elcplot

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Abstract

elcplot produces plots of the net source and background time series for a single EPIC time series FITS file (the output of **lccorr**), along with either the Good Time Intervals (GTIs) or the background flare time series and Fraction Exposure, on a single page.

1 Instruments/Modes

Instrument	Mode
EPIC MOS	IMAGING, TIMING
EPIC PN	IMAGING, TIMING

2 Use

pipeline processing	yes
interactive analysis	yes

3 Description

elcplot takes the output of **lccorr** as input. **elcplot** produces plots of the EPIC time series. These plots show both net and background light curves as well as either the Good Time Intervals (GTIs) or the background flare time series and the Fractional Exposure of each bin on a single page. Good Time Intervals are shown by a value 1.0. Bad time intervals are indicated by a 0.0. These values are shown as a histogram. If there are more than 200 GTIs, the GTIs are binned up to show a maximum of 200 intervals, for clarity. If such a binning takes place, it is indicated in the bottom right hand corner of the plot. The background flare time series is binned up in the same way as the net and background light curves. On the same plot the fractional exposure times of each bin are shown as points, plotted using a similar binning scheme to the net and background lightcurves. A portrait output is the most suitable.

The input FITS files must contain net count rates, background count rates and the associated errors, as produced by **lccorr**. The time series must follow a regular binning scheme (i.e. equispaced time bins) [1]. The bin width is given by the keyword `TIMEDEL`. The GTI file should be that produced by **tabgtigen**.

Plots give count rates on the Y-axis against time on the X-axis after either `TSTART` (keyword in the FITS file), the default, or the user can choose to use either the start time (UTC) of the exposure (DATE-OBS

keyword) by selecting tscaleoffset=0.0 or a value specified by the user in either MJD days or seconds. The user can also choose to flag the 'forcestart' parameter, so that the first recorded time value of the time series is always used and the last recorded time value is the last value used. This may be useful to the user who chooses that all of his lightcurves (MOS or PN) start and finish (using **evselect**) at the same time for comparison, even if the DATE-OBS keyword is different for the two cameras. The time on the X-axis can also be displayed in either seconds or days as specified by the user.

elcplot allows the user to input the device type (e.g. Xwindow, Postscript, ...) for the output. The y-scale of the background counts can be forced to be the same as the source counts by setting the parameter 'bkgdyscale' to 'yes'. Otherwise the y-axis is scaled to the most appropriate value for the background counts.

As described in [1], light curves should be rebinned if necessary in order to limit the number of plotted data points to 512. If such a rebinning takes place, a warning is raised and the new bin size is indicated on the top right of the plot.

3.1 Examples

To create a colour (C) portrait (V) postscript (PS) plot, called plot.ps, with light curves showing both the net and the background count rates and the GTIs and Fractional Exposures, from the FITS files 'output_ts.ds' and 'mos1.gti' for the time series and GTIs etc respectively, where the counts are binned up by a factor 2, the time is plotted in days and the y-scale of the background lightcurve is forced to be the same as that of the net count rate lightcurve, and a time offset is given by the user in MJD days, the user can use:

```
elcplot set=output_ts.ds plotdevice=/VCPS plotfile=plot.ps use gtiset=yes gtiset=mos1.gti units=days
bkgdyscale=yes binsize=2 offset=yes offsetstyle=user tscaleoffset=50900.0 ounits=days
```

To create a colour portrait postscript plot, called plot.ps, with light curves showing both the net and the background count rates and the GTIs and Fractional Exposures, from the FITS files 'output_ts.ds' and 'mos1.gti' for the time series and flare time series (flare.ds) etc respectively, where the counts are binned up by a factor 5, the time is plotted in secs and the y-scale of the background lightcurve is left as a free parameter, and the user chooses the time offset given by the keyword DATE-OBS in days, the user can use:

```
elcplot set=output_ts.ds plotdevice=/VCPS plotfile=plot.ps usegtiset=no useflareset=yes flareset=flare.
bkgdyscale=no binsize=5 offset=yes offsetstyle=dateobs ounits=days
```

4 Parameters

This section documents the parameters recognized by this task (if any).

Parameter	Mand	Type	Default	Constraints
set	yes	dataset	No default	

Name of the FITS file containing the time series. Case sensitive.

gtiset	yes	dataset	No default	

Name of the FITS file containing the GTIs. Case sensitive.

binsize	no	Integer	5	Constraint : positive value

plotdevice	no	String	"/PS"	Constraint : valid device type

Not case sensitive.

plotfile	no	String	"plot.ps"	less than 1024 char.

Name of the output file containing the plot. Case sensitive.

bkgdyscale	no	boolean	no	yes/no

To scale the y-axis of the plot of the background counts to be the same as the y-axis of the plot of the source counts

units	no	string	secs	secs or days

units for the x-axis

offset	no	boolean	no	yes/no

Would the user like to specify an offset for the time-axis

offsetstyle	no	string	auto	auto/dateobs/user

The type of offset to be used - auto uses the first bin in the timeseries as the, dateobs uses the DATEOBS keyword to provide the zeropoint and user means that the user can supply the offset using the tscaleoffset parameter.

tscaleoffset	no	real	0.0	Constraint : greater than or equal to zero

The offset value to be applied to the time-axis

ounits	no	string	days	secs or days

units in which the offset value 'tscaleoffset' is specified

5 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

- **noTimedelKeyword** *(error)*
  The Keyword TIMEDEL should be present in the input file

- **badBinWidth** *(error)*
  The bin width should be more than 1 in the input file

Different number of rows in columns RATE, ERROR, BACKV and BACKE *(error)*
The number of rows in each column of the input file should be identical

- **noDataInTimeSeries** *(error)*
  data set empty

- **noClobber** *(error)*
  SAS_CLOBBER is set to 0 so the existing file can not be overwritten

- **badPgplotDevice** *(error)*
  Invalid DEFAULT device and/or output file

- **allNetRateAreNull** *(error)*
  After rebinning, all the net rate values were found to be nulls

- **allBkgRatesNull** *(error)*
  After rebinning, all the background rate values were found to be nulls

- **allRateValuesAreNull** *(error)*
  All the data points have null or negative values

- **allTsValuesAreNull** *(error)*
  All the data points have null or negative values

- **negativeRawSourceCounts** *(error)*
  The raw count rates are negative and should not be.

- **negativeSourceError** *(error)*
  The count rates are negative and should not be.

- **negativeBackgroundRate** *(error)*
  The background count rates are negative and should not be.

- **negativeBackgroundError** *(error)*
  The background error rates are negative and should not be.

- **bothGtiAndFlare** *(error)*
  Can only plot either GTI set or flare set, not both

- **badOffsetUnit** *(error)*
  The value of –ounits was not recognized.

- **badOffsetStyle** *(error)*
  The value of –offsetstyle was not recognized.

- **noContentKeyword** *(warning)*

  corrective action: CONTENT keyword should be present in the input file header

- **fileWillBeClobbered** *(warning)*

  corrective action: Existing file output file will be overwritten

CONTENT parameter for input file is .... *(warning)*

corrective action: The CONTENT parameter is not ''EPIC SOURCE TIMESERIES' as expected

- **noKeyword** *(warning)*

corrective action: This HDUCLASS keyword is missing from the FITS header

- **badKeyword** *(warning)*

corrective action: This HDUCLASS keyword is incorrect the FITS header

Exposure time less than 0 *(warning)*

corrective action: The exposure time should be positive

Count rate negative *(warning)*

corrective action: Count rate must be positive

Count rate errors negative *(warning)*

corrective action: Count rate errors must be positive

- **allBackvValuesAreNull** *(warning)*

corrective action: All of the BACKV values in the time series seem to be nulls or NaNs.

Binning_Factor must be positive, set to default value : 1 *(warning)*

corrective action: Binning_Factor is negative and should be positive, default value of 1 chosen

- **rebinningSchemeAltered** *(warning)*

corrective action: Increase binsize value until the number of points to plot is lower than 512 [1]

- **noTstartKeyword** *(warning)*

corrective action: TSTART keyword should be present in header of GTI file

- **noTstopKeyword** *(warning)*

corrective action: TSTOP keyword should be present in header of GTI file

- **badPgplotDevice** *(warning)*

corrective action: The device type and output file are invalid

- **newPgplotDevice** *(warning)*

corrective action: The device type and output file are set to the defaults.

- **checkOffsetUnit** *(warning)*

  corrective action: Time unit chosen is not seconds or days, so choosing default secs

- **backgroundNotSubtracted** *(warning)*

  corrective action: This indicates that the net lightcurve plotted is calculated from the counts minus the background

- **getXmmDate13** *(warning)*

  corrective action: The DATE-OBS keyword is not in a suitable format

- **badLabelsLowerTime** *(warning)*

  corrective action: The time (minus offset) at the left-hand edge of the plot is smaller than -2.0e8 in the chosen units. Unfortunately the plotting subroutine does not handle well values in this range. For the time being (until we fix this behaviour), if you want sensible numbers printed, you will have to use a different offset value, such that the start time becomes greater than -2.0e8

- **badLabelsUpperTime** *(warning)*

  corrective action: The time (minus offset) at the right-hand edge of the plot is larger than 2.0e8 in the chosen units. Unfortunately the plotting subroutine does not handle well values in this range. For the time being (until we fix this behaviour), if you want sensible numbers printed, you will have to use a different offset value, such that the start time becomes smaller than 2.0e8

6 Input Files

1. EPIC FITS Time Series [1] (generated by **lccorr**).

7 Output Files

1. Postscript Source Time Series [1] (Deliverable PPS product)

8 Algorithm

```
Subroutine elcplot

  Recover parameters (File names, Device type, Binning factor, Output file, x-axis units)
```

```
   Read source time series FITS file :
      Get dataset and table.
      Check important keyword consistency (notably TSTART and TIMEDEL).
      Call a warning or error if necessary.

   Recover all light curves included in table
   Net source rates and errors & background rates and errors are recorded in arrays
      of dimension Nlightcurve * Nbins.

   Open plot : create view surface in specified device format (check its validity).

   if (usegtiset)  then

   Recover GTIs

   end if

   if (useflareset) then

   Recover Flare light curve  and rebin according to the lightcurve binning pattern
   end if

      Delete gaps in data (when the IEEE NaN constant is found).

      Increase binsize if necessary to limit the number of points to 512.

      Rebin rate and error columns by binsize

      Create a labelled plot page separated into two panels in which time is graduated
      on X-axis (see Comments), and count rates on Y-axis (in counts/sec).

      Draw net source and background time series and GTIs on different panels.

   Release memory.

   Close plot.

End subroutine  elcplot
```

9 Comments

- **elcplot** only produces plots of light curves measured by EPIC or OM. We note that no RGS Source Time Series FITS file is specified in [1].
- Error rates are rebinned following a quadratic scheme (Central limit theorem).
- Time intervals all have the same length, the first one is [TSTART , TSTART + Binsize*TIMEDEL] where `TIMEDEL` is the bin width read from the file [1].
- We note in [1] that the keyword `TIMEDEL` is specified in MJD. We have assumed it to be given in seconds.
- The output devices are those of the PGPLOT library. The device list is governed by the drivers available to PGPLOT. The output is best viewed as portrait.

References

[1] SSC. XMM Survey Science Centre to Science Operations ICD for SSC Products. Technical Report XMM-SOC-ICD-0006-SSC Issue 2.1, SSC, Mar 2000.