ESAS into SAS

Carlos GABRIEL & Aitor IBARRA

XMM-Newton Science Operations Centre – ESAC / ESA

What is ESAS?

- Extended Source Analysis Software (ESAS):
  * package for the analysis of EPIC **MOS** and **pn** observations (by SS & KK),
    [suited especially for analysis of extended sources and **diffuse background**]

- ESAS includes routines creating
  * source and model quiescent particle background spectra and
  * exposure-corrected, background-subtracted (particle and soft proton) images

- Spectra and images produced for user-defined regions within the FOV

+ software for mosaicking multiple (not necessarily co-aligned) observations

Whole package composed of f77 routines, Perl scripts and FITS calibration files

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ESAS integration into SAS

Motivation:

- ease and secure the future maintenance,
- avoid diverging development,
- immediate profit on both development sides,
- make it **more comfortable** to users.

ESAS integrated in SAS as single package (esas)

>> all programs and scripts included (called individually),

>> should be complemented with workflow

> Integration performed mainly by Aitor

> future maintenance (of "new" code) by Steve in SAS environment

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Integration of f77 code

- Integration through Fortran-90 wrappers

- every f77 routine called through a corresponding F90 module,
- F90 code in charge of setting up SAS I/F (param files) and call routine,
  >> mapping of "old" ESAS parameters to new SAS param file.

- F90 wrapper

- checks standard SAS environment variables,
- use of all the standard SAS functionalities (-p, -d, -version),
- replace f77 compiler with NAG F95 compiler,
- minor changes done during this process (data types and initializations).

>> GUI for each of the executables

>> solidity of S/W

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Integration of Perl code

- ESAS contains a set of perl scripts and binaries
- The perl scripts call several SAS tasks (evselect, eexpmap, …) and also native ESAS binaries
- param and lyt files added to original Perl modules >> SAS like

- ESAS processing = perl scripts + f77 calls + ftools calls.

"ESAS chain"

We can easily implement this processing chain as a new workflow inside "psechain"

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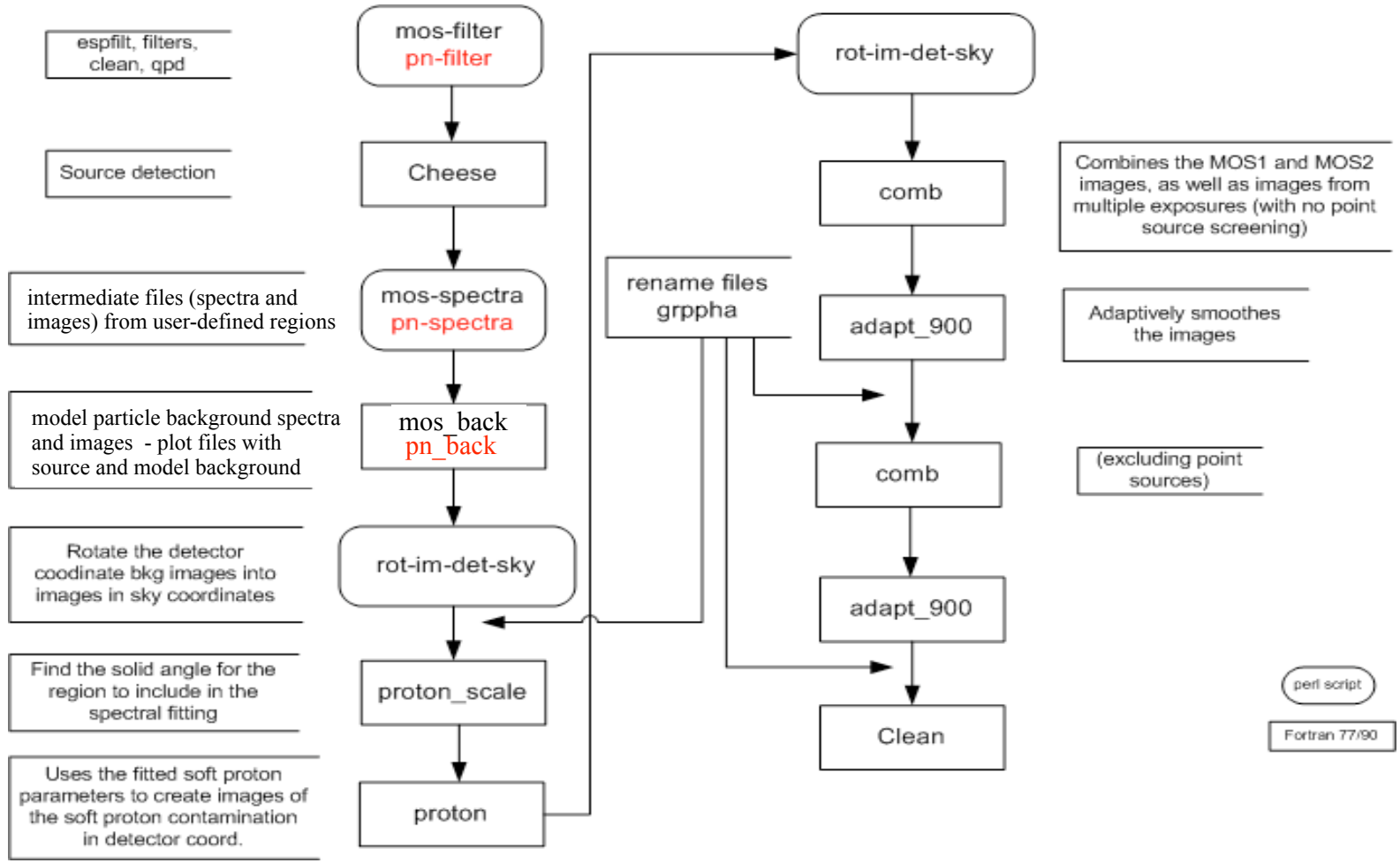
ESAS workflow scheme



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ESAS workflow scheme 1x1: Xfilter

Originally running cifbuild, odfingest + e[m][p]chain

In esas, just taking event files from emchain (emproc in near future)

>> espfilt : light curve filtering through count rate histogram

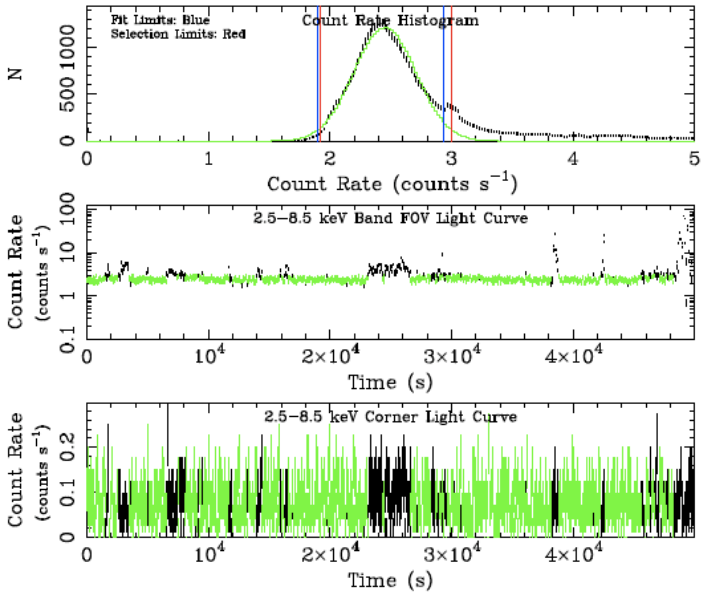
Output:

>> eg. mos1S001-clean.fits pnS003-clean.fits

>> qdp file showing selection (and quality)

>> mos'prefix'-obj-image-det-soft.fits

=[0.2-0.9] keV image for finding anomalous state mos CCDs



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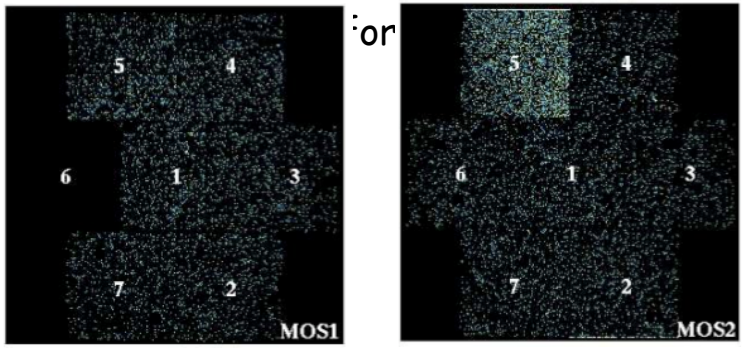

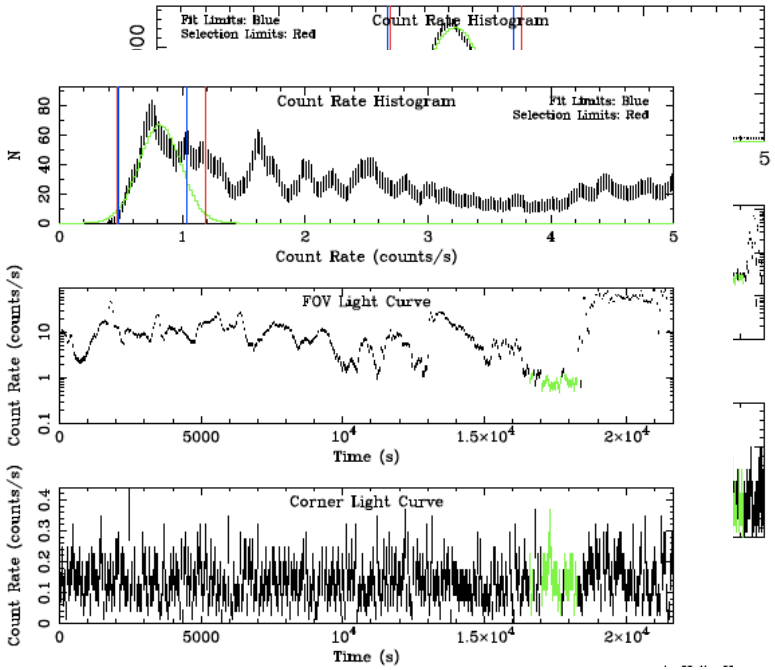

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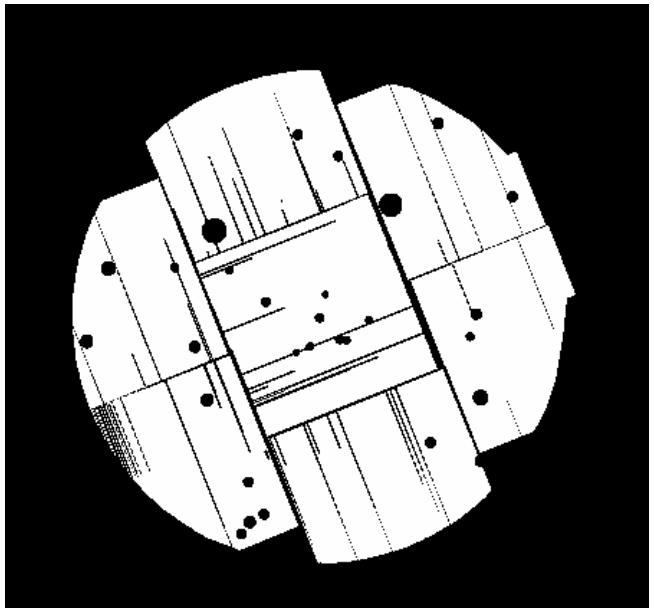
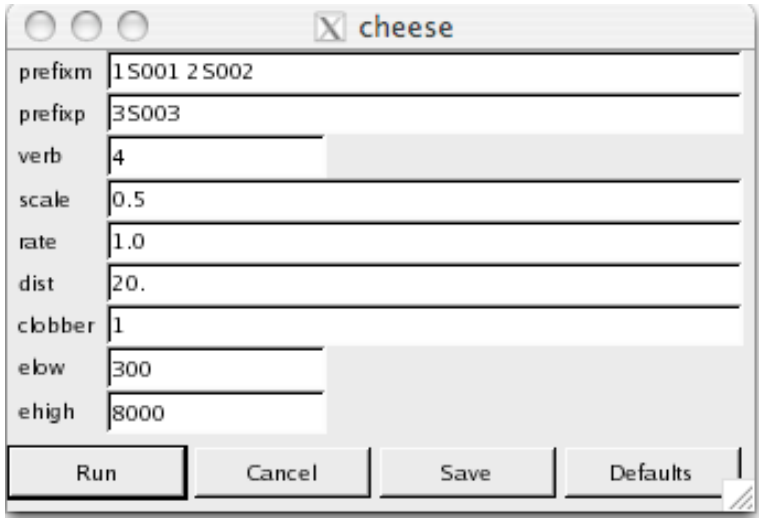
ESAS workflow 1x1: point sources

Running source detection for excising sources from spectra and images





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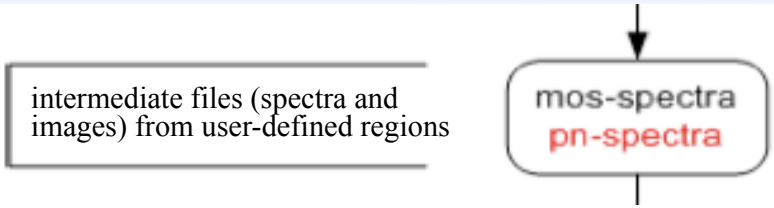
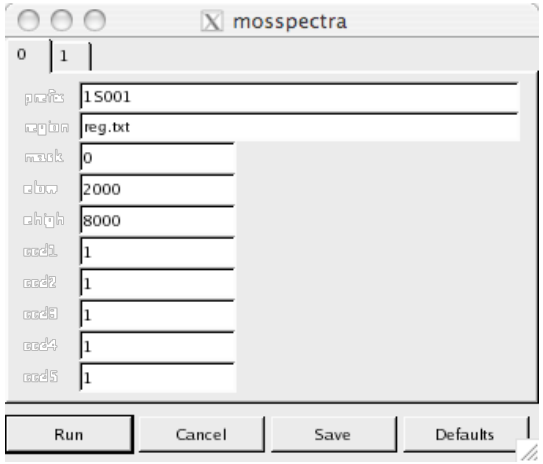
ESAS workflow 1x1: [mos][pn]spectra



produce intermediate files (spectra and images) from user-defined regions + RMFs, ARFs and exposure maps



empty region >> full FOV

- Use of filter-wheel closed calibration files for producing spectrum from selected region
- corner spectrum from observation and from fwc data also produced
- for PN data also OOT data processing in addition to normal data processing

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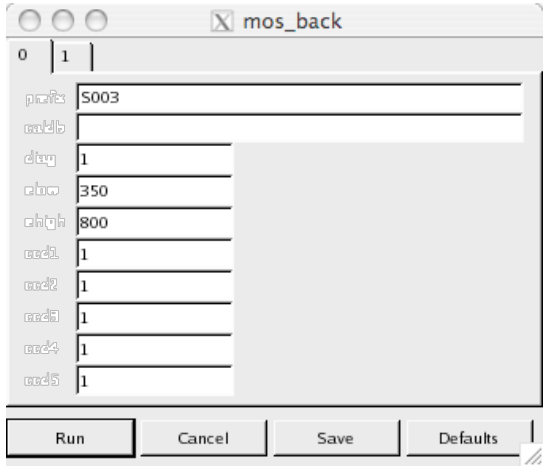
ESAS workflow 1x1: [mos][pn]back

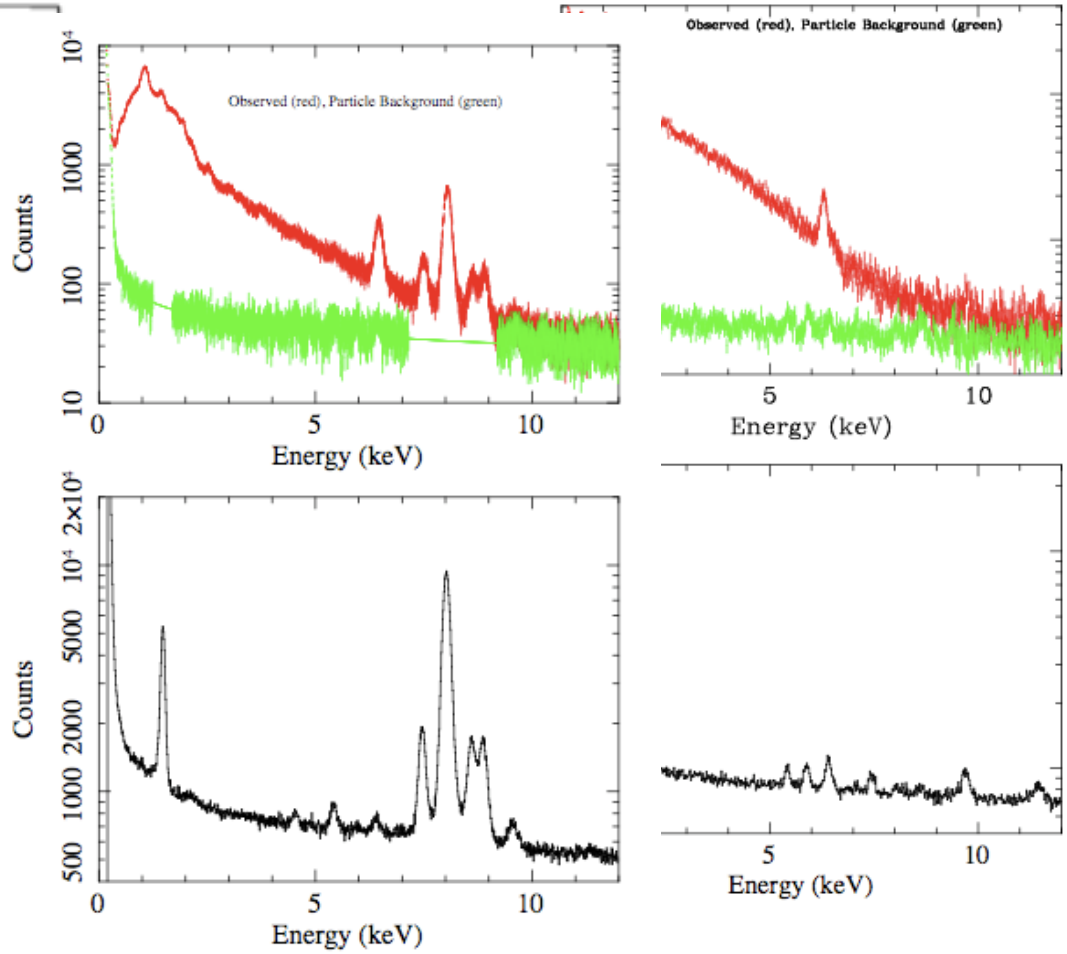
model particle background spectra and images - plot files with source and model background

mos_back
pn_back

creation of model particle backgr
and images for the selected regic

>> use of qpb files from CALDB





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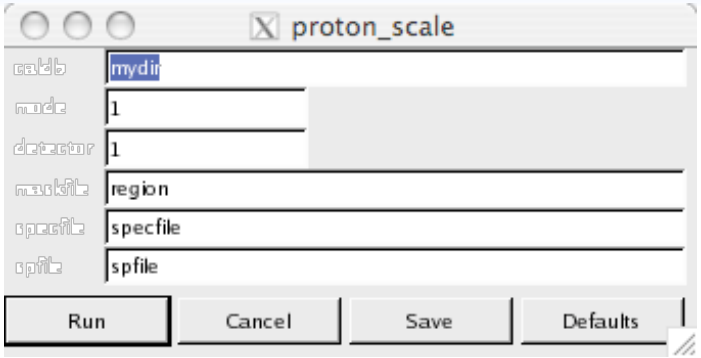
ESAS workflow 1x1: proton & -scale

Find the solid angle for the region to include in the spectral fitting

proton_scale

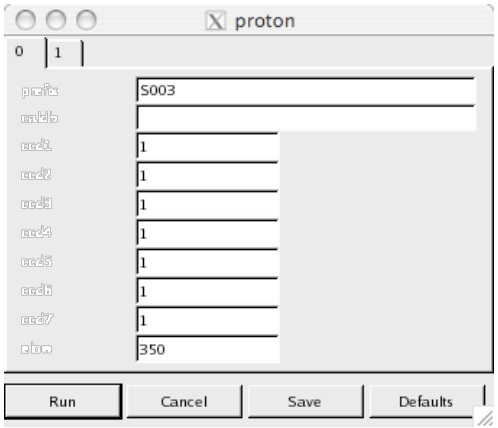


preparation for soft proton background determination >> spectral parameters for soft proton contamination

>> solid angle for the region to be included in spectral fitting: proton_scale

Uses the fitted soft proton parameters to create images of the soft proton contamination in detector coord.

proton



soft proton contamination maps from model sp detector maps + spectral fitting results: proton

+ use of rot-im-det-sky to get image in sky coordinates

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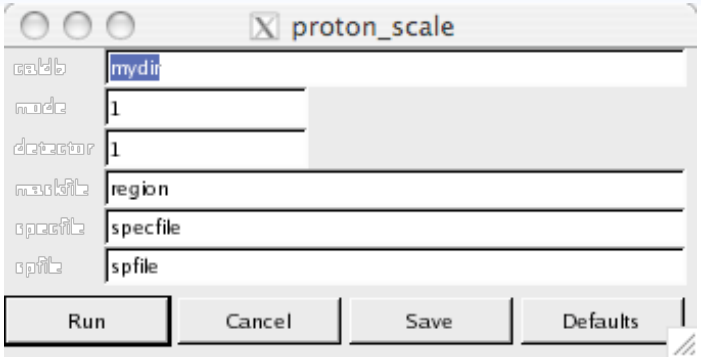

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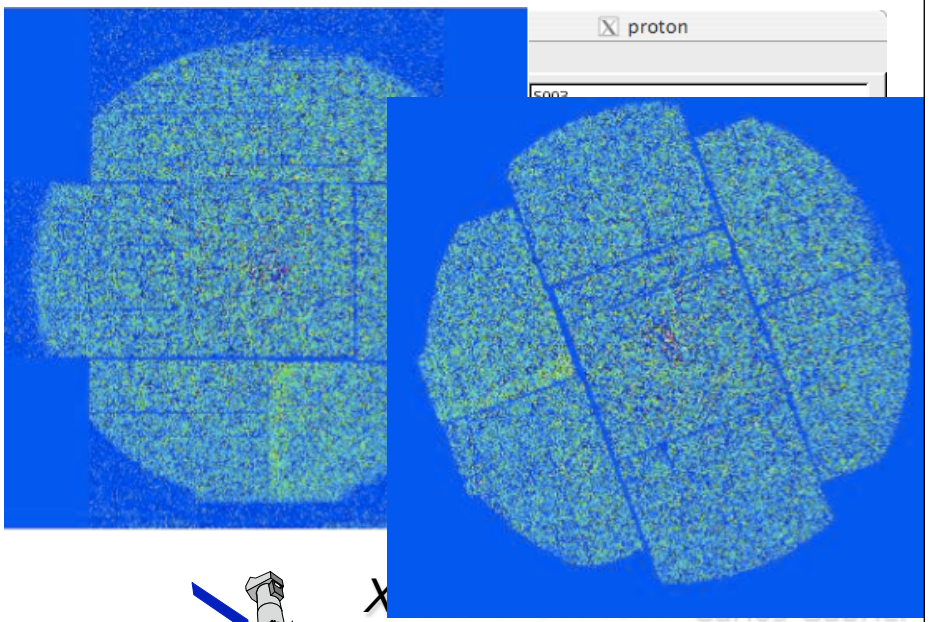

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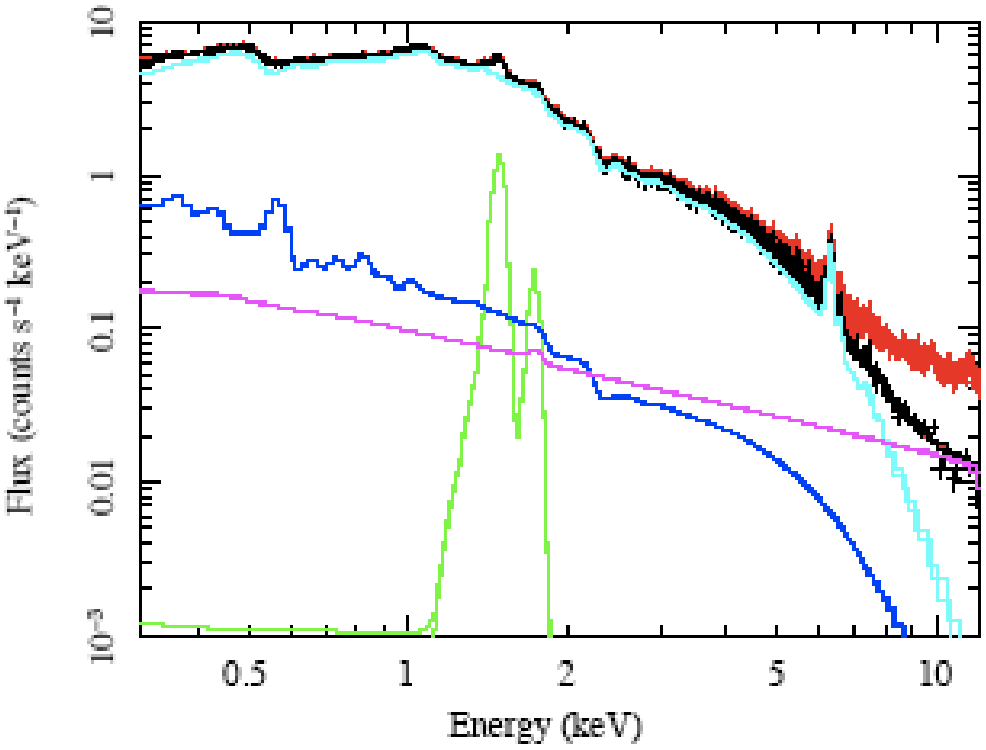
Spectral analysis - outside ESAS

Spectral analysis is not a specific part of ESAS, but it is providing input and using the output of the analysis - here performed through Xspec



background subtracted and fitted spectrum
observed spectrum
fitted cluster spectrum
fitted cosmic background spectrum
fitted soft proton component
Al Kα and Si Kα instrumental lines

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

from SS & KK Cookbook

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

AND

K. D. KUNTZ
Johns Hopkins University, Baltimore, MD
kuntz@milkyway.gsfc.nasa.gov

XMM-Newton Carlos Gabriel
Astronomy Science Operations Division
Science Operations Department

ESAS calibration files

- Set of calibration files.

– Filter wheel closed data: per instrument and CCD (including diverse quality) = 26+
- Quiescent particle background data: per instrument and CCD = 26
- SP flare data: per instrument and filter * 6 levels + expmap = 63

>> need of simplification of calibration files (Kip's proposal?)

>> future of CALDB into CCF ??

>> access of calibration data through DAL instead of ftools?
>> implies re-writing f77 code

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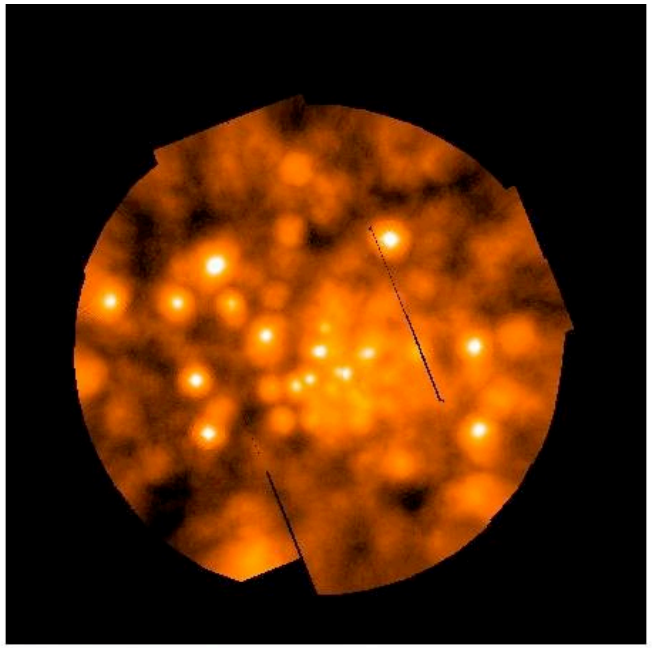
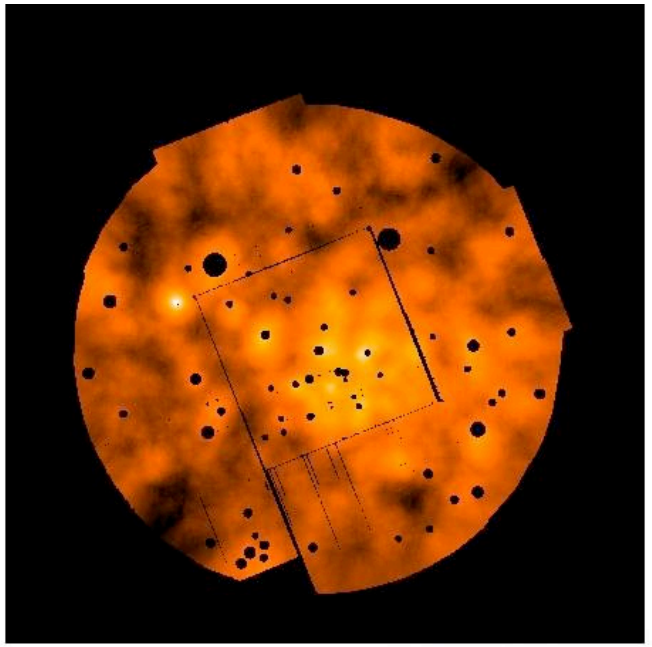
Tests going on

Test run on M101 (obsid: 0104260101,0212480201) locally

SS reports some issue with source detection ... working on it





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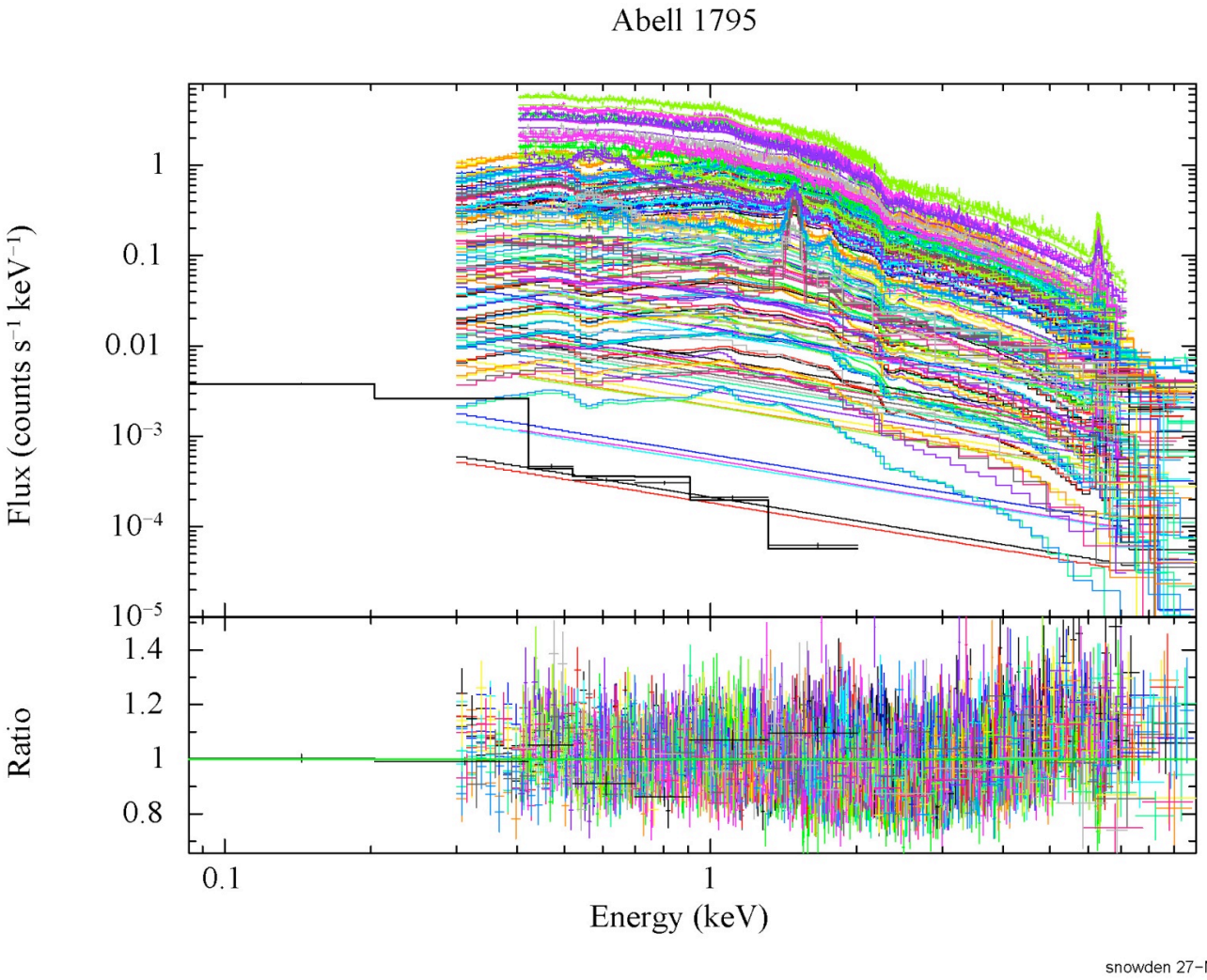
from SS:

PN in ESAS

- PN software nearly complete
  - Needs testing on additional data sets
  - Possible over-estimation of background
  - Data probably not useful below ~0.4 keV or above 7.2 keV

from SS:



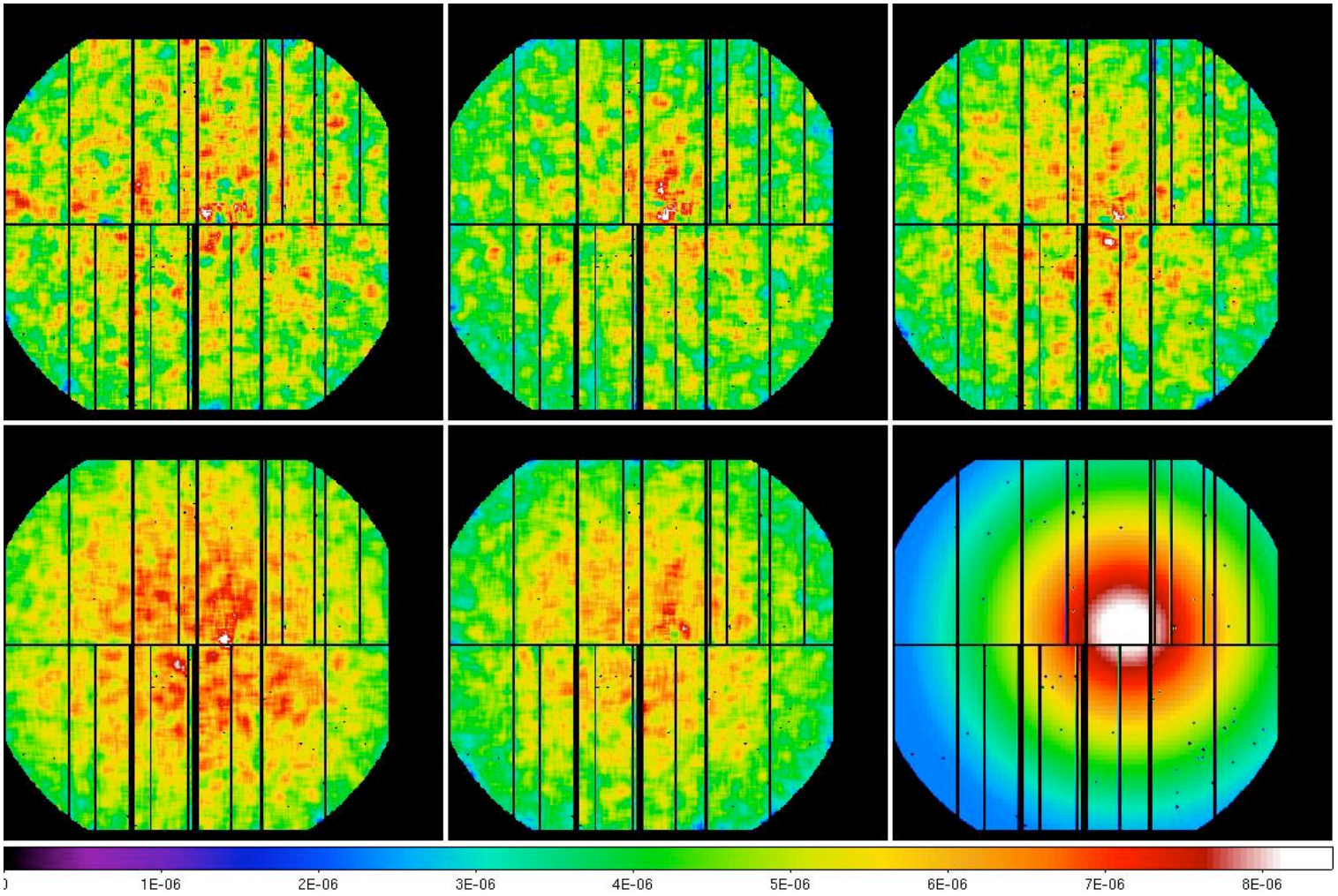
Priogress on ESAS for the PN model particle background.

Radial profile spectral fit of Abell 1795 using 10 annuli and a RASS spectrum.

χ^2_ν~1.5 for 7829 DOF

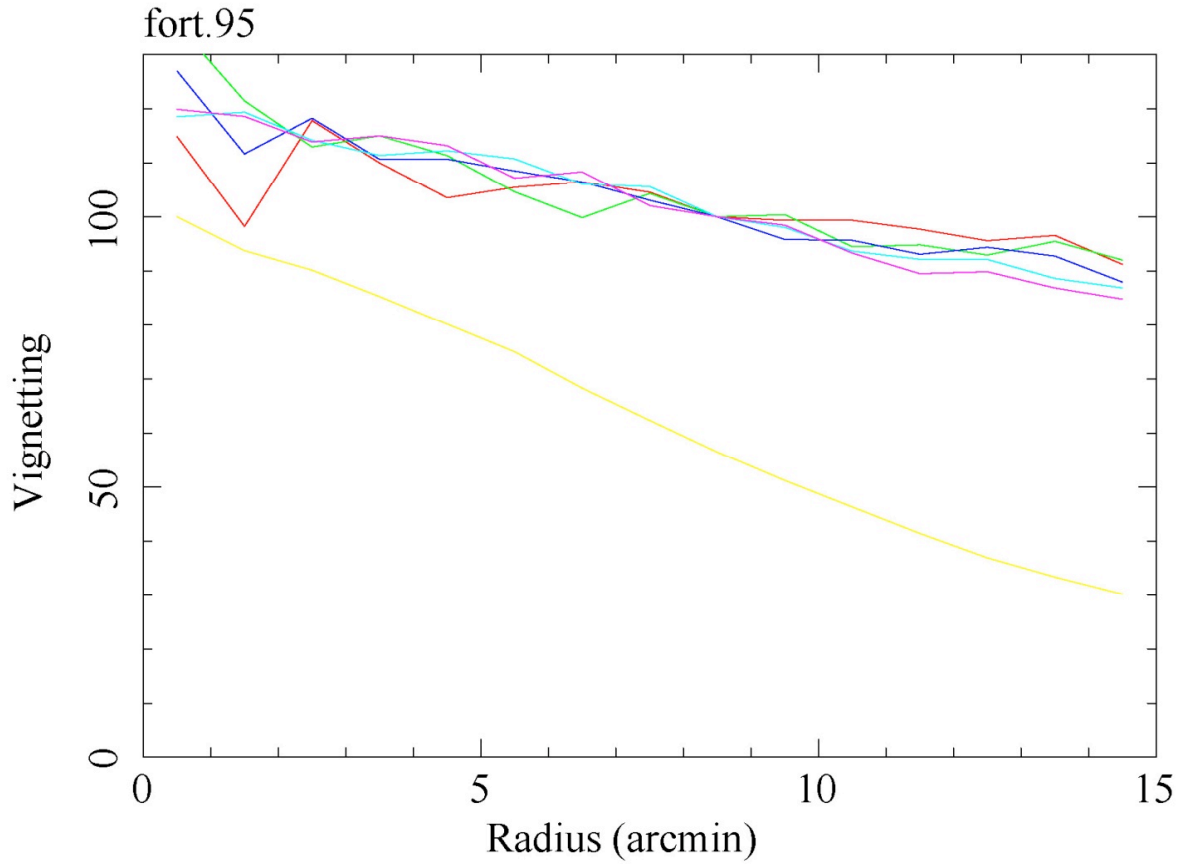
from SS: PN Soft Proton Vignetting

Instrument maps from low to high energy with
an exposure map for reverence



from SS: PN Soft Proton Vignetting

Radial profiles, again with photon vignetting



Future work

- Finish testing both in ESAC and GSFC, incl. PN upgrade (needed for SAS 9)
- Document the single tasks (needed for SAS 9)
- Transform the CALDB files into CCF, following simplification (SAS 10)
- Upgrade ESAS error and warning messages >> standard SAS msg (SAS 10)
- Replace low level cfitsio call for dal calls ?
  - not possible in f77 >> coding everything in F90 ?
- ESAS workflow to be implemented into "psechain" (SAS 9 / SAS 10)
- Inclusion of test-harness cases (SAS 9 / SAS 10)

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