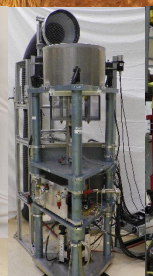

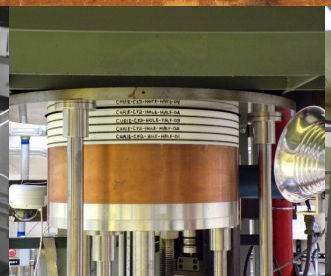

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LANL FY23 NCSP Highlights

Joetta Goda
LANL NCSP Task Manager

February 21, 2024

LA-UR-24-21101

A very busy year…

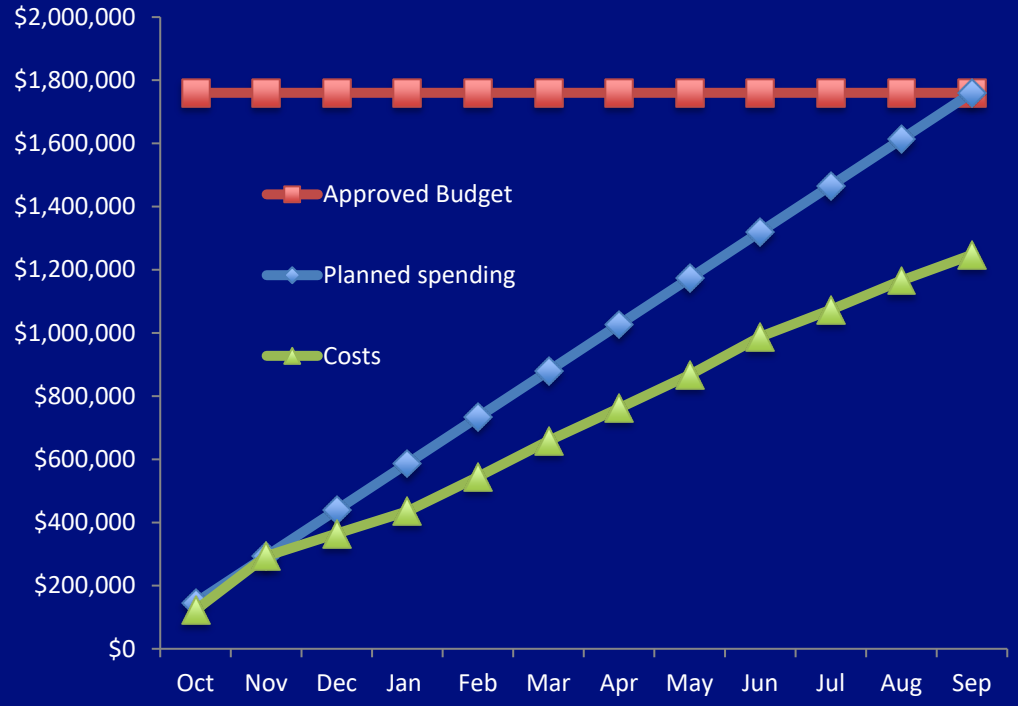
NNSA National Nuclear Security Administration

FY23 was a very busy year

- 14 Integral Experiment Milestones
- 8 Make-it-Happen List Items
- 56 weeks of NCERC Operations
  - More than half for NCSP

- Analytical Methods
- Integral Experiments
- Training and Education
- Nuclear Data

Analytical Methods



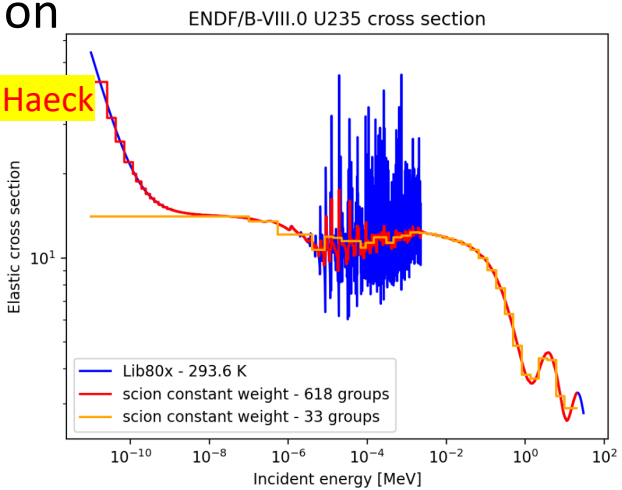
AM1	MCNP Maintenance and Support, Uncertainty Analysis Development, and Modernization
	See talks by Mike Rising, Alex Clark and Wim Haeck
AM2	NJOY Development and Maintenance, Uncertainty Analysis Development, and Modernization
	See talk by Wim Haeck
AM3	Development of an Adaptive-in-temperature Method…in MCNP6
	See talk by Camden Blake
AM5	Benchmark Intercomparison Study
AM7	Incorporation of Benchmark Experiment Correlations into Whisper

Analytical Methods Highlights

NJOY Modernization

- Shift from a module-based to a component-based format
- Components can be developed and deployed faster than modules
- Regular releases with testing and validation

See talk by Wim Haeck

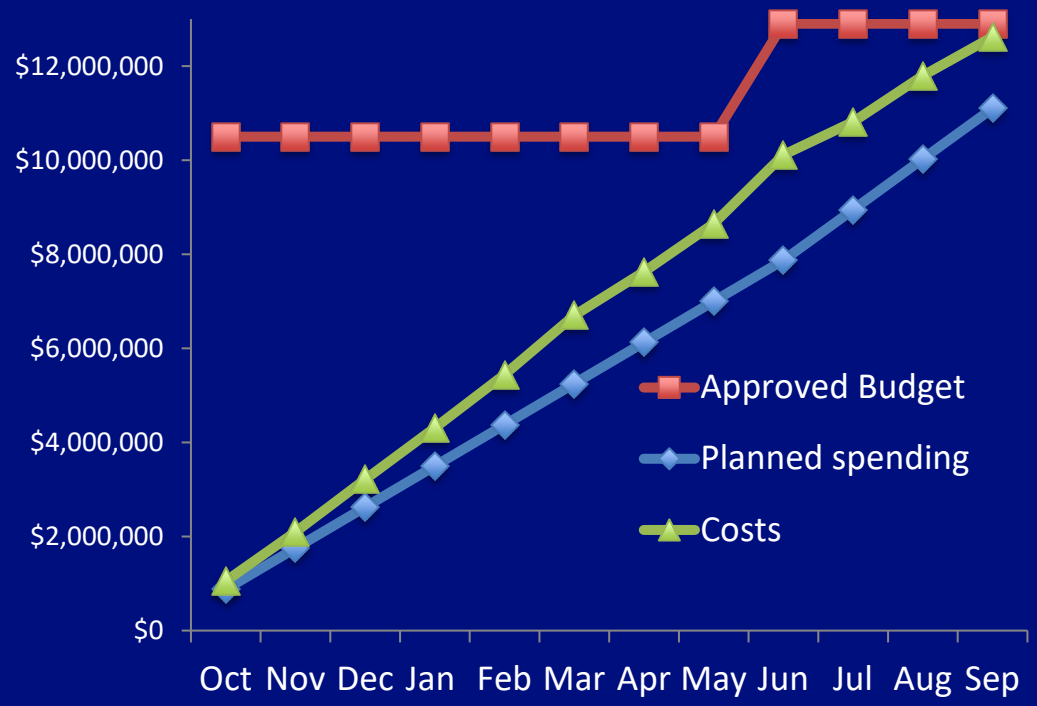


Whisper Updates

See talk by Alex Clark

- Progress towards cohesive framework to provide ND covariances to Whisper
- Addressing need for a review and SQA process for nuclear data covariances
- Improving the interconnectivity of Whisper to existing tools and databases.

Integral Experiments



FY23 Experiment Campaigns

IER 153: PFUNS
IER 518: Joint Measurements at Sandia
IER 519: TEX-Pu-Hanford
IER 532: TEX-U-Hf
IER 537: CERBERUS
IER 555: Godiva Benchmark Update
IER 574: Godiva Characterization
IER 577: EUCLID

Preparation for FY24 Experiments

Preparations beyond FY24

Analysis of Completed Experiments

IER 121: NeSO
IER 423: Flattop Benchmark
IER 578: Jupiter High Pu-240
IER 488: MUSiC
IER 557: Godiva Repeatability

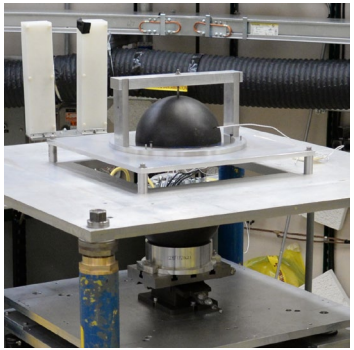
Prompt Fission Neutron Uranium Spectrum (IER 153)

Unique approach to determining PFNS to reduce uncertainties in ^{235}U PFNS, especially above 5 MeV, using threshold neutron detectors/activation foils.

MIHL Item

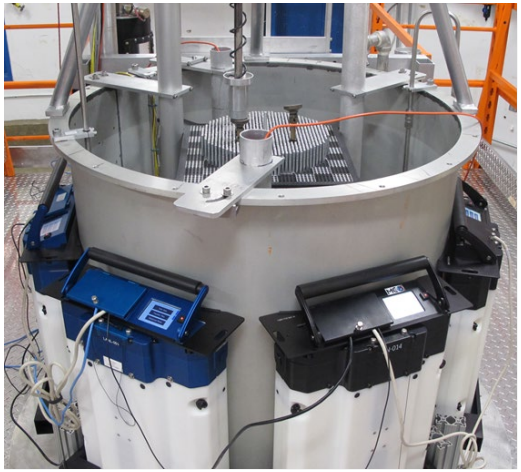
- Published analysis of preliminary activation run
- Preparations for high power runs **CED-3a milestone**
  - Relocated components to lower dose areas
  - Analyzed calibration runs in FY22
  - Prepared irradiation and counting plans
  - Continued upgrades to Count Room
    - New Aegis detector, calibration sources,…

Complementary to chi-nu experiment performed at LANSCE recently and subsequent nuclear data evaluation



Joint Measurements at Sandia (IER 518)

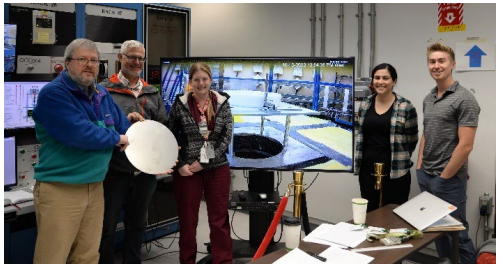
- Provide data on configurations above multiplication of 20, the high end of the fundamental physics benchmarks available at the time.
- LANL executed in early FY23 (IRSN, LLNL in FY22)
- Measured 9 configurations
  - In-core organic scintillator detectors
  - Ex-core He-3 detectors



TEX-Pu-Hanford (IER 519)

- Designed to validate absorbers present in Hanford waste tanks, particularly Fe and Mn.
- Considerable effort to have ready for early execution as replacement. **CED-3a milestone.**
- Handstack performed; paused when predicted critical exceeded calculations and lifting capacity.
- Will resume later.

TEX-Hf (IER 532)



- Hafnium is a strong neutron absorber important for marine propulsion systems

  "The experiments were requested by Naval Reactors to provide a suite of unclassified, clean, and well-characterized benchmarks to drive improvements to hafnium nuclear data." –Mike Zerkle, NNL

- 7 configurations to validate the neutron absorption and scattering cross sections of hafnium in a highly enriched uranium (HEU) system
- Experiment execution began in FY22 and completed in FY23
- **CED-3b milestone**

MIHL Item

CERBERUS (IER 537)

- **CED-3a milestone**

MIHL Item

- Resolve uncertainties in the elastic and inelastic scattering cross sections of ^{63}Cu and ^{65}Cu with a focus on the intermediate energy spectrum
- 3 weeks in FY23, remaining experiments in early FY24
- Jemima plate measurements performed

See talk by Kristin Stolte

Godiva Benchmark (IER 555)

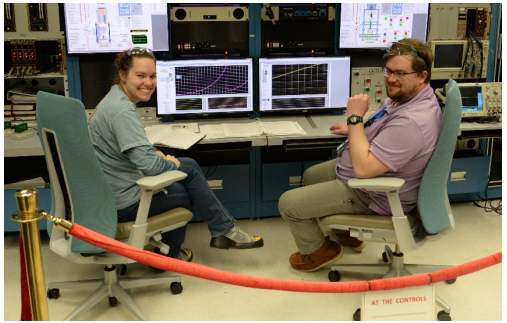
See talk by Jeff Favorite

MIHL Item

- Extensive measurements, both physical and neutronic.
- Will be combined with information obtained during Godiva disassembly for move from TA-18 to NCERC to completely redo benchmark evaluation for ICSBEP.
- **CED-3a and CED-3b milestones**

Godiva Characterization (IER 574)

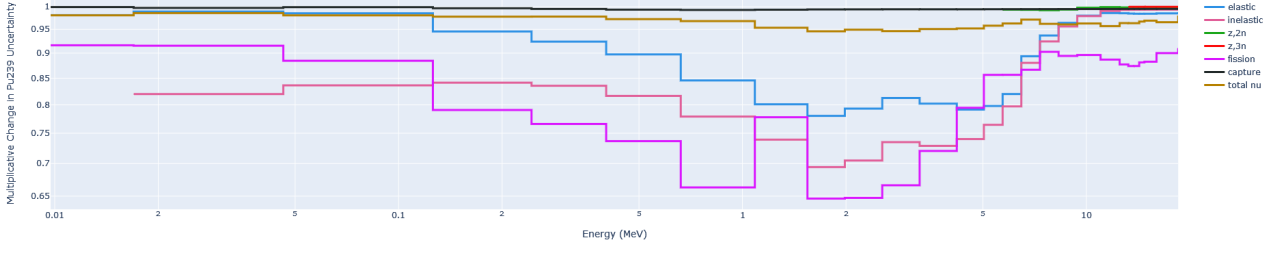
- Characterize radiation field around Godiva, in particular, common measurement locations.
- Used Activation foils, fission foils, TLDs and active dosimetry measurements.
- Collaboration with Sandia; used similar process performed for ACRR.
- **CED-3a and CED-3b milestones**



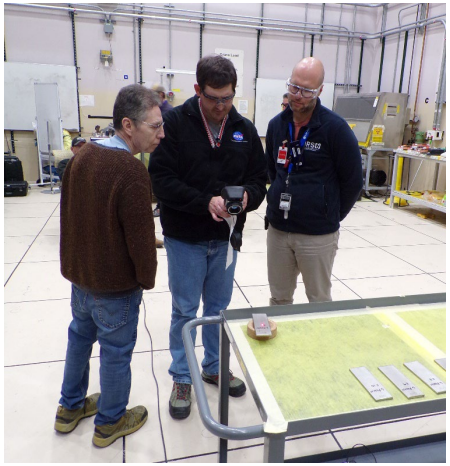
EUCLID (IER 577)

See talk by Bob Little

- EUCLID resulted in many advancements useful to NSCP:
  - EUCLID Adjustment Tool (EAT)
  - MCNP FSEN
  - FAUST-tk/ACE-tk advancements
  - New experiment data
  - New analysis capabilities
- Two configurations built at NCERC
- 6 responses measured
- Combined use of responses useful to constrain nuclear data and help in understanding of Pu-239 scattering



Prepared for FY24 Experiments…



IRSN MOX Experiment (IER 296)

- Intermediate energy, MOX fuel benchmark need
- Performed Physical Measurements and Labeling
  - Mass, dimensions, dose, gamma spectroscopy, radiography

Godiva CAAS Shielding Benchmark (IER 498)

- Designed room return shield and ordered high-capacity stand.

TEX-U-Chlorine (IER 499)

- Chlorine absorption validation data in uranium system
- All parts procured from CED-2 design except for PVC
- Decision to change chlorine-bearing compound from PVC (solid plastic) to powdered sodium chloride in aluminum container.
- Paused to update calculations and design containers.

And Beyond FY24…

See talk from Geordie McKenzie

Low Temperature TEX (IER 479)

- Investigation of critical masses of uranium systems below room temperature to address criticality in transportation

Molybenum Experiment Preliminary Design (IER 517)

See talk by Cole Kostelac

- Molybdenum Optimized Benchmark System Demonstrating Integral Correlations (MOBY DICK) **CED-1 milestone**

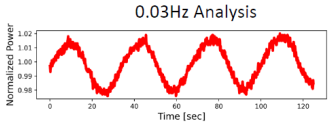
See talk by Peter Brain

True Intermediate Pu Experiment Preliminary Design (IER 551)

- Experiment for Unresolved Resonance Of Plutonium Actinides (EUROPA)
- Intermediate energy benchmarks for Pu using ZPPR PANN and PAHN
- **CED-1 milestone**

Pile Oscillator (IER 579)

- Method to measure neutronics parameters such as lifetime and beta effective. **CED-0 milestone.**
- Demonstration Measurements at Missouri S&T Reactor



Analysis of Completed Experiments

NeSO (IER 121)

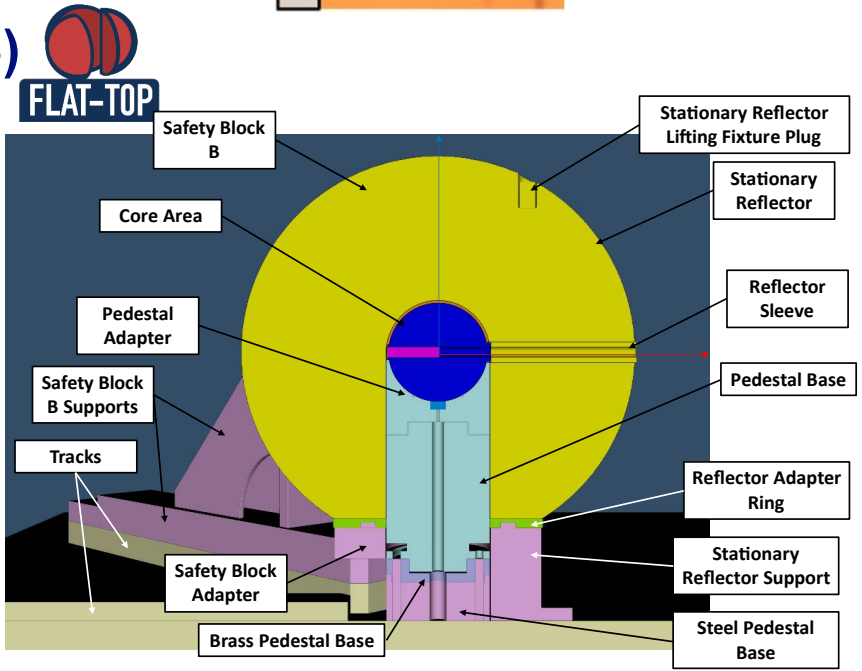
- Neptunium Subcritical measurements
- Chemistry analysis of source material in FY22

See talk by Alex Clark

Flattop Benchmark Update (IER 423)

- Modern, detailed benchmark with reduced uncertainty
- Benefits past and future experiments performed on Flattop
- ICSBEP Section 1 completed **CED-3b milestone**
- Section 1 & 3 submitted to independent reviewer, Alfie O'Neil, UK NNL

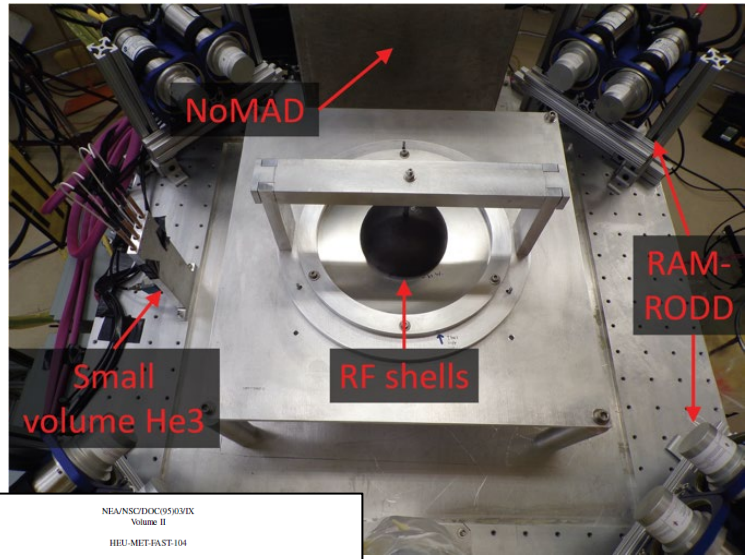
MIHL Item

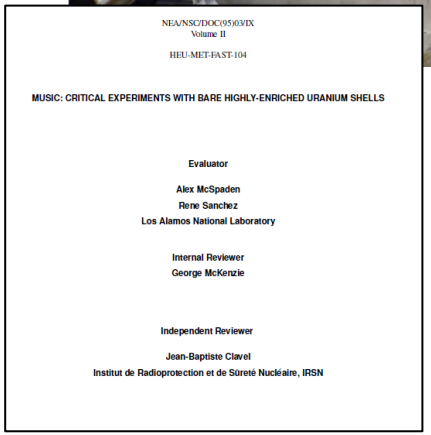


See talk by Kristin Stolte

MUSiC (IER 488)

- Benchmark measurements of HEU systems that span a wide range of reactivities from deeply subcritical through slightly above delayed critical.
- 10 configurations, 2 critical, 8 subcritical
- First of 3 ICSBEP evaluations submitted **CED-4a milestone**
- Analysis of Subcritical Configuration Data
  - NoMAD He-3 detectors (IER 567)
  - Organic Scintillator detectors (IER 568)
  - Active Interrogation





NEA/NSC/DOC/(95)/03/IX
Volume II

HEU-MET-FAST-104

MUSIC: CRITICAL EXPERIMENTS WITH BARE HIGHLY-ENRICHED URANIUM SHELLS

Evaluator

Alex McSpaden
Rene Sanchez
Los Alamos National Laboratory

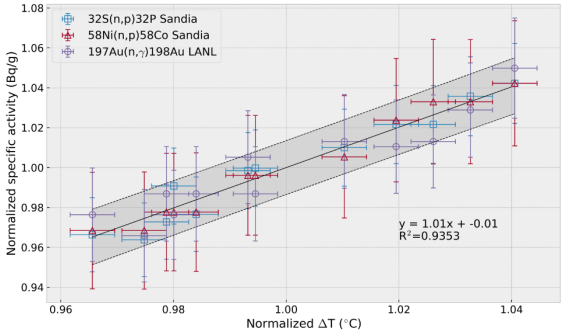
Internal Reviewer
George McKenzie

Independent Reviewer

Jean-Baptiste Clavel
Institut de Radioprotection et de Sûreté Nucléaire, IRSN

MIHL Item

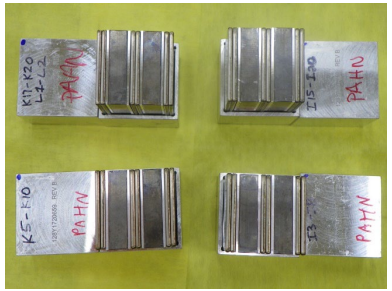
Godiva Reproducibility (IER 557)



- Final report with Sandia, PNNL and LANL data. **CED-3b milestone.**
- Papers at ICNC and ANS showing low std. dev. and strong correlation to temperature rise

Jupiter High Pu-240 (IER 578)

- Lead void measurements in Pu system for JAEA design of transmutation system
- Experiment performed in 2019
- LANL Criticality Safety Analysts (CSA) from NCS Division, mentored by John Bess to gain exposure to benchmark evaluation process
    - Alex Brown
    - David Shepherd

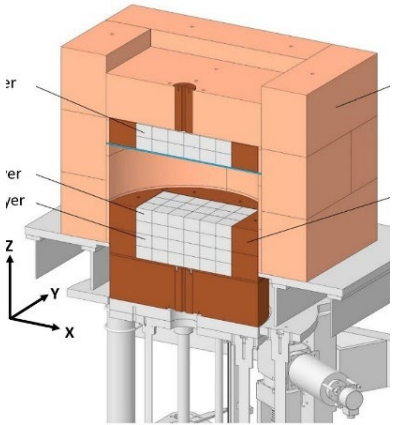


Upcoming 2024 ICSBEP Meeting

Out of 6 Benchmark Evaluations

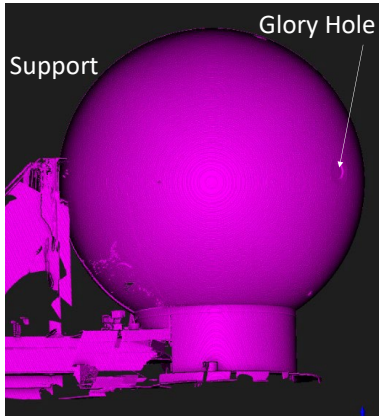
3 are at NCERC

1 is at Sandia



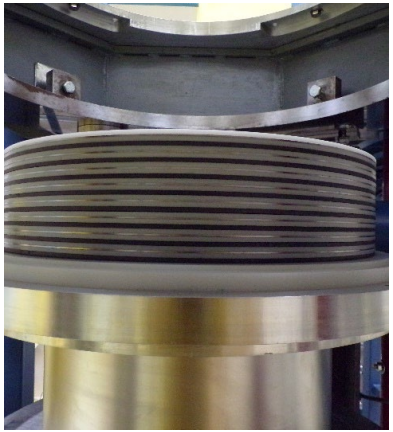
PU-MET-FAST-047

Jupiter: Pu ZPPR Plates, Lead Updated with new material composition documented after ICSBEP 2021 Meeting



HEU-MET-FAST-XXX

Flattop-HEU: Sphere of HEU Reflected by Spherical Natural Uranium



HEU-MET-MIX-XXX

TEX-HEU Critical Experiments with Hafnium

FUND-SANDIA-HE3-MULT?

High Multiplication Subcritical Benchmark at Sandia National Laboratory LEU SPR/CX Facility

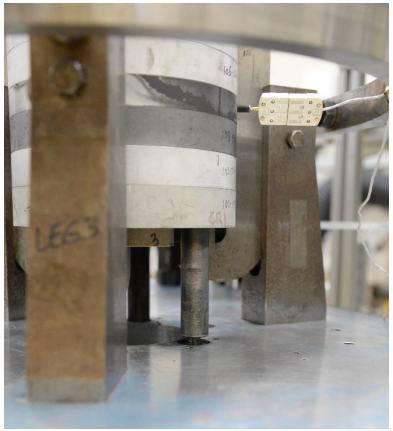
NCSP, NCERC and Sandia are central to generation of new experimental data for benchmark evaluations

Future ICSBEP Meetings

Upcoming NCERC Critical Experiment Evaluations

PU-MET-FAST-050

Jupiter High Pu-240: Fast-Spectrum Critical Assemblies with a Pb-Pu Core Surrounded by a Copper Reflector

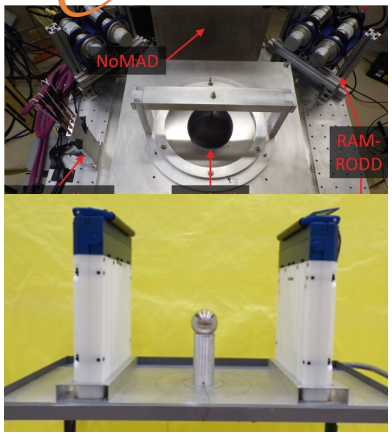


HEU-MET-FAST-086

Godiva: With updates and configurations measured at NCERC

HEU-MET-FAST-XXX

CERBERUS: A Zeus Configuration with HEU and Copper Reflected by Copper



FUND-NCERC-HEU-HE3_MULT-
MUSiC Subcritical with He-3 detector responses

FUND-NCERC-NP-HE3-MULT-
NeSO: Neptunium Subcritical Observations

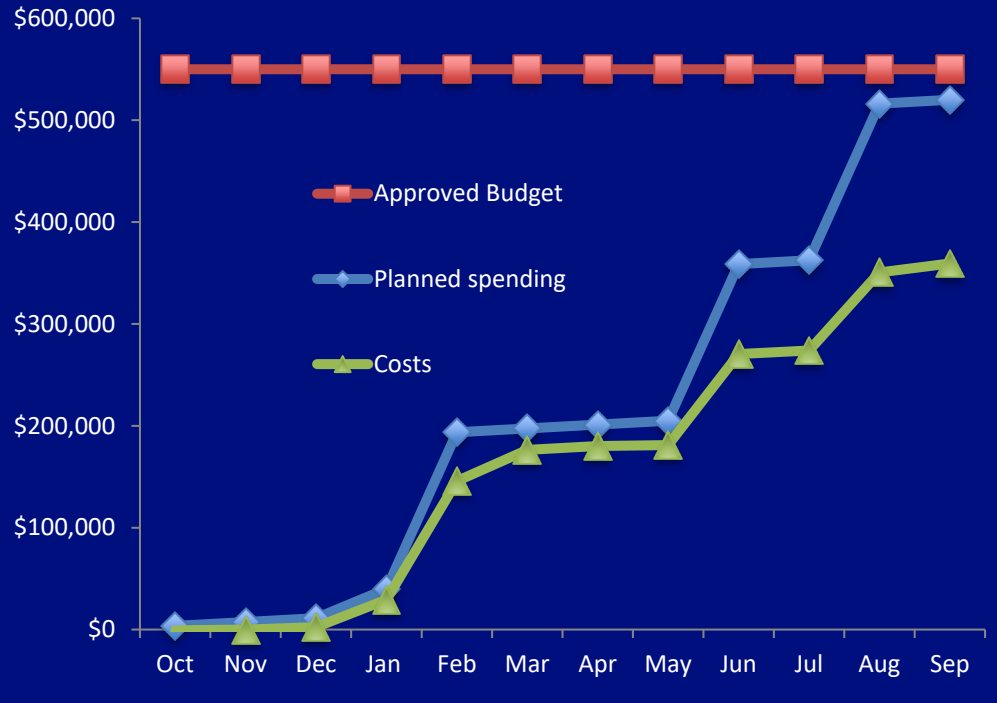
NCERC-FO Behind the Scenes

- **Control Room Upgrades!**
- KRUSTY components shipped back to NASA or disposed of by MSTS Waste Generation Services.
- Permanent modification to Planet to minimize component exposure to radiation.
- A forklift charging station was installed in the NCERC warehouse
- Four Cognizant System Engineers were qualified.

Banner year for Assessments

- MSS Maintenance Assessment
- Vital Safety System (VSS) Assessment
- NA-LA Criticality Safety Assessment
- EA-32 Assessment for worker safety and health
- DOE-STD-1070-94 Assessment of the National Criticality Experiments Research Center (NCERC) Training and Qualification Program

Training & Education

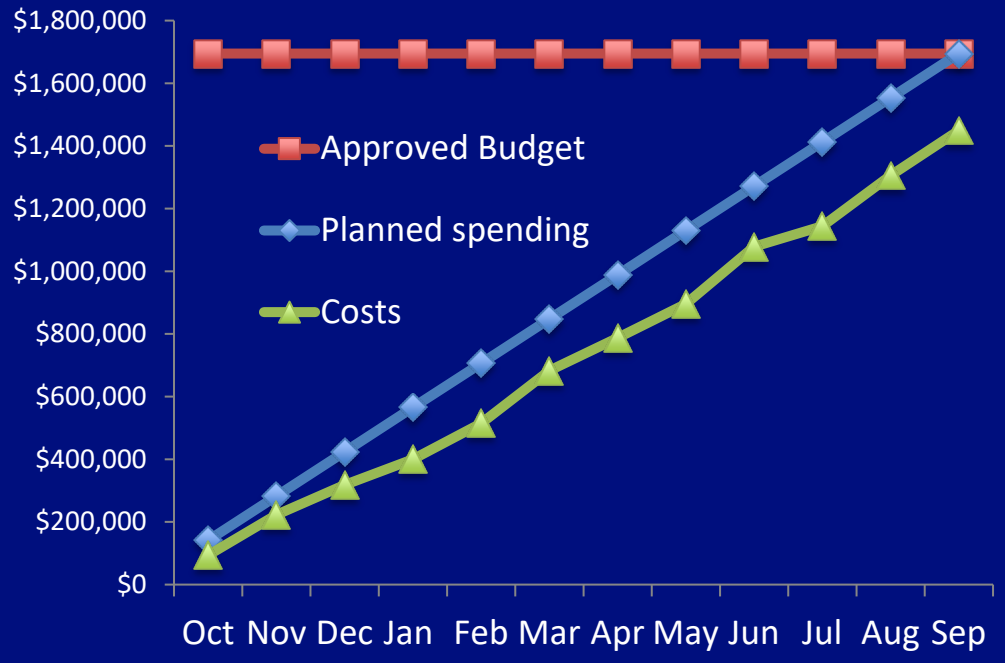


TE3	Conduct Hands-On Criticality Safety Training Course at NCERC
TE6	Development of University Pipeline for Criticality Safety Professionals

NCSP Classes

- **39 students total!**
- January – CSE Class
- June – Manager's Course
- August – CSE Class

Nuclear Data



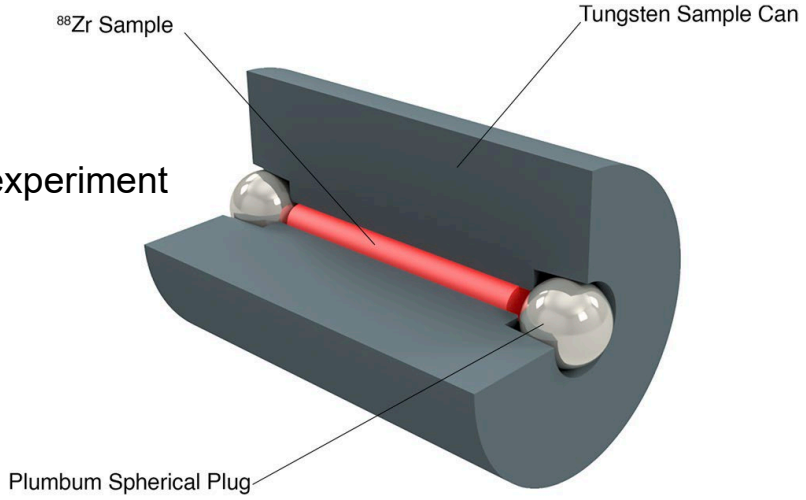
ND1	Nuclear Data Evaluation and Testing
	See talks by Ionel Stetcu, Denise Neudecker (presented by Matt Devlin) and Mark Paris (presented by Bob Little)
ND2	Nuclear Data Measurements at LANSCE
	See talks by Esther Leal Cidoncha, Thanos Stamatopoulos and Matt Devlin
ND 2a	Prompt Fission Neutron Spectra (PFNS) Measurement of Plutonium-240
	See talk by Matt Devlin
ND 2b	Unresolved and Fast Measurements of Uranium-233 (n,γ)

MIHL Item

Nuclear Data Highlight

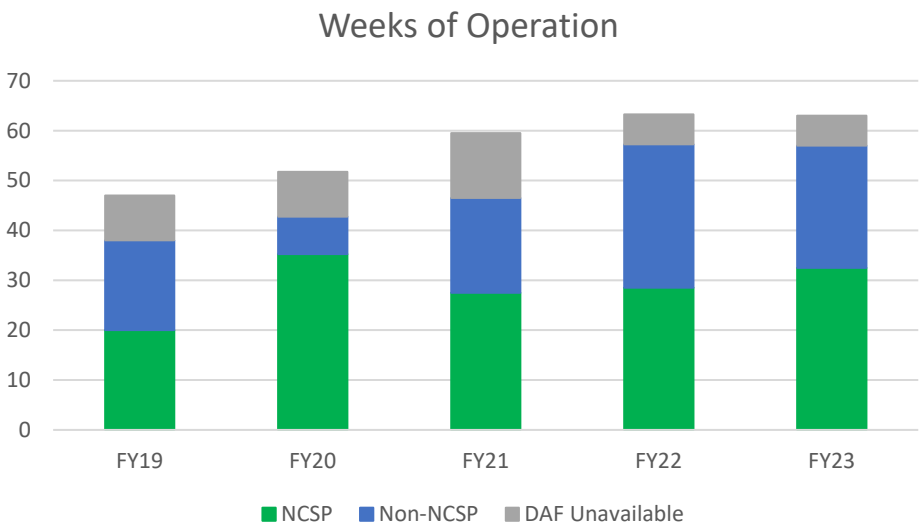
^{239}Pu Measurements Using DICER at LANSCE

- High-quality ^{239}Pu(n,tot) data at low energies were requested to perform a re-evaluation that will improve calculations for thermal plutonium solutions.
- The Device for Indirect Capture Experiments on Radionuclides (DICER) was developed to provide (n,tot) and (n,γ) cross sections on radionuclides on extra small samples (ng-mg, 1mm).
- "Clinton" ^{239}Pu material (99.953(4)% purity: highest in the world) was chemically purified
- Two liquid, 8 µL Pu samples, dissolved in DCl
  - 3.6 mg, to address the 0.2 meV– ~100 eV range
  - 7.4 mg, to address the 100 eV – ~500 eV range
- Tungsten canister design previously used during the ^{88}Zr experiment



See Thanos' talk on ^{149}Sm for more on DICER

NCERC UTILIZATION



DAF Unavailable (6 weeks)

- 3 weeks Holiday Closures
- 3 weeks Maintenance/Other

NCSP (32 weeks)

- 3 weeks NCSP Classes (IER 462)
- 1 week MOX ZPPR (IER 296)
- 2 weeks TEX-Pu-Hanford (IER 519)
- 3 weeks TEX-U-Hf (IER 532)
- 7 weeks CERBERUS (IER 537)
- 2 weeks Godiva Benchmark (IER 555)
- 2 weeks Godiva Characterization (IER 574)
- 7 weeks EUCLID (IER 577)
- 5 weeks MNT/SRV/ISI/PMT/training (IER 466)

Non-NCSP (24 weeks)

- 8 weeks NA-10:
  - PF-4, NMM, NWWC Classes, Godiva Ops
- 4 weeks NA-20:
  - University Measurements, Keepin
  - Arms Control, PVT, Godiva SLFPY
- 8 weeks NA-80, DTRA:
  - ER Classes, RTOs, QuickDraw, Crown Jewels
- 4 weeks Other:
  - Archive samples, Staging/Measurements

FY23 was a productive year!

- CED-0: Pile Oscillator (IER 579)
- CED-1: Moly (IER 517), EUROPA (IER 551)
- CED-3a: PFUNS (IER 153), TEX-Pu-Hanford (IER 519), CERBERUS (IER 537), Godiva (IER 555), Godiva Characterization (IER 574)
- CED-3b: Flattop (IER 423), TEX-U-Hf (IER 532), Godiva Benchmark (IER 555), Godiva Reproducibility (IER 557), Godiva Characterization (IER 574)
- CED-4a: MUSiC (IER 488)

90+ Publications between IE, AM, and ND
92 Work Control Documents issued or revised
34? Surveillances, In-service Inspections, and Maintenance Activities performed

Fissionable Material Moves (CY)

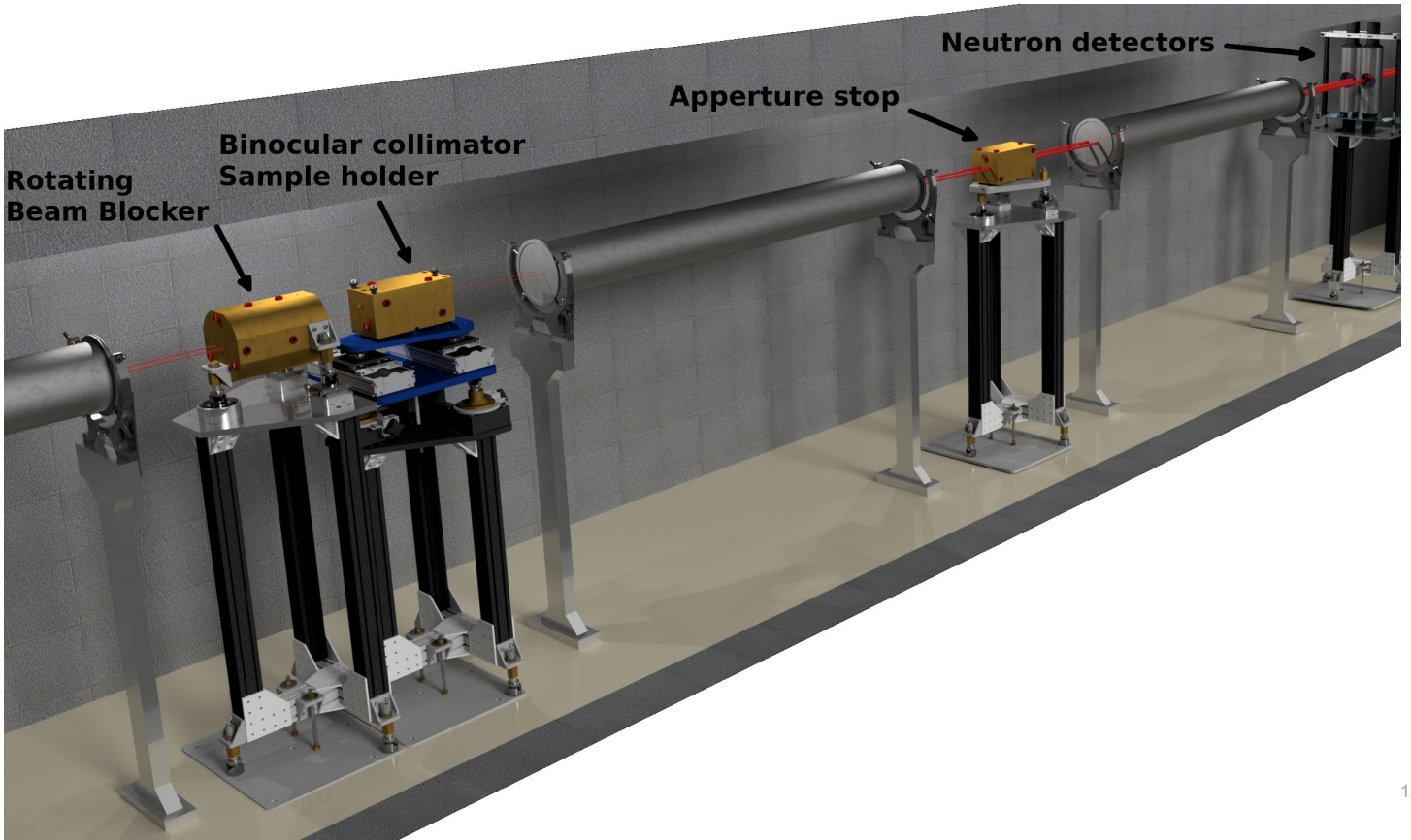
2023 – 187 moves
2022 – 182 moves
2021 – 170 moves
2020 – 55 moves
2019 – 216 moves
2018 – 179 moves
2017 – 163 moves
2016 – 97 moves

Acknowledgements

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

This work was supported by the US Department of Energy through the Los Alamos National Laboratory. Los Alamos National Laboratory is operated by Triad National Security, LLC, for the National Nuclear Security Administration of the US Department of Energy under Contract No. 89233218CNA000001.

^{239}Pu@DICER


Neutron detectors
Apperture stop
Binocular collimator
Sample holder
Rotating
Beam Blocker

Technical Support

TS4	Succession Planning

Semi-annual Crew Member Training

- Two sessions, one for
  - January requalification of current crew members
  - May focused on new crew members