OAK RIDGE National Laboratory

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# Nuclear data performance assessment

Will Wieselquist

WANDA2026

U.S. DEPARTMENT of ENERGY

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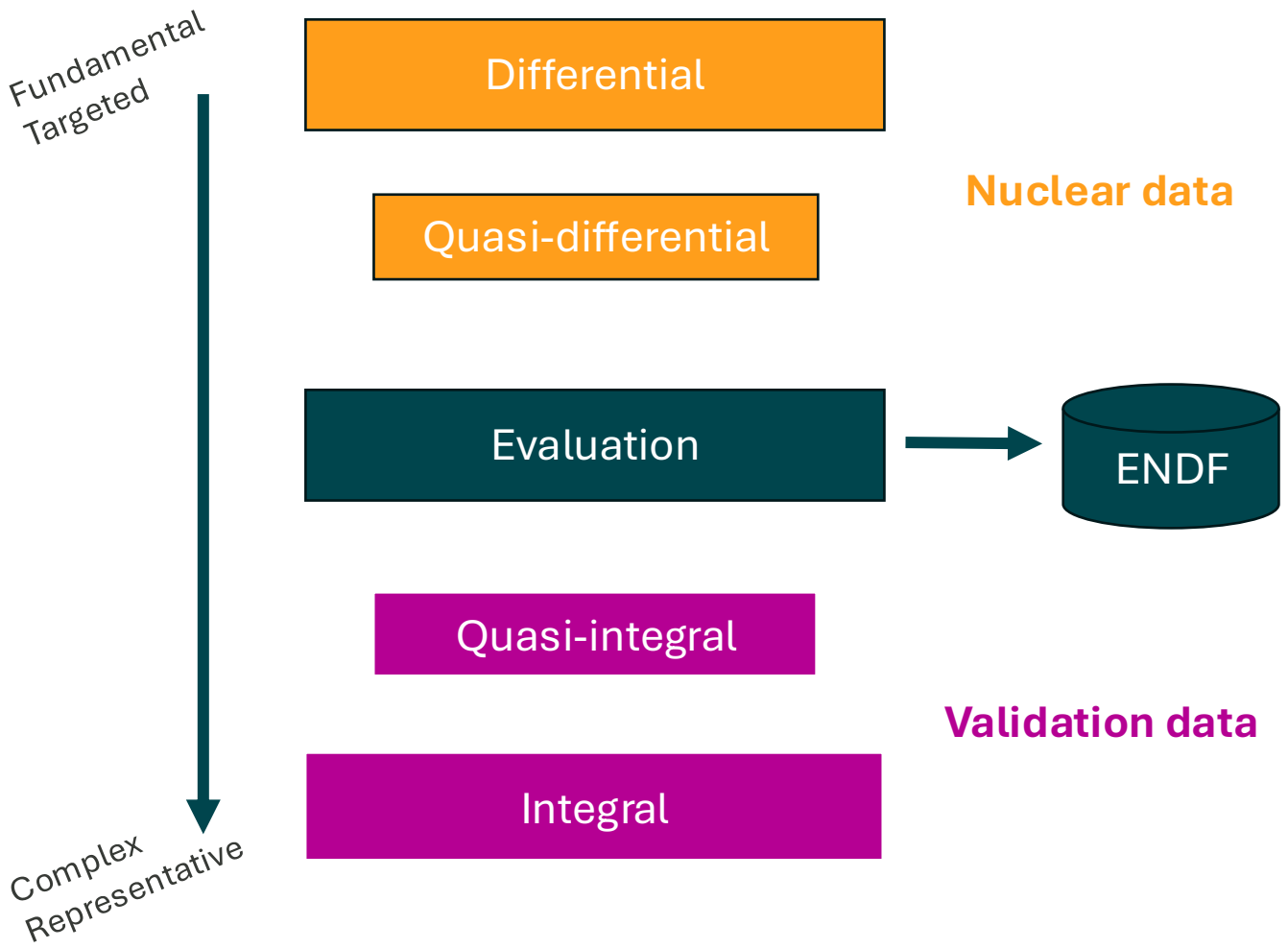
FOR THE US DEPARTMENT OF ENERGY

# Assessing data performance

- WANDA is mainly concerned nuclear data
- Validation demands high-quality “integral data”
  - Destructive assay of spent fuel measures concentration of 20-50 nuclides
  - Critical experiment
  - Concrete labyrinth
- In many cases, a **nuclear data** need may be suspected but without validation data, it is hard to verify or even justify, for example
  - Cl-35(n,p) evaluation is useful, but a critical benchmark that is highly sensitive is also needed
  - CE FPY is needed, but some quasi-integral “burst fission” of UO2 at intermediate energy would be very valuable



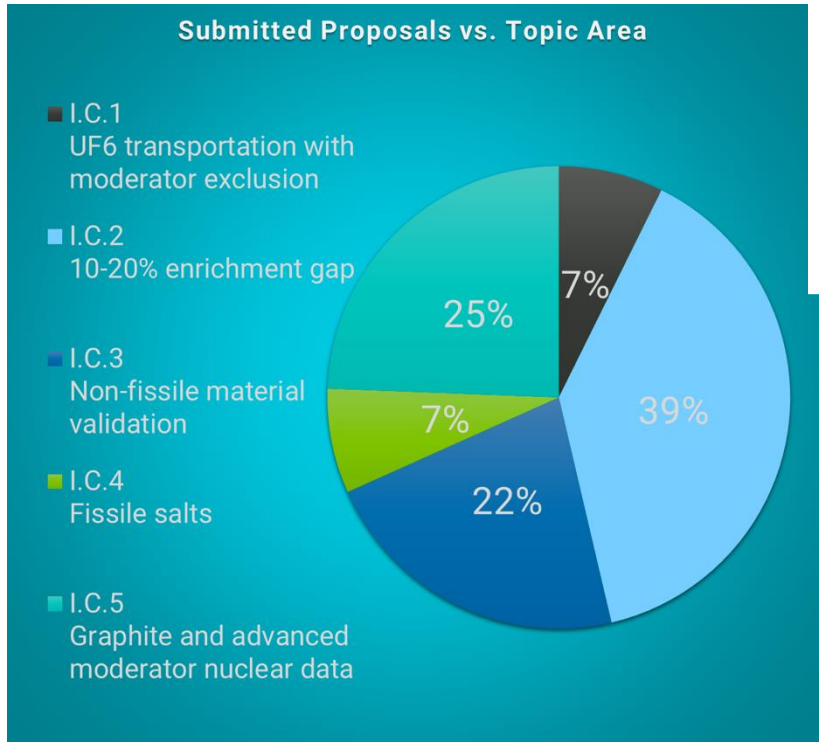
# Experiment-driven performance assessment: DNCSH

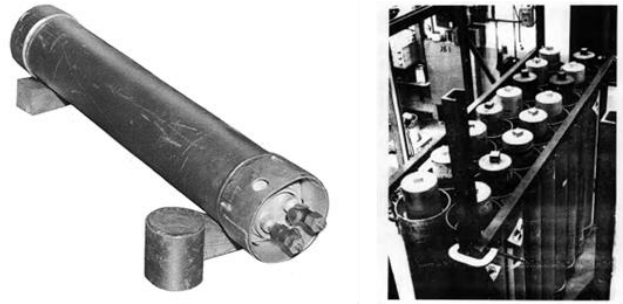
Mission is to pursue **experiments** that provide the maximum benefit for deployment of HALEU-based advanced reactors: mainly criticality benchmarks (integrals), but also quasi-integral/differential, differentials that improve our confidence.

*Next (and final) Call #3: March 18, 2026.*

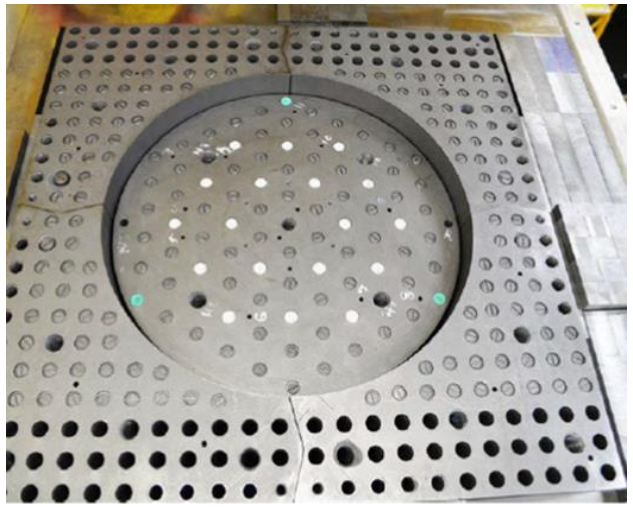
DNCSH

DOE/NRC Criticality Safety for Commercial-Scale HALEU for Fuel Cycle and Transportation



**Benchmark of Historical Y-12 Critical Experiments with $UF_6$ Cylinder Model 8A Cylinders**
**– LLNL with ORNL, CS Engineering, UT (Y-12, USA)**



**THETA: TRISO-form HALEU-fueled Experiment for Transport Applications**
**– LANL with Kairos (NCERC, USA)**

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# Validation-driven performance assessment: SCALE

- Automated
  - Nuclear data library generation based on ENDF/B beta or preliminary evaluations
  - Running and reporting of entire validation suite
- Continue to add validation cases supporting NCSP and NRC sponsors
- Last non-automated reports: scale.ornl.gov

The SCALE 6.3 validation report four-volume set is now available on OSTI:

1. **SCALE 6.3 Validation: Reactor Physics**
2. **SCALE 6.3 Validation: Nuclear Criticality Safety**
3. **SCALE 6.3 Validation: Spent Nuclear Fuel**
4. **SCALE 6.3 Validation: Radiation Shielding**

- Analysis models including representative advanced reactor spent fuel https://code.ornl.gov/scale/analysis
- Validation models https://code.ornl.gov/scale/validation

| Application | Est. number of validation cases (typically independent) | Est. number of comparisons to measurement |
|---|---|---|
| Reactor physics | 11 reactors | 215* measurements |
| Radiation shielding | 21 systems | 157 configurations |
| Spent fuel | 21 reactors | 236 decay heat 205 RCA** |
| Criticality safety | 111 systems | 810 configurations |

* ~6 types of measurements per cycle, ~3 cycles per reactor
** Radiochemical Assay (RCA) with variable 1-20 samples per reactor over multiple cycles/assemblies (does not include 15-40 nuclides measured per RCA)

# Summary of needs

- Content needs
  - Robust representation of uncertainty and correlation across all nuclear data sufficient to generate physical realizations
  - US-based activation library would limit multi-library shenanigans (JEFF+ENDF/B ☹)
- Nuclear data needs
  - Quasi-integral/integral experiments to gain additional confidence in ENDF/B thermal moderators/reflectors: Be, BeO, MgO, ZrH, YH, graphite
  - Cl-35(n,p), U238(n,n'), Li-7(n,g)
  - No significant regression in performance for important applications
    - Never again have ENDF/B 8.0 situation where it performed much worse for depletion and shielding than ENDF/B-7.1
    - No version-specific recommendations for applications!
- Validation data needs
  - Intermediate spectrum fission product concentrations from burst fission
  - Decay heat for high burnup >70 GWd/MTU
  - Reactivity responses for HALEU systems
    - Horizontal Split Table at INL will hopefully address
  - Isotope production benchmark resource
- Methodology needs
  - Map bias across all validation cases to likely errors/uncertainty in nuclear data
  - Optimize experiment funding based on dollars of benefit to stakeholders