

ARTEMIX / YAFITS

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(LERMA)

Archive, Data Mining and Visualisation

ARTEMIX

Service

Remote visualisation of ALMA
science Archive

ADASS 2017 (Trieste)

Astronomical Data Analysis Software and Systems XXVI
ASP Conference Series, Vol. 521
Marco Molinaro, Keith Shortridge, and Fabio Pasian, eds.
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ARTEMIX - Alma RemoTE MIning eXperiment

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Abstract. Even if not yet in full operation mode, the ALMA observatory has already delivered huge amounts of data. Those data are accessible to download via the ALMA science archive portal from their parent project id. We present here ARTEMIX (Alma RemoTE MIning eXperiment), a development from the Paris Observatory that aims at exploring new tools for metadata and datacube remote visualisation. ARTEMIX does not reprocess the calibrated data. It is thought as a collection of display facilities which aim is to ease the definition of trans-project subsamples. Future developments, like automated subsample selection via higher-level data analysis are possible, but require the access to fully imaged data-cubes that are not provided yet.

YAFITS

Tool

Standalone Quick Look Viewer

ADASS 2019 (Leiden)

Astronomical Data Analysis Software and Systems XXVIII
ASP Conference Series, Vol. 523
P.J. Teuben, M.W. Pound, B.A. Thomas, and E.M. Warner, eds.
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ARTEMIX and YAFITS : Remote Viewer Experiments

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Abstract. ARTEMIX¹ — The access to astronomical data has never been so simple for our community. From a technical side, it is however more and more difficult. The size and the number of the current and future data-sets raise the question of the best way for astronomers to visualise and to analyse archived observations. The increasing speed of network communications and the much powerful computing capacities of dedicated servers as compared to personal machines naturally question the choice of centralised data-center with remote (client-server) tools versus individual and local softwares. The advent of cloud-based services has already taken over for editing (i.e. overleaf, sharelatex²...) or scripting (jupyter-notebooks³). We present here ARTEMIX: an experiment of a service based on the World Wide Web to explore the ALMA scientific data products (cubes in FITS-format): select a data-set, visualize its content and perform some fundamental measurements. We also introduce YAFITS : its standalone and generalised version, running inside Docker⁴. The strength of these tools is to let the user directly manipulate and display on-line the FITS content without any local resource, other than a simple browser (no download, no local software).



EUROPEAN ARC
ALMA Regional Centre || IRAM

Goals

- (i) Search by products not by instrumental configuration
- (ii) Provide trans-project queries (ie famous sources)
- (iii) Have a rapid idea of the data content (fits files)**

Means

- (i) ALMA observing configuration previews (meta-data)
- (ii) ALMA cube previews (science products QA2)**

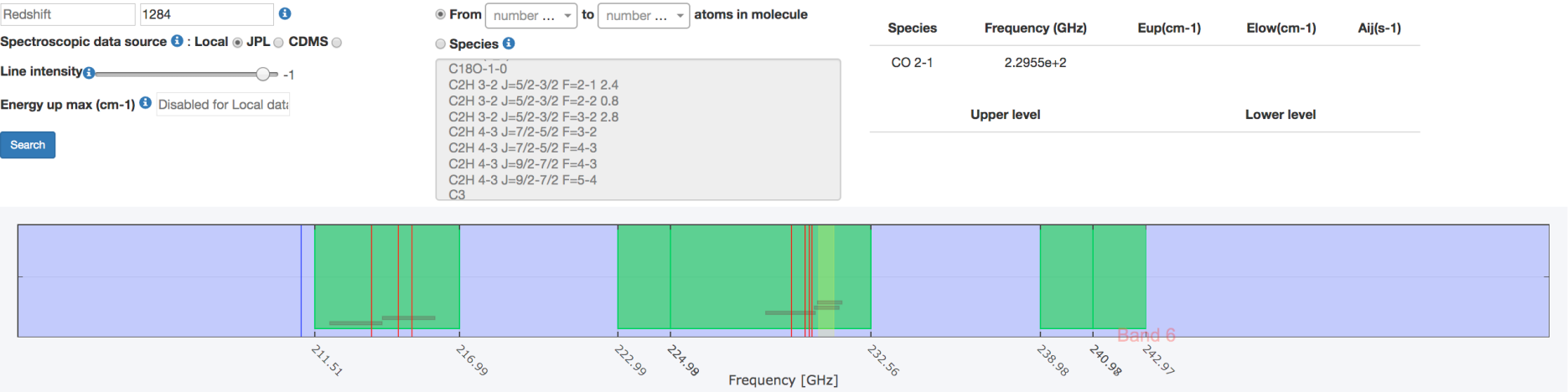
Context (1)

- (i) To stand **just beyond what is provided by the ALMA Observatory Science Archive** (not delivering data, not providing material for data reduction). —> Redirection to the ALMA Science Archive
- (ii) To **use public meta-data** and **public fits data cubes**
- (iii) **Not to redo what already exist** in the ASA (ie rapid metadata query by multi-filters)

Context (2)

- > To Provide **a pilot study** of **remotely** operated tools for **quick look** visualisations (regular discussions with F. Stoer, **ie new ASA interface**)
- > Not developed in ESO coding standards, but with **selected new techno** i.e. Serveur HTTP:NodeJS, Database:MongoDB; FITS server:python...
- > Developed at the Paris Observatory, LERMA, in the framework of the French AA-ANO3 duties coordinated by the OASU (OASU, Obs. Paris, OSUG, IRAM)

ARTEMIX interface



Warning : the collection of FITS files used by ARTEMIX and copied from the Alma Science Archive is already quite large. However, it is incomplete; we strive to improve the situation until we have a full copy of the ensemble of FITS files present in the ASA. Please also notice that only a relatively small fraction of all ALMA raw data are actually turned into images. Please go to the [ALMA archive](#) and download raw data for a complete overview of the data.

All InfoFitsData

Show all data.*.pbcor.fits and *.pbcorr.fits*.image.fits*.clean.fits*.cont.fits and *.line.fits

#	Fits file	Target	RA	DEC	Cube size	Freq. range	Proj. code	uid
1	Info	M87	12:30:49.42	12:23:28.04	4500x4500x1	136.991 --- 152.995	2015.1.01352.S	uid://A001/X2d6/X2be
2	Info	M87	12:30:49.42	12:23:28.04	4500x4500x1	136.991 --- 152.995	2015.1.01352.S	uid://A001/X2d6/X2be
3	Info	M87	12:30:49.42	12:23:28.04	4500x4500x1	136.991 --- 152.995	2015.1.01352.S	uid://A001/X2d6/X2be
4	Info	M87	12:30:49.42	12:23:28.04	3200x3200x1	222.993 --- 243	2015.1.01352.S	uid://A001/X2d6/X2c2
5	Info	M87	12:30:49.42	12:23:28.04	3200x3200x1	222.993 --- 243	2015.1.01352.S	uid://A001/X2d6/X2c2
6	Info	M87	12:30:49.42	12:23:28.04	3200x3200x1	222.993 --- 243	2015.1.01352.S	uid://A001/X2d6/X2c2

J200012 30 49.423 +12 23 28.04

New ALMA query interface

Not yet the default one

NextCloud Overleaf WritingStud Mendeley Jupyter GitLab NED ADS AstroPh ARTEMIX EU-HOU Obspm Annuaire SOGo

Autres favoris

Source name (Resolver): m87 + 1 tab-subfilter

12 30 51.464 +12 23 7.69

Molecules

Lines

Redshift

All

0.00436 (estimated)

6

Reset extremes

Alpha H30alpha

N2D+ J=3-2

CO v=0 2-1

CH3OH v=0 3(-2,2)-4(-1,4)

H13CCCN J=26-25

CH3CHCN v15=1 24(1,13)-23(1,12)

CN v=0 N=2-1 J=3/2-3/2 F=5/2-5/2

H2CO 3(1,2)-2(1,1)

C17O J=2-1

SO2 v=0 6(4,2)-7(3,5)

CH2DOH 5(4,1)-4(4,0) o1

CH3OH v=1 16(2,14)-15(1,15) ++

u-line U-221914

13CO v=0 2-1

C18O 2-1

H2CO 3(2,1)-2(2,0)

H2CO 3(0,3)-2(0,2)

CH3OH v=0 5(4,4)-4(2,2)

DCO+ v=0 J=3-2

SO 35sigma v=0 5(5,4)-4(4)

SO 35sigma v=0 7(8,7)-7(7)

CH3OH v=0 11(1,0)-0(0,0)

214 GHz

216 GHz

218 GHz

220 GHz

222 GHz

224 GHz

226 GHz

228 GHz

230 GHz

3

4

5

6

7

8

9

10

Observations (1)

Projects (13)

Publications (10)

Source: m87_SE

Source is text match only. For source name searches, use the search menu at the top left. Column filters apply only to this tab.

Project code

Source

Ra

Dec

Band

Cont. sens.

Frequency support

Release date

Publications

Ang. res.

Min. vel. res.

Array

Mosaic

Max. reco. scale

FOV

Scientific category

Science keywords

2013.1.00862.S

M87_SE

12:30:51.464 +12:23:07.690 6

0.02

212.08..231.47GHz

2016-08-25

2

1.06

1.26

12m

11.24

26.26

Cosmology

Galaxy groups

Context (3)

Other similar software tools

- A powerful server-side visualization tool (PI: Erik Rosolowsky) which allows users to browse and manipulate the very large ALMA data cubes without having to download them to disk first : **CARTA** (Cube Analysis and Rendering Tool for Astronomy)
- Japanese Virtual Observatory (**JVO**) science-ready ALMA images (JVO portal (<http://jvo.nao.ac.jp/index-e.html>))

—> **Use different implementations, different heuristics. New field but large potential of remote (cloud-based) data inspection. Testbed for new methods. Room for several experiments**

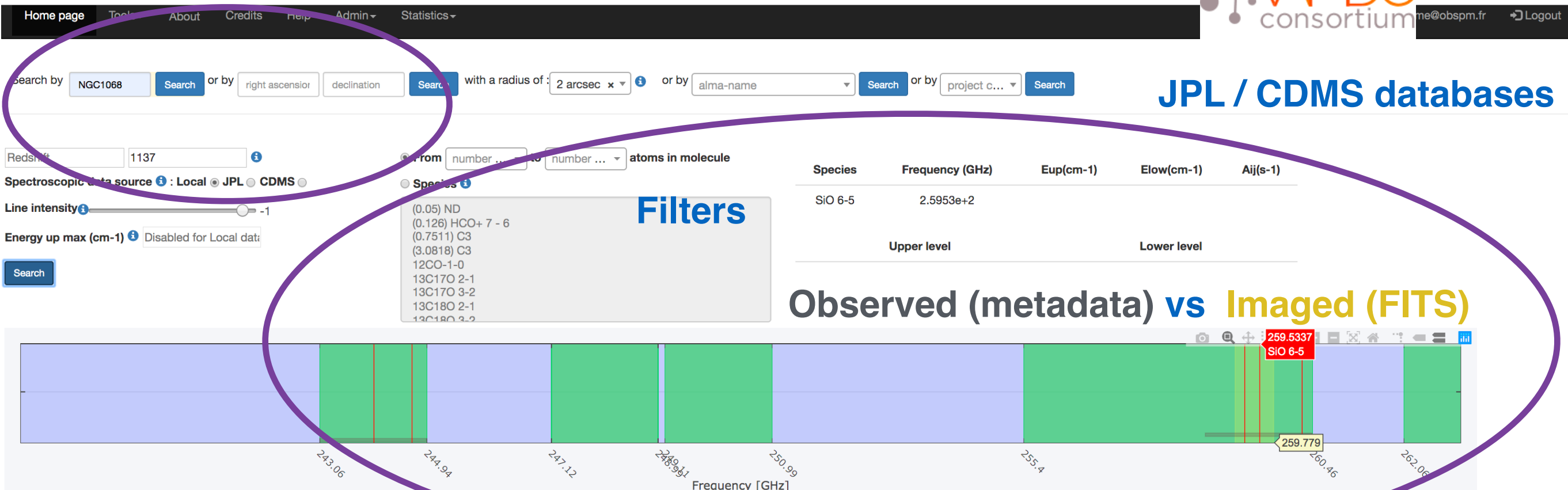
1- Region of Interest

- > Display the **frequency range observed** (basebands) for all the projects that correspond to a given region of interest
- > Display the region of interest into **AladinLite** (help getting velocity / redshift if searched by sesame-name)
- > Display a **table of the header keywords** for all fits files that correspond to this region of interest (different Project codes, different FoV...)
- > Display a **table with all the metadata** for these projects (resolution, t_obs..)

Goal : quick visual inspection of what has been observed .vs. what has been imaged. Provide a link to the data cube (or 2D)

- > On click in the table : overlay the frequency slice that has been imaged (**metadata vs fits header**), overlay the FoV (fits header box)
- > Link to **ADS** for publication check
- > Link to **ESO/NRAO ALMA archive** for data retrieval
- > **Addition of spectral line from JPL / CDMS via VAMDC + Filters**

1- Region of Interest

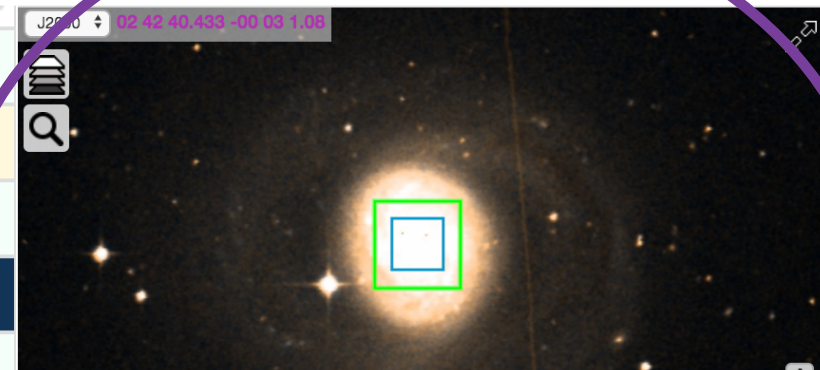


Warning : the collection of FITS files used by ARTEMIX and copied from the Alma Science Archive is already quite large. However, it is incomplete, we will improve the situation until we have a full copy of the ensemble of FITS files present in the ASA. Please also notice that only a relatively small fraction of all ALMA raw data are actually turned into images. Please go to the [ALMA archive](#) and download raw data for a complete overview of the data.

All Info FitsData

Show all data. ☒ *.pbcor.fits and *.pbcorr.fits ☐ *.image.fits ☐ *.clean.fits ☐ *.cont.fits and *.line.fits

ID	Info	Target	RA	Dec	Size	Frequency	File	UID
45	Info	NGC1068	02:42:40.71	-00:00:47.94	60x60x44	215.794 --- 216.75	2013.1.00221.S	uid://A001/X121/X382
46	Info	NGC1068	02:42:40.71	-00:00:47.94	512x512x1	243.622 --- 260.296	2013.1.00221.S	uid://A001/X121/X37e
47	Info	NGC1068	02:42:40.71	-00:00:47.94	512x512x21	243.726 --- 244.241	2013.1.00221.S	uid://A001/X121/X37e
48	Info	NGC1068	02:42:40.71	-00:00:47.94	512x512x26	259.102 --- 259.779	2013.1.00221.S	uid://A001/X121/X37e
49	Info	NGC1068	02:42:40.71	-00:00:47.94	500x500x110	129.051 --- 130.485	2013.1.00221.S	uid://A001/X121/X386



2- Quick Look Viewer

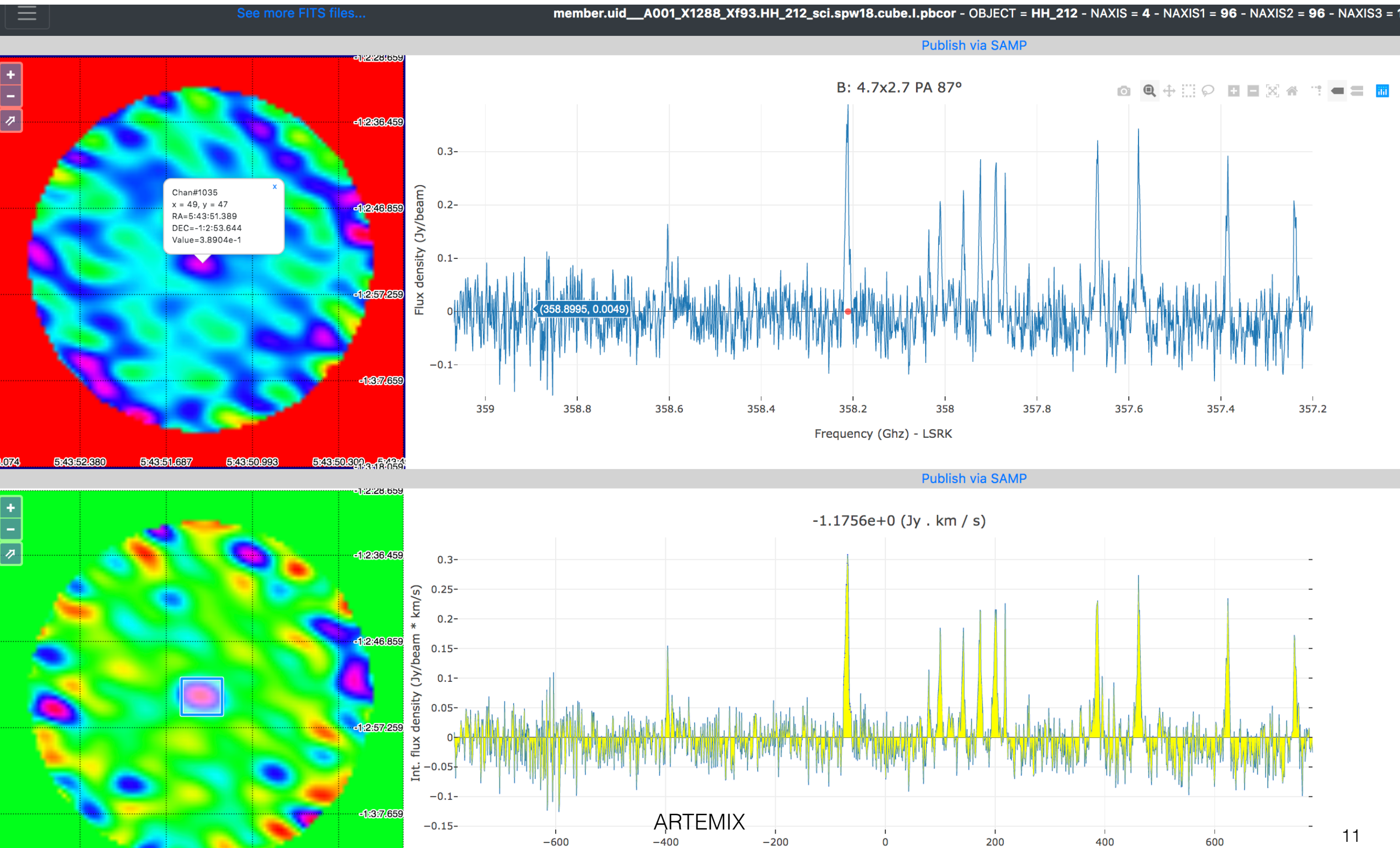
- > **Display the data cube** (2 images, 2 spectra) : 1 channel map, 1 moment map, 1 spectra extracted from a pixel, 1 spectra extracted from a spatial region (square). Interactive and self-consistent
- > Based on **GILDAS Mapping « go view »**. Same functionalities implemented (frequency selection, region selection, integrated flux computation)
- > Link to the detailed fits header
- > **New viewer implementation (faster)** based on **OpenLayers / Highcharts**
- > **Interoperabilty**

Goal : give a quick look preview of the data cube content

- Sometimes (oldest data) the x-axis reference frame varies (LSR, HELIO, BARY...). No computation done apart Freq —> Vel and Vel —> Freq in the same frame.
- Only slices have been extracted (not always the best cut-out or spectral resolution). No re-calibration applied (PI are encouraged to retrieve the ALMA raw data and use the standard pipeline)

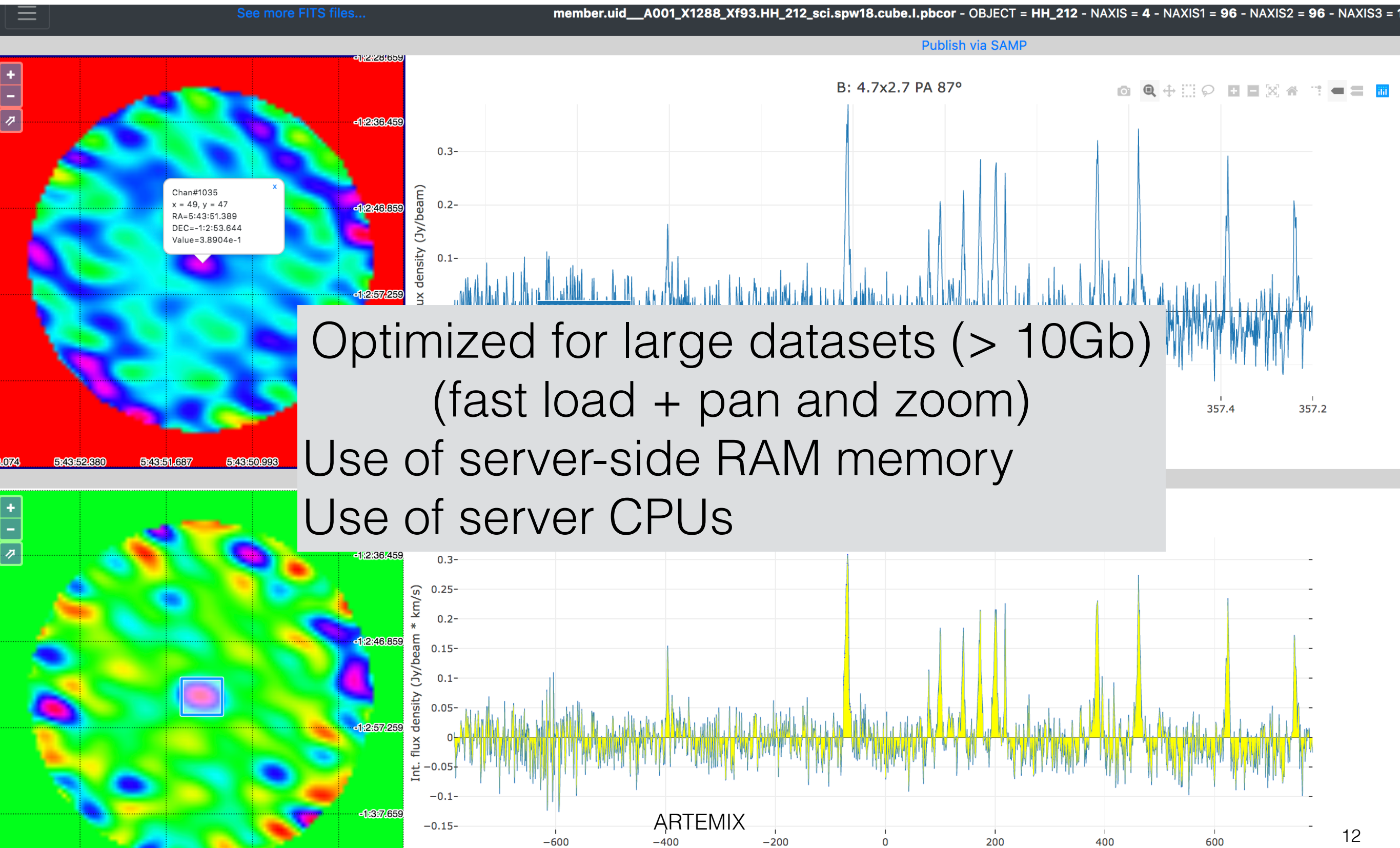
2- Quick Look Viewer

http://artemix.obspm.fr/fits/visit/?relFITSFilePath=//2017/2017.1.01053.S/science_goal.uid_A001_X1288_Xf91/group.uid_A001_X1288_Xf92/member.uid_A001_X1288_Xf93/product/member.uid_A001_X1288_Xf93.HH_212_sci.spw18.cube.l.pbcor.fits

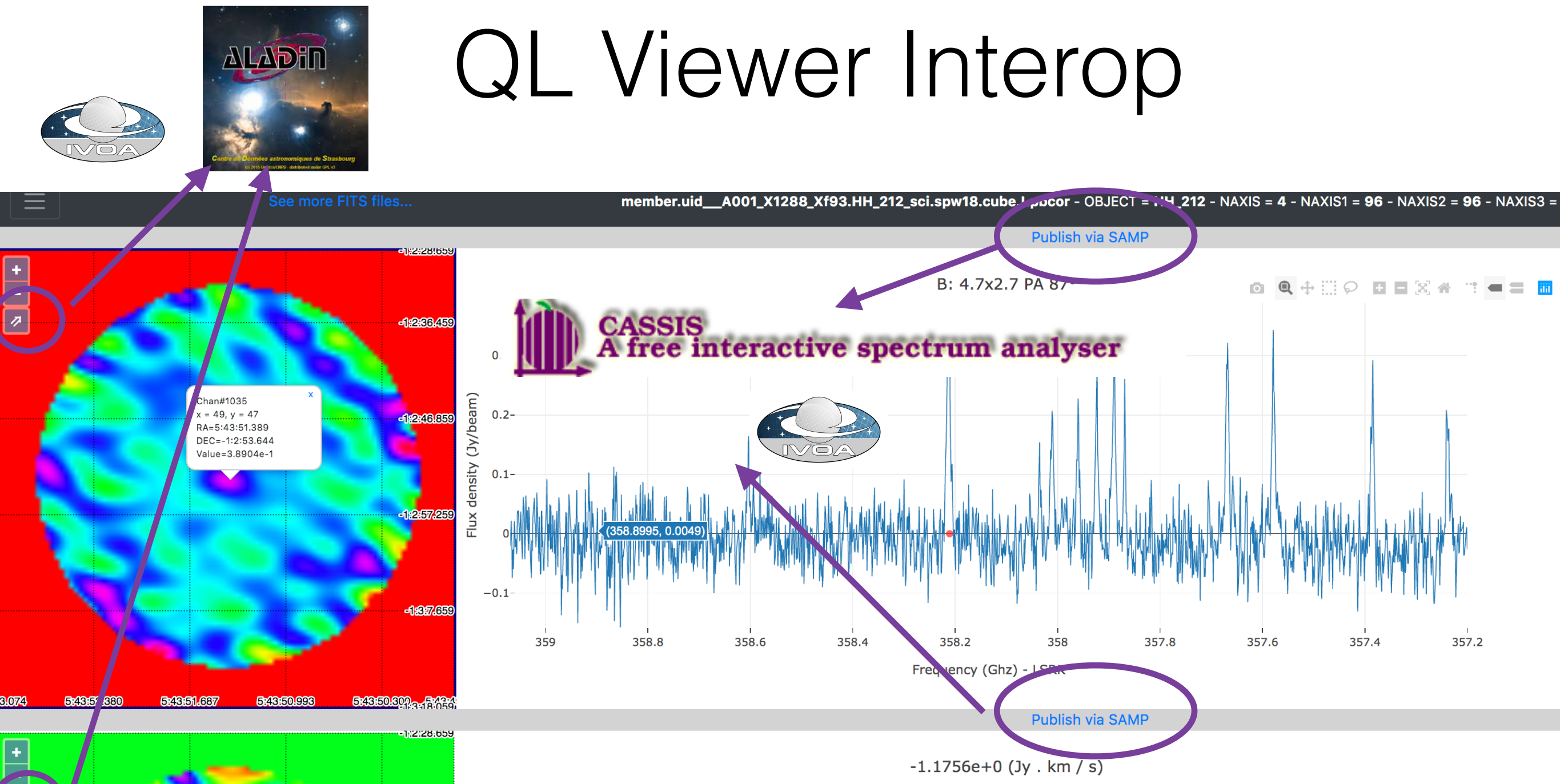


2- Quick Look Viewer

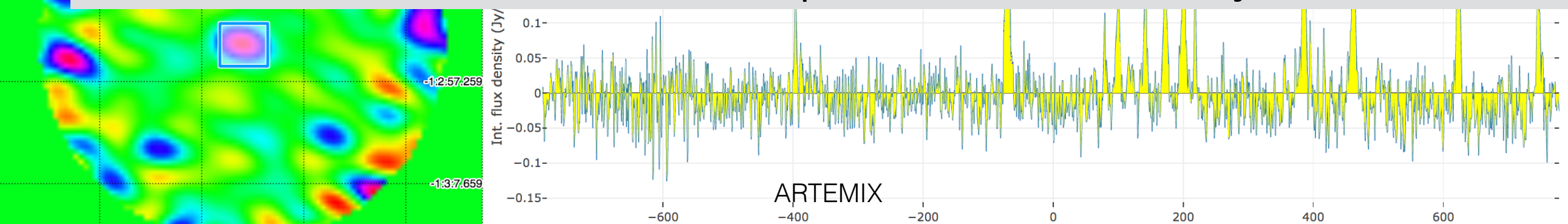
http://artemix.obspm.fr/fits/visit/?relFITSFilePath=//2017/2017.1.01053.S/science_goal.uid_A001_X1288_Xf91/group.uid_A001_X1288_Xf92/member.uid_A001_X1288_Xf93/product/member.uid_A001_X1288_Xf93.HH_212_sci.spw18.cube.I.pbcor.fits



QL Viewer Interop



- Export spectra / Images in dedicated external software
- Immediate use on Desktop for further analysis



Conclusions (1)

1. Service on-line <http://artemix.obspm.fr> —> Remote Quick-Look access to science data products
2. New features : **Faster viewer** based on Open Layers, **interoperability** via SAMP for spectra AND images. Access to **molecular databases** via VAMDC. Overlay expected line frequencies

Proof of Concept done. Bottle-neck : size of the FITS-archive: to host a full copy not possible. Other possibilities (i) download FITS on-demand (ii) get the viewer closer to a complete copy of the scientific data (FITS).

More information : get in touch with artemix.lerma@obspm.fr (P. Salomé, M. Caillat, N. Moreau, Y-A, Ba).

Local Archive

1. Completed up to 2016 (Full science data base in local)
2. From 2017 and later : local copy of files < 2 Gb (more than 96% of the # of file but about 15% of the total size (scaled on 2016)).

Project code - Statistics

The table below shows the project code of the public data and the related number of fits files.

Search by project code, title, category

Search:

#	Project code	#of FITS files	Title	Category	Release date
219	2017.A.00056.S	2412	The nature of Planck compact sources at 353 microns	Galaxy evolution	2018-09-07
148	2017.A.00054.S	421	ACA Observatory Project: SMC Band 6 CO and continuum mapping	Local Universe	2018-11-07
147	2017.A.00053.S	20	ALMA ACA Band-8 observatory project: Mapping fine structure lines of neutral atomic carbon in local bright galaxies	Active galaxies	2018-11-07
125	2017.A.00035.S	18	Using eclipses to determine the size of a neutron star jet	Stars and stellar evolution	2018-11-28
174	2017.A.00034.S	88	Witnessing the Formation of a Spiral Galaxy in the Early Universe	Galaxy evolution	2018-10-17
230	2017.A.00032.S	51	A confirmation of a gravitationally unstable gas disk in the brightest unlensed submillimeter galaxy at z=4.3	Active galaxies	2018-08-29
160	2017.A.00030.S	2	First radioactive molecule observed in space: 26AlF in a stellar-merger remnant	Stars and stellar evolution	2018-10-25
220	2017.A.00018.S	28	Studying the effects of variable UV heating on the outer disk	ISM and star formation	2018-09-07
129	2017.1.01701.S	6	The Edge-On disk of HH 30: How much flatter can it get?	Disks and planet formation	2018-11-23

Local Archive

1. Completed up to 2016 (Full science data base in local)
2. From 2017 and later : local copy of files < 2 Gb (more than 96% of the # of file but about 15% of the total size (scaled on 2016)).

Project code: MousId:

[List of fits coming from ALMA](#)

Id	Url	Size (MB)	Download
0	https://almascience.eso.org/dataPortal/requests/anonymous/2154156459686/ALMA/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.cube.I.mask.fits.gz/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.cube.I.mask.fits.gz.tar	0.6645760000000001	Download
1	https://almascience.eso.org/dataPortal/requests/anonymous/2154156459686/ALMA/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.cube.I.pb.fits.gz/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.cube.I.pb.fits.gz.tar	173.377536	Download
2	https://almascience.eso.org/dataPortal/requests/anonymous/2154156459686/ALMA/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.cube.I.pbcor.fits/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.cube.I.pbcor.fits.tar	679.691264	Waiting to be downloaded
3	https://almascience.eso.org/dataPortal/requests/anonymous/2154156459686/ALMA/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.mfs.I.mask.fits.gz/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.mfs.I.mask.fits.gz.tar	0.01024	Download
4	https://almascience.eso.org/dataPortal/requests/anonymous/2154156459686/ALMA/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.mfs.I.pb.fits.gz/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.mfs.I.pb.fits.gz.tar	1.4735360000000002	Download
5	https://almascience.eso.org/dataPortal/requests/anonymous/2154156459686/ALMA/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.mfs.I.pbcor.fits/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19.mfs.I.pbcor.fits.tar	5.771264	Download
6	https://almascience.eso.org/dataPortal/requests/anonymous/2154156459686/ALMA/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19_21_23_25.cont.I.mask.fits.gz/member.uid___A001_X133d_X405e.GRB_980425_sci.spw19_21_23_25.cont.I.mask.fits.gz.tar	0.01024	Download

Perspectives

—> We have developed a **Standalone version of the viewer : Yafits**. Inside a **Docker** : simplified the installation procedure. Deploy the Docker image + specify path to FITS + run.

More information : get in touch with artemix.lerma@obspm.fr (P. Salomé, M. Caillat, N. Moreau, Y-A, Ba).

YAFITS

radio astronomy

data visualisation

image cube

visual analytics

DOI 10.5281/zenodo.3696974

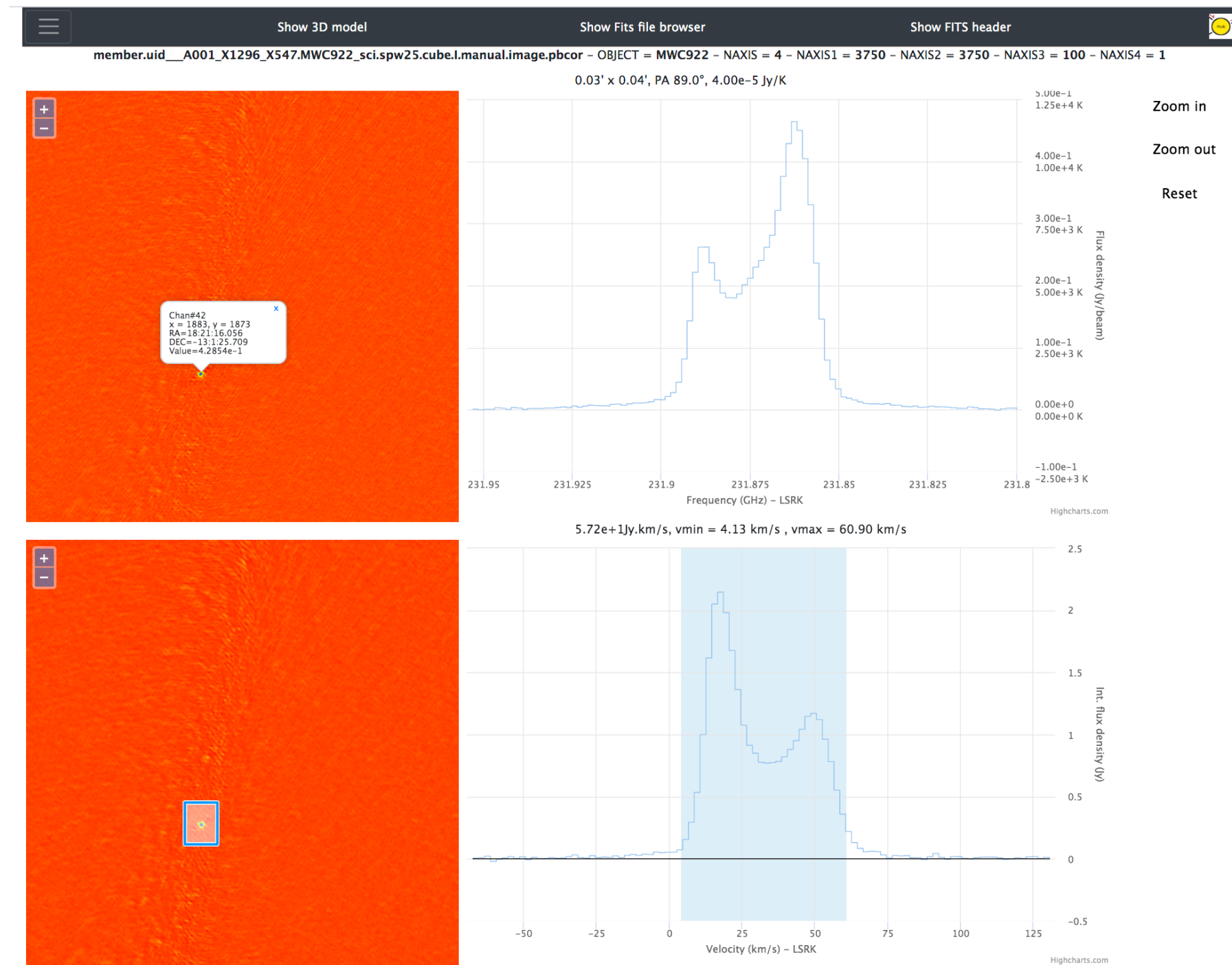
—> Talk by Nicolas Moreau (<http://www.france-ov.org/twiki/bin/view/JOURNEESSpecifiques/SemiHackAThon6>)

Architecture, Technical aspects, Development environment, Install

- Deployed inside Docker - No dependences - Easy configuration (PATH)
 - Uses external libraries : Highcharts (spectra) and Openlayers (Images)
 - Same as included in ARTEMIX but just need a file-system with FITS file
 - Designed for radio-astronomy datacubes (takes into account beam-sizes)
 - Tested with MUSE, SITELE, ALMA, NOEMA data
-
- Discussions with IRAM to deliver the package to the Observatory

YAFITS

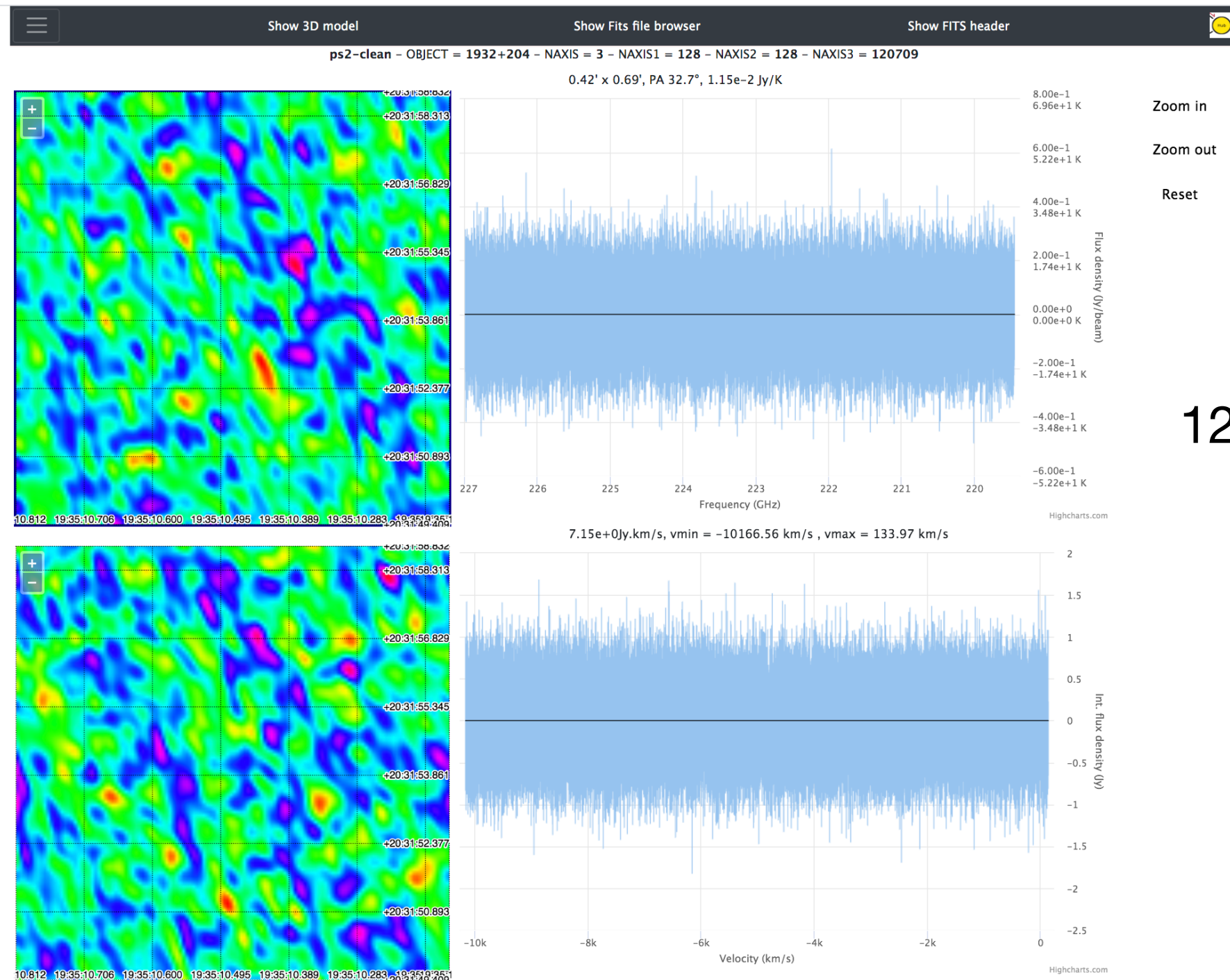
Effort to have a fluid interactivity for large images (2048 x 2048) and large spectra (120 000 channels) once loaded in memory (like locally)



3750 x 3750 x 100

YAFITS

Effort to have a fluid interactivity for large images (2048 x 2048) and large spectra (120 000 channels) once loaded in memory (like locally)



128 x 128 x 120 709

YAFITS



[See more FITS files...](#)

GG_Tau_cont_tclean.image.pbcor - OBJECT = GG_Tau - NAXIS = 4 - NAXIS1 = 540 - NAXIS2 = 540 - NAXIS3 = 1 - NAXIS4 = 1 etc.

Flux in box : 1.7246e+0 Jy etc.

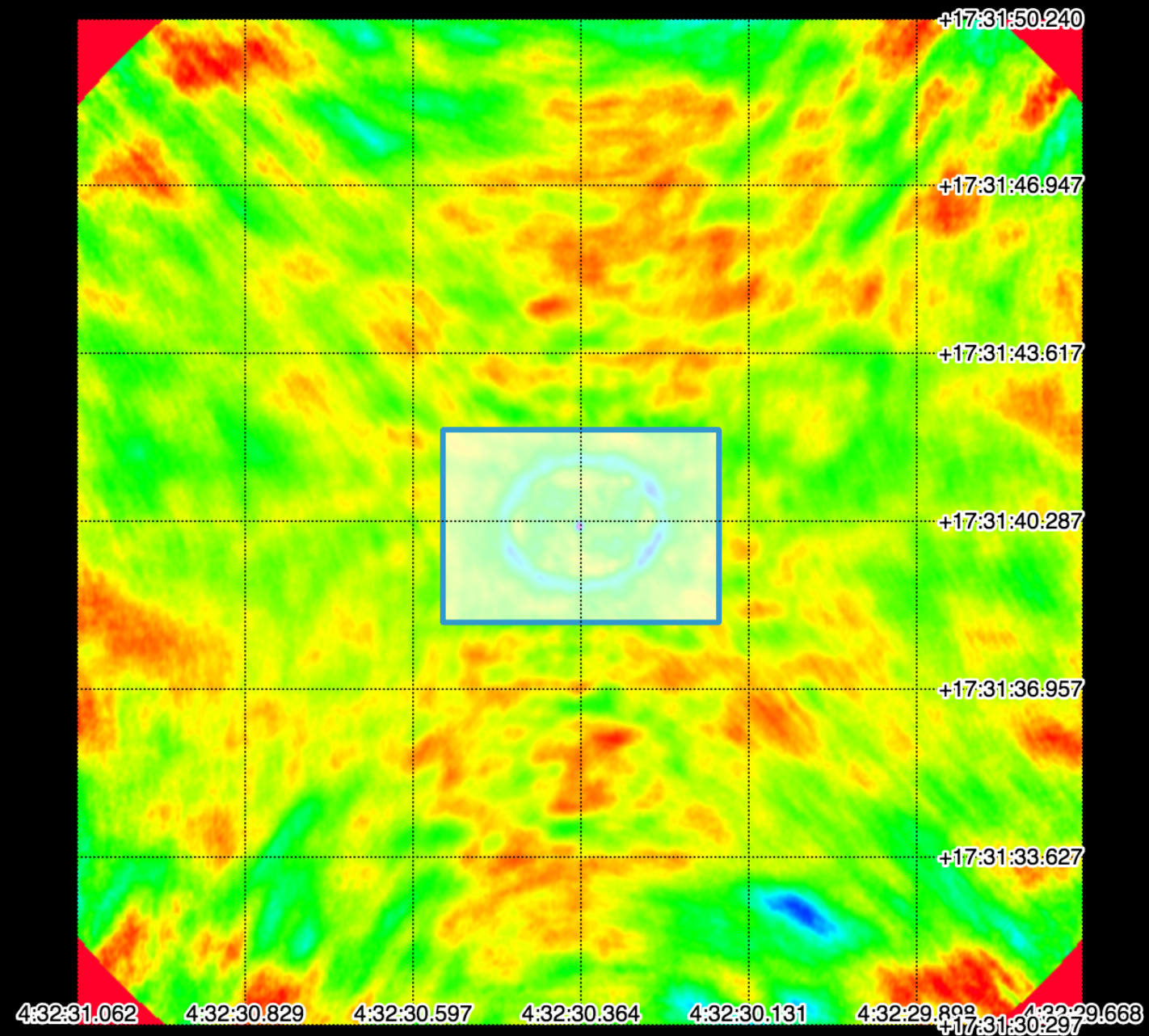
iRA=401 iDEC=160 RA=4:32:30.026 DEC=+17:31:36.217 - Flux density : -6.9101e-4 Jy/beam



M

C

B



YAFITS



[See more FITS files...](#)

GG_Tau_cont_tclean.image.pbcor - OBJECT = GG Tau - NAXIS = 4 - NAXIS1 = 540 - NAXIS2 = 540 - NAXIS3 = 1 - NAXIS4 = 1 etc.



M

C

B

Infos



Flux in box : 1.7246e+0 Jy

sum:1.7246e+0 Jy

min:-2.3376e-3 Jy/beam

max:1.2628e-2 Jy/beam

mean:1.3523e-3 Jy/beam

stdev:1.6538e-3 Jy/beam

numpix:15244 pixels (!=Nan)

percentage of total number of pixels:5.2277e+0 %

boundingRect:216,196,103,148 pixels



Copy as JSON

Close

4:32:31.062 4:32:30.829 4:32:30.597 4:32:30.364 4:32:30.131 4:32:29.899 4:32:29.668
+17:31:30:297

YAFITS

Show 3D model

- Monitoring

- 3D / experimental

YAFITS server infos - 03/06/2020 - 09:38:26

Name - ae6f75b25012

CPU summary - 32 logical processors on 2 sockets.

Memory summary

Physical memory : 125.64 GB, used memory : 7.56 GB, percentage : 6.01%

Informations per data cube. [Purge data idle for more than 300 second\(s\)](#)

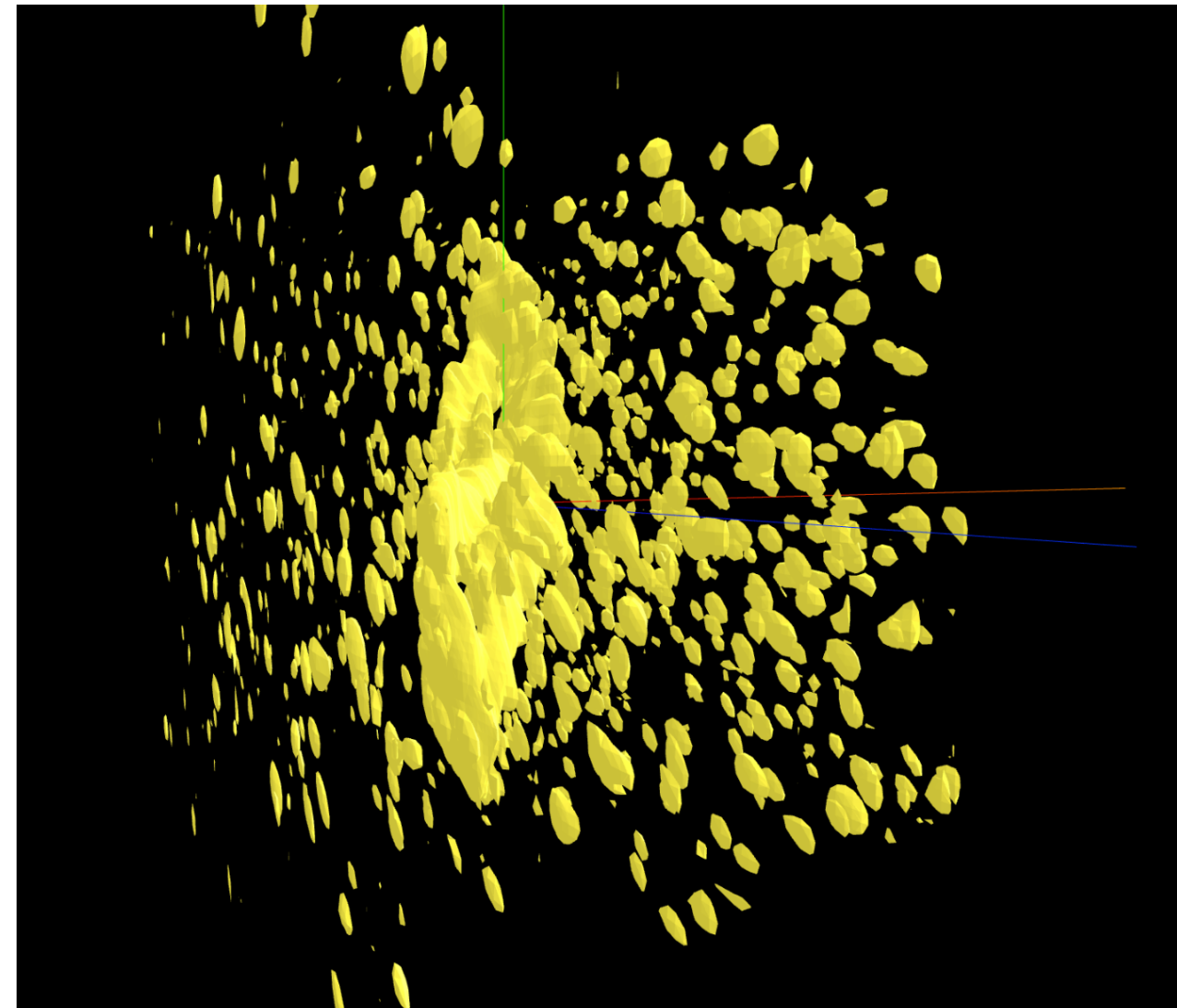
Show entries

Search:

path	creationTime	lastAccess	naxisn	size	idle
//trash/cl.fits	03/06/2020 - 09:31:47	03/06/2020 - 09:33:38	256x256x387x1	193.5 MB	288
//trash/ps2-dirty.fits	03/06/2020 - 09:31:18	03/06/2020 - 09:31:37	128x128x120709	7.37 GB	408

Showing 1 to 2 of 2 entries

Previous Next



Summary - Artemix / Yafits

1. **Service on-line. Latest stable version 2018** <http://artemix.obspm.fr> —> Remote Quick-Look access to ALMA science data products. Next : full archive access (on-demand download).
2. New features : **Faster viewer** based on Open Layers, **interoperability** via SAMP for spectra AND images. Access to **molecular databases** via VAMDC. Overlay expected line frequencies

Developed a **Standalone version of the viewer : Yafits**. Running inside **Docker** : simplified the installation procedure. No dependencies.

Pilot tools and prototypes

- Regular discussions with ESO (ALMA Scientific Archive) - F. Stoer.
- Design of the spectral viewer prototyped in Artemix now on ESO website
- Regular discussion with IRAM - several meetings
- Interest for the remote viewer (standalone). Discussions on-going
- Contact with instrument coordinators (SITELE, NIKA2)

*Posters **ADASS** 2016, 2019. Talks at **ALMA-ARC-nodes** meetings. Visits IRAM, **CDS**/Strasbourg, collaboration with M. Araya Univ. Chile (Machine Learning). Next : less technical talks, target scientific attendance (tools now ready enough). Next : **Data Mining tools on the database**, into Yafits, link with **MINERVA***

Thank you !