RAPID Demonstration

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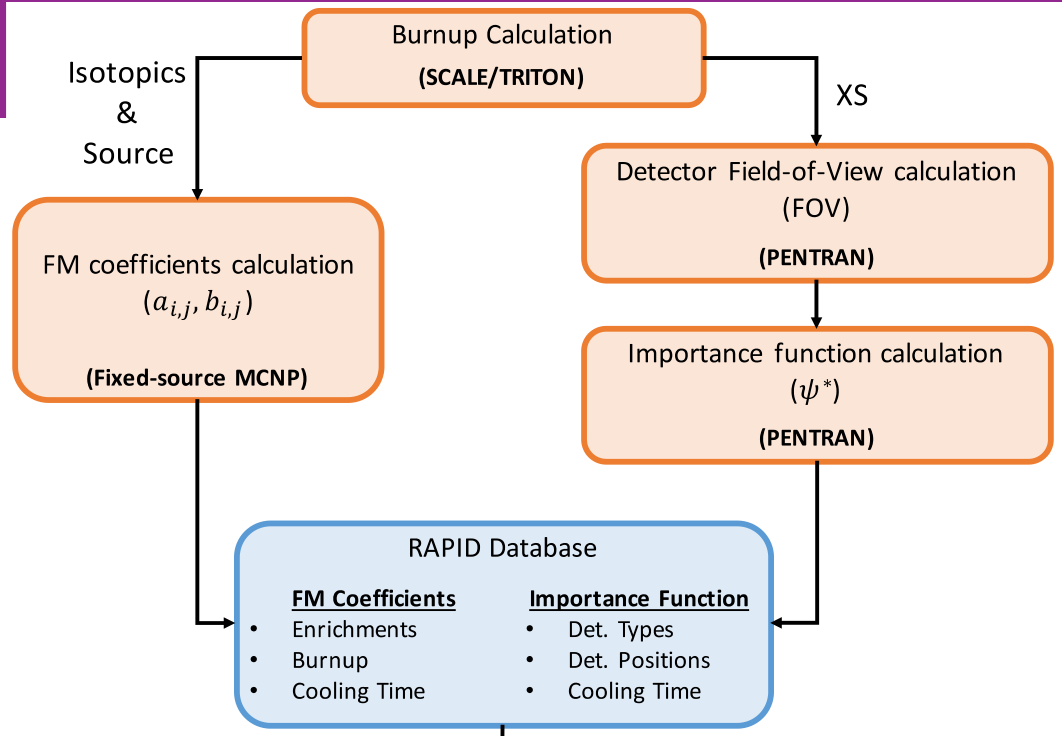
Outline

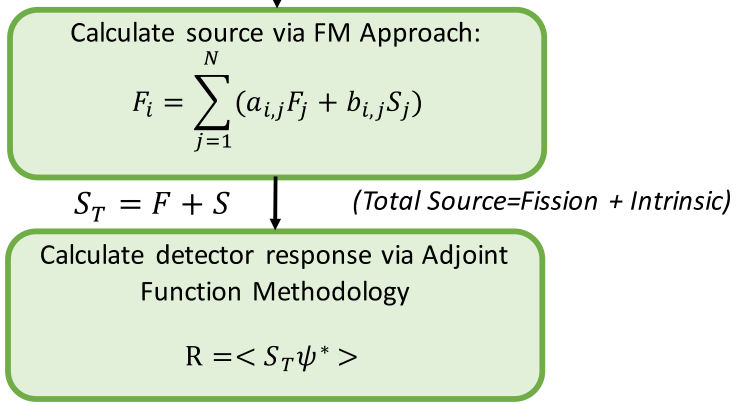
- RAPID Code System Structure
- Description of Inputs and Outputs
- RAPID Demonstration
  - Spent Fuel Pool Calculation – loaded with assemblies of various burnups & cooling times
  - Full Cask Calculation – loaded with fresh fuel assemblies

RAPID Code System Structure

One-Time Pre-Calculation



Real-Time Calculation



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RAPID : One-time Pre-calculation
What must a user do?

For "standard" pools and Casks:

a. Modify sample input for SCALE for your application, or use your preferred software to obtain the following information:
   - material composition & source as a function of enrichment, burnup, cooling time, etc.

For "specific" applications

a. Prepare an input for SCALE
b. Prepare an input for MCNP

RAPID Driver –
Pre- and Post- Processing for RAPID (P3RAPID)

```
p3RAPID - Pre- and Post-Processing for RAPID
This is a script for creating, running, and processing FM coefficients.
This script is also used to automatically plot RAPID calculation results.

EXECUTION:
./prapid $1 $2 $3 $4
  $1 - Run Mode (see below)
  $2 - Assembly Type (available: 1)
  $3 - Burnup  (available: 1, 2, 3, 4, 5)
  $4 - Cooling Time  (available: 1, 2, 3, 4)

RUN MODES:
  -rs : run SCALE calculation
  -ps : process SCALE calculation outputs
  -mm : make & test MCNP input files
  -rm : run all MCNP input files
  -pm : process completed MCNP calculations & clean directory (upon prompt)
  -cm : create MCNP reference model
 -plt : plot RAPID fission density (no inputs required)
      : -g option will create animated GIFs of fission density (no inputs required)
   -h : this help menu (no $2-$4 required)
```

RAPID Input & Output Files

I/O	Directory	File	Description
INPUT	./	`rapid.inp`	Main RAPID input
	./	[*name*]`.inp`	Pool layout definition
	./	`blinky.txt`	RAPID output header
	./db/	`db.inp`	Database configuration
	./db/	`matmap.inp`	Assembly material map
	./db/	`bndcor.dat`	Axial boundary correction factors
	./db/a*/	*	Database files; multiple directories possible.
OUTPUT	./	[*name*]`.log`	RAPID run log
	./	[*name*]`_db.dat`	Database summary
	./	[*name*]`_fis2d.dat`	2D fission denisities (FDs)
	./	[*name*]`_fis3dc.dat`	3D collapsed FDs
	./	[*name*]`_fis3d.dat`	Full 3D FDs

rapid.inp – Algorithm Execution Parameters

```
1  2x2FM
2  / nz nzr nzb npins nxp nyp
3  144 29 12 336 19 19
4  / nzf nar nars
5  3 2 2
6  /sor ktolp ktols, maxkp, maxks
7  1.87 1e-7 1e-7 300 300
8  /usebnd useslope isk mode
9  0 1 1 0
10 /ncollapsexy
11 3
12 /cmap
13 6 7 6
```

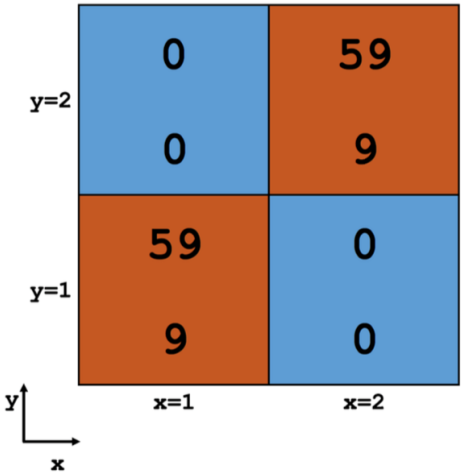
Problem Name

General Assembly Info

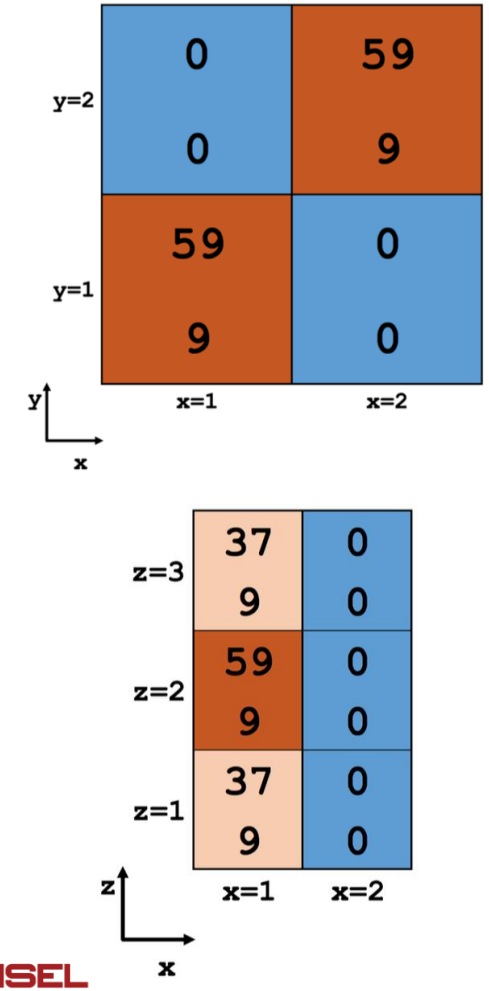
Convergence Parameters

Problem Type

Coefficient Handling



'problemname'.inp – Problem Material Distribution




```
1  /nxa, nya, nza
2  2 2 3
3  /Cooling Time Distribution (years), size=nxa X nya
4  9 0
5  0 9
6  /Assembly Type Distribtion, size=nxa X nya
7  /iza=1
8  1 1
9  1 1
10 /iza=2
11 1 1
12 1 1
13 /iza=3
14 1 1
15 1 1
16 /Burnup Distribution (MWd/MTHM), size= nxa X nya for each iza
17 /iza=1
18   37254      0
19        0 37254
20 /iza=2
21   59169      0
22        0 59169
23 /iza=3
24   37254      0
25        0 37254
```

X,Y,Z Number Assemblies

Cooling Time (Years)

Assembly Type

Burnup (MWd/MTHM)

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Example Problems Descriptions

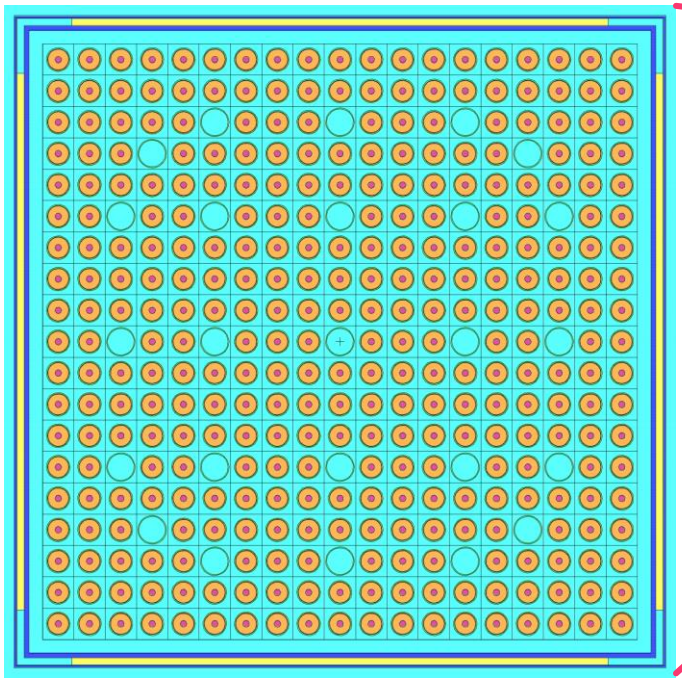
I2S-LWR 9x9 Spent Fuel Pool

I2S-LWR FUEL ASSEMBLY

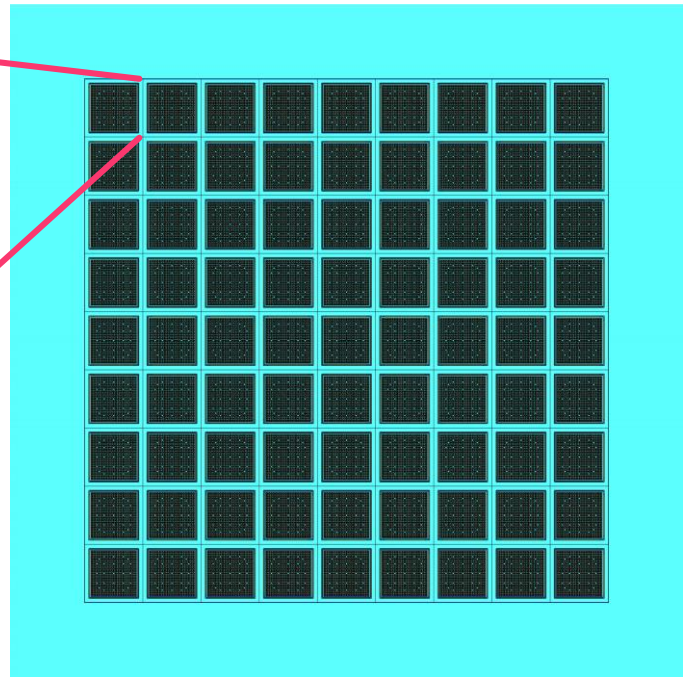
- 19x19 fuel lattice
  - 335 fuel rods, 24 control/guide tubes, 1 instrumentation tube
- U_3Si_2 fuel enriched to 4.95 wt-% ^{235}U

SPENT FUEL POOL

- Based on AP1000 SFP
- Consider a 9x9 segment of SFP (81 assemblies)
- Storage cell walls made of Metamic® (B4C-Al) between SS plates



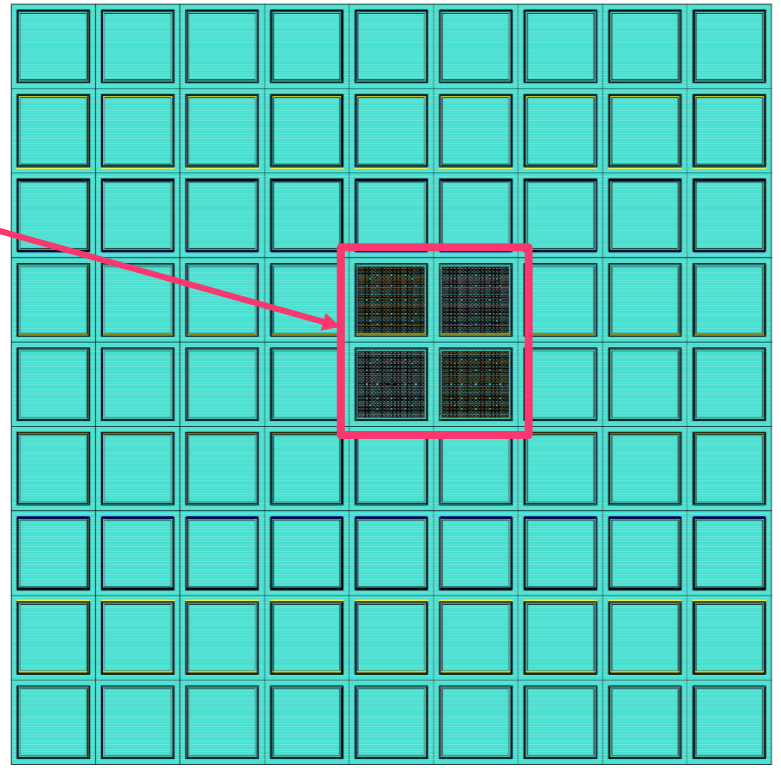
Assembly in a Storage Cell



9x9 Segment of SFP

I2S-LWR Spent Fuel Pool - Test cases

- Performed eigenvalue calculations for a **2x2 segment** of the reference SFP. *Note that the fuel regions of the model are partitions into 32,256 fission regions (tallies).*
  - CASE 1 – Radially Dependent Burnup (Axially constant)
  - CASE 2 – Radially and Axially Dependent Burnup



Description of Test cases – Pool segments

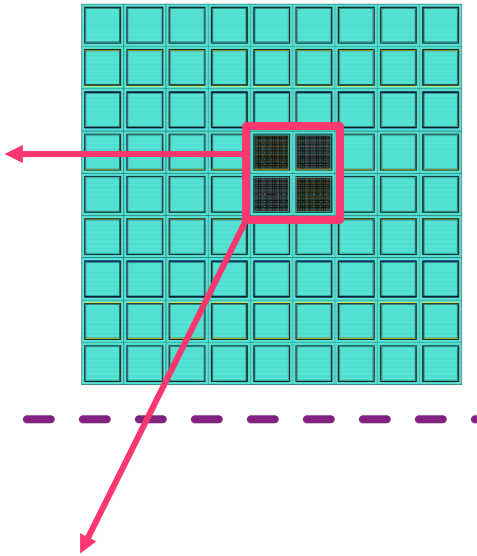
CASE 1 – Axially Constant (Radial Distribution)

0 GWd/MTHM - yr	37 GWd/MTHM 9 yr
37 GWd/MTHM 9 yr	0 GWd/MTHM - yr

0 GWd/MTHM - yr	48 GWd/MTHM 9 yr
48 GWd/MTHM 9 yr	0 GWd/MTHM - yr

0 GWd/MTHM - yr	0 GWd/MTHM - yr
0 GWd/MTHM - yr	0 GWd/MTHM - yr

POOL



CASE 2 – (Radial Distributions)

Z=1

0 GWd/MTHM - yr	0 GWd/MTHM - yr
0 GWd/MTHM - yr	0 GWd/MTHM - yr

Z=2

48 GWd/MTHM 9 yr	37 GWd/MTHM 9 Yr
37 GWd/MTHM 9 yr	48 GWd/MTHM 9 yr

Z=3

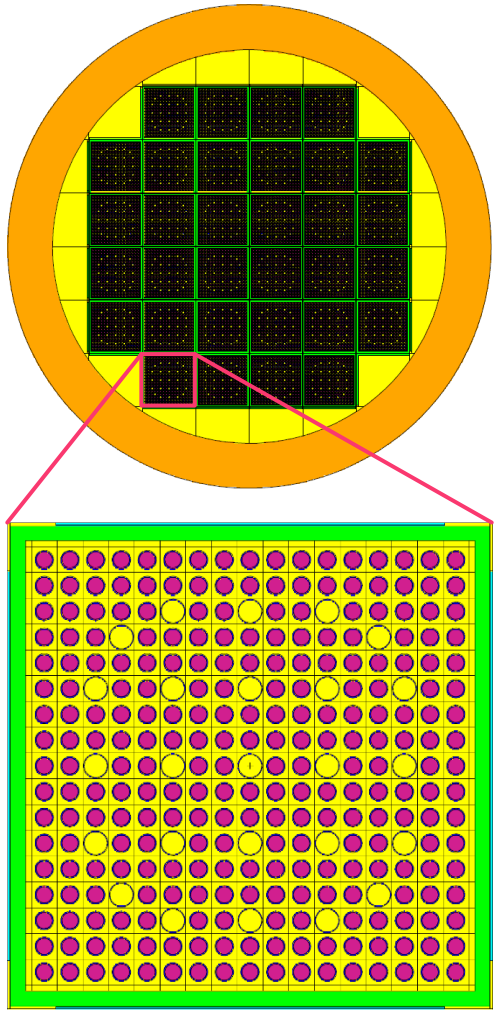
0 GWd/MTHM - yr	0 GWd/MTHM - yr
0 GWd/MTHM - yr	0 GWd/MTHM - yr

*'0 year' cooling time refers to ~14 days

GBC-32 Cask Computational Benchmark

- **Geometry**
  - 32 Fuel assemblies
  - Stainless steel (SS304) cylindrical canister
  - Inter-assembly Boral absorber panels

- **Fuel assembly**
  - 17x17 Optimized Fuel Assembly (OFA)
  - 25 instrumentation guides
  - Fresh UO2 4% wt. enriched fuel pins



Questions?

THANKS