

Virtual European Solar & Planetary Access (VESPA) Access to Solar System & heliophysics data

Stéphane Erard
Baptiste Cecconi
Pierre Le Sidaner
Cyril Chauvin
Chloé Azria
Laura Debisschop
Vincent Génot
Nicolas André
Jean-Michel Glorian

Observatoire de Paris (PADC)

IRAP/CNRS, Toulouse (CDPP)

Bernard Schmitt
Damien Albert
Anni Määttänen
Ehouarn Millour
Frédéric Schmidt
Nicolas Manaud
Pierre Fernique

IPAG, Grenoble

IPSL/CNRS (LATMOS), Paris
IPSL/CNRS (LMD), Paris
IPSL/CNRS (GEOPS), Paris
Spacefrog, Toulouse
CDS/CNRS, Strasbourg



Journées ASOV 2022

11 April 2022

stephane.erard@obspm.fr

VESPA Europlanet-2024 / Participants



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)



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



Europlanet 2024 RI has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149

Science users, but also education / outreach

=> FAIR access

Scope:

Planetary Science

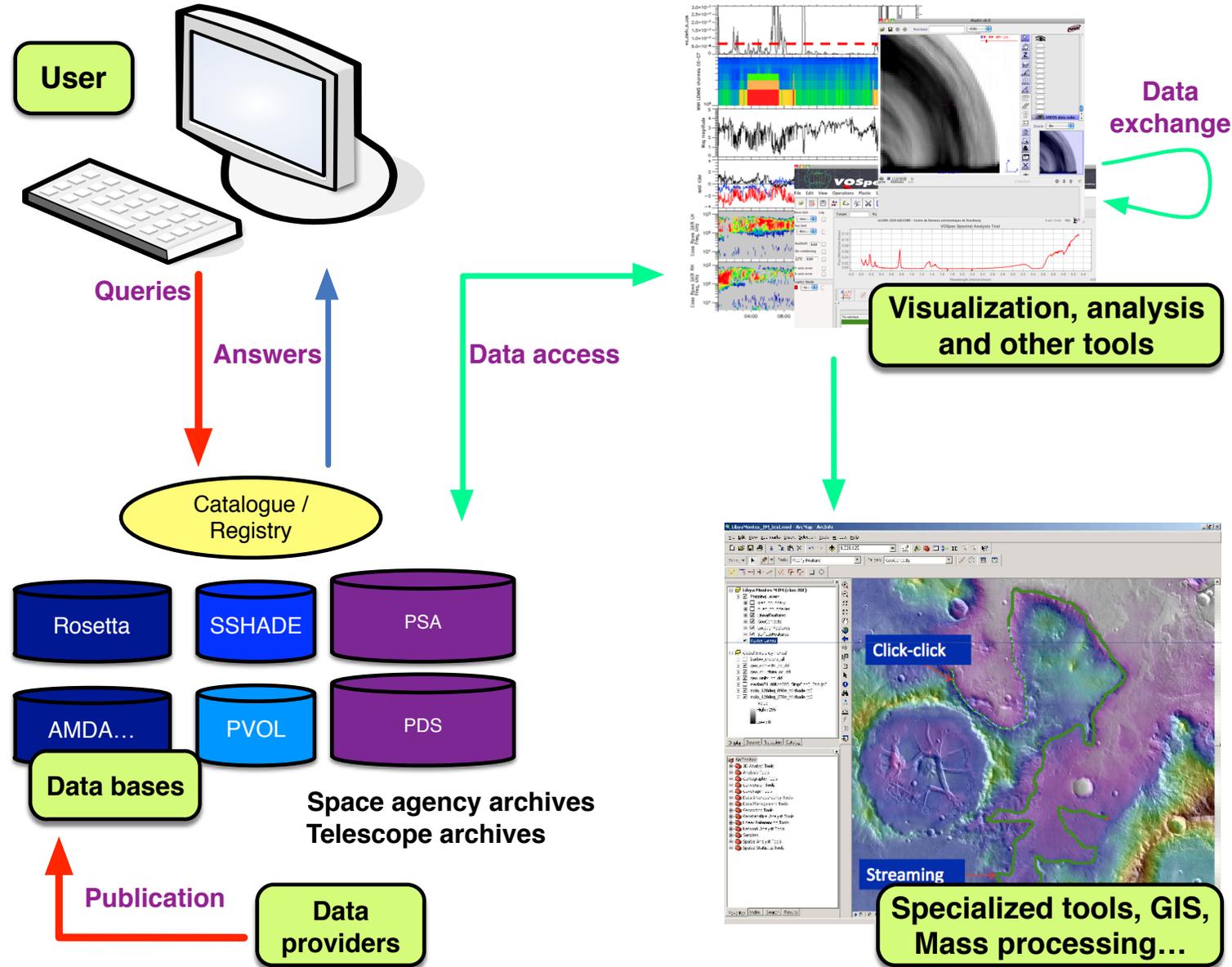
Heliophysics

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:

EPN-TAP: relies on TAP + adds specific vocabulary:

Mostly *reflected* light, but also particles, e-m fields + laboratory samples => new UCDs

Funny coverages: time scales/location, coord systems on many bodies (ellipsoids), etc

=> **EPNCore metadata** - IVOA standard; open to user feedback

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

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

Currently 62 data services published, ~ 15 more in development

Includes ESA's PSA (25+ million files!) + New or updated infrastructures: SSHADE, PVOL, AMDA..

Will include data produced during Europlanet 2024 RI (experimental & field studies)

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

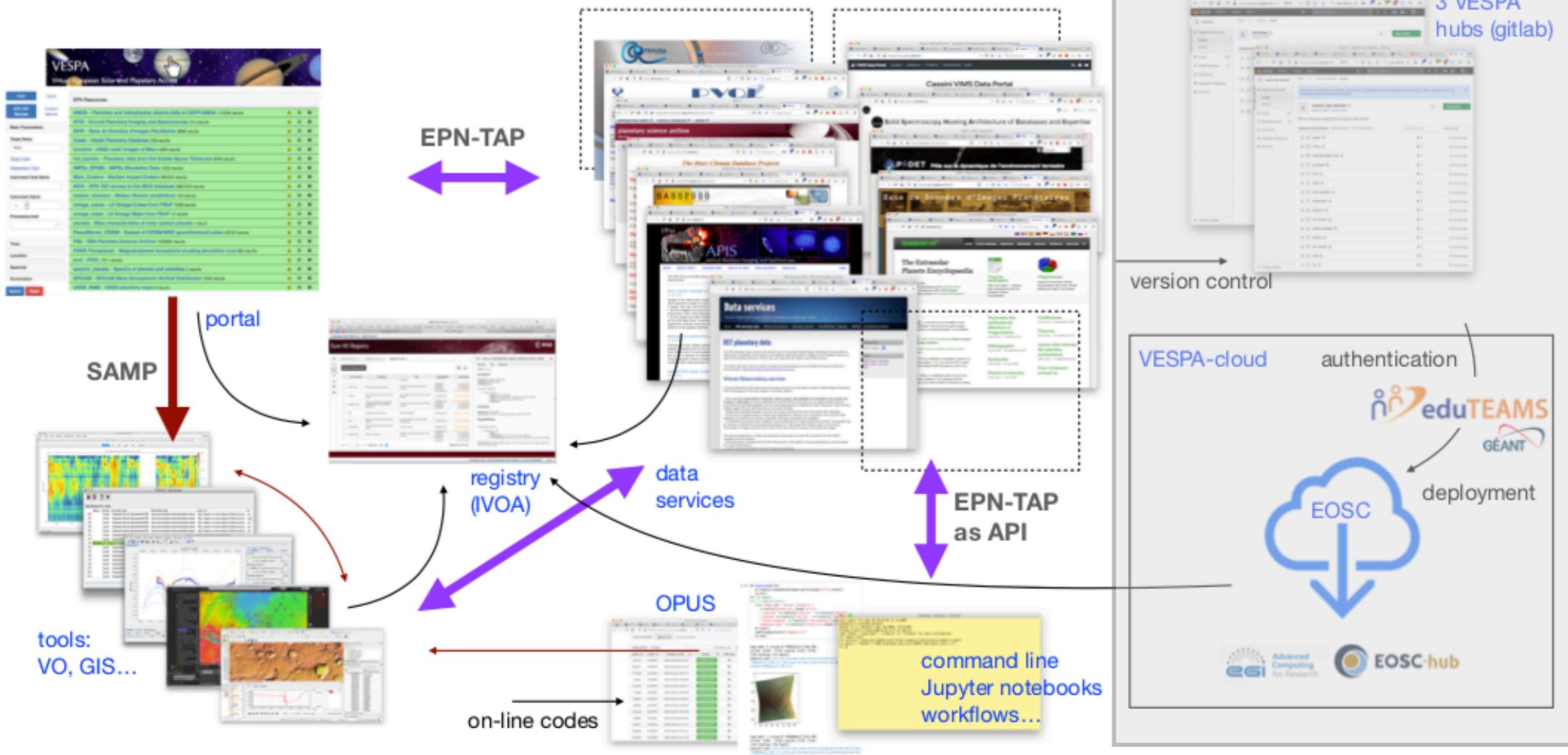
VESPA portal (other access modes are available)

4- Connection to powerful display and analysis tools:

Tools from astronomy (VO, with planetary science updates) + GIS and various environments

VESPA: infrastructure

Maintenance functions



VESPA: Recent developments

1- EPN-TAP protocol

Currently an IVOA Proposed Recommendation: <https://github.com/ivoa-std/EPNTAP>

Being updated / corrected according to RFC for coming Interop

2- Dedicated client (VESPA portal: <http://vespa.obspm.fr>)

Can query all EPN-TAP services together; uses SAMP, datalink, STC-S and MOC, etc

Supports other protocols (PDAP to ESA and JAXA, PDS keyword search to NASA)

Layout being improved; alternative facets-based search being implemented (ElasticSearch)

3- Servers

DaCHS 2.5 includes extended support and mixin; some services on **Vollt** (ESA PSA, VizieR_planets)

taplint 3.4.2 includes an **EPN-TAP validator**

4- Sustainability

Services preserved on a common gitlab. Allows quick deployment (including on EOSC, validated)

5- Workflows

OPUS platform used in VESPA; ML techniques being assessed

VESPA: Interfaces

1- EPN-TAP is TAP compliant

Any TAP client can access the services (does not depend on the VESPA portal)

2- New connected tools

Das2 (time series with adaptive resolution) => **Autoplot with SAMP**

WMS/WCS (georeferenced, OGS protocols) => **QGIS with SAMP and fits support** (via GDAL)

=> **HiPS/WMS converter** (see JCM's presentation)

Images => **ImageJ with SAMP and extended fits support** (provides processing functions to the VO)

3- New / coming functions

PDS4 (tables) **support in TOPCAT**

Spectral cubes: Aladin's CASSIS plugin (inputs for planetary science)

Spectral band lists support in CASSIS (inputs for planetary science; data in SSHADE, see Bernard's)

Spectral analysis (surfaces): workflow project

Dynamic spectra (radio): workflow project (see Baptiste's 2021 presentation)

Europlanet VESPA: Data services connected via EPN-TAP / field

Open
Open in test | upgrade required
Drafted
Scheduled 2024 (selection)
• New or upgraded in 2021/22
• New content in 2021/22

Atmospheres

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

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 (from H2020 prog, Konkoly Obs)
- MP3C: Small body properties (OCA)
 - Vesta & Ceres spectroscopy - VIR/DAWN (IAPS)
- DynAstVO: NEO refined parameters (IMCCE)
- MPCorb: Small bodies orbital cat (MPC/Heidelberg)
 - Rosetta ground-based support (Edinburgh)
 - 67P illumination config (IRAP)
 - Meteor_showers predictions (IMCCE)
 - Occultations predictions, ast & sat (IMCCE)
 - LuckyStar, occultations (ERC prog, LESIA)
 - Natural satellites db (IMCCE)
- VizieR asteroid spectra (CDS / LESIA)

Solid spectroscopy

- SSHADE ices & minerals spectro (IPAG & network)
 - Planetary Spectral Library (DLR)
 - PDS spectral library (LESIA)
 - Berlin Reflectance Spectral Lib (DLR)
 - Hoserlab (Winnipeg U)

Surfaces

- Mars craters (Jacobs U, + update by GEOPS)
 - USGS planetary maps WMS (Jacobs U)
- PlanMap: geol maps (H2020 prog, Jacobs U)
 - CRISM WCS service (MRO, Jacobs U)
 - M3 WMS service (Chandrayaan-1, Jacobs U)
 - HRSC nadir images, WMS (MEx, Frei Univ)
 - OMEGA cubes and maps (MEx, IAS)
- VIMS satellites, w/geometry (Cassini, LPG)
- Mars topo preTharsis (GEOPS)
 - Global spectral param of Mercury (DLR)

Magnetospheres / radio

- APIS (HST/Cassini, LESIA)
- NDA (Jupiter & Sun radio, LESIA/CDN)
- AMDA (CDPP / IRAP)
 - MAG data (VEx, IWF Graz)
- MASER & related services (LESIA)
 - RadioJove (LESIA & US amateur network)
 - Iitate HF data of Jupiter (Tohoku Univ, Jap)
 - UTR-2 Juno ground support (Kharkiv)
 - MDISC & JASMIN (modeling, UCL)
 - Cluster & Themis data (IAP, Prague)
 - IMPEX models (from FP7 prog, IWF Graz)
- Hisaki (Tohoku Univ., Jap)
 - Transplanet (CDPP / IRAP)
- LOFAR Jupiter (CBK/PAS, Warsaw)
 - Magnetic field simus (LMSU)
 - ASPERA & MARSIS atm obs (MEx, Iowa U)

Solar

- HELIO AR & 1T3 solar features (FP7 prog, LESIA)
- Bass2000 (LESIA)
 - Radio Solar db (Nançay, LESIA)
- CLIMSO (Pic du Midi, IRAP)
- IPRT/AMATERAS (Tohoku Univ, Jap)
 - Gaia-DEM (SDO, IAS)
 - EIT_syn (SoHO, IAS)
 - e-Callisto (Windisch, Sw)

Generic / interdisciplinary

- BDIP (LESIA)
- PVOL (UPV/EHU & amateur network)
 - Telescopic planetary spectra collection (LESIA)
- PSA complete archive (ESA)
- HST planetary data (LESIA, to CADC archive)
 - Catalogues of planetary maps (Budapest)
- VizieR_planets: Planetary Science catalogues (CDS)
 - Gas absorption cross-sections (Granada)
 - Planets then satellites properties (LESIA/IMCCE)
 - Nasa dust catalogue (IAPS)
 - Stellar spectra, support for observations (LESIA)
 - DARTS (JAXA - currently via PDAP)
 - ESA sky planetary data (ESA)
 - Interface with VAMDC ?

Exoplanets

- Encyclopedia of exoplanets (LUTH/LESIA)
 - Catalogue of exo disks (LESIA)
 - Interface with DACE (Geneva)
 - ARTECS climate simulations (AOTS/INAF)
 - Atmospheric studies (UCL)
- Exotopo: exoplanet surface simulations (GEOPS)

VESPA-F: national level

1- ANO / INSU:

Europlanet VESPA => 3 SNO in France: SSHADE (from GhoSST), VESPA, MASER

Connects elements from all SNOs in the field (MP3C in review; FRIPON in progress)

2- ANO5 VESPA:

Local data services in ObsParis (~ 20 public ones)

Plans to enlarge the service to other contributors (coming proposal)

VESPA portal = EPN-TAP client, with local registry

3- CNES-INSU data nodes (Pôles de Données):

Surfaces: organized around 3 ANO5 (VESPA, PSUP, SSHADE)

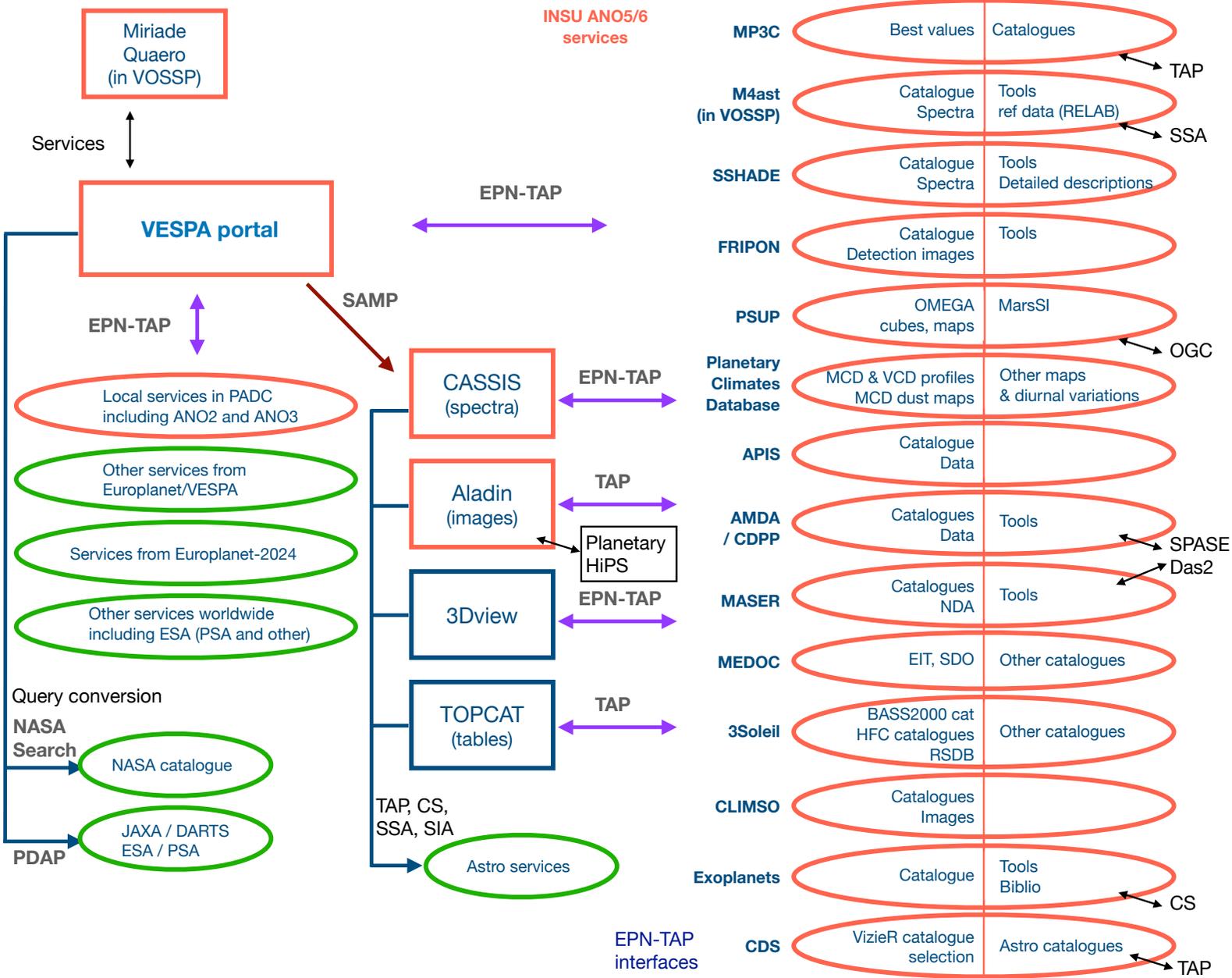
Small bodies: VESPA could provide interoperability as well

4- Sustainability:

Service definition files stored on a common gitlab

Cured by 3 teams via git issues, allow quick deployment (including on EOSC, validated)

VESPA & INSU services



Other interfaces on complete service

VESPA: Other usages

1- EPNCore is convenient for your own private work

Design your personal data tables / organisation in advance — will save time eventually

Any data table can use EPNCore consistent vocabulary

=> Will benefit from powerful visu/analysis VO tools: Aladin, TOPCAT, CASSIS, etc

Powerful data handling/management functions for private data (including space experiments)

2- Any institute/team can publish in the VO

Off-the-self solution to distribute results with high visibility

Light system, docs and tutos available + Support from VESPA team (See Chloé's presentation)

Infrastructure is maintained by the VO community

3- VESPA is designed to support projects from calls

Open Science policy:

National and EU-funded projects (ERC, H2020...) require the data to be made available

4- Guidelines:

Provide metadata, as complete as possible; Think about convenient formats

Larger projects may require a Data Management Plan (DPM)

VESPA: Challenges

0- Enforce sustainability

DOI, DMP... on-going

1- Access to PDS data

Some PDS4 products supported, depending on exact formats (√ tables, √ fits...)

PDS3 still challenging (existing IDL solutions with Jupyter notebooks)

2- Coordinate systems

Need for a consistent naming scheme

Need to be interoperable with OGC standards / tools

3- Facilities / observatory list

Ongoing in IVOA (see Laura's presentation)

4- Interoperability with space agencies / observatories:

√ ESA / PSA - include Guest Storage Facility?

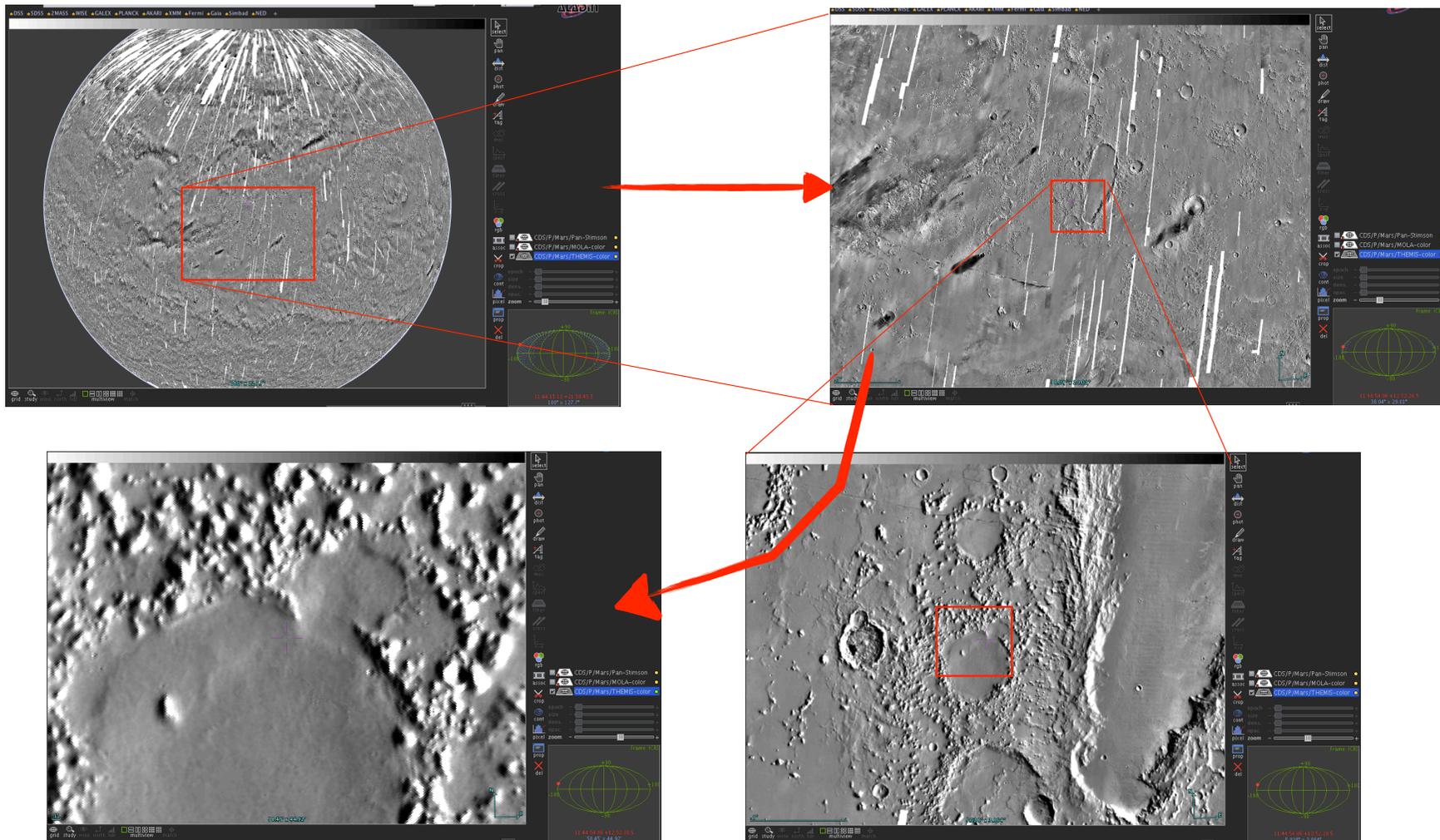
NASA, JAXA, ISRO? - discussed in the IPDA

ESO, CADK, Noirlab?

VESPA: Using VO tools in practical Planetary Science situations

VESPA and VO tools: images and maps

Multiresolution maps (HiPS) in Aladin



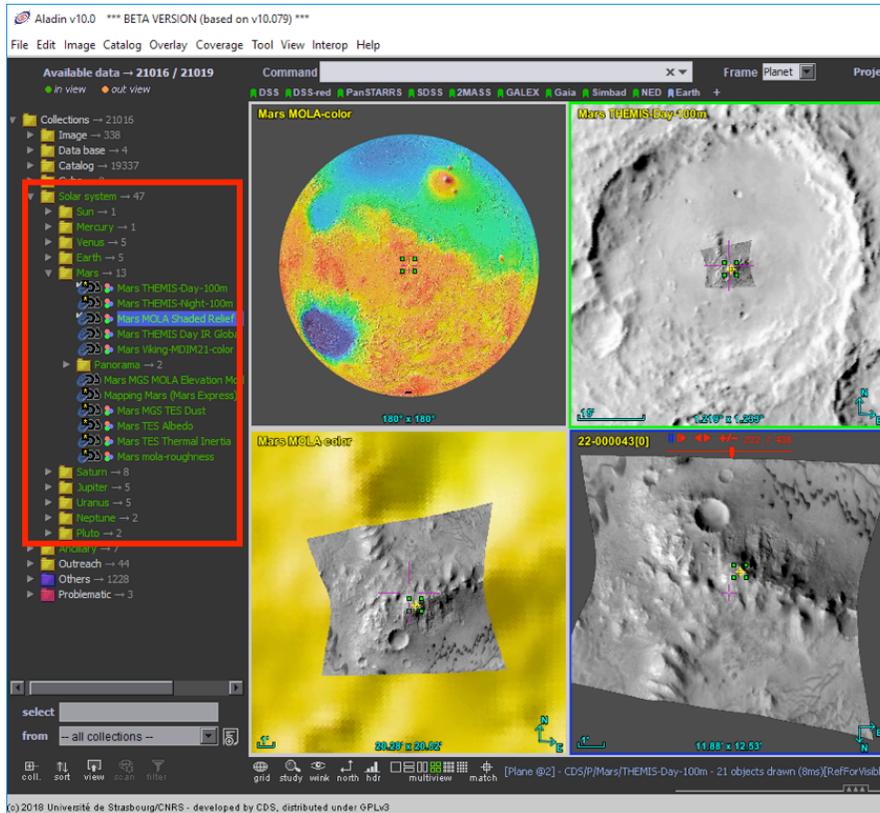
<http://aladin.u-strasbg.fr/AladinLite/doc/API/examples/mars-visualisation/>

Currently 60+ planetary HiPS available for use (from USGS maps and more)

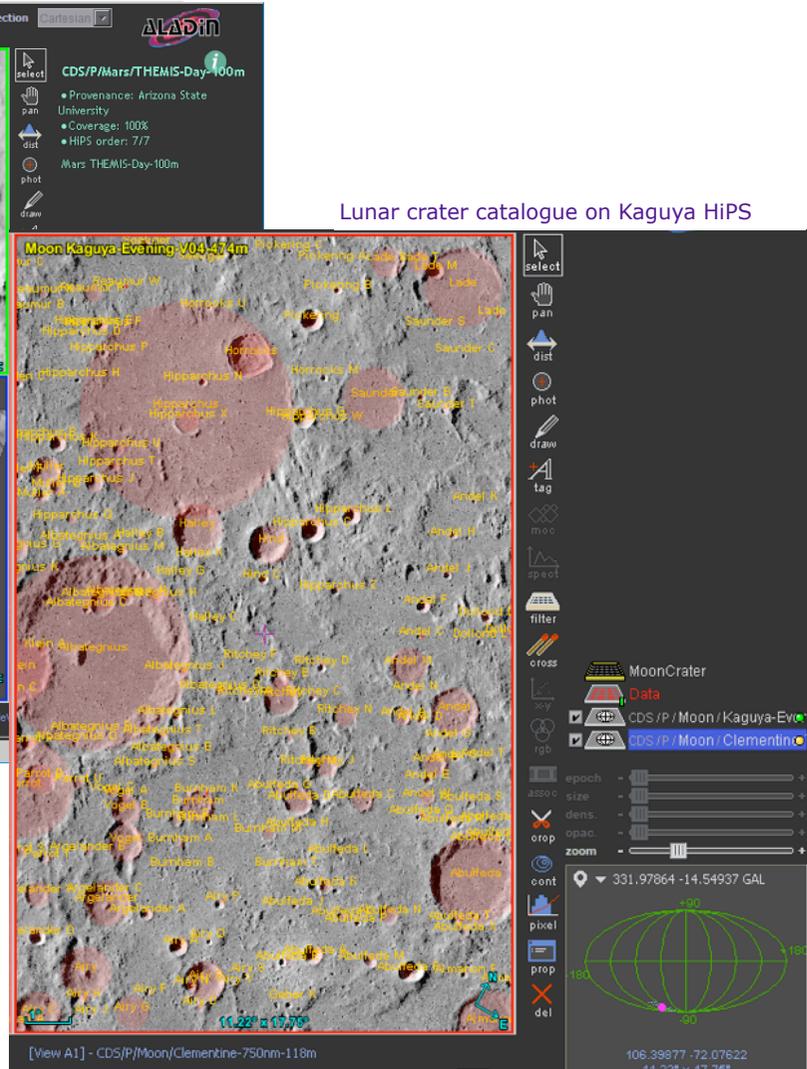
VESPA and VO tools: overplotting elements

Aladin (CDS/CNRS):

Georeferenced images + objects superpositions



CRISM cubes on MOLA HiPS



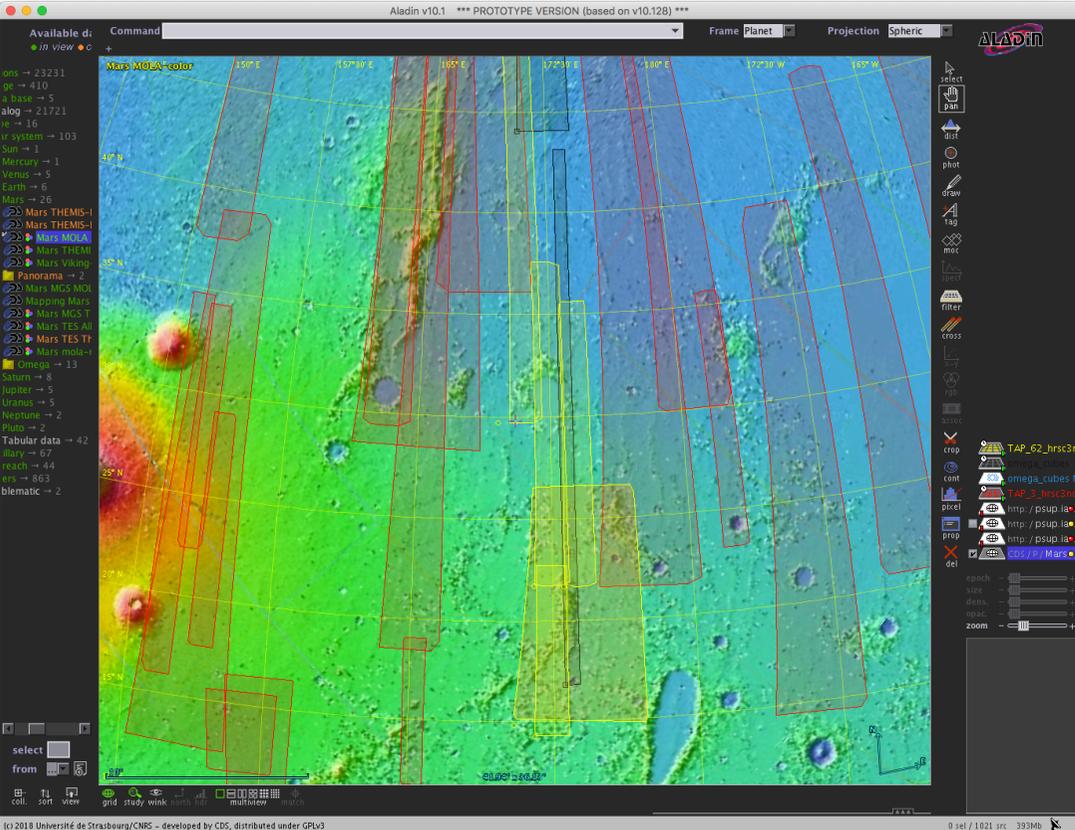
Lunar crater catalogue on Kaguya HiPS

Relies on IAU planetary coordinate frames (fits' WCS)

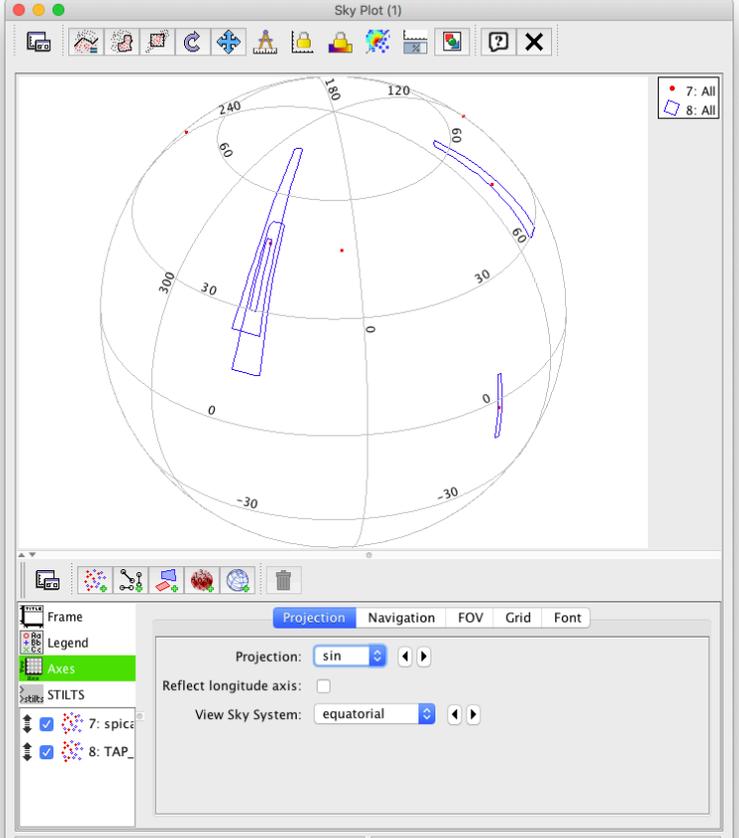
Footprint-based searches (STC-S strings) 2D overlaps based on actual footprints, in TAP
(MOCs to come, with additional temporal/spectral coverages)

Typical request:
identify overlapping images / spectral cubes from different datasets based on footprints (also works with point features)

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)

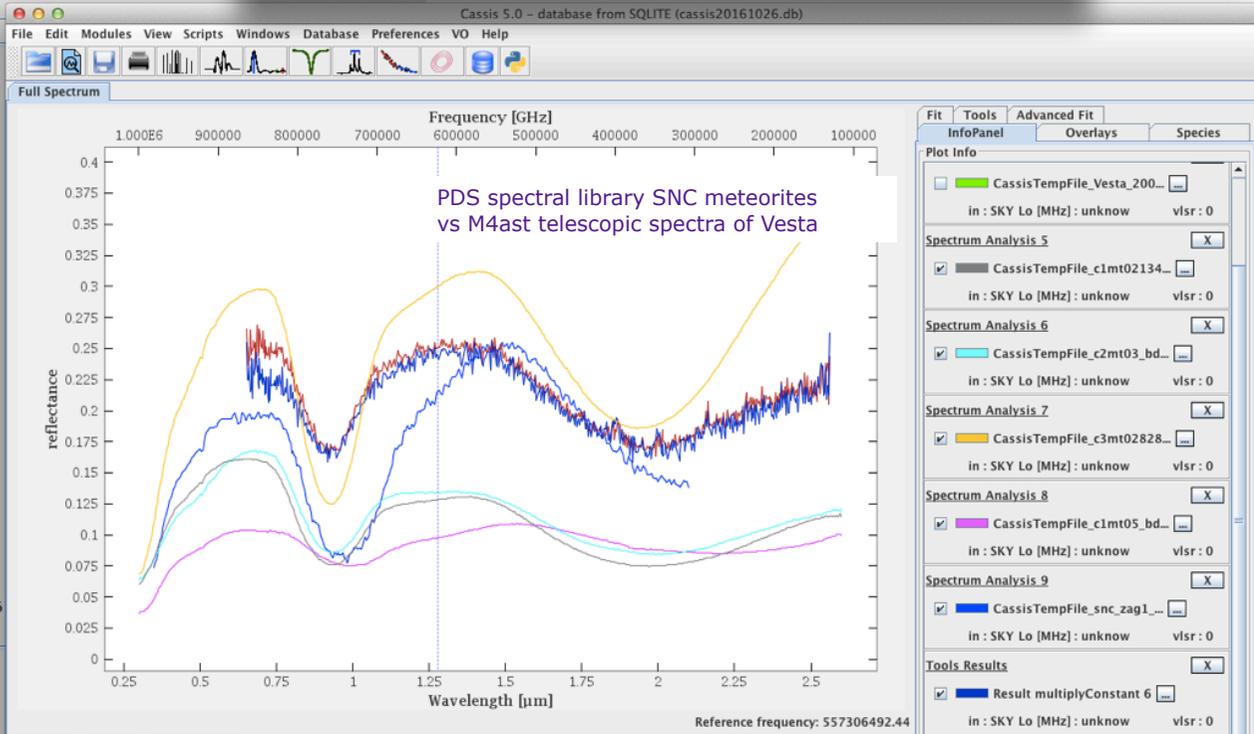
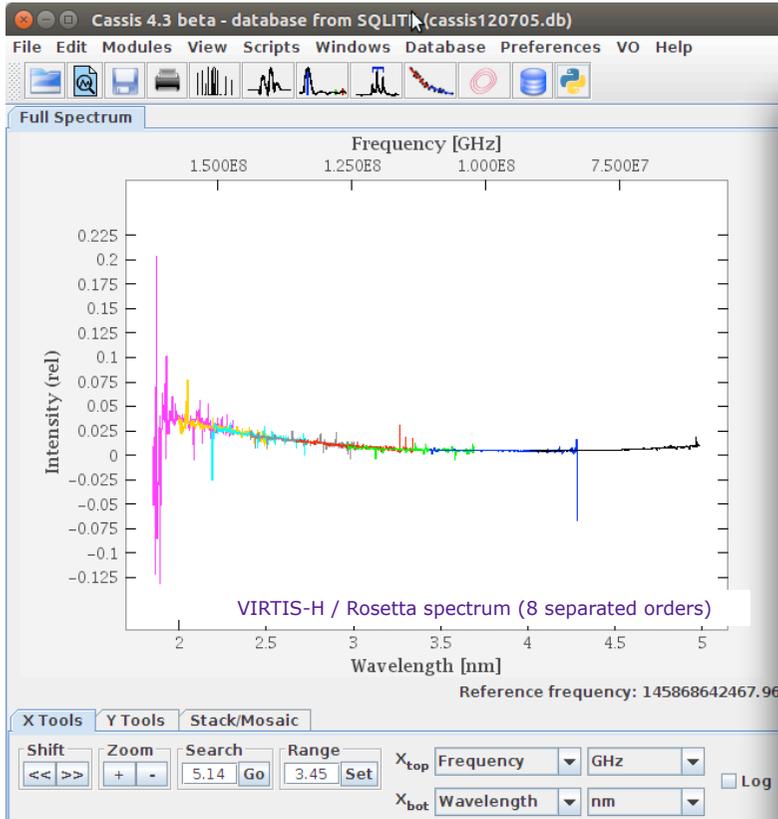
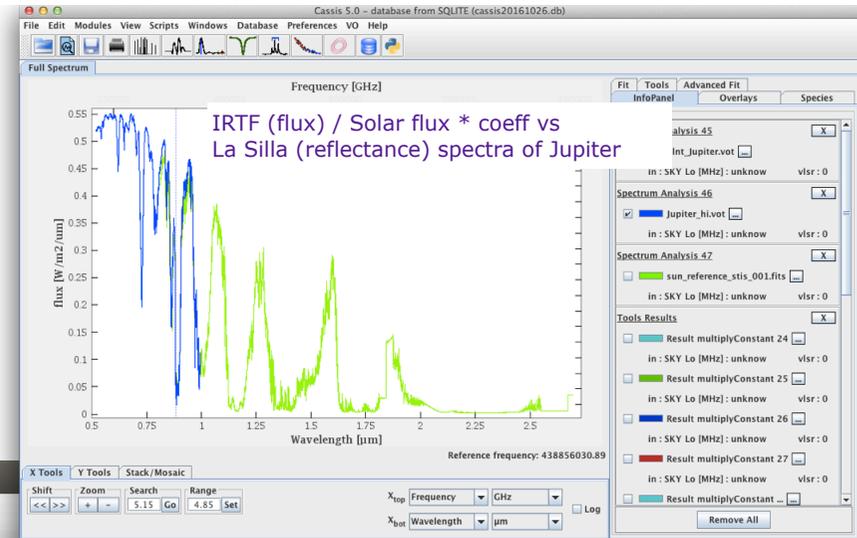


Selected SPICAM profiles (red) and overlapping HRSC images (blue) in TOPCAT (Mars-Express observations)

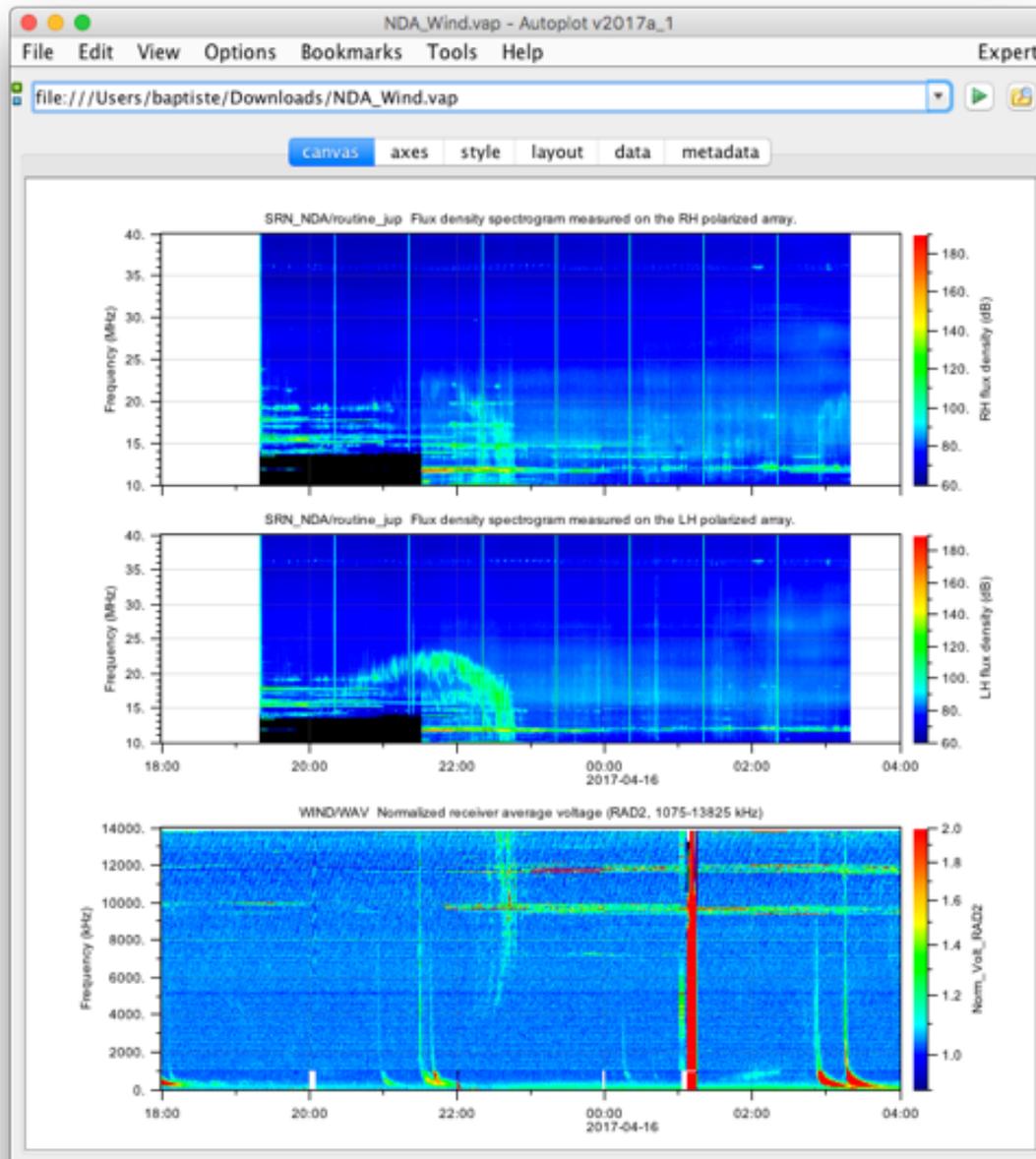
VESPA and VO tools: spectroscopy

CASSIS from v5 (IRAP/CNRS)

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



VESPA and VO tools: time series



Nançay Decameter Array

Wind/Waves

Autoplot (Iowa Univ):
time series / dynamic spectra
Support for das2 protocol
with adaptive resolution
SAMP connection added