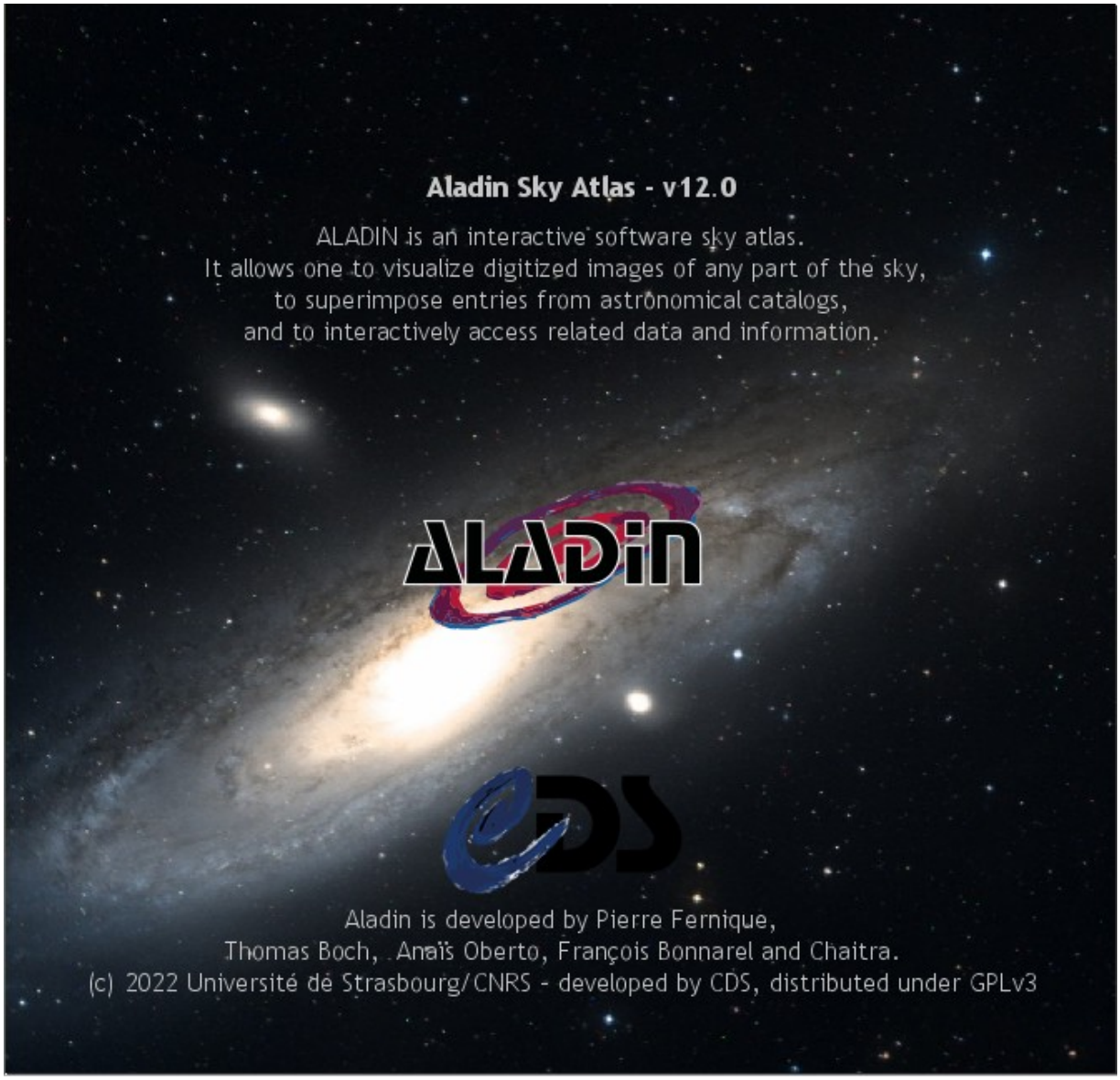
Aladin

User Manual

Pierre Fernique



June 2022 – Recent additions appear in brown.

Translation: Caroline Bot, Hendrik Heinl, Mihaela Buga, Katharina Lutz, Thomas Boch, Mark Allen with help from deepl.com

Aladin - User manual
June 2022
Centre de Données astronomiques de Strasbourg
Strasbourg Astronomical Observatory

1 Introduction

The Aladin software is an interactive atlas of the sky. It allows users to view digitised images of the sky and superimpose information from catalogues or astronomical databases.

Aladin is distributed in two forms: a lighter version "Aladin Lite" for web browsers, and a more complete version "Aladin Desktop" for classic desktop use. This manual concerns Aladin Desktop only.

Aladin Desktop allows you to access interactively most of the image data and astronomical catalogues provided by major agencies, data centres, institutes and local projects, including Simbad/CDS, NED/NASA, VizieR/CDS, MAST/STScI/NASA, CADC, SkyView/HEASARC/NASA, ESAC/ESA, JAXA, SDSS/SLOAN, SkyBot/IMCCE, i.e. all the data available in the so-called "Virtual Observatory".

Aladin is a software dedicated to astronomy professionals. It can also be used by teachers, students and amateurs. It is free of charge, and the holder of the rights is the University of Strasbourg/CNRS (see legal notice). It has been translated into several languages including English, French, Italian, German, Iranian, Russian, Chinese, Japanese, Spanish, ...

Aladin is commonly used for:

- Visualisation and verification of image and catalogue data;
- Exploration of available astronomical data;
- The preparation of observation missions;
- The generation of field maps.

Aladin is developed by the Strasbourg Astronomical Data Center (CDS). It is compatible with most desktop computer configurations including Windows, Linux and Mac. It does not require significant computing resources unless it has to handle very large catalogues (several hundred thousand objects).

Created in 1999, Aladin supports the standards of the International Virtual Observatory alliance (IVOA) (or "Virtual Observatory"), it is interconnectable with other visualisation and analysis tools (TOPcat, CASSIS, DS9, SPLAT, ...). All these strong points make it a powerful tool for data exploration and integration.

Aladin's website address is http://aladin.cds.unistra.fr.

2 Installation

The method of installing Aladin depends on your hardware configuration. In any case, it will only take a few seconds.

Installation

Aladin requires only a few megabytes of disk space for installation and 256 megabytes of RAM is sufficient for most jobs.

Any system

URL: http://aladin.cds.unistra.fr/java/nph-aladin.pl

This URL uses WebStart technology specific to software written in Java. If you already have Java installed[1], a simple click on this URL will install and launch the application.

Technical note: Depending on your security system, you may have to save the launch file (extension " Aladin.jnlp "), then explicitly indicate (generally via a right-click contextual menu[2]) that you want to open this file with " Java Web start ".

Specific alternatives for each Operating System

Windows

URL: http://aladin.cds.unistra.fr/java/Aladin.exe

If you are working under Windows, the fastest and easiest method is to simply copy the "Aladin.exe" file into one of your folders, or even on your desktop. That's all you have to do! Or ... it is not impossible that you will have to convince your anti-virus software that Aladin is not a virus.

Mac

URL: http://aladin.cds.unistra.fr/java/Aladin.dmg

The installation on Macintosh is in the form of a classic "dmg" package. You download it, open it, and copy the "Aladin.app" file to your "Application" folder. That's it! Or ... you will probably need to allow Aladin to run in the security centre of your Mac. A quick tour of your favourite search engine will give you the solution for your specific system.

1 http://www.java.com
2 In the case of a Mac, it may be necessary to hold down the *Ctrl* key to see the start button appear.

Linux and other Unix systems

URL: http://aladin.cds.unistra.fr/java/Aladin.tar

The installation under Linux is presented as a "tar" archive file. You download the file, you unzip the files using the command "tar xvf Aladin.tar" or any other equivalent utility. That's it!

Note: Aladin can be used on locally stored data. However, it is preferable to have an Internet connection, even a low-speed one (≥ 200Ko/s) to be able to access astronomical databases as well.

For more details on the installation of Aladin or to access the latest version under test, please refer to the following web page:

http://aladin.cds.unistra.fr/java/nph-aladin.pl?frame=downloading

3 Getting started

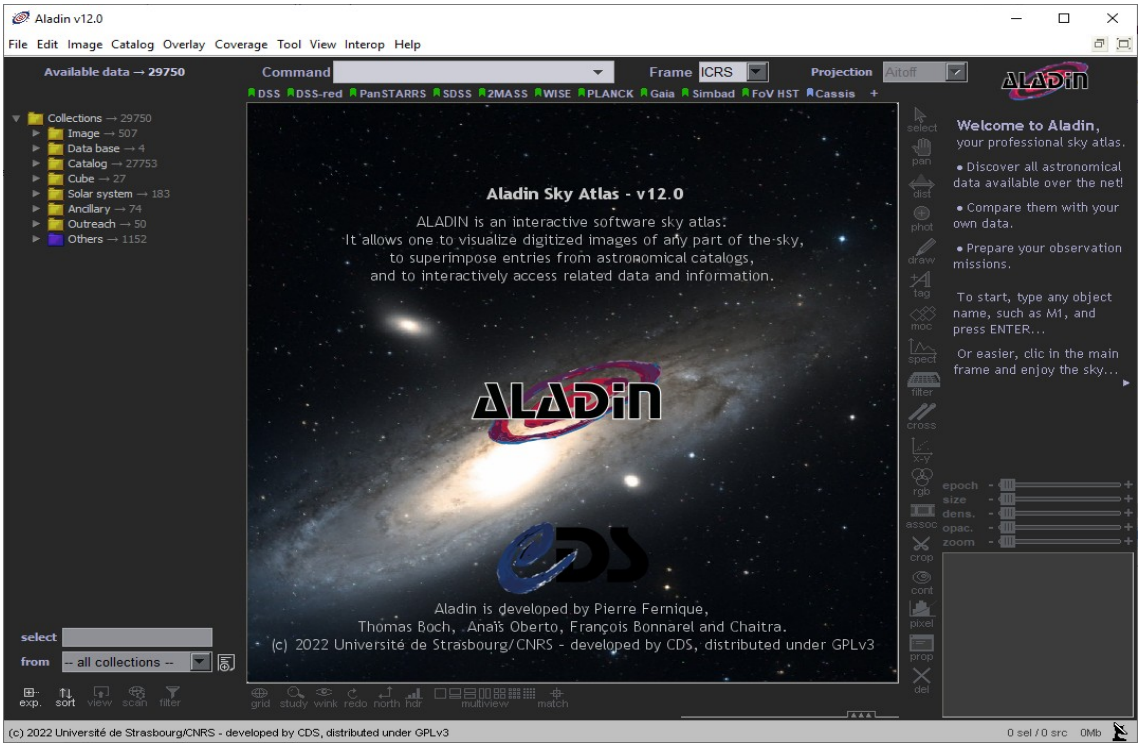
To give you a brief overview of Aladin's potential, here is a typical scenario for viewing image and catalogue data around an astronomical object:

1. *Launch of Aladin*
2. *Searching for an astronomical image of the M51 object*
3. *Search for Simbad data around this object*
4. *Loading of the Gaia catalogue around this object*
5. *Data visualization (moving, zooming...)*
6. *Consultation of measurements and original data*
7. *Backup*

We will follow this scenario step by step.

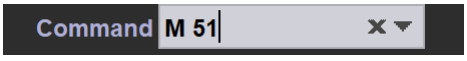
Launch of Aladin (1)

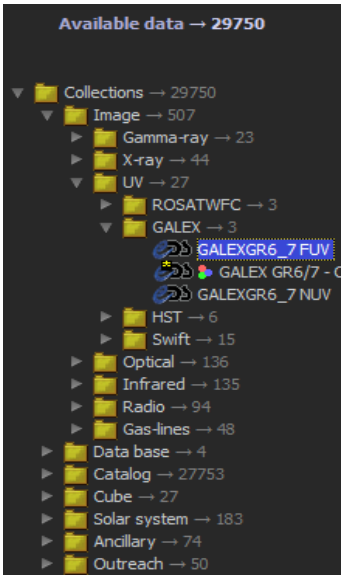
Launching Aladin depends on the type of hardware configuration you have. Under Windows and Macintosh, a double-click on the Aladin icon will launch the application. Under Linux and other Unix stations, you need to place the following command: Aladin



Data loading (2, 3 and 4)

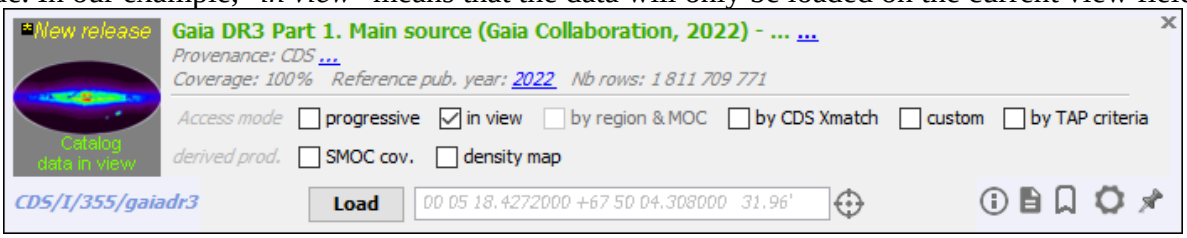
The easiest way to load an image of an astronomical object into Aladin is to click in the central panel to load a sky background - by default the colour DSS - and then enter the name or position of the central object in the input field labelled 'Command'. In our example, it is "M51".





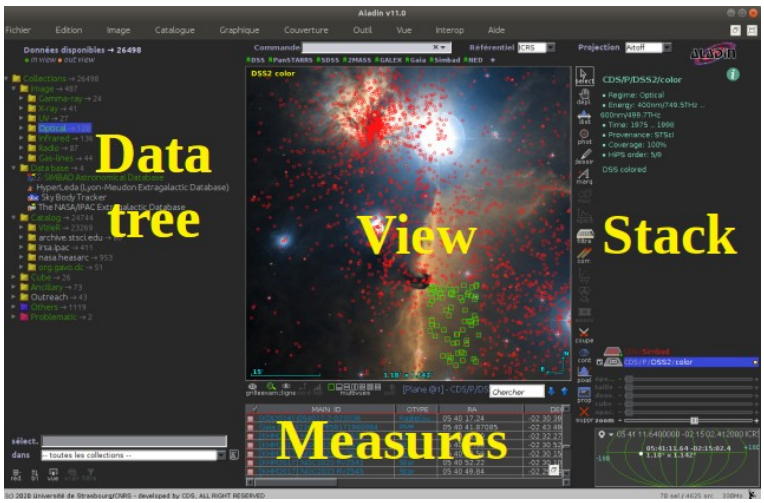
To choose a sky background other than the default one, it is necessary to open the *Data Discovery* Tree which is visible on the left of the Aladin window, then double-click on the desired sky background. In the example opposite, GALEX GR6/7 in colour. In the same way, you can load Simbad data from the "Data base" branch and the Gaia catalogue from the "Catalog/VizieR/I-Astrometrical Data/Gaia DR3.../Gaia DR3 Source..." branch. Due to the large number of collections described in the tree, it is often more convenient to simply enter a keyword in the "select" field below the tree - for example "Gaia" - to keep only the relevant collections in the tree.

Each time you select a collection in the tree, a window appears next to it offering the different possible access modes. Double-clicking on the name of the collection in the tree is a shortcut to use the default access mode. In our example, "*in view*" means that the data will only be loaded on the current view field.



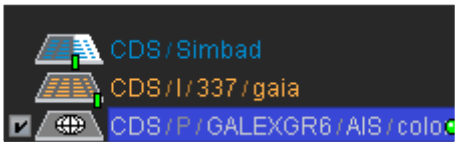
Data visualization (4)

Data visualization is done in Aladin's main window.
It is mainly composed of 4 elements:



1. **The collections tree ("Data tree"):** displays all available data collections (>20,000 collections of images, cubes, catalogues).
2. **Stack:** presents all the data loaded in the form of a stack of "plans. The observer's eye is at the top of the stack and will see "transparently" all the activated plans.
3. **The View:** displays the portion of the image visible according to the stack plans and the zoom and superimposes on this image graphic symbols corresponding to the astronomical objects in the loaded tables and catalogues.
4. **Measures:** displays the parameters of the astronomical objects selected in the view with the mouse (magnitude, parallax...).

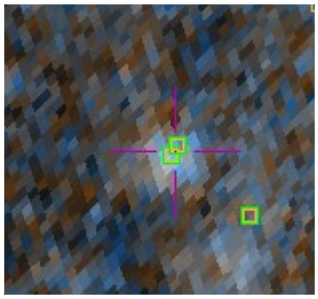
<u>*Activation of a plan:*</u> The activation or deactivation of a plan is done by clicking on the logo of each plan in the stack. It is also possible to change the transparency of these plans by means of the small ruler at the bottom of each



logo. Finally, by swapping plans with the mouse (click/drag/drop) you can change the foreground to make the view easier to read.

Zoom adjustment: The most immediate way to adjust the zoom factor is to use the mouse scroll wheel with the mouse pointer positioned "in view". If you don't have a scroll wheel mouse, you can use the ruler just below the stack.

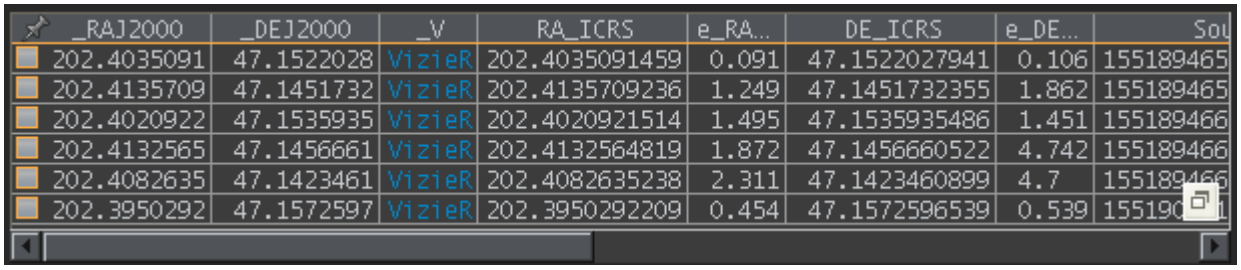
Centering on a particular object: The centre of the view shows a crosshairs (a small magenta cross). The simplest method of pointing and zooming to a particular object is to place the crosshairs on the object in question (with a simple mouse click) and then zoom in using the mouse scroll wheel. The view will automatically centre itself on the object.



Consultation of original measurements and data (6)

The view shows the objects from catalogues and tables in superimposition - in our example Simbad and Gaia. Each of these objects can be selected with the mouse, either by clicking on them or by enclosing them in a selection rectangle (click outside any object - move - release) .

The selected objects appear surrounded by a small green square. The measurements associated with them appear in the form of a table in the measurements panel. Some values appear underlined in blue as a "web link".



_RAJ2000	_DEJ2000	_V	RA_ICRS	e_RA...	DE_ICRS	e_DE...	Sou
202.4035091	47.1522028	VizieR	202.4035091459	0.091	47.1522027941	0.106	155189465
202.4135709	47.1451732	VizieR	202.4135709236	1.249	47.1451732355	1.862	155189465
202.4020922	47.1535935	VizieR	202.4020921514	1.495	47.1535935486	1.451	155189466
202.4132565	47.1456661	VizieR	202.4132564819	1.872	47.1456660522	4.742	155189466
202.4082635	47.1423461	VizieR	202.4082635238	2.311	47.1423460899	4.7	155189466
202.3950292	47.1572597	VizieR	202.3950292209	0.454	47.1572596539	0.539	155190

By clicking on one of the links, Aladin will open your browser and display additional information. The first link is generally used to display the complete original recording, in our example the Gaia recording from the first source provided by the VizieR catalogue service.

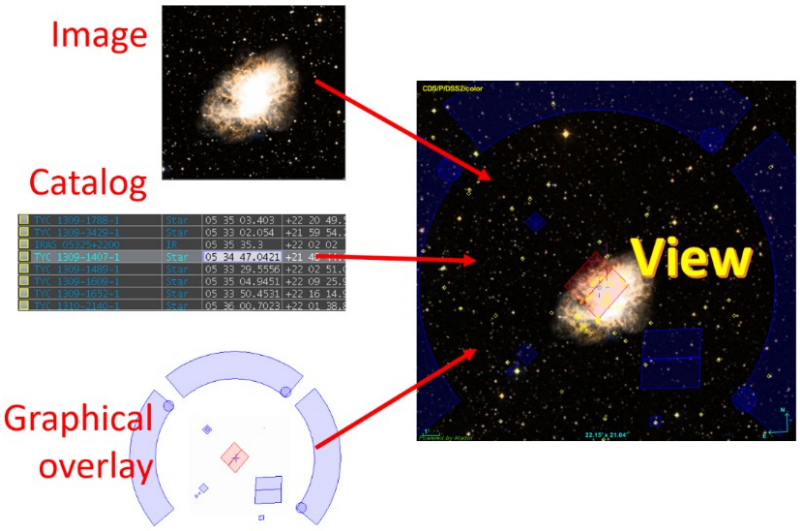
Backup (7)

Aladin offers several backup options in order to keep the current view as an image or a file for scientific publication, etc. Through the menu *" File => Save the current view => PNG " you* will obtain an image file corresponding to the current view easily usable in most office tools.

After this quick introduction to the tool, let's take a closer look at the treatment possibilities offered by Aladin.

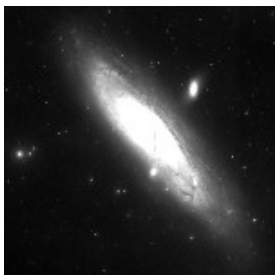
4 Overview of the data handling options

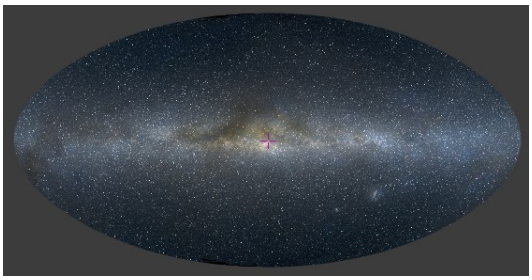
Aladin supports the following 3 main types of data which can be visualised in one or several ***"views"***: ***images***, ***catalogues*** and ***graphical overlays.*** A set of tools is available in Aladin for each of these types of data.



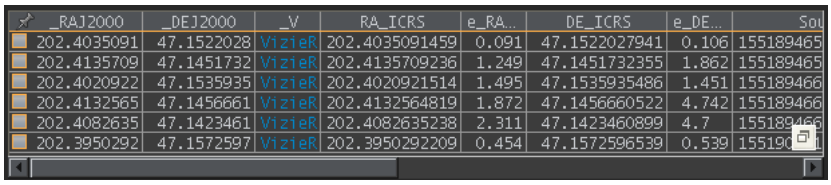
Aladin "vocabulary"

- **An astronomical image** represents a field of view in the sky. Additional information about the origin and calibration of the image (position in the sky, pixel size, projection type...) is usually provided. Aladin supports two types of astronomical image: "regular" images (with a rectangular pixel array), and also HiPS (Hierarchical Progressive Survey) images.



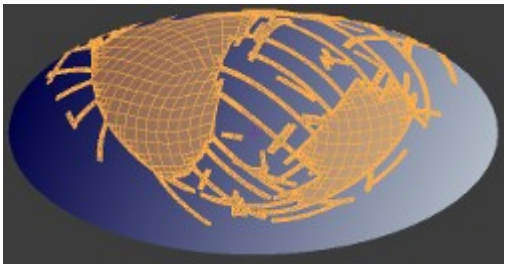


- **An astronomical catalog** is made of one or several tables whose rows represent information characterising one astronomical object or "source" (typically including an identifier, position in the sky, physical features etc.). Aladin supports regular tables in various formats, but also tables generated dynamically from an HiPS catalog;



_RAJ2000	_DEJ2000	_V	RA_ICRS	e_RA...	DE_ICRS	e_DE...	Sou
202.4035091	47.1522028	VizieR	202.4035091459	0.091	47.1522027941	0.106	155189465
202.4135709	47.1451732	VizieR	202.4135709236	1.249	47.1451732355	1.862	155189465
202.4020922	47.1535935	VizieR	202.4020921514	1.495	47.1535935486	1.451	155189466
202.4132565	47.1456661	VizieR	202.4132564819	1.872	47.1456660522	4.742	155189466
202.4082635	47.1423461	VizieR	202.4082635238	2.311	47.1423460899	4.7	155189466
202.3950292	47.1572597	VizieR	202.3950292209	0.454	47.1572596539	0.539	155190

- **A data collection** is a set of homogeneous data (images, tables, spectra, etc), characterised by a unique name and homogeneously accessed;
- **A coverage map** represents a region covered by a data collection called MOC for Multi-Order Coverage map . A MOC can not only describe a spatial coverage, but also a temporal one, or both simultaneously;

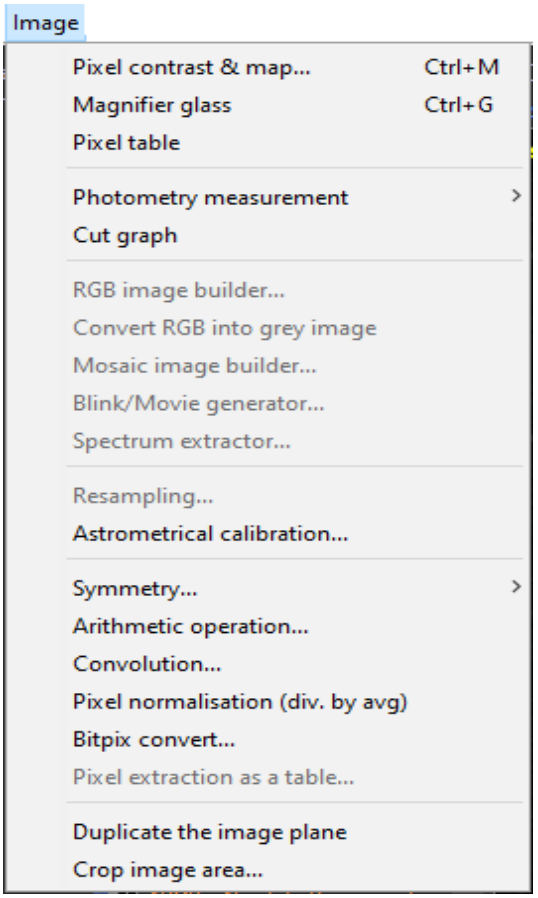


- **A graphical overlay** represents one or several graphical items (line, circle, polygone...) with associated positions on the sky;
- **A view** is a projection of a part of an image, within which symbols associated to each catalog source and/or graphical overlays can be plotted;

- **Coordinates** in the sky usually represent a pair of angles (*RA* – Right Ascension, *DEC* – Declination)[3]. Aladin does not handle the distance to the observer, but only the representation on the sky.
- **A date** unsurprisingly represents a specific moment in the time scale.

We will briefly describe the various ways one can use Aladin to handle images, catalogs, graphical overlays and views.

Image treatment

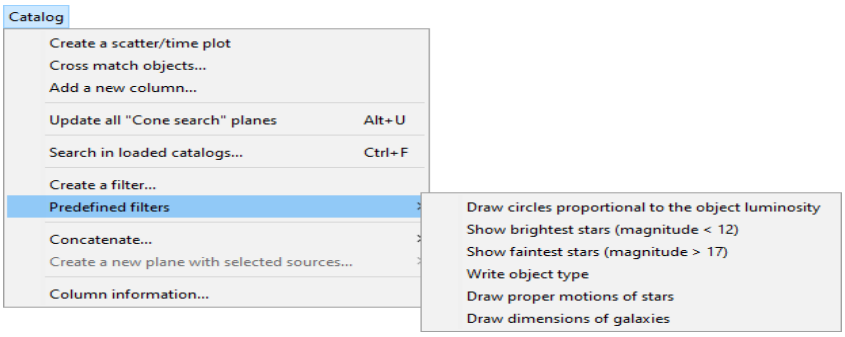


Several approaches to handling images are available in Aladin: one can control the image grey-scale or colour levels. Images can be accessed in preview mode (e.g. jpeg or png) or with their full pixel values (FITS). Different capabilities are available for accessing small or big images, regular images or HiPS.

The most common image treatment features are:

- Adjusting the pixel dynamics (contrast);
- Photometric measurements within polygon or circular areas;
- Rotation or other symmetry operations (up / down, right / left);
- Rotation or other symmetry operations (up / down, right / left);
- Generation of composite images (creating one color image from 2 or 3 other color images, mosaics, cubes,...);
- Image resampling as a function of the astrometric solution of another image;
- Astrometric calibration of an image (using either parameters or the correspondence with another catalogue or image);
- Pixel calculations (sum, subtraction, multiplication, division, convolutions, standardisation);
- Extraction of a sub-image from an image;

Operations on catalogues



Aladin can handle two types of catalogues: Classical catalogue tables where a table can be overlaid on images. Also, HiPS "progressive catalogues", where the number of sources shown depends on the size of the view. Several operations are possible, according to the type of the catalogue:

- Handling measurements associated to sources (selection, filtering, sort, pointing,...);
- Parametrizing of the graphical representation of the sources with respect to the measurements values (e.g. : drawing of circles whose size is proportional to the magnitudes, proper motion arrows, errors ellipse);

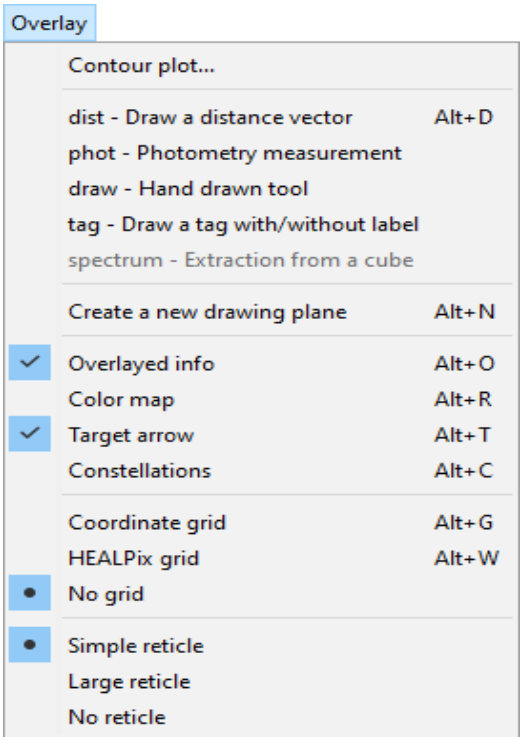
3 it can also be "Longitude" et "Latitude" in conformity with the chosen spatial reference system.

- Cross-matching between the sources of two catalogues;
- Plotting a graph-based representation of points clouds, given two physical scales of a catalogue;
- Calculating new column of measurements;
- Generation of subsets of tables.

Operations on graphical overlays

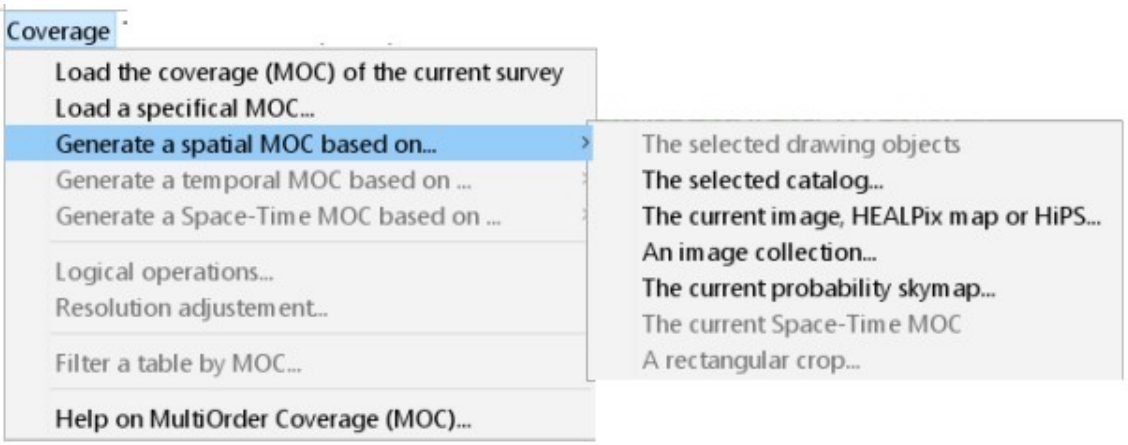
Aladin handle several types of graphical overlay. Several operations are possible with respect to the overlay type:

- Contour extraction;
- Measurements graphical tools (photometry, angular distances);
- Tagging tools;
- Freehand drawings;
- Textual annotation;
- Image graph-based representations with respect to the line segment or the third dimension for the cubes.
- Superposition of a coordinated grid or constellations;
- Image shifts, and rotation.



Operations on the coverages

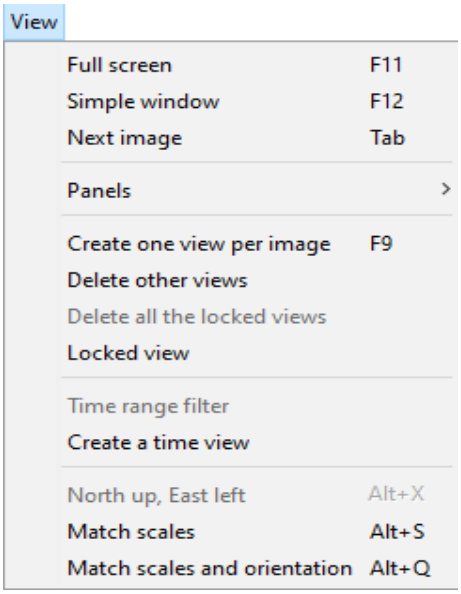
Aladin uses the MOC (Multi-Order Coverage) to characterise sky coverages. It is a method to describe a spatial coverage (i.e. a possibly complex region of the sky), or a temporal coverage (i.e. a list of temporal periods), or both simultaneously. This technique allows to perform logical operations (unions, intersections, etc) in an extremely efficient and fast way.
In order to generate a MOC from a data collection, either the data collection has already been precalculated and it only needs to be accessed like a data collection derived product, or Aladin can generate the derived product from the data collection (images, sources, catalogues).



Operations on views

- Superposition of catalogues, graphical overlays, and eventually other images overlays using the semi transparency functionality;

- Zooming and moving;
- Multi view side by side visualisation (2,4,9 or 16 simultaneously views);
- Views synchronisation (same scale, same orientation);
- Generation of “temporal” view;
- Generation of “sticker” view around an object of interested;
- Full screen visualisation.



These different operations are possible through an ordinary graphical interface. As usual, in order to integrate the various working habits, several options are available:

1. the menu bar in the upper side of the main window;;
2. the toolbars (clickable buttons list);
3. contextual menus accessible by right clicking or CTRL click (Mac);
4. keyboard shortcuts (keys combination).

Note : These operations can also be handled using script commands. See the end of this manual for more details (see 7.1)

We will next discover, in more detail, different elements corresponding to the graphical interface, how do they function, etc.

5 The graphical interface in detail

Aladin offers a rich and sophisticated graphical interface that allows you to perform most basic functions in just a few clicks. The main window concentrates all the functions for selecting and viewing data:

- The tree of data collections;
- The view(s);
- The battery;
- The measurements panel.

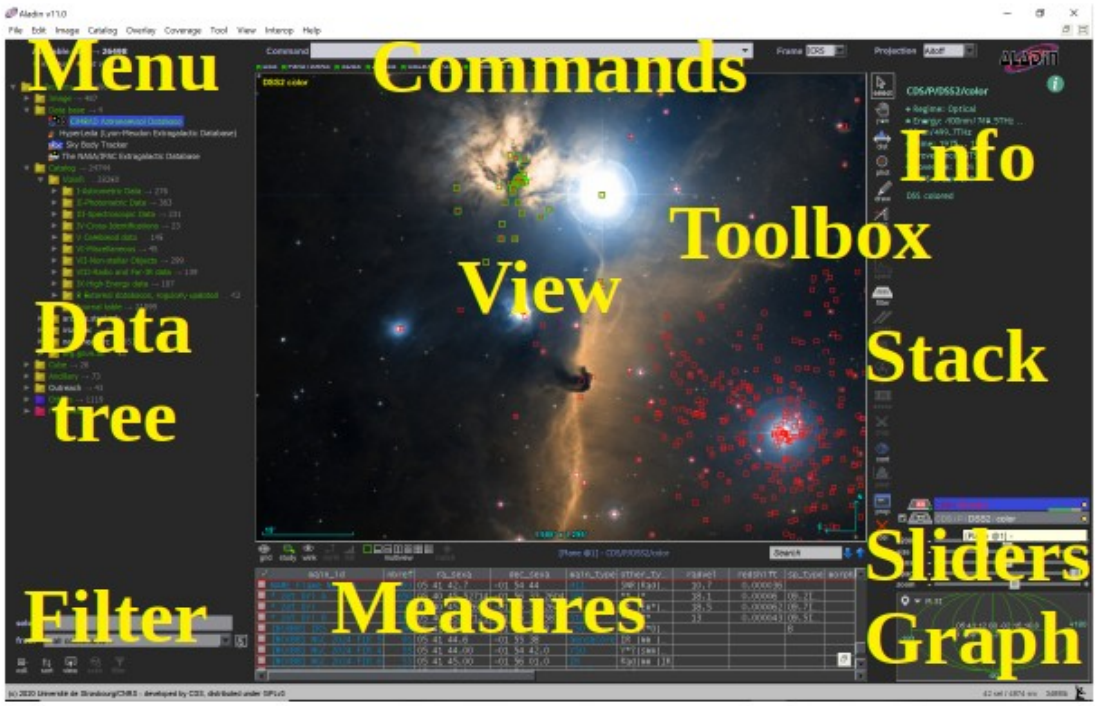
Several other windows allow various controls, of which the main ones are:

- Pixel dynamics control (contrast);
- Contour extraction;
- The edition of the filters applied to the catalogues;
- The calculation of correlations between catalogues;
- The calculation and addition of new columns on the catalogues;
- Checking the astrometric calibration;
- Image resampling control;
- Arithmetic operations on images;
- The generation of HiPS (progressive readings);
- The generation of MOCs (spatial and/or temporal coverages);
- Backups;
- The management of user preferences (configuration);
- The command console for using the scripting mode.

We are now going to review the different elements of the interface, present their role, their interactions…

5.1 The main window

Aladin gathers in a single window most of the elements that are necessary for data selection, visualisation and exploitation. In the main window, one finds: on the left: the menu side bar, a tree for data collections ("data discovery tree") and its own filtering system ("Filter"), on the right hand side: a command panel, a toolbox, a stack with sliders, an information list on top and a multi-usage panel ("graph") at the bottom, at the center, the main panel displays the views, with a panel for measures below.



Tip: The relative proportions of the different elements can be modified by locating the mouse at the interface between the different panels. When the cursor displays a symbol for changing proportions, click and drag to change the size of the panels. These proportions will be kept from one session to the next.

Guided Tour

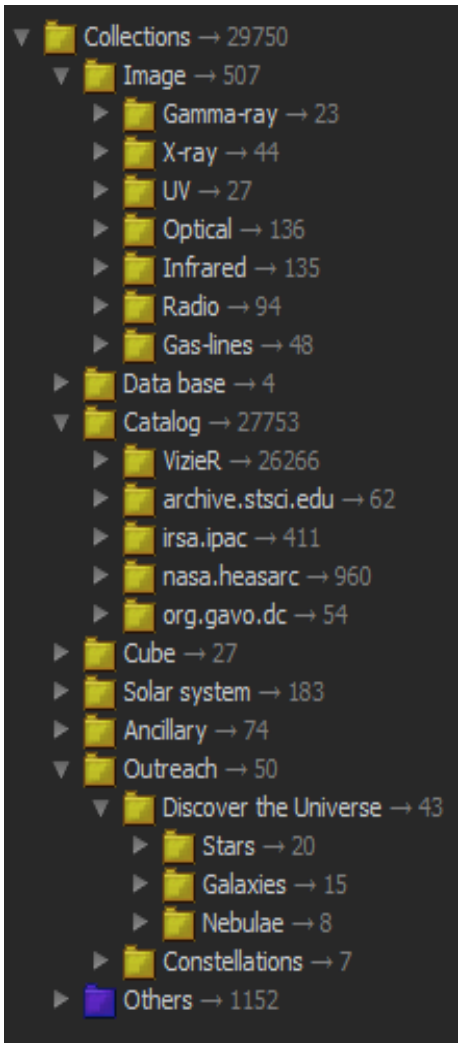
Menu:	**Help=>Aladin guided tour...**
Keyboard shortcut :	**F1**

To help the discovery of the main window, Aladin suggests a "guided tour" that you will find in the "Help" menu. Once the function is active, use your mouse and move over the different elements of the main window to see a description of the elements.

5.1.1 Discovery Data Tree

The Discovery Data Tree allows the discovery, visualization, exploration, sorting, filtering and loading of all available Aladin compatible data collections. This tree therefore contains the description of several tens of thousands of data collections, coming from different agencies and data

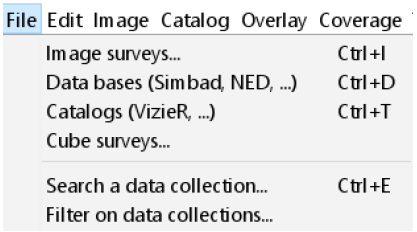
centers -among which the CDS (Centre de Données astronomiques de Strasbourg)- but also research projects, and so on. This represents a very large fraction of astronomical data that are public on the internet.



The structure of the tree is dynamic. It depends on the available data and of the editorial responsibility of the CDS, especially for the order of the different divisions. Currently, the first level of the tree is divided in 3 categories: collections that are selected and sorted by CDS in yellow, and all other collections in blue.
The yellow branches of the tree are sorted by CDS along three criteria: 1- by data type ": "Image", "Catalog", "Cube", 2 – by highly used specific servers : "Data base", and 3 – for outreach : "Outreach". Every collection at this level usually appears only once.
The blue branches of the tree also have the same subdivision by data type, then by the origin of servers. A single data collection (or a similar one) may appear several times as it may be served simultaneously by different data centres. It is up to the user to check and choose the best one for his needs.

Opening and closing branches is done thanks to the small triangle on the left of each line. This triangle creates an action at a single depth. On the opposite, the icon located at the bottom of the tree enables the user to open or close the full depth the selected branch  . On the other hand, the order of appearance of the branches as well as the collections can be modified by means of the sorting icon located under the tree  , either globally or for a particular branch depending on the current selection.

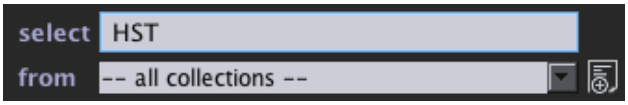
Quick access

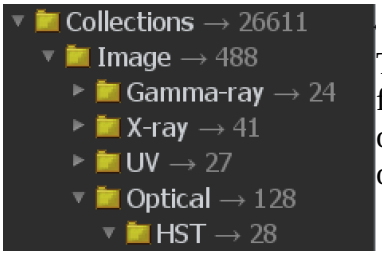


The main menu "File" has functionalities to open and directly access some specific branches of the collection data tree. This menu also hosts ways to filter the data tree.

Filtering the data tree

The easiest way to find a specific collection is to filter the data tree, either by keyword or by more complex constraints taking into account different known properties of this collection.

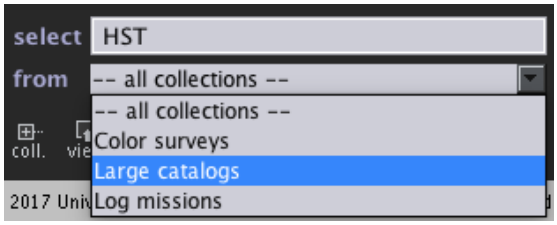




The small form located under the data tree allows you to enable the filtering functionalities. There are two levels of filtering. The simplest one is to type a keyword in the "select." field. The tree will then show only the collections that correspond to this keyword. The number of

collections in each branch is labeled on the right of each line and the total number of selected collections is displayed on top of the tree.

For a more advanced filtering, one needs to create a "dedicated filtering rule" with the icon located at the left of the form  . These rules may be saved and used later in your future sessions thanks to the menu that unfolds at the "in" part of the form. How to create filtering rules is fully described in section 5.4 - Filtering the data tree.



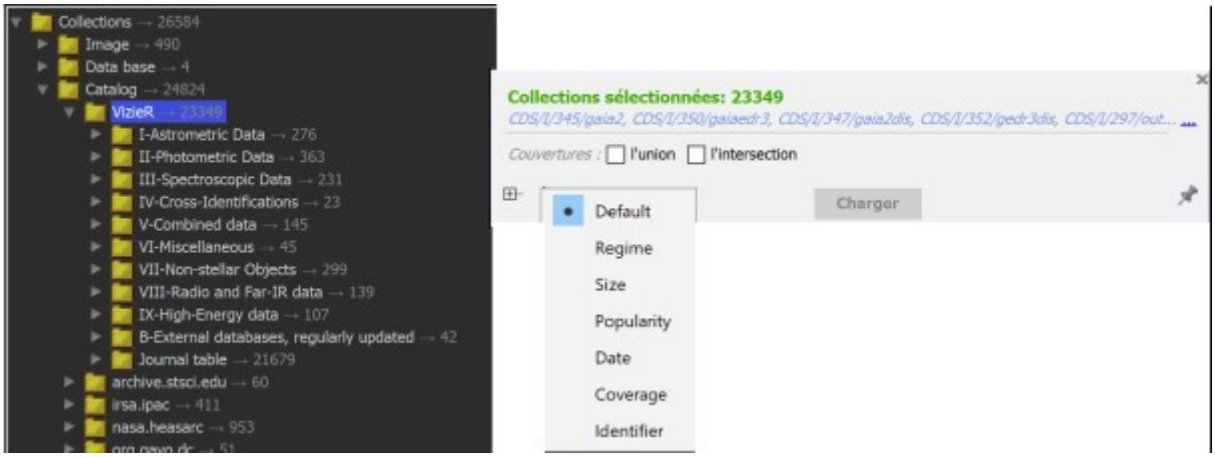
The "filter" icon at the bottom right is green is a filtering rule is active. Clicking on this icon deletes this action and restores the original state of the data tree.

Sorting the data tree

A small sorting data tree logo allows to sort the data tree according to different criteria. It appears under the data tree, but also in the access window. Both do almost the same thing, but not quite.

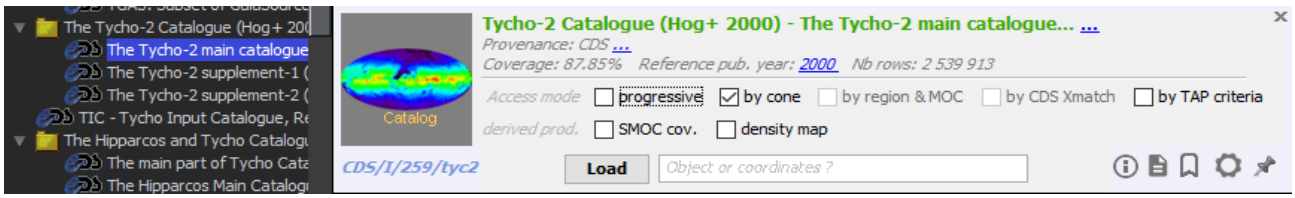
The one at the bottom is general for the whole data tree, and therefore limited to sortable global properties.

On the other hand, the one in the access window applies to the branch concerned, and often allows more sorting. VizieR branch is a good example because it is possible to sort by popularity as shown in the example below:



The Access window

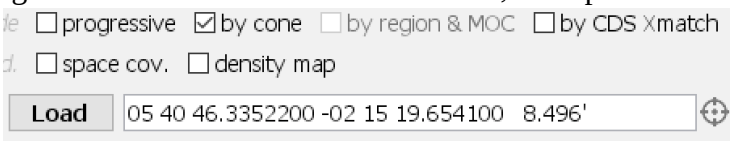
By selecting a leaf of the tree with your mouse, a specific collection is selected. This is when the "*access window*" appears close to the selected collection. In this window, a short description is given (title, description, coverage properties, volumes, …) as well as a set of different ways to access the data collection and the associated products like a density map, a coverage map (MOC) or other related collections.



Note : Mouse hovering over another entry in the tree will dynamically change the window content and its position on the screen to stay facing right. If you wish to temporarily suspend this behaviour in order to be able to preserve the content and manually determine its position, click on the "pin" icon at the bottom right. .

Shortcut: The most logically used access mode being already pre-checked, it is this one that will be chosen in case of a direct double-click on the leaf of the tree.

Some access modes require additional information to be able to load the data. This can be the designation of the field of view ("by cone"), the selection of a particular region or a specific MOC ("by region or MOC"), the pre-selection of another table ("by Xmatch CDS"), or even the entry of particular criteria ("by criteria" or "custom"). The input box that appears when the "by cone" check mark is selected allows you to designate the relevant field of view by indicating the astronomical object (or the long/lat coordinate), as well as the radius of the interrogation cone.
By default this box takes the cone covering the current field of view. However, it is possible to modify this default behaviour, either by entering the desired target and radius directly on the keyboard or by using the "target" icon . This will allow you to specify the query circle directly in the view with the mouse (click/drag) (see 5.2.1).

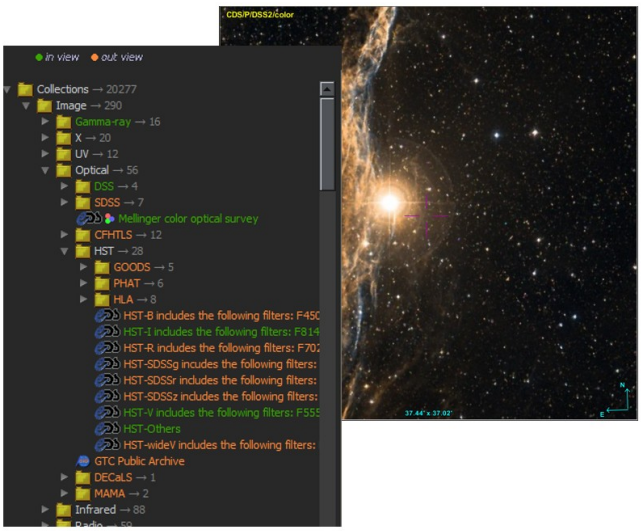


Note: Some settings are permanently predefined, but can be temporarily modified for the current Aladin session via the icon .

When a multiple designation is entered in the collections tree, either by selecting several leaves (CTRL and/or SHIFT key enabled) or by selecting one or more branches, the form shows the access modes and collective derived products for the designated collections. For example, it may be possible to request the union or intersection of the spatial coverage of the selected collections.

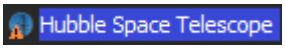
Locate the collections present in the field of view

Loading data activates Aladin's view and therefore automatically colors some leaves and branches of the tree in green or orange. This color code indicates which collections in the tree have (green color) or do not have (orange color) data in the current view field (spatially and/or temporally).



Activating the "view" icon 

below the tree temporarily hides collections that do not have data in the field of view (orange color). Changing the field of view by zooming or moving to another position will affect the tree after one or two seconds.

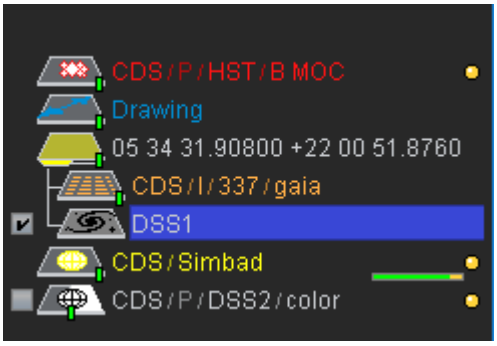
Technical note: This functionality is based on the availability of a description of the coverage of each collection (a MOC). Unfortunately, this one is not always available. Collections that do not have them will always appear in white and cannot be filtered. A small alert 

symbol will make you aware of it.

To overcome this problem, Aladin can temporarily generate missing MOCs only on the 

current view field using the small "scan" icon below the tree, after selecting the collections concerned. This operation is time-consuming because it really queries the servers of these collections. It can therefore only be used on a limited number of collections and in a relatively small field of view.

5.1.2 The stack



The stack represents all the data loaded in memory that can be displayed in a view. The stack is structured as a set of "planes", named, and superimposed one on top of the other. The user observes them from above, in transparency.

Types of planes

Planes can be of different types depending on the nature of the data they contain. They are identified by different specific logos (see 8.1). Mouse hovering over the logo or plane name displays information describing the plane in the area above the stack. At the same time, if it is a classic image, the corresponding field of view can be temporarily displayed in superposition of the current view.

Pile and the associated view

In the simplest case, the stack contains only one image with a few catalogue planes and/or graphic overlays centered on the same area of the sky. It is then possible to create a view displaying the image and overlapping graphic symbols.

To create a view for a plan, there are two methods:

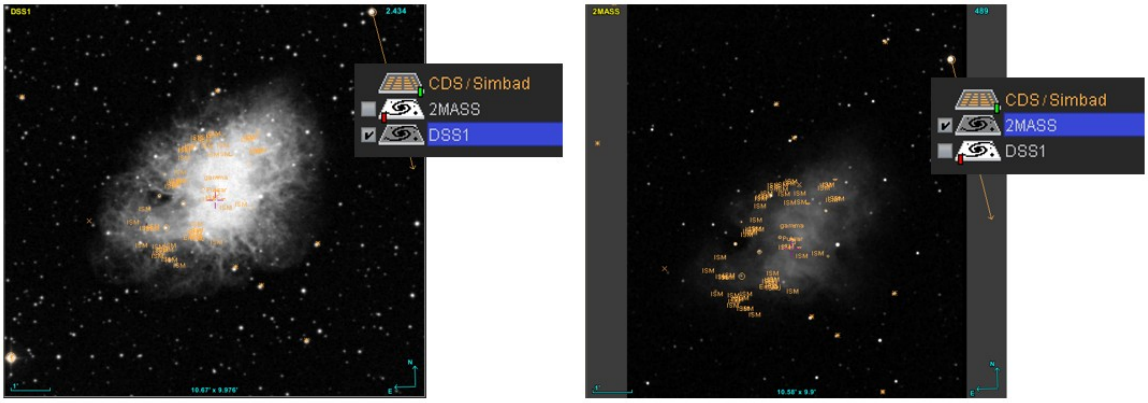
- Either by clicking on the check mark to the left of the plan logo ☑;
- Or by "clicking/sliding/dropping" the plan logo from the stack to the view.

To activate another plane in the same view, click on its logo  .The proportion of grey in the logo indicates the level of semi-transparency. When the logo is completely greyed out, the plane is fully activated.

Tip: It is possible to create a view based only on a plane - catalog, without a background image. To do this, you must use the "click/drag/drop" view creation method described above.

Another image plane of the same field can be inserted in the stack in order to compare these two images, either by semi transparency (see corresponding section), or alternatively by clicking on the

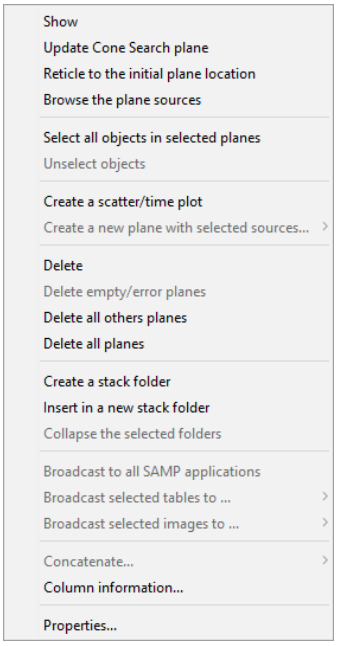
check mark of one image then the other, or by creating a composite plane (false colors or blinking planes).



It is also possible to simultaneously load image planes and/or catalogues in the stack that do not represent the same position in the sky. The visualization of the two sky zones can be done either alternately by activating one or the other of the respective image planes, or simultaneously by using several views displayed side by side (see 5.1.3).

Hierarchical structure

In order to facilitate the organization of the stack, it may be desirable to group certain plans into a folder or even a sub-folder. The creation of a folder is done either by the main "Edit" menu, or by using the contextual menu of the stack (right click or CTRL click).



Contextual menu

The stack has a contextual menu accessible by using the right button (resp. Apple+click for Mac). This menu contains all the functions specific to the manipulation of planes, for example their deletion, or the display of their properties.

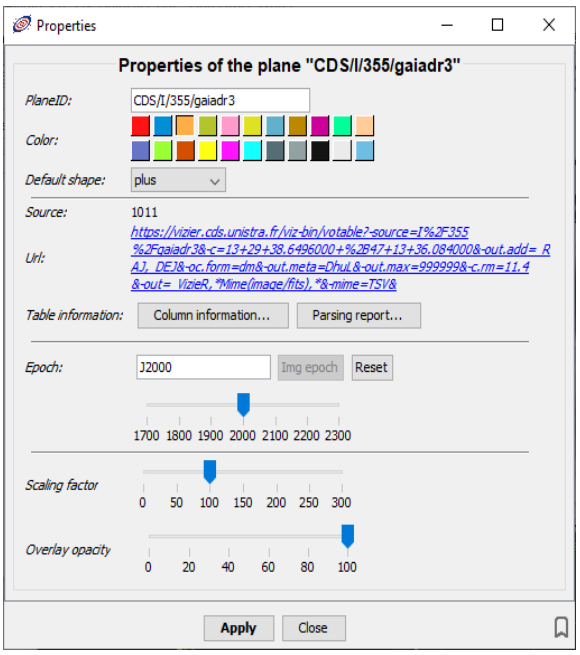
Selection

Selecting a plane from the stack is done by clicking on its name - not on its logo (plane activation). The selected plane appears with a blue background. It is possible to select several planes simultaneously by holding down the Ctrl key, or Shift key if it is a group of consecutive planes. Some items of the main menu, or the contextual menu, as well as the toolbar icons will be enabled or disabled depending on the nature of the selected plan(s). For example, if it is an image plane, the "contour" button will be activated.

Properties

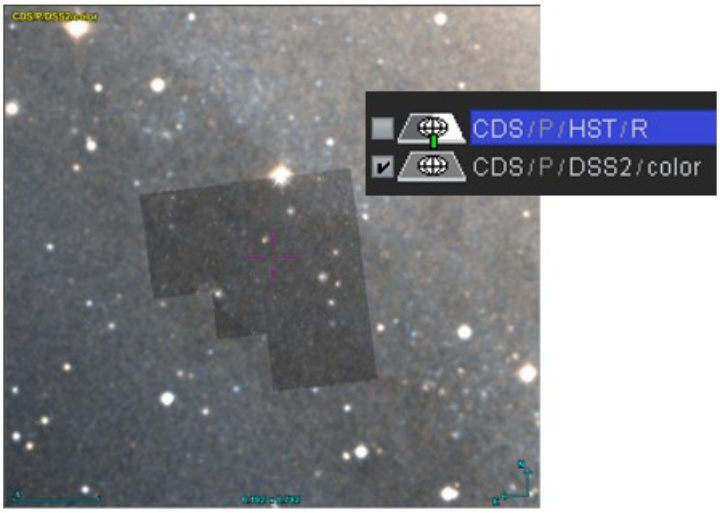
Icon: prop.
Menu : Edit > Properties
Shortkey : Ctrl + Enter
Script : set…, status …

The display of the "properties" of a plane is done either by the "*prop*." button, by the main menu "*Edit => Properties*" or by the contextual menu of the stack (right click or CTRL click). The window that opens shows both the generic properties: name of the plane, origin of the data... but also the properties specific to the nature of the plane. This window also allows you to modify some of these properties. For example, it will be possible to change the graphic symbol used to draw the sources of a catalog or to adjust the rotation angle of an instrumental field of view. The properties window also allows you to view or even copy the Web address used by Aladin to obtain the data.

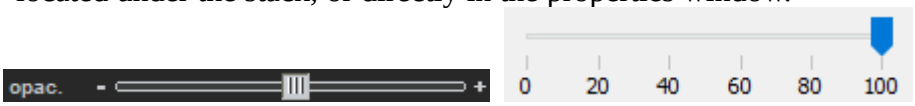


Transparency control

Some planes can be displayed in semi-transparency over the background image. It can be a catalogue plane or one that contains an instrumental field ("FoV") or an "image" plane above another image. Whenever possible, the logo of the plan in question is provided with a small stick. This can be dragged to the right to increase the opacity level of the plane, or to the left to decrease it.



Tip: In order to have a larger slider, the transparency level can also be controlled either by the "opac." slider. "located under the stack, or directly in the properties window.

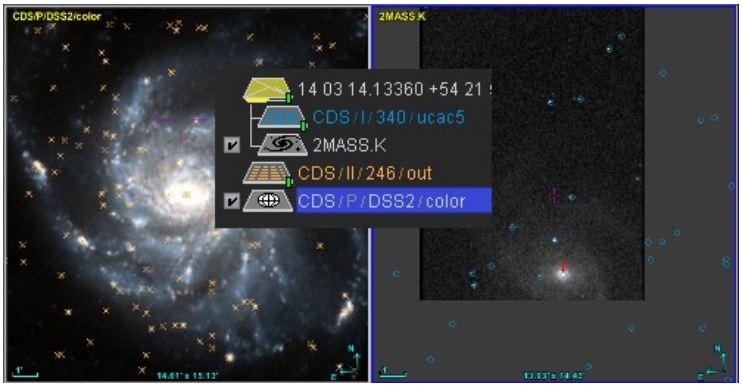


Various tips and tricks

- At the bottom right of the view, an icon symbolizes the observer's eye 

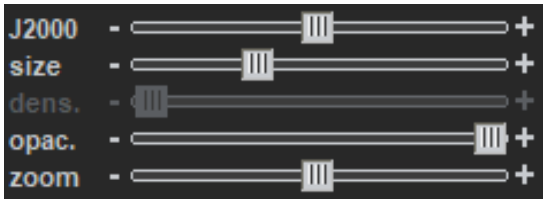
. This element can be clicked to hide all the graphical plans with a single click and display only the background image. A second click on the eye will restore the previous configuration.
- To help you locate the data, double-clicking on the plane's logo will briefly flash the associated data during a few seconds.

- A catalogue plane at the top of the stack will by default be systematically projected on all images of the same field located below it. In the case of the multiview (see next section) it may be interesting to restrict the projection of a catalogue plan to a particular image. To do this, simply place the catalogue and the image concerned in the same "folder". Then via the "properties" associated with the "folder", select "scope: local": the folder then appears as a closed envelope and the catalogues found there are no longer plotted on the other images.



5.1.3 Control sliders

Below the pile there is a set of rulers. They allow various controls:

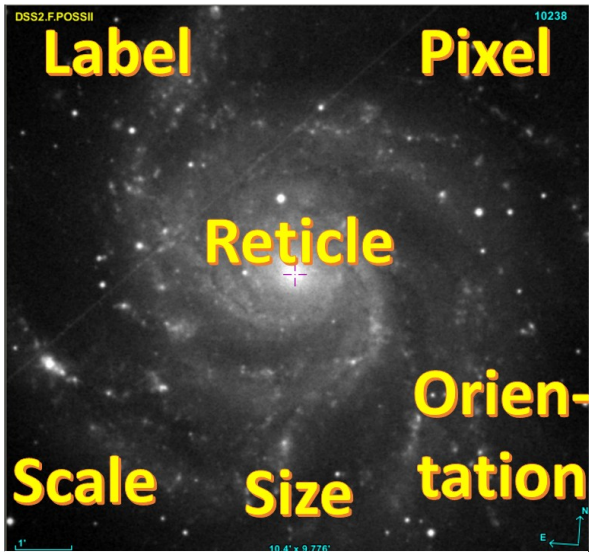


- **J2000** : Adjustment of the time of the view. If the sources of the selected plane have their own proper motions, the objects will be displayed at the specified year. By default, the year of the current image if it is known, is taken, otherwise the year 2000. Clicking on the title of the slider resets it to its original value;
- **Size**: modifies the factor to be applied to the size of the graphic overlays of the selected planes;
- **Dens**.: Modification of the density. In the case of a HiPS catalog plane, the action of this slider will temporarily change the HiPS order[4] selected for the field of the view, and thus, modify the density of the sources that appear in the view. In the case of a coverage plane, the change in density changes the maximum order of the MOC used to view this coverage.
- **Cube** : Choice of the current image of a cube. In the case of a selection of a cube plane, or HiPS cube, the action of this ruler allows to adjust the "slice" of the cube to be displayed in the view;
- **Opac**. : Changing the opacity. When a plane is displayed in overlay of another plane, this slider affects the transparency level of the foreground. This function is also possible via the small slider directly under the logo of each shot in the stack;
- **Zoom** : Changing the zoom factor of the view.

Technical note: some of these sliders may not be present in your interface. You may then add them using your user preferences (see 5.21).

4 In this context, the order of a HiPS or MOC represents the level of resolution used for the display (see 6.2). This is the surface of the HEALPix diamond associated with this order.

5.1.4 The view



The view panel (or views) is the main element of the Aladin interface. The view displays a representation of the activated data in the stack. In general, it is an image on which symbols representing the sources of the catalogues are superimposed. Information elements located at the edge provide additional information: a title (label), a reticle, a scale, the size of the field on the sky and its orientation.

Location of objects in the view

To plot astronomical objects at their exact position, Aladin uses the astrometric solution associated with the image, for example a centered tangential projection. In general, images, especially those encoded in FITS format, or progressive surveys (HiPS) are provided with an astrometric solution. If this is not the case - for example for a JPEG image - it is possible to calculate your own astrometric solution (menu: *Image => Astrometric calibration* - see 5.14). It may happen that objects do not overlap exactly with the image either because their positions are not precise or because the astrometric solution is uncertain.

Activating planes

Icon : 
Script : **show … , hide …**

The planes that appear in the view are the ones that have been activated in the stack by clicking on the corresponding icon. Once activated, a double-click on this logo will briefly flash the data to make it easier to locate. It is possible to adjust the transparency level, or even temporarily hide one or the other of the planes, or even the background image (see 5.1.2).

Switching to the next image

Menu : **View => Next image**
Shortkey: **Tab**

When the stack contains several images, it is possible to quickly switch from one image to another by simply activating the corresponding image plane. Automatically, all graphical planes (catalogues and drawings) that can be superimposed on the image will be activated. Using the "*View => Next image*" menu or the "*TAB*" button performs the same operation. This feature is particularly useful when the view is viewed in full screen or in a single window (see below).

Semi-transparent image

Icon : 
*Script :***set … opacity=[0..100]**

It is also possible to display a semi-transparent image over another image. This is especially useful when the image to be displayed in transparency is smaller than the background image. To activate the semi-transparency of an image, it is necessary to use the small slider that appears under the logo

of the projected image plane. When the slider is fully pulled to the right, the top image will completely hide the corresponding portion of the bottom image.

It may be useful to switch the image planes in the stack to change the images in the foreground and background.

Reticle

Menu : **Overlay => Simple/Large reticle…**
Script : ***coordinates* or *object name***

The reticle are used to identify a particular position in the view. In general, this is the last position clicked. The reticle can be drawn either as a small magenta cross or as two straight lines crossing each other transversely. It is also possible not to display it (*Overlay menu => Reticle*). The coordinates of the reticle are displayed in the "*Command*" field of the "*Command Banner*". Conversely, entering a position, or even an object name, in this field causes the reticle to move to the corresponding position.

Tip: It is not necessary to click in the field, you can directly enter your target on the keyboard even if the cursor is in the main view.

The 5 actions in the view

The actions performed by the mouse in the view are:

- Select: selection of graphic overlays, including catalogue sources;
- pan : shifting the field of view;
- Zoom : enlargement / reduction of the field of view;
- Rotation :change of view orientation;
- Time-based filtering: time display restriction.

The first 2 modes are exclusive, and by default, the "Select" mode is activated. Before performing a mouse action, take a look at the toolbar to make sure you are in the desired mode.

Tip: When there is no object to select, the Pan mode will replace the default Select mode.

Objects selection:

Button: **select** 

Mouse : **click** or **click/drag**

When Aladin displays graphical objects (astronomical catalogue sources or graphical overlays), it is possible to select some of these objects when the "*Select*" mode is activated. If this is not the case,

click on the "*select*" button at the top of the button bar. The selection of an object is done by clicking on it or by creating a selection rectangle encompassing the object or objects concerned (click outside any object, then drag and drop). The selected objects are surrounded by a small green square. For astronomical sources, the associated measurements appear in the measurement panel below the view (see 5.1.8).

The selected objects - when it is graphical overlays and not catalog sources - can generally be moved. To do this, it is necessary to click/drag one of the small green control squares that were displayed during the selection. In addition, in the case of instrumental fields of view (see 5.2.3 - FoV), the corners will allow rotation.

Pan mode

Button: **Pan** 

Menu : **Edit => Pan mode**
Shortkey: **Alt+Z**
Mouse: **click/drag middle button**

It is possible to drag the image by using the "*Pan*" button and then click and drag the image in the desired direction.

Tip: Using the middle mouse button allows you to directly perform a "*Drag & Drop*" while remaining in "Select" mode.

Zoom

Slider: **zoom** 

Menu : **Edit => Zoom…**
Shortkey: **F2, F3 - F4** *(pointed zoom)*
Mouse: **wheel**
Script : **zoom …**

Aladin allows you to quickly zoom in on any portion of the image.

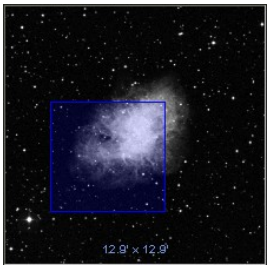
The zoom factor can be changed in different ways :

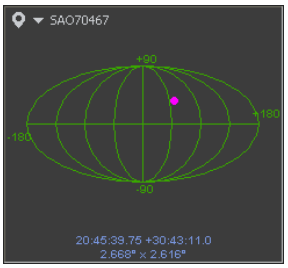
- By manipulating the mouse wheel with the pointer in the view;
- By using the slider below the stack;
- By using the main menu "*Edit => Zoom*";
- By using the "pointed zoom" menu and then clicking in the view (hold down the Shift key to "zoom out"). To quickly return to the default mode ("*select*"), move the mouse pointer out of the view panel.

If the image has an astrometric calibration, an increase in the zoom will center the image on the current position of the reticle (unless the view has been "locked" - see below). It is therefore very easy to zoom in on a particular object by moving the crosshairs over the object (single click) and then using the mouse wheel.

Contextual Zoom & pan

Zooming and paning operations can also be performed with the mouse and wheel using the contextual "zoom graph" that appears at the bottom right. In the case of a visualization of a classic image, it presents the entire image in the form of a thumbnail, and in superposition a blue frame represents the region currently visible in the view. For progressive surveys (HiPS), the thumbnail is replaced by a global representation of the celestial sphere in AITOFF projection on which is located the currently visible field of view.





Location history

The history of the different targets is stored and accessible through the drop-down menu displayed in the contextual "zoom graph" described in the previous paragraph. These positions are stored from one session to the next. By default, these are all targets that have been queried on a server. It is also possible to manually add the current position of the reticle by clicking on the symbol to the left of this drop-down menu.

Rotation

View : 

Mouse : **Ctrl + drag/drop**
Image type : **HiPS only**
Script : **northup …, unnorthup …**

The rotation operation allows the image to rotate in the view. The easiest method is to use the mouse as if you were moving the view, while holding down the Ctrl key. It is also possible to rotate the North-East direction indicator directly, without having to hold down the Ctrl key.

To cancel the rotation and redirect the north of the image to the north, click on the "North" 

icon located below the view.

Restriction of use: Rotation is only possible on progressive surveys (HiPS). The classical images can only be temporarily reoriented to the North at the top via the "*North*" icon, but without the possibility of choosing another rotation angle.

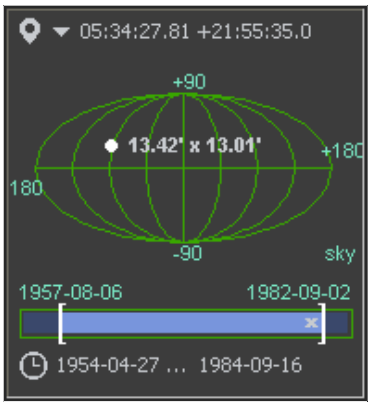
Time filtering

Menu : **View => Time range filter**
Script: ***ISODATE1 ISODATE2***

Any view can have a time window associated with it in the form of a start date and an end date[5]. Therefore, only data falling within the time window will be plotted (catalogue sources, portion of space-time coverage (STMOC). Data without time stamps will also be displayed.

5 The time reference is TCB or Barycentric Coordinate Time

If time filtering is applied, the relevant date range is displayed beside the field size of the view (bottom middle of the view).

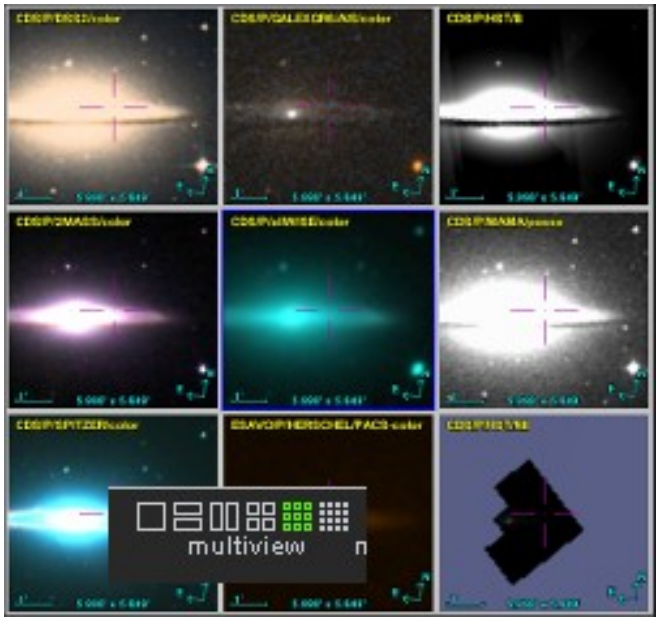


With the mouse, it is possible to dynamically adjust the time window associated to the view by using the controls of the time slider (opening and closing bracket) which appears in the Aladin tracking panel. The deletion of the time window, and therefore of the associated filtering, is done by clicking on the small cross appearing to the left of the upper time boundary, or more simply, by double-clicking in the time interval delimited by the 2 brackets.

Coordinate grid

Icon : **grid**
Menu : **Overlay => Coordinate grid**
Overaly => HEALPix grid
Shortkey: **Alt+G**
*Script :***grid …**

The activation of a grid is done either by the "*grid*" icon located under the view, or by the "*Graph => Coordinate grid*" menu for a grid in longitude / latitude or "*HEALPix grid*" for a HEALPix grid (see 6.2). The grid spacing depends on the current zoom factor to display only a reasonable number of segments. The grid frame is the same as the one used to display the current position under the mouse. It is not possible to display several grids simultaneously in different frames of reference.



In the case of a grid in longitude / latitude, when the view is very wide, the grid may appear partially truncated if the astrometric solution of the current image cannot be used to calculate a position very far from the image (e. g. digitalized Schmidt plate).

Multiple views or "multiview"

In order to easily compare multiple images, it is convenient to create multiple views simultaneously. The main panel can be subdivided into 2, 4, 9 or 16 subpanels. Each of these panels can display a different image and superimposed graphic objects. These images may be of different regions of the sky and/or the same region of the sky. It is also possible to use several panels for the same image, for example to view several details of the image.

Restriction: Note that in the case of HiPS, this last function is only possible after duplicating the HiPS plane as many times as there is a view.

Number of views

Icon : **multiview** 

Menu : **View => Panels => 1 panel, 2 panels …**
Shortkey: **Maj-F1, Maj+F2, Maj+F3, Maj+F4**
Script : **mview …, cview …**

The number of "visible" views can be changed either by using the "*multiview*" switch located at the bottom left under the view panel, or by using the "*View => 1, 2, 4, 9, or 16 panels*" menu. In case there are more views used than panels available, a scroll bar appears to the right of the main window to access the other views. It is possible to manage several thousand views (see 6.7 - creating thumbnail views). Only visible views actually use RAM.

Assigning views

Assigning an image to a view is done by dragging and dropping the logo of the corresponding plane of the stack into the selected panel.
It is also possible to create as many views as there are images in the stack in a single operation using the "*View => Create one view per image*" menu.

Tip: It is possible to drag and drop a JPEG, PNG, FITS image from your work environment (Windows desktop, Desktop Linux...) and/or from your web browser to a particular view.

Current View

The current view is surrounded by a blue border, i.e. the one on which the zoom functions will be operated, for example. Simply click on a view to make it the current view. By holding down the Shift key, you can select multiple frames simultaneously, for example, to indicate which ones should be deleted.

It is possible to view the current view (blue border) in "monoview" by returning to a single panel. The other views are not deleted and are always accessible via the vertical scroll bar that appears to the right of the window or when returning to multiview mode. The current view can also be viewed in full screen ("*View => Full screen*" menu) or in single window mode ("*View => Single window*" menu) - see below.

Matching views

Icon : **match** 

Menu : **View => Match…**
Shortkey : **Alt+S, Alt+Q**
Script : **match …**

In multiview, it is possible to match the scale, even the orientation of different images but for the same region of the sky. This operation is accessible either through the menu "*View => Match scales*" or "*View => Match scales and orientations*". Or, in the latter case, by the "*match*". The match between scales applies only to standard images. It does not change the pixels, but simply automatically selects the nearest center and zoom factor to view the same area of the sky. On the other hand, the match of scale and orientation reprojects the images either based on the position of the 4 corners of each classic image, or by using the same HiPS projection for progressive readings. Thus the fields of view are identical but the pixels are distorted. The "matched" views are

automatically selected, identifiable by their blue edges. If their orientation has also been aligned, the edge of the concerned views appears in red.

Locked view

Menu : **View => Locked view**
Script : **lock …, unlock …**

When double-clicking in a view, all other views for the same region of the sky will automatically center on the clicked position. The same applies if you click in the measurements (see 5.1.8). To inhibit this zoom change, it is possible to lock a view so that it always keeps the same center ("View => Locked View" menu). A locked view shows a small lock in its lower left corner. 

Move and copy

It is easy to move a view from one panel to another by simply clicking, dragging and dropping it with the mouse and having previously positioned the mouse pointer on the edge of the view to be moved. The cursor changes shape to indicate that copying/moving is possible. Holding the Ctrl key simultaneously with this operation will duplicate the view.

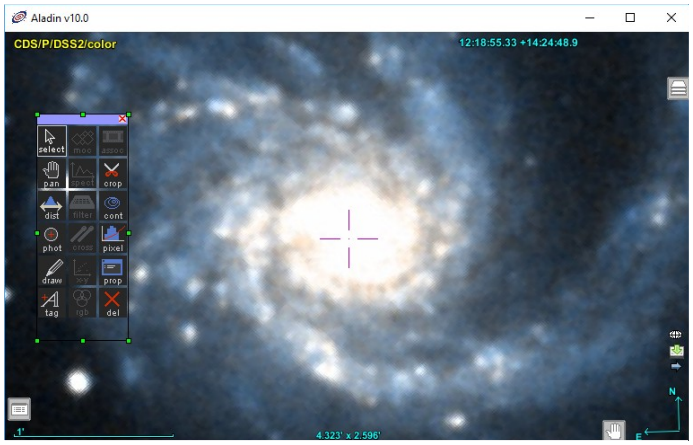
Deletion

Deleting a view does not mean deleting the image and/or catalogues used for that view; the data remains accessible in the stack. On the other hand, deleting an image in the stack will delete all the views that use it. The "*View => Delete other views*" menu allows you to quickly delete all views except the current view.

Full screen and simple window modes

Icons: 
Menu : **View=>Full screen, Simple window**
Shortkey : **F11, F12**

A view can be displayed using the entire screen. It can also use a single window. In both cases the adjacent panels (stack, measurements, trees, ...) will no longer be displayed directly, but can still be accessed using control buttons on top of the view. A click on one of these buttons turns it into a control panel displayed in semi-transparency above the view. These control panels can be moved and modified in size and transparency by clicking on them in order to make the control handles necessary for these actions appear. The mouse wheel in the top margin allows the transparency factor to be changed.



Moving the mouse over the top of the window temporarily brings up the menu bar. Typing on the keyboard will open a text field to submit an object, position or script command.

By using the "*F11*" or "*F12*" key, you can switch to these viewing modes. The " *Esc " key* will return to normal display mode.

5.1.5 The main toolbar

Located between the stack and the view, vertically, the "*toolbar"* provides quick access to the most commonly used tools:

- ***select*** *Mode* : selection of objects in the view
- ***pan*** *Mode*. : moving the view

- **dist** Graphic overload of distance measurements
- **phot** Graphic overlay of photometric measurements
- **draw** Graphic overlay of freehand drawing
- **tag** Graphic overlay for brand positioning
- **spect** Supercharge graphic extraction of a spectrum from a cube

- **moc** MOC handling tool (blankets)
- **filter** Catalogue filter generation
- **cross** Catalogs correlation cross tool
- ***x-y*** Generation of a scatterplot graphic
- **rgb** Colour image generator
- **assoc** Generator of image associations (mosaics/animated seq.)
- ***crop*** Extraction of a sub-image or sub-MOC
- ***cont*** Generator of contours
- ***pixel*** Opens the Pixel Dynamics Control window.
- ***prop*** Opening the properties window
- ***del*** Deleting the current item

Activation

The buttons are activated according to the shots selected in the stack. Some buttons remain grayed out if they are not affected by the shot type or if the number of selected shots does not correspond to the action to be taken.

Help

Holding the mouse on one of the buttons will display a small window with a brief explanation of the action of the button ("tooltip"). The extended waiting time will be completed by a more detailed explanation in the free area above the stack.

Modes and tools

The first 2 buttons concern the modes of action of the mouse in the view to select objects, move the view field (see above, the view modes). These are exclusive buttons. All the other buttons concern tools. In this section we will only detail those tools that have not been described in the other sections of this document.

Graphic tools: dist., phot. draw, tag and spect.

Buttons: 

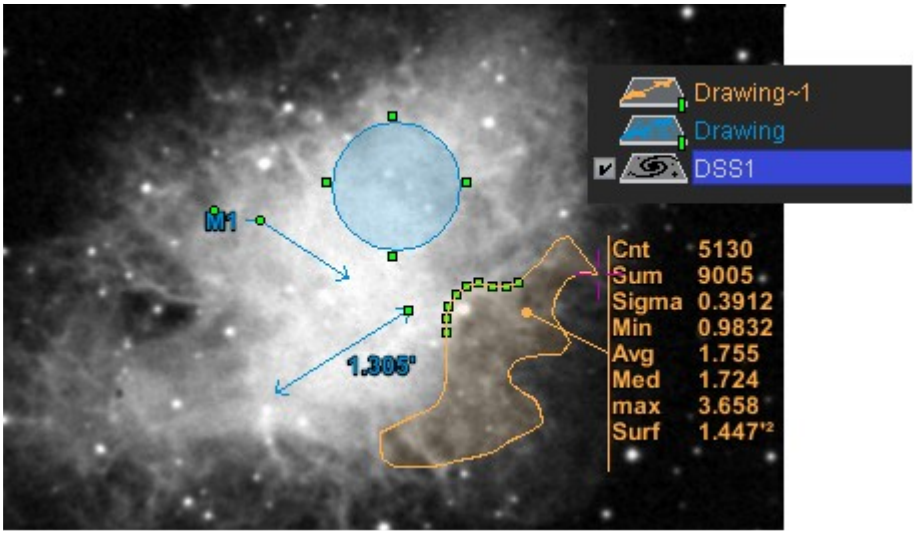
Menu: **Overlay=> dist, photo, draw, tag, spect**
Shortcut: **Alt+D** *(distance)*

Script: **draw ...**

The 5 buttons give access to the graphic overlay tools for distance measurements, photometric measurements, freehand plotting, marker/text placement. Activating one of them automatically creates a "graphic overload" plan on the top of the stack. The graphic elements that will be placed with the mouse in the view will be stored in this plane, with celestial coordinates, and can therefore be viewed on other images.

Selecting and moving

Graphic overloads created by one of these 5 tools can be selected (*Select tool*) or even moved by means of a mouse click/move. When they are selected, small green handles appear on their edges or ends.



Technical detail: When several elements are moved simultaneously, the movement is calculated on the celestial vault (in RA, DEC) only for the object under the mouse and then transferred to the other objects concerned. Holding down the Shift key changes this behaviour to consider only a movement in XY coordinates for all objects. These two techniques do not give the same result, especially when the objects to be moved are several degrees apart or close to the poles.

Viewing and modifying properties

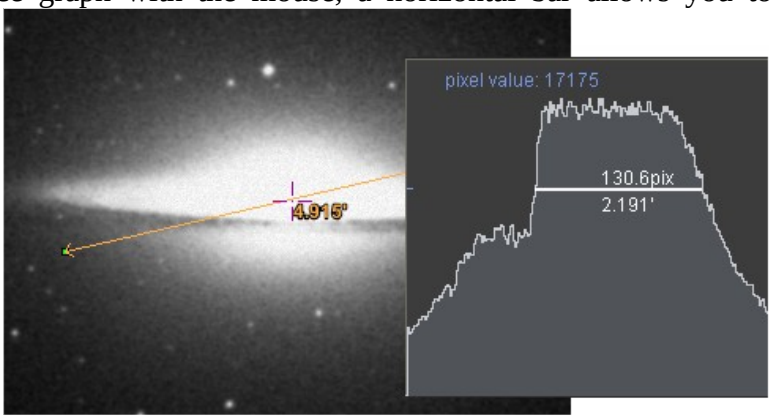
After selecting a single graphic overlay, it is possible to display or even modify the specific properties of this graphic element by clicking on the "*Properties*" button or via the *"Edit -> Properties"* menu. This can be its position, size, colour, title, etc...

A few tips

- It is possible to display the position of a mark next to it. To do this, select the mark in question and use the context menu (right click or CTRL click) and select *"display object identifier*".
- When drawing freehand ("*drawing"* tool) you can either hold down the mouse button to draw a "continuous" drawing or click several times to draw successive straight lines. In the latter case, it is necessary to take the pointer out of view to stop the drawing process or double-click for the last vertex.
- To create a polygon using the drawing tool, the last control point must coincide with the first point. To help you, the cursor changes shape when you fly over the first vertex again.
- In order to create a new *drawing* so that the new graphic overloads are not in the same graphic plane, it is necessary to first create a graphic plane level via the menu "*Graphic > create* new *drawing plane"* (Alt+N).

Cutting graph associated with the distance tool

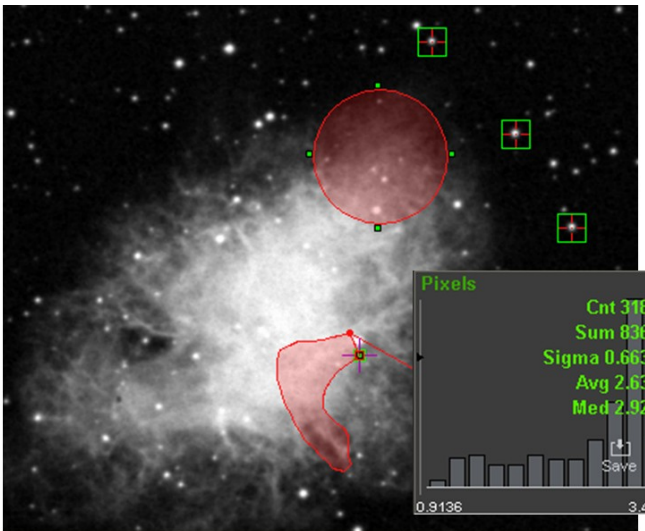
When the double arrow used to measure a distance has been selected in the view, the multifunction panel - at the bottom right of the main window - displays a "slice graph" representing the distribution of pixel values along the segment measuring the distance. If this segment is moved in the view with the mouse, the slice graph changes according to the position in the image. On the other hand, if you hover over the slice graph with the mouse, a horizontal bar allows you to calculate the distance, angular and in pixels, of a particular peak. For example, this method can be used to quickly approximate the width at mid-height of a star.



On the other hand, in the case of a true colour image (see 8.1 - supported data types), the levels of the 3 components Red/Green/Blue will be plotted simultaneously.

Photometric measurements associated with the "phot" and "draw" tools

The photometric measurement tool can be used in two ways: either automatically by extracting a star from the image in the view by a simple click on it, or manually by a click/extend to draw a circle of a specific radius. In the first case, Aladin will use a barycentric measurement algorithm to determine the central position of the astronomical object as well as the parameters of an encompassing ellipse. In the second case, there will be a simple statistical calculation of the pixels inscribed in the circle or the polygon: count, mean, standard deviation, minimum, maximum, sum...



ID	s_region	Origin	RA (ICRS)	DE (ICRS)	Count	Sum
Poly...	FoV	dss1	05:34:27.20...	+22:00:36.3...	3180	8365.1
Phot 3		dss1	05:34:23.30...	+22:04:21.9...	501.2	593.
Phot 5		dss1	05:34:19.01...	+22:03:15.2...	560.87	527.
Phot 7		dss1	05:34:16.10...	+22:02:07.4...	601.48	460.

These measurements are displayed in the multi-purpose panel on top of the pixel value distribution histogram.

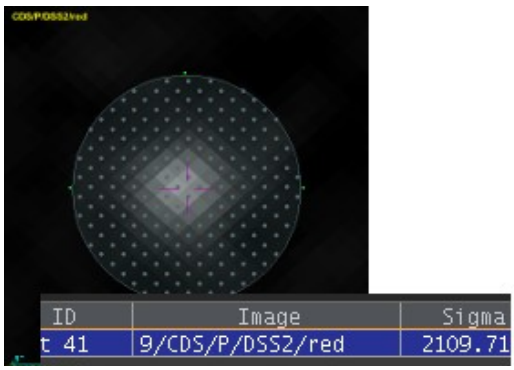
It is possible to save the statistical measurements by pressing the "save" button on this histogram. The calculated measurements are associated to the photometric object and can be consulted and manipulated (sorting, selection, saving, ...) in the measurement window under the main view (just like a classic catalogue).

Application restrictions: The original pixels of the astronomical image to which the photometric tool is applied must necessarily be available (not possible for a JPEG or PNG image), whether for a conventional image, or for a progressive HiPS reading. And in the latter case, only the manual circle mode is available. Please note that only pixels whose centre is within the circle are taken into

account in the calculation of the statistics. A sufficient zoom will show a point at the centre of each pixel concerned by the statistical measurement.

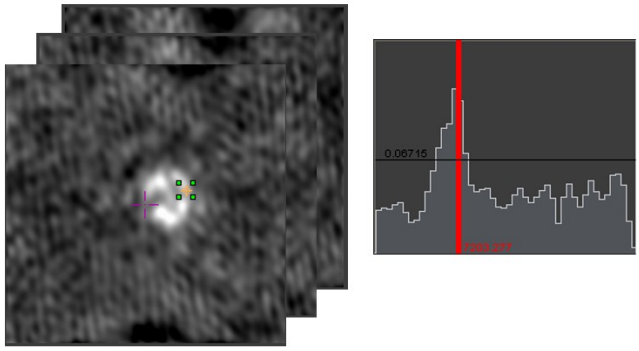
Note: When the automatic extraction algorithm fails to determine the centre of the object under the mouse, no mark is inserted.

Note: In the case of HiPS progressive scan measurement, pixel extraction is performed at the current view resolution. The order of this resolution is indicated as a prefix to the name of the image on which the measurement is taken. This means that for low zoom factors, statistical calculations will be performed on pixels that are already the result of averaging pixels of higher resolutions.



Depth cutting associated with the "Spect" tool

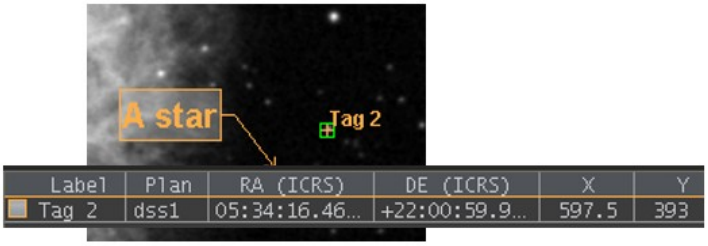
The positioning and selection of a mark by the "*Spectrum*" tool in an image cube also generates a cutting graph just like the "*dist"* tool, but this time in the direction of the depth of the cube. On the graph thus obtained in the multi-purpose panel, the vertical red line corresponds to the position of the current image of the cube (a cube under Aladin is displayed as a sequence of images). The value at the foot of this mark indicates the physical quantity corresponding to the current image of the cube (e.g. a speed). As with the distance tool, moving the marker with the mouse automatically adjusts the graph. On the other hand, hovering over the graph with the mouse displays the value of the corresponding pixel (ordinate of the graph). A horizontal click/drag will move the red line of the current image and thus move the current image in the view.



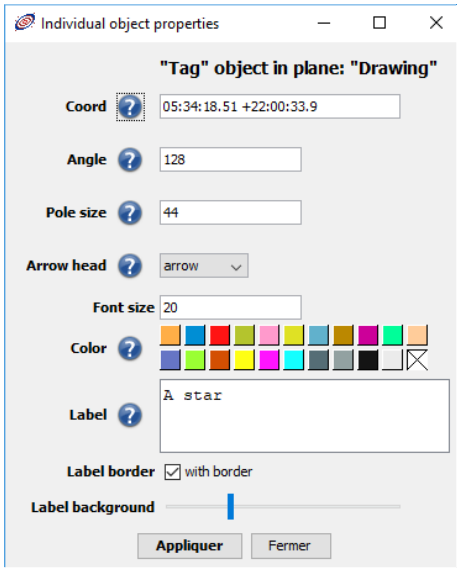
Note: The use of the "Spect", "Phot" or "Draw" (polygon) tools on a cube are capable of generating a spectrum respectively pointed or averaged over the area which will be viewable and manipulable using the CASSIS plugin developed by IRAP/Toulouse. Please refer to section 6.5 for details.

Special features of the tool "Tag ."

The "*tag*" tool can be used either with a simple click or by clicking/dragging.



A single click inserts a cross identified by a serial number at the exact location of the mouse, to which are associated positioning measurements in X, Y (origin at the FITS, i.e. (0.0) in the middle of the lower left pixel) and longitude, latitude presented in the measurement window. These measurements can be manipulated like a classic catalogue (sorting, selection, saving...).



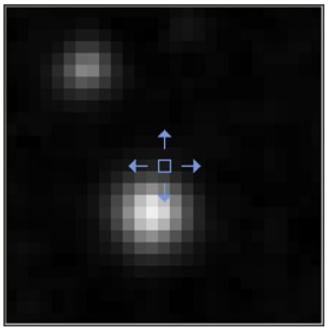
Click and drag insertion allows the creation of a more complex "tag", accompanied by the entry of a text associated with the tag. It offers a more sophisticated visualization (positionable text stem, selectable end of the stem, size, border and background of the text that can be modified, ...). However, no positioning measurements are stored.

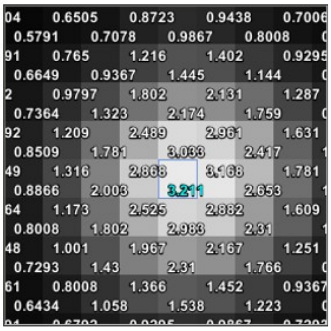
It is often more convenient to modify a posteriori the specific parameters of such a tag by displaying its properties ("*Prop.*" button after selecting the tag).

The "magnifying glass" or "pixel table" tool

Menu: **Image => Magnifier glass, Pixel table**
Shortcut: **Ctrl+G**

When the magnifying glass is activated, the multi-purpose panel - at the bottom right of the main window - will be temporarily used to display an enlargement of the pixels around the mouse pointer as it hovers over the view.
Using the arrow keys (up, down, right, left arrows) makes it possible to move the mouse pointer pixel by pixel.





It is also possible to select the display of the pixel value table under the mouse. This is a display similar to the magnifying glass, but with a higher magnification so that the values can be displayed in superimposition.

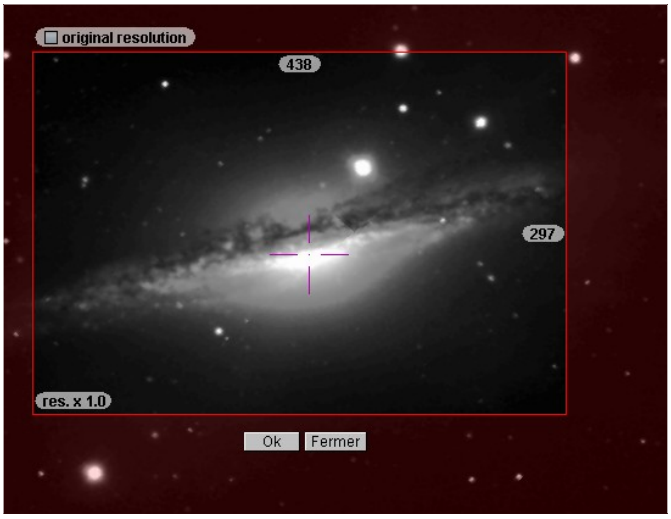
The cutting tool

Button: **cut** 

Menu: **Image => Crop image area**
Type of images: **HiPS or classic images**
Script: **crop ...**

The cutting tool allows you to extract a sub-image from a previously loaded image. This can be of any type, classic image, in colour, in real pixel values, or even from a progressive HiPS reading. By activating this tool, you can delimit the rectangular extraction area with the mouse. Once the area has been delimited, it is possible to manually adjust the positioning values a posteriori by clicking directly in the cartridges and then editing the appropriate values.

The extracted image is automatically inserted into the stack. In the case of a greyscale image, its colour table will be inverted so that it can be easily located by superimposing it on the original image.



Technical note: In the case of an image extracted from a progressive scan, if the progressive scan is displayed in preview mode, the extraction process is a simple visual capture of the sub-image, fast but not free of distortion. On the other hand, when the progressive survey provides access to the true pixel values, the extraction will be the result of a pixel-by-pixel bilinear sampling process to ensure that the original astrometry and photometry is optimally preserved. The choice of the final resolution of such an extracted image can be adjusted either by modifying the factor indicated at the bottom left of the extraction rectangle, or by ticking the "*original resolution*" selector at the top left. It is recommended to check the corresponding size in pixels at the selected resolution before starting the extraction operation.

Tip: The same cutting tool can be used on a MOC in order to extract a rectangular under MOC.

The deletion tool

Button: 

Menu: **Edit => Delete**
Edit => Delete All
Shortcut: **Del** *or* **Shift+Del**
Script: **rm** and **reset**

The delete tool is context dependent. Depending on the element(s) selected with the mouse, it deletes either:

- The graphic overloads;
- The views;
- The plans.

On the other hand, pressing the "*Shift*" key at the same time will delete all the data loaded into Aladin. Notice that Aladin does not have an "*undo*" function.

5.1.6 The secondary toolbar

Located under the data collection tree and under the view, the sub toolbar allows the actions described below.

Collection tree (see 5.1.1):

- **coll.**: Development/reduction of the selected branch;
- **sort**: Sort the collection tree according to various criteria;
- **view**: Filtering of collections that do not have a result in the current view;
- **scan**: Dynamic creation of a cover for collections that do not have one;
- **filter**: Activation of filtering.

View:

- **grid**: Activating the coordinate grid;
- **study** : Examination of the astronomical object under the mouse (see 5.9);
- **wink**: Temporarily suspends the display of graphic overloads in the view;
- **redo**: Update of stack plans produced by a cone query;
- **north**: Forced rotation North at the top, East on the left;
- **hdr**: Switches from preview viewing mode to real dynamic mode (HDR for "High Dynamic Resolution");
- **multiview**: Control of the number of views visible simultaneously;
- **match** : Temporary use of a single projection for all selected views.

5.1.7 The command banner

In the upper part of the main window, below the menu, a control bar groups four control elements:

- The command field;
- The spatial referential selector;
- The current projection selector;
- The list of bookmarks.

The command field

The command field is used for a variety of purposes: viewing coordinates under the mouse as it hovers over the view, entering a position, coordinates, or a script command.

Entering a position

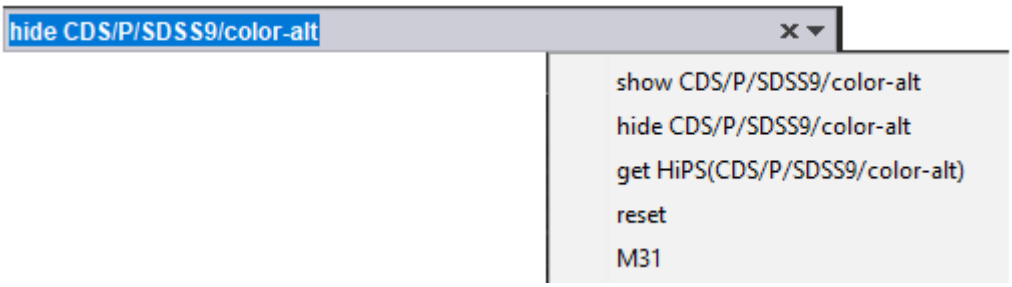
The main function of the command field is to enter an astronomical position. The coordinates of the target must be entered as a longitude and latitude pair. The reference frame used must correspond to the one specified (ICRS, J2000, B1950d, XY image,...) in the selector on the right of the input field. The validation of the position entered by the *Enter* key causes the crosshair (magenta cross) to be moved to the corresponding position in the view and the view to be centred on this position.

It is also possible to enter an astronomical object identifier. In this case the validation (*Enter* key) will first automatically query the "*CDS Sesame"* service, which will return the best known position of the object by consulting the Simbad and NED databases andcertain large VizieR astronomical catalogues. Then, based on the recovered coordinates, Aladin will move the reticle and centre the view on this position. This function is also accessible via the menu *" Tool => Resolution of an object name "*.

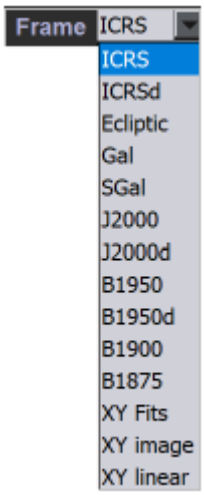
Tip: If the view is still empty, entering an astronomical position or object identifier will load a default astronomical survey - usually the colour DSS (which can be changed by user preferences – see 5.21).

Script command

The position field can also be used to enter any script command supported by Aladin, not just a position (see 7.1 - Aladin by script). On the left side of the input field, a small triangle opens a drop-down menu of the history of commands executed by Aladin. This list contains not only the previous script commands executed, but also commands equivalent to a previous action performed using the graphical user interface and the mouse. You can then re-execute the same action, or even edit and modify it before re-executing it.



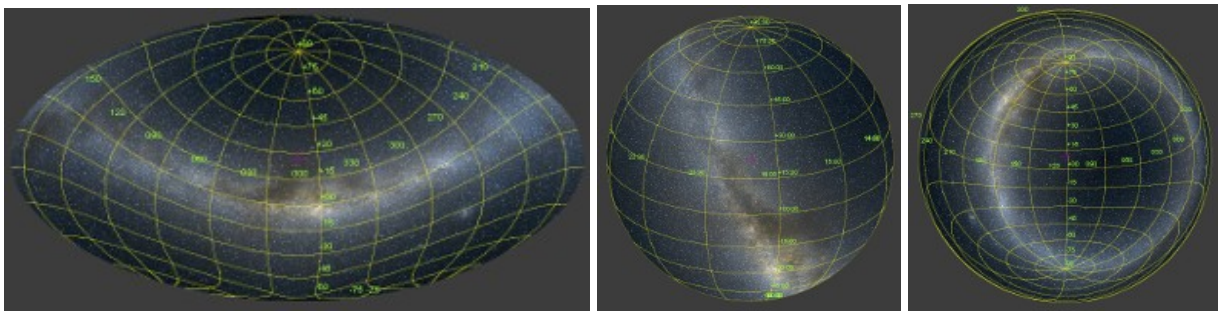
The reference frame and projection selectors



The two selectors to the right of the control field are used to indicate on the one hand the spatial reference frame used by default, and on the other hand the projection used for display in the view.

Note: the suffix "*d" in* some of the proposed reference systems means "*degrees"* and indicates that the display and entry of coordinates will be done in decimal numbers (e.g. 256.67555 -47.17031) and not in sexagesimal notation (e.g. 17 06 42.1320 -47 10 13.116) (see glossary).

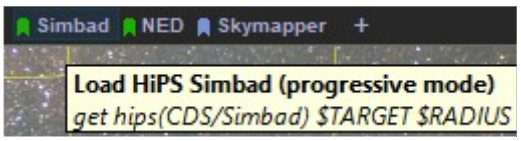
The modification of its selectors will be reflected in the view, either by a simple adjustment of the coordinate grid in the case of classic images (only the reference frame will be modifiable in this case), or by the transformation of the image itself in the case of a progressive HiPS survey in order to plot it in the reference frame and the chosen projection. For example, it is possible to visualise the complete vault of the sky in galactic referential / AITOFF projection or in equatorial ICRS / spherical projection, etc.



Tip: in multi-view mode, it may be desirable not to display all views in the same frame of reference / projection. To do this, it is necessary to choose a specific reference and projection via the properties of the planes associated with each view.

Bookmarks

Below the command field, a list of bookmarks provides quick access to predefined actions. This is usually the loading of a specific collection for the current position, but it can be any type of action. The bookmarks marked with a green "bookmark" have been predefined by the CDS, the blue-grey ones are defined by you.



Hovering over a bookmark displays after a few seconds the script command(s) that will be executed if the bookmark is executed by clicking on it. You can update the list of bookmarks visible in this bar, as well as create or modify bookmarks by clicking on the "+" icon on the far right of the bookmarks bar, or via the "*Tools -> Bookmarks...*" menu.

Tip: The bookmark symbol displayed in various places in the Aladin interface, particularly in the "*access window*" of each collection, allows you to immediately create the corresponding bookmark.

Now let's take a look at the bottom of the main window: the "*measures panel*".

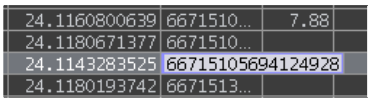
5.1.8 The measures

The "*measurement panel*" is located at the bottom of Aladin's main window. It is used to view the measurements associated with the sources. It is a very powerful tool that allows you to select, sort and filter tables.

Note: This panel is retractable and may not be visible. If this is the case, click on the small tab symbolised under the view.

Only sources that have been selected, individually or collectively, thanks to the mouse view (see 5.1.4) appear in the Measurements panel. These measurements are presented in the form of a table where each line shows the values associated to a source.

Selected sources appear surrounded by a green square in the view. Hovering with the mouse over a selected source causes this source to blink and simultaneously makes the corresponding measurements visible by highlighting the line in blue. Symmetrically, hovering over a line in the measurements table causes the corresponding source to flash in the view if it is visible. On the other hand, selecting a line in the table (by double-clicking on it) will move the view to centre it on the corresponding source.

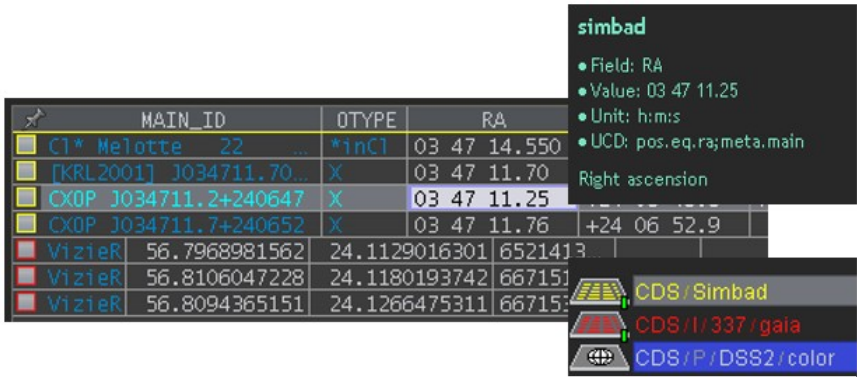


The first line of the table displays the header that describes the contents of each column. Clicking on a header box sorts the rows in ascending and descending order according to the values in the column. A small triangle appears to the right of the label to indicate the sort column. The sorting will be alphabetical or numerical depending on the contents of the column. The width of a column can be enlarged or reduced by clicking and dragging the right edge of a box in the header. When a cell is still too narrow to display the full value, hovering the mouse over the cell temporarily enlarges it to reveal the rest of the value.

Measurements from different catalogues

If the selected sources come from different catalogues, several tables which do not necessarily have the same columns will follow one another. The colour of the square at the beginning of the line allows you to quickly identify the origin of the data (same colour as the plan in the stack).

The header line always corresponds to the table of the last selected line (clicked with the mouse), or to the one pointed under the mouse. The colour of the line under the header follows the colour of the corresponding catalogue.

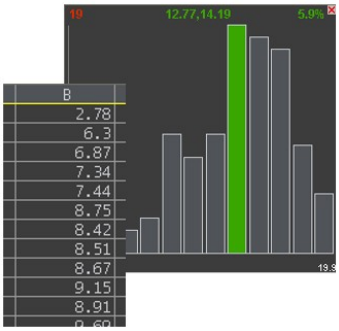


Cell information

If you hover over a measurement cell, additional information associated with that cell is displayed in the free area above the stack. This will include the table title, the field name, its value, its unit, the UCD (Unified Column Descriptor) associated with this column and its description.

Histogram of column values

By hovering over a column in the measurement table, the histogram of the distribution of the values in this column appears in the multi-purpose panel on the right. Moving the mouse over one of the bars of this histogram restricts the display in the view to these sources only. In the case of a numerical series, the width of the bars can be modified by using the mouse wheel.



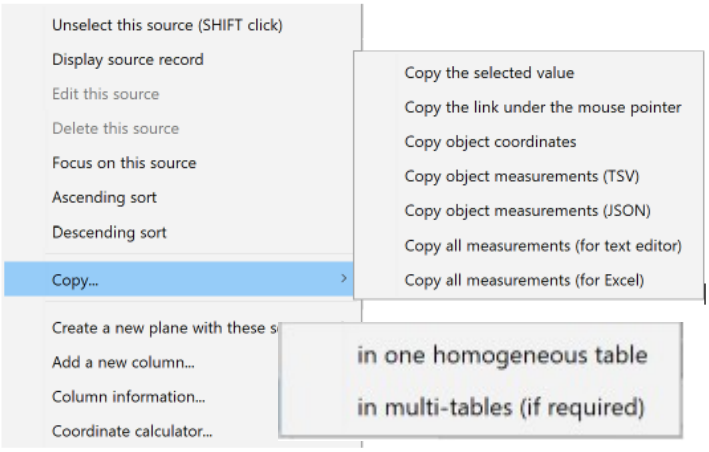
Links and buttons

As in a web browser, the values marked in blue are "links" to additional information available on the net. The web address that will be called up is displayed at the bottom of Aladin's window when the mouse pointer hovers over the link. A mouse click on a link opens your web browser, which will load the corresponding web page.
Usually the first link of a measurement line will load the original registration page of the website that provided the data (Simbad, NED, VizieR...).

Some values can also be displayed as a button. Just like a web link, the activation of such a button causes additional data to be loaded via the net. However, instead of opening your browser, the data will be inserted into the stack so that it can be viewed immediately in Aladin. Most often these are archive images associated with a list of observations.

Datalink

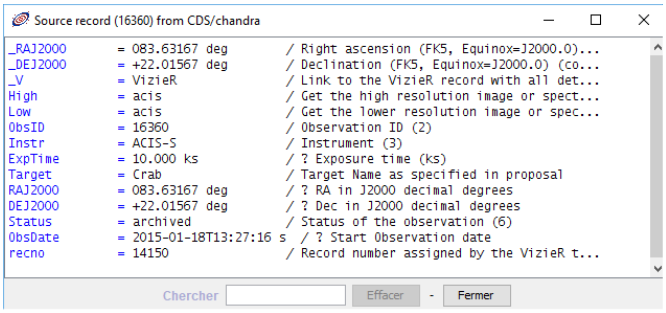
It can happen that several links are associated to the same button. These links appear in the form of a small drop-down menu. This multiple choice system called "DataLink" may require an intermediate form to be filled out in order to load the data designated by the selected link. This may be, for example, to specify the portion of the original image to be loaded.



Context menu

The measurement window has a number of functions that can be accessed via a right-clickable context menu.

In particular, this menu gives access to various functions for using the clipboard to make a copy/paste. It also offers the possibility to create a new catalogue plan containing a copy of the sources/measurements present in the measurements window. This duplication can be done identically ("in *multi-tables if necessary"*) or in a regenerated table in order to merge tables that may not have the same column structures and names.

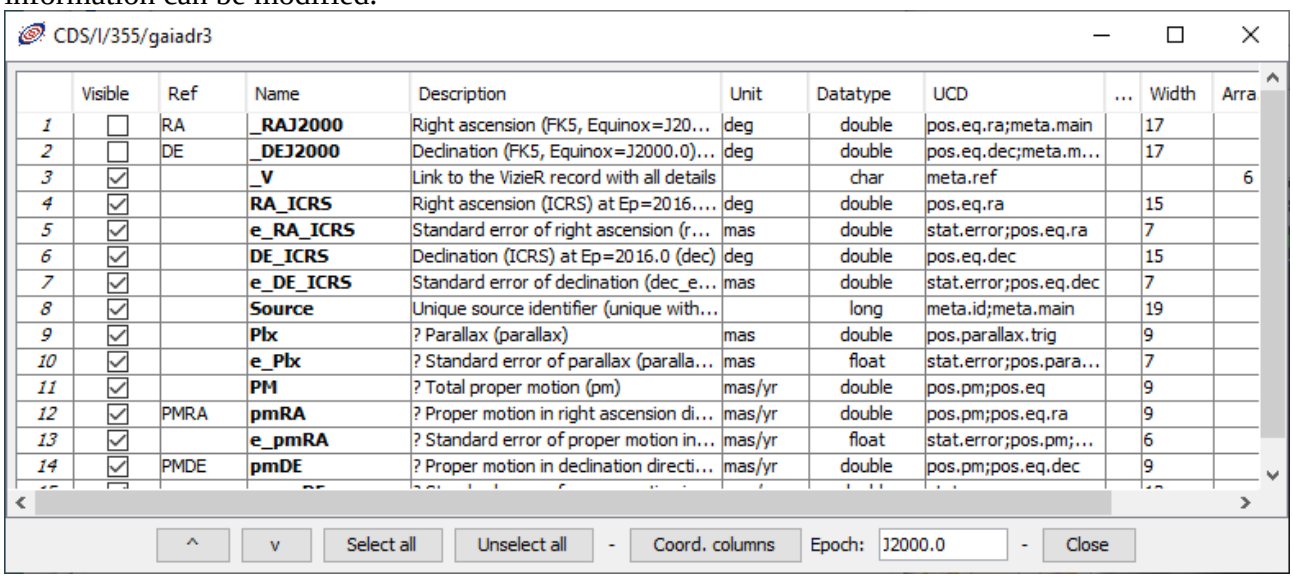


Tip: In order to easily compare two possibly non-consecutive lines, the "*View Record*" menu allows you to view the line as a record in a separate window. Only non-empty fields are shown.

Finally, the "*Column information...*" entry gives access to the table column description window.

Column information

The column description panel accessible either via the measurement contextual menu or via the main "*Catalogue*" menu displays in the form of a table all the information specific to each column: its description, its unit, its data type, its UCD, cell size, display precision, ... Some of this information can be modified.



The column entitled "*Visible*" allows you to select the columns that will be displayed or hidden in the table of measurements.

The column named "*Ref" is used to* identify the columns (and its format) used by Aladin to extract the coordinates (RA, DE, GLON, GLAT, ELON, ELAT) as well as the own motion (PMRA, PMDE) of the source associated with the measurement line. This mechanism will also be used to identify the column providing a date associated with this source (JD, MJD, ISOTIME, YEARS, DATE). It is possible to manually modify this selection by clicking in the corresponding box. The small contextual menu which then opens allows you to indicate the nature of this column.

Note: In the case of a table without spherical coordinate support, it may be possible to indicate columns of image coordinates (X, Y) at the FITS (centre origin of the bottom-left pixel).

The two buttons at the bottom left allow you to change the order in which the columns appear in the measurements window.

Independent window

The measurement panel can be temporarily detached from the main window by clicking on the logo at the bottom right. This method provides a larger workspace for the view and, on the other hand, to work more easily on a larger number of measurements. Note that the Aladin measurement table can display several hundred thousand lines without any problem. The reintegration of the measurement window in its original place is simply done by clicking again on the same logo, or by closing the window.

Source selections

The source selection can be done either by menu, mouse or a search expression.

Menu selection

Menu: **Edit => Select ...**
Shortcut: **Ctrl+A** *(all objects)*
Script: **select ...**

The main menu "*Edit*" offers a sub-menu for selecting all sources, i.e. all sources present in the catalogue drawings in the stack. It is also possible to select only the sources of one or some specific planes via the "*Edit => select all objects in the selected planes"* menu. You will first have to select the planes from the stack (see 5.1.2).

Mouse selection

Mouse selection is the most common method. It allows you to choose sources according to their positions in the view.

- *To select a source* simply click on it in the view;
- *To select multiple sources* it is necessary to enclose them in a selection rectangle. To do this, click on an area without a source slightly above to the left of the first source to be selected, then while holding down the mouse button, extend the selection by moving the mouse pointer downwards to the right. During this operation, a rectangle shows the selection area in the view. When you release the mouse button, all sources within the rectangle will be selected;
- *To add sources* to a first selection, proceed as before, but hold down the *Shift* key.

Selection by search expression

Menu: **Catalog => Search in the loaded catalogs ...**
Shortcut: **Ctrl+F**
Script: **search ...**

Aladin offers a powerful method for selecting sources based on their measurement values. To do this, it is necessary to enter a search expression in the small "*Search*" box located just above the right-hand side of the measurements panel.

When the search expression is validated by pressing the "*Enter"* key, all sources, for which one of the measurements meets the search expression, are selected. Only the sources of the **activated catalogue plans** will be concerned (see 5.1.2 - Activating a plan in the stack). If the search expression is preceded by a '+' character, the sources to be selected will be added to the current selection. Conversely, the presence of the '-' character at the beginning of the search expression will lead to the deselection of the sources concerned among the sources previously selected, i.e. it will make them disappear from the table of measurements.

The search expression follows a simple and efficient syntax. It can be:

- a text string;
- possibly including wildcards: '?'. (any character), '*' (any sequence of characters);
- possibly preceded by a column name and a test operator (=, !=, <, >, <=, >=) to restrict the search to a particular column;

Additionnally:

- the column name can include wildcards (' ?' or '*');
- the column name can be framed by two vertical bars '|' to indicate the absolute value;
- there is no distinction between upper and lower case letters either for the column name or for the value.

Note: For convenience, searching for a simple text string without specifying a particular column is always considered as a sub-string to be searched. For example, a search for "gal" will result in "*gal*".

A few examples:

- `Star` sources whose measurements include the word "star".
- `otype=uv` sources whose "otype" column has the value "uv".
- `mag*>=12` first column whose name starts with "mag", the numerical value must be greater than or equal to 12
- `|pm*|<5` Same principle as above but only the absolute value is taken into account.
- `type!=g*` "type" column whose values do not begin with the letter “g”.
- `bmag!=""` "bmag" column not empty

Deselection

Menu: **Edit => Unselect objects ...**
Shortcut: **Ctrl+U**

- *To deselect a source* from a previous selection, click on the source while holding down the *Shift* key.
  Alternatively click on its line in the measurement window and then use the "*Deselect this source*" or *Shift-Click* contextual menu.
- *To deselect all the sources* - this is equivalent to "cleaning" the measurement table - simply click in the view anywhere outside any source or use the *"Edit => deselect all sources"* menu.

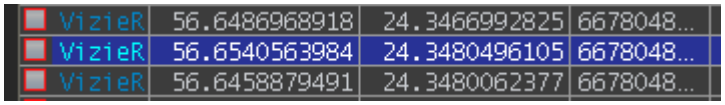
Tip: To avoid accidentally "losing" a selection, you can "tick" the sources in your table so that you can reselect them later (see paragraph below).

Counters

The ratio of the number of selected sources (i.e. whose measurements are displayed) to the total number of sources appears in the counter at the bottom right of the Aladin window.

Navigation in the measures

The exploration of the measurements, and in particular the quick visualization of the associated source, is done by selecting a particular line in the table of measurements. The selected line appears on a blue background " fixed on the line " even if the mouse is not on it.



The selection of a line of measurements is done either manually with the mouse or by a search expression.

Selection of a measurement line with the mouse

Mouse selection is made either in the measurements panel by a simple mouse click (outside a web link or button) or in the view by clicking on a selected source (green square). This causes the cross-hairs (magenta cross) to be moved to the corresponding source. And if the selection was made via the table by double-clicking, the view is automatically centred on the source (unless the view has been "locked" – see 5.1.4).

Selecting a measurement line via an expression

The box used to select sources also allows you to select a particular line of measurements. Thus entering an expression - **WITHOUT performing validation** (without pressing *Enter*) - and using the two arrows to the right of the input box allows you to select the next/previous line of measurements corresponding to the expression. The "*UP arrow*" and *"DOWN arrow*" keys, or the mouse *wheel, can* also be used to move to the next or previous measurement, respectively. As with the mouse selection, the view is automatically centred on the corresponding source. If the expression is empty, the next or previous line is simply selected.

Browsing of sources and measurements of a plan

It is possible to browse all the measurements of a plan by using the same mechanism of the two arrows described in the previous paragraph. Open the contextual menu by right-clicking on the

name of the plan in the stack and choose the "Browse the plane sources" menu. The view is automatically refocused on the object corresponding to the current measurement line.

Deselection

Deselecting the line is done by a simple click in the measurement panel (outside a web link or button).

Inhibited behaviours

When a measurement line is selected, some automatic behaviours are inhibited:

- The header of the measurement panel remains the one associated with the selected line even if the mouse moves outside the line in question (this allows sorting on this table, for example);
- Moving the mouse, in the view, over the other selected sources will no longer scroll the associated measurements.

Measure check box

Menu: **Edit => Tag ..., UnTag ...**
Contextual menu: **Tag..., Untag these sources...**
Script: **tag ... untag ...**

A small coloured box appears to the left of each line of measurements. It not only allows you to identify the original plan of the data by the colour code, but also to "tag" some lines and, therefore, the corresponding sources, so that you can easily find them again later.

Two menus allow you to manipulate the "tagged" sources:

- The menu that appears when you click on the pin in the header of the tag column;
- The main menu "*Edit*".

In the view, the sources whose lines of measurement are tagged appear with a magenta square instead of the usual green square.

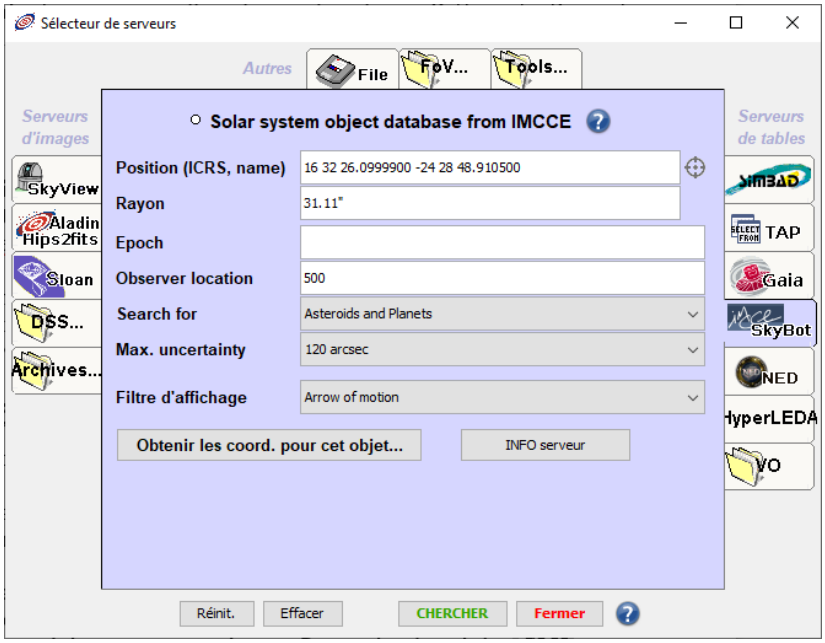
Add/calculate a new column

Aladin offers the possibility to add a new column of values. This operation is described in detail in section 5.13.

5.2 The server selector

Menu: **File => Open server selector ...**
Shortcut: **Ctrl+L**
Script: **get ..., load ...**

As a complement to the data collection tree, Aladin provides direct access to certain forms dedicated to specific servers. This is the "*server selector*" window.



This window consists of several query forms that can be selected using tabs. The tabs on the left side of the window are for image servers, the tabs on the right side are for tabular data servers.

These tabs and forms may evolve over time as new possibilities are offered by the astronomical community.

5.2.1 Entering information

Most of these forms require the entry of at least two elements essential for a cone query: a position and a radius.

The position can be either an astronomical object identifier resolved by the Sesame mechanism of the CDS (search in Simbad + NED + some large catalogues), or astronomical coordinates expressed in the current reference frame (see. 5.1.7).

The radius corresponds to the radius of the cone query on the sky. This value can be followed by a unit ("°", " ' " " " or " deg ", " arcmin ", " arcsec "). The default unit is the arc minute. It is also possible to specify a rectangular area using the following syntax: W x H where W is the width of the rectangle in right ascension and H is the height of the rectangle in declination. These two values can be followed by a unit. If the queried server only supports cone (resp. rectangle) querying, Aladin will always choose an area that completely covers the designated field (encompassing circle, resp. encompassing rectangle).

Automatic entry

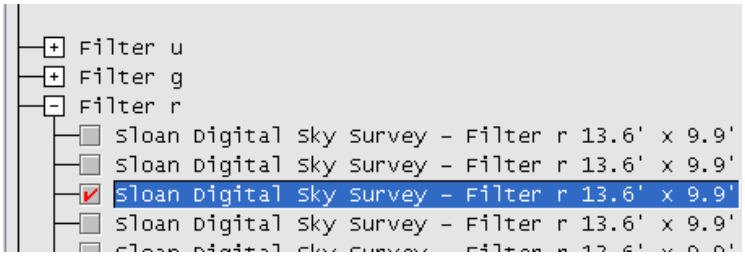
In the current form, the position and radius are automatically filled in according to the previously loaded data in order to cover the same field on the sky. It is also possible to explicitly designate an area of the sky on an image that has already been loaded by means of the "*target*" button that appears behind the position input field. Aladin invites you to designate the area by clicking/dragging/releasing in the view.

When switching from one form to another via the tabs, the values indicated in the first form will be retained in the second form.

5.2.2 List and tree

Some servers require two steps to load the data: first to designate the area of the sky, then to select from the available images or catalogues those you wish to load. In the second step, Aladin displays the available data in the form of a list or tree. This list/tree has many functions:

- Moving the mouse over an item displays the corresponding field(s) of view in the main window;
- When the data is in the form of a tree, a right click brings up a sub-menu to control the tree;
- When the data is in list form, it is possible to sort the data by clicking on the column headings;
- Clicking on an item displays the information relating to this data as well as certain specific query parameters;
- Each item is preceded by a checkbox which allows you to designate several items to be loaded. These boxes can be checked either manually or by clicking in the view to designate only those elements that explicitly contain the clicked position. The "Reset. "button allows you to deselect all the checkboxes. The " Clear " button deletes the list / tree.



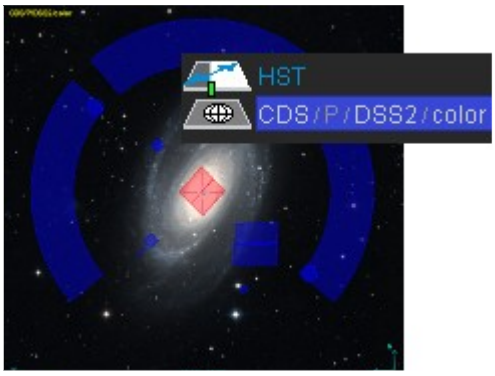
5.2.3 Some specific forms

"File" - Local access or by URL.

This form allows you to upload personal data, either via local files or via a web address (url). This data has to be compatible with one of format supported by Aladin (see 8.1). The "*Browse*" button allows you to navigate through the file selector of your operating system in order to identify the concerned file.

Tip: Local data can also be loaded by clicking and dragging a file icon from a window on your desktop or file manager into the Aladin window. The same applies to images or links displayed in a web browser.

Tip: In the case of a local directory name, Aladin will explore the entire contents of the directory and its sub-directories and build a tree of available data. It will create a file named ".aladin_idha" which will allow him to quickly reload this description for another use.

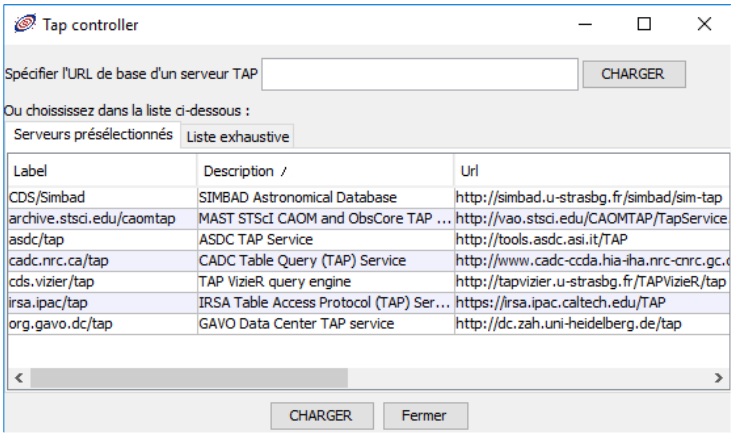


"FOV" - The instrumental Fields of View

This form provides access to a description list of instrumental fields of view ("FoV") of a large number of telescopes. These fields can be superimposed on the images to prepare an observation mission. They can be moved or even rotated by means of a mouse selection.

It is possible to define one's own instrument fields in the form of an XML file. The syntax description and some examples can be found at http://aladin.cds.unistra.fr/java/FAQ.htx#FoV.

"TAP" - Access to TAP-compatible servers



This tab provides access to servers that support the *Table Access Protocol (*TAP). Activating this tab displays a list of servers pre-selected by the CDS, as well as the exhaustive list of compatible servers. Although this query mode is also available via the collection tree, it may be more convenient to use this tab if you wish to query a particular TAP server. Once the server has been selected, a TAP query form is proposed (see 5.3).

"SkyView - The HEASARC/NASA image server

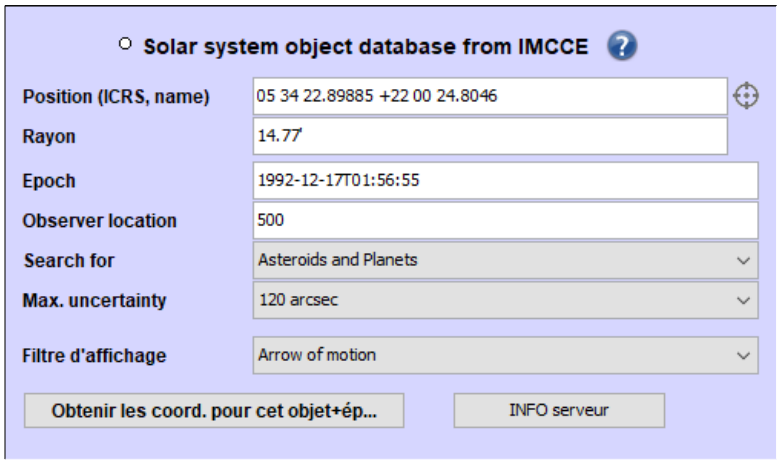
SkyView is an image generation service managed by HEASARC/NASA. It provides images from a very large number of reference surveys, dynamically resampled in a projection chosen by the user.

"Gaia" - The astrometric reference catalogue

Gaia is THE reference astrometric catalogue from the European mission of the same name. It contains almost two billion sources with an unrivalled astrometric accuracy. Being part of the distribution consortium of this catalogue (CU9), the CDS proposes this specific form.

"SkyBot" - Objects of the solar system (except planets)

The "*SkyBot*" tab opens a form for accessing objects in the solar system (other than planets). The Institute of Celestial Mechanics of Paris (IMCCE) provides Aladin with its database of ephemerides, which allows you to find, with excellent precision, the asteroids and other objects of the solar system present in your image according to the epoch of your image.



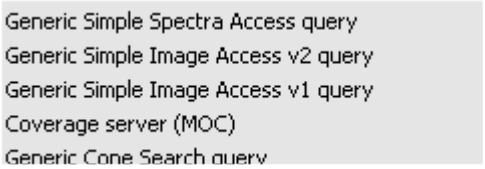
The date field is automatically filled in according to the epoque of the current image.

Note: the time indicated in the header of the image is not always very precise, hence possible positioning errors. In this case, you will need to enter the date manually.

On the other hand, it is possible to enter the name of an asteroid or comet in the position field so that SkyBot replaces it with its celestial position on the date mentioned. To do this, press the button *"Get coordinates for this object + epoch*".

"VO" - Generic access to the VO

The VO tab offers a series of generic forms specific to each of the protocols defined by the VO - the Virtual Observatory. As long as you know the address of a specific server compatible with one of the VO protocols, you will be able to query it directly.



5.2.4 Adding a personal server

The "*server selector*" window can be adapted to your own servers. Thus, it is possible to define a personal server that will add its own tab/form. To do this, it is necessary to create a small file with information such as name, description, web address, various parameters, and load it into Aladin like any other file. In order to retrieve this form each time it is launched, it may be necessary to indicate it in the Aladin start command line:

```
java -jar Aladin.jar yourFile
```

Example of a description file:

```
%ActionName             MyServer
%Aladin.Label           Test
%Description            This is an example of a server
%URL                    http://mon.site.web//base/req?yy=$1&xx=$2
%Param.Description      $1=Parameter 1
%Param.Description      $2=Parameter 2
%ResultDataType         Mime(image/fits)
```

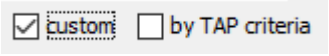
The complete syntax is described in Aladin's FAQ (http://aladin.cds.unistra.fr/java/FAQ.html#Glu).

Tip: Such a record can be copied/pasted without going through a file.

5.3 Criteria-based query forms

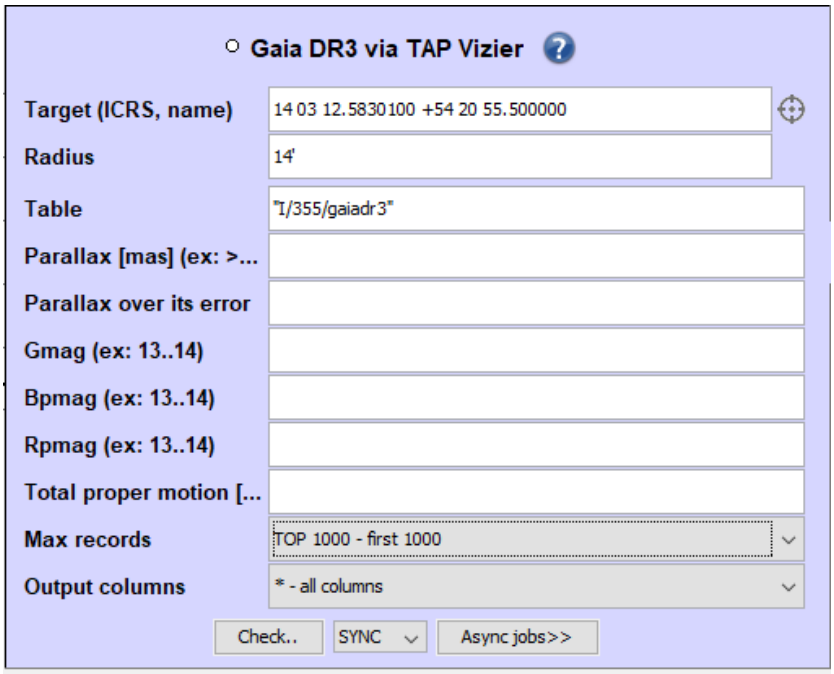
Some data providers distribute their collections through a particular IVOA protocol called TAP for "*Table Access Protocol*". This query protocol allows the user to write and then submit a query in a syntax referring to any field in the server database structure. These queries must follow the ADQL (Astronomical Data Query Language) syntax defined by the IVOA, which is a derivative of the SQL language[6].

Although very powerful and versatile, such a request is difficult to build. This is why Aladin offers two types of forms to help you write and then submit such a request. These are offered to you from the "*access window*" that appears when you click on the name of a collection in the collections tree (see 1). The simplified form will be called if you select the "*custom*" selector, while the generic TAP form is associated with the "*by TAP criteria*" selector.



6 http://www.ivoa.net/documents/latest/ADQL.html

Customised TAP form

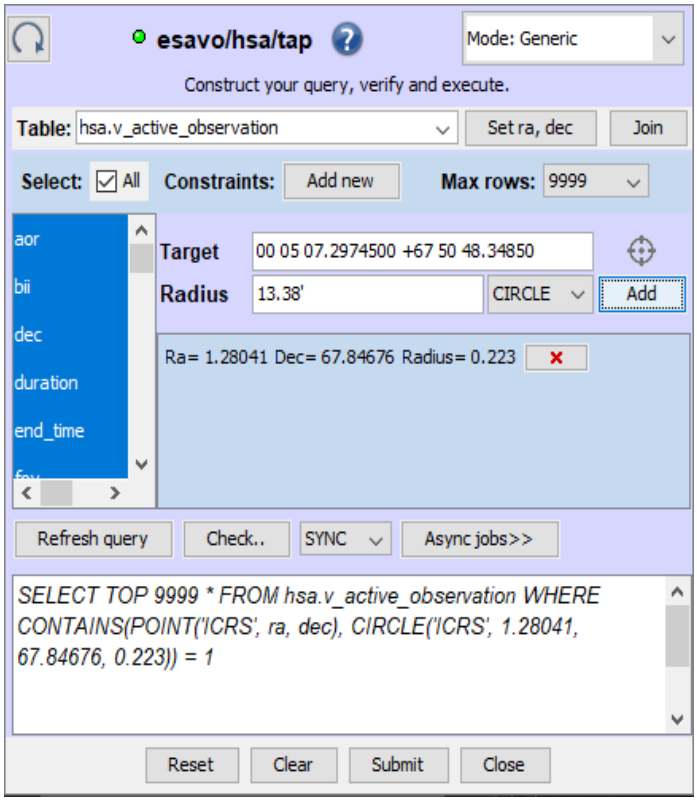


The simplified TAP form has been "customised" beforehand by the CDS to allow you to constrain a predefined list of criteria, relating to one or more tables in the database that you wish to query.

This form is easy to use but does not allow you to choose any other criteria than those selected by the SSC. The ADQL query corresponding to your selections appears at the bottom of the form, and if you wish, you can edit it directly and then submit it.

Generic TAP form (by criteria)

The generic TAP form sets out all the possible tables and query criteria. You will need to select the table to be queried unless it has been automatically pre-selected. Then, using the control buttons, add the constraints you want on each of the available fields. The question mark at the top of the form opens a new window displaying the descriptions and other metadata associated with each field in each table. Such a form requires a good knowledge of the internal structure of the Supplier's database.



As with the simplified form, the corresponding ADQL query is displayed in the bottom panel. You can edit it manually if you wish, then all you have to do is submit your request.

Let's now take a look at the filtering of the collection tree.

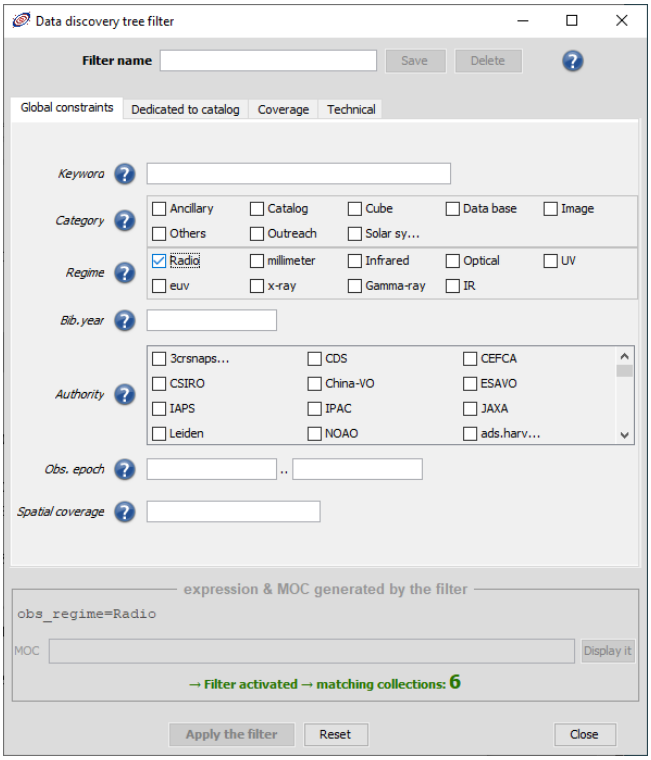
5.4 Filtering the collection tree

Icon: 
Menu: **File => Filter on data collections ...**

The collection tree presents several tens of thousands of collections. In addition to the simple keyword filter presented in section 5.1.1, Aladin offers a sophisticated and fast mechanism to view only those collections that meet certain criteria. These can be of different natures: temporal, spatial, in flow, or on any characteristic that will have been associated with a collection.

The filter window is opened by clicking on the icon to the right of the selector at the bottom of the tree, or by means of the menu "*File -> Filter on data collections...*".
This window has a central part with 4 tabs, each of them grouping the selectors and input fields specific to a category of constraints:

- Global constraints;
- Specific to the catalogues;
- Coverage;
- Technical.



The lower part of the window displays the logical expression corresponding to the constraints entered through the tabs. And just below, in green color, the number of collections selected by the filtering rule and now displayed in the collections tree.

The upper part of the window allows you to name the filtering thus created and save it for later use, possibly in a future session of Aladin. From now on it will be available in the selector below the tree.

Properties and coverings

Aladin's filtering system uses the properties associated with each of the tree's collections. These properties are represented in the form of a list of predefined keywords to which the provider of the collection associated one or more numerical values, or in a specific or free vocabulary. These properties can be viewed by displaying the "*access window*" associated with the selected collection, then clicking on the icon 

For spatial filtering, Aladin uses all the MOCs, i.e. the covers of each collection on the celestial sphere (see 4).

Restriction of use: The collections are distributed by many data providers around the world. Even if they are working to describe their collections in common IVOA standards, there are some differences mainly on the keywords to be filled in or not, and on

the vocabulary to be used for such or such property. This heterogeneity on metadata must be taken into account when developing a filtering rule, and the results obtained are only a reflection of the quality of the initial descriptions. On the other hand, coverage (MOC) is not systematically provided by data providers. These collections can therefore not be filtered spatially and/or temporally.

Technical note: [7]Aladin's filtering is based on a library developed by the CDS, installed on the one hand in the Aladin client itself and on the other hand in a remote server: the MocServer . The joint use of these two elements offers a powerful, flexible and very fast filtering system. Some technical details on this mechanism are provided in the section 8.3 at the end of the document.

Syntax of collection filtering rules

As an alternative to the selectors in the filter form, you can directly enter a filter rule in its internal form, i.e. a string describing a series of conditions. Thus, a basic rule is a condition to be fulfilled in the form of a "keyword = value" expression. This string can be directly passed in the "*Select"* field under the collection tree, or in the lower part of the filter form.

Example: **`ID = CDS/P/DSS2/colour`**

In this condition, the keyword is nothing more than the name of a field in the properties associated with each collection. It can also be a comma-separated list. The wildcards " * " (any sequence of characters) and "? " (any character) can be included. In the same way the value can be single, or multiple (separated by commas), and can also include wildcards. An interval is represented by its two bounds separated by two consecutive dots (..). Finally the condition is not limited to equality (=) but can also be difference (!=) and comparisons on numerical values or dates (>,<,>=, <=).

Several simultaneous conditions can be organised using the logical operators AND (&&), OR (||), EXCEPT (&!) and parentheses to ensure the order of the logical operations.

Examples:

- **`ID = CDS*,ESA`**: with ID begins with "CDS" or "ESA".
- **`obs_* = *NASA*`**: where one of the fields beginning with "obs_" contains the word "NASA".
- **`bib_year = 1996 .. 2000`**: year of publication between 1996 and 2000 inclusive
- **`moc_order < 3 && (moc_order > 10 || moc_skyfraction = 1)`**
- **`hips_builder = !*:`** whose hips_builder field is empty
- **`obs_regime = X-ray,UV &! ID = CDS*`**: whose obs_regime is "X-ray" or "UV", unless the ID starts with "CDS".

Note: When the field is not filled in, the collection is discarded with the notable exception of the condition " = **!* "** i.e. " empty ".

5.5 The pixel dynamics manager

Button: ***pixel*** 

Menu: **Image => Pixel contrast & map ...**
Shortcut: **Ctrl+M**

7 http://alasky.cds.unistra.fr/MocServer/query

Type of images: **HiPS and classic images**
Script: **cm**

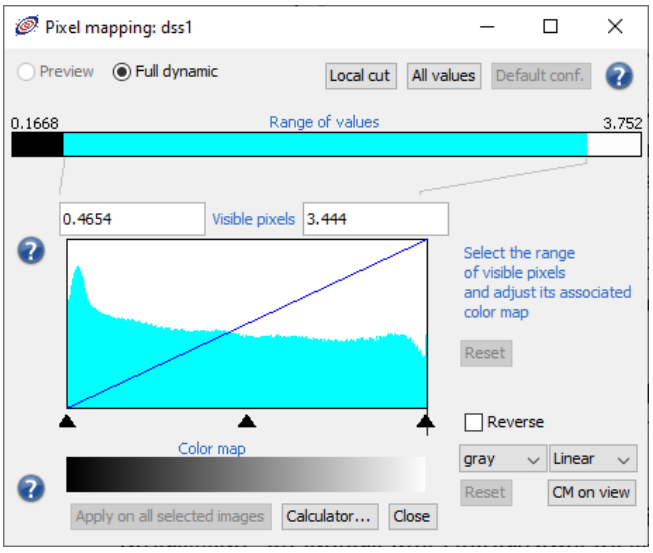
Aladin uses a specific algorithm to optimize the contrast of astronomical images. These are characterised by a dynamic range of pixel values that is often very wide, and sometimes with outliers (edge of the detector, saturation, unknown values...). However, the "monochrome" (or false colour) visual rendering can generally only take 256 values on your graphics card. Therefore Aladin samples the pixels in order to apply a threshold: all pixel values below the low threshold will be displayed in white, those above the high threshold in black, and intermediate values will be converted between 0 and 255. Aladin's "automatic thresholding" usually gives a good contrast on "interesting" pixels.

The 256 pixel values can be displayed either in grayscale, positive or negative, or with a colour table that matches each pixel value to a particular colour.

It is possible, however, that the "interesting" pixels are not the ones you are interested in, or that the automatic thresholding algorithm is not well adapted to the characteristics of the images you are viewing. To manually adjust the pixel dynamics, you can use the menu *" Image => Pixel contrast & map ... ", or* more directly the " pixel " button accessible in the toolbar.

The Pixel Dynamics window can be read from top to bottom as follows:

- The top bar shows the totality of the pixel values present in the image. The blue zone corresponds to the range of values chosen by Aladin to be displayed;
- The middle rectangle displays the histogram of the distribution of the selected pixels and overprints the transfer function applied to convert the selected range of values to 256 values;
- Finally, the bar at the bottom presents the table of colours chosen to represent the 256 calculated values.

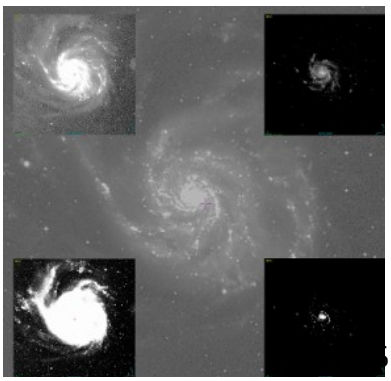


Example: The pixel values shown here are between 0.1668 and 3.752, the selected range includes pixels between 0.4654 and 3.444 which are converted into 256 grey levels using a linear transfer function.

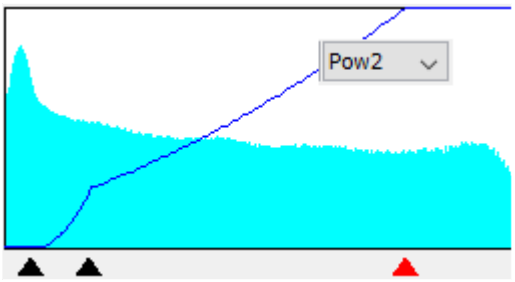
Several buttons, selector and hotspots allow you to adjust the settings of the pixel rendering algorithm.

Contrast and brightness adjustment

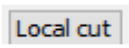
- "*Intuitively":* The simplest method uses the technique implemented in the "DS9" software: using the mouse, click and hold down the right button and then move the mouse over the surface of the view, you will be able to intuitively adjust both contrast and brightness depending on the position of the mouse within the view.



- "*Based on specific rules":* In the pixel control window, you can initially adjust the values of the selected range either by manually entering (and validating by the *return key*) these values in the numeric fields above the pixel histogram, or by clicking and dragging on the right or left limits of the range of values (top bar). This action forces Aladin to read back all the pixels of the image file. This may take a few tenths of a second or more, depending on the size of the image. An alternative, much faster option is to play only with the conversion method of the selected range, without changing the limits. This can be done by first using the transfer function . By linear default, it can be replaced by one of the following functions: Asinh, Log, Sqrt, Pow2. Then, in order to refine your function, a second operation, linear on two segments, can be applied by composition to your first choice. To do this you must play on the 3 control triangles placed under the histogram in order to determine the respective slopes of the two segments.



Tip: The manual research for the range of "interesting" pixels to be displayed can be tedious, and can vary from one region to another in the same image (centre of a star, background of the sky). The *"Local cut*" button asks Aladin to apply his thresholding algorithm only around the current position of the reticle, and on a radius of one sixth of the current view. So to adjust the contrast on a specific star or galaxy, simply click on it, adjust the zoom and then activate the "*Local cut*" button.

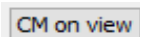


Note: This automatic thresholding action is always applied when the "*hdr"* icon is activated (under the view).

Colour tables

Aladin has some colour tables common in astronomy. These can not only be adjusted via the control of the transfer function as described above, but also reversed.

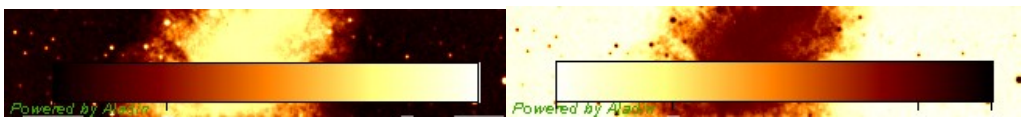
Tip: Use the "*CM on view*" button to display the colour table overlay in the view. Its size and position can be changed by clicking on the colour table and then acting on the control handles.



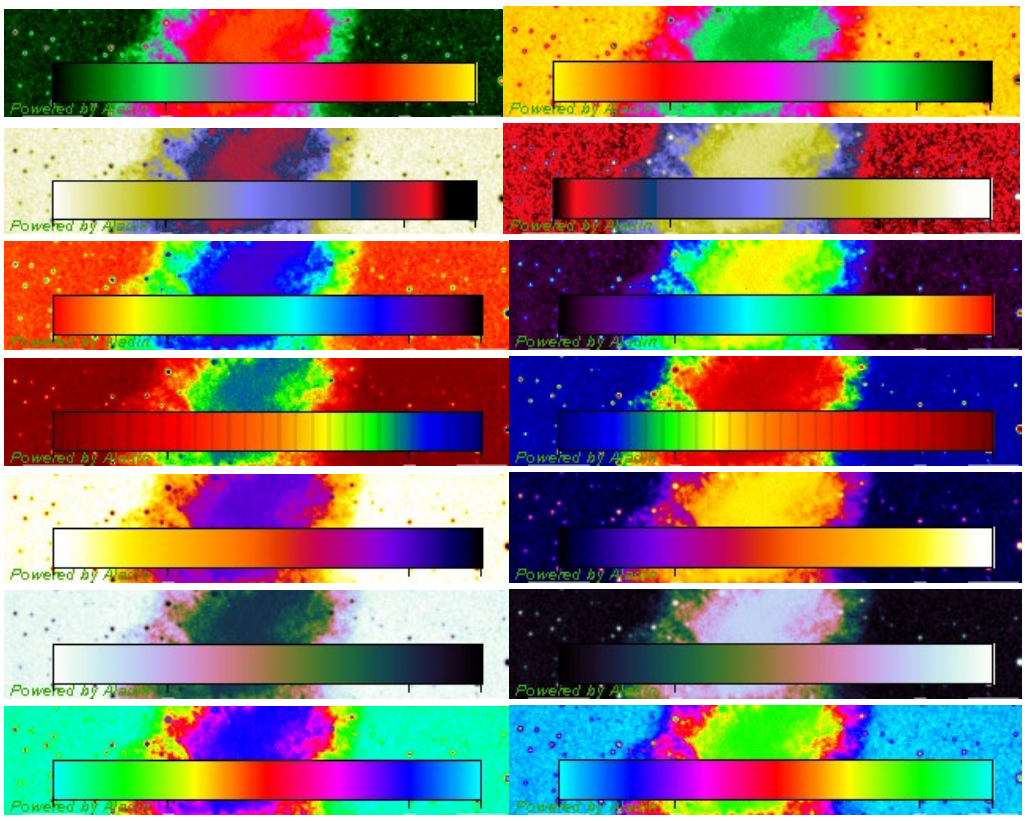
Here is the list of colour tables with a simple linear transfer function and their rendering in normal and reverse mode:

- Gray:

- BB:

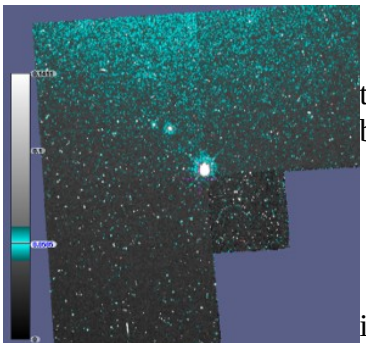


- A:
- Stern:
- Rainbow:
- Eosb:
- Fire:
- Cubhlx:
- Polar:



Note: IDL users can also dynamically load an IDL colour table via the IDL-Aladin library (see 7.5).

Quick pixel scanning

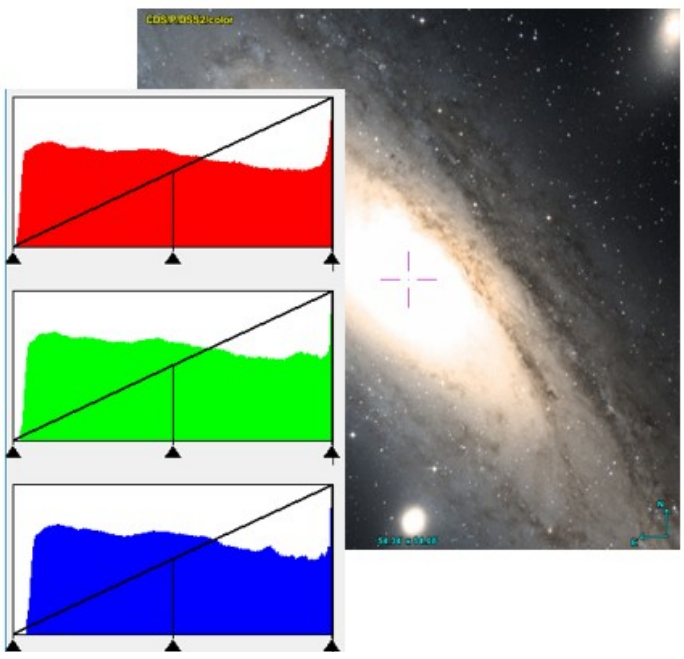


By hovering over the colour table bar with the mouse pointer, Aladin will temporarily use a particular colour table to highlight the positions of the corresponding pixels in the image. The image will be displayed in grey level, and the pixels concerned in cyan.

Special images, special cases

In the case of a true colour image, or a cube of images, the window is adapted according to the nature of the pixels.

Colour image



Aladin can manipulate images in "real" colours (colour composition - see 5.15, JPEG , PNG or colour FITS images). In this case, there is no automatic thresholding and the dynamic control window shows 3 histograms one above the other, with their control sliders, corresponding to the distribution of pixel values in the 3 components Red, Green and Blue. Each histogram has its 3 control sliders as for a classic image.

Holding down the *Shift* key while moving a slider synchronizes the sliders of the 2 other colour components, allowing an adjustment to be made simultaneously on the 3 components.

Cubes of images

Aladin can manipulate picture cubes (see 5.16- image associations, or FITS cubes). In this case, the histogram of the pixel distribution only concerns the image currently being displayed. If the cube is being scrolled, the histogram will dynamically change according to the current image. All the possibilities for adjusting the pixel dynamics are the same as for a simple image. In the case of very large cubes (several hundred megabytes), operations to modify the original threshold may take a few seconds for the result to be visible on all the images making up the cube.

Multi-images

Aladin can manipulate images from multi-CCD sensors. These will be displayed simultaneously in the view, but will not necessarily have the same contrast adjustment. To apply the same pixel adjustment function to all CCD sensors, use the '*Apply to selected images*' button at the bottom of the pixel window.

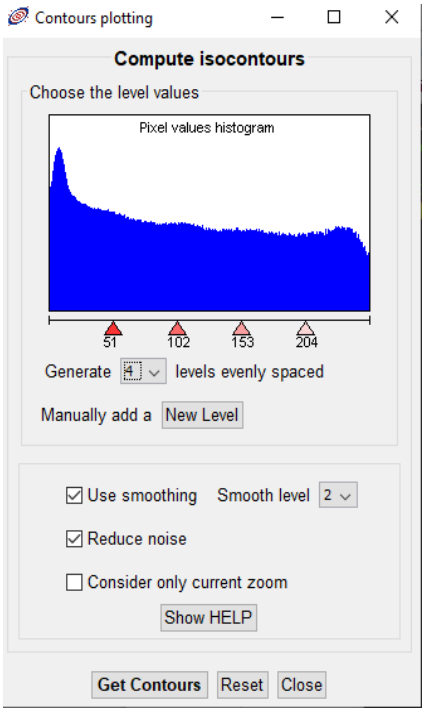
HiPS image

In the case of HiPS images, the pixels can be viewed either in " *Preview "* mode or in " *Full Dynamic* " mode. Pixel dynamics adjustments will only be fully possible in the latter mode.

5.6 Contour generator

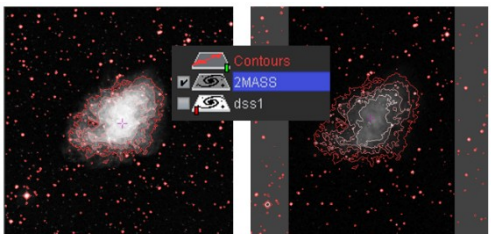
Button: **Cont** 

Menu: **Overlay => Contour plot...**
Type of images: **HiPS and classic images**
Script: **contour ...**



Aladin has a contour extraction tool to generate isocontours of an image. The menu "*Overlay => Contour plot...*" opens a control window allowing you to adjust the number of isophotes desired as well as their pixel level in relation to the histogram of pixel distributions present in the image. It is possible to smooth or reduce the image noise, or to reduce the extraction to the portion of the image visible in the view.

The contours will be stored in a plane of the stack, which can be superimposed on the original image, but also on other images (usage of celestial coordinates). This property makes it easy to compare two images that do not, for example, have the same wavelength.



Tip: The properties window associated with a contour plane (menu: *Edit => Properties)* allows you to adjust a posteriori the levels and the colour of each contour.

Restriction of use: contour extraction is possible on a progressive survey (HiPS), but it will be automatically flanged to the current field of view. Internally, the generation algorithm does not work on the HEALPix pixels, but on a sub-image extracted from the HiPS survey (see 5.1.5- The cutting tool).

5.7 Calculators

Aladin has several tools to help you in your calculations, whether it be for current numerical values, pixel values or spherical coordinates. Aladin also offers a conversion tool for the various units.

5.7.1 Algebraic calculation by script command

Menu: **Tool => Calculator...**
Script: **= *expression***

For any classical algebraic calculation, you can directly enter your expression in the form of a script command. It must begin with the character "=" like a spreadsheet formula. All the classical operators, parentheses, and common mathematical functions are supported. Some functions specific to astronomy are also supported:

x,+,*,/,%,^	addition, subtraction, multiplication, division, modulo, power
exp(x)	Euler's number 'e' raised to the power of x
ln(x)	the natural logarithm (base 'e') of x
log(x)	the base 10 logarithm of x
sqrt(x)	the correctly rounded positive square root of x
ceil(x)	the largest (closest to positive infinity) integer value
floor(x)	the smallest (closest to negative infinity) integer value
round(x)	the value of the argument rounded to the nearest integer
abs(x)	the absolute value of the argument
sin(x)	trigonometric sine of an angle (x in radians)
cos(x)	trigonometric cosine of an angle (x in radians)
tan(x)	trigonometric tangent of an angle (x in degrees)
asin(x)	the arc sine of a value (result in radians)
acos(x)	the arc cosine of a value (result in radians)
atan(x)	the arc tangent of a value (result in radians)
sinh(x)	the hyperbolic sine of x
cosh(x)	the hyperbolic cosine of x
tanh(x)	the hyperbolic tangent of x
sind,cosd,tand	trigonometric functions of an angle (x in degrees)
asind,acosd,atad	the arc trigonometric functions (result in degrees)
rad2deg(a)	the measurement of the angle a in radians
deg2rad(a)	the measurement of the angle a in degrees
min(x,y)	the smaller of x and y
max(x,y)	the larger of x and y
atan2(x,y)	the angle (in radians) corresponding to x,y in Cartesian coordinates
atan2d(x,y)	the angle (in degrees) corresponding to x,y in Cartesian coordinates
dist(x1,y1,x2,y2)	Cartesian distance between x1,y1 and x2,y2
skydist(ra1,de1,ra2,de2)	spherical distance (coord in degrees or sexa with ':' as separator

Examples:

```
= 3*8
= 1024 * (132E-7 +1/32.2)
= -skydist(05:34:43.68,+21:59:28.1,184.50849,-05.79883)*-60 -sin ( -
  round( 100+1e-03)%(3*2) + -cos(32.2+8^(7-5*max(3.1/8.7) ) ) * -(6-
  2E+5)
```

Tip: The "=" character can also be inserted after the algebraic expression rather than before.

5.7.2 Conversion by script command

Script: **convert *xxx unit1* into *unit2***

Aladin also integrates a conversion library[8] taking into account most of the usual physical units. This library is used through the "convert" script command, which can be entered directly in the command banner.

The syntax is: **convert** *xxx* unit1 **into** unit2.

The value is usually a scalar, or an algebraic expression, or possibly a date, or even a number expressed in sexagesimal (longitude or latitude of a coordinate).

The units must be one of those in the table below, or a combination of units using conventional operators (e.g. km/s). They may be prefixed by a letter specifying a multiple or sub-multiple (e.g. mHz). The list of these multiples is given in the second table.

solMass	solar mass	me	me(electron_mass)
gauss	Gauss(10-4T)	mu0	(magnetic constant)
pi	pi(=3.14...)	"hhmmss"	hour minutes seconds (sexagesimal time without separator)
ph	photon		
pc	parsec	Pa	Pascal
yr	year	cal	calorie
µ0	(magnetic constant)	cd	candela(lumen/sr)
geoMass	Earth mass	lx	lux(lm/m2)
Ry	Rydberg(13.6eV)	jovMass	Jupiter mass
JD	Julian Date	min	minute
\h	hbar(Planck constant)	lm	lumen
inch	inch	byte	byte(8bits)
Hz	Herz	solRad	solar radius
Angstrom	Angstrom(0.1nm)	alpha	(constant fine structure)
Mgeo	Earth mass	arcmin	minute of arc
rad	radian	uas	micro-second of arc
"d:m:s"	degree arcminute arcsecond (sexagesimal angle from degree)	"m:s"	minutes seconds (sexagesimal time from minutes)
erg	erg(10-7J)	"h:m:s"	hour minutes seconds (sexagesimal time from hours)
mas	milli-second of arc		
"month"	month	---	
eV	electron-Volt	au	astronomical unit
"day"	Day of month number	kg	kilogram
mag	magnitude	sec	second (use 's')
"datime"	Fully qualified date/time (ISO-8601)	al	light-year
"date"	Fully qualified date	bar	bar(10+5Pa)
"YYYYMMDD"	Fully qualified date (without separator)	Lsun	solar luminosity
"h:m"	hour minutes (sexagesimal time from hours)	mmHg	mercury_mm
muB	(Bohr magneton)	"MM/yy"	Month/Year(from 2000 when yy<50)
mp	mp(proton_mass)	u	atomic mass unit
Å	Angstrom(0.1nm)	t	tone
ct	count	s	second

8 This library was developed by the CDS to handle the physical quantities of the catalogues managed by the VizieR service (http://vizier.cds.unistra.fr/doc/catstd.htx).

MJD	Modified Julian Date (JD-2400000.5)	H	Henry
m	metre	G	G(constant gravity)
l	litre	eps0	(electric constant)
k	k(Boltzmann)	F	Farad
h	hour	D	Debye (dipole)
Wb	Weber(V.s)	barn	barn(10-28m2)
solLum	solar luminosity	C	Coulomb
g	gram	"MM/YY"	Month/Year(from 1900)
arcsec	second of arc	deg	degree
e	e(electron_charge)	Rsun	solar radius
d	day	A	Ampere
c	c(speed_of_light)	a0	(Bohr radius)
a	year	?	pi(=3.14...)
dyn	dyne(10-5N)	mol	mole
sr	steradian	µas	micro-second of arc
?	hbar(Planck constant)	hr	hour(use 'h')
W	Watt	atm	atmosphere
V	Volt	Mjup	Jupiter mass
T	Tesla	%	percent
S	Siemens(A/V)	"ddmmss"	degree arcminute arcsecond (sexagesimal
R	R(gas_constant)	angle without separator)	
Sun	Solar unit	degF	Fahrenheit
pix	pixel	Jy	Jansky(10-26W/m2/Hz)
N	Newton	degC	Celsius
K	Kelvin	Ohm	Ohm(V/A)
bit	binary information unit	lyr	light-year (c*yr)
J	Joule	Msun	solar mass

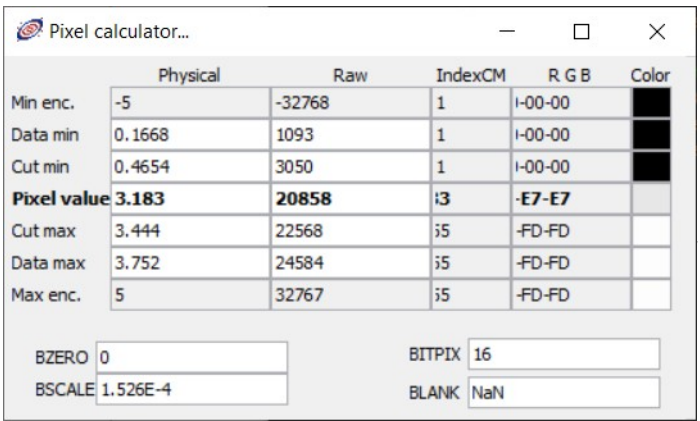
Symbol	Explanation	Value	Symbol	Explanation	Value
d	deci	*10–1*	da	deca	*10*
c	centi	*10–2*	h	hecto	*102*
m	milli	*10–3*	k	kilo	*103*
u	micro (*µ*)	*10–6*	M	mega	*106*
n	nano	*10–9*	G	giga	*109*
p	pico	*10–12*	T	tera	*1012*
f	femto	*10–15*	P	peta	*1015*
a	atto	*10–18*	E	exa	*1018*
z	zepto	*10–21*	Z	zetta	*1021*
y	yocto	*10–24*	Y	yotta	*1024*

Examples:

```
convert 1/10m into nm                    => 1.0E8 nm
convert 2a into d                        => 730.5 d
convert 20011210 "YYYYMMDD" into MJD     => 52253.0 MJD
convert 10:10:8 "d:m:s" into deg         => 10.1688888888889 deg
```

5.7.3 Pixel calculator

Calculations on pixel values are common in astronomy because, most of the times,



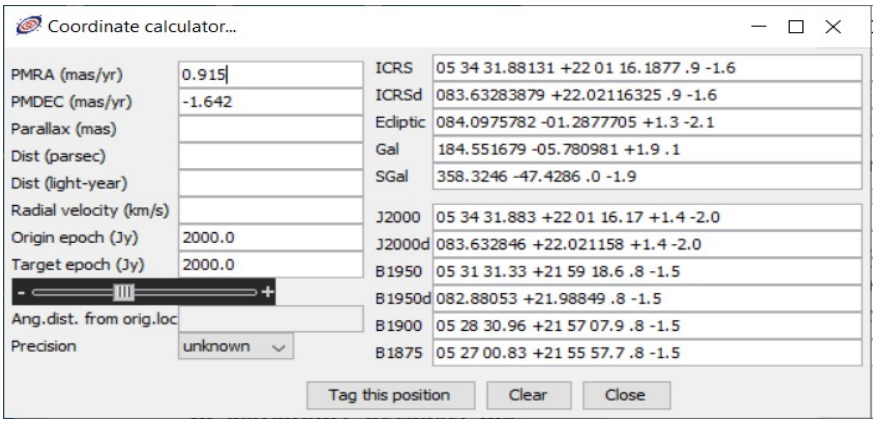
images use a transformation function: the internal coding in the form of a real or integer (raw), will be multiplied by a constant factor (keyword FITS BSCALE), then the result will be added to another constant (keyword FITS BZERO). Therefore, the conversion from the coding value to the represented physical value, follows the rule: value = BZERO + BSCALE * raw.
On the other hand, for display, this physical pixel value will have to be converted into a colour (or greyscale) table index between 0 and 255, or even 1 and 255 if channel 0 is used for transparency. This conversion depends on the choices made to control the colour table (transfer function, range of physical values of the pixels to be displayed) (see 5.5).

Both of these conversion operations can be managed in the pixel calculator. This appears in a window via the menu "Tool -> *Pixel calculator".*

This form can be used freely by manually assigning the constants BZERO and BSCALE and the value of a pixel. These values, the parameters of the colour table, and the pixel value will be automatically filled in if you click in an image displayed in the view.

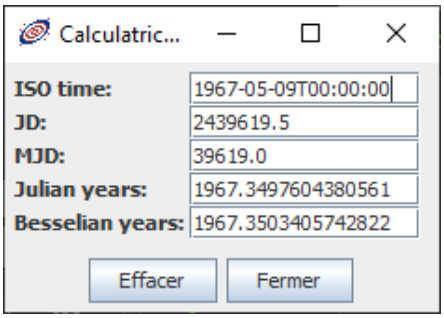
5.7.4 Coordinate calculator

As with pixels, calculations relating to astronomical coordinates are very common: conversions of the sexagesimal or decimal representation, modification of spatial referential (e.g. conversion B1875 to ICRS), taking into account the time of observation in relation to the time of display with knowledge of the proper motion and/or radial velocity, etc. These calculations can be complex. Aladin offers you a "coordinate calculator" accessible through the menu "*Tool -> Coordinate calculator".*



You can use this calculator by directly entering the coordinates and other position parameters, then validate with "*Enter" to* obtain the same coordinates in other systems and times. You can also click in the view, or even in the measurement window, to take into account the position under the mouse. In the case of catalogue measurements, if the catalogue has its own motion and/or radial velocity information, these parameters will also be filled in and used.

5.7.5 Time calculator



Aladin provides a small utility for converting dates. It is accessible through the menu "Tools → Time Calculator". This tool allows you to obtain the equivalences between a date expressed in ISO format (YYYY-MM-DDTHH:MM:SS), and the correspondences in Julian Days (JD), in Modified Julian Days (MJD), in decimal Julian years, or in decimal Besselian years. Just fill in one of the fields, and validate with the "*Enter*" key to obtain the equivalences in the other systems.

5.8 Catalogue Filter Manager

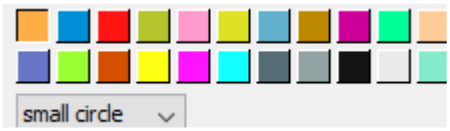
Button: **Filter** 

Menu: **Catalog => Create a filter...**
Data type: **HiPS catalogues and classic catalogues**
Script: **filter ...**

Catalogue filtering in Aladin is a powerful tool for an "intelligently" viewing of the sources.

Note: Catalogue filters should not be confused with collection tree filtering.

Default behaviour (without filter)

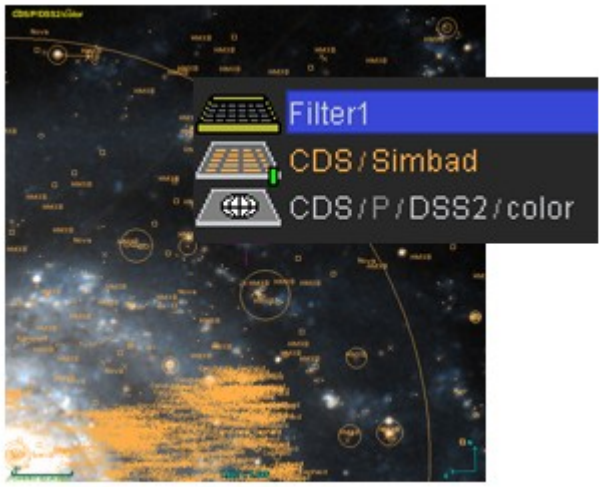


By default, Aladin represents the sources, using graphic symbols, all identical for a given catalogue plan (colour and shape). The shape is only dependent on the number of sources (smaller symbols for dense catalogues). The colour and shape can be modified a posteriori by using the properties attached to the catalogue layer (*"Edit => Properties"* menu), the size using the "*size"* slider under the stack.

However, it may be interesting to constrain shape and colour based on the measurement values associated with each source. To do this it is necessary to use what Aladin calls "*a filter*".

Filter definition

For Aladin, a filter will be applied to one or more catalogue plans in order to modify the way the graphic symbols are drawn in the view. This is one or more rules that will tell Aladin how to draw the sources according to the values present in the measurements of each source. Thus it will be possible to draw circles proportional to the magnitude, error ellipses on the position, arrows whose orientation and size depend on the values of its movement...

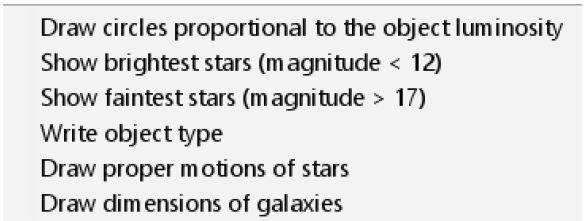


<u>*Representation of the filter in the stack*</u>

The filter is represented as a special plan in the stack that applies to all catalogue plans below it.

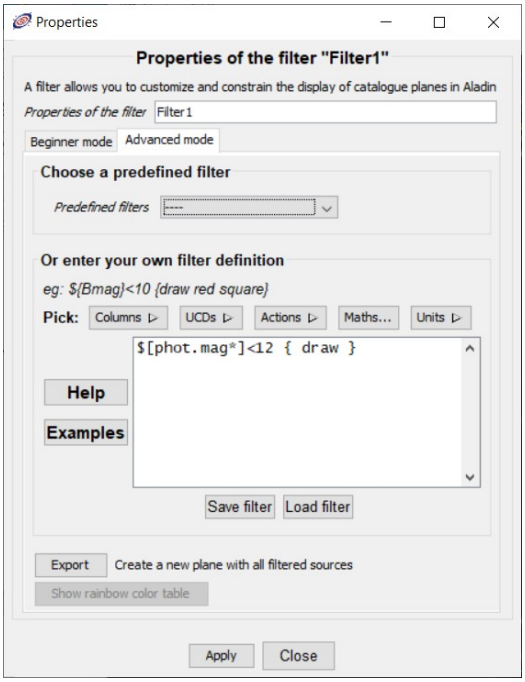
Predefined filter

Aladin offers some predefined filters that correspond to the most common manipulations in astronomy. You can select them and apply them immediately via the "*Catalog => Predefined filters"* menu.



On the other hand, it is often necessary to fine-tune the filter constraints and to do this, you need to manually create or edit your filter rules. This will be detailed in the next section.

Filter generation



A filter is generated using the "*Filter*" button in the toolbar or from the *"Catalog => Create a filter"* menu. Two modes are available via tabs:

- The "*beginner*" mode, which is the same as using a predefined filter (see above);
- The "*expert*" mode where you are in charge of editing your own filtering rules.

The expert mode panel allows you to edit the filter rules in the central edit box, and offers a range of editing aids:

- Many commented examples that can be used as a basis for your own filters;
- Buttons to access the column references of the catalogues currently loaded in Aladin;
- A button to access the graphic "actions" to be implemented;
- Buttons to access the available mathematical functions and physical units.

You can also reload a filter from a previously saved file.

Syntax

To understand the syntax of a filter, let's start with the following example. Suppose you want to display "object types", and only for bright sources. This filter can be written as follows:

```
${B}<18 { draw ${OTYPE}  }
```

Only lines with a value in column "B" (magnitude B) of smaller than 18 will be retained, and the display will focus on the contents of the column "OTYPE" (type of object).

As we can see, a basic filter follows the following syntax:

```
un_test { une_action }
```

- The test is optional and if it is not available, all sources are concerned;
- It is possible to indicate several actions, separated by the character ';' or a line break;
- It is possible to have several consecutive "test{action}" groups, knowing that it is the action associated with the first "true" test in the list that will be taken into account, the other lines being ignored.

```
${class}="Star" {draw square}
${class}="Radio" {draw rhomb}
${class}="Galaxy" {draw more}
```

- Lines beginning with '#' are comments.

The test

- The test uses the usual comparison operators (=, !=, <, >, >=, <=).
- It can contain parentheses and boolean operations AND (&&), OR (||), NOT (!).
- It can use mathematical functions (abs, cos, deg2rad, exp, ln, log, rad2deg, sin, sqrt, tan);

Example: Drawing of the sources according to the following expression:

```
log( abs(${Fi})/${Fx} ) > 44 { draw }
```

- It is necessary to use quotes (") for strings. Wildcards '?' and '*' are allowed;
- The "*undefined(...)*" operator is used to identify rows that do not have a value for a given column.

Graphic actions

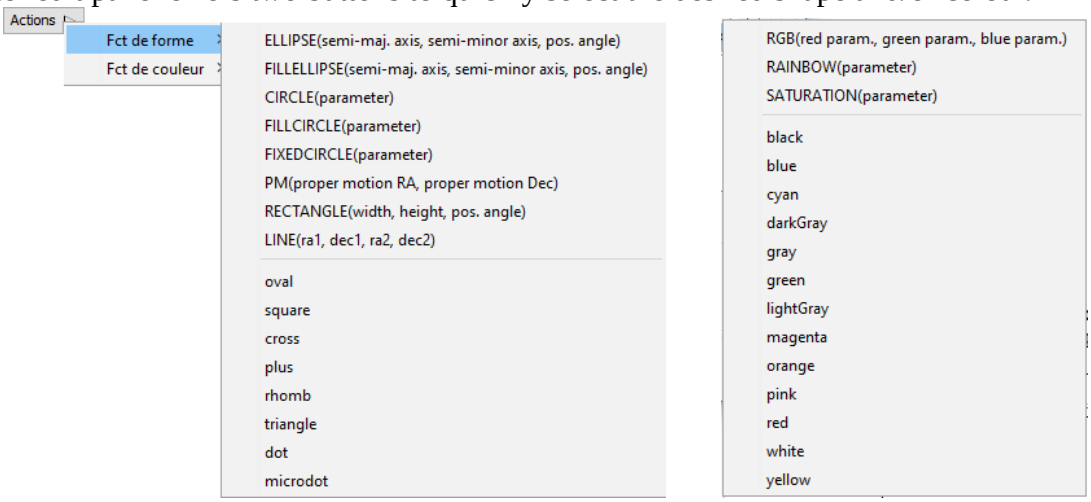
Two actions are possible:

- *draw:* to display a source;
- *hide*: rarely used, it allows to hide particular sources.

In the case of a "draw", the action can concern the **shape** and/or the **colour of** the line. The syntax is as follows:

```
draw colour shape
```

The filter edit panel offers two buttons to quickly select the desired shape and/or colour.



The shape and colour functions can refer to columns and/or use arithmetic expressions.

Example: drawing red triangles:

```
{ draw red triangle }
```

Example: Ellipse plotting

```
{ draw ELLIPSE(0.5*${MajAxis},0.5*${MinAxis},${PosAng}) }
}
```

Example: Drawing squares whose colour depends on the magnitude
`{ draw RAINBOW(${magB}) square }`

Special functions

- ***FILLCIRCLE***: solid circle;
- ***FIXEDCIRCLE****:* Circle whose size is fixed (not subject to the zoom value of the view);
- ***PM*****:** Arrow whose orientation and size depend on the two angles indicating proper movement;
- ***LINE***: plotting of a segment, very useful to visualise the results of a correlation between 2 catalogues.

The *CIRCLE*, *FILLCIRCLE* and *RAINBOW* functions accept two optional parameters that provide the minimum and maximum values used for tracing. Example: `draw CIRCLE(${A},1,10)` will draw proportional circles for the values in column "A", the smallest circle having 1 pixel radius, the largest circle 10 pixels.

If the "draw" action is on a string (ex: `draw "star")` or a reference to a column (ex: draw ${ObjectClass}), it will be the string or the value of the column that will be displayed.

Column name or UCD

The reference to a column value is classically made by the name of the column thanks to the syntax **${COLUMN_NAME}**. This method implies that the filter is more or less dedicated to a particular catalogue since it is necessary to know explicitly the names of the columns. To write more generic filters, for example taking into account the magnitude regardless of the column name given by the author, Aladin uses UCDs.

UCDs, or Unified Content Descriptors, provide an independent characterisation of the columns in the catalogue. Each column has been associated with a UCD which allows to know the physical quantity represented by the column. For example a column with magnitudes will be labelled by the UCD "pos.mag". The list of UCDs is maintained by an international committee and is available on the IVOA website[9]. Most astronomy servers provide their catalogues in VOTable format already annotated with these UCDs.

When a filter rule uses a UCD, the syntax used is **$[UCD]**. Wildcards '*' and '?' are allowed. For example $[phot*] is the first column with a UCD that starts with 'phot', in other words, the first column with magnitude measurements.

In summary, the reference to a column by its name is written with *braces*, the reference to a column by its UCD with *square brackets*.

Example: Drawing a circle proportional to the magnitude
for all sources brighter than 12
`$[phot*]<12 { draw circle(-$[phot*]}) }`

9 http://www.ivoa.net/Documents/latest/UCDlistMaintenance.html

To simplify the entry of references to columns, the editing panel of a filter offers two buttons "*Columns*" and "*UCDs"* which allow to click in a list on the column name, respectively on the UCD, so that the corresponding text is automatically written at the position of the cursor in the editing window.

In case sources are selected in the view, and thus show their measurements, it is possible to designate a column by simply clicking on it in the measurements panel. To do this, it is necessary to choose the "*Point..."* sub-menu when you click in "*Columns"* or "*UCDs*".

Physical units

The indication of physical units (e.g. arcmin, Jy...) in the test allows you to avoid manual conversion for expressions using columns whose values are not expressed in the same unit. The units can be composed as shown in the example below. This is a powerful function that allows you to write very generic filters.

Example: Drawing a circle proportional to the flux in X (UCD: phot.flux;em.X-ray) for all sources whose energy level is higher than the mentioned threshold.

```
$[phot.flux;em.X-ray]>10^-8 erg/m^2/s
{ draw circle($[phot.flux;em.X-ray]) }
```

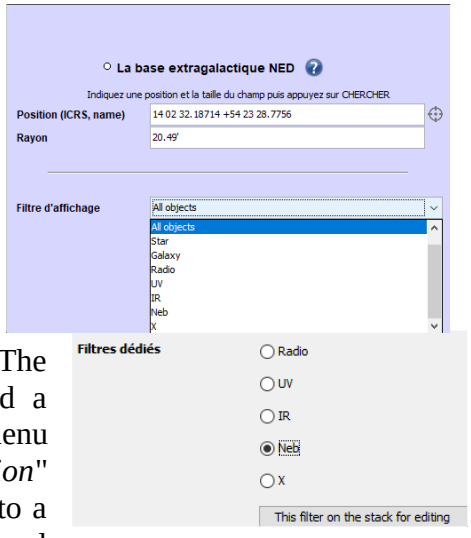
Updating a filter

To find the editing window of a filter, select this filter in the stack and then display its properties via the menu *"Edit => Properties"*.

Scope of application of a filter

In order to be applied, a filter must be activated (click on its logo in the stack). By default, a filter is applied to all the catalogue plans below it in the Aladin stack. On the other hand, if a filter is placed in a folder in the stack, it will only apply to the catalogue drawings in this folder, even if this folder does not have the "local" property activated (see 5.1.2).

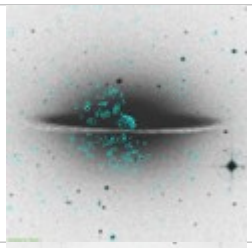
Filter dedicated to a single catalogue plan

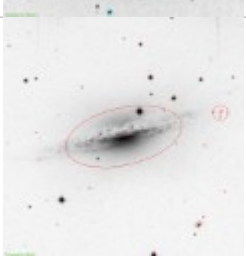


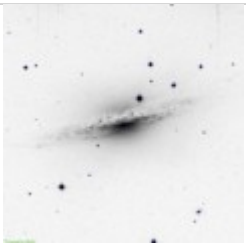
Some servers offer a series of filters dedicated to their data (Simbad , NED , Skybot ...). They appear in some data query forms (see 5.2) like a drop-down list, at the end of the list of query parameters.

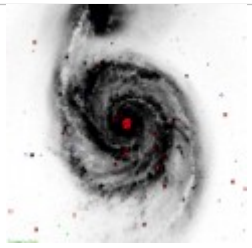
A "dedicated" filter, if activated, does not appear in the stack and it is only applied on the catalogue plan concerned. It inhibits the action of any other generic filter on that plane. The choice or activation of a "dedicated" filter can be modified a posteriori via the "properties" associated with the plan (*Edit* menu *=> Properties...).* Via the "*This filter on the stack for edition*" button, it is also possible to "transform" a "dedicated" filter into a generic filter in order to modify it and/or apply it to several catalogue plans.

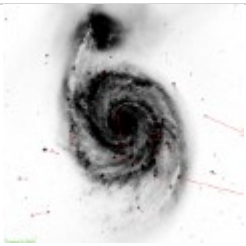
Examples of generic filters

Circles according to magnitude	`{`
	` draw circle(-$ [phot.mag*])`
	`}`
		

Position ellipses
+
Default display
	`{`
	` draw ellipse(`
	`  0.5*$ [phys.angSize.smajAxis],`
	`  0.5*$ [phys.angSize.sminAxis],`
	`  $[pos.posAng])`
	` draw`
	`}`
		

Blue squares for bright sources	`$[phot.mag*]<17 {`
	` draw blue square`
	`}`
		

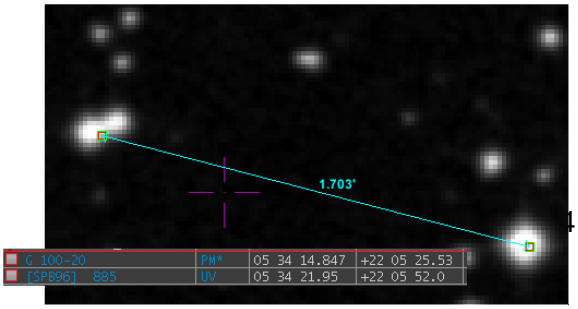
Different coloured symbols depending on the class of the object	`$[src.class]="Star`
	`  {draw red square}`
	`$[src.class]="Radio`
	`  {draw blue rhomb}`
	`$[src.class]="Galaxy"`
	`  || $[src.class]="Seyfert"`
	`  {draw green plus}`
		

Proper motions	`{`
	` draw pm(`
	`  5*$ [pos.pm;pos.eq.ra],`
	`  5*$ [pos.pm;pos.eq.dec])`
	`}`
		

5.9 The "Automatic measurement" tool

Menu: **Tool => Auto-distance measurer**

The "*automatic distance measurement*" tool is activated via the "*Tool*" menu. When this tool is activated, the selection of two catalogue sources



results in the temporary drawing of a segment between these two objects with the display of their angular distance measurement.

Tip: To precisely determine the distance between two astronomical objects in an image, and not in a catalogue, use the "*phot"* tool and click on each of these objects beforehand so that Aladin can calculate the barycentric centroid for each of them. Then select the two measurement points to see the precise separation distance.

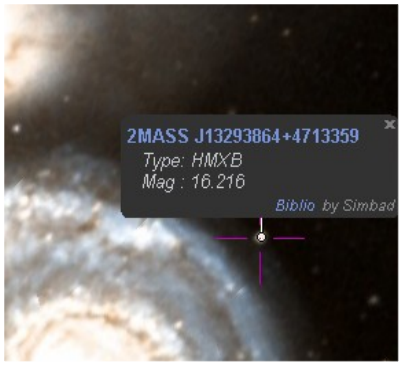
5.10 The "study" tool

Button: ***study*** 

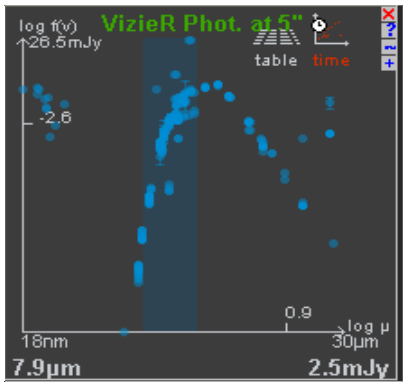
Menu: **Tool => Simbad pointer**
Tool => VizieR photometry pointer

Aladin relies on the CDS databases to examine the astronomical object pointed at by the mouse. If the object has already been studied by the scientific community additional information on this object can be provided, The automatic “study” mode is activated through the menu "*Tool -> Simbad pointer"* and "Tool -> *VizieR photometry pointer".* It can also be activated by clicking on the "*study*" icon below the view. If this icon is orange then the Simbad pointer is active, if it is green both the Simbad and VizieR pointers are active. 

Simbad pointer



To get results from the "*Simbad pointer*", click in the view and hold the mouse at the position of interest for 3 seconds. Aladin will query the Simbad database and return the most precise identifier, magnitude, type and coordinates known for the astronomical object at or near the mouse position. The radius of this search depends on the zoom factor, and corresponds to one 20th of the size of the view. In case of Simbad is providing several sources, the one that has been studied the most - i.e. mentioned or cited in the largest number of research articles - will be selected.
Then, Aladin displays a label superimposed on the view, attached to the selected source. A mouse click on the name of the object in this label will open your web browser on the Simbad page corresponding to this object. In the same way, a mouse click on the "*Biblio*" link will display the Simbad page of all scientific articles associated with this source.



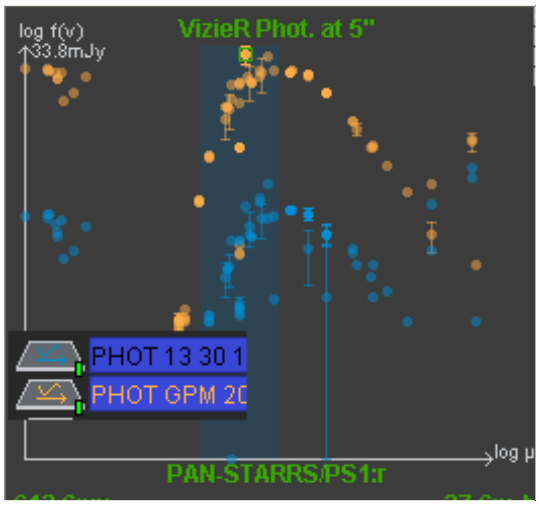
VizieR pointer

The "*Vizier pointer*" is activated in the same way as the "*Simbad pointer*" by clicking on the intended location and holding the mouse in this position for a few seconds. Aladin will then query the VizieR catalogue service in order to dynamically construct a SED (Spectral Energy Distribution) based on a collection of catalogues with flux measurements in different filters located nearby the mouse position. The resulting figure is displayed in the multi-purpose panel at the bottom right.

Caution: There is no guarantee that each of these measurements is actually for the same astronomical object, nor that these flux measurements are really comparable. These are only measurements obtained within a few arcseconds of the mouse position.

The graph can be displayed in wavelength or frequency by pressing the small "~" button in the upper right corner. The vertical bar represents the optical band. The graph can be enlarged if necessary by changing the proportion of the lower and right-hand panels in the Aladin window. If necessary, the small "+" button will open your browser with the same figure but drawn by a more powerful Web tool provided by the CDS, which allows for printing and saving.

A click on the icon "table" on top of the graph or on one of the points in the figure leads to the creation of a new catalogue plane containing all the measurements. The sky location of these measurements will now also be visible in the view, and the values displayed in the measurements window. The line corresponding to the clicked point will be automatically selected.



The simultaneous selection of several planes from the "*VizieR pointer*" measurements results in the superimposed plotting of the SEDs in the multi-purpose panel.

Tip: In the case of a joint activation of both "pointers", the VizieR query will not take into account the position directly under the mouse but the coordinates of the object provided by Simbad. This method increases the likelihood that the flux measurements are actually taken for the same object.

Finally, in the case where the flux data is dated, a "time" icon appears beside the "table" icon. Its activation will generate a time graph (see section XX) whose x-axis will be the date and y-axis the corresponding flux value. This provides a light curve, keeping in mind the warning previously mentioned about the heterogeneous origin of the data and the various calculation methods.

5.11 Catalogue correlator

Button: **cross** 

Menu: **Catalogue => Cross match objects ...**
Data type: **Classic catalogues only**
Script: **xmatch ...**

Aladin integrates a source correlation tool. The aim is to determine the sources common to two catalogues. The correlator will consider 2 catalogue plans, operate the correlation and generate a new catalogue plan containing the common objects.

Note: The correlator described here only applies to pre-loaded catalogues, not to be confused with the possibility of correlating a local map and a remote table located at the CDS via the "*collection tree" and the* "*access window*".

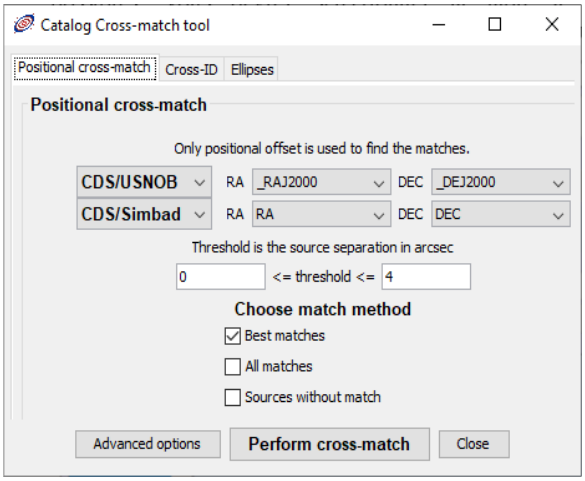
The window that controls the correlation can be accessed via the "*cross"* button or the "*Catalogue => Cross match objects ..."* menu.

The 3 modes of correlation

Aladin offers 3 correlation modes accessible via the tabs at the top of the correlation window:

- A correlation based solely on the position;
- A "per field" correlation based on the presence of identical values in a column of each catalogue (typically an identifier);
- Position-based correlation with consideration of error ellipses.

Correlation by position



The panel of the positional correlator allows to indicate the 2 catalogues concerned as well as the columns corresponding to the position (ra,dec). If there is no ambiguity, the names of the columns have already been correctly filled in by Aladin. It is then necessary to indicate the upper or lower separation limit for which the sources will be correlated. It is expressed in arc seconds. Finally, a selector offers 3 choices:

1. When there are several objects in the correlation circle, only the closest source will be correlated;
2. Or on the contrary, all combinations will be kept;
3. Alternatively, only sources with no counterparts will be retained.

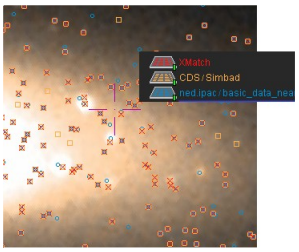
Correlation by field

Field correlation consists of bringing together sources with a field value that is present identically in both catalogues. This type of correlation is dedicated to a field that uniquely identifies each source, for example an identifier, a serial number, etc. In the database, this is called a "join".

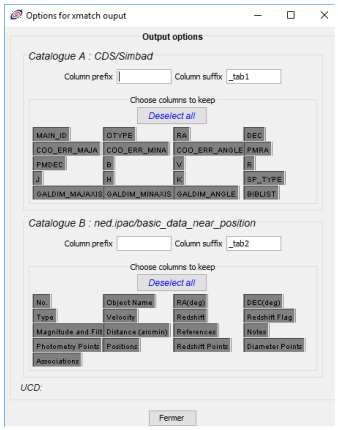
Correlation by ellipses

The panel for controlling correlation by ellipses is similar to that for simple correlation by position. The notable difference is the possibility to specify not only the position columns but also the columns that give the position error. This error must be expressed in the form of 3 fields describing an ellipse: the major axis, the minor axis and the orientation with respect to the north.

Choice of fields to be kept



When Aladin performs a correlation, he creates a new catalogue plan with the results. Each pair of correlated sources will correspond to a source in the result plane, and by default, all measurements from both sources will be retained. To avoid possible confusion on column names, they will be automatically suffixed with " _tab1 ", respectively " _tab2 ".



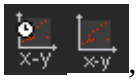
By using the *"Advanced options"* button in each of the correlation forms, it is possible to explicitly choose the columns to be kept and to specify the suffixes or possibly the prefixes of the column names.

Columns and UCDs

When the mouse pointer hovers over the buttons to select the columns, the corresponding buttons in the two catalogues will be displayed on a blue background. This correspondence is based on common UCDs for these two columns (a UCD is an attribute specific to each column which characterises its physical meaning - e.g. "pos.eq.dec" for a declination measurement - see the description of UCDs in the 5.8 section).

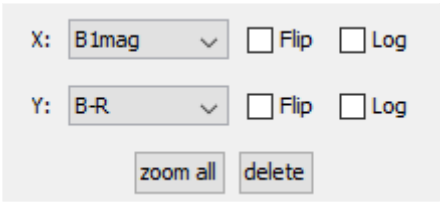
Note: Some UCDs should only appear once in a table ("meta_main"). Thus, if the correspondence is displayed on a red background, it means that there will be a conflict of UCDs. To remove the conflict, it is necessary to click on the name of the preponderant column by holding down the *Ctrl* key. In the absence of any indication, the column of the first catalogue will be the most important one.

5.12 Scatter plot / time series

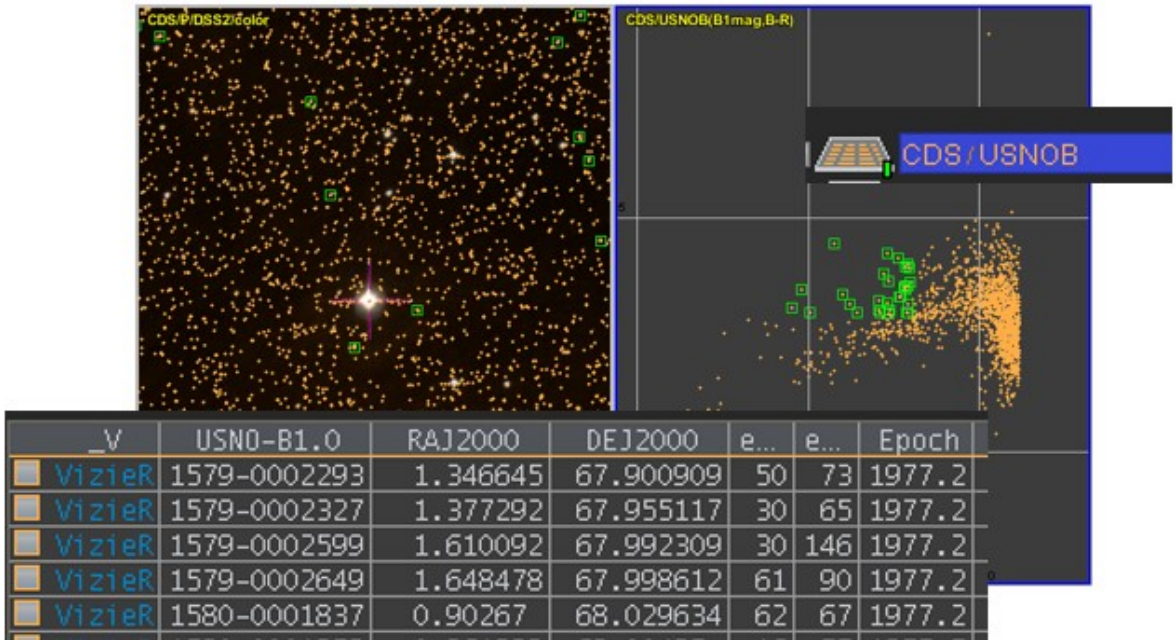
Button: **x-y** 

,
Menu: **Catalog => Create a scatter/time plot**
Data type: **Classic catalogues only**

The "*scatter plot*" tool allows you to compare two quantities taken from the measurements in a catalogue. Activating this tool after selecting the catalogue plan in the stack will create an additional view that will display the a scatter plot. At the same time, Aladin will open the properties window of this plane so that you can specify the two quantities to be compared.



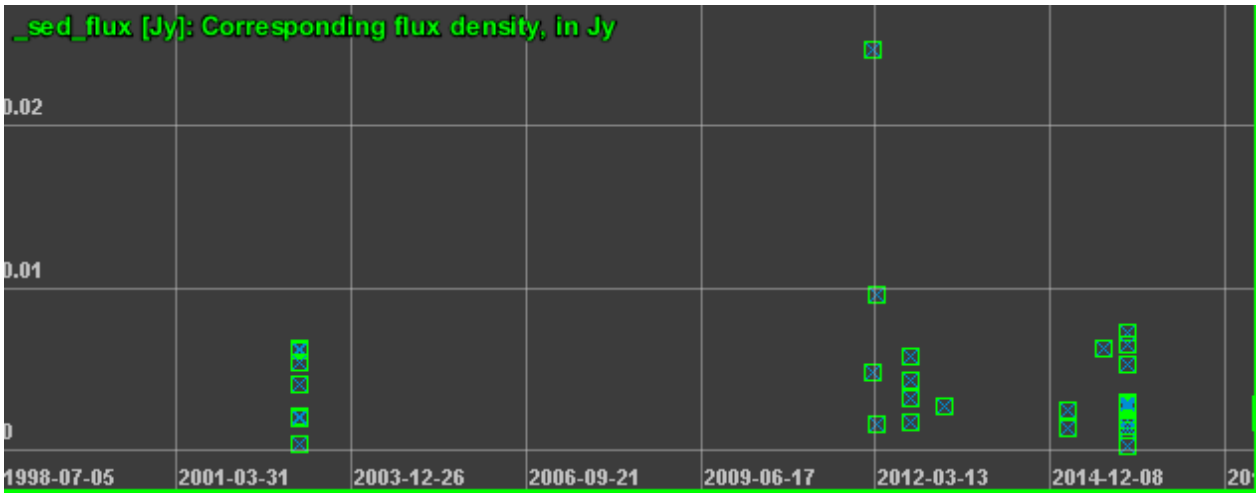
The "*scatter plot*" can be manipulated in a similar way to a classic view (zoom, move). It is possible to select the concerned sources and by this means to be able to immediately see, in another view, their location on the sky.



_V	USNO-B1.0	RAJ2000	DEJ2000	e...	e...	Epoch
VizieR	1579-0002293	1.346645	67.900909	50	73	1977.2
VizieR	1579-0002327	1.377292	67.955117	30	65	1977.2
VizieR	1579-0002599	1.610092	67.992309	30	146	1977.2
VizieR	1579-0002649	1.648478	67.998612	61	90	1977.2
VizieR	1580-0001837	0.90267	68.029634	62	67	1977.2

Tip: It is possible to plot several "scatter plots" from different planes simultaneously on the same graph. To do this, drag and drop the logo of the planes for which you wish to visualize the scatterplot on an already created graph. However, it will be necessary to indicate the columns concerned for each added plane.

In the particular case of a "*time series*", i.e. when the column chosen for the x-axis is a date, the view used has specific characteristics. The zoom behaviour differs slightly: only the time scale (x axis) will be impacted by the zoom factor, and not the value scale (y axis), which will have the effect of contracting (resp. expanding) the graph horizontally. On the other hand, such a "temporal" view can superimpose the time component of a temporal or spatio-temporal MOC (see 5.1.4).

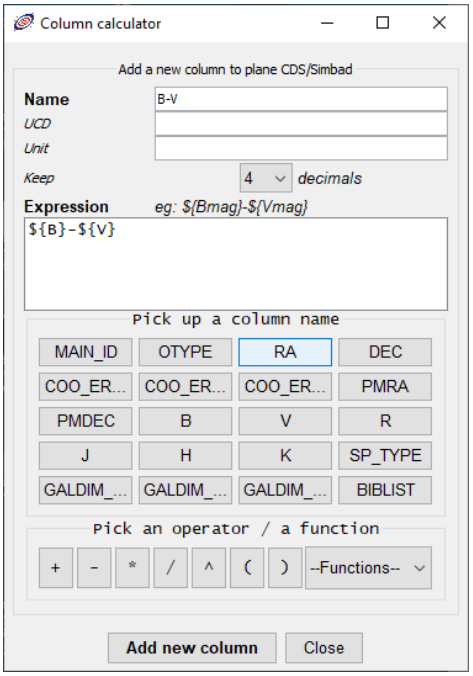


Note: The "*scatter plot"* tool remains relatively basic. Do not hesitate to use another tool such as TOPcat in conjunction with Aladin through the SAMP exchange interface described in section 6.4.

5.13 Column calculator

Menu: **Catalog => Add a new column...**
Measurements pop-up menu: **Add a new column...**
Script: **addcol ...**

The catalogues contain a set of measurements that can be viewed in the "*measurements panel*" by selecting the relevant sources (see 5.1.8). These measurements are presented as several columns of values. Aladin provides the possibility of adding columns that are obtained by calculation on the values of other columns. For example, it is possible to create a "*B-V*" column providing the difference between two columns of magnitude "*B*" and "*V*".



Acces to the window

The window for managing the calculation of a new column is opened either by the contextual menu of the "*measures panel*" (right click or CTRL click), or via the main menu "*Catalog => Add a new column...*". In the latter case, you will have to specify the catalogue concerned beforehand by selecting its plan in the stack.

General information on the new column

The creation of a new column requires the specification of a name. Optionally you can specify the unit of the new column and the UCD to be associated with (see 5.8). You can also specify the number of significant decimal when displaying values.

Calculation expression

To create a new column, it is necessary to indicate the calculation expression that Aladin must use to generate the values of this new column. The entry is made in the central box entitled "*Expression*". The syntax used follows the usual conventions of an algebraic expression. References to other columns respect the syntax:

`${column_name}`

To avoid typing errors, the window displays a list of buttons with the names of the columns in the relevant catalogue. A mouse click on one of them inserts, at the cursor position in the expression entry panel, the reference to the concerned column.
It is also possible to insert the operators (+, -, *, /...) and any mathematical functions (abs, cos, sin, rad2deg, ...) by clicking on the corresponding buttons and selectors.

Generation of the column

Once created using the "*Add new column*" button, the new values will appear on the far right of the measurement table, and in a brown/orange colour so that they can be easily distinguished from the original measurements. This new column can be used like all the other columns: sorted, filtered... It will be saved with the other columns if necessary.

DEC	COO_...	COO_...	C...	PMRA	PMDEC	B-V	B	V	R
58 07.2						0.7999	19.9	19.1	18.634
02 06.9						0.8140	19.93	19.116	18.632
02 47.6						0.5730	19.476	18.903	18.556
03 30.2						0.7539	20.043	19.289	18.883
05 17.6						0.7330	19.789	19.056	18.626

5.14 Astrometrical calibration window

Menu : **Image => Astrometrical calibration**
Types of images : **fits, jpeg, png only**

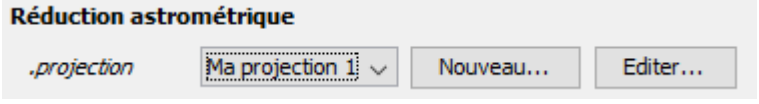
Whenever Aladin superimpose sources over an image, it uses astrometric solution associated to the image. More precisely, this information makes the link between each and every pixel in the image and the corresponding position in the sky, and vice-versa. There are several possibilities usually describing the method used to project a part of the celestial sphere onto a plane (tangential, sinusoidal, ...). Aladin handles the most commonly used projection in astronomy (SINUS, TANGENTIAL, AITOFF, ZENITAL_EQUAL_AREA, STEREOGRAPHIC, CARTESIAN, NCP, ZPN, ...)

Information on the astrometric calibration

Aladin supports 4 methods in order to obtain the astrometric calibration for an image :

1. When dealing with FITS format images, the calibration information is present in the keywords from the FITS header (according to the WCS standard);
2. In the case of the JPEG or PNG images, Aladin is also able to recognise the astrometric calibration given in its comment segment. This calibration has to follow the syntax of the FITS keywords, adding an '\n' at the end of each line;
3. The calibration associated to a JPEG or PNG image can also be stored in a text file having the same name as the associated image, but having an "*.hhh*" extension. In this case, the syntax can be either FITS (header aligned on 80 bytes), or ASCII with an ordinary carriage return;
4. Finally, Aladin also handle the astrometric calibration once the image was loaded from a list compatible with the VO (Virtual Observatory) standard: SIA (Simple Image Access, see 8.1 - Types of supported data).

Tip: In the first two cases, the FITS header can be visualised via the *Edit => FITS header* menu.

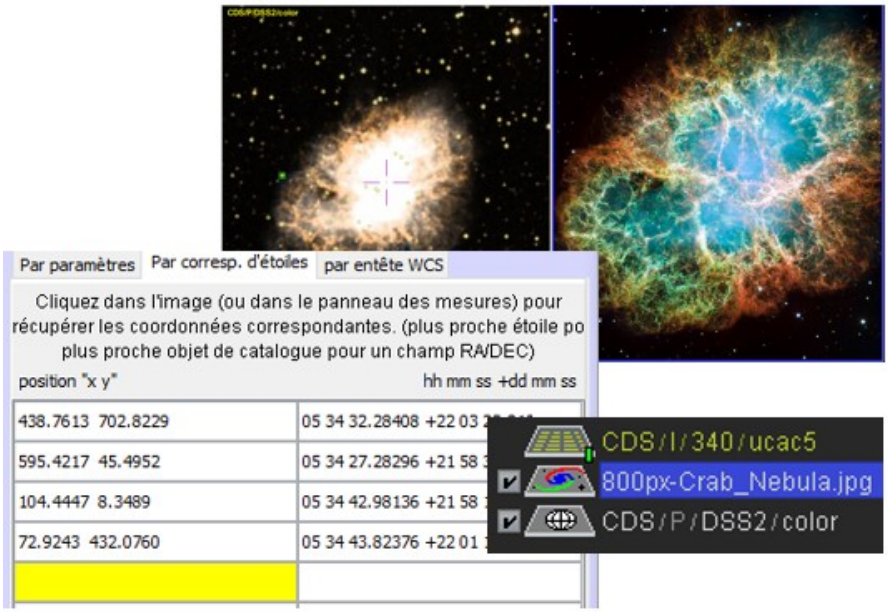


One image can support several astrometric calibrations, in particular if it was generated manually. In order to switch from an astrometric solution to another, just display the plane properties and change the selection.

However, if the image do not have an astrometric calibration, Aladin may still generate views but will not be able to superimpose sources or graphical overlays having celestial coordinates. "*No astrometrical reduction*" will be displayed in the location field, when moving the mouse cursor over this kind of image. But, it is possible to add graphical overlays manually (freehand drawings, marks), contours… These graphical will have no other coordinates than the XY coordinates specific to the image.

Creation/modification of an astrometric calibration

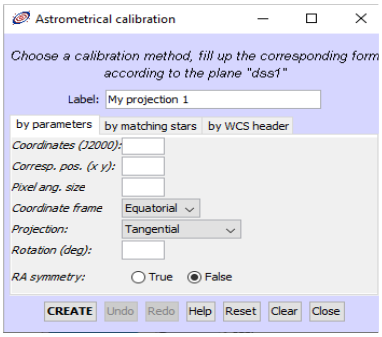
Aladin can be used to create manually an astrometric solution for an image which do not have one, but also to refine an already existing one. The first step is to select the image plane in the stack (just click on the image name) and then, secondly, use the menu *"Image => Astrometric calibration…"*.



The calibration window will ask you to give a name for this new calibration you just created.

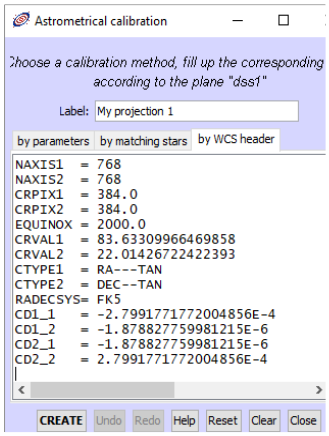
Then, the user dispose of 3 methods to create/modify a calibration :

1. By parameters;
2. By matching stars;
3. By WCS header.



Calibration using the parameters

The first tab displays basic parameters for the astrometric solution, namely the celestial position and the image corresponding pixel coordinates, the pixel angular size, the projection method, a rotation angle and the increasing direction of the right ascension.



Calibration using the WCS header

The 3th tab displays FITS keywords describing the parameters for the calibration in the WCS standard. If the standard is known, you can directly modify the parameters. For example, one can use the astrometric solution from another image by copy/paste its WCS parameters.

Tip : It is also possible to modify the value of the WCS keyword via the script command: set PlanID FITS:keyword=value (see 7.1 - Aladin by script)

Calibration by star matching

The table displayed in the 2nd tab is used to write a list of XY image coordinates and their corresponding celestial coordinates. It is a powerful and flexible method allowing to obtain rapidly good calibrations. We will briefly describe this method here. For more details, please check the CDS[10] website and refer to the online dedicated tutorial. Assuming we loaded an JPEG non calibrated image in the left view, and in the right view, a DSS image from the same field of view

10 http://cds.unistra.fr/tutorials/pdf/aladin-tutorial-astrometric-calibration.pdf

overlayed with an astrometrical catalogue, such as UCAC5. In order to calibrate the JPEG image, one can use the following method: click successively on a star in the non-calibrated image, and then click on the corresponding UCAC5 source from the DSS image. For every click, Aladin fills in the table form the calibration board. Four corresponding measures are usually enough to get a good calibration.

Note: When one needs to determine the coordinates for a start using the clicking method, Aladin uses a barycentre centroid algorithm. If it is not possible to determine the centre (the star is too wide), a message will be display to inform you that the clicked location will be taken as it is.

Tips :

- It can be useful to perform a “rotation” (Ctrl+click/navigate in the view, - only possible for a progressive HiPS survey) of the reference image in order to get closer of the orientation of the image needing to be calibrated.
- It is better to display only the brightest low proper motion sources. Using a filter for the catalogue ease the identification of the corresponding sources, for example :
  `$[pos.pm;pos.eq.dec]<3 mas/yr && $[pos.pm;pos.eq.ra]<3 mas/yr && $[phot.mag*]<17 { draw circle(-$[phot.mag*]) }`
- If no catalogue is loaded, the celestial coordinates will then be the ones resulting from the DSS image calibration. But, the precision of the calibration will be lower.
- Using the semi-transparence (Menu “i*mage=>Transparency level*”) to visualise the image one just calibrated with the DSS image as background, allows you to simply check in a glance the quality of the calibration.

Do and undo

During the calibration creation or adjustment process, it is possible to go back
to a former solution by using the “Redo” and “Undo” buttons at the bottom of the window.

5.15 RGB colour image generator

Icon: 

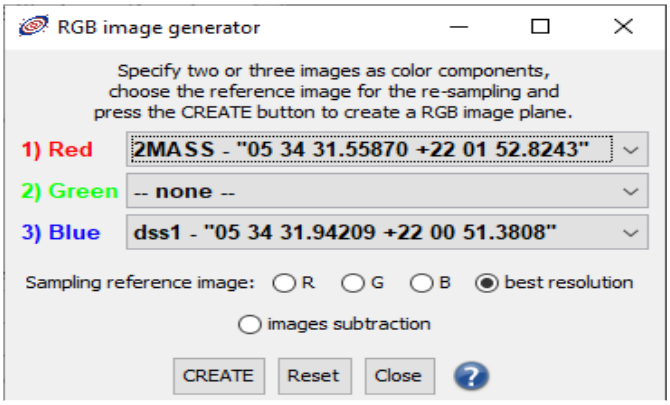
rgb
Menu: **Image => RGB image builder...**
Type of images: **fits, jpeg or png in grayscales**
Script: **RGB, RGBdiff**

Aladin can create a true colour image from 2 or 3 "B&W" images. To do this, Aladin will assign the first image to the "red" component and the other two images to the "green" and "blue" components. The true colour image will be stored in a stack plane.

Resampling

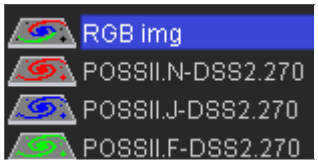
In order to ensure that the pixels of the images correspond to the same positions in the sky, Aladin resamples two of the images according to the astrometric solution of the third. This is called the *"reference image*". By default, the image with the smallest angular size of the pixel will be used as a reference. Resampling is based on the "*nearest pixel"* algorithm (see 5.16).

Access to the window



The window for generating a colour image can be accessed either through the menu *" Image => RGB image builder... "* or through the "rgb*"* button.

The default selection of images for each component depends on the state of the stack. If there are two or three plans selected, Aladin will use them to fill in the form. Otherwise, Aladin will consider the 3 images at the top of the stack, or the first 2. If he knows the wavelengths of the images, Aladin will sort them according to this parameter.



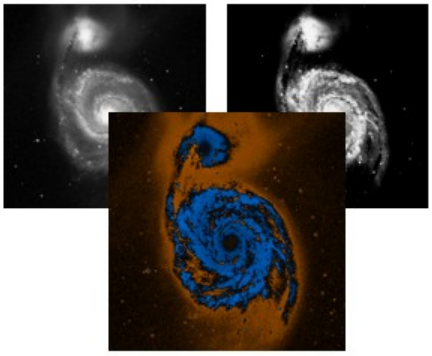
Tip: When the mouse cursor is over the logo of the created RGB plan, the logos of the 3 original images appear in the colour of their own component.

Special case of 2 images

Only 2 images can be selected. In this case, the third colour component will be calculated based on the other 2 by taking the average of the values of the other 2 images. This method builds very beautiful coloured images especially if the missing component is the green one (default mode).

Differences between 2 images

With 2 images, it is also possible to perform colour subtraction. The positive differences will be the values of the first colour component, the negative differences will be the values of the second colour component. Also, the differences will be normalized between 0 and 255 for maximize the contrast. This method is very interesting to quickly visualise even the slightest variations between 2 images.



5.16 Image associations: cubes & mosaics

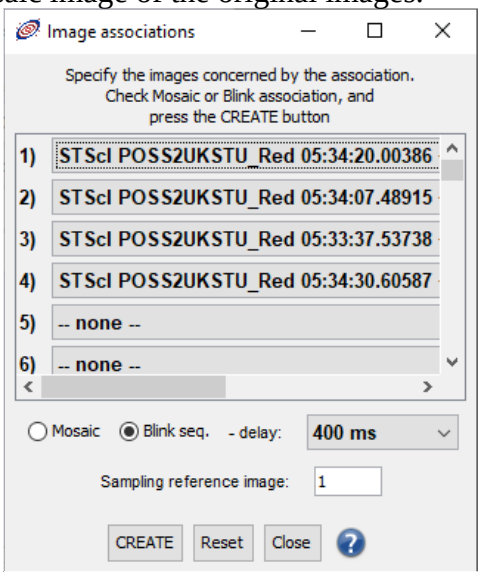
Icon: **assoc** 

Menu: **Image => Mosaic image builder…**
Image => Blink/Movie generator...

Type of images: **fits, jpeg or png in grayscales**

Script: **blink ..., mosaic ...**

Aladin can associate 2 or more images by combining them either in the form of a cube which he will display as an animated sequence, or by creating a new mosaic image of the original images.

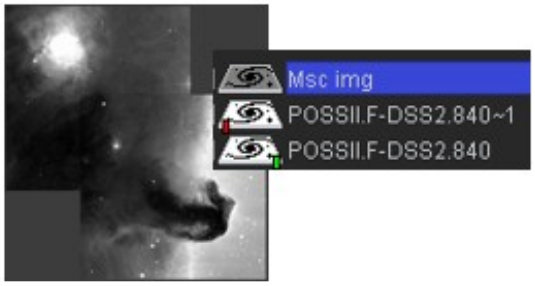


Access to the association window

The window that opens via the menu " *Image => Mosaic image builder... "* or " *Image => Blink/Movie generator "*, or via the " assoc " button allows you to control the association. You will indicate the original image plans, the initial sequence delay in the case of producing a cube and the reference image if a resampling is required to superimpose the pixels.

Mosaic

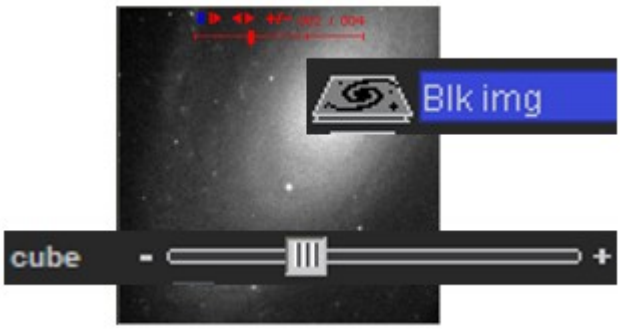
In case of production of a "mosaic" image, the resulting image will have the size required to contain all the original images in the projection grid of the reference image. The obtained image will be visualised and manipulated like any other image in Aladin. The average will be used for overlapping areas.



For more information: This mosaic image generation function is relatively simplistic (number of images limited to RAM, no background adjustment, no exclusion mask, ...). However you can also generate a mosaic of images in the form of a HiPS. To do this, please refer to section 6.2.

Cube or "animated sequence"

A cube is visualised by Aladin as an animated sequence, i.e. frame after frame. The logo in the stack is identified by a double line at its base symbolising the thickness of the cube. The handling of a cube is described in the section on "the view" in 5.1.2.



The scrolling control of the cube is done either via the red icons superimposed on the view, or via the "cube" slider located under the stack. If this slider is not visible, activate it via the user preferences (*Edit* menu).

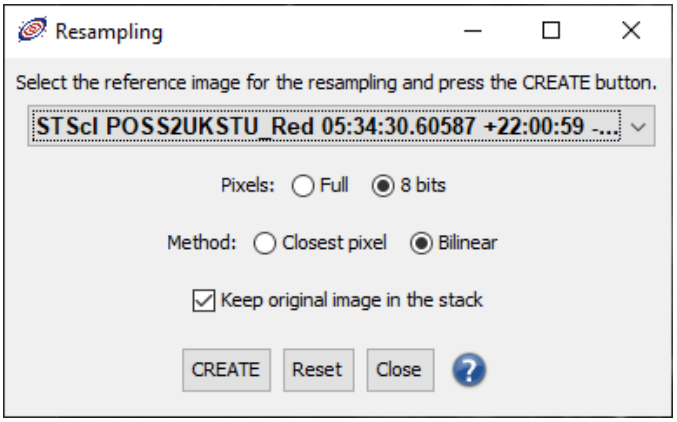
Tip: It is possible to add a new image to an existing cube. To do this, you must click/drag the logo of the new image in the view where the cube is scrolling. After a short pause required to resample the new image, the scrolling of the cube resumes with one more image.

For more information: It is possible to extract a localised spectrum from a cube (see 5.1.5- Depth cutting associated with the "Spect" tool).

5.17 Image resampling

Menu **Image => Resampling...**
Type of images: **fits, jpeg or png in grayscales**
Script: **resamp ...**

Principle



Even if it concerns the same field of the sky, each image usually is provided with its own astrometric solution. This means that a particular pixel does not necessarily point to the same place in the sky. In order to compare two pixel-by-pixel images, it is often necessary to resample one of them against the other, known as the "reference image". In concrete terms, Aladin will go through all the pixel positions of the reference image, deduce their coordinates in the sky, and then using this time the astrometric solution of the second image, for each celestial position previously calculated, he will deduce the value of the pixel, either the closest to the position found, or a bilinear approximation of the 4 closest pixels. At the end of the process you will have two images with the same pixel "grid" for a single astrometric solution.

Access to the window

The window that controls resampling is opened by the menu *"Image => Resampling..."*. The image to be resampled must first be selected from the stack. In the window, you must indicate the reference image, whether or not to keep the full pixel value or just the 8-bit coded "grey levels", choose the method for estimating the pixel value and finally indicate whether the original image should be replaced by the resampled image or kept in the stack.

Warning: It should be noted that the resampling methods proposed by Aladin (closer or bilinear) do not necessarily ensure the conservation of the flux, i.e. the sum of the pixel values before resampling is not necessarily the same as after.

Note: A resampled image shows the logo  in the view.

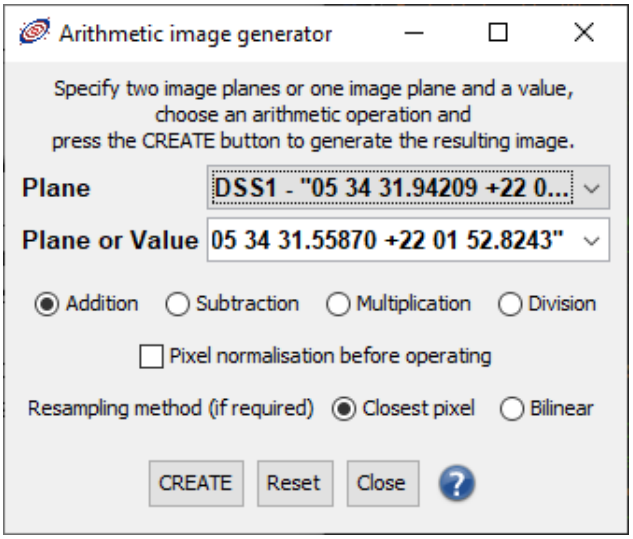
Tip: The use of semi-transparent images (see 5.1.2) provides a much faster and more flexible alternative to resampling. However, it is less precise since it does not act pixel by pixel but only on the basis of the 4 corners and globally approximates the position of the other pixels.

5.18 Arithmetic operations on images

Menu: **Image => Arithmetic operation...**
Image => Convolution...
Image => Pixel normalisation
Type of images: **fits**

Script: **+, -, *, /, conv, norm, kernel**

Addition, subtraction, multiplication and division



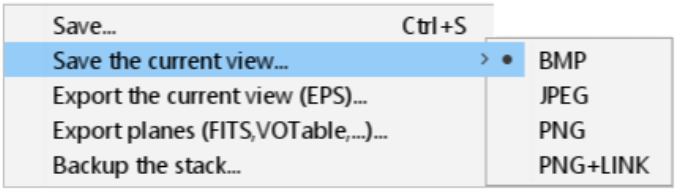
Aladin offers a simple interface to perform basic calculations on a pair of images: addition, subtraction, multiplication, division. The dedicated control window is available via the menu " *Image => Arithmetic operation... "* (accessible only if at least two images are present in the stack). Aladin will proceed pixel by pixel, resampling the second image if necessary, so that it matches the pixel grid of the first. It is possible to request a prior normalisation of the pixel range of two images so that their values are distributed around 1 by prior division by the average. The result of the operation will be seen as a new image plane in the stack.

Convolution

Additionally, the menu " *Image => Convolution ... "* allows you to "convolve" the current image with a specific matrix, i.e. to calculate a new image according to the product of each original pixel (and those nearby) with a particular matrix. The sub-menu proposes the matrices commonly used in astronomy (Gauss, Mex, Tophat, ...) of various sizes. You can also define your own convolution matrix using the script command: "conv" (see 7.1). The resulting image will replace the original image in the stack. If you wish to keep the original image, it is necessary to duplicate it beforehand (menu: *" Image => Duplicate the image plane"*).

5.19 Backups, exports and printing

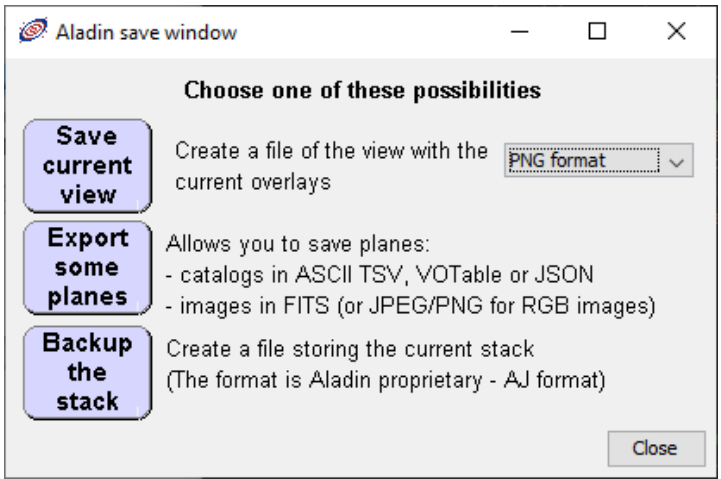
Menu: **File => Save..., File => Export..., File => Export...**
File => Save..., File => Print..., File => Print...
Shortcut: **Ctrl +S, Ctrl +P**
Script: **save ..., export ...**



Save, export and print functions can be accessed through the main "*File*" menu.

Aladin has several possibilities to save your work:

- Printing the view(s);
- Saving the current view. Supported formats are BMP , JPEG , PNG and EPS . This last format is especially indicated for scientific publication;
- Exporting one or more plans from the stack. The images will be exported in FITS , JPEG or PNG,



the catalogues in TSV (Tab-Separated-Value) or VOTABLE (see 8.1), FITS and JSON for the MOCs;

- backup of the stack and views for later re-use.

Generation of a "clickable" map

In the case of saving the view Aladin proposes the " *PNG+LINK* " format. This format is dedicated to the creation of "*clickable web maps*". The view is saved in regular PNG format. A second file is simultaneously generated with the ".lnk" extension. It contains, in a basic ASCII format, the clickable objects present in the view, their position in the PNG image as well as a URL to access the complete associated record. These two files placed on a Web server will allow the easiness creation of a clickable map. For more details on the method, the format and examples of implementation, please consult the following address:
http://aladin.cds.unistra.fr/java/FAQ.htx#Map.

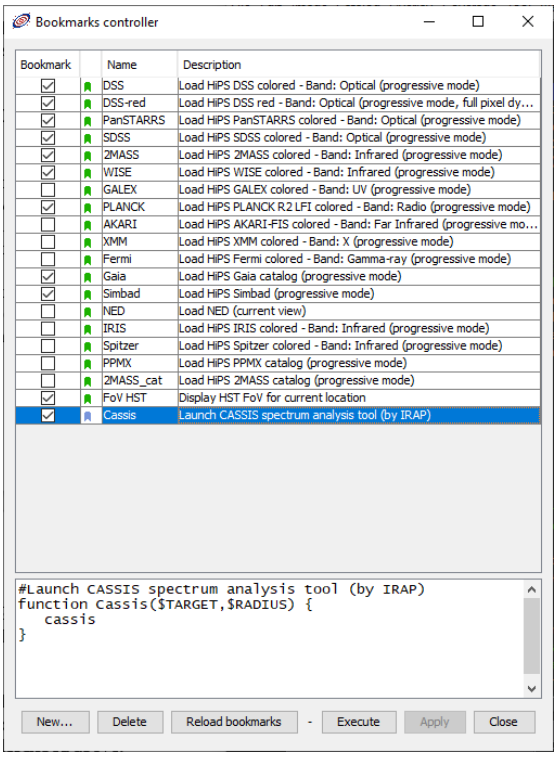
5.20 Bookmarks

Icon: 
Menu: **Tool => Bookmarks...**
Script: **function ..., call ...**

Aladin provides a "bookmark" mechanism that allows you to perform a series of predetermined actions with a simple mouse click on one of the buttons visible in the control panel (see 5.1.7).

Some bookmarks have been predefined by the CDS team. They appear with a green symbol. You can create your own bookmarks with a blue symbol.

The window that opens by clicking on the "+" icon on the far right of the bookmarks bar, or via the *"Tool -> Bookmarks..."* menu, allows you to view existing bookmarks, modify them, or even create new ones. In the upper part of this window you will find the table of defined bookmarks. If you select a row, the actions associated with this bookmark appear in the panel below the table.



A bookmark is stored internally as a "script function", i.e. a list of script commands (see 7.1). A name, and optional parameters, will be attached to it. Two predefined parameters are particularly useful: $TARGET which will be replaced by the position of the reticle when the bookmark is called, and $RADIUS for the radius covering the current field of view. Adding a comment above the function definition, will provide a short description. This information will be displayed via the "tooltip" of the corresponding bookmark.

Technical note: Resetting Aladin's "cache" (see glossary), or installing a new version may cause the update of the bookmarks displayed in the bar below the

menu. Your own bookmarks are not deleted, however. Simply revalidate them in the window described above.

5.21 User preferences

Menu: **Edit => User preferences...**

Aladin groups together most of the user's configuration parameters in the preferences window. You can thus define the following items:

- The language of the graphic interface (English, French, Italian, ...);
- Activation of the "Wizard" mode offering context-sensitive help;
- The rendering of the interface (light or dark theme, font size and icons);
- The style of the access window to files and directories (depending on the operating system, or specific to the Aladin application);
- The choice of control strips under the stack;
- The default directory where Aladin searches or saves local files;
- The spatial reference frame and the default projection;
- The default pixel display mode (inverted video, colour table...);
- The activation or not of the dedicated filters (see 5.8);
- The default image server;
- The default site of the server directory (see 5.2), i.e. the machine that provides the server directory with a list of available servers every time it is started ...;
- The graphic choices of the coordinate grid and view information (colour, font size);
- The activation of the CDS metrology tools (log);
- The size of the local buffer (cache);
- Automatic filtering of FITS data extensions considered irrelevant;
- Access and manipulation of planetary data.

Some clarifications:

Interface – UI scale: Screens with a particularly high number of pixels relative to the physical size (HDPI screens) may require fonts, icons and other interface elements to be scaled up. This enlargement factor can be automatic ("auto"), leaving the Operating System to make the most appropriate choice. Unfortunately this is not always the case. This is why Aladin offers manual alternatives in terms of percentage of growth (110%, 120%...) and allows the user to determine this growth factor himself. It is therefore necessary to carry out some tests to choose the best option.

File dialog style: Some operating systems provide forms for accessing files and directories that can be reused by software such as Aladin. This keeps the same working habits from one program to another. However, some Operating Systems do not offer all the expected functionalities, for example the selection of a directory. This is why the user is left free to opt for a generic form, provided by the Java library.

Permanent disk cache: Aladin's function requires to download a large amount of data, especially when browsing progressive surveys. Statistics show that a user often works on the same data, the same place in the sky, which means that he will often reload the same data. This is why Aladin relies heavily on the notion of "buffering", i.e. copies on the local disk of the most frequently accessed data. This allows for a much faster visualisation, but it saves resources that the planet really needs. Do not hesitate to provide a large value.

CDS logs: You are using Aladin developed by the Strasbourg Astronomical Data Centre for free. You will greatly help the development team by activating this usage statistics mechanism (short usage reports (los) automatically transmitted to the CDS). They are anonymous and do not contain any local or personal information (file names, directories, ...). These statistics are valuable to justify the activity of the CDS to its French governmental authorities, and to decide on future developments. You can of course reject this option according to your preferences.

Planetary data: Starting with Aladin version 12, it is possible to activate access to planetary data (surfaces, catalogues, coverage). However, these data are dependent on the evolution of the IVOA standards associated with planets. The current state of these protocols does not always provide an optimal way to differentiate planetary data from celestial data. Access to planetary data is therefore provided "as is", with no guarantee of a consistent display. When this option is enabled, the collection tree will display a new "Solar System" branch to access these resources. If Aladin cannot be sure that the data to be overlaid are consistent (same planet, only celestial, ...) it will display an alert message reminding the potential problem.

The preferences window also allows you to:

- Create your own translation language (see below);
- Reload all data server definitions during the session, which will also have the effect of resetting Aladin's internal metadata cache.

Note: Some parameters are not configurable through the preferences window, but simply kept from one session to another, for example, the size and location of the Aladin window, the type of reticle (large or classic), whether or not to activate tooltips on the sources, etc.

Tip: The configuration parameters are kept in a simple ASCII file ".aladin.conf" which can be edited in the ".aladin" directory present in your home directory ($HOME in unix, \Users\YourName in Windows). To reset the settings to the original configuration, simply delete this file.

Management of the interface language

Aladin supports several languages for its graphical interface. It is possible to create your own translation if the language you want is not yet supported or not fully translated. To do this, use the "*New translation*" button and specify - in English - your language and the corresponding "2 letter" code (e.g. "French" - "fr"). Aladin opens an editing window that displays all the expressions that need to be translated (in English), those that have already been translated if necessary and those that are no longer necessary (used by an earlier version). You can install your translation which will appear at the next session as a possible language alternative in the list of supported translations.

Further information:

- Expressions that are not translated will appear in English.
- Aladin supports non-ASCII languages (e.g. Chinese...) and possibly written from right to left (e.g. Persian...).
- It is possible to complete or fix an existing translation. To do so, you must first install the language in question and then press the "New translation" button, leaving the "Language" and "2 letter code" fields blank. Your translation additions will only concern your own installation of Aladin.

Note: If you wish, you can contact the CDS[11] and Aladin's development team in order to share your work with the user community. Your translation file is saved in the same directory as Aladin's configuration file (see above) with the name "Aladin-langue-version-perso.string...".

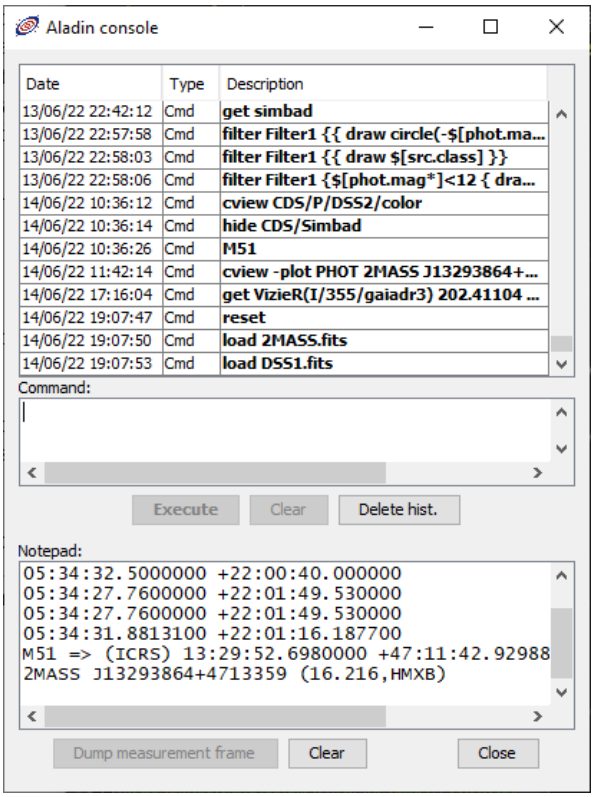
5.22 The script console

Menu: **Tool => Script Console...**
Shortcut: **F5**

All the actions that can be performed via the graphical interface can also be done by "online commands". The aim is to be able to use Aladin in "script" mode to execute repetitive actions, to instruct treatments to be performed or to control Aladin remotely.

These commands can be submitted through different channels, the main ones being:

- The "Command" field under the menu;
- The "Script Console";
- A command file;
- The standard input.



The script console is opened via the menu "*Tool => Script Console...*". This window displays, as a table, all the commands equivalent to the actions that have already been carried out via the graphical interface during the session, as well as for previous sessions. It is a useful help to learn the syntax. It is possible to type one or more commands directly into the input field in the middle of the window.

Tip: selecting one or more commands from the table with the mouse will copy them into the input field for editing and execution.

Alternative to the console

If you want to quickly pass a command without opening the command console, you can enter it directly in the "Command" field under the main menu (see 5.1.5).

The small triangle to the left of this field opens the history of all previously executed script commands (via a real script command, or via an action in the GUI). This list can also be consulted by using the *Up* and *Down* arrows in the input field.

Tip: You do not need to click on the "Command" field before entering a command on the keyboard. By using the *"up" and "down"* arrows, you can quickly display the previous (or subsequent) commands again.

11 cds-question to unistra.fr

Please refer to the "Aladin by script" section (see 7.1, below) for more information on controlling Aladin by script.

6 Ancillary tools

Aladin has additional tools that enlarge its scope of application, including:

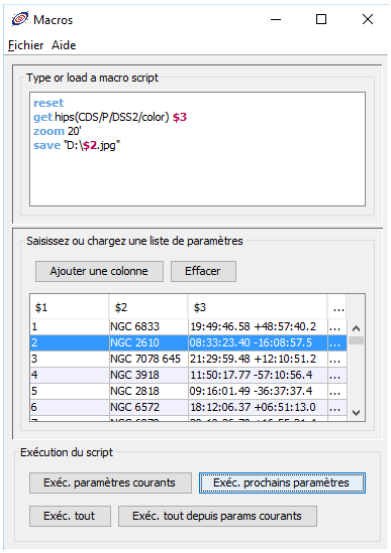
- A "macro" manager for repetitive work;
- A tool for generating progressive surveys (HiPS);
- A tool for generating coverage map (MOC);
- A mechanism for interaction with other astronomical tools compatible with the "Virtual Observatory";
- A source extraction tool: S-extractor;
- A "thumbnail view" generator

We will briefly present each of these tools.

6.1 The macro manager

Menu: **Tool => Macro controller...**
Script: **macro ...**

To facilitate repetitive processing, Aladin offers a "macro" mechanism based on script commands (see 7.1). The idea is to write a script that uses text commands that can incorporate variable names so that the script can be used repeatedly, for example on a list of object names.



The macro window is available via the menu "*Tools => Macro controller...*". It is divided into 3 parts:

1. The top panel allows you to enter a script. This can include "variables" named $1, $2, etc..;
2. The middle panel provides a list of values that the variables can take;
3. The bottom panel is used to control the execution.

Alternatively, the value list loading (central table) can be generated from the sources of one of the catalogue plans of the stack (*File* menu of the "*Macros*" window).

The script as well as the parameter values can be saved for later reloading (same menu).

Tip: When entering the script, Aladin automatically recognises the syntax and highlights it with colours. Commands are "clickable" to quickly display related help.

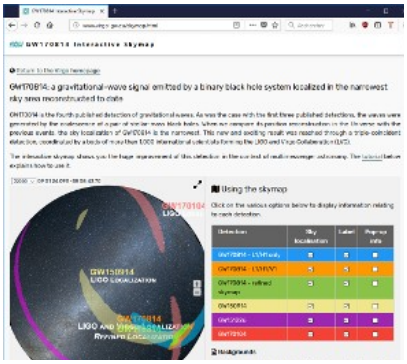
6.2 HiPS progressive survey generator

Menu: **Tool => Generate a HiPS based on...**
Command line: **java -jar Aladin.jar -hipsgen ....**

Aladin integrates the "Hipsgen" library for generating HiPS progressive surveys. This library, developed and maintained by the CDS, enables a HiPS to be built quickly and efficiently from a collection of individual images.

A HiPS, or Hierarchical Progressive Survey, is a mosaic of astronomical images stored as hierarchical tiles using the HEALPix sky grid. This is a method invented by the CDS and adopted by the IVOA (International Virtual Alliance) in the form of an international standard whose document is available at the following address: http://www.ivoa.net/documents/HiPS/. The creation of a HiPS consists of generating the mosaic, cutting, and then generating the tree structure of the tiles that make up the final HiPS. Depending on the number of original images and their sizes, this process can take from a few seconds to several days.

Technical details: Hipsgen can process 1 terapixel sources in about ten hours on a medium-power machine. It can handle from 1 to several million source image files. It can manage the a posteriori addition of additional images in an existing HiPS. It is the tool used by the CDS and most other data centres that provide progressive HiPS surveys: ESAC, JAXA, IRAP, CADC, HEASARC, ...



Note: To display a HiPS directly in a web page, use "*Aladin Lite*[12]". This is a code developed by the CDS, written in JavaScript dedicated to displaying HiPS in a web browser *(opposite, the use of Aladin Lite by the VIRGO team to visualise probable areas of gravitational wave emissions).*

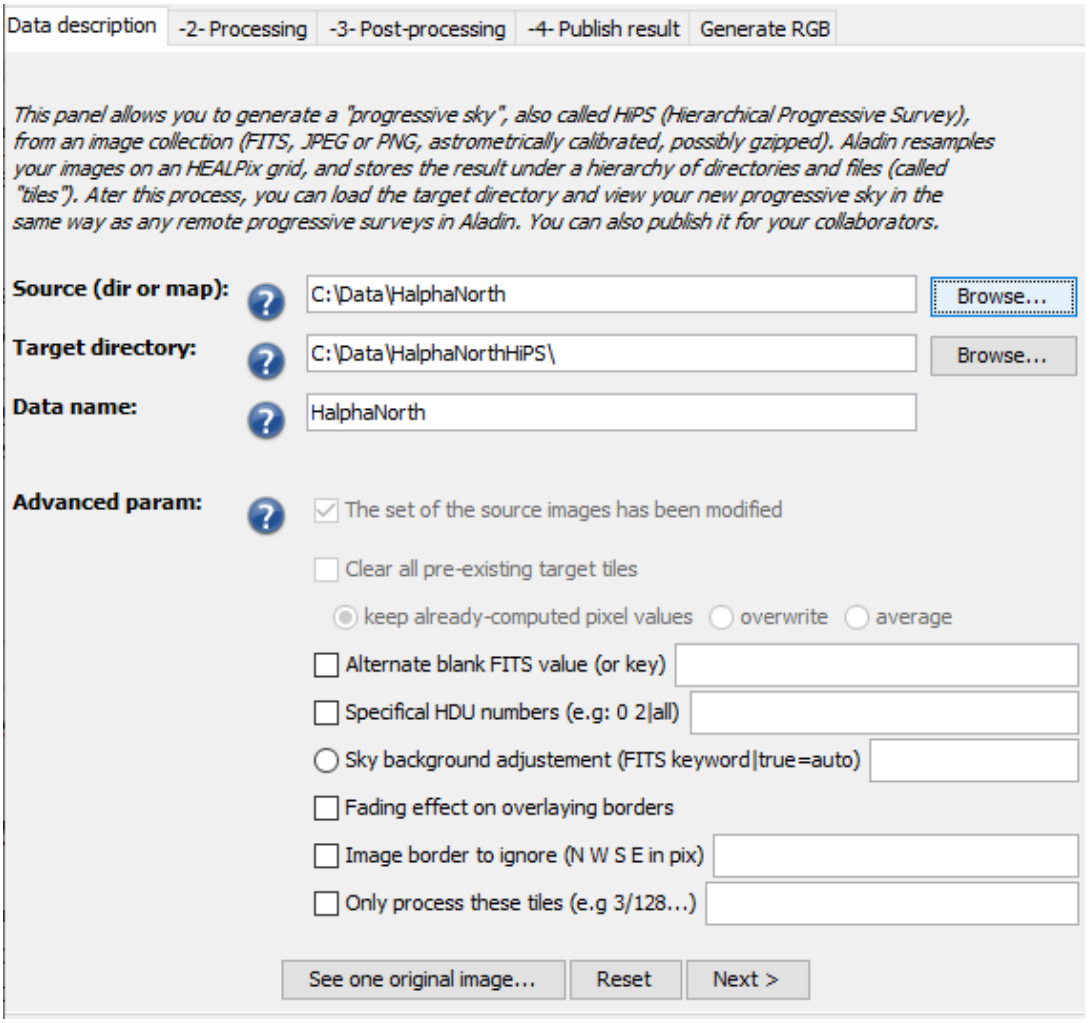
Aladin handle Hipsgen either through the graphical interface via the menu "*Tool -> Generate a HiPS based on...*", or through the Aladin command line with the "-hipsgen" option. A document dedicated to the generation of HiPS by online command is available on the CDS website[13].

The use of Hipsgen through Aladin's graphical interface is carried out in several consecutive operations that can be configured using a form with successive tabs that we will present briefly.

Tab 1: Data description - inputs and outputs

The first tab describes the location of the source image collection. These images can be in FITS, JPEG or PNG. In all cases, these images must have an astrometric calibration. This calibration can be classically internal to the image file in the form of WCS (World Coordinate System) keywords integrated in the FITS header, or in a JPEG or PNG "comment segment", or external, as an ASCII file with the same name and ".hhh" extension.

12 http://aladin.cds.unistra.fr/AladinLite/doc/
13 http://aladin.cds.unistra.fr/hips/HipsIn10Steps.gml



Tip: Verify the presence of a compatible astrometric calibration just by displaying a coordinate grid on an image loaded in Aladin.

Note: The set of source images can be reduced to a single "HEALPix map", i.e. a FITS file describing the sky in a global way using a HEALPix cutout.

The collection of source images is identified by the directory of the disk on which they are stored (directly or in a tree structure). This can be directly the name of the file in the case of a single image. This form can also be used to indicate the directory where the HiPS to be produced will be stored.

This first form also proposes a list of selectors and input fields specifying the operating mode of the HiPS generator:

- **BLANK**: This input field allows you to specify a specific pixel value to identify those that should not be taken into account. This field is normally filled in in the FITS header of the image, but often absent;
- **HDU**: A FITS file can be structured in several extensions called HDU. This field is used to indicate which extension(s) should be taken into account;
- **Sky background**: Method of adjusting the level of "sky background" from one image to another and avoiding "patchy" effects. This input field can take either the value of a keyword, present in the FITS header of the images and explicitly providing the "sky background" value for each image (e.g. BKGROUND), or the "auto" value. In this case,

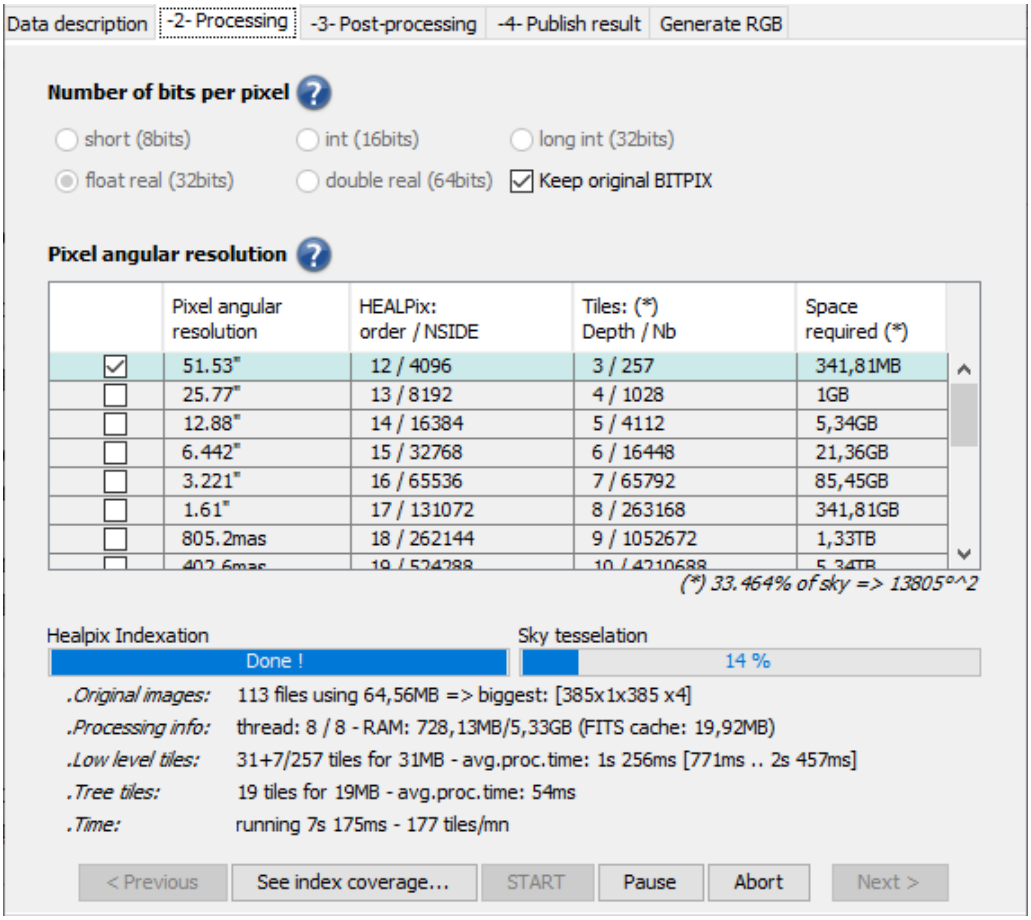
Aladin/Hipsgen will perform a statistical analysis of each image and will try to determine each "background" value automatically;

- **Fade in/out**: Activating this selector will cause a "link" effect for each overlay of source images. By default, a simple average is calculated for each pixel of these overlapping areas. In fade mode, this average will be weighted by the distance to the nearest edge (only on the 6th of the width (respectively height);
- **Image edges**: In case the source images have unexposed edges (no measurement values), or erroneous edges (outliers at the edge of the original sensor), this field allows you to indicate the number of pixels of the image edges to be ignored;
- **Restriction of the region to be processed**: the last input field allows the HiPS calculation to be restricted to a specific region determined by a sequence of HEALPix indices.

Once these various parameters have been entered, let's move on to the actual creation of the HiPS.

Tab 2: Creation - generation of FITS tiles

The second tab allows you to specify the encoding method to be used to store the pixel values, as well as the final resolution of the HiPS to be generated. Aladin/Hipsgen uses the first image present in the source directory to determine the default values.



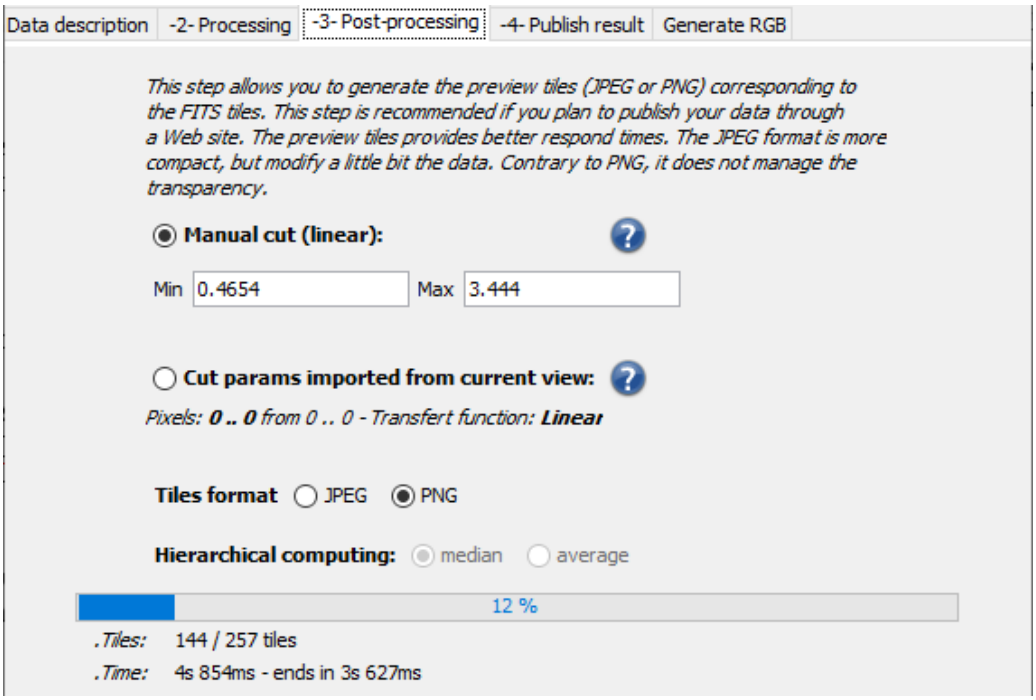
Now we just have to start creating the HiPS. This is done in two steps corresponding to the two progress bars. Firstly, the source images are indexed in the HEALPix system, then processed, pixel by pixel, to produce the HiPS tiles for each hierarchical level.

Tip: The "*see coverage"* button is activated at the end of the first phase and allows you to control the area covered by all the source images (as a MOC).

At the end of step 2, the HiPS is ready, but only available as FITS tiles. These tiles contain all the dynamics of the original pixel values, but are large in terms of disk space and, when used, in transfer time.

Tab 3: Post processing - JPEG/PNG tile generation

The third tab allows you to create a second or even third set of HiPS tiles, but this time, the tiles will be compressed in JPEG or PNG. These alternative tiles will be added to the tree structure produced in phase 2 of HiPS generation. The advantage of generating both HiPS tiles in FITS and JPEG/PNG format will give HiPS display tools - such as Aladin Desktop or Aladin Lite - the opportunity to choose their access mode, either fast in compressed tiles, or slower but with all the dynamics of the pixel values.

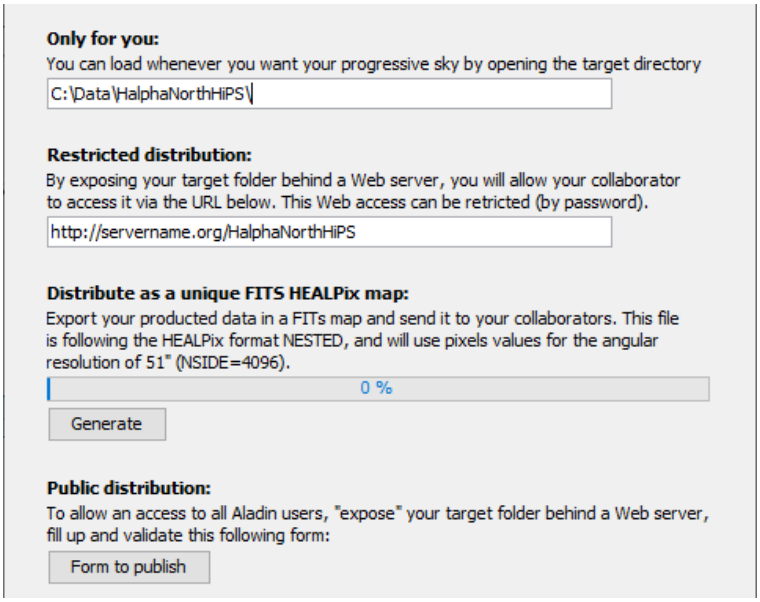


The parameters on this tab allow you to specify the range of pixel values that will be used to generate the compressed tiles. Two methods are proposed. The first one consists in providing the two bounds of the range. The second method will take the current setting used by the display of the HiPS generated in step number 2. This method is more flexible and powerful since it is possible to take into account the transfer function as you have defined it (see 5.5).

The last selector of this form describes the method of calculating hierarchical tiles. Each HiPS hierarchical level divides by 4 the number of tiles by aggregating 4 pixels into 1, either by a mean or a median method.

Tab 4: Publication

The penultimate tab describes the different possibilities for using or even publishing the HiPS product.



Since a HiPS is in fact only a tree structure of files, a simple distribution of it through an http server will be enough to make it accessible to everyone. Thus, loading the URL of this HiPS in Aladin will make it accessible like any other HiPS. If it is not a restricted HiPS, the IVOA standard mentioned above indicates the procedure to follow in order to make your HiPS visible to the astronomical community, and thus make your HiPS accessible, notably through Aladin's "collection tree".

The last tab is for generating a colour HiPS from two or three previously generated greyscale HiPS.

Tab 5 : Generate RGB

The last tab is used to generate a colour HiPS from two or three previously generated greyscale HiPS. Each tile of the colour HiPS is generated from the corresponding tiles of the original HiPS. It is necessary to decide which original HiPS is used for the red, green and blue components. In addition, the range of pixel values that is taken into account for each colour component must be set, especially if the original HiPS have inhomogeneous contrasts. The choice of these parameters depends on the desired result: visual quality, highlighting of weak objects, etc.

Aladin has two methods:

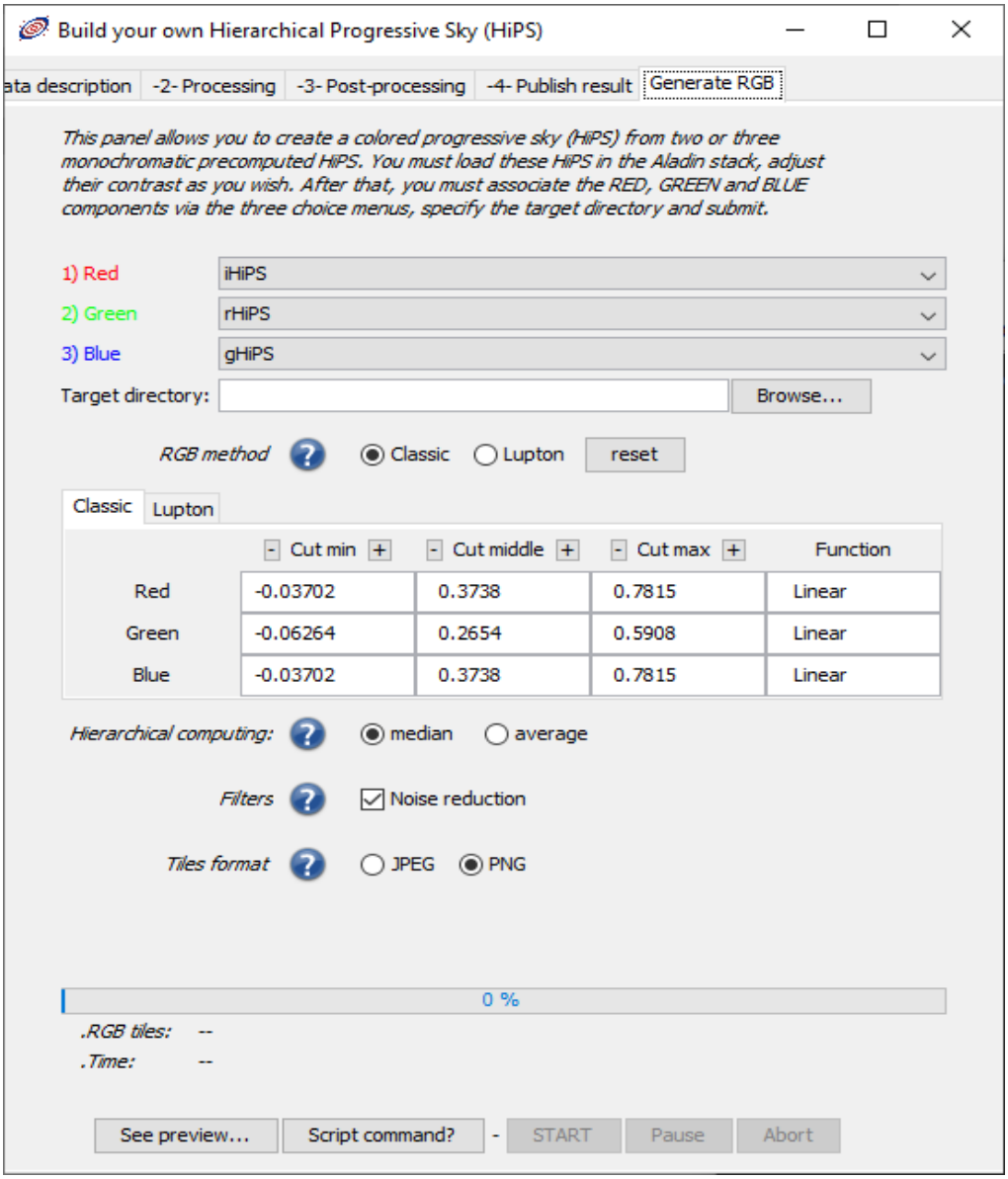
1. **Classic**: For each original HiPS, the pixel range is determined using the same method as the visual rendering used by Aladin for its interface (see 5.5- Pixel dynamics). It is necessary to define the adopted interval ("cut min", "cutmax"), and possibly an alternative transfer function to "Linear", as well as a median threshold (cut middle). To facilitate the entry of these values, they will be automatically transferred from the visual rendering setting if the HiPS concerned has been loaded into the stack.

2. **Lupton**: also Aladin allows to define the 3 parameters required to apply the algorithm proposed by Lupton (min, strech and Q). For more information on this method, please see the article "Preparing Ref-Green-Blue Images from CCD Data".[14]

Note: To generate the RGB HiPS, it is essential that these HiPS are available on the local machine and not only accessible via an http server. Furthermore, if these original HiPS are loaded into the Aladin stack, it is possible to dynamically visualise the final result that will be obtained according

14https://ui.adsabs.harvard.edu/abs/2004PASP..116..133L

to the selected parameters. The use of multi-windowing will greatly help in the dynamic adjustment of parameters.



The form also offers the possibility to adjust 3 output parameters:

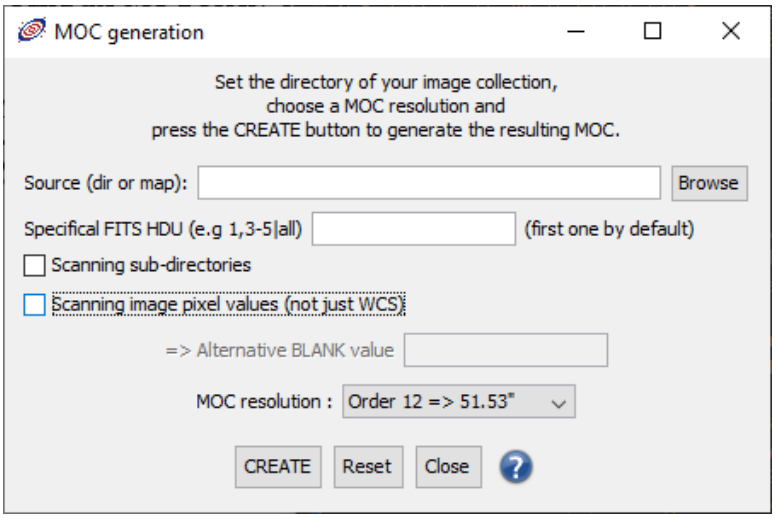
1. **The HiPS hierarchy calculation method:** This is the method for generating the parent tile from its 4 "daughter" tiles, i.e. what pixel value to keep for the 4 corresponding pixels in the deeper hierarchy level. This can be an average of the 4 pixels involved, or a "false median", i.e. one of the values of 2 median pixels. The second method is interesting for highlighting large structures and filaments. These calculation methods are applied colour component by colour component.
2. **The noise reduction filter:** The application of a Gaussian filter smoothes the background noise.
3. **Tile format**: The PNG format can manage potential transparency, which is interesting in the case of partial sky surveys. JPEG offers a better compression rate and faster generation, but does not allow transparency, and may introduce undesirable visual effects due to its compression algorithm.

Note: The "Script command" button displays the parameters of the script command equivalent to the choices indicated in the form. This allows you to visually prepare the desired rendering, but to launch the generation of the colour HiPS via a command line "Aladin -hipsgen...".

6.3 MOC coverage generator

Menu: **Couverage => Generate a spatial MOC based on…**
=>An image collection
Order line: **java -jar Aladin.jar -mocgen ....**

Aladin integrates the Mocgen library to generate a spatial MOC coverage from a collection of images. As with the generation of a HiPS, Aladin/Mocgen will process a collection of source images stored in a directory in the form of a list or tree structure of image files. The supported formats are identical to those described in the previous section (see 6.2).



Mocgen's control parameters do not present any difficulties. However, it should be noted that there is a big difference in processing time if one chooses to build the MOC solely on the basis of the WCS header of each image without trying to examine each pixel of each image one by one.

For more information: there is no need to generate a MOC following the creation of a HiPS. In fact, when the HiPS is generated, the corresponding MOC will already have been calculated and stored in the root directory of the HiPS under the file name "Moc.fits".

One can also create a temporal MOC or a Space-Time MOC: *Couverage => Generate a temporal MOC… , Couverage => Generate a Spatial-Time MOC based on…*

6.4 Interaction with VO tools: SAMP

Menu: **Tool => VO tools**
Data types: **Catalogues, Images, Spectra** (no HiPS)

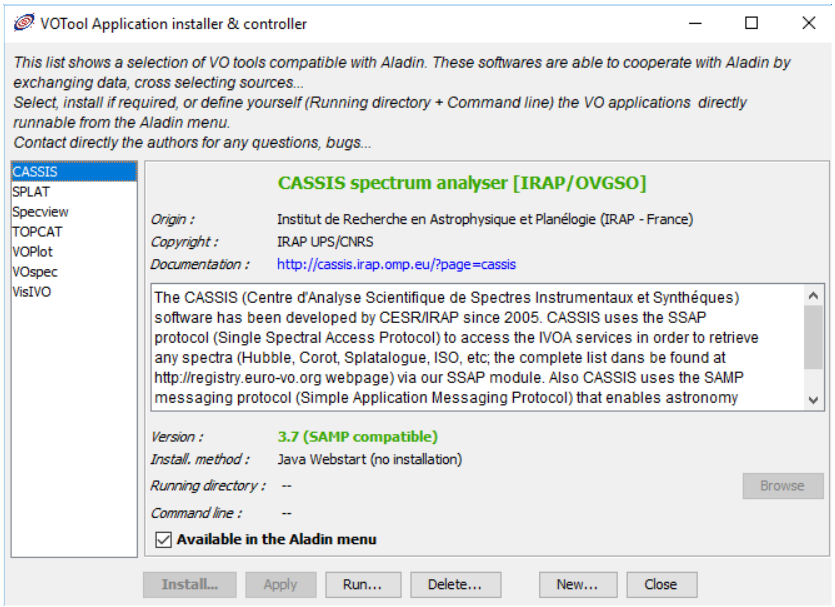
Aladin manipulates images and catalogues to generate views. However, it can rely on other independent applications to carry out other processes such as generating 2D graphs, displaying spectra, etc. For this purpose, Aladin implements the protocol standardised by the Virtual Observatory called SAMP for Simple Application Messaging Protocol..

Principle

SAMP allows applications to dialogue with each other so that they can not only transmit data to each other, but also interact with each other. Thus the selection of an astronomical source will, for example, be visualised simultaneously in all applications.

Installation

Aladin facilitates the use of SAMP by presenting in a window a list of applications that can "dialogue" with Aladin. This window offers the possibility to easily install one or other of these applications, so that they appear in the *"Tool => VO tools => ..."* menu and can be easily started. This list is dynamically updated, so that it shows the new features, the new versions available...



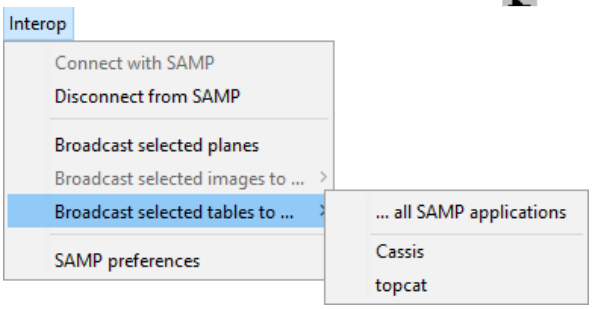
SAMP connection

To make two SAMP-compatible applications interact, they only need to run simultaneously. Aladin offers the possibility to start another SAMP application directly from the menu " *Tool => VO tools*".

When the two applications are running, they will "see" each other according to the mode that is specific to each one, for example in an "Interop" menu (TOPCAT, VOPlot, VOSpec, Aladin...), "*File => SAMP"* (DS9), or thanks to a dedicated icon (CASSIS, Aladin).

Aladin visualises the SAMP "connections" using the radar antenna icon at the bottom right of his main window. If this icon is drawn with a series of "waves", it means that one or more other SAMP compatible applications are running and can interact with Aladin.

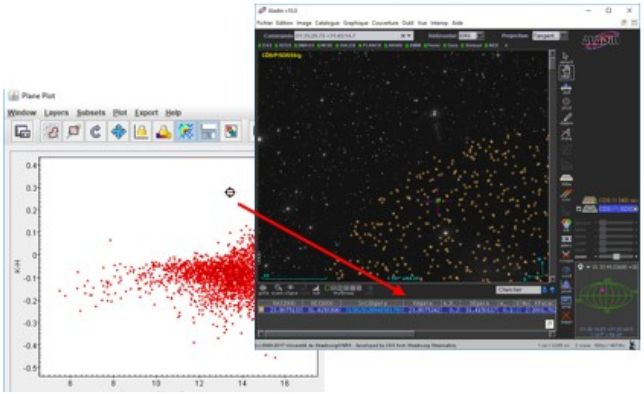
The "*Interop*" menu groups together all the functionalities associated with SAMP and gives access to the options. It is also possible to use the contextual menu (right-click or CTRL click) by placing the mouse directly on the "antenna".



Data transfer

Once Aladin is "connected" to another application, it can receive data (images, tables, etc.) that will appear as new plan in the stack. He can also send data. The method consists in selecting the plan(s) concerned in the stack, then opening the "*Interop"* menu to designate the "target" SAMP application in the appropriate sub-menu.

Interactions



Usually, when the data is tables or catalogues, the sources selected in one application are automatically selected in the other application. This is a very convenient method for locating where sources with peculiarities in their measurements are located in the Aladin field and in a colour/colour graph in TOPcat.

Note: The "SAMP" actions depend on the applications, it is possible that an object selection is simply ignored by a SAMP compatible application but which did not want to implement this feature.

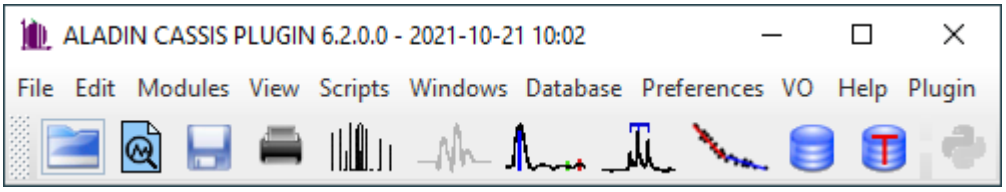
6.5 Spectra manipulation via CASSIS

Menu: **Tool => VO tools => CASSIS...**
Type of data: **Classic FITS cubes**

The "spect" tool may be used to extract a spectrum from a data cube previously loaded into Aladin (see section 5.1.5). This is a basic tool for visualisation only. Therefore, Aladin can use an external tool specialised in spectral analysis: CASSIS. This is a software package developed by IRAP (Toulouse/France), and a Aladin-compatible plugin can be easily downloaded/installed for use in interaction with Aladin.

Installation/execution of the CASSIS plugin

The CASSIS plugin can be installed and run in a few clicks via the menu "Tool → OV Tools → CASSIS spectrum alalyzer".



Spectrum extraction and analysis via CASSIS

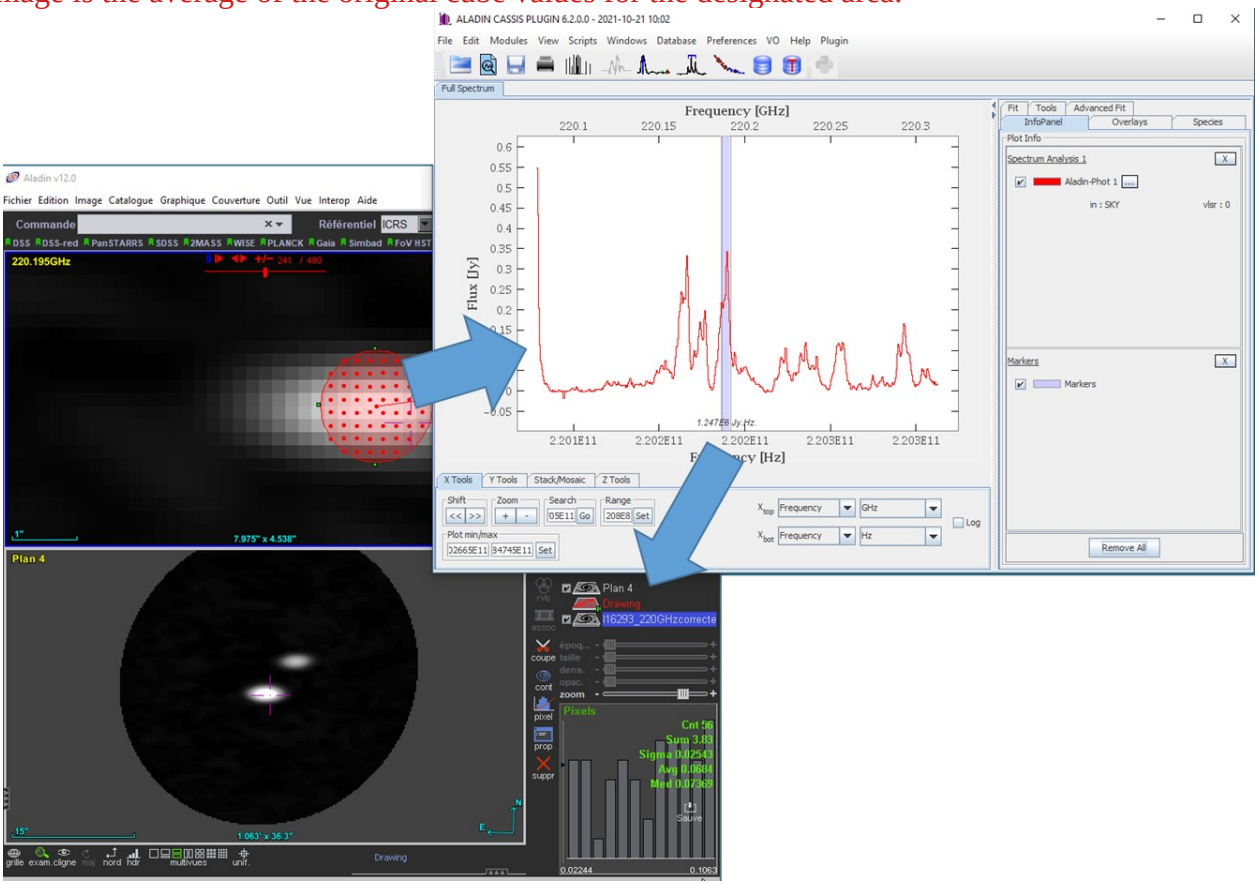
Aladin has three tools for extracting a spectrum from a data cube. These are the “spect” tool, which extracts at a single point, the “phot” tool and the “draw” tool, which averages the values over a circle or polygon. As soon as CASSIS is active, each extracted spectrum is automatically transferred to CASSIS for display and analysis. In case the data cube does not have information about the scales that are used, CASSIS offers a small form to fill in the required information.

A post modification of the extraction tools (position, surface) is possible and automatically updates the corresponding spectra in CASSIS.

Usage of CASSIS

The CASSIS plugin is almost identical to its regular version. It has a few additional functions specific to its use in association with Aladin. In particular, it is possible to use the central mouse

button to designate an area on the spectrum which results in the creation of an image in Aladin. This image is the average of the original cube values for the designated area.



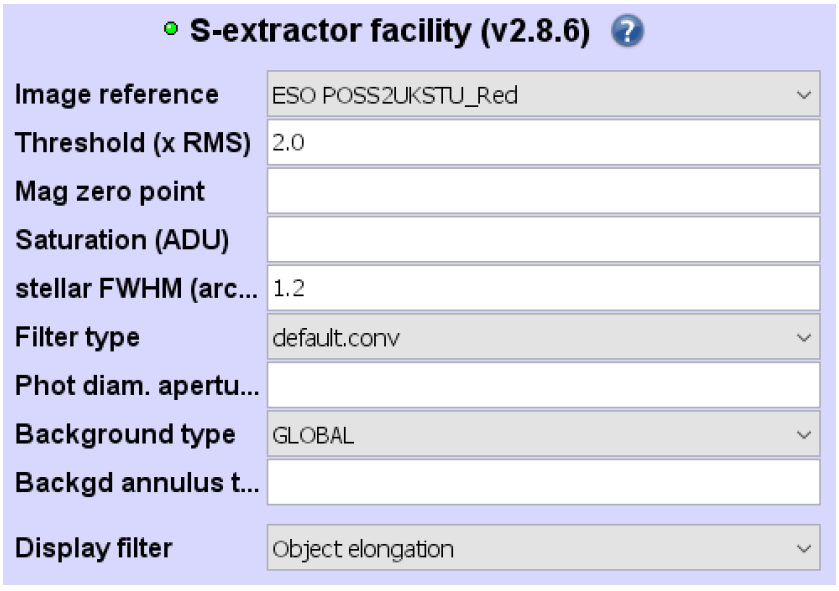
The CASSIS documentation is available online (http://cassis.irap.omp.eu/help/) and directly accessible via the CASSIS menu "*Help → Users-s manual*".

6.6 Source extraction via SExtractor

Menu: **File => Server selector => Tools => S-extractor...**
Type of images: **Classic FITS images**

Aladin does not have native automatic source extraction tools. However, he can use the "SExtractor" which is a software commonly used by astronomers to extract sources from an image and calculate magnitude values (Bertin & Arnouts - 1996).

The menu " *File => Server selector => Tools => S-extractor* " opens the " Server selector " on the tab concerning the SExtrator tool. This



form presents the main parameters for source extraction and a selector to designate the concerned image - plane.

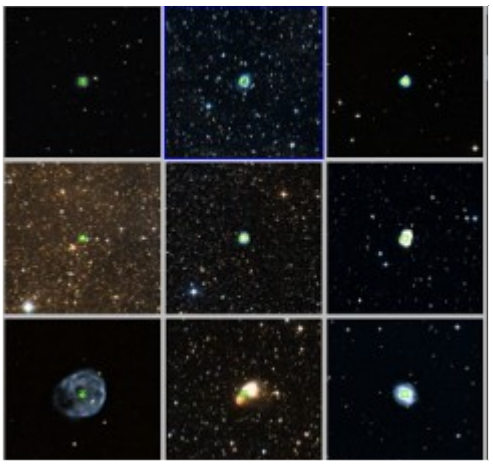
Validation of this form involves remote querying of a server located at the CDS in Strasbourg and dedicated to this type of work. This machine will run SExtractor on your image, and return the extracted source table. These will appear in the stack and therefore projected on the image.

6.7 Generation of thumbnails

Menu: **View => Create one view per image**
Image types: **HiPS and classic images**
Script: **thumbnail ...**

Aladin offers the possibility to easily generate thumbnails for a list of objects, i.e. a series of images centred on the objects in the list. To do this, Aladin will create as many "views" (see 5.1.3) as there are objects. The relevant objects are either those selected in the current view, or all the sources in a catalogue plan or a plan containing only graphic marks.

Example of use



Suppose you want to create thumbnails of the most famous "planetary nebulae";

- Load the colour HiPS DSS by clicking on the first bookmark;
- In the collection tree, load the "CDS/Outreach/Nebulae/PN" catalogue using the "Select" field;
- Create thumbnail views via the menu "*View => Create thumbnail views"*.

The thumbnail views are automatically locked in their central position as indicated by the small padlock at the bottom left of each thumbnail view (see 5.1.4- locked view).

Tip: Since the thumbnail views are all locked it is easy to delete only the *thumbnail views* using the menu *"View => Delete all the locked views"*.

Alternative

It is also possible to use a macro (see 6.1) to generate the thumbnails one by one and save them in individual files.

7 Aladin for experts

In this section we will briefly present different aspects of Aladin, aimed at informed users or data providers, who would like to share Aladin's potential with their users. We will discover the following:

- How to use Aladin in script mode;
- Extend Aladin by developing java plugins;
- How IDL and Aladin can talk to each other.

7.1 Scripting Aladin

As an alternative to the graphical interface, Aladin can be controlled with commands. These allow the same operations to be carried out as with the mouse, but in an environment where the "interlocutor" is not necessarily a user in front of his keyboard, but may be another program.

The different applications of script commands

Script commands can be used in different contexts:

- As an alternative to using the mouse enter script commands into the console or the control field (see above)
- As "remote" control by another programme through:
  - the standard input. A shell script, or other python/perl/etc scripts will be able to submit commands to Aladin.
  - the "*execCommand(String)*" method so that another java application sharing the same Java Virtual Machine (JVM) can communicate with Aladin. (http://aladin.u-strasbg.fr/java/FAQ.htx#Launch)
- To make bookmarks
- To write macros (see previous section)

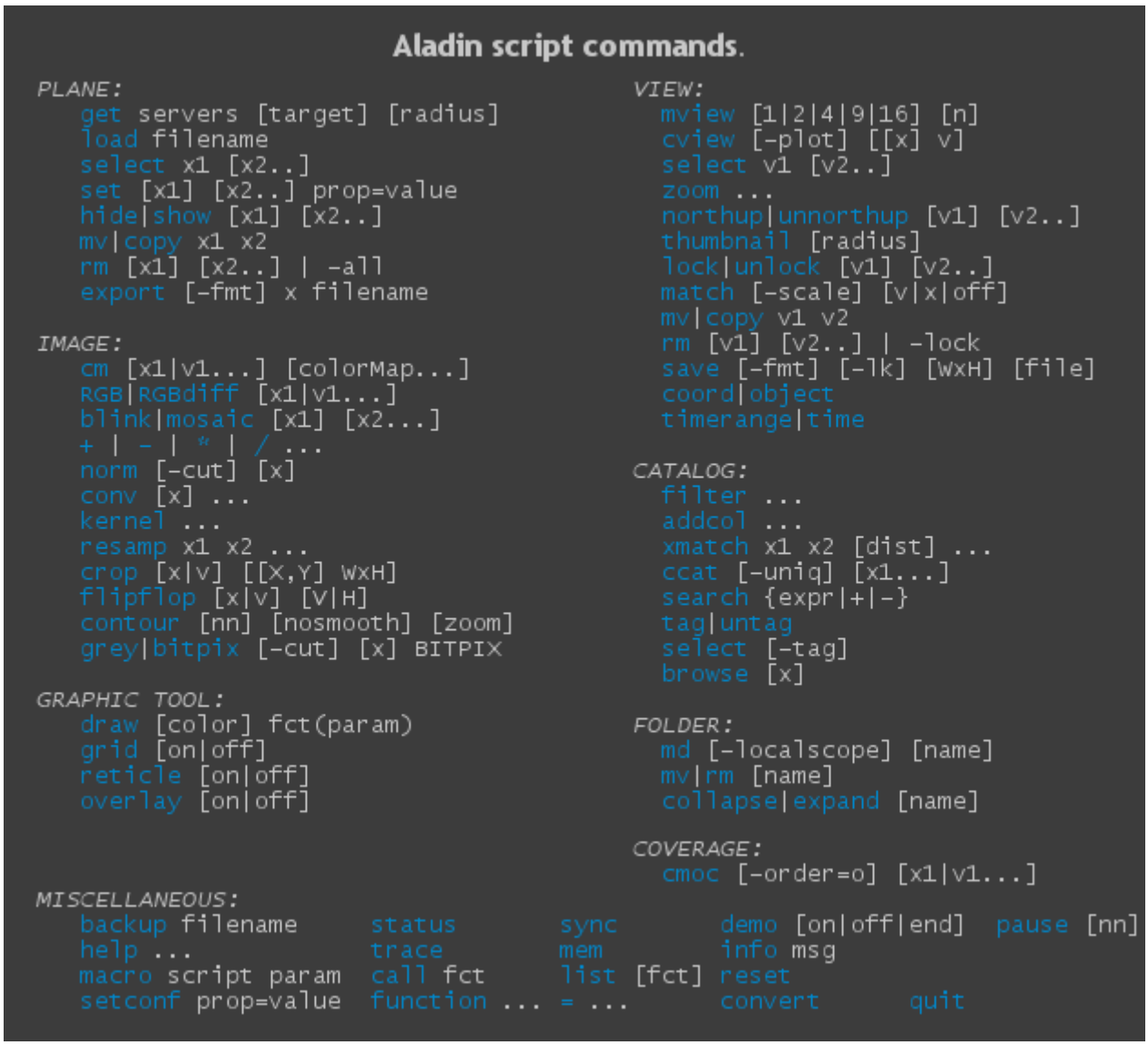
Example script

Example: Loading an image by URL, adding Simbad, activating the grid and switching to the "BB" colour table:

```
get File(http://myServer/myImage.fits)
get Simbad
grid on
cm bb noreverse
```

List of commands

The list of commands and a description of each one is available from Aladin's integrated help suite, which is accessible through the menu *" Help => Help on script commands " (or Ctrl+F5)*. This menu temporarily transforms the view panel into a hypertext allowing you to quickly navigate through the help. You can also use the script command "***help*** *xxx*" where *xxx* is the name of the command.



Use of stack planes as "variables".

In the context of scripts, it is possible to use stack planes as “variables” accessible by name or position in the stack. Thus all script commands generating a plane can be prefixed by "`PlaneLabel = command...`" to indicate that the result of the command will be assigned to the *"PlaneLabel" plane* (resp. *@n* where *n* is the plane number, @1 being the bottom plane of the stack). If this plane already exists, the previous "value" of this plane will be replaced, otherwise it will be created on the top of the stack.

Example: Assigning an DSS/ESO image of M1 the “MyImage” plane:
`MyImage = get ESO(DSS1) M1`

This method is particularly practical and powerful when script commands concern arithmetic operations on images (additions, subtractions, multiplication, normalisation, convolution...).

Example: Difference of 2 images in J and F band:

```
A = get Aladin(J) M1
B = get Aladin(F) M1
Diff = A - B
```

7.2 Launch of Aladin from the command line

Like any Java application, Aladin must be run using a Java virtual machine. The command to be executed in a console follows the following syntax:

```
java [java_options] -jar Aladin.jar [Aladin_options] ...
```

Example: `java -Xmx2g -jar Aladin.jar theme=classic image.fits`

The most common Java option is "-XmxNg" where "*N" is the* number of GB that the virtual machine will use. Depending on your hardware configuration, choose a value from 1 to 2.

The options specific to Aladin are as follows:

```
Usage: Aladin [options...] [filenames...]
       Aladin -hipsgen ...
       Aladin -mocgen ...
       Aladin -help
       Aladin -version

   Options:
       -help: display this help
       -version: display the Aladin release number
       -local: without Internet test access
       -theme=dark|classic: interface theme
       -location=x,y,w,h: window position & size
       -treewidth=w: default tree panel width (0=closed)
       -screen="full|cinema|preview": starts Aladin in full screen
              cinema mode or in a simple preview window
       -script="cmd1;cmd2...": script commands passed by parameter
       -nogui: no graphical interface (for script mode only)
              => noplugin, nobookmarks, nohub
       -noreleasetest: no Aladin new release test
       -nosamp: no usage of the internal SAMP hub
       -noplugin: no plugin support
       -[no]log: with/without anonymous statistic reports
       -[no]beta: with/without new features in beta test
       -[no]planet: with/without planetary data
       -old: obsoleted facilities re-activated (without any warranty)
       -trace: trace mode for debugging purpose
       -debug: debug mode (very verbose)

       -hipsgen: build HiPS by script (see -hipsgen -h for help)
       -mocgen: build MOC by script (see -mocgen -h for help)

   The files specified in the command line can be :
       - images: FITS (gzipped,bzipped,RICE,MEF,...), HEALPix maps, JPEG,GIF,PNG
       - tables: FITS, XML/VOTable, CSV, TSV, S-extractor, IPAC-TBL, Skycat or ASCII tables
       - properties: propertie record list for populating the data discovery tree
       - graphics: Aladin or IDL or DS9 regions, MOCs
       - directories: HiPS
       - Aladin backup : ".aj" extension
       - Aladin scripts : ".ajs" extension
```

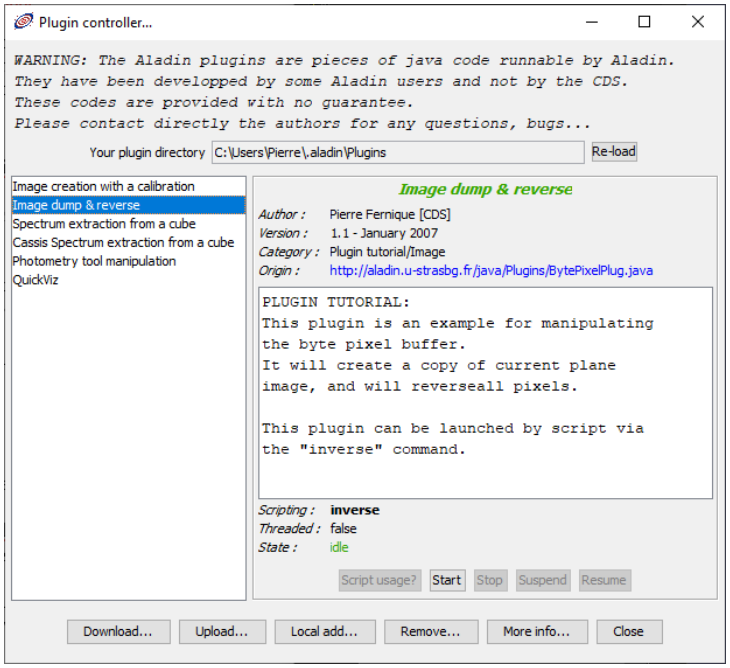
7.3 Aladin extension: the "plugins".

Menu: **Tool => Plugins...**

Aladin was written in the programming language Java. It thus is possible to develop extensions to Aladin in order to carry out additional processing, which are not foreseen in the basic version. These extensions are called *"plugins*" and must also be written in Java.

Installing plugins

The installation and management of plugins is done from the "*Plugin Manager*", which can be found in the menu "*Tool => Plugins => Plugin Manager...*". In this window, you can view at a glance all plugins already installed, and access other plugins available on the official Aladin website (via the *"Load...*" button).



For Plugins to be installed, they need to be compiled (.class or .jar), and located in the ".aladin/Plugins" directory in your home directory (`$HOME` on Unix, \Users\ yourName on Windows). After you have copied them to this location, you need to click on the "*Re-load*" button for them to be taken into account. It is also possible to drag and drop them from your working environment to the "Plugin Manager" list.

Writing a plugin

Writing a Plugin requires some knowledge of Java. In order to access methods for manipulating the stack, images, and catalogues, the object class *"AladinPlugin"* needs to be extended.

Note: A Plugin is a Java extension of Aladin. Thus, plugins have access to internal data structures with the same speed as Aladin's native code, and don’t need to duplicate them.

The technical documentation to create a Plugin is available at the following address: http://aladin.cds.unistra.fr/java/FAQ.htx#plugins. A good way to get started is getting inspired by the examples on the official Aladin website.

7.4 VOApp & VOObserver interfaces

Aladin can be "driven" by another Java application via two dedicated Java interfaces called *VOApp* and *VOObserver*. These two programming interfaces are symmetrical and can be implemented in both applications in order to control the possible interactions. For example, it is possible for one of the applications to send a table to the other application, and if the user selects a line from this table in the other application, receive a "callback" specific to the selected line and act accordingly.

These interfaces are formally defined in the abstract classes "*VOApp*" and "*VOObserver" of* Aladin's *cds.tools* source package. They can be downloaded individually from the CDS website. [15]

Note: VOApp is the result of a CDS/VOIndia collaboration started in 2004 to manage the interactions between Aladin and VOPlot. Subsequently, the IVOA drew inspiration from this interface to develop the PLASTIC standard, later renamed SAMP and also supported by Aladin. You will logically find the same interaction functions. However, you must bear in mind that interactions via VOApp are 100 to 1000 times faster. On the other hand, SAMP extends the field of use for applications that do not share the same Java virtual machine, or even with a web browser under http protocol (WebSAMP). These two methods are therefore complementary. It is up to you to choose which one is the most appropriate according to the context of your development.

VOApp

The VOApp interface has 9 method signatures that you can implement in your application. As Aladin implements this interface, these 9 methods are already implemented in Aladin.

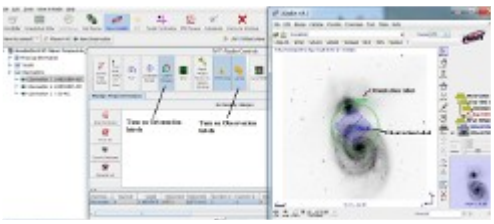
The first 4 methods manage the sending or receiving of a catalogue in VOTABLE format, respectively an image in FITS format:

- `String putVOTable(VOApp app, InputStream in,String label);`
- `InputStream getVOTable(String dataID);`
- `String putFITS(InputStream in,String label);`
- `InputStream getFITS(String dataID);`
- `void showVOTableObject(String oid[]);`
- `void selectVOTableObject(String oid[]);`

The 3 other methods respectively manage the display of the application, the execution of a command specific to the application, and finally the addition of a VOObserver "listener" interacting with a mouse click (see next paragraph):

- `void setVisible(boolean flag);`
- `G-string execCommand(G-string cmd);`
- `void addObserver(VOObserver app,int eventMasq);`

For more information: This technique is used by ESO's "*GuideCam*" software for the preparation of observations from European telescopes (the VLT for example), as well as by "*APT*", the NASA equivalent for the Hubble telescope and the JWST telescope.



VOObserver

The *VOObserver* interface complements *VOApp* in a specific context of astronomical image manipulation. It offers the possibility of registering your application as a "listener" with a mouse click in Aladin in order to receive the position and/or value of the corresponding pixel.

It includes only 2 method signatures:

- `void position(double raJ2000,double deJ2000);`
- `void pixel(double pixValue);`

Launch of Aladin

The instantiation of Aladin from your application can be done in the following way:

15 http://aladin.cds.unistra.fr/java/VOApp.java, http://aladin.cds.unistra.fr/java/VOObserver.java

```
VOApp aladin = cds.aladin.launch();
```

Example of use

```
import cds.tools.*;
public class mytool implements VOObserver {
   public void startAladin() {
      // Instantiate Aladin
      VOApp aladin = cds.aladin.Aladin.launch();
      // Register me for Position and Pixel events
      aladin.addObserver(this,VOApp.POSITION|VOApp.PIXEL);
   }
   // VOObserver callback method for coordinate positions
   public void position(double raJ2000,double deJ2000){
      System.out.println("The current Aladin coordinates are: "+raJ2000+" "+deJ2000);
   }
   // VOObserver callback method for pixel value
   public void pixel(double pixValue) {
      System.out.println("The current Aladin pixel value is: "+pixValue);
   }
}
```

7.5 IDL / Aladin Interactions

IDL (Interactive Data Language) is both a language and a calculation engine for image processing. It is widely used in the astronomical community. A set of IDL functions (".pro" extension file) is available at http://aladin.cds.unistra.fr/java/idl_aladin_interface.tar.gz. It allows to access Aladin from within the IDL environment. You will then be able to exchange images, tables, colour tables, etc.

For more information on using the Aladin Library for IDL, please refer to the FAQ at http://aladin.cds.unistra.fr/java/FAQ.htx#IDL

8 Good to know

Aladin, through its successive versions, is more than 20 years old... it's already a good vintage. You will find a lot of technical and practical information in the FAQ available at the following address: http://aladin.cds.unistra.fr/java/FAQ.htx. This document is continuously updated with new versions, so do not hesitate to take a look at it from time to time to spot new features. There are also a few "online tutorials", i.e. practical works that allow you to experiment Aladin on astronomical case studies. You can also watch videos of presentations. These supports are provided either by the CDS http://aladin.cds.unistra.fr/AladinDesktop/#Documentation or by collaborators or external users reusing Aladin for their own purposes (the web search engines will lead you there quickly).

The following sections present some technical notes that may shed light on Aladin's practice. For more information, please refer to the FAQ mentioned above.

8.1 The types of data supported

Aladin supports most of the formats used in astronomy, whether for images, catalogues or data "groupings". In addition, it takes into account the most widespread compression algorithms.

Format	Type of data	Logo	Comments
FITS	Image [+ WCS]].		No size limit
JPEG	Colour image [+WCS] [+WCS		< 100 Megapixels [16]
GIF	Colour image		
PNG	Colour image [+WCS] [+WCS		
HCOMP	FITS image compression		Applicable to *FITS* images only
FITS- RGB	Image [+WCS]].		
FITS-CUBE			<1024x512x512
FITS-RICE	FITS image compression		Applicable to FITS images only
FITS-GZIP	FITS image compression		Applicable to FITS images only
HiPS image	Progressive image survey		Pre-standards and IVOA standard (FITS,JPEG,PNG tile support)
PDS	Planetary image		Including header and without compression
ASTRORES	Catalogue		Predecessor of VOTable, (supported for compatibility)
VOTABLE	Catalogue		Standard IVOA totally supported (base64, BINARY2, FITS, …) <1 million sources
TBL	Catalogue		Format IPAC <1 million sources
HiPS catalogue	Progressive catalogue survey		IVOA standard (TSV tile)

16 Based on a machine with 1Gigabyte of RAM

FITS-ST	Catalogue		FITS table in ASCII <1 million sources
FITS-SB	Catalogue		FITS table in binary <1 million sources
TSV	Catalogue		"Tab separated value" <1 million sources
CSV	Catalogue		"Character separated value" (classic spreadsheets) <1 million sources
BSV	Catalogue		"Blank separated value" <1 million sources
SEXTRACTOR	Catalogue		Default format of S-extractor
HiPS cube	Cube progressive survey		Pre-standards and IVOA standard (FITS,JPEG,PNG tiles)
MOC 1.0 to 2.1	Coverage (space & time)		IVOA standard + JSON support
HEALPix map	Celestial map		FITS MFITS dedicated to HEALPix maps (RING & NESTED support)
MultiOrder skymap	Probability map		FITS MFITS dedicated to probability map (VIRGO/LIGO)
MEF	Multiple data		FITS multiple extensions
AJ	Aladin Stack		Stack backup
AJS	Script Aladin		Script command file
FoV	Field of view		Description of instrumental fields of view (note IVOA)
DS9 regions	Graphic overloads		Graphic overloads at DS9
IDL regions	Graphic overloads		Graphic overloads at IDL
IDHA	List of images		SIA alternative, (supported for compatibility)
SIA, SIA2	Image list [+WCS].		Standard IVOA
SSA	Spectrum list		Standard IVOA
TAP, ObsTAP, EpnTAP	Result query VO database		IVOA standards (based on VOTable)
Datalink	List of links		IVOA standards (based on VOTable)
GLU	List of server descriptions		CDS format
properties	List of collection descriptions		HiPS format extension properties
GZIP	Compression		Applicable to all other formats

Aladin automatically recognises the nature of the data based on the content: the extension of the file name or the presence of a "*Content-type*" for an *http* stream does not affect the recognition of the file.

Exception: The *AJS* format (Aladin script) is an exception because its nature cannot be recognised automatically without risk of confusion. To remove the ambiguity, Aladin will use the ".ajs" file extension and/or the presence of the following comment on the first line: " #AJS ".

8.2 FITS standard and astrometric calibration

For astrometric calibration, Aladin follows the official FITS standard: the first pixel at the bottom left is numbered (1,1) and the corresponding celestial position is centred on the pixel. Concretely, the coordinate at the bottom left of the first pixel is therefore (0.5,0.5).

Note: IDL does not follow the official FITS standard, the bottom left coordinate of the first pixel is (0.0).

Aladin recognises several calibration methods: standard WCS, old DSS1 method, ... as well as most common projections.

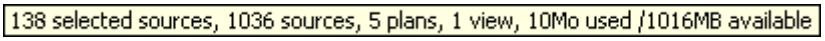
8.3 Performance and technical constraints

Aladin's development follows two rules:

1. Ensure the best possible compatibility with existing hardware and operating systems;
2. Offer the best possible performance in this context.

To meet these two constraints, Aladin makes the best use of the "Java" programming language. Java" applications require the presence of a "Java engine" installed on your computer. Most operating systems already have a java engine installed by default. If this is not the case, it is possible to install it free of charge from http://www.java.com/download.

A counter at the bottom right of the window indicates the amount of memory used by Aladin. By holding the mouse over this counter, a window displays this value and indicates the maximum amount of memory that can be used. This limit depends on how the java machine was initialized when Aladin was started. To increase this value please refer to the corresponding section in the FAQ (http://aladin.cds.unistra.fr/java/FAQ.htx#huge).



8.3.1 Image management

Aladin knows how to manage any image size. Depending on your hardware configuration and the memory allocated to the Java virtual machine, Aladin will be able to choose different more or less fast strategies:

- For images of a few megabytes, the image is fully loaded into memory;
- For images of a few hundred megabytes, Aladin will use disk space to save RAM. The impact on the fluidity of manipulation is very light;
- For images of several gigabytes, Aladin will implement a two-step access: a first immediate display in low resolution, then when the zoom factor is compatible with your memory capacity, a second display in high resolution for the visible portion of the image. The method for reading the low-resolution image has been optimised to limit disk accesses, making it possible to obtain a first view in a few seconds, whatever the size of the image. This two-level resolution strategy is more constraining (waiting time to load high-resolution pixels when moving) but allows to manipulate any image size as long as it can be stored on a hard disk.
- For progressive surveys (HiPS), Aladin loads only the tiles required according to the field of view. These tiles are saved in an internal cache ($HOME/.aladin/Cache/HPX) so that they can be quickly reloaded if necessary. The tile display is a compromise between drawing

speed and distortion limitation. The principle is based on cutting each tile to be drawn in the current projection into as many sub-elements as necessary to avoid the shearing phenomenon that can occur if the tile is particularly stretched (drawn by bilinear approximation). Although the progressive survey is displayed in real pixel values, Aladin does not load these into RAM, but works on an internal copy of each tile reduced to 256 levels. If necessary, he will look for the pixel value under the mouse directly in the disk cache. A change in the range of pixel values will result in a complete reload from the cache of the tiles being viewed.

8.3.2 Catalogue management

The handling of the classic catalogues is done by a full load in RAM. It is necessary to count approximately 300 bytes per source, which gives a limit of around 1.5 million objects that can be manipulated with a computer with 1 Gigabyte of RAM. In practice, the limit is rather around 1 million objects in order to leave enough RAM for images and applications.
On the other hand, in the case of a HiPS catalogue, the impact on the RAM memory is not very significant since Aladin will only view tiles in the current field and at the current resolution. As with HiPS images, Aladin will keep the tiles already loaded in an internal cache so that they can be reloaded quickly if necessary.

8.3.3 Filtering collections via the MocServer

Aladin, from version 10 onwards, offers integrated access to a very large number of data collections from the CDS and servers compatible with Virtual Observatory protocols. This functionality is notably illustrated by the collections tree and the associated tools (selection, filtering, etc.).
The library used by Aladin to access, store and manipulate the properties and MOCs of these collections was developed by the CDS. It is implemented, firstly, on a remote server managed by the CDS called MocServer (http://alasky.cds.unistra.fr/MocServer/query). This server supports spatial filtering based on MOCs. These represent a volume to large (several GB of metadata) to be loaded on the Aladin client. On the other hand, all the properties of the collections represent only a small volume of information (a few MB). Thus this same library is also implemented in the Aladin client, which is responsible for filtering properties. These two simultaneous implementations are transparent for the user (as long as he has internet access). It should be noted that at start-up, Aladin will synchronise the properties it has with those of the MocServer. These are kept in the local cache ($HOME/.aladin/Cache) in the form of a single file "Multiprop.bin".

9 Keyboard shortcuts

Access to data collections

Images	Ctrl+I
Data bases	Ctrl+D
Catalogues and tables	Ctrl+T
Search for a collection	Ctrl+E
Access to local files	Ctrl+O
Server Selector	Ctrl+L

View manipulation

Zoom in	F2 or mouse wheel
Zoom out	F3 or mouse wheel
Pointed zoom	F4
Slide/move the view	Alt+Z
Next image	Tab
1 view	Shift+F1
4 views	Shift+F2
9 views	Shift+F3
16 views	Shift+F4
Generation of 1 view per image	F9
Copy crosshair position	Ctrl+W
Standardize the scale	Alt+S
Standardize the scale and the orientation	Alt+Q
North up	Alt+X

Tools

Print	Ctrl+P
Activate the magnifying glass	Ctrl+G
Activate the coordinate grid	Alt+G
Activate the HEALPix grid	Alt+W
Activate the information about the image	Alt+O
Constellation display	Alt+C
Distance measurement	Alt+D

Handling of plans

Properties	Alt+Entry
Display FITS header	Alt+H

Handling of sources

Select all sources	Ctrl+A
Deselection	Ctrl+U
Search by expressions	Ctrl+F

Windows

New Aladin window	Alt+N

Open the pixel control	Ctrl+M
Backup window	Ctrl+S
History window	Ctrl+H
Control Console	F5
Full screen	F11
Single Window View	F12
End full screen/single window	Escape

Others

Copy	Ctrl+C
Paste	Ctrl+V
Save	Crel+S
Delete selection	Suppr
Delete all	Shift+Sup
Help of the script commands	Ctrl+F5
Guided tour	F1

Glossary

ADQL	Language dedicated to the interrogation of astronomical databases, derived from SQL. IVOA standard http://www.ivoa.net/documents/latest/ADQL.html (see TAP).
AJ	Aladin's dedicated file format for stack backup.
AITOFF	A geometric projection representing the entire sphere as a flattened ellipse.
ASTRORES	Predecessor of VOTable (see below).
B1950	Equatorial space reference system FK4, equinox 1950.
BITPIX	Coding specific to the FITS format. Defines how a pixel value is stored (see below) by specifying the number of binary elements (bits) and the representation of the value (integer or real).
BSCALE	The multiplicative factor specific to the FITS format allowing the conversion of a pixel value stored in a FITS file into its physical equivalent value.
BZERO	The constant specific to the FITS format allowing the conversion of a pixel value stored in a FITS file into its physical equivalent value.
Cache	A technique for storing retrieved data on the local disk to prevent it from being reloaded later.
CADC	Canadian Astronomy Data Centre. Associated database.
CASSIS	Software for the manipulation of astronomical spectra. Developed by the Institut de Recherche en Astrophysique et Planétologie.
CDS	Centre de Données astronomiques de Strasbourg.
(S)CS	(*Simple Cone Search*) Protocol for accessing a list of astronomical sources located in a circle on the celestial sphere. IVOA standard http://www.ivoa.net/documents/latest/ConeSearch.html
DSS	*(Digitized Sky Survey)* Historical reference celestial survey, digitised from collections of photo plates from Schmidt telescopes.
DS9	FITS astronomical image viewing and manipulation software. Developed by the Smithsonian Astrophysical Observatory.
ECL	Ecliptic space reference frame.
ESAC	*(European Space Astronomy Centre)* Satellite Data Centre of the European Space Agency (ESA).
ESO	*(European Organisation for Astronomical Research in the Southern Hemisphere)* Intergovernmental Organisation for Astronomy in Europe.
FITS	*(Flexible Image Transfert Support)* File format dedicated to the storage of images or astronomical tables.
FK4	Equatorial space reference frame. Precursor to FK5 (see B1950)
FK5	Equatorial space reference frame. Precursor to ICRS (see J2000)
Gaia	European astrometric satellite. Related data.
GAL	Galactic space reference frame.
GZIP	Generic, lossless file compression format.
HCOMP	A lossy image compression format.
HDR	*(High Dynamic Resolution)* Aladin display mode for viewing astronomical images. Takes into account the full range of pixel values.
HEASARC	*(High Energy Astrophysics Science Archive Research Center)* NASA High Energy Data Centre (see SkyView).
HEALPix	System of hierarchical partitioning and indexing of the sphere into cells of equal area. Particularly used in progressive surveys (HiPS) and coverages (MOC).

HiPS *(Hierarchical Progressive Survey) Infrastructure for storing and describing a collection of data located on the sphere (image, cube or catalogue), allowing hierarchical access by HEALPix tiling. IVOA standard:* http://ivoa.net/documents/HiPS

ICRS *(International Celestial Reference System)* Equatorial space reference frame commonly used since the Hipparcos mission (1997). Allows location at the millisecond of arc.

IDL Commercial software and associated language for scientific data manipulation.

J2000 Equatorial space reference frame. FK5 equinox 2000 system.

Java Programming language, notably used to write Aladin (see JVM).

JRE See JVM.

JVM *(Java Virtual Machine)* Software environment allowing the execution of a program written in the Java language such as Aladin.

IVOA *(International Virtual Observatory Alliance)* International organisation whose main motivation is the production of interoperability standards for astronomical data.

JAXA *(Japan Aerospace Exploration Agency) Japan Aerospace Exploration Agency.*

JPEG Image format, general use, lossy compressed, without transparency management.

MAST *(Mikulski Archive for Space Telescopes)* NASA archive of astronomical data.

MOC *(Multi-Order Coverage map)* Data format and associated file. Describes spatial, temporal, or mixed coverage. Often used to describe the coverage of a data collection. MOC is an IVOA standard : http://ivoa.net/documents/MOC

MocServer CDS server. Directory service of spatially and temporally indexed collections.

NASA *(National Aeronautics and Space Administration)* Governmental organisation in charge of US space programmes.

NED *(NASA/IPAC Extragalactic Database)* NASA database of astronomical objects. Worldwide reference.

OV *(Observatoire Virtuel)* see IVOA.

Pixel The smallest element of an image, usually square, encoding the colour or measurement level corresponding to its location.

PMRA,PMDEC Values characterising the proper motion of an astronomical object on the celestial sphere. Variations in RA and DEC.

PNG A general-purpose, lossless compressed image format that supports a transparency channel.

RA *(Right Ascension)* The first component of an astronomical coordinate corresponding to the longitude in an equatorial reference frame. It is expressed in decimal or sexagesimal degrees (see DEC).

RICE Lossless FITS image compression format.

SAMP *(Simple Application Message Protocol)* Protocol governing interactions between 2 or more compatible applications. IVOA standard : http://ivoa.net/documents/SAMP

Sesame CDS service and server. Dedicated to the resolution of astronomical object names in celestial coordinates.

Sexagisimal Representation of spherical coordinates as two triplets (hours, minutes, seconds) and (degrees, minutes, seconds).

SIA *(Simple Image Access)* Protocol for accessing a list of images. IVOA standard http://ivoa.net/documents/SIA

Simbad CDS service and database. Dedicated to astronomical objects studied in the scientific literature. Worldwide reference (see Sesame).

SkyView HEASARC's image generation service.

SDSS *(Sloan Digital Sky Survey)* Near-infrared astronomical survey.

SSA *(Simple Spectra Access)* Protocol for accessing a list of spectra. IVOA standard http://ivoa.net/documents/SSA

TAP	*(Table Access Protocol)* Protocol for querying a database. IVOA standard http://ivoa.net/documents/TAP
TOPcat	Reference software for the manipulation of astronomical tables. University of Bristol.
TSV	*(Tab Separated Value)* ASCII file format dedicated to tables whose elements are separated by a tab.
UCD	*(Unified Content Descriptor)* Physical characteristic. A keyword from a list of terms covering all physical quantities used in astronomical catalogues. Generally used to characterise a column in an astronomical table. IVOA standard : http://www.ivoa.net/documents/latest/UCDlist.html
VizieR	CDS service and server. Database of astronomical catalogues. World reference.
VO	*(Virtual Observatory)* see IVOA.
VOApp	Java interface allowing to interact programmatically with Aladin.
VOTable	File format. Dedicated to the storage and transfer of data tables and associated metadata (column names, units, UCDs, links, ...) encoded in XML form. IVOA standard : http://ivoa.net/documents/VOTable.
WCS	(*World Coordinate System*) Coding mechanism for the function of converting image X,Y coordinates to their long,lat correspondence on the celestial sphere. Usually stored in the header of a FITS image.

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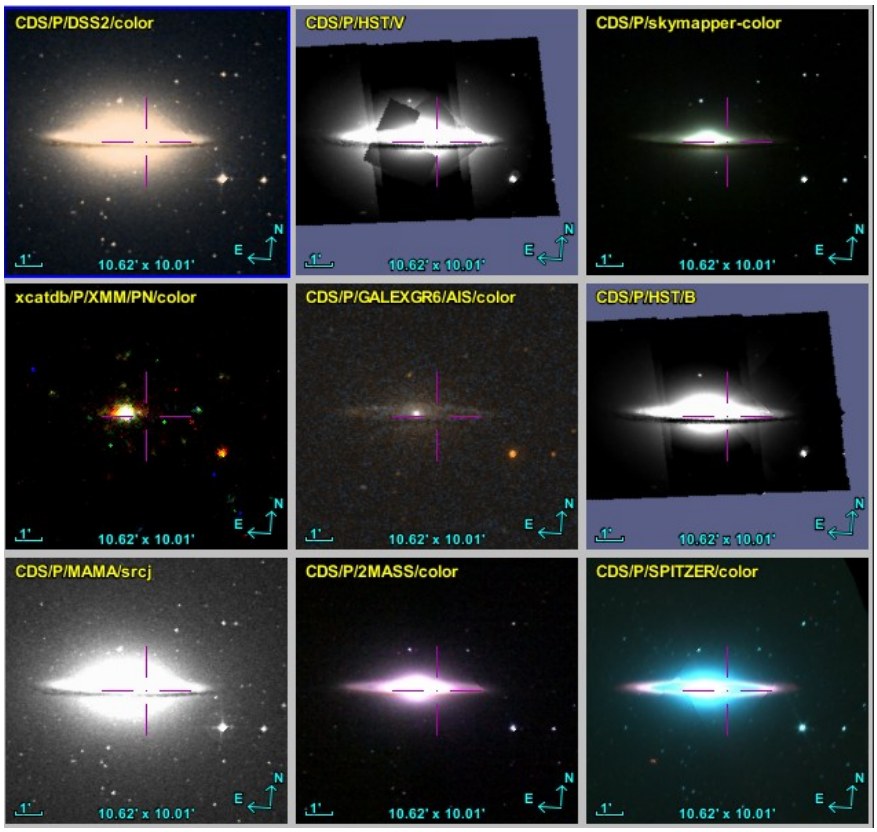

The Sombrero (M104) in 9 progressive HiPS readings.