SOFIA Help

Table of Contents

SOFIA Science Data Archive: Overview

The SOFIA Science Data Archive at IRSA is the repository for all data collected by SOFIA. The archive has data from most instruments (EXES, FIFI-LS, FLITECAM, FORCAST, FPI+, GREAT, HAWC+), Cycles 1 through Cycle 9, with some data from pre-Cycle 1. (More information below.)

Note that there are also SOFIA Science Data Archive video tutorials, available at the IRSA YouTube channel. Look for the playlist collecting all the SOFIA videos in one place.

Contents of page/chapter:

Background

SOFIA was an 80/20 partnership of NASA and the German Aerospace Center (DLR), consisting of an extensively modified Boeing 747SP aircraft carrying a 2.7-meter (106 inch) reflecting telescope (with an effective diameter of 2.5 meters or 100 inches). The aircraft was based at NASA's Armstrong Flight Research Center in Palmdale, California. The SOFIA Program Office was at NASA Ames Research Center in Moffett Field, California, which managed SOFIA's science and mission operations in cooperation with the Universities Space Research Association (USRA; Columbia, Maryland.) and the German SOFIA Institute (DSI; University of Stuttgart).

More information about SOFIA and its instrument suite can be found at the SOFIA mission page at IRSA, specifically :

- the data page, which includes handbooks and the list of known issues with SOFIA data;
- the instruments page, which includes pages for each of the SOFIA instruments.

Terminology, Hints, and Tips

Telescope & Data Terminology

◊ **Mission ID** is a unique mission identifier. In the SOFIA framework, a mission is the same as a SOFIA flight. (List of all the SOFIA Mission IDs in the SOFIA Science Data Archive, retrieved via TAP.)

◊ **Flight Series** means a grouping of missions (flights) close in time where SOFIA originates from the same airfield and the same instrument is used.

◊ **Plan ID** is the identifier for the observing plan which contains all the observations (AORs). Each accepted observing program has a Plan ID; this can be thought of as basically a proposal ID. (List of all the SOFIA Plan IDs in the SOFIA Science Data Archive,retrieved via TAP.)

- ◊ **AOR** is astronomical observation request, an individual SOFIA observation sequence. Each AOR involves many frames, and therefore multiple files.
- ◊ **AOR ID** is the AOR identifier. The AOR ID is assigned during the creation of the final version of an AOR to be used in flight. Multiple observations in one or more flights and/or instrument configurations can be associated with a single AOR.
- ◊ **Observation ID** is the combination of Mission ID and AOR ID, which together uniquely identifies each SOFIA observation. An observation will contain multiple data files. AOR ID by itself is not sufficient since some AORs are spread across multiple flights.

In practice, during a SOFIA mission (or flight), several Plan IDs (or programs) are executed, and each of these consist of one or more AORs.

The Mission ID, Plan ID, and AOR ID are metadata that can be found in the header of an AOR file.

Data levels

- ◊ **Level 0:** raw data in FITS format.
- ◊ **Level 1:** raw data in FITS format.
- ◊ **Level 2:** data corrected for instrument artifacts (e.g., flat-fielded, dark-subtracted, bad pixels removed).
- ◊ **Level 3:** flux calibrated and telluric corrected data (e.g., units of Jy/pix).
- ◊ **Level 4:** Any data product generated from the combination of Level 3 files (e.g., a mosaic) is a Level 4 product. For most instruments, Level 4 products could be generated from observations obtained across multiple flights, or even multiple flight series and observing cycles.

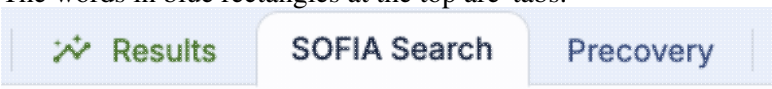
Note that not all instruments will have all data levels, and not every flight will have data from every level. The following are the expected data levels, at most, from each instrument:

- ◊ EXES: 0, 1, 2, 3
- ◊ FIFI-LS: 1, 2, 3, 4
- ◊ FLITECAM: 0, 1, 2, 3
- ◊ FORCAST: 1, 2, 3, 4
- ◊ FPI+: 1, 2, 3, 4
- ◊ GREAT: 1, 3, 4
- ◊ HAWC+: 0, 2, 3, 4

For much more information, see the SOFIA data processing page.

Tool Terminology

The words in blue rectangles at the top are 'tabs.'



This icon in the upper left  pulls open a "drawer" from the left hand side which enables you to add or remove tabs from this top level (see below). Most of these tabs allow searching. The side drawer also can allow you to change the appearance (dark or light mode) (see below).

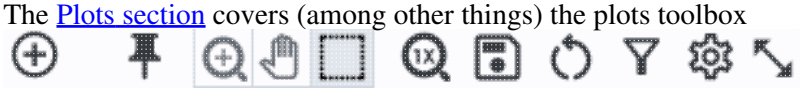
When you have results loaded into the SOFIA Archive, your browser window is divided into "**panes**", like "window panes." The contents of the panes depends on what you are doing with the tool, but could include an image pane, at least one table pane, and/or a plot pane. You can expand any of the window panes by clicking on the expand icon: 

Each of the three main kinds of 'panes' in the display has its own toolbox in its upper right corner which operates on things in that pane, and the basic functionality for each of these panes is covered elsewhere

in this document:

◊ The Tables section covers (among other things) the tables toolbox

◊ The Plots section covers (among other things) the plots toolbox



◊ The Visualization section covers (among other things) the images toolbox

In the SOFIA Archive, you can search by position or orbital parameters for moving targets, or any of a number of other SOFIA-specific searches. Searching is in its own section.

Instruments & Data Available, and Caveats

Data currently in the SOFIA Science Data Archive

Data from most instruments (EXES, FIFI-LS, FLITECAM, FORCAST, FPI+, GREAT, HAWC+), Cycles 1 through Cycle 9, are available in the SOFIA Science Data Archive.

Cycle dates and instruments: Which data are in the SOFIA archive?

Not all instruments, all cycles are in the SOFIA Science Data Archive. The table summarizes which data are in the Archive. (DNE means does not exist, e.g., data do not exist for this instrument in this cycle.) HIPO data are available here.

Cycle	Observation dates	EXES	FIFI-LS	FLITECAM	FORCAST	FPI+	GREAT	HAWC+	HIPO	Schedule/ Flight Plans link
Short Science	12/10 -04/11	DNE	DNE	DNE	No	DNE	Yes	DNE	DNE	...
Basic Science	05/11 - 12/11	DNE	DNE	DNE	No	DNE	Yes	DNE	DNE	...
Cycle 0	07/12 - 11/12	DNE	DNE	DNE	No	DNE	Yes	DNE	here	...
Cycle 1	04/13 - 02/14	DNE	DNE	Yes	Yes	DNE	Yes	DNE	here	here
Cycle 2	02/14 - 02/15	Yes	Yes	Yes	Yes	DNE	Yes	DNE	here	here
Cycle 3	03/15 - 12/15	Yes	Yes	Yes	Yes	Yes	Yes	DNE	here	here
Cycle 4	02/16 - 02/17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	DNE	here
Cycle 5	02/17 - 11/17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	here	here
Cycle 6	05/18 - 03/19	Yes	Yes	DNE	Yes	Yes	Yes	Yes	DNE	here
Cycle 7	04/19 - 03/20	Yes	Yes	DNE	Yes	Yes	Yes	Yes	DNE	here

Cycle	Observation dates	EXES	FIFI-LS	FLITECAM	FORCAST	FPI+	GREAT	HAWC+	HIPO	Schedule/ Flight Plans link
Cycle 8	08/20 - 06/21	Yes	Yes	DNE	Yes	Yes	Yes	Yes	DNE	here
Cycle 9	07/21 - 09/22	Yes	Yes	DNE	Yes	Yes	Yes	Yes	DNE	here

◊ List of all the SOFIA Mission IDs in the SOFIA Science Data Archive (retrieved via TAP)
◊ List of all the SOFIA Plan IDs in the SOFIA Science Data Archive (retrieved via TAP)

All proprietary periods have expired. All the data in the archive are public.

Not in the archive:

Some early data through Cycle 0 are not in this archive.

◊ HIPO data are available here
◊ FORCAST commissioning data are available here
◊ Commissioning data for EXES, FIFI-LS, and HAWC+ are available here

More data?

Some teams may still plan to deliver reprocessed or high-level products to IRSA; with a few exceptions, those kinds of deliveries will, in general, be treated as Legacy deliveries and therefore be linked from the SOFIA mission page, and the data available through tools like the Data Collection Explorer.

Specific items, caveats, etc. to keep in mind

General information

- In an all-sky search, some columns in the result table have missing PLAN ID (i.e., PLAN ID= unknown). These are typically calibration observations.
- In an all-sky search, many rows of the result table have the Proposal PI column blank. These are typically calibration observations but may also be data products combining many different observations.
- Some observation dates are erroneously set to 1970.
- Data that are not public have release dates that are the actual, future release dates. Data that are aleady public may have the most recent processing date, as opposed to the date that the original observations actually went public.
- Some AOR ID and Plan ID are erroneously set to obviously incorrect values.
- Some positions, especially in the earliest data, have larger uncertainties. Recommend larger search radii to be sure you're catching all the relevant observations.
- The Preview tab in the results is only populated for (some) GREAT, FIFI-LS, and HAWC+ Level 4 products, and other instruments (or low level data for any instrument) will have a blank "No Preview Available." This is working as intended.
- When NAIF ID appears to conflict with Target Name, believe the NAIF ID. This is most common for some of the calibration AORs.
- Some data may only be available at Level 1 if they were never processed beyond that level.
- If the Observation Type is not OBJECT, do not not necessarily believe the Target or NAIF ID fields; it could be, e.g., flatfields at a completely different position (not the stated target).
- On searching for occultation observations: there are two choices. Easier: use the precovery search. Search for the occulter of interest, and look for results with target_moving = 0, which is equivalent to no NAIF_ID. Harder: do an all-sky query and filter the results by the object name of the occulter you're interested in (example:

Titan). Results for that object but with no NAIF_ID are likely occultations, since the telescope was pointing at a sidereal target. You can confirm by looking at the proposal abstract in the AOR tab (example: 06_0160).

- The GUI filtering menu for Product Type considers blank fields to be "NULL" (for example, FLITECAM raw data), which seems a bit misleading but is working correctly (this is a feature not a bug).

EXES

- EXES started operations in 2015, so no data are available before that date.
- Level 1 raw files have no Product Type; Level 2 files have Product Type "raw".
- The EXES instrument does not have Level 4 data products, so an all-sky query for EXES Level 4 returns no results.
- Peculiar values for spectral resolution indicate calibration files.

FIFI-LS

- FIFI-LS started operations in 2014, so no data are available before that date.
- Peculiar values for spectral resolution are shown here as propagated from the FITS headers.
- Level 4 wxy_resampled, HDU 10, display shows pixels in units of Jy even though it's a coverage map.

FLITECAM

- FLITECAM was retired in 2018, so no data exist after that date for this instrument.
- The blank spectral resolution for FLT_A1_LM (energy bounds 4.4-5.53 microns) is working as intended; the Observer's Handbook doesn't list R for that combination of grism and order sorting filter.
- The FLITECAM instrument does not have Level 4 data products, so an all-sky query for FLITECAM Level 4 returns no results.
- OC1E FLITECAM data is only Level 1, so there is no Level 2/3.
- Some data products may be included in the download that according to the Data Handbook should not have been saved or archived.

FORCAST

- The FORCAST instrument only rarely has Level 4 data products, so an all-sky query for FORCAST Level 4 returns relatively few results.
- The cross-dispersed modes, X-, were not used in Cycle 4 and Cycle 5, so an all-sky query for FORCAST, GRISM, FOR_XG063 or FOR_XG111, returns 0 results.
- The FORCAST definition of SW and LW cameras is fluid so a few short wavelengths (such as 6.4 micron and 11.2 micron) fall under the LW category. This should not surprise the user. A complete definition of SW and LW cameras is provided in the Observer's Handbook, which can be found on the Proposal Documents page.
- Users should be aware that in the FORCAST query menu, the second number that appears on the Spectral Element menu is the filter width (in microns) of a given filter. This is not the same as the spectral resolution, which is the quantity provided in the FORCAST result tab under "Details". Most spectra are resolution (R)~100; cross-dispersed spectra (XG*) are R~1000. Medium and narrow-band imaging filters can also have a resolution (R~45-70).
- FORCAST footprints in the coverage tab may be larger than expected. NAXIS* and CDELT* are the same for different levels, yet Level 1 is shown with a much smaller footprint than Levels 2-3. The valid data really is a 256x256 square, but the Level 2 coadd has an actual fits header with NAXIS*=656, with the valid data embedded within a square of NaNs. The coverage software sees the 656 pixel dimensions in the actual FITS headers and draws the larger square.
- FORCAST FOR_F086 energy_bounds and spectral resolution may not be populated.

FPI+

- FPI+ started operations in 2015, so data is only available after that date.
- The FPI+ Instrument Team has not generated an instrument handbook, so this is not currently available.

GREAT

- The GREAT instrument does not have Level 2 data products, so an all-sky search for GREAT Level 2 returns 0 results.
- Not all the GREAT data are in FITS format. All the Level 1 data are FITS files, while Level 3 data are tarfiles consisting of CLASS files, and Level 4 can be either CLASS or FITS. (Level 2 data do not exist for this instrument.)
- GREAT Level 4: velocities derived by Firefly are wrong.
- GREAT previews may not exist for all data.
- For the GREAT instrument, a frequency channel is defined as a delta function, not as a Gaussian with a FWHM. This has to be kept in mind when performing a query by frequency. This is not the case for the other instruments.
- Some early GREAT observations have low spectral resolution (~1e3 instead of the usual ~1e7) from a rarely-used continuum mode.
- Some GREAT Line values seem unusual, like an observation of Jupiter with Line="L2_saturn", but those refer to continuum settings originally used on one calibrator but that may sometimes be used on others.
- GREAT files with INSTMODE=CAL have incorrect coordinates, target name, and NAIF ID. Unfortunately the INSTMODE keyword isn't visible to users without downloading the files

HAWC+

- HAWC+ started operations in 2016, so HAWC+ data is only available after that date.
- The raw data from HAWC+ correspond to Level 0 rather than Level 1. (Level 1 is raw for all the other instruments.)
- A few early HAWC+ observations used both band A and B in the same Observation, which results in the band B energy_bounds not being computed correctly since the ingest code sees a band A Observation and doesn't expect or allow for spectral elements to change within an Observation.

Side Menu and Adding to the Tabs Menu

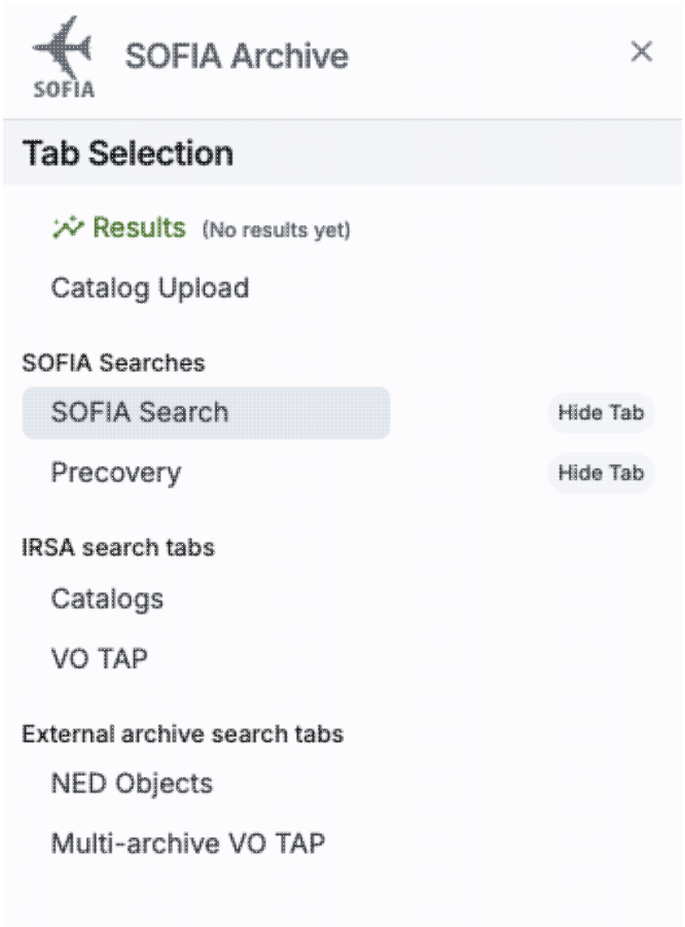
This icon  in the upper left pulls open a "drawer" from the left hand side; the top of it looks like this:

The highlighted bar ("Results" in this example) is the tab you have in the foreground on your main window.

You can use this side menu to add (or remove) blue tabs from the top of your SOFIA Archive interface. By default, Results, SOFIA Search, and Precovery are shown.

Under "IRSA search tabs," Catalogs and VO TAP search IRSA holdings.

Under "External archive search tabs," NED Objects and Multi-archive VO TAP (that is, a general TAP

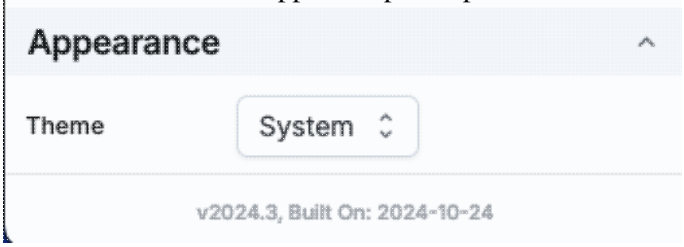


search) search other (non-IRSA) archives.

Click on the "Hide Tab" button to remove that corresponding tab.

Side Menu and Appearance

This icon  in the upper left pulls open a "drawer" from the left hand side; the bottom of it looks like this:



This controls the appearance of the tool in your browser -- do you want it to run as light mode, dark mode, or respect whatever preferences you have set on your system? Try out the different modes; you may have a preference!

User Login

In the far upper right, there is a link to log in. The SOFIA Archive can remember you when you return. (This mattered far more when there was proprietary data.) See the user registration section for more information.

Getting More Help

The "Help" icon  leads you into this online help. There are also context-sensitive help markers throughout the tools (). You can also download a PDF version of this manual; look at the top left of the help window. (The PDF may be easier to search than the web pages; use your PDF reader's search function.)

You can submit questions to the IRSA Help Desk.

A set of frequently asked questions (FAQs) about the SOFIA Archive is here.

The IRSA YouTube channel has lots of short videos about IRSA tools.

Found a bug? The known bugs and issues in this version of the SOFIA Archive are listed here. If you think you have found a bug, before reporting it, please check this list, and read this online SOFIA Archive help. It may be a "feature" we already know about. If you have found a new, real bug, then please do contact us via the IRSA Help Desk. Please include your operating system version and your browser software and version. If you can, please also include any specific error message you may have gotten. (NB: In our testing, copying shortcuts worked on Windows and Linux; the command-C did not always work on Macs, but selecting and clicking the right mouse button often did when command-C did not.)

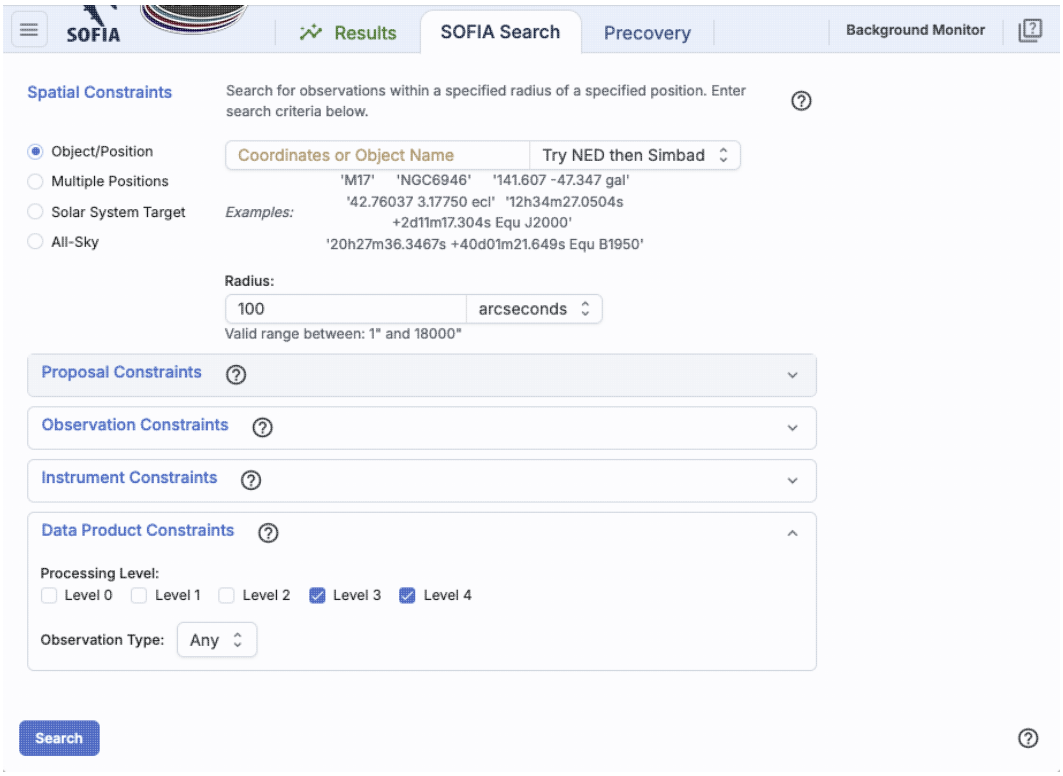
SOFIA Science Data Archive: Searching

This section is an overview of how to search in the SOFIA Science Data Archive. There are several different ways to search. In all cases, after entering your search parameters, click on the blue "Search" button to actually launch the search.

Contents of page/chapter:

Searching by Position (Spatial Constraints)

This search is the most common search performed on astronomical archives. Enter your central position and cone (circle) radius, then all observations (those meeting all the rest of your entered criteria) intersecting that cone are returned.



You may enter a target name, and have either NED-then-Simbad or Simbad-then-NED resolve the target name into coordinates (such as M17 or NGC6946). Alternatively, you may enter coordinates directly. These coordinates can be in decimal degrees or in hh:mm:ss dd:mm:ss format. By default, it assumes you are working in J2000 coordinates; you can also specify galactic, ecliptic, or B1950 coordinates as follows:

- '141.607 -47.347 gal' means 141.607, -47.347 degrees in galactic coordinates
- '42.76037 3.17750 ecl' means 42.76037, +3.17750 degrees in ecliptic coordinates
- '12h34m27.0504s + 2d11m17.304s Equ J2000" specifies the RA and Dec in J2000 coordinates
- '20h27m36.3467s +40d01m21.649s Equ B1950' specifies the RA and Dec in B1950 coordinates

As you are completing a valid coordinate entry, it echoes back to you what it thinks you are entering. Look right below the box in which you are typing the coordinates to see it dynamically change.

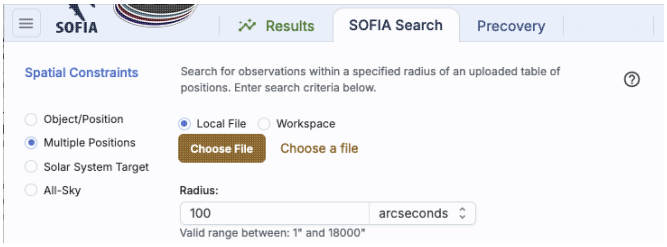
You specify the radius over which you want to search. You may enter this radius in arcseconds, arcminutes, or degrees; just change the drop-down option accordingly.

Tips and Troubleshooting

- Pick your search radius units from the drop-down first, and then enter a number; if you enter a number and then select from the drop-down, it will convert your number from the old units to the new units. There are both upper and lower limits to your search radius; the tool will tell you if you request something too big or too small.
- All options do **not** have to be populated to do a search. Options from the first section can be combined with additional constraints under any other category.
- Specifically because you can populate the rest of the page, if you are experimenting with searching for different things, it is really easy to leave in an inadvertent constraint for an AOR name or a PI name when searching for a different target, for example, resulting in 'no data found' when you know for sure that there are data in the archive for that target. When in doubt, restart the tool to clear all the fields.

Searching by Position in Batch Mode

The position search can also be done for multiple positions in "batch mode" from a list of objects given in a file. Select "Multiple positions" from the left. You can load a file from your local disk or the IRSA Workspace, which is a bit of disk space for you at IRSA.



The file must be in IPAC table file format, which is ASCII text with headers explaining the type of data in each column, separated by vertical bars.

A sample input file looks like this:

```
|              ra|             dec|
|          double|          double|
|             deg|             deg|
 266.461876096161 -28.9303475510113
 317.385694084404 -41.1537816217576
 267.210580557307 -27.7929408211594
 229.172700517754   0.2598861324350
 299.510225672473 -38.7735055243326
 213.945501950887  13.3596597685085
 262.341432853080 -23.7518928284717
 271.202769466020 -21.7274227022229
 291.167629785682 -29.2569222675305
 272.336516119634 -20.2761650442889
 237.391628608612   2.5906013137112
```

As for searching on targets one at a time, from the front screen, you specify the radius over which you want to search. You may enter this radius in arcseconds, arcminutes, or degrees; just change the drop-down option accordingly.

Tips and Troubleshooting

- Pick your units from the drop-down first, and then enter a number; if you enter a number and then select from the drop-down, it will convert your number from the old units to the new units. There are both upper and lower limits to your search radius; the tool will tell you if you request something too big or too small.
- For batch searches, if you want to use a different search radius for each target, add a column to the input table. If the table uploaded has a 'radius' column, the API will overwrite the single radius search and take the one specified in each row in the table.
- So that you can more easily tie results to input, when you get results back from a batch search, the input RA and Dec are columns appended to your results table.
- The maximum number of targets that can be requested in a batch search is 1000.

- It is really, really easy to time out if you search on all instruments for even a few hundred sources. We recommend narrowing your search before uploading a large, unfiltered list to this tool.

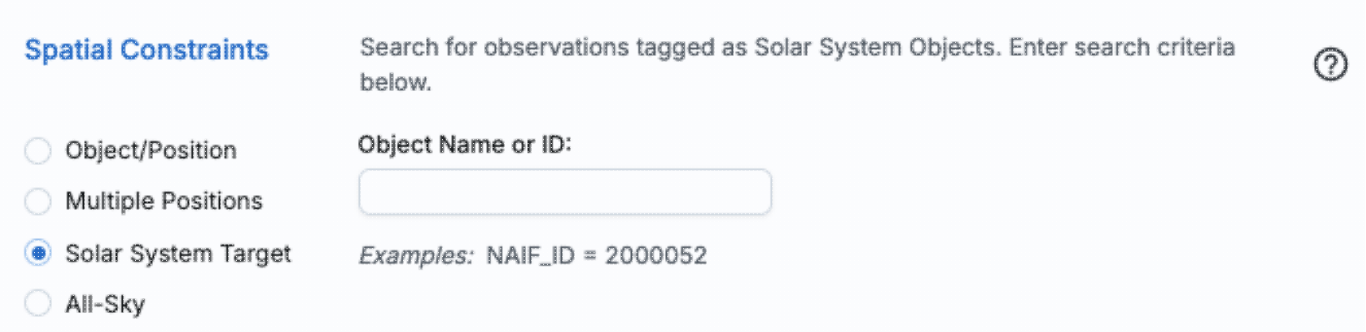
Tips and Troubleshooting: Having problems making a valid IPAC table? Assemble something close to the correct IPAC table file format, then pass it through the the IPAC table validator. The most common errors include the following :

- No hyphens allowed in column names, or filename!
- Column names should be all in lower case
- No empty lines at the end of the input file.
- IPAC table files should end in ".tbl".
- Make sure there are not lots of extra whitespace (spaces, tabs, etc.) at the ends of lines, particularly the header lines.
- Check for and remove odd non-standard characters like curly quotes or Greek letters, and other non-printing special characters (like tabs).
- If using the table verification service, name resolution may fail for some targets with Greek letters or other unusual characters -- provide coordinates for the troublesome names, or remove them.

Searching by Solar System Target (NAIF ID)

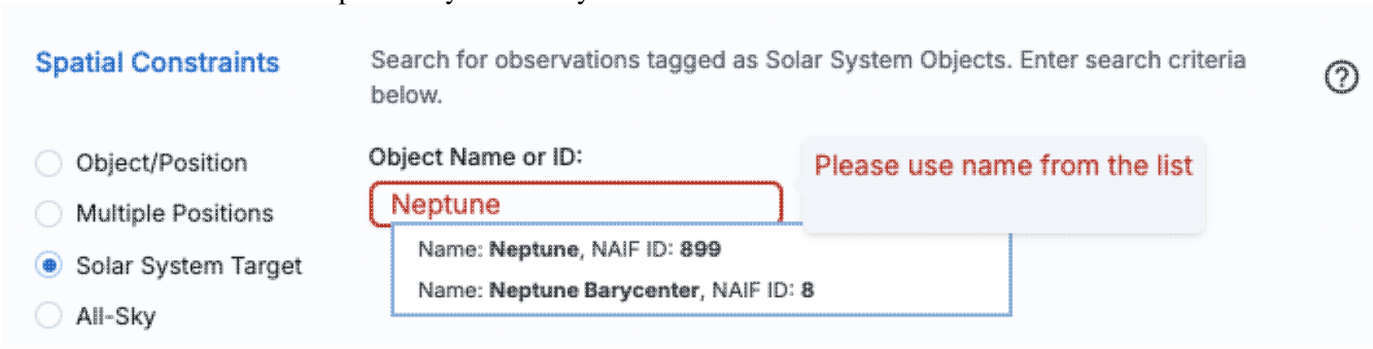
This search will retrieve data explicitly declared to be observations of these moving targets in the SOFIA database -- that is, the telescope 'knew' it was a moving target and tracked on the target. This means, for example, that observations of a moving target performed as a fixed-target observation of an RA/Dec will not appear, nor will serendipitous observations of a moving target that happens to appear in a fixed-target observation. To find such observations, see the section below on "Precovery." Note also that if incorrect target information was entered at the telescope, observations may not be retrieved.

You can search on the name of a moving target (Solar System Object, SSO), but that gets translated immediately to a NAIF ID. The accepted naming conventions are the ones that have been approved for use by the CSBN and its predecessors. SSOs are assigned NAIF IDs, which are a unique integer identifier for known Solar System bodies. (See here or here for more about NAIF and NAIF IDs; in brief, every body in the Solar System has a number.) News reports occasionally use unofficial or unapproved names; you cannot use these names to access objects. For asteroid names, one can enter either the ID number, name or designation, e.g. 2, 887, 1917, Pallas, Alinda, Cuyo, 1981 QB, 1996 GQ, or 2010 CG18. It can also handle names with apostrophes and dashes like O'Connell and Pic-du-Midi. For comet names, one can enter either the whole name e.g. 10P *or* Tempel 2, 73P-B *or* Schwassmann-Wachmann 3, 2009 WJ50, or 2010 D1. (For experts: we are calling this API.)



If you know the NAIF ID, just type that in; if you know only the name, it will attempt to resolve the name for you into a NAIF ID. You may need to wait a second or two. You may need to carefully read what it is

suggesting to make sure you have selected the NAIF ID you really want. For example, Neptune's NAIF ID is different than that for the Neptunian system's barycenter:

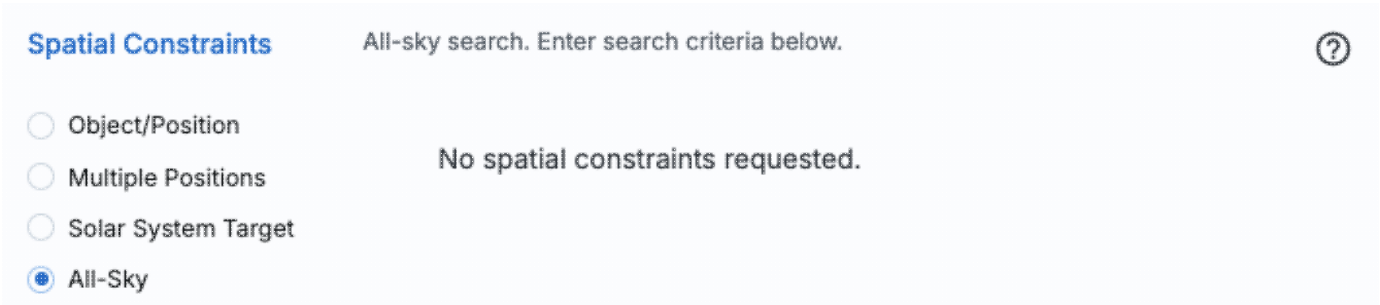


Even if only one suggestion is given, you need to explicitly select that suggestion in order to implement the search.

Searching the Whole Sky (All-Sky Search)

In the search pane, you can also search the entire archive, the whole sky. If you do not impose additional constraints, then you will return all of the data in the archive.

The reason you might want this "all sky" option is because you can, e.g., retrieve all of the observations associated with a program that has observations all over the sky, or return all of the observations associated with a mission (flight), or all of the FORCAST observations. In order to use sensibly the "all sky" option in this fashion, though, you should impose additional constraints (see below). Click on the arrows to expand any of those searches in the search window.



Tips and Troubleshooting

- All options do **not** have to be populated to do a search. However, when doing an all-sky query, to avoid timeouts due to an excessive number of returned observations, we suggest imposing additional constraints -- try asking for only one instrument, or only the highest level products, or only data from a certain observer or year.

Proposal Constraints Search

Click on the arrow to expand the options for this search. Using proposal constraints, you can obtain all of the data associated with a particular observing program or observer. You can constrain this search using the Primary Investigator or Plan ID.

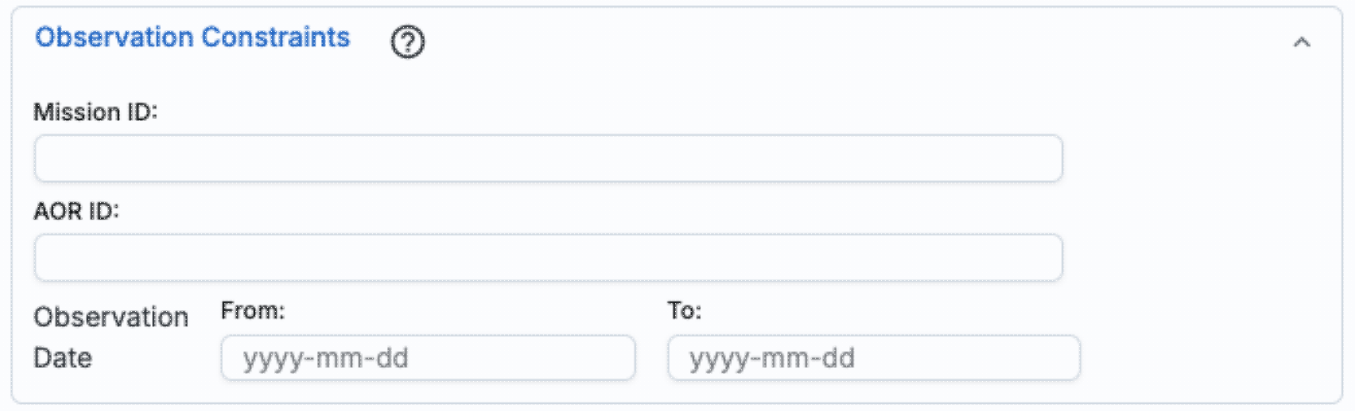
The primary users of this search may very well be observers retrieving data from their own program(s), as follows:

Both fields do **not** have to be populated to do a search.

Tips and Troubleshooting: The PI search is somewhat flexible. If Jane Q. Astronomer submitted a proposal where she entered her name as "Jane Q. Astronomer," then you can find her program by searching on "Jane" or or "Jan" or "Astronomer" or "Astron." (Note that you do not need a wildcard ["*"] character to search on partial strings.)

Observation Constraints Search

Click on the arrow to expand the options for this search. Using observation constraints, you can obtain all of the data associated with a particular mission (flight), AOR, or date range. The primary users of this search are likely to be observers retrieving data from a flight where a given set of observations were included, perhaps to determine if a bright object was observed close in time to another observation.



You can limit the search to be all the data associated with a Mission ID, AOR ID, Plan ID, or observation date range. (For a list of dates corresponding to SOFIA Observing Cycles, see the Overview section.)

Searches over large date ranges will take more time.

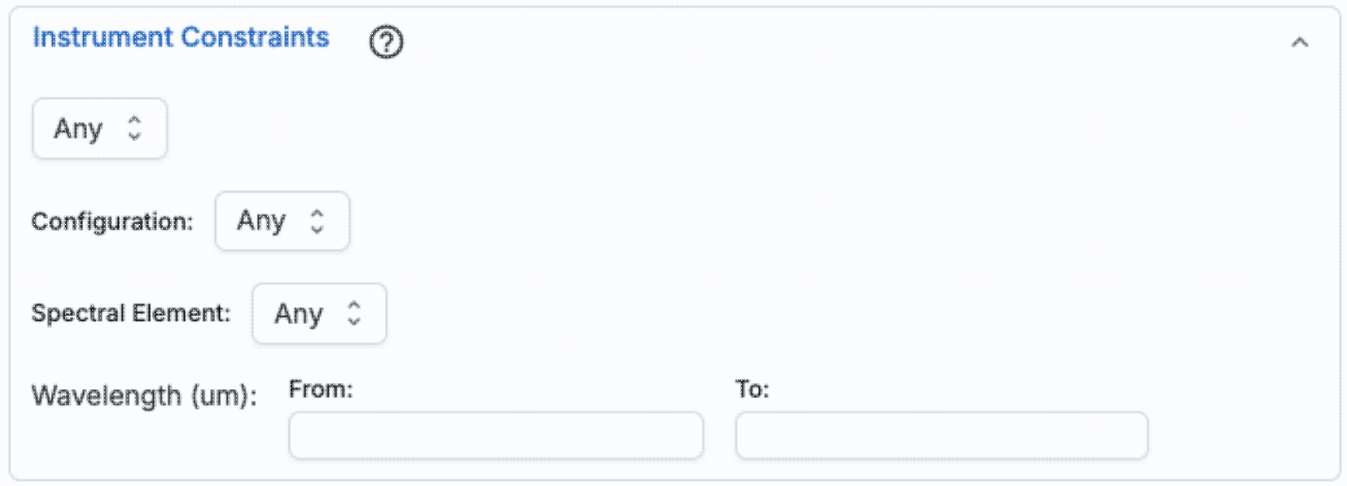
All options do not have to be populated to do a search.

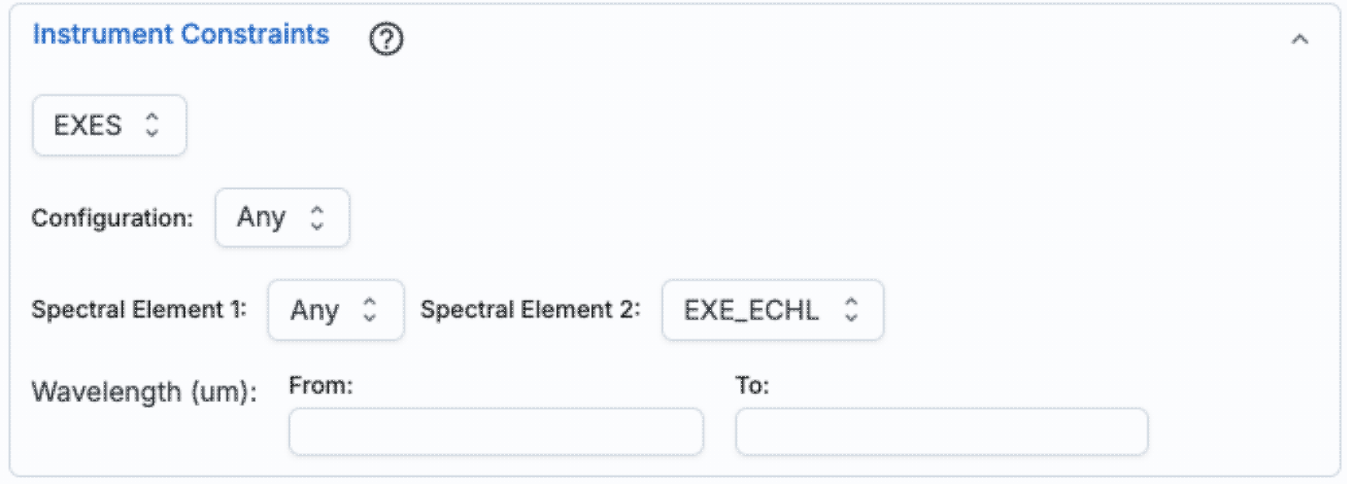
Instrument Constraints Search

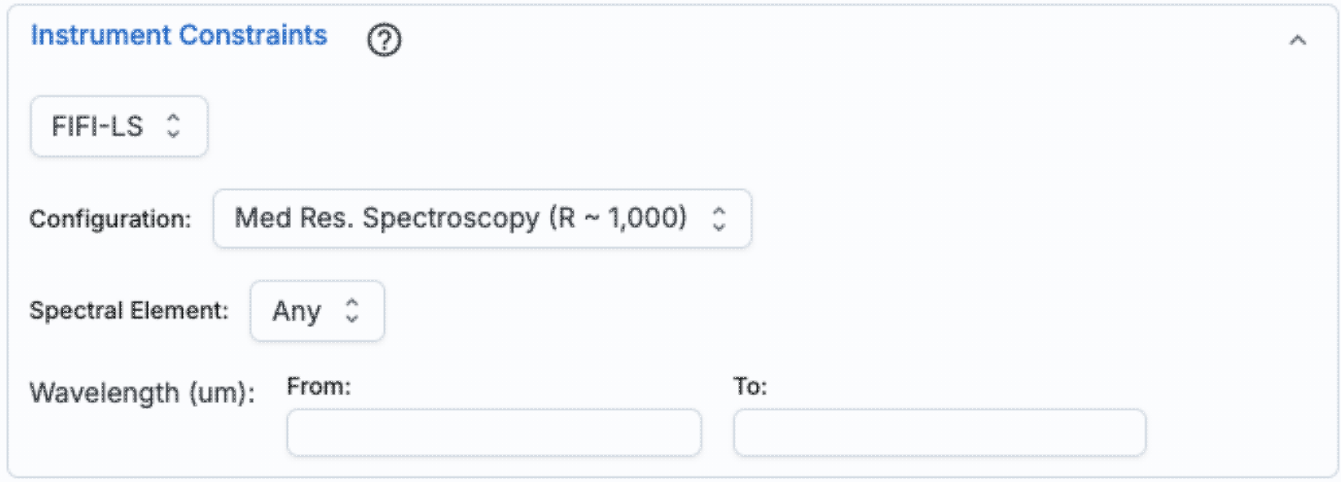
Using instrument constraints, you can obtain all of the data associated with a particular instrument and/or configuration. Users of this option might be trying to find other observations similar to theirs taken on the same mission (flight).

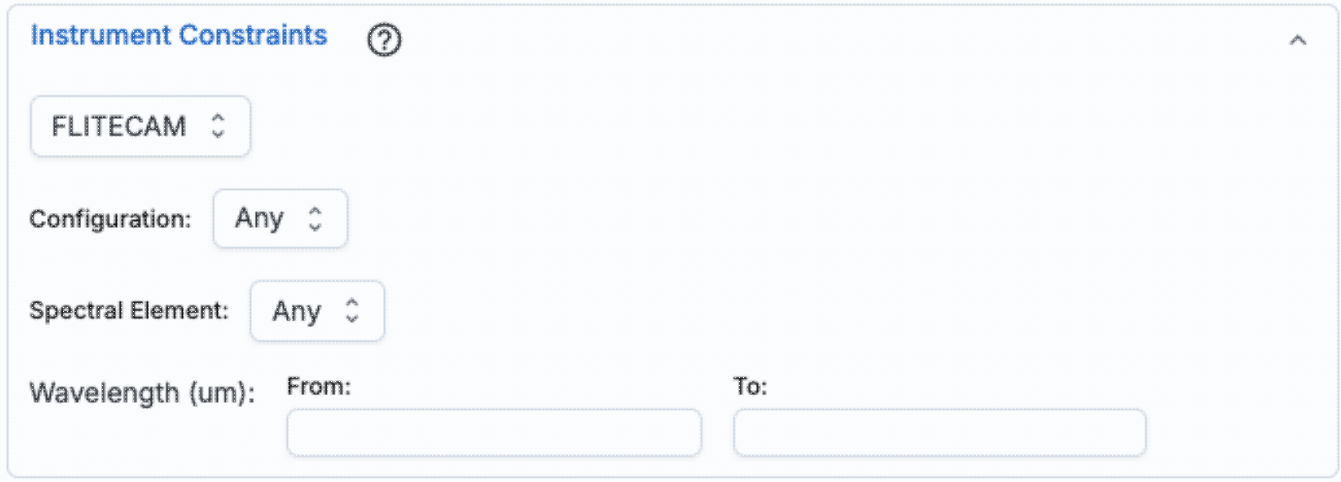
Instrument constraints dynamically change in response to the value chose in the drop-down in this section of the search screen. By choosing a different drop-down, your available choices change to reflect the possible values in instrument constraints for that instrument.

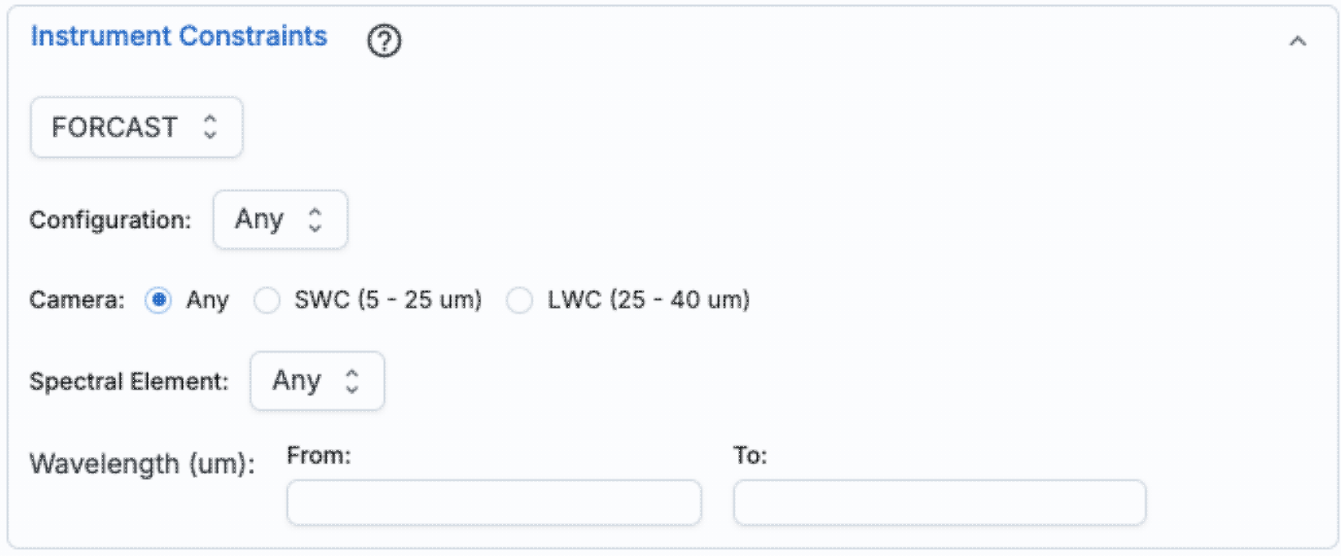
Depending on the instrument, you can ask for any configuration, or different spectral elements, wavelength ranges, etc.

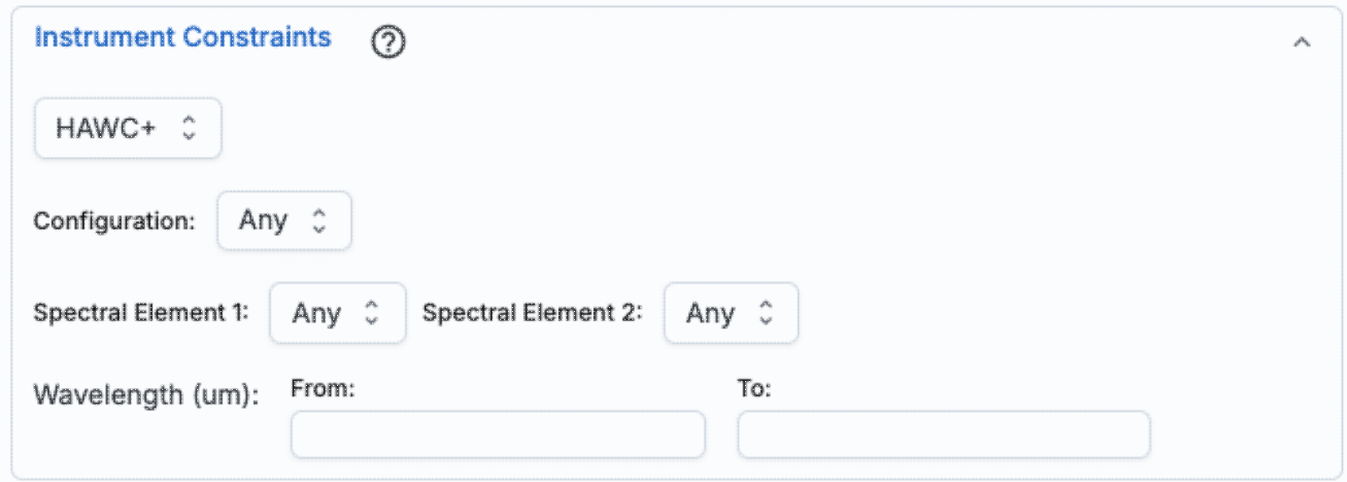





Instrument Constraints
FIFI-LS
Configuration:
Med Res. Spectroscopy (R ~ 1,000)
Spectral Element:
Any
Wavelength (um):
From:
To:


Instrument Constraints
FLITECAM
Configuration:
Any
Spectral Element:
Any
Wavelength (um):
From:
To:

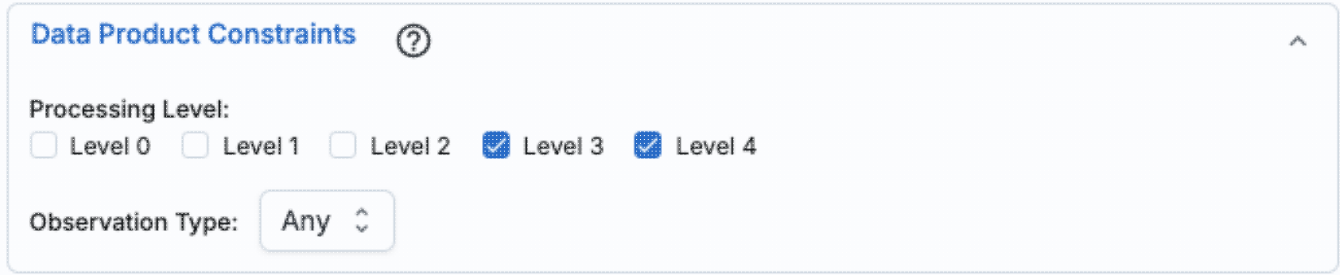

Instrument Constraints
FORCAST
Configuration:
Any
Camera:
Any
SWC (5 - 25 um)
LWC (25 - 40 um)
Spectral Element:
Any
Wavelength (um):
From:
To:



Data Product Constraints Search

Using data product constraints, you can obtain all of the data corresponding to a specific processing level. You might use this, combined with other constraints, to find highly processed data products (level 4) taken of a particular region. (See the overview chapter, specifically the part on data levels, for more information on what

data levels mean.)



You can specify whether you want observations of a particular object ("object" drop-down option), as opposed to calibration data, or just retrieve all data.

Observation type could be any of the following, but is a strong function of which instrument and levels you have selected:

- Any
- Object
- Standard_Flux
- Standard_Telluric
- Flat
- Dark
- Focus loop
- Sky

Abstract Search

The way to use the SOFIA abstract search is to search for projects meeting your search criteria in the abstract search page, make a note of the project primary investigator(s) (PIs) and/or Plan ID(s), and then search for the corresponding proposal(s).

Precovery (Searching for SSOs)

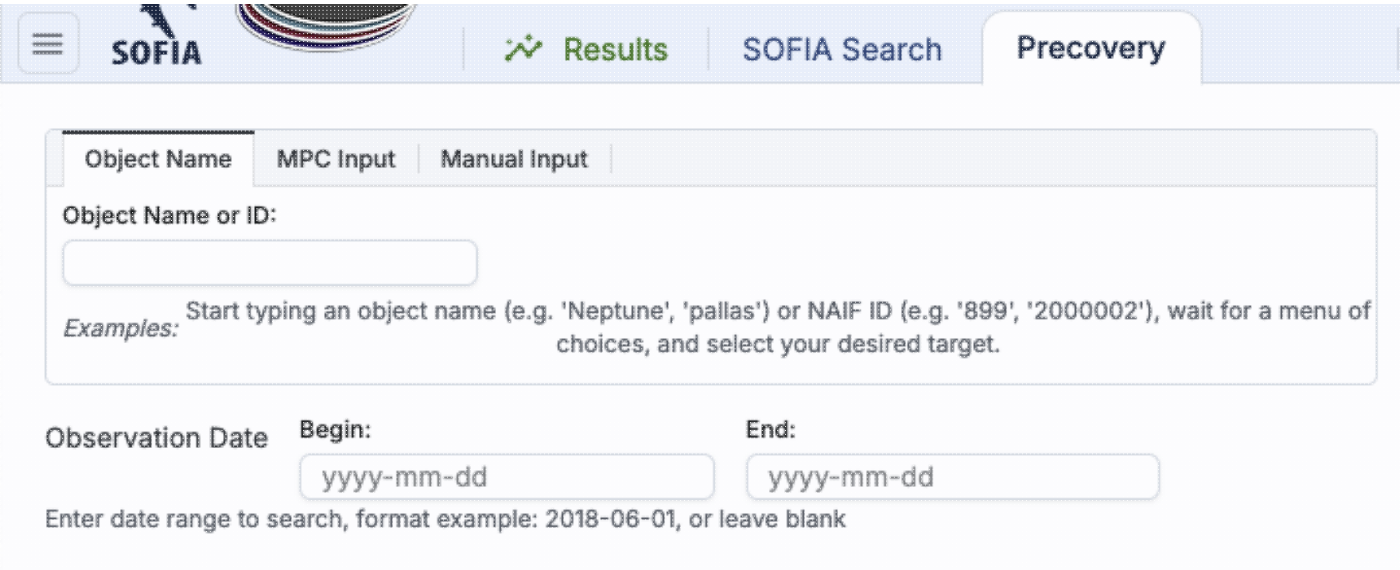
It is also possible to search for specific SSOs in data obtained serendipitously, e.g., observations of a moving target that may appear in a fixed-target observation. (Note that this depends on having accurate orbital parameters and image positions/times to work.) The reason it's called "precovery" is because you can obtain pre-discovery images of a newly discovered object using this approach.

The search can be performed for comets or asteroids using the object name or the six orbital parameters supplied by the user either individually or in the Minor Planet Center (MPC) one-line element format.

What the system is doing is using IRSA's Moving Object Search Tool (MOST), taking the orbital ephemeris (either searching for the ephemeris based on the name that you enter, or taking the orbital information you give it), calculating where the object was over the time range that you request (over the entire mission if date constraints are left blank), identifying the individual exposures in which it calculates that your object should be present, and returning to you all those data.

As a result, **requests over long time baselines can take a long time.** You can make a request that takes so much time that it times out, and you get no search results. In order to shorten search times, ask it to search over a smaller time baseline.

Searching by object name :

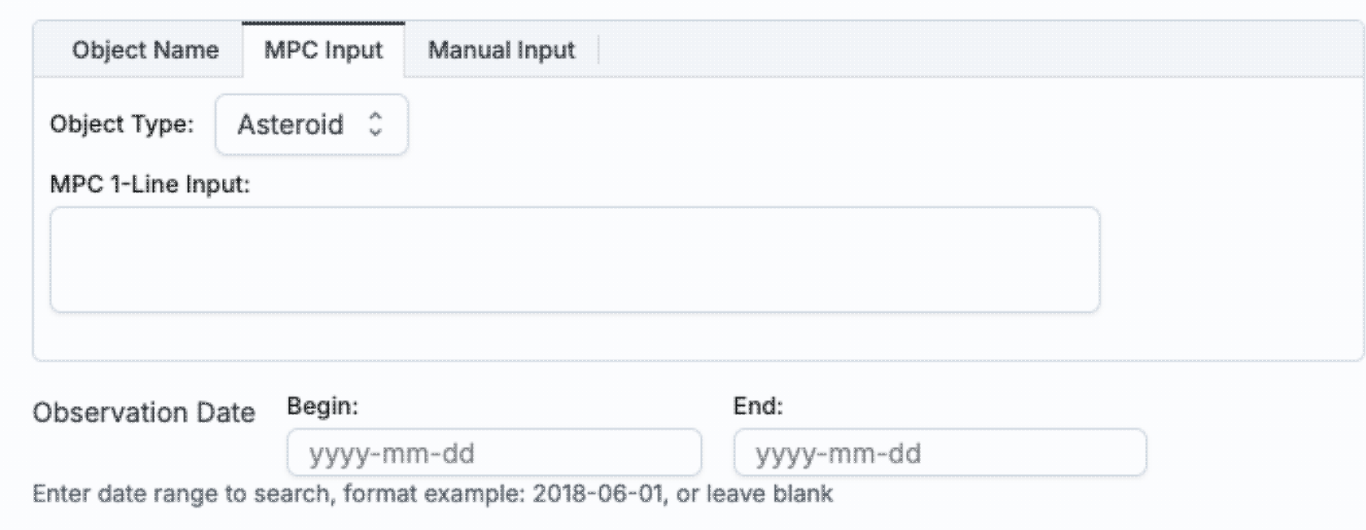


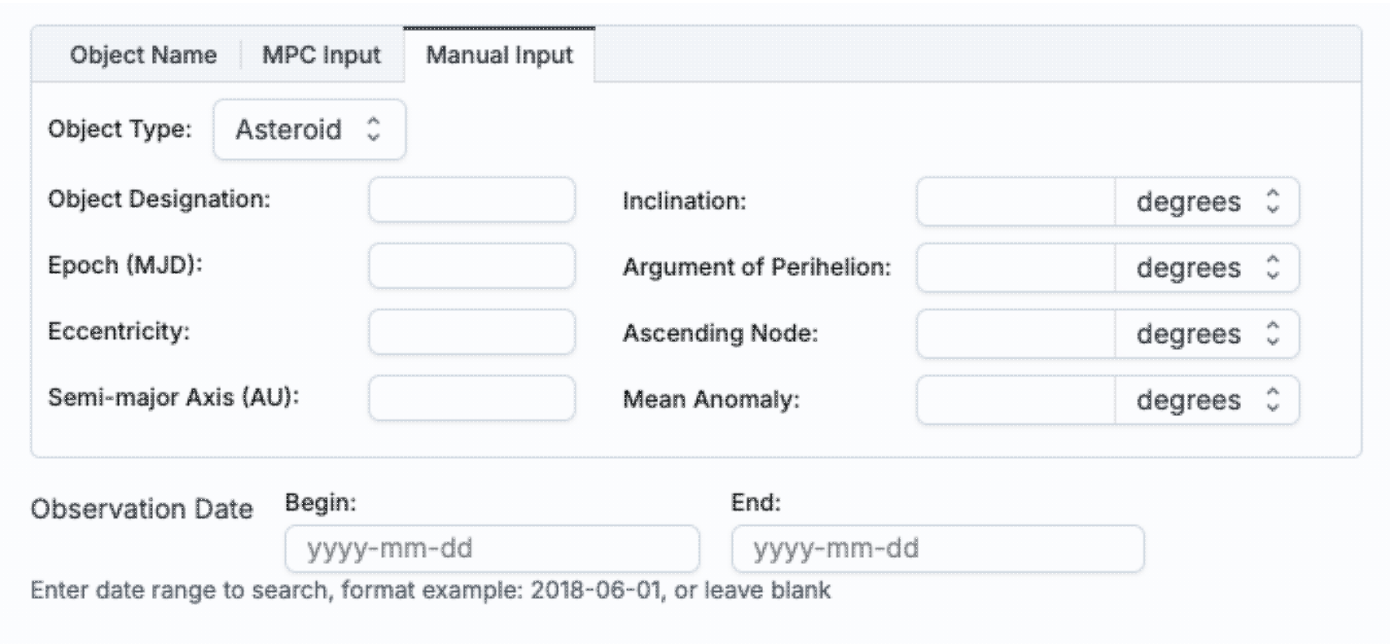
You can search by object names by entering the name in the "Object Name" field. It looks up the NAIF ID for you; select the NAIF ID corresponding to your object. The accepted naming conventions are the ones that have been approved for use by the CSBN and its predecessors. SSOs are assigned NAIF IDs, which are a unique integer identifier for known Solar System bodies. (See here or here for more about NAIF and NAIF IDs; in brief, every body in the Solar System has a number.) News reports occasionally use unofficial or unapproved names; you cannot use these names to access objects. For asteroid names, one can enter either the ID number, name or designation, e.g. 2, 887, 1917, Pallas, Alinda, Cuyo, 1981 QB, 1996 GQ, or 2010 CG18. It can also handle names with apostrophes and dashes like O'Connell and Pic-du-Midi. For comet names, one can enter either the whole name e.g. 10P *or* Tempel 2, 73P-B *or* Schwassmann-Wachmann 3, 2009 WJ50, or 2010 D1. (For experts: we are calling this API.)

Tips and Troubleshooting

- It will take a second or two to turn the name into a NAIF ID. You can't search without a NAIF ID, so please just try to be patient and pick the NAIF ID from the list, even if it just gives you one option.

Searching by orbit (MPC or manual):





The standard six orbital elements for asteroids are *eccentricity (e), semimajor axis (a), mean anomaly (M), inclination(i), longitude of the ascending node ("Node"),* and *argument of perihelion (w)*. For comets, the elements are *eccentricity (e), perihelion distance (q), time of perihelion passage (Tp), inclination(i), longitude of the ascending node ("Node"),* and *argument of perihelion (w)*. Notice that for comets, *perihelion distance* is used instead of *semimajor axis* and *time of perihelion passage* is used instead of *mean anomaly*. The reason for replacing these two parameters is to allow for cases where long period comets have a parabolic or hyperbolic orbit. Other parameters you may see include mean motion (n), absolute magnitude (H), and slope parameter (G). A good description of the orbital parameters is given in JPL's Solar System Dynamics website.

You can search for objects by either inputting the orbital parameters by hand or by using a properly-formatted Minor Planet Center input string. This latter option allows the user to cut-and-paste a line directly from a table of orbital elements in MPC Format into the search field. There are a number of orbital element tables available at the MPC website, for example, observable NEO and observable comets. The complete list of minor planets can be found at the MPC Orbit (MPCORB) Database.

Information on the format of the element tables is given by following sites: minor planet format and comet format.

MPC Element Input Examples (definitions: e=eccentricity, a=semimajor axis, M=mean anomaly, i=inclination, Node=longitude of the ascending node, w=argument of perihelion, q=perihelion distance, Tp=time of perihelion passage, n=mean motion, H=absolute magnitude, and G=slope parameter):

Asteroid: Icarus:

Designation	H	G	Epoch	M	w	Node	i	e	n	a
01566	16.9	0.15	K1128	78.13687	31.35339	88.02734	22.82772	0.8268277	0.88069351	1.0779191

Comet: C/2010 A4 (Siding Spring):

Name/Desig	Tp	q	e	w	Node	i	Epoch	H	G	Name
CK10A040	2010 10 8.7896	2.738033	0.990439	271.6989	346.6856	96.7301	20110208	12.5	4.0	C/2010 A4 (Siding Spring)

Asteroid, truly one line input that can be copied into the search form:

```
00001    3.53  0.15 K20CH 205.54543   73.72487   80.27236   10.58790  0.0781685  0.21424211
```

Comet, truly one line input that can be copied into the search form :

```
CK13X010  2016 04 19.4301  1.324203  1.000478  165.1818  131.5699  163.1947  20210203  10.
```

However, be cautious about using one-line ephemerides for comets, as non-gravitational forces can render them irrelevant rapidly. Searching by object name (C/2013 X1 in this case) is more likely to return results.

Observation Date (Begin and End):

You may provide a time baseline over which the search should be constrained. If left blank, it searches the entire SOFIA archive. **Requests over long time baselines can take a long time.** You can make a request that takes so much time that it times out, and you get no search results. In order to shorten search times, ask it to search over a smaller time baseline.

SOFIA Science Data Archive: Search Results

Results of a search of the SOFIA Science Data Archive appear in two different window panes, each of which could have several tabs.

Contents of page/chapter:

Terminology

Panes

The search results appear in two "panes" (like "window panes"). You can grab and drag the division between the two panes to change their relative sizes. The left is usually tables of search results and the right is usually images (or lists of images, or stuff about images, or plots).

Tips and Troubleshooting

- Note that each new search overwrites the results in the results tab -- that is, a second search doesn't *add* to the results tab; it *replaces* the contents of the results tab. This is different than some other IRSA tools.
- See here for more about the different kinds of instruments and data levels you could have searched for.

General Layout Information

The left pane of the search results contains lists of observations that met your criteria. The right pane of the search results contains more details of the observations. The right pane changes depending on what row you have selected (clicked on) in the left pane.

Left pane

The left pane initially has at least two and up to eight tabs -- one called "AOR" that is a list of AORs, and then one for each instrument you have selected ("instrument tabs"). The columns are different in each tab. Each line includes basic information about the observation(s) which fulfill your search critera.

Each tab is its own table, which behaves in the same way that tables throughout IRSA tools with this look and feel. See the Tables section for more details, but in summary you can change the width of the columns, sort by columns, filter by column values, hide columns, etc.

The AOR tab provides the most compact view of the observations meeting your search criteria. Note that you can scroll to the right and find the following (if applicable): (1) a link to the abstract; (2) a link to any publications; and (3) a link to QA (quality assurance) comments. Note that not all observations have links to all three.

The instrument tabs contain more information than is shown. To "turn on" a column, click on the gears and select the additional columns to show. More information on column selection in general can be found in the tables section.

The corresponding data can be downloaded by checking the box at the start of each row (or the box at the top of the column of boxes to select all) and clicking "Prepare download". (See the section on downloads for more information.)

Depending on what you do after your initial search (load catalogs, extract spectra from the data), you could add more tabs to both the left and the right window pane; see the catalogs section and/or the visualization section.

Right pane

The right pane of the search results contains several tabs that enable exploration of the data returned by your search. Click on a row in the left pane and the contents of the right pane change.

When the "AOR" tab is in the foreground on the left, you only have two tabs on the right: "Coverage" and "Details." Details shows you more information about the observation you have selected. Coverage gives you a visual overview of the observations you have retrieved. After you have viewed the Coverage tab at least once, color swatches appear in each of the instrument tabs on the left; these colors correspond to the colors used in the Coverage tabs.

When any of the instrument tabs are in the foreground on the left, you have 5 tabs on the right:

- ◊ Data - where possible, this shows you the FITS file, data table, and/or plot corresponding to the row you have selected on the left. You can interact with this as with any other image or table or plot. Spectra are complicated and include images, tables, and plots.
- ◊ Preview - especially for cases where the individual data file is not easy to show or may not be representative of the final combined data product, the pipeline may have generated a preview of the final data product (e.g., a png) which can be seen here. This most frequently happens for GREAT and HAWC+ observations, but can be found for some other instruments too.
- ◊ Coverage - a visual overview of the footprints of the observations you have retrieved.
- ◊ Chart - a plot of the table on the left. Initially, this seems very boring, as it is just ra/dec of the retrieved observations, but eventually, you may find spectra or plots from catalogs in this tab. (More information about plots.)
- ◊ Details - more details about the row you have selected.

Tips and Troubleshooting

- ◊ The Coverage image has lots of information as well as some special properties; go here for more information.
- ◊ SOFIA data can be *really* complicated. We have included features in the Data tab to try to make it more human-readable, and we have focused on the higher level products (at the expense of the lower level products). If the Data tab has a File Contents menu, you can use it to explore more fully what is included in that data file. When "Extracted Data" is a choice, the tool is trying to help you with a 'value-added' view of what is in the file, but you can still access the original contents of the file.

About Images

Interacting with images is covered in the visualization section; there are many sophisticated capabilities available.

About Tables

Interacting with images is covered in the tables section. You can manipulate columns and create new columns.

About Plots (or Charts)

Interacting with plots (sometimes called charts) is covered in the plots section. You can make some sophisticated plots.

About Spectra

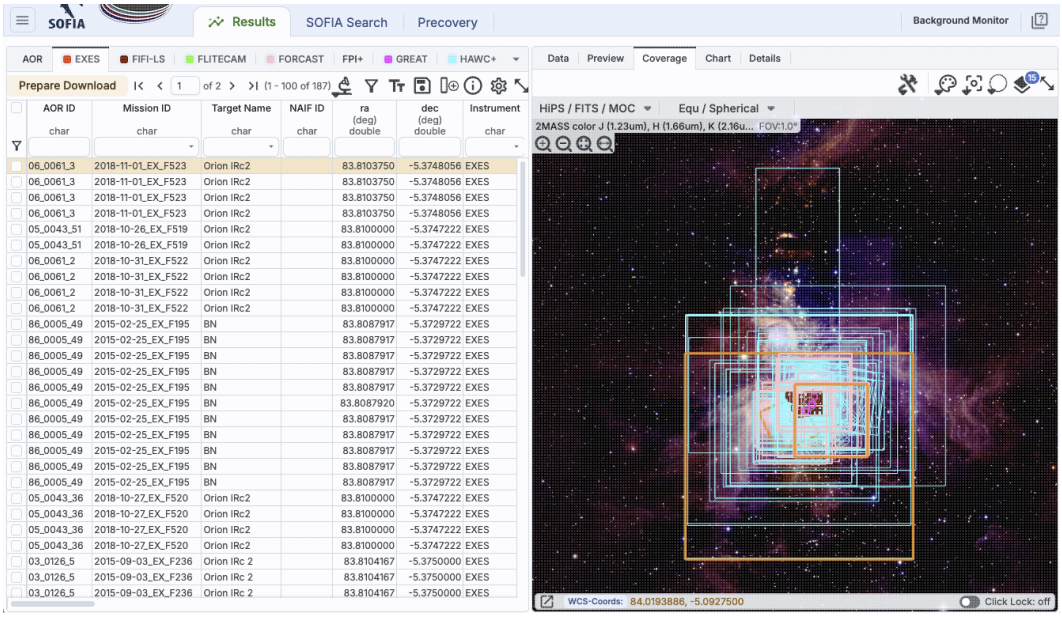
Interacting with spectra in the SOFIA Archive is a special case of images, tables, *and* plots, and as such is covered in the spectra section; there are many sophisticated capabilities available.

About Catalogs

If you load a catalog into the tool, you will create a table and a plot and overlay the catalog on the images. If it is a large catalog, the catalog may be shown as hierarchical cells; see here for more information.

Position Results

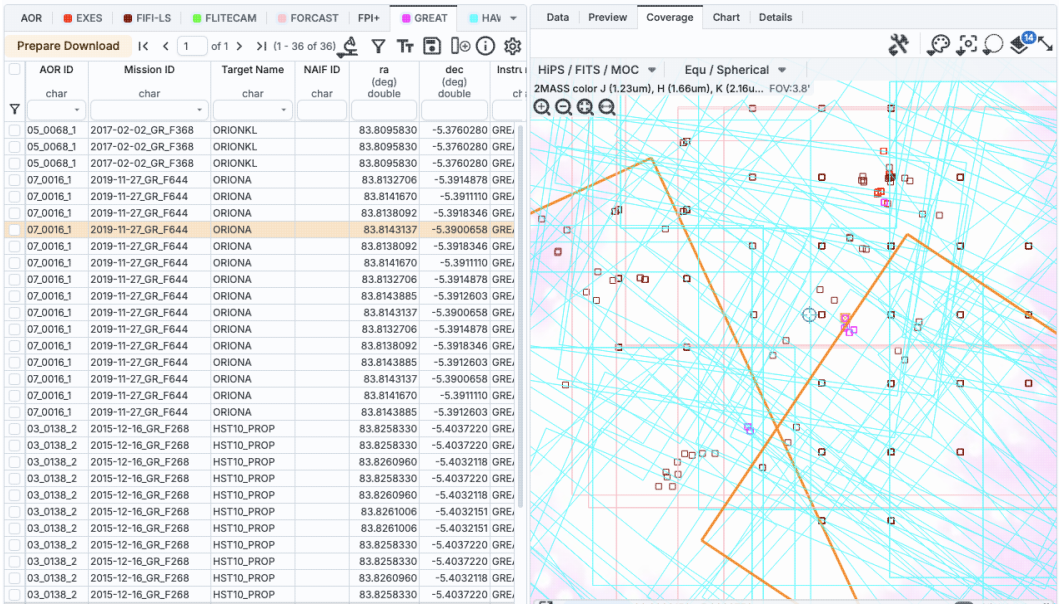
Here is an example of search results for M42, all instruments, all default parameters:



AOR ID	Mission ID	Target Name	NAIF ID	ra (deg)	dec (deg)	Instrument
06_0061_3	2018-11-01_EX_F523	Orion IRc2		83.8103750	-5.3748056	EXES
06_0061_3	2018-11-01_EX_F523	Orion IRc2		83.8103750	-5.3748056	EXES
06_0061_3	2018-11-01_EX_F523	Orion IRc2		83.8103750	-5.3748056	EXES
06_0061_3	2018-11-01_EX_F523	Orion IRc2		83.8103750	-5.3748056	EXES
05_0043_51	2018-10-26_EX_F519	Orion IRc2		83.8100000	-5.3747222	EXES
05_0043_51	2018-10-26_EX_F519	Orion IRc2		83.8100000	-5.3747222	EXES
06_0061_2	2018-10-31_EX_F522	Orion IRc2		83.8100000	-5.3747222	EXES
06_0061_2	2018-10-31_EX_F522	Orion IRc2		83.8100000	-5.3747222	EXES
06_0061_2	2018-10-31_EX_F522	Orion IRc2		83.8100000	-5.3747222	EXES
06_0061_2	2018-10-31_EX_F522	Orion IRc2		83.8100000	-5.3747222	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087920	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
86_0005_49	2015-02-25_EX_F195	BN		83.8087917	-5.3729722	EXES
05_0043_36	2018-10-27_EX_F520	Orion IRc2		83.8100000	-5.3747222	EXES
05_0043_36	2018-10-27_EX_F520	Orion IRc2		83.8100000	-5.3747222	EXES
05_0043_36	2018-10-27_EX_F520	Orion IRc2		83.8100000	-5.3747222	EXES
05_0043_36	2018-10-27_EX_F520	Orion IRc2		83.8100000	-5.3747222	EXES
03_0126_5	2015-09-03_EX_F236	Orion IRc 2		83.8104167	-5.3750000	EXES
03_0126_5	2015-09-03_EX_F236	Orion IRc 2		83.8104167	-5.3750000	EXES
03_0126_5	2015-09-03_EX_F236	Orion IRc 2		83.8104167	-5.3750000	EXES

The many cyan polygons are HAWC+ observations.

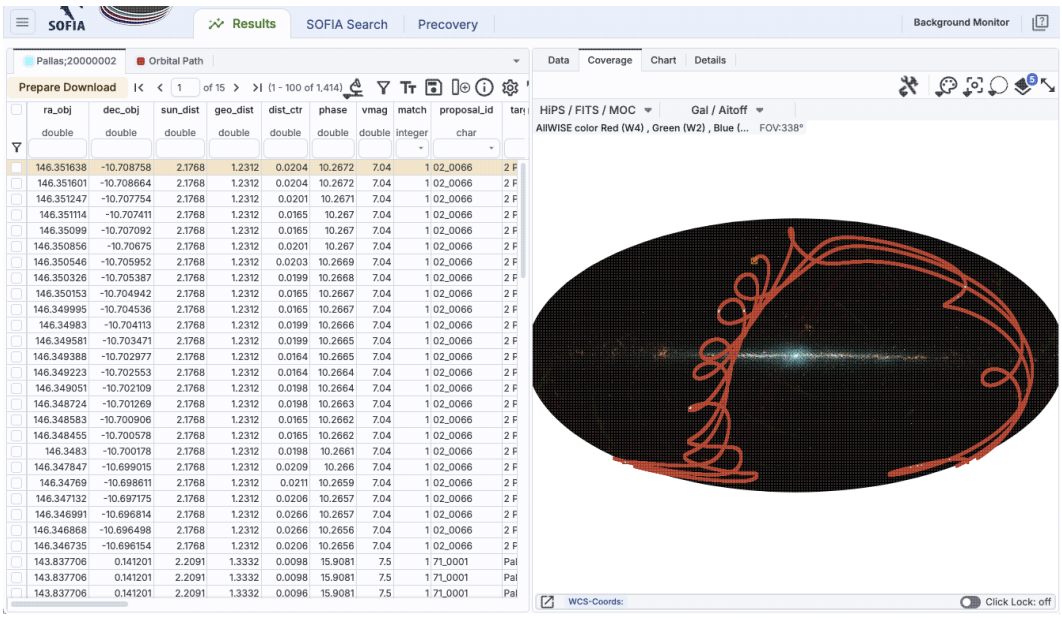
Zooming in very close, you can see the individual pointings for EXES, FIFI-LS, and GREAT observations:



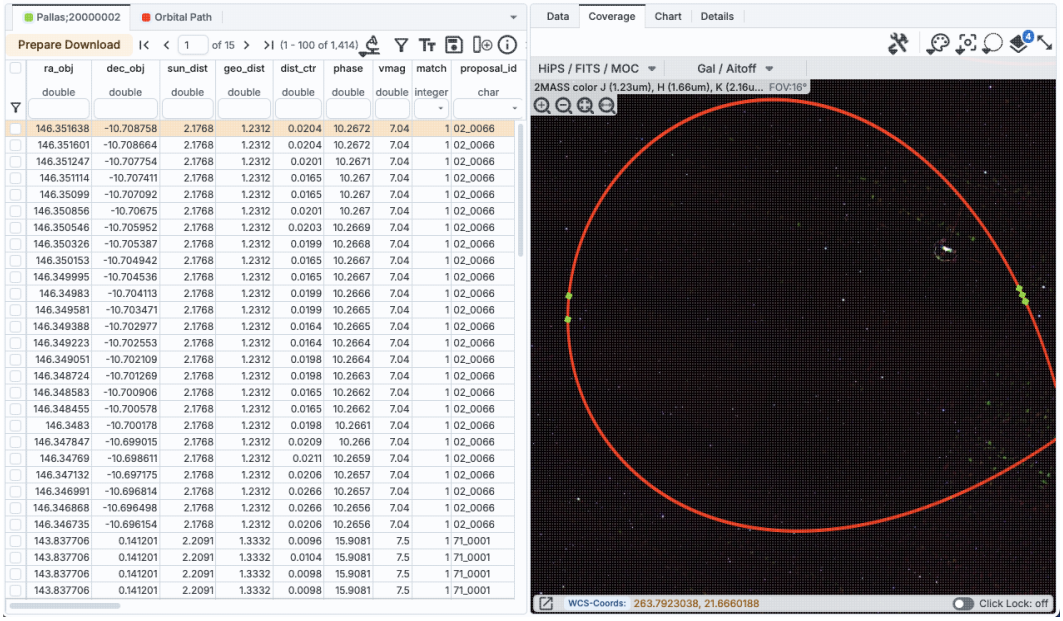
Solar System Object/Orbit Results

If you do a Solar System search, you will have different tabs. The tabs on the left will be the observations that match your search, and the calculated orbital path. The tabs on the right will be the same as for the data product tabs.

Here is an example of search results for Pallas, all other default parameters:



The red squiggle is the calculated Pallas orbit; it's very difficult to see the green SOFIA footprints until you zoom in:



Here, the green footprints are more visible on top of the track.

Downloading Data

Downloading is covered in separate section.

SOFIA Science Data Archive: Images

SOFIA data includes many FITS images, but the SOFIA Archive provides HiPS images for context setting. This chapter covers some basics about images, including an introduction to HiPS images and coverage images; visualization tools are covered in another chapter.

Contents of page/chapter:

Introduction

There are basically two kinds of images you can find in the SOFIA Archive, FITS and HiPS. More information about HiPS is in the next section below.

FITS images you may be most familiar with have a header and an image. But FITS images can be far more complicated, and most SOFIA FITS files are more complicated. A FITS file is a header plus a "data unit", or an HDU. A single HDU can be an image, a spectrum, a table, or a data cube. Thus, a single HDU can have multiple data planes. FITS files can have multiple HDUs, each of which can have multiple data plane. FITS files can also be a mixture of images and tables and cubes. Many of the SOFIA high-level data files are multi-plane, multi-HDU, mixed images and tables in the same file. A description of how to use the SOFIA Archive to interact with these complicated data files is in the spectra section, because most of these complicated files are spectra.

Much more detail about interacting with images in general can be found in the Visualization section.

HiPS Images: General Information & Definitions

HiPS stands for hierarchical progressive surveys, and these kinds of images are multi-resolution HEALPix images (where HEALPix stands for Hierarchical Equal Area isoLatitude Pixelation). (Also see IVOA docs on HiPS.) In practice, what this means is that you can interact with images of a very large chunk of sky, and as you zoom, the pixel size changes dynamically. HiPS images are fundamentally different than FITS images, and as such, what you can do with the HiPS images are different than what you can do with the FITS images.

The whole point of HiPS images is to provide on-demand resolution changes. Zoom out, and it loads large pixels. Zoom in, and it loads smaller pixels. HiPS images are designed to cover large areas of sky efficiently. If you need to visualize many degrees, this is the image type to use.

There are HiPS images from all over the world available via the web; the complete list of HiPS images available from the images search page includes (once the "IRSA Featured" checkbox is unchecked) many HiPS images from CDS.

HiPS images typically have the color and stretch set by the person who originally made them. The color table can be remapped within this tool. But, you cannot, in general, change the stretch of HiPS images with as much flexibility as you can with FITS images. This is why there may be multiple versions of some data sets in the list

of HiPS images.

HiPS maps typically come with a **Multi-Order Coverage map (MOC)**. A MOC is a format developed by the International Virtual Observatory Alliance to specify sky regions. In this context, a MOC tells you via a simple boolean yes/no, is there sky coverage from this data set in this region. You can overlay a MOC from one data set onto a completely different data set's HiPS image.

Things that define a HiPS image. When selecting a HiPS image, the tool gives you a table. The table that appears has several columns that summarize important things about the available HiPS images:

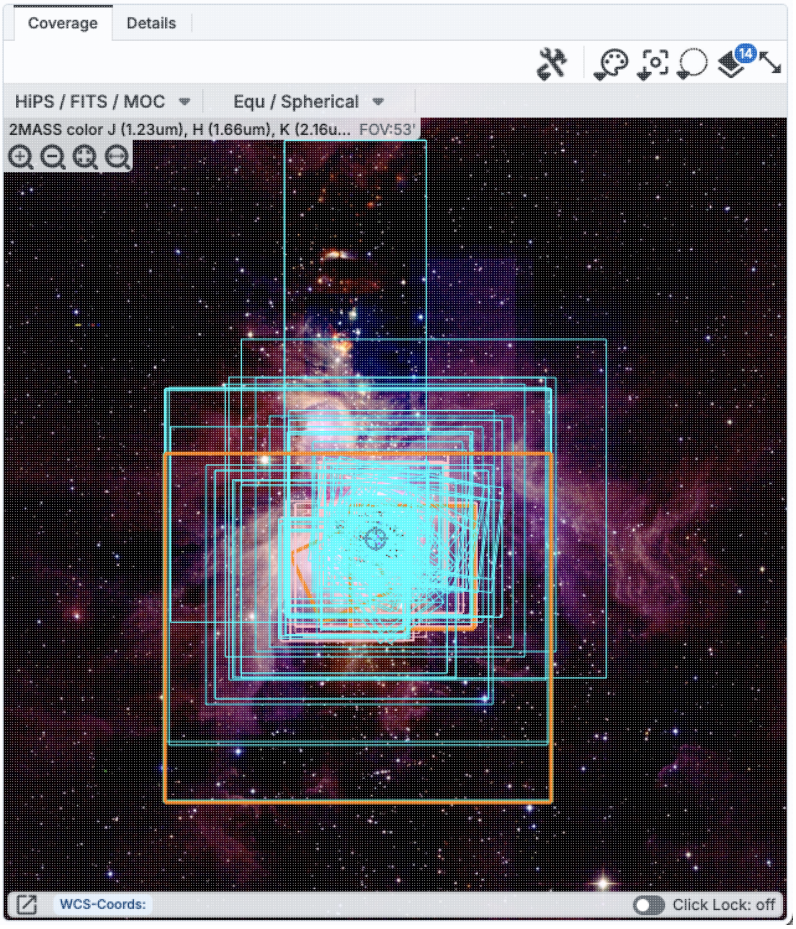
- Type - image (all that is available in this context)
- Properties - links to more information for that image
- Title - descriptive words for the HiPS image
- Waveband - Approximate wavelength range
- Coverage - Approximate sky coverage (100% or less) -- HiPS images often carry with them something referred to as "MOC", or multi-order coverage. This number gives an indication of the sky coverage of the data.
- Pixel scale - At the highest order (zoomed in the most), this is the pixel size
- HiPS Order - HiPS order, e.g., how deep you can zoom
- Frame - coordinate sytem, e.g., equatorial, galactic, etc.
- Release date - Date that HiPS image became available
- Dataset IVOA ID - Unique (worldwide) identifier for the dataset

Coverage Image

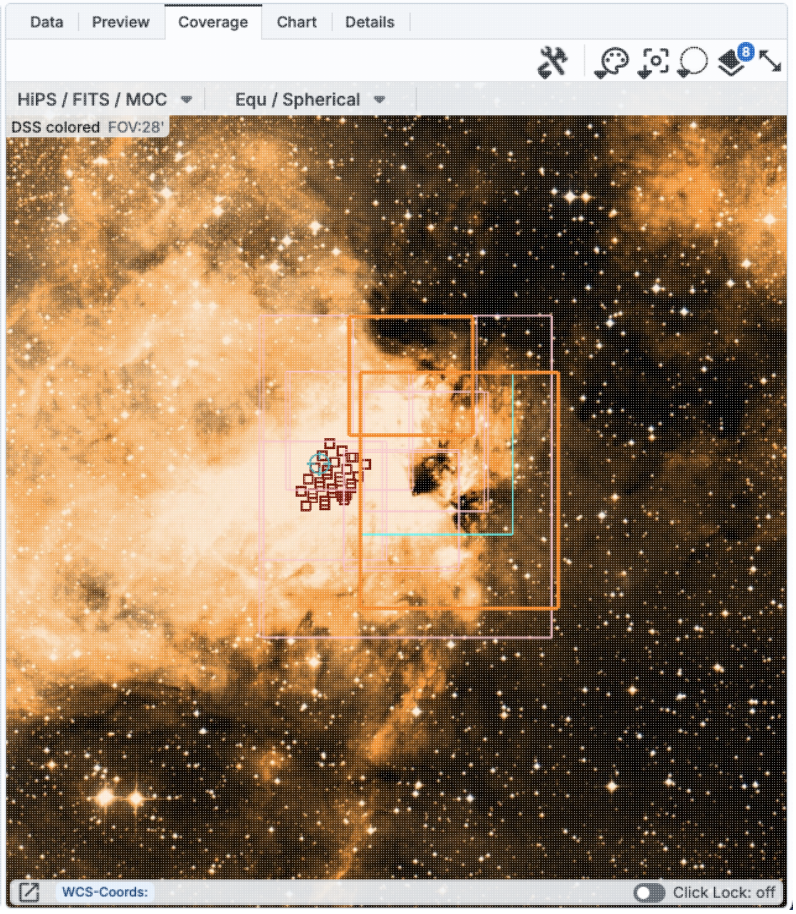
The SOFIA Archive provides for you a "coverage image", which is basically a way for it (and you) to keep track of where you are working on the sky. This may initially be surprising.

You may have a coverage image like this -- this is an example of a coverage image showing the results of a search on M42. The background HiPS image is a 2MASS image.

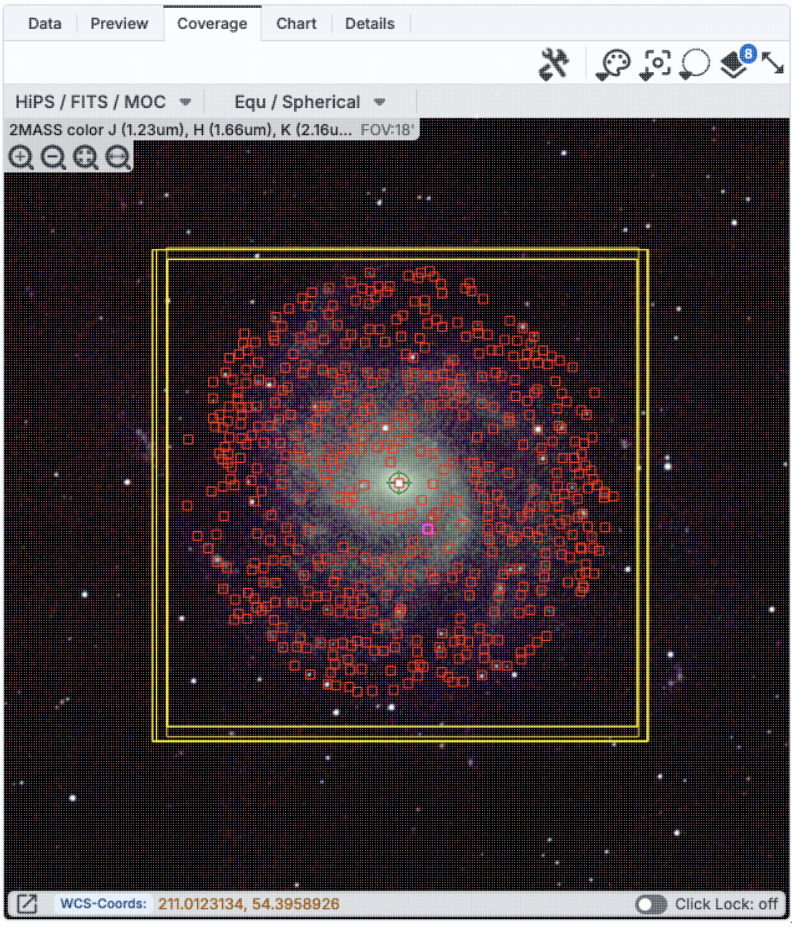
M42 was a very popular target! The polygons correspond to different images found by the search. The orange ones correspond to the currently-selected ones in each corresponding instrument tab. There are many more pointings down in the 'murk' in the center. The circle with crosshairs is the position used for the search.



This coverage image is a DSS (optical) HiPS image, showing a less popular target, M17. The polygons are largely FORCAST images (the single cyan one is HAWC+), and the points are FIFI-LS pointings.

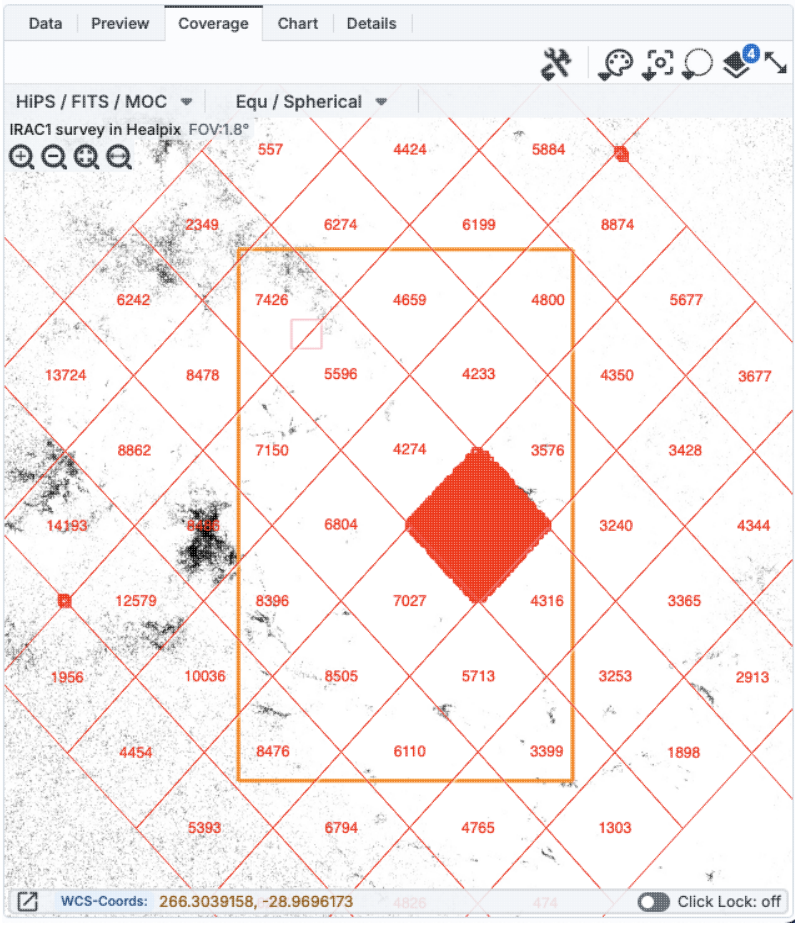


This coverage image is 2MASS again, of M101. The yellow polygons represent FIFI-LS coverage, the single fuchsia point is a GREAT pointing, and the small red squares are point sources from a WISE catalog overlaid.



Finally, this coverage image is IRAC-1 again, of the Galactic Center. The large orange polygon (which is the same as several other pink polygons, plus the small pink polygon in the upper left) is the coverage from this SOFIA Legacy program. The many-thousand-source Gaia catalog from this region is overlaid in red. Because there are so many sources in the catalog, the tool has shown the HEALPix cells and the total number of sources in that cell. I've clicked on one cell and it has rendered the several thousand sources in that one cell. The tool is rendering the catalogs in a hierarchical fashion, similar to how HiPS images work. You can control what this threshold is and how it

renders the cells from the layers pop-up.

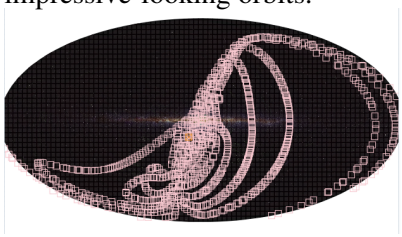


In all cases, you can interact with the coverage image in pretty much exactly the same way as you would any other image loaded into this tool; see the the visualization chapter for much more about those tools. The thing that makes a coverage image a little bit different than any other image you might load, however, is that it can automatically adapt, even beyond what a HiPS image can intrinsically do. The next subsection includes more details about how it can automatically change to accomodate your needs and zoom level.

Tips and Troubleshooting

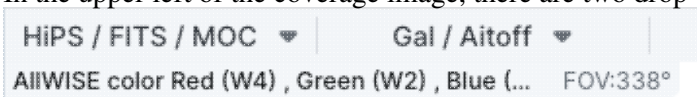
- When showing the coverage of SOFIA observations, images will be generally shown as large polygons, but spectra will be represented as points.
- You can change the colors (and symbols) in the coverage image; see the visualization chapter.
- If there is no color swatch in the header of the instrument tab, there are no polygons on the coverage image (e.g., no observations were returned for that instrument).
- The currently selected row will be highlighted orange, but this only works from instrument tabs; nothing will change in the image if you change rows in the AOR tab.
- If there are too many image polygons to manage, the tool may fall back to showing just the positions of the data products it has retrieved. (Whether that is the central point or the lower left corner of the image depends on the data product itself.)
- If there are more than 1500 points, the tool may fall back to using hierarchical catalogs, which can be confusing.
- If you do a multiple target search, so that you can more easily tie results to input, when you get results back from a batch search, the input RA and Dec are columns appended to the end of your results tables.
- If you have done a search for a Solar System Object, you may also have a calculated orbit show up on the coverage tab. If you give it a nearby asteroid with a long time baseline, it can calculate

impressive-looking orbits.

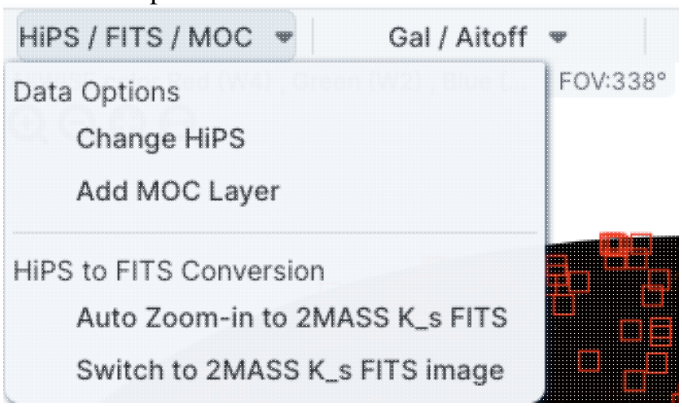


Upper Left HiPS menus

In the upper left of the coverage image, there are two drop-down menus.



The first drop-down menu looks like this.

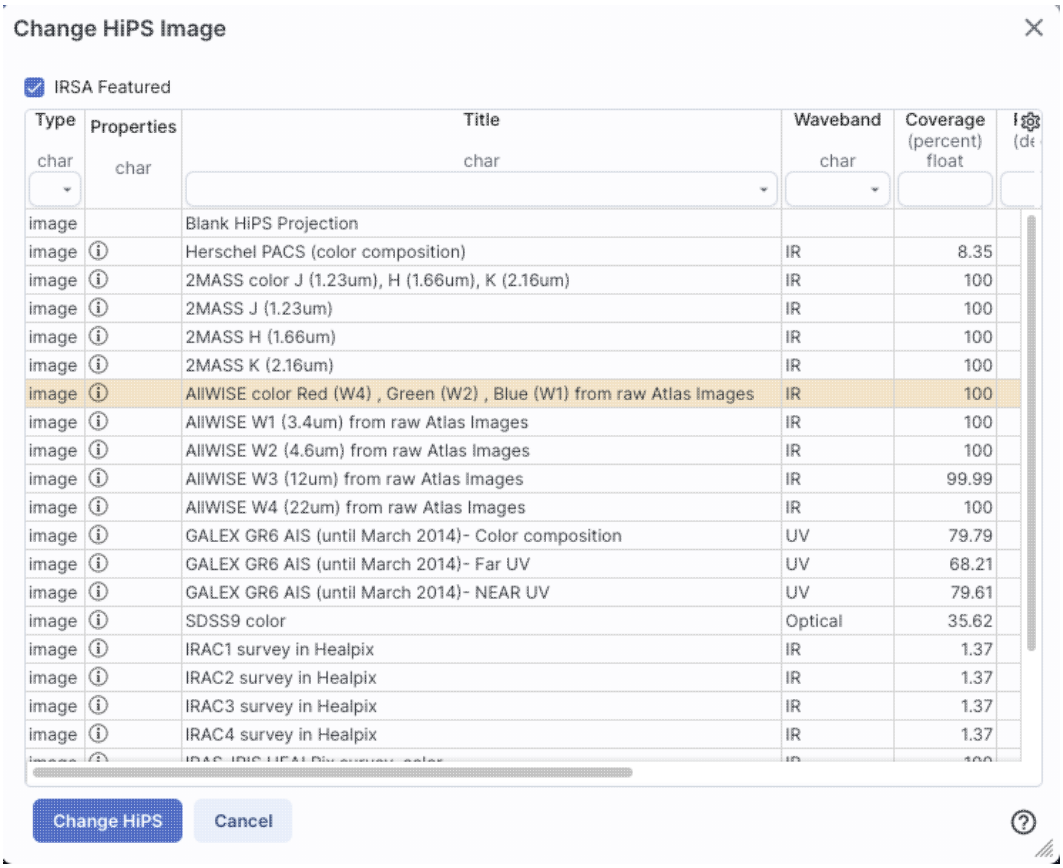


There are two sections here.

Under "Data Options", you can change what data are shown.

Change HiPS: Changing HiPS images

The choices made by any given creator of a HiPS image may result in any particular region being saturated or too faint to see. Color stretches are set by the creator of the HiPS map and cannot be changed; color tables can be somewhat changed by this tool, but that may be insufficient for your needs. If the HiPS map as shown does not suit your needs and you wish to change the HiPS image, click on the "HiPS/MOC" menu, and then click "Change HiPS". It brings up this pop-up:



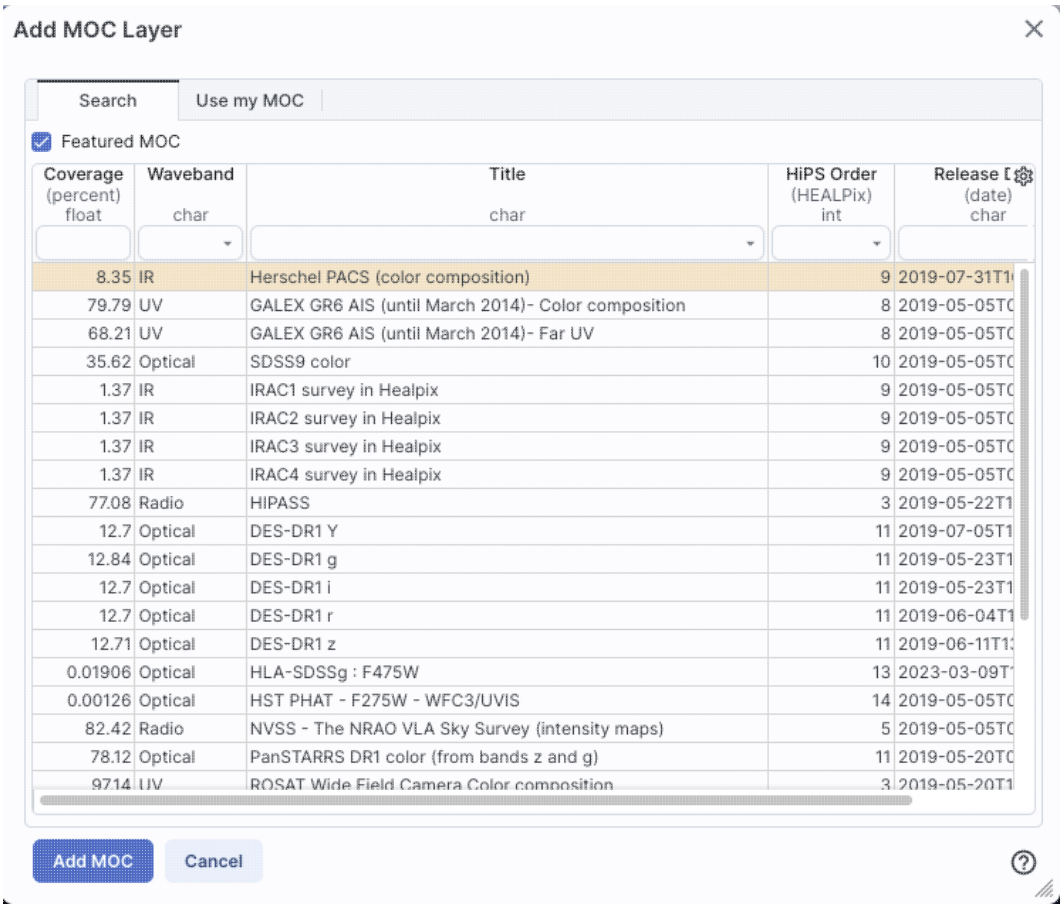
Type	Properties	Title	Waveband	Coverage (percent)	
char	char	char	char	float	
image		Blank HiPS Projection			
image	ⓘ	Herschel PACS (color composition)	IR	8.35	
image	ⓘ	2MASS color J (1.23um), H (1.66um), K (2.16um)	IR	100	
image	ⓘ	2MASS J (1.23um)	IR	100	
image	ⓘ	2MASS H (1.66um)	IR	100	
image	ⓘ	2MASS K (2.16um)	IR	100	
image	ⓘ	AllWISE color Red (W4) , Green (W2) , Blue (W1) from raw Atlas Images	IR	100	
image	ⓘ	AllWISE W1 (3.4um) from raw Atlas Images	IR	100	
image	ⓘ	AllWISE W2 (4.6um) from raw Atlas Images	IR	100	
image	ⓘ	AllWISE W3 (12um) from raw Atlas Images	IR	99.99	
image	ⓘ	AllWISE W4 (22um) from raw Atlas Images	IR	100	
image	ⓘ	GALEX GR6 AIS (until March 2014)- Color composition	UV	79.79	
image	ⓘ	GALEX GR6 AIS (until March 2014)- Far UV	UV	68.21	
image	ⓘ	GALEX GR6 AIS (until March 2014)- NEAR UV	UV	79.61	
image	ⓘ	SDSS9 color	Optical	35.62	
image	ⓘ	IRAC1 survey in Healpix	IR	1.37	
image	ⓘ	IRAC2 survey in Healpix	IR	1.37	
image	ⓘ	IRAC3 survey in Healpix	IR	1.37	
image	ⓘ	IRAC4 survey in Healpix	IR	1.37	

Things to note:

- To select a new image, click on the row corresponding to the new HiPS image you want, and click "Change HiPS" on the bottom left.
- To cancel without selecting a new image, click "Cancel."
- This is an interactive table, so all the filtering and column manipulation tools apply here too. You can filter down the columns to find the image you want to use.
- To learn more about each HiPS map, click on the i with the circle in the second column. It will spawn another window with standardized information about the HiPS map.
- By default, it shows HiPS maps corresponding to IRSA data collections. To see a more comprehensive list, unclick the box marked "IRSA Featured."
- A blank HiPS image (basically a blank canvas) is also available from the list of HiPS images.

Add MOC Layer: Adding a MOC Overlay

It is often useful to see what other data are available. Looking at a Herschel/PACS far-IR HiPS map? Overlay a Chandra MOC to see what X-ray data might be available to go with your IR data. Click on the "HiPS/MOC" menu, and then click "Add MOC Layer." It brings up this pop-up:



Things to note:

- Coverage (the first column) is the fraction of the sky covered by that MOC.
- To select a new MOC, click on the row corresponding to the new MOC you want, and click "Add MOC" on the bottom left.
- To cancel without selecting a new image, click "Cancel."
- This is an interactive table, so all the filtering and column manipulation tools apply here too. You can filter down the columns to find the image you want to use.
- By default, it shows MOCs likely to be most interesting for IRSA users. To see a more comprehensive list, unclick the box at the top left.
- If you have your own MOC FITS file, you may upload it via the "Use my MOC" tab on the top center.
- If you try to upload a MOC FITS file via the upload tab, it will behave as if you have uploaded it here.

Under "HiPS to FITS Conversion", you can control whether the viewer will automatically toggle between image types as needed.

By default, the coverage image is most likely a HiPS image. FITS images are best for small regions of the sky, and HiPS images are best for large regions of sky.

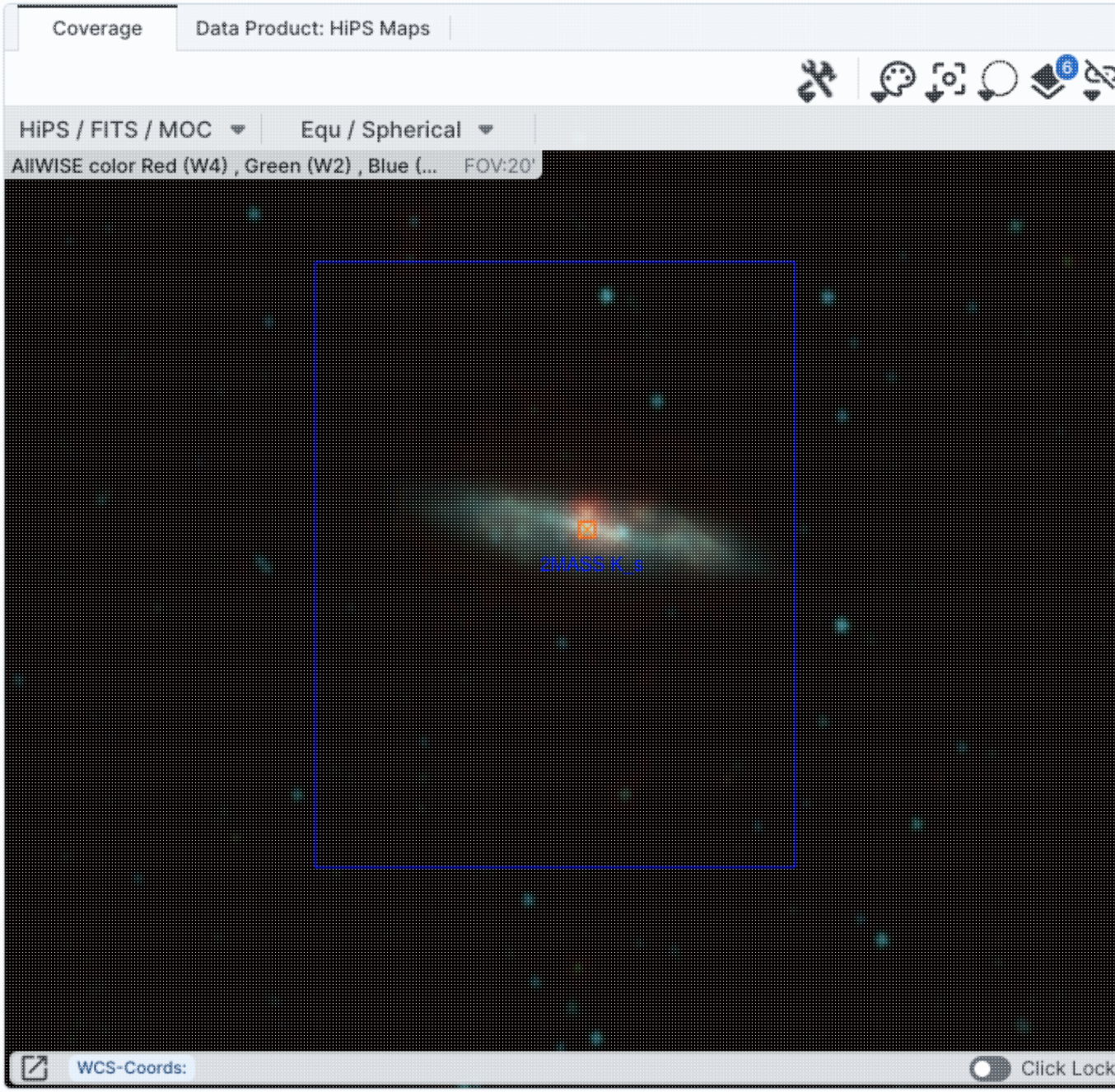
Auto Zoom-in to 2MASS K_s FITS:

If you select this, then when you zoom in very close to a target, it will automatically convert to a FITS image when you get close enough.

Switch to 2MASS K_s FITS image:

If you select this, then it will jump directly to a FITS image centered on the currently selected target.

Note that if you swap between HiPS and FITS and back again, it will include a region on the HiPS image that is the footprint of the FITS images you had just loaded. A label appears at the center of that footprint, which may be disconcerting if you are not zoomed out enough to see the region itself. Here is an example, zoomed out so it is more clear what is going on:



The second drop-down menu looks like this.

There are three sections in this menu.

Orientation

Under "Orientation", you can control whether the coordinates are in Galactic or Equatorial J2000 (RA/Dec). This can be used in conjunction with the image readout and/or the coordinate layer button (both described in the visualization section)

Center Galactic

If you select "Center Galactic", the HiPS image slews to put Galactic North up, the Galactic Center in the center of the field of view, and the Galactic Plane horizontally across your field of view. This is useful if you have been zooming or scrolling around to look at individual sources and need to bring it back to a familiar orientation quickly.

Projection

Under "Projection", you can control whether the display is in Spherical or Aitoff coordinates. Aitoff projection works better for all-sky displays.

SOFIA Science Data Archive: Visualization

A list of the data files meeting your search criteria are shown in the instrument tabs that are the results of your search. Where possible, the data files are shown on the right. When they are images, you can interact with them using the tools described on this page; you can also interact with the coverage image using the tools on this page. This section covers working with FITS (or HiPS) images; basic information about HiPS images is here. For data tables, tables and plots are covered in other sections. The colored circle that may be overlaid by default is the search position you submitted. You can add and overlay catalogs and add other layers to your image. See the Catalogs section for more on catalogs. If you would like to know more about visualization of spectra, see the Spectra section, which also covers more about how the tool deals with some of the very complicated SOFIA data files.

All of the interactive image visualization tools work the same basic way, and here we describe these basic options, in roughly the order in which you might encounter them in the window.

Contents of page/chapter:

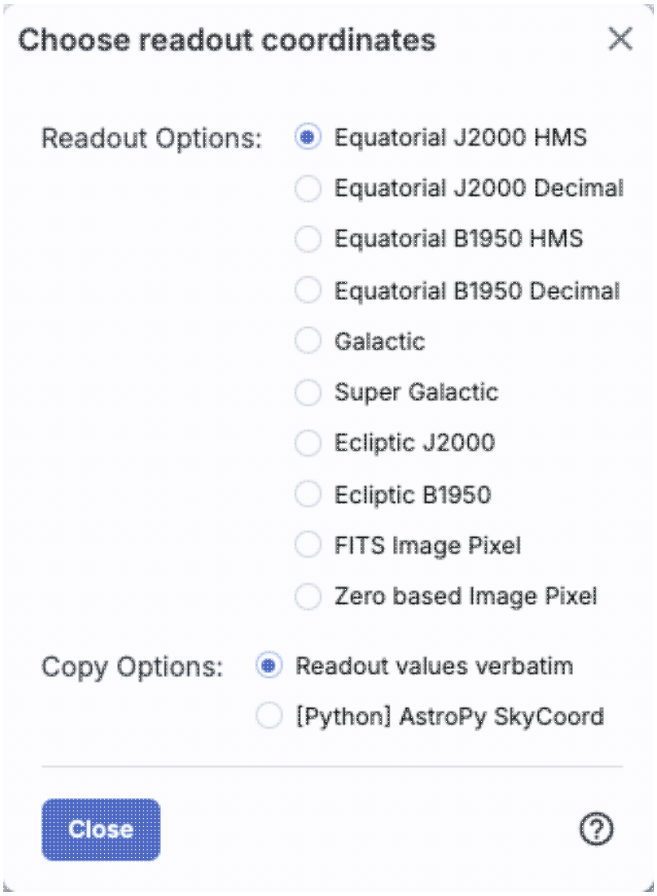
The FITS/HiPS Viewer

You can interactively explore the image with the mouse. Move your mouse over any image that is loaded into the viewer. Details about the image and, specifically, the pixel beneath your mouse cursor, appear along the bottom left of the image window. Some information is updated in real time (coordinates); some information (pixel value) is updated when you stop moving your mouse for a second or two. The image can be interactively investigated in this fashion.

You can change the units of what is being read out, in terms of coordinates or pixel values.

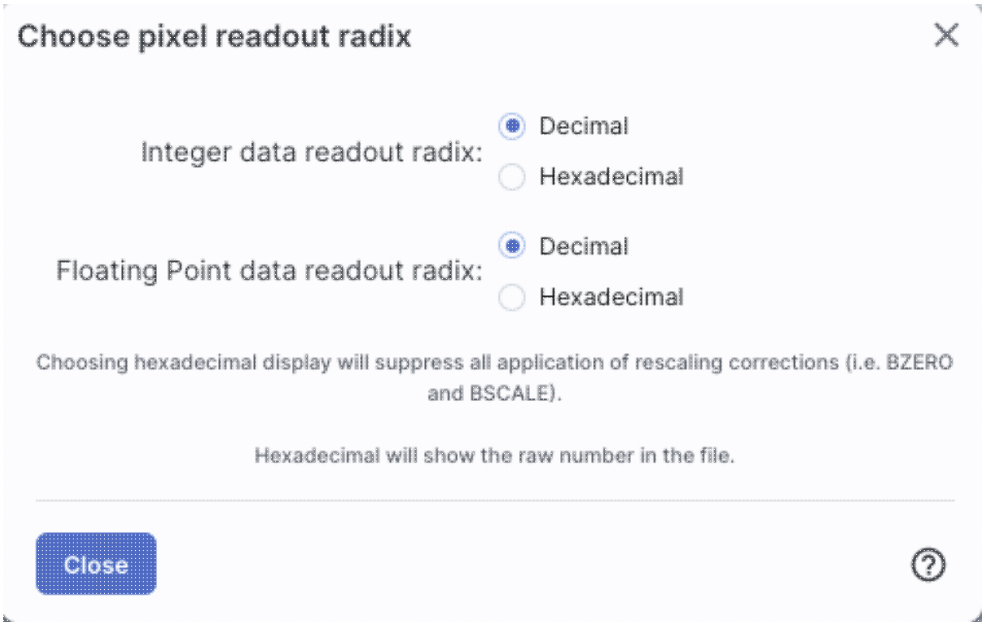
If you click on the label of the coordinates, "EQ-J2000" in the screenshot example above, you get this pop-up, from which you can choose the coordinates from among:

- Equatorial (RA/Dec) J2000 in hh:mm:ss ddd:mm:ss format
- Equatorial (RA/Dec) J2000 in decimal degrees



- Galactic in decimal degrees
- Equatorial B1950
- Ecliptic J2000
- Ecliptic B1950
- FITS Image Pixel
- Zero-based Image Pixel

If you click on the "click lock" toggle, the coordinates stop dynamically updating when you move your mouse, and they update only when you click on the image. When you do that, little clip boards appear next to each coordinate readout; clicking on those copy the position to your clipboard. From this pop-up window here as shown, you can control the format of the coordinates that are copied to your clipboard -- they can be as shown in the readout, or in the format that Python is expecting (for easy pasting into code).



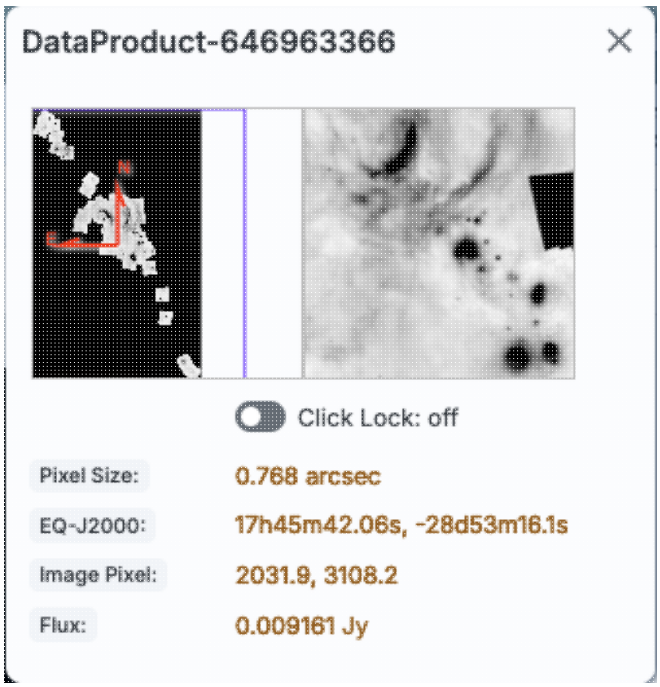
If you have a FITS image loaded, you have an additional readout. Click on the label of the readout, "Flux" in the tiny snippet of a screenshot example above, and you get this pop-up, from which you can choose the pixel readout from among:

- Integer data readout in decimal
- Integer data readout in hexadecimal
- Floating point data readout in decimal
- Floating point data readout in hexadecimal

If you choose the hexadecimal options, it will suppress all rescaling

corrections found in the header, like BZERO or BSCALE. It will just show you the raw binary number in the file. (For example, if the value in decimals is 5.13795757, the binary value in the file is 0x40a46a26; here is a conversion tool between decimal and hex.)

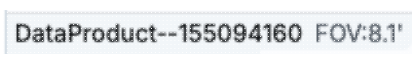
In the lower left of the images, if you click on this: , you get this pop-up. If you have a FITS image loaded, at the top of this pop-up, it shows the whole image; the orientation of the image is given with a compass rose. There is also a zoom-in of the image at the location under your cursor. Underneath that in the pop-up, whether you have a FITS or HiPS image loaded, you can get a readout of the pixel size, a readout of location on the image in two different coordinate systems, and a readout of the pixel value. You can change the units of those values by clicking on the name of the field: "Pixel Size", "EQ-J2000", "Image Pixel", and "Value". Each results in a pop-up, as above.



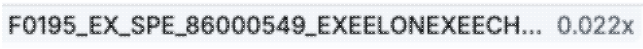
You can make the cursor 'stick' on a particular place on the image -- flip the "Click Lock: off" switch to "on" (either in the pop-up or in the lower right of the image window), and then click on the image at your desired location. When this is clicked, small "clipboards" appear near the position readout. Click on that icon to copy that position to your clipboard.

Image Information

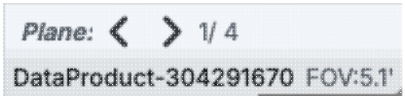
The upper left corner of the loaded image has a label that tells you basic things about the image you are viewing. The telescope and/or instrument and/or channel and/or data release is first, in black. The field of view follows, in a paler font; this corresponds to the (horizontal) width of the image window. The currently selected image is outlined in brown; other images are outlined in grey.



Sometimes, the label is simple. If it's a single-plane image, it tells you you the data product and the current field of view (FOV).



Spectra often won't have a field of view, but will tell you the filename or data product and the zoom factor.



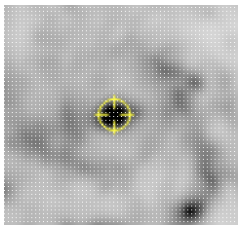
If it looks something like this, with the icons and arrows present, the file you are viewing has multiple planes. (Note that SOFIA files often have many HDUs as well as planes.) The arrows allow you to click through the image planes in the order they are loaded. In this case, the data shown are images, so there is a FOV as well.

Sometimes the planes have names, and if so, that is indicated. If there are many planes, you can type in a plane number to jump directly to that plane.

Some SOFIA data can have multiple HDUs **and** multiple planes.

The concept of coverage images (and the issues unique to them) are covered in another section, but the basic interactions with them are the same as for any other images. They are, however, HiPS images. Choices of what you can do and what you can manipulate with HiPS images can be different than your choices for FITS images, but are largely the same as discussed in the rest of this chapter. For HiPS images, the FOV is the angular size of the width of the HiPS viewer.

For all images, even if the image as displayed is smaller than the window, the FOV readout is the width of the window, not the image. If you shrink your browser screen, the FOV can get smaller because the viewer gets smaller. If you load more than one image, the FOV can get smaller because two viewers must fit in the same pane.


The target on which you searched is overlaid on the main image with a cross-hair marker, sometimes called a "reticle." You can remove this (or change its color) from the layers pop-up, described below.

Breaking Out of the Pane (and Going Back)

Panes: The search results screen is broken up into panes - the left is a list of items (observations or sources for loaded catalogs), and the right is images or spectra. If you have more than one image loaded in, the image pane may be further subdivided.

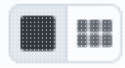
Make it big! For some purposes, it is useful to individually view just the table, or the images, or the plots, as large as possible. In any pane, this icon  appears in the upper right of the pane. Clicking on it will expand the pane into a larger window, as big as possible given your browser size.

Go back the way it was: 

The large "Close" arrow at the upper left is always available in the expanded views, and enables you to return back to the pane view.

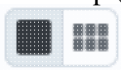
Also see the next section on image navigation. You have different image navigation options when you are in expanded view (as compared with the default view in a pane).

FITS Image Navigation



Single or Tiled Images

In the top (often upper left) of the images window pane, you may sometimes have these icons:



The first icon means "show images one at a time in this pane." The second icon means "show all the images I have loaded in groups of up to 3 at a time" (see below for more on this).

Paging through single image views

If you have many images loaded in and you choose to view many images at once, it will show up to 3 images per page. It will then give you navigation aids at the top of the pane, like this:

In this example, images 16-18 of 187 images are shown. Use the arrows to navigate through the 63 'pages' of 3 images each.

Default views

For most results, the default view is one image at a time.

Expanded views

As noted above, if you click on this icon  , it makes the images pane take up the entire browser window. When you do that, you have different image navigation options:

The first icon (the big square) denotes "show one image at a time." The second icon (the cluster of four squares) denotes "show smaller images of all the images I have loaded at once," e.g., tiled images. The third icon brings up a pop-up window with a list of the images you have loaded.

When viewing one image at a time, you get additional choices for navigating through the list of images:

the arrows take you forward and backward; the dots tell you where in the list you are. The "Auto play" tickbox scrolls through the list automatically.

When viewing many images at once, you get a "scroll images" switch. If you toggle this on, then each image tile becomes bigger, and you can use your mouse to scroll up and down through the collection of images. If you are on a Mac, your scrollbar may be hidden until you try to scroll.

When viewing the list of images that are loaded in, the table behaves like any other table in this tool -- that is, it is searchable, sortable, etc. However, as of this writing, the wavelength column is not correctly populated.

Tips and Troubleshooting

- ◊ When going from the 'window pane' view to the 'expanded' view, the images pane will only show you the images that you can see in the window pane view. That is, if you are looking at one image in the images window pane when you hit 'expand', it will only give you access to one image in the expanded view (even if you have more than one loaded into the tool). If you are looking at 3 images (out of many) in the images window pane when you hit 'expand', it will only give you access to those 3 images image in the expanded view.
- ◊ When you are in the 'scroll images' view, and you try to scroll, if your mouse is in a currently active (selected) image (that is, highlighted in brown), then your image will zoom rather than scroll. Just move your mouse over to another image, and then your window will scroll rather than zoom. Or, find your scrollbar.

Image Toolbar (FITS and HiPS)

The image toolbox is always present as a row of tools associated with the images you have loaded, or that are loaded on your behalf. They're generally located above the images you have loaded, with most of them on the upper right. Letting your mouse hover over any of these icons will result in a "tool tip" that appears in order to remind you what the icon does. Most items apply equally to FITS and HiPS images, but some only apply to FITS images.

This is the image toolbox when you have clicked on a FITS image you have loaded:

And, this is the image toolbox when you have clicked on a HiPS image you have loaded:

The two toolbars are different, but if the same icon appears, it has the same effect on the image. Many of the icons have a downward pointing black triangle, which means that there are additional options in a drop-down menu that appear when you click on the icon.

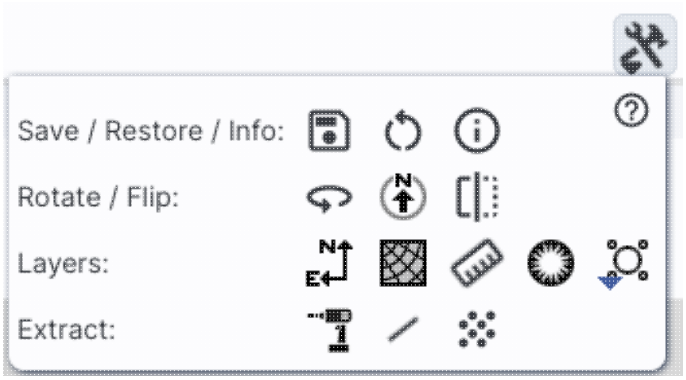
We now discuss each icon in the order in which they appear.

Tools drop down
The choices here look like this:

jump to save

jump to rotate

jump to layers



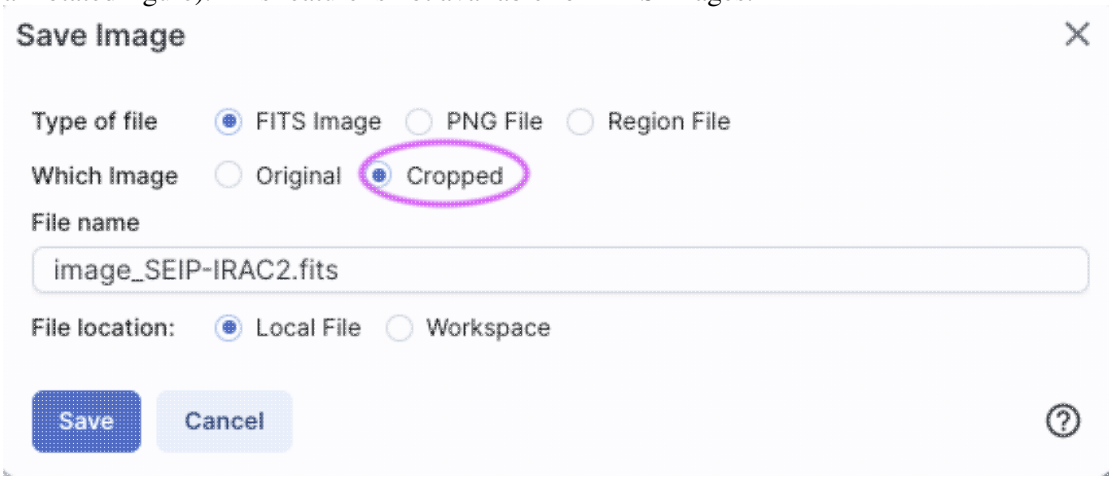
jump to extract

Saving the image

The diskette icon will allow you to save the current image. You can save files to your local disk or to the IRSA Workspace. Note that **you** control where the file is saved on your disk through your browser; your browser may be configured to store all downloads in a particular location on your disk.

If the current image is a FITS file, you can save it as a FITS or PNG or regions file to your local disk. If it is a HiPS file, your only choices are PNG or regions file. Saved FITS images will not save the color stretches or overlays; it will just save the underlying FITS image. Saved PNG files WILL include any overlays or annotations you have placed on the image, but will not include the underlying FITS image. Saved regions files will not save the underlying image, but will just save the overlays as a DS9 Regions file. See the DS9 website for more information on the syntax of these DS9 region files.

Note that you can save the original or a cropped version of a FITS file; see the "select region" icon below to crop, then click on the save icon. Be sure to save the cropped FITS image (see annotated figure). This feature is not available for HiPS images.



Note that if you overlay a large catalog on an image, then turn around and save a regions file from the catalog overlay, the full catalog may not be saved to the regions file. If you have >5,000 sources, it's entirely likely that not every source will be overlaid on the image (because of hierarchical catalogs display), and thus will not be in the regions file. If you want to save your entire catalog as a regions file, **save the catalog from the table pane**.

The saved PNG is the same size as it is on your screen. If you want a big version, make the desired image big on your screen (view one-at-a-time; see here) before saving the PNG.

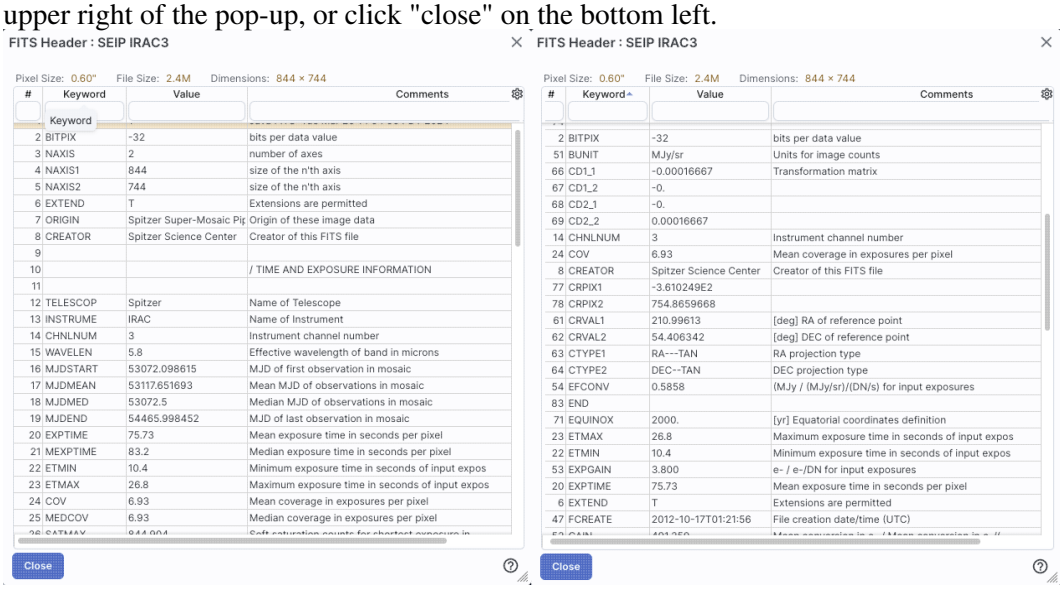
You can't save HiPS images from within this tool. To download your own copy, you will have to track down the original source of the image.

Restoring everything to the defaults

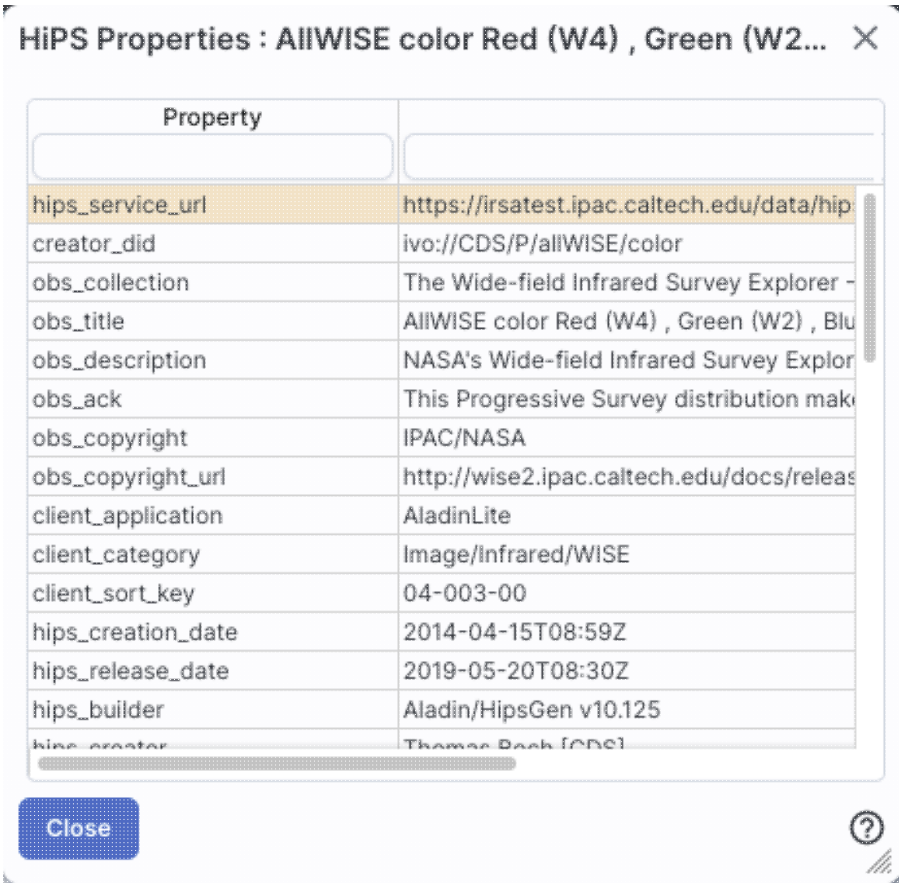
If you've played around a lot with the image, you may want to undo everything you've done. Click this button to restore everything to their original default values. Some layers may persist; remove them via the layers icon.

Viewing the image header

This icon displays a pop-up window with information about the image. If a FITS image is selected, it will show the FITS header of the image; if a HiPS image is selected, it will show the HiPS properties of the image. These are Firefly tables like all the other tables in this tool, so they are sortable and filterable, etc. If you click on the columns in the pop-up, it will sort the keywords alphabetically by that column. This is useful for finding individual keywords in particularly densely populated FITS headers. Click the header again to sort in reverse-alphabetical order, and a third time to return to the default order. Below are examples of an original and sorted FITS header. To make this window go away, click on the 'x' in the upper right of the pop-up, or click "close" on the bottom left.



For comparison, an example of the HiPS properties window is here:



Rotating the image so that North is up

Images retrieved from the SOFIA are frequently NOT North-up/East-left. Clicking this icon will orient the selected image so that North is up. (This option is only available for FITS, not HiPS, images.)

Flipping the image on the y-axis

Clicking on this icon flips the image on the y-axis. (This option is only available for FITS, not HiPS, images.)

Add a compass rose

When you click this icon, arrows appear on the image showing which direction is North and which is East. Clicking on this icon a second time removes this compass rose. (You can also remove this layer via the layers icon, described below.)

Add a coordinate grid

Click on this icon to overlay a coordinate grid on the image. (Only available for FITS images, not HiPS, but see information on HiPS grid in the WCS section.) Click it again to remove it. Customize the units of the grid (to, e.g., Galactic coordinates) via the "layers" icon (described below).

Measuring a distance

When you click this icon, at first, nothing seems to happen. However, you can now click and drag to draw a line on the image, and the length of the line is displayed (in the middle of the

line). The units for the measured distance (and the color of the overlay) can be changed from the "layers" icon (described below). You can calculate the difference in RA and Dec separately via the layers icon as well; find the layer associated with the distance measurement and tick the "offset calculation" box. When it displays the offset calculation, it will give you the angle in degrees in one corner, and the length of the line segment in the RA and Dec directions, in the units you have specified. When you are done with the distance tool, you can click on the

that appears next to the image toolbar, or click on this icon a second time to remove the distance tool. (You can also remove this layer via the layers icon.)

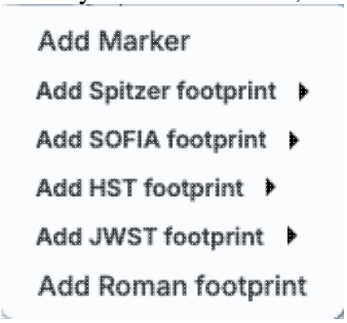
Read in a DS9 Regions file

When you click this icon, you get a pop-up window from which you can read in a DS9 regions file from your local disk. See the DS9 website for more information on the syntax of these DS9 region files. The supported regions are text, circle, box, polygon, line, and annulus. To make this window go away without doing anything, click on the 'x' in the upper right of the pop-up.

Tips and Troubleshooting: If you overlay a list of sources you created in ds9 regions format from your disk, it will only be overlaid on the current image, not all of the images you have loaded. If you want to have it overlaid on all the images you have loaded, create a catalog from your source list and overlay it as a catalog. Then it will appear on all of the images you have loaded, provided that the positions overlap on the sky.

Put a marker on the image

When you click this icon, a drop-down menu appears with several possible options:



The first overlay choice (simply called 'marker') is a red circle. Initially, it appears in the center of the images, and is meant to be moved to wherever you first click in the image. It looks like this:

. The dash-dot line around it means that it is 'active', so you can move (click and drag the marker) or resize it (click and drag the dash-dot boundary). You can change the color of the marker (and change the label) via the "layers" icon (described below). You can also remove this layer via the layers icon. There are several additional options in the drop-down, enough that they have their own section below.

Drill down through the image

If your FITS image has multiple planes or HDUs, especially if each plane or HDU represents a different wavelength, it can be useful to "drill" down through the image cube at a given position on the sky. (You are unlikely to find this kind of file in the ZTF archive.) This tool allows you

to do just that. When activated, this tool extracts the data at the place your mouse clicks down through the cube. For more information on saving the information, see the extraction section below.

Draw a line in the image

When this tool is activated, you can draw a line in your FITS image with your mouse, and it will extract for you the pixel values along that line. If you have more than one image loaded and visible, you can shift-click in another image to see the same line in another image. For more information on saving the information, see the extraction section below.

Make points in the image

When this tool is activated, you can click in your FITS image with your mouse, and it will extract for you the pixel values at the location of your click, creating a catalog for you as you click. If you have more than one image loaded and visible, you can shift-click in another image to extract points from another image. For more information on saving the information, see the extraction section below.

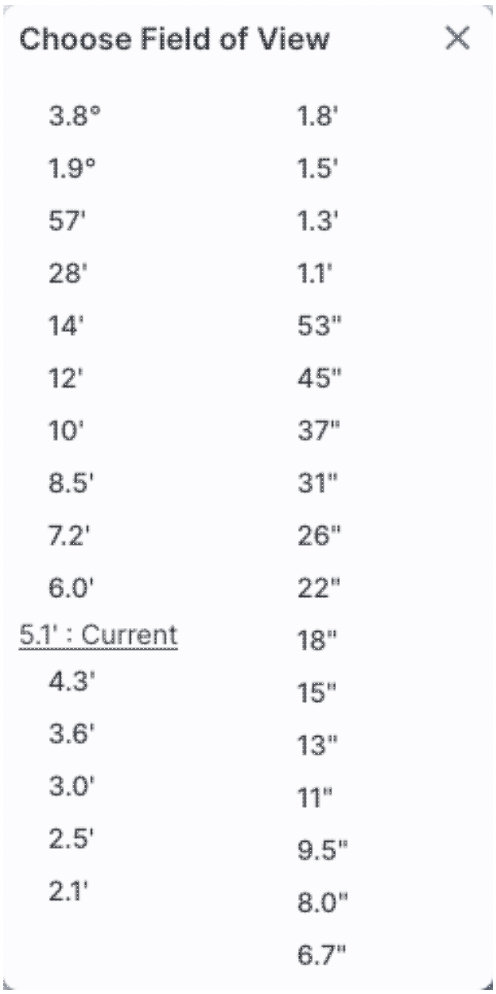
Zoom

When your mouse is in an image, these options appear in the upper left of the image.

Zooming in or out

Clicking on these magnifying glass icons zooms in or out of the image. The readout of the net effect of your zooming on the displayed field of view (FOV) appears at the top left of each image.

If you click zoom in or out rapidly, a pop-up window appears to allow you to more rapidly select the zoom level (field of view) you want. Select the desired level, or click on the 'x' in the upper right to make the window go away. Here is an example:



You can alternatively zoom using the mouse wheel (or drag forward and backward on a touchpad or magic mouse).

Note that there is a maximum (or minimum) allowed zoom level, and they are different for FITS and HiPS images. A notification will appear when you have reached the maximum (or minimum) allowed zoom level for a given image. To enlarge images more (or less) than that, please repeat your search to obtain new images with smaller (or larger) spatial extent. HiPS images are specifically designed for large areas, so if you need a big area, use HiPS. If you want to zoom in close enough to see individual original pixels, your best choice is FITS.

See also the section on changing coverage images, specifically that on automatic transitions while zooming.

Fit image to screen or fill screen

These two icons are designed to maximize the available space in your browser window. The first one automatically picks a zoom level such that the image entirely fits within the available space (which could be your whole browser window, or just the portion of it where that image is loaded). The second one automatically picks a zoom level such that the image fills as much of the available space as possible (e.g., it is zoomed such that short axis of the window is filled with the image, whether that short axis is left-right or up-down).

By default, the images that are returned are frequently but not always centered on your search target. Clicking on these icons let you see the whole image that is returned, whether or not it is centered on your target.

This is available for both FITS and HiPS images, though note that FITS images retrieved from IRSA using this tool are typically small, and HiPS images cover the sky, so fitting the image to the screen might not be what you want to do.

Note that if spectra are displayed, sometimes the zoom level isn't particularly well behaved, because spectra are intrinsically different than images.

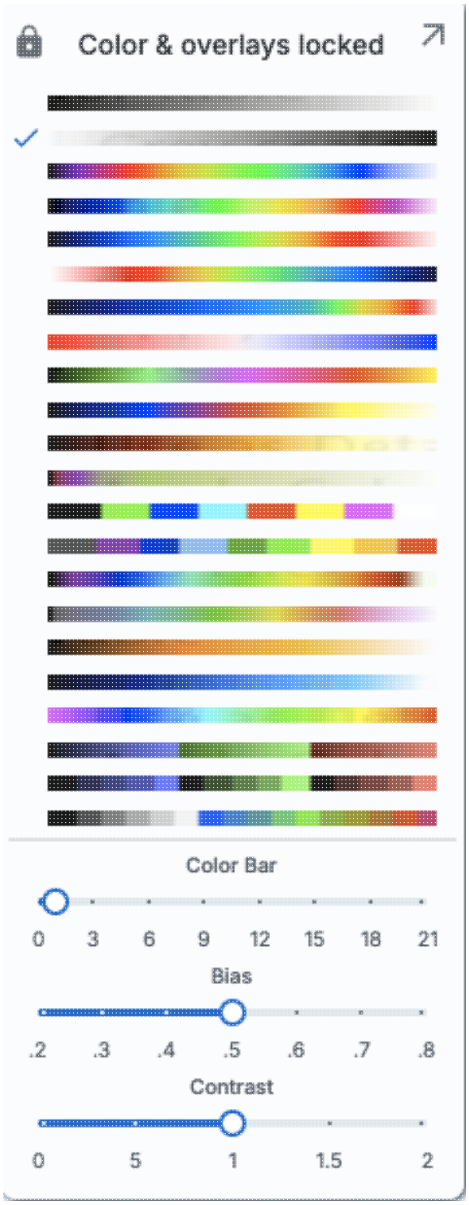
Zooming to a 1-to-1 size

Clicking this icon will zoom the image such that one pixel in the image is one pixel on your screen. This option is only available with FITS images; HiPS images by their nature have pixels of varying sizes, so this button would have no meaning in this case.

Color table drop down

This icon enables you to change the color table of the displayed image. (This option is available for FITS and HiPS images.) When you click the button, a drop-down menu appears.

- The top of the menu either says "Color and overlays locked" or "Color and overlays unlocked" -- by default, all of the (FITS) images that you have loaded are locked together for color and overlays. What that means is if you change the color table (via this menu), then the color table for all the (FITS) images are changed. (Or, if you add a layer to one image, then the layer is added to all the images; see below.) If you don't want this to happen, select "Color and overlays locked" to unlock it. Select the text again to lock it again.
- The arrow in the upper right creates a pop-up window out of this drop-down menu so that you can leave the choices up while settling on the best option.
- The next portion of the menu has a wide variety of color table choices. Select your new color table from the options shown.
- Alternatively, you can use the "color bar" slider to move among the color tables by number. These numbers correspond to the color bar number used in the Python implementation of the Firefly tools.
- Below the color bar slider, there are sliders controlling the bias and contrast. Click or drag the slider to change the image display.



Color stretch drop down

This icon enables you to change the color stretch of the displayed image. (This option is only available for FITS, not HiPS, images.) Because this is complicated, for much more information, please see below.

Re-center the image drop down

Clicking this icon produces a drop-down menu:

By default, "Pan by table row" is turned on (checked), but, depending on how you have loaded your images, or whether you have catalogs loaded, it may not seem to do very much. However, if you have a catalog loaded and are zoomed in on your images, as you scroll through your catalog, the FITS image underneath will move as needed when you have selected an observation in a different part of the sky than was originally shown.

Other choices are to center on the target of the observation, center the image in the window, or center on a target of your choice. For the last of those, you can simply center on that target, or center and leave a marker on the image at that location.

Selecting a region drop down

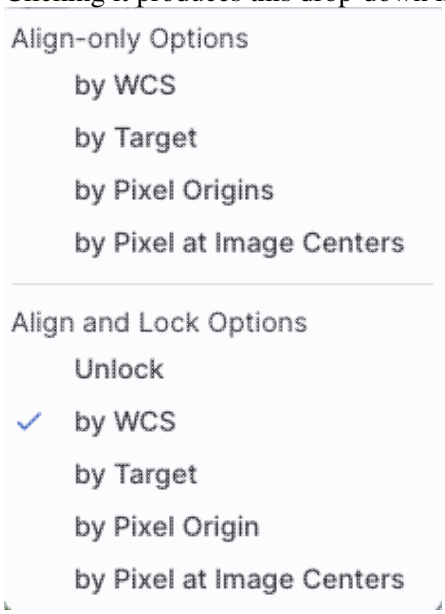
When you click this icon, you can select a region of the image for further actions. Because this is complicated, for much more information, please see below.

Image Layers: Viewing/Changing the Layers on the Image

Every time you add something new to the image, you add a 'layer' to the image. This is complex, so please see below for much more information.

Lock/unlock images

You may have this "lock images" icon appear in your toolbar; it will appear as the first icon if they are locked and the second icon if they are unlocked. The main purpose of this icon is to lock all the images you have loaded for zooming, scrolling, etc. You need to specify how it locks and for how long. Clicking it produces this drop-down menu:



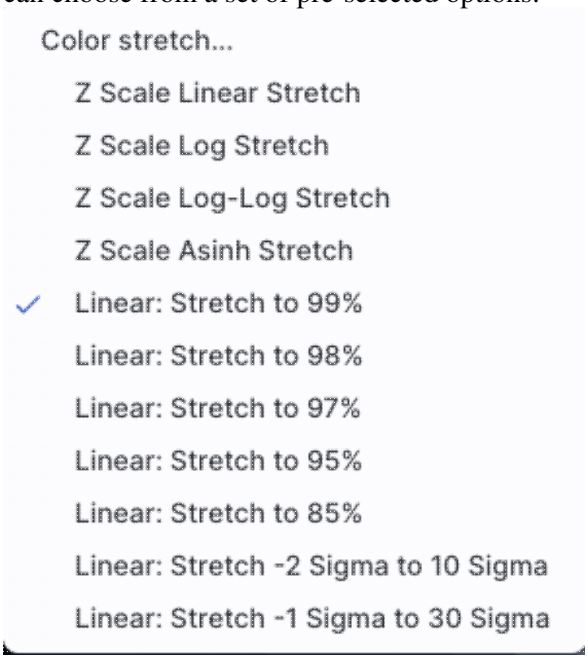
The first set of options aligns the images only once, temporarily; the second set of options makes the

alignment persist ("lock") when you move the images (that is, when you move one, they all move). You can align by the images' WCS (e.g., RA and Dec), by the target, by the pixels according to the origin of the coordinate system in the image header, or by the pixel at the image center. The most common choice is likely the WCS align and lock. This is discussed in more detail in the WCS section.

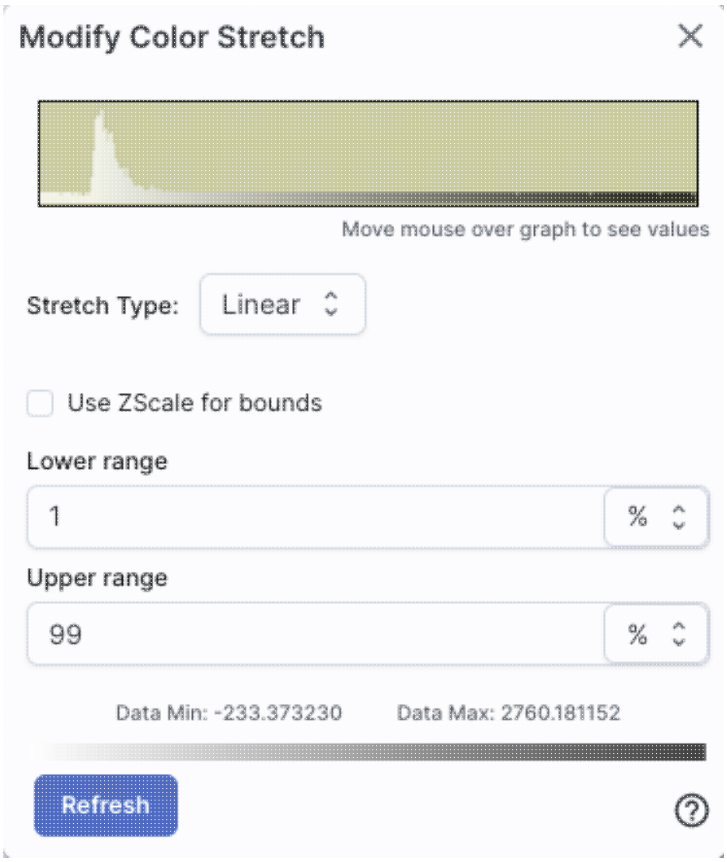
Getting help
Clicking on this icon takes you to this help page.

Specific information on Color Stretches

This icon enables you to change the color stretch of the displayed image. (This option is only available for FITS, not HiPS, images.) When you click the button, a drop-down menu appears with a variety of choices. You can choose from a set of pre-selected options:



If you pick the first one, "color stretch", you can customize the stretch. A pop-up window appears with a histogram of the values in the image, and you can change the stretch type and range.



If you pick a color stretch from the pre-defined options, the pop-up window reflects this change. If you change the color stretch in the pop-up window, the drop-down menu changes correspondingly.

Example: Display the pop-up for color stretch. From the main drop-down, pick 'Linear stretch to 99%'. Go back to the color stretch pop-up. Note that it has filled out the stretch type and ranges to reflect the current choice. Then -- either with the pop-up window still up or not -- go back and pick a different pre-defined stretch from the standard options. Note that the values in the pop-up change to reflect this current choice. From the pop-up, pick a different stretch type -- try "histogram equalization." Select "refresh" to update the images. Go back to the drop-down menu. The last 7 items have changed to be based on histogram equalization, as opposed to the "linear" default.

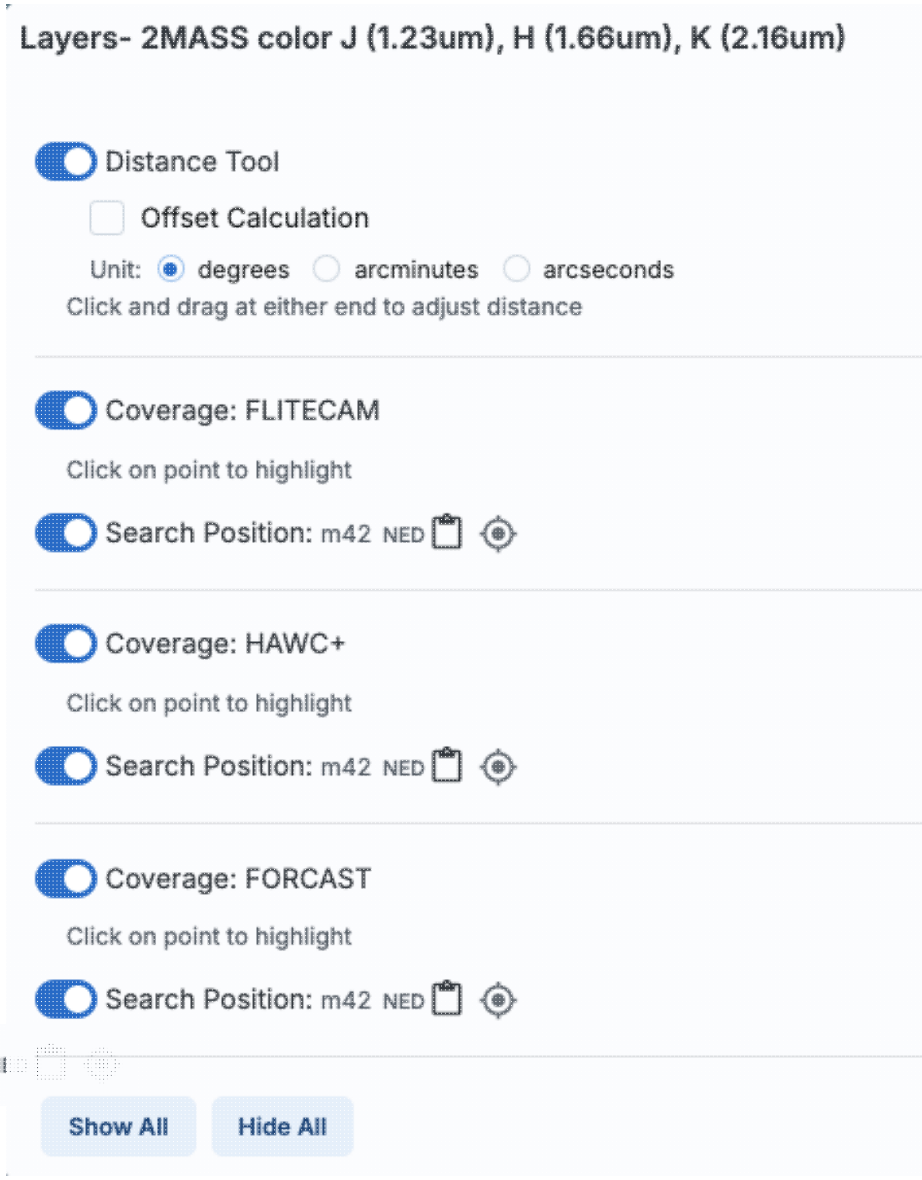
Viewing/changing the layers on the image

Every time you add something new to the image, you add a 'layer' to the image. You can have an image with a lot of annotations on it.

The number that appears circled in blue over the layers icon tells you at any given time how many layers you have on the currently selected image (the image outlined in brown).

If you click this layers icon, you will get a pop-up window with a list of all the layers you have on top of the image. Here (on the right) is an example of a well-populated layers pop-up; in real life, this is scrollable to see several more layers, and you can see the scrollbar here). From this pop-up, you can:

- turn layers off and on (click on the switch on the left of the corresponding row);
- remove layers entirely (click on the 'x' on the right of the corresponding row);
- change colors of overlays (see below);
- change symbol shapes and sizes (for overlaid catalogs), including hierarchical catalog settings;
- change annnotations (for markers);
- or change units (for the coordinate grid or the distance tool).

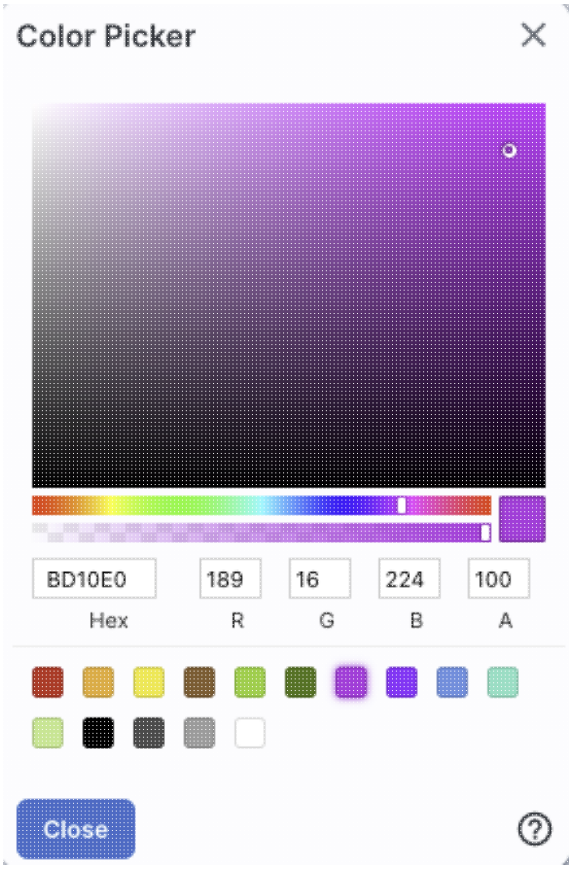


To add entirely new layers, though, you need to go to other options within the toolbar.

You can "show all" or "hide all" with the buttons on the lower left of the pop-up window. To make this pop-up window go away, click on the 'x' in the upper right of the pop-up.

Note the target description:

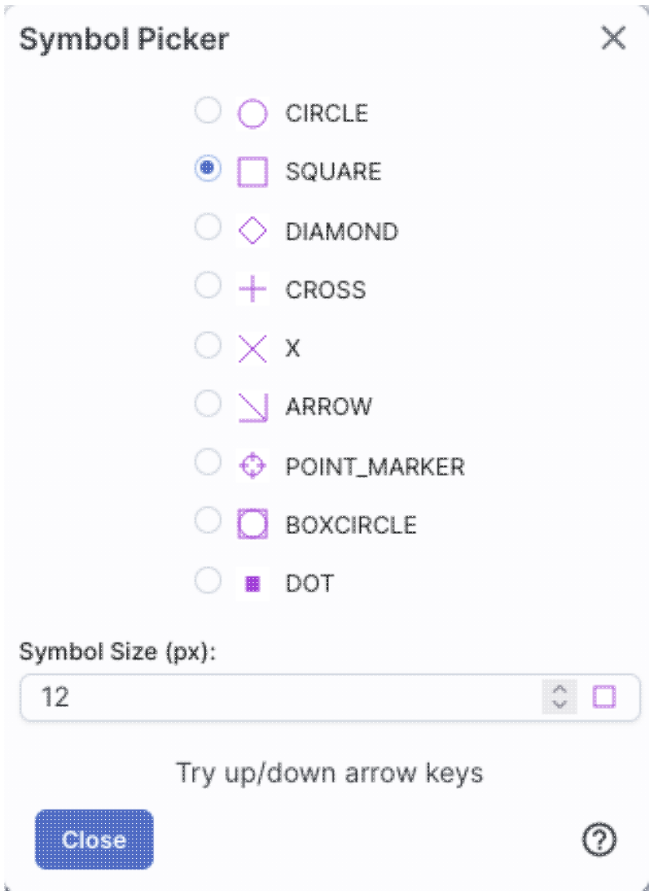
This reminds you of the target on which you searched -- here, it was M42 in J2000. The first icon in the row is a toggle to show or hide the target. After the target name, the two icons next in that row indicate, respectively, "copy this location to the clipboard" and "center image on this position."



Where it's possible to change colors of a layer, click on the 'colors' link to be taken to a new pop-up from which you can select a new color.

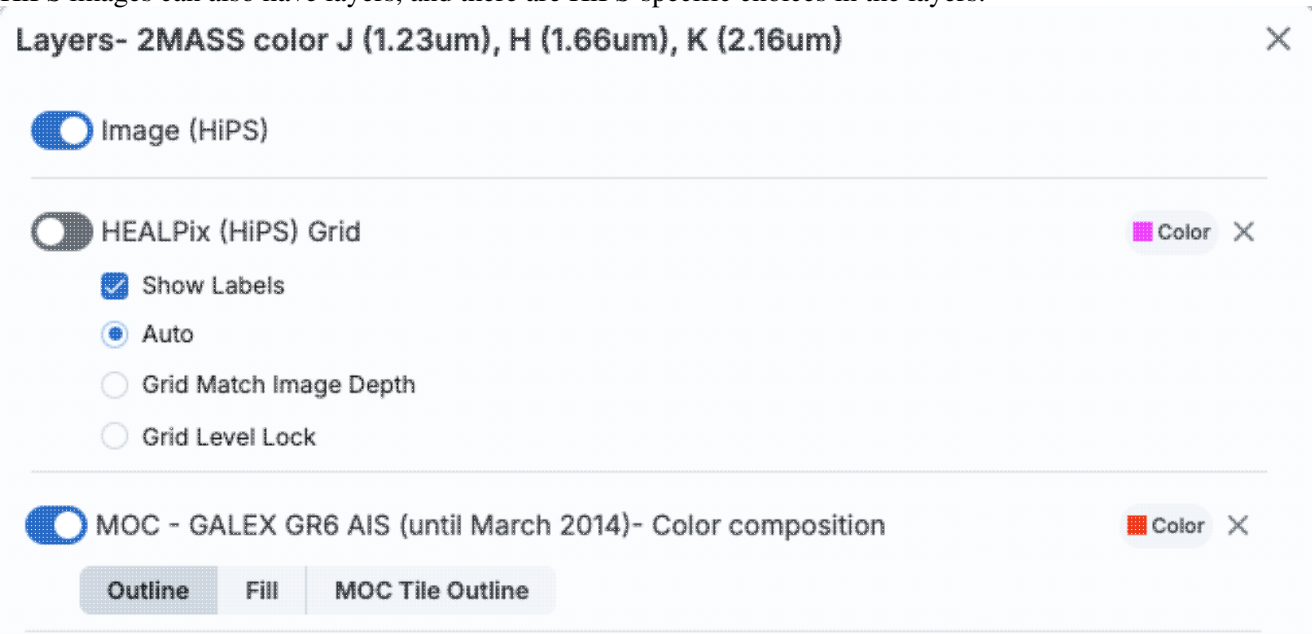
From here, you can click on your desired color in the top colorful box. Immediately below that box, you can change the color and saturation of the top box so that you can select from a different range of colors. Below that, you can enter numerical hex codes or RGBA values (where the value for RGB is between 0 and 255, and A is in units of percent, e.g., 50 = 50%). Finally, you can also select from a pre-defined set of 15 colors by clicking on any of the small boxes. Note that the numerical codes update as you select different colors. Your choices are implemented as soon as you select them. Click 'Close' to close the window, or click 'x' in the upper right.

If you have a catalog loaded into the tool, you can also obtain this pop-up by clicking on the color swatch in the heading of the catalog tab.



For catalogs or the search target, you can also select the symbol shape and size. To adjust the size, type in the symbol size in pixels or use the up/down arrow keys to change the size by one pixel at a time. Your choices are implemented as soon as you select them. Click 'Close' to close the window, or click 'x' in the upper right.

HiPS images can also have layers, and there are HiPS-specific choices in the layers:



HEALPix (HiPS) Grid

To turn on these choices, toggle the switch to the left of "HEALPix (HiPS) Grid". (See images section for more information on HiPS images in general.)

Auto: This option overlays a position grid, with the tile numbers marked in the center of each box. As you continue to zoom in, when smaller tiles are needed, they are drawn, with the new tile numbers marked. You may not zoom beyond HiPS Norder level 14 tiles. The numbers after the "/" is in the "NESTED" (as opposed to RING or NUNIQ) numbering system; see the IVOA standards document for more information.

Grid Match Image Depth: If you select this option, the grid will adjust to a new level when you zoom in and a new level of HiPS image both exists and is used for the display.

Grid Level Lock: Selecting this option yields an additional numerical drop-down menu. The higher number you pick, the smaller the grid boxes are that are drawn. When this option is selected, the boxes stay the same size regardless of how zoomed-in on the image you are.

HiPS MOC

To turn on these choices, toggle the switch to the left of "MOC".

A MOC tells you via a simple boolean yes/no, is there sky coverage from this data set in this region. The choices here are:

◊ Outline - an attempt to outline the entire region covered by the data; it still sometimes struggles near the edges of coverage, so zoom in to get a better sense of the coverage edges.
◊ Fill - filled regions, where you can control the opacity of the overlay by going to the color picker; you control the opacity by changing the number above the "A".
◊ MOC Tile Outline - individual tile outlines, where the tiles are set by the MOC tiles themselves (as opposed to tiles created by the mosaic tiles that make up the data set).

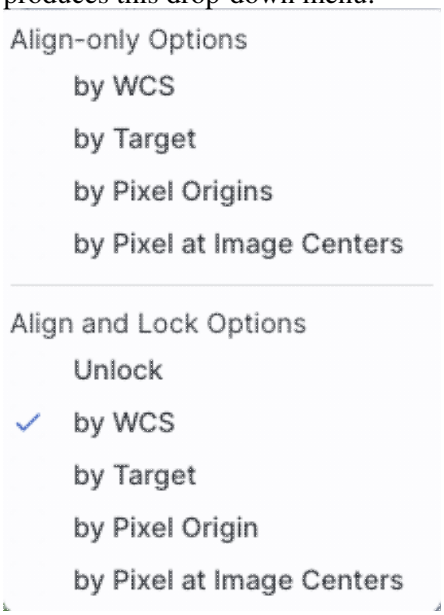
Tips and Troubleshooting:

- The entire concept of a MOC is built upon the "tiles" that are inherent to the HiPS concept. As a result, those tiles are imprinted on how the MOC is rendered, especially near edges or corners of coverage. Strange behavior may result; you can always zoom in to get a better sense of the coverage. For authoritative information, download the actual data for the region you are concerned about.
- For the "fill" option for a MOC, depending on how you display a MOC, you may see two shades of color in the MOC. It is important to note, though, that the information it is displaying does not include depth of coverage, merely boolean "is there data there or not." Why is it displaying shading? Well, it's rounding. For example, a given WISE MOC might be generated at order 13. At this order, there are 805,306,368 HEALPixels on the sky, and they are about 26 arcseconds across. When zoomed out far, there is no point in trying to show each of these pixels, so the application "rounds up" the MOC to an order in which there are roughly 100-200 displayed HEALPixel polygons horizontally across the image. When it does this, it flags the rounded up polygons with the paler color. So the boundaries of a coverage region in the MOC all get a paler color. If you zoom in far enough on a MOC, the two-tone colors go away.
- You might be here in the documentation looking for more information on hierarchical catalog settings; this is also related to HEALPix.

World Coordinate System (WCS) Alignment

As described above, there is a way to lock/unlock images to each other  for position matching. This section describes the image locking in more detail.

When aligning images, you can specify how the images align and for how long. Clicking the lock images icon produces this drop-down menu:



The first set of options aligns the images only once; the second set of options makes the alignment persist ("lock") when you move (zoom, etc.) the images.

You can align by the images' WCS (world coordinate system, e.g., RA and Dec), by the target (align by target on the screen, regardless of position in the sky), by the pixels according to the origin of the coordinate system in

the image header, or by the pixel at the image center. The most common choice is likely the WCS align and lock.

Note that aligning by WCS puts North up, and aligned so that each image has the same angular scale.

Extraction Tools

Several tools allow you to extract information from images or image planes, but only for FITS (not HiPS) files. Many of the files found in the SOFIA Archive are literally the files for which the drill extraction was designed.

-  -- Extract down through image planes
-  -- Extract a line from the image
-  -- Extract points from the image

All three of these follow the same basic structure --

1. Intitiate extraction mode
2. Set aperture
3. Try extraction; repeat if desired
4. Pin (retain) extraction if desired
5. Download (as table or chart) if desired
6. Repeat if desired
7. Click on "end extraction" to finish the process.

The drill pokes down through multiple planes, the line moves across pixels in a plane, and the points extracts points from a plane.

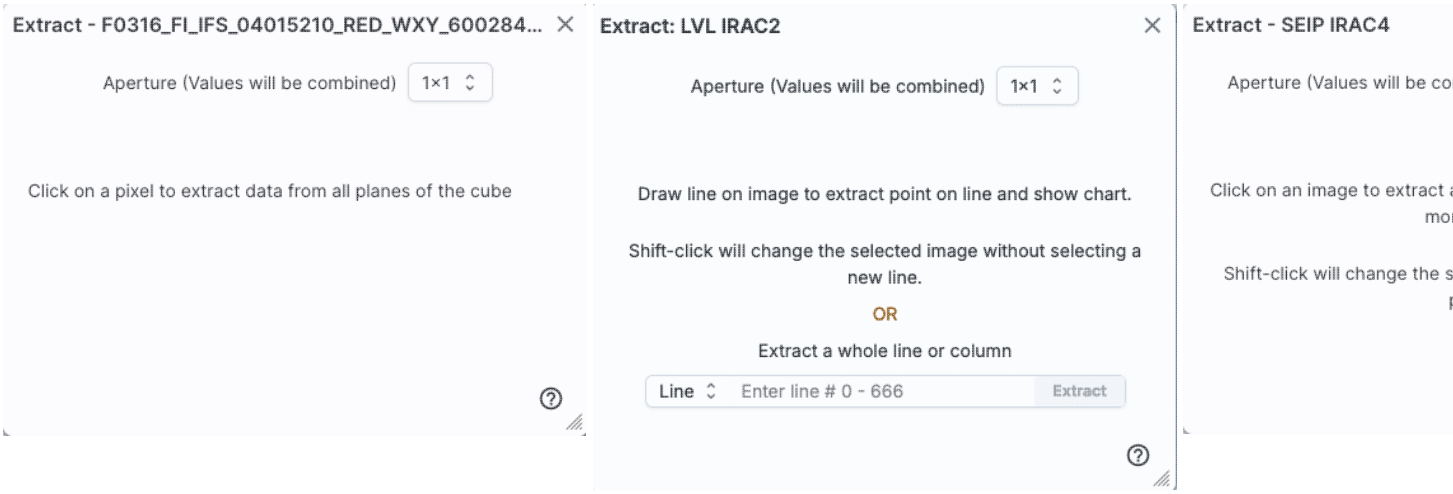
Here, we cover the basic approach, with specifics of each tool integrated as we go along.

Intitiate extraction mode. When you click on one of these icons, you enter into the extraction mode. Text appears next to the image toolbar to remind you that you are in this mode: 

When you are done, to end this mode, click on this "end extraction."

When starting out, the pop-up window that you get depends on the tool you pick.

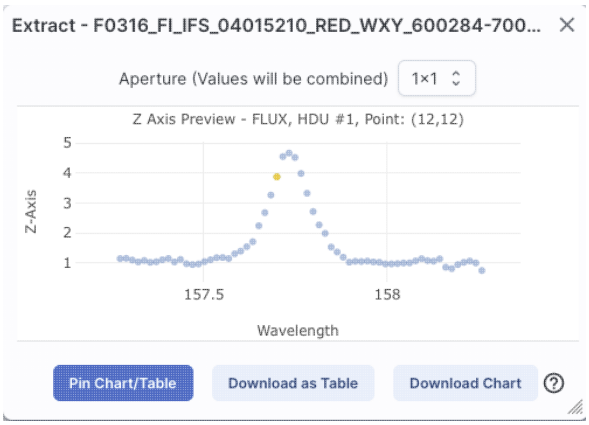
For the drill: for the line: and for the points:



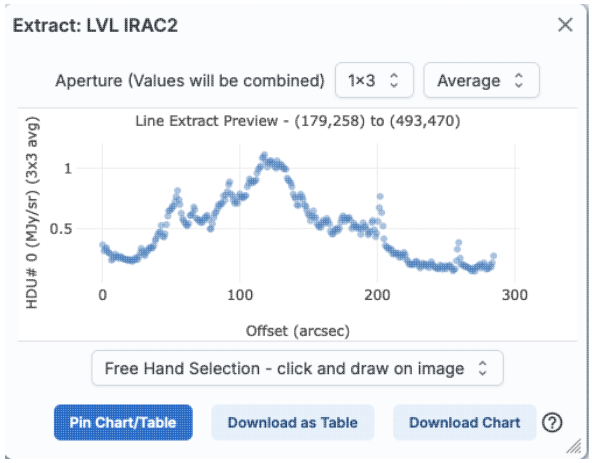
Set aperture. In all three cases, the top center of the extract pop-up window has a drop-down from which you can select the aperture value. For the drill and points, you can choose, in pixels, 1x1, 3x3, 5x5, or 7x7. Values can be summed or averaged. For the line, it's a little different. The apertures are 1x1, 1x3, 1x5, or 1x7, and you control whether the points are summed or averaged. You can have it extract along a line that you draw with your mouse on the image (useful for examining brightness profiles, e.g., across spiral arms of a galaxy), or you can have it extract an entire line or column of the image that you specify (useful in the cases where the 'image' is a file where the first row is an extracted spectrum, the second row is the error, the third row is a mask, etc.).

Try extraction. From this point, you can click on your image, or click and drag for the line tool. The pop-up then contains a plot of your extraction.

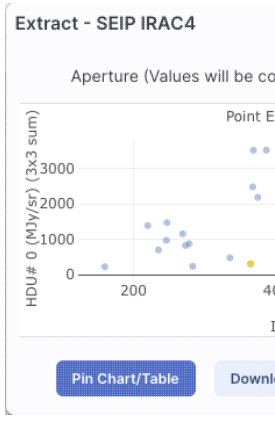
For the drill:



for the line:



and for the points:

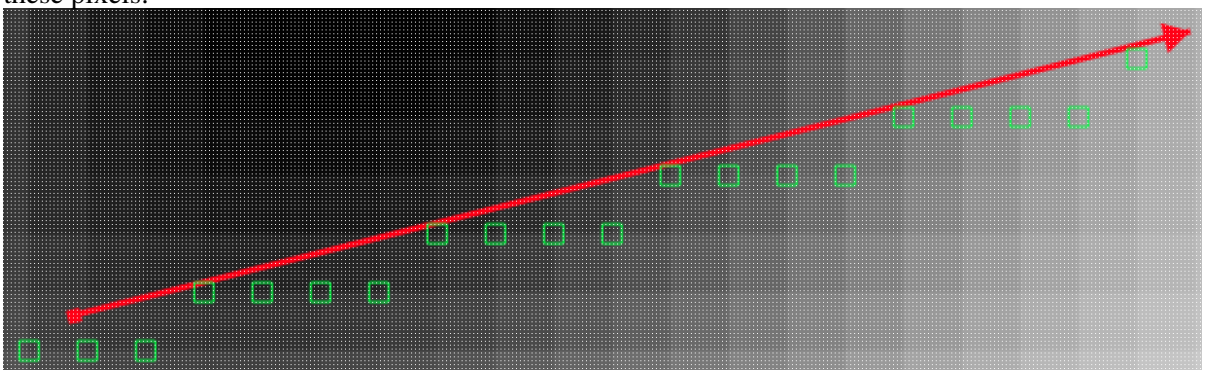


In each of these cases, it does the best that it can to label the axes accordingly. The cube that is used for the drill example here follows the spectral data model so that it is recognized as a spectrum, and it plots against wavelength. The line extraction is a 1x3 average and plots the offset in arcseconds from the initial mouse click, given the WCS information in the header of the image. The point extraction is a 3x3 sum, and plotted in image x coordinates, but can be changed to show image y coordinates.

Note that for the line, if you have more than one image loaded and visible, you can shift-click on a new image to see the same line on a new image. Similarly, for the points, you can shift-click to change images without extracting points. For the line extraction, if you want to change at this point to extraction along a line or column, use the drop-down menu at the bottom of the pop-up (shown here as "free hand selection").

Pin extraction. Once you have an extraction that you like, you can retain the extraction for further analysis. "*Pin chart/table*" extracts the information as a table, just like any of the other tables in this tool, with an accompanying plot. You can then manipulate the table/plot just like any other table or plot in this tool. If the tool recognizes the extraction as a spectrum, you may have additional capabilities.

Once you pin or save your extraction, the tool leaves a "footprint" of your extraction on the image so that you can remember what the extraction was. **NOTE THAT it is not interpolating** across fractional pixels here. It is averaging if you have asked it to average, but particularly if your pixels are large, if you draw a line that is diagonally across pixels, it will be immediately obvious that it's not interpolating. This line gets rendered as these pixels:



The point appears on the image at the lower left corner of the relevant pixel.

You can pin as many different extractions as you want. Each one will result in new tabs with the corresponding table at the bottom of the screen. There are navigation aids within the tables section that may help.

Download extraction. You can download the extraction as a table or plot without pinning it. *Download as Table* saves the table to your local disk with all the same options as a regular table. *Download Chart* saves the plot as shown, as a png file.

After pinning an extraction, you also have the extraction appearing as a table in the tables section of your window and as a plot in the plots section of your window. As with any table in this tool, you can save the table by clicking on the diskette icon in the table. You can choose from a variety of formats; see the tables chapter for more information. Similarly, as with any plot in this tool, you can save the plot by clicking on the diskette icon in the plot. See the plots chapter for more information.

Repeat extraction. As long as the extraction pop-up is still open, you can continue to click points or draw lines to make additional extractions.

End extraction mode. 

When you are done, to end the extraction, click on "end extraction" to end the extraction. Alternatively, just click on the 'x' in the upper right corner of the extraction pop-up.

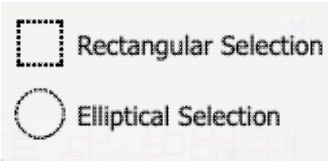
Tips and Troubleshooting:

- The FIFI-LS high-level data cubes that have one wavelength per plane are, in fact, among the data files for which the drill extraction was built. If you drill and then pin the extraction, the data table (and accompanying plot) has the extracted flux densities and errors(!) propagated properly.
- Other data products from other SOFIA instruments are represented as images (because, well, they are images), but they are also relatively advanced data products; the first row of the image may be the spectrum, the second the errors, etc. The line extraction tool allows you to plot (and extract/pin) just one row (or column) from the image without having to carefully draw a line on the image with your mouse.

Region Selection

 When you click this icon, you can select a region of the image, from which then you can do a whole host of things to the image and to the catalog you may have overlaid upon it.

First, from the drop-down, you are given a choice of a rectangular selection or an elliptical selection:

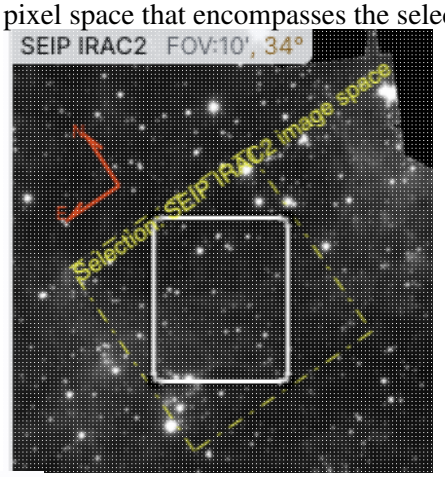


After you make that choice, you can click and drag in the image, selecting a box or a circle on the image. For the circle, your click is the center of the circle and the drag is the radius of the circle; for the box, your first click is one corner of the rectangle, and the drag is the opposite corner of the rectangle. This region can be resized by grabbing and dragging the corners of the box or the pixels delineating the corners of a box around your code. If you need to move the image underneath, you can hold the shift key and click and drag.

When you have selected a region of the image, additional icons appear above the image, and exactly which icons you see is a function of whether you are working on a FITS or HiPS image, and whether or not you have a catalog overlaid:  These icons allow you to do several things:

 *Crop the image*
(FITS only) Crop the image to the selected region. Then you can save the cropped FITS image via the save icon described above.

Note that, if you have a rotated FITS image such that a crop would have to bisect pixels, it will show you the region that encompasses your selection. If you crop at that point, then, it will crop in image space (such that pixels are not bisected). See the figure below -- in the original image, north is up. This has been rotated 45 degrees. The selected region is in white. The yellow dash-dot line is the crop in pixel space that encompasses the selected region.



 *Select sources* (and *cancel selection*)
(Only if a catalog is overlaid) Select the catalog sources overlaid on the image within the region. Selecting highlights the sources in the list and plot with a different color row or symbol. Once there are

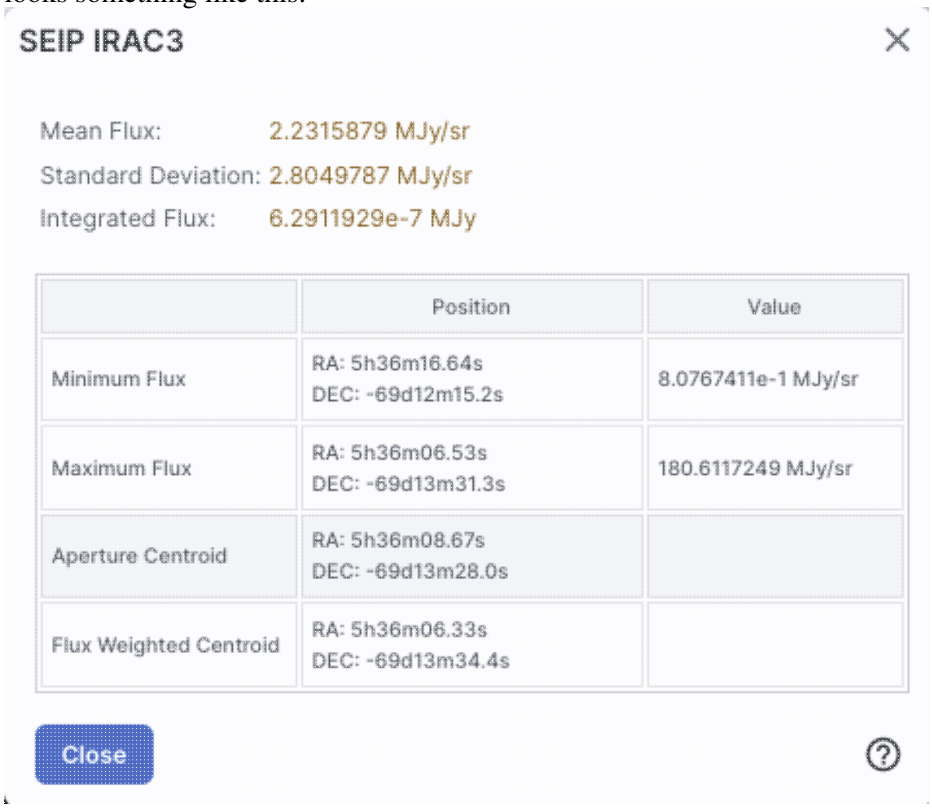
selections made, the second icon appears to give you an option to cancel the selection.

Filter sources
(Only if a catalog is overlaid) Filter the overlaid catalog down to the sources within the enclosed area. When you choose to impose a filter via this selection mechanism; the filters icon changes above the catalog to indicate that there is a filter applied ( ). To clear the filters, click on the cancel filters icon (which also appears after you impose filters): . There is much more on filters in the Tables section.

Zoom the image
Zoom the image to fit the selected area into your field of view.

Recenter the image
Recenter the image on the selected area.

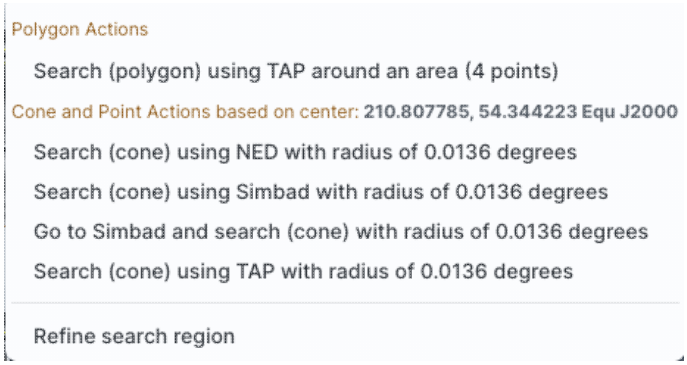
Obtain statistics
(FITS only) Obtain statistics from the image on the region. The statistics option results in a pop-up that looks something like this:



Note that it calculates the location of the minimum and maximum fluxes, and the aperture and flux-weighted centroids; the flux values given are in the same units as the FITS file. If you put your mouse over the row of the table in the pop-up, that location appears as an 'x' on the image.

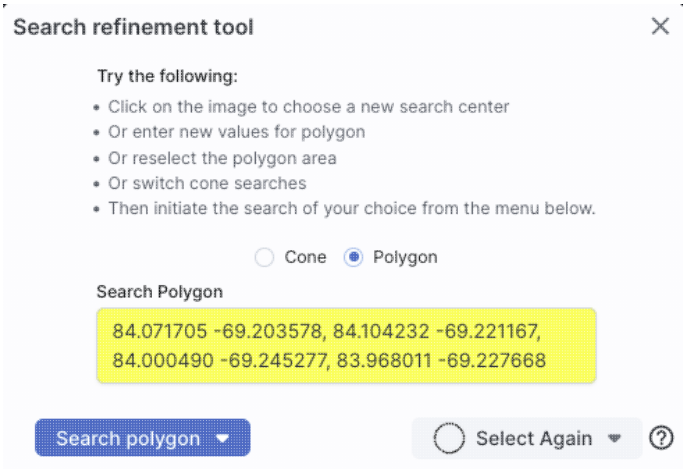
Search

This tool implements a new search, an "action", on the region you have selected. It results in this drop-down (right). where this example is based on a region centered on 84.036131, -69.224431, J2000 decimal degrees, over a 4-cornered polygon. (You can also use the region tool to define a cone; this example happends to be a rectangle.) From this drop-down, you can launch:



- ◊ A TAP polygon search over this region (more information about TAP searches)
- ◊ A NED cone search at this position with a radius attempting to correspond to this polygon (more information about NED searches); results loaded into this tool.
- ◊ A Simbad cone search at this position with a radius attempting to correspond to this polygon; results loaded into this tool.
- ◊ A Simbad cone search at this position with a radius attempting to correspond to this polygon, but launch another browser window or tab at Simbad with the results.
- ◊ A TAP cone search at this position with a radius attempting to correspond to this polygon (more information about TAP searches); results loaded into this tool.
- ◊ Refine the search region.

The last option brings up another pop-up window (similar to this) that allows you to refine the search region iteratively by choosing a cone or polygon, setting the center, and setting the cone size or polygon vertices.



From here, you can change the kind of search, refine the positions, launch searches from your refined

position (blue button on lower left), and select from the image again (drop-down on the lower right).

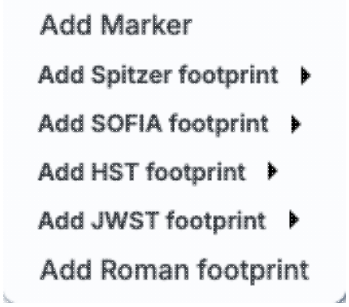
When you are working with the selection tool, this: End Select appears next to the image toolbar to remind you that you are in that mode. If you are refinifng positions for a search, it will be End Search Marker. Either way, when you are done with the selection tool, if your other actions don't turn off the selection tool, click on that text to turn it off.

Tips and Troubleshooting

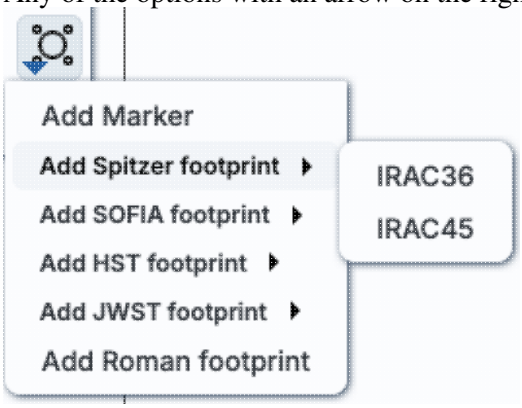
- The "region selection" tool also appears in the slightly different context of interactive target refinement in several other places in this tool, where it works in a a very similar fashion.

Footprints

The marker icon ( ) has a drop-down menu with several possible options:



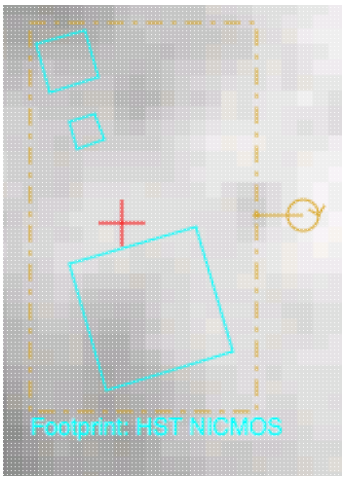
Any of the options with an arrow on the right can expand to additional subsidiary choices, e.g.,:



We now describe these various footprints here.

For each of these choices, the markers appear initially in the center of the loaded images. The first mouse click you make in any of the images will move the marker to that location.

Each of these marker choices, when overlaid and/or selected as 'active', has a dot-dash square around it. If it is asymmetrical (most of them are), it has an additional "appendage" and a red plus at the center of the footprint:



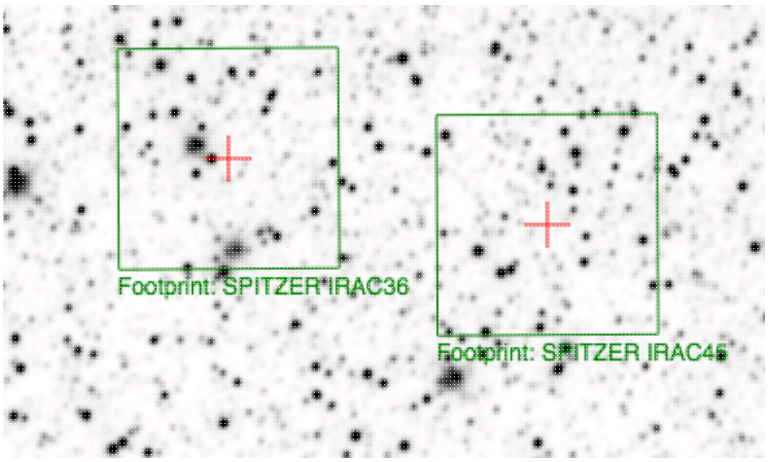
These so-called "handles" allow you to resize and/or rotate the marker, depending on the nature of the marker. These handles only appear when the marker is selected as active; if you wait a few seconds, they vanish.

Tips and Troubleshooting

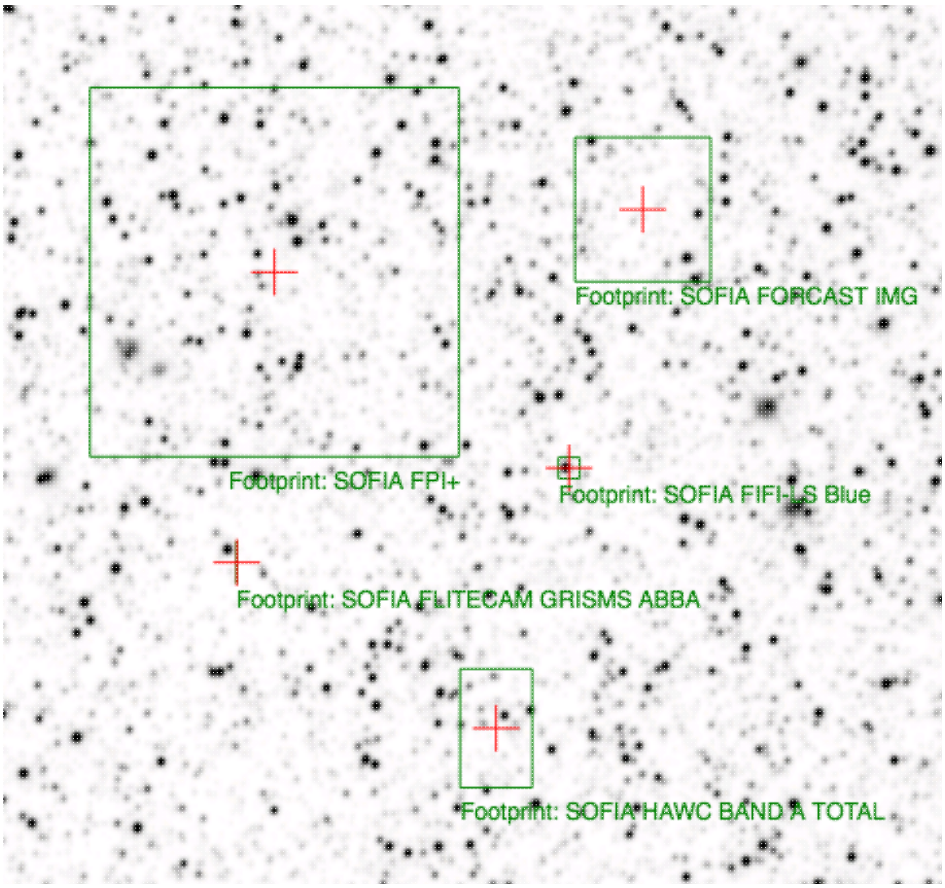
- Some of these footprints are *large*. If you have a small image, some of these footprints will be larger than your image. Zoom out to see it, or find a larger image to use. If you overlay, say, a Nancy Grace Roman Space Telescope (formerly WFIRST) footprint on a 2MASS Atlas FITS image, you may need to zoom out a considerable amount before you can see the Roman footprint. You will see the center indicator of the marker before you will see the Roman footprint itself.
- You can add multiple copies of the same marker using the layers pop-up (described generally above). From the layers pop-up, there is a link right under the 'angle' option that says "Add another [marker type]" -- click on that to get an additional marker of the same type. You can also add a label to the marker from the layers pop-up, or change its color.
- If you have many footprints on the same image, you may have trouble grabbing and moving footprints lower in the stack of layers on the image. For example, overlay footprint 1, then footprint 2, and you might have a hard time grabbing and rotating footprint 1 after footprint 2 has been added. The only workaround here is to use the layers pop-up (described generally above) to temporarily hide footprint 2, then move footprint 1, then restore footprint 2.
- If you have images of very different resolutions loaded (e.g., IRAS and really anything else), sometimes it struggles to render the marker on each image. You may need to place markers on one image at a time. (Unclick the "lock color & overlays" option to place markers one image at a time.)

The first overlay choice (simply called 'marker') is a red circle.

The remaining markers are all footprints from various telescopes: Spitzer, SOFIA, HST, JWST, and Roman. HST, JWST and Roman are derived from information provided via MAST (see http://gsss.stsci.edu/webservices/footprints/help.html ⧉.) For Roman in particular, they are pre-launch values.



Spitzer/IRAC 3.6 and 4.5 micron footprints. These two footprints are placed separately from each other. The footprint can be moved or rotated. Click and drag the center of the footprint. A circle appears with four small circles ("handles") around it. Grab and drag the small circles to rotate it, or drag the big circle to move it. Change the color, delete, or add more copies of the IRAC footprints from the layers pop-up.

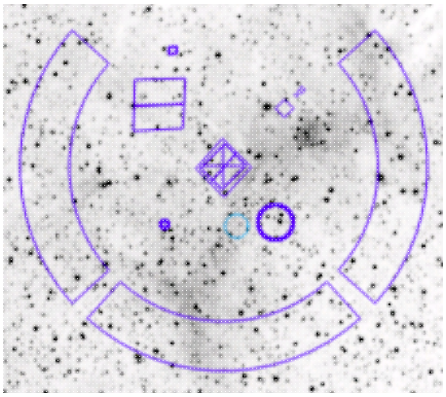


SOFIA footprints. Several different SOFIA footprints are available; the graphic here shows a selection of them. The available footprints (all of which are placed separately) are:

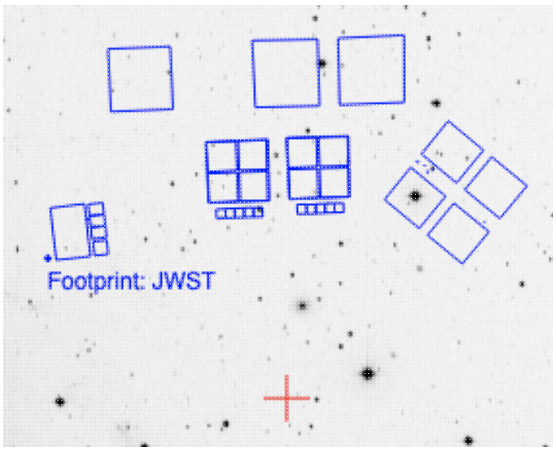
- FIFI-LS
  - Blue (50-120 microns)
  - Red (110-200 microns)
- FLITECAM
  - Imaging

    - Grism ABBA
    - Grism AB
- FORCAST
    - Imaging
    - Grism a
    - Grism b
- FPI+
- HAWC+
    - 53 microns (Band A), Total Intensity
    - 53 microns (Band A), Polarization
    - 89 microns (Band C), Total Intensity
    - 89 microns (Band C), Polarization
    - 154 microns (Band D), Total Intensity
    - 154 microns (Band D), Polarization
    - 214 microns (Band E), Total Intensity
    - 214 microns (Band E), Polarization

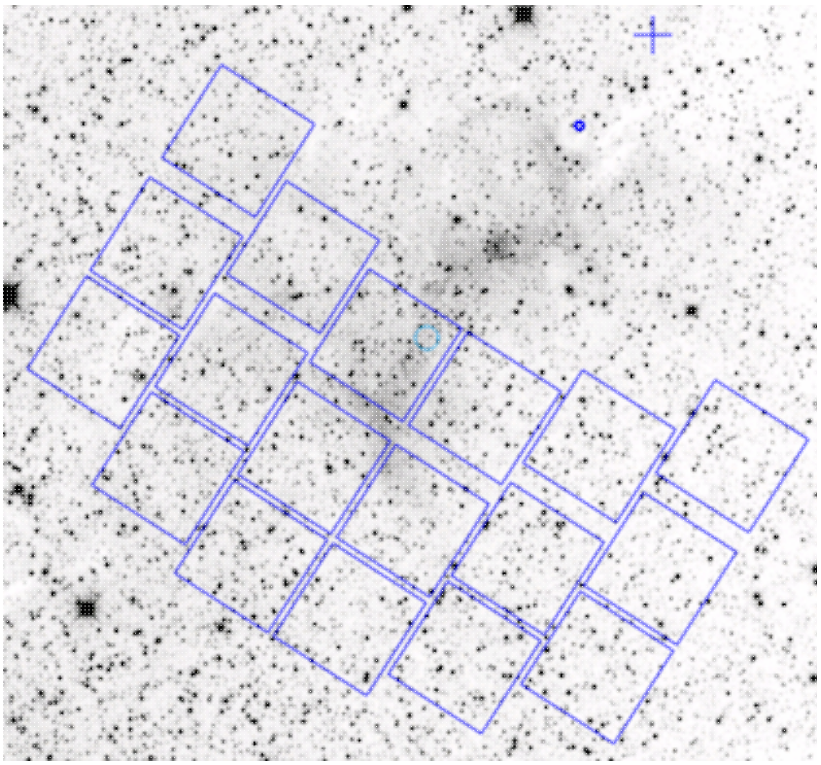
Change the color, delete, or add more copies of the SOFIA footprints from the layers pop-up.



HST footprints. You can overlay the whole focal plane footprint, shown here, or individual instrument footprints (NICMOS, WFPC2, ACS/WFC, ACS/HRC, ACS/SBC, WFC3/UVIS, and WFC3/IR). Consult the HST documentation for specifics on which apertures are which. The footprint can be moved or rotated. Click and drag the center of the footprint. A circle appears with four small circles ("handles") around it. Grab and drag the small circles to rotate it, or drag the big circle to move it. **Note that** if you overlay the footprint on a very small image, nothing will appear to have happened. You need at least a 45 arcmin image to comfortably see the footprint. Change the color, delete, or add more copies of the HST footprints from the layers pop-up.



JWST footprints. You can overlay the whole focal plane footprint, shown here, or individual instrument footprints (FGS, MIRI, NIRCAM, NIS, and NIRSPEC). **Note that** if you overlay the footprint on a very small image, nothing will appear to have happened. You need at least a 30 arcmin image to comfortably see the entire JWST focal plane. Please consult the JWST documentation for details about the footprints. In all cases, if the footprint is 'active', a circle near the middle of the footprint will appear with four small circles ("handles") around it. Grab and drag the small circles to rotate it, or drag the big circle to move it. Change the color, delete, or add more copies of the footprints from the layers pop-up.



Nancy Grace Roman Space Telescope focal plane footprint. As above, the footprint can be moved or rotated. Click and drag the boresight (the cross hairs), which appears by default to the upper right of the array of squares. A circle appears, centered on the boresight, with four small circles ("handles") around it. Grab and drag the small circles to rotate it, or drag the big circle to move it. **Note that** if you overlay the footprint on a very small image, nothing will appear to have happened. You need at least a 60 arcmin image to comfortably see the footprint, and even then you will probably have to click and drag to see the entire footprint. Consult the Roman documentation for specifics on the apertures. Change the color, delete, or add more copies of the Roman footprint from the layers pop-up.

SOFIA Science Data Archive: Tables

All of the tables in the SOFIA Science Data Archive (whether they are catalogs, or spectra, or the contents of a FITS or HiPS header, or a list of results) are interactive tables, and they have the same basic properties, discussed in this section. The specific broad cases of catalogs and spectra are in other sections.

Contents of page/chapter:

Table Header

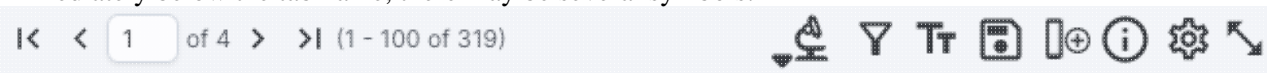
These interactive tables -- called Firefly tables, after the software that is running here -- all have the same functionality, regardless of the contents of the table. If it looks like this sort of table, you can work with it whether it is a catalog, an image header, a list of images, etc.

If you have loaded a catalog into a tab and it doesn't take up the whole screen, to see more of the window, grab the divider between the window panes and slide it up/down or over as needed, or use the expand arrow icon ( ) to enlarge the window pane to take up the whole window.

The table is shown exactly as it has been provided to the tool, with all columns as defined by the creator of the table. To understand what each column is, please see the documentation associated with that catalog or table.

The tab (and table) name itself likely indicates its origin. To remove the tab, it is likely that you can click on the "X" on the tab.

Immediately below the tab name, there may be several symbols:



which we now describe, going from left to right along the top of the tab.

Table navigation
The first thing to notice is that (typically) only the first 100 rows of the retrieved catalog (or table) are displayed in the table. In the example here, there are 319 sources that were retrieved as a result of the search, grouped into 4 'pages.' The left/right black arrows plus the page number allow you to navigate among these 'pages' of 100 sources each. Note that the entire set of results (not just the 100 rows you are currently viewing) can be sorted by clicking on any column's name.


Table Actions: Searches
This drop-down has choices to launch new searches, and as such, it has a separate section below.

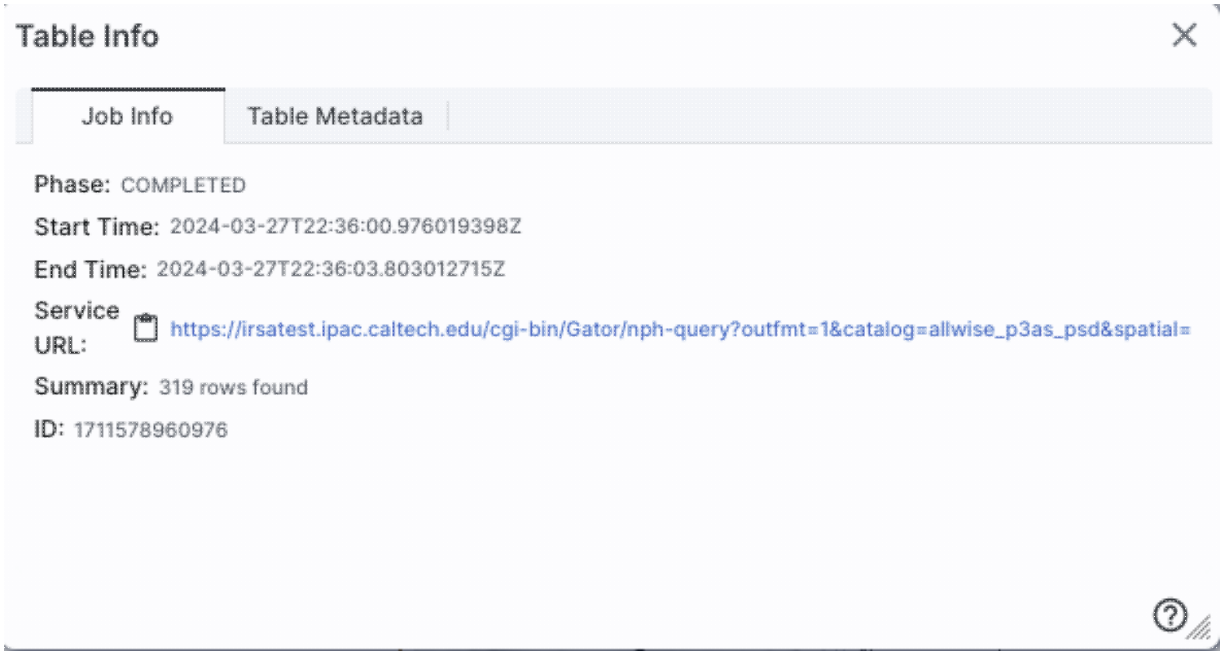
Filter
Filters are complex and powerful enough that they are covered in a separate section below.

Table as text
Clicking on this changes the table display into a fixed-width text display. The icon then changes to click this again to return to the default table view.

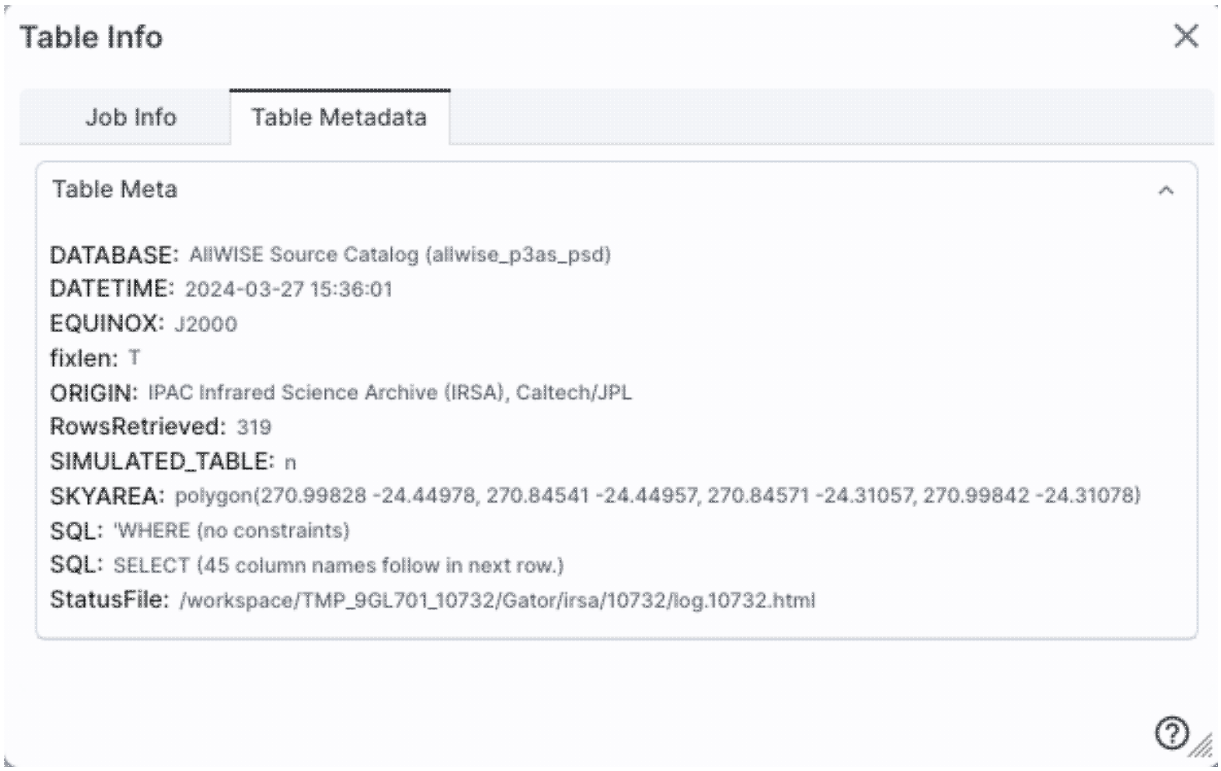
Save table
This is how you can save the table. It has a separate section below.

Add a column
This icon adds a new column to the table. This has a separate section below.

Info link
You may or may not see this icon. This is an "information" button and, if it exists, it may provide additional information about the table. It could have information about the job that was used to retrieve it:



where the direct link to the job is given there (and can be copied by clicking on the clipboard, ready to be pasted into a helpdesk query, for example), with a job id as shown. It could also just have information about the table metadata:



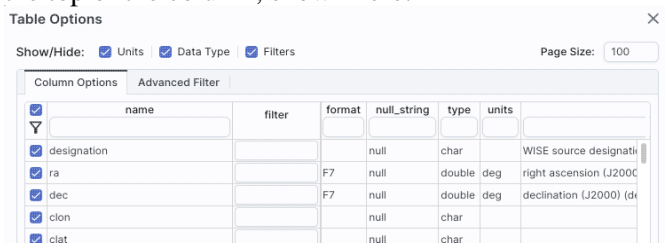
where the information about this table includes information about the query that produced it.

Row details

You may or may not see this icon. This is how you get more information about the currently-selected row. It has a separate section below.

Table options

Clicking on this icon brings up options for the table, e.g., how many rows are displayed per page, which columns are shown, metadata about each column if available, whether units and data types are shown at the top of the column, shown here:



By default, it is often but not always the case that all columns are shown. To show or hide columns, select the tickbox in each given row. The default page size is 100 rows. Note that expanding the page size to numbers much greater than 100 may result in a substantial performance degradation (e.g., your browser will appear to freeze or not appear to be doing anything while it manages and renders the large table). See the Filters section below for more things to do from the table options pop-up.

Expand

Clicking on this expands the catalog window pane to take up the entire browser window. To return to the prior view, click on "Close" in the upper left.

Help

The last option on the top of the catalog tab may be a context-sensitive help marker, which should bring you to this online help.

Table Columns

Depending on what you did to display a table, the columns that are shown may be in easily-human-readable form, or may reflect column names used within the individual catalog. Please consult the detailed documentation associated with your specific table if the headers are not clear to you.

The table is shown exactly as it appears in the corresponding database (or as it appeared on your disk), with all columns as defined for that catalog. To understand what each column is, please see the documentation associated with that catalog. (For IRSA catalogs, this documentation is available via navigating through the IRSA website.)

Clicking on the column names sorts the table by that column; clicking once sorts in ascending order, clicking a second time sorts in descending order, and clicking a third time returns the table to the original order. Small arrows appear next to the column names to remind you if the column is sorted in ascending or descending order. When you do a single-position search on catalogs, depending on how you do it, it could be that two new columns are appended to the end of the catalog as it is returned to you. These columns are:

- dist - the distance between the source in question and the location you specified
- angle - the position angle between the target position you requested and the object it found (degrees E of N)

When you do a multi-position search on catalogs, you could have three new columns prepended to the catalog as it is returned to you. These columns are :

- cntr_01 - the target position you requested
- dist_x - the distance between the target position you requested and the object it found
- pang_x - the position angle between the target position you requested and the object it found (degrees E of N)

These additional columns can help you assess if the target it found is the target that should be matched to the position you requested.

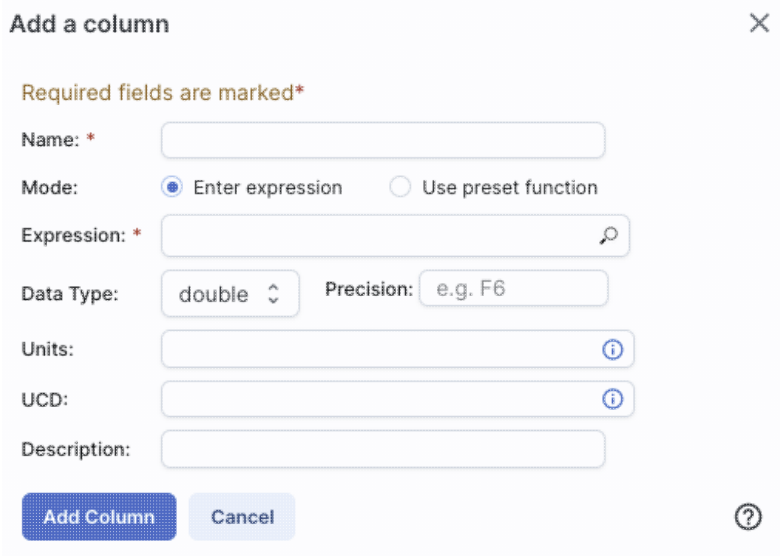
It could be that, when you do a multi-position search on catalogs, you have an option for "one-to-one matching". If that is selected, the line (and only one line) of output is included for each line of input. It chooses the closest source within the radius you specify, or if there is no match, it adds a line indicating no match.

Tips and Troubleshooting

- You can hide or display columns; click on the gears () to get to the table options, and tick the box corresponding to the row you want to hide or show.
- If you are constructing and loading your own catalog where you don't specify the formatting, the tool tries to guess the formatting of the column based on the first row's values. Therefore, if you have a value in the first row that happens to be a string like "null" where the rest of the column isn't like that, or happens to have only one decimal place where the rest of the column has 2 or more, it will guess incorrectly and format the other rows just like the first one. Try editing your catalog file to put the most general case as the first row.

Adding Columns

This icon  allows you to add a new column to your catalog. When you click on it, it brings up this pop-up window:



This window asks for:

- *Name* of the column (required) -- it cannot have special characters like a minus sign or a percent symbol; you can only use letters, numbers, and underscores.
- *Mode* "Enter expression" or "Use preset function" -- options shown here correspond to "Enter expression" options; the preset function options are included in the last bullet here.
- *Expression* (required) -- using basic SQL operators, you can manipulate columns to create the new column. (See more on this below.)
- *Data Type* -- specify if your new column is a double precision floating point ("double"), a long integer ("long"), or a string ("char").
- *Precision* -- if you have selected "double" for data type, select how many decimal places your new column should display. For example, if you want the numbers to display as 1.23, enter "F2".
- *Units* -- specify the units of your new column. For more information, see IVOA documentation
- *UCD*, or unified content descriptor -- for VO compliance, add this for your new column. For more information, see IVOA documentation
- *Description* -- add a description for your new column.
- *Select a preset* -- if you select "Use preset function", you can choose (a) "set filtered rows to 'true' and the rest to 'false'", (b) "set selected rows to 'true' and the rest to 'false'", or (c) "number rows in current sort order". These options are useful for tagging items you have selected in myriad ways (from plots, images, complicated filters), or ordered in complicated ways. For example, if you have constructed a complicated filter, then you can create a column that is true for the selected rows; if you cancel the complicated filter, you can then easily recreate the complicated filter by simply filtering on your newly created column.

In order to construct the expression for your new column, your input should follow the syntax of an SQL expression. If you click on the magnifying glass next to the form input, you get a pop-up window that can help you construct an expression; click "apply" to apply the expression.

You need to use the column names exactly as they appear in your catalog. Supported operators are: +, -, *, /, =, >, <, >=, <=, !=, LIKE, IN, IS NULL, IS NOT NULL. You may use functions as well; for a list of all available

functions, see here. Some examples include:

- "w3mpro" - "w4mpro"
- sqrt(power("w3sigmpro",2) + power("w4sigmpro",2))
- ("ra"-82.0158188)*cos(radians("dec"))
- "phot_g_mean_mag"-(5*log10(1000/"parallax") - 5)

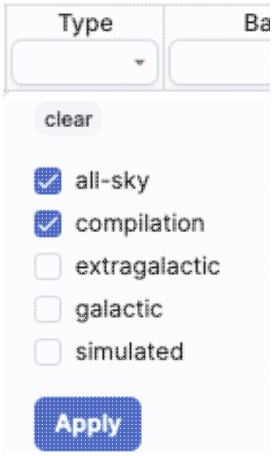
Tips and Troubleshooting

- When you create a new column that is calculated from other columns, it is created statically. That is, it is not dynamically updated like a spreadsheet, but calculated once and left alone after that.
- When you create a new column, the header of the new column is red to let you know that the column is not present in the original catalog.
- When you save the catalog, the header of the saved catalog indicates that you have added a column. When you load the catalog back into the tool, the header of the new column is still red.
- You can edit or delete columns after you have created them; click on the gears ( ) to get to the table options, and then click on the edit icon to bring up a dialog box to edit or delete the column.
- You can hide columns; click on the gears ( ) to get to the table options, and tick the box corresponding to the row you want to hide or show.
- If you create a new column that turns a floating point column into an integer with the "FLOOR()" function, you need to be sure to set the resulting column type to "long". For example, if you have data covering several days or years, and you have a column that is a floating-point MJD, you can convert it into an integer, e.g., via FLOOR(mjd) for days or FLOOR(mjd/365.24) for years, then you can use the drop-down filter menu for the new column to quickly compare different time ranges. But, the new column must be an integer (e.g., "long") in order for this to work properly.
- If you need to, say, take the square root of a column that occasionally has a negative number, and you want it to attempt to handle this in a physically reasonable manner, you can construct expressions like this for a column named 'col' that has some positive and some negative numbers:
  if("col">=0,sqrt("col"),-sqrt(-"col"))

Table Filters

Filters are a *very* powerful way of exploring the table full of search results. Click on this icon in order to start the process of adding filters. A text entry box appears above each of the current catalog columns, with a small version of the filter icon corresponding to that row on the far left. You can type operators and values in these boxes -- hit return or tab after typing or click in another box to implement the filter.

Example: From a catalog, show only those sources with declination above a certain value (say, 31 degrees), type "> 31" in the box at the top of the "dec" column. Or, if you have retrieved a WISE catalog and would like to only view the objects with a W1 (3.4 micron) profile-fitted magnitude less than 6 magnitudes, in the box at the top of the 'w1mpro' column, type "< 6" in the form.



For columns (fields) with a limited set of choices, on the right edge of the text entry box, an arrow appears; click on it to get a drop-down from which you can select the available choices. To implement the filter, make the choices, and click "Apply" when you are done. Click "clear" in the top of the drop-down menu to remove that filter.

After you impose a filter, then the number of rows in the table is restricted according to the rules you have specified, and the "filters" icon on the top right of the catalog pane has changed to remind you that there has been a filter applied, in this case four filters:  . To clear the filters, click on the cancel filters icon (which also appears after you impose filters):  .

Filters can be used in combination. Note that the filters between columns are logically "AND"ed together, but filters within the same column can be logically "AND"ed or "OR"ed together; examples are below.

The available logical operators are :

- = which means 'equal to' (exactly!), e.g., the parameter on which you are querying (the column headers as shown) is exactly equal to this value you are specifying.
- > which means 'greater than'
- < which mean 'less than'
- != which means 'not equal to' (exactly!)
- >= which means 'greater than or equal to'
- <= which means 'less than or equal to'
- IN which means 'included within this list', e.g., the parameter on which you are querying is included within the list you are specifying (if the column filter is free-form text, type "value1,value2" and it will give you rows that have value1 or value2).
- LIKE which means 'resembles the text that is entered', e.g., the text resembles the text that you type in the box.
- IS which effectively is the same as =
- IS NOT which effectively is the same as !=

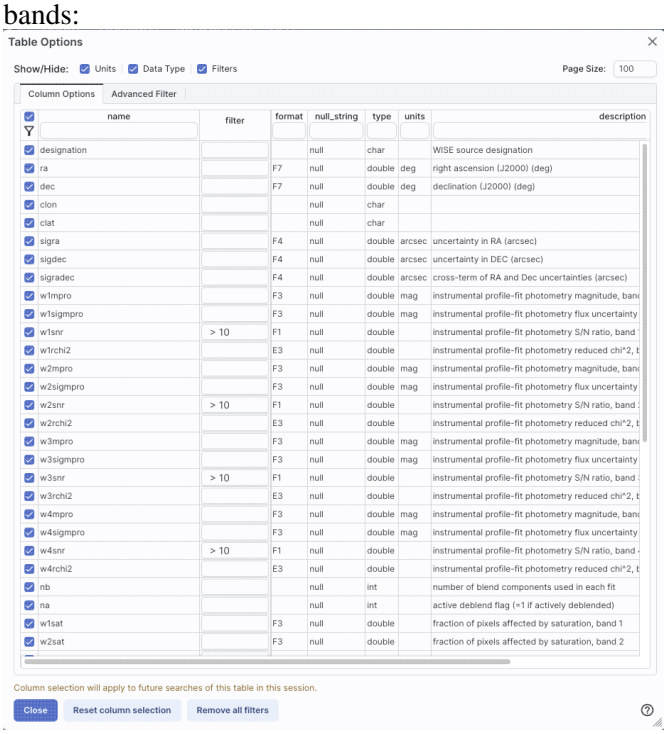
Examples:

- Retain rows for which a certain parameter is not an empty string: !="
- Retain rows for which a certain parameter is not NULL and is larger than 1.234: > 1.234 and IS NOT NULL
- Retain rows that have values between -0.5 and 1.25: > -05 and < 1.25
- Retain rows with a parameter greater than one value or exactly not equal to another value: > 12345 or != 3000
- Retain rows with a parameter equal to one of the values in a list: IN a,b,c,d

You can also interactively impose filters from plots from a catalog. Moreover, all the same operators that are available for making plots can be applied in filters. In both cases, see the plots section for more information.

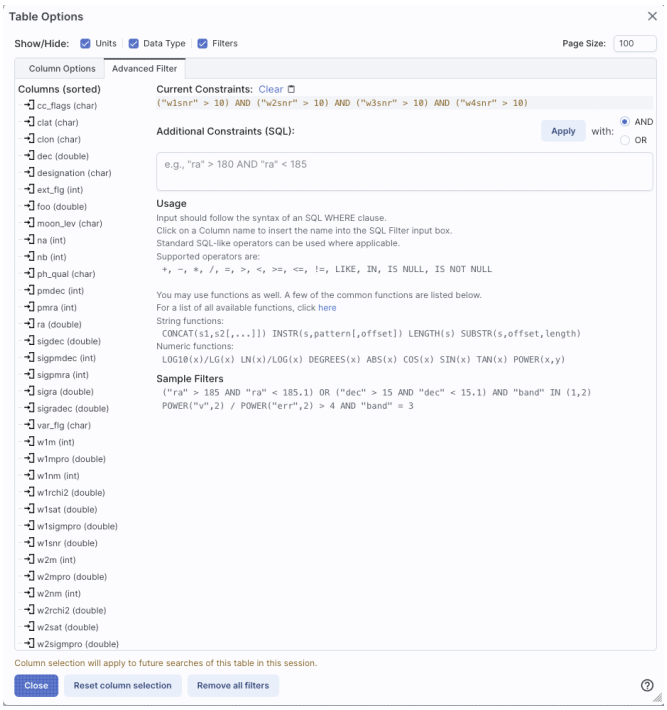
You may also be able to select rows one at a time via the far left column and then filter that down. Example: Retrieve a catalog of any sort. Select rows by ticking the box on the far left, say, every other row out of the first 12. Click on the filter icon on the top of the column. The filter is imposed to only include the 6 rows you selected.

If you click on the table options icon ( ), you get a pop-up that includes a place to filter columns. Here is an example of the table columns for a WISE catalog that has been filtered to just have SNR>10 for each of the four bands:



You can type in constraints in the filter box in much the same way as you can from the catalog itself; note that the column description is included here, which may make this way of setting filters more useful when working with a new (to you) catalog.

The second tab is the advanced filter interface:



Here, the columns are listed alphabetically on the left, the constraints you have imposed are in the "current constraints" box, and you can apply additional SQL constraints via the free-form text box. Hints for syntax are given below the entry box. This window can be resized such that you can see the whole set of hints and imposed filters. Note that in this interface, column headers must be enclosed within double quotes.

Cancelling filters

After you impose a filter, then the "filters" icon on the top right of the catalog pane has changed to remind you that there has been a filter applied, in this case just one filter:  To clear all the filters at once, click on the cancel filters icon (which also appears after you impose filters):  .

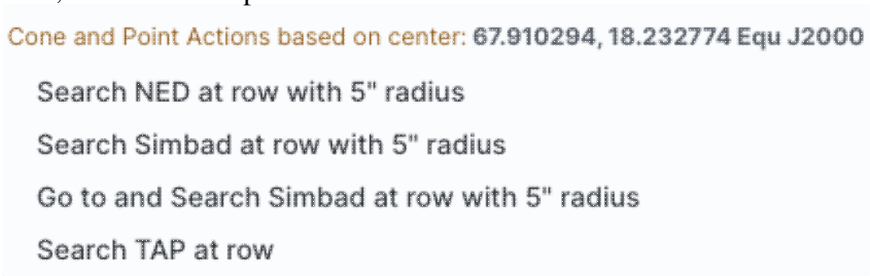
Tips and Troubleshooting

- If you impose logically inconsistent restrictions such as "exposure_time > 160" and "exposure_time < 100" (">160;<100" in the filter box for a column called "exposure_time"), no data will result, because no data are (can be) both less than 160 seconds long and greater than 100 seconds long at the same time. However, "exposure_time > 160 or < 100" works just fine (">160 or <100" in the filter box for the column "exposure-time").
- If you impose nonsensical filters (like using a letter where a number should be, like "w1snr < f") then it will let you know that something has gone really wrong, and let you go back to fix it.
- However, a filter like "ph_qual < f" could be valid -- if the column with which you are working is a string, then a string is a valid filter. It is case-insensitive. For the ph_qual column in the 2MASS catalog, the values are always three letters, such as AAA or ABA or CUU. A filter like "ph_qual < f" will operate as if you have alphabetized the list. Any string that starts with A comes before F and so will be retained. If you do "ph_qual < BBB" then AAA will be left in, but so will "BAU", because alphabetically, BAU precedes BBB.
- If you impose filters from a plot, it can manifest as several filters on the catalog, e.g., one for each side of the square you have drawn on the plot. If you want to remove, say, just one of the four filters (rather than all of them by cancelling all filters), you can do so from the table options pop-up.

- If you want to copy all of the "current constraints", even if the entire field is not visible to you, you can click on the clipboard icon to copy the entire string, and then paste it into another field or application to see what it is.
- If you are choosing filters from a list of terms, cancelling those filters might not work the way it cavalierly seems like it should. If a down arrow appears next to the filter box, then a list of options you can select is available. Tick the boxes you want, and click "Apply" to apply the filter. Now, if you want to change the filter, click the down arrow, select different options, and click "Apply" again to re-impose the new filter. To remove the filter, you have to treat it like you would when applying a modified second filter -- unselect the choices, or hit 'clear', and **then hit Apply again**. If you deselect the choices and then click elsewhere in the window without hitting clear, your actions are interpreted as 'cancel without doing anything' as opposed to 'impose the new filter I just set' (which is 'cancel all filters'). When you are resetting the filter to be 'select nothing', it is treating that as a new filter setting, so you need to set up that filter and click 'Apply' in order for it to understand.
- If you impose filters from a plot, image, or table, you can cancel them from a plot, image, or table. That is, if you impose filters from a plot, and different additional filters from the image, when you click the 'cancel filters' icon from the table, *all* the filters are canceled at once. If you have filters imposed from multiple places, clicking on 'cancel filters' doesn't cancel just the filters imposed from that place; it cancels all of them. If you want to be able to reconstruct a complicated set of filters, though, you can add a column to your table that is one of the preset functions -- set it to true if the row is filtered. Then you can cancel all your filters at any time but you can easily recover the filtered data by filtering on that one new column.

Table Actions

 This icon implements a new search, an 'action', on the currently selected row of the table. When you click on it, it reveals a drop-down:



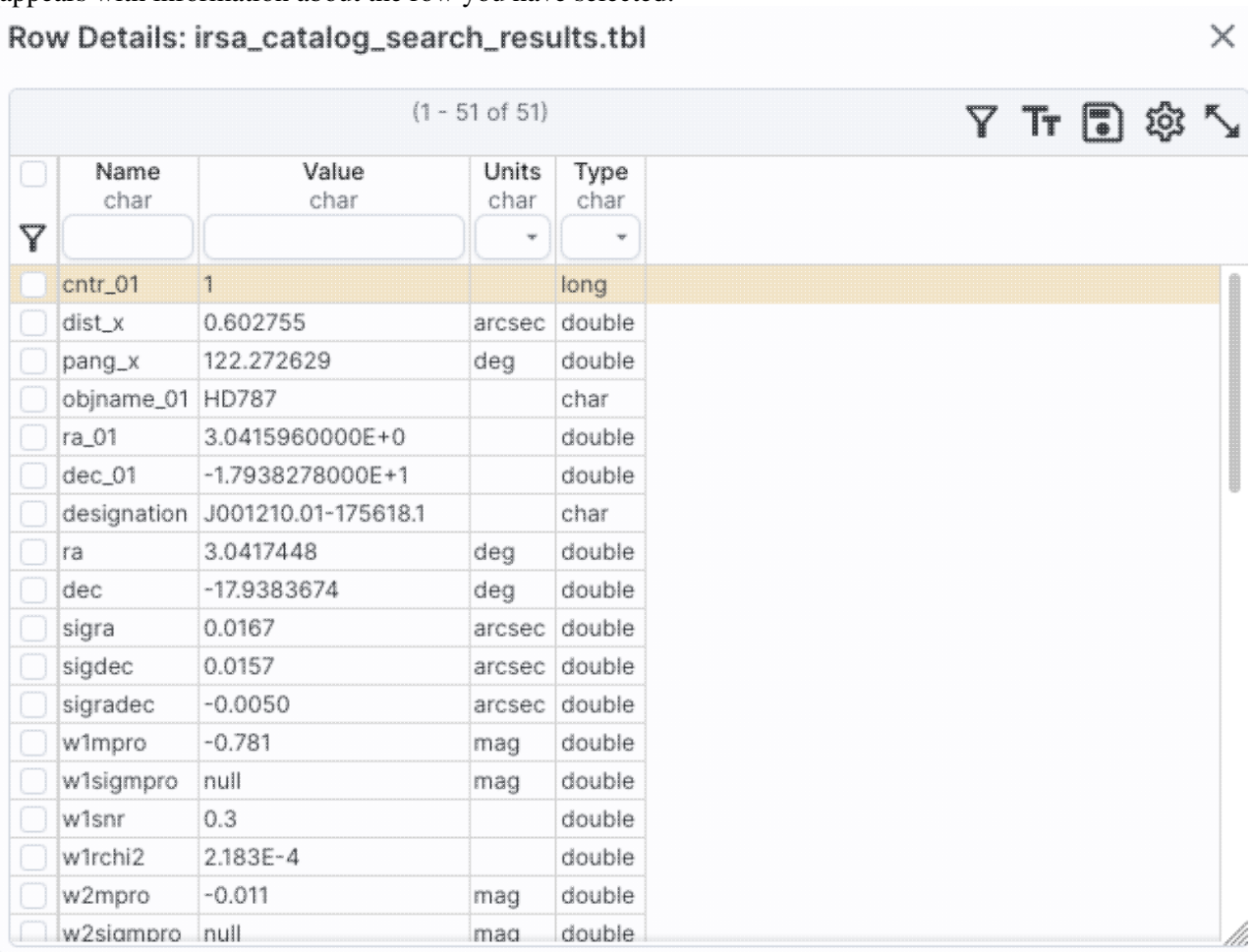
For this example, the selected row is 67.910294, 18.232774 in J2000 decimal degrees. From this drop-down, you can:

- Launch a NED search at this position with a 5 arcsecond radius (more information about NED searches)
- Launch a Simbad search at this position with a 5 arcsecond radius, and put the results in a table here in the tool
- Launch a Simbad search at this position with a 5 arcsecond radius, but start another browser window or tab at Simbad with the results
- Launch a TAP cone search at this position (more information about TAP searches)

Any of these searches (except the search that launches another browser window with the Simbad results) places the search results into this same tool.

Row Details

 This icon is not always available. When it is available, when you click on it, a new pop-up window appears with information about the row you have selected:



In some tools, this content appears as additional tab elsewhere in the tool (not in the table pane, but often viewable at the same time as the table itself), as an additional tab called "Details."

In either incarnation, this information is sometimes called a "property sheet."

This table consists of each of the columns of the retrieved catalog with additional information about each field where available. (Not every catalog may have this information available.) For additional information, please consult the full documentation that accompanies the catalog.

Note that if you leave the pop-up or tab open as you select different rows in your main table (or catalog), it is dynamically updated.

Tips and Troubleshooting

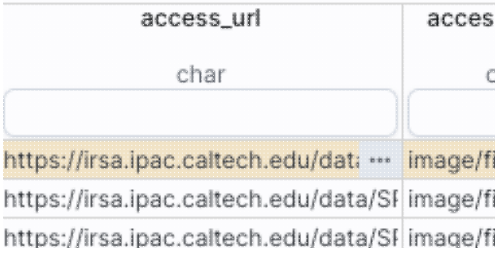
- The property sheet is a more expanded, vertical view of the information shown in a row of a catalog, along with documentation of the catalog columns. If you think of the main table (catalog) view as a single row that you have to scroll left and right to see in its entirety, this view is sort of an orthogonal

view, where you have all of the same contents of that row but shown as its own table, with the full header description, if available, and you can scroll up and down to see the entire contents (as opposed to left-right). *This is sometimes a more user-friendly way to view any given row.*

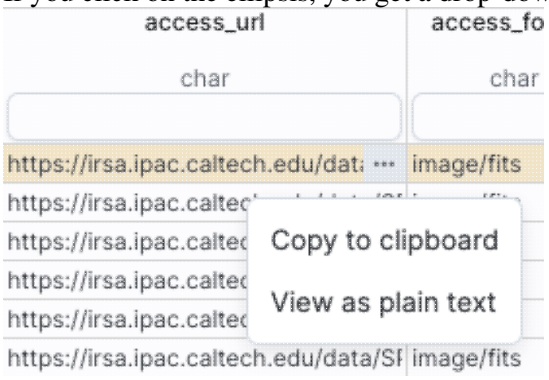
- Because you can sort/filter the data in the property sheet, you can restrict what values are shown. Those filters are respected as you page through your main table.
- When changing rows in the main table, the property sheet scrolls to preserve the visibility of whatever row in the details tab is highlighted. If you scroll down in the property sheet *without changing the highlight*, when you change rows in the main table, because the first row in any table is always highlighted by default, the property sheet will scroll back to the top.

Table Cells

Some cell values may be too long for the cell space. If that is the case, an ellipsis ("...") will appear in the cell as you mouse over it:



If you click on the ellipsis, you get a drop-down menu:



from which you can choose to copy the cell value or view it in a pop-up window.

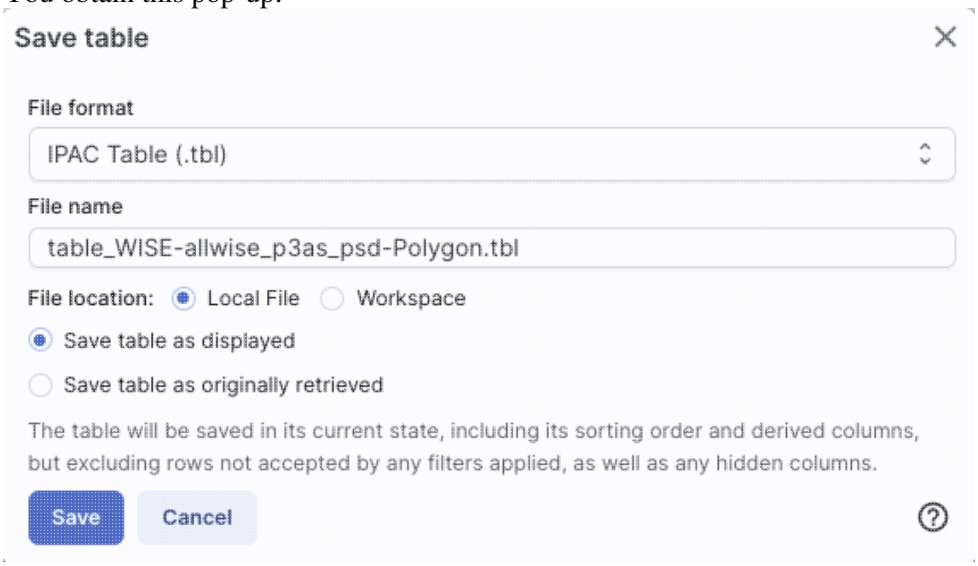
If you view it in a pop-up window, it will attempt to format it in a readable fashion:

which, for most cells, will be functionally indistinguishable from no special formatting. It will only matter for very complicated cells.

Saving Tables

Click on the diskette icon ( ), if available, to save the table.

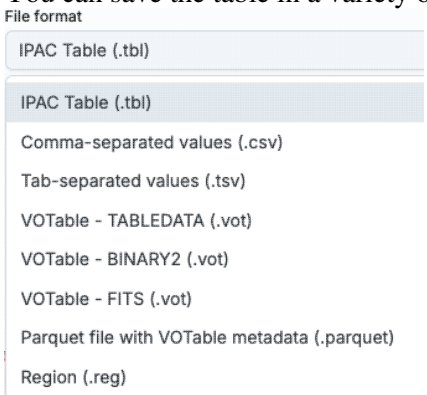
You obtain this pop-up:



You have several choices to make. In order, they are:

File format

You can save the table in a variety of formats:



It defaults to saving it as an IPAC table file, which is basically ASCII text with headers explaining the type of data in each column, separated by vertical bars.

Other formats include comma-separated values (csv, suitable for, e.g., Excel), tab-separated values (tsv), and three different versions of VO tables. You can save the file in parquet file format, which is a highly efficient, compressed, column-oriented format for tabular data that has been adopted by many recent wide area survey projects. You can also save the file in DS9 Regions file format. The advantage of saving it here as a regions file (as opposed to from the visualization) is that this way, the entire catalog is guaranteed to be saved.

File name

The tool tries to make a guess at a sensible filename. Feel free to change it to something that makes sense to you.

File location

You may save your file to a local file (on your disk) or, if you are logged in, in the IRSA Workspace.

Modifications to the table

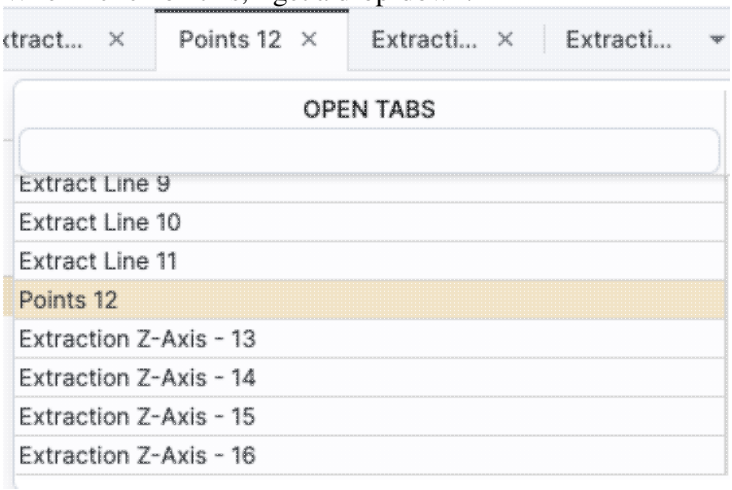
Depending on what you have been doing to the table at this point, you may have filtered or added columns. If you want to save the table as it is currently displayed, with all filters as imposed and any columns hidden, and any added columns as shown, select "Save table as displayed." If you want to save the original table, with all rows and the original columns intact, choose "Save table as originally retrieved."

Table Navigation

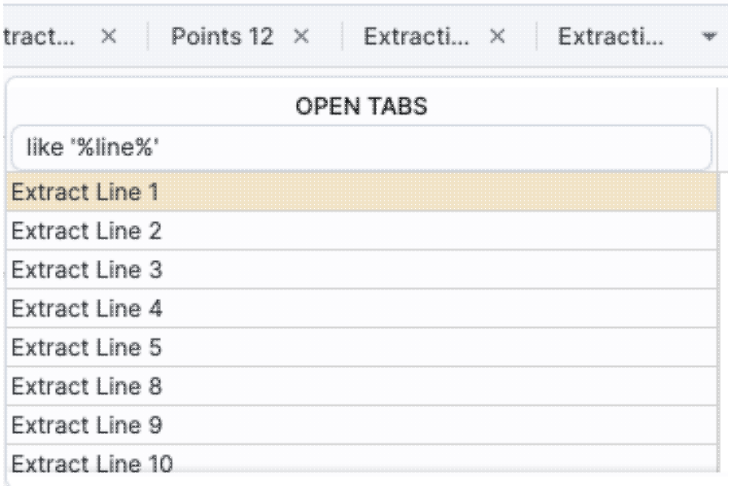
At any time, you can move among tables by just clicking on the tab name. But, with the ability to extract data from images (or SOFIA spectral cubes) comes the ability to rather quickly drown in tables. There is a way to navigate among a lot of table tabs that have accumulated.

This is probably best explained via an example. Here, I have tabs showing that I have extracted several lines, drills, and points from my images:

On the far right of the collection of tabs, at the top right of the table pane, I have a downward pointing arrow. When I click on this, I get a drop-down:



This drop-down shows that the tab marked "Points 12" is in the foreground (it is shaded yellow) and this drop-down has a filter box at the top. That filter box at the top works just like the filters discussed above, so if I want to find the tabs with the extracted lines, I can type "line" in the box, and it will filter down the list, leaving only those tabs with "line" in the name:



Then, from there, I can select the tab I want to bring to the foreground. (When I select a tab to bring to the foreground, that tab is also in the foreground for plotting.)

In this fashion, I can navigate easily among many tabs that are open at the same time, even if I have so many tabs that their headers are not completely shown.

SOFIA Science Data Archive: Catalogs

Catalogs are a special case of tables; the basic functionality of tables is covered in the Tables section. You can choose from any of a wide variety of catalogs to load for overlaying on your visualized data. Plotting catalogs is covered in the Plots section.

Contents of page/chapter:

Introduction

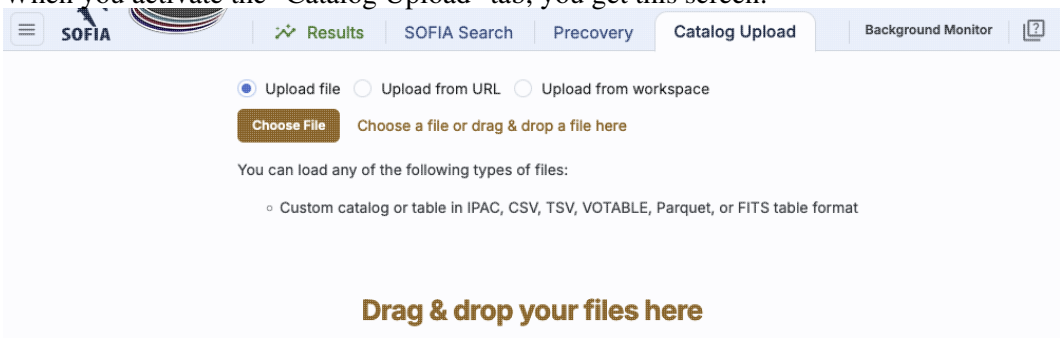
There are several different ways to get catalogs into the SOFIA Archive. You can retrieve them via any of several blue tabs at the top of the page after your initial search.

This chapter focuses on the most local and straightforward of a few of those additional blue tabs.

When you click on the "hamburger" in the upper left  , it pulls open a "drawer" from the left hand side which enables you to add or remove tabs from the row of blue tabs on the top of your window. You can add (or remove) "Catalog Upload", and also, under "IRSA search tabs," "Catalogs." The other catalog searches acessible from the "drawer" are covered in another chapter.

Catalog Upload

When you activate the "Catalog Upload" tab, you get this screen:



You may upload a file from disk (you can use the system browser to identify the file, or drag-and-drop them into this window), from the web via a URL, or from the IRSA Workspace. Click "Load" in the lower left to actually load the file.

The file can be in any of a number of formats, which we now briefly describe.

IPAC table format (*.tbl)

IPAC table format is plain text with a particular formatting. IRSA has a table reformatting and validation service which may be helpful, or you can download just about any catalog you find through IRSA, and mimic that format.

If you want it recognized as a catalog, your table file MUST have RA and Dec values, and unless it is specified, it assumes J2000. (See also "tips and troubleshooting", below.)

You can add a "SYMBOL" parameter to change the shape (X, SQUARE, CROSS, EMP_CROSS, DIAMOND, DOT) of catalog marks, e.g.:

```
\SYMBOL = X
```

You can add a "DEFAULT_COLOR" parameter to assign a CSS color name or a HEX value to catalog marks, e.g., either of these two:

```
\DEFAULT_COLOR = lightcyan
\DEFAULT_COLOR = #00FF00
```

You can find the CSS color code or the CSS color HEX values online.

Comma-separated values (CSV) format (*.csv)

CSV format is often accepted by spreadsheet programs, and most spreadsheet programs can output CSV. It is plain text, with values for each column separated by commas.

Tab-separated values (TSV) format (*.tsv)

TSV format is sometimes accepted (or generated) by spreadsheet programs, and sometimes in tabular data downloaded from journal articles from the 90s. It is plain text, with values for each column separated by tab characters.

VOTable (*.vot)

Virtual Observatory (VO) tables are a special case of XML tables. (All VO Tables are XML but not all XML are VO Tables.) It is a format developed by the International Virtual Observatory Alliance (more information here). XML tables initially look to the human eye like it might be HTML, but they are easier to parse with code. There are packages in astropy that handle VO Tables.

Parquet (*.parquet)

Parquet file format is a highly efficient, compressed, column-oriented format for tabular data that has been adopted by many recent wide area survey projects. It can enable faster searching for large tables. There are packages in astropy that handle parquet files.

FITS files (*.fits)

FITS tables can be loaded into this tool. Note that this tool is flexible enough to handle multiple header data units (HDUs), so that you can upload a FITS file that has both images and tables. The ZTF Image Service will only let you load tables, however.

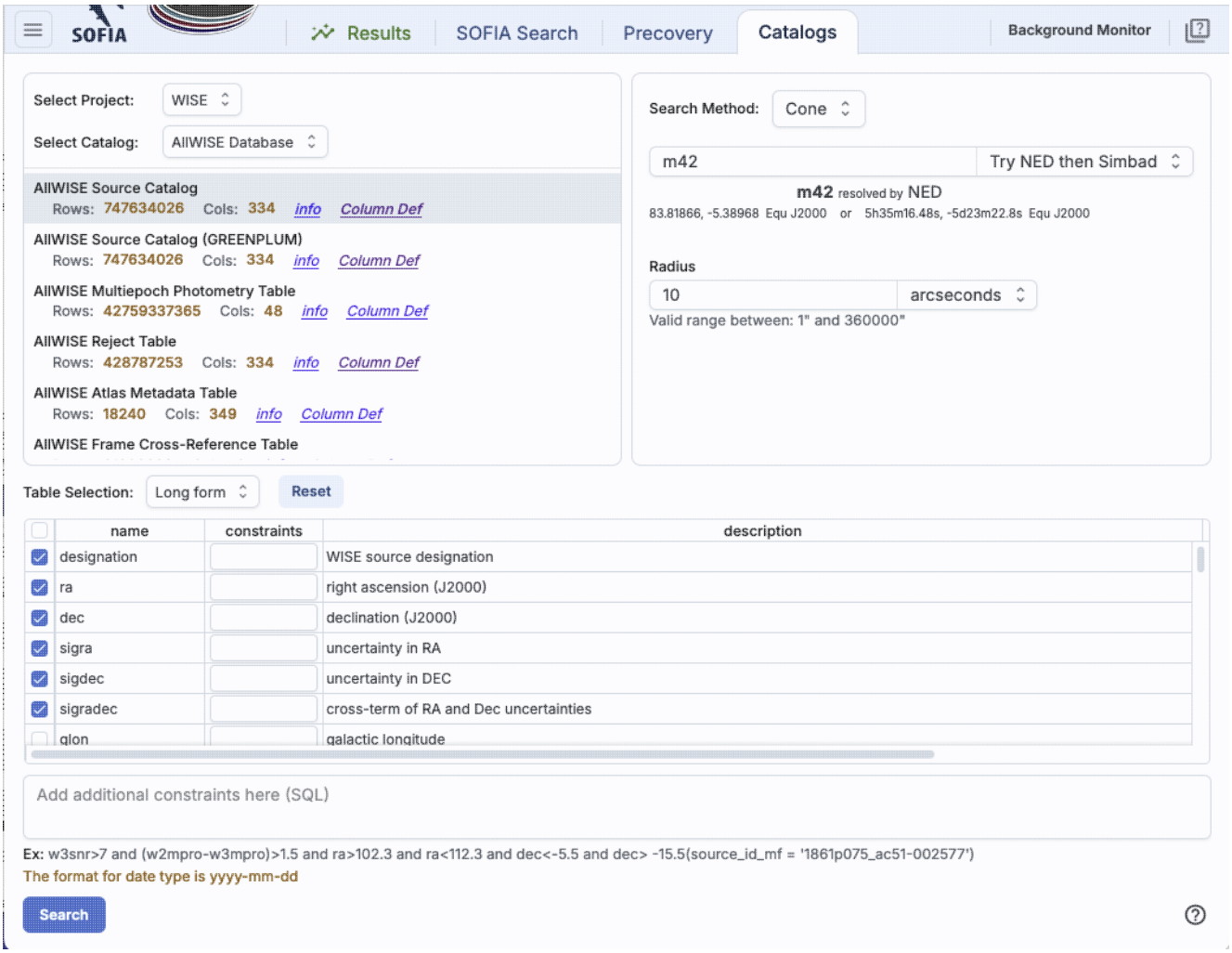
Nearly every file you load will result in a preview of the file you have uploaded. The tables are then shown and, if catalogs, interacted with in the same way as the other catalogs described here.

Tips and Troubleshooting

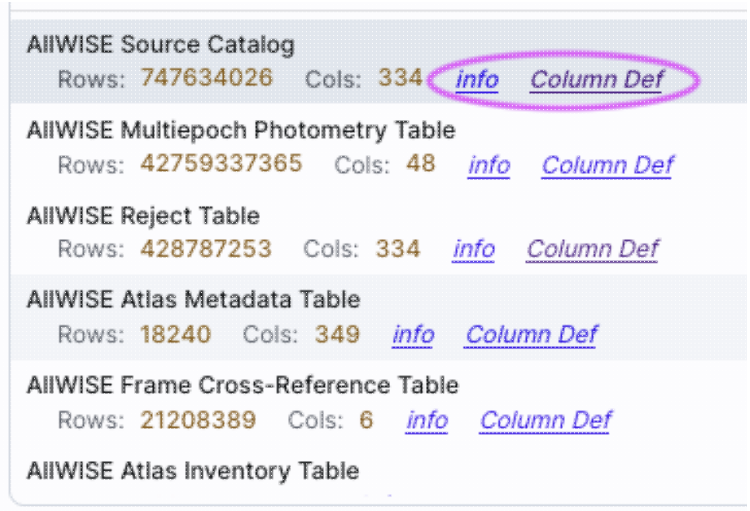
- If you would like to have your catalog overlaid on an image, it needs to have RA and Dec columns. If the tool doesn't seem to recognize your RA and Dec columns, check your formatting, or try headers of "ra" instead of "RA" and "dec" instead of "DEC" or "Dec". If you have columns like "_RA2000" and "_DE2000", it's going to be confused.
- Unless specified, the tool assumes any coordinates you give it are J2000.

- If there are no discernible positions in the uploaded file, it will still let you plot columns from the file after you've loaded it; it just can't overlay things on images in that case.
- This interface looks a lot like the file upload window that is available in other tools such as IRSA Viewer, but if you try to upload things that aren't catalogs here, it will give you an error.

IRSA Catalogs -- Searching for catalogs at IRSA



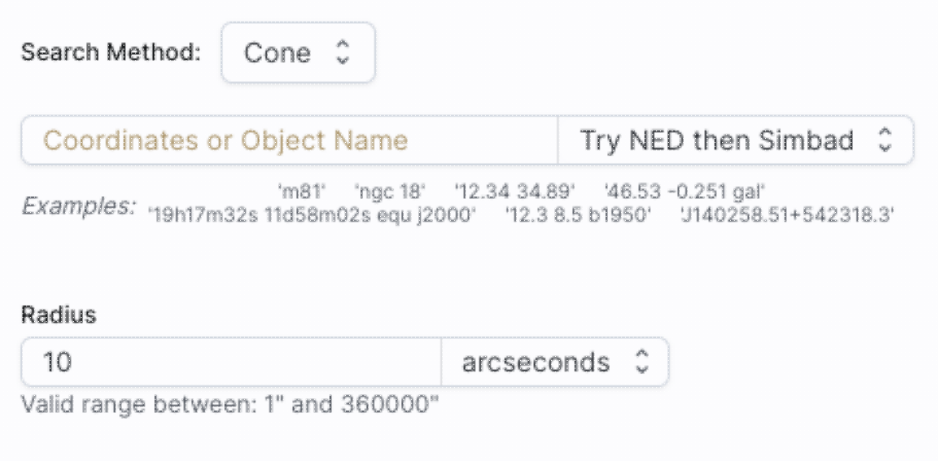
The upper left quadrant of this window is where you specify which catalog you want to search. To change catalogs, first select the "project" under which they are housed at IRSA, such as 2MASS, IRAS, WISE, MSX, etc. The available choices underneath that change according to the project you have selected. A short description is provided for each of the catalogs, with links for more information (including definitions of the sometimes cryptic column names); an example is here:



The upper right quadrant of this window is where you specify the target (the position is sometimes pre-filled with its best guess as to what you want) and the search method (cone, elliptical, box, polygon, multi-object, all-sky), and the parameters that go with that search method (e.g., the radius of the cone). The parameters for each of these searches change dynamically as you select search options, which we describe next.

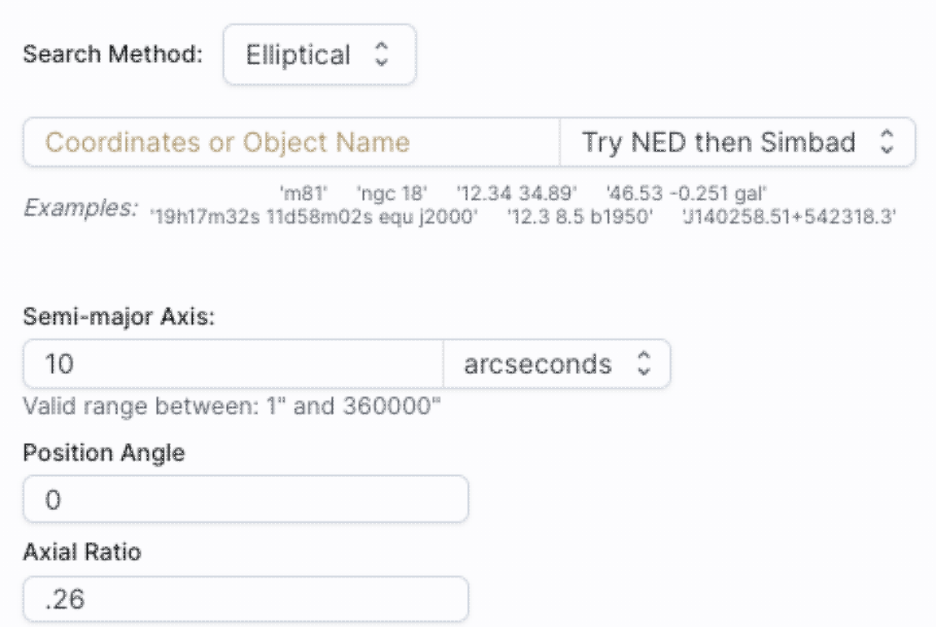
Tips and Troubleshooting: Pick your units from the drop-down first, and then enter a number; if you enter a number and then select from the drop-down, it will convert your number from the old units to the new units. There are both upper and lower limits to your search radius; it will tell you if you request something too big or too small. Note that these limits are catalog-dependent.

Cone search:



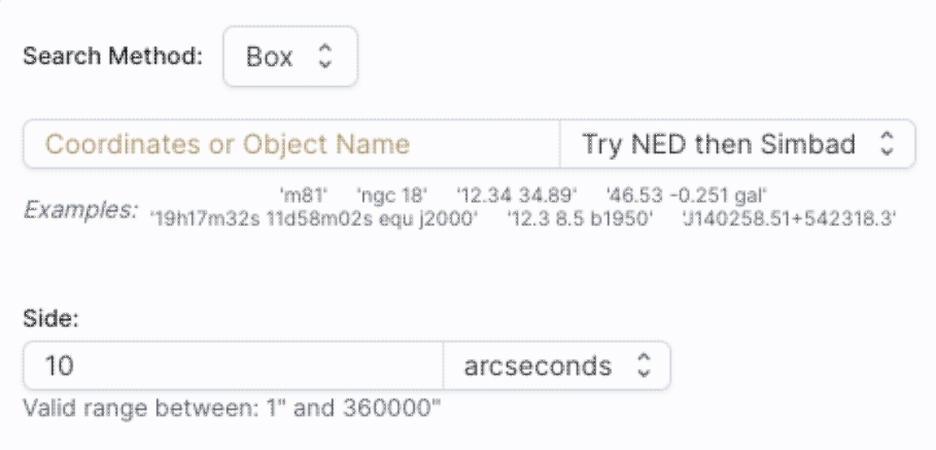
You can put in a position, but sometimes it attempts to guess a position, based on prior searches. You specify the cone radius; the default is 10 arcsec.

Elliptical search:



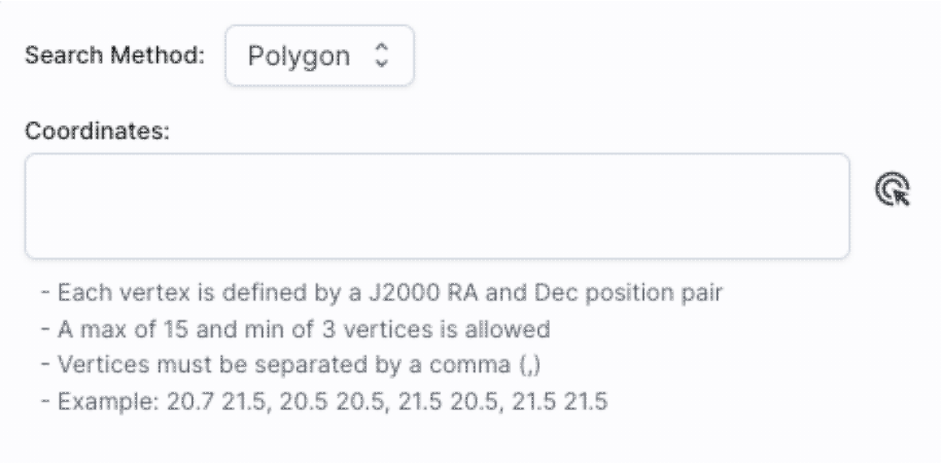
You can put in a position, but sometimes it attempts to guess a position, based on prior searches. You specify the search ellipse's semi-major axis, position ratio, and axial ratio. Defaults are as shown.

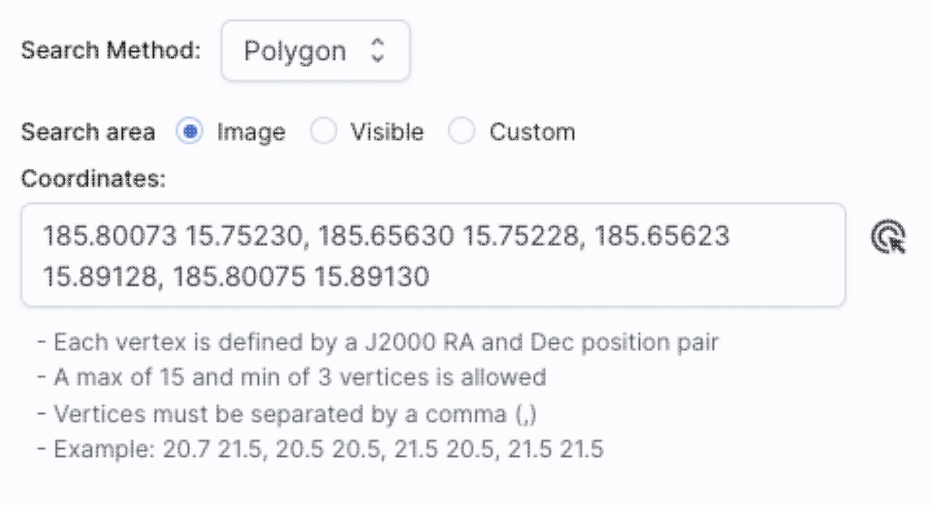
Box search:



You can put in a position, but sometimes it attempts to guess a position, based on prior searches. You specify the box's length on a side; default is as shown.

Polygon search:

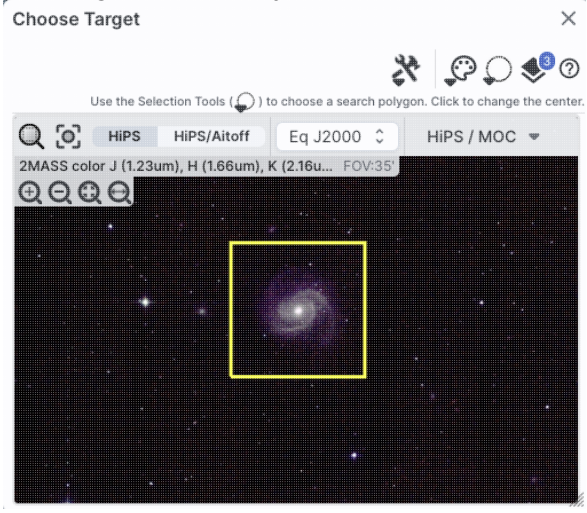




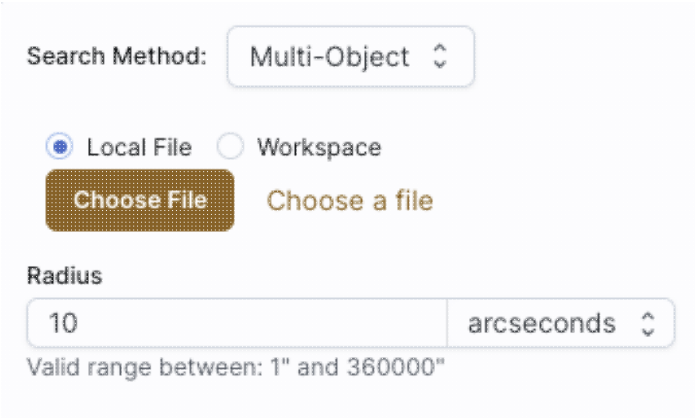
For this, note that it no longer has a single target location. It will sometimes try to pre-fill the vertices of the position it thinks you want, based on prior searches. If you have images loaded, it will give you choices based on the current image -- you can select whether you want the catalog request to match the entire area of the image you have selected ("image"), or just the portion of the image you can see in the current view ("visible"), or your own ("custom") area. (However, note that if you have selected a HiPS image before searching, you are limited to a maximum of 5 degrees.) The list of vertices in the coordinates box are in decimal RA and Dec in degrees. You must enter at least 3 and at most 15 vertices, separated by a comma. Note that, for overlaying catalogs on HiPS images, you cannot select "image", because HiPS images are generally very, very large, so this would result in too many points being returned. There is a maximum of 5 degrees imposed on catalog searches to match HiPS images.

If you select a rectangular region of your image and then select a polygon catalog search, you will have a fourth radio button above, "selection", which matches the corners of your selected image region.

If you select the "bullseye" icon on the right ( ), you get a pop-up with a way to interactively select your target; this works just like this interactive target refinement (go there for more details) :



Multi-Object search:



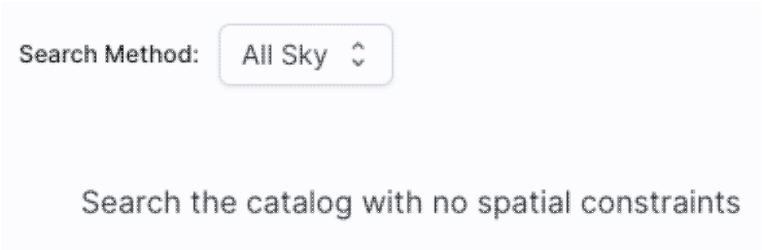
For a multi-object search, it can't guess what position you want. You need to upload a file (from your disk or the IRSA Workspace) in IPAC table format, which is a varietal of plain text. (IRSA has a table validator which may be helpful.) Note that you also have to specify the radius over which to search for each of the targets in your list.

When you do a multi-position search on catalogs, three new columns are added to the catalog as it is returned to you. These columns are :

◊ cntr_01 - the target position you requested
◊ dist_x - the distance between the target position you requested and the object it found
◊ pang_x - the position angle between the target position you requested and the object it found

These additional columns can help you assess if the target(s) it found is the target that should be matched to the position you requested.

All-sky search:



Because this is an all-sky search, it does not have a single target entry box. In order to constrain this search, you need to impose constraints on the bottom of the screen (see below).

The bottom of this window allows you to set restrictions on specific columns. It gives you a list of all the available column names in the corresponding catalog. (Most catalogs have identical "standard" and "long form" selections, but some have more columns available in "long form".) From here, you can choose what to display (tickboxes on the left), and filter what is returned ("constraints" column). For example, only return objects with values in column y that are greater than x. If you add more than one restriction, they are combined logically using an "AND" operators; be careful, because you can thus restrict data such that none of the catalog meets your criteria.

Click on "Search" to initiate the search. It will load the catalog into a tab of its own. The objects will also be overlaid on any images you have loaded, and a default x-y plot will be shown. (For more on the x-y plots, see Plots section.) All of these representations are interlinked -- clicking on a row in the table shows it on the image and in the plot, and clicking on an object in the image shows it in the table and in the plot, and clicking on an object in the plot shows it in the table and on the image.

To close the catalog search window without searching for a catalog, click on "Cancel".

Tips and Troubleshooting

- If the catalog search is successful quickly, it will promptly return the results in a tab of its own.
- The search may take a long time to return, especially if you have asked for a large catalog, and you may think that nothing has happened, but be patient and eventually it will return a tab.
- Use large search radii with caution! Be sure you understand how many sources you are likely to retrieve. Searches that retrieve more rows will take longer. Searches that retrieve tens of thousands of rows will take quite a while.
- If you want to impose additional constraints on the catalog during your initial search, you can do so in the lower half of the screen (e.g., SNR > n in some band, or an SQL command), you can place constraints at this point. However, be advised that it is easy to combine constraints such that no sources are retrieved!
- If you overlay a large catalog, the tool will show cells with a number enclosed indicating the number of sources in that region. As you zoom in closer and closer, the tool will adjust those bins to smaller and smaller cells until it shows you individual sources. Go here for more information!
- If you overlay a large catalog, then turn around and save a regions file from the catalog overlay, then the entire catalog may not be saved. To get a large catalog saved as a regions file, save it from the table.
- By default, it may show you fewer columns than are available in the full catalog. By selecting "long form" (above the list of columns), you can access the full range of available columns. In some cases, there are literally hundreds of columns that you can access!

The search results are then shown in a Firefly table and you can interact with it.

Interacting with Catalogs

When you load a catalog, the tool may create a table, a plot, and/or, if your catalog has position information (e.g., RA and Dec), it overlays the catalog on an image. All three of these ways of displaying the catalog are interlinked and interactive.

Catalogs are a special case of tables; the basic functionality of tables is covered in the Tables section. You can sort and filter the table.

Plots are also covered in a different section. You can make scatter plots, heat maps, and histograms. You can plot columns from your catalog, including simple mathematical manipulations of catalog columns.

If the catalog has positions included, the catalog will also be overlaid on the loaded image(s). The Visualization section includes information about that. Each catalog that you load is overlaid on the image using different, customizable symbols and colors.

When you have catalogs loaded into the tool, the header of the catalogs has the name of the catalog and a color swatch:

This color swatch corresponds to the symbol color that is used in the image overlays. You can change the color by clicking on the color swatch in the header, or by navigating to the layers in the image pane. See the color picker section of the visualization chapter for more information.

Tips and Troubleshooting

- Large catalogs will be displayed hierarchically! See next section.

- If you save the overlays from an image as a regions file, you may not get your complete catalog, especially if it is a large catalog (see next section!). However, you can save the full contents of a single catalog as a regions file using the "save" (diskette) icon in the table toolbar, instead of the image toobar.
- The "color swatches" may not appear immediately. To make loading faster, sometimes the colors don't load until they are actually needed. If you are in a situation where no images are visible, then no color swatches may appear until you ask the tool to show you an image (like the coverage image), and then the color swatches will appear.

Hierarchical Catalog Display

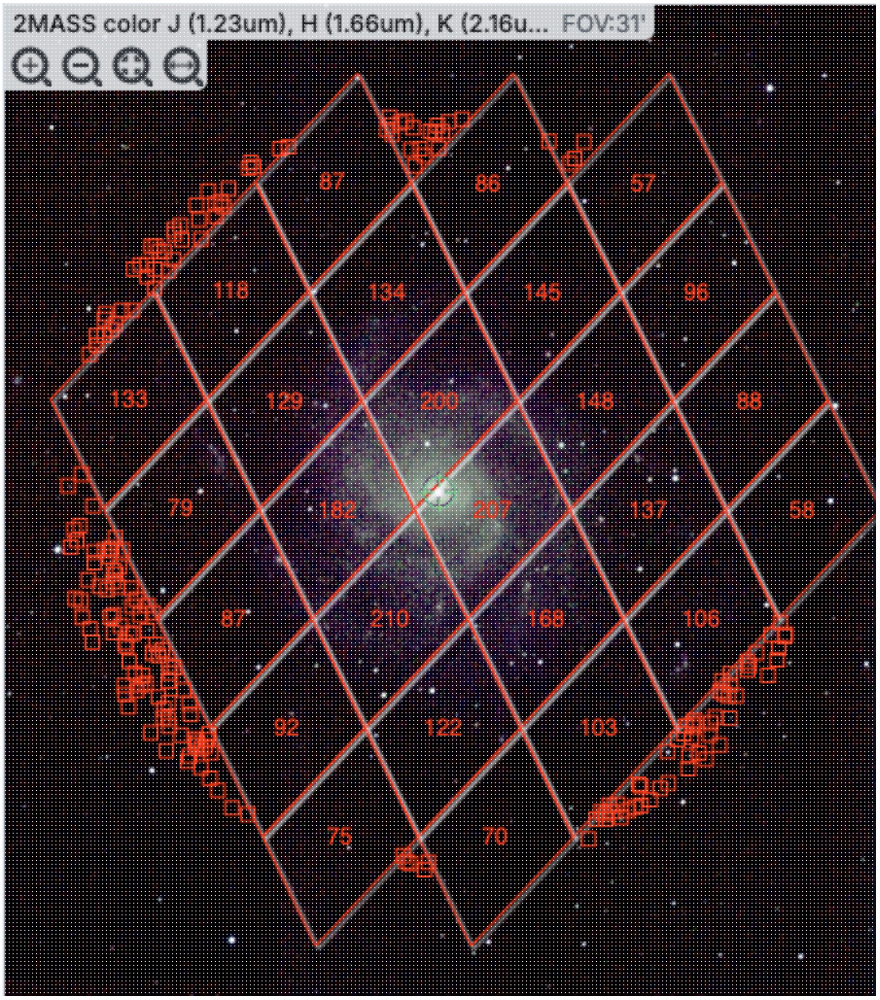
If you have a large catalog loaded into the tool overlaid on top of lots of images, the possibility exists that the computer or the network could be overwhelmed trying to render all the points on all the images. Historically we dealt with this by "thinning out" the catalog and not showing all the points. However, there is a better solution, which is now employed here!

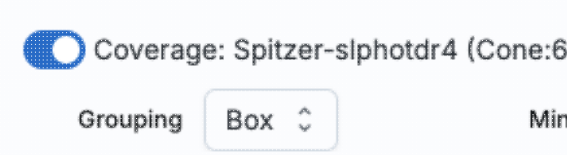
For catalogs below about 1000 points, the tool will show the individual points on the image.

For catalogs above that threshold, the tool will bin up the catalogs based on HEALPix pixels (see HiPS section here for more links). In summary, the sky is broken up into sections, and the tool will show symbols with a number indicating the number of sources in that region. Then, when you zoom in, it will dynamically adapt to show you smaller and smaller cells until it shows you all the individual sources.

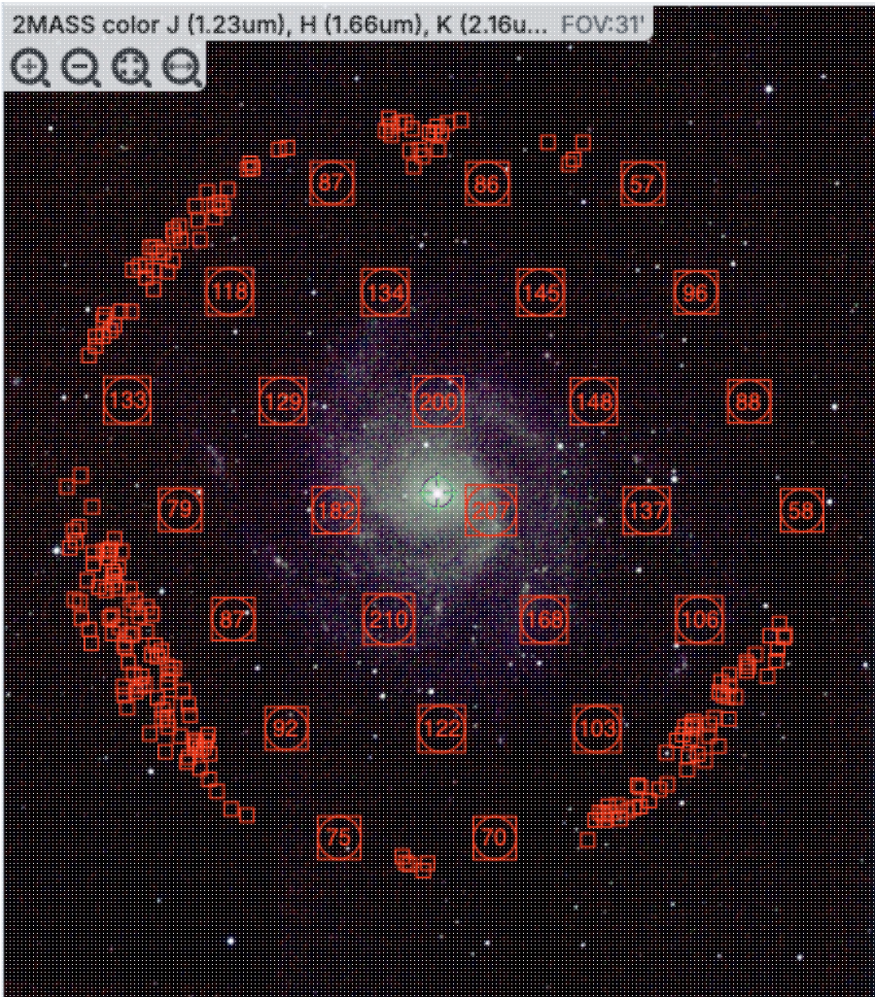
From the layers icon ( see visualization chapter), you can bring up many display options. Below are examples of what is displayed, the options seen in the layers, and additional options. The same catalog and zoom level and minimum group size are used for each view. The "Min Group" option here is 50, so if there are cells with fewer than 50 sources, then the individual sources are shown, and if there are more than 50 sources, then the cell is shown with a number inside corresponding to the number of sources from the catalog. (See below for additional information.)

In this view, the 'cells' used are the cells explicit
the size of the cells is very clear. In the top row
across the top have fewer than 50 sources (so the
individual sources are shown), then the next row
57 sources respectively.

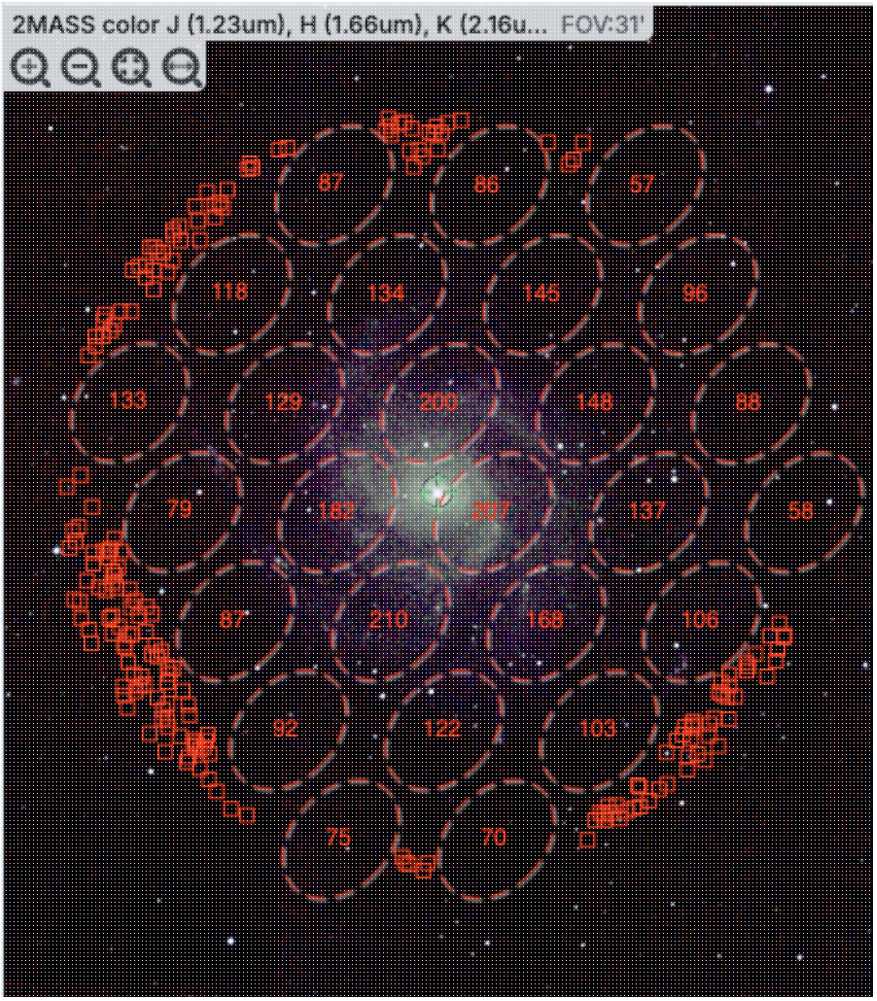


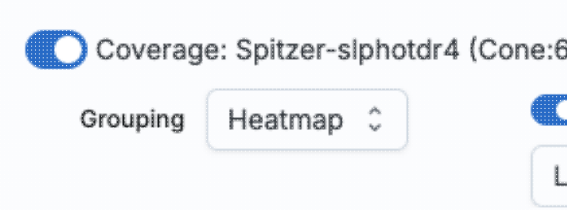


In this view, the 'cells' are shown by circles encl
sizes are the same as in the prior screenshot, but
obvious to new users.

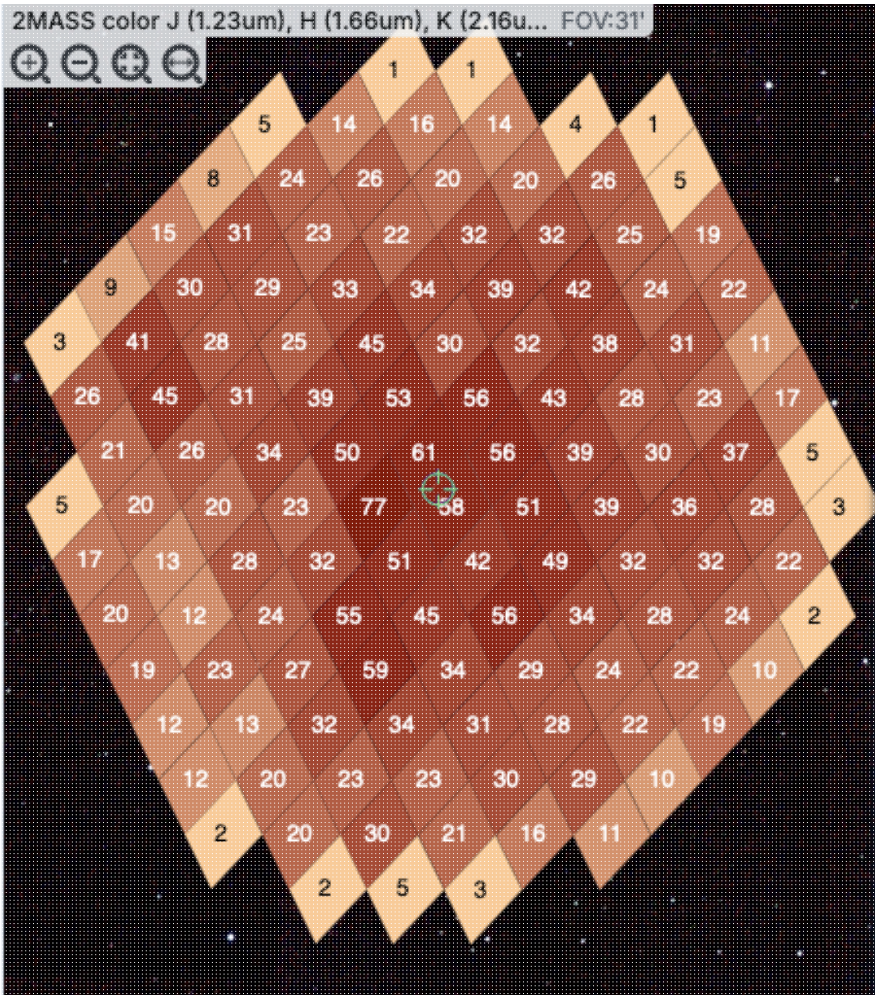


In this view, the 'cells' are shown by ellipses sho
cell sizes are the same as in the prior screenshot,
less obvious to new users. It may be more obvio
groups of points.



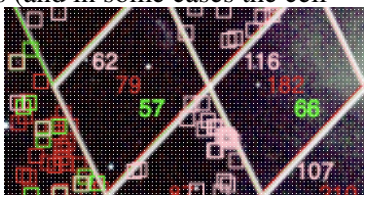


Finally, in this view, the 'cells' are again shown a
color of the cells corresponds to the number of s
"Linear", "Linear Compressed", or "Log Stretch
the color range by changing the color using the
which you can also change the transparency. Thi
how many sources are in each cell, but makes it
though you can change the transparency of this
still can make seeing the image challenging in so



Tips and Troubleshooting

- For all of these renditions, when you zoom in close enough, it will dynamically adapt and show you individual sources when you zoom in. (That is, it no longer decimates the overlaid catalog, which is what it used to do.)
- For all of these renditions, if you click on a cell, it will display all of the sources in the cell. You can click on many cells in a row and it will continue to display all the sources it can until it reaches the point at which it thinks performance will suffer, at which point it will turn some of the points back into cells.
- If you want to have more of your catalog shown as individual sources, pick a smaller "min group" number.
- If you have more than one catalog loaded, the numbers within the cells (and in some cases the cell indicators themselves) will be offset slightly so that you can see them.



- If you have a catalog that includes sources from all over the sky, it very well may just give you box groupings, and may not allow you to change that view until you zoom in.
- If you have cells where only 1/4 of a cell is populated, it automatically renders a smaller cell, so if you have a sparsely populated but still large catalog, the size of the display will always be "small" size cells.

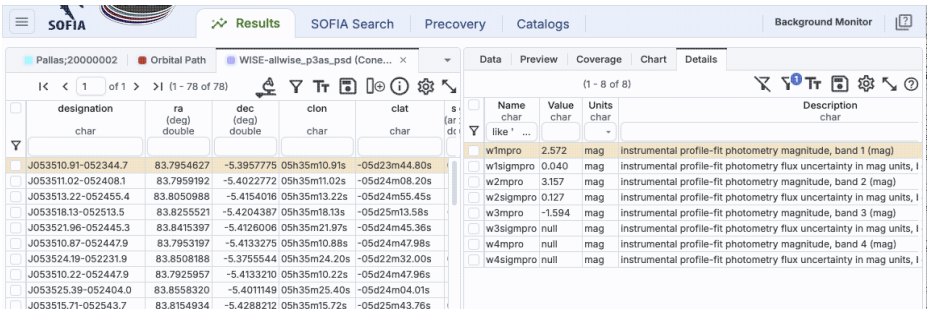
- If you are looking at many footprints from, say, a complex, and long ObsCore search, if you have more than 30,000 footprints, it may not be able to render all of the outlines of all of those images. It may render the centers of all of those images as if it were a catalog, in which case you will encounter these kinds of hierarchical catalog display options.

Details Tab

When you have a table loaded on the left, you will have an additional tab on the right hand side, under the plot, called "Details." This additional tab is sometimes called a "property sheet." This tab is, itself, another Firefly table, and consists of each of the columns of the retrieved catalog with additional information about each field where available. (Not every catalog may have this information available.) This information can be used to learn more about each of the columns in retrieved. For additional information when it is showing details about a catalog, please consult the full documentation that accompanies the catalog.

Tips and Troubleshooting

- The property sheet is a more expanded, vertical view of the information shown in a row of a table or catalog, along with documentation of the catalog columns. Because you can sort/filter the data in the property sheet, you can restrict what values are shown. Those filters are respected as you page through a catalog. So, for example (see screenshot below), you can pull up the property sheet, filter it down to only show the profile-fitted magnitudes and errors by filtering on "mpro", and then step through the values in the catalog and inspecting the brightnesses as shown in the property sheet for each source.
- When changing rows in the main table, the property sheet/details tab scrolls to preserve the visibility of whatever row in the details tab is highlighted. If you scroll down in the property sheet *without changing the highlight*, when you change rows in the main table, because the first row in any table is always highlighted by default, the property sheet will scroll back to the top.



SOFIA Science Data Archive: Other Searches

There are several other searches you can add to the SOFIA Archive using the side menu to add to the tabs at the top. This chapter covers the more complex of these choices. The VO searches retrieve some sort of tables, many of which are catalogs. For the results of any of these searches, if the tool recognizes positions in a catalog, it will overlay the catalog on images and make plots.

Contents of page/chapter:

Introduction & Terminology

There is a lot of terminology in this chapter to understand.

- VO = Virtual Observatory
- TAP = table access protocol. TAP services enable complex queries of tables using ADQL.
- ADQL = astronomical data. query language
- ObsCore = core components of Observation Data Model
- Data model = A standard logical structure for a type of dataset; more flexible and general than a data format.
- ObsTAP = TAP service that serves ObsCore tables

There are myriad places on the web to learn more about TAP queries and ADQL, as well as all the rest of the VO standards and protocols. We just provide a brief overview here in the context of this tool.

The SOFIA Archive can help you interactively create ADQL which then you can copy and use in your own code elsewhere.

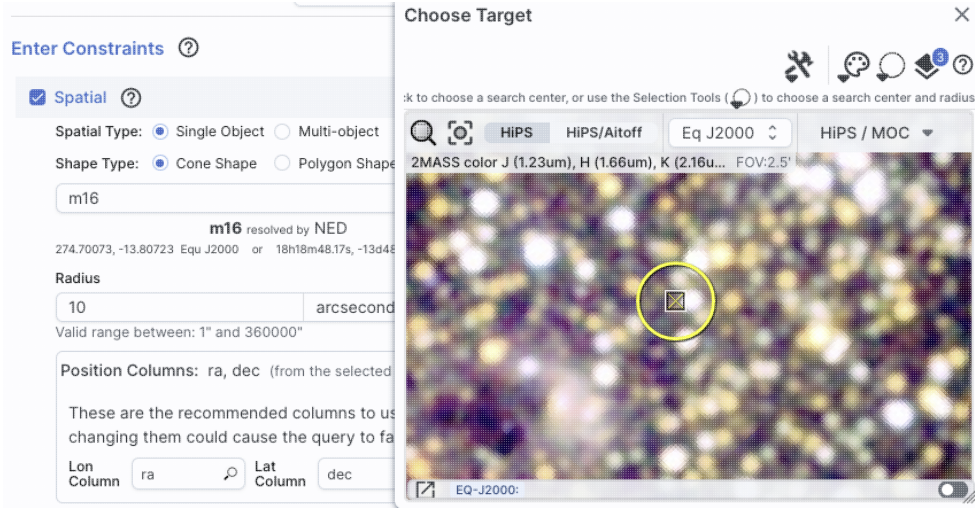
By using TAP and ObsTAP queries, you can use IRSA services to talk to other archives that also comply with these standards, world-wide.

The first part of this section talks about interactive target refinement and some constraints that are common to more than one of the searches discussed here, and then specifics of particular searches follow after that.

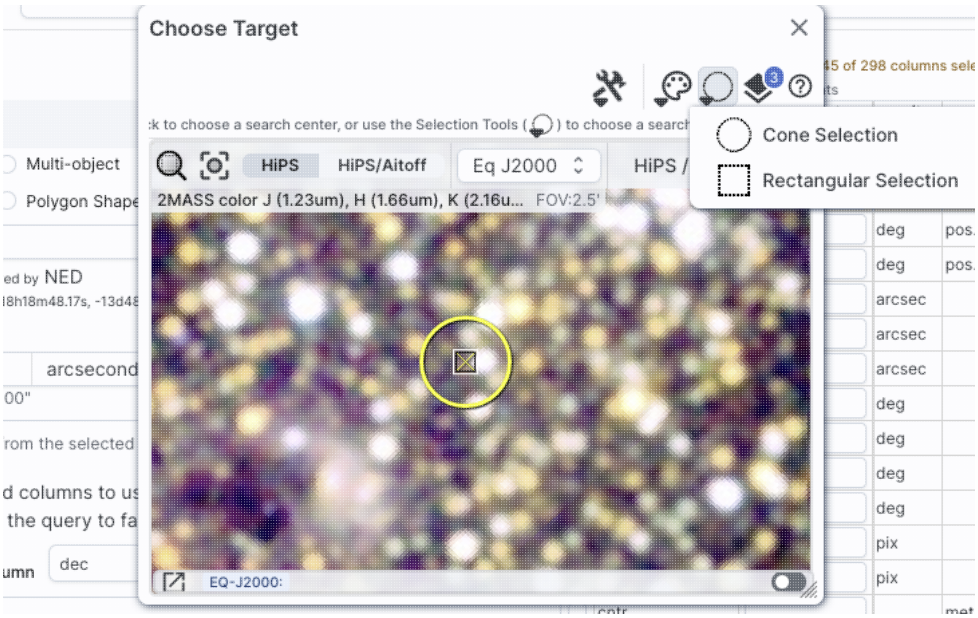
Interactive Target Refinement

Whenever you see this icon  in IRSA tools, you can click on it to bring up a window to **interactively refine your target selection via clicking on a HiPS map**. Here, we are using a TAP search to demonstrate this process, but you can find this kind of target refinement in several places in IRSA tools.

When you click on the icon  you bring up a window:



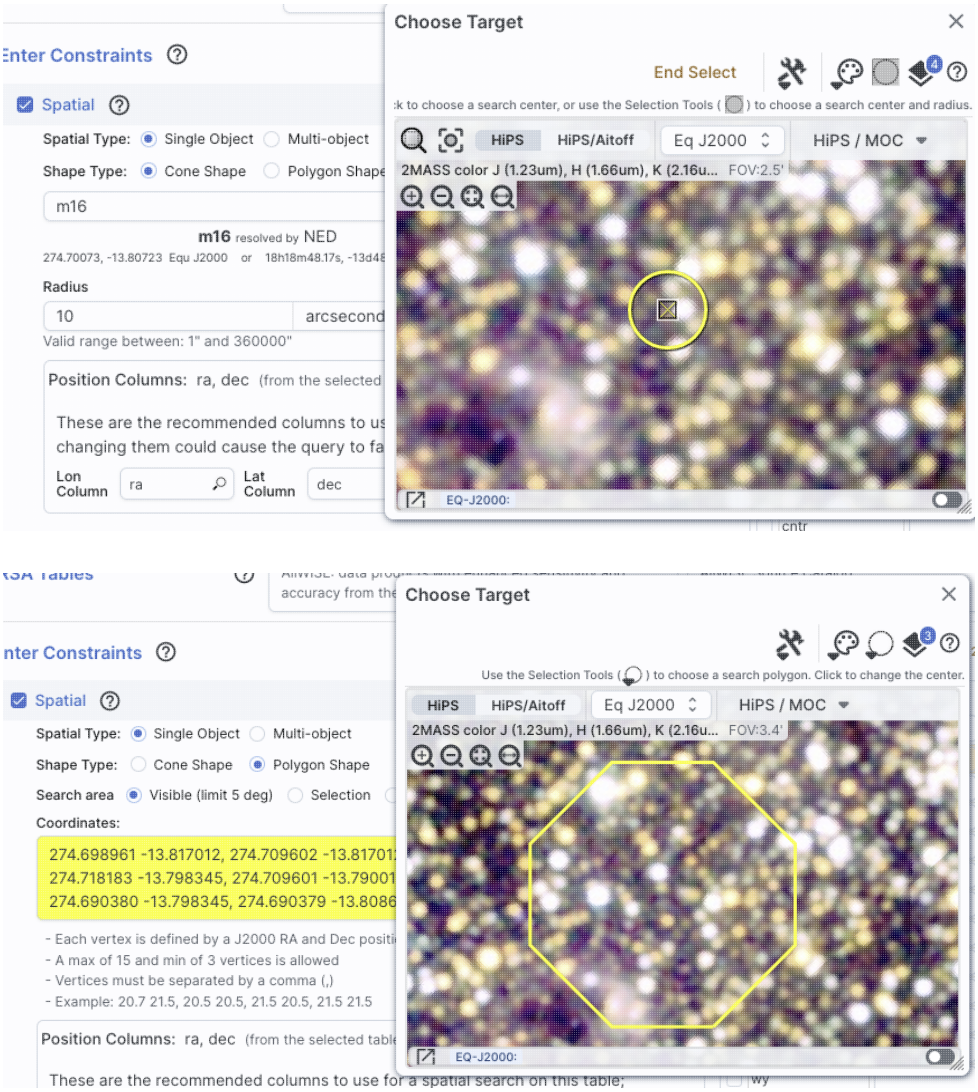
If you have entered a target already, the window arrives already centered on the target. If not, it is centered on the galactic center, zoomed out. If you have entered a cone search radius already, then the circle drawn on the image is that cone size. You can manipulate this image with the same basic tools as in the visualization tools.



To change the search region interactively, choose the selection tools and draw a shape on the image.

Note that if you have selected a cone search on the left, no matter what you select on the right, it will give you a cone search. If you change the cone position or radius in the yellow boxes after you change the selection, it will update the region in the image.

If you want to quit out of the selection without changing, click on "end selection" (the brown text near the top of the image).



If you select polygon on the left, and you use the selection tool for "cone selection" on the right, you will get a spherical polygon (a polygon where the line segments are on a sphere).

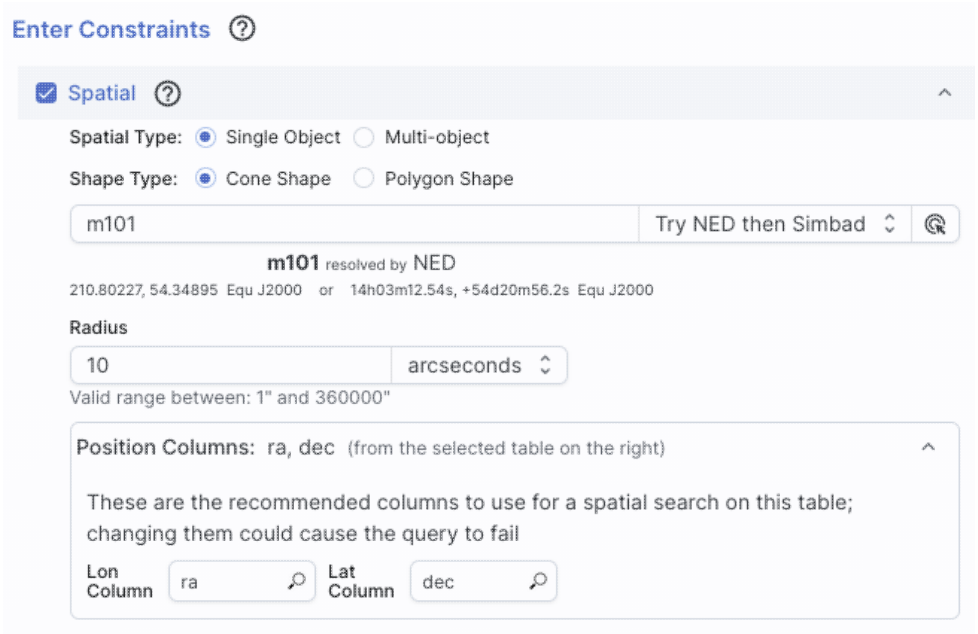
When you are done with this pop-up window, click on the 'x' in the upper right of the window. Then you can continue with whatever you were doing before you started to refine your target parameters.

VO TAP Searches: More information about constraints

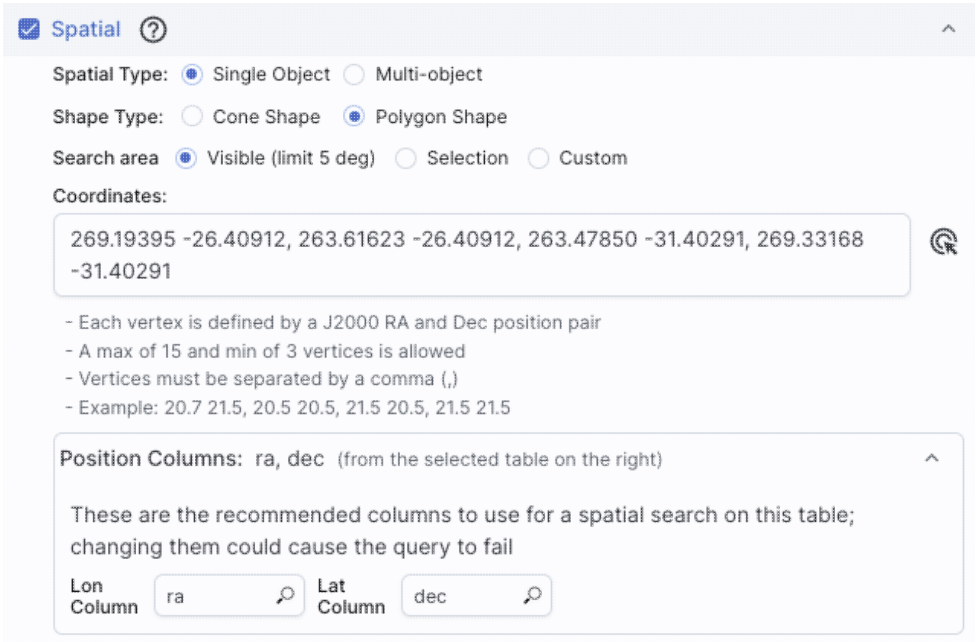
You can have several different ways of constraining your search depending on the options you have selected before the "Enter Constraints" section, and the options depend on what kind of service is available at the TAP service you have selected. If the options do not appear initially, click on the downward arrow to "unfold" the options.

Enter Constraints: Spatial

This part of the interface allows you to specify the details of a spatial search. You need to specify both what kind of search you want to do and which columns of the catalog are to be used for coordinates.



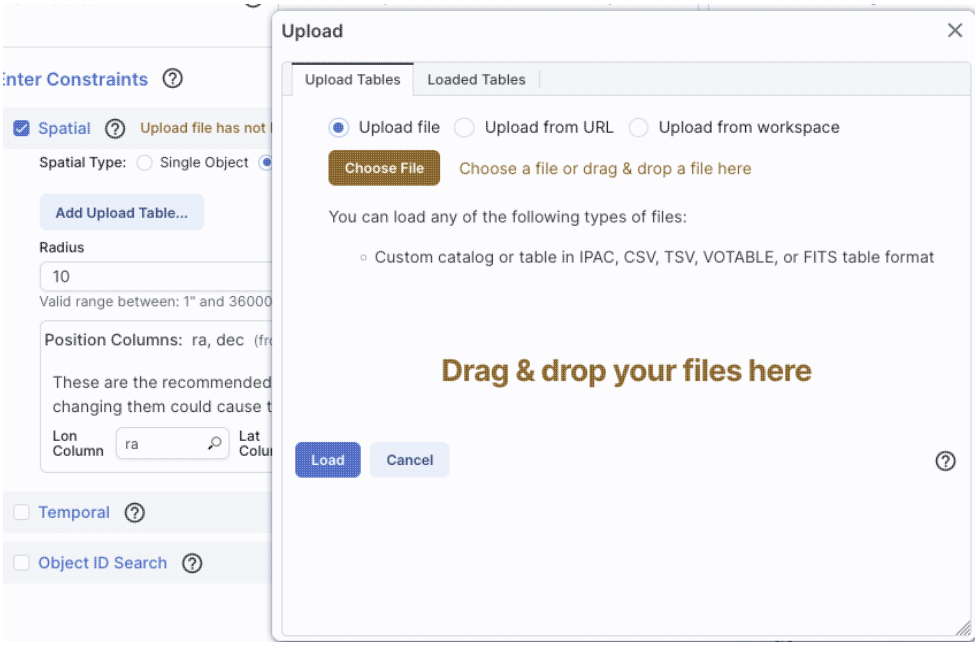
This is what it looks like when you do a **single target cone search**; note that you have the same name resolution options as in any other search here.



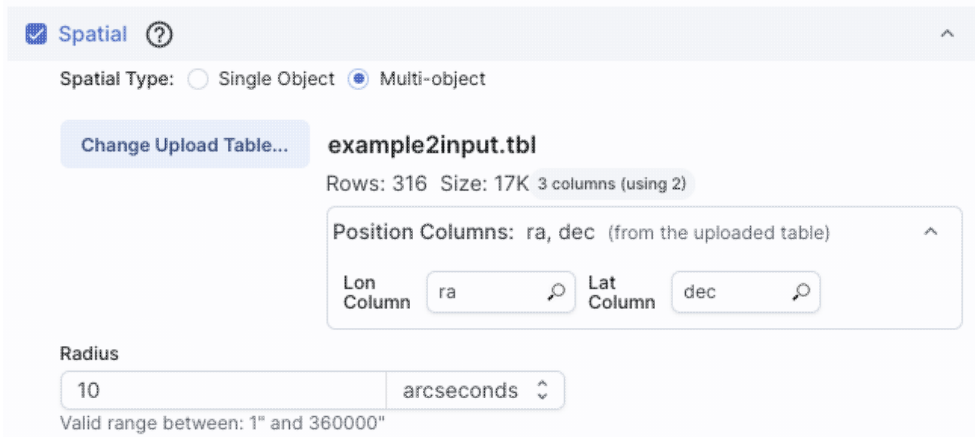
And, this is what it looks like when you do a **single target polygon search**. The search areas here (visible, selection, and custom) are the same as when you do a polygon search on catalog -- that is, you can select whether you want the catalog request to match the entire area of the image you have selected ("image"), or just the portion of the image you can see in the current view ("visible"), or your own ("custom") area. The list of vertices in the coordinates box are in decimal RA and Dec in degrees. You must enter at least 3 and at most 15

vertices, separated by a comma.

You can also click on this icon to interactively refine your search position.

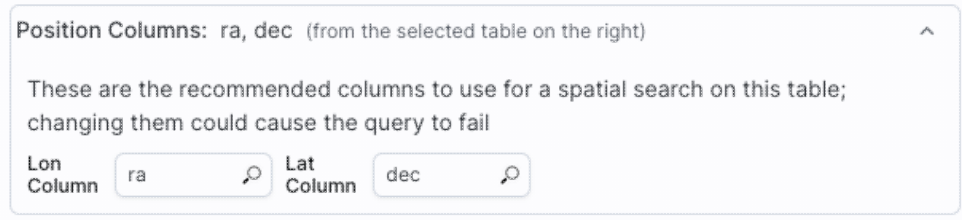


If you want to perform a **multi-target search**, click on "multi-object", which automatically brings up this pop-up, from which you can load a table from disk ("Upload tables" tab) or select one of the tables you have already loaded into the tool (click on the "Loaded tables" tab). Your uploaded catalog has to follow all the same rules as normal catalogs from disk.



After you find your file with your listed positions and upload it, the tool attempts to guess which two columns are the position columns. In this example, it has (correctly) guessed that the position columns are "ra" and "dec". If it guesses wrong, or can't figure it out, you can help it along by clicking

on the down-arrow to 'expand' that part of the panel and selecting the two coordinate columns to use.

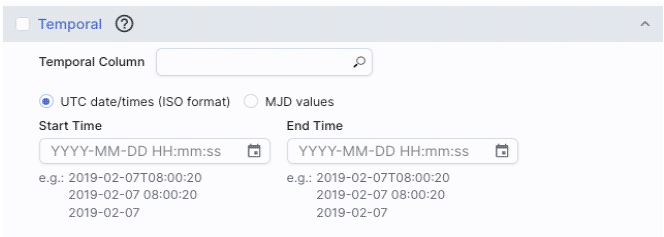


Regardless of what configuration you use, the last thing to check is which columns the tool has assumed are the position columns in the catalog to be matched to your position, region, or list of positions. Again, it attempts to make an educated guess as to the right columns, but if it guesses wrong, you can help it along by clicking on the down-arrow to 'expand' that part of the panel and selecting the two coordinate columns to use.

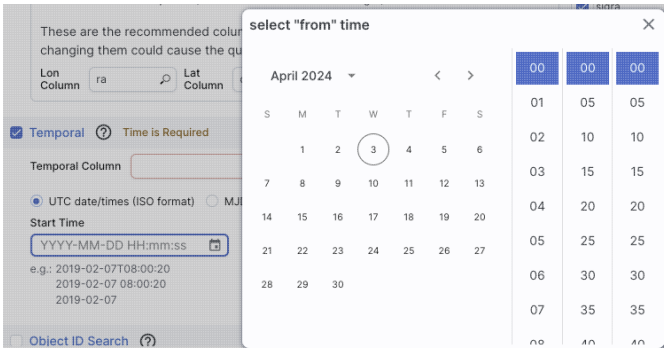
Enter Constraints: Temporal

This part of the interface allows you to specify which column of the catalog is to be used for timing, and allows you to constrain the date in two different systems.

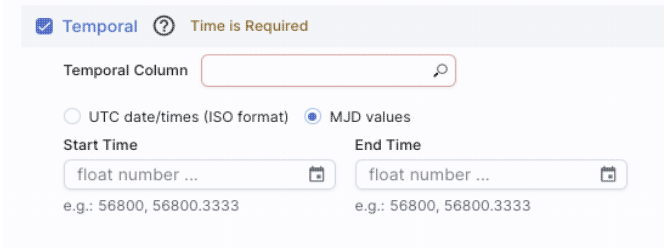
This is what the panel looks like initially, where you specify the column in the catalog you are searching with the time and then the dates. If you don't remember what the column is in the catalog, click on the magnifying glass to get a pop-up with a list of all of the columns.



For the dates and times, if you click on the calendar icon at the far right of the entry box, you get a pop-up from which you can specify the date and time, shown here.



If you would like to work in MJD instead of ISO dates, select the "MJD" radio button. Note that it echoes below the box what it thinks you've entered in two different systems (UTC and MJD) to verify what you have entered.



Enter Constraints: Object ID

This part of the interface allows you to match object IDs.

This is what the panel looks like initially:

This is what the panel looks like after you have selected your uploaded list of IDs (in this case, a file called "gaiaids.tbl", which consists of an IPAC table file that is just the list of Gaia IDs, in a column called "gaiaid"), and it is being matched against the Gaia DR3 main catalog, where the relevant catalog is "source_id".

Tips and Troubleshooting

◊ The names have to match exactly, so in the case of this example, since the Gaia column source_id is a long, the IPAC table file must also cast the Gaia ID as a long.

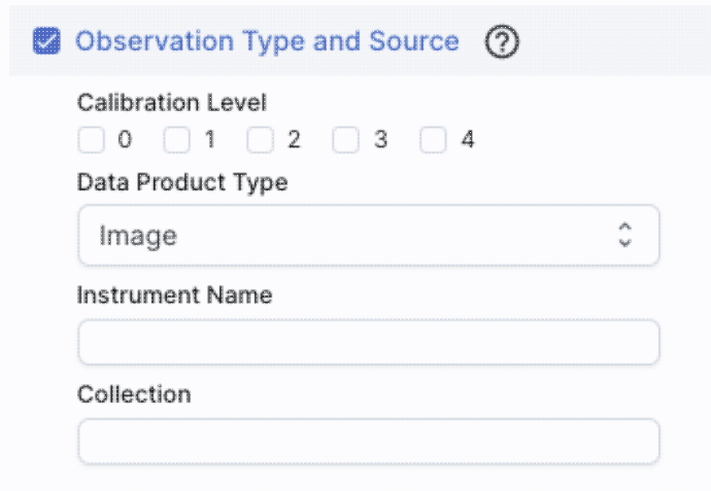
◊ If the catalog to which you are matching is not indexed by the name column you are using, the search may take a long time.

◊ If you are doing, say, an object ID search, you need to turn off the position search, otherwise it doesn't understand what you want it to do.

VO ObsCore Searches: More information about constraints

These are several additional ways of constraining your search depending on the options you have selected before the "Enter Constraints" section. These options appear if you have configured an ObsCore search from a Multi-archive VO TAP search. If all of these options do not appear initially, click on the downward disclosure arrow to "unfold" the options.

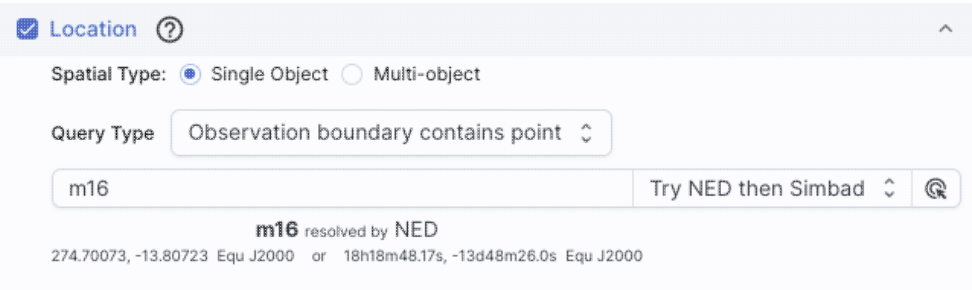
Enter Constraints: Observation Type and Source



This panel provides a way to constrain the:

◊ *Calibration level* - 0 is the least processed and 4 is the most processed, and not all instruments provide all levels
◊ *Data product type* - image, cube, spectrum, SED, time series, visibility, event, measurement, or none specified. You can select more than one of these at a time by using a right mouse click.
◊ *Instrument name* - must match exactly, wild cards not accepted
◊ *Collection* - must match exactly, wild cards not accepted

Enter Constraints: Location

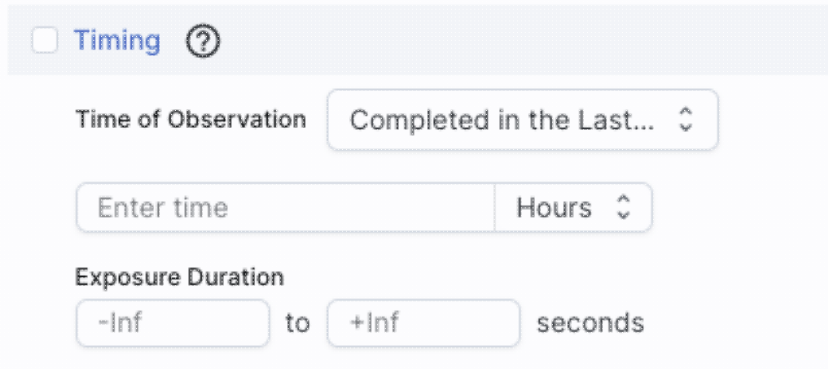


This panel provides a way to constrain the location of your search. Here, it is a single object search, which works just like it does above, including the interactive target refinement via the bullsye icon. You can also upload a list of targets by selecting "multi-object" -- it brings up the same pop-up as above, from which you can load a table from disk ("Upload tables" tab) or

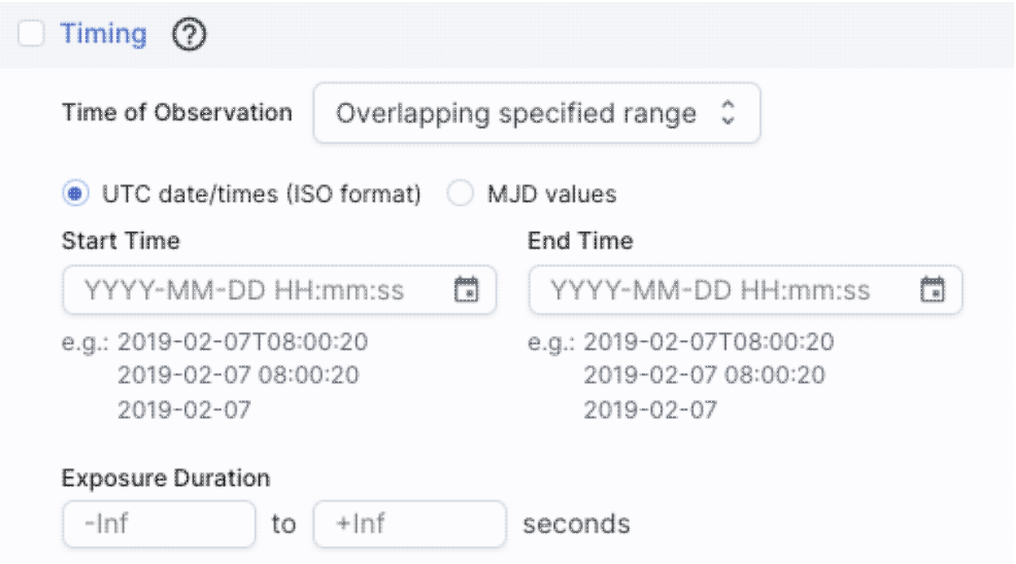
select one of the tables you have already loaded into the tool (click on the "Loaded tables" tab). Your uploaded catalog has to follow all the same rules as normal catalogs from disk.

You can specify via the drop-down the type of your query: "observation boundary contains point", "observation boundary contains shape", "observation boundary is contained by shape", "observation boundary intersects shape", and "central point (s_ra, s_dec) is contained by shape." The latter refers to the columns "s_ra" and "s_dec" in the ObsTAP table.

Enter Constraints: Timing

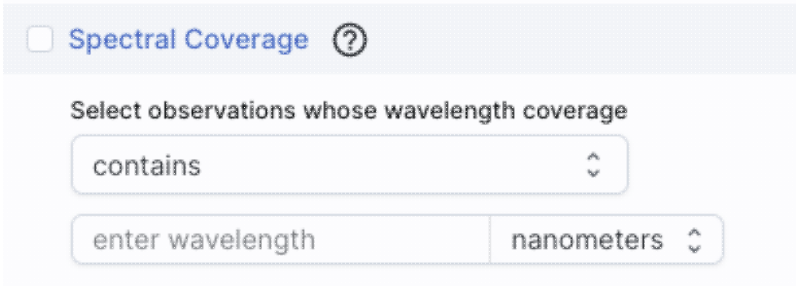


This panel provides a way to constrain the observation time of your search. This is the default option, where you want data completed in the last x hours (or other unit of time).

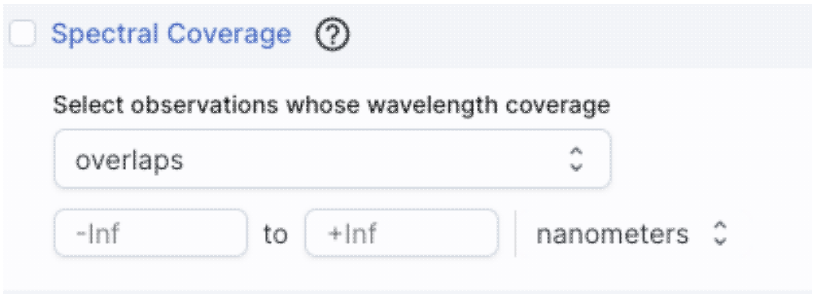


This is the alternate option, where you want data overlapping a specified date range, where you can specify UTC or MJD times.

Enter Constraints: Spectral Coverage



This panel provides a way to constrain the spectral coverage of your search. This is the default option, where you want data containing a given wavelength.

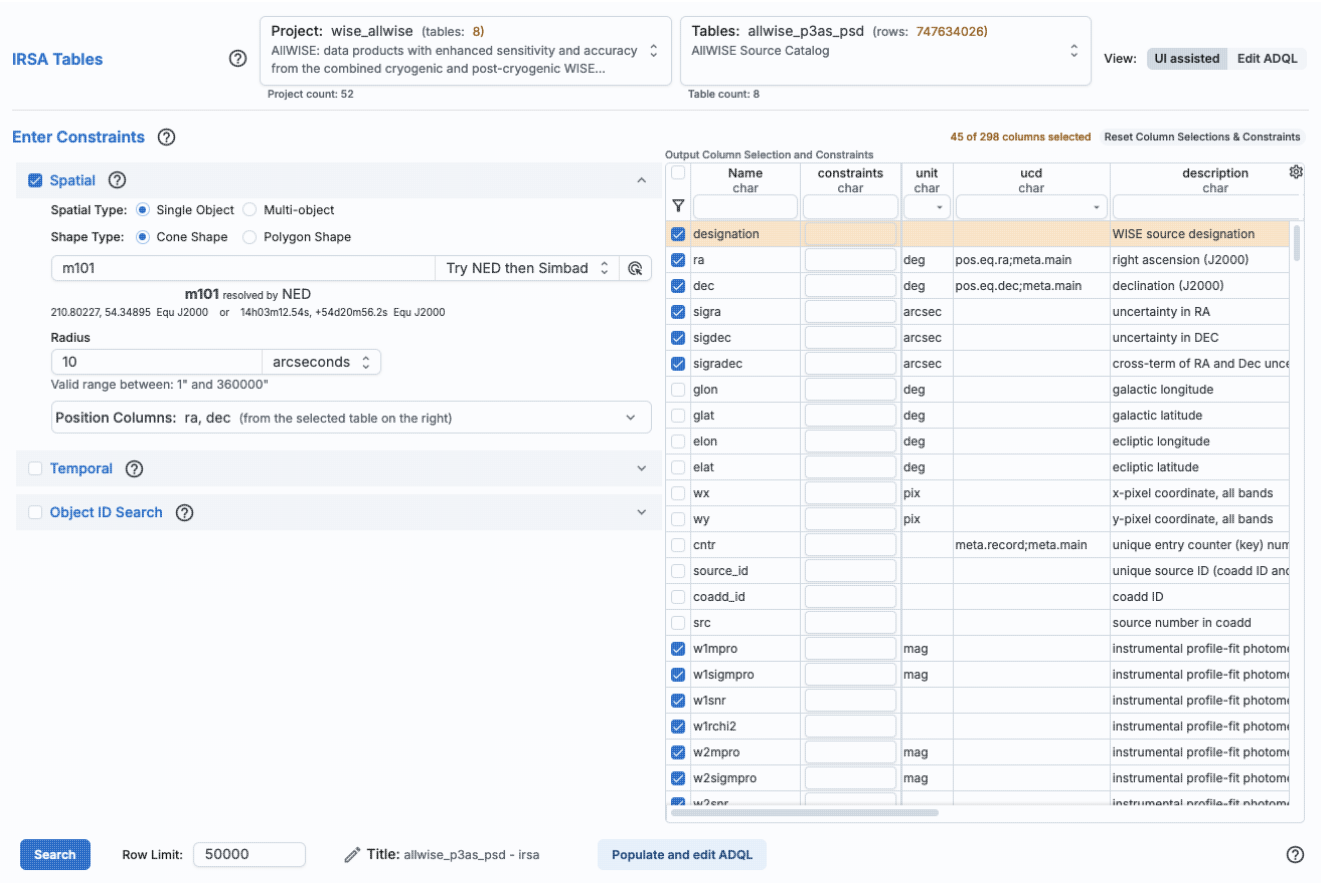


This is the alternate option, where you want data overlapping a specified wavelength range.

IRSA VO TAP Search

To see this tab as a choice on the top, you may need to select it from the side menu. (You may also find yourself having landed here from a Multi-archive VO TAP search, in which case you need to go there for more information.)

This is what the IRSA VO TAP search screen looks like:



Just do it: a quick start

Select Table: It comes up ready to search on *IRSA Tables*. You first need to select the "project" (sometimes called "Table Collection" or "Schema" in other contexts). Then, having selected that, the drop-down menu on the right changes to reflect the tables available under that schema.

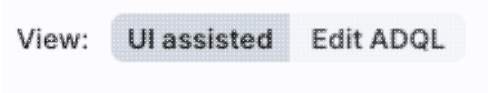
Then **Enter Constraints**: On the **left**, you can impose a variety of constraints. In addition to selecting the tickbox indicating that you wish to impose a particular kind of constraints, you need to specify which columns should be used for those constraints. More information on these constraints is above. On the **right** is a list of the columns in the selected table, with tickboxes to indicate which columns will be returned. You can also set constraints on the columns from here, following the same filter rules as for any tables here. Above this section of the screen, there is an indication of which columns are selected (e.g., 45 of 298 columns). You can reset the column selection via the button here as well.

Then to **actually do it**, click "Search."

Getting more out of it: Taking advantage of additional options

Selecting a Query Type

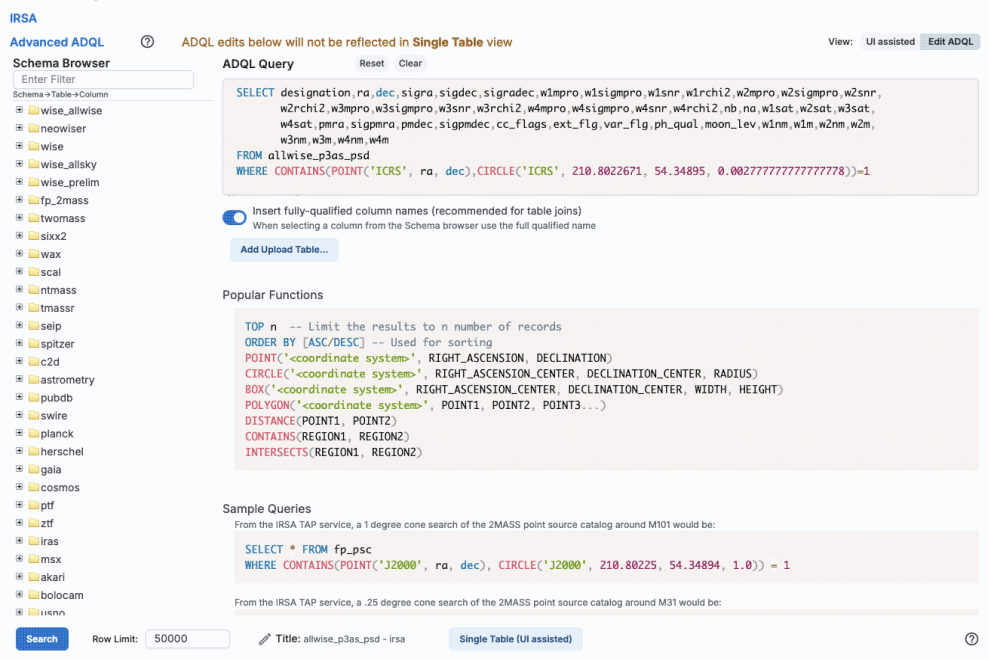
On the far right of the top row, there is a slider or button:



By default, it is set to "UI-assisted", as opposed to "Edit ADQL". Especially when starting out, UI-assisted is easier. By using the UI assisted" option, you can select pre-defined options and have the interface construct the query in ADQL. Alternatively, if you are already fluent in ADQL, you can select the second option, "Edit ADQL", to construct even more complex queries.

After populating the search parameters using the UI, you can click the button on the bottom, "Populate and edit ADQL" -- this takes the parameters you have entered, creates the ADQL, and launches the "Edit ADQL (advanced)" interface.

Advanced ADQL



You can get to this screen by selecting "Edit ADQL (advanced)" in step two, or by clicking on "Populate and edit ADQL" after filling out the UI.

You can select the schema from the left side of the screen. Each of the schemas can expand into viable tables and then columns within each table via clicking on the "+" to the left of the folder icon. Click on a column name to have it appear at the location of your cursor in the ADQL query box on the right. If you have the tickbox checked on the right that says "Insert fully-qualified column names", clicking on the column name inserts fully-qualified column names at your cursor location in the box.

You can type the ADQL directly into the box. If you configured a search on the "UI assisted" page, this box is already pre-filled with the ADQL version of your search, and you can proceed to edit it further.

Examples of useful functions and queries are given on the lower right of this window; you may need to scroll down.

Tips and Troubleshooting

- All the drop-downs near the top are roughly searchable. This is very useful if you are trying to find a particular table or service that you can't quite recall. Click in the drop-down area, type the first letter of what you are looking for, and it will jump to the first instance of a string starting with that letter. Hit that letter again, and it goes to the second instance of a string starting with that letter.
- Not every table available via this interface even has RA/Dec or, if it does, it may not be searchable via positions. If you have selected a table that doesn't have positions, it will not yield results if you try to search by position.

- There is a maximum number of returned rows at the bottom. If you are anticipating more than this number of rows, increase this number!
- If you arrive at the advanced ADQL page from the "Populate and edit ADQL" button, this is a one-way trip -- any changes you make to the ADQL here are NOT transmitted automatically back to the "UI Assisted" query page.

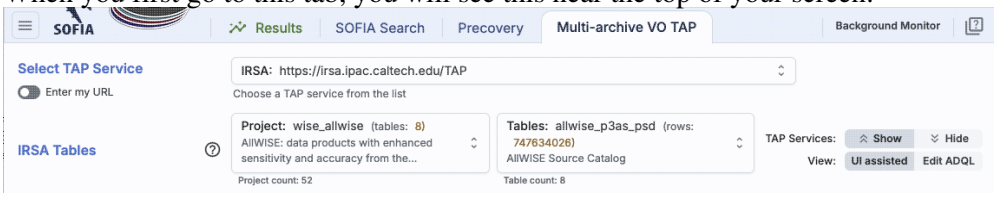
If you choose to use the GUI, you can work within it to set the constraints you desire at the bottom of the screen; see VO TAP: More About Constraints for all of the information about setting constraints.

The result of an IRSA TAP search is a catalog that can be interacted with like any other catalog in this tool.

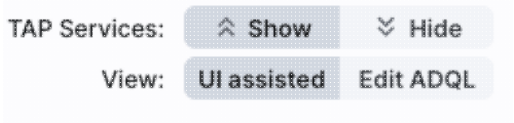
Multi-archive VO TAP Search

To see this tab as a choice on the top, you may need to select it from the side menu. Or, you may land in this tab from a table action.

When you first go to this tab, you will see this near the top of your screen:



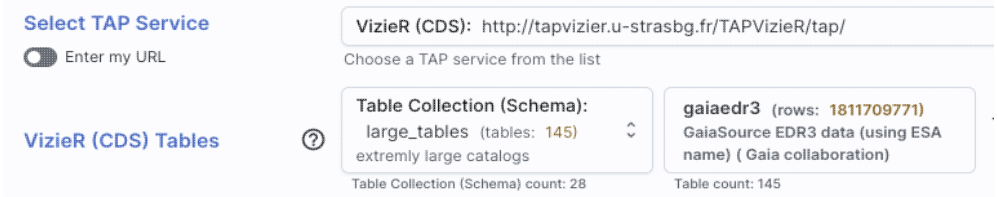
At the top, you now have a choice of which TAP service you want to use, and it defaults to IRSA's. You can select your favorite from the list, or use the toggle on the left to enter your own custom URL. If you want to hide this top row after setting it (to, say, regain screen real estate), look for this on the far right:



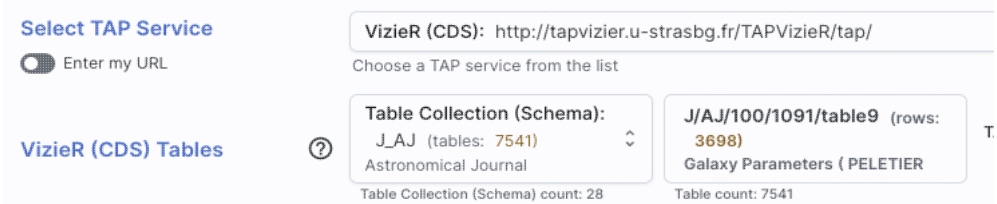
the "TAP Services:" button (show/hide) will reveal or conceal this top row.

The rest of this search screen is basically identical to that which you get from the IRSA VO TAP Search screen, even if you pick a TAP service other than IRSA's (with a few exceptions, including if it's ObsCore; see below).

For VizieR's services in particular, because there are so many tables, the tool will give you a slightly different interface under the "Tables" section of the window. Here is the default Vizier choices as of this writing:

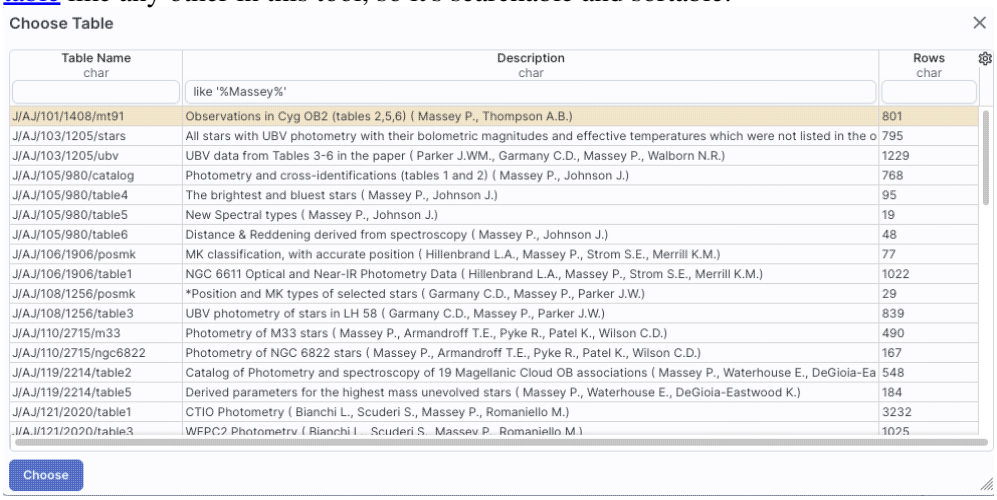


Note that it tells you how many tables and rows are available. Switching to tables associated with journal articles, far more tables are available:



Now, if you click on the second tier menu (J/AJ/100/1091/table9), you get a pop-up, which is another Firefly

table like any other in this tool, so it's searchable and sortable:



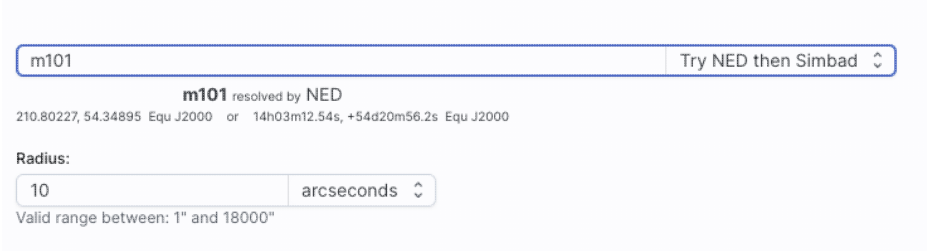
which makes it trivially easy to find tables in which you are interested, such as those associated with papers by Massey, as shown. Select the table that you want to search, and then continue to specify the rest of your search, just as described above in the IRSA VO TAP Search screen discussion.

The result of any VO TAP search is a catalog that can be interacted with like any other catalog in this tool.

NED Objects -- Searching for NED objects

(NED= NASA Extragalactic Database.)

To see this tab as a choice on the top, you may need to select it from the side menu.



As for the other catalog searches, the tool may pre-fill the target position with its best guess of the coordinates of the target with which you have been working. You can use an object name in place of coordinates. Note that although NED is used for name resolution, the actual search is then performed using coordinates, as opposed to name. In this case, you are limited to a cone search, so the next option is the cone search radius. Pick your units from the drop-down first, and then enter a number; if you enter a number and then select from the drop-down, it will convert your number from the old units to the new units. There are both upper and lower limits to your search radius; it will tell you if you request something too big or too small.

From the NED results, you have one-click access to the fully detailed information from NED on any object returned from such a search. The search results will generally include a column "Details", though you may have to scroll to the right to see it. Clicking on a link in this column takes you directly to the full NED information display for the selected object in a new window.

The result of any NED search is a table that behaves like any other table in this tool.

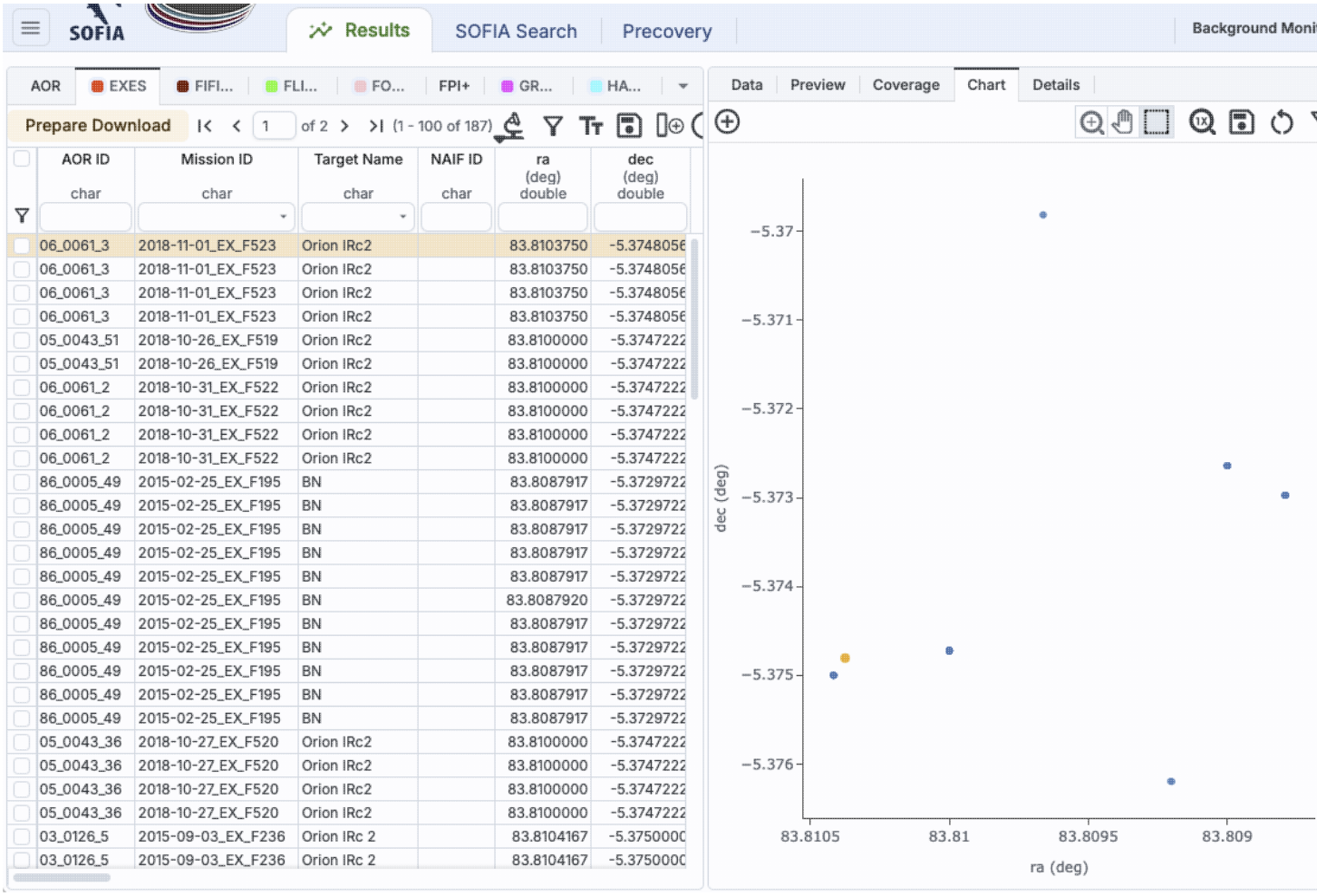
SOFIA Science Data Archive: Plots

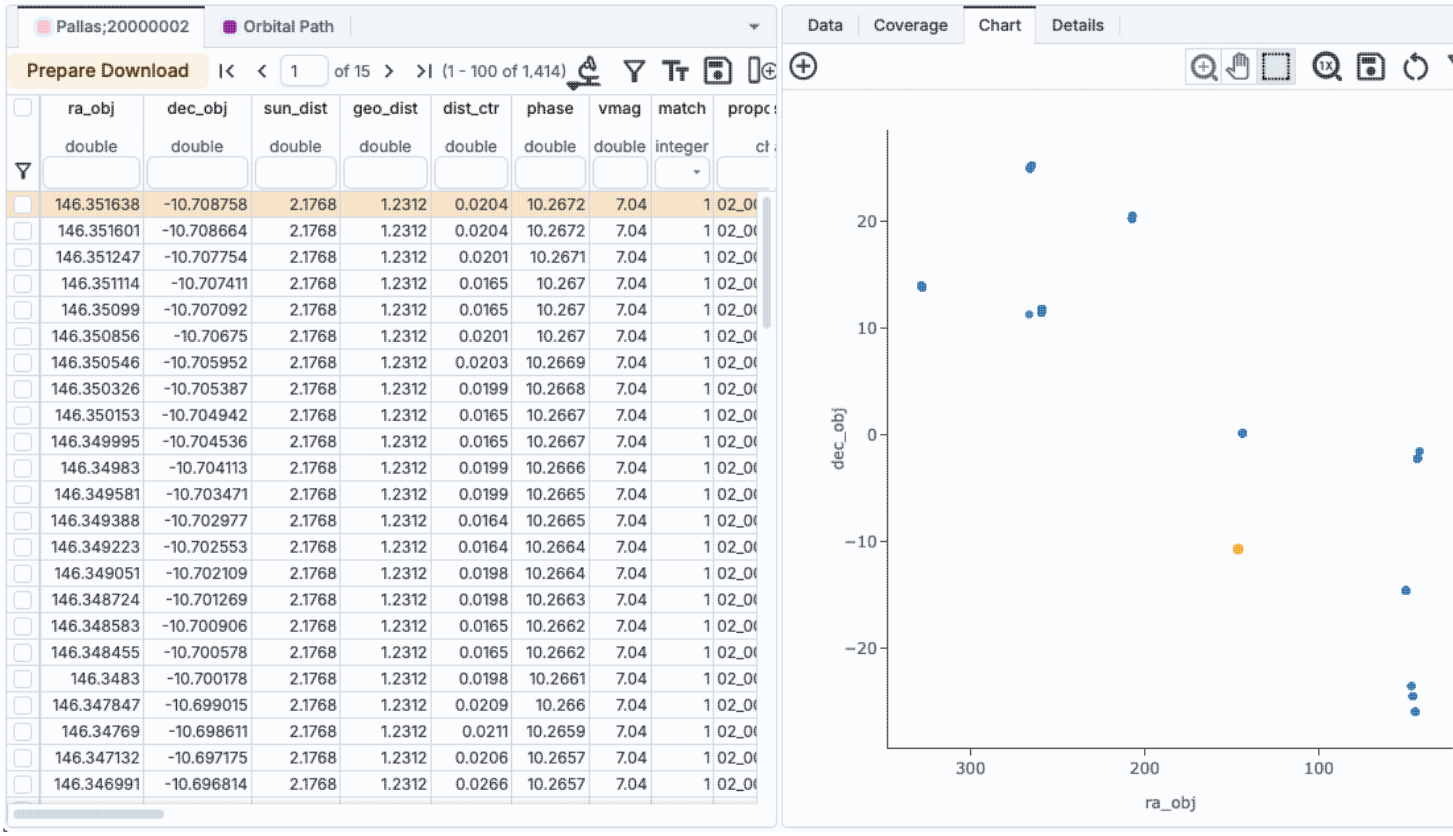
Plots (sometimes called charts) are made from Tables, and, more commonly (or usefully) from Catalogs. Plotting is covered in this section. The Tables section discusses tables more generally, and the specific case of loading catalogs is in another section. If your table has RA and Dec in it, the Visualization section covers how the catalog can be overlaid on images. If your plot is a spectrum, the Spectra section also covers that.

Contents of page/chapter:

Default Plot

When doing a position search for a fixed target, the default plot is often somewhat less than useful -- it grabs the requested positions from the list of observations, or even just the coordinates of the reference pixel (the CRVAL 1 and 2) of the retrieved images (see first screenshot below). If you have constrained your search results to only return the most centered image, this is an even more phenomenally uninteresting plot, because it has a single point. If you do a search on a moving target, the default plot is the RA and Dec of the object that it finds with data, so moderately more interesting (see second screenshot below).


SOFIA
Results
SOFIA Search
Precovery
Background Moni
AOR
EXES
FIFI...
FLI...
FO...
FPI+
GR...
HA...
Prepare Download
1
of 2
(1 - 100 of 187)
AOR ID
char
Mission ID
char
Target Name
char
NAIF ID
char
ra
(deg)
double
dec
(deg)
double
06_0061_3 2018-11-01_EX_F523 Orion IRc2 83.8103750 -5.3748056
06_0061_3 2018-11-01_EX_F523 Orion IRc2 83.8103750 -5.3748056
06_0061_3 2018-11-01_EX_F523 Orion IRc2 83.8103750 -5.3748056
06_0061_3 2018-11-01_EX_F523 Orion IRc2 83.8103750 -5.3748056
05_0043_51 2018-10-26_EX_F519 Orion IRc2 83.8100000 -5.3747222
05_0043_51 2018-10-26_EX_F519 Orion IRc2 83.8100000 -5.3747222
06_0061_2 2018-10-31_EX_F522 Orion IRc2 83.8100000 -5.3747222
06_0061_2 2018-10-31_EX_F522 Orion IRc2 83.8100000 -5.3747222
06_0061_2 2018-10-31_EX_F522 Orion IRc2 83.8100000 -5.3747222
06_0061_2 2018-10-31_EX_F522 Orion IRc2 83.8100000 -5.3747222
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087920 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
86_0005_49 2015-02-25_EX_F195 BN 83.8087917 -5.3729722
05_0043_36 2018-10-27_EX_F520 Orion IRc2 83.8100000 -5.3747222
05_0043_36 2018-10-27_EX_F520 Orion IRc2 83.8100000 -5.3747222
05_0043_36 2018-10-27_EX_F520 Orion IRc2 83.8100000 -5.3747222
05_0043_36 2018-10-27_EX_F520 Orion IRc2 83.8100000 -5.3747222
03_0126_5 2015-09-03_EX_F236 Orion IRc 2 83.8104167 -5.3750000
03_0126_5 2015-09-03_EX_F236 Orion IRc 2 83.8104167 -5.3750000
Data
Preview
Coverage
Chart
Details
1x
−5.37
−5.371
−5.372
−5.373
−5.374
−5.375
−5.376
dec (deg)
83.8105
83.81
83.8095
83.809
ra (deg)



You can change what is plotted (see below) but plots of image metadata may not be what is most desirable.

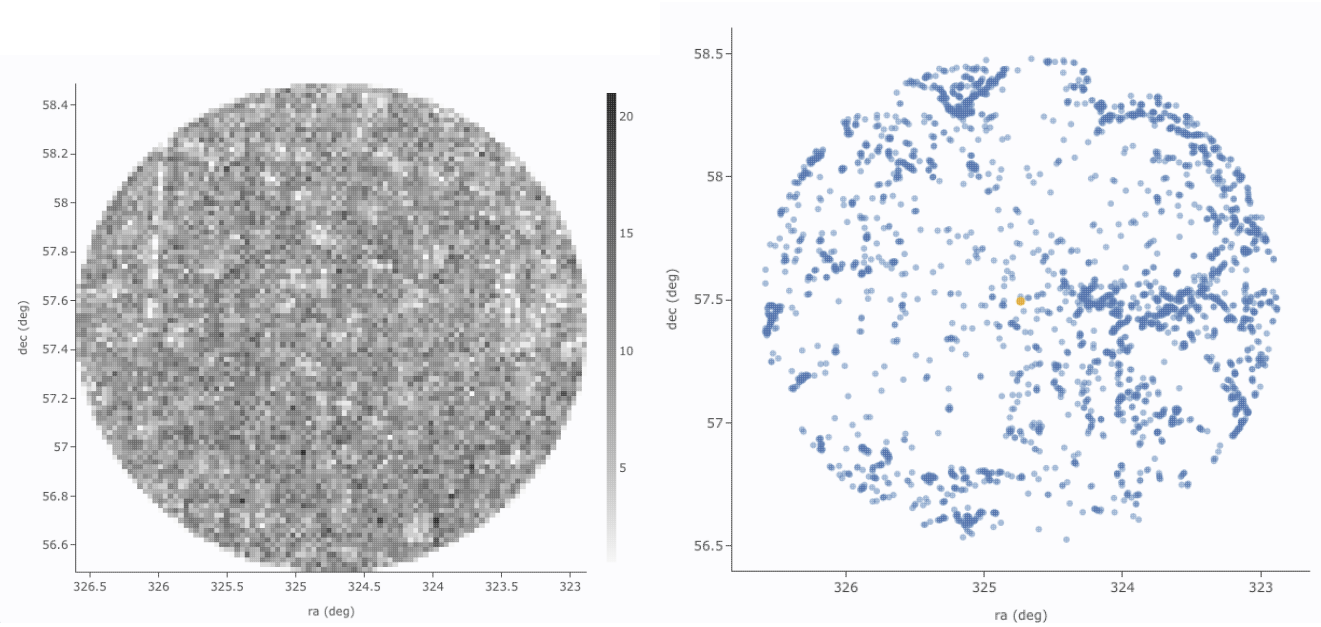
Try loading in a catalog and keep reading! The default plot for a catalog will also be RA and Dec.

Note that all of these RA/Dec plots follow astronomical convention -- RA increases to the left.

To obtain a full-screen view of your plot, click on the expand icon in the upper right of the window pane:  .
To return to the prior view, click the "Close" arrow in the upper left.

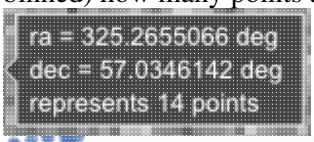
Plot format: A First Look

If you have loaded a catalog with many (> 5,000) points, you may have an RA/Dec plot that looks something like the one on the left here. If you have loaded a catalog with few (< 5,000) points, you will have an RA/Dec plot that looks more like the one on the right here.



The difference between them is that, for larger catalogs (left), the plot is binned -- more points are encompassed in a black tile and fewer points are encompassed in a white tile. In the context of this tool, this is called a **heatmap**. The shades of grey correspond to how many points are encompassed in each 'cell', with the density scale given on the right hand side of the plot. For smaller catalogs (right), each individual point is shown as a blue dot. In the context of this tool, this is called a **scatter plot**. Note that even when individual points are shown, where the points overlap, the color is darker.

In either case, letting your mouse hover over a point tells you the values of the point under your cursor, and (if binned) how many points are represented:



for binned plots, and

for just one point.

Clicking (in an unbinned plot) highlights that point, and it stays highlighted, though you must keep your mouse on the point in order to see the information about it.

The reason the tool makes a heatmap for large catalogs is to more fairly represent the point density -- and to make the plotting faster. In these cases, though, it will not give you the option to overplot errors (see below). If you have a heatmap and want a scatter plot *by default*, you need to filter or otherwise restrict the catalog to have fewer points (see below). You can change the bin size and shading via the plot options pop-up (more on this below).

Plot Navigation

The top of the plot window has a row of icons something like this:


which we now describe.

Add new plot
You may or may not have this icon. Clicking on this icon adds a new plot. This has a separate section below.


Plot mode
This trio of icons controls the plot interaction 'mode'. By default, you are in 'selection' mode, as seen here -- the last icon is darker, like a pushed-in button. To activate the other modes, click on the other icons, and they become darker or "pushed in."

Zoom mode
When this mode is active, when you click and drag in the plot, the plot is zoomed to the region you have selected. Even when this mode isn't active, you can also zoom using your scroll feature on your mouse. To return to the original view, click on .

Pan mode
When this mode is active, when you click and drag in the plot, it moves around in response to where you drag. To return to the original view, click on .

Select mode
When this mode is active, when you click and drag in the plot, you are given additional options at the top of the plot : The checkmark means "select" and the funnel means "filter." The difference is that filtering (temporarily) limits what is shown in the plot, catalog, and image (see general information on filters), and selecting just highlights the points enclosed within your selection. To cancel either one, click on cancel filters or cancel selection .

Re-scale plot
Return to the view that optimizes the range of x and y to show the currently displayed points.

Tips and Troubleshooting: Did you accidently zoom in the plot with your magic mouse or touchpad? Click on this icon to reset the plot.

Save plot
Save the plot. It will save as a png file, wherever your browser is configured to save files. The saved png is the same size as it is on your screen. If you want a big version, make the desired plot big on your screen (expand the view to take up as much space as possible) before saving the png.

Undo
Restore everything to the defaults. If you've played a lot with the plot, you may want to undo everything you've done. Click this icon to restore everything back to the defaults.

Filter from plot
Pull up interactive filters. This button brings up filters for the displayed catalog in an interface like all the other tables here, except you don't see the values in the catalog themselves; you can enter filters here in the same way you can everywhere else in this tool (see general information on filters).

Configure plot
Click on this icon to change what is plotted (much more on this below).

Expand plot

Click on this icon to make the plot take up the whole browser window. To return to the prior view, click the "Close" arrow in the upper left.

Help
This icon may not appear, but if it does, it is a context-sensitive help marker, which should bring you to this online help.

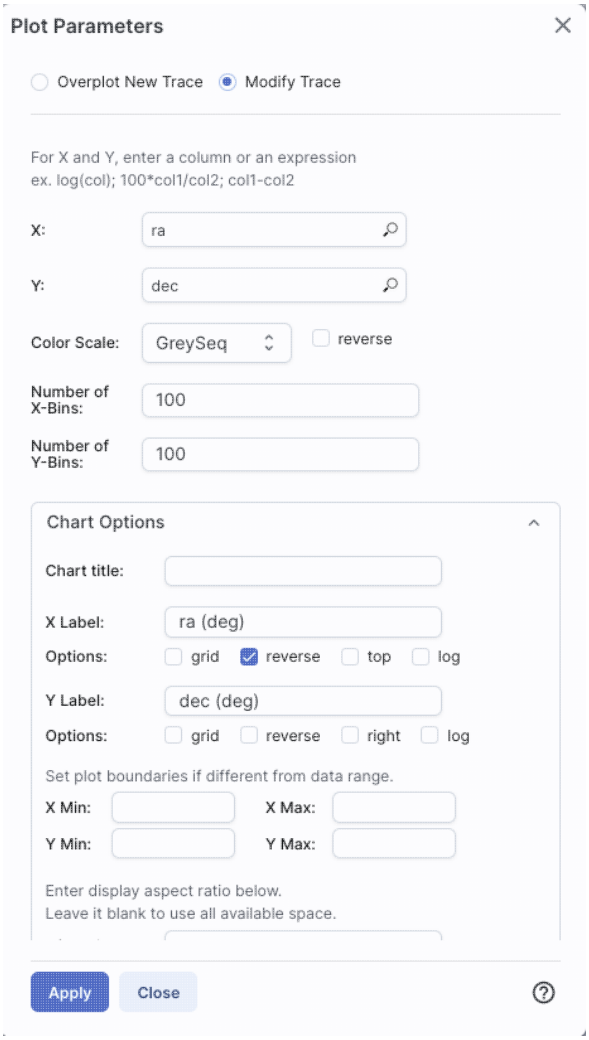
Plot Linking: Plots are linked to catalog and image(s)

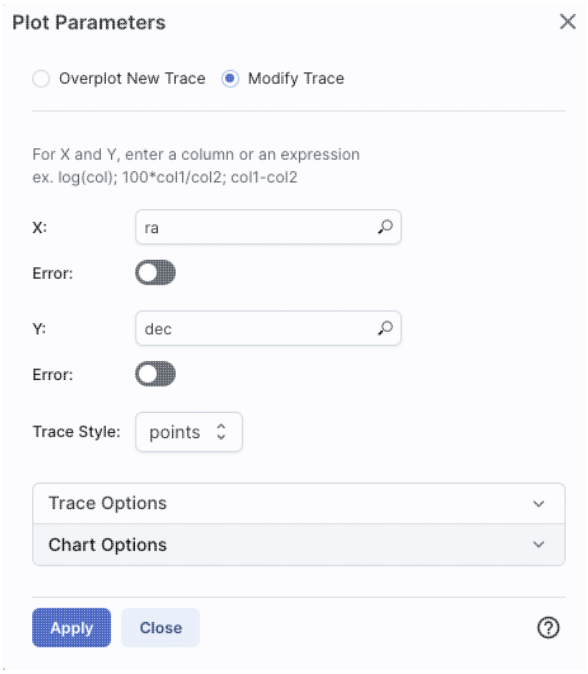
If you move your mouse over any of the points in the plot, you will get a pop-up telling you the values corresponding to the point under your cursor. For scatter plots, if you click on any of the points, the object(s) corresponding to that point will be highlighted in the overlays in the images shown, and highlighted in the catalog table. This works the other way too -- click on a row in the catalog, or an object in the images, and the object will be highlighted in the plot or the catalog or the image.

Changing What is Plotted

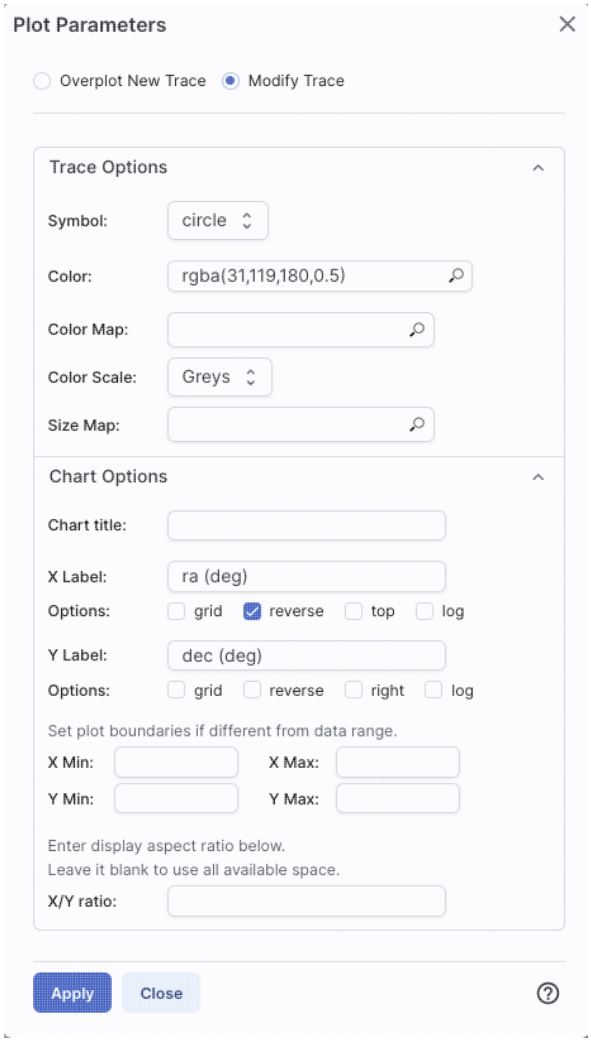
To change what is plotted, click on the gear icon in the upper right of the plot window pane: . Configuration options then appear; the options are a little different depending on whether the points are binned or not. This section describes how to change what is plotted, i.e., the "Modify Trace" option at the top of both of these pop-ups. The overplotting option (and, for that matter, adding plots) are covered in more detail below.

This is the configuration window for a binned (a.k.a. heatmap and/or greyscale) plot. By default, the "chart options" may be hidden; to reveal them, click on the name "Chart Options" or the disclosure arrow on the right. To hide them again, click on the disclosure arrow on the right.





The configuration window for a plot that shows individual points, once fully extended, is much longer (and scrollable), and so is shown here in two parts. Both the "Trace Options" and "Chart Options" may be hidden by



default; to reveal them, click on the name or the disclosure arrow on the right. To hide them again, click on the disclosure arrow on the right.

Options found in both kinds of plots

In either case, you can **specify what should be plotted on each axis**. The magnifying glass is a link that brings up a table that lists all of the available columns in the catalog. Alternatively, you can just start typing, and viable options appear below the box. Whatever you put in the box must match the column name as shown in the catalog *exactly*.

Click on the black triangle to reveal additional options.

In both of the examples above, RA is plotted on the x-axis. It has pulled the column name for the label; in this table, the column is "ra" rather than "RA", and it is case-sensitive. It has copied over the units ("deg") from the catalog, and plotted the x-axis increasing to the left as per astronomical convention. You can change what column is plotted, and whether or not errors are shown. Under "**Chart Options**", you can specify:

◊ title of the plot;
◊ labels on the x and y-axis;
◊ whether or not there is a grid shown;
◊ whether or not the axis is reversed (as for ra in the examples above);
◊ whether the x-axis is on the top or bottom and the y-axis is on the left or right;
◊ whether or not the axis is logarithmic;

- ◊ the maximum and minimum values of the plot range;
- ◊ the aspect ratio of the plot (e.g., square or rectangular).

By default, the boundaries of the plot are set to encompass the full data range. Here you can change the boundaries to specific numbers. (This can also be set via filtering from the plot; see below.)

You can enter **simple mathematical relations** in these boxes too, such as (for a WISE catalog) "w1mpro-w4mpro" to put [W1]-[W4] on one axis. Supported operators:

- ◊ +,-,*,/
- ◊ abs(x), acos(x), asin(x), atan(x), atan2(x), ceil(x), cos(x), exp(x), floor(x), lg(x), ln(x), log10(x), log(x), power(x,y), round(x), sin(x), sqrt(x), tan(x)
- ◊ degree(x) and radians(x) are also supported -- these are the same functions as in ADQL and convert radians to degrees or degrees to radians. For small astrometric offsets, you could make a scatterplot of dec2-dec1 vs. (ra2-ra1)*cos(radians(dec1)) instead of typing cos(dec1*pi()/180). (NB: pi() is also a supported function you can use, instead of typing 3.14159.)
- ◊ Non-alphanumeric column names (e.g., those with - or + or similar characters) should be quoted in expressions.

Click "Apply" to apply, and "Close" to return to the plot without making changes. (For the latter, you can also click the 'x' in the upper right.)

Options found only in binned plots

(Plots are binned by default if there are > 5,000 points in the catalog.) From the pop-up, you can control the color table that is used (greyscale is the default; there are many other choices in the drop-down menu), as well as the number of bins in the x and y directions. The default value for the number of bins is 100 in both directions.

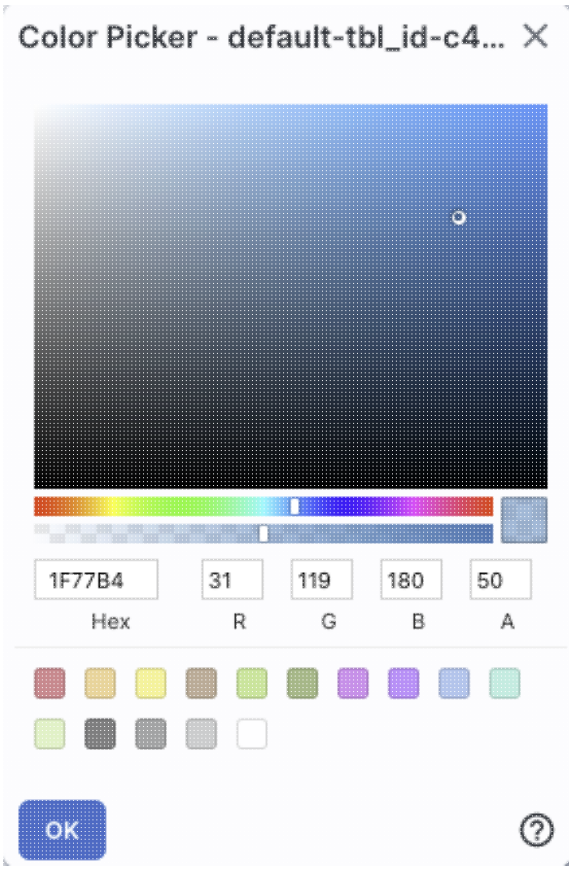
Options found only in plots showing individual points

You can add errors. Toggle the error switch, and then additional choices appear. From there, you can select symmetric or asymmetric errors, and then you can specify an error as either an existing column in the catalog, or calculated from a column in the catalog.

Under "**Trace Style**," you can control whether the points are shown as individual points, connected points, or just lines connecting the points.

Under **Trace Options**, you have many choices.

- ◊ Choose the **symbol type**: circle (default), open circle, square, open square, diamond, open diamond, cross, x, upward-pointing triangle, hexagon, or star.
- ◊ Choose the **color**. By default, the point color is a mid-range blue that is darker where more points. This is specified by the rgba vector shown in the example here (31, 119, 180, 50) where the last number is in units of fraction of 1, so 0.5=50% in this example. Click on the magnifying glass to bring up a color picker window:



From here, you can click on your desired color in the top colorful box. Immediately below that box, you can change the color and saturation of the top box so that you can select from a different range of colors. Below that, you can enter numerical hex codes or RGBA values (where the value for RGB is between 0 and 255, and A is in units of percent, e.g., 50 = 50%). Finally, you can also select from a pre-defined set of 15 colors by clicking on any of the small boxes. Note that the numerical codes update as you select different colors. Click "OK" to implement your color choice, or click 'x' in the upper right to close the window without changing the color.

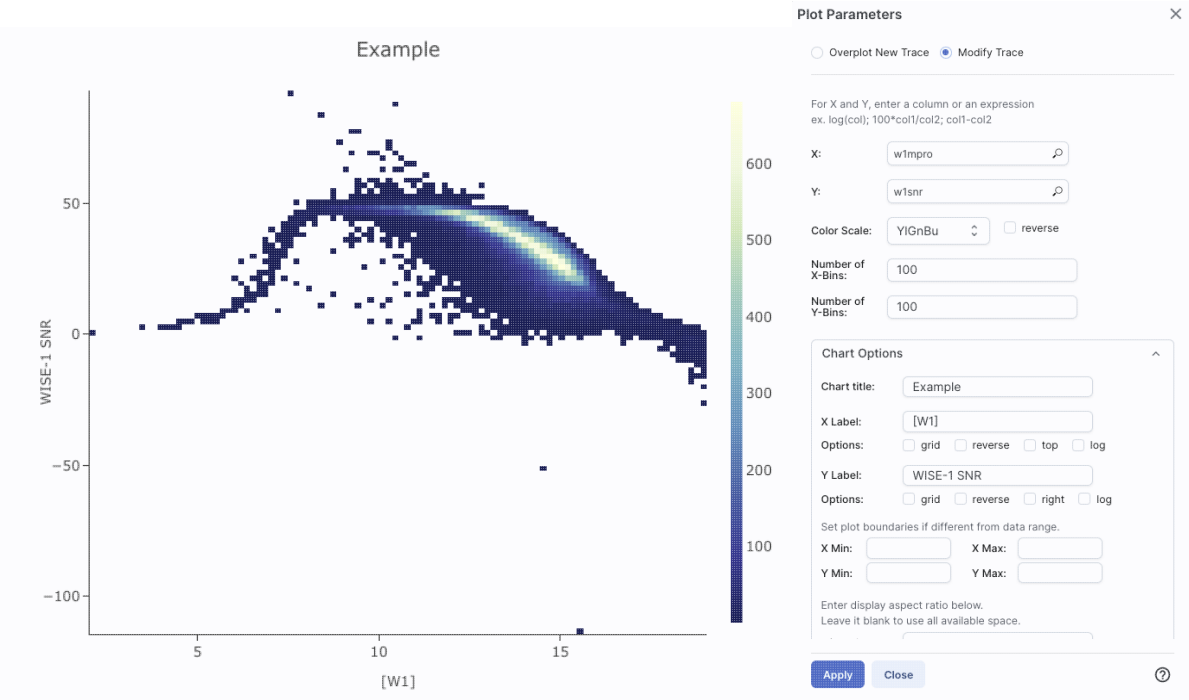
Tips and Troubleshooting: Don't like the transparency feature of the points that makes them darker when there are more points? Set the last value of the vector (A) to 1. Don't like the blue? Pick a diferent color entirely. Want the faintest point to be brighter than it is by default? Set the last element of the color vector ("A") to be 0.7 or 0.8.

◊ Choose the **color map**. By default, all of the points are the same color, but darker where there are more points. You can change this such that the color scale of the points is tied to a column value, such as w1snr (WISE-1 signal-to-noise ratio) in a WISE catalog. If you select this option, you can also change the color scale to any of many different options (see the drop-down). Simple mathematical relations (as above) are also permitted in this box.

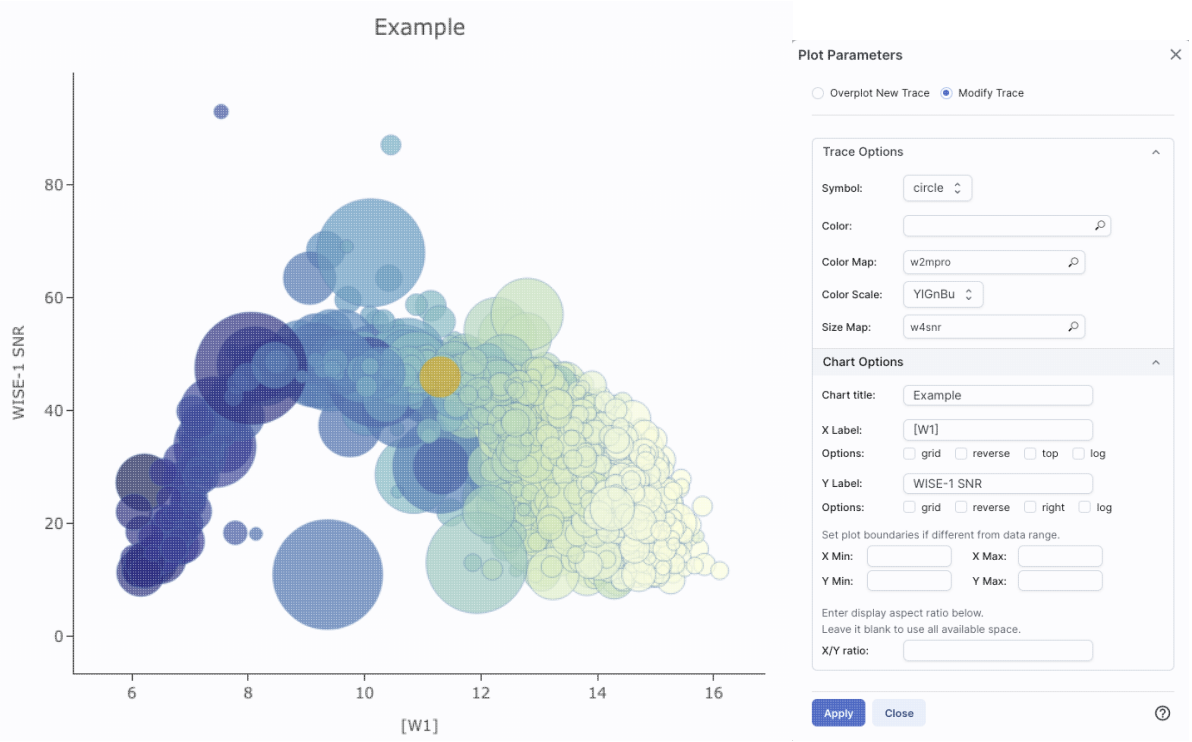
◊ Choose the **size map**. By default, all of the points are the same size. You can change this such that the color scale of the points is tied to a column value, such as w1snr (WISE-1 signal-to-noise ratio) in a WISE catalog. Simple mathematical relations (as above) are also permitted in this box.

Example: Load a large WISE catalog. Plot w1snr (WISE-1 signal-to-noise ratio) vs. w1mpro (WISE-1 profile fitted magnitude). It defaults to a heatmap. Change the labels, making the y-axis label "WISE-1 SNR" rather than the more cryptic column header "w1snr". Change the x-axis label to "[W1]." Change the greyscale to

yellow-green-blue ("YlGnBu") to make it easier to see the lowest-populated bins. Depending on your catalog, you may need to adjust the ranges. Obtain this plot:



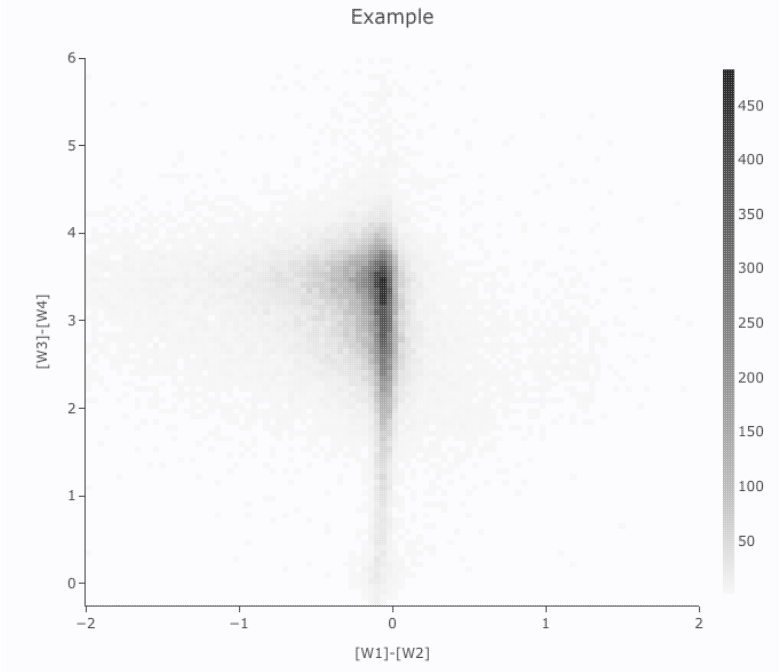
Example: Load either a smaller WISE catalog, or the same large WISE catalog, but filter it down such that w1snr, w2snr, and w3snr are all greater than 10, which limits the number of points to be <5,000. Plot w1snr vs. w1mpro. It shows the points individually. Change the labels. Change the point color map to scale with w2mpro (WISE-2 profile fitted magnitude). Change the point size map to scale with w4snr (WISE-4 signal-to-noise). Obtain this plot:

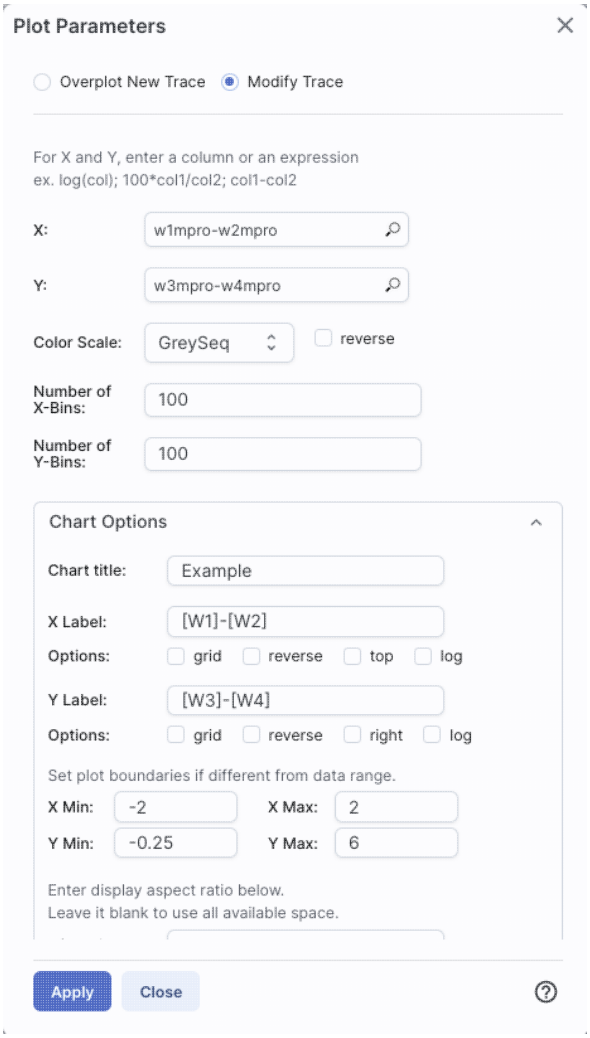


Plotting Manipulated Columns

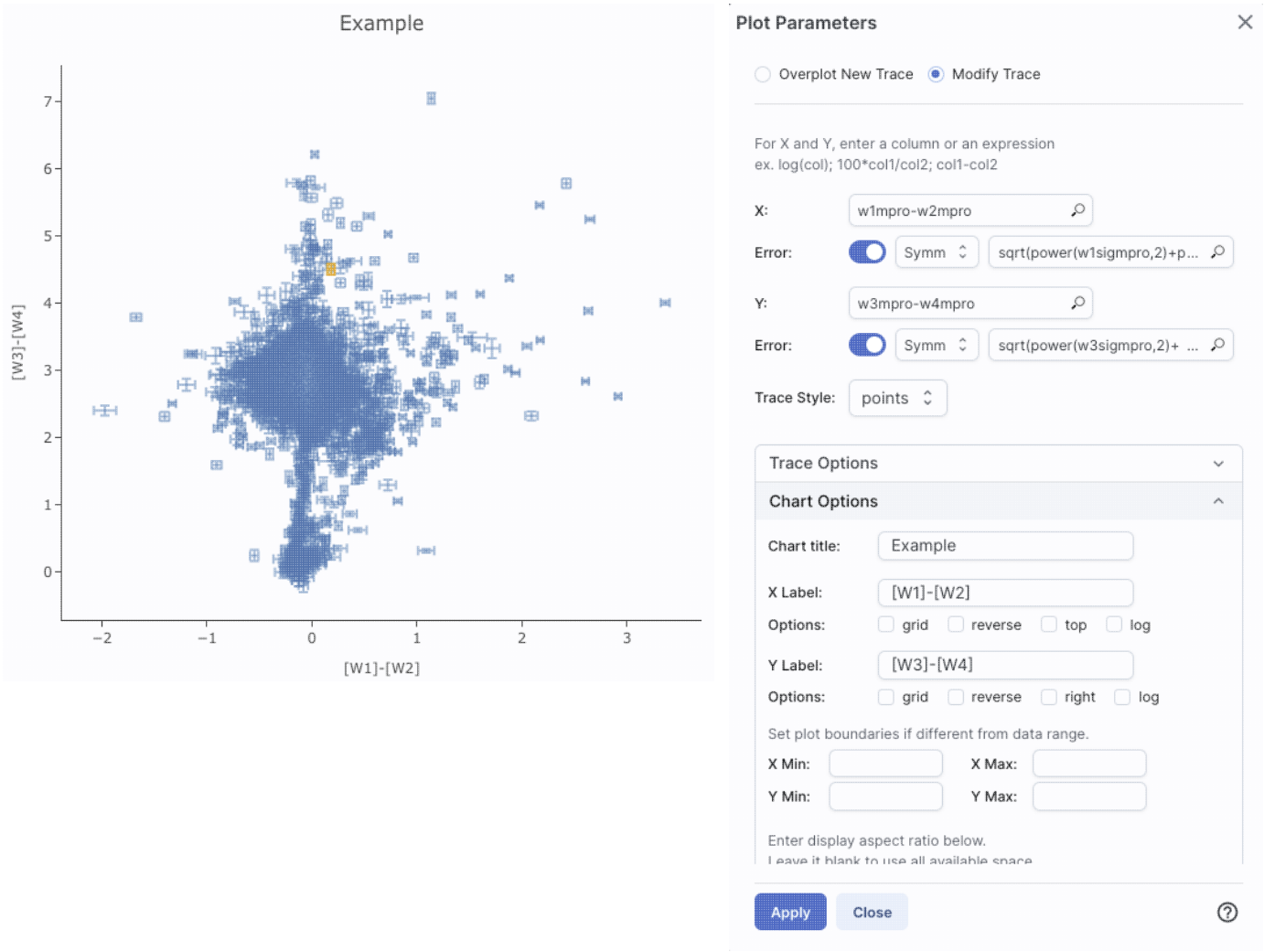
You can choose a single column to plot against another column, as above. However, you can also do simple mathematical manipulations.

For example, if you have loaded a WISE catalog, you can plot [W1]-[W2] vs. [W3]-[W4]. In terms of the names of the columns in the database, this is w1mpro-w2mpro vs. w3mpro-w4mpro.





If you have few enough points that the plot is not binned, you can add errors that you calculate. Here, the expression for the x-axis errors is sqrt(power(w1sigmpro,2)+power(w2sigmpro,2)) and for the y-axis errors, it is sqrt(power(w3sigmpro,2)+power(w4sigmpro,2)) -- that is, the errors for the individual photometric points added in quadrature.



Restricting What is Plotted (from the plot)

You can also restrict what data are plotted in any of several different ways.

You can filter the catalog from the table itself (discussed in another section).

You can set axis limits on the plot itself from the plot options pop-up (discussed above).

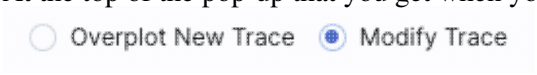
However, and perhaps more powerfully, you can set limits from the plot itself using a rubber band zoom. Click on the select icon in the plot  Then, click and drag in a sub-region of the plot. New icons appear:  If you click on the funnel icon, only those data points that pass the filter are shown in the plot, in the table, and/or overlaid on the image(s). (This is the behavior of 'filter', as opposed to 'select'; the former restricts what is shown, the latter just highlights the points.) For more on filters, see the filtering discussion in the tables section.

Example: Obtain a WISE catalog of a star-forming region, say IC1396. Filter down the catalog to only have detections at all four WISE bands. (Limits have undefined errors, so ask the catalog to filter down such that w1sigmpro>0, w2sigmpro>0, w3sigmpro>0, and w4sigmpro>0). Plot w1mpro-w4mpro on the x-axis, and

w1mpro on the y-axis. Reverse the y-axis to put bright objects at the top. Click and drag in the plot to select the bright and red objects, and filter them down to get a subset of bright and red sources. For clarity, the screenshot here has the sources selected, not filtered.

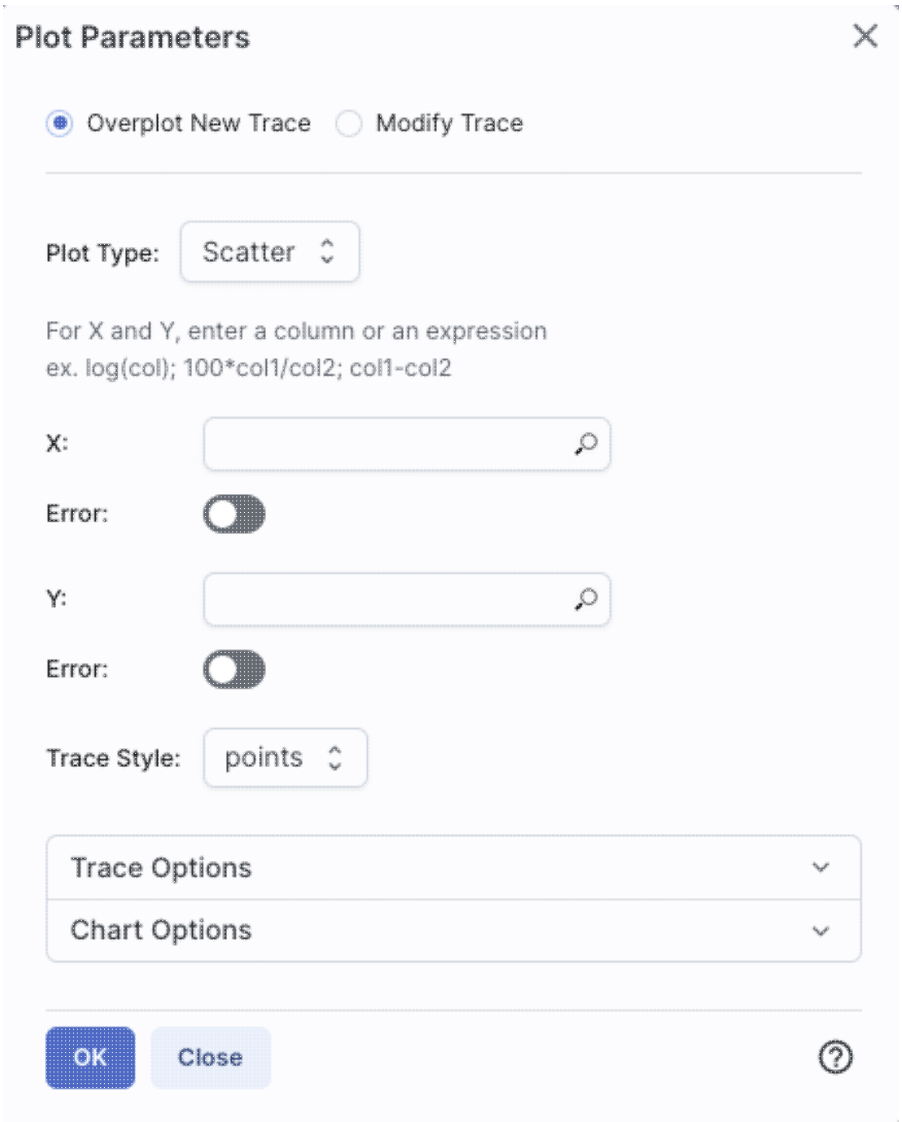
Overplotting

At the top of the pop-up that you get when you click on the gears, you have two radio buttons:



They are "Overplot New Trace" and "Modify Trace." Modifying traces (plots) has been covered above; in this section, we will cover overplotting. This is sometimes called "multi-trace," meaning that more than one thing is plotted.

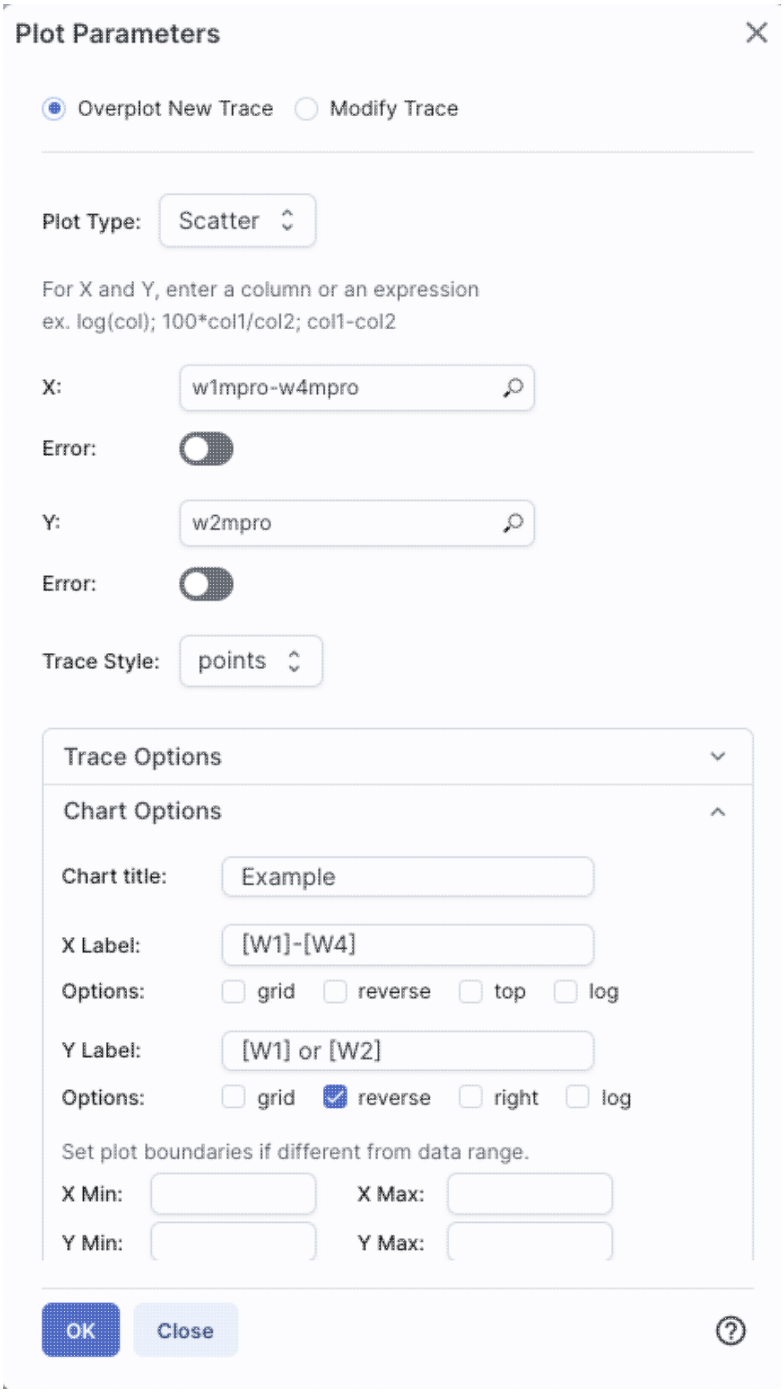
When you select "Overplot New Trace," you get a new interface that is very similar to the original interface where you selected what to plot:



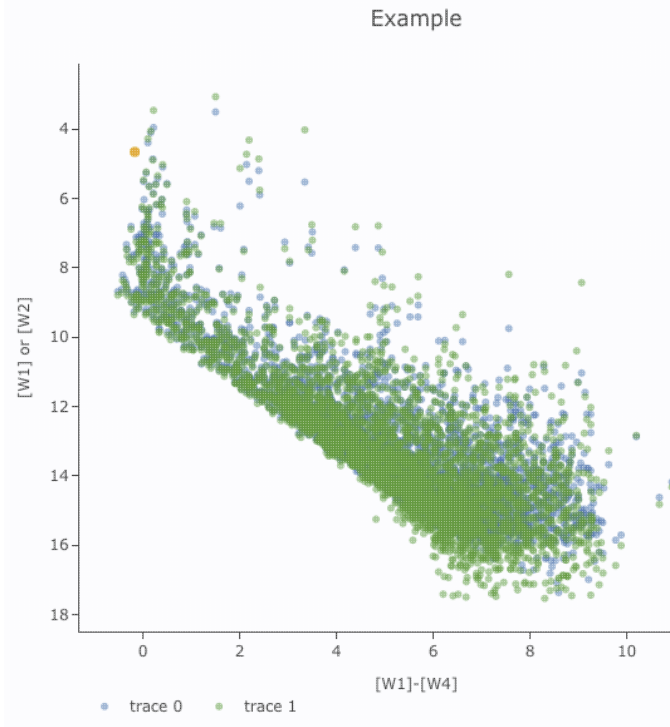
As before, you need to :

- select a plot type (scatter, heatmap, histogram);
- tell it what column(s) (and and manipulations thereof) you want for x, y, and associated errors;
- select the trace style (points, connected points, lines);
- set any additional trace options;
- set any additional chart options.

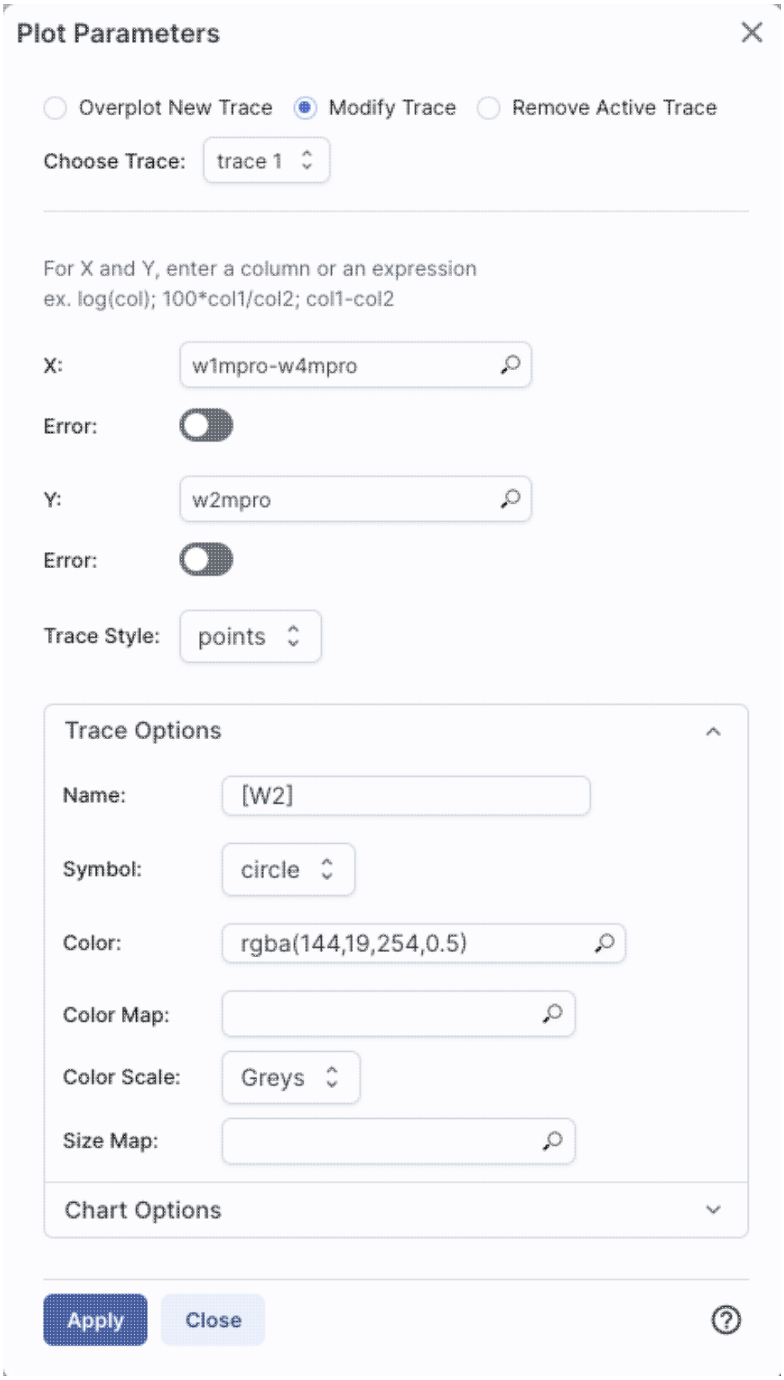
The best way to explain how to use this feature is probab
example. We have a plot of [W1] vs. [W1-W4] from abo
add on top of it a plot of [W2] vs. [W1-W4]. Click on the
bring up the pop-up. Select "Overplot New Trace." Enter
"w1mpro-w4mpro" for x and "w2mpro" for y. Expand "C
Options." Note that it has preserved the overall chart title
before, but has erased the X and Y labels (and lost the re
the y axis) because the overplot could literally be anythin
need not be the same columns or even the same units as
already plotted. Type them in again. Here is the configur



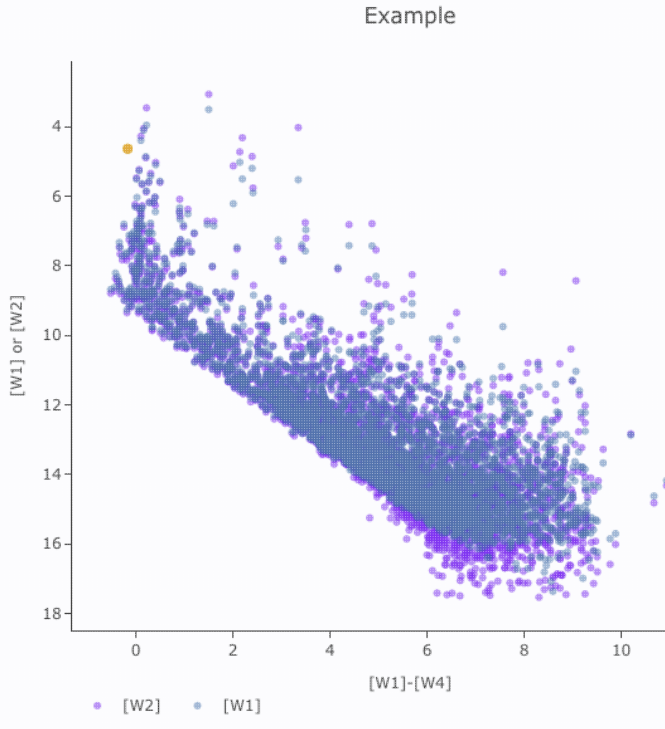
window right before clicking "ok", and the resultant plot



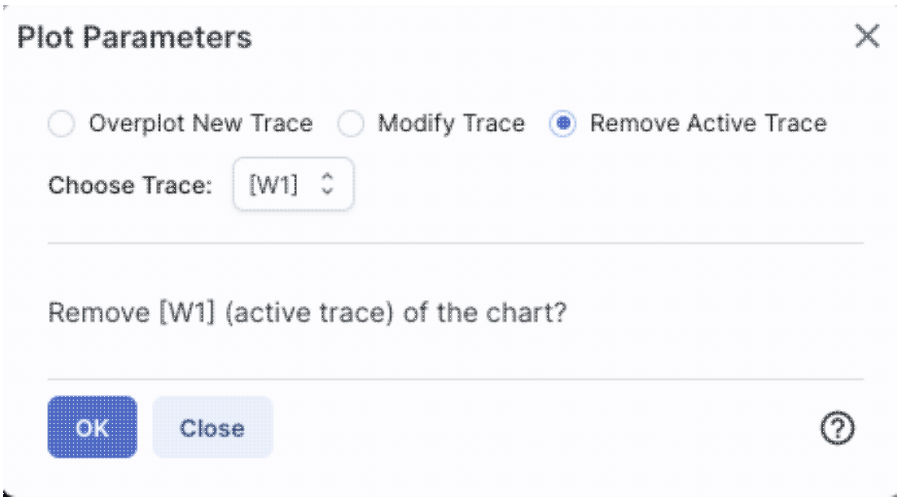
After you add the overplot, if you click on the gears agai
that the choices at the top of the window have changed. Y
add another overplotted trace, modify a trace, or remove
trace. Each trace that you add is a new 'layer' on the plot.
drop-down menu near the top of the window controls wh
is 'active' for setting the x, y, errors, trace style, name, sy
color, etc. there is now a drop-down menu at the top of th
There is a legend on the plot specifying which color corr
to which trace. In this example, the plot above has appea
a blue and green color scheme, which may be too hard to



differentiate. To change the new points' color, click on th
ensure "Modify Trace" is selected, select "trace 1" (as op
"trace 0", the first one you loaded), go down and expand
"Trace Options" and pick a different color. You can also
the legend name from "Trace 1" to, in this case, "[W2]".
"apply" to apply the changes to the plot. Note that once y
change the trace name, the relevant drop-down menus in
pop-up window and the legends on the plot update accor



Note that the pop-up spawned by clicking the gears now has an additional option at the top: "Add New Chart", "Overplot New Trace", "Modify Trace", and "Remove Active Trace." From here, you can modify a trace you have already plotted (as described above), overplot another trace (also as described above), or remove the selected trace:

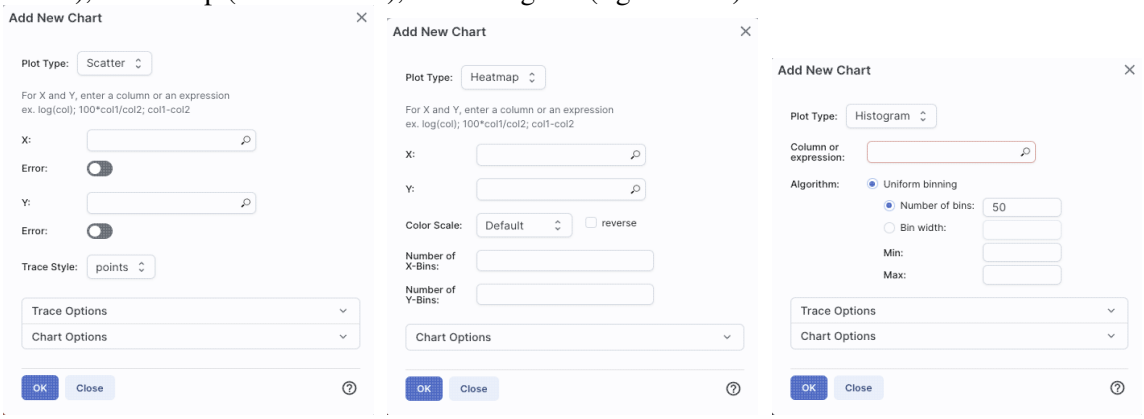


Tips and Troubleshooting

- Right now, the overplotting only works from the same catalog -- that is, you cannot plot [W1] vs. [W1]-[W4] from one catalog and overplot [W1] vs. [W1]-[W4] from another catalog. (We enthusiastically await this capability too.)
- You can easily get yourself into a physically nonsensical situation, say, by overplotting a histogram onto a scatter plot. If you find yourself in a hopeless mess, click on the "undo" icon to reset everything  and try again.
- When you have more than one thing (trace) plotted, double click on the legend to bring that trace to the foreground and temporarily hide the other traces.
- You can overplot a scatter plot on top of a heatmap if you really want to!

Adding Plots

 Clicking on this icon brings up a dialog from which you can choose to make another scatter plot (left below), a heatmap (center below), or a histogram (right below):



The options for these plots here are very similar to what is described above. You can specify which columns to plot or manipulate and plot, specify labels, etc.

Scatter plots allow you to choose points, connected points, or lines; you can add errors to each point.

Heatmap plots are binned scatter plots; you can choose what color scale and how many bins to use.

Histogram plots allow you to choose how many bins or the bin width. Note that, if you provide a minimum number, the binning starts at the minimum value you provide, and may exceed the maximum you entered in order to fit in a whole bin.

You can change what is plotted after plotting by clicking on the gears, as described above.

You can have many plots up at the same time.

You can view multiple plots all at once or one at a time by clicking on the corresponding icons above the plots (just as when you have multiple images loaded).  The single box means "one at a time", the set of four boxes means "all the plots at once". If you are viewing one at a time and have more than one plot loaded, you will see the ">" and "<" signs (as in the image here), and you can scroll among the plots by clicking on these arrows (just as when you have multiple images loaded).

Tips and Troubleshooting

- Note that many plots of a large catalog may make your browser run slowly.
- You can force the tool to make a scatter plot even if you have a catalog of >5,000 points; it just might make your browser slow down. You can even overplot a scatter plot on top of a heatmap if you really want to!
- To remove a plot, click on the 'x' in the upper right corner of the plot.

SOFIA Science Data Archive: Spectra

Visualization of SOFIA spectra use capabilities of Tables, (image) Visualization, and Plots. Generic help on those capabilities can be found in those other sections; since spectra are a special case of plots, this section focuses on spectra specifically found in the SOFIA Science Data Archive.

Contents of page/chapter:

Introduction

Some of the spectral files in the SOFIA Science Data Archive show the spectrum as an image, some as a table, and some as a plot. In many of the more processed data (e.g., levels 3 and 4), you can interact with the spectrum as rendered in any of these ways. Some of the data products are multi-plane files, and you can scroll through them and/or pick the plane to visualize. Some of the data products, if you view the original planes, have data that may be hard to interpret at first glance. In those cases, the SOFIA Science Data Archive does some simple extraction and presents that extracted data to you in a form (converting units and presenting as plots or tables) that make more scientific sense for quick assessment of the data; these are labeled "extracted data" and can be thought of as sort of a "value added" view of the data.

To visualize spectra, you must be on the search results page, with an instrument tab in the foreground on the left (not the AOR tab) and have the "Data" tab in the foreground on the right. (And, of course, your search must have returned spectra.)

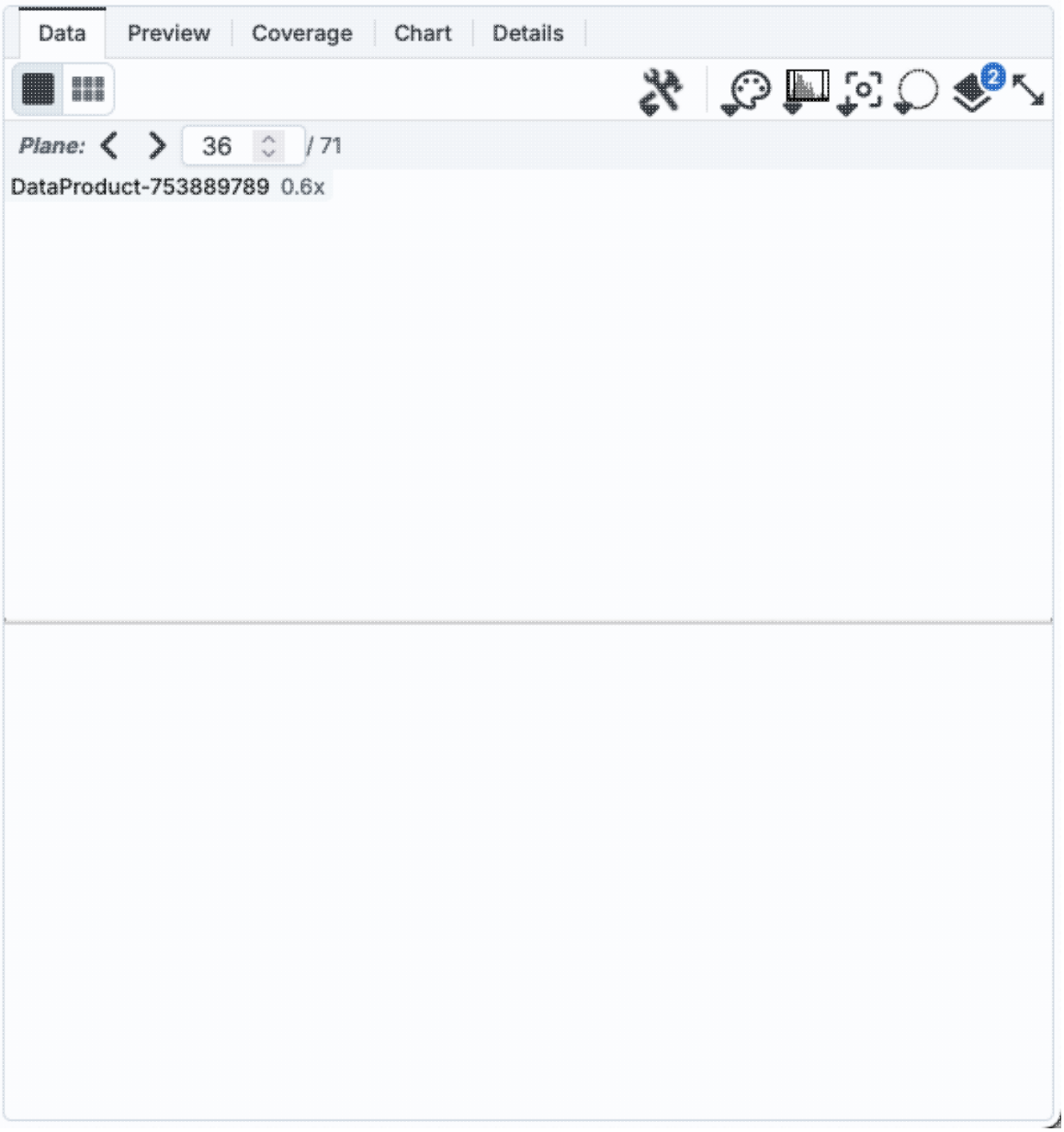
Image Planes

Images can be interacted with as described in the (image) Visualization section. However, zooming has little/no meaning in particular for the extracted spectrum.

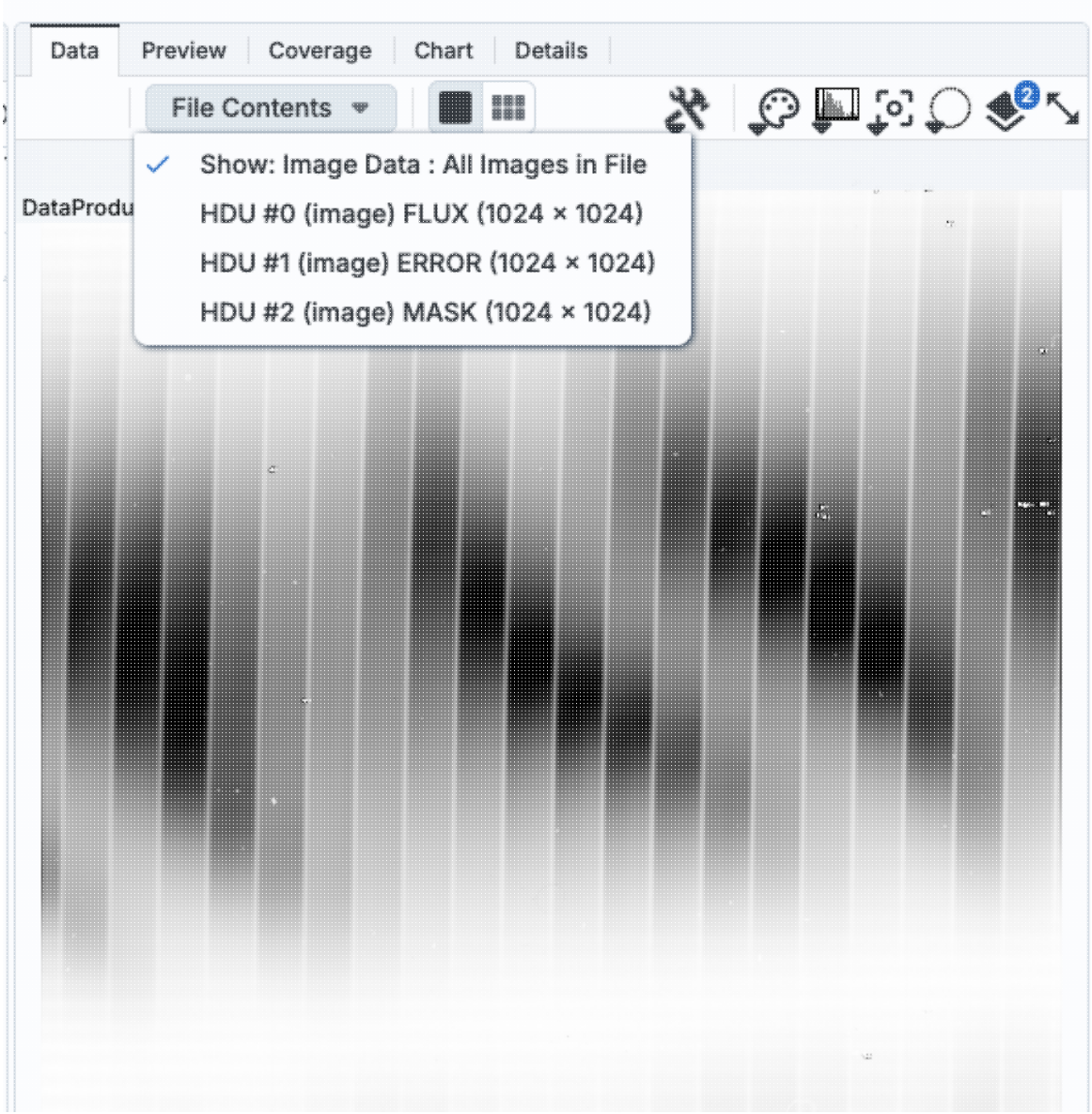
When there are multiple image HDUs or planes (see images section for more on HDUs and planes), you can click on the arrows in the top of the image to scroll through the planes.

If the data are stored as a multi-plane FITS file, you may be able to scroll through the planes, as in this EXES Level 2 "raw" product:

If the data are stored as a multi-plane FITS file, but where each plane is a separate, extracted spectrum, it may look like this EXES Level 3 "spec" product:



If there are additional HDUs, sometimes there is a "File Contents" menu that appears at the top of the data window, from which you can select a different HDU image (this is an EXES "readouts_coadded" file):

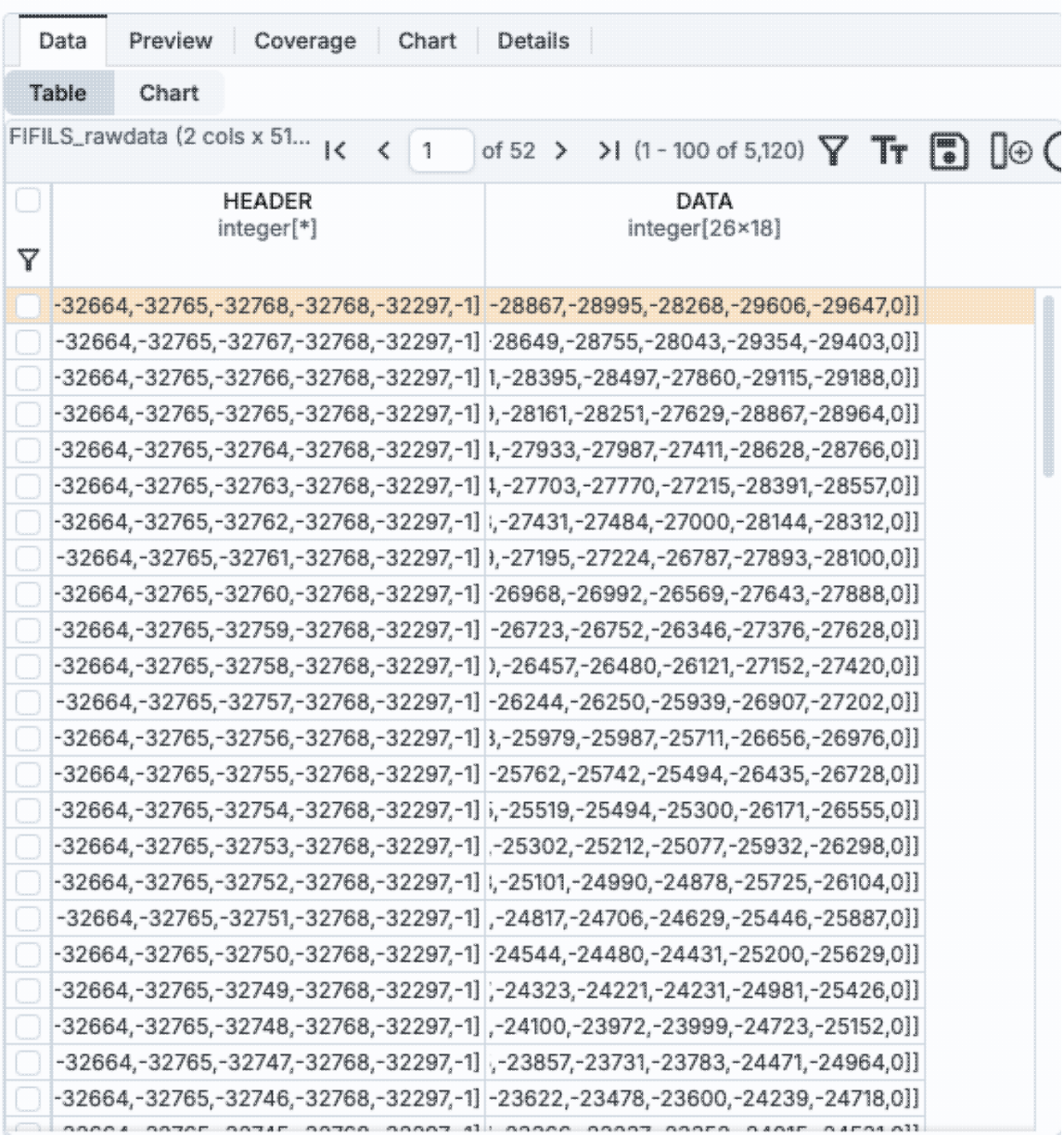


By default, it shows you all the images in the file and in this case, you can navigate using arrows as in the examples above, but you can also navigate to different HDUs using the "File Contents" menu.

Data Tables

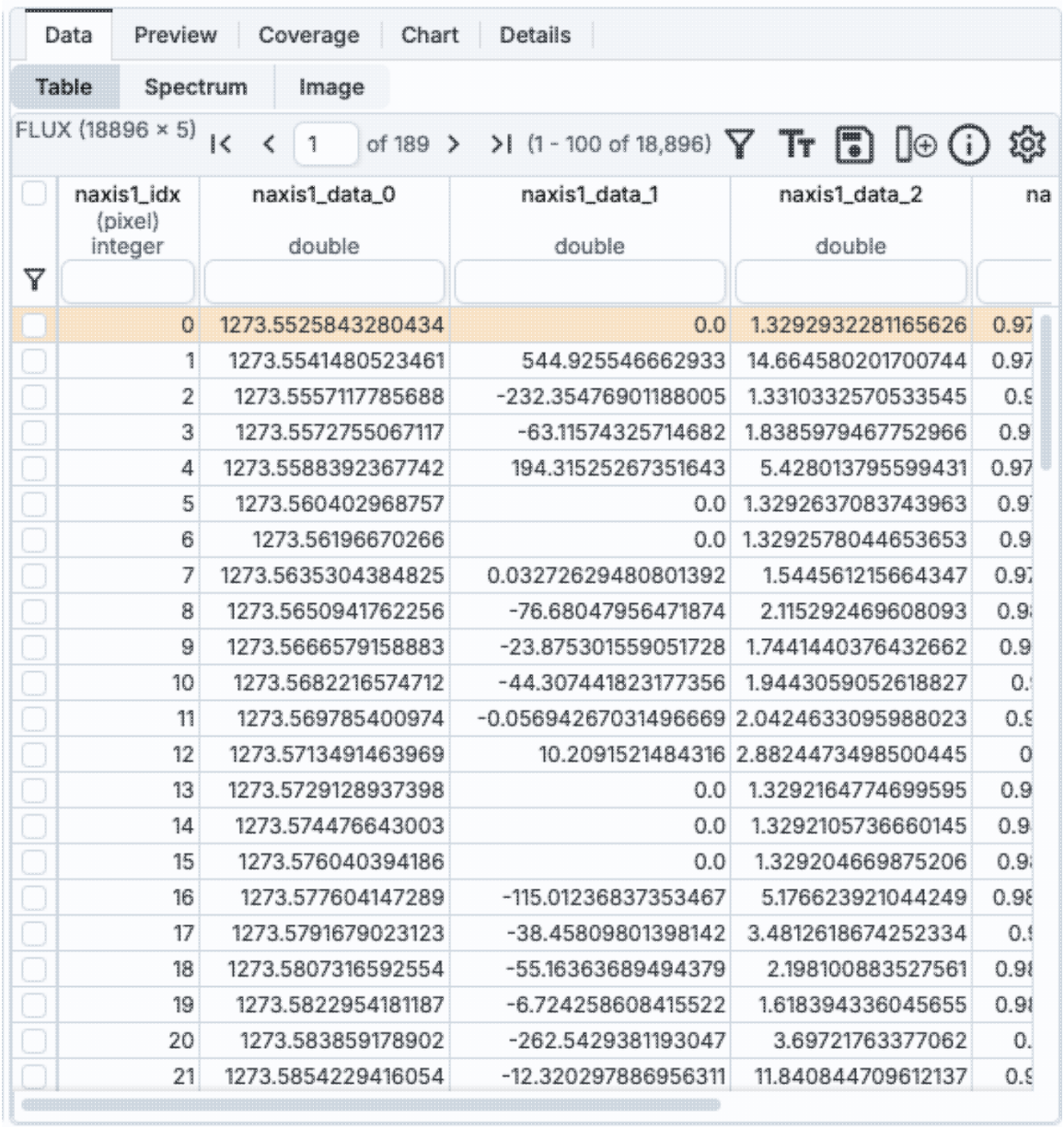
Each of these tables can be interacted with as described in the Tables section. Note that you can copy or view the contents of a table cell.

Some FITS files are (nearly unreadable) tables, as in the case of this FIFI-LS Level 1 product:



Most of the really unreadable ones are lower-level data products.

Many of the higher level tables have useful information but may still be cryptic, such as this EXES level 3 "sky_orders_merged_1d" product:



naxis1_idx (pixel) integer	naxis1_data_0 double	naxis1_data_1 double	naxis1_data_2 double	na
0	1273.5525843280434	0.0	1.3292932281165626	0.97
1	1273.5541480523461	544.925546662933	14.664580201700744	0.97
2	1273.5557117785688	-232.35476901188005	1.3310332570533545	0.9
3	1273.5572755067117	-63.11574325714682	1.8385979467752966	0.9
4	1273.5588392367742	194.31525267351643	5.428013795599431	0.97
5	1273.560402968757	0.0	1.3292637083743963	0.9
6	1273.56196670266	0.0	1.3292578044653653	0.9
7	1273.5635304384825	0.03272629480801392	1.544561215664347	0.97
8	1273.5650941762256	-76.68047956471874	2.115292469608093	0.9
9	1273.5666579158883	-23.875301559051728	1.7441440376432662	0.9
10	1273.5682216574712	-44.307441823177356	1.9443059052618827	0.
11	1273.569785400974	-0.05694267031496669	2.0424633095988023	0.9
12	1273.5713491463969	10.2091521484316	2.8824473498500445	0
13	1273.5729128937398	0.0	1.3292164774699595	0.9
14	1273.574476643003	0.0	1.3292105736660145	0.9
15	1273.576040394186	0.0	1.329204669875206	0.9
16	1273.577604147289	-115.01236837353467	5.176623921044249	0.98
17	1273.5791679023123	-38.45809801398142	3.4812618674252334	0.9
18	1273.5807316592554	-55.16363689494379	2.198100883527561	0.98
19	1273.5822954181187	-6.724258608415522	1.618394336045655	0.98
20	1273.583859178902	-262.5429381193047	3.69721763377062	0.
21	1273.5854229416054	-12.320297886956311	11.840844709612137	0.9

Note that this table has a choice at the top to view it as a table, a spectrum, or an image. In this specific case, the 'table' view is the most human-readable, but see the next section.

Plots (Charts)

In some very specific cases like the one immediately above, where the data as shown seem nearly-but-not-quite human readable, the tool is smart enough to do better.

Some FITS files can be rendered as plots (sometimes called charts), as in the case of this EXES Level 3 "mrgordspec" product:

Note that the label of this plot is "extracted data." This means that the data shown here are converted in some way compared to the original data in the FITS file, and if you use the "File Contents" menu at the top left (more on this below), you can access the original data as well as these extracted (or "value added", if you will) data. The tab at the top says "spectrum" as well -- if you want to see the constituent data, you can click on "table" to get it.

Each of these plots can be interacted with as described in the Plots section. The axes labels and units are extracted (interpreted) from the FITS file itself, and may be cryptic, but are meant to give you some indication of the file contents before you download it to work with on your own disk.

Choosing among Table, Chart, or Image

For some products, you can choose whether to view the data product/data product plane as a table, chart, or image. The data come up with a default choice, but you can pick a different option. In this:

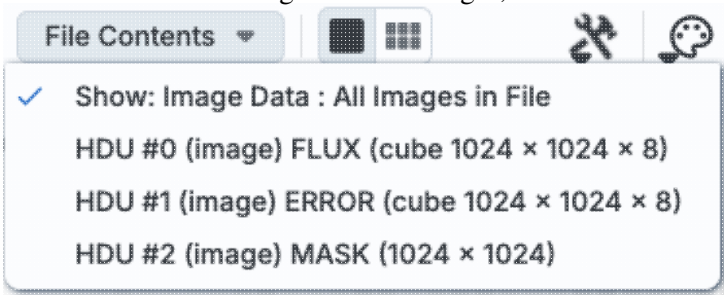
, "Image" is selected; to pick another option, just click on your choice.

File Contents Menu

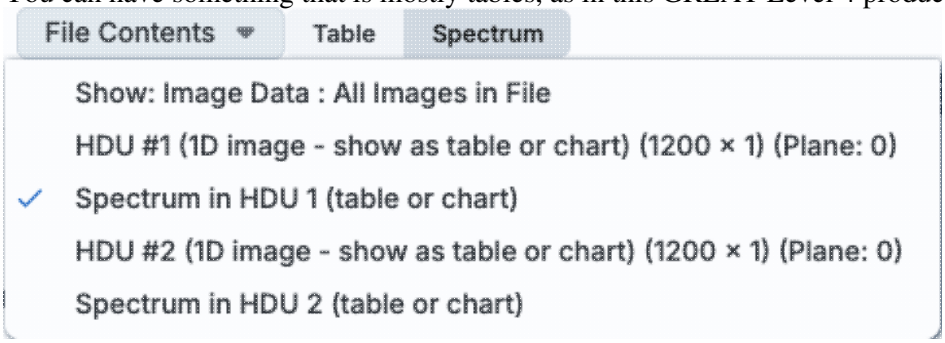
Some products have a "File Contents" menu: 

You can use this menu to select which part of the data product to view.

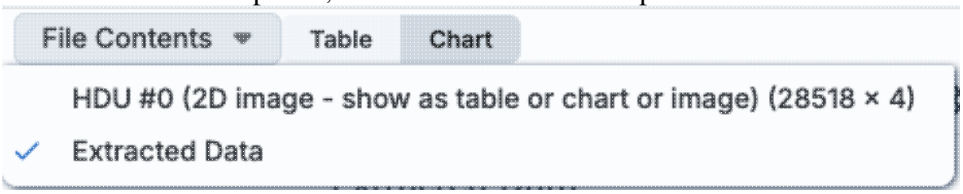
You can have something that is all images, as in this EXES Level 2 product:



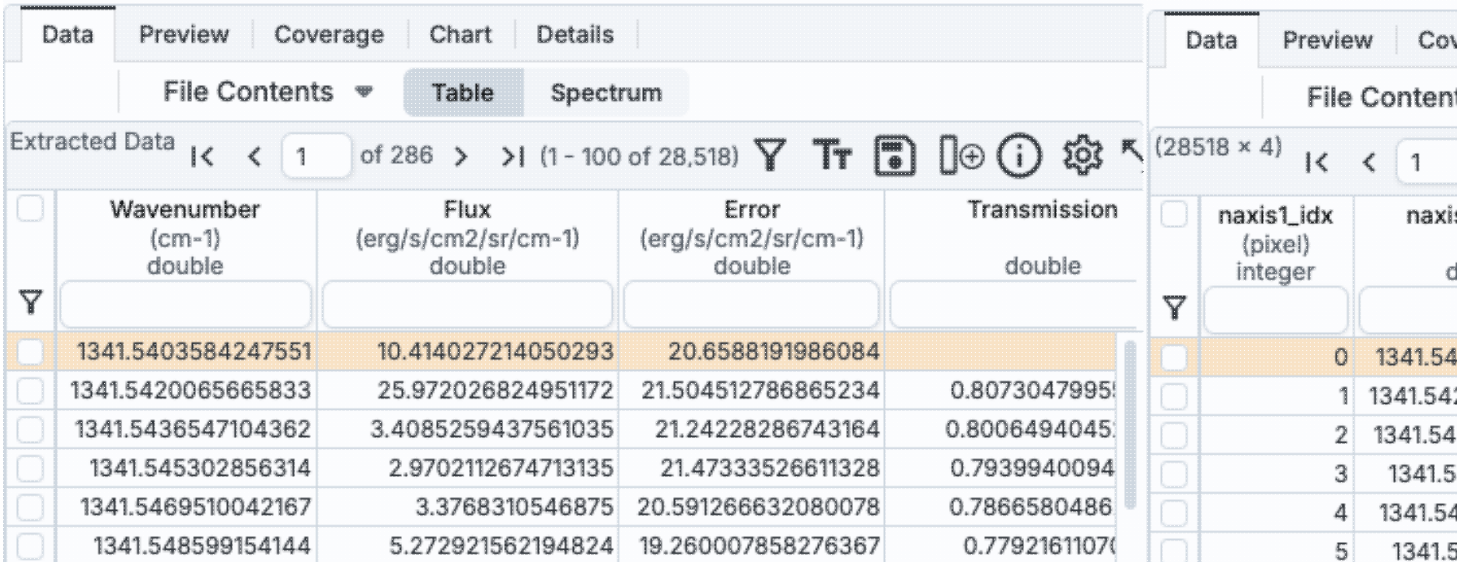
You can have something that is mostly tables, as in this GREAT Level 4 product:



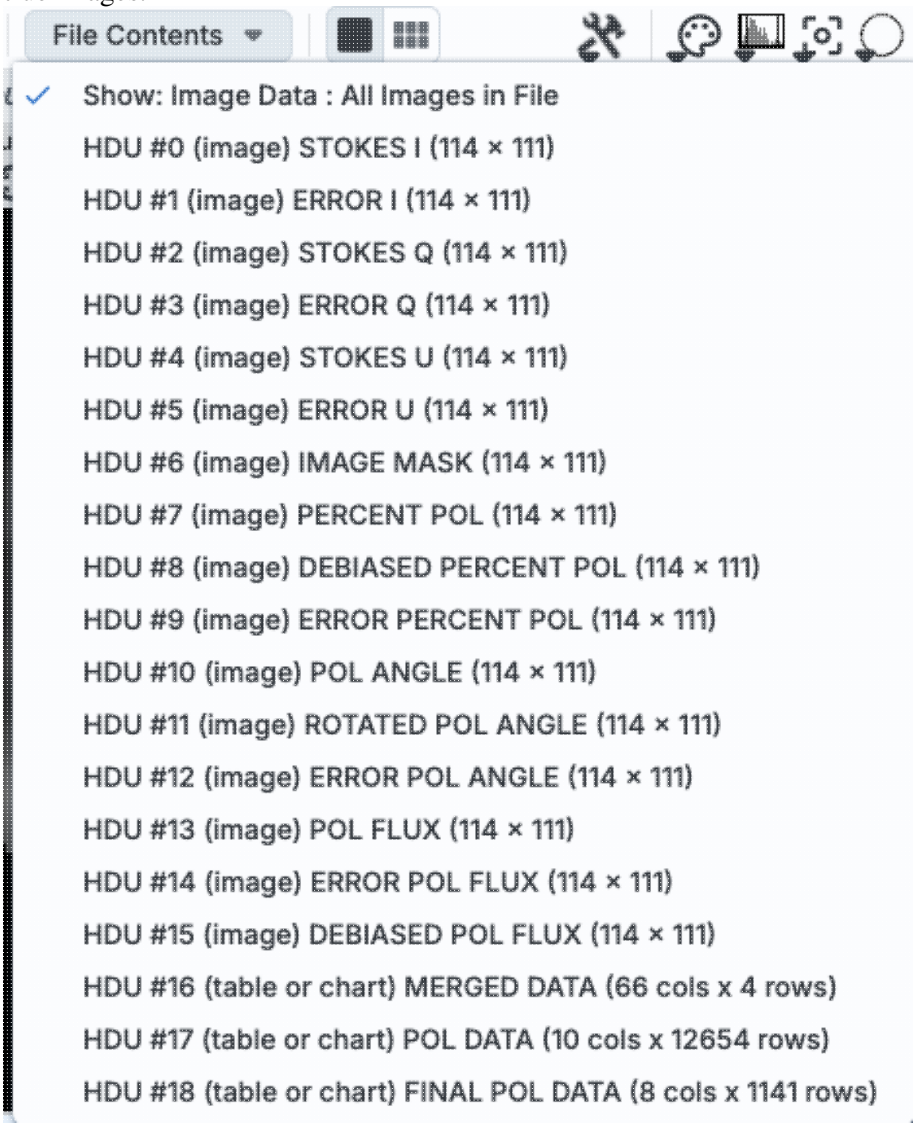
You can have these options, as for this EXES Level 3 product:



In this case, you can view the original data, seen here as "HDU #0 (2D image - show as table or chart or image)." Or, you can view the "Extracted Data." Note that this option is indented on the menu. This view of the data is extracted from the original FITS data, and is sort of a value-added view of the data that the tool is presenting you, and this view should be the default for data products with this option. The "Extracted Data" view will combine information so as to, e.g., plot flux as a function of wave number. If you go back to the "HDU #0..." view, and view that as a table or plot, you will find data with columns like "naxis1_data_0," which is what is provided by the data file itself, but the "Extracted Data" view interprets naxis1_data_0 properly as wavenumber. Here is an example for this EXES Level 3 product; the first is the "Extracted Data" table view and the second is the "HDU #0" table view. You can see how the "Extracted Data" view is easier to scientifically interpret.

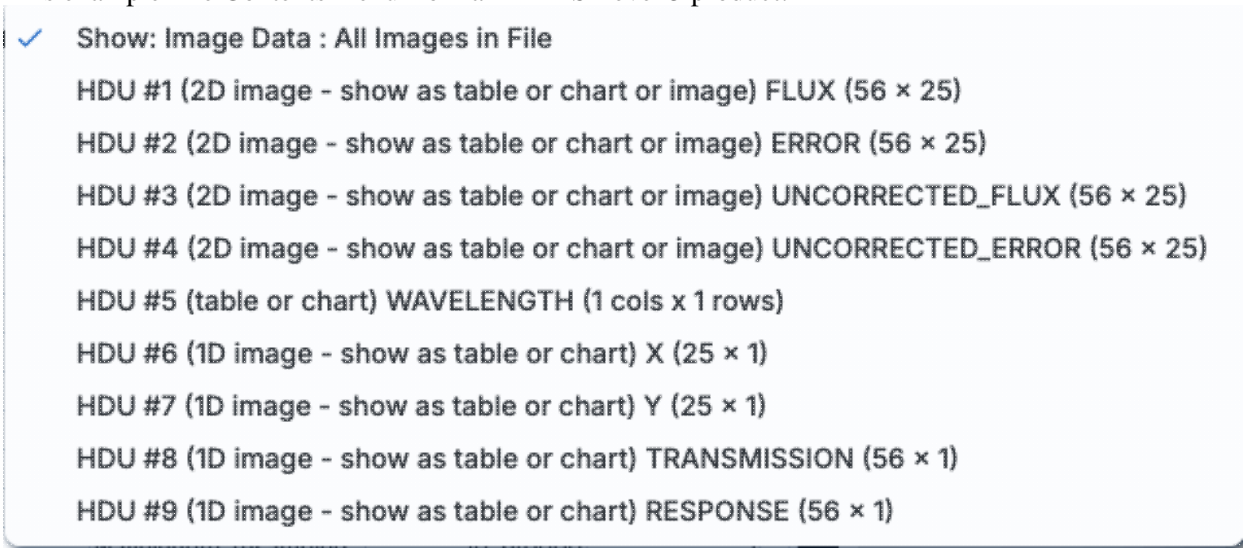


This long example File Contents menu is from a HAWC+ Level 4 product, and nearly all the image planes are true images.



In this case, the selected option is "All Images in File," and it becomes a view like the multi-plane images described above, where you use the arrows to page through the image planes. However, this menu can also be used to select the image you would like to view, or view the last three planes (which are tables).

This example File Contents menu from a FIFI-LS Level 3 product:



shows a mixture of 2D images and tables, including one that contains a single table cell. This menu also has an "All Images in File," and you can scroll through all the images. But the data products in this file are far more diverse than just images, and the File Contents menu is the most efficient way of exploring these other data planes.

Wavelengths

Some data products provide wavelengths, but those wavelengths may be in unexpected places. Here are the two most unusual.

This FIFI-LS Level 4 product shows wavelength as one of the planes within the HDU, and you can scroll through the wavelengths using the second set of blue arrows.

This FIFI-LS Level 3 product shows the wavelength of the pixel under your cursor when you stop moving your mouse (look lower center of this screen snapshot). **Note that** this only appears when viewing HDUs from the File Contents menu (as opposed to "all images in file").

SOFIA Science Data Archive: Downloading Data

Contents of page/chapter:

Overview

In the simplest case, on the search results page, just click the checkboxes on the far left of each row to pick specific observations to download, and then click the "Prepare Download" button 

to begin the packaging (and downloading) process. A pop-up window will appear in order to define exactly what kinds of data you would like to have packaged up. Clicking "prepare download" in the pop-up initializes this process.

To select *all* of the data you have displayed, click on the checkbox at the top of the column of checkboxes, and all of the rows are automatically clicked (even those on subsequent pages if you have more than one page). Then click "Prepare Download" to initiate the packaging process.

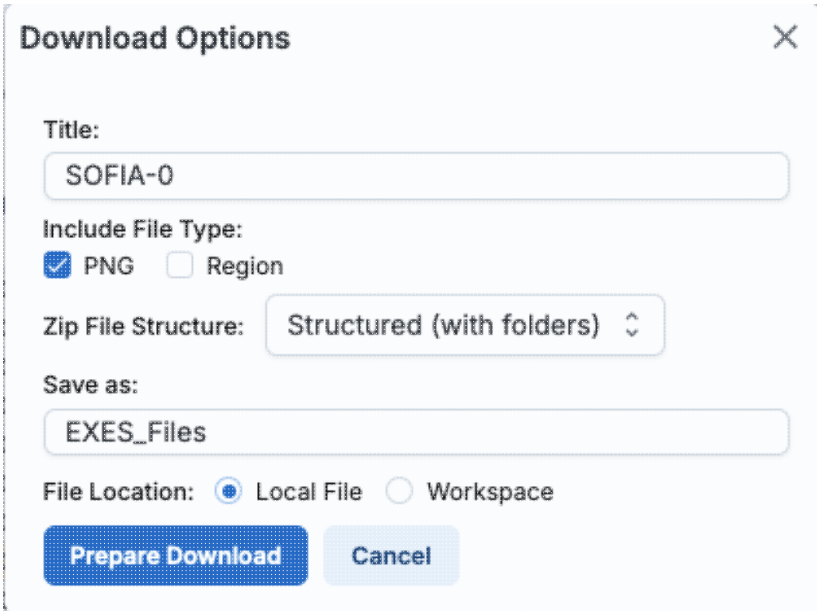
The packaging process spins off into the background monitor, which keeps track of its progress and notifies you when the downloads are complete. You can choose to have an email sent to you to let you know when things are ready, even after the packaging process has started.

(If you want to save an individual image, stretch, and/or overlays, use the visualization diskette icon.)

Note that **you** control where the data are saved on your disk through your browser; your browser may be configured to store all downloads in a particular location on your disk. Look for a "Downloads" folder or search for recently modified files.

Options for Downloading Data

From the pop-up, you can choose what to download:



(The options may be slightly different, depending on the tab from which you initiate the download.)

The first row is the name by which this packaging job will be known to the background monitor - change it to whatever you want (time or a description of your search is usually the most helpful).

The second row shown here may not always appear, but is an indicator of whether you want any PNGs (e.g., preview images) or region files (created from overlays on your image). Not every download will really have these files, but the option will appear when inititated from an instrument tab.

The next row controls whether the observations are bundled one per subdirectory or are all in one directory.

The fourth row controls the filename for the packaged download file -- by default it has a string constructed from a terse summary of the search.

The fifth row controls whether the file is saved to your local disk or the IRSA Workspace.

Click "Prepare Download" in the pop-up window, and it will go do it!

When it packages up the data, it will spin off to the background monitor and create zip files. This process could be virtually instantaneous, or take some time. You can watch it in the background monitor.

Tips and Troubleshooting

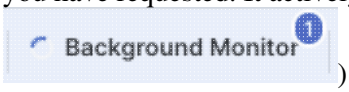
- If you initiate the download from, say, an EXES tab, you won't get FIFI-LS data. Make sure you are on the tab you want before initiating the download.
- If you download from the AOR tab, you will get all the levels of data associated with that AOR. If you want only, say, Level 4 data, select only those files from the instrument tab.
- Note that **you** control where the data are saved on your disk through your browser; your browser may be configured to store all downloads in a particular location on your disk. Look for a "Downloads" folder or search for recently modified files.
- You will download zip files. Depending on how, exactly, you unzip your files, your computer may put the contents of each *zipfile* into one directory, rather than, say, the contents of each *observation* into one directory. If you are using a GUI-based method (e.g., click to uncompress), there should be a

preferences option to allow you to uncompress subsequent zipfiles into the same root directory. You can also set flags on the command line to put all files from the same observation in the same directory.

- Double-clicking on the saved downloads should uncompress them, and then you should be off and running. However, some Windows users have reported having difficulty unzipping files downloaded from the SOFIA archive using the default application. We recommend using 7-zip.

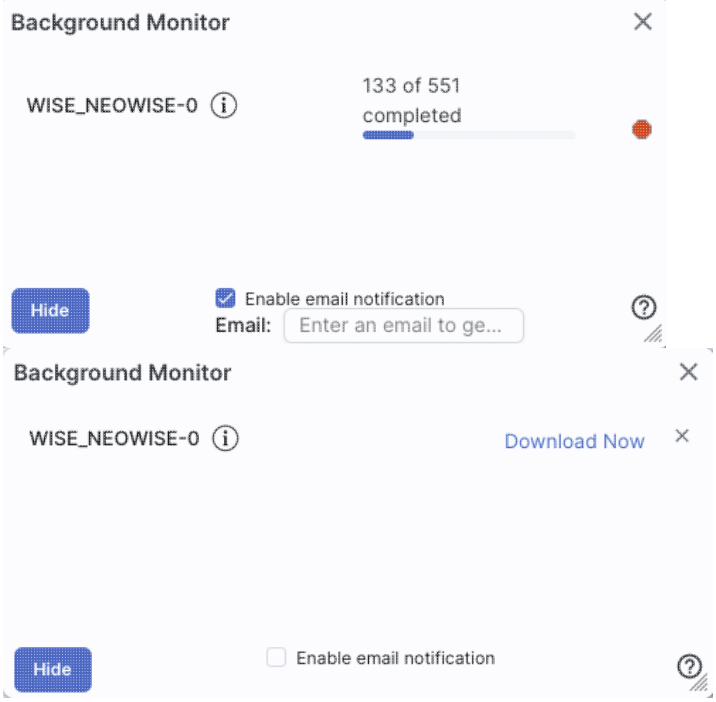
Background Monitor

The Background Monitor appears as blue text 

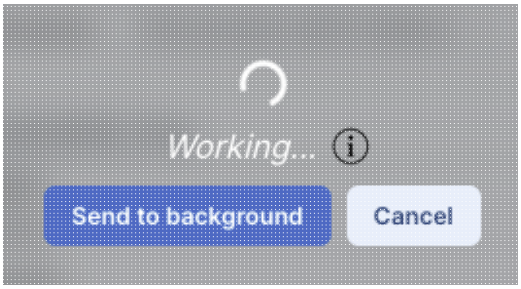
in the upper right of your window to keep track of the data downloads you have requested. It actively changes to reflect what it is doing (e.g., this is preparing a download or catalog: 

) Larger catalog requests can be sent to the Background Monitor.

A pop-up window can be called up at any time by clicking the "Background Monitor" tab. You can watch your data being retrieved. It will update that window when the data are available for download and/or overlay on your image, providing a link (or links) for obtaining the data. Remove them from the list by clicking on the 'x'.



If you have made, say, a large catalog request and don't want the pending catalog request to occupy screen space while it loads, you can click on the button marked "send to background" to reclaim your screen space, seen here:



When the background monitor finishes, however, you will have to actively tell it to display results; it doesn't do it automatically if you have sent it to the background.

To stop any query mid-way through, click on the little red octagon ("stop sign") that appears next to the query in the Background Monitor pop-up.

If you are having technical difficulties, click on the circle with an "i" in it to get additional information, like this:

In this case, the job is executing, at the time as given, with a job id as shown.

SOFIA Science Data Archive: API and URL Construction

Introduction

There are two ways to interact with the SOFIA Science Data Archive in an automatic or semi-automatic fashion.

Batch searching
: You can pass a list of up to 1000 sources to the SOFIA Science Data Archive from the search screen, and then bundle up the results to download all at once in any of a variety of formats. More information on that is in the Searching section. This option is best if you don't want to write code to search and parse the results, and/or if you have at most a few thousand sources.

API, or application programming interface
: An API, or application programming interface, enables programs to create a URL that will launch the tool with some fields pre-populated. This is described in this section.

Parameters

Parameter	Description
WorldPt	Coordinates of the search position (semi-colon separated) - example: 10.68479;41.26906;EQ_J2000
radiusInArcSec	Radius of search in arcsecondsspatialConstraintsPossible values are: position, allsky, multi, or sso (precovery not supported)naifidSearch Solar System objects (moving targets) by NAIF ID.planIdAlphanumeric value representing a Plan IDaorIdAlphanumeric value representing an AOR IDworldPt or ra/deccoordinates of the search worldPt format - lon;lat;Csys - eg: 1.0;2.3;EQ_J2000 or 5;4;GAL ra, dec format - ra=1&dec=2 - always j2000srradius of search (optional) sr format options: d or none - degrees, m - arcminutes, s - arcseconds sr=1.1d or sr=1.1 - 1.1 degrees sr=150s - 150 arcseconds sr=22m - 22 arcminutesprocessingLevel Processing level values, in a comma-separated string list Combination of accepted values are: LEVEL_0, LEVEL_1, LEVEL_2, LEVEL_3, and LEVEL_4instrumentInstrument name Available values: FORCAST, EXES, FIFI-LS, FLITECAM, FPI_PLUS, GREAT, or HAWC_PLUSexecutetrue or false - if true execute the search and show the results

Examples

Description	URL
Open SOFIA search panel with all sky option set	https://irsa.ipac.caltech.edu/applications/sofia/?api=search&spatialConstraiints=allsky&execute=false
Open SOFIA search panel with a particular	https://irsa.ipac.caltech.edu/applications/sofia/?api=search&WorldPt=83.773986;-5.418506;EQ_J2000&sr=

Description	URL
object coordinates pre-filled	
Return SOFIA results from a fixed target cone search with specified radius in arcseconds	https://irsa.ipac.caltech.edu/applications/sofia/?api=search&WorldPt=83.773986;-5.418506;EQ_J2000&sr=
Search and return SOFIA result with following criteria: all-sky, plan ID, and AOR ID	https://irsa.ipac.caltech.edu/applications/sofia/?api=search&spatialConstraiints=allsky&planId=70_0002&a
Open SOFIA search panel with specific processing levels LEVEL_1 and LEVEL_2	https://irsa.ipac.caltech.edu/applications/sofia/?api=search&WorldPt=83.773986;-5.418506;EQ_J2000&sr=
Open SOFIA search panel with a object ra, dec, and radius pre-filled	https://irsa.ipac.caltech.edu/applications/sofia/?api=search&ra=83.7739862708531&dec=-5.4185069603443
Open SOFIA search panel with specific instrument configuration	https://irsa.ipac.caltech.edu/applications/sofia/?api=search&ra=83.7739862708531&dec=-5.4185069603443
Search SOFIA and return results for SSO object	https://irsa.ipac.caltech.edu/applications/sofia/?api=search&naifid=2000001&spatialConstraiints=sso&exec

SOFIA Science Data Archive: User Registration for the IRSA Archives

There is one user registration for all IRSA applications, but data access, preferences, search history, data tagging, etc., are all unique to each archive.

While you certainly **do not have to register** to search the archive, download data, analyze data, and write a paper, you may wish to register.

Log In

The "Login" link is in the far top right of the page.

Select this option to log in if you know your password, or to create a new account.

Create New Account

Find this option by selecting "Login" in the far top right of the browser window, and then "Create an account" appears as an option in the lower left of the pop-up window.

Select this option to create a new account.

Forgot your Username or Password

If you do not remember your username or password, select this option to retrieve this lost information.

Find this option by selecting "Login" in the far top right of the browser page, and then "forgot your password?" appears as an option below the Login button.

Edit Profile

Find this option by logging in, and then clicking on your account name in the top right of the browser window. Then, select "Edit Profile" to change your password on an existing account.

Change Password

Find this option by logging in, and then clicking on your account name in the top right of the browser window. Then, select "Change Password" to change your password on an existing account.

Update Email

Find this option by logging in, and then clicking on your account name in the top right of the browser window. Then, select "Update Email" to change your email on an existing account.

SOFIA Science Data Archive: FAQs

Do you have any tutorial videos?

Yes. The IRSA YouTube channel has several tutorials that are relevant to the SOFIA Science Data Archive -- see the SOFIA playlist as well as the set of "micro-tutorials" relevant for more than one archive. The videos are in HD; you may need to manually use the YouTube gear menu to force it to realize this. There is also English Closed-Captioning available.

I have a bunch of targets and I want to get all the images for these targets. Can I do this?

You can give it a list of sources, up to 1000 sources, and it will go away and think about it and load them all into the browser. You can customize the stretch, color table, etc. You can then ask it to prepare the download for you, and when it's done, if you want, mail you a list of URLs to download the data.

I've created a nice image within the FITS viewer, and I have the stretch and overlays exactly the way that I want them. How do I save this?

Click on the diskette icon and tell it to save the PNG file. If you just save the FITS file, you will lose the overlays, and if you just save the overlays (as a ds9 region file), you will lose the underlying image.

What do I do with the zip files I get when I download data?

To uncompress the files you have downloaded, type "unzip foo.zip". To uncompress multiple files at once, type "unzip '*.zip'" (the single quotes are important), or "unzip *.zip" -- you just have to escape out the wildcard. If you have a Windows machine, try 7zip.

How do I get more help?

The "Help" blue tab leads you into this online help. You can also download a PDF version of this manual; look at the top right of the help window.

You can submit questions to the IRSA Help Desk.

Found a bug? The known bugs and issues in this version of the SOFIA Science Data Archive are listed here. If you think you have found a bug, before reporting it, please check this list, and read this online help. It may be a "feature" we already know about. If you have found a new, real bug then please do contact us via the IRSA Help Desk. Please include your operating system version and your browser software and version. If you can, please also include any specific error message you may have gotten. (NB: In our testing, copying shortcuts worked on Windows and Linux; the command-C did not work on Macs, but selecting and clicking the right mouse button did.)

SOFIA Science Data Archive: Notice to Users -- Privacy Notice

The data contained in this archive are managed by the NASA/IPAC Infrared Science Archive (IRSA), which includes an archive of images, catalogs, and spectra from multiple telescopes and missions, managed by the Jet Propulsion Laboratory. This website is maintained by the Infrared Processing and Analysis Center (IPAC), located on the campus of the California Institute of Technology (Caltech).

The information you provide on a Caltech website will be used only for its intended purpose. We will protect your information consistent with the principles of the Privacy Act, the e-Government act of 2002, the Federal Records Act and, as applicable, the Freedom of Information Act. This notice is posted pursuant to the California Online Privacy Protection Act of 2003 (Cal Bus and Prof Code Sections 22575-22579).

Submitting information is strictly voluntary. By doing so, you are giving Caltech your permission to use the information for the intended purpose. In addition, Caltech may also furnish this information to NASA at NASA's request. If you do not want to give Caltech permission to use your information, simply do not provide it. However, not providing certain information may result in Caltech's inability to provide you with the information or services you desire.

Caltech never collects information for commercial marketing. We will only share your information with a government agency if it relates to that agency, or as otherwise required by law. Caltech/JPL never creates individual profiles or gives your information to any private organization.

We collect no personal information about you when you visit this Web site, unless otherwise stated or unless you choose to provide this information to us. However, we collect and store certain information automatically for use in site management and security purposes. What we collect and store automatically in terms of site statistics is:

- The Internet Protocol (IP) address for the domain from which you access the Internet (e.g., 123.456.789.012) whether the domain is yours individually or is provided as a proxy by your Internet Service Provider (ISP)
- The date and time you access our site
- The pages you access (recorded by the text and graphics files that compose that page)
- The Internet address of the website from which you linked directly to our site.

We use the summary statistics to help us make our site more useful to visitors, such as assessing what information is of most and least interest to visitors, and for other purposes such as determining the site's technical design specifications and identifying system performance or problem areas.

The website also collects and stores information about your search options, such as

- Name resolver choice (NED/Simbad)
- Page size (number of rows)
- Which search results (tabs) should be displayed
- Email address, if provided, for email notifications
- Search parameters so that you can resubmit your search via your search history
- Data tags, if you create one
- Plus, additional preferences that may be developed in the future, such as those tied to the visualization options.

If you register as a user, these options will be kept in our database (along with your login ID and password via MD5 hash) and used for your session the next time you log in. If you do not register as a user, these options are set via cookies kept on your computer; if you clear your cookies and start a new session, these preferences are lost.

At no time is your private information, whether stored in persistent cookies or elsewhere, shared with third parties who have no right to that information. If you do not wish to have session or persistent cookies stored on your machine, you can turn them off in your browser. However, this may affect the functioning of the website on your computer.

IPAC will protect all such information consistent with applicable law.

Comments Sent by E-mail

You may choose to provide us with personal information, as in an e-mail containing your comments or questions. We use this information to improve our service to you or to respond to your request. There may be times when your message is forwarded, as e-mail, to other IPAC employees who may be better able to help you. We normally do not share our e-mail with any other outside organizations, unless determined necessary for security purposes or when required by law. Remember that email isn't necessarily secure. You should never send sensitive or personal information like your Social Security number in an email. Use postal mail or secure websites instead.

Security Notice IPAC is part of the Division of Physics, Mathematics and Astronomy at the California Institute of Technology ("Caltech"), and operates this website as part of a federally funded computer system used to accomplish Federal functions. Unauthorized attempts to defeat or circumvent security features, to use the system for other than its intended purposes, to deny service to authorized users, to access, obtain, alter, damage, or destroy information, or otherwise to interfere with the system or its operation is prohibited. Evidence of such acts may be disclosed to law enforcement authorities and may result in criminal prosecution under the Computer Fraud and Abuse Act of 1986 and the National Information Infrastructure Protection Act of 1996, codified at section 1030 of Title 18 of the United States Code, or other applicable criminal laws.

IPAC uses software programs to monitor this website for security purposes to ensure it remains available to all users and to protect information in the system. Any and all uses of this system and all files on this system may be intercepted, monitored, recorded, copied, audited, inspected, and disclosed to authorized Caltech, JPL, NASA, law enforcement personnel, as well as authorized officials of other agencies. By accessing this website, you are expressly consenting to such interception, monitoring, recording, copying, auditing, inspection and disclosure at the discretion of Caltech or NASA. Users have no explicit or implicit expectation of privacy.

Disclaimers

Disclaimer of Liability

With respect to documents available from this server, neither Caltech, nor the United States Government, nor any of their employees, makes any warranty, express or implied, including the warranties of merchantability and fitness for a particular purpose, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

Disclaimer of Endorsement

Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by Caltech or the United States Government. The views and opinions of authors expressed herein do not necessarily state or reflect those of Caltech or the United States Government, and shall not be used for advertising or product endorsement purposes.

Copyright Status

For information on possible copyright infringement, please visit Caltech's "Copyright Infringement" page.