High Energy Solar Physics Data in Europe
(HESPE)

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Beneficiaries

- **Università di Genova (UNIGE)***
- **Fachhochschule Nortwestschweiz (FHNW)**
- **University of Glasgow (UNIGLA)**
- **Universitaet Graz (UNIGRA)**
- **Centre National de la Recherche Scientifique (CNRS)**
- **University of California at Berkeley (UCB)**

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This document provides the User Manual for the Graphical User Interface (GUI) with which the HESPE database of visibilities and science ready products is presented to the users.

The HESPE database GUI can be reached either at http://www.hespe.eu/data/browse-and-obtain/, clicking the 'go' button in the 'HESPE Science Products Database' table; or directly at the external URL: http://hsp.cs.technik.fhnw.ch/browser/.

While submitting this deliverable, the HESPE database contains around one thousand processed flares. HESPE will keep on filling its database, which will be updated even after the end of the HESPE effort.

Part 1: Using the pre-processed HESPE science ready products

When requesting data for an entire flare from the *HESPE Web-Frontend* (see Part 2), the user receives a ZIP file with all quick look images as PNGs, but also a set of FITS files with data structures ready to be used in Solar Software (SSW) in IDL. The generic and open format of the FITS file allows using the data in any other analysis software as well. The following sections give a short introduction to all available data products and how to use them with example codes for SSW.

1.1 Maps

For every processed time-energy bin, a set of map data structures in separate FITS files is available. The pattern of the file name is: {start energy}_{start time}_{field of view}_{imaging algorithm}_{type of visibilities}.fits.

The processing pipeline creates up to 16 maps for each time-energy bin: four imaging algorithms in two different modalities (photon and electron) and two different resolution. Table 1 shows how to interpret the file name components on this example:

12_730206349.8288884200000000_64_bpmap_photon.fits

Code 1 shows a possible usage in SSW.

Name Component	Explanation	Example
`start energy`	Integer value in keV where the bin begins	12keV
`start time`	Double precision floating point timestamp: seconds after January 1, 1979	20-Feb-2002 11:05:49.829

`field of view`	Integer value in arc seconds of the shown field of view in the map	64 arc seconds
`imaging algorithm`	One of the following image reconstruction algorithms: • bpmap • memnjit • uvsmooth • visclean	Back projection
`type of visibilities`	Possible values are: photon or electron	Photon visibilities

Table 1: This is a list describing the components making up the map file names.

1.2 Visibilities

The visibilitybag.fits or visibilitybag_electron.fits files contain all computed visibilities for the entire event. How those files are read, filtered and used to create maps is shown in Code 2.

1.3 Light-curves

The nine corrected count rate light-curves of the observing summary are available in the lightcurves.fits file. The rate is generated from detectors 1, 3, 4, 6, 8 and 9 for the following energy bands shown in Code 3 (detector 2 is neglected owing to hardware malfunctions).

1.4 Spectrogram

The time and energy binning of the spectrogram data (spectrogram.fits) is constant for all flares in the *HESPE Database*. The exact binning can be found in the time and energy axis in the FITS file. In addition, the flare list metadata is attached the spectrogram FITS file. Code 4 demonstrates how to create a spectrogram plot and combine it with data from the flare list structure.

1.5 Spectroscopy

Both FITS data files hsi_spectrum.fits and hsi_srm.fits are inputs to the spectroscopy tool OSPEX. The time intervals in the count spectrogram and the *Spectrometer Response Matrix (SRM)* are in-sync with the time intervals for imaging found by the *Interval Selection Algorithm*.

The result of the photon flux model fitting can be restored from the spectra_fit_results.fits file as it is shown in the basic example in Code 5.

```
map=MRDFITS('12_730206349.8288884200000000_64_bpmap_photon.fits',1)

MRDFITS: Binary table.  15 columns by  1 rows.

IDL> help, map

** Structure <d0ead60>, 15 tags, length=16528, data length=16513, refs=1:

   DATA             FLOAT     Array[64, 64]

   XC               FLOAT           914.168

   YC               FLOAT           255.662

   DX               FLOAT           1.00000

   DY               FLOAT           1.00000

   TIME             STRING    '20-Feb-2002 11:05:49.829'

   ID               STRING    ' '

   DUR              FLOAT          0.000000

   XUNITS           STRING    'arcsec'

   YUNITS           STRING    'arcsec'

   ROLL_ANGLE       FLOAT          0.000000

   ROLL_CENTER      FLOAT     Array[2]

   VIS_TYPE         STRING    'photon'

   ATTEN_STATE      BYTE         1

   TITLE            STRING    'backprojection: photons / cm^2 / s /
arcsec^2'

IDL> plot_map, map
```

Code 1. This code block shows how to import a map from the FITS file and plot it.

```
IDL> visbag = MRDFITS('visibilitybag.fits',1)

MRDFITS: Binary table.  15 columns by  20800 rows.

IDL> help, visbag, /str

** Structure <d11ba00>, 15 tags, length=112, data length=102, refs=1:

   ISC             INT              0

   HARM            INT              1

   ERANGE          FLOAT     Array[2]

   TRANGE          DOUBLE    Array[2]

   U               FLOAT          0.220757

   V               FLOAT         0.0105845

   OBSVIS          COMPLEX   (      5.25808,     -9.54516)

   TOTFLUX         FLOAT           10.6171

   SIGAMP          FLOAT           6.84332

   CHI2            FLOAT          0.919405

   XYOFFSET        FLOAT     Array[2]

   TYPE            STRING    ' '

   UNITS           STRING    ' '

   ATTEN_STATE     INT              0

   COUNT           FLOAT          0.000000

IDL> vis_bpmap, visbag[where(visbag.erange[0] eq 6.0 AND visbag.trange[0]
gt anytim('20-Feb-2002 11:06') AND visbag.trange[1] lt anytim('20-Feb-2002
11:08'))], map=map

IDL> plot_map, make_map(map)IDL>
```

Code 2. This code block shows how to import visibilities from FITS and generate a back projected map of all visibilities starting at 6 keV and in the time interval between 11:06:00 and 11:08:00 UT

```
IDL> obs_sum = mrdfits('lightcurves.fits',0)

MRDFITS: Image array (9,179)  Type=Real*4

IDL> time = mrdfits('lightcurves.fits',1)

MRDFITS: Image array (179)  Type=Real*8

IDL> energy = mrdfits('lightcurves.fits',2)

MRDFITS: Image array (2,9)  Type=Int*2

IDL> print, string(energy)+"keV"

       3keV        6keV

       6keV       12keV

      12keV       25keV

      25keV       50keV

      50keV      100keV

     100keV      300keV

     300keV      800keV

     800keV     7000keV

    7000keV    20000keV

IDL> help, obs_sum

OBS_SUM          FLOAT     = Array[9, 179]

IDL> utplot, time, obs_sum[0,*], time[0], title="Corrected Count Rate from
"+ trim(energy[0,0]) + " to "+ trim(energy[0,1]) +" keV"
```

Code 3. This code block demonstrates how to access the light-curves of the observing summary.

```
IDL> spec = mrdfits('spectrogram.fits',1)

IDL> time_axis = mrdfits('spectrogram.fits',2)

IDL> energy_axis = mrdfits('spectrogram.fits',3)

IDL> flare_info = mrdfits('spectrogram.fits',4)

IDL> flare_info = mrdfits('spectrogram.fits',4)

IDL> utplot, time_axis.time, time_axis.time[0], /nodata,  /ylog,
yrange=[4,200], /ystyle

;mark the peak time

IDL> outplot, replicate(flare_info.peak_time,2) , [4,200]

IDL> contour, spec.data, time_axis.time, energy_axis.mean, zticks=25,
/overplot
```

Code 4. This code block shows how to access the spectrogram, time energy axes and extended flare list metadata.

```
IDL> ospex = ospex(spex_specfile = 'hsi_spectrum.fits', spex_drmfile =
'hsi_srm.fits')

IDL> ospex->plot_spectrum, this_interval = 4

IDL> ospex->restorefit, file='spectra_fit_results.fits'

IDL> ospex->plot_spectrum, this_interval = 4, /show_fit, /use_fitted,
spex_units = 'flux', /bksub, /photon, /overlay_back
```

Code 5. This code block shows how to use the spectroscopy data files with the OSPEX tool.

Part 2: Using the HESPE Web-Frontend

The HESPE Web-Frontend is built of 5 modules: *Event Selection*, *Lightcurve*, *Interval Selection*, *Preview* and *Download*. Each module consists of a header and a body. While the body contains all the content of the module, the header contains only the module name and an arrow that can be used to hide (or show, respectively) the module (see Figure 1).

Figure 1. The header of the Lightcurve module. With the white arrow, the module content can be shown (or hidden respectively).

2.1 Event selection module

When first accessing the *HESPE Web-Frontend*, the *Event Selection* module is shown to the user. Within this module (see Figure 2) a list with all the processed events is presented. This list can be sorted according to every row criteria, which makes it easier to browse the events. Additionally, several filters can be applied to the list. When using these filters, the entries in the list which do not meet the filter criteria are removed from the list. There is a filter for the timeframe (of the event start time), a filter for the duration of the event and a filter for the GOES class. Each filter is represented by a slider with a minimum and a maximum value. The last filter is the Flare ID filter. By entering a Flare ID and then pressing "Enter", the list is searched for the event with the given Flare ID.

When clicking on an entry in the list, the data of the according event is loaded from the database and all the other modules are populated with this data. Those modules, which before have been hidden, are then shown and the *Event Selection* module is hidden (to show it again, the white arrow in the module header has to be clicked). In addition, the *Floating Menu* is shown as soon as an event has been clicked in the events list.

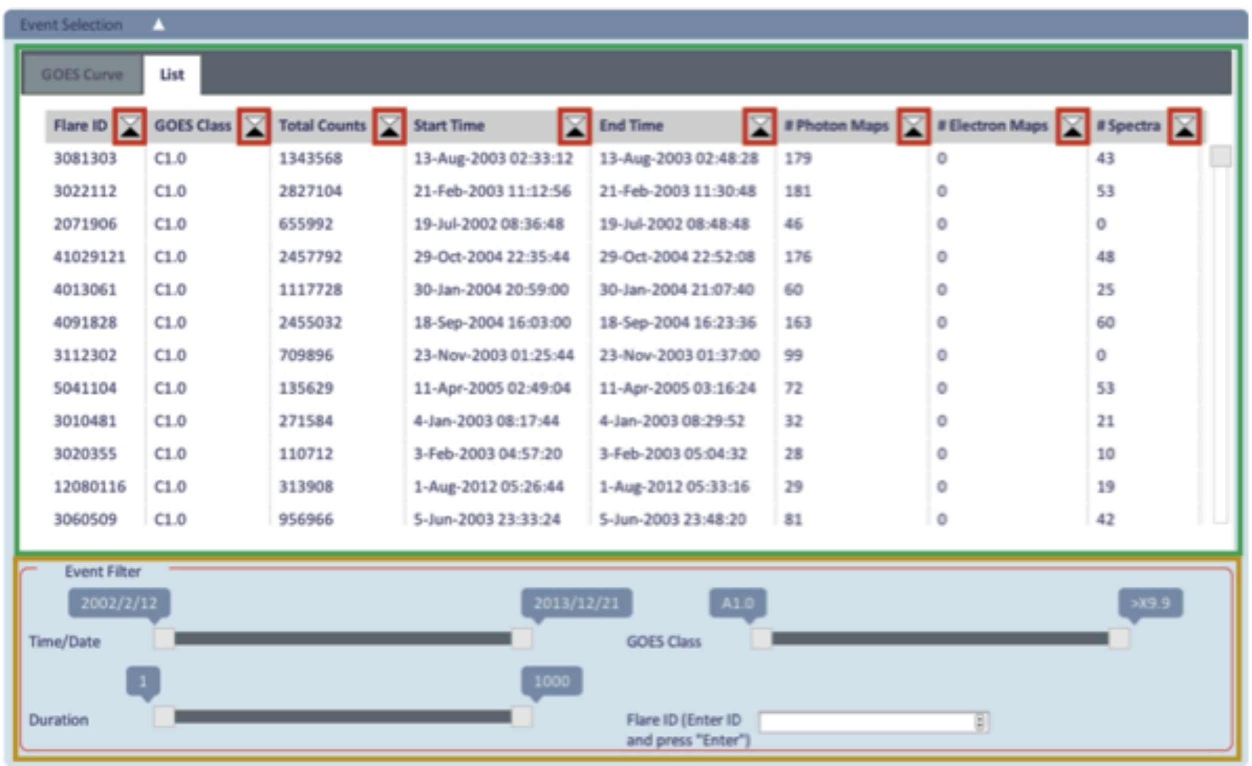

Figure 2. The Event Selection module. It contains a list of all processed events (green), and several filters (yellow) to limit the number of events displayed. With the arrows (red), the list can be sorted by every row criteria.

2.2 Floating Menu

The *Floating Menu*, located at the top of the screen, contains a selector for the type of science product displayed (*Photon Maps*, *Electron Maps* or *Spectra*), which on change also changes all the science products displayed in the *HESPE Web-Frontend* (only the lightcurves and the spectrogram stay the same). All the preview images within the *HESPE Web-Frontend* have been created using a specific reconstruction algorithm. Changing the selector for the algorithm (possible values are: *UV Smooth*, *MEM_NJIT*, *CleanVis*, *Backprojection*) changes the preview images to the according images created with the newly selected algorithm. Both selectors (*Display* and *Algorithm*) only allow the selection of choices that actually are present within the science products of the event. If *Spectra* are selected as display type, the *Algorithm* selector is hidden. Next to the two selectors, some information about the currently selected event is shown (the flare ID, the start time and the GOES class). The *Floating Menu* is always visible at the top of the screen (after having selected an event).

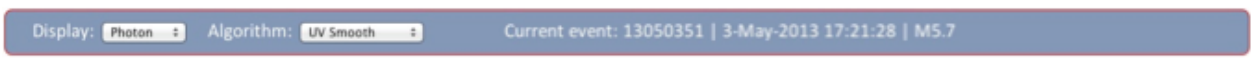

Figure 3. The Floating Menu that shows some information about the currently selected event and allows changing of the display type and the reconstruction algorithm.

2.3 Lightcurve module

The *Lightcurve Module* shows the lightcurves (see Figure 4) of the event and provides a slider. The slider (which has a red line attached so the user can easily see where exactly the slider is set at the moment) can be used to "move" within the time axis and is connected to the other two time-sliders that are part of the *Interval Selection* and the *Preview* modules. Moving the slider causes the connected sliders to move as well. This also moves the preview images to always represent the position of the slider (see Preview Module below).

2.4 Interval Selection Module

The *Interval Selection Module* shows the spectrogram of the event. In addition, for every *TimeEnergyInterval* created by the *HESPE Software Framework* for the event, a green box is plotted on the spectrogram (see Figure 5). As in the *Lightcurve Module*, a slider can be used to move within the time axis (this slider is also connected to the other time-sliders and the preview images).

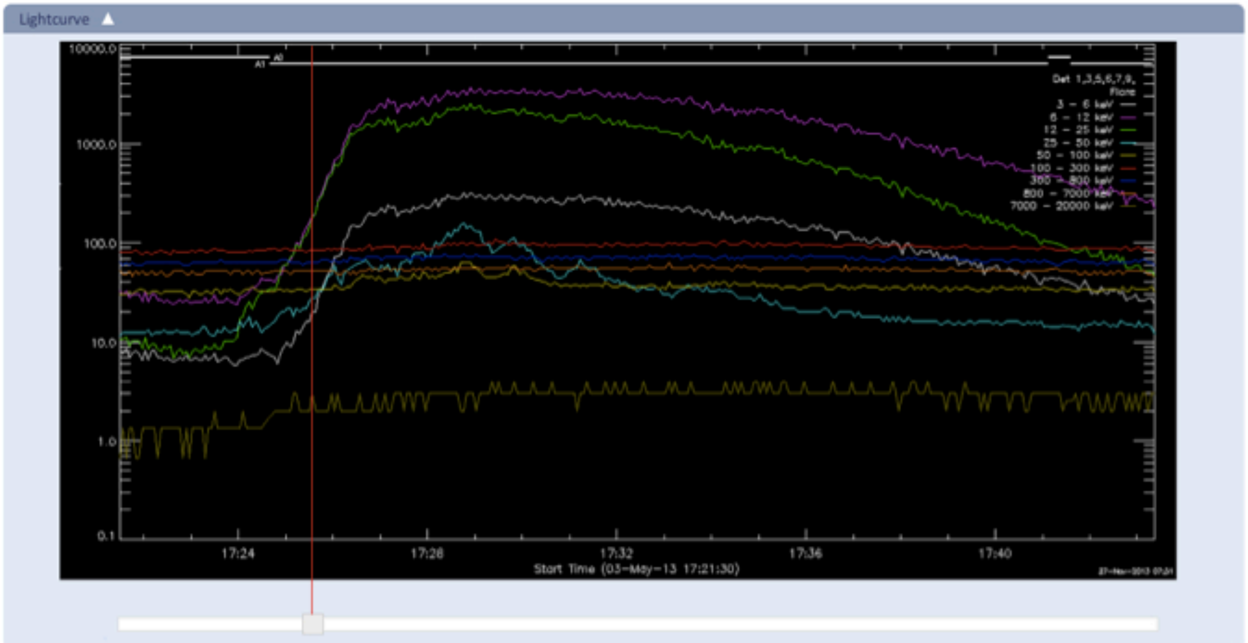

Figure 4. The Lightcurve Module showing the light-curves and a slider on the time axis.

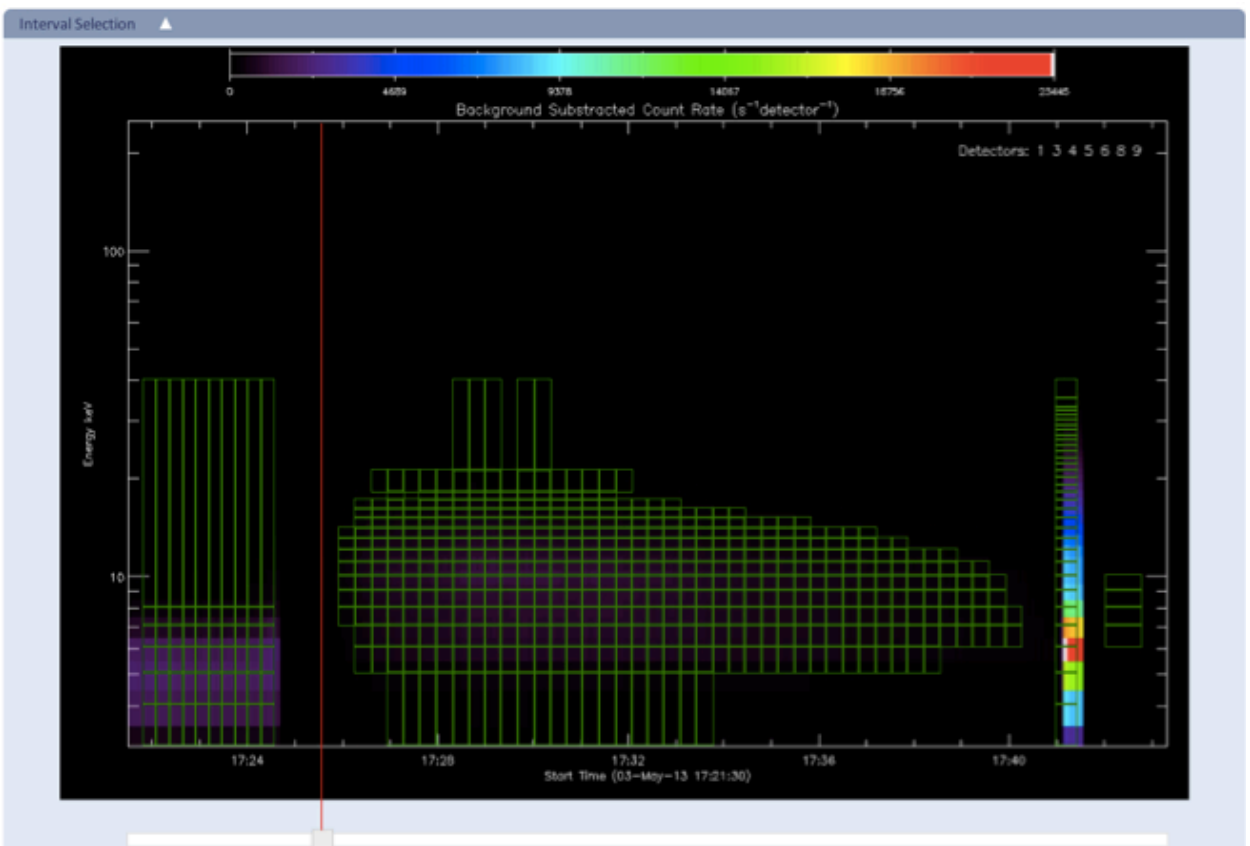

Figure 5. The Interval Selection Module shows the spectrogram with all the created TimeEnergyIntervals as overlay. For each TimeEnergyInterval a map exists.

Clicking in a green box shows the according map or the spectra respectively (see Figure 6). Changing the reconstruction algorithm in the *Floating Menu* also changes the map shown after clicking in a green box in the *Interval Selection Module*.

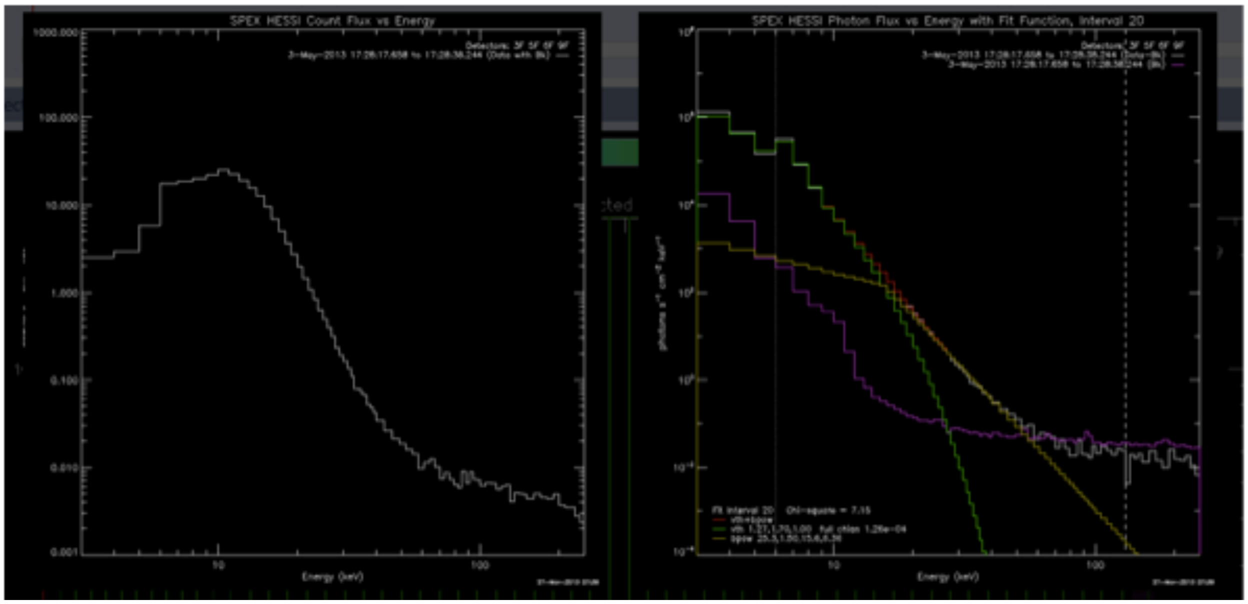

Figure 6. A spectrum and a fitted spectrum, as shown after clicking in one of the green boxes in the Interval Selection Module (within the Floating Menu the Display selector must be set to Spectra).

2.5 Preview Module

The *Preview Module* presents all the created maps and spectra to the user (see Figure 7). Changing the display type or the algorithm within the *Floating Menu* also changes the images shown within the *Preview Module*. There are two sliders within the *Preview Module*. The vertical slider slides the images vertically and therefore slides the energy bins, and the horizontal slider slides the images horizontally and therefore slides the time axis. This horizontal slider is also connected to the two other time-sliders in the *Lightcurve Module* and the *Interval Selection Module*. The red box in the *Preview Module* shows the position of the red line connected to the two sliders in the *Lightcurve Module* and in the *Interval Selection Module*. The images within the red box have been created with the data behind the green boxes under the red line within the *Interval Selection Module*.

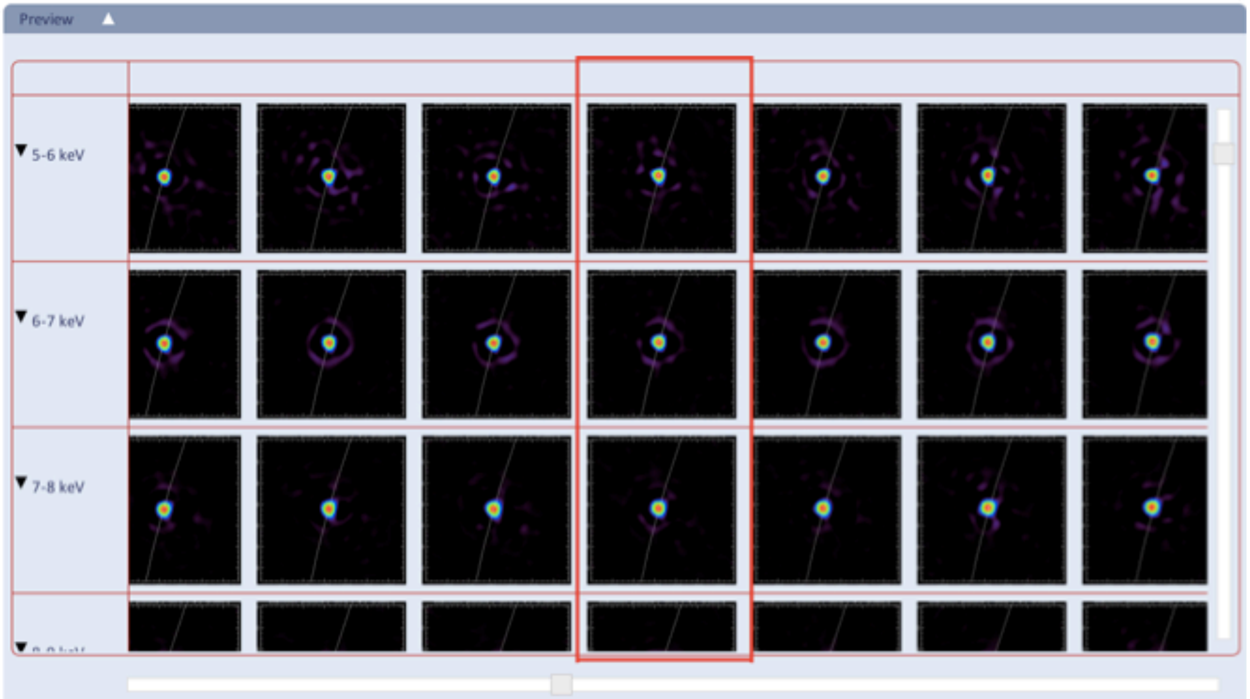

Figure 7. The Images Preview Module showing Photon Maps created with the UV Smooth reconstruction algorithm. Two sliders can be used to slide the time axis or the energy bins. The red box shows the position of the red line of the sliders within the Interval Selection Module and the Lightcurve Module.

2.6 Download Module

The last module is the *Download Module*. Using this module, the user can download the HESPE science products (see Figure 8). There are several possibilities the user can choose from. First of all, by selecting either "Entire Event" or "Current Selection" within the *Data Volume* part, either all the science products belonging to the event can be downloaded, or only a part of it. If "Current Selection" has been chosen, the user can choose which science products to download within the *Data Products* part (only data products which actually exist can be selected, other products are disabled). The download of the science products can then be started by clicking the "Download" button.

After clicking the "Download" button, a new window is opened (Attention: PopUp-Blockers may prevent this behavior and therefore downloading would not work). This window must not be closed until the download has been finished. This may take some time during which the user can continue browsing events. The requested science products are then collected on the server and put into a *ZIP* file that is downloaded by the user.

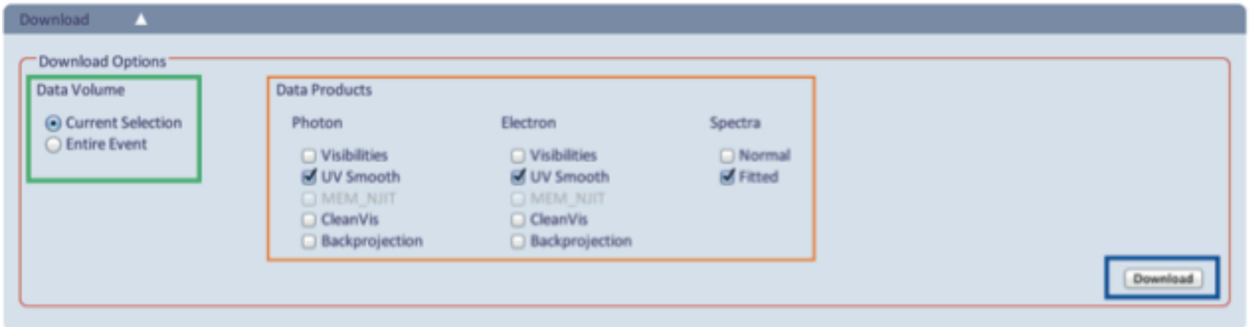

Figure 8. The Download Module which can be used to download the HESPE science products. The user can choose between downloading all the science products or only parts of it (green box). If "Current Selection" has been chosen, the user can choose between the different available science products (orange box). A click on the download button (blue box) then starts the download of the files.