FRIB

LISE Rate Reader + Comparison to Experiment

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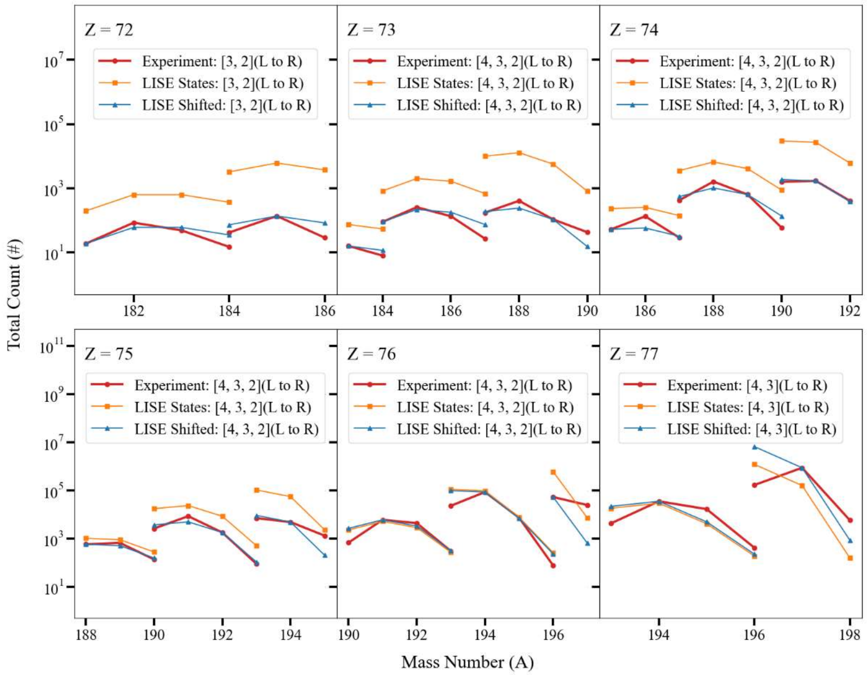
Foreword

- The goal of this code is to read results files from LISE (transmission values) and then plot them against experimentally measured rates
- In order to have the LISE values and Experimental values show up on the same scale, you need to set your beam rate in the LISE file roughly equal to the total number of beam counts during that given experimental run
- The end goal is a comparison plot like this
- Here there is even a built-in shifting function being used to correct the underlying errors in the charge state model
- To see more figures like this, reference my thesis



Software Versions

- Double check your versions

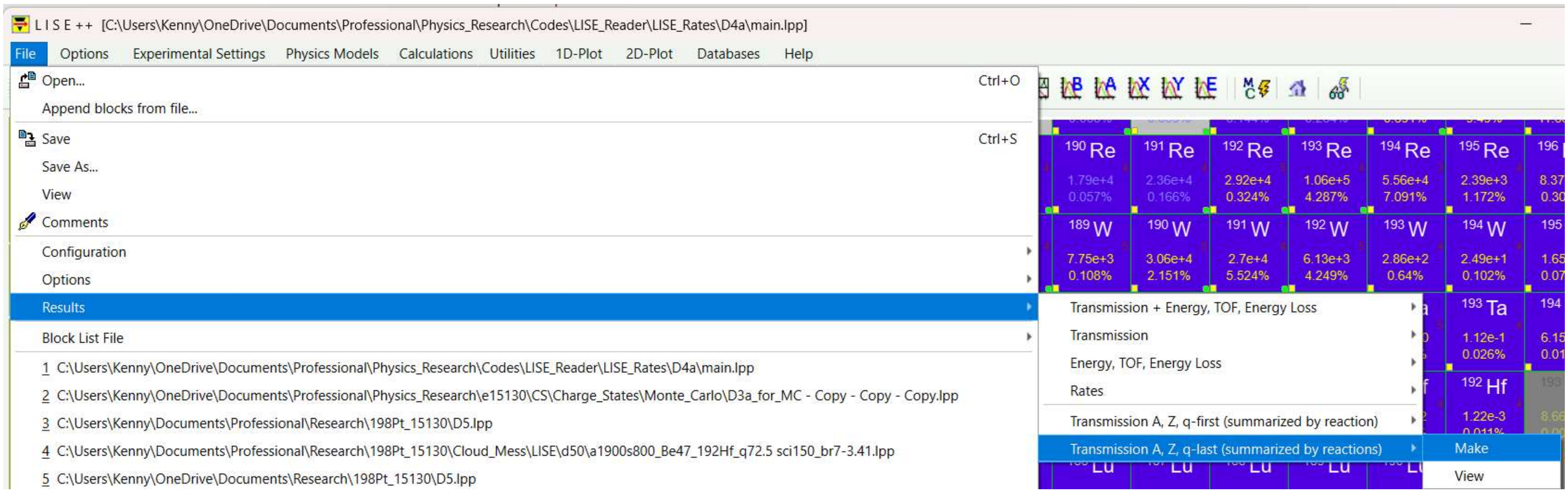
```
import matplotlib as mpl
import pandas as pd
import numpy as np
import scipy
import sys
import jupyter_core


print(mpl.__version__)
print(pd.__version__)
print(np.__version__)
print(scipy.__version__)
print(sys.version)
print(jupyter_core.__version__)
```

```
3.5.3
1.3.5
1.21.6
1.7.3
3.9.10 (tags/v3.9.10:f2f3f53, Jan 17 2022,
4.9.2
```

Preparing the LISE File

- Make your desired settings in the LISE file
- Calculate transmission of all products
- Then follow this:

This will make your LISE rate file with extension res4



Preparing Experimental Yields

- Count the total observed events for each identified nuclide blob
  - You can use the 1D_fitter script I made if you reduced your experimental data down to 1D spectra
  - Technically you could rewrite the MonteCarlo reader script I made to count 2D spectra as well, but that would require additional work
- Organize it into an excel file with the following format:

	Z	A	q	Z-q	A-3q	Yield
7218169	72	181	69	3	-26	19
7218269	72	182	69	3	-25	85
7218369	72	183	69	3	-24	49
7218469	72	184	69	3	-23	15
7318369	73	183	69	4	-24	16
7318469	73	184	69	4	-23	8
7218470	72	184	70	2	-26	42

Initializing

- Set your paths and define key variables and flags
- You can see how I organized my data in the home directory
- Feel free to organize and access your data however you wish
- Variables & Flags:
  - dset → For my data organization
  - param → This allows you to compare the upper and lower bound of a given parameter adjustment such as changing target thickness
  - SHIFT → Normalize the LISE data to the experimental data
  - SAVE → Save the plots to a png file in your working directory

```python
dset = 'D6a1'
param = 'none'
SHIFT = 0
SAVE = 0

# Define paths
YIELDfile = f'Experimental_Rates\\{dset}\\{dset}_yields.xlsx'
TRANSfile = f'LISE_Rates\\{dset}\\main.res4'
print(TRANSfile)
```

Filtering and Matching Data

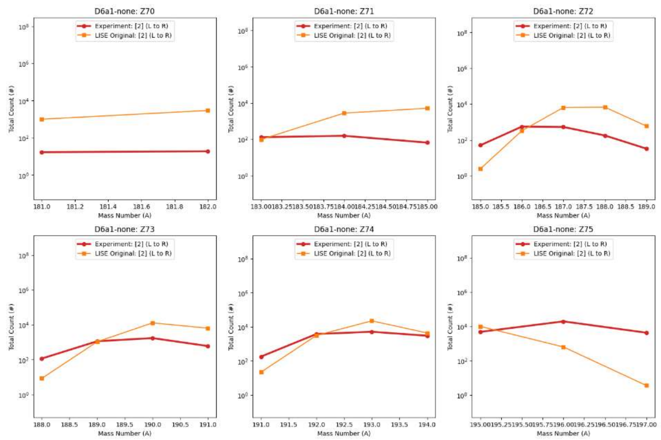
- You can Filters to your experimental data if that is necessary
  - Here we take out the primary beam and only show He-like charge state Z-q = 2

```
# Clean Beam
try:
    beam = Ydf.loc[78,:,198].index
    Ydf.drop(beam,inplace=True)
except KeyError:
    pass

#### FILTER ####
Ydf = Ydf[Ydf['Z-q']==2]
```

- You want to compare all present experimental data to LISE
- So we also look for an overlap between the two data sets and remove anything that doesn't have a value in both experimental and LISE data

```
#Only show Lise values that have a corresponding experimental data counterpart
Ldf = Ldf[Ldf['ID'].isin(list(Ydf['ID']))]
```

- Here are the results



Visualizing Parameter Variation

- You can set a parameter to vary and plot the upper and lower bound of those variations
- To do this you need to follow the same file structure I have in my LISE_Rates directory
- Each adjusted parameter has its own directory
- Within parameter directory, the naming convention goes as follows

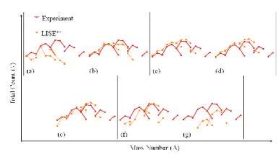
l1
model
targ
main
main.res4

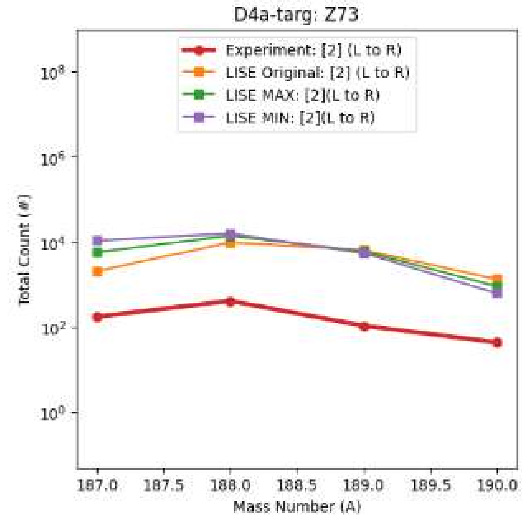
```
dset = 'D4a'
param = 'targ'
SHIFT = 0
SAVE = 0
```

Then simply change the param variable to the name of the directory, and voila

targ_mn
targ_mn.res4
targ_mx
targ_mx.res4

An alternative to this is to just run the main code with param = none and just adjust the LISE file every time. To see a result of this see Figure 3.8 of my thesis





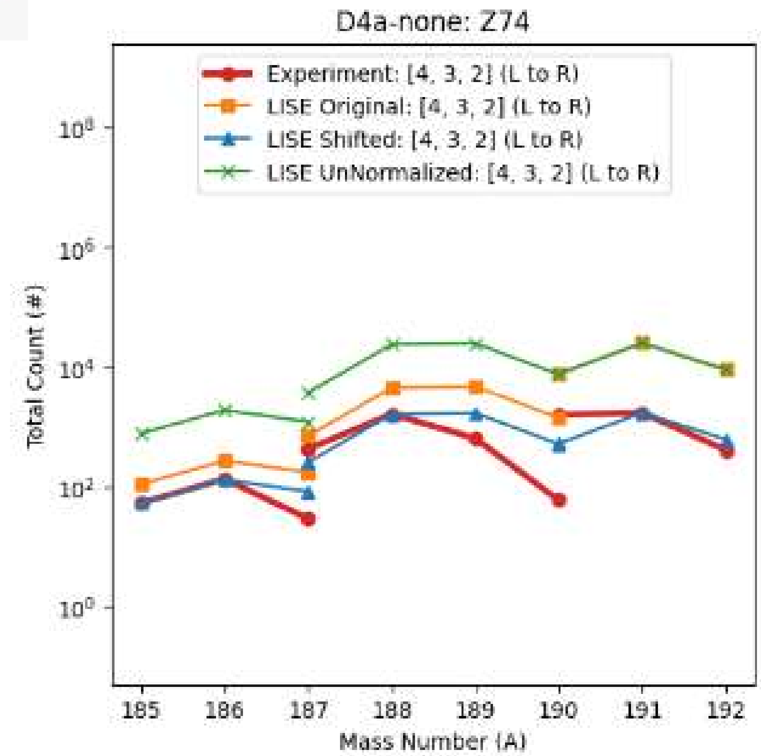
Correcting Charge State Normalizations

- There were significant charge state discrepancies in the 198Pt exp at NSCL
  - K. Haak et al., PRC 108 (2023) 034608
  - Also see Thesis

```
dset = 'D4a'
param = 'none'
SHIFT = 1
SAVE = 0
```

```
#### FILTER ####
# Ydf = Ydf[Ydf['Z-q']==2]
```

- These were corrected with Monte Carlo calculations for targets below equilibrium thickness
- But the Ni target data was at equilibrium and the charge state values simply needed to be shifted
- You can turn the SHIFT flag ON, and it will shift each state individually to experiment values with a log chi squared minimization
- However, it is then the global normalization is uncertain, I have provided an UnNormalized version that takes the shifted values and aligns them with the most populated charge state (He-like in this case)



Afterword

- There is a final cell in this code that was meant to scan for parameters that should be considered in the error evaluation when estimating transmission error bars with LISE

```
### For use in systematically locating impactful parameters on
### Join this data with experimentally identified ions and look

dset = 'D4b'
YIELDfile = f'Experimental_Rates\\{dset}\\{dset}_yields.xlsx'
TRANSfile = f'LISE_Rates\\{dset}\\main.res4'
RES1file  = f'LISE_Rates\\{dset}\\main.res1'
```

- This method works by looks for incredibly tiny transmissions and providing the point in the separator where these tiny transmissions occur
- This is most likely done better with varying each and every parameter and observing the change in transmission of most products as a whole
- This is really a food for though

Here this shows how small the transmissions are at the FS slits position

```
Tdf Before Filter: (530, 45)
After Filter: (123, 45)

[          ID     AEl    A   Z  Qf  Q1  Fs_sl trans
 82   7619774  197Os  197  76  74  73        0.001
 114  7619172  191Os  191  76  72  73        0.000
 148  7519573  195Re  195  75  73  72        0.000
 337  7318670  186Ta  186  73  70  69        0.003]
```