NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM
NEWSLETTER

# FALL 2022

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Aug 7-18,2023

One-week Manager's Course Dates:
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## A Message from the NCSP Manager

As I write the introduction for this quarter's newsletter, I have just returned from the NCERC Futures meeting at Los Alamos. With more than 140 registered participants from eight different program focus areas, including NCS, training, nuclear data, reactors, nuclear emergency response, nuclear forensics, weapons performance and weapons engineering, the meeting provided a forum for each program to discuss technical needs and capabilities for shaping the future of NCERC. LANL will publish a report on this meeting in the upcoming months. This meeting is a perfect segue into one of the FY23 NCSP upcoming tasks: revising the NCSP Mission and Vision document. More to come on that in FY23.

This has been an exciting latter part of the 4th quarter of the fiscal year in terms of integral experiments. Sandia is currently executing IER 305, *Critical Experiments with $UO_2$ Rods and Molybdenum Foils*, which is a collaboration with France's Institute for Radioprotection and Nuclear Security (IRSN). LLNL and LANL recently completed the nuclear accident dosimetry intercomparison exercise using the Godiva IV critical assembly at NCERC with 10 different sites participating. This vital exercise tests dosimetry personnel and equipment capability to perform personnel dose determinations quickly and accurately in the unlikely event that a nuclear criticality accident should occur.

LANL recently expanded NCERC's capabilities with IER 153, the *Prompt Fission Uranium Neutron Spectrum (PFUNS) Experiment using Threshold Activation Detectors*. With some help from MSTS and the Nevada Field Office and funding from NA-22, LANL upgraded the NCERC count room. This upgraded NCERC capability opened the door for more efficient activation and fission foils measurements on many types of experiments.

The LLNL-designed TEX-Hafnium experiment, an NCSP collaboration with NNSA's Naval Reactors, is ongoing at NCERC as I write this. Look for more information on the NCERC Futures meeting and these integral experiments in next quarter's newsletter.

The FY23 NCSP Five-Year Plan was issued in August, and Doug and I continue to have discussions with the IE task managers to work out the final FY23 Integral Experiment Priority list which will be issued in October.

Looking forward to another great year in FY23.

Angela S. Chambers

National Nuclear Security Administration

U.S. DEPARTMENT OF ENERGY

## A Note from the Criticality Safety Support Group (CSSG)

We would like to announce a change in CSSG leadership and a new member. Beginning in October, Fitz Trumble will transition to Emeritus status. To support this change, Jennifer Alwin, Los Alamos National Laboratory is now a new member of the CSSG. Please visit the CSSG web page, https://ncsp.llnl.gov/criticality-safety-support-group, to read Jennifer's bio.

## Congratulations B.J. Marshall (ORNL) – Vice Chair of the ICSBEP Technical Review Group

*The NCSP Management Team congratulates B.J. on his selection by the NEA for this opportunity. We requested he provide a few details about the ICSBEP and the direction of his work.*

My first OECD/NEA ICSBEP Technical Review Group (TRG) meeting was in 2017 in Washington, D.C.; I don't know that I could have talked my management into sending me if it had been in Paris that year. It was appropriate that Oak Ridge re-engage with the TRG, and I was the logical choice given my leadership on SCALE nuclear criticality safety validation projects over the several years leading up to that meeting. I'm glad that Brad Rearden, Mike Dunn, and Steve Bowman had the confidence in me to lead the validation tasks, and thankful for mentorship on using benchmarks from many people over the years but especially Davis Reed and Don Mueller. I also appreciate the confidence of the person or persons who nominated me to step into this new role as vice chairperson of the TRG, and the members of the TRG who supported my nomination.

Working in close cooperation with the recently nominated chair Catherine Percher, my primary focus will be on Section 3 of both existing and new benchmarks. It is essential that the benchmark model description be accurate and complete to maximize its usefulness to potential users. Validation is a significant cost incurred by all code users, and accuracy, completeness, and ease of use of benchmark models are key to limiting the burden of this process. Ideally, well-defined benchmarks will also run quickly to reduce the computational effort of performing validation for a new code version or new data library. We need to be mindful of the barrier that validation represents to the adoption of new codes and data and do what we can to streamline the generation and execution of benchmarks to support not only accurate but also efficient validation efforts around the world.

## IER-305 experiments at the SPRF/CX

*SAND2022-12373 O*

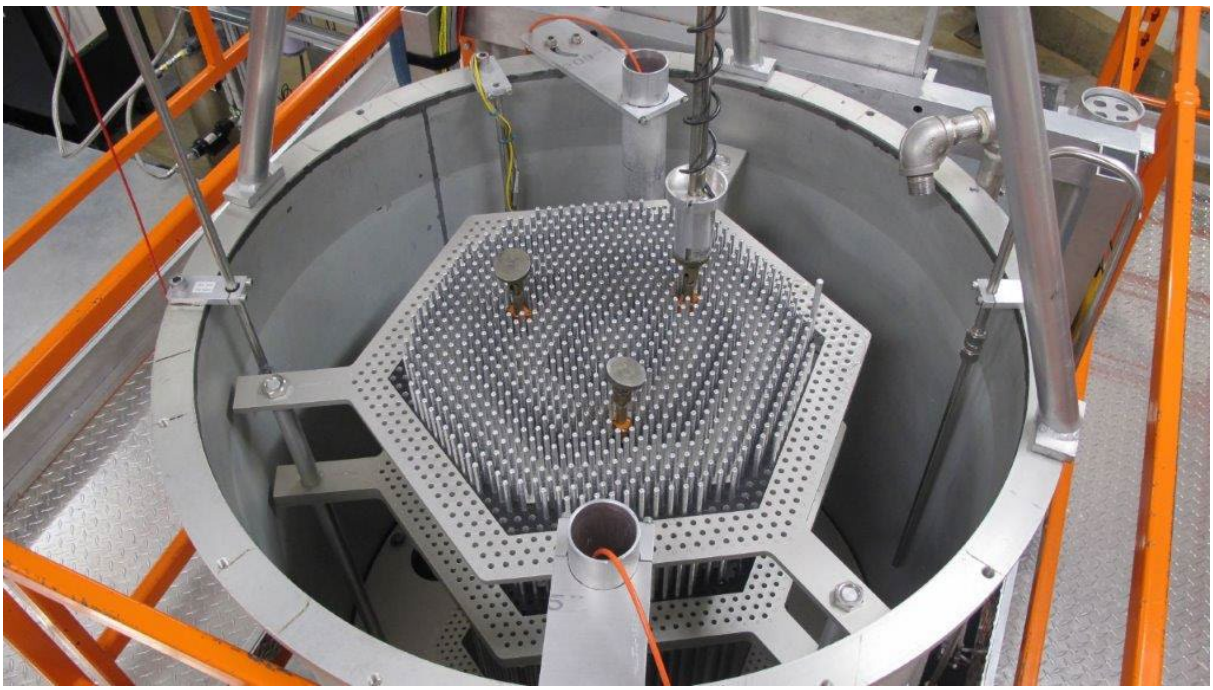
On 1 September 2022, the first approach to critical on a new triangular pitch core at the SPRF/CX was completed. This experiment marks the first approach to critical in several years on a new core design and the first triangular pitch critical experiment performed with 7uPCX fuel to date at the facility. This new core design marks the first that was designed, built, and executed under the recently implemented NQA-1 quality standard—requiring a large coordinated effort between the Operations, Engineering, and Experiment organizations.

This experiment is part of a larger experimental series being executed in collaboration with IRSN in France. This collaboration resulted in the design of an integral experiment focused on investigating

sensitivities to molybdenum nuclear data. The molybdenum sleeves associated with this experiment were provided by IRSN. The subsequent approach to critical experiments with 397 molybdenum sleeves in the SPRF/CX assembly were successfully performed during the week of 12 September 2022.

This integral experiment is supported by the DOE Nuclear Criticality Safety Program, funded, and managed by the National Nuclear Security Administration for the Department of Energy.

*Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.*



Near critical core load with 867 fuel rods and 397 molybdenum sleeves at SPRF/CX executed on 13 September 2022.

## Measurements for Flattop-HEU Benchmark Reevaluation

Kristin Stolte, Theresa Cutler, Charlie Kiehne, Kelsey Amundson, Dave Hayes

*LA-UR-22-29086*

In June 2022, high-fidelity measurements of the Flattop critical assembly were taken at the National Criticality Experiments Research Center (NCERC) at the Nevada National Security Site by a team from Los Alamos National Laboratory, Figure 1. Flattop-HEU is composed of a sphere of highly enriched uranium (HEU) surrounded by a thick spherical natural uranium (NU) reflector as shown in Figure 2 and Figure 3. These measurements were taken as part of the reevaluation of the Flattop-HEU benchmark evaluation for the International Criticality Safety Benchmark Evaluation Program (ICSBEP) Handbook. This reevaluation is being completed to update the benchmark to modern standards with significantly improved fidelity and uncertainty analysis because Flattop-HEU is relied upon heavily for nuclear data and analytical methods validation. [1] The measurements taken during this campaign address the largest identified uncertainties determined during a preliminary reevaluation in 2015. [2]

Figure 1. LANL Team with CMM and Flattop.

Figure 2. Close-up of Flattop, in Closed Position, with Fullcap, HEU Core, and Pedestal Adapter (L-R) Arranged on the Tabletop.

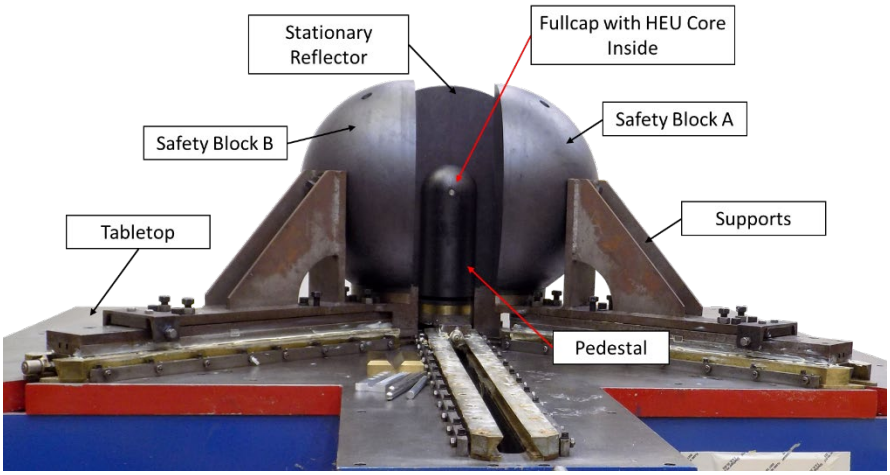



Figure 3. Expanded View of Flattop showing Locations of Core and Reflector Components.

The preliminary reevaluation identified that the largest uncertainties were associated with the mass and dimensions of the NU and HEU components.[2] To reduce the uncertainties associated with these categories, four different high-fidelity, calibrated measurement tools were used: a high-precision balance to weigh the glory hole pieces, a coordinate measuring machine (CMM) to determine the true diameter of the reflector components and HEU core, a set of high-precision calipers, and a pycnometer to measure the volume of the smaller pieces through gas displacement. The CMM and pycnometer were ordered specifically for this measurement campaign but will be useful for many other experiments in the future.

The CMM was used in two separate modes. The first mode was a scanning mode, which creates a 3D information-rich rendering of the scanned components. Figure 4 shows two of these scans being completed, and Figure 5 shows the digital results of the second scan. The second mode used with the CMM was point measurements made with a “ruby tip” probe at the end of the arm which inferred the diameter of the reflector piece from the locations of the touches.

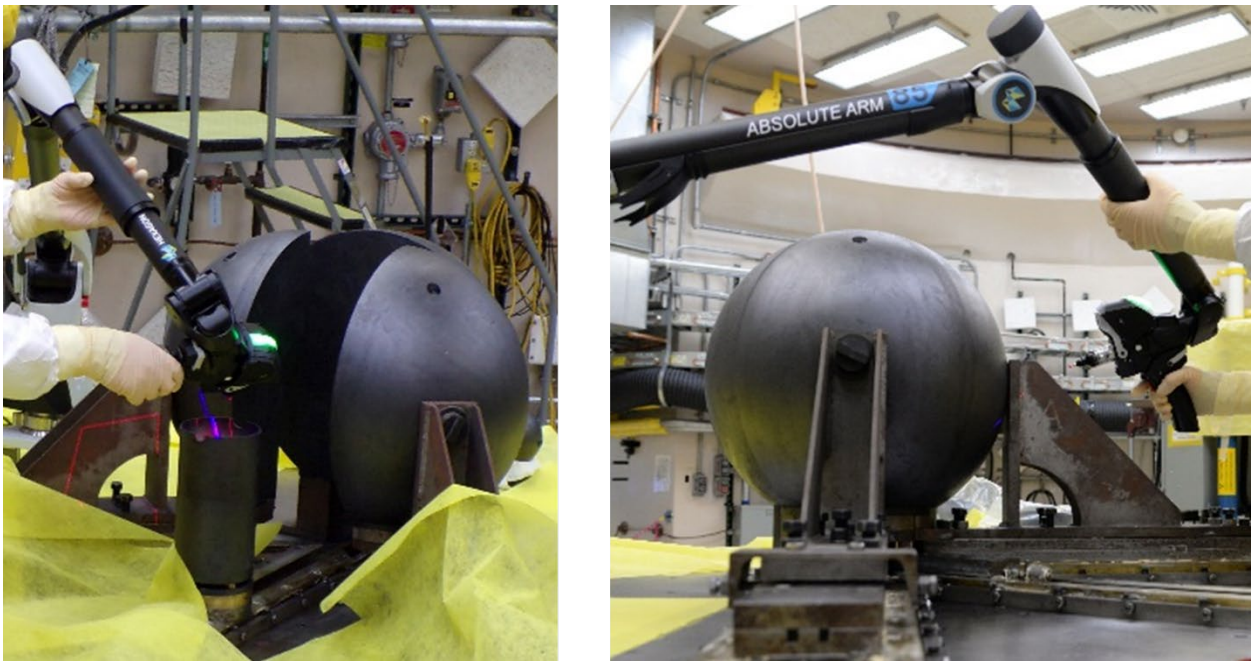



Figure 4. CMM Scans being Completed on Flattop.

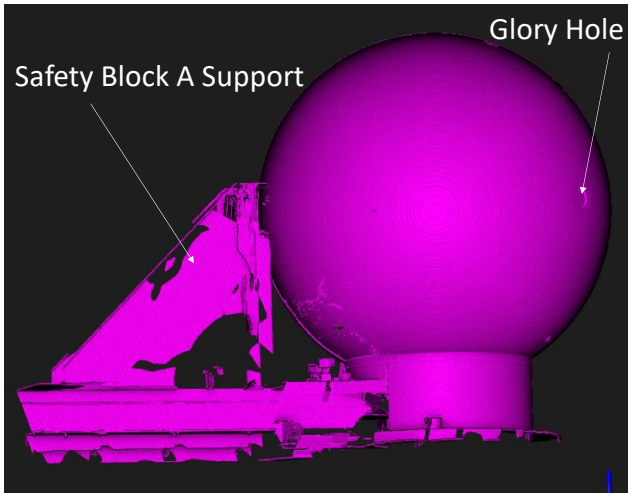



Figure 5. Digital Rendering of CMM Scan for Closed Flattop Configuration Showing Support for Safety Block A and Glory Hole.

Work has begun on the uncertainty analysis and Section 1 for the benchmark reevaluation. The preliminary results for the total mass-based uncertainty and largest individual uncertainties will be discussed at the upcoming American Nuclear Society winter meeting. [5] These preliminary results show that a marked improvement over the results of the original evaluation can be achieved. Upon completion of the reevaluation, the benchmark evaluation will be submitted for inclusion as a revision to the original Flattop-HEU evaluation, HEU-MET-FAST-028, in the ICSBEP Handbook. [3,4] This work may also necessitate the reevaluation of other benchmarks in the handbook that use Flattop, such as PU-MET-FAST-006; U233-MET-FAST-006; MIX-MET-FAST-002; and SPEC-MET-FAST-003. Future experiments such as a study of reactivity changes due to plutonium aging (IER 301) and an Americium worth experiment (IER 515) will benefit greatly from these measurements and revised benchmark.

REFERENCES

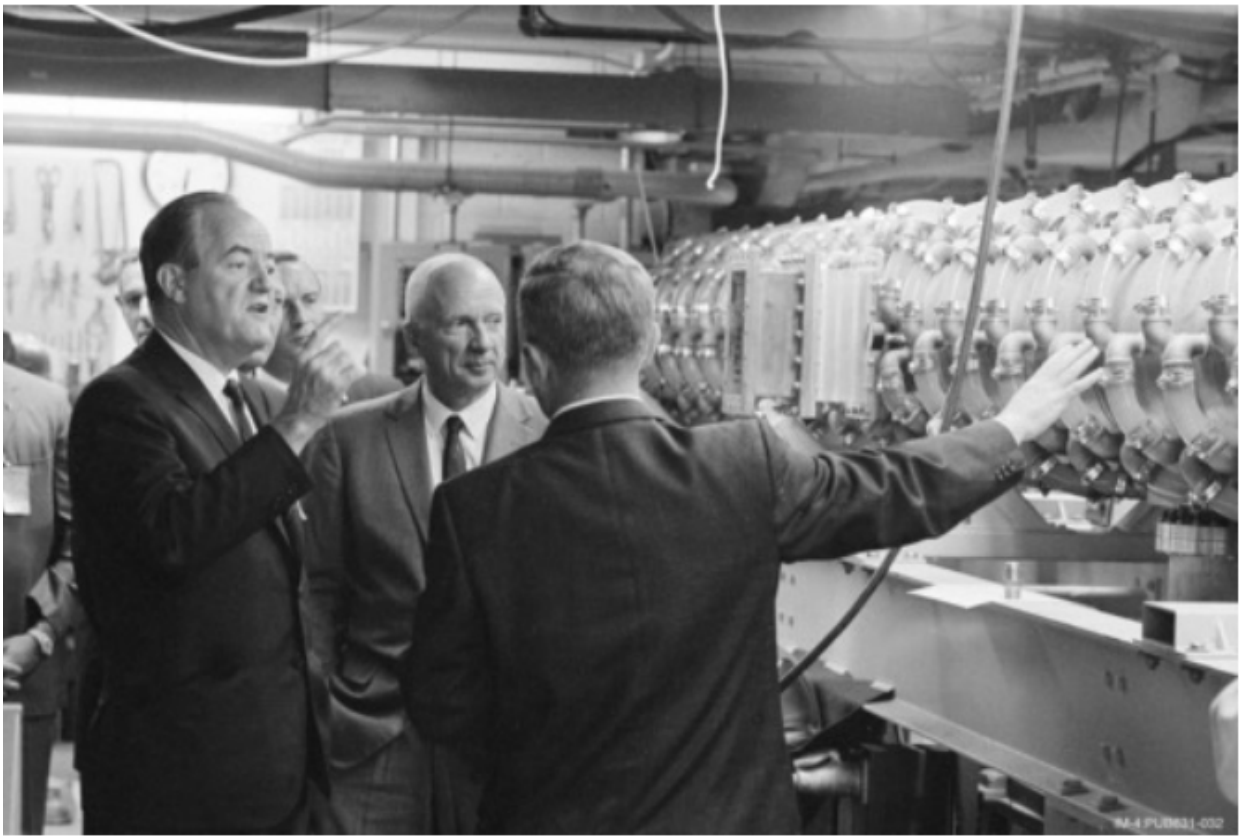
1. D. HAYES, T. BREDEWEG, T. CUTLER, J. GODA, T. GROVE, J. HUTCHINSON, J. LAMPROE, G. MCKENZIE, A. MCSPADEN, W. MYERS, R. SANCHEZ, and J. WALKER, “A New Era of Nuclear Criticality Experiments: The First 10 Years of Flattop Operations at NCERC,” Nuclear Science and Engineering, 195, sup1, S37–S54 (2021).
2. J. A. FAVORITE, “Preliminary Flattop-25 Reevaluation Results,” LA-UR-15-29661 (2015).
3. R. W. BREWER, T. P. McLAUGHLIN and V. DEAN, “Uranium-235 Sphere Reflected by Normal Uranium using Flattop,” International Handbook of Evaluated Criticality Safety Benchmark Experiments, HEU-MET-FAST-028, Revision 1, Nuclear Energy Agency, Organization for Economic Co-Operations and Development (September 2015).
4. J. BESS, T. IVANOVA, L. SCOTT, and I. HILL, The 2020 Edition of the ICSBEP Handbook, Nuclear Energy Agency, Organization for Economic Co-Operations and Development (2020).
5. K. STOLTE, T. CUTLER, C. KIEHNE, K. AMUNDSON, and D. HAYES, “High-Fidelity Measurements for Flattop -HEU Benchmark Reevaluation,” Trans. of Am. Nuc. Soc. 127 (2022).

## LANSCE Facility at Los Alamos Turns 50

Los Alamos is celebrating the LANSCE (Los Alamos Nuclear Science) facility during the week of September 9 for 50 years of contributions! Since FY20, LANSCE has been one of three facilities providing nuclear data measurements to the NCSP, along with the Gaerttner Linear Accelerator facility at RPI and GELINA (the Gael Linear Accelerator located in Belgium). Current and upcoming NCSP experiments at LANSCE include the keV capture cross section

of U-233, the prompt fission neutron spectrum of Pu-240, low-energy neutron measurements of Pu-239, and Cl-35 (n,p) cross sections.

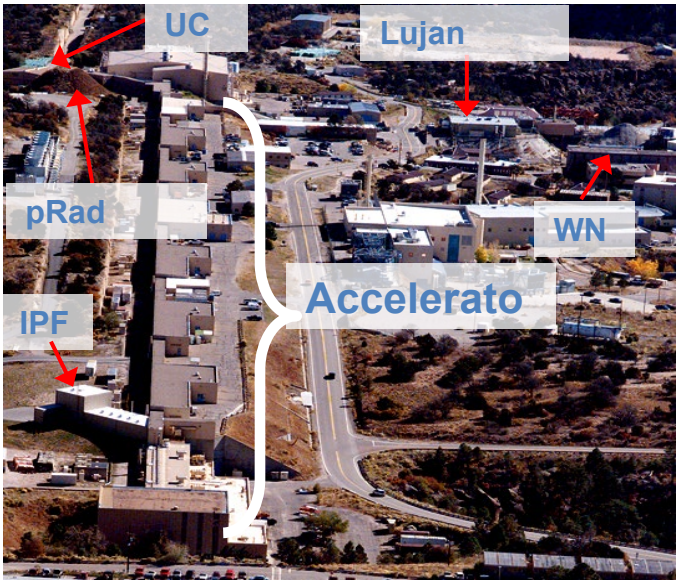
LANSCE was known as LAMPF (Los Alamos Meson Physics Facility) when it opened in 1972. Then, as now, the centerpiece of the facility was an 800-MeV proton accelerator. See an image below of then.



Vice-President Hubert Humphrey when he visited LASL in 1966 to discuss the proposed LAMPF with Lab Director Norris Bradbury and LAMPF Director Louis Rosen

The accelerator itself has undergone refurbishment and upgrades over time and several unique experimental areas have grown around it in support of a variety of scientific and defense missions. The two experimental facilities currently used for NCSP measurements are the Lujan Neutron Scattering Center and the Weapons Neutron Research (WNR) Facility.

A photo (right) shows the layout of LANSCE today. UCN is the Ultra-Cold Neutron Facility, IPF is the Isotope Production Facility, and pRad is proton radiography. The accelerator itself is nearly a mile long.



NCSP leadership visited LANSCE earlier this year and received updates on ongoing experiments and toured several of the experimental facilities.

Angela Chambers and Doug Bowen with LANL researcher Esther Leal Cidoncha standing by the DANCE capture array, which was used in the U-233 capture experiment. Preliminary data from that experiment is shown in Figure 3.

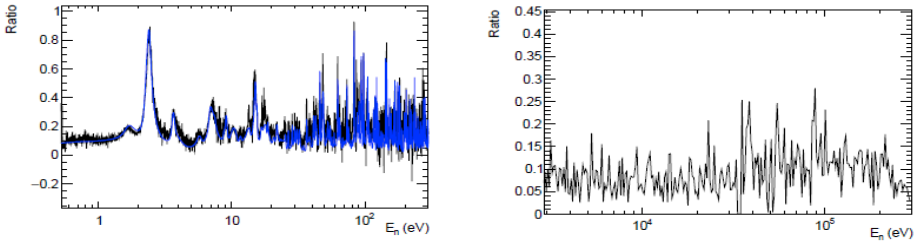



Figure 3: Preliminary comparison of the fission to capture ratio on $^{233}$U for events with cluster multiplicities from (4,6) (black line) with the ENDF/B-VIII evaluation (blue line). The experimental data have been scaled by eye for initial comparison in the Resolved Resonance Region.

The researchers at LANSCE are indeed celebrating 50 years of accomplishments, but also looking forward to future enhancements and innovations that will continue to enable cutting-edge science in support of multiple programs and missions.

## Annual NCSP Budget Execution Meeting and FY23-27 Five-Year Plan

This year we held the annual NCSP Budget Execution meeting in person at the Las Vegas National Atomic Testing Museum on Wednesday, July 20, and Thursday, July 21. The NCSP Management Team visited some Nevada National Security Sites (Nuclear Accident Dosimetry lab, the National Criticality Experiments Research Center in the Device Assembly Facility, and the Blue Box in Mercury). The FY2023 NCSP budget was finalized during the meeting, although a later budget reduction required some changes to the funding and tasks. The NCSP Program Manager approved the FY23 – FY27 five-year plan on August 9. The plan is posted on the website at https://ncsp.llnl.gov/sites/ncsp/files/2022-08/ncsp_five-year_execution_plan_fy2023-2027_-_final.pdf.

## NCSP Technical Program Review and Joint Meetings

Please save the date for the FY23 Technical Program Review (TPR) and joint meetings to be held on February 21 – 24, 2023, in Albuquerque, New Mexico. Sandia National Laboratory will host the meetings. More information will be made available as details are known. The NCSP website will provide a TPR registration site this fall. This will be an in-person meeting and no virtual options will be available.

## ANS Winter Meeting 2022

The 2022 American Nuclear Society (ANS) Winter Meeting will be held November 13 – 17, 2022 in Phoenix, Arizona. The Nuclear Criticality Safety Division (NCSD) will sponsor the technical session "Recent Nuclear Safety Program Technical Accomplishments." This session is scheduled for Tuesday, Nov. 14th, from 1-3PM. The papers to be presented include:

- "Preliminary Chlorine Worth Study Benchmark Evaluation," Jeff Favorite, Travis Grove, Theresa Cutler, LANL
- "Four New Plutonium Thermal Epithermal eXperiments (TEX) Critical Configurations Optimized to Test Thermal Scattering Laws," Catherine Percher, LLNL
- "TEX-HEU: Baseline Assemblies Benchmark and Results, HEU-MET-MIXED-021," Jesse Norris, LLNL
- "Design of Critical Experiments Targeting Epithermal Cross Sections of Tantalum," David Ames, SNL
- "ORNL Neutron Cross Section Measurements of $^{90}$Zr," Klaus Guber, ORNL

## Libby Johnson: On the frontier for nuclear safety

Contributions by Oak Ridge National Laboratory physicist, Libby Johnson, one of the world's first nuclear operators may be found here. She helped standardized the field of criticality safety with peers from ORNL and Los Alamos National Laboratory. Calvin Hopper, Doug Bowen, and others supported the ORNL reporter who wrote the article.

## Training and Education

## August 2 week NCS Hands-on Training Courses

The NCSP 2-week hands-on training course for NCS Engineers was successfully completed at from August 8-19, 2022, at the Desert Research Institute (near the National Atomic Testing Museum) in Las Vegas, NV, Sandia National Laboratory in Albuquerque, NM, and the National Criticality Experiments Research Center at the Nevada National Security Site. This was the largest course the NCSP ever conducted with a total of 26 students. Thanks to all the course points-of-contact and our numerous logistics support staff, instructors, and experimenters that made the course possible. – NCS*P Training and Education Coordinator, Doug Bowen*


Photo of the August 2022 students at the Desert Research Institute – Lecture portion of the course. Photo courtesy of Doug Bowen, ORNL.

Photo of the August 2022 students who attended the hands-on portion of the course at Sandia National Laboratory. Photo courtesy of David Ames, SNL.

## Two-week Practitioner Course Dates:

- January 23 – February 3, 2023
- 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

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|---|---|
| Sep 12 – 16, 2022 | Practical MCNP for the Health Physicist, Radiological Engineer, and Medical Physicist (online) |
| Oct 3 – 7, 2022 | Intermediate MCNP6 (online) |
| Oct 24 – 28, 2022 | Introduction to MCNP6 (online) |
| Dec 5 – 7, 2022 | Variance Reduction with MCNP6 (online) |

## 2022 MCNP® User Symposium

The 2022 MCNP® User Symposium will be held October 17 - 21. The symposium will be a hybrid event. The in-person option will take place at the Los Alamos J.R. Oppenheimer Center. The virtual option will use the Cvent platform. The symposium website is available at www.lanl.gov/mcnp2022.

Registration is open and the call for abstracts is out.

Important deadlines are as follows:

- The deadline for non-US citizens to register for the symposium is September 19. This will be the absolute last day that we can accept registrations from non-US citizens and attempt to get the required approvals. We still encourage non-US citizens to register as soon as possible and remind you to complete and submit all of the requested information. That information is required whether you plan to attend in-person or virtually.
- The deadline to submit abstracts is September 19.
- The deadline for US citizens to register is October 3.

Please see the website for information on registration and abstract submission.

Any suggestions or questions can be sent to mcnp2022@lanl.gov.

## SCALE Fall Courses

The next training block will be held in person at Oak Ridge National Laboratory in October. 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 is found at https://utconferences.eventsair.com/scale-fall-2022/register/Site/Register. More information about the courses is found at https://www.ornl.gov/scale/training.

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| October 3 – 7 | SCALE/ORIGEN Standalone Fuel Depletion, Activation, and Source Term Analysis |
| October 10 – 14 | SCALE Modeling and Simulation for Nuclide Inventory and Decay Heat in LWR Spent Nuclear Fuel |
| October 24 – 28 | SCALE Criticality Safety Calculations |