CARTA

Cube Analysis and Rendering Tool for Astronomy

DOI 10.5281/zenodo.3377984

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@ALMA Spanish Days, IAC [2025/02/18]

ALMA

ESO

NAOJ National Astronomical Observatory of Japan

NRAO

Outline

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- Driver for CARTA
- CARTA
- CARTA in the ALMA Science Archive
- Stand-alone CARTA
- Practice with continuum image
- Practice with cube

Credits to Kazi Rygl, Elisabetta Liuzzo, et al.
I-TRAIN #12: CARTA tutorial
EU ALMA school (presentation, materials)

Why use CARTA?

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- Many fits visualization tools in the market (link here)
  (DS9, QFitsView, Aladin, APLpy, fv, CARTA, …)
- CARTA was made to address the interferometric data context
  - Continuum
  - Spectral cubes
  - Full polarization
  - Flux extraction
  - Spectral fitting
  - Momentum maps (integrated flux, velocity, velocity dispersion)
  - Position-velocity diagrams
  - Built to deal with heavy data (eg, 1TB cubes, parallelization)
  - FITS or HDF5
  - Can be used directly from the ALMA Science Archive

CARTA

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HOME FEATURES GALLERY ROADMAP INSTALLATION TEAM ABOUT

CARTA

Cube Analysis and Rendering Tool for Astronomy, is a next-generation image visualization and analysis tool designed for ALMA, VLA, and SKA pathfinders.

Ubuntu/RedHat/MacOS

Installation | User Manual | Helpdesk

New release: v4.1
January 2024

ASA vs stand-alone

Working with CARTA in the ASA

- No need to download data
- No need to install CARTA
- Can open multiple ASA images and overlay these
- Save png but not FITS to disk

Working with CARTA on your device

- Slightly bigger interface
- Save FITS/png to disk
- Can load locally stored data and overlay these
- Can load your regions/catalogs

CARTA in ASA

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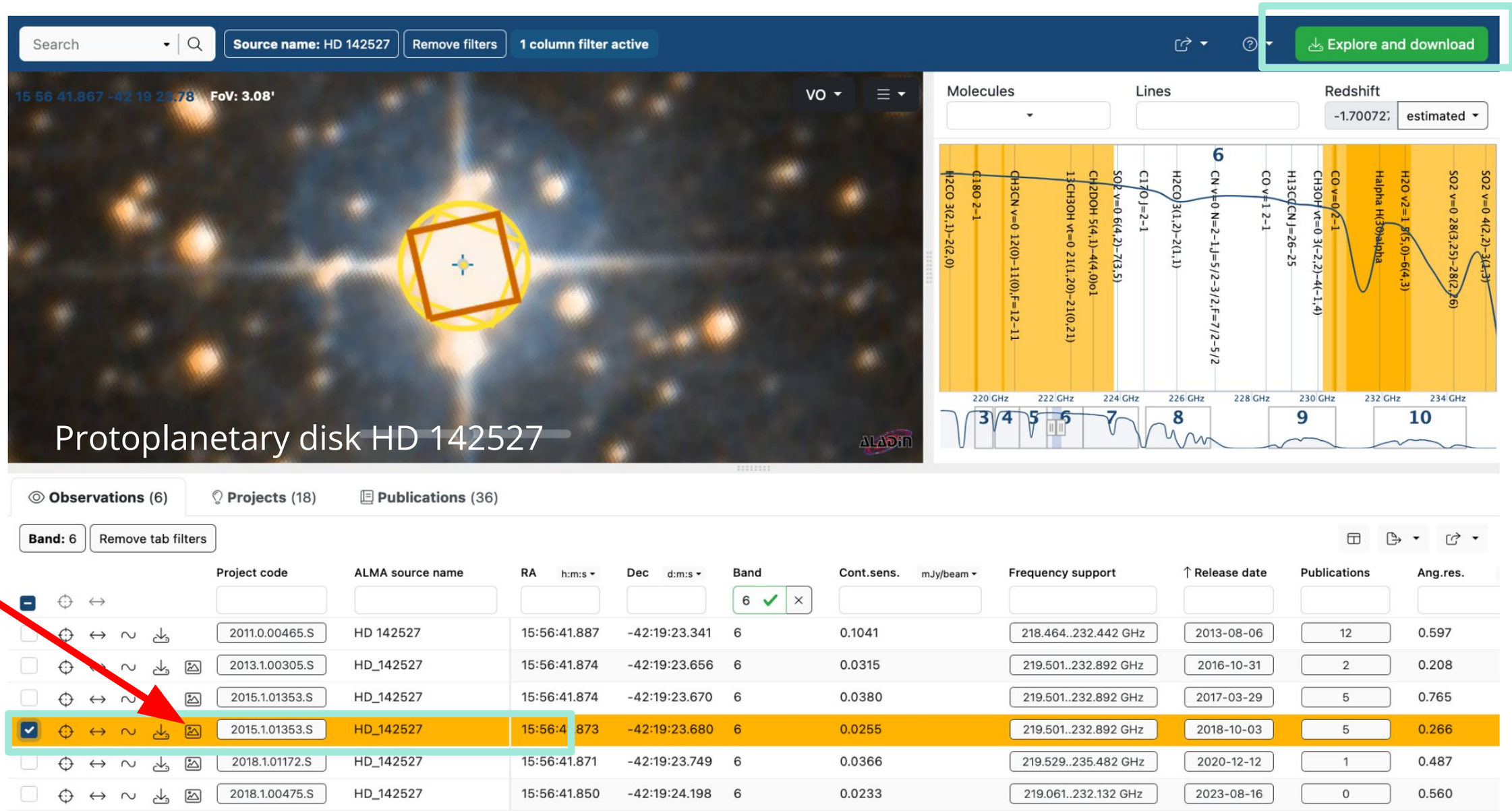
Using CARTA in the ASA https://almascience.eso.org/aq/



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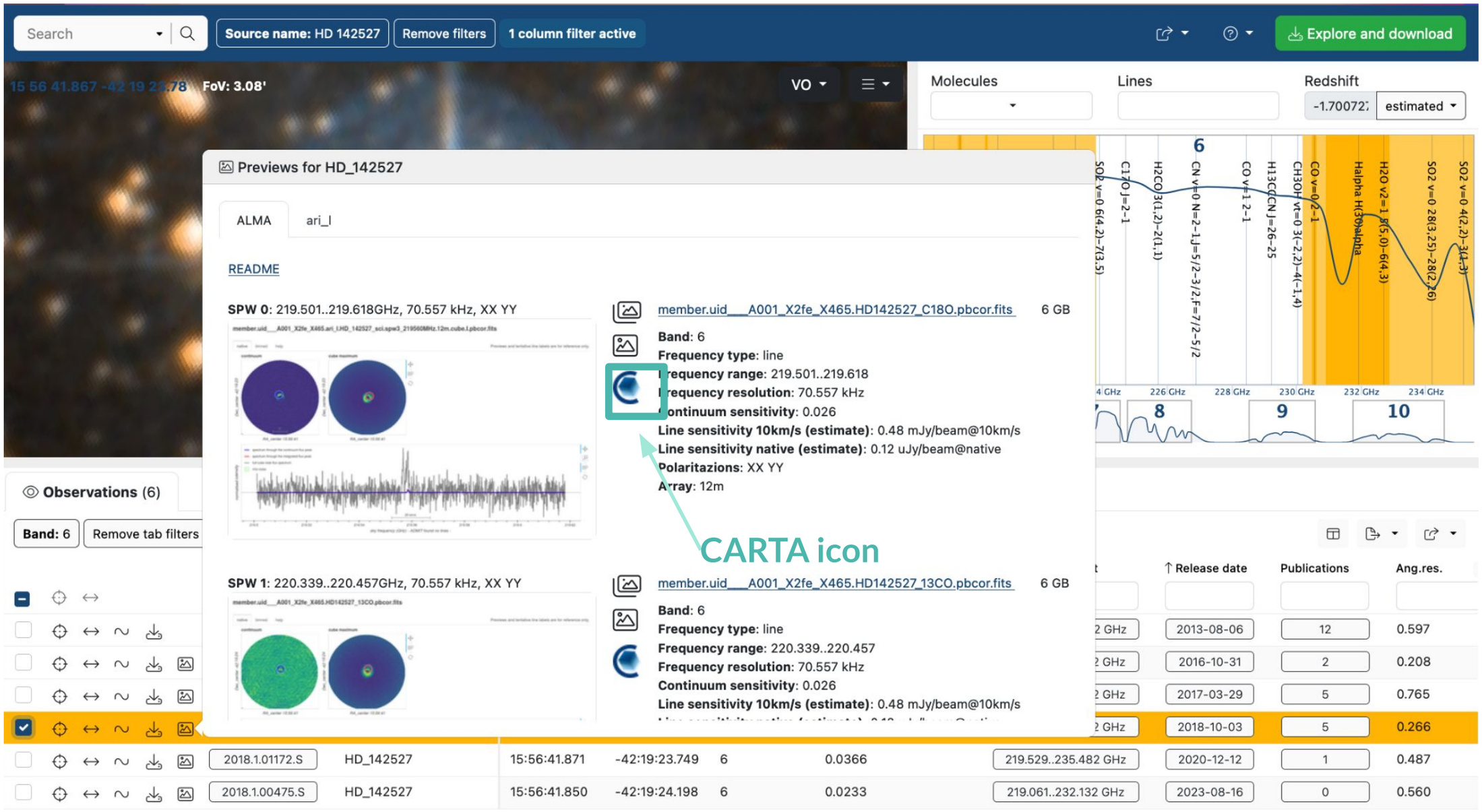
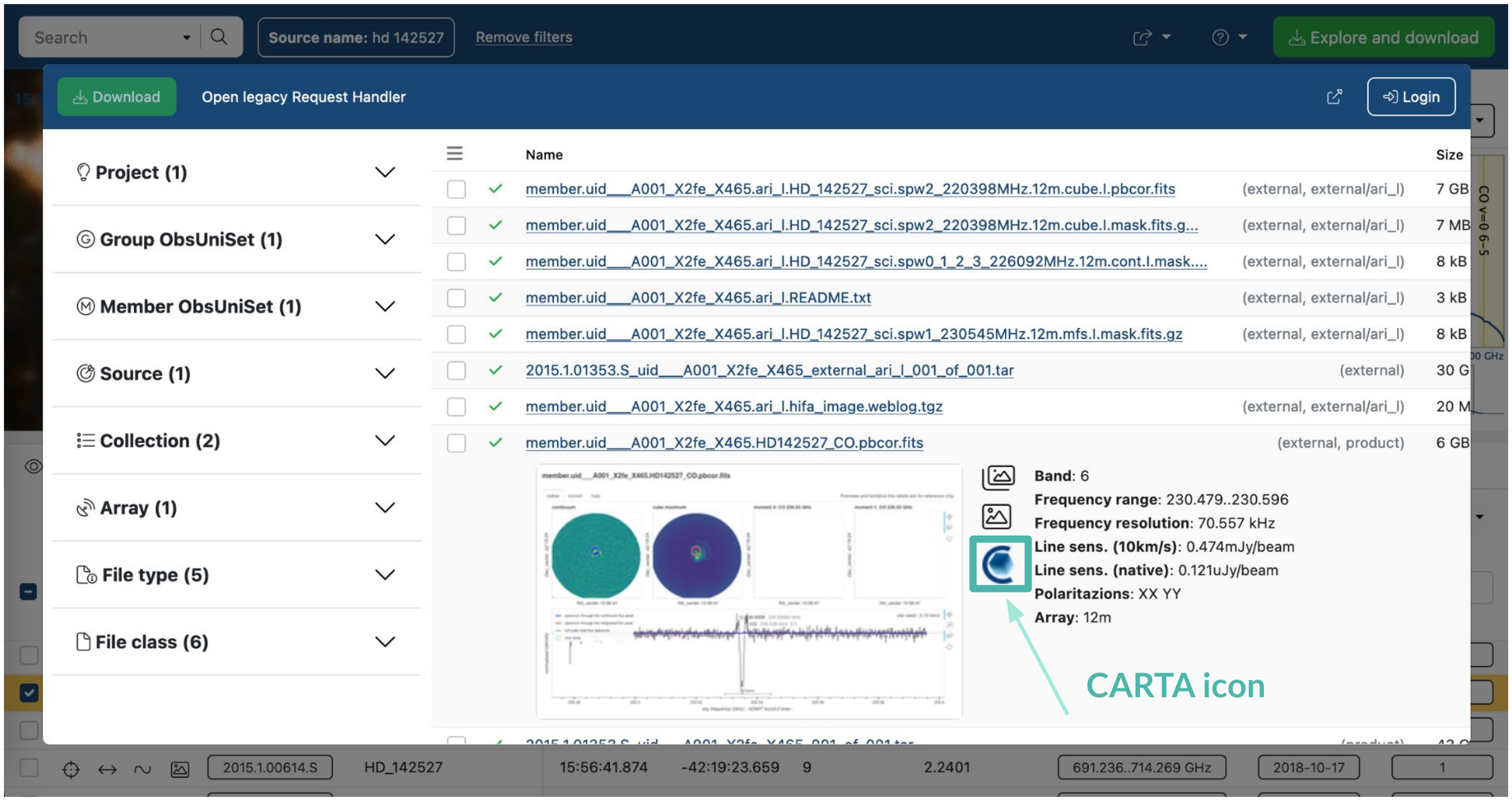
Previews hovering the mouse over the 5th icon



CARTA in ASA

CARTA icon



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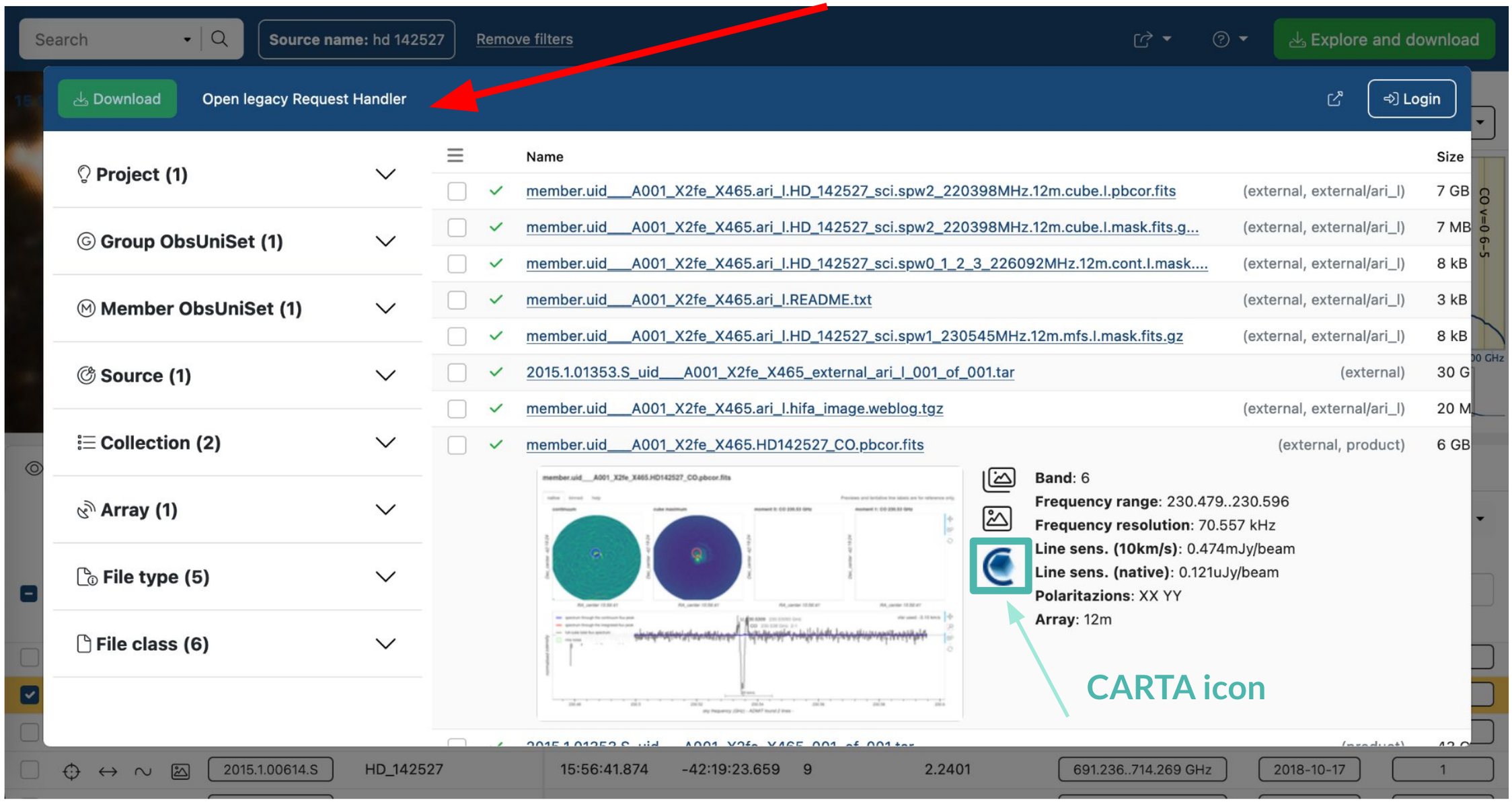
Open legacy Request Handler



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CARTA previews for fits files in Product

ALMA Request Handler | Login

Anonymous User: Request #2165002684535 ✔

Request Title: click to edit

Download Selected

☑ readme ☑ product ☑ auxiliary ☐ raw ☐ raw (semipass) ☐ external

Project / OUSet / Executionblock	Updated	File	Size	Accessible	Actions
Request 2165002684535			46 GB		
Project 2015.1.01353.S					
Science Goal OUS uid://A001/X2fe/X463					
Group OUS uid://A001/X2fe/X464					
Member OUS uid://A001/X2fe/X465	2020-07-10				
SB HD_14252_a_06_TE					
readme		member.uid___A001_X2fe_X465.README.txt	15 kB	✔	
product		2015.1.01353.S_uid___A001_X2fe_X465_001_of_001.tar	46 GB	✔	
product		member.uid___A001_X2fe_X465.HD142527_13CO.flux.fits.gz	2 GB	✔	
product		member.uid___A001_X2fe_X465.HD142527_13CO.image.fits	7 GB	✔	
product		member.uid___A001_X2fe_X465.HD142527_13CO.pbcor.fits	7 GB	✔	
product		member.uid___A001_X2fe_X465.HD142527_C18O.flux.fits.gz	2 GB	✔	
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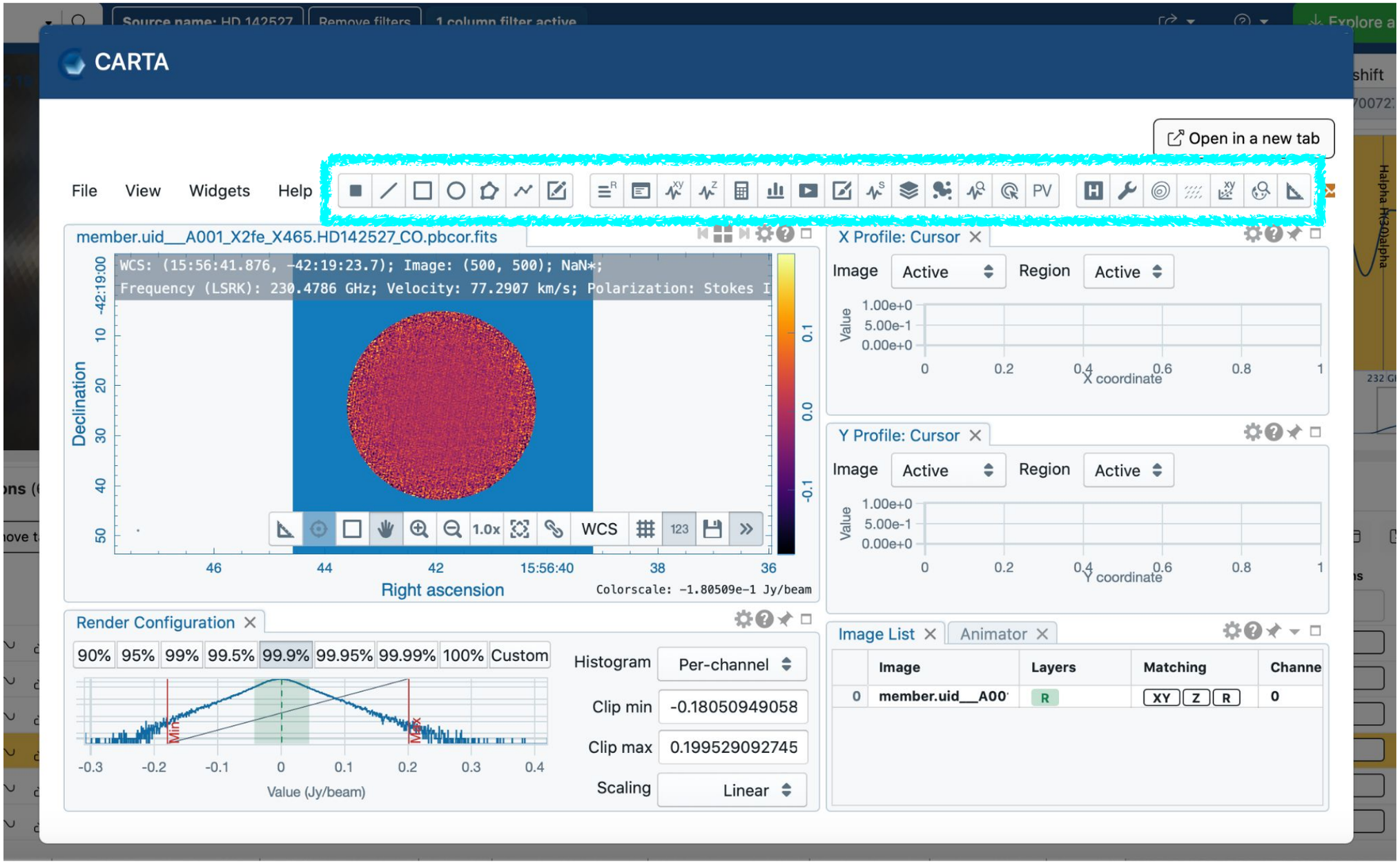
product		member.uid___A001_X2fe_X465.HD142527_cont.pbcor.fits	4 MB	✔	

CARTA icons

CARTA in ASA

Open CARTA in a new tab



CARTA functionalities

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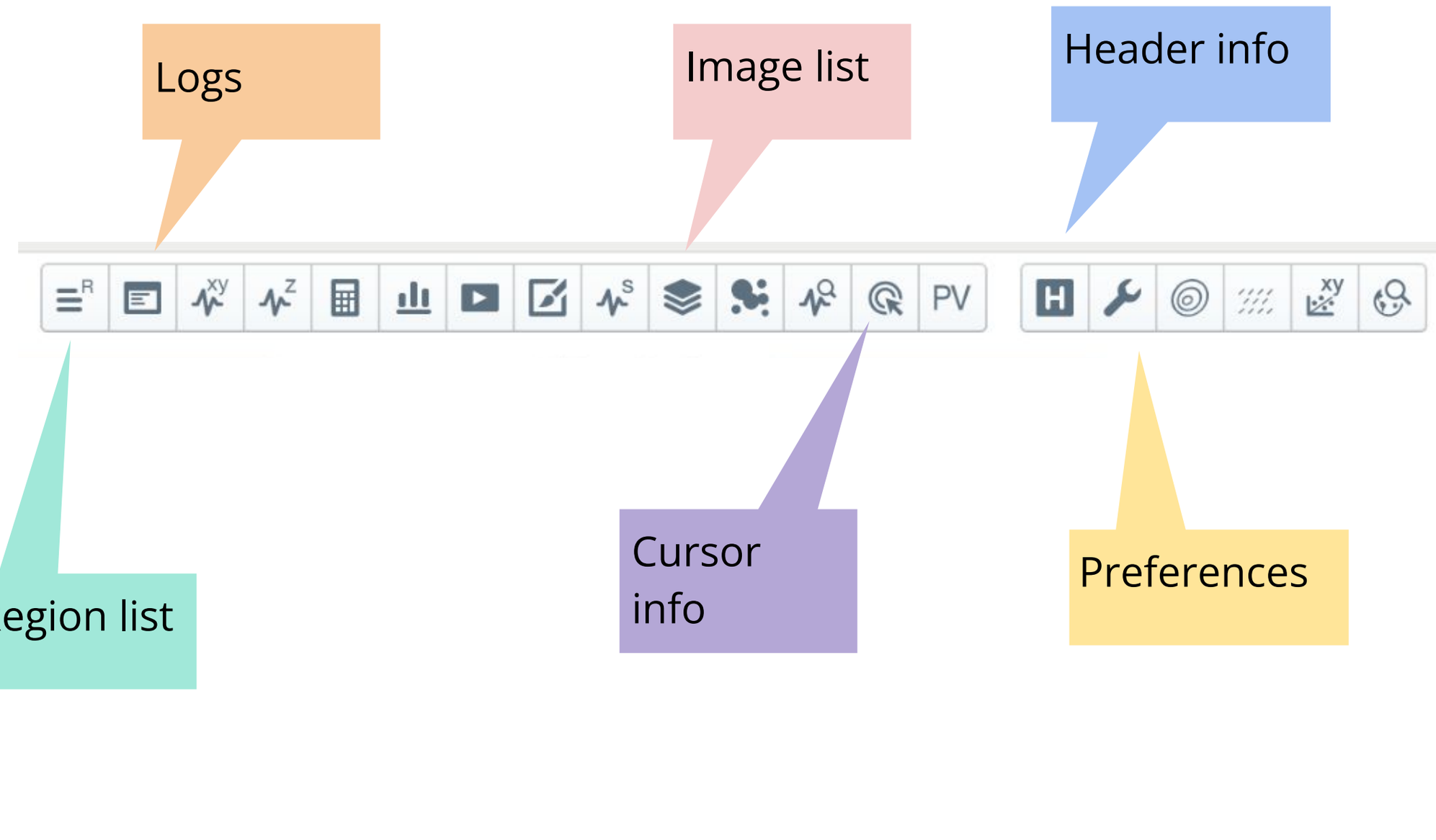
Auxiliary Widgets - basics



CARTA functionalities

Analysis Widgets - more info

Spatial (xy) and spectral (z) profiler

Animation

Stokes Analysis

PV diagrams

Image fitting

Statistics

Histograms

Rendering

Catalog (overlay)

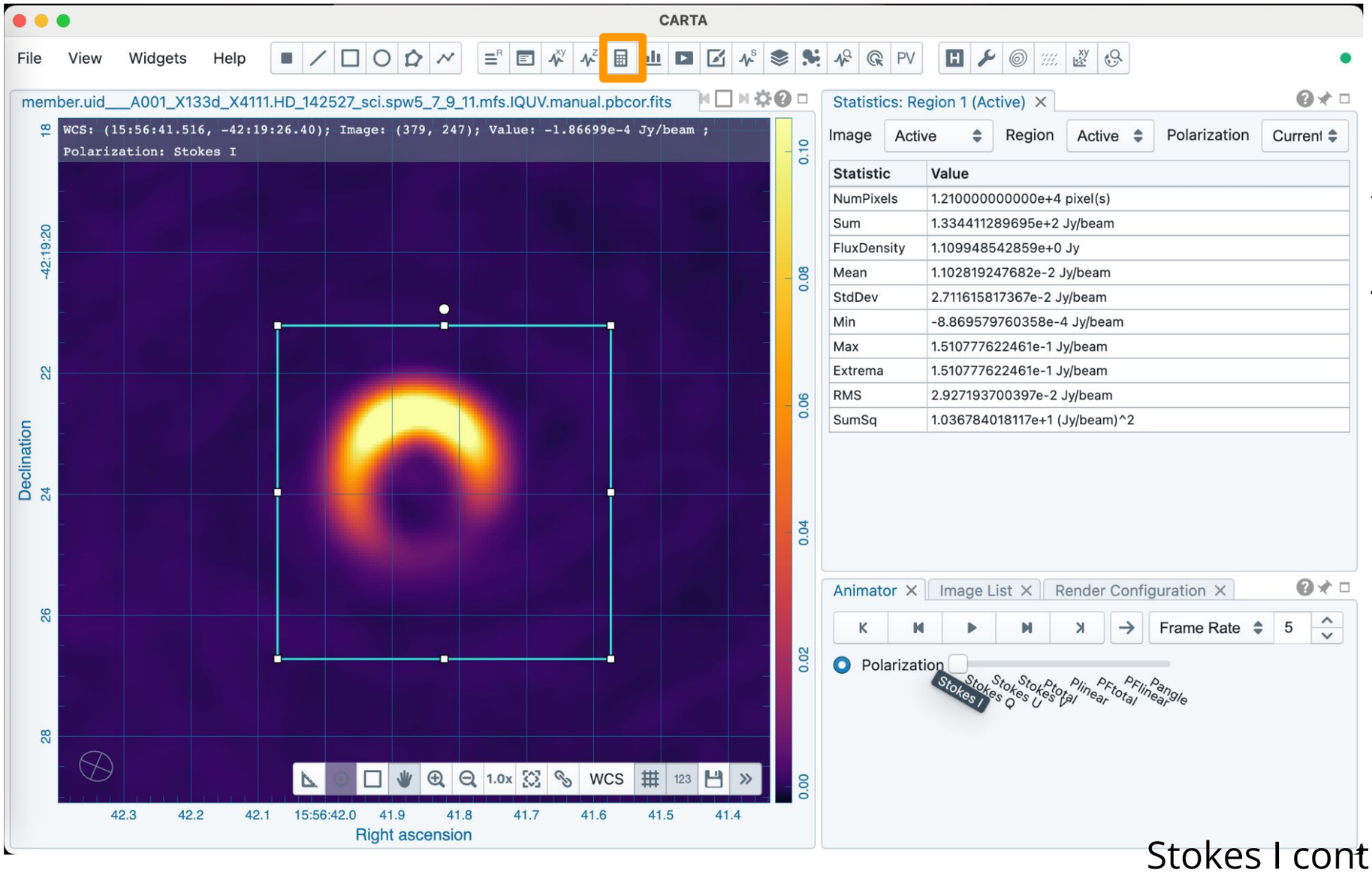
Spectral line query

Contour plots (o) and vector overlays (//)

Online catalog query

Stand-alone CARTA

Statistics widget - Peak flux and flux density

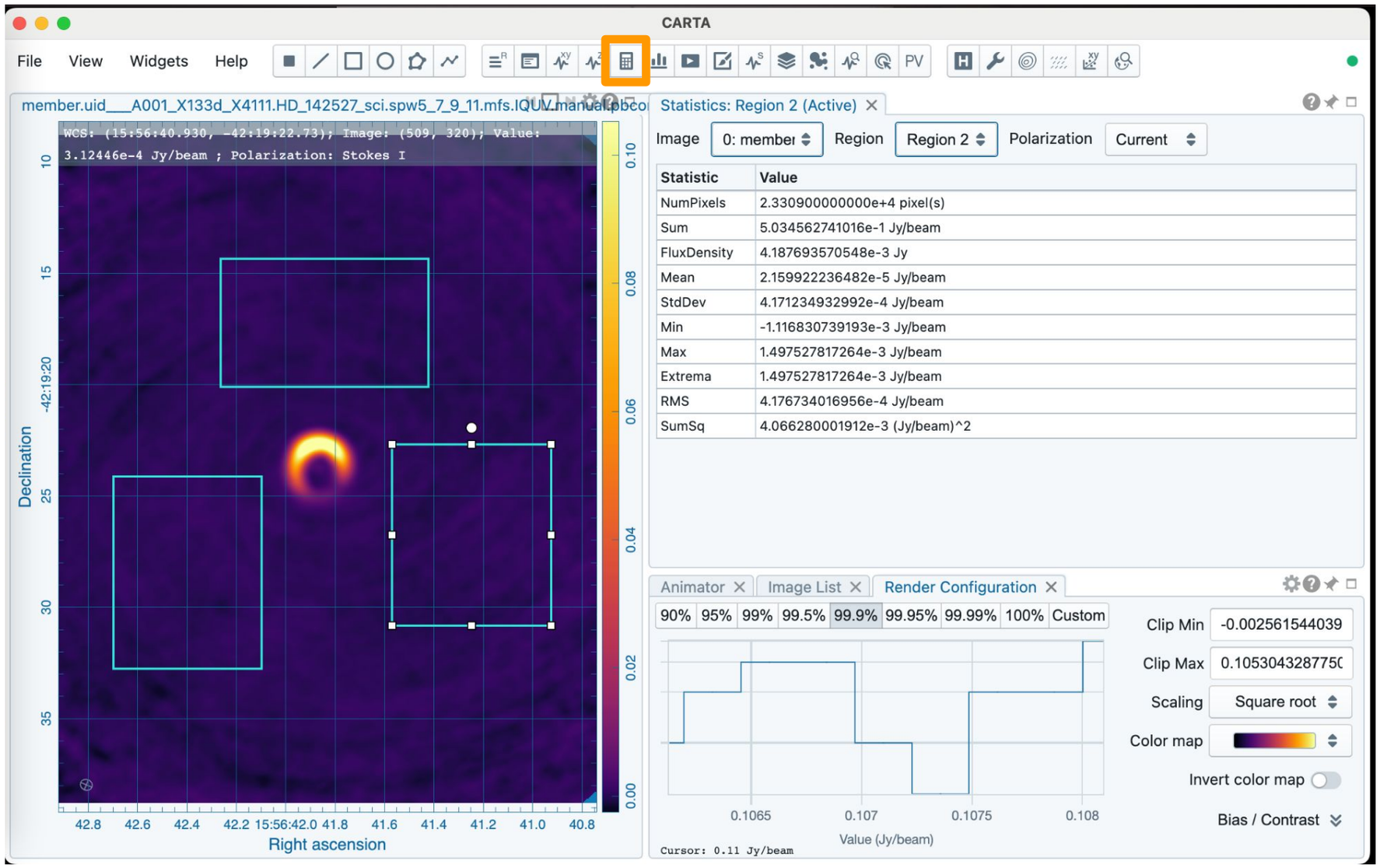


For getting the peak of the target emission, use a Region on the Target.

Stokes I continuum map, HD 142527

Stand-alone CARTA

Statistics widget - rms



For getting the RMS noise of the map, use a few Regions excluding the Target and image edges (higher noise) and get the mean RMS.

Stokes I continuum map, HD 142527

Stand-alone CARTA

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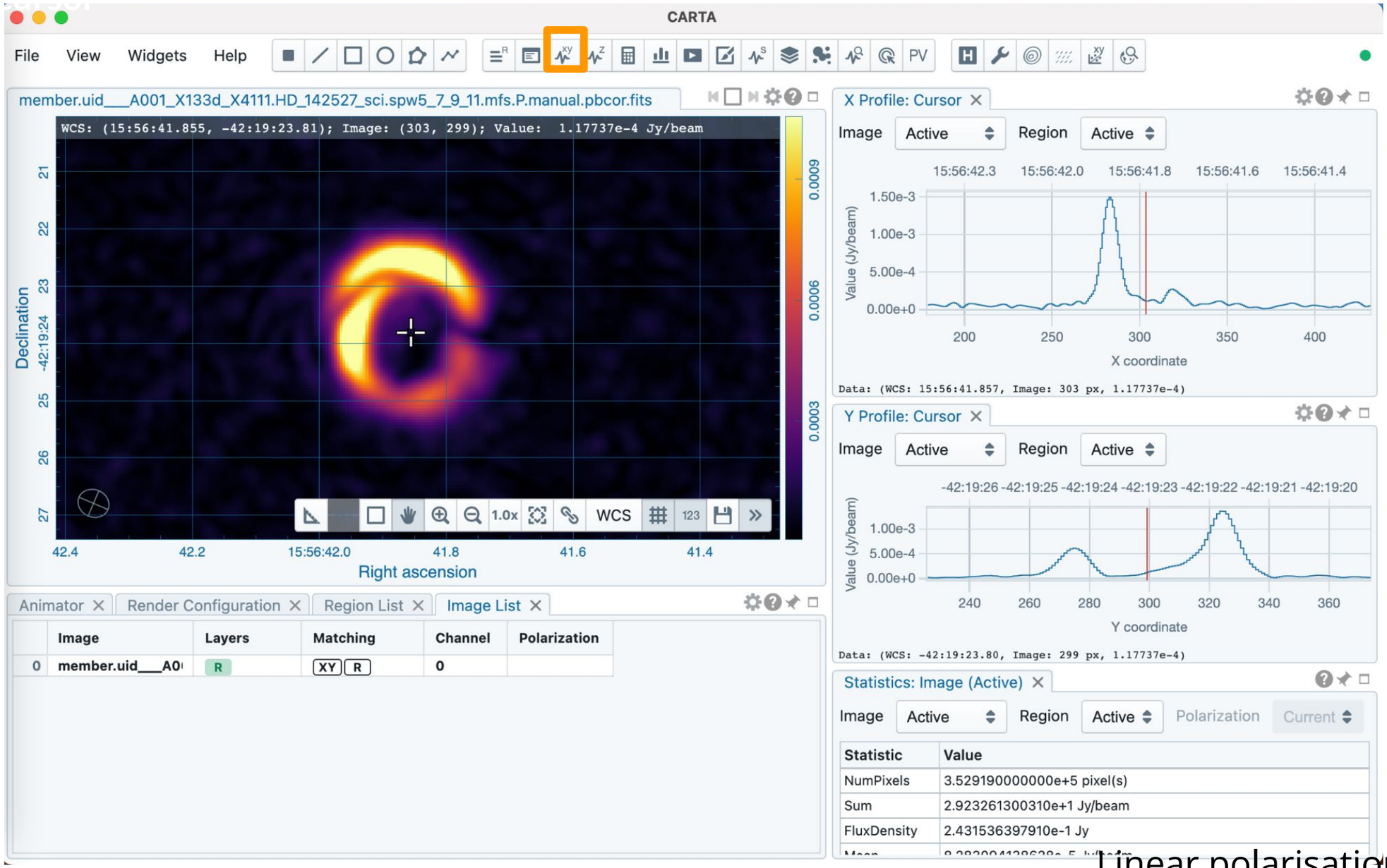
Spatial profiler -fix position with “F”



Linear polarisation map, HD 142527

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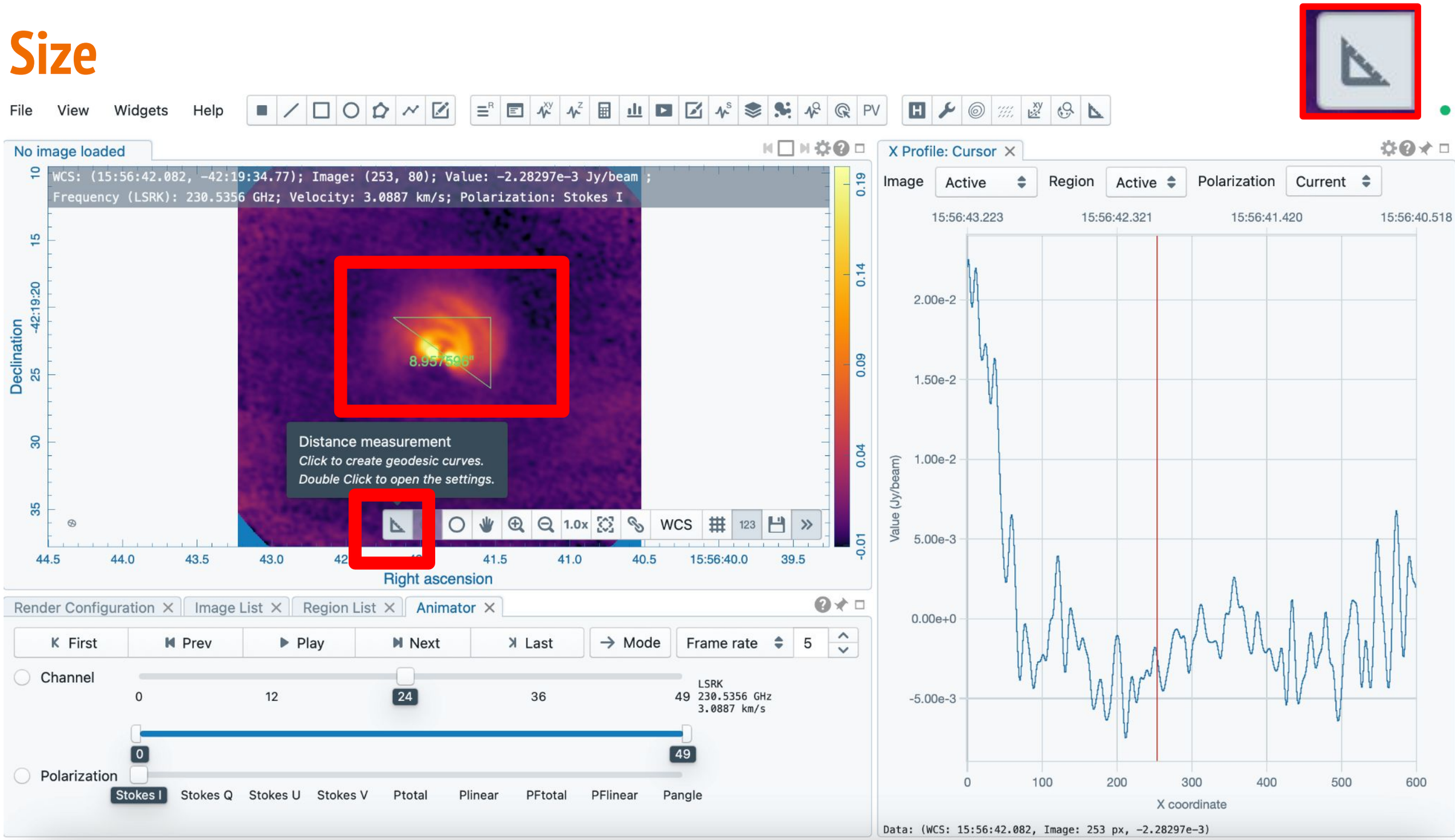
Size



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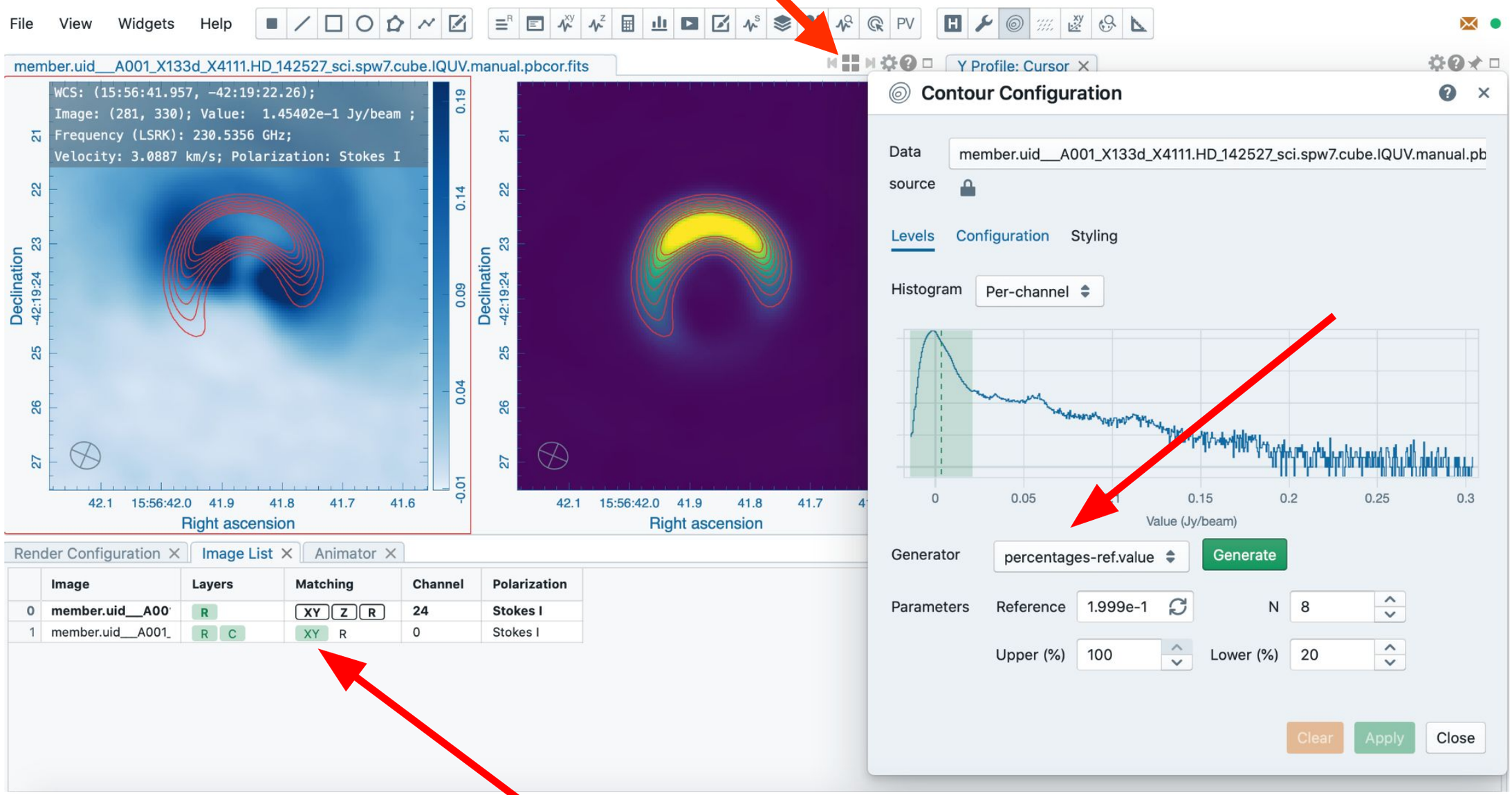
Contours overlay



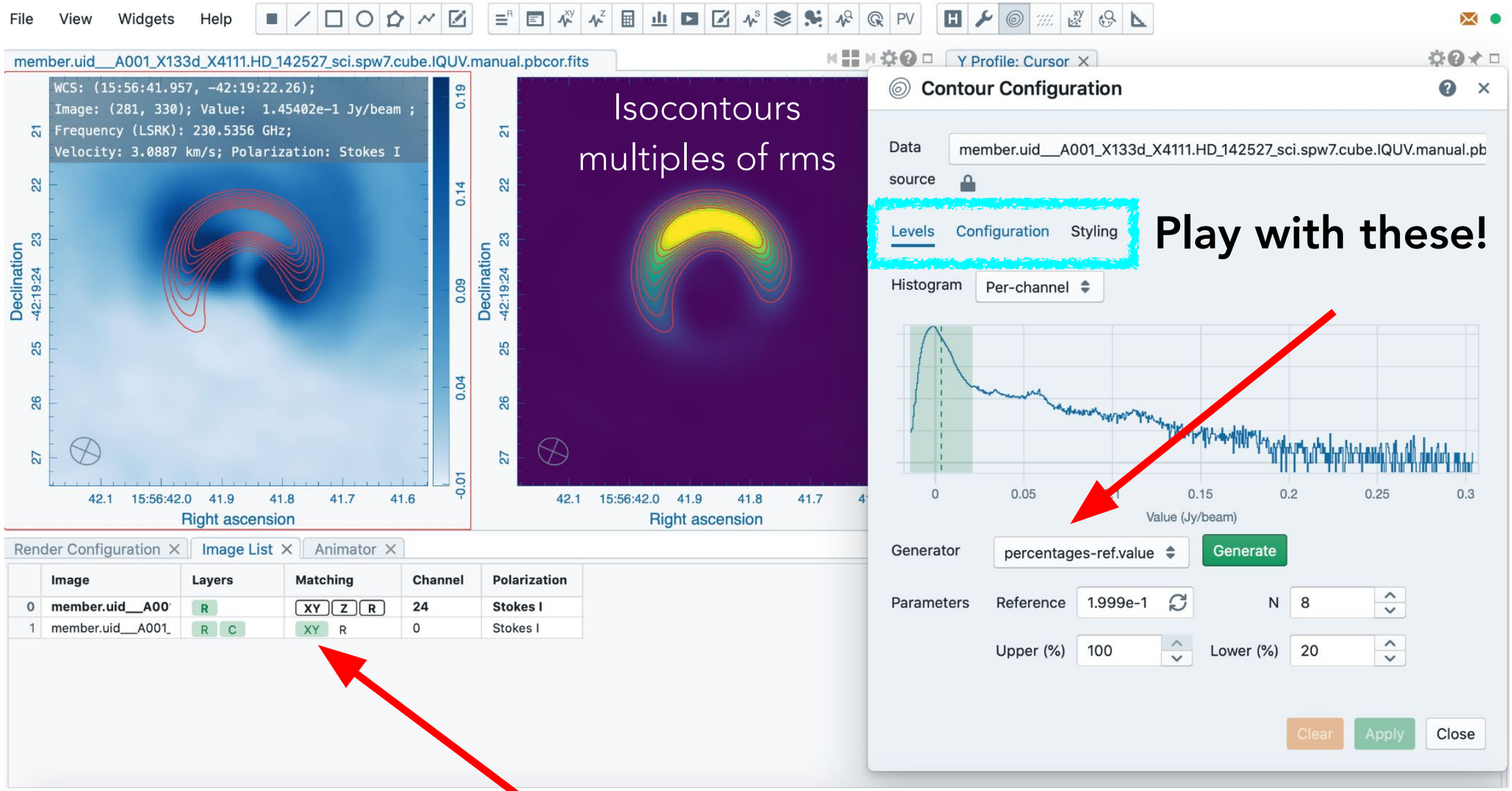
Stand-alone CARTA

Practice
(5min + 2min Q&A)

- *eso137-0.continuum.image.pbcor
  - Flux density (compare it with total sum and size in beams)
  - Peak flux
  - rms
- Same with *eso137-0.CO21.image.pbcor,
  but in different channels
- Use different type of regions
- Try out the distance/size widget
- Overlay continuum contours onto the CO(2-1) cube

Stand-alone CARTA

Contours overlay



Stand-alone CARTA

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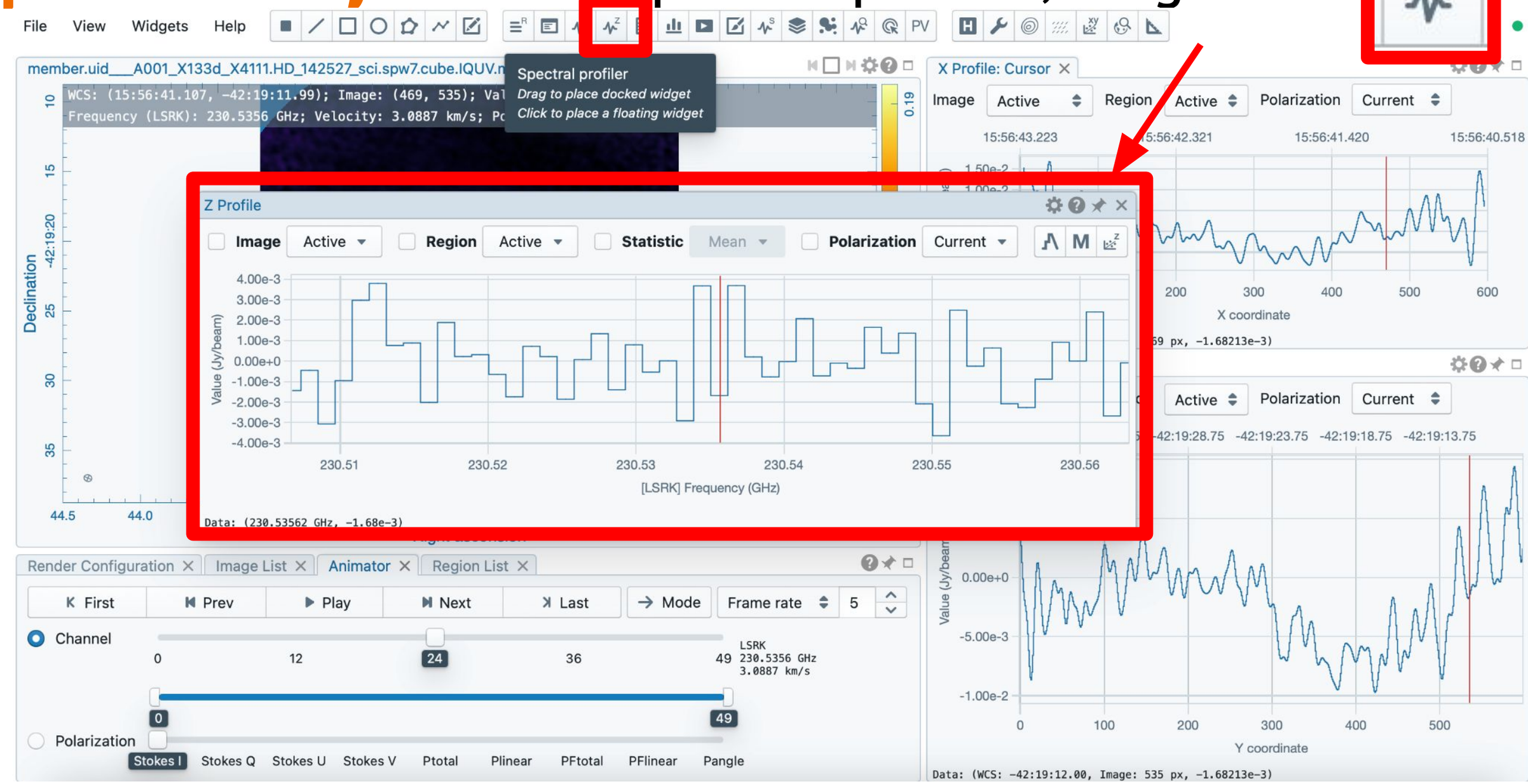
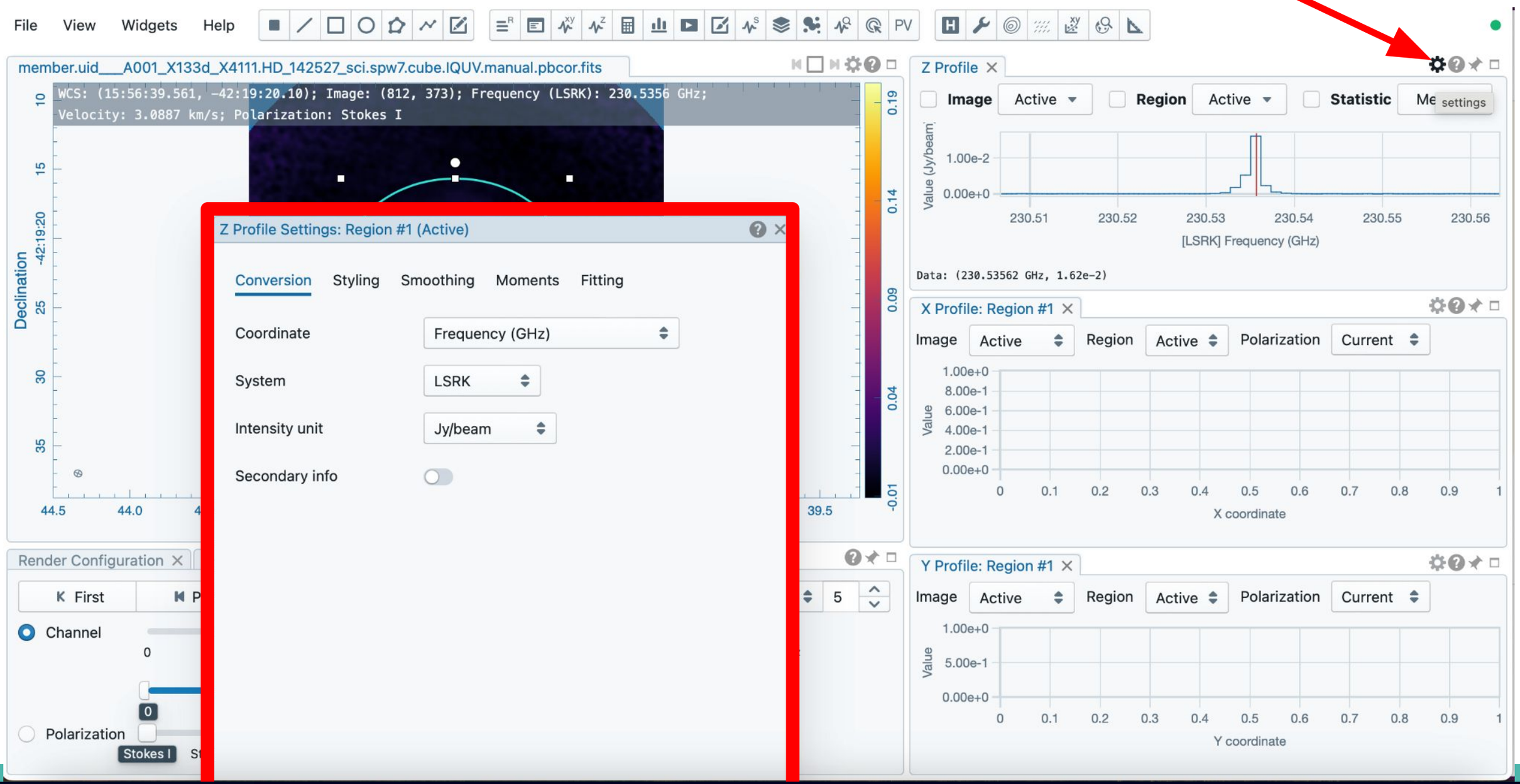
Spectral analysis: click spectral profiler, drag it



Stand-alone CARTA

Moments: settings in z profile



Stand-alone CARTA

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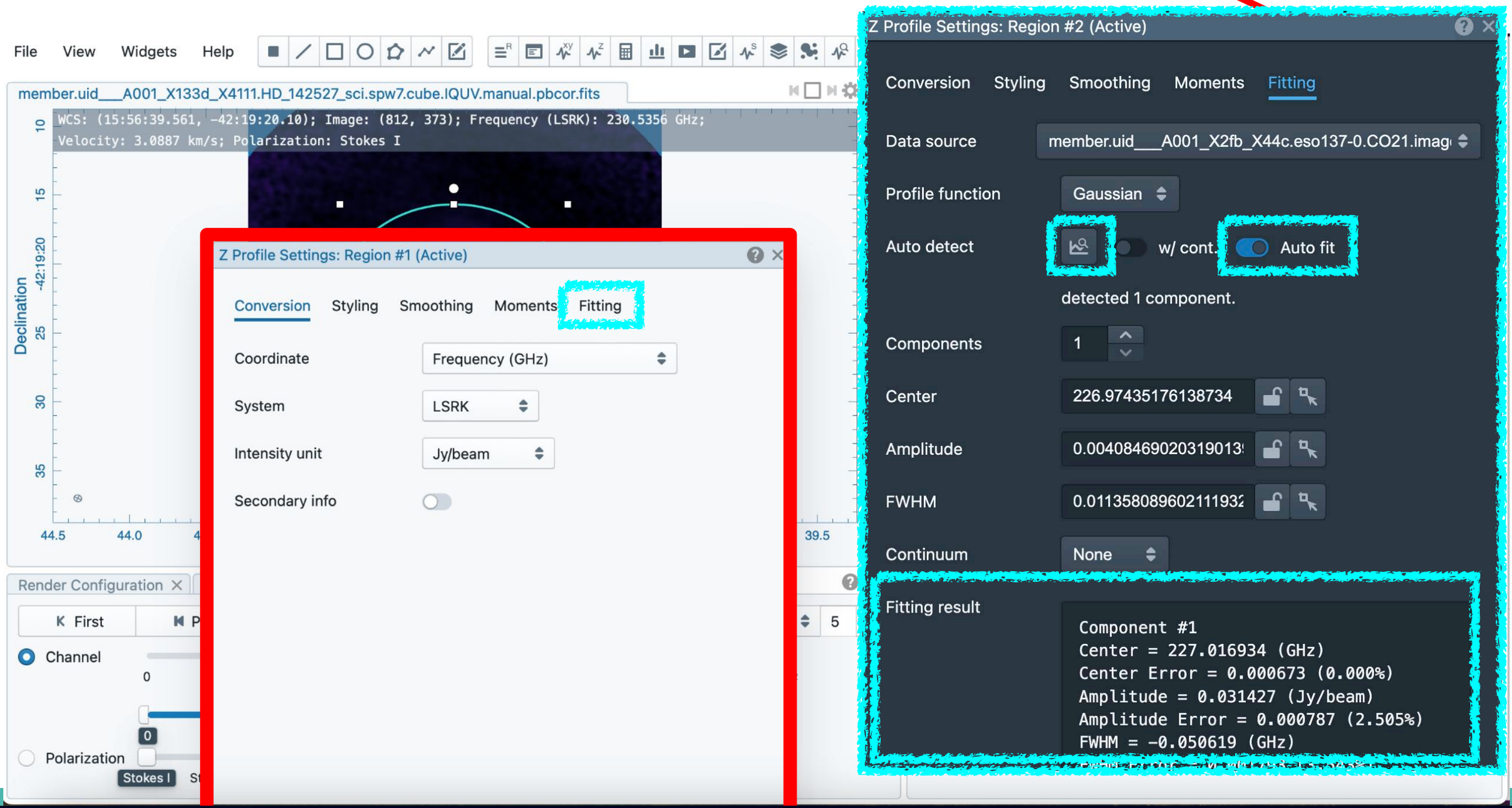
Moments: settings in z profile



Stand-alone CARTA

Spectral profile: Moments available

Available moments

-1: Mean value of the spectrum

0: Integrated value of the spectrum

1: Intensity weighted coordinate

2: Intensity weighted dispersion of the coordinate

3: Median value of the spectrum

4: Median coordinate

5: Standard deviation about the mean of the spectrum

6: Root mean square of the spectrum

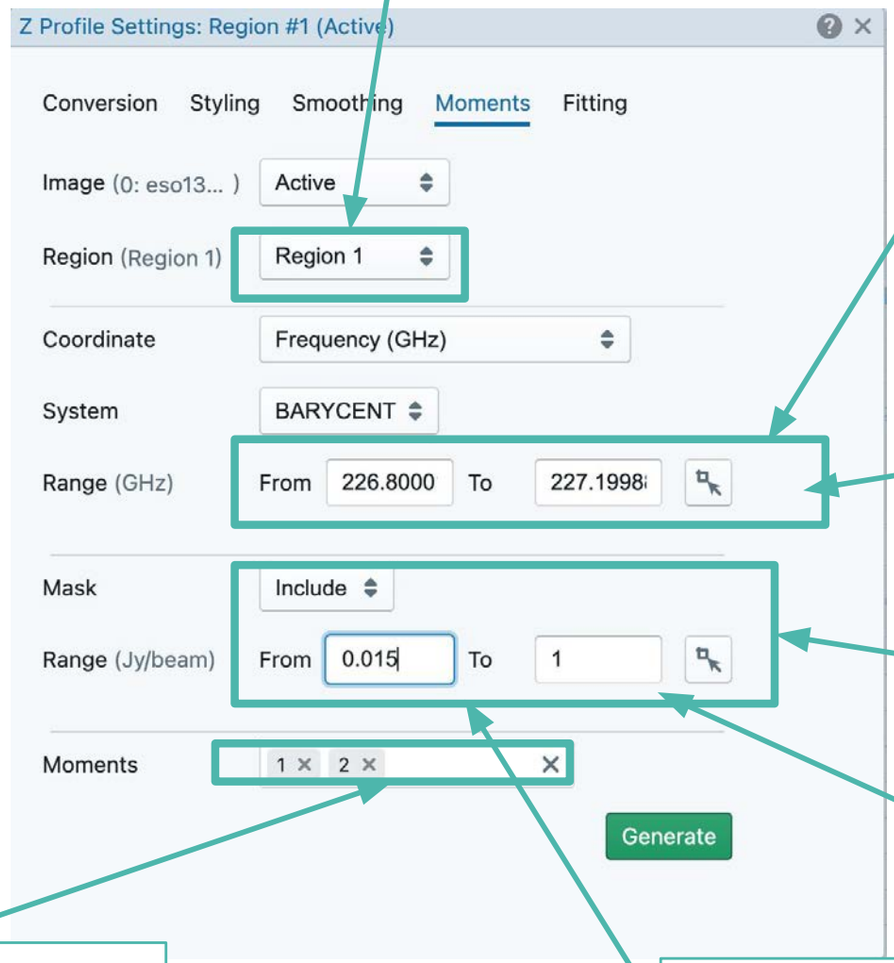
7: Absolute mean deviation of the spectrum

8: Maximum value of the spectrum

9: Coordinate of the maximum value of the spectrum

10: Minimum value of the spectrum

11: Coordinate of the minimum value of the spectrum



Choose Region

Select with the cursor

Choose frequency range

Choose Mask

Peak flux

Choose Moments

put 3xrms

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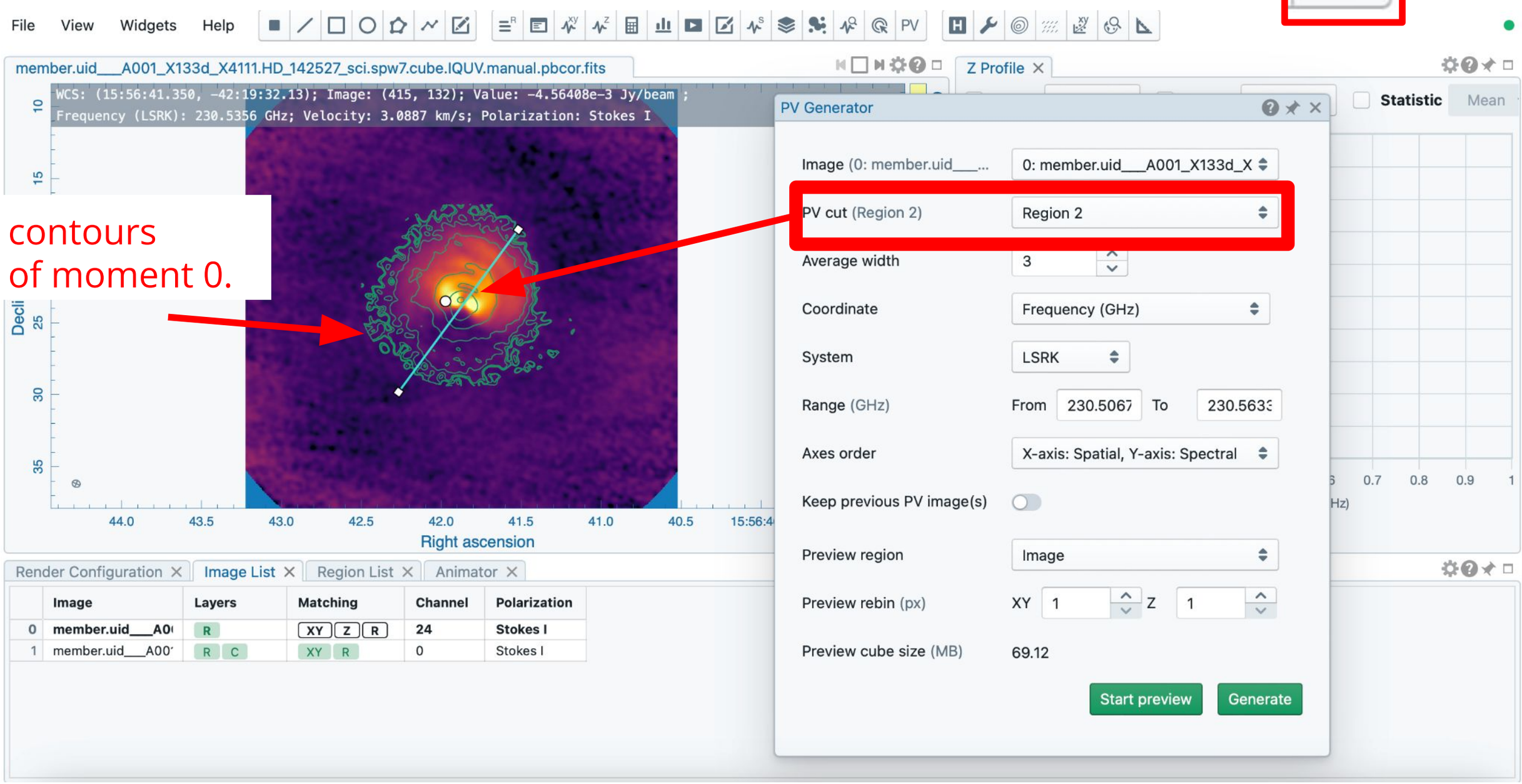
Position Velocity diagrams

PV



contours
of moment 0.

Stand-alone CARTA

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Practice
(5min + 2min Q&A)

- *eso137-0.CO21.image.pbcor
- Obtain different moment maps playing with different Z profile settings
- Extract fluxes
- Extract different PV diagrams

More on CARTA

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- cartavis.org
- I-TRAIN #12: CARTA tutorial
- EU ALMA school (presentation, materials)
  - Exercises on spectral line fitting
  - Catalogue interfaces
  - Polarization imaging analysis
- Comrie, Wang, Hsu, et al., (2018) https://ui.adsabs.harvard.edu/abs/2021zndo...3377984C/abstract