

The ACTIVATION / GAMMA_SOURCE Interface to CINDER2008

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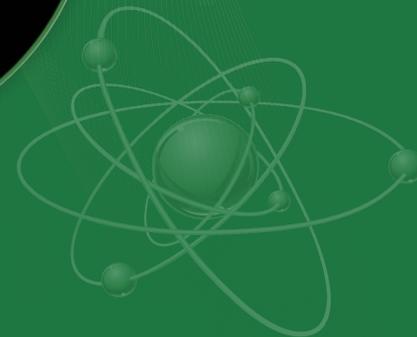
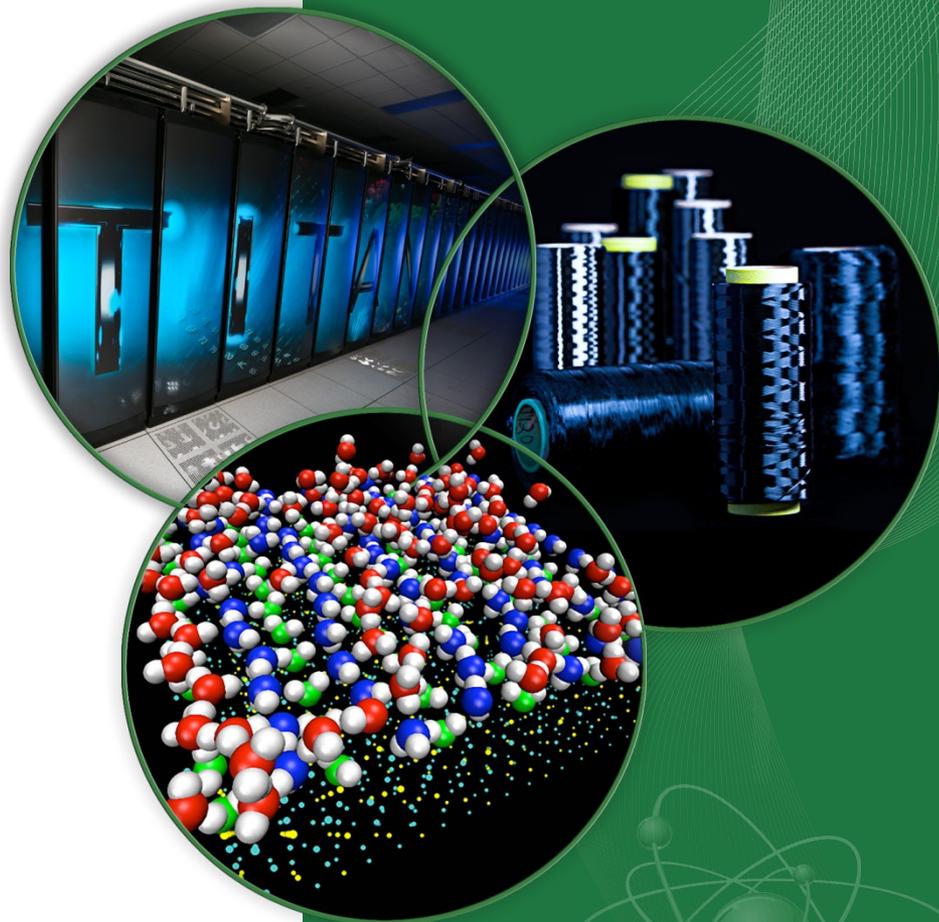
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Outline

- Previous talk described CINDER2008 – a new and improved version of the CINDER code
 - While CINDER2008 runs better and does more consistent calculation, the input preparation is still challenging
- This talk will describe an interface to CINDER2008 which
 - Comes in a “make-style” package
 - Provides a script-based mechanism for preparing the input files necessary to perform CINDER2008 execution
 - Processes the output files from a CINDER2008 run
 - Interfaces the CINDER2008 code to MCNPX transport
- Next talk will describe Library_Maker to modify and update cross section libraries

What's in the Box...

- CINDER2008 code as distributed directly by LANL
 - Very slight modifications to make more robust compilation
 - 3 sample problems check compilation / numerical consistency
- ACTIVATION – a perl script to process MCNPX output, prepare CINDER2008 inputs, and run CINDER2008
 - Ten sample problems check execution (needs MCNPX)
- GAMMA_SOURCE – perl script to turn CINDER2008 output into SDEF card for further MCNPX transport
 - Two ACTIVATION sample problems also use GAMMA_SOURCE
- All sample problems provide example inputs as well as test codes

But Wait – There's More!

- A hierarchical Makefile system to:
 - Compile CINDER2008 and POST
 - Test CINDER2008 and POST
 - Tests execution and checks to see if answers are numerically equivalent to development machine
 - Test ACTIVATION and GAMMA_SOURCE
 - Requires MCNPX; and does not check numerics
 - Installs in system-wide location and tests installation
- Patchfiles for MCNPX provide spallation products without histp file
- Library_Maker code and example problem

Typical Workflow

- MCNPX calculation provides neutron fluxes (tabular region) and spallation products (model region)
- MCNPX output provides well-formatted duplicate of input for cell properties and material compositions
- ACTIVATION script processes MCNPX outp (and histp) files together with normalization (i.e., power) history and runs CINDER2008 to produce inventories at specified time steps
- GAMMA_SOURCE processes ACTIVATION / CINDER2008 output to produce SDEF card for second MCNPX run
- MCNPX run provides (possibly self-shielded) dose rates from radionuclide inventory

Initial MCNPX Calculation

- Must properly equip MCNPX input file:
- An f4:n tally provides cell-averaged neutron fluxes with “appropriate” energy binning
 - Matching energy binning to standard libraries is best
 - No multiplier bins or FQ card
- Spallation products (i.e., residual nuclei from model region) written to histp file or with “rnucs” card from included patchfile
 - If you don't use one, you don't get those nuclei
 - histp file will be used in three htape3x calculations
- Table 60 provides cell information in outp file
- No repeated structures or lattices

Example MCNPX Input (Excerpt)

```
...
c      ---- cell cards ----
      10  4  -6.49          -1          $  first target disk, Zr
      20  6 -16.6           -2          $  second target disk, Ta
      30  1 6.31402E-02     -3          $  third target disk, W
      40  3 8.67377E-02     -4          $  graphite beamstop
      50  2 7.49809E-02     -30 20      $  concrete wall (albedo)
...
c      ---- data cards ----
...
phys:n 2500 3j 20
phys:h 810.0 0 1.0 j 0 j
c
sdef  x=d1 y=d2 z=-0.1 vec=0 0 1 dir=1 erg=800 par=9
c sigmax = sigmay = 1.0 cm
sp1 -41 2.35482 0
sp2 -41 2.35482 0
c
prdmp  j -15 j 1
histp  10 20 30 40
nps    5000
print  40
```

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      50  2 7.49809E-02     -30 20      $  concrete wall (albedo)
...

```

```
...
c      ---- data cards ----
```

Use models for neutrons over 20 MeV and protons

```
phys:n 2500 3j 20
phys:h 810.0 0 1.0 j 0 j
```

```
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histp 10 20 30 40
nps 5000
print 40
```

histp provides spallation products in desired cells

Example MCNPX Input (Tallies)

Cell-averaged fluxes for same cells called out in histp card

```
c
f4:n 10 20 30 40
e4    1e-10 1e-9 1e-8 1e-7
      4.1400E-07 1.1200E-06 3.0600E-06 1.0700E-05 3.7300E-05
      1.0100E-04 2.1400E-04 4.5400E-04 1.5800E-03 3.3500E-03
      1.5000E-02 2.1900E-02 2.4200E-02 3.1800E-02 5.2500E-02
      1.1100E-01 1.5800E-01 2.4700E-01 3.6800E-01 4.9800E-01
      6.0800E-01 7.4300E-01 8.2100E-01 1.1100E+00 1.4200E+00
      1.8300E+00 2.2300E+00 2.3500E+00 2.4700E+00 3.0100E+00
      3.6800E+00 4.9700E+00 6.0600E+00 7.4100E+00 8.6100E+00
      1.0000E+01 1.2200E+01 1.4200E+01 1.4900E+01 1.6900E+01
      2.0000E+01
```

ACTIVATION Input File Excerpt

- Code Names
- Title Lines
- File Names
- Run Options
- Cinder Options
- Normalization
- History
- Cell List

```
title_lines
  WNR Target 4
  test targets

files
  mcnp_x_outp act01o
  mcnp_x_histp act01h

run_options
  dname      act01-
  dcounter   1

normalization
  snorm      2.8e13

history
  1 1.0E+00
      1.0E+0 s
  1 0.E0
      30.0 s
  . . .
```

ACTIVATION Input File Excerpt

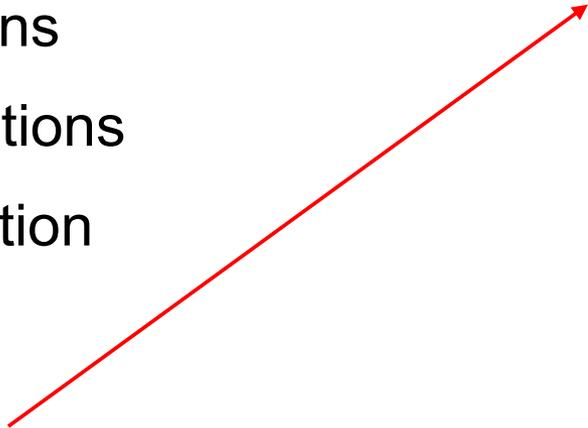
- Code Names
- Title Lines
- File Names
- Run Options
- Cinder Options
- Normalization
- History
- Cell List

```
...
cell_list
  Zr target
  10

cell_list
  Ta target
  20

cell_list
  W target
  30

cell_list
  all targets
  10 20 30
```



Problem Execution

- mcnp_x n=act01
- mv histp act01h
- activation inpact01 outact01

Output

- One of the individual CINDER2008 runs
- Appears in specified subdirectory
- Saves CINDER2008 inputs
- Saves data outputs
- Human outputs

```
% ls -ls act01-1
total 22232
   864 alldnz
   180 brief
  1620 discrete
     4 fluxes
     4 input
     4 lastab
     4 locate
     4 material
 14012 newshort
   656 results
    40 score
  2060 spectra_activity
     8 spectra_h
     8 spectra_l
  2060 spectra_ts_decay
     4 splprods
    52 tables_by_element
   136 tables_by_grp
    32 tables_by_major
    92 tables_by_mass
   388 tables_by_nuclide
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Installation via Makefile

- Basic Unix / Linux installation, works with suitable Windows and Mac as well
- Tested with gfortran, Intel, Portland, Lahey, etc.
- Installs into [/usr/local/]cinder08
- Includes precompiled executables

Summary

- ACTIVATION and GAMMA_SCRIPT provide a more convenient interface to CINDER2008
- The distribution package provides a tested clean, reproducible installation
- Ongoing collaboration intends to continue improving performance and utility, including post-processing analysis and visualization
- Anticipate RSICC release later in 2015