The Journal of Open Source Software

GRISView: A Python package for visualization of GRIS spectro-polarimetric data

Taras Yakobchuk [1]

1 Leibniz-Institut fuer Sonnenphysik, Freiburg, Germany

DOI: 10.xxxxxx/draft

Software

- Review
- Repository
- Archive

Editor: Axel Donath

Reviewers:

- @dstansby
- @wtbarnes

Submitted: 27 March 2023
Published: unpublished

Summary

GRISView is a visualization and analysis tool created to facilitate working with spectro-polarimetric data obtained with the GREGOR telescope at the Observatorio del Teide (Tenerife) using the GRIS instrument. It is written in Python and has a GUI made using PyQt5 cross-platform framework (*PyQt*, n.d.) and PyQt-based plotting package PyQtGraph (*PyQtGraph*, n.d.). The program provides easy access for specialists as well as non-expert users to calibrated science-ready data cubes in a format distributed through the Science Data Center (SDC) archive website at https://archive.sdc.leibniz-kis.de/. GRISView includes the following features: - Advanced view, pan and zoom controls for map images and spectra, different viewing modes and layouts for plots - POI (Point-of-Interest) and ROI (Region-of-Interest) for easy inspection and comparison of multiple spectra across the map images - Colorbars with interactive histograms to adjust map images' contrast and customize color schemes - Measures to calculate distances between given map points in different units using included WCS (World Coordinate System) information - Contour generation for map images with easy level adjustment and colors selection - Multiple profile cut plots along given map directions - Browsing spectra using the mouse and keyboard shortcuts, labeling and quick navigation through spectral lines and user-defined markers - Relative scale for simple wavelength difference measurement for spectra - Building plot for input and derived parameters, fitting and normalization of spectra to user-defined quiet Sun continuum - Importing inversion results, showing maps for obtained physical parameters and checking the quality of the fits - Exporting spectra and map plots as images suitable for publication, presentation etc. - Saving and restoring working sessions - Quick view and search through data files metadata - Built-in manual describing program panels and features

The Journal of Open Source Software

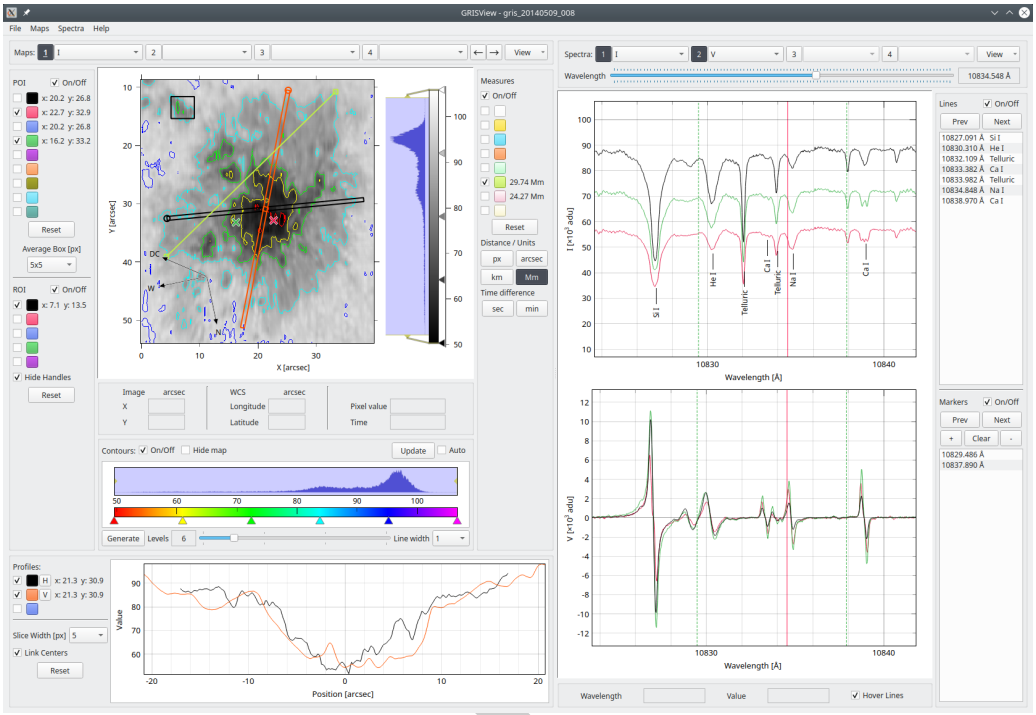

Figure 1: GRISView GUI main window.

Figure 1 illustrates the main window of the program. The left section is used for plotting maps, while spectra are displayed on the right. The GUI of the program has a wide range of customization options. The visibility of most panels and graphical elements can be toggled on and off. The relative width of the main sections can be adjusted, increasing useable working space and allowing the user to set the size aspect ratio for the export. One can enable up to 4 parameters at a time and display plots in a side-by-side layout or in one-by-one mode, with keyboard shortcuts for quick switching and comparison. A separate dialog window lists all keyboard and mouse shortcuts.

Statement of Need

Solar physics research requires not only advanced instrumentation but also software tools to view and analyze incoming data. The GREGOR telescope is one of the largest solar telescopes in the world with a 1.5-meter primary mirror, observing the Sun in visible, ultraviolet, and infrared light (Schmidt et al., 2012). GREGOR is equipped with several instruments, including the GREGOR Infrared Spectrograph (GRIS) (Collados et al., 2012), which provides high-resolution spectra of the Sun's chromosphere and transition region. Visualization of its multidimensional data cubes stored in multiple files can be a challenging task. Typically, researchers write their own code using packages like *matplotlib* in Python or generic viewers that often do not support specific instrument data structures and are not suitable for efficient interactive analysis. In the case of the GRIS spectro-polarimetric data, the data cube has four dimensions: two spatial coordinates, the wavelength and the 4 Stokes parameters, measuring the polarisation of the incoming light. For time series observations, time, as another dimension, comes on top. As a result, exploring data cubes that are more than 3-D can be slow, problematic and not thorough enough. Previously a proprietary in-house software called CASSDA GUI, written in IDL, provided functionality to visualize, correct and analyze GRIS data. However, the IDL-based GUI, apart from being pretty slow, required a valid IDL license and the installation of additional third-party software. As a result, it was decided to create a new tool with better usability that would be fast, cross-platform and open-source. GRISView was developed to meet these

requirements and is fully compatible with GRIS data of all observation modes as distributed by SDC. It can meet the needs of a wide range of users, from students to researchers. In the future, we would like to extend GRIS to support solar spectro-polarimetric imaging data from other instruments, such as IBIS@DST, HINODE SOT/SP, IRIS and VTF@DKIST in the future.

References

Collados, M., López, R., Páez, E., Hernández, E., Reyes, M., Calcines, A., Ballesteros, E., Díaz, J. J., Denker, C., Lagg, A., Schlichenmaier, R., Schmidt, W., Solanki, S. K., Strassmeier, K. G., Lühe, O. von der, & Volkmer, R. (2012). GRIS: The GREGOR infrared spectrograph. *Astronomische Nachrichten*, *333*(9), 872–879. https://doi.org/https://doi.org/10.1002/asna.201211738

PyQt: Python bindings for the qt company's qt application framework. (n.d.). https://riverbankcomputing.com/software/pyqt/download

PyQtGraph: Scientific graphics and GUI library for python. (n.d.). https://www.pyqtgraph.org/

Schmidt, W., Lühe, O. von der, Volkmer, R., Denker, C., Solanki, S. K., Balthasar, H., Bello González, N., Berkefeld, Th., Collados, M., Fischer, A., Halbgewachs, C., Heidecke, F., Hofmann, A., Kneer, F., Lagg, A., Nicklas, H., Popow, E., Puschmann, K. G., Schmidt, D., … Waldmann, T. A. (2012). The 1.5 meter solar telescope GREGOR. *Astronomische Nachrichten*, *333*(9), 796–809. https://doi.org/https://doi.org/10.1002/asna.201211725