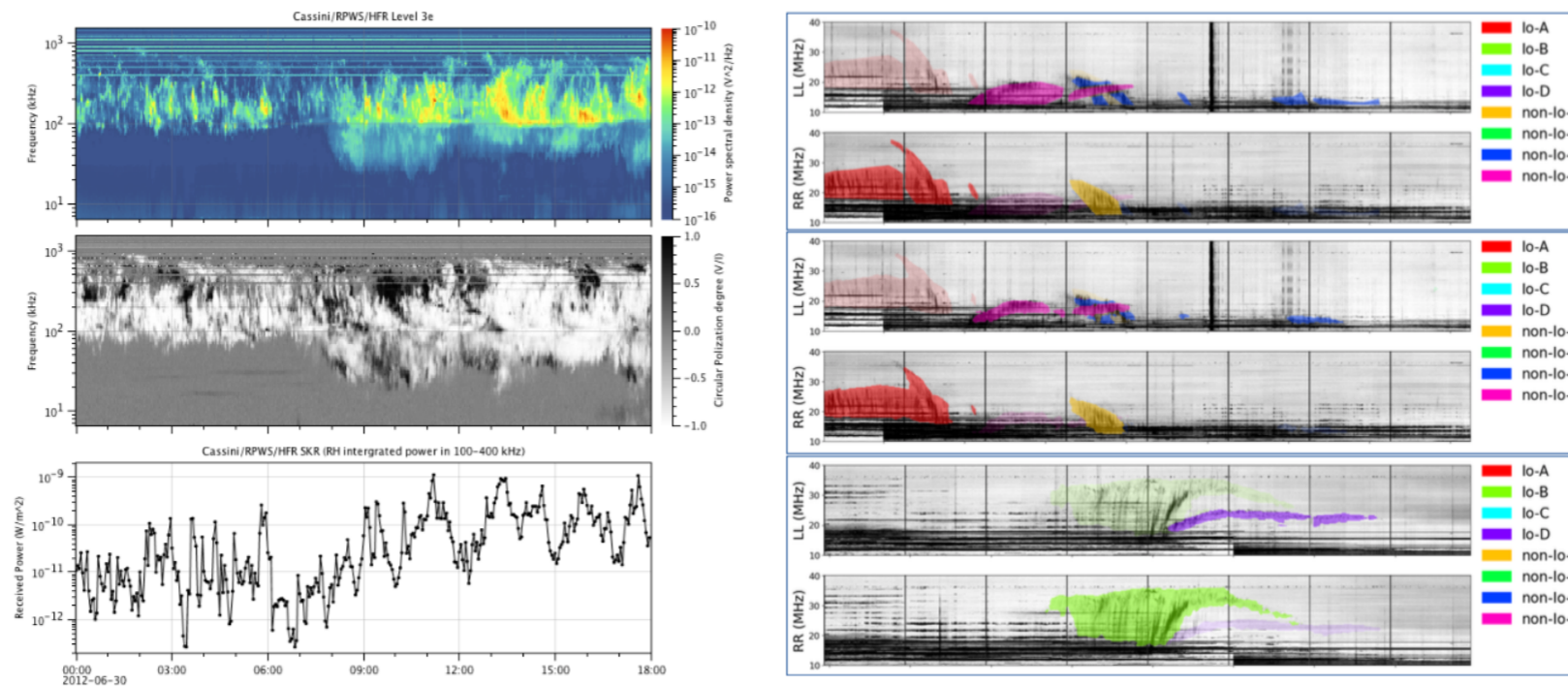


# MASER

## Measurement, Analyses, Simulations of Emissions in the Radio range <https://maser.lesia.obspm.fr>

- **Science-ready** and **Open science** Toolbox for low frequency radio astronomy  
**publishing, discovery, sharing, display, modeling ...**



Cecconi, B., Loh, A., Sidaner, P. L., Savalle, R., Bonnin, X., Nguyen, Q. N., et al. (2020). MASER: A Science Ready Toolbox for Low Frequency Radio Astronomy. *Data Science Journal*, 19(18), 1062. <https://doi.org/10.5334/dsj-2020-012>

The Europlanet-2024 Research Infrastructure project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149.

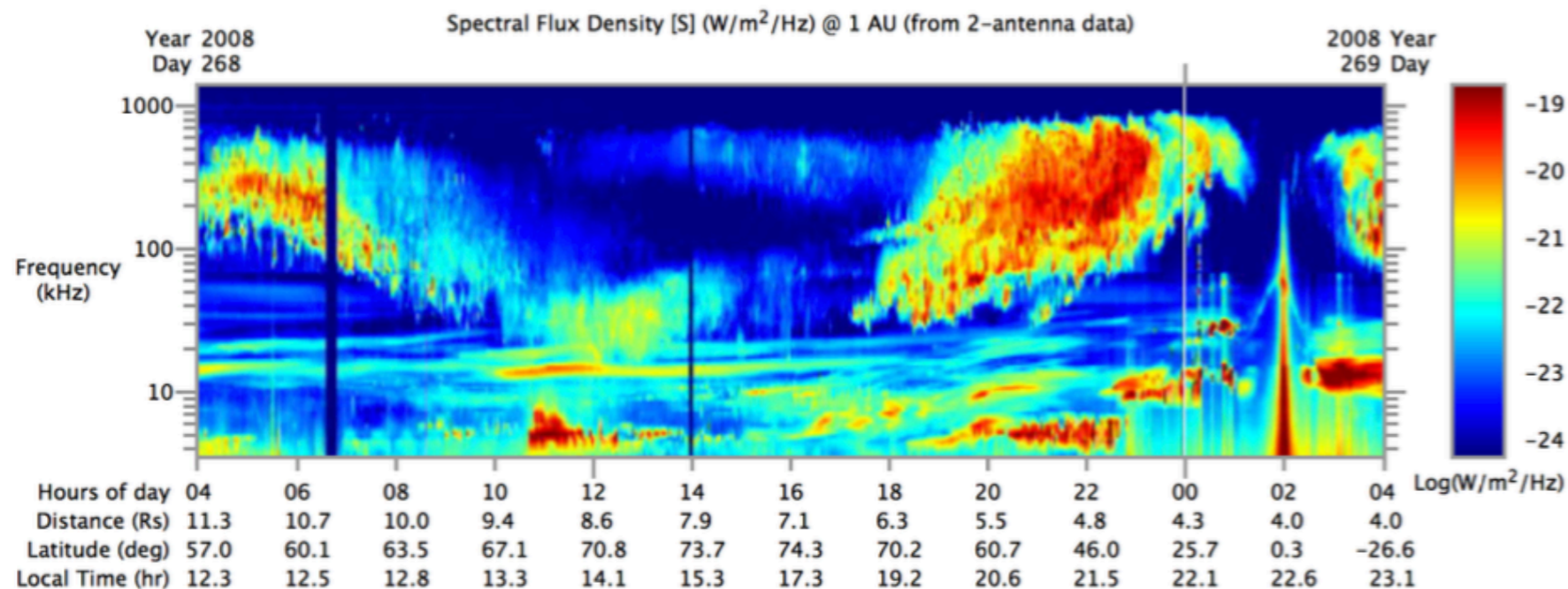
# MASER

## Why and for whom?

- Low frequency radioastronomy:
  - large collections (long time scales and/or high resolution...)
  - event/features not always predictibles (sporadic, intermittent...)
- Users needs:
  - **discovery** of datasets
  - online access for **visualisation**
  - python library for **programmatic access**
  - **annotation and sharing** of event/feature catalogues
  - **hosting** datasets

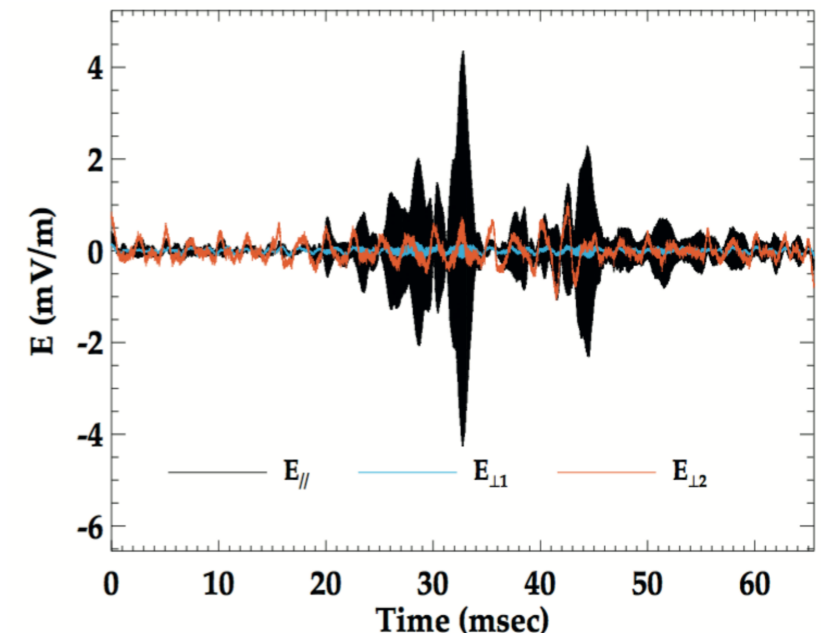
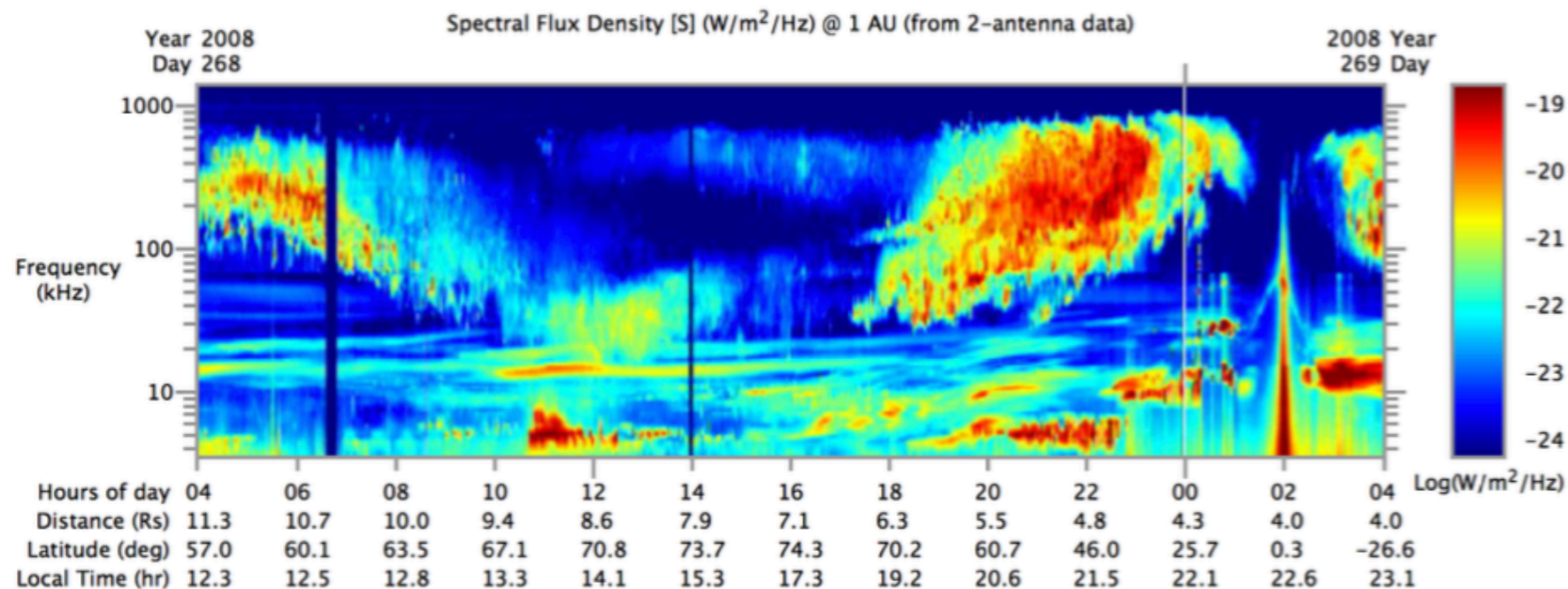
# Data product types

- Mostly **spectrograms (aka dynamic-spectra)**. Measured parameter (flux, polarization...) depending on time and frequency.
- Sometime: “**waveform**” (direct sampling of electric signal temporal fluctuations). Much higher data rate needed.
- also, **events**. timestamp + label + parameters (coverage) + data ? waveform snapshot can be considered as an event.
- and **catalogues** of events/features
- NB: *imaging data not in the scope of MASER*



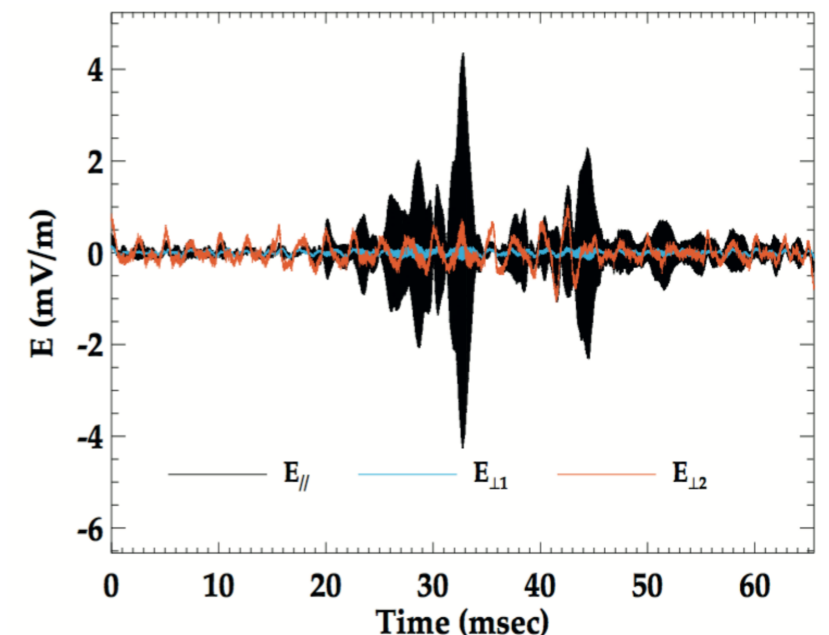
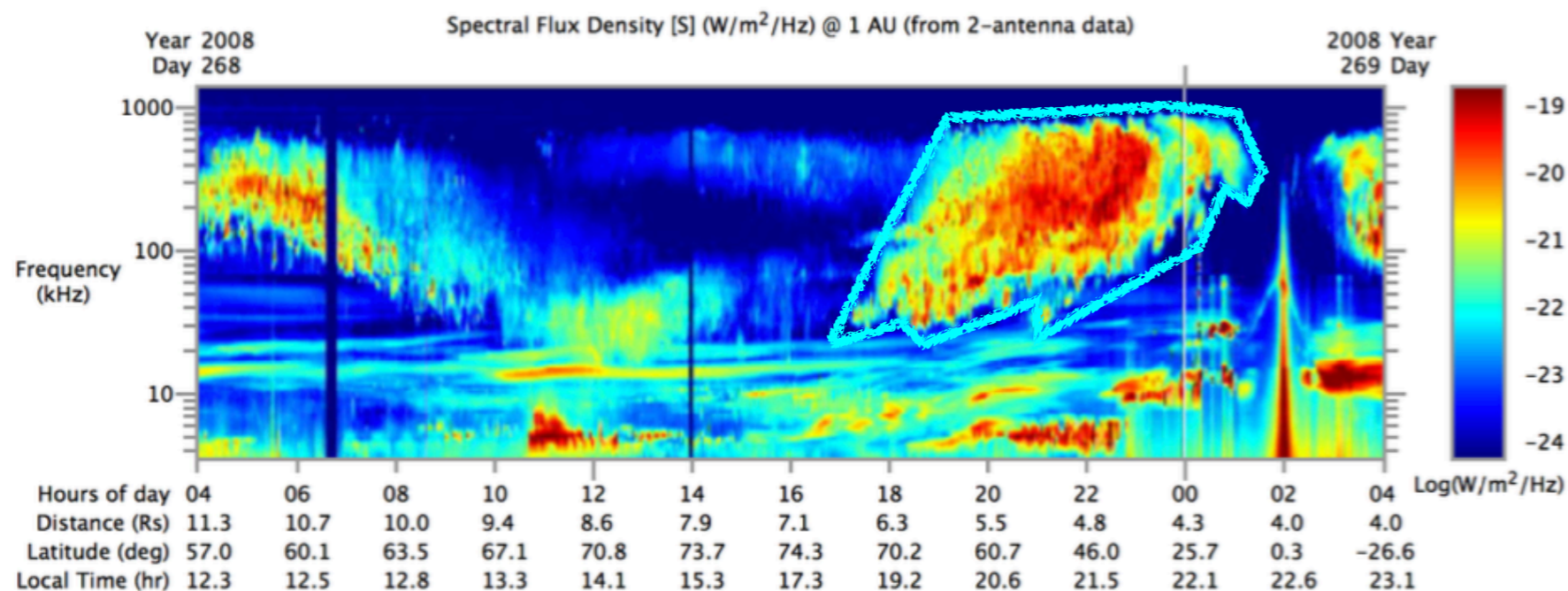
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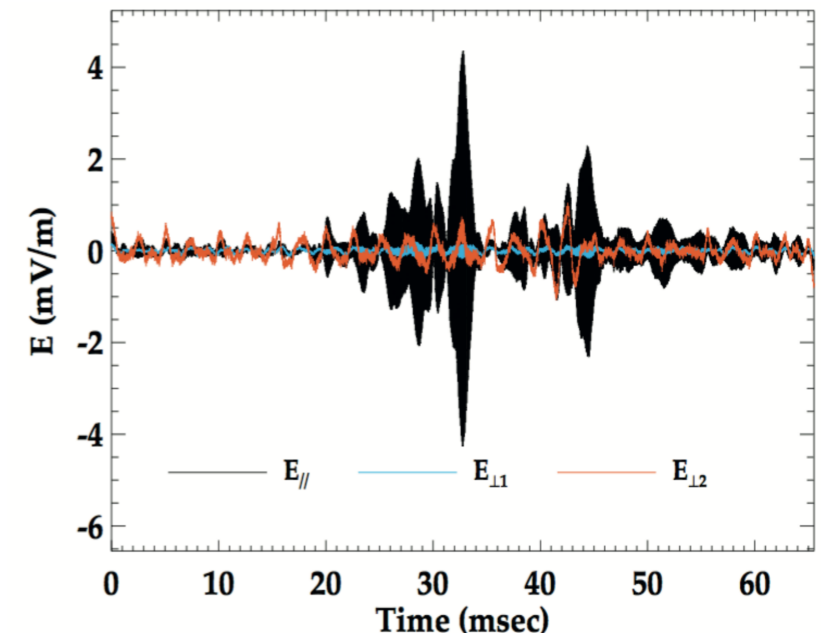
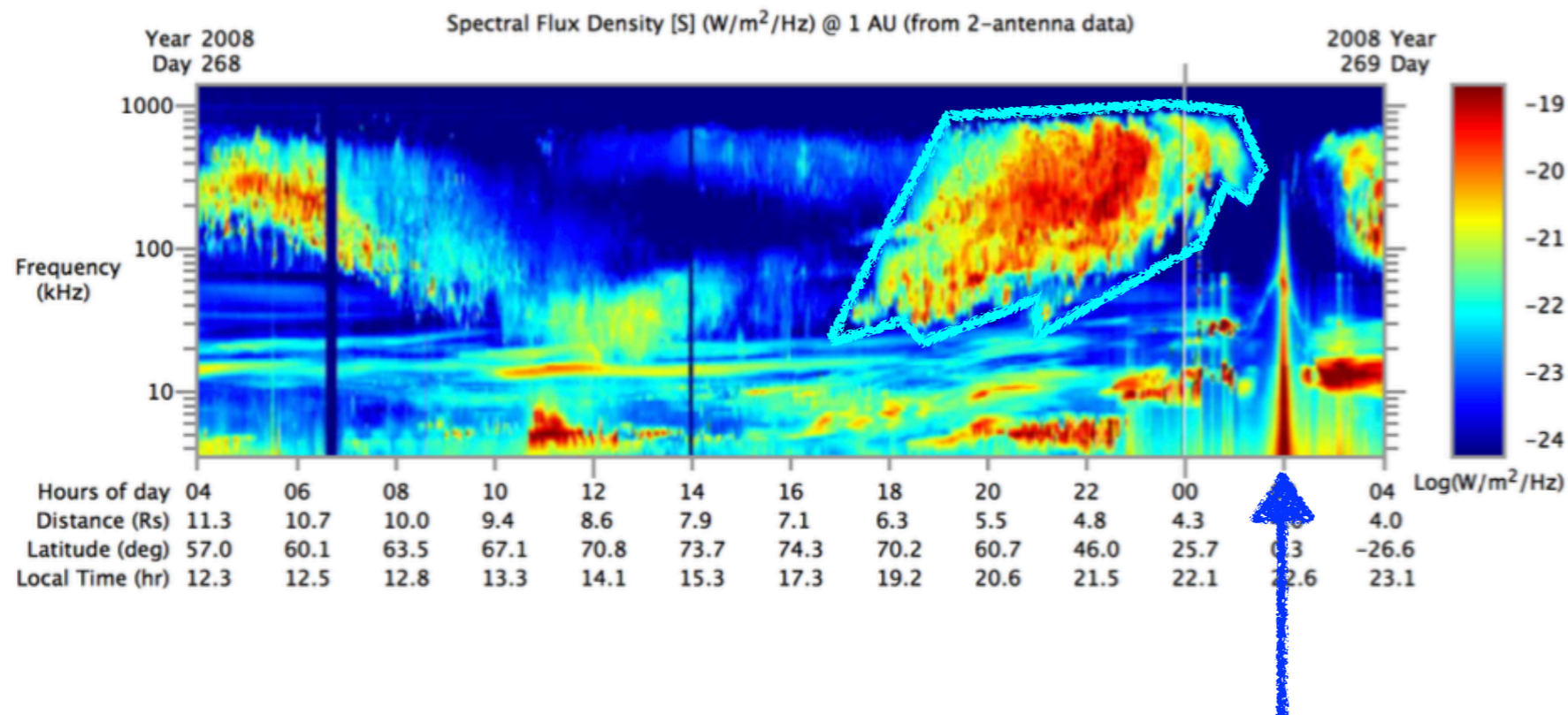
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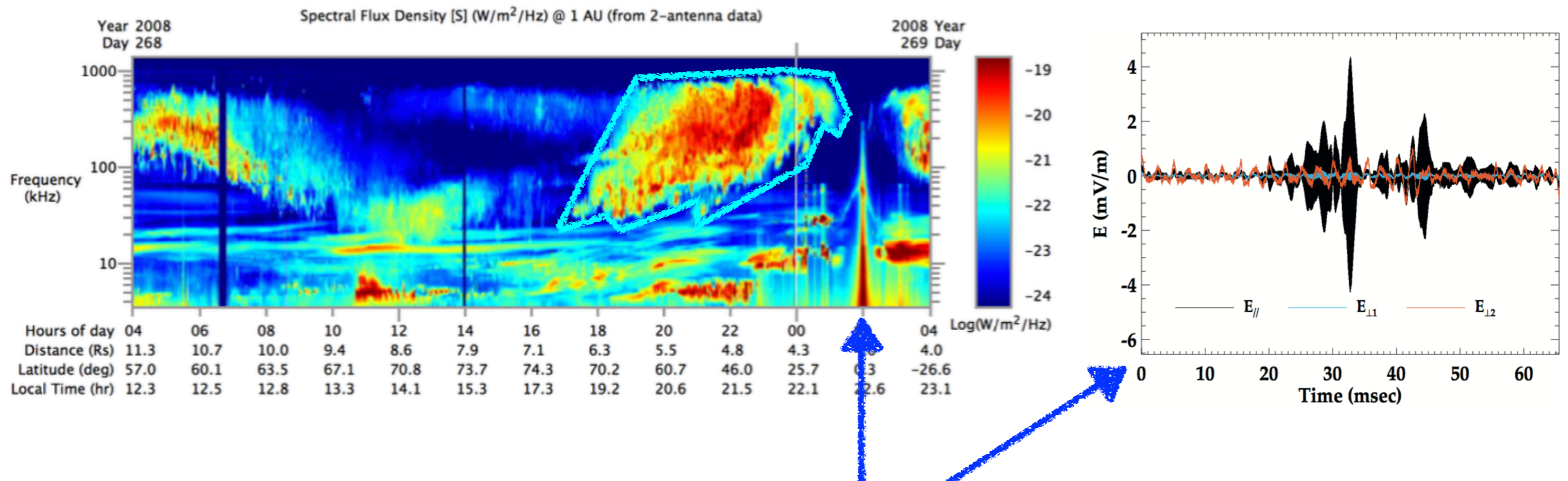
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- NB: *imaging data not in the scope of MASER*

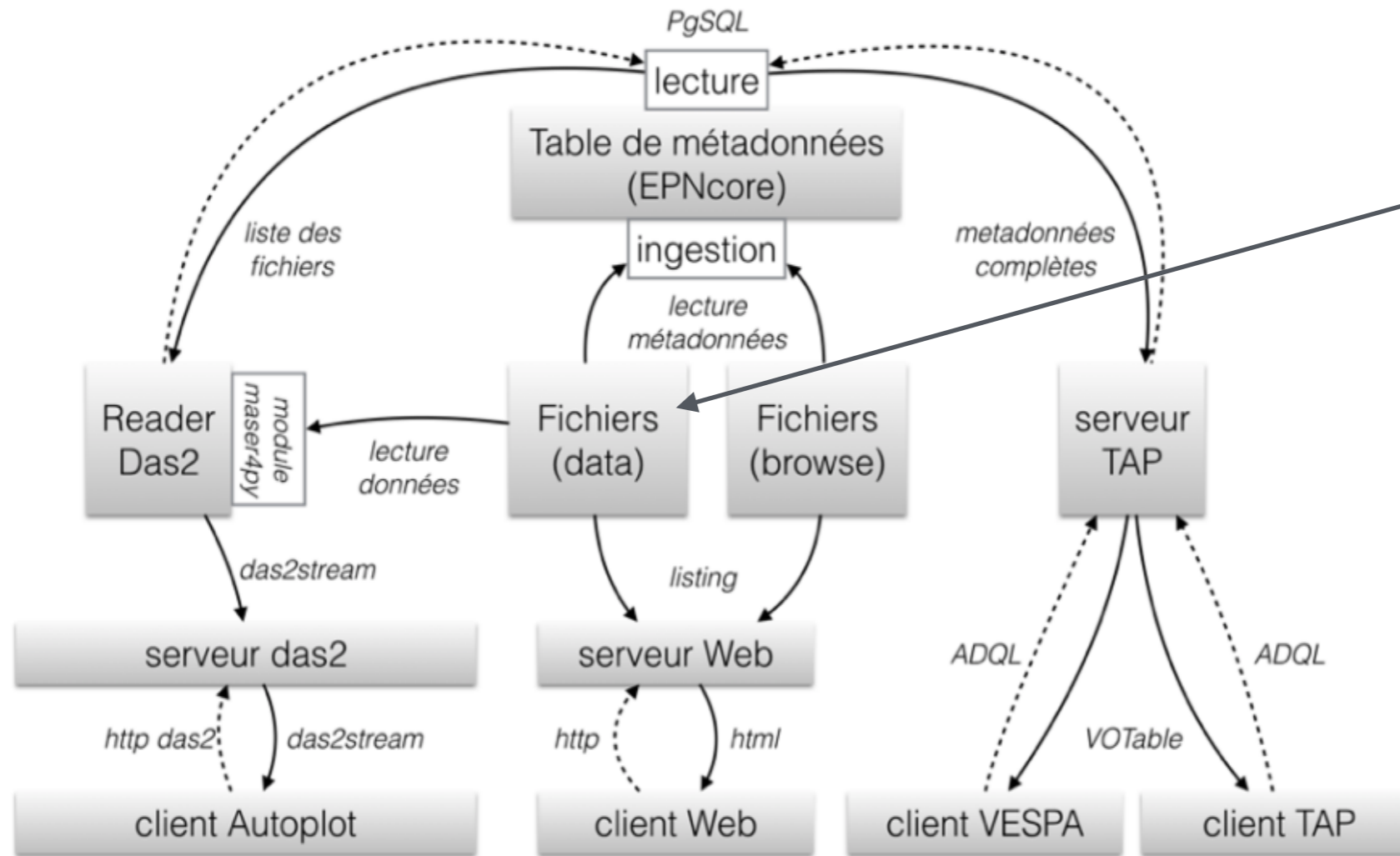


# Data product types

- Mostly **spectrograms (aka dynamic-spectra)**. Measured parameter (flux, polarization...) depending on time and frequency.
- Sometime: “**waveform**” (direct sampling of electric signal temporal fluctuations). Much higher data rate needed.
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- and **catalogues** of events/features
- NB: *imaging data not in the scope of MASER*



# MASER Architecture



- Data file in FITS, CDF...
- TFCat Catalogues
- Paper supplement material...

Figure 5. Ecosystème MASER : relation entre les différentes interfaces mises en place.

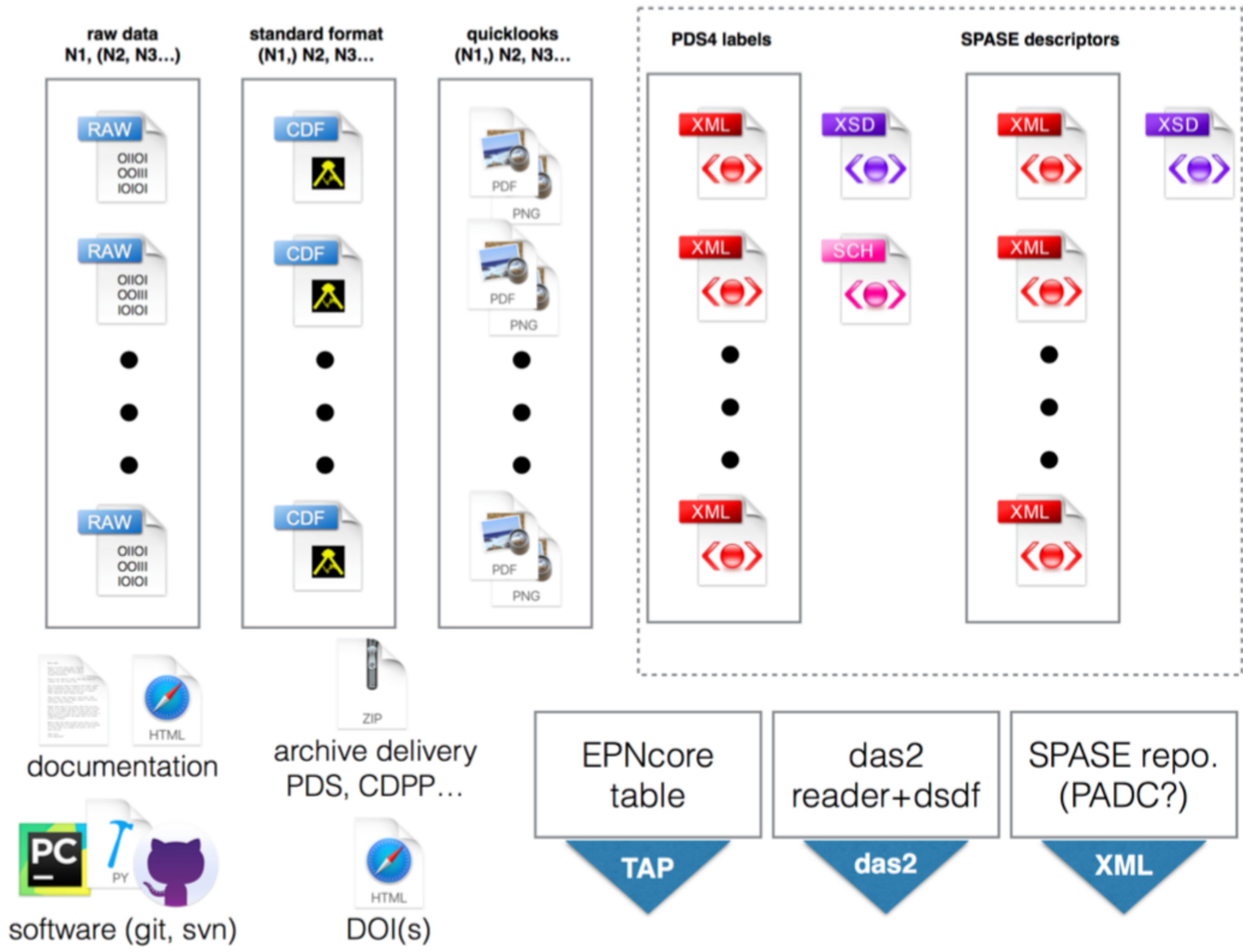
**Access  
(stream)**

**Access  
(web)**

**Discovery**

DMP + DOI (+landing page) per collection





# Interfaces

- **IVOA:**
  - EPN-TAP (solar system data discovery)
  - TAP (tabular data access): 2 servers (PADC: <http://voparis-tap-maser.obspm.fr>, CDN: <http://vogate.obs-nancay.fr>)
  - Datalink (linking between data, quicklook, access)
  - UWS (run on demand): 1 server, <https://voparis-uws-maser.obspm.fr/client/>
  - IVOA registry
- **IHDEA:**
  - das2: data streaming, 2 servers (PADC: <http://voparis-das-maser.obspm.fr/das2/server>, CDN: <https://das2server.obs-nancay.fr/das2/server>)
  - CDF-ISTP (format)
  - SPASE registry
- **DOI:**
  - publishing collections (<https://maser.lesia.obspm.fr/publications/doi/>)
  - landing page with schema.org
- **Other:**
  - TFCat (Time-Frequency Catalogue) <https://gitlab.obspm.fr/maser/catalogues/tfcats>
  - WebGeoCalc (local instance of WGC/SPICE server developed by NASA/JPL)

# EPN-TAP service configuration

- DaCHS servers (v2.6)
- Resource configuration using CustomGrammar (external python script parsing data files), CDFGrammar or ODBCGrammar
- Subjects in IVOA/UAT keywords (not updated in Registry yet)
- Datalink implemented on some services to relate with previews, data streaming interfaces, documentation...

# Example with Voyager/PRA collection

Non sécurisé — vespa.obspm.fr/planetary/data/display/?&resource\_id=ivo://vopdc.obsp

VESPA Virtual European Solar and Planetary Access

Form Query  
EPN-TAP Services Custom Service

Back To Services Results  
Results in service **voyager\_pra**

**voyager\_pra - Voyager PRA Datasets**  
Voyager PRA (Planetary Radio Astronomy) Datasets catalog. The dataset are originally published by several data centers: NASA/PDS, NASA/NSSDC, NASA/GSFC, Univ. Iowa and CNES/SERAD.  
Credits:  
Creators: Baptiste Ceconi  
Publisher: Paris Astronomical Data Centre

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

granule_uid	dataprodct_type	target_name	time_min (d)	time_max (d)	access_url	datalink_url
VG2-U-PRA-3-RDR-LOWBAND-6SEC-V1.0:VG2_URN_PRA_6SEC.TAB	dynamic_spectrum	Uranus	1986-01-19T00:00:00.000	1986-01-31T00:00:00.000	http://maser.obspm.fr/...	http://voparis-tap-m...
VG2-S-PRA-3-RDR-LOWBAND-6SEC-V1.0:PRA_V.TAB	dynamic_spectrum	Saturn	1981-09-08T00:00:45.999	1981-09-28T23:59:08.000	http://maser.obspm.f...	http://voparis-tap-m...
VG2-S-PRA-3-RDR-LOWBAND-6SEC-V1.0:PRA_IV.TAB	dynamic_spectrum	Saturn	1981-08-14T00:00:00.000	1981-09-07T23:59:58.000	http://maser.obspm.f...	http://voparis-tap-m...
VG2-S-PRA-3-RDR-LOWBAND-6SEC-V1.0:PRA_III.TAB	dynamic_spectrum	Saturn	1981-07-22T00:00:00.999	1981-08-13T23:59:12.000	http://maser.obspm.f...	http://voparis-tap-m...
VG2-S-PRA-3-RDR-LOWBAND-6SEC-V1.0:PRA_II.TAB	dynamic_spectrum	Saturn	1981-07-01T00:00:04.000	1981-07-21T23:59:13.000	http://maser.obspm.f...	http://voparis-tap-m...
VG2-S-PRA-3-RDR-LOWBAND-6SEC-V1.0:PRA_I.TAB	dynamic_spectrum	Saturn	1981-06-05T00:00:00.000	1981-06-30T23:59:15.999	http://maser.obspm.f...	http://voparis-tap-m...
VG2-S-PRA-3-RDR-LOWBAND-6SEC-V1.0:PRA.TAB	dynamic_spectrum	Saturn	1981-06-24T00:00:46.999	1981-08-31T22:05:33.999	http://maser.obspm.f...	http://voparis-tap-m...
VG2-N-PRA-3-RDR-LOWBAND-6SEC-V1.0:VG2_NEP_PRA_6SEC	dynamic_spectrum	Neptune	1989-08-11T00:00:00.000	1989-08-31T00:00:00.000	http://maser.obspm.f...	http://voparis-tap-m...

## Table links

Where?	Description	What?
<a href="#">Link</a>	Data Product	<b>#this</b> VG2-U-PRA-3-RDR-LOWBAND-6SEC-V1.0:
<a href="#">Link</a>	Label File	#documentation VG2-U-PRA-3-RDR-LOWBAND-6SEC-V1.0:VG2_URN_PRA_6SEC.TAB
<a href="#">Link</a>	Data Collection repository	#parent VG2-U-PRA-3-RDR-LOWBAND-6SEC-V1.0:V

## Index of /data/voyager/pr/PDS/VG2-U-PRA-3

Name	Last modified	Size	Description
<a href="#">Parent Directory</a>		-	
<a href="#">AAREADME.TXT</a>	2013-02-06 10:40	15K	
<a href="#">CATALOG/</a>	2013-02-06 11:12	-	
<a href="#">CHECKSUMS.TXT</a>	2020-04-19 18:15	2.5K	
<a href="#">DATA/</a>	2013-02-06 11:12	-	
<a href="#">DOCUMENT/</a>	2013-02-06 11:12	-	
<a href="#">ERRATA.TXT</a>	2012-02-03 09:51	6.0K	

# Example with NDA collection

The screenshot shows a web browser window with the URL `vespa.obspm.fr/planetary/data/display/?&resource_id=ivo://vopx`. The page features a header with the VESPA logo and navigation menus. The main content area displays search results for the NDA Obs. Database, including a table of observation records and a sidebar with plotting tools and example queries.

## Back To Services Results

### Results in service NDA Obs. Database

**NDA Obs. Database - Nancay Decameter Array observation database**  
Dynamic Spectra of the Routine observation of Jupiter with the Nancay Decameter Array. This dataset contains two series of dynamic spectra recorded on each of the Nancay decameter sub-arrays (i.e. on Left Hand and Right Hand Polarization). The receiver is sampling from 10 MHz to 40 MHz with 75 kHz steps on the spectral axis. It records one spectrum every second on each polarization. The list of observation frequencies is provided.

**Credits:**  
**Creators:** Baptiste Cecconi  
**Contributors:** Andrée Coffre, Emmanuel Théas, PADC  
**Publisher:** Station de Radioastronomie de Nançay (SRN)

Show 50 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	datalink
S991231_cdf	dynamic_spectrum	Sun	1999-12-31T07:54:05.290	1999-12-31T14:40:59.390	<a href="http://realtime.obs-...">http://realtime.obs-...</a>	SEND
S991230_cdf	dynamic_spectrum	Sun	1999-12-30T08:01:00.189	1999-12-30T14:43:59.240	<a href="http://realtime.obs-...">http://realtime.obs-...</a>	SEND
S991229_cdf	dynamic_spectrum	Sun	1999-12-29T07:57:00.159	1999-12-29T14:47:59.209	<a href="http://realtime.obs-...">http://realtime.obs-...</a>	SEND
S991228_cdf	dynamic_spectrum	Sun	1999-12-28T07:57:00.170	1999-12-28T14:51:58.749	<a href="http://realtime.obs-...">http://realtime.obs-...</a>	SEND
S991227_cdf	dynamic_spectrum	Sun	1999-12-27T08:59:00.239	1999-12-27T14:55:59.310	<a href="http://realtime.obs-...">http://realtime.obs-...</a>	SEND
S991226_cdf	dynamic_spectrum	Sun	1999-12-26T07:52:05.290	1999-12-26T14:59:59.369	<a href="http://realtime.obs-...">http://realtime.obs-...</a>	SEND
S991225_cdf	dynamic_spectrum	Sun	1999-12-25T07:51:05.240	1999-12-25T15:03:59.280	<a href="http://realtime.obs-...">http://realtime.obs-...</a>	SEND

Submit Reset

Afficher un menu

### Plotting tools

- TOPCAT
- Aladin
- SPLAT
- CASSIS
- 3DView

### Example queries

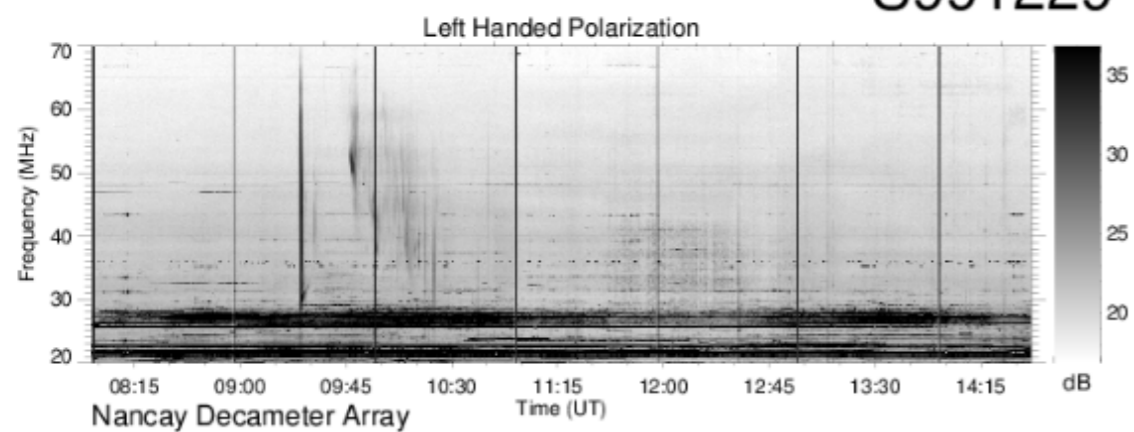
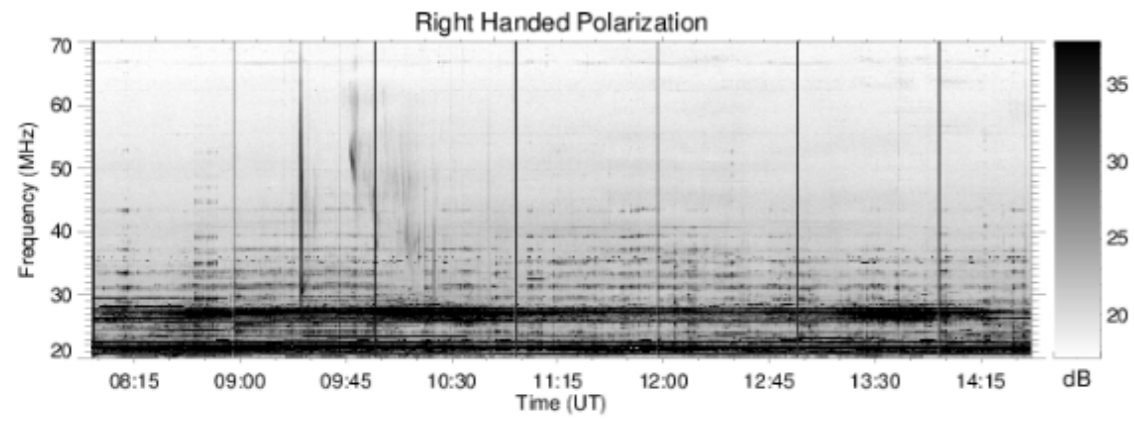
Saturn in March 2012

### Help

Help

The bottom right corner of the page shows two spectral plots. The top plot is labeled 'S991229' and the bottom plot is labeled 'S991225'. Both plots show intensity versus frequency, with a prominent signal around 15 MHz.

## Table links



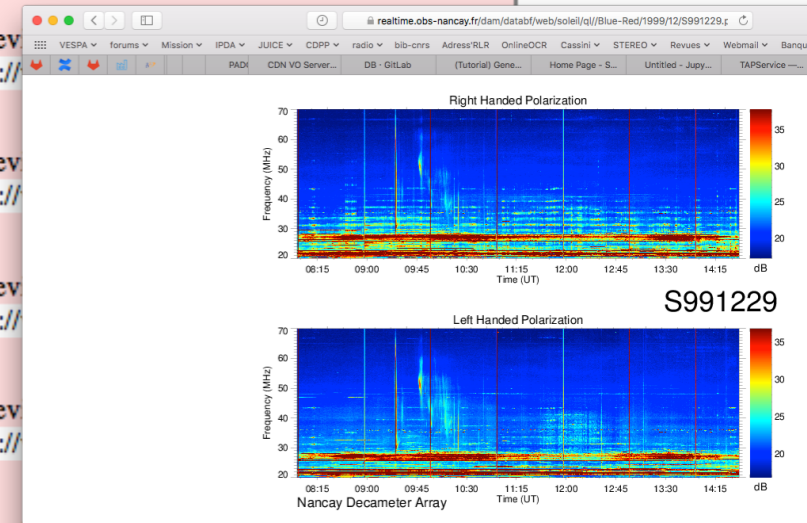
S991229

Where?	Description	What?
<a href="#">Link</a>	Das2 access (Left-Hand polarization)	#cutout ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	Das2 access (Right-Hand polarization)	#cutout ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	Das2 access (differential polarization)	#cutout ivo://vopdc.obspm/~?nda/S991229_cdf

Afficher un menu

Where?	Description	What?
<a href="#">Link</a>	Das2 access (Left-Hand polarization)	#cutout ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	Das2 access (Right-Hand polarization)	#cutout ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	Das2 access (differential polarization)	#cutout ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	PDF Preview (Greyscale)	#preview ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	PDF Preview (Color)	#prev ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	PNG Preview (Greyscale)	#prev ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	PNG Preview (Color)	#prev ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	PNG Thumbnail (Greyscale)	#prev ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	PNG Thumbnail (Color)	#prev ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	RT1 raw data file	#prog ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	The full dataset.	#this ivo://vopdc.obspm/~?nda/S991229_cdf
<a href="#">Link</a>	A preview for the dataset.	#preview ivo://vopdc.obspm/~?nda/S991229_cdf

Afficher un menu



# Example with NDA collection (target\_name=Jupiter)

The screenshot shows the VESPA web interface. At the top, there is a navigation bar with various menu items like 'VESPA', 'forums', 'Mission', etc. Below the navigation bar is a banner for 'VESPA Virtual European Solar and Planetary Access' featuring images of planets. The main content area is titled 'Back To Services Results' and 'Results in service NDA Obs. Database'. A green box highlights the description of the 'NDA Obs. Database - Nancy Decameter Array observation database', which contains dynamic spectra of Jupiter. Below this, there is a table of search results with columns for granule\_uid, dataproduct\_type, target\_name, time\_min (d), time\_max (d), access\_url, and datalink. The table lists several entries for Jupiter observations. On the left side, there are search filters for 'Main Parameters' including Target Name (Jupiter), Target Class, Dataproduct Type, Instrument Host Name, Instrument Name, and Processing level. On the right side, there are 'Plotting tools' (TOPCAT, Aladin, SPLAT, CASSIS, 3DView) and 'Example queries' (Saturn in March 2012). At the bottom right, there are two small spectral plots.

Non sécurisé — vespa.obspm.fr/planetary/data/display/?f-url\_op=&f-schema\_op

VESPA Virtual European Solar and Planetary Access

Form Query

EPN-TAP Services Custom Service

Main Parameters

Target Name: Jupiter

Target Class

Dataproduct Type

Instrument Host Name

Instrument Name

Processing level

Time

Location

Spectral

Illumination

Data Reference

Submit Reset

Afficher un menu

### Back To Services Results

### Results in service NDA Obs. Database

**NDA Obs. Database - Nancy Decameter Array observation database**

Dynamic Spectra of the Routine observation of Jupiter with the Nancy Decameter Array. This dataset contains two series of dynamic spectra recorded on each of the Nancy decameter sub-arrays (i.e. on Left Hand and Right Hand Polarization). The receiver is sampling from 10 MHz to 40 MHz with 75 kHz steps on the spectral axis. It records one spectrum every second on each polarization. The list of observation frequencies is provided.

**Credits:**  
Creators: Baptiste Cecconi  
Contributors: Andrée Coffre, Emmanuel Théas, PADC  
Publisher: Station de Radioastronomie de Nançay (SRN)

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	datalink
J991231_cdf	dynamic_spectrum	Jupiter	1999-12-31T14:48:00.219	1999-12-31T22:47:59.280	http://realtime.obs-...	SEND
J991230_cdf	dynamic_spectrum	Jupiter	1999-12-30T14:51:00.199	1999-12-30T22:50:59.259	http://realtime.obs-...	SEND
J991229_cdf	dynamic_spectrum	Jupiter	1999-12-29T14:55:00.090	1999-12-29T22:54:59.140	http://realtime.obs-...	SEND
J991228_cdf	dynamic_spectrum	Jupiter	1999-12-28T14:59:00.169	1999-12-28T22:58:59.240	http://realtime.obs-...	SEND
J991227_cdf	dynamic_spectrum	Jupiter	1999-12-27T15:03:00.170	1999-12-27T23:02:59.259	http://realtime.obs-...	SEND
J991226_cdf	dynamic_spectrum	Jupiter	1999-12-26T15:07:00.150	1999-12-26T19:07:09.199	http://realtime.obs-...	SEND
J991225_cdf	dynamic_spectrum	Jupiter	1999-12-25T15:11:00.180	1999-12-25T23:10:59.229	http://realtime.obs-...	SEND

### Plotting tools

- TOPCAT
- Aladin
- SPLAT
- CASSIS
- 3DView

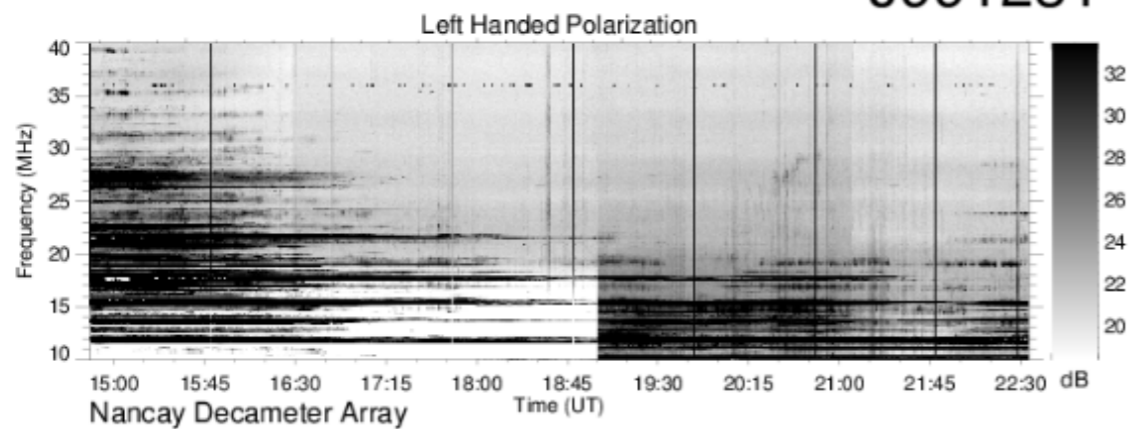
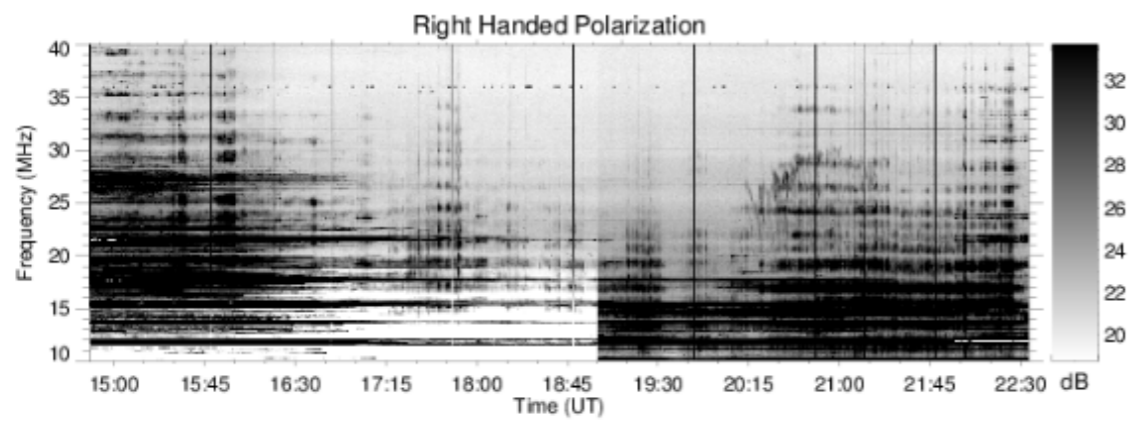
### Example queries

Saturn in March 2012

### Help

Help

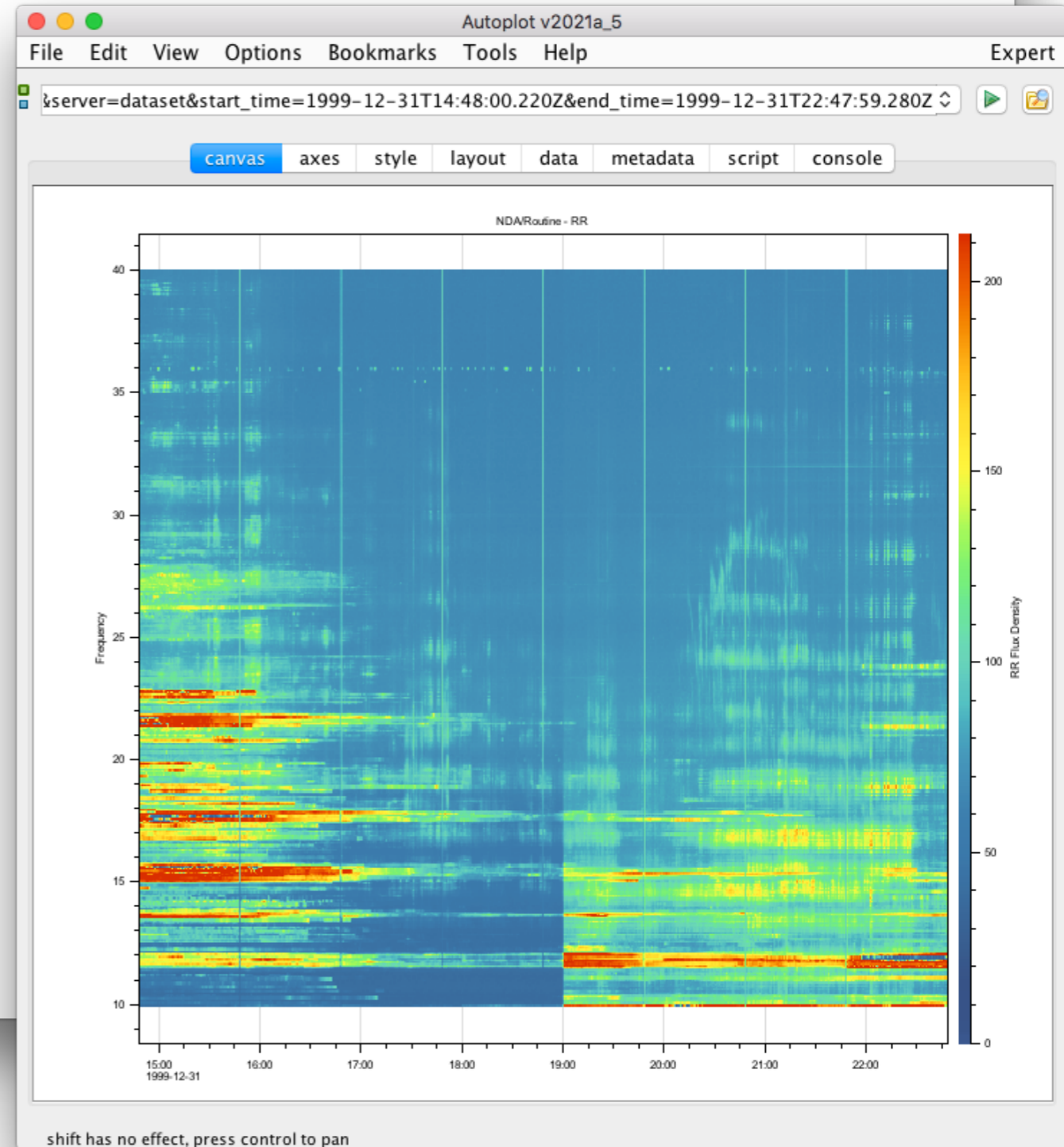
## Table links



J991231

Where?	Description	What?
<a href="#">Link</a>	Das2 access (Left-Hand polarization)	#cutout ivo://vopdc.obspm/~?nda/J991231_cdf
<a href="#">Link</a>	Das2 access (Right-Hand polarization)	#cutout ivo://vopdc.obspm/~?nda/J991231_cdf
<a href="#">Link</a>	Das2 access (differential polarization)	#cutout ivo://vopdc.obspm/~?nda/J991231_cdf

Afficher un menu



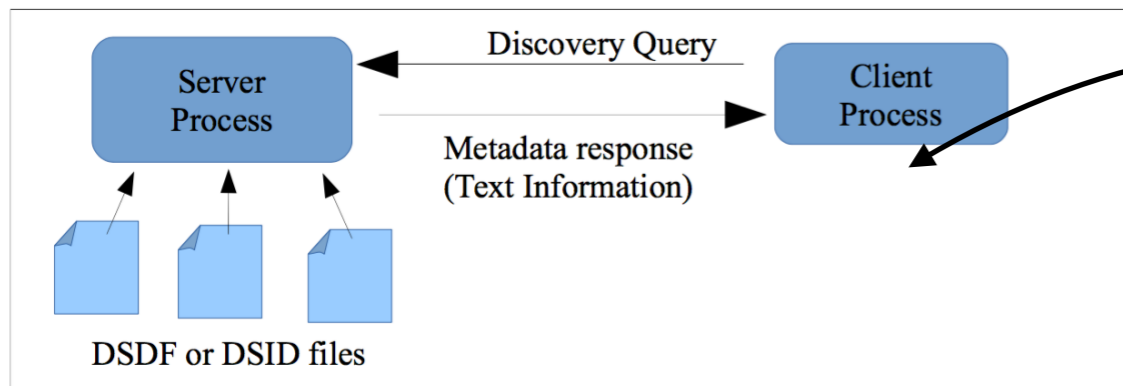
Autoplot



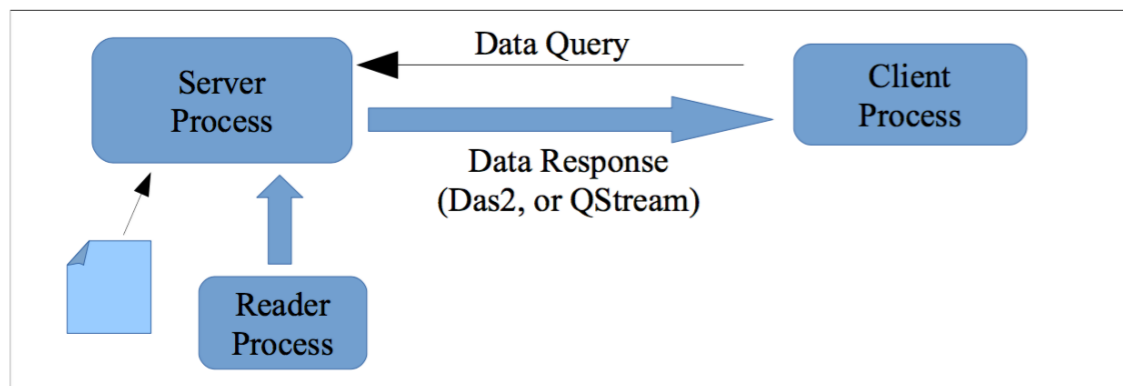
# Data on demand

- **Large data rate or long times intervals**  
=> need for optimized client/server distribution system.
- Existing solution developed by University of Iowa (USA):  
server=**Das2** (<http://das2.org>) and client=**Autoplot** (<http://autoplot.org>)
- **Built for space data** (low data rate), but capable of serving long **resampled** times series.  
**Tested with success on ground Nançay datasets:** adapted also for ground based high data rate collections.
- Very simple configuration:  
data collection description files + data reader that produces “das2stream” formatted data.
- Implemented on LESIA, CDPP, and Nançay data collections (using the Maser4py modules):
  - LESIA: <http://voparis-maser-das.obspm.fr/das2/server>
  - Nançay: <https://das2server.obs-nancay.fr/das2/server>

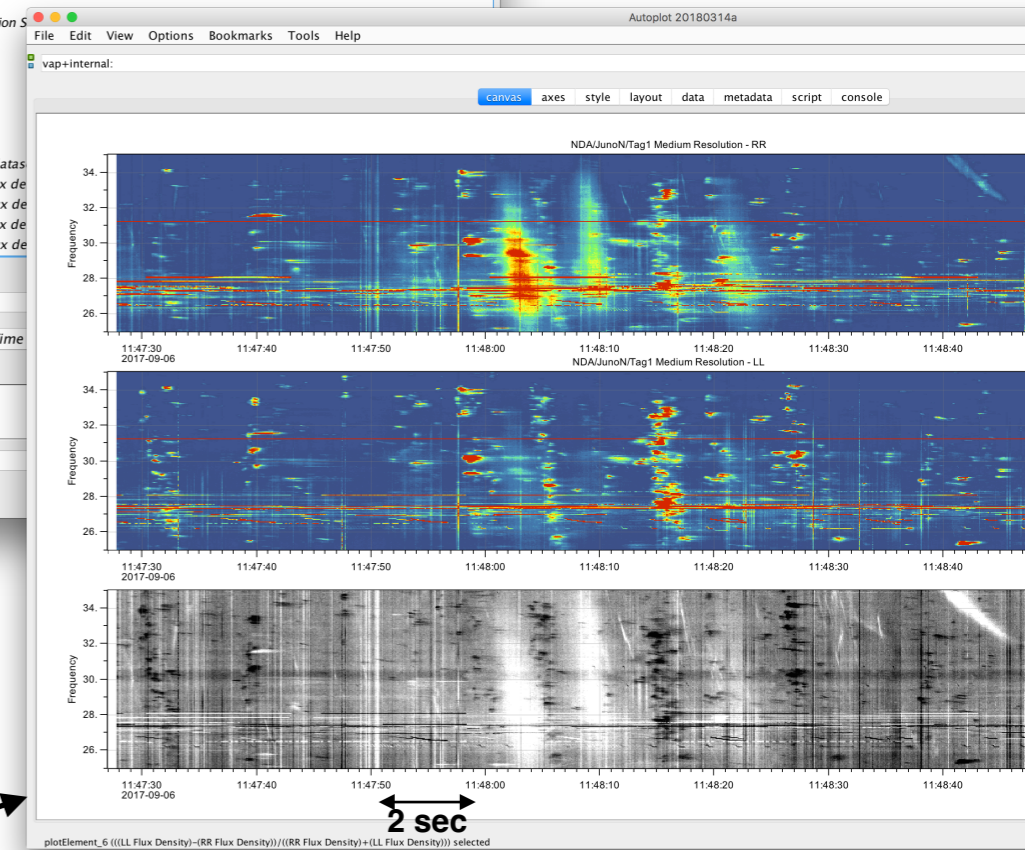
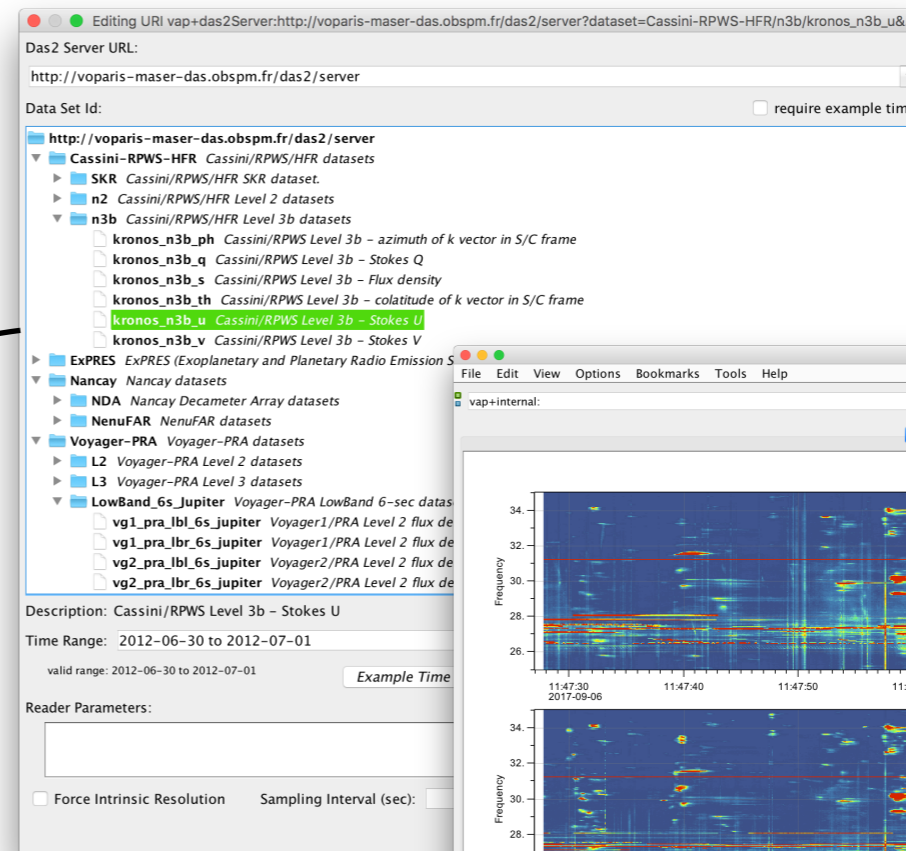
# Das2 / Autoplot process



Discovery Query Information Flow



Data Query Information Flow



NDA/JunoN dataset (3TB/day)

- Das2 = **data distribution** system for time series + **on demand resampling** (averaging on the fly).  
HTTP REST Query: data collection + time interval + temporal resolution

# UWS for run on demand

- ExPRES code (Exoplanetary and Planetary Radio Emission Simulator)  
<https://github.com/maserlib/ExPRES>  
<https://voparis-uws-maser.obspm.fr/client/jobs/ExPRES> (using OPUS)
- Modelling of the spectro-temporal shape of radio emissions.
- Used in *Cecconi et al., Planet. Space Sci (2021) mission planning of JUICE*  
supplementary material: <https://doi.org/10.25935/8ZFF-NX36>

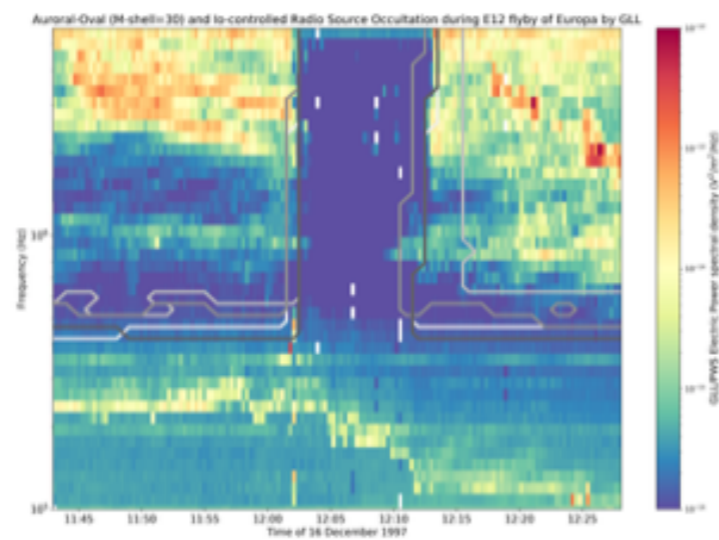
UWS MASER Job List

Job List for: ExPRES-dev

JobId	runId	Creation Time	Phase	Edit Job	Control
47784a	ExPRES-dev	2021-11-10 17:37:57	COMPLETED	Edit Job	▶ ○ 🗑
88b016	ExPRES-dev	2021-11-10 17:36:19	COMPLETED	Edit Job	▶ ○ 🗑
780fa3	ExPRES-dev	2021-11-10 17:34:40	COMPLETED	Edit Job	▶ ○ 🗑
7b9993	ExPRES-dev	2021-11-10 17:30:57	COMPLETED	Edit Job	▶ ○ 🗑
dc18b0	ExPRES-dev	2021-11-10 17:29:04	COMPLETED	Edit Job	▶ ○ 🗑
ca2f3f	ExPRES-dev	2021-11-10 17:28:37	COMPLETED	Edit Job	▶ ○ 🗑
fdfb1	ExPRES-dev	2021-11-10 17:26:08	COMPLETED	Edit Job	▶ ○ 🗑
be924e	ExPRES-dev	2021-11-10 17:24:40	ERROR	Edit Job	▶ ○ 🗑
2b40bf	ExPRES-dev	2021-06-14 19:15:04	COMPLETED	Edit Job	▶ ○ 🗑
1c74b3	ExPRES-dev	2021-06-14 15:18:26	COMPLETED	Edit Job	▶ ○ 🗑
b0c41e	ExPRES-dev	2021-06-11 12:54:43	COMPLETED	Edit Job	▶ ○ 🗑
241500	ExPRES-dev	2021-06-10 18:20:47	COMPLETED	Edit Job	▶ ○ 🗑
a40d9d	ExPRES-dev	2021-06-10 17:50:15	ERROR	Edit Job	▶ ○ 🗑
830999	ExPRES-dev	2021-06-10 17:48:14	COMPLETED	Edit Job	▶ ○ 🗑
91db47	ExPRES-dev	2021-06-10 17:42:29	ERROR	Edit Job	▶ ○ 🗑

## Galileo E12 Flyby

- ▶ [ExPRES data](#) (ExPRES configuration and output)
- ▶ [Cosmographia data](#) (Cosmographia configuration, 'pov' and 'top' movies)



# Time-Frequency Catalogue Model & Format

- **Why?**

In low frequency radio astronomy, *spectro-temporal* (aka *time-frequency*) features are key for science analysis.

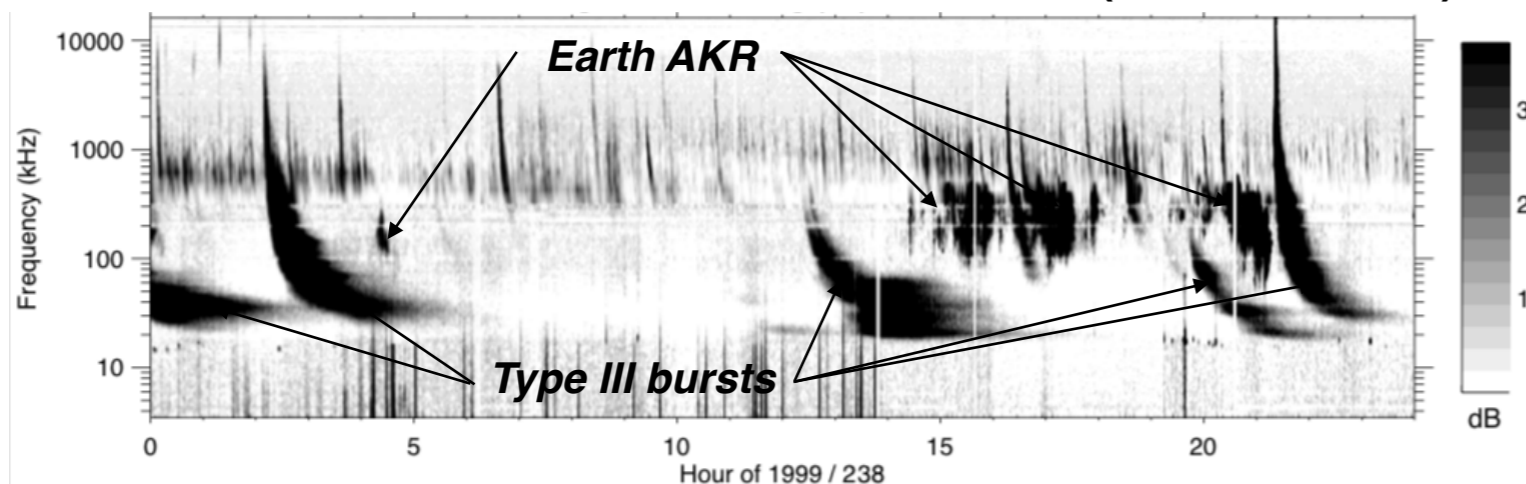
- **Features:**

- planetary emissions (auroral, lightnings...)
- solar emissions

- **Geometries:**

- contour of feature (polygon, points...)
- skeleton line / shape of feature (line, points)

## Solar bursts + Earth AKR emissions (Cassini/RPWS)



## Jupiter DAM emissions (Nançay/NDA)

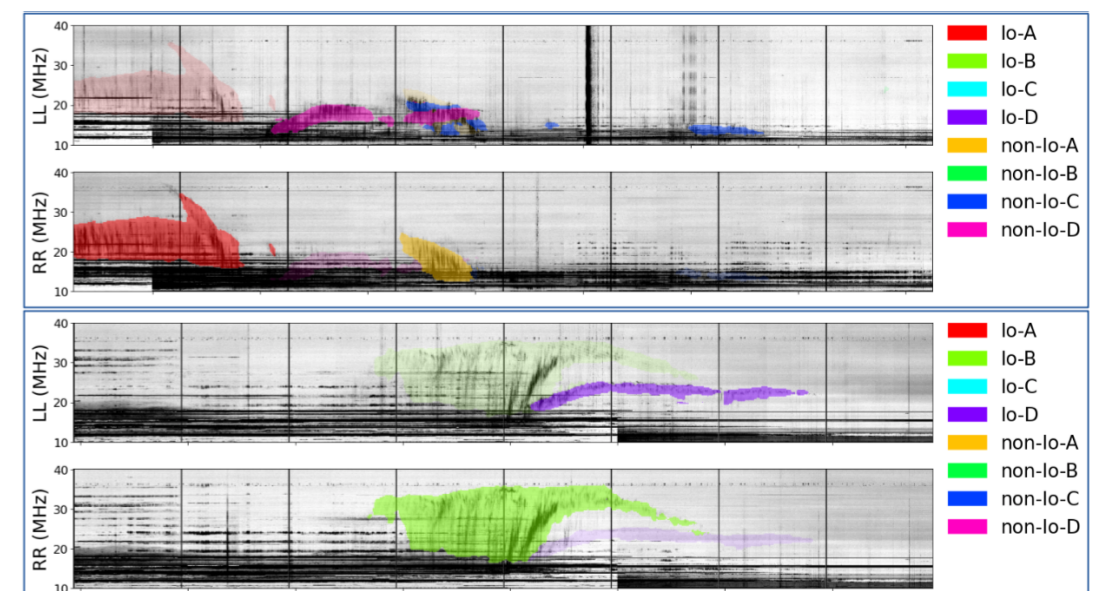


Figure 4. Spectrogrammes radio du NDA annotés, avec (en haut) le catalogue publié (Marques et al. 2017), (au milieu) les événements reconstruits pour la même observation, et (en bas), de nouveaux événements sur une observation récente (hors du catalogue d'entraînement).

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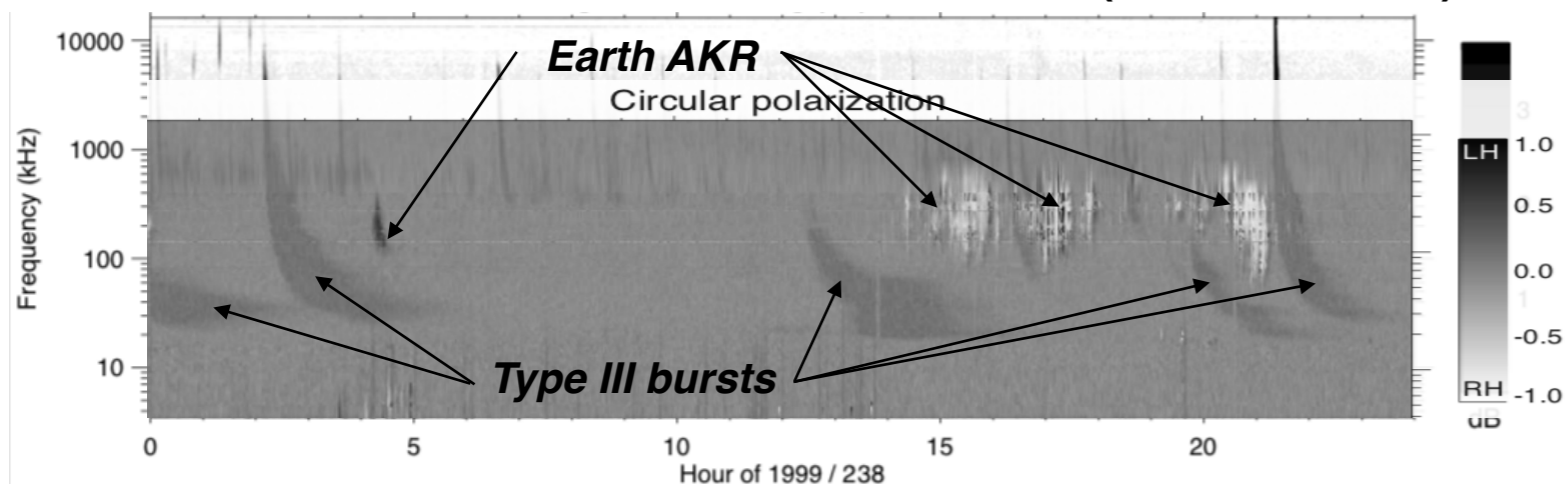
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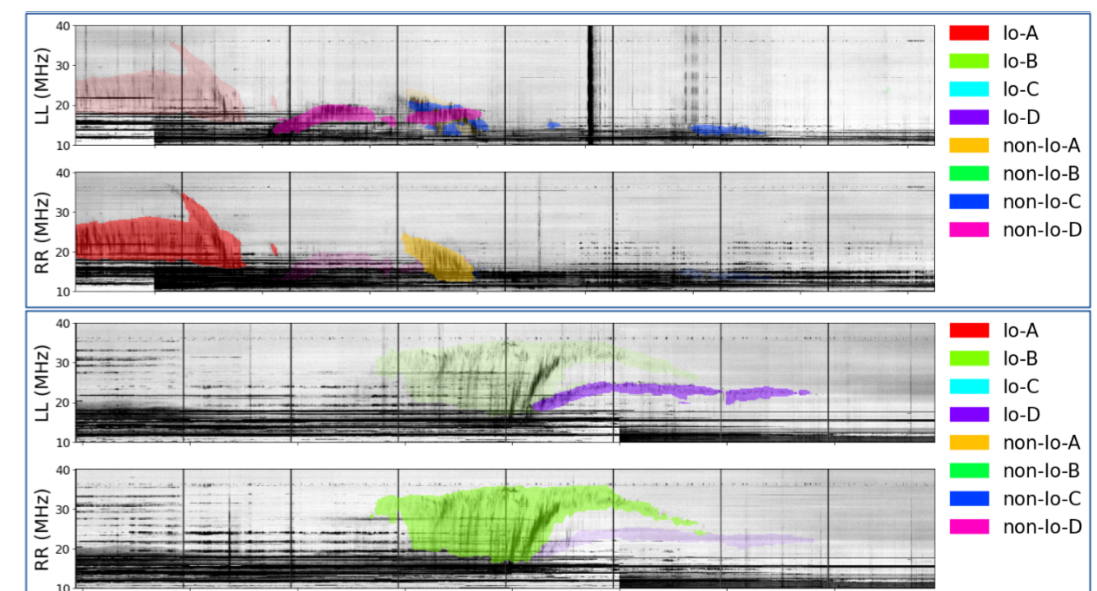


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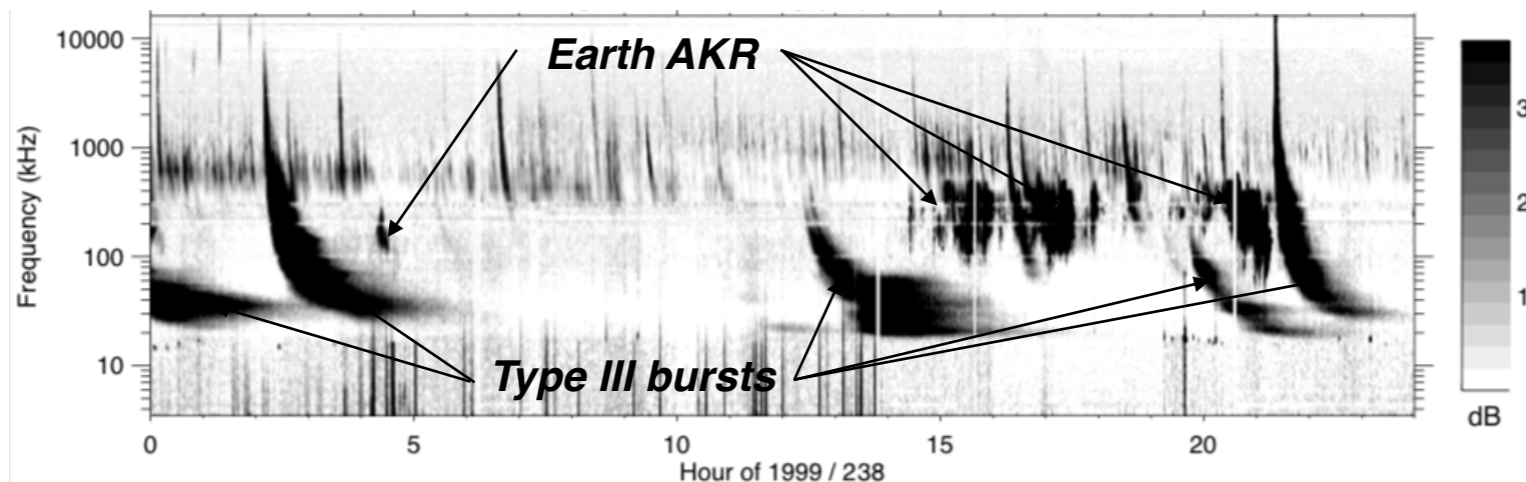
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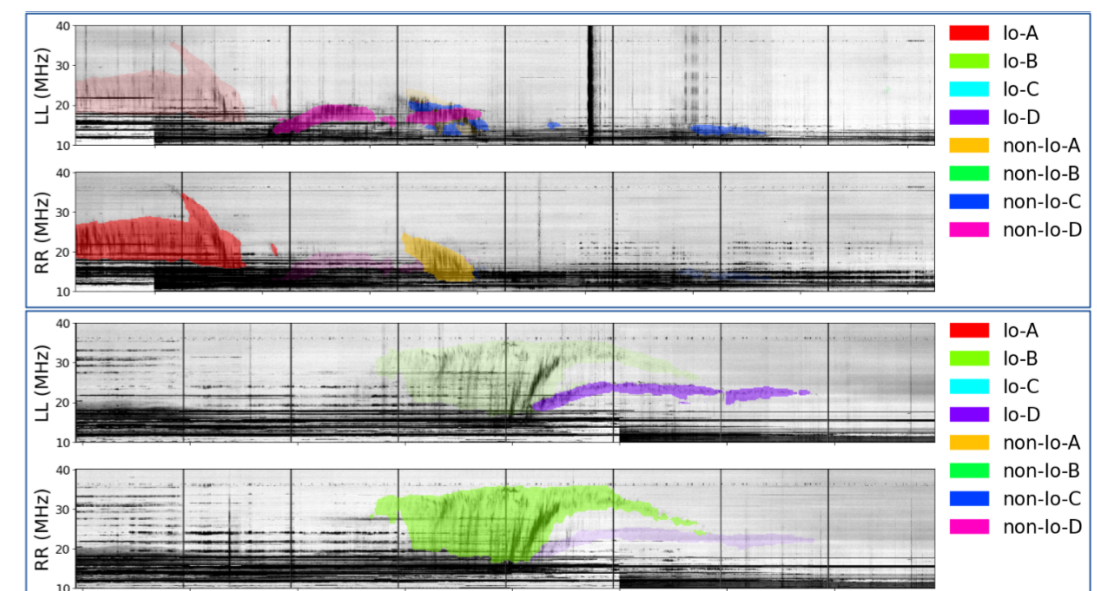


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# TFCat

- TFCat Model
  - A **TF-geometry** is a geometry (point, line-string, polygon, multi-points, multi-line-strings, multi-polygon), with coordinates in time and frequency (or wavelength, or wavenumber, or energy).
  - The **catalogue contains a list of features**, with a TF-geometry (or a set of geometries), and parameters.
  - The **catalogue contains a definition of the features additional properties**, with data type, description, unit, UCD, etc.
  - The **catalogue contains a set of global properties**, at catalogue level, with data type, description, unit, UCD, etc.
  - The **catalogue contains a description of the CRS** (coordinate reference system) defining the temporal and spectral axes, as well as the frame reference position.
- **Specification:** Cecconi, B., M. B. Taylor, X. Bonnin, A. Loh. (2022), JSON Implementation of Time-Frequency Radio Catalogues: TFCat (Version 1.0). PADCC. <https://doi.org/10.25935/6068-8528>
- **Publication:** Cecconi, B., Louis, C. K., Bonnin, X., Loh, A., & Taylor, M. B. (2023). Time-frequency catalogue: JSON implementation and python library. *Frontiers in Astronomy and Space Sciences*, 9, 1049677. <https://doi.org/10.3389/fspas.2022.1049677>
- **Validator:** in STILTS ! (thanks to Mark Taylor)

# TFCat + TAP exploration

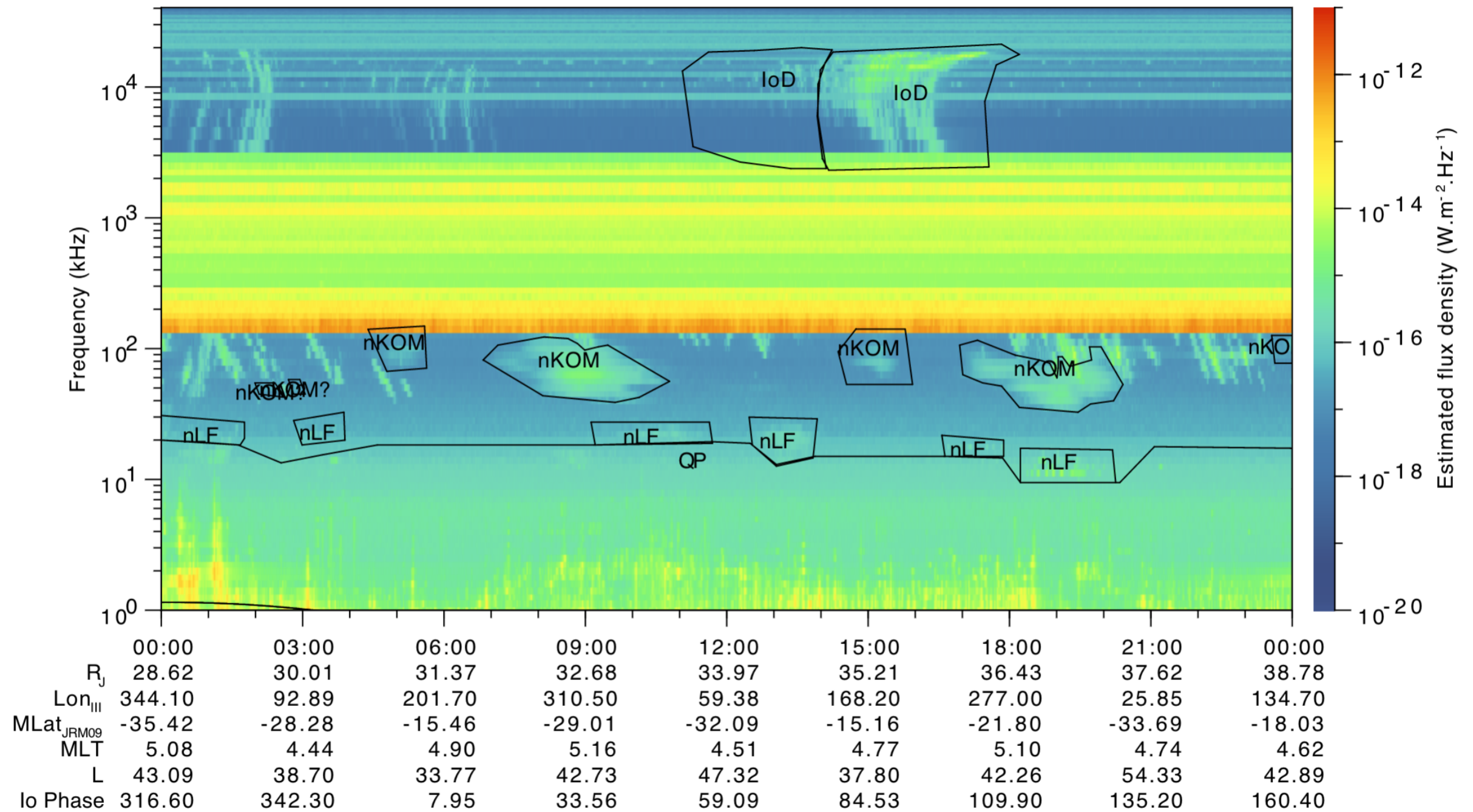
- 1 Feature per row, Geometry as JSON string, Feature mapped properties into columns
- JSON-string allows to keep all information (geometry type, CRS, coordinates) of Feature for future use.

Id	Time_start	Time_end	Freq_min [Hz]	Freq_max [Hz]	Geometry_type	Geometry	Quality	Area [s.Hz]	Nop
cassini_faraday_patches_2006-emi-0	2006-09-12T09:02:26.750000	2006-09-12T09:19:14.740000	24730.0	43469.0	MultiPoint	<pre> {"type": "Feature", "crs": {"name": "Time-Frequency", "properties": {"time_coords": {"id": "unix", "name": "Timestamp (Unix Time)", "unit": "s", "time_origin": "1970-01-01T00:00:00.000Z", "time_scale": "TT"}, "spectral_coords": {"name": "Frequency", "unit": "Hz", "ref_position": {"id": "Cassini"}}}, "geometry": {"type": "MultiPoint", "coordinates": [[1158051858.75, 24730.0], [1158051874.75, 24730.0], [1158051890.75, 24730.0], [1158051890.75, 25318.0], [1158051906.75, 25318.0], [1158051922.75, 25318.0], [1158051938.75, 25318.0], [1158051954.75, 25920.0], [1158051970.75, 25920.0], [1158051986.75, 29845.0], [1158052002.75, 29845.0], [1158052018.75, 29845.0], [1158052034.75, 29845.0], [1158052050.75, 26536.0], [1158052066.75, 26536.0], [1158052082.75, 26536.0], [1158052098.75, 26536.0], [1158052114.75, 26536.0], [1158052130.75, 26536.0], [1158052146.75, 26536.0], 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# TFCat in Autoplots

Juno Waves data - Electric Field Flux Density



2017-03-29 (088)

# Summary

- MASER: solar system radioastronomy
  - possible extension to transient low frequency radio astronomy (starting of official operation in Jan 2022)
- IVOA integration:
  - EPN-TAP + Datalink 👍
    - search engine for local data management tools
    - data discovery
  - UWS works very well for job on demand
- Community Specific:
  - Das2: data streaming interface for dynamic spectra
  - TFCat for event/feature catalogues (next => FT-MOC !)