

# Improving the next TENDL library for fusion

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- ① Past activities in FPA-168.01:  
     $\implies$  *Task 6.2*
- ② Background:  
     $\implies$  *the TENDL-2011 library*
- ③ Future activities:  
     $\implies$  *TENDL-2013 and beyond*

Objective of FPA-168.01: to generate a consistent TENDL based general purpose/activation sub-library for Fe, Cr, W, Mn Ta, V, Mn (major Eurofer constituents) and demonstrate/prove consistency of the produced data with EAF data for activation and JEFF data for neutron transport.

### Activities:

1. Report on TENDL's unification methodologies and format, and processing aspects (NRG & CCFE),
2. Generation and delivery of unified TENDL-2011 base library (NRG & CCFE),
3. Processing and delivery of applications libraries for transport and activation from TENDL-2011 neutron library (CCFE).
4. **V& V: of modelling capabilities on the Eurofer constituents Fe, Cr, W, Ta, V, Mn including differential excitation function comparisons (NRG)**

⇒ report delivered in December 2013 and TENDL-2011 released in December 2011.

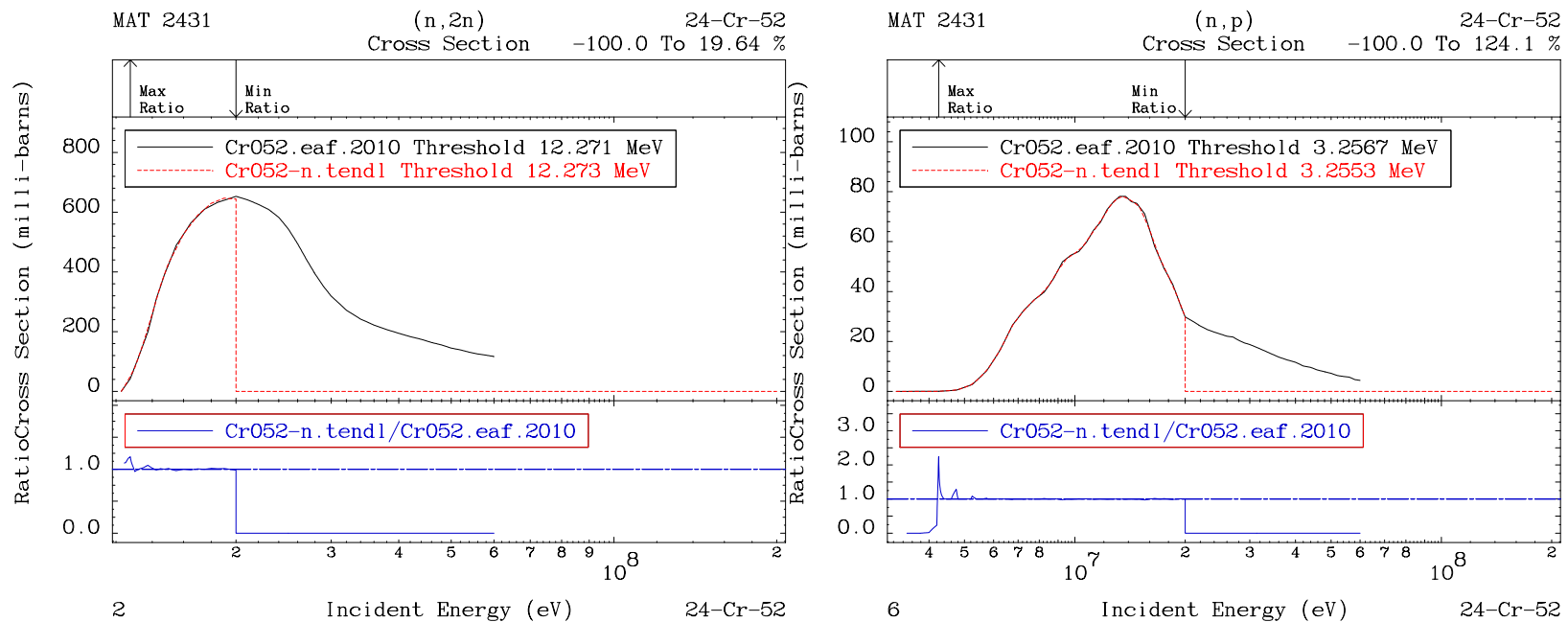
# TENDL-2011: Importing other cross sections: *autonorming*



The *autonorming* capability of the TALYS system is a key functionality in this project (see EFF-1219 for details).

In practice, this functionality needs care to be properly implemented. In this work, it is extensively used to reproduce cross sections from the EAF-2010 library.

**Main drawback:** it is not possible to obtain "better" results than the autonormed library.



## Conclusions of FPA-168.01 (NRG point of view)

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- ➡ TENDL-2011 was largely improved compared to the last releases,
- ➡ Development of a "unified format" (with processing),
- ➡ V& V work performed by CCFE and NRG has shown good performances for fusion application (on the differential level),
- ➡ Validation with the activation database (J. Kopecky's work) has shown global good results,
- ➡ Large amount of adjusted and autonormed cross sections.

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- 
- ✌ But still a lot needs to be done to "outperform" EAF-2010,
  - ✌ more adjustments of TALYS parameters,
  - ✌ less autonorms, better modeling,
  - ✌ validations with activation measurements and with EAF-2010,
  - ✌ and more...

# Future work




Within FPA-168.02, the following will be achieved:


- ➔ Study of the integration of the GDH model and deuteron break-up model in TALYS,
- ➔ Priority list for improvements to fusion relevant activation cross sections,
- ➔ Use the above list to improve the TENDL library.



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Asian Nuclear Prospects 2010


**Nuclear Science and Data Needs for Advanced Nuclear Systems**

R.A. Forrest

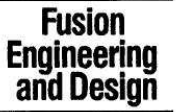
*International Atomic Energy Agency, Vienna International Centre, P.O. Box 100, A-1400 Vienna, Austria.*



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[www.elsevier.com/locate/fusengdes](http://www.elsevier.com/locate/fusengdes)

Data requirements for neutron activation  
Part I: Cross sections

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Available online 28 February 2006

## Example of possible improvements without *autonorming*



Preliminary work obtained by adjusting TALYS parameters and using the above mentioned references.

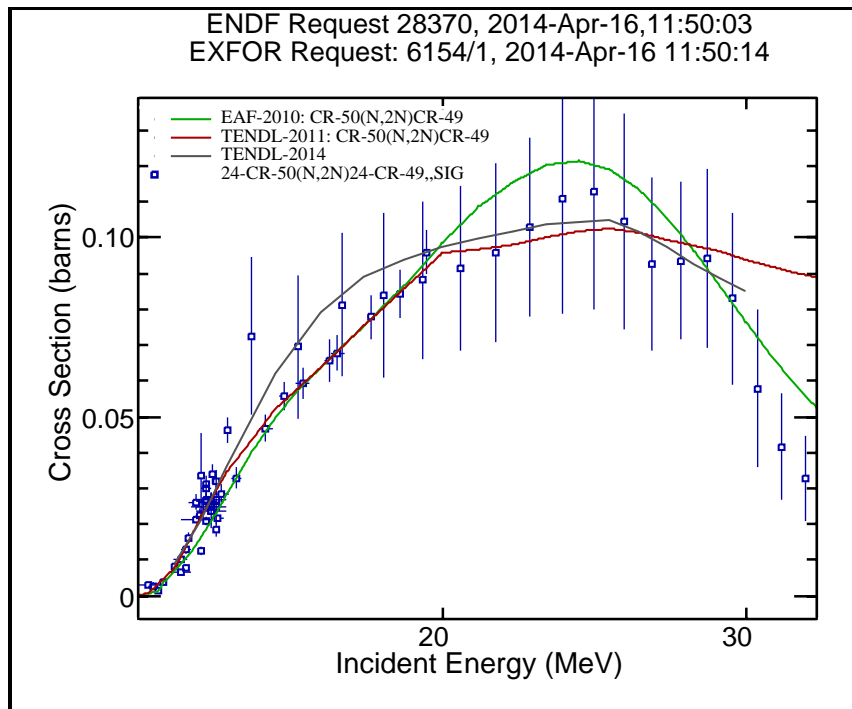
reaction	Spectrum	C/E	
		EAF-2010	TENDL-2014
$^{48}\text{Ca}(n,2n)$	fns_7hour	0.88	1.08
$^{45}\text{Sc}(n,2n)$	fns_5min	1.07	0.95
	fns_ScSmGd	1.63	1.45
$^{90m}\text{Zr}(n,p)$	fns_heat5	1.2	1.2
	Cf252_flux1	1.37	1.15
$^{94}\text{Zr}(n,p)$	fns_5min	1.03	1.00
$^{124m}\text{Sn}(n,2n)$	fns_5min	1.15	1.04
	fns_Sn	0.88	0.88
$^{150}\text{Sm}(n,p)$	fng_ScSmGd	1.24	0.92
$^{158}\text{Gd}(n,p)$	fng_ScSmGd	1.17	0.90
$^{158}\text{Gd}(n,\gamma)$	fng_ScSmGd	2.00	1.34
$^{156}\text{Dy}(n,2n)$	fng_Dy	1.12	1.08



# Example of possible improvements without *autonorming*



$^{50}\text{Cr}$  cross sections were extensively validated for EAF-2010: (n,2n), (n, $\gamma$ ), (n,p)....  
 We can adjust TALYS parameters to obtain better cross sections and C/E.



Spectrum	C/E	
	EAF-2010	TENDL-2014
fng_vanad	0.79	0.99
fng_Cr	0.73	0.92
fzk_ss316	0.76	0.72
fzk_ss316	0.74	0.70
rez_DF	0.98	0.95
rez_DF	0.79	0.77
fns_5min	0.51	0.77

What can be done in the next grant ?

- ☞ Include better physical model in TALYS (**task 5.1**)
  - ⇒ (1) GDH model from KIT (pre-equilibrium),
  - ⇒ (2) deuteron break-up model from IFIN-HH.

This task is related to KIT and IFIN-HH: important for the distribution and sustainability of these models

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And later (next grant), shall we include uncertainties ? (and their validation)