



Efficient image cube visualization with CARTA

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and
the CARTA development team



ASTRON
2020/03/16



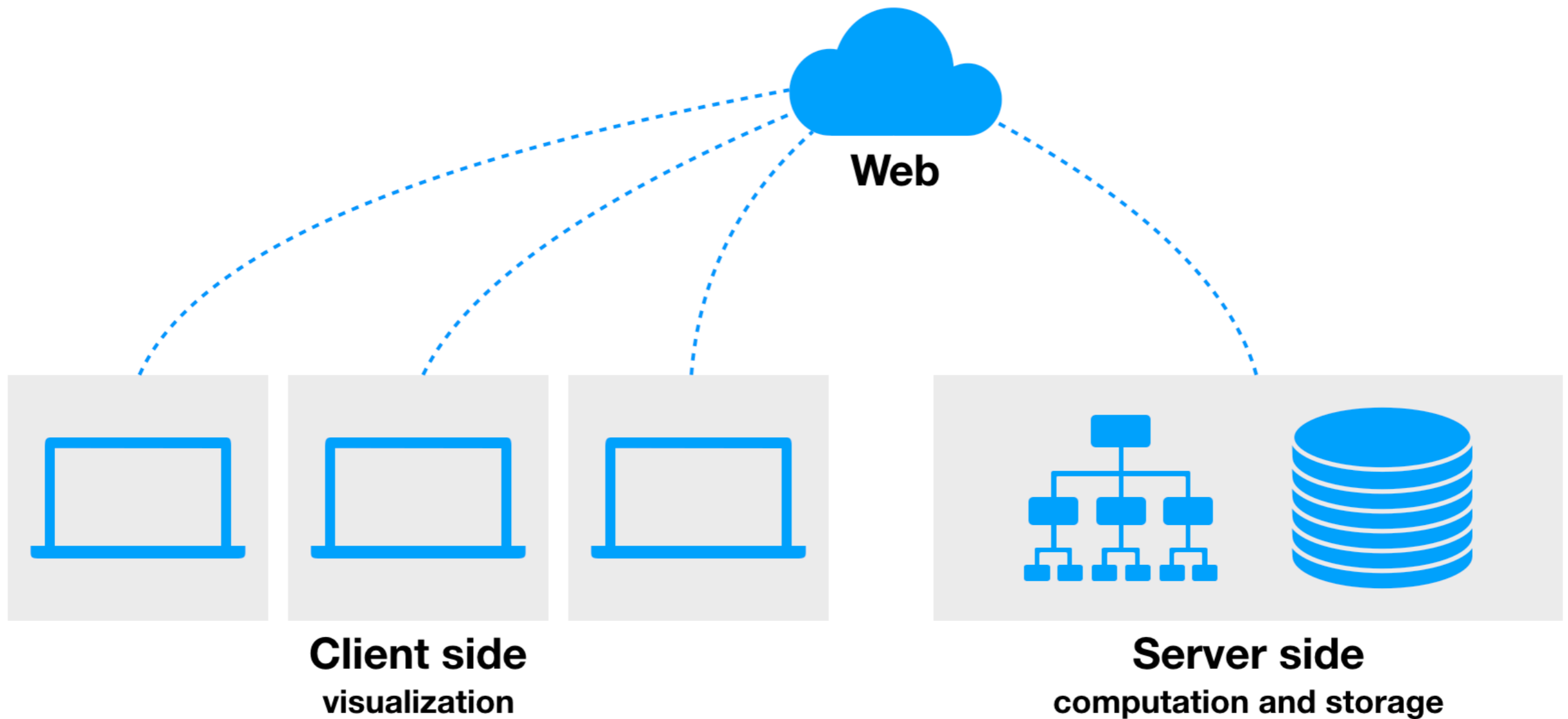


**Cube
Analysis and
Rendering
Tool for
Astronomy**

Goals

- Provide an efficient way to visualize and analyze large image cubes from ALMA, VLA, MeerKAT, and ASKAP, etc.
- Ensure scalability for future telescopes, such as ngVLA, SKA, JWST, LSST, etc.
- Provide pleasant user experience
- Serve as a next-generation image viewer of CASA
- Serve as a remote viewer of image archives (e.g., ALMA)

Client-server architecture





<https://www.gohawaii.com/de/islands/kauai/regions/south-shore/poipu-beach-park>

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CARTA team



- Frontend team
- Backend team
- Build, deploy, and test team
- Management team
- Science team

Releases and activities

- **v1.0: December 29th, 2018**

basic image and spectral/spatial

profile viewing capabilities



CARTA f2f meeting at Cape Town
January 23-29, 2019

- **v1.0.1: March 6th, 2019**

enhanced file browser

- **v1.1: May 2nd, 2019**

Initial support of ROI with tools for statistics, histogram, and spectral profile. Initial support of HDF5 image.

Initial support of server-side authentication. Command-line startup method (desktop).

Releases and activities

- **v1.2: August 28th, 2019**

New server authentication. Customizable and reusable user preferences and layouts. Tiled rendering. More ROI. Region import/export. New Stokes widget. HDF5 image support. Introducing enhanced profile delivery strategies.

- **v1.2.1: October 30, 2019**

ds9 region import/export, critical bug fixes.



CARTA f2f meeting at Socorro
November 12-16, 2019

- **v1.2.2: January 3, 2020 (latest release)**

Critical bug fixes.

- **v1.3: ~Late March, 2020**

Image overlay. Contour rendering.

- **v1.4: May-June, 2020**

Enhanced image overlay. Catalogue overlay.

Key features as of v1.2

- **Memory efficient:** With 1 GB of RAM, a 16000x16000 pixel image can be loaded quickly and a 16000x16000x1000(channel) image cube (1TB!) can be loaded quickly too.
- **Highly customizable and reusable GUI:** Plenty of GUI options including layouts are configurable and reusable to fit users' tastes.
- **GPU accelerated rendering at client side:** WebGL enabled.
- **Parallelization at server side:** I/O bounded threading control.

Key features as of v1.2

- **Responsive and progressive update of spectral profile:**
Once a region spectral profile is requested, CARTA updates partial profile to users shortly and the request is interruptible at any time.
- **Tiled rendering of raster image:** Image data are broken into tiles with multiple resolutions and delivered to the client side dynamically according to zoom level and screen resolution. Tiles are cached to reduce network usage.
- **Efficient visualization with HDF5 (IDIA schema) image:**
Acceleration with pre-calculated statistics and rotated image data.

Future functionality

v1.3 and beyond

- Image overlay, contour rendering
- Vector field rendering and marker rendering
- Catalogue support
- Spectral line analysis tools
- Fitting tools
- Moment generator
- PV generator
- Channel maps
- Multi-image view
- Volume rendering
- Collaboration tools
- Scripting interface (Python3)
- Three-color image blender
- Interactive clean with CASA
- Stokes analysis tool

Feature requests are very welcome!

Portals

- Homepage and download
<https://cartavis.github.io>
- User manual
<https://carta.readthedocs.io/en/latest/>
- Source code
<https://github.com/CARTAVIS>
- Feature request and Helpdesk
carta_helpdesk@asiaa.sinica.edu.tw
<https://github.com/CARTAVIS/carta/issues>
- DOI: [10.5281/zenodo.3377894](https://doi.org/10.5281/zenodo.3377894)



CARTA

Cube Analysis and Rendering Tool for Astronomy

DOI [10.5281/zenodo.3377984](https://doi.org/10.5281/zenodo.3377984)

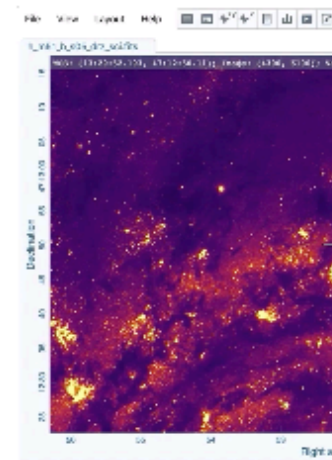
The CARTA team

CARTA is developed by
[Academia Sinica Institute of Astronomy and Astrophysics \(ASIAA\)](#)
[Inter-University Institute for Data Intensive Astronomy \(IDIA\)](#)
[National Radio Astronomy Observatory \(NRAO\)](#)
[Department of Physics, University of Alberta](#)



CARTA

CARTA is the Cube Analysis and Rendering Tool for Astronomy, providing visualization and analysis of astronomical data. It is designed to be user-friendly and easy to use, with a focus on providing usability and accessibility to a wide range of users. The tool is built using modern technologies and computing resources.



Download and Install

CARTA utilizes discrete operating systems. The CARTA Desktop 'local' version is available for download and installation on a computer directly connected to the internet.

- Local version 1.2 download
 - [macOS 10.13 10.14](#)
 - [RedHat 7](#)
 - [Ubuntu 16.04 LTS](#)

CARTA supports ...

- Desktop version: macOS, Ubuntu Linux and Redhat Enterprise Linux
 - Standalone App
 - Remote mode (much more efficient than ssh+x11 or vnc)
- Server version: Ubuntu Linux and Redhat Enterprise Linux
 - With authentication support
 - Supported web browser: Chrome, Safari, Firefox, Edge
- Image format: CASA, FITS, MIRIAD, HDF5 (IDIA schema)
 - Some performance...
 - Image loading: HDF5 > FITS = MIRIAD > CASA
 - Region spectral profile: HDF5 > CASA >> FITS = MIRIAD

Demo

File View Layout Help

M17_SWex.image

WCS: (18:20:22.23, -16:11:52.4); Image: (276, 444); Value: 8.72743e-2 Jy/beam;
 Frequency (LSRK): 86.7490 GHz; Velocity: 18.4400 km/s

Decination: 11:00, 30, 13:00

Right ascension: 26, 25, 24, 23, 22, 21, 18:20:20, 19, 18, 17

Z Profile: Region #1

Region: Region 1 | Statistic: Mean | Stokes: Current

Data: (86.748954 GHz, 2.53e-2)

Statistics: Region 1

Statistic	Value
NumPixels	6764 pixel(s)
Sum	1.7094e+2 Jy/beam
Mean	2.5272e-2 Jy/beam
StdDev	6.1038e-2 Jy/beam
Min	-6.0895e-2 Jy/beam
Max	2.2261e-1 Jy/beam
RMS	6.6059e-2 Jy/beam
SumSq	2.9516e+1 (Jy/beam) ²

X Profile: Cursor

Data: (276 px, 8.73e-2)

Z Profile: Region #2 (Selected)

Region: Region 2 | Statistic: Mean | Stokes: Current

Data: (86.748954 GHz, 1.25e-2)

Histogram: Region 2 (Selected)

Y Profile: Cursor

Data: (444 px, 8.73e-2)

Render Configuration

90% 95% 99% 99.5% 99.9% 99.95% 99.99% 100% Custom

Cursor: 0.27 Jy/beam

Histogram

Per-Channel

Scaling: Linear

Color map:

Invert color map:

Clip Min: -0.064197

Clip Max: 0.1821850!

Apply Contours Clear

Region List

Name	Type	Pixel Center	Size (px)	P.A. (deg)
Cursor	Point	(276.0, 444.0)		0.0
Region 1	Rectangle	(264.0, 457.4)	(89.2 × 76.0)	0.0
Region 2	Polygon	(322.3, 344.4)	(76.1 × 107.2)	0.0

Animator

Frame rate: 5

Channel:

Req: 10; Current: 10

Download CARTA

<https://cartavis.github.io>

