

VESPA: recent progress & shopping list

Stéphane Erard
Baptiste Cecconi
Pierre Le Sidaner
François Andrieu
Angelo Pio Rossi
Mikhail Minin
Pierre Fernique
Chiara Marmo
Vincent Génot
Nicolas André
Michel Gangloff

PADC / Observatoire de Paris

Jacobs Univ, Bremen

CDS, Strasbourg
GEOPS, Univ Paris Sud
IRAP, CDPP

Nick Achilleos
Kevin Benson
Bernard Schmitt
Maria Teresa Capria
Benoît Carry
Ricardo Hueso
Anni Määttänen
Ehouarn Millour
Ondrej Santolík
Jan Soucek
Manuel Scherf
Tarek Al-Ubaidi
William Thuillot
Ann Carine Vandaele

UCL, London

IPAG, Grenoble
IAPS, Rome
OCA, Nice + IMCCE
EHU/PVU, Bilbao
LATMOS
LMD, Paris
IAS, Prague

IWF, Graz

IMCCE
IASB-BIRA, Brussels



VESPA includes 18 contributing participants (labs) in 13 beneficiary institutes:

Observatoire de Paris
(IMCCE, LESIA)



IAPS/INAF Rome



Jacobs Univ. Bremen



CNRS
(IRAP IPAG LATMOS
GEOPS CDS)



IWF Graz



IASB-BIRA Brussels



UCL London



IAP Prague



+ Contributions from
the community

UPV/EHU Bilbao



IGN/PAS Wrocław



Univ. Bern



SINP/Lomonosov Univ.



GFI Toulouse



Variety of data / specificities for the Solar System

- Perimeter of data to be accessed

- Ground-based: moving objects on dark sky
- Space-borne (PSA/PDS), including HR imaging in various coord frames
- Time series, Parameter lists, Atmospheric / 3D, Volume...
- Variations with time (secular, seasonal, local time)
- Experimental / lab support data
- Simulations on demand

- Physical data access:

Main issue: existing PDS3 (space borne) archives - no software!

FITS (sometimes)

CDF (plasma physics)

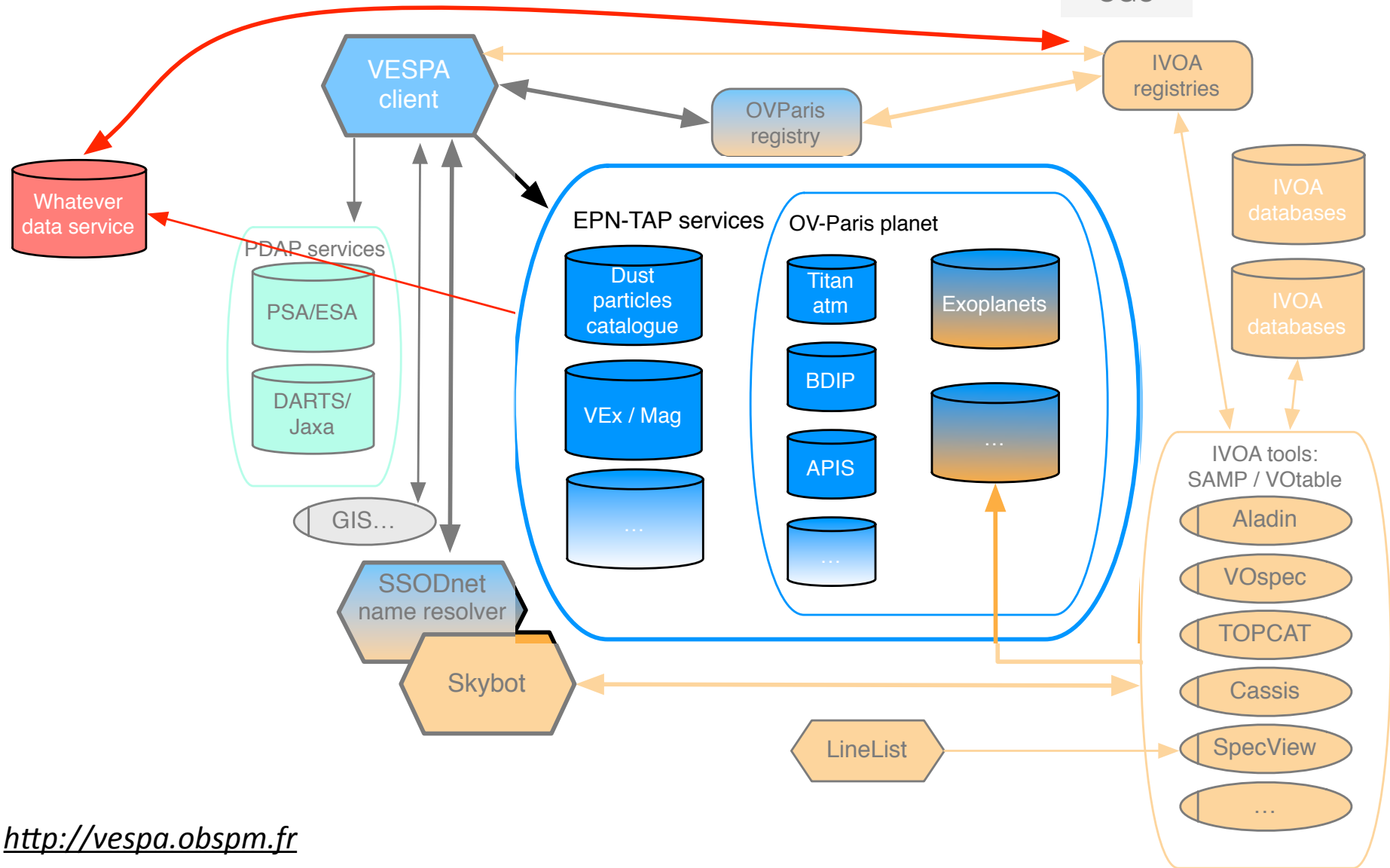
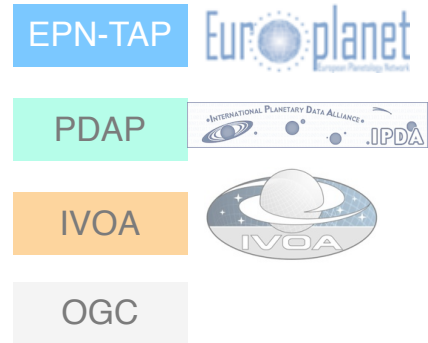
+ funny formats: netCDF, HDF5, TIFF, GeoTIFF, data streams...

A Virtual Observatory in Planetary Science

Built on astronomical VO developments

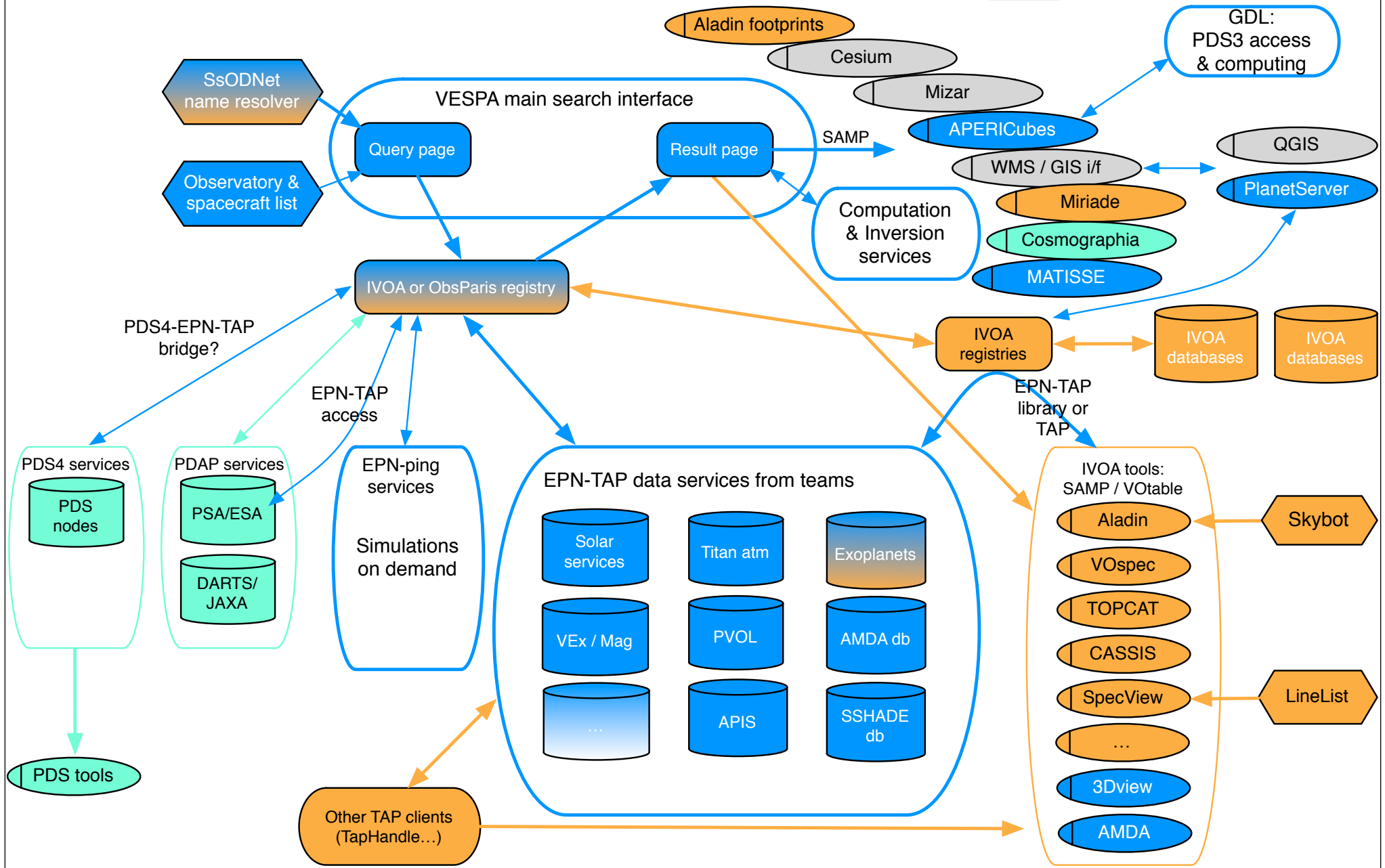
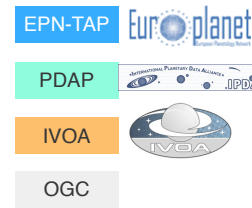
+ previous European programs: IMPEX, HELIO, VAMDC...

+ interfaces with: PDS, GIS/OGC, etc...



A Virtual Observatory in Planetary Science

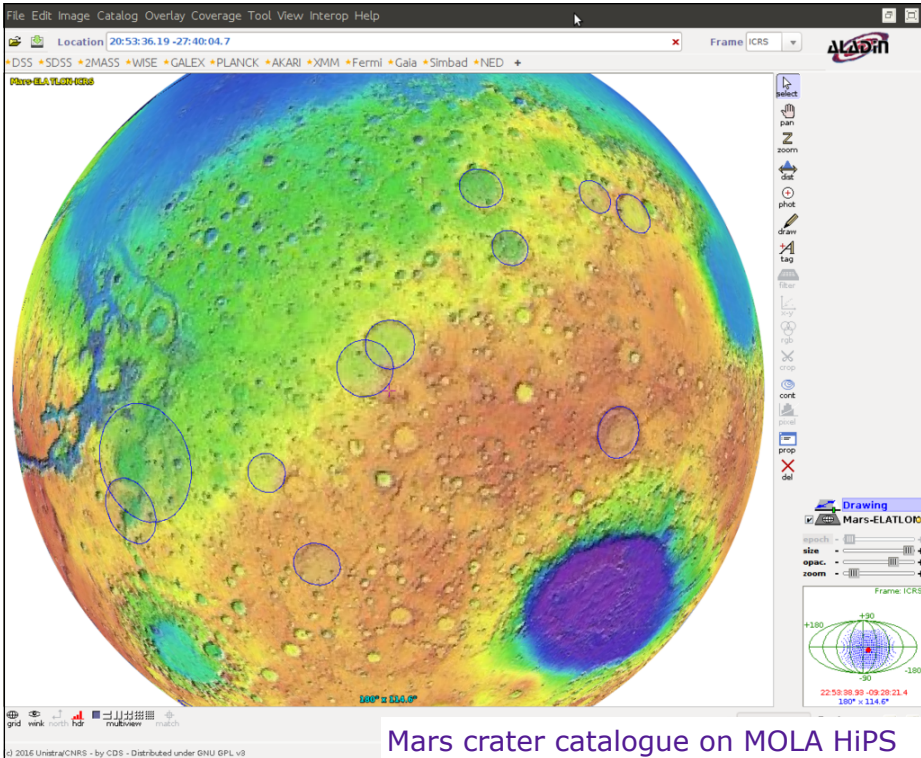
Connecting more pieces...



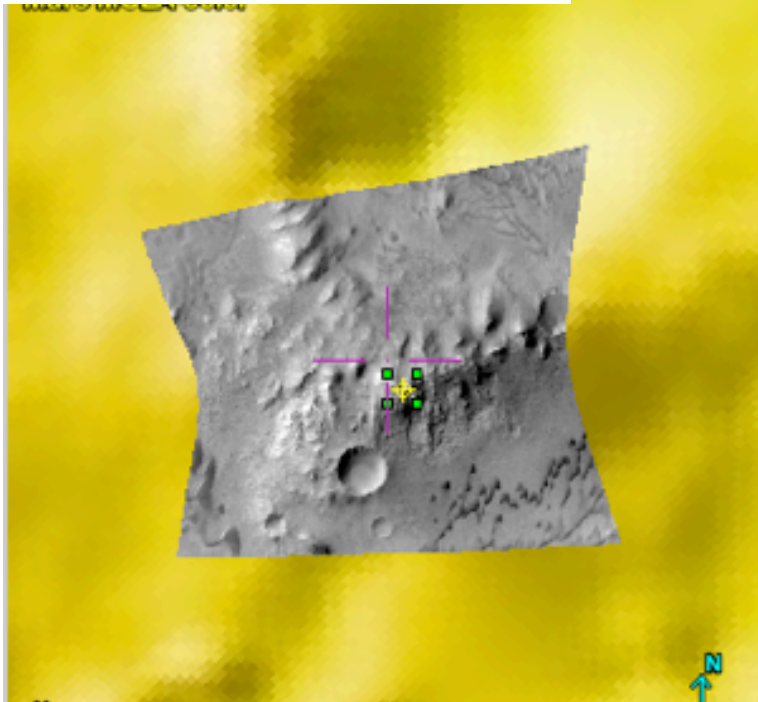
VESPA DAL:

Data Model: EPNCore (EPN-TAP parameters)

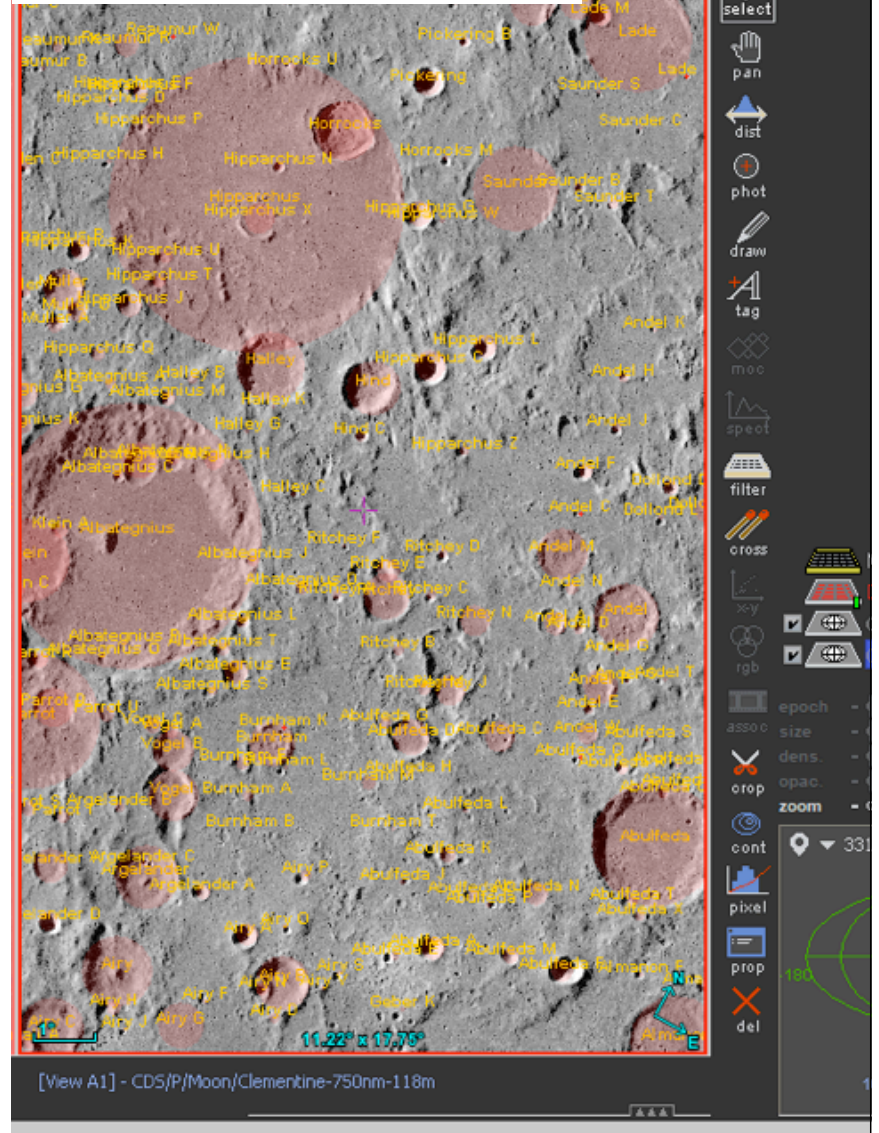
- **Similar to ObsCore, but wider scope**
- **Describe all data axes: spatial, spectral, time, viewing geometry**
 - => IAU body-related coord systems needed in STC, to be reviewed
- **Some parameters are entirely new** e.g., incidence/emergence angles
- **Include description of data in files** e.g., reflectance measurements
- **Some parameters reused from ObsCore, with specificities**
 - Ex: s_region - must use E-handed frames (IAU standard on planets)
 - => We need at least a generic E-handed frame in STC strings to implement the IAU standard! Call it BODY, or BODY-FIXED, or E-HANDED?
 - => POLYGON('BODY-FIXED', 150, -30, 30, -30... etc



CRISM footprint on THEMIS HiPS, Mars



Lunar crater catalogue on Kaguya HiPS



Coordinates are provided in eastward convention (IAU)
s_region must use the same convention

VESPA DAL:

Main Data Access Protocol: EPN-TAP 2.0

- TAP + set of EPNCore parameters — similar to ObsTAP, wider scope
- Data can be integrated in the table or in linked files (one file / table entry)
- Require Utype (EPNCore / EPN-TAP doc in progress)
 - UCDs - used by some tools to understand data correctly (spectro, ...)
 - => First contribution to UCD list discussed this week
(viewing angles, main reflectance quantities...)
- Need to identify observations / simulations / experimental data
- Use hash lists for multivalued fields (UCDs, targets, instruments...)
 - => additions required in ADQL to support search functions
 - ivo_hashlist_has RegTAP function to handle lists of values
 - Need to combine ivo_hashlist_has with LIKE e.g., to extract UCDs from lists

VESPA DAL:

Registry:

- **Initial issue sorted out Dec 2017** (ivo-id related)
- **EPN-TAP currently in v 2.0, v 2.1 in development — will co-exist**

Protocol version can be retrieved from registry

- **VESPA client will soon combine results from many services**

Need to track credits & origin of data

=> Need to retrieve credits, bib reference, boiler plate, etc... from registry

=> Add in param or field of TAP output VOTable — to be used by the clients

VESPA DAL:

Other Data Access Protocols

- (EPN-)TAP covers most needs — e.g., a sort of basic planetary SIAP
- PDAP (IPDA) supported by VESPA client — seems stalled
- VOevents — need to be able to tell that the event occurs at a named planet or a spacecraft (e.g., "Jupiter", "Juno") in the WHERE section
- Connects with non-VO protocols: das2stream, OGC (WMS, WCS...)
(see Baptiste's presentation for the former)
- Need a method to call simulations and compare with observations - **now experimenting with datalink** (see Pierre LS's presentation)
- **Will use SLAP in the near future** to handle both solid phase and gas spectroscopy (to support identification of species)

VESPA / EPN-TAP clients:

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

- **Current version queries all services, then lists individual results**
- **Next version will integrate queries & service results pages**
- **A future version will integrate individual results from all services**

Only displays selected EPN-TAP services from the registry

<= quality check is expected from the portal (requirement from Europlanet and CNRS/INSU in France)

Current VESPA interface

VESPA Virtual European Solar and Planetary Access

Navigation: All VO, Custom resource, Direct Query, Advanced Query, Help

Main Parameters

Target Name: EPN Resources

Granule UID: [input]

Granule GID: [input]

Obs ID: [input]

Time selection: [input]

Location: [input]

Spectral: [input]

Time: [input]

Photometry: [input]

Instrument: [input]

Optional: [input]

Submit Reset

Results in service WEx

Show 10 entries

Column visibility Show all Hide all

Select All in current page Reset Selection

granule_uid	dataprodukt_type	target_name	time_min (d)	time_max (d)	access_url
VI0026_07G	spectral_cube	Venus	2006-05-16T17:12:20.414	2006-05-16T17:23:00.457	ftp://psa.esac.esa.i...
VI0026_07C	spectral_cube	Venus	2006-05-16T17:12:20.414	2006-05-16T17:23:00.457	ftp://psa.esac.esa.i...
VV0026_07G	spectral_cube	Venus	2006-05-16T17:12:20.424	2006-05-16T17:23:00.466	ftp://psa.esac.esa.i...
VV0026_07C	spectral_cube	Venus	2006-05-16T17:12:20.424	2006-05-16T17:23:00.466	ftp://psa.esac.esa.i...
VI0026_08C	spectral_cube	Venus	2006-05-16T17:27:48.478	2006-05-16T17:38:31.261	ftp://psa.esac.esa.i...
VI0026_08G	spectral_cube	Venus	2006-05-16T17:27:48.478	2006-05-16T17:38:31.261	ftp://psa.esac.esa.i...
VV0026_08G	spectral_cube	Venus	2006-05-16T17:27:48.672	2006-05-16T17:38:31.453	ftp://psa.esac.esa.i...
VV0026_08C	spectral_cube	Venus	2006-05-16T17:27:48.672	2006-05-16T17:38:31.453	ftp://psa.esac.esa.i...
VT0027_00C	spectral_cube	Venus	2006-05-18T01:25:15.669	2006-05-18T02:01:54.510	ftp://psa.esac.esa.i...
VT0027_00G	spectral_cube	Venus	2006-05-18T01:25:15.669	2006-05-18T02:01:54.510	ftp://psa.esac.esa.i...

Plotting tools

- TOPCAT
- Aladin
- SPLAT
- CASSIS
- 3DView

Plotting tools

- TOPCAT
- Aladin
- SPLAT
- CASSIS
- 3DView

Example queries

Saturn in March 2012

© Paris Observatory 2016

Contact : support.epntap@obspm.fr

Showing 91 to 100 of 15,682 entries

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Earth Footprints

Data Selection Metadata Selection All Data All Metadata



Form ADQL Query

All Services Custom Service

Main Parameters ▲

Target Name

Granule UID

Granule GID

Target Class

Dataproduct Type

Obs ID

Measurement Type

Location ▼

Spectral ▼

EPN Resources

abs_cs - Data for numerical modeling of planetary atmospheres 13 results	📄	🔍	🔄	🔍	ℹ️
AMDA - Planetary and heliophysics plasma data at CDPD/AMDA 985834 results	📄	🔍	🔄	🔍	ℹ️
APIS - Auroral Planetary Imaging and Spectroscopy 41331 results	📄	🔍	🔄	🔍	ℹ️
BASECOM - The Nançay Cometary Database 15611 results	📄	🔍	🔄	🔍	ℹ️
bass2000 - Bass2000 solar survey archive 276689 results	📄	🔍	🔄	🔍	ℹ️
BDIP - Base de Données d'Images Planétaires 16906 results	📄	🔍	🔄	🔍	ℹ️
BIRA-IASB TAP - Profiles from SPICAV-SOIR/VEx 2672 results	📄	🔍	🔄	🔍	ℹ️
CLIMSO - CLIMSO coronagraphs at pic du midi de Bigorre 301138 results	📄	🔍	🔄	🔍	ℹ️
CRISM - CRISM data from Earth Server 2 20722 results	📄	🔍	🔄	🔍	ℹ️
DynAstVO - Asteroid orbital database and ephemerides 17135 results	📄	🔍	🔄	🔍	ℹ️
ExoPlanet - Extrasolar Planets Encyclopaedia 3631 results	📄	🔍	🔄	🔍	ℹ️

Results in service VVEx

Show 10 entries

Column visibility Show all Hide all

Select All in current page Reset Selection

granule_uid	dataproduct_type	target_name	time_min (d)	time_max (d)	access_url
VV0026_07G	spectral_cube	Venus	2006-05-16T17:12:20.414	2006-05-16T17:23:00.457	ftp://psa.esac.esa.i...
VV0026_07C	spectral_cube	Venus	2006-05-16T17:12:20.414	2006-05-16T17:23:00.457	ftp://psa.esac.esa.i...
VV0026_07G	spectral_cube	Venus	2006-05-16T17:12:20.424	2006-05-16T17:23:00.466	ftp://psa.esac.esa.i...
VV0026_07C	spectral_cube	Venus	2006-05-16T17:12:20.424	2006-05-16T17:23:00.466	ftp://psa.esac.esa.i...
VV0026_08C	spectral_cube	Venus	2006-05-16T17:27:48.478	2006-05-16T17:38:31.261	ftp://psa.esac.esa.i...
VV0026_08G	spectral_cube	Venus	2006-05-16T17:27:48.478	2006-05-16T17:38:31.261	ftp://psa.esac.esa.i...
VV0026_08G	spectral_cube	Venus	2006-05-16T17:27:48.672	2006-05-16T17:38:31.453	ftp://psa.esac.esa.i...
VV0026_08C	spectral_cube	Venus	2006-05-16T17:27:48.672	2006-05-16T17:38:31.453	ftp://psa.esac.esa.i...
VT0027_00C	spectral_cube	Venus	2006-05-18T01:25:15.669	2006-05-18T02:01:54.510	ftp://psa.esac.esa.i...
VT0027_00G	spectral_cube	Venus	2006-05-18T01:25:15.669	2006-05-18T02:01:54.510	ftp://psa.esac.esa.i...

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Earth Footprints

- Plotting tools
- TOPCAT
 - Aladin
 - SPLAT
 - CASSIS
 - 3DView

Example queries

Saturn in March 2012

New VESPA interface (in dev)

VESPA / other EPN-TAP clients:

EPN-TAP libraries

- **Java version in 3Dview, CASSIS**
- **JavaScript version to be implemented in AMDA**

Generic TAP clients (TAPhandle, TOPCAT, Aladin...)

- **Complete access to EPN-TAP services, but no extra support (conversions, etc...). Datalink support welcome in TOPCAT 4.6!**

Astropy & PyVO for VESPA

- **Working on Jupyter tutorials**

Data services connected via EPN-TAP

Currently:

39 interoperable data services connected, from 13 institutes (~ 15 in dev)

Encompass many aspects of Solar System studies:

- surfaces
- small bodies / satellites / rings / dynamics
- atmospheres
- magnetospheres / radio observations
- solar physics / planetary plasmas
- exoplanets
- solid spectroscopy / experimental reference data

Several high-quality amateur services preselected (PVOL, RadioJove...)

Most services implemented on DaCHS + some on TAPlibrary (ESA/PSA...)

Very efficient call/workshop procedure to involve the community

Future/possible data services raising issues

- PSA (ESA space missions archive)

10 millions files, 70 experiments — service open, but table ~ empty

Data description need to be extracted from headers and docs

- discussion tomorrow in SSIG II

- VizieR catalogues (solar system related)

Description scheme to be identified — on-going at CDS

- Telescopic / ground-based archives?

e.g. other ESA archives (Herschel...)

e.g. CADC, ESO interfaces ;)

Tools connected to / used by VESPA

- Standard/existing tools associated to VESPA/Europlanet:

Aladin (CDS/CNRS), **CASSIS** (IRAP/CNRS) - See Pierre F's presentation

Both include Planetary Science updates from VESPA

3Dview (CNES/IRAP/GFI): plot along s/c trajectories

MATISSE (ASI/IAPS): 3D visu for *some* PDS3 data, supports shape models

- New tools developed in VESPA:

Planetary Cesium Viewer (GEOPS/CNRS)

APERICubes (*some* PDS spectral cubes, ObsParis) - see Renaud's presentation

QGIS SAMP plug-in (VO-GIS bridge, Jacobs Univ)

ImageJ SAMP plug-in & improved fits support (ObsParis, in progress)

- Other useful tools in VESPA context:

TOPCAT (Bristol), **SPLAT-VO** (Heidelberg), **Autoplot** (Iowa), **Mizar** (CNES)

+ possibly **VOspec** (ESA), **DS9** (SAO), **Cosmographia** (JPL)

Tools connected to / used by VESPA

Tools are connected though SAMP

Need for additional SAMP messages:

- **For PDS files, possibly several ones (PDS3 vs 4, detached labels...)**
- **geoJSON**
- **das2stream**
- **etc...**

Functions needed (but not found yet):

- **statistic tools**
- **basic arithmetic tools** (averaging on the fly, in particular vectors/profiles)
- **image segmentation**

Favorite VESPA tools

Aladin (CDS/CNRS):

Georeferenced images + objects superpositions

45 planetary HiPS (USGS maps)

The screenshot displays the Aladin v10.0 interface, a multi-panel software for astronomical data visualization. The top menu bar includes File, Edit, Image, Catalog, Overlay, Coverage, Tool, View, Interop, and Help. The main workspace is divided into several panels:

- Left Panel:** A hierarchical tree view of available data collections, including 'Solar system' (Sun, Mercury, Venus, Earth, Mars) and 'Planets' (Saturn, Jupiter, Uranus, Neptune, Pluto). The 'Mars' collection is expanded, showing various data types like THEMIS Day/100m, MOLA-color, and MOLA-roughness.
- Top Center:** A 'Command' field and a 'Frame' dropdown menu set to 'Planet'. The 'Projection' is set to 'Cartesian'.
- Top Right:** A metadata panel for the selected object 'CDS/P/Mars/THEMIS-Day-100m', showing provenance (Arizona State University), coverage (100%), and HiPS order (7/7).
- Main Viewport:** A 2x2 grid of maps:
 - Top-left: 'Mars MOLA-color' showing a global color-coded topographic map of Mars.
 - Top-right: 'Mars THEMIS Day 100m' showing a grayscale THEMIS Day 100m image of Mars with a central crater.
 - Bottom-left: 'Mars MOLA-elev' showing a grayscale MOLA elevation map of Mars.
 - Bottom-right: A zoomed-in view of the crater from the THEMIS Day 100m image, showing detailed surface features and a coordinate frame.
- Right Panel:** A large map of the Moon titled 'Moon Kaguya-Eveing V04-474m', showing a grayscale Kaguya image with numerous craters labeled with names like 'Plinius', 'Lada', 'Scaevola', etc. A coordinate frame is overlaid on the map.
- Bottom Right:** A control panel with various tools (select, pan, dist, phot, draw, tag, moc, filter, cross, xy, rgb) and a 'MoonCrater' data layer. It also includes a zoom slider and a coordinate display showing '331.97864 -14.54937 GAL'.

At the bottom of the interface, there is a footer: '© 2018 Université de Strasbourg/CNRS - developed by CDS, distributed under GPLv3'.

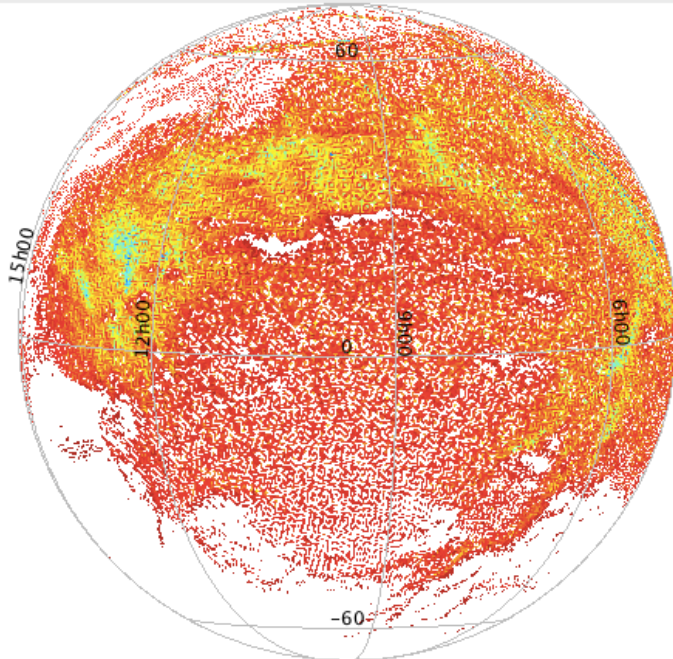
Lunar crater catalogue on Kaguya HiPS

CRISM cubes on MOLA HiPS

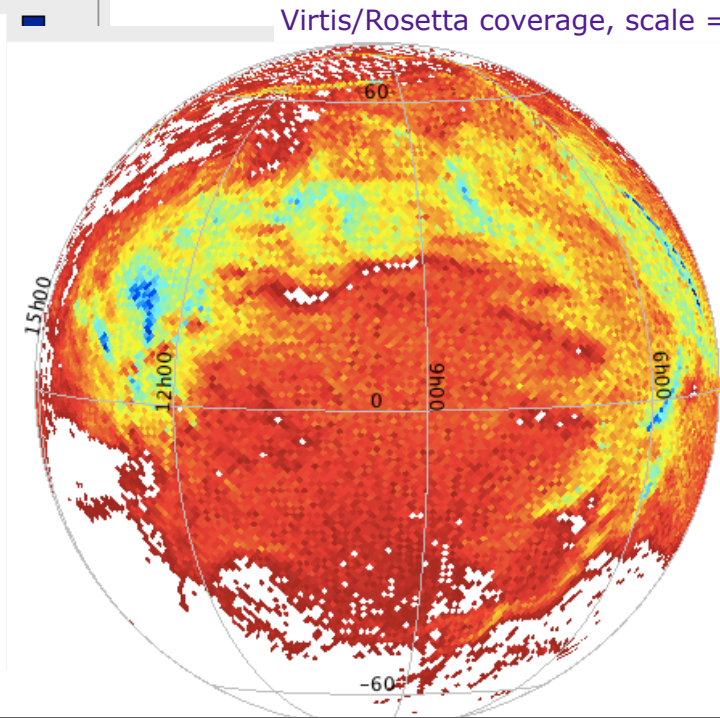
Relies on IAU planetary coordinate frames (fits' WCS)

New functions in VESPA

Multiresolution maps in TOPCAT (Bristol Univ)



Virtis/Rosetta coverage of 67P for a selected mission phase, scale = 7



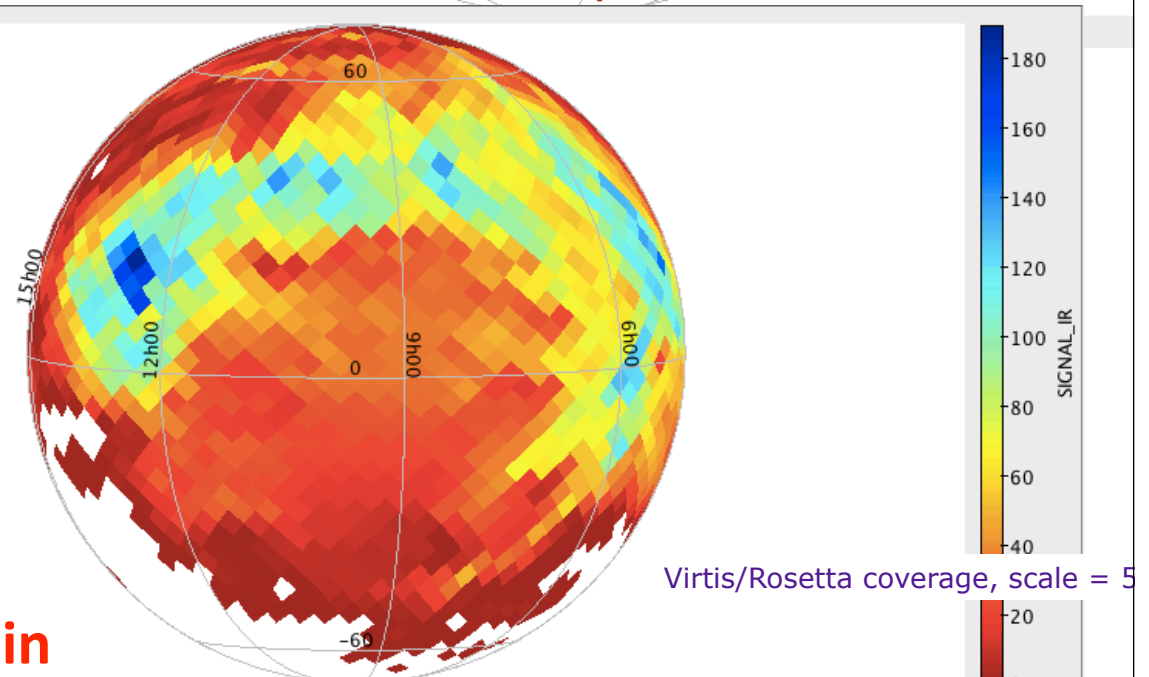
Start from a table of sparse observations (lon/lat)

VIRTIS/Rosetta on 67P

Integrate / average on healpix cells

Modify resolution / scale on the fly

Need a std format usable in Aladin

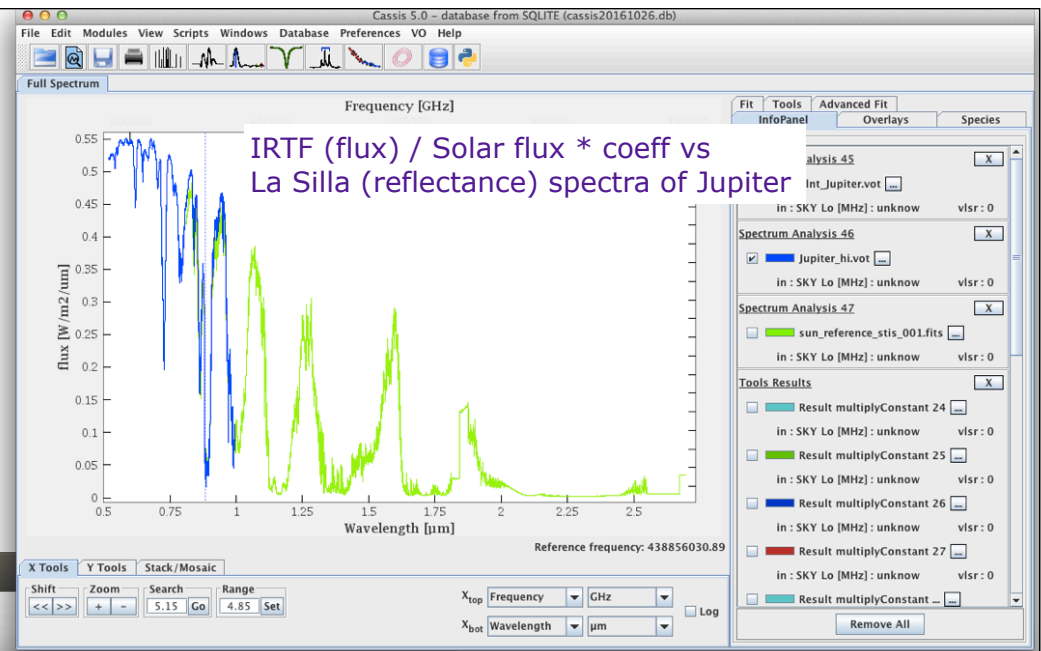


Virtis/Rosetta coverage, scale = 5

Updated VESPA tool

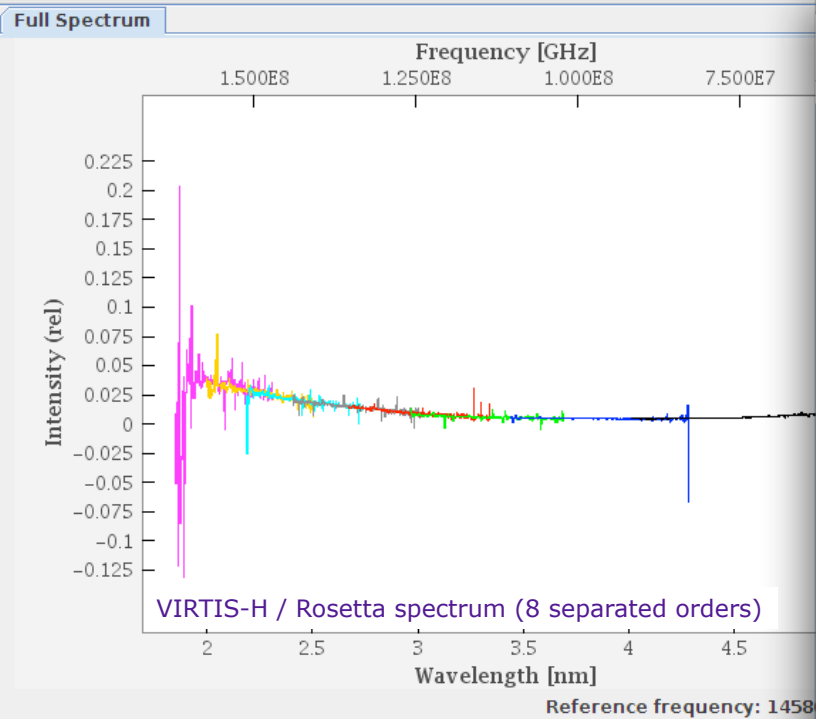
CASSIS v5 (IRAP/CNRS)

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



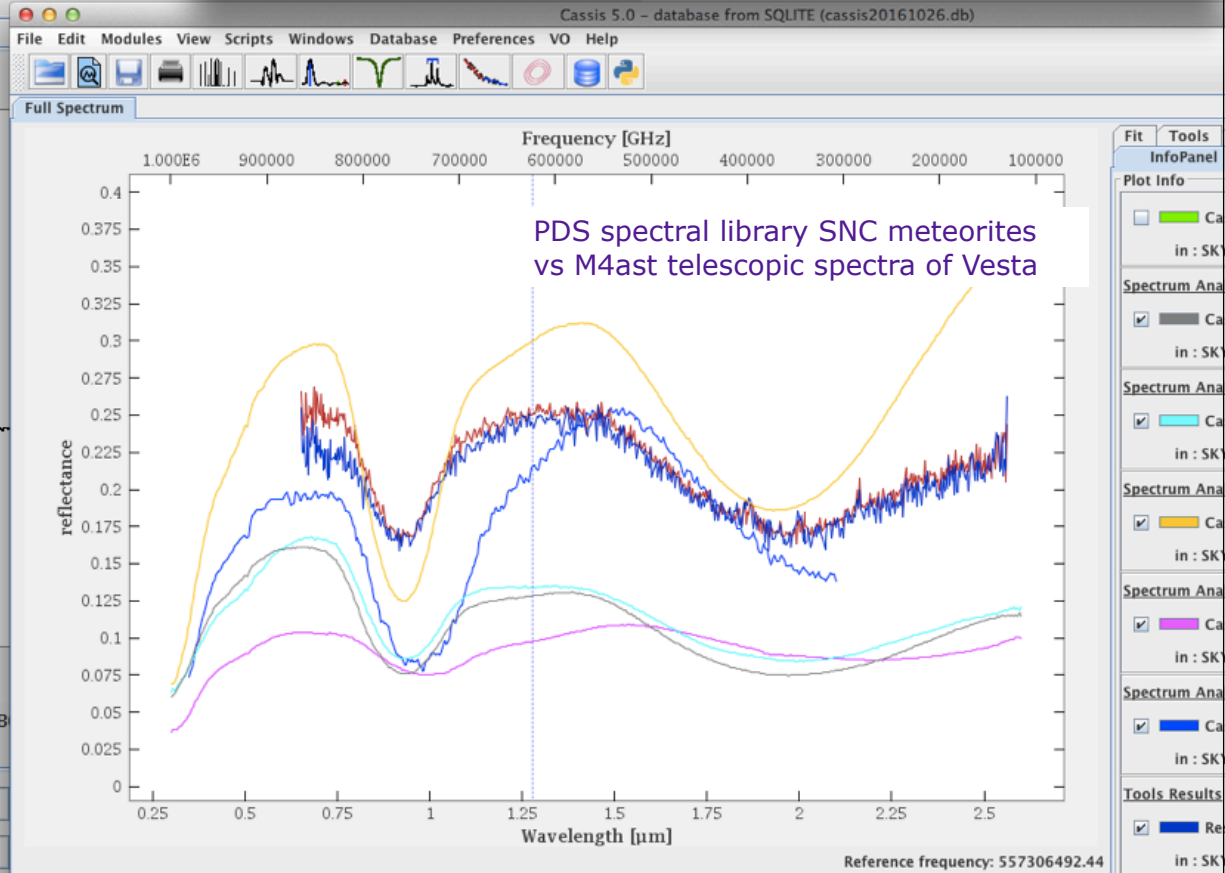
Cassis 4.3 beta - database from SQLITE (cassis120705.db)

File Edit Modules View Scripts Windows Database Preferences VO Help



X Tools Y Tools Stack/Mosaic

Shift Zoom Search Range X_{top} Frequency GHz X_{bot} Wavelength nm



New VESPA tools: VO-GIS connection

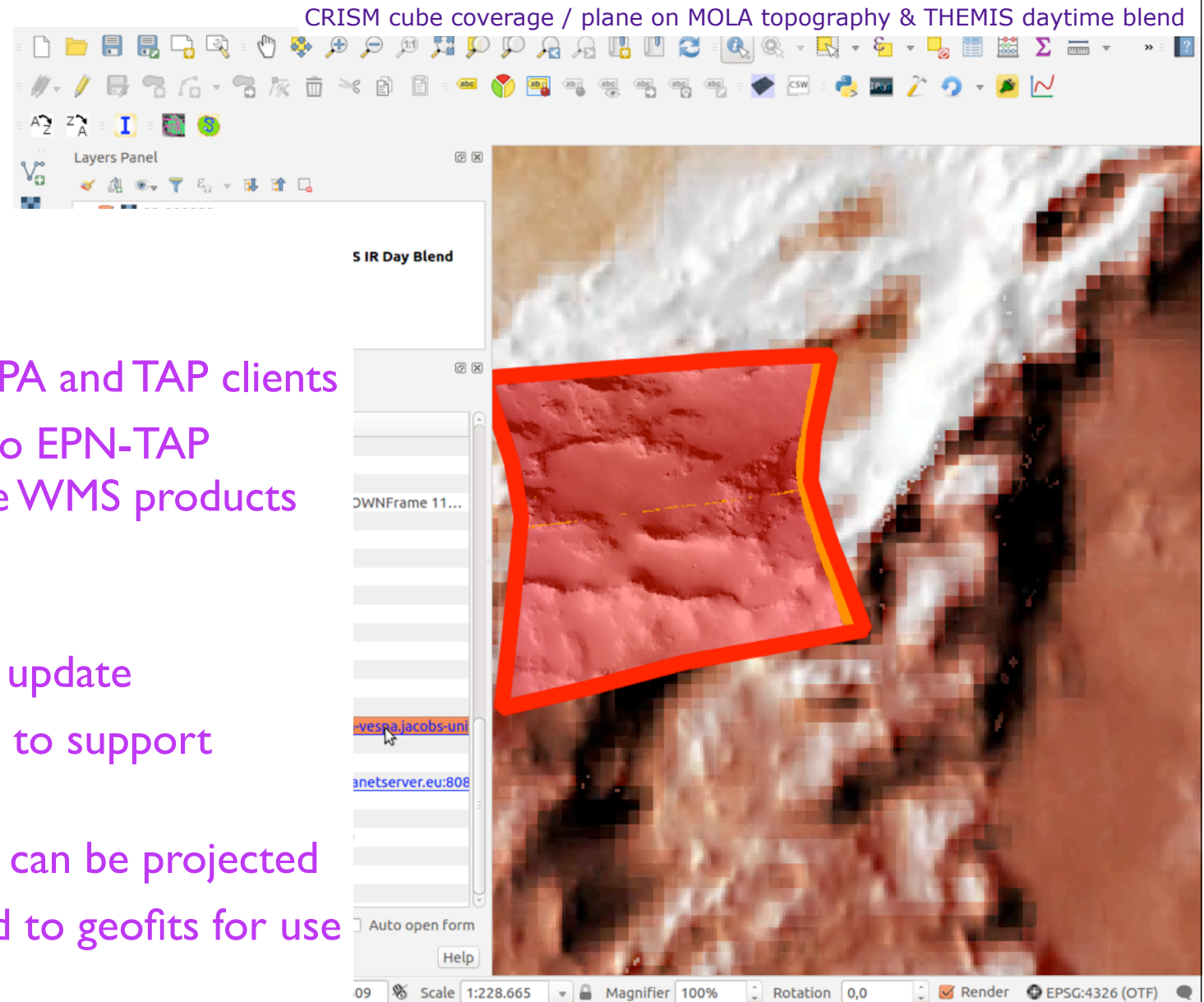
QGIS (open source):

SAMP plug-in installed

- receives data from VESPA and TAP clients
- Provides visualization to EPN-TAP services which distribute WMS products
(=> planetary mapping)

GEOfits format / GDAL update

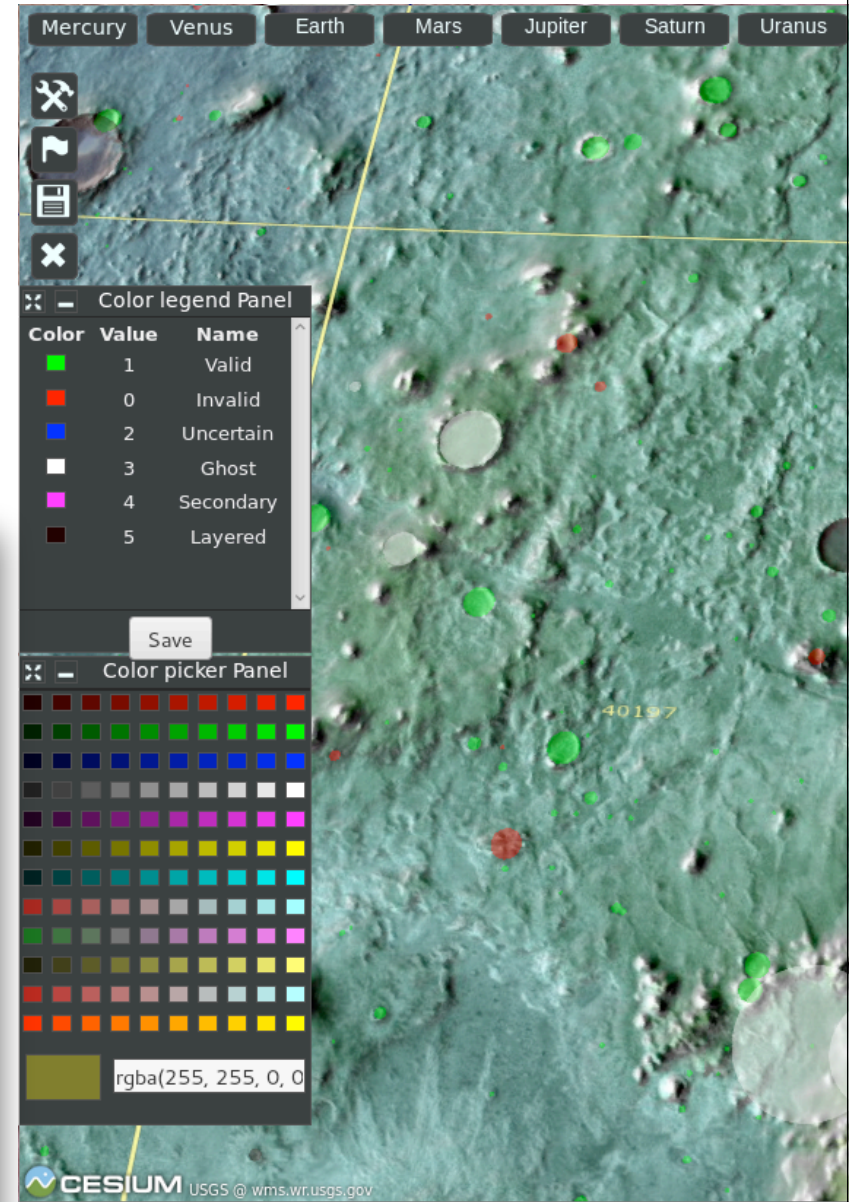
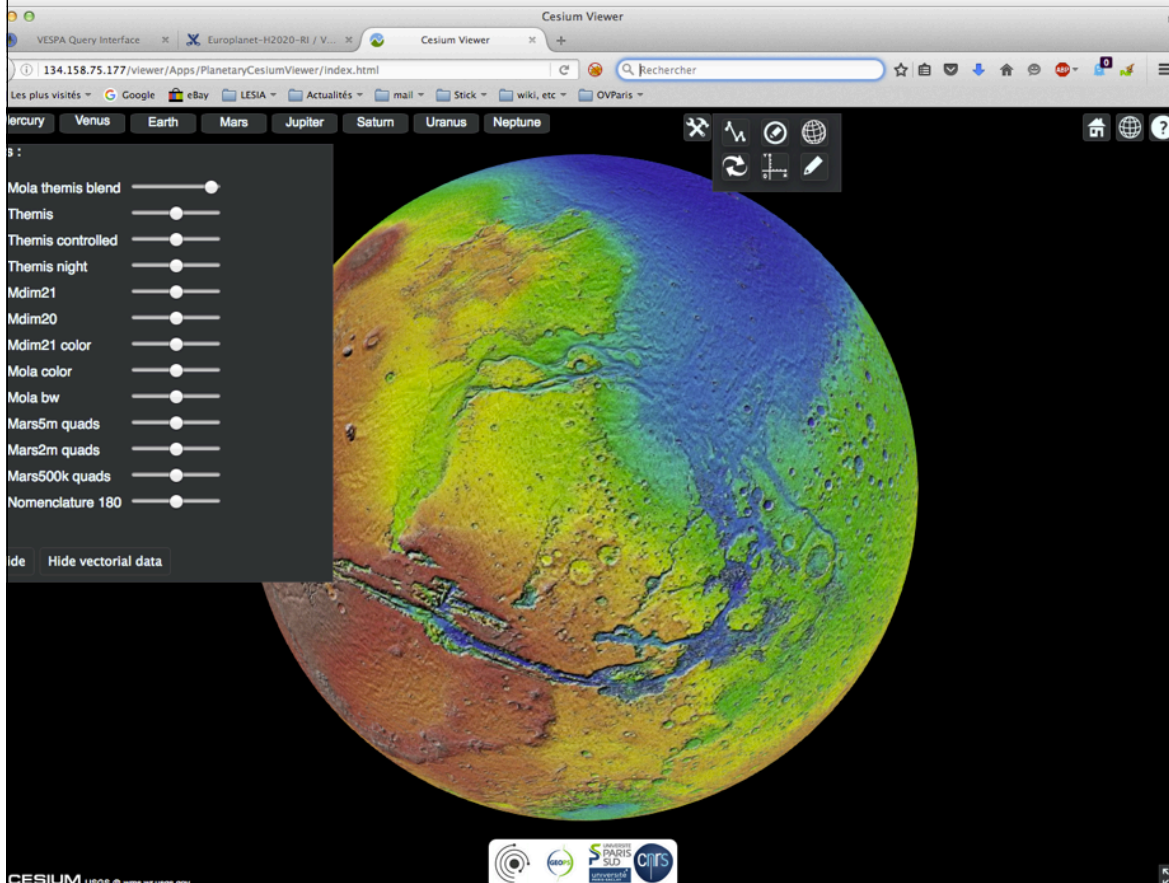
- WCS (small) extension to support planetary surfaces
- georeferenced fits files can be projected
- geoTIFF files converted to geofits for use in VO tools



New VESPA tool

Planetary Cesium Viewer (GEOPS/CNRS)

- Quick multiresolution 3D visu
- Supports elliptic shapes
- Annotation/validation tool
- SAMP implementation



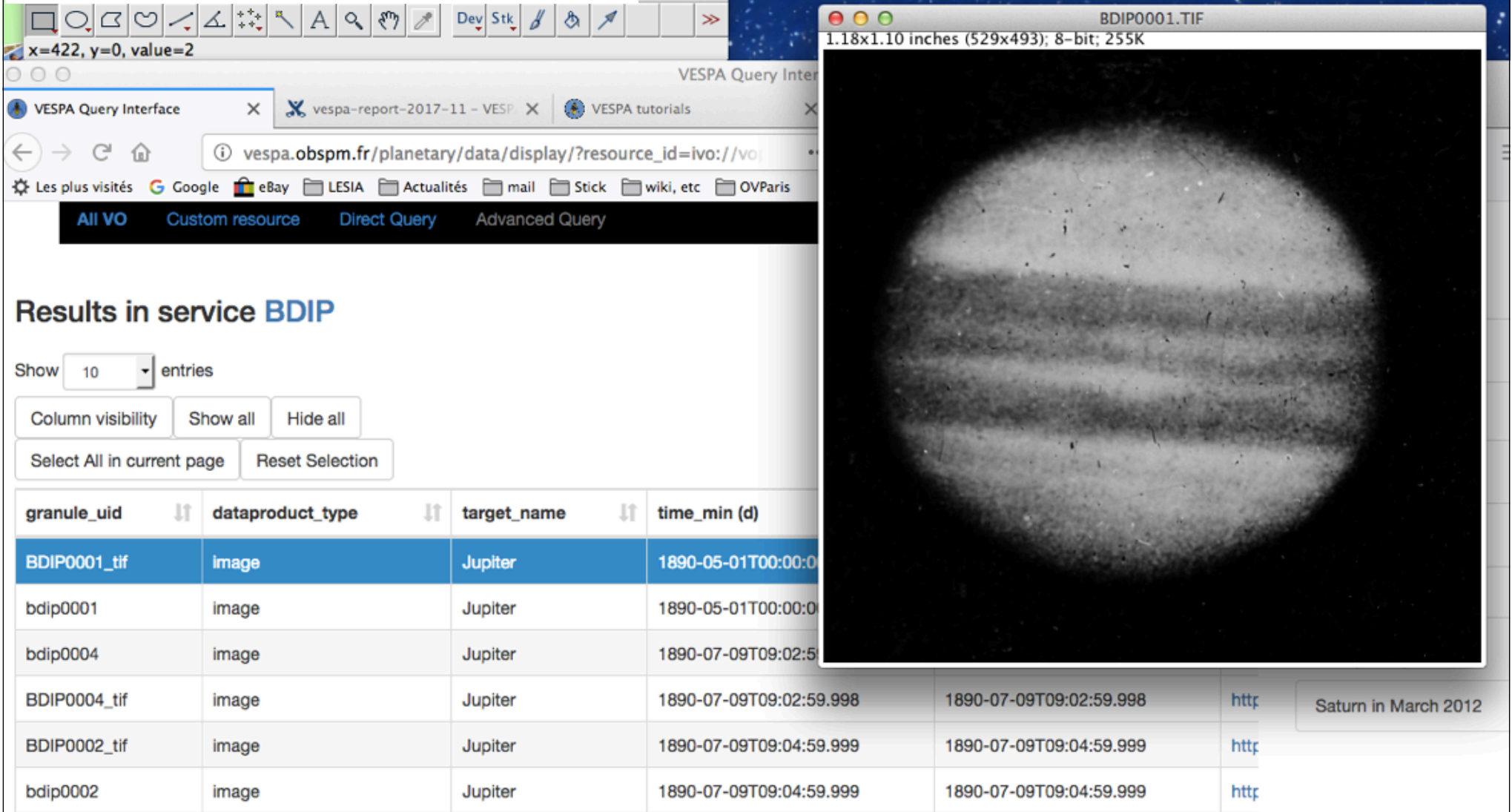
Robbins Mars craters database in PCV

New tools in VESPA

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 a web browser window with the VESPA Query Interface. The browser address bar shows the URL: `vespa.obspm.fr/planetary/data/display/?resource_id=ivo://vo`. The page displays search results for Jupiter images. A table lists the results, with the first row highlighted in blue. To the right, a window titled "BDIP0001.TIF" is open, showing a grayscale image of Jupiter with its characteristic bands. The window title bar indicates the image size is 1.18x1.10 inches (529x493) and it is 8-bit, 255K.

Results in service BDIP

Show 10 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	1890-07-09T09:02:59.998	http
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

Next steps

- **More data services!** - including external contributors
- **Process answers from multiple services**
- **Finalize VO-GIS interface** - including geofits (ESS paper being reviewed)
- **Develop interface with lab spectroscopy services**
(minerals and ices spectra, band lists, etc) - now 4 services implemented
- **Bridge EPNCore and PDS4**
- **Connect simulation services, use with related data services**
requires different protocols
- **Formalize docs / standards => submit to IPDA & IVOA**
and refine/complete tutorials

Next steps, 2

- **Europlanet Gateway proposal**, submitted to EU call, March 2018

Application of FAIR principles, consolidation, sustainability, collaborations

- **Europlanet-RI next bid** to be submitted, March 2019

Will focus more (= also) on knowledge extraction, machine, learning, etc

Will associate non beneficiary teams / institutes

search interface <http://vespa.obspm.fr>

web site (w/ tutos) <http://www.europlanet-vespa.eu>

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

github <https://github.com/e pn-vespa>