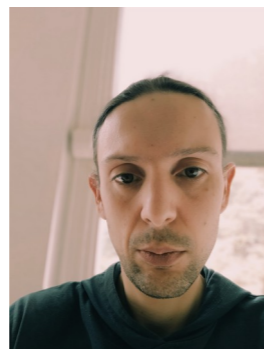




YAFITS

Distributed Quick Look Viewer

e-Tool for Radio-astronomy



N. Moreau, Y-A Ba, P. Salomé
LERMA, Observatoire de Paris

Project origin

An experiment for **data mining** the ALMA science Archive

- **ARTEMIX** : a **service to search and display** ALMA data (on-line since 2018)

Artemix

Search by Search or by Search with a radius of or by Search or by Search

Redshift

Spectroscopic data source: Local JPL CDMS

Line intensity

Energy up max (cm-1)

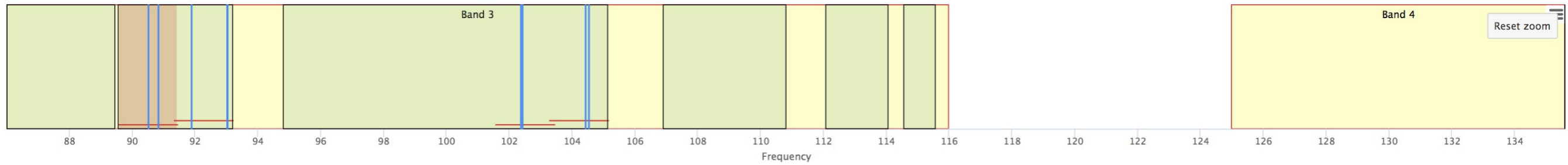
Search

From to atoms in molecule

Species

- (0.05) ND
- (0.126) HCO+ 7 - 6
- (0.7511) C3
- (3.0818) C3
- 12CO-1-0
- 13C17O 2-1
- 13C17O 3-2
- 13C18O 2-1
- 13C18O 3-2

Species	Shifted Frequency (GHz)	Rest Frequency (GHz)	Eup(cm-1)	Elow(cm-1)	Aij(s-1)
HC3N 10-9	9.0824e+1	9.0979e+1			
	Upper level			Lower level	



Highcharts.com

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.

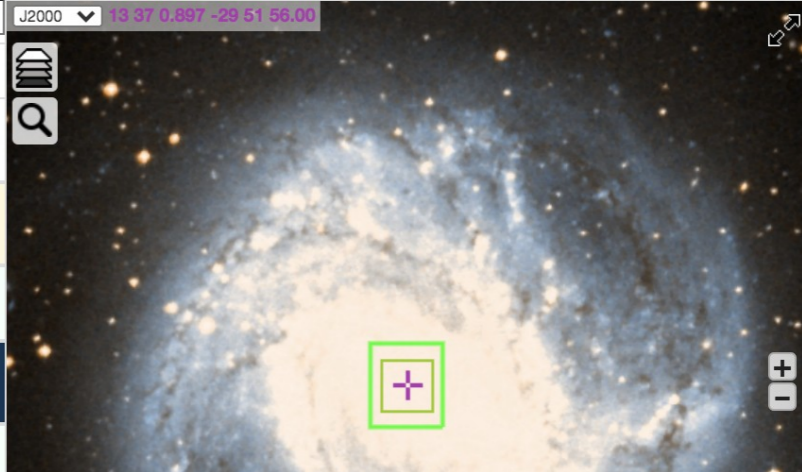
Show all data. *.pbcor.fits and *.pbcorr.fits *.image.fits *.clean.fits *.cont.fits and *.line.fits

All Info Metadata Available fits file(s) for selected metadata : 5

Show 10 entries

Search: J2000

Metadata											
#	Target	Band	RA	DEC	Res (")	Freq. Range (GHz)	Proj. code	Release Date	PI name	Search Alma Fits	
1	m83	3	13:37:0.92	-29:51:56.74	2.0458	99.94 --- 101.93; 101.7 --- 103.69; 112.08 --- 114.07; 114.57 --- 115.57	2012.1.00762.S	2017-01-19	Hirota, Akihiko	<input type="button" value="search"/>	
2	M83	3	13:37:0.92	-29:51:56.74	62.2649	85.59 --- 87.58; 87.47 --- 89.46; 97.58 --- 99.57; 99.46 --- 101.45	2013.1.01312.S	2016-12-28	Hirota, Akihiko	<input type="button" value="search"/>	
3	M83	3	13:37:0.90	-29:51:56.00	1.5194	89.57 --- 91.44; 91.34 --- 93.21; 101.57 --- 103.44; 103.28 --- 105.15	2015.1.00175.S	2018-03-20	Harada, Nanase	<input type="button" value="search"/>	
4	M83	3	13:37:0.90	-29:51:56.00	1.4378	95.06 --- 96.94; 96.84 --- 98.71; 107.06 --- 108.94; 108.84 --- 110.71	2015.1.00175.S	2018-02-17	Harada, Nanase	<input type="button" value="search"/>	



Project origin

An experiment for **data mining** the ALMA science Archive

- **ARTEMIX** : a **service to search and display** ALMA data (on-line since 2018)

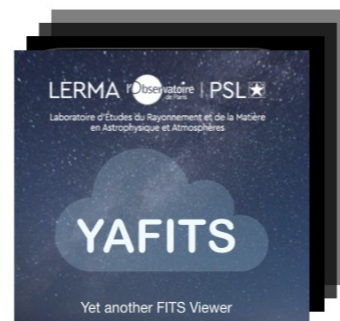
A standalone **Viewer inside web-browser**

- **YAFITS** : a **distributed Quick-Look** FITS Viewer (sitting on the data / no-install for the user)

YAFITS

Yet Another FITS viewer

Distributed Quick Look Viewer
D-QLV

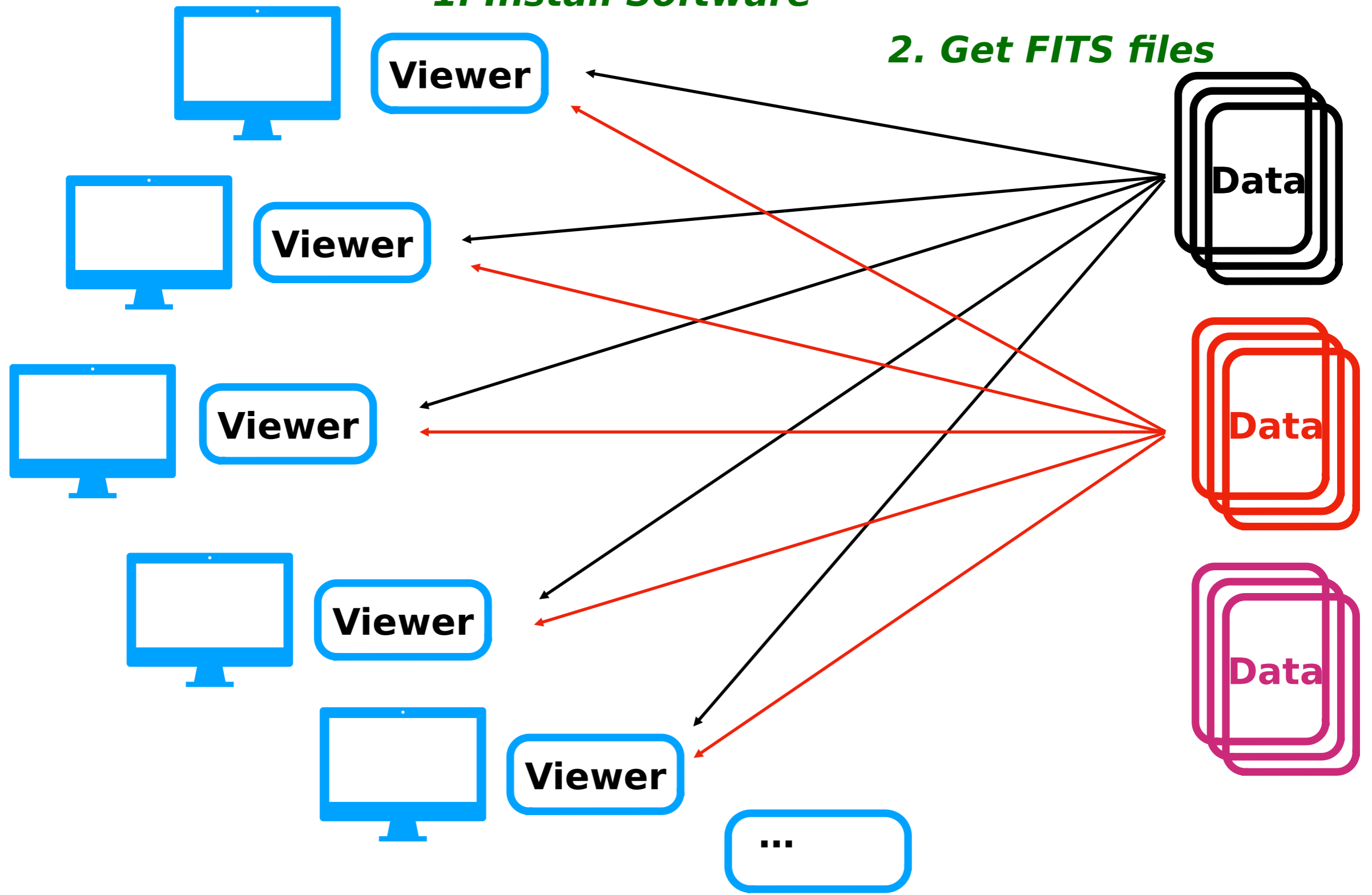


Local Viewer

3. Software display FITS

1. Install Software

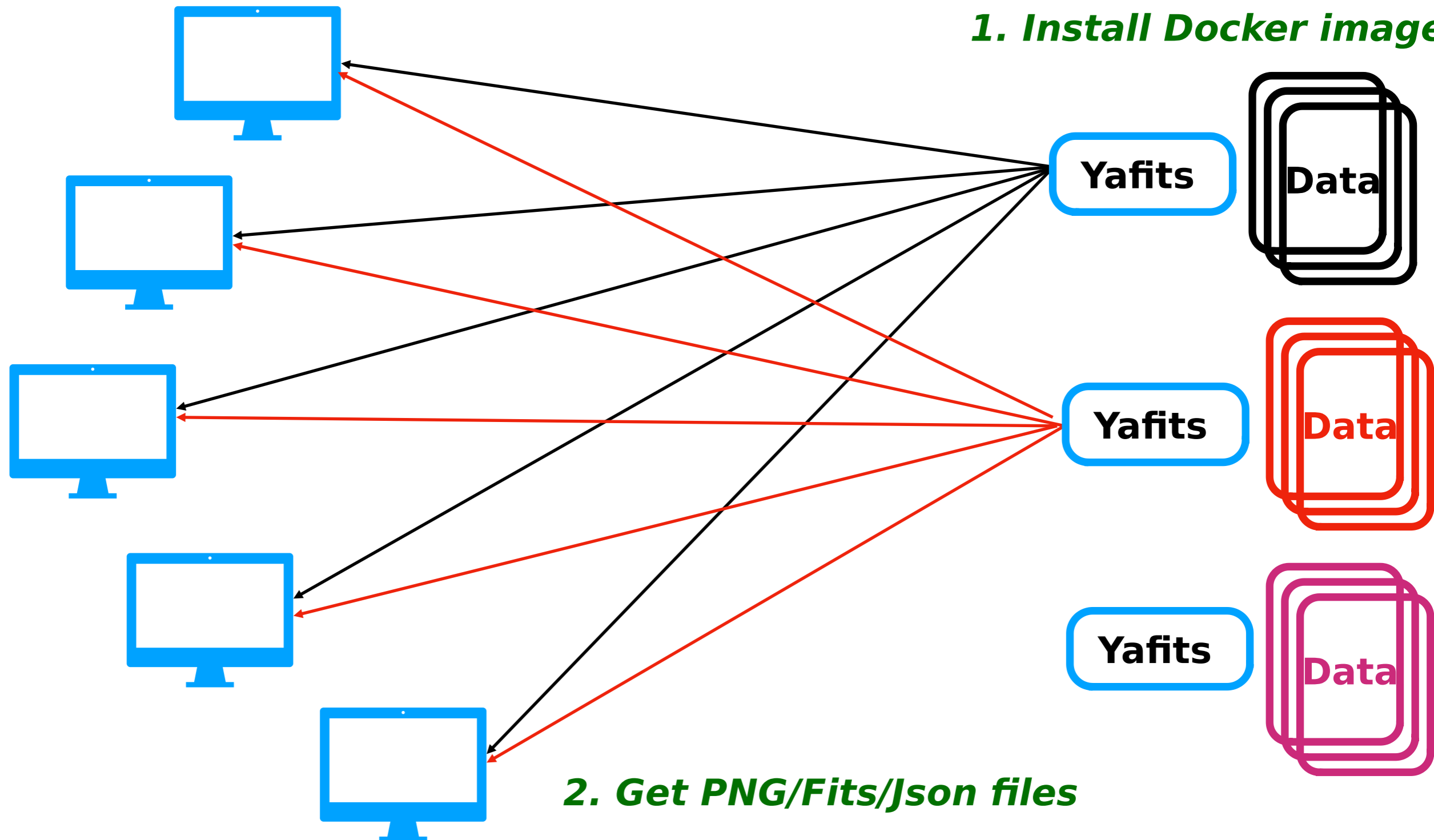
2. Get FITS files



Remote Viewer

3. Web browser display

1. Install Docker image



2. Get PNG/Fits/Json files

Local / Remote

Local

Large range of analysis tools

But

Need to download all the fits files to be checked (even if no detection)

Speed limited by local computer performances and/or software optimization (for display)

Remote

Optimization on dedicated machines (load fits, calculations)

No need to download fits files on local disk (if many and from different projects)

But

Delay for loading (11 MB/s at most) large file (> 10 GB)

Limited analysis

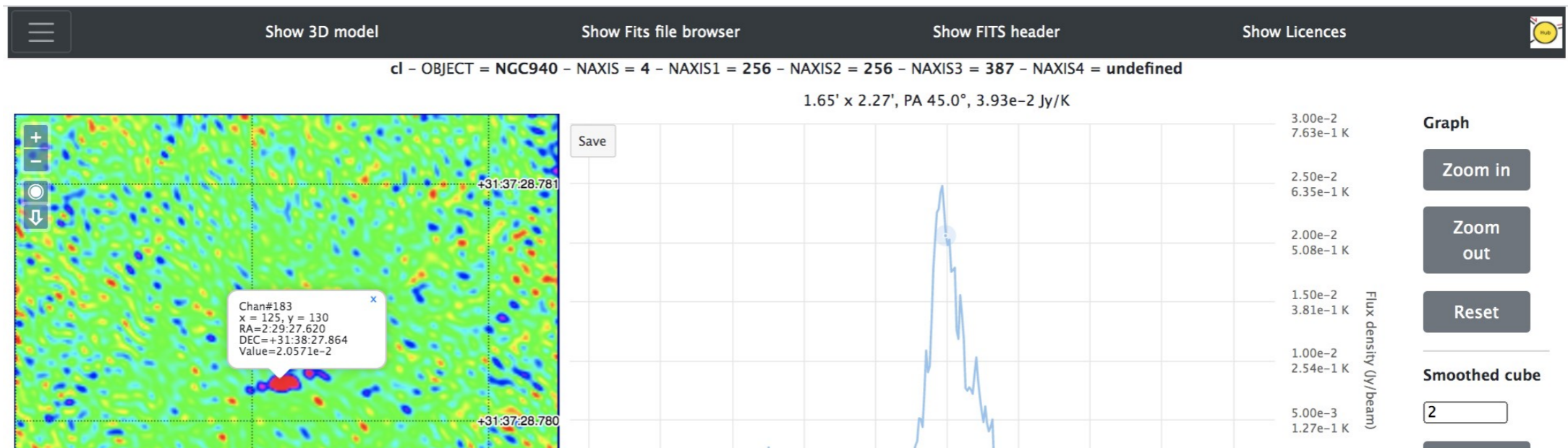
YAFITS

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

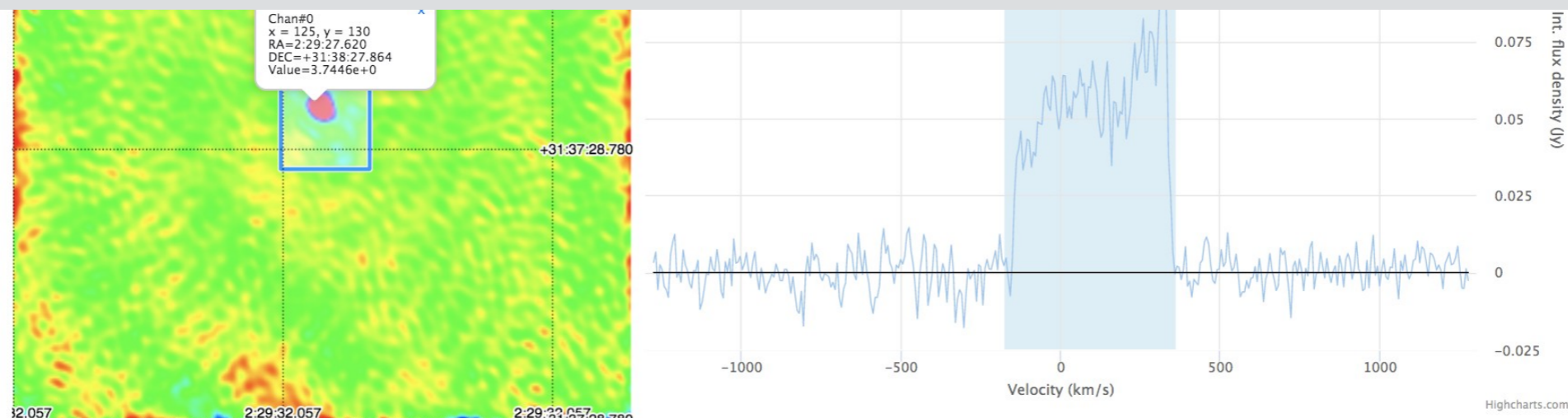
Display the data cube (2 images, 2 spectra) : 1 channel map, 1 moment map, 1 spectra extracted from a pixel, 1 spectra extracted from a spatial region (square).

—> Based on **GILDAS Mapping « go view »**. Same functionalities implemented (frequency selection, region selection, integrated flux computation)

YAFITS



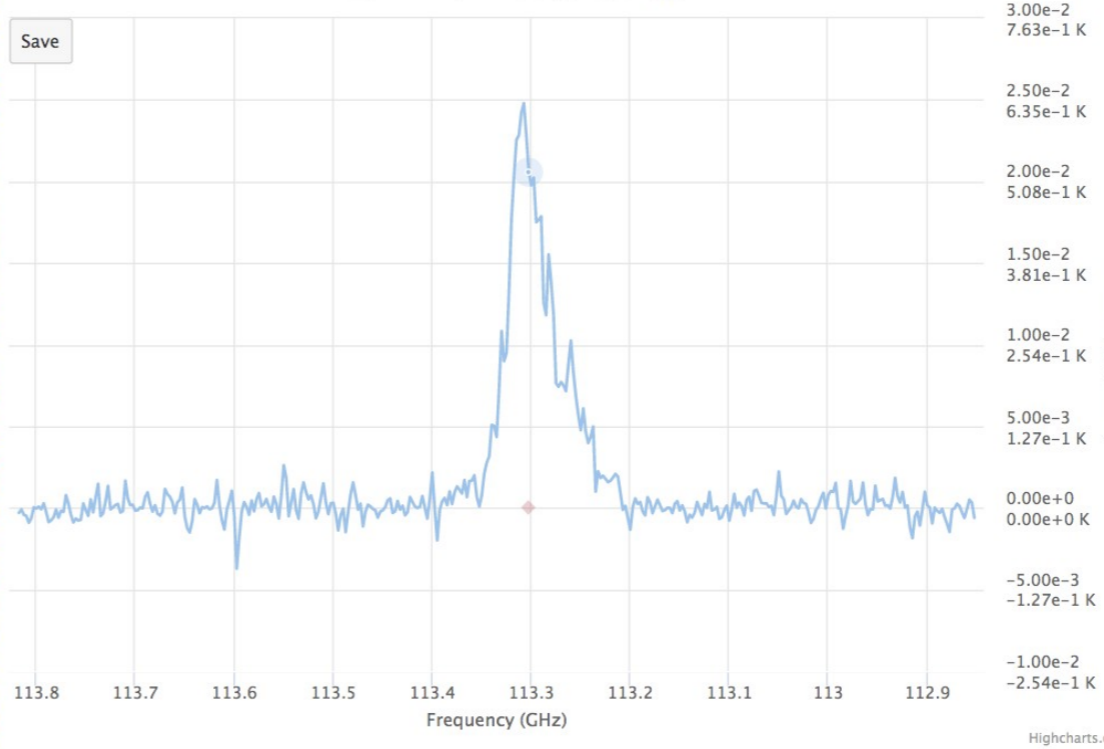
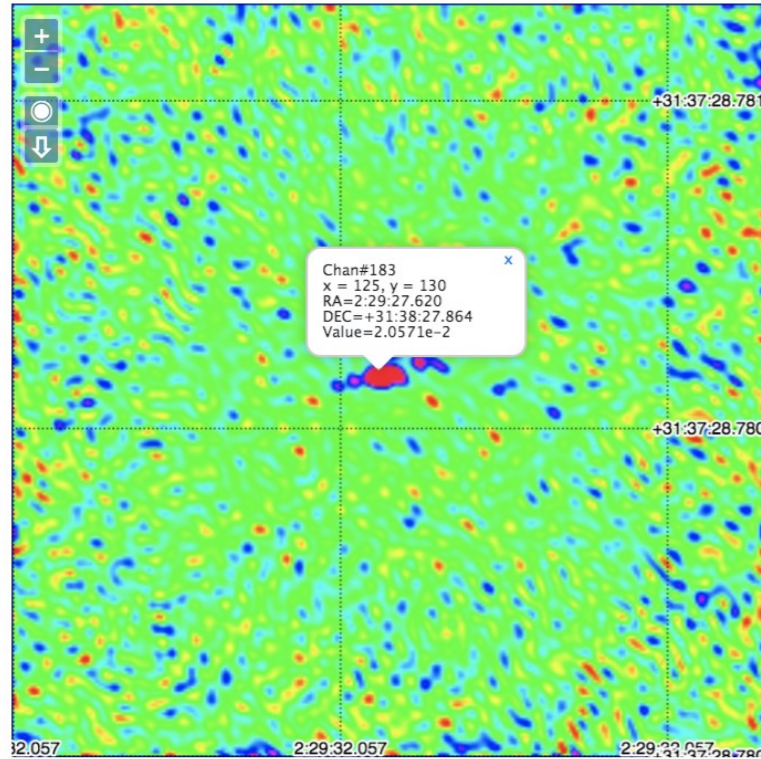
Optimized for large datasets (still Ok for $> 10\text{Gb}$)
(fast load + pan and zoom)
Use of server-side RAM memory
Use of server CPUs
Visualization of 1D, 2D and 3D cubes



YAFITS 3D 2022

cl - OBJECT = NGC940 - NAXIS = 4 - NAXIS1 = 256 - NAXIS2 = 256 - NAXIS3 = 387 - NAXIS4 = undefined

1.65' x 2.27', PA 45.0°, 3.93e-2 Jy/K



Graph

Zoom in

Zoom out

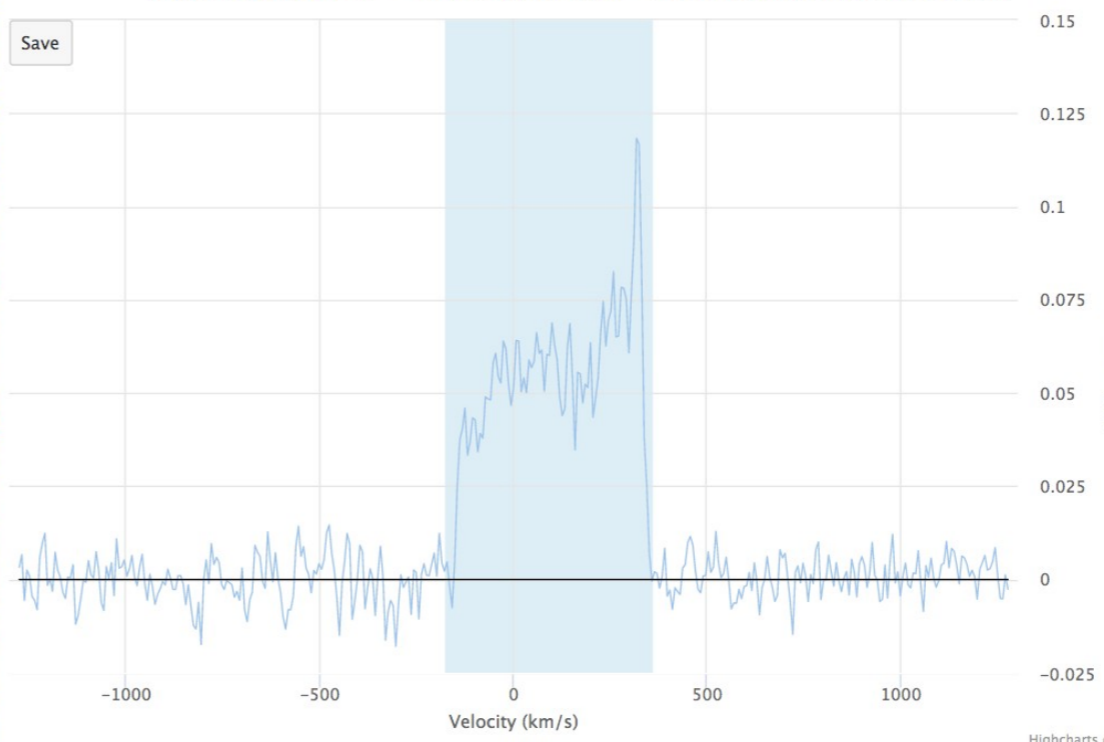
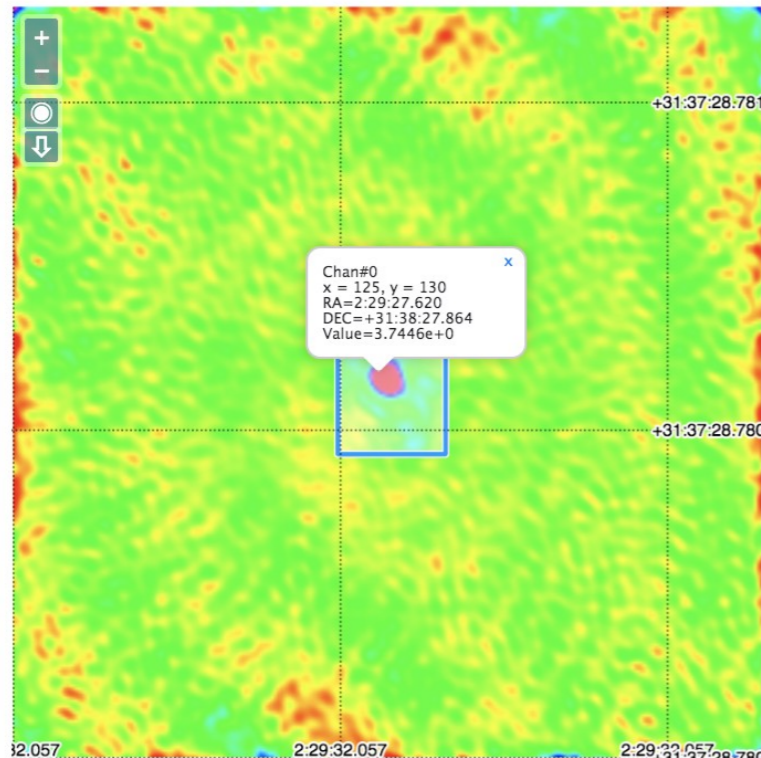
Reset

Smoothed cube

Download

View

2.85e+1Jy.km/s, vmin = -175.10 km/s, vmax = 361.62 km/s, imin : 219, imax : 138



Highcharts.com

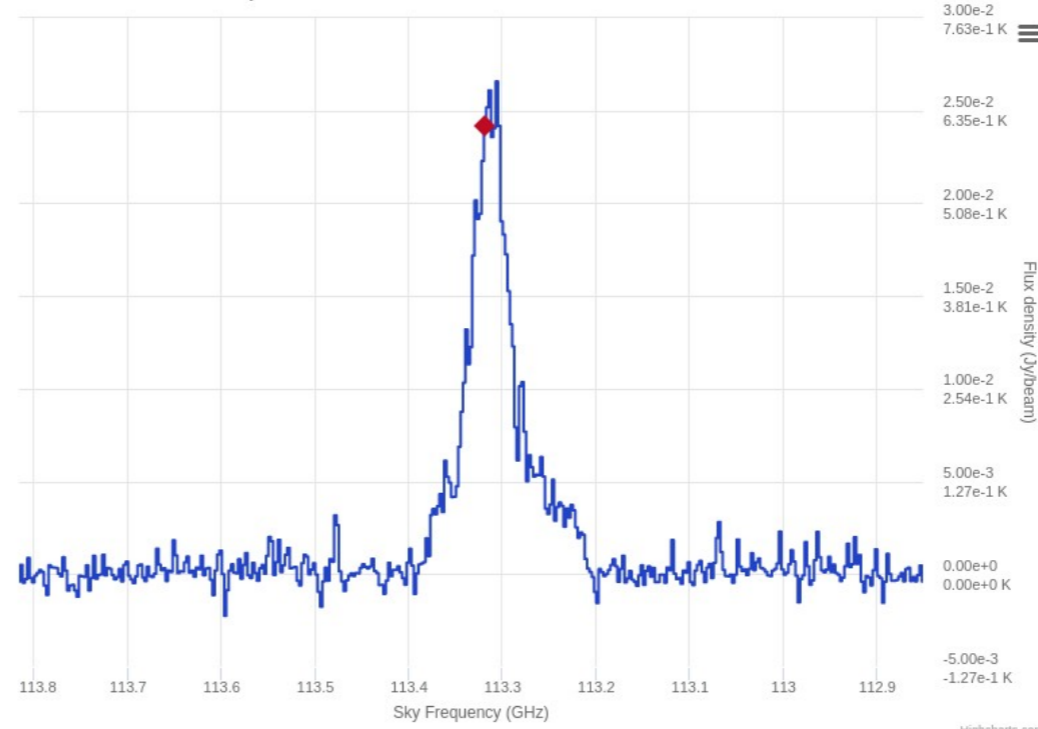
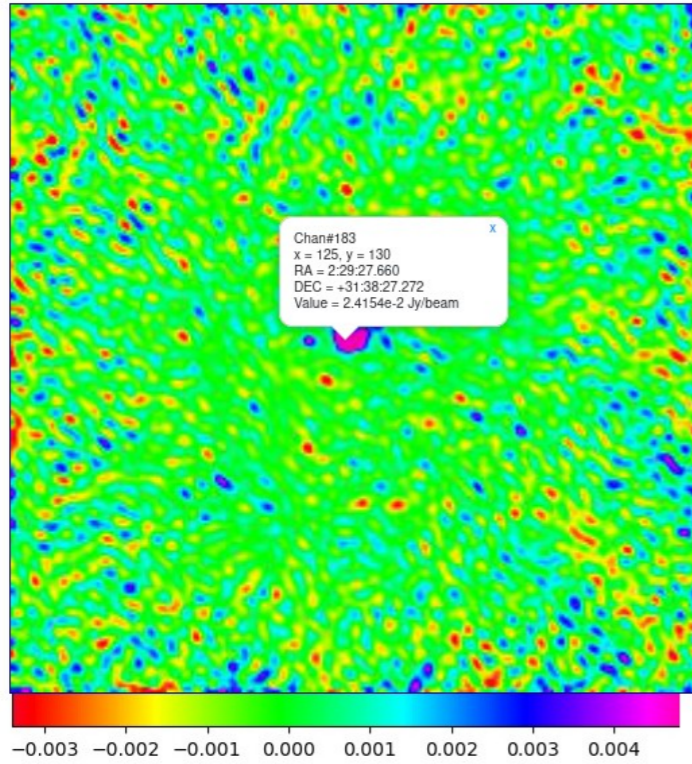
Highcharts.com

YAFITS 3D

ci - OBJECT = NGC940 - NAXIS = 4 - NAXIS1 = 256 - NAXIS2 = 256 - NAXIS3 = 387 - CDELTA3 = -6.613 km/s- LINE = CO(1-0) GHz [more headers ...](#)

Chan#187 rms=1.08e-3 Jy/beam mean=9.71e-6 Jy/beam
@Cursor

1.65' x 2.27', PA 45.0°, 3.93e-2 Jy/K
@Pixel x=125 y=130



Graph

Zoom in

Zoom out

Reset

Spectral
smooth factor

Download

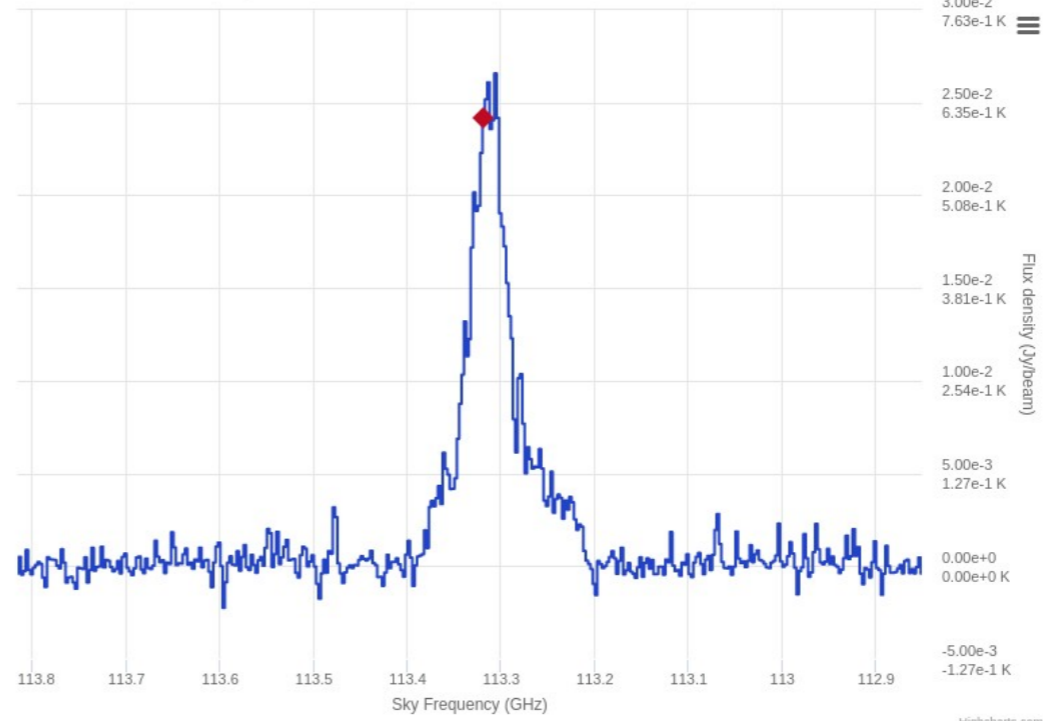
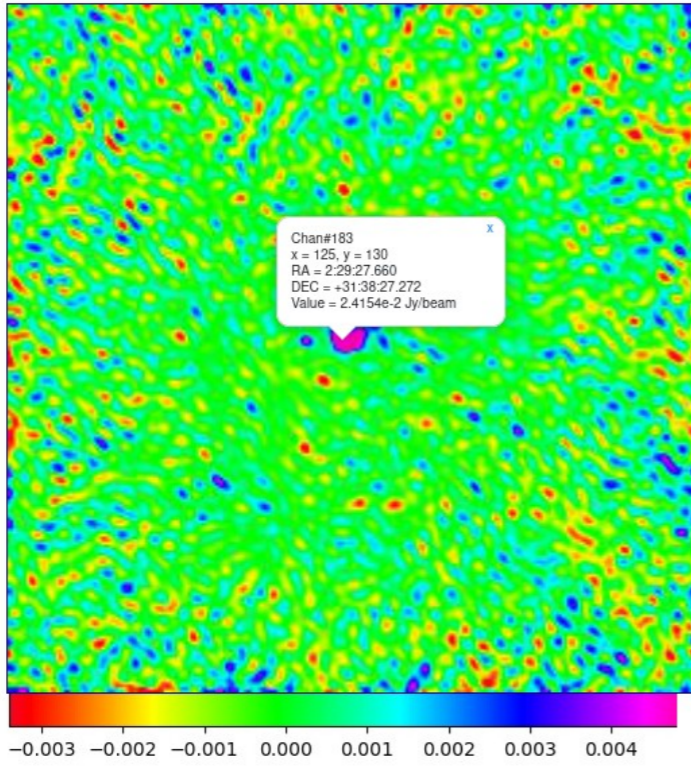
View

YAFITS 3D

cl - OBJECT = NGC940 - NAXIS = 4 - NAXIS1 = 256 - NAXIS2 = 256 - NAXIS3 = 387 - CDELTA3 = -6.613 km/s - LINE = CO(1-0) GHz more headers ...

Chan#187 rms=1.08e-3 Jy/beam mean=9.71e-6 Jy/beam @Cursor

1.65' x 2.27', PA 45.0°, 3.93e-2 Jy/K @Pixel x=125 y=130



Graph

Zoom in

Zoom out

Reset

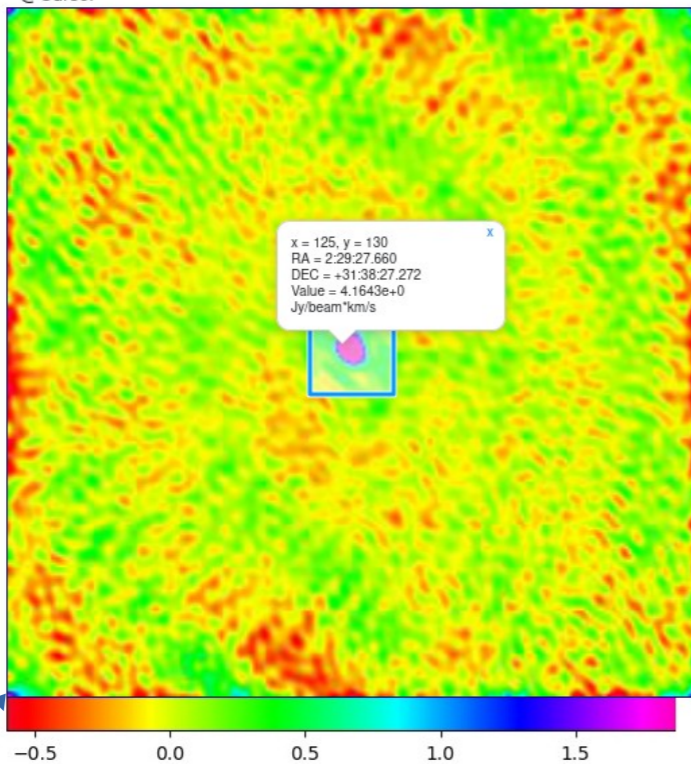
Spectral smooth factor

2

Download

View

Color bars

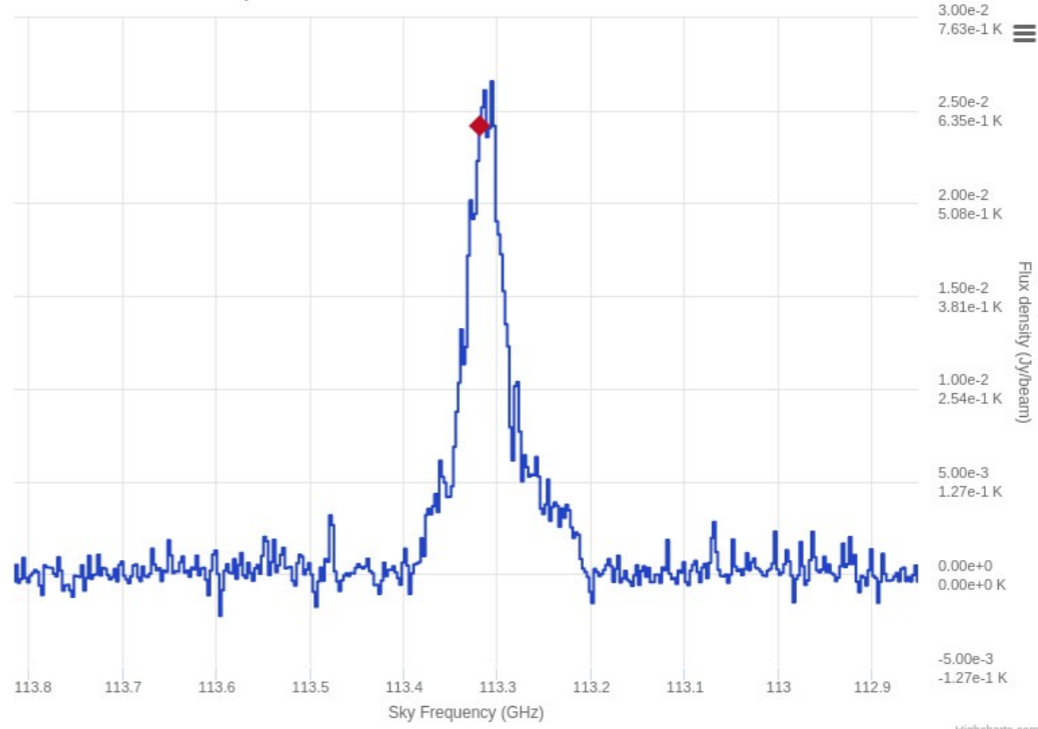
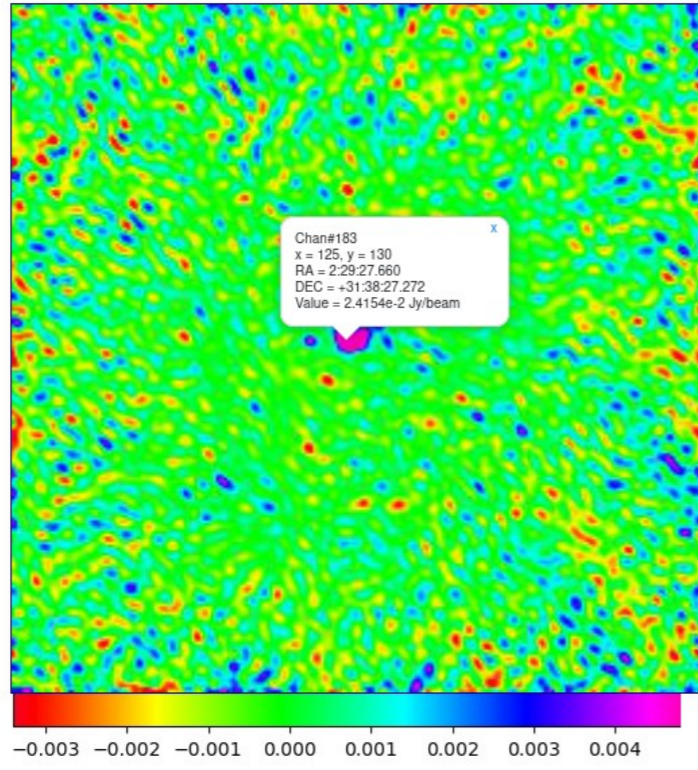


YAFITS 3D

cl - OBJECT = NGC940 - NAXIS = 4 - NAXIS1 = 256 - NAXIS2 = 256 - NAXIS3 = 387 - CDELT3 = -6.613 km/s- LINE = CO(1-0) GHz [more headers ...](#)

Chan#187 rms=1.08e-3 Jy/beam mean=9.71e-6 Jy/beam @Cursor

1.65' x 2.27', PA 45.0°, 3.93e-2 Jy/K @Pixel x=125 y=130



Graph

Zoom in

Zoom out

Reset

Spectral smooth factor

Download

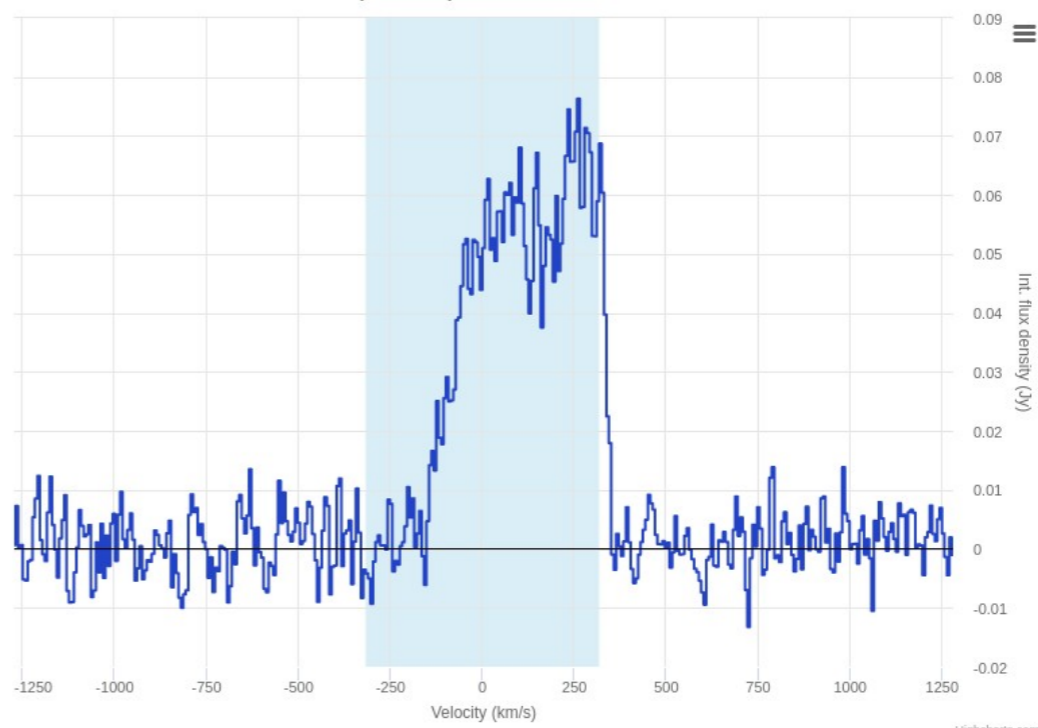
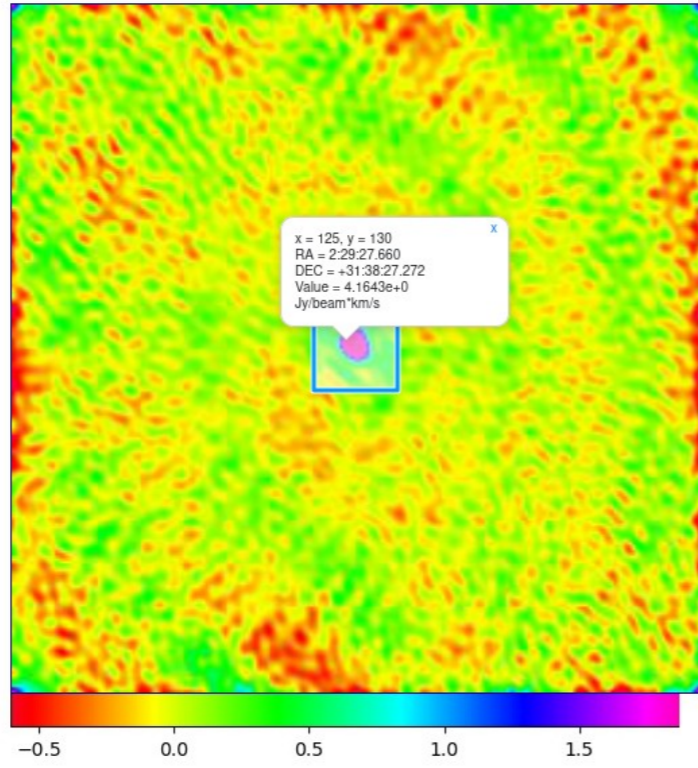
View

More informations about images :

- displayed channel
- cursor coordinates
- rms

rms=1.89e-1 Jy/beam*km/s mean=2.34e-3 Jy/beam*km/s @Cursor

2.38e+1 Jy.km/s, vmin=-314.09 km/s , vmax=320.76 km/s, imin=145, imax=241 @Box xmin=112 xmax=143 ymin=112 ymax=143



Highcharts.com

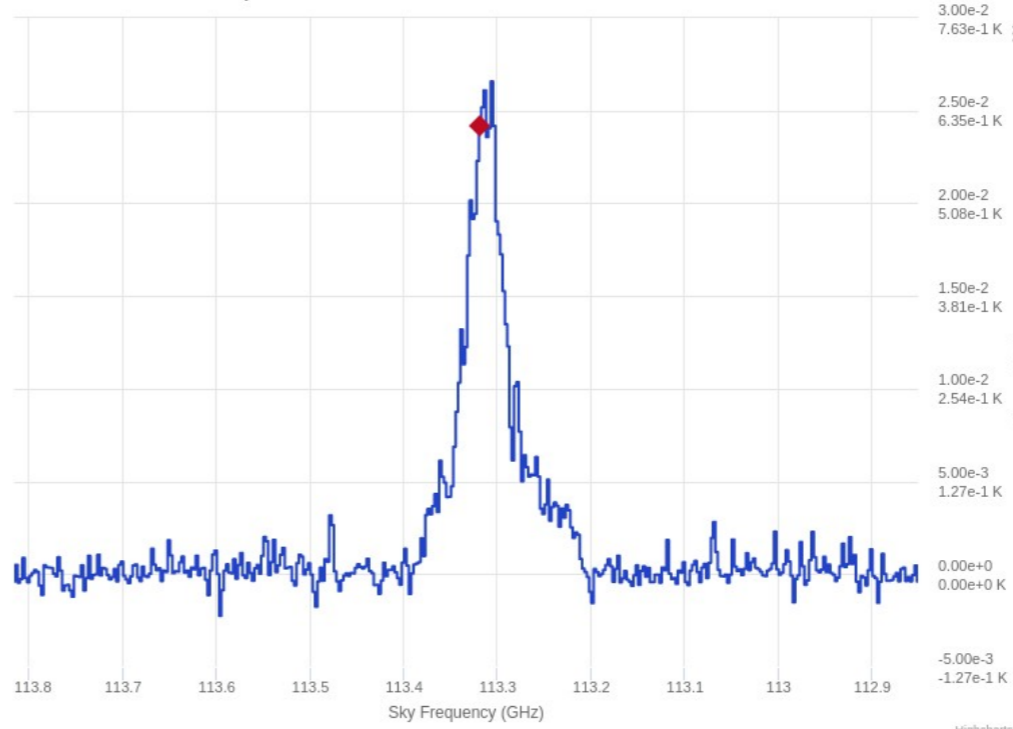
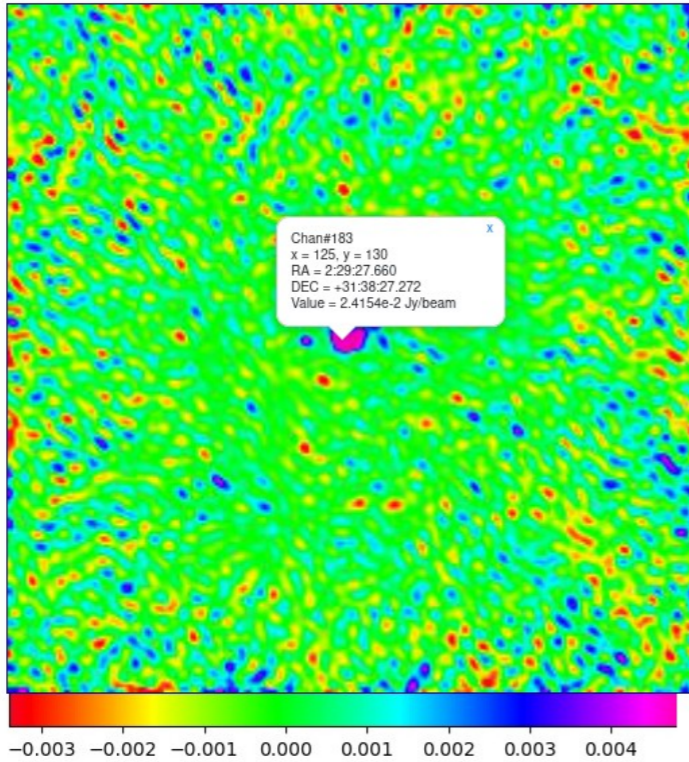
Highcharts.com

YAFITS 3D

cl - OBJECT = NGC940 - NAXIS = 4 - NAXIS1 = 256 - NAXIS2 = 256 - NAXIS3 = 387 - CDELTA3 = -6.613 km/s - LINE = CO(1-0) GHz [more headers ...](#)

Chan#187 rms=1.08e-3 Jy/beam mean=9.71e-6 Jy/beam
@Cursor

1.65' x 2.27', PA 45.0°, 3.93e-2 Jy/K
@Pixel x=125 y=130



Graph

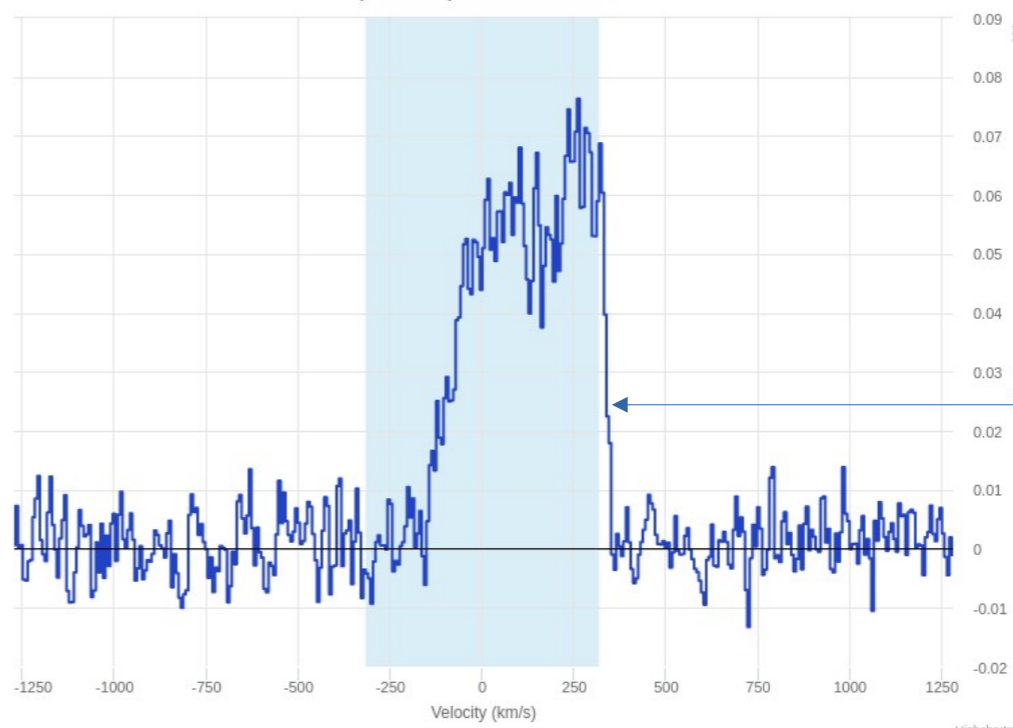
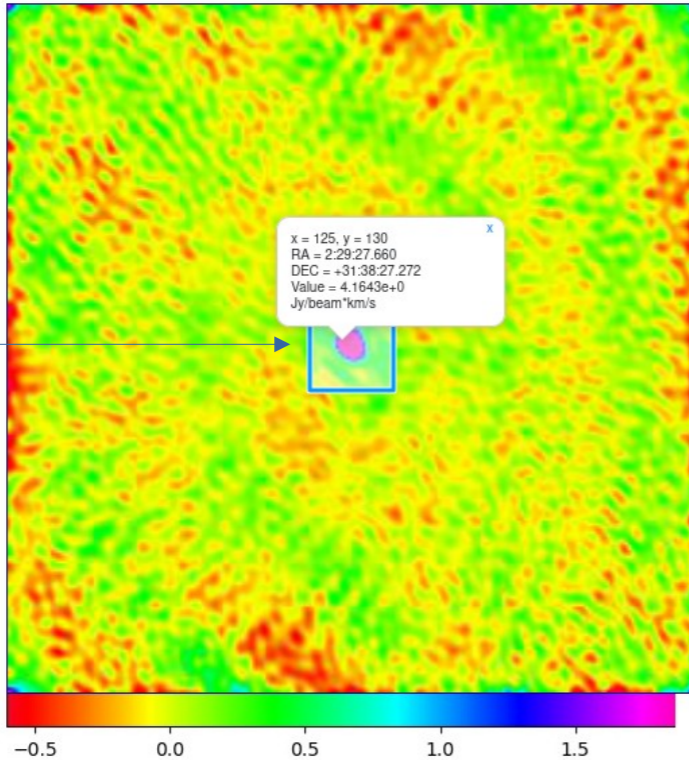
- Zoom in
- Zoom out
- Reset

Spectral smooth factor

-
- Download
- View

rms=1.89e-1 Jy/beam*km/s mean=2.34e-3 Jy/beam*km/s
@Cursor

2.38e+1 Jy.km/s, vmin=-314.09 km/s, vmax=320.76 km/s, imin=145, imax=241
@Box xmin=112 xmax=143 ymin=112 ymax=143



Central area of the curve selected by default

Box selected by default at the center of the image

x = 125, y = 130
 RA = 2:29:27.660
 DEC = +31:38:27.272
 Value = 4.1643e+0
 Jy/beam*km/s

YAFITS Interop

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

The screenshot displays the YAFITS Interop web interface. At the top, there are navigation links: "Browse Fits files", "Query Fits files", and "Help (3D)". A status bar shows: "cl - OBJECT = NGC940 - NAXIS = 4 - NAXIS1 = 256 - NAXIS2 = 256 - NAXIS3 = 387 - CDELTA3 = -6.613 km/s - LINE = CO(1-0) GHz more headers ...".

Below the status bar, there are two main panels:

- Left Panel (Heatmap):** A color-coded heatmap of the spectral data. The x-axis is labeled "Sky Frequency (GHz)" and ranges from -0.003 to 0.004. The y-axis represents flux density. A purple circle highlights the "G" and "R" icons in the bottom left corner of the heatmap.
- Right Panel (Spectral Plot):** A line plot showing flux density (Jy/beam) versus Sky Frequency (GHz). The x-axis ranges from 113.8 to 112.9 GHz. The y-axis ranges from -4.00e-3 to 4.00e-3 K. A vertical red line is positioned at 113.371 GHz, labeled "12CO-1-0 | rest=115.271 GHz".

On the far right, there are control buttons for the graph: "Zoom in", "Zoom out", "Reset", "Download", and "View". Below these is a "Spectral smooth factor" input field with the value "2".

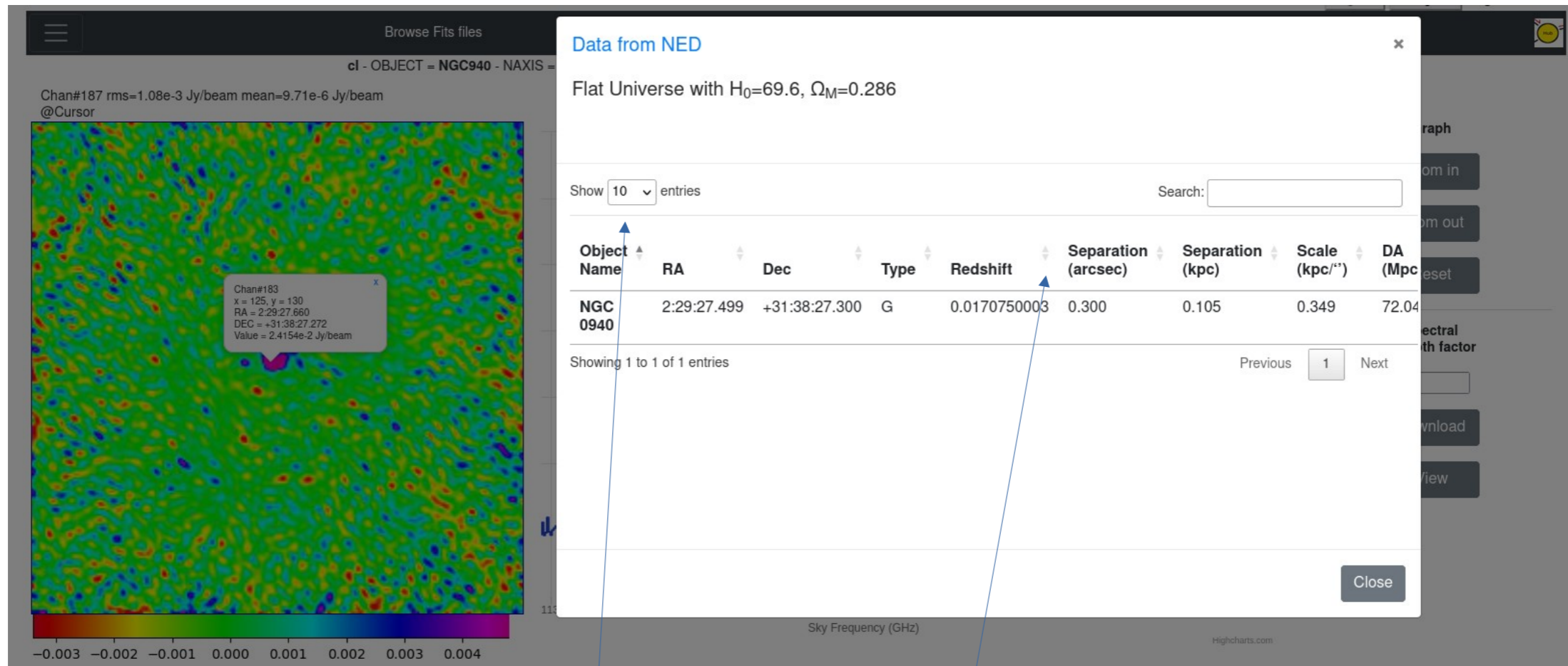
Two purple arrows indicate export options:

- An arrow points from the heatmap to the **ALADIN** logo, which is associated with the Centre de Données astronomiques de Strasbourg.
- An arrow points from the spectral plot to the **CASSIS** logo, described as "A free interactive spectrum analyser".

At the bottom center, the **IVOA** logo is visible.

YAFITS Interop

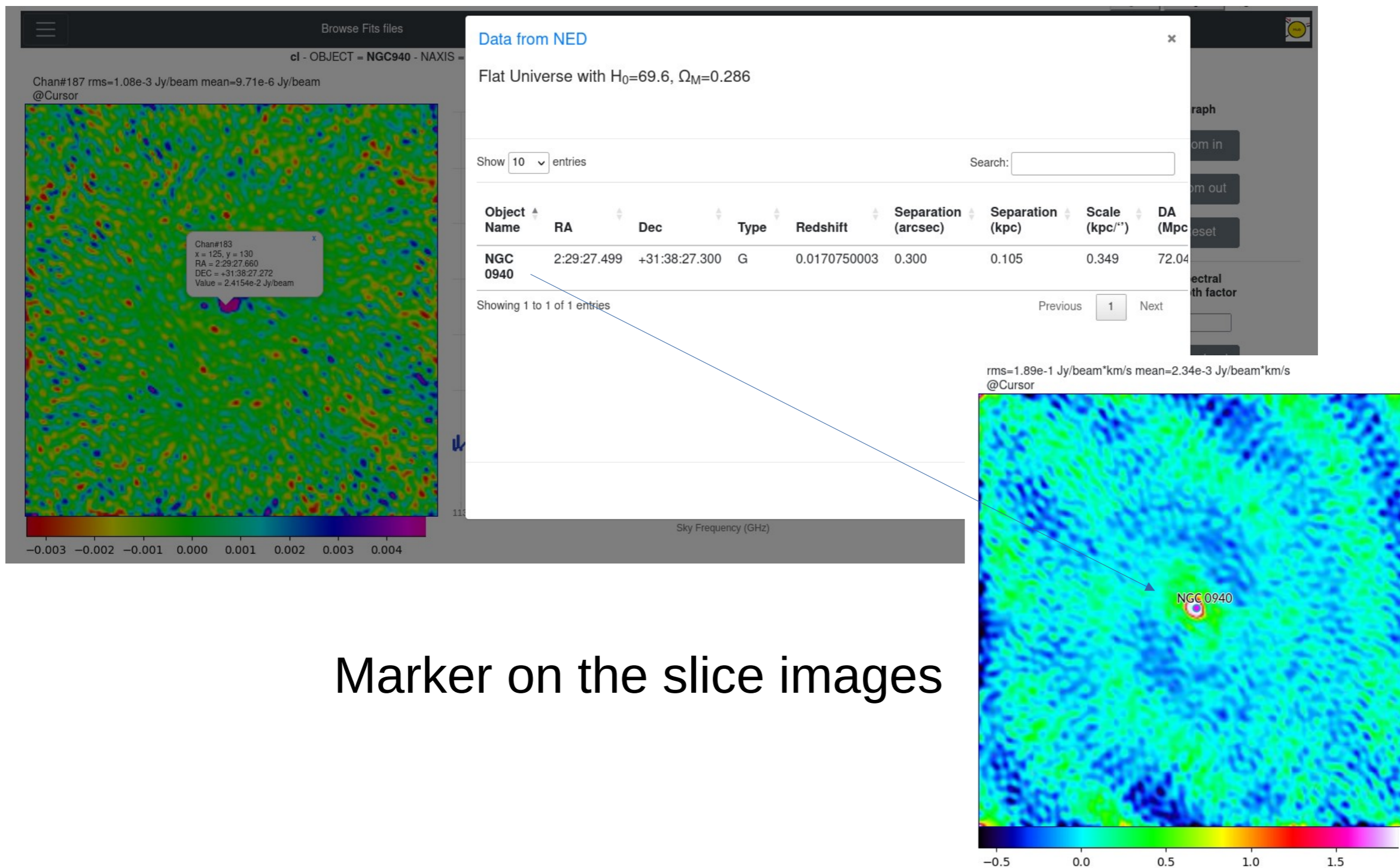
Searching a source in NED catalog by coordinates



What's new : tabbed list, sortable columns

YAFITS Interop

Selecting a source in NED catalog



Marker on the slice images

SAMP Interoperability

PNG image in Aladin

The screenshot displays the Aladin v11.0 software interface. The main window shows a heatmap of the NGC 0940 region, with the label "NGC 0940" and a red crosshair marker. The interface includes a menu bar (Fichier, Edition, Image, Catalogue, Graphique, Couverture, Outil, Vue, Interop, Aide), a command line (02:29:25.04 +31:37:12.4), and a toolbar with various icons for selection, zoom, and data manipulation. A sidebar on the right contains a welcome message and a list of data sources (DSS, PanSTARRS, SDSS, ZMASS, GALEX, Gaia, Simbad, NED). The bottom status bar indicates the image size as 5.7' x 5.594'.

Aladin v11.0

Fichier Edition Image Catalogue Graphique Couverture Outil Vue Interop Aide

Données disponibles Commande 02:29:25.04 +31:37:12.4 Référentiel ICRS Projection Aitoff

DSS PanSTARRS SDSS ZMASS GALEX Gaia Simbad NED +

Collections 145-241.percent99.gist_rainbow.direct

select Bienvenu sur Aladin, votre atlas professionnel du ciel.

- Accédez à toutes les données astronomiques disponibles sur le net !
- Comparez-les avec vos propres données.
- Préparez vos missions d'observations.

Pour débiter, saisissez un nom d'objet, par exemple M1, puis validez par ENTER... Ou tout simplement, cliquez dans la fenêtre principale pour explorer le ciel.

Drawing
cl.fits-undefined
145-241.percent99.gis

époq... +
taille +
dens. -
opac. +
zoom -

suppr

sélect. dans -- toutes les collecti...

dév. tri vue scan filtre grille exam. cigne nord hdr multivues unit.

5.7' x 5.594'

(c) 2020 Université de Strasbourg/CNRS - developed by CDS, distributed under GPLv3 0 sel / 0 src 506Mo

SAMP Interoperability

FITS image in Aladin

The screenshot displays the Aladin v11.0 software interface. The main window shows a dark field with a bright star labeled "NGC 0940" in red. The interface includes a menu bar (Fichier, Edition, Image, Catalogue, Graphique, Couverture, Outil, Vue, Interop, Aide), a toolbar with various icons, and a central panel with a command line and a list of collections. The bottom status bar shows the copyright information: "(c) 2020 Université de Strasbourg/CNRS - developed by CDS, distributed under GPLv3".

Aladin v11.0

Fichier Edition Image Catalogue Graphique Couverture Outil Vue Interop Aide

Données disponibles Commande Référentiel ICRS Projection Aitoff

DSS PanSTARRS SDSS ZMASS GALEX Gaia Simbad NED +

cl.fits-undefined

collections

select dépl. dist. phot. dessin marq. moc. spect. filtre. corr. x-y. rnb. assoc. coupe. cont. pixel. prop. zoom. suppr.

Bienvenue sur Aladin, votre atlas professionnel du ciel.

- Accédez à toutes les données astronomiques disponibles sur le net !
- Comparez-les avec vos propres données.
- Préparez vos missions d'observations.

Pour débuter, saisissez un nom d'objet, par exemple M1, puis validez par ENTER...

Ou tout simplement, cliquez dans la fenêtre principale pour explorer le ciel.

Drawing

cl.fits-undefined

145-241.percent99.gis

epoq... -

taille -

dens. -

opac. -

zoom -

1.94' x 1.94'

sélect. dans -- toutes les collecti...

1' 5.7' x 5.594'

grille exam. cline nord hdr multivues unif.

(c) 2020 Université de Strasbourg/CNRS - developed by CDS, distributed under GPLv3

0 sel / 0 src 294Mo

YAFITS Spectro

Browse Fits files
Query Fits files
Help (3D)

oriona-12co10-cube - OBJECT = ORION-IRC2 - NAXIS = 3 - NAXIS1 = 689 - NAXIS2 = 575 - NAXIS3 = 450 - CDELTA3 = -0.406 km/s - LINE = 12CO(2-1) GHz [more headers ...](#)

Chan#225 rms=1.02e+1 K (Ta*) mean=1.06e+1 K (Ta*)
@Cursor

11.25' x 11.25', PA 0.0°
@Pixel x=345 y=288

CO 2-1 | rest=230.5389 GHz

Graph

Zoom in

Zoom out

Reset

Spectral smooth factor

Download

View

CO 2-1 | rest=230.5389 GHz

2.83e+2 K.km/s, vmin=-13.84 km/s, vmax=32.08 km/s, imin=168, imax=281
@Box xmin=301 xmax=387 ymin=251 ymax=323

Possible species	Observed Frequency (GHz)
CO 2-1	230.5311

CO 2-1 | rest=230.5389 GHz

2.83e+2 K.km/s, vmin=-13.84 km/s, vmax=32.08 km/s, imin=168, imax=281
@Box xmin=301 xmax=387 ymin=251 ymax=323

CO 2-1 | rest=230.5389 GHz

2.83e+2 K.km/s, vmin=-13.84 km/s, vmax=32.08 km/s, imin=168, imax=281
@Box xmin=301 xmax=387 ymin=251 ymax=323

CO 2-1 | rest=230.5389 GHz

2.83e+2 K.km/s, vmin=-13.84 km/s, vmax=32.08 km/s, imin=168, imax=281
@Box xmin=301 xmax=387 ymin=251 ymax=323

rms=6.12e+1 K (Ta*)*km/s mean=4.04e+1 K (Ta*)*km/s
@Cursor

Search NED Data for a flat universe ▼

H₀ Ω_M Search

Redshift Velocity DL

hh:mm:ss ; dd:mm:ss ; Name

Show Clear

Search for species in local database

Search lines in : Do not search Local

Line intensity

Energy up max K

Number of atoms

YAFITS 2D



See more FITS files...

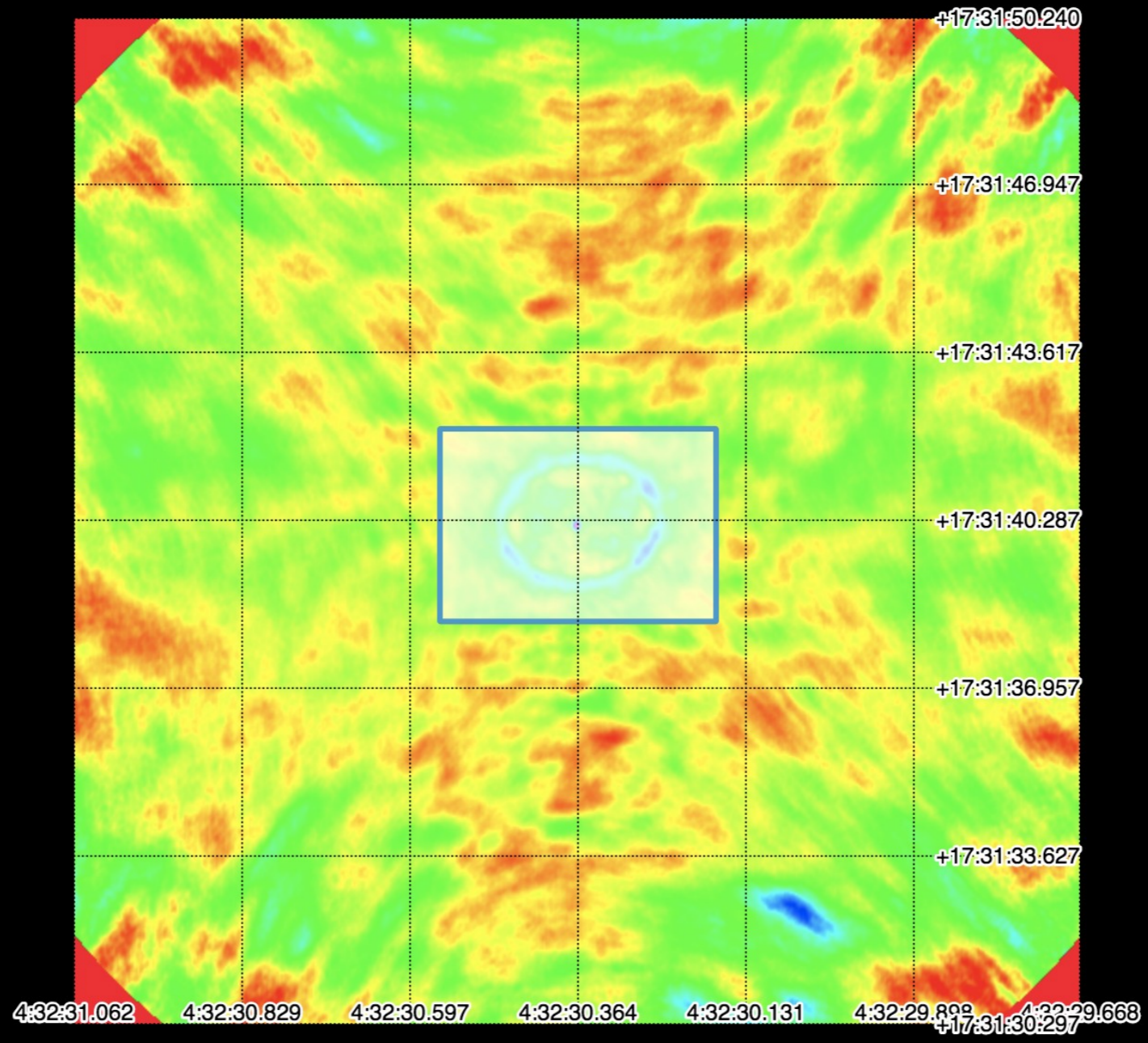
GG_Tau_cont_tclean.image.pbcor - OBJECT = GG_Tau - NAXIS = 4 - NAXIS1 = 540 - NAXIS2 = 540 - NAXIS3 = 1 - NAXIS4 = 1 etc.

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



- Home
- Settings
- M
- C
- B



YAFITS 2D

See more FITS files...

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

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

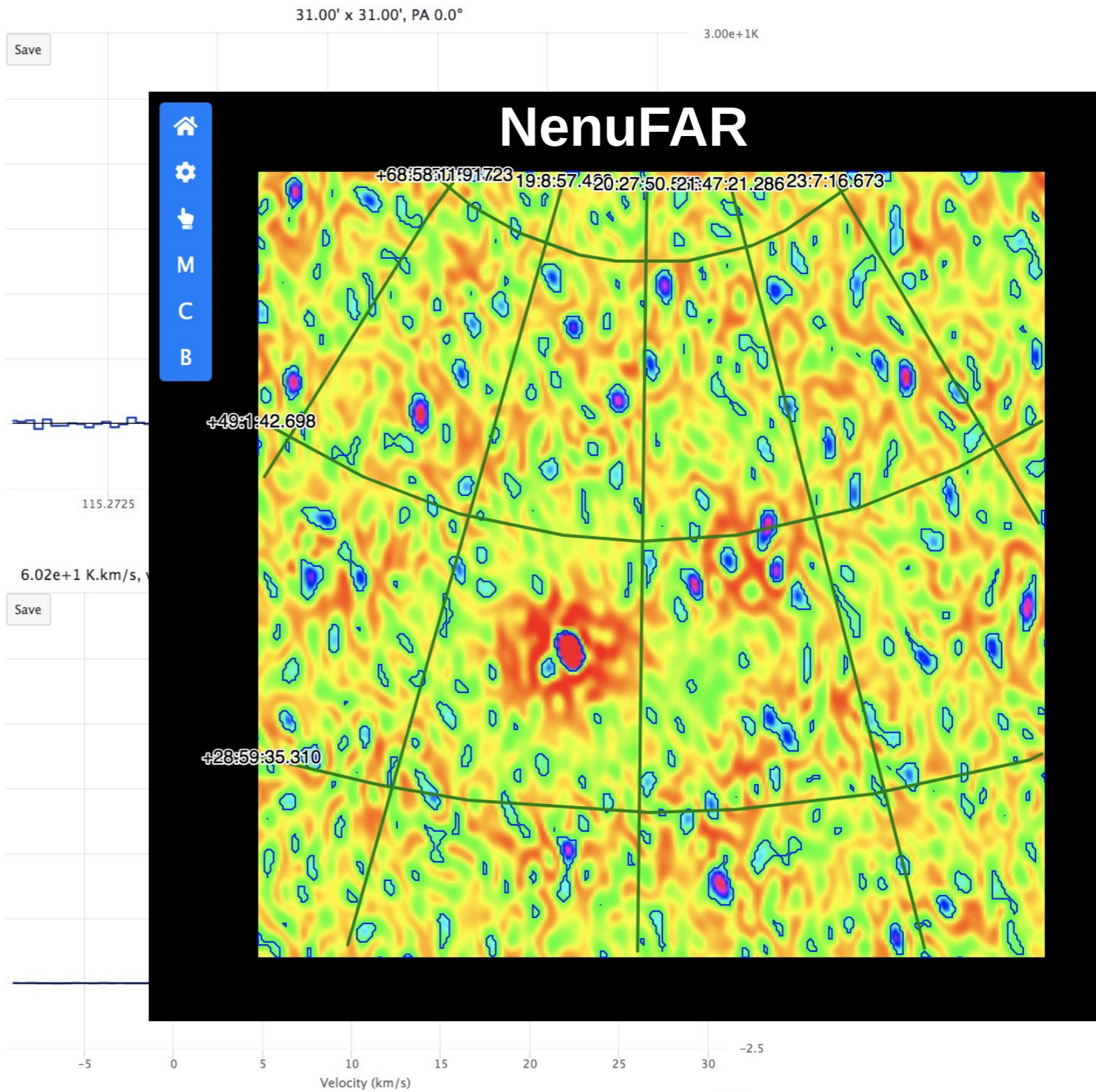
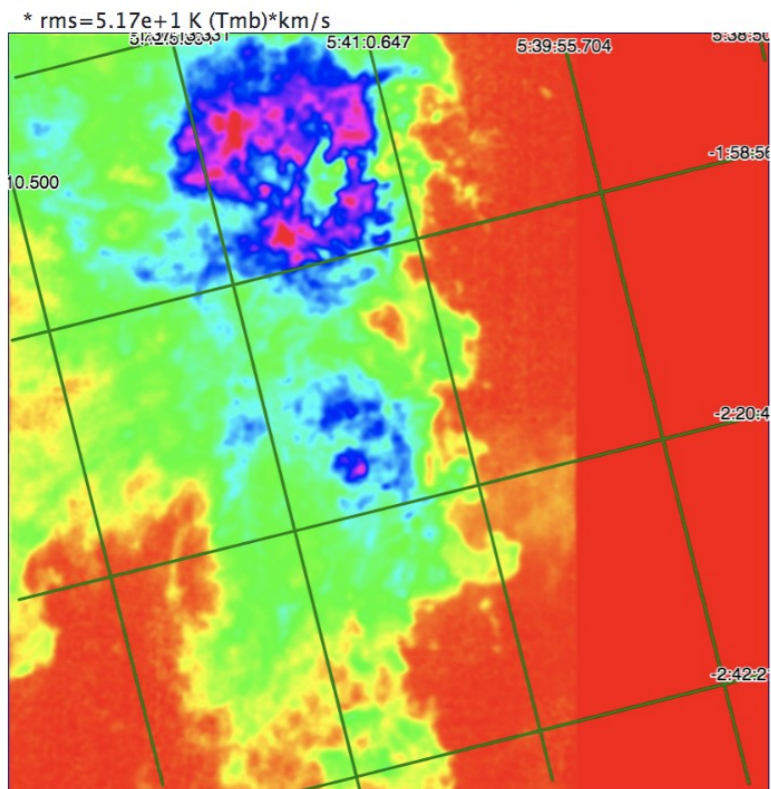
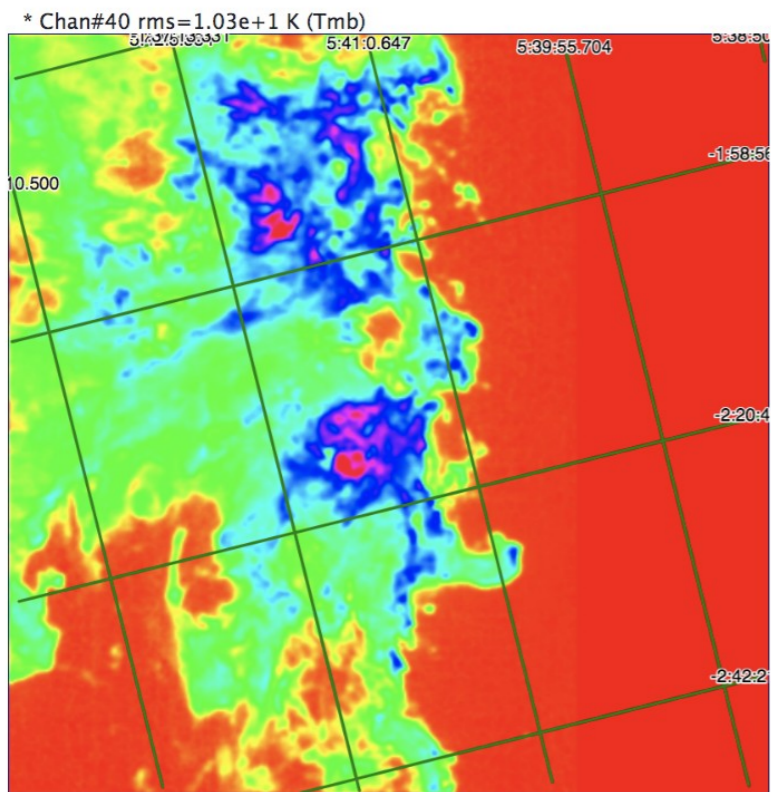


Copy as JSON

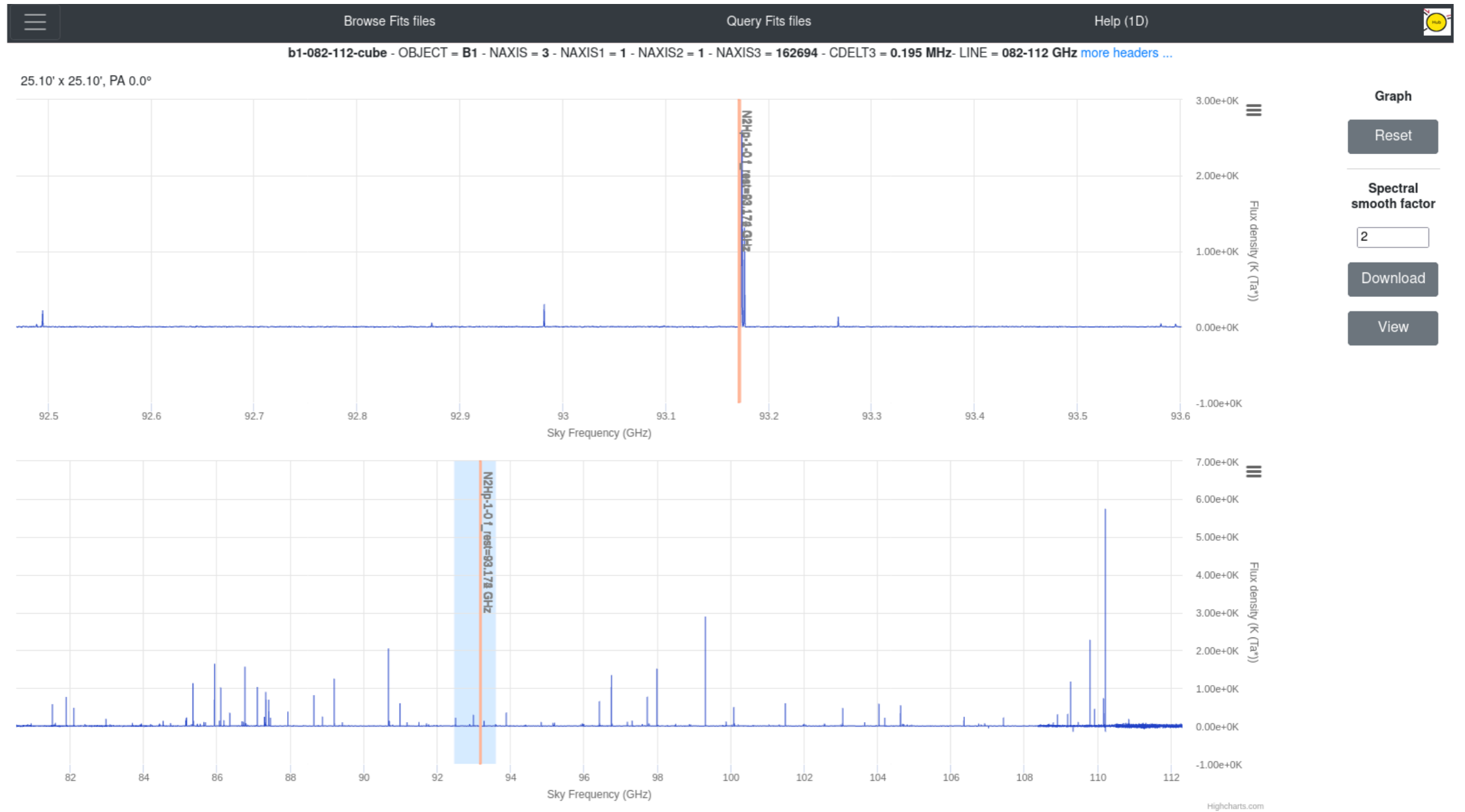
Close

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 2D and 3D Gnomonic



YAFITS 1D

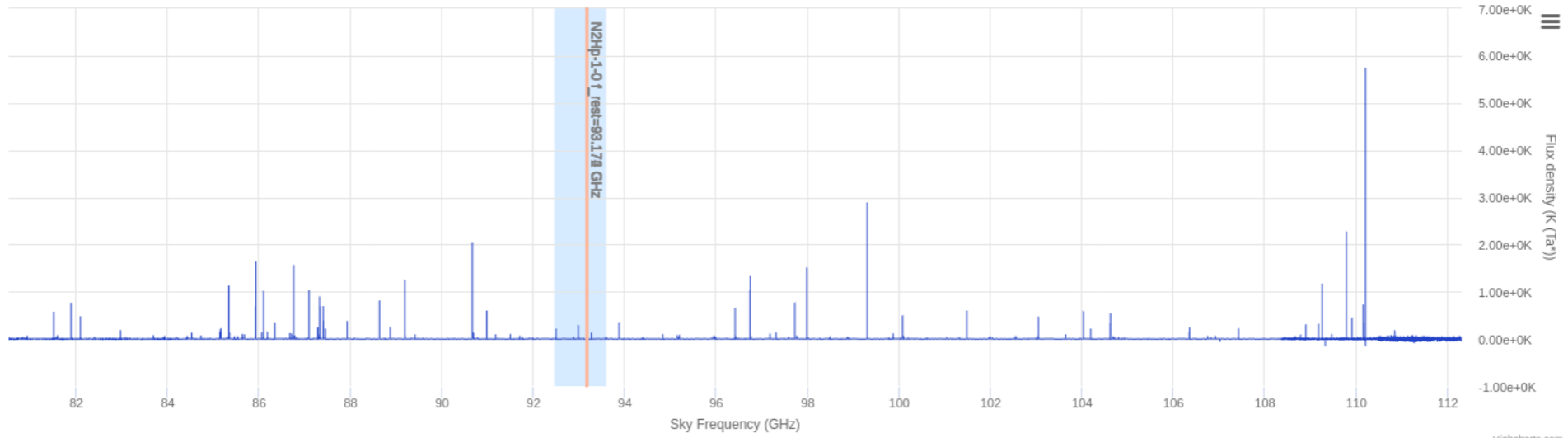
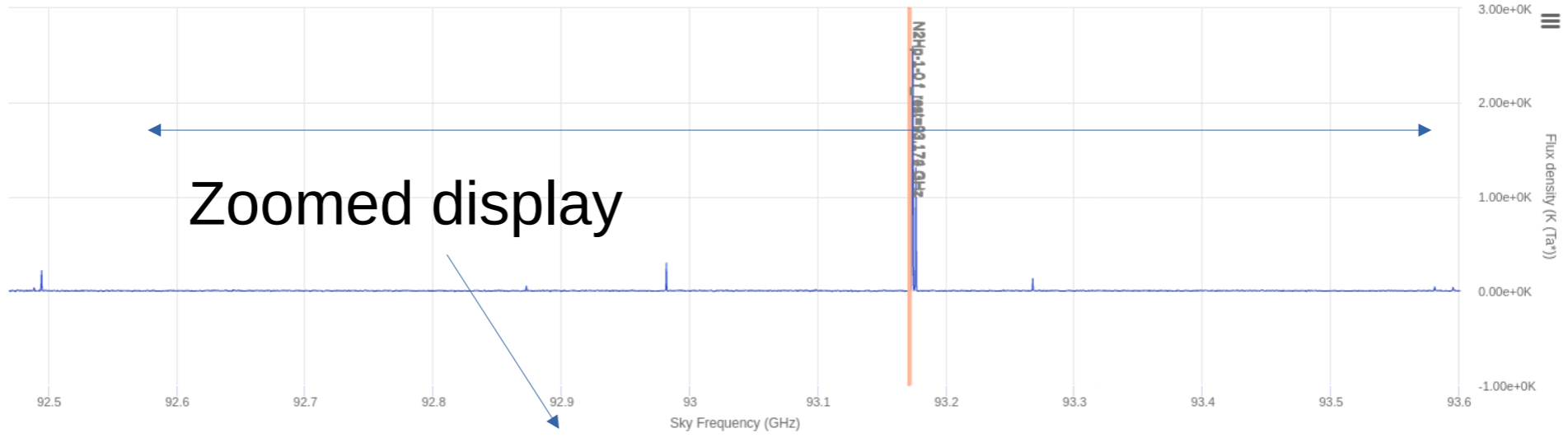


Full spectrum display

YAFITS 1D

b1-082-112-cube - OBJECT = B1 - NAXIS = 3 - NAXIS1 = 1 - NAXIS2 = 1 - NAXIS3 = 162694 - CDELTA3 = 0.195 MHz - LINE = 082-112 GHz [more headers ...](#)

25.10' x 25.10', PA 0.0°



Graph

Reset

Spectral
smooth factor

2

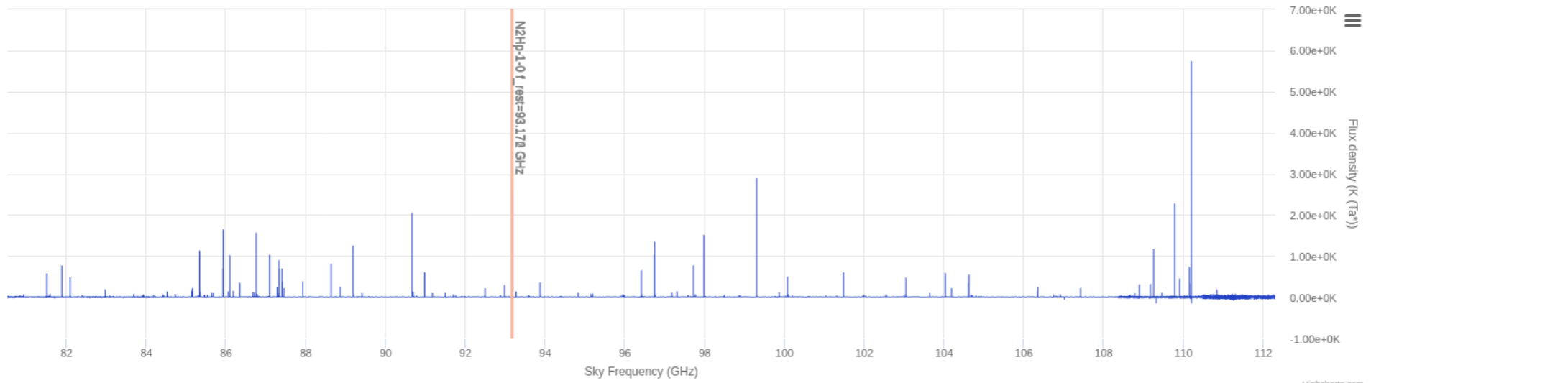
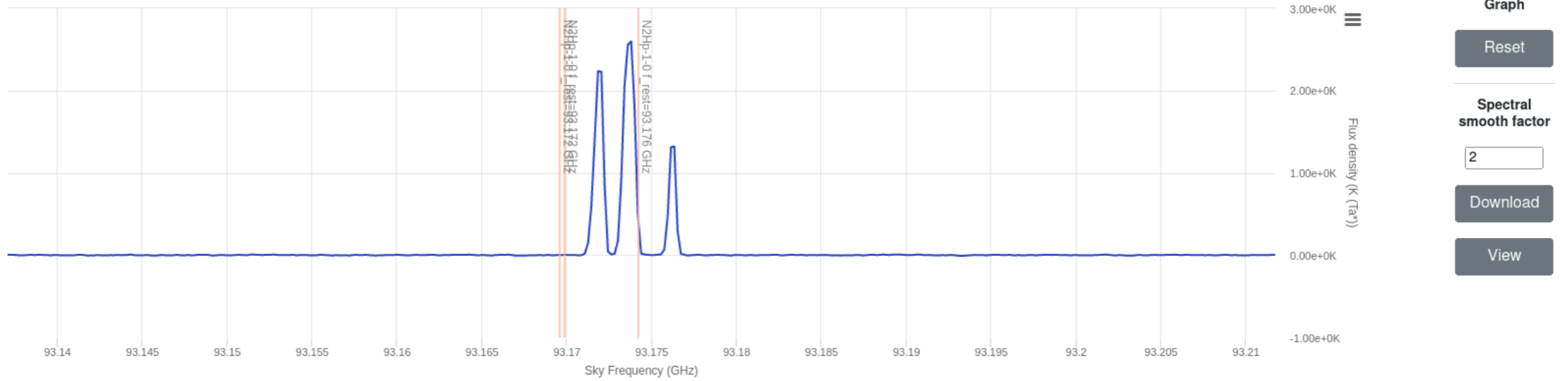
Download

View

YAFITS 1D

b1-082-112-cube - OBJECT = B1 - NAXIS = 3 - NAXIS1 = 1 - NAXIS2 = 1 - NAXIS3 = 162694 - CDELTA3 = 0.195 MHz - LINE = 082-112 GHz [more headers ...](#)

25.10' x 25.10', PA 0.0°



Architecture, Technical aspects, Development environment, Install

<https://yafits.obspm.fr/>

radio astronomy

data visualisation

image cube

visual analytics

DOI 10.5281/zenodo.3696974

Deployed inside Docker

- No external dependency
- Easy configuration (PATH)

Uses external libraries : Highcharts (spectra) and Openlayers (Images)

Designed for radio-astronomy datacubes

Tested with ALMA, NOEMA data, but also MUSE and SITELLE,

Technical evolution

Server optimization

- Faster fits file loading time
- Faster image generation time

Installation on IRAM large programs database

Development of a test suite for deployment on IRAM large program archive :

- Comparison of Yafits and Gildas output
- Non regression tests between Yafits versions

Gildas / Yafits comparison

- Tests are executed through a configurable script (bash, python + selenium)
- For each cube, some data are extracted from Yafits web Ui and stored in a JSON file (statistics and values from images and spectra)
- The same data are extracted from the cube opened in Gildas into JSON files (scripts in command line)
- Gildas is installed in a docker container for easy deployment on any host server
- Content of JSON files is compared and a summary is generated

Gildas / Yafits comparison

Comparison between Yafits and Gildas

target : Yafits current version v23.3.1

reference : Gildas version jun22a

Total errors
0

[11157-n2hp10-pdbi_30m-cube](#)

Test	Errors
check_upper_image	0
check_upper_spectrum	0
check_lower_image	0
check_lower_spectrum	0
check_lower_spectrum	0

[12co10-cube-cube](#)

Test	Errors
check_upper_image	0
check_upper_spectrum	0
check_lower_image	0
check_lower_spectrum	0
check_lower_spectrum	0

[12co21-cube-cube](#)

Test	Errors
check_upper_image	0
check_upper_spectrum	0
check_lower_image	0
check_lower_spectrum	0
check_lower_spectrum	0

Global results summary

Gildas / Yafits comparison

Comparison between Yafits and Gildas

target : Yafits current version v23.3.1

reference : Gildas version jun22a

Total errors
0

[11157-n2hp10-pdbi_30m-cube](#)

Test	Errors
check_upper_image	0
check_upper_spectrum	0
check_lower_image	0
check_lower_spectrum	0
check_lower_spectrum	0

[12co10-cube-cube](#)

Test	Errors
check_upper_image	0
check_upper_spectrum	0
check_lower_image	0
check_lower_spectrum	0
check_lower_spectrum	0

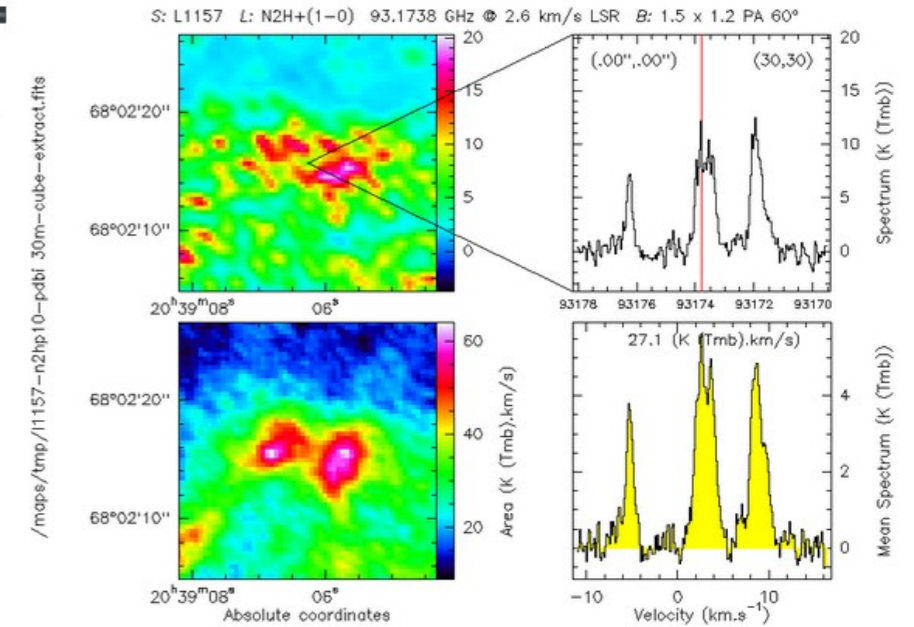
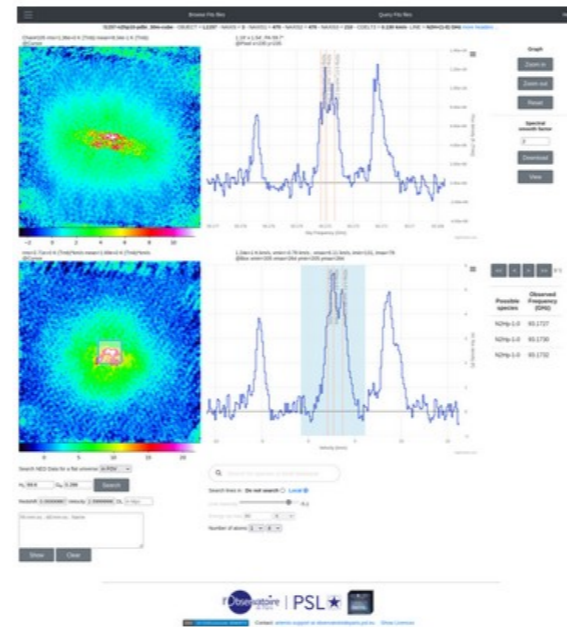
[12co21-cube-cube](#)

Test	Errors
check_upper_image	0
check_upper_spectrum	0 </td
check_lower_image	0
check_lower_spectrum	0
check_lower_spectrum	0

Detailed view



Datafile	Total errors
11157-n2hp10-pdbi_30m-cube.json	0



Section	Total errors
check_upper_image	0

Tests	Results
rms value	Success yafits value = 1.355089545249939 gildas value : 1.3550477027893 difference : 0.003 %
channel value	Success yafits value = 105 gildas value : 106 difference : 0.943 %
min value	Success yafits value = -4.956695556640625 gildas value : -4.9566955566406 difference : 0.000 %
max value	Success yafits value = 19.58310890197754 gildas value : 19.583108901978 difference : 0.000 %
refPixel x value	Success yafits value = 235 gildas value : 236 difference : 0.424 %
refPixel y value	Success yafits value = 235 gildas value : 236 difference : 0.424 %

Yafits @ IRAM

iram Institut de Radioastronomie Millimétrique
DEV Data Management System (DMS)

*** NOT IN PRODUCTION MODE ***

Browse
Show programs
Add a dataset
Find files

History → Data Management System / Show programs / EMPIRE

Current user
philippe.salome
Logout

Edit Attach file Full screen

Search:

Go

created → edited → ask for publishing → published

EMPIRE (EMIR Multiline Probe of the ISM Regulating Galaxy Evolution)
PIs: Frank Bigiel
<https://empiresurvey.webstarts.com/index.html>
First data release (DR1) - 2019 June 11th

Project: 12co10

Browse Fits files Help (3D)

source=ngc2903;line=12co10;product=cube - OBJECT = ngc2903 - NAXIS = 3 - NAXIS1 = 120 - NAXIS2 = 139 - NAXIS3 = 375 - CDELTA3 = 4000.000 km/s - LINE = 12CO(1-0) GHz [more headers ...](#)

Chan#188 rms=4.56e-2 K (Tmb) mean=1.38e-2 K (Tmb)
@Cursor

25.65' x 25.65', PA 0.0°
@Pixel x=60 y=70

Graph

Zoom in
Zoom out
Reset

Spectral smooth factor

View

rms=5.65e+3 K (Tmb)*km/s mean=1.57e+3 K (Tmb)*km/s
@Cursor

2.79e+4 K.km/s, vmin=362369.80 km/s, vmax=738369.80 km/s, imin=140, imax=234
@Box xmin=52 xmax=67 ymin=60 ymax=78

Next steps

- Finalizing the integration of Yafits on **IRAM Large Program database**
- Work in progress : prototyping « Visualization of SKA data with high volume of users and high amount of data »
- Improving sources search interface
- Plugging an automated source detection software in Yafits (D. Cornu is joining the project)