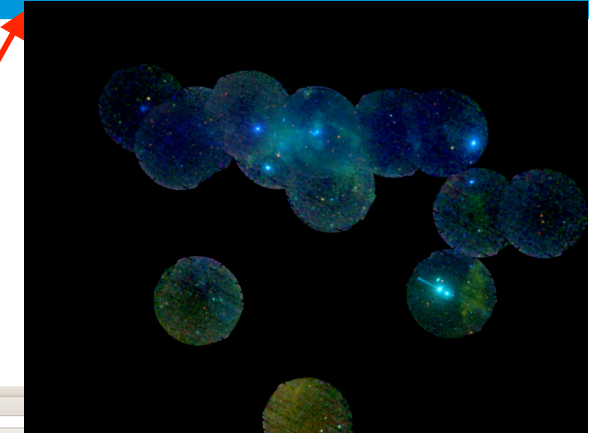
Bulk reprocessing will take place in 2019 ... 4XMM

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

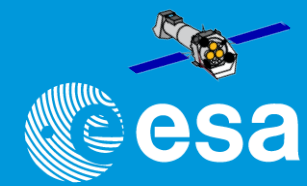
Where is the XMM-Newton data? In XSA

Contents of the XSA:

- ODF/PPS of ~ 14000 pointed observations
- SDF of ~ 4,000 slew observations
- SDF of ~ 200,000 Slew Survey sub-exposures
- 775.153 detections (3XMM-DR8 catalogue) / 531.454 unique sources
- 6.880.116 OM sources (XMMOM SUSS 3 catalogue)
- 72352 Slew Survey sources (XMMSL2)



How to get XMM-Newton data? The XSA



XMM-Newton Science Archive

HOME SEARCH AIO SYSTEM CATALOGUES AND TOOLS DOCUMENTATION USER GUIDE CONTACT

XMM-Newton Science Archive Search

Position File

Name Equatorial Galactic Ecliptic

Target in Field of View Circle Box

Name M51 for Simbad

M51 resolved by Simbad

Observation and Proposal filters

Observation ID

Start Time between

Target Type

HOME SEARCH COMMAND & URL ACCESS INTERACTIVE ANALYSIS TA

Back to Search Close all

Results #1

OBSERVATIONS (10)

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

			Obs.ID	EPIC	RGS	ESASky	Target	RA	DEC	Rev	Distance	Start Date	End Date	
<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	2
<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	4
<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	5
<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	3
<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	9
<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	6
<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	6
<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	7
<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	1

1 of 1 Page size: 100

Displaying 1-10 of 10

Postcard Preview

Interactive Analysis Save/Open as Send Image to

P0112840201EPX000IMAGE8000_FIT

Flux (10⁻¹⁴ W/m²/Å)

Selection expr: ID_BAND==0 & ID_INSTR==0
Number of sources: all 140 selected.
Radii: fixed.

Postcard Preview

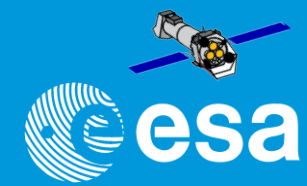
Save/Open as Send Spectrum to

Source 3 RGS Fluxed Spectrum (product:P0112840201RGX000FLUXED1003)

Fluxed Counts (Photons/cm²s/Angstrom)

Wavelength (Angstroms)

Processing from XSA (using RISA)



XMM-Newton Science Archive

HOME SEARCH COMMAND & URL ACCESS INTERACTIVE ANALYSIS TAP QUERIES

Back to Search

Back to Results

Interactive Analysis RGS - Spectra Visualization



File Edit View Zoom Scale Color Regions WCS Analysis
Help

000 13:28:35.156 +46:57:04.42 (FK5) 40920.000 6200.000 (physical)

Obs Id 0112840201
Instrument EPN
Exposure S002
View background flaring Plot
Flag --
Pattern --
PI (eV) -
Product Type Spectra
Centre & optimize src region
Get JS9 Source Edit source region in JS9
Reset Form

File Edit View Zoom Scale Color Regions WCS Analysis
Help

001 13:28:44.351 +47:06:04.76 (FK5) 39000.000 17000.000 (physical)

Obs Id 0112840201
Instrument EPN
Exposure S002
View background flaring Plot
Flag 0
Pattern <=4
PI (eV) 500 - 2000
Product Type Spectra
Centre & optimize src region
Get JS9 Source circle(23720.00, 28760.00, 1144.16)
Get JS9 Background circle(21640.00, 30840.00, 1253.34)
Reset Form

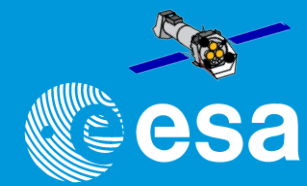
Submit

File Edit View Zoom Scale Color Regions WCS Analysis
Help

001 13:28:44.351 +47:06:04.76 (FK5) 39000.000 17000.000 (physical)

0.3 1.0 2.3 4.8 10.0 20.1 40.4 81.2 161.9

All the individual sources detected



XMM-Newton Science Archive

HOME SEARCH COMMAND & URL ACCESS INTERACTIVE ANALYSIS TAP QUERIES

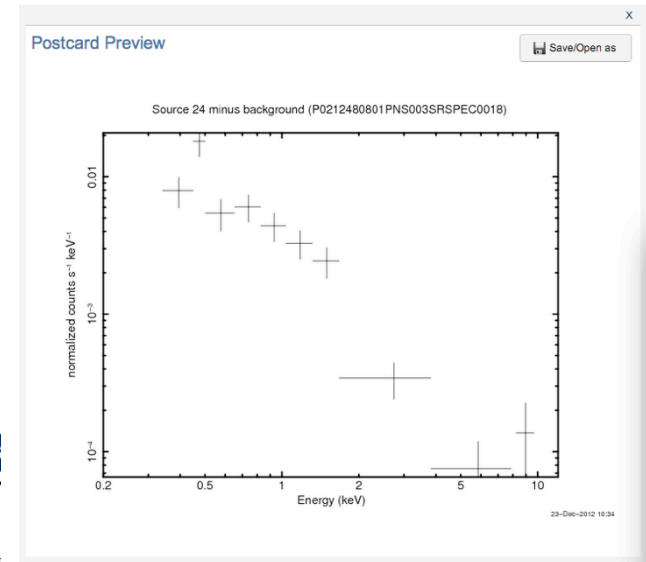
Back to Search Close all

Results #1 Results #2 Results #3

OBSERVATIONS (1) EXPOSURES (10) EPIC PPS SOURCES (145) OM PPS SOURCES (562) 3XMM-DR8 CAT (145) OM SOURCE CAT (714) PUBLICATIONS (57) PROPOSALS (1)

Columns Column units Display selected Save table as Send table to Source Repr.

ObsID	Src Nu	RA	DEC	Pos.Err	Det ML	Img	FC	LC	Spec	ESAsky	Total Flux	Tot.Flux.Err	Tot Count Rate	Tot Count Rate	Src Ext	Src Ext Err
0112840201	50	13h 30m 28.68s	+47d 16' 03.5"	0.8	120	N/A		N/A	N/A		1.93E-14	5.72E-15	0.0113	1.23E-03	0.0	
0112840201	143	13h 28m 58.42s	+47d 11' 49.8"	2.1	11	N/A		N/A	N/A		7.84E-15	5.05E-15	0.0053	1.33E-03	0.0	
0112840201	3	13h 29m 39.78s	+47d 12' 39.0"	0.2	5131	N/A		N/A	N/A		2.06E-13	8.15E-15	0.1606	3.66E-03	0.0	
0112840201	91	13h 30m 05.24s	+47d 04' 34.4"	1.3	35	N/A		N/A	N/A		1.47E-14	6.27E-15	0.0068	1.12E-03	0.0	
0112840201	46	13h 30m 04.68s	+47d 14' 16.4"	1.2	12	N/A		N/A	N/A		1.24E-14	3.69E-15	0.0038	8.16E-04	0.0	
0112840201	23	13h 29m 58.26s	+47d 13' 20.7"	1.3	8	N/A		N/A	N/A		7.03E-15	2.59E-15	0.0034	9.38E-04	0.0	
0112840201	103	13h 29m 07.55s	+47d 21' 36.7"	1.4	20	N/A		N/A	N/A		1.85E-14	1.06E-14	0.0097	1.95E-03	0.0	
0112840201	95	13h 29m 44.26s	+47d 25' 54.0"	1.6	32	N/A		N/A	N/A		3.04E-14	1.74E-14	0.0069	1.36E-03	0.0	
0112840201	137	13h 28m 35.73s	+47d 17' 35.0"	1.9	8	N/A		N/A	N/A		1.92E-14	2.04E-14	0.0091	2.89E-03	0.0	



XMM-Newton Science Archive

HOME SEARCH COMMAND & URL ACCESS INTERACTIVE ANALYSIS TAP QUERIES

Back to Search Close all

Results #1 Results #2 Results #3

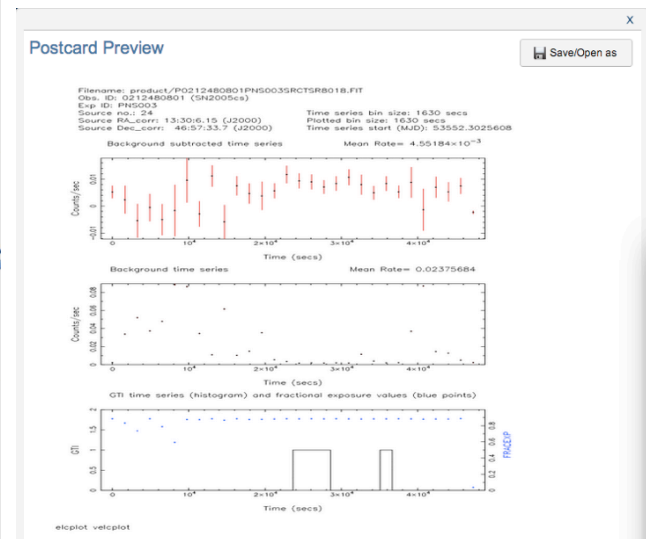
OBSERVATIONS (1) EXPOSURES (10) EPIC PPS SOURCES (145) OM PPS SOURCES (562) 3XMM-DR8 CAT (145) OM SOURCE CAT (714) PUBLICATIONS (57) PROPOSALS (1)

Columns Column units Display selected Save table as Send table to

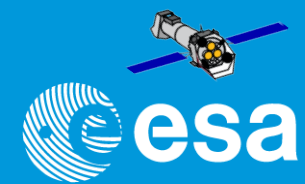
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0112840201	3XMM J133051.9+471629	13h 30m 52.31s	+47d 16' 31.0"	2.3	17	Good				N/A	N/A		6.90E-03	1.44E-03	2.23E-14	1.03E-14	3.42E-16
0112840201	3XMM J133047.8+471442	13h 30m 47.82s	+47d 14' 42.6"	2.1	8	Good				N/A	N/A		4.44E-03	1.16E-03	1.96E-14	9.27E-15	8.57E-16
0112840201	3XMM J133044.2+470359	13h 30m 44.27s	+47d 03' 59.4"	0.7	628	Good				N/A	N/A		4.81E-02	2.88E-03	7.30E-14	1.25E-14	1.30E-14
0112840201	3XMM J133043.8+471621	13h 30m 43.80s	+47d 16' 22.6"	1.1	69	Good				N/A	N/A		9.50E-03	1.31E-03	1.00E-14	4.70E-15	1.17E-15
0112840201	3XMM J133037.3+471602	13h 30m 37.52s	+47d 16' 02.9"	1.6	10	Good				N/A	N/A		4.28E-03	1.07E-03	5.82E-15	4.51E-15	6.20E-16
0112840201	3XMM J133037.3+472305	13h 30m 37.37s	+47d 23' 05.4"	2.8	42	Good				N/A	N/A		1.43E-02	2.25E-03	8.60E-14	4.06E-14	8.90E-15
0112840201	3XMM J133036.2+471322	13h 30m 36.24s	+47d 13' 20.9"	2.0	6	Suspect parameters				N/A	N/A		9.11E-03	3.45E-03	1.15E-14	6.93E-15	0.00E00
0112840201	3XMM J133035.5+470630	13h 30m 35.52s	+47d 06' 30.4"	1.5	16	Good				N/A	N/A		5.08E-03	1.05E-03	1.06E-14	5.62E-15	1.23E-15
0112840201	3XMM J133033.9+472015	13h 30m 33.96s	+47d 20' 14.6"	1.6	12	Good				N/A	N/A		5.34E-03	1.34E-03	1.97E-14	9.20E-15	1.03E-16
0112840201	3XMM J133033.9+470943	13h 30m 33.89s	+47d 09' 42.4"	1.3	51	Suspect parameters				N/A	N/A		1.14E-02	2.66E-03	2.81E-14	1.12E-14	2.77E-15
0112840201	3XMM J133033.4+471638	13h 30m 33.49s	+47d 16' 36.1"	2.5	50	Good				N/A	N/A		1.69E-02	2.20E-03	2.27E-14	1.22E-14	4.14E-15
0112840201	3XMM J133032.7+471335	13h 30m 32.81s	+47d 13' 35.1"	0.8	208	Good				N/A	N/A		1.65E-02	1.51E-03	3.44E-14	7.97E-15	2.90E-15
0112840201	3XMM J133032.5+472305	13h 30m 32.56s	+47d 23' 05.8"	1.7	14	Good				N/A	N/A		4.14E-03	1.17E-03	4.56E-14	2.64E-14	2.46E-16
0112840201	3XMM J133030.8+472218	13h 30m 30.80s	+47d 22' 19.2"	0.8	290	Good				N/A	N/A		3.35E-02	2.68E-03	4.93E-14	1.03E-14	8.50E-15
0112840201	3XMM J133029.1+471139	13h 30m 29.31s	+47d 11' 37.2"	2.0	14	Good				N/A	N/A		4.45E-03	1.03E-03	1.06E-14	4.70E-15	7.44E-18
0112840201	3XMM J133029.1+471429	13h 30m 29.23s	+47d 14' 29.0"	1.0	91	Good				N/A	N/A		1.07E-02	1.30E-03	2.39E-14	6.22E-15	1.89E-15

1 of 2 Page size: 100

Displaying 1-100 of 145



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:

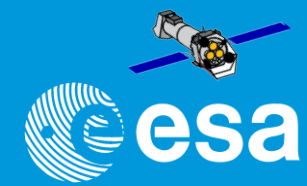
*R1*EVENTLI* / *R2*EVENTLI* are the event list files in PPS and PROC
*R1*SRCLI* / *R2*SRCLI* are the source list files in PPS and PROC
SRSPEC are the source subtracted spectra in PPS and PROC
Response matrices are products in PROC (*Matrix*), as well as fluxed spectra (*fluxed*)
Intermediate RGS products 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



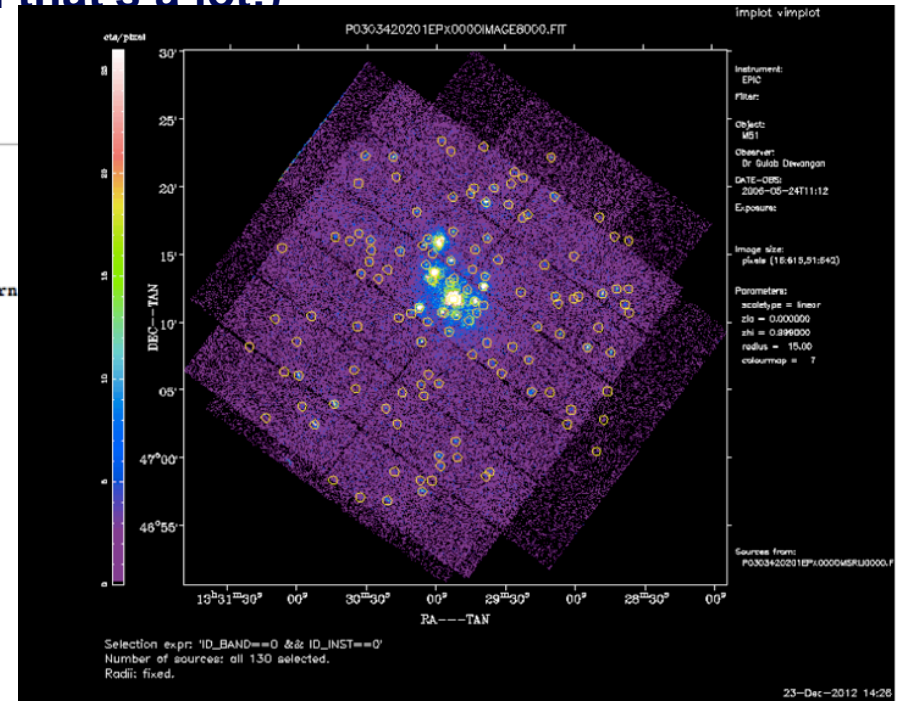
PPS Index Summary can help a lot to recognize correspondence FileType <-> FileName
 ... but also to find everything produced by PPS (and that's a lot!)



[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						



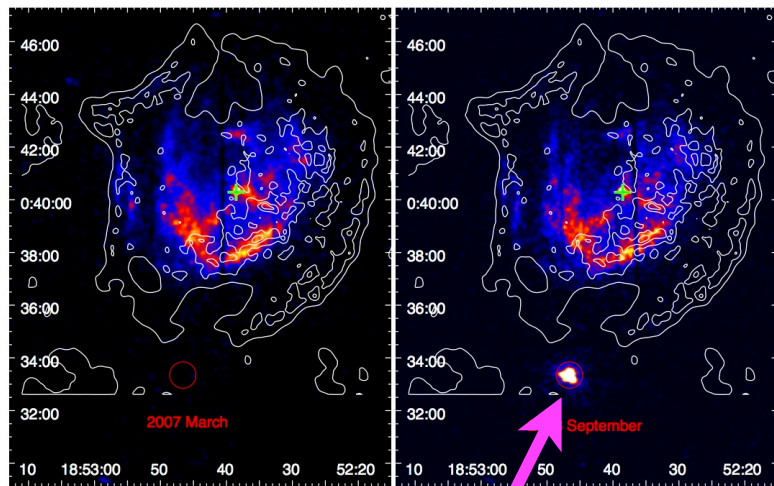
Source	Inst.	Exp. Id	RA	Dec	RADEC Err	Count	Band 8 Flux	EPIC Det ML	Inst. Det ML	Overtime	EPIC Extent	EPIC Flags	Srcdet
1 (001)	EPN	S003	13 29 52.54	47 11 44.6	0.2	12549.8 ±138.9	1.5e-12 ±3.32e-14	50374	22575	22545	2 ±0	FFFFFFFFFFFF	Y
Filename			Content			Band							
P0303420201PNS003SRSPEC0001.FTZ			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										

Importance of archive + S/W analysis capabilities

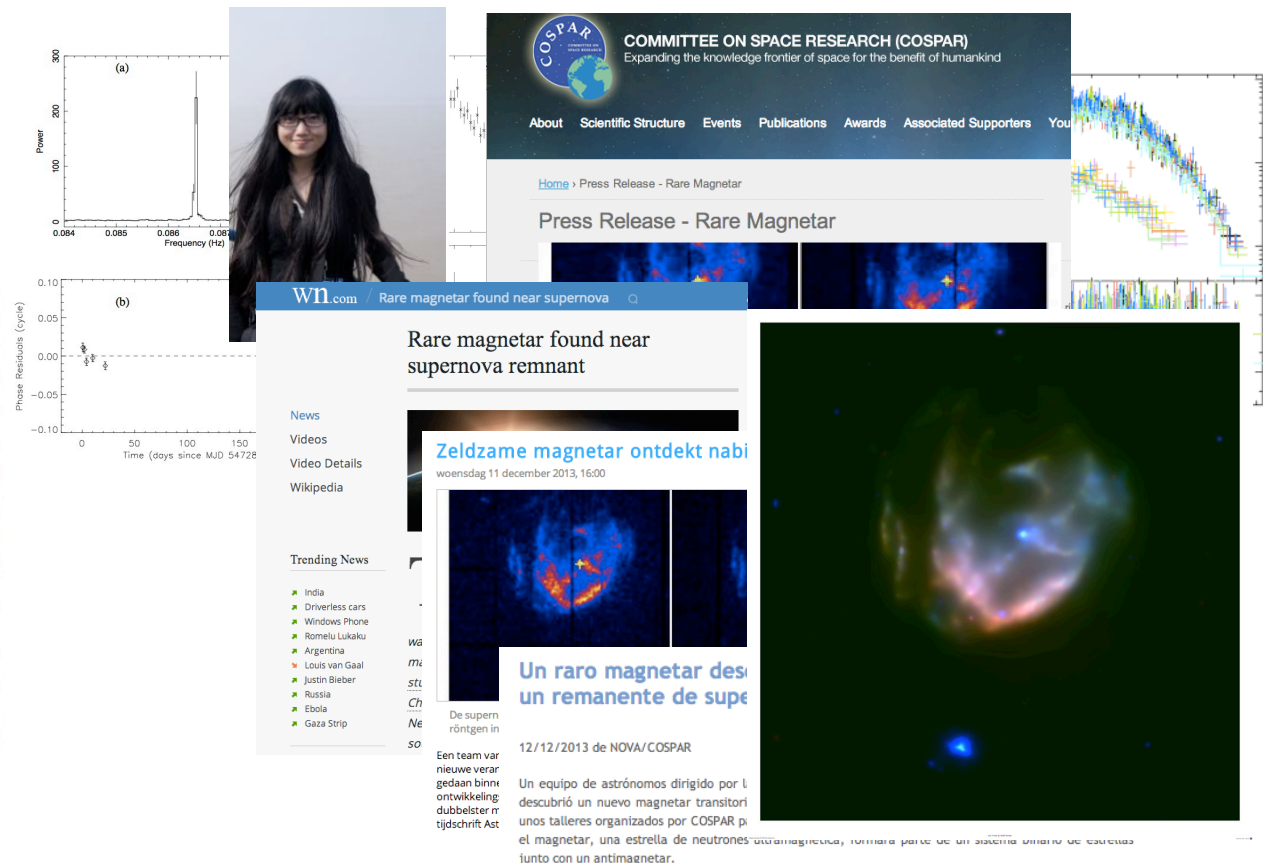
Is **deep** access to data needed after a mission is over?

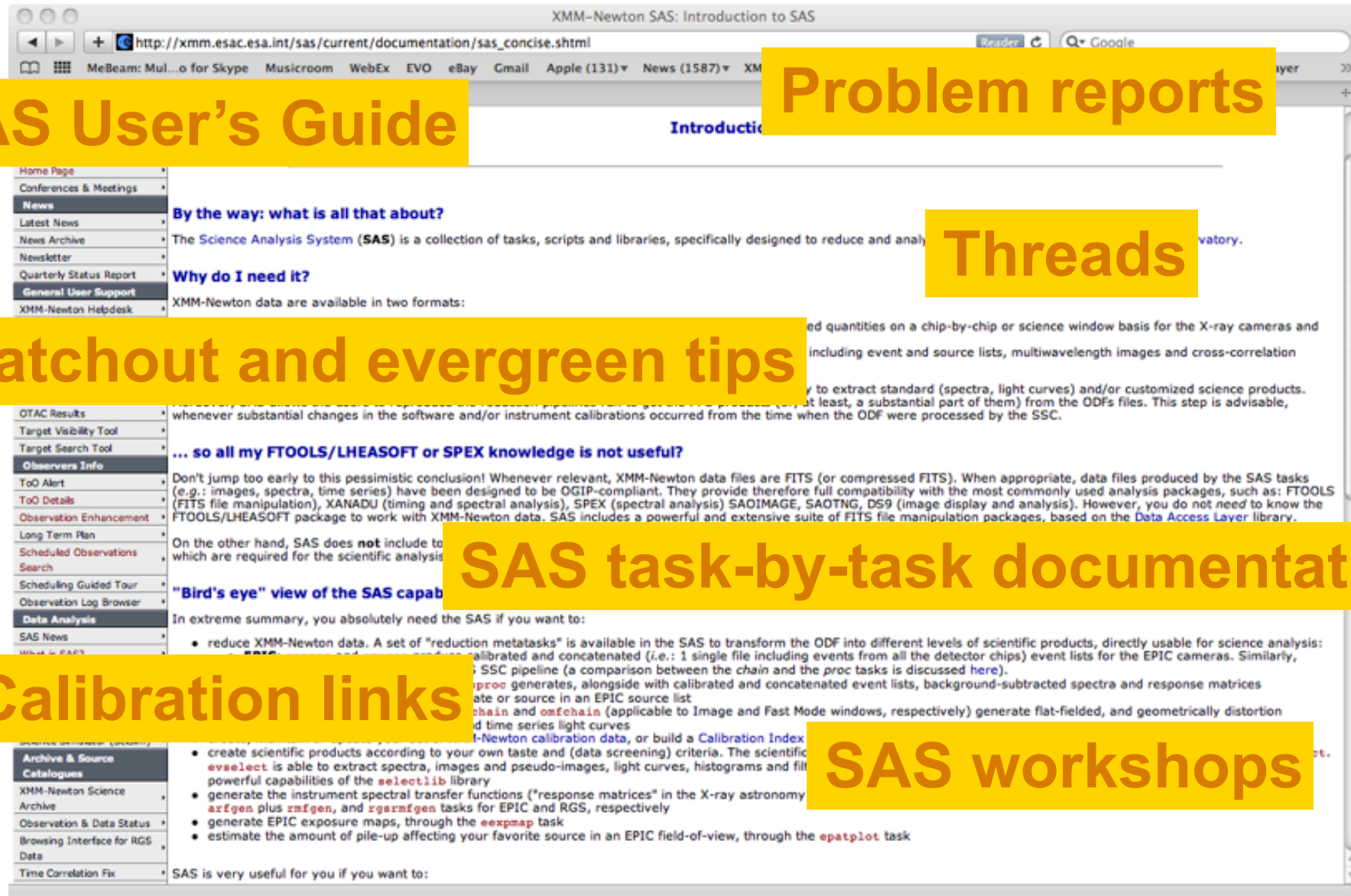
- data flood - only a certain percentage of the data acquired gets properly analysed
- data analysis tools are a major part of archival research
- data combination ... data extension ... evolution of processing techniques ...
- ...

Transient magnetar discovered in archival data / identified in a COSPAR Workshop by a student 5 years after data taken & published



3XMM J185246.6+003317





The screenshot shows the XMM-Newton SAS documentation website. Several sections are highlighted with yellow boxes:

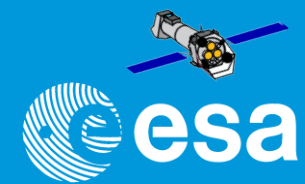
- SAS User's Guide**: Located in the top left, covering the introductory part of the documentation.
- Problem reports**: Located in the top right, pointing to a section on the page.
- Threads**: Located in the middle right, pointing to a section on the page.
- Watchout and evergreen tips**: Located in the middle left, pointing to a section on the page.
- SAS task-by-task documentation**: A large box at the bottom right, covering the main content area.
- Calibration links**: Located in the bottom left, pointing to a section on the page.
- SAS workshops**: Located in the bottom right, pointing to a section on the page.

The page content includes a navigation menu on the left, a main text area with sections like "By the way: what is all that about?", "Why do I need it?", and "Bird's eye" view of the SAS capabilities, and a list of bullet points at the bottom.

... 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

Shaping the SAS future: 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

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)

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:

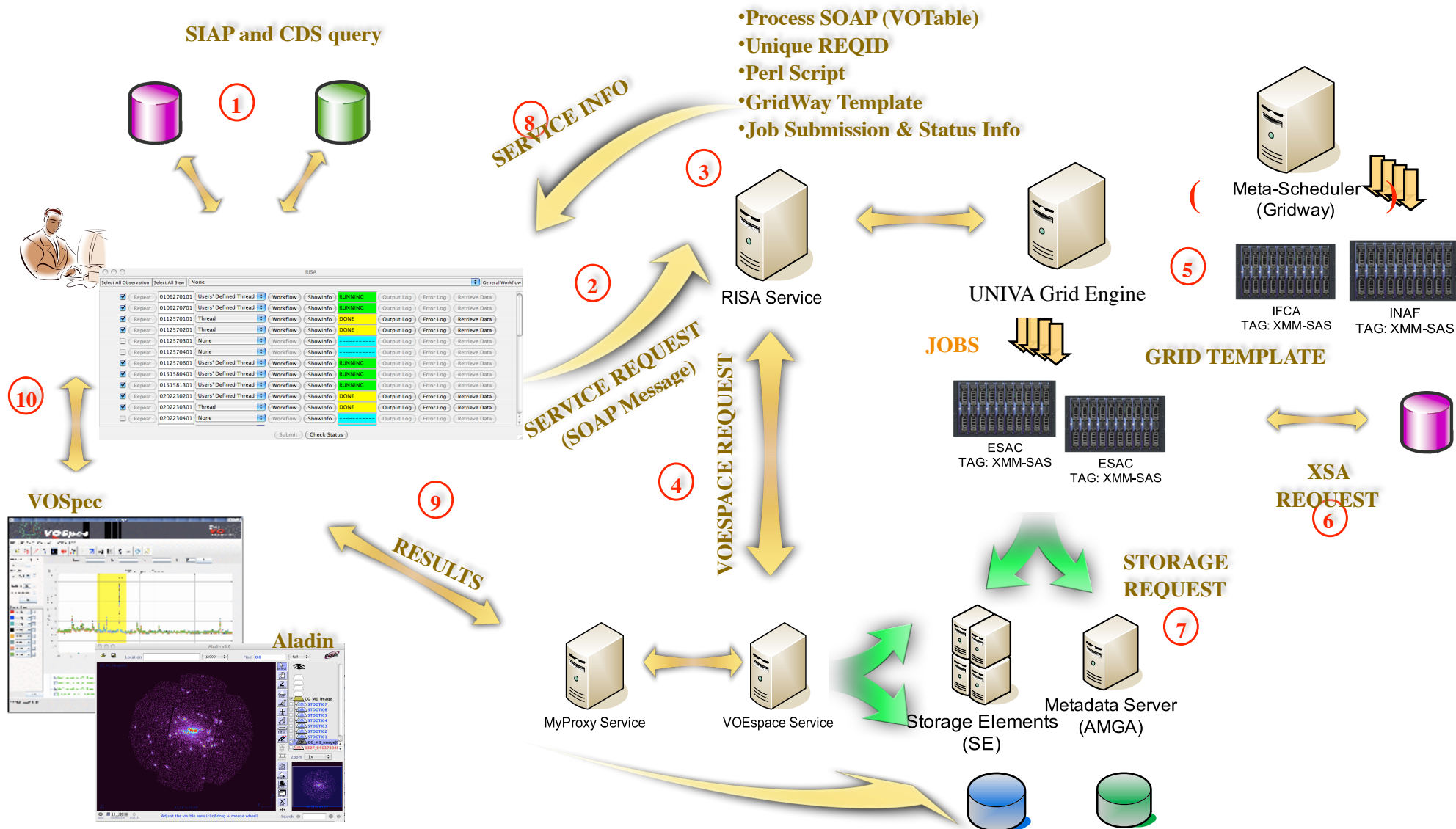
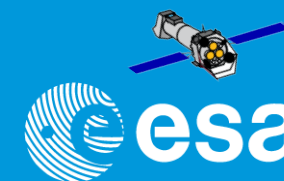
- no own scripting possible ...
"only" SAS workflows

but

... FTOOLS could be added

... other "certified" S/W

Remote Interface for Science Analysis (RISA)



Working with RISA



Define workflow, set SAS tasks parameter

Search data

XSA Access (AIOClient)

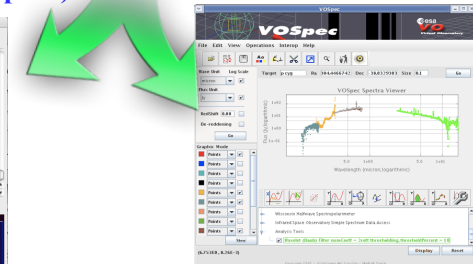
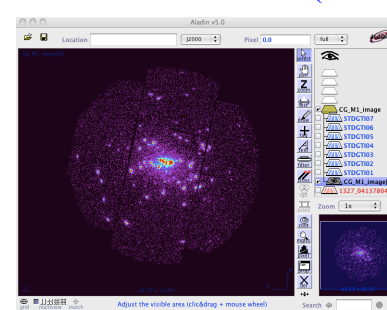
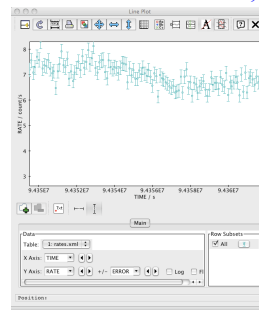
Let the GRID work (Web Service + GridWay)

Choose data, get info (SIAP)



“VO” Access results, retrieve data for local work (VOEspace)

Start web service



RISA β version released years ago... but not yet public

- showing full analysis capabilities, full access to all parameters
massive processing capability << ---- >> highest granularity
- several configurable “pipelines” integrated in the system
- processing start at ODF or PPS level
- documentation written as “threads”

Main lines of development:

- services to be integrated into the next XSA version (on-the-fly reprocessing, +++)
- more user friendly / intuitive GUI
- “light” RISA services
(mini-pipelines for fast response)
- combination of observations

Advantages:

- reduction of maintenance to single OS
 - ideal for processing large amounts of data
 - complement for archive >> on-the-fly reprocessing
 - sizeable according to needs
- >> 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)