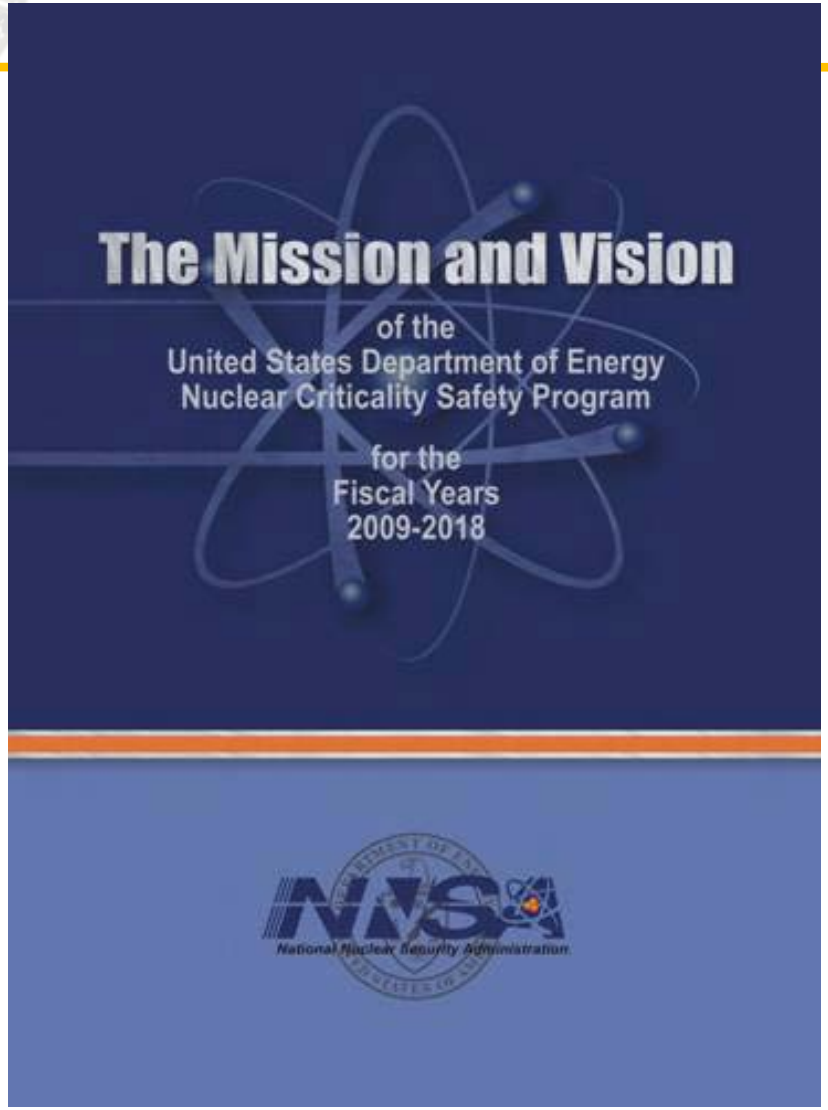
# Nuclear Data Capabilities Supported by the DOE NCSP

**NPWG Meeting**

**Santa Fe, New Mexico**

**November 4, 2010**

# The NCSP Mission & Vision



# The NCSP Mission & Vision

- **THE NCSP MISSION**
  - The NCSP mission is to 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 U.S. Department of Energy (DOE).
- **THE NCSP VISION**
  - The NCSP will be a ***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 Technical Elements

- **International Criticality Safety Benchmark Evaluation Project** (ICSBEP) – Reference Technical Data for Criticality Safety Engineers Worldwide
- **Analytical Methods** – Maintain and improve the Production Codes and Methods for Criticality Safety Engineers (e.g. MCNP, SCALE, & COG)
- **Nuclear Data** – Perform Measurements of Basic Nuclear (Neutron) Physics Cross-Sections and Generate New Evaluated Cross-Section Libraries and Covariance Data for Use in Production Criticality Safety Codes
- **Integral Experiments** – Critical and Subcritical Experiments at the Critical Experiments Facility (CEF) Now Being Stood Up at the Device Assembly Facility (DAF) in Nevada; the Sandia Criticality Experiments Facility; and additional experimental capabilities at Valduc, France – provide integral tests of codes and nuclear data
- **Information Preservation and Dissemination** (IPD) – Protects Valuable Analyses and Information Related to Criticality Safety
- **Training and Education** – Web-based training modules and the Hands-On Criticality Safety Course at LLNL for the Department's Criticality Safety Engineers, Line Management, and Oversight Personnel

# Nuclear Data Vision

The ND element will sustain world-class expertise and capabilities to continually improve and disseminate measured and evaluated differential cross-section and covariance data in a manner that is responsive to the needs of those responsible for developing, implementing, and maintaining criticality safety.

# Nuclear Data Goals

- Actively engage the end-users to identify their nuclear data needs through the NCSP Website and develop/disseminate evaluated nuclear data files
- Develop/utilize modern nuclear model codes to produce world-class nuclear data evaluations of cross sections and covariances
- Assess, perform, analyze, and document nuclear data cross-section measurements
- Test, analyze, and document the performance of nuclear data measurements and evaluations to continually improve data
- Sustain NCSP nuclear data capabilities/expertise through continual improvements of data files

# Differential Measurement Capabilities

- ORELA is shut down.
- Primary US Measurement Facility is RPI
- High Energy Measurements can be made at Los Alamos (LANCE)
- As required, measurements can be made at GEAL in Belgium

# Nuclear Data Request (NDR) Process

- The goal is to provide a systematic and efficient means to identify, design, and approve all new nuclear data measurements or new evaluations.
- It will ensure that the Requestor's nuclear data needs are well understood and met by integrating all capabilities of the NCSP to take appropriate action to address the need.
- NDAG Manager or designee will review the NDR in accordance with these goals and recommend approval to the NCSP Manager to authorize work necessary to address the data need.

# Beta Version

## U. S. Department of Energy
## Nuclear Criticality Safety Program

NCSP Home Page

NDR Request Form

Privacy & Legal Notice

The purpose of this webpage is to provide a mechanism for End Users to submit Nuclear Data Need Request for consideration/processing. Nuclear Data Need Request guidelines and an example links (including the Nuclear Data Need Request form) are also provided. If you have any questions regarding the process, please contact the NDAG Chairperson, R.D. McKnight at rdmcknight@anl.gov

- Submit NDR request
- Nuclear Data Need Request Status
- Administrative access only
- NDAG Approval (NDAG Chair only)
- NCSP Manager Approval (DOE HQ only)
- Guidelines for a Nuclear Data Request
- Sample Nuclear Data Request

## NUCLEAR DATA REQUEST FORM

**NOTICE:** The End User must verify all information is ***UNCLASSIFIED***

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**Please provide the following information:**

**Requestor Name:**

**Last Name: [*]** **First Name: [*]** **Middle Name:**

**Organization:[*]**

**E-mail Address: [*]**

**Retype E-mail Address: [*]**

**Telephone No.: [*]**

***[*] Required fields***

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**Target Nuclide: [*]**

**Reaction/Process: [*]**

**Incident Energy Range: [*]**

**Requested Accuracy: [*]**

**Application Area: [*]**

**Justification: [*]**

**Impact:**

**The Requestor acknowledges all information is approved for public release. [*]** ☐ **I Agree**

**DC Name or Review and Release Number:**

Submit Reset

# Differential Data Contributions During the Last 5 Years

- **NCSP Nuclear Data Evaluation Contributions in past 5 years (includes new evaluations and covariance data file updates):**
  - U-233, U-235, U-238, Pu-239, Th-232,
  - Gd-155, Gd-156, Gd-157, Gd-158
  - Cl-35, Cl-37, Pa-231, Pa-239,
  - K-39, K-40, K-41, F-19
  - Mn-55, Cr-50, Cr-52, Cr-53, Cr-54
  - Ni-58, Ni-60
  - Ti-46, Ti-47, Ti-48, Ti-49, Ti-50
  - Be-9, O-16, Pu-240, Np-237

# Proposed Differential Data Contributions for the Next 5 Years

- Elements

  Beryllium (Be), Calcium (Ca), Carbon (C-12), Cerium (Ce), Chromium (Cr-50, 52, 53, 54), Copper (Cu-63, 65), Dysprosium (Dy-161,162,163,164), Gadolinium (Gd-155,156,157,158,160), Iron (Fe-56), Manganese (Mn-55), Neptunium (Np-237), Nickel (Ni-58, 60, 61, 62, 64), Oxygen (O-16), Plutonium (Pu-239), Titanium (Ti-46, 47, 48, 49, 50), Tungsten (W-182, 183, 184, 186), Uranium (U-235), Uranium (U-238), Vanadium (V-51), Zirconium (Zr), Planning for fission measurements

- Compounds

  Silicon Dioxide ($SiO_2$)

# Integral Experiments Vision

The IE element will provide a sustainable infrastructure and a systematic, interactive process to assess, design, perform, and document integral criticality safety-related benchmark-quality experiments to support, safe, efficient fissionable material operations.

# Integral Experiment Goals

- General purpose fast-burst and dry system criticality experiments and training facility at Criticality Experiments Facility (CEF) located at the Device Assembly Facility (DAF) in Nevada.
- General purpose water moderated criticality experiments and training facility at SNL
- General purpose actinide solution super-prompt critical assembly and large horizontal split-table capability at Valduc, France
- Supports new reactor and fuel cycle designs, waste disposal, criticality accident detection and response, military applications, and nuclear counter-terrorism applications
- Fully integrated research program with integral experiments, state of the art sensitivity/uncertainty analysis, nuclear data processing, and benchmark analysis

# Integral Measurement Capabilities

- Critical Experiment Facility (CEF) Staff continued making limited subcritical and fundamental physics measurements during CEF construction.
- CEF is scheduled to start nuclear operations in March 2011 for criticality experiments and training.
- Sandia National Laboratory will continue to perform water moderated criticality experiments and training.
- The US DOE continues collaborations with the French government for joint measurements/data acquisition
- VNIITF, Russia may continue to perform experiments for US requested data needs if appropriate.

# Integral Experiment Request Process

- Process should:
  - Identify the Nuclear Data Needs Precisely
  - Assess the Available Experimental Materials and CEF Capabilities for the Data Need
  - Use Tsunami to Design the Experiment
  - Ensure ICSBEP Publication
  - Ensure Quality/Precision of the Experiment in Design and Execution (QA/QC)
  - Establish an Ongoing Transparent Process
  - Federal NCSP Operations Authorization of Integral Experiments

# $C_E$dT Process

- CED-0: Mission Need
- CED-1: Form the $C_E$DT;  Conceptual Design
- CED-2: Final Experiment Design
- CED-3: Approve Execution as Part of NCSP Five-Year Plan Process
- CED-4: Analysis and Publication of the Data in ICSBEP Handbook
- The team will consist of: Requestor, NDAG member, Experimenter, ICSBEP Member, Methods member

# Current Status of Proposed Experiments

- To Date: Requests for Experiments submitted through the LLNL Website
- 1 VNIITF critical experiment in progress
- 1 SILENE critical experiment in progress
- 1 Sandia critical experiment in progress
- 4 CEF critical experiments in design process
- 10 additional CEF critical/subcritical experiments are in the review process for value/need
- 7 CEF subcritical experiments are in progress
- 3 stockpile science experiments are in the approval process
- 4 NCT type experiments are in the process of being submitted
- Submitted at: http://ncsc.llnl.gov/

# U. S. Department of Energy
# Nuclear Criticality Safety Program

NCSP Home Page

IER Request Form

Privacy & Legal Notice

The purpose of this webpage is to provide a mechanism for End Users to submit proposed Critical and Subcritical Integral Experiments Requests for consideration/processing. An explanation of the process and association links (including the Integral Experiments Request form) are also provided. If you have any questions regarding the process, please contact the CEdT Manager, Nichole Ellis at ellis_9899@msn.com or 803-381-3710

- Submit Integral Experiment Request
- Approved Experiments $C_E dT$ Members and Current Status
- Administrative access only
- NDAG Approval (NDAG Chair only)
- NCSP Manager Approval (DOE HQ only)
- Critical & Subcritical Experiment Design Team Process Manual

# REQUEST FOR INTEGRAL EXPERIMENTS FORM

**NOTICE:** The End User must verify all information is ***UNCLASSIFIED***

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**Please provide the following information:**

**Form Status:** Working draft

**Requestor Name:**

**Last Name: [*]** **First Name: [*]** **Middle Name:**

**Affiliation:[*]**

**E-mail Address: [*]**

**Retype E-mail Address: [*]**

**Telephone No.: [*]**

***[*] Required fields***

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**Experimental Request Title:[*]**

**Description of Application/Purpose (same level of detail as in DOE-STD-3007-2007):** *[6000 chars max]*

**Select Those That Apply and Explain:**

**Programmatic Funding Available (optional):**

**User Assessment of Available Integral Data (ICSBEP, Published, UnPublished, etc.):** *[6000 chars max]*

**Suggested Experiment Concept (optional):** *[6000 chars max]*

**$C_E$dT Manager Comments:** *[6000 chars max]*

**NDAG Chairperson Comments:** *[6000 chars max]*

**NCSP Manager Comments:** *[6000 chars max]*

Approval Section Here

**The Requestor acknowledges all information is approved for public release. [*]** ☐ **I Agree**

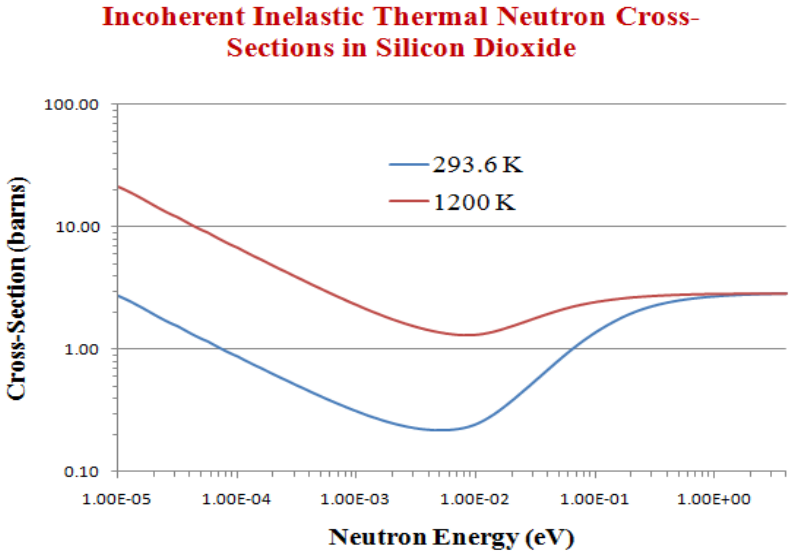
**DC Name or Review and Release Number:**

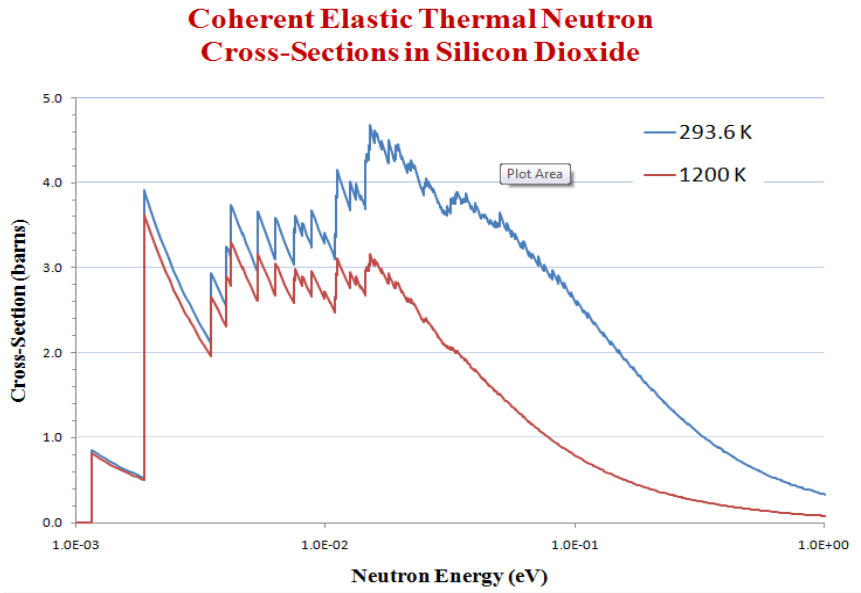
Submit Reset

# NCSP Work to address Thermal Scattering Data Needs

- Evaluated nuclear data libraries have limited S(α,β) or thermal scattering law data for moderators important for nuclear applications (~20 moderators in ENDF/B-VII.0)
- Example NCSP thermal data needs: $SiO_2$, HF, $D_2O$, $CH_2$, $C_2F_4$, etc.
- Also, no covariance data available for S(α,β) data files currently in ENDF/B
- ORNL has been performing work with NCSU to provide thermal scattering data for moderators important for criticality safety applications
- ORNL-NCSU planning to provide S(α,β) covariance data for future thermal evaluations

ORNL work with NCSU produced new $SiO_2$ Evaluation in FY2010



# NCSP is partnering with other programs to improve accuracy of prompt neutron fission spectrum data

- The uncertainty in prompt fission neutron spectrum (PFNS) has been identified as a significant contributor to k-eff uncertainties for many systems
- LANL is developing an integrated code package to analyze PFNS experimental data, perform model calculations, determine sensitivities, and create covariances.
- LANL will deliver improved calculations of PFNS for NCSP:
  - 2010 Pu-239
  - 2012 U-235
  - 2014 U-238
- In addition, the "ChiNu" project at LANSCE will measure PFNS for Pu-239
  - Low-energy (100 keV to 1 MeV) emission – June 2013
  - High-energy (6 – 12 MeV) emission – June 2015

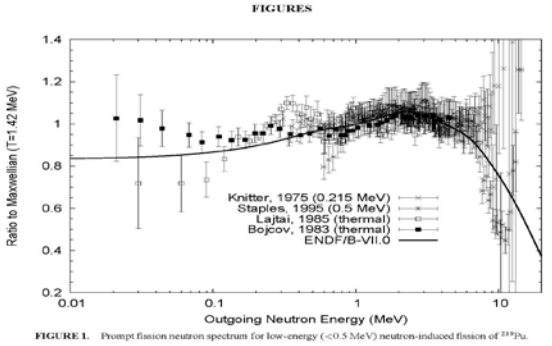


FIGURE 1. Prompt fission neutron spectrum for low-energy (<0.5 MeV) neutron-induced fission of $^{239}$Pu.

Note discrepant data at high and low emission energies

Initial estimates of PFNS uncertainties

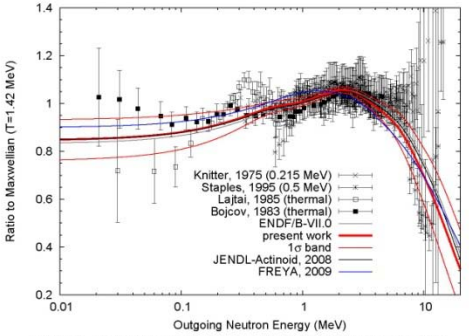


FIGURE 10. Final 1σ uncertainty band after including a "model error" component below 500 keV.

# Questions?