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**Title:** An Interactive 2D Plotting Tool for MCNP Tally Data Visualization

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# An Interactive 2D Plotting Tool for MCNP Tally Data Visualization

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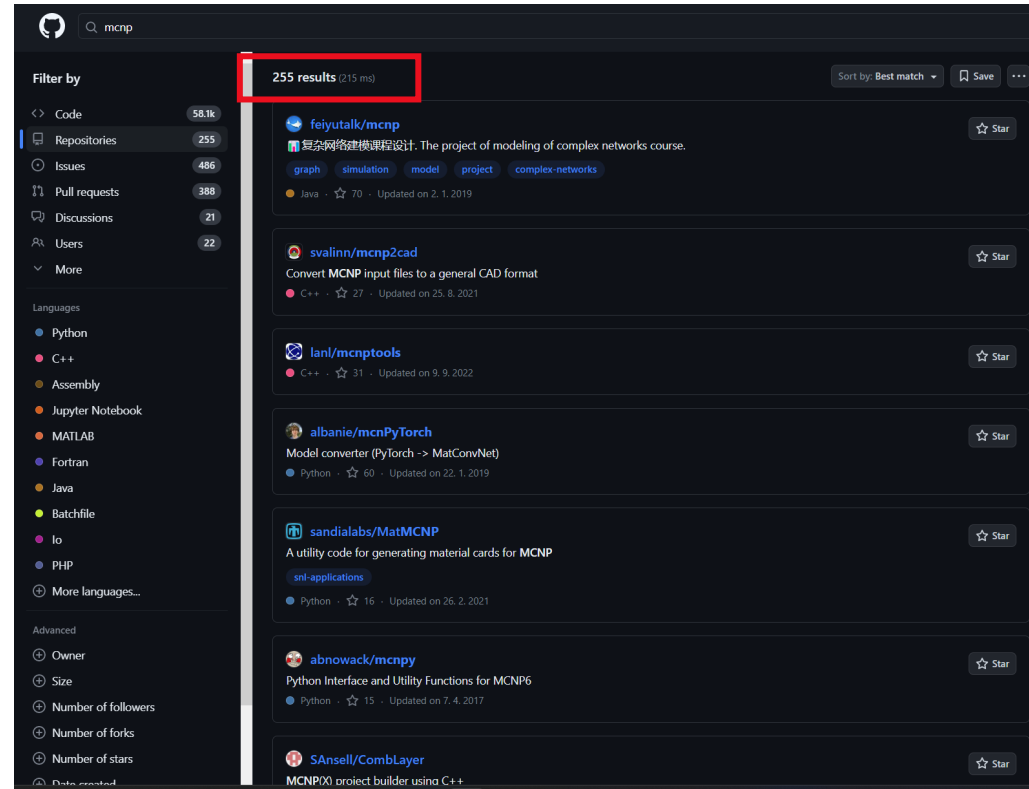
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# Content:

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



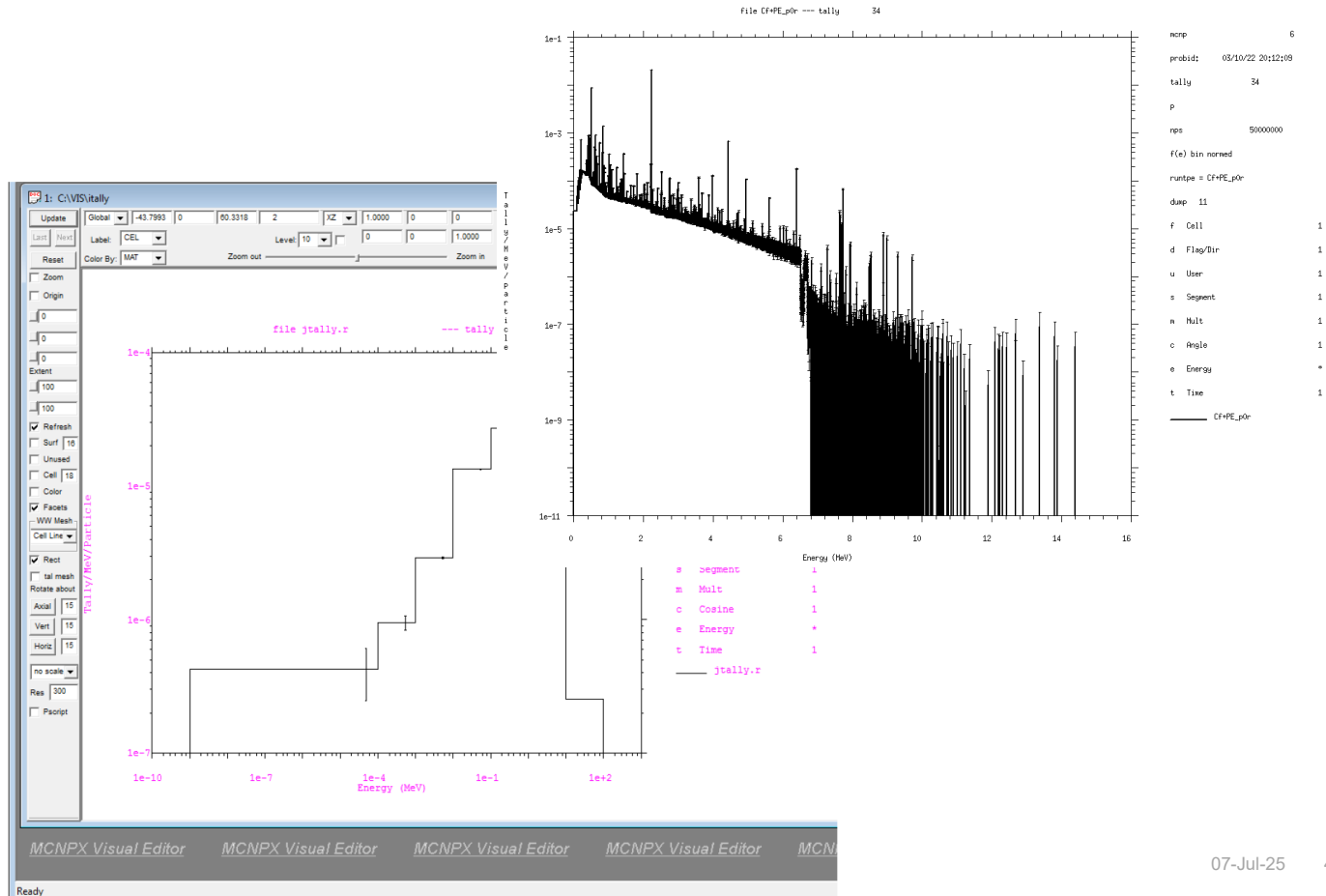
# Available MCNP tally plotting tools

## MCNPLOT (built-in tool):

- Terminal-based
- Old interface
- **Universal** and **powerful**
- Successor possibly in – MCNP 6.4.0?

## Other options:

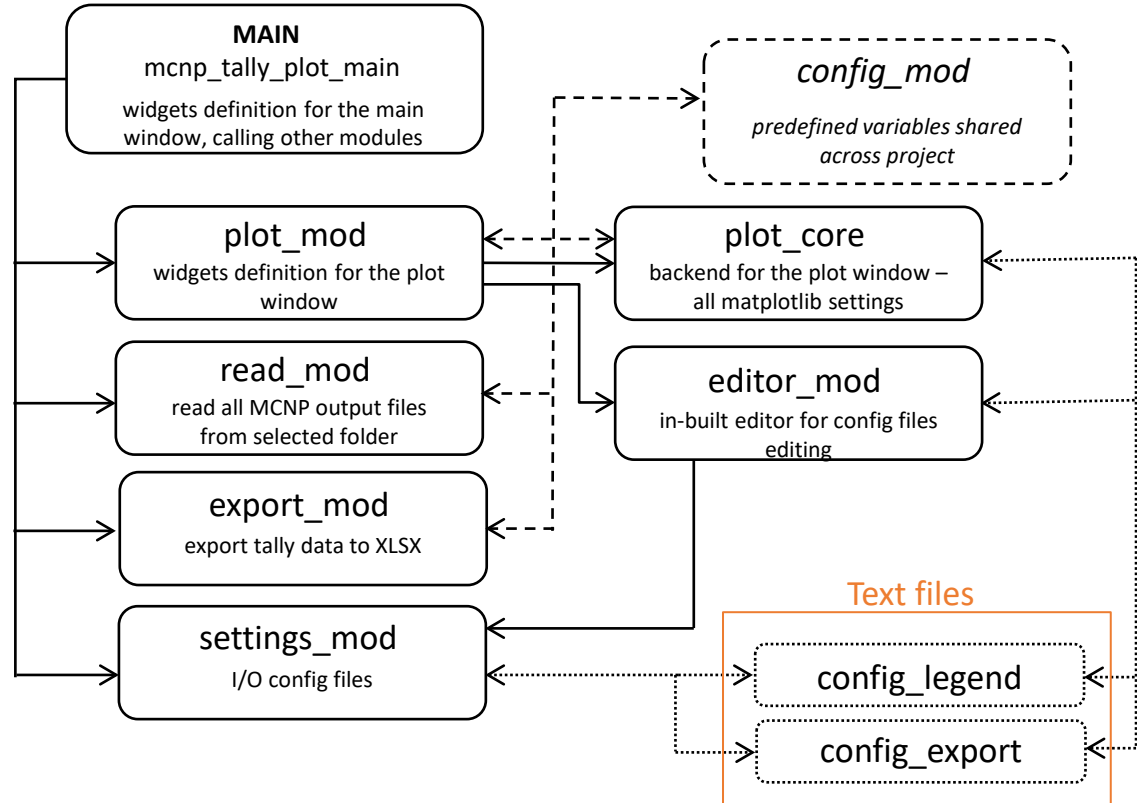
- Dedicated SW
  - VisEd (not fully compatible with MCNP6.2 and newer)
  - Attila4MC + Tecplot – for Unstructured Mesh
  - ParaView – for FMESH, Unstructured Mesh
- Universal plotting SW
  - MS Excel
  - Origin
  - Gnuplot
- Custom Scripts



# Setup - project details, code structure

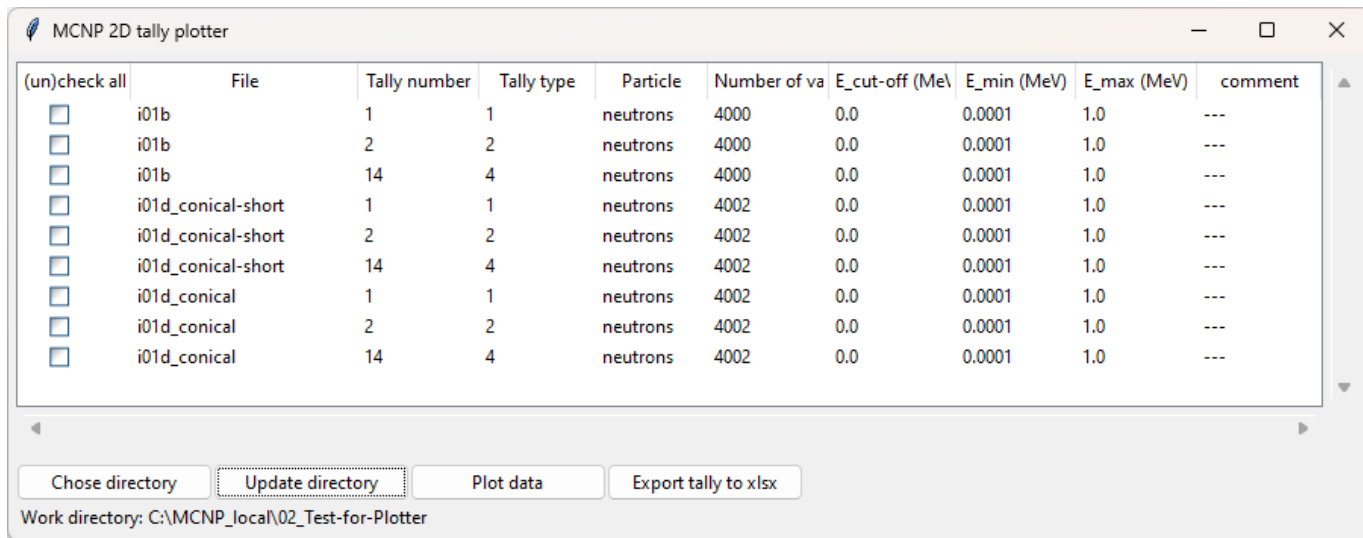
## Language and packages

- 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,  $E_{\text{cut}}$ ,  $E_{\text{min}}$ ,  $E_{\text{max}}$  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

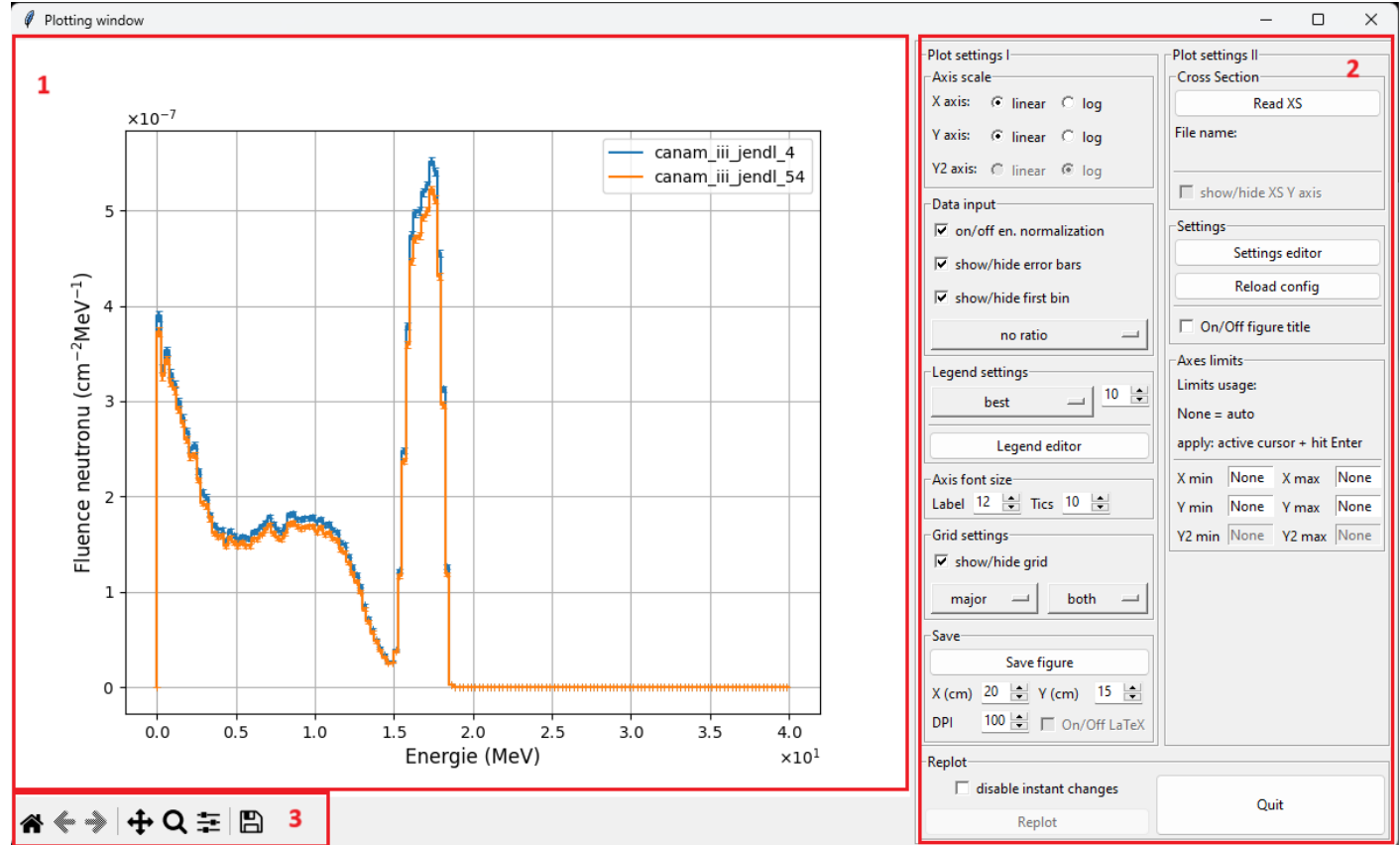
## 2. Plot settings

- Scale, Limits
- Data manipulation (error bars, **Ratio plots**, etc.)
- Styling and labels (titles, legend, font size, grid, etc.)
- Plot export

## 3. Plot toolbar

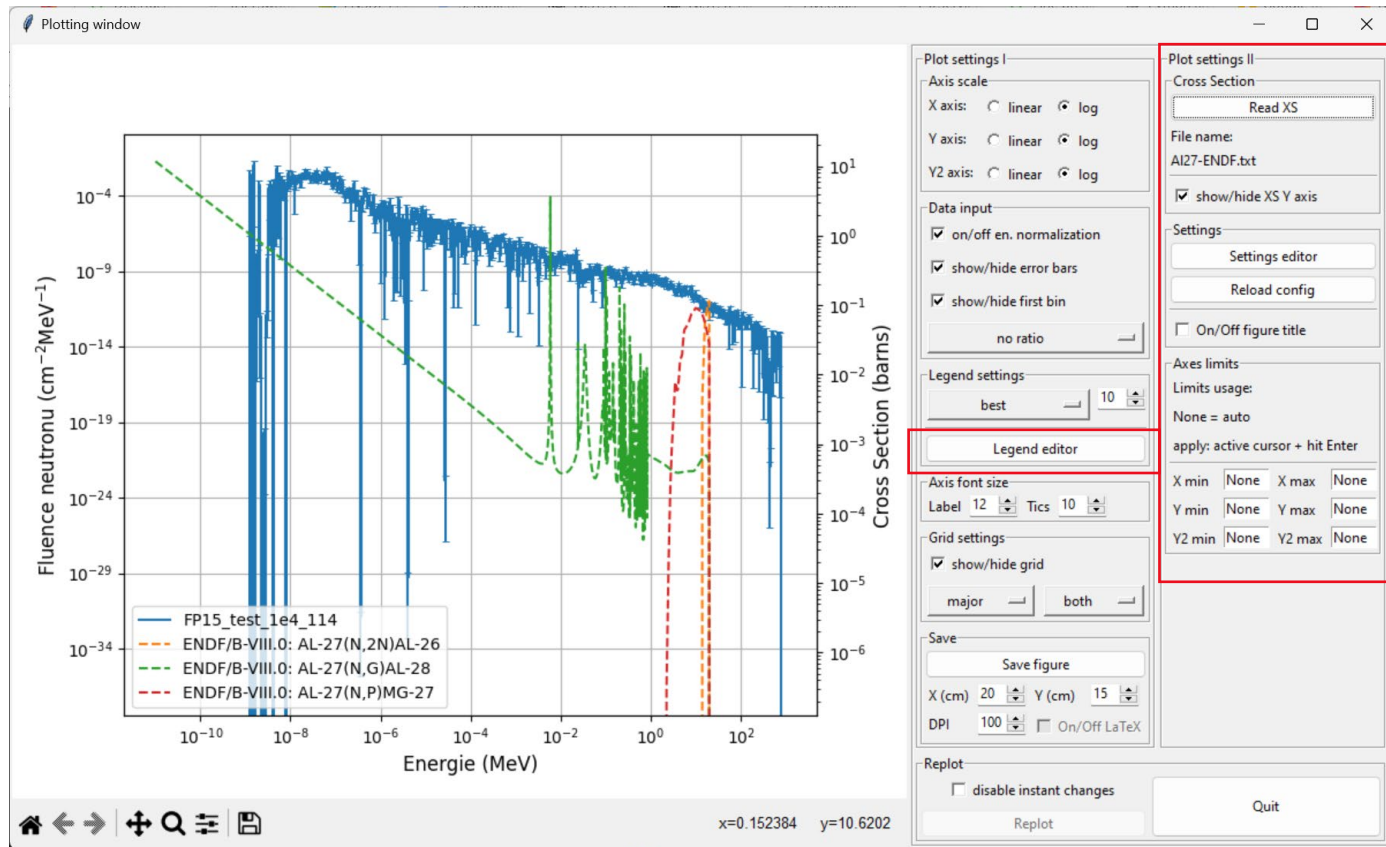
- Reset
- Undo/Redo
- Move/Zoom
- Alignment and spacing
- Save

- Automatic vs. Manual replotting



# Plotter description – additional settings, XS

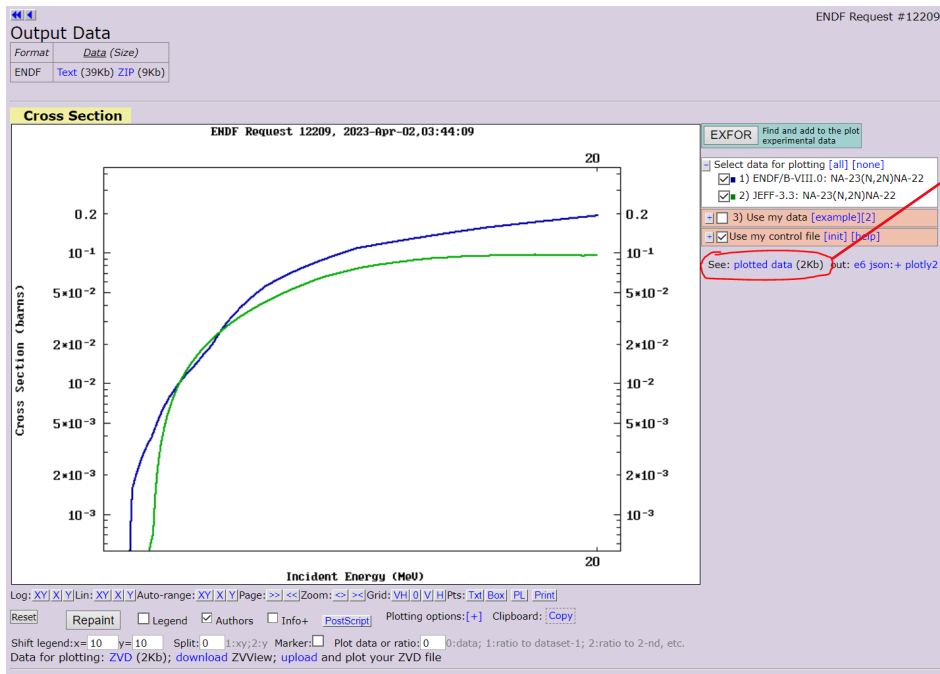
- Cross Sections – supports adding a pointwise XS on secondary Y axis
- Config file editor – additional settings without widgets + settings storage, e.g. plot title, axes titles
- Axes min./max. limits – default: Auto
- Tally name (legend) editor – allows setting more descriptive names to each tally



# 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

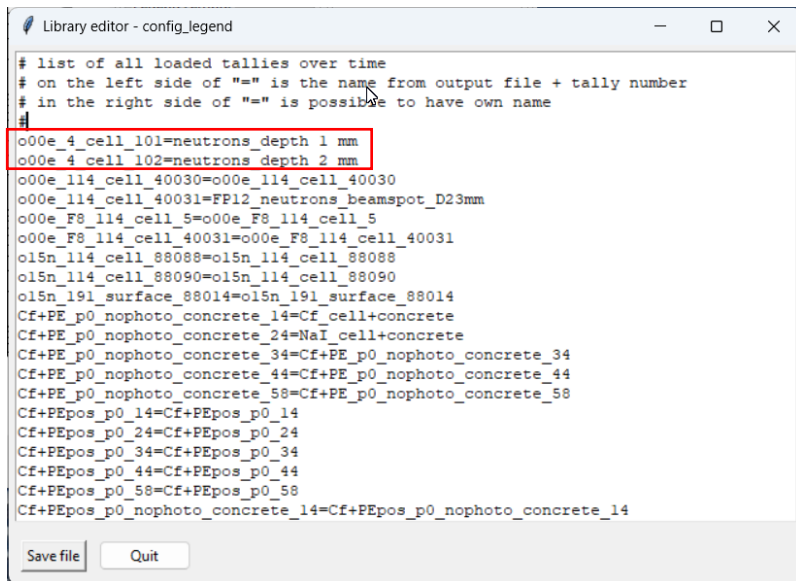
XS selection is activated by removing „#“ from the line containing dataset name in the text file:



```
#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.)



```
# list of all loaded tallies over time
# on the left side of "=" is the name from output file + tally number
# in the right side of "=" is possible to have own name
#
o00e_4_cell_101=neutrons_depth 1 mm
o00e_4_cell_102=neutrons_depth 2 mm
o00e_114_cell_40030=o00e_114_cell_40030
o00e_114_cell_40031=FP12_neutrons_beamspot_D23mm
o00e_F8_114_cell_5=o00e_F8_114_cell_5
o00e_F8_114_cell_40031=o00e_F8_114_cell_40031
o15n_114_cell_88088=o15n_114_cell_88088
o15n_114_cell_88090=o15n_114_cell_88090
o15n_191_surface_88014=o15n_191_surface_88014
Cf+PE_p0_nophoto_concrete_14=Cf_cell+concrete
Cf+PE_p0_nophoto_concrete_24=NaI_cell+concrete
Cf+PE_p0_nophoto_concrete_34=Cf+PE_p0_nophoto_concrete_34
Cf+PE_p0_nophoto_concrete_44=Cf+PE_p0_nophoto_concrete_44
Cf+PE_p0_nophoto_concrete_58=Cf+PE_p0_nophoto_concrete_58
Cf+PEpos_p0_14=Cf+PEpos_p0_14
Cf+PEpos_p0_24=Cf+PEpos_p0_24
Cf+PEpos_p0_34=Cf+PEpos_p0_34
Cf+PEpos_p0_44=Cf+PEpos_p0_44
Cf+PEpos_p0_58=Cf+PEpos_p0_58
Cf+PEpos_p0_nophoto_concrete_14=Cf+PEpos_p0_nophoto_concrete_14
```



```
# hashtag is used for commenting
# = is used as separator, spaces are not allowed between setting and value!
# at the end of file must be empty line
# for the return of default value type <None>
# upper/lower index in plot labels works with <$><$>
# e.g. $text {lower index}$ $text^{(upper index)}$
#
# initial mcnp output directory
work_dir_path=C:\Users\dusan\Desktop\test_plotter\josef_uranium
# initial export directory
export_dir_path=C:\Users\dusan\Desktop\test_plotter
# initial XS dir
xs_dir_path=C:\Users\dusan\Desktop\test_plotter\josef_uranium
# figure resolution in DPI
fig_dpi=300.0
# figure x dimensions
fig_x_dimension=None
# figure y dimensions
fig_y_dimension=None
# figure output formats (png, pdf, ps, eps and svg)
fig_format=png
# x ax title
x_title=Energy (MeV)
# y ax title
y_title=Flux (cm$^{(-2)}$)
ratio=no ratio
data_var=non
leg_pos=best
leg_size=10
grid_switch=True
grid_opt=major
grid_ax=both
ax_label_size=12
tics_size=10
x_scale=linear
y_scale=linear
xs_switch=False
y2_title=Cross Section (barns)
save_fig=False
error_bar=True
latex=False
x_lim=False
x_min=1e-07
x_max=None
y_lim=False
y_min=None
y_max=None
y2_lim=False
y2_min=None
y2_max=10000000000.0
```

# 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](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