

Virtual European Solar & Planetary Access (VESPA)

Providing access to Solar System & heliophysics data

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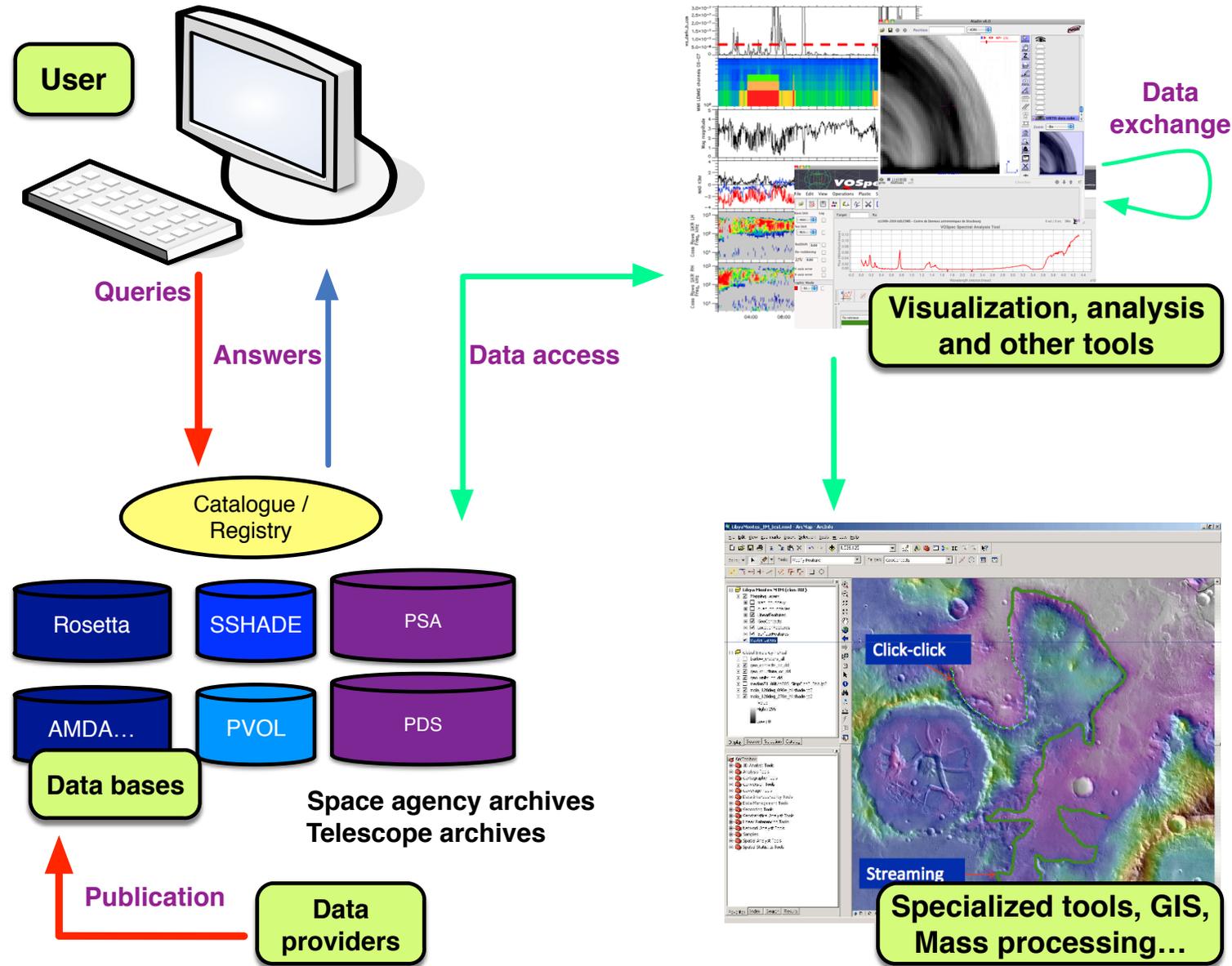
VESPA ASTRO-CC workshop 2026

25-27 mars 2026
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Science users, but also education / outreach
=> FAIR access

Scope:
Planetary Science
Heliophysics
Exoplanets

Research teams, institutes
EU projects
=> Open Science



What VESPA provides to the community

1- A vocabulary to describe physical & observational parameters making sense to researchers:

EPNCore metadata

Very broad scope: surfaces, atmospheres, small bodies, magnetospheres, heliophysics

2- A user interface to search data based on science-relevant parameters:

VESPA portal (other access modes are available)

3- Data services provided by VESPA participants and other teams:

Currently 95 data services open (much more in progress) and ~70 planetary HiPS

+ New or updated data infrastructures: SSHADE, PVOL, AMDA, MASER

4- Connection / adaptation of powerful display and analysis tools:

Tools from astronomy (VO, with planetary science updates) + GIS and others + Jupyter notebooks

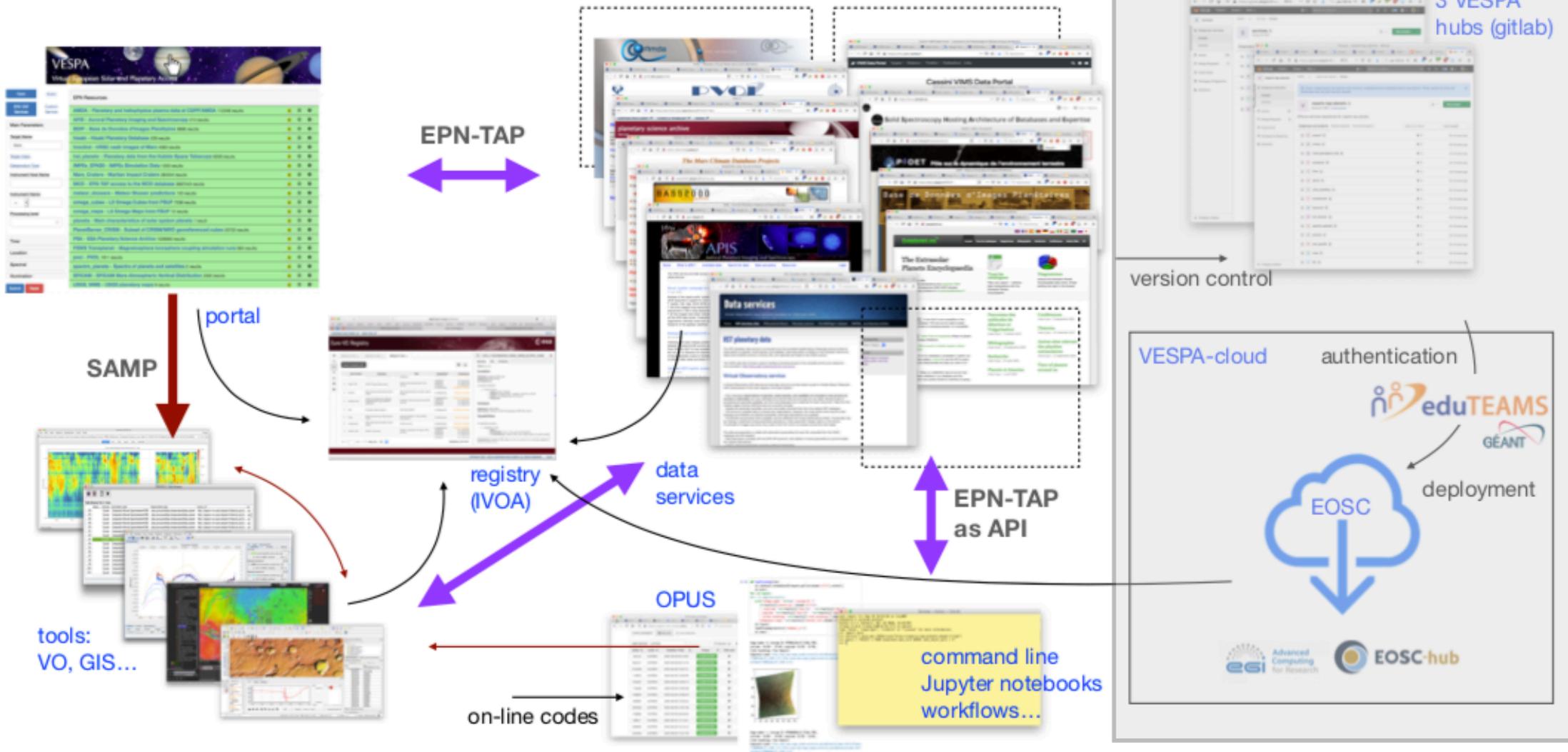
=> Contributive, interoperable, Open Science system, providing FAIR access to the data

This data system is available for - users *to access* data

- science teams *to distribute* data

VESPA: infrastructure

Maintenance functions



VESPA service (as seen in the portal)

A table providing description of each file / data element

Results in service apis

Show 10 entries

Column visibility Show all Hide all

Describing parameters

Data elements

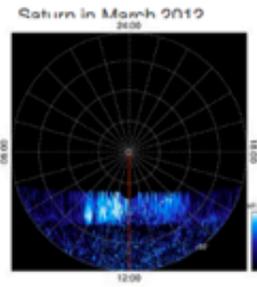
granule_uid	dataprodukt_type	target_name	time_min	time_max	access_url	granule_gid	obs_id	ta
o4bd01ycq_cyl_pdf	image	Saturn	1997-10-11T03:53:03.524	1997-10-11T04:09:43.724	o4bd01ycq_cyl.pdf	cylindric_proj	o4bd01ycq	pl
o4bd01ycq_pol_n_pdf	image	Saturn	1997-10-11T03:53:03.524	1997-10-11T04:09:43.724	o4bd01ycq_pol_n.pdf	polar_proj_north	o4bd01ycq	pl
o4bd01ycq_pol_s_pdf	image	Saturn	1997-10-11T03:53:03.524	1997-10-11T04:09:43.724	o4bd01ycq_pol_s.pdf	polar_proj_south	o4bd01ycq	pl
o4bd01ycq_proc	image	Saturn	1997-10-11T03:53:03.524	1997-10-11T04:09:43.724	o4bd01ycq_proc.fits	processed_data	o4bd01ycq	pl
o4bd01ycq_proc_pdf	image	Saturn	1997-10-11T03:53:03.524	1997-10-11T04:09:43.724	o4bd01ycq_proc.pdf	processed_data	o4bd01ycq	pl
o4bd01ycq_x2d	image	Saturn	1997-10-11T03:53:03.524	1997-10-11T04:09:43.724	o4bd01ycq_x2d.fits	original_data	o4bd01ycq	pl
o4bd01yeq_cyl_pdf	image	Saturn	1997-10-11T04:15:43.524	1997-10-11T04:28:37.134	o4bd01yeq_cyl.pdf	cylindric_proj	o4bd01yeq	pl
o4bd01yeq_pol_n_pdf	image	Saturn	1997-10-11T04:15:43.524	1997-10-11T04:28:37.134	o4bd01yeq_pol_n.pdf	polar_proj_north	o4bd01yeq	pl
o4bd01yeq_pol_s_pdf	image	Saturn	1997-10-11T04:15:43.524	1997-10-11T04:28:37.134	o4bd01yeq_pol_s.pdf	polar_proj_south	o4bd01yeq	pl
o4bd01yeq_proc	image	Saturn	1997-10-11T04:15:43.524	1997-10-11T04:28:37.134	o4bd01yeq_proc.fits	processed_data	o4bd01yeq	pl

Showing 1 to 10 of 15,506 entries

Plotting tools

- TOPCAT
- Aladin
- SPLAT
- CASSIS

Example queries



Example EPN-TAP request:

Typical for surfaces (assuming all data are correctly described):

Mars, a given region (Tharsis volcanoes area)

Illumination conditions ($i \leq 20^\circ$ / phase)

Local time or season, etc

Results from all services
=> need to be described at similar level

Footprints can be sent to plotting tools
from the portal

<https://vespa.obspm.fr>

The screenshot shows the VESPA Query Interface in a web browser. The browser's address bar contains the URL: `vespa.obspm.fr/planetary/data/?f-url_op=&f-schema_op=&f-target_name`. The page features a header with the VESPA logo and the text "Virtual European Solar and Planetary Access". Below the header, there are two main sections: "Form" and "Query".

The "Form" section includes "Main Parameters" with the following fields:

- Target Name:** Mars
- Target Class:** (empty)
- Dataproduct Type:** (empty)
- Instrument Host Name:** (empty)
- Instrument Name:** TAP query
- Processing level:** (empty)

The "Query" section displays "EPN Resources" with a list of datasets and their result counts:

- hrsc3nd - HRSC nadir images of Mars 6 results
- omega_cubes - L3 Omega Cubes from PSUP 70 results
- PlanetServer_CRISM - Subset of CRISM/MRO georeferenced cubes 48 results
- abs_cs - Data for numerical modeling of planetary atmospheres 0 result
- AMDA - Planetary and heliophysics plasma data at CDDP/AMDA 0 result
- APIS - Auroral Planetary Imaging and Spectroscopy 0 result
- BASECOM - The Nançay Cometary Database 0 result
- bass2000 - Bass2000 solar survey archive 0 result
- BDIP - Base de Données d'Images Planétaires 0 result

Below the resources list, the "Generated WHERE clause of ADQL statement:" is shown:

```
SELECT * FROM ... WHERE ((c1min <= c1max AND c1min <= 265.0 AND c1max >= 235.0) OR (c1min > c1max AND (c1min <= 265.0 OR c1max >= 235.0))) AND c2max >= -15.0 AND c2min <= 15.0 AND (1 = ivo_hashlist_has(lower("target_name"), lower('Mars')) OR 1 = ivo_hashlist_has(lower("target_name"), lower('4')) OR 1 = ivo_hashlist_has(lower("target_name"), lower('499')) AND "incidence_min" <= 20.0 AND "spatial_frame_type" = 'body')
```

The "EPN-TAP compilation results" section is currently empty. At the bottom, there is a section for "PDAP Resources (by dataset)".

On the right side of the interface, there are sections for "Plotting tools" (TOPCAT, Aladin, SPLAT, CASSIS, 3DView) and "Example queries" (Saturn in March 2012, 3DView).

VESPA portal

Redesigned from UX analysis

Refine your search

ADQL Query

Data Services

Main Parameters

Target Name

Target Class

Dataproduct Type

Instrument Host Name

Instrument Name

Processing level

Time

Location

Spectral

Illumination

Data Reference

Optional

Reset

Submit

abs_cs - Data for numerical modeling of planetary atmospheres 13 results

APIS - Auroral Planetary Imaging and Spectroscopy 74175 results

BaseCom - The Nançay Cometary Database 6886 results

bass2000 - Bass2000 solar survey archive 357033 results

BDIP - IAU database of historical planetary images 16906 results

cassini_jupiter - Cassini RPWS/HFR Calibrated Jupiter Flyby Dataset 7 results

CLIMSO - CLIMSO coronagraphs at Pic du Midi de Bigorre 1021345 results

cpstasm - CLUSTER STAFF-SA Spectral Matrix Data 11688 results

DynAstVO - Asteroid orbital database and ephemerides 29733 results

eit_syn - Synchronous synoptic maps of the solar corona from EIT/SoHO 18482 results

ExoPlanet - Extrasolar Planets Encyclopaedia 5177 results

Exotopo - Simulated Topography of Exoplanets 1800 results

expres - EXPRES Simulation Database 38946 results

Gaia-DEM - Thermal

HFC1AR - Heliophy

HFC1T3 - Heliophy

hisaki - Hisaki Plan

hrsc3nd - HRSC na

litateHF - litate HF

IKS - IR spectrosc

ILLU67P - Illuminat

Results in service VVEx

Show 10 entries

Column visibility Show all Hide all

Select All in current page Reset Selection

id	dataprod_type	target_name	time_min (s)	ti	
V0026_07G	spectral_cube	Venus	2006-05-16T17:12:20.414	2f	
V0026_07C	spectral_cube	Venus	2006-05-16T17:12:20.414	2f	
V0026_07G	spectral_cube	Venus	2006-05-16T17:12:20.424	2f	
V0026_07C	spectral_cube	Venus	2006-05-16T17:12:20.424	2f	
V0026_08C	spectral_cube	Venus	2006-05-16T17:27:48.478	2f	
V0026_08G	spectral_cube	Venus	2006-05-16T17:27:48.478	2f	
V0026_08G	spectral_cube	Venus	2006-05-16T17:27:48.672	2f	
V0026_08C	spectral_cube	Venus	2006-05-16T17:27:48.672	2006-05-16T17:38:31.453	ftp://psa.esac.esa.L...
VT0027_00C	spectral_cube	Venus	2006-05-18T01:25:15.669	2006-05-18T02:01:54.510	ftp://psa.esac.esa.L...
VT0027_00G	spectral_cube	Venus	2006-05-18T01:25:15.669	2006-05-18T02:01:54.510	ftp://psa.esac.esa.L...

Showing 91 to 100 of 15,882 entries

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First Previous Next Last

Earth Footprints

Refine your search

ADQL Query

[Back To Services Results](#)

PVOL - Amateur images database

Tabular View

Gallery View

Select All in current page Reset Selection

gallery_view



Alternative access:

VESPA portal: Queries all services, discovery tool

VO tools (internal clients)

Other TAP web clients (taphandle, etc)

Jupyter notebook, command line (python libs)



Access to public EPN-TAP data services through Jupyter notebook

```
In [1]: import pyvo as vo
from matplotlib import pyplot as plt
from astropy.table import Table
import urllib
# beware that this is incompatible with IDLpy
from astroquery.utils.tap.core import TapPlus
import astropy.io.votable as vot
```

1- Search an EPN-TAP data service

Example from VIRTIS / Venus-Express

Here we search a service in the registry from keywords.

```
In [2]: # Search the VO registry for TAP services about the VIRTIS instrument
```

```
In [3]: tap_services = vo.registry.search(servicetype='tap',keywords=['VIRTIS'], includeaux=True)
print(tap_services.to_table)

print('pyvo version: '+vo.__version__)
# will work in pyvo 1.5:
#r2 = vo.registry.search(datamodel="epntap")
#r2
```

```
<bound method DALResults.to_table of <Table length=3>
      ivoid          res_type      ... intf_roles
      -----
      object          object      ... object
      -----
      ivo://cds.vizier/j/a+a/585/a53 vs:catalogservice ...      std
      ivo://cds.vizier/j/a+a/647/a119 vs:catalogservice ...      std
      ivo://padc.obspm.planeto/vvex/q/epn_core vs:catalogresource ...      std>
pyvo version: 1.4.1
```

We manually choose a service that uses the epn-tap data model (can be automatized in pyvo 1.5)

```
In [4]: tap_services = vo.registry.search(servicetype='tap',keywords=['VIRTIS'], ivoid='ivo://padc.obspm.planeto/vvex/q/epn_core')
resource = tap_services[0]
mytable = list(resource.get_tables().keys())[0]
print('schema and table to query:',mytable)
myurl = resource.access_url
print('url of the TAP service:',myurl)
query = 'SELECT top 100 * FROM ' + mytable
```

schema and table to query: vvex.epn_core

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

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

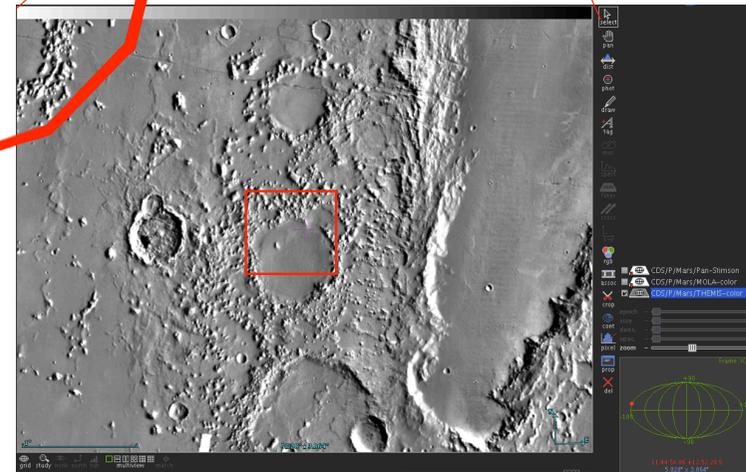
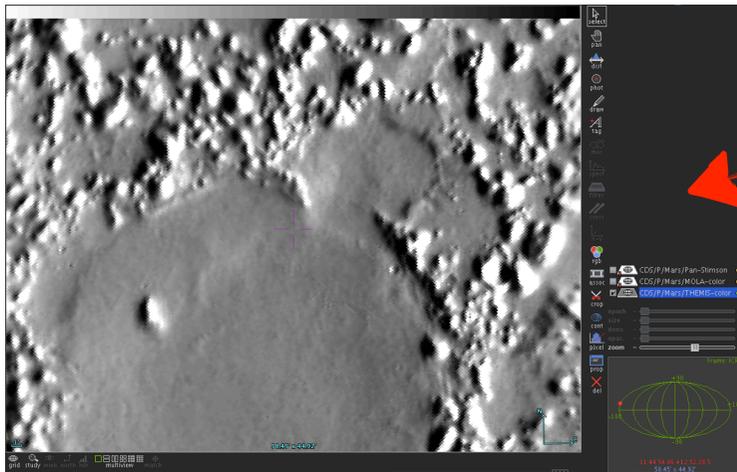
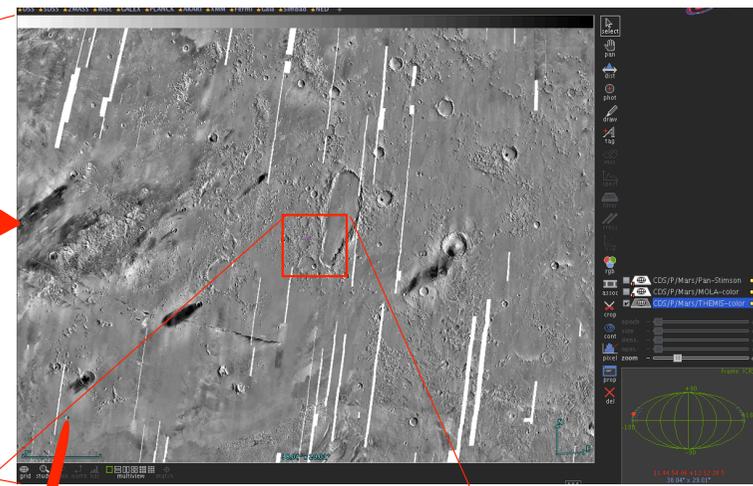
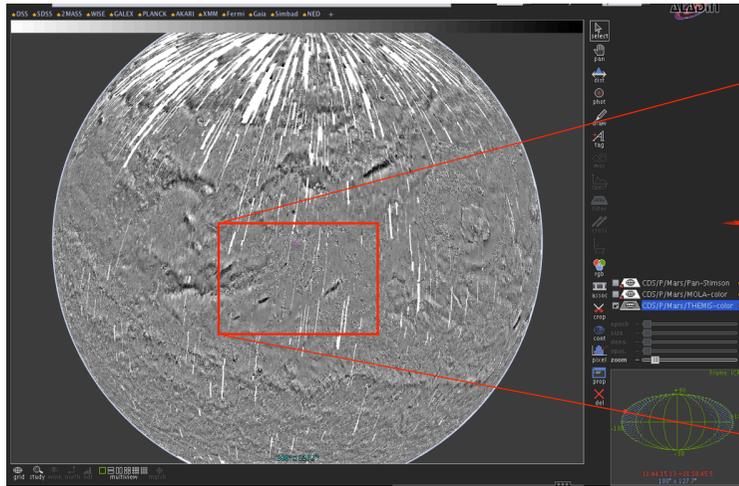
Tutorials: <https://github.com/ejn-vespa/tutorials>

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

Intermission: Using VO tools in practical Planetary Science situations

VESPA and VO tools: images and maps

Multiresolution maps (**HiPS**) in Aladin



<http://aladin.u-strasbg.fr/AladinLite/doc/API/examples/mars-visualisation/>

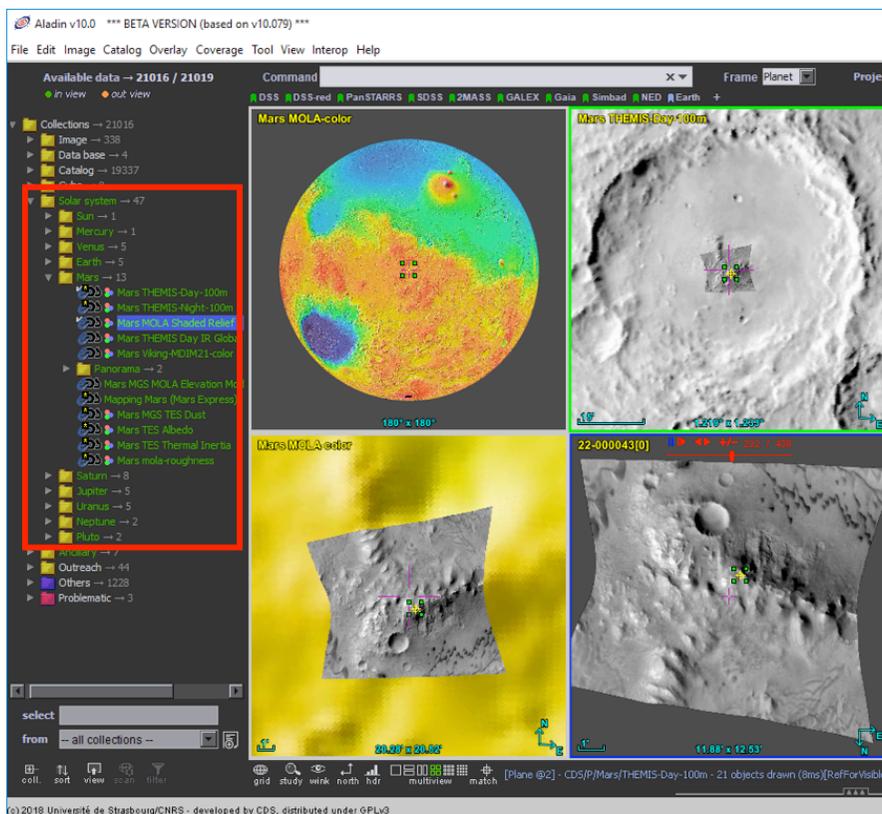
Currently 68 planetary HiPS available for use (from USGS maps and more)

VESPA and VO tools: overplotting elements

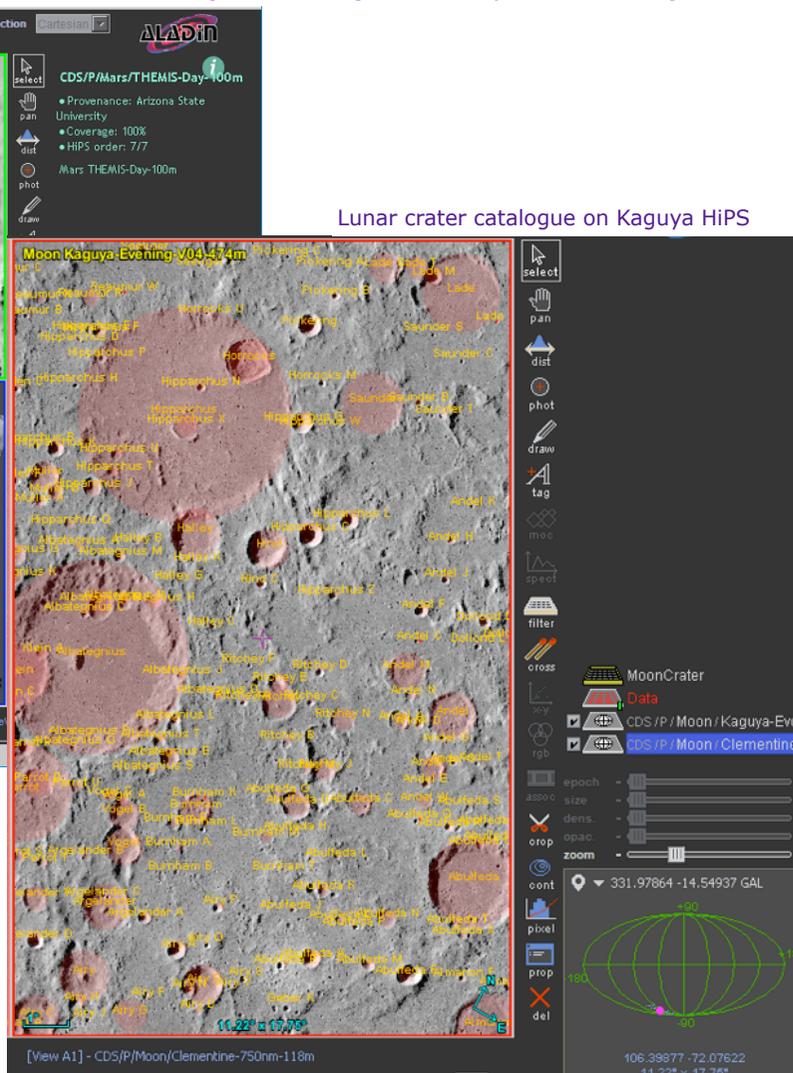
Aladin (CDS/CNRS):

Georeferenced images + objects superpositions

70 planetary HiPS (USGS maps and more)



CRISM cubes on MOLA HiPS



Lunar crater catalogue on Kaguya HiPS

Relies on IAU planetary coordinate frames (fits' WCS)

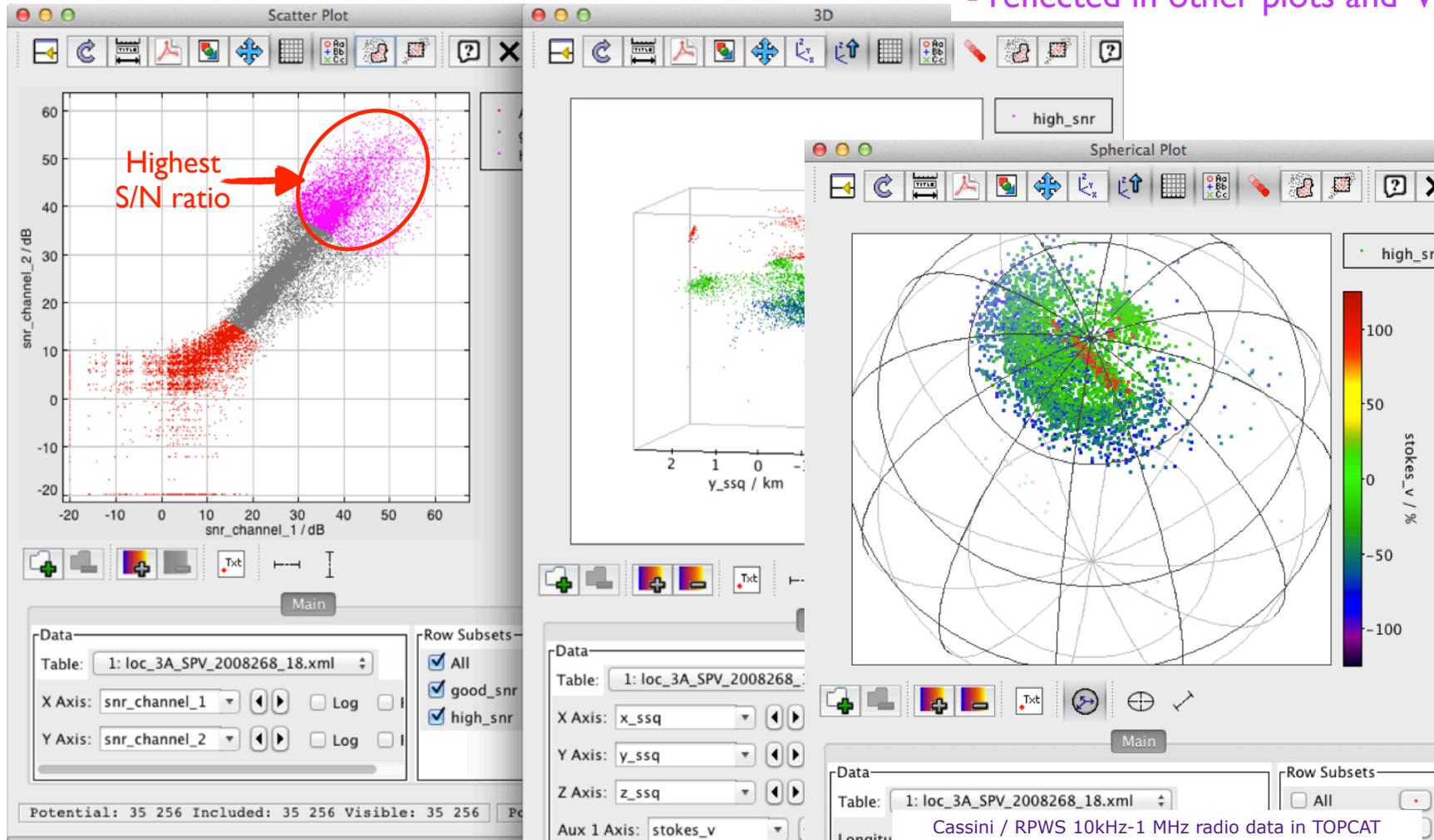
VESPA and VO tools: tabular data

TOPCAT (Bristol Univ):

Allows data selection

- by formula or graphically

- reflected in other plots and VO tools

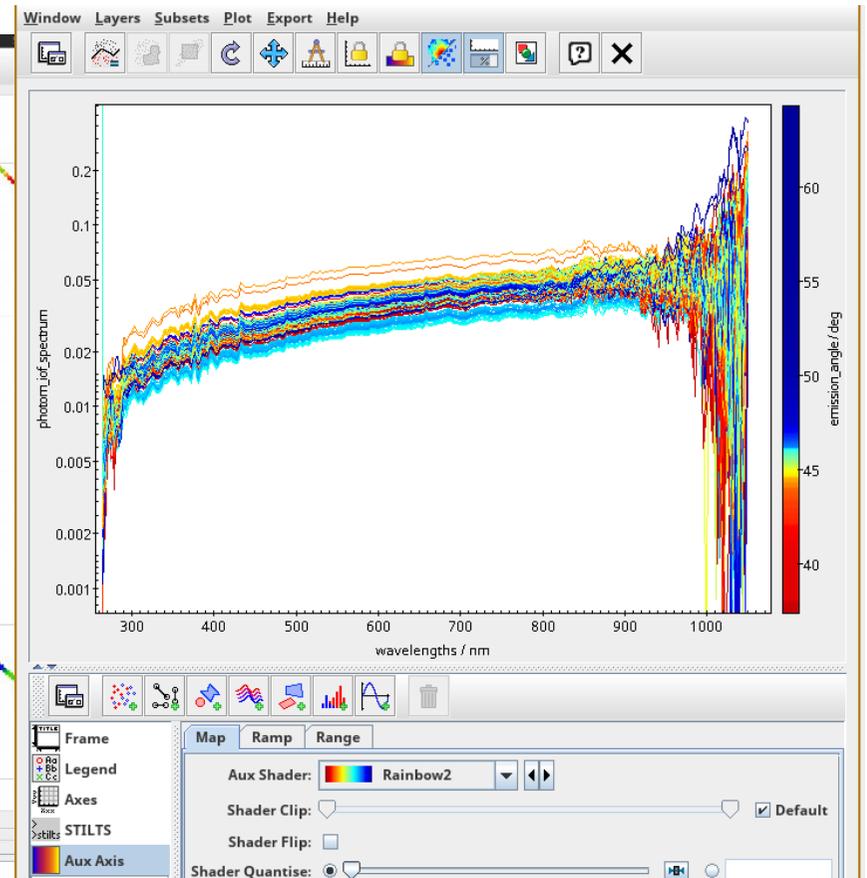
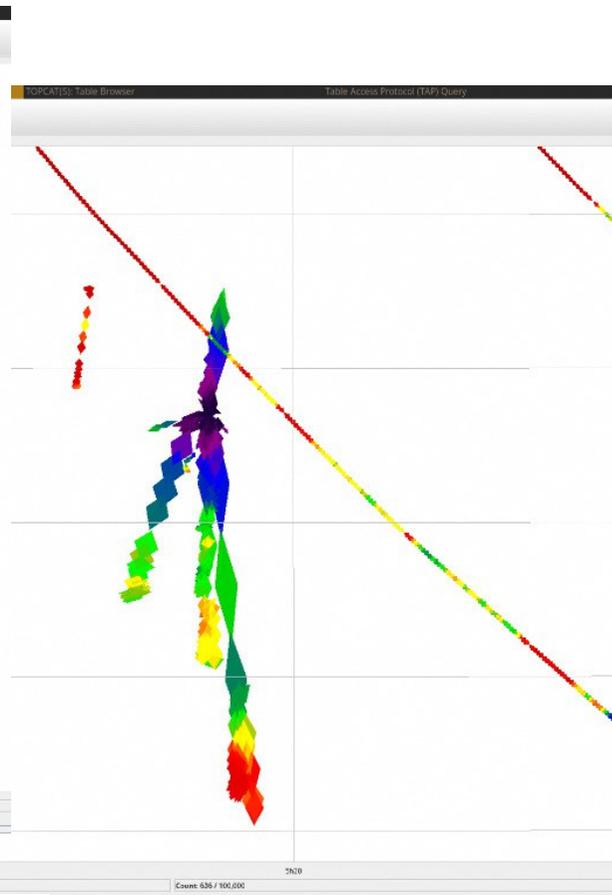
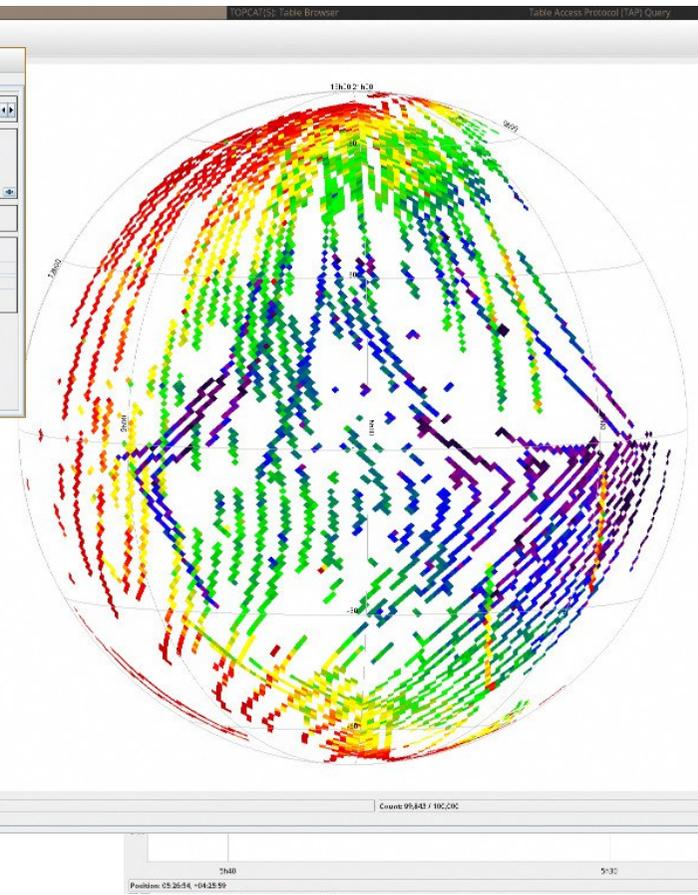


VESPA and VO tools: spectra support

TOPCAT (Bristol Univ):

New graphic functions

- MOC and datalink support
- Can now include spectra in tables (powerful, but demanding)

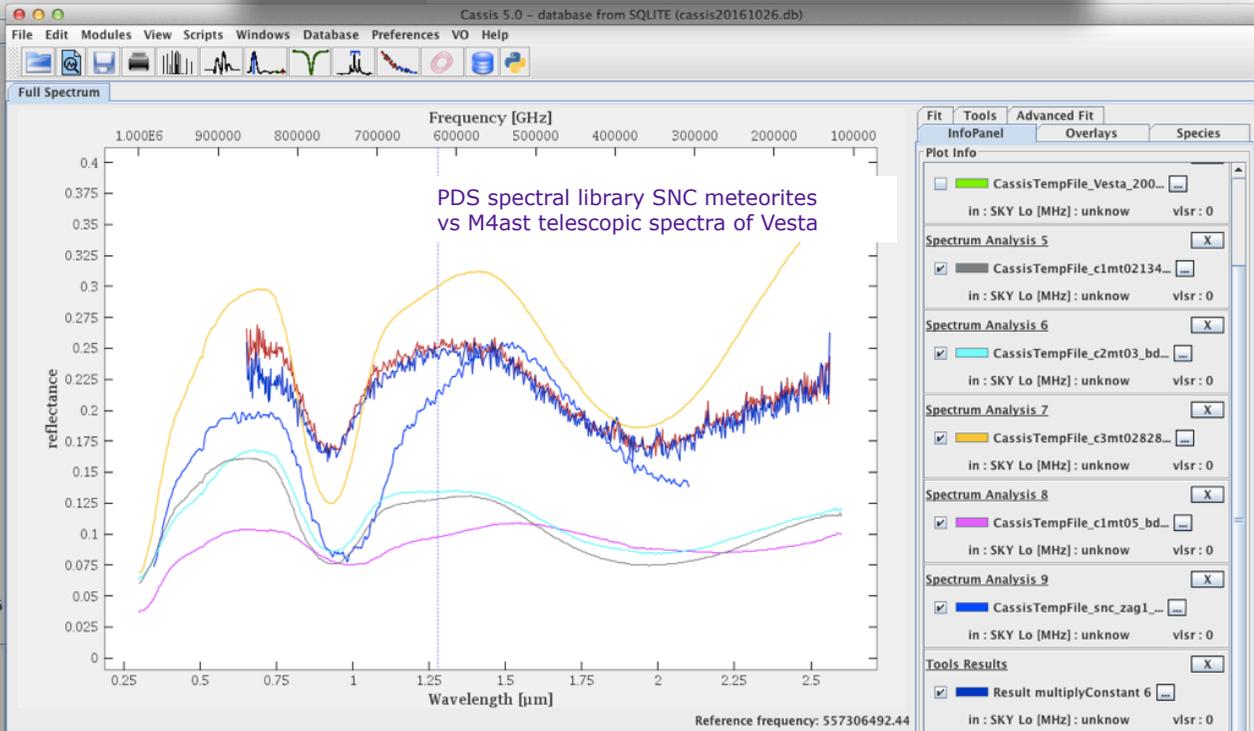
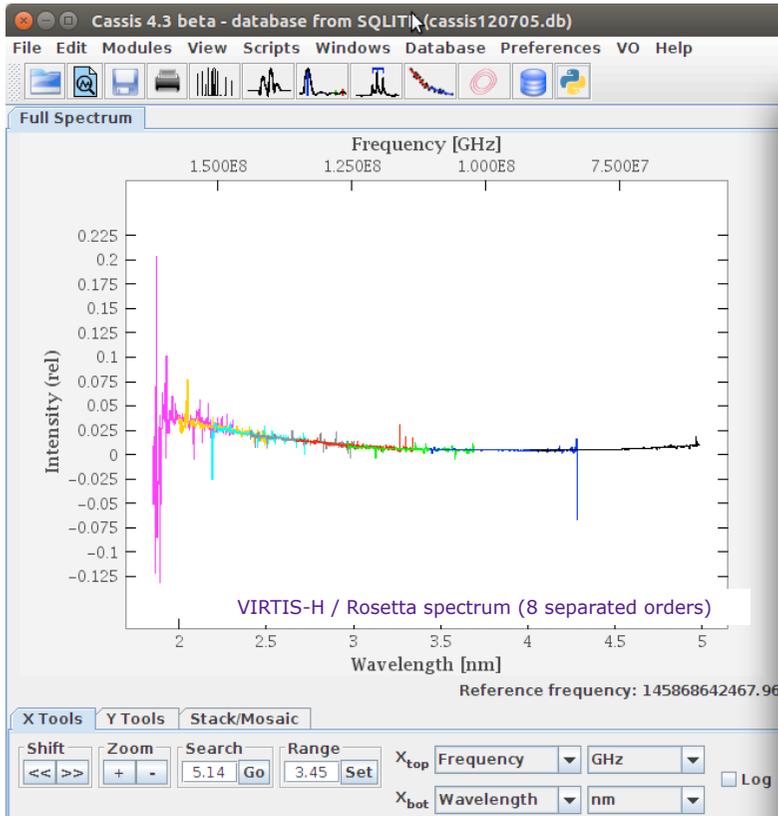
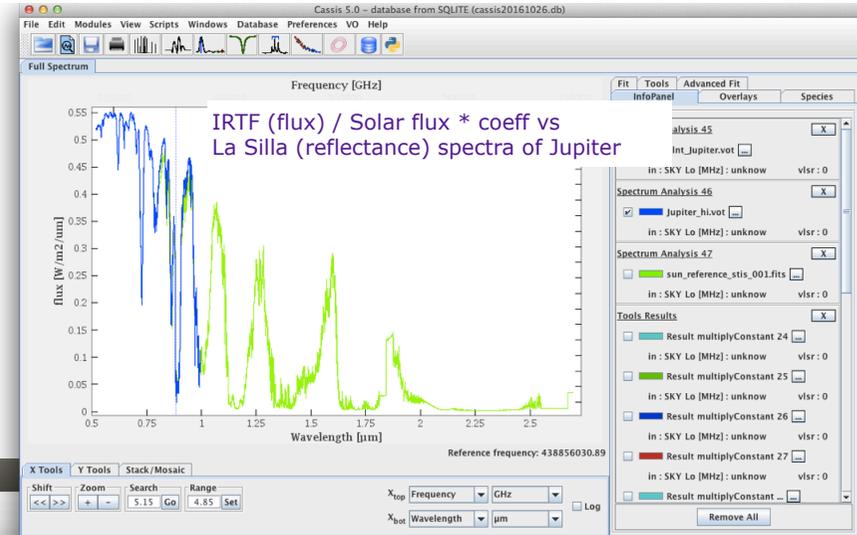


Mercury MESSENGER footprints (MOCs) and spectra in TOPCAT

VESPA and VO tools: spectroscopy

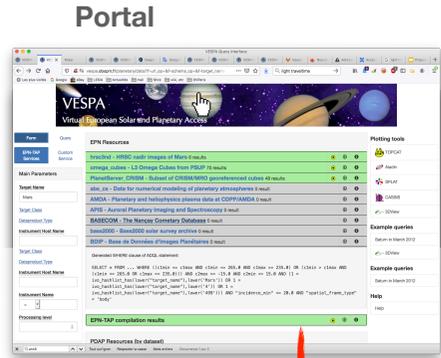
CASSIS from v6 (IRAP/CNRS)

- Supports data in flux & various types of reflectance (scaling)
- Auto converts spectral axis & flux
- Supports échelle spectra



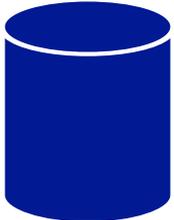
VESPA VO-GIS bridge

service with fits images & spectra



Portal

EPN-TAP query



TAP servers

Results in service VEX

grainid_srl	instrument_type	target_name	time_min_00	time_max_00	access_url
V0008_070	spectral_cube	Venus	2006-06-16T17:23:03.414	2006-06-16T17:23:03.437	ftp://open.vexac.org...
V0008_070C	spectral_cube	Venus	2006-06-16T17:23:03.414	2006-06-16T17:23:03.437	ftp://open.vexac.org...
V0008_070	spectral_cube	Venus	2006-06-16T17:23:03.424	2006-06-16T17:23:03.466	ftp://open.vexac.org...
V0008_070C	spectral_cube	Venus	2006-06-16T17:23:03.424	2006-06-16T17:23:03.466	ftp://open.vexac.org...
V0008_09C	spectral_cube	Venus	2006-06-16T17:27:48.478	2006-06-16T17:30:31.261	ftp://open.vexac.org...
V0008_090	spectral_cube	Venus	2006-06-16T17:27:48.478	2006-06-16T17:30:31.261	ftp://open.vexac.org...
V0008_090C	spectral_cube	Venus	2006-06-16T17:27:48.478	2006-06-16T17:30:31.261	ftp://open.vexac.org...
V0008_09C	spectral_cube	Venus	2006-06-16T17:27:48.472	2006-06-16T17:30:31.453	ftp://open.vexac.org...
V0008_090C	spectral_cube	Venus	2006-06-16T17:27:48.472	2006-06-16T17:30:31.453	ftp://open.vexac.org...
VT0027_000	spectral_cube	Venus	2006-06-16T02:01:54.510	2006-06-16T02:01:54.510	ftp://open.vexac.org...
VT0027_000	spectral_cube	Venus	2006-06-16T02:01:54.510	2006-06-16T02:01:54.510	ftp://open.vexac.org...

link:
geofits image,
spectrum

Results in service VEX

grainid_srl	instrument_type	target_name	time_min_00	time_max_00	access_url
V0008_070	spectral_cube	Venus	2006-06-16T17:23:03.414	2006-06-16T17:23:03.437	ftp://open.vexac.org...
V0008_070C	spectral_cube	Venus	2006-06-16T17:23:03.414	2006-06-16T17:23:03.437	ftp://open.vexac.org...
V0008_070	spectral_cube	Venus	2006-06-16T17:23:03.424	2006-06-16T17:23:03.466	ftp://open.vexac.org...
V0008_070C	spectral_cube	Venus	2006-06-16T17:23:03.424	2006-06-16T17:23:03.466	ftp://open.vexac.org...
V0008_09C	spectral_cube	Venus	2006-06-16T17:27:48.478	2006-06-16T17:30:31.261	ftp://open.vexac.org...
V0008_090	spectral_cube	Venus	2006-06-16T17:27:48.478	2006-06-16T17:30:31.261	ftp://open.vexac.org...
V0008_090C	spectral_cube	Venus	2006-06-16T17:27:48.472	2006-06-16T17:30:31.453	ftp://open.vexac.org...
V0008_09C	spectral_cube	Venus	2006-06-16T17:27:48.472	2006-06-16T17:30:31.453	ftp://open.vexac.org...
VT0027_000	spectral_cube	Venus	2006-06-16T02:01:54.510	2006-06-16T02:01:54.510	ftp://open.vexac.org...
VT0027_000	spectral_cube	Venus	2006-06-16T02:01:54.510	2006-06-16T02:01:54.510	ftp://open.vexac.org...

link:
WMS/WCS query

service with OGC-type products

OGC servers

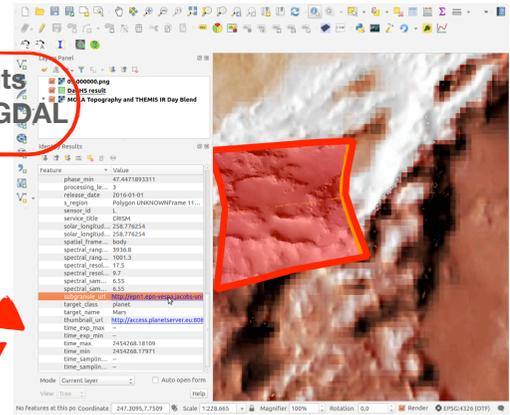


Std OGC query

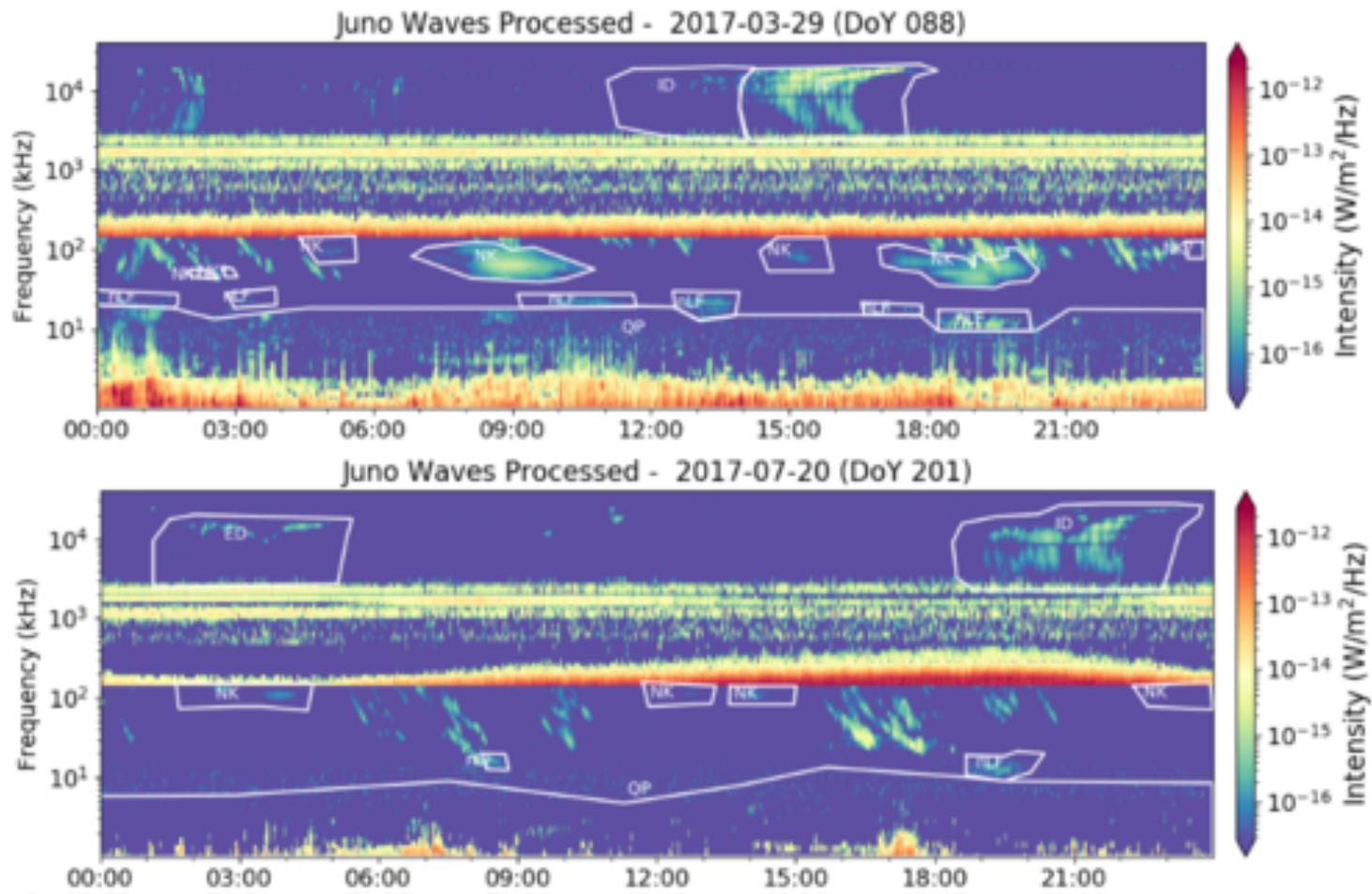
SAMP interface

Geofits driver / GDAL

QGIS



Locating features in dynamical spectra: TFCat

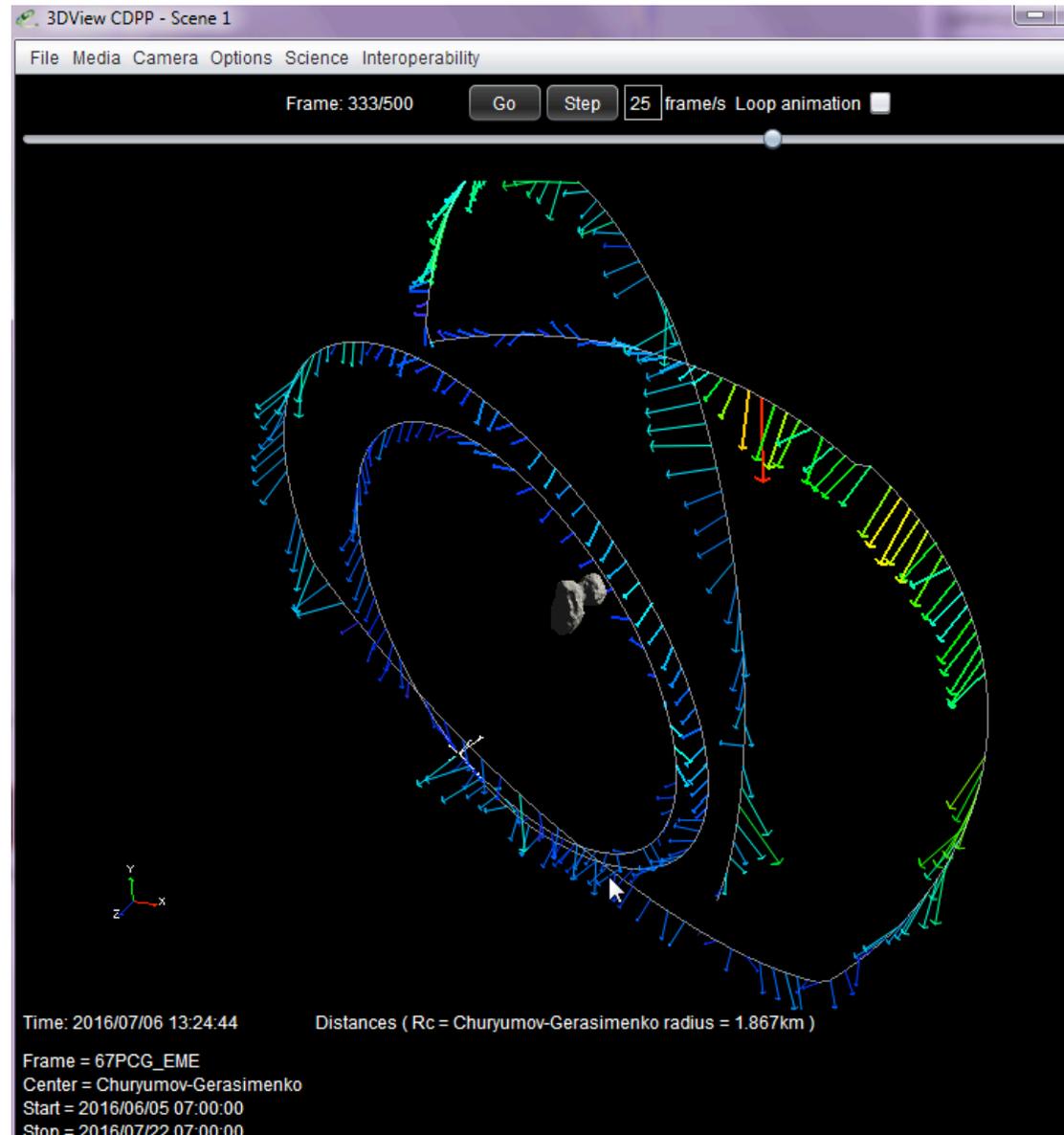


Jupiter radio emissions identified in Juno/Waves data (dynamical spectra), in Autoplot

VESPA and VO tools: space borne data

3Dview (CNES/IRAP):

- Spice kernels from all space missions
- image projection capacities
- Better Spice support from collaboration with ESA

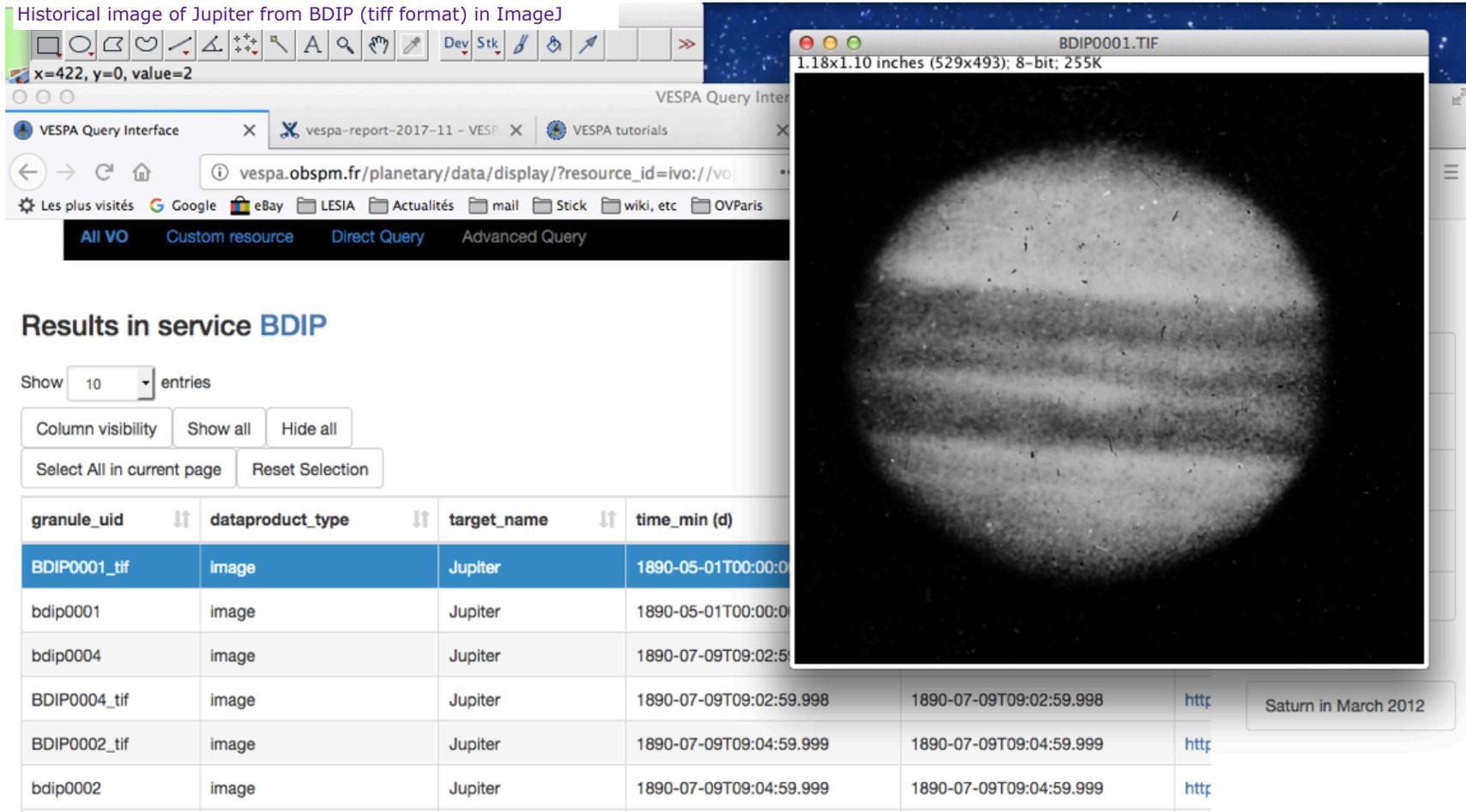


VESPA and VO tools: image processing interface

ImageJ (open source):

- SAMP connection installed (input only)
- Provides support for unusual data types (TIFF...) & format conversion
- Provides image processing functions in the VO

Historical image of Jupiter from BDIP (tiff format) in ImageJ



The screenshot shows the VESPA Query Interface with search results for Jupiter images. The interface includes a search bar, navigation buttons, and a table of results. A preview window on the right shows a historical image of Jupiter from BDIP (tiff format) in ImageJ, with a toolbar and status bar.

Results in service **BDIP**

Show entries

Column visibility Show all Hide all

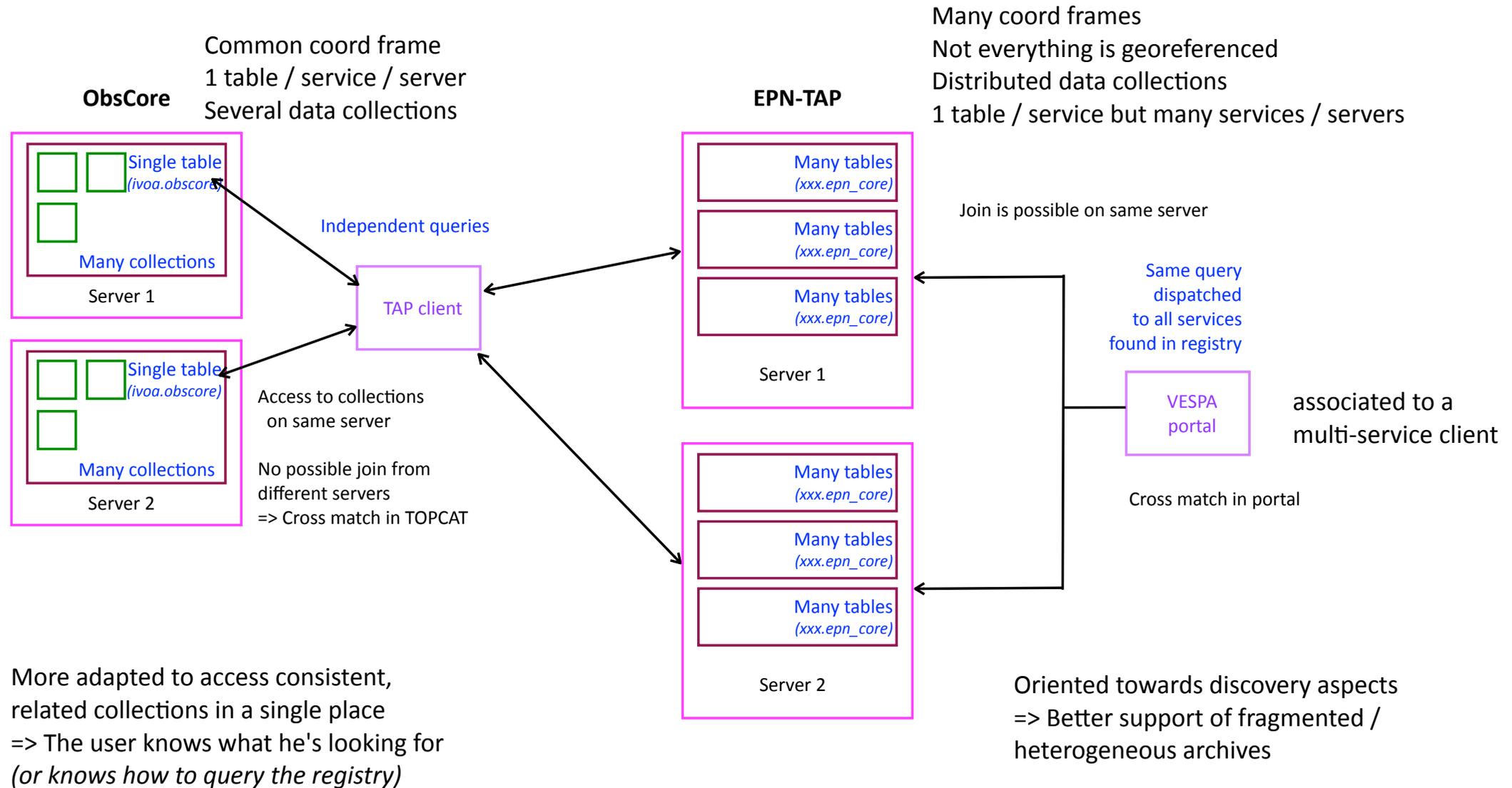
Select All in current page Reset Selection

granule_uid	dataproduct_type	target_name	time_min (d)		
BDIP0001_tif	image	Jupiter	1890-05-01T00:00:00		
bdip0001	image	Jupiter	1890-05-01T00:00:00		
bdip0004	image	Jupiter	1890-07-09T09:02:59.998		
BDIP0004_tif	image	Jupiter	1890-07-09T09:02:59.998	1890-07-09T09:02:59.998	http
BDIP0002_tif	image	Jupiter	1890-07-09T09:04:59.999	1890-07-09T09:04:59.999	http
bdip0002	image	Jupiter	1890-07-09T09:04:59.999	1890-07-09T09:04:59.999	http

Saturn in March 2012

Service implementation

ObsCore vs EPN-TAP



VESPA service installation

1- Install data server

- Preferred solution:** DaCHS - in a VM or container
- will handle internal database and registration

2- Design data service

Identify EPN-TAP parameters of interest, gather information, organize

3- Set up data service

Write a configuration file, ingest data, make data available

4- Tests, tests, tests

- **Compliance with EPN-TAP standard** (use taplint validator)
- **Check this actually provides a service to the users**
- **Publish when OK**

VESPA service installation

Pre-requirements:

0a- Access to VESPA wiki

<https://voparis-wiki.obspm.fr>

You may have access already - drop a line if not

0b- Backing up your work

Service definition files (not the data) will be stored in a common gitlab at Paris Observatory

<https://voparis-gitlab.obspm.fr/vespa>

This ensures sustainability and simplifies interactions / support

This also makes it simple to deploy the service on a final server when ready

Consider this as your own backup space on a common server - requires an invitation

=> Send your email, we will sent back an invitation to eduTEAMS VESPA Virtual Organisation
when validated, log in the gitlab to create your account, we'll provide access

VESPA service installation

1- Install the TAP server (currently Debian 12, DaCHS on port 80, awstats, postgres...)

=> clone https://voparis-gitlab.obspm.fr/vespa/dachs/docker_dachs_server

then edit the .env file with your info

then type `cd conf`

`docker up -d`

Options (in dev):

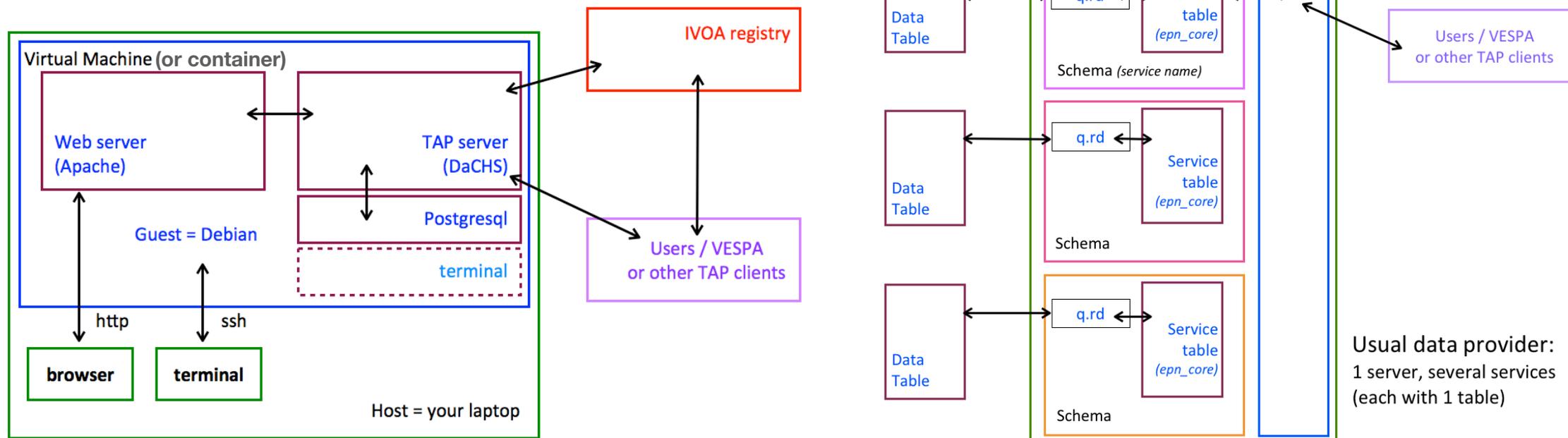
- host on EOSC VM (one example running)
- host at PADC: you're still in charge, DaCHS is updated via CI on updates; Ifs possible
- private services: required to handle PI experiments (ground segment of space instrument)
private VESPA portal available for cross-matches

VESPA service installation

1- Install data server

Preferred solution: DaCHS 2.6+ - in a VM or container

- will handle internal database and registration



VESPA service installation

2- Design data service

Identify EPN-TAP/ EPNCore parameters, gather information, organize

EPN-TAP services consist in 1 table describing

- a series of elements (granules) - rows
- with standard parameters - columns (some are mandatory)

=> need to identify

- granules / granularity (usually: files)
- If there are natural / convenient ways to group them
- values of EPN-TAP mandatory parameters
- quantities of interest (search and descriptive parameters) and how to store them in EPN-TAP parameters

This is science, not technical work — you must know or imagine how users want to access your data

=> Make it as complete as possible, remain consistent with existing services!

Typical metadata from EPNCore

EPNCore vocabulary:

A core of ~ 40 columns / parameters always present (can be empty)

~ 180 standard columns / parameters available to chose from (new ones are possible)

1- Basic info

Target name or ID + class, time, data IDs, release date, etc

2- Provenance info

Instrument, Observer, etc + possibly processing history

3- Link to the data

File (URL + format) or scalar quantities (eg, orbital parameters)

Thumbnail if possible (used in the portal)

4- Coverages

Spatial, temporal, spectral, illumination conditions; possibly other ones

- beware that units / scales are predefined

VESPA service installation

2- Design data service

Identify EPN-TAP/ EPNCore parameters, gather information, organize
- examples are available from voparis-gitlab

=> *Docs:*

<https://ivoa.net/documents/EPNTAP/>

Detailed vocabularies:

http://www.europlanet-vespa.eu/EPN_TAP.shtml

=> *Template / guide (XLS sheet):*

https://voparis-wiki.atlassian.net/wiki/download/attachments/56898983/EPN-TAP_parameters_List_template.xlsx?version=2&modificationDate=1713947811158&cacheVersion=1&api=v2

=> *Complete example (and links to shorter ones):*

<https://voparis-wiki.obspm.fr/display/VES/Setting+up+an+EPN-TAP+service+in+EPN-2024>

VESPA service installation

3- Set up data service

Write a configuration file (q.rd), with support from VESPA teams

Ingest data (various possible situations, the simplest one is via a CSV file)

Includes general info describing the service itself (for the registry)

4- Validation

Test, check data access, review

Publish (*both* in the IVOA registry and the VESPA portal)

Docs:

<https://voparis-wiki.obspm.fr/display/VES/Building+the+resource+descriptor+for+your+EPN-TAP+service+in+DaCHS>

<http://docs.g-vo.org/DaCHS/tutorial.html#epn-tap>

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

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

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

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