

# Planetary Science Virtual Observatory: VESPA/Europlanet outcome and prospects

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VESPA includes 19 contributing participants (labs) in 14 institutes:

Observatoire de Paris  
(IMCCE, LESIA, PADC)



CBK-PAN Warsaw



Jacobs Univ. Bremen



CNRS  
(CDS IPSL IPAG  
IRAP)



IWF Graz



IASB-BIRA  
Brussels



SpaceFrog Toulouse  
**SPACEFROG.**

OATS/INAF Trieste



DLR Berlin



+ Contributions from  
the community

UPV/EHU Bilbao



Univ. Bristol



UCL London



SINP-MSU Moscow



Univ. Heidelberg



# VESPA Europlanet-2020: What has been provided to the community?

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

**VESPA portal** <http://vespa.obspm.fr>

2- A set of data services provided by VESPA participants and other teams:

**52 data services open at the end of EPN2020**

**Includes ESA's PSA (10+ million files!)**

**New or updated infrastructures: SSHADE, PVOL, AMDA**

3- Connection with powerful display and analysis tools:

**Tools from astronomy (VO, with planetary science updates)**

**+ Earth observation (GIS) + space archives (PDS)**

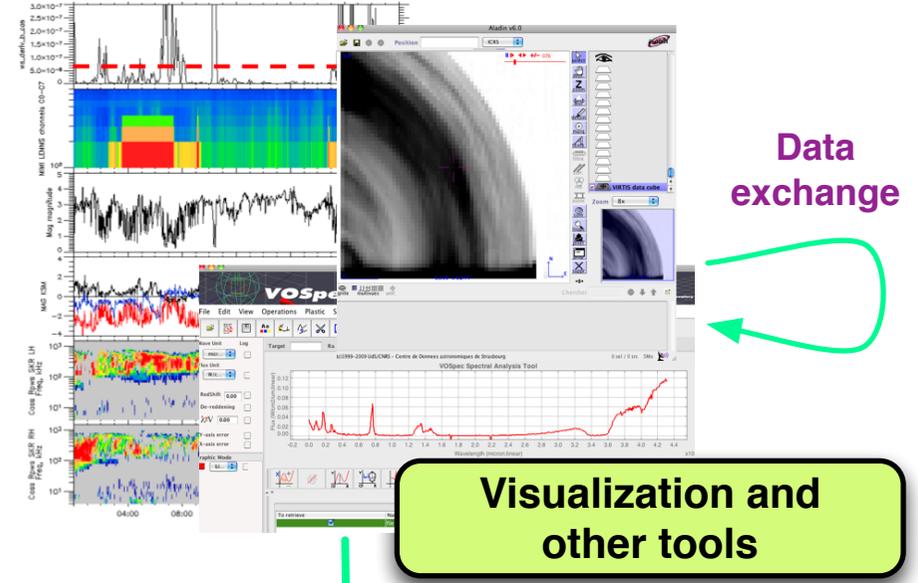
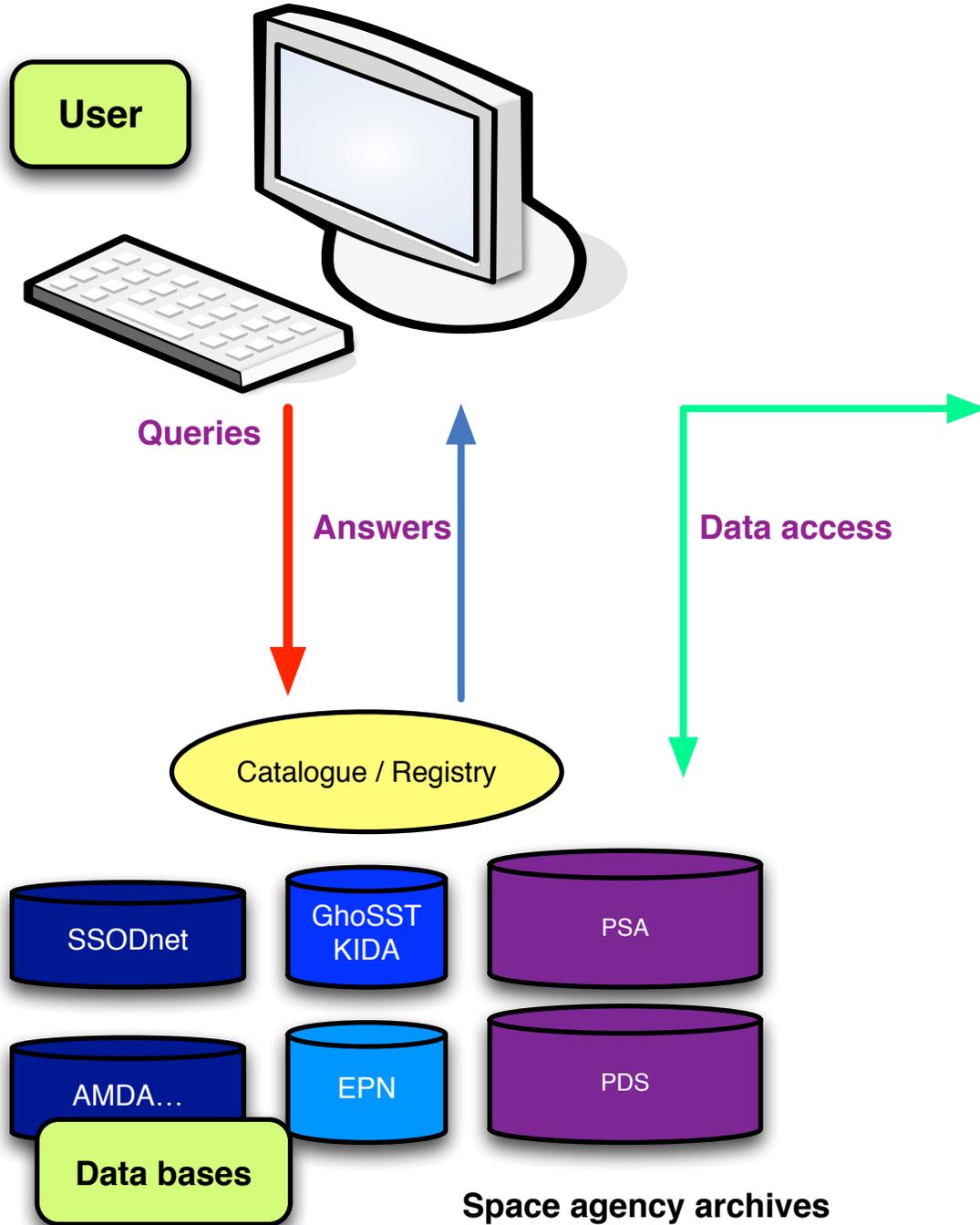
(plus the required infrastructure and standards, docs)

(plus dissemination & intense networking in community and consortia)

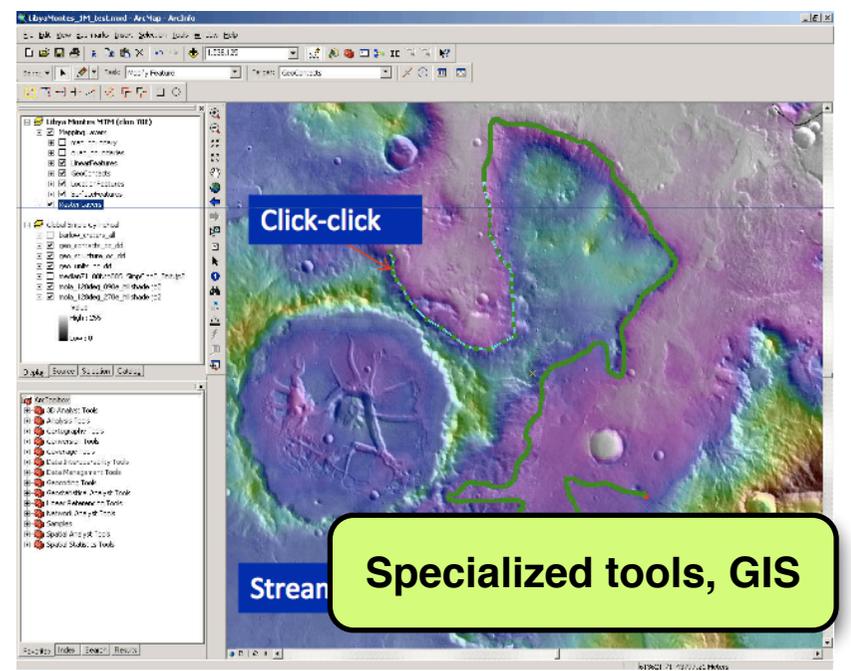
**=> Open Science system, providing FAIR access to the data**



# User's experience



**Visualization and other tools**



**Specialized tools, GIS**

# VESPA in EPN 2024: status, objectives

**Continuation of successful activity in EPN2020**

**=> Extension of Virtual Observatory for Planetary Science & solar system studies**

**Evolution from Data stewardship to Enabling data analysis**

- Strong action about sustainability of data services
- Coupled with upper level functions, e.g. Machine Learning, GMAP...

**Some activities detailed below...**

# Infrastructure

**Making data more FAIR; adding processing functions**

- **Move to EOSC**

**=> Data services on cloud; processing close to the data**

Parallel activity: EOSC early adopters programme (VESPA-Cloud, on-going)

- **Codes on line**

**=> Adapt OPUS platform from CTA & ESCAPE** (on local cluster then EOSC); authentication supported by GEANT / eduTEAMS

- **doi infrastructure for datasets**

**=> adapted from CNES dev. Will connect data and publications**

- **NoSQL/ElasticSearch applications of EPNCore**

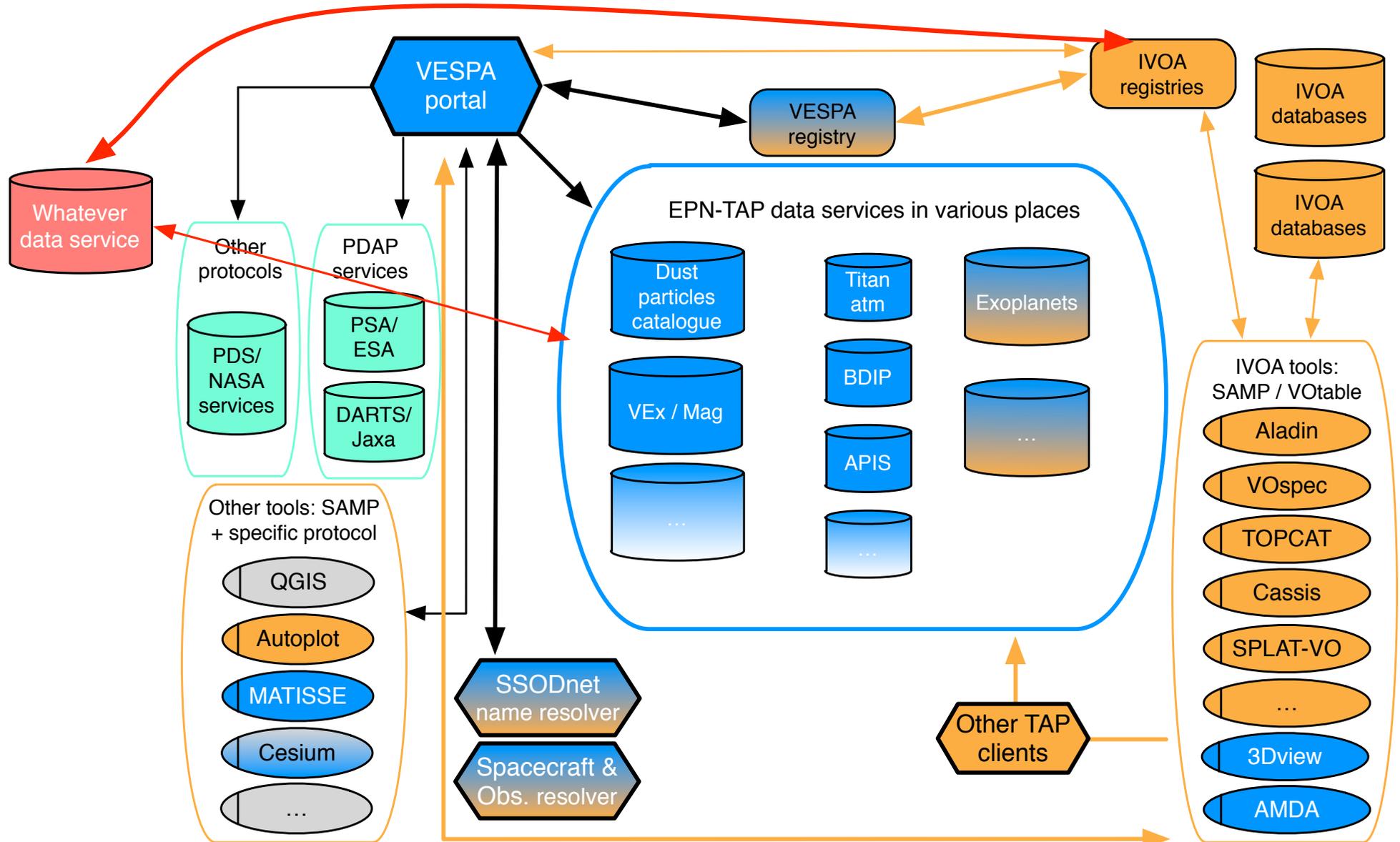
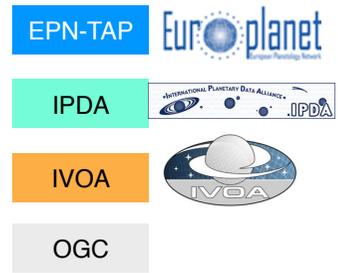
**=> set up a bridge with NASA PDS4 archives**

# A Virtual Observatory in Planetary Science

Built on astronomical VO developments

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

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



## Tools and interfaces

Improve visu and analysis functions

- Upgrade VESPA portal

=> Improvement of interfaces via User Experience analysis

- Upgrade of VO tools

=> Involves main VO tools (Aladin, CASSIS, TOPCAT) and servers (DaCHS)

New functions related to handling of footprints, adaptive resolution, etc

Based on upgraded data description



Form

Query

EPN-TAP Services

Custom Service

Main Parameters

Target Name

Target Class

Dataproduct Type

Instrument Host Name

Instrument Name

Processing level

Time

Location

Spectral

Illumination

EPN Resources

- abs\_cs - Data for numerical modeling of planetary atmospheres 13 results
- AMDA - Planetary and heliophysics plasma data at CDP/AMDA 1217441 results
- APIS - Auroral Planetary Imaging and Spectroscopy 55371 results
- BASECOM - The Nançay Cometary Database 15611 results
- bass2000 - Bass2000 solar survey archive 313365 results
- BDIP - Base de Données d'Images Planétaires 16906 results
- cassini\_jupiter - Cassini RPWS/HFR Calibrated Jupiter Flyby Dataset 7 results
- CLIMSO - CLIMSO coronagraphs at pic du midi de Bigorre 808951 results
- cpstasm - CLUSTER STAFF-SA Spectral Matrix Data 11688 results
- DynAstVO - Asteroid orbital database and ephemerides 20659 results

Results in service VEx

Show 10 entries  
 Column visibility Show all Hide all  
 Select All in current page Reset Selection

id	dataproduct_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...

Showing 91 to 100 of 15,682 entries

Plotting tools

- TOPCAT
- Aladin
- SPLAT
- CASSIS
- 3DView

Example queries

Saturn in March 2012

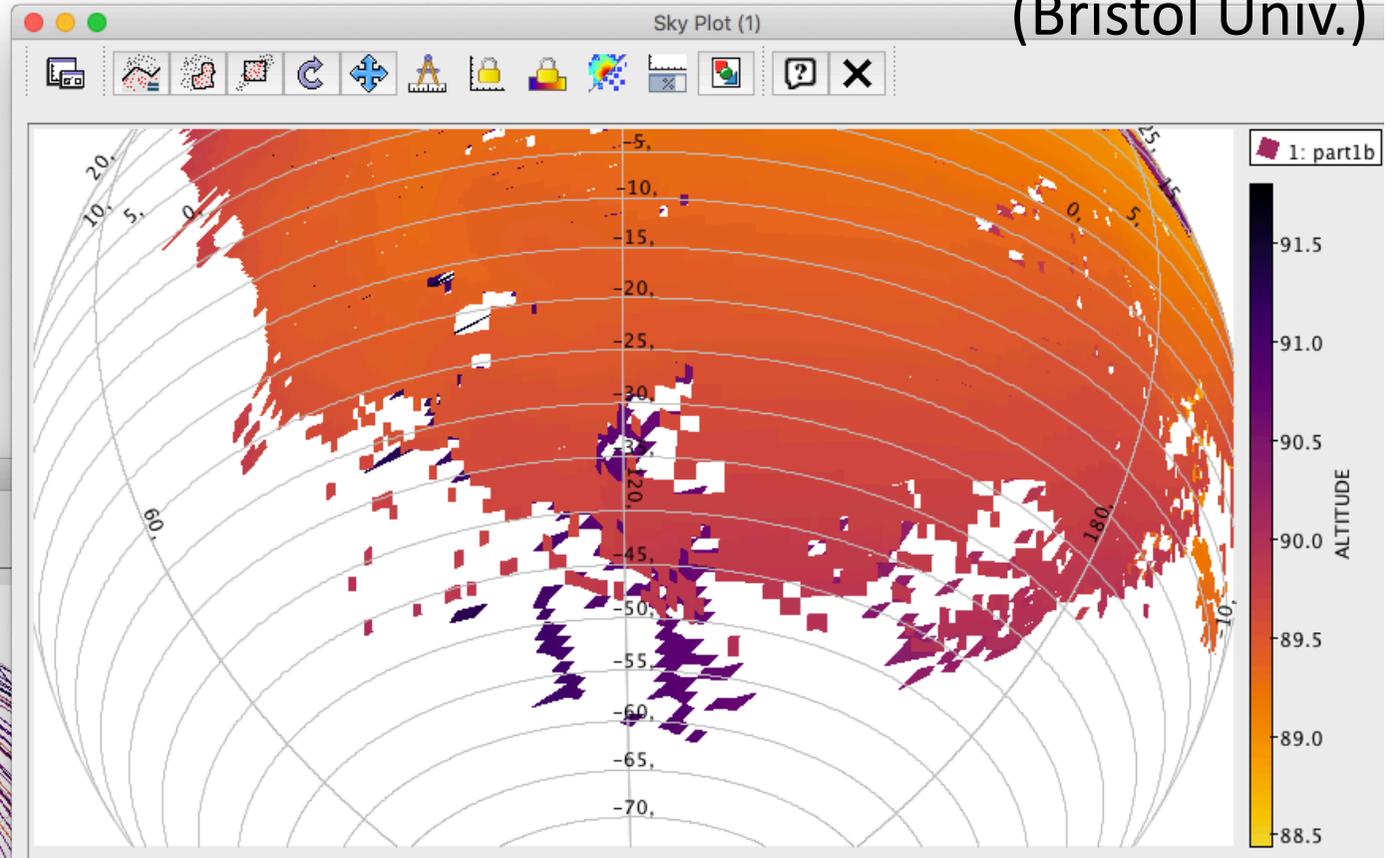
VESPA portal

http://vespa.obspm.fr



# New functions in VESPA

# Support for extended pixels in TOPCAT (Bristol Univ.)



VIRTIS/Rosetta observations of 67P, individual pixels

Position is defined by a quadrilateral instead of a point

Particularly useful for imaging spectroscopy and to display image footprints

# Design of internal services

## Set up computational services & workflows

- **VO-GIS bridge** => follow on of previous activity; use of common CRS in VO and OGC/GIS tools; improvements in GDAL lib (fits support)
  - **Surfaces** => **3D visu** (DTM); imaging spectroscopy data model; interface with USGS and GMAP services
  - **Time series** => das2 in AMDA and other tools
  - **General Circulation Models**: setup for Venus, upgrades for Mars
  - **VizieR Solar System catalogues**: prepare future EPN-TAP service
- ...

## New data services

**30-50 new services expected**

- **Internal services**

From VESPA and other WP in Europlanet 2024

- **Annual calls and implementation workshops**

First workshop in Toulouse, 2020; focus on H2020 / ERCs projects

- **Amateur services**

preselected => PVOL enlargement; RadioJove upgrade...

# Data services connected via EPN-TAP / field

Open  
Open in test  
In development  
Being studied

## Atmospheres

- \* - Titan profiles - CIRS (Cassini, LESIA)
- Venus spectroscopy - VIRTIS (VEx, LESIA)
- Mars Climate Database (modeling, LMD-LESIA)
- Venus profiles - SPICAV/SOIR (VEx, IASB-BIRA)
- Mars profiles - SPICAM (MEx, LATMOS)
- All MEx derived atmospheric products (via MEx IDS)
- Venus cloud products (LATMOS)

## Small bodies

- M4ast (ground based spectroscopy, IMCCE)
- 1P/Halley spectroscopy - (IKS / Vega-1, LESIA)
- BaseCom - (Nançay obs, LESIA)
- TNOs are cool - (Herchel & Spitzer + compilation, LESIA & LAM & Utinam)
- \* - SBNAF - (outcome of the H2020 prog, Konkoly Obs)
- Cometary lines catalogue (IAPS)
- Vesta & Ceres spectroscopy - VIR/DAWN (IAPS)
- \* - DynAstVO: NEO refined parameters (IMCCE)
- MPCorb: Small bodies orbital cat (MPC/Heidelberg)
- Rosetta ground-based support (via C. Snodgrass)
- 67P illumination config (IRAP)
- \* - Meteor\_showers predictions (IMCCE)

## Surfaces

- CRISM WMS service (MRO, Jacobs U)
- Mars craters (Jacobs U, + update by GEOPS)
- \* - USGS planetary maps (Jacobs U)
- M3 WMS service (Chandrayaan-1, Jacobs U)
- \* - HRSC data (MEx, Frei Univ)
- OMEGA cubes and maps (MEx, IAS)
- \* - VIMS calibrated/geometry cubes (Cassini, LPG)
- MarsSI GIS (Lyon)

## Solid spectroscopy

- \* - SSHADE: ices & minerals (IPAG & network)
- Planetary Spectral Library (DLR)
- \* - PDS spectral library (LESIA)
- Berlin Reflectance Spectral Lib (DLR)

## Magnetospheres / radio

- \* - APIS (HST/Cassini, LESIA)
- NDA (Jupiter radio Nançay, LESIA) \* New/updated in 2019/20
- AMDA (CDPP / IRAP)
- MAG data (VEx, IWF Graz)
- \* - MASER & Juno support (LESIA) + associated services
- RadioJove (LESIA & US amateur network)
- \* - Iitate HF data of Jupiter (Tohoku Univ, Jap)
- UTR-2 Juno ground support (Kharkiv)
- MDISC (modeling, UCL)
- \* - Cluster & Themis data (IAP, Prague)
- Interface with IMPEx models (IWF Graz)
- Hisaki (Tohoku Univ., Jap)
- \* - Transplanet (CDPP / IRAP)
- \* - LOFAR Jupiter (SRC/PAS, Varsovie)

## Exoplanets

- Encyclopedia of exoplanets (compilation, LUTH/LESIA)
- Transit observations (Bern)
- Interface with DACE (Geneva)

## Solar

- HELIO AR & 1T3 solar features catalogues (LESIA)
- \* - Bass2000 (LESIA)
- Radio Solar db (Nançay, LESIA)
- \* - CLIMSO (Pic du Midi, IRAP)
- \* - Iitate AMATERAS (Tohoku Univ, Jap)

## Generic / interdisciplinary

- BDIP (LESIA)
- Planets then satellites characteristics (LESIA/IMCCE)
- \* - PVOL (UPV/EHU & amateur network)
- Gas absorption cross-sections (Granada)
- \* - Nasa dust catalogue (IAPS)
- Stellar spectra, support for observations & exopl. (LESIA)
- Telescopic planetary spectra collection (LESIA)
- Interface with VAMDC (TBD)
- \* - PSA complete archive (ESA)
- \* - HST planetary data (LESIA, to CADC archive)
- DARTS (JAXA - currently via PDAP)



## Consolidation

- 3 VESPA hubs

=> **ObsParis, Heidelberg, Trieste will backup data services and possibly substitute for providers with IT policy issues**

Other solutions to be studied, including containers (Docker) and EOSC

- Good practices for providers (gitlab, etc)
- Service monitoring, validators...
- Improving description of services & resources (UCDs, registry...)

## Standards & Sustainability

- **Will prepare docs for EPN-TAP (IVOA working draft)**

but also exoplanets DM, band lists, coord systems, etc

- Join activity with consortia (IVOA, IPDA...)

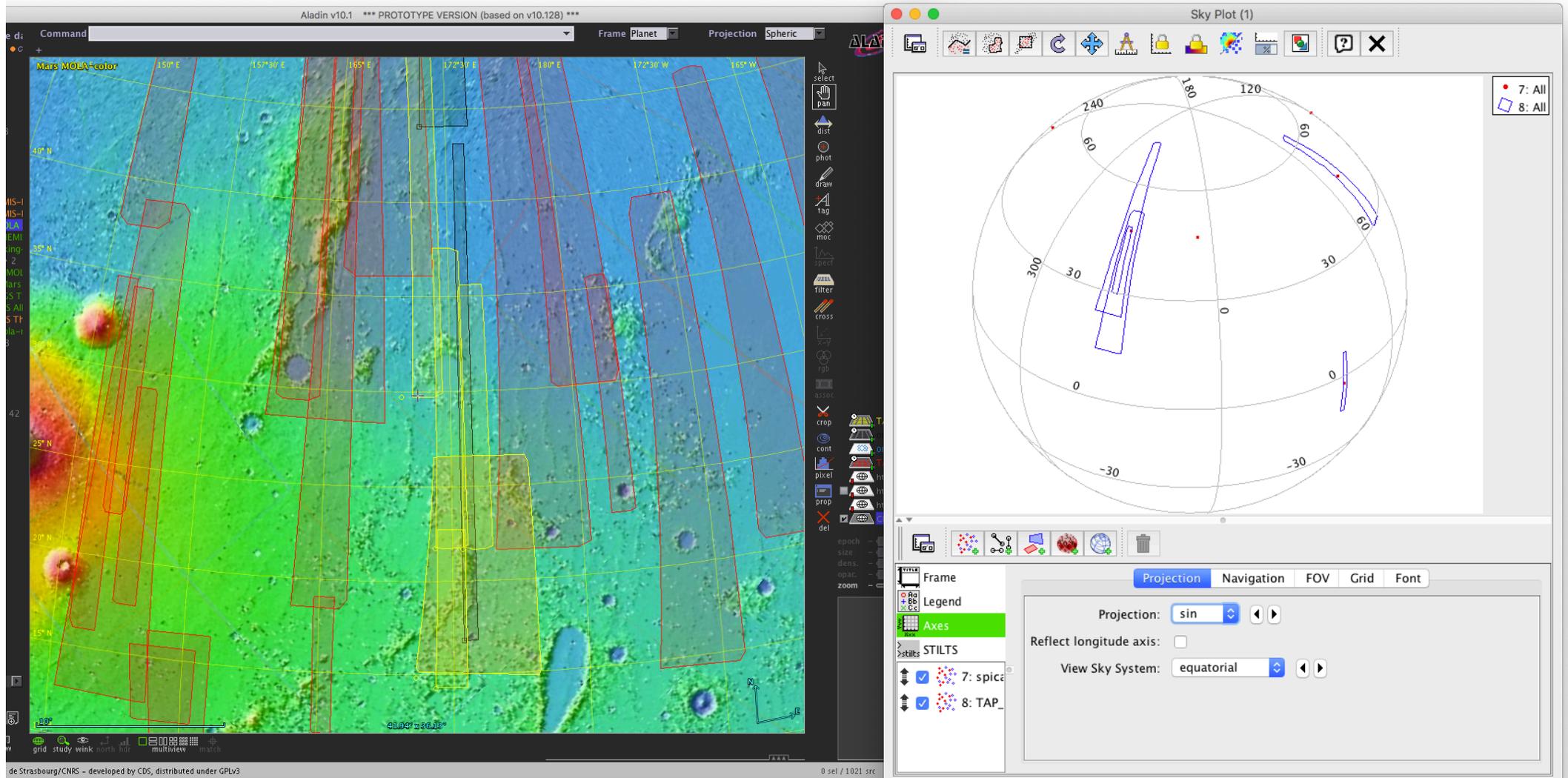
Solar System IG in IVOA

The Europlanet Society is now a member of IPDA

- Tutorials for users, focussing on practical situations

# Example tutorial (June 2019) 2D overlaps based on actual footprints, in TAP

Particularly useful to identify overlapping images / spectral cubes from different services, based on footprints (also with point features)



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



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

# Conclusion: VESPA prospects in EPN2024

- More data services
- Will secure existing services
  - regional hubs, services on European Open Science Cloud / EOSC, etc*
- Will be connected to other “Virtual Activities“:
  - space weather
  - machine learning
  - planetary mapping
- Will associate non-beneficiary teams/institutes, including outside EU

search interface      <http://vespa.obspm.fr>  
web site (with tutos)      <http://www.europlanet-vespa.eu>  
wiki      <https://voparis-confluence.obspm.fr>  
github      <https://github.com/epn-vespa>  
EPN2024 slack (short term interaction):  
<https://app.slack.com/client/T0L9WPQMN/C0L9WPQUQ>

