

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**

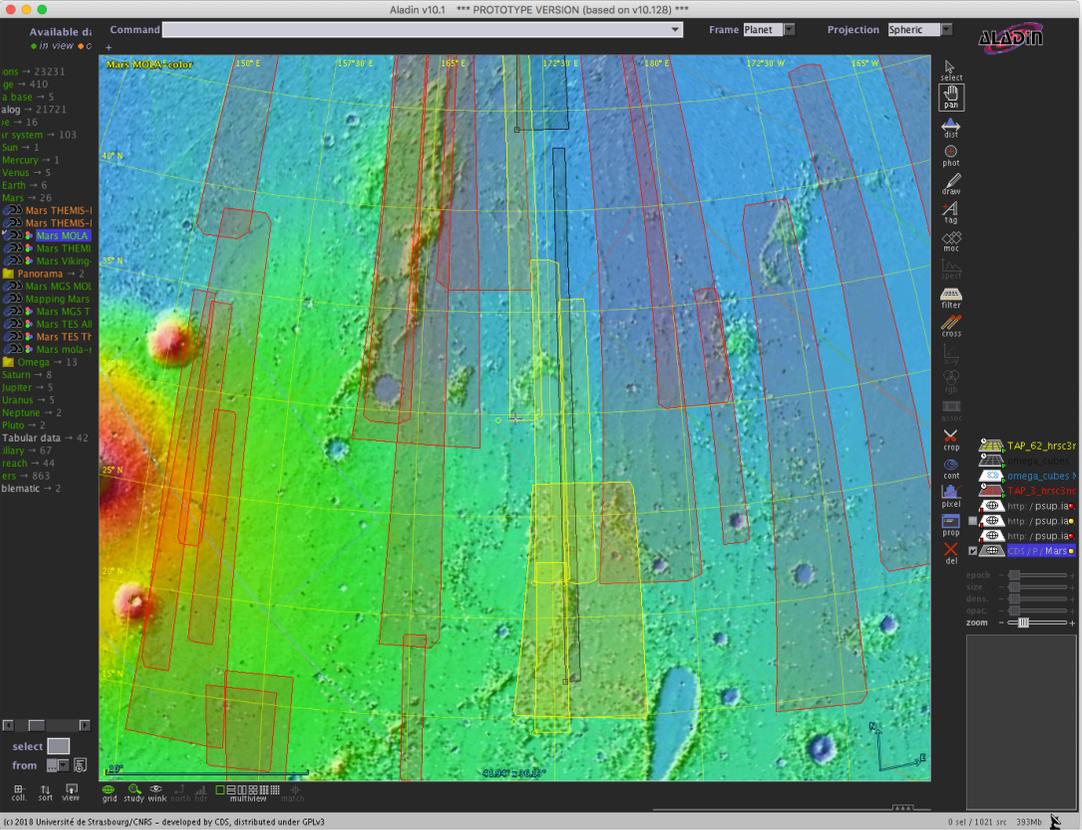
Footprint-based searches (contours)

2D overlaps based on actual footprints, in TAP

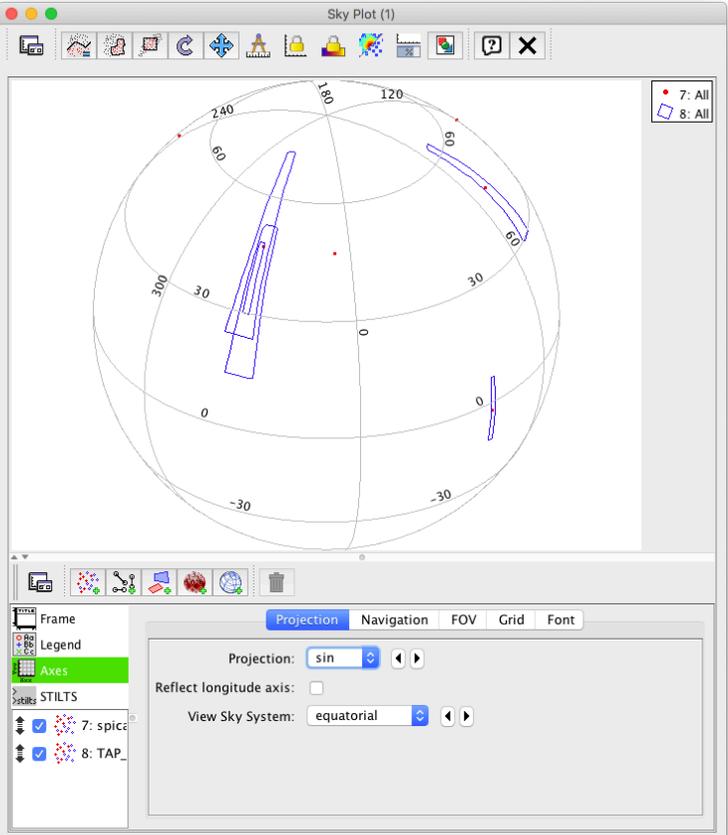
Typical request:

- 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/epe-vespa/tutorials/blob/master/surfaces/HRSC_vs_OMEGA/HRSC_vs_OMEGA-tutorial.md



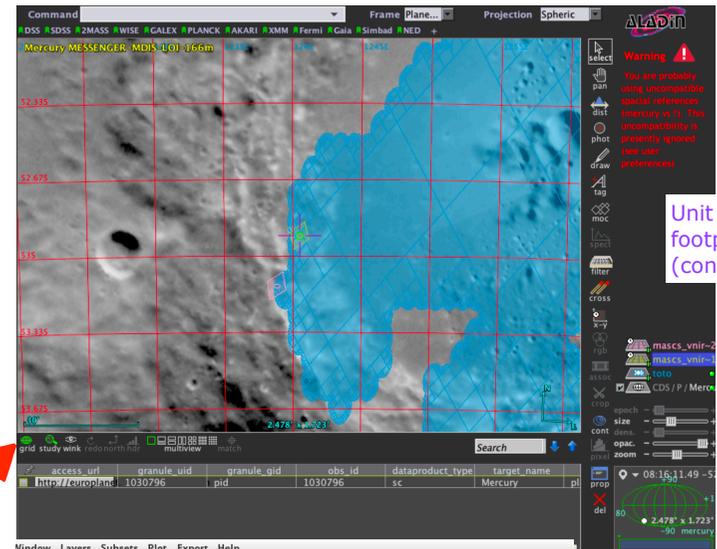
HRSC (red) and selection of OMEGA cubes (black) in Aladin
Overlapping HRSC images in yellow (Mars-Express observations)



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



Unit and spectra footprints in Aladin (connected to CASSIS)

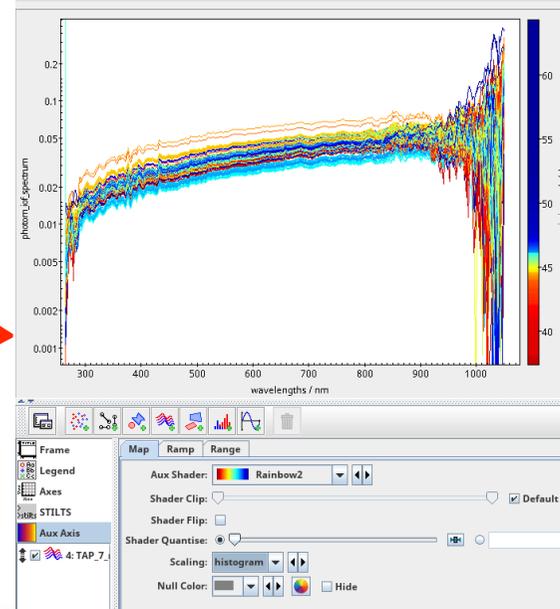
Additional selection parameters

Visu in AladinLite

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

Data found in unit footprint

A volcanic unit in VESPA geoportal + intersecting spectral footprints

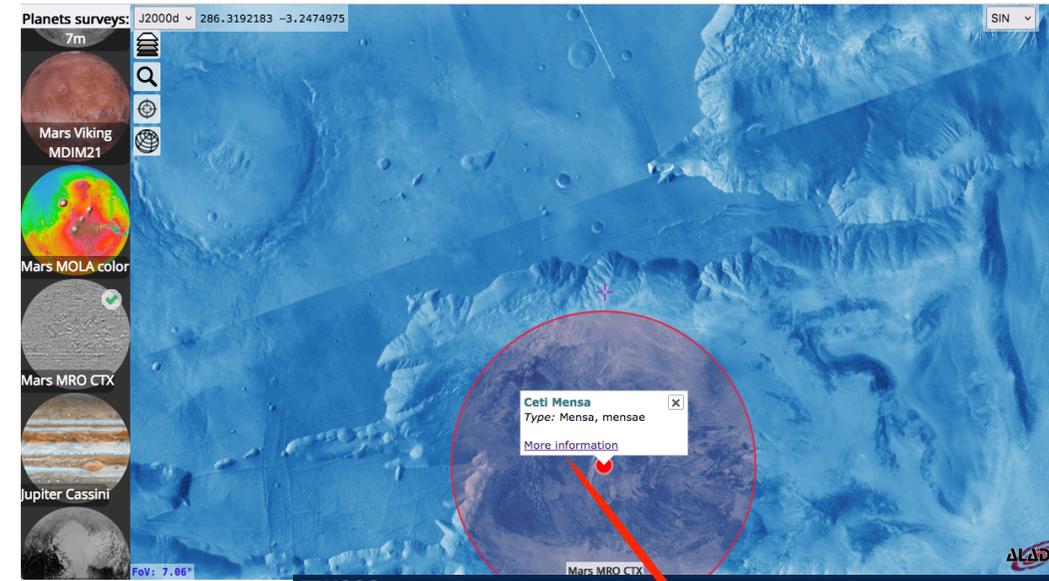
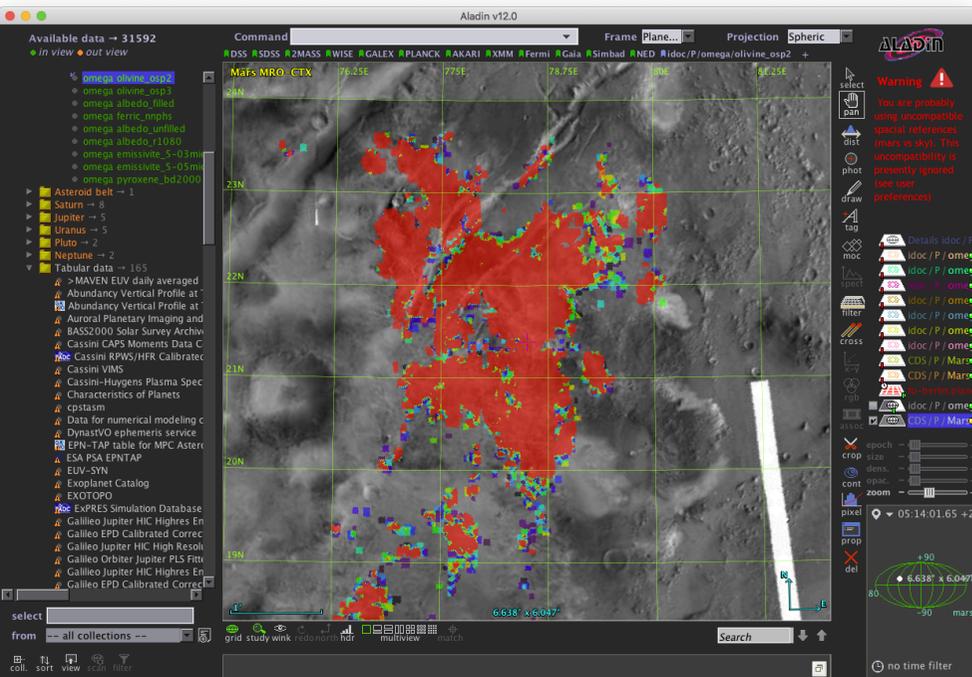


Other uses of the geoportal

- 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



USGS

Gazetteer of Planetary Nomenclature

MARS – Ceti Mensa

Home

About

Nomenclature

Mercury

Venus

The Moon

Mars System

Mars

Phobos

Deimos

Asteroids

Jupiter System

Saturn System

Basic Info

Status and Origin

Feature Name	Ceti Mensa	Approval	Adopted by IAU

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

Query MPC / IAU in TOPCAT => TNO list

Name	Type	Unit	Indexed
magnitude	float	mag	
slope_parameter	float	mag	
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	

ADQL Text

```
SELECT * FROM mpc.epn_core where semi_major_axis > 30.0709
```

Query on TNOs

Cross-match in TOPCAT => select spectra

Match Criteria: Algorithm: Exact Value

Table 1: mpc

Matched Value column: toLowerCase(target_name)

Table 2: TAP_1_gaiadr3.sso_reflectance_spectrum

Matched Value column: denomination

Match Selection: Best match, symmetric

Join Type: 1 and 2

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

Query Gaia in TOPCAT => retrieve all spectra

Metadata

Name: gaiadr3.sso_reflectance_spectrum

Columns: 10

Rows (approx): 10

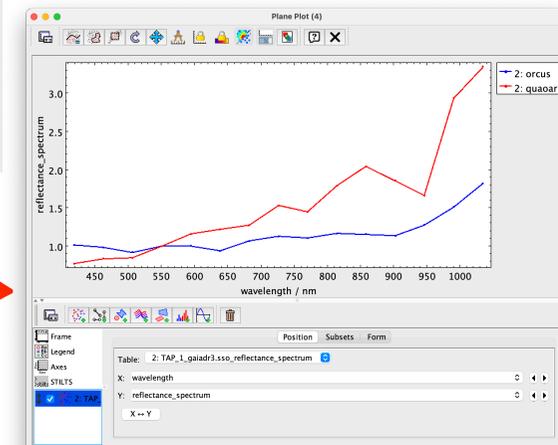
Foreign Keys: 0

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

ADQL Text

```
select * from gaiadr3.sso_reflectance_spectrum
```

Spectra in TOPCAT or CASSIS => spectral arithmetic available



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

Refine your search

ADQL Query

Data Services

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

Main Parameters

Target Name: Vesta

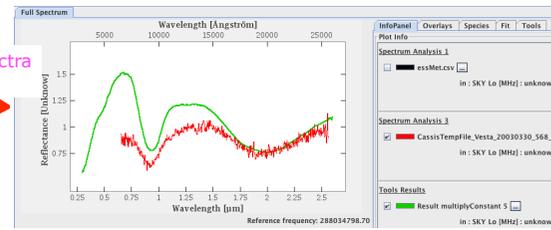
Target Class

Dataproduct Type

Query on Vesta spectra

Selected Vesta spectra in CASSIS

Retrieve selected spectra from VESPA portal



Refine your search

ADQL Query

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#unclassified#meteorite#snc	ah 84001, split 92, powder < 125 m
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#unclassified#meteorite#snc	ah 84001, split 92, chip, largest face
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#unclassified#meteorite#snc	ah 84001, split 271, face 1
sample	natural#solid#mars#rock#unclassified#unclassified#unclassified#unclassified#meteorite#snc	ah 84001, split 271, spot 2 (including brown carbonate)
sample	natural#solid#meteorite#rock#unclassified#unclassified#unclassified#unclassified#snc	coarse crystalline, sand-size particles.497 mg. stone 1, mask 48, pyx 4
sample	natural#solid#meteorite#rock#unclassified#unclassified#unclassified#unclassified#snc	brownish spot
sample	natural#solid#meteorite#rock#unclassified#unclassified#unclassified#unclassified#snc	powder from lithology b
sample	natural#solid#meteorite#rock#unclassified#unclassified#unclassified#unclassified#snc	coarse powder (di-ol ac fel) june 28, 1911

Showing 1 to 23 of 23 entries

Show 25 entries

Data Selection

Metadata Selection

All Data

All Metadata

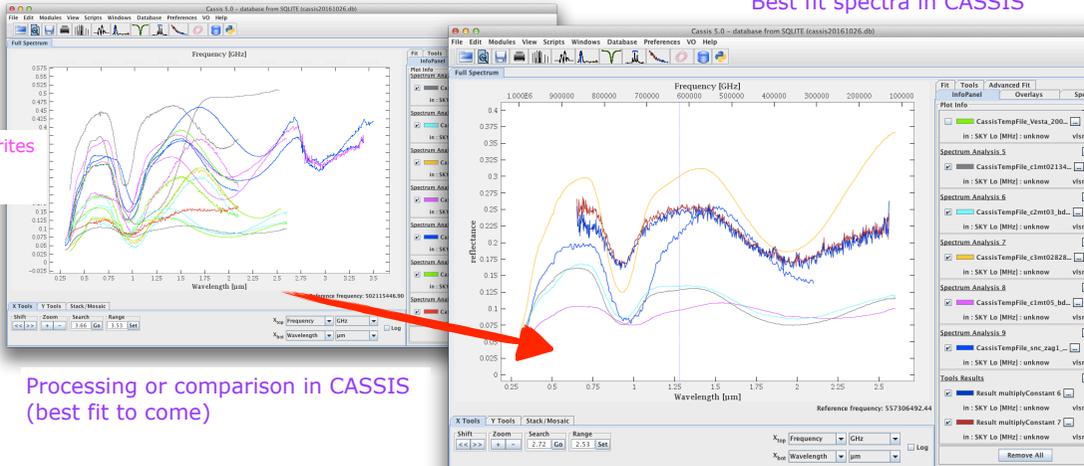
Download Thumbnails

Footprints

SELECT * FROM crism_speclib_epr_core WHERE ("target_class" LIKE "%snc%") AND ("dataproduct_type" LIKE "%ep%") AND "sample_classification" LIKE "%snc%";

Query on SNC spectra

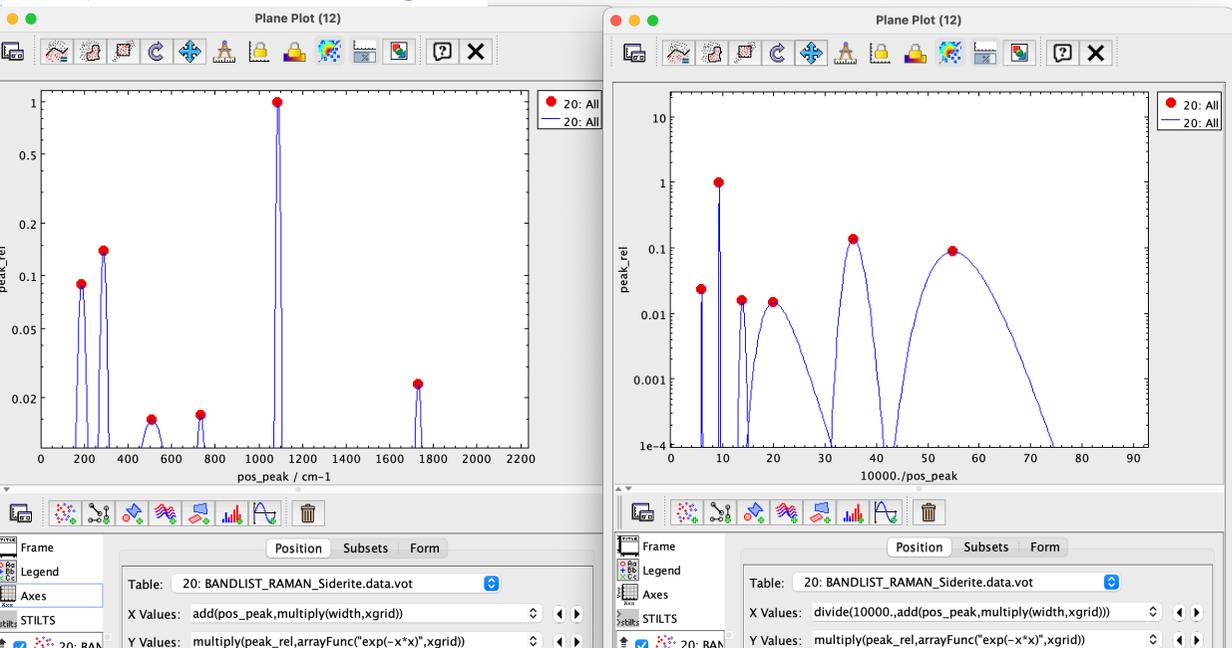
Retrieve SNC meteorites spectra from VESPA portal



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

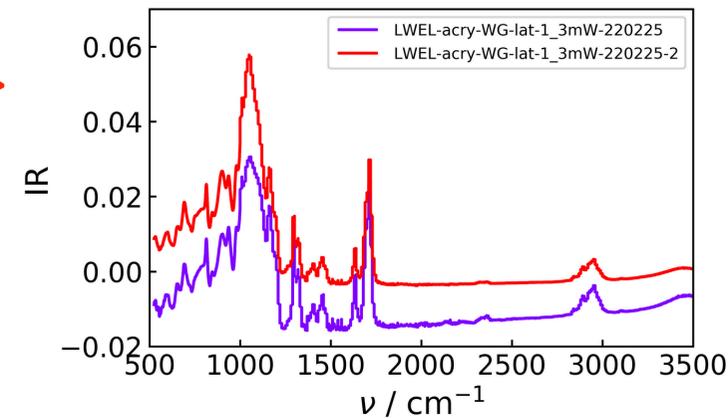


Spectral simulation
or
Extraction of bands from observations
& comparison in notebook

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

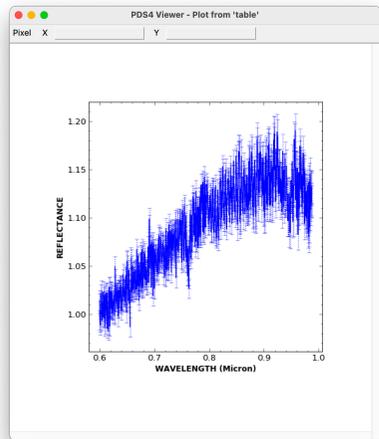
[814.0, 901.0, 1050.0, 1300.0, 1710.0]

```
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)



PDS4_viewer (NASA)

Copy/Paste URL

urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_250bettina_nics_tab	spectrum
urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_250bettina_dolores_mrb_tab	spectrum
urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_250bettina_dolores_lrr_tab	spectrum
urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_22kalliope_emmi_tab	spectrum
urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_224oceana_dolores_mrb_tab	spectrum
urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_224oceana_dolores_lrr_tab	spectrum
urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_216kleopatra_nics_tab	spectrum
urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_201penelope_dolores_lrr_tab	spectrum
urn:nasa:pds:gbo.ast-m-type.fornasier.spectra:data:indivspectra_201penelope_dolores_lrb_tab	spectrum

Download
Send Tables
Send Spectra
Send Images
Send CDF
Send VIRTIS PDS cubes
Send Das2stream
Send PDS4 table

Data Selection Metadata Selection All Data All Metadata

```
SELECT * FROM spectro_m_ast.epn_core
```

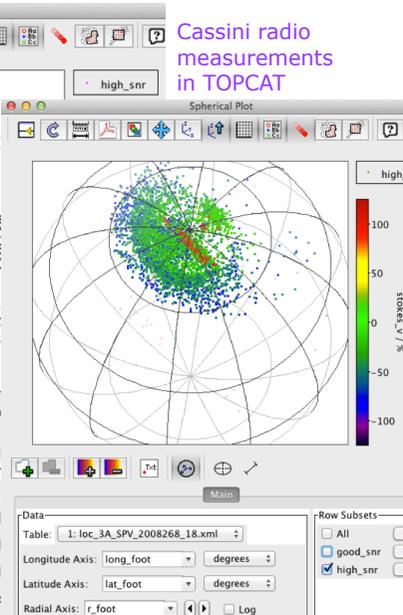
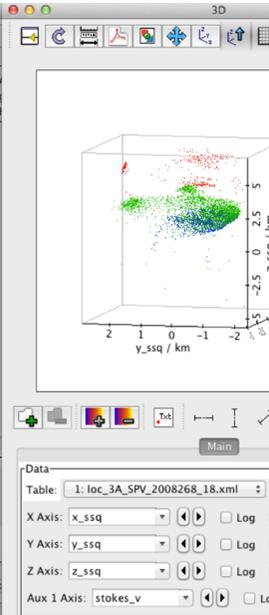
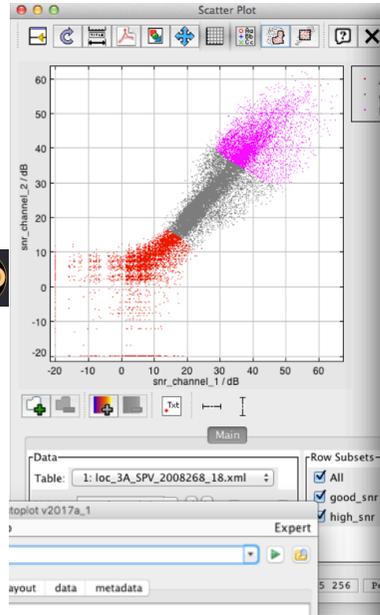
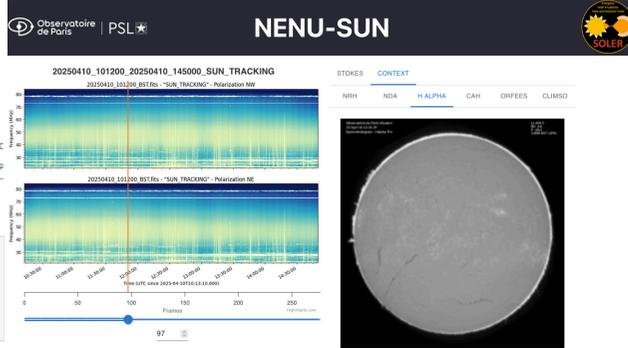
VESPA portal

SAMP

TOPCAT (Bristol Univ)

Other use cases

Comparison of simultaneous observations of the Sun



Cassini radio measurements in TOPCAT

```

% Loaded DLM: PYTHON3, Vtk Compiled module: VIRTISPOS, Vtk Compiled module: V_HEADPOS, Vtk Reading label VIB025_08_C
ALink Compiled module: V_POSPAR, Vtk Compiled module: V_STRONUM, Vtk Compiled module: V_READPOS, Vtk Compiled module:
V_GETPATH, Vtk Compiled module: V_DOPPOS, Vtk Compiled module: V_QUEBOS, Vtk Compiled module: V_LISTPOS, Vtk Compiled
module: V_TYPEROS, Vtk Compiled module: V_POINTPOS, Vtk Compiled module: V_SWAPDATA, Vtk Compiled module: SWAP_
ENDIMG_REPLACE, Vtk Number of objects found: 2 in Vtk VIRTISPOS: File in use: VIB025_08_C.ALINK Structure
<C7680000, @ type: length=107499408, data length=107499407, refs=1 Vtk LABEL STRING Array[15] Vtk
TABLE FLOAT Array[432, 256, 3] Vtk QUEUE_NAME STRING Array[2] Vtk QUEUE_DIM LONG
Array[3] Vtk QUEUE FLOAT Array[432, 256, 240] Vtk SUP_NAME STRING Array[3] Vtk SUP_DIM
LONG Array[2] Vtk SUFFIX UNIT Array[3, 240]

# pass it to python
IDL.run("ps tt.que")
tutu = IDL.ss
IDL.run("help, ss")
# retrieve wvl vector from cube file
IDL.run("wvl=tt.table(*,256/2,0)")
wvl = IDL.wvl
# cube size
tutu.shape
tutu.shape

(248, 256, 432)
    
```

```

# Plot one IR spectrum of Venus nightside
from matplotlib import pyplot as plt
pypis.plot(wvl,tutu[10,101,:])
p2= plt.ylim(0,0.2)
plt= plt.show()

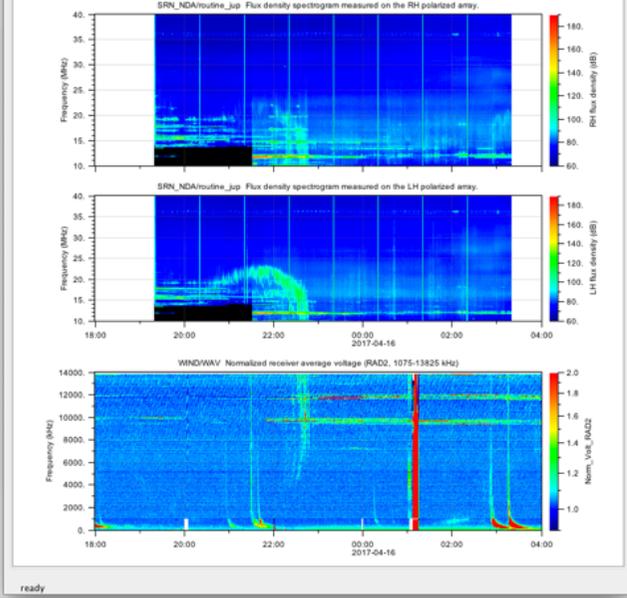
# print wvl of interest for image, in micron
wvl[78]

1.7574998

# Plot image of Venus nightside in O2 emission band
imgplot = plt.imshow(tutu[10, 78], cmap=plt.cm.Greys, vmin=0, vmax
plt.colorbar()
plt.show()
    
```



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

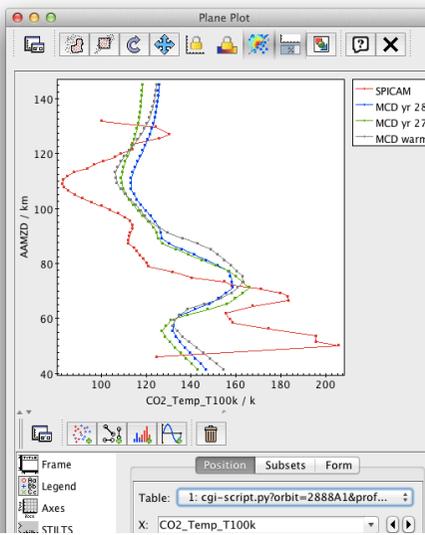


Nancay Decameter Array

Wind/Waves

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

SPICAM and MCD atmospheric profiles in TOPCAT (several scenarios)



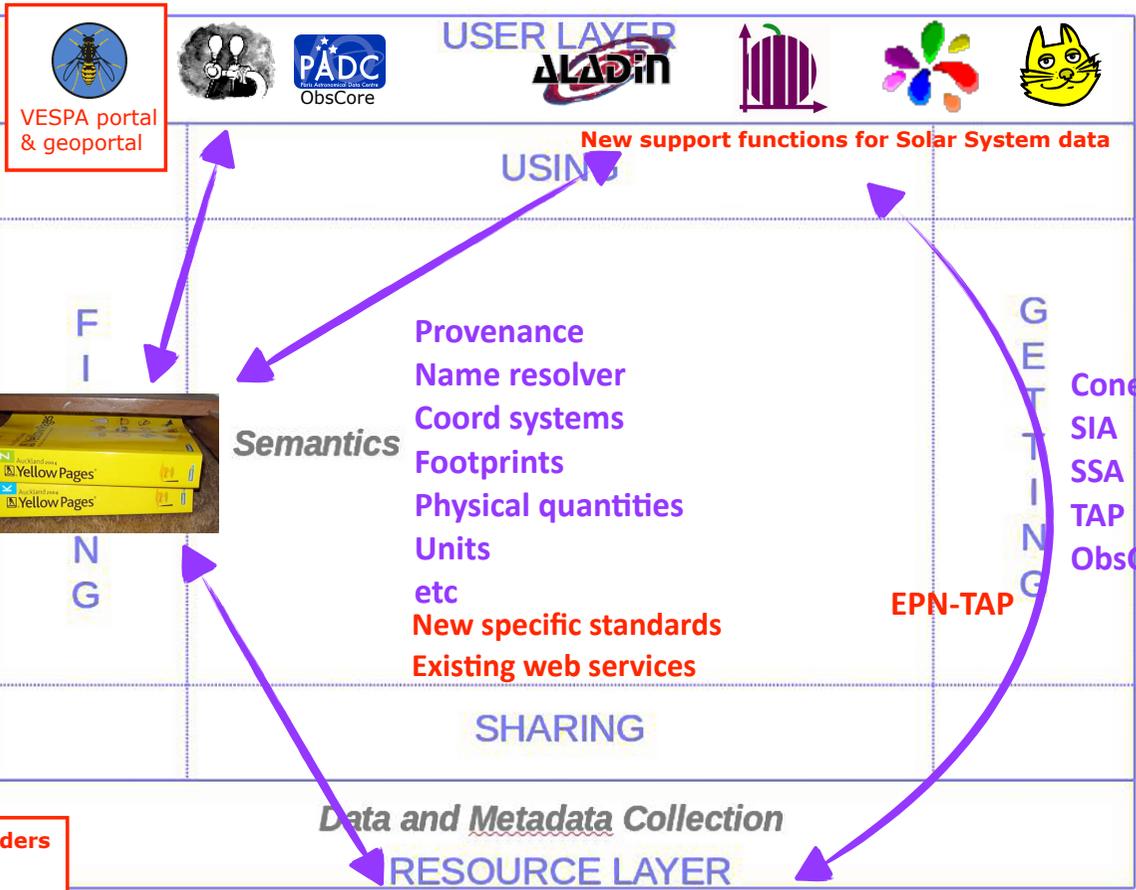
VESPA & IVOA infrastructure

VO connection of Open Source applications

Command line & Notebooks Portals SAMP connectivity USERS Desktop applications



Python libraries: astropy, pyvo, etc
Contribution to astropy



- 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/ejn-vespa/tutorials>

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