Nuclear Structure Evaluators Traineeship at Lawrence Livermore National Laboratory

Workshop for Applied Nuclear Data Activities (WANDA) 2026

February 10, 2026

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Prepared by LLNL under Contract DE-AC52-07NA27344.

ENSDF is the ONLY comprehensive repository for nuclear structure and decay data

Nuclear Structure Data

Discrete Quantized States

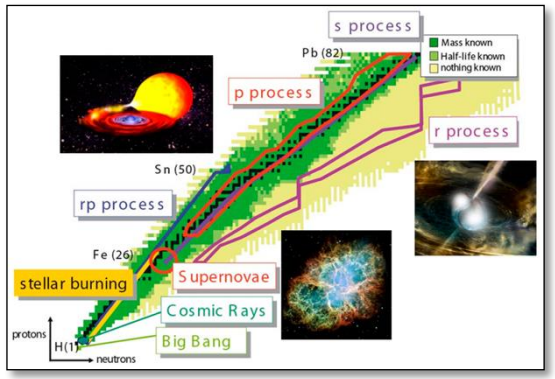
- Excitation Energy
- Half-life
- Angular Momentum
- …

Emitted Radiation

- Energy
- Intensity
- Dipole, Quadrupole, …
- …

Nuclear Decay Data

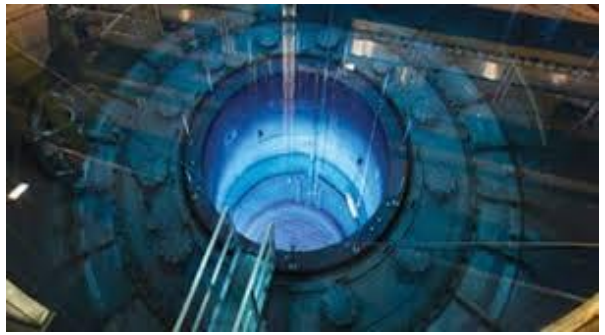
Basic Science



Astrophysics

FRIB RIKEN NISHINA CENTER FAIR TRIUMF GANIL laboratoire commun CEA/DRF spiral2 CNRS/IN2P3

Applications

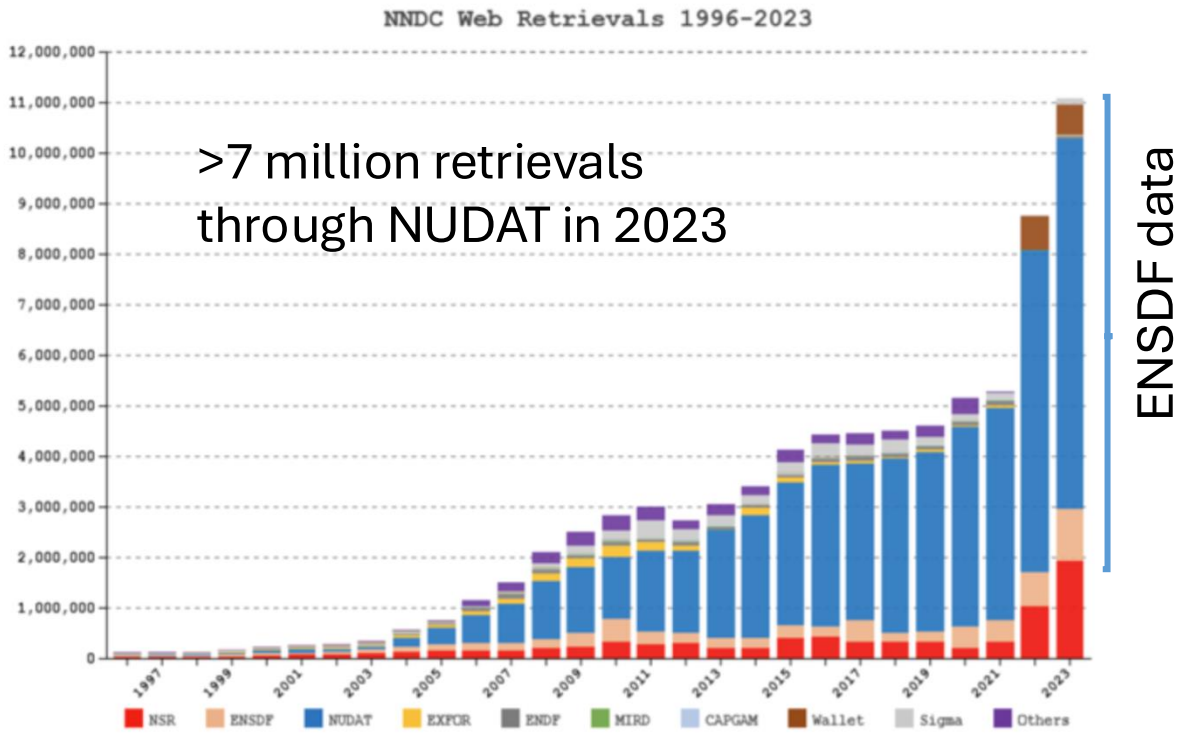


Nuclear Energy

Homeland Security

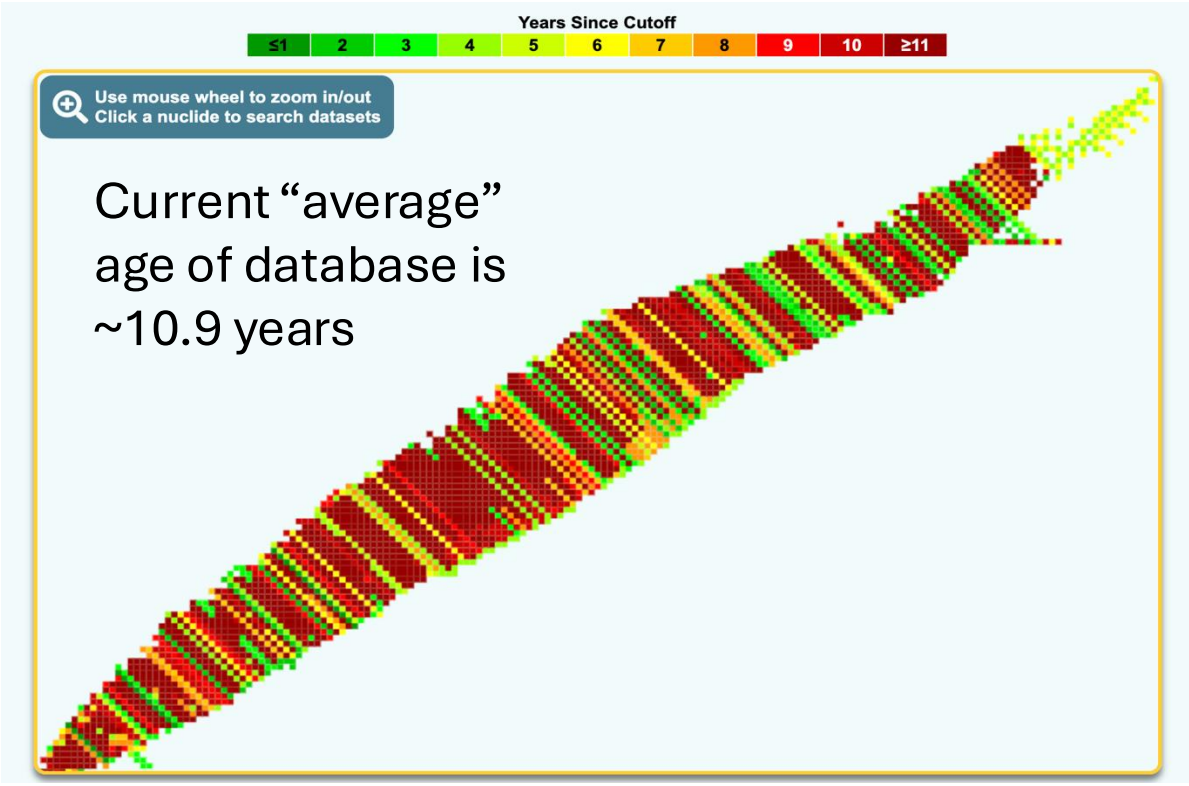
Stockpile Stewardship

Challenges and Need



>7 million retrievals through NUDAT in 2023

ENSDF data



Current "average" age of database is ~10.9 years

Aging Database + Growing Volume of Data = Demand for New Evaluators

We formed a team to respond the FOA in 2024

- increase entry points into the nuclear data evaluator community,
- support retention of evaluators, and
- expand the pool of nuclear data evaluators while still enabling them to continue scientific research.

DEPARTMENT OF ENERGY (DOE)
OFFICE OF SCIENCE (SC), NUCLEAR PHYSICS (NP)
NATIONAL NUCLEAR SECURITY ADMINISTRATION (NNSA), DEFENSE NUCLEAR NONPROLIFERATION RESEARCH AND DEVELOPMENT

NUCLEAR DATA INTERAGENCY WORKING GROUP (NDIAWG) RESEARCH PROGRAM

FUNDING OPPORTUNITY ANNOUNCEMENT (FOA) NUMBER: DE-FOA-0003238

FOA TYPE: Initial
CFDA NUMBER: 81.049

FOA Issue Date:	**January 4, 2024**
Submission Deadline for Letters of Intent:	**February 5, 2024 at 11:59pm Eastern Time** **A Letter of Intent is required.** **Letters of Intent must be submitted by an authorized institutional representative.**
Letter of Intent Response Date	**February 19, 2024 days at 11:59pm Eastern Time**
Submission Deadline for Applications:	**April 4, 2024 at 11:59pm Eastern Time**

A collaborative team building structure data evaluation capability at LLNL to meet the demand

NNDC/BNL

Libby McCutchan (PI)

Manager of XUNDL Database
Manager of ENSDF Database
10+ years as ENSDF evaluator

Chris Morse (Co-I)

Lead on ENSDF modernization project and ENSDF evaluator

LLNL

Vincent Cheung

Expertise in nuclear data library management and radiation detection

Kay Kolos (LLNL-PI)

Expert in fission, nuclear decay mechanisms, and radiation studies

Anthony Ramirez

Specializes in fission (FPY), nuclear reactions and structure

Training done in hybrid approach: Virtual meeting with mentors every other week and in-person meeting every quarter

Background of the trainees

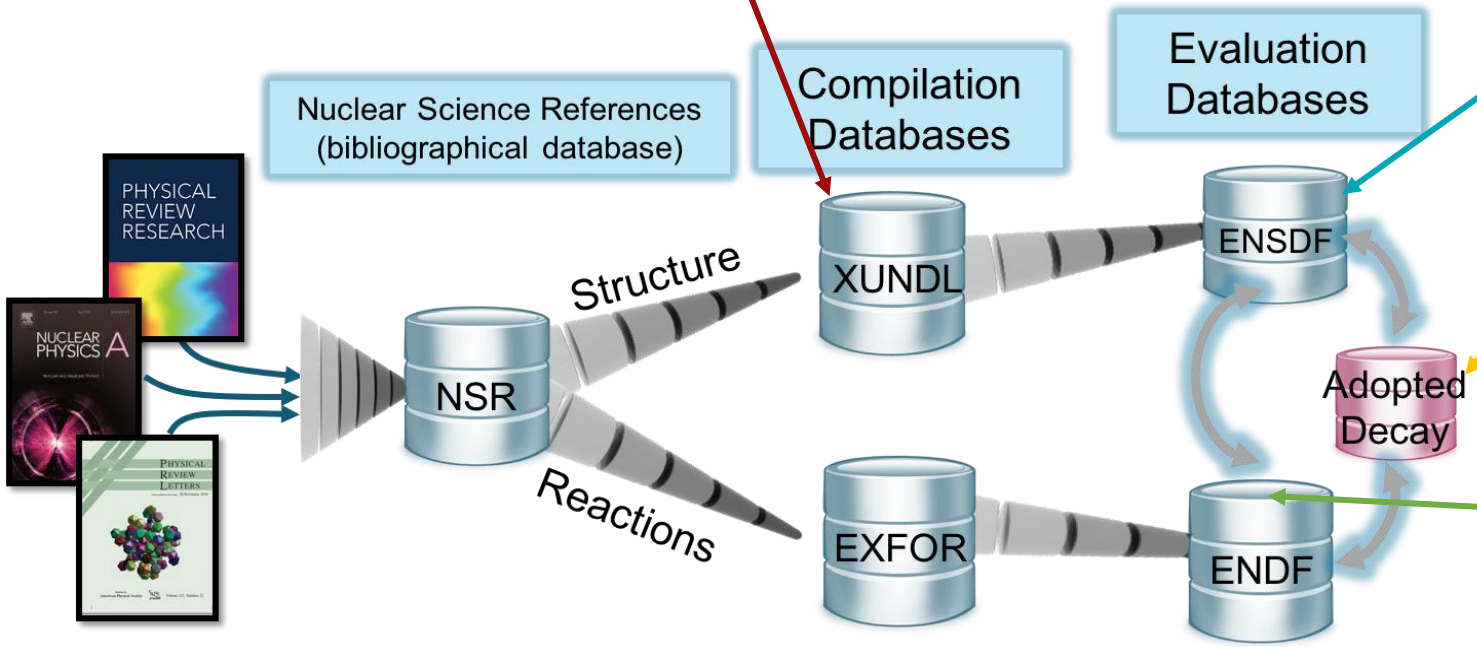
- Joined LLNL in 2019
- Specializes neutron and gamma-ray spectroscopy techniques
- Current work focuses on fission, nuclear reactions and structure (neutron and photon measurements), and detector development

- Joined LLNL in 2021
- Specializes on nuclear data library management and radiation detection
- Also supports nuclear and atomic database infrastructure and high-energy nuclear physics

XUNDL ENSDF

A comprehensive training to bring new nuclear structure data to databases

Objective 1: Training for XUNDL Database Compilations
- Familiarize trainees with the XUNDL database structure
- Extract and vet experimental data from publications
- Learn tools and codes for data extraction and conversion

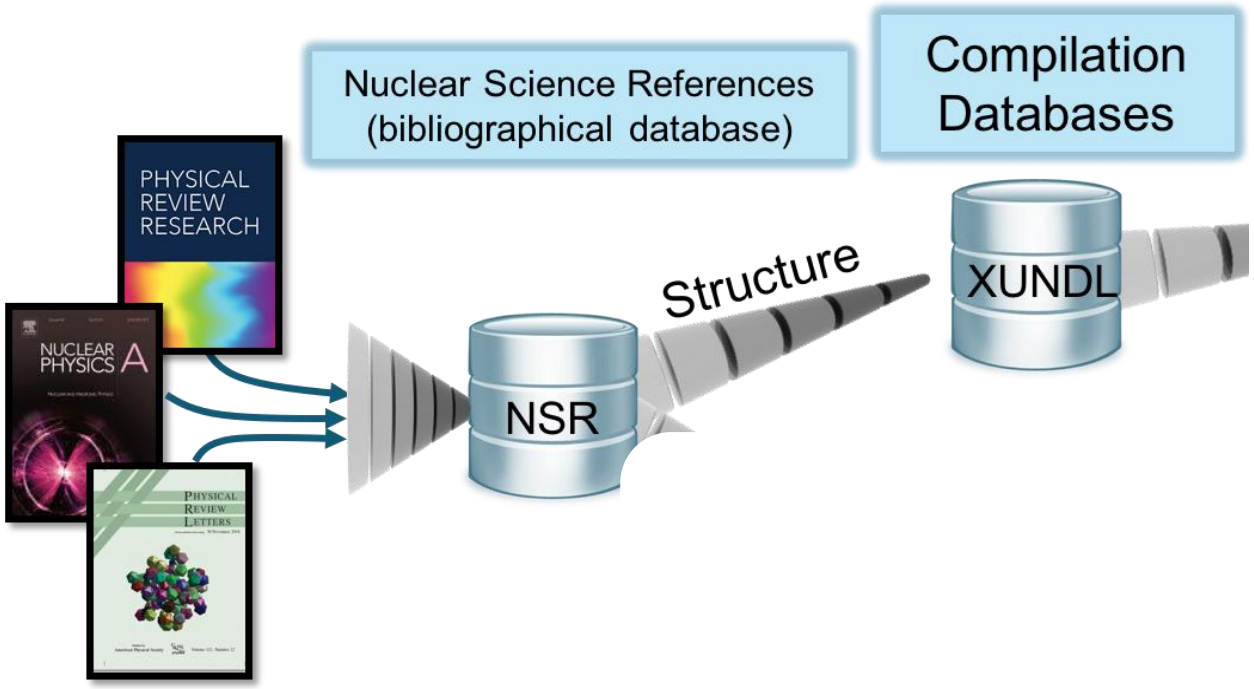


Objective 2: Training for ENSDF Database Evaluations
- Full nuclide evaluations for the ENSDF database

Objective 3: Training for Adopted Decay Data Evaluations
- Focus on specific ENSDF and radioactive decay datasets

Objective 4: Training for ENSDF to ENDF Decay Data Translation
- Converting ENSDF decay data to the ENDF Decay Sublibrary

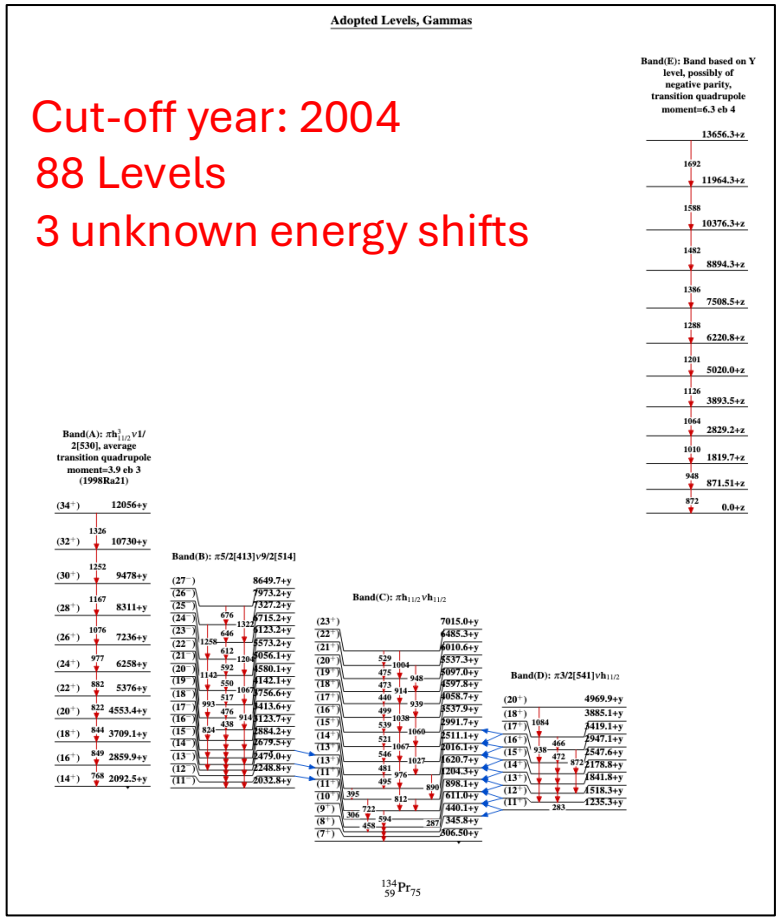
We compiled new published data into the eXperimental Unevaluated Nuclear Data Library



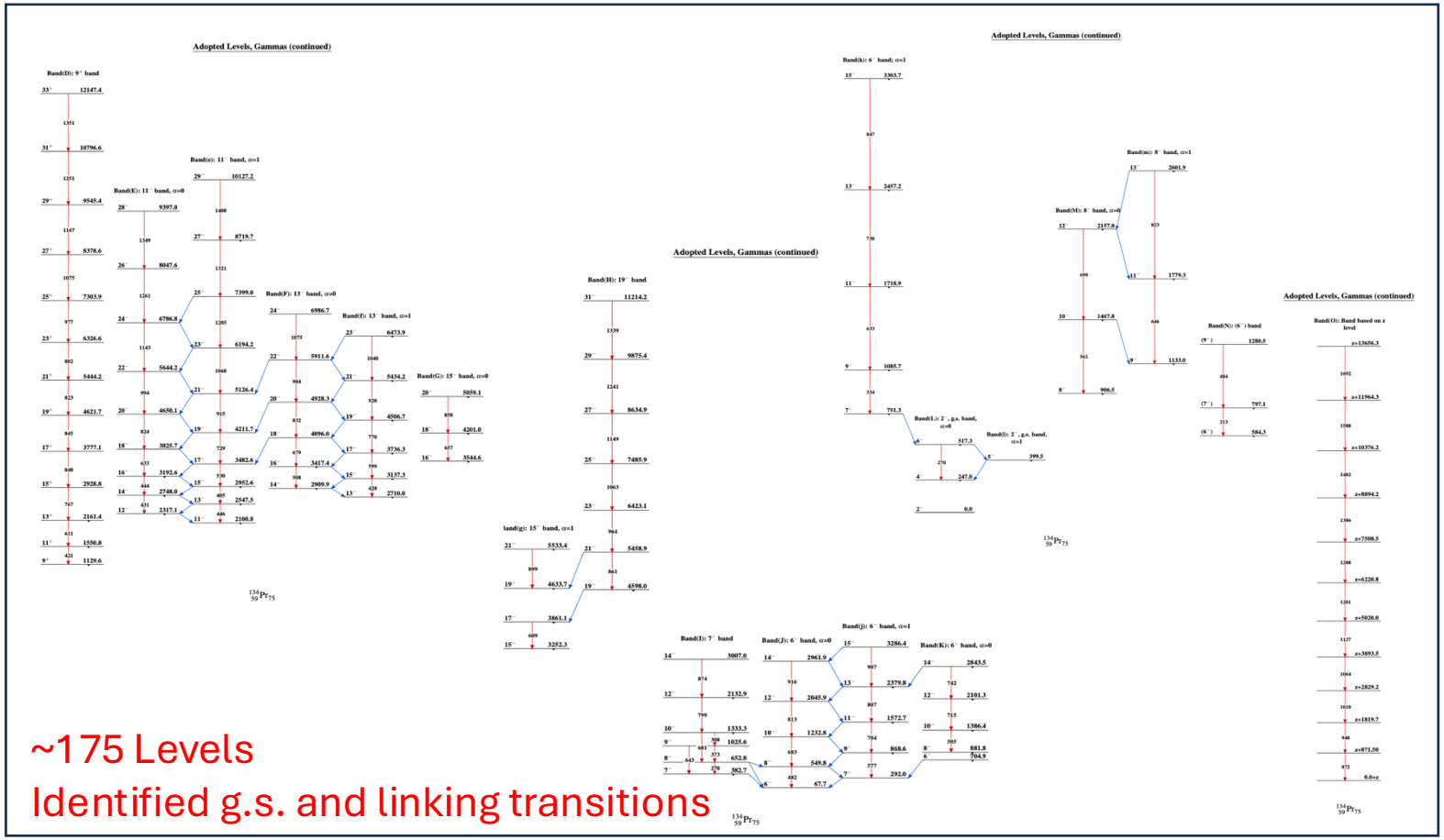
- Our team delivered 60 XUNDL compilations in FY 25.
- These are compiled from decay and reaction experiments selected by mentors to familiarize mentees with the database structure.
- Data are in the same format as the evaluation.

XUNDL ENSDF

Evaluation often involves merging understanding of nuclear structure with discrepancies



^{134}Pr – 2004 Adopted Levels, Gammas



^{134}Pr – 2026 Adopted Levels, Gammas

Decay data serve two purposes

- Decay data are first scrutinized for level structure information such as
  - Level energy
  - Spin-parity
- These information will be incorporated into the adopted levels and gammas dataset
- We put recommended data from the adopted levels and gammas datasets into the final form of decay dataset
- The decay dataset thus respects both the decay emission from experiment and level information from the adopted dataset

It takes more time to incorporate and curate a decay dataset due to its hybrid nature.

XUNDL ENSDF

A=134 Status

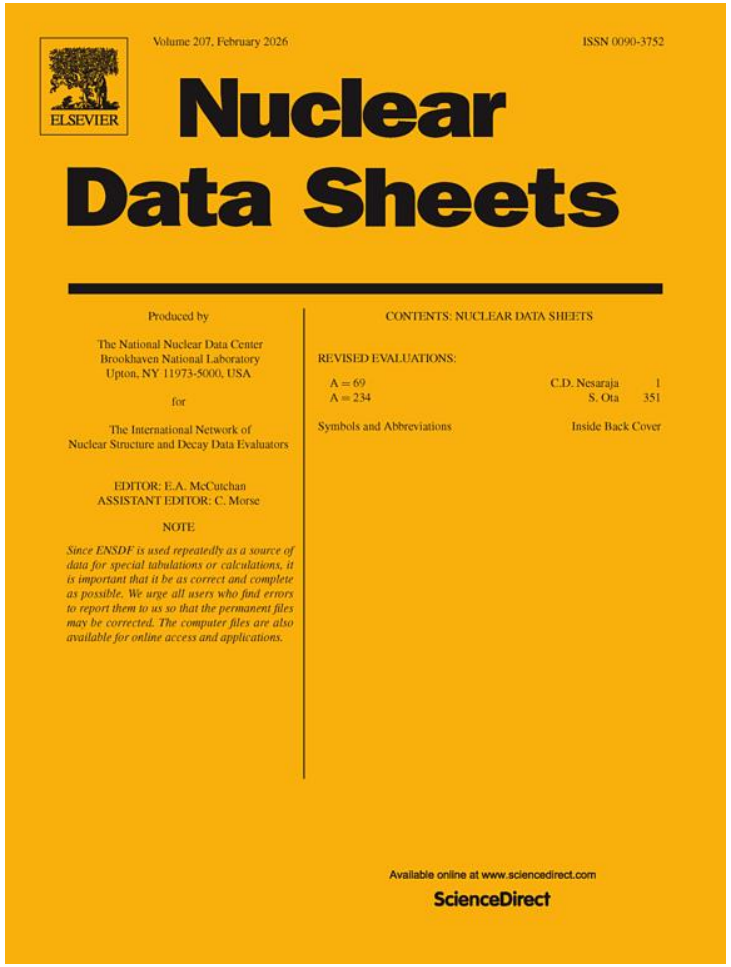
	$_{64}$Gd	$_{63}$Eu	$_{62}$Sm	$_{61}$Pm	$_{60}$Nd	$_{59}$Pr	$_{58}$Ce	$_{57}$La	$_{56}$Ba	$_{55}$Cs	$_{54}$Xe	$_{53}$I	$_{52}$Te	$_{51}$Sb	$_{50}$Sn	$_{49}$In	$_{48}$Cd
Lead	VC	AR	VC	VC	VC	AR	AR	VC	VC	AR	VC	AR	LM	CM	AR	AR	AR
# of new papers	0	0	0	2	2	2	4	1	4	2	9	3	11	4	7	5	2
# of Reaction datasets	0	0	1	1	1	1	3	3	6	6	3	0	1	0	0	0	0
# Decay datasets	1	0	1	1	4	1	3	2	3	1	5	2	5	3	1	0	0

- We started from the edges where either
  - new experiments are compiled and adopted as evaluations as they are the first measurements made to study the nuclides, or
  - there are no new measurements made from last cut-off.
- We then move inwards to merge new measurements with existing datasets before we perform the adopted levels and gammas evaluations

ready for review
near completion
in progress

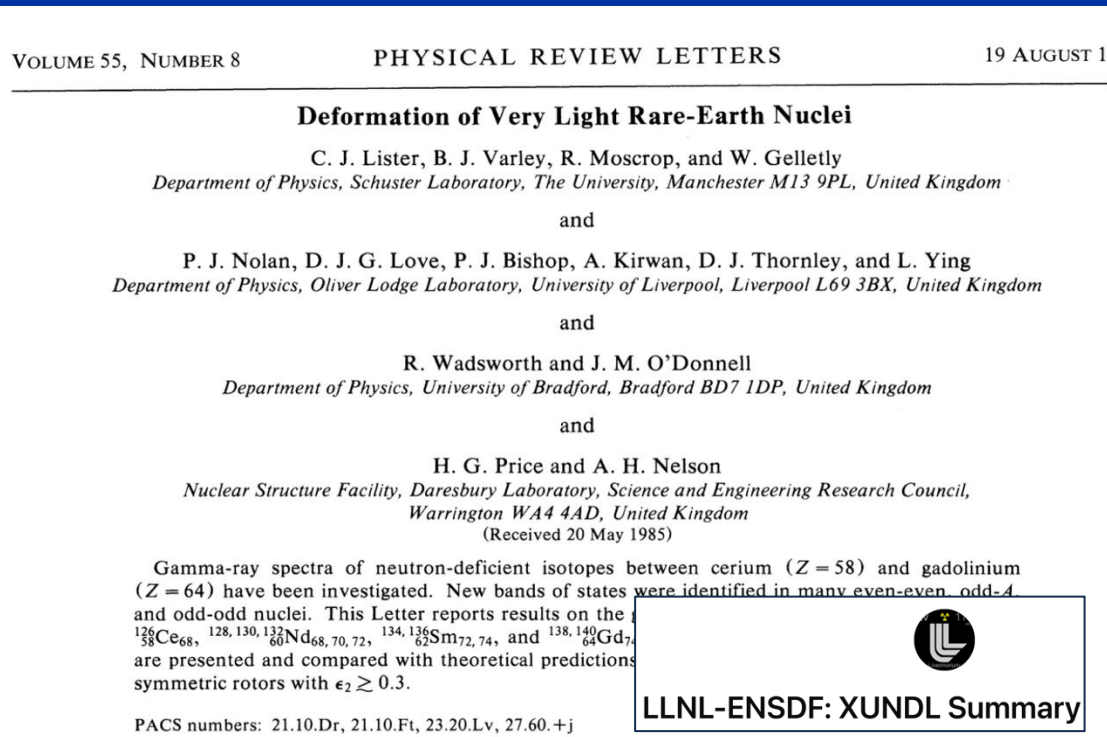
The product of a mass chain evaluation is a publication in the Nuclear Data Sheets

- We are finalizing the evaluations within our team of mentors and mentees.
- The submission process involves having an evaluator in the ENSDF community to review our evaluations.
- New evaluations will be published in Nuclear Data Sheets and pushed to NNDC server for retrieval.



Use of AI

- We explored ways to incorporate AI into our evaluation workflow and found it is best for language output
- Chatbot has $\mathcal{O}(10)$ published XUNDL summary from publications as “knowledge files”
- It takes a publication as an input and write summary as the output.
- It speeds up the workflow but often needing further revision



VOLUME 55, NUMBER 8 PHYSICAL REVIEW LETTERS 19 AUGUST 1985

Deformation of Very Light Rare-Earth Nuclei

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(Received 20 May 1985)

Gamma-ray spectra of neutron-deficient isotopes between cerium ($Z = 58$) and gadolinium ($Z = 64$) have been investigated. New bands of states were identified in many even-even, odd-A, and odd-odd nuclei. This Letter reports results on the $^{126}_{58}Ce_{68}$, $^{128,130,132}_{60}Nd_{68,70,72}$, $^{134,136}_{62}Sm_{72,74}$, and $^{138,140}_{64}Gd_{74}$ are presented and compared with theoretical predictions symmetric rotors with $\epsilon_2 \gtrsim 0.3$.

PACS numbers: 21.10.Dr, 21.10.Ft, 23.20.Lv, 27.60.+j

LLNL-ENSDF: XUNDL Summary

E(^{46}Ti)=205,210 MeV. ^{92}Mo(^{46}Ti,2p2n)^{134}Sm at Daresbury Van de Graaff. Enriched ^{92}Mo target (1–3 mg/cm^2) on ≈30 mg/cm^2 Pb backing. γ rays detected with 4 BGO-shielded HPGe detectors at 135°, with coincident neutrons (37 NE213) and charged particles (Si ΔE–E telescope) for channel selection. Ground-state band established via particle-γ-γ coincidences: E(2^+)=163 keV, E(4^+)=316 keV, E(4^+)/E(2^+)=2.94, consistent with a well-deformed axially symmetric rotor; deformation ε_2≈0.25–0.30 deduced using Grodzins systematics.

Summary and Outlook

- We are working to expand the pool of structure data evaluator through
  - compiling new unevaluated data to XUNDL,
  - performing mass chain evaluation, and
  - exploring other ENSDF-related activities.
- We started discussing how we can be incorporated into USNDP workforce following completion of the traineeship.