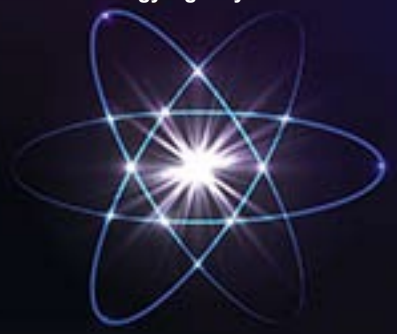
NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

NEWSLETTER

SPRING 2023

IN THIS ISSUE



Please contact Marsha Henley for information or contributions:

henleym@ornl.gov

DATES TO REMEMBER

Hands-On Training & Education Course Dates:
Two-week Practitioner Course Dates:
Aug 7-18,2023

One-week Manager's Course Dates:
Sandia – April 17-21, 2023
NCERC - June 5-9, 2023

T&E Page: https://ncsp.llnl.gov/training-education

LINKS TO REMEMBER

NCSP Website
NCSP Program Management
NCSP Mission and Vision
NCSP Five-Year Execution Plan
NCSP Planning Calendar
Previous NCSP Newsletters
CSSG Taskings
Nondestructive Assay Program

A Message from the NCSP Manager

The Annual International Criticality Safety Benchmark Evaluation Project Meeting (ICSBEP) is being held in France this week. Five of the ten submitted benchmarks are NCSP sponsored benchmarks. Congratulations to all of the teams submitting benchmarks. Once approved by the technical review group, the benchmark evaluations will be placed in the ICSBEP Handbook. The primary purpose of the ICSBEP is to compile critical and subcritical benchmark experiment data into a standardized format that allows criticality safety analysts to easily use the data to validate calculation tools and cross-section libraries.

During the first week of May, LLNL is hosting a "TEX 2.0" meeting. LLNL and LANL have been designing and executing critical experiments to address criticality safety benchmark data needs as part of the Thermal/Epithermal eXperiments (TEX) series for almost a decade. The TEX experiments were based on recommendations that came out of a meeting convened by the NCSP in July of 2011, which brought together nuclear criticality safety practitioners, critical experimenters, and nuclear data experts to discuss experimental needs relevant to criticality safety. One big focus of the meeting was the lack of experimental data in the intermediate energy range, and a consensus prioritization of data needs was published in the TEX meeting minutes. NCS practitioners have been invited to discuss their site's needs for experimental data, mainly with a focus on any benchmark validation needs.

Please enjoy the Spring Issue of the NCSP Newsletter.

Angela S. Chambers

NNSA National Nuclear Security Administration

U.S. DEPARTMENT OF ENERGY

2023 NCSP Technical Program Review Meeting

The 2023 Technical Program Review (TPR) and joint meetings were held February 21 – 24, 2023, in Albuquerque, New Mexico. Sandia National Laboratory hosted the meetings at the Clyde Hotel. The agenda included a total of 80 presentations from international collaborators, NCSP site program managers, and technical principal investigators that covered NCSP work for all technical program elements from FY2022 or invited talks for more recent work. Approximately 120 people attended the in-person meeting over the three-day period. Registration represented three foreign institutions (AWE, French Alternative Energies and Atomic Energy Commission (CEA), and Institut de Radioprotection et de Surete Nucleaire (IRSN)), two industry (CS Engineering and Sigma Science), ten national labs (Argonne, Brookhaven, Lawrence Livermore, Los Alamos, Naval Nuclear, Oak Ridge, Pacific Northwest, Sandia, Savannah River and Y-12), three universities (North Carolina State, Rensselaer Polytechnic Institute, and University of New Mexico), and two US government agencies (Defense Nuclear Facilities Safety Board and the Department of Energy) Dr. David Epp, Senior Manager, Nuclear Facilities and Applied Technologies from Sandia National Laboratories gave the group a warm welcome. Later that evening, we enjoyed a group dinner at the Sawmill Market with over 80 able to attend.

The Nuclear Data Advisory Group (NDAG) meeting was also held on February 23 and led by Mike Zerkle, Naval Nuclear Laboratory. Agenda topics included fission product credit priorities, nuclear data requests, review of the NCSP 5-year plan nuclear data priorities, and new nuclear data needs.

The 2023 TPR Presentations web page is now available with all the presentations approved for public distribution at this time. Several presentations are still under review and when they are available an announcement email will be sent to all attendees.

Brookhaven National Laboratory will host the 2024 TPR.

CSSG Happenings

The CSSG charter and work instructions have been updated to reflect recommendations from the recent CSSG self-assessment.

Tasking 2022-03 (LANL Request for NCS Assistance) has been completed. The Tasking Response can be obtained from the NCSP Manager.

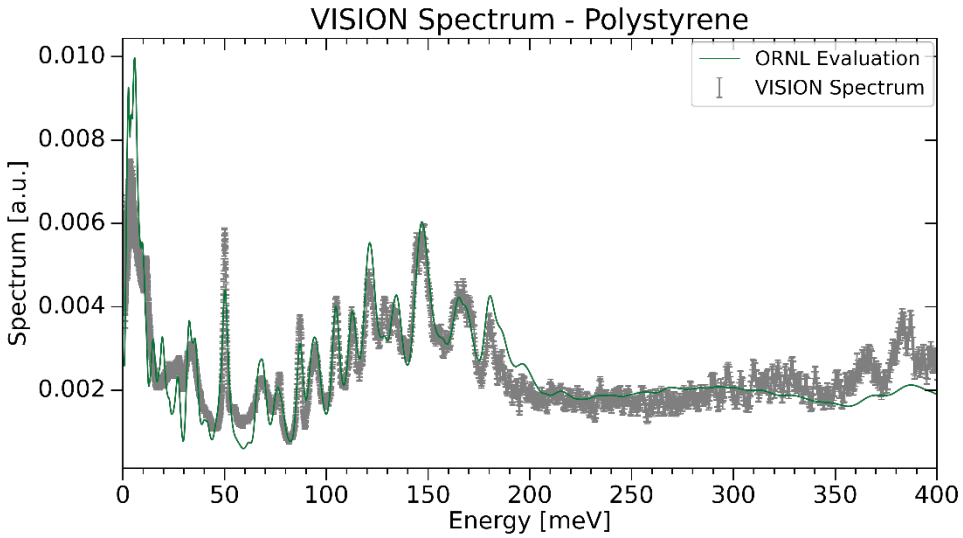
The next CSSG meeting will be held in conjunction with the ANS Annual Meeting in Indianapolis.

Please contact any CSSG member with your ideas on how the CSSG can help you or NCS in general.

Evaluation and Validation of Thermal Neutron Scattering Files

Chris Chapman, ORNL

Recent thermal neutron measurements conducted at RPI and the Spallation Neutron Source (SNS) at ORNL were used in the development of a methodology for the evaluation and validation of thermal neutron scattering files. Inelastic neutron scattering (INS) measurements carried out at the VISION beamline of the SNS as well as thermal transmission measurements from the NCSP-funded enhanced thermal target + cold moderator addition to RPI LINAC were combined to evaluate several materials of interest to NCSP, including, polystyrene (see Fig. 1), polyethylene, and Lucite. These evaluations were performed by modifying the phonon density of states until a best-fit estimate was reached between both the differential and total cross sections. More weight was put on agreement with the total cross section measurements. The resulting cross sections were found to be in better agreement than the existing ENDF library (when available), giving credence to the methodology.



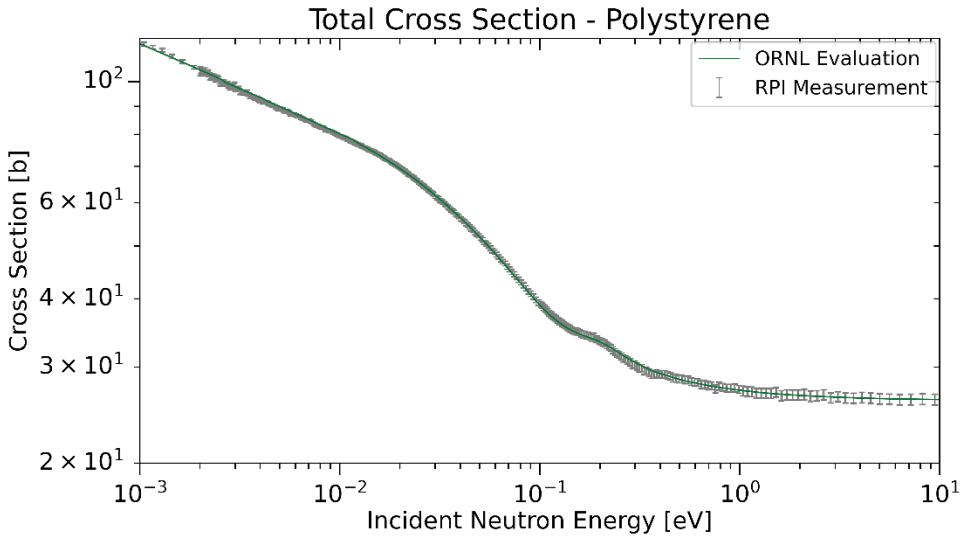


Figure 1: Inelastic spectra (top) and Total Cross Section (bottom) of Polystyrene

Additionally, differential INS measurements at the SEQUOIA and ARCS beamlines of the SNS were used in conjunction with several integral benchmarks from the ICSBEP handbook and the LLNL pulsed neutron die-away (PNDA) measurements from LLNL to validate the evaluation of these materials. These validation efforts showed not only the importance of proper characterization of materials used in validation measurements (as industrial additives can affect the cross section), but also the importance of utilizing differential and total cross section measurements into the validation effort.

Thermal Neutron Transmission Capability Development at ORNL

Kemal Ramic, ORNL

Moving from differential (inelastic scattering measurements that probe phonon spectra) to quasi-integral (total cross section as measured by transmission) to integral (k_{eff} benchmarks) level, validation of thermals scattering law (TSL) libraries can be done seamlessly assuming that the underlying physics and nuclear data at above thermal energies are accurate. However, it has been shown that the benchmarks are most sensitive to the total thermal cross sections of the material, even though one can obtain the same cross section with different phonon spectra, as presented for polyethylene at the latest TPR meeting. Therefore, validating different TSLs for the same material should rely on both differential and transmission measurements.

To this end, we have initiated work to develop transmission capabilities at the VISION beamline located at the Spallation Neutron Source at ORNL. VISION will provide a facility to conduct both double differential scattering measurements and transmission measurements. Moreover, since the SNS is a user facility, this functionality will be available to the general public free of cost through a general user proposal system. The temperature range offered by VISION is another unique capability that spans from 5 to 1300 K, allowing for the study of cryogenic materials and materials of interest to advanced high-temperature reactors.

The VISION beamline employs a non-conventional setup for transmission measurements, where the sample is positioned only ~29 cm from the detector, necessitating the use of neutron-absorbing collimators (Figure 1a). Figure 1b demonstrates the impact of these

collimators on the measured transmission of copper. Initially, we used 3D printed polymer collimators spray-painted with boron nitride, but we are currently working to improve their effectiveness by directly 3D printing B4C collimators.

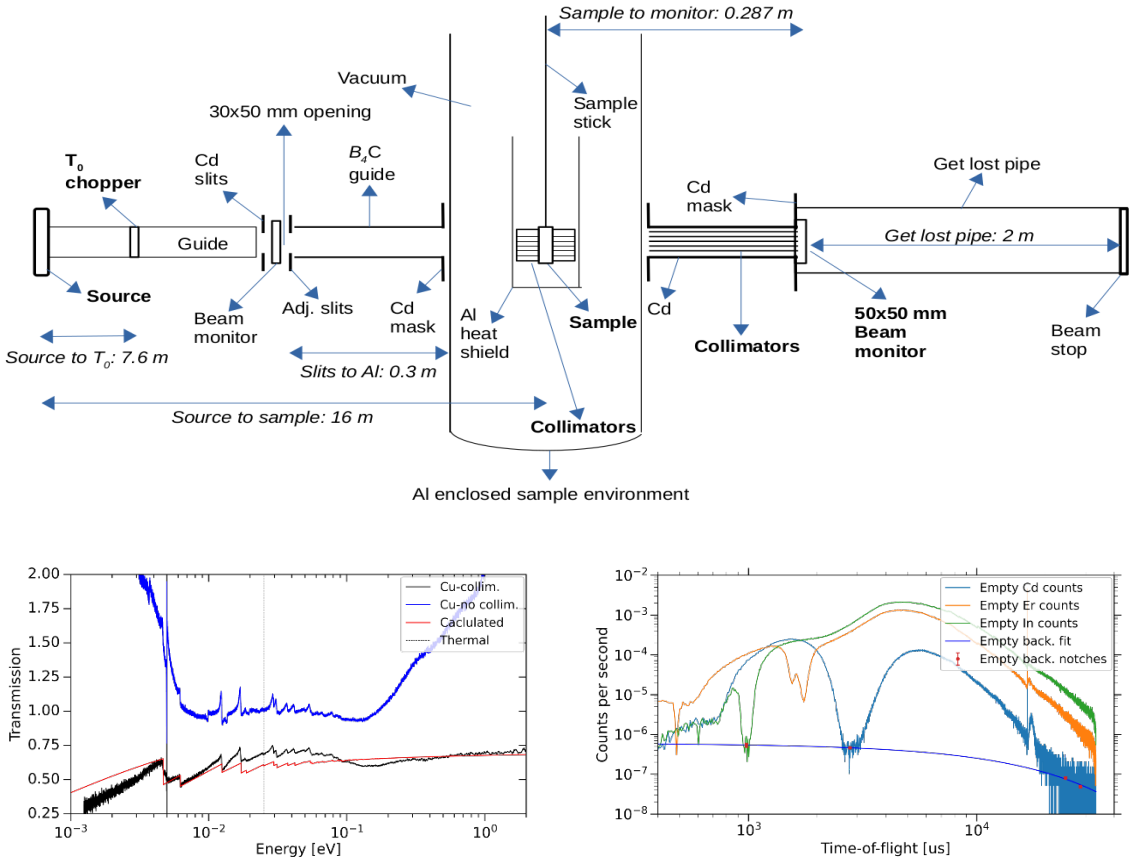


Figure 1: a) VISION transmission setup, b) preliminary copper transmission data, c) preliminary background measurements

For accurate transmission measurements, it is crucial to characterize the background accurately. Like RPI, we plan to use Indium and Cadmium, with addition of Erbium, black resonance filters. As shown in Figure 1c, we can characterize the background; however, thicker Cadmium and Erbium filters are needed. Additionally, with the high thermal neutron flux available at SNS, these measurements can be completed much more quickly. Once the transmission capability is fully developed and validated, the VISION beamline at SNS ORNL will be an essential tool for evaluating and validating TSLs.

EUCLID Experiment Performed at the DOE's National Criticality Experiments Research Center (NCERC)

LA-UR-23-21026

J. Alwin, B.W. Bell, A. Clark, T. Cutler, M. J. Grosskopf, W. Haeck, M. Herman, J. Hutchinson, N. Kleedtke, J. Lamproe, R.C. Little, I. Michaud, D. Neudecker, M. Rising, T. Smith, N. Thompson, S. Vander Wiel, N. Wynne

The EUCLID (Experiments Underpinned by Computational Learning for Improvements in nuclear Data) measurement campaign was completed during November 2022 to January 2023

at the DOE's National Criticality Experiments Research Center (NCERC) at the Nevada National Security Site (NNSS). This is the first experiment series of its kind optimized by Artificial Intelligence (AI) and machine learning (ML) to reduce unconstrained physics spaces in ^{239}Pu nuclear data, a feat which has never been attempted previously. To this end, it uses the most amount of Pu ever in an NCERC experiment. EUCLID is a joint project sponsored by Los Alamos Laboratory Directed Research and Development (LDRD) and the DOE Nuclear Criticality Safety Program (NCSP). This work includes collaboration between NEN, XCP, CCS, T, and NCERC-FO divisions at Los Alamos National Laboratory (LANL), along with facility support by MSTS.

Predictive simulations are utilized to answer many important questions of NNSA mission. Nuclear data are required inputs for predictive simulations and they often dominate the total uncertainty of these simulations. Unconstrained physics spaces exist in nuclear data that might bias simulations of systems beyond benchmark experiments, which could become a major issue when producing and working with special nuclear material in new processes. This project designed validation experiments optimized to reduce fast ^{239}Pu compensating errors, that are crucial to understand for many NNSA missions.

One goal of the experiment was to perform measurements of multiple response types, as doing so can help constrain nuclear data in ways that critical experiments alone cannot. Tools did not exist, however, to generate the needed sensitivities of these responses to nuclear data. This project developed the necessary tools and generated sensitivities of previous experiments, which will be available to the community. In addition, new tools were developed to perform ML-supported nuclear data adjustment as well as to optimize the experiment design via AI/ML.

The AI/ML-supported experiment found that it would be ideal to have two configurations, with very different geometries. They were both minimally reflected by aluminum with no interstitial materials. The "low mass" configuration (~40 kg of Pu, Fig. 1 left) is cube-like and minimizes neutron leakage. The "high mass" configuration (~110 kg Pu, Fig. 1 right) is slab-like and maximizes neutron leakage.
The experiment was built on the Planet critical assembly machine at NCERC, which allows the critical mass to be separated vertically into two halves and brought together in a safe manner remotely. Both configurations utilize the Zero Power Physics Reactor (ZPPR) plutonium plates, which are placed inside "buckets". These buckets are loaded on the machine in a specific geometry. Experimental criticality values of these configurations in Table 1. are similar but simulations aren't, indicating that they are querying nuclear data differently. We will also study the integral responses listed in Table 2 via instruments in Fig. 2 to better map out ^{239}Pu nuclear data.

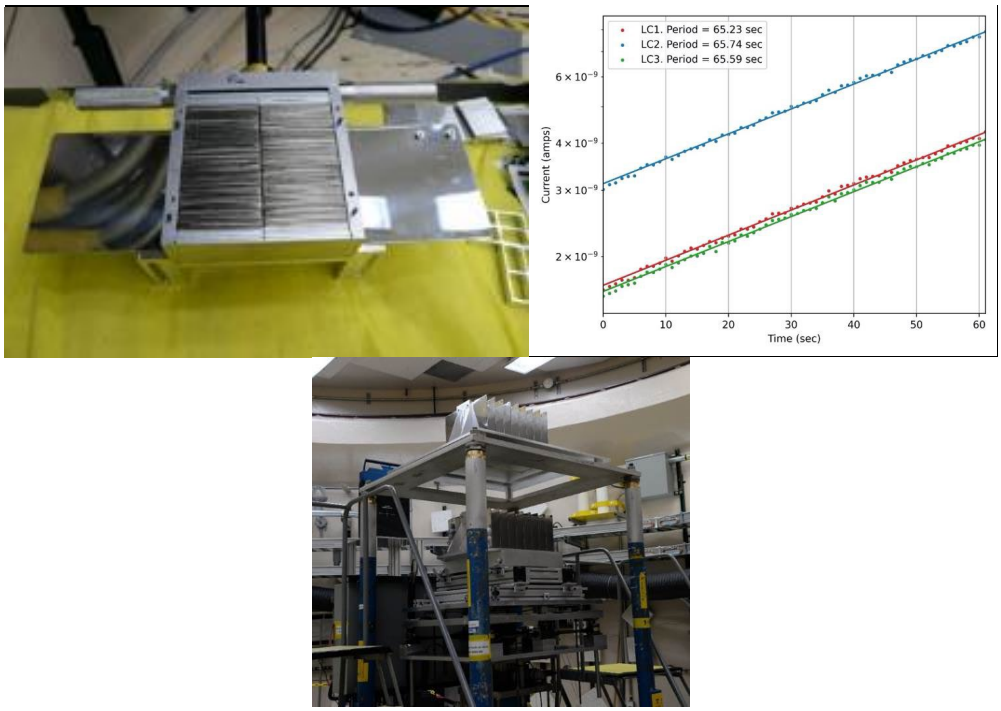


Fig. 1: The image on the left shows a single bucket with ZPPR plates for the low mass configuration. Results from this configuration are shown in the middle. The high mass configuration on the Planet assembly is shown on the right.

Table 1. EUCLID Preliminary Data

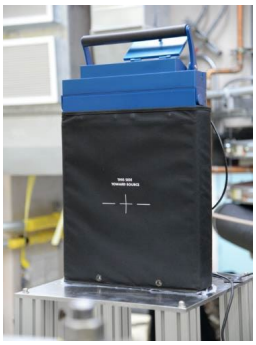
Configuration	Experiment		Simulated (ENDF/B-VIII.0)	
3x2 (low mass)	1.00029	0.002*	1.00012	0.00003
8x1 (high mass)	1.00038	0.003*	0.99838	0.00003

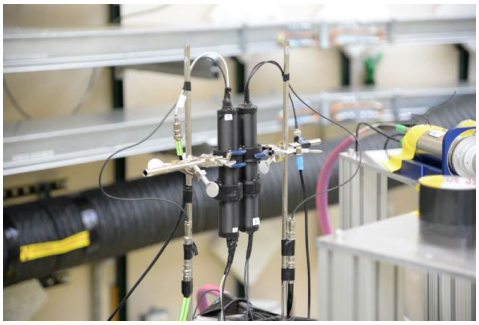
* These uncertainties are not evaluated. This is a rough estimate based on previous experiments with ZPPR plates.

Table 1 gives preliminary measured and simulated results. In addition to the critical experiment, other responses were measured to help to further constrain fast ^{239}Pu data. Table 2 shows the measurement responses that were used, and the Fig. 2 shows the equipment utilized to obtain these responses.

Table 2. EUCLID Measured Responses

Measurement Method	Observable			
	σ	ν	β	PFNS
Critical experiments	✓	✓		✓
Neutron Multiplication Measurements	✓	✓	✓	
Reaction rate ratios	✓	✓		✓
Neutron Leakage Spectra	✓			✓
Rossi-α	✓	✓	✓	
Reactivity Coefficient	✓		✓	





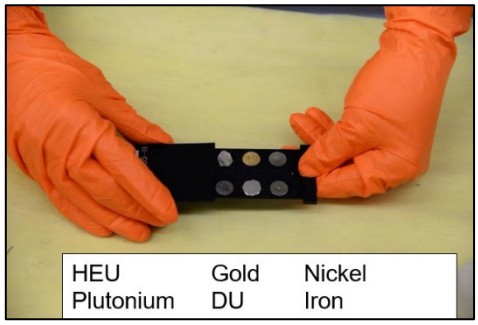


Fig. 2: The image on the left shows a He3 detector system used to perform neutron multiplication measurements. Three organic scintillator systems were utilized to perform Rossi-α and neutron leakage spectra measurements (one system shown in the middle). Foils used to determine reaction rate ratios are shown at right.

Acknowledgements

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NCSP OSTI Search Instructions

A document with instructions for searching the NCSP collection of documents at OSTI.GOV is now available here and from the Information Preservation & Dissemination web page. As documents are sent quarterly to the NCSP for each site's program, they are provided to OSTI so that they can be marked as part of the NCSP collection. Also, documents related to the Seventy-Five Years of Nuclear Criticality Safety Documents – A Bibliography that are found in OSTI will have keywords attached to them. This should make searching OSTI for NCS-related documents much easier and more thorough.

Training and Education

January 23 – February 3, 2023 Two-week Hands-on NCS Practitioner Course

A 2-week NCSP hands-on NCS training course was successfully executed at the National Atomic Testing Museum (NATM), Sandia National Laboratory (SNL), and at the National Criticality Experiments Research Center (NCERC) from January 23-February 3, 2023. A total of 27 students attended the course over the 2-week period (26 at NATM, 13 at SNL and 14 at NCERC).

Photograph of participants of the 2-week hands-on course in Jan/Feb 2023 at the NATM

Photograph of the participants of the 2-week hands on course at SNL

Photograph of the participants of the 2-week hands-on course at NCERC

Two-week Practitioner Course Dates:

- August 7 – 18, 2023

Registration is open (courses to be held in person)

The first week (lectures and workshops) will held at the National Atomic Testing Museum (NATM) while the second week (hands-on portion) will be held at the National Criticality Experiments Research Center (NCERC) and Sandia National Laboratories. The courses are designed to meet the ANSI/ANS-8.26, "Criticality Safety Engineer Training and Qualification Program," requirement for hands-on experimental training. The NATM portion of the course involves virtual classroom lectures and workshops for NCS Evaluation development and the NCERC and SNL portions of the course involve hands-on experiments with the critical assemblies. MSTS, LANL, ORNL, LLNL, SNL, Y12 and NFO staff participate in the course execution.

One-week CSO/Manager's Course Dates:

- Sandia CSO/Manager Course – April 17 – 21, 2023
- NCERC CSO/Manager Course – June 5 – 9, 2023

Registration is open (courses to be held in person)

The courses are designed for fissile material handlers, process supervisors, line managers and regulators with criticality safety responsibilities. Mission Support and Test Services (MSTS), LANL, ORNL, LLNL, SNL, Y12 and Nuclear Facility Operator (NFO) staff participate in the course execution.

MCNP® Courses

Class Information: https://mcnp.lanl.gov/classes.html

Fees and Registration Information: https://mcnp.lanl.gov/class_registration.html

Apr 10 – 14, 2023	Intermediate MCNP6 (online)
Jun 5 – 9, 2023	Introduction to MCNP6 (online)
Jun 19 – 23, 2023	Criticality Calculations with MCNP6
Aug 21 – 25, 2023	Introduction to MCNP6
Aug 28 – Sep 1, 2023	Using NJOY to Create MCNP ACE Files and Visualize Nuclear Data
Oct 2 – 6, 2023	Intermediate MCNP6
Oct 23 – 27, 2023	Introduction to MCNP6 (online)
Dec 4 – 8, 2023	Variance Reduction with MCNP6

SCALE Courses

The next training block will be held in person at Oak Ridge National Laboratory in March 2023. There will be no virtual or hybrid option for the courses. The courses will be held Monday–Thursday, 8:00 am–5:00 pm and Friday, 8:00 am–12:00 pm ET. The registration website will open soon. More information about the courses is found at https://www.ornl.gov/scale/training.

Mar 6 - 10, 2023	SCALE/TRITON Lattice Physics and Depletion
Mar 13 - 17, 2023	SCALE/Criticality Safety and Radiation Shielding
Mar 20 – 24, 2023	SCALE/ORIGEN Standalone Fuel Depletion, Activation, and Source Term Analysis
Mar 27 – 31, 2023	SCALE Criticality Safety Calculations

SCALE Users' Group Meeting

We are pleased to announce that registration is open for the 7th SCALE Users' Group Workshop that will be held as a hybrid meeting on April 26-28, 2023. You can register on the meeting website at https://scalemeetings.ornl.gov . The meeting is offered free of charge to participants. Certain portions of the workshop will be in-person only or virtual only. Registration is unlimited for virtual participation. In-person participation is limited to a total of 75 people per day due to room capacity.

Twelve hands-on tutorials will be presented: eight virtual only and four in-person only, as specified on the agenda at https://scalemeetings.ornl.gov/agenda/. The in-person tutorials are limited to 25 participants, and the virtual tutorials have unlimited participation. To be able to participate in tutorials, registrants must have a user license for SCALE 6.2 or 6.3 beta, as applicable to that tutorial. Information on eligibility and how to request a SCALE license is available on https://www.ornl.gov/scale/releases.

You are invited to participate in the meeting and contribute with presentations and discussions on impactful and innovative applications of SCALE. In the SCALE Open Mic session participants can present lightning talks and engage the audience in lively Q&As. The Best SCALE Model Contest provides an opportunity for all end users to present their most innovative models and compete for special recognition.

Contributions for the SCALE Model Contest session require only a single page showing one or more images of a SCALE model. Participants will have 5–10 minutes during the session to provide background on the model, present additional information as desired, and answer questions. The image(s) can be based on SCALE 6.2 or 6.3 beta rendering. For the SCALE Open Mic session, no formal presentation is required, but presentation slides are welcome as needed.

Please email scalehelp@ornl.gov for any related question or suggestion.

Nuclear Energy Agency (NEA) Courses and Workshops

Information about Nuclear Energy Agency (NEA) courses is found at https://www.oecd-nea.org/dbcps/training-courses/.

Mar 6 – 10, 2023	MCNP6 Advanced
Apr 3 – 7, 2023	OpenMC
Apr 12 – 13, 2023	FRENDY (Online)

May 22 – 26, 2023	SCALE TRITON Lattice Physics and Depletion
Jun 19 – 23, 2023	FISPACT
Jul 3 – 7, 2023	PENELOPE