

	<b>VIALACTEA WP5</b> <b>3D Visual Analytic Client</b> <b>User Manual</b>	<b>Ref.:</b> <b>Issue:</b> <b>Date:</b> <b>Page:</b>	VL-OACT-XX-2016-XX 1.3 5/12/2016 1/14
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### Document version tracking

Issue	Date	Pages	Description of changes	Comments
1	19/01/2016	all	Document created	
1.1	18/02/2016	all	Document updated according to Visual Analytic Client v0.7	
1.2	04/04/2016	all	Document updated according to Visual Analytic Client v0.8	
1.3	05/12/2016	all	Document updated according to Visual Analytic Client v1	

### Applicable & Reference documents.

Doc. Ref.	Title	Ref.	Issue	Date
AD1	VIALACTEA WP5 Deliverable Item 5.2: 3D Visual Analytic Front-end module and Visual Analytic portlets for the Science Gateway - v0	VL-OACT-DI-2014-001	1	30/09/2014
AD2	VIALACTEA WP5 Deliverable Item 5.3: 3D Visual Analytic Front-end module and Visual Analytic portlets for the Science Gateway – v1	VL-OACT-DI-2015-001	1	30/09/2015
AD3	VIALACTEA WP5 Deliverable Item 5.4: 3D Visual Analytic Front-end module and Visual Analytic portlets for the Science Gateway – v2	VL-OACT-DI-2016-001	1	19/09/2016

### Acronyms and Abbreviations

FITS	Flexible Image Transport System
IDL	Interactive Data Language
SED	Spectral Energy Distribution
VLKB	ViaLactea Knowledge Base
LUT	LookUp Table
VisIVO	Visual Interface with the Virtual Observatory

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## 1. Introduction

The present document is the user manual of the Vialactea Visual Analytic Client (following referred as Client). The Client, based on VisIVO<sup>1</sup> backbone, offers a 2D and 3D visual analytics environment allowing the astronomers to easily conduct research activities interacting in a simple way with the Vialactea Knowledge base and the Search&cutout service.

This manual has to be considered as integration document of the deliverables D5.1 [AD1] and D5.2 [AD2] of WP5.

Most of the technical implementation and architecture details of the designed software are fully described in [AD1], [AD2], [AD3]. Hence, this document is mainly focused on the functionalities available to the end users.

## 2. Set Up Configuration

At the first execution of the Client, the user is asked to setup the *IDL* or *GDL* path (select where the IDL/GDL binary executable is located, typically in macOS this path is `/Applications/exelis/idl/bin/idl` and in Linux is `/usr/local/bin/idl`) and the *Tile* path (select where the `openlayers.html` is located within the unpacked `tiles.zip`) as shown in the following figure. The user can also change anytime this setup selecting File → Settings in the menu bar of the Starting Window.

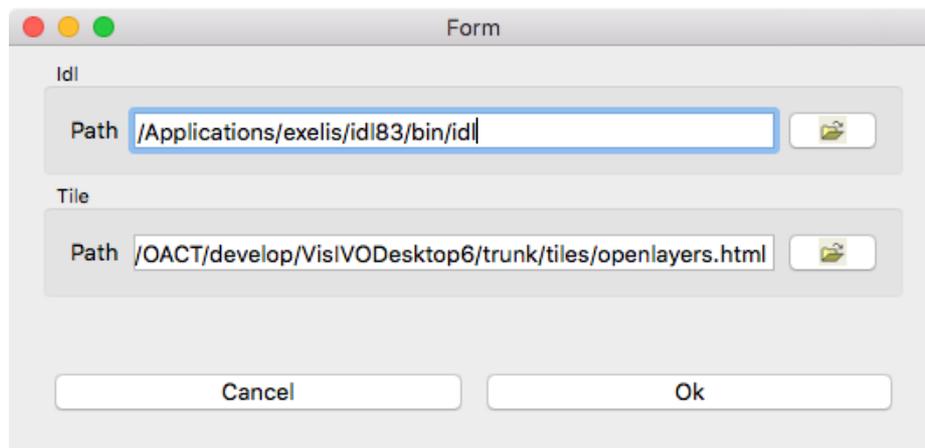


Figure 1. Setup window

## 3. Starting Window

The Starting Window shows an overview of a section of the galactic plane (longitude from  $-180^\circ$  to  $+180^\circ$  and latitude from  $-1^\circ$  to  $1^\circ$ ). This can be used from the user to perform a visual selection of the region of interest.

<sup>1</sup> <http://visivo.oact.inaf.it>

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The selection of the region of interest can be carried out choosing a point on the map and specifying the radius of selection or picking up a rectangular region (see fig.2). The maximum radius accepted by the *Search&Cutout*<sup>2</sup> services is 2 degrees while the maximum sides [dl,db] is 1 degrees.

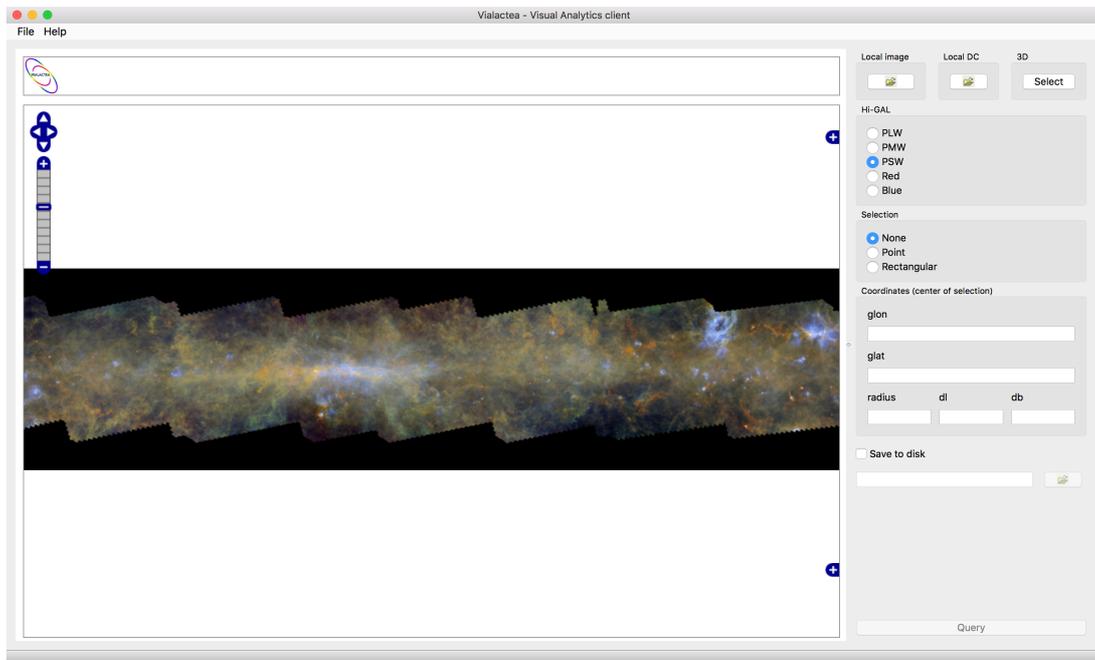


Figure 2. Starting window interface

Clicking on the “Query” button the Client will open on a separate window the FITS image containing the user selected region that is used as starting point for performing the visual analytic operations.

If the user checks “Save to disk”, the image is saved locally for future uses of it, and then it can be re-loaded by clicking on the “Local Image” button.

The “Local DC” button allows the user to load and visualize a velocity datacube FITS file that is already stored on a local disk.

The “Select” button, under the 3D section allows the user to specify the range of coordinates on which to perform a 3D visualization of compact sources on the galactic plane.

#### 4. **2D maps visualisation**

Once the selected region has been downloaded or locally loaded from the Starting Window, the 2D maps visualization window is shown. The user can interact with the displayed image changing the palette used to map pixel values with colours. There are a set of predefined LUT embedded in the Client, for each of them is possible to select if use linear or logarithmic scale.

<sup>2</sup> <http://vialactea.iaps.inaf.it/vialactea/eng/dbaccess.php>

The image can be zoomed with mouse wheel and panned dragging it when the SHIFT button is pressed.

Contrast and saturation of the visualized image can be changed by keeping pressed the mouse left button and moving on the image. Passing the mouse over the image allows to display on the bottom of the window the pixel value, and coordinates expressed as pixel (X, Y), galactic (GLON, GLAT), fk5 (RA, DEC) and ecliptic (RA, DEC) as shown in fig 3.

```
<value> 841.5 <image> X: 229.641 Y: 229.634 <galactic> GLON: 40.0188 GLAT: -0.01897 <fk5> RA: 286.121 DEC: 6.29517 <ecliptic> RA: 288.342 DEC: 28.7137
```

Figure 3: Information of the pixel under the mouse cursor

If the visualized map is downloaded from the Search&Cutout service, on the right panel a list of 2D maps and datacube available in the Vialactea knowledge base within the selected region are shown (following referred as VLKB items). To have an idea of the region covered by each of these elements a footprint is visualized if the users click on one of this item (figure 4).

Furthermore, the user can interact with the image performing the following operations:

- Add an image as layer (see section 4.1)
- Compact sources visualization and analysis (see Section 4.2)
- Visualization of Filaments (see Section 4.3)
- Visualization of Datacubes (see Section 4.4)
- 3D Visualization (see Section 4.5)

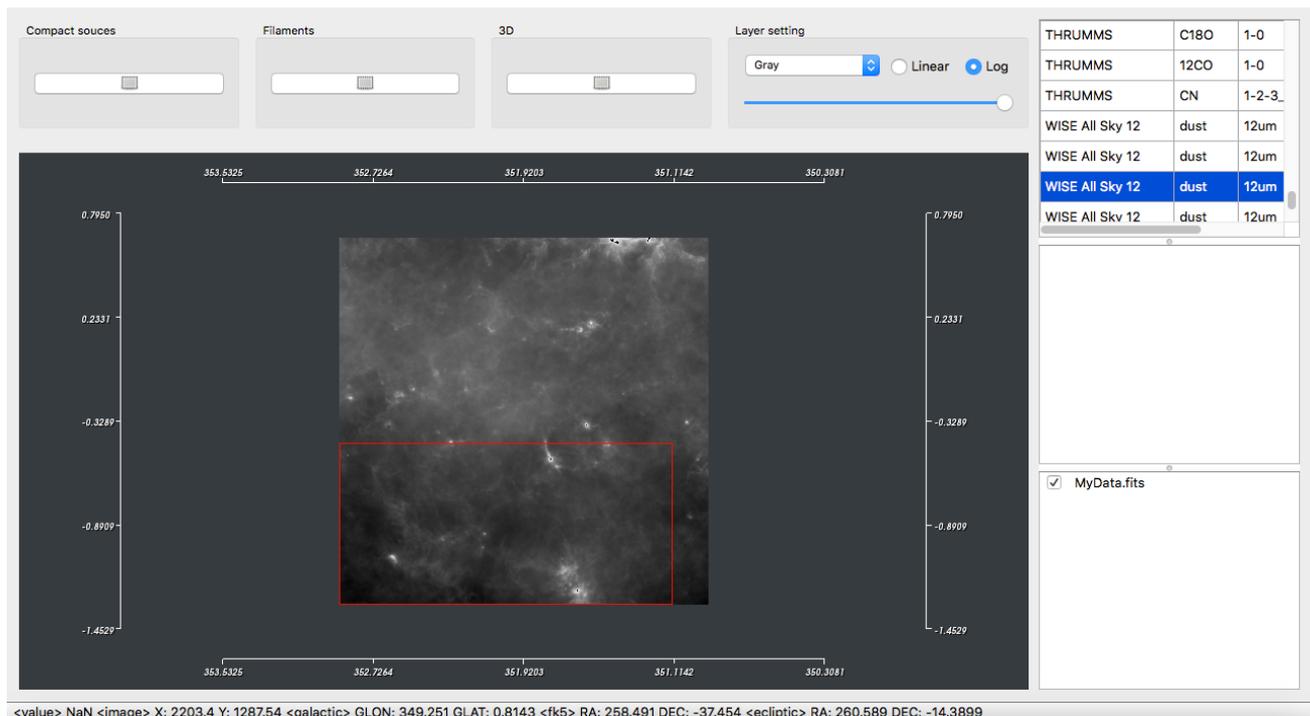


Figure 4: Visualization of the footprint of selected item

## 4.1. Add an image as layer

Double clicking on one of the VLKB items, if it is a 2D map image, it is added as new layer on top of the FITS images already displayed. The new layers are aligned (position, scaling pixel size, rotation) to the "image base" using to the information contained into their header.

Each loaded layer is shown in the table (following referred as Layer items) in the bottom part of right panel. Layer Items is organized as a reverse stack: the user eye is on the bottom of this stack and sees all activated layer by transparency. The user can move a visualized layer up or down in the Layer Items to change the visualization order.

Using the checkbox on the left of each row within the Layer items, the user can activate or deactivate the visualisation of the relative layer. The opacity can be modified selecting a row in the Layer items and using the slider in the "Layer setting" located in the upper part of the window.

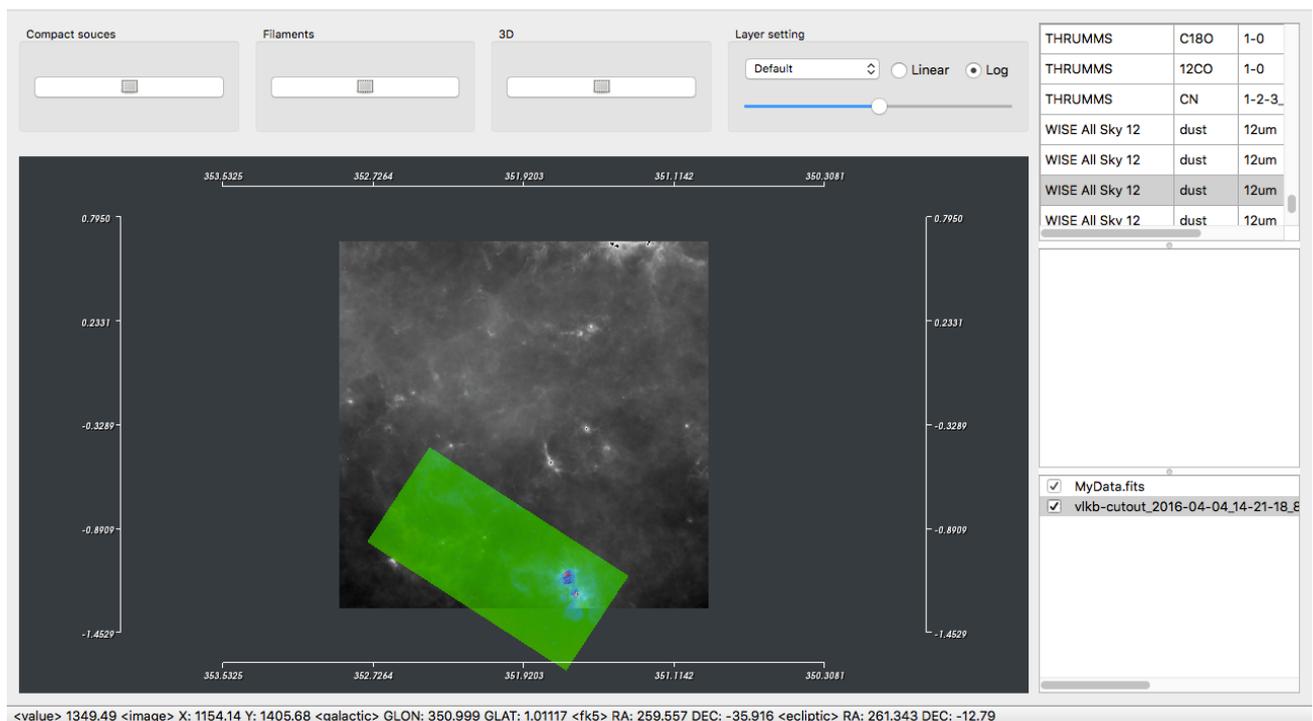


Figure 5: Visualization of a new layer image

## 4.2. Compact sources visualization

The user can display compact sources overlapped to the fits image.

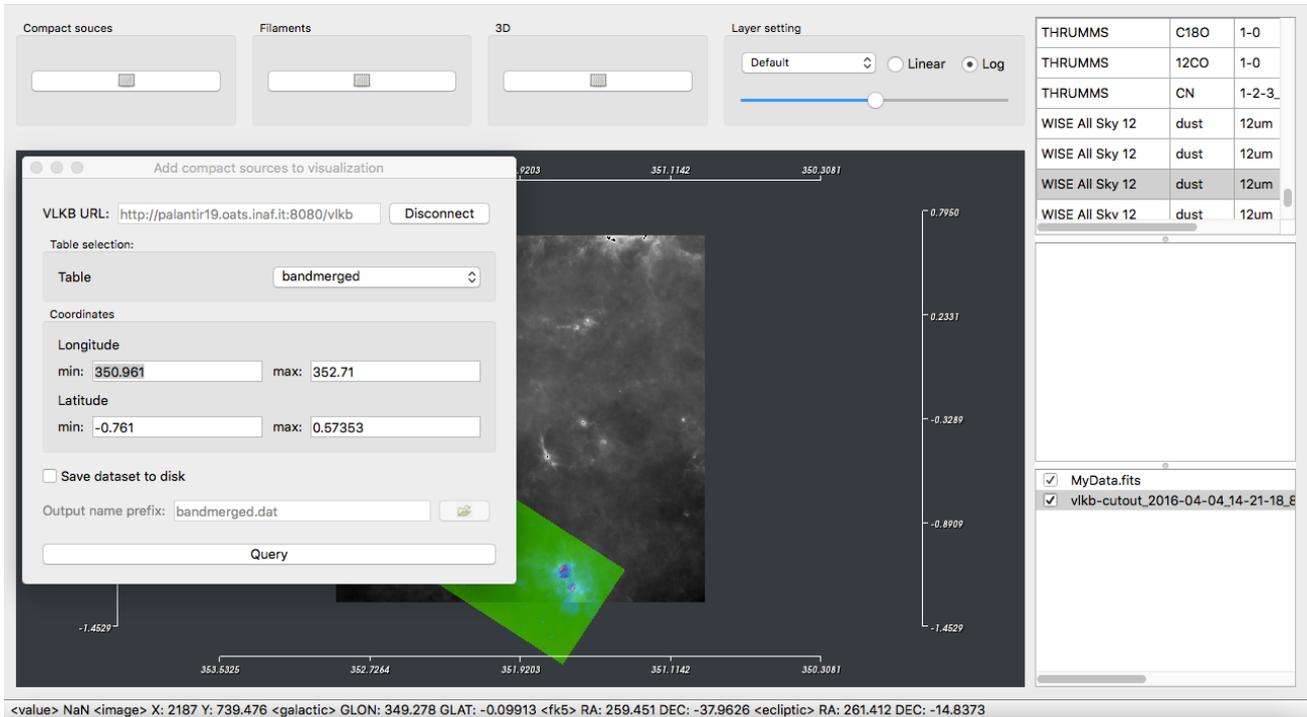


Figure 6. Adding compact sources from VLKB to visualization screen

If the user decides to retrieve compact sources dataset from the VLKB he/she should click on the "Compact Source" button (or use the shortcut cmd ⌘ +R on macOS system or ctrl+R on Linux) and make a rectangular selection of the region of interest on the visualized image. The tool, extracting coordinates from the selection made by the user, queries the VLKB (see fig. 6) and automatically displays the compact sources on top of the image on which the user is doing the analytic operations (see fig.7). By default, the Client queries the VLKB to obtain sources from bandmerged table. If the user wants to download and visualize the compact sources of just one band he/she can select the desired one from a dropdown list "Table" in the panel as show in figure 6.

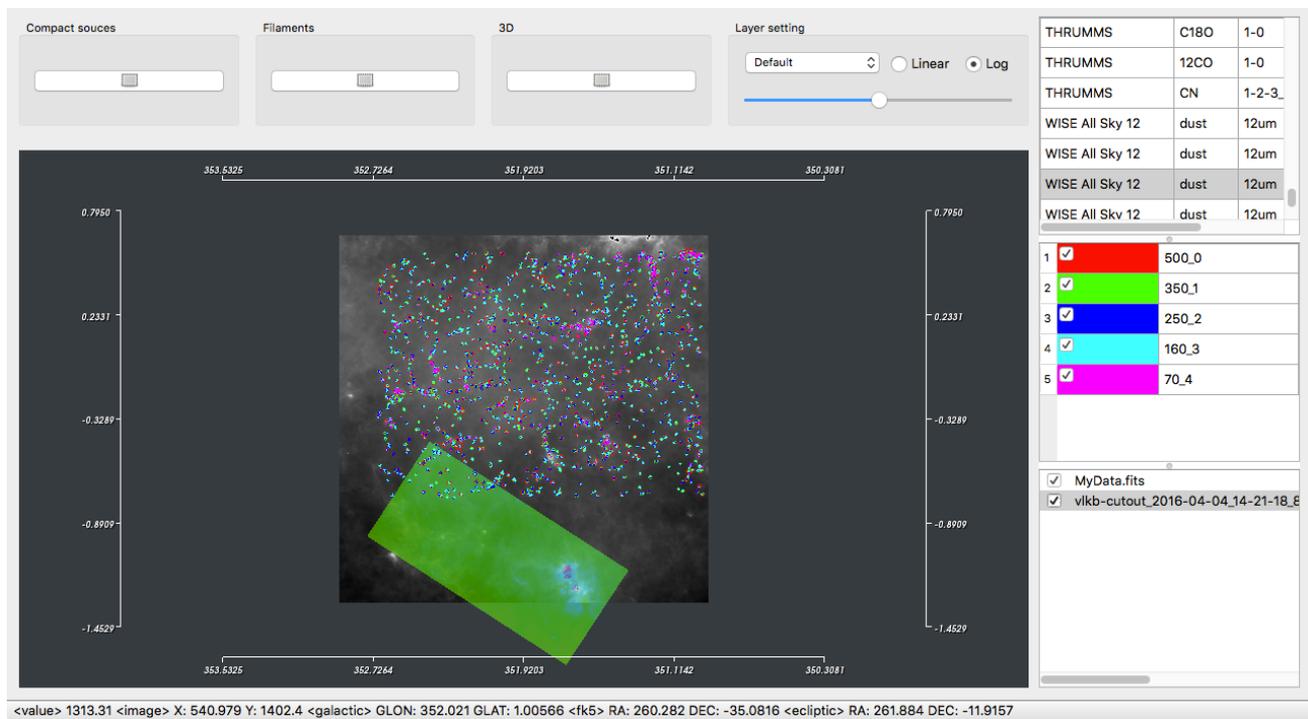


Figure 7. Visualization of compact sources from the VLKB

The compact sources are shown in different colours on the image depending on the relative wavelength (70  $\mu\text{m}$ , 160  $\mu\text{m}$ , 250  $\mu\text{m}$ , 350  $\mu\text{m}$  and 500  $\mu\text{m}$ ). As for the layers, using the checkbox in *Layer element* the user can select/de-select the compact sources to display. Double clicking on the coloured cell of each row, it is possible to change the colour used to render the sources in the visualization.

#### 4.2.1. SED Analysis

From the menu bar going to Window  $\rightarrow$  Select, or pressing the keyboard shortcut cmd ⌘ +S on OsX system or ctrl+S on Linux, the user can select one or more of the visualized clumps to perform the SED analysis.

There are three different kind of fitting operations available, one for the fit with the theoretical models and two for the analytical fit. Fitting operations are performed from the menu bar selecting Action  $\rightarrow$  Fit and then "Theoretical model" or "Grey-body" to perform the fit with the theoretical models or the analytical fits. Fit operations are performed using IDL<sup>3</sup> routines integrated, in a transparent way for the user, within the client of the visual analytics tool.

<sup>3</sup> <http://www.exelisvis.com/ProductsServices/IDL.aspx>



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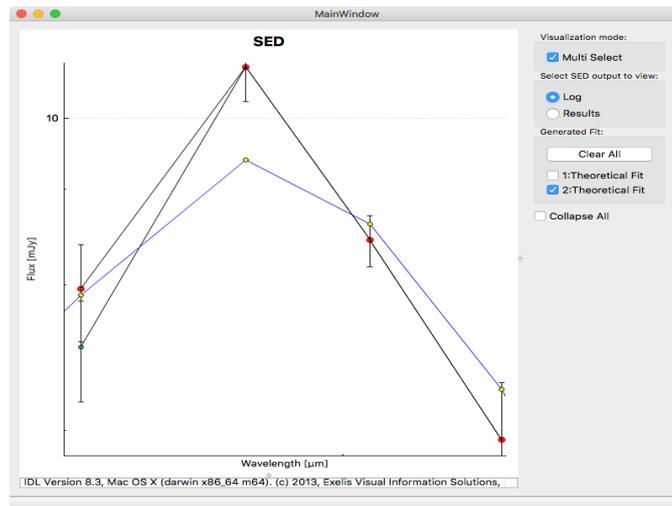


Figure 8. SED plot: in blue the theoretical fit performed on the selected SED

In the right panel the user can choose to visualize the output log or the results of the SED fitting operation. A list of SED appears once a new fit is performed so that the user can select/deselect the SED fit to visualize or press the “Clear All” button to remove all the plotted fits.

If the “Multi Select” visualization mode is activated, the user can perform the fit only on the selected nodes on the graph.

In case the SED presents multiple associations, the user can choose to sum the fluxes of counterparts obtaining the SED with a cumulative flux. This operation is done by checking “Collapse All” from the right panel. In figure 9 the SED drawn in red line is the collapsed one while the dashed lines are the original SEDs.

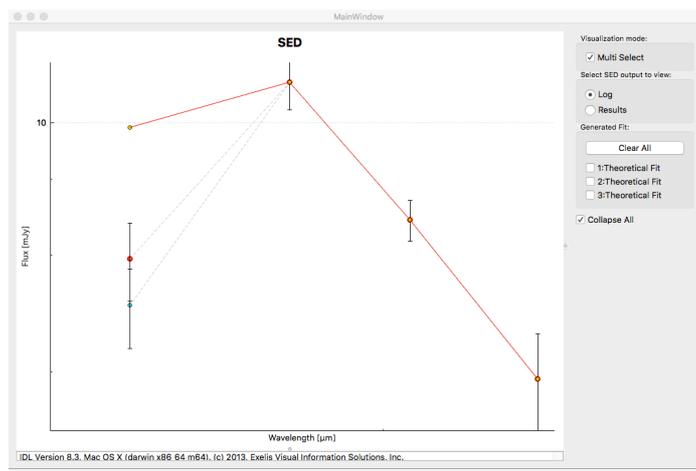


Figure 9: SED plot: in blue the theoretical SED that fit the collapsed one drawn in red

### 4.3. Filaments Visualization

Starting from a visualized 2D FITS image, the filaments candidates stored within the VLKB, can be visualized by selecting the “Filaments” button on top of the window and making a

rectangular selection. The filaments are displayed on top of the image as shown in figure 10. The filaments are visualized with contour and spine and using the checkbox in “Layer items” the user can select if visualize or remove the filaments (or its components) from visualization. Double clicking the coloured cell it is possible to change the colour of the filaments.

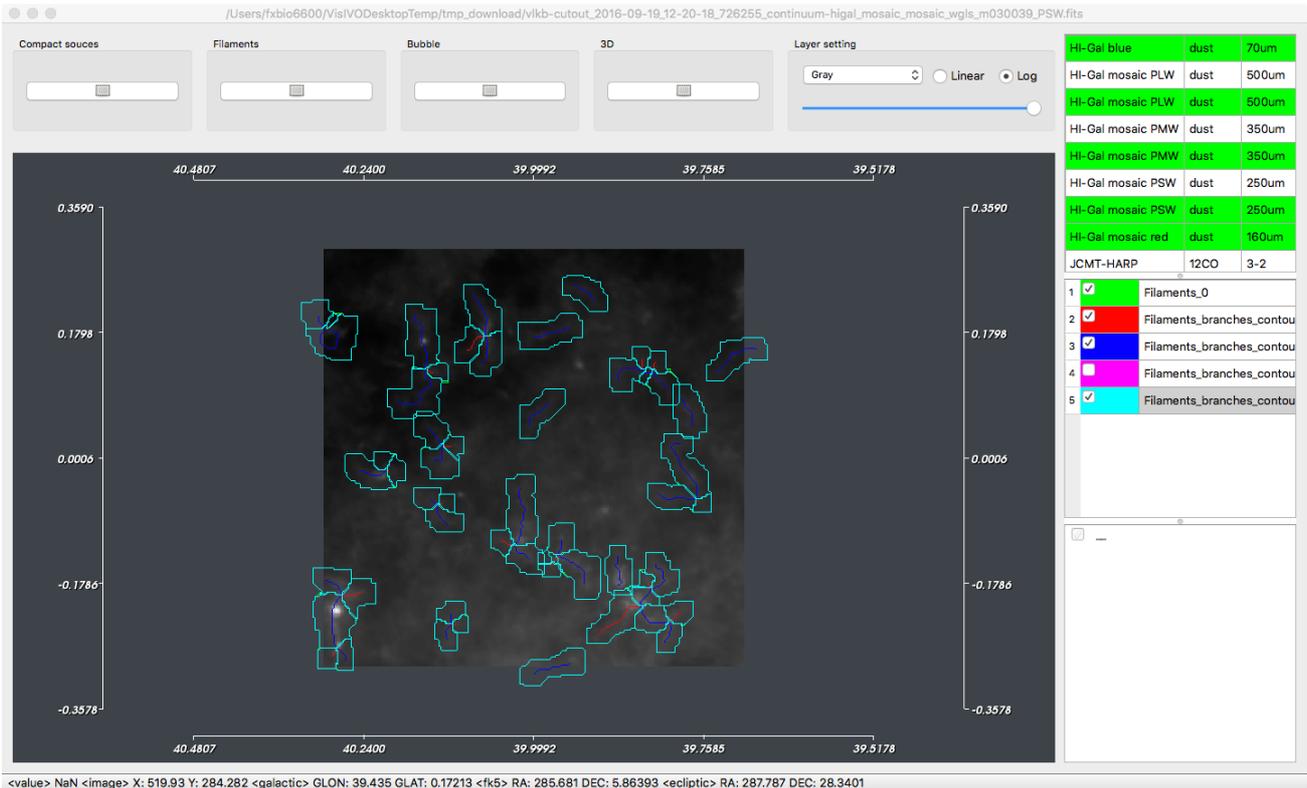


Figure 10. Filaments visualization

#### 4.4. Datacube visualization

Selecting a radiocube from “VLKB items” on the visualization window (see figure 4), the user can query the Search&Cutout service in order to get and visualize the datacube (see figure 11).

The 3D datacube visualization (left panel) can be controlled by the mouse movements and pre-defined views (e.g. front, back or top) can be selected by the Camera Control buttons on the top panel of the window.

The 3D visualization can be zoomed with mouse wheel and panned dragging it when SHIFT button if pressed.

The 3D visualization of the datacube (see figure 11) is rendered using isosurfaces algorithm with thresholds that the user can change in real-time using the slider “Threshold” located in the top panel.



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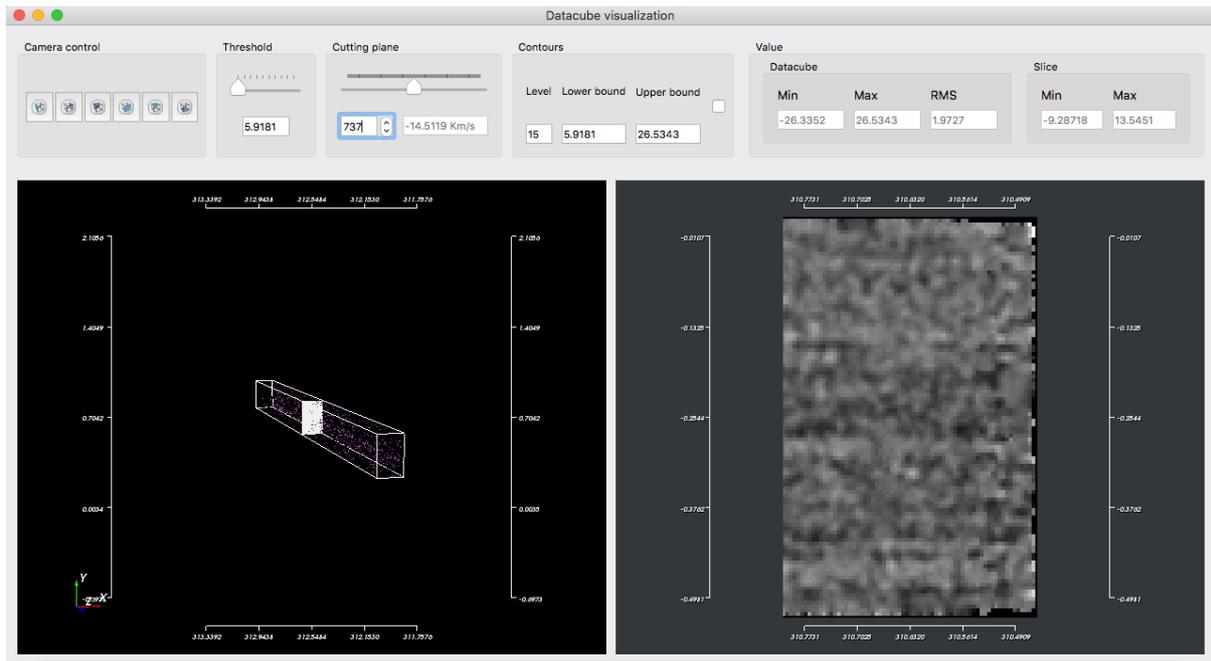


Figure 11: 3D datacube visualization

The right panel shows a single slice of the velocity datacube. With the “Cutting Plane” slider, the user can select which slice to visualize.

Contrast and saturation of the visualized slice can be changed by keeping pressed the mouse left button and moving on the image. Passing the mouse over the image allows to display on the bottom of the window the pixel value, and coordinates expressed as pixel (X, Y), galactic (GLON, GLAT), fk5 (RA, DEC) and ecliptic (RA, DEC).

If the checkbox in “Contours” is checked then the isocontours are displayed on top of the selected slice as shown in fig. 12. The contours are also reported on the 2D map image. Contours can be changed by selecting the “Level” and the Upper and Lower bound.

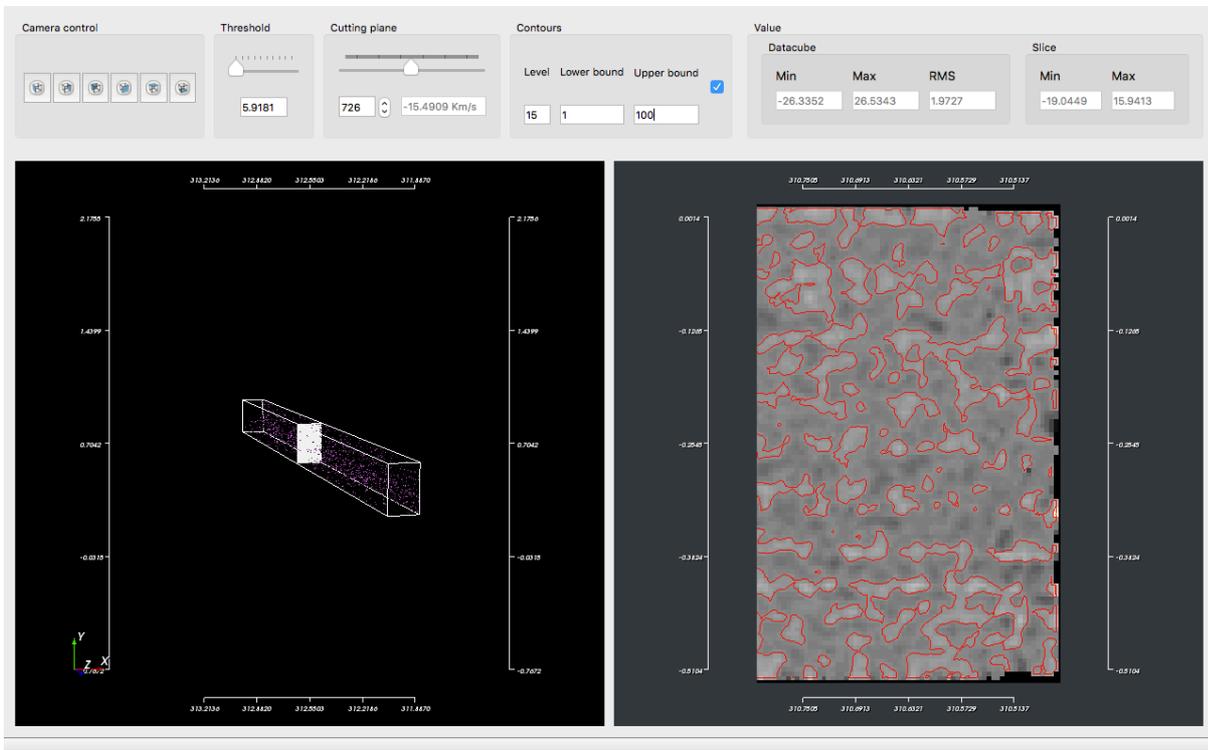


Figure 12. Contours display on the 3D datacube visualization

### 4.5.3D Visualization for sources on galactic plane

The user can select a region of interest within the FITS image to query the VLKB obtaining a 3D visualization of compact sources on the galactic plane in that region (see fig. 13). Alternatively, the 3D visualization can be performed by clicking on the 3D button of the Starting window (see fig. 2) and then choosing the longitude and latitude min – max bounds (in degrees) of the region of interest.

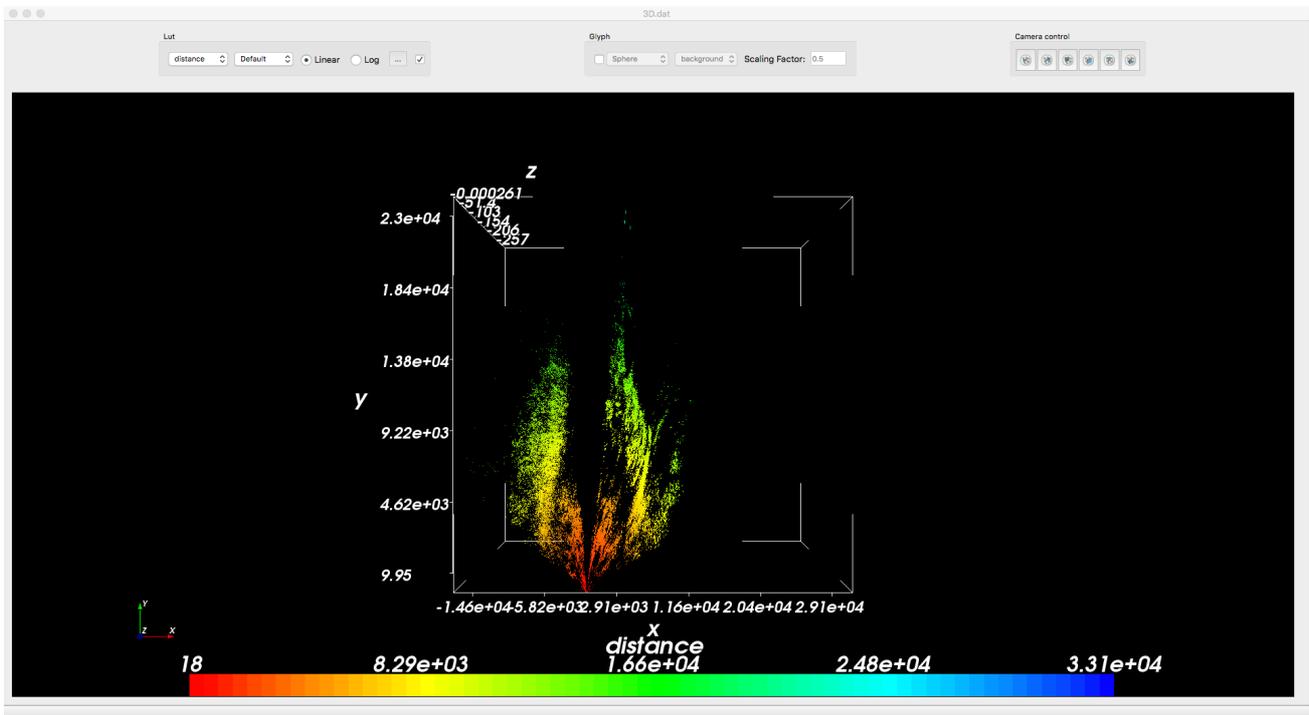


Figure 13. 3D Visualization of sources on galactic plane

The 3D view is interactive and the camera position can be moved with mouse operations. The Lut colormap scalar and type can be changed by selecting the corresponding checkbox and can be visualized in linear or logarithmic form.

If the number of visualized point is less than the value set in the Starting Window File → Settings menu (Figure 14) a glyphs can be visualized on top of the points scaled per the selected field.

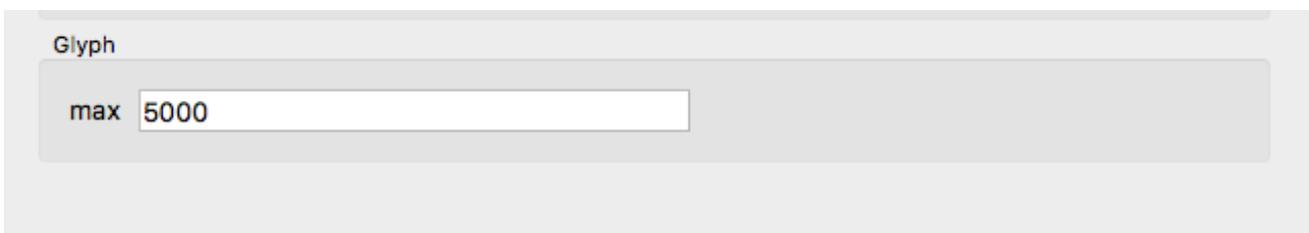


Figure 14: maximum number of point for glyph visualization

Users can select in the 3D visualization to extract the sources of interest. This selection is currently implemented as rectangular selection; the freehand selection is being under bug fixing.