

Aladin

25th October 2022. Updated to: Aladin v12

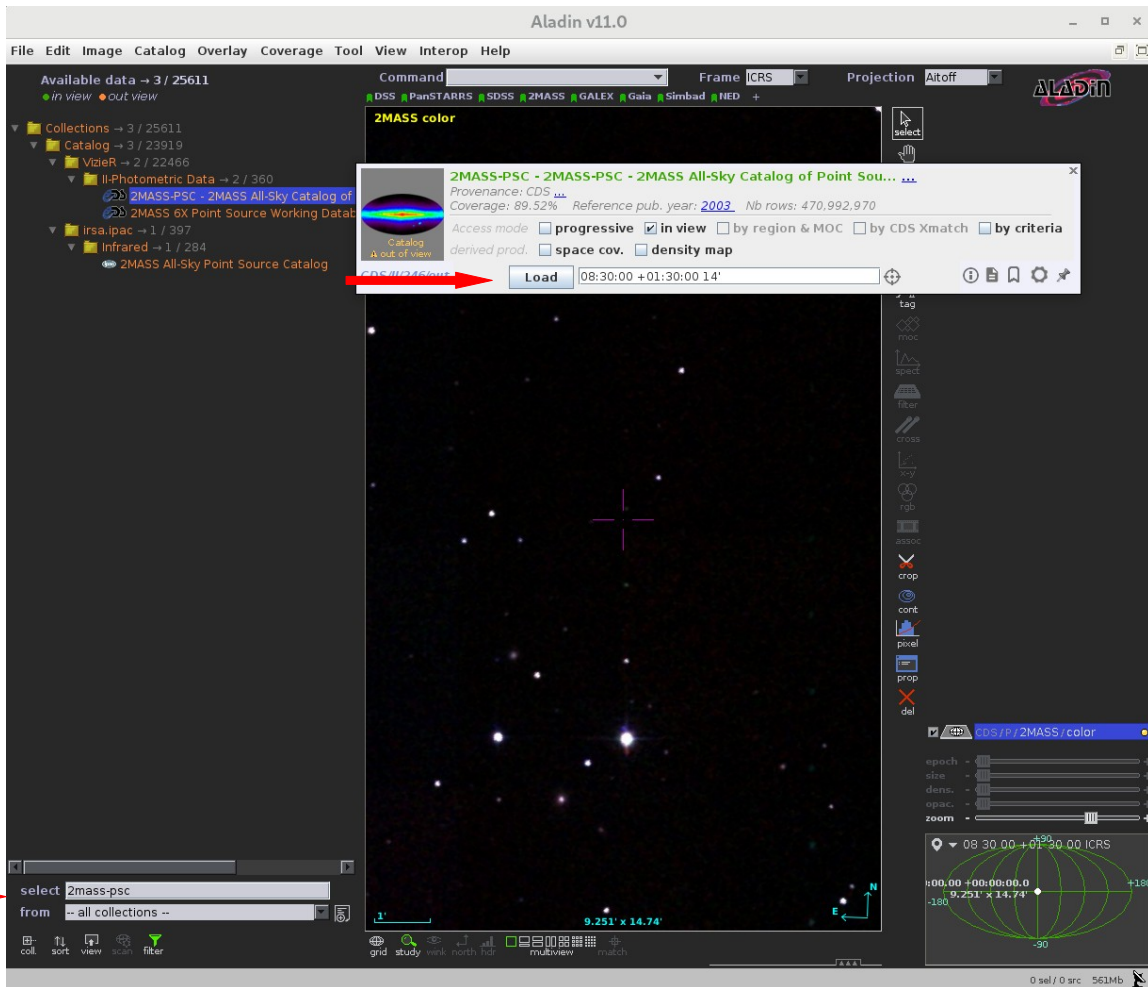
I) Science case: **Discovery of Brown Dwarfs mining the 2MASS and SDSS databases with Aladin.**

- **Scientific background:** Brown dwarfs are objects occupying the gap between the least massive stars and the most massive planets. They are intrinsically faint objects so their detection is not straightforward and, in fact, was almost impossible until the advent of global surveys at deep optical and near-infrared bands. We propose here to mine the 2MASS-PSC and SDSS-DR12 databases to identify T-type brown dwarfs through an appropriate combination of colours in the optical and the infrared, an approach that perfectly fits into the Virtual Observatory.
- **Workflow:** In this tutorial we will explore how to perform the download of data, cross-match of catalogs, sources selection and filtering with Aladin Sky Atlas.

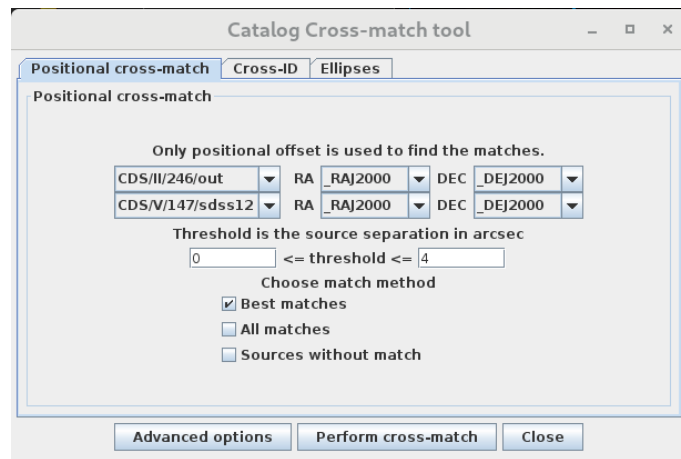
- Launch Aladin: Open a terminal and type: `java -jar Aladin.jar &`
 - Load a sky map (HiPS). On the left hand panel, go to the discovery tree and navigate through the folders: *Collections* → *Image* → *Infrared* → *2MASS* and click on “2MASS color J (1.23 μ m), H(1.66 μ m), K(2.16 μ m)”. A new window will pop up. Click on **Load** in this new window. The sky map will be displayed in the central panel.

You can also click “2MASS” on top of the central panel, just below the **Command** box.

- **Discovery:** Search 2MASS-PSC and SDSS-DR12 sources around RA:08h 30m DEC:01d 30m with a 14 arcmin radius.
 - On the left panel of the Aladin window, click on the **select** box located in the bottom corner and type “2MASS-PSC”. The discovery tree will open and show the available catalogs.
 - Click in the “2MASS-PSC - All-Sky Catalog of Point Sources” photometric catalog. A new window will pop up.
 - Write 08:30:00 +01:30:00 14’ in the *position/radius* box next to the **Load** button and click on **Load**. Aladin will load in the main window a plane named “CDS/III/246/out” with 683 sources (you can see the number of sources on top of the right panel by placing the cursor on the name of the plane). You can zoom in/out by using the scroll button on your mouse.

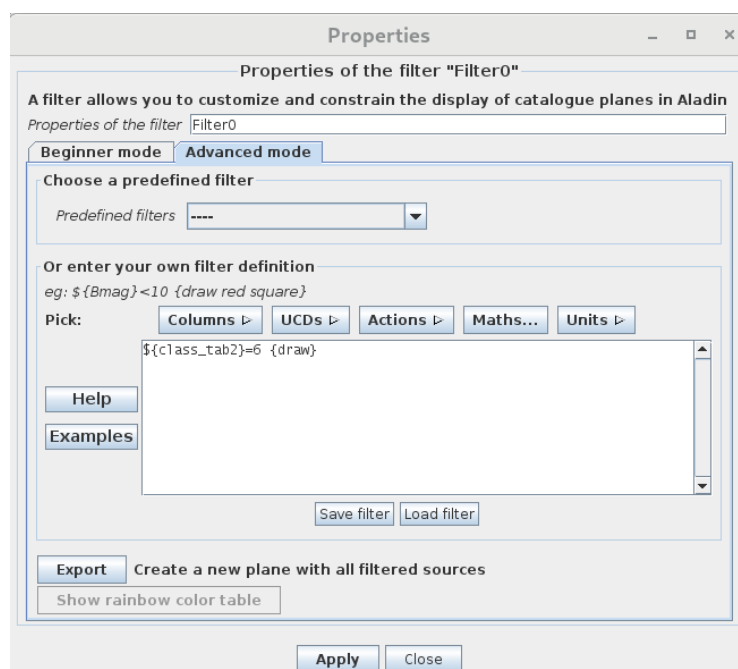


- If you wish you can modify the name of the plane, and colour and/or the shape of the symbols of this plane by doing the following:
 - Click on the **prop** button on the right panel of the Aladin main window. A new window ("Properties of the plane...") will pop up.
 - Write "2MASS-PSC" in **Plane ID**.
 - Select the color and /or shape you wish.
 - Click on **Apply**.
 - Repeat the same steps for the SDSS-DR12 catalog. Select the SDSS-DR12 catalog in the *V – Combined data* folder. A new plane named "CDS/V/147/sdss12" will be loaded with 12404 sources.
- **Crossmatching:** Find common sources in 2MASS-PSC and SDSS-DR12 catalogs.
 - In the Aladin main window: *Catalog* → *Cross match objects*.
 - First catalog: 2MASS-PSC (CDS/II/246/out). Second catalog: SDSS-DR12 (CDS/V/147/sdss12). Default threshold (4 arcsec) and bestmatch option.
 - Click on **Perform cross-match**. A new plane named "Xmatch" with 679 sources will be loaded. It contains columns from the 2MASS and SDSS DR12 catalogs.

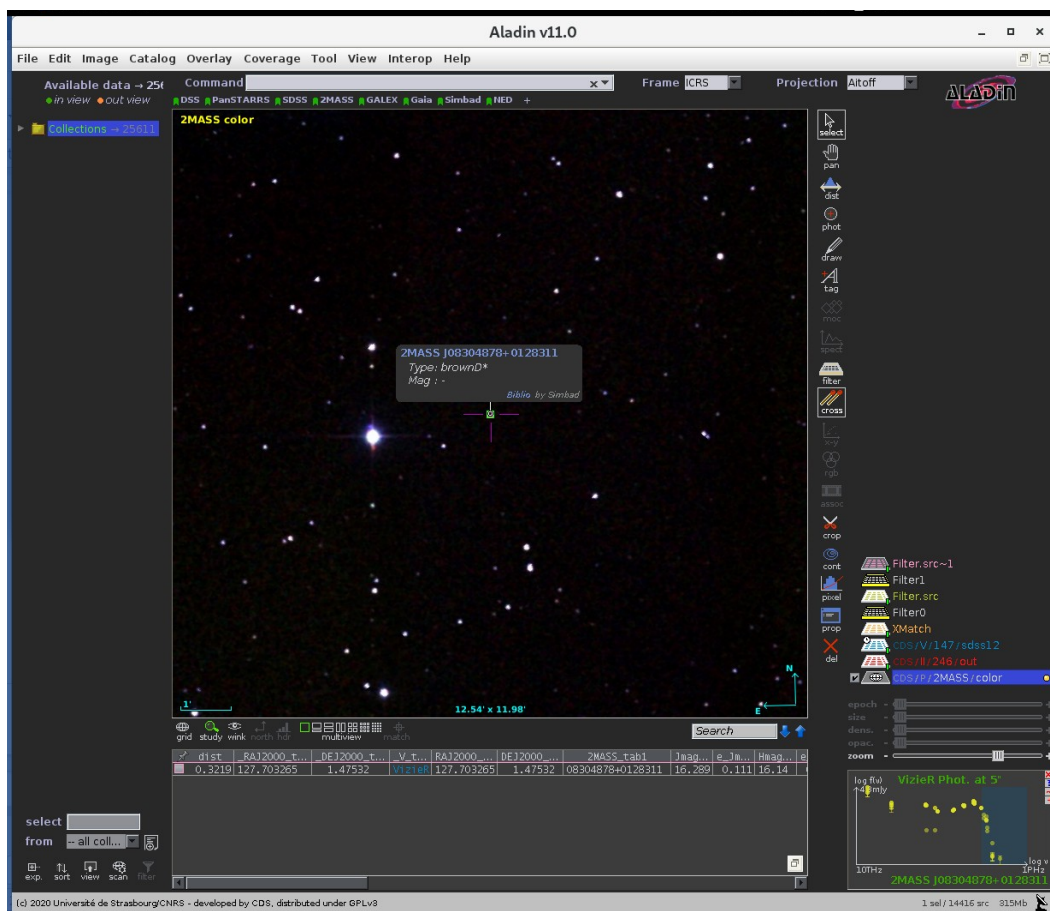


- **Filtering:**

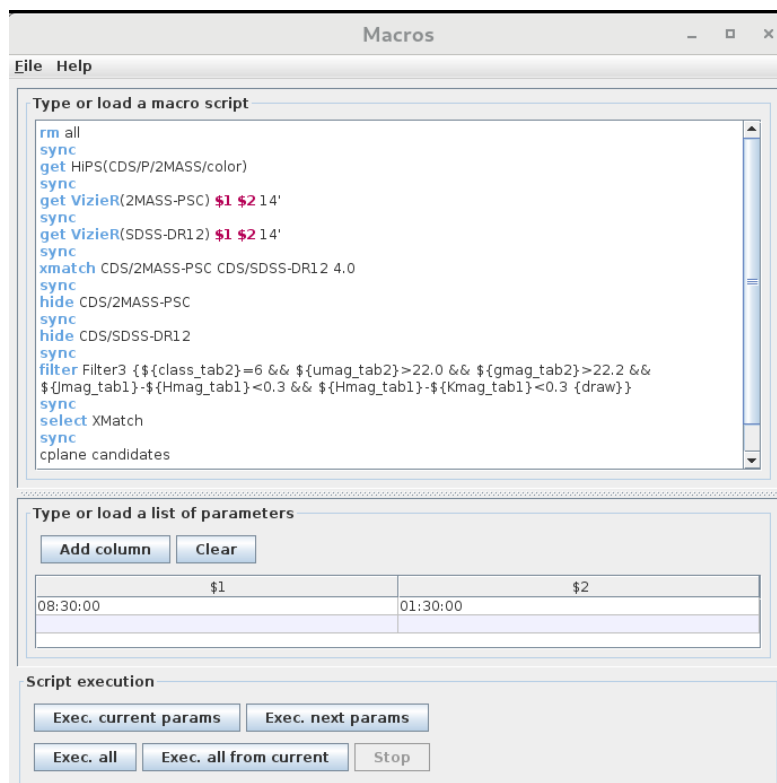
- In this step we will select point sources using the SDSS flag (class=6). "class" is a column of the SDSS- DR12 catalog that provides information on the type of object (3=galaxy, 6=star).
 - Click on the "XMatch" plane. The name of the plane would appear highlighted.
 - In the Aladin main window: *Catalog* → *Create a filter* (or click on the **Filter** button on the right panel of the Aladin main window) → *Advanced mode* → *Columns* → *Columns in loaded catalog*. A new window ("Available columns") will pop up. Select the "class_tab2" column from the Xmatch plane. The label of this column will be copied to the "Properties" window.
 - Complete the filter condition. It should be `#{class_tab2}=6 {draw}`
 - Click on **Apply**. Then click on **Export** to create a new plane with the filtered sources.



- A new plane “*Filter.src*” will be loaded in the Aladin main window. It contains 650 sources.
- Now, let's select sources with no detection in the u,g SDSS bands ($u > 22.0$ & $g > 22.2$, since brown dwarfs are cool objects not detected in the blue SDSS bands) and sources fulfilling the brown dwarf criteria provided by Burgasser et al. (2000, Apj, 531, L57): $((J-H) < 0.3 \ \&\& \ (H-K) < 0.3)$.
 - Click on the icons on the left of the names of the planes to hide them all but “*Filter.src*”.
 - Click on the “*Filter.src*” plane.
 - Repeat the same steps as in the previous filter. The filter condition now should be:
 - $\{umag_tab2\} > 22.0 \ \&\& \ \{gmag_tab2\} > 22.2 \ \&\& \ \{Jmag_tab1\} - \{Hmag_tab1\} < 0.3 \ \&\& \ \{Hmag_tab1\} - \{Kmag_tab1\} < 0.3 \ \{draw\}$
 - Click on **Apply**. Then click on **Export** to create a new plane with the filtered sources. A new plane “*Filter.src~1*” will be loaded in the Aladin main window. It should contain 1 source (RA_2MASS:127.703265deg; DEC_2MASS:1.475320deg). NOTE: You will get information on the source by clicking on it.



- **Analysis:** We can now use Simbad to confirm the brown dwarf nature of this object:
 - Place the cursor on the source.
 - After a few seconds a small window with basic information of the object will appear. If it does not, click on the right mouse button and select *Astronomical object exploration (Simbad & Vizier)*.
 - By clicking on the object name (in blue) a new tag will open in your browser with the information available in *Simbad* for this particular object.
- **Advanced scripting in Aladin:** Aladin has a script mode to build a list of commands to be processed. The workflow can be executed automatically for a list of targets.
 - If you closed Aladin, launch it again (java -jar Aladin.jar &). If your Aladin was still open, click on any plane, then click on right mouse button and select **Delete all planes**.
 - In the Aladin main window: *Tool* → *Macro Controller*
 - In the **Macros** window:
 - *File* → *Load script* → Load the script file “script_aladin” available in the school web page.
 - *File* → *Load params* → Load the param file available in the school web page.
 - Click on the coordinates and then click on **Exec. current params**. You will get the source identified in previous workflows.



- More information on how to build scripts in Aladin can be found at Aladin main window: [Help → Help on script commands](#) or [Tool → Script console](#).
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NOTE: Before running each of the following examples, it is convenient to remove all loaded catalogs and images by clicking the right mouse button over any of the planes in the panel to the right in the main window and selecting **Delete all panels**.

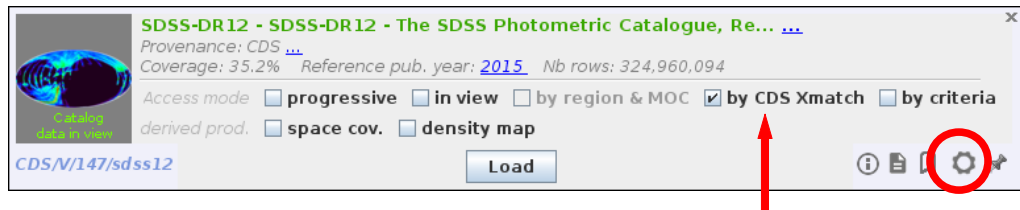
II) Other functionalities:

- **CDS-X match:** This option is suitable when we want to cross-match a catalog of sources with another VO catalog in different sky regions or when the region to load is too large, for example.
 - We will repeat the exercise described in the [Discovery](#) section of the science case using this time the CDS-X match option.
 - Load a sky map (HiPS). On the left hand panel, go to the discovery tree and navigate through the folders: [Collections](#) → [Image](#) → [Infrared](#) → [2MASS](#) and click on “2MASS color J (1.23um), H(1.66um), K(2.16um)”. A new window will pop up. Click on **Load** in this new window. The sky map will be displayed in the central panel.

You can also click “2MASS” on top of the central panel, just below the **Command** box.
 - Load 2MASS-PSC sources around RA:08h 30m DEC:01d 30m with a 14 arcmin radius as described above. For clarity, the steps are repeated here:
 - On the left panel of the Aladin window, click on the **select** box located in the bottom corner and type “2MASS-PSC”. The discovery tree will open and show the available catalogs.
 - Click in the “2MASS-PSC - All-Sky Catalog of Point Sources” photometric catalog. A new window will pop up.
 - Write 08:30:00 +01:30:00 14' in the *position/radius* box next to the **Load** button and click on **Load**. Aladin will load in the main window a plane named “CDS/II/246/out with” 683 sources (you can see the number of sources on top of the right panel by placing the cursor on the name of the plane). You can zoom in/out by using the scroll button on your mouse.
 - Cross-match the 2MASS catalog loaded in the previous step with SDSS-DR12 in an alternative way:
 - On the left panel of the Aladin window, click on the **select** box located in the bottom corner and type “SDSS DR12”. The discovery tree will open and show the available catalogs.

- Select the SDSS-DR12 catalog in the *V – Combined data* folder. A new window will pop up.
- Select **by CDS-X match** and click **Load**. A new plane called “CDS/V/147/sdss12” via Xmatch” will be loaded. It contains 679 sources with the corresponding columns of the 2MASS and SDSS DR12 catalogs.

Note: In the pop up window, the previous to the last symbol on the bottom right corner of the SDSS-DR12 window opens a new window where the configuration parameters of the cross-match can be changed.



- Some functionalities using the previously loaded catalogs:
 - The **time controller** allow us to visualize the sources in a catalog observed in a determined time range.

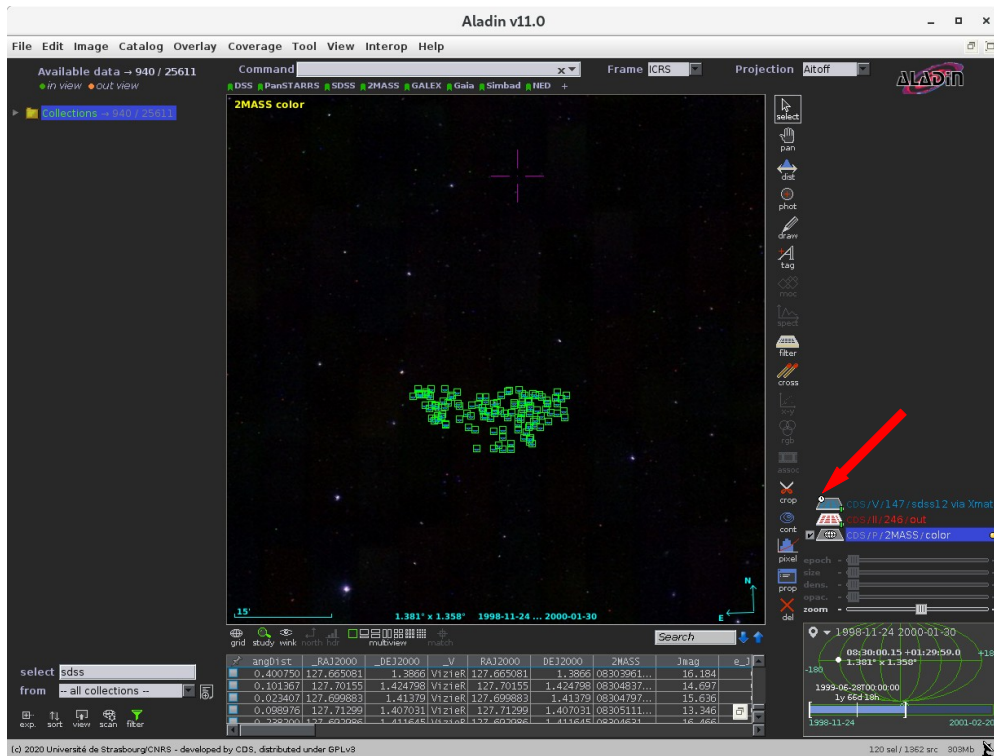
- Deselect the 2MASS plane (*CDS/III/246/out*) by clicking on the plane icon.

Notice that the “CDS/V/147/sdss12 via Xmatch” plane shows a clock icon. This is because the SDSS DR12 catalog contains an epoch column. At the bottom of the right panel, under the plane stack, you can see the time range covered by the SDSS DR12 observations: 1998-11-24 to 2001-02-20.

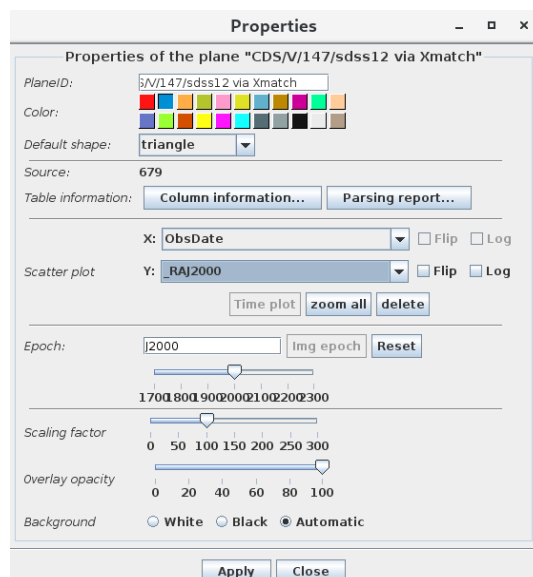
- To show sources observed between the first half of the covered interval, type 1998-11-24 2000-01-30 in the **Command** box, on top of the central panel. Press the *enter* button. The sources observed in that interval will be displayed in the central panel.

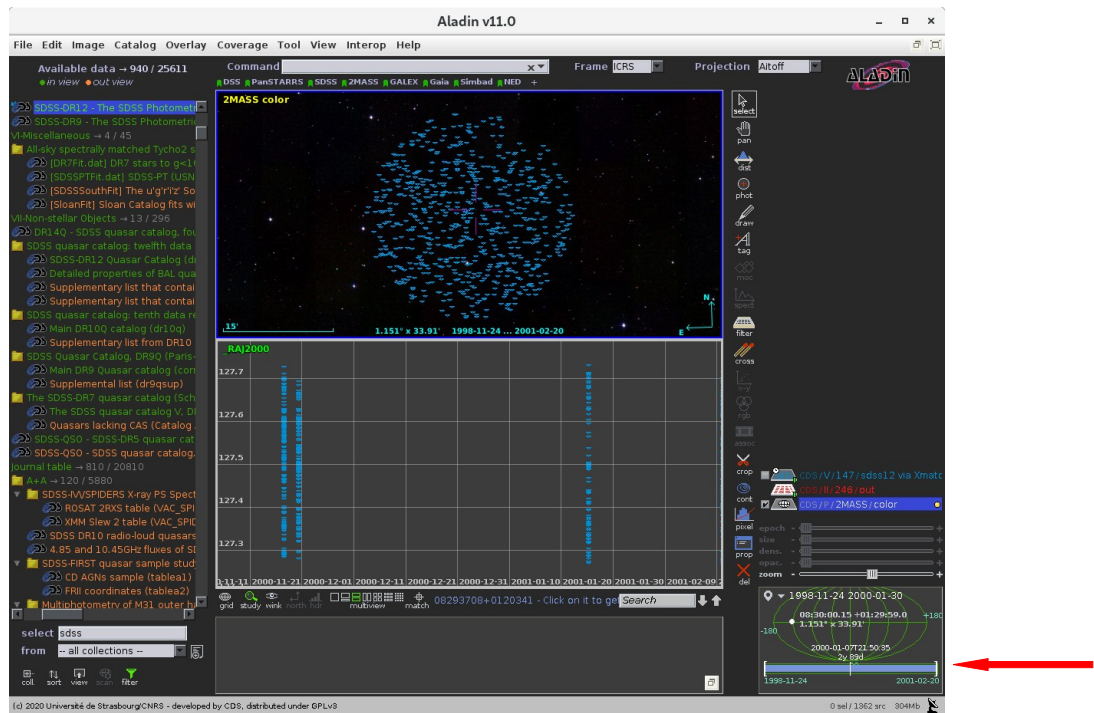
Note: When a time range has been set, it can be adjusted with mouse actions on the time controller displayed under the space controller in the right bottom panel.

- You can create a new plane with these sources. With your mouse, select all the sources shown in the central panel. Then click on the right mouse button over the plane in the right panel and select *Create a new plane with selected sources in one homogeneous able*. A new plane named “Select.src” with 120 sources will be created.

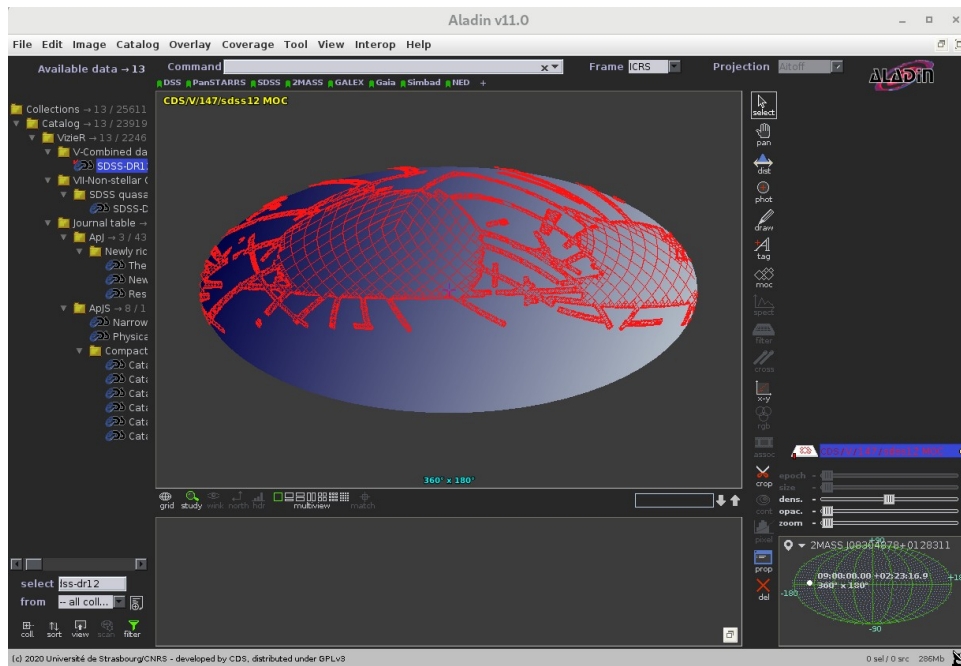


- The **time plot** shows the time distribution of the sources contained in the selected plane.
 - Select the “CDS/V/147sdss12” plane. *Catalog* → *create a scatter/time plot*. Alternatively, you can press the **Scatter plot** button on the right panel of the Aladin main window. A new window will pop up.
 - Select “_RAJ2000” to be displayed in the Y axis. The X axis is by default the epoch column, named “ObsDate”. Click **Apply**. A second panel with the time distribution will be displayed under the sky-view plane. Notice that you can quickly change his selection with your mouse wheel. You can also scroll on the time bar situated on the bottom of the right panel to control the displayed epoch in the plot.

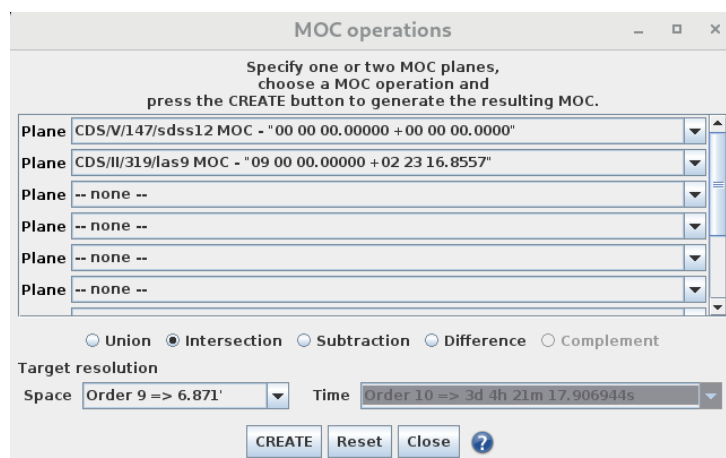




- **MOC (Multi-object coverage)**. Used to describe sky regions (e.g. footprints) and provides a very fast mechanism to perform operations (union, intersection,...) between them.
 - How to obtain the sky coverage of SDSS DR12:
 - After removing all the planes in the stack, select **View → Panels → 1 panel** to set a unique view panel.
 - On the left panel of the Aladin window, click on the **select** box located in the bottom corner and type “SDSS DR12”. The discovery tree will open and show the available catalogs.
 - Select the SDSS-DR12 catalog in the **V – Combined data** folder. A new window will pop up.
 - Select **SMOC cov.** and then click on **Load**. The footprint of the SDSS-DR12 catalog will be loaded in the main window.
 - Click on the “CDS/V/147/sdss12 MOC” panel. It will appear on top the sky coverage: 14520 sq. deg., 35.198% of sky.

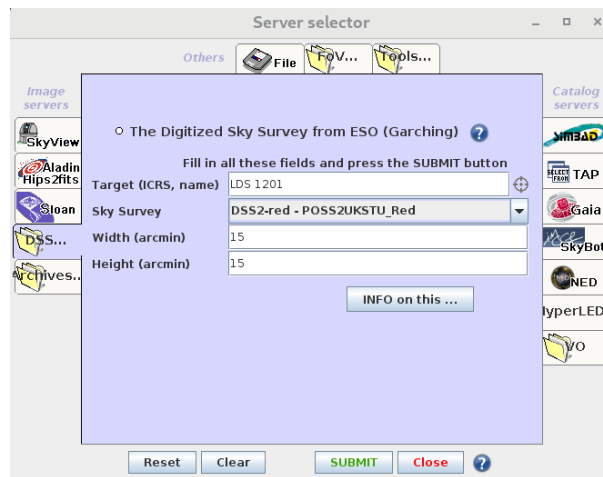


- How to obtain the region of the sky in common between SDSS DR12 and UKIDSS Large Area Survey9 (LAS9):
 - Repeat the same steps to obtain now the UKIDSS LAS9 MOC, typing on the **select** box on the left panel “UKIDSS LAS9” and selecting the “UKIDSS-DR9 Large Area Survey”. Keep marked only **SMOC cov.** to load the MOC.
 - *Coverage* → *Logical operations*. A new window will pop up.
 - Select the “CDS/V/147/sdss12 MOC” and the “CDS/II/319/las9 MOC”, and choose **Intersection**. Click on **Create**. A new plane with the coverage of the intersection of both MOCs will be loaded in the main window with a sky coverage of 3654 sq. deg and 8.86% of the sky.

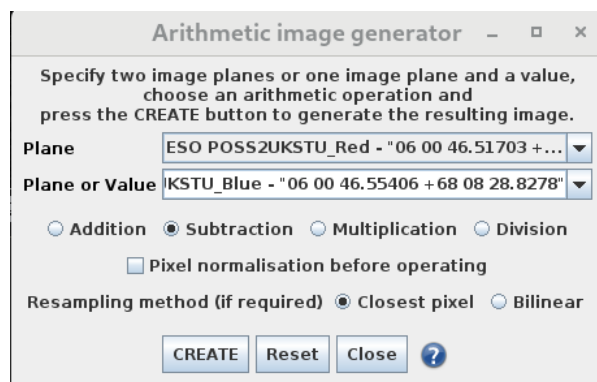


- Arithmetic operations between images.

- *File* → *Open server selector*. A new window will pop up.
- On the left hand side, select *DSS label* and choose *DSS from ESO*.
- Write “LDS 1201” in the **Target (ICRS, name)** box and select *DSS2-red – POSS2UKSTU_Red* in the drop down of **Sky Survey**. Click on **Submit**. The corresponding image will be loaded in the main window.



- In the same Server selector window, select *DSS1 – POSS1_Red and UKSTU_Blue* and click on **Submit**. The corresponding image will be loaded in the main window.
- *Image* → *Arithmetic operation*. A new window will pop up.
- Select the previous loaded images and chose **Subtraction**. Then click on **Create**. A new image named “Sub” with the subtracted image will be loaded in the main window.

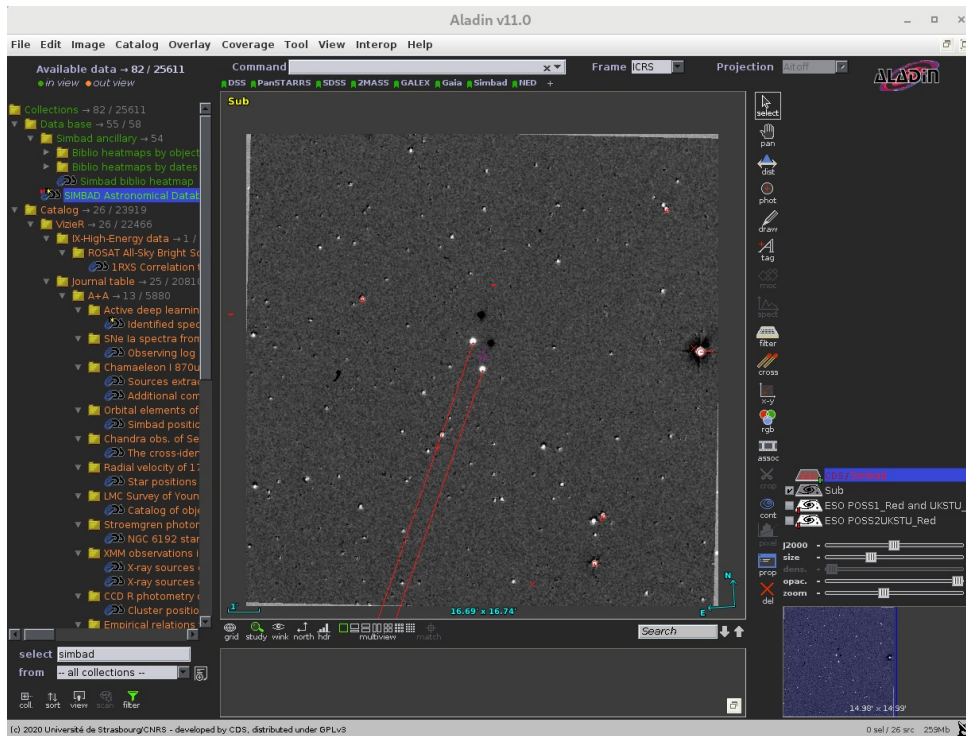


In this case, a high proper motion binary system lies in the center of the image and the position of the components of the system at the observation epochs can be clearly seen.

- You can check the epoch of observation of the images by clicking on the right mouse button over each image and then on “*Properties*”. A new window will

pop up with some basic information of the image. Alternatively, you can press the **prop** button on the right panel of the Aladin main window.

- On the **select** box located in the bottom corner of the left panel type “Simbad”. Select the “*SIMBAD Astronomical Database*” and click **Load**. A new plane named “*CDS/Simbad*” will be loaded. By default, the proper motions of the stars contained in *Simbad* are displayed.



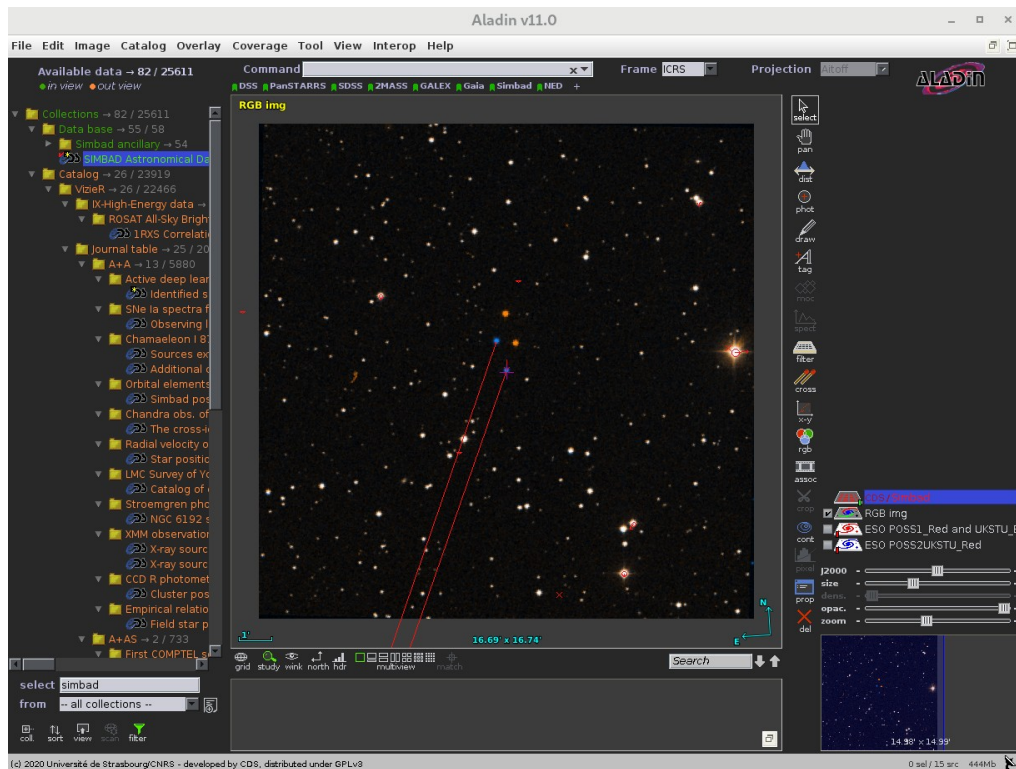
■ RGB builder. Compose an RGB image with Aladin.

- Repeat the first steps in the example above to load the two DSS images centered in “LDS 1201”.
- **Image** → **RGB image builder**. Alternatively, you can press the **rgb** button on the right panel of the Aladin main window. A new window will pop up.
- Select the two previously loaded images and click on **Create**. A new image named “*RGB img*” with the resulting color composed image will be loaded in the main window.

In this case, a high proper motion binary system lies in the center of the image and the position of the components of the system at the observation epochs can be clearly seen.

NOTE: Although the **RGB image builder** is meant to build a three color composed image (red, green and blue), it is also able to build it with only two images, as noted in this example.

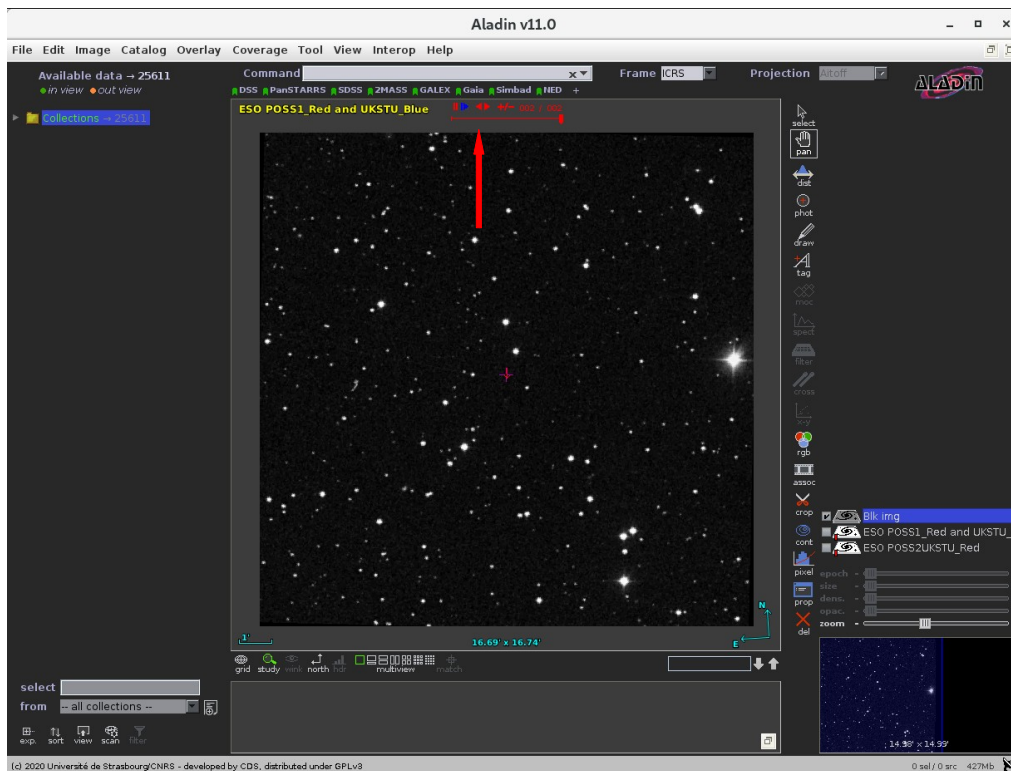
- On the **select** box located in the bottom corner of the left panel type “Simbad”. Select the “SIMBAD Astronomical Database” and click **Load**. A new plane named “CDS/Simbad” will be loaded. By default, the proper motions of the stars contained in *Simbad* are displayed.



■ Blink/movie using images with Aladin.

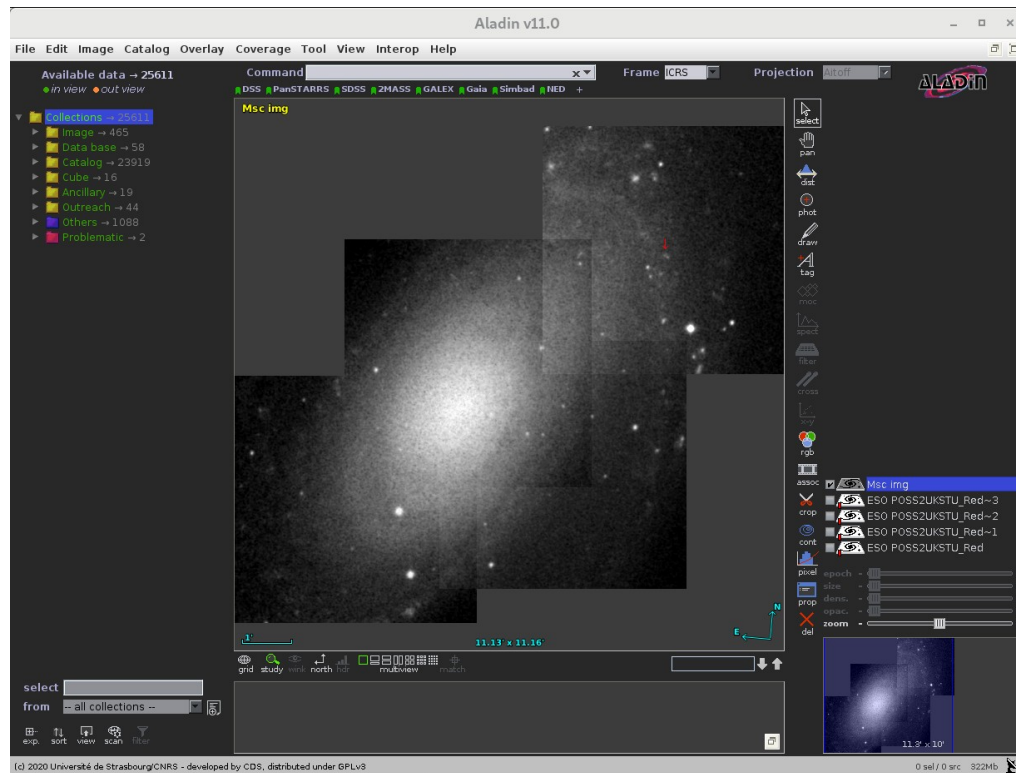
- Repeat the first steps in the example above to load the two DSS images centered in “LDS 1201”.
- *Image* → *Blink/movie generator*. Alternatively, you can press the **assoc** button on the right panel of the Aladin main window. A new window will pop up.
- Select the previously loaded images and make sure that **Blink seq.** is selected at the bottom of the window. Then click on **Create**. A new plane named “Blk img” with the resulting movie will be loaded in the main window.

In this case, a high proper motion binary system lies in the center of the image and the apparent motion of the components can be clearly seen. On the top side of the central panel there are control buttons for the movie to stop, play, move forward/backward...

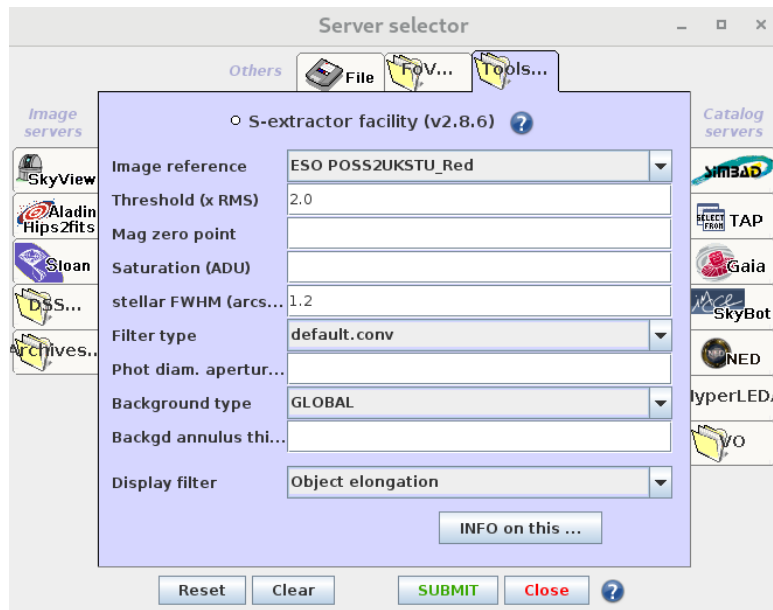


■ **Mosaic builder** using images with Aladin.

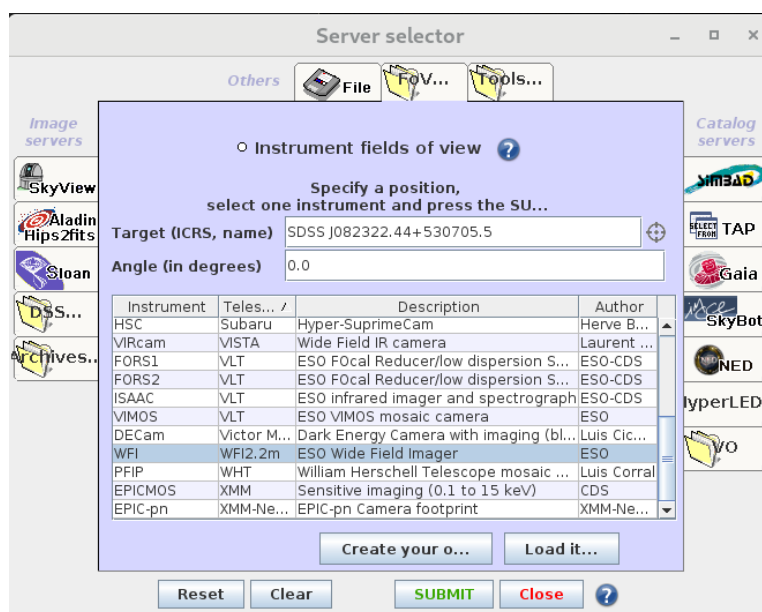
- *File* → *Open server selector*. A new window will pop up.
- On the left hand side, select *DSS* label and choose *DSS from ESO*.
- Write 09 55 55.63423 +69 01 55.9684 in the **Target (ICRS, name)** box and select *DSS2-red – POSS2UKSTU_Red* in the drop down of **Sky Survey**. Change **Width** and **Height** to 5 arcmin. Click on **Submit**. The corresponding image will be loaded in the main window.
- Repeat the previous step with the following coordinates and the same width and height:
 - 09 55 32.07698 +69 04 51.2255
 - 09 55 08.96959 +69 02 57.2765
 - 09 54 49.20075 +69 07 25.5246
- *Image* → *Mosaic image builder*. Alternatively, you can press the **assoc** button on the right panel of the Aladin main window. A new window will pop up.
- Select each of the loaded images and make sure that **Mosaic** is selected at the bottom of the window. Then click on **Create**. A new plane named “*Msc img*” with the built mosaic will be loaded in the main window.

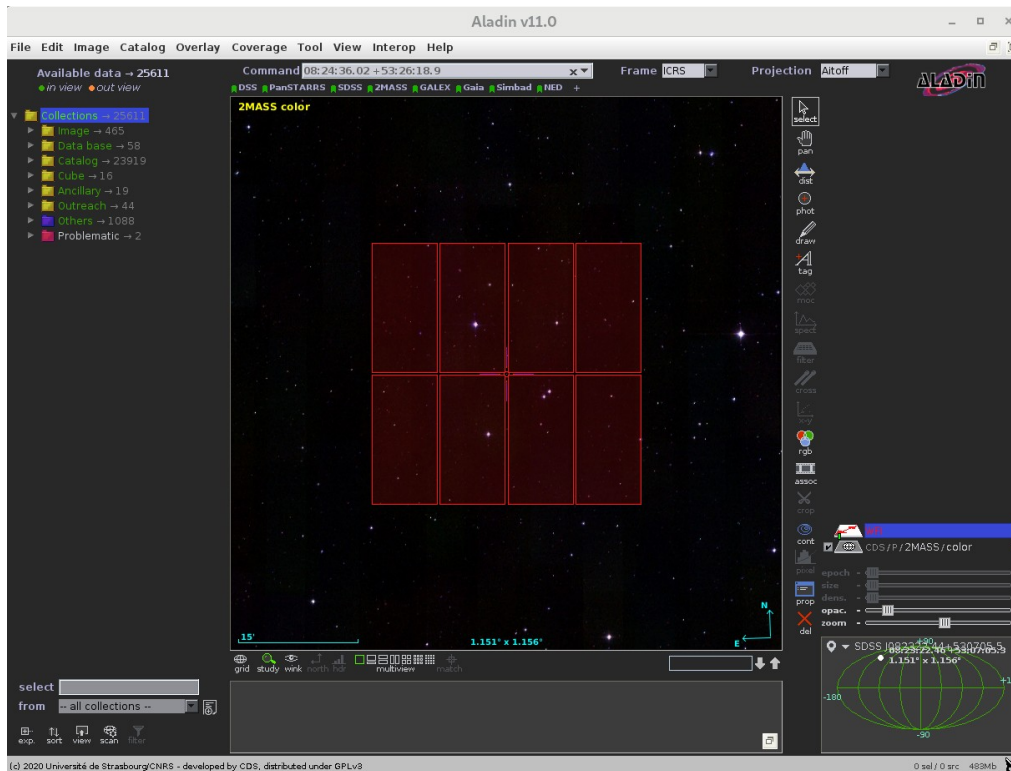


- **SExtractor**: extract astrometry and photometry of a loaded image.
 - *File* → *Open server selector*. A new window will pop up.
 - On the left hand side, select *DSS* label and choose *DSS from ESO*.
 - Write 00:10:15.02 -13:38:05.9 in the **Target (ICRS, name)** box and select *DSS2-red – POSS2UKSTU_Red* in the drop down of **Sky Survey**. Click on **Submit**. The corresponding image will be loaded in the main window.
 - *File* → *Open server selector*. A new window will pop up.
 - Select *Tools* → *S-extractor* on the top labels.
 - Select the loaded image in **Image reference** and click on **Submit**. A new plane named “S-ex ESO POSS2UKSTU_Red” with the extracted source catalog will be loaded in the main window.

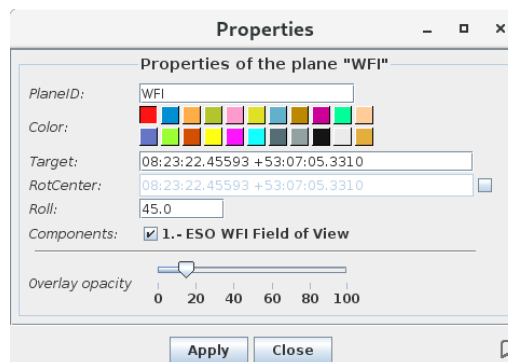


- Display instruments **Field of Views**, useful to check whether one or another instrument's FoV covers the desired region.
 - On top of the central panel, click “2MASS” just below the **Command** box. This will load the HIPS 2MASS survey.
 - Write SDSS J082322.44+530705.5 in the **Command** box to center the view around that object. Zoom in by using the scroll button on your mouse.
 - **File** → **Load instrument FoV**. A new window will pop up.
 - Write SDSS J082322.44+530705.5 in the **Target (ICRS, name)** box and select **WFI**. Click on **Submit**. A new plane named “WFI” with the WFI FoV will be loaded in the main window.





Try to change the **Angle** in the FoV window to change the rotation of the displayed FoV. You can also modify it on the current view by clicking on the **prop** button on the right panel of the Aladin main window. In the Properties window, you can change the angle in the **Roll** box.



- Many other functionalities are available, like:
 - Astrometric calibration: *Image* → *Astrometrical calibration*
 - Visualization of 2, 4, 9 or 16 panels (images) with the possibility of matching views (unifying sizes and orientation): *View* → *Panels*
 - Generate a MOC from a loaded catalog: *Coverage* → *Generate a spatial MOC based on*
 - Export images: *File* → *Export the current view (EPS)...*
 - Export planes: *File* → *Export planes (FITS, VOTable...)*
 - Save the current session: *File* → *Backup the stack*
 - ...

NOTE: We refer the user to the [F.A.Q](#) section of Aladin for details on these and other functionalities. A manual on the use of Aladin is available [here](#) (in english).