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Updating of the ENDF/B-VIII.1b2 Candidate Evaluations with Reaction Cross Sections from IRDFF-II

Prepared by

A. Trkov

Jozef Stefan Institute
Ljubljana, Slovenia

R. Capote

International Atomic Energy Agency
Vienna, Austria

February 2024

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

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1. Introduction

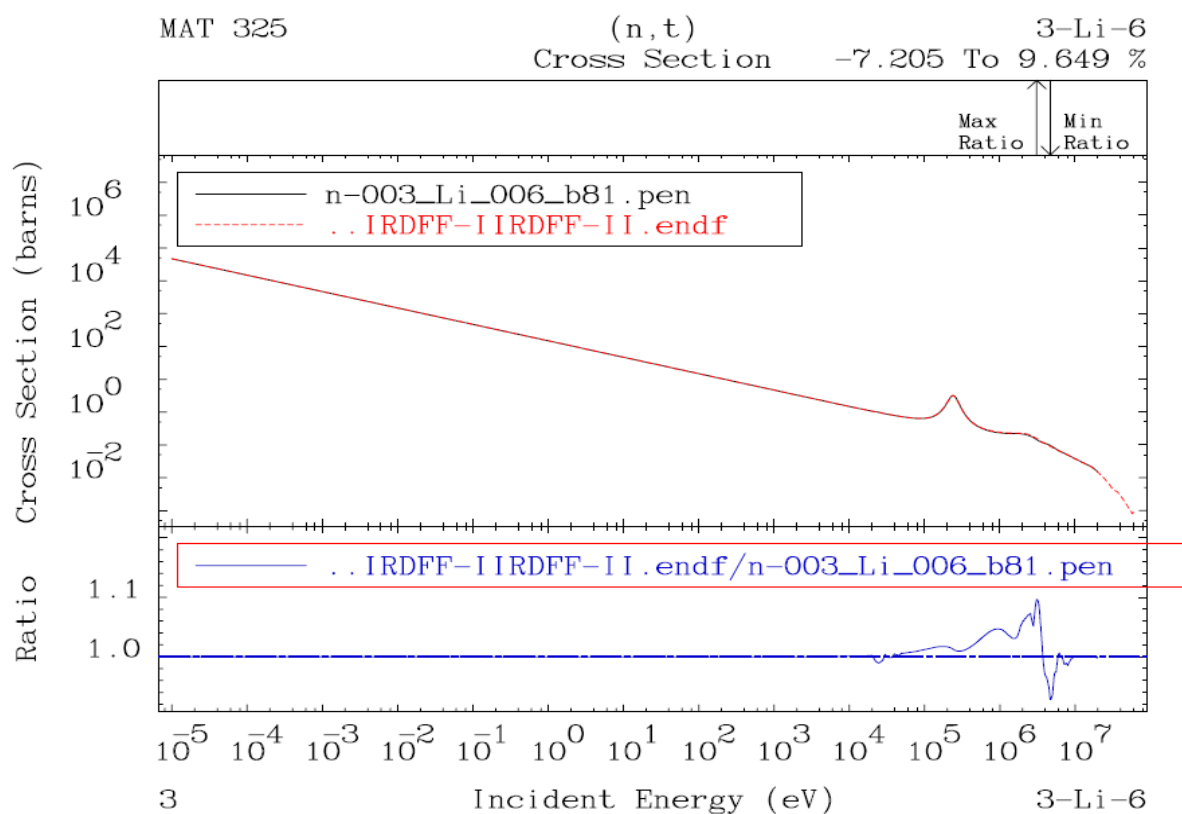
In addition to the neutron cross section Standards, the dosimetry reaction cross sections are the most rigorously evaluated nuclear data that include covariance information extending to at least 60 MeV. The most recent neutron dosimetry library is IRDFF-II, available from the IAEA. It is desirable that evaluated data in the new libraries should be consistent with the dosimetry cross sections so that integral reaction rates can be calculated directly from detailed Monte Carlo calculations.

In this report the reaction cross sections in IRDFF-II are compared to the equivalent cross sections in ENDF/B-VIII.1b1. Changes to the candidate evaluations for ENDF/B-VIII.1b2 are proposed.

2. Proposed Evaluation Changes

Li-6

There are differences in the (n,t) reaction cross sections. **Unless a new evaluation becomes available, replacement with IRDFF-II is proposed.**



Implementation

None.

Li-7

ENDF/B-VIII.1b1 contains:

MT 24 = $n + {}^7\text{Li} \rightarrow 2n + \alpha + d$

MT 25 = $n + {}^7\text{Li} \rightarrow 3n + \alpha + p$

MT 52-82 = $n + {}^7\text{Li} \rightarrow n + {}^7\text{Li}^* \rightarrow n + t + \alpha$ (reactions flagged for breakup in ENDF/B-VIII.1b1)

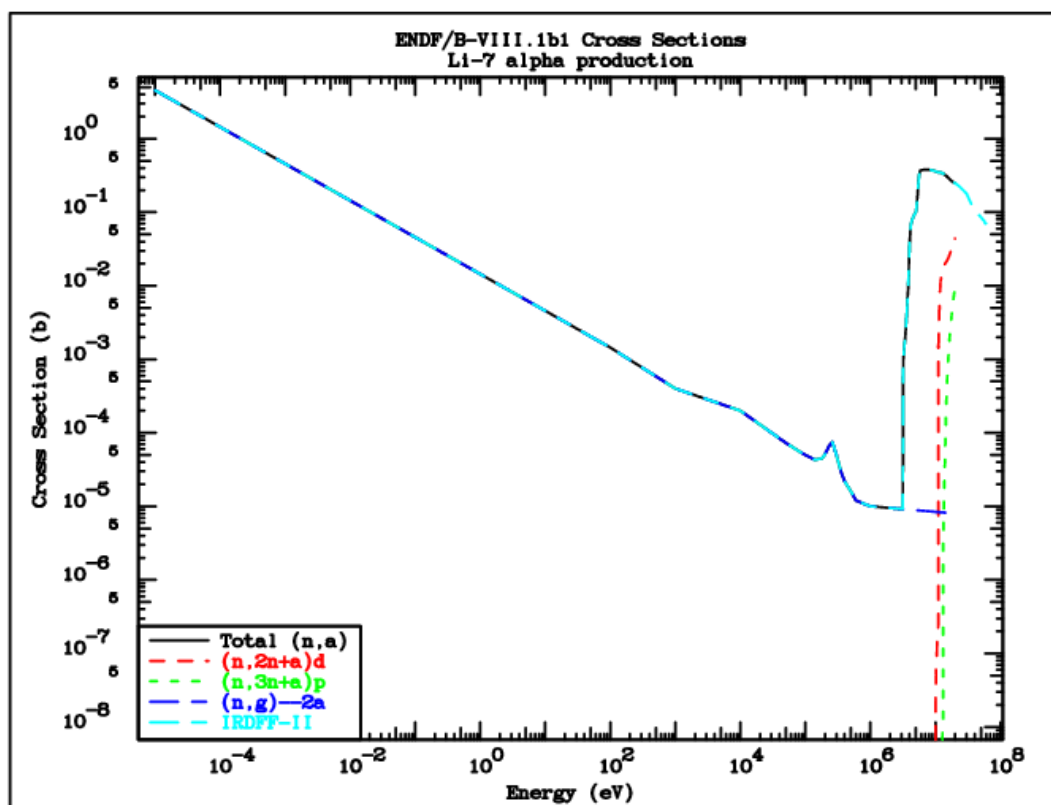
MT 102 = $n + {}^7\text{Li} \rightarrow {}^8\text{Li}^* \rightarrow {}^8\text{Be}^* \rightarrow 2\alpha$ (NOT flagged for breakup in ENDF/B-VIII.1b1)

IRDF-2 contains:

MT205 = $n + {}^7\text{Li} \rightarrow t + X$

MT207 = $n + {}^7\text{Li} \rightarrow \alpha + X$

MT 205 in IRDF-2 is exactly equivalent to the sum of the discrete inelastic levels that are flagged for breakup in ENDF/B-VIII.1b1. The two libraries are consistent.



MT 207 in IRDF-2 is exactly equivalent to the sum of MT 24, 25 plus twice MT 102, since two alphas are emitted when ${}^8\text{Li}^*$ decays with a half life of 840 ms into ${}^8\text{Be}^*$, which in turn breaks up almost instantly into two alphas. The two libraries are consistent.

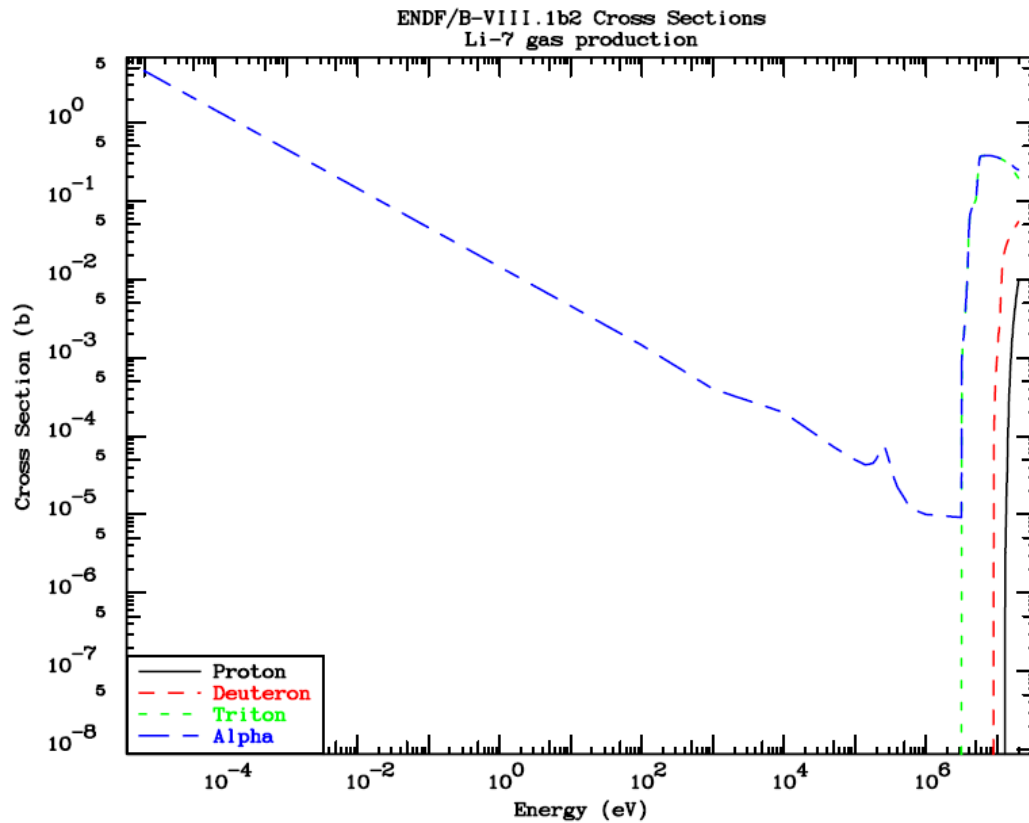
MT 203, 204 are not present in IRDF-2, but they are equivalent to MT 25, 24 in ENDF/B-VIII.1b1, respectively.

WARNING: The capture reaction in ENDF/B-VIII.1b1 is not flagged for breakup. This is a potential pitfall for the users to miss the alpha production from low-energy neutrons where capture reaction is the main contributor.

Proposal: Although the cross sections in ENDF/B-VIII.1b1 are consistent with IRDFF-II, the summation process to obtain the gas production cross sections is not straightforward. The proposal is to add MT 203, 204, 205, 207 to the ENDF/B-VIII.1b2 for the convenience of the user.

Implementation

There are no changes to the cross sections in the original file. The gas-production cross sections were added to the ENDF evaluation.



B-10

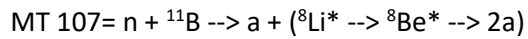
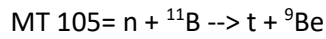
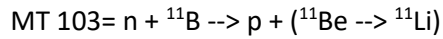
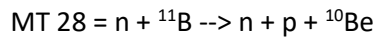
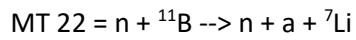
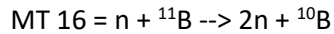
The total alpha emission cross sections MT 107 and the discrete level alpha emission cross sections MT 800, 801 agree in the two libraries to within the reconstruction tolerance of 0.1 %. **No changes are proposed for ¹⁰B.**

Implementation

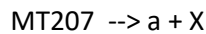
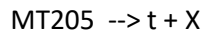
None.

B-11

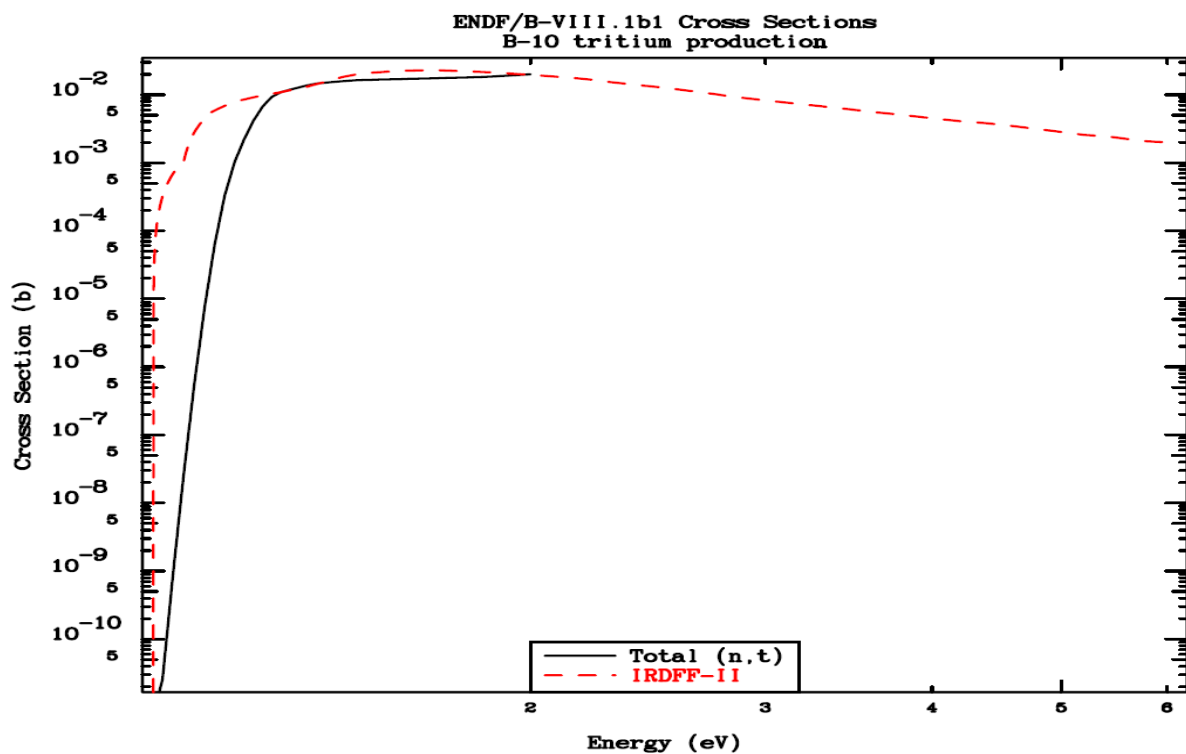
The ENDF/B-VIII.1b1 contains:

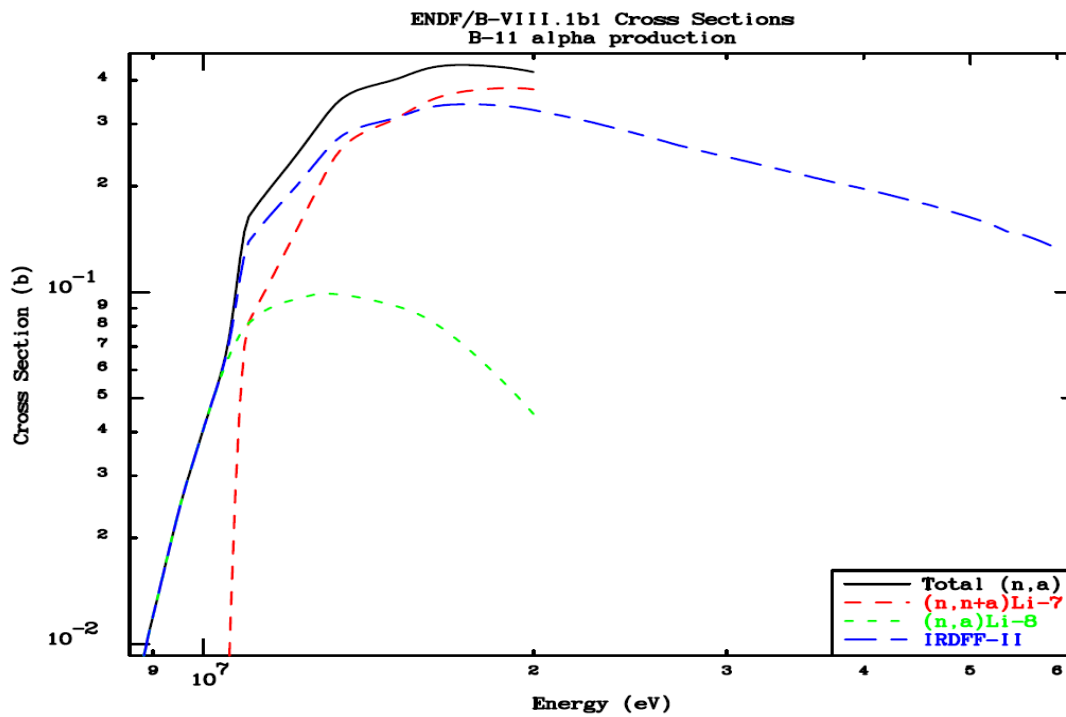


The IRDFF-II contains:



The cross sections in the two libraries are NOT consistent. Gas production cross sections can be tedious to reconstruct. It would be convenient to the users if they were available in the ENDF file. **The proposal is to add the gas production cross sections as redundant quantities into the ENDF/B-VIII.1b2 evaluation for the convenience of the users if consistency could be ensured, even though this is not strictly in line with the ENDF-6 format rules.**





Implementation

None at present.

F-19

The two-neutron emission cross sections (MT 16) in ENDF/B-VIII.1b1 are fully consistent with IRDFF-II.

No action is necessary.

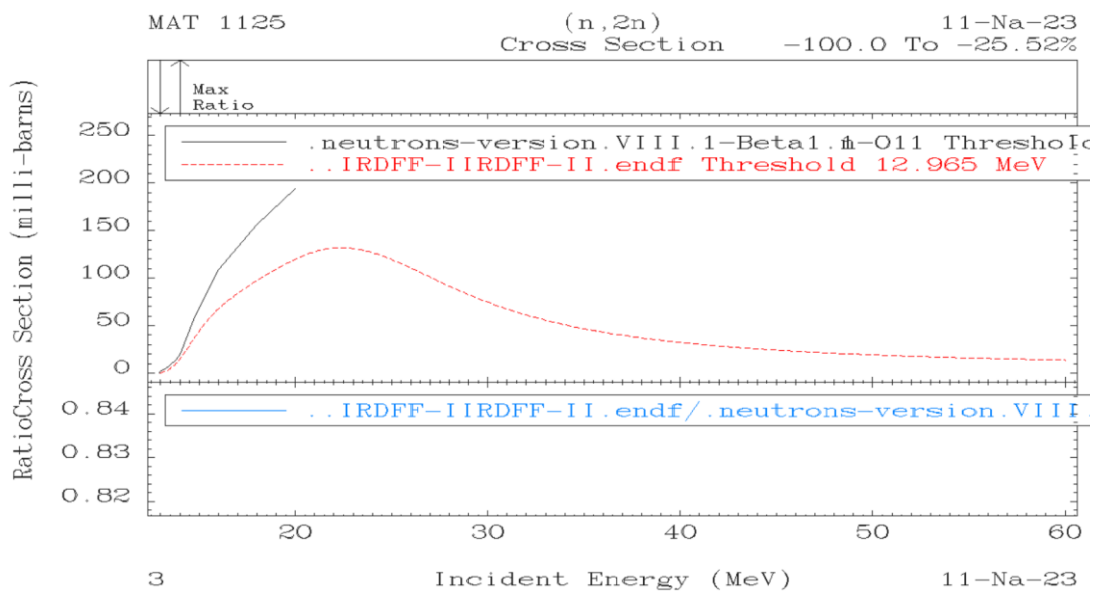
Implementation

None.

Na-23

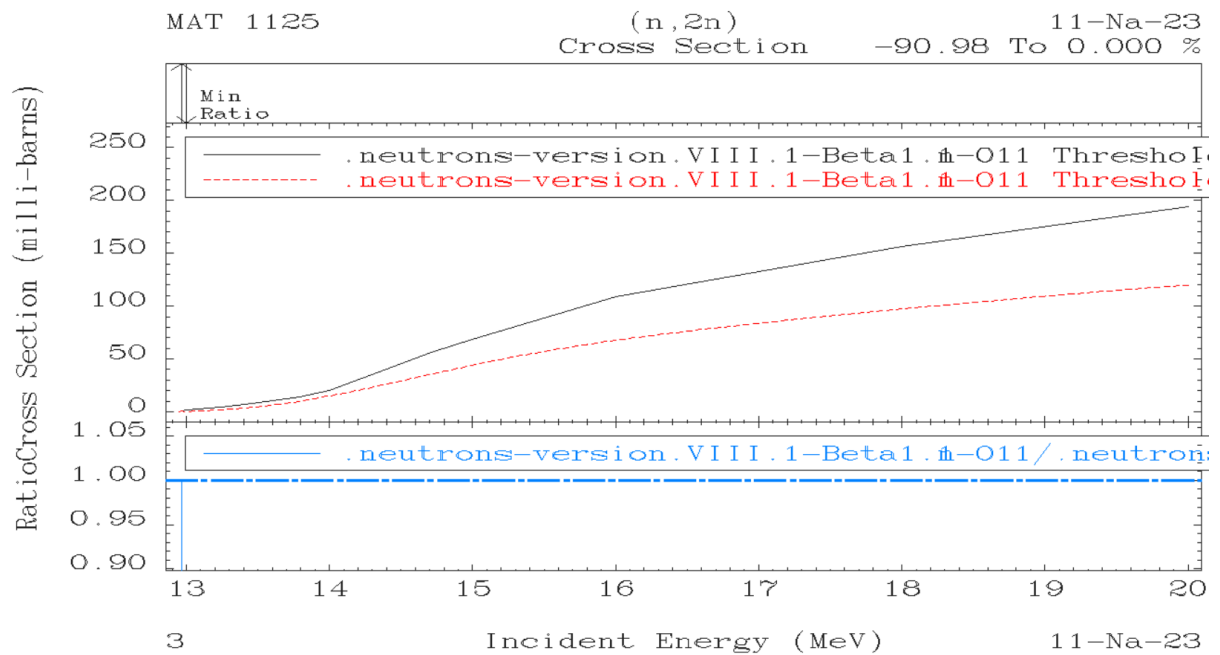
The two-neutron emission cross sections (MT 16) in ENDF/B-VIII.1b1 differ significantly from IRDFF-II.

Replacement of MT 16 with IRDFF-II is proposed.



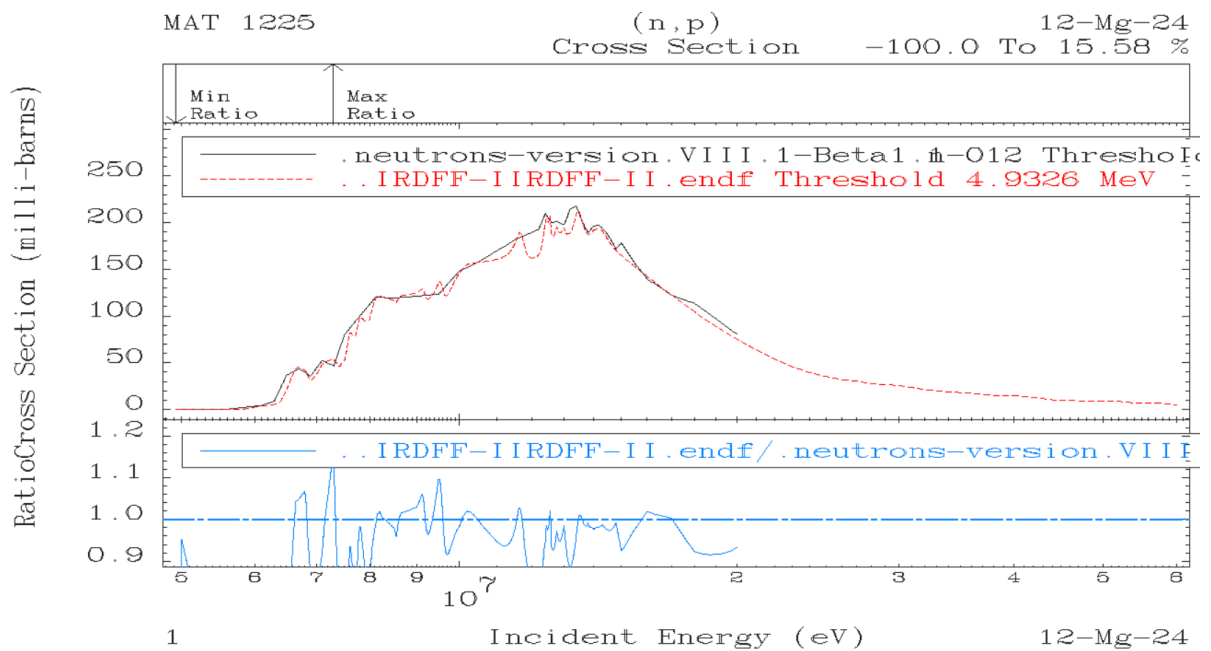
Implementation

The (n,2n) cross section in the file was replaced with the data from IRDFF-II up to 20 MeV.



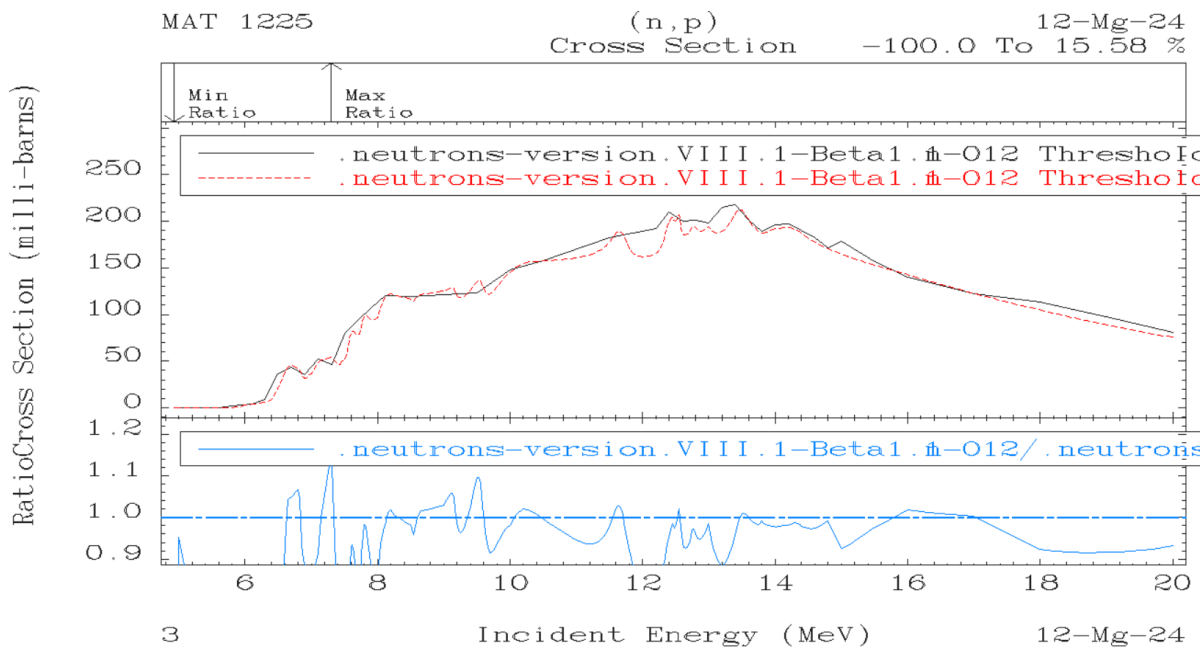
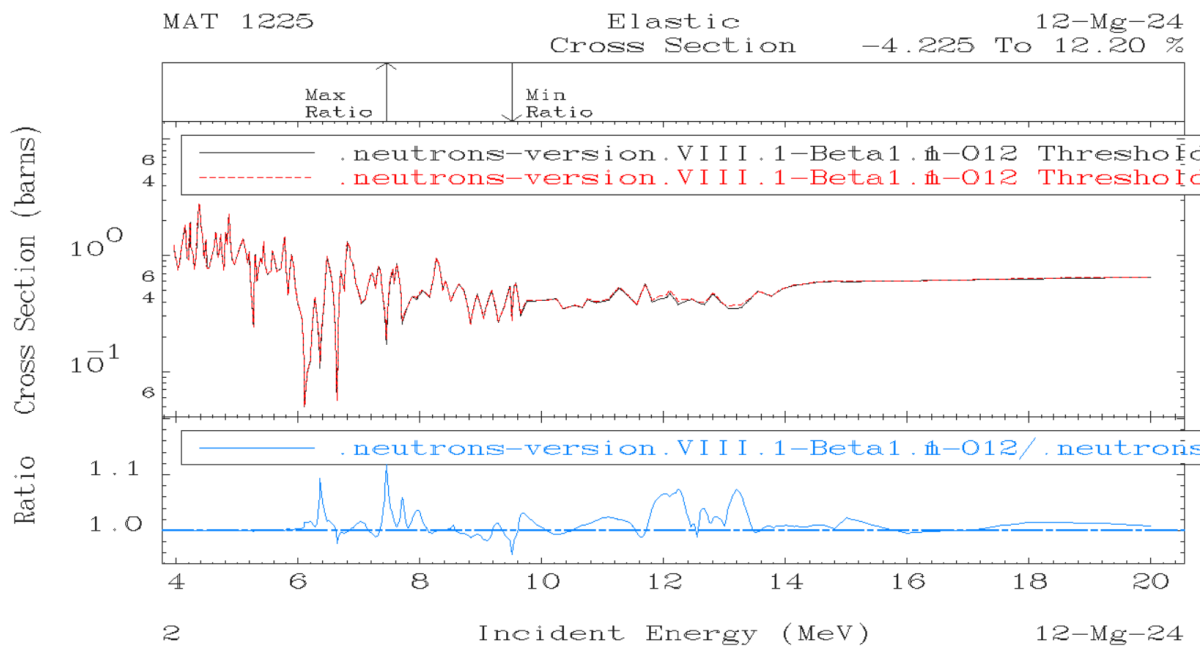
Mg-24

The proton emission cross sections (MT 103) in ENDF/B-VIII.1b1 differ significantly from IRDFF-II, which has more structure in the shape. **Replacement of MT 103 with IRDFF-II is proposed.**



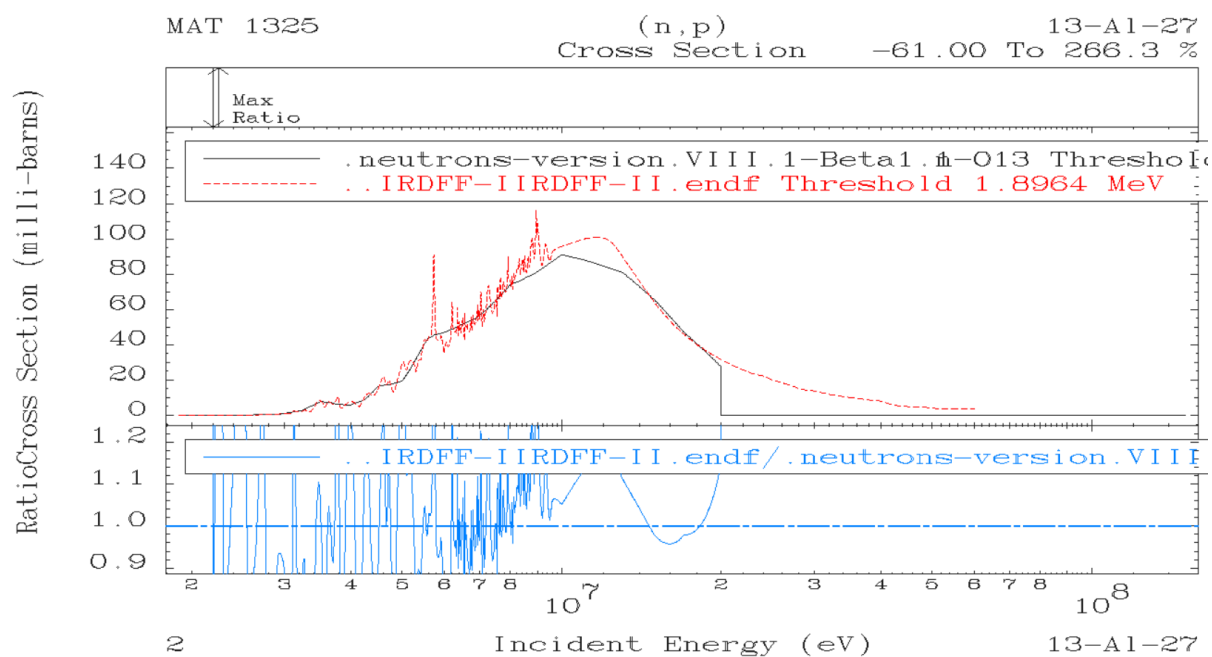
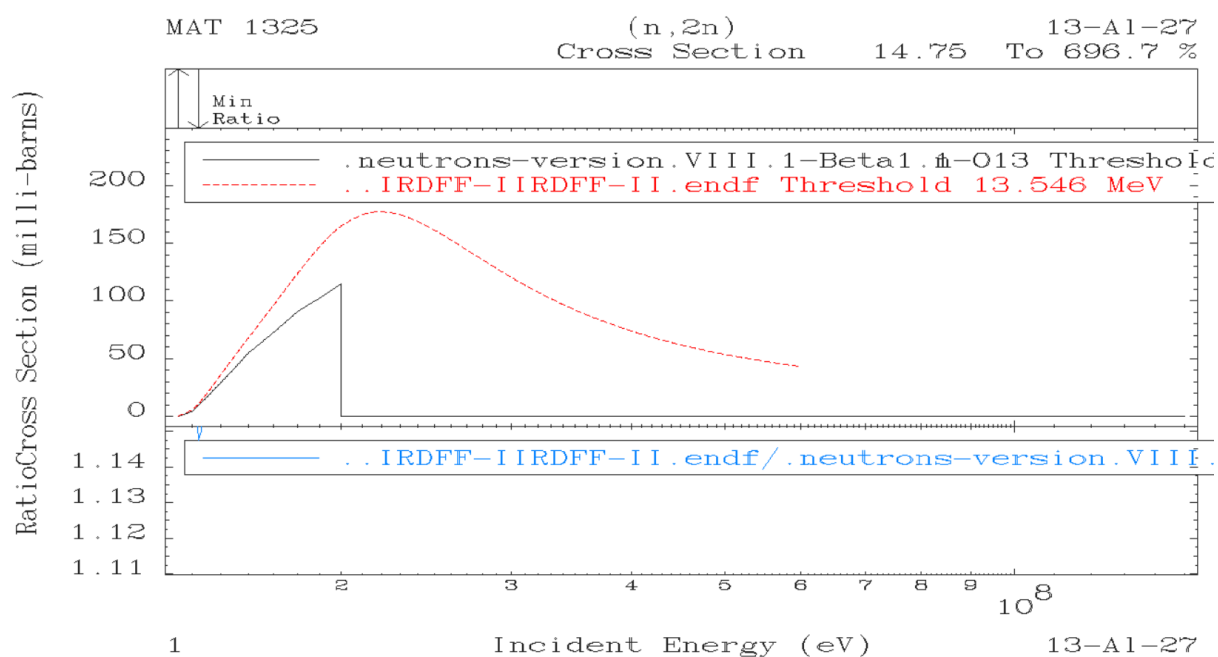
Implementation

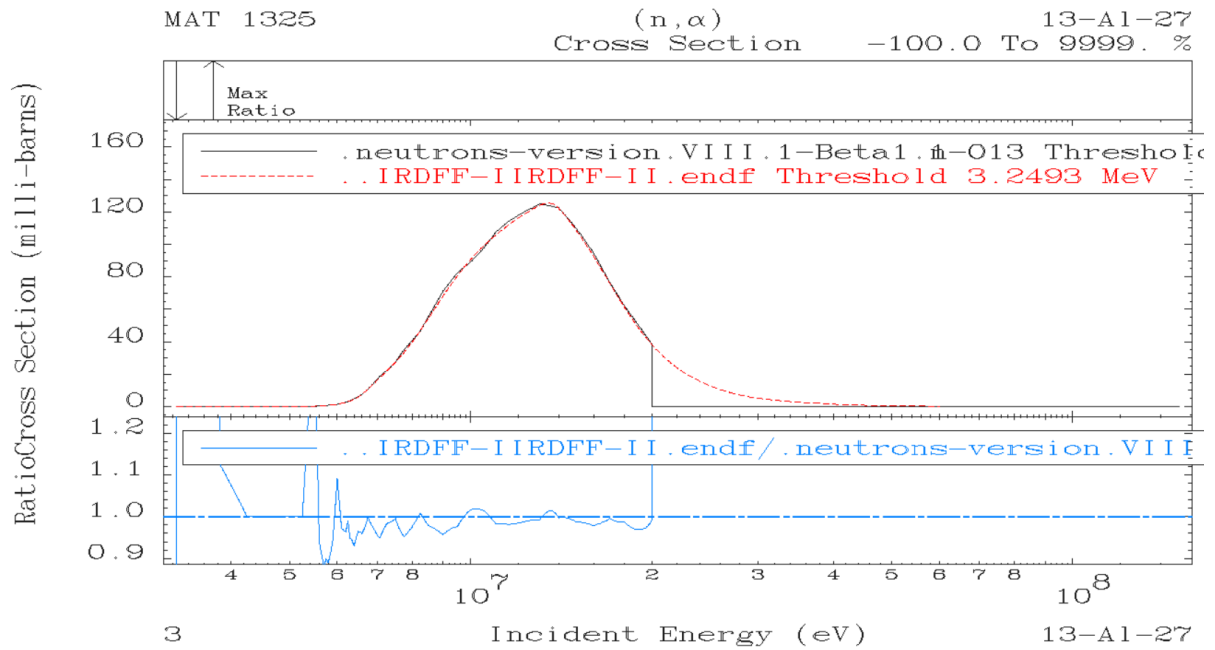
The (n,p) cross section in the file was replaced with the data from IRDFF-II up to 20 MeV. The fluctuations in the elastic cross sections are amplified, but not dramatically so.



Al-27

The ENDF/B-VIII.1b1 evaluation includes MT 16, 103 and 107. The cross sections extend up to 20 MeV. Above this energy they are lumped into MT 5. The cross sections below 20 MeV differ significantly from IRDFF-II. The two-neutron emission cross sections also include the isomer excitation function, but the original file already contains the branching ratio in MF 9, so the IRDFF-II data are ignored. The Na-24 production cross sections are also given in MF 10/MT 5. **It is proposed to replace the MT 16, 103, 107 cross sections below 20 MeV with IRDFF-II and add the Na-24 production cross section. Note that the discrete level excitation function for proton and alpha emission are given in the original file, therefore the cross sections need to be re-scaled such that the sums match the total particle production data in IRDFF-II.**

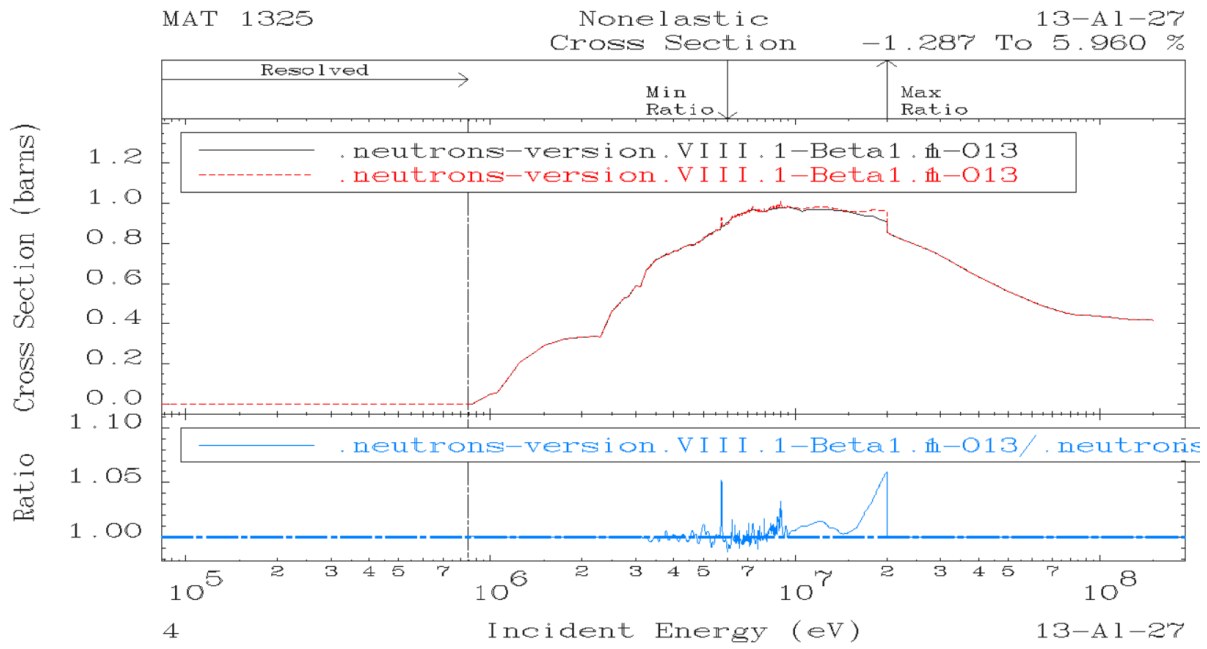
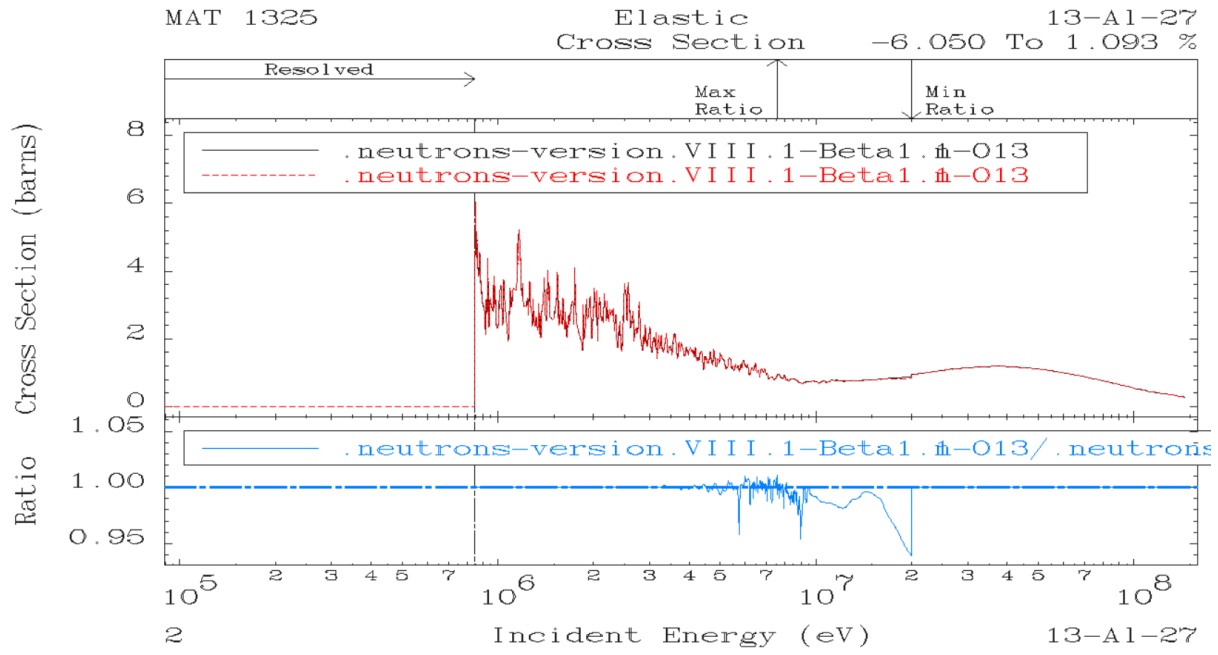


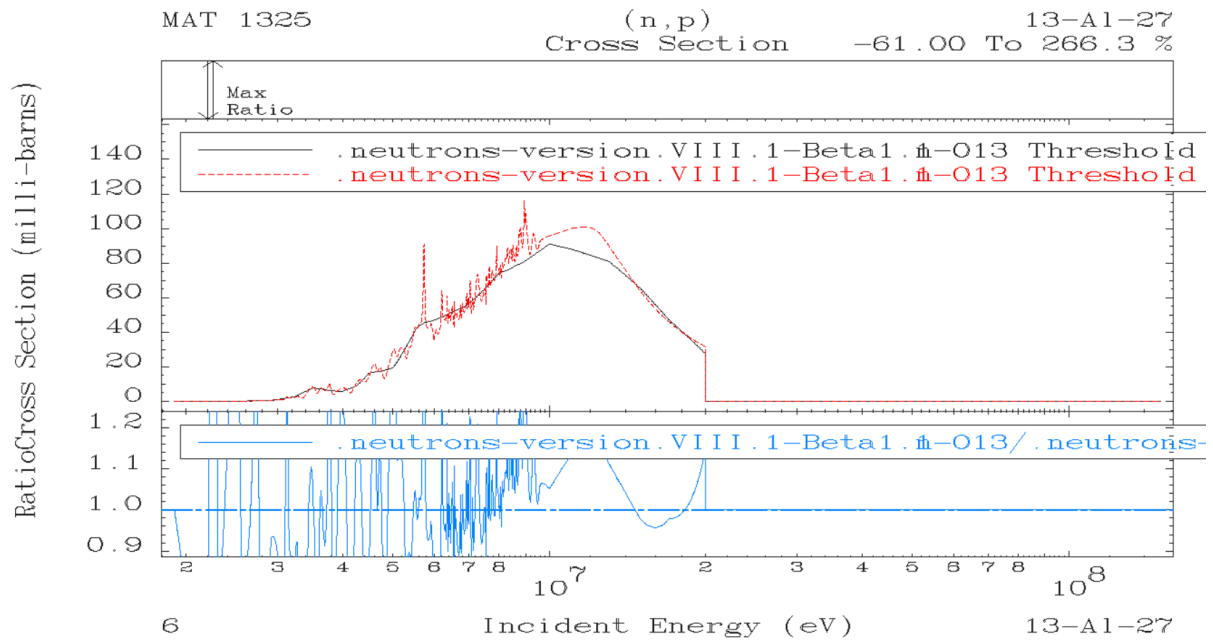
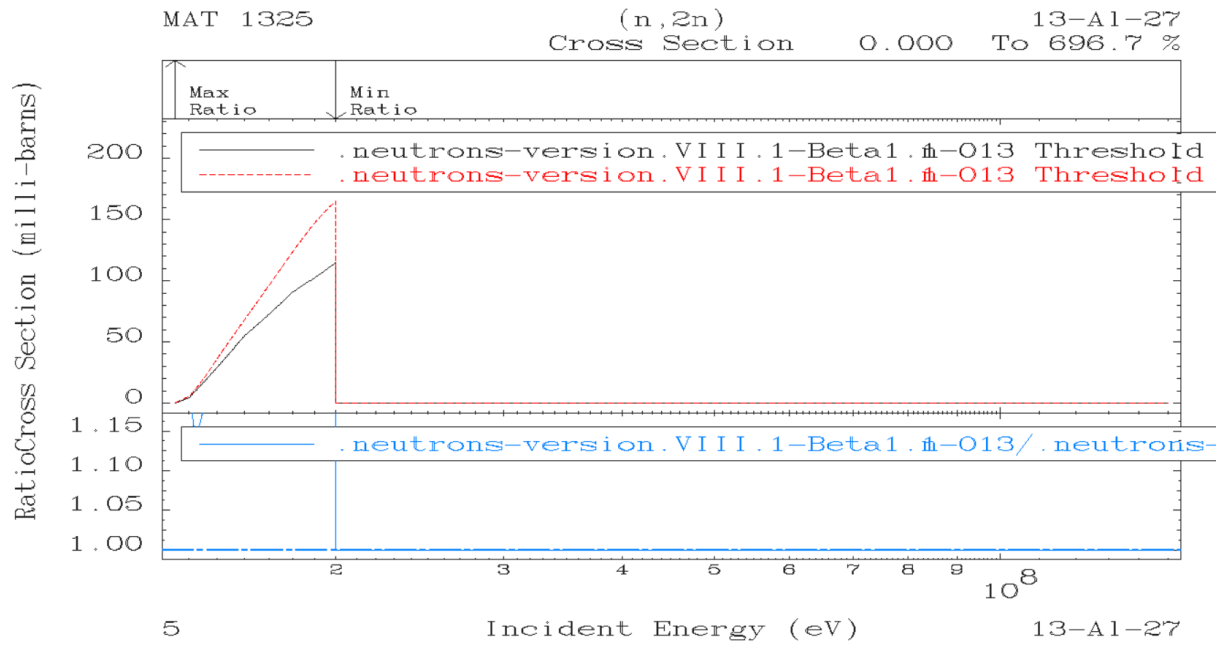


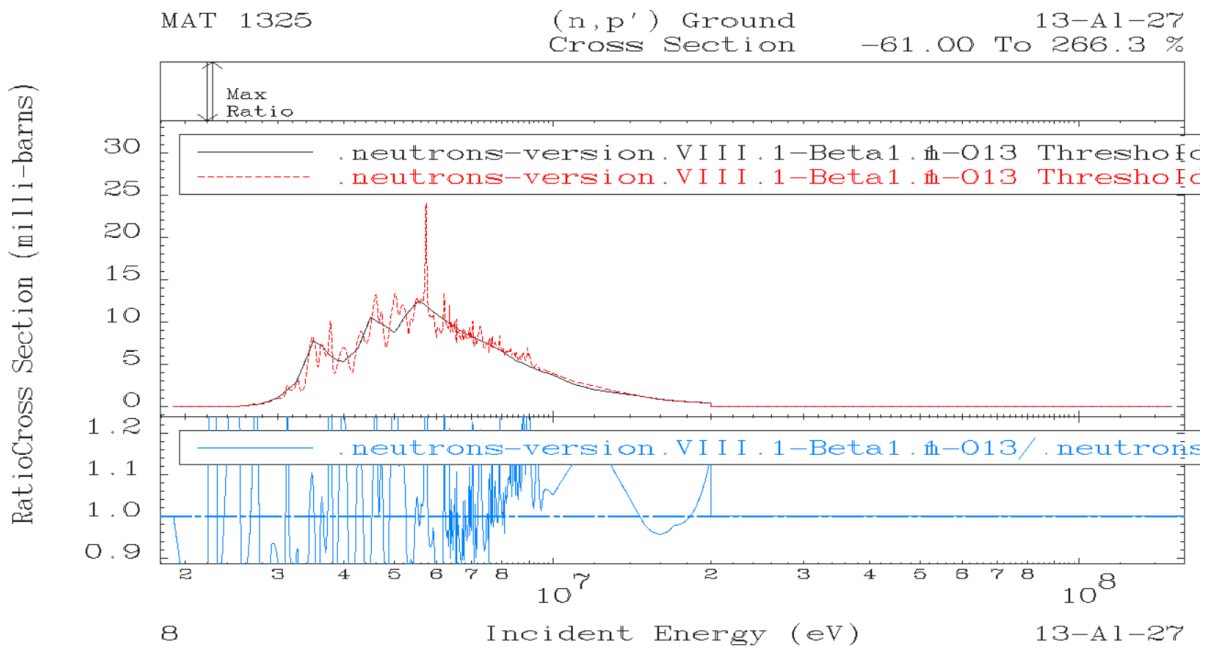
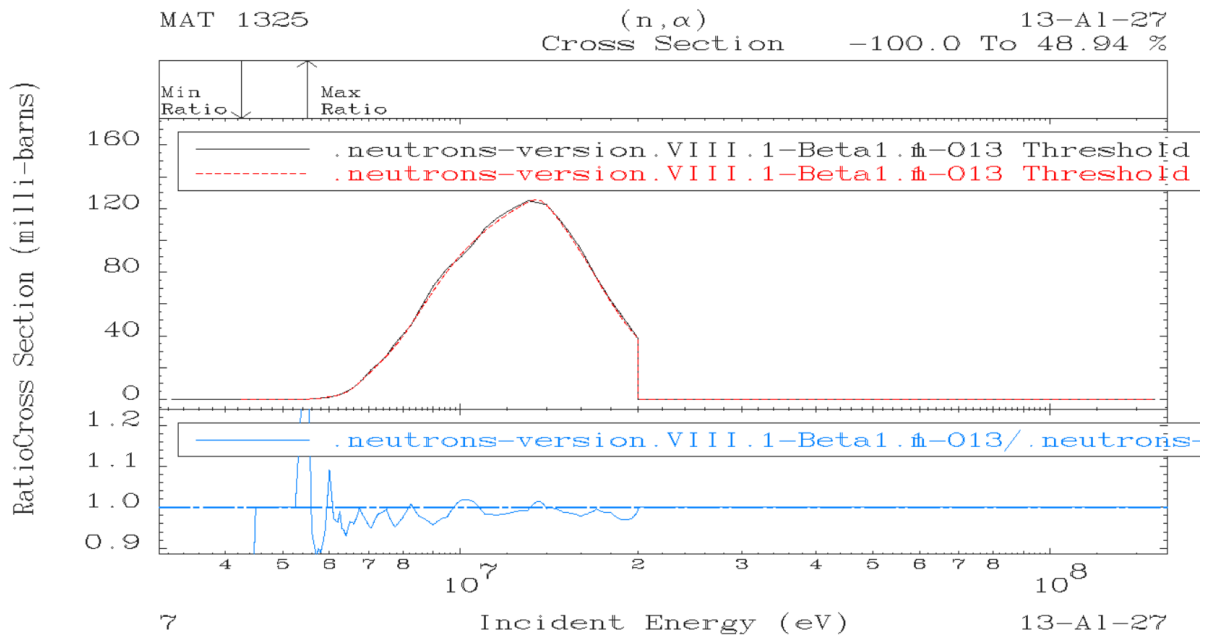
Implementation

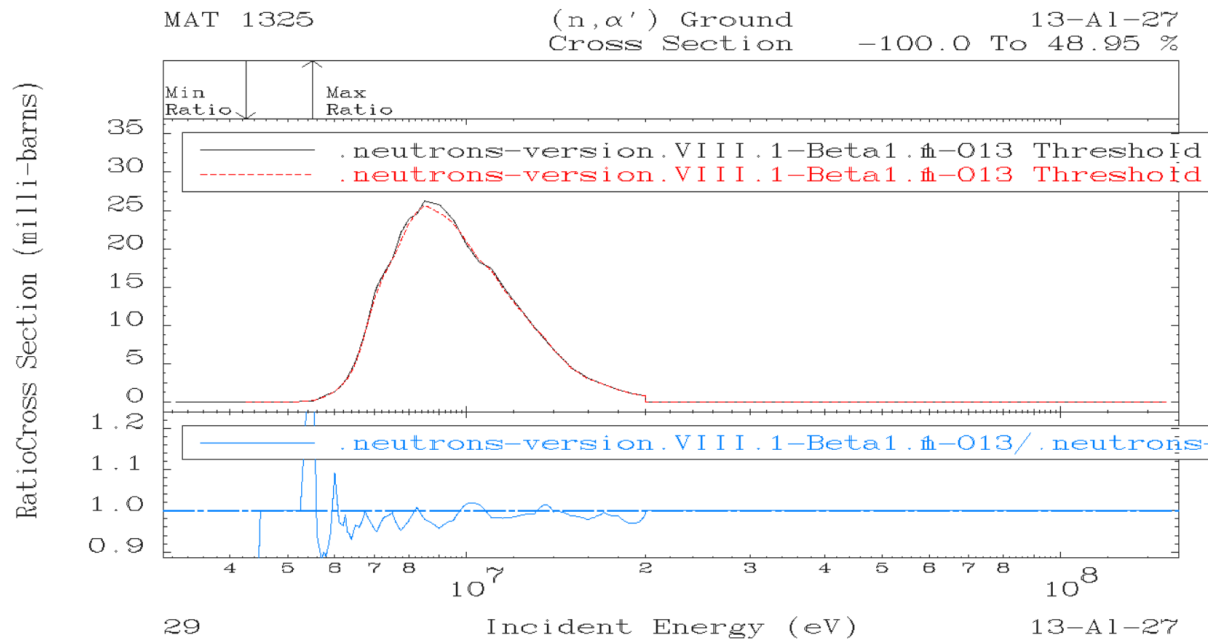
The insertion of the (n,2n) cross sections from IRDFF-II up to 20 MeV was straightforward. The branching ratio data for this reaction were left unchanged. The original evaluation contains discrete level data for the proton- and alpha-emission cross sections. The ratios of the total particle emission in the ENDF file and in IRDFF-II for the (n,p) and (n,α) reactions was calculated. The discrete level and the continuum cross sections were scaled by this ratio. The new total particle emission cross sections were obtained by summation. The deuteron- and triton-emission cross sections in the original file were left unchanged. All cross sections were inserted up to 20 MeV, since above this energy the lumped MT 5 representation is used in the original ENDF file, which makes consistent corrections to the implied cross sections virtually impossible.

The total cross sections were left unchanged and the difference due to the updated cross sections was dumped on elastic, resulting in differences up to 5 % in the elastic and the non-elastic cross sections. In the plots below the comparison is given only for the first discrete level of the (n,p) and the (n,α) reactions for brevity.



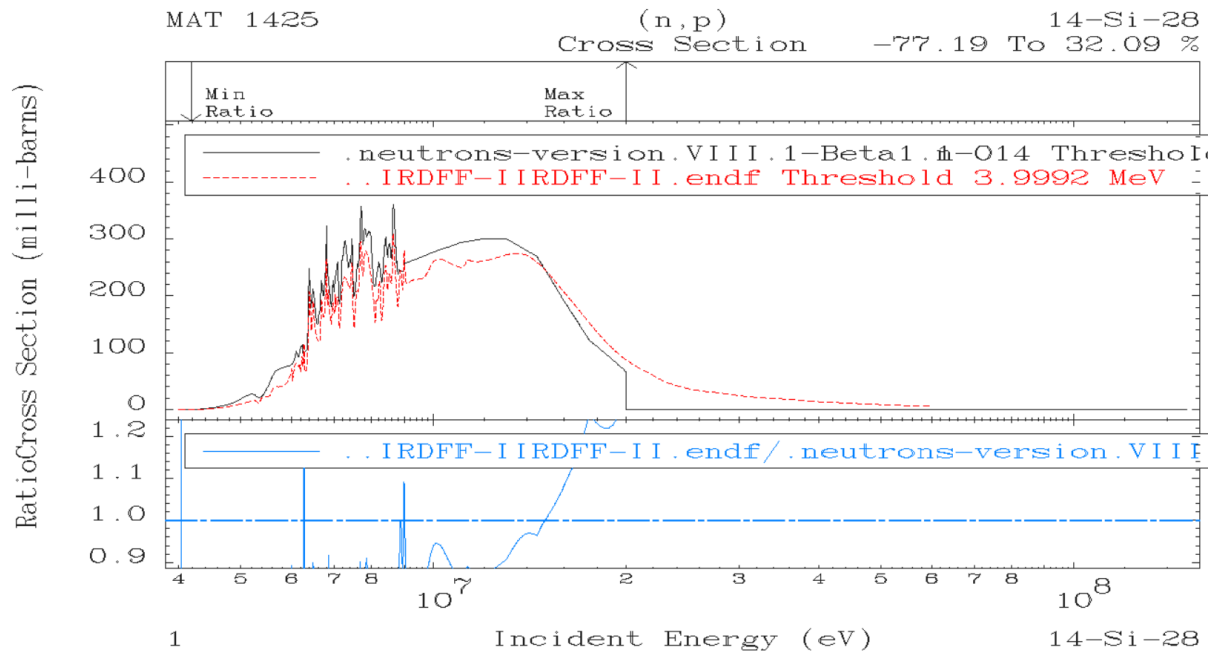






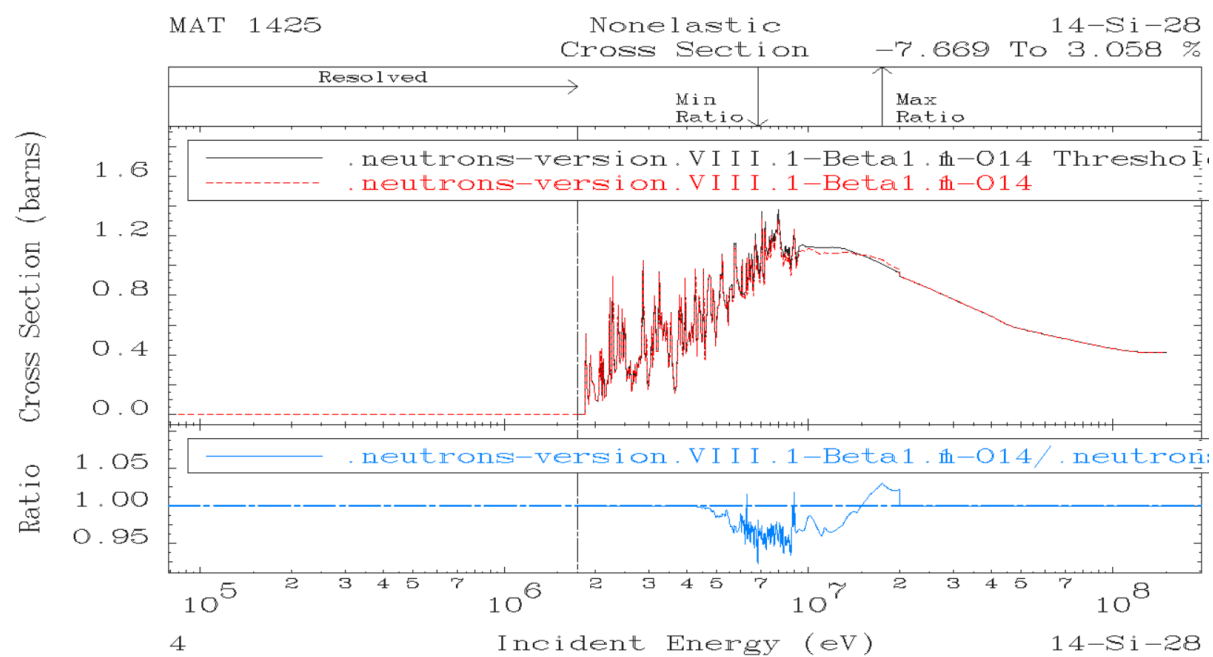
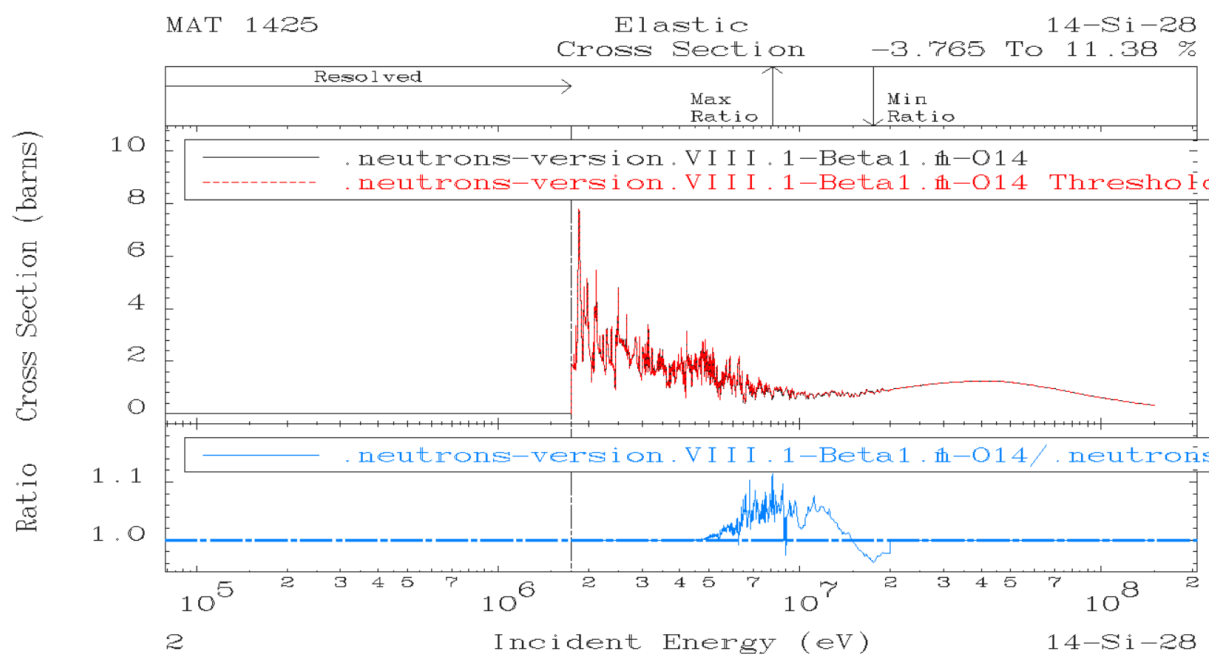
Si-28

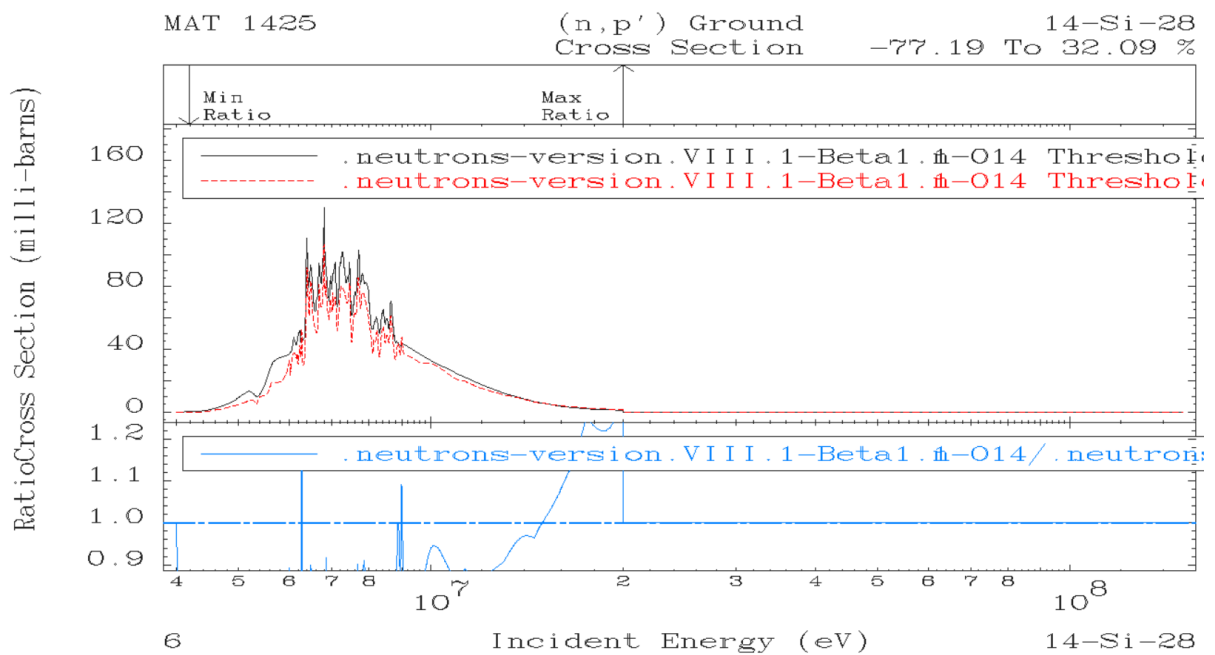
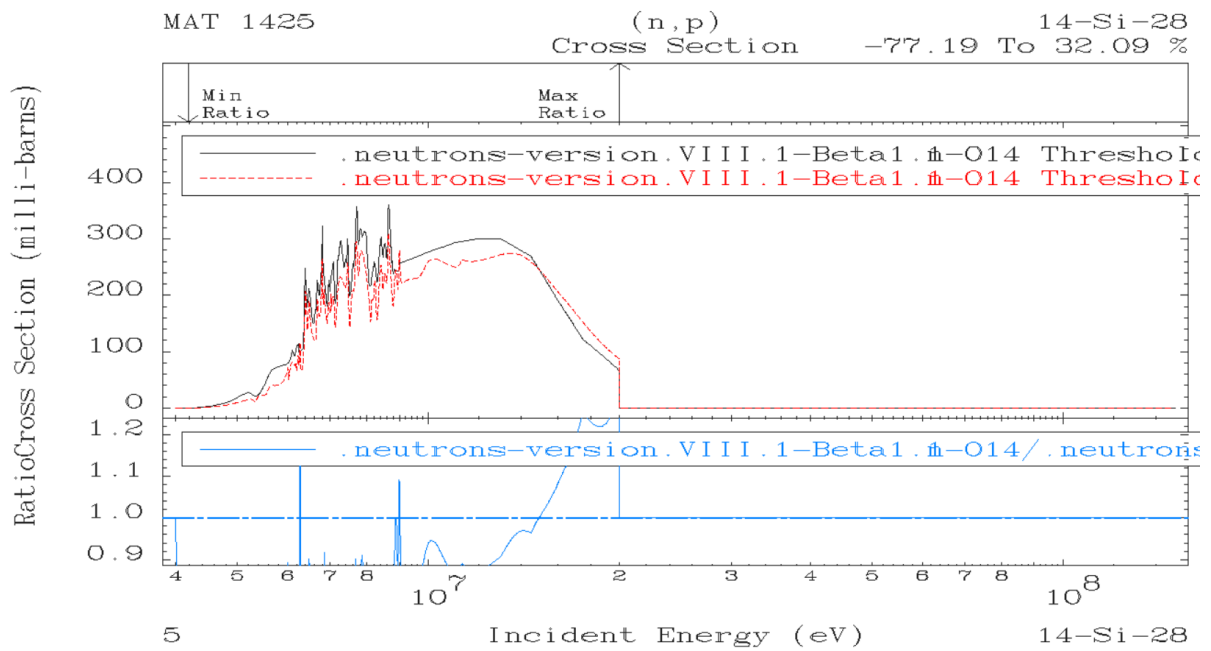
The ENDF/B-VII.1b1 evaluation contains the proton-emission cross section (MT 103), which differs significantly from IRDFF-II. **It is proposed to replace the cross sections below 20 MeV with IRDFF-II.**



Implementation

The original ENDF file contains discrete level data for the (n, p) reaction. The ratio of the total proton emission cross sections in the ENDF file and in IRDFF-II was calculated. The discrete level and the continuum cross sections were scaled by this ratio. The new total proton emission cross sections were obtained by summation. The total cross sections were left unchanged, dumping the difference to elastic. The difference in the elastic and the non-elastic cross sections amounted to about 9 % and 7 %, respectively.



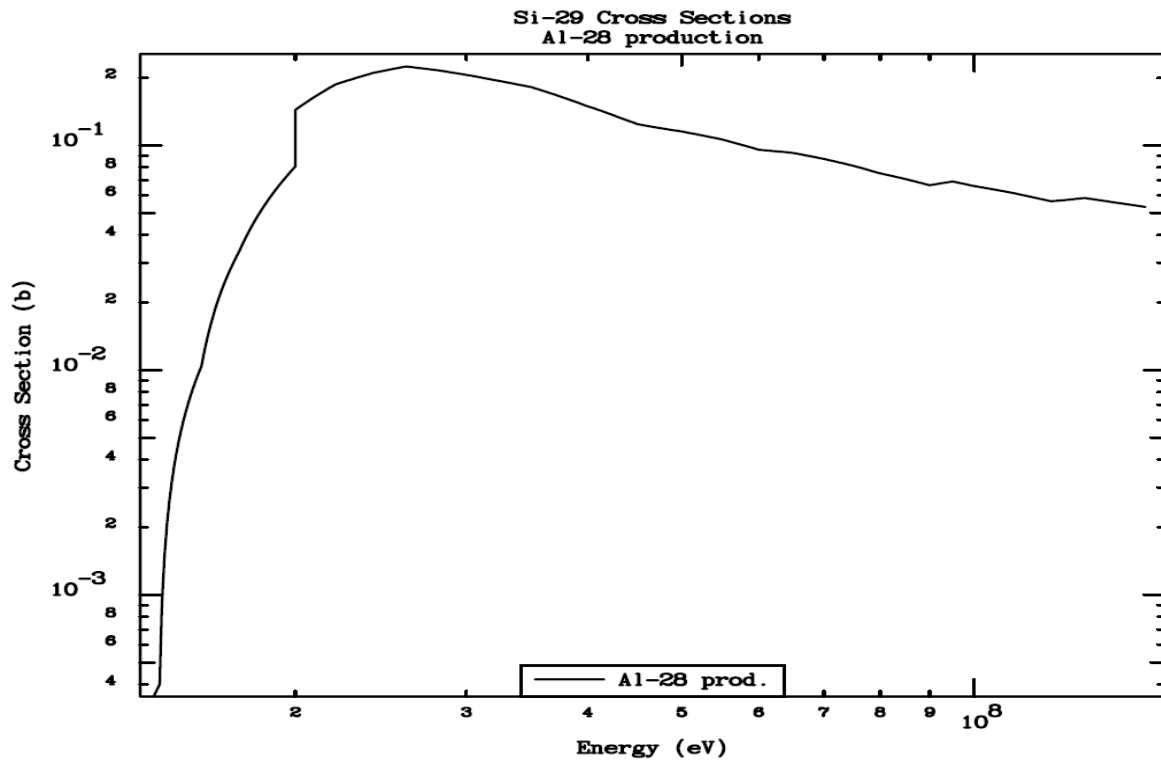


Si-29

The ENDF/B-VIII.1b1 evaluation contains the Al-28 production cross section under MF 10/MT 5 representation. **Inclusion of this lumped reaction into ENDF/B-VIII.1b1 could be considered.**

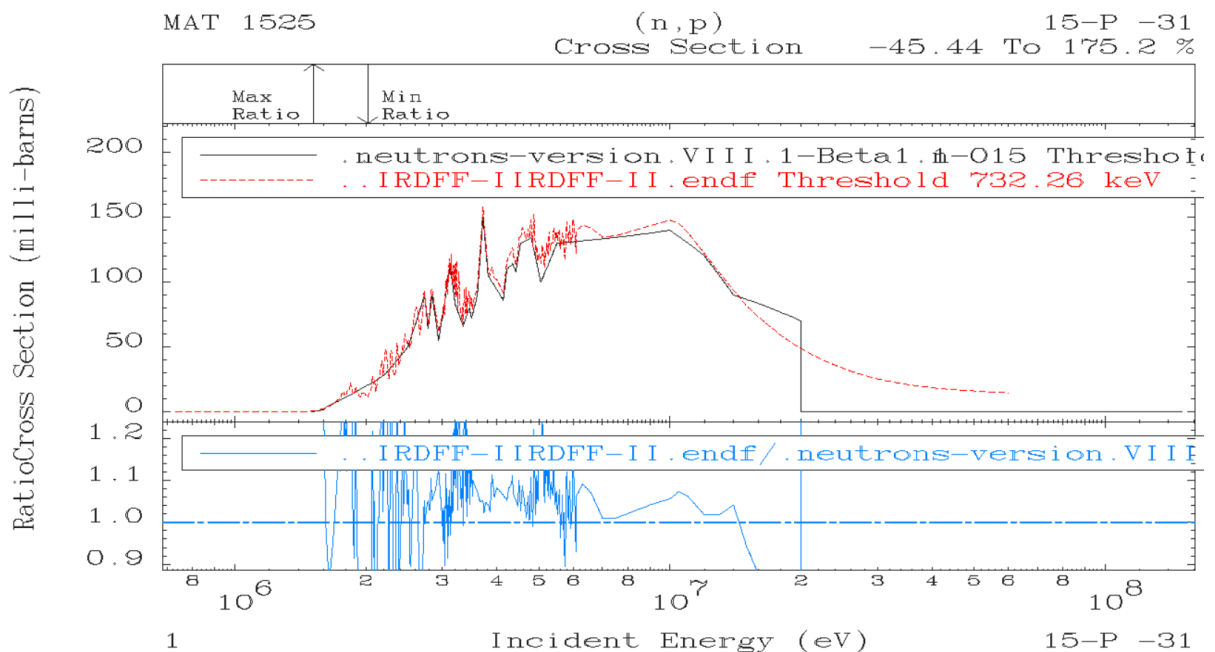
Implementation

The MF 8, 10 and 40 for the Al-28 production in MT 5 were inserted into the original ENDF file from IRDFF-II.



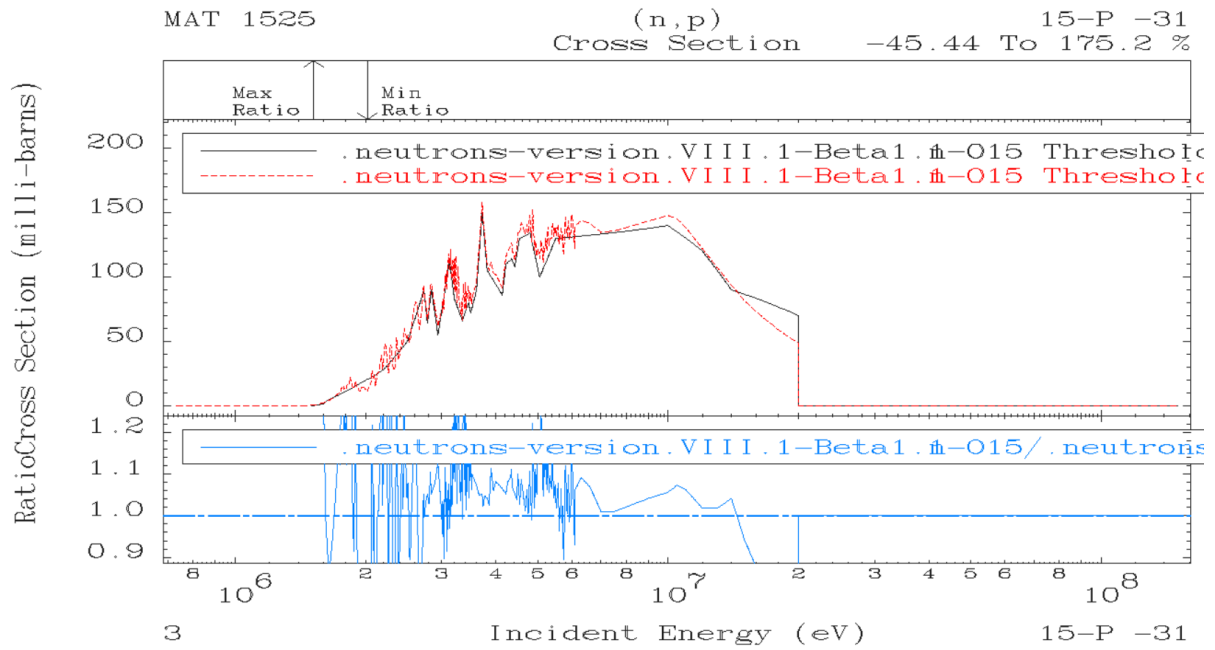
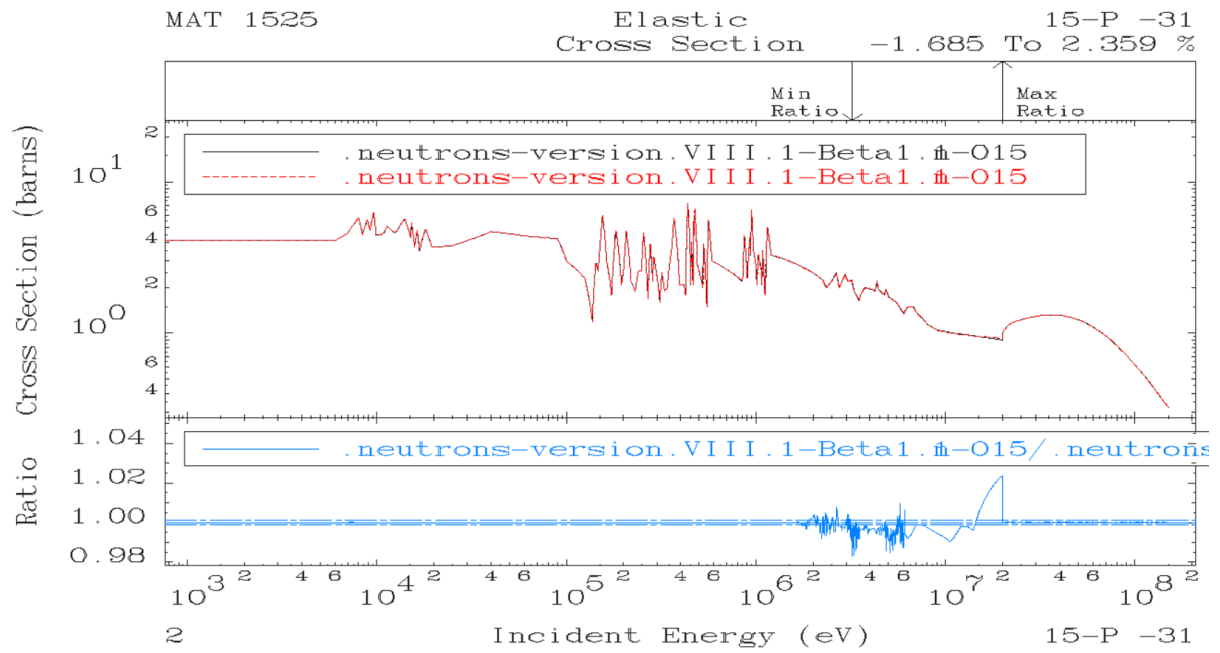
P-31

The ENDF/B-VII.1b1 evaluation contains the proton-emission cross section (MT 103), which differs significantly from IRDFF-II. **It is proposed to replace the cross sections below 20 MeV with IRDFF-II.**



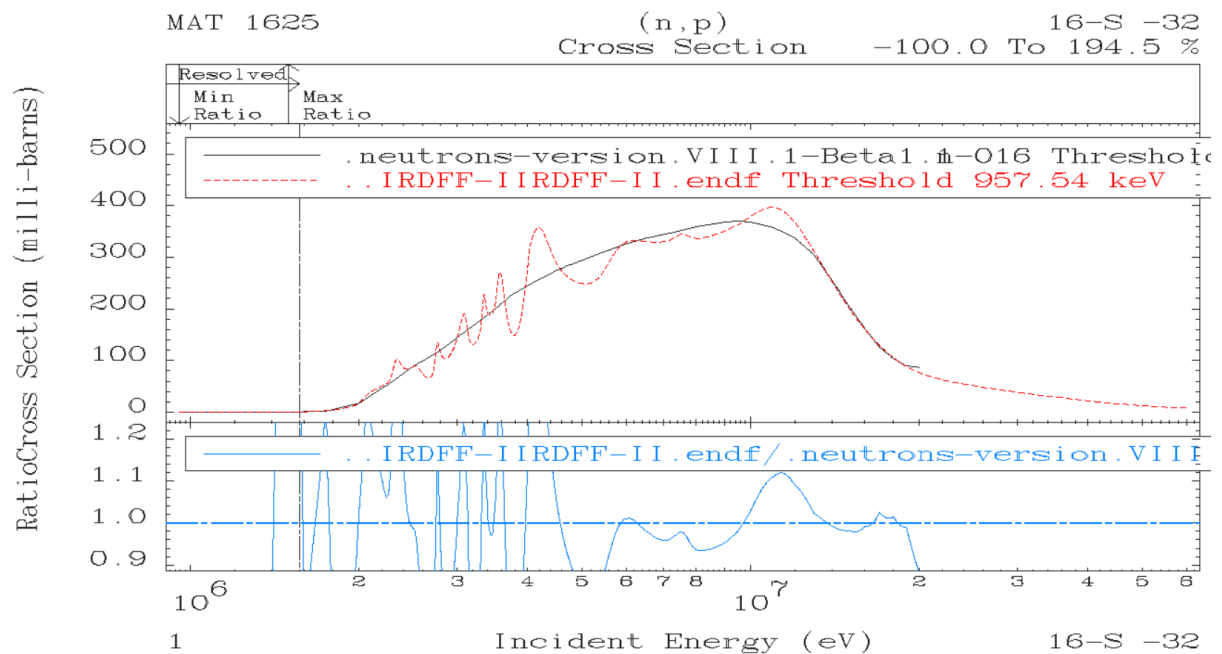
Implementation

The (n,p) cross sections are inserted into the original ENDF file up to 20 MeV because above this energy the reaction is implicitly included in the lumped MT 5 reaction. The elastic cross section is affected by up to 2 %.



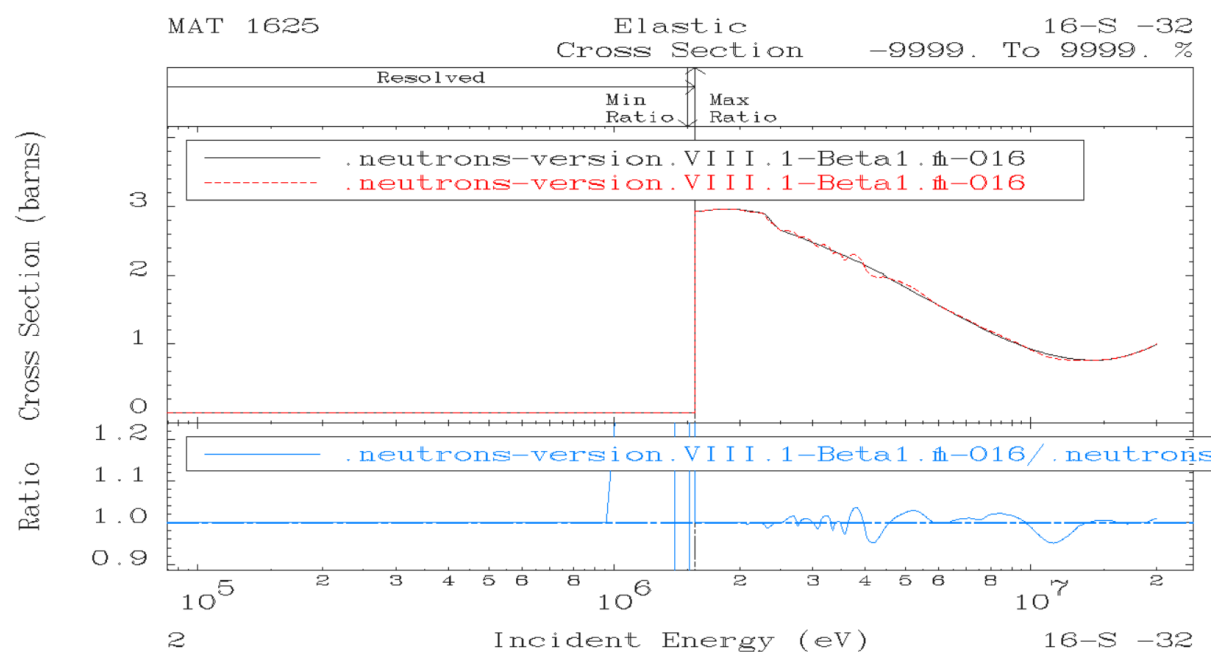
S-32

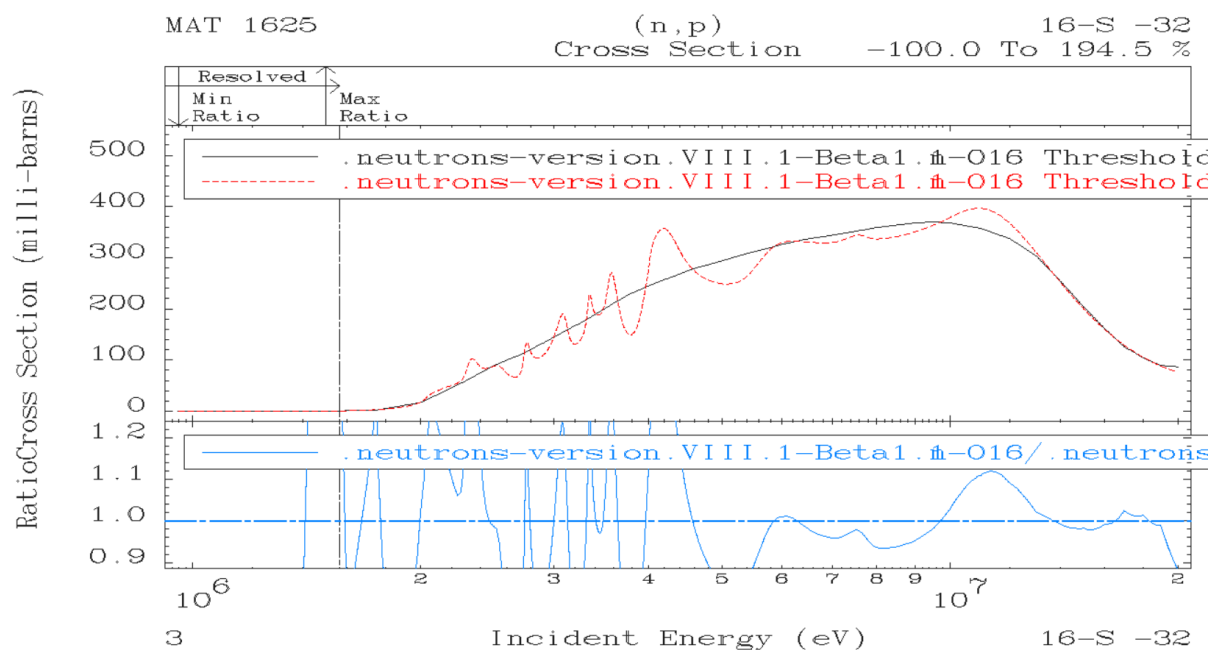
The ENDF/B-VIII.1b1 evaluation contains the proton emission cross section MT 103 representation. In the IRDFF-II library the cross section has more structure. **Replacement with IRDFF-II cross section is proposed.**



Implementation

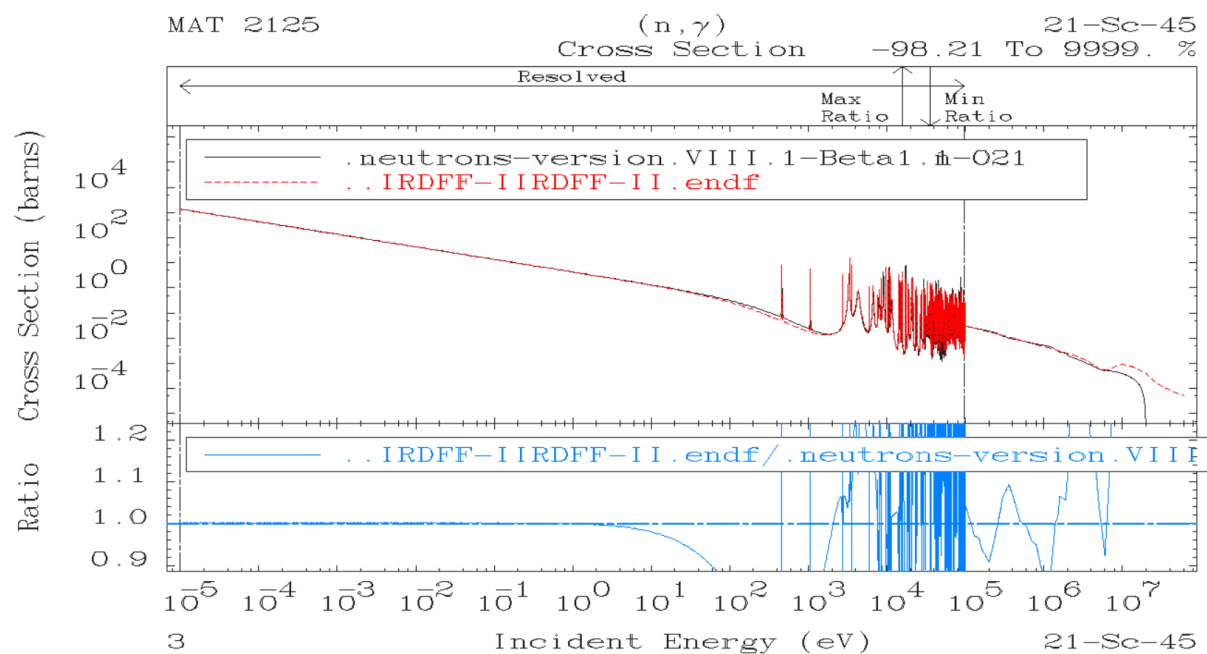
The (n,p) cross sections are inserted into the original ENDF file. The elastic cross section is affected by up to about 2 %.





Sc-45

In the ENDF/B-VIII.1b1 evaluation the reaction that has a match in IRDFF-II is the capture cross section. Since in ENDF/B-VIII.1b1 the cross sections are defined by the resonance parameters, replacement is not straightforward. **The proposal is to take no action.**

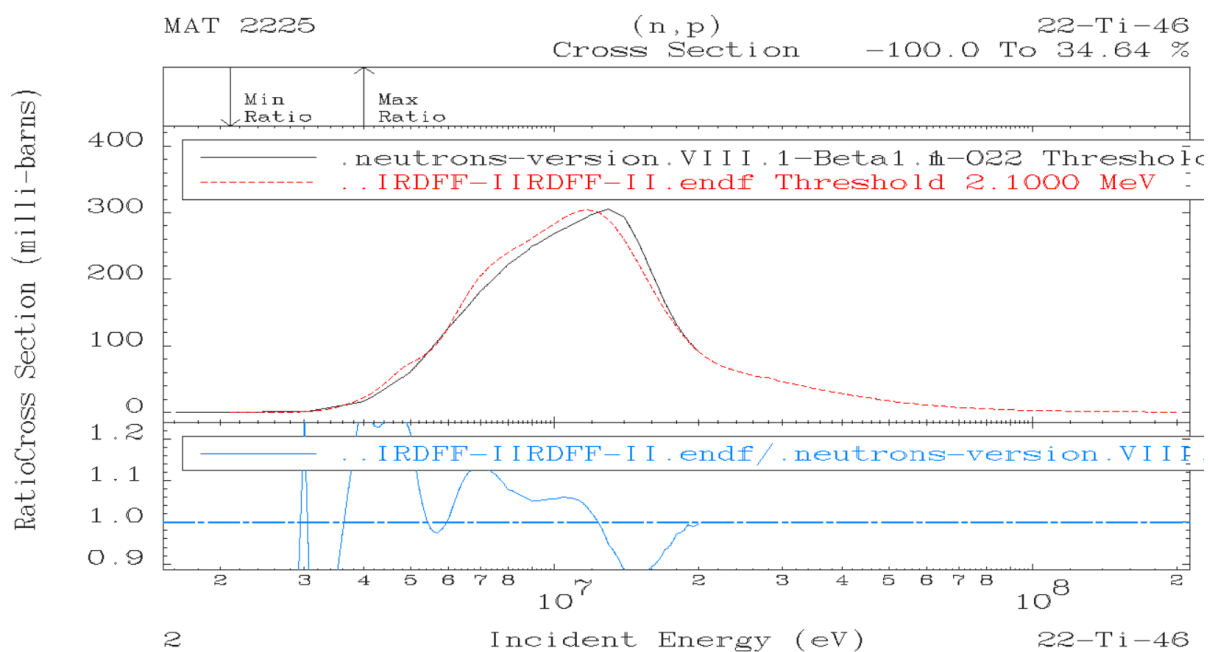
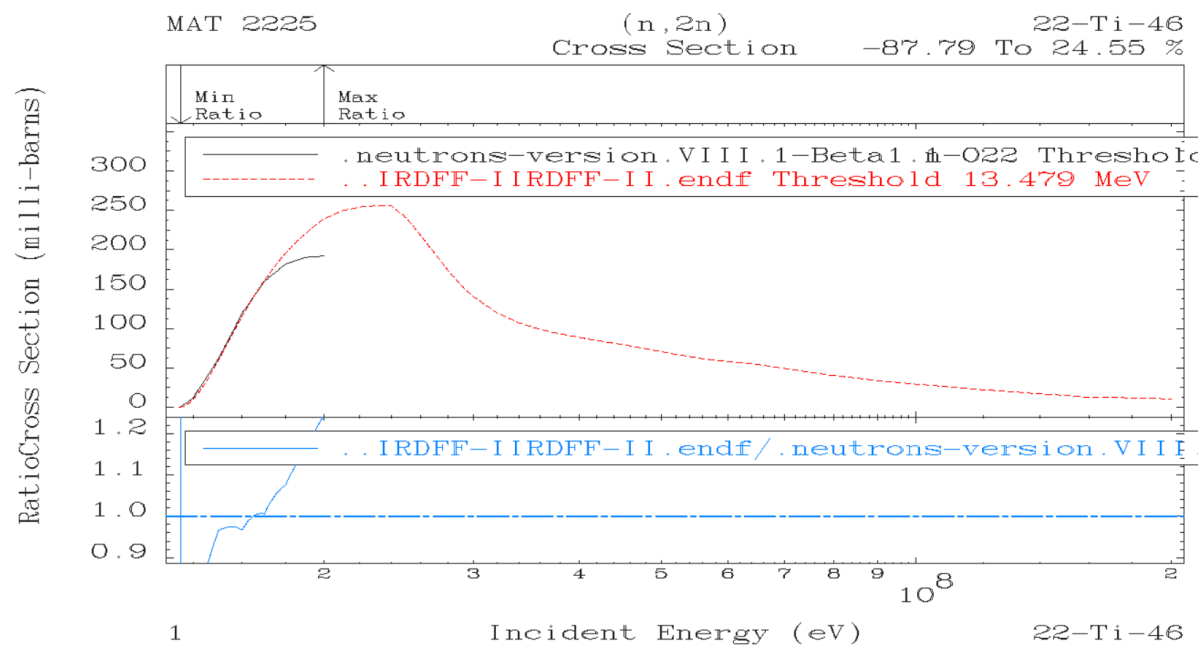


Implementation

No action is needed.

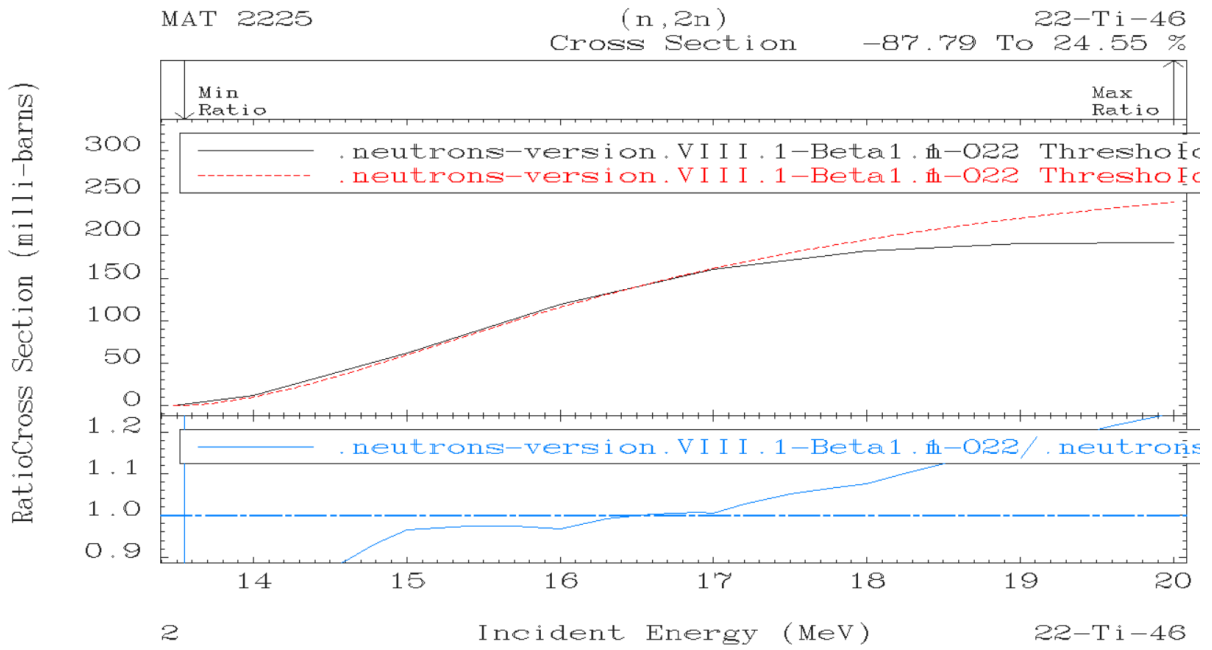
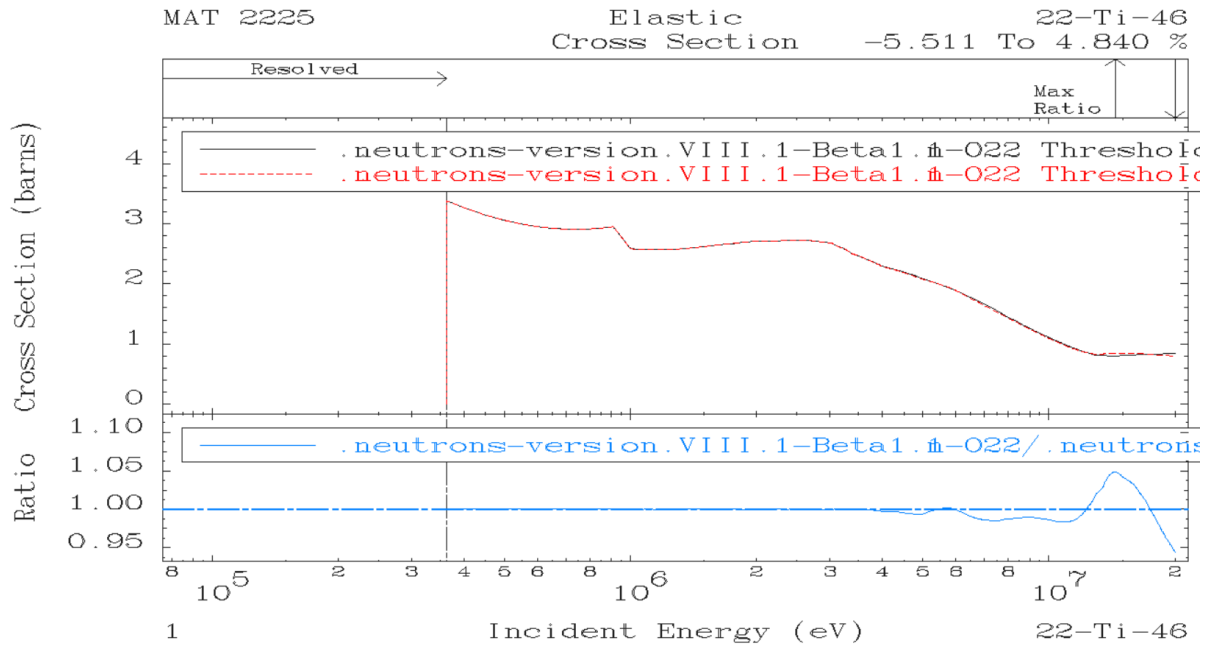
Ti-46

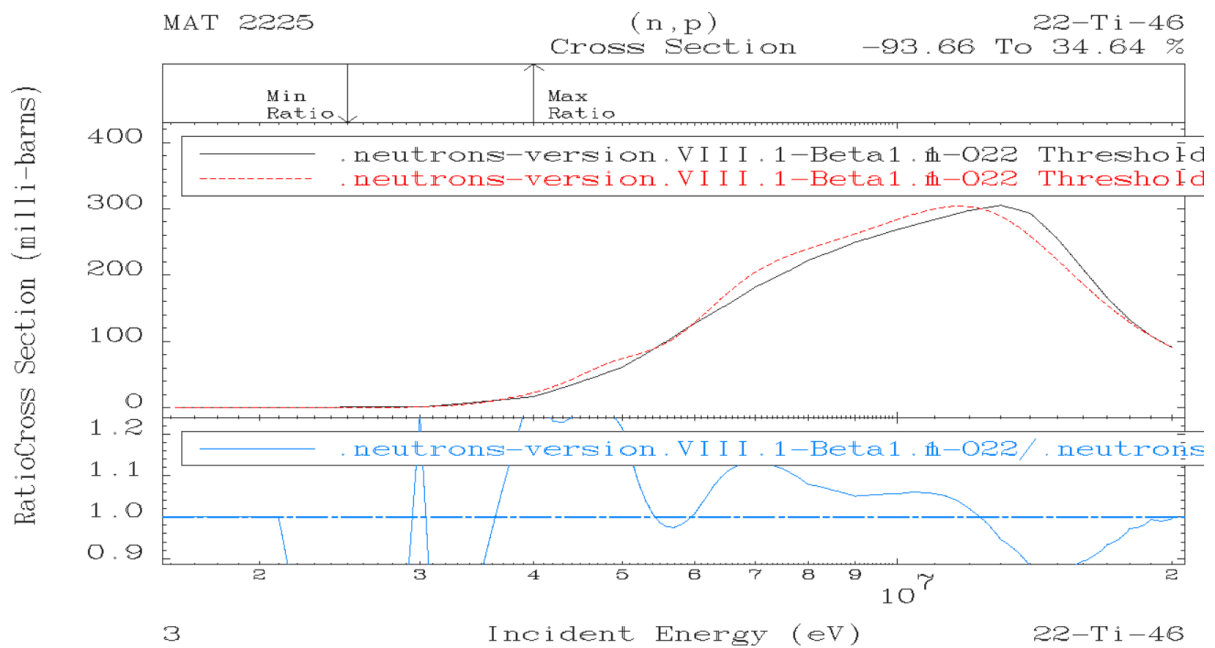
The ENDF/B-VIII.1b1 evaluation contains MT 16 and MT 103 reaction cross sections that have a match in the IRDFF-II library. **Replacement with IRDFF-II cross sections is proposed.**



Implementation

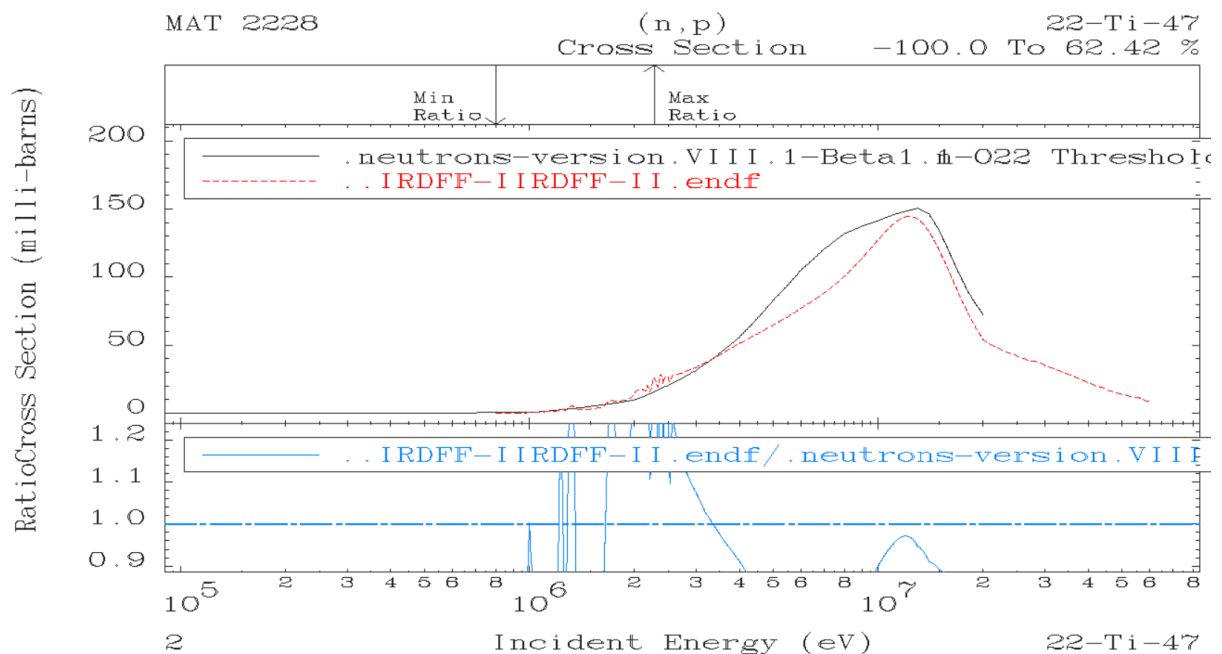
The (n,p) cross sections are inserted into the original ENDF file. The reaction has a positive Q-value, so there is essentially no threshold. The elastic cross section is affected by up to about 5 %.





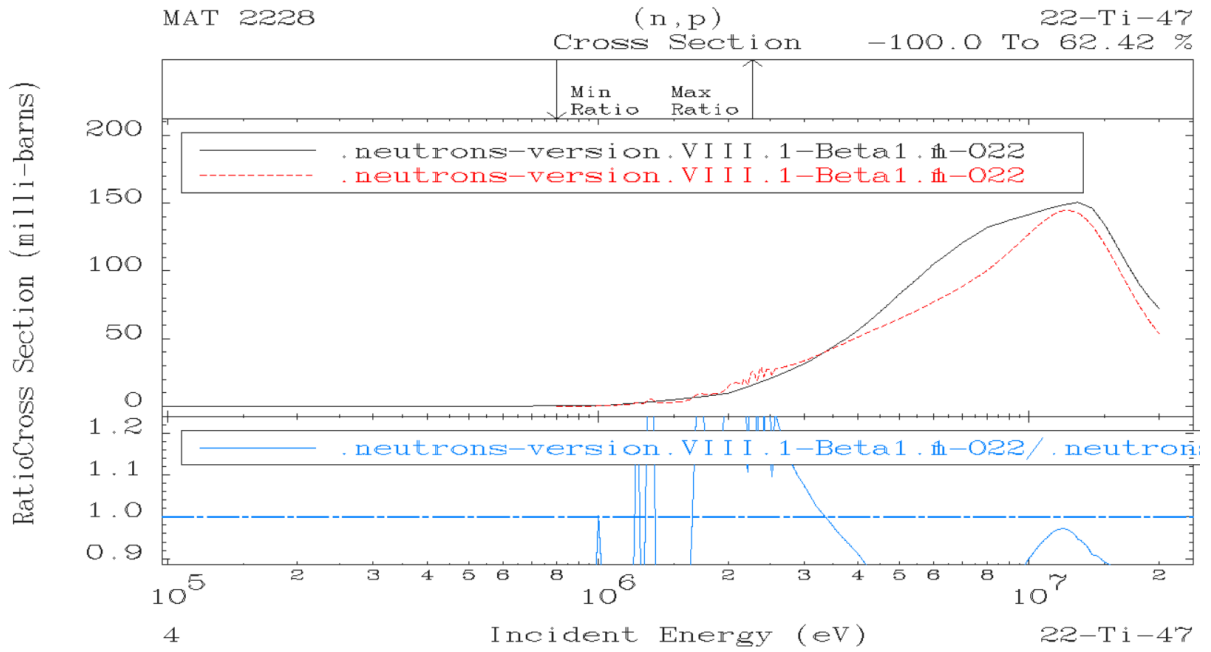
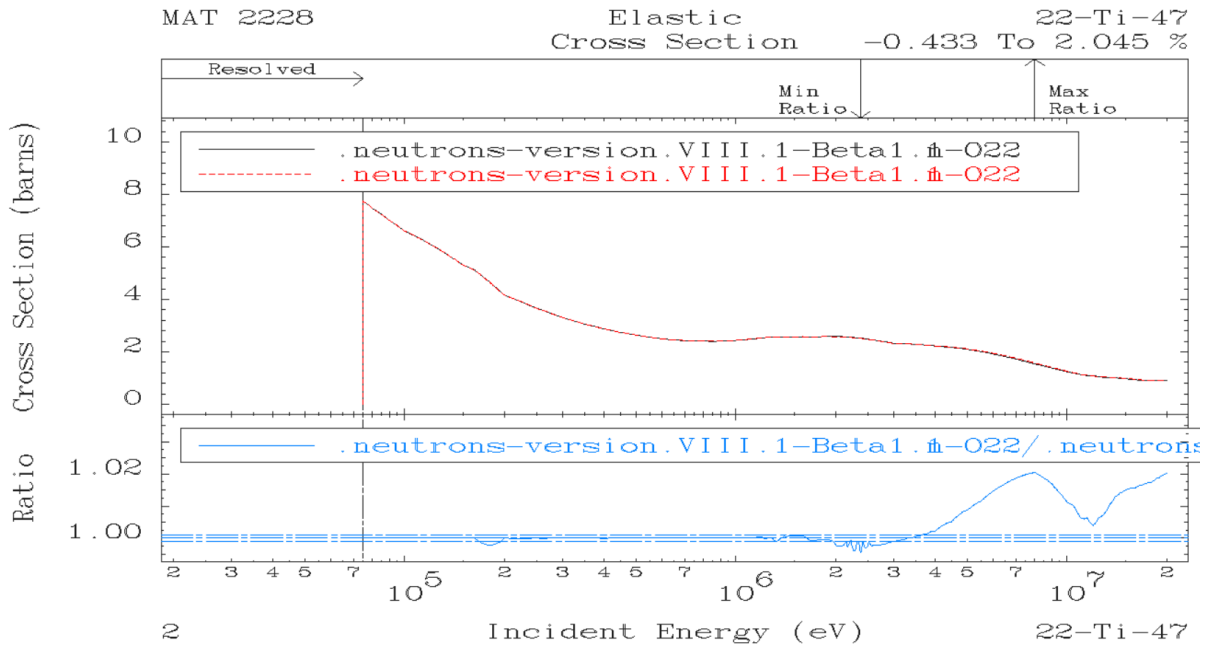
Ti-47

The ENDF/B-VIII.1b1 evaluation contains the MT 103 reaction cross sections that have a match in the IRDFF-II library. The reaction has a positive Q-value; the pseudo-threshold is at 800 keV. **The proposal is to replace the cross sections with IRDFF-II.**



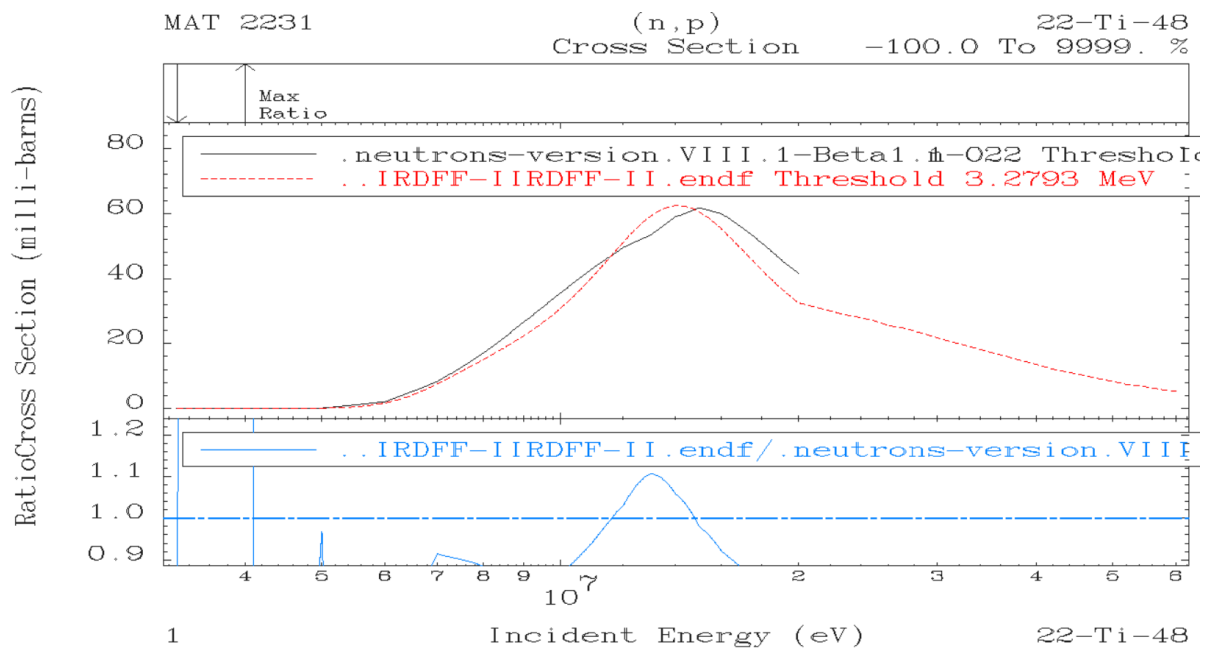
Implementation

The (n,p) cross sections are inserted into the original ENDF file. The reaction has a positive Q-value, so there is essentially no threshold. The elastic cross section is affected by up to about 2 %.



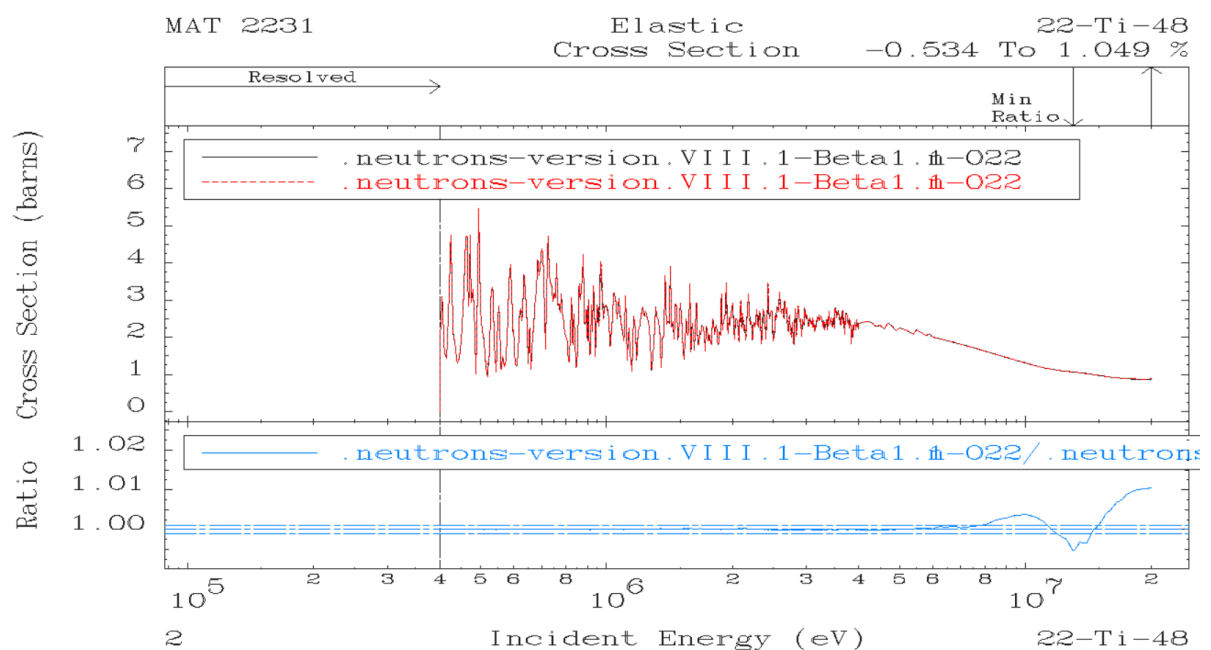
Ti-48

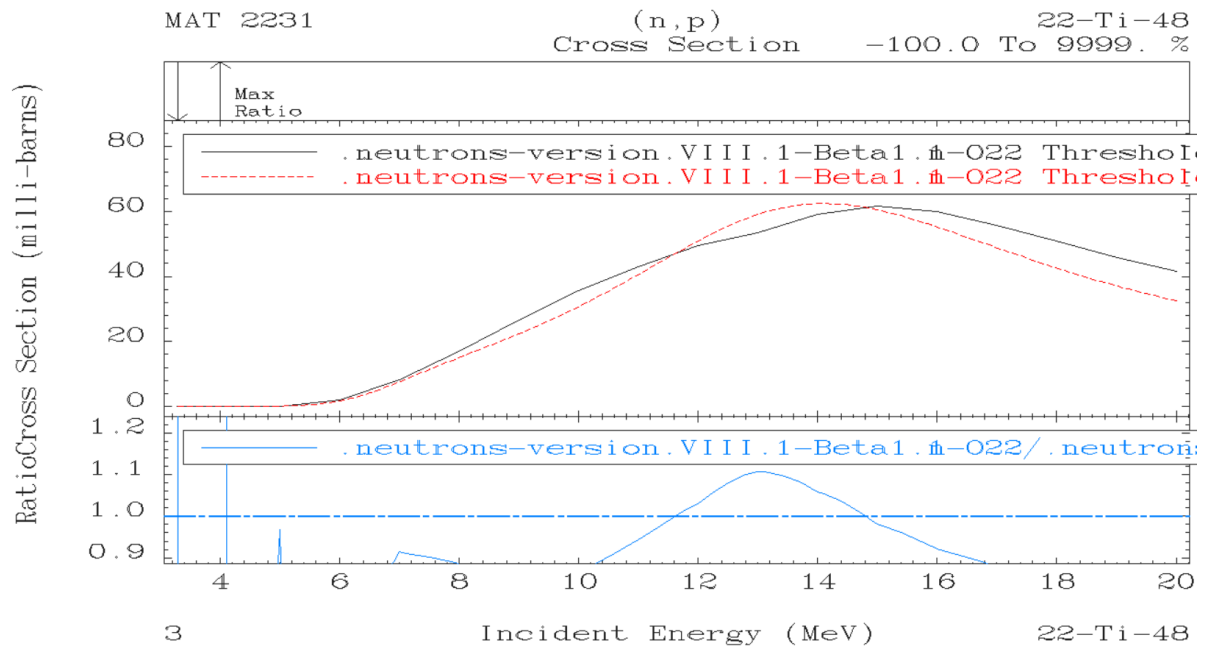
The ENDF/B-VIII.1b1 evaluation contains the MT 103 reaction cross sections that have a match in the IRDFF-II library. **The proposal is to replace the cross sections with IRDFF-II.**



Implementation

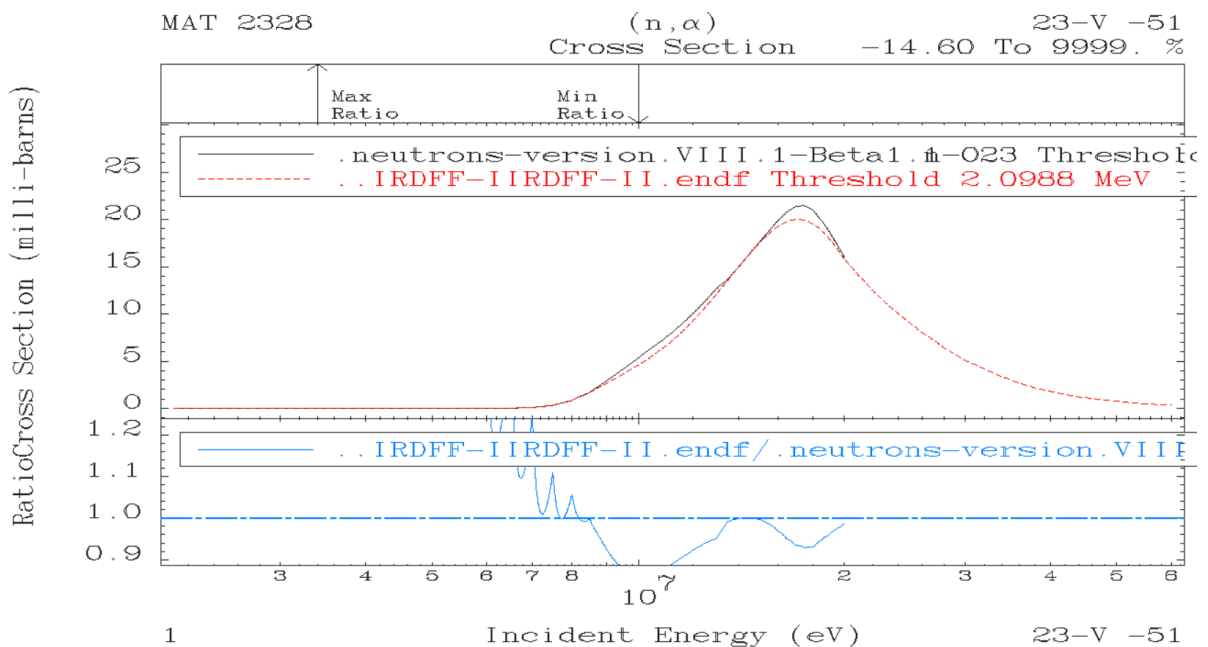
The (n,p) cross sections are inserted into the original ENDF file. The reaction has a positive Q-value, so there is essentially no threshold. The elastic cross section is affected by up to about 1 %.





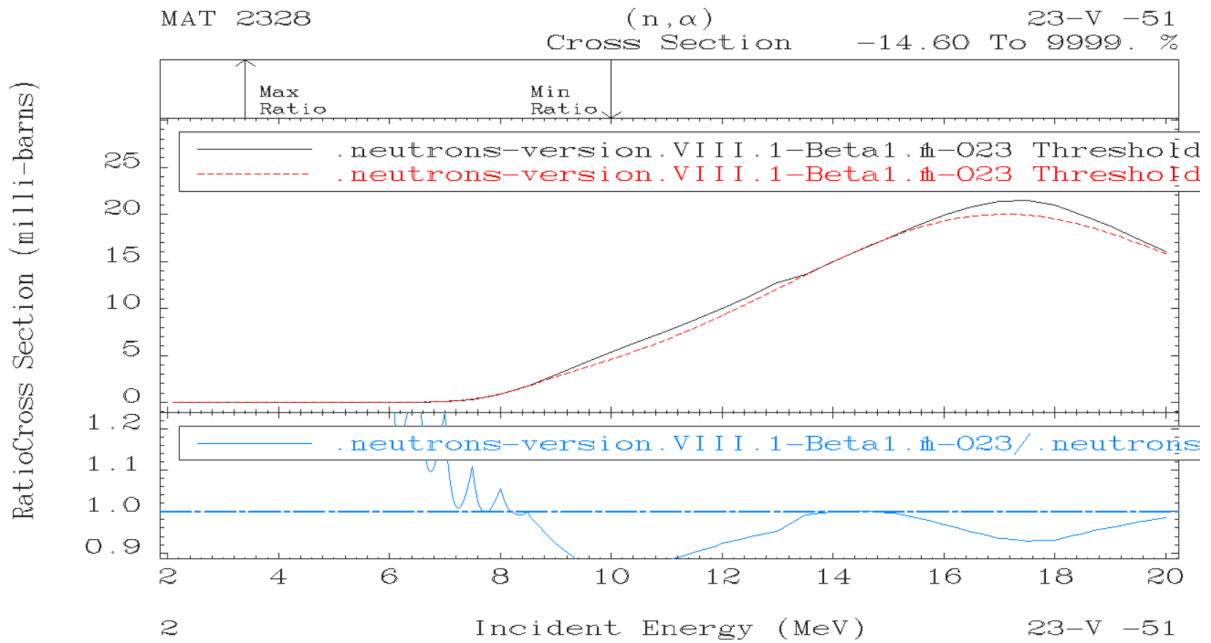
V-51

The ENDF/B-VIII.1b1 evaluation contains the MT 107 reaction cross sections that have a match in the IRDFF-II library. It also includes the Sc-48 production cross section in MF 10/MT 5 since the alpha-emission is not exactly equal to Sc-48 production at higher energies. **The proposal is to replace the MT 107 cross sections and add the Sc-48 production cross sections from IRDFF-II.**



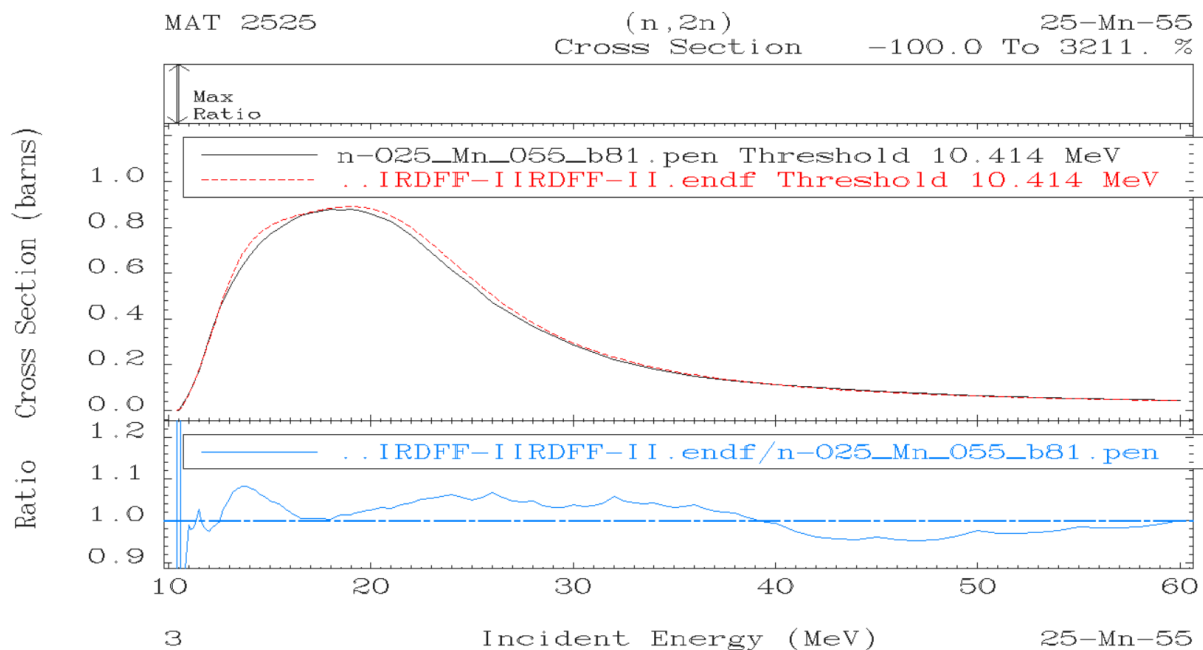
Implementation

The largest difference in the elastic cross section is less than 0.2 %. The (n,α) cross section was inserted into the original ENDF file up to 20 MeV.



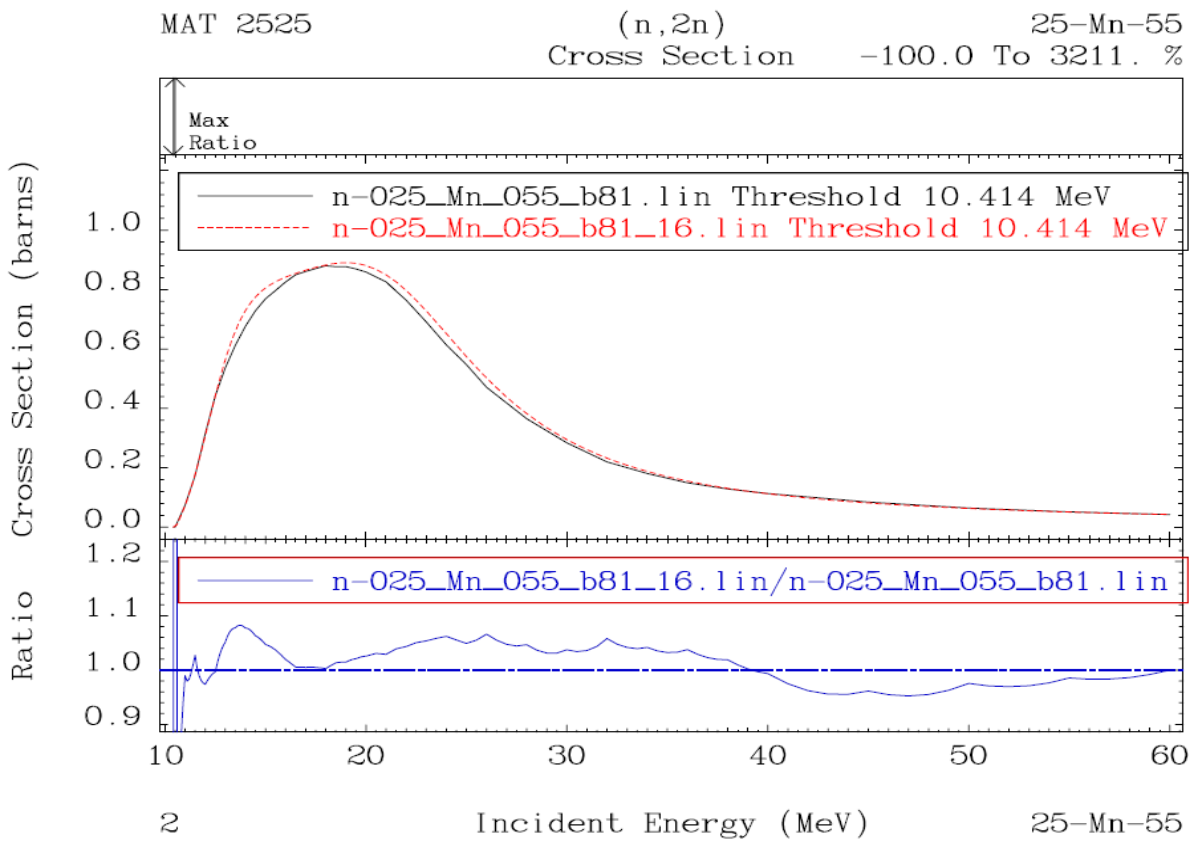
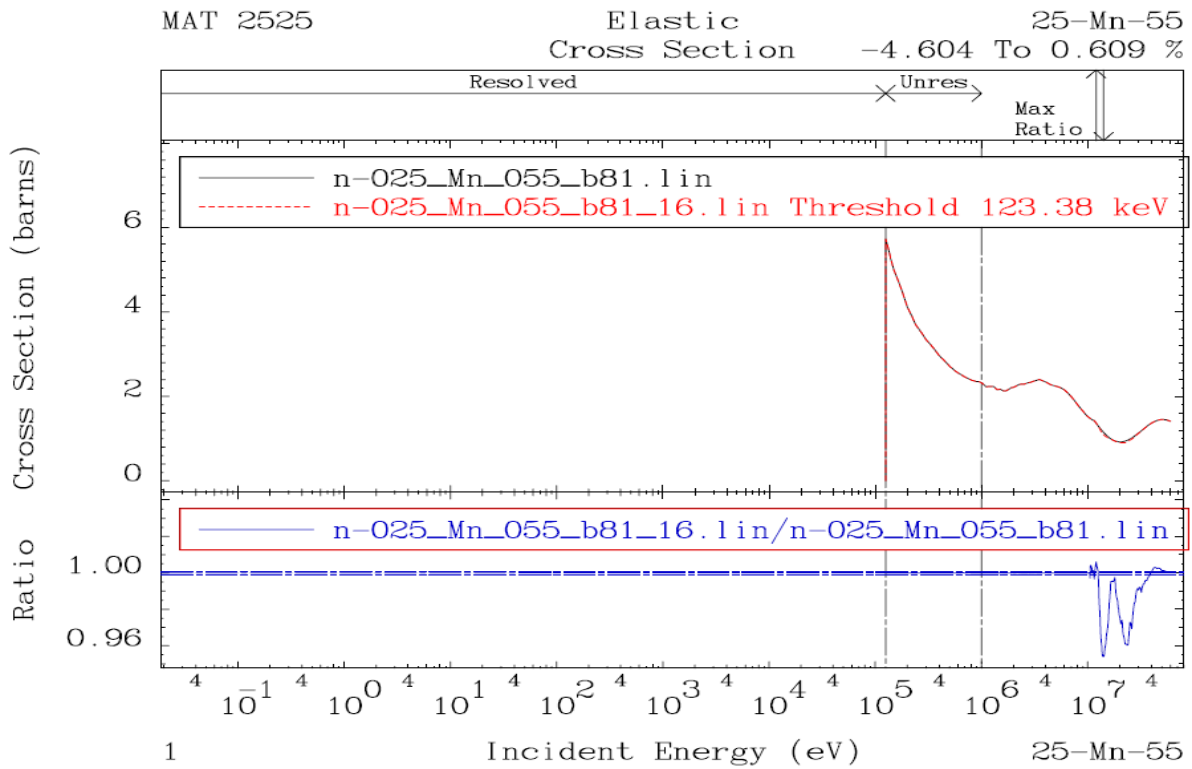
Mn-55

The ENDF/B-VIII.1b1 evaluation contains the MT 16, 102 reaction cross sections that have a match in the IRDFF-II library. The two-neutron emission cross sections MT 16 differ, but the capture cross sections MT 102 are the same in the two libraries. **The proposal is to replace the MT 16 cross sections with IRDFF-II.**



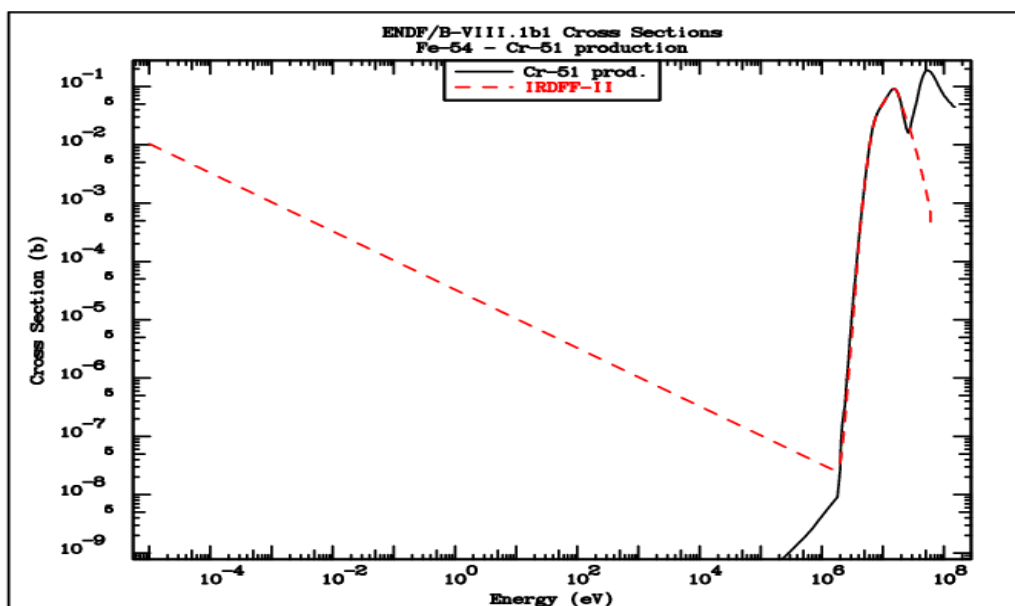
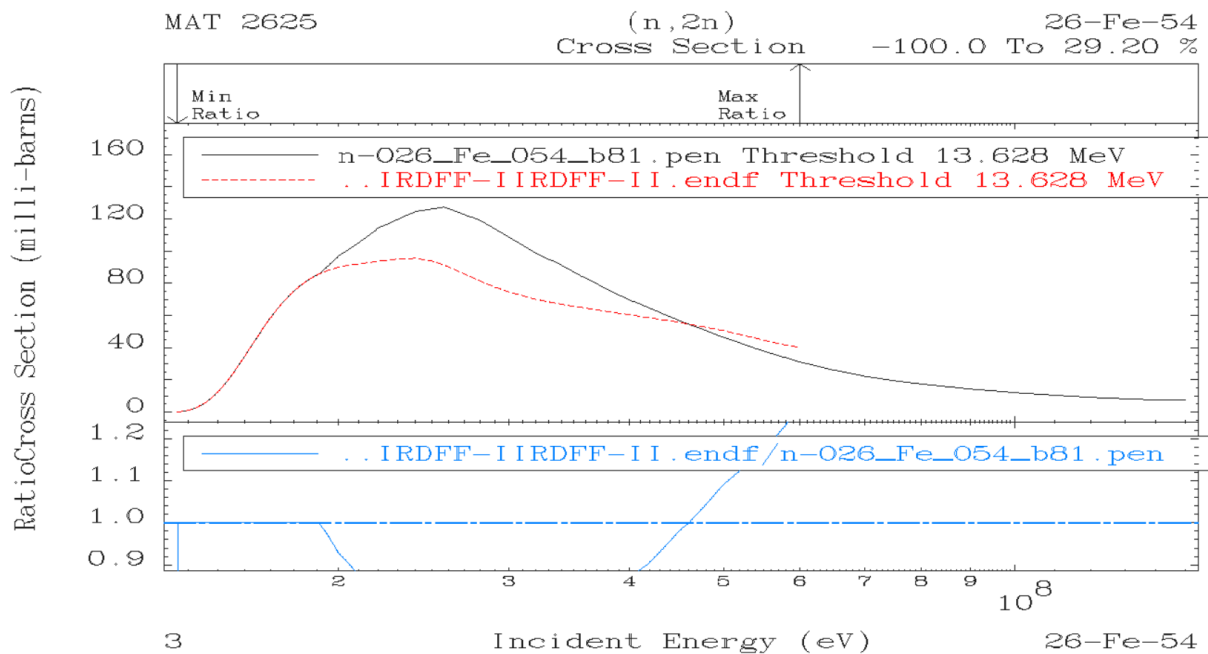
Implementation

The capture cross section in the original ENDF file is equal to IRDFF-II and requires no change. The elastic cross section is affected by up to 5 %. The original evaluation has explicitly represented cross section in pointwise form over the full energy range, hence the (n,2n) cross section could be included up to 60 MeV.



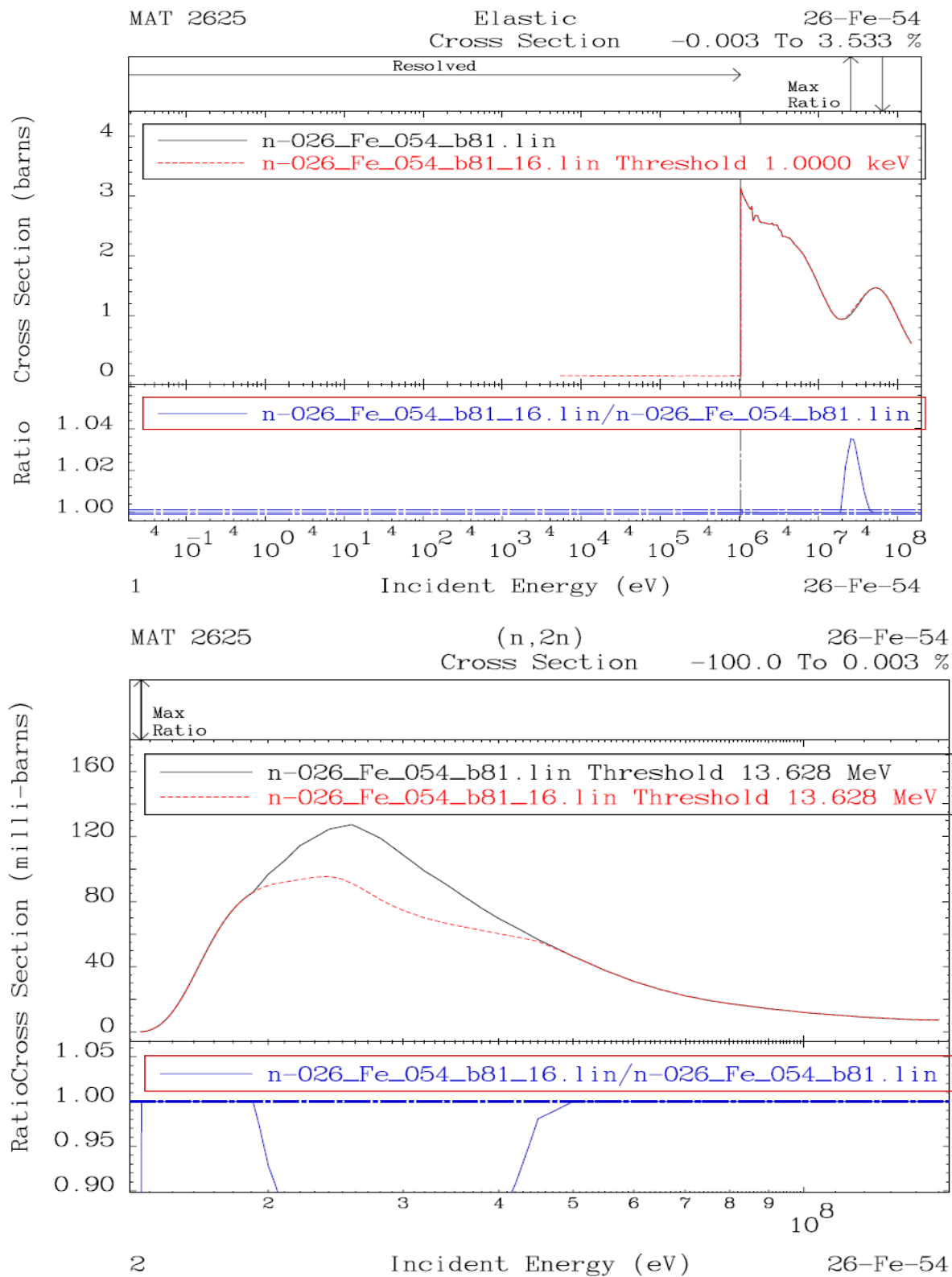
Fe-54

The ENDF/B-VIII.1b1 evaluation contains the MT 16, 103 and 800-series reaction cross sections that can be matched with the IRDFF-II library. The two-neutron emission cross sections MT 16 differ significantly. The proton and alpha emission cross sections are the same at least up to 20 MeV. The alpha emission cross sections in ENDF/B-VIII.1b1 are given as discrete levels with a threshold of about 520 keV. The total alpha emission cross sections in IRDFF-II have no threshold and are extrapolated to thermal as $1/v$. Above pseudo-threshold up to 20 MeV the Cr-51 production cross section in ENDF/B-VIII.1b1 can be extracted from the multiplicities in MF 6/MT 5 and is equal to MT 107 in IRDFF-II up to 20 MeV. **The proposal is to replace the MT 16 cross sections with IRDFF-II and take no action regarding MT 103. The question of alpha-emission needs a more detailed investigation before proposing any change to the evaluation.**



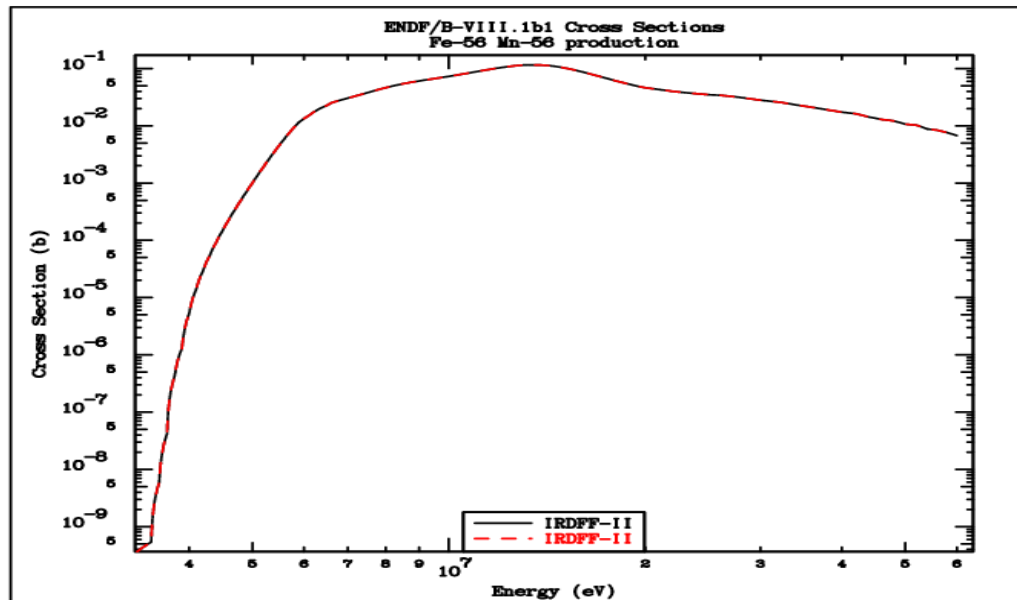
Implementation

The (n,2n) cross section from IRDFF-II was inserted into the original ENDF file up to 45 MeV to avoid a discontinuity. The maximum difference in the elastic cross section is less than 4 %. No change is needed for the (n,p) cross sections. The question about the sub-threshold (n, α) cross sections needs a more detailed investigation, so no changes were made.



Fe-56

The ENDF/B-VIII.1b1 evaluation contains the proton emission reaction cross sections (MT 600 series) that have a match in the IRDFF-II library as MT 103. The cross sections are in full agreement. **No action is needed.**

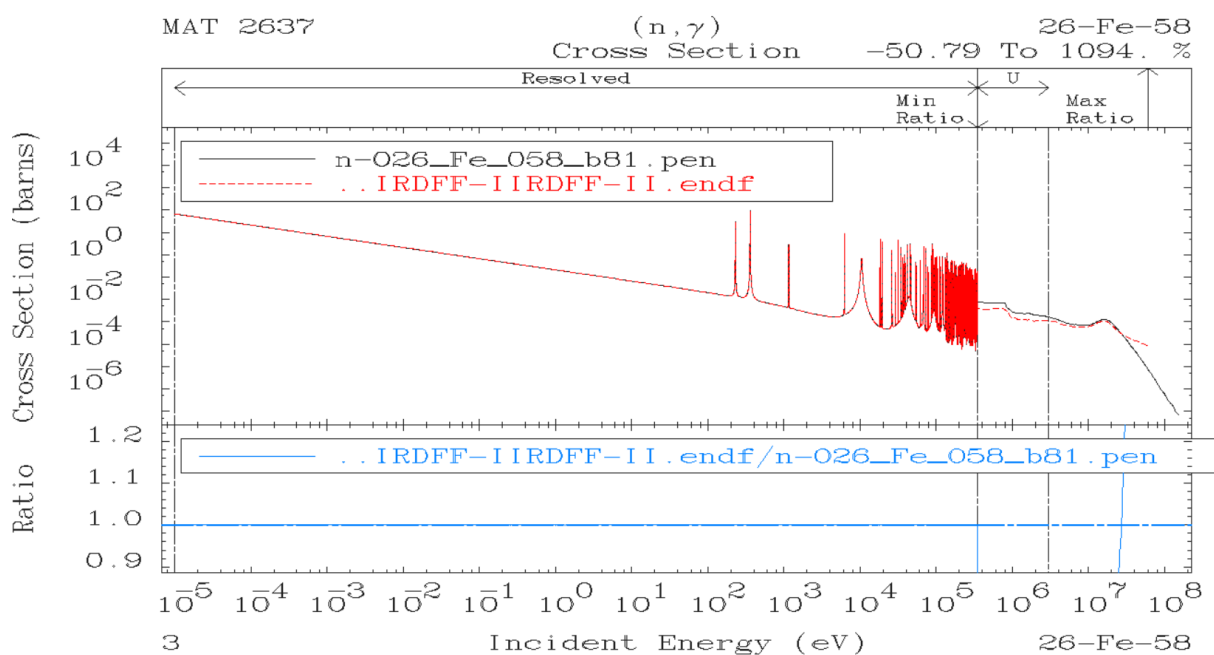


Implementation

No action is needed.

Fe-58

The ENDF/B-VIII.1b1 evaluation contains the capture reaction cross sections MT 102 that have a match in the IRDFF-II library. The cross sections in the resonance range are the same. **There are differences above the resonance range, which require further investigation.**

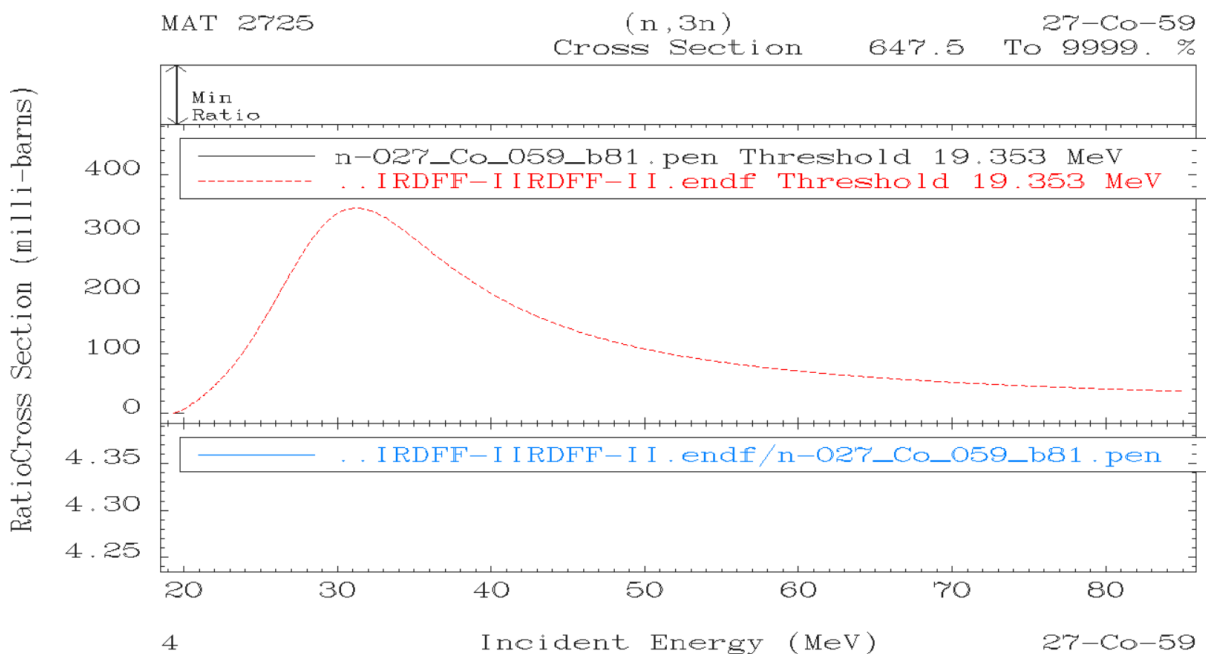
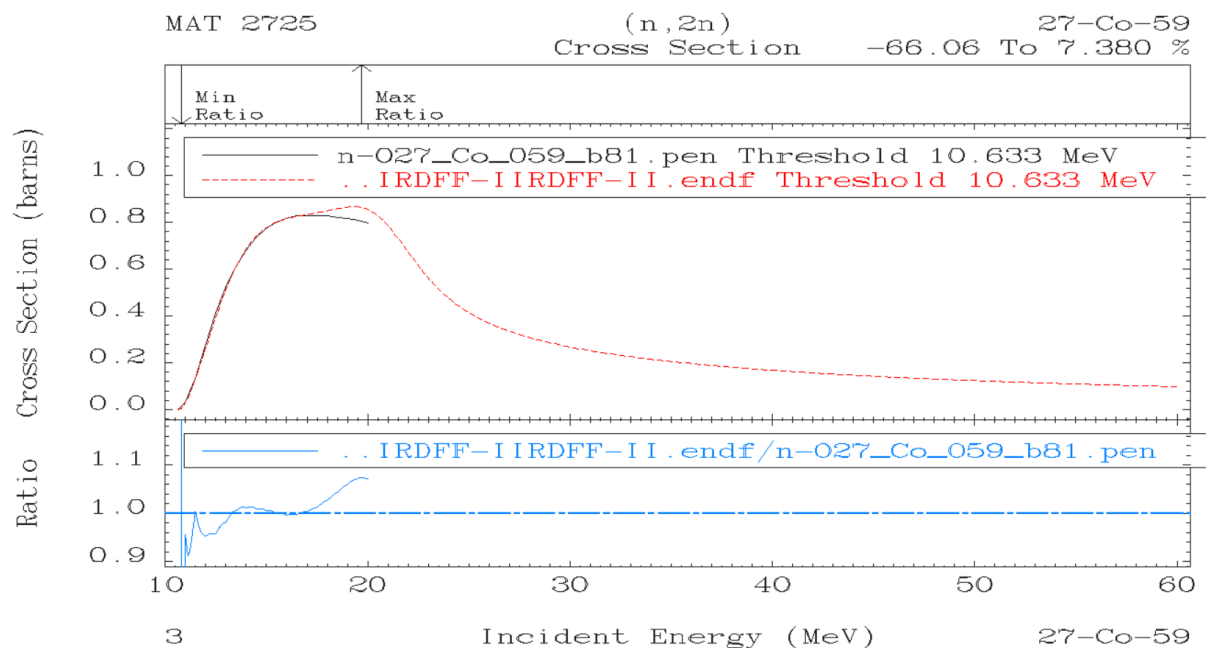


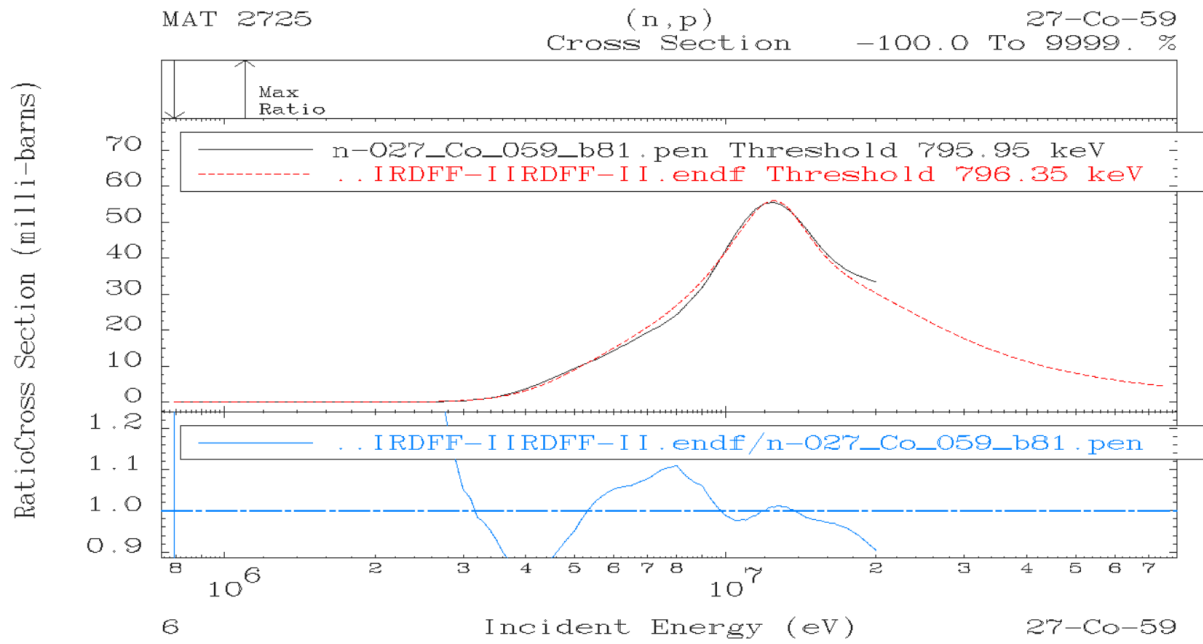
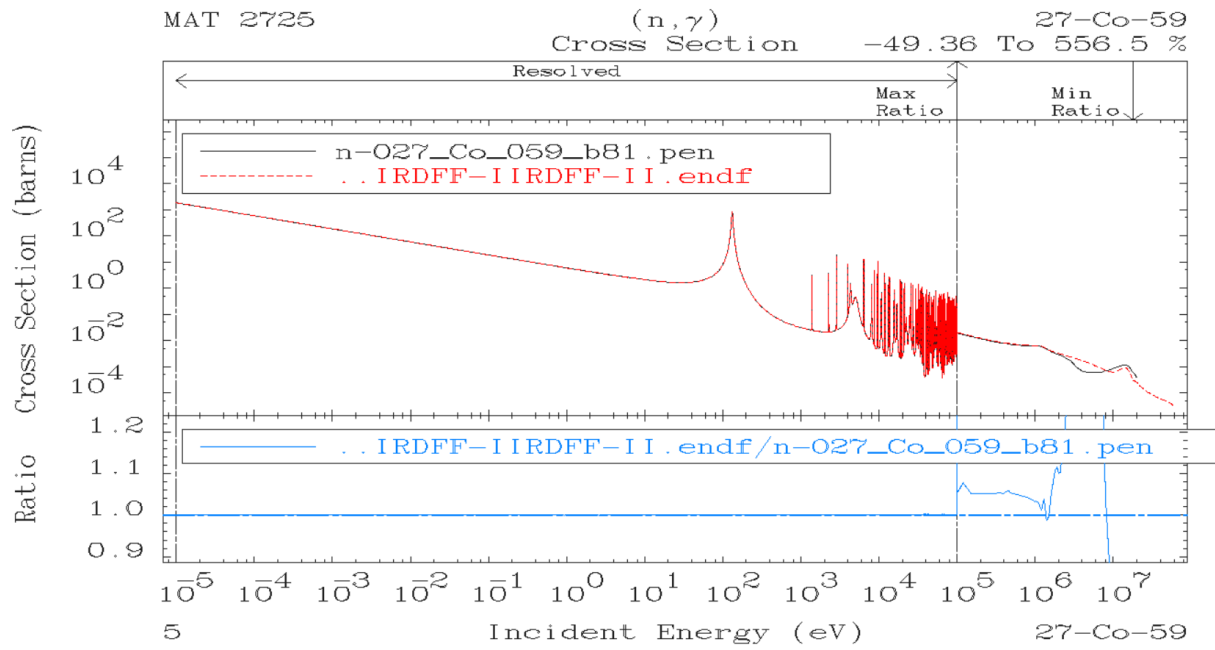
Implementation

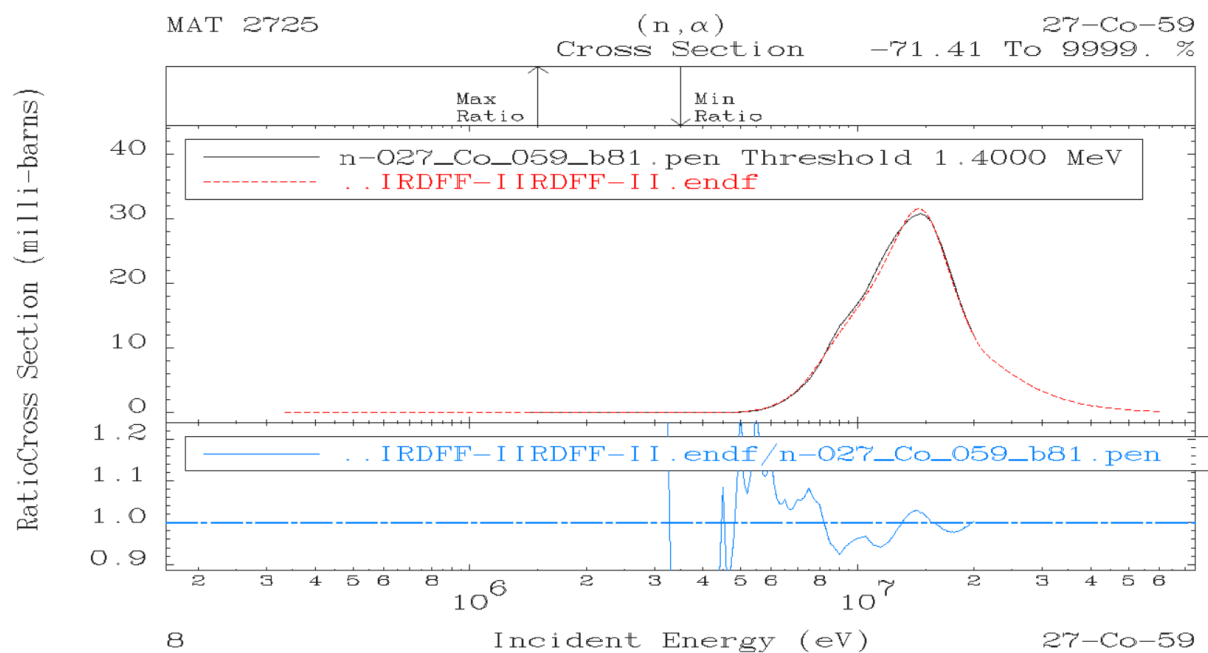
There are differences above the resonance range, which require further investigation, so no changes to the cross sections were made.

Co-59

The ENDF/B-VIII.1b1 evaluation contains the two- and three-neutron emission reaction cross sections MT 16, 17, the capture cross sections MT 102 and the proton- and alpha-emission cross sections MT 103, 107 that have a match in the IRDFF-II library. **The proposal is to replace all threshold reaction cross sections from IRDFF-II, even though the MT 17 reaction has a threshold above 19 MeV. The capture cross sections in the resonance range are the same. There are differences above the resonance range, which may require further investigation.**

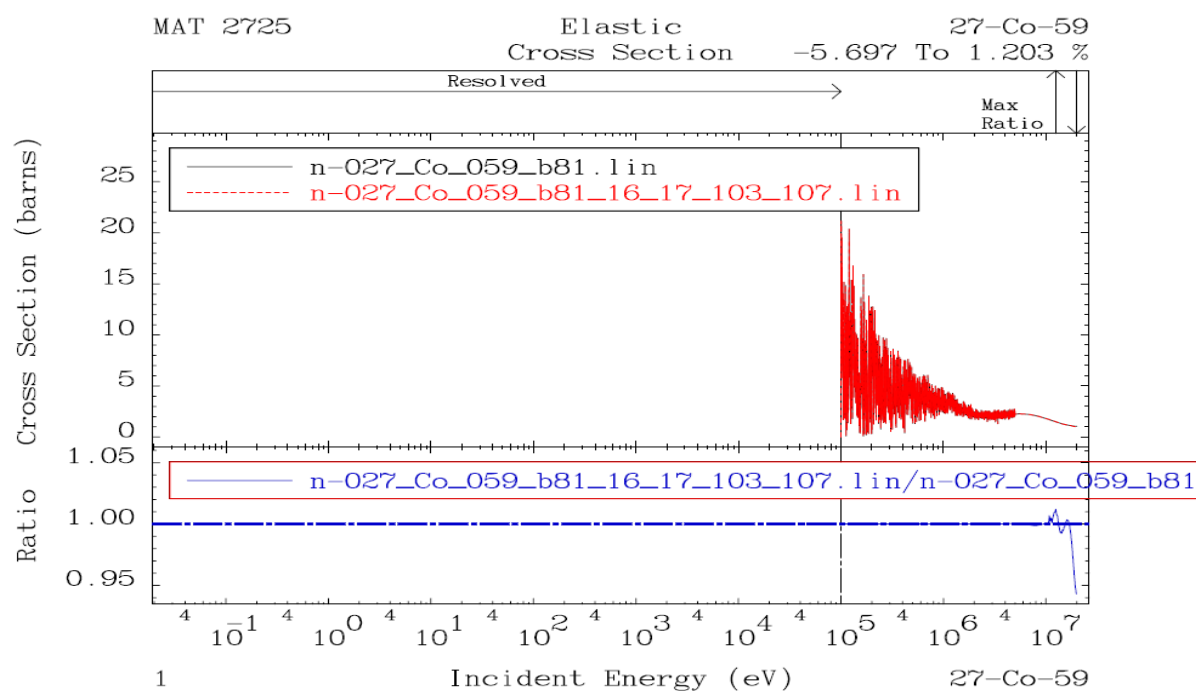


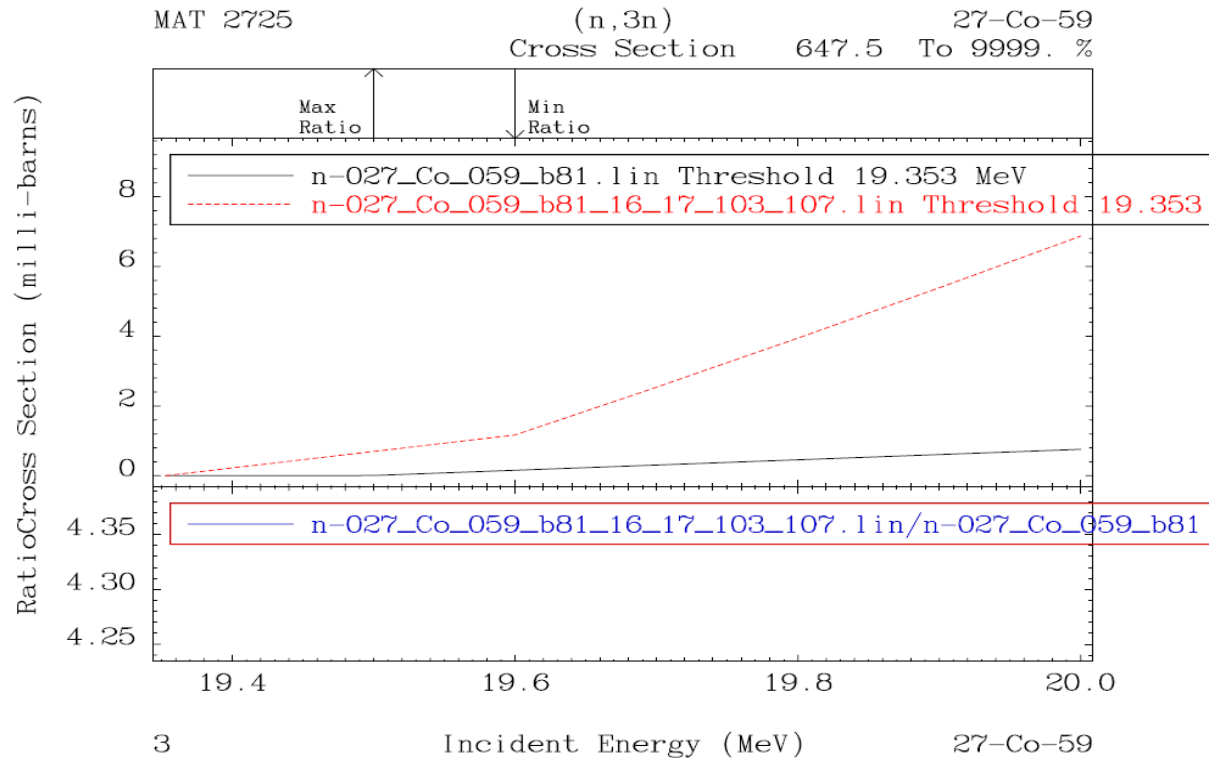
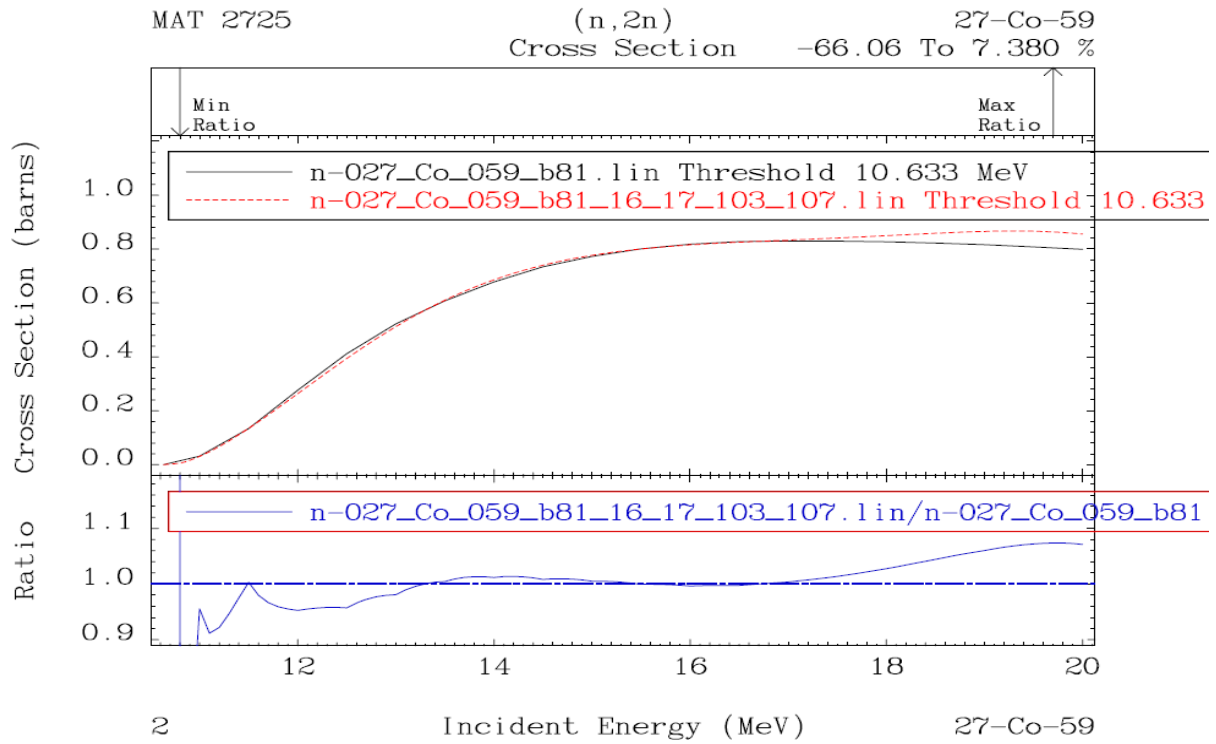


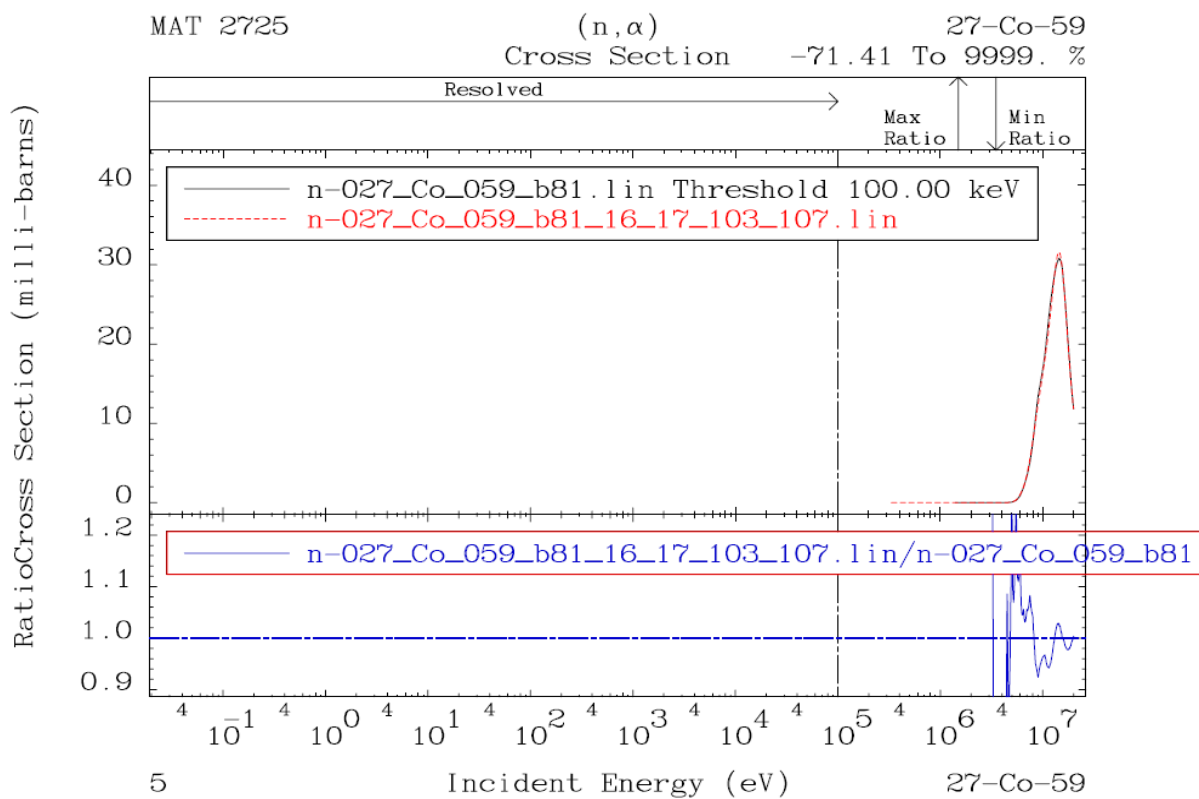
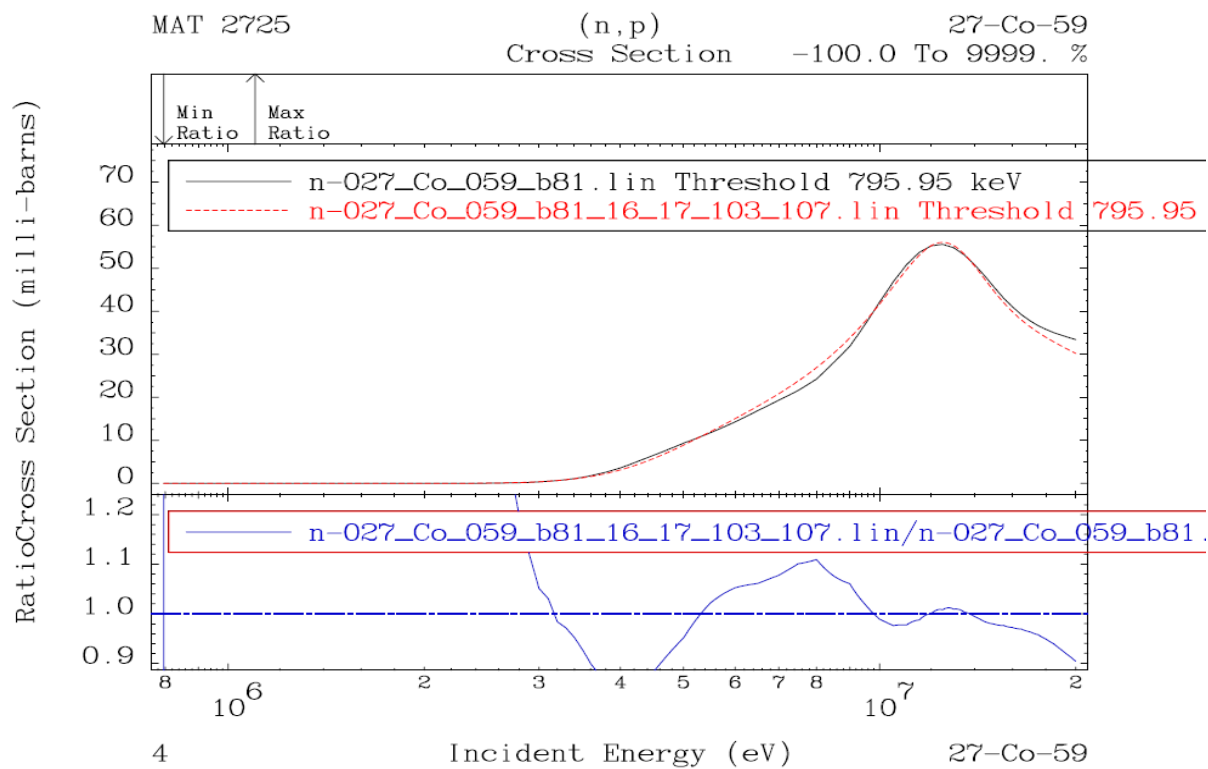


Implementation

Cross sections for the (n,2n), (n,3n), (n,p), (n,a) were replaced with IRDFF-II. The change in the elastic cross section approaches 5 % near the upper end of the evaluation at 20 MeV.

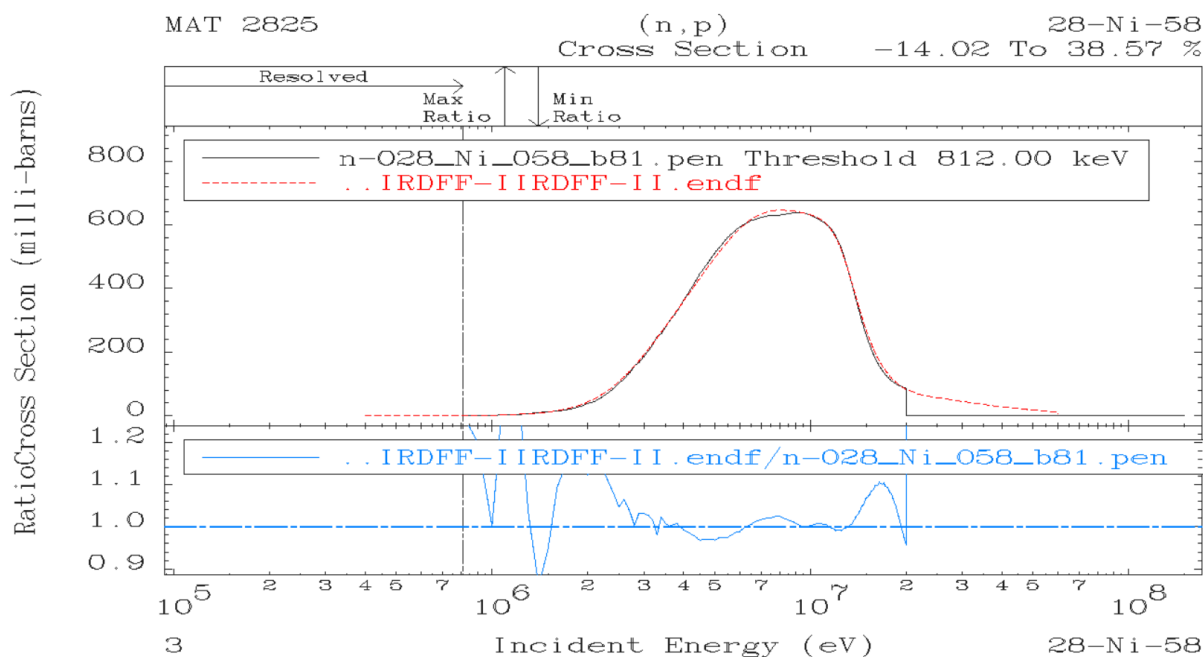
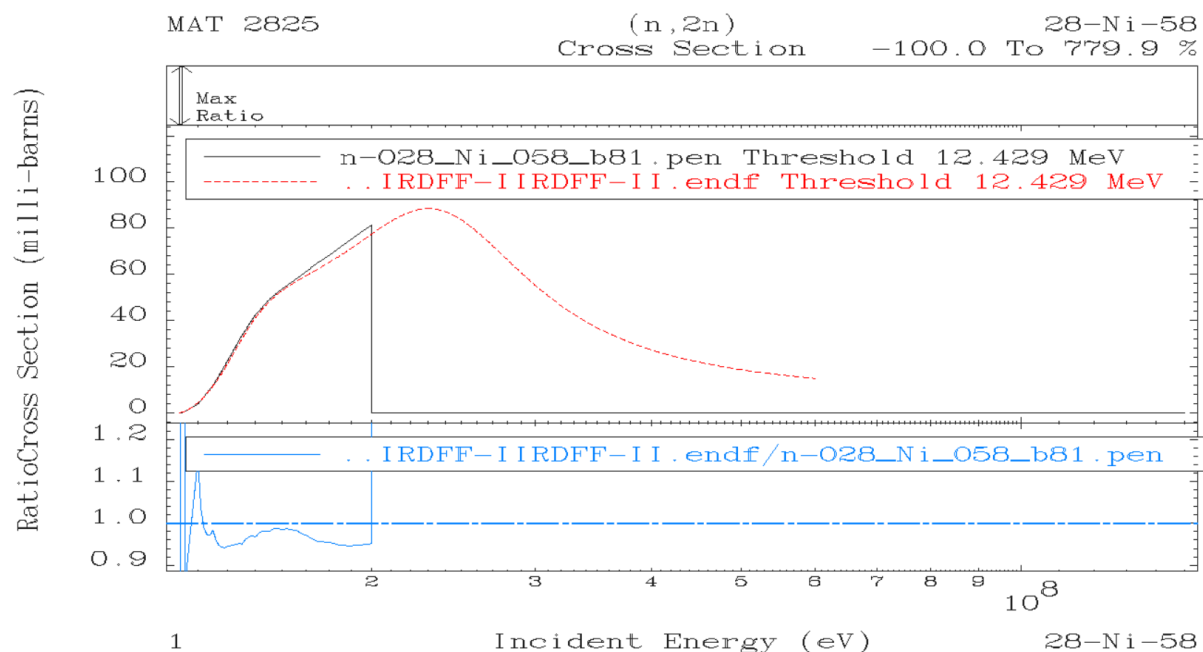






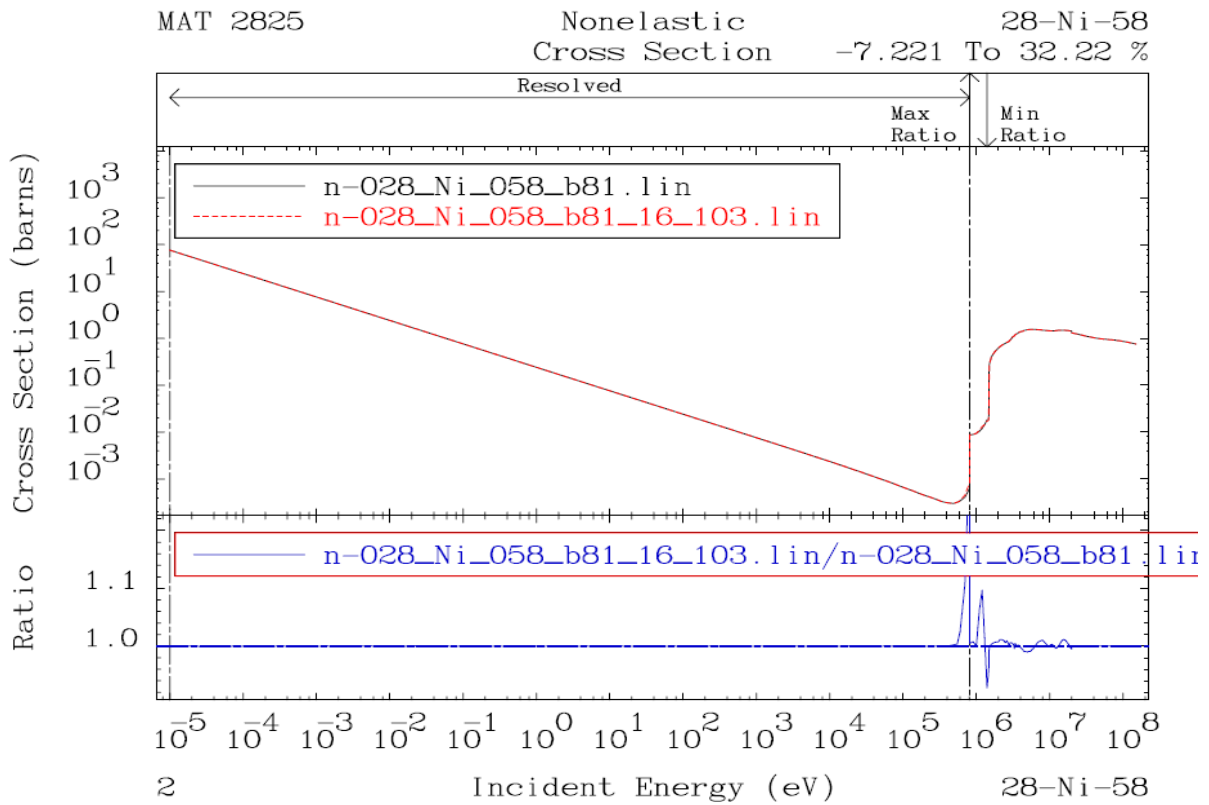
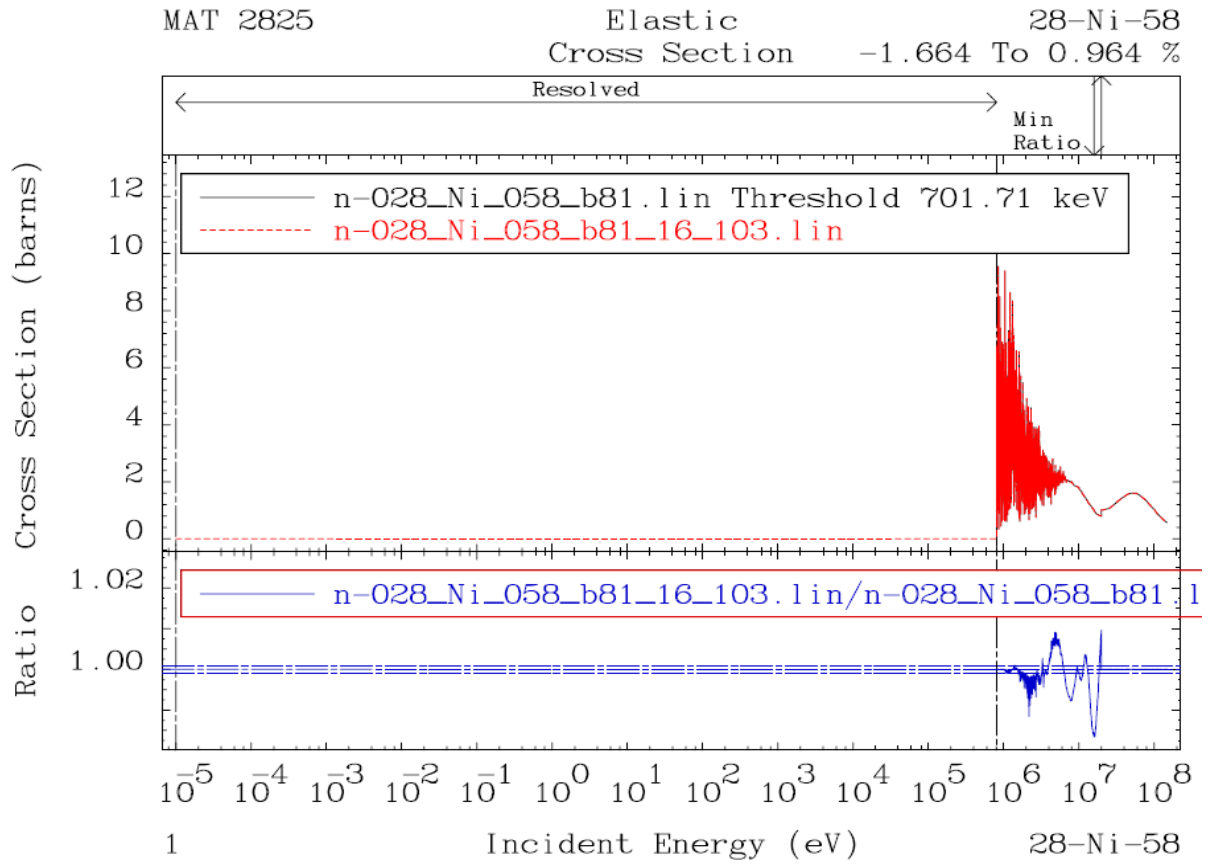
Ni-58

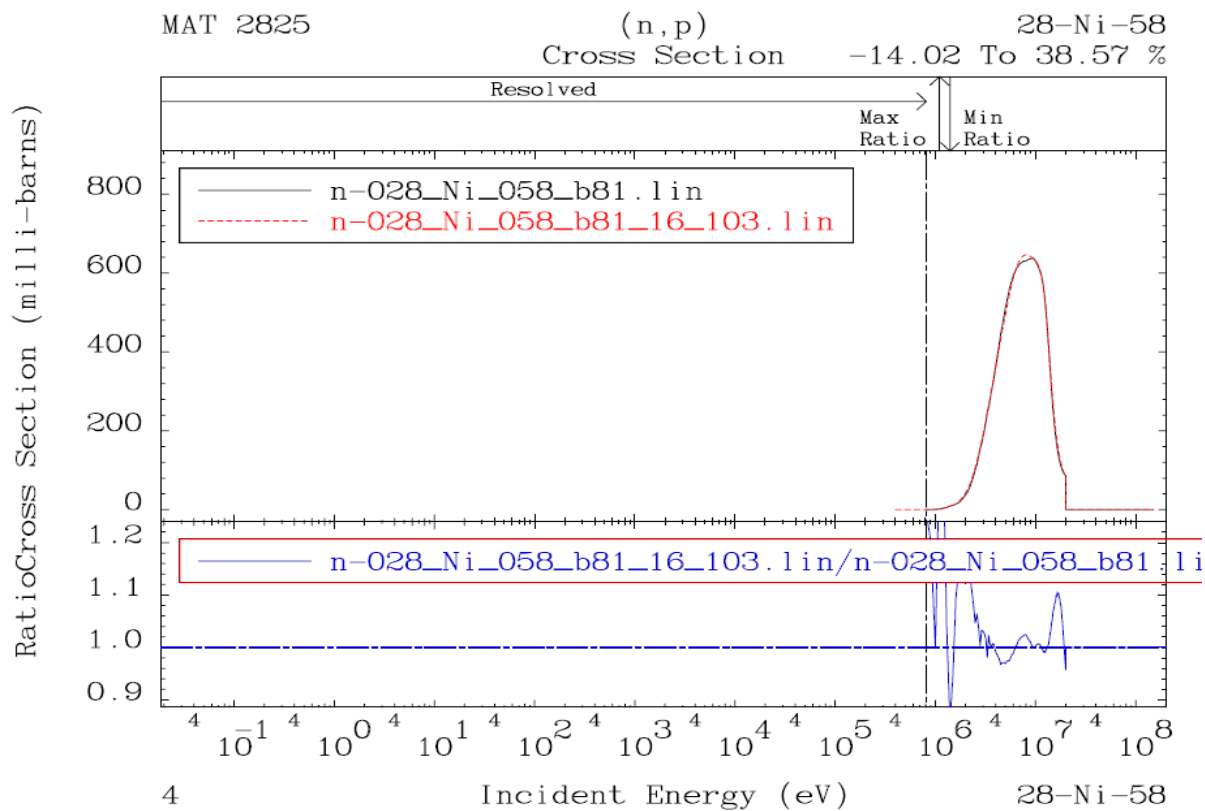
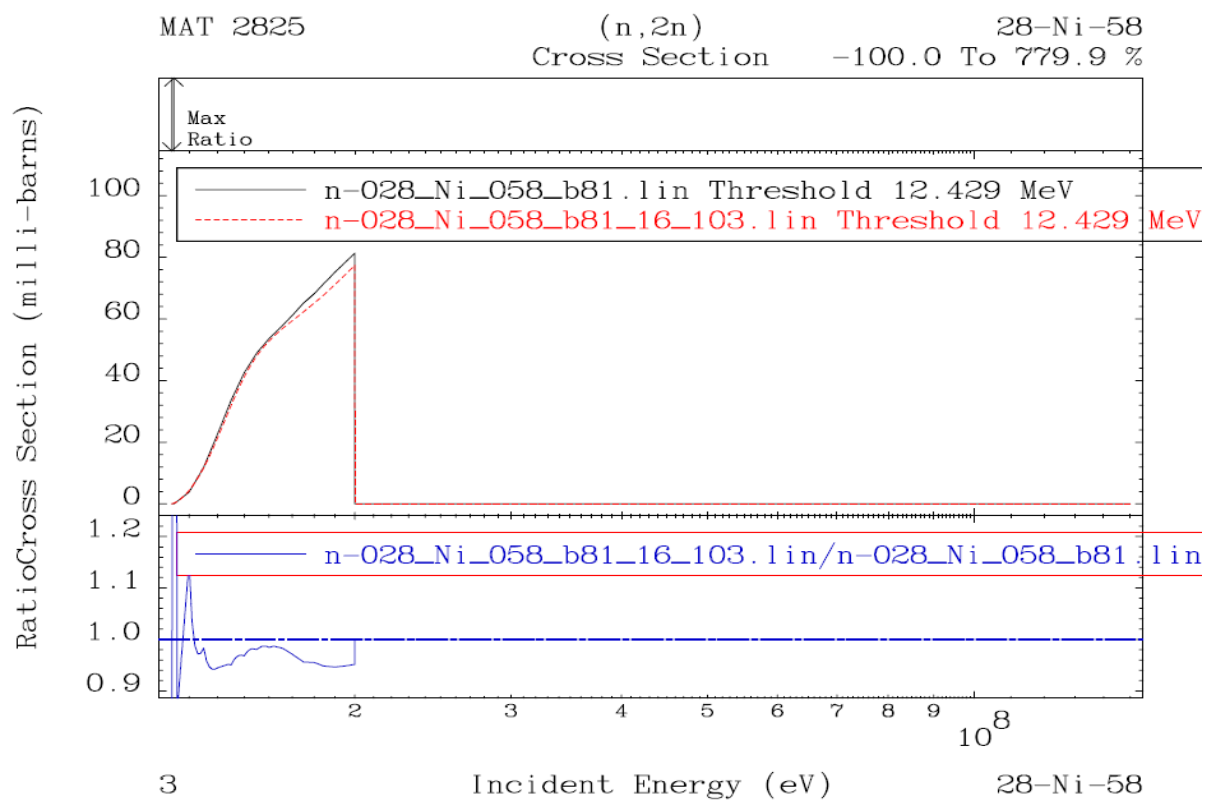
The ENDF/B-VIII.1b1 evaluation contains the two-neutron MT 16 and proton-emission reaction cross sections MT 103 that have a match in the IRDFF-II library. **The proposal is to replace both reaction cross sections from IRDFF-II up to 20 MeV.**



Implementation

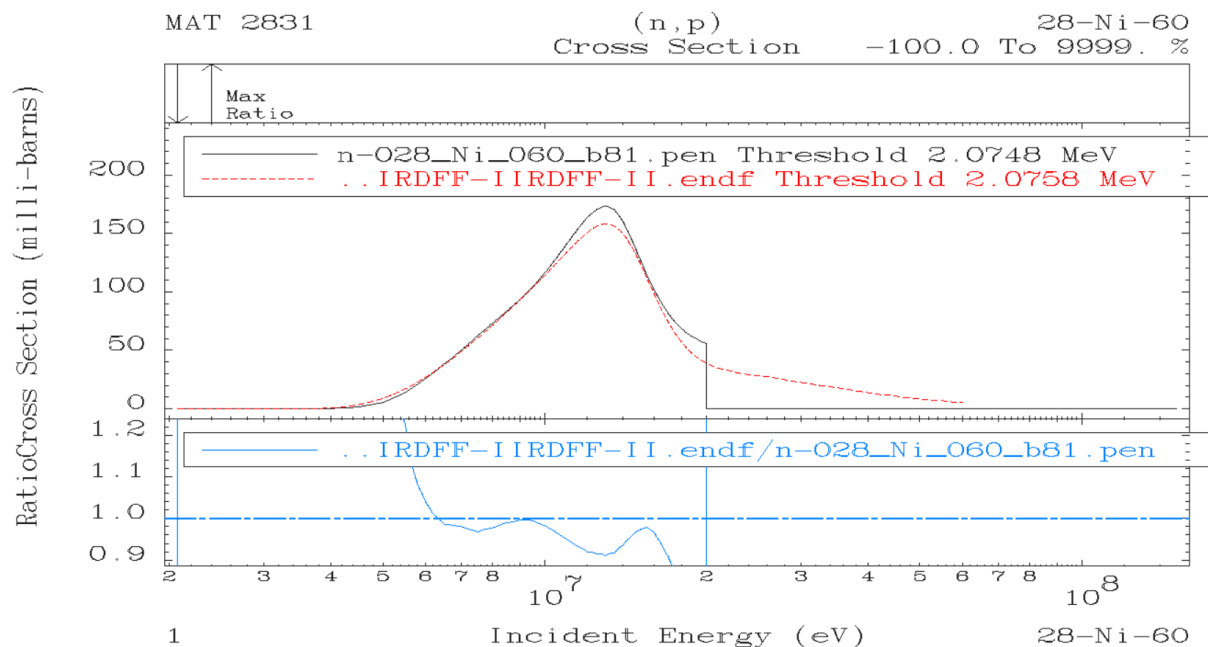
Cross sections for the MT 16 and MT 103 reactions were inserted from IRDFF-II up to 20 MeV. The changes in the elastic and non-elastic cross sections were not larger than 1.7 %, except near the pseudo-threshold.





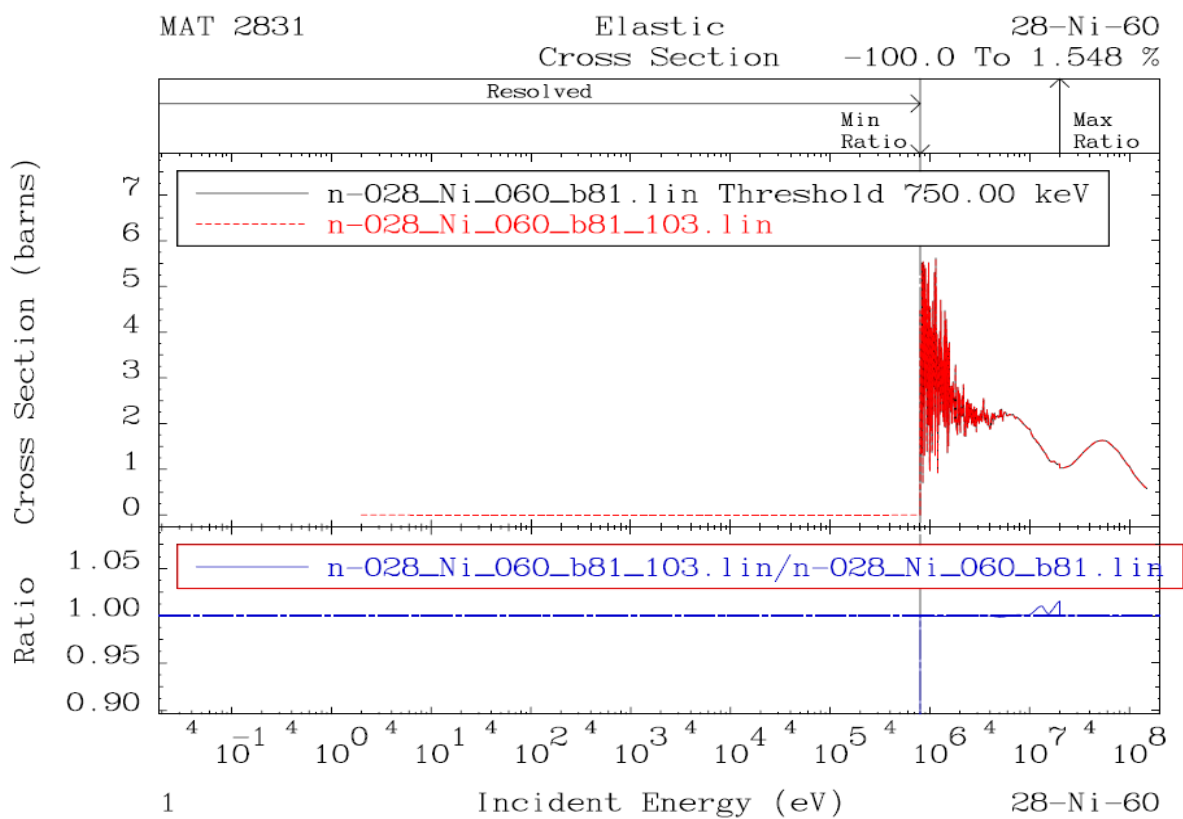
Ni-60

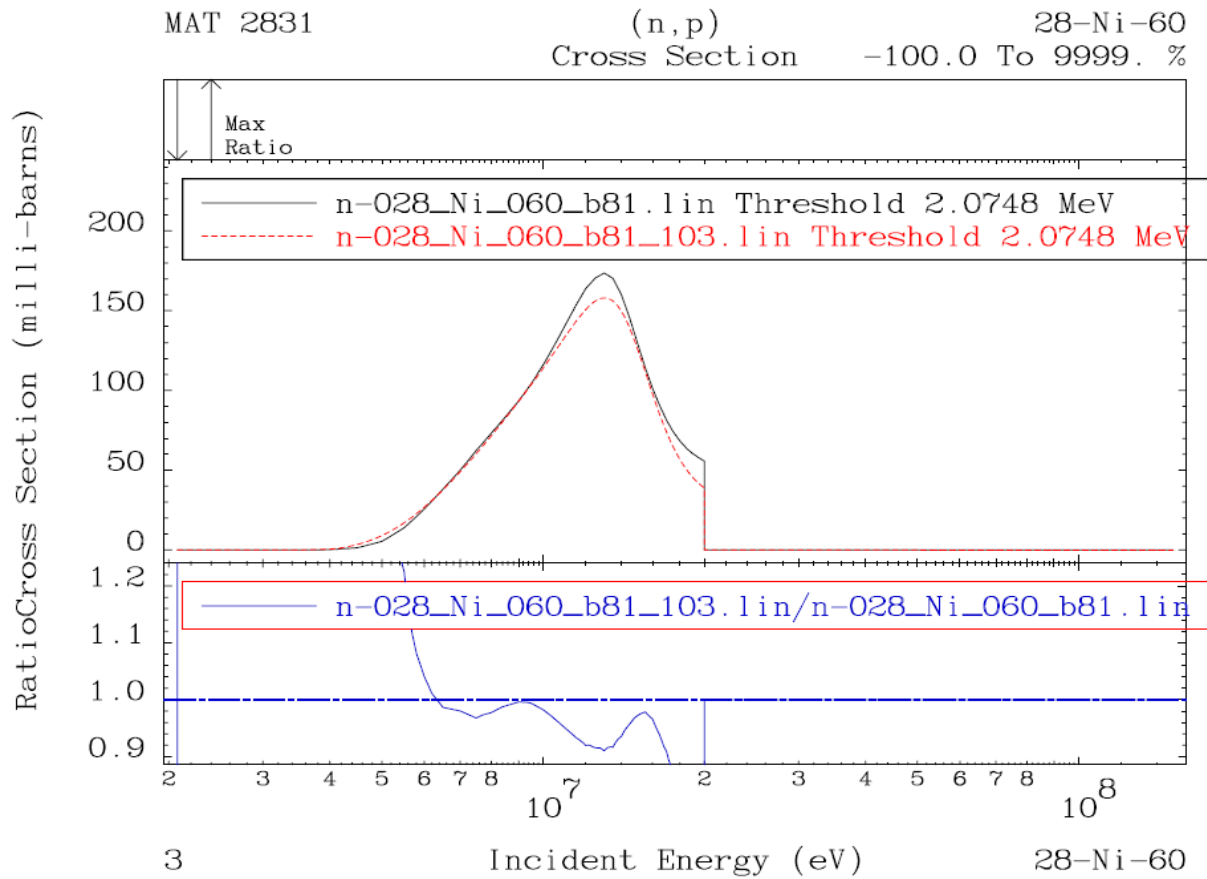
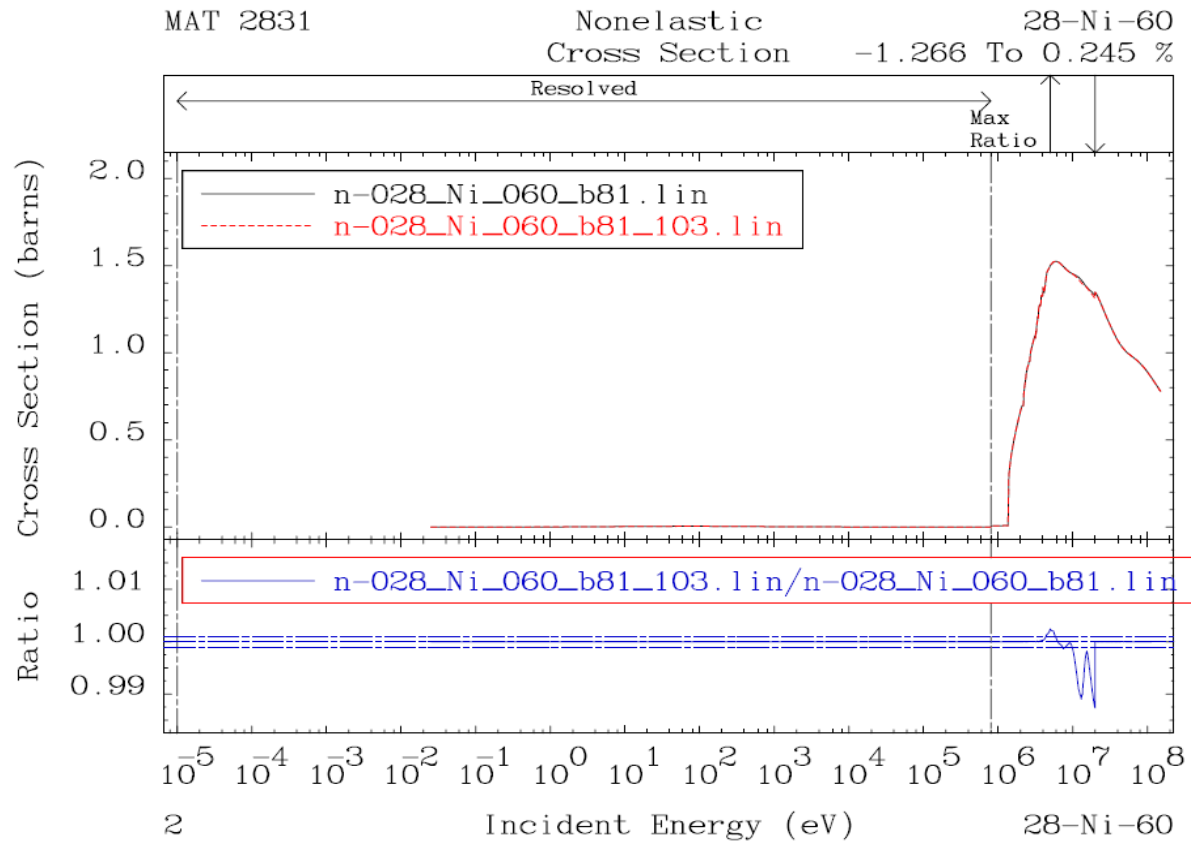
The ENDF/B-VIII.1b1 evaluation contains the proton-emission cross sections MT 103 that have a match in the IRDFF-II library. **The proposal is to replace the reaction cross sections from IRDFF-II up to 20 MeV.**



Implementation

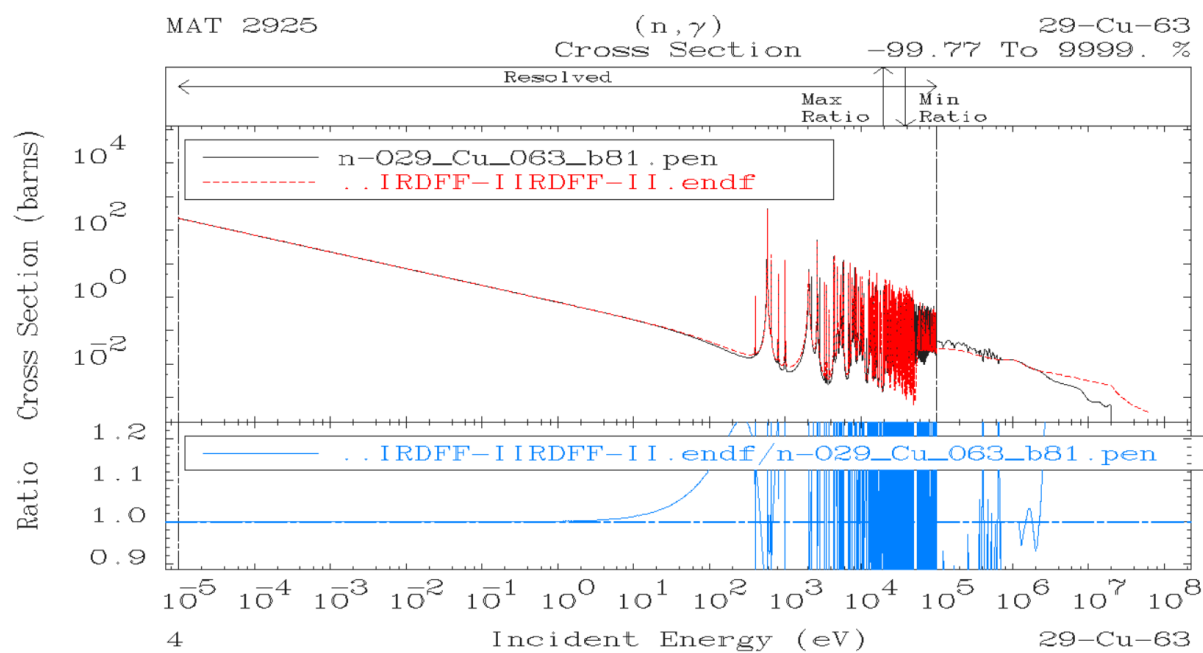
The (n,p) reaction cross sections were replaced with the data from IRDFF-II up to 20 MeV. The corresponding changes in the elastic and the non-elastic cross sections were less than 1.5 %.





Cu-63

The ENDF/B-VIII.1b1 evaluation contains the capture cross sections MT 102 that have a match in the IRDFF-II library. The cross sections in ENDF/B-VIII.1b1 are more recent, hence **no action is required**.



Implementation

No action is needed.

Cu-65

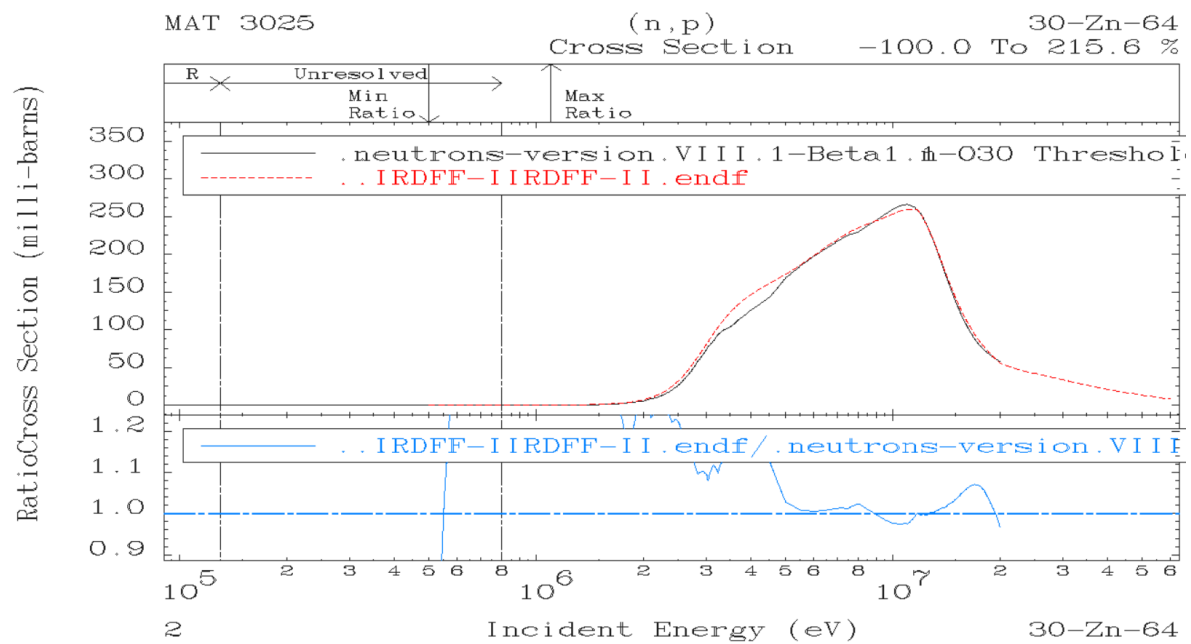
The ENDF/B-VIII.1b1 evaluation contains the two-neutron emission cross sections MT 16 that have a match in the IRDFF-II library. The cross sections in both libraries are equal, hence **no action is required**.

Implementation

No action is needed.

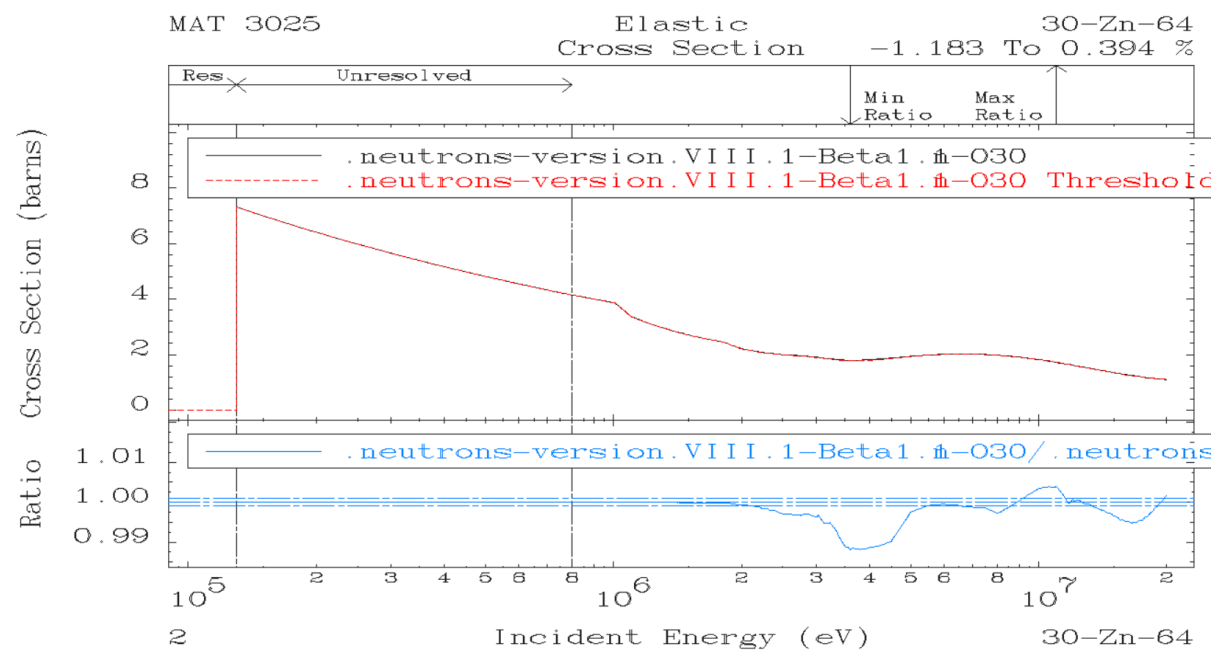
Zn-64

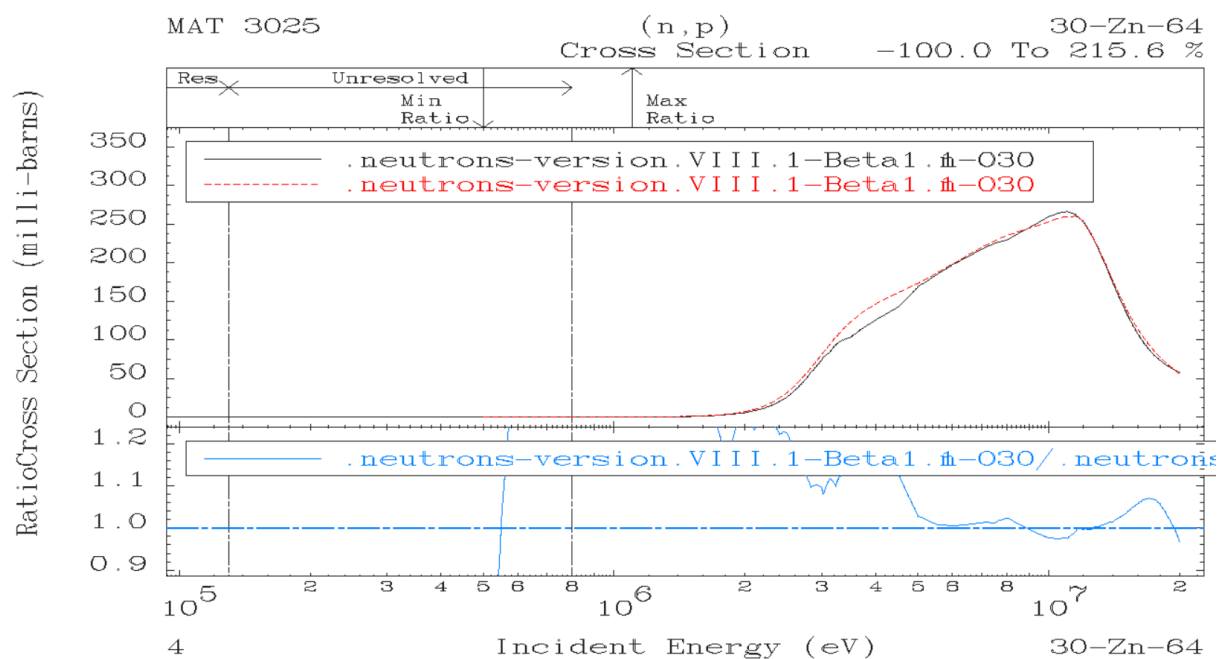
The ENDF/B-VIII.1b1 evaluation contains the proton emission cross sections MT 103 that have a match in the IRDFF-II library. **The proposal is to replace the cross sections with IRDFF-II.**



Implementation

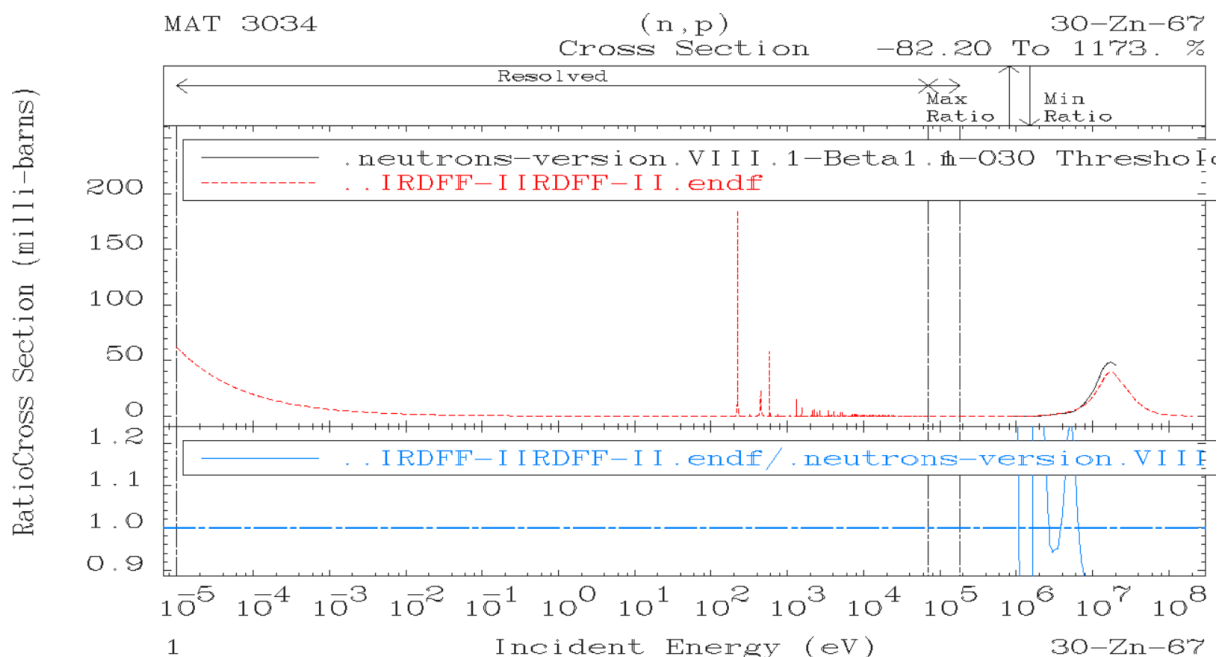
The (n,p) cross sections from IRDFF-II were inserted into the original ENDF file up to 20 MeV. The maximum change to the elastic cross sections was about 1 %.





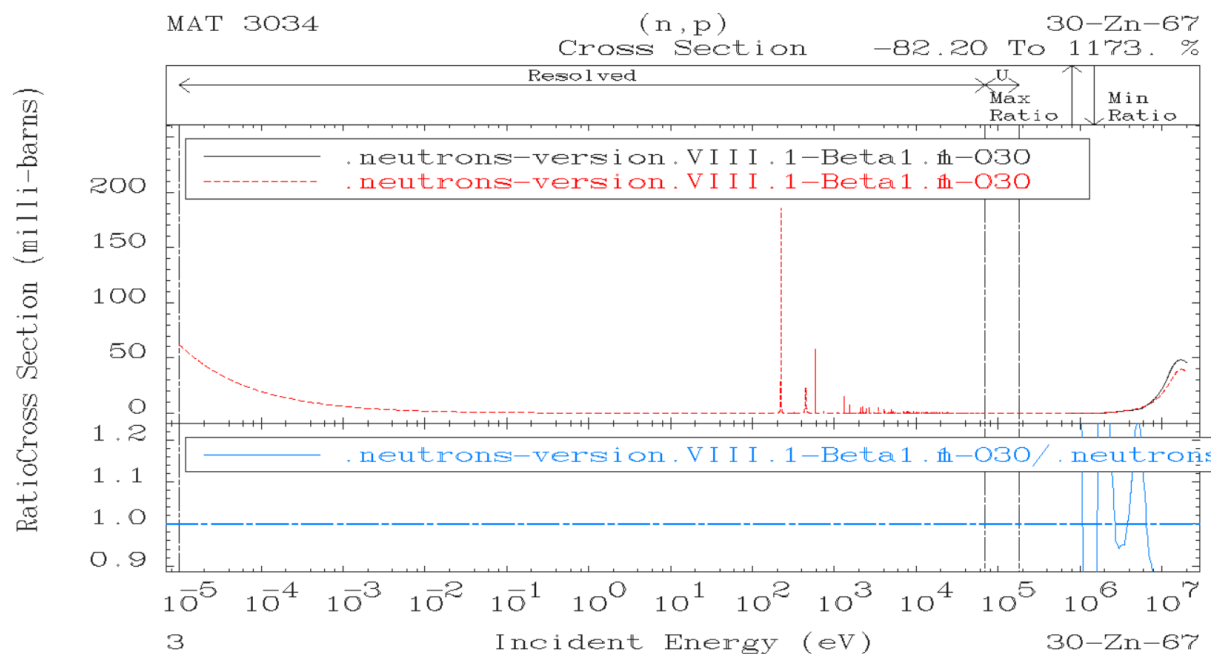
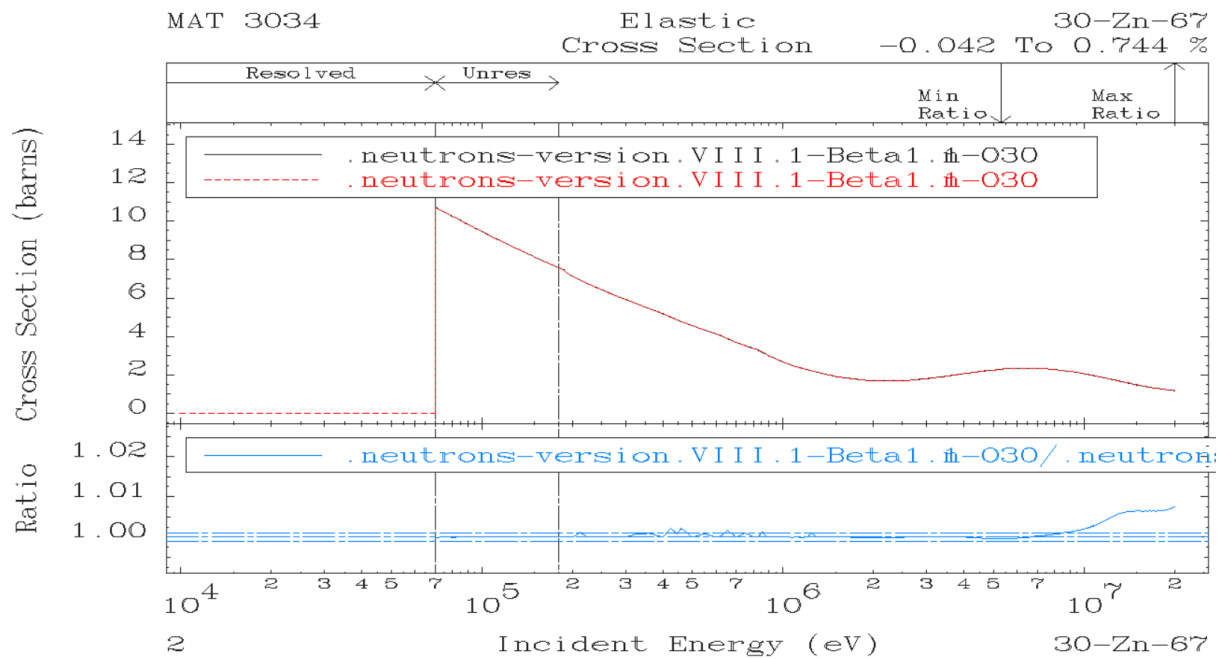
Zn-67

The ENDF/B-VIII.1b1 evaluation contains the proton emission cross sections MT 103 that have a match in the IRDFF-II library. The reaction has a positive Q-value and has no threshold. The cross sections in IRDFF-II have some resonance structure in the resolved resonance range. **The proposal is to replace the cross sections with IRDFF-II, but care is needed to ensure unitarity in the resonance region.**



Implementation

The (n,p) reaction has a positive Q-value and has no threshold. The cross sections in IRDFF-II extend down into the resonance range. To preserve unitarity in the resonance range the (n,p) cross sections were effectively subtracted from the elastic background to preserve the total. Note that this correction is very small since the (n,p) cross section in the sub-threshold energy region is small.

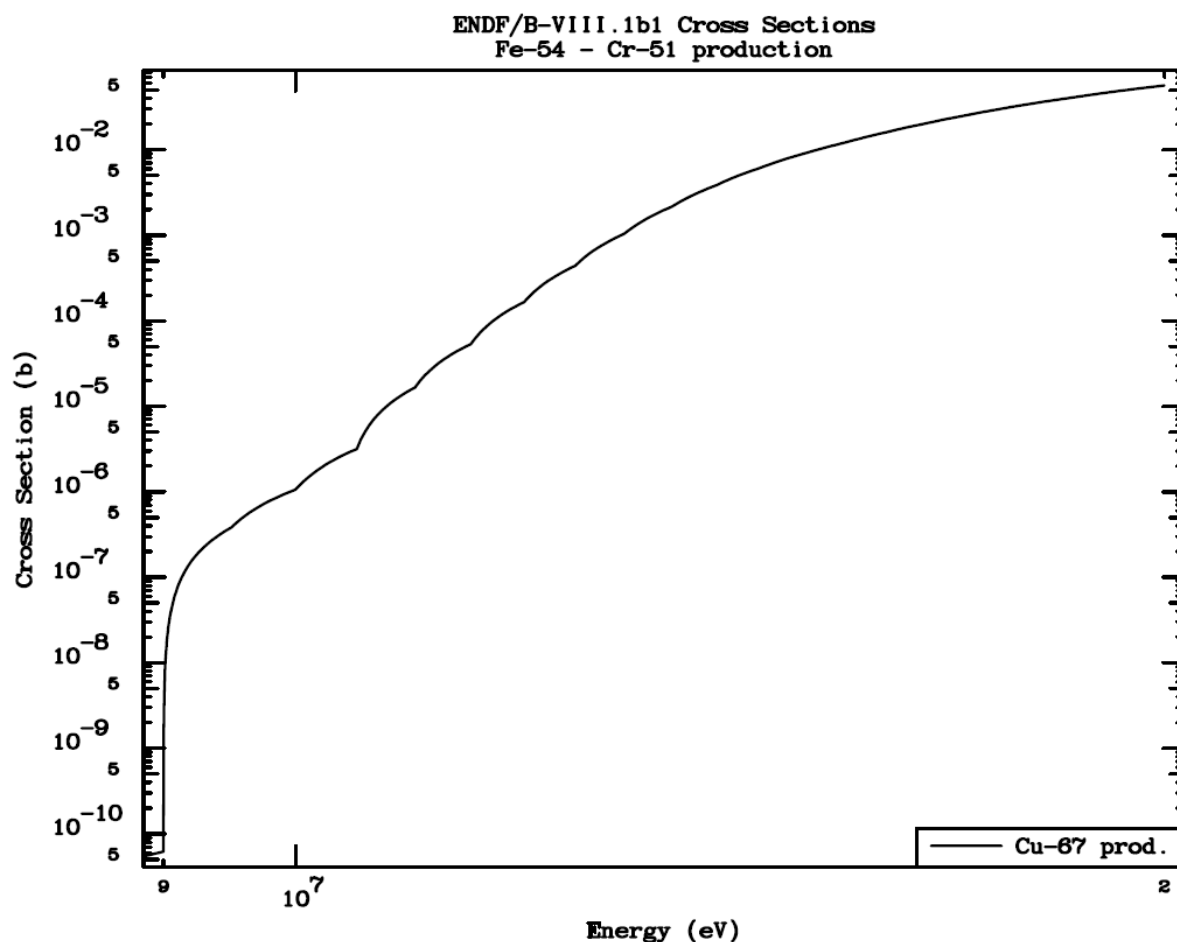


Zn-68

The ENDF/B-VIII.1b1 evaluation contains no cross sections that have a match in the IRDFF-II library, but it contains the Cu-67 production cross sections in MF 10/MT 5 that might be of interest to the user. **The proposal is to consider the Cu-67 production cross sections in the ENDF/B-VIII.1b2 file.**

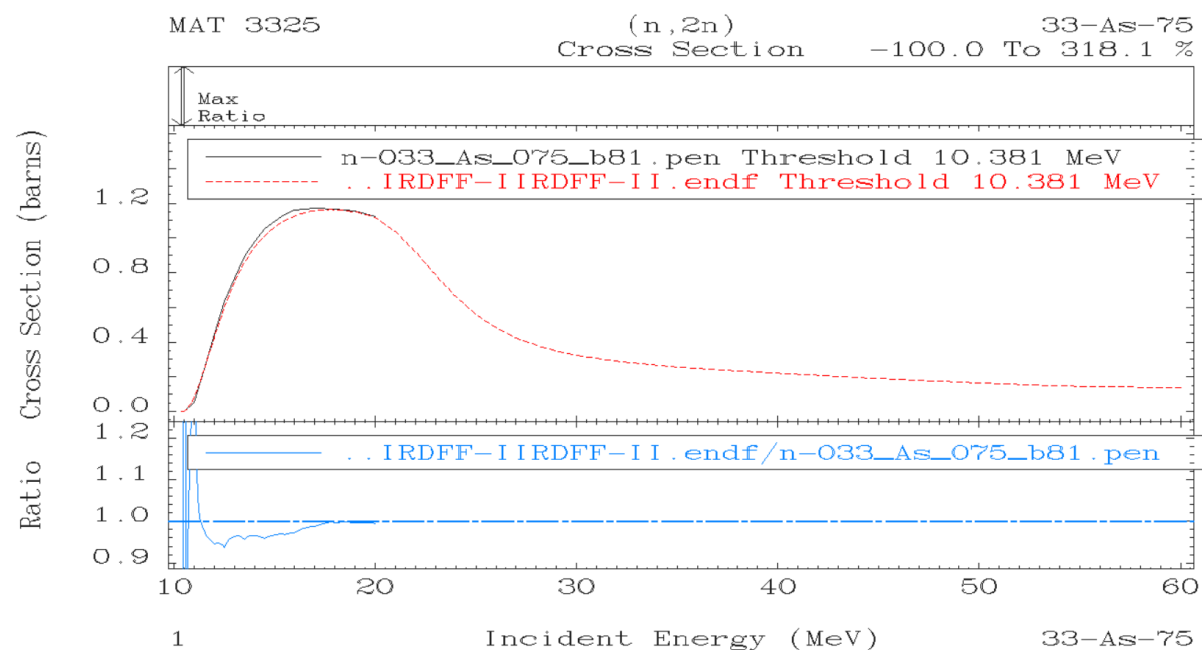
Implementation

The MF 8, 10 and 40 of reaction MT 5 were inserted into the original ENDF file.



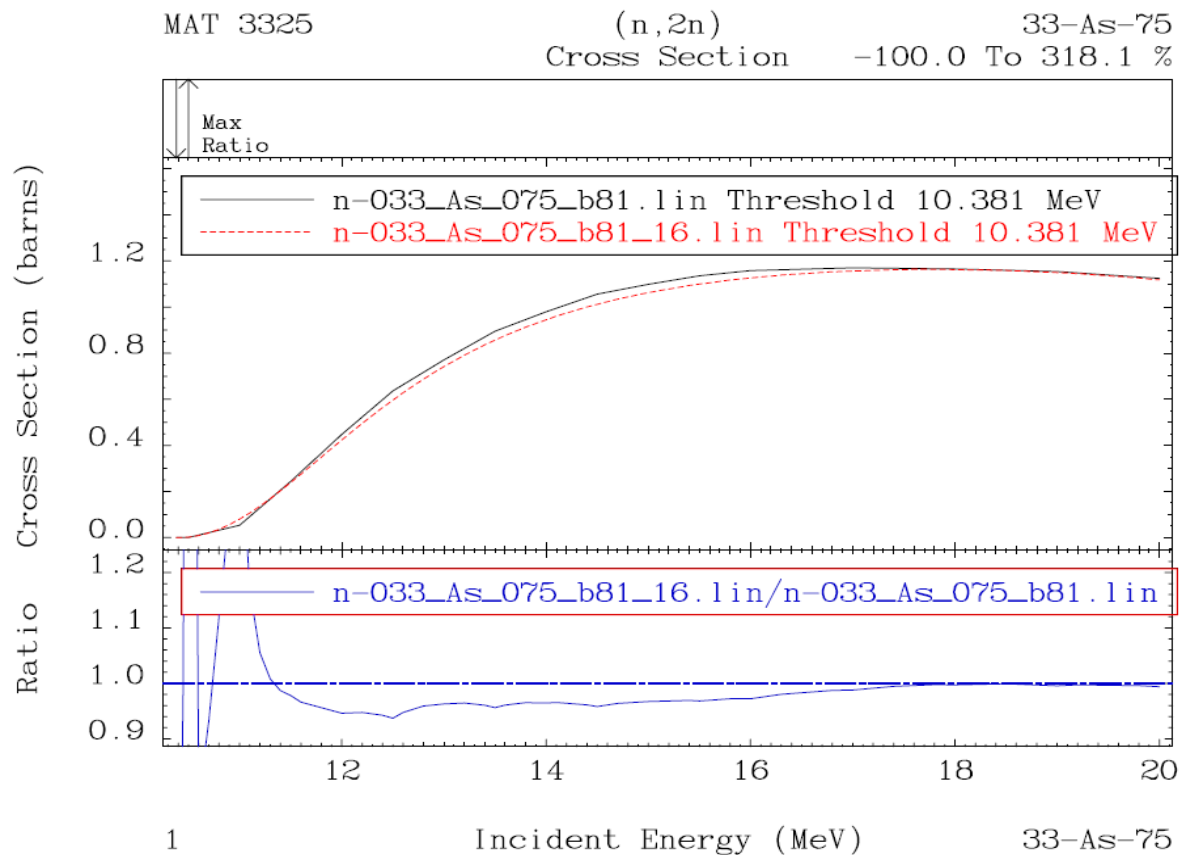
As-75

The ENDF/B-VIII.1b1 evaluation contains the two-neutron emission sections MT 16 that have a match in the IRDFF-II library. **The proposal is to replace the cross sections with IRDFF-II.**



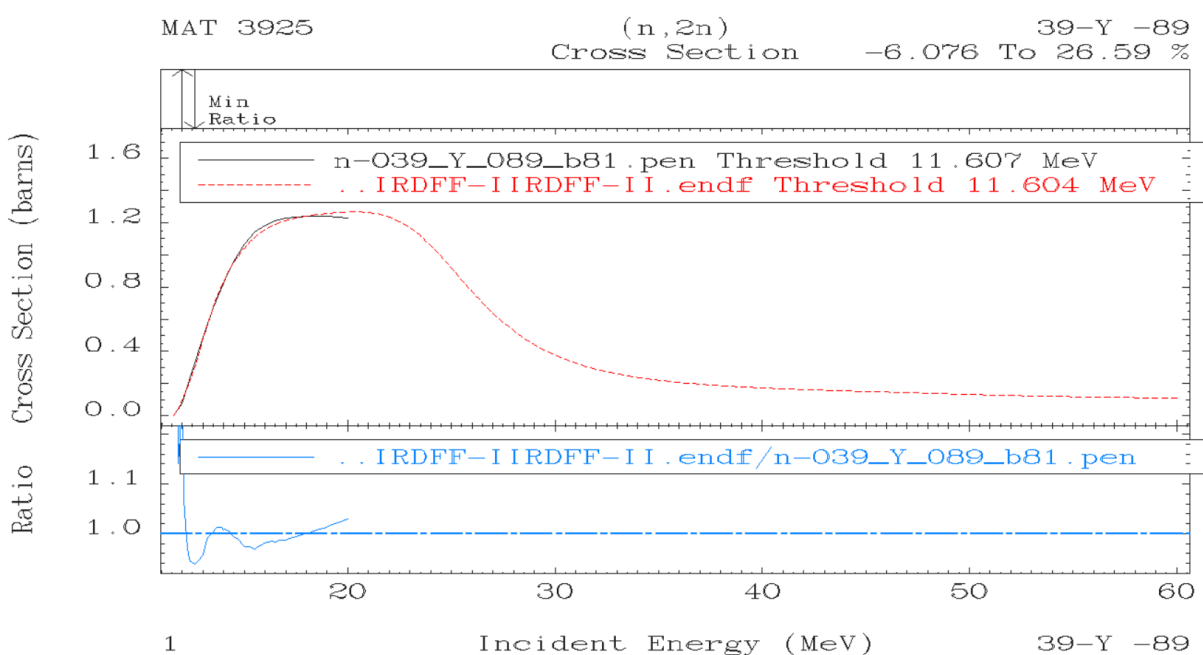
Implementation

The MT 16 cross sections from IRDFF-II were inserted into the original ENDF file. The impact on the elastic cross sections is negligible.



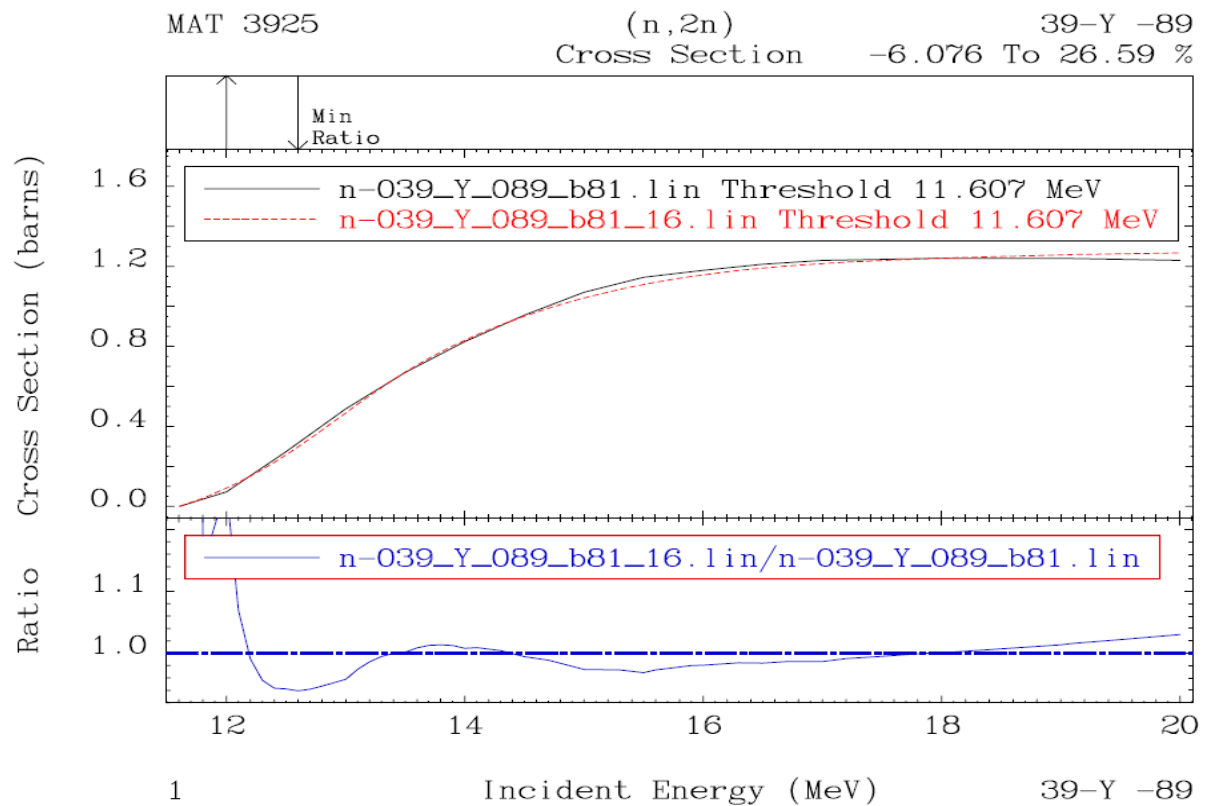
Y-89

The ENDF/B-VIII.1b1 evaluation contains the two-neutron emission sections MT 16 that have a match in the IRDFF-II library. **The proposal is to replace the cross sections with IRDFF-II.**



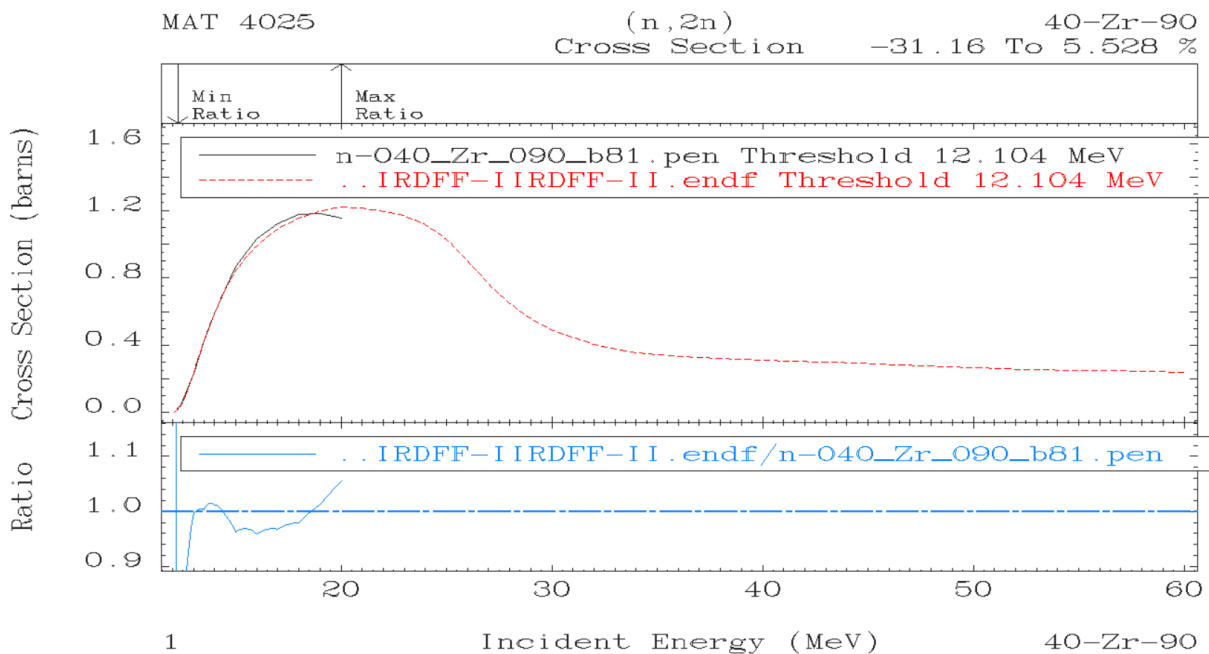
Implementation

The MT 16 cross sections from IRDFF-II were inserted into the original ENDF file. The impact on the elastic cross sections is negligible.



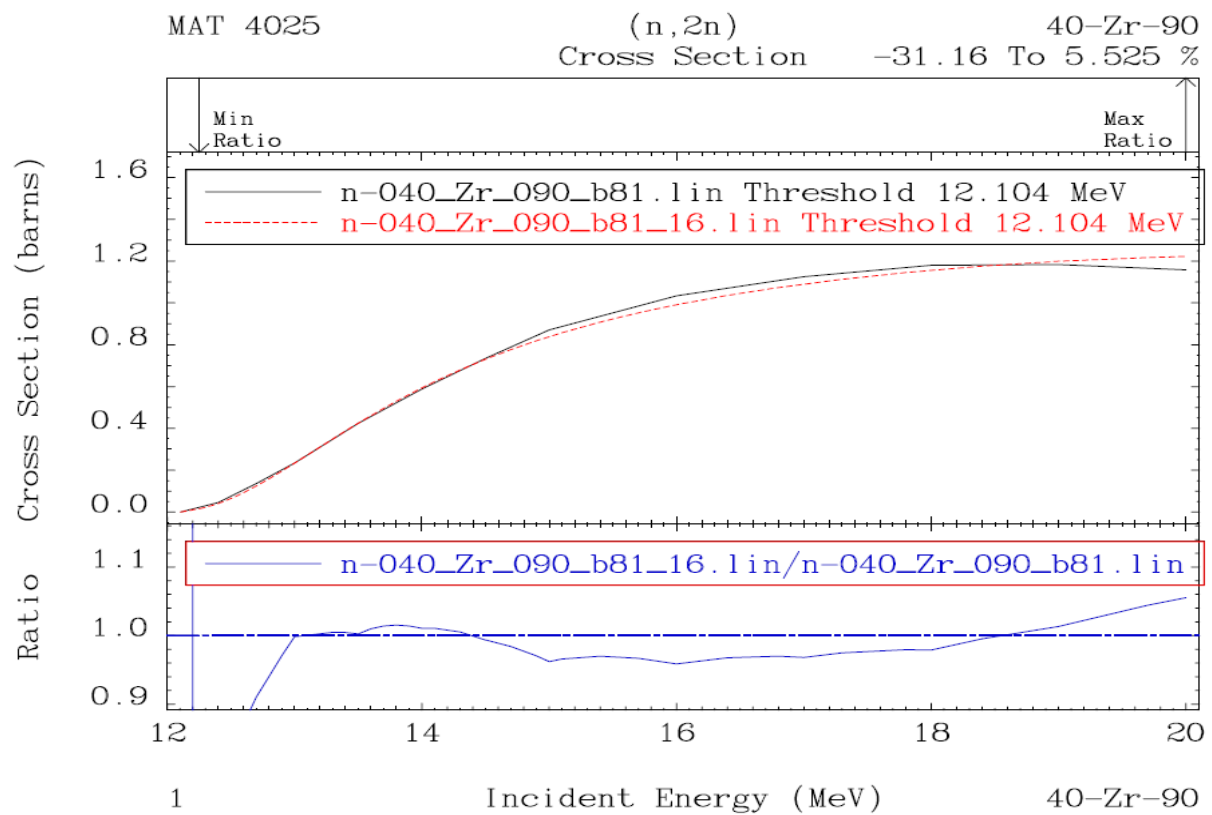
Zr-90

The ENDF/B-VIII.1b1 evaluation contains the two-neutron emission sections MT 16 that have a match in the IRDFF-II library. **The proposal is to replace the cross sections with IRDFF-II.**



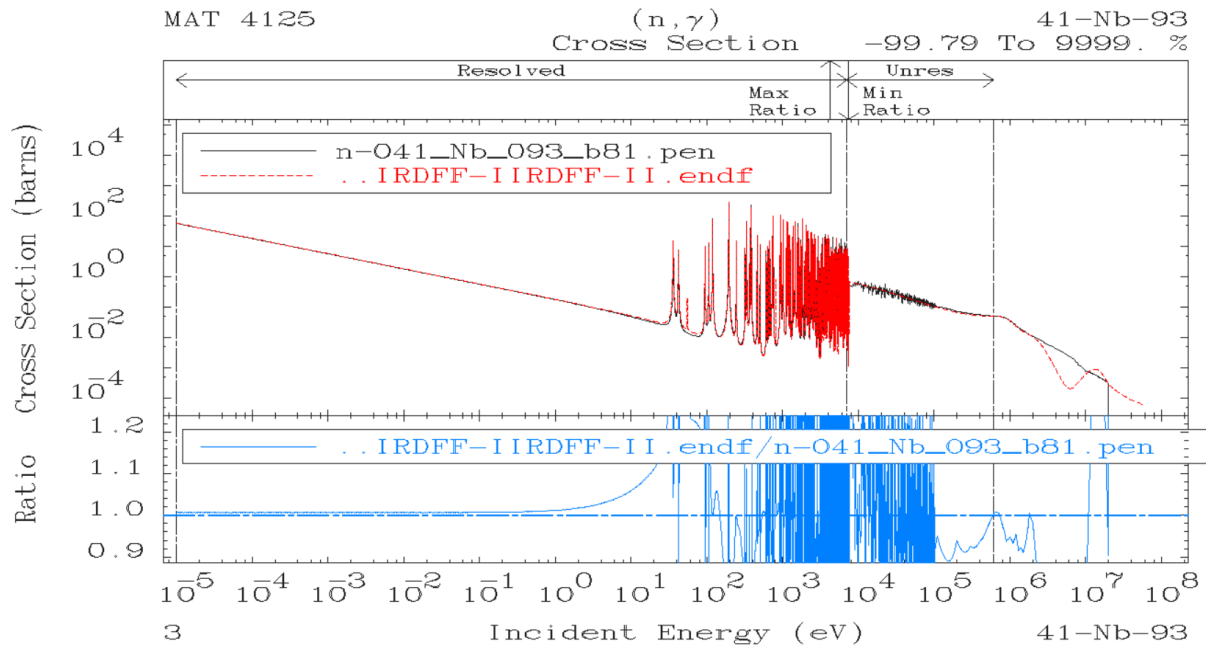
Implementation

The MT 16 cross sections from IRDFF-II were inserted into the original ENDF file. The impact on the elastic cross sections is negligible.



Nb-93

The ENDF/B-VIII.1b1 evaluation contains the inelastic, two-neutron emission and capture cross sections. The capture cross sections differ, particularly above the resonance range. The inelastic, the two-neutron emission and the capture cross sections are given in MF 10 with their respective MT numbers, giving the excitation functions for the isomers. **The differences compared to IRDFF-II need a more detailed investigation. The consistency of the inelastic and the two-neutron emission cross sections needs to be checked.**

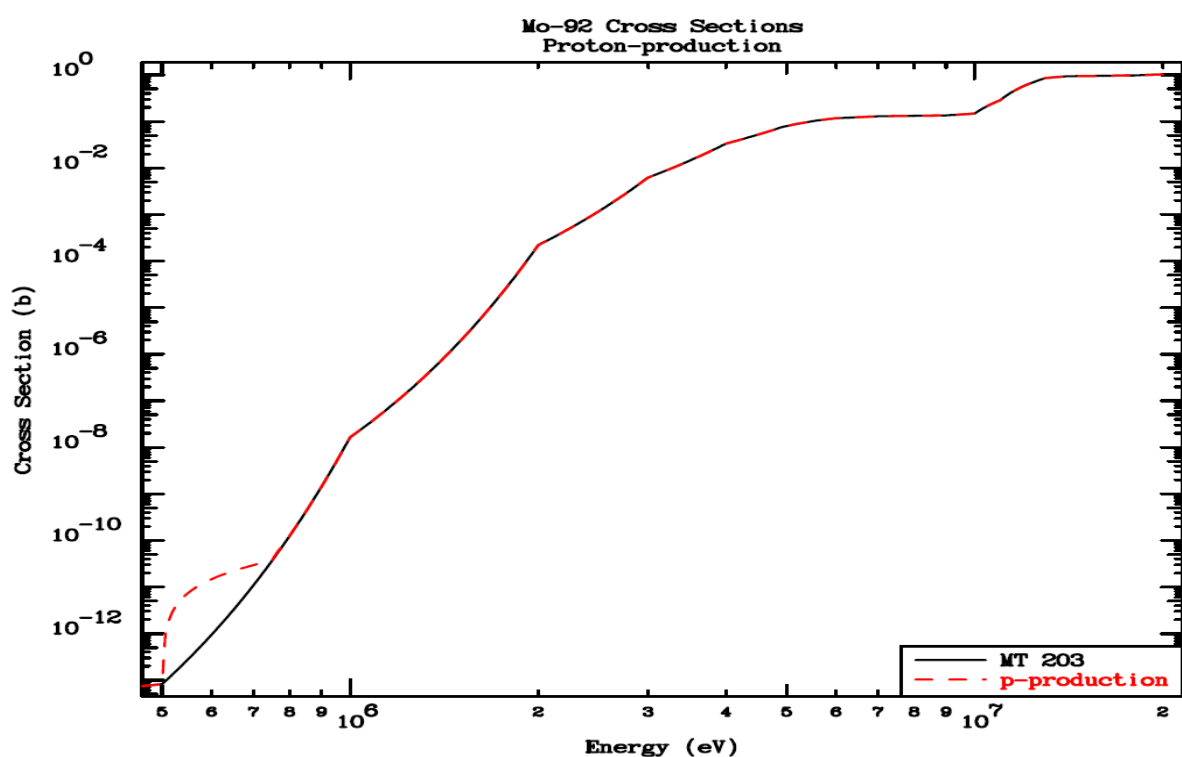
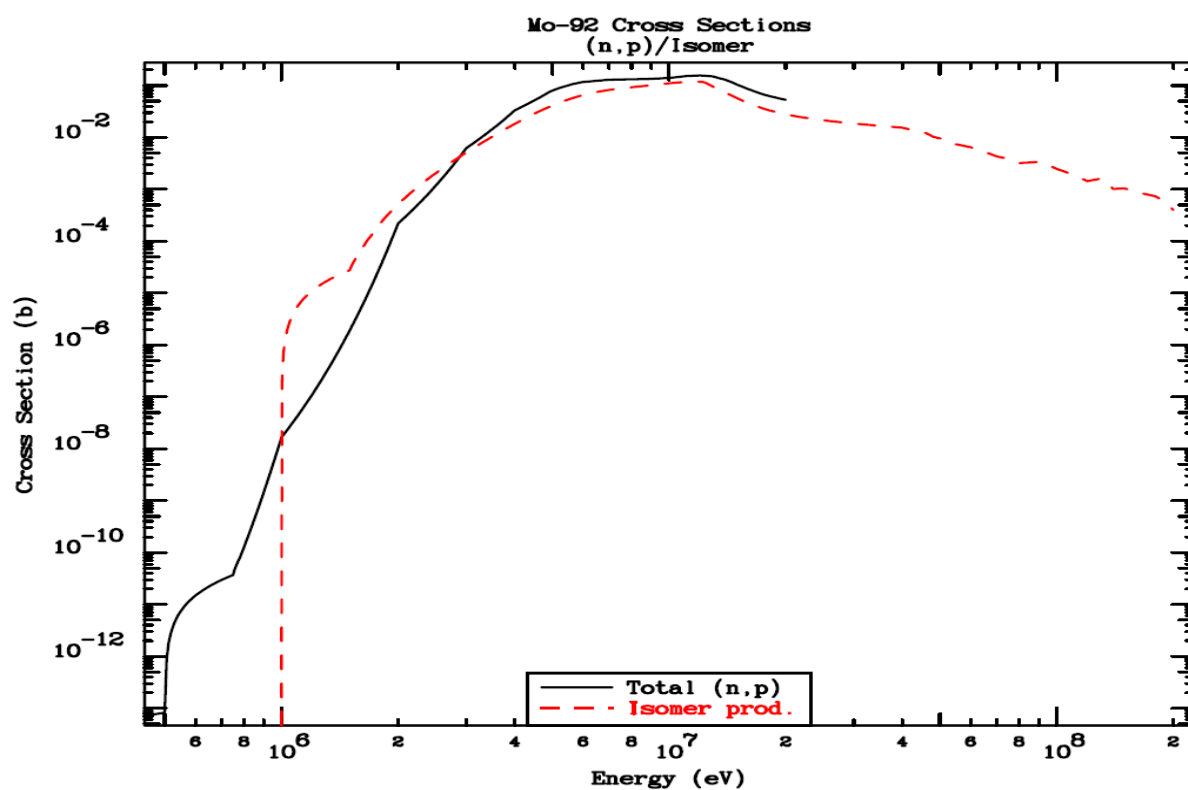


Implementation

None at present.

Mo-92

The ENDF/B-VIII.1b1 evaluation contains the proton emission cross sections in MF 10/MT 103, giving the excitation functions for the isomer production. Another peculiarity of the evaluation is the inclusion of explicit channels like MT 28, 103, 111, which all contribute to proton production, but do not have double-differential data. The same is true for the reactions contributing to the other charged particles. However, the evaluation includes gas-production data MT 203, 204, 205, 206 and 207, including the double-differential data. The case of proton-emission was checked, and the sum of the contributing reaction is equal to MT 203, except near threshold. Nevertheless, there is a danger that the processing codes might interpret the evaluation incorrectly, if tracking charged particles. **The consistency of the proton emission cross sections needs to be checked.**

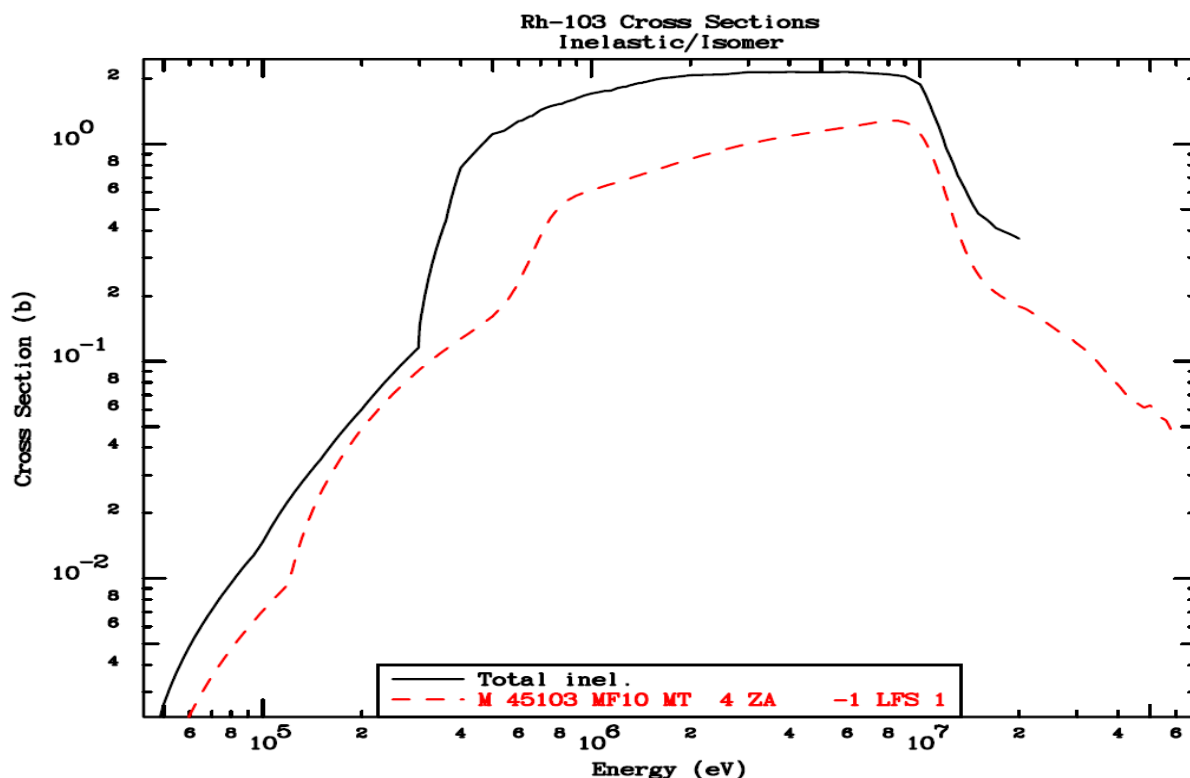


Implementation

The proton-emission cross section MT 103 (including discrete levels) is related to the isomer production, but the latter depends on the summation of higher levels feeding the long-lived isomeric level, so the inclusion of the isomer production from IRDFF-II is valid.

Rh-103

The IRDFF-II evaluation contains the inelastic cross sections in MF 10/MT 4, giving the excitation functions for the isomer production. **The consistency of the inelastic cross sections needs to be checked.**



Implementation

The cross sections for the excitation of the isomer in IRDFF-II do not contradict the inelastic cross sections in the original ENDF file. The data in MF 8, MF 10 and MF 40 can be entered into the original ENDF file. There is no impact on any other cross sections for this evaluation.

Ag-109

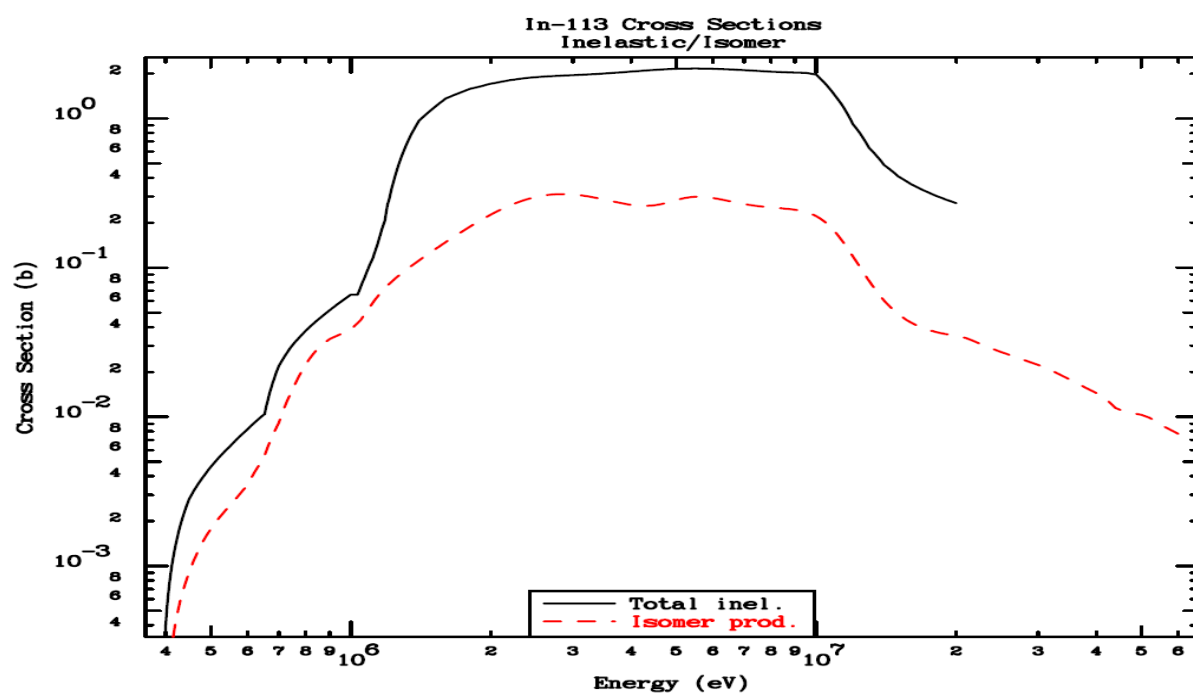
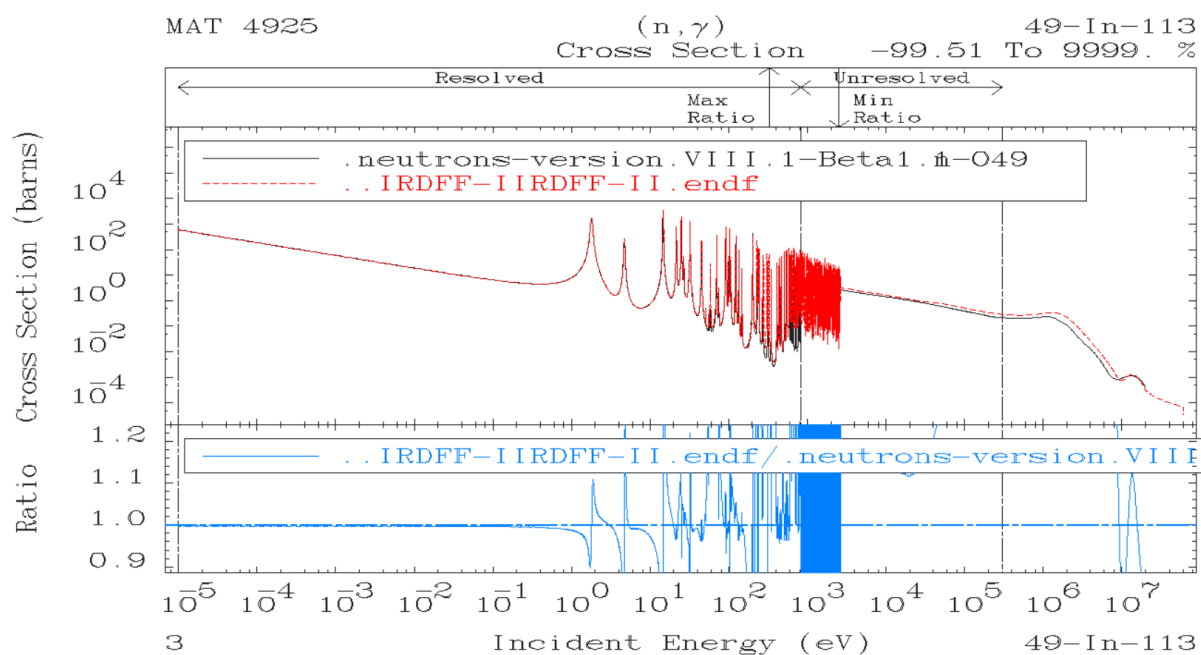
The ENDF/B-VIII.1b1 evaluation contains the capture cross sections while IRDFF-II contains the excitation function for the isomer production in MF 10/MT 102. **The consistency of the capture cross sections needs to be checked.**

Implementation

None at present.

In-113

The ENDF/B-VIII.1b1 evaluation contains inelastic MT 4 and capture MT 102 cross sections. In IRDFF-II the capture cross sections are given in MF 3/MT 102, but both are also given in MF 10/MT 4,102, providing the excitation functions for the isomer production. The resonance parameters underlying the two evaluations differ significantly, so a partial replacement of capture cross sections from IRDFF-II is not possible. It is also not straightforward to check the consistency of the inelastic cross sections. **The IRDFF-II cross sections might be included after carefully checking the consistency.**

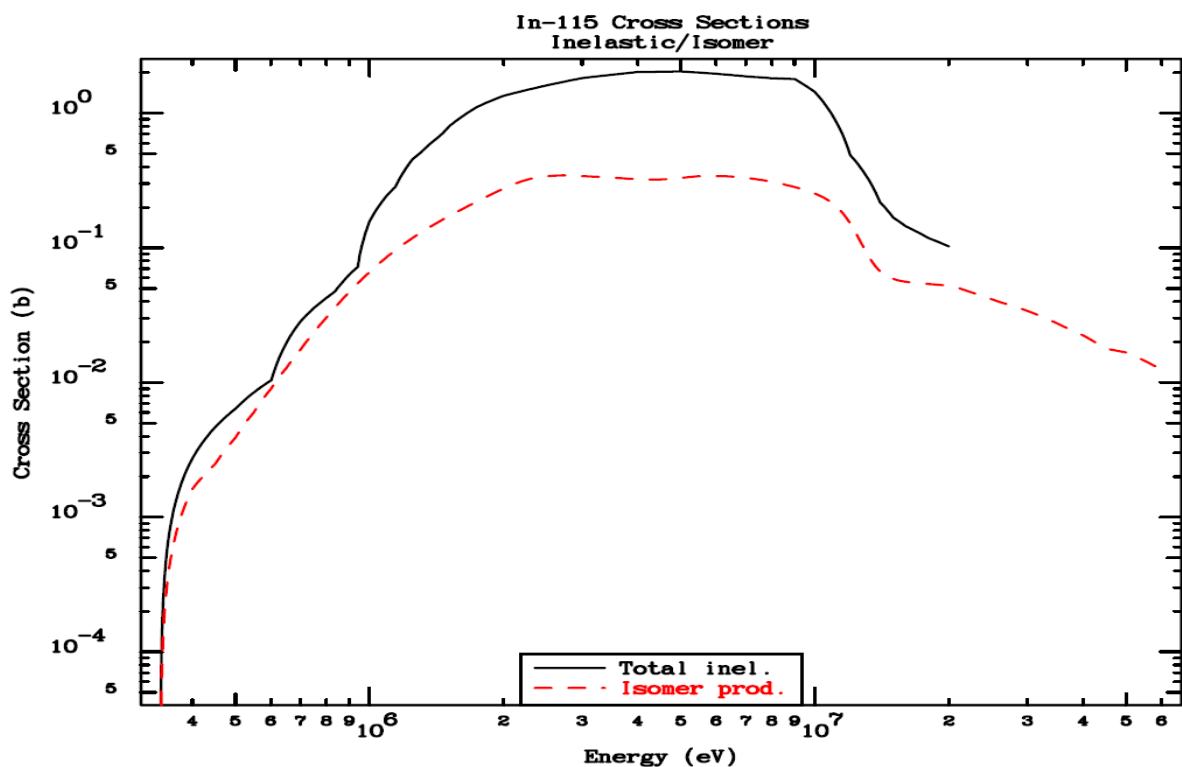
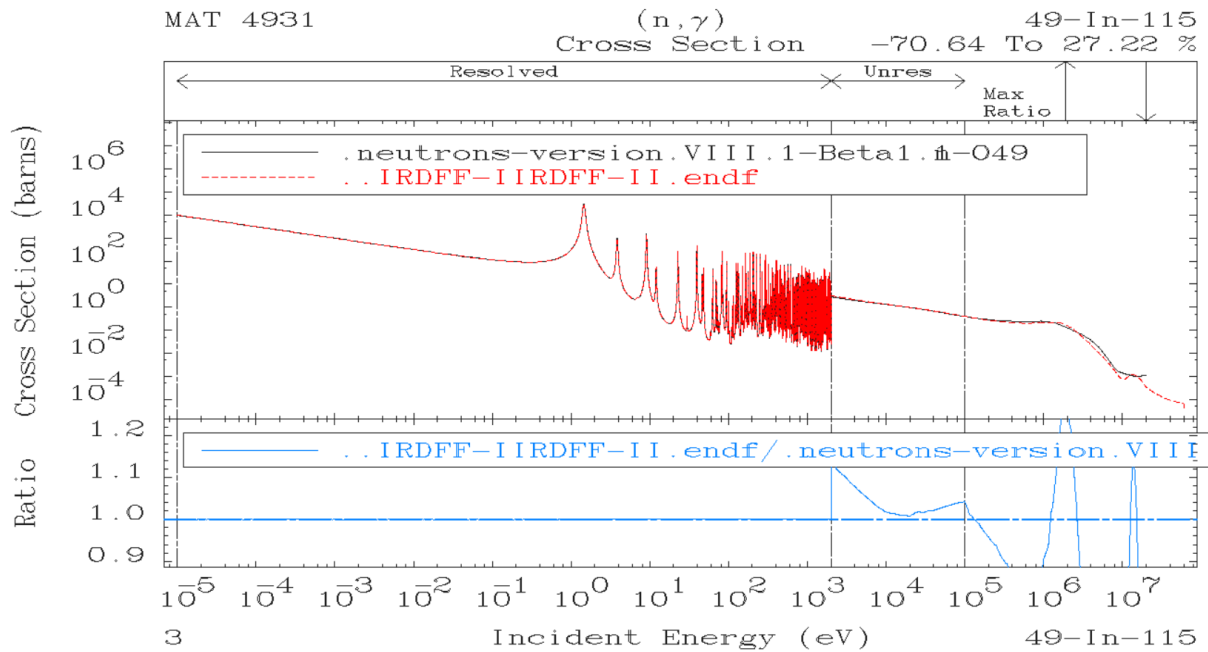


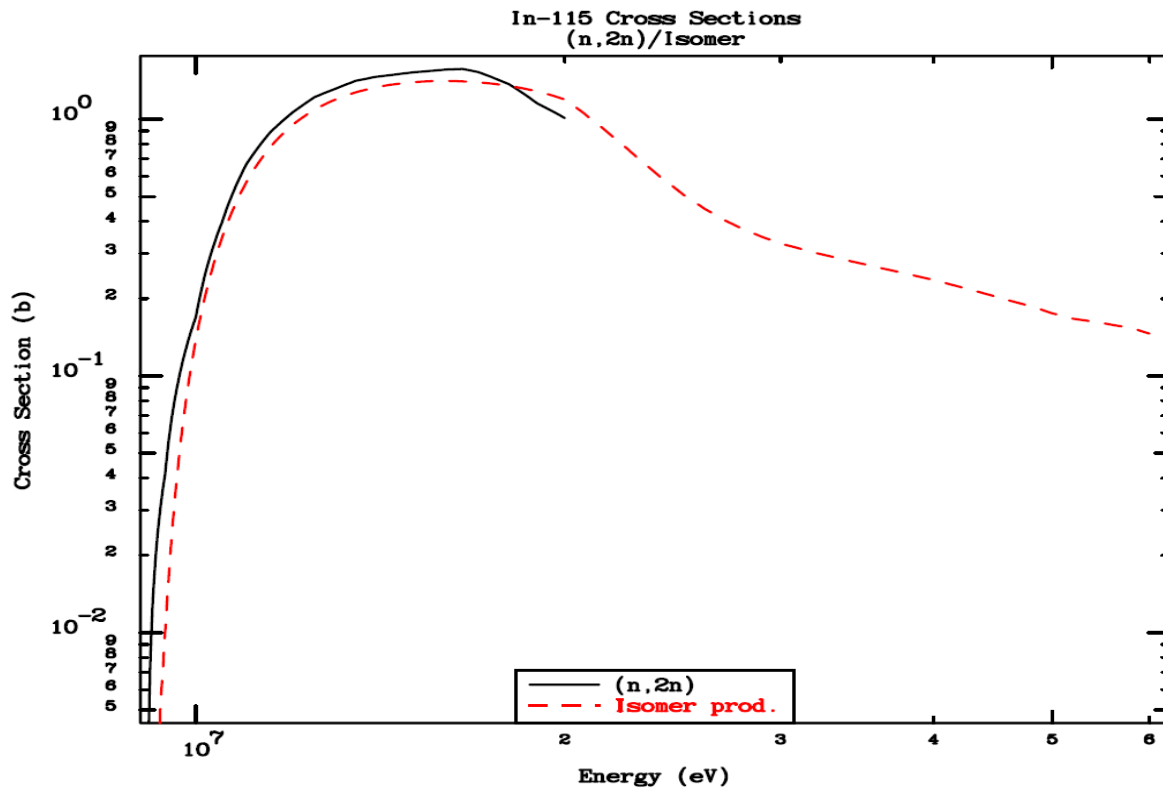
Implementation

The capture cross sections are not changes and the isomer production cross sections In-114m are not included from IRDFF-II. Isomer production cross sections In-113m depend not only on the inelastic cross sections but also on the whole cascade of levels, so the isomer production cross sections from inelastic scattering are included from IRDFF-II.

In-115

The ENDF/B-VIII.1b1 evaluation contains two-neutron emission MT 16, inelastic MT 4 and capture MT 102 cross sections. In IRDFF-II the capture cross sections are given in MF 3/MT 102 but all three are also given in MF 10/MT 4, 16,102, providing the excitation functions for the isomer production. The capture cross sections in the two libraries differ above the resonance range. It is also not straightforward to check the consistency of the inelastic cross sections. **The IRDFF-II cross sections might be included after carefully checking the consistency of the cross sections in MF 10.**



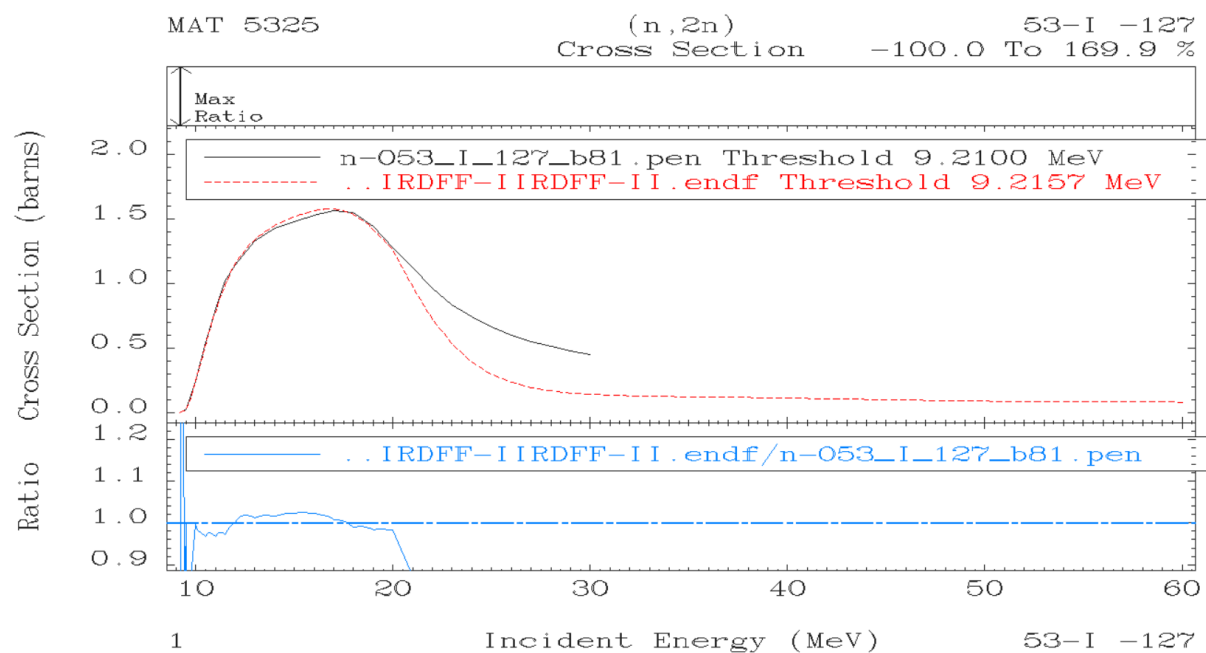


Implementation

The capture cross sections are not changes and the isomer production cross sections In-116m are not included from IRDFF-II. Isomer production cross sections In-114m and In-115m depend not only on the inelastic and (n,2n) cross sections, respectively, but also on the whole cascade of levels, so the isomer production cross sections from inelastic scattering and (n,2n) are included from IRDFF-II.

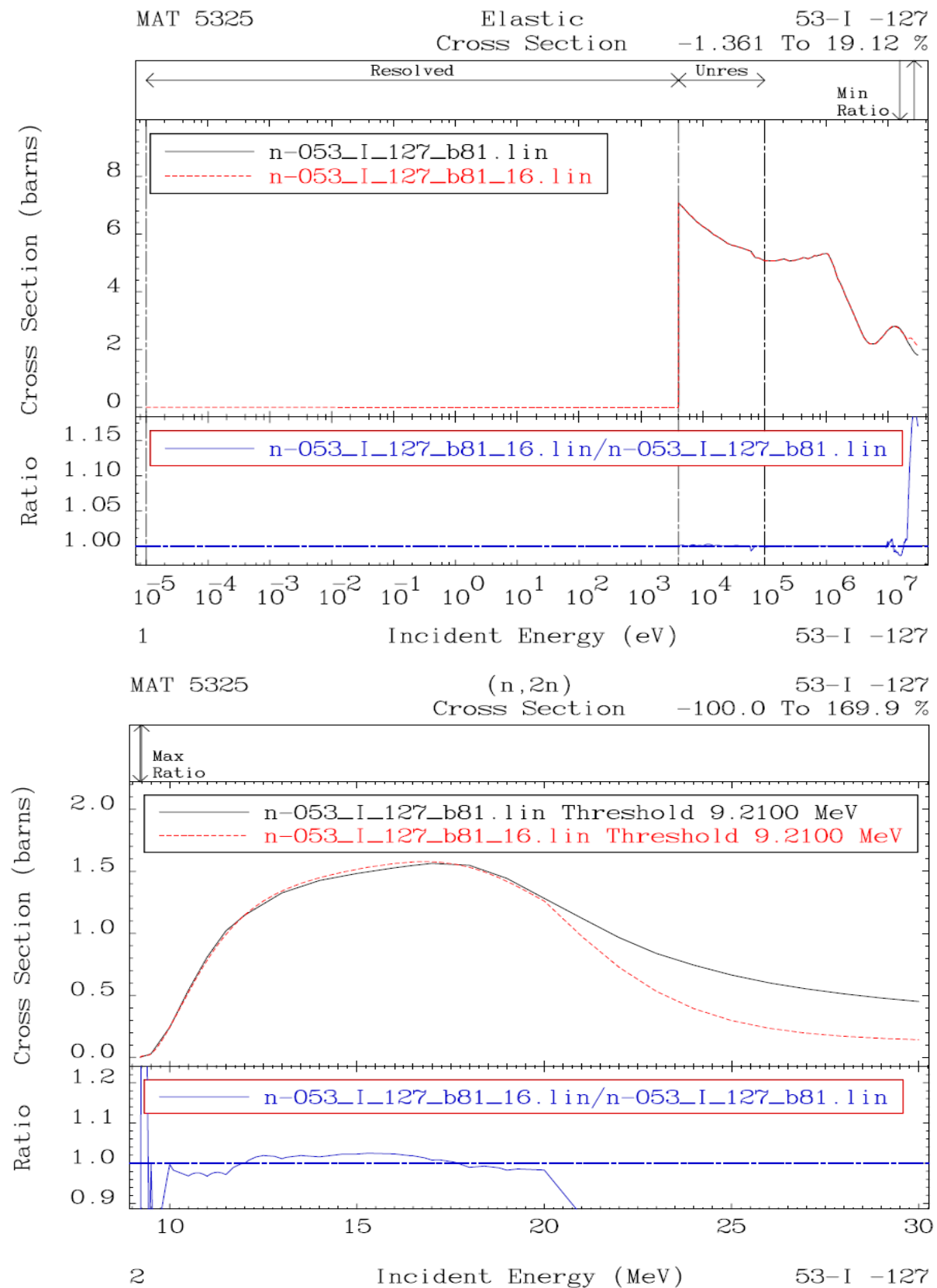
I-127

The ENDF/B-VIII.1b1 evaluation contains the two-neutron emission cross sections MT 16. **It is proposed to replace the cross sections with those from the IRDFF-II library.**



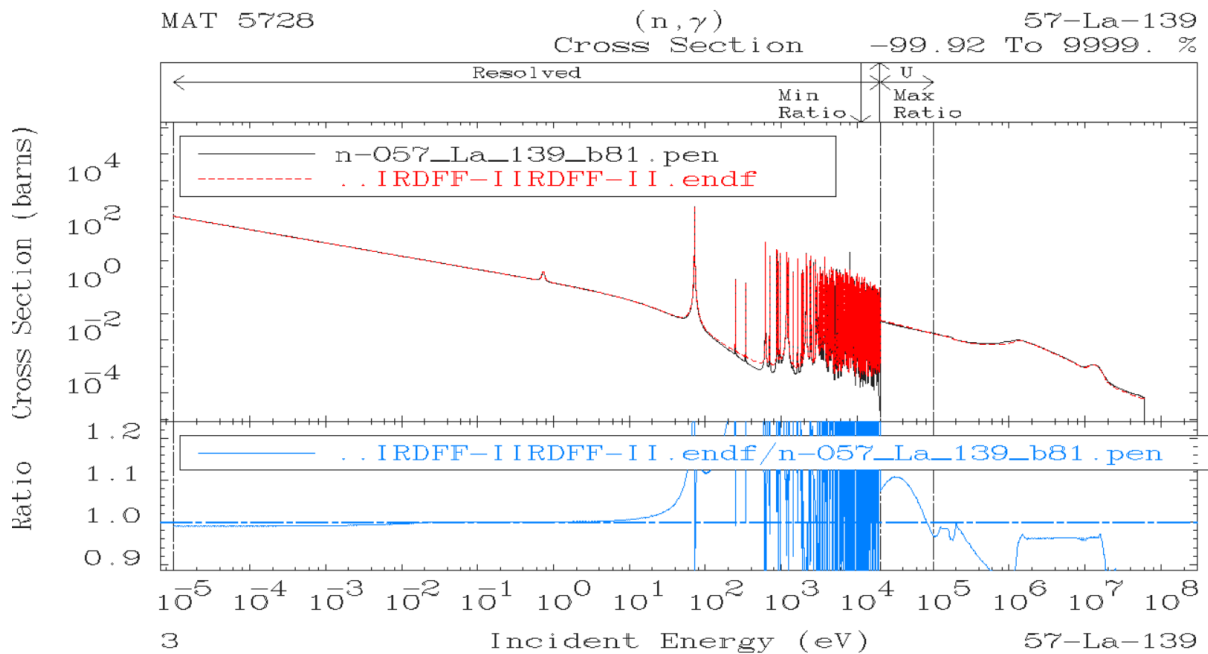
Implementation

The MT 16 cross sections from IRDFF-II were inserted into the original ENDF file up to 30 MeV. The IRDFF-II cross sections drop rapidly above 20 MeV, giving rise to significant increase in the elastic cross section. It might be worth considering using the IRDFF-II cross sections only up to 20 MeV.



La-139

The ENDF/B-VIII.1b1 evaluation contains the capture cross sections. The cross sections differ in the resolved resonance range and above. **Considering that it might be difficult to make changes to the cross sections and preserve unitarity, the proposal is to make no changes to the evaluated data file.**

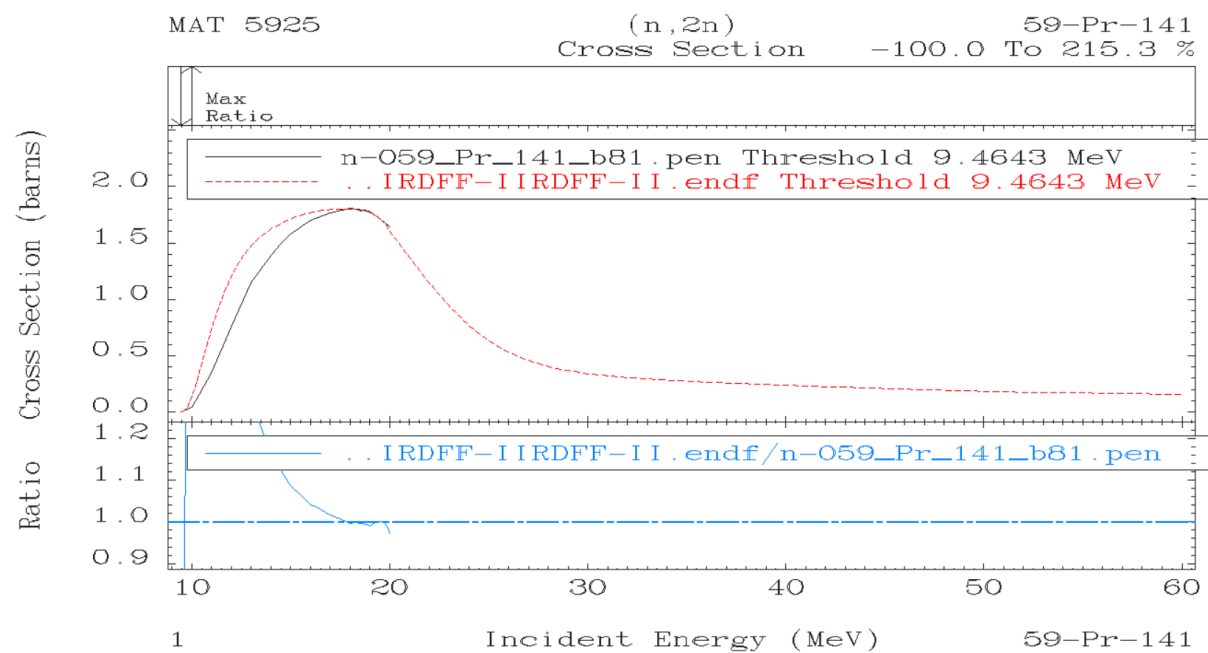


Implementation

None.

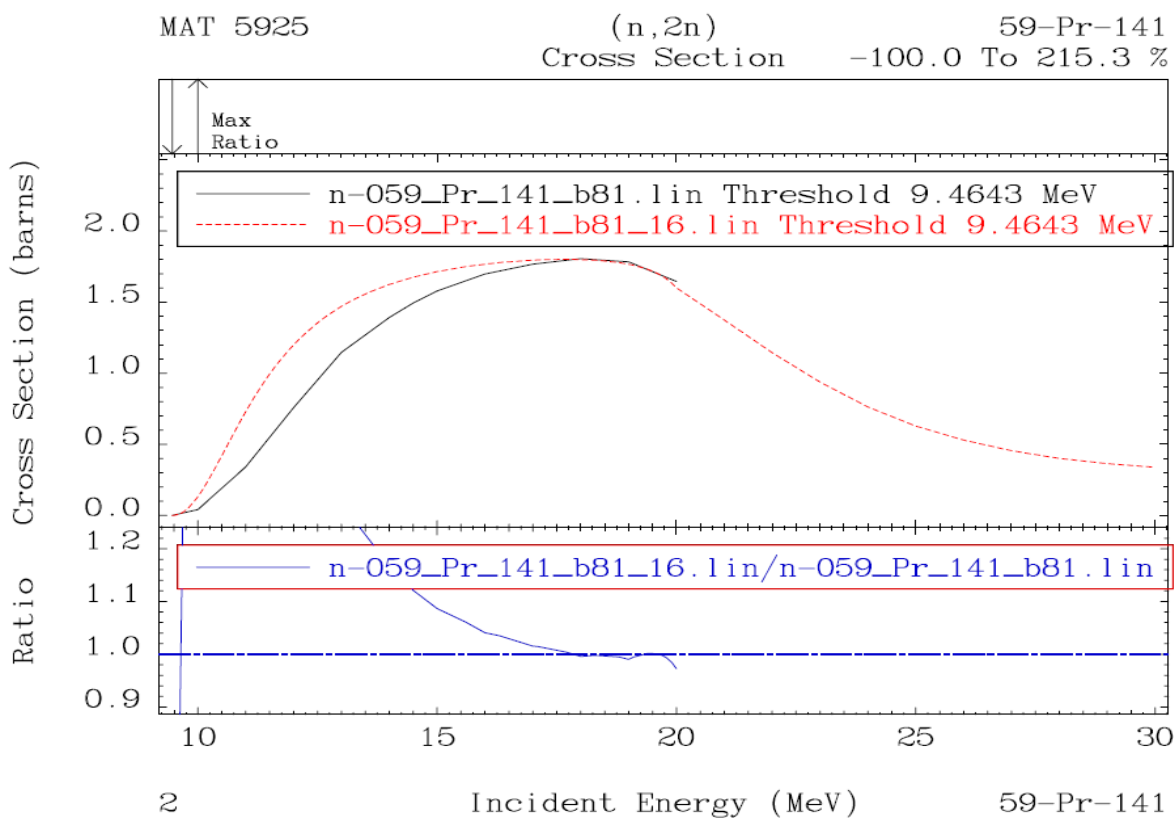
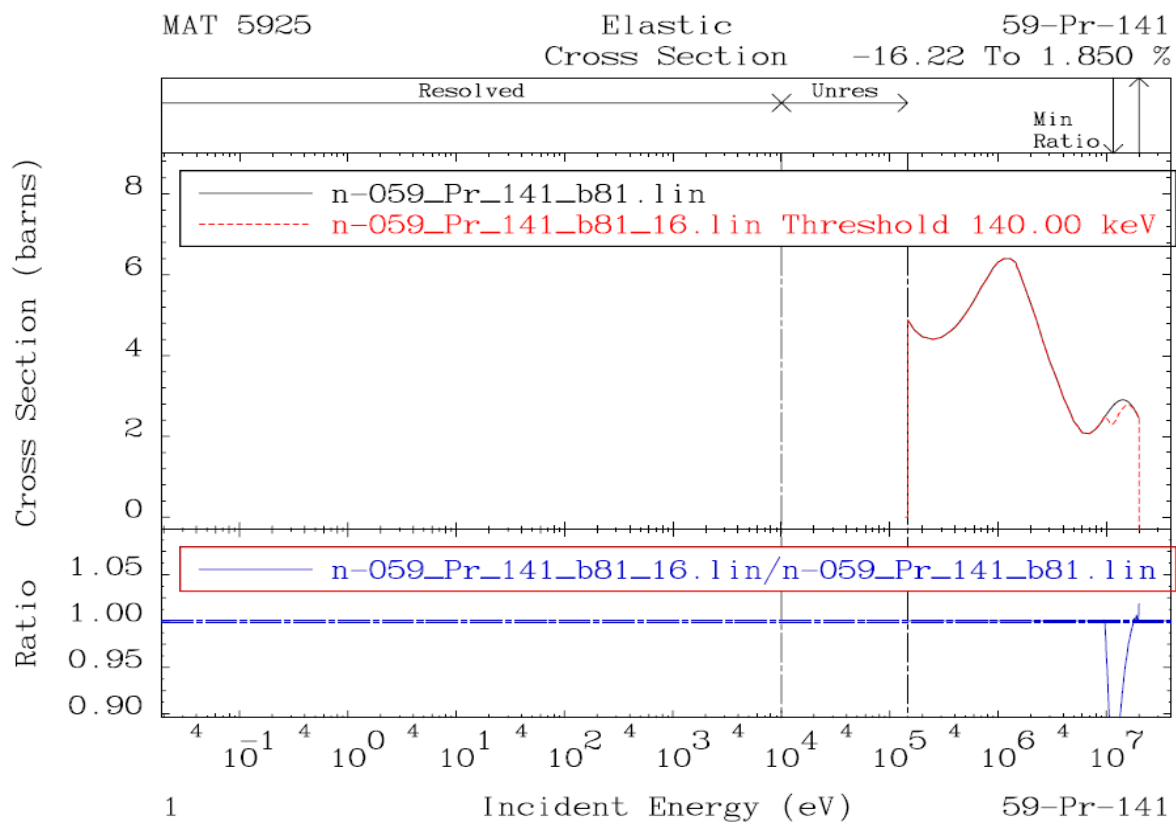
Pr-141

The ENDF/B-VIII.1b1 evaluation contains the two-neutron emission cross sections MT 16. **It is proposed to replace the cross sections with those from the IRDFF-II library.**



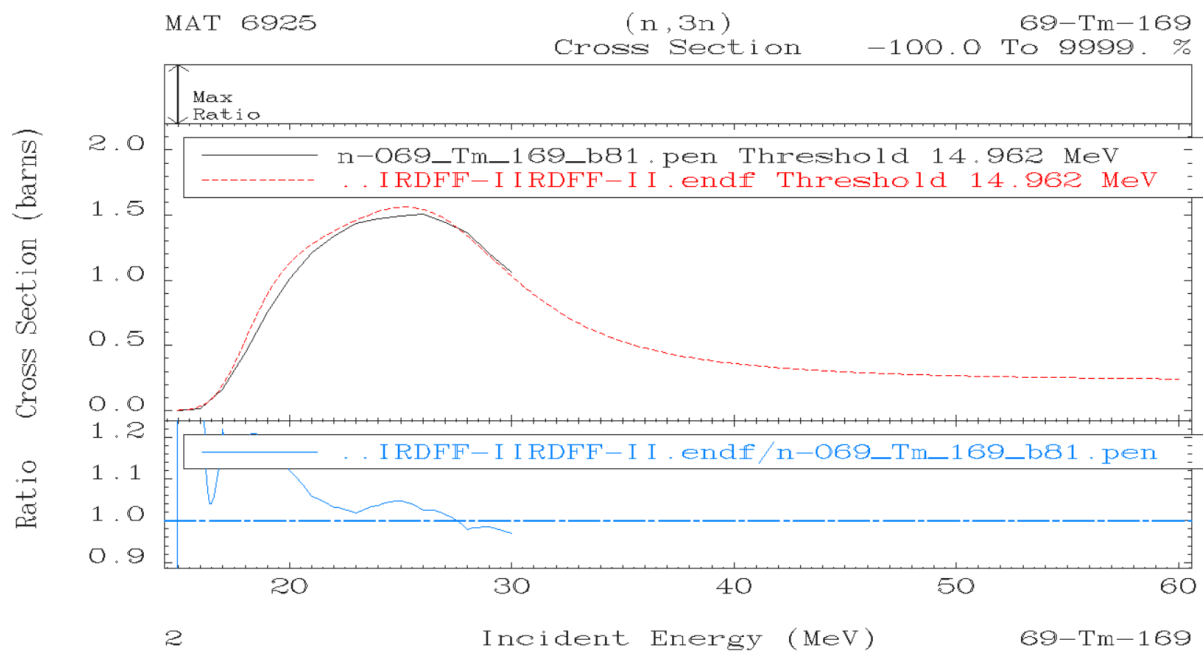
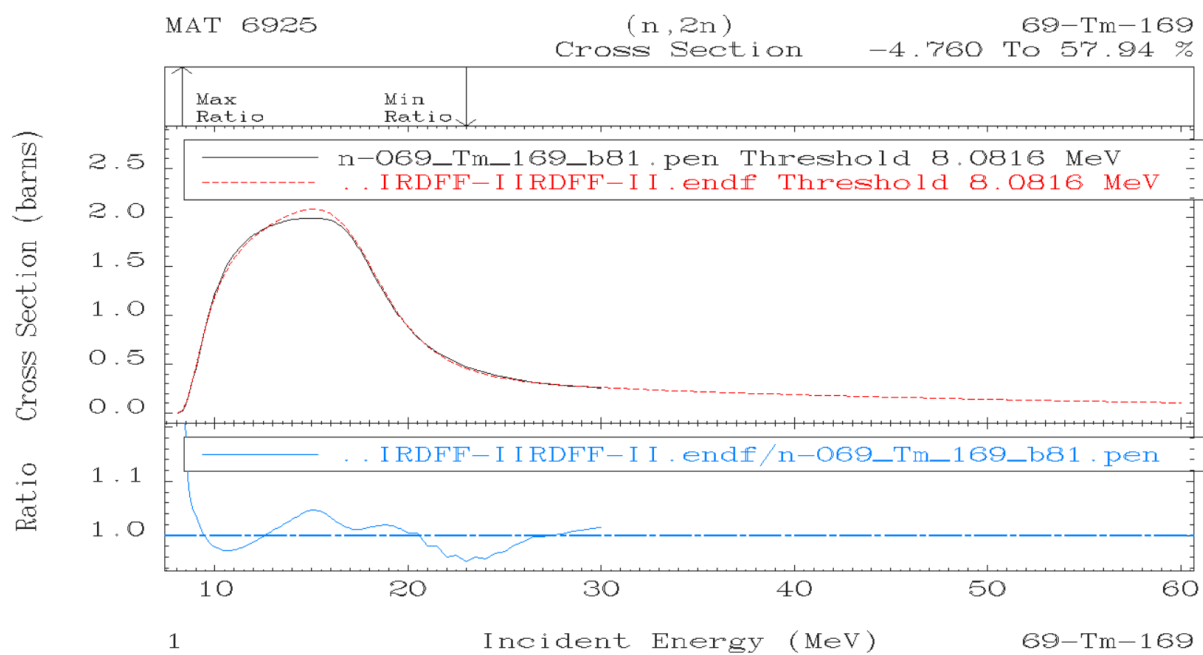
Implementation

Insertion of the MT 16 cross sections from IRDFF-II library into the original ENDF file makes a significant impact on the elastic cross sections. Suitability of the modification might need some further consideration.



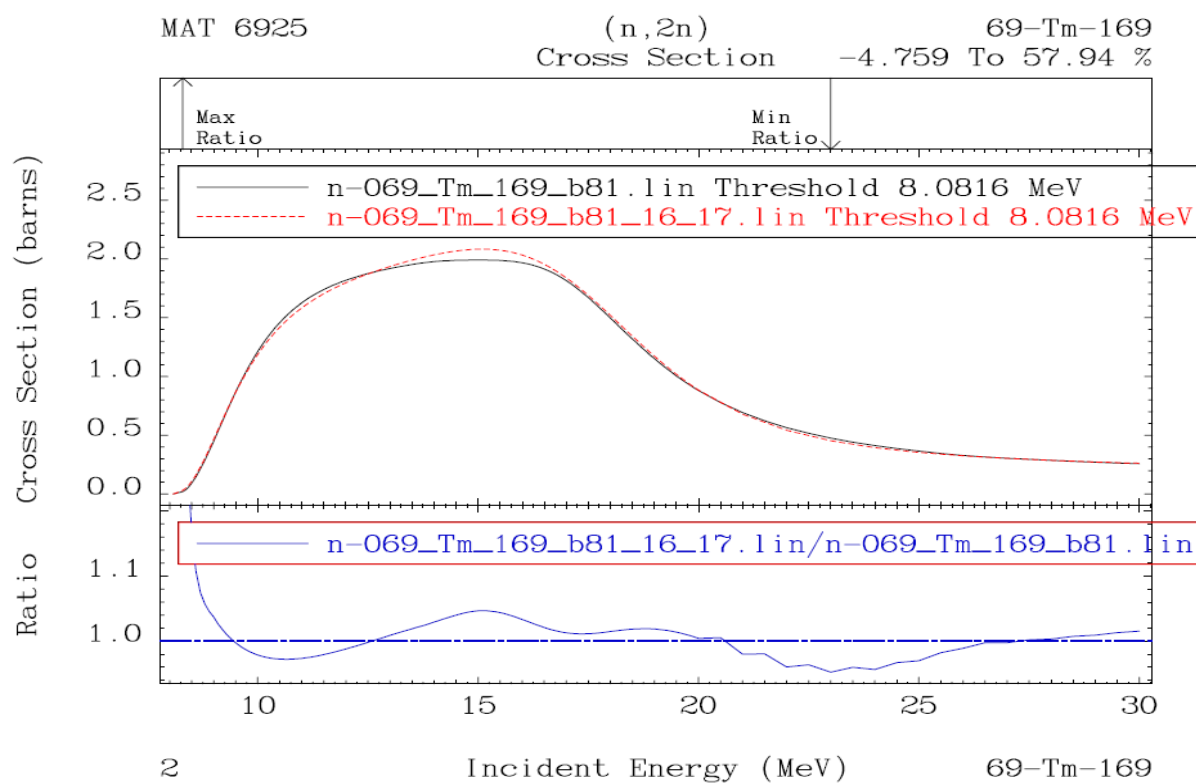
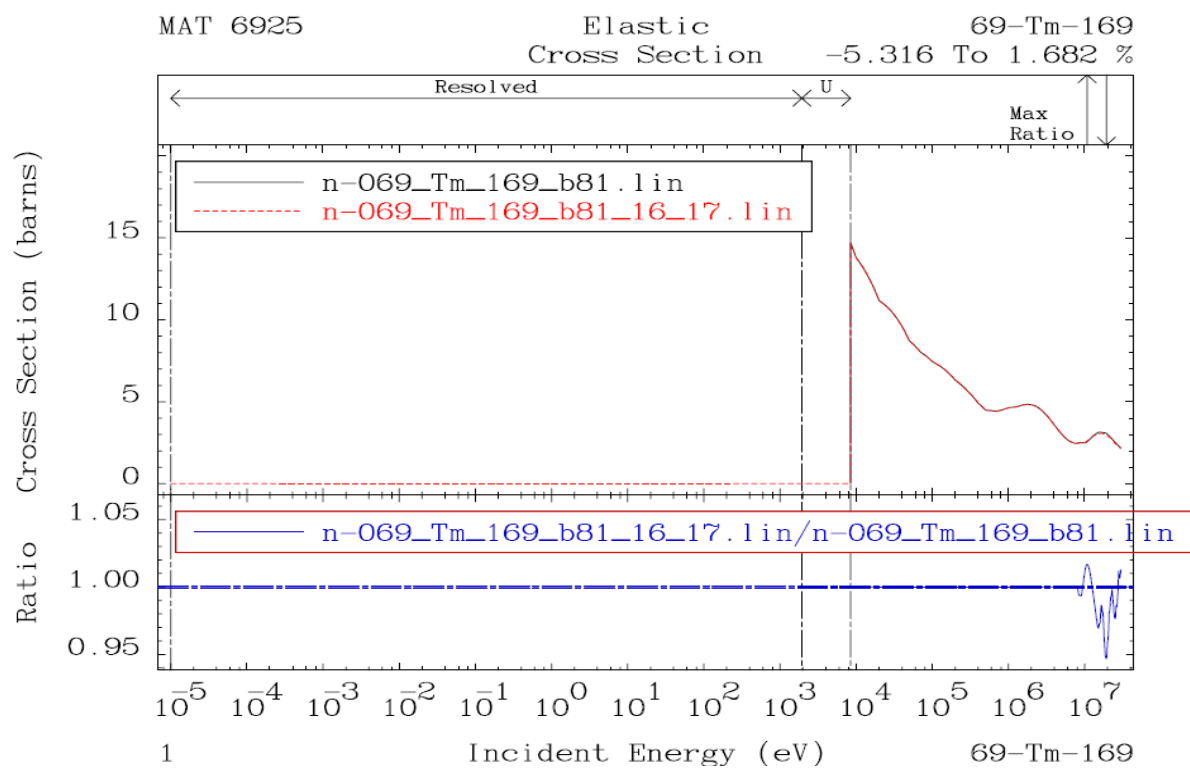
Tm-169

The ENDF/B-VIII.1b1 evaluation contains the two- and three-neutron emission cross sections MT 16, 17. **It is proposed to replace the cross sections with those from the IRDFF-II library.**



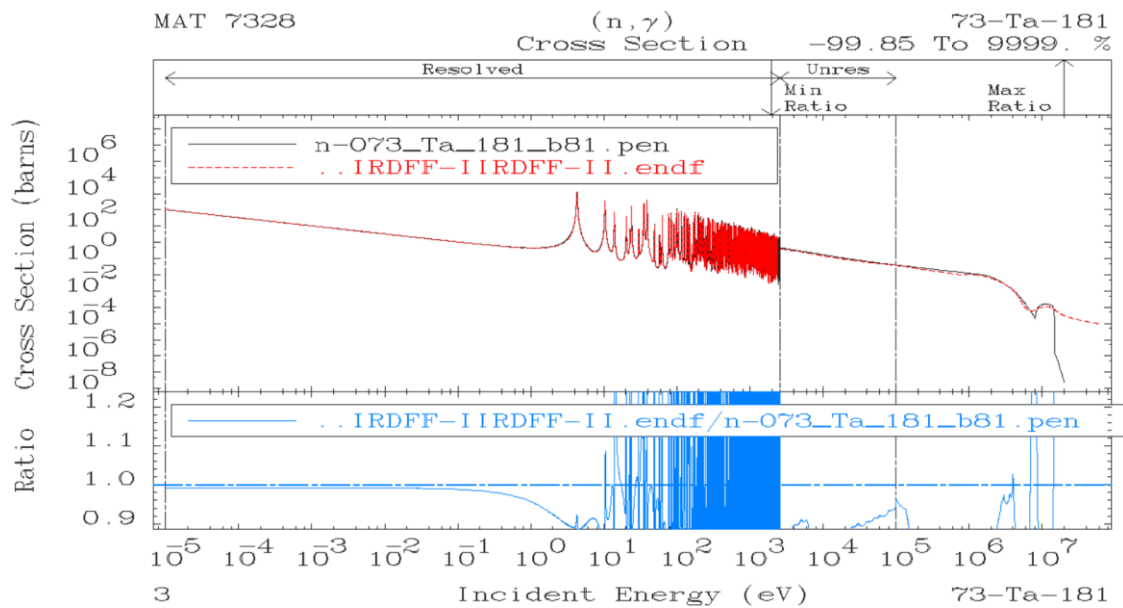
Implementation

The substitution of MT 16 from IRDFF into the original ENDF file affects the elastic cross sections by up to 5 %. The new (n,2n) cross section extends to 30 MeV.



Ta-181

The ENDF/B-VIII.1b1 evaluation contains the capture cross sections. Considering that it might be difficult to make changes to the cross sections and preserve unitarity, **the proposal is to make no changes to the evaluated data file.**

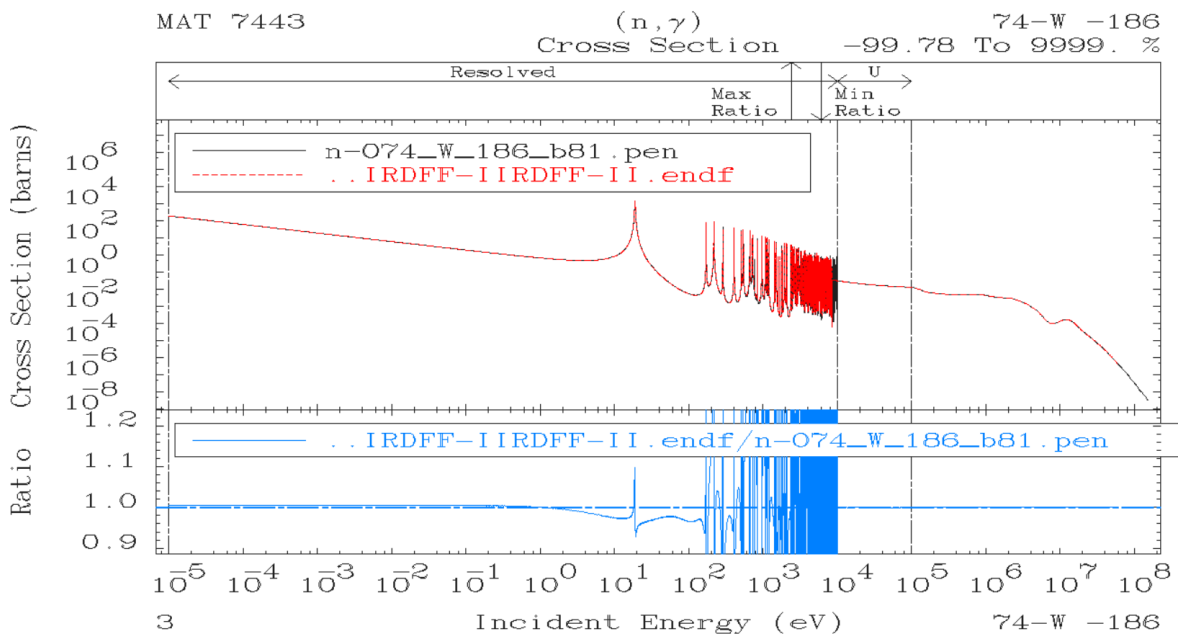


Implementation

None.

W-186

The ENDF/B-VIII.1b1 evaluation contains the capture cross sections. Considering that it might be difficult to make changes to the cross sections and preserve unitarity, **the proposal is to make no changes to the evaluated data file.**

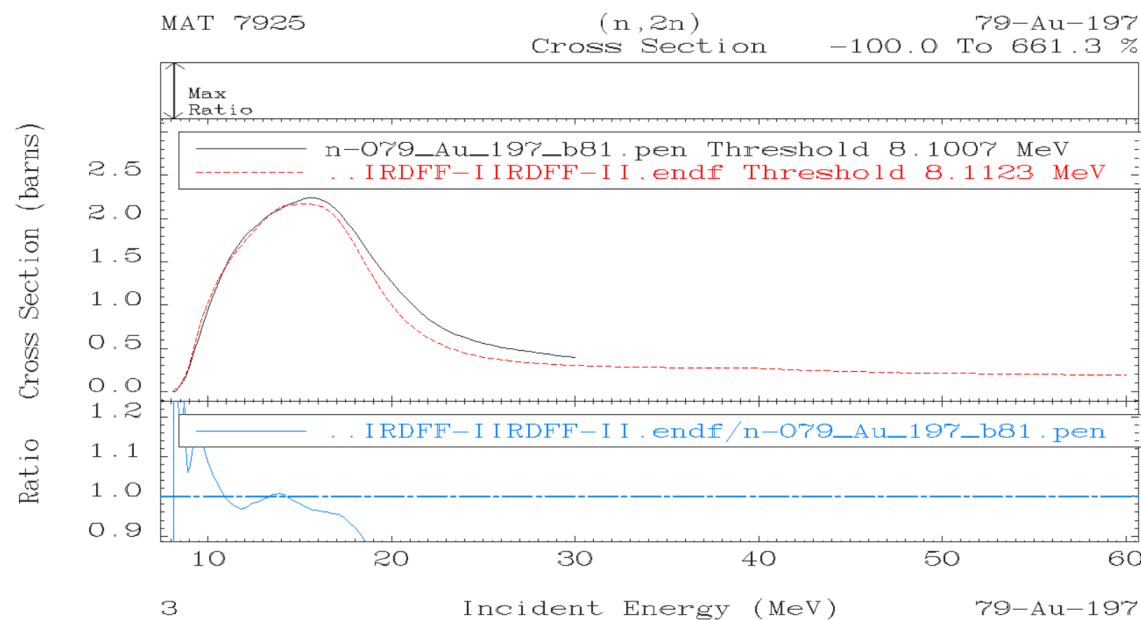


Implementation

None.

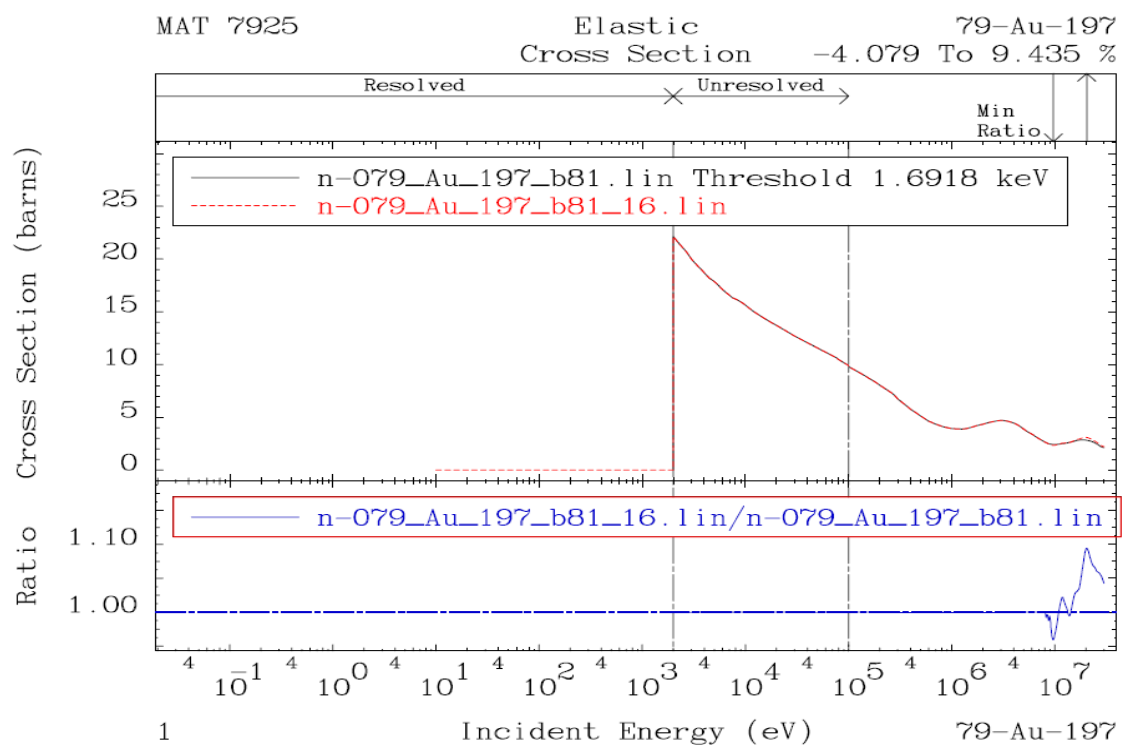
Au-197

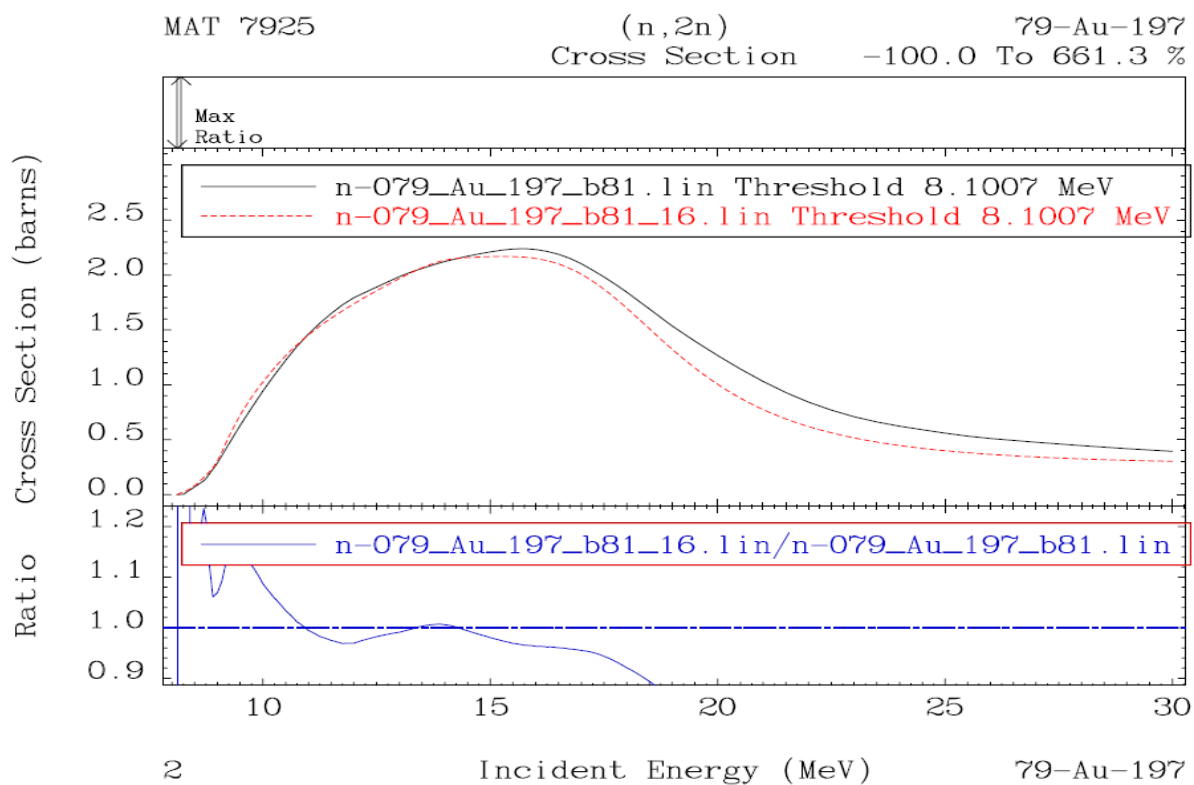
The ENDF/B-VIII.1b1 evaluation contains the two-neutron MT 16 and capture MT 102 cross sections. The capture cross sections are in full agreement with IRDFF-II. The two-neutron emission cross sections differ. **It is proposed to replace the cross sections for MT 16 with those from the IRDFF-II library.**



Implementation

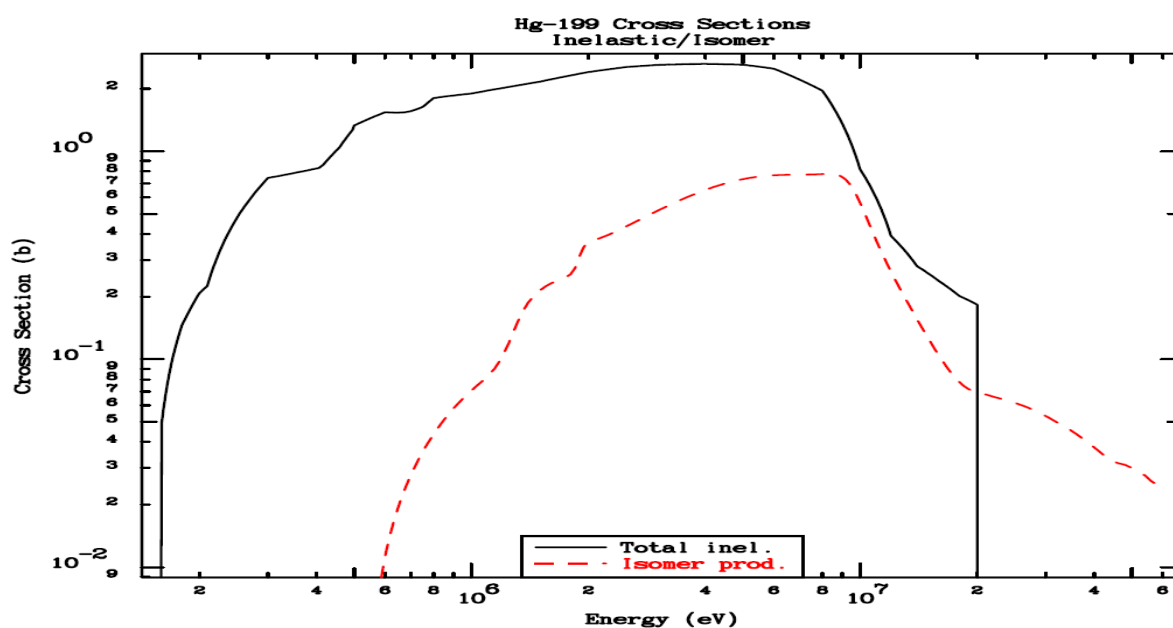
The elastic cross section is affected by up to 10 %. The (n,2n) cross sections extend to 30 MeV.





Hg-199

The ENDF/B-VIII.1b1 evaluation contains the inelastic MT 4 and MT 51-91 cross sections. The IRDFF-II contains the excitation functions for the isomer production in MF 10/MT 4. Cross sections cannot be compared directly. **Consistency needs to be established before any decision is made about the possible use of IRDFF-II for this reaction in ENDF/B-VIII.1b2.**

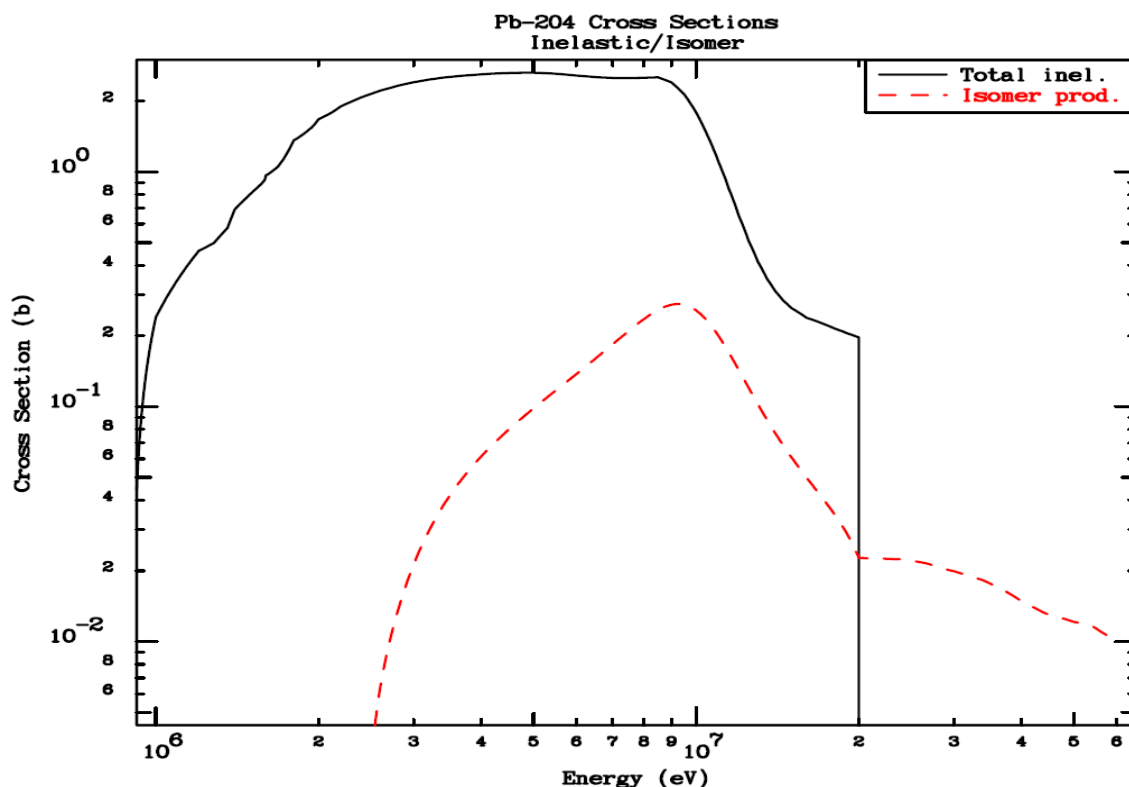


Implementation

Isomer production cross sections Hg-199m depend not only on the inelastic cross sections but also on the whole cascade of levels, so the isomer production cross sections from inelastic scattering are not in contradiction with the inelastic cross sections in MF 3, and so the data from IRDFF-II are included in the new ENDF file.

Pb-204

The ENDF/B-VIII.1b1 evaluation contains the inelastic MT 4 and MT 51-91 cross sections. The IRDFF-II contains the excitation functions for the isomer production in MF 10/MT 4. Cross sections cannot be compared directly. **Consistency needs to be established before any decision is made about the possible use of IRDFF-II for this reaction in ENDF/B-VIII.1b2.**

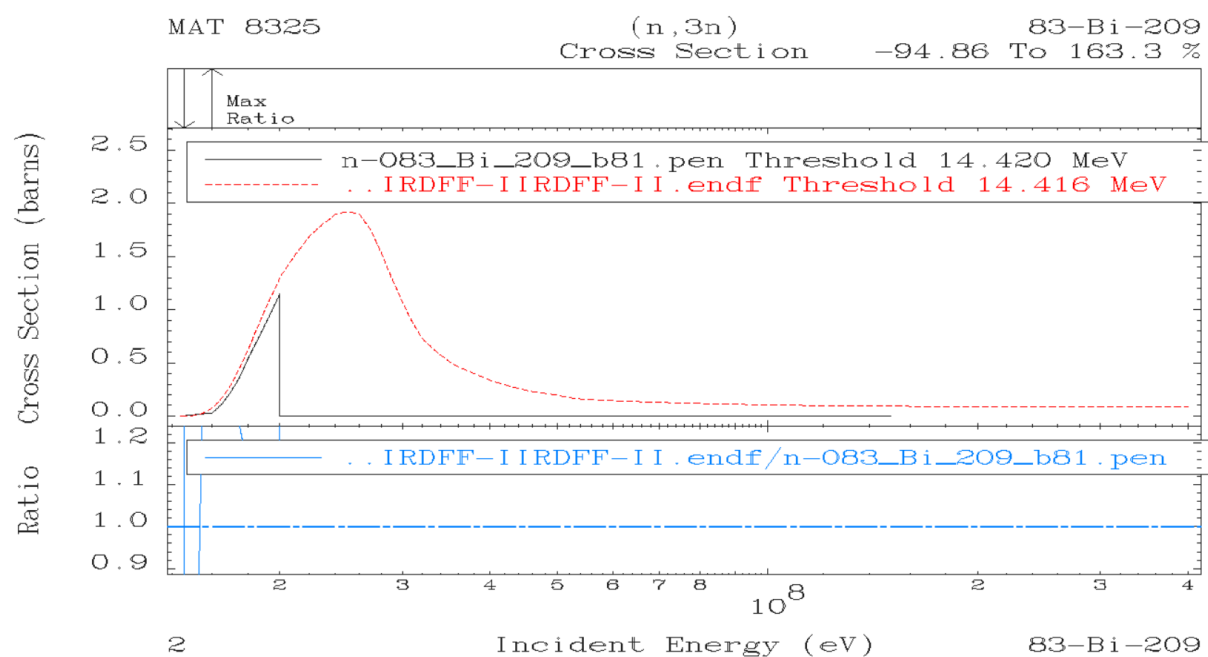
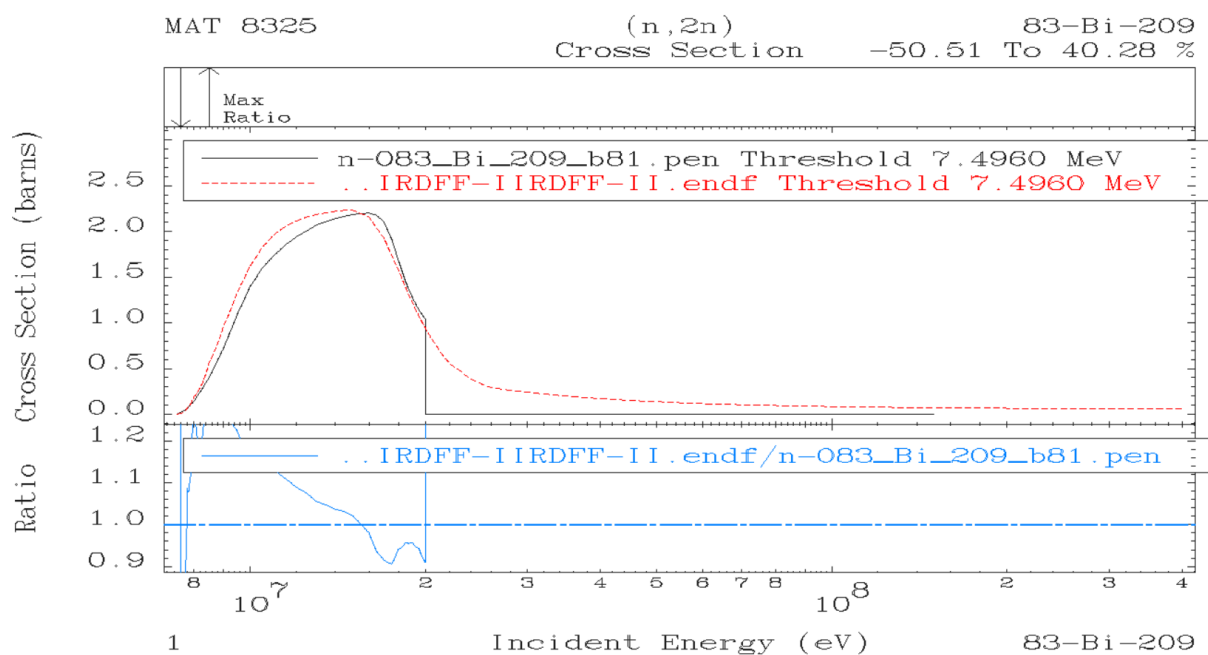


Implementation

Isomer production cross sections Pb-204m depend not only on the inelastic cross sections but also on the whole cascade of levels, so the isomer production cross sections from inelastic scattering are not in contradiction with the inelastic cross sections in MF 3, and so the data from IRDFF-II are included in the new ENDF file.

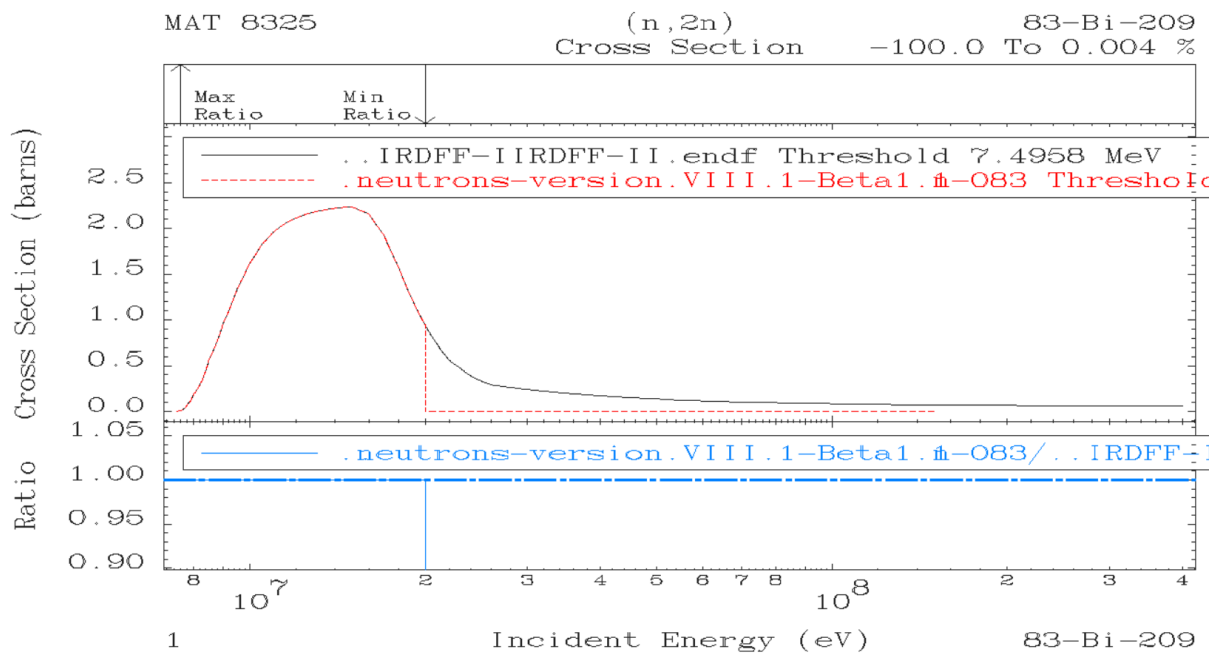
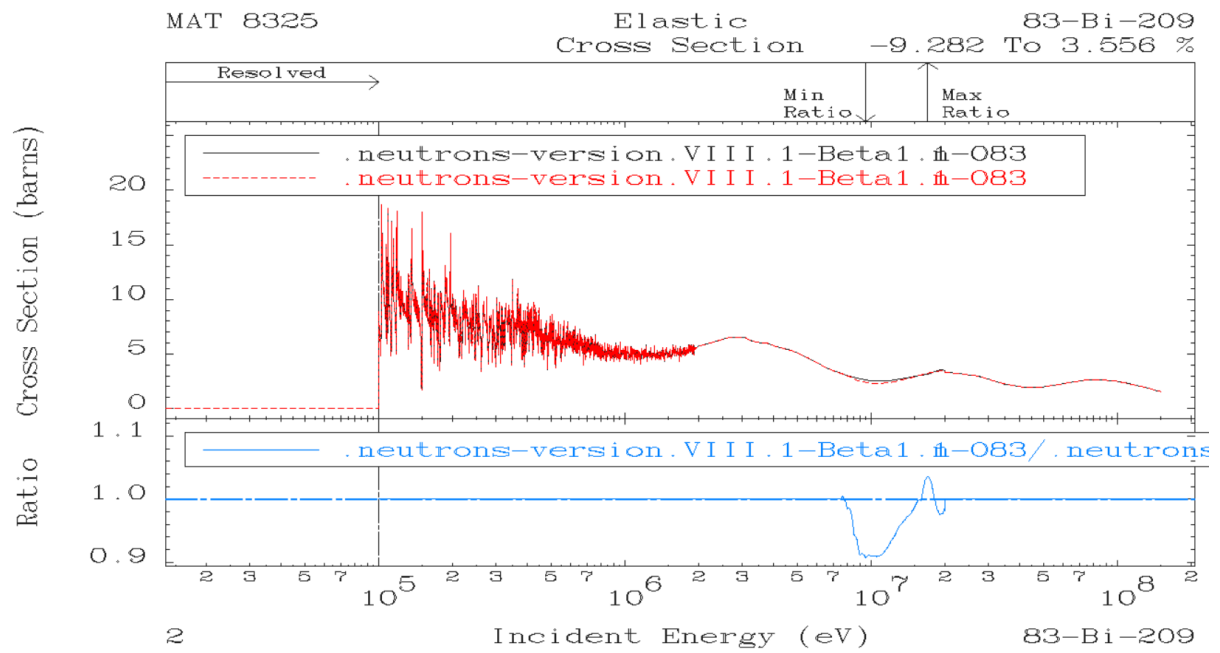
Bi-209

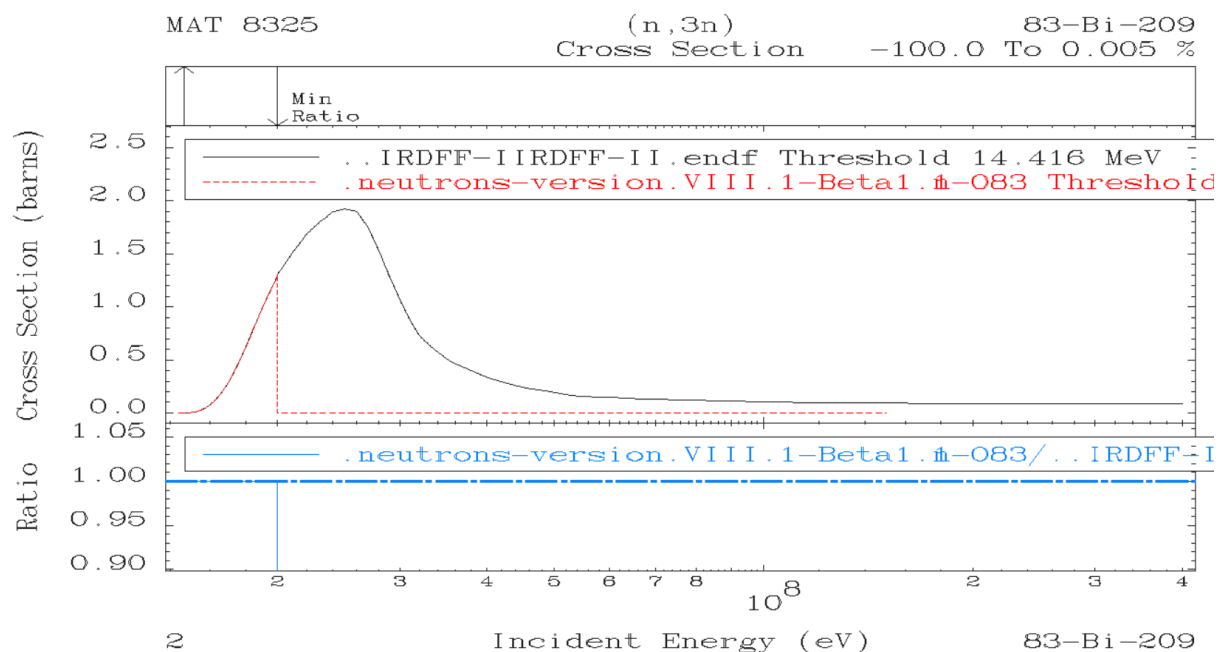
The ENDF/B-VIII.1b1 evaluation contains the two- and three-neutron emission cross sections MT 16 and MT 17. The IRDFF-II library in addition contains multiple neutron emission (up to 6) cross sections MT 37, 152, 153. However, the evaluation is hindered by the "dual representation" in which all non-elastic cross sections are lumped into MT 5. The four-neutron emission threshold is at 22.55 MeV, the five- and six- neutron emission thresholds are even higher. Adjusting the multiplicities of residuals, neutrons and gammas for the corresponding reactions in MF 6/MT 5 is tricky. **It is proposed to replace only the two-neutron MT 16 and three-neutron emission cross sections MT 17 from the data in IRDFF-II.**



Implementation

The elastic cross sections are affected by up to 10 %. The (n,2n) and (n,3n) cross sections from IRDFF-II were inserted into the original ENDF file up to 20 MeV because at higher energies the dual representation in MT 5 is used and the implied cross sections cannot be updated consistently.

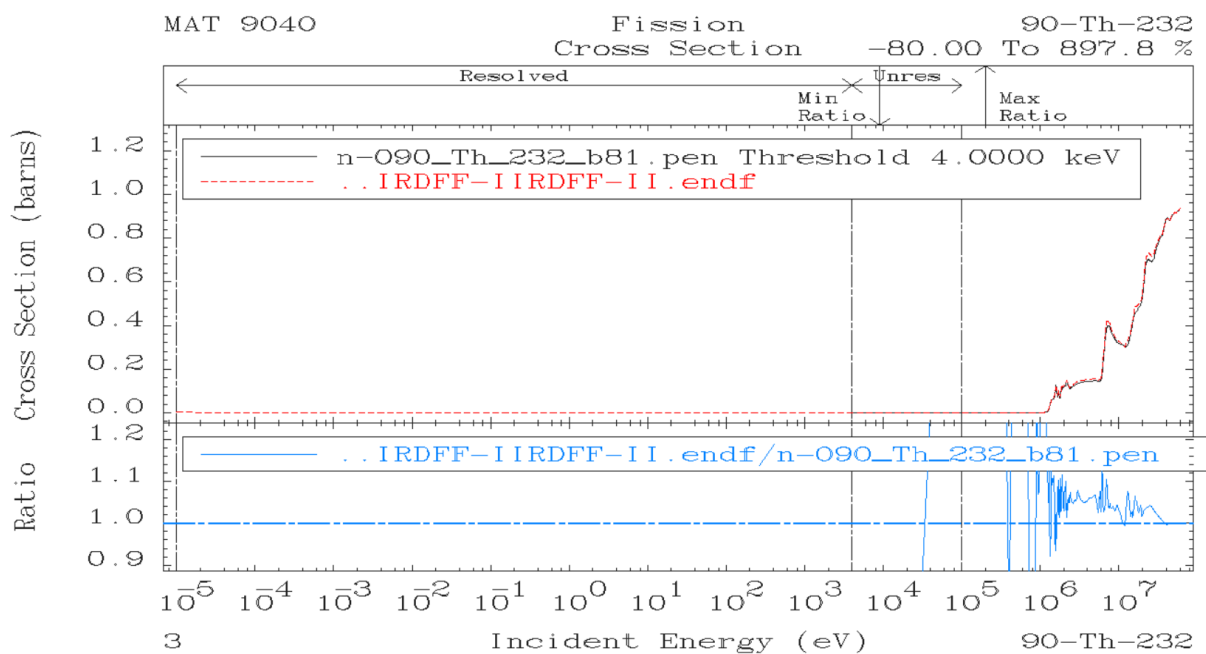


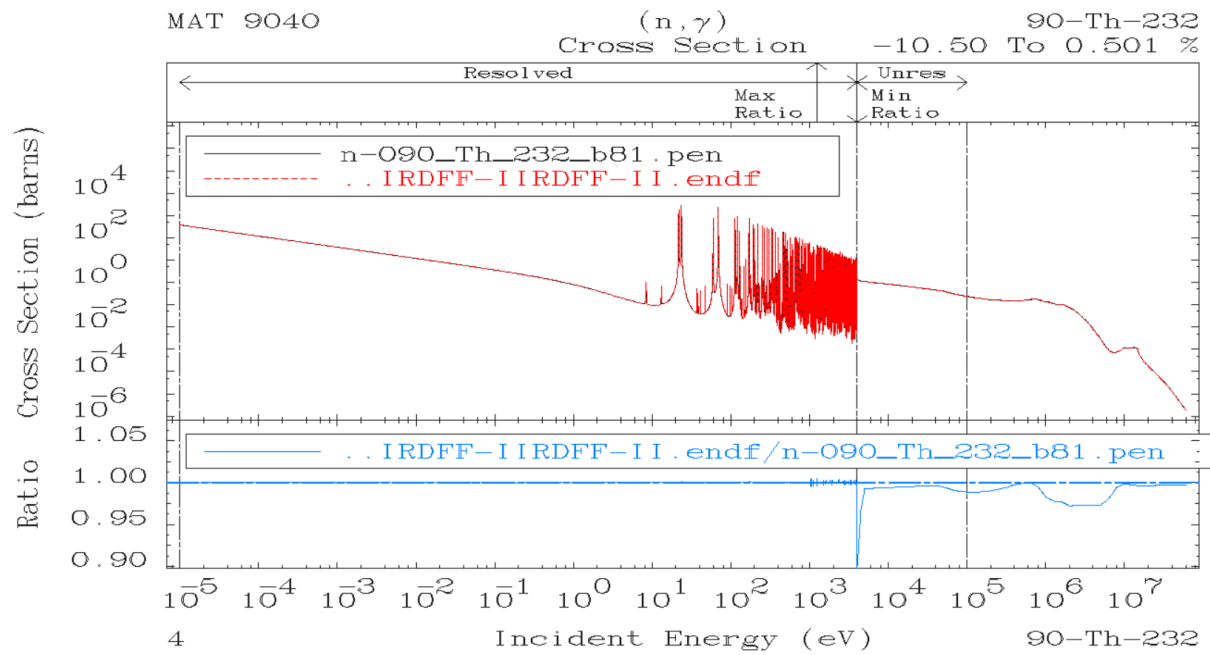


Th-232

The ENDF/B-VIII.1b1 evaluation contains fission and capture cross sections MT 18, 102 that can be compared to IRDFF-II. The cross sections in the two libraries are different above the resonance range.

The differences require further study, so no recommendations for change can be made.



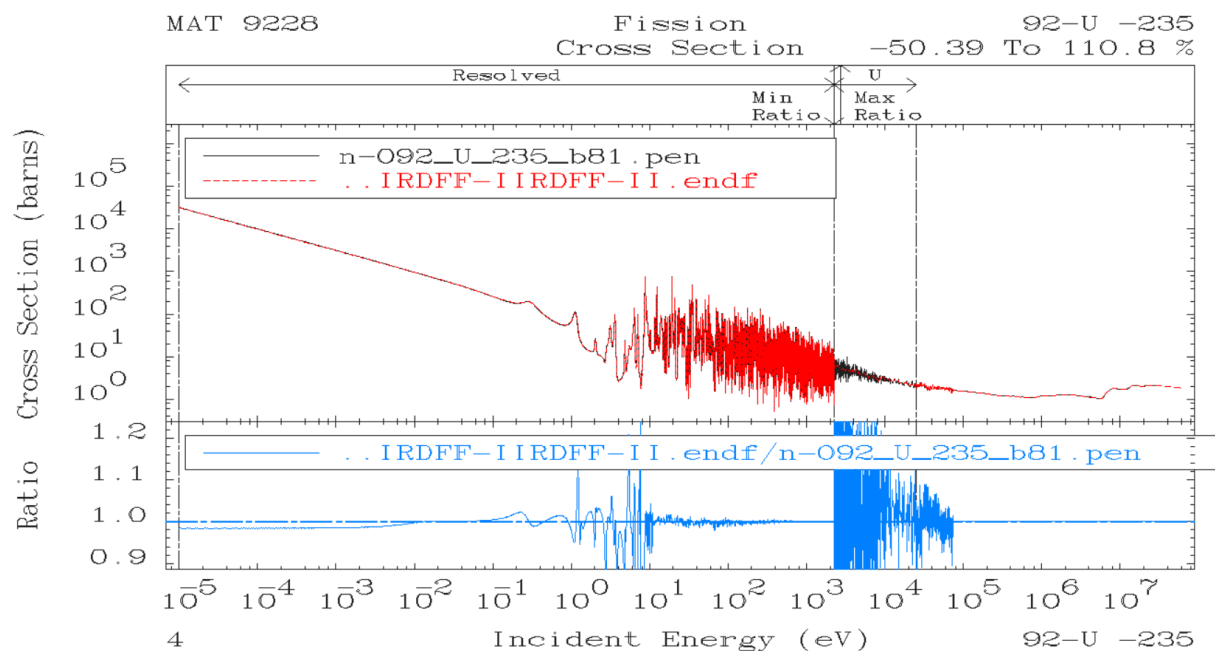


Implementation

None.

U-235

The ENDF/B-VIII.1b1 evaluation contains fission and capture cross sections MT 18 that can be compared to IRDFF-II. **The cross sections in ENDF/B-VIII.1b1 represent a new evaluation, hence no changes to the evaluation are proposed.**

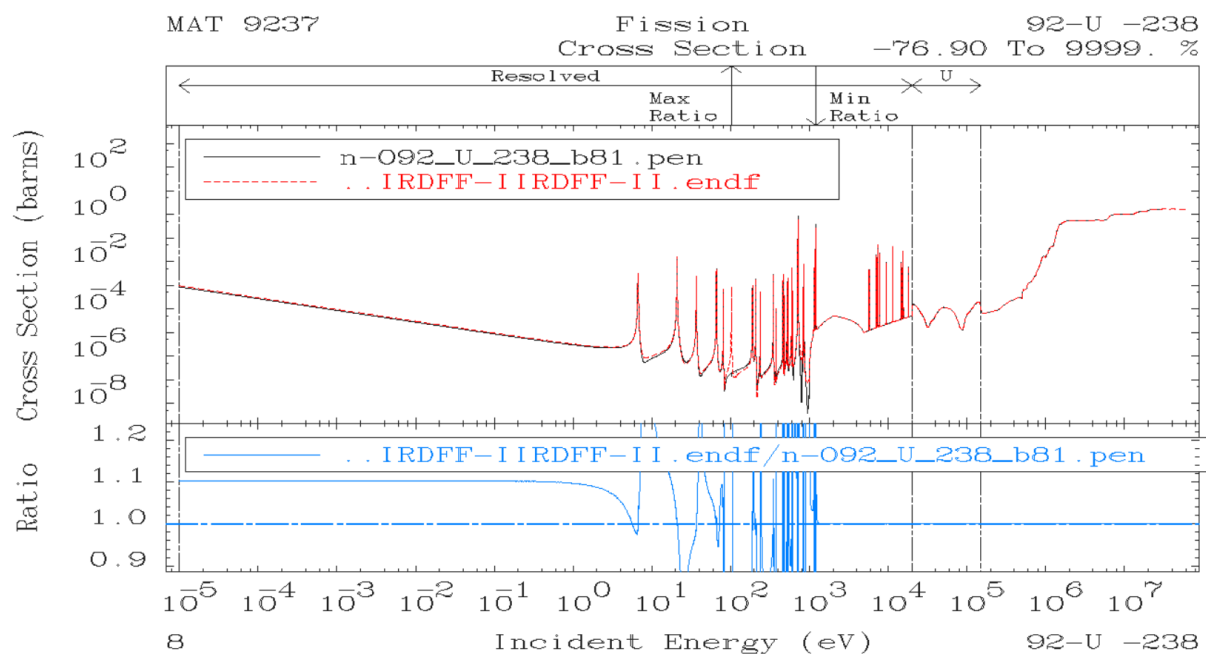
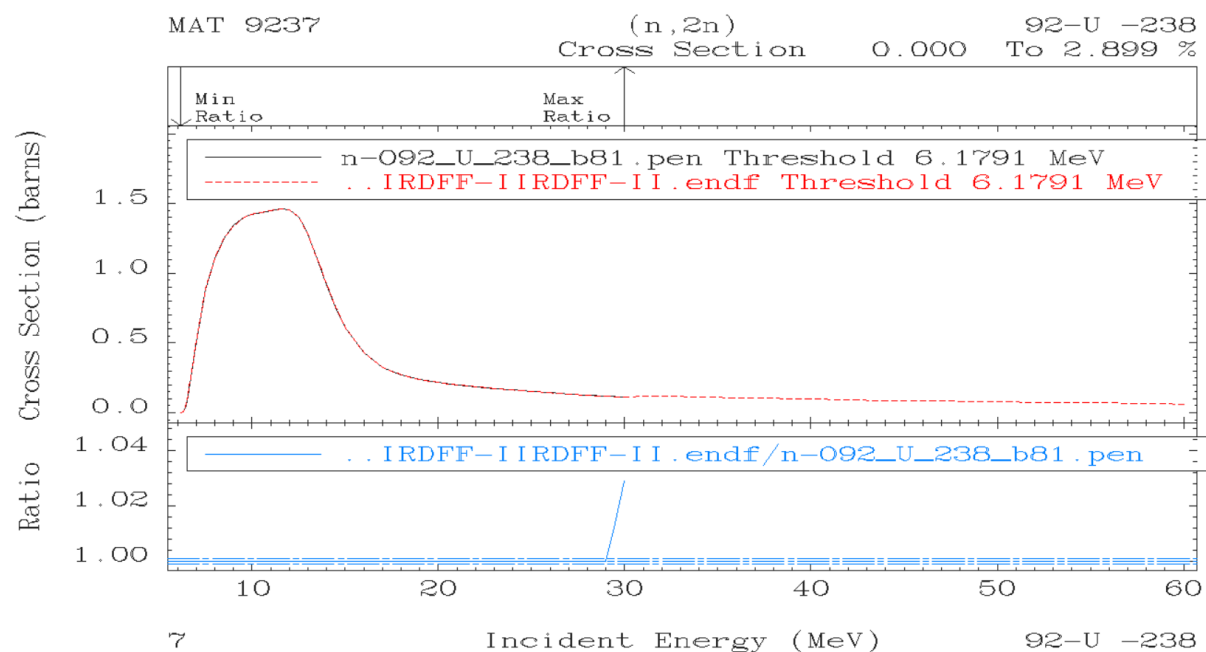


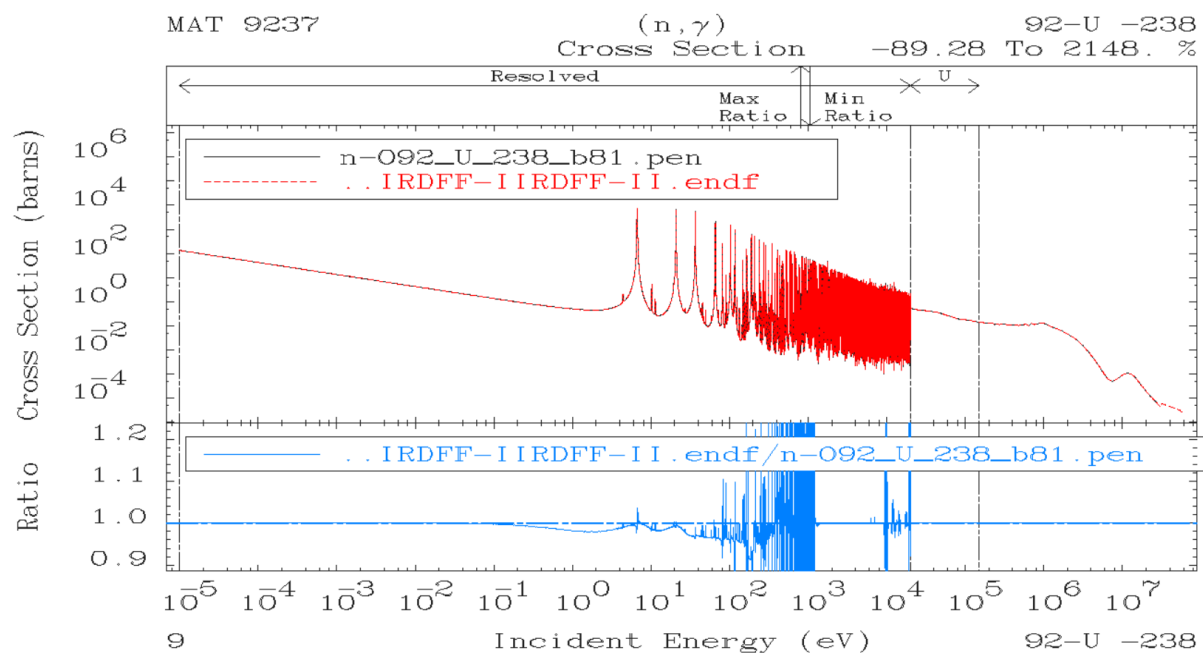
Implementation

None.

U-238

The ENDF/B-VIII.1b1 evaluation contains two-neutron emission, fission and capture cross sections MT 16, 18, 102 that can be compared to IRDFF-II. The cross sections in the two libraries for MT 16 are the same but MT 18 and MT 102 are different. **The ENDF/B-VIII.1b1 evaluation is newer, so no change to the ENDF/B-VIII.1b1 evaluation is proposed.**





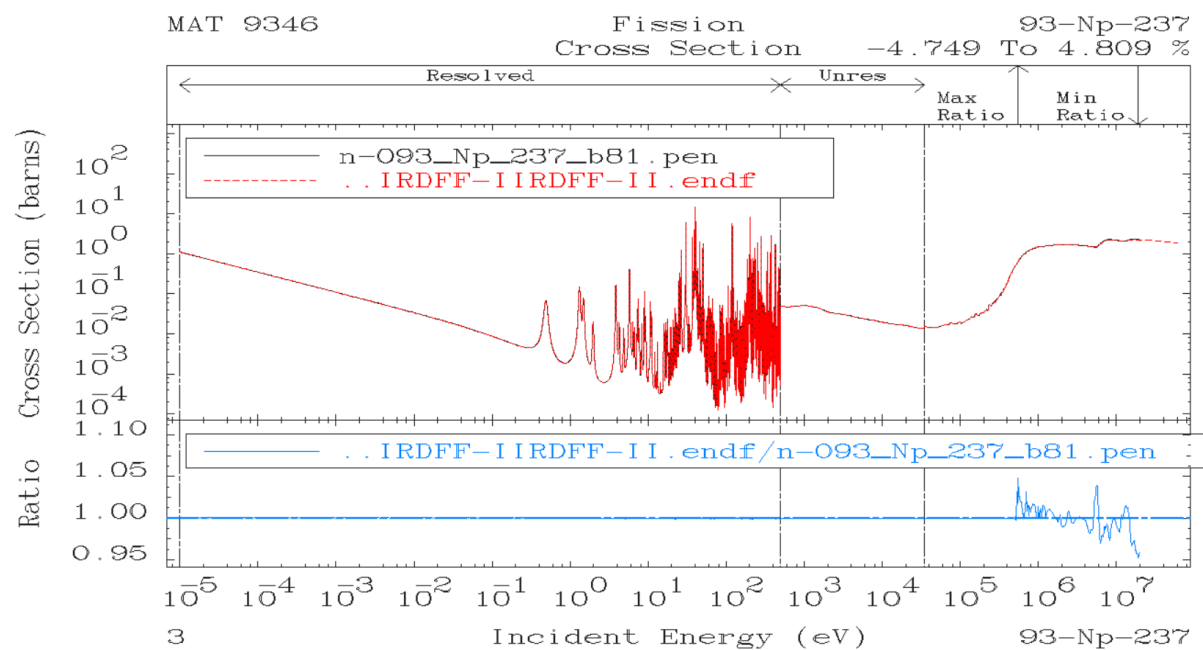
Implementation

None.

Np-237

The ENDF/B-VIII.1b1 evaluation contains fission cross sections MT 18 that can be compared to IRDFF-II.

No change to the ENDF/B-VIII.1b1 evaluation is proposed before a more detailed investigation is made.

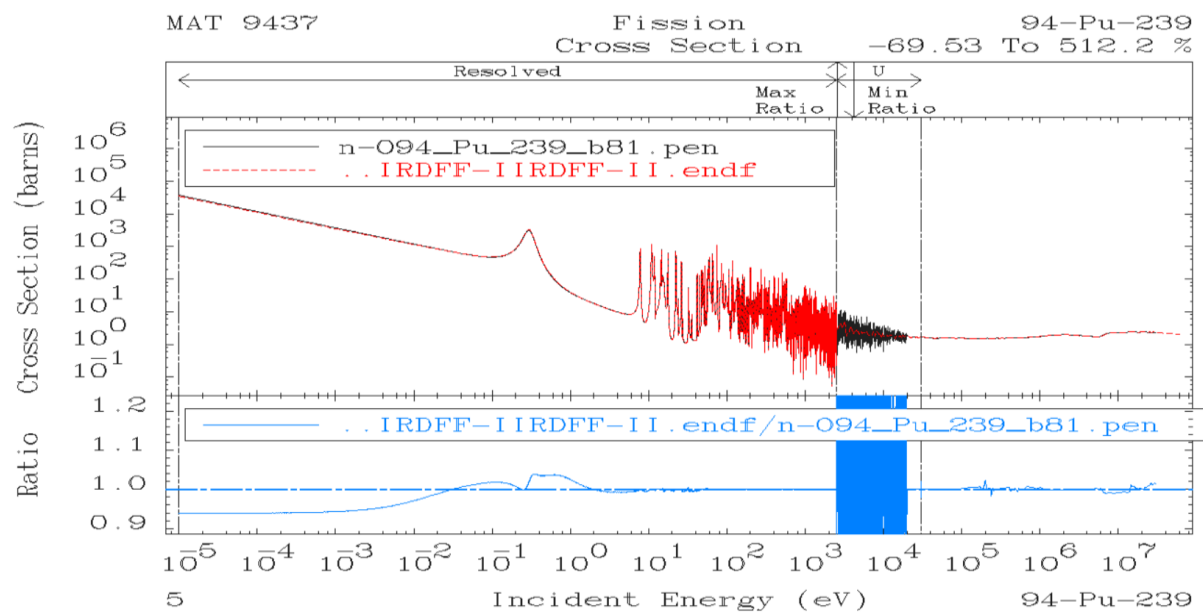


Implementation

None.

Pu-239

The ENDF/B-VIII.1b1 evaluation contains fission cross sections MT 18 that can be compared to IRDFF-II. **The ENDF/B-VIII.1b1 evaluation is newer, so no change to the evaluation is proposed.**

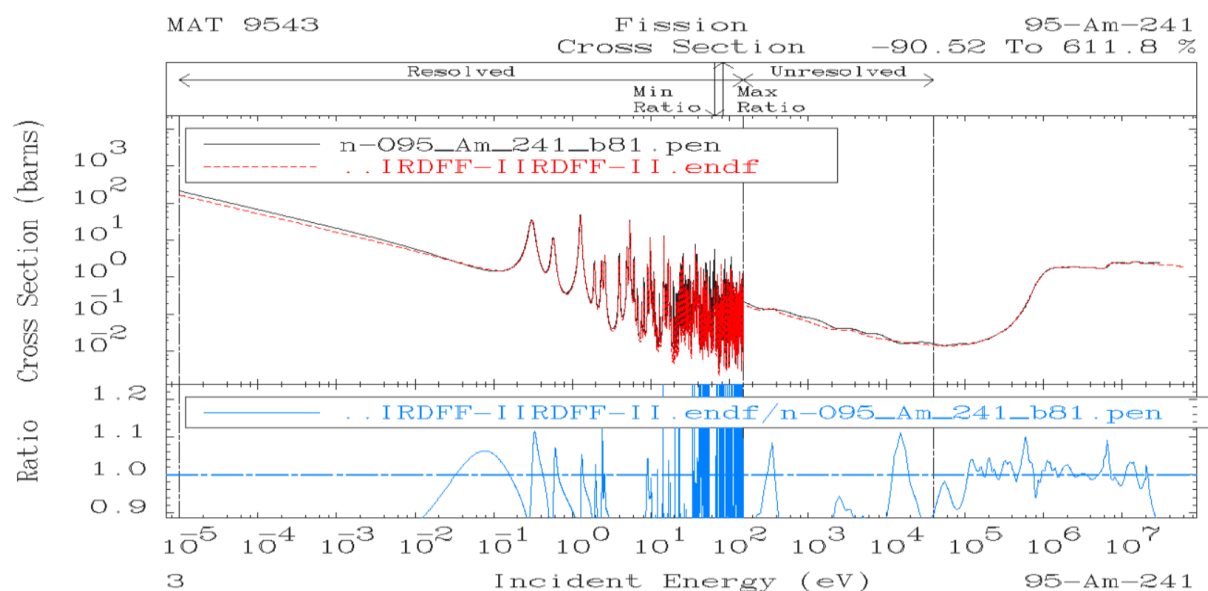


Implementation

None.

Am-241

The ENDF/B-VIII.1b1 evaluation contains fission cross sections MT 18 that can be compared to IRDFF-II. **The ENDF/B-VIII.1b1 evaluation is newer, so no change to the evaluation is proposed.**



Implementation

None.

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>
