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THE ANALYSIS OF EXPERIMENTAL DATA FOR THE ISOTOPES OF NI

Prepared by
N. Dzysiuk

June 2021

IAEA Nuclear Data Section
Vienna International Centre, P.O. Box 100, 1400 Vienna, Austria

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Nuclear Data Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna
Austria

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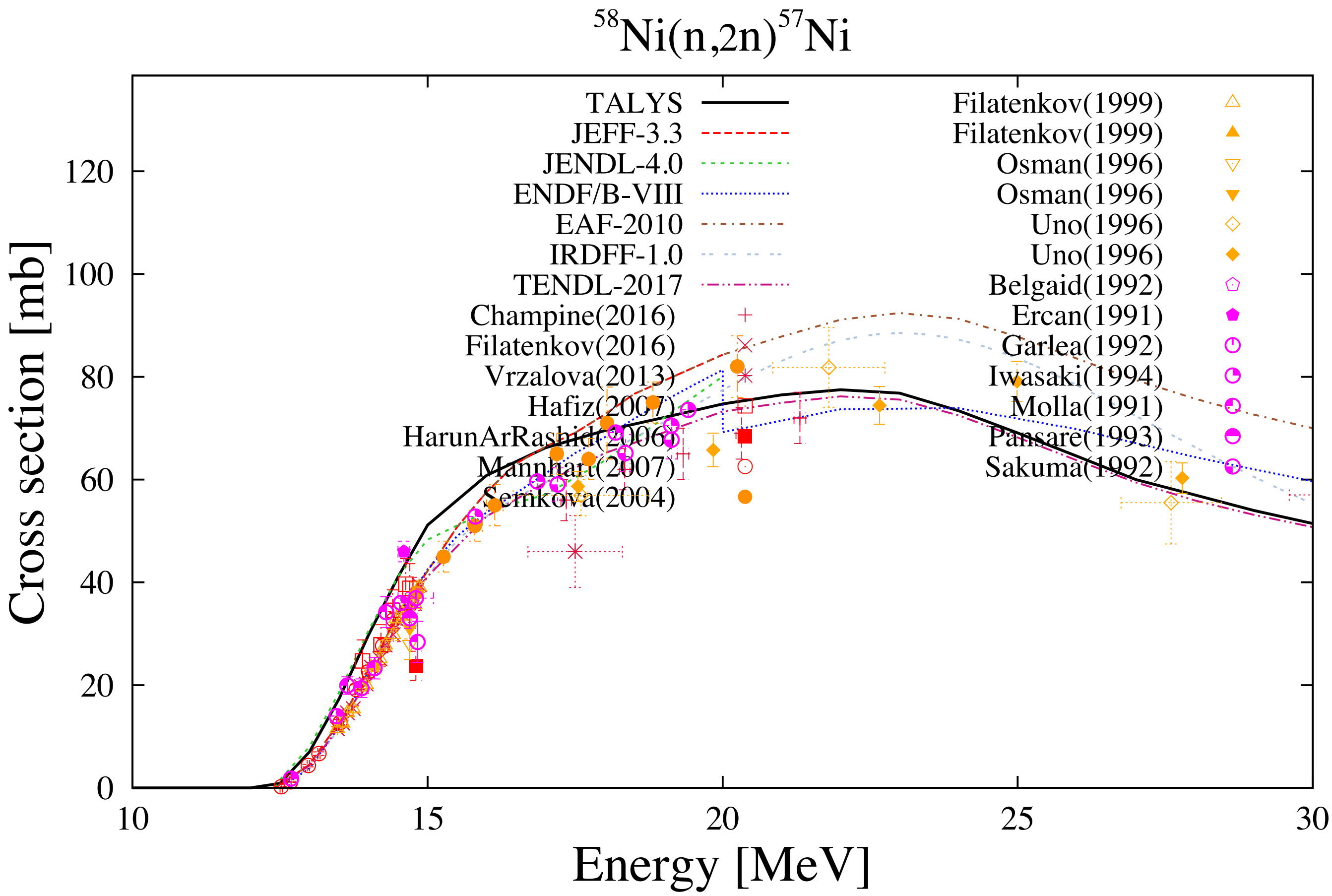
The analysis of experimental data for the isotopes of Ni

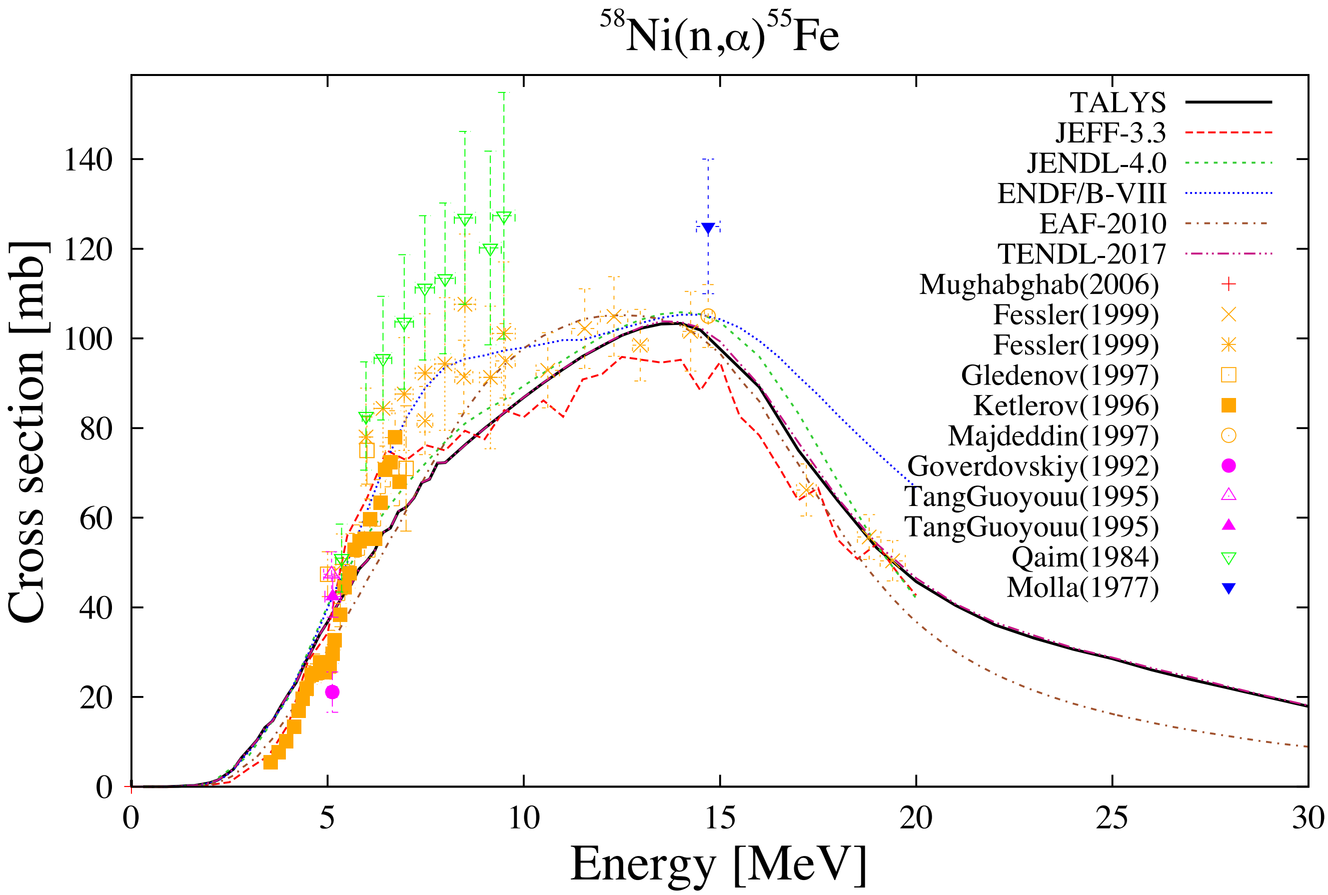


Harun-Ar-Rashid (2006) is underestimated

Reason:

- Incorrect quantum yield value was used: 84.9 % while it should be 81.7 %. Moreover, in Table 3, where systematic errors (statistical errors are even not mentioned) are presented, uncertainty of quantum yield was listed as 0.3-1.0, in reality: it is up to 3.9%.
- In Table 3 there is nothing mentioned about coinciding summing effects. But in this particular case of the decay scheme and a close geometry of measurements a significant underestimate of the peak area of 1377.63 keV might be observed.
- In the paper it is said: “Before measurement of the activity of the product nuclei, sufficient cooling time was allowed for the decay of the short-lived components”. In the same time there was no corresponding correction introduced for the decay of gamma peak of interest. Therefore this source of systematic error was not considered properly, but could lead to underestimation of corresponding peak area and underestimated cross section value itself.

Ercan (1991) is overestimated
Reason: Difficult to explain. Paper does not contain too many details for the proper analysis.

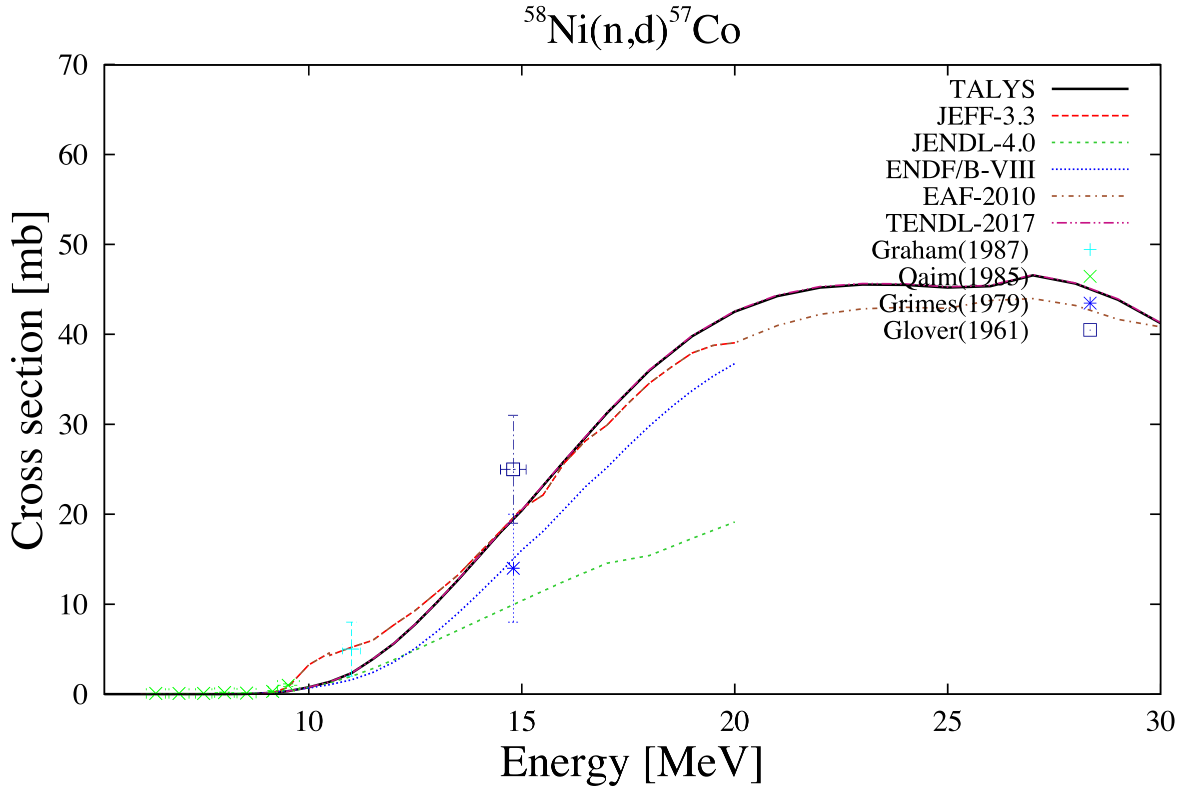


Qaim (1984) is overestimated

Reason: In this work authors have been using a SAND II algorithm, which is based on the unfolding iterative process to solve the Fredholm's equation of the first kind. This is the integral equation and the result of unfolding depends on what was the initial approximation at the very first iteration. Therefore authors put at first iteration the distribution they wanted to get at the end. Then this algorithm just improved this initial distribution. But from experience this algorithm does not work well to unfold the peak-like structures. Therefore our point is: the spectral distribution of Qaim is incorrect and does not include a higher energy tail. Additionally the mean energy being calculated for a wrong distribution will be also wrong. Monte Carlo simulations give a tail on the right side of the distributions and it is different to the ones suggested by authors. A bit overestimated neutron flux resulted in the overestimated cross-section value.

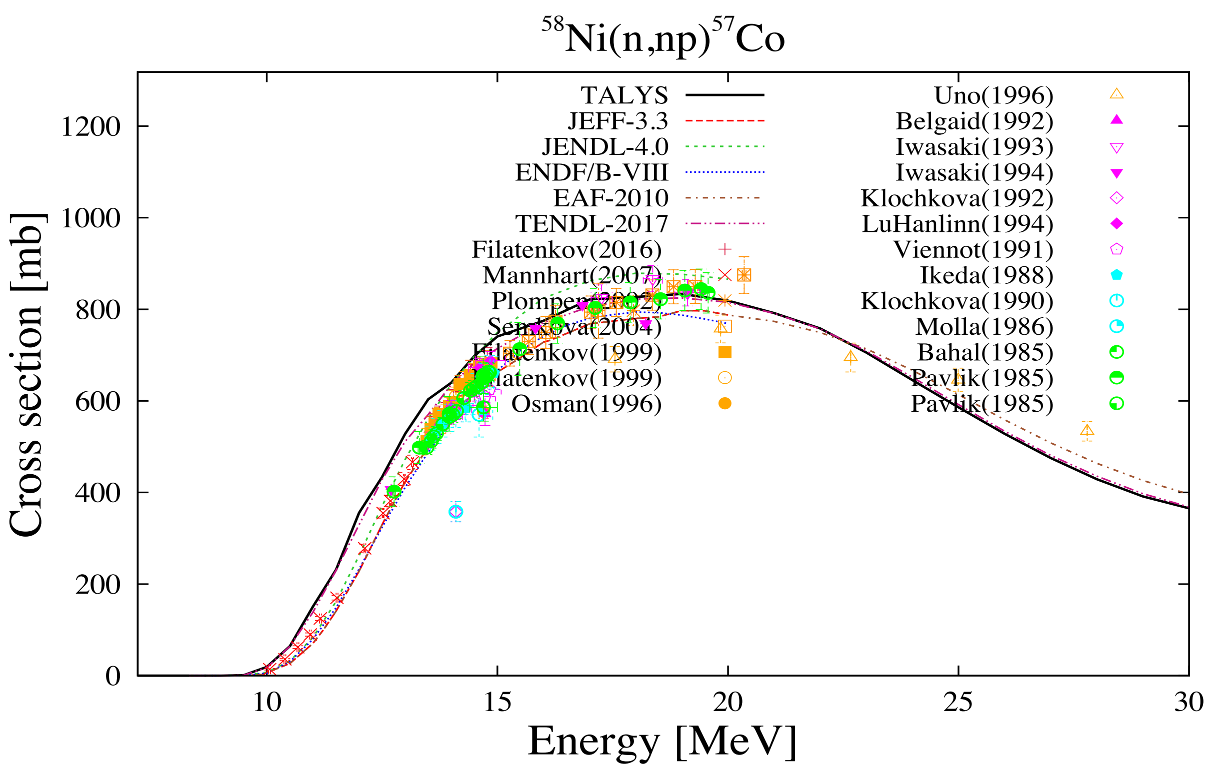
Molla (1977) is overestimated

Reason: In the EXFOR database there is no directly measured cross section value (125 mb). Seems the value is derived from unknown systematic. This paper, which is assigned for this entry, has no any information about this cross section.



Grimes (1979) is underestimated

Reason: The observed underestimation could be connected to the fact that authors during cross section determination used the isotopic abundance of ^{58}Ni as 58 % but the real value is 68.07 %.



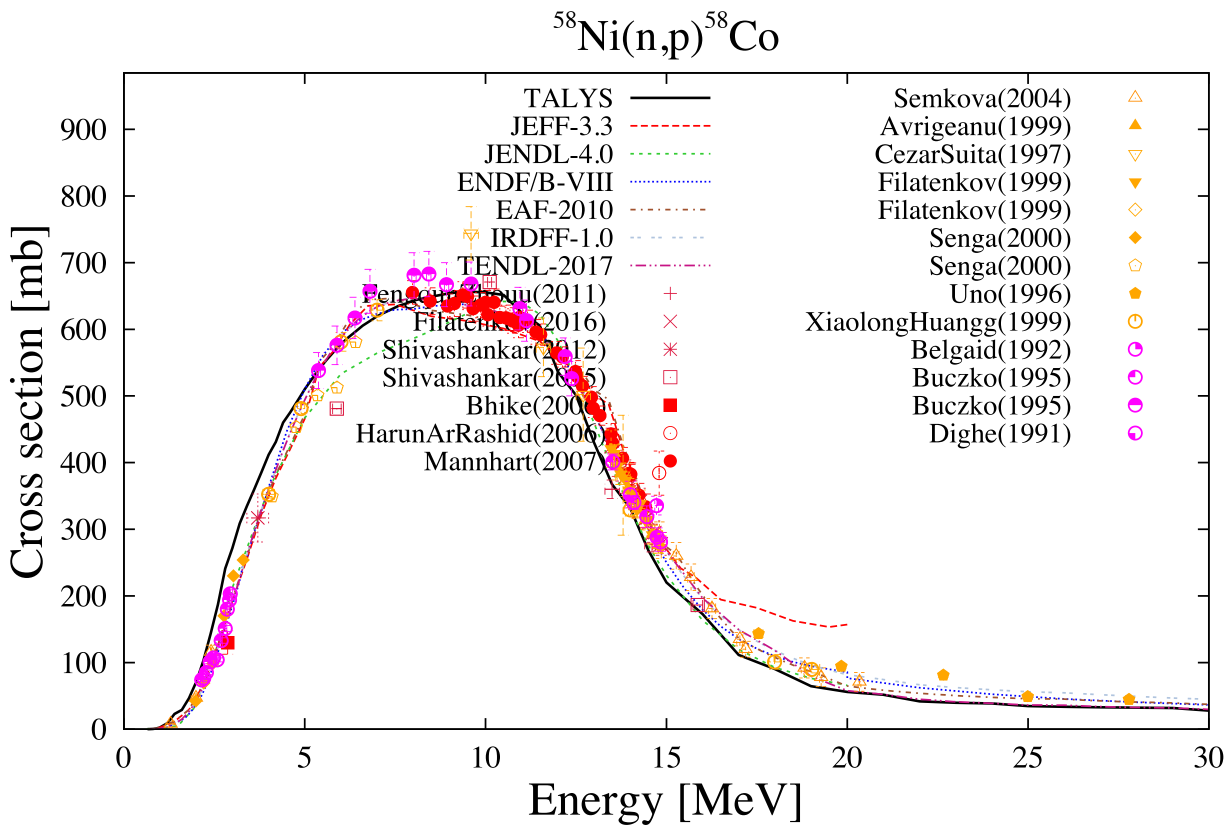
Klochkova (1992) is underestimated
Paper is missing thus the analysis was not performed.

Uno (1996) is underestimated

Reason: The first experimental point is a bit underestimated because of uncertainty related to a lower energy neutron flux in the used technique.

Belgaid (1992) is underestimated

Reason: For the cross section determination the authors used 270.9 d as a half-life of ^{57}Co while the real tabulated value is 271.79 d. The uncertainty related to the timing is one of the possible reasons of underestimation in general. Also there is no explanation of discrimination of (n,np) and (n,d) channels.

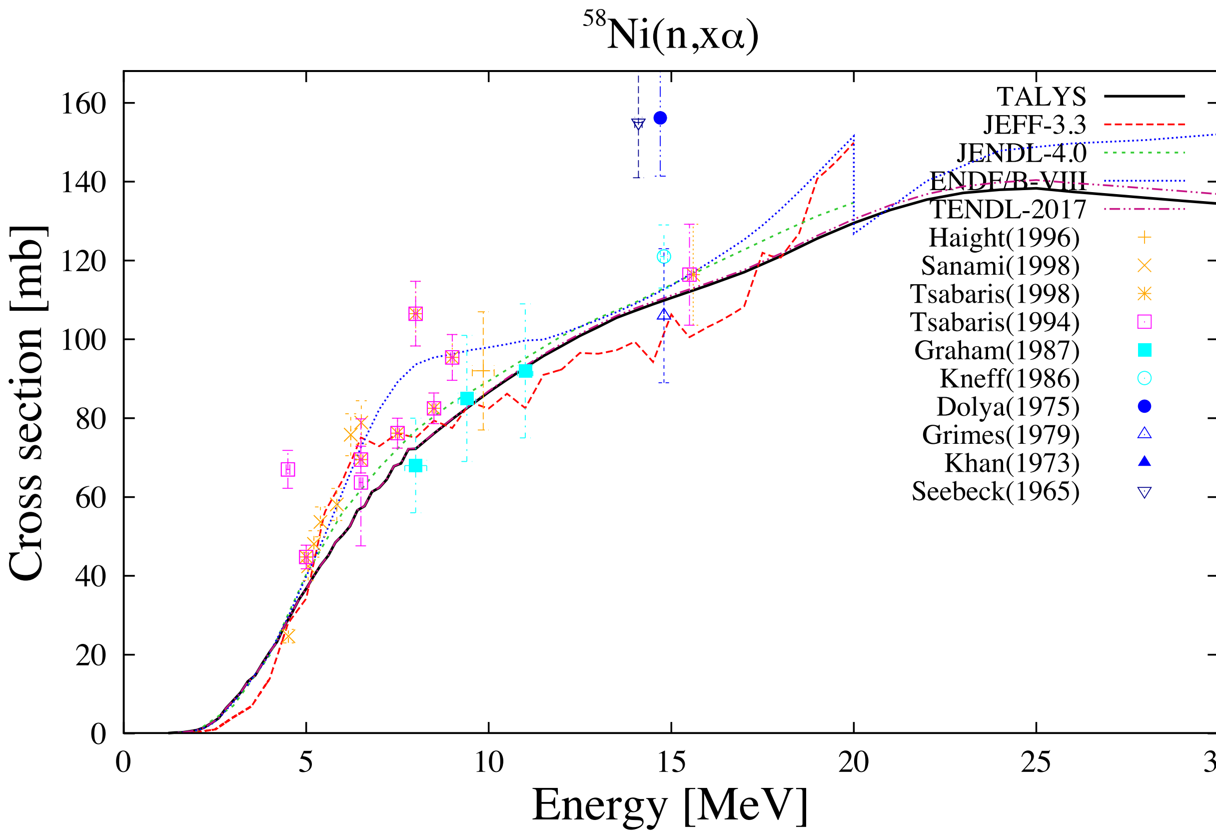


Cezar Suita (1997) is overestimated

Reason: The value is overestimated at 9.6 MeV. Authors have the same overestimation for a similar reaction at this specific energy and it might be a reason of using Equation 2, a second term, which was calculated based on the measured neutron spectrum and cross section value. Since in both cases cross section is overestimated then the neutron spectrum was determined incorrectly, according to the exclusion method, but due to very little information available (even energy of deuterons is missing) it is hard to specify what was wrong. Also p.102, bullet 1, there it is mentioned that the lower energy part of neutron spectrum was restored from other data. But it is know that the neutron spectrum on the detector is unique for each installation.

Harun-Ar-Rashid (2006) is overestimated

Reason: A possible summing of gamma-lines. In the measurements the natural specimens have been used. There is an interfering with the ^{60}Ni(n,t)^{58}Co reaction. Nothing is mentioned about such type of correction.

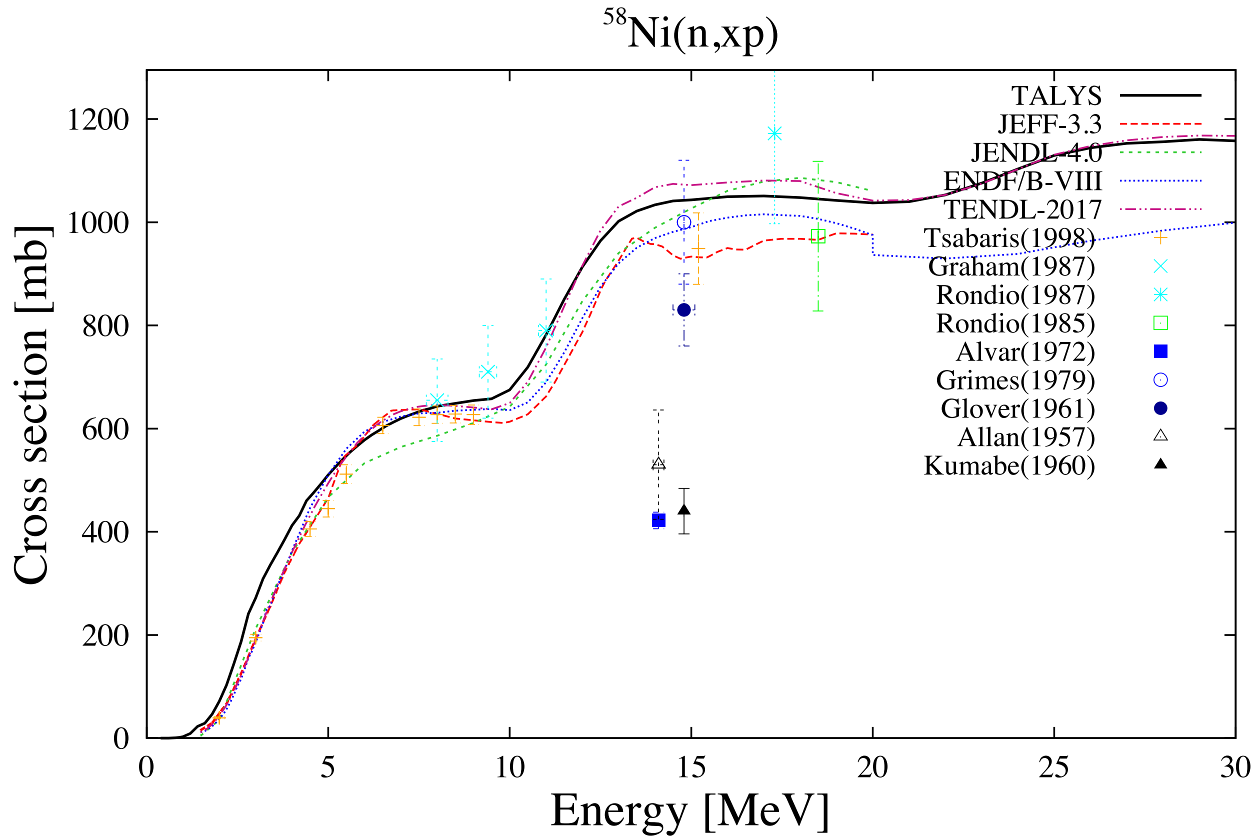


Dolya (1975) is overestimated

Reason: There are almost no details about the experiment and authors are referring to the proceedings. Additionally, they claim that their result is in a good agreement with Seebeck and consider it as a proof/reference.

Seebeck (1965) is overestimated

Reason: The overestimation of cross section took place because of the technical side of the experiment conducting (p. 389). In this experiment CsI(TI) detector was used for detecting α-particles. To the author's point of view, in order to decrease the background it was reasonable to use a thinner scintillator crystal and a layer of Araldite (glue) to connect to the light pipe. But that extra later may be also ionized and lead to extra counts.

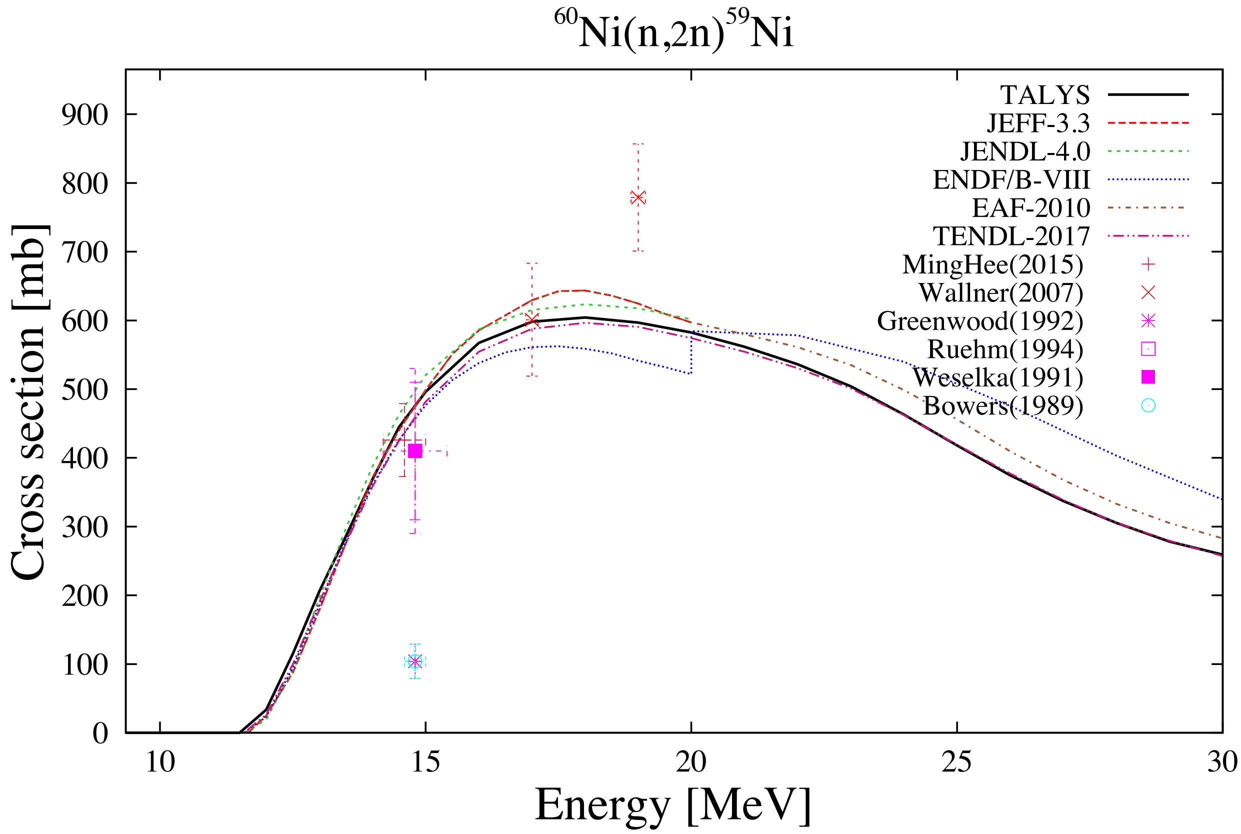


Kumabe (1960) is underestimated

Reason: Low sensitivity of film detector

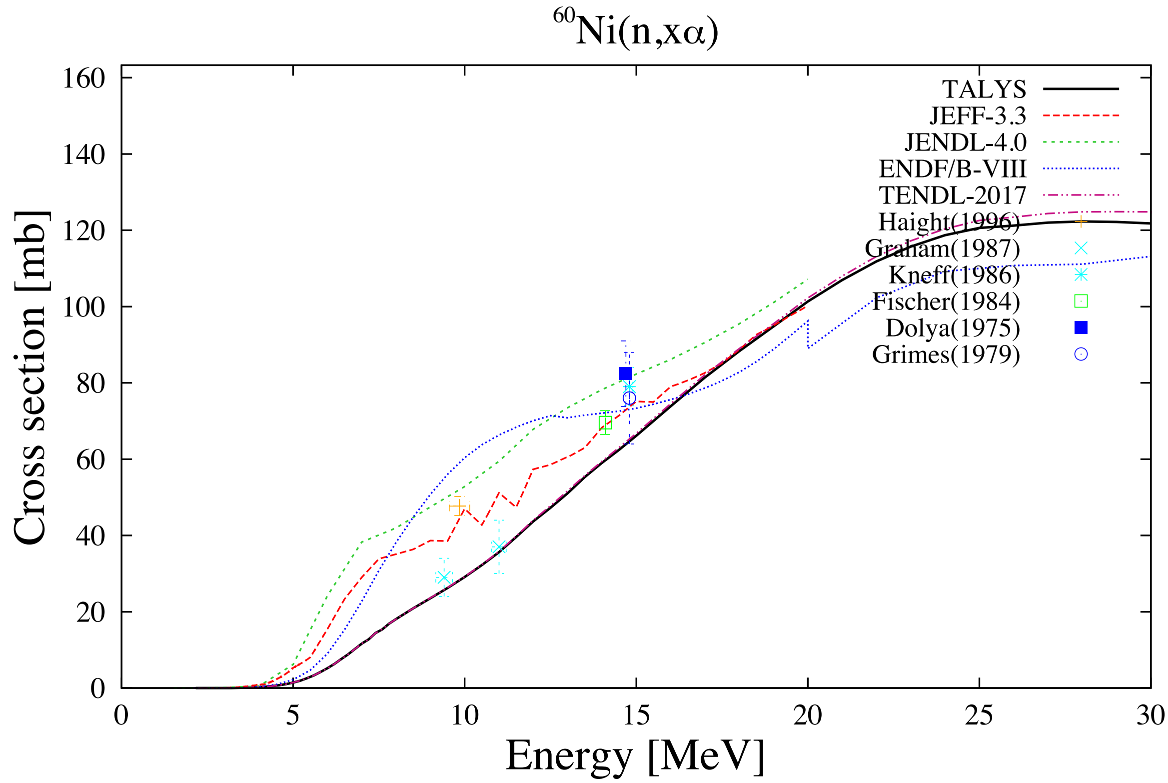
Allan (1957) is underestimated

Reason: Low sensitivity of film detector



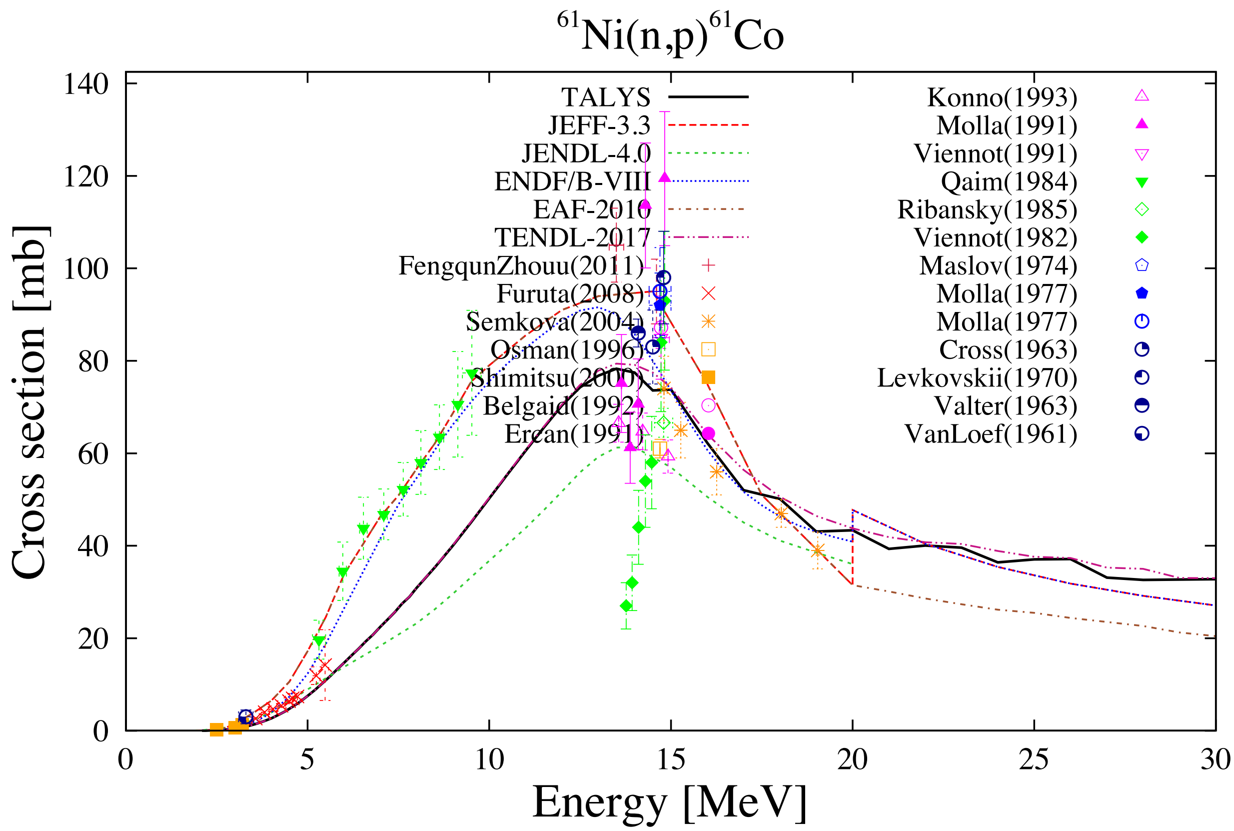
Greenwood and Bowers (1989) is underestimated

Reason: In this case there is a systematic error. Three sequential measurements resulted in the cross section value that is decreasing. That means there is an activity loss during performing a long-term experiment with measurement of X-rays. Apparently their results are non-repeatable within the same experiment.



Graham (1987) is underestimated

Reason: This cross section value is underestimated due to reason of using the enriched ^{60}Ni. Of course in this way the interfering reactions were omitted, but due to a bigger thickness of enriched specimen some extra amount of α-particles were stopped (self-absorption) (page 62). This effect is less pronounced in case of ^{58}Ni, which was also measured at the same time, therefore that cross section is in a good agreement with other experimental data as well as theoretical evaluations.



Qaim (1984) is overestimated.

Reason: In this work authors have been using a SAND II algorithm, which is based on the unfolding iterative process to solve the Fredholm's equation of the first kind. This is the integral equation and the result of unfolding depends on what was the initial approximation at the very first iteration. Therefore authors put at first iteration the distribution they wanted to get at the end. Then this algorithm just improved this initial distribution. But from experience this algorithm does not work well to unfold the peak-like structures. Therefore our point is: the spectral distribution of Qaim is incorrect and does not include a higher energy tail. Additionally the mean energy being calculated for a wrong distribution will be also wrong. Monte Carlo simulations give a tail on the right side of the distributions and it is different to the ones suggested by authors. A bit overestimated neutron flux resulted in the overestimated cross-section value.

Viennot (1982) is underestimated

Reason: In the experiment the author was using a gamma line of 67.4 KeV. There are 2 problems: 1) efficiency calculation is missing as for explanations, 2) Ge(Li) detectors are very difficult to measure low energy gammas because of a thick dead-layer. Therefore a peak count rate should be much less.

Konno (1993) is underestimated

Paper is unavailable therefore the analysis was not performed.

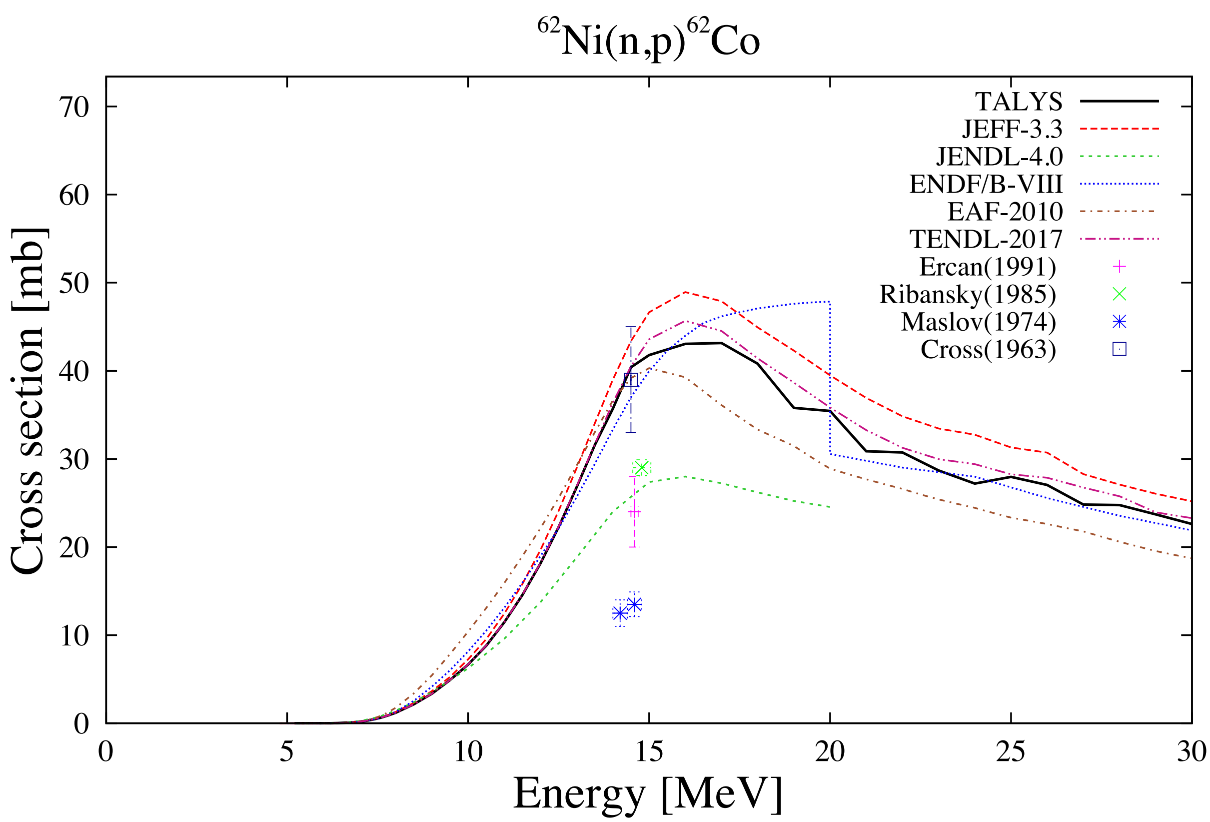
Molla (1977) is overestimated

Reason: In this paper the authors used incorrect quantum yield for 67 keV gamma-line: 97% instead of 84.7%. Should they determine the rest corrections in a right way, their result must be underestimated. Because of overestimation in this case the only reason is incorrect counting efficiency, what is typical for the very low gamma energies. Also in the paper in Table 1 (p. 274) Q value of this reaction is given as +0.51 MeV but it has to be -0.54 MeV.

Molla (1991) is overestimated
Reason: This paper does not contain too explicit explanations of the experiment details.

Belgaid (1992) is overestimated.

Reason: The authors used the natural specimens not enriched. ^{62}Ni has a higher abundance comparing to ^{61}Ni. And the ^{62}Ni(n,d) reaction leads to the same reaction product ^{61}Co so may contribute to the peak area of interest. No information about any corrections.



Cross (1963) Paper is missing. The needed analysis was not performed.

Maslov (1974) is underestimated

Reason: The authors described the measurements of a total cross section. Both (isomeric and ground) states have the same 1.17 MeV gamma-line. If the spectrum measurement was performed after 5 min then they actually counted only isomeric state. No information about needed corrections. This is a reason of underestimation.

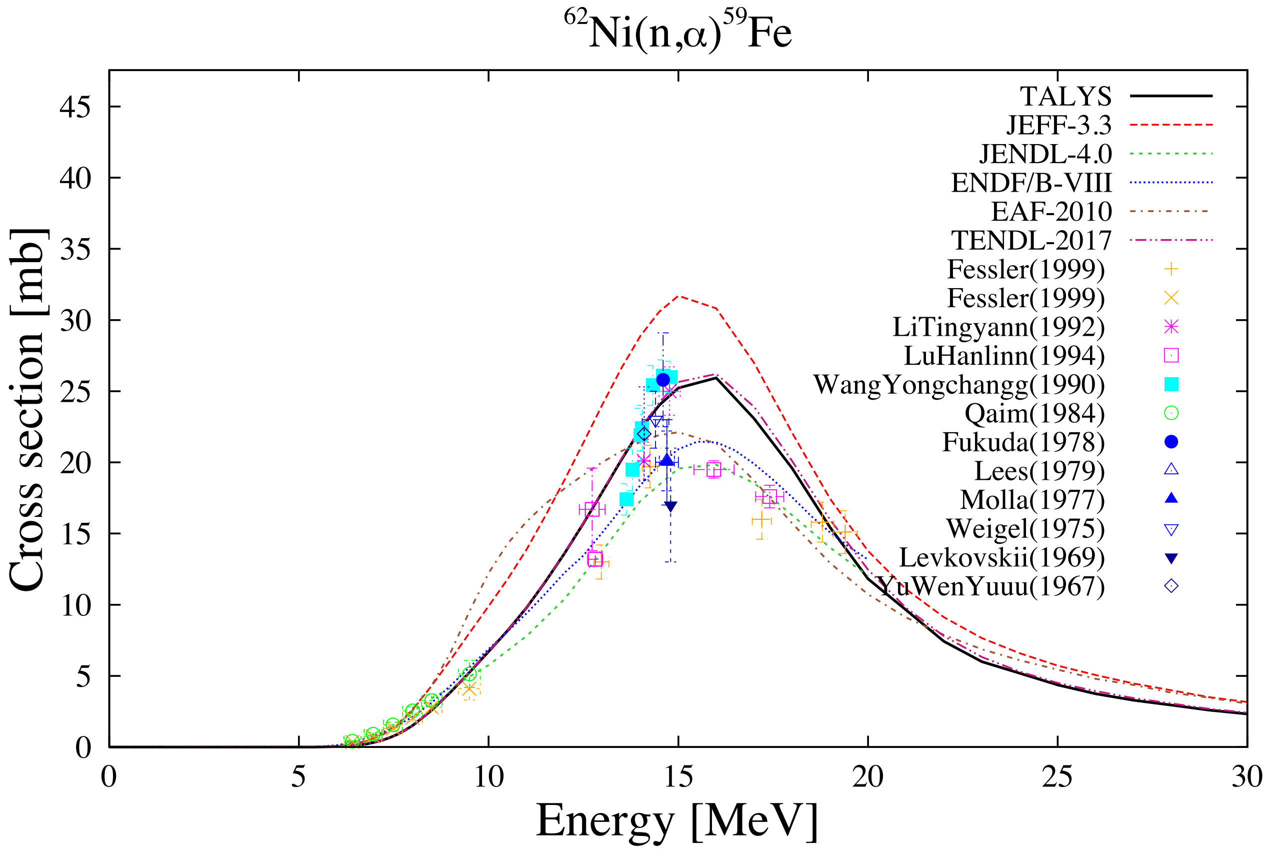
Ercan (1991) is underestimated

Reason: Paper does not contain too many details for the analysis.

Ribansky (1985) is underestimated

Reason:

- $^{64}Ni(n,np)^{63}Co$, $T_{1/2}$ = 27.5 s: four separate irradiations and measurements were carried out, the same decay data were utilized as in recent measurements of Jullich, but results are in striking difference – the cross section estimate of Ribansky and co-authors is 3 times lower in comparison with their result for the same cross-section.
- $^{62}Ni(n,p)^{62m,g}Co$, $T_{1/2}$ = 13.95 min (m-state) and $T_{1/2}$ = 1.5 min (g-state): four separate irradiations and measurements were carried out for the cross section measurement of the m-state and, probably, of g-state. In the same way for this particular reaction channel four separate measurements are necessary to measure only ^{62g}Co because of a short half-life and possibility to count irradiated sample only within first minute after irradiation of Ni, otherwise counting will include both contributions from g- and m-states to the same gamma peak of 1,172.9 keV. For ^{62m}Co counting only one irradiation is needed and several counting may be done after one irradiation only. With such information, most probably, the cross section value of 17.3 mb, presented by authors for g-state, must be assigned only to m-state. Then cross section estimate for g-state (11.7 mb) must be considered as in 2 times lower comparing to other data available and a reason for this case (and for the case 1, above) is, the most probably, due to a poor experimental technique being used for counting and cross section measurements of short-lived reaction products.

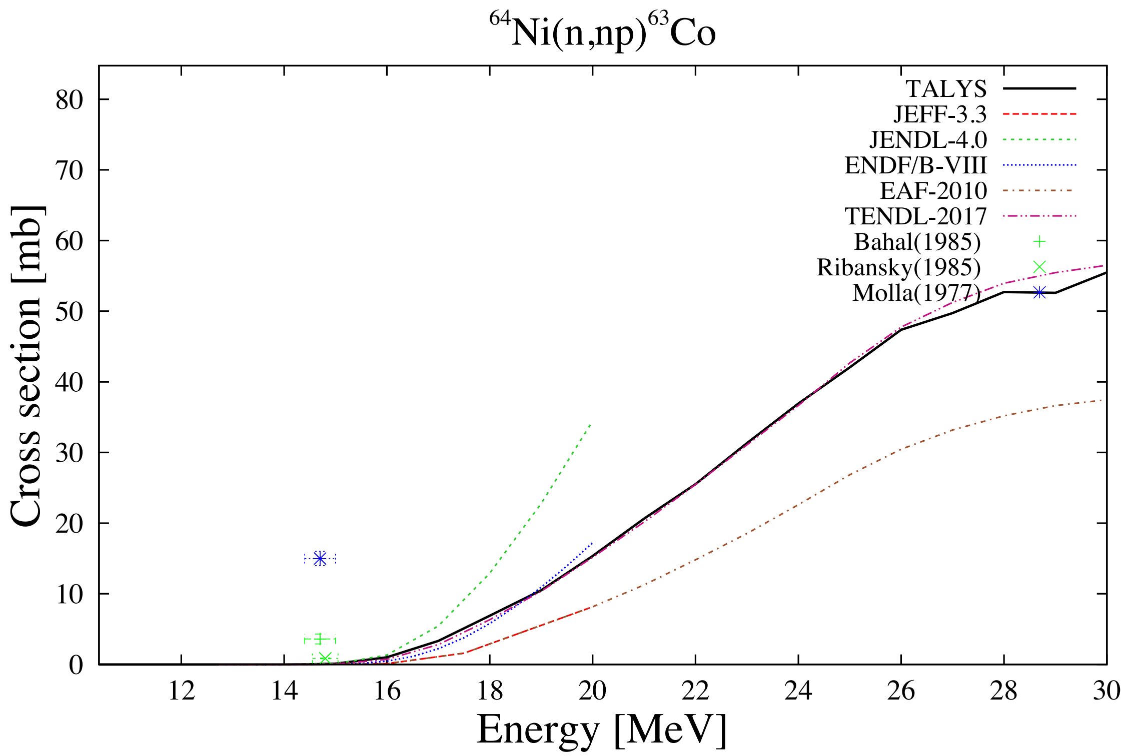


Levkovsliy (1969) is underestimated

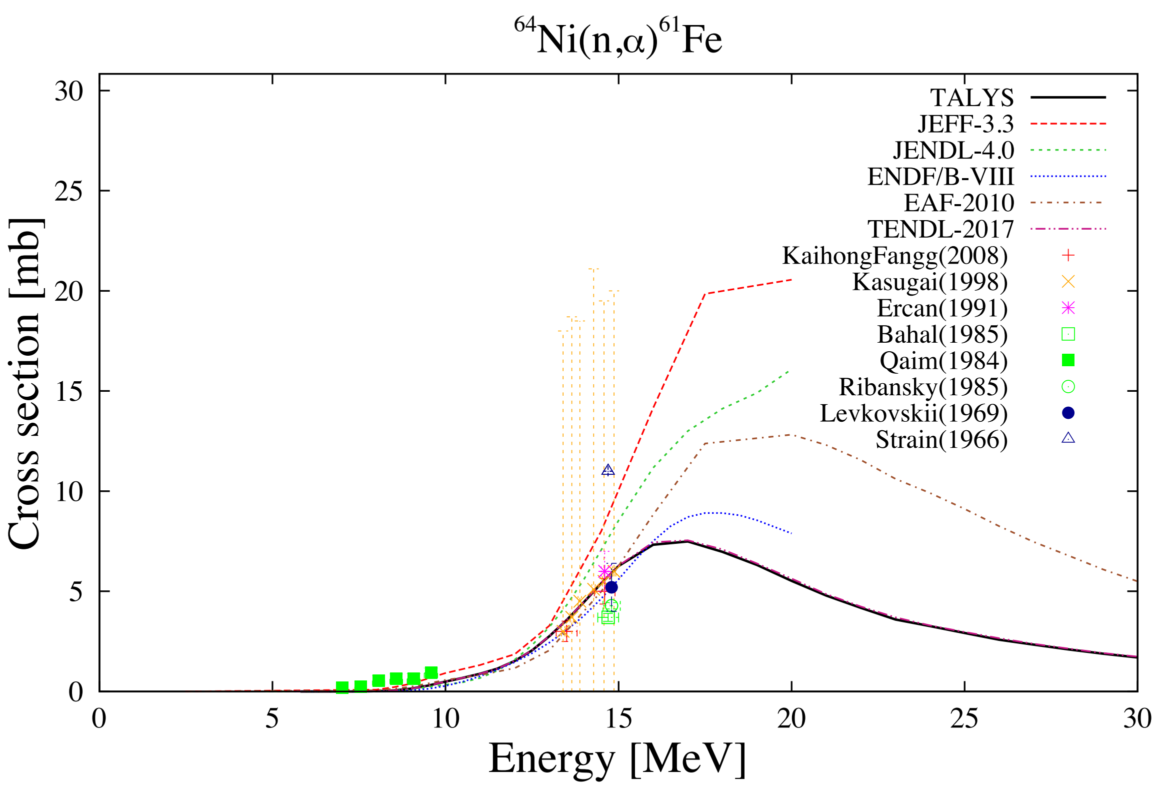
Reason: The authors have measured a 17 mb cross section value but it must be about 25 mb. The possible reason of this small underestimation is using the wrong $T_{1/2}$. In the experiment they used 47 d (^{59}Fe) but the real tabulated value is 44.5 d.

Molla (1977) is underestimated

Reason: This paper is dealing with measurements of (n,p) channel: “A systematic study of (n,p) reactions at 14.7 MeV”. No data about (n,α).



Molla (1977) is overestimated
Reason: The paper does not contain any information about this channel. Author did not measure ^{64}Ni.



Strain (1966) is overestimated

Reason: The cross section is two times overestimated due to a wrong value of quantum yield. Authors used the relative value of 0.48 but it should be 0.214.

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

E-mail: nds.contact-point@iaea.org
Fax: (43-1) 26007
Telephone: (43-1) 2600 21725
Web: http://nds.iaea.org