



Extending the 3D capabilities of the CASA viewer



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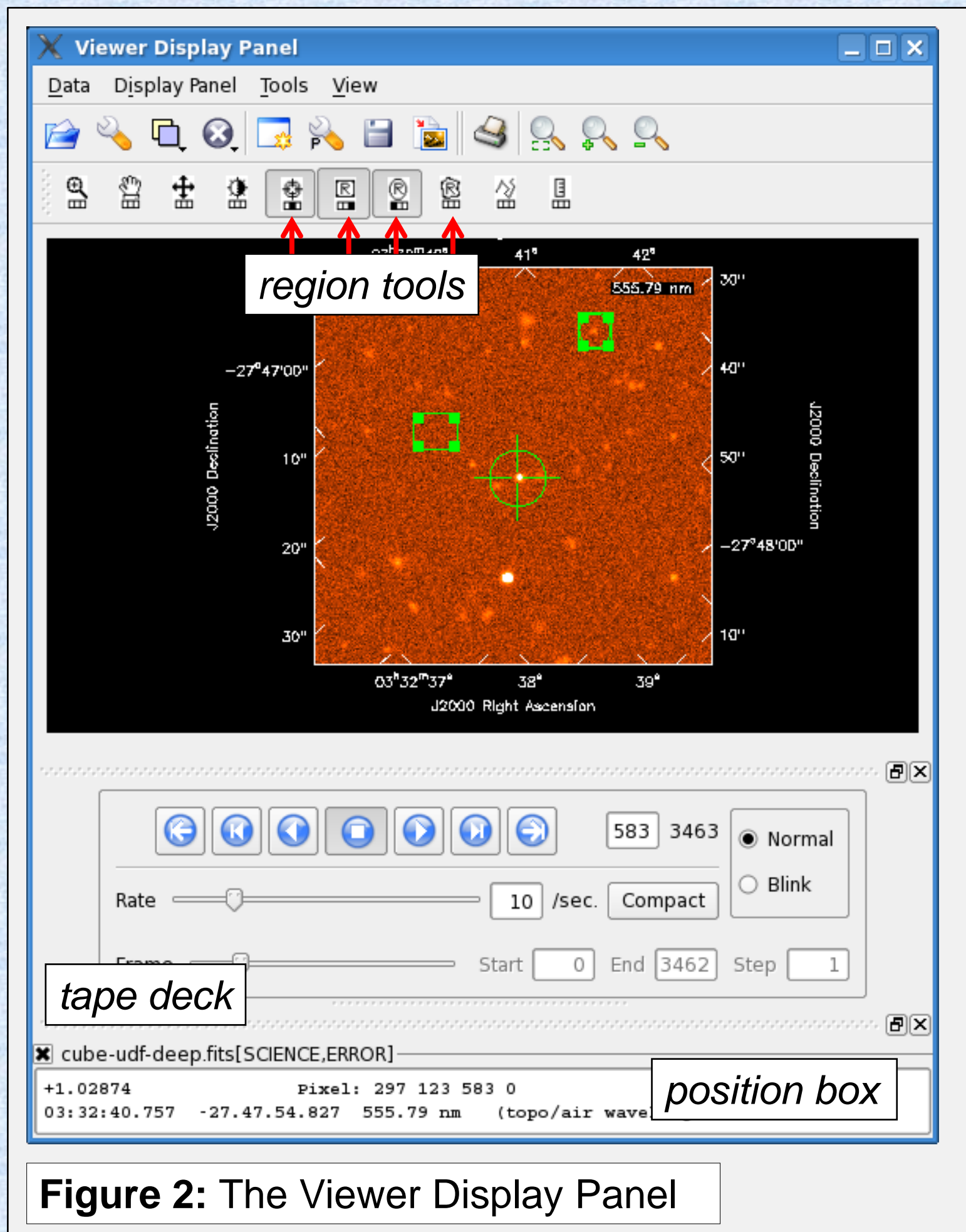
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Abstract

The majority of present and future ESO facilities, such as the VLT, ALMA and the E-ELT, feature instruments which produce datacubes (i.e., 2 spatial, 1 wavelength/frequency dimension). In this context, the need for an ESO based visualization tool capable of handling datacubes was identified. Rather than starting a new application from scratch, it was decided to develop this visualization tool as part of the CASA software to extend its capabilities. Handling data that is augmented with a pixel-to-pixel error and data quality information is an important requirement for the visualization tool, and we have defined a format to store such data in a single FITS file. We present the current status of the project and give an outlook of future developments.

1. CASA and the CASA viewer

CASA, the Common Astronomy Software Applications package, is being developed with the primary goal of supporting the data processing of the next generation of radio astronomical telescopes such as EVLA and ALMA (see <http://casa.nrao.edu/> and poster 114 by D. Petry). The CASA infrastructure consists of a set of C++ tools bundled together under an iPython interface as a set of data reduction tasks. The CASA viewer can be used from within the iPython interface, but also as an independent application. The viewer uses the cross-platform widget library Qt (<http://qt.nokia.com/products>). Figure 1 shows the various viewer windows when working with 3D data cubes. The functionality of the “Viewer Display Panel”, the “Load Data”, the “Data Display Options” and the “Image Profile” windows are further explained in Figures 2-5, with an emphasis on the contributions from this project. The viewer described here is part of the CASA 3.3 release (http://casa.nrao.edu/casa_obtaining.shtml)



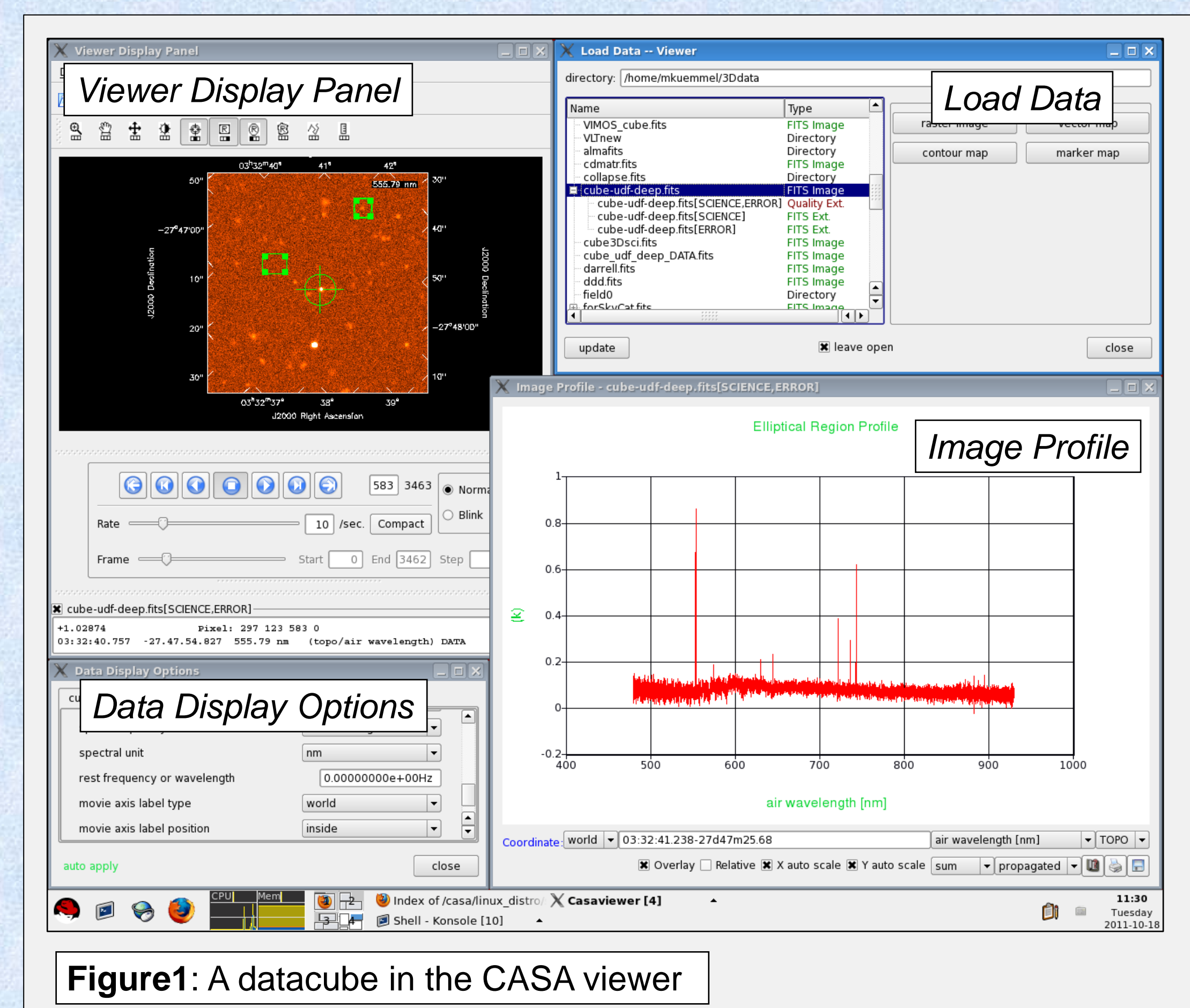
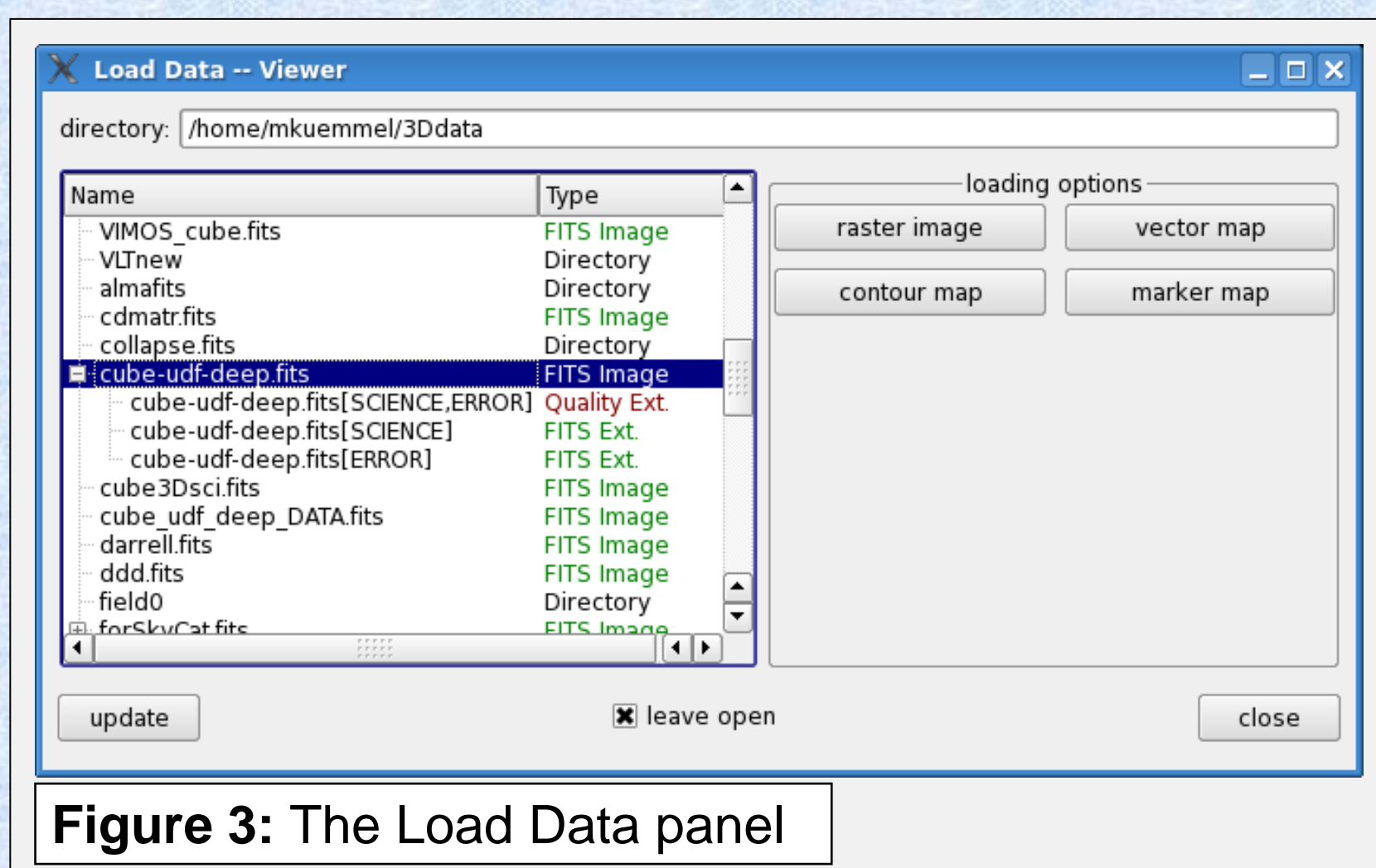
2. Viewer Display Panel

Figure 2 shows the **Viewer Display Panel** with a datacube loaded. The two spatial dimensions (Right Ascension and Declination) are in the xy-plane, the spectral dimension is along the z-direction. For datacubes:

- The “tape deck” provides movements along the spectral axis. Individual channels can be selected via a slider or via direct input.
- The “position box” shows the values of individual pixels and their position (the lattice and absolute coordinates)
- Several “region tools” allow to mark areas of different shape (point, rectangle, ellipse, polygon). The spectral profile in these regions is shown in the “Image Profiler”

3. Load Data

Figure 3 shows the **Load Data** window. The user can select images in various formats (FITS, CASA image) to be displayed in the main window. We have developed a FITS format description to store datacubes that have in addition to the science data also pixel-by-pixel error values and data quality information. In this format, science data, error and quality information is stored in separate extensions of the same FITS file. Special keywords point from each type of data to the corresponding other extensions, e.g. from the science data extension to the error extension and the data quality extension. This FITS format is already implemented in the CASA viewer. In the example shown the science data and associated error in image “cube-udf-deep.fits” can be loaded together (marked as “[SCIENCE,ERROR]”) in order to access the data and error for display and processing (error propagation). Alternatively, each extension can be loaded separately.



4. Data Display Options

Figure 4 show the **Data Display Options** window. The options set therein control the display of the data in the Main Window. Important options for datacubes include:

- Minimum and maximum cut levels
- For datacubes with errors: switch between displaying the data or the error
- Changing the units (wavelength or frequency or velocity)
- Select between wavelength and air wavelength or between radio velocity and optical velocity
- Adding or changing the rest frequency/wavelength to allow velocity units

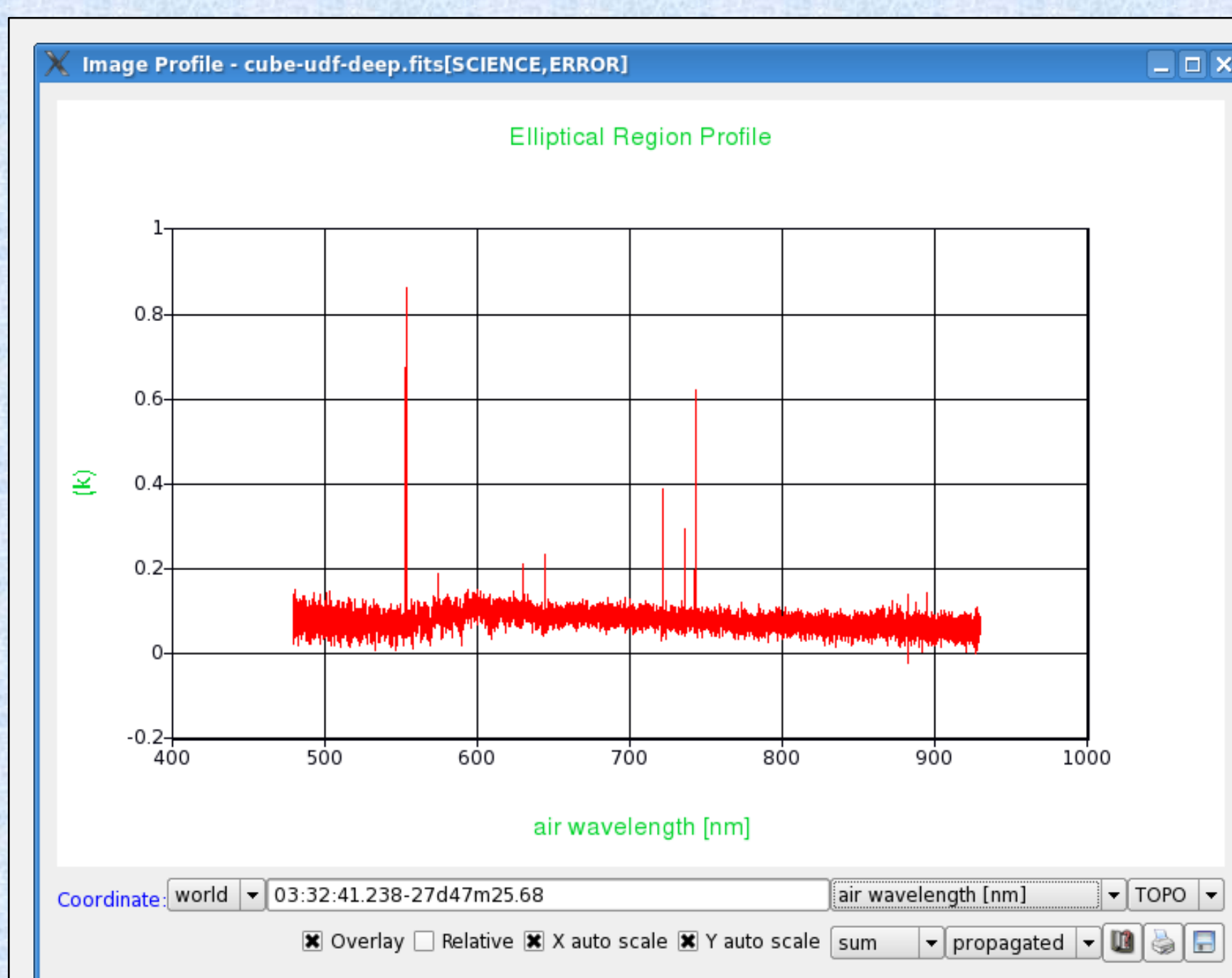
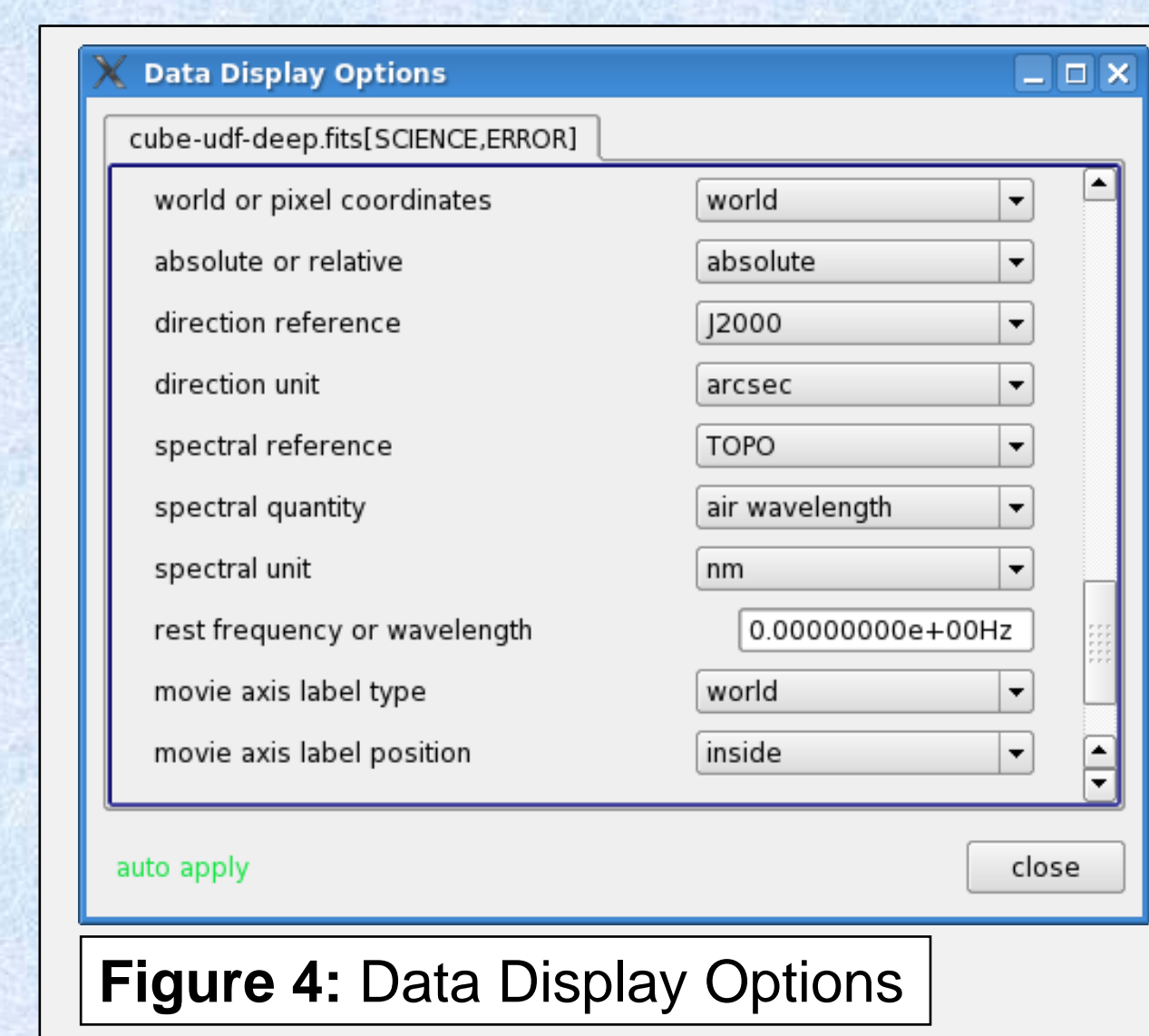


Figure 5: The Image Profile Window

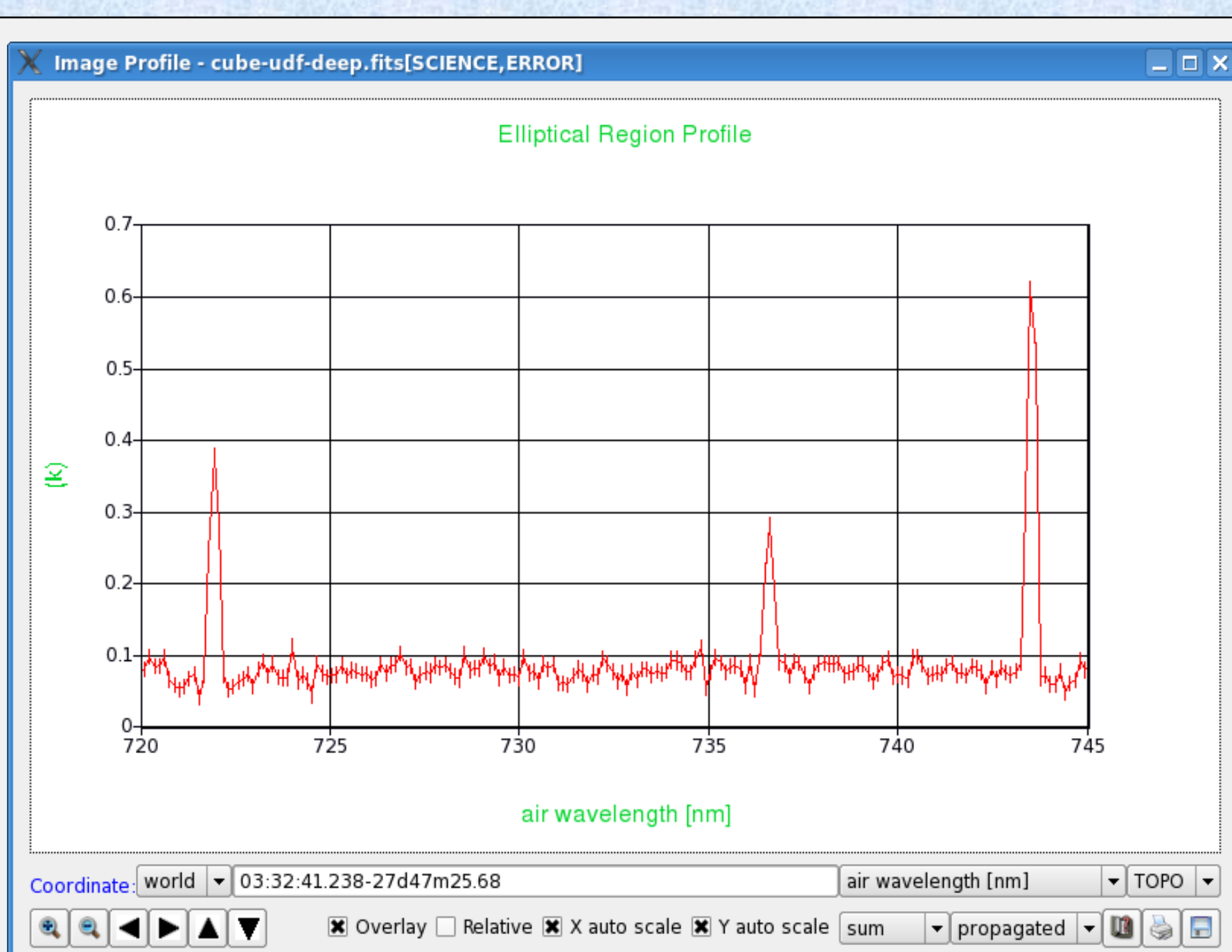


Figure 6: The Image Profile Window (zoomed)

5. Image Profile

Figure 5 shows the **Image Profile** window with a spectrum extracted from an elliptical region selected interactively in the Viewer Display Panel. For regions, the combine types “mean”, “median” and “sum” are supported. The Image Profiler can plot error bars, as can be seen in Figure 6. For datacubes with errors, the error bars are computed from the error values. As an alternative for region extractions, also the “root mean squared error” within the region can be plotted as error bars. As shown in Figure 6, user can interactively define zoom levels with the mouse and browse between the zoom levels or move in the xy-plane with arrow buttons.

6. Outlook

The next requirements to be implemented in the CASA viewer to improve its 3D capabilities are:

- Generation of 2D reconstructed images over a user-defined wavelength range
- Spectral line fitting (in the Image Profiler)
- 2D Gaussian fitting in the image plane (in the Viewer Display Panel)
- Export of operation results

For a live demonstration, please come to the ESO demo (D1)!