Virtual European Solar & Planetary Access (VESPA)

Providing access to Solar System & heliophysics data

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VESPA ASTRO-CC workshop 2026

25-27 mars 2026

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VESPA in a nutshell (2026)

- **An activity in successive Europlanet programmes, started 2011**
- **Provides 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 95 data reviewed EPN-TAP services (cross-searchable from tools and portals)

- 30+ contributing institutes worldwide

- ESA's Planetary Science Archive (PSA, 38 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

Footprint-based searches (contours)

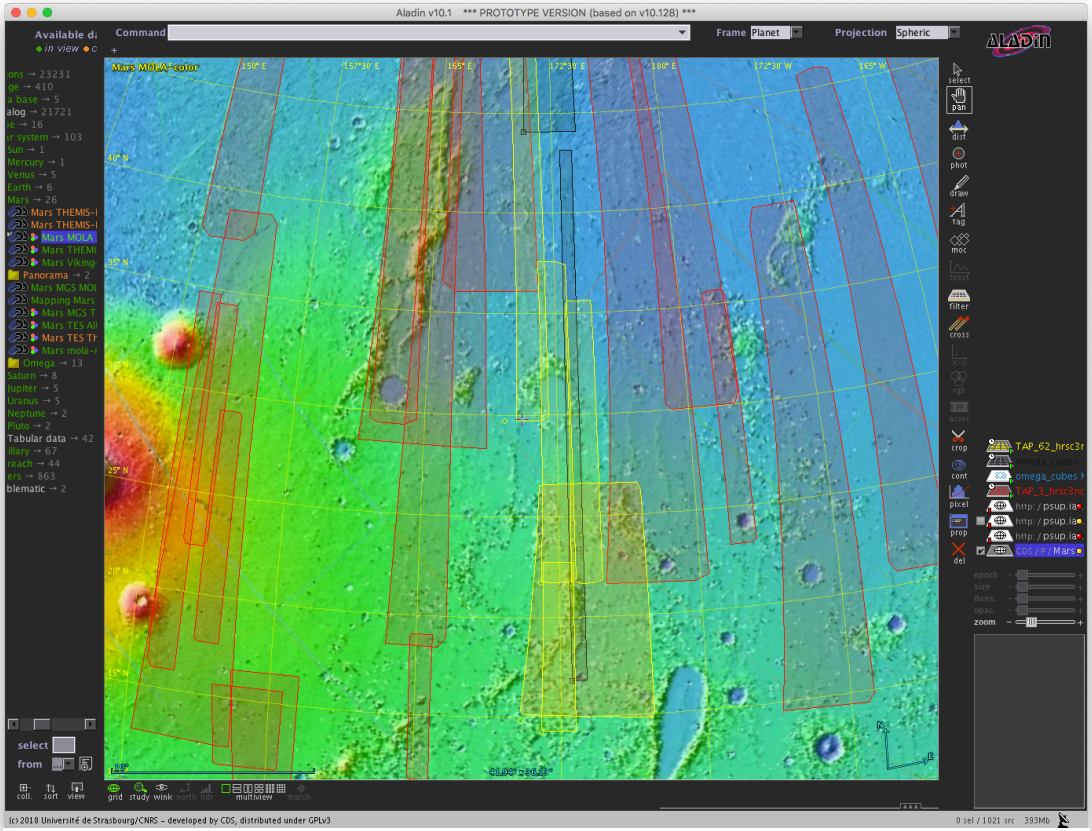
2D overlaps based on actual footprints, in TAP

Typical request:

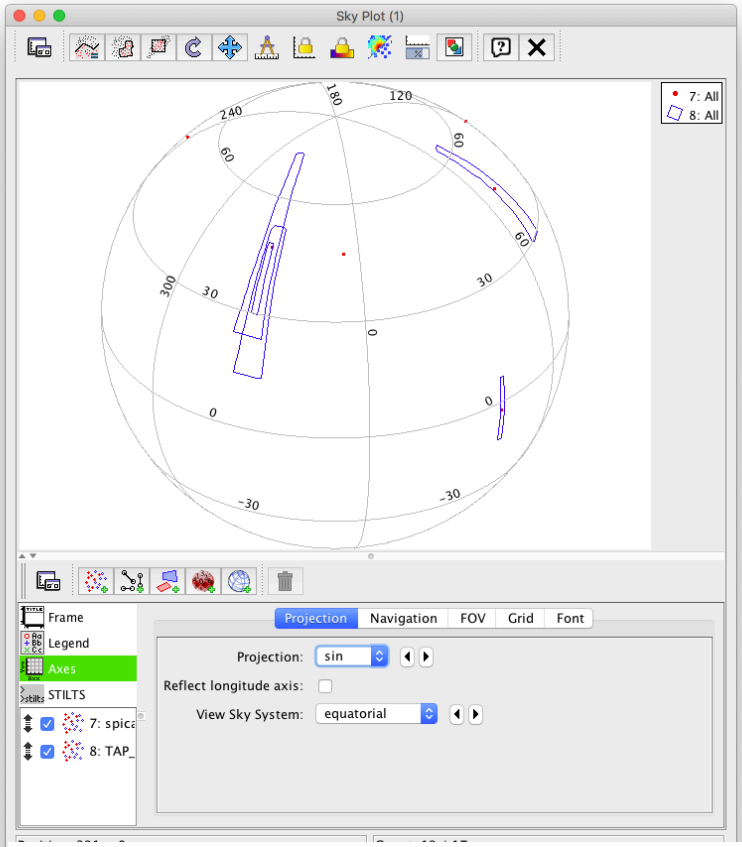
- **identify overlapping images / spectral cubes from different datasets based on footprints** (also works with point features)

(from TAP query using s_region)

Tutorial: https://github.com/epn-vespa/tutorials/blob/master/surfaces/HRSC_vs_OMEGA/HRSC_vs_OMEGA-tutorial.md



HRSC (red) and selection of OMEGA cubes (black) in Aladin
Overlapping HRSC images in yellow (Mars-Express observations)



Selected SPICAM profiles (red) and overlapping HRSC images
(blue) in TOPCAT (Mars-Express observations)

Spectra vs geologic units

1- Set the VESPA geoportal to Mercury (MESSENGER MDIS)

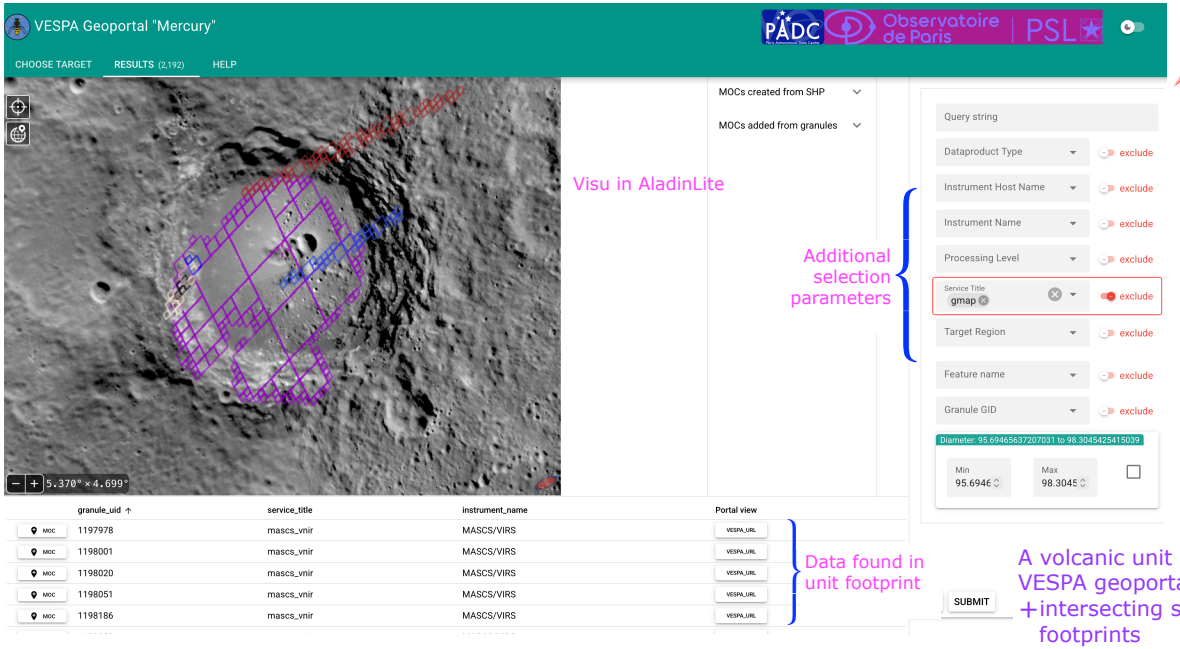
2- Drop a shapefile of a Mercury pyroclastic deposit (Leon-Dasi et al 2023, from analysis of MESSENGER images) **=> converts to MOC**

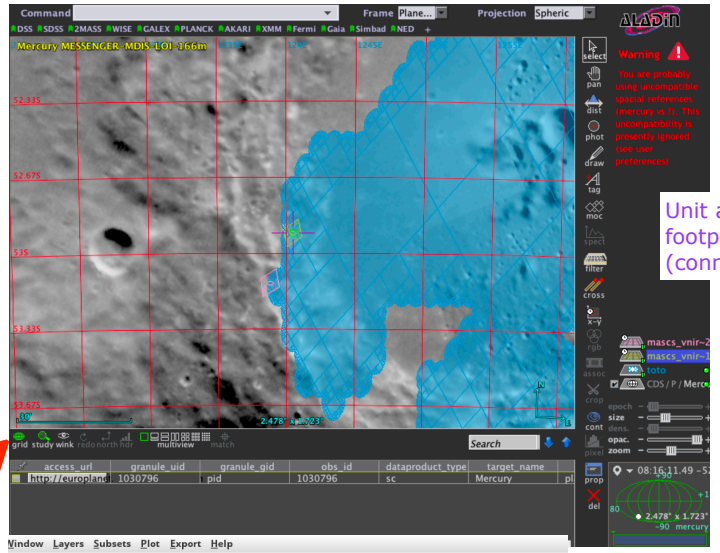
=> identifies all MESSENGER spectra in this unit, with footprint and conditions

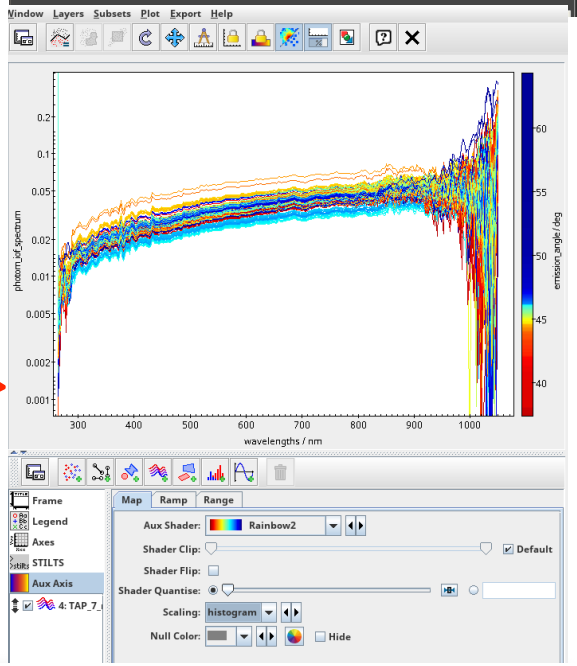
3- Send the unit MOC and spectrum footprints to Aladin

4- Send all spectra to TOPCAT

=> average spectrum and variability, possibly with selection on illumination angles





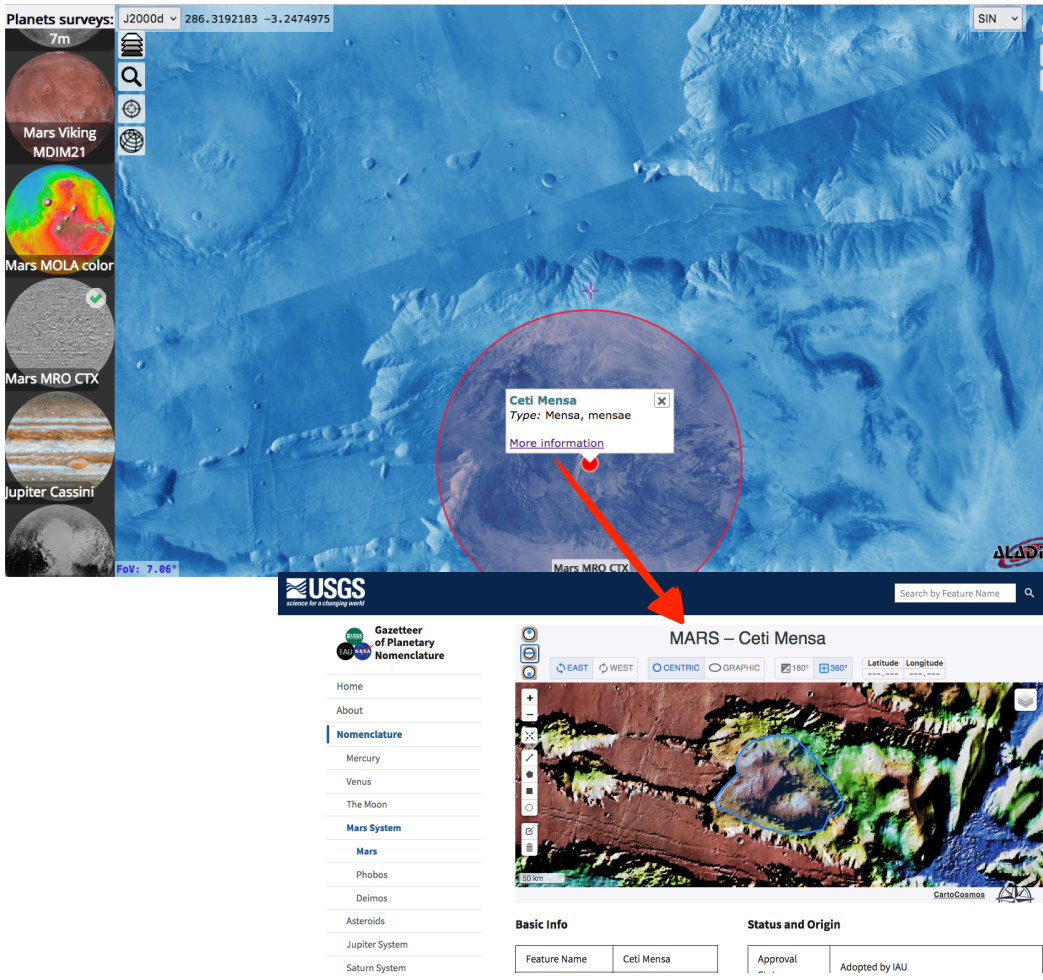


Other uses of the geoportal

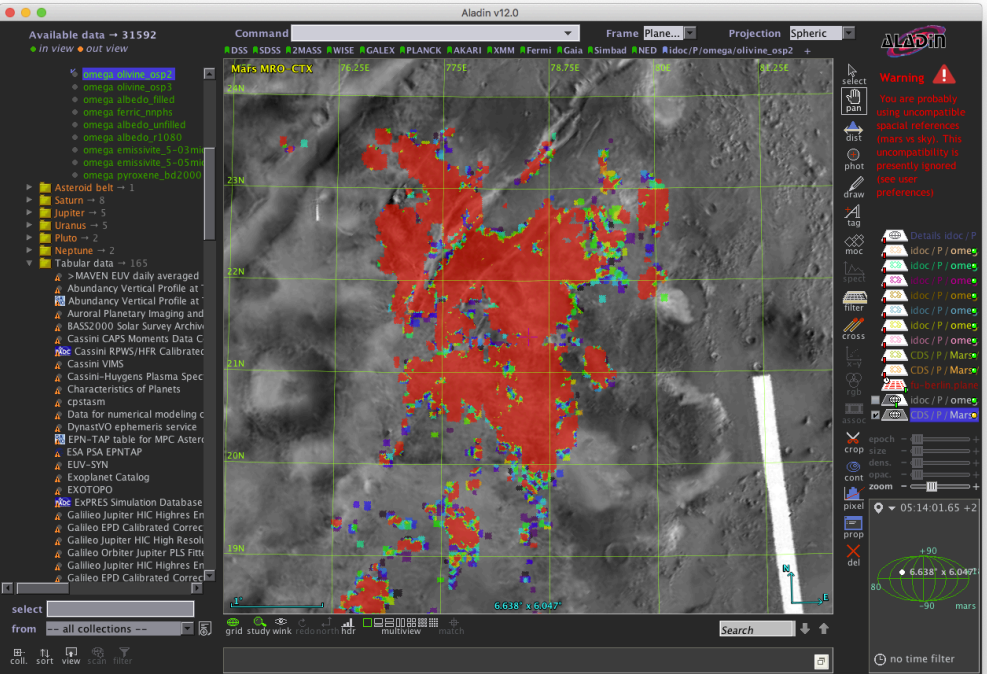
- **readily identifies overlapping observations**
- **Multi-resolution maps (HiPS) can be used as data source, e.g. for mineral abundance**
- **Connection with IAU nomenclature and USGS services from AladinLite**

(replace calls to SIMBAD when in planetary mode)

AladinLite planets explorer
https://aladin.cds.unistra.fr/AladinLite/planets-explorer



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:

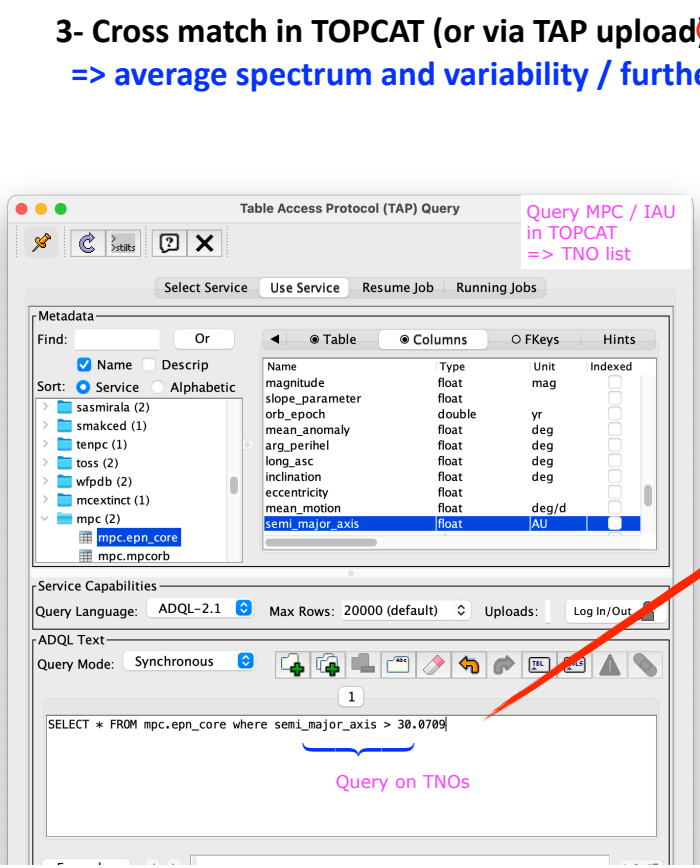
EPN-TAP (MPCorb, NEOCC, MP3C, DynAstVO…) [external APIs (SsODNet, JPL SBDb, Lowell Astorb…) may be OK for small populations]

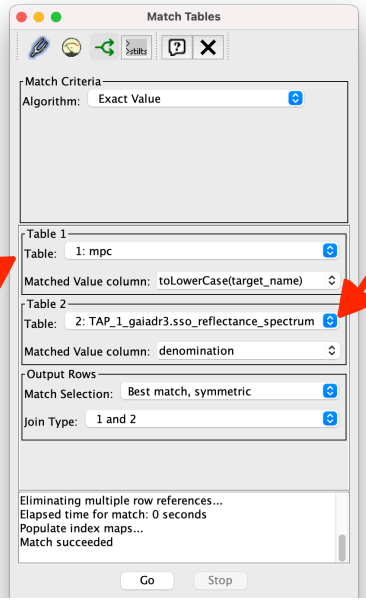
=> list of targets with names in TOPCAT

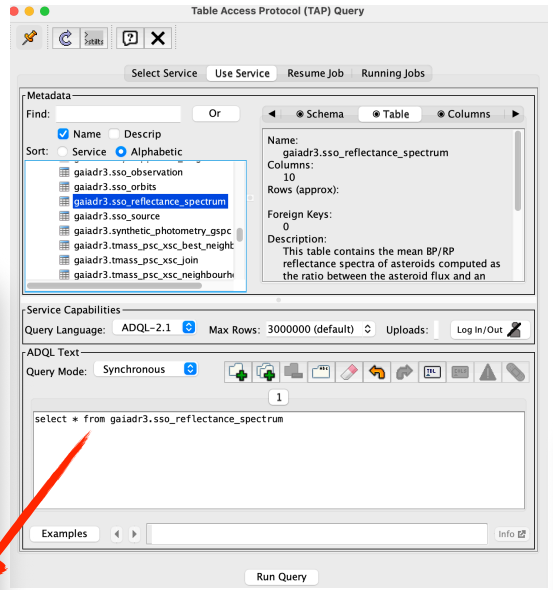
2- Query an asteroid spectra service: EPN-TAP (spectro_asteroids, M4ast…) or TAP (Gaia)

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

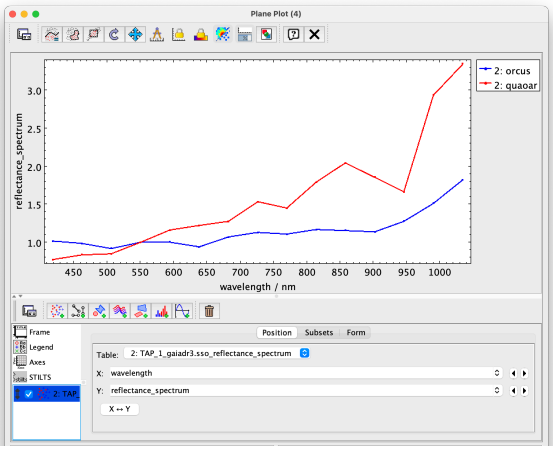
=> average spectrum and variability / further classification







Much easier with EPN-TAP services ;)



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)

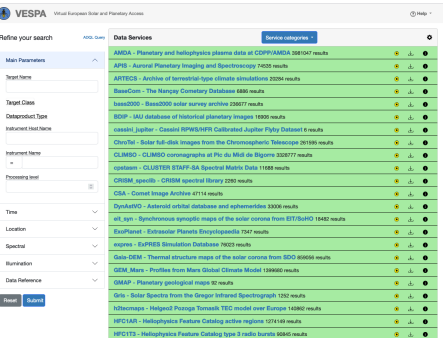
=> Plot as point cloud or plate model

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)

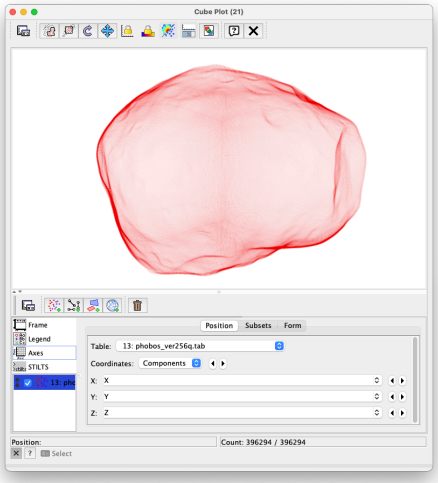
Support for space experiment in operation, or thermal simulations

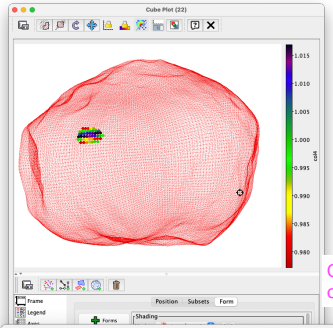
Retrieve shape model from PDS, ESA, DAMIT…



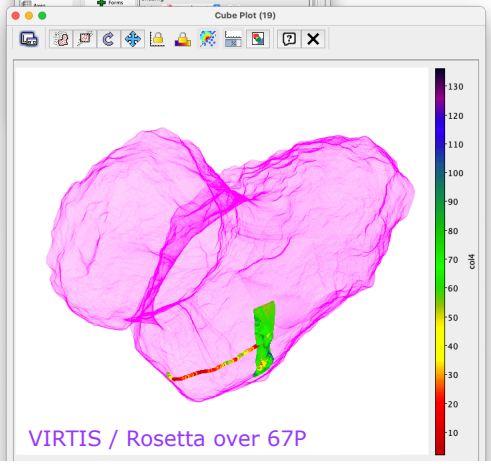
Select data files from VESPA portal or other sources

Phobos shape as point cloud in TOPCAT





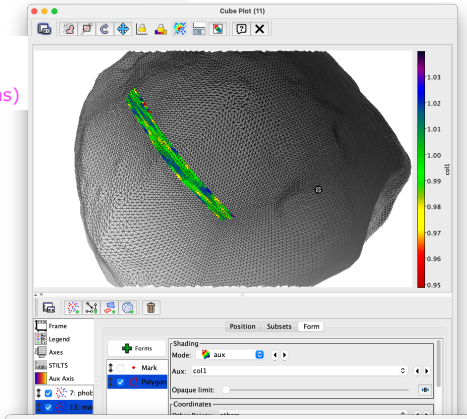
Overplot data with central (x,y,z) coordinates

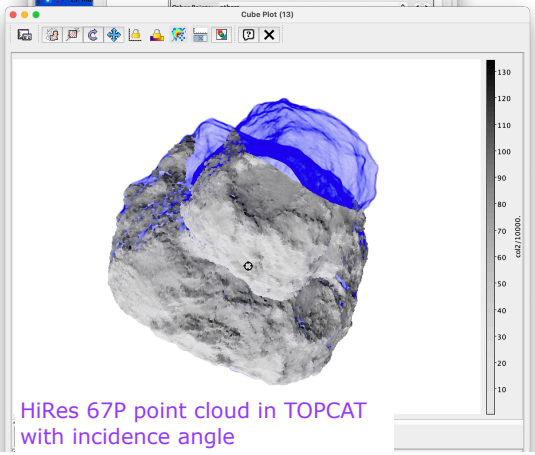


VIRTIS / Rosetta over 67P

Shape as plate model in TOPCAT

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





HiRes 67P point cloud in TOPCAT with incidence angle

Comparing observations and reference lab spectra

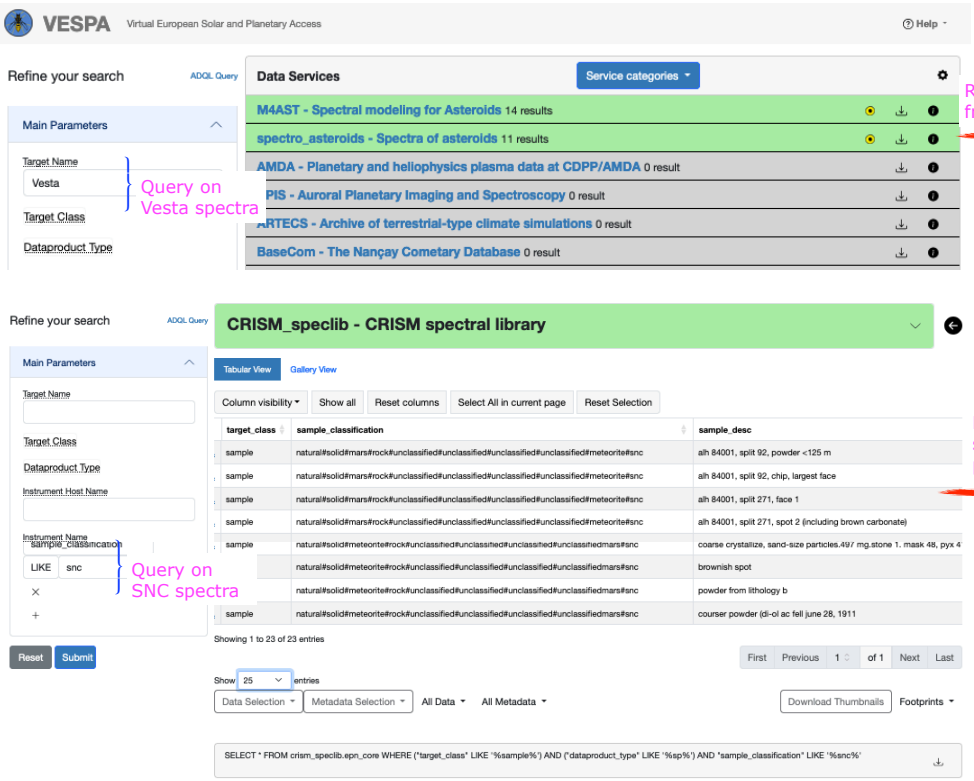
1- Locate spectra of (4) Vesta from the VESPA portal => results found in M4ast & spectro_asteroids

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

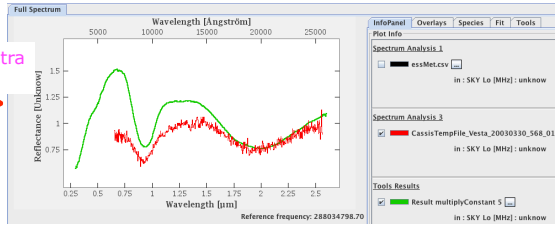
In CRISM_speclib search for *sample_classification like "%snc%"*

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

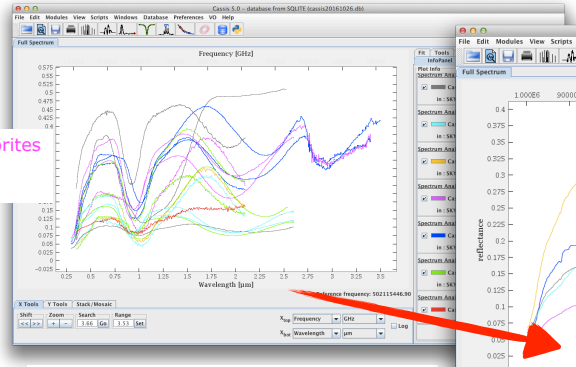


Retrieve selected spectra from VESPA portal

Selected Vesta spectra in CASSIS

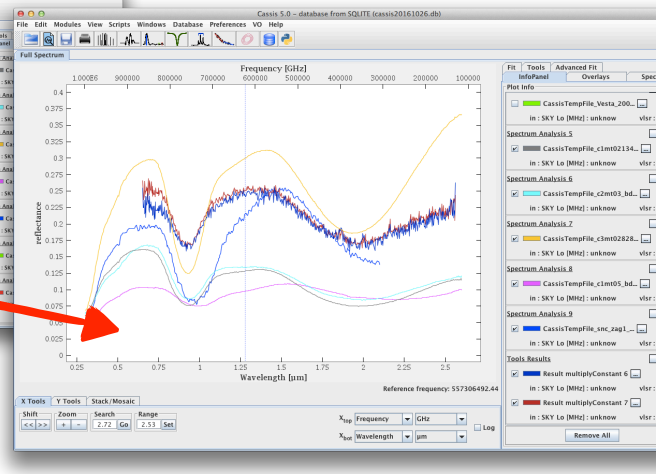


Retrieve SNC meteorites spectra from VESPA portal



Processing or comparison in CASSIS (best fit to come)

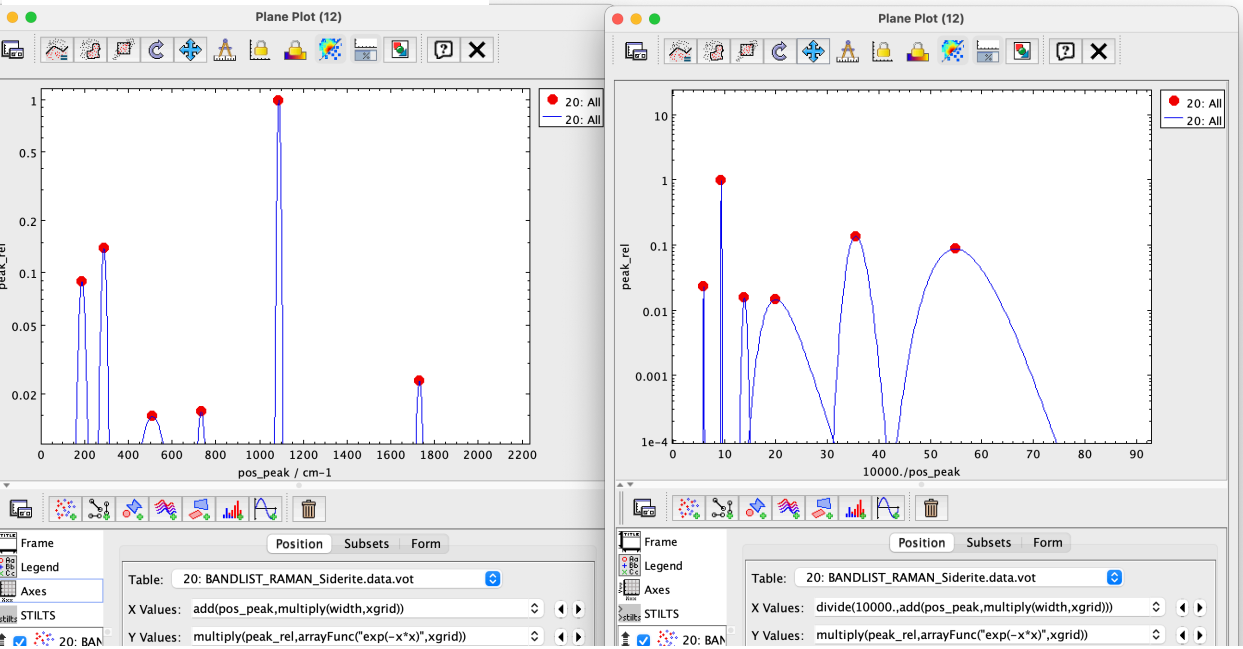
Best fit spectra in CASSIS



Other spectral analyses

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

Bands from a SSHADE siderite sample in TOPCAT, in wavenumber and wavelength

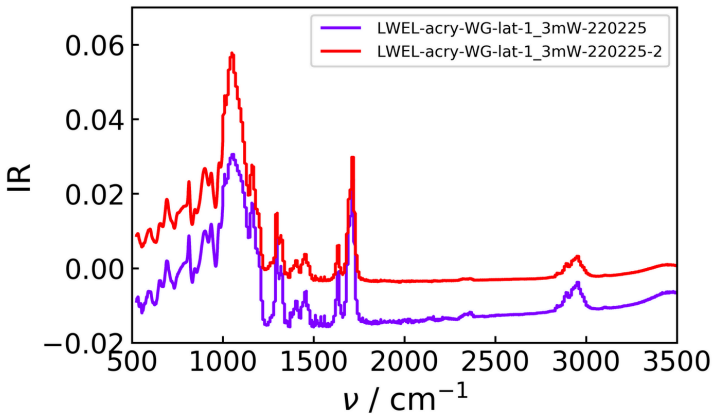


Spectral simulation
or
Extraction of bands from observations
& comparison in notebook

```
for peak in peaks:
    temp=data_select.index
    wav.append(temp[peak])
print(wav)
```

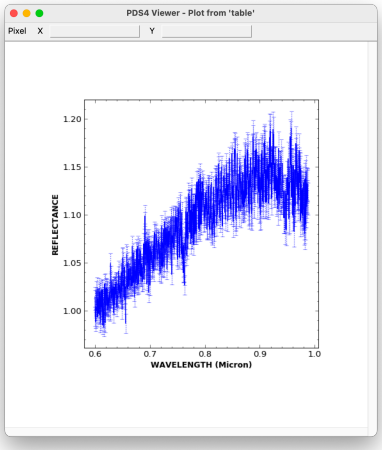
```
[814.0, 901.0, 1050.0, 1300.0, 1710.0]
```

```
In [65]:
# plot data
with rc_context(fname=rc_fname):
    for i in fn:
        temp=data_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('$\\nu$ / 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)



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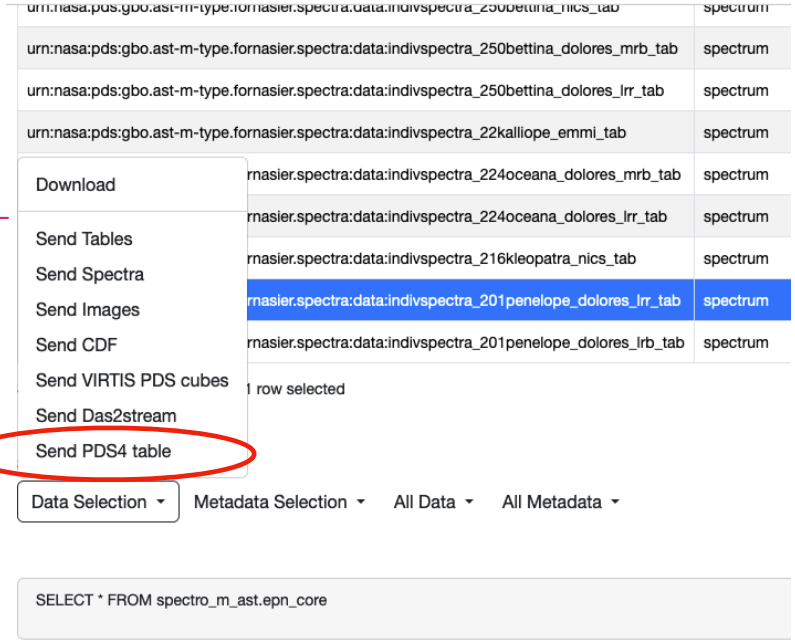
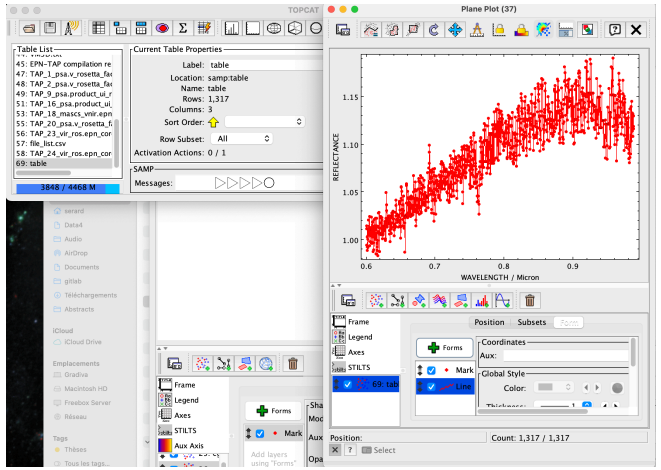


SAMP



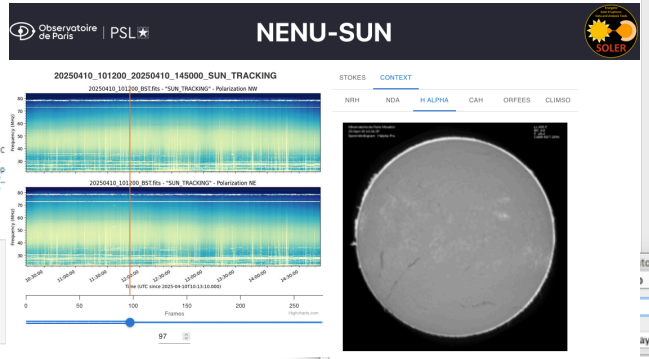
PDS4_viewer (NASA)

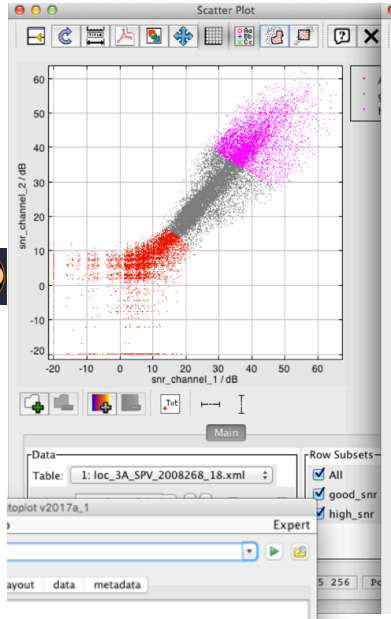
VESPA portal

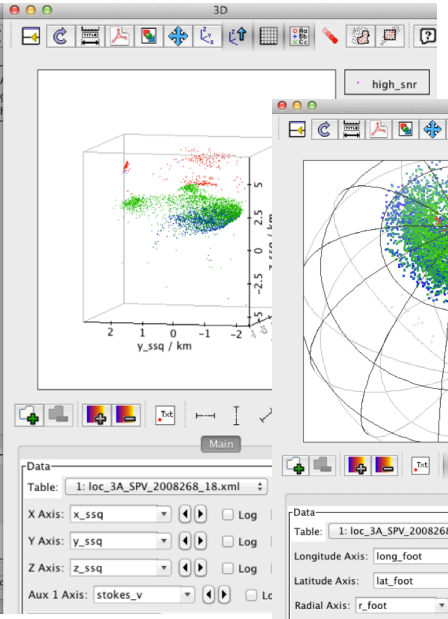
TOPCAT (Bristol Univ)

Other use cases

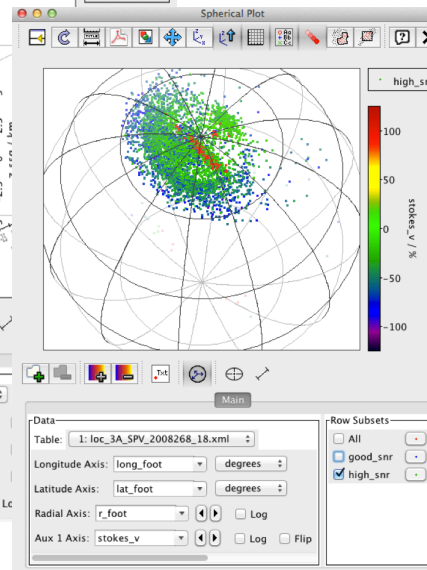
Comparison of simultaneous observations of the Sun

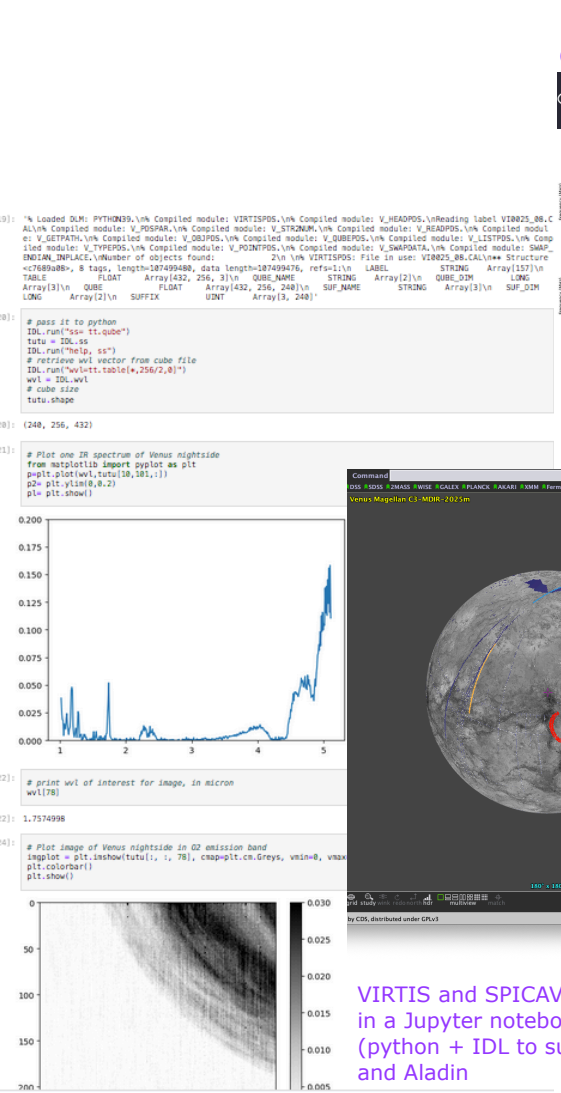


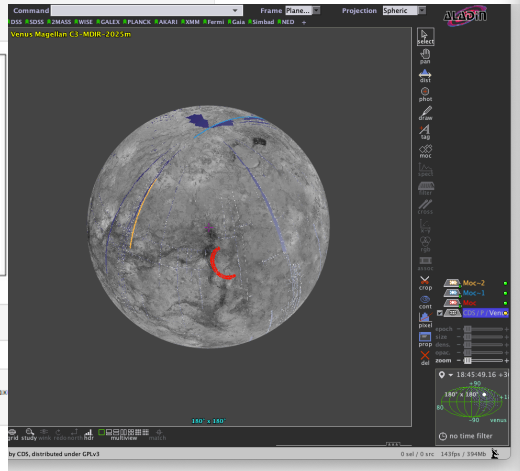




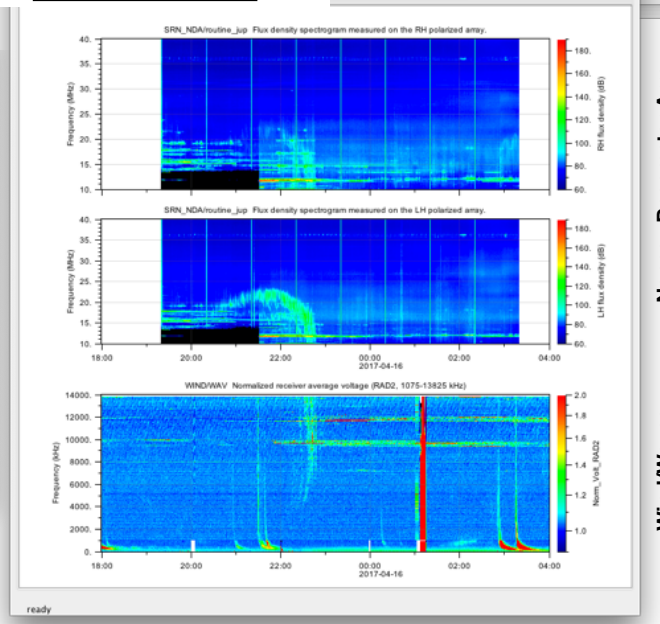
Cassini radio measurements in TOPCAT







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

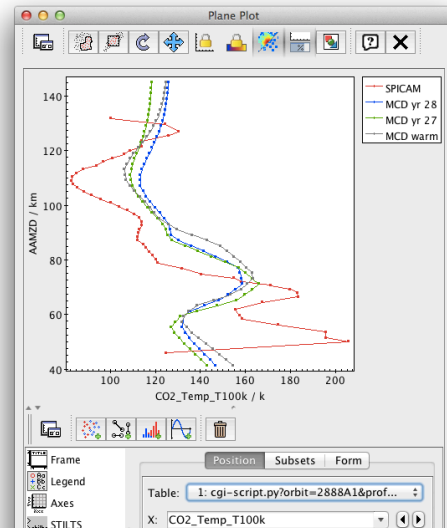


Nançay Decameter Array

Wind/Waves

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

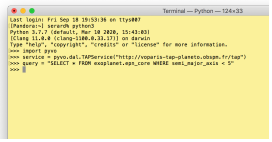
SPICAM and MCD atmospheric profiles in TOPCAT (several scenarios)



VESPA & IVOA infrastructure

VO connection of Open Source applications

Command line & Notebooks | Portals | SAMP connectivity | USERS | Desktop applications



jupyter

Python libraries: astropy, pyvo, etc

Contribution to astropy

VESPA portal & geoportal

PADC ObsCore

USER LAYER

ALADIN

New support functions for Solar System data

USING

REGISTRY

FINDING

Semantics

- Provenance
- Name resolver
- Coord systems
- Footprints
- Physical quantities
- Units
- etc

New specific standards

Existing web services

GETTING

Cone Search
SIA
SSA
TAP
ObsCore

EPN-TAP

DATA ACCESS PROTOCOLS

SHARING

Data and Metadata Collection

RESOURCE LAYER

- 3DView
- APERICUbes
- QGIS
- JHelioviewer
- ImageJ, AstroImageJ
- Autoplot

Installation procedures

+ Workshops

New data providers
New services

Data servers in institutes
Data services / protocols
Data description / DM / metadata
Data / formats

EPNCore
Contribution to fits

Virtual Observatory

VESPA contribution

Summary

- **EPN-TAP provides interoperability to data services (scriptable API)**

  => allows cross-searches among services (and other services worldwide)

  => improves content of existing 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/

Geoportal: https://padc-findme.obspm.fr

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

Web site: http://www.europlanet-vespa.eu/