# Secondary distribution update in ENDF/B-VIII.1 -LANL/KAERI evaluation files for 58 isotopes

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## Update procedure

- Updating new angular distributions and energy spectra
  - Adopting cross sections from ENDF/B-VIII.0
    - Cross sections of ENDF/B-VIII.0 for (n,p) and (n,$\alpha$) if data available, where threshold energies are recalculated using mass data by Audi2012 and FRDM2012
  - Adding new data
    - Cross sections of discrete levels and continuum state if no data available, where cross sections of (n,p$_{tot}$) and (n,$\alpha_{tot}$) are normalized to those of ENDF/B-VIII.0.
  - Adding/Replacing new data
    - Angular distributions of discrete levels and continuum state if no data or isotropic data available
    - Exclusive energy spectra if no data or inclusive spectra available.
- Code: CoH$_3$
- Formatting: DeCE
- Processing: NJOY2016
- Simulation: MCNP-6.2

# LANL-KAERI new evaluation ("nzv2") for nz reactions

-new calculations on 62 nuclei, but only 58 isotopes will be updated in ENDF/B-VIII.1 (by excluding Fe isotopes)

-H1 and He4 distributions for MT=600-609 and MT=800-809

-Merge to the ENDF/B-VIII.1 will be completed by April 28, 2023

*"New Evaluation on Angular Distributions and Energy Spectra for Neutron-induced Charged Particle Measurements"* *H.I. Kim, H.Y. Lee, T. Kawano, et al., Nucl. Instr. Meth.* *A 963, 163699 (2020)*

Discrete levels for (n,p)

| Nucleus | nzv1 | nzv2 | en80 | nucleus | nzv1 | nzv2 | en80 | nucleus | nzv1 | nzv2 | en80 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $^{27}$Al | 20 | 20 | 20 | $^{52}$Cr* | 32 | 10 | 0 | $^{65}$Cu* | 31 | 10 | 0 |
| $^{28}$Si | 14 | 14 | 14 | $^{53}$Cr* | 24 | 10 | 0 | $^{64}$Zn* | 40 | 10 | 0 |
| $^{29}$Si | 16 | 16 | 16 | $^{54}$Cr* | 17 | 10 | 0 | $^{65}$Zn* | 40 | 10 | 0 |
| $^{30}$Si | 6 | 6 | 6 | $^{54}$Fe | 34 | 34 | 34 | $^{66}$Zn* | 32 | 10 | 0 |
| $^{31}$Si | 1 | 1 | 1 | $^{56}$Fe | 10 | 10 | 10 | $^{67}$Zn* | 26 | 10 | 0 |
| $^{32}$Si | 1 | 1 | 1 | $^{57}$Fe | 18 | 18 | 18 | $^{68}$Zn | 8 | 8 | 0 |
| $^{35}$Cl | 30 | 30 | 30 | $^{58}$Fe | 17 | 17 | 17 | $^{69}$Zn | 17 | 17 | 17 |
| $^{36}$Cl | 16 | 16 | 16 | $^{56}$Co* | 40 | 10 | – | $^{70}$Zn | 1 | 1 | 0 |
| $^{37}$Cl* | 18 | 10 | 0 | $^{57}$Co* | 30 | 10 | – | $^{73}$As* | 40 | 10 | 0 |
| $^{39}$K * | 35 | 10 | 0 | $^{58}$Co | 40 | 40 | 40 | $^{74}$As* | 40 | 10 | 0 |
| $^{40}$K * | 40 | 10 | 0 | $^{59}$Co* | 27 | 10 | 0 | $^{90}$Zr | 12 | 12 | 12 |
| $^{41}$K * | 30 | 10 | 0 | $^{56}$Ni* | 32 | 10 | – | $^{91}$Zr | 6 | 6 | 6 |
| $^{46}$Ti* | 40 | 10 | 0 | $^{57}$Ni* | 40 | 10 | – | $^{92}$Zr | 1 | 1 | 1 |
| $^{47}$Ti* | 28 | 10 | 0 | $^{58}$Ni* | 40 | 10 | 0 | $^{93}$Zr | 17 | 17 | 17 |
| $^{48}$Ti* | 35 | 10 | 0 | $^{59}$Ni* | 40 | 10 | 0 | $^{94}$Zr* | 10 | 10 | 10 |
| $^{49}$Ti* | 25 | 10 | 0 | $^{60}$Ni* | 40 | 10 | 0 | $^{95}$Zr | 16 | 16 | 16 |
| $^{50}$Ti | 9 | 9 | 0 | $^{61}$Ni* | 40 | 10 | 0 | $^{96}$Zr | 3 | 3 | 3 |
| $^{49}$V | 40 | 40 | 40 | $^{62}$Ni* | 25 | 10 | 0 | $^{107}$Ag* | 40 | 10 | 0 |
| $^{50}$V* | 40 | 10 | 0 | $^{63}$Ni | 26 | 26 | 26 | $^{109}$Ag | 31 | 31 | 31 |
| $^{51}$V* | 35 | 10 | 0 | $^{64}$Ni* | 14 | 10 | 0 | $^{180}$Ta* | 40 | 10 | 0 |
| $^{50}$Cr* | 40 | 10 | 0 | $^{63}$Cu* | 23 | 10 | 0 | $^{181}$Ta* | 36 | 10 | 0 |
| $^{51}$Cr* | 40 | 10 | 0 | $^{64}$Cu | 40 | 40 | 40 | $^{197}$Au* | 32 | 10 | 0 |

* employed different numbers of discrete levels between nzv1 and nzv2

Discrete levels for (n,$\alpha$)

| Nucleus | nzv1 | nzv2 | en80 | nucleus | nzv1 | nzv2 | en80 | nucleus | nzv1 | nzv2 | en80 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $^{27}$Al | 20 | 20 | 20 | $^{52}$Cr* | 40 | 10 | 0 | $^{65}$Cu* | 25 | 10 | 0 |
| $^{28}$Si | 16 | 16 | 16 | $^{53}$Cr* | 40 | 10 | 0 | $^{64}$Zn* | 36 | 10 | 0 |
| $^{29}$Si | 20 | 20 | 20 | $^{54}$Cr* | 35 | 10 | 0 | $^{65}$Zn* | 40 | 10 | 0 |
| $^{30}$Si | 12 | 12 | 12 | $^{54}$Fe | 24 | 24 | 24 | $^{66}$Zn* | 23 | 10 | 0 |
| $^{31}$Si | 15 | 15 | 15 | $^{56}$Fe | 19 | 19 | 19 | $^{67}$Zn* | 40 | 10 | 0 |
| $^{32}$Si | 1 | 1 | 1 | $^{57}$Fe | 39 | 39 | 39 | $^{68}$Zn* | 31 | 10 | 0 |
| $^{35}$Cl | 21 | 21 | 21 | $^{58}$Fe | 10 | 10 | 10 | $^{69}$Zn | 18 | 18 | 18 |
| $^{36}$Cl | 32 | 32 | 32 | $^{56}$Co* | 40 | 10 | – | $^{70}$Zn | 1 | 1 | 0 |
| $^{37}$Cl | 6 | 6 | 6 | $^{57}$Co* | 34 | 10 | – | $^{73}$As* | 40 | 10 | 0 |
| $^{39}$K* | 39 | 10 | 0 | $^{58}$Co | 40 | 40 | 40 | $^{74}$As* | 23 | 10 | 0 |
| $^{40}$K* | 40 | 10 | 0 | $^{59}$Co* | 40 | 10 | 0 | $^{90}$Zr | 9 | 9 | 9 |
| $^{41}$K* | 31 | 10 | 0 | $^{56}$Ni* | 24 | 10 | – | $^{91}$Zr | 40 | 40 | 40 |
| $^{46}$Ti* | 40 | 10 | 0 | $^{57}$Ni* | 25 | 10 | – | $^{92}$Zr | 40 | 40 | 40 |
| $^{47}$Ti* | 40 | 10 | 0 | $^{58}$Ni* | 31 | 10 | 0 | $^{93}$Zr | 27 | 27 | 27 |
| $^{48}$Ti* | 25 | 10 | 0 | $^{59}$Ni* | 40 | 10 | 0 | $^{94}$Zr | 40 | 40 | 40 |
| $^{49}$Ti* | 40 | 10 | 0 | $^{60}$Ni* | 30 | 10 | 0 | $^{95}$Zr | 9 | 9 | 9 |
| $^{50}$Ti* | 26 | 10 | 0 | $^{61}$Ni* | 40 | 10 | 0 | $^{96}$Zr | 10 | 10 | 10 |
| $^{49}$V | 40 | 40 | 40 | $^{62}$Ni* | 27 | 10 | 0 | $^{107}$Ag* | 40 | 10 | 0 |
| $^{50}$V* | 28 | 10 | 0 | $^{63}$Ni | 28 | 28 | 28 | $^{109}$Ag | 2 | 2 | 2 |
| $^{51}$V* | 35 | 10 | 0 | $^{64}$Ni | 1 | 1 | 0 | $^{180}$Ta* | 40 | 10 | 0 |
| $^{50}$Cr* | 40 | 10 | 0 | $^{63}$Cu* | 40 | 10 | 0 | $^{181}$Ta* | 33 | 10 | 0 |
| $^{51}$Cr* | 40 | 10 | 0 | $^{64}$Cu | 40 | 40 | 40 | $^{197}$Au* | 40 | 10 | 0 |

* employed different numbers of discrete levels between nzv1 and nzv2

# Plans for secondary distribution beyond EDNF/B-VIII.1

- LANL-KAERI are working to complete new evaluation based on new experimental LENZ data of Fe-54, Fe-56 and Ni-56, Ni-58, Ni-59, Ni-60
  - will update cross sections for (n,p) $_{MT=103}$, (n,np) $_{MT=28}$, (n,d) $_{MT=104}$, (n,a) $_{MT=107}$, and (n,an) $_{MT=22}$
  - will update differential cross sections of discrete states for protons and alphas in MT=600-609 and MT=800-809
- New evaluation on Fe and Ni is planned to be presented at the 2023 CSEWG.

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