OAK RIDGE National Laboratory

Description and use of the SCALE Sampler Parametric Capability for Engineering Analysis and Optimization with Solutions

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Outline

1. Introduction
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3. Scoping calculations for subcritical limits with solutions
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Introduction

- Sampler was introduced for UQ via random sampling in SCALE 6.2
  - Can sample nuclear data, number densities, and dimensions
- Parametric capability added in 6.2.2 for quantities in input
  - Deterministic sweeps through specified variables
  - Range and number of points both user-specified
  - Provides capability to cover parametric space, including multiple variable sweeps, with no scripting by analyst
- Sampler can also be used to convert between engineering specifications and input parameters
  - Examples: diameters to radii, masses to number densities

Sequence input

- Sampler designed to work with an existing SCALE input
  - CSAS presented here, but Sampler can be used with any sequence
- Each variable to be modified is defined in a variable block
  - Some differences between variable blocks for parametric variables and for random sampling/evaluation variables
  - Variables defined via calculations are evaluated in each parametric input
- New SCALE input written for each parametric case
  - Run within Sampler or normally as standalone SCALE inputs

Sequence input (continued)

- Parametric block provides which variables to sweep and how many points to use
- Multiple variables can be considered in a single calculation
- Sampler generates all combinations of variables
  - Number of cases generated is product of the points for each variable

```
read parametric
   variables= radius conc end
   n_samples= 10     5    end
end parametric
```

Sequence input (continued)

- Variable blocks for variables in the parametric block:
  - Set distribution=uniform
  - Provide minimum and maximum
  - Nominal value is ignored but required to be between min and max
- Values used are calculated as:
  - *n_samples*=1 uses just the minimum
  - *n_samples*=2 uses the minimum and maximum
  - *n_samples*= ≥ 3 creates minimum, maximum, and (n-2) equally spaced additional inputs

Sequence input (continued)

Variable block definition

```
read variable[conc]
   distribution=uniform
   minimum=100 value=150 maximum=200
     cases= conc end
end variable
```

CSAS input (siren or placeholders)

```
Solution mix=1 rho[uo2f2]=100 92235 10
92238   90   molar[hfacid]=5   density=?
temp=300 volfrac=1.0 end solution
```

```
Solution mix=1 rho[uo2f2]=#{conc} 92235
10  92238  90  molar[hfacid]=5  density=?
temp=300 volfrac=1.0 end solution
```

SIREN expressions are also supported to define path to variable without altering SCALE input:

```
siren="/csas5/comps/solution/rho/value"
```

Sequence input (continued)

- Sampler can also be used to create MCNP inputs for code comparisons

Variable block definition

```
read variable[r_inner]
   distribution=uniform
   minimum=10 value=15 maximum=20
   cases= radius end
end variable
Read variable[r_outer]
   distribution=expression
   expression="r_inner+30"
   cases=radius end
End variable
```

MCNP input (placeholders)

```
C surface cards
1 sph 0 0 0 #{r_inner}
2 sph 0 0 0 #{r_outer}
```

Scoping calculations for subcritical limits

- Example 1: SCL for mass of UO_2F_2 solution in spherical tank
- Different concentrations studied with a fixed mass
- Concentration calculated for each radius generated in the parametric sweep

```
read variable[r_inner]
   distribution=uniform
   minimum=17 value=18 maximum=19
end variable
```

```
read variable[conc]
    distribution=expression
   expression="10700/((4/3)*3.1415927
      *r_inner^3)/1000)"
end variable
```

Number of radii generated is set in the parametric block

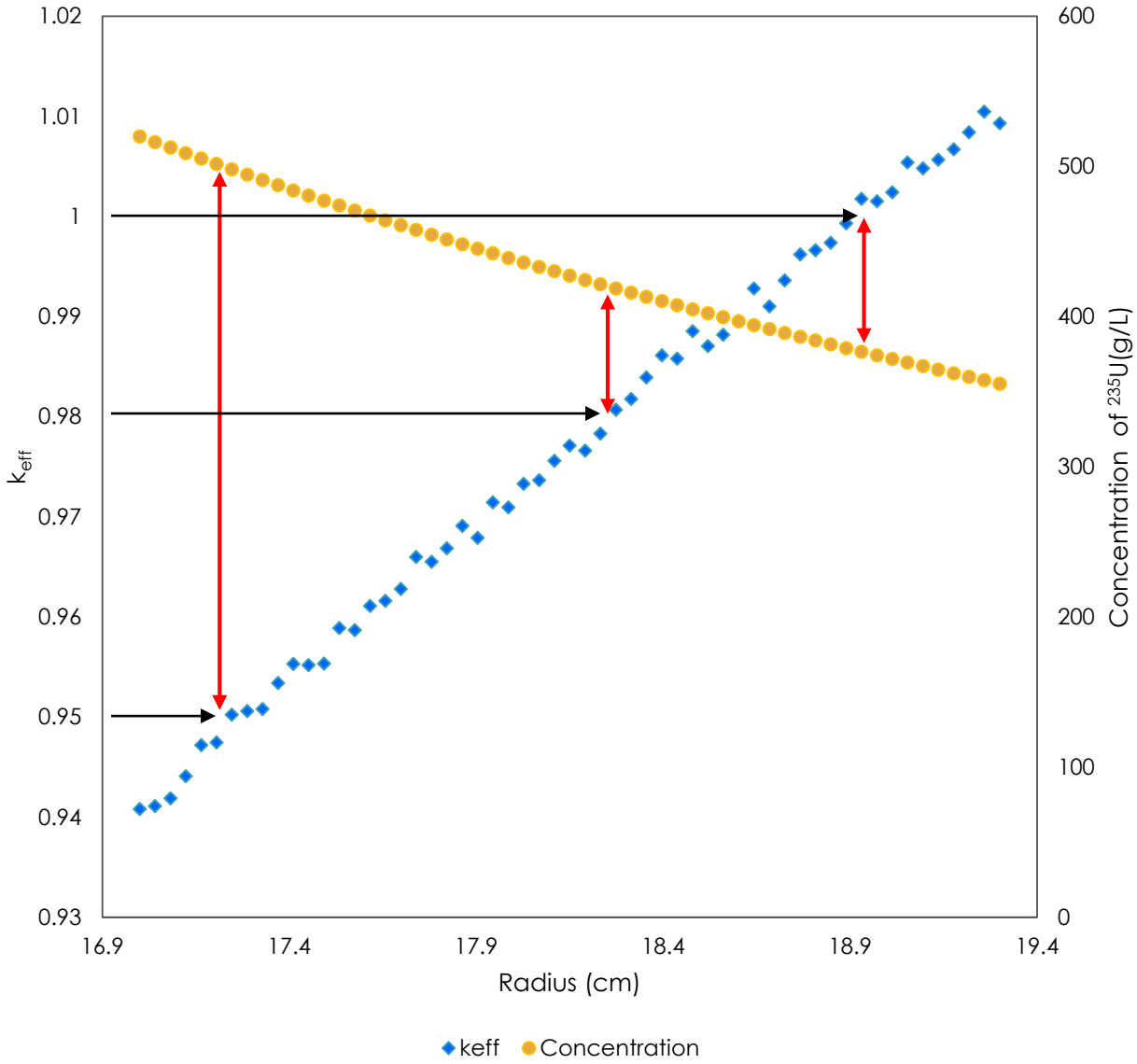
Scoping calculations for subcritical limits (continued)

r_inner	conc	k_{eff}
17	519.93	0.94082
17.0411	516.18	0.94111
17.0821	512.47	0.94189
17.1232	508.79	0.94408
17.1643	505.15	0.9472
17.2054	501.53	0.94746
…	…	…
19	355.32	1.00931

k_{eff} = 0.95 with a 17.28 cm radius and 495.35 g/L

k_{eff} = 0.98 with an 18.26 cm radius and 419.33 g/L

k_{eff} = 1.00 with an 18.92 cm radius and 377.11 g/L

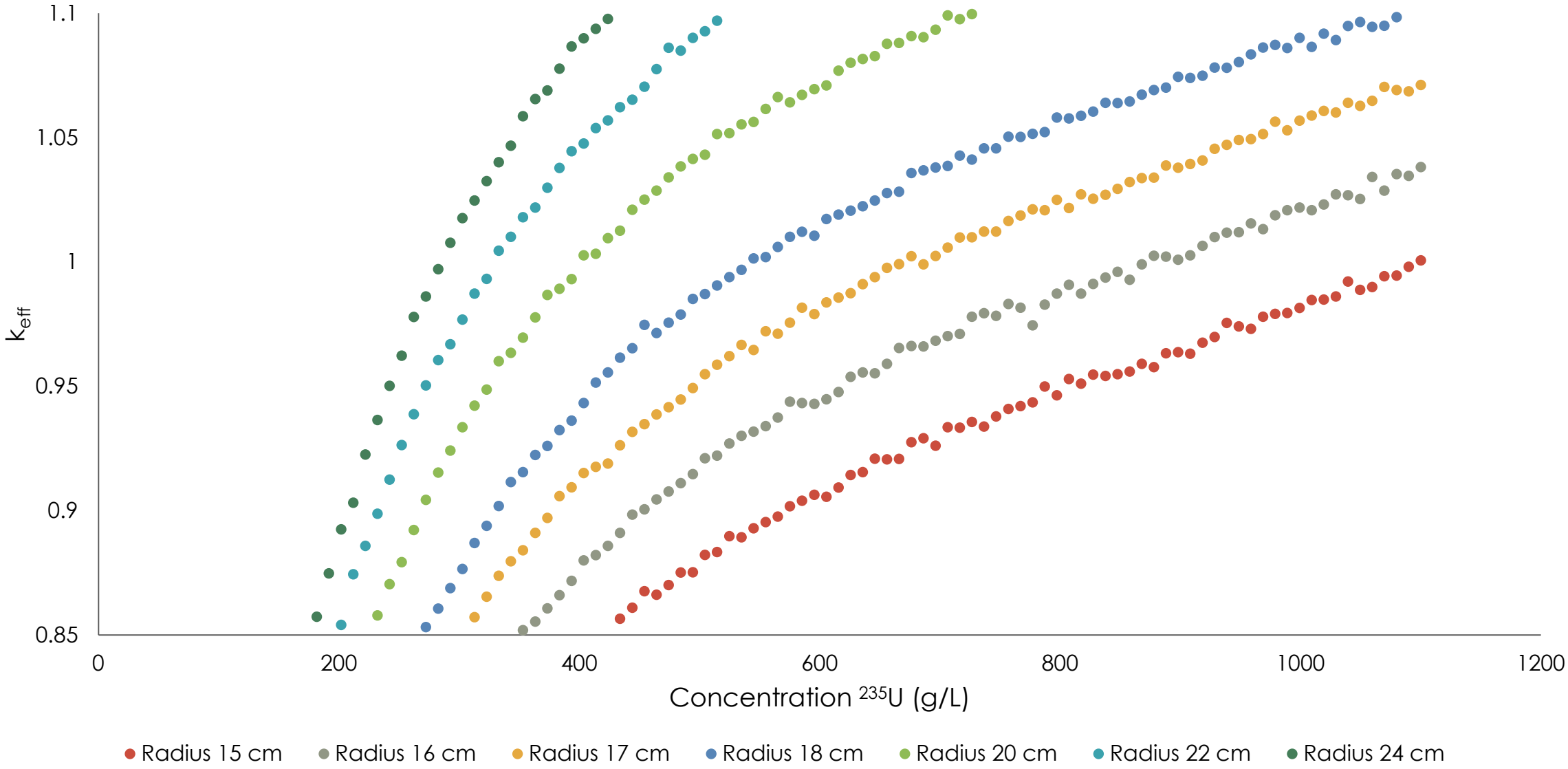


Scoping calculations for subcritical limits (continued)

- Example 2: Scoping SCL parameters for mass in solutions
- Multiple parameter sweeps on tank radius and solution concentration to observe trends in k_{eff}
- 10 different radii and 110 different solution concentrations

```
read parametric
   variables= radius conc end
   n_samples= 10     110  end
end parametric
```

Scoping calculations for subcritical limits (continued)



Conclusion

- Parametric capability added to Sampler in SCALE 6.2.2
- Useful for establishing system behavior with respect to several variables and their ranges
- Useful capability for parametric studies necessary for NCS evaluations

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Questions?

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