Laboratoire d'Études Spatiales et d'Instrumentation en Astrophysique

ExPRES in MASER

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IVOA November 2018 College Park Interoperability Meeting

Outline

- MASER

- Application example: ExPRES
  - Auroral radio emissions
  - Daily simulation

- VESPA access: queries

- Das2 / Autoplot: display

- UWS: simulations handling

- ESA/JUICE

MASER

- **Measure, Analyse, Simulate Emissions in the Radio range** (https://github.com/maserlib)

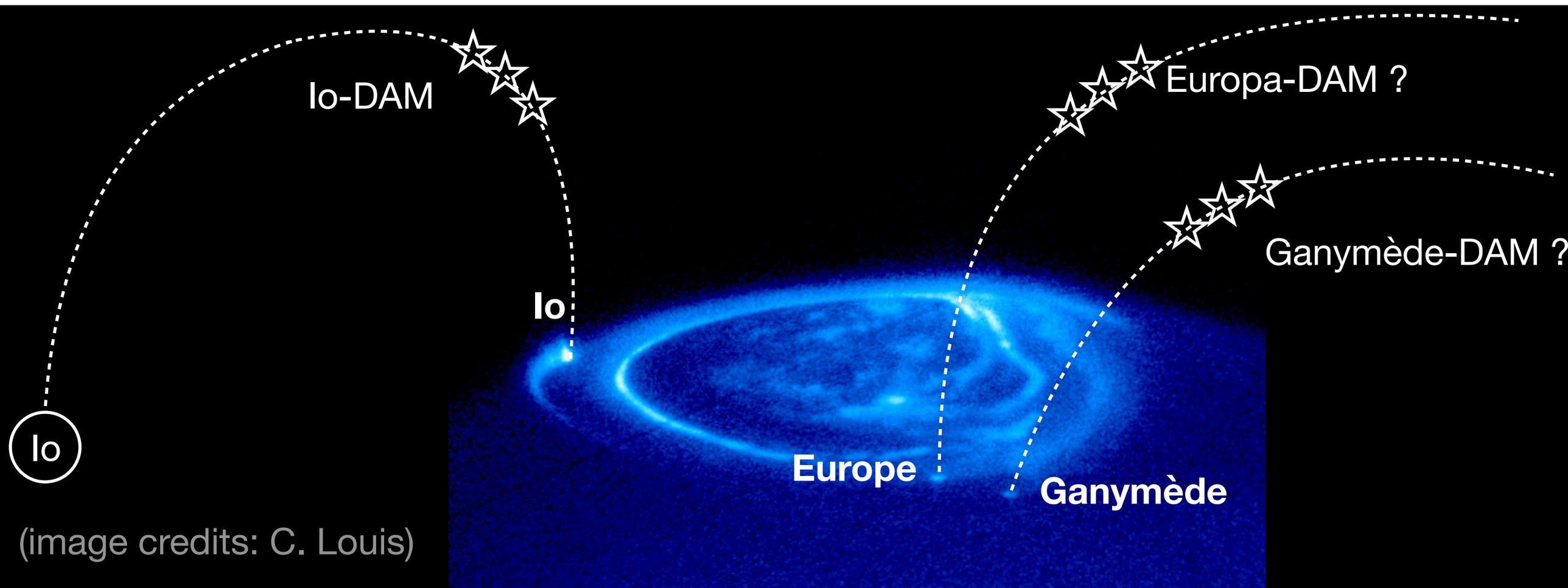
- Toolbox that performs **analysis** & gives data **access**

  - Maser4py (https://github.com/maserlib/maser4py)
  - Python 3.5+ modules
  - Data reading (≠ formats) / homogeneous interface
  - Analysis tools (simulations)

  - Cassini, Voyager
  - Demeter, Interball, Viking, ISEE3, Wind
  - Nançay Decameter Array, NenuFAR
  - RadioJOVE

Auroral radio emissions

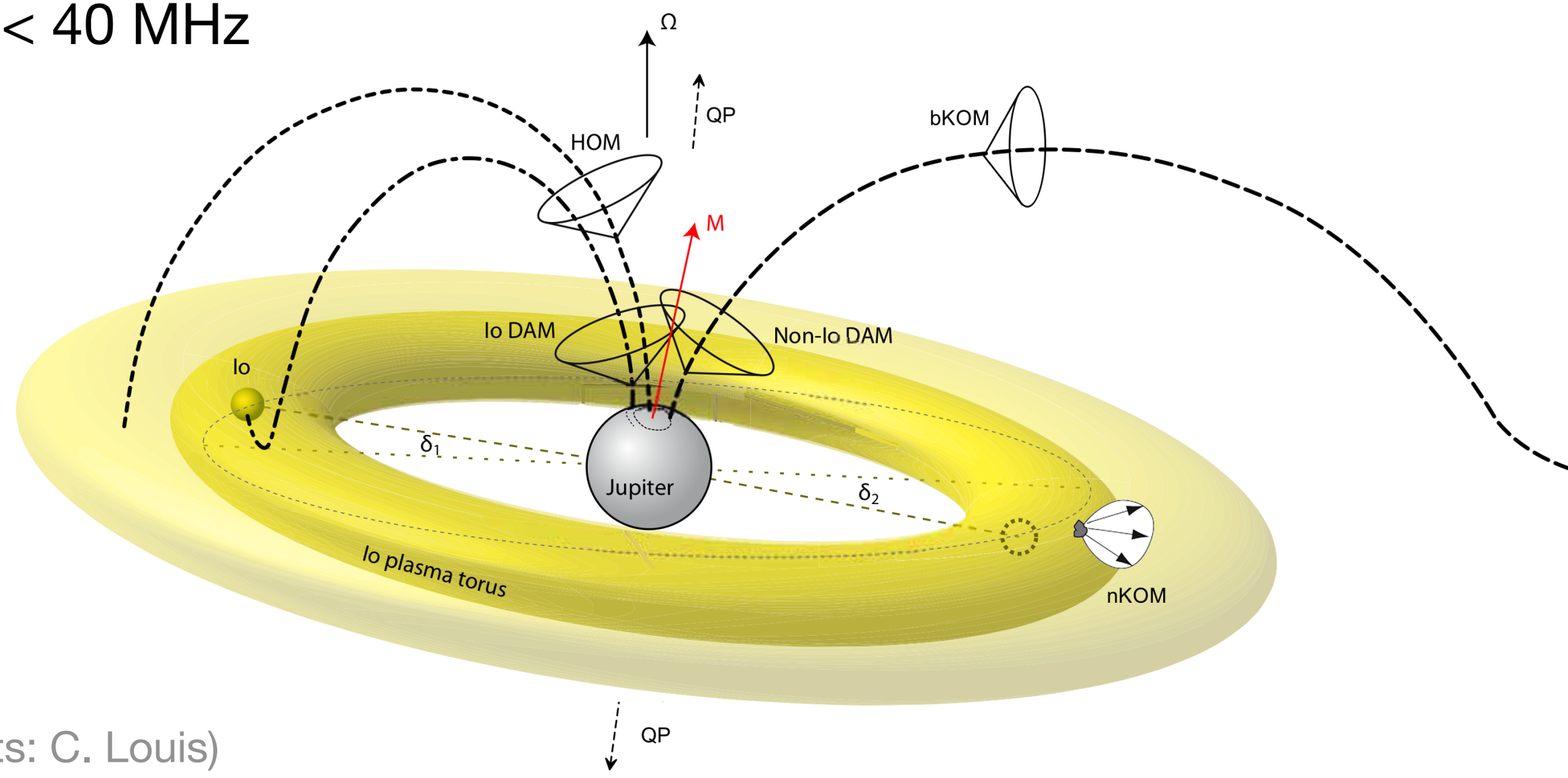
- Context:
  - Accelerated e^- + planetary magnetic field
  - Cyclotron Maser Instability (Treumann et al. 2006)



(image credits: C. Louis)

Auroral radio emissions

- Properties:
  - Anisotropy
  - Polarization
  - < 40 MHz

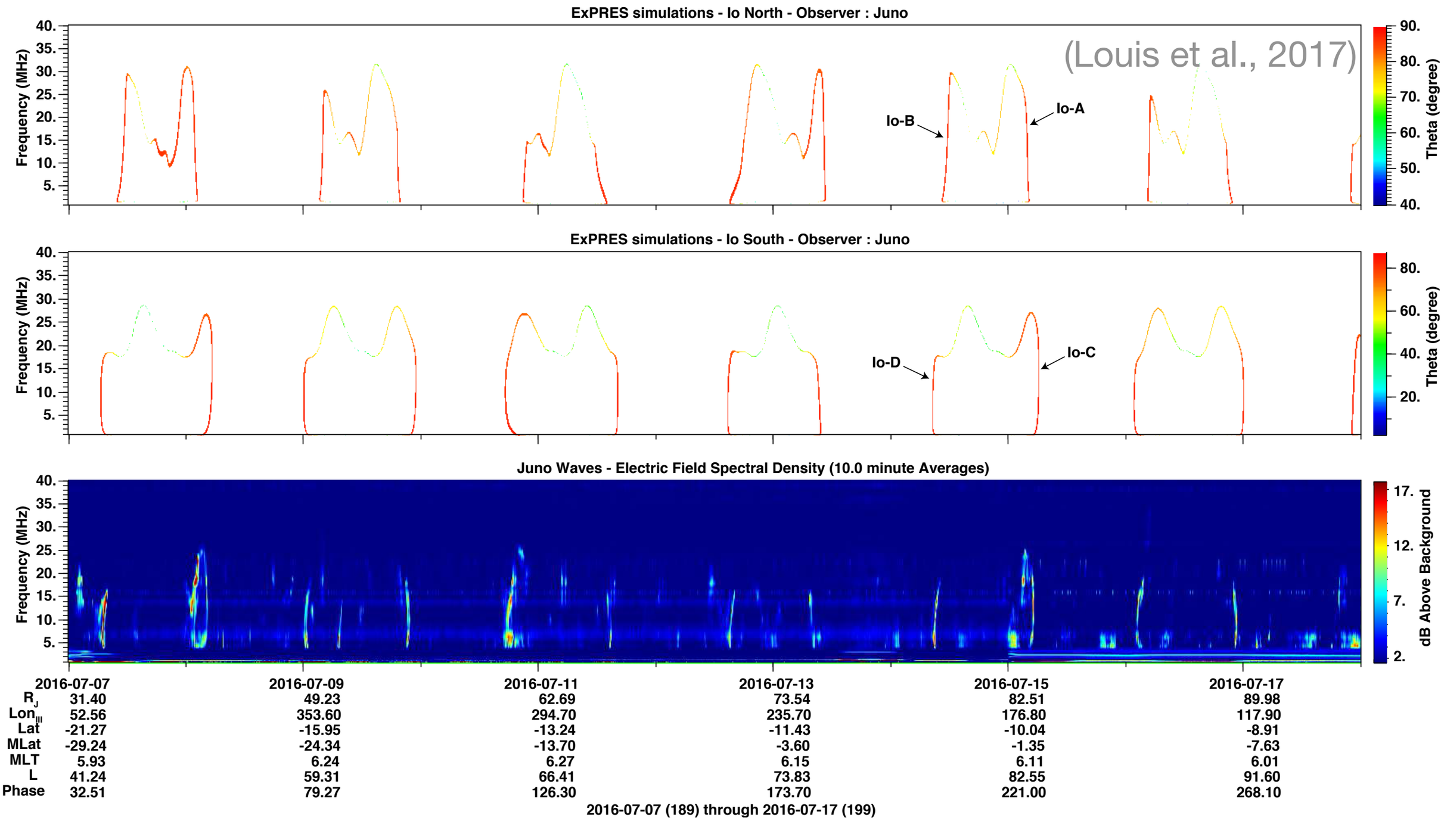


(image credits: C. Louis)

ExPRES

(S. Hess et al.)

- Exoplanetary and Planetary Radio Emission Simulator



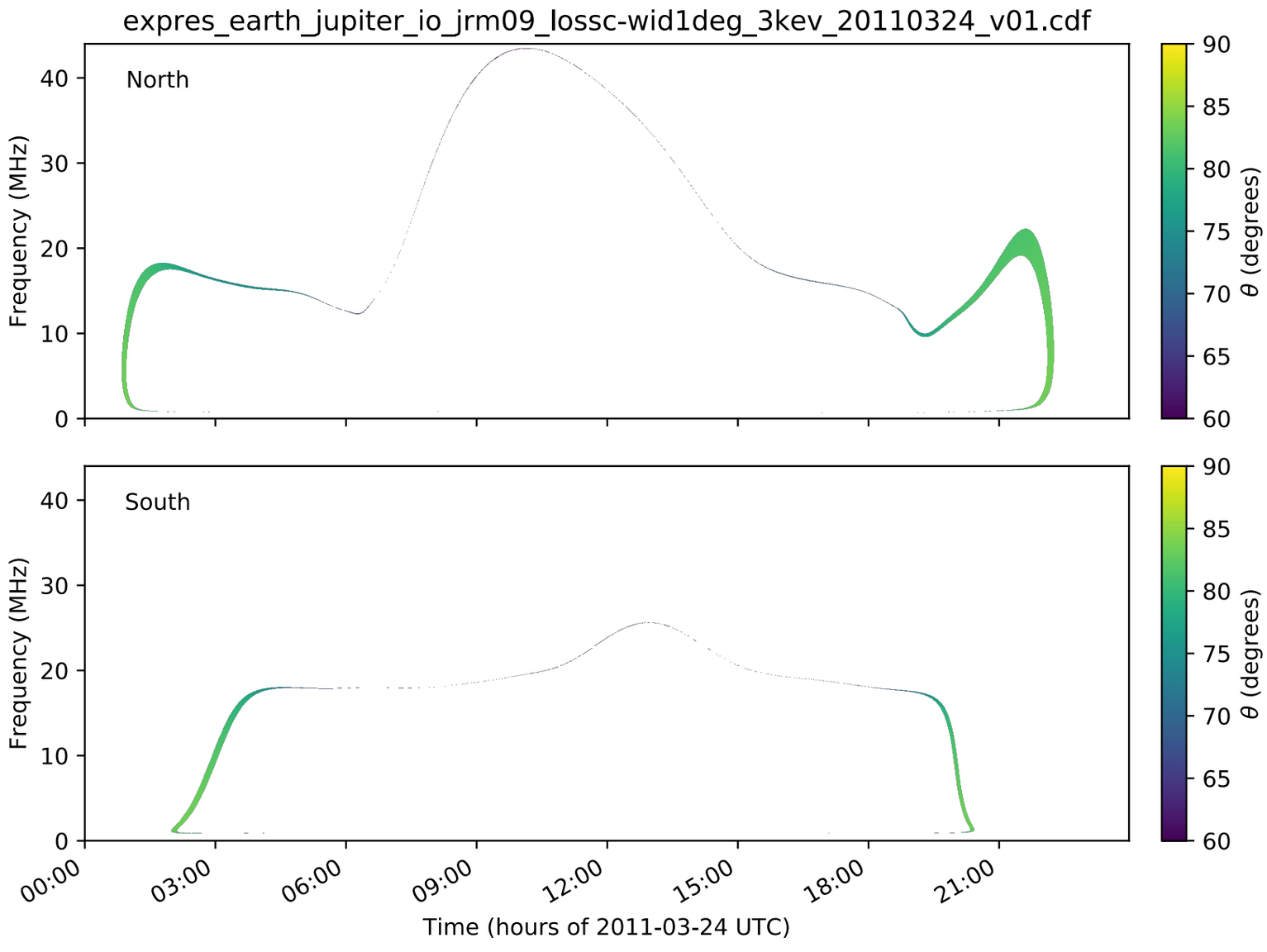
(Louis et al., 2017)

	2016-07-07	2016-07-09	2016-07-11	2016-07-13	2016-07-15	2016-07-17
R_J	31.40	49.23	62.69	73.54	82.51	89.98
Lon_{III}	52.56	353.60	294.70	235.70	176.80	117.90
Lat	-21.27	-15.95	-13.24	-11.43	-10.04	-8.91
MLat	-29.24	-24.34	-13.70	-3.60	-1.35	-7.63
MLT	5.93	6.24	6.27	6.15	6.11	6.01
L	41.24	59.31	66.41	73.83	82.55	91.60
Io Phase	32.51	79.27	126.30	173.70	221.00	268.10

ExPRES - Daily outputs

- Common Data Format (CDF) files

- Quicklooks / thumbnails (PDF & PNG files):



VESPA query interface

VESPA Query Interface 05/11/2018 14:04

(http://www.europlanet-vespa.eu/)

All VO (/planetary/data/epn/query/all/) Custom resource (/planetary/data/epn/query/resource/) Direct Query (/planetary/data/epn/query/text/) Advanced Query

Help (/planetary/data/epn/h

Submit Reset

Main Parameters

Target Name (Standard name of target)

Target Class (Standard type of target)

Asteroid
Comet
Dwarf Planet
Exoplanet

Granule UID (Unique granule identifier)

Granule GID (Granule group identifier)

Dataproduct Type (Science organization of data product)

Catalog
Catalogue Item
Cube
Dynamic Spectrum

Obs ID (Observation identifier)

Measurement Type (UCD defining the nature of the data)

Time selection

Data range is included in the range

defined by min/max values

Time Min (Acquisition start time)

Time Max (Acquisition stop time)

Location

Spectral

Time

Photometry

Instrument

Optional

Submit Reset

Plotting tools

TOPCAT (http://www.star.b full.jnlp)

Aladin (http://aladin.u-strasbg.fr/java/np aladin.pl? frame=get&id=ala

SPLAT (http://astro.dur.a

CASSIS (http://cassis.irap.

3DView (http://3dview.cdp

Example queri

Saturn in March 2012 (/planetary/data/e target_name=Satu 03-01T00%3A00%3 04-01T00%3A00%3 <%3D&c1max=& <%3D&c2max=& <%3D&c3max=& <%3D&c1_resol_ <%3D&c2_resol_ <%3D&c3_resol_ <%3D&spectral_r <%3D&spectral_s <%3D&spectral_r <%3D&time_exp_ <%3D&time_sam <%3D&phase_ma <%3D&incidence_ <%3D&emergenc

See C. Chauvin presentation!

ExPRES - VESPA access

VESPA Query Interface 05/11/2018 14:05

(http://www.europlanet-vespa.eu/)

All VO (/planetary/data/epn/query/all/) Custom resource (/planetary/data/epn/query/resource/) Direct Query (/planetary/data/epn/query/text/) Advanced Query

Help (/planetary/data/epn/h

Results in service serpe

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)
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180131_v01	dynamic_spectrum	Jupiter#Io	2018-01-31T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180130_v01	dynamic_spectrum	Jupiter#Io	2018-01-30T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180129_v01	dynamic_spectrum	Jupiter#Io	2018-01-29T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180128_v01	dynamic_spectrum	Jupiter#Io	2018-01-28T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180127_v01	dynamic_spectrum	Jupiter#Io	2018-01-27T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180126_v01	dynamic_spectrum	Jupiter#Io	2018-01-26T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180125_v01	dynamic_spectrum	Jupiter#Io	2018-01-25T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180124_v01	dynamic_spectrum	Jupiter#Io	2018-01-24T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180123_v01	dynamic_spectrum	Jupiter#Io	2018-01-23T00:00:00.000
expres_earth_jupiter_io_jrm09_lossc-wid1deg_3kev_20180122_v01	dynamic_spectrum	Jupiter#Io	2018-01-22T00:00:00.000

Showing 1 to 10 of 93 entries

Page 1 of 10

First | Previous | Next | Last

Data Selection | Metadata Selection | All Data | All Metadata

Footprints

Plotting tools

TOPCAT (http://www.star.bris.ac.u full.jnlp)

Aladin (http://aladin.u-strasbg.fr/java/nph-aladin.pl?frame=get&id=aladin.jnlp

SPLAT (http://astro.dur.ac.uk/~p

CASSIS (http://cassis.irap.omp.eu

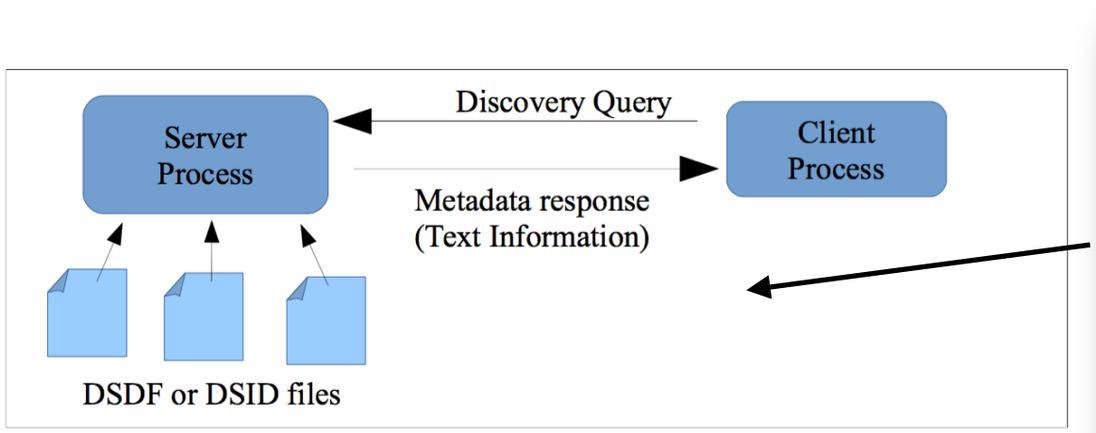
3DView (http://3dview.cdpp.eu/G

Example queries

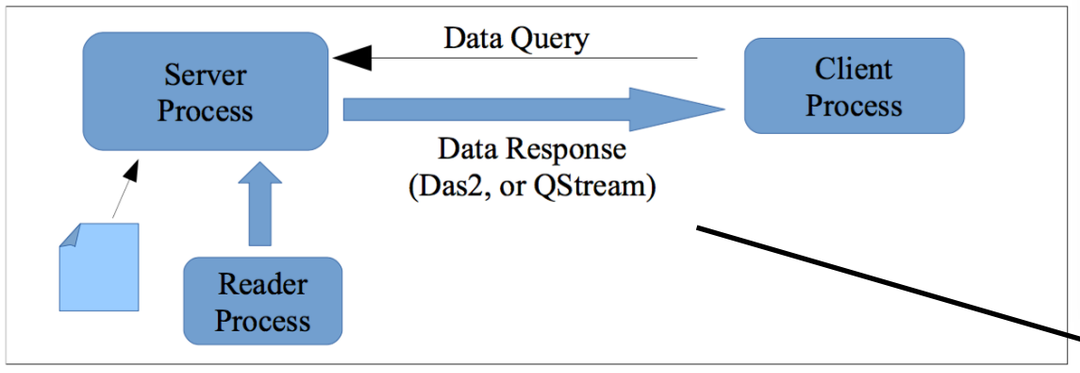
Saturn in March 2012 (/planetary/data/epn/que target_name=Saturn&gra 03-01T00%3A00%3A00.00(04-01T00%3A00%3A00.00(<%3D&c1max=&c2min_(<%3D&c2max=&c3min_(<%3D&c3max=&c1_resc <%3D&c1_resol_max=&(<%3D&c2_resol_max=&(<%3D&c3_resol_max=&s <%3D&spectral_resolutic <%3D&spectral_samplin <%3D&spectral_range_n <%3D&time_exp_max=& <%3D&time_sampling_st <%3D&phase_max=&inc <%3D&incidence_max=& <%3D&emergence_max=

Das2 - Autoplot

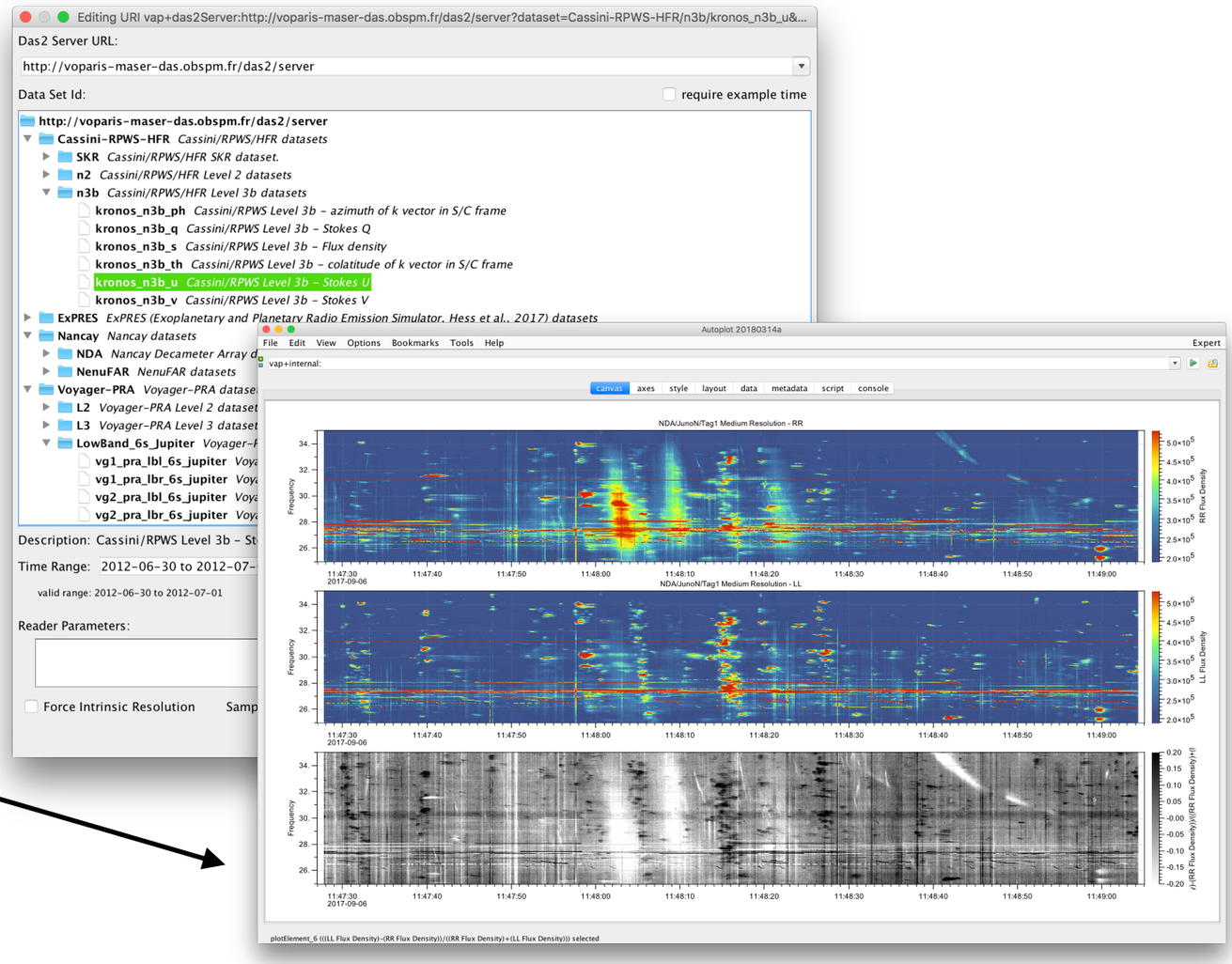
- **Das2** (University of Iowa Radio and Plasma Wave group)
  - *long/high-resolution* **time-series** data distribution for plotting purposes
  - *server-side* **resampling** → optimize transmitted data volume



Discovery Query Information Flow



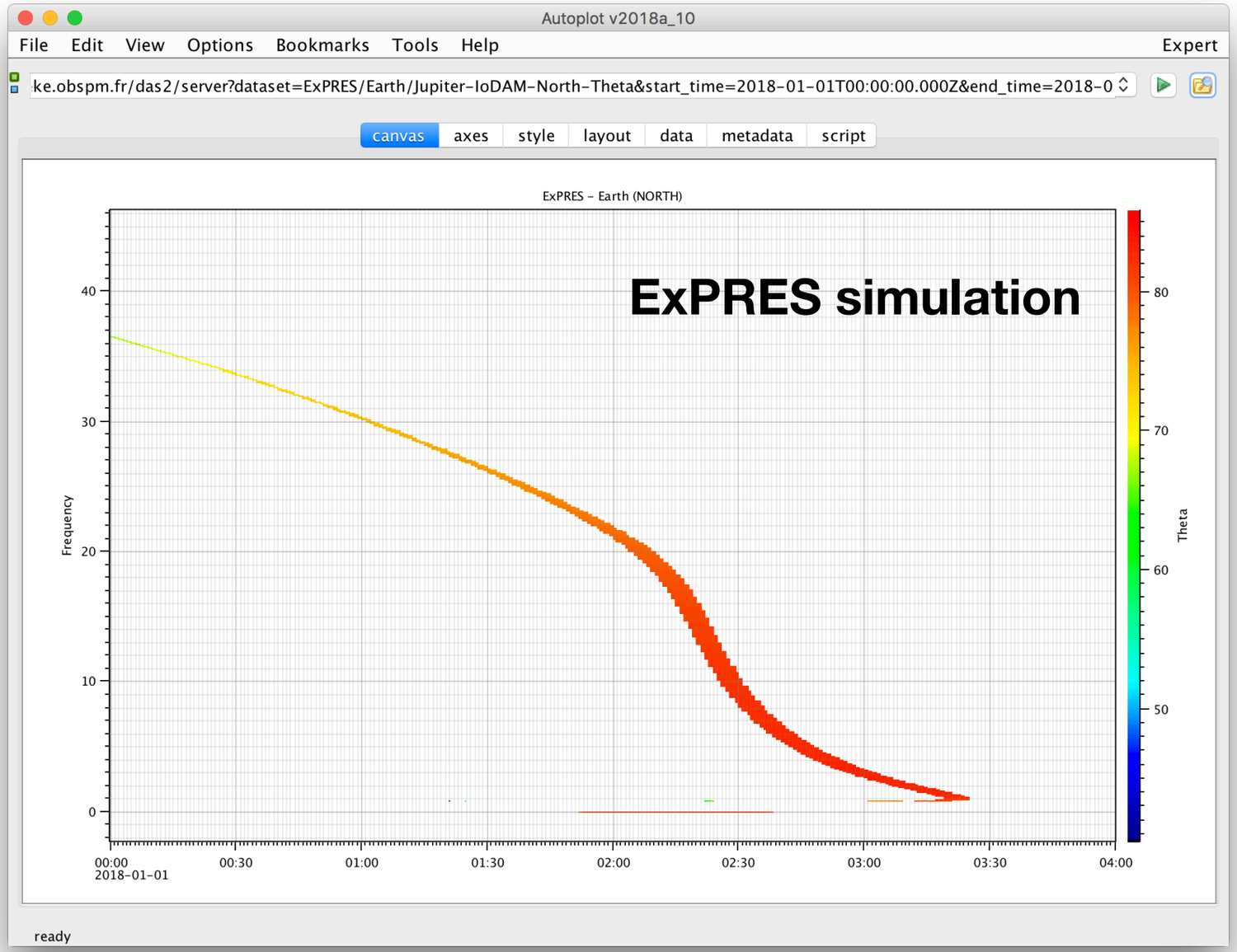
Data Query Information Flow



(images credits: B. Cecconi)

Das2 - Autoplot

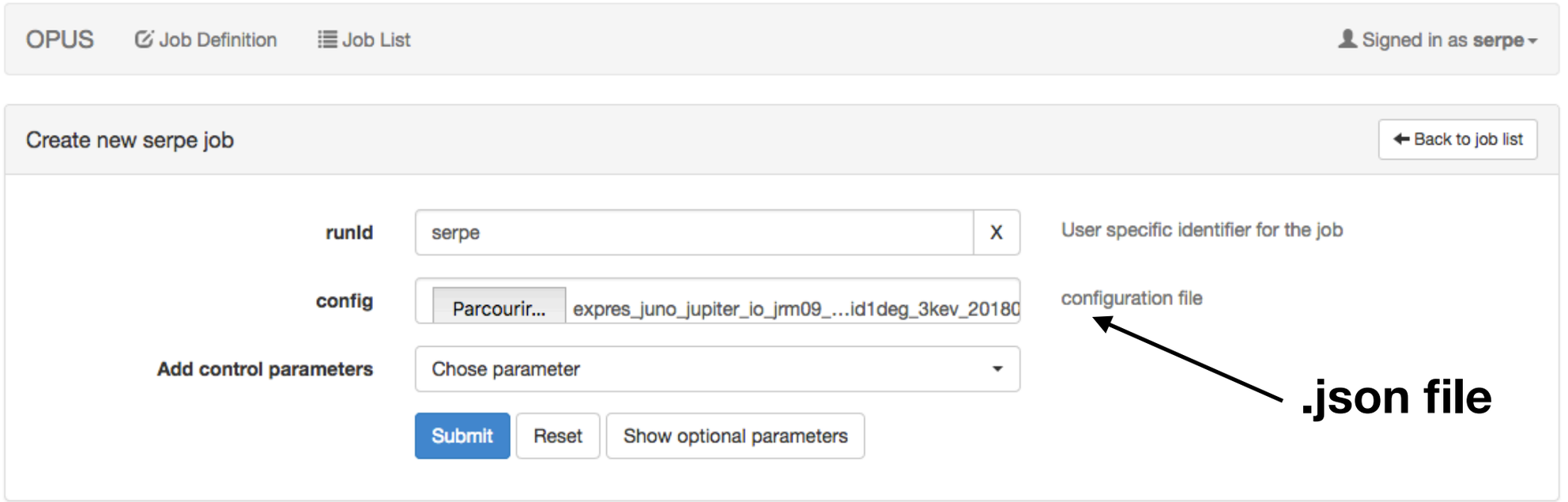
- **Autoplot** (Faden et al., 2010):
  - *interactive* **browser** for data on the web
  - read **Das2 data streams**



UWS

- **Universal Worker Service pattern**: asynchronous job executions on a service

- **OPUS** (Observatoire de Paris UWS System), see M. Servillat talk



UWS/OPUS Jobs

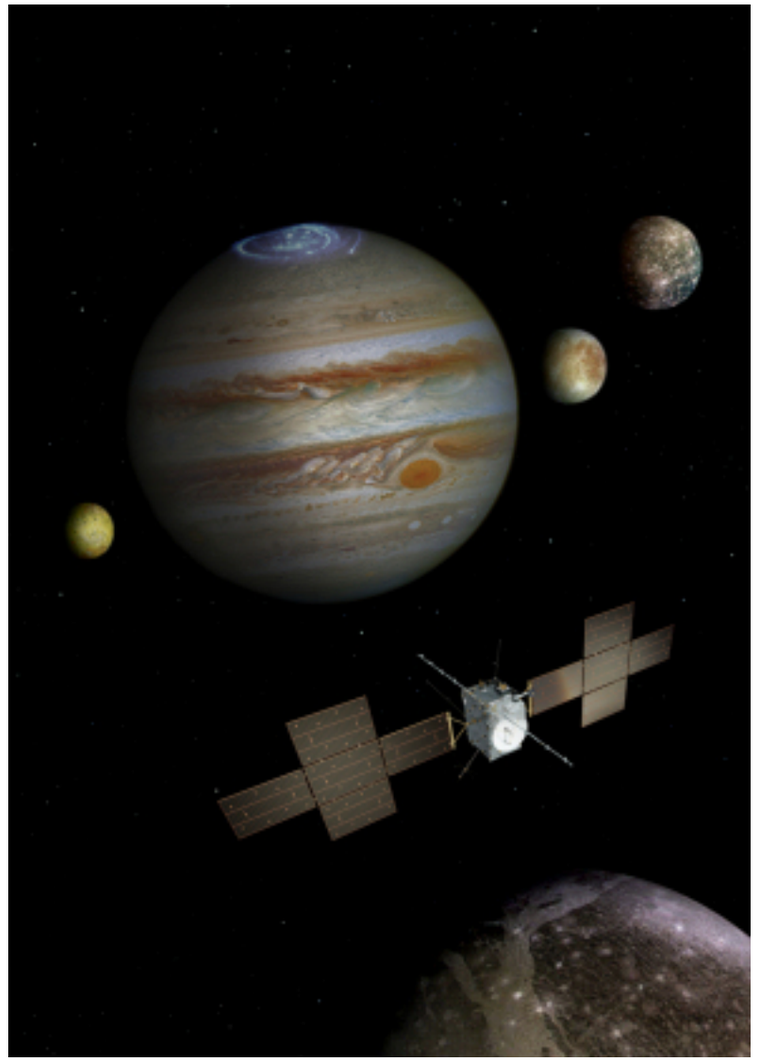
OPUS | Job Definition | Job List | Signed in as **serpe**

Job List for serpe | Refresh Job List | Create New Job

jobId	runId	Creation Time	Phase	Details	Control
d73672	serpe	2018-10-25 16:23:47	COMPLETED	Properties | Parameters | Results	Start | Abort | Delete
9a750e	serpe	2018-10-24 15:40:05	COMPLETED	Properties | Parameters | Results	Start | Abort | Delete
1155eb	serpe	2018-10-24 15:36:29	ERROR	Properties | Parameters | Results	Start | Abort | Delete
253b8b	serpe	2018-10-24 15:34:07	COMPLETED	Properties | Parameters | Results	Start | Abort | Delete
482c0e	serpe	2018-10-24 15:24:50	ERROR	Properties | Parameters | Results	Start | Abort | Delete
7d7597	serpe	2018-09-05 11:57:52	ERROR	Properties | Parameters | Results	Start | Abort | Delete
f4e8db	serpe	2018-09-05 09:04:12	ERROR	Properties | Parameters | Results	Start | Abort | Delete
265c3f	serpe	2018-09-05 09:04:09	ERROR	Properties | Parameters | Results	Start | Abort | Delete
cf936c	serpe	2018-09-03 17:43:57	ERROR	Properties | Parameters | Results	Start | Abort | Delete
866235	serpe	2018-09-03 17:35:02	COMPLETED	Properties | Parameters | Results	Start | Abort | Delete
2d129f	serpe	2018-09-03 17:33:21	COMPLETED	Properties | Parameters | Results	Start | Abort | Delete
62e3b1	serpe	2018-09-03 17:26:48	ERROR	Properties | Parameters | Results	Start | Abort | Delete
ed88a4	test_uws_REST	2018-08-09 17:32:51	COMPLETED	Properties | Parameters | Results	Start | Abort | Delete
dbfabb	test_serpe_uws	2018-08-08 17:38:00	COMPLETED	Properties | Parameters | Results	Start | Abort | Delete

ESA/JUICE mission

- **JUICE** (Jupiter Icy Moon Explorer)
  ESA mission to explore Jupiter and its moons.
  Launch in 2022, arrival at Jupiter in 2029, 3 years nominal mission. Last part of mission in orbit around Ganymede.



- Two radio receivers onboard:
  - **RPWI/JENRAGE** (Radio and Plasma Waves Investigation/ Jovian Environment Radio Astronomy and Ganymede Exploration): multichannel radio receiver 80 kHz - 45 MHz, dedicated to Jovian radio emission
  - **RIME** (Radar for Icy Moon Exploration): ice-penetrating radar to study the subsurface structure of the icy moons down to 9km depth with vertical resolution of 30m in ice, operating at ~9 MHz

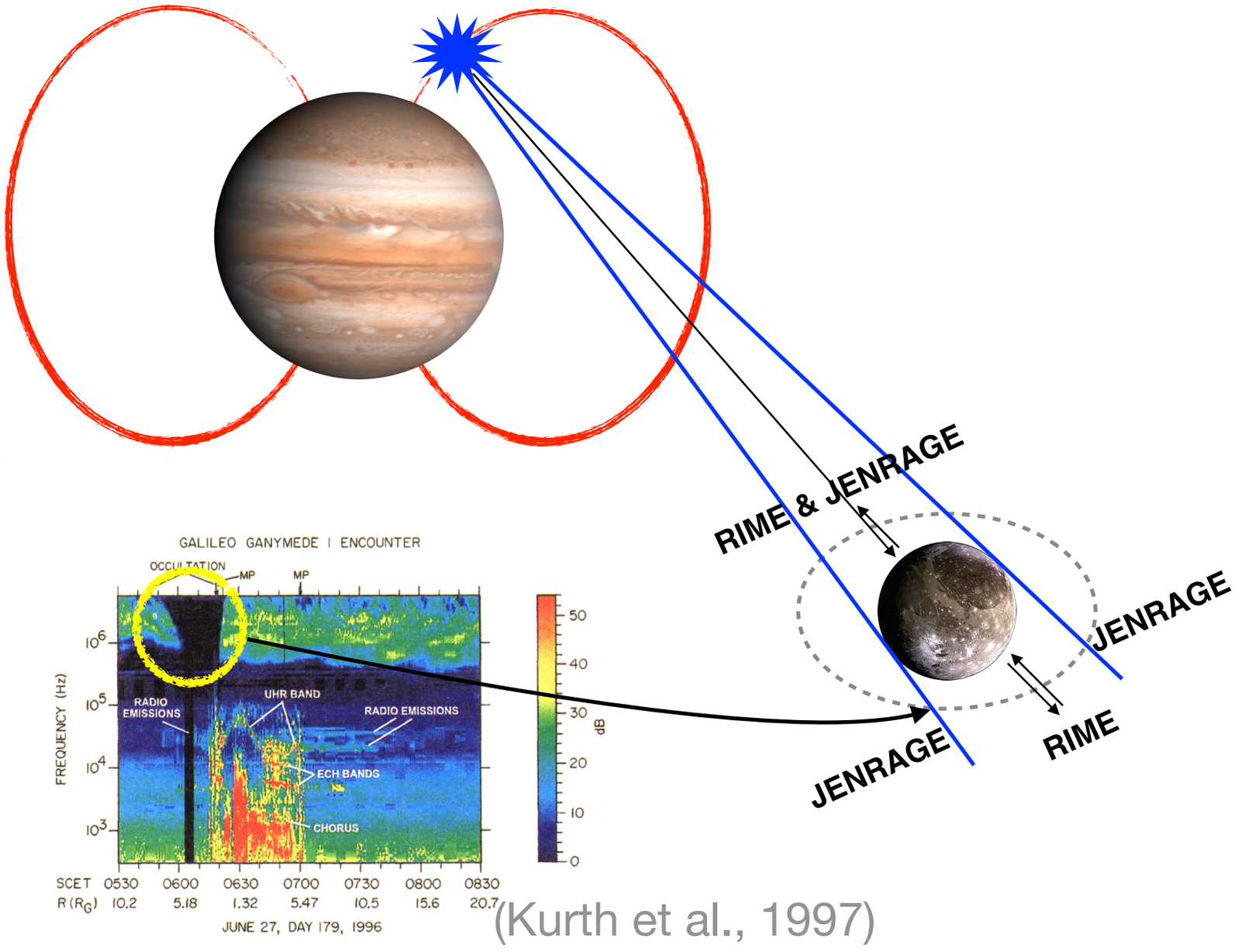
- **Jovian radio emission** = *signal* for JENRAGE, *noise* for RIME (> radar echo signals)
  Need radio emission modeling for observation planning of RIME and for radio occultation studies (by Ganymede ionosphere with JENRAGE)

ESA/JUICE mission

- **JENRAGE**:
  Remote probing of Ganymede ionosphere with radio occultation

- **RIME**:
  Operation only when Jovian radio emission probability is low + in anti-Jovian side

- **Both**:
  Passive radar using Jovian radio emission as radar signal source and interferometry with echo on surface and subsurface



(Kurth et al., 1997)

ESA need: modeling of radio source location → ExPRES

Next steps

- MASER update / new capabilities (e.g. automatic parasite cleaning on dynamic spectra)

- ExPRES service soon to be published on a public TAP server (next Cassini, RadioJOVE)

- ExPRES with UWS: allowing ESA/JUICE to determine jovian radio source location → observation planning

- Ground support to space missions (Solar Orbiter, Parker Solar Probe, JUICE with NDA)