Son of all reaction codes: TALYS

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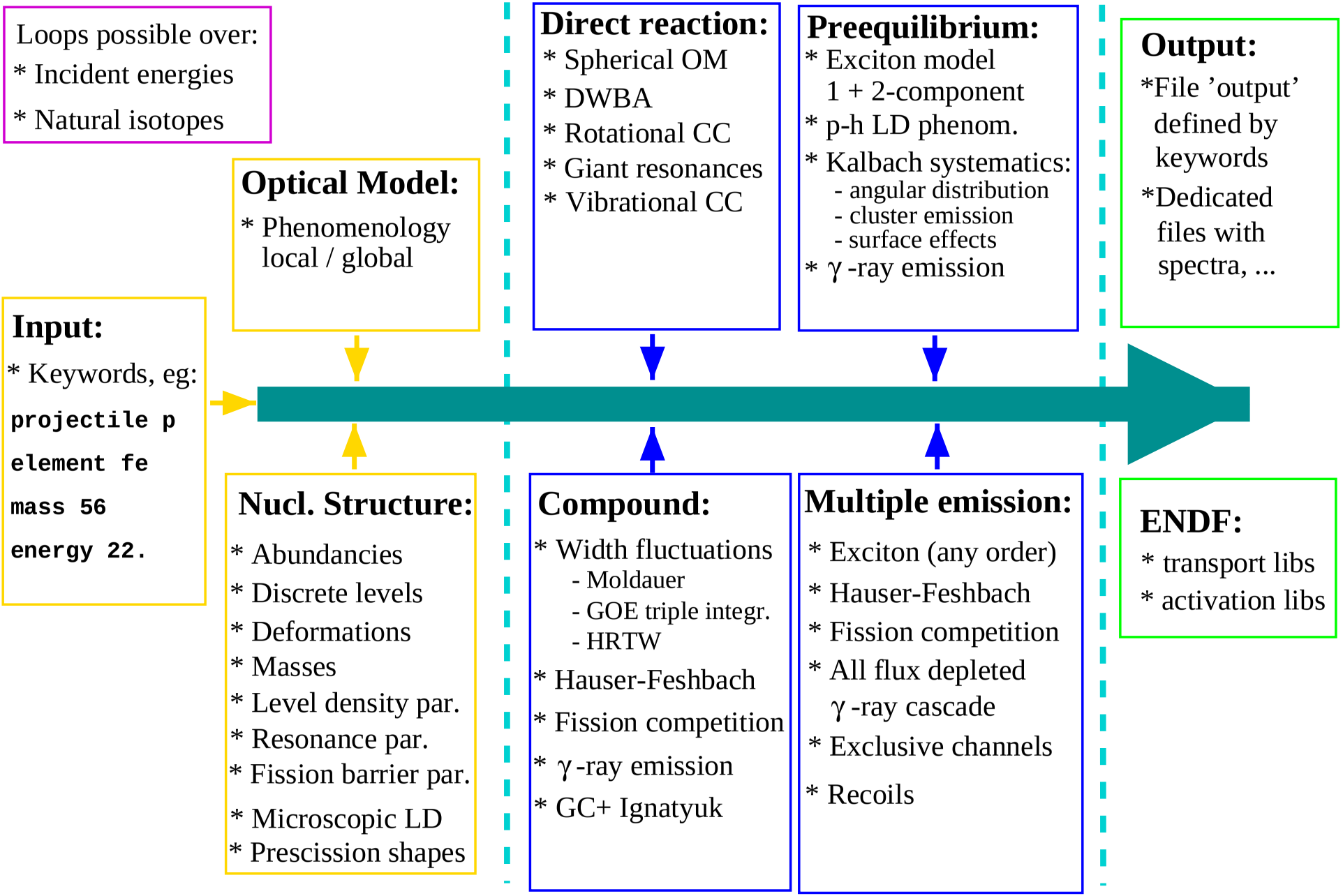
- TALYS vs. experiments
- Conclusions

TALYS

TALYS: nuclear reaction software by NRG Petten (Koning, Duijvestijn) and CEA Bruyères-le-Châtel (Hilaire)

- Energy range 1 keV - 200 MeV.
- Neutrons, protons, deuterons, tritons, helions, alphas and photons.
- First completeness, then quality.
- Many nuclear reaction models implemented.
- Continuous, smooth description over a wide energy and mass range.
- Automatic generation of data in ENDF-6 format.
- TALYS is not yet generally available.

TALYS: CALCULATIONAL SCHEME



Structure of TALYS

Technical features of version 0.56:

- FORTRAN-77, though still readable
- 40000 lines (+ 20000 lines of ECIS97)
- 45% of lines are comments
- 252 subroutines
- Three main parts: Input, initialization and reaction models

Verification and validation

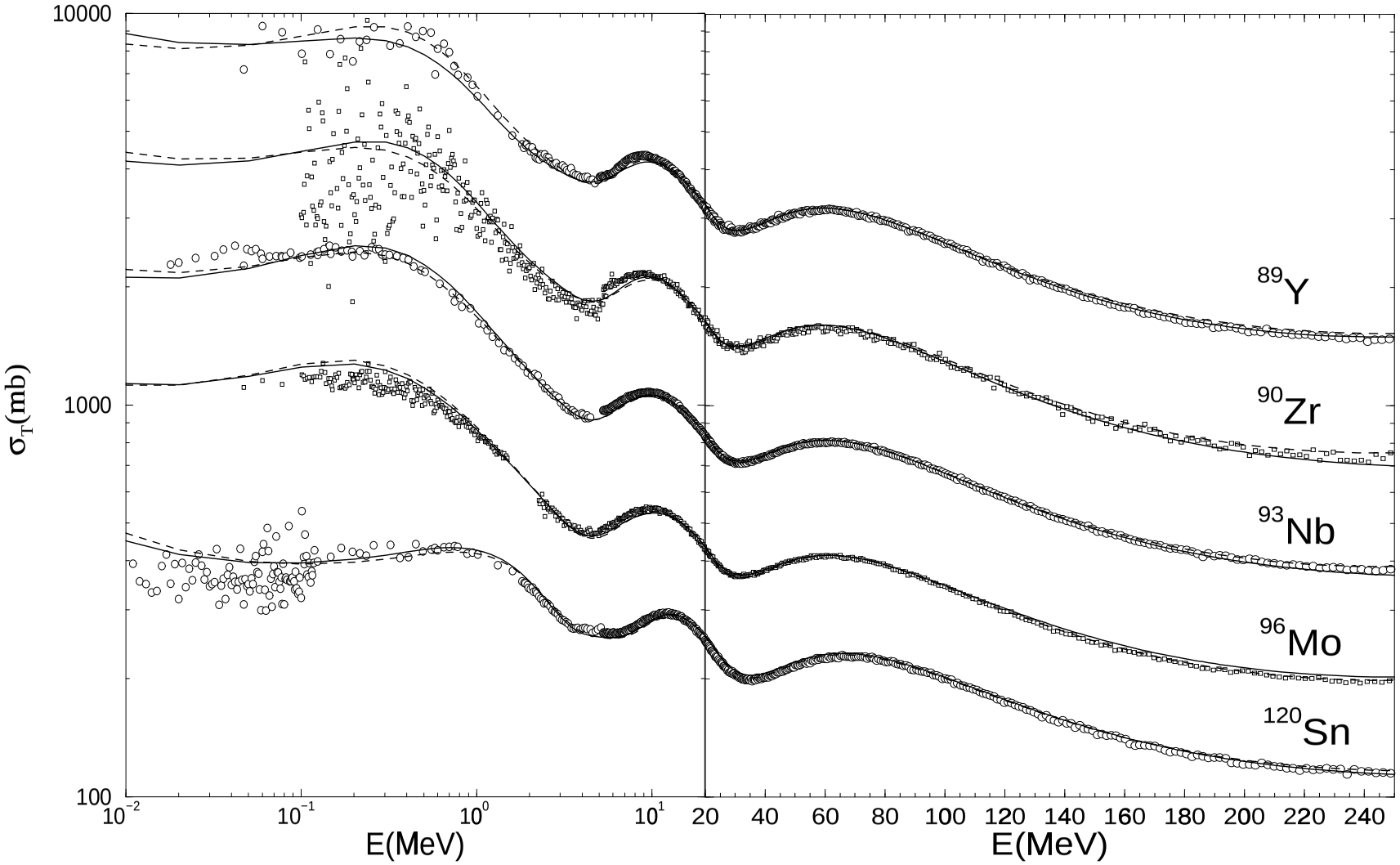
- Very extensive input handling and checking
- 148 different keywords
  - Each keyword has a validity range: TALYS stops if violated.
  - MONKEY code to test robustness of TALYS: creates random input files using all keywords.
- Dripline-to-dripline calculations including automatic ENDF-6 library generation (20 or 200 MeV).

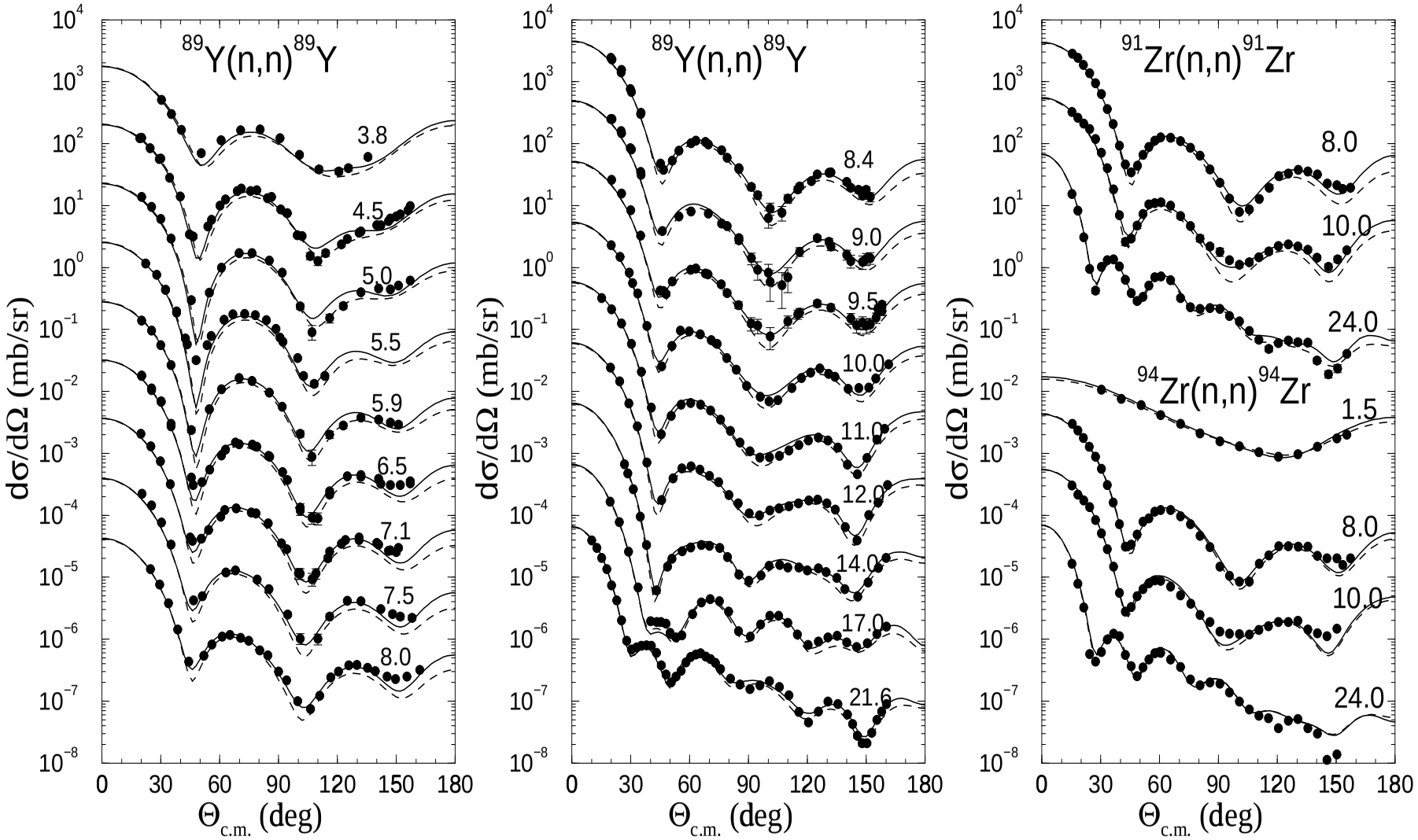
Data produced by TALYS

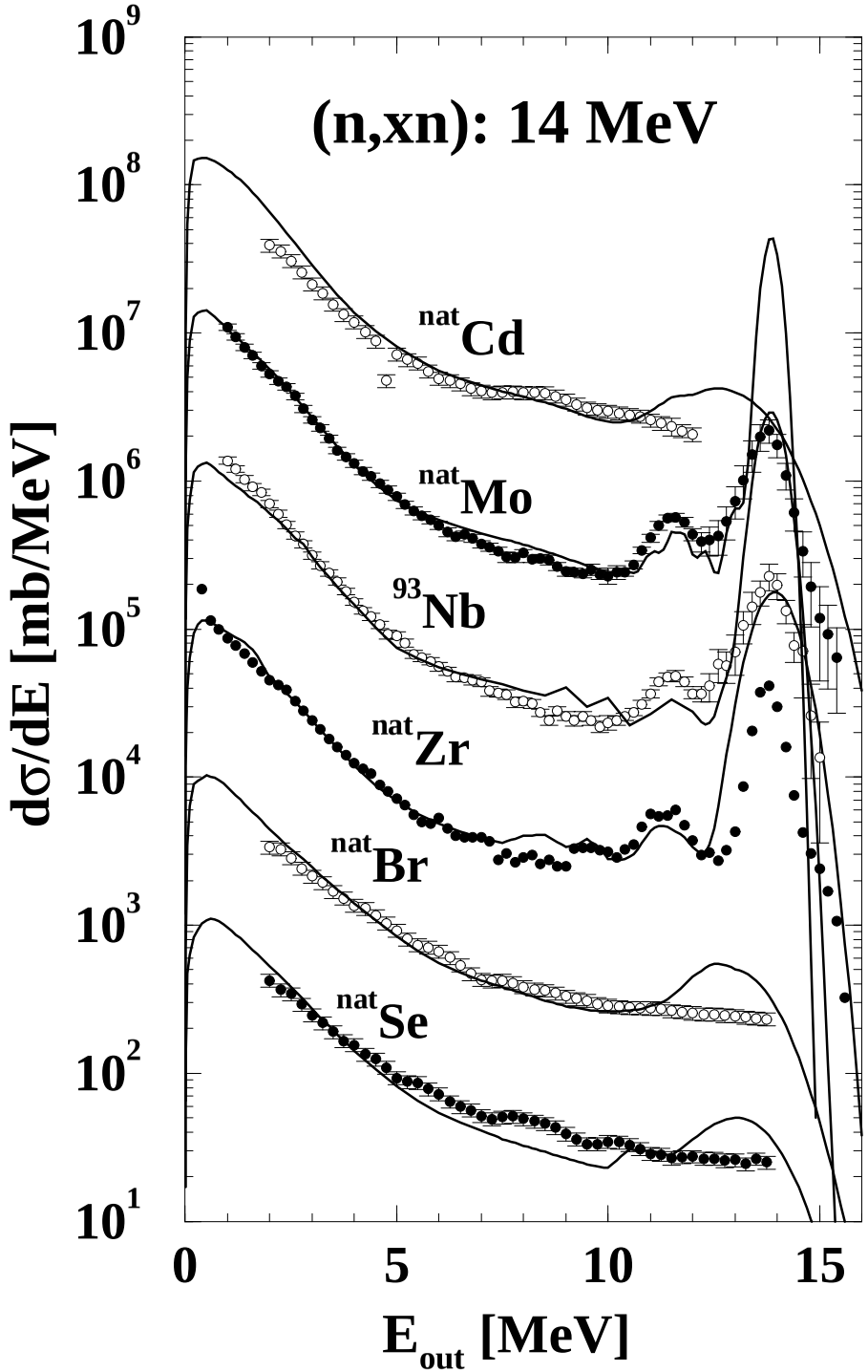
- Total, elastic and reaction cross sections.
- Inelastic cross sections.
- Elastic and inelastic angular distributions.
- All exclusive reaction channels (e.g. (n,p), (n,2n), (n,nd2a)).
- All exclusive double-differential spectra.
- All exclusive isomeric production cross sections.
- All exclusive discrete and continuum gamma ray production cross sections.
- Photonuclear reactions.
- Reactions on isomeric targets.

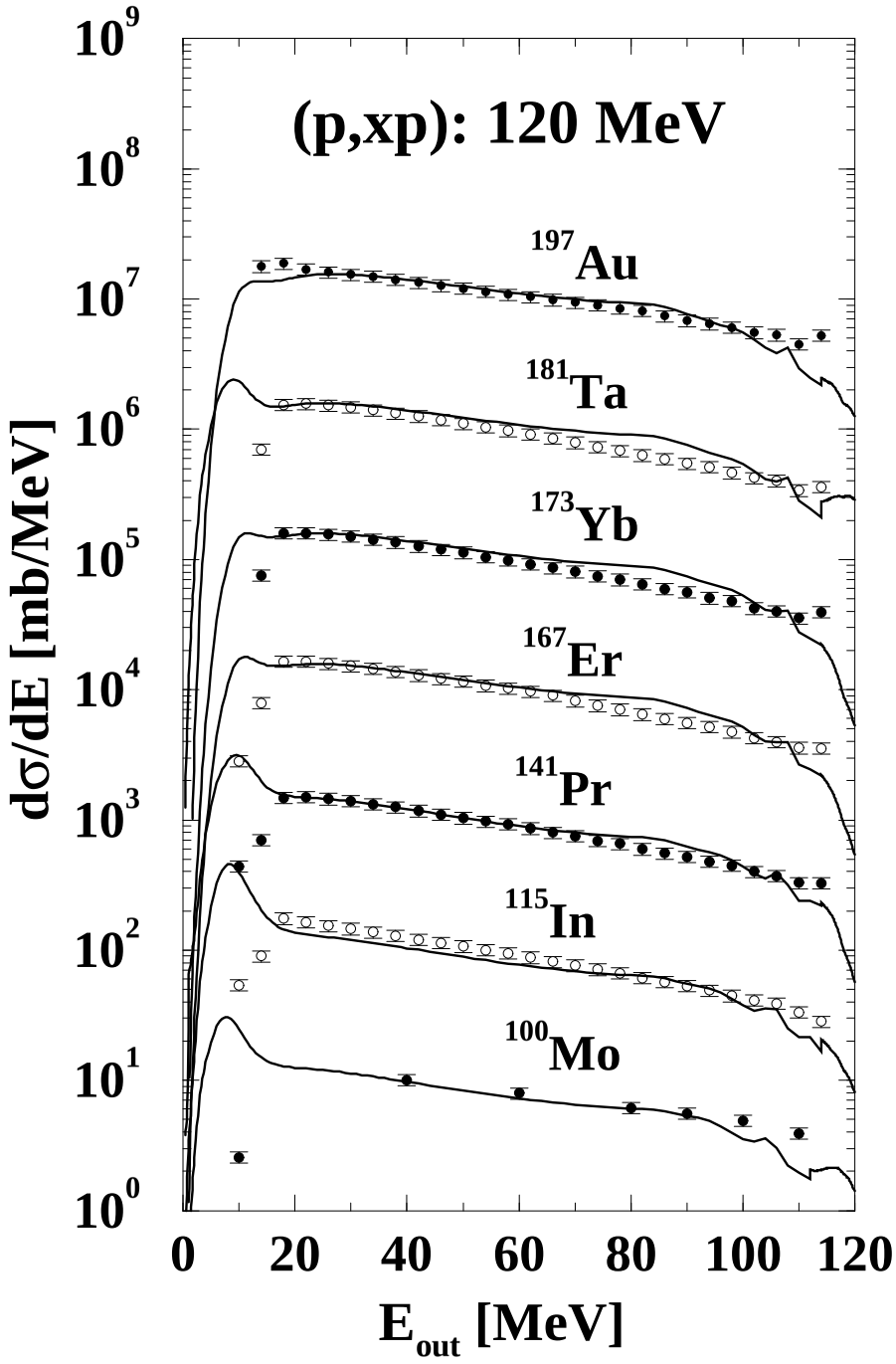
Data produced by TALYS

- Fission cross sections.
- Total particle production cross sections (n,xn).
- Total particle production double-differential spectra.
- Residual production cross sections (including isomers).
- Activation libraries in EAF and ENDF-6 format.
- Transport libraries in ENDF-6 format.

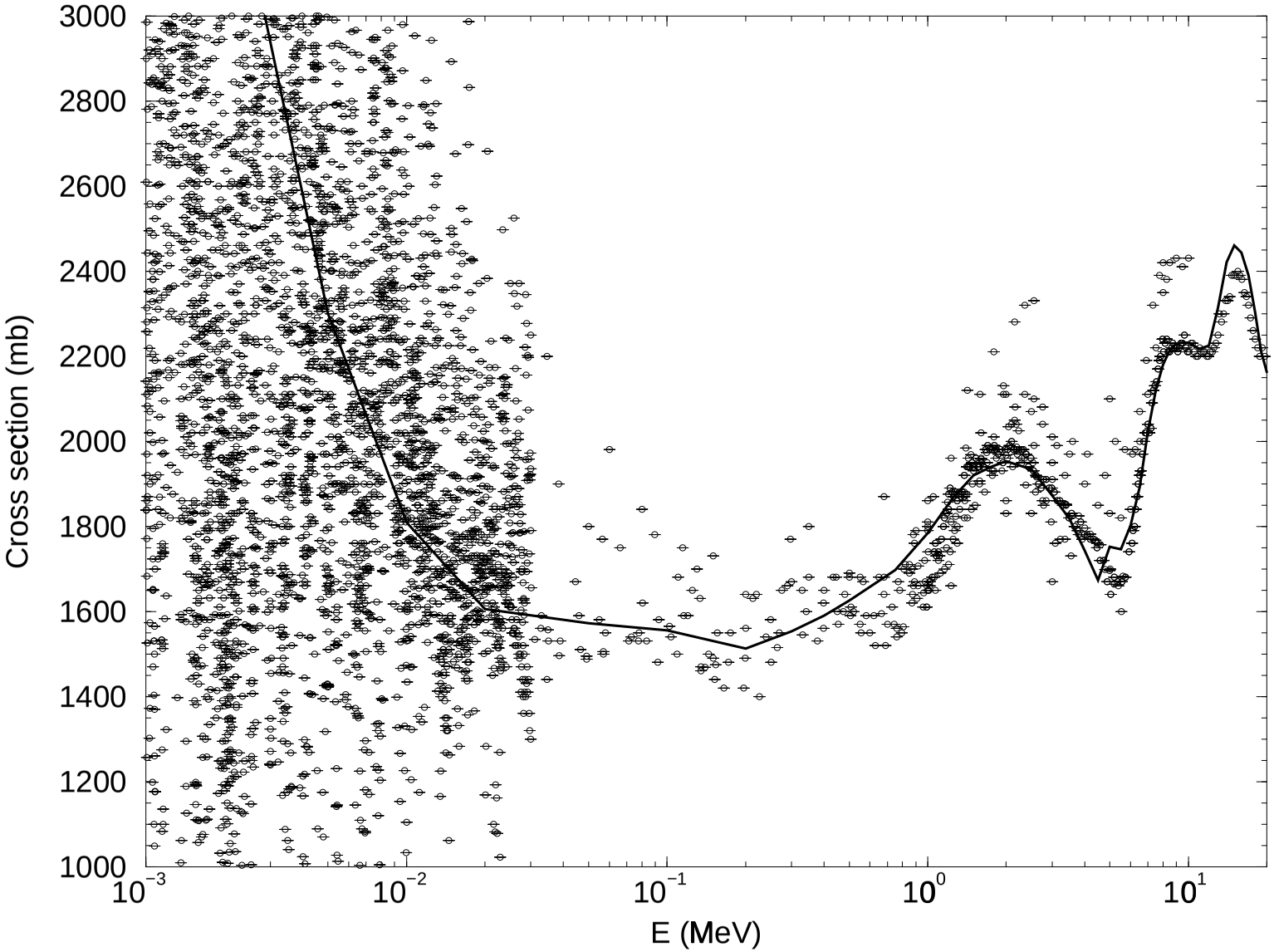

10000
1000
100
σ_T(mb)
10^{-2}
10^{-1}
10^{0}
10^{1}
E(MeV)
20
40
60
80
100
120
140
160
180
200
220
240
E(MeV)
^{89}Y
^{90}Zr
^{93}Nb
^{96}Mo
^{120}Sn


^{89}Y(n,n)^{89}Y
3.8
4.5
5.0
5.5
5.9
6.5
7.1
7.5
8.0
^{89}Y(n,n)^{89}Y
8.4
9.0
9.5
10.0
11.0
12.0
14.0
17.0
21.6
^{91}Zr(n,n)^{91}Zr
8.0
10.0
24.0
^{94}Zr(n,n)^{94}Zr
1.5
8.0
10.0
24.0
dσ/dΩ (mb/sr)
Θc.m. (deg)

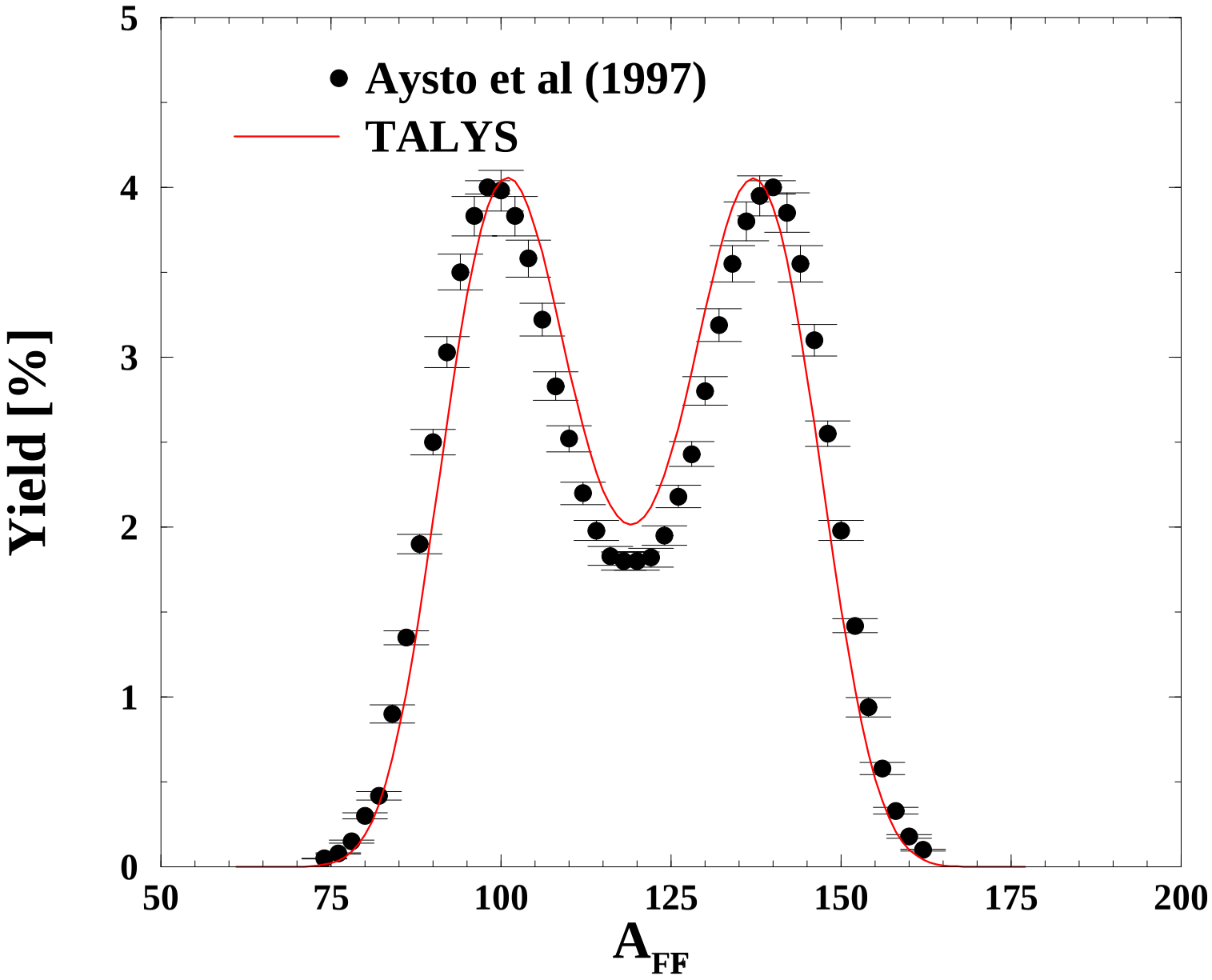

(n,xn): 14 MeV
dσ/dE [mb/MeV]
E_out [MeV]
natCd
natMo
93Nb
natZr
natBr
natSe
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
0
5
10
15


(p,xp): 120 MeV
197Au
181Ta
173Yb
167Er
141Pr
115In
100Mo
dσ/dE [mb/MeV]
E_out [MeV]
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
0
20
40
60
80
100
120

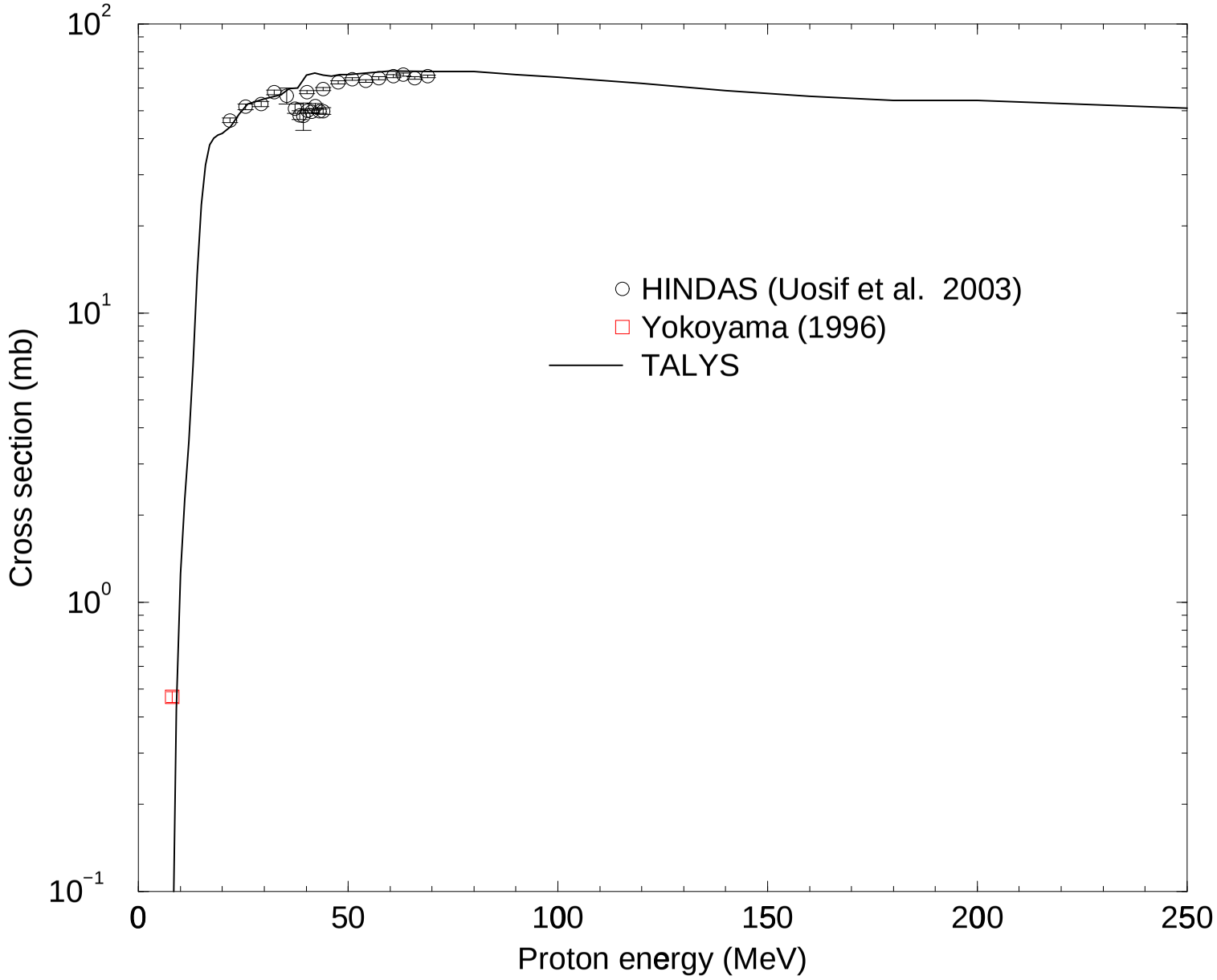
TALYS: ^{239}Pu(n,f)



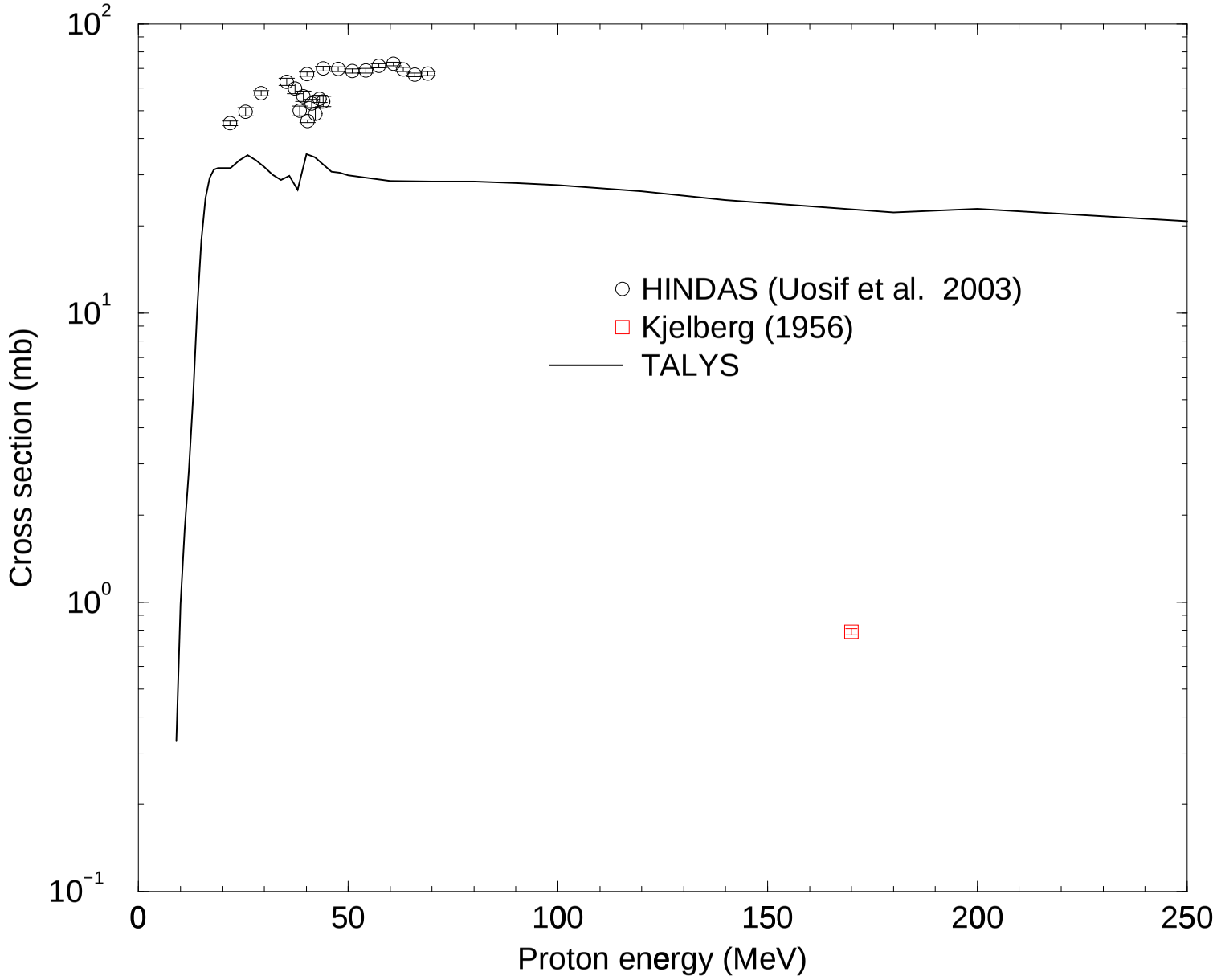
20 MeV p + ^{238}U


Aysto et al (1997)
TALYS
Yield [%]
A_{FF}
0
1
2
3
4
5
50
75
100
125
150
175
200

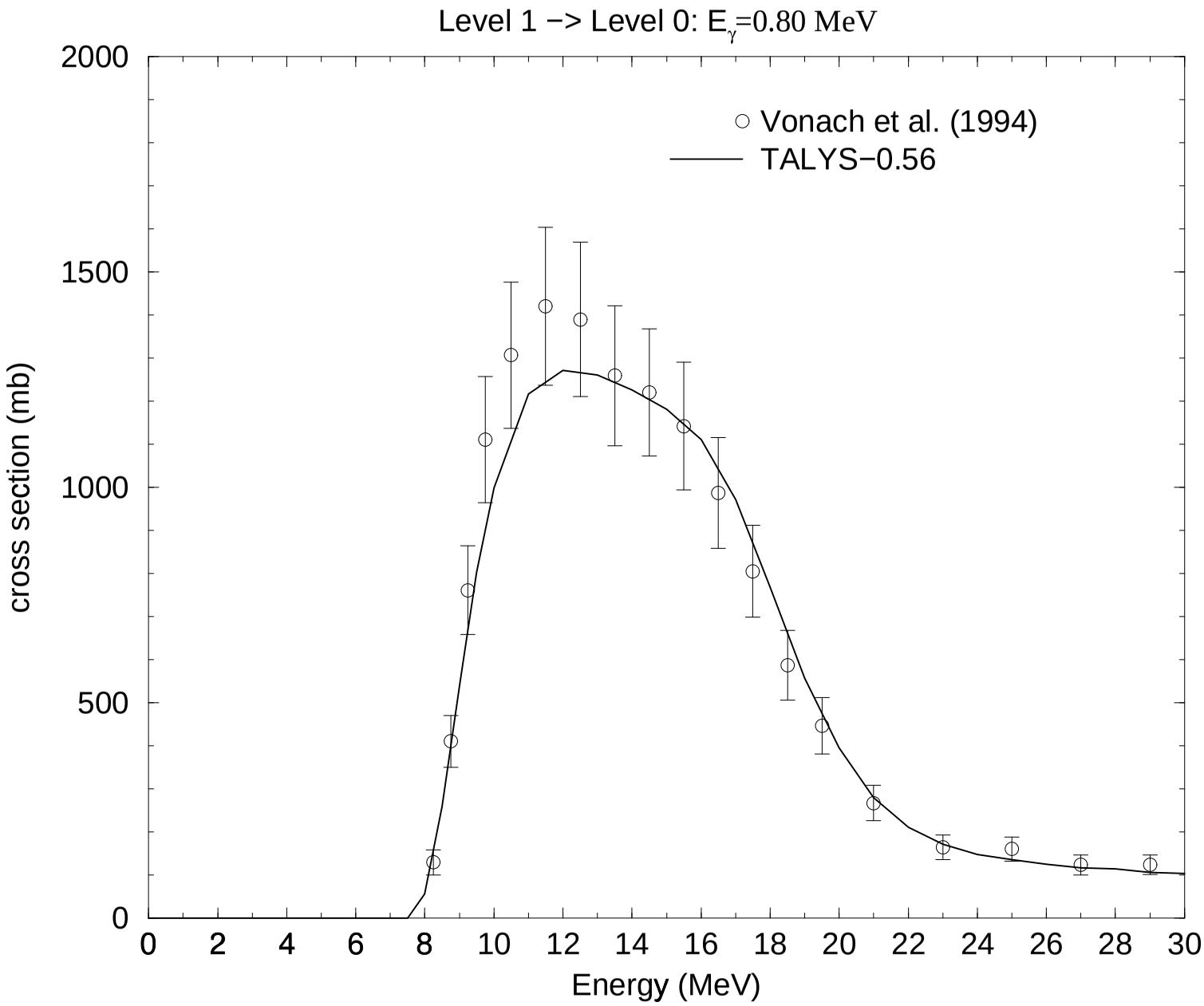
$^{nat}U(p,f)^{95}Zr$


Cross section (mb)
10^{2}
10^{1}
10^{0}
10^{-1}
0
50
100
150
200
250
Proton energy (MeV)
HINDAS (Uosif et al. 2003)
Yokoyama (1996)
TALYS

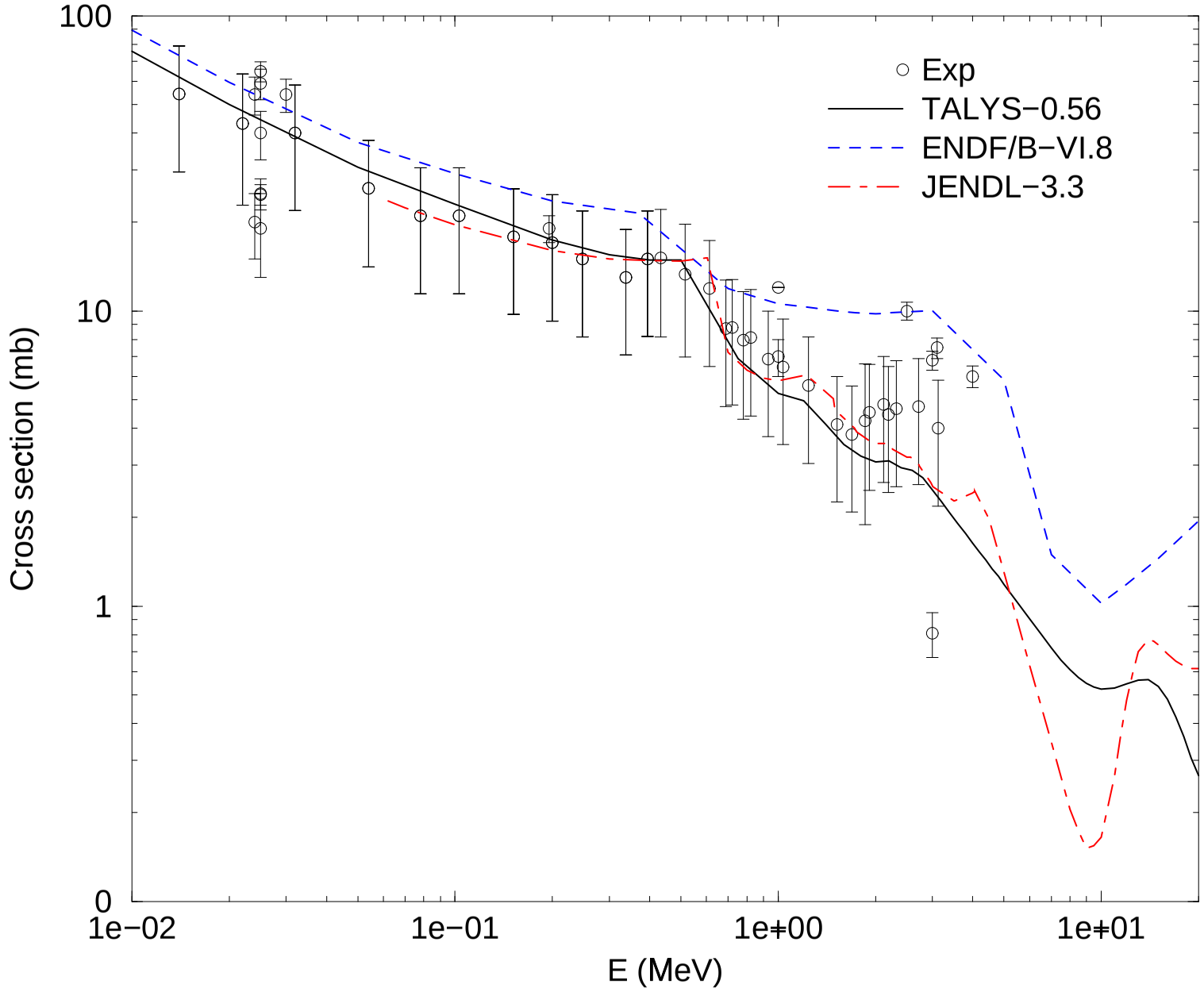
$^{nat}U(p,f)^{131}I$


HINDAS (Uosif et al. 2003)
Kjelberg (1956)
TALYS
Cross section (mb)
Proton energy (MeV)
10^2
10^1
10^0
10^-1
0
50
100
150
200
250

^{207}Pb(n,2nγ)


Level 1 −> Level 0: E$_\gamma$=0.80 MeV
Vonach et al. (1994)
TALYS−0.56
cross section (mb)
Energy (MeV)
0
500
1000
1500
2000
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

^{74}Ge(n,γ)


Exp
TALYS−0.56
ENDF/B−VI.8
JENDL−3.3
Cross section (mb)
E (MeV)
100
10
1
0
1e−02
1e−01
1e+00
1e+01

Conclusions

- TALYS: NRG Petten - CEA Bruyères-le-Châtel evaluation code system
- URR - 200 MeV, 12 < A < 300
- Almost complete in terms of predicted observables.
- Goals:
  - Both academical and applied.
  - Compete with other evaluation code systems on completeness, predictive power, speed, programming techniques and user-friendliness.
  - Major revision of future (JEFF-3) nuclear data files.
- Upgrade to FORTRAN-90/95 underway, using ModLib working group.
- Release of TALYS foreseen at ND2004 in Santa Fe.