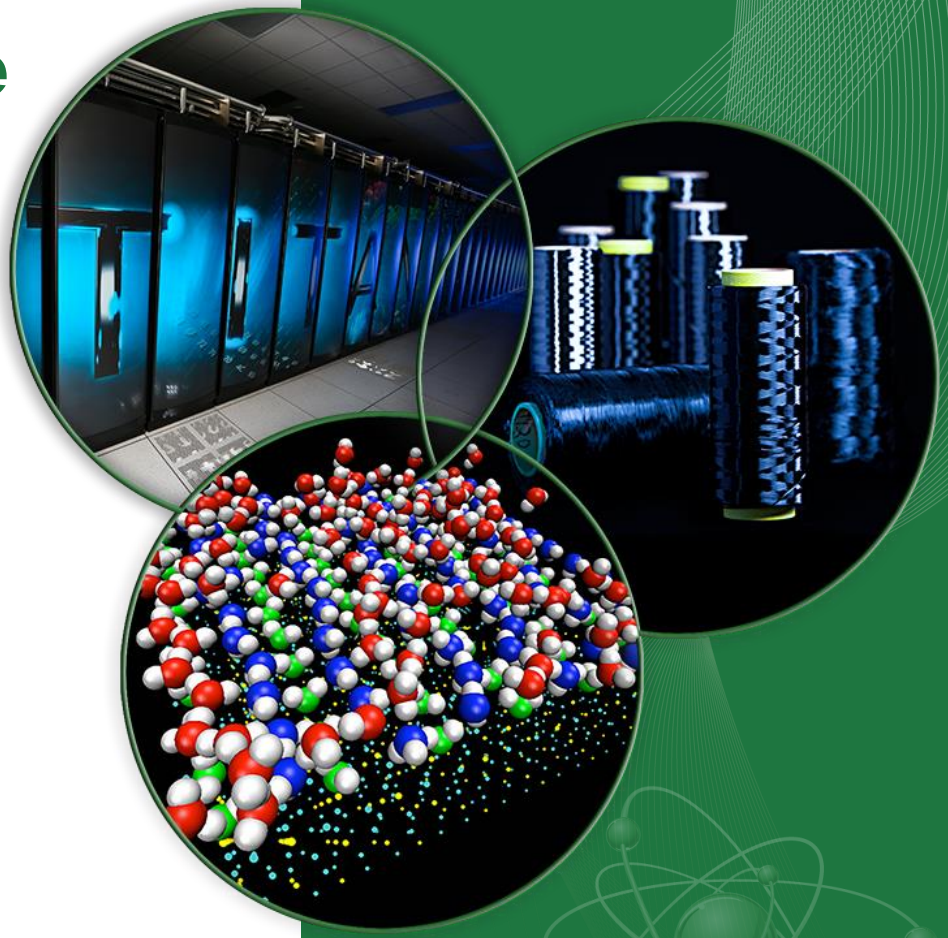
The CINDER08 Library Maker Code



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Outline

- History of CINDER libraries
- Motivation for the LIBRARY MAKER tool
- Code overview
- Input data for LIBRARY MAKER
- The data selection process
- Example input file
- Example output

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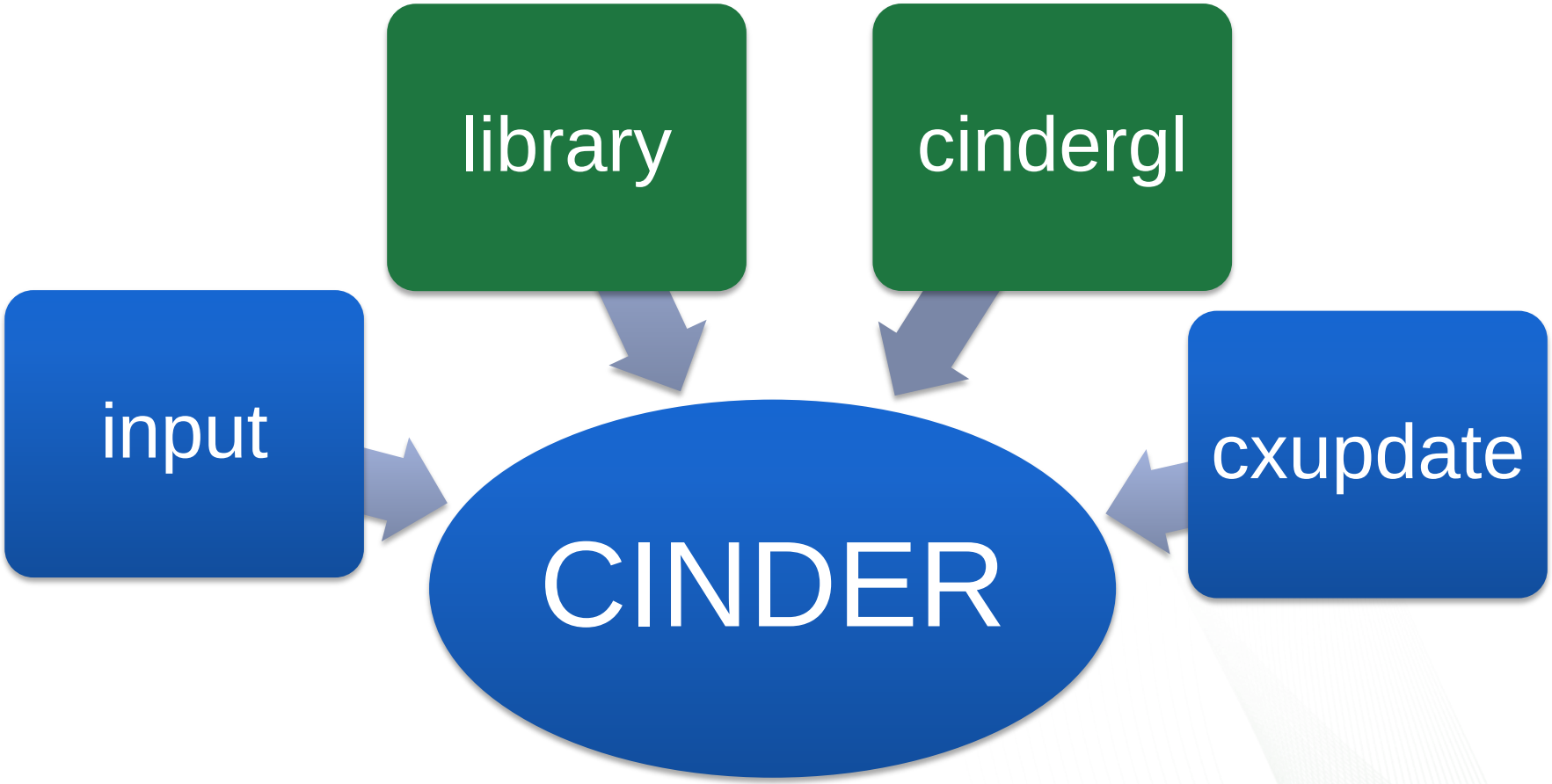
CINDER2008 Inputs



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CINDER Library History

- CINDER90 came with one library containing all activation relevant information:
  - decay times
  - neutron activation cross sections
  - branching ratios
  - fission yields
  - hazard classification factors
  - decay gamma spectra
- Fixed multigroup activation cross sections
- Fixed multigroup decay gamma spectra
- User could provider library inforamtion thu CXUPDATE file

Biggest STRENGTH = Biggest WEAKNESS

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CINDER08 Changes to Library Concept

- Provide three libraries (fission, fusion, flat weighted)
- Provide detailed decay gamma library separate from general library (cindergl.dat)
- Provide a tool to cast user specific libraries

LIBRARY MAKER CODE

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LIBRARY MAKER Overview (1)

- Was developed at LANL by Shannon Holloway together with the CINDER08 code: both are written in FORTRAN90
- Generates a CINDER library (multi-component isotopic data sets)
- Fits together consistent isotopic information from different data sources
- Makes choices picking nuclear data from multiple data library sources
- Was actually used to produce the standard CINDER08 libraries

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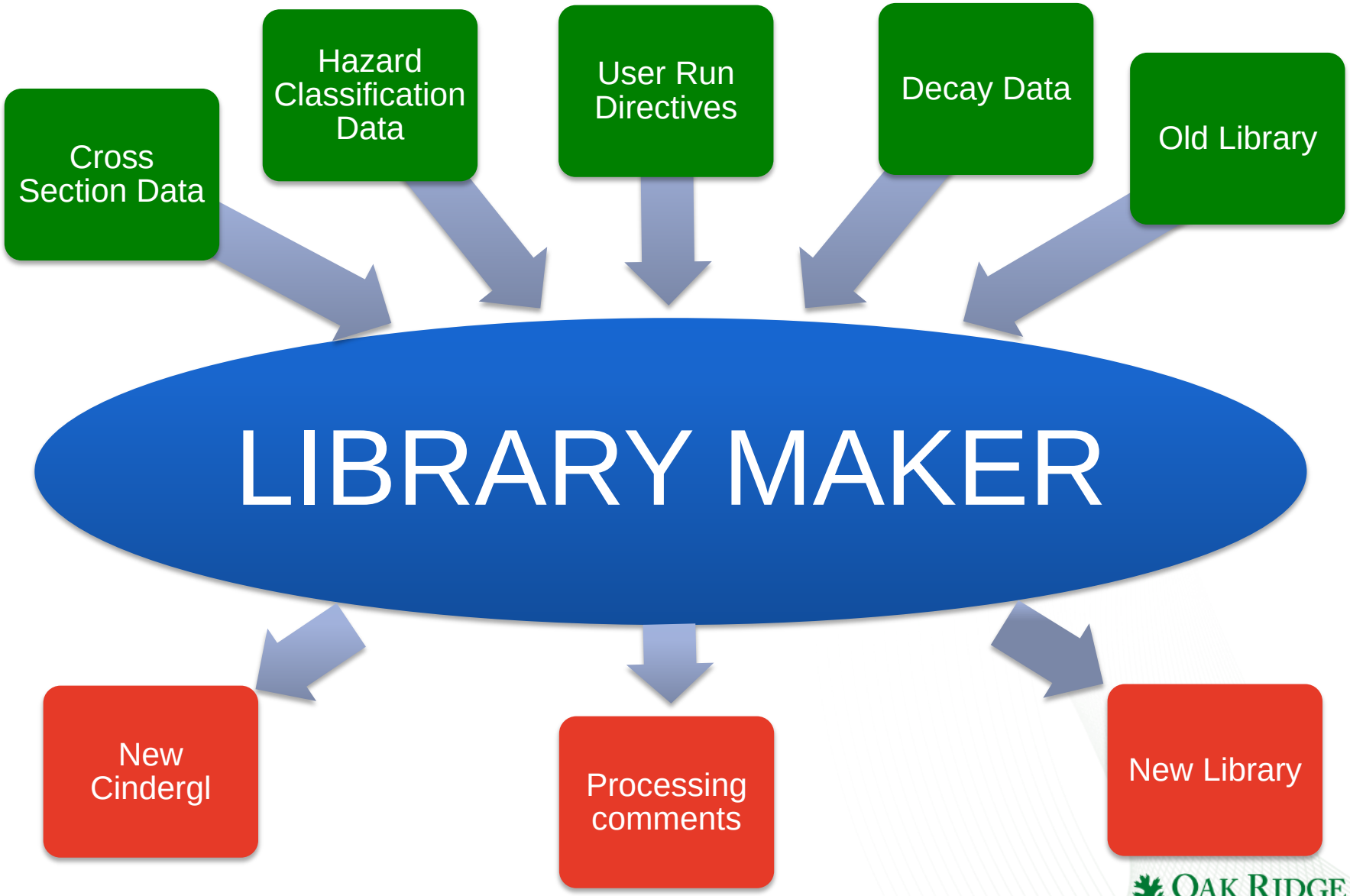
LIBRARY MAKER Overview (2)



Decay Data Files

- Decay source files have to be in ENDF-6 format
- Contain: half lives, isotope characteristica (excitation energy, spin, parity, abundance, half-life, decay modes), decay products, decay product energies
- All covered isotopes of a source (ENDF/B, JEF, JENDL …) are contained in one file
- As many as 10 sources can be considered

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Activation Cross Sections

- Provided in GENDF format (groupwise ENDF)
- Processed from ENDF formated libraries by NJOY code with the GROUPR module
- Cross sections are in one file per isotope identified by the ENDF MAT number
- Cross sections are provided in directories corresponding to a specific source (ENDF-B-VII.1, JEF3.3 …)
- Cross sections from as much as 10 sources can be considered

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Hazard Classification File

- Provides air and water dilution factors and CAT3 hazard classification values for analyses of nuclear hazards according US-CFR (could be substituted by other country specific information)

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Fission Yield Data

- The fission yield data are fixed for now and based on ENDF/B-VI
- Main reason why an old library has to be provided as starter

Data Selection

- Option of building complete library or supplementing/modifying library
- In case multiple decay sources are provided:
  - data for a specific isotope are picked from the first source of a ranked list
  - data for isotopes with beta decay the first source providing decay gamma information is picked
- In case of multiple activation cross section sources:
  - the source with the most complete (abundant) reaction branches is picked
  - If multiple sources provide equally complete data, the ranking of the source listing is decisive
  - Also mixing of partial cross sections from different sources is possible

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Example setup

```
~/input
  cfr.dat
  C08lib_fission.b8
  cindergl.dat
  new_library
  new_cindergl.dat
  processing_comments
~/decay/endfb-vii.1/decay_endfb-vii.1-all
~/xs/list_endfb7.1
~/xs/e71/n-ENDF-B-VII.1.endf.list_short
        /fission/mat8225
                 mat8231
                 mat8234
                 mat8237
        /fusion/mat8225
                mat8231
                mat8234
                mat8237
        /flat/mat8225…
```

Example Input

```
CINDER
 CINDERLIB = 'C08lib_fission' ,
 USE_CINDER = .TRUE. ,
 MAX_NBR_PROTONS = 104 ,
 CINDERGL = 'cindergl.dat'
/

&INITIALIZE
 NUM_DEC_FILES = 1 ,
 NUM_ABS_FILES = 1 ,
/

&DEC_FILE_INFO
 ENDF6_FILE(1) = 'decay/endfb-vii.1/decay-endfb-vii.1-all' ,
 DECAY_FILE_REF(1) = 'E71' ,
/
```

Example Input (cont)

```
&GAMMA_SPECTRA
/

&ABS_FILE_INFO
 DIR(1) = 'xs/e71/fission/' ,
 PREFIX(1:2) = 'mat' ,
 ABS_FILE_REF(1) = 'E71' ,
 MAT_LIST_FILE(1) = 'xs/e71/n-ENDF-B-VII.1.endf.list_short' ,
 LAST_RESORT = 0 ,
/

&USER_CHOICES
 SINGLE_LIB = .TRUE. ,
/

&LIBRARY_HEADERS
 LIB_DESCRIPTION = 'CINDER TEST LIBRARY' ,
 NEUTRON_GRP_STRUCTURE = 'FISSION 66-GROUP STRUCTURE' ,
/
```

Library Modifications

```
#3524: 2060820  Pb206     H-L=   STABLE    DKref:E70 LEVEL_E: 0.0000E+00
SPIN:   0.0 PARITY:  1.0
  NO (N,F) CROSS SECTION
...
 #3395: 1990780 Pt199   PRODUCED BY ( 2A ) REF: E70 GROUPS =  66- 64
  0.0000E+00  5.1148E-10  5.5621E-11
   #3438: 2010800 Hg201   PRODUCED BY ( 2NA ) REF: E70 GROUPS =  66- 63
  0.0000E+00  1.6486E-06  6.9568E-08  1.1815E-11
```

```
#3524: 2060820  Pb206     H-L=   STABLE    DKref:E70 LEVEL_E: 0.0000E+00
SPIN:   0.0 PARITY:  1.0
  NO (N,F) CROSS SECTION
...
 #3395: 1990780 Pt199   PRODUCED BY ( 2A ) REF: E71 GROUPS =  66- 64
  0.0000E+00  2.7856E-10  2.9628E-11
   #3396: 1990781 Pt199m1 PRODUCED BY ( 2A* ) REF: E71 GROUPS =  66- 64
  0.0000E+00  2.3272E-10  2.5978E-11
   #3438: 2010800 Hg201   PRODUCED BY ( 2NA ) REF: E71 GROUPS =  66- 63
  0.0000E+00  1.6472E-06  6.9402E-08  1.1805E-11
```

Conclusion

- LIBRARY MAKER will allow for flexible build and modifications of custom libraries for CINDER08 applications
- The tool will be included in the upcoming release of the CINDER08 package
- Test problems of library modifications will be provided with the package

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