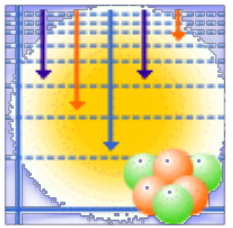
Argonne NATIONAL LABORATORY

Member of the US Nuclear Data Program

Argonne Nuclear Data Program



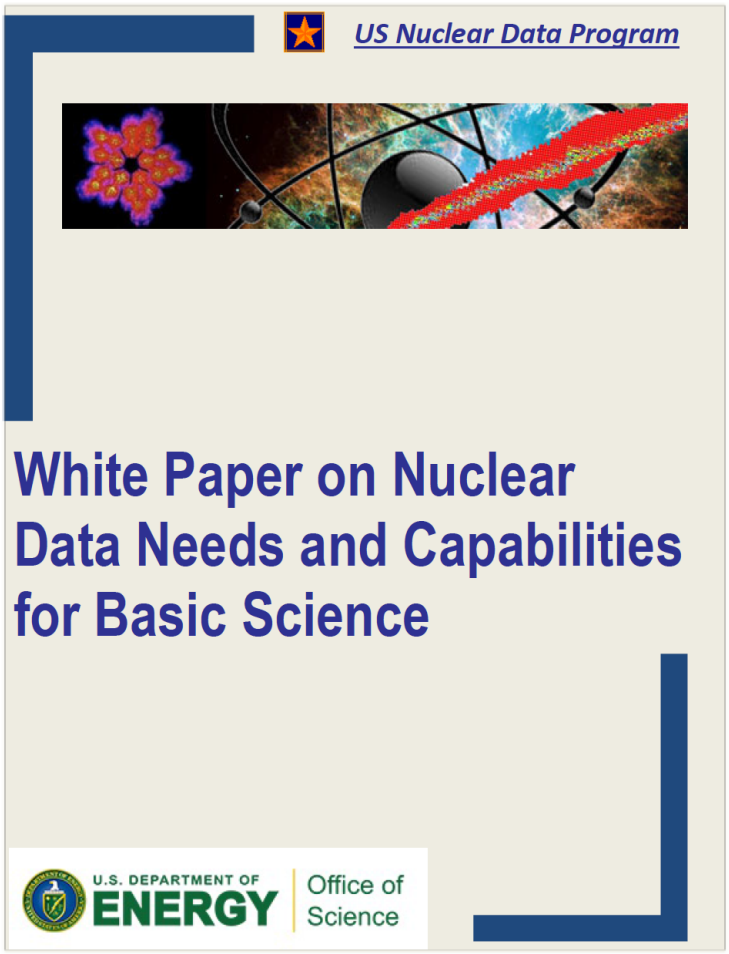
❑ Nuclear Data Compilations & Evaluations

- ✓ nuclear structure compilations and evaluations - **ENSDF & XUNDL**
- ✓ evaluation of atomic masses and nuclear properties - **AME & NuBase**
- ✓ decay data evaluations in support of IAEA-CRP & other horizontal evaluations (nuclear isomers, medical isotopes, nuclear moments etc.)

❑ Complementary ND Research Activities

- ✓ intersections between basic and applied nuclear physics & astrophysics - via collaborative agreements with a little or no cost to USNDP

ND White Paper - Basic Science



arXiv:1705.04637, May 12 2017

ND Workshop

- ✓ University of Notre Dame, August 10-11 2016
- ✓ M. Thoennessen (MSU) reported at the last USNDP

Editors

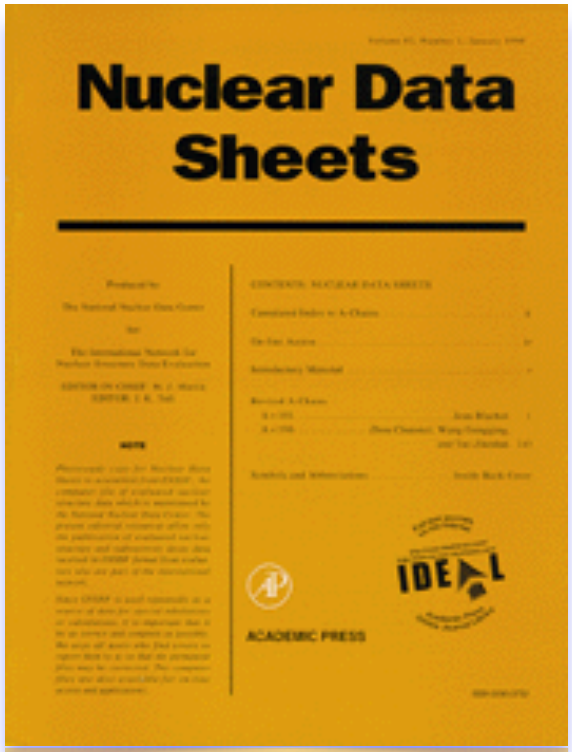
J. Batchelder (UC Berkeley)
T. Kawano (LANL)
J. Kelley (NCSU & TUNL)
F.G. Kondev* (ANL)
E. McCutchan (BNL)
M. Smith (ORNL)
A. Sonzogni (BNL)
M. Thoennessen* (MSU)
I. Thompson (LLNL)

Many Thanks!!!!

ENSDF & XUNDL

ENSDF

- 60 evaluations of individual nuclides were completed & submitted to NNDC
- 1 review was completed
- A=188 was updated following the reviewer's comments and resubmitted to NNDC
- A=177 - work is continuing



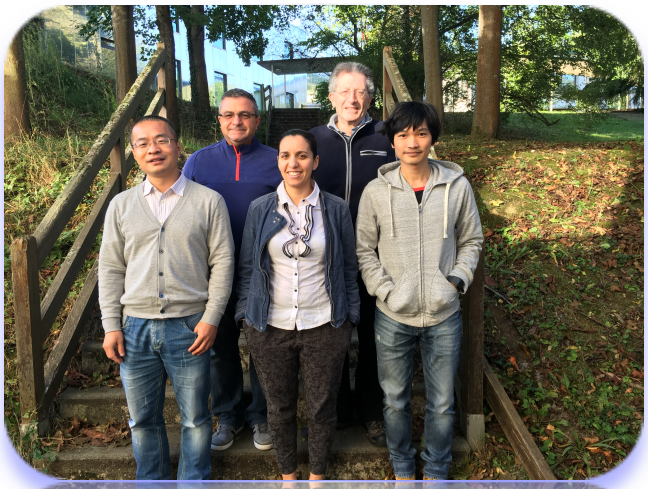
XUNDL

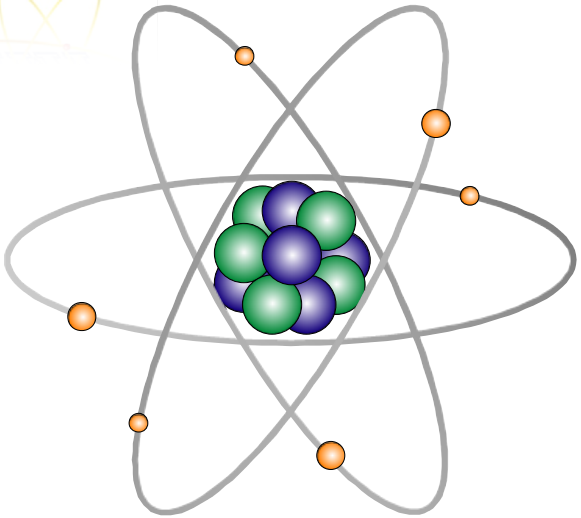
- 13 papers (115 data sets) were compiled & submitted to NNDC

Training & Mentoring

- **new (positive) development** -
  Yuichi Ichikawa (RIKEN) will visit ANL Nov. 6-15, 2017

Atomic Mass Evaluation & NuBase





$= N \cdot$ + $Z \cdot$ + $Z \cdot$

– binding energy

AME2016 & NUBASE2016

- completed and published in March 2017 in Chinese Physics **C**

Nuclear Data Research Activities

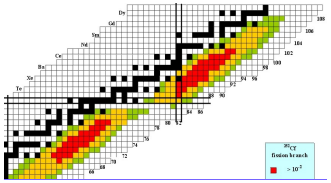
relatively small effort (0.1 FTE) - complements and benefits the evaluation activities - sought after collaborator with little or no cost to USNDP

- at **ANL** - nuclei far from stability, spectroscopy of heavy and super-heavy nuclei, K-isomers, beta-delayed spectroscopy & mass measurements; ***decay spectroscopy*** of actinide nuclei and nuclei of importance to applications of medical isotopes and metrology
  - ✓ **CARIBU** – properties of neutron-rich nuclei (nuclear structure & masses, astrophysics & applications - beta-delayed gamma's and neutrons, independent fission yields & isomeric ratios in fission)

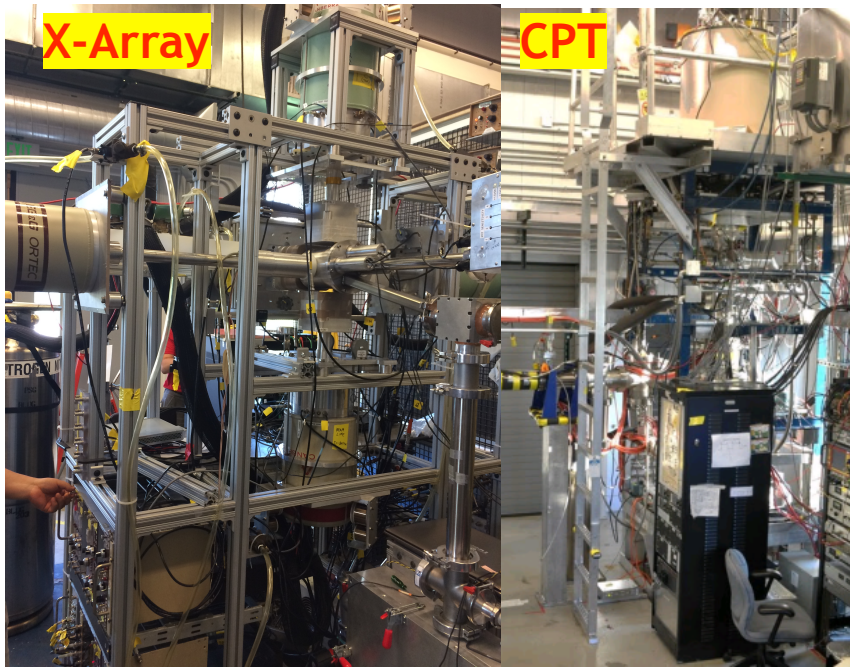
- at **MSU** (Coulex & decay spectroscopy), **TRIUMF** (decay spectroscopy) & **RIKEN** (decay spectroscopy) – properties of neutron-rich nuclei far from the line of stability

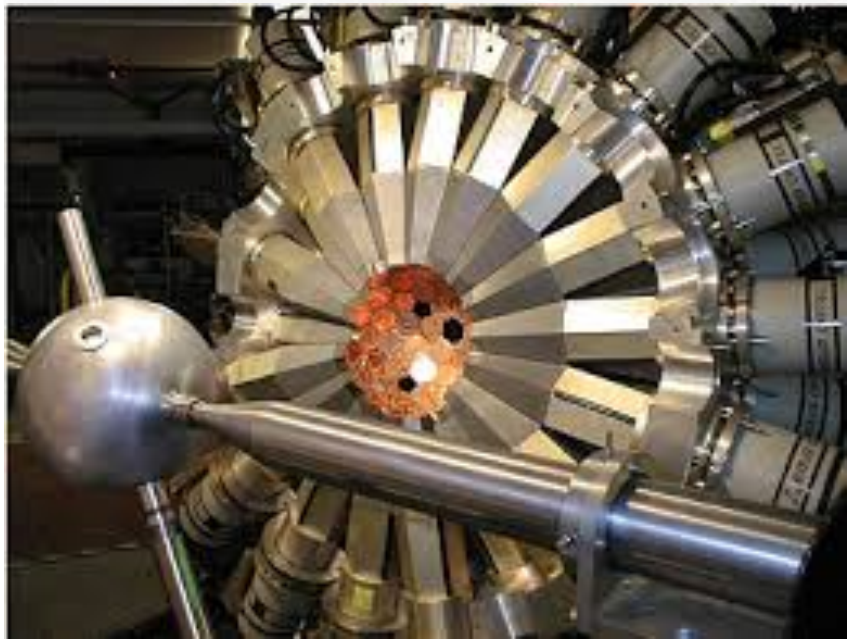
- at **Australian National University** & **RCNP-Osaka** (isomers, astrophysics & medical isotopes physics), at **Jyvaskyla University** (spectroscopy of SHE)

CARIBU@ANL



- SF fission of ^{252}Cf (3.1%) 1.7 Ci - $6.3 10^{10}$ dps
- Gas Catcher, Isobar Separator (m/Δm~10000), MR-TOF (m/Δm~100000)
- LE, high-purity & high-quality beams





- X-Array (5 Ge CLOVERs) & 2 LEPS
- large plastic scintillator
- SATURN moving tape system
- CPT

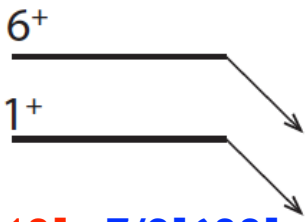
- New beam line - high sensitivity for beta-decay spectroscopy
- Gammasphere upgrade for simultaneous discrete & calorimetric gamma-ray studies

Decay studies of ^{162}Eu

Previous: assuming a single-decaying state

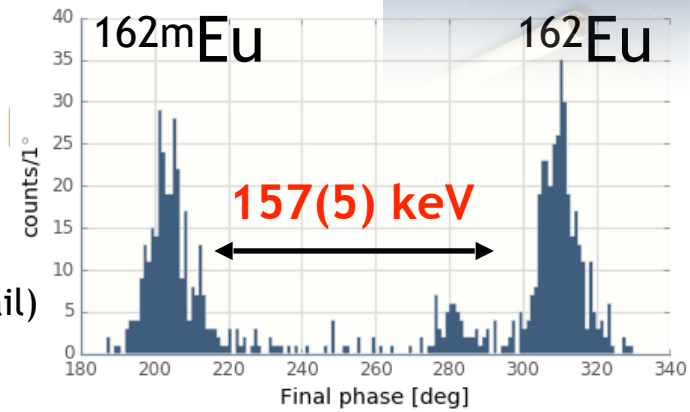
10.6 (1) s from Gd X-rays
Greenwood et al. PRC 35 (1987) 1065

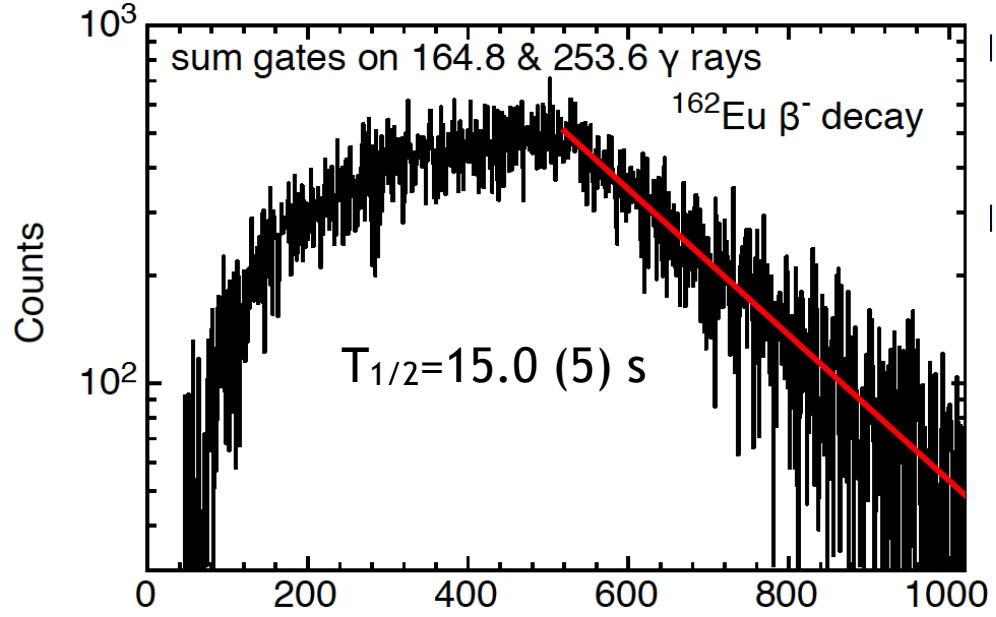
11.8 (14) s from β-decay spectra
Wu et al. PRL 118 (2017) 072701

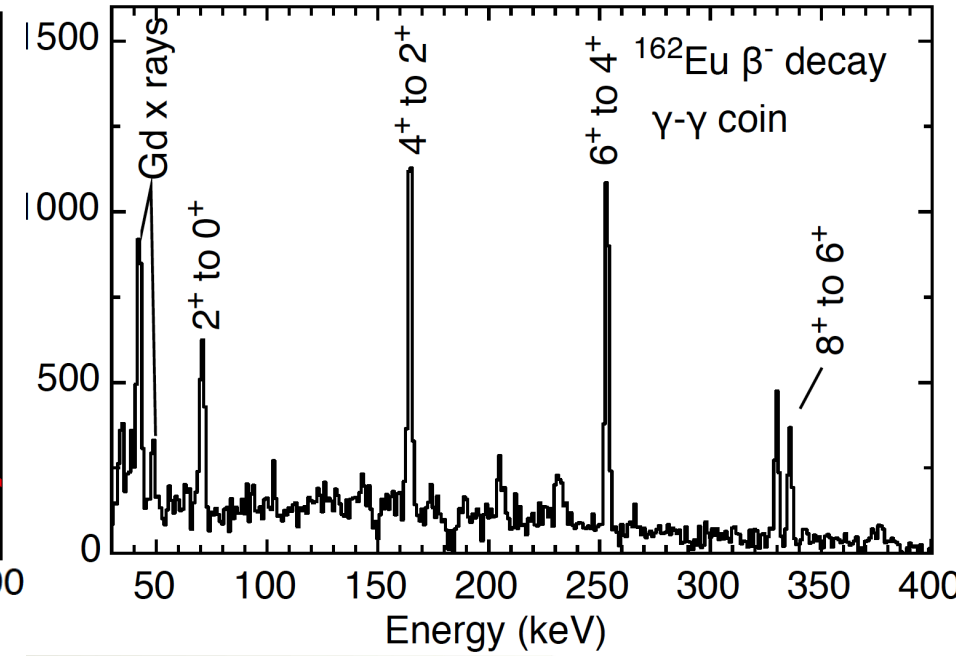


π5/2[413] ν7/2[633]

(deformed shell-model seems to fail)







Implications for data evaluation

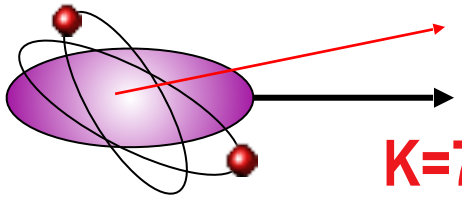
- **beta-decay of deformed nuclei**
  - role of K hindrance

Atomic Data and Nuclear Data Tables 103–104 (2015) 50–105

Configurations and hindered decays of K isomers in deformed nuclei with A > 100

F.G. Kondev [a,*], G.D. Dracoulis [b,1], T. Kibédi [b]

✓ nuclear structure & astrophysics, interpretation of TAGS data, applications (theoretical modeling - Kawano et al.)



K=7

π7/2+[404] ν7/2-[514]

$Q_{\beta-}$ = 1190.2 keV

7^- 3.8x10^{10} y

^{176}Lu

19.9

19.2

log *ft* ~19

ΔK=7

retarded by 10^{14}

π7/2+[404] π9/2-[514]

ν9/2+[624] ν7/2-[514]

8^+ 998

6^+ 597

4^+

2^+ 88

0^+ 0

^{176}Hf

ω i=R

K=0

$Q_{\beta-}$ = 1937 keV

7^- 2.36 h

9^- 1364

8^- 1479

4.8

5.0

log *ft* ~5

ΔK=1

8^-

8^+ 1059

^{178}Ta

6^+ 632

4^+ 307

2^+ 92

0^+ 0

^{178}Hf

Future (FY18 and beyond) Plans

- **Continue contributing to XUNDL & ENSDF - top priority**
  - ✓collaboration with RIKEN on training new data evaluators - there is a good opportunity for bringing new blood into ENSDF; China next???

- **Continue AME & NuBase collaborative activities**
  - ✓ maintain the currency (5-6 yrs cycle) and quality

- **Continue topical collaborations with IAEA-NDS and other ND centers**

- **Continue research activities** with emphasis on nuclear structure physics and astrophysics, and their intersection with the applied nuclear physics
  - ✓ **ATLAS & CARIBU** – nuclear structure, masses & astrophysics, beta-delayed gammas & neutrons, fission yields and isomeric ratios etc.
  - ✓ **NSCL (FRIB), RIKEN & IMP (HIAF)**– nuclear structure, masses & astrophysics