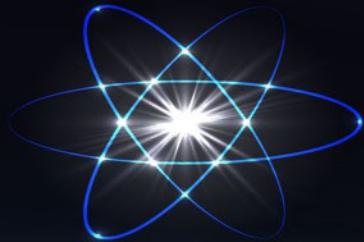




# Overview of the NCSP Nuclear Data Program

WANDA-2022 Workshop



Presented by:

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NCSP Execution Manager

**Section Head, Nuclear Criticality, Radiation Transport, and Safety**  
**Oak Ridge National Laboratory**

# 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**



Defense Nuclear Facilities Safety Board

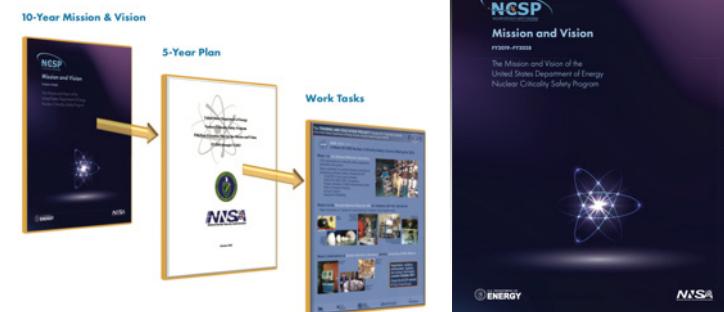
## NCSP 5-year plan

### Mission

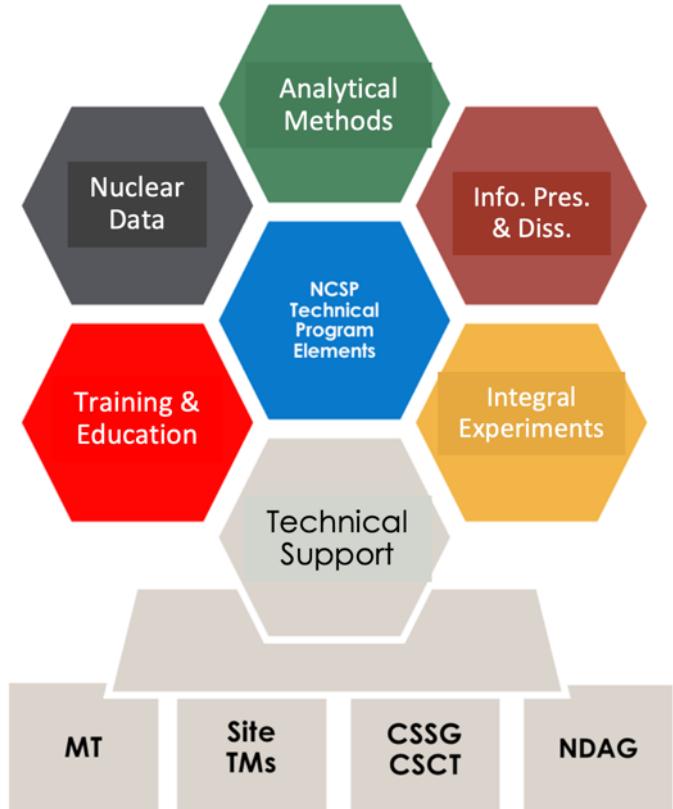
Provide sustainable expert leadership, direction and the technical infrastructure necessary to develop, maintain, and disseminate the essential technical tools, training, and data required to support safe, efficient fissionable material operations within DOE.

### 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

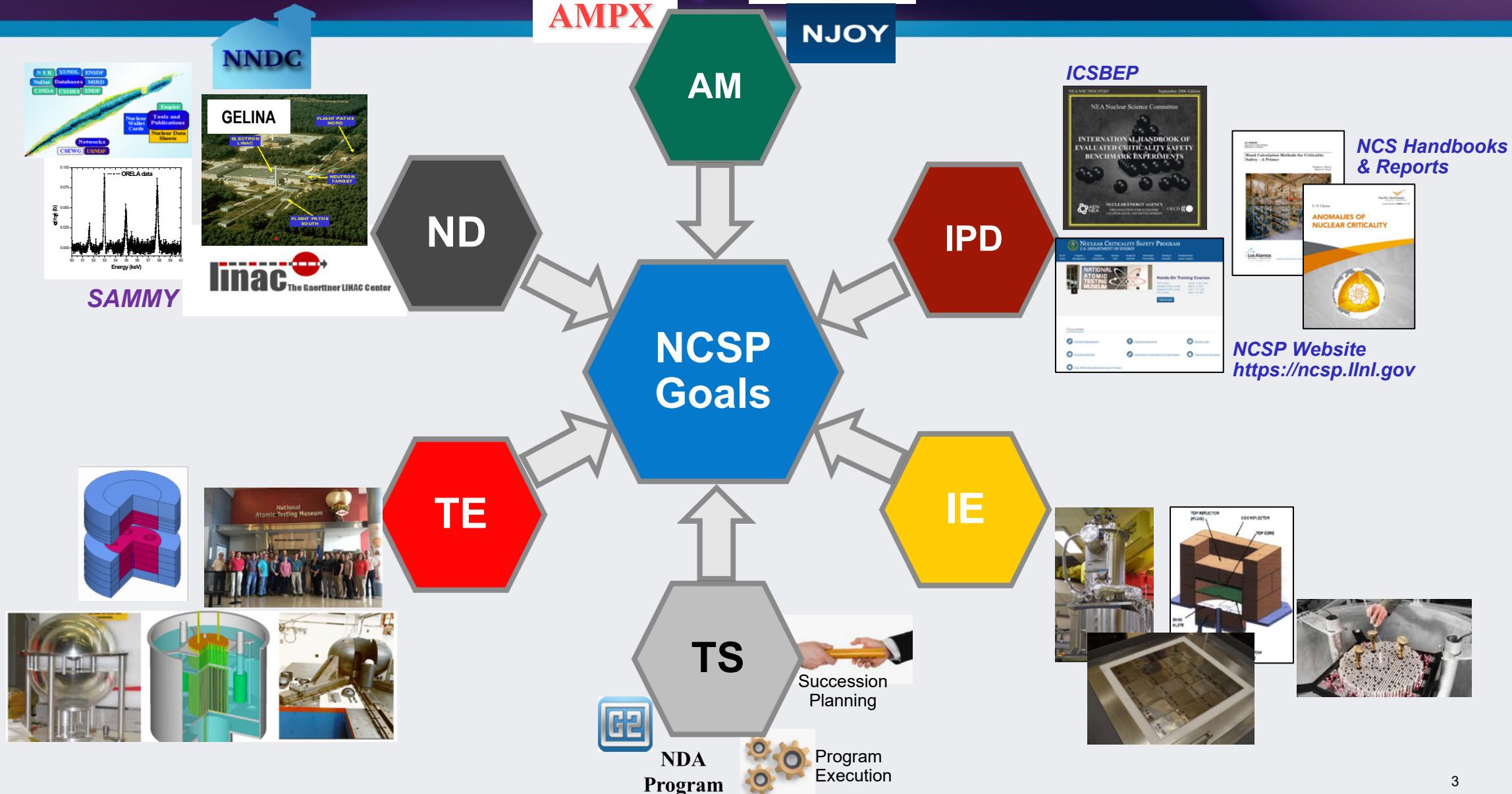
**TMs** – Task managers

**CSSG** – Criticality Safety Support Group

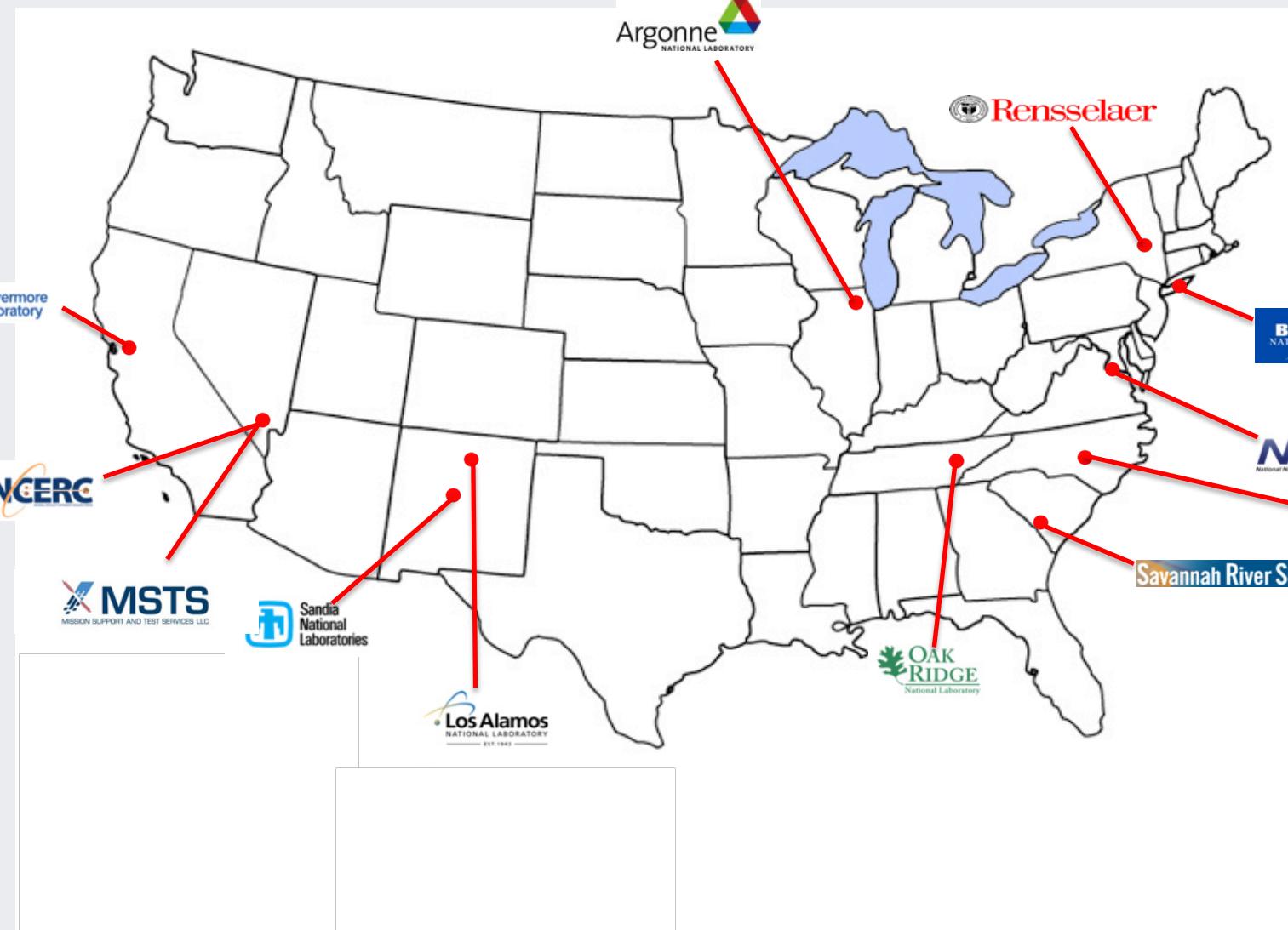
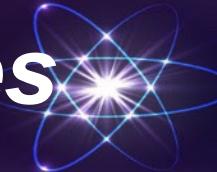
**CSCT** – Criticality Safety Coordinating Team

**NDAG** – Nuclear Data Advisory Group

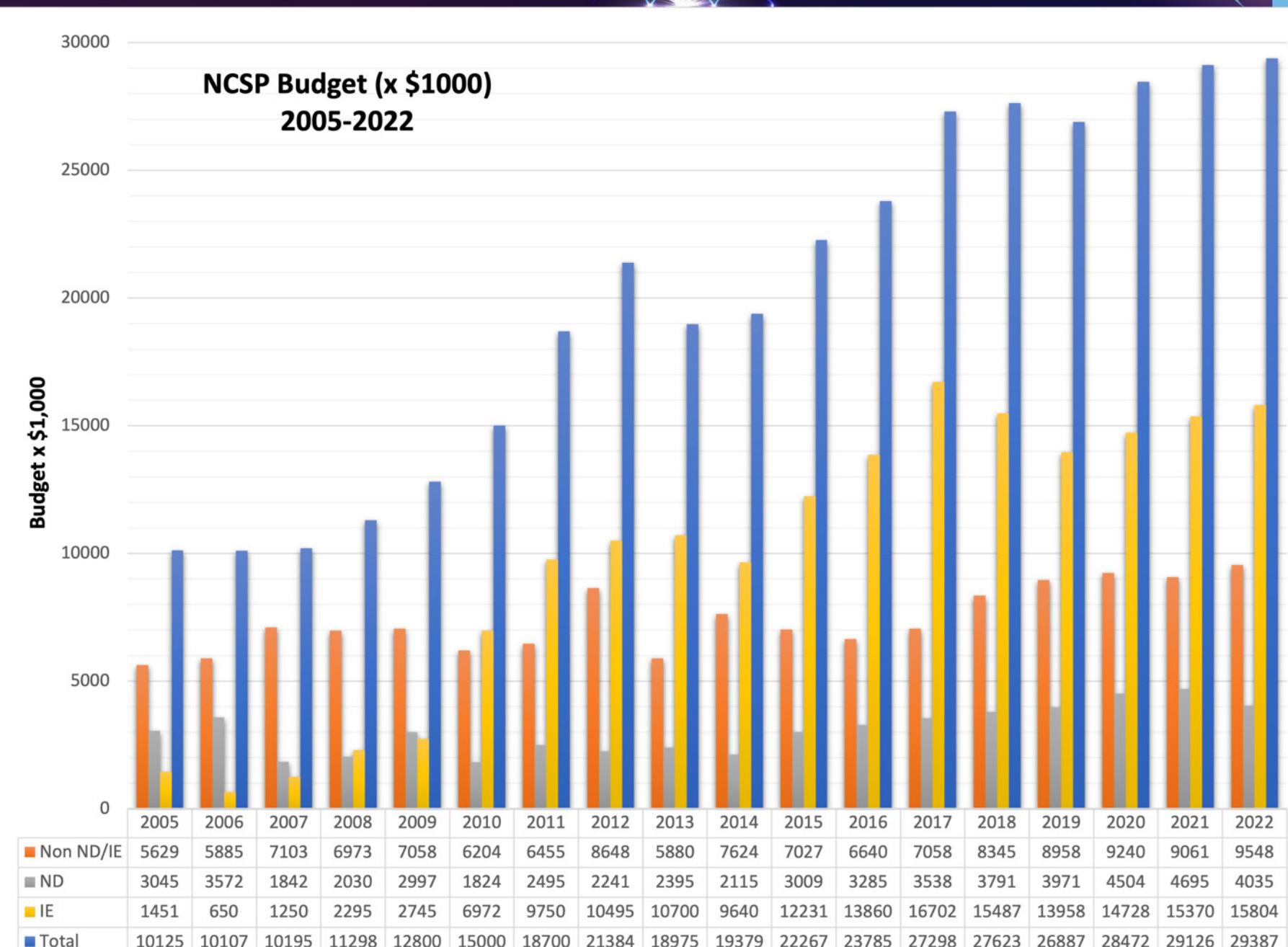
# Technical Program Element Activities



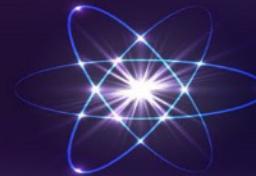
# Current NCSP Work Sites



# NCSP Nuclear Data and Integral Experiment Budget (>2005)



# 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)

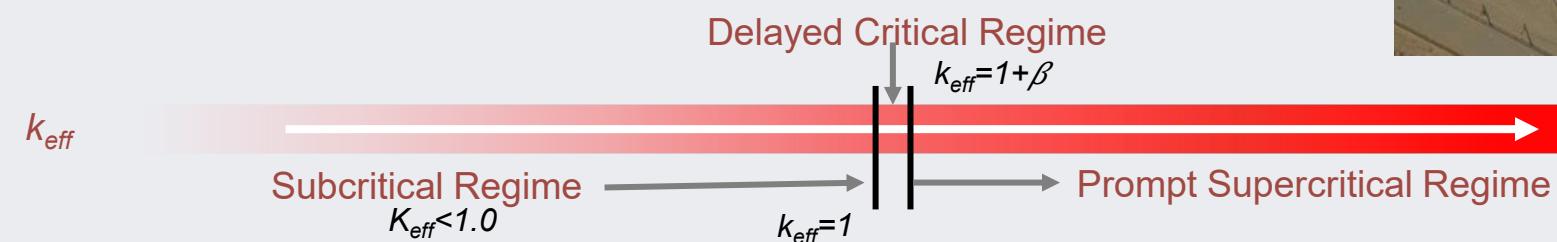
DAF/NCERC

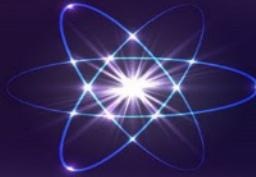


SNL/TA-V/SPR Facility



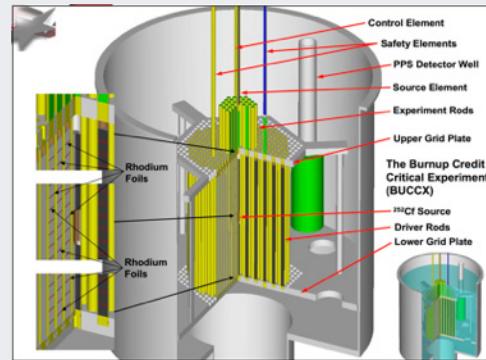
SPR Facility



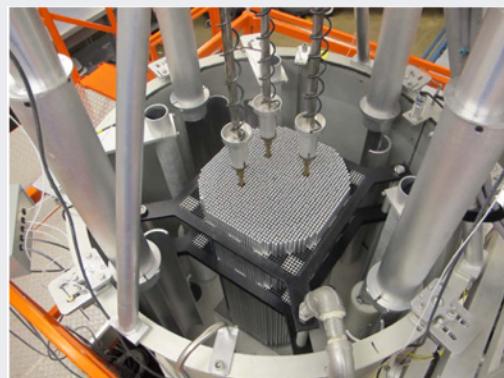
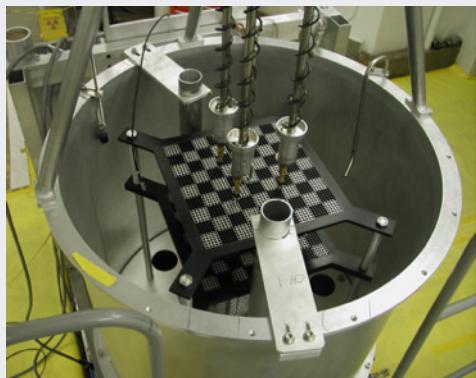


## Sandia National Laboratory

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



**SNL – 7uPCX – U(6.9) UO<sub>2</sub> rods**



## NCERC/DAF

**NCERC – Np-237 Sphere**



**NCERC – BeRP Ball**



**NCERC – TACS**



**NCERC – Godiva IV**



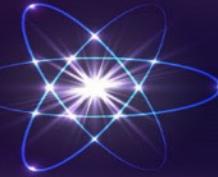
**NCERC – Flattop**



**NCERC – Planet**



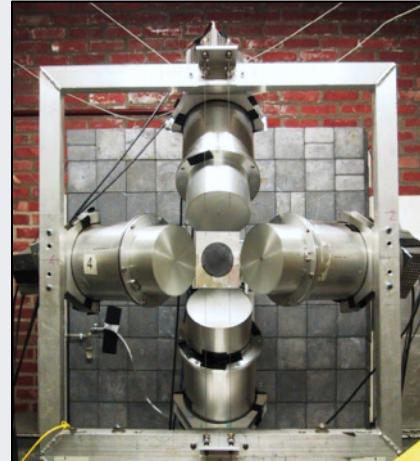
# NCSP Differential Experiments



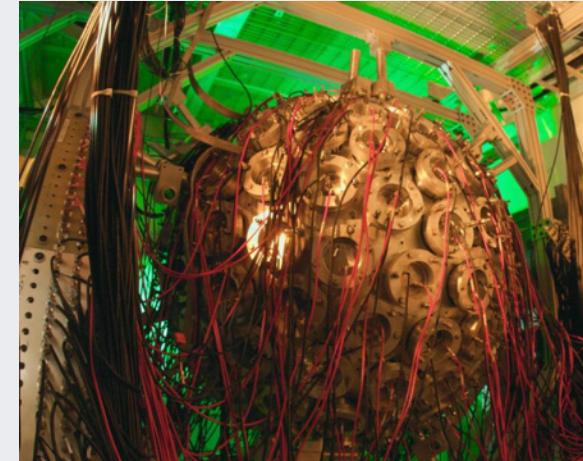
- NCSP differential nuclear data measurements are performed at
  - JRC-Geel GELINA Facility (Geel, Belgium)
  - RPI LINAC (Troy, NY)
  - LANL (Los Alamos, NM) LANSCE/Lujan Neutron Scattering Center



GELINA



GELINA



LANL - DANCE



JRC-Geel (GELINA)



RPI LINAC  Rensselaer



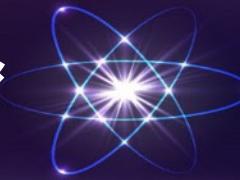
LANL LANSCE  Los Alamos NATIONAL LABORATORY

## Photos referenced from:

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

[http://www.linac.rpi.edu/public\\_html/accelerator.html](http://www.linac.rpi.edu/public_html/accelerator.html)

# 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/sites/ncsp/files/2021-10/fy22-26\\_ncsp\\_five-year\\_execution\\_plan.pdf](https://ncsp.llnl.gov/sites/ncsp/files/2021-10/fy22-26_ncsp_five-year_execution_plan.pdf)

Appendix B Nuclear Data Priorities, Basis Statements, and Milestones							
Nuclear Data Measurements							
Materials	Pre-FY2019	FY2019	FY2020	FY2021	FY2022	FY2023	Post-FY2023
Cerium ( <sup>142</sup> Ce)							
Basis	Neutron transmission and capture of <sup>142</sup> Ce in the resonance range. Cerium is an element that is predominately <sup>140</sup> Ce (88.450 a/o) and <sup>142</sup> 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. <sup>142</sup> 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 ( <sup>35</sup> Cl)							
Basis	Measurement of the <sup>35</sup> 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 <sup>35</sup> Cl (n,p) cross sections needed for poison credit in these environments. A need for improved <sup>35</sup> Cl cross sections has been specifically identified at LANL and Y-12.						
Lanthanum ( <sup>140</sup> La)							
Basis	Measurement of neutron transmission and yield of <sup>140</sup> La in the resonance range. Lanthanum is an element that is predominately <sup>138</sup> 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 ( <sup>95</sup> Mo)							
Basis	Measurement of neutron capture in <sup>95</sup> Mo in resonance range, URR. Neutron transmission measurements previously completed at RPI. <sup>95</sup> 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 ( <sup>237</sup> Np)							
Basis	Measurement of <sup>237</sup> Np fission cross section in fast energy range. <sup>237</sup> Np is an actinide of interest in nuclear criticality safety for applications at ORNL and other sites. Applications include <sup>238</sup> Pu production w/ HFIR at ORNL (low NCSP 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 ( <sup>181</sup> Ta)							

# NCSP Evaluation Priorities – FY22 NCSP 5-Year Plan (Appendix . B)



Be-9	HF	Polystyrene	U-233
LANL	LLNL/NCSU	LLNL/NCSU	IRSN
Beryllium Carbide	Hf-176, Hf-177, Hf-178, Hf-179, Hf-180	Pu-238, Pu-240, Pu-241, Pu-242	LANL
LLNL/NCSU	ORNL	LANL	ORNL
Beryllium Hydride	La	Pu-239	U-234
LLNL/NCSU	ORNL	IRSN	LANL
CaH2	Li-6	LANL	U-235
LLNL/NCSU	LANL	ORNL	LANL
Ce	Lithium-7 Deuteride	Pu-240	U-236
ORNL	LLNL/NCSU	LANL	LANL
Cu-63, Cu-65	Lithium-7 Hydride	Reactor Grade Graphite (20% Porosity)	U-238
LANL	LLNL/NCSU	LLNL/NCSU	BNL
ORNL	N-14	Rh-103	LANL
Fe-54, Fe-56, Fe-57	ORNL	IRSN	Uranium metal
BNL	O-16	NNL	LLNL/NCSU
IRSN	LANL	ORNL	V-51
ORNL	Paraffin	Sr-88	ORNL
Fe-56	LLNL/NCSU	ORNL	Zirconium Hydride
BNL	Pb-204, Pb-206, Pb-207, Pb-208	Ta	NNL
IRSN	BNL	LANL	LLNL/NCSU
ORNL	IRSN	NNL	Zr-90, Zr-91, Zr-92, Zr-94, Zr-96
H2O	NNL	ORNL	BNL
LLNL/NCSU	ORNL		
	RPI		

# NCSP Measurement Priorities – FY22 NCSP 5-Year Plan (Appendix B)



Fe-54

IRSN

RPI

Mo-95

IRSN

LANL

NNL

RPI

Polystyrene

ORNL

RPI

Pu-239

IRSN

LANL

Pu-240

LANL

LLNL

U-233

LANL

V-51

ORNL

Zr-90, Zr-91, Zr-92, Zr-94, Zr-96

ORNL

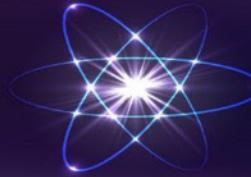
Polyethylene

RPI

Yttrium Hydride

RPI

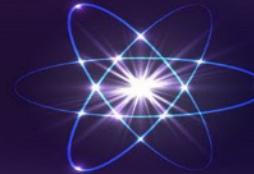
# NCSP "Make It Happen List"



**Table 2.2 NCSP “Make-It-Happen” List for FY2022**

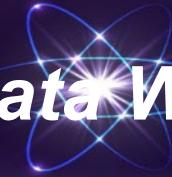
No.	Milestone	Technical Program Element	Lead Site
1	Production and delivery of hafnium to NCERC in support of TEX-Hf (IER 532)	IE	NNL
2	Conduct nuclear accident dosimetry exercise (IER 538)	IE	LLNL
3	Complete TEX low temperature DU surrogate testing (IER 547)	IE	LLNL
4	Submit TEX HEU benchmark report to the International Criticality Safety Benchmark Experiment Program (IER 297)	IE	LLNL
5	Complete critical experiments with UO <sub>2</sub> Rods and molybdenum foils (IER 305)	IE	SNL
6	Complete measurements for the Flattop benchmark (IER 423)	IE	LANL
7	Complete fabrication of lithium for critical experiment (IER 499)	IE	Y-12
8	Complete high multiplication neutron subcritical measurements (IER 518)	IE	SNL
9	Measure the fission neutron spectrum shape using threshold activation detectors (IER 153)	IE	LANL
10	Promote use of MCNP Version 6.3 at DOE sites (Task LANL-AM1)	AM	LANL
11	Complete prompt fission neutron spectrum (PFNS) measurement of Plutonium-240 at LANSCE (Task LANL-ND2)	ND	LANL
12	Complete Zr-91 measurements at GELINA (Task ORNL-ND1)	ND	ORNL
13	Complete site acceptance tests for accelerator section #1 at RPI (Task RPI-ND3)	ND	NNL
14	Complete GELINA neutron production target (Task Y12-ND1)	ND	Y-12
15	Complete Sandia CSO/Manager course pilot course (Task ORNL-TE1, SNL-TE1)	TE	ORNL SNL
16	Publish updated CEDT manual.	IE	ORNL SNL

# NCSP "Make It Happen List"



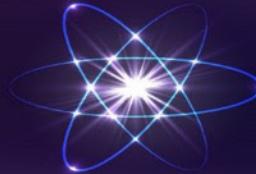
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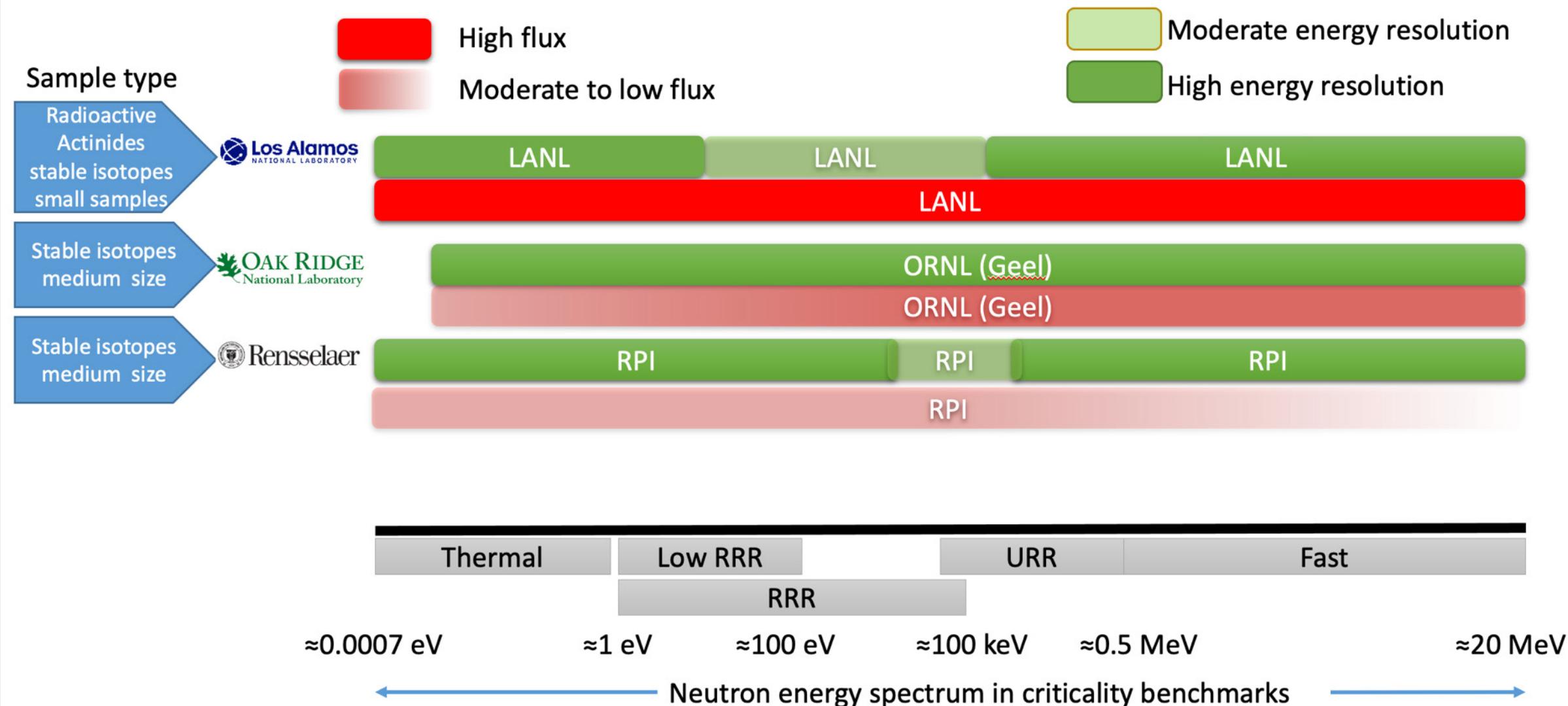
- NCSP Nuclear Data work items support many different programs
  - Improvements to U-235, U-238, and Pu-239 are cross-cutting for virtually all programs
  - U-233, Pu-240, Np-237 of interest to NNSA (NA-10 & NA-20), DOE-NE, NCSP international collaborators, and the NRC
  - Pb and Fe are cross cutting 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 are 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, NRC and being done to resolve a historical discrepancies impacting NCS for facility processing with UF6

# NCSP Benefits/Successes

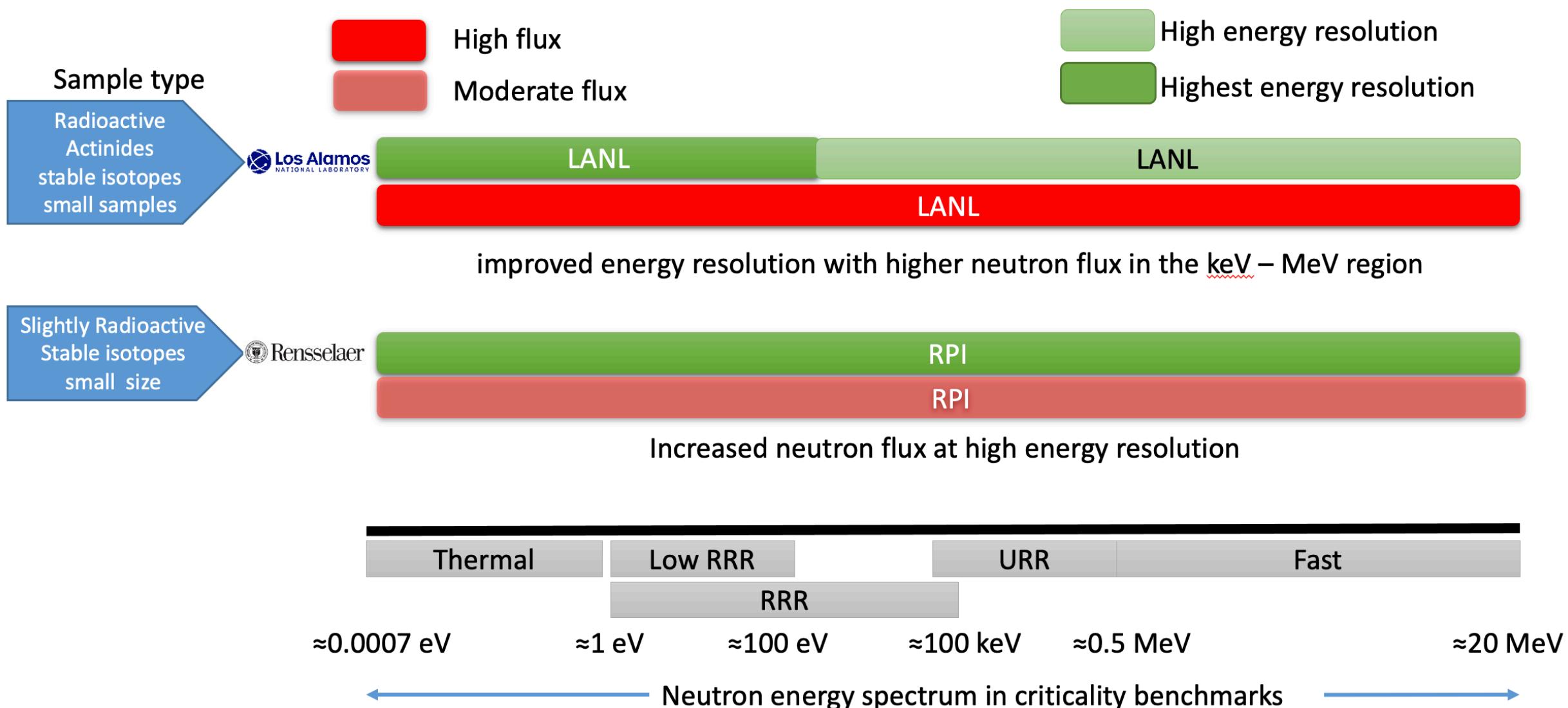


- NCSP support of each major ENDF/B library release supports reduced bias in eigenvalue ( $k_{\text{eff}}$ ) computations to support nuclear criticality safety limit development
- NCSP Integral experiments at NCERC and Sandia are funded by the NCSP to "keep the doors open" and to provide new critical 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)
  - Y-12 recently completed a DU neutron depletion 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

# Current NCSP capabilities for $(n,\chi)$ , $(n,tot)$ and $(n,f)$ measurements



# Future NCSP capabilities for $(n, \gamma)$ , $(n, \text{tot})$ and $(n, f)$ measurements



# Questions

