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An Interactive 2D Plotting Tool for MCNP Tally Data Visualization

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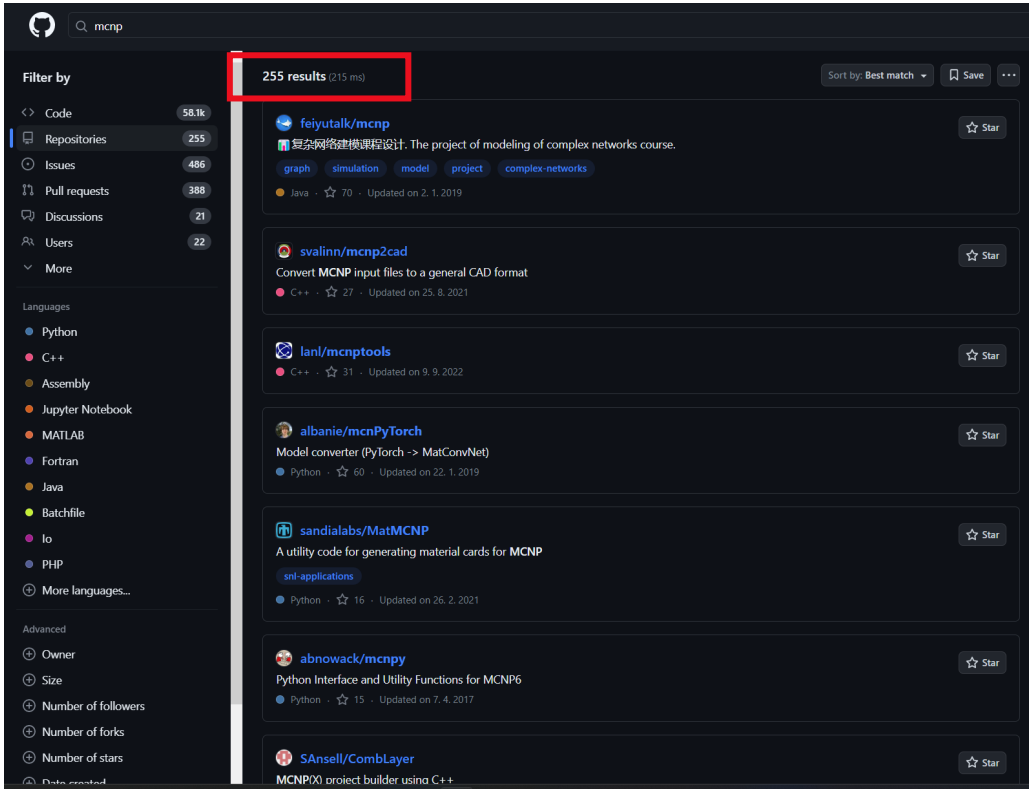
Content:

1. Introduction and motivation
2. Code structure
3. Description of the Graphical User Interface
4. Conclusion

Motivation and Introduction

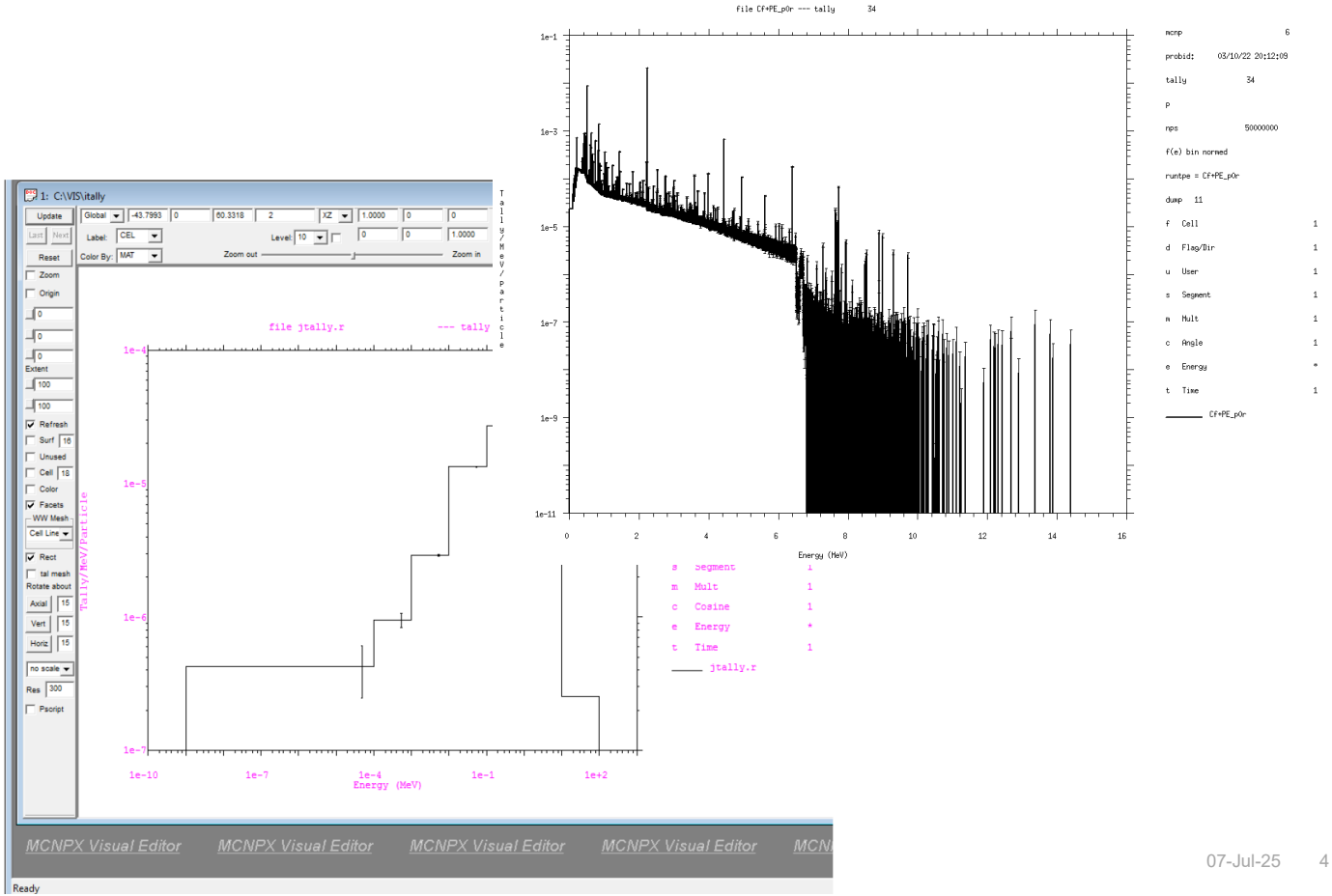
- Need to analyze and compare large number of results from one or multiple files
- Inspired by a variety of tools available on GitHub => over 255 repositories with “MCNP” in the name (e.g., MCNP Tools, PyNE, etc.)
- Various output formats: *OUTPUT* × *RUNTPE* × *MCTAL* × *MDATA* × *MESHTAL*
- Open-source approach



Available MCNP tally plotting tools

MCPLOT (built-in tool):
- Terminal-based
- Old interface
- **Universal** and **powerful**
- Successor possibly in – MCNP 6.4.0?

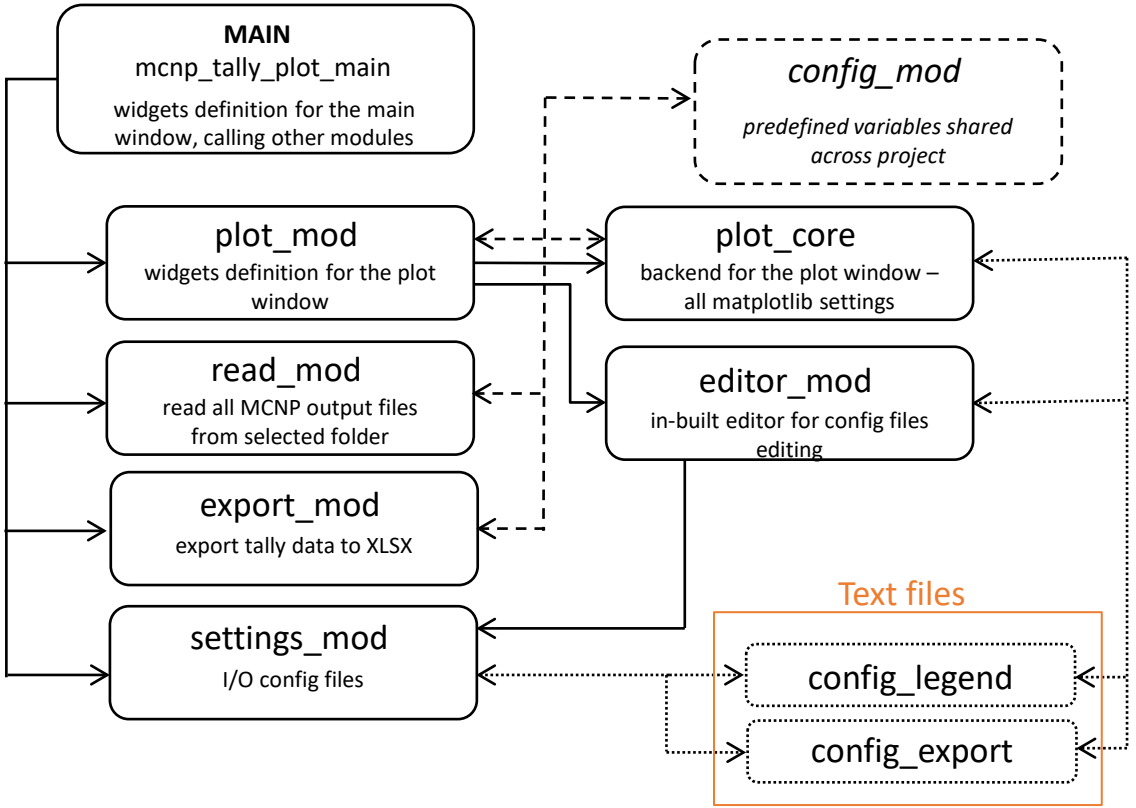
Other options:
- Dedicated SW
  - Vised (not fully compatible with MCNP6.2 and newer)
  - Attila4MC + Tecplot – for Unstructured Mesh
  - ParaView – for FMESH, Unstructured Mesh
- Universal plotting SW
  - MS Excel
  - Origin
  - Gnuplot
- Custom Scripts



Setup - project details, code structure

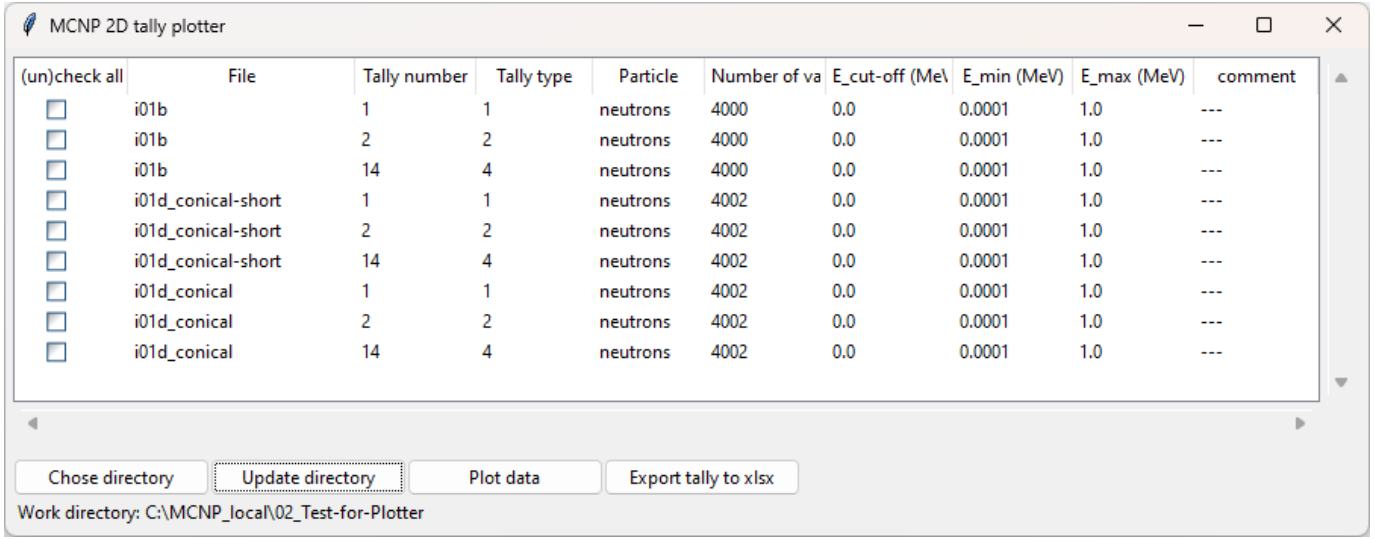
Language and packages

- Python 3
- Tkinter GUI environment + **ttkwidgets** extension (shallower learning curve than Qt)
- Other common modules:
  - **matplotlib** – plotting
  - **pandas** + **openpyxl** – data export
  - default Python 3 packages
- **pyinstaller** – simple and fast compiling
- virtual environments – **Conda** and **venv**
- Tested on Windows 11, Linux Mint (Ubuntu) 22.1, macOS 15 Sequoia



Plotter description – Main window

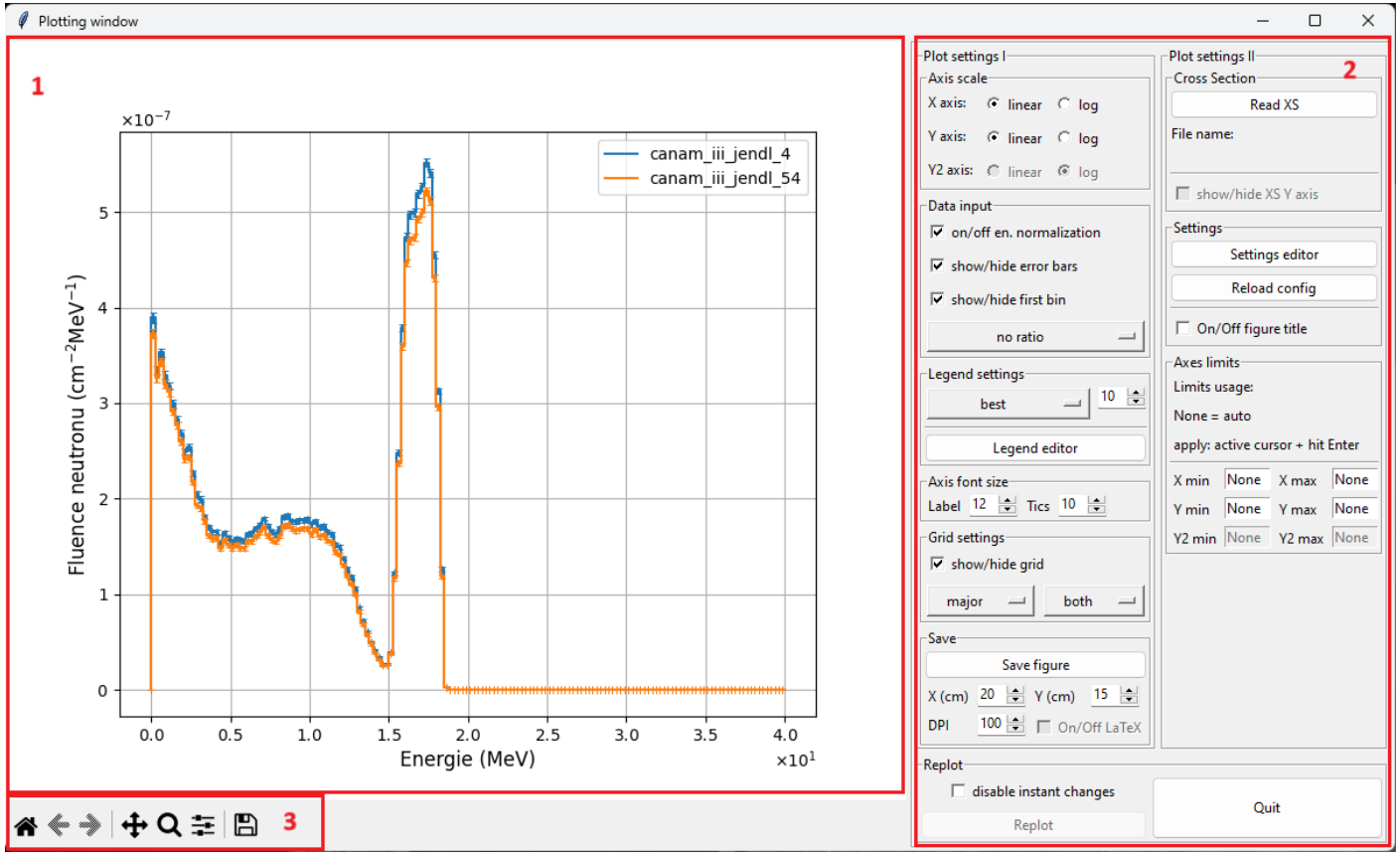
1. Set a **work directory** with **MCNP output files** (ignores hidden MS/Linux/Mac files, nested folders and all non **output** files)
   a) Pick up results from latest dump
   b) Display key information: file name, tally number and type, number of values, E_{cut}, E_{min}, E_{max} and comments
   c) Sort results by columns
2. Processing
   a) Plot selected tally
   b) Export selected tally to .xlsx file



Plotter description – Plot window

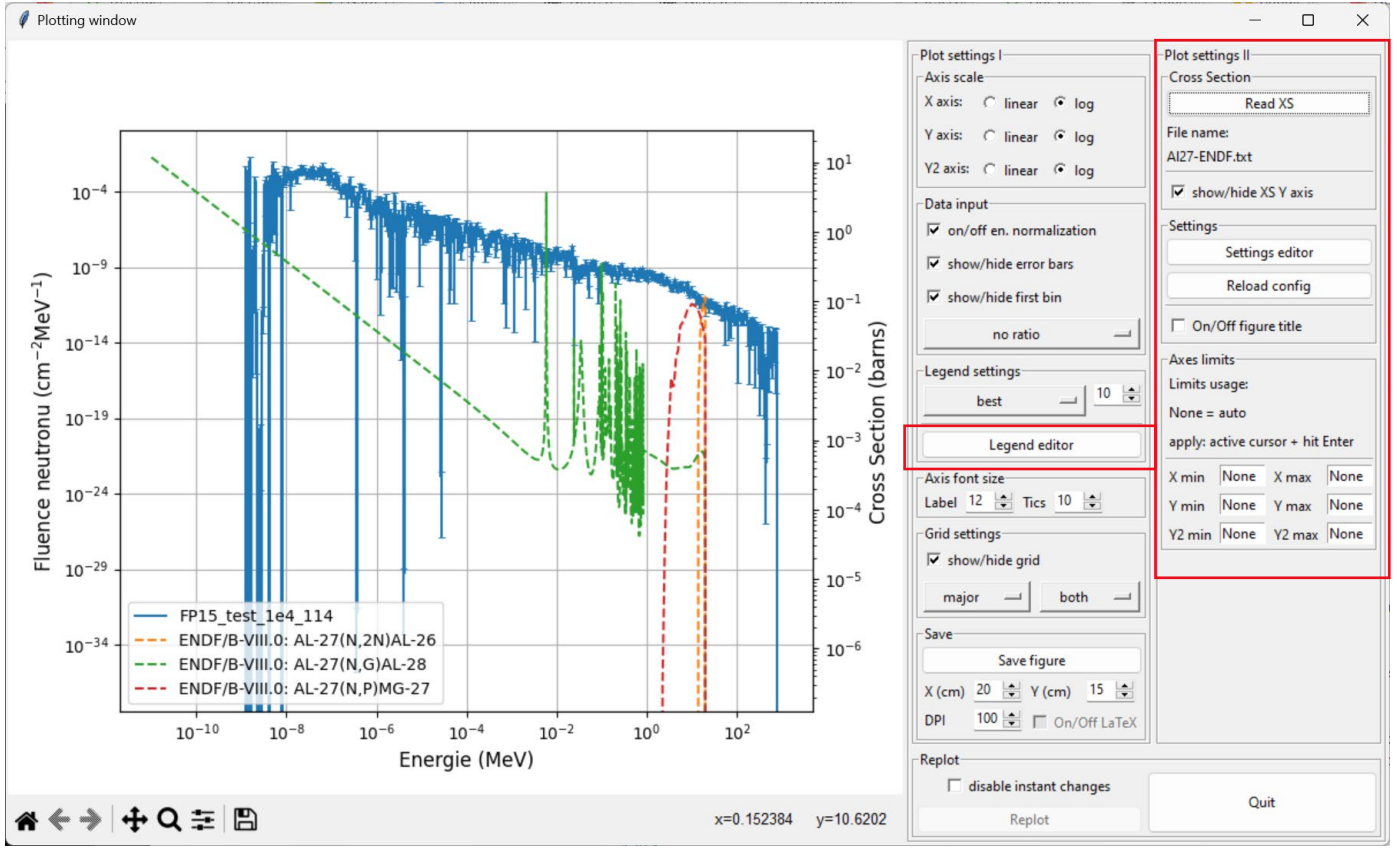
1. Plot window
2. Plot settings
   - Scale, Limits
   - Data manipulation (error bars, **Ratio plots**, etc.)
   - Styling and labels (titles, legend, font size, grid, etc.)
   - Plot export
3. Plot toolbar
   - Reset
   - Undo/Redo
   - Move/Zoom
   - Alignment and spacing
   - Save

- Automatic vs. Manual replotting



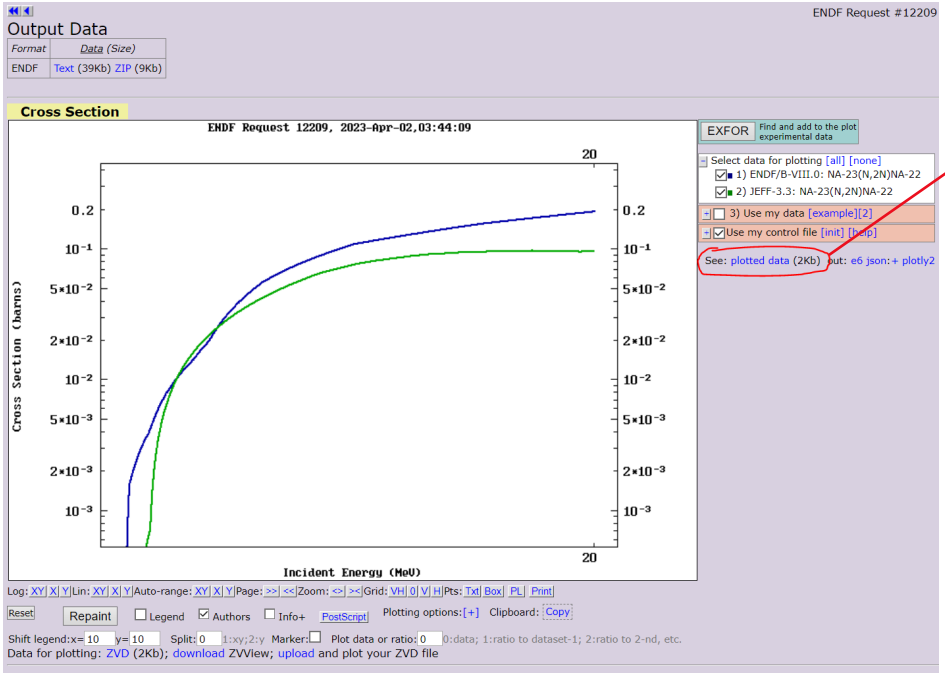
Plotter description – additional settings, XS

- Cross Sections – suports adding a pointwise XS on secondary Y axis
- Config file editor – additional settings without widgets + settings storage, e.g. plot title, axes titles
- Axes min./max. limits – default: Auto
- Tally name (legend) editor – allows setting more descriptive names to each tally



Plotter description – source of XS data

- Added for simple and fast comparison with XS data
- Simple solution using pointwise **plotted data** from ENDF database
- XS selection is based on text file modification

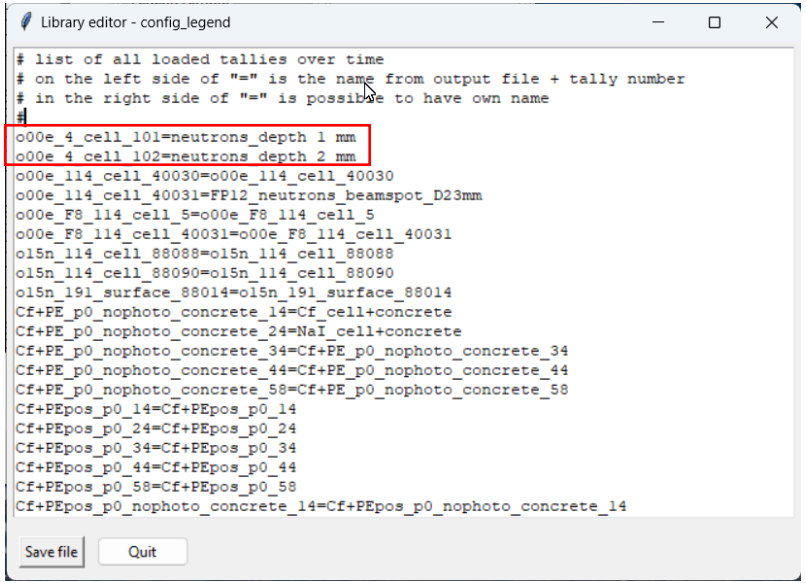


XS selection is activated by removing „#“ from the line containing dataset name in the text file:

```
#ZVview-data-copy:   2-Apr-2023 03:44:09
#=====================================
#
#name:   ENDF/B-VIII.0: NA-23(N,2N)NA-22
#X.axis: Incident Energy
#Y.axis: Cross Section
#wdata:  2
#ldata:  12
#data...
#            X           Y
#          MeV        barns
         12.95           0
           13      0.0016
        13.24       0.004
        13.46       0.008
        13.79      0.0142
           14        0.02
         14.4        0.04
        14.71       0.056
           15      0.0684
           16       0.109
           18       0.156
           20       0.194
//
#-------------------------------------------------------------------------------
#
#name:   JEFF-3.3: NA-23(N,2N)NA-22
#X.axis: Incident Energy
#Y.axis: Cross Section
#wdata:  2
#ldata:  17
#data...
#            X           Y
#          MeV        barns
       13.0518           0
```

Plotter description – config files

- In-built editor enables quick editing of configuration files
- **config_legend** – stores all tally names from current and old output files with user-defined names used in the plot legend
- **config_export** – stores plotter settings and allows modify plot features that are not available via the GUI (e.g. axes and plot titles, etc.)



Conclusion

- Provides fast, easy comparison of multiple MCNP tallies directly from output files
- Tested with tallies as F1, F2, F4, F5
- Supports quick and easy data export (XLSX, plot figures)
- Remembers recent working and export folders
- Available on GitHub: https://github.com/dusankr/MCNP_TallyPlotter

Potential future work and improvements:

- Broader testing and validation
- Restore plot configuration from previous session
- Add support for HDF5 formatted MCNP run files
- Log files implementation for error tracking
- Expand plot customization features
- Compile with Nuitka for faster, standalone executables
- Allow user to select from all dump histories and view corresponding NPS
- Add support for ACE/ENDF toolkits

Thank you for your attention