



D. Rochman

SANDA task 4.1: Nuclear reaction code developments and evaluations



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**SANDA – general meeting, via remote connection, 9-11 March
2022**

Task 4.1

Task 4.1: Nuclear reaction code developments and evaluations

Task coordinator: PSI, partners: CEA/DAM/DIF, CEA/DEN, PSI, CNRS/IPHC, TUW, UB, UU

Task 4.1.1: TALYS development

Task 4.1.2: Nuclear reaction evaluation

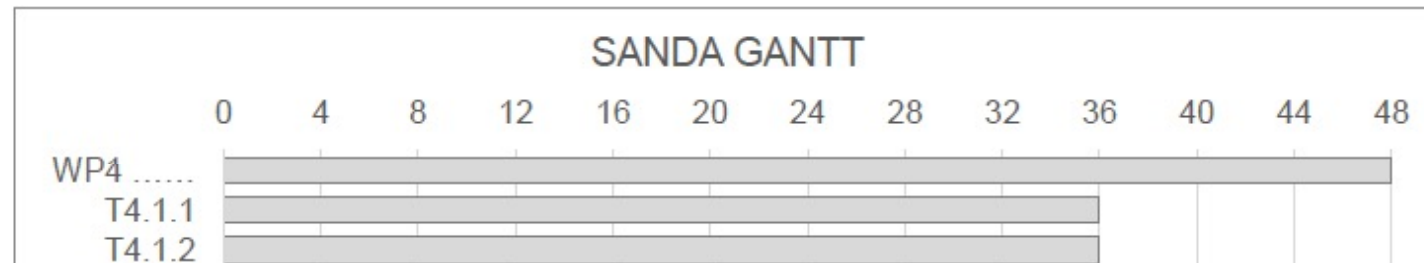


Table 3.1c: List of Deliverables⁴

4.1	Report on code development, methods	4	PSI	R	PU	40
4.2	Report on new nuclear reaction data evaluation	4	CEA	R	PU	48

T0: September 2019

T36: August 2022

T40: December 2022

T48: August 2023

Task 4.1

Task 4.1: Nuclear reaction code developments and evaluations

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Task 4.1.1: TALYS development

Task 4.1.2: Nuclear reaction evaluation

Table 3.2a: List of milestones

Milestones:				
M.4.1: availability of TALYS modules (CEA/DAM/DIF): M32				
M.4.2: availability of new EMPIRE modules/models (UB): M32				
M.4.3: availability of evaluated files for important actinide isotopes (CEA/DEN, CNRS): M32				
M.4.4: availability of evaluated files for important fission products (CEA/DEN, PSI): M36				
4.1	Availability of TALYS modules	4	32	Short communication
4.2	Availability of new EMPIRE modules/models	4	32	Short communication
4.3	Availability of evaluated files for important actinide isotopes	4	32	Presentation or ENDF file

T0: September 2019

T32: May 2022

T36: August 2022

Subtask 4.1.1: “TALYS development”

- PSI/IAEA:
 - New version of TALYS released in December 2021
 - New evaluation tool (T6) developed with various partners

TALYS-based evaluated nuclear data library

Home Reference & us Citations Feedback TALYS



TENDL-2021

“ We believe that our great goal can be achieved with systematism and reproducibility. We are so outside the box, that the box is a point!”

How to reference

Sub-library files

1. Neutron
2. Proton
3. Deuteron (updated)
4. Triton
5. He3
6. Alpha
7. Gamma
8. Fission yields
9. Thermal scattering

Application libraries & tar files (ENDF, GND, ACE, PENDF...)

V&V

1. FISPACT-II reports
2. FISPACT-II validation

TMC files

3. Random ENDF-6 files from other libraries
4. Random ACE files based on ENDF/B-VII.1
5. Random ACE files based on TENDL
6. Random ENDF files based on TENDL

TENDL-2021: (release date: December 30, 2021)

Last update: February 23, 2022

TENDL is a nuclear data library which provides the output of the TALYS nuclear model code system for direct use in both basic physics and applications. The 11th version is TENDL-2021, which is based on both default and adjusted TALYS calculations and data from other sources (previous releases can be found here: [2008](#), [2009](#), [2010](#), [2011](#), [2012](#), [2013](#), [2014](#), [2015](#), [2017](#) and [2019](#)).

Up to 2014, TENDL was produced at NRG Petten. Since 2015, TENDL is mainly developed at PSI and the IAEA (Nuclear Data Section). Still, many people contribute to TENDL with the testing and processing of the files.

TENDL contains evaluations for seven types of incident particles, for all isotopes living longer than 1 second: Z=1 ¹H to Z=115 ²⁹⁵Mc (about 2800 isotopes), up to 200 MeV, with covariances.

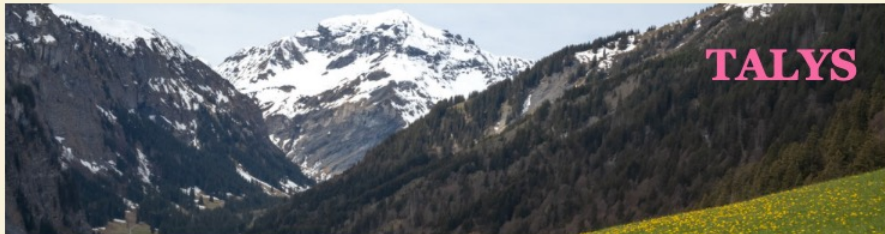
TENDL is **not** a default or shadow library. Not a single neutron evaluation is based on default calculations. With the HFR approach, all resonances follow statistical hypothesis. For major isotopes, greater care was used during the evaluation process.

All TENDL-2021 neutron files are original except 24. The 24 following files are taken from JEFF-4.0To: ^{1,2,3}H, ^{3,4}He, ^{6,7,11}B, ^{10,11}B, ^{7,9}Be, ^{12,13}C, ^{14,15}N, ^{16,17,18}O, ¹⁹F, ^{23,24}Th, ^{233,235,238}U and ²³⁹Pu.

A set of tools, called T6, was used to produce it. T6 stands for TALYS, TEFAL, TASMAN, TARES, TAFIS and TANES. Each code produces a part of the library. Processing tools such as NJOY, CALENDF, PREPRO are also used in T6. These codes, and the processing steps are developed by A.J. Koning, D. Rochman and J.Ch. Sublet. Still, the help and feedback of the whole nuclear data, processing and user community is extremely useful. TENDL would not exist without the constructive remarks from all over the world.

TALYS

Home Reference & us Citations Feedback TALYS



TALYS

“ Completeness & quality”

Authors:
A. Koning
S. Hilaire
S. Goriely

Download the TALYS package

1. TALYS-1.96 (1.22 Gb)
2. TALYS-1.95 (1.10 Gb)
3. TALYS-1.9 (858 Mb)
4. TALYS-1.8 (882 Mb)
5. TALYS-1.6 (630 Mb)
6. TALYS-1.4 (404 Mb)
7. TALYS-1.2 (403 Mb)
8. TALYS-1.0 (252 Mb)

TALYS versions by others:

Special version with GDH model

TALYS-1.96: (release date: December 30, 2021)

Last update: 30 december 2021

TALYS is an open source software package (GPL license) for the simulation of nuclear reactions. TALYS has been developed at

- NRG Petten, the Netherlands
- CEA-Bruyeres-le-Chatel, France
- University of Brussels, Belgium
- International Atomic Energy Agency, Vienna

Under linux, use the command 'tar xvf talys.tar' to unzip and untar the TALYS package.

The total TALYS package is in the talys/ directory and contains the following directories and files:

- README outlines the contents of the package and all installation details
- talys.setup is a script that takes care of the installation
- source/ contains the source code of TALYS
- structure/ contains the nuclear structure database
- doc/ contains the documentation
- samples/ contains input and output files of sample cases

Arjan Koning

Subtask 4.1.1: “TALYS development”

TALYS

TALYS-Related Software and Databases

TALYS and the TALYS-related packages are open source software and datasets ([GPL License](#)) for the simulation of nuclear reactions.

TALYS

Arjan Koning, Stephane Hilaire, Stephane Goriely

Nuclear reaction model code.

- Download [TALYS-1.96](#)
- Download [previous versions](#)
- Read Tutorial

Created at    UNIVERSITE LIBRE DE BRUXELLES  IAEA

EXFORTABLES

Arjan Koning

Experimental nuclear reaction database based on EXFOR.

- Download [EXFORTABLES-1.0](#)
- Read Tutorial

RESONANCETABLES

Arjan Koning, Dimitri Rochman

Database for thermal cross sections, MACS and average resonance parameters.

- Download [RESONANCETABLES-1.0](#)
- Read Tutorial

Created at  IAEA  PSI

ENDFTABLES

Arjan Koning

Code to translate ENDF nuclear data libraries into tabular format.

- Download [ENDFTABLES-1.0](#)
- Read Tutorial (Chapter 2)

Libraries-2020

Arjan Koning

Evaluated nuclear data libraries and EXFOR in tabular format.

- Libraries-2020 [15GB]
- Read Tutorial (Chapter 3)
- View [Data Explorer](#)

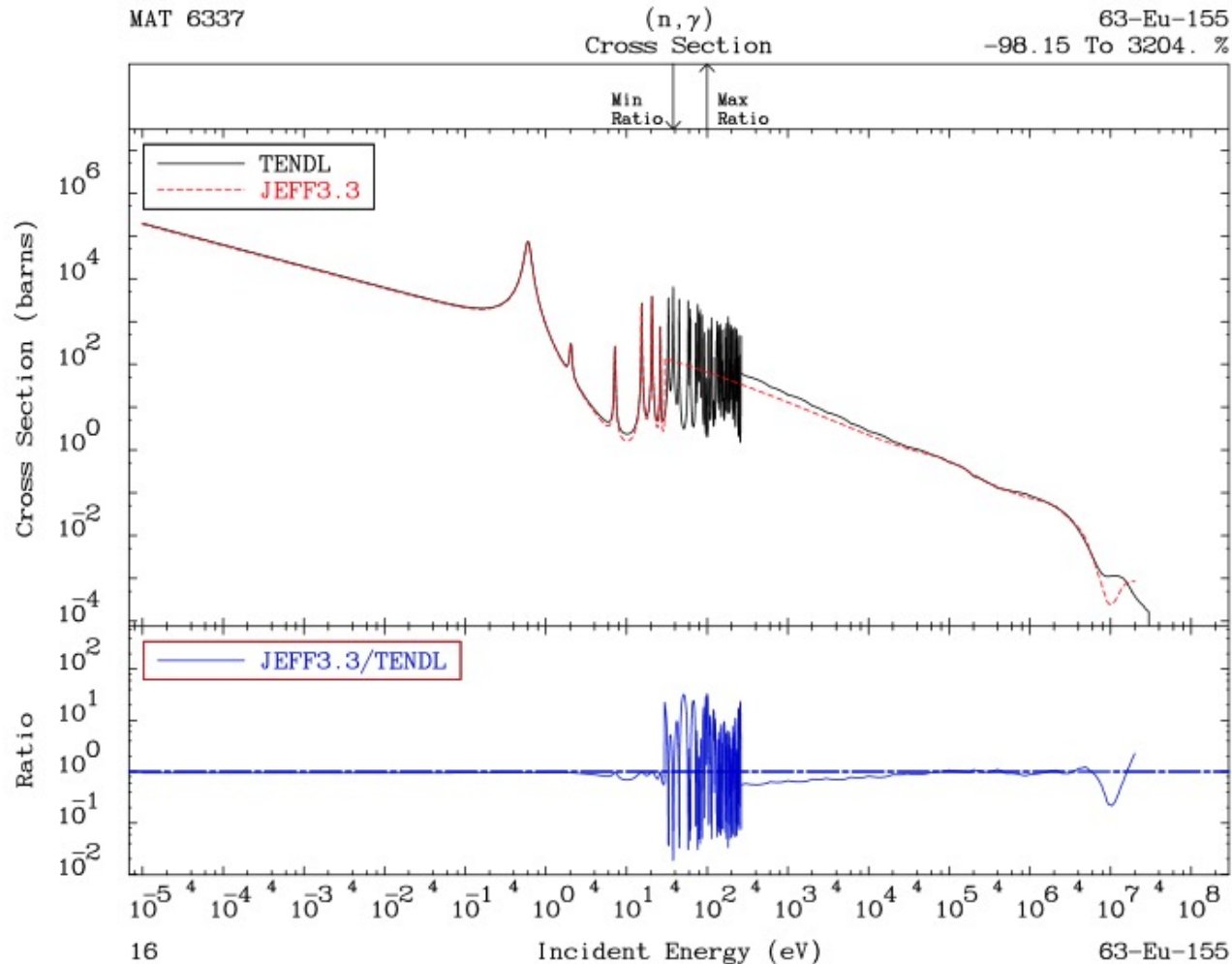
- <https://nds.iaea.org/talys/>
- EXFORTABLES: formatted
- experimental data for automatic
- use (plots, fit)
- RESONANCETABLES: ready to
- use resonance tables
- ENDFTABLES: ready to use x-y cross
- sections
- Libraries-2020: systematically
- processed data libraries

Subtask 4.1.1: “TALYS development”

- CEA DAM/CEA DEN/CNRS/IPHC
 - TALYS: Implementation of Engelbrecht-Weidenmüller transformation done .. test and validation underway
 - JLM/QRPA pre-equilibrium based spin rule + Update of QRPA tables
 - Postdoc Work on statistical decay of Fission fragments with TALYS (debugging/implementation/validation in TALYS)
 - Work on ^{238}U evaluation is scheduled for may/june (related to IPHC measurements+CEA-DEN collaboration)
 - 1st results on ^{239}Pu uncertainties with MCMC (towards a reference calculation).
 - PhD work started at IPHC and CEA DAM/DEN (measurements+evaluations)

Subtask 4.1.1: “TALYS development”

- PSI/IAEA/CEA: New evaluations for JEFF-4 and TENDL
 - Xe135, Cs133, Ag107, Ag109, Eu151, Eu153, Eu154, Eu155, Lu173, Lu175, Lu176, Pm148m and Pu238



Subtask 4.1.1: “Light elements”



SANDA WP4

Development of Nuclear Data Evaluation Technique for Light Nuclei

Status of Work performed by
Nuclear Data Group at TU Wien, Austria
H. Leeb, B. Raab, T. Srdinko

H. Leeb
February 8, 2021

Development of Nuclear Data Evaluation Technique for Light Nuclei – Status Report
1st Annual Meeting, Project SANDA

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H. Leeb
February 8, 2021

Development of Nuclear Data Evaluation Technique for Light Nuclei – Status Report
1st Annual Meeting, Project SANDA



Evaluation for Light Systems

Nuclei are not satisfactory at present
very accurate for evaluation
range, of limited use only at high energies
resonance region is still not established
evaluation technique for light nuclear systems

ure

Evaluation update based on observables
based on modified GLS technique for large
scale evaluations proposed by Schnabel&Leeb

Uncertainty information: determination
of covariance matrices including model
defects based on Gaussian processes for
resonance and high-energy region using
the prior covariance matrix of the unified
Bayesian evaluation procedure

$$A_0(E, E') = f(E, E') A_0^{\text{RMat}}(E, E') + [1 - f(E, E')] A_0^{\text{TALYS}}(E, E')$$

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Status of work performed

main work performed in 2020

- 1) Modification of moduls of GENEUS to accommodate various types of observables (integral, differential cross sections, ...) considering all subchannels associated with the same compound nucleus
 - solved for integral and most angle differential data,
 - some open problems for double-differential data
- 2) Automatic determination of a consistent set of observables with regard to sum rules, integral relations and other dependencies
 - solved for integral and angle-differential data,
 - further work required for double differential and breakup data
- 3) Implementation of the Large Scale Bayesian GLS algorithm developed at TU Wien
 - a prototype of an extended module for GENEUS is under construction, but its completion requires the completion of point 2).
- 4) Construction of a module for the generation of the prior information based on calculations with TALYS and GECCOS in terms of the Large Scale GLS algorithm
 - at present only preparatory analytical work has been performed
 - numerical implementation is envisaged for this year.

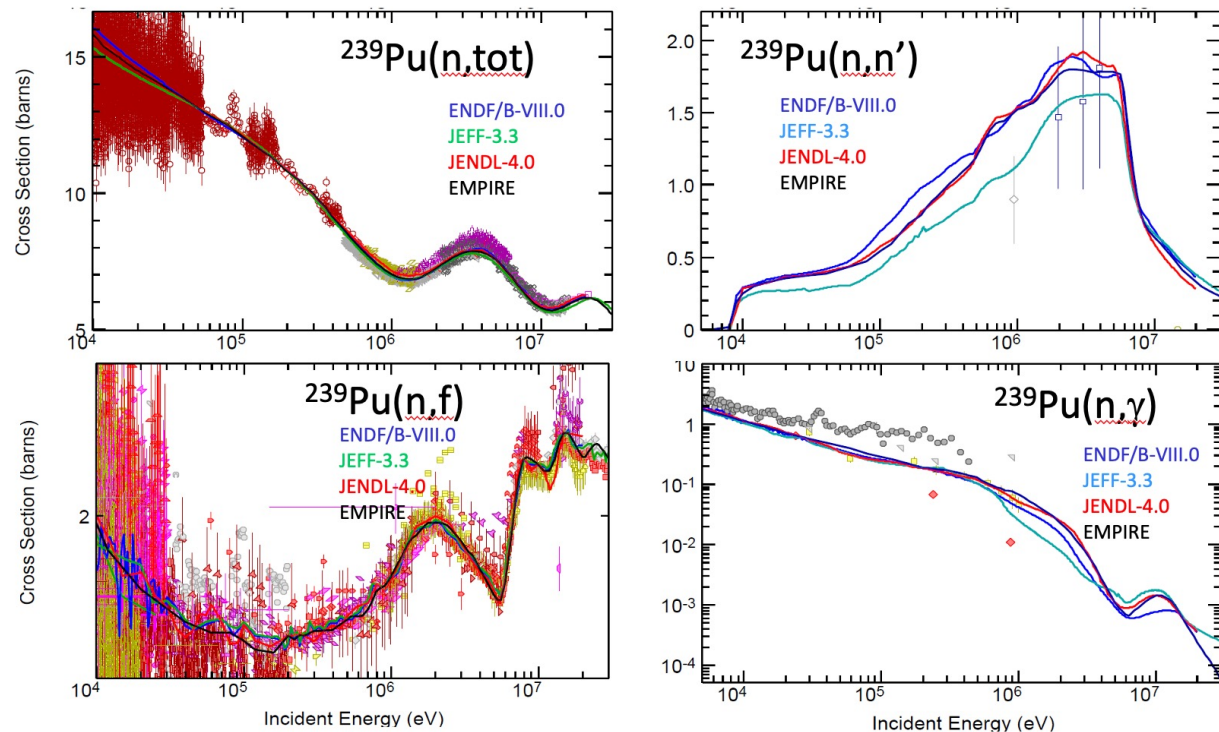
Apart from these points there are efforts to develop a proper data system allowing for efficient storage and in- and output of experimental, intermediate and evaluated data.

Subtask 4.1.1: “EMPIRE developments”

- UB:
 - Full and consistent model calculations for the neutron induced reaction data on ^{238}Pu - ^{242}Pu isotopes for the incident energy range 0.01-30 MeV. These model calculations will represent the starting point for new evaluations performed by an IAEA collaboration.

UB –Task 4.1

Preliminary model calculations for n+ ^{239}Pu cross sections



Plans/conclusions

- All participants have started their work, with slight delays (PhD work with experimental data)
- Very good collaboration between partners, and with outside collaborators (other evaluator communities, JEFF, TENDL, IAEA, ENDF)
- Participations to (online) meetings and support for future library releases

