Handbook of the screening tool

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1 Introduction

The screening tool is a Graphical User Interface (GUI) that allows a quick visualisation and screening of the XMM-Newton pipeline products (PPS) as well as the XMM-Newton catalogue. The GUI is written in `Python` and uses several modules including `matplotlib` to display plots and graphics, and `pyfits` to read and handle fits files. It has an interface to the SAOImage `ds9` application (`ds9.si.edu`) for image display. The tool is able to display the (scientific and auxiliary) images produced by the XMM-Newton pipeline as well as light curves and spectra of the brightest sources. Long term light curves (including hardness-ratios) can be displayed using the information from the XMM-Newton catalogue.

The last version of the software is available at `http://www.mpe.mpg.de/~scarpano/screening.html`. Both files `screening.py` (main code) and `screening.py` (containing additional routines) are required. Note that before launching the program one must edit the `screening.py` file to indicate the path to the directory containing the XMM-Newton PPS via the `root_dir` parameter (ex:`/home/user/XMMdata/`) appearing at the top of the code. This directory should list the observation IDs with `/pps` as subdirectories (ex:`/home/user/XMMdata/0018540101/pps/`). The path and filename of the XMM-Newton catalogue should also be specified via the `ltvcatfile` parameter (ex:`/home/user/XMMcatalogue/3XMM_DR6cat_v1.0.fits`).

2 Detailed description of the tool capabilities

The main window of the GUI is shown in Fig. 1.

The right part of the GUI is a plot/graphic window, and a toolbar is available for some image manipulation like zooming, pan, saving plots. The text window at the bottom left of the GUI displays any parameter entered
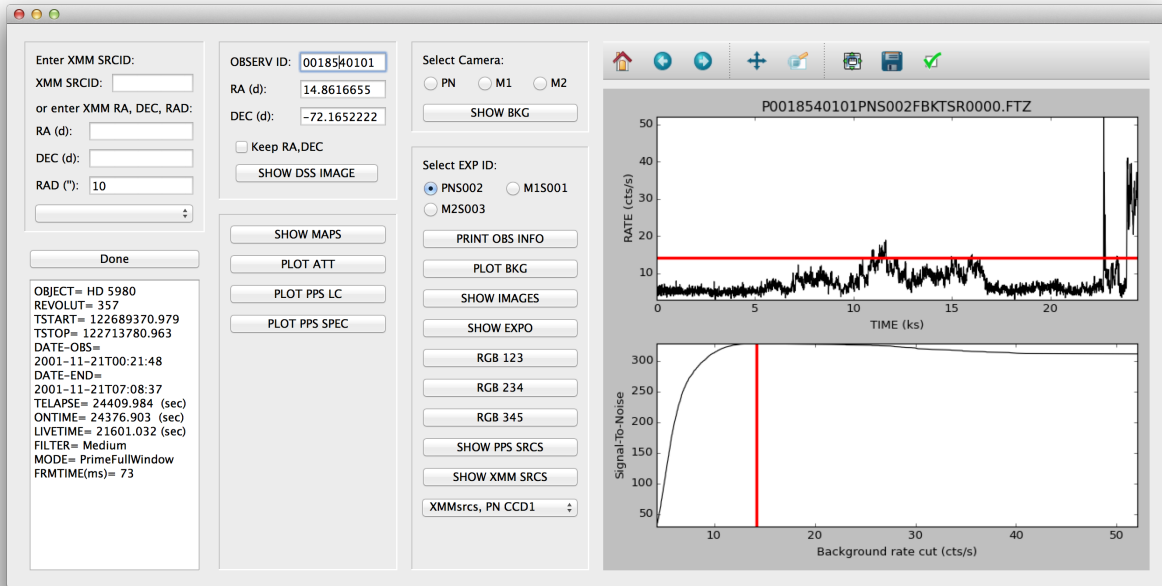
Figure 1: GUI main window after inserting the observation ID.

by the user or extracted from the XMM-Newton PPS or catalogue. Except for the analysis of the XMM-Newton catalogue, the user should start the tool by inserting the observation ID to analyse and eventually specify the coordinates of the source he/she wants to inspect via the `RA` and `DEC` boxes (the coordinates of the target are used as default). This will centre all images opened in ds9 on those new coordinates. By clicking the box `Keep RA, DEC`, the values will be conserved when the observation ID is changed (useful to follow a source appearing in several observations). The `SHOW DSS IMAGE` displays a 15′x15′ optical image of the field of view from the Digital Sky Survey at SAO using `ds9`.

2.1 Visualisation of XMM-Newton PPS products

Most of the buttons from the second and third columns of the GUI are dedicated to the analysis of the PPS products:

* `SHOW MAPS`: opens in `ds9` the merged EPIC mosaic image, and the exposure, background and sensitivity maps.

* `PLOT ATT`: plots the changes in the spacecraft attitude (changes in RA, DEC, pointing and position angle).

* `PLOT PPS LC`: opens a new window that lists, for all exposure IDs, the sources for which a PPS light curve is available, and plots for the selected source the background-subtracted light curve and the light curve of the corresponding background region.

* `PLOT PPS SPEC`: opens a new window that lists, for all exposure IDs, the sources for which a PPS spectrum is available and displays the corresponding pdf file.

* `SHOW BKG`: shows the merged background image (five for each instrument, one for each energy band), for the selected camera.

* `PRINT OBS INFO`: prints information about the observation performed like the date, the exposure time, the observing mode, the filter used, etc.

* `PLOT BKG`: plots the total background light curve, indicating the amount of flares occurring during the observation, as well as the signal-to-noise ratio as a function of the rate threshold.

* `SHOW EXPO`: displays the exposure map for the selected exposure ID.

* `SHOW IMAGES`: displays in `ds9` the images in the different energy bands separately.

* `RGB 123`, `RGB 234`, `RGB 345` show the Red-Green-Blue images in band 1-2-3, 2-3-4 and 3-4-5, respectively.

* `SHOW PPS SRCS`: displays on the top of the scientific image, the position of the PPS sources in the observed field of view, after selection of the desired exposure ID.

* `SHOW XMM SRCS`: displays on the top of the scientific image, the position of the catalogue sources in the observed field of view, after selection of the desired exposure ID.

* `XMMsrcs, PN CCD*`: displays the position of the catalogue sources on the specified pn CCD. Used for a more accurate screening of pn out-of-time events, bad columns, etc.

2.2 Visualisation of XMM-Newton Catalogue data

The first column of the main window is dedicated to the selection of a source from the catalogue. A source can be selected in 2 ways: either by entering the source ID directly (via the `XMM SRCID` label) or by defining an area of the sky (via the `RA`, `DEC`, `RAD` labels) and then selecting the source from the drop list menu. Once a source is selected, a new GUI window dedicated to the analysis of a specific source from the catalogue now appears like in Fig. 2. The first button `NEXT SRCID` will move to the next source from the catalogue (useful for a systematic screening), and the `SHOW SUM. PAGE` will open a webpage containing the 3XMM summary page for the first observation where the source is observed (with links to other observations). The `PRINT SRC INFO` shows some information about the source like the MJD of the first and last detections, the number of times the source has been detected, etc.

It is possible to display simultaneously data from EP, PN, M1 and/or M2 instruments. Light curves (appearing in the main window of the GUI) are displayed for the selected band (from 1 to 9). The colours of the datapoints are different for each instrument (black for EPIC, green for MOS1, blue for MOS2 and red for PN). At the x-axis, time is displayed in MJD with T0 and in years, at the top. Some flags are displayed around EP data points only, using parameters from the catalogue:

- data points with `VAR_FLAG=T` have yellow diamond (`VAR_FLAG` indicates whether any variability probability is $< 1e\text{-}5$).

- data points with `EP_EXTENT>0` have magenta square, and nothing for `EP_EXTENT=0` or undefined (`EP_EXTENT` is the source extent in arcsecs)

- data points with `SUM_FLAG` are represented with pentagons (=0: black, =1: blue, =2: green, =3: red, =4: cyan; `SUM_FLAG` indicates the quality of the detection: 0=clean, 4=suspect)

`PLOT HR` plots the hardness ratio light curve where HRi (i= 1, 2, 3, 4) is defined as:

$$\text{HR}i = \frac{\text{B}(i+1)\text{−B}i}{\text{B}(i+1)\text{+B}i} \tag{1}$$

Sub-images of the source from the different observations can be viewed via the `SHOW SUBIMAGES` button.
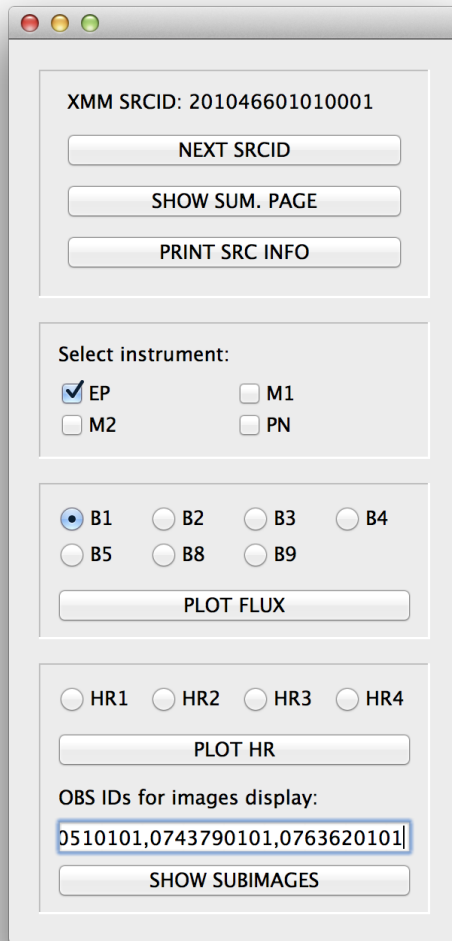
Figure 2: New GUI window dedicated to the analysis of a specific source of the XMM-Newton catalogue.