Status report on the V& V analyses

D. Rochman, A.J. Koning and J.C. Sublet

NRG, Petten, The Netherlands,

CCFE, Culham, U.K.

EFF meeting, Paris, France, April 2013

Contents

① Activities in FPA-168.01:

$\Longrightarrow$ *Task 6.2*

② Background:

$\Longrightarrow$ *TENDL libraries*

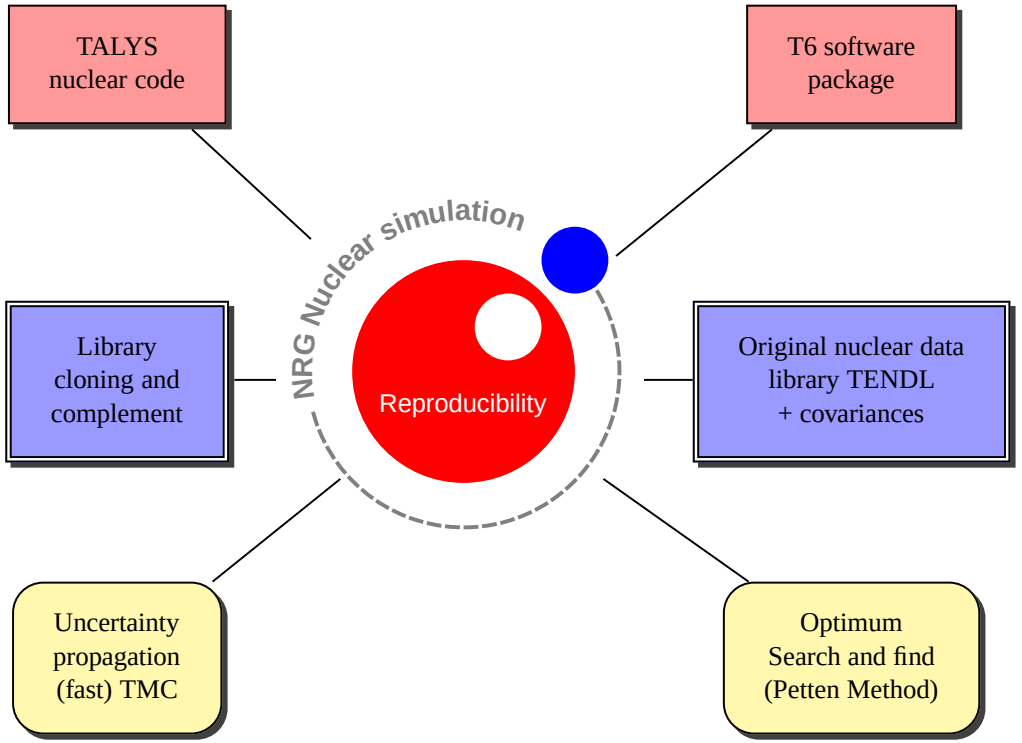
③ Development:

$\Longrightarrow$ *cross section comparison*

④ Process feedback

⑤ Random (evaluations+experiments)

⑥ Conclusions



Task 6.2

Objective: 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)

Last activity: to be delivered by the end of 2013.

Background: TENDL-2011/2012 (www.talys.eu/tendl-2012)

- Collaboration between NRG, CCFE, JUKO Research, Uppsala University, IAEA/NDS, CEA Bruyeres-le-Châtel and Vattenfall
- Neutrons: 2435 ENDF files (200 MeV, MF1-15 and MF31-40), plots, ACE, EAF, processed files
- random files (do your own Total Monte Carlo)
- Based on TALYS + automatic normalization
- Imported files: ^{1,2,3}H, ^{3,4}He, ^{6,7}Li, ^{9}Be, ^{10,11}B, ^{nat}C, ^{14,15}N, ^{16}O, ^{19}F, ^{235,238}U, ^{239}Pu

- Default: Global calculations by TALYS-1.48 and TARES (resonances) which are overruled by
- Adjusted TALYS calculations (340 input files) and Resonance Atlas-based TARES calculations which are overruled by
- TALYS-normalization to 200 (experimental) evaluated reaction channels from other libraries (e.g. IRDFF, light nuclides, main channels of the big 3)

Background: TENDL-2011/2012 (www.talys.eu/tendl-2012)

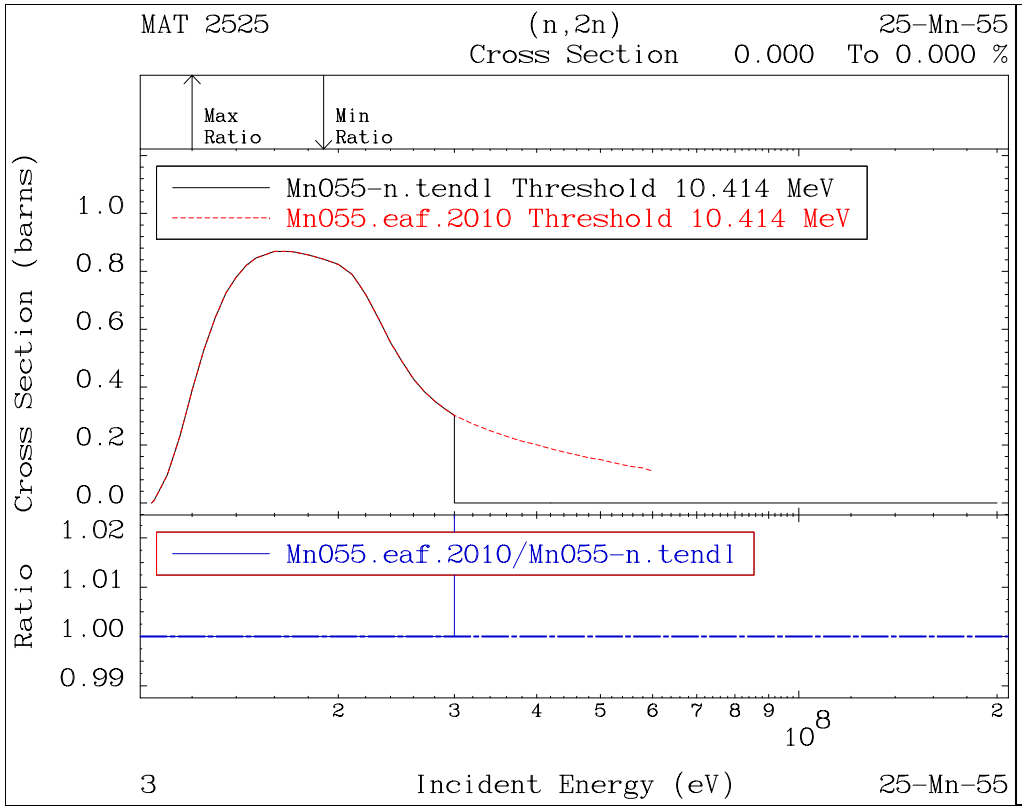
	Neutron	Proton	Deuteron	Triton	Alpha	Helium3	Photon	Fi. Yields	Covariances
TENDL-2012	**2435**	**2429**	**2428**	**2348**	**2429**	**2429**	**2430**	**-**	**2338**
TENDL-2011	**2425**	**2429**	**2419**	**2431**	**2429**	**2428**	**2428**	**574**	**2416**
TENDL-2010	**2394**	**1157**	**1159**	**1156**	**1159**	**1140**	**1152**	**529**	**1086**
TENDL-2009	**2375**	**1163**	**1164**	**1116**	**1163**	**1127**	**1165**	**509**	**1141**
TENDL-2008	348	344	336	339	342	338	327		**342**
(JEFF-3.1.2)	*381*	*26*						*44*	*32*
(ENDF/B-VII.1)	*423*	*47*	*5*	*3*		*2*	*163*	*80*	*146*
(JENDL-4.0)	*406*								*90*

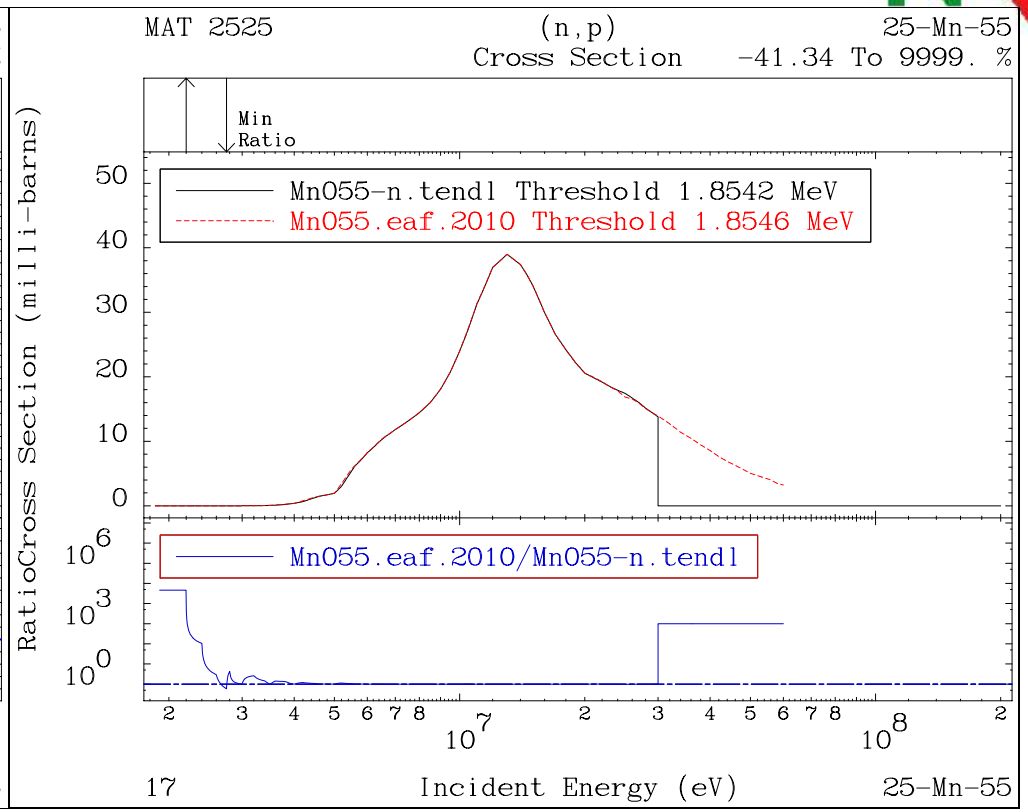
Development

Production of Eurofer isotopes in TENDL: Fe, Cr, W, Ta, V, Mn
Comparison of cross sections with 2011 and 2012 TENDL production methods.
See next slides for:

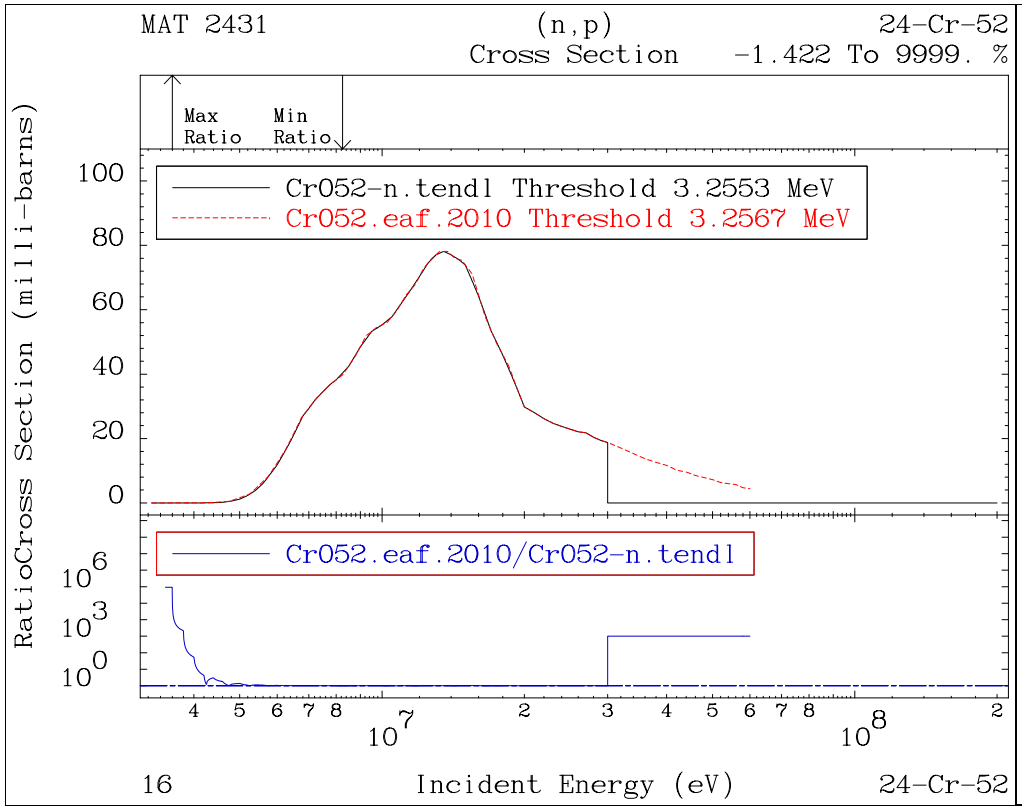
1. ^{55}Mn(n,2n), ^{55}Mn(n,p)
2. ^{52}Cr(n,t), ^{52}Cr(n,p)
3. ^{186}W(n,γ), ^{186}Cr(n,p)
4. ^{181}Ta(n,p), ^{181}Ta(n,^{3}He)

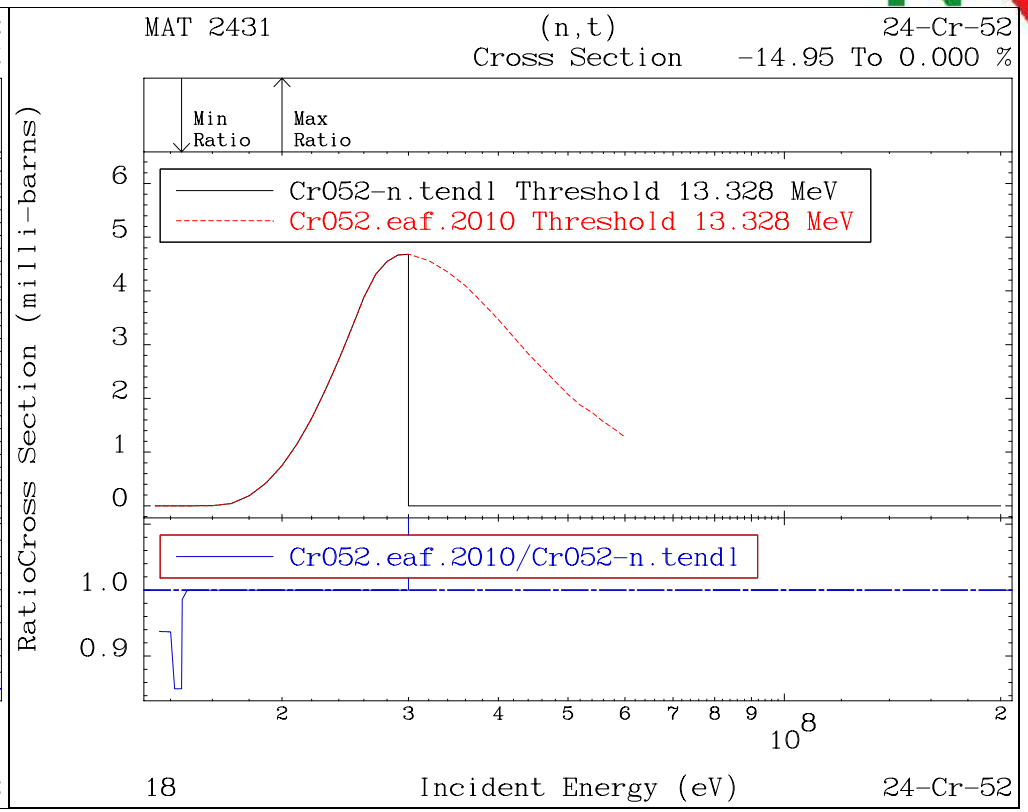
^{55}Mn


MAT 2525
(n,2n)
Cross Section
25-Mn-55
0.000 To 0.000 %
Max Ratio
Min Ratio
Mn055-n.tendl Threshold 10.414 MeV
Mn055.eaf.2010 Threshold 10.414 MeV
Cross Section (barns)
Mn055.eaf.2010/Mn055-n.tendl
Ratio
Incident Energy (eV)
3
25-Mn-55

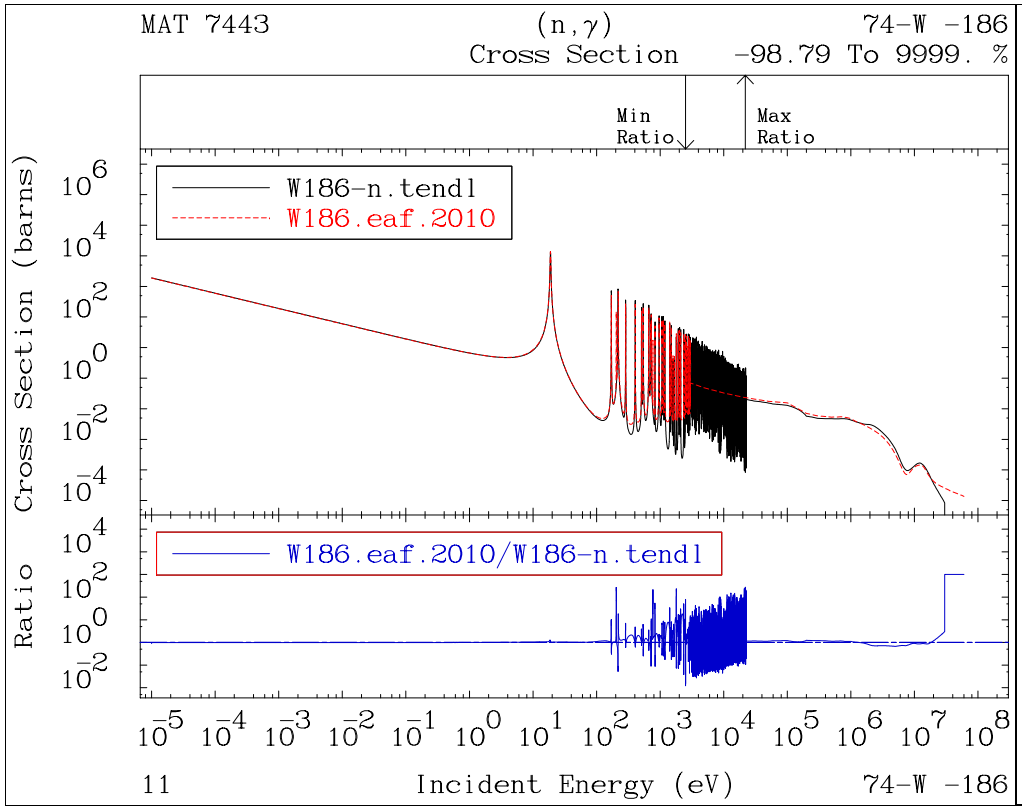

MAT 2525
(n,p)
Cross Section
25-Mn-55
-41.34 To 9999. %
Min Ratio
Mn055-n.tendl Threshold 1.8542 MeV
Mn055.eaf.2010 Threshold 1.8546 MeV
RatioCross Section (milli-barns)
Mn055.eaf.2010/Mn055-n.tendl
Incident Energy (eV)
17
25-Mn-55

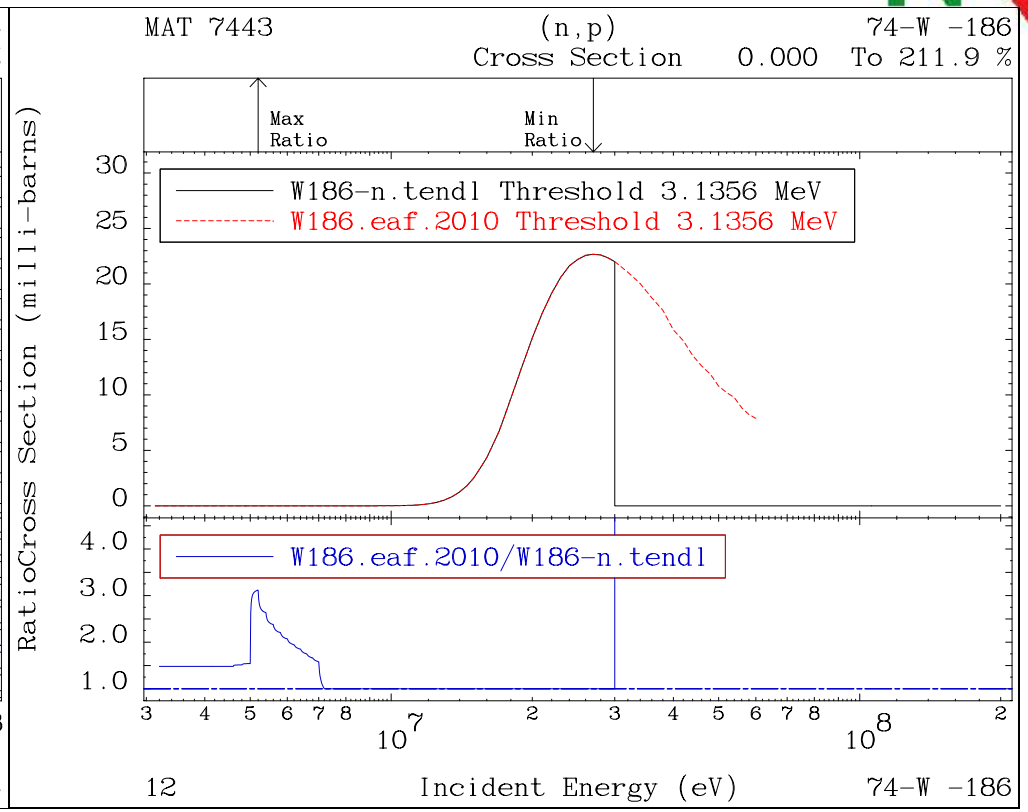
^{52}Cr


MAT 2431
(n,p)
24-Cr-52
Cross Section
-1.422 To 9999. %
Max Ratio
Min Ratio
Cr052-n.tendl Threshold 3.2553 MeV
Cr052.eaf.2010 Threshold 3.2567 MeV
Cr052.eaf.2010/Cr052-n.tendl
RatioCross Section (milli-barns)
Incident Energy (eV)
16
24-Cr-52

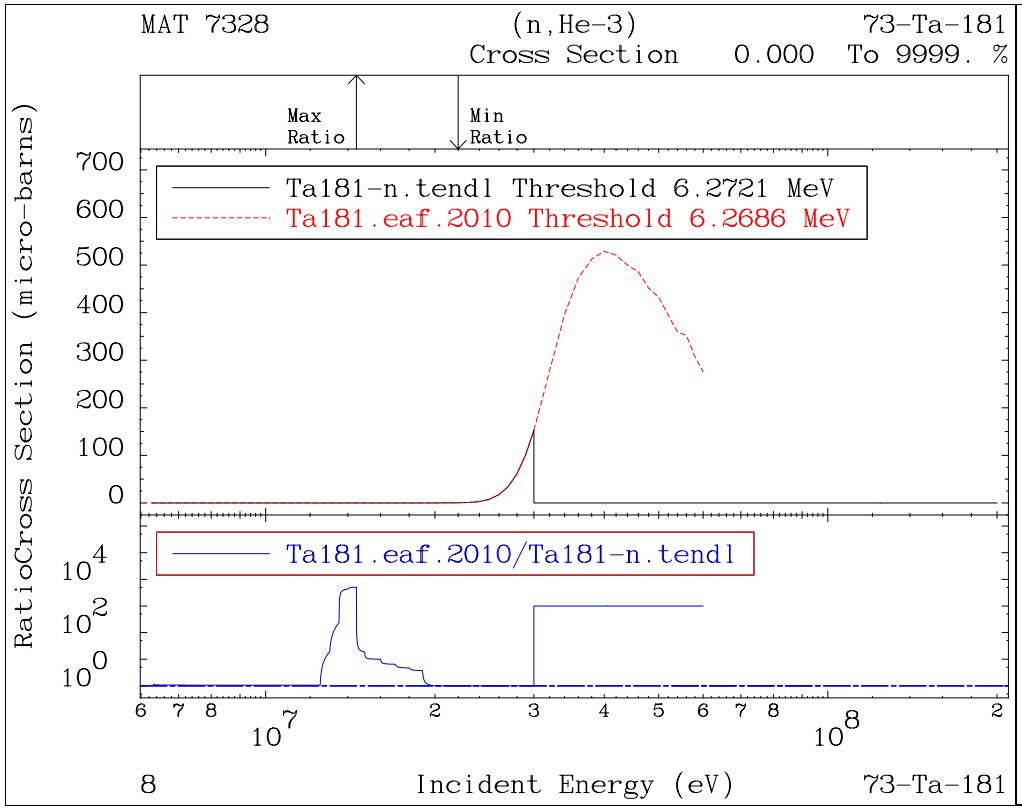

MAT 2431
(n,t)
24-Cr-52
Cross Section
-14.95 To 0.000 %
Min Ratio
Max Ratio
Cr052-n.tendl Threshold 13.328 MeV
Cr052.eaf.2010 Threshold 13.328 MeV
Cr052.eaf.2010/Cr052-n.tendl
RatioCross Section (milli-barns)
Incident Energy (eV)
18
24-Cr-52

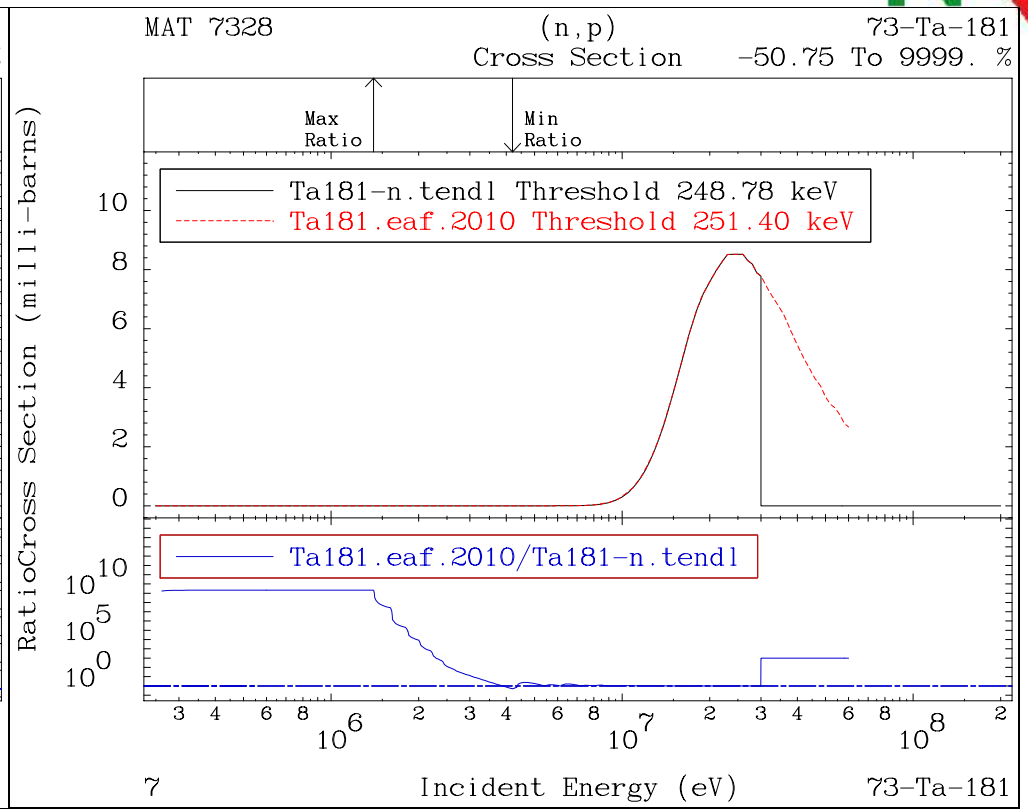
^{186}W


MAT 7443
(n,γ)
74-W -186
Cross Section
-98.79 To 9999. %
Min Ratio
Max Ratio
W186-n.tendl
W186.eaf.2010
W186.eaf.2010/W186-n.tendl
Ratio Cross Section (barns)
11
Incident Energy (eV)
74-W -186


MAT 7443
(n,p)
74-W -186
Cross Section
0.000 To 211.9 %
Max Ratio
Min Ratio
W186-n.tendl Threshold 3.1356 MeV
W186.eaf.2010 Threshold 3.1356 MeV
W186.eaf.2010/W186-n.tendl
RatioCross Section (milli-barns)
12
Incident Energy (eV)
74-W -186

^{181}Ta


MAT 7328
(n,He-3)
73-Ta-181
Cross Section
0.000 To 9999. %
Max Ratio
Min Ratio
Ta181-n.tendl Threshold 6.2721 MeV
Ta181.eaf.2010 Threshold 6.2686 MeV
Ta181.eaf.2010/Ta181-n.tendl
RatioCross Section (micro-barns)
Incident Energy (eV)
8
73-Ta-181

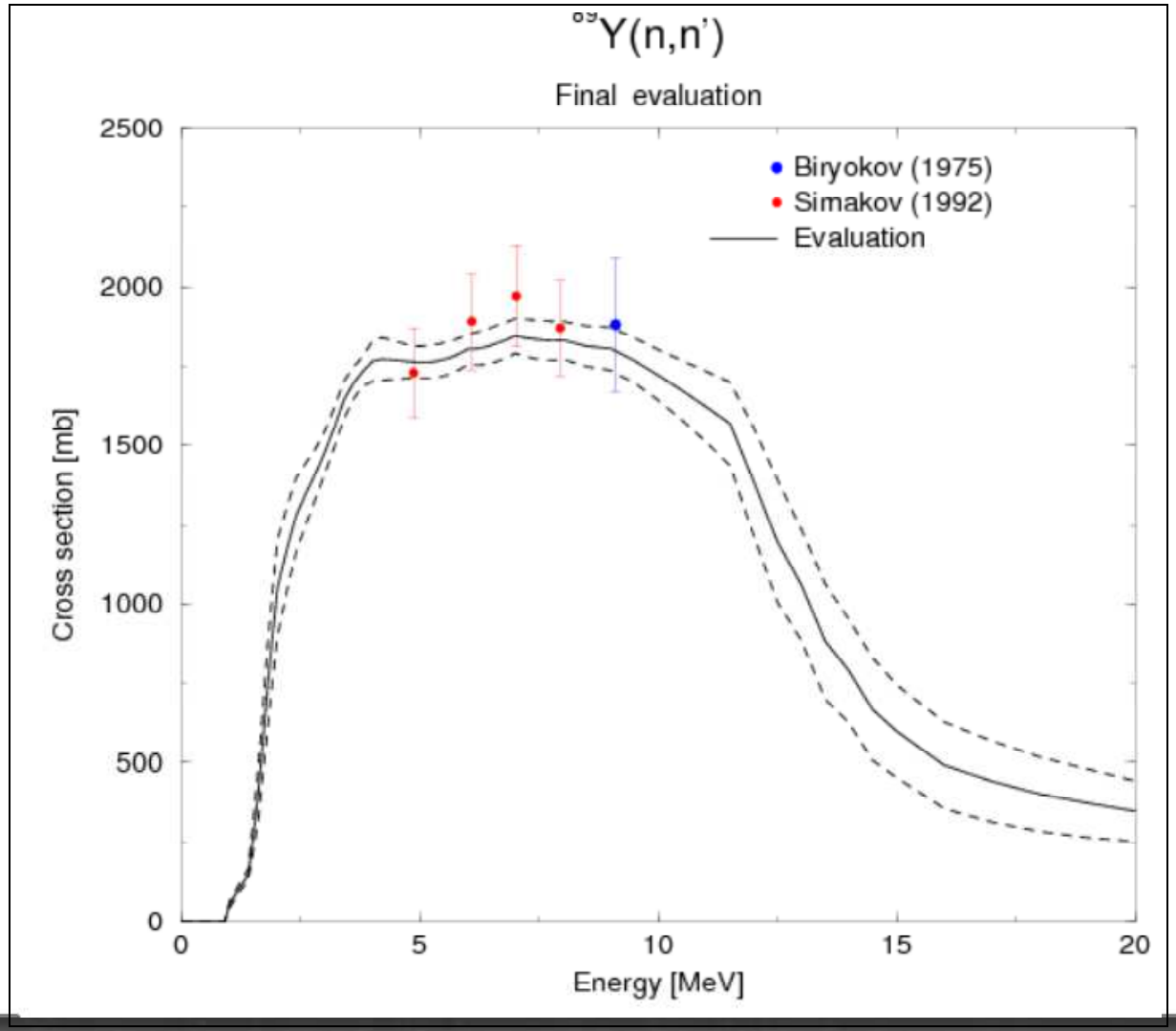

MAT 7328
(n,p)
73-Ta-181
Cross Section
-50.75 To 9999. %
Max Ratio
Min Ratio
Ta181-n.tendl Threshold 248.78 keV
Ta181.eaf.2010 Threshold 251.40 keV
Ta181.eaf.2010/Ta181-n.tendl
RatioCross Section (milli-barns)
Incident Energy (eV)
7
73-Ta-181

Process feedback for TENDL-2013

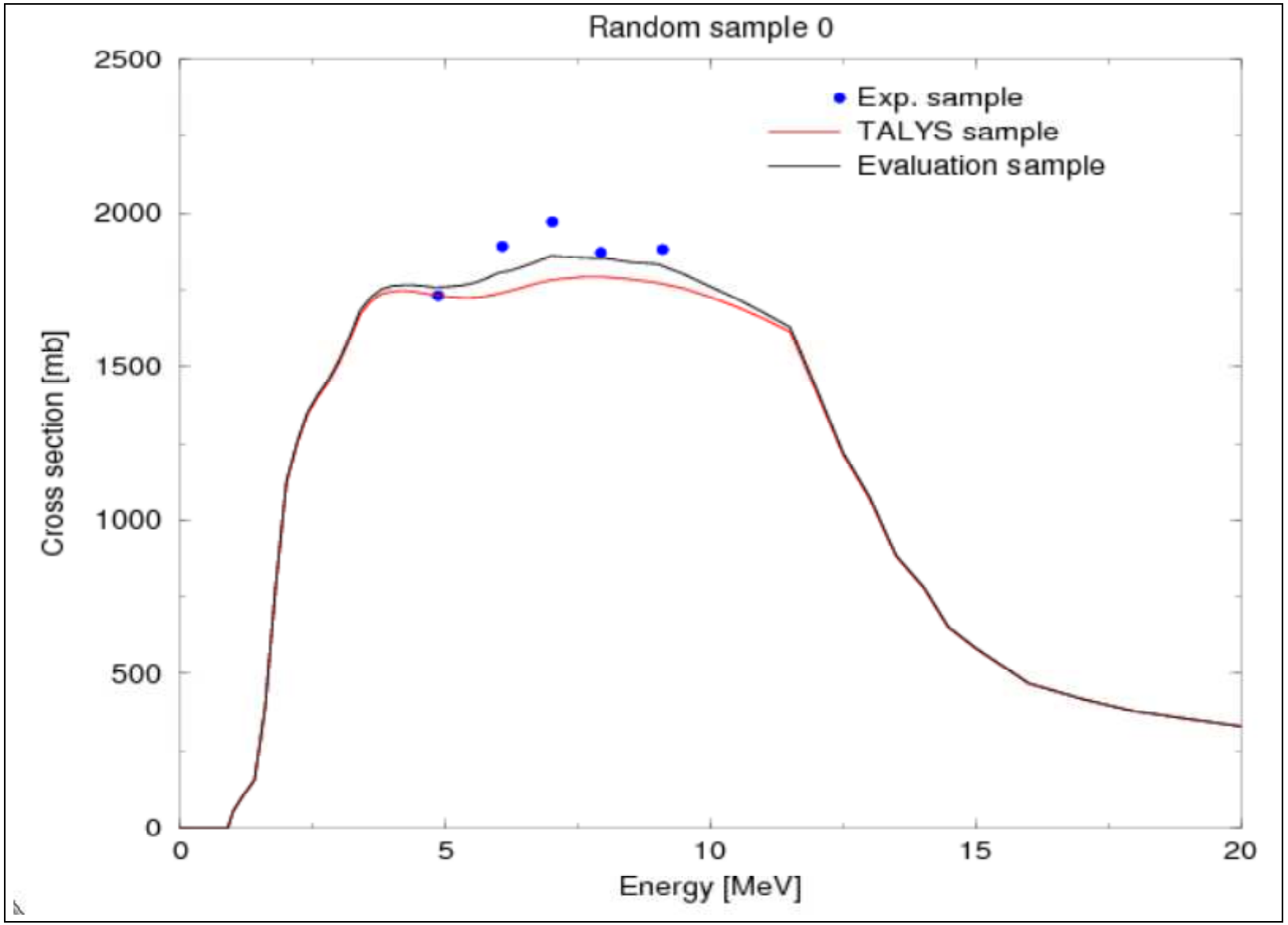
1. Damage discontinuity at 30 MeV (shown by Pereslavtsev, MacFarlane a.o.): Use consistent LAB/CM flag in MF6
2. MF33 problem (Eastwood, CCFE): use MAT1 instead of ZA, better test of correlations
3. MF6: energy balance scallops (MacFarlane): solve with adapted energy grid.
4. Revalidate 30 keV capture data with HFR approach
5. Inf and NaN in a few proton files (Stankovskii)
6. MAT number inconsistentcy between TENDL and decay data (Eastwood, CCFE)

Random evaluation+ experiments

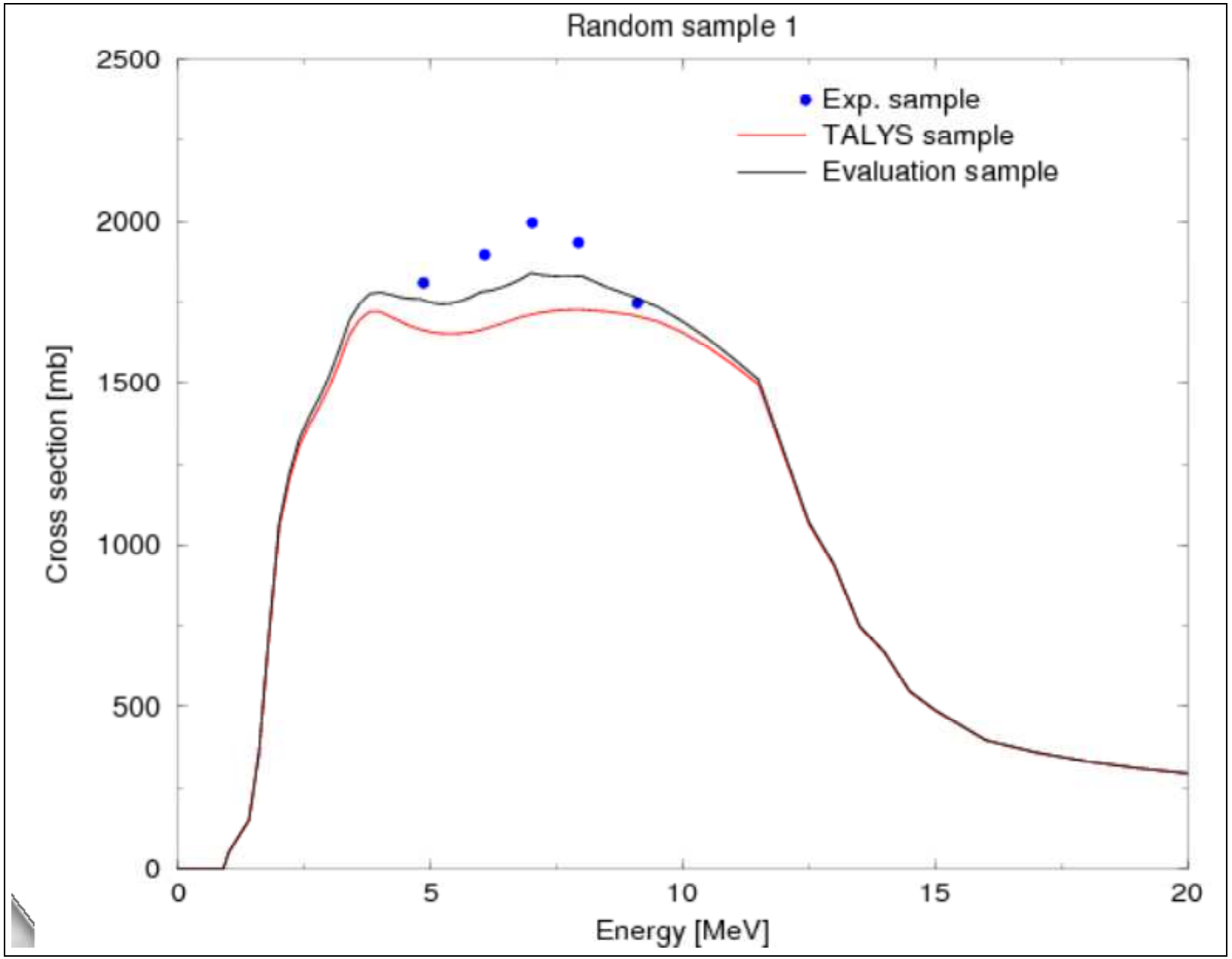
With random input parameters for TALYS, we can also use random experimental data: ”Total Unified Monte Carlo”



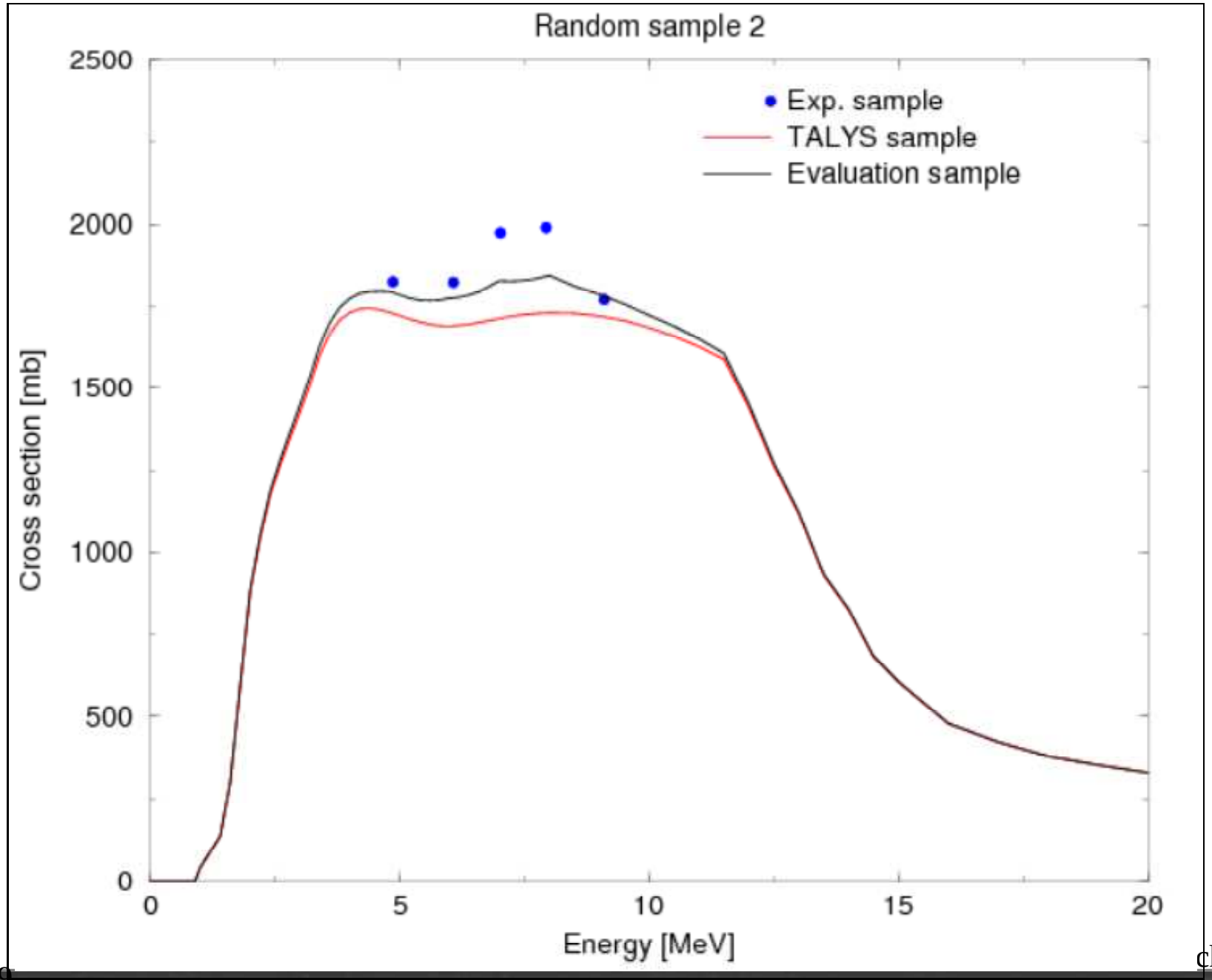
Random evaluation+ experiments: example on ^{89}Y



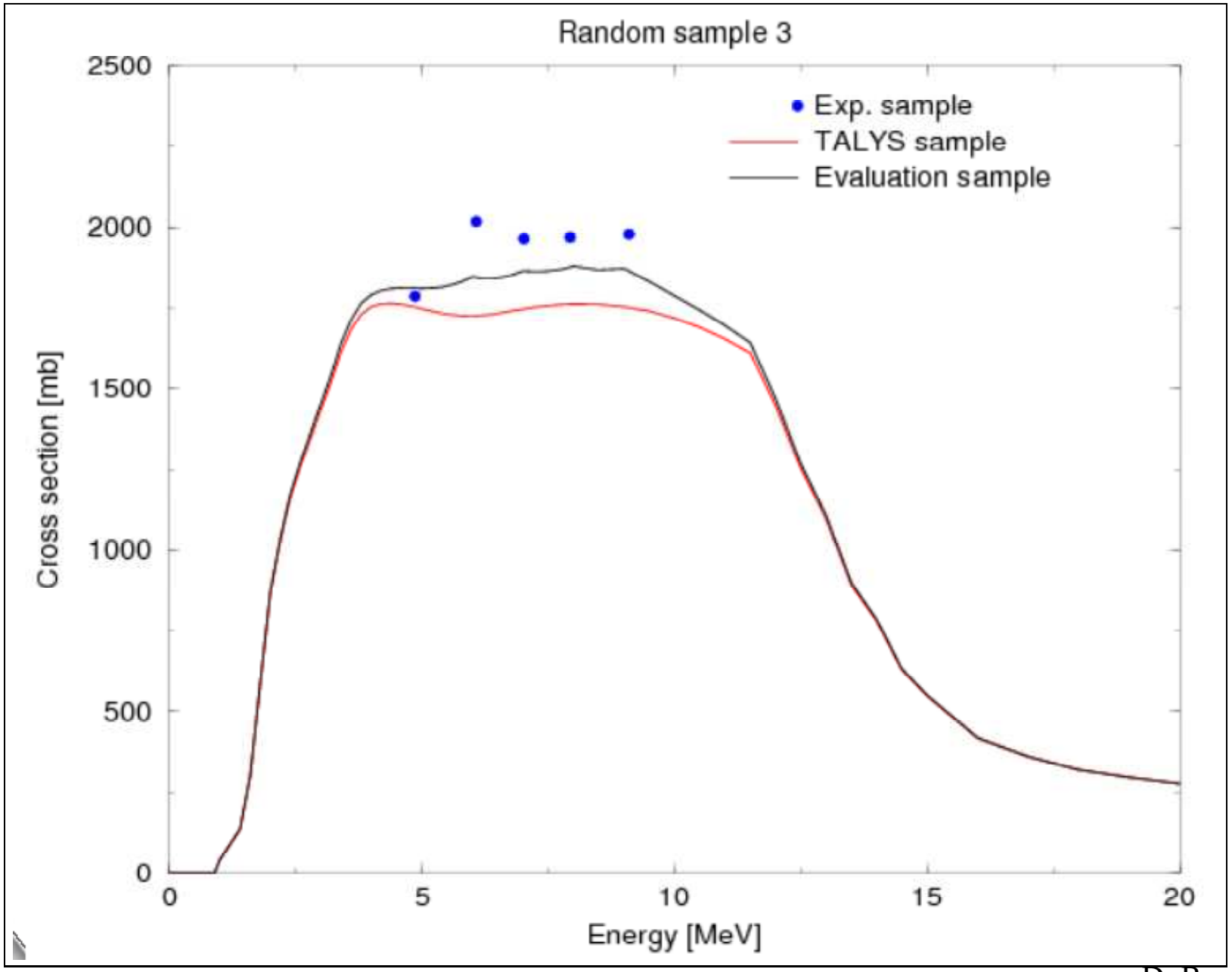
Random evaluation+ experiments: example on ^{89}Y



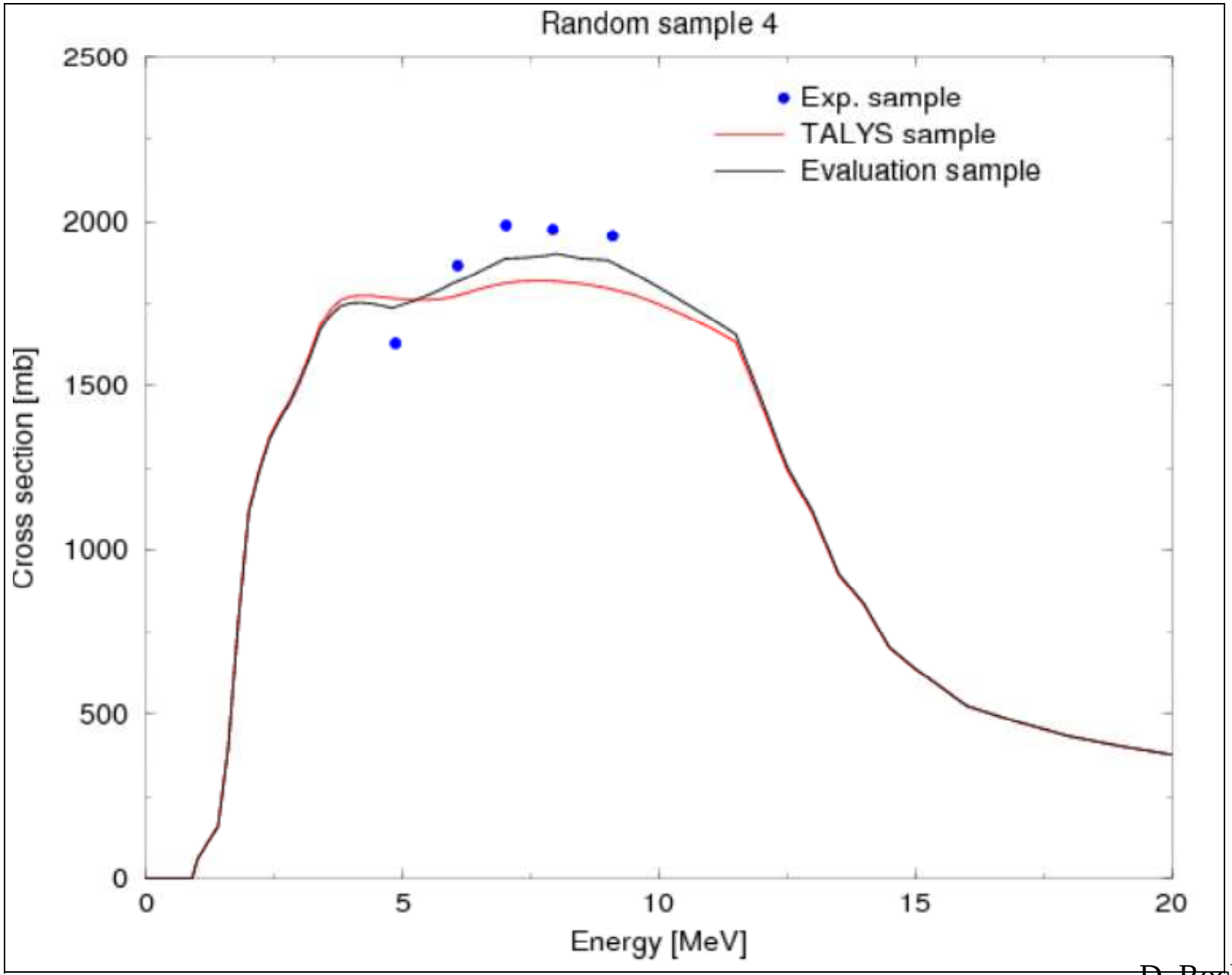
Random evaluation+ experiments: example on ^{89}Y



Random evaluation+ experiments: example on ^{89}Y



Random evaluation+ experiments: example on ^{89}Y



Conclusions and Future improvements

- First steps towards V & V of the TENDL Eurofer elements,
- All new work will be included in TENDL-2013,
- Shall we focuss on a given set of cross sections for these elements (or all of their cross sections)?
- New possibilities with the ”Total Unified Monte Carlo”,
- Still, improve global model and uncertainties,

☺And finally nuclear data world domination (and world peace).