CARTA: Cube Analysis and Rendering Tool for Astronomy

Jürgen Ott[1] & the CARTA team

[1]National Radio Astronomy Observatory, Socorro, NM, USA; jott@nrao.edu

CARTA is the "*Cube Analysis and Rendering Tool for Astronomy*", a new image visualization and analysis tool designed for the ALMA, VLA, SKA pathfinders, and the ngVLA. The mission of CARTA is to provide usability and scalability for the future by utilizing modern web technologies and computing parallelization. To account for large images that are hosted remotely, CARTA applies a remote server approach that is accessible from a local web-based client. A desktop version bundles the server-client structure in a single application. Our focus on performance is reflected in short, progressive loading times, with only seconds to load TB sized multi-dimensional image cubes (FITS, CASA, MIRIAD, HDF5-IDIA). The current version of CARTA (v.1.2) includes flexible coordinate transformations of images, image statistics and histograms, spatial and spectral profiles, cube animators and Stokes analysis, regions of interest and configurable layouts. World-coordinate support for image overlays and a scripting language are some of the core functionalities that are currently under development.

CARTA is a collaboration of the Academia Sinica (ASIAA), Taiwan, the Inter-University Institute for Data Intensive Astronomy (IDIA), South Africa, the National Radio Astronomy Observatory (NRAO), USA, and the University of Alberta, Canada. The CARTA homepage is available at **https://cartavis.github.io** (doi: 10.5281/zenodo.3377984).

Architecture and Performance

CARTA has a server-client structure, where the server (backend) is responsible for computation and I/O that can be launched close to the location of the images. Several clients (frontends), providing the visualization, can be opened in local browsers that connect to the backend via the web. This flexible design is ideal for data repositories such as large image archives. The design also allows for future, additional features such as collaboration modes, where multiple users can share the exact same layout and data and interact with the same CARTA backend. We also offer a desktop version that bundles the frontend and backend in a standalone image viewer.

CARTA is Built for Performance

TB images can be loaded in a matter of seconds. This is achieved by a multi-threaded backend and WebGL on the frontend side for GPU accelerated rendering. Image displays are compressed tiles that are dynamically updated when the respective image portions are in the field of view.
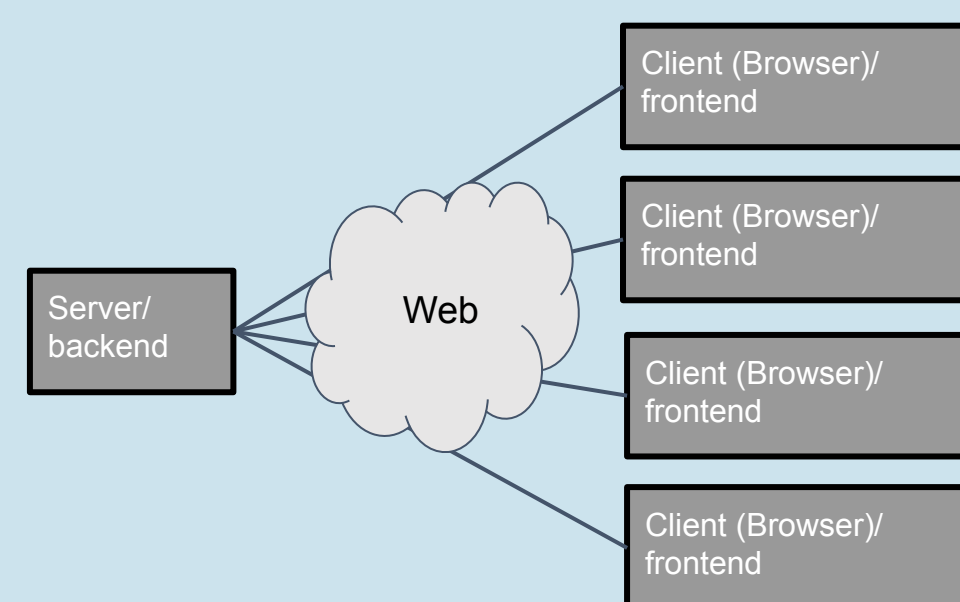
CARTA Applications

CARTA will be integrated in the IDIA SKA-precursor, NRAO, and ALMA archives and the CASA interferometric data reduction package. It will also be used for future ngVLA applications.

Development Path

upcoming v 1.3/1.4 (spring 2020)
- Multiple image overlays with full World Coordinate System (WCS) support (initial implementation v 1.3; full implementation in v 1.4)
- Contour images
- Catalog overlays
- Session resuming

v 1.5 (mid 2020)
- Moment generator
- Position-Velocity cuts
- Profile smoothing
- Zoom to position by input of coordinates and frequency/velocity
- Spectral fitting
- Cutouts and download
- Distance measure tool
- Viewing rotated cubes

Widgets

CARTA is based on individual widgets in the browser client that communicate with each other. Widgets can be opened, closed, moved, docked, floated, and tabbed. A new addition is a Stokes cube analysis widget to display spectral polarization properties of cubes.
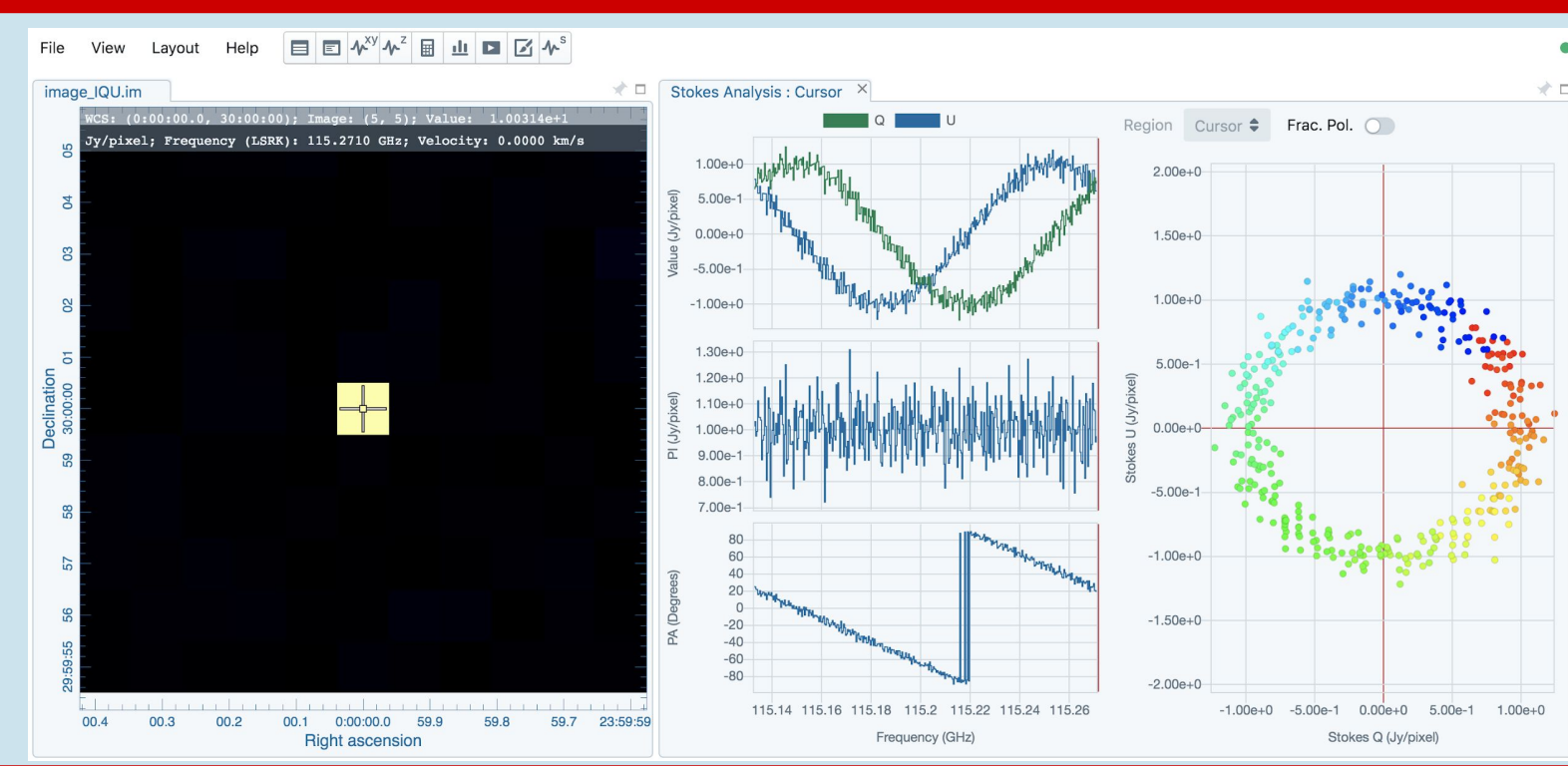
Preferences

CARTA can save and restore widget configurations, light and dark modes, colormap, scaling, and labeling preferences. Performance setting such as tiling and compression levels can also be set.

Profiles

Spectral and spatial profiles can be displayed with optional RMS levels, cursor position as vertical line, multiple axes, and styles. The profiles can be saved as data files or png.

Open a new widget

Widgets can float in front

Widgets can be tabbed

Region statistics

Spatial Profile

Spectral Profile

Flexible coordinate system overlay (here: Equatorial grid on a GALACTIC image

Rotated elliptical, rectangular, polygon, and cursor regions

Region histograms

Widgets can be docked at different positions

Region creation, pan, zoom, grid, label, save as png

Histogram and clip level setting

Colormap and scaling functions

Region list

Animator for images, planes, Stokes

https://cartavis.github.io