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The TENDL team

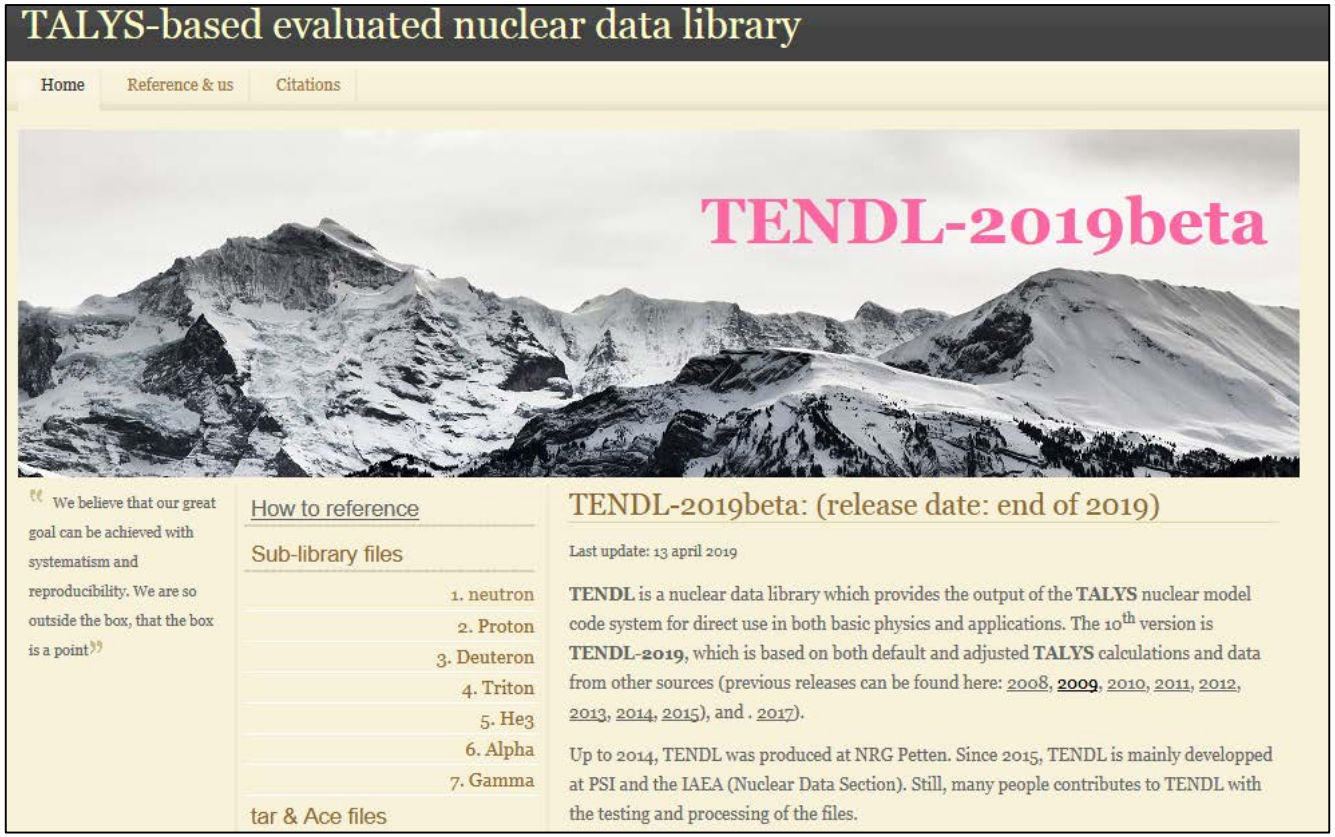
Status and updates: TENDL

WPEC meeting, 27-28 June, 2019, OECD/NEA, Paris, France

Zertifiziertes Managementsystem
STARS
ISO 9001

Summary

- What is TENDL
- What is new



- All slides are available here: https://tendl.web.psi.ch/bib_rochman/presentation.html

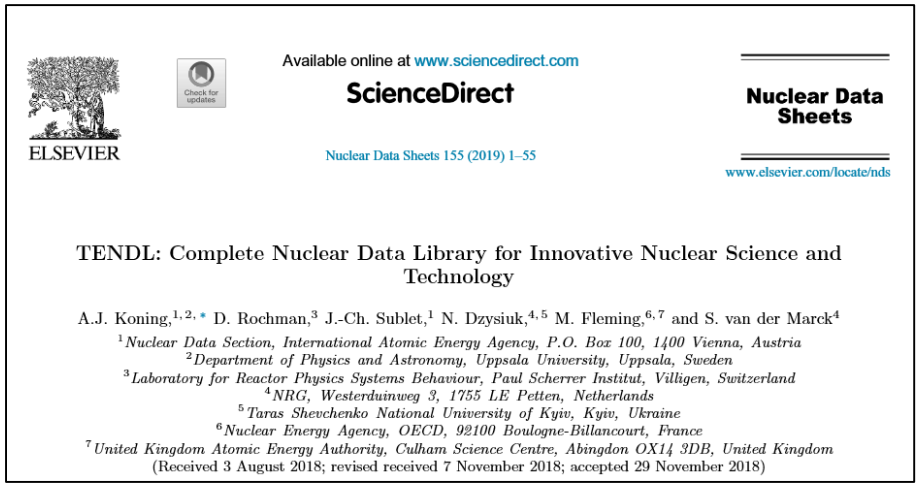
What is the TENDL project ?

- TENDL: TALYS evaluated nuclear data library,
- Goal: improve simulations for TENDL and/or other libraries, or solving

$$0 \leq \chi^2 \leq 1$$

$$\chi^2 = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{C_i - E_i}{\Delta E_i}\right)^2$$

- Available at https://tendl.web.psi.ch/home.html
- Comes from T6 (software package)
- T6 leads to TENDL, TMC, BMC, HFR…
- See for instance NDS 155 (2019) 1



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Available online at www.sciencedirect.com

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Nuclear Data Sheets

Nuclear Data Sheets 155 (2019) 1–55

www.elsevier.com/locate/nds

TENDL: Complete Nuclear Data Library for Innovative Nuclear Science and Technology

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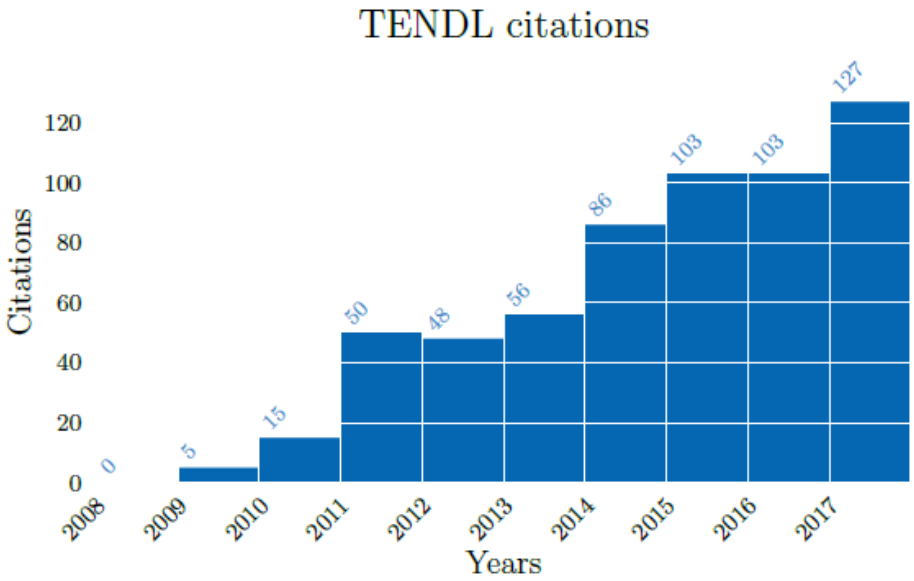
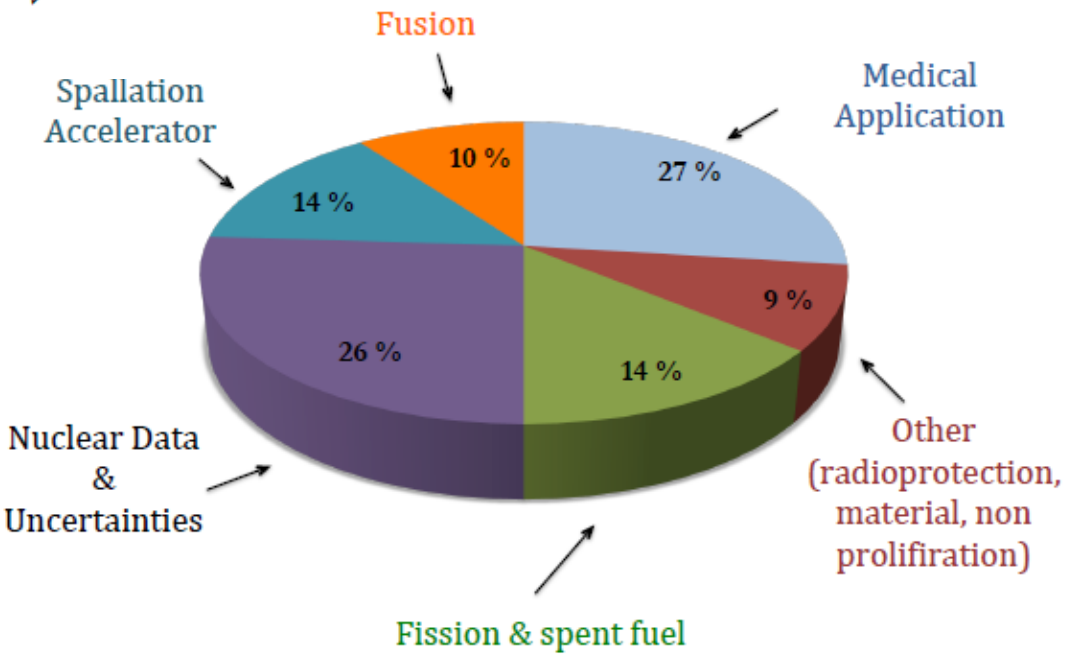
What is the TENDL project ?

- TENDL is in fact a by-product of a series of codes,
- This is one fundamental difference with other libraries (no manual work),
- It allows to perform „TMC“ for Total Monte Carlo (uncertainty propagation)
- Methods: reproductibility & completeness, development of a portable system, and making use of the knowledge included in other libraries (JEFF, ENDF/B, JENDL),
- Background: theoretical calculations (TALYS) with experimental inputs, with original resonance evaluations,
- Impact:
  - TENDL-2008 to 2017 (2800 isotopes),
  - Neutrons, protons, deuterons, tritons, He3, alpha and gamma induced,
  - all isotopes, all cross sections with covariances, 0-200 MeV,
  - more than 300 isotopes in the NEA JEFF-3.3 library,
  - more than 50 isotopes in the US ENDF/B-VIII.0 library,
  - more than 450 publications using TENDL

What is the TENDL project ?





TENDL-2019, what is new ?

- To be release at the end of 2019
- Mainly developed between IAEA and PSI

- Beta versions already available (https://tendl.web.psi.ch/tendl_2019/tendl2019.html)

- Similar structure as the previous TENDL
  - 2813 isotopes, 200 MeV, with covariances
  - Neutrons, protons, deuterons, tritons, He3, alphas, and gammas

- New and simplified T6 available “on demand”

- TALYS-1.95 (above resonances)
- TARES-1.4 (resonances)
- NJOY-2016
- PREPRO-2018
- Other codes/tools

- New “library” database (comparisons, import…)

TENDL-2019, what is new ?

- New T6:
  - Newest code versions,
  - more verifications,
  - Linux RedHat/Mac,
  - tested with latest compilers

- Similar structure as the previous TENDL libraries
  - 2813 isotopes, 200 MeV, with covariances
  - Neutrons, protons, deuterons, tritons, He3, alphas, and gammas
  - ACE (PURR for all isotopes, gamma production (iopp=1) included)?
  - ENDF-6 files in different options (MF3 MT5 at 0, 20 or 60 MeV)
  - EAF files
  - MF32 and/or MF33
  - Input files
  - Random files

TENDL-2019, what is new ?

- TALYS-1.95/TEFAL

  - Improved photon strength function: Simplified Modified Lorenzian (better estimated of neutron capture c.s.)

  - 30 MeV spectrum problem found by Kwon/Konno solved

  - Improvement of specific nuclides (esp. Ni isotopes)

  - Includes correct isomeric branching ratios for thermal neutron capture cross sections, *e.g.* ^{93}Nb(n, gamma)^{94m}Nb (~50 cases)

  - Isomeric production of discrete level number > 30 implemented, solves remaining decay heat problems from CCFE benchmarks

TENDL-2019, what is new ?

- TARES-1.4: resonance formatting and analyzing tool

- Measured/compiled/evaluated resonances:
  - Based on latest JENDL-4.0, ENDF/B-VIII.0 and JEFF-3.3
  - Based on the latest Atlas, 6th edition (2018)

- Statistical resonances:
  - Based on CALENDF
  - Translating the unresolved range from TALYS into statistically resolved range
  - Consistency between the RRR, URR and fast range

- Covariances in MF32 and MF33
  - Consistency between both format
  - Consistent with the random files (using the ENDSAM from IJS)

Conclusion and future

- The TENDL library is improving year after year, TENDL-2019 being (hopefully) a better set

- The new T6 code package allows to produce TENDL, random files and to go further,

- Still, as proven by distributing T6, many improvements are necessary

- Good example for the future expert group on “Modern Nuclear Data Evaluation Methods”

- Future:
  - TENDL based on TALYS-2.0
  - Include reaction data not yet in TENDL
    - Evaluated Gamma-ray Activation File (EGAF)
    - Prompt Fission Gamma Spectra
  - Produce FY library at every release
  - Correct TALYS, experiments and linearity: GP+ MLO + LM from UU

  (Gaussian process + Marginal Likelihood Optimization + Levenberg-Marquardt
  UU: Uppsala University)

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Wir schaffen Wissen – heute für morgen