https://doi.org/10.61092/iaea.b02j-mqm3

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INDC International Nuclear Data Committee

Report on
Quality Assessment of IAEA Medical Isotope Data

Prepared by
Natalie Gaughan

June 2021

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Printed by the IAEA in Austria

June 2021

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Internship report
Natalie Gaughan
Supervisor: Arjan Koning
March 2018 – March 2019

International Atomic Energy Agency
Nuclear Sciences and Applications Department
Physics and Chemistry Division
Nuclear Data Section

Introduction

In the field of medical isotope production, there is ongoing interest in identifying new useful isotopes and new production routes for isotopes already in use. In order to analyse isotope production routes, it is necessary to know cross section and yield data for the relevant reactions.

To this end, the Nuclear Data Section at the IAEA has is interested in consolidating and organizing nuclear reaction data. Many data sets from different experiments are found in the EXFOR database. EXFOR contains cross section and yield data for all types of reactions. TALYS, a code that models nuclear reactions theoretically, is widely used as another way to obtain cross section or yield values. TALYS is particularly important for reactions that have not been studied experimentally very much.

Generally, the best way to get an accurate understanding of a reaction is to use a combination of theoretical and experimental data, considering both TALYS and EXFOR. For this purpose, it is necessary to know how accurate TALYS is, and which experimental data is reliable. The overall purpose of this internship was to assist in evaluating current capabilities of predicting medical isotope production data.

Database

For some reactions that are relevant to medical applications, the experimental data available is not always very reliable. There are several reasons for this, such as unclear cross section definitions, using incorrect (outdated) decay data to calculate beam current, etc.

IAEA-TECDOC-1211 [1] evaluates the available experimental cross section data for several important reactions. Each data set is either "selected" or "deselected" by the TECDOC for use in calculating recommended cross-section and yield values.

The first task of this internship was to build a "database" from IAEA-TECDOC-1211. In this database, each entry has the EXFOR accession number of the data, and a quality score of either 0 or 1. A quality score of 1 indicates that the TECDOC found the data to be acceptable, and a quality score of 0 indicates that the TECDOC says this data should be excluded. This database

includes every reaction in section 5.1 of IAEA-TECDOC-1211, which are reactions that produce diagnostic gamma emitters.

Some special cases arose while compiling this database. For a few publications, the TECDOC does not give an accession number. In these cases, the correct EXFOR entry could usually be found by searching the authors names. In 2 cases, the publications still were not found in EXFOR. In 9 other cases, the accession number given in the TECDOC turned up no results when searched for in EXFOR. It appears that some accession numbers may have changed since the TECDOC was written. In these cases, all but 1 publication were found by searching the authors names in EXFOR.

For 12 publications, EXFOR only has yield values, not cross section values. Other special cases are that a few data sets were deemed acceptable by the TECDOC for a certain energy range only, or after being altered in some way (renormalized or shifted). Additionally, there is now some new data that has been added to EXFOR since the TECDOC was published. These data sets are included in the database but their quality scores have been left blank. The database is included in this report in Appendix 1.

Evaluation of TALYS cross sections

The second main goal of this internship was to evaluate the cross sections calculated by TALYS. For each reaction in section 5.1 of the TECDOC, cross sections were obtained from TALYS and plotted with experimental data. The plots can be found in Appendix 2.

Certain reactions show discrepancies between TALYS and the experimental data. These discrepancies should be examined in the future. It is interesting to note that a few reactions have similar discrepancies. Common trends are that TALYS's excitation function is shifted to low energy, or only the right side (downward slope) is too low, in relation to the experimental data.

Next, some input parameters were adjusted to see how they affect the cross section calculations. The parameters tested were rvadjust n, rvadjust p, gnadjust, gpadjust, aadjust, and ldmodel. In general, aadjust, gnadjust, and gpadjust did not change the cross section very much. rvadjust n generally made little difference or shifted the excitation function to the left. rvadjust p could change the height of the peak. ldmodel 2 and ldmodel 5 generally gave the best results in terms of matching TALYS to the experimental data, because they tend to increase the right side of the curve (shifting the portion of the curve with a downward slope to higher energy). Figures 1-4 show examples of these effects.

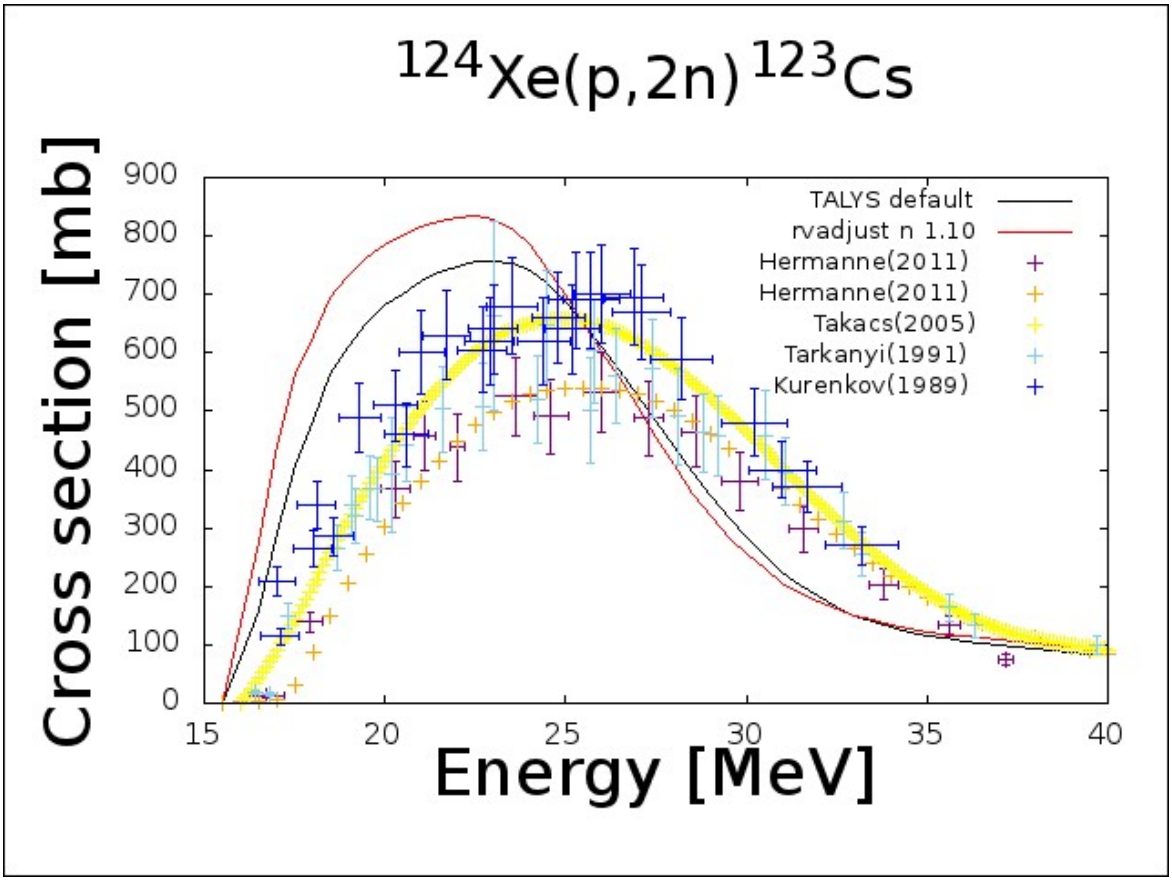


Figure 1. rvadjust n sometimes shifts the excitation function to the left (for both >1 and <1).

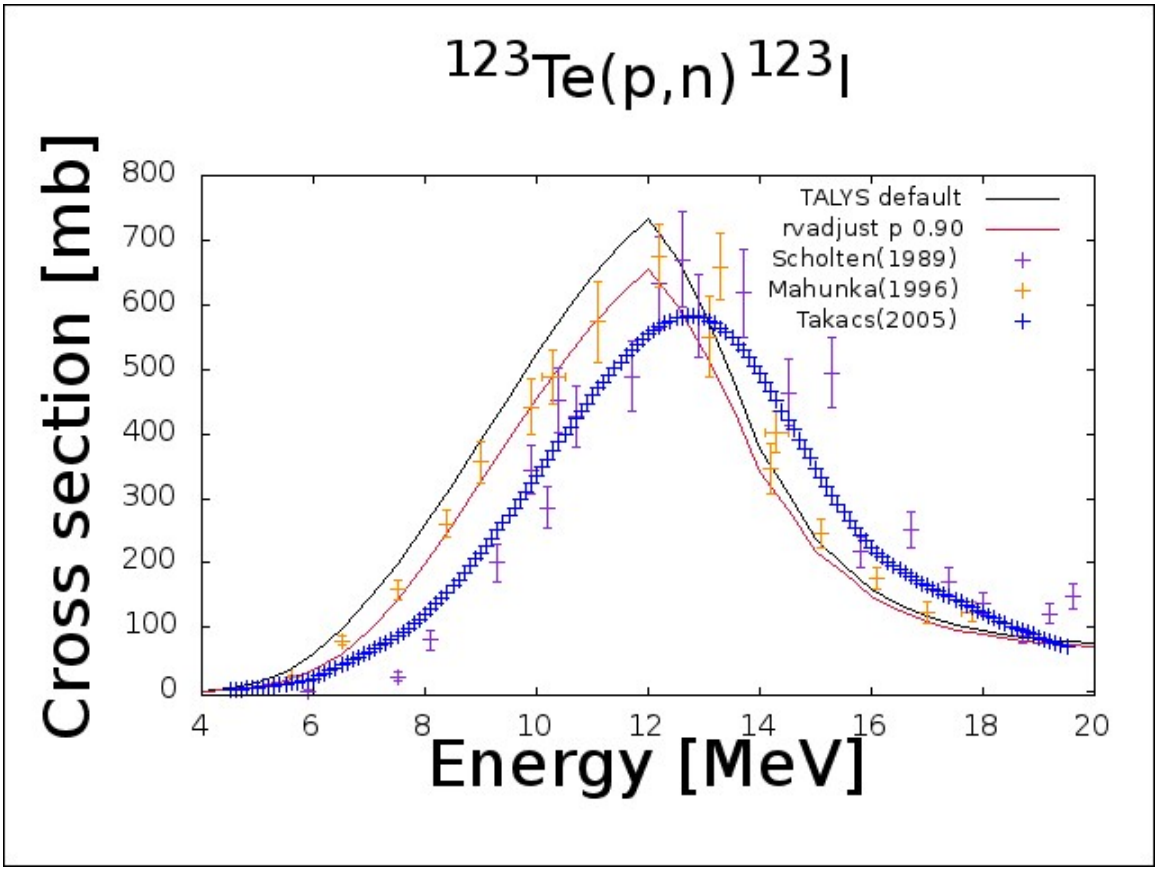


Figure 2. rvadjust p changes the height of the peak.

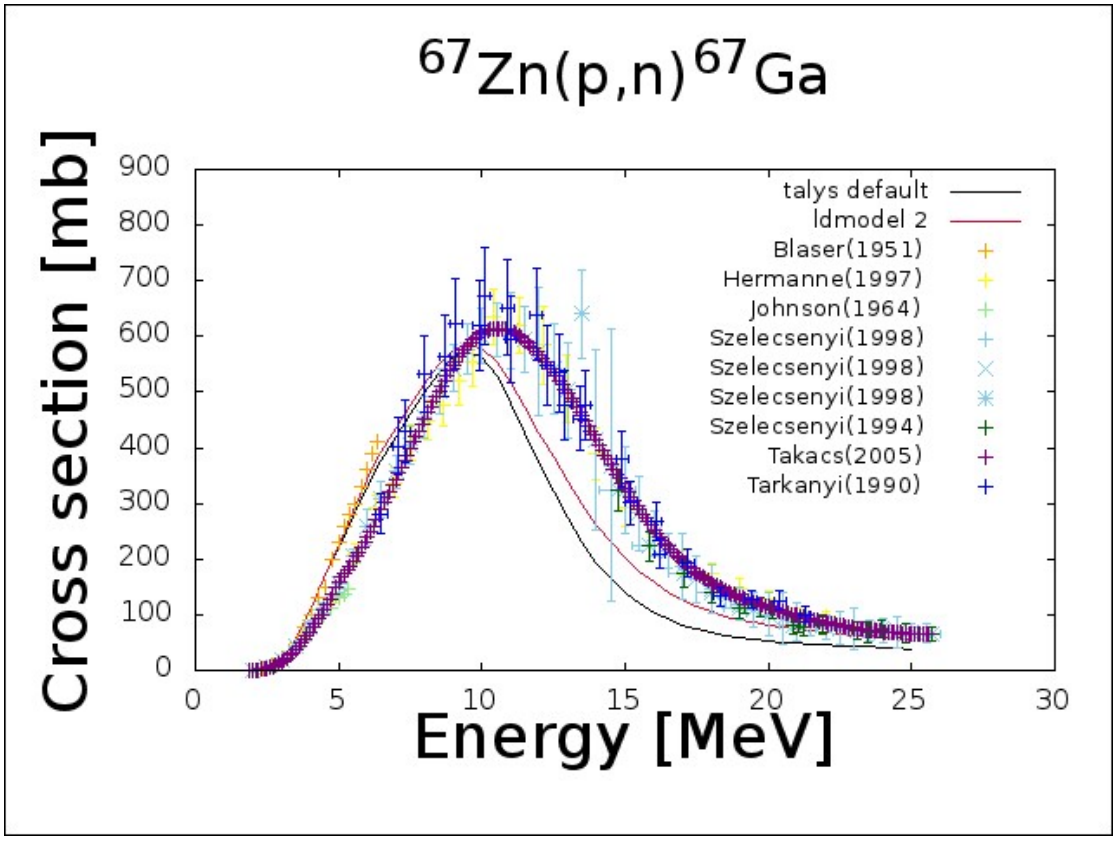


Figure 3. ldmodel often increases the right side of the curve.

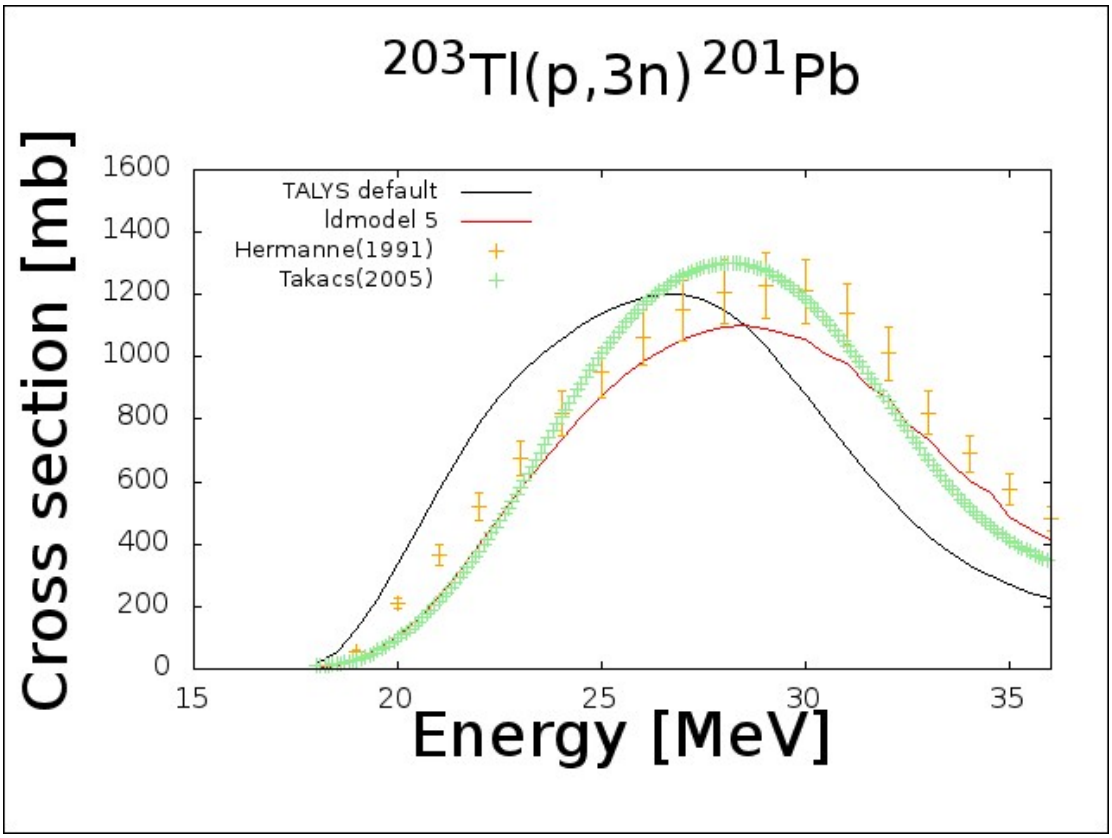


Figure 4. ldmodel 5 often increases the right side of the curve, or shifts the entire curve to the right.

Evaluation of yield calculations from TALYS

The third main task in this internship was to evaluate the yield calculation capabilities in TALYS. As an example, yield calculations for the $^{111}Cd(p,n)^{111}In$ reaction are shown in Figure 5. These were calculated using the TALYS's default setting for irradiation time (1 day) and beam current (1 mA). This reaction was chosen because the cross sections from TALYS match pretty well to experimental data and the TECDOC.

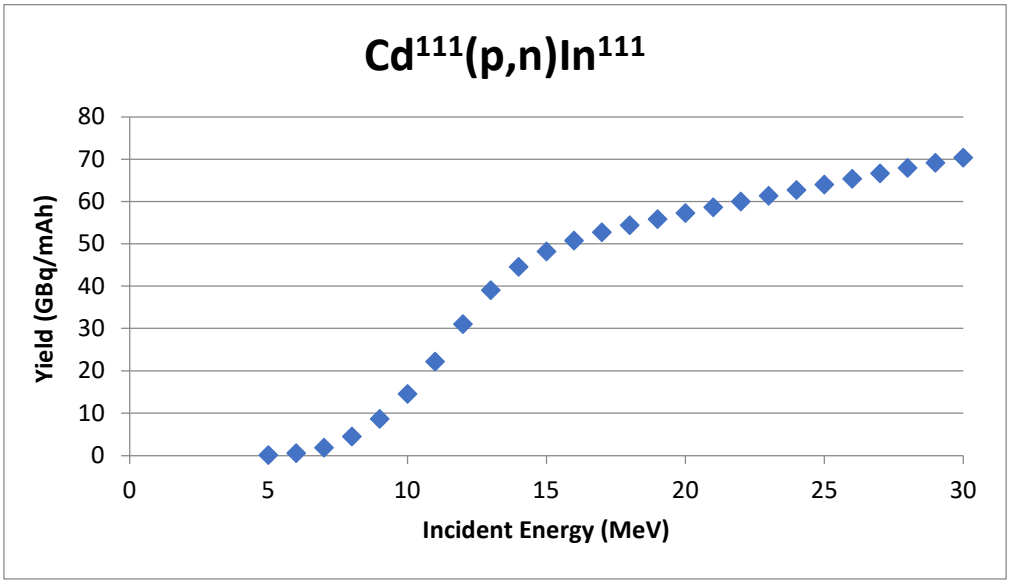


Figure 5. Yield calculated with TALYS for $^{111}Cd(p,n)^{111}In$.

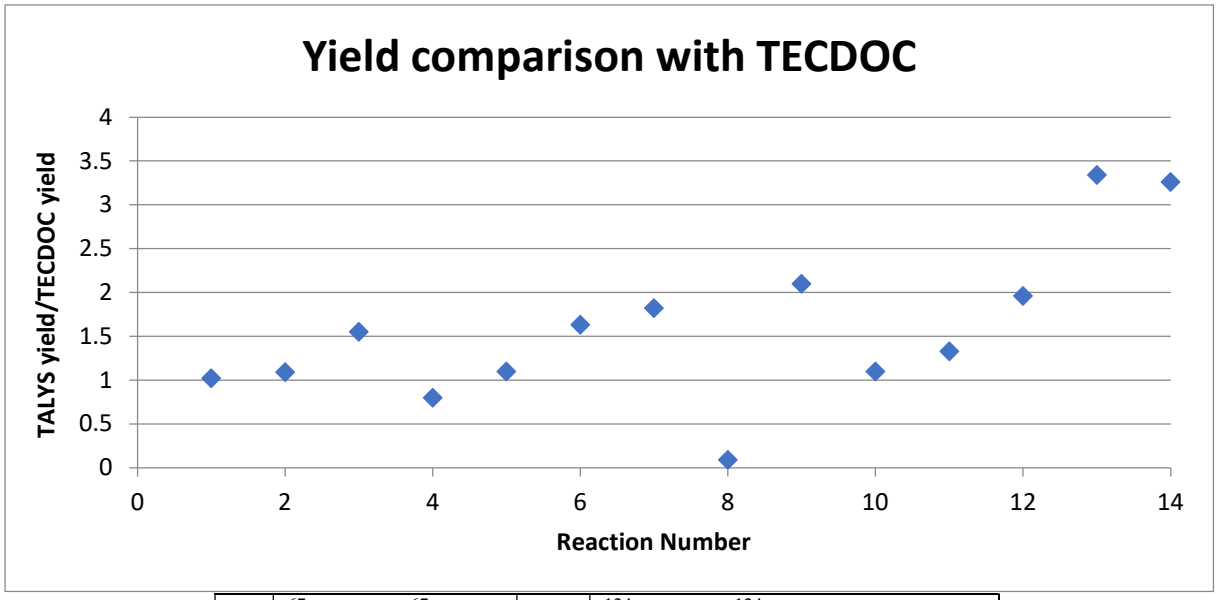
The TECDOC gives recommended yield values for each reaction at a range of incident energies. Yield results from TALYS were compared to these values. Two reactions from TECDOC section 5.1 were not included in this analysis, $^{nat}Kr(p,x)^{81}Rb$, and $^{124}Xe(p,pn)^{123}Xe$. TALYS does not give yield calculations for natural targets (the yield output files show all zeros). For the (p,pn) reaction, there are discrepancies in the experimental data, so the TECDOC does not give recommended yield values.

The result of this evaluation is that TALYS calculates yields correctly, subject to the accuracy of the cross section. When the cross sections calculated by TALYS are correct, then the yield values it gives are also correct.

For example, the TALYS cross sections match the experimental data pretty well for the reaction $^{111}Cd(p,n)^{111}In$. For this reaction, the yield results from TALYS are within 20% of the suggested values in the TECDOC.

Figure 6 shows how TALYS compares to the recommended yields in the TECDOC. The TECDOC gives yield values for a range of incident energies. Yields were calculated in TALYS for each of these energies, and the ratios of the TALYS value to the TECDOC value were calculated at each energy point. Then the ratios were averaged for the energy points in the main part of the excitation function curve. The extremities of the excitation function were not included in the averaging because they often gave a disproportionately worse ratio. From a practical standpoint this is not a big problem because the cross section is so low at those points that even if the ratio is large, the actual values are still small.

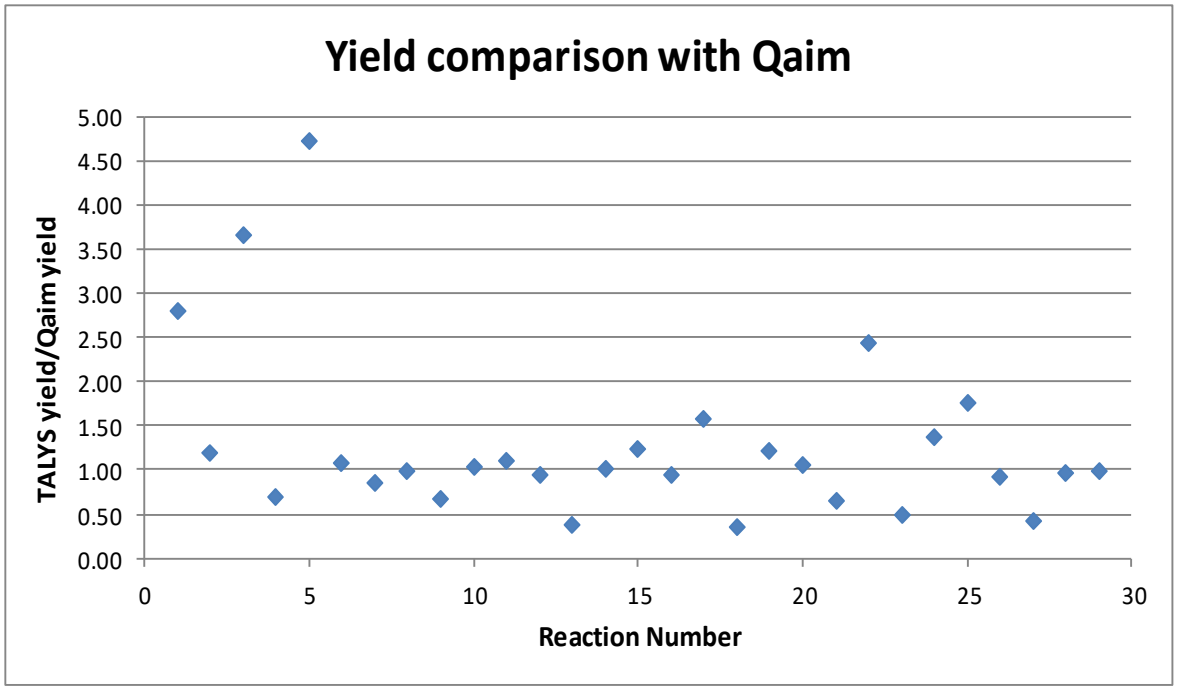
Even for cases where the TALYS cross sections are not as accurate, the yield results still make some sense. If the TALYS cross sections are too high, then the yield values will be similarly high. From this evaluation it can be said that the yield calculation function in TALYS works correctly (provided that the cross sections used to calculate the yield are accurate).



1	^{67}Zn (p,n) ^{67}Ga	8	^{124}Te (p,n) ^{124}I
2	^{68}Zn (p,2n) ^{67}Ga	9	^{127}I (p,5n) ^{123}Xe→^{123}I
3	^{82}Kr (p,2n) ^{81}Rb	10	^{127}I (p,3n) ^{125}Xe→^{125}I
4	^{111}Cd (p,n) ^{111}In	11	^{124}Xe (p,2n) ^{123}Cs→^{123}Xe→^{123}I
5	^{112}Cd (p,2n) ^{111}In	12	^{203}Tl (p,3n) ^{201}Pb→^{201}Tl
6	^{123}Te (p,n) ^{123}I	13	^{203}Tl (p,2n) ^{202m}Pb→^{202}Tl
7	^{124}Te (p,2n) ^{123}I	14	^{203}Tl (p,4n) ^{200}Pb→^{200}Tl

Figure 6. Comparison of TALYS yield results with TECDOC recommended values.

A similar comparison was performed with a 2016 article by Qaim [2], which examines nuclear data needs for radionuclides used in medical applications. This article gives a specific energy range for each reaction, so those values were used as Ebeam and Eback in TALYS. Again, the ratios between the TALYS yield and the yield from this article were calculated. The results are shown in Figure 7.



1	^{38}Ar(p,n)^{38}K	11	^{89}Y(p,n)^{89}Zr	21	^{75}As(p,3n)^{73}Se
2	^{44}Ca(p,n)^{44}Sc	12	^{90}Zr(p,n)^{90}Nb	22	^{76}Se(p,2n)^{75}Br
3	^{45}Sc(p,n)^{45}Ti	13	^{94}Mo(p,n)^{94m}Tc	23	^{79}Br(p,3n)^{77}Kr
4	^{61}Ni(p,n)^{61}Cu	14	^{120}Te(p,n)^{120g}I	24	^{82}Kr(p,2n)^{81}Rb
5	^{62}Ni(p,n)^{62}Cu	15	^{124}Te(p,n)^{124}I	25	^{85}Rb(p,3n)^{83}Sr
6	^{64}Ni(p,n)^{64}Cu	16	^{40}Ar(p,3n)^{38}K	26	^{88}Sr(p,3n)^{86}Y
7	^{66}Zn(p,n)^{66}Ga	17	^{45}Sc(p,2n)^{44}Ti→^{44}Sc	27	^{122}Te(p,2n)^{120g}I
8	^{76}Se(p,n)^{76}Br	18	^{55}Mn(p,4n)^{52}Fe	28	^{125}Te(p,2n)^{124}I
9	^{82}Kr(p,n)^{82m}Rb	19	^{59}Co(p,3n)^{57}Ni	29	^{141}Pr(p,2n)^{140}Nd→^{140}Pr
10	^{86}Sr(p,n)^{86}Y	20	^{75}As(p,4n)^{72}Se→^{72}As		

Figure 7. Comparison of TALYS yield results with Qaim 2016.

Summary

Regarding the reliability of experimental data, the TECDOC is a very useful resource, but it does not include every medical isotope. The document is already 18 years old. A similar evaluation may be needed in the future to evaluate other isotopes that have gained interest in the last 18 years. In some cases, the TECDOC excluded data because the publication was not clear in exactly what quantities were measured/calculated. Perhaps this can be avoided in the future.

As for TALYS, in general the code is fairly accurate. It produces excitation functions with the approximate correct shape and peak height for most reactions. On a more precise level however, there is room for improvement in understanding how to better match the theory to the experimental data. Since TALYS has similar discrepancies for several reactions, such as the right side of the curve being too low, it is possible that the same solution will fix the problem

for all or many reactions. The yield calculation capability in TALYS works properly. As long as the cross section data is accurate, the yields will be accurate as well.

References

[1] "Charged particle cross-section database for medical radioisotope production: diagnostic radioisotopes and monitor reactions," International Atomic Energy Agency, Vienna, Austria, IAEA-TECDOC-1211, 2001.

[2] S. M. Qaim, "Nuclear data for production and medical application of radionuclides: Present status and future needs," *Nuclear Medicine and Biology*, vol. 44, pp. 31-49, Jan. 2017

Appendix 1

Database based on IAEA-TECDOC-1211, Section 5.1 on diagnostic gamma-emitters

Questions and potential problems are color-coded by type.
Key:

- Yellow: not found in EXFOR. TECDOC did not give an EXFOR accession number, and it was not found by searching for the authors or the reaction.
- Neon green: The TECDOC gave an EXFOR number, but the publication/reaction was not found with that number.
- Blue: Same as the neon green case, but the publication/reaction was found in EXFOR with a different accession number by searching the authors
- Pink: EXFOR shows multiple accession numbers for the same publication and reaction, and it was not clear which one is relevant
- Purple: the only EXFOR number found for that reaction and publication was for yields, not cross sections
- Teal: uncertain about target A
- Dark green: The data were adjusted in some way for the TECDOC.

Notes:

- Some data sets are only selected within a certain energy range. In these cases the quality score has format "Quality_1: 1 0. 12." where, in this example, the data is selected between 0 and 12 MeV.
- Some data sets used natural targets.
- Some additional data sets were found in EXFOR that were not mentioned in the TECDOC, and are included in this database with the quality score left blank.
    - Some are (p,x)

Special cases/questions:

- For Zn-68, many sources used a natural target. The TECDOC says this is fine between 17 and 30 MeV because the Zn-67 contribution is negligible in this range (see TECDOC page 160). Does this mean that those data sets are only good in that range?
- TECDOC notes on Kr82(p,2n)Rb81: "The three "production cross-section" measurements for the ^{nat}Kr(p,xn)^{81}Rb process by Acerbi et al. (1981), Steyn et al. (1991) and Kovács et al. (1991), can, however, also be used for evaluation up to 22 MeV after normalisation." (TECDOC page 170)
    - 3 data sets from ^{nat}Kr(p,xn)^{81}Rb are also used for Kr82(p,2n)Rb81, so these 3 appear twice in this database

Zn67(p,n)Ga67 ----------

Projectile: p
Target El : Zn
Target A : 0
Final El : Ga
Final A : 67
X4 ID : O0086017
Quality 1 : 0

Comment 1: IAEA-TECDOC-1211: “Data excluded: although very good agreement exists with the results of other groups up to 10 MeV, it is noted that the rapid decrease of the excitation function in the tail is unusual for a (p,n) reaction in this energy region.”

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : B0048005
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 0
Final El : Ga
Final A : 67
X4 ID : O1062003
Quality 1 : 0
Comment 1: Cross section data from this publication was selected by IAEA-TECDOC-1211. However, O1062003 is yield data, and no cross section data for this publication and reaction was found in EXFOR.

Bonardi, M., Birattati, C.:
Optimization of irradiation parameters for Ga-67 production from Zn(p,xn) nuclear reactions.
J. Radioanalytical Chemistry **76** (1983) 311

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : A0494 (EXFOR does have similar reactions like Zn66 or Zn68, but not this exact reaction)
Quality 1 : 1 0. 12.
Comment 1: IAEA-TECDOC-1211: “Data selected. Remark: Since the values are "estimated" values above 12 MeV based on a ‘tail-fitting’ procedure, the results are used only up to this energy.”

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : T0126012 (TECDOC says B0068)
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn

Target A : 0
Final El : Ga
Final A : 67
X4 ID : D0089003
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : A0510090
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: although the energy position of the cross-section maximum is in good agreement with the majority of the other works, the cross-section values were unexpectedly high over the whole energy range."

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : A03210051
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: energy shift towards higher energy."

Projectile: p
Target El : Zn
Target A : 0
Final El : Ga
Final A : 67
X4 ID : A04980023
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : C05060041 or C05060051 These are identical and one will be deleted from EXFOR.
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga

Final A : 67
X4 ID : D40040031
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : D4093008
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : D40250031
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 67
Final El : Ga
Final A : 67
X4 ID : D41470021
Quality 1 :
Comment 1:

Zn68(p,2n)Ga67 ----------

Projectile: p
Target El : Zn
Target A : 0
Final El : Ga
Final A : 67
X4 ID : O0086017
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 0
Final El : Ga
Final A : 67
X4 ID : O1062003

Quality 1 : 0
Comment 1: Cross section data from this publication was selected by IAEA-TECDOC-1211. However, O1062003 is yield data, and no cross section data for this publication and reaction was found in EXFOR.
Bonardi, M., Birattati, C.:
Optimization of irradiation parameters for Ga-67 production from Zn(p,xn) nuclear reactions.
J. Radioanalytical Chemistry **76** (1983) 311

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : A04940052
Quality 1 : 1
Comment 1: : IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : D40880052
Quality 1 : 1
Comment 1: : IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 0
Final El : Ga
Final A : 67
X4 ID : D0089003
Quality 1 : 0
Comment 1: : IAEA-TECDOC-1211: “Data excluded: cross-section values too low.”

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : A0510094
Quality 1 : 1
Comment 1: : IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67

X4 ID : A03210061
Quality 1 : 0
Comment 1: : IAEA-TECDOC-1211: “Data excluded: energy shift towards higher energy.”

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : B0053003
Quality 1 : 0
Comment 1: : IAEA-TECDOC-1211: “Data excluded: cross-section values too low (even after normalisation by the compiler).”

Projectile: p
Target El : Zn
Target A : 0
Final El : Ga
Final A : 67
X4 ID : A04980023
Quality 1 : 1
Comment 1: : IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : D40040042
Quality 1 : 1
Comment 1: : IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : D4276006
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : E1935006
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : O1002003
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : C05060061
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : D40930091
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : D40250041
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : B0024005
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67

X4 ID : B0050013
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : D41470031
Quality 1 :
Comment 1:

Projectile: p
Target El : Zn
Target A : 68
Final El : Ga
Final A : 67
X4 ID : C05060101
Quality 1 :
Comment 1:

Kr00(p,x)Rb81 ----------

Projectile: p
Target El : Kr
Target A : 0
Final El : Rb
Final A : 81
X4 ID : O0847003
Quality 1 : 0
Comment 1: Cross section data from this publication was selected by IAEA-TECDOC-1211. However, O0847003 is yield data, and no cross-section data for this publication and reaction was found in EXFOR.
Acerbi, E., Birattari, C., Bonardi, M., De Martinis, C., Salomone, A.:
Kr(p,xn) excitation functions and ^{81}Rb-^{81m}Kr generator studies.
Int. J. Applied Radiation Isotopes **32** (1981) 465

Projectile: p
Target El : Kr
Target A : 0
Final El : Rb
Final A : 81
X4 ID : A04890021
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: “Data from natural target excluded, cross-section values too low. Remark: Data on natural Kr (Kovács b) excluded; too low cross-sections values.”

Projectile: p
Target El : Kr
Target A : 82 or 83?
Final El : Rb
Final A : 81
X4 ID : A04890031 (Kr82) or A04890041 (Kr83)
Quality 1 : 1 0. 20.
Comment 1: IAEA-TECDOC-1211: "Data on enriched target selected, after being normalized. Remark: The data measured on enriched target (Kovács a) were normalised and included in the evaluation up to 20 MeV as Kovács, B."

- Unsure which is Kovacs a and which is Kovacs b

Projectile: p
Target El : Kr
Target A : 0
Final El : Rb
Final A : 81
X4 ID : none
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: cross-section values extremely high."

Lamb, J.F., Baker, G.A., Goris, M.L., Khetigan, A., Moore, H.A., Neesan, W.C., Winchell, H.S.:
Production and clinical evaluation of a commercial krypton-81m gas generator and its delivery system.
British, J. Radiology Special Report 15: Clinical and Experimental Applications of Krypton-81m. (ed. Lavender, J.P.) (British Institute of Radiology, London, 1978), p. 23.

Projectile: p
Target El : Kr
Target A : 0
Final El : Rb
Final A : 81
X4 ID : D0115004
Quality 1 : 0
Comment 1: Quality = 0 because this is yield data, not cross-section. No cross-section data was found in EXFOR for this publication and reaction. Data was also excluded by IAEA-TECDOC-1211: "too low cross-section values."

Mulders, J.J.L.:
Yield curves and beam current dependent production rates of Rb radioisotopes produced by protons on a krypton gas target.
Int. J. Applied Radiation Isotopes **35** (1984) 475

Projectile: p
Target El : Kr
Target A : 0
Final El : Rb
Final A : 81
X4 ID : A04990022 or A04990032
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Kr82(p,2n)Rb81 ----------

Projectile: p
Target El : Kr
Target A : 0
Final El : Rb
Final A : 81
X4 ID : O0847003 (36-KR-0(P,X)37-RB-81-G,IND/M+,TTY,,DT)
Quality 1 : 1 0. 22.
Comment 1: IAEA-TECDOC-1211: "Data selected after normalization" (see first paragraph on TECDOC p170)

Projectile: p
Target El : Kr
Target A : 82
Final El : Rb
Final A : 81
X4 ID : A04890031
Quality 1 : 1 0. 22.
Comment 1: IAEA-TECDOC-1211: "Data selected after normalization" (see first paragraph on TECDOC p170)

Projectile: p
Target El : Kr
Target A : 0
Final El : Rb
Final A : 81
X4 ID : A04890021
Quality 1 : 1 0. 22.
Comment 1: IAEA-TECDOC-1211: Data selected after normalization" (see first paragraph on TECDOC p170)

Projectile: p
Target El : Kr
Target A : 0
Final El : Rb
Final A : 81
X4 ID : A04990022 or A04990032
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Cd111(p,n)In111----------

Projectile: p
Target El : Cd
Target A : 111
Final El : In

Final A : 111
X4 ID : B0048010
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 111
Final El : In
Final A : 111
X4 ID : B0052016
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 111
Final El : In
Final A : 111
X4 ID : A0335005
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 0
Final El : In
Final A : 111
X4 ID : A05000023
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 111
Final El : In
Final A : 111
X4 ID : P0019006
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 111
Final El : In
Final A : 111
X4 ID : A01350022
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 111
Final El : In
Final A : 111
X4 ID : A0001004
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 111
Final El : In
Final A : 111
X4 ID : D4027002
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 111
Final El : In
Final A : 111
X4 ID : T0124008 (TECDOC says B0065)
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Cd
Target A : 111
Final El : In
Final A : 111
X4 ID : C0345002
Quality 1 :
Comment 1:

Cd112(p,2n)In111----------

Projectile: p
Target El : Cd
Target A : 112
Final El : In
Final A : 111
X4 ID : C0345003
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: values reported only above the investigated energy range."

Projectile: p

Target El : Cd
Target A : 112
Final El : In
Final A : 111
X4 ID : P0019011
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Cd
Target A : 112
Final El : In
Final A : 111
X4 ID : A0001007
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Cd
Target A : 112
Final El : In
Final A : 111
X4 ID : D4027007
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Cd
Target A : 112
Final El : In
Final A : 111
X4 ID : D4320002
Quality 1 :
Comment 1:

Projectile: p
Target El : Cd
Target A : 112
Final El : In
Final A : 111
X4 ID : C0392005
Quality 1 :
Comment 1:

Te123(p,n)I123 ----------

Projectile: p
Target El : Te
Target A : 0

Final El : I
Final A : 123
X4 ID : A0266002
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: shifted to higher energies. Remark: the compiler calculated the cross-sections for the above reaction up to the threshold energy of the ^{124}Te(p,2n) reaction using the results measured on natural tellurium targets."

Projectile: p
Target El : Te
Target A : 123
Final El : I
Final A : 123
X4 ID : D0093002
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: only one low energy point reported, too low cross-section value."

Projectile: p
Target El : Te
Target A : 123
Final El : I
Final A : 123
X4 ID : none
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Hupf, H.B., Eldridge, J.S., Beaver, J.S.:
Production of iodine-123 for medical applications.
Int. J. Applied Radiation Isototopes **19** (1968) 345

Projectile: p
Target El : Te
Target A : 123
Final El : I
Final A : 123
X4 ID : D4142002
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Te
Target A : 123
Final El : I
Final A : 123
X4 ID : A04730021
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211: "Data selected. Remark: The compiler also calculated the cross-sections for the above reaction up to the threshold energy of the ^{124}Te(p,2n) reaction using the results measured on natural tellurium targets."

The TECDOC says that two data sets were taken from this source but does not explain the difference between the two. Is it from the natural target, A0473004?

Projectile: p
Target El : Te
Target A : 0
Final El : I
Final A : 123
X4 ID : B01670021 or B01670031 (unsure which)
Quality 1 : 0
Comment 1: Quality = 0 because this is yield data, not cross-section. No cross-section data was found in EXFOR for this publication and reaction. Data was also excluded by IAEA-TECDOC-1211: "shifted to higher energies, too high cross-section values."
Van den Bosch, R., De Goeij, J.J.M., Van der Heide, J.A., Tertoolen, W., Theelen, H.M.J., Zegers, C.:
A new approach to target chemistry for the iodine-123 production via the ^{124}Te(p,2n) reaction.
Int. J. Applied Radiation Isotopes **28** (1977) 255

Projectile: p
Target El : Te
Target A : 0
Final El : I
Final A : 123
X4 ID : O1260002
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: systematically too low cross-section values. Remark: The compiler calculated the cross-sections for the above reaction up to the threshold energy of the ^{124}Te(p,2n) reaction using the results measured on natural tellurium targets."

Te124(p,2n)I123 ----------

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 123
X4 ID : A0266008
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: significantly higher than those of the other authors."

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 123
X4 ID : B00900032

Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.
Kondo a and Kondo b have different enrichments according to the TECDOC, but it is not clear what the enrichments are (See p188 of TECDOC)
Kondo, K., Lambrecht, R.M., Wolf, A.P.:
^{123}I production for radiopharmaceuticals-XX. Excitation functions of the ^{124}Te(p,2n)^{123}I and ^{124}Te(p,n)^{124}I reactions and effect of target enrichment on radionuclidic purity.
Int. J. Applied Radiation Isotopes **28** (1977) 395

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 123
X4 ID : B00900031
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.
Kondo a and Kondo b have different enrichments according to the TECDOC, but I'm not sure what the enrichments are (See p188 of TECDOC)
Kondo, K., Lambrecht, R.M., Wolf, A.P.:
^{123}I production for radiopharmaceuticals-XX. Excitation functions of the ^{124}Te(p,2n)^{123}I and ^{124}Te(p,n)^{124}I reactions and effect of target enrichment on radionuclidic purity.
Int. J. Applied Radiation Isotopes **28** (1977) 395

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 123
X4 ID : D4019003
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Te
Target A : 0
Final El : I
Final A : 123
X4 ID : B01670021 or B01670031 (unsure which)
Quality 1 : 0
Comment 1: Quality = 0 because this is yield data, not cross-section. No cross-section data was found in EXFOR for this publication and reaction. Data was also excluded by IAEA-TECDOC-1211: "values are significantly higher than those of the other authors."
Van den Bosch, R., De Goeij, J.J.M., Van der Heide, J.A., Tertoolen, W., Theelen, H.M.J., Zegers, C.:
A new approach to target chemistry for the iodine-123 production via the ^{124}Te(p,2n) reaction.
Int. J. Applied Radiation Isotopes **28** (1977) 255

Projectile: p

Target El : Te
Target A : 124
Final El : I
Final A : 123
X4 ID : C0346004
Quality 1 :
Comment 1:

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 123
X4 ID : B0071009
Quality 1 :
Comment 1:

Te124(p,n)I124 ----------

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 124
X4 ID : A0266009
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 124
X4 ID : B00900022
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: energy shift towards higher energies. Remark: 2 sets of data are available on targets of different enrichments and are included (Kondo a and Kondo b, see Fig. 5.1.9a [on page 193 of TECDOC])."
Kondo a and Kondo b have different enrichments according to the TECDOC, but it's unclear what the enrichments are.
Kondo, K., Lambrecht, R.M., Wolf, A.P.:
^{123}I production for radiopharmaceuticals-XX. Excitation functions of the ^{124}Te(p,2n)^{123}I and ^{124}Te(p,n)^{124}I reactions and effect of target enrichment on radionuclidic purity.
Int. J. Applied Radiation Isotopes **28** (1977) 395

Projectile: p
Target El : Te
Target A : 124
Final El : I

Final A : 124
X4 ID : B00900021
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: energy shift towards higher energies. Remark: 2 sets of data are available on targets of different enrichments and are included (Kondo a and Kondo b, see Fig. 5.1.9a [on page 193 of TECDOC])."
Kondo a and Kondo b have different enrichments according to the TECDOC, but it's unclear what the enrichments are.

Kondo, K., Lambrecht, R.M., Wolf, A.P.:
^{123}I production for radiopharmaceuticals-XX. Excitation functions of the ^{124}Te(p,2n)^{123}I and ^{124}Te(p,n)^{124}I reactions and effect of target enrichment on radionuclidic purity.
Int. J. Applied Radiation Isotopes **28** (1977) 395

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 124
X4 ID : D4019002
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected

Projectile: p
Target El : Te
Target A : 0
Final El : I
Final A : 124
X4 ID : A0473003
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: energy shift towards higher energies."

Projectile: p
Target El : Te
Target A : 0
Final El : I
Final A : 124
X4 ID : B01670032
Quality 1 : 0
Comment 1: Quality = 0 because this is yield data, not cross-section. No cross-section data was found in EXFOR for this publication and reaction. Data was also excluded by IAEA-TECDOC-1211: "energy shift towards higher energies"

Van den Bosch, R., De Goeij, J.J.M., Van der Heide, J.A., Tertoolen, W., Theelen, H.M.J., Zegers, C.:
A new approach to target chemistry for the iodine-123 production via the ^{124}Te(p,2n) reaction.
Int. J. Applied Radiation Isotopes **28** (1977) 255

Projectile: p
Target El : Te
Target A : 0

Final El : I
Final A : 124
X4 ID : O1260003
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: “Data excluded: energy shift towards higher energies.”

Projectile: p
Target El : Te
Target A : 124
Final El : I
Final A : 124
X4 ID : B0071008
Quality 1 :
Comment 1:

^{127}I(p,5n)^{123}Xe→^{123}I ----------

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : O0306003
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : B0081004
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211: “Data selected. Remark: Data were adjusted upwards by 30% because the authors used a very old gamma abundance value which is higher than the more recent values.”

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : A03630041
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127

Final El : Xe
Final A : 123
X4 ID : D0116006
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: “Data excluded: cross-section values too low.”

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : A0161002
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : E1867015
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : R00070021
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : E1868002
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : A0265002 (TECDOC says R0024)
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : A0062002A
Quality 1 :
Comment 1:

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : B0148002
Quality 1 :
Comment 1:

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : R00050022
Quality 1 :
Comment 1:

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : A0918013
Quality 1 :
Comment 1:

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 123
X4 ID : C0967004
Quality 1 :
Comment 1: (p,x)

^{127}I(p,3n)^{125}Xe→^{125}I ----------

Projectile: p

Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : O0306004
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : B0081003
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211: "Data selected. Remark: Data were corrected upwards by 30% because the authors used a very old γ-abundance value."

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : A03630031
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : D0116005
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : A0161003
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125

X4 ID : E1867014
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : R00070022
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : E1868003
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : A0265003 (TECDOC says R0024)
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : O0768338
Quality 1 :
Comment 1:

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : A0062002B
Quality 1 :
Comment 1:

Projectile: p

Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : R00050023
Quality 1 :
Comment 1:

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : O2052013
Quality 1 :
Comment 1: (p,x)

Projectile: p
Target El : I
Target A : 127
Final El : Xe
Final A : 125
X4 ID : C0967005
Quality 1 :
Comment 1: (p,x)

^{124}Xe(p,2n)^{123}Cs→^{123}Xe →^{123}I ----------

Projectile: p
Target El : Xe
Target A : 124
Final El : Cs
Final A : 123
X4 ID : A04360021
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Xe
Target A : 124
Final El : Cs
Final A : 123
X4 ID : D4029002
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Xe
Target A : 124

Final El : Cs
Final A : 123
X4 ID : D4238002
Quality 1 :
Comment 1:

^{124}Xe(p,pn)^{123}Xe→^{123}I ----------

Projectile: p
Target El : Xe
Target A : 124
Final El : Xe
Final A : 123
X4 ID : A04360022
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Xe
Target A : 124
Final El : Xe
Final A : 123
X4 ID : D4029003
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Xe
Target A : 124
Final El : Xe
Final A : 123
X4 ID : D4238004
Quality 1 :
Comment 1:

Projectile: p
Target El : Xe
Target A : 124
Final El : Xe
Final A : 123
X4 ID : D4238003
Quality 1 :
Comment 1: (p,x)

Tl203(p,3n)Pb201 -> Tl201----------

Projectile: p
Target El : Tl

Target A : 203
Final El : Pb
Final A : 201
X4 ID : C1027002
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: “Data excluded: cross-section values too low.”

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 201
X4 ID : D0114007
Quality 1 : 0
Comment 1: Cross section data from this publication was selected by IAEA-TECDOC-1211. However, D0114007 is yield data, and no cross-section data for this publication and reaction was found in EXFOR.
Bonardi, M., Birattari, C., Salomone, A.:
^{201}Tl production for medical use by (p,xn) nuclear reactions on Tl and Hg natural and enriched targets.
Proc. Int. Conf. Nuclear Data for Science and Technology, September 1982, Antwerp, Belgium (ed. Böckhoff, K.H.), D. Riedel, The Netherlands (1983) 916
Additional information in: F. Girardi, L. Goetz, E. Sabbioni, E. Marafante, M. Merlini, E. Acerbi, C. Birattari, M. Castiglioni, F. Resmini
Preparation of ^{203}Pb compounds for studies on pathways and effects of lead pollution

Projectile: p
Target El : Tl
Target A : 0
Final El : Pb
Final A : 201
X4 ID : D0114003
Quality 1 : 0
Comment 1: Quality = 0 because this is yield data, not cross-section. No cross-section data was found in EXFOR for this publication and reaction. Data was also excluded by IAEA-TECDOC-1211: “Data on natural targets excluded: cross-section values too low.”
Bonardi, M., Birattari, C., Salomone, A.:
^{201}Tl production for medical use by (p,xn) nuclear reactions on Tl and Hg natural and enriched targets.
Proc. Int. Conf. Nuclear Data for Science and Technology, September 1982, Antwerp, Belgium (ed. Böckhoff, K.H.), D. Riedel, The Netherlands (1983) 916
Additional information in: F. Girardi, L. Goetz, E. Sabbioni, E. Marafante, M. Merlini, E. Acerbi, C. Birattari, M. Castiglioni, F. Resmini
Preparation of ^{203}Pb compounds for studies on pathways and effects of lead pollution

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 201

X4 ID : A04940022
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 201
X4 ID : T0148005 (TECDOC says B0168)
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 201
X4 ID : C1028002
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: cross-section values too low."

Projectile: p
Target El : Tl
Target A : 00
Final El : Pb
Final A : 201
X4 ID : P0013003 (TECDOC says P013 – This seems to be a typo in the TECDOC)
Quality 1 : 0
Comment 1: IAEA-TECDOC-1211: "Data excluded: discrepant."

Projectile: p
Target El : Tl
Target A : 00
Final El : Pb
Final A : 201
X4 ID : A0185005
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Tl203(p,2n)Pb202m -> Tl202----------

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 202m
X4 ID : D0114008
Quality 1 : 0

Comment 1: Cross section data from this publication was selected by IAEA-TECDOC-1211. However, D0114008 is yield data, and no cross-section data for this publication and reaction was found in EXFOR.

Bonardi, M., Birattari, C., Salomone, A.:
^{201}Tl production for medical use by (p,xn) nuclear reactions on Tl and Hg natural and enriched targets.
Proc. Int. Conf. Nuclear Data for Science and Technology, September 1982, Antwerp, Belgium (ed. Böckhoff, K.H.), D. Reidel, The Netherlands (1983) 916
Additional information in: F. Girardi, L. Goetz, E. Sabbioni, E. Marafante, M. Merlini, E Acerbi, C. Birattari, M. Castiglioni, F. Resmini
Preparation of ^{203}Pb compounds for studies on pathways and effects of lead pollution
Int. J. Applied Radiation Isotopes **26** (1975) 267

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 202m
X4 ID : A04940021
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 202m
X4 ID : T0148008 (TECDOC says B0168)
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Projectile: p
Target El : Tl
Target A : 00
Final El : Pb
Final A : 202m
X4 ID : A0185004
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

Tl203(p,4n)Pb200 -> Tl200----------

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 200
X4 ID : C1027003 or C1027004
Quality 1 : 0

Comment 1: IAEA-TECDOC-1211: “Data excluded: only data sets that were selected for the ^{203}Tl(p,3n)^{201}Pb reaction were considered.”

Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 200
X4 ID : D0114006
Quality 1 : 0
Comment 1: Cross section data from this publication was selected by IAEA-TECDOC-1211. However, D0114006 is yield data, and no cross-section data for this publication and reaction was found in EXFOR.
Bonardi, M., Birattari, C., Salomone, A.:
^{201}Tl production for medical use by (p,xn) nuclear reactions on Tl and Hg natural and enriched targets.
Proc. Int. Conf. Nuclear Data for Science and Technology, September 1982, Antwerp, Belgium (ed. Böckhoff, K.H.), D. Reidel, The Netherlands (1983) 916
Additional information in: F. Girardi, L. Goetz, E. Sabbioni, E. Marafante, M. Merlini, E Acerbi, C. Birattari, M. Castiglioni and F. Resmini
Preparation of ^{203}Pb compounds for studies on pathways and effects of lead pollution
Int. J. Applied Radiation Isotopes **26** (1975) 267

Projectile: p
Target El : Tl
Target A : 00
Final El : Pb
Final A : 200
X4 ID : D0114002
Quality 1 : 0
Comment 1: Quality = 0 because this is yield data, not cross-section. No cross-section data was found in EXFOR for this publication and reaction. Data was also excluded by IAEA-TECDOC-1211: “Data on natural targets excluded.”
Bonardi, M., Birattari, C., Salomone, A.:
^{201}Tl production for medical use by (p,xn) nuclear reactions on Tl and Hg natural and enriched targets.
Proc. Int. Conf. Nuclear Data for Science and Technology, September 1982, Antwerp, Belgium (ed. Böckhoff, K.H.), D. Reidel, The Netherlands (1983) 916
Additional information in: F. Girardi, L. Goetz, E. Sabbioni, E. Marafante, M. Merlini, E Acerbi, C. Birattari, M. Castiglioni and F. Resmini
Preparation of ^{203}Pb compounds for studies on pathways and effects of lead pollution
Int. J. Applied Radiation Isotopes **26** (1975) 267

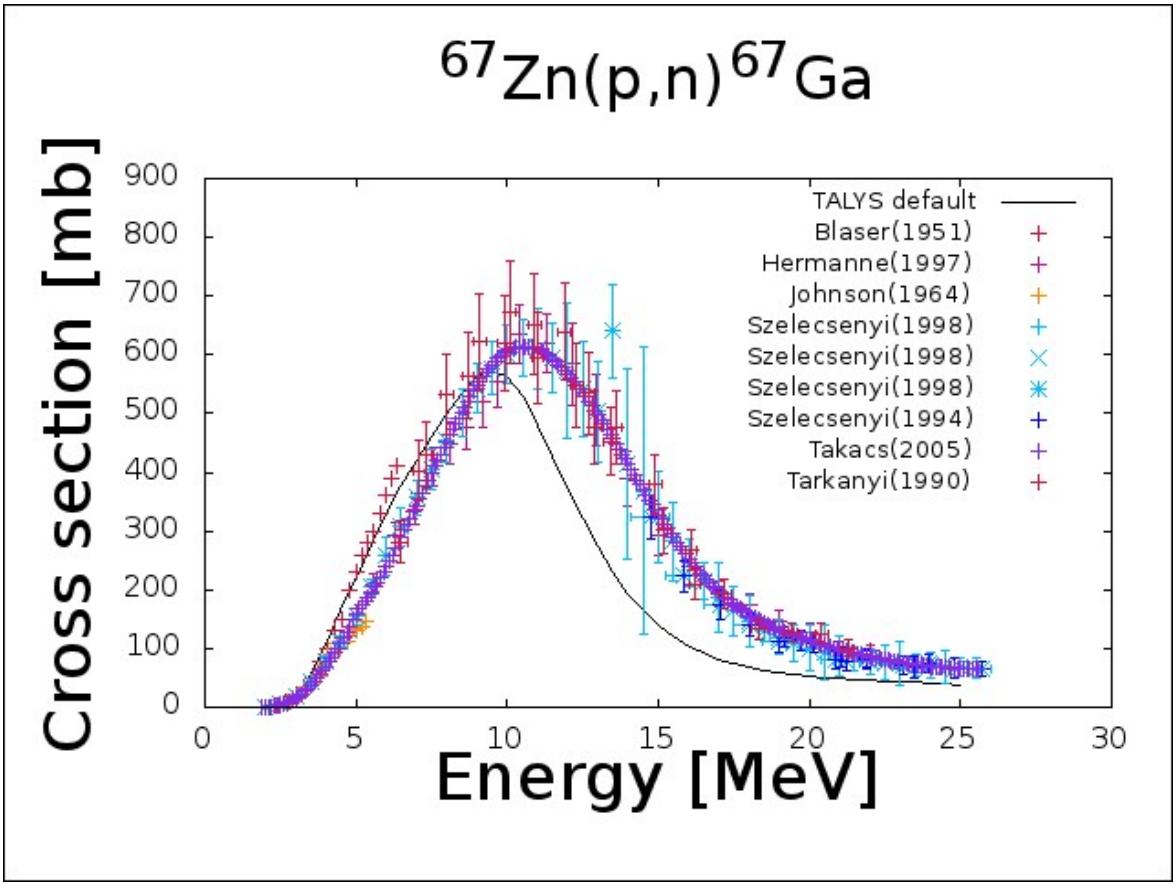
Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 200
X4 ID : A04940023
Quality 1 : 1

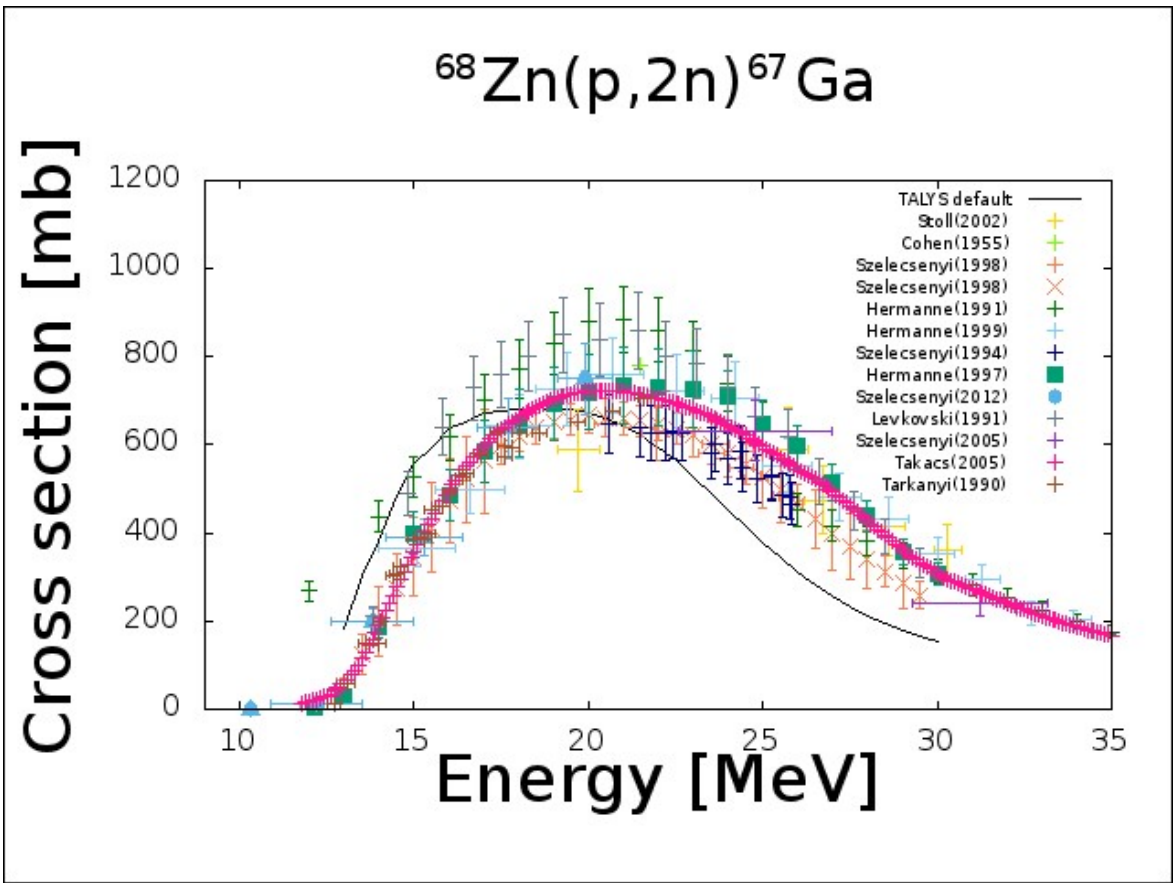
Comment 1: IAEA-TECDOC-1211 – Data selected

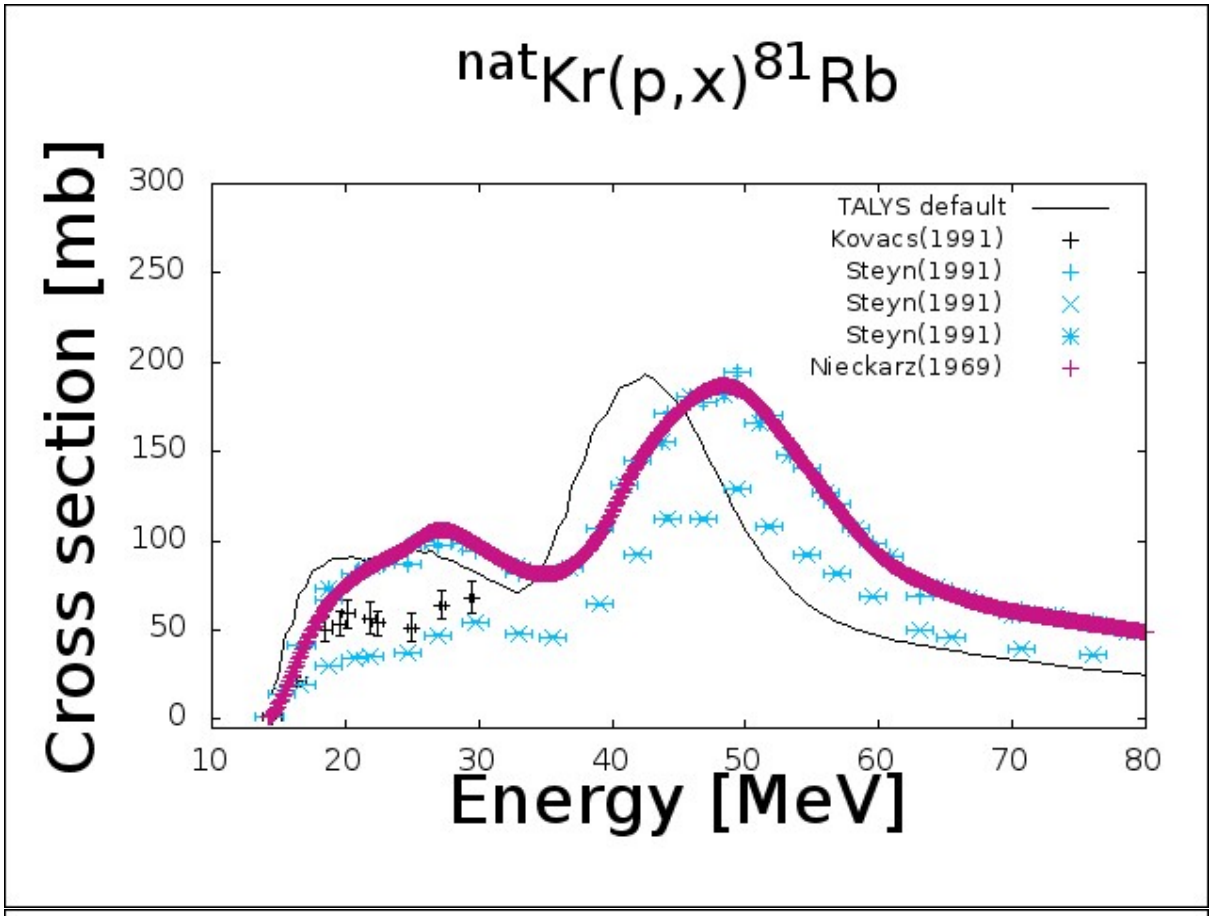
Projectile: p
Target El : Tl
Target A : 203
Final El : Pb
Final A : 200
X4 ID : T0148003 (TECDOC says B0168)
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

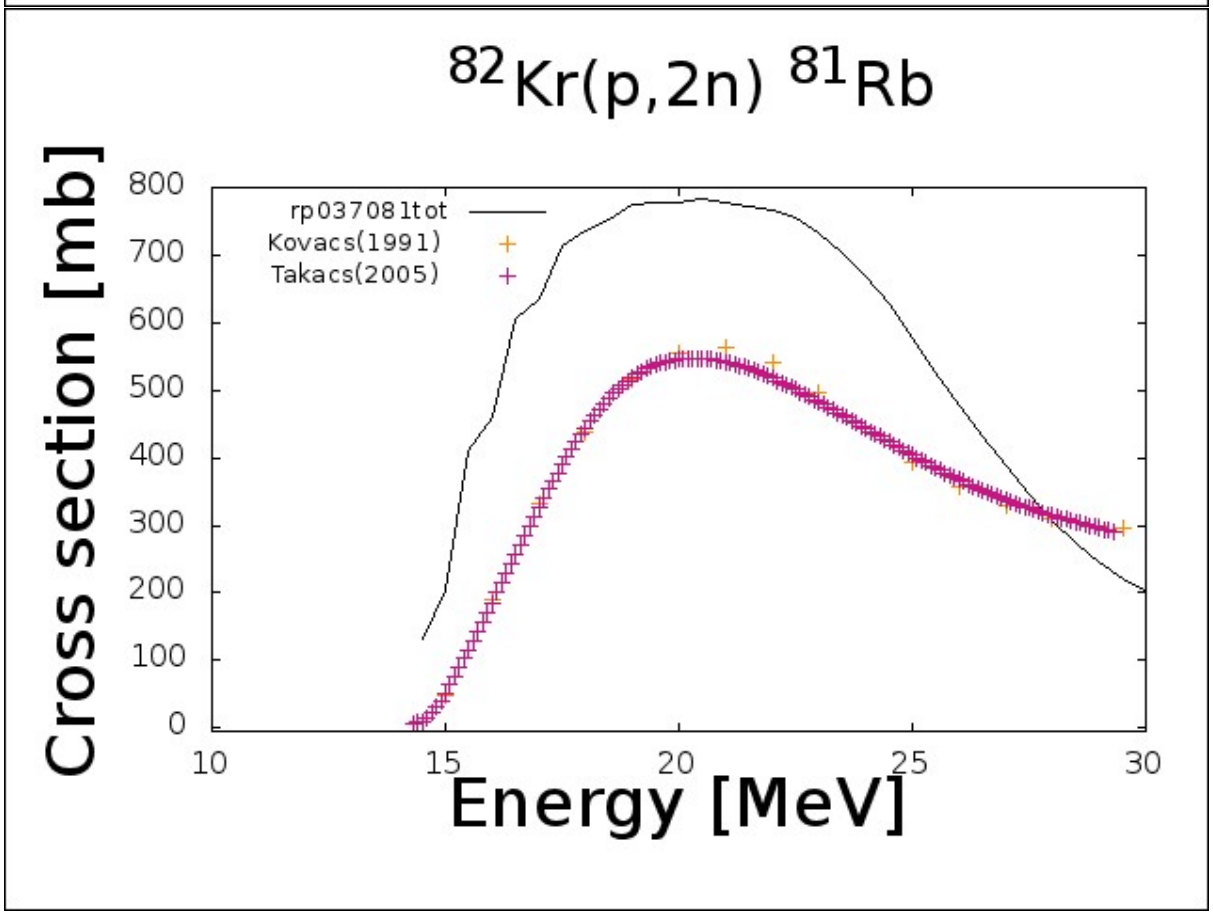
Projectile: p
Target El : Tl
Target A : 00
Final El : Pb
Final A : 200
X4 ID : A0185006
Quality 1 : 1
Comment 1: IAEA-TECDOC-1211 – Data selected.

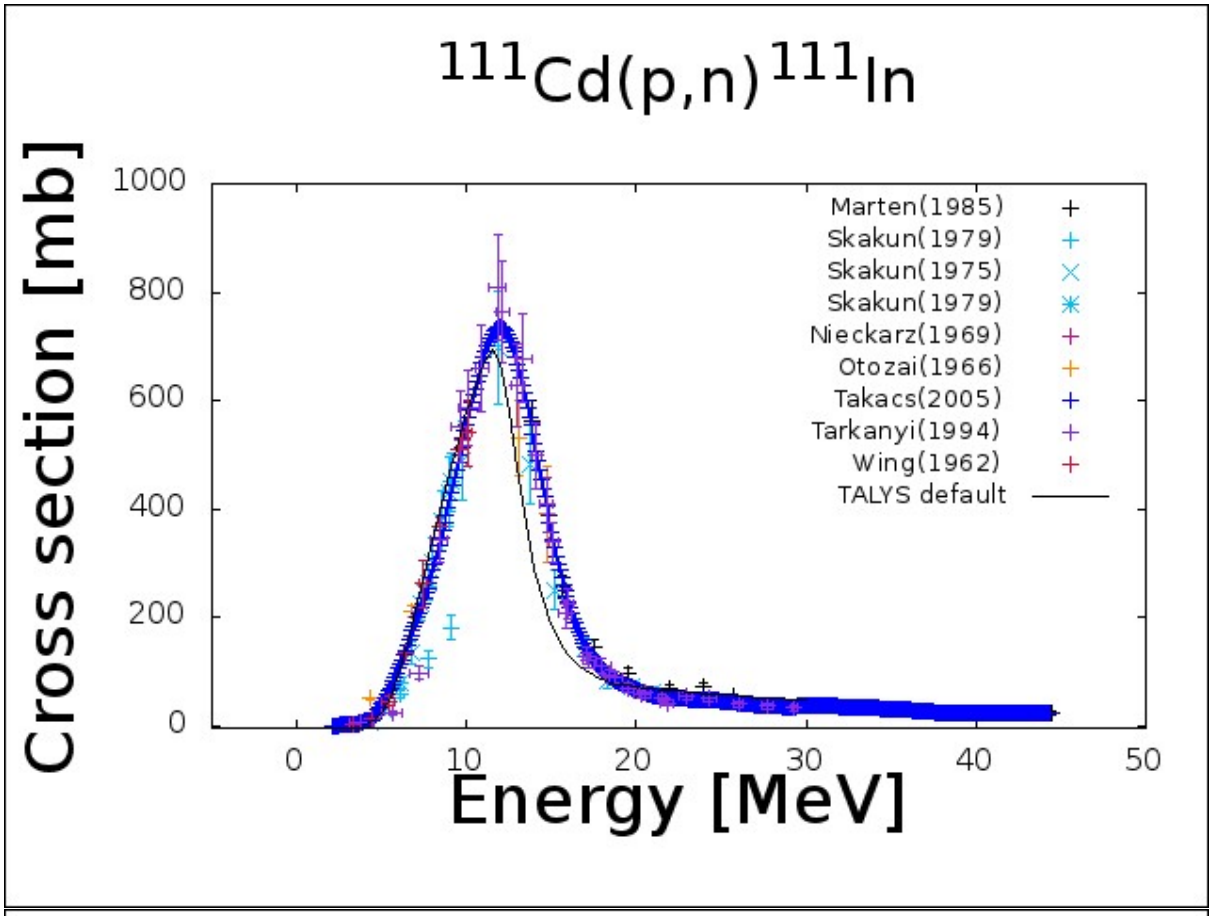
Appendix 2

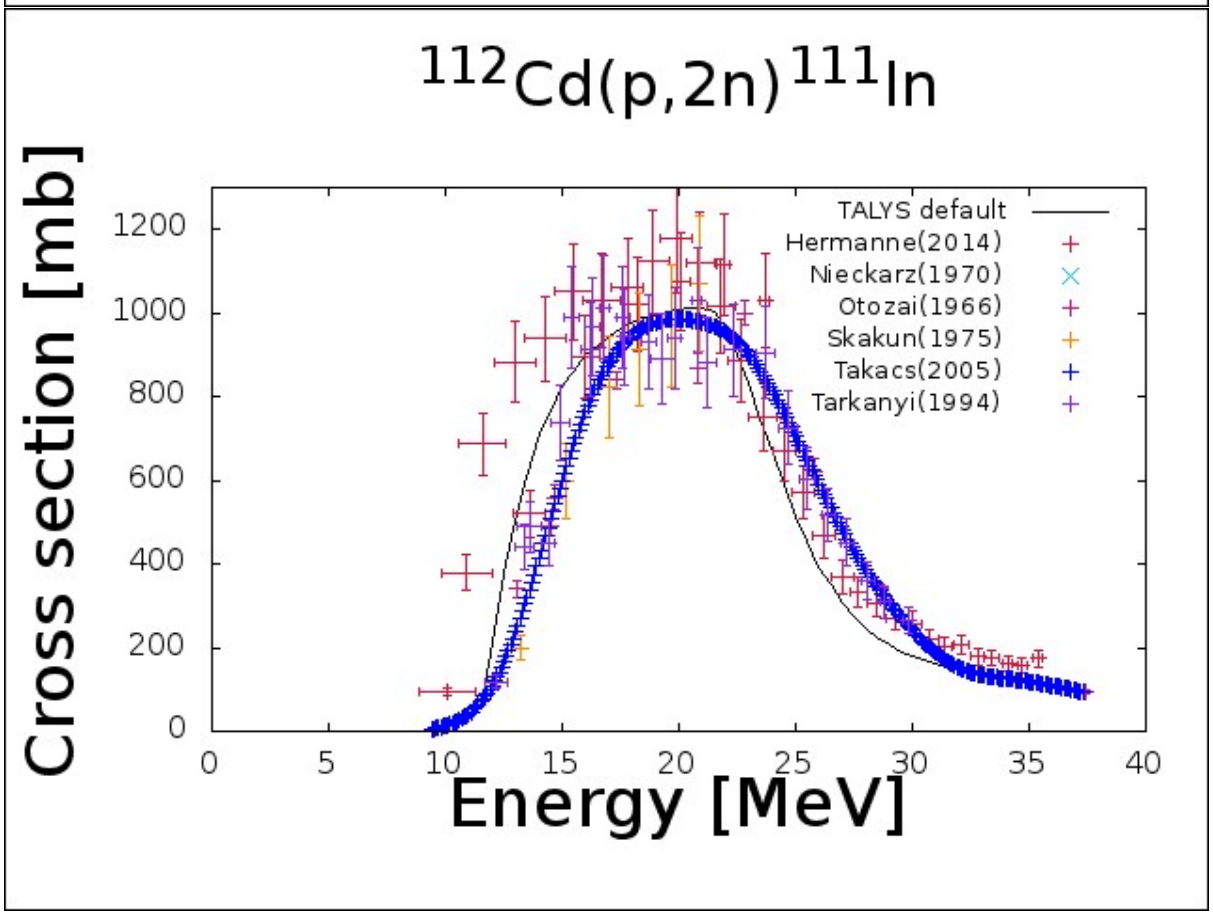

^{67}Zn(p,n)^{67}Ga
Cross section [mb]
Energy [MeV]
TALYS default
Blaser(1951)
Hermanne(1997)
Johnson(1964)
Szelecsenyi(1998)
Szelecsenyi(1998)
Szelecsenyi(1998)
Szelecsenyi(1994)
Takacs(2005)
Tarkanyi(1990)

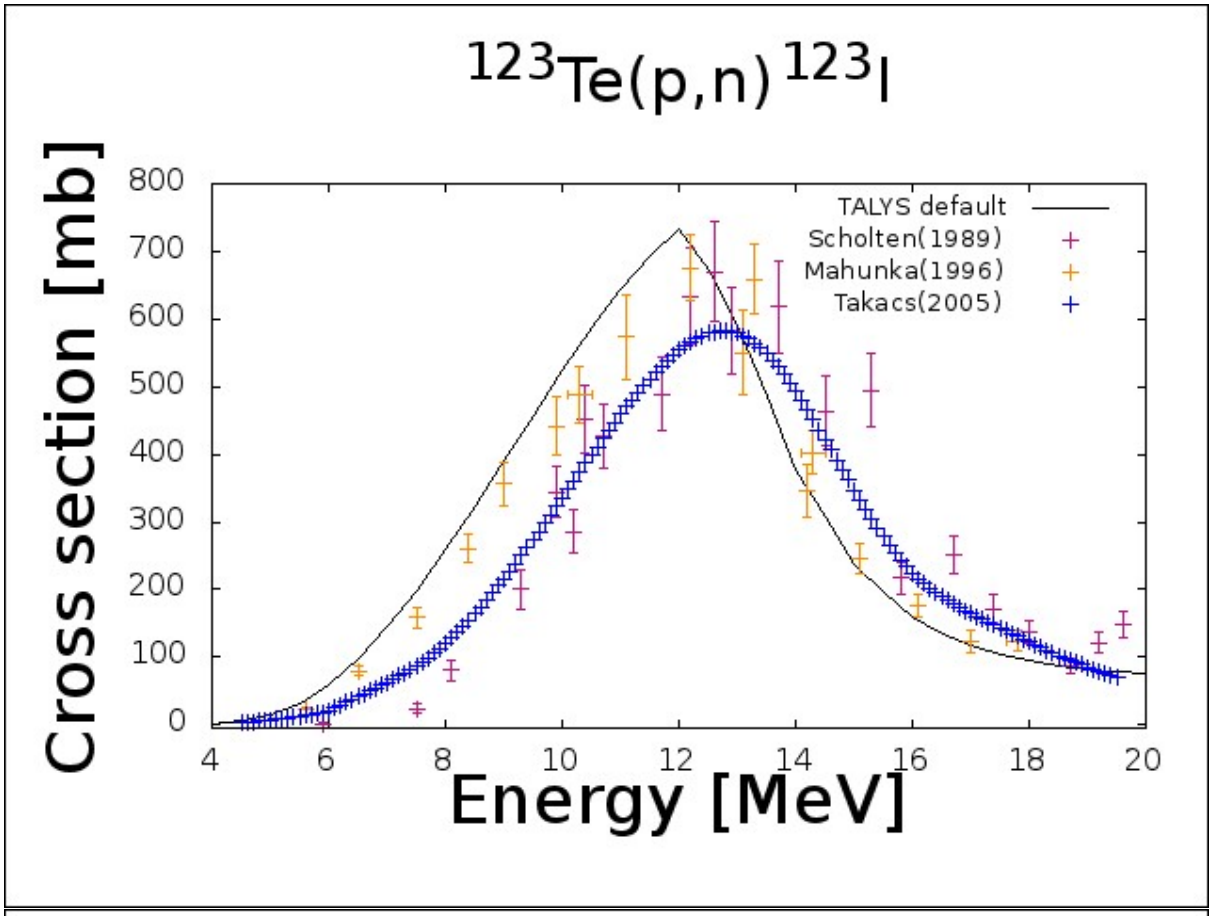

^{68}Zn(p,2n)^{67}Ga
Cross section [mb]
Energy [MeV]
TALYS default
Stoll(2002)
Cohen(1955)
Szelecsenyi(1998)
Szelecsenyi(1998)
Hermanne(1991)
Hermanne(1999)
Szelecsenyi(1994)
Hermanne(1997)
Szelecsenyi(2012)
Levkovski(1991)
Szelecsenyi(2005)
Takacs(2005)
Tarkanyi(1990)

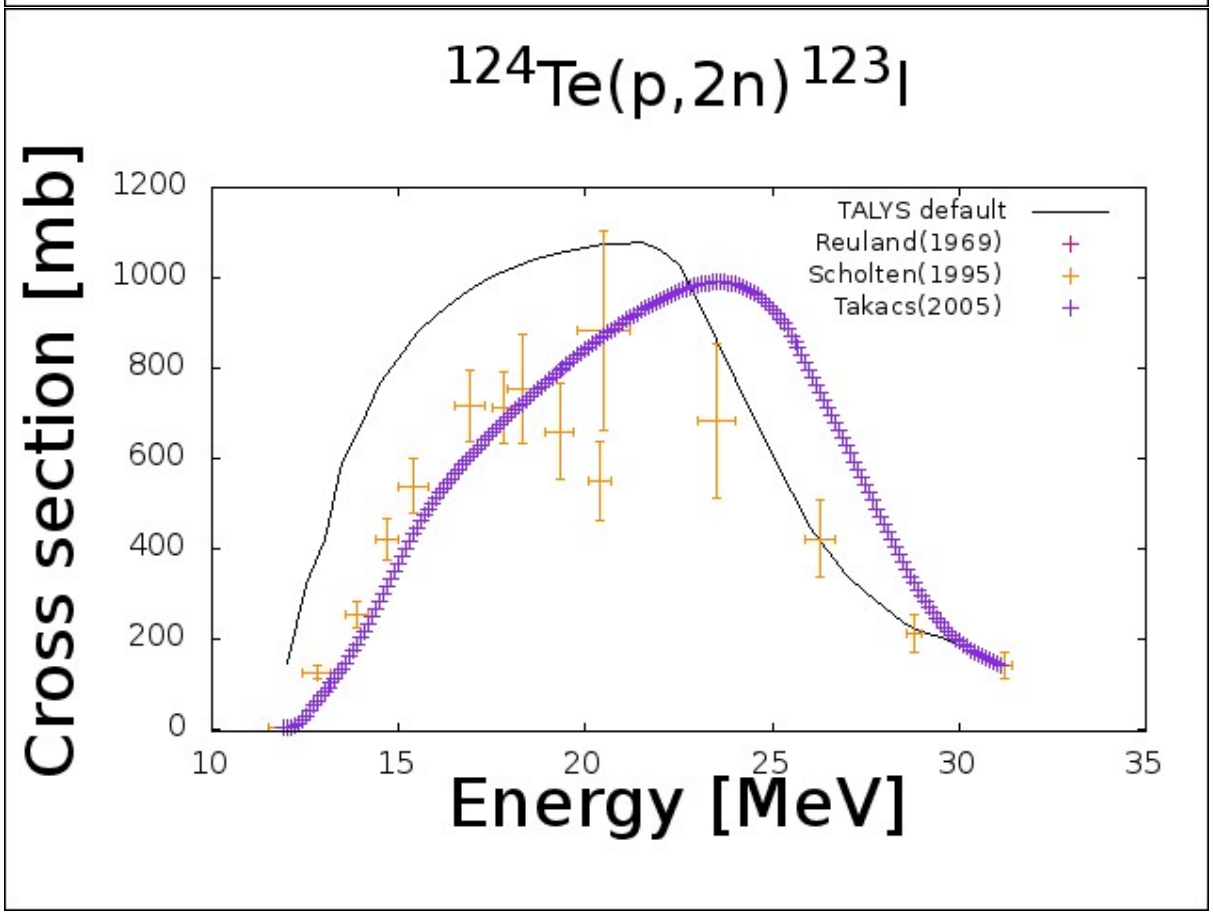

natKr(p,x)81Rb
Cross section [mb]
Energy [MeV]
TALYS default
Kovacs(1991)
Steyn(1991)
Steyn(1991)
Steyn(1991)
Nieckarz(1969)
0
50
100
150
200
250
300
10
20
30
40
50
60
70
80

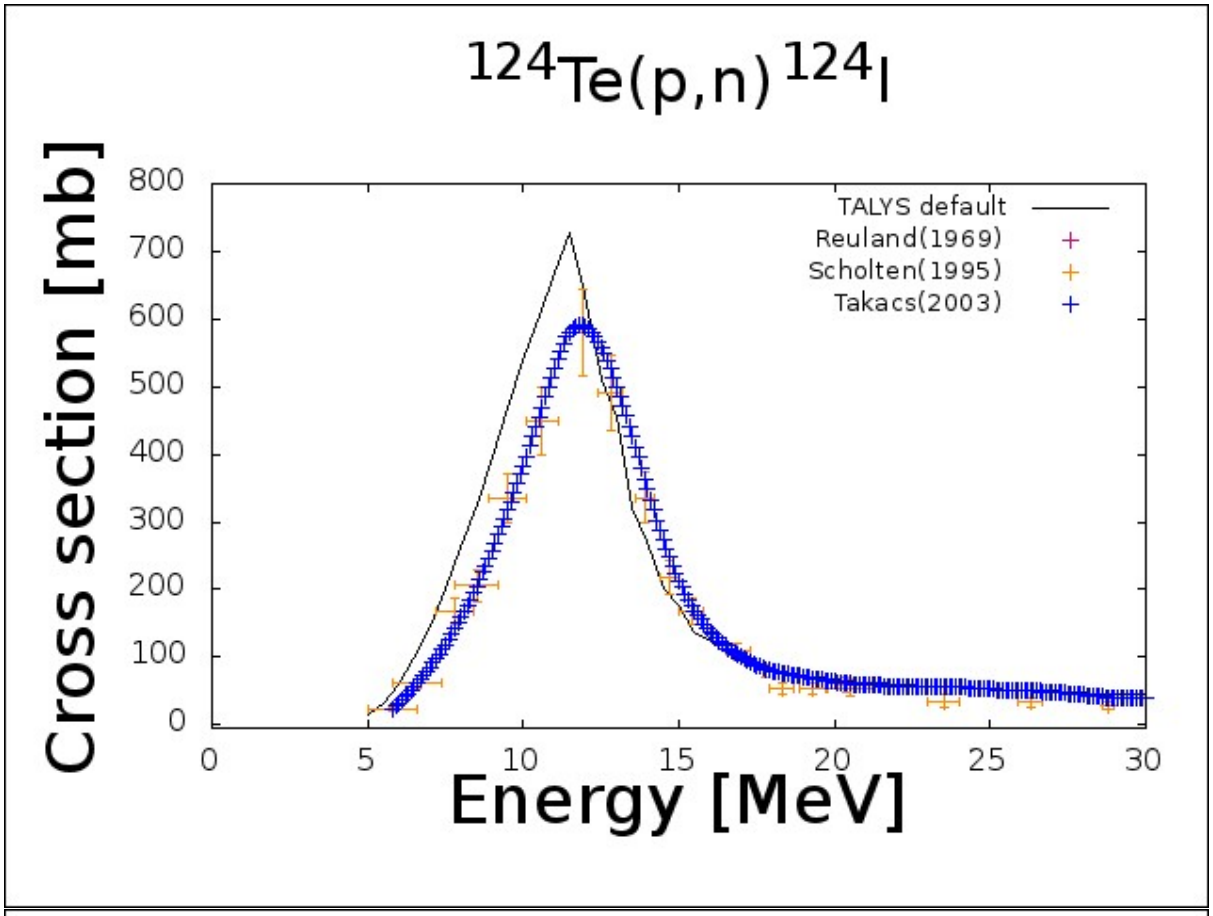

82Kr(p,2n) 81Rb
Cross section [mb]
Energy [MeV]
rp037081tot
Kovacs(1991)
Takacs(2005)
0
100
200
300
400
500
600
700
800
10
15
20
25
30

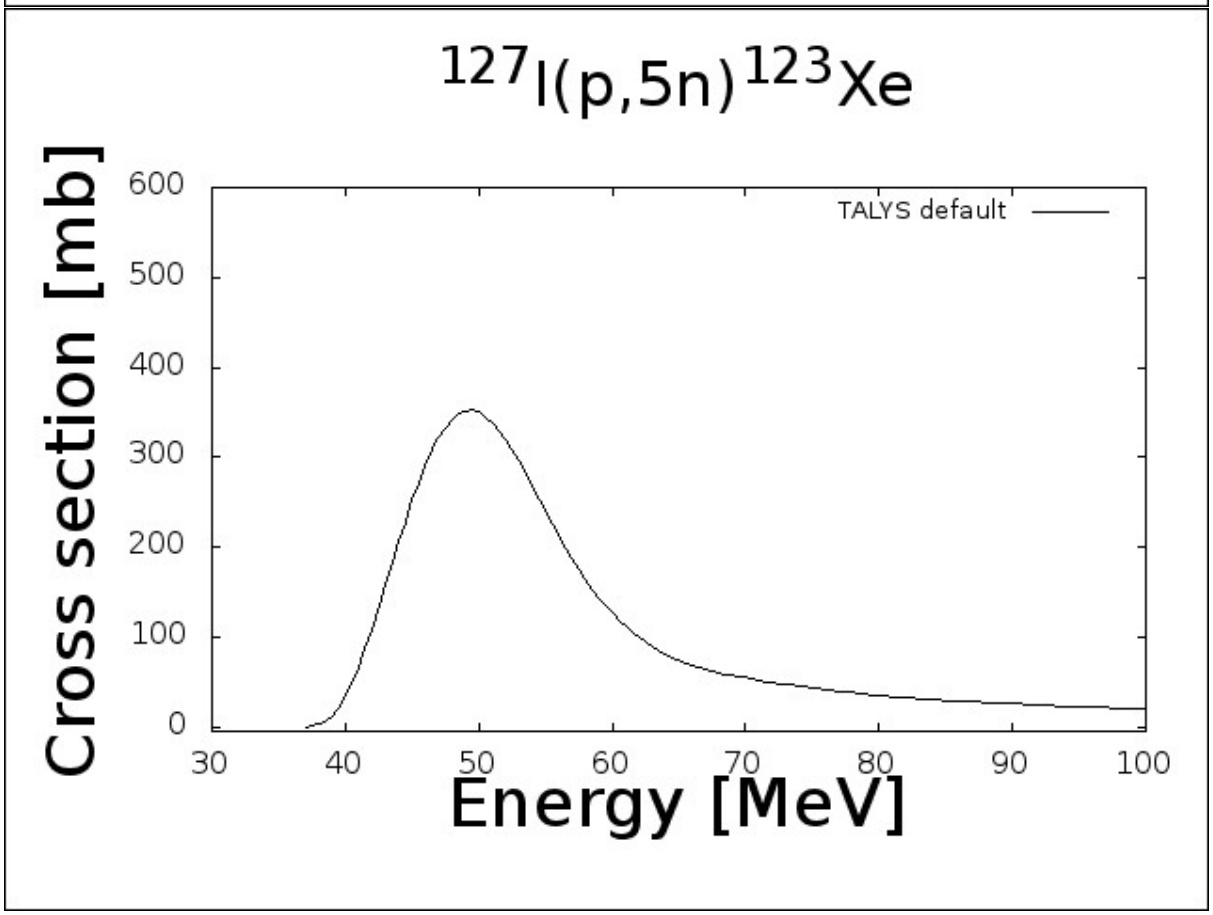

$^{111}Cd(p,n)^{111}In$
Cross section [mb]
Energy [MeV]
Marten(1985)
Skakun(1979)
Skakun(1975)
Skakun(1979)
Nieckarz(1969)
Otozai(1966)
Takacs(2005)
Tarkanyi(1994)
Wing(1962)
TALYS default

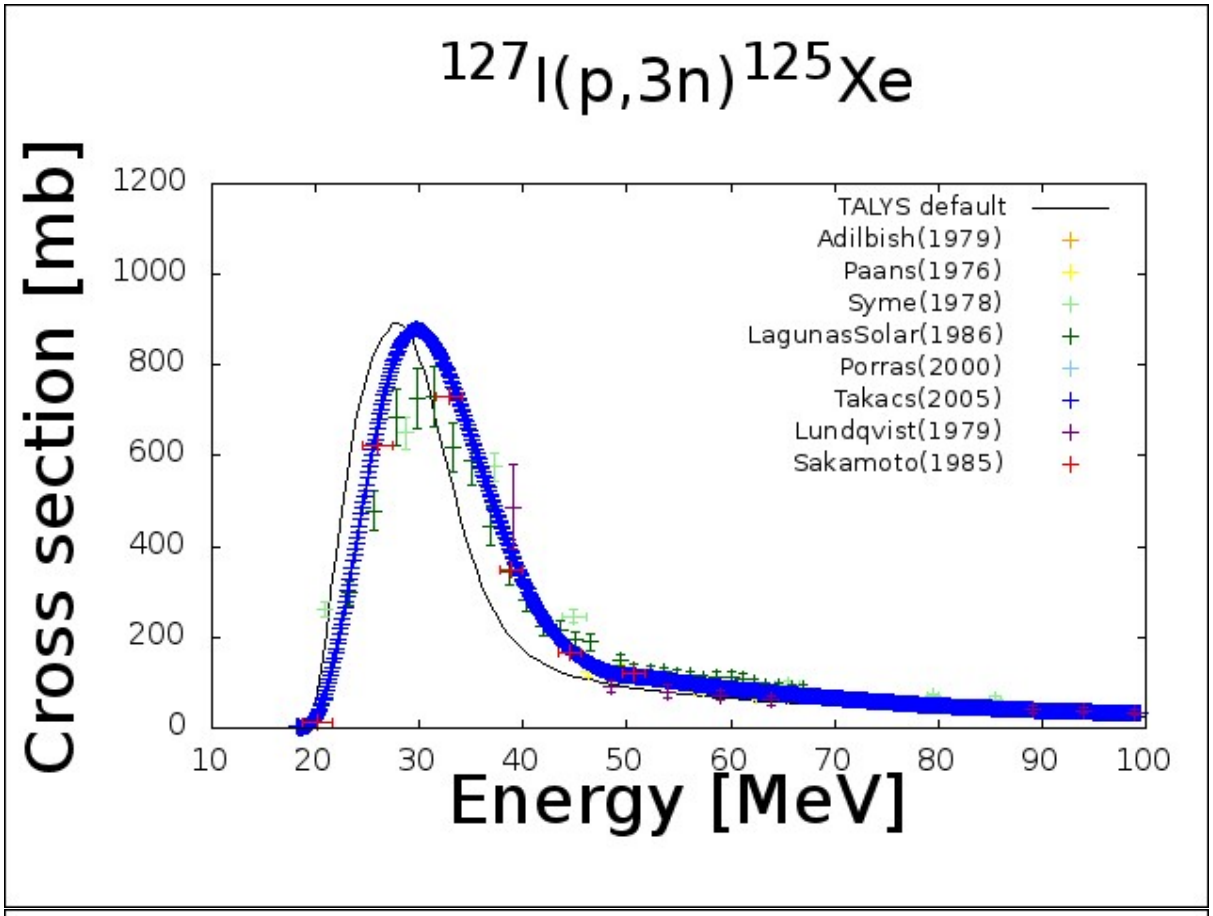

$^{112}Cd(p,2n)^{111}In$
Cross section [mb]
Energy [MeV]
TALYS default
Hermanne(2014)
Nieckarz(1970)
Otozai(1966)
Skakun(1975)
Takacs(2005)
Tarkanyi(1994)

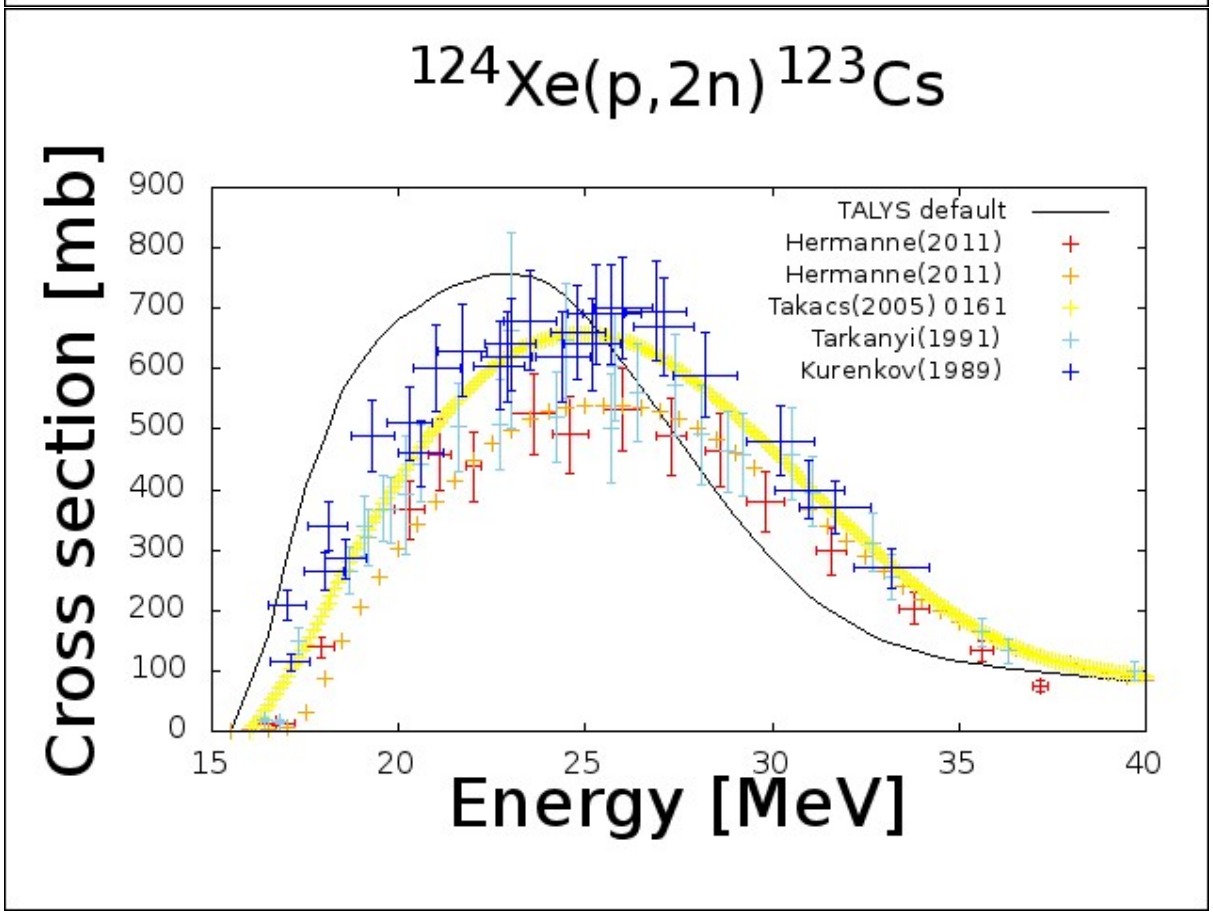

^{123}Te(p,n)^{123}I
Cross section [mb]
Energy [MeV]
TALYS default
Scholten(1989)
Mahunka(1996)
Takacs(2005)
0
100
200
300
400
500
600
700
800
4
6
8
10
12
14
16
18
20

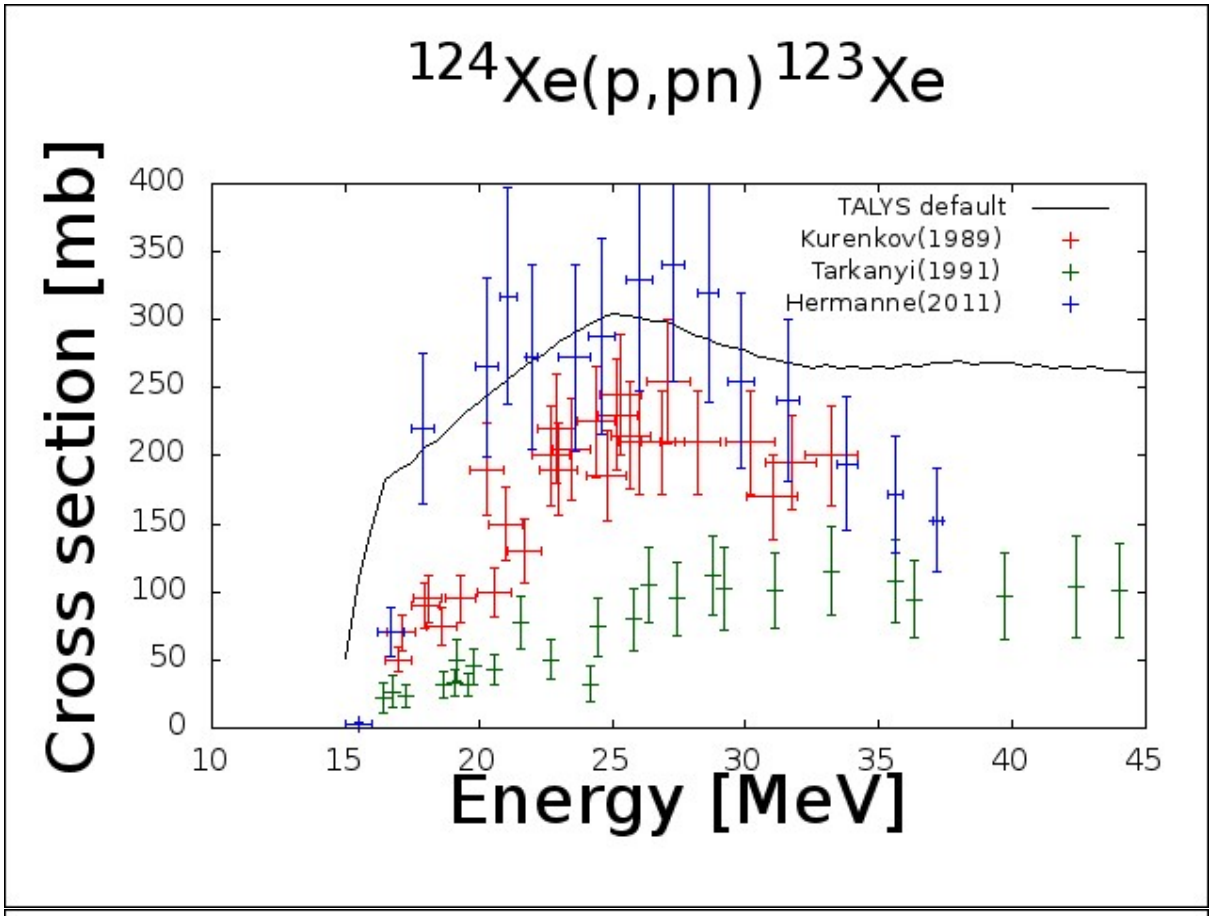

^{124}Te(p,2n)^{123}I
Cross section [mb]
Energy [MeV]
TALYS default
Reuland(1969)
Scholten(1995)
Takacs(2005)
0
200
400
600
800
1000
1200
10
15
20
25
30
35

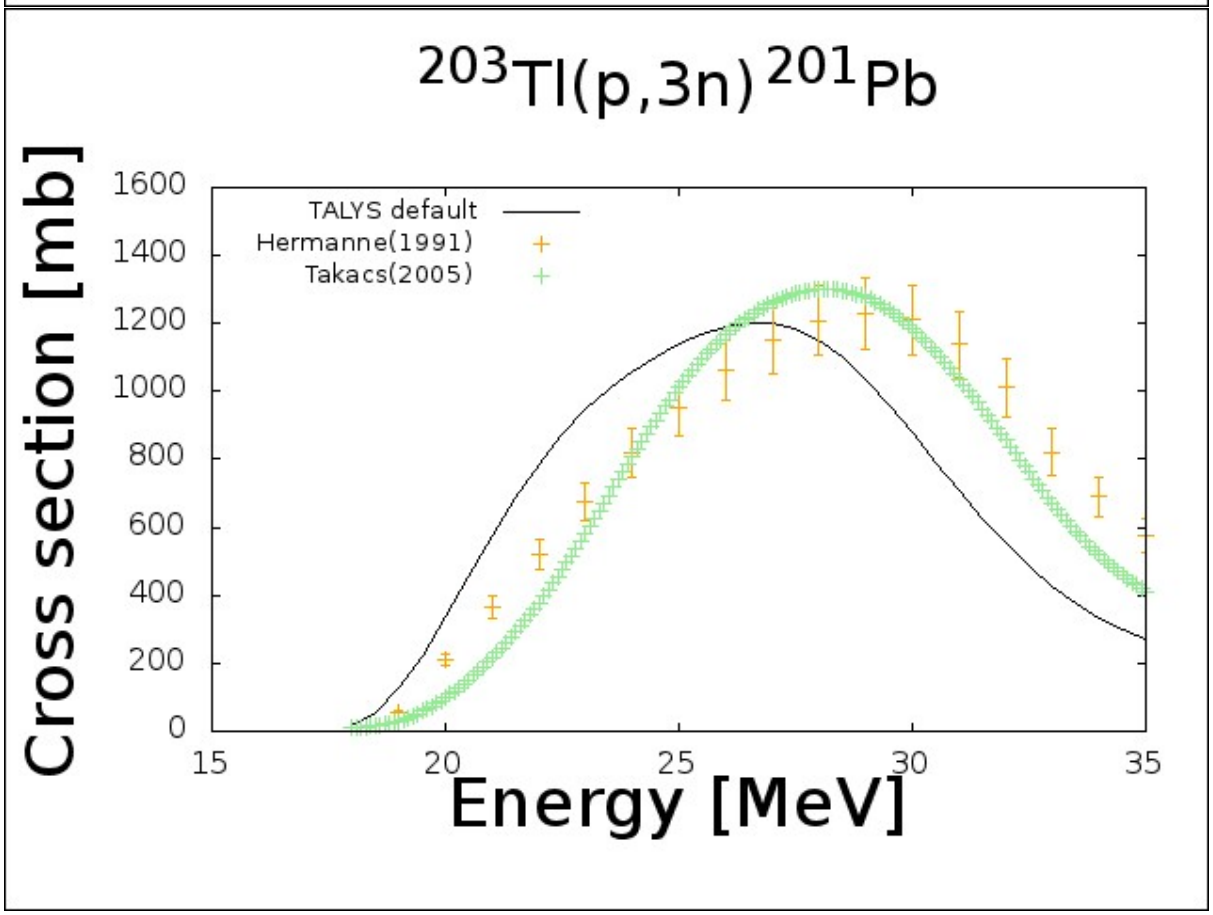

124Te(p,n)124I
Cross section [mb]
Energy [MeV]
TALYS default
Reuland(1969)
Scholten(1995)
Takacs(2003)
0
100
200
300
400
500
600
700
800
0
5
10
15
20
25
30

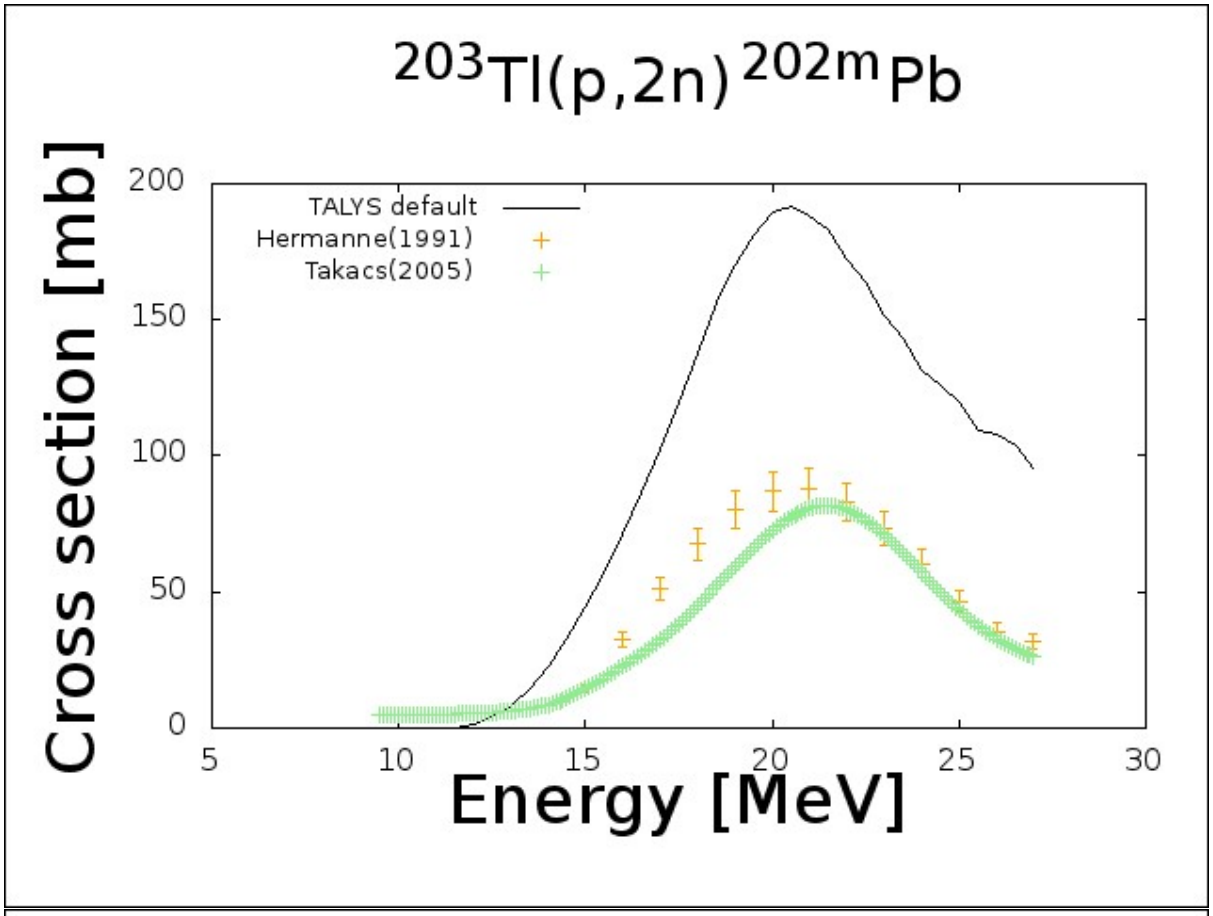

127I(p,5n)123Xe
Cross section [mb]
Energy [MeV]
TALYS default
0
100
200
300
400
500
600
30
40
50
60
70
80
90
100

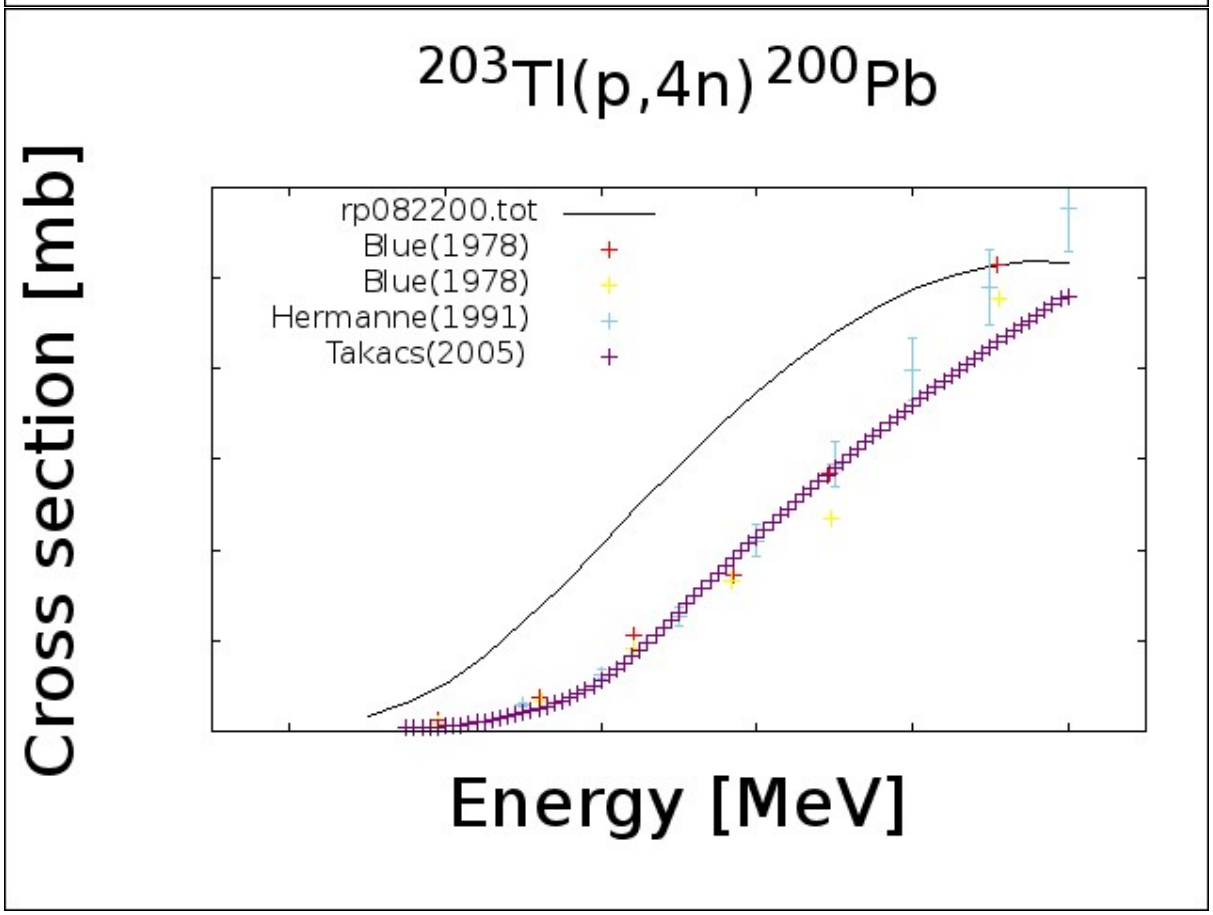

$^{127}I(p,3n)^{125}Xe$
Cross section [mb]
Energy [MeV]
TALYS default
Adilbish(1979)
Paans(1976)
Syme(1978)
LagunasSolar(1986)
Porras(2000)
Takacs(2005)
Lundqvist(1979)
Sakamoto(1985)


$^{124}Xe(p,2n)^{123}Cs$
Cross section [mb]
Energy [MeV]
TALYS default
Hermanne(2011)
Hermanne(2011)
Takacs(2005) 0161
Tarkanyi(1991)
Kurenkov(1989)


124Xe(p,pn)123Xe
Cross section [mb]
Energy [MeV]
TALYS default
Kurenkov(1989)
Tarkanyi(1991)
Hermanne(2011)
0
50
100
150
200
250
300
350
400
10
15
20
25
30
35
40
45


203Tl(p,3n)201Pb
Cross section [mb]
Energy [MeV]
TALYS default
Hermanne(1991)
Takacs(2005)
0
200
400
600
800
1000
1200
1400
1600
15
20
25
30
35


^{203}Tl(p,2n)^{202m}Pb
Cross section [mb]
Energy [MeV]
TALYS default
Hermanne(1991)
Takacs(2005)
200
150
100
50
0
5
10
15
20
25
30


^{203}Tl(p,4n)^{200}Pb
Cross section [mb]
Energy [MeV]
rp082200.tot
Blue(1978)
Blue(1978)
Hermanne(1991)
Takacs(2005)

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