



NCSP Nuclear Data Program

WANDA-2023 Workshop



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Background / History–Mission Vision–Organization

Early history

- Defense Nuclear Facilities Safety Board (DNFSB) Recommendations:
 - 93-2 (3/23/1993): Need for a general-purpose critical experiment capability that will ensure safety in handling and storage of fissionable material.
 - 97-2 (5/19/1997): Need for improved criticality safety practices and programs to alleviate potential adverse impacts on safety and productivity of DOE operations.
- **DOE Implementation Plan for 93-2 and 97-2 recommendations resulted in establishment of the US NCSP**



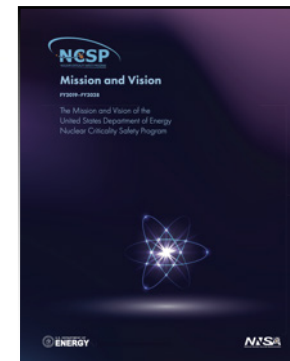
NCSP 5-year plan

Mission

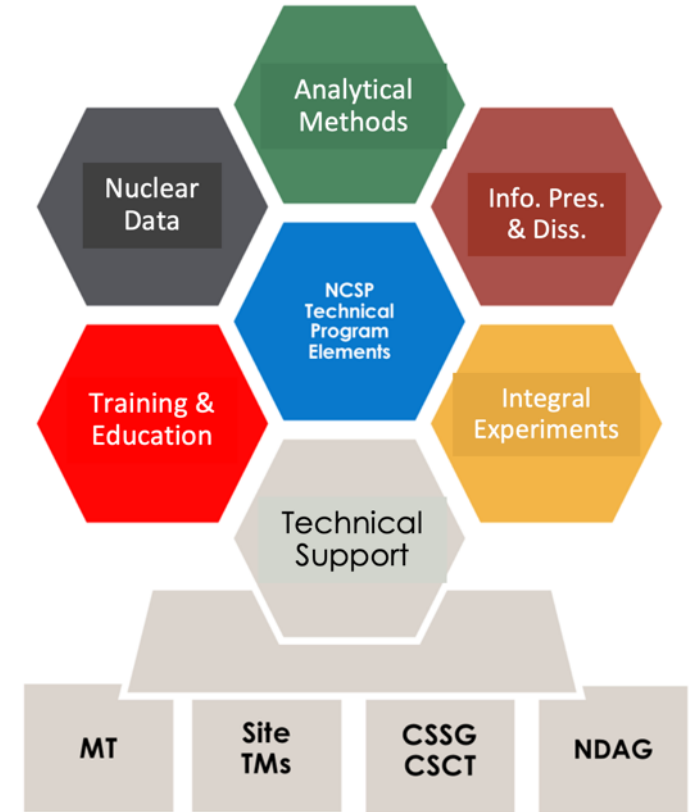
Provide sustainable expert leadership, direction and the technical infrastructure necessary to develop, maintain, and disseminate the essential technical tools, training, and data required to support safe, efficient fissionable material operations within DOE.

Vision

Continually improving, adaptable, and transparent program that communicates and collaborates globally to incorporate technology, practices, and programs to be responsive to the essential technical needs of those responsible for developing, implementing, and maintaining nuclear criticality safety.



NCSP organization



- TS** – Technical Support
- MT** – Management team
- TMs** – Task managers
- CSSG** – Criticality Safety Support Group
- CSCT** – Criticality Safety Coordinating Team
- NDAG** – Nuclear Data Advisory Group

Technical Program Element Activities

SCALE
AMPX

MCNP6

NJOY

NNDC

AM

ND

IPD

NCSP
Goals

TE

IE

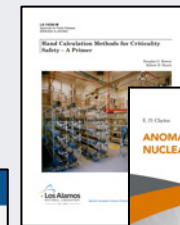
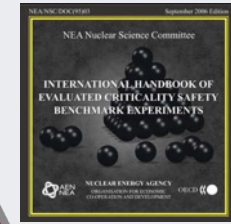
TS



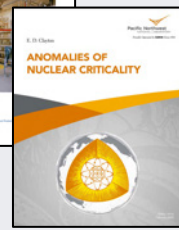
NDA
Program



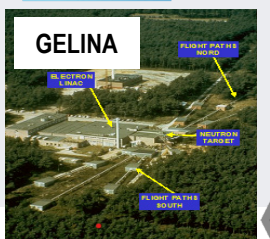
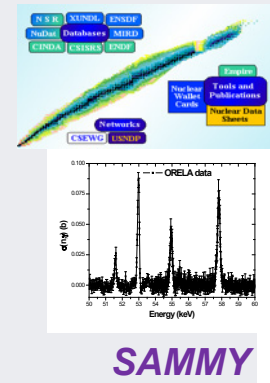
ICSBEP



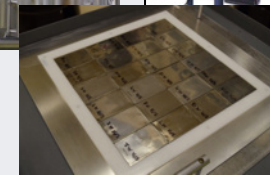
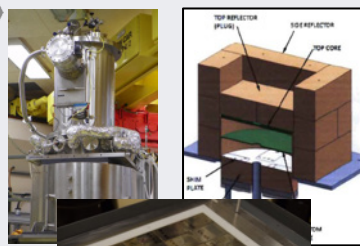
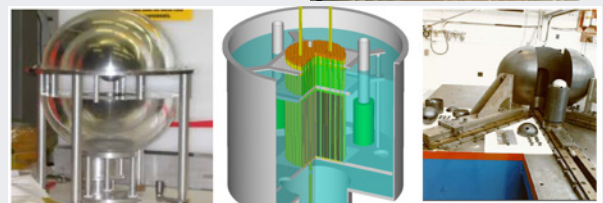
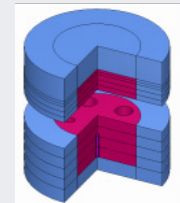
NCS Handbooks
& Reports



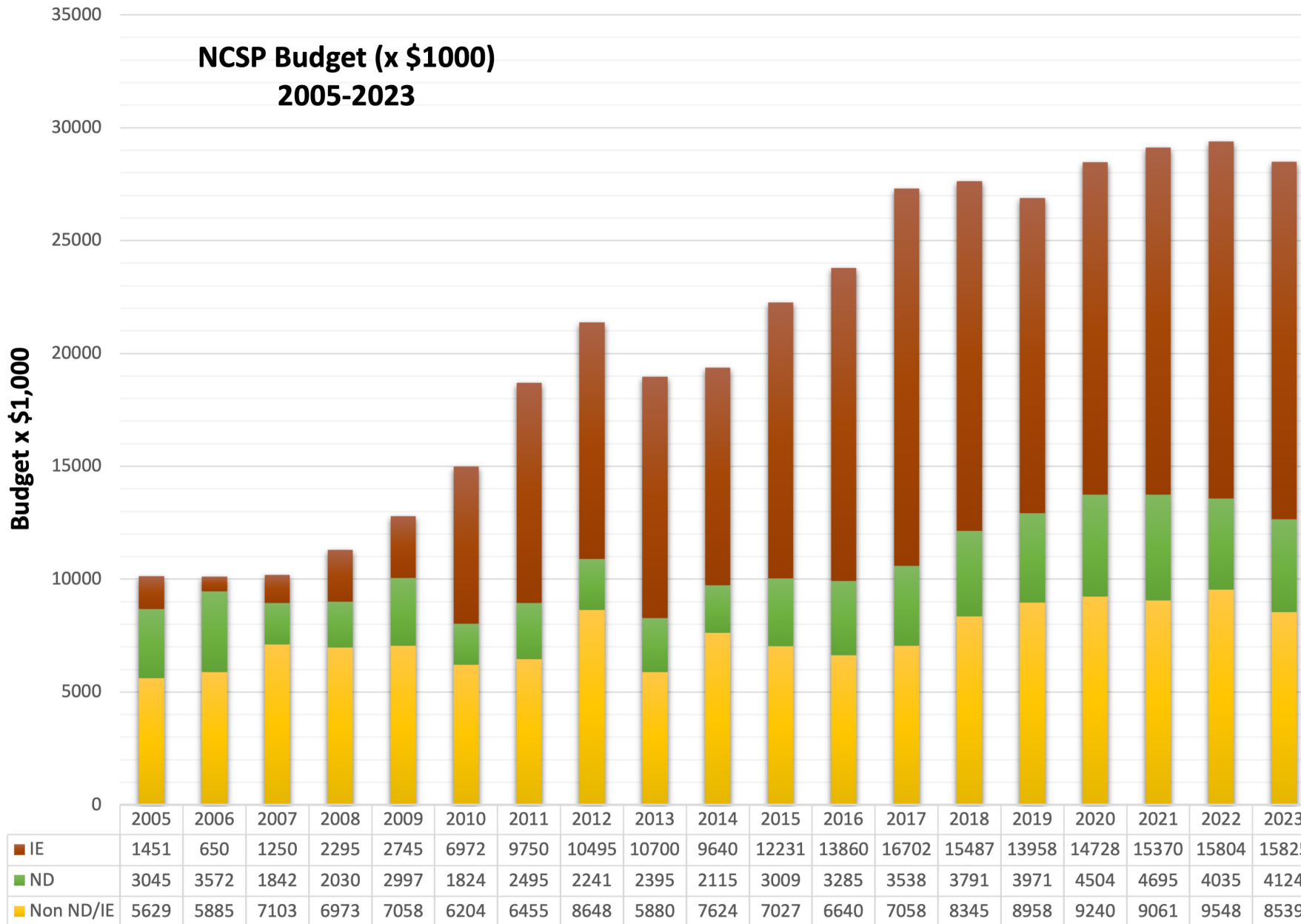
NCSP Website
<https://ncsp.llnl.gov>



linac
The Gaertner LINAC Center



NCSP Nuclear Data and Integral Experiment Budget (>2005)

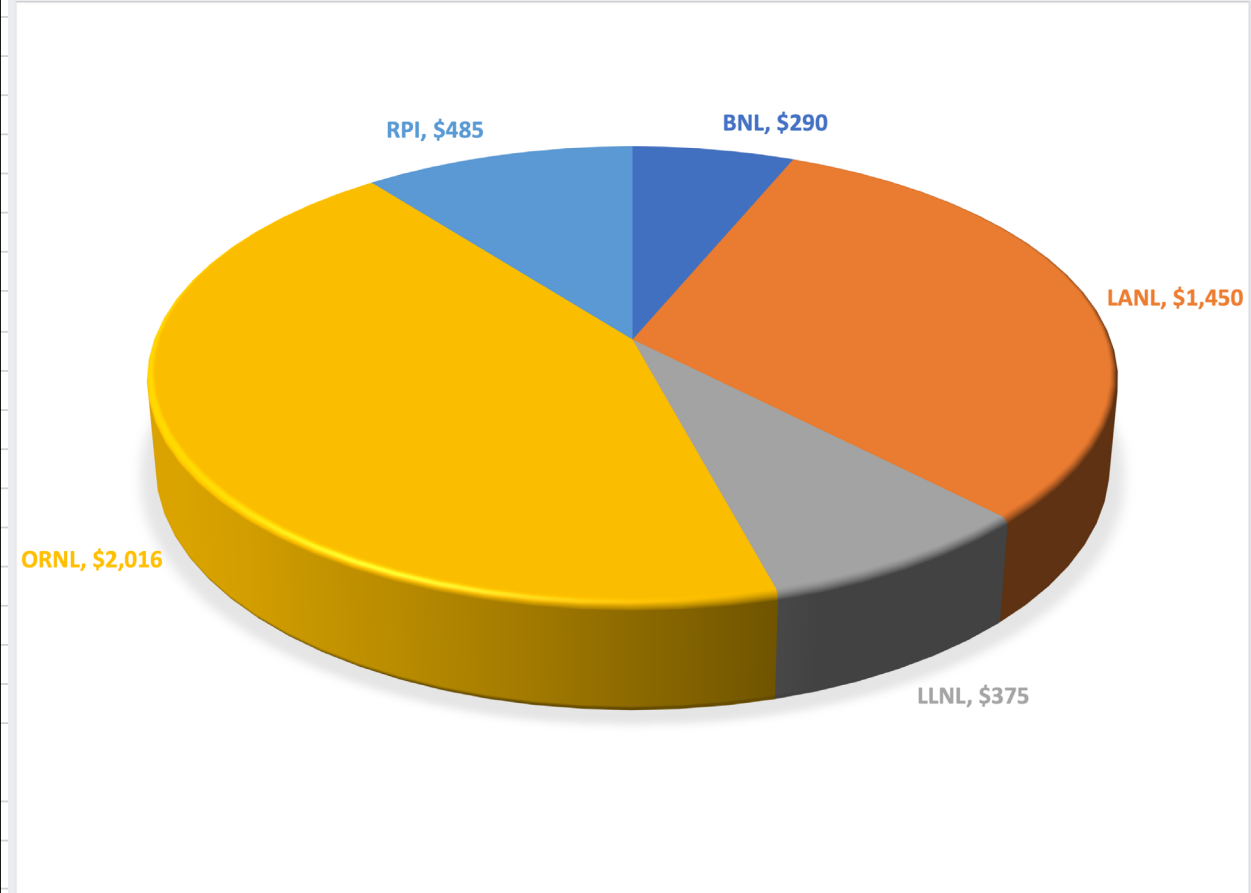


NCSP Nuclear Data Tasks and Budget (2023)



Nuclear Data Tasks by NCSP Site

BNL
BNL-ND1 – National Nuclear Data Center (NNDC) Support to the NCSP
LANL
LANL-ND1 – Nuclear Data Evaluation and Testing
LANL-ND2 – Nuclear Data Measurements at LANSCE
LANL-ND2a – Prompt Fission Neutron Spectra (PFNS) Measurement of Plutonium-240
LANL-ND2b – Unresolved and Fast Measurements of U233(n,gamma)
LLNL
LLNL-ND5 – Dev. & Implementation of a Modern Doppler Broadening Approach Including Atomic Binding Effects
LLNL-ND9 – Scoping Study: Li-6 Doped Liquid Scintillator Array for Fission Correlations
LLNL-ND11 – Fabricate the Pu240 PPAC targets and fission detector components
LLNL-ND8 – Study: Fission TPC Measurement of the U-233/U-235 (n,f) Cross Section Ratio
LLNL-ND7 – ‘Alpha-N’ Benchmark Measurements
LLNL-ND12 – Thermal Scattering Law Evaluations and Methods Development
ORNL
ORNL-ND1 – Nuclear Data Measurements
ORNL-ND3 – Isotopic Sample Leases to Support ND1 ND Measurements
ORNL-ND6 – SAMMY Nuclear Data Evaluation Code Modernization
ORNL-ND9 – Evaluation of Thermal and Resolved Resonance Ranges of UO2 and PUO2
ORNL-ND4 – Thermal Neutron Total Cross Section Measurements for Improvement of Criticality Calculations and Propagation of Scattering Kernel Uncertainties
ORNL-ND2 - Nuclear Data Evaluations and Testing
ORNL-ND11 – Thermal neutron scattering measurements and evaluations for DHS applications at temperature
RPI
RPI-ND1 – Resonance Region Nuclear Data Measurement Capability at RPI
RPI-ND3 – RPI/ORNL: LINAC 2020 Nuclear Data Capabilities Maintenance Plan



NCSP Integral Experiments

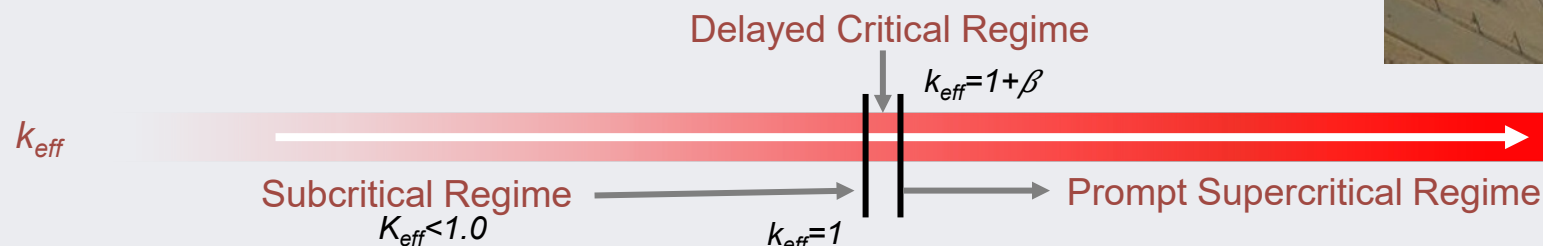


- NCSP integral measurements are performed at
 - Sandia National Laboratories (SNL) and
 - National Criticality Experiments Research Center (NCERC), currently operated by Los Alamos National Laboratory
 - NCERC is located at the Nevada National Security Site (NNSS) inside the Device Assembly Facility (DAF)
- Types of experiments that can be performed
 - Subcritical
 - Rocky Flats shells, BeRP ball, Np-237 sphere, TACS shells, etc.
 - Critical/Delayed Supercritical
 - NCERC: Planet, Comet, Godiva IV, Flattop
 - Sandia: Sandia Pulse Reactor critical assembly (2 fuel types, currently)
 - Prompt Supercritical
 - NCERC: Godiva IV (< 300 deg. C pulse)

DAF/NCERC



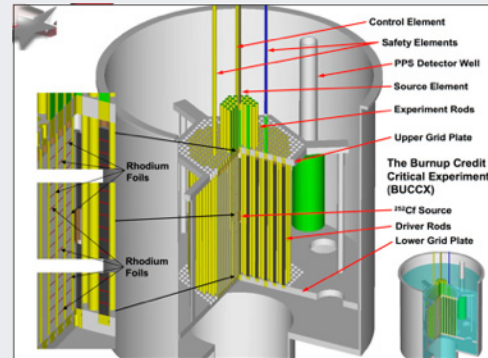
SNL/TA-V/SPR Facility



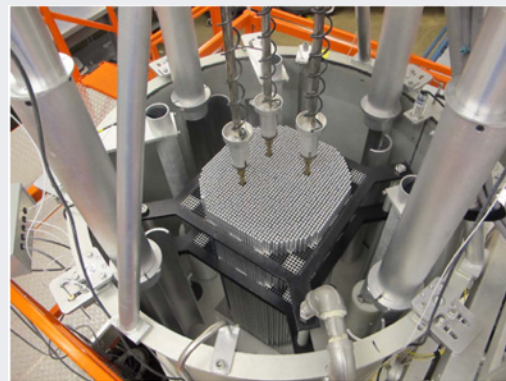
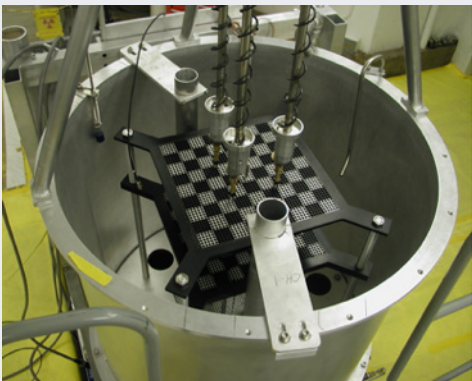


Sandia National Laboratory

SNL – BUCCX – U(4.31)/Fission Product Experiments



SNL – 7uPCX – U(6.9) UO₂ rods



NCERC/DAF



NCERC – Np-237 Sphere



NCERC – BeRP Ball



NCERC – TACS



NCERC – Godiva IV



NCERC – Flattop



NCERC – Comet



NCERC – Planet

NCSP Differential Experiments



- NCSP differential nuclear data measurements are performed at
 - JRC-Geel GELINA Facility (Geel, Belgium)
 - ORNL Spallation Neutron Source (Oak Ridge, TN)
 - RPI LINAC (Troy, NY)
 - LANL (Los Alamos, NM) LANSCE/Lujan Neutron Scattering Center

JRC-Geel (GELINA)



RPI LINAC  Rensselaer



LANL LANSCE



ORNL SNS



Photos referenced from:

http://www.linac.rpi.edu/public_html/accelerator.html

<https://neutrons.ornl.gov/sns>

<https://ec.europa.eu/jrc/en/research-facility/linear-electron-accelerator-facility>

<https://lansce.lanl.gov/>

Nuclear Data Measurements & Evaluation Work for NCSP



- **Objective:** Provide measured and evaluated thermal, resonance, unresolved resonance, and fast region cross section data to address the priority NCSP nuclear data needs
- **Vision:** Addresses multiple Nuclear Data 5- and 10-year goals and attributes identified in the NCSP Vision
- **Final product:** Rigorous ENDF/B evaluations produced from cross section measurements and analyses.
- Measurement work effort focused on NCSP priorities by NCSP Nuclear Data Advisory Group (NDAG)
- NCSP 5-year plan provides a listing of Nuclear Data measurement and evaluation priorities for the program
- **DOWNLOAD:** <https://ncsp.llnl.gov/program-management/ncsp-five-year-execution-plan>

**Appendix B
Nuclear Data Priorities, Basis Statements, and Milestones**

Nuclear Data Measurements							
Materials	Pre-FY2019	FY2019	FY2020	FY2021	FY2022	FY2023	Post-FY2023
Cerium (¹⁴² Ce)							
Basis	Neutron transmission and capture of ¹⁴² Ce in the resonance range. Cerium is an element that is predominately ¹⁴² Ce (88.450 a/o) and ¹⁴⁰ Ce (11.114 a/o) and can be found in chemical processing streams because it is commercially used as a catalyst or additive for chemical applications (e.g., glass polishing powder). As a result, cerium appears as an admixed material in process streams. ¹⁴² Ce is also a stable fission product. The primary interest for cerium cross sections is for poison credit in NCS analyses. The need for improved cerium cross sections has been specifically identified for the Hanford Plutonium Finishing Plant and other similar operations. Isotopically enriched sample required.						
Chlorine (³⁵ Cl)							
Basis	Measurement of the ³⁵ Cl (n,p) cross section in the resonance range. Chlorine is present in fuel cycle facilities in Pu solutions, electrorefining processes, chloride salts, and as brine/drift in some repository environments. Improved ³⁵ Cl (n,p) cross sections needed for poison credit in these in these environments. A need for improved ³⁵ Cl cross sections has been specifically identified at LANL and Y-12.						
Lanthanum (¹³⁹ La)							
Basis	Measurement of neutron transmission and yield of ¹³⁹ La in the resonance range. Lanthanum is an element that is predominately ¹³⁹ La (99.910 a/o) and a stable fission product. The primary NCS interest is for fission product credit. In the latest edition of the ENDF nuclear data library, the resonance analysis is based on parameters obtain with an experimental set up which is known to have certain problems. Currently, ENDF/B-VIII evaluations for La do not have adequate covariance data based on experimental data. Improved covariance data are needed to support sensitivity/uncertainty analyses for fission product credit applications. Natural samples can be used.						
Molybdenum (⁹⁸ Mo)							
Basis	Measurement of neutron capture in ⁹⁸ Mo in resonance range, URR. Neutron transmission measurements previously completed at RPL. ⁹⁸ Mo is a stable fission product and the primary absorbing nuclide in natural Molybdenum. Molybdenum isotopes are currently encountered in irradiated fuel as fission products or in molybdenum alloys in research reactors and space reactors. The current primary interest in NCS is for fission product credit for transport casks, irradiated fuel storage, and reprocessing plants (UPu-MoZr deposits in French reprocessing plant equipment for example). Needs identified by NR and IRSN for fission product credit and Y-12 for U-Mo applications (lower priority). Isotopically enriched sample required.						
Neptunium (²³⁷ Np)							
Basis	Measurement of ²³⁷ Np fission cross section in fast energy range. ²³⁷ Np is an actinide of interest in nuclear criticality safety for applications at ORNL and other sites. Applications include ²³⁷ Np production w/ HFIR at ORNL (low NCS priority) and fast burst reactor for LANL. Nuclear data improvements will improve critical mass estimates. On the HFIR there is a request for fission cross section in the energy range from 200 keV to 20 MeV. The application list was fast systems, and the required accuracy is 1.5-4%. This requirement comes from the desire to improve the current low accuracy in the covariance matrix (6-8%).						
Tantalum (¹⁸¹ Ta)							

NCSP "Make It Happen List"



No.	Milestone	Technical Program Element	Lead Site
1	Completion of TEX/Hf experimental campaign (IER 532)	IE	LLNL/LANL
2	Complete Godiva Benchmark measurements (IER 555)	IE	LANL
3	Resume 5-year AWE/LLNL fissile measurement campaign	IE	AWE/LLNL
4	Design and procurement of shielding benchmark (IER 498)	IE	LANL/ORNL
5	Complete TEX/MOX final design report	IE	IRSN/LANL/LLNL
6	Submit benchmark evaluation of experiments with UO ₂ Rods and molybdenum foils for international publication (IER 305)	IE	SNL/IRSN
7	Submit benchmark evaluation of the MUSIC critical experiments (IER 488)	IE	LANL
8	Submit benchmark evaluation of experiments for the Flattop benchmark series (IER 423)	IE	LANL
9	Submit benchmark evaluation of the TEX/TSL critical experiment for international publication	IE	LLNL
10	Publish preliminary results for measurement of the fission neutron spectrum shape using threshold activation detectors (IER 153)	IE	LANL
11	Complete fabrication of remaining lithium wafers for critical experiment (IER 575)	IE	Y12
12	Complete execution of the copper critical experiment campaign (IER 537)	IE	LANL
13	Publish TEX low temperature DU surrogate testing results (IER 547)	IE	LLNL
14	Complete measurements for Godiva Characterization (IER 574)	IE	LANL/SNL
15	Complete prompt fission neutron spectrum (PFNS) measurement of Plutonium-240 at LANSCE (LANL-ND2a)	ND	LANL
16	Validation of design with initial RF window testing for accelerator section #1 at RPI (RPI-ND3)	ND	RPI/NNL
17	Beta release of US national ENDF/B-VIII.1 nuclear data library	ND	BNL
18	Complete Zr-92 nuclear data measurements at GELINA	ND	ORNL

- NCSP Nuclear Data work items support many different programs
 - Improvements to U-235, U-238, and Pu-239 are cross-cutting for virtually all programs
 - U-233, Pu-240, Np-237 of interest to NNSA (NA-10 & NA-20), DOE-NE, NCSP international collaborators, and the NRC
 - Pb and Fe are cross cutting for virtually all programs
 - Cl-35 cross cutting for NNSA NA-10 (electrorefining, Pu aqueous chloride processing) and DOE-NE/NRC (molten chloride salt reactors) where there a significant uncertainties associated with the (n,p) reaction. Needs for repository situations (DOE-EM/WIPP)
 - Zr & Hf of interest to NNSA NA-30 (NR)
 - Ta cross cutting with NNSA NA-10 for pit production
 - HF Thermal Scattering Law work cross cutting with NNSA (NA-10, NA-20), DOE-NE, and NRC



- NCSP support of each major ENDF/B library release supports reduced bias in eigenvalue (k_{eff}) computations to support nuclear criticality safety limit development
- NCSP Integral experiment capabilities at NCERC and Sandia are funded by the NCSP to ensure facility availability for sponsor use (non-NCSP) and for new critical experiments to support the NCS community
- NCSP performs differential measurements at RPI, LANL (LANSCE), ORNL (Spallation Neutron Source) and GELINA (Geel, Belgium)
 - GELINA is available via collaboration between DOE/NNSA NA-20 and Euratom (JRC-Geel)
 - Y-12 recently manufactured and shipped a DU neutron production target for NCSP use
- NCSP funds all aspects of the nuclear data pipeline to support the NCS community
 - Supporting process operations with hands-on operations with fissionable material
- NCSP supports university proposals for our human resource pipeline – many success stories here

Questions

