Nuclear Data Group Report
LBNL+UCB

June 2021 – Oct 2022

M. Shamsuzzoha Basunia

Lawrence Berkeley National Laboratory

Berkeley, CA 94720

NSDD Technical Meeting, Canberra, Australia, October 24-28, 2022

Nuclear Data Group Members (LBNL+UCB)

Staff:

- **L. A. Bernstein (LBNL + UCB) (Group Leader) (~42%)**
- **M. S. Basunia (LBNL) (100%)**
- **Bethany Goldblam (LBNL) (33%)**
- **A. M. Hurst (UCB) (30%)**
- **J. C. Batchelder (UCB) (75%)**
- **Andrew Voyles (UCB - 20%)**
- **Josh Brown (UCB – 20%)**

Contractors:

- **J. K. Tuli (UCB) – ENSDF - until Sept 30, 2021**
- **Walid Younes (UCB) (50%) – FPY, Natural Language Processing**

Activities:

- **ENSDF**
  - Responsibility: 33 mass chains: 21-30, 81, 83, 90-93, 166-171, 184, 186, 187, 191-193, 210, 211, 212, 213, 214
  - Several over 10-years (since cut-off):
    - 24, 25, 27, 29, 30, 81, 92, 93, 166, 167, 169, 184, 187, 191
- Decay of nuclei far from stability, direct and beta delayed proton and alpha emitter evaluation (Batchelder)
- Development of the Natural Language Processing tools (Goldblum, Younes)
- EGAF modernization, (n,n'γ) – Baghdad Atlas, γ-X- coincidences (Hurst)
- **Measurements:**
  - High-energy (n,x), (p,x) reactions for Isotope Production (Voyles)
  - GENESIS (Gamma Energy Neutron Energy Spectrometer for Inelastic Scattering), (n,n'γ) (Brown)
  - Recent award from NNSA DNN R&D to obtain partial γ-ray cross sections using GENESIS for active neutron interrogation applications (Goldblum)

Mass chain evaluation

- **Nuclear Data Sheets:**
  - A=186, Batchelder, Hurst, Basunia, NDS 183, 1, 2022
  - A=213, Basunia, NDS 181, 475, 2022
- **Submitted (May, 2021 – Sept, 2022):**
  - A=30 (Basunia – 9 nuclides, Chakraborty (India) – 1 nuclide)
  - A=191 (Basunia – 13 nuclides)
  - A=213 (Basunia – 12 nuclides)
- **Pipeline:**
  - A=24 (Basunia, Chakraborty) – Final – will be published soon
  - A=231 (Balraj, Tuli, Browne) – Final – November, 2022 Issue?
- **Reviewed:**
  - Two mass chains

Horizontal Evaluation

Atomic Data and Nuclear Data Tables xxx (xxxx) xxx

Contents lists available at ScienceDirect

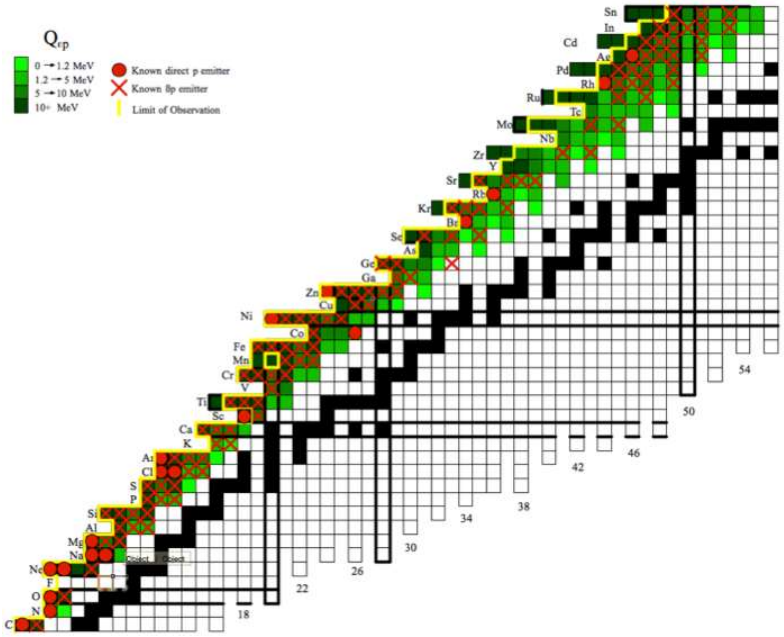
Atomic Data and Nuclear Data Tables

journal homepage: www.elsevier.com/locate/adt

Recommended values for β^+-delayed proton and α emission

J.C. Batchelder *

Department of Nuclear Engineering, University of California, Berkeley, CA 94720, USA
Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA



Nuclear Inst. and Methods in Physics Research, A 995 (2021) 165095

Contents lists available at ScienceDirect

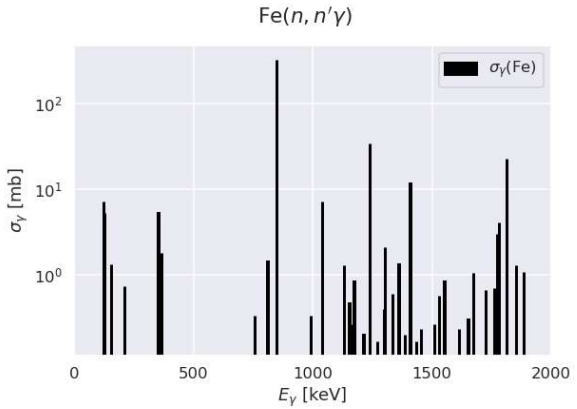
Nuclear Inst. and Methods in Physics Research, A

journal homepage: www.elsevier.com/locate/nima

The Baghdad Atlas: A relational database of inelastic neutron-scattering $(n, n'\gamma)$ data

A.M. Hurst [a,*], L.A. Bernstein [a,b], T. Kawano [c], A.M. Lewis [d], K. Song [a]

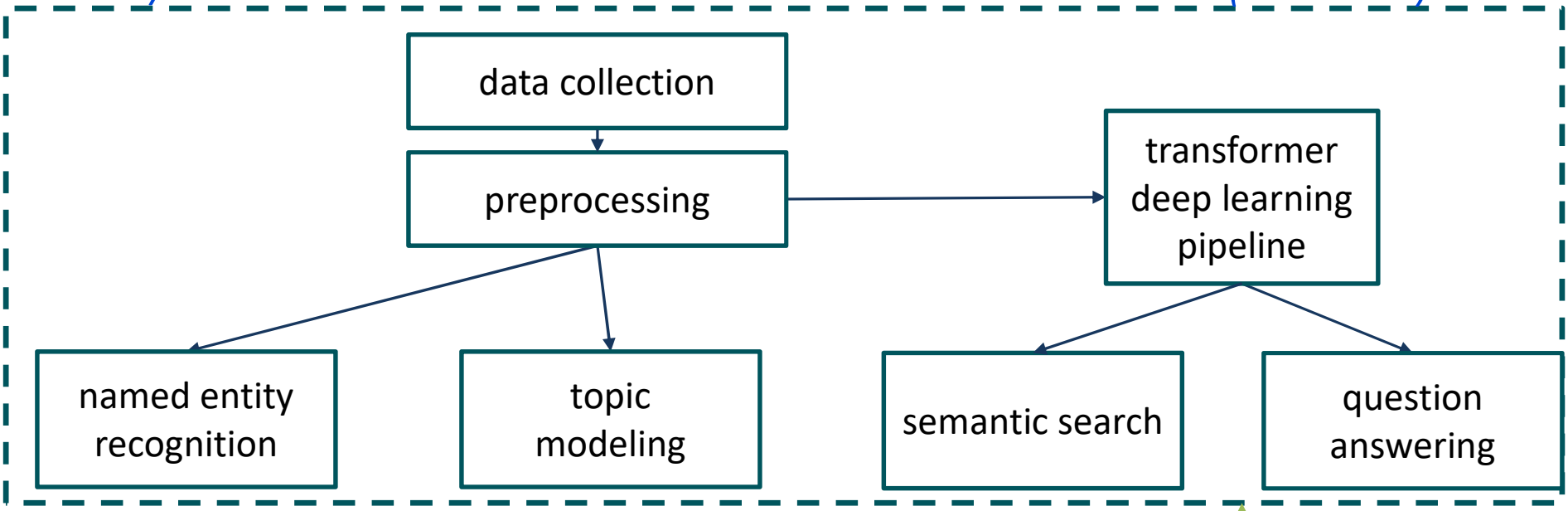
[a] Department of Nuclear Engineering, University of California, Berkeley, CA 94720, USA
[b] Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA
[c] Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM 87545, USA
[d] Naval Nuclear Laboratory, Schenectady, NY 12301, USA



7090 (n,n'γ) transitions
75 natural & enriched targets
All normalized to the ^{56}Fe 2 → 0 transition
Part of CoNDERC project (https://www-nds.iaea.org/conderc/)

NucScholar

AI/ML methods to accelerate nuclear science literature search (Goldblum)



Accomplishments to date:

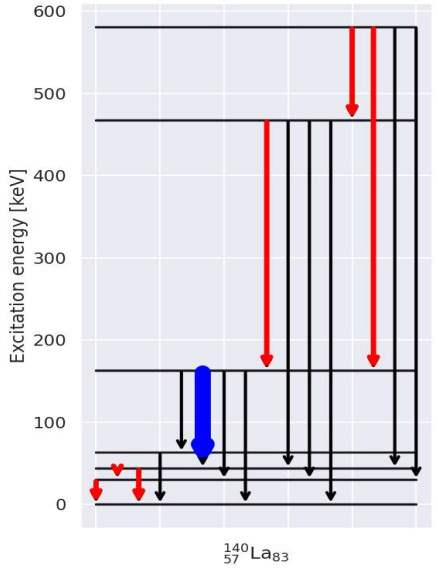
- Automated classification of manuscripts into experiment v. theory and NSR topical areas
- Nuclear-physics specific semantic search using a fine-tuned BERT model
- Prototype search engine available at https://nucscholar.lbl.gov/

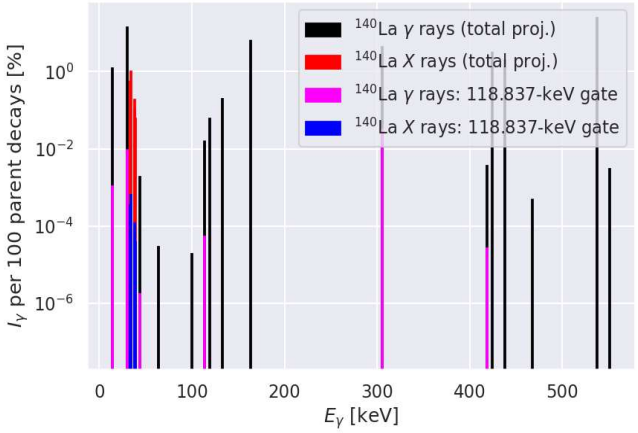
Keyword and natural language queries

γ-X-ray coincident database

- Fieldable-spectroscopy techniques require coincident decay data including X-rays from IC/EC.
- DTRA-funded robust portable γ/X-ray coincidence detector system (Si-drift and CeBr detectors) developed at PNNL
- Developed a coincident-decay database providing γ/γ and γ/X-ray energies and intensities on an absolute scale.
- Primary motivation is fission-product debris nuclides.

Approximately 3,200 decay-data sets (α, β⁻, ε/β⁺) from ENSDF translated into JSON format





GENESIS

- **New neutron-induced γ/neutron emission spectra are required**
  - Advanced reactor systems
  - Neutron active interrogation
- **Measurement observables coupled with reaction model calculations in forward modeling approach to extract (n,n'γ) cross sections**

Priority	Elements
First	C, N, O, Na, Al, Si, Fe, Cu, Pb, W, U, Pu
Follow-up	He, Li, Be, B, Cl, Cr, Mn, Ni, Ge, Br, Cd, I, Cs, La
Remaining	F, Mg, P, S, Ar, K, Ca, Ti, As, Kr, Mo, Sn, Sb, Xe, Gd, Bi, Np, Am

S. McConchie, et al., Technical Report No. ORNL/TM-2021/1900, 2021.

GENESIS includes HPGe detectors and organic scintillators to enable measurement of double-differential neutron and gamma emission spectra

Organizational Efforts/Contributions:

Nuclear Science Advisory Committee:

- L. A. Bernstein
- NSAC - Nuclear Data Subcommittee Chair: L.A. Bernstein
- NSSC Nuclear Data Summer School, UC Davis, Aug 1 – 12, 2022

Contributions:

- The Tri-laboratory Effort in Nuclear Data (TREND) for Isotope Production, DOE Isotope Program Strategy Meeting, Virtual, April 24, 2022. (L.A. Bernstein)
- The ICTP-IAEA Workshop on Nuclear Structure and Decay Data: Theory, Experiment and Evaluation, October 3 -14, 2022, ICTP, Trieste. (M.S. Basunia)
- Compound-nucleus reactions: (n,γ) and (n,n'γ), NSSC Nuclear Data Summer School, UC Davis, August 2022 (A.M. Hurst)

NSAC has received the first ever *Nuclear Data Charge*

U.S. Department of Energy
and the
National Science Foundation

April 13, 2022

Professor Gail Dodge
Chair, DOE/NSF Nuclear Science Advisory Committee
College of Sciences
Old Dominion University
4600 Elkhorn Avenue
Norfolk, Virginia 23529

Dear Professor Dodge:

This letter is to request that the Nuclear Science Advisory Committee (NSAC) establish an NSAC Sub-Committee to assess challenges, opportunities, and priorities for effective stewardship of nuclear data.

Increasingly, access to accurate, reliable nuclear data plays an essential role in the success of Federal missions such as non-proliferation, nuclear forensics, homeland security, national defense, space exploration, clean energy generation, and scientific research. Data access is also key to innovative commercial developments such as new medicines, automated industrial controls, energy exploration, energy security, nuclear reactor design, and isotope production.

NSAC is requested to develop a strategic plan with prioritized recommendations to guide federal investment in the U.S. Nuclear Data Program (USNDP). This will consist of two separate steps and corresponding reports that will serve as a basis to inform the strategic plan:

1) Assess USNDP Status, which would include the following actions:
   a. Assess and document recent achievements in nuclear data and their impact.
   b. Survey current and future federal and non-federal needs for reliable, accurate, secure, accessible nuclear data.
   c. Assess the role, competitiveness, and importance of the USNDP in an international context.
2) Based on the USNDP Status Report above, provide recommendations for maintaining effective stewardship of nuclear data, which includes the following actions:
   a. Identify challenges for nuclear data stewardship in the future, including identifying and prioritizing the most compelling opportunities to enhance and advance NP stewardship of nuclear data and the impact if those opportunities can be realized.
   b. Describe possible ways the Nuclear Data (ND) community can work to train and retain a diverse, equitable, and inclusive workforce capable of sustaining the U.S. ND enterprise.
   c. Identify access needs for facilities and instrumentation, crosscutting opportunities with other federal programs, and potentially mutually beneficial interactions with other domestic and international stakeholders.

The NSAC Nuclear Data (NSAC-ND) Charge Subcommittee

Person	Org	Person	Org
Friederike Bostelmann	ORNL	Arjan Koning	IAEA/Petten
Mike Carpenter	ANL/Atlas	Ken LaBel & Tom Turflinger	NASA & Aerospace
Mark Chadwick	LANL	Caroline Nesaraja	ORNL
Max Fratoni	UCB	Syed Qaim	Jülich
Ayman Hawari	NC State	Catherine Romano	Aerospace
Lawrence Heilbronn	UTK	Sunniva Siem	Univ. of Oslo
Calvin Howell	TUNL	Artemis Spyrou	MSU
Jo Ressler	LLNL	Etienne Vermeulen	LANL
Thia Keppel	J-lab	Ramona Vogt	LLNL

The subcommittee split into topical groups on Energy, Basic Science Nonproliferation, National Security, Medical and Space Applications

The first NSAC-ND report

Totals: 95 pages, 6 Chapters, 33 figures, 7 tables, 293 references

1. Recent USNDP Accomplishments: 25 items; 23 pages
2. International efforts/collaborations: 4 pages
3. Nuclear Data needs (50 pages): Basic Science (8); Energy (9) including 4 detailed tables; Medical (8); National Security (3); Nonproliferation (8); Space (10).
4. Crosscutting Needs: Workforce Development; Ongoing Fission Evaluation; Accelerated Decay Data Evaluation; Statistical Structure Evaluation; (n,x) data & High energy data (5 pages).

Topics were not covered: fusion, materials damage

Publications/Invited talks

- **Published about 14 articles (FY 2021-22): (Selected ones)**
  - Measurement and Modeling of Proton-Induced Reactions on Arsenic from 35 to 200 MeV - M.B. Fox, *et al.,* Phys. Rev. C **104**, 064615 (2021)
  - β decay of neutron-rich ^{76}Cu and the structure of ^{76}Zn; U. Silwal, …,J.C. Batchelder, et.al; Phys Rev. C. **106**, 044311 (2022).
  - Positron Emission Intensity in the Decay of ^{86g}Y for Use in Dosimetry Studies; M.S. Uddin, S.M. Qaim, …, M.S. Basunia, et. Al.; *Molecules 27*(3), 768 (2022)
  - Current nuclear data needs for applications; Karolina Kolos, …,L.A. Bernstein; Phys. Rev. Res. 4, 021001 (2022).
  - Lawson Criterion for Ignition Exceeded in an Inertial Fusion Experiment. H. Abu-Shawareb et al; Phys. Rev. Lett. 129, 075001 (2022).
- **Invited and contribution talks - 21 (FY 2021-22): (Selected ones)**
  - Improving the double-differential ^{238}U(n,n'γ) cross section using n-γ coincidences". Workshop for Applied Nuclear Data Activities 2022. Virtual. February 5, 2022. (L.A. Bernstein)
  - The Tri-laboratory Effort in Nuclear Data (TREND) for Isotope Production, DOE Isotope Program Strategy Meeting, Virtual, April 24, 2022. (L.A. Bernstein)

Thank you

Questions/Comments