

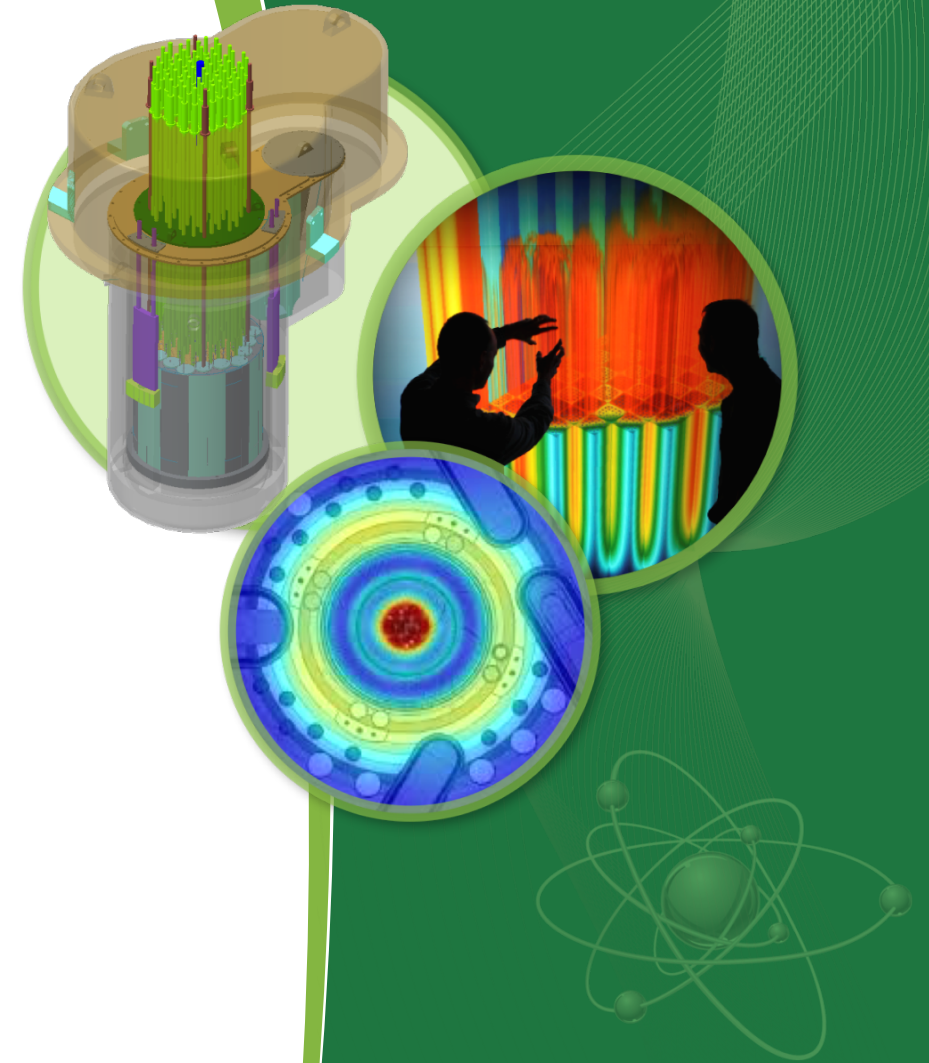
Introduction to AMPX

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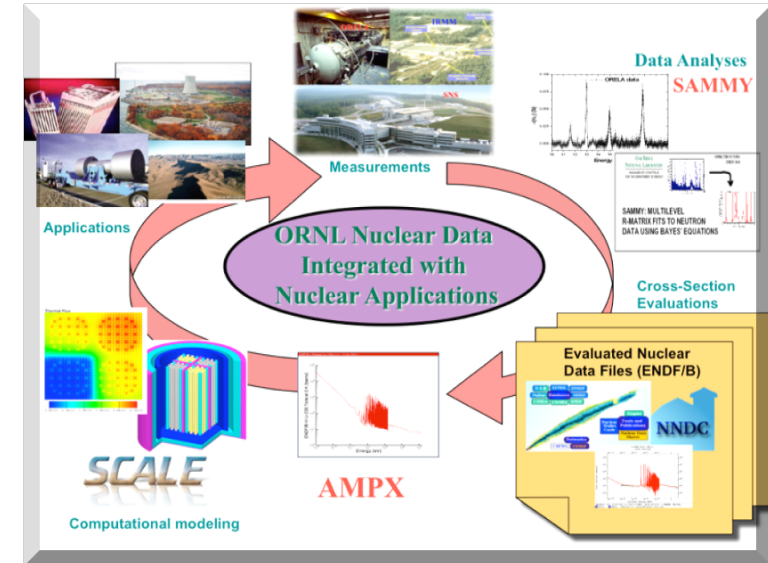


Outline

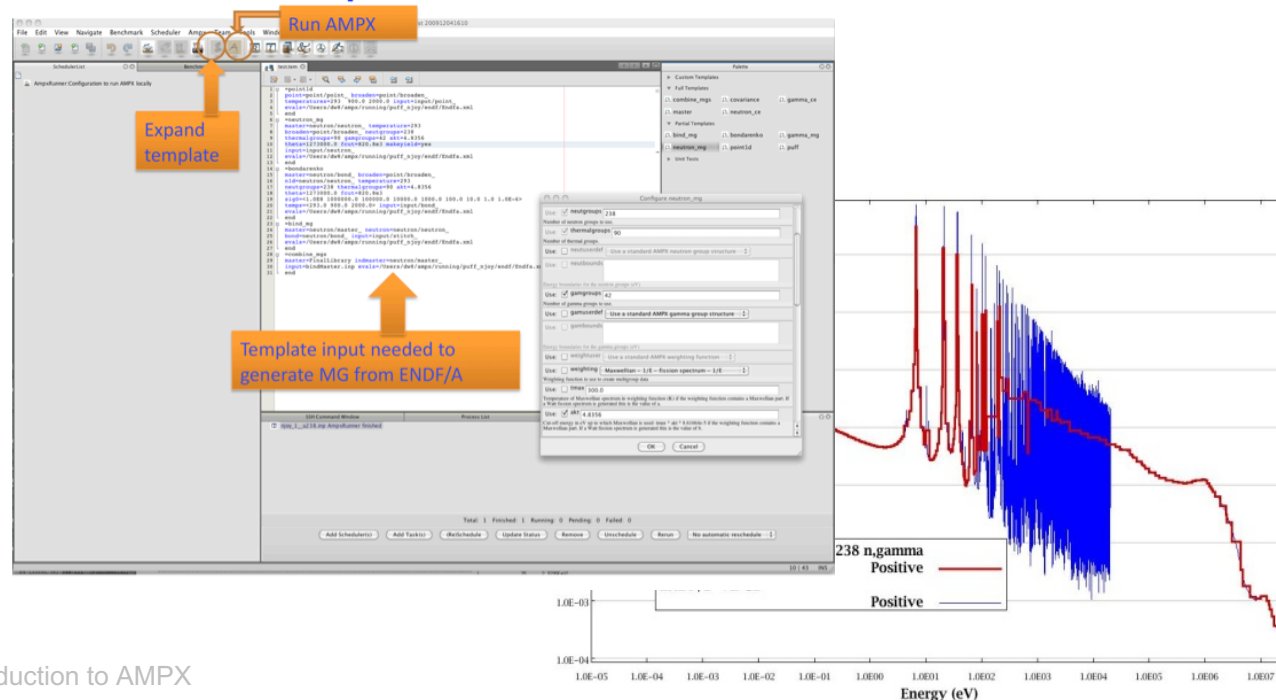
- Introduction to AMPX
- Content of ENDF files
- Brief overview of AMPX modules
- Overview of ExSite

AMPX processing capabilities vital for SCALE

- SCALE relies upon AMPX for continuous energy (CE), multigroup (MG), and covariance data libraries
 - MG and CE cross section data
 - Cross section uncertainty data to support sensitivity/uncertainty (S/U) methods in SCALE
- AMPX processes ENDF/B-formatted nuclear data evaluations to produce cross section libraries



AMPX Graphical User Interface



Data libraries released with SCALE 6.2:

- CE ENDF/B-VII.0 and ENDF/B-VII.1
- 238-group ENDF/B-VII.0
- 252-group ENDF/B-VII.1
- 200n47g ENDF/B-VII.0 and B-VII.1
- 27n19g ENDF/B-VII.0 and B-VII.1
- Recommended covariance data library
 - Evaluated and approximate covariance data
 - Covariance data for all ENDF/B nuclides (neutron)

AMPX nuclear data processing history

- AMPX processes data in evaluated nuclear data files (ENDFs) to provide CE, MG, Covariance, and ORIGEN Data Libraries for SCALE
- AMPX developed and maintained at ORNL for over 40 years
- 1990: ENDF Formats changed significantly with ENDF/B-VI release in 1990—AMPX could no longer process latest ENDF files for SCALE
- 1995—2002: Extensive AMPX upgrade to update AMPX to process latest ENDF/B data
- 2008-2012: AMPX upgrades for generation of continuous-energy shielding libraries
- 2002—2012: AMPX routinely processes latest ENDF/B Formats (e.g., ENDF/B-VI & –VII.0 data libraries in SCALE)
- 2012 – Present: Modernization effort to implement SQA and modern software design/development practices
- Last formal release as stand-alone in 1977
- Current version available with SCALE 6.2

Version	Year	Time between Releases
ENDF/B-I	1968	-
ENDF/B-II	1970	2 years
ENDF/B-III	1972	2 years
ENDF/B-IV	1974	2 years
ENDF/B-V	1978	4 years
ENDF/B-VI	1990	12 years
ENDF/B-VII	2006	16 years
ENDF/B-VII.1	Dec 2011	5 years
ENDF/B-VII.2 or ENDF/B-VIII	TBD	

ENDF structure

File 1: General information

File 2: Resonance parameters

File 3: Point-wise reaction cross sections

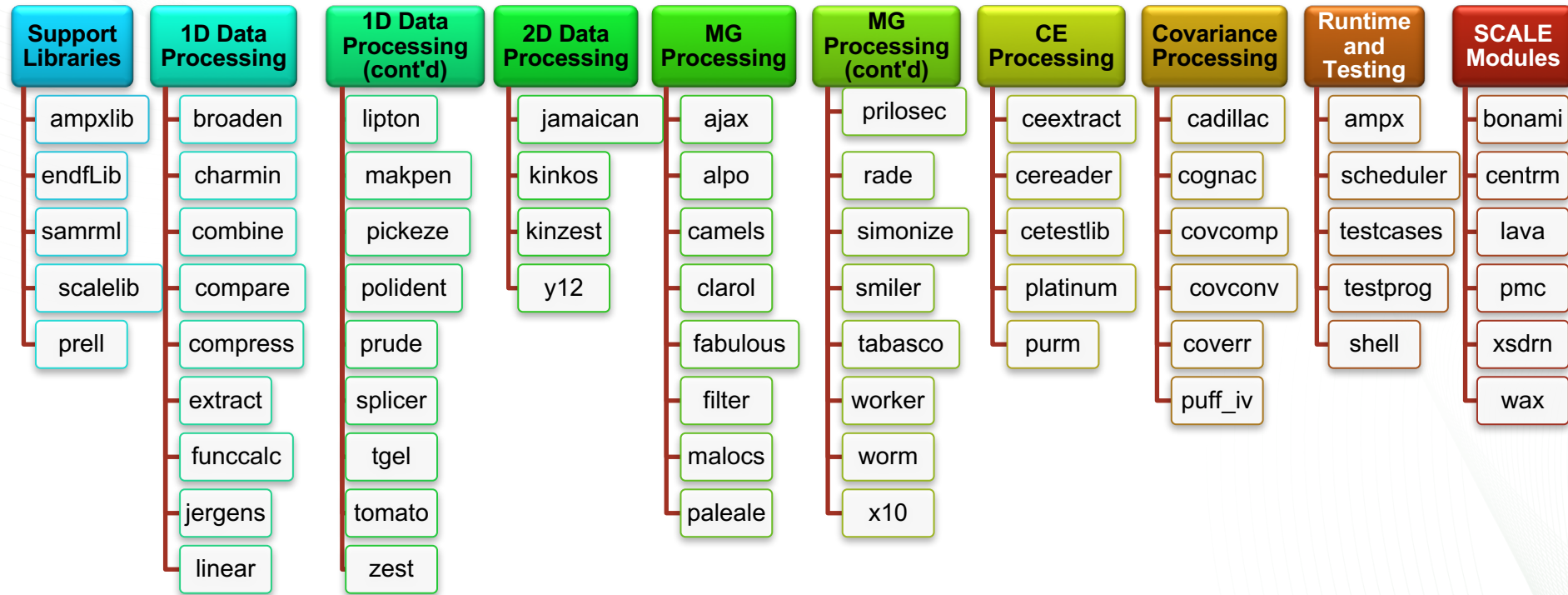
Files 4 and 5: Kinematic data for incident neutron.

File 6: Kinematic data. Angular and exit energy correlated

Files 12, 13, 14 and 15: Gamma yield kinematics

- Other information exists in ENDF containing covariance and decay information
- The information listed here is used to generate MG and CE libraries

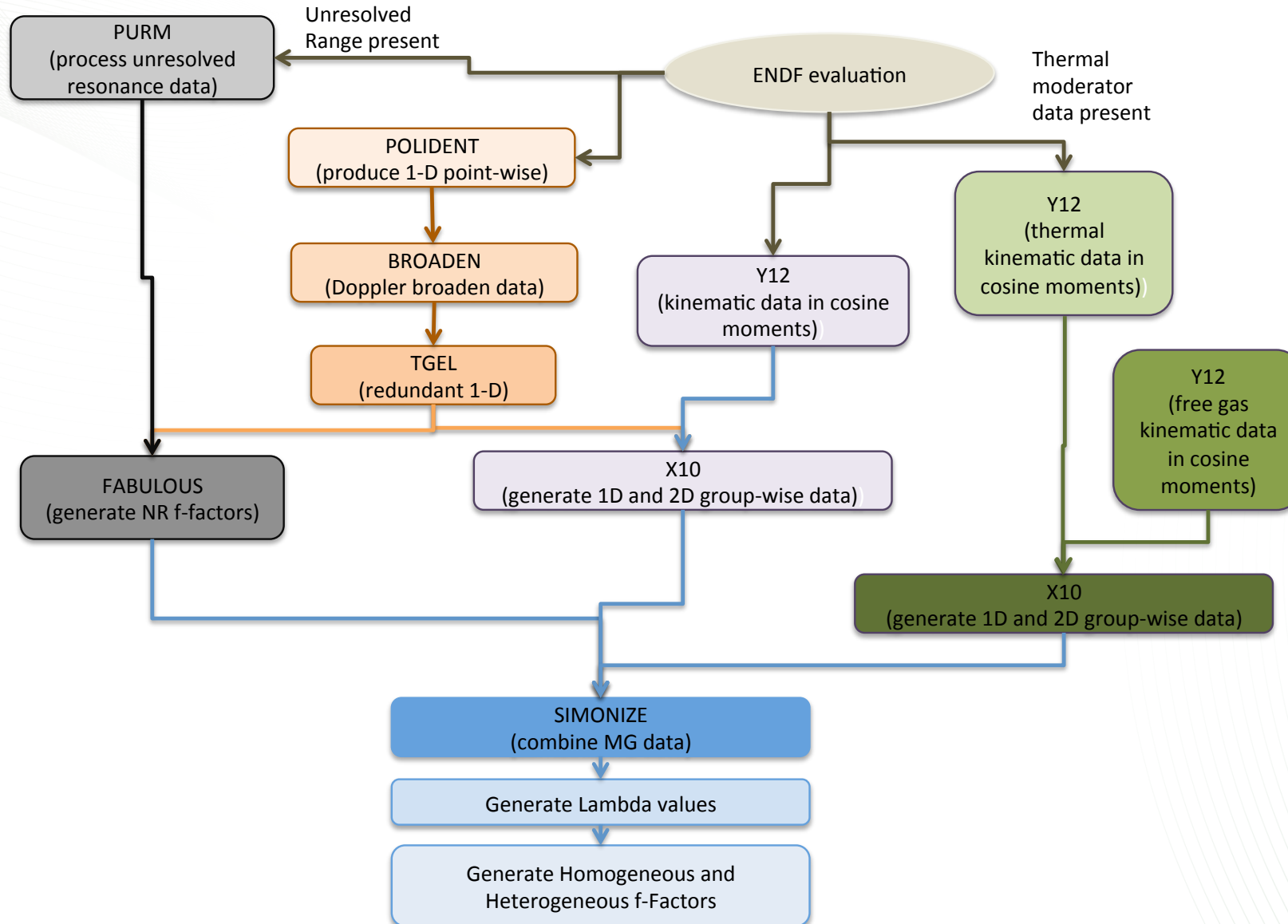
AMPX modular code system



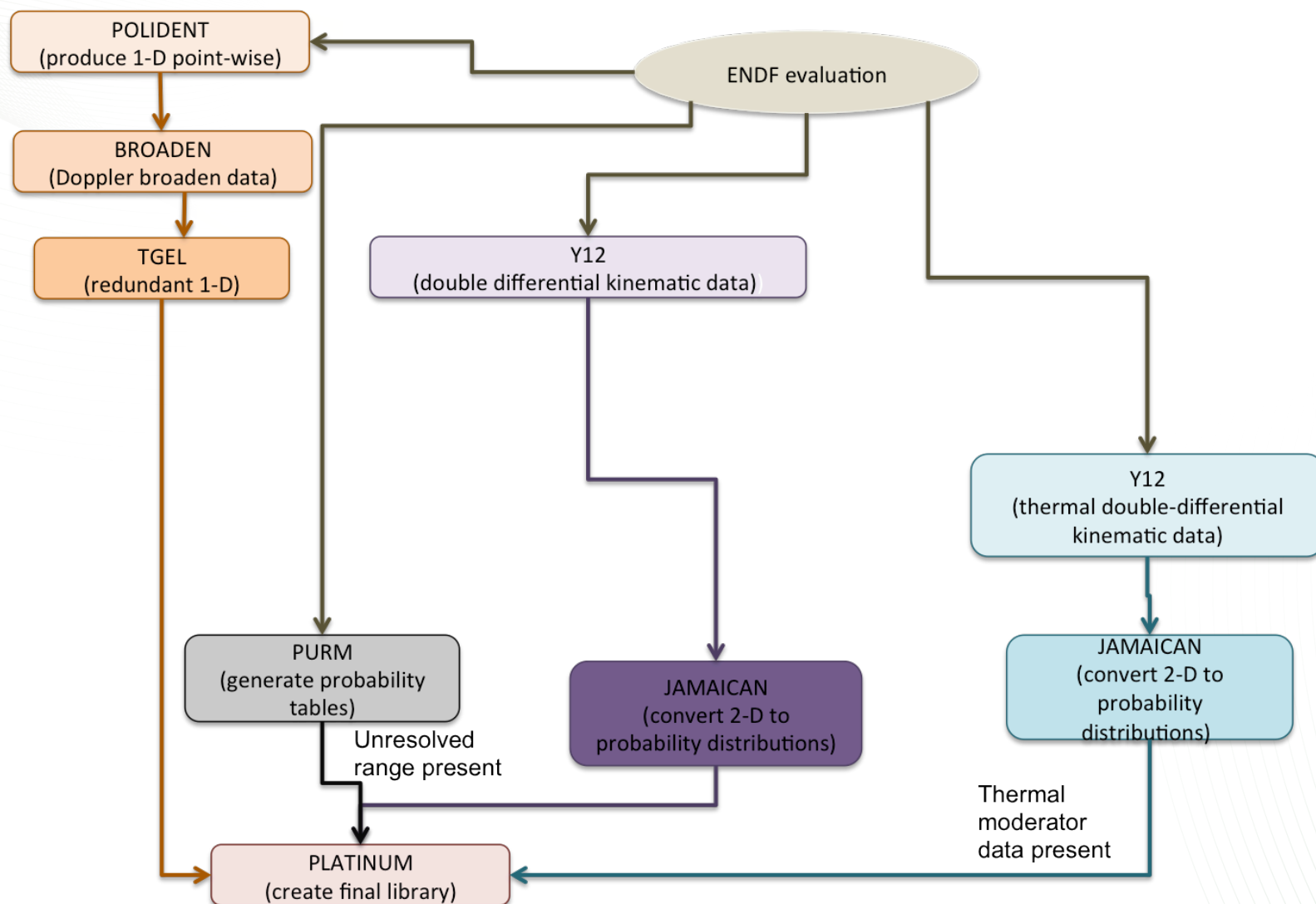
The most important AMPX modules

- Polident:
 - Reads the point-wise data from the ENDF library
 - Reconstruct point-wise cross section data from resonance parameters
- broaden: Doppler broadens the point-wise data
- y12: reads the kinematic data from the ENDF file
- x10: groups average point-wise data and kinematic data
- jamaican and platinum: combine point-wise data and kinematic data into continuous energy libraries
- puff_iv: processes covariance data

Processing MG libraries

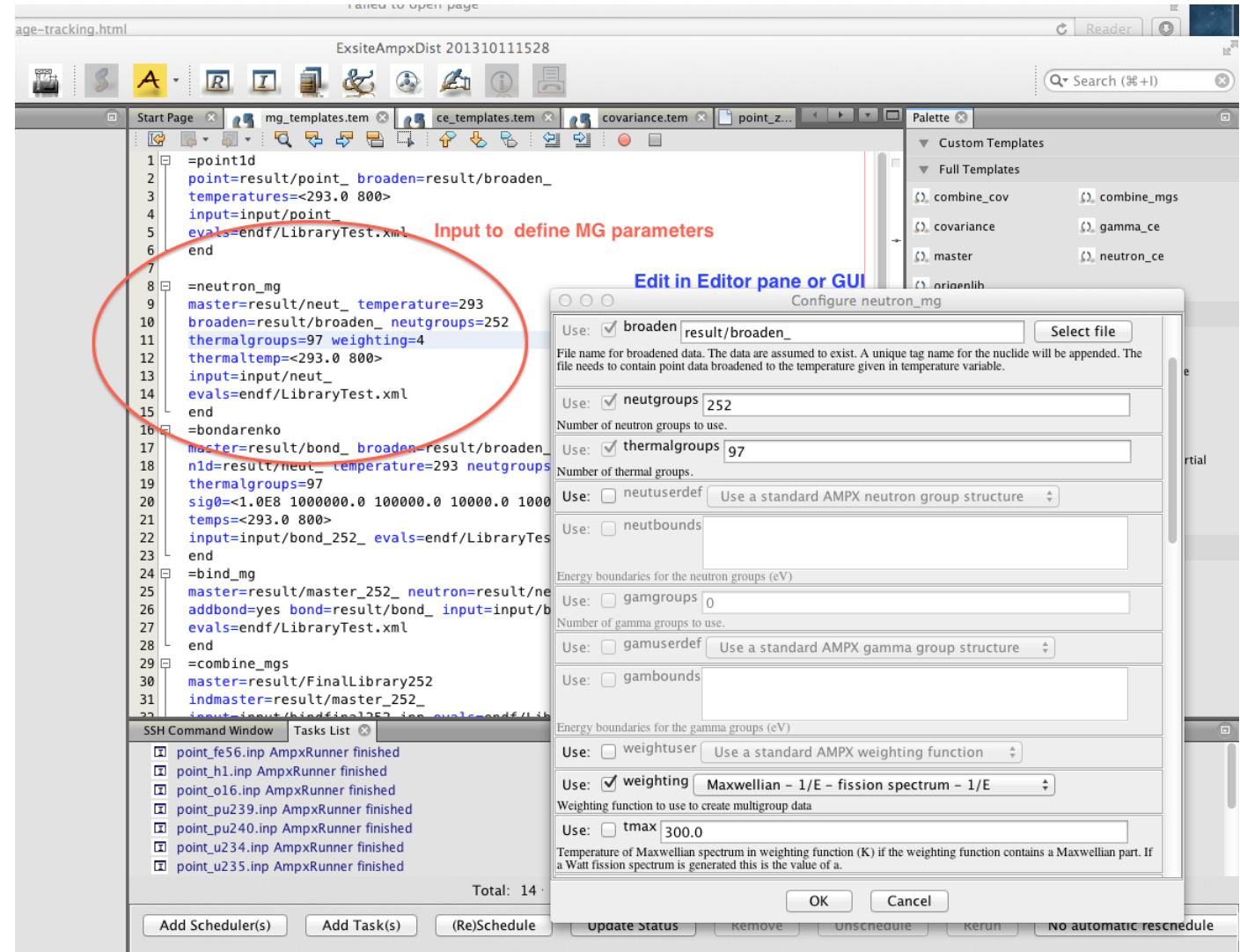


Processing CE libraries



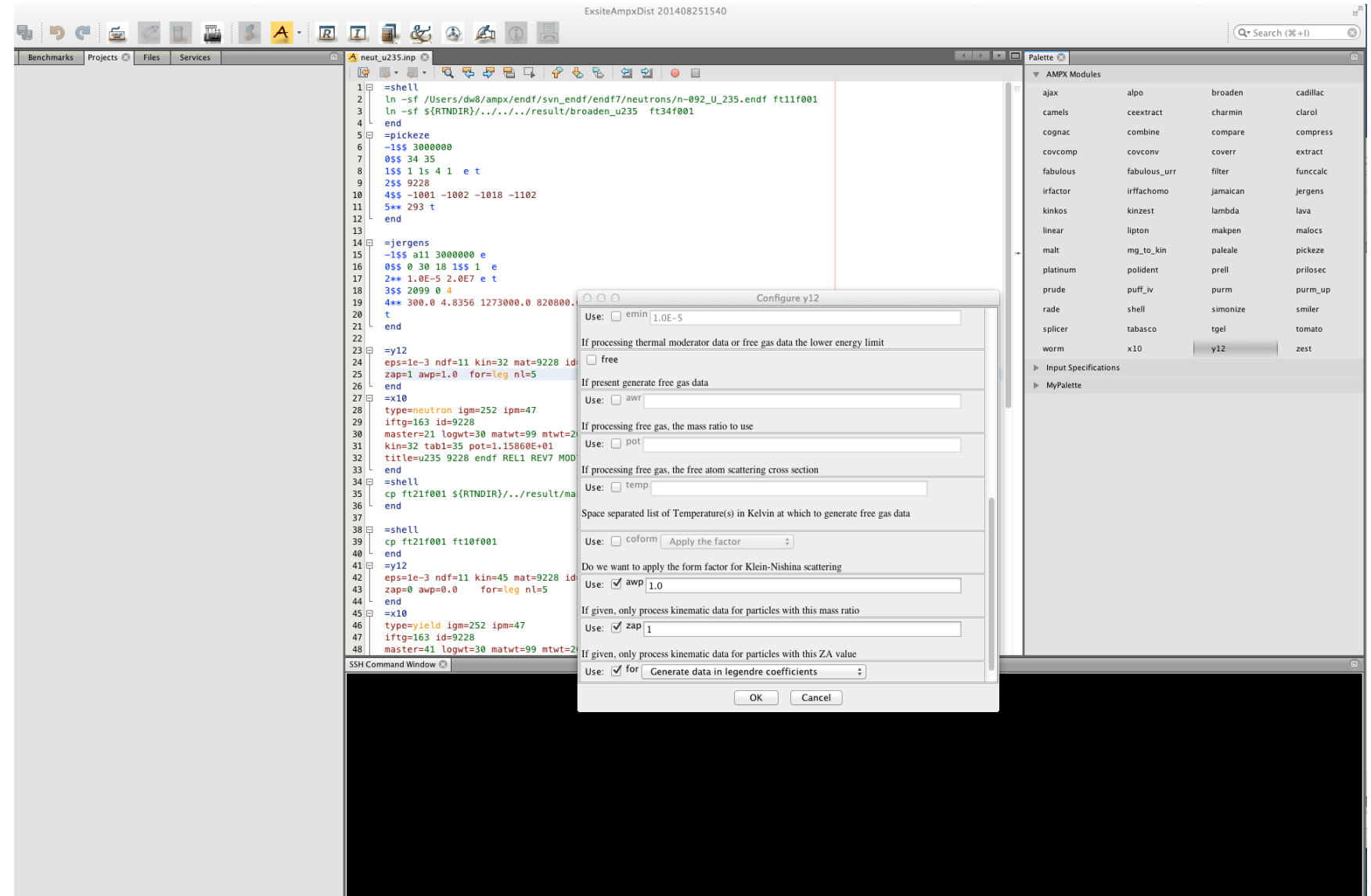
Processing libraries

- Edit templates with relevant parameters
- Expand to generate input files for AMPX
- Available for MG, CE, and covariance library production



Processing CE libraries (continued)

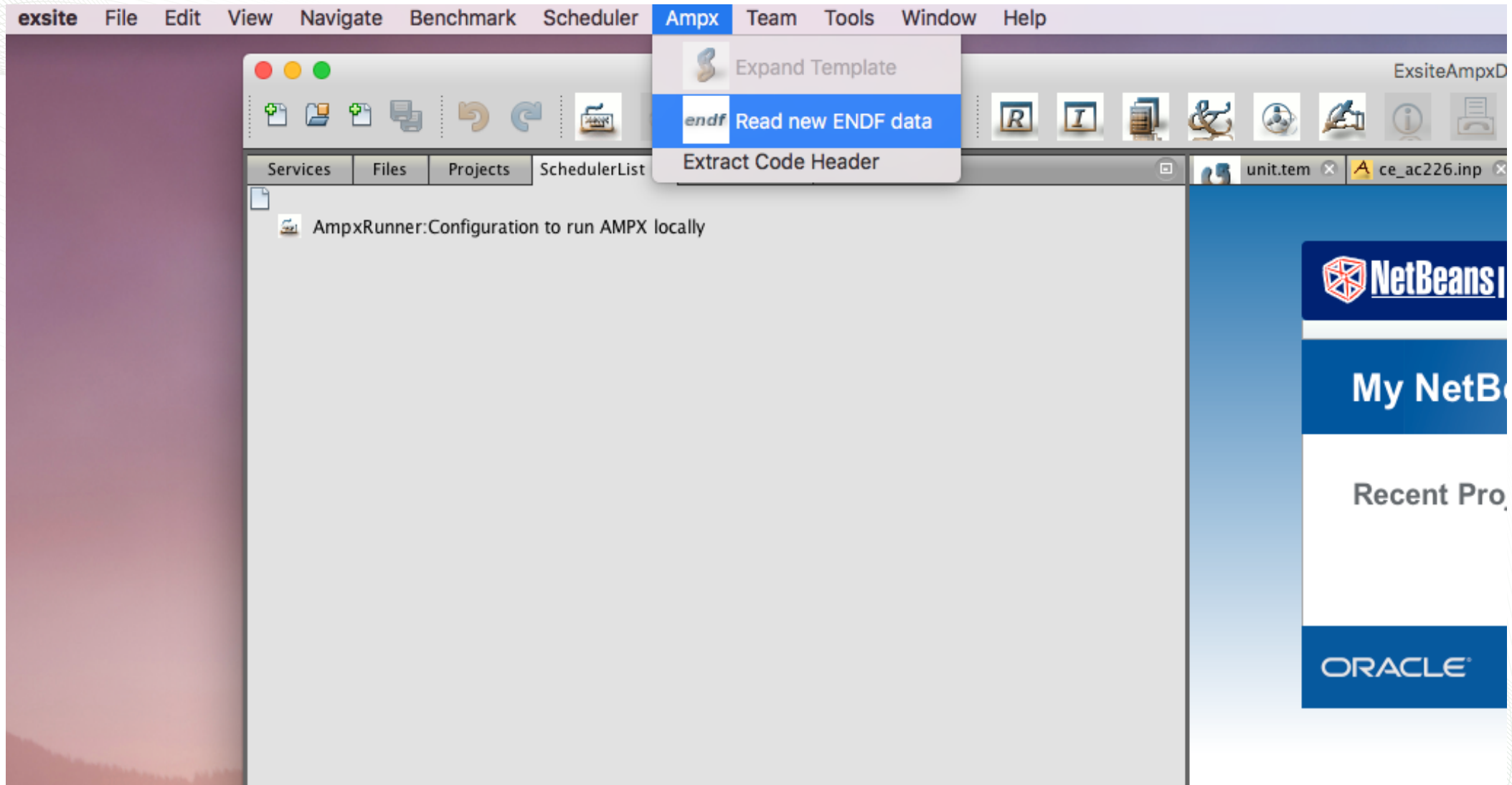
- Edit input files



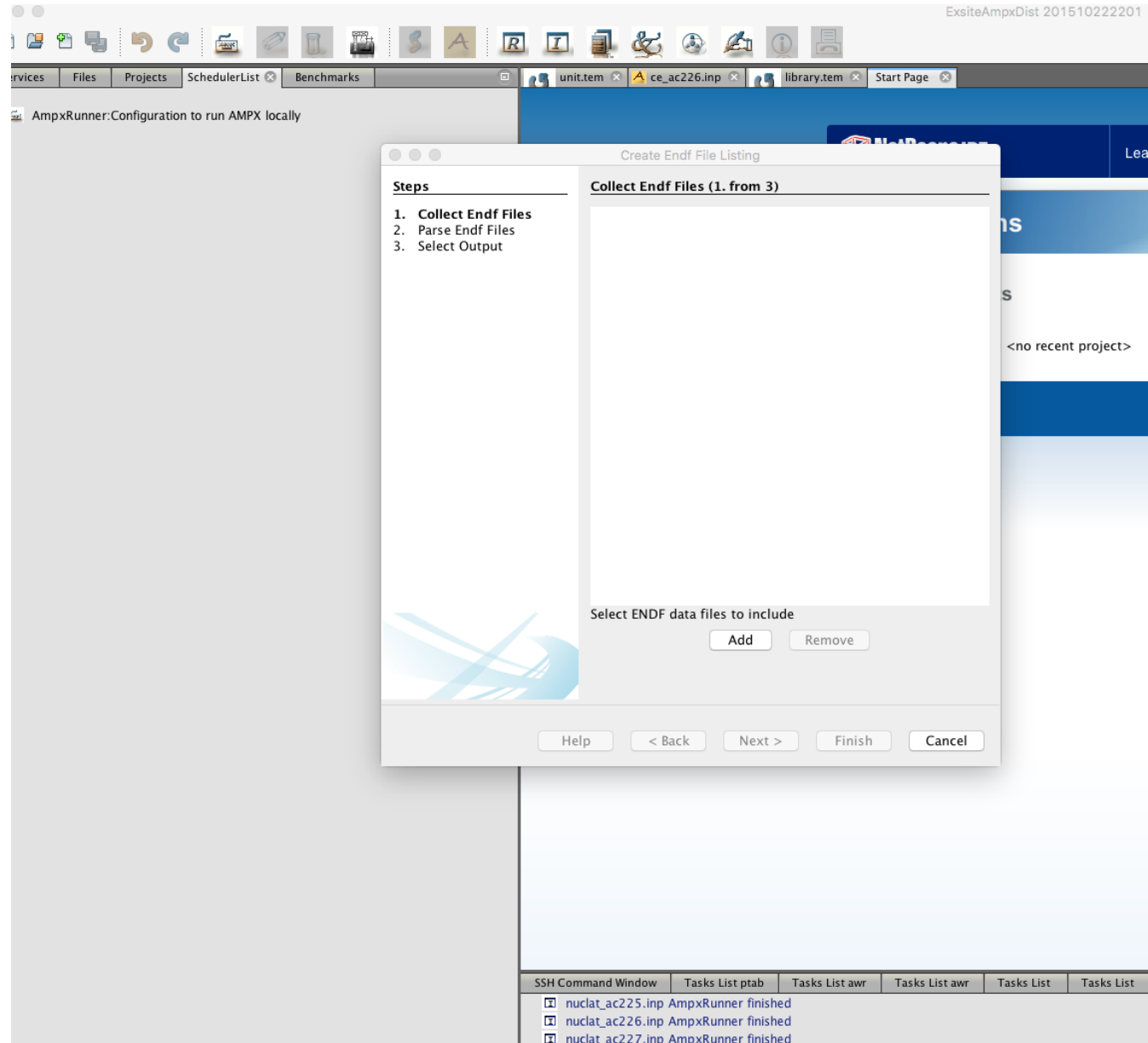
Generating a SCALE cross section library

- Example files template and input files are located in the Ampx/examples directory in SCALE installation
- ExSite is located in Ampx/exsite/bin/exsite in SCALE installation
- AMPX only runs on Linux and Darwin
- If needed ExSite can be used on a Windows platform to prepare the input files provided, then the absolute pathname option is used in the template files

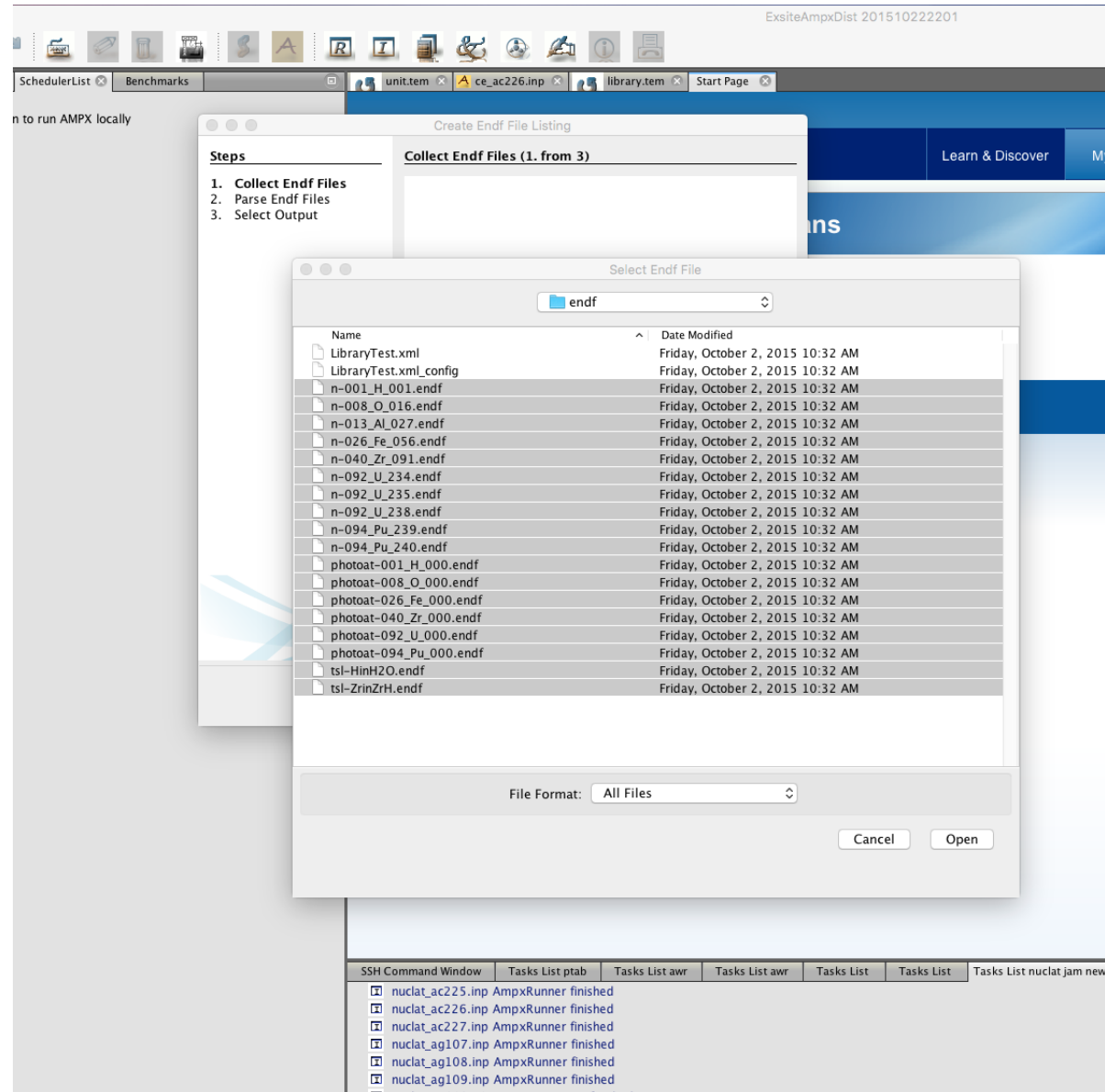
Generating a SCALE cross section library (continued)



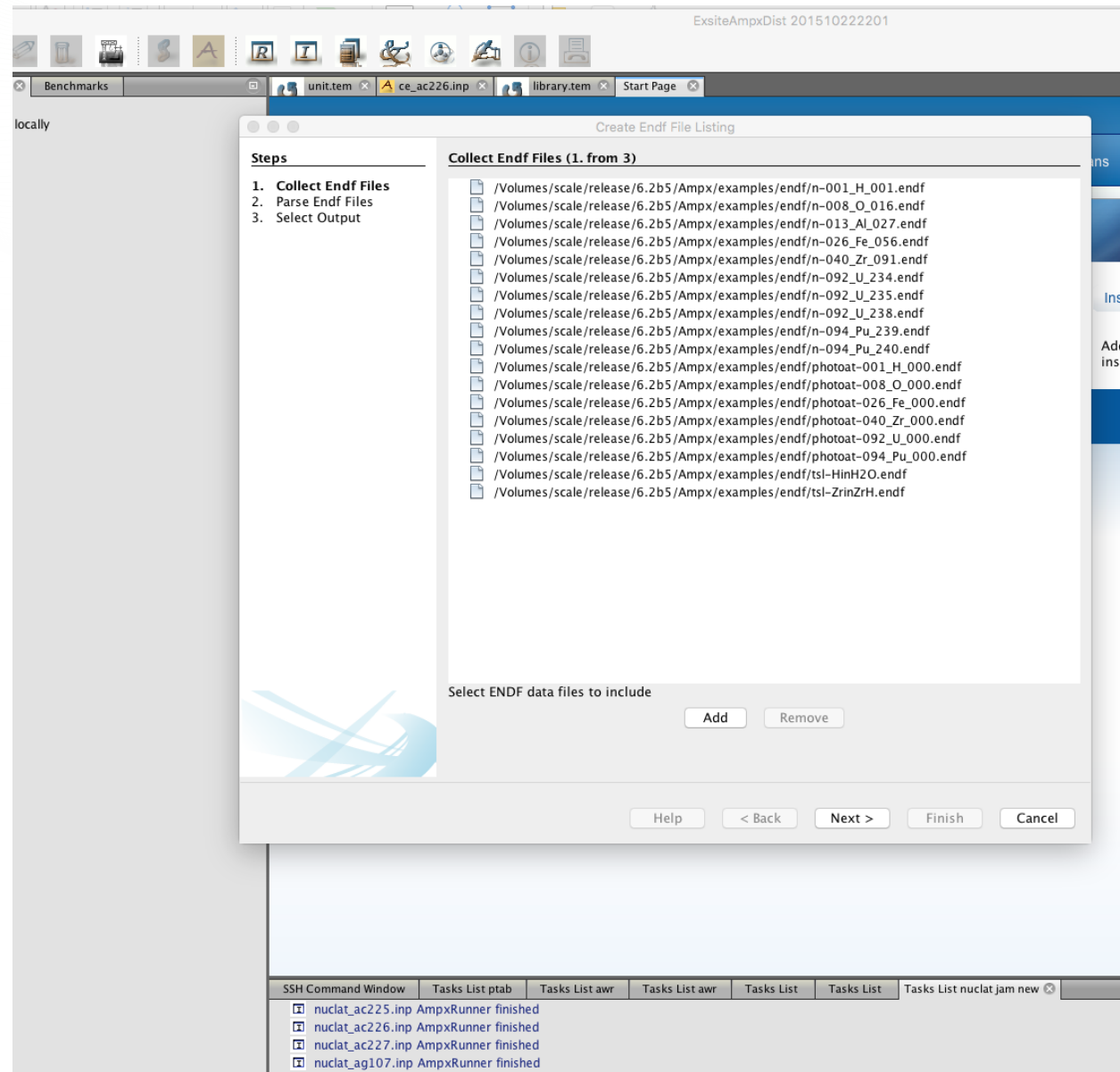
Generating a SCALE cross section library (continued)



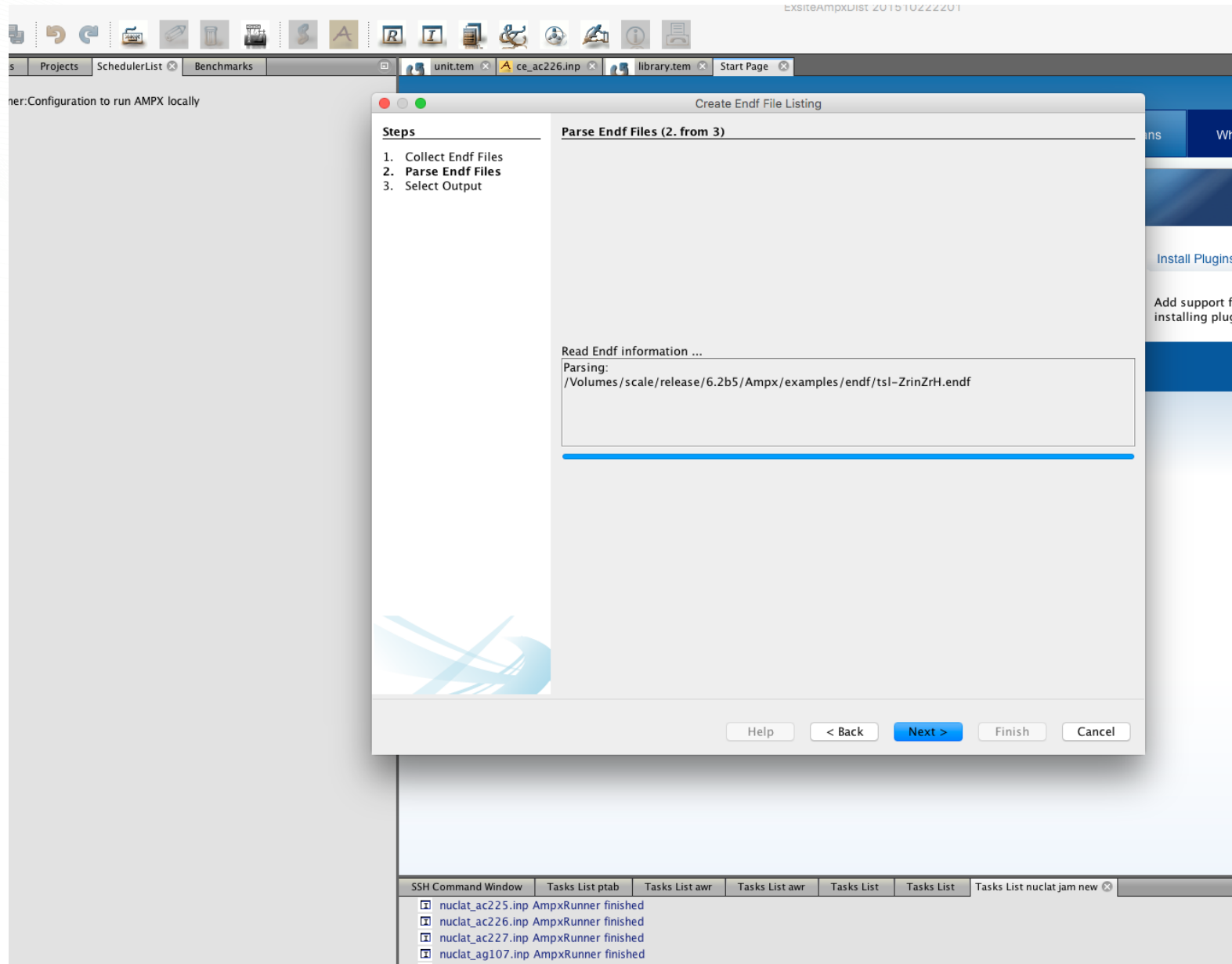
Generating a SCALE cross section library (continued)



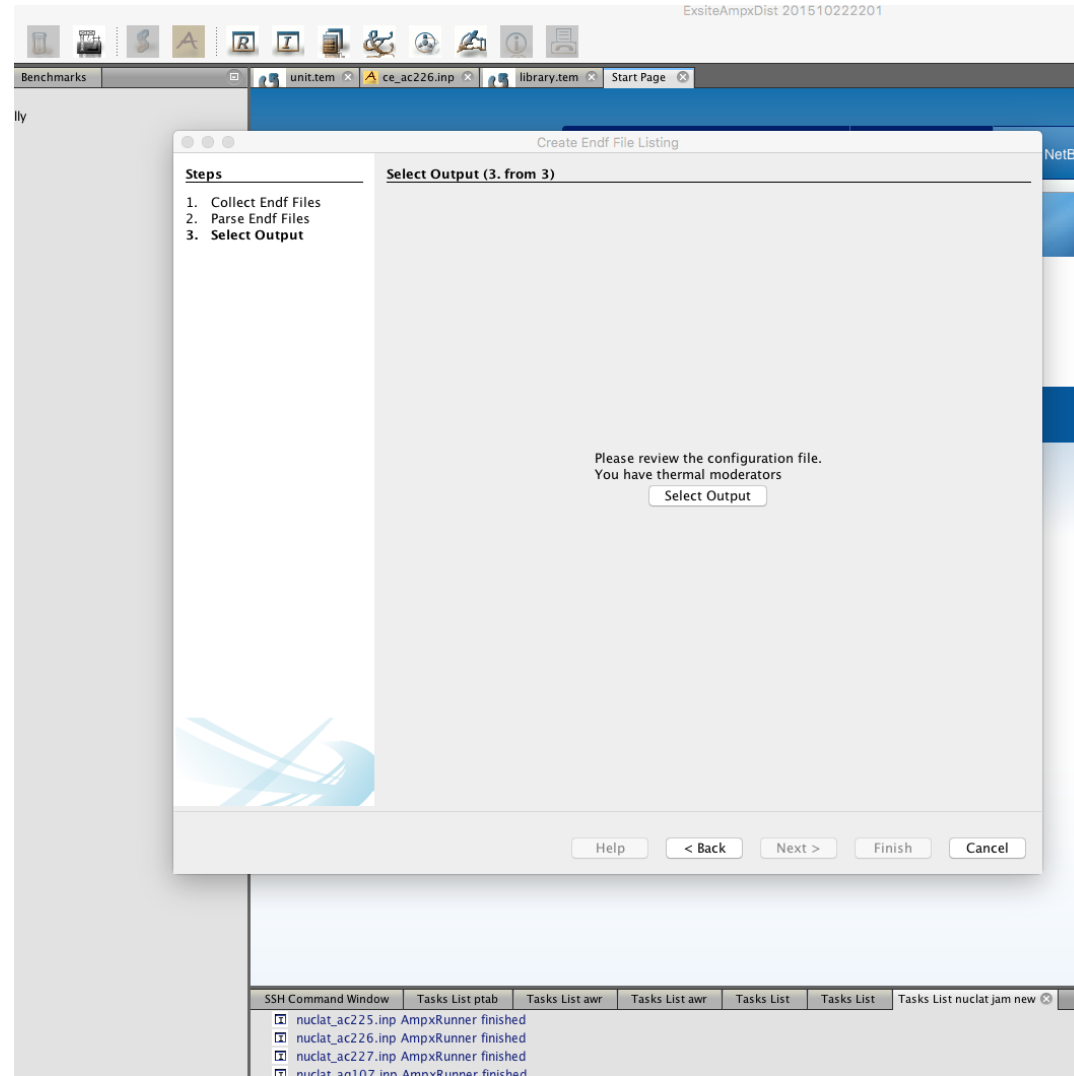
Generating a SCALE cross section library (continued)



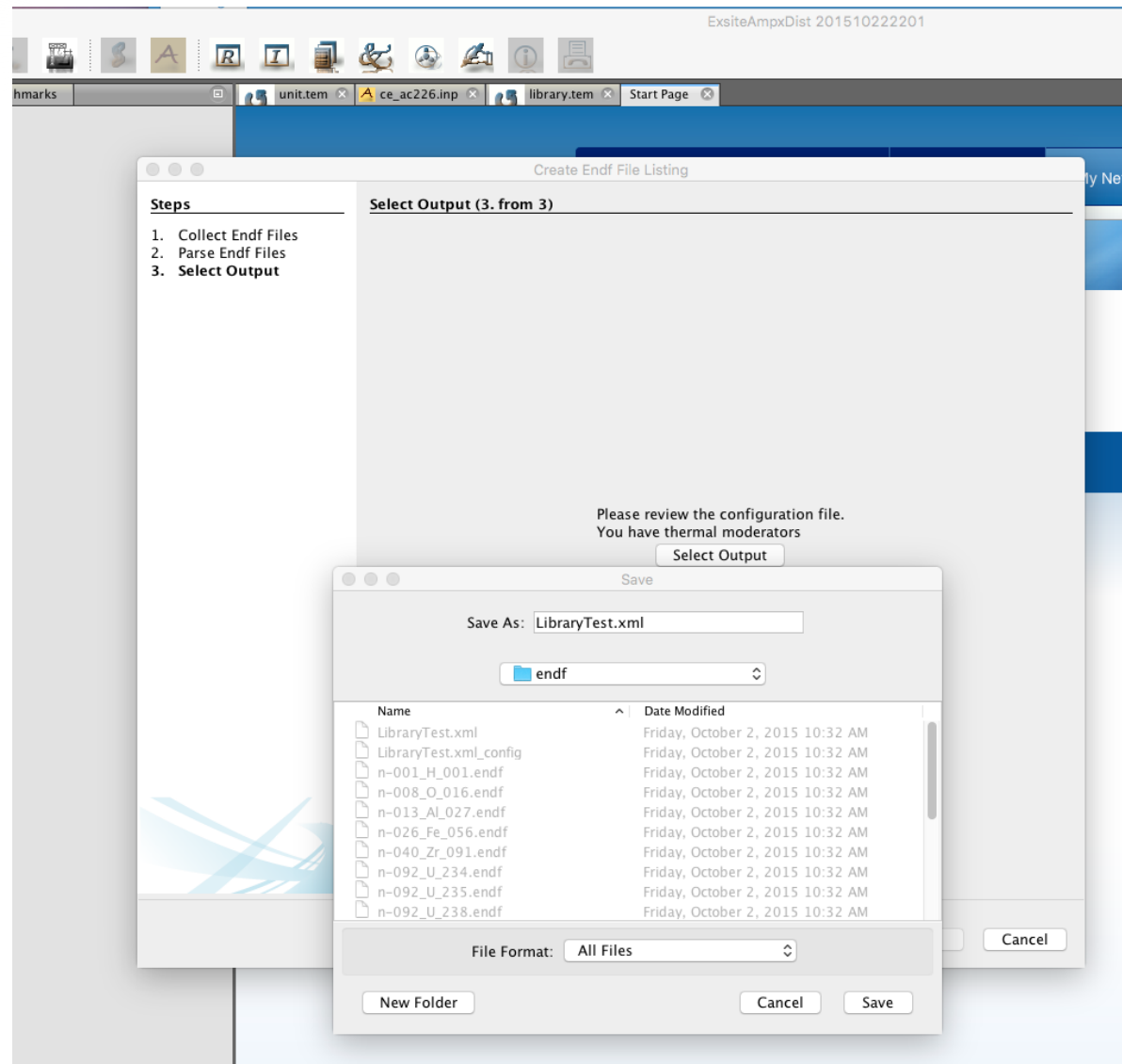
Generating a SCALE cross section library (continued)



Generating a SCALE cross section library (continued)



Generating a SCALE cross section library (continued)



Editing the generated configuration file

- Unfortunately, the configuration file may need some hand editing for the thermal moderators
- ENDF does not always use the same material number as stated in the file
- The ZA given for the thermal moderator is not always correct

```
<ConfigFile>

<!-- metastable nuclei for which the scale id is different from the real za value -->
<metastable>
</metastable>

<!-- nuclei for which the scale id is different from the real za value -->
<specialNuclei>
  <nuclei endf="125" realza="1001" scaleza="8001001" name="hfreegas" /> <!-- for h1 SCALE uses ID=8001001 -->
  <nuclei endf="128" realza="1002" scaleza="8001002" name="dfreegas" />
</specialNuclei>

<!-- thermal nuclei -->
<thermal>
  <nuclei endf="1" realza="101" > <!-- thermal evaluation h_h2o -->
    <fastMat endf="125" scaleza="1001" name="h-1" /> <!-- bound with fast evaluation h1 uses SCALE ID=1001 -->
  </nuclei>

  <nuclei endf="58" realza="158" > <!-- thermal evaluation zr_zrh -->
    <fastMat endf="4028" scaleza="1040091" name="zr91-zr5h8" /> <!-- bound with fast evaluation zr91 uses SCALE ID=1040091 -->
  </nuclei>
</thermal>

</ConfigFile>
```


Editing the generated configuration file (continued)

The screenshot displays the ExSiteAmprDist 20151022201 application interface. The main window is divided into several panes:

- Left Pane:** Contains a tree view with the following items:
 - AmprRunner: Configuration to run AMPX locally
 - unit.tem
 - ce_ac226.inp
 - library.tem
 - Start Page
 - LibraryTest.xml_config
 - mg_templates.tem
- Center Pane:** Displays the configuration file `LibraryTest.xml_config` with the following content:

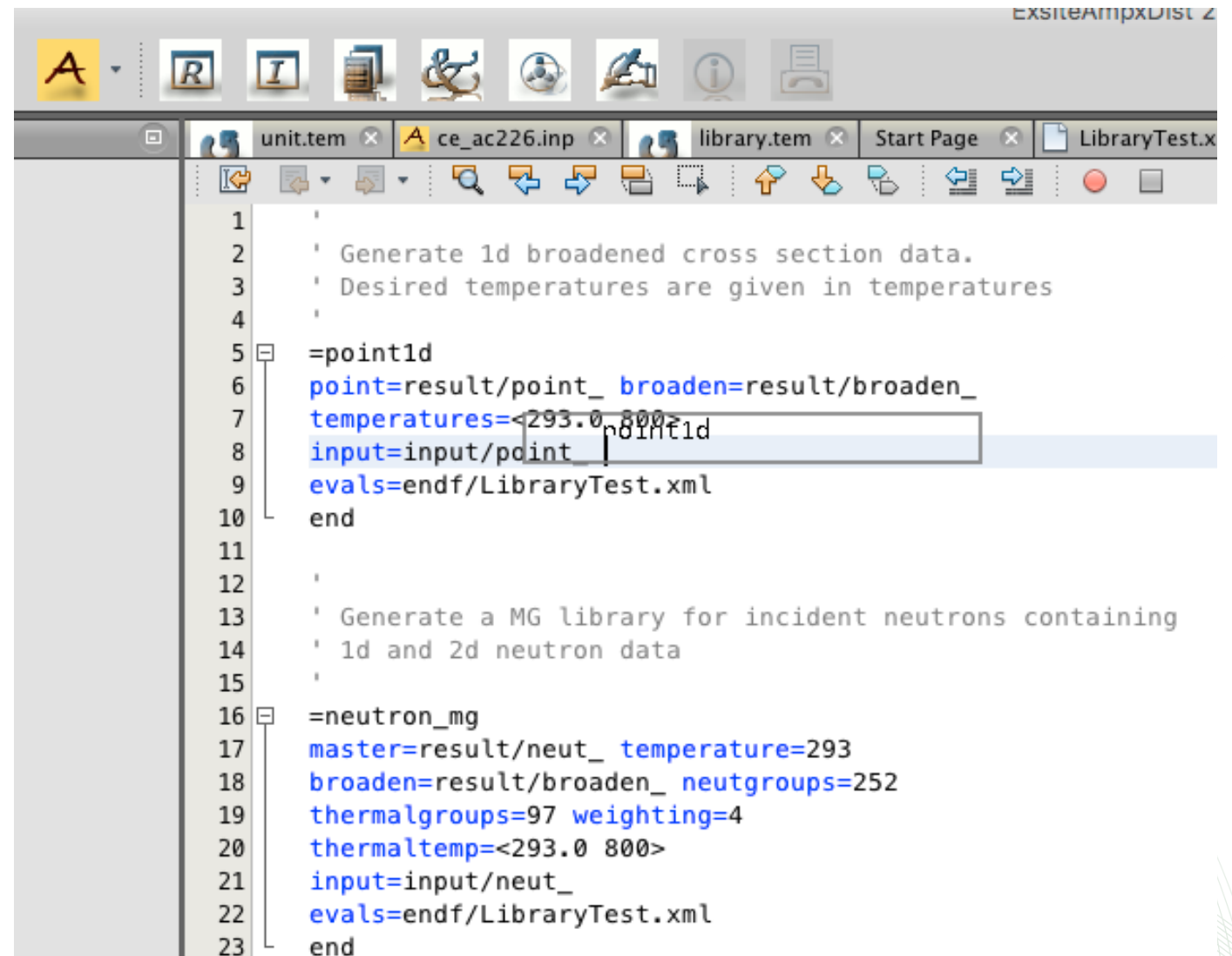
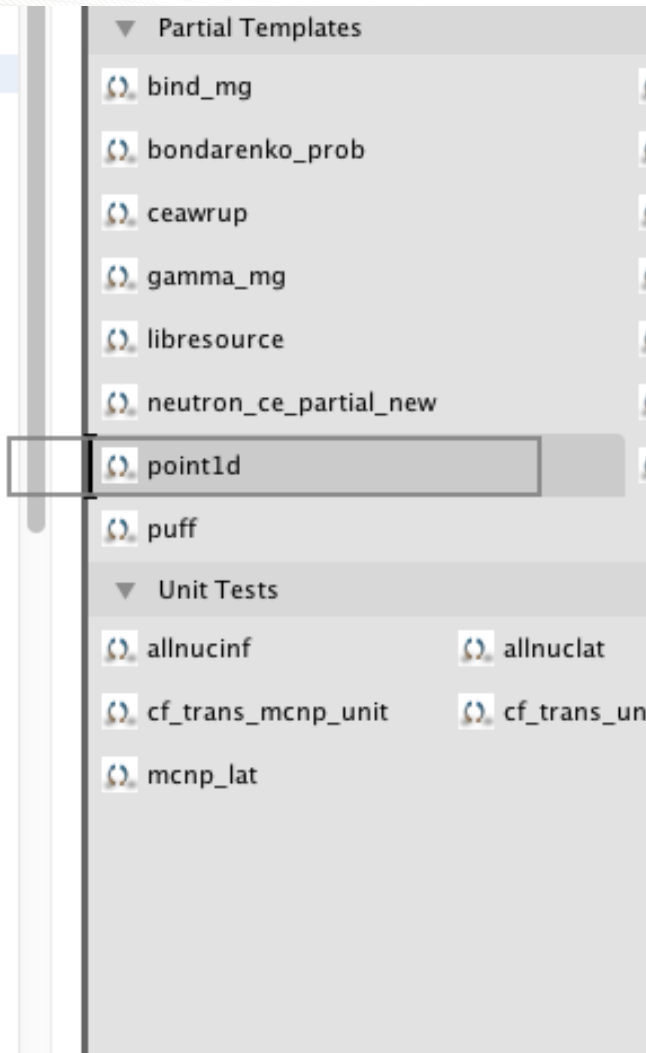
```
1  *
2  * Generate 1d broadened cross section data.
3  * Desired temperatures are given in temperatures
4  *
5  *
6  * =point1d
7  * point=result/point_ broaden=result/broaden_
8  * temperatures=<293.0 800>
9  * input=input/point_
10 * evals=endf/LibraryTest.xml
11 * end
12 *
13 * Generate a MG library for incident neutrons containing
14 * 1d and 2d neutron data
15 *
16 * =neutron_mg
17 * master=result/neut_ temperature=293
18 * broaden=result/broaden_ neutgroups=252
19 * thermalgroups=97 weighting=4
20 * thermaltemp=<293.0 800>
21 * input=input/neut_
22 * evals=endf/LibraryTest.xml
23 * end
24 *
25 *
26 * Generate NR bondarenko data. A neutron library generated
27 * by neutron_mg is needed. The desired background values are
28 * given in sig0 and the desired temperature are in
29 * temps.
30 *
31 * Please note, that AMPX can also generate NR f-factors using data
32 * from the probability table in the URR region. Use
33 * template ptable to generate probability tables
34 * (see ce_templates.tem for an example) and the use
35 * template bondarenko_urr
36 *
37 * =bondarenko
38 * master=result/bond_ broaden=result/broaden_
39 * n1d=result/neut_ temperature=293 neutgroups=252
40 * thermalgroups=97
41 * sig0=<1.0E8 1000000.0 100000.0 10000.0 1000.0 100.0 10.0 1.0 1.0E-6>
42 * temps=<293.0 800>
43 * input=input/bond_252_ evals=endf/LibraryTest.xml
44 * end
45 *
46 *
47 * Combine the libraries generated by neutron_mg and bondarenko
48 * into one MG library. Also sets a title and parameters
49 * needed if using the CENTRM option in SCALE.
50 *
51 * Please note that you must use oldzaves if you intend to use
```
- Right Pane:** Contains a **Palette** with the following sections:
 - Custom Templates:** test
 - Full Templates:** combine_cov, combine_mgs, covariance, gamma_ce, master, neutron_ce, origenlib
 - Partial Templates:** bind_mg, bondarenko, bondarenko_prob, ce_library_table, ceawrup, f-factors, gamma_mg, libraryhtml, libsource, neutron_ce_partial, neutron_ce_partial_new, neutron_mg, point1d, ptable, puff
 - Unit Tests:** allnucinf, allnuciat, cf_leak_unit, cf_trans_mcnf_unit, cf_trans_unit, mcnf_inf, mcnf_lat
- Bottom Pane:** Contains a **SSH Command Window** showing a list of tasks and their status. The tasks are listed in a table with columns for Task Name, Status, and Progress. The tasks are: nuclat_ac225.inp, nuclat_ac226.inp, nuclat_ac227.inp, nuclat_ag107.inp, nuclat_ag108.inp, nuclat_ag109.inp, nuclat_ag110.inp, nuclat_ag111.inp, nuclat_ag112.inp, nuclat_ag113.inp, nuclat_ag114.inp, nuclat_ag115.inp, nuclat_ag116.inp, and nuclat_ag117.inp. All tasks are marked as "finished".

At the bottom of the interface, there is a summary bar showing the total number of tasks and their status:

Total: 1125 Finished: 769 Running: 22 Pending: 334 Failed: 0

Below the summary bar, there are buttons for managing tasks: Add Scheduler(s), Add Task(s), (Re)Schedule, Update Status, Remove, Unschedule, Rerun, and No automatic reschedule.

Editing the generated configuration file (continued)



Editing the generated configuration file (continued)

Configure point1d

Use: ☒ point
Output file name for point data. A unique tag name for the nuclide will be appended.

Use: ☐ eps
Precision to which to create the grid in the resolved resonance range.

Use: ☒ broaden
Output file name for broadened data. A unique tag name for the nuclide will be appended.

Use: ☒ temperatures
List of temperatures to broaden the data to (K).

Use: ☐ reactions
List of MTs to broaden. By default 1 (total), 2 (elastic), 18,19,20,21 and 38 (fission) and 102 (capture) are broadened

Use: ☐ mt_option
Add additional reaction values to be broadened

Use: ☒ input
Name of the AMPX input files to create. Tag name will be appended

Use: ☒ evals
Pick Endf xml summary listing or an endf file

Use: ☐ absolute ☐
Should files names in the input file appear as typed

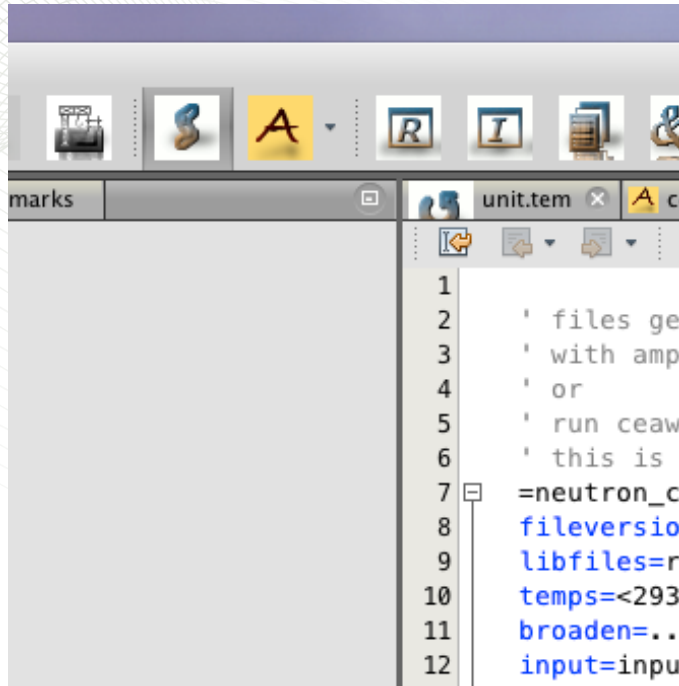
MG library templates

- For multigroup libraries, the following templates are needed
 - point1d
 - neutron_mg
 - bondarenko_prob or bondarenko
 - bind_mg
 - combine_mgs
- If there are no thermal moderators, Template Master combines all the above steps into one template
- Thermal moderators are more complicated, as thermal evaluations from one ENDF file must be combined with one or more fast evaluations from a different ENDF file

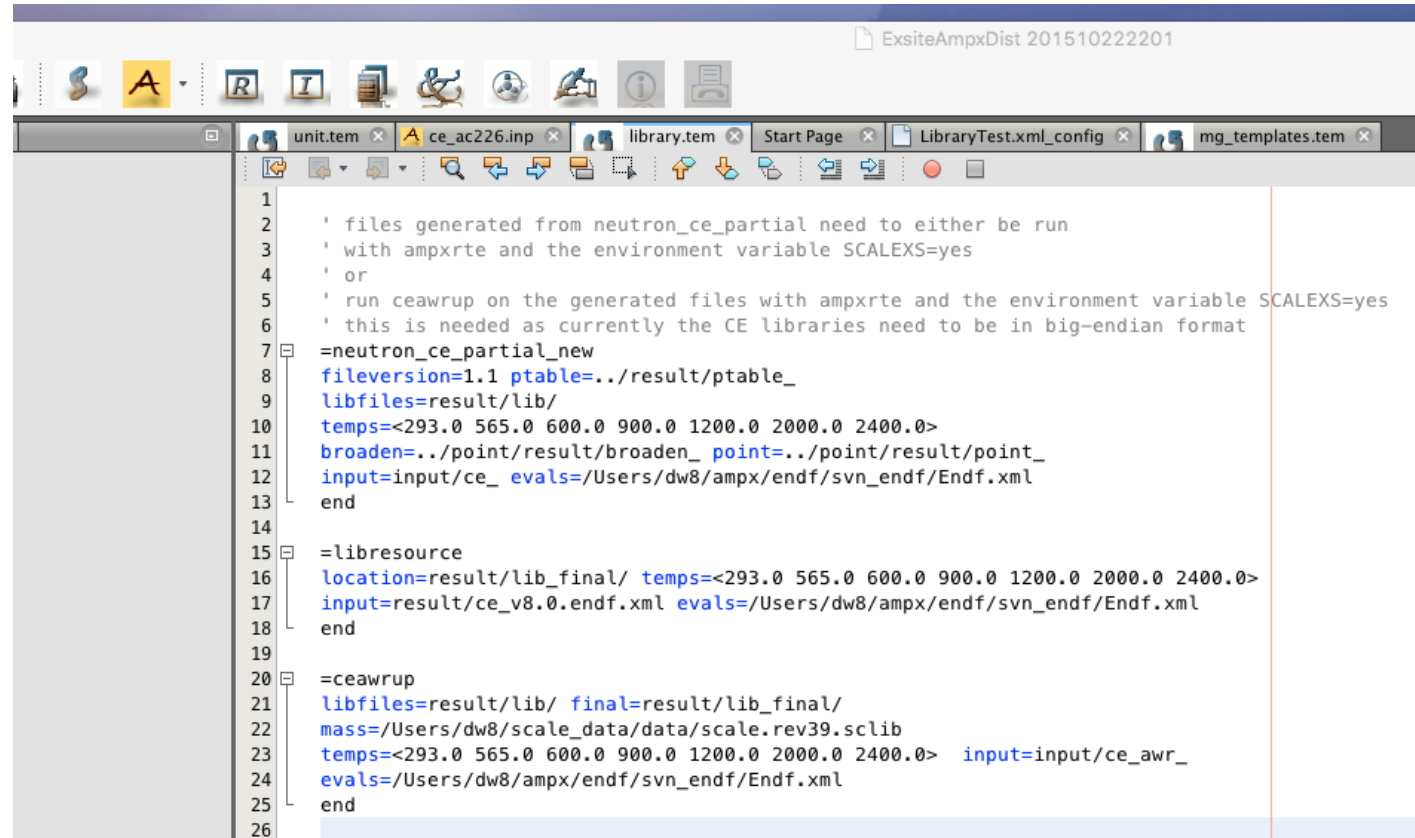
MG library templates (continued)

```
' Generate a MG library for incident neutrons containing  
' 1d and 2d neutron data  
'  
] =neutron_mg  
master=result/neut_ temperature=293  
broaden=result/broaden_ neutgroups=252  
thermalgroups=97 weighting=4  
thermaltemp=<293.0 800>  
input=input/neut_  
evals=endf/LibraryTest.xml  
- end  
  
'  
' Generate NR bondarenko data. A neutron library generated  
' by neutron_mg is needed. The desired background values are  
' given in sig0 and the desired temperature are in  
' temps.  
] =bondarenko  
master=result/bond_ broaden=result/broaden_  
n1d=result/neut_ temperature=293 neutgroups=252  
thermalgroups=97  
sig0=<1.0E8 1000000.0 100000.0 10000.0 1000.0 100.0 10.0 1.0 1.0E-6>  
temps=<293.0 800>  
input=input/bond_252_ evals=endf/LibraryTest.xml  
- end
```

MG library templates (continued)



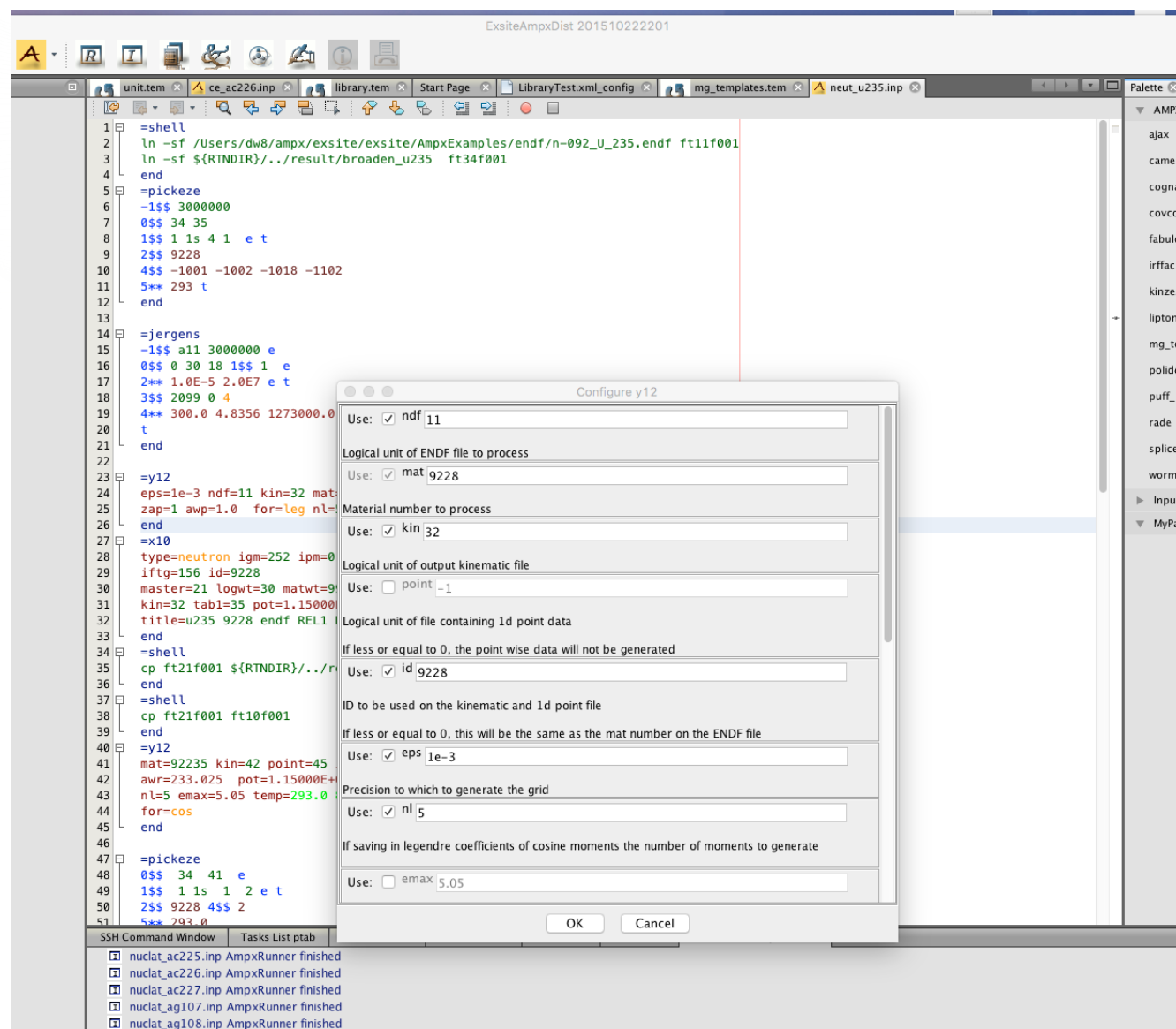
```
1  
2 ' files ge  
3 ' with amp  
4 ' or  
5 ' run ceaw  
6 ' this is  
7 =neutron_c  
8 fileversio  
9 libfiles=r  
10 temps=<293  
11 broaden=..  
12 input=inpu
```



```
ExsiteAmpxDist 201510222201  
unit.tem x ce_ac226.inp x library.tem x Start Page x LibraryTest.xml_config x mg_templates.tem x  
1  
2 ' files generated from neutron_ce_partial need to either be run  
3 ' with ampxrte and the environment variable SCALEXS=yes  
4 ' or  
5 ' run ceawrup on the generated files with ampxrte and the environment variable SCALEXS=yes  
6 ' this is needed as currently the CE libraries need to be in big-endian format  
7 =neutron_ce_partial_new  
8 fileversion=1.1 ptable=../result/ptable_  
9 libfiles=result/lib/  
10 temps=<293.0 565.0 600.0 900.0 1200.0 2000.0 2400.0>  
11 broaden=../point/result/broaden_ point=../point/result/point_  
12 input=input/ce_ evals=/Users/dw8/ampx/endl/svn_endf/Endf.xml  
13 end  
14  
15 =libresource  
16 location=result/lib_final/ temps=<293.0 565.0 600.0 900.0 1200.0 2000.0 2400.0>  
17 input=result/ce_v8.0.endf.xml evals=/Users/dw8/ampx/endl/svn_endf/Endf.xml  
18 end  
19  
20 =ceawrup  
21 libfiles=result/lib/ final=result/lib_final/  
22 mass=/Users/dw8/scale_data/data/scale.rev39.sclib  
23 temps=<293.0 565.0 600.0 900.0 1200.0 2000.0 2400.0> input=input/ce_awr_  
24 evals=/Users/dw8/ampx/endl/svn_endf/Endf.xml  
25 end  
26
```

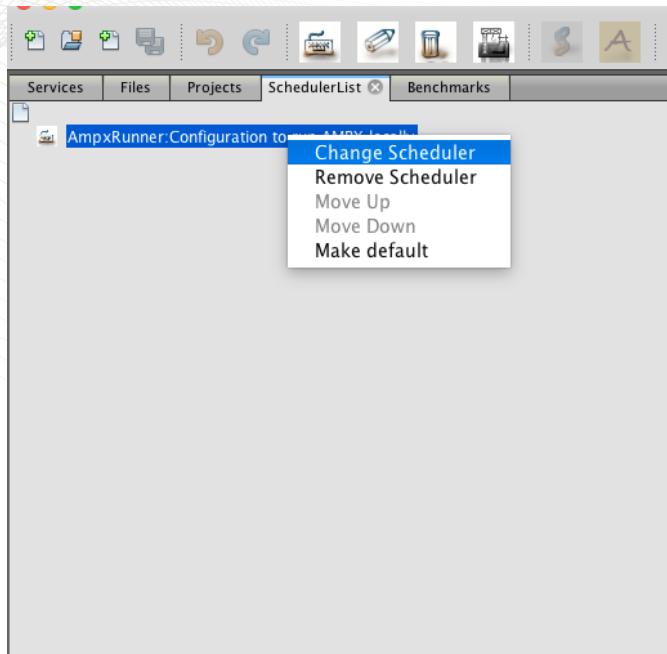


This will generate input files that can be viewed in ExSite



Input files can be run as follows

- From the command line using the usual SCALE commands (ampxrte is the preferred way)
- From the graphical user interface (GUI) if pressing the Ampx button (if set up correctly - see next slide)
- From the GUI in batch mode, if the system does not have a queuing system



5 | =pickeze
6 | -1\$\$ 3000000
7 | 0\$\$ 34 35
8 | 1\$\$ 1 1s 4 1 e t
9 | 2\$\$ 9228
10 | 4\$\$ -1001 -1002 -1018 -1102

Change Scheduler

Name: AmpxRunner

Description: Configuration to run AMPX locally

Type: local

Host:

Directory:

Scheduler: /Users/dw8/ampx/ampx_scale/build/install/bin/scheduler

RSH command:

Custom Data

Program: /Users/dw8/ampx/ampx_scale/build/install/bin/ampxrte

Switches:

Output Extension: ☒ Retrieve ☐ Append

Message Extension: ☒ Retrieve

44 | for=cos
45 | end
46 |
47 | =pickeze
48 | 0\$\$ 34 41 e
49 | 1\$\$ 1 1s 1 2 e t
50 |

To test the new libraries, there are a few templates that set up SCALE input files

- Allnucinf: infinite medium cases for all nuclides in the library
- Allnuclat: pincell cases for all nuclides in the library
- cf_leak_unit: ^{252}Cf source in a sphere for each nuclide
- cf_trans_unit: transmission through a block of material for each nuclide

Intermediate resonance factors

- The templates outlined above generate narrow resonance factors (Bondarenko-factors)
- In conjunction with some SCALE modules, AMPX can also generate intermediate resonance (IR) factors using homogeneous and heterogeneous lattices
- The current SCALE libraries contain homogenous IR factors for $Z > 40$ and heterogeneous IR-factors for some selected nuclides
- The template `ffactor` generates input files for homogenous IR factors

Summary

- AMPX is used to generate MG and CE libraries for SCALE
- Covariance libraries and decay libraries can also be generated
- With the help of ExSite, it is easy to generate SCALE libraries from ENDF data
- Templates in ExSite generate SCALE input files to demonstrate how the MG and CE libraries are to be used