SCALE Activities in FY23

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ORNL AM2 SCALE: Overview

• NCSP-facing codes
  – criticality safety (CSAS)
  – shielding (MAVRIC)
  – sensitivity/uncertainty (TSUNAMI and Sampler)
  – bias analysis (VADER)

• Maintain new/current production version (v6.3 series)
  – coordination – management, SQA
  – support – interact with users, documentation, scalehelp@ornl.gov
  – maintenance – fix bugs

• New capabilities/features (v7.0 series)

6.3 Product Owners

<table>
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<tr>
<th>Product</th>
<th>Owner</th>
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<tbody>
<tr>
<td>AMPX</td>
<td>Jordan McDonnell</td>
</tr>
<tr>
<td>CSAS</td>
<td>Kursat Bekar</td>
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<tr>
<td>DATA</td>
<td>Jesse Brown</td>
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<tr>
<td>FULCRUM</td>
<td>Rob Lefebvre</td>
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<tr>
<td>MAVRIC</td>
<td>Cihangir Celik</td>
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<tr>
<td>OMNIBUS</td>
<td>Seth Johnson</td>
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<tr>
<td>ORIGAMI</td>
<td>Steve Skutnik</td>
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<tr>
<td>ORIGEN</td>
<td>BK Jeon</td>
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<td>POLARIS</td>
<td>Matt Jessee</td>
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<tr>
<td>SAMPLER</td>
<td>Ugur Mertyurek</td>
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<tr>
<td>STDCOMP</td>
<td>Rob Lefebvre*</td>
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<tr>
<td>TRITON</td>
<td>Rike Bostelmann</td>
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<tr>
<td>TSUNAMI</td>
<td>Jordan McDonnell*</td>
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<td>VADER</td>
<td>BJ Marshall</td>
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<tr>
<td>XSPROC</td>
<td>Kang Seog Kim</td>
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*Interim owner

New product owner for FY23/FY24
SCALE 6.3 In a Nutshell

- Significant strides towards modernizing and centralizing Monte Carlo capabilities with Shift integration
- Improvements to uncertainty quantification and sensitivity analysis
- Performance improvements to Polaris for LWR lattice calculations
- New capabilities targeting advanced reactors

1. MAVRIC – radiation shielding
2. CSAS – criticality safety
3. TRITON – general reactor fuel depletion
4. ORIGEN – general depletion/decay/activation
5. ORIGAMI – LWR spent fuel isotopics generation
6. Polaris – LWR reactor fuel depletion
7. TSUNAMI – sensitivity, similarity analysis, and data assimilation
8. Sampler – general uncertainty propagation
9. AMPX – nuclear data processing (transforms ENDF/B to SCALE format)
10. SCALE nuclear data libraries – curated, verified, and validated
11. ORIGEN reactor libraries – data to generate system-specific spent fuel isotopics
12. VADER – trending-based validation
13. OMNIBUS – Leadership class Monte Carlo Transport (experimental)
Updates on scale.ornl.gov

- 6.3 validation reports slated for Q2/Q3 FY24
- 6.3 online manual https://scale-manual.ornl.gov
- 6.3.2 maintenance patch will be available in Q2/Q3 FY24
- Full reference list on https://ornl.gov/scale/references
- New version info site https://scale.publicsites.ornl.gov/

2023 Publications:


Code updates

- **Fulcrum GUI**
  - Fission point visualization with 2-D version *(SCALE 6.3.2)*

- **Criticality Accident Alarm System (CAAS) modeling with Shift sequences**
  - CSAS-Shift saves mesh-based fission source in HDF5 *(7.0 beta)*
  - MAVRIC-Shift reads mesh-based fission source from HDF5 for detector modeling with automated CADIS variance reduction *(7.0 beta)*

2-D views of fission neutrons starting points overlayed on Castor Cask model
Improvements to S/U capabilities

- External $F^*(r)$ read capability for CLUTCH method enables straightforward $F^*$ sensitivity studies and uncertainty reduction (7.0 beta)

- Ability to calculate $F^*(r)$ from deterministic adjoint fluxes and birth spectrum (Denovo and KENO, respectively) on the same mesh (7.0 beta)

```plaintext
read tallies
  read sensitivity
    method=CLUTCH
  read fstar
    file=external.3dmap
  end fstar
end sensitivity
end tallies
```

New input data block named `sensitivity` in `tallies` data block
Improvements to UQ with Sampler

- Allow specification of user-defined distributions for input quantities, such as density, temperature, geometry

- Improvements to parametric capability to find target values (see figure on right)

- Ability to calculate correlation coefficient of any two output quantities—basically $c_k$ equivalent for anything

![Diagram showing Target $k_{eff}=1.3$ and $k_{eff}=0.95$]
In-progress efforts for 7.0 betas

- Capability to apply user defined perturbation to the CE cross sections within the defined energy range
- MG version of CLUTCH method
- Enhancements in $c_k$ output edits; uncertainty and $c_k$ per nuclide and uncertainty plots vs. energy
- New k-eff estimators in CSAS-Shift and TSUNAMI-Shift sequences
- Particle track visualization

```
read perturbation
  nuc=SCALE_ID MT=reaction_mt
  mul=multiplier
  emin=min_energy emax=max_energy
end perturbation
```
Summary

• SCALE 6.3 available from RSICC
  - New features
  - New ENDF/B-VIII.0 data including covariances
  - Updated parallel infrastructure enables parallel capability on Windows
  - Production release with maintenance until 2026 at minimum addressing
    • Code or data bugs
    • Performance
    • Ease of installation

• New Government Use Agreement (GUA) for SCALE 7.0 beta access
  - Site licenses available for non-commercial testing and feedback, handled through ORNL technology transfer
  - Inquire by sending an email about the “GUA” to scalehelp@ornl.gov

These primers, written for SCALE 6.2 are still a great way to learn SCALE/CSAS in 6.3.

https://www.osti.gov/biblio/1760121
https://code.ornl.govSCALE/primers/kenovi
https://www.osti.gov/biblio/1760129
https://code.ornl.govSCALE/primers/kenova