

SCALE in 2021 and Beyond

SCALE Users' Group Workshop
July 27, 2020

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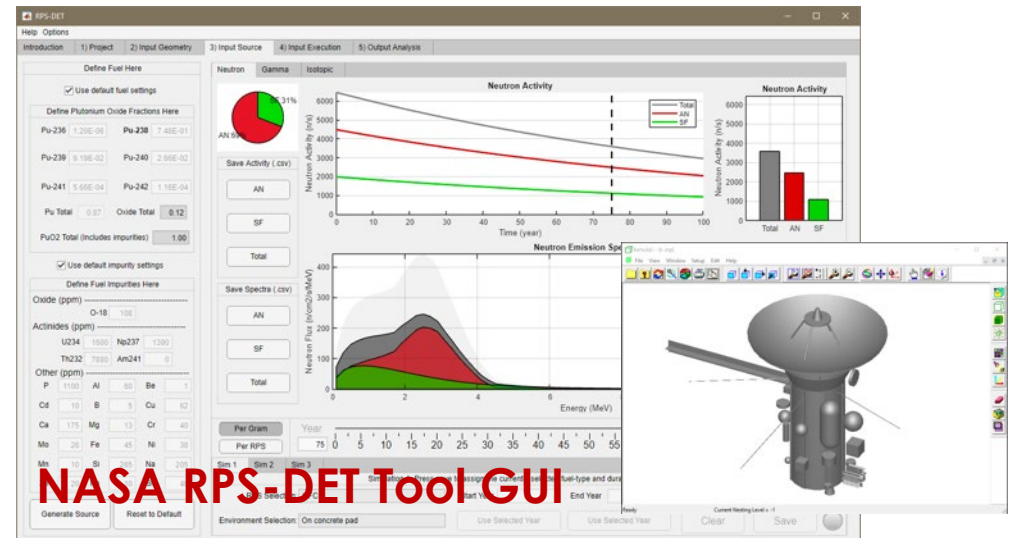
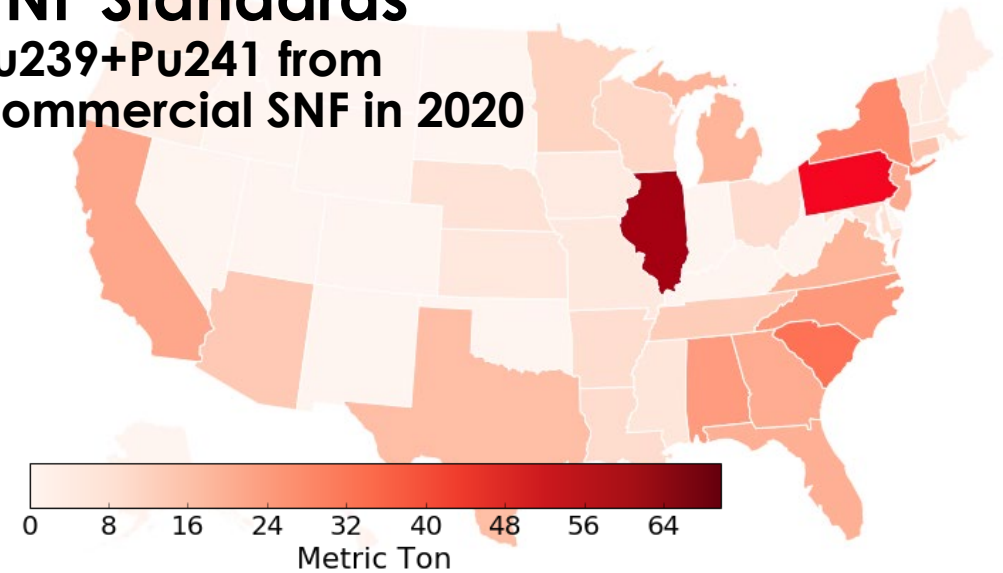
Overview

- Near term activities
 - Support
 - Optimize
 - Innovate
- Vision for SCALE in 2021 and beyond
 - Release schedule
 - Key features

Users of SCALE

- Conventional users (2004 to Jan 2020)
 - ~15000 copies of SCALE
 - ~9500 unique users in 61 nations
 - ~5000 6.2.* users (6.2.4 is last production release)
- ORNL UNF Standards Project
- DOE CASL VERA Core Simulator
- DOE Exascale Computing Project (ECP)
- X-Energy DoD Micro Reactor Shielding Design
- NASA The Radioisotope Power System Dose Estimation Tool (RPS-DET)
- IAEA RADAR Safeguards System
- ORNL Transformational Challenge Reactor (TCR)

UNF Standards Pu239+Pu241 from Commercial SNF in 2020



SCALE 6.3 Team

Director

Will Wieselquist

Direction Team

Production Coordinator

Rob Lefebvre

User Support Coordinator

Germina Ilas

Technology Coordinator

Seth Johnson

Quality Assurance Coordinator

Marsha Henley

NCSP Representative

B.J. Marshall

NRC Representative

Matt Jessee

Radiation Transport Group Leader

Bob Grove

Nuclear Data and Criticality Safety Group Leader

Doug Bowen

Product Owners

AMPX	Doro Wiarda
CSAS	Kursat Bekar
DATA	Andrew Holcomb
FULCRUM	Rob Lefebvre
MAVRIC	Cihangir Celik
OMNIBUS	Seth Johnson
ORIGAMI	Steve Skutnik
ORIGEN	Will Wieselquist*
POLARIS	Matt Jessee
SAMPLER	Ugur Mertuyurek
STDCOMP	Rob Lefebvre*
TRITON	Rike Bostelmann
TSUNAMI	Will Wieselquist*
VADER	Shane Hart
XSPROC	Kang Seog Kim

*Interim owner

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Bruce Bevard

Business Ops Manager

Linsey Aloisi

NCSP Execution Manager **NCSP Management**

Doug Bowen

Business Systems

Marsha Henley

Support sponsors and users

- Newsletter 52, thanks to User Support Coordinator, Germina Ilas
- New releases, thanks to Production Coordinator, Rob Lefebvre
 - 6.2.4 maintenance update for production series
 - two 6.3 beta releases per quarter

Table 1. SCALE version support and end-of-life dates

Version	0,1,2,3,4...4.4a	5.0	5.1	6.0	6.1	6.2	6.3
Customer support	No	No	Limited	Limited	Limited	Yes	Yes
Technical support	No	No	No	No	No	Yes	Yes
Release date	2000	2004	2006	2009	2011	2016	~2020
End-of-life date	NA	NA	2019	2019	2020	~2023	~2026

customer support: installation, compatibility with OS
technical support: help using the code

- Virtual Users' Group Workshop and Training, thanks to Sandra Poarch, Germina Ilas, Marsha Henley

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<https://www.ornl.gov/file/spring-2020-scale-newsletter/display>

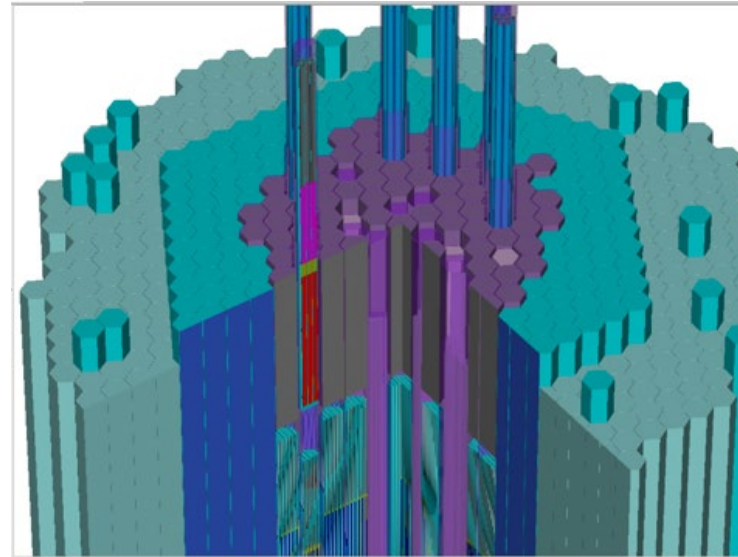
- 4-volume SCALE validation report 2020
 - vol 1: Summary
 - vol 2: Criticality Safety
 - vol 3: Reactor Physics
 - vol 4: Shielding

Optimize capabilities and processes

- Communication via website
 - gather SCALE publications in one place with OSTI download link
 - QA & release info (in progress)
 - "known discrepancies" tracked on webpage for each production release
 - beta release page with official SQA feature descriptions
 - online documentation for each beta release
- SCALE code repository is home to 3 major projects
 - *HPC-focused (Exnihilo)*: Denovo, Shift
 - *Nuclear data processing*: AMPX
 - *"Traditional" sequences*: ORIGEN, MAVRIC, TRITON, CSAS, Polaris, ORIGAMI, Sampler, etc.
- Software usage
 - Traditional end-users of "sequences"
 - SCALE should be a one-stop shop for input setup/job launch/analysis
 - Application builders
 - API users linking to SCALE for capabilities
 - Driving SCALE input/processing output
 - Methods R&D
 - Benchmark implementation
 - Realistic test bed
- Development processes
 - Open source and export-controlled code in same repo, under same QA plan
 - Feedback loop
Request→Plan→Feature→Release→Feedback

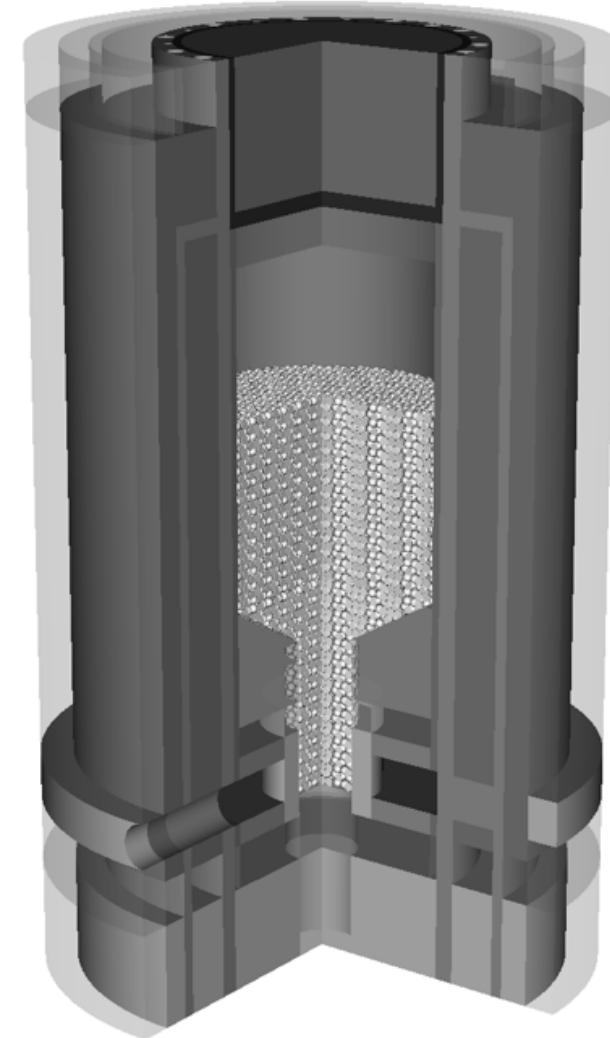
Innovate with new methods and data

- CE and MG method improvements
 - Fast reactor MG library
 - Improved HTGR performance
- Shift integrations
 - parallel MAVRIC-Shift
 - nodal methods in TRITON-Shift
- Sensitivity indices in Sampler
- Sensitivity methods in ORIGEN
- 3D Visualization in Fulcrum
- Modernization of trend analysis code (USLSTATS → VADER)
- ENDF/B-VIII data with new scattering kernels



SCALE Model of EBR-II

SCALE Model of HTR-10



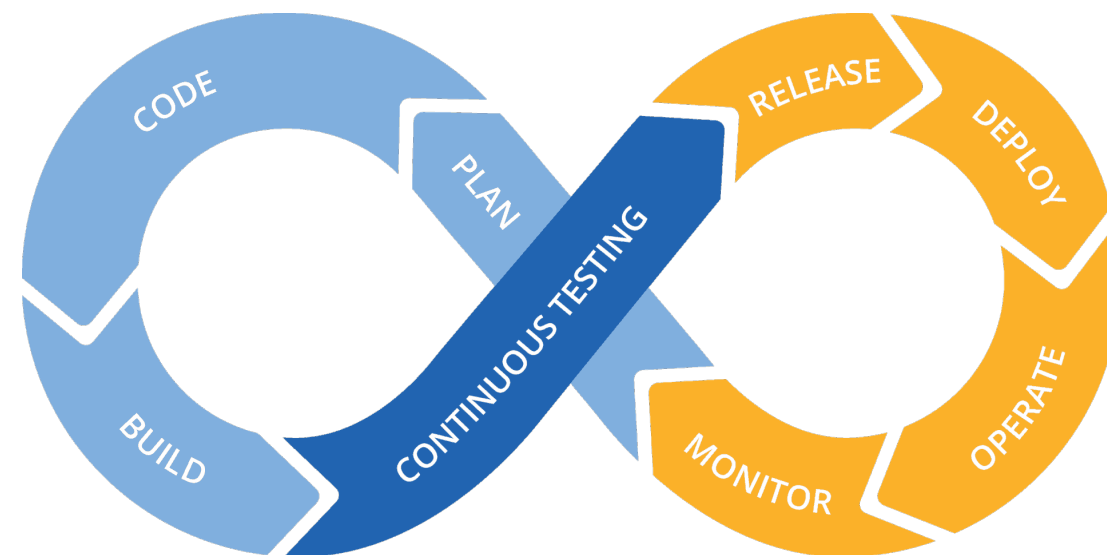
Looking forward: important releases

- *No more maintenance releases for the 6.2 series (6.2.4 was last)*
- **September 2020**: SCALE 6.2.4 validation report
- **Dec 2020**: first in the 6.3 series, 6.3.0
 - maintenance releases (6.3.1, 6.3.2, ...) as needed
 - **September 2021**: SCALE 6.3 validation report
- **Mid 2021**: 7.0 beta1
- **Dec 2023**: 7.0 series release (7.0.0)
 - no more technical support for 6.2

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Vision for SCALE 7.0 betas (2021-2023)

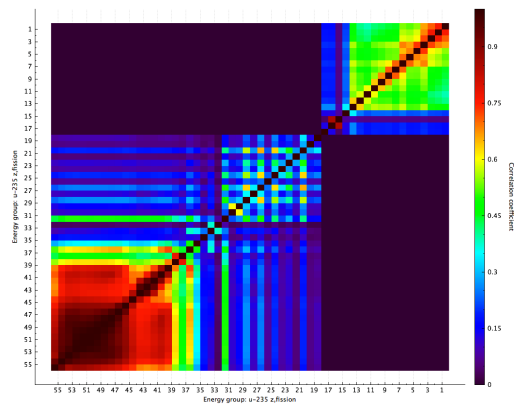
INFRASTRUCTURE

- Installation and verification is trivial 😊
 - Fulcrum-guided installation asks **which codes to install** and knows which data sources those depend on--only that data is downloaded
 - Users run test suites from Fulcrum or command line
 - fast-running installation tests
 - code-specific verification & validation suites
 - **user-created test suites**
- Linking external applications to SCALE
 - Non-export controlled parts of SCALE are **openly available**
 - High-quality, easy-to-use APIs with online documentation targeting ORIGIN and XSPROC
 - C++ based with Python and Fortran interfaces
 - Standard data formats let's users easily load their own data

Vision for SCALE 7.0 betas (2021-2023)

DATA UNCERTAINTY AND SENSITIVITY

- New uncertainty data
 - delayed neutron
 - thermal scattering
 - energy release/deposition



- Cross-correlations
 - correlations can exist between any data (delayed neutron fraction and decay constant)

- correlations can be added by validation/data assimilation processes

- Sampling

- random samples (realizations) of data can be made on-the-fly
- realizations are traceable and reproducible across platforms

- Sensitivity

- SDF format is generalized
- can store sensitivity of **any response** to **any nuclear data**

Vision for SCALE 7.0 betas (2021-2023)

CAPABILITIES

- Shift-based reactor physics is a complete non-LWR reference solution
 - flexible and performant geometry (MCNP-style, KENO-style, randomized, some CAD capability?)
 - robust source convergence monitoring
 - fuel flow models (HTGR/MSR)
- Polaris
 - significantly faster runtime
- non-LWR lattice physics capability
- Search and optimization
 - any SCALE model can define parameters for search/optimization
- ORIGEN reactor libraries
 - rapid isotopics generation for HALEU, HBU, ATF, and non-LWR systems
 - stable interfaces to severe accident analysis, inventory management and fuel cycle

Vision for SCALE 7.0 betas (2021-2023)

DOCUMENTATION

- Website
 - Recent journal papers/TMs (~weekly updates) with inputs processing
 - 7.0 Beta release notes
 - 6.3.* Production release "known discrepancies" page
 - Add to suite annually based on current priorities
- Manual
 - Web HTML and PDF versions
 - Updated each beta release
- Validation Reports
 - Annual validation report for the current production version of SCALE
 - Validation suites available to users, automated run and post-
- New Primers
 - CSAS in the works
 - Others to follow

Summary

- Upcoming SCALE 6.3.0 features will be discussed at this Workshop--current beta used in some tutorials
- Version 7.0 next 😊 (betas to start in 2021)
 - increase installation ease and verification robustness
 - add/refine sensitivity and uncertainty (with better connection to validation for non-keff responses)
 - best in world Monte Carlo reactor physics with Shift
 - generalize sensitivity storage, search and optimization
 - provide online manual, validation report, primers, window into our SQA

Acknowledgements

Thanks to our DOE, NCSP, NRC sponsors and GAIN for their support for this meeting!

Thanks to Sandra Poarch and Germina Ilas for planning this meeting!

Thanks to our speakers and tutorial leaders and all other participants!