

FITS Extractor – Quick User Guide

This short manual describes how to use the FITS Extractor tool for batch extraction and interpolation of spectra from FITS binary tables. It assumes the reader is already familiar with standard FITS formats.

1. Start the application

Run the command

```
python fits_extractor.py
```

to execute the script. The graphical interface will open automatically. The script requires some non-standard python packages to be installed. To install them, run the command

```
pip install -r requirements.txt
```

in the according directory or install the required packages by yourself. Check the provided “requirements.txt” file for information about the packages you need to install.

2. Load FITS files or directories

Drag and drop a FITS file or a directory containing multiple FITS files into the drop area. The application shows the number of files and total size as well as the file or directory path.

3. Load column key values

Click “**Load Key Values**” to scan the FITS files for available binary table columns. Detected column names will populate the dropdown boxes on the right-hand side. This process can take some time. Column names are featured in the dropdown boxes as soon as one of the provided FITS files features such a column.

4. Select the relevant FITS keys

From the dropdown boxes, select the columns corresponding to wavelength, flux, and flux error. Optionally, enable and select continuum or status columns if your data includes them.

FITS files with altering column names cannot be read by the application and will be skipped.

5. Optional: Filtering using STATUS key

Check “Use status key” to enabling filtering the data by status. Provide a STATUS key that consists of 0/1 values for every flux value. If the value is 0, the flux value is set to 0 and effectively discarded. A status value of 1 leaves the flux value unchanged.

6. Optional: Interpolation (*recommended*)

Check “Interpolate Values” to resample the spectrum onto a uniform wavelength grid. Flux and flux error values are interpolated via linear interpolation. If continuum extraction is enabled, continuum values are also interpolated.

If interpolation is disabled, raw wavelength, flux and flux error values are used.

7. Optional: Normalization

Check “Perform Normalization” to normalize the spectrum while extracting. Spectra can be normalized in two ways:

- Normalization with respect to maximum flux value: The normalization scales the flux values by dividing them by a representative maximum flux value, calculated as the median flux within a small window around the true peak. This ensures that outliers or noise do not dominate the normalization process. The flux errors are adjusted accordingly, maintaining proper error propagation. Maximum Normalization is performed when no CONTINUUM key is provided. Please note that normalization is automatically skipped if the flux maximum is negative, as this indicates invalid or inverted flux values.
- Normalization with respect to continuum value: The normalization scales the flux values by dividing them by the respective continuum value. Flux error values are propagated accordingly. Continuum Normalization is performed when enabling the CONTINUUM key. Please note that normalization is automatically skipped if continuum and flux values differ in sign or length.

If normalization is disabled, the extracted flux values will remain in their original scale.

8. Optional: Plotting

Check “Plot Extracted Spectra” to view a matplotlib preview for each extracted spectrum. The preview will show after each extracted spectrum, essentially stalling the workflow until it is closed.

9. Extract spectra

Click “**Extract .fits Spectra**”. Each file is processed sequentially. The tool performs the following steps:

1. Reads wavelength, flux, and error arrays from the FITS binary table.
2. Optionally filters data using the STATUS key.
3. Optionally interpolates the data to a uniform wavelength grid using linear interpolation.
4. Optionally normalizes the data in one of the supported ways as explained above.
5. Creates new FITS Primary HDUs for flux and flux error.
6. Writes both files into the subfolder 'extracted/'.

10. Output Files

Two files per input FITS are created:

- `_[interp]_[stat]_[c][normX]_spec.fits` – the interpolated spectrum
- `_[interp]_[stat]_[c][normX]_err.fits` – the interpolated flux error

The file names consist of the input file name, the object name as stated in the FITS header, a five-letter identifier, and the ending explained above, each separated by an underscore.

If interpolation is performed, the output file will include “*interp*”. If status filtering is enabled by selecting a status key, the output file name will include “*stat*”. Likewise, if maximum normalization is performed, the file name will contain “*normX*”, where X ranges from 0 to 2. A value of 0 indicates successful normalization, while 1 or 2 denote issues that caused normalization to be skipped. Continuum normalization is denoted by “*cnormX*”.

If an input file is skipped, no output files will be created. Files are skipped for one of three reasons, each throwing their own unique error message in the console:

- “warn: File is not compatible!” – The input file is not a FITS file.
- “err: File is not loading correctly!” – The FITS data cannot be read from the file, likely due to a corrupted file.
- “err: File throws error when extracting!” – The FITS file does not meet the previously set binary table column requirements.

Additional Notes

Pressing the “**Show Files**” button will show the file names of all input files for easy verification that the right files are loaded into the application.

After successfully extracting all spectra, the application will close automatically.

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Designed for rapid spectrum extraction and normalization.

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