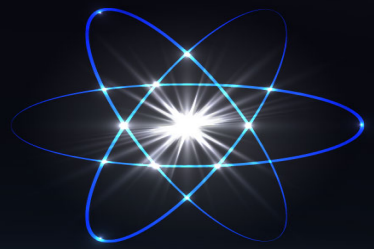
NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

Overview of the NCSP Nuclear Data Program

WANDA-2021 Workshop, Jan. 25-Feb. 3, 2021



Presented by:
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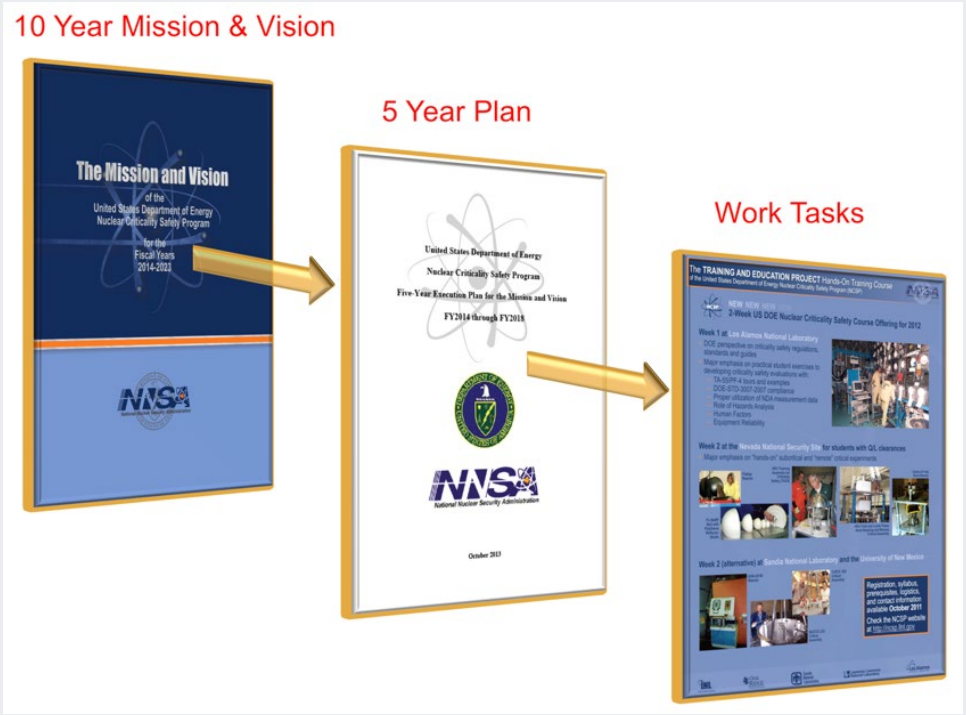
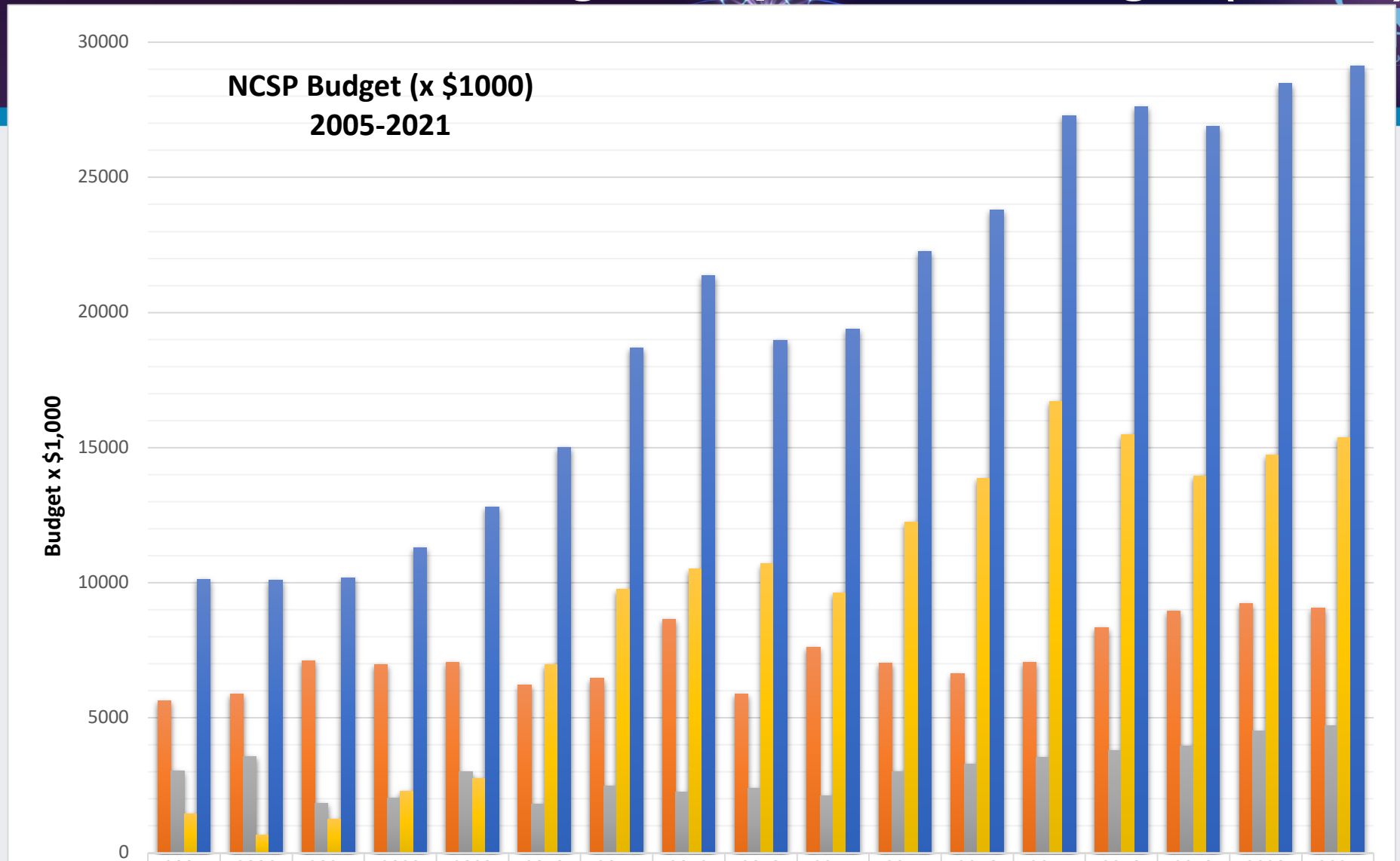
NCSP Organization and Overview

- 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 the Department of Energy.
- 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.

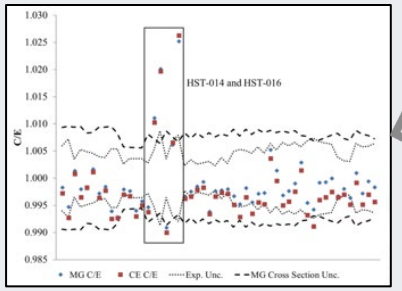


NCSP Nuclear Data and Integral Experiment Budget (>2005)



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Non ND/IE	5629	5885	7103	6973	7058	6204	6455	8648	5880	7624	7027	6640	7058	8345	8958	9240	9061
ND	3045	3572	1842	2030	2997	1824	2495	2241	2395	2115	3009	3285	3538	3791	3971	4504	4695
IE	1451	650	1250	2295	2745	6972	9750	10495	10700	9640	12231	13860	16702	15487	13958	14728	15370
Total	10125	10107	10195	11298	12800	15000	18700	21384	18975	19379	22267	23785	27298	27623	26887	28472	29126

NCSP Nuclear Data Program



Nuclear Data Gaps/Needs

Integral Measurements (Critical Experiments)

Publish Critical Benchmark (ICSBEP Handbook)

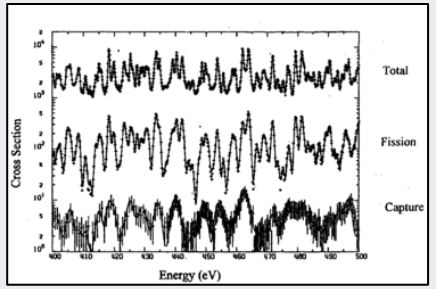
Nuclear Data Testing

Differential Nuclear Data Measurements

Measurement Data Processing (SAMMY)

Generate ENDF Libraries & new Cross Sections (AMPX, NJOY)

Nuclear Criticality Safety Applications



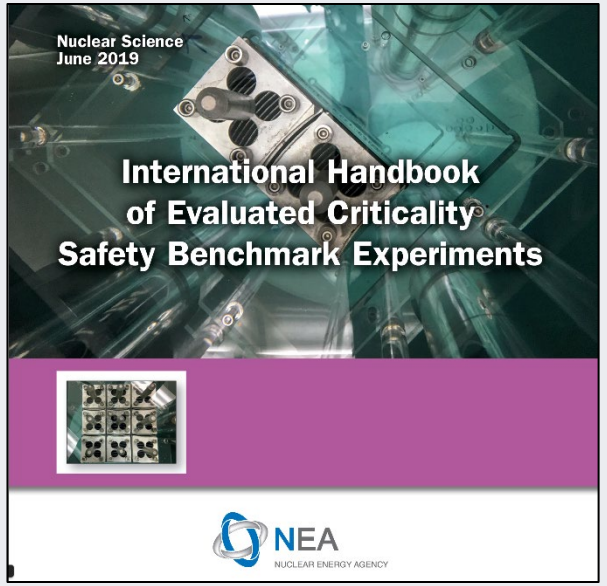
ENDF B-VIII.0

NCSP Continual Investment in Integral Experiments

IER	NCERC Experiments in Progress
121	Neptunium Subcritical Measurements
150	NCT / NTNF Material # 1
151	NCT / NTNF Material # 2
153	Measure The Fission Neutron Spectrum Shape Using Threshold Activation Detectors
268	PDV Measuremetns of Godiva for Validation of Multi-Physics SImulation
292	LLNL Foil Irradiation add-on to NCT Material #2 Measurement (IER-151)
296	MOX Experiments Using Pu ZPPR Plates
297	TEX: U (Jemima Plates) Baselines
329	TEX-23: Baseline ^{233}U Fast-Inter-Therm Experiments Using Surplus ZPPR ^{233}U Plates
423	FLATTOP Benchmark
489	U-235 Unresolved Resonance Region (URR) Integral Experiment
498	Design a shielding benchmark with a metal critical source
519	Thermal/Epithermal Experiments (TEX) with Absorbers to Provide Validation Benchmark
520	Thermal/Epithermal Experiments (TEX) for ^{240}Pu
528	TEX Pu with Tantalum
532	TEX: Jemima Plates Hafnium
537	Copper Critical Experiment
538	Full Dosimetry Exercise Around GODIVA Reactors
539	New Horizontal Split Table Critical Assembly Machine

IER	Sandia Experiments in Progress
230	Characterize the Thermal Capabilities of the 7uPCX
304	Temperature dependent critical benchmarks
305	Critical Experiments with UO_2 Rods and Molybdenum foils
306	Critical Experiments with UO_2 Rods and Rhodium Foils
441	Epithermal HEX Lattices with SNL 7uPCX Fuel for Testing Nuclear Data
522	Design of an Intermediate Energy Spectrum Experiment using the Existing SPR/CX G
523	Beryllium Oxide Critical Assembly

FY2021
NCSP IE
Budget
$15,370,000



ICSBEP Handbook Evaluation Designator	Title of Recently Completed Benchmarks
LEU-COMP-THERM-078	Water-Moderated Square-Pitched U(6.90)O2 Fuel Rod Lattices with 0.52 Fuel-to-Water Volume Ratio (0.855 cm Pitch)
HEU-MET-FAST-101	KRUSTY: Beryllium-Oxide and Stainless-Steel Reflected Cylinder of HEU Metal
PU-MET-MIXED-003	TEX Plutonium Assemblies with Tantalum: Plutonium- Aluminum Metal Alloy Plates with Varying Thicknesses of Polyethylene Moderator, Interstitial Tantalum and a Thin Polyethylene Reflector
LEU-COMP-THERM-102	Pitch Variation Experiments in Water-Moderated Square-Pitched U(6.90)O2 Fuel Rod Lattices with Fuel to Water Volume Ratios Spanning 0.08 to 0.67

NCSP Continual Investment in Nuclear Data Experiments

Completed Work by the NCSP & Partners

Element/Isotope	Measurements/Evaluations
U-233	U-233
Al	Al-27
F	F-19
Si	Si-28,29,30
Cl	Cl-35,37
K	K-39,41
Ni	Ni-58,60
Co	Co-59
Cr Nat	Cr-52,50,53,54
Cr-53	
Cu	Cu-63,65
Ti-48	Ti-50,49,48,47,46
Ti Nat	
Mn	Mn-55
W	W-182,183,184,186
Cu	Cu-63,65
Ca	Ca-40
Dy	Dy-156,158,160,162,162,163,164
Gd	Gd-152,154,156,157,158,160
O	O-16
Pb	Pb-208
Pu-239	Pu-239
W	W-182, 183, 184, 186
U	U-234, 235, 236, 238

Element/Isotope	Evaluations
Lucite	C5O2H8
Polyethylene	CH2
Beryllium	metal
Beryllium Oxide	BeO
Crystal Graphite	
Reactor Graphite	
Silicon Carbide	SiC
Silicon Dioxide	SiO2
Uranium Dioxide	UO2
Uranium Nitride	UN
Hexagonal Ice	H2O
Yttrium Hydride	YH2
FLiBe liquid	
Paraffinic Oil	
Uranium Hydride	UH3

FY2021
NCSP ND
Budget
$4,695,000

NCSP Continual Investment in Nuclear Data Experiments

In Progress per NCSP 5-year Plan

https://ncsp.llnl.gov/docs/FY21-25_NCSP_Five-Year_Execution_Plan.pdf

Element/Isotope	Measurement	Evaluations
Cr-50,53	Capture (RPI, FY21)	ORNL (FY24)
Fe-54	Capture (RPI, FY21)	
Mo-95	Capture (LANL, FY21)	
Np-237	Fission (LANL, FY21-24)	
Pu-240	PFNS (LANL/LLNL, FY21-22)	
U-233	Capture (ORNL, LANL)	Renormalize fission data (ORNL FY21-FY24), New evaluation of fast region (LANL/IRSN FY21-FY24)
Zr-90,91,92,94,96	Capture & Transmission (ORNL)	
Polystyrene	Subthermal Transmission (ORNL/RPI, FY21)	
Polyethylene	Subthermal Transmission (RPI, FY21)	
Ce nat, 142		Transmission, Capture (ORNL FY21)
Cl-35		(n,p) (ORNL, FY21-FY24)
Cu-63,65		Revised evaluation (ORNL FY21)
Hf-176, 177, 178, 179, 180		Re-evaluation of RRR and URR data. (ORNL/IRSN FY21-FY24)
Fe-56		Revise high energy resonance region evaluation (ORNL/IRSN FY21-FY24)
La-139		Resonance region evaluation (ORNL FY21-FY22)
Pb-208		Revised evaluation (ORNL FY21-FY23), NE collaboration for fast reactor applications (RPI/BNL/NNL/IRSN FY21-FY23)
Li-6		Extend evaluation to higher energies (LANL FY21-FY24)

Element/Isotope	Measurement	Evaluations
Sr-88		Revaluate resonance region (ORNL, FY21-FY23)
Ta		Resonance evaluation (ORNL/NNL FY21-FY22)
U-235		Evaluate new PFNS, inelastic scattering, and fission cross section when new data are available (LANL FY21-FY23), Revisit URR evaluation (ORNL/IRSN FY23)
U-238		Updated evaluation based on new data (LANL FY21-FY23)
Pu-239		
V-51		Updated resonance region evaluation and fast scattering angular distribution (ORNL FY21-FY23)
Water (H20)		Thermal scattering evaluation (LLNL/NCSU FY21)
Hydrofluoric Acid (HF)		Thermal scattering evaluation (LLNL/NCSU FY21)
Uranium Hexafluoride (UF6)		Thermal scattering evaluation (LLNL/NCSU FY21)
Uranium Metal (U)		Thermal scattering evaluation (LLNL/NCSU FY21)
Uranium Carbide (UC)		Thermal scattering evaluation (LLNL/NCSU FY21)
Lithium Hydride (6LiH, 7LiH)		Thermal scattering evaluation (NNL FY21)
Lithium Deuteride (7LiD)		Thermal scattering evaluation (NNL FY21)
Beryllium Hydride (BeH2)		Thermal scattering evaluation (NNL FY21)
Polystyrene (C8H8)n		Thermal scattering evaluation (ORNL FY21-FY23)

NCSP Cross-Cutting Nuclear Data Work

- Examples of NCSP cross-cutting ND work:
  - 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, and NRC
  - Pb and Fe are cross cutting for virtually all programs
  - Cl-35 cross cutting for NNSA NA-10 (electrorefining) and DOE-NE/NRC (molten chloride salt reactors) where there a significant uncertainties associated with the (n,p) reaction.
  - 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, NRC and being done to resolve a historical discrepancies impacting NCS for facility processing with UF6

NCSP Benefits/Successes (1)

- 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 experiments at NCERC and Sandia are funded by the NCSP to ”keep the doors open” and to provide new critical benchmarks for NCS purposes
  - NCSP 5-year plan defines the experiments funded for the year
  - The NCERC also supports work for a variety of programs and organizations
- NCSP performs differential measurements at RPI, LANL (LANSCE), and GELINA (Geel, Belgium)
  - GELINA is available via collaboration between DOE/NNSA NA-20 and Euratom (JRC-Geel)
  - NCSP is constructing a new neutron production target at Y-12
- 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

NCSP Benefits/Successes (2)

- Integral benchmarks and differential measurements performed by the NCSP benefit all users of ENDF/B libraries
  - Integral experiments
    - Used to train NCS personnel and others many different programs
    - KRUSTY critical experiments were in collaboration with NASA for space power applications
    - NCERC can be used to support many other sponsors, e.g., DOD, Homeland Security, DOE-NE, etc.
  - Differential measurements
    - Differential measurement collaborations for neutron and gamma libraries will support eigenvalue (k_{eff}), multi-physics methods, and criticality accident alarm system applications, e.g., criticality accident simulations and criticality accident alarm system coverage applications

Questions