

Virtual European Solar & Planetary Access (VESPA) 2025: Reload



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EPSC 2025, Helsinki
8 Sept 2025
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VESPA in a nutshell

- Activity in successive Europlanet programmes, started 2011
- Provide Open access to Solar System data:
 - Open Science policy
 - Contributive system open to the community
 - FAIR principles: Findable / Accessible / Interoperable / Reusable
- Uses the Virtual Observatory framework

=> The core VESPA team is still active beyond Europlanet *programmes*, in the Europlanet Society

Currently 94 data reviewed EPN-TAP services (cross-searchable from tools and portals)

- 30+ contributing institutes worldwide
- ESA's Planetary Science Archive (PSA, 37 Mfiles), some NASA / PDS assets
- Results from 10+ European programmes
- Derived data from ~ 12 space borne instruments
- Pro-Am network activities — e.g., Europlanet Telescope Network

Spectra vs geologic units

- 1- Set the VESPA geoportal to Mercury (MESSENGER MDIS)
- 2- Drop a shapefile of a Mercury pyroclastic deposit (Leon-Dasi et al 2023, from analysis of MESSENGER images) => converts to MOC
=> identifies all MESSENGER spectra in this unit, with footprint and conditions
- 3- Send the unit MOC and spectrum footprints to Aladin
- 4- Send all spectra to TOPCAT
=> average spectrum and variability, possibly with selection on illumination angles

VESPA Geoportal "Mercury"

CHOOSE TARGET RESULTS (2,192) HELP

MOCs created from SHP
MOCs added from granules

Query string

Dataproduct Type
Instrument Host Name
Instrument Name
Processing Level
Service Title **gmap**
Target Region
Feature name
Granule GID

Diameter: 95.69465637207031 to 98.3045425415039
Min: 95.69465637207031 Max: 98.3045425415039

Additional selection parameters

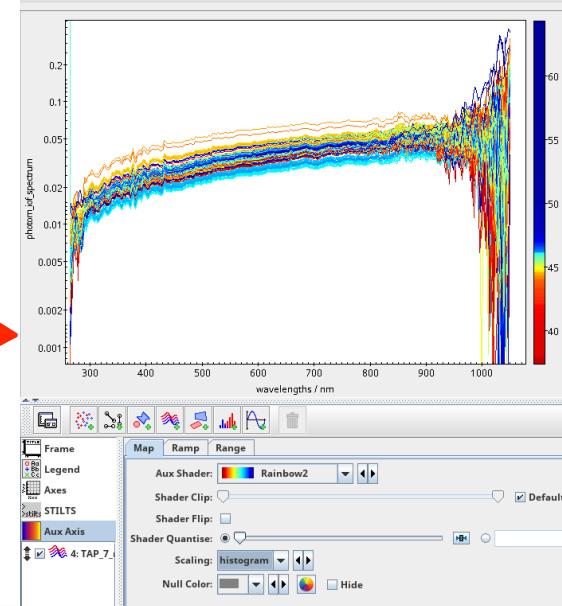
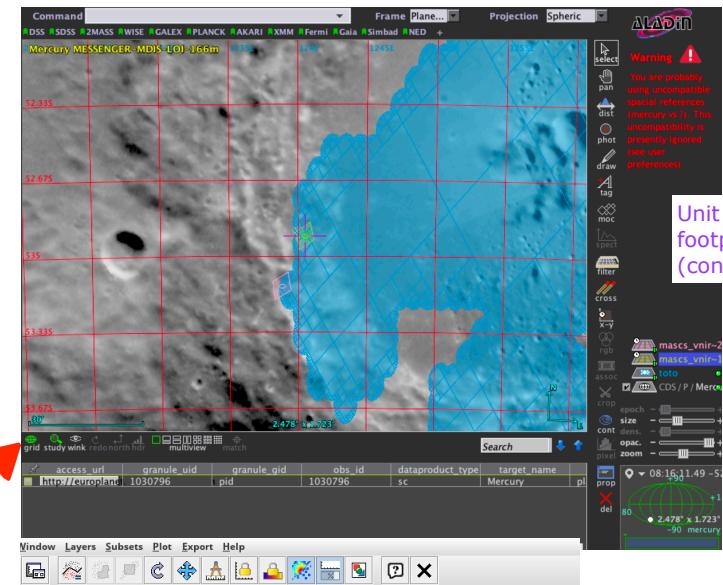
A red bracket labeled 'Data found in unit footprint' points to the bottom of the search interface.

granule_uid	service_title	instrument_name	Portal view
1197978	mascs_vnir	MASCS/VIRS	VESPA_URL
1198001	mascs_vnir	MASCS/VIRS	VESPA_URL
1198020	mascs_vnir	MASCS/VIRS	VESPA_URL
1198051	mascs_vnir	MASCS/VIRS	VESPA_URL
1198186	mascs_vnir	MASCS/VIRS	VESPA_URL

5.370° × 4.699°

5.370° × 4.699°

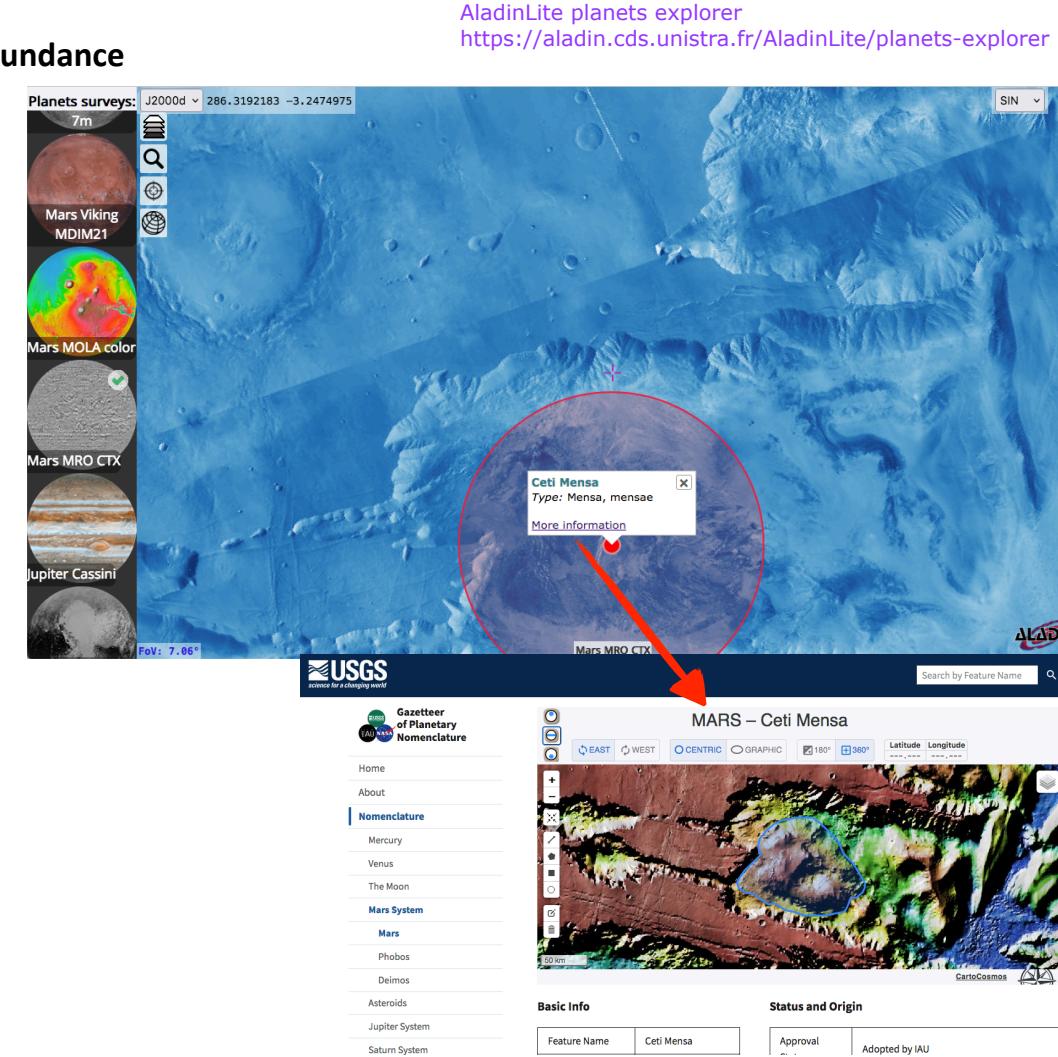
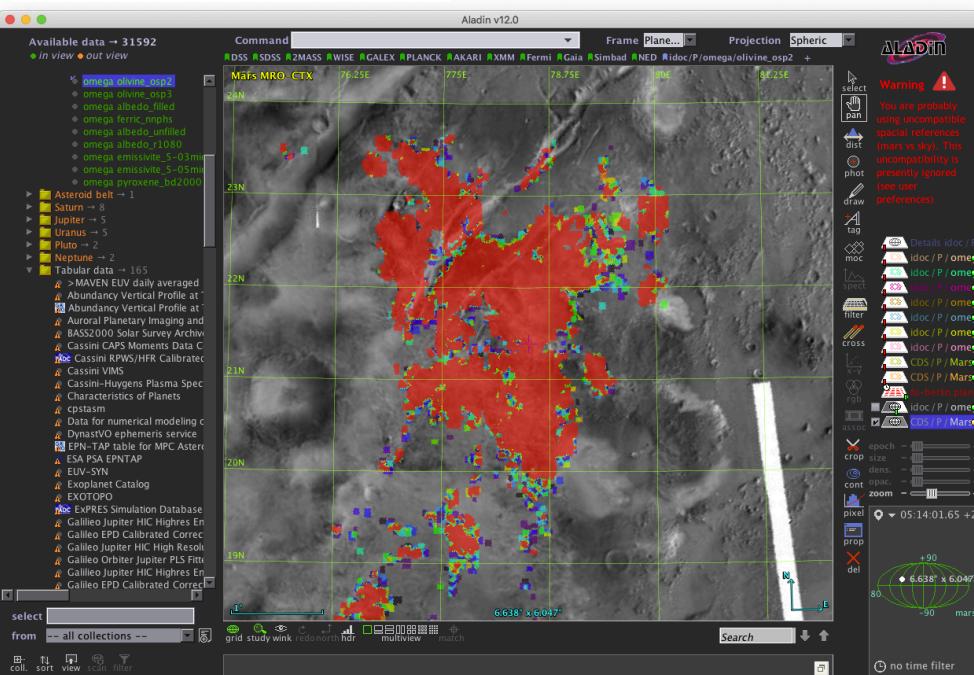
A volcanic unit in VESPA geoportal + intersecting spectral footprints



Other uses of the geoportal / HiPS / MOC

- Readily identifies overlapping observations
- Multi-resolution maps (HiPS) can be used as data source, e.g. for mineral abundance
- Connection with IAU nomenclature and USGS services from AladinLite
(replace calls to SIMBAD when in planetary mode)

OMEGA olivine map over CTX/MRO HiPS
in Jezero crater area, in Aladin



Spectra of TNOs

1- Select TNOs or family of interest from a specialized service:

EPN-TAP (MPCorb, NEOCC, MP3C, DynAstVO...) [external APIs (SsODNet, JPL SBDdb, Lowell Astorb...) may be OK for small populations]

=> list of targets with names in TOPCAT

2- Query an asteroid spectra service: EPN-TAP (spectro_asteroids, M4ast...) or TAP (Gaia)

3- Cross match in TOPCAT (or via TAP upload) based on name

=> average spectrum and variability / further classification

Query MPC / IAU
in TOPCAT
=> TNO list

The screenshot shows the TOPCAT interface with a search bar at the top containing "Query MPC / IAU in TOPCAT => TNO list". Below the search bar is a "Select Service" button. The main area is titled "Table Access Protocol (TAP) Query" and contains a "Metadata" section. In the "Find:" field, "Name" is checked. In the "Sort:" field, "Service" is selected. A tree view on the left lists datasets: sasmirala (2), smakpc (1), tempc (1), toss (2), wfpdb (2), mcextinct (1), mpc (2), mpc.epn_core, and mpc.mpcorb. The "mpc.epn_core" dataset is currently selected. The "ADQL Text" section at the bottom contains the query: "SELECT * FROM mpc.epn_core where semi_major_axis > 30.0709". A blue bracket underlines the "mpc.epn_core" part of the query, with the text "Query on TNOs" written below it.

Query Gaia in TOPCAT
=> retrieve all spectra

The screenshot shows the TOPCAT interface with a search bar at the top containing "Query Gaia in TOPCAT => retrieve all spectra". Below the search bar is a "Select Service" button. The main area is titled "Table Access Protocol (TAP) Query" and contains a "Metadata" section. In the "Find:" field, "Name" is checked. In the "Sort:" field, "Alphabetic" is selected. A tree view on the left lists datasets: gaiadr3.sso_observation, gaiadr3.sso_orbits, gaiadr3.sso_reflectance_spectrum, gaiadr3.sso_source, gaiadr3.synthetic_photometry_gspc, gaiadr3.tmass_psc_xsc_best_neight, gaiadr3.tmass_psc_xsc_join, and gaiadr3.tmass_psc_xsc_neighbour. The "gaiadr3.sso_reflectance_spectrum" dataset is currently selected. The "Service Capabilities" section at the bottom indicates "Query Language: ADQL-2.1", "Max Rows: 3000000 (default)", and "Uploads: Log In/Out". The "ADQL Text" section at the bottom contains the query: "select * from gaiadr3.sso_reflectance_spectrum". A blue bracket underlines the "gaiadr3.sso_reflectance_spectrum" part of the query, with the text "Query Gaia in TOPCAT => retrieve all spectra" written to its right.

Spectra of TNOs

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Table Access Protocol (TAP) Query

Query MPC / IAU in TOPCAT => TNO list

Select Service Use Service Resume Job Running Jobs

Metadata

Find: Or

Sort: Service Alphabetic

Service Capabilities

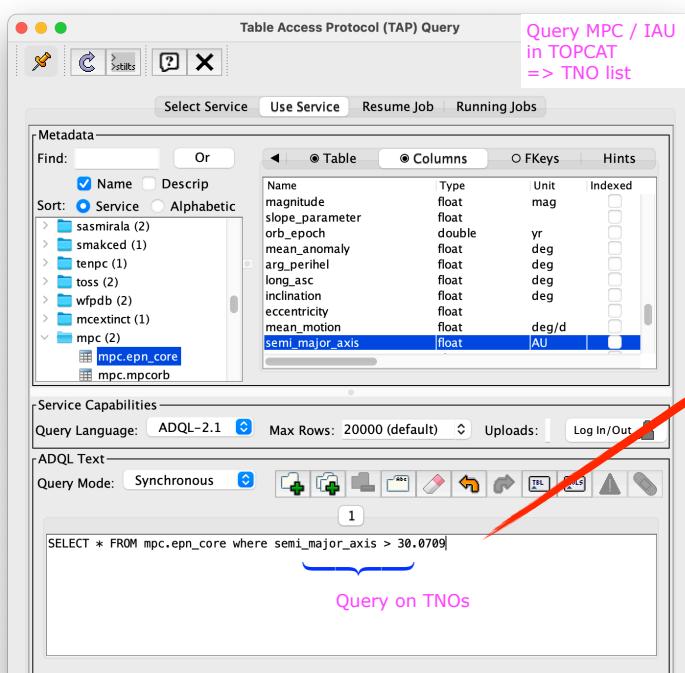
Query Language: ADQL-2.1 Max Rows: 20000 (default) Uploads: Log In/Out

ADQL Text

Query Mode: Synchronous

SELECT * FROM mpc.epn_core where semi_major_axis > 30.0709

Query on TNOs



Cross-match in TOPCAT => select spectra

Match Tables

Match Criteria Algorithm: Exact Value

Table 1: 1: mpc

Matched Value column: toLowerCase(target_name)

Table 2: 2: TAP_1_gaiadr3.sso_reflectance_spectrum

Matched Value column: denomination

Output Rows

Match Selection: Best match, symmetric

Join Type: 1 and 2

Go Stop

Eliminating multiple row references...
Elapsed time for match: 0 seconds
Populate index maps...
Match succeeded

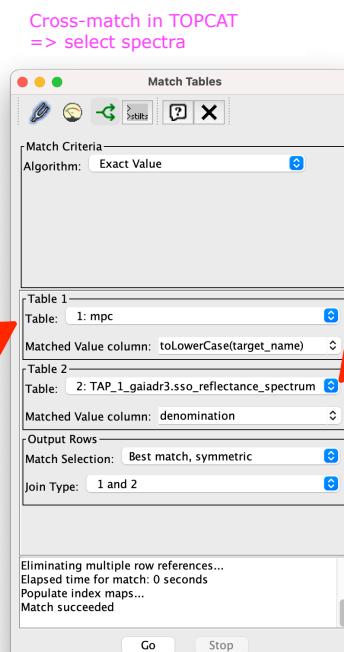


Table Access Protocol (TAP) Query

Select Service Use Service Resume Job Running Jobs

Metadata

Find: Or

Sort: Schema Table Columns

Name: gaiadr3.sso_reflectance_spectrum

Columns: 10

Rows (approx): 0

Foreign Keys: 0

Description: This table contains the mean BP/RP reflectance spectra of asteroids computed as the ratio between the asteroid flux and an

Service Capabilities

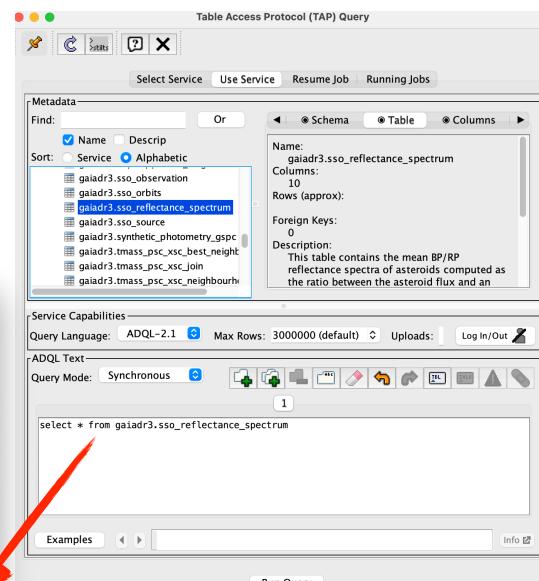
Query Language: ADQL-2.1 Max Rows: 3000000 (default) Uploads: Log In/Out

ADQL Text

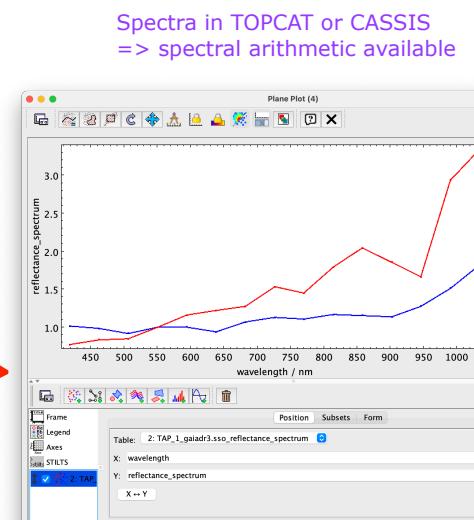
Query Mode: Synchronous

select * from gaiadr3.sso_reflectance_spectrum

Run Query



Query Gaia in TOPCAT
=> retrieve all spectra



Much easier with EPN-TAP services ;)

Spectra of TNOs

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Table Access Protocol (TAP) Query

Query MPC / IAU in TOPCAT => TNO list

Select Service Use Service Resume Job Running Jobs

Metadata

Find: Or

Sort: Service Alphabetic

Name	Type	Unit	Indexed
magnitude	float	mag	
slope_parameter	float		
orb_epoch	double	yr	
mean_anomaly	float	deg	
arg_perihel	float	deg	
long_asc	float	deg	
inclination	float	deg	
eccentricity	float		
mean_motion	float	deg/d	
semi_major_axis	float	AU	

Service Capabilities

Query Language: ADQL-2.1 Max Rows: 20000 (default) Uploads: Log In/Out

ADQL Text

Query Mode: Synchronous

SELECT * FROM mpc.epn_core WHERE semi_major_axis > 30.0709

Query on TNOs

Cross-match in TOPCAT => select spectra

Match Tables

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Match Selection: Best match, symmetric

Join Type: 1 and 2

Go Stop

Eliminating multiple row references...
Elapsed time for match: 0 seconds
Populate index maps...
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Table Access Protocol (TAP) Query

Metadata

Find: Or

Sort: Service Alphabetic

Name: gaiadr3.sso_reflectance_spectrum

Columns: 10

Rows (approx): 0

Foreign Keys: 0

Description: This table contains the mean BP/RP reflectance spectra of asteroids computed as the ratio between the asteroid flux and an

Service Capabilities

Query Language: ADQL-2.1 Max Rows: 3000000 (default) Uploads: Log In/Out

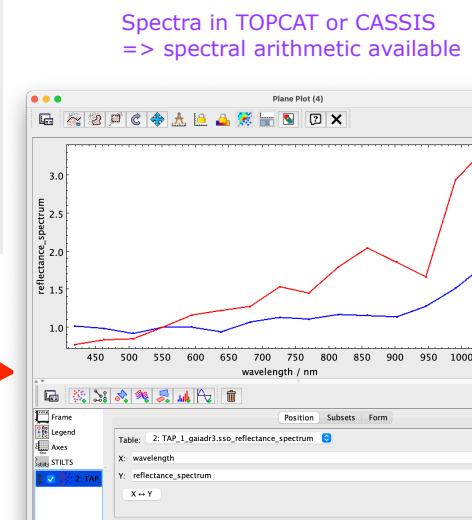
ADQL Text

Query Mode: Synchronous

select * from gaiadr3.sso_reflectance_spectrum

Run Query

Query Gaia in TOPCAT
=> retrieve all spectra



Images on shape models

1- Load a 3D shape model of the target in TOPCAT (implemented for VESPA)

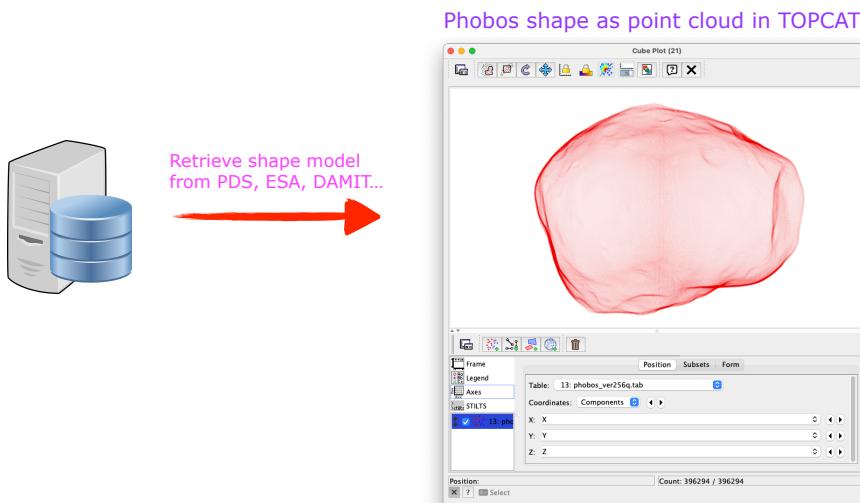
Direct support of .ver files (ESA, PDS, DAMIT) or conversion from SPICE DSK (command line)

=> Plot as point cloud or plate model

2- Query a image / cube service: EPN-TAP (VIRTIS Rosetta...) or direct upload from Jupyter notebook (PDS4)

3- Overplot on central coordinate (for quicklook) or plates (figures)

Support for space experiment in operation, or thermal simulations



Images on shape models

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=> Plot as point cloud or plate model

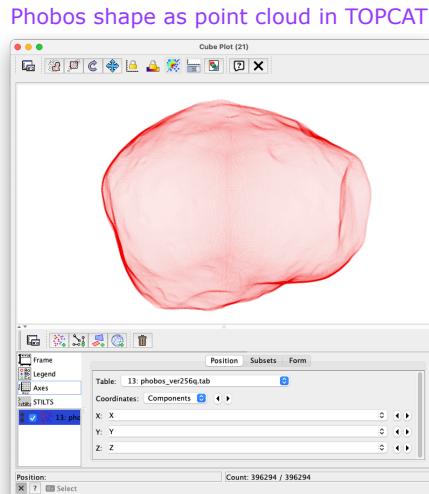
2- Query a image / cube service: EPN-TAP (VIRTIS Rosetta...) or direct upload from Jupyter notebook (PDS4)

3- Overplot on central coordinate (for quicklook) or plates (figures)

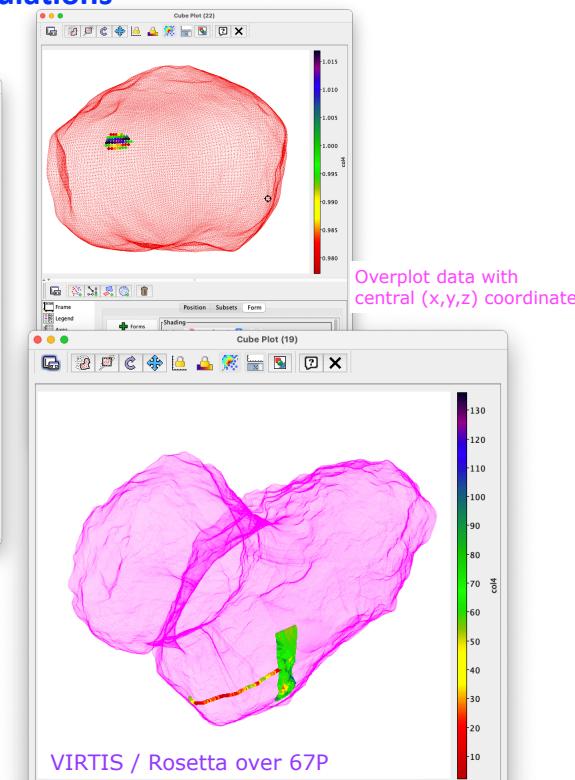
Support for space experiment in operation, or thermal simulations



Retrieve shape model
from PDS, ESA, DAMIT...



Select data files from
VESPA portal or other
sources



Overplot data with
central (x,y,z) coordinates

Images on shape models

1- Load a 3D shape model of the target in TOPCAT (implemented for VESPA)

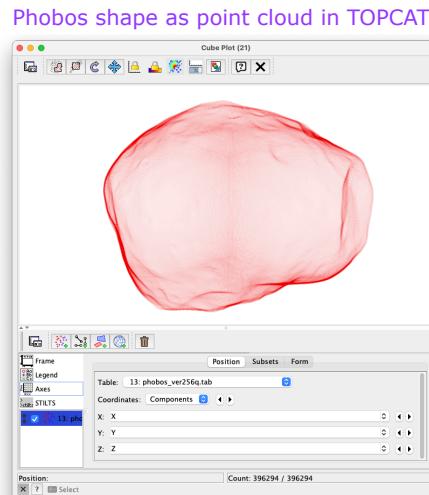
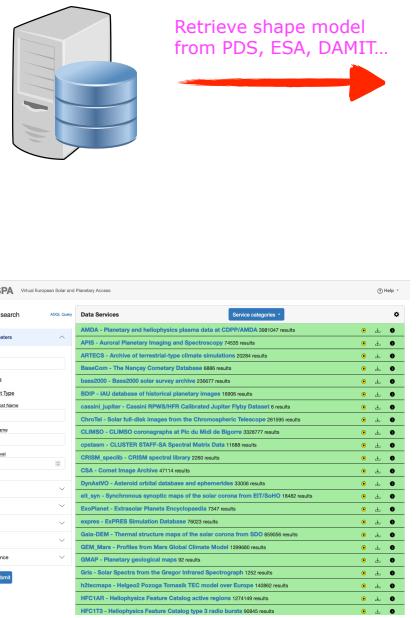
Direct support of .ver files (ESA, PDS, DAMIT) or conversion from SPICE DSK (command line)

=> Plot as point cloud or plate model

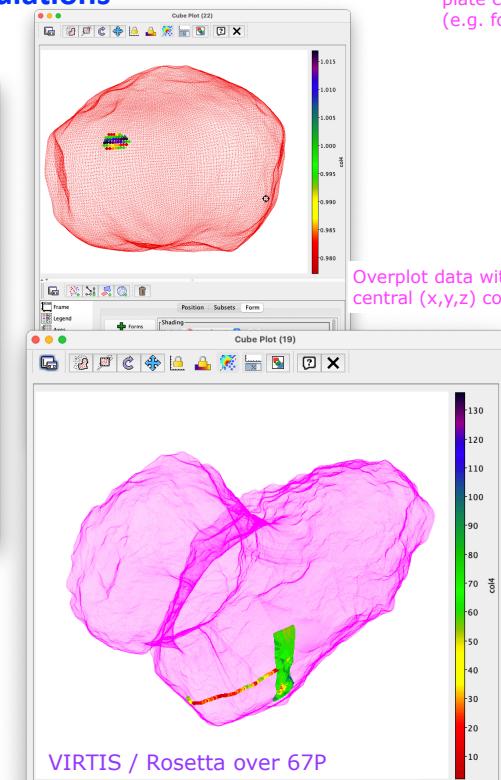
2- Query a image / cube service: EPN-TAP (VIRTIS Rosetta...) or direct upload from Jupyter notebook (PDS4)

3- Overplot on central coordinate (for quicklook) or plates (figures)

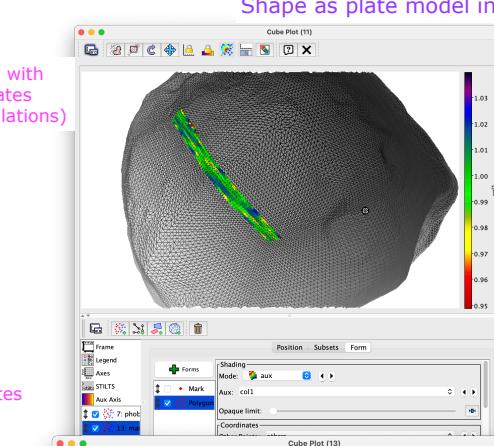
Support for space experiment in operation, or thermal simulations



Select data files from
VESPA portal or other
sources



Overplot data with
plate coordinates
(e.g. for simulations)



HiRes 67P point cloud in TOPCAT
with incidence angle

Comparing observations and reference lab spectra

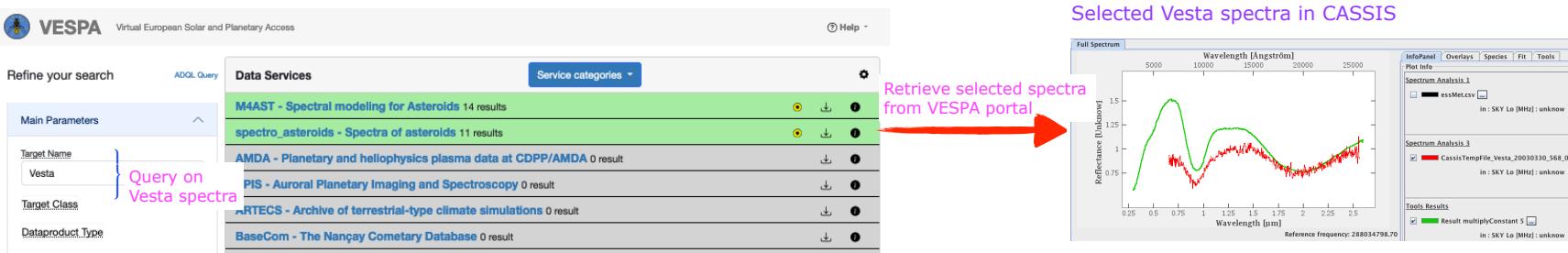
1- Locate spectra of (4) Vesta from the VESPA portal => results found in M4ast & spectro_asteroids

Send spectra to CASSIS (or TOPCAT or SPLAT-VO) from service result page

2- Query the VESPA portal for spectra of SNC meteorites => CRISM_speclib and SSHADE

In CRISM_speclib search for *sample_classification like "%snc%"*

3- Send selected results to CASSIS => analysis, best matches — can support unmixing, classification, etc in Jupyter notebooks



Comparing observations and reference lab spectra

1- Locate spectra of (4) Vesta from the VESPA portal => results found in M4ast & spectro_asteroids

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The screenshot shows the VESPA portal interface. On the left, there is a sidebar with 'Refine your search' and 'Main Parameters' sections. A pink box highlights the 'Target Name' field set to 'Vesta'. Below it, a blue box highlights the 'Query on Vesta spectra' section. In the center, a 'Data Services' panel lists several categories: 'M4AST - Spectral modeling for Asteroids' (14 results), 'spectro_asteroids - Spectra of asteroids' (11 results), 'AMDA - Planetary and heliophysics plasma data at CDPP/AMDA' (0 results), 'PIS - Auroral Planetary Imaging and Spectroscopy' (0 results), 'ARTECS - Archive of terrestrial-type climate simulations' (0 results), and 'BaseCom - The Nançay Cometary Database' (0 results). A red arrow points from the 'spectro_asteroids' section to the right side of the screen.

VESPA Virtual European Solar and Planetary Access

Refine your search ADQL Query

Main Parameters

Target Name: Vesta

Query on Vesta spectra

Data Services

- M4AST - Spectral modeling for Asteroids 14 results
- spectro_asteroids - Spectra of asteroids 11 results
- AMDA - Planetary and heliophysics plasma data at CDPP/AMDA 0 result
- PIS - Auroral Planetary Imaging and Spectroscopy 0 result
- ARTECS - Archive of terrestrial-type climate simulations 0 result
- BaseCom - The Nançay Cometary Database 0 result

Refine your search ADQL Query

Main Parameters

Target Name:

Target Class:

Dataproduct.Type:

Instrument Host Name:

Instrument Name

sample_classification

LIKE snc

Query on SNC spectra

CRISM_speclib - CRISM spectral library

Column visibility Show all Reset columns Select All in current page Reset Selection

target_class	sample_classification	sample_desc
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#meteorite#snc	ah 84001, split 92, powder <125 m
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#meteorite#snc	ah 84001, split 92, chip, largest face
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#meteorite#snc	ah 84001, split 271, face 1
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	ah 84001, split 271, spot 2 (including brown carbonate)
sample	natural#solid#meterite#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	coarse crystallize, sand-size particles 497 mg stone 1, mask 48, pyc 4
sample	natural#solid#meterite#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	brownish spot
sample	natural#solid#meterite#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	powder from lithology b
sample	natural#solid#meterite#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	coarser powder (di-oil ac fell june 28, 1911)

Show 1 to 23 of 23 entries

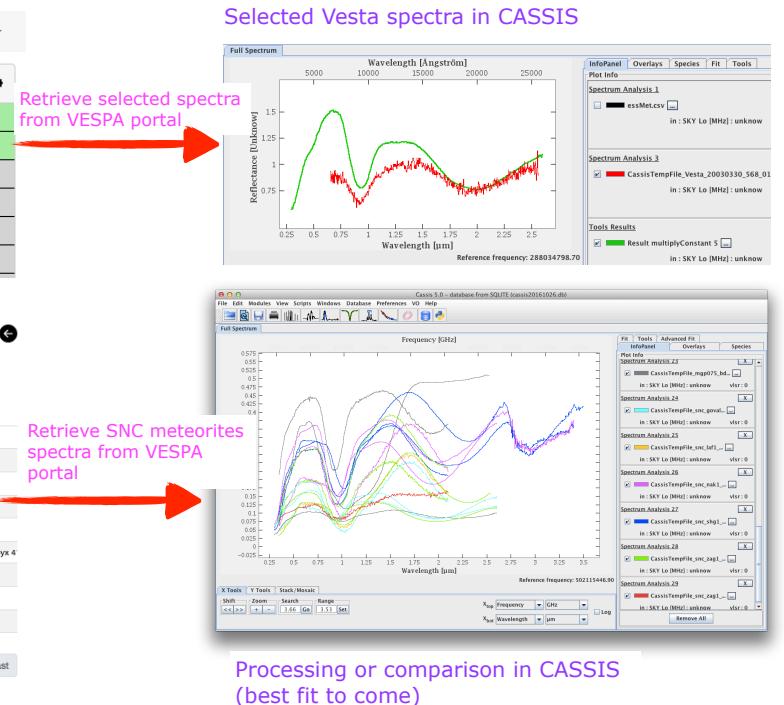
First Previous 1 of 1 Next Last

Show 25 entries

Data Selection Metadata Selection All Data All Metadata

Download Thumbnails Footprints

SELECT * FROM crism_speclib.epn_core WHERE ("target_class" LIKE "%sample%") AND ("dataproduct_type" LIKE "%snc%") AND "sample_classification" LIKE "%snc%"



Comparing observations and reference lab spectra

1- Locate spectra of (4) Vesta from the VESPA portal => results found in M4ast & spectro_asteroids

[Send spectra to CASSIS \(or TOPCAT or SPLAT-VO\) from service result page](#)

2- Query the VESPA portal for spectra of SNC meteorites => CRISM_speclib and SSHADE

[In CRISM_speclib search for *sample_classification* like "%snc%"](#)

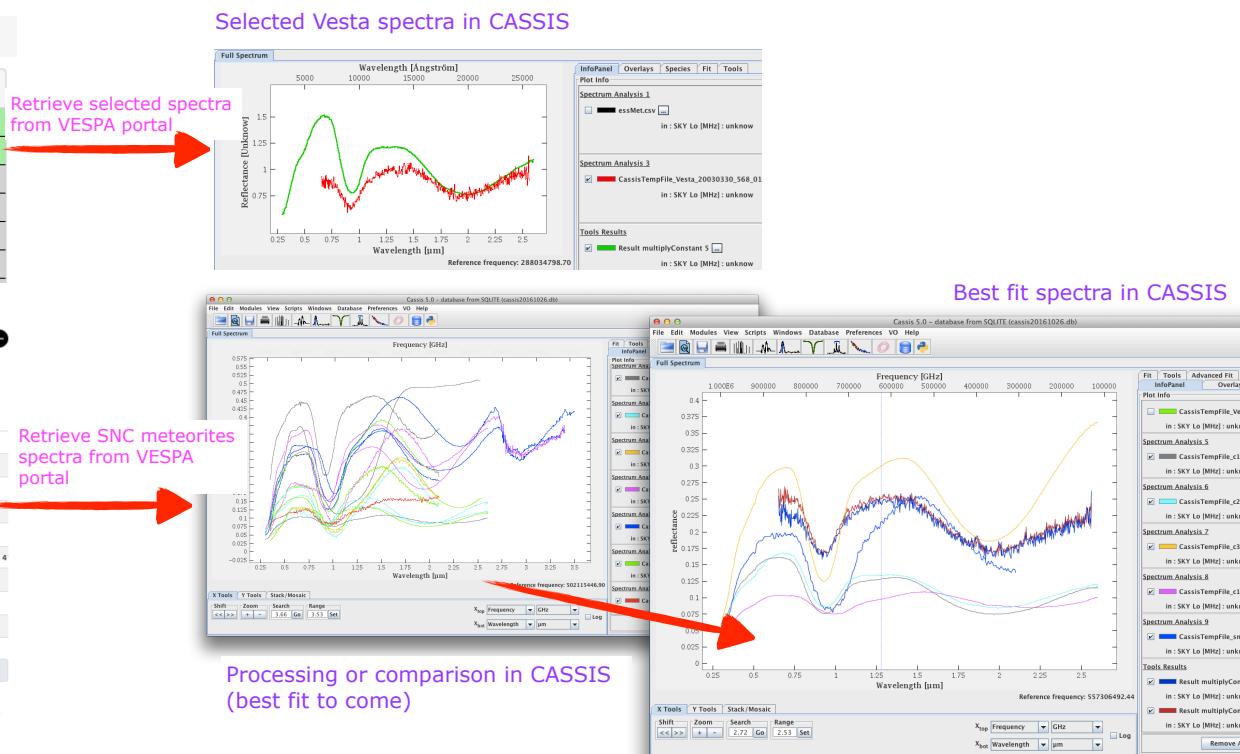
3- Send selected results to CASSIS => analysis, best matches — can support unmixing, classification, etc in Jupyter notebooks

The screenshot shows the VESPA portal interface. On the left, there is a sidebar with 'Refine your search' and 'Main Parameters' sections. A pink box highlights the 'Target Name' field set to 'Vesta' and the 'Query on Vesta spectra' section. The main area shows a 'Data Services' table with several rows. A red arrow points from the 'Vesta' query to the 'spectro_asteroids - Spectra of asteroids' row, which has a green background. Another red arrow points from this row to the right-hand figure.

Service categories	Count
M4AST - Spectral modeling for Asteroids	14 results
spectro_asteroids - Spectra of asteroids	11 results
AMDA - Planetary and heliophysics plasma data at CDPP/AMDA	0 result
PIS - Auroral Planetary Imaging and Spectroscopy	0 result
ARTECS - Archive of terrestrial-type climate simulations	0 result
BaseCom - The Nançay Cometary Database	0 result

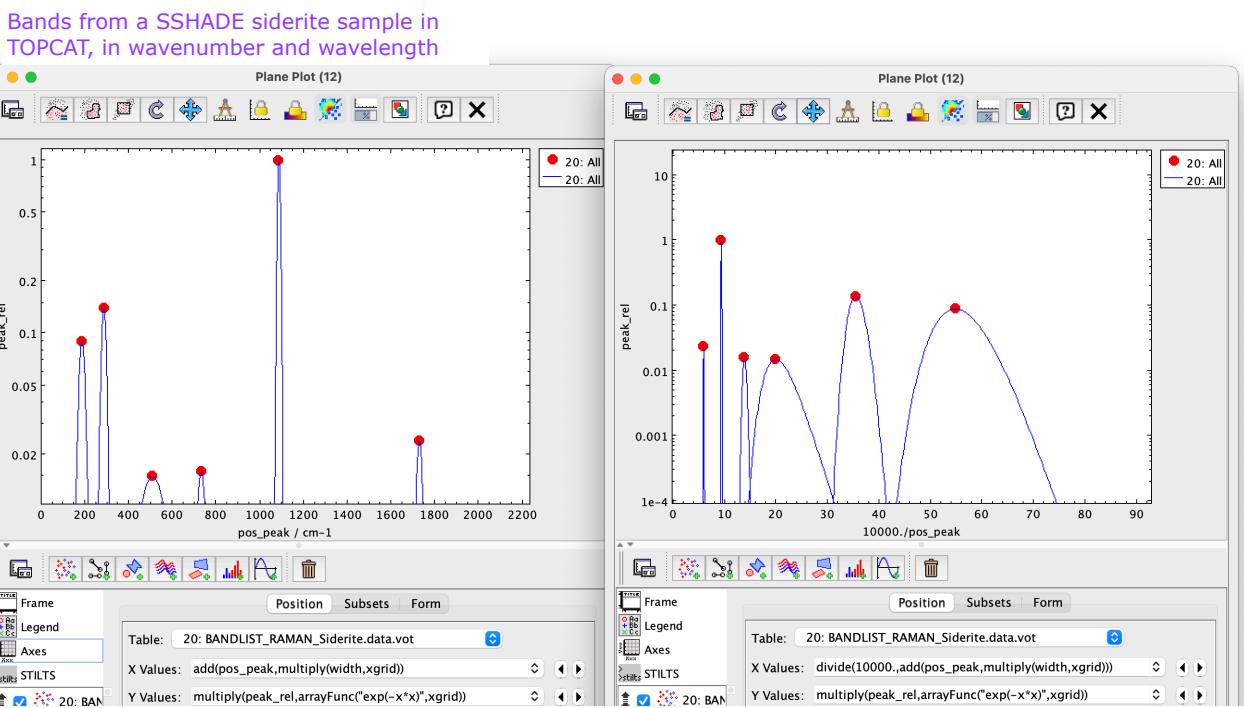
This screenshot shows the CRISM_speclib search results for SNC meteorites. A pink box highlights the 'Target Class' field set to 'snc' and the 'Query on SNC spectra' section. The main table lists various sample entries, each with a target class of 'snc'. A red arrow points from the 'snc' query to the first sample entry, which is highlighted in blue. This entry is then shown in more detail in the right-hand figure.

Column visibility	Show all	Reset columns	Select All in current page	Reset Selection
target_class	sample_classification	sample_desc		
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#meteorite#snc	aih 84001, split 92, powder <125 m		
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#meteorite#snc	aih 84001, split 92, chip, largest face		
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#meteorite#snc	aih 84001, split 271, face 1		
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#meteorite#snc	aih 84001, split 271, spot 2 (including brown carbonate)		
sample	natural#solid#meteore#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	coarse crystallize, sand-size particles, 497 mg stone 1, mask 48, ppx 4		
sample	natural#solid#meteore#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	brownish spot		
sample	natural#solid#meteore#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	powder from lithology b		
sample	natural#solid#meteore#rock#unclassified#unclassified#unclassified#unclassified#mars#snc	coarser powder (di-oil ac fell june 28, 1911)		



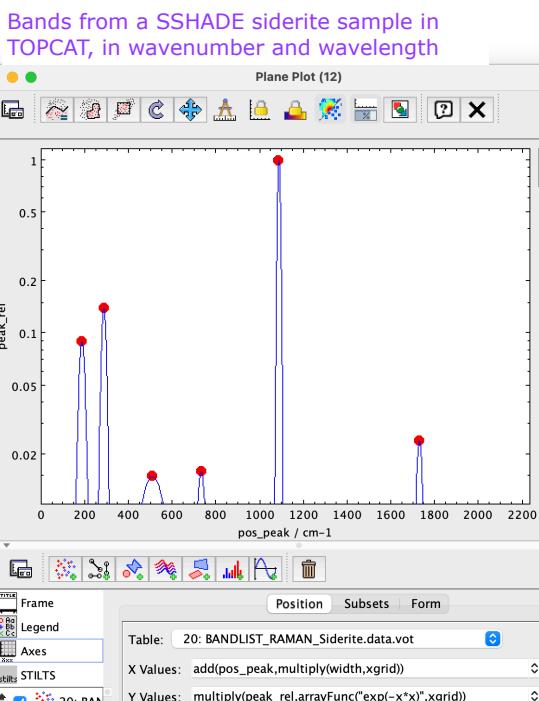
Other spectral analyses

- Get band lists of solids from SSHADE (minerals & ices)
- Use them to model spectra and fit observations in workflows / Jupyter notebooks



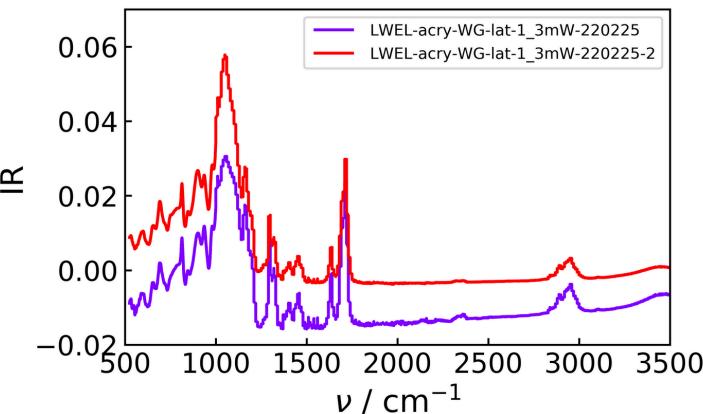
Other spectral analyses

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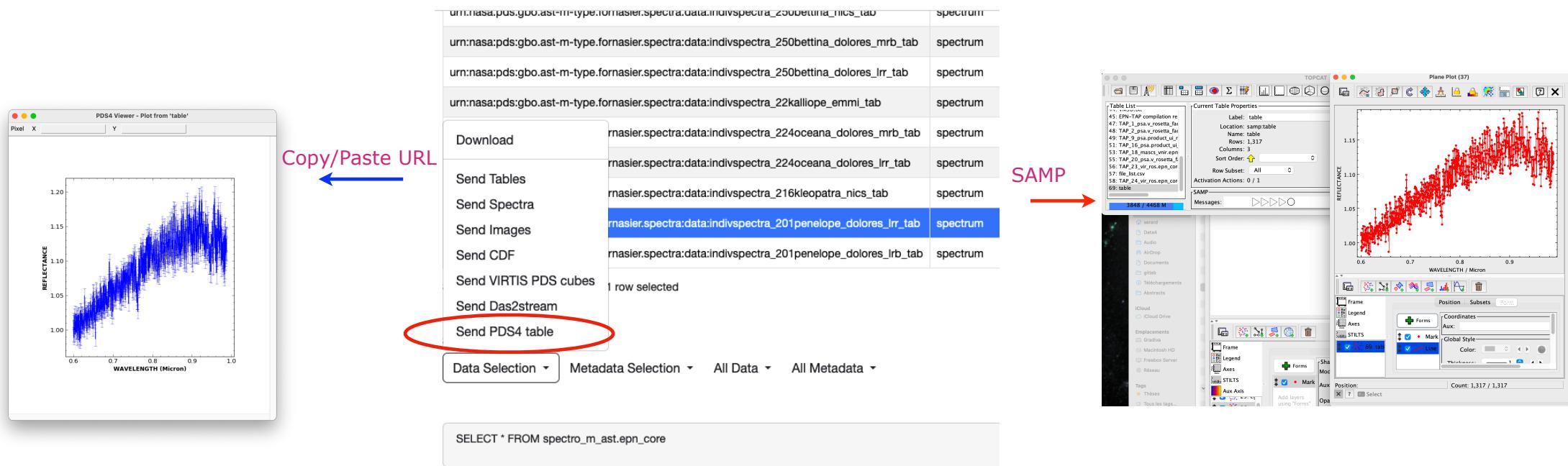
Spectral simulation
or
Extraction of bands from observations
& comparison in notebook

```
for peak in peaks:  
    temp_data_select.append(peak)  
    wav.append(temp[peak])  
    print(wav)  
  
[814.0, 901.0, 1050.0, 1300.0, 1710.0]  
  
In [65]:  
# plot data  
with rc_context(fname=rc_fname):  
    for i in fn:  
        tempdata_fitted_sg[i].  
        plt.plot(temp, lw=1.5, color=colors[i], label=fn[i])  
        plt.bar(wav, 0.01, width=20, color='black')  
        plt.xlim(500, 3500)  
        plt.ylim(-0.02, 0.07)  
        plt.xlabel('ν / cm⁻¹')  
        plt.ylabel('IR')  
        plt.legend(fontsize=8, frameon=True)
```



PDS4 tables are supported by TOPCAT

Other PDS4 datatypes can be plotted with PDS4_viewer (manual connection for now)

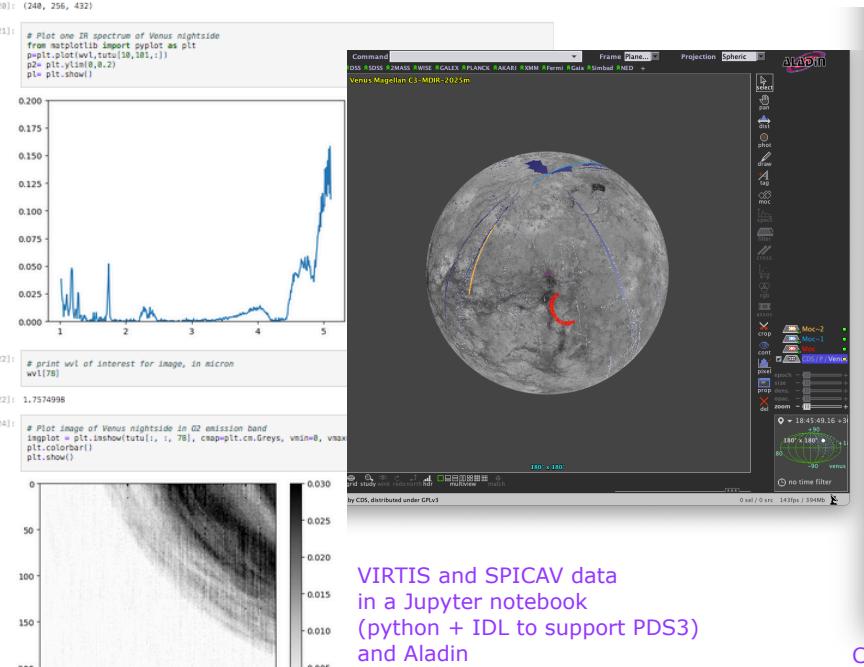


PDS4_viewer (NASA)

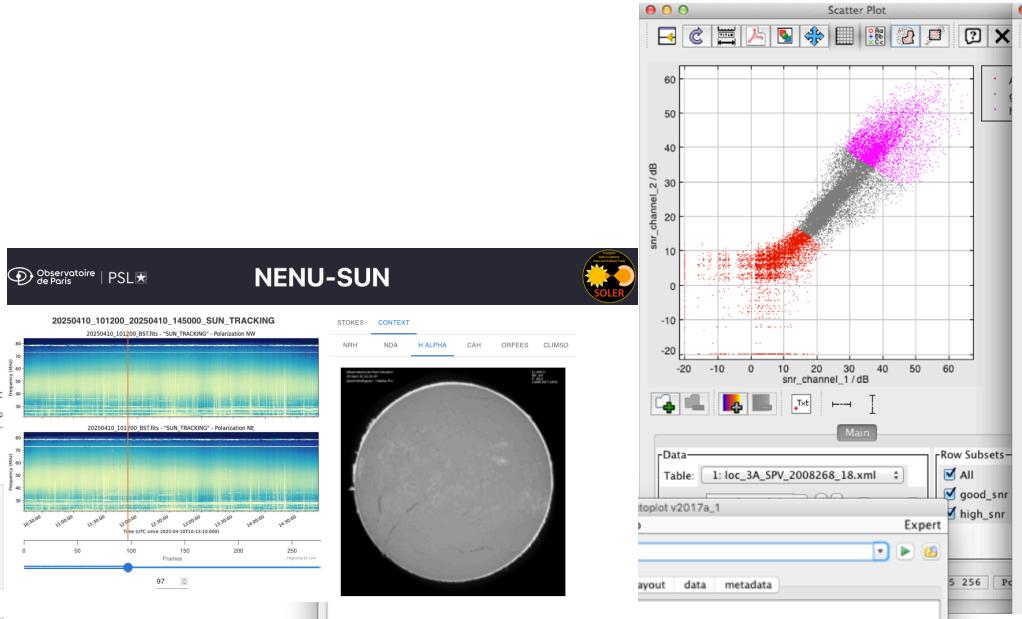
VESPA portal

TOPCAT

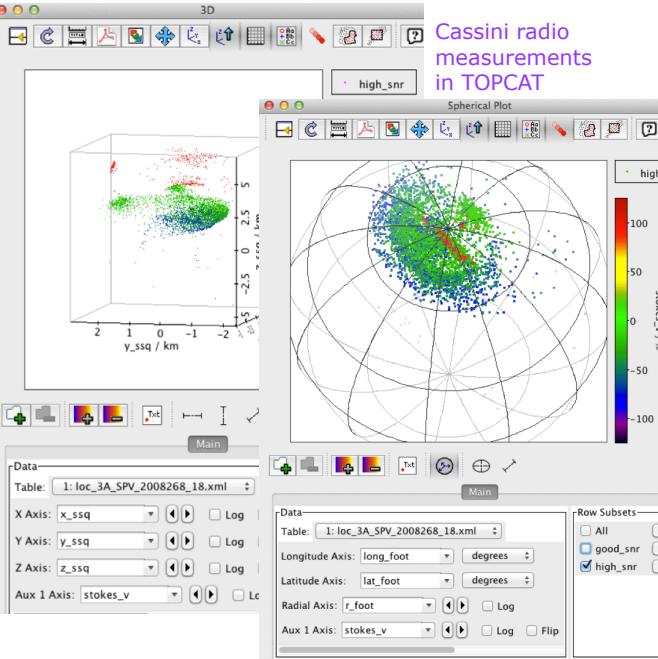
Other use cases



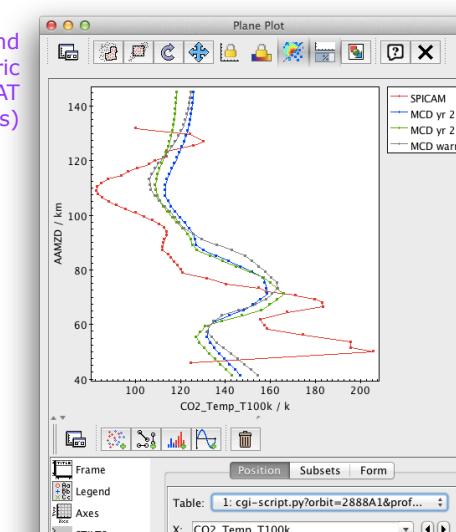
VIRTIS and SPICAV data in a Jupyter notebook (python + IDL to support PDS3) and Aladin



Comparison of radio dynamic spectra (ground/space) in Autoplot

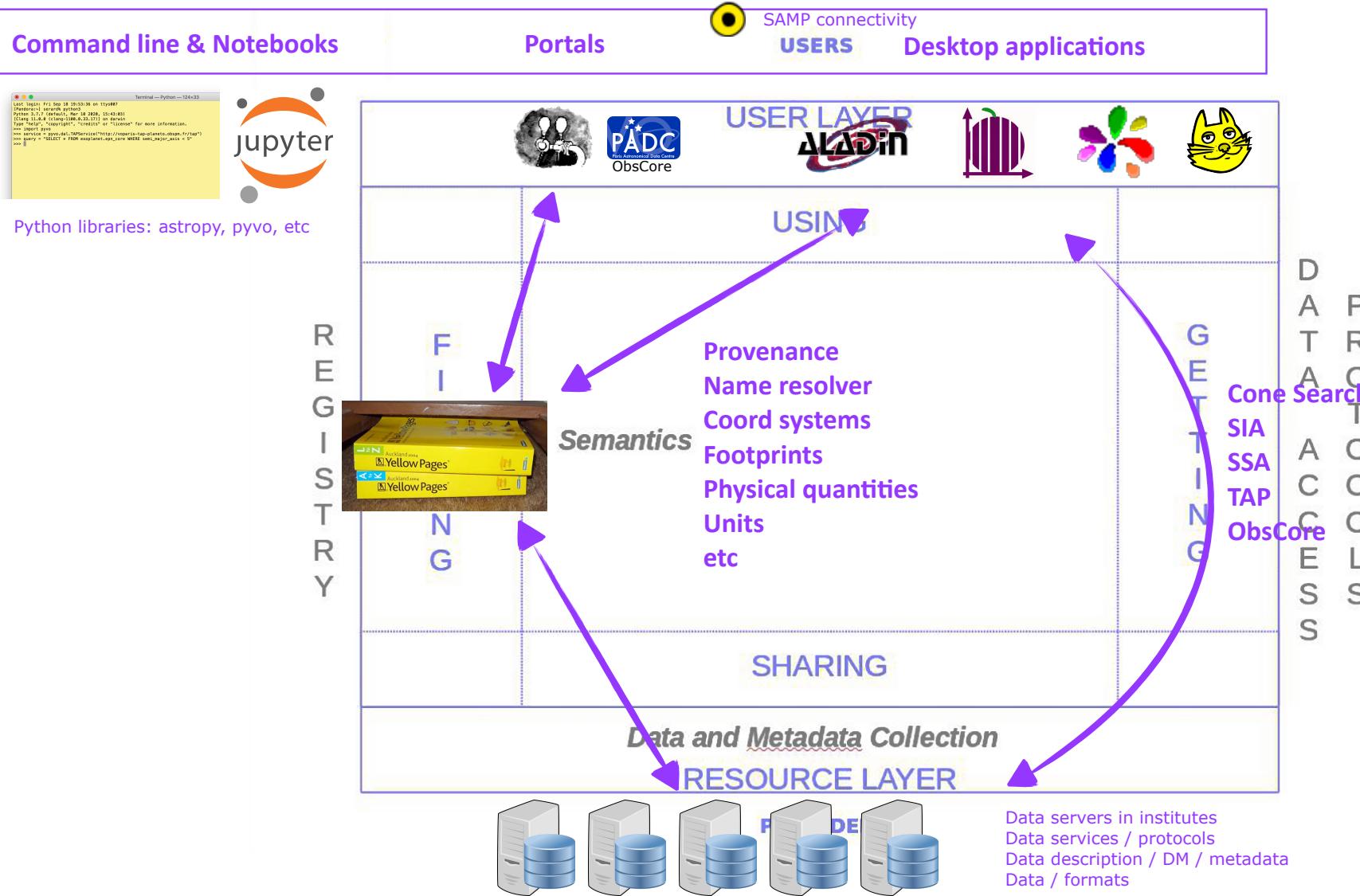


Nanocar Dismantlers Away

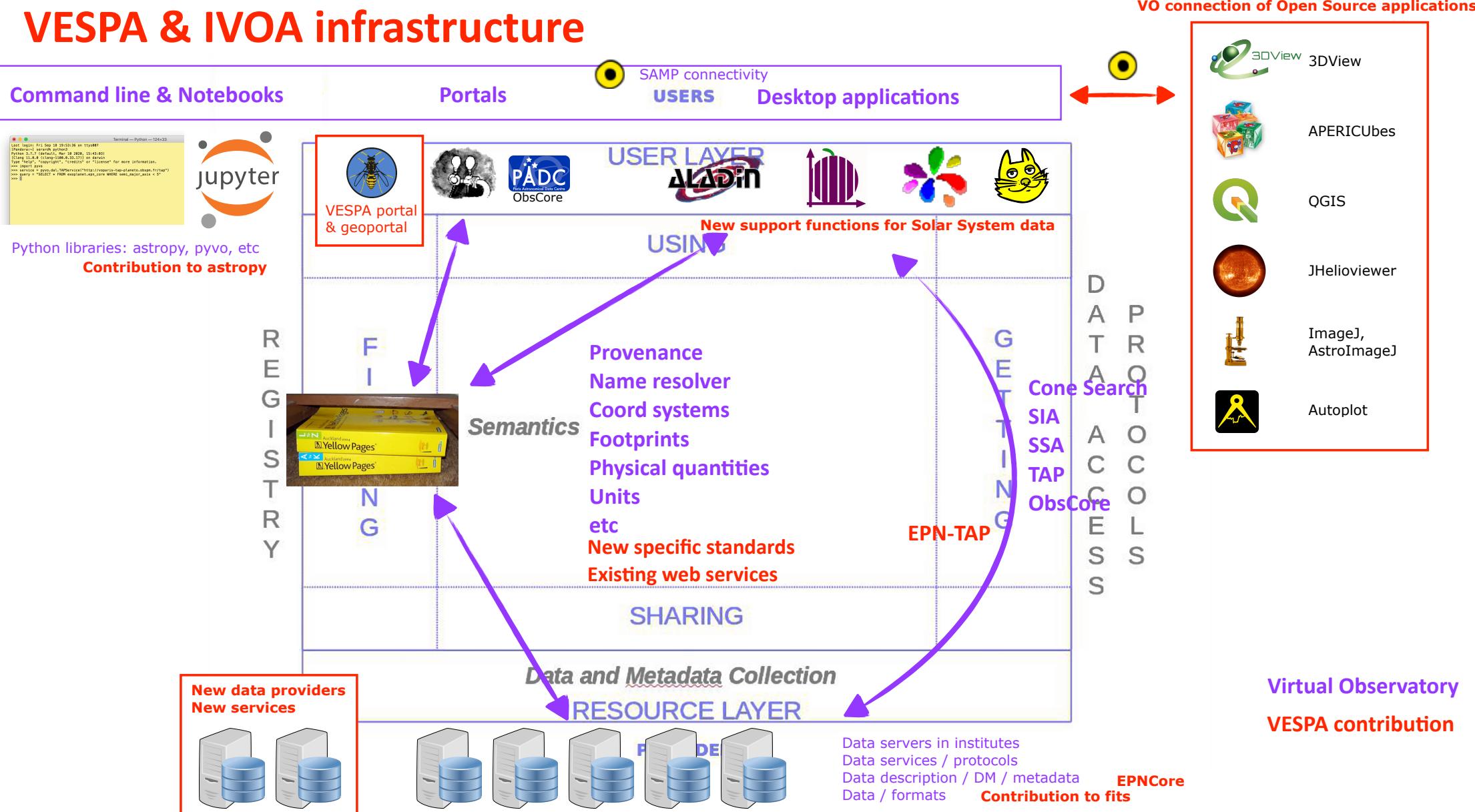


SPICAM and
MCD atmospheric
profiles in TOPCAT
(several scenarios)

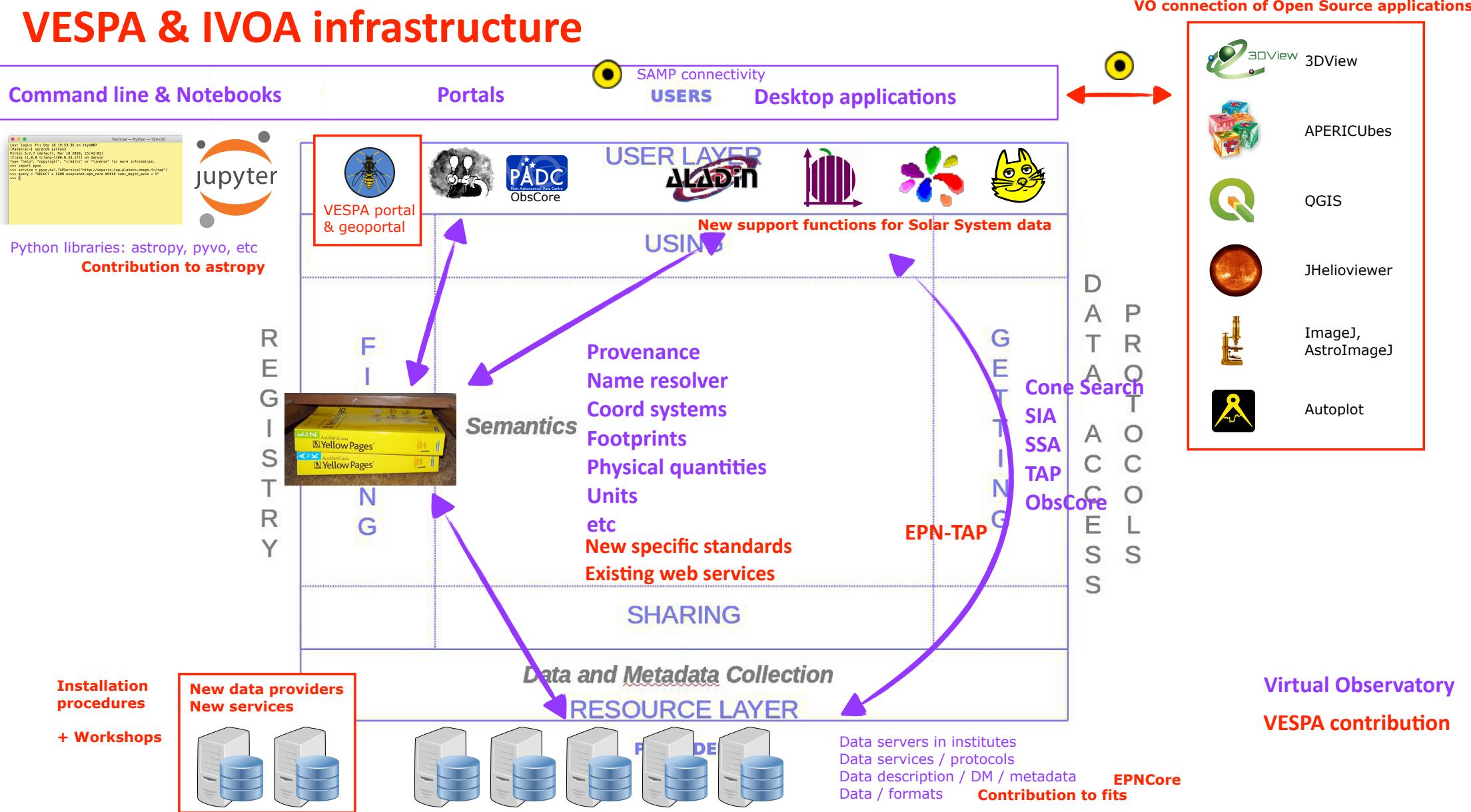
VESPA & IVOA infrastructure



VESPA & IVOA infrastructure



VESPA & IVOA infrastructure



New services in VESPA

Data

Currently 94 data reviewed EPN-TAP services (cross-searchable from the portal)

- NEOCC from ESA is published (@ESRIN)
- NEOROCKS (European programme) under review (@ASI)
- Ongoing: patrimonial Small Body data from ObsParis (including from PDS SBN datasets, @ObsParis)
- Two VIRTIS / Rosetta services (@ObsParis)

Comet phase: complete EPN-TAP table with illumination, linking to the PSA archive

Recalibrated dataset: M-channel, comet phase linking to data at ObsParis

Tools

- Big and beautiful upgrade of main portal — gallery view, global result table, PDAP dropped
- Geospatial portal now open for feedback
- Shape models in TOPCAT
- NenuSun tool for heliophysics

Prospects

- EPN-TAP provides interoperability to ~ half of these services (scriptable API)
 - => allows cross-searches among services (and other services worldwide)
 - => improves content of databases & services

This was possible thanks to Europlanet programmes

- VESPA provides functionalities to **display and analyse Solar System data** (planetary science / heliophysics / exoplanets) and a **framework for processing pipelines & workflows, including on EOSC**
- VESPA also provides a simple data sharing procedure to any research team
 - => **distributed infrastructure open to the community**

VESPA is really the extension of the VO to the Solar System

Can be used to manage space instruments or ground / lab experiments

[Study for the ground segment of MIRS / MMX at LIRA](#)

Main portal: <https://vespa.obspm.fr/>

Geospatial portal: <https://padc-findme.obspm.fr>

Tutorials: <https://github.com/epn-vespa/tutorials>

Web site: <http://www.europa-planet-vespa.eu/>