The International Evaluation of the Neutron Cross Section Standards

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STANDARDS TO BE EVALUATED

Reaction	Energy Range
H(n,n)	1 keV to 200 MeV
^{3}He(n,p)	thermal to 50 keV
^{6}Li(n,t)	thermal to 1 MeV
^{10}B(n,α)	thermal to 1 MeV
^{10}B(n,$\alpha_1\gamma$)	thermal to 1 MeV
^{197}Au(n,γ)	thermal, 0.2 to 2.5 MeV
^{235}U(n,f)	thermal, 0.15 to 200 MeV
^{238}U(n,f)	2 to 200 MeV *

The International Neutron Cross Section Standards Evaluation

- WPEC and CSEWG
  - Encourage /motivate new measurements where necessary.
  - Investigate experimental work to get better information on corrections and uncertainties.
  - Mainly interested in the final product, the standards evaluation.
- IAEA Coordinated Research Project.
  - Refines/improves the evaluation process.
  - Seeks to improve the understanding of the uncertainties.
  - The focus is on the evaluation process.

IAEA CRP
on
Improvement of the Standard Cross Sections for Light Elements

Objectives

• Improve the methods for determining the covariance matrix for R-matrix fits**.** Upgrade computer codes using this methodology.

• Study the reasons for uncertainty reduction in R-matrix fits.

• Evaluate cross sections and covariance matrices for neutron induced standard reactions for the light elements, H(n,n), ^{3}He(n,p), ^{6}Li(n,t), ^{10}B(n,α) and ^{10}B(n,$\alpha_1\gamma$).

• Establish the method and computer codes for combining the light element with the heavy element evaluations.

•Perform the combining procedure to obtain the standards evaluations.

CRP Activities

- Improvements to the experimental data in the standards database
  - In addition to the data sets introduced after the ENDF/B-VI evaluation and before the formation of the CRP, more than 30 data sets have been added to the standards database.

- R-matrix evaluations
  - Evaluations are underway or completed for the H(n,n), ^{3}He(n,p), ^{6}Li(n,t),
  - ^{10}B(n,$\alpha_1\gamma$), and ^{10}B(n,α) cross sections by Hale and/or Chen.

- Microscopic calculations leading to independent determinations of R-matrix poles for light elements are nearing final stages.
  - Refined Resonating Group Model used for ^{3}He(n,p).
  - Effective NN potentials used for 6Li(n,t).

- Generalized least squares evaluations for the ^{6}Li(n,t), ^{10}B(n,α), ^{10}B(n,$\alpha_1\gamma$), Au(n,γ), ^{235}U(n,f), and ^{238}U(n,f) standard cross sections.
  - GMA Coding improvement by Pronyaev.
  - GMA calculations using 415 sets of data.

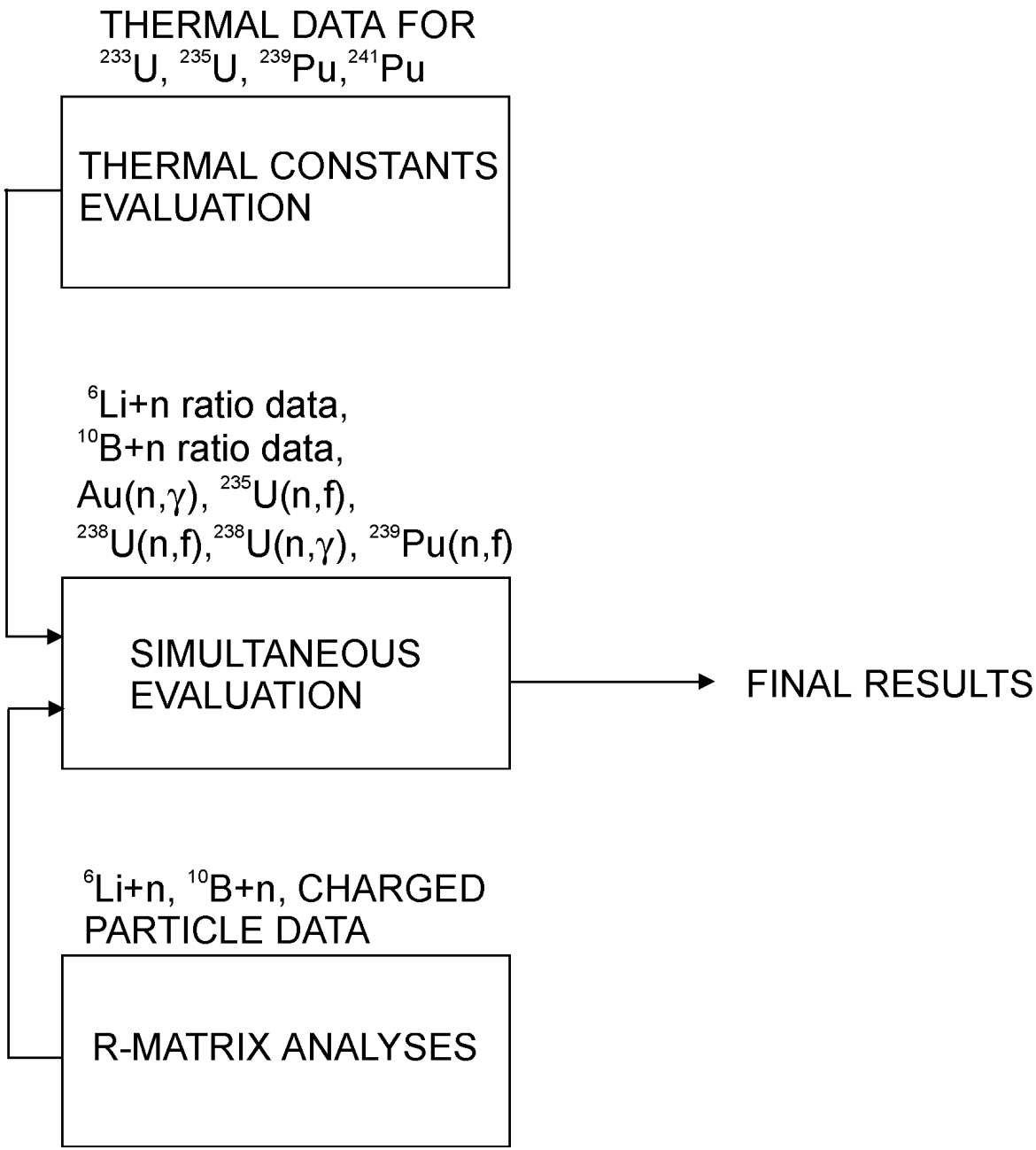
CRP Activities (cont.)

- Comparisons of R-matrix and model independent least squares codes for values of the cross sections and covariances produced.
  - Using a database of $^{6}Li(n,t)$ data sets.
    - Model independent codes GMA, GLUCS & SOK agree.
    - With R-matrix codes, differences are observed near the 250 keV resonance, for relativistic vs non-calculations.
    - R-matrix codes give smaller variances than model independent codes.
    - Some comparisons of R-matrix and model independent codes have been done.
    - Further work focused on R-matrix code comparisons is underway using very basic input that is suitable for the R-matrix and model independent codes that are used in the intercomparisons.

CRP Activites (cont.)

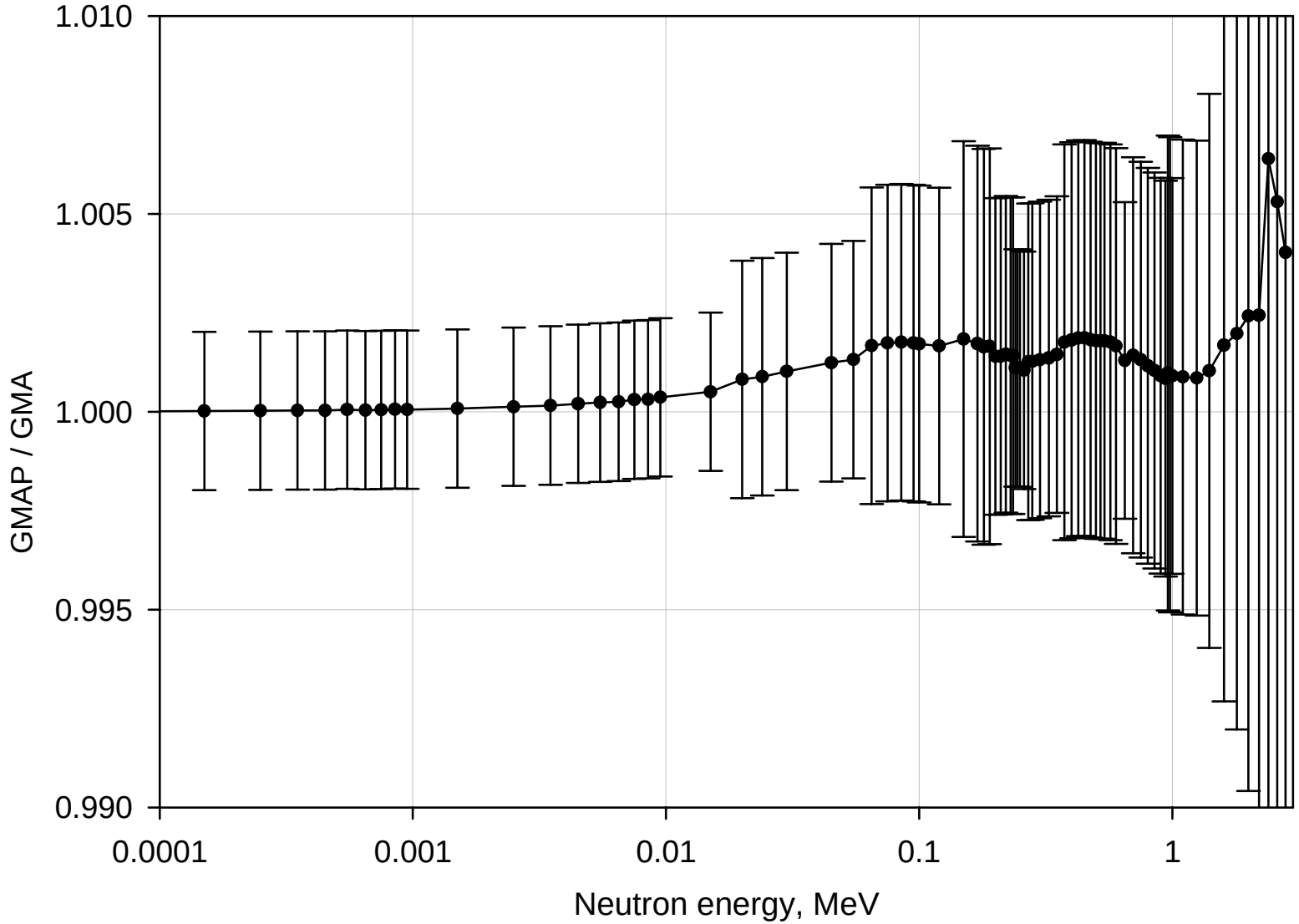
- Combining of R-matrix and generalized least squares evaluations.
  - R-matrix results obtained for the ^{6}Li(n,t), ^{10}B(n,α) and ^{10}B(n,α$_1$γ), cross sections have been used as input to the GMA program to perform a combining of R-matrix and generalized least squares outputs. The R-matrix input was cross section, uncertainty and the correlation matrix.
  - The combination procedure requires that independent databases be used for the R-matrix and GMA codes.
  - Ratio measurements are used in the GMA code.
  - All ^{6}Li+n and ^{10}B+n data not in the form of ratios to standards are used in the R-matrix analyses.

NEW STANDARDS EVALUATION PROCEDURE

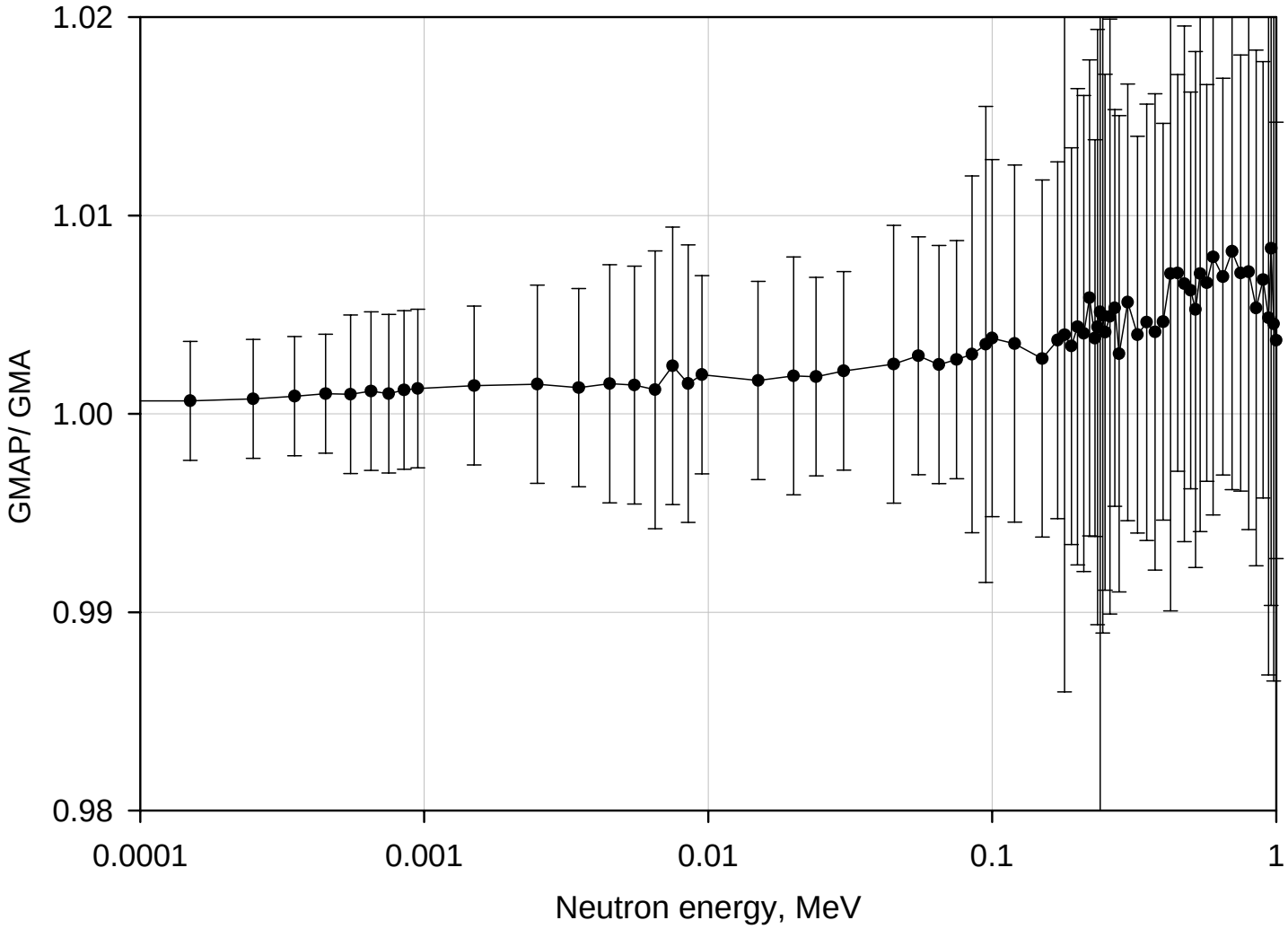


CRP Activities (cont.)

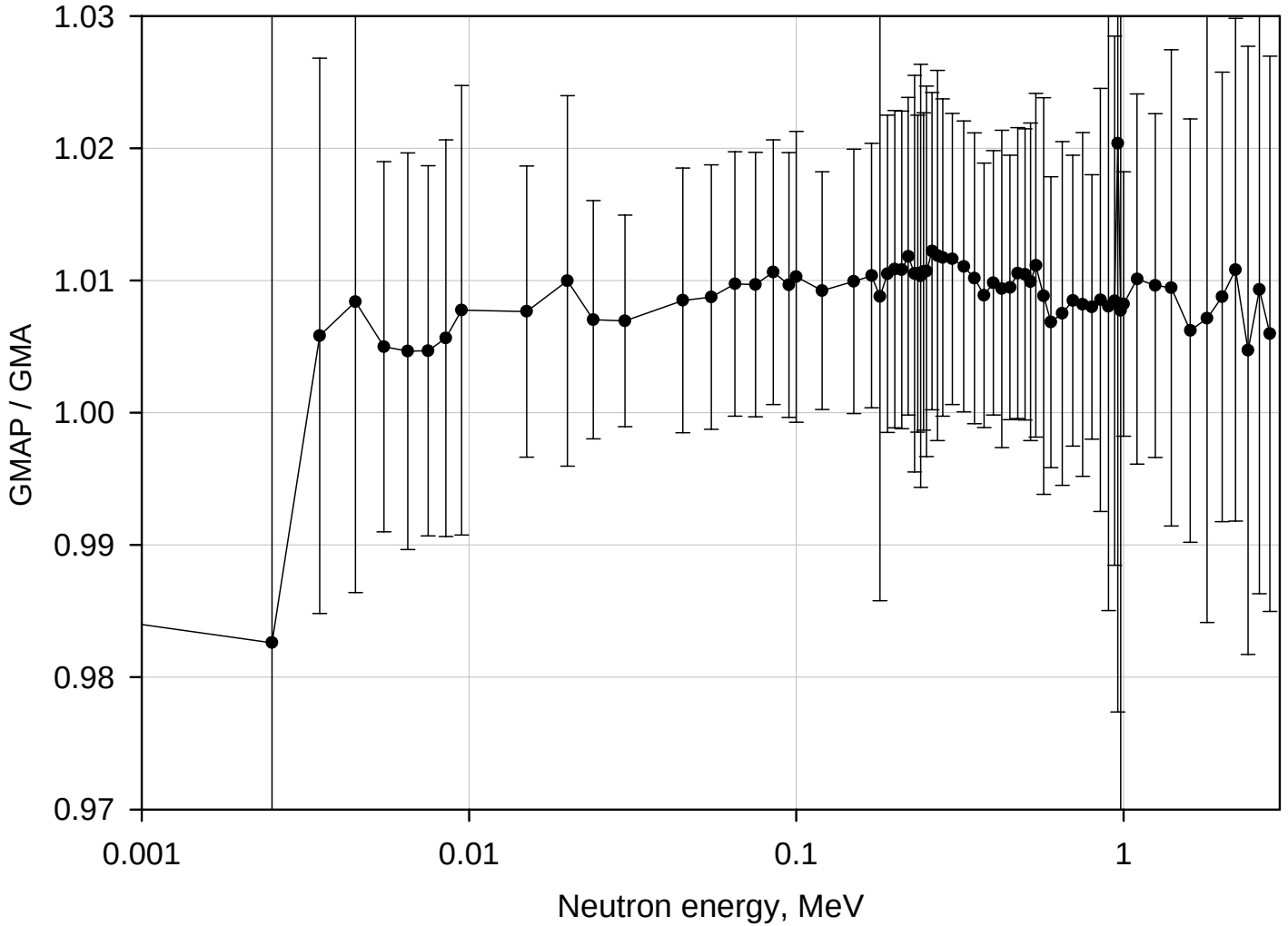
- Studies of the effect of Peelle's Pertinent Puzzle (PPP) and its effect on the standards evaluation.
  - •Results commonly from use of correlated discrepant data.
  - •Noticed early in the activities of the CRP.
  - •Seen in model independent LS analyses.
  - •Maybe not present in EDA R-matrix work.
    - •Only normalization and relative uncertainty used.
  - •Seen to some degree in RAC R-matrix work.
    - •Normalization, relative and medium energy range correlations are used.
  - •Seen in PADE2 (analytical expansion) fits to some degree.
  - • Chiba-Smith (used in GMAP)and logarithmic transformation (used in SOK) were tested and found to give similar results for reducing PPP.



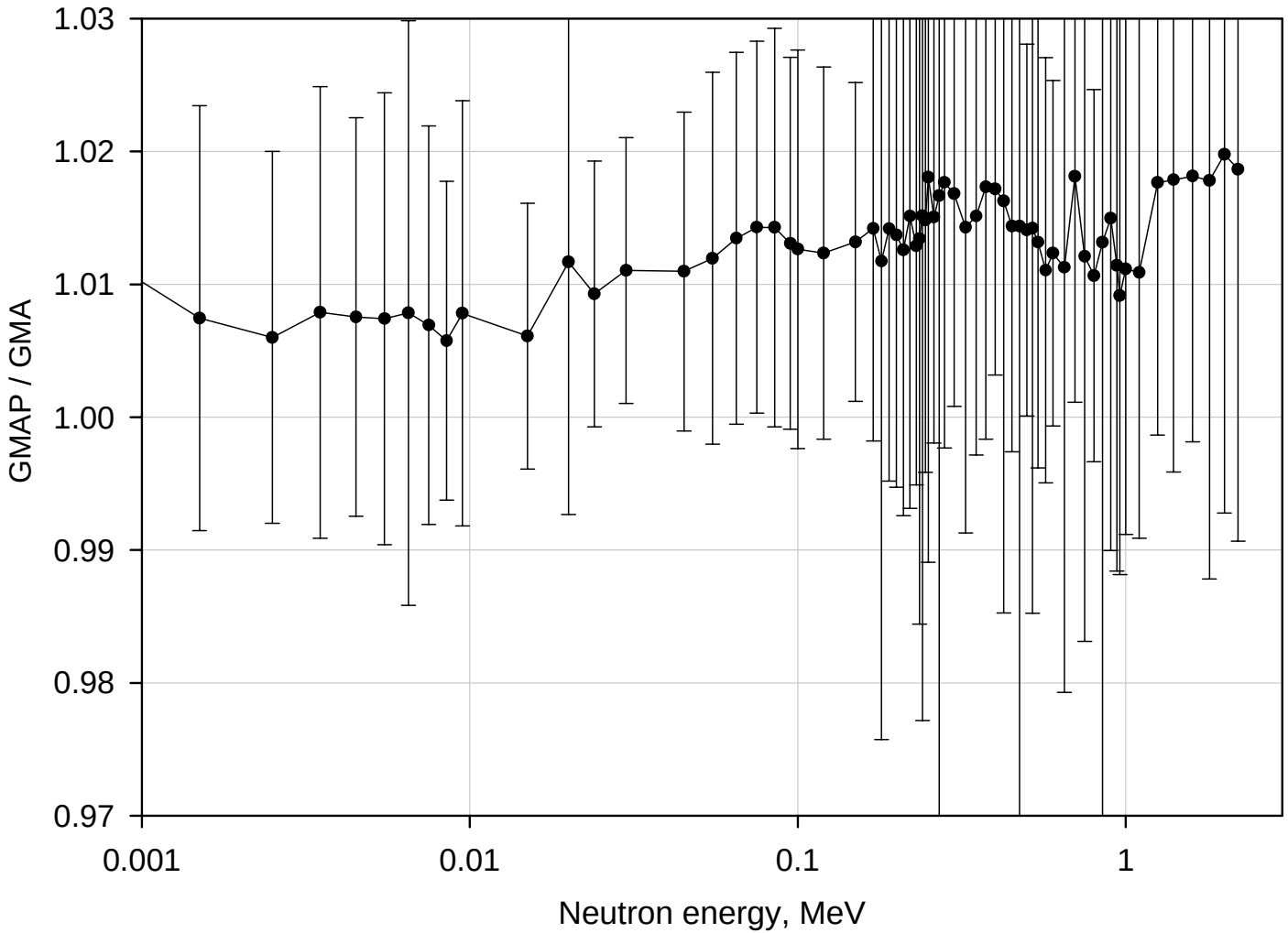
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for the ^{6}Li(n,t) reaction. Note MERC was used so these are lower limits to PPP effect.



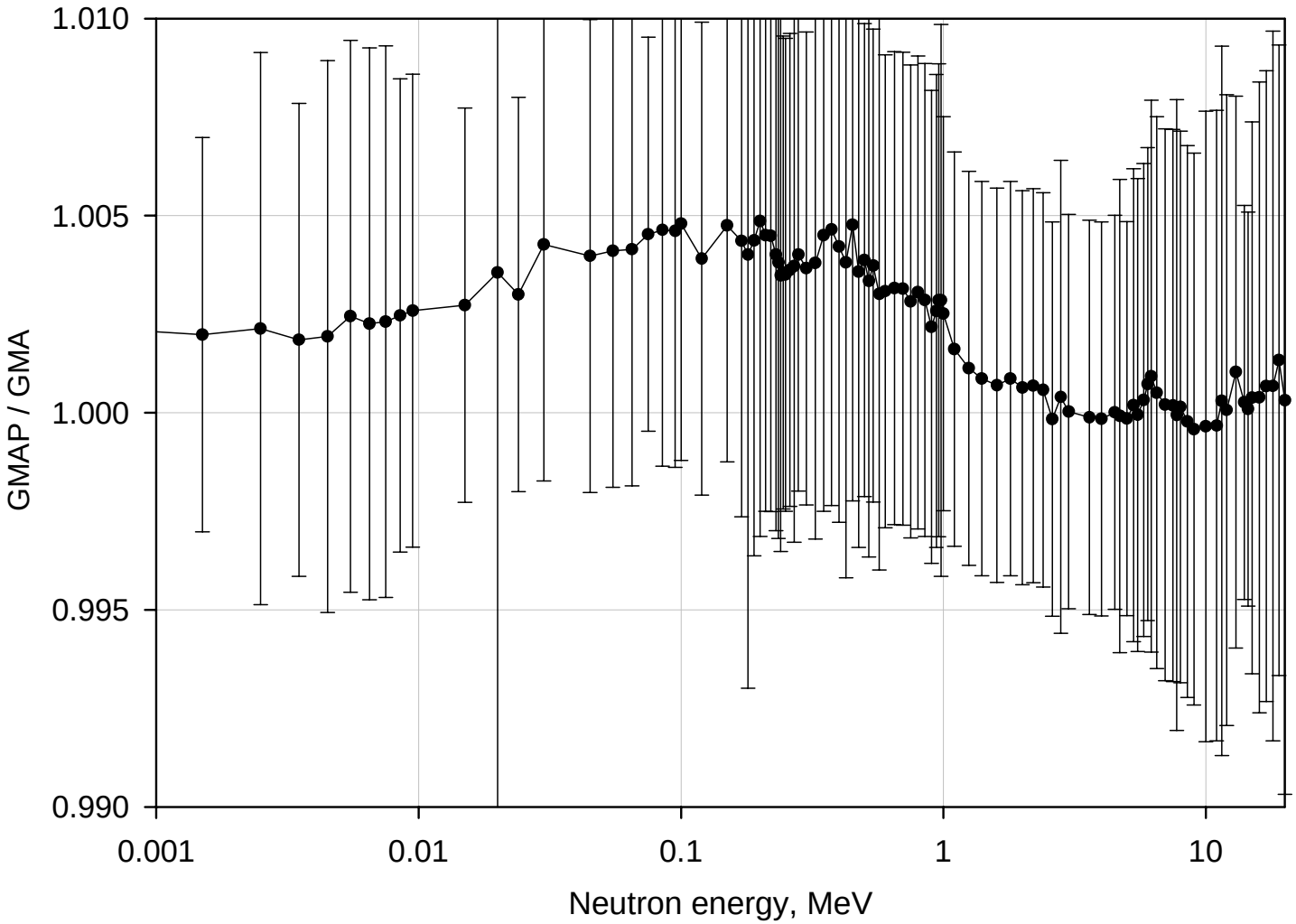
Ratio of GMAP fit using the Chiba-Smith option to exclude PPP to the standard GMA fit for the ^{10}B(n,a1) reaction. Note MERC was used so these are lower bounds to the PPP effect.



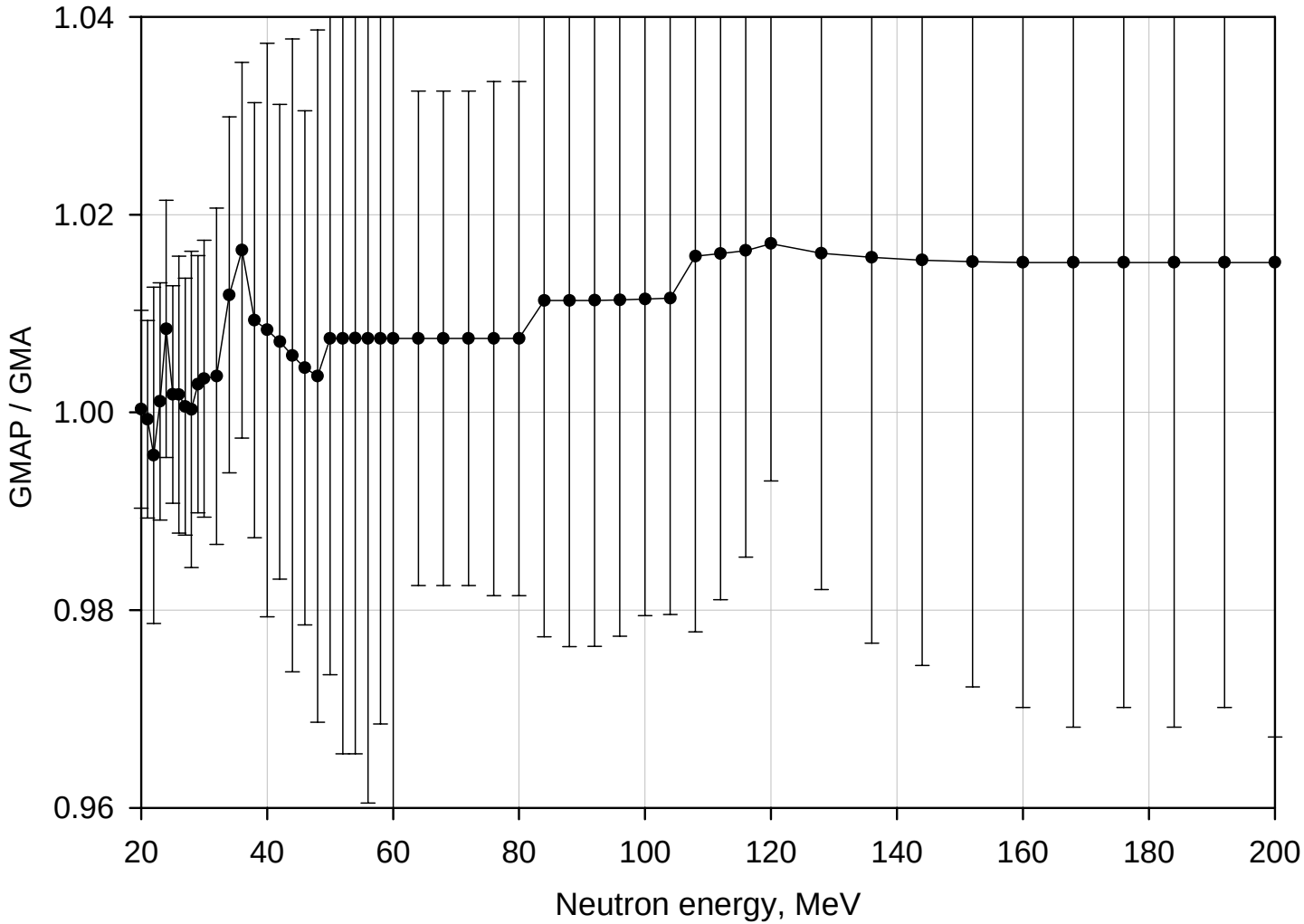
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for ^{197}Au(n,γ) reaction. Note MERC was used so these are lower limits to the PPP effect.



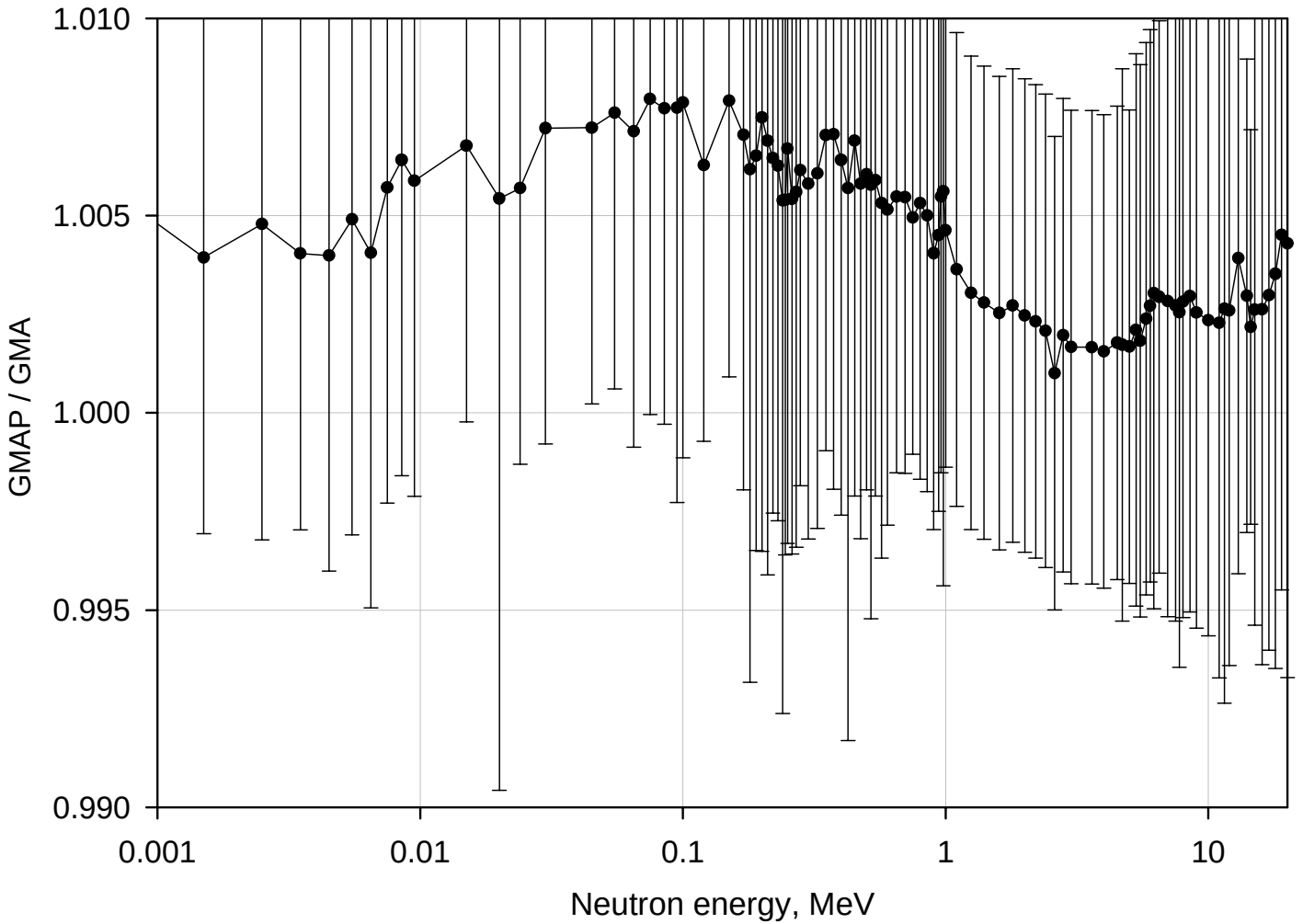
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for ^{238}U(n,γ). Note MERC was used so these are lower limits to the PPP effect.



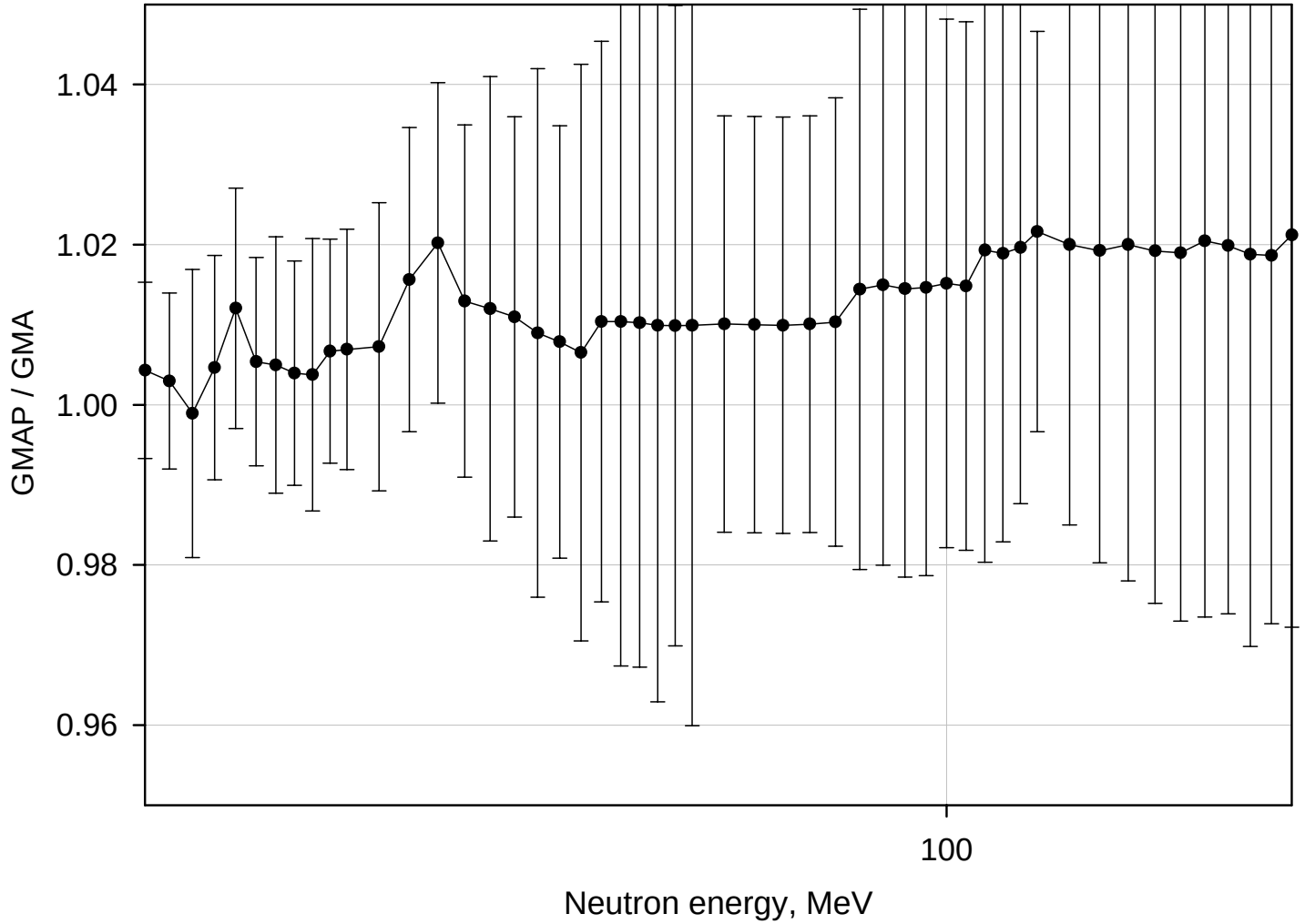
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for the ^{235}U(n,f) reaction. Note MERC was used so these are lower limits to the PPP effect.



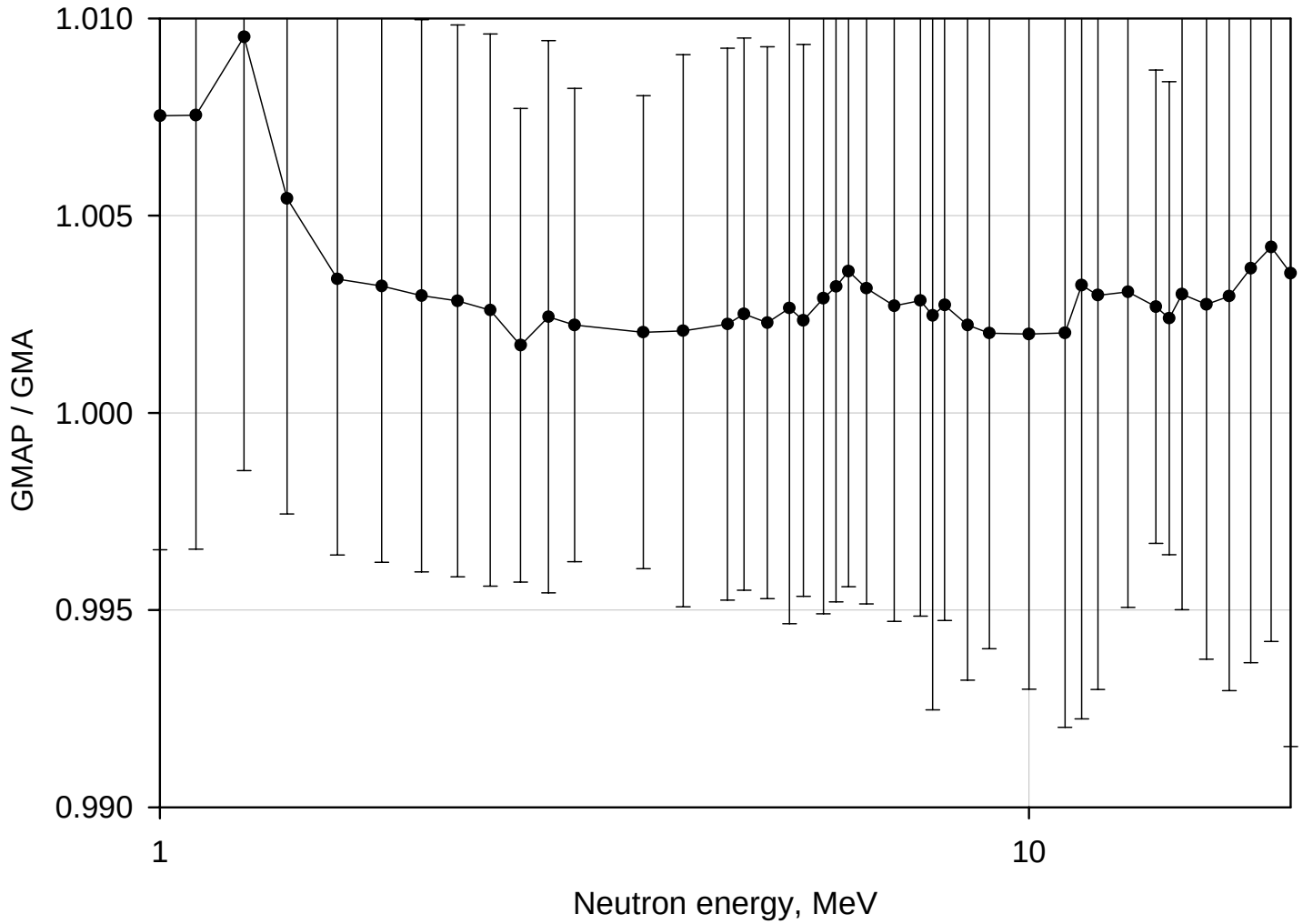
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for the ^{235}U(n,f) reaction. Note MERC was used so these are lower limits to the PPP effect.



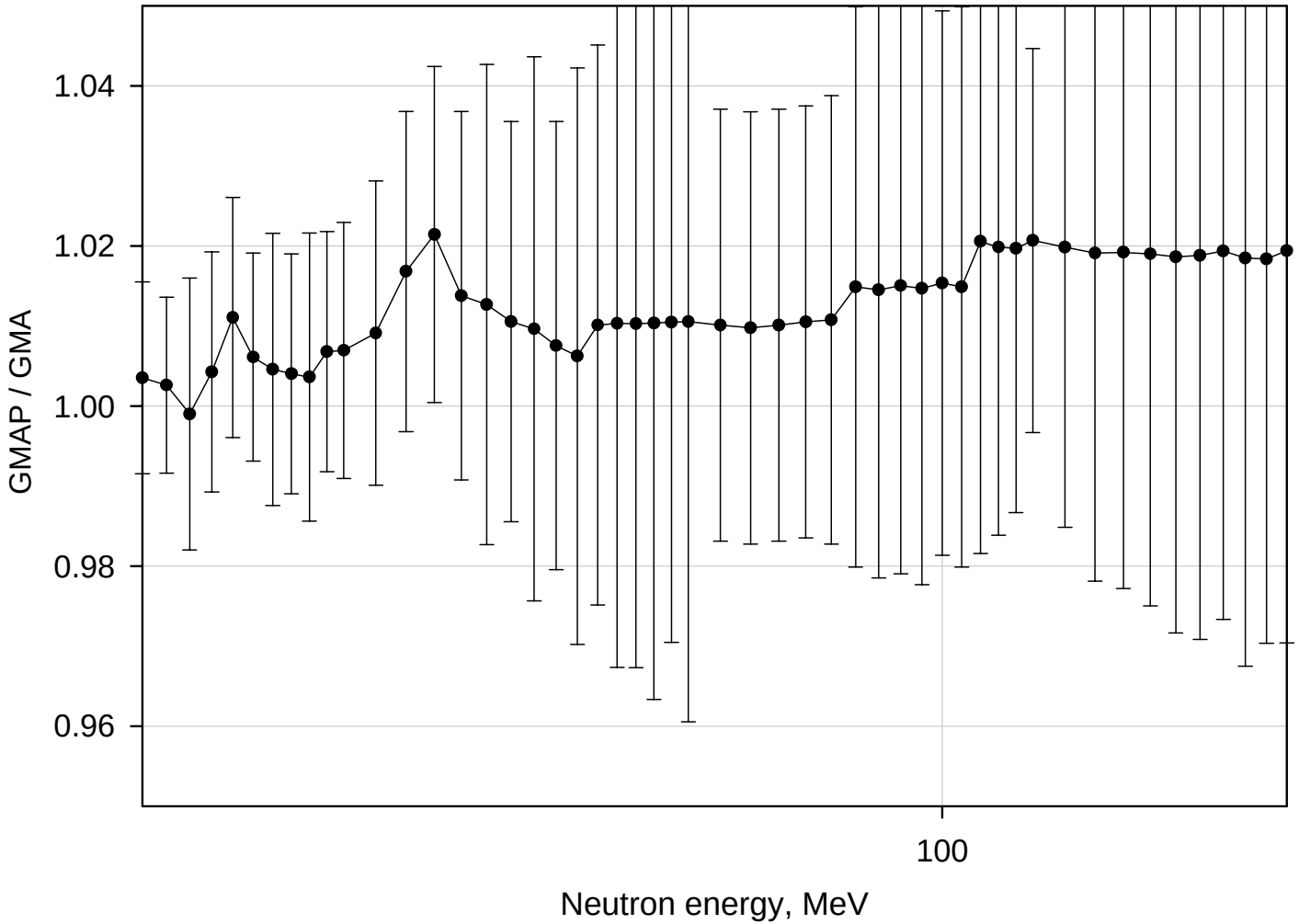
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for the ^{239}Pu(n,f) reaction. Note MERC was used so these are lower limits to the PPP effect.



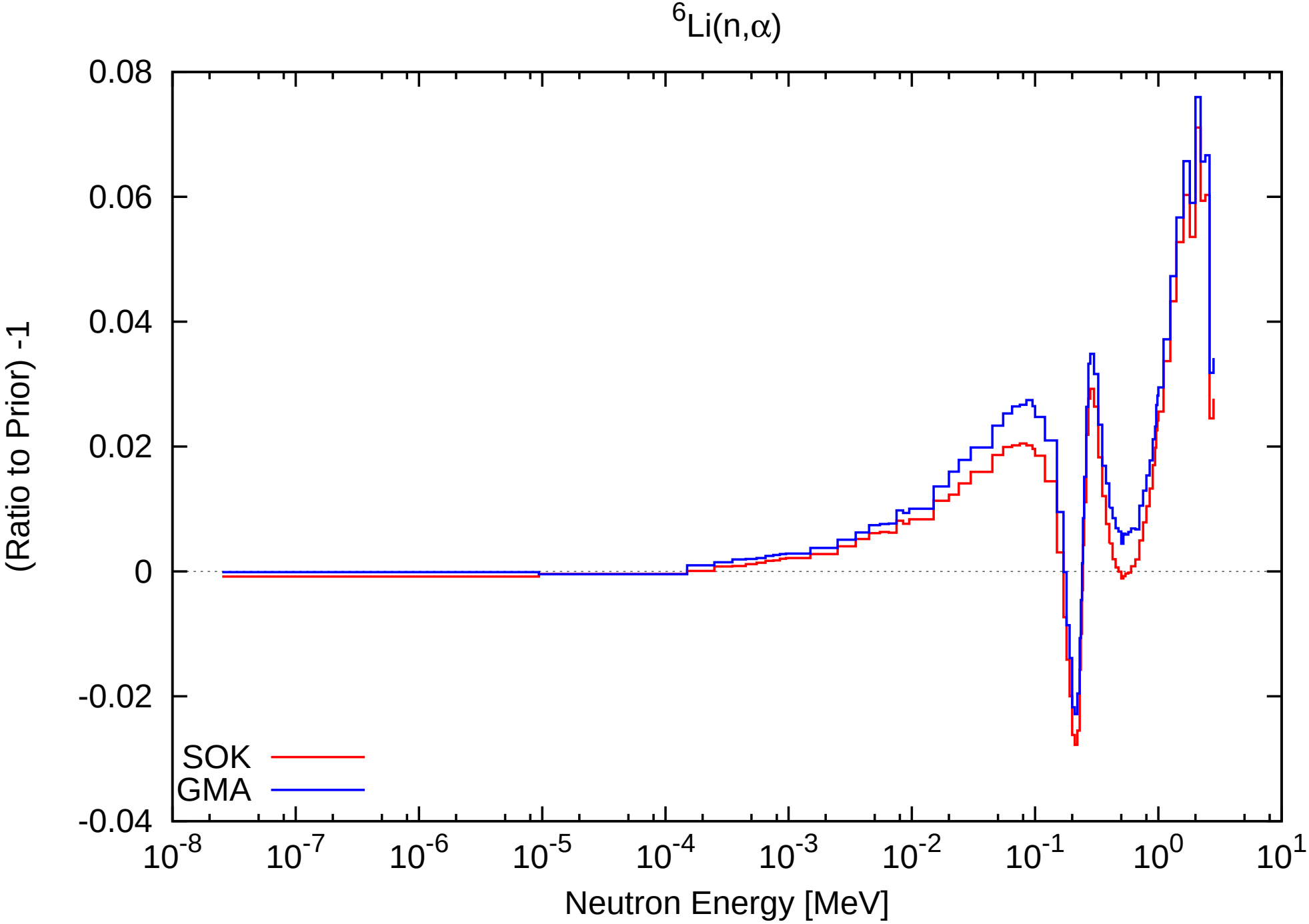
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for the ^{239}Pu(n,f) reaction. Note MERC was used so these are lower limits to the PPP effect.

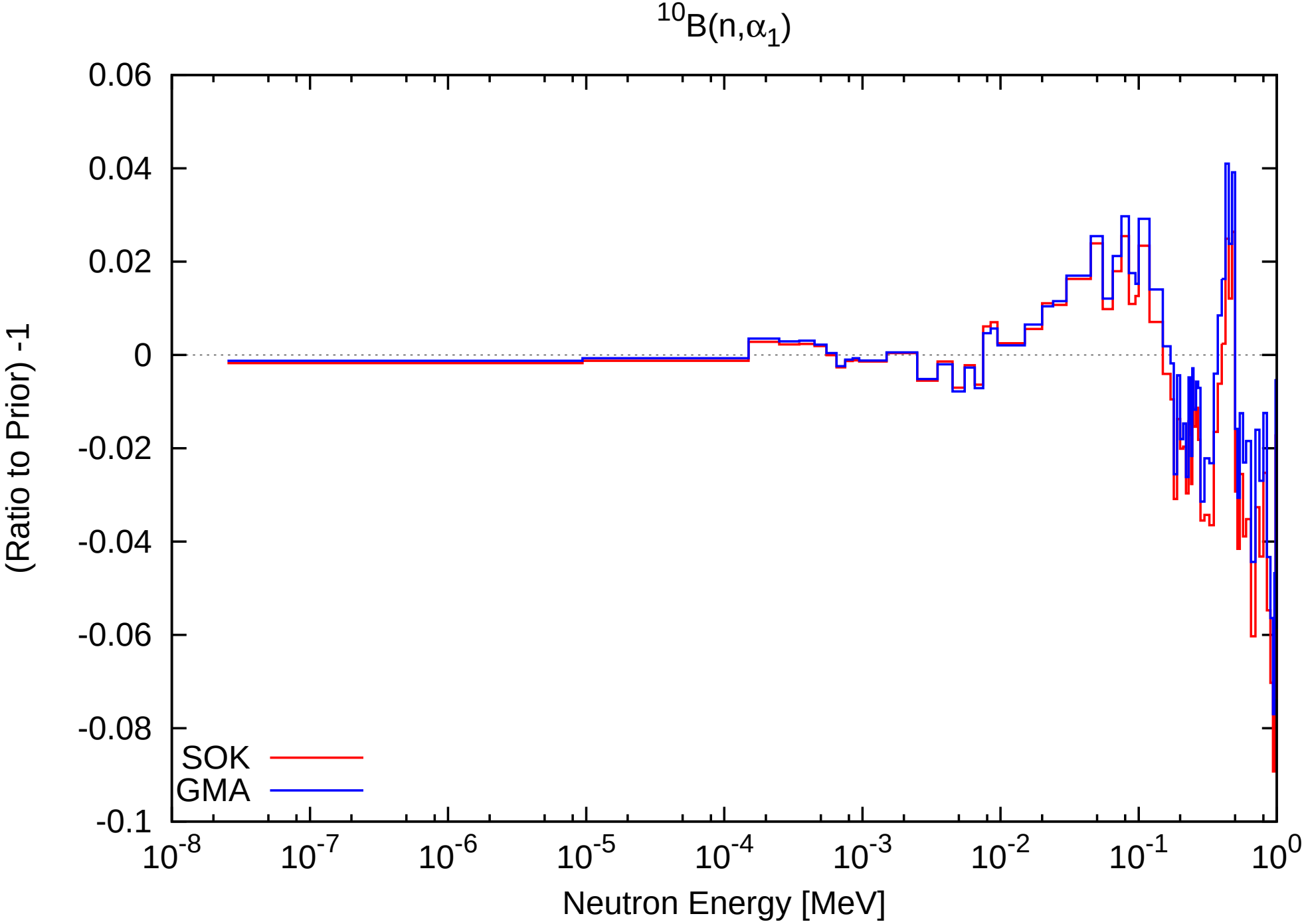


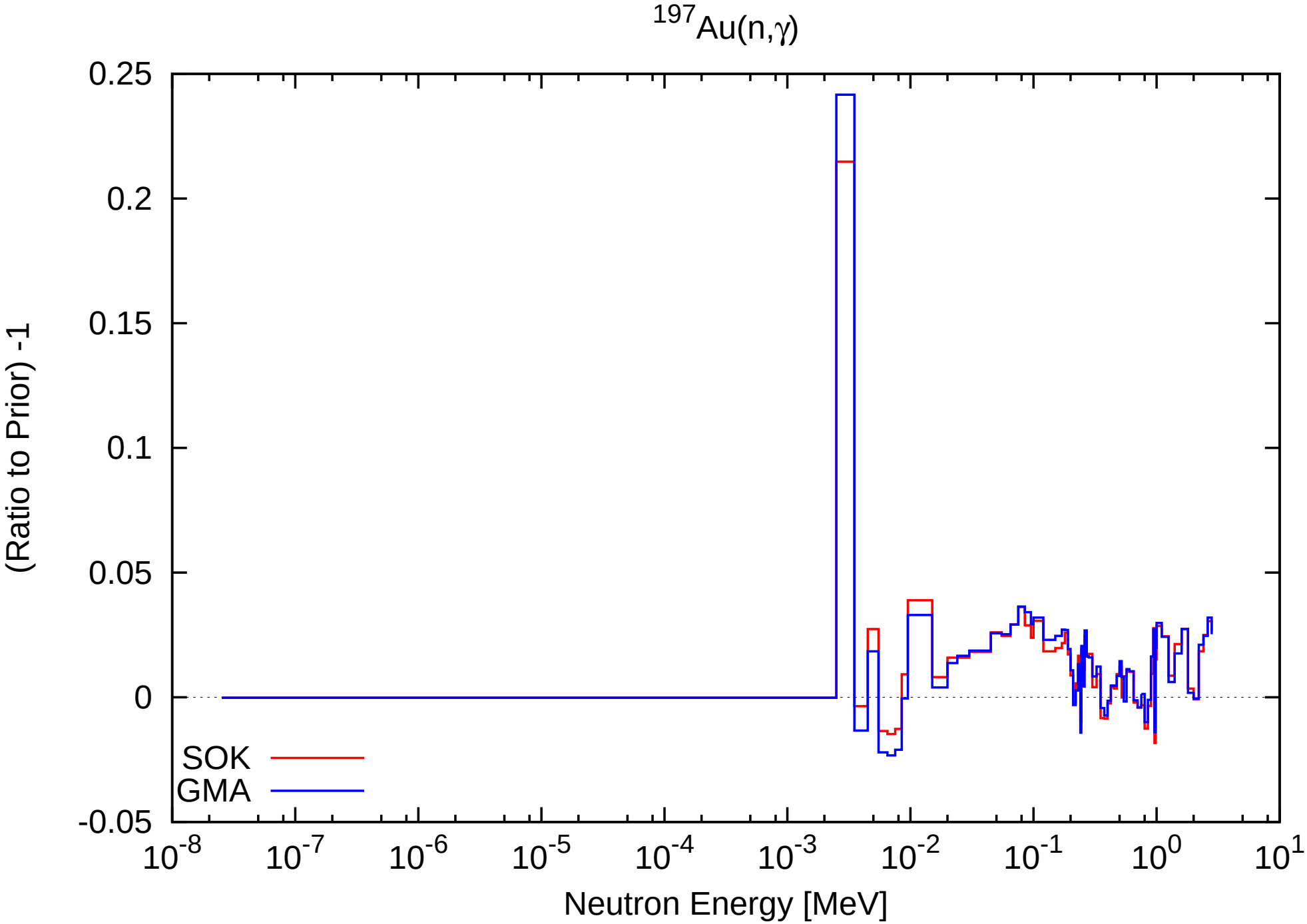
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for the ^{238}U(n,f) reaction. Note MERC was used so these are lower limits to the PPP effect.

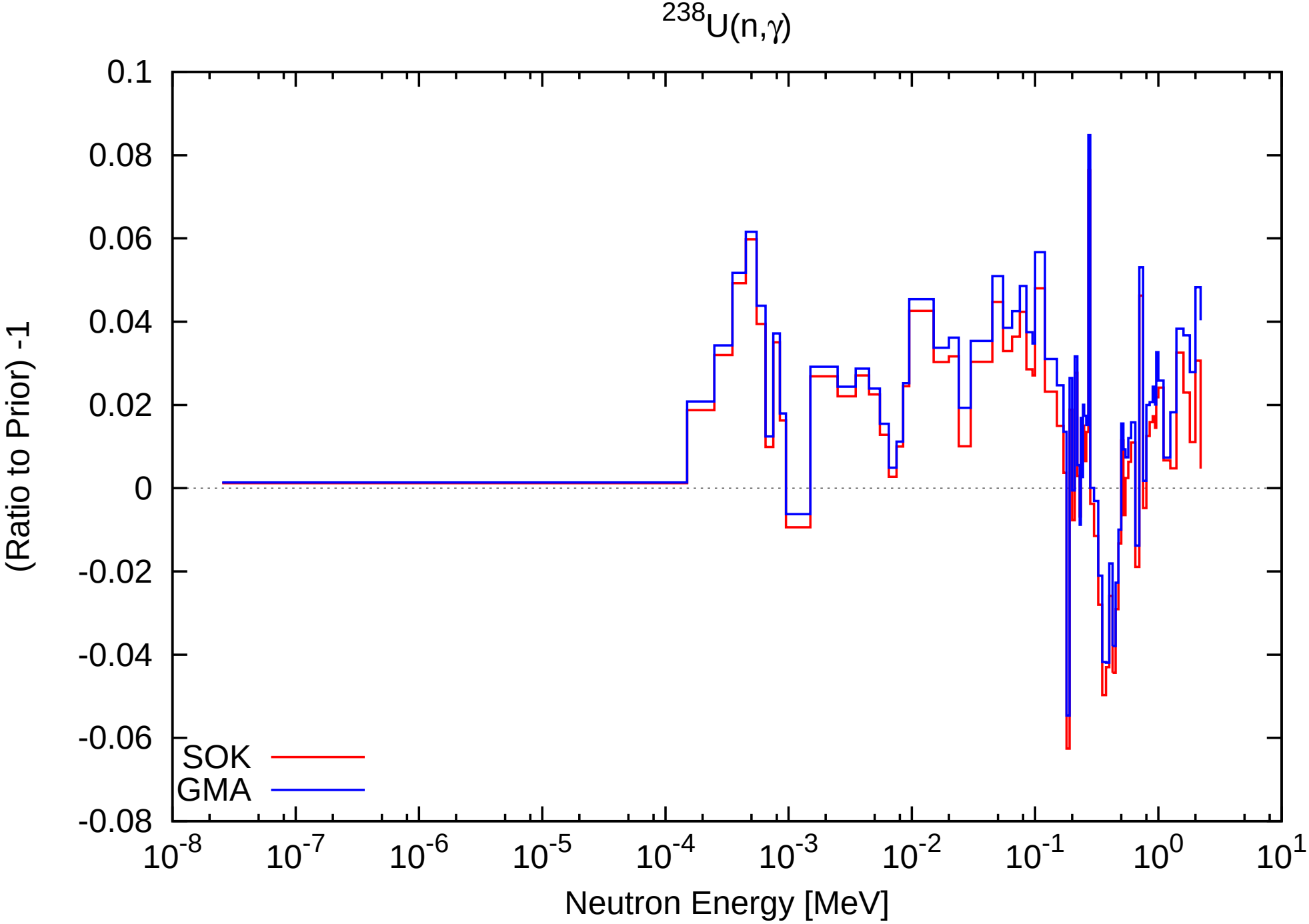


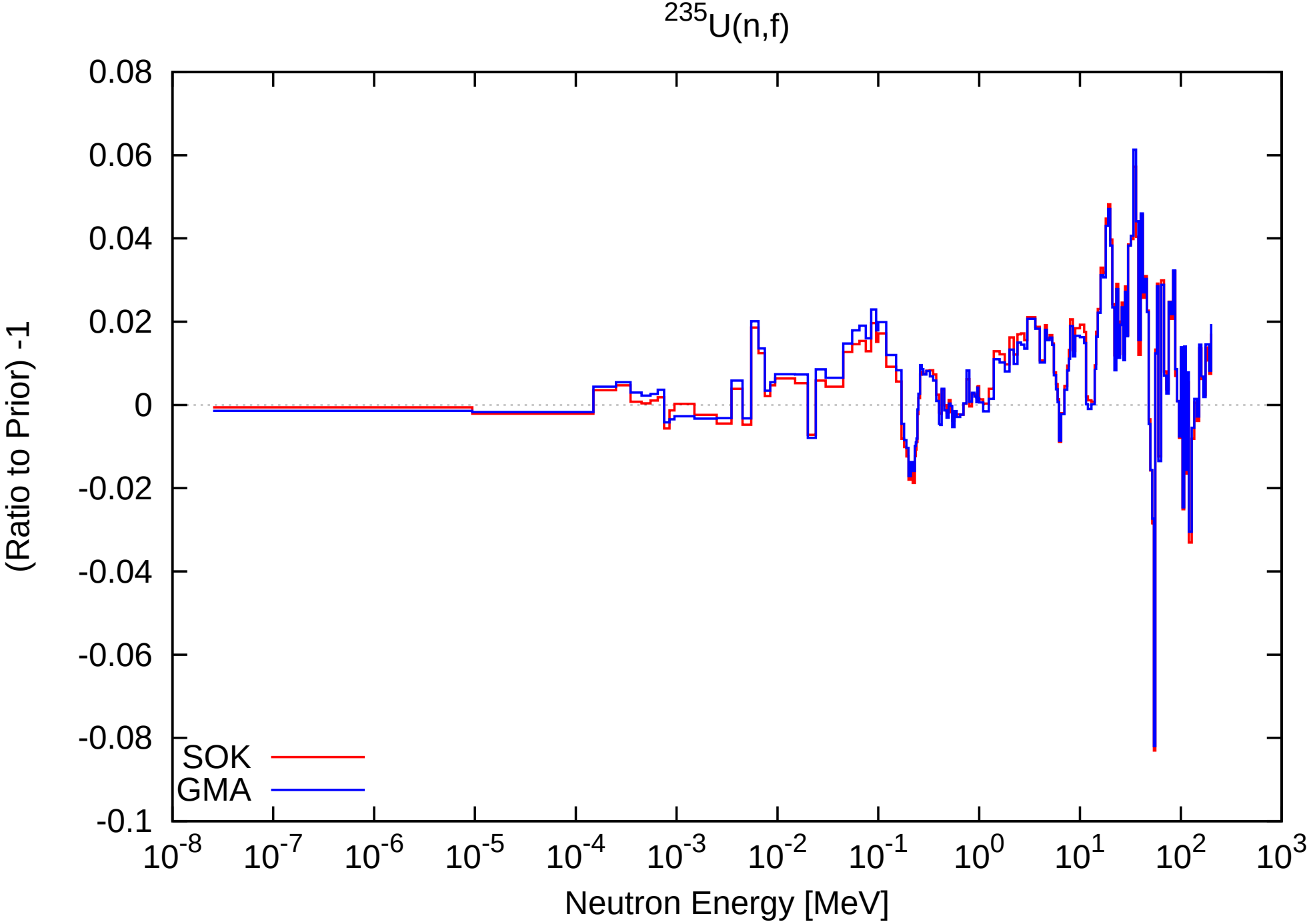
Ratio of GMAP fit using Chiba-Smith option to exclude PPP to the standard GMA fit for the ^{238}U(n,f) reaction. Note MERC was used so these are lower limits to the PPP effect.

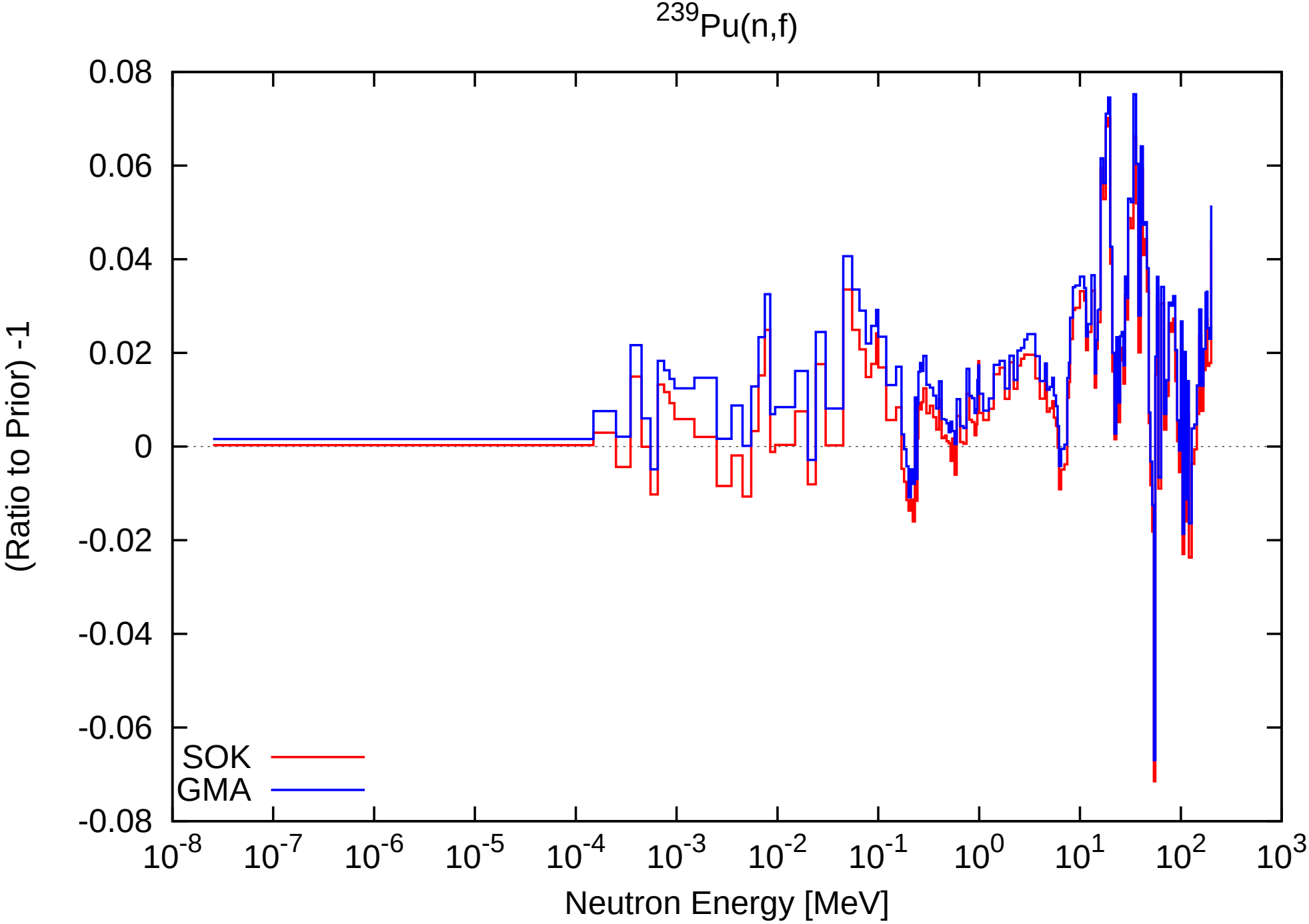

^{6}Li(n,α)
0.08
0.06
0.04
0.02
0
-0.02
-0.04
(Ratio to Prior) -1
SOK
GMA
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
Neutron Energy [MeV]

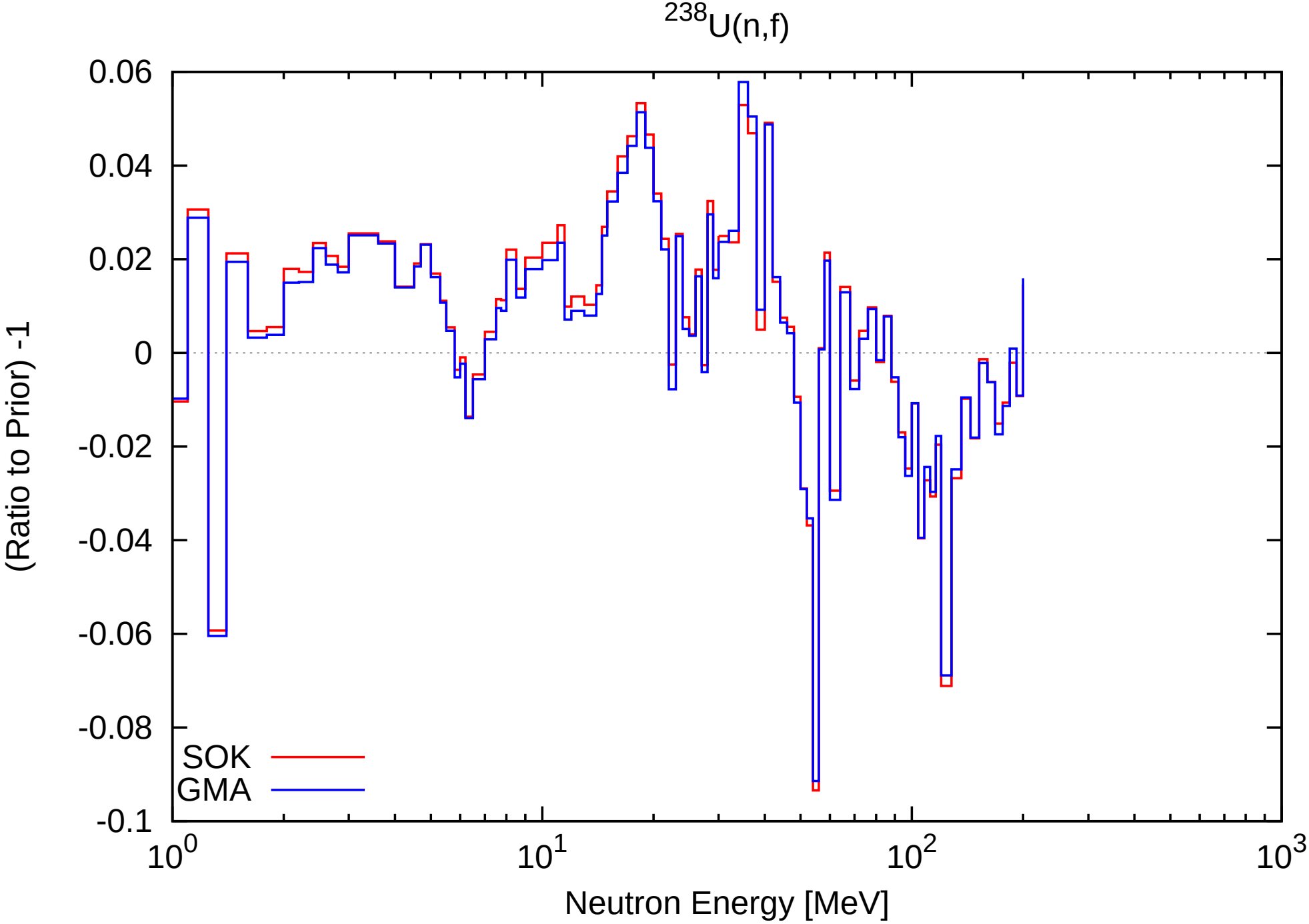

^{10}B(n,α_1)
(Ratio to Prior) -1
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
SOK
GMA
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Neutron Energy [MeV]

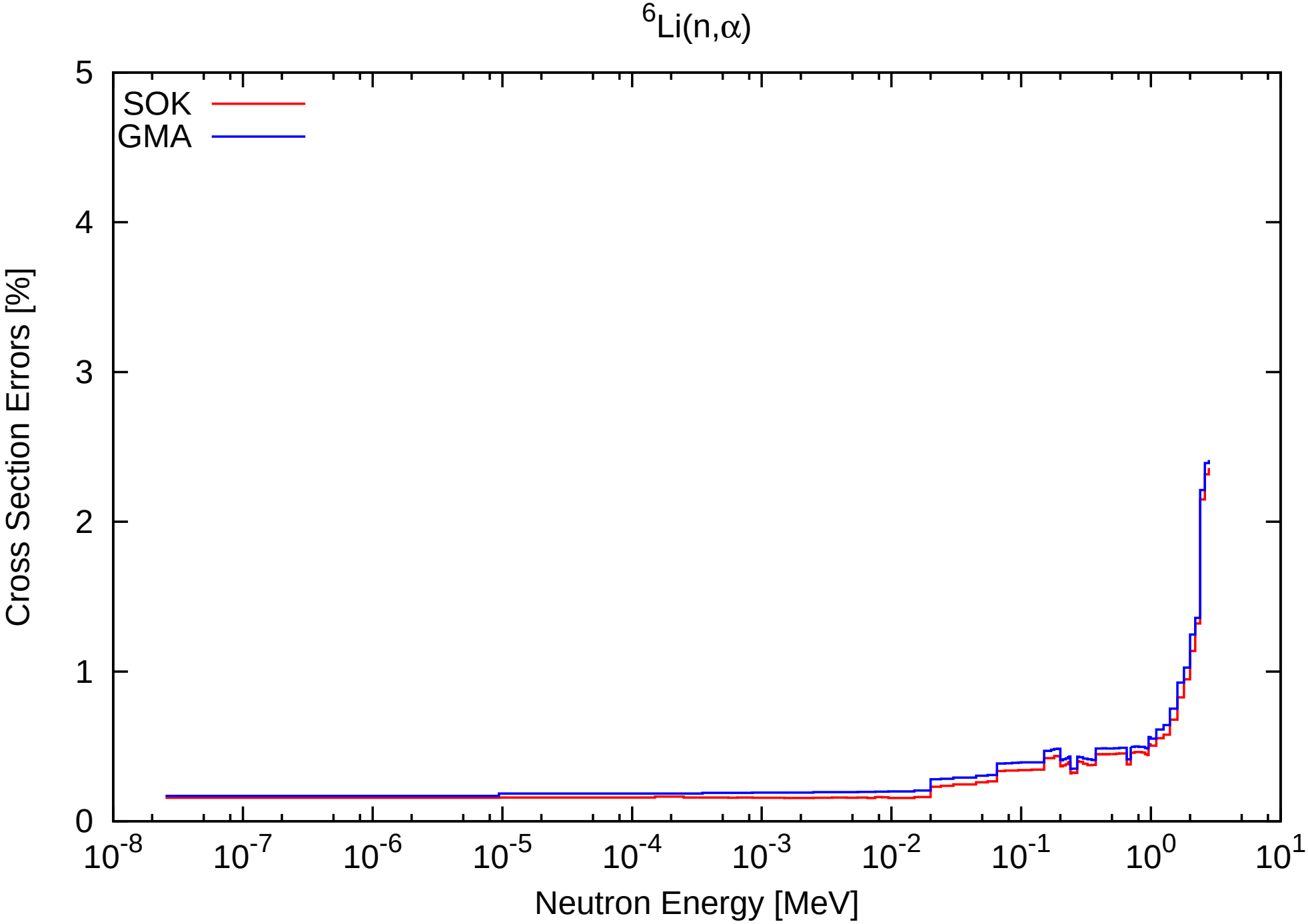

^{197}Au(n,γ)
(Ratio to Prior) -1
0.25
0.2
0.15
0.1
0.05
0
-0.05
SOK
GMA
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
Neutron Energy [MeV]

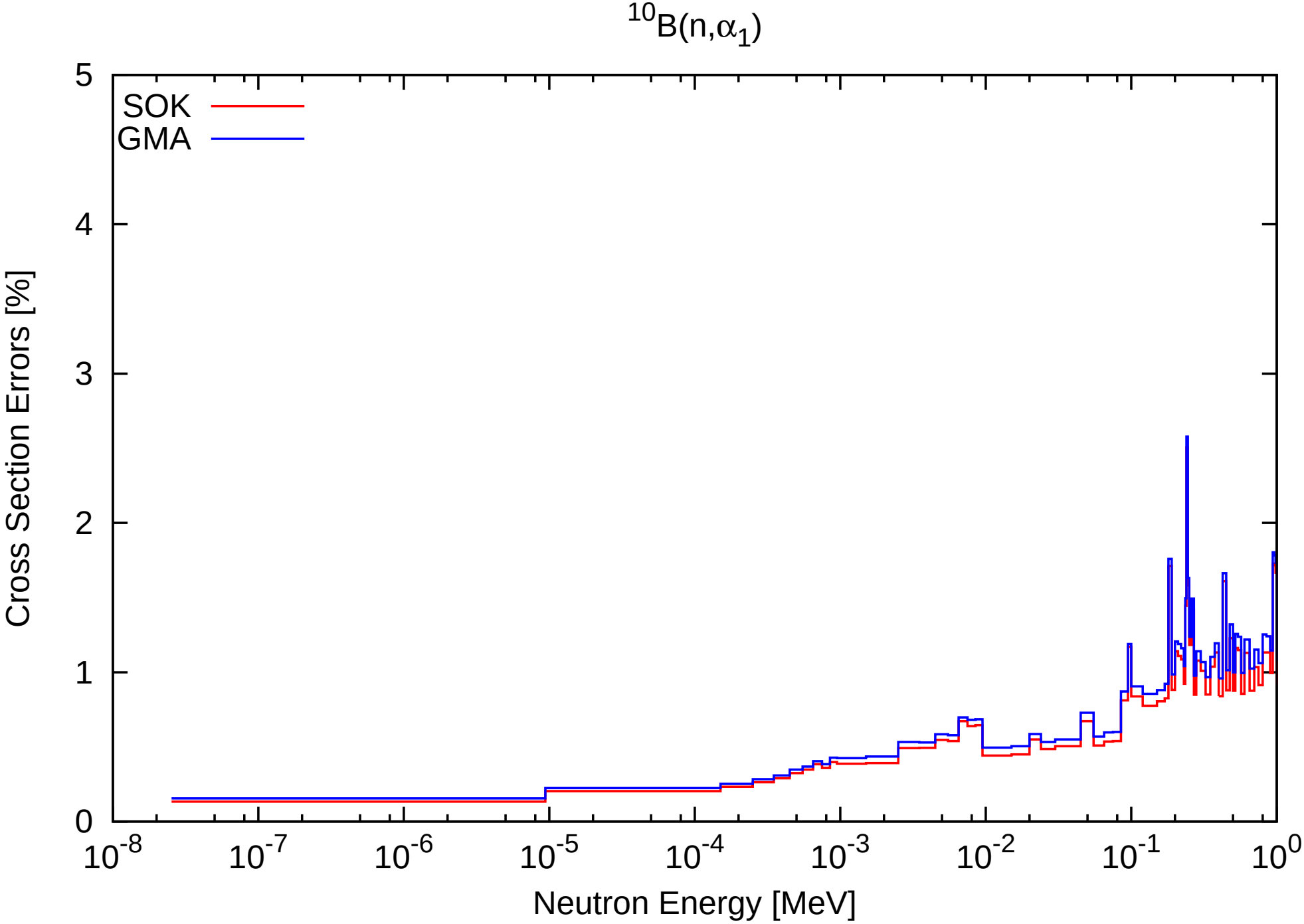

^{238}U(n,γ)
(Ratio to Prior) -1
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
SOK
GMA
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
Neutron Energy [MeV]

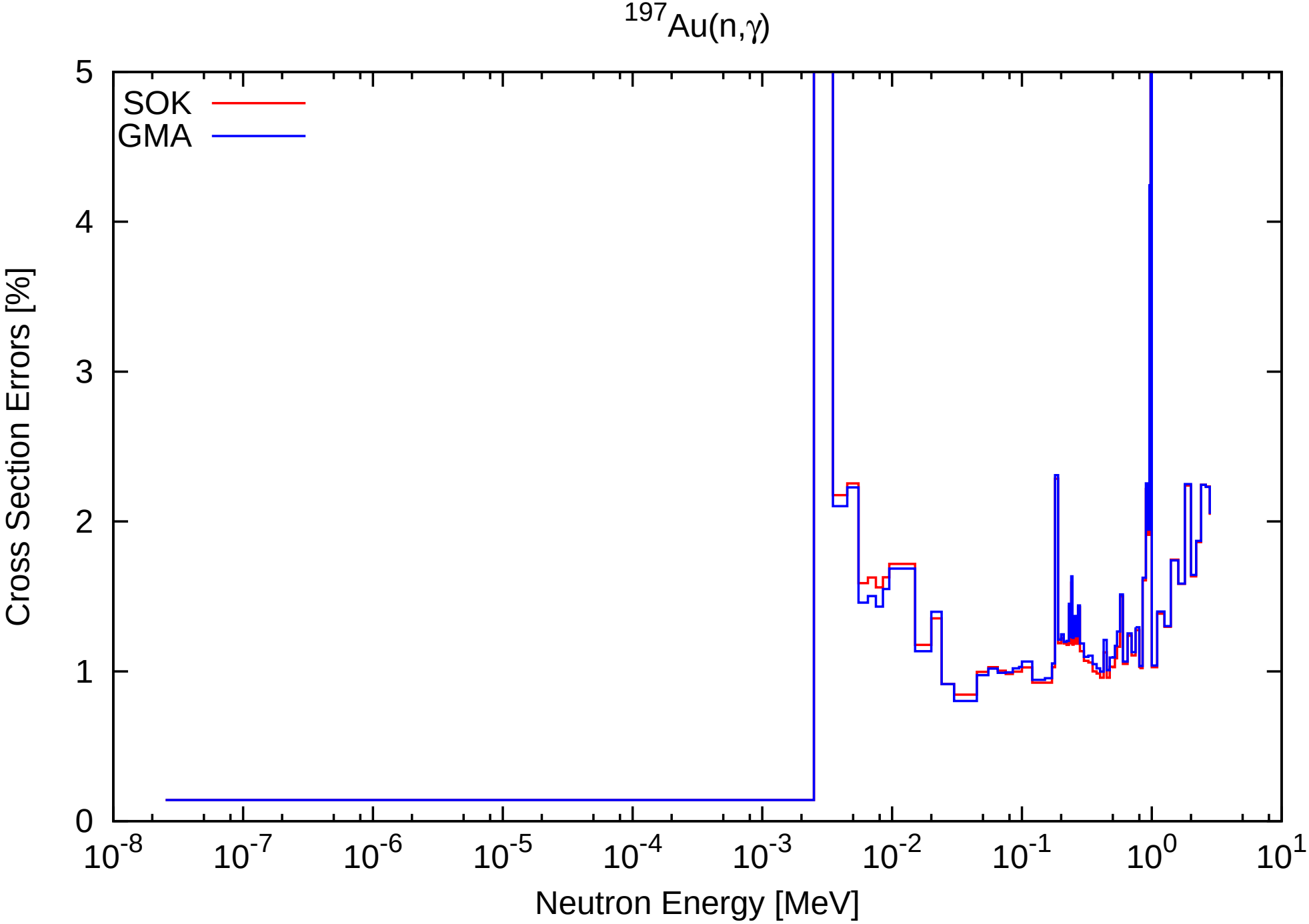

^{235}U(n,f)
(Ratio to Prior) -1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
SOK
GMA
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Neutron Energy [MeV]

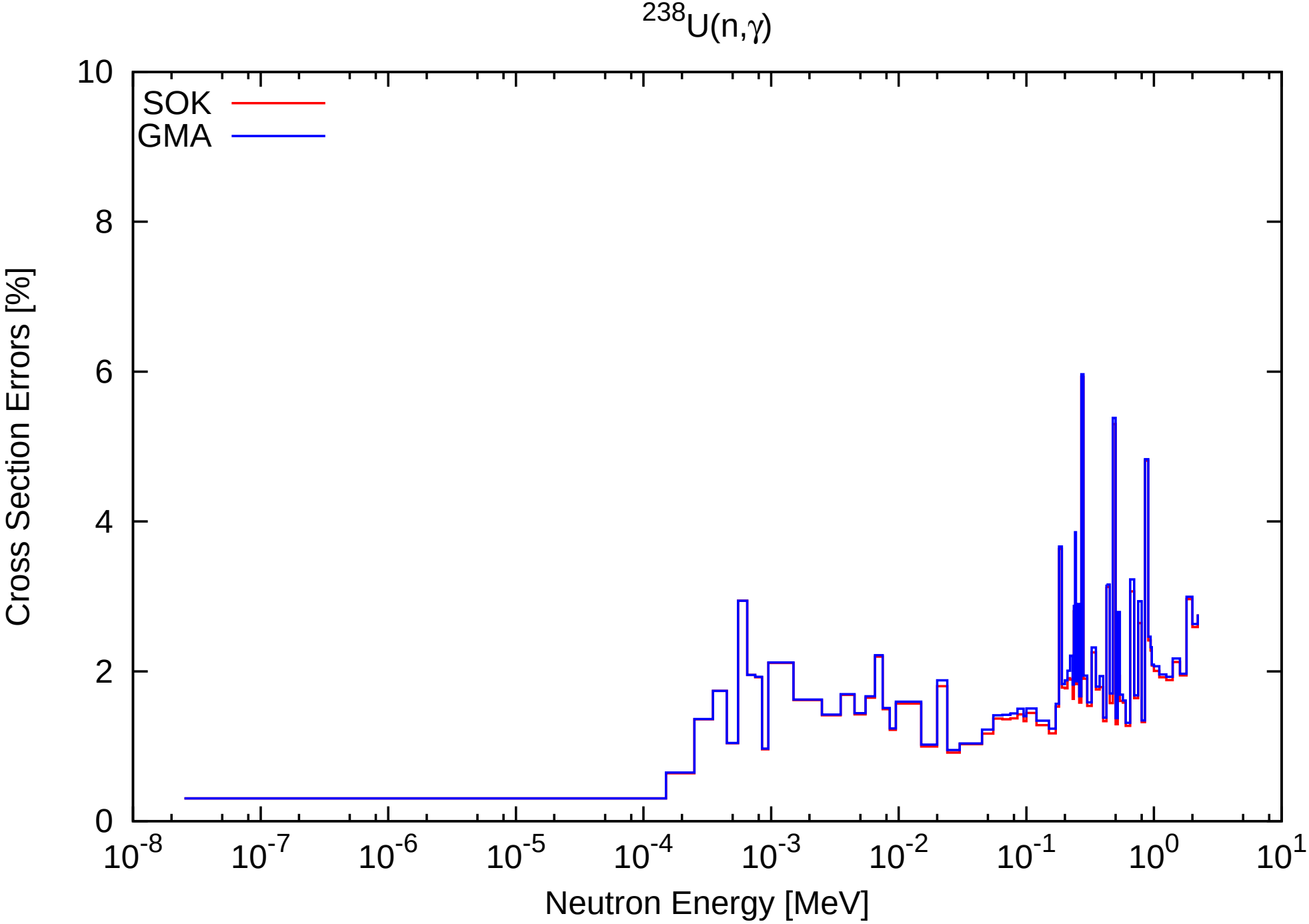

^{239}Pu(n,f)
(Ratio to Prior) -1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
SOK
GMA
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Neutron Energy [MeV]

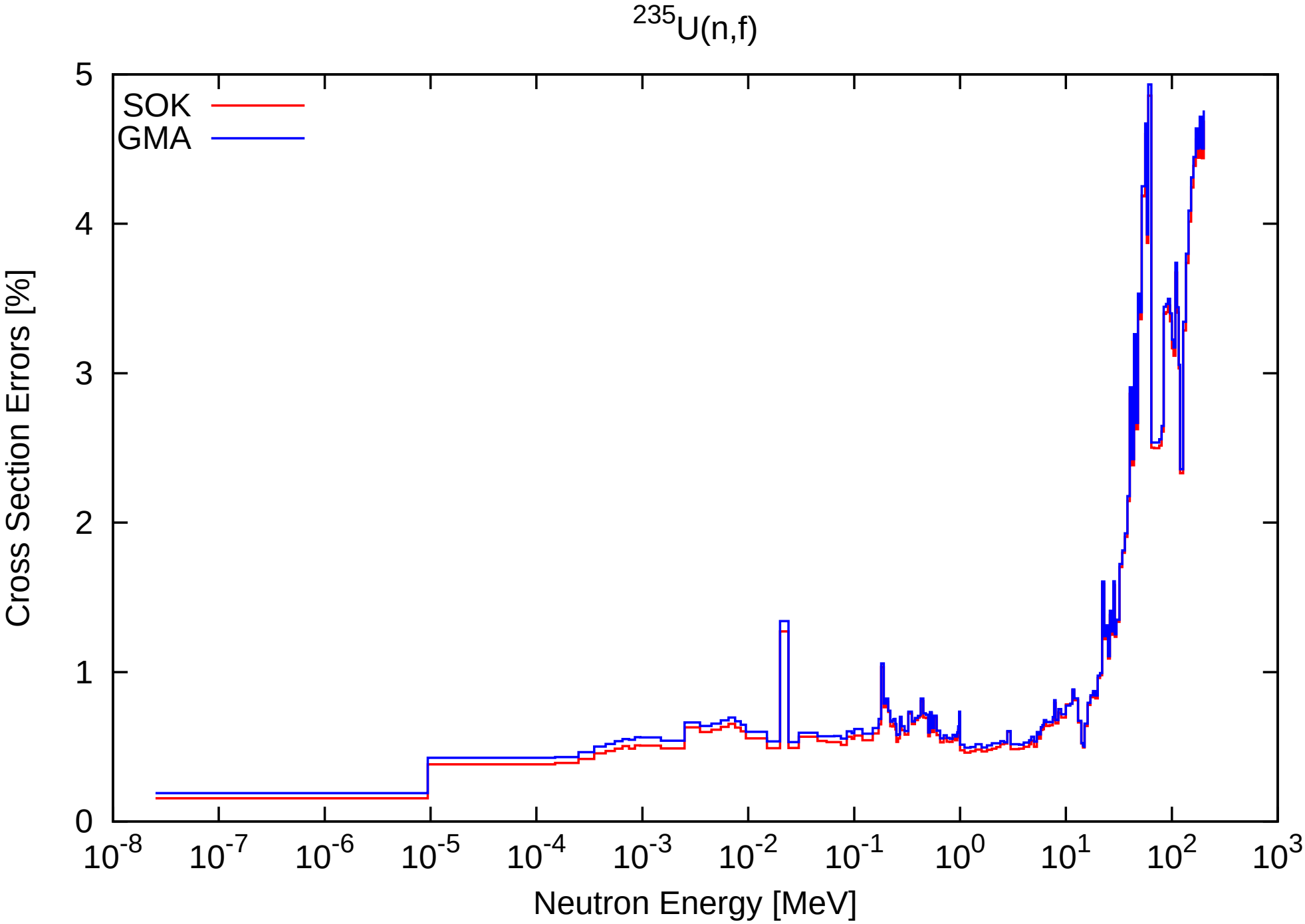

^{238}U(n,f)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
(Ratio to Prior) -1
10^0
10^1
10^2
10^3
Neutron Energy [MeV]
SOK
GMA

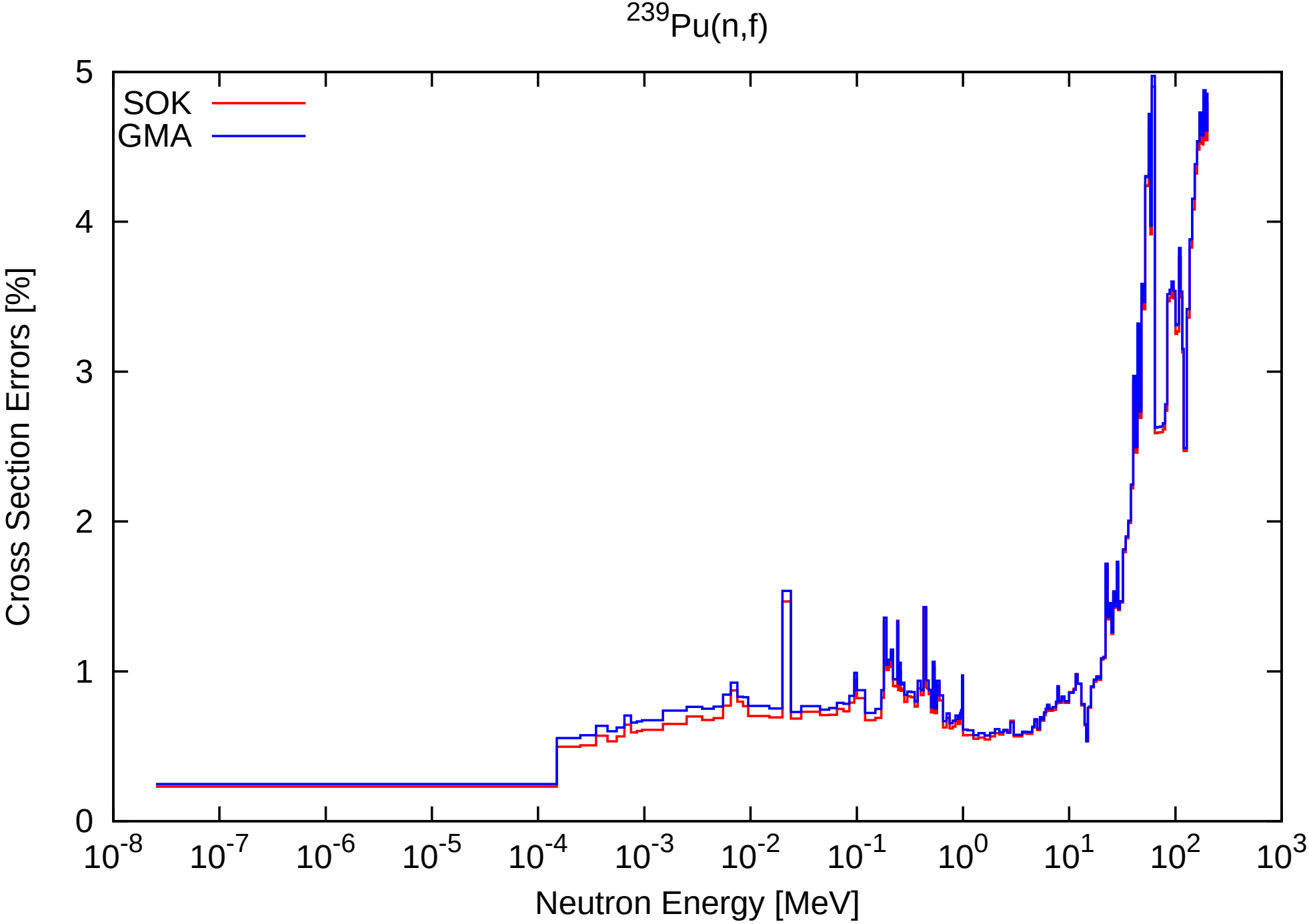

^{6}Li(n,α)
SOK
GMA
Cross Section Errors [%]
Neutron Energy [MeV]
0
1
2
3
4
5
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}

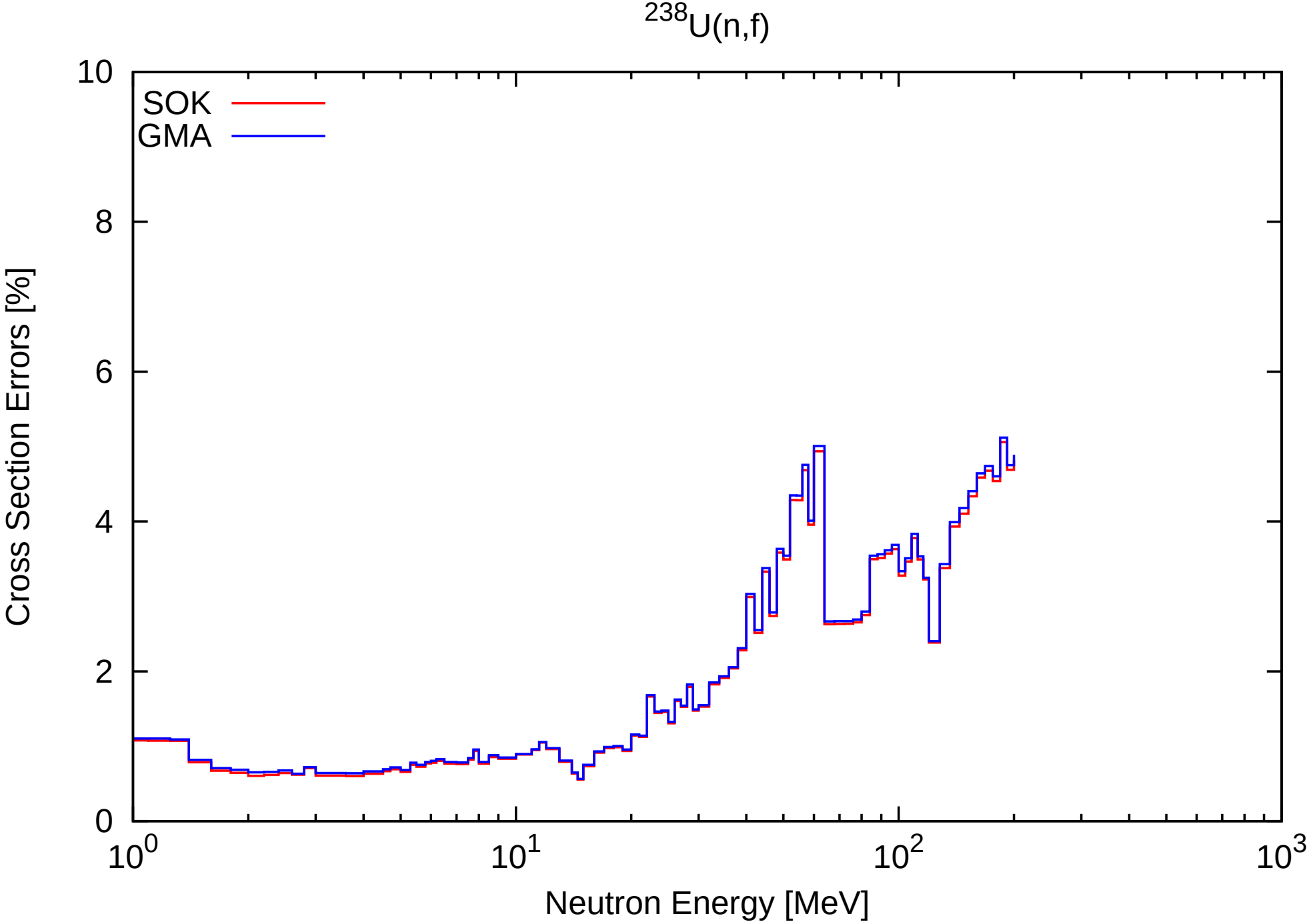

$^{10}B(n,\alpha_1)$
SOK
GMA
Cross Section Errors [%]
0
1
2
3
4
5
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Neutron Energy [MeV]


^{197}Au(n,γ)
SOK
GMA
Cross Section Errors [%]
Neutron Energy [MeV]
0
1
2
3
4
5
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}


^{238}U(n,γ)
SOK
GMA
Cross Section Errors [%]
Neutron Energy [MeV]
0
2
4
6
8
10
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}


^{235}U(n,f)
SOK
GMA
Cross Section Errors [%]
0
1
2
3
4
5
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Neutron Energy [MeV]

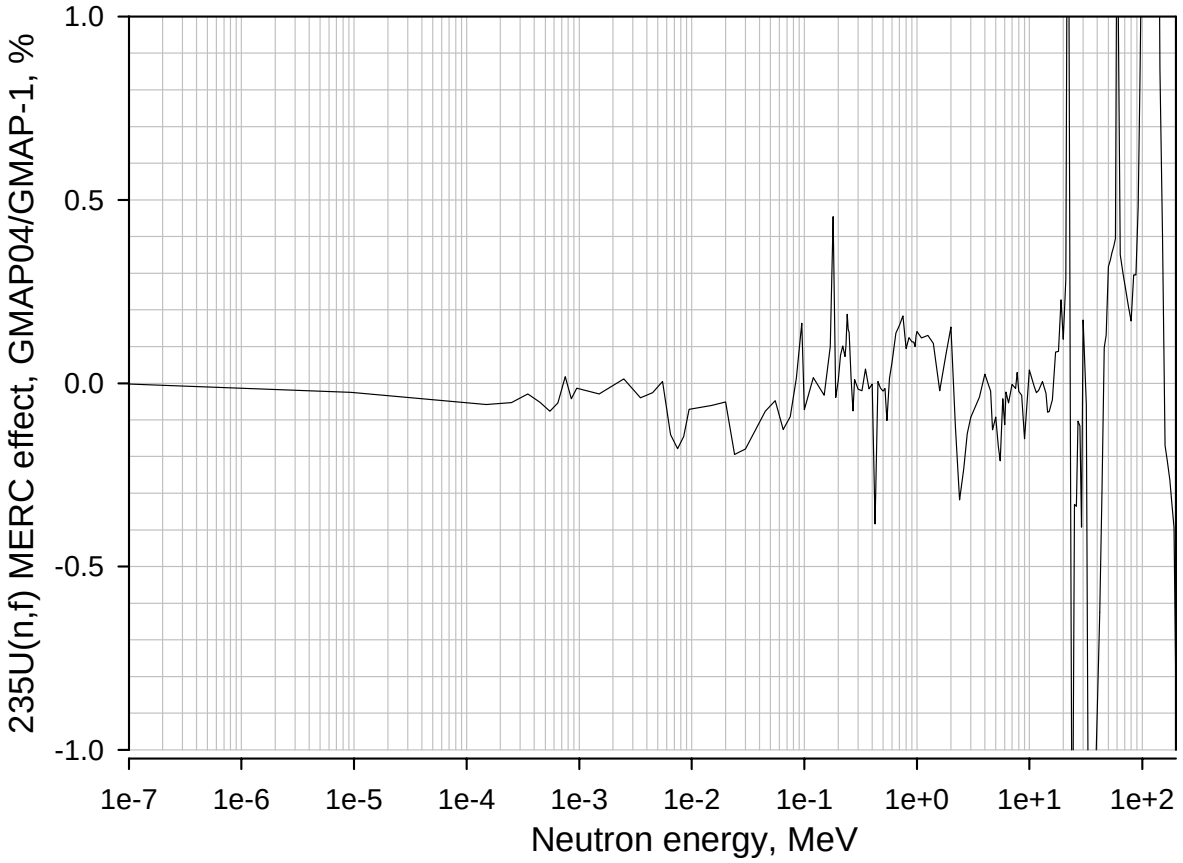

^{239}Pu(n,f)
SOK
GMA
Cross Section Errors [%]
0
1
2
3
4
5
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Neutron Energy [MeV]

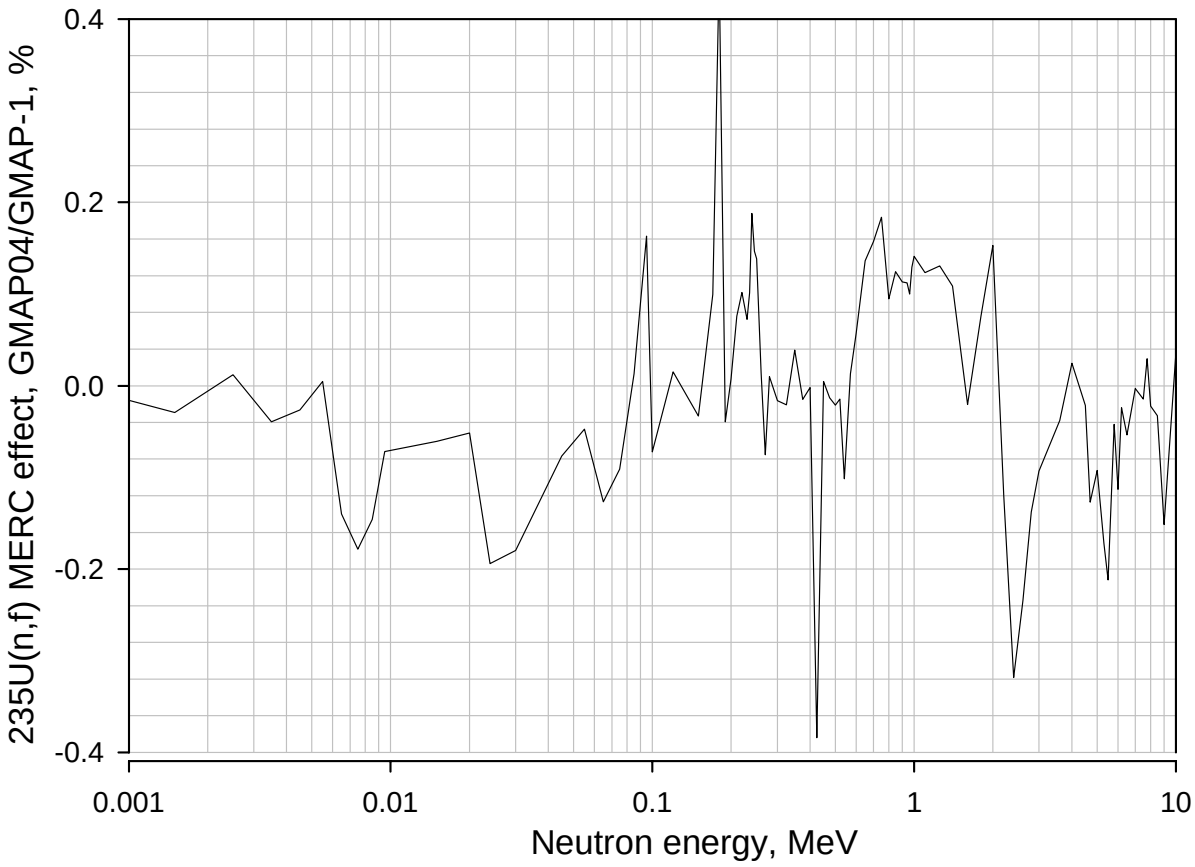

^{238}U(n,f)
SOK
GMA
Cross Section Errors [%]
Neutron Energy [MeV]
0
2
4
6
8
10
10^0
10^1
10^2
10^3

CRP Activities (cont.)

- Studies of the small uncertainties resulting from evaluations
  - The importance of considering the covariances not just the variances is stressed.

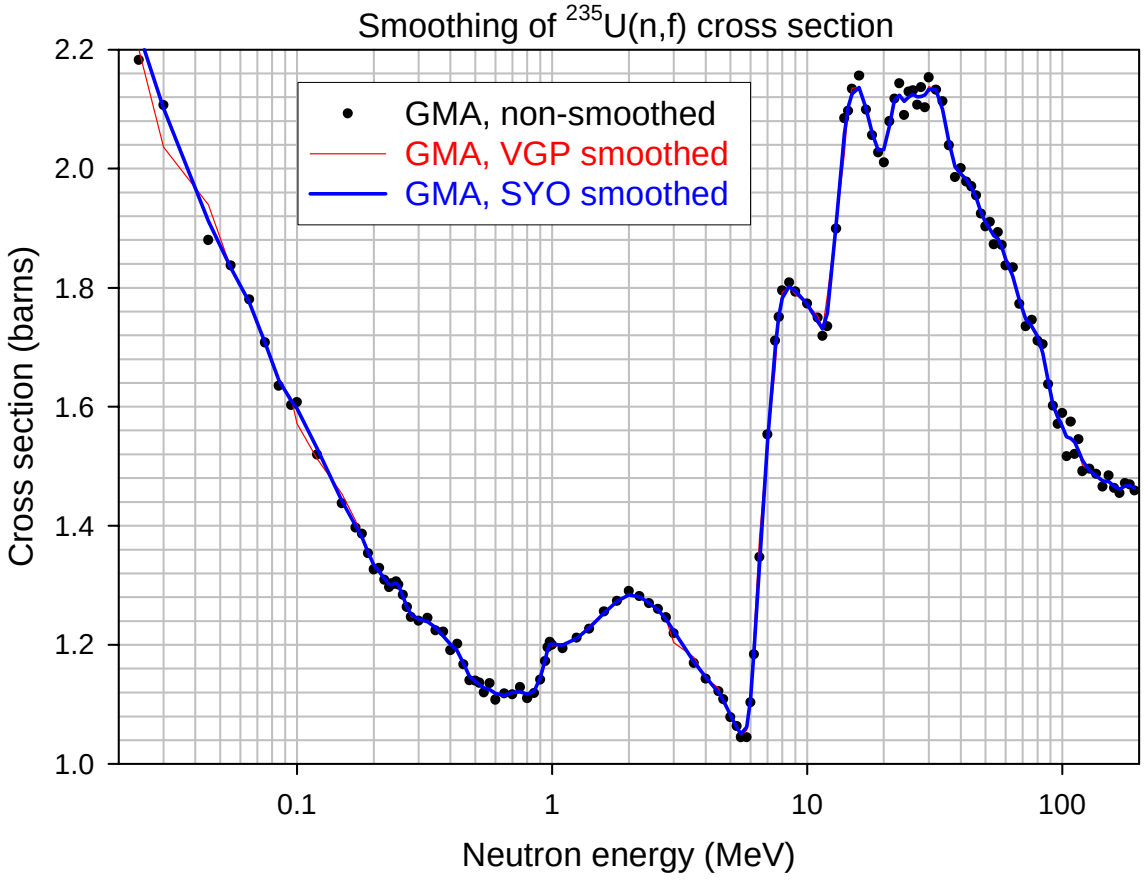
- Methods for handling discrepant data.
  - Inspection of experimental data.
  - Incorporating medium energy range correlation component (yields larger final uncertainty).

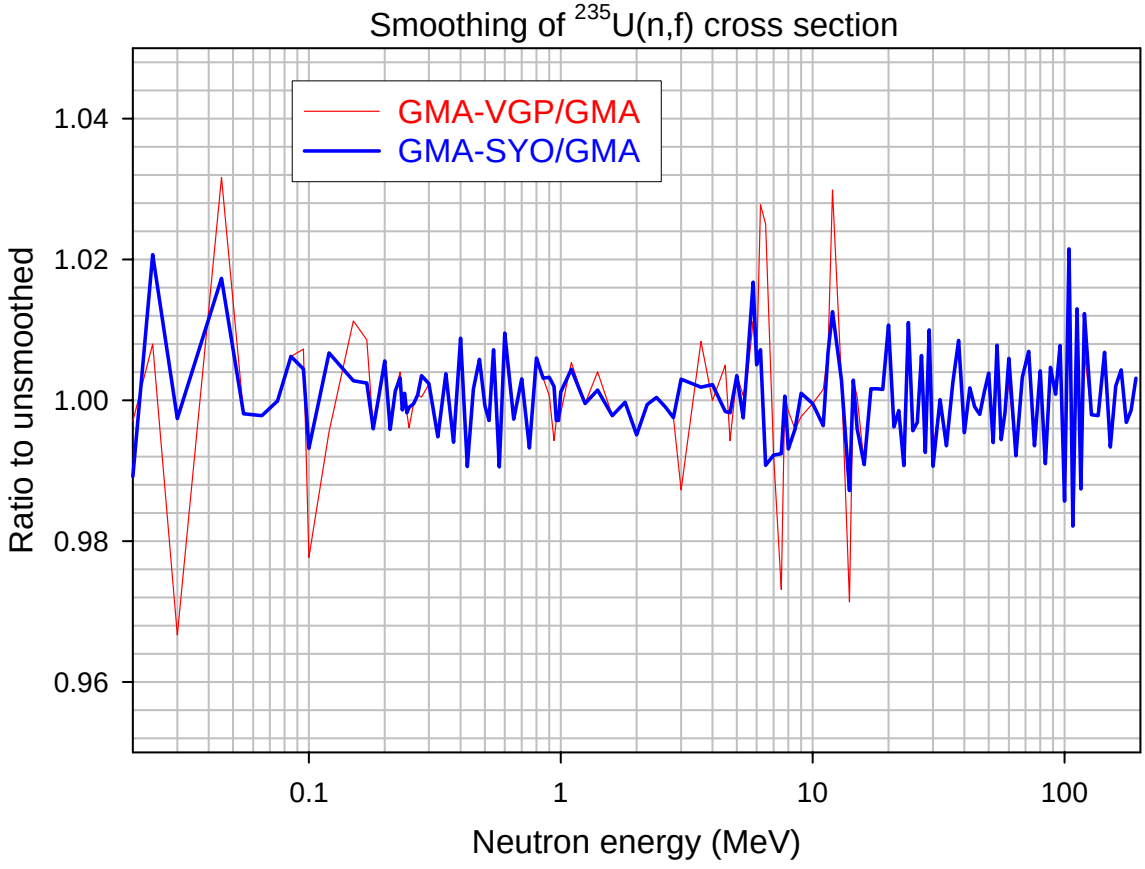

1.0
0.5
0.0
-0.5
-1.0
235U(n,f) MERC effect, GMAP04/GMAP-1, %
1e-7
1e-6
1e-5
1e-4
1e-3
1e-2
1e-1
1e+0
1e+1
1e+2
Neutron energy, MeV

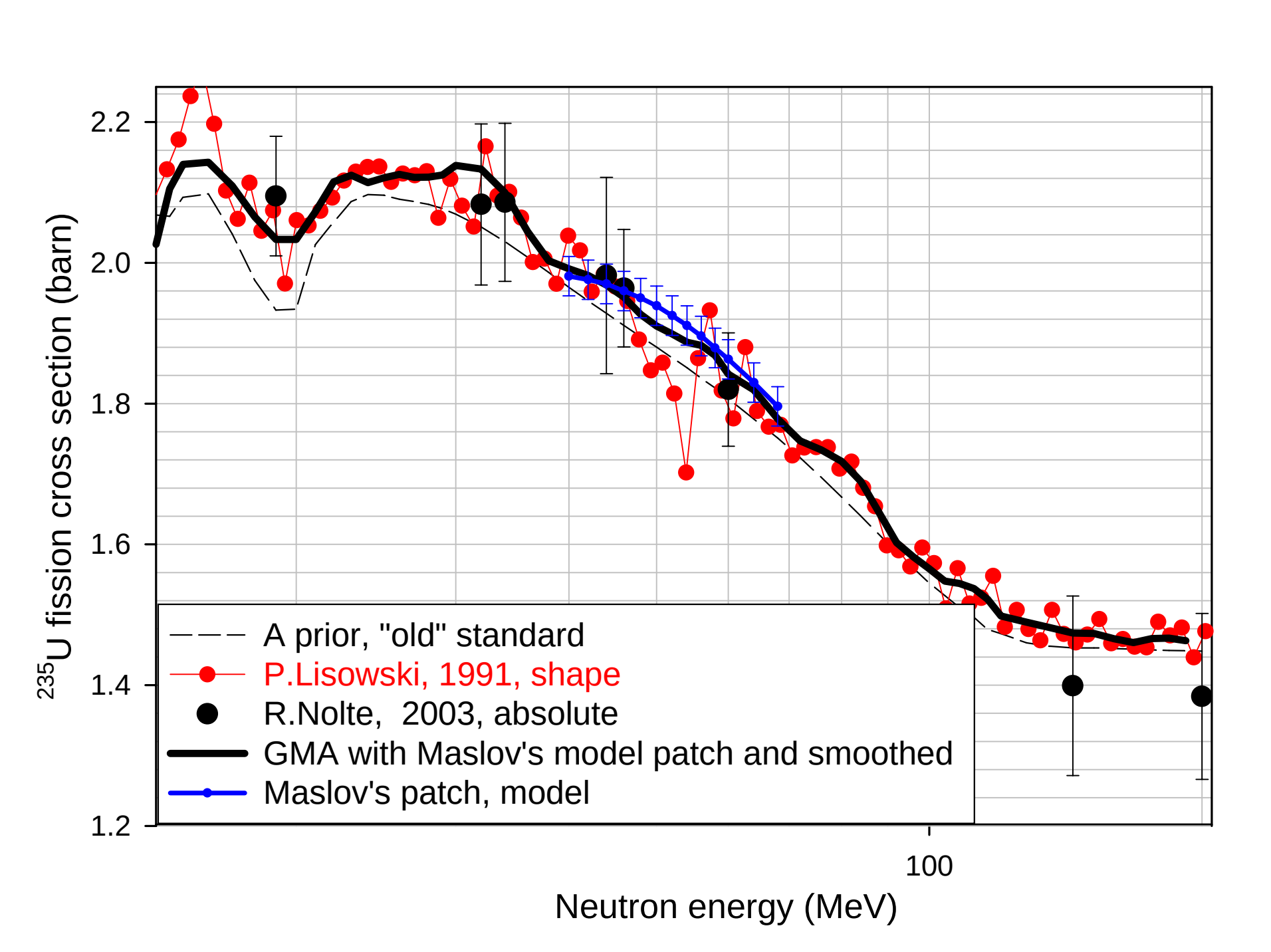

0.4
0.2
0.0
-0.2
-0.4
235U(n,f) MERC effect, GMAP04/GMAP-1, %
0.001
0.01
0.1
1
10
Neutron energy, MeV

CRP Activities (cont.)

- Methods for smoothing evaluated data
  - $^{6}Li(n,t)$, $^{10}B(n,\alpha)$ and $^{10}B(n,\alpha_{l}\gamma)$ data are basically smooth due to the use of the dominance of the R-matrix fit.
  - A simple smoothing algorithm is used to remove fluctuations.
  - Models provide a method for removing unphysical effects.


Smoothing of 235U(n,f) cross section
GMA, non-smoothed
GMA, VGP smoothed
GMA, SYO smoothed
Cross section (barns)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.1
1
10
100
Neutron energy (MeV)


Smoothing of 235U(n,f) cross section
GMA-VGP/GMA
GMA-SYO/GMA
Ratio to unsmoothed
1.04
1.02
1.00
0.98
0.96
0.1
1
10
100
Neutron energy (MeV)


2.2
2.0
1.8
1.6
1.4
1.2
235U fission cross section (barn)
100
Neutron energy (MeV)
A prior, "old" standard
P.Lisowski, 1991, shape
R.Nolte, 2003, absolute
GMA with Maslov's model patch and smoothed
Maslov's patch, model

Standards Meetings

- Three meetings were held since the last CSEWG meeting to discuss the standards.
  - A workshop was hosted by LANL in April. Activities included:
    - R-matrix discussions.
    - PPP comparisons.
    - Estimation of medium energy range correlation components for discrepant data.
    - Studies and comparisons of LANL, JENDL and the present evaluations for the ^{235}U(n,f) and ^{239}Pu(n,f) cross sections.

LANL Standards Workshop

Allan Carlson

Vladimir Pronyaev

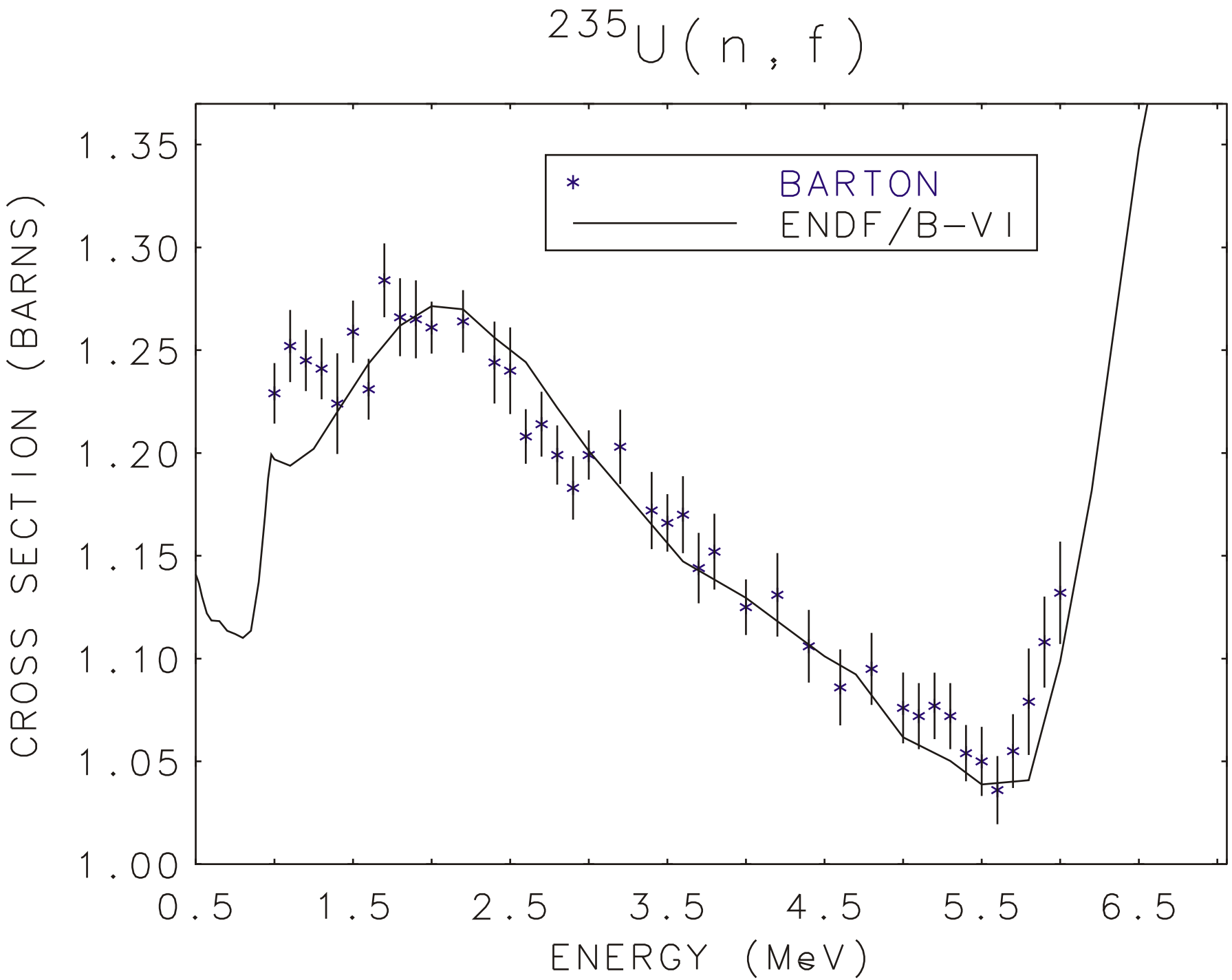
Sebastian Lemaire

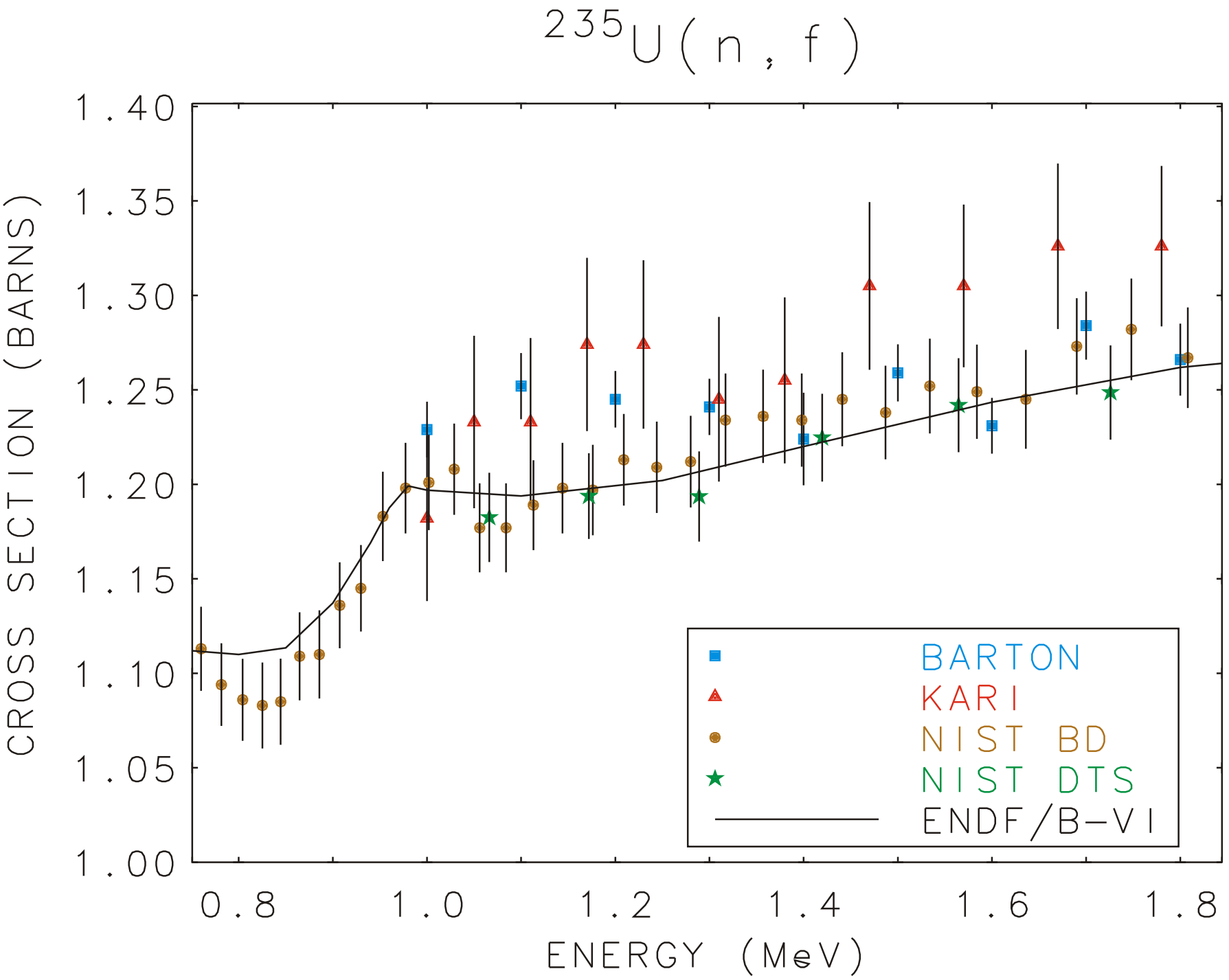
Ken Hanson

Don Smith

Toshihiko Kawano

Patrick Talou


235U(n,f)
BARTON
ENDF/B-VI
CROSS SECTION (BARNS)
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.5
1.5
2.5
3.5
4.5
5.5
6.5
ENERGY (MeV)


^{235}U(n,f)
CROSS SECTION (BARNS)
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.8
1.0
1.2
1.4
1.6
1.8
ENERGY (MeV)
BARTON
KARI
NIST BD
NIST DTS
ENDF/B-VI

Standards Meetings (cont.)

- A "side" meeting was held after the ND2004 conference. Topics were:
  - Status of the database.
  - Progress reports on the individual evaluations.
  - Problems and possible solutions concerning the ^{6}Li(n,t) R-matrix analyses.
  - Establishing the ^{235}U(n,f) cross section required for ENDF/B-VII.
  - Thermal data concerns.

ND2004 Standards Side Meeting Attendees

Josch Hambsch | Allan Carlson | Bob Haight | Vladimir Pronyaev | Wolf Mannhart

Nancy Larson | Patrick Talou | Hartmut Hofmann | Georgios Georginis | Gerry Hale | Eric Pitcher | Siegfried Tageson

Standards Meetings (cont.)

- The third RCM of the CRP with a complete agenda of activities leading to the ENDF/B-VII standards.

Standards Third RCM Attendees

Allan Carlson | Sergei Badikov | Siegfried Tageson | Hartmut Hofmann | Gerry Hale | Vladimir Pronyaev

Herb Vonach | Chen Zhenpen | Soo Oh | Nancy Larson | Evgeniy Gai | Josch Hambsch | Toshihiko Kawano

Combination Procedure used for ENDF/B-VII Standards Evaluation

•RAC is used for both the lithium and boron analyses using charged-particle data and the entire lithium and boron neutron database except ratio measurements. These ratio measurements are the only lithium and boron data in the GMA database.

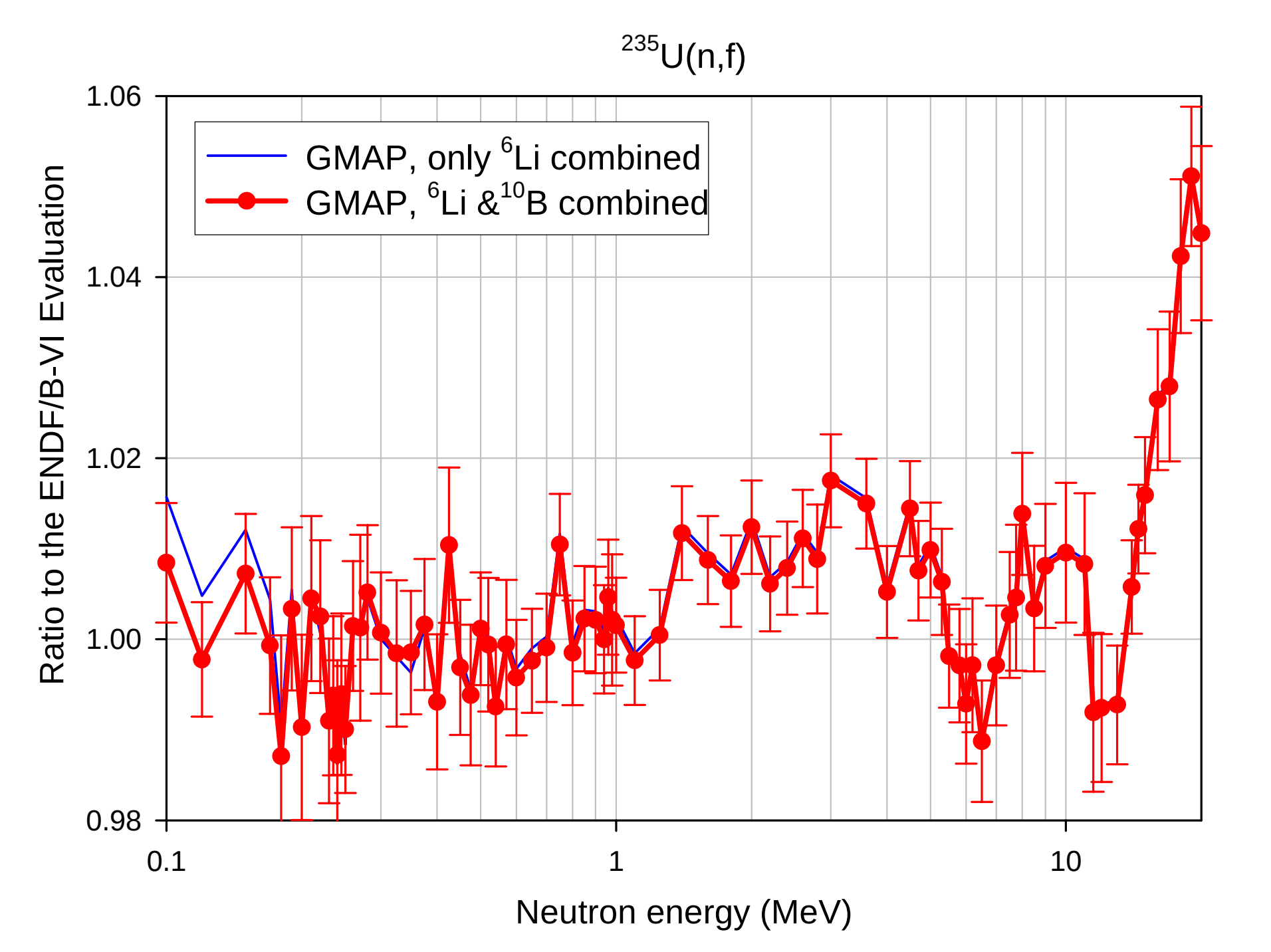
•EDA is used for the lithium analysis using charged-particle data and the entire lithium neutron database except ratio measurements that are used in GMA.

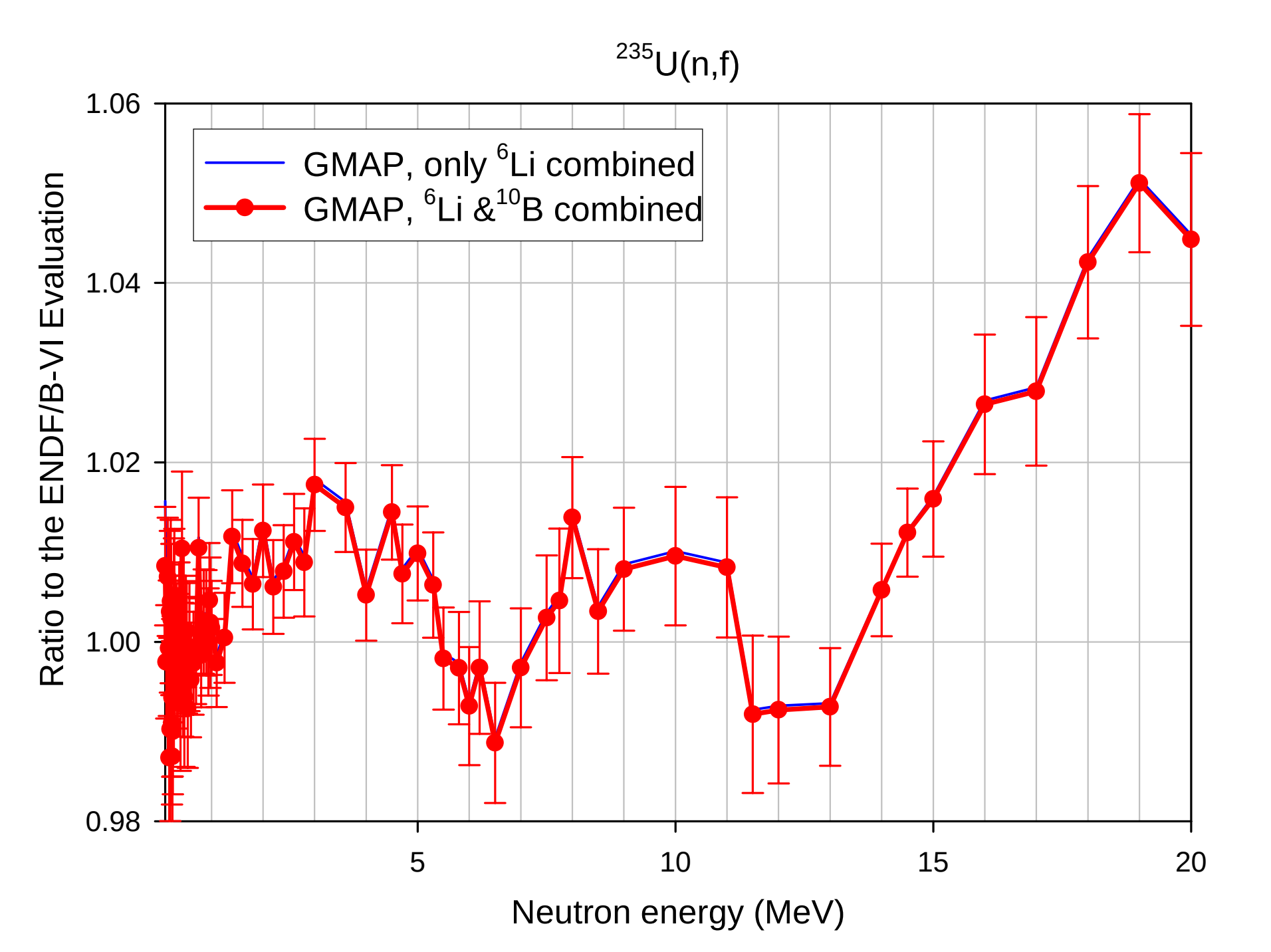
•Since the the RAC and EDA central values (cross sections) were not identical for the lithium analyses, the average (unweighted) cross sections from these analyses were used for the R-matrix cross section input to the GMA combination process. The R-matrix input is treated like the addition of another experimental data set to the GMA program. The RAC covariance matrix was used. At each energy point, half the difference betwen the RAC and EDA results was treated as a model uncertainty that was added to the RAC covariance matrix of uncertainty.

Combination Procedure used for ENDF/B-VII Standards Evaluation (cont.)

•Since the EDA analysis for the boron system is not available at this time, the RAC results alone were used for the boron R-matrix input to GMA. This was done to provide data for the impact on the other cross sections from the R-matrix boron analysis. Since this impact was found to be relatively small, it is expected that when the EDA boron results are completed, they will also have little effect on the other cross sections.

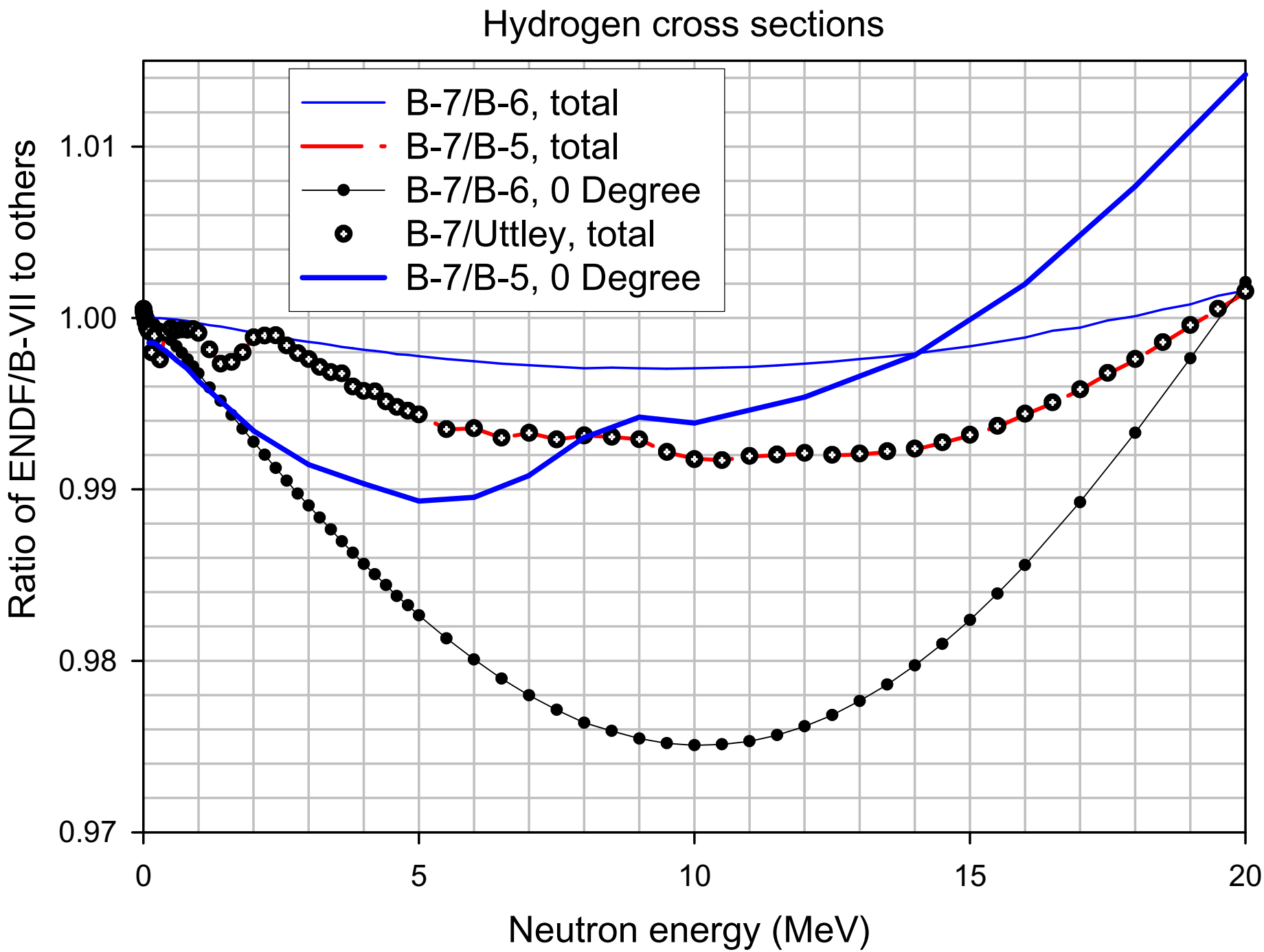
•It is anticipated that the boron cross sections will be obtained in a manner similar to that used for the lithium cross sections when the EDA analysis is complete. No boron data will be released until that process is complete.

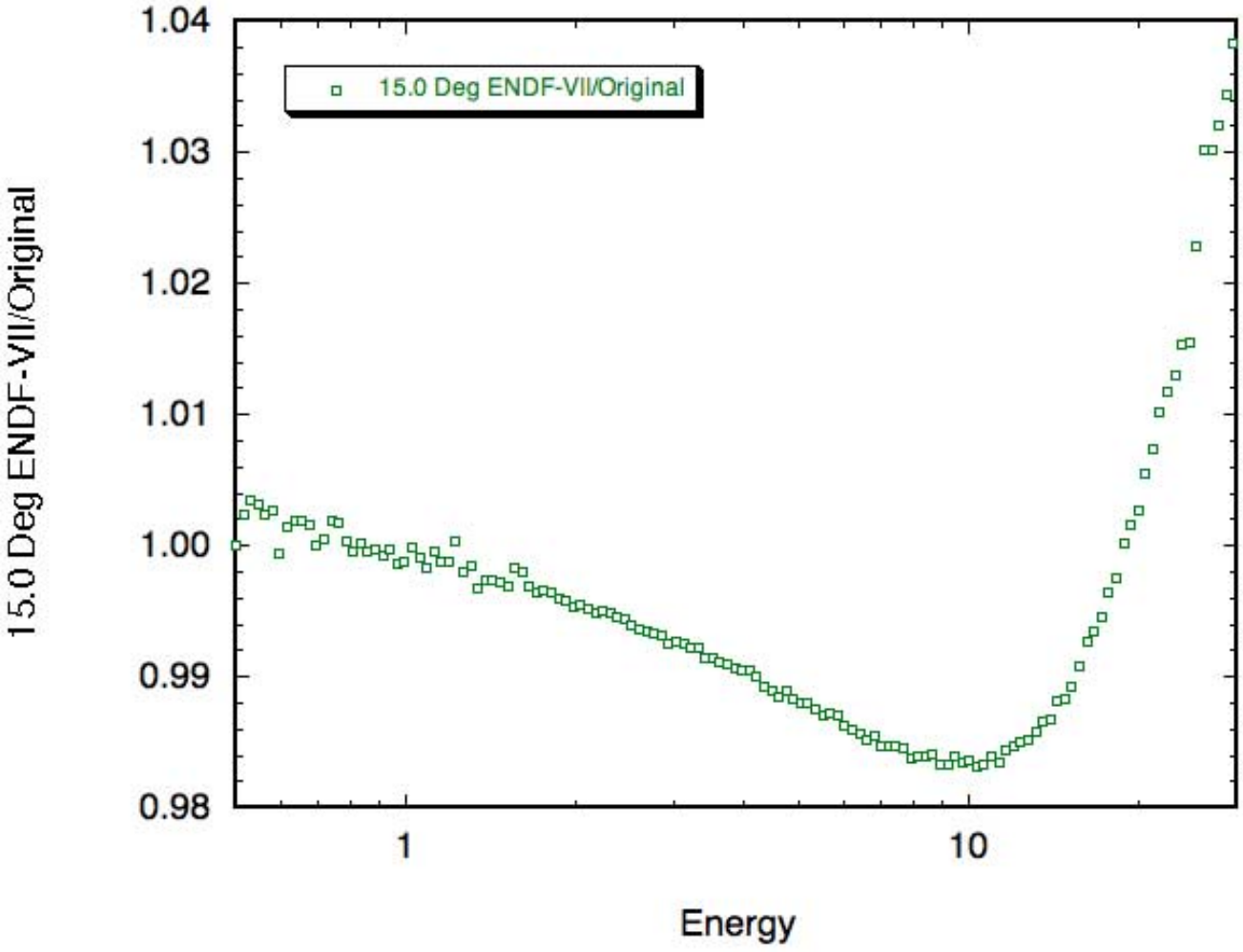

^{235}U(n,f)
GMAP, only ^{6}Li combined
GMAP, ^{6}Li &^{10}B combined
Ratio to the ENDF/B-VI Evaluation
1.06
1.04
1.02
1.00
0.98
0.1
1
10
Neutron energy (MeV)


^{235}U(n,f)
GMAP, only ^{6}Li combined
GMAP, ^{6}Li &^{10}B combined
Ratio to the ENDF/B-VI Evaluation
Neutron energy (MeV)
1.06
1.04
1.02
1.00
0.98
5
10
15
20

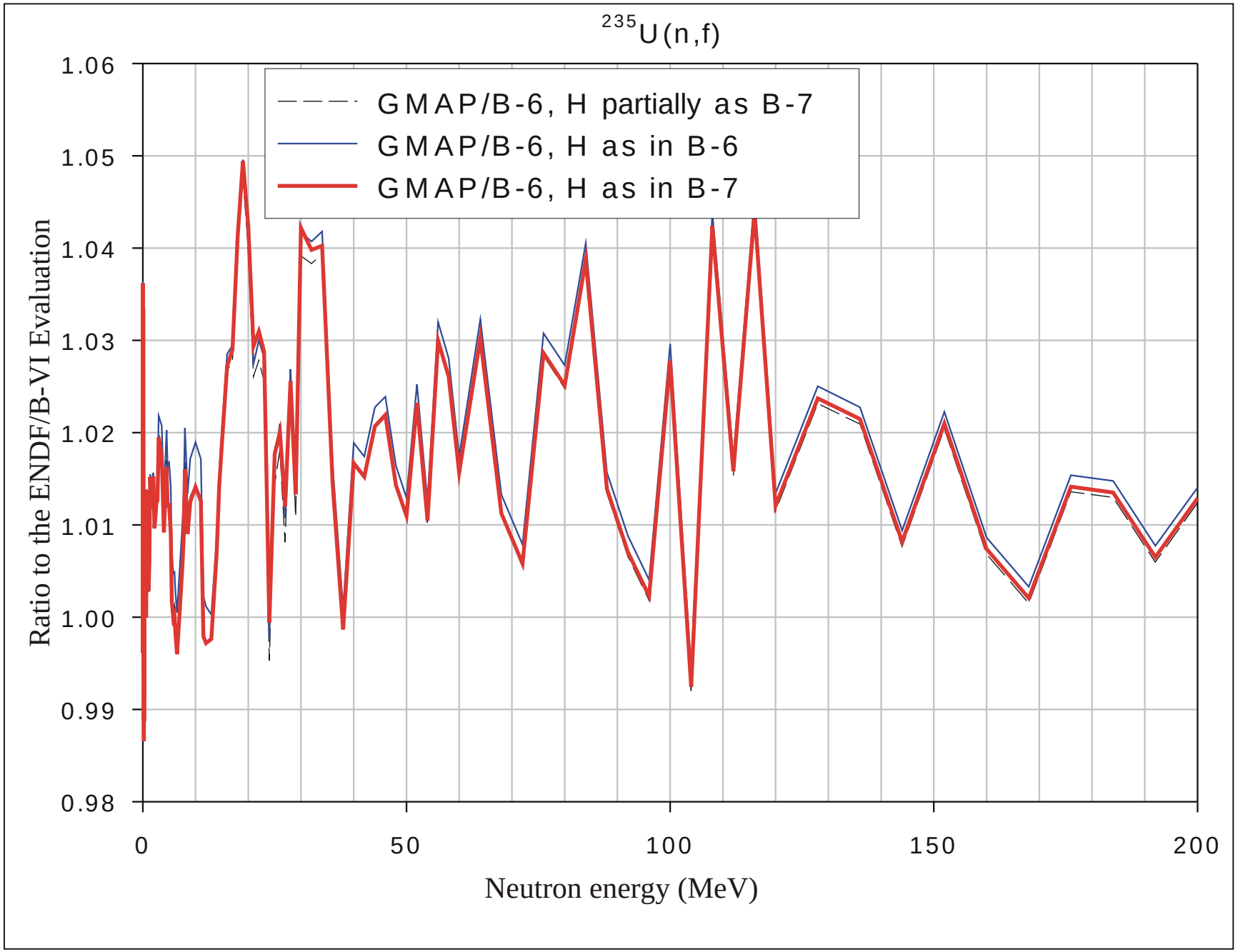
Cross Section Results

- H(n,n)
  - An evaluation by Hale has been completed up to 30 Mev. It will be released only up to 20 MeV to ensure proper merging with the higher energy evaluation. The complete evalution which extends to 200 MeV should be released in February 2005.
  - This evaluation was used to renormalize all data relative to the hydrogen standard.

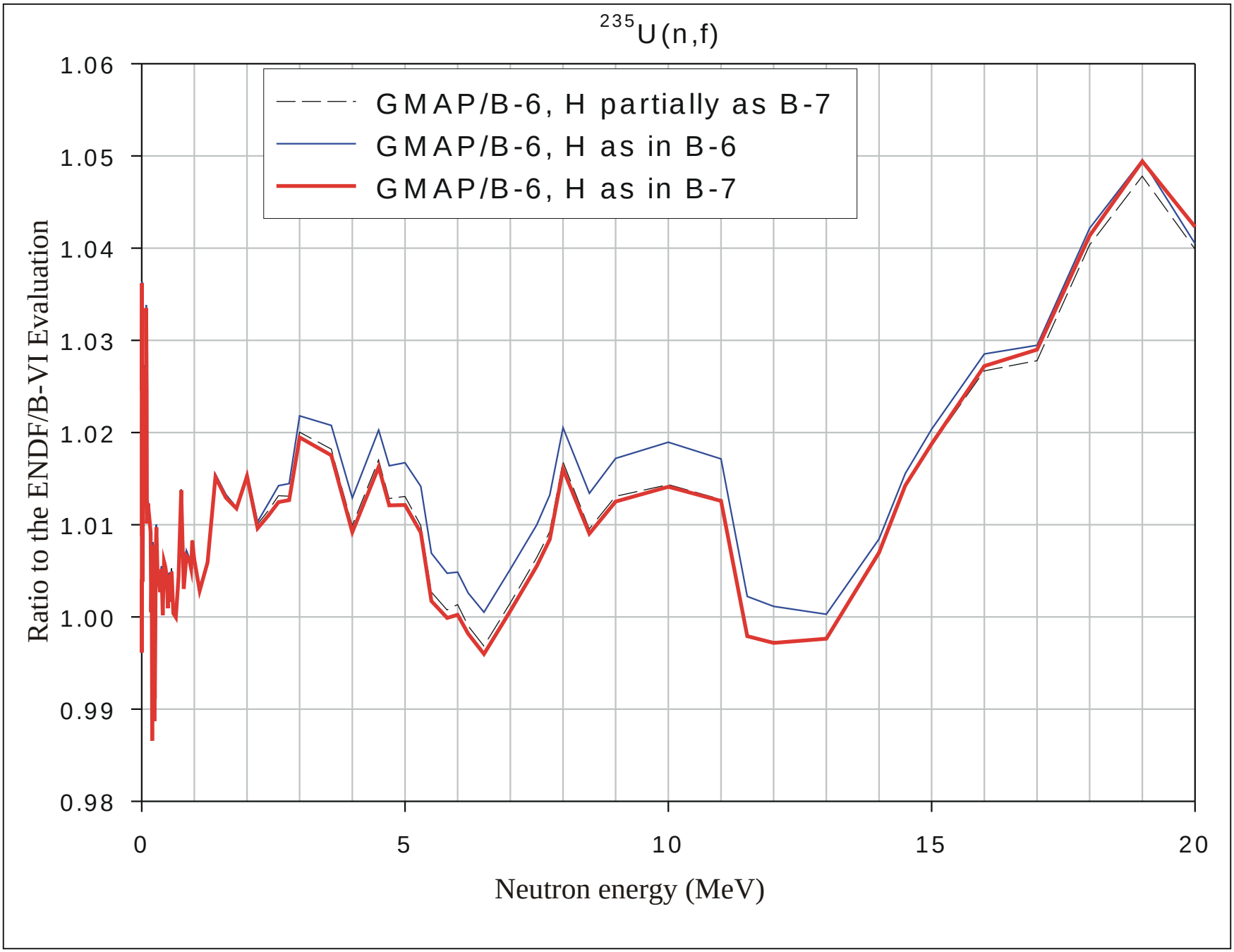

Hydrogen cross sections
B-7/B-6, total
B-7/B-5, total
B-7/B-6, 0 Degree
B-7/Uttley, total
B-7/B-5, 0 Degree
Ratio of ENDF/B-VII to others
1.01
1.00
0.99
0.98
0.97
0
5
10
15
20
Neutron energy (MeV)



Ratio of laboratory hydrogen cross section for protons at 15 degrees calculated with ENDF/B-VII to that used by Lisowski for the ^{235}U(n,f) cross section measurement.



Changes in the 235U(n,f) cross section as a result of converting the standards database from the ENDF/B-VI to the ENDF/B-VII hydrogen standard.



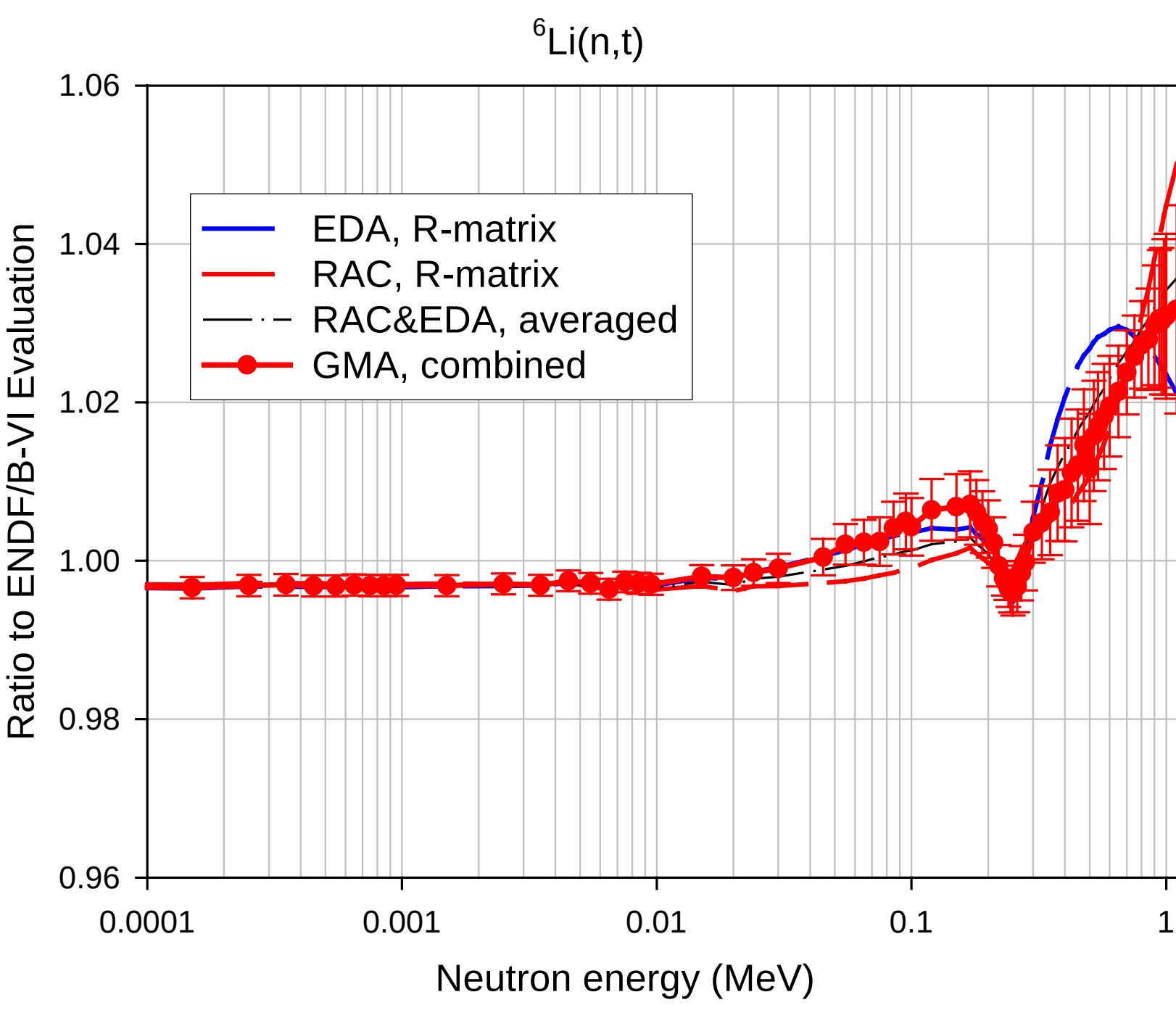
Changes in the 235U(n,f) cross section as a result of converting the standards database from the ENDF/B-VI to the ENDF/B-VII hydrogen standard.

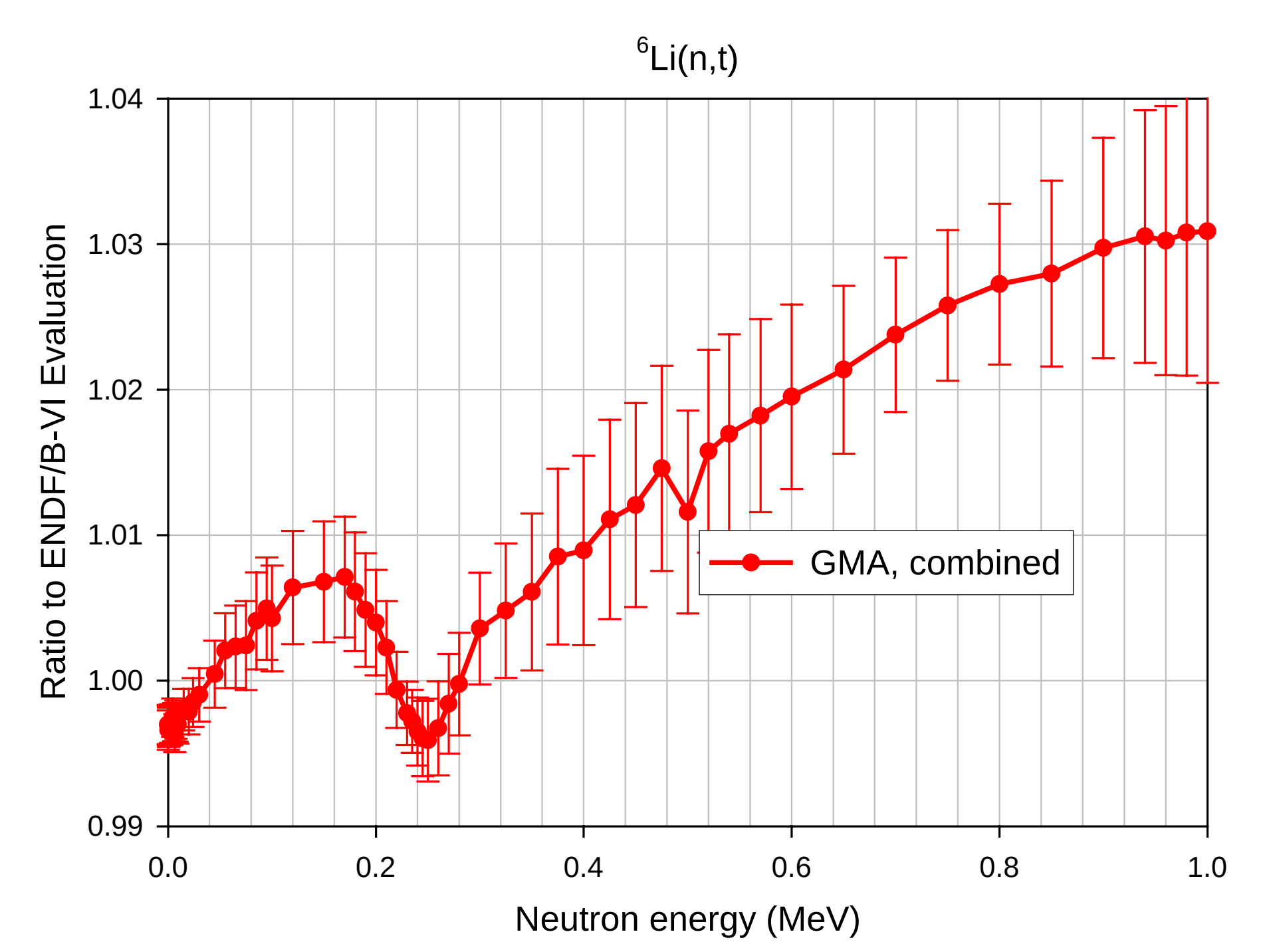
Cross Section Results (cont.)

^{3}He(n,p)

- This evaluation is nearly complete. It should be finished by Nov 30, 2004.

- ^{6}Li(n,t)
  - The evaluation is complete. These results were obtained by averaging EDA and RAC output which were then used as input to GMA. The upper energy bound is 1 MeV as it was for ENDF/B-VI. Users are cautioned about using this as a standard near the resonance at ~240 KeV due to the rapid change of the cross section with energy.


^{6}Li(n,t)
EDA, R-matrix
RAC, R-matrix
RAC&EDA, averaged
GMA, combined
Ratio to ENDF/B-VI Evaluation
1.06
1.04
1.02
1.00
0.98
0.96
0.0001
0.001
0.01
0.1
1
Neutron energy (MeV)

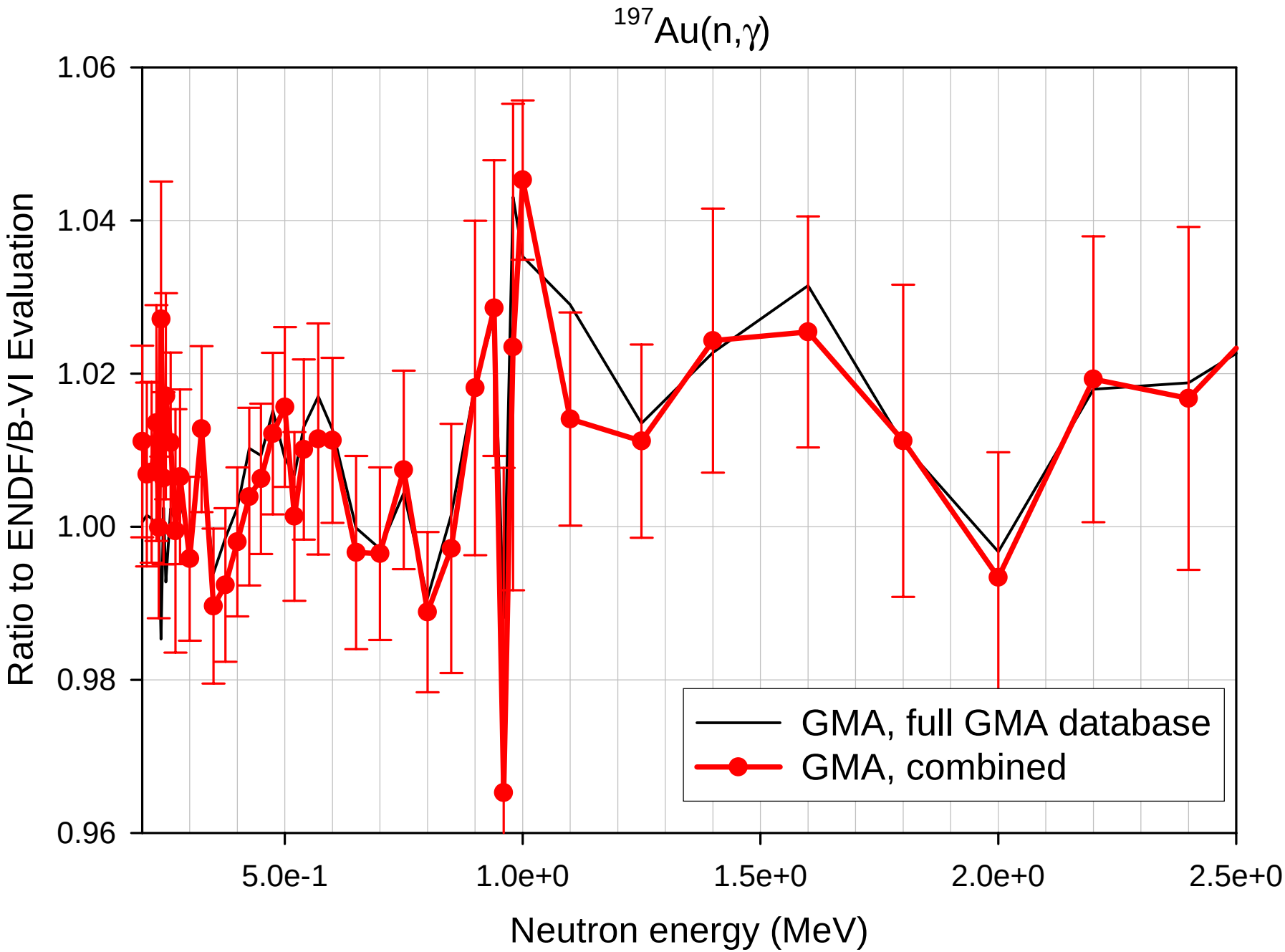

^{6}Li(n,t)
Ratio to ENDF/B-VI Evaluation
Neutron energy (MeV)
GMA, combined
1.04
1.03
1.02
1.01
1.00
0.99
0.0
0.2
0.4
0.6
0.8
1.0

Cross Section Results (cont.)

- $^{10}B(n,\alpha)$ and $^{10}B(n,\alpha_1\gamma)$
  - These evaluations are not finished. It is anticipated that they will be finished by December 2004.

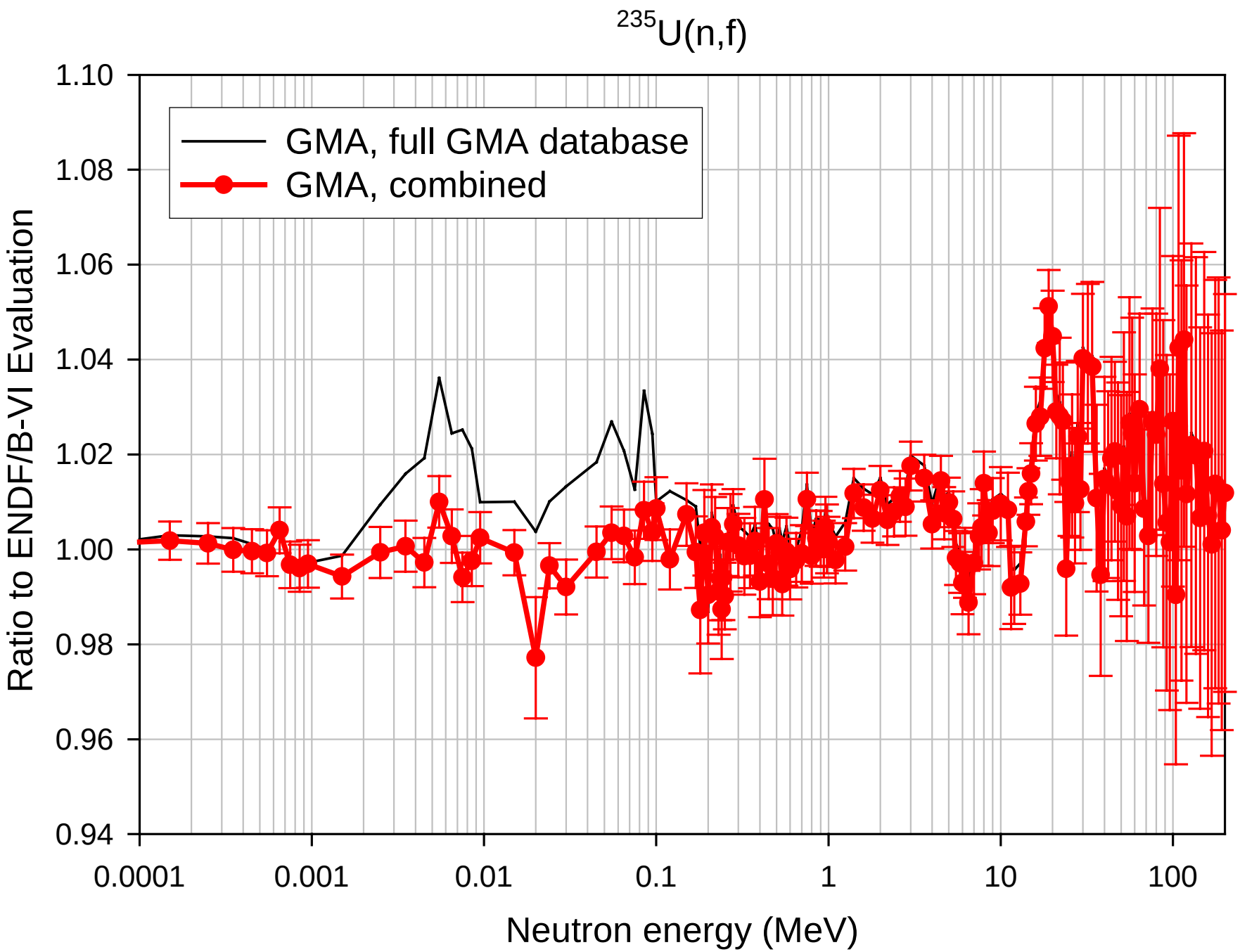
- C(n,n)
  - This evaluation will be carried over from ENDF/B-VI. Very few new measurements have been made of this standard and those that were made agree very well with the ENDF/B-VI evaluation.

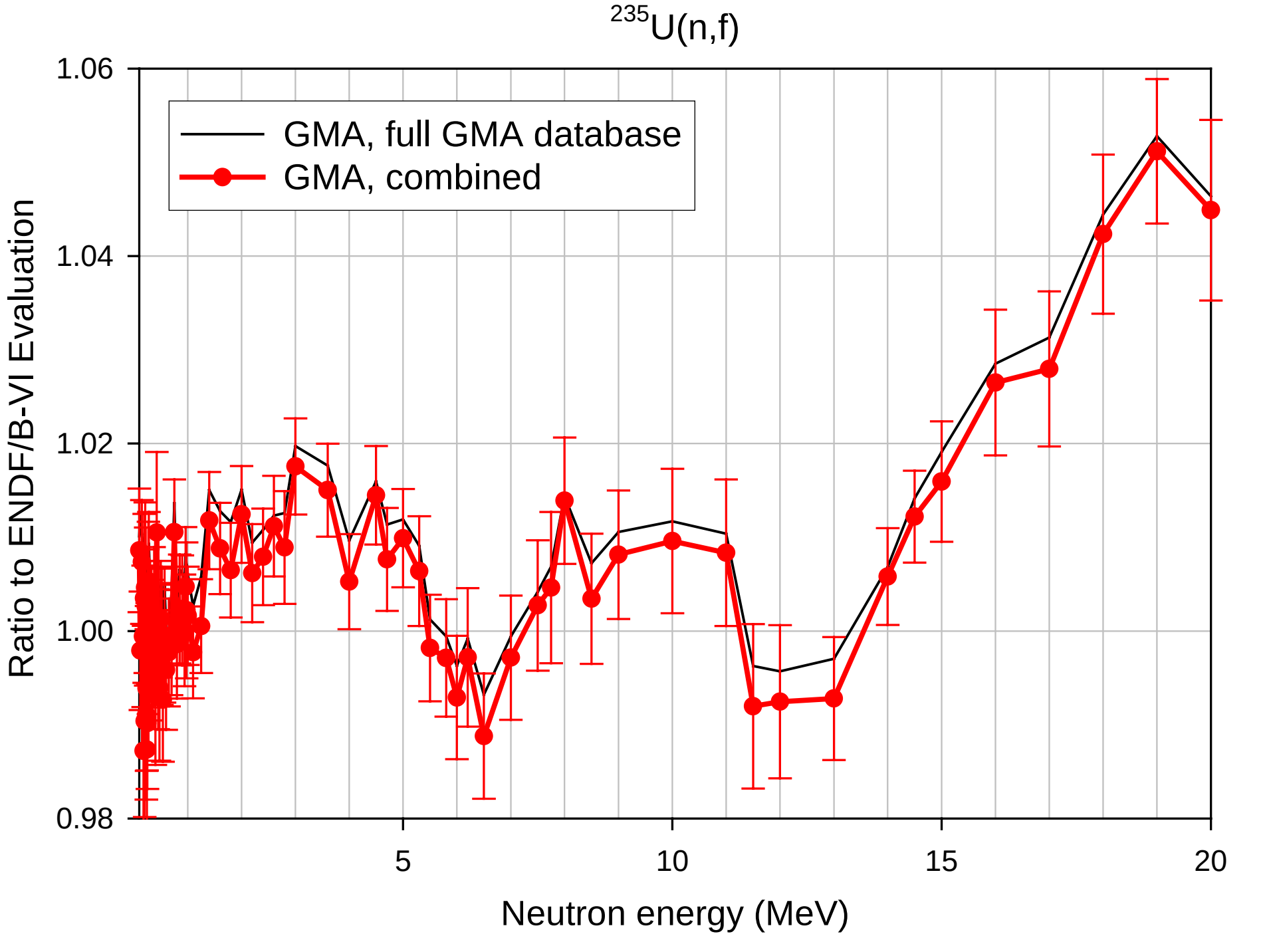
- Au(n,γ)
  - This evaluation is complete.

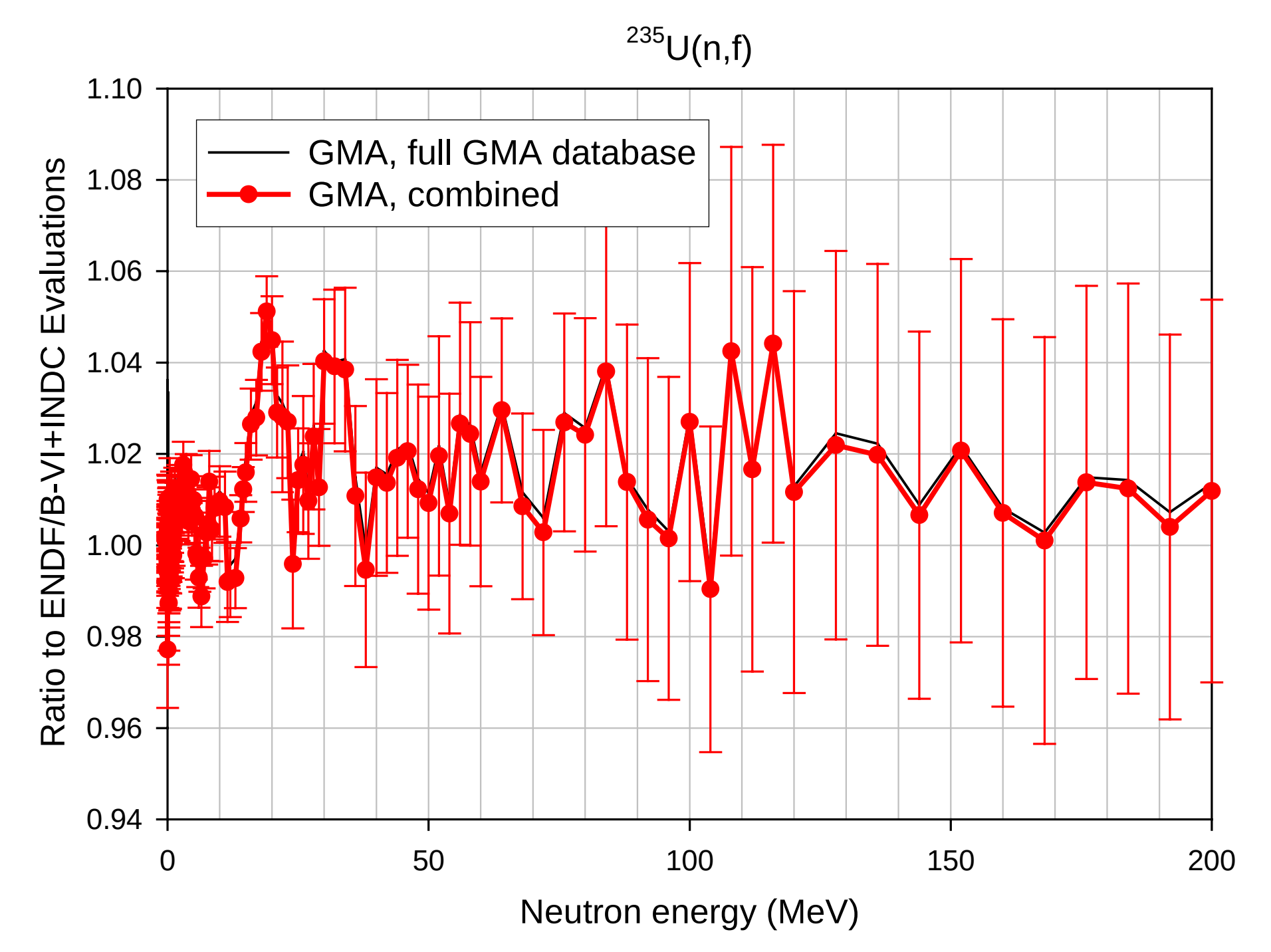

^{197}Au(n,γ)
Ratio to ENDF/B-VI Evaluation
1.06
1.04
1.02
1.00
0.98
0.96
5.0e-1
1.0e+0
1.5e+0
2.0e+0
2.5e+0
Neutron energy (MeV)
GMA, full GMA database
GMA, combined

Cross Section Results (cont.)

- $^{235}U(n,f)$
  - The evaluation is complete to 20 MeV. It will be extended to 200 MeV when the hydrogen standard is available to that energy.
  - An improved K1 results from this evaluation.
    - New K1=721.6 b
      - 0.8 b increase from Arif coherent scattering data.
      - 1.9 b increase from Gwin high accuracy ν data.
    - Hardy K1 value=722.7 ± 3.9 b
  - Good agreement is expected with GODIVA.
    - Calculations with preliminary results from this evaluation gave k_{eff}= 0.99971

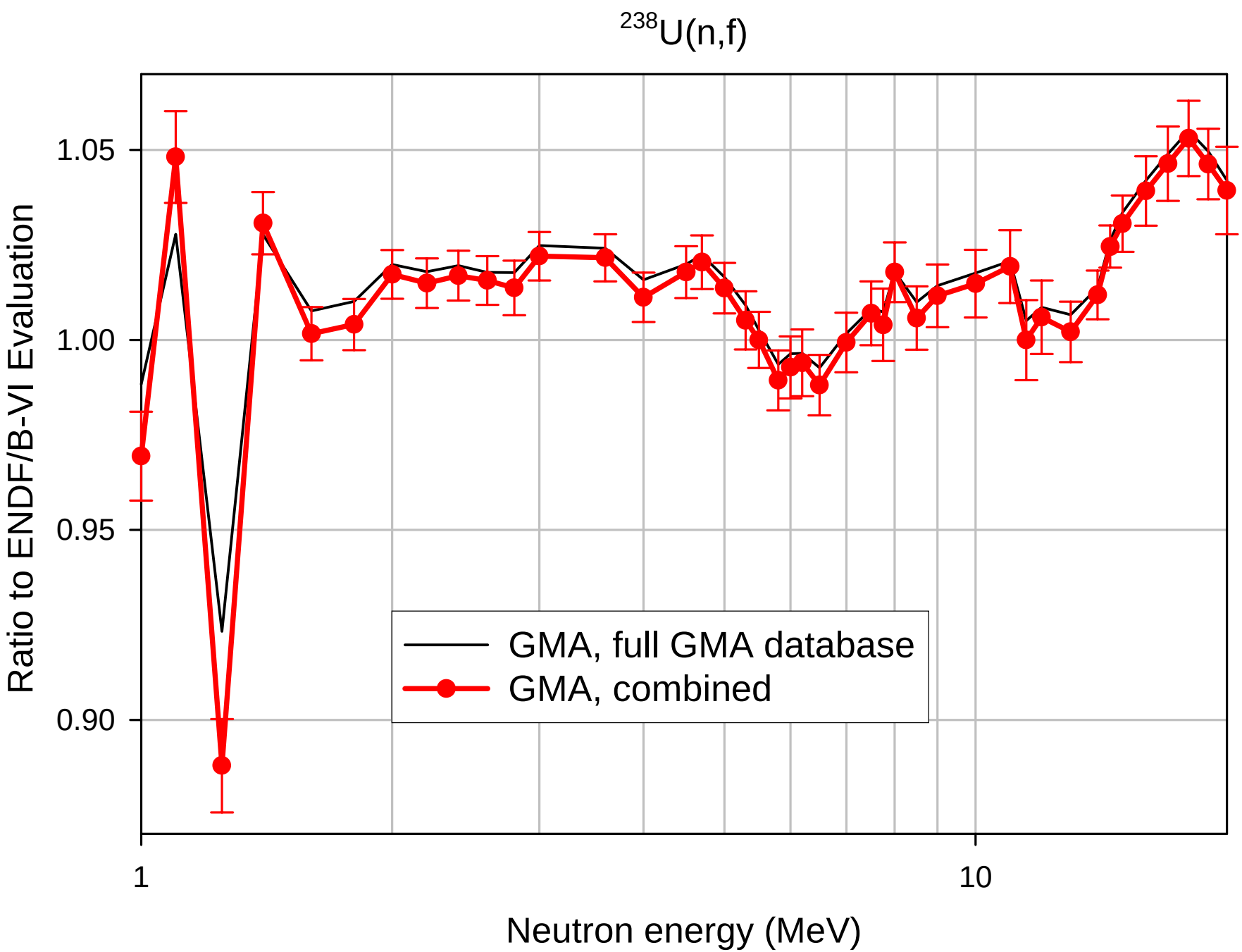

^{235}U(n,f)
GMA, full GMA database
GMA, combined
Ratio to ENDF/B-VI Evaluation
Neutron energy (MeV)
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.0001
0.001
0.01
0.1
1
10
100

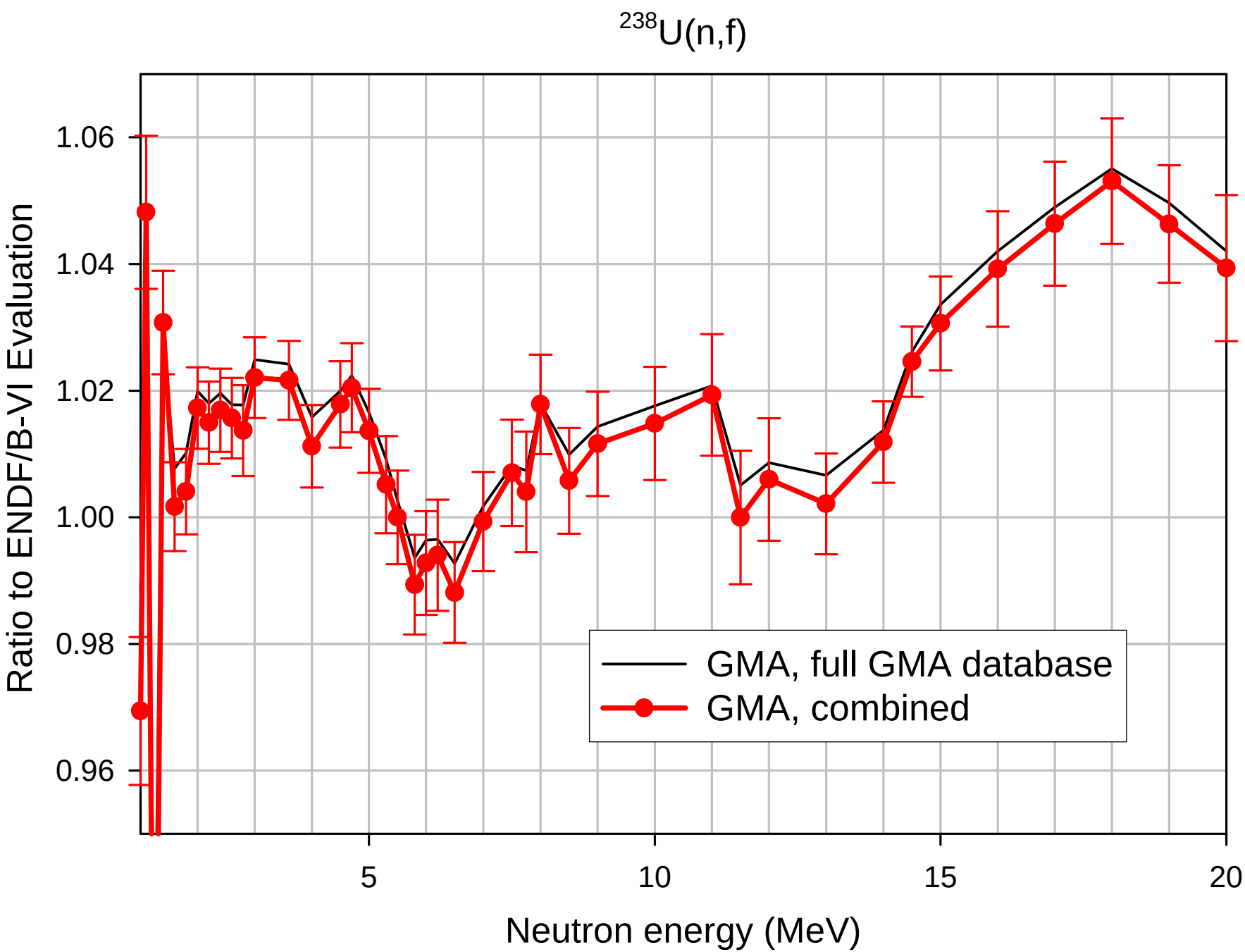

^{235}U(n,f)
GMA, full GMA database
GMA, combined
Ratio to ENDF/B-VI Evaluation
1.06
1.04
1.02
1.00
0.98
5
10
15
20
Neutron energy (MeV)


^{235}U(n,f)
GMA, full GMA database
GMA, combined
Ratio to ENDF/B-VI+INDC Evaluations
Neutron energy (MeV)
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0
50
100
150
200

Cross Section Results (cont.)

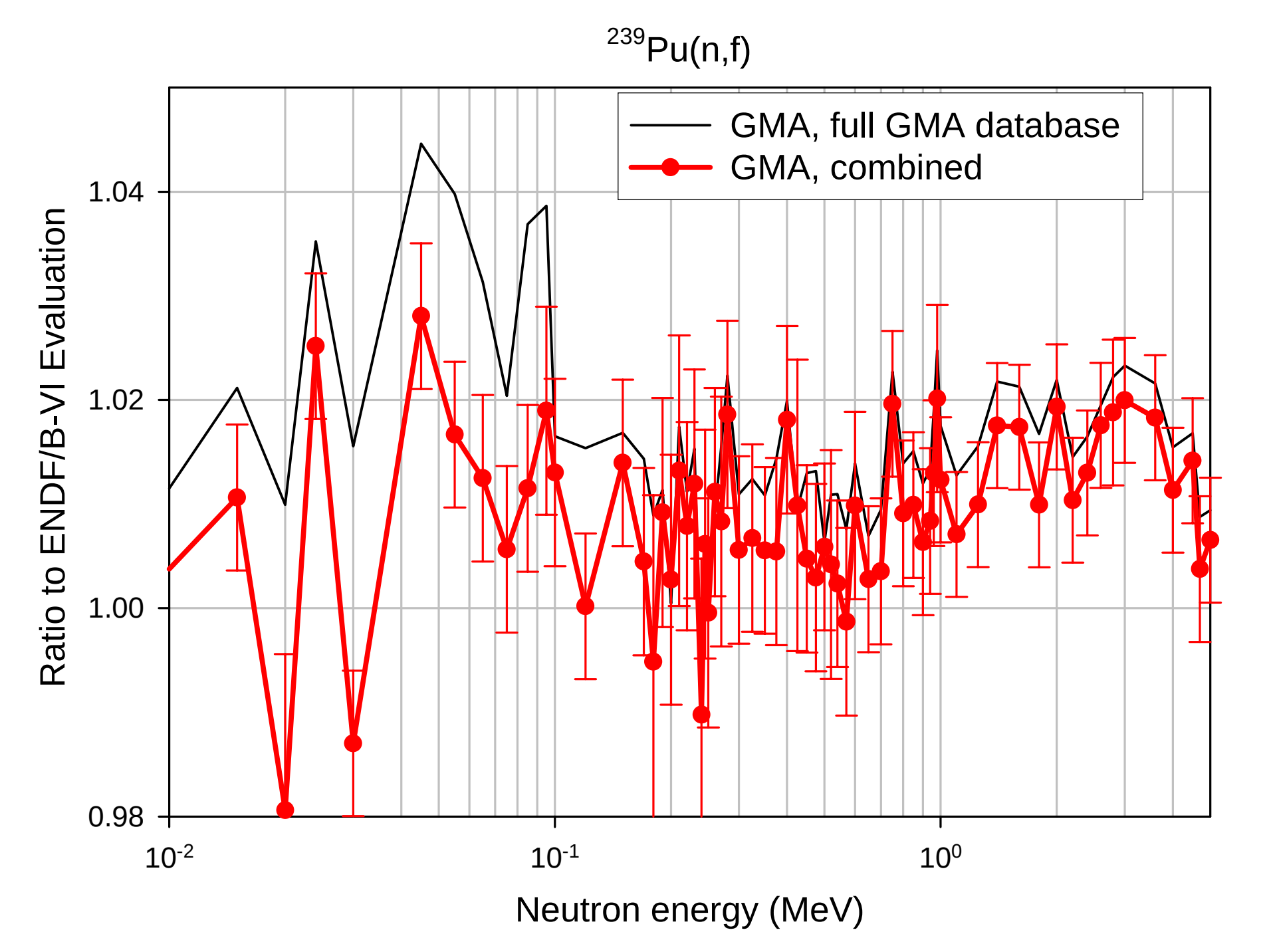
- ^{238}U(n,f)
  - This evaluation is complete to 20 MeV. It will be extended to 200 MeV when the hydrogen standard is available to that energy.
  - It is recommended that this cross section be accepted as an ENDF standard.
  - It is recommended that the lower energy bound for use as a standard be changed to 2 MeV.

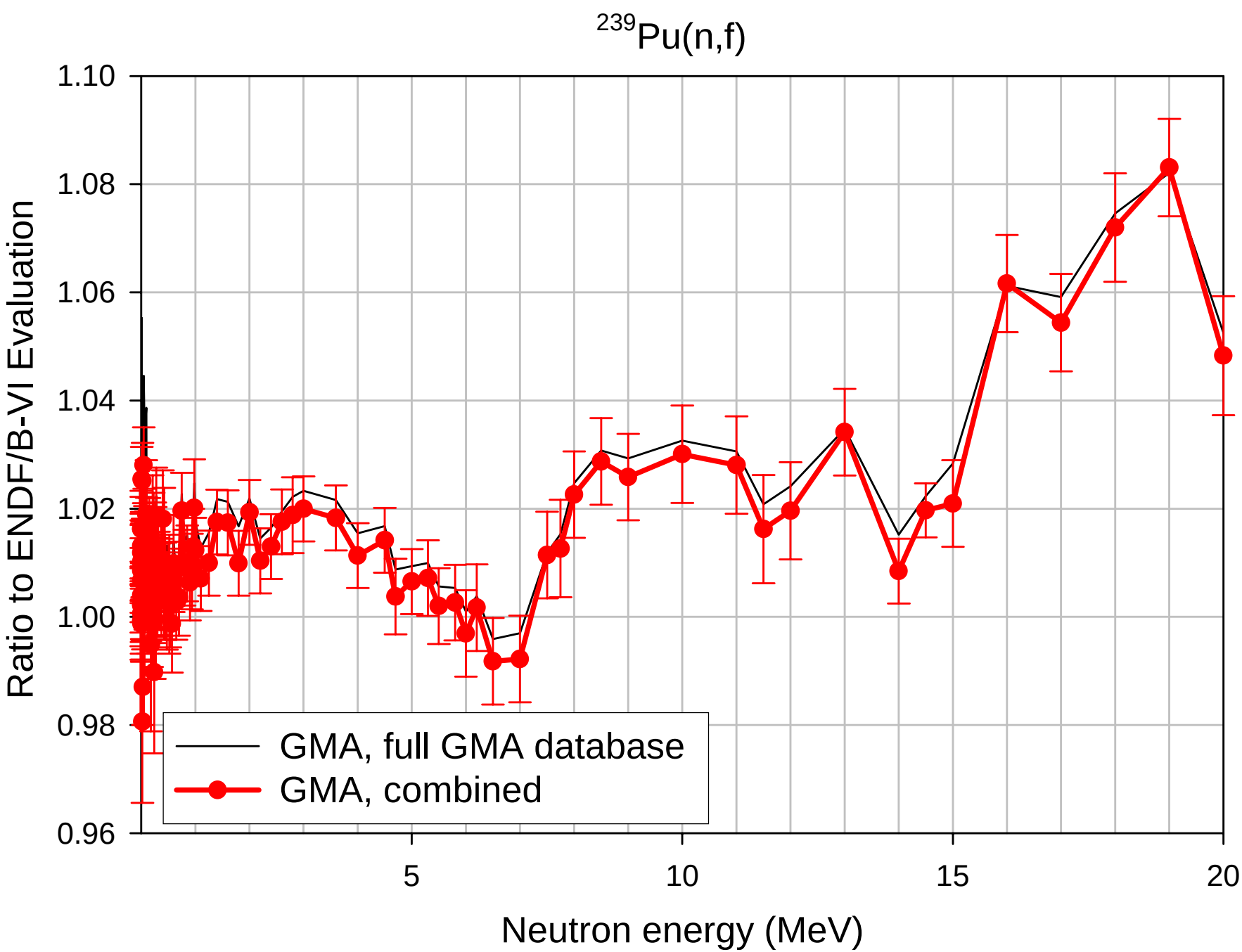

^{238}U(n,f)
Ratio to ENDF/B-VI Evaluation
1.05
1.00
0.95
0.90
1
10
Neutron energy (MeV)
GMA, full GMA database
GMA, combined


^{238}U(n,f)
Ratio to ENDF/B-VI Evaluation
1.06
1.04
1.02
1.00
0.98
0.96
5
10
15
20
Neutron energy (MeV)
GMA, full GMA database
GMA, combined

Cross Section Results (cont.)

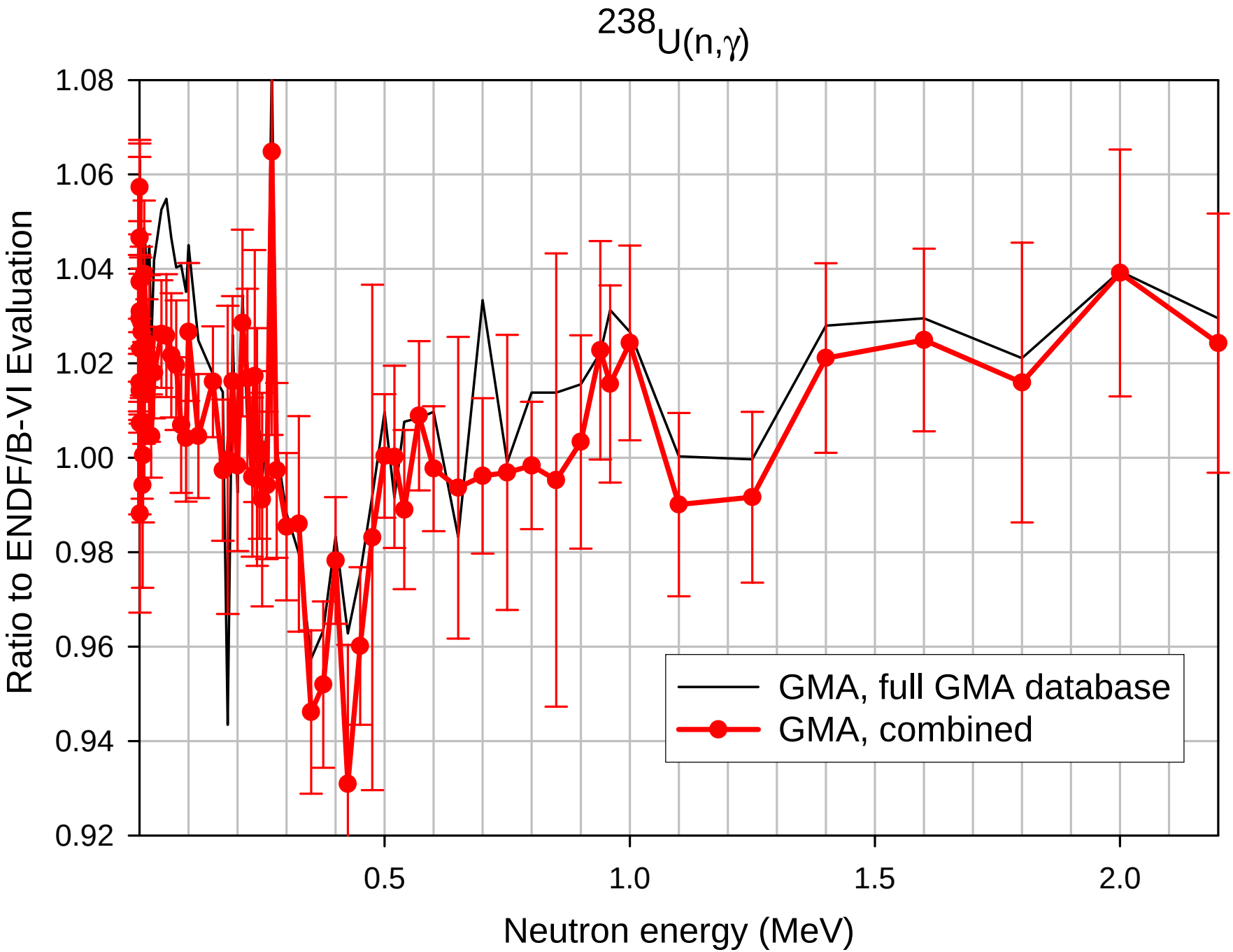
- ^{239}Pu(n,f)
  - This evaluation is complete to 20 MeV. It will be extended to 200 MeV when the hydrogen standard is available to that energy.
  - This is not a standard cross section.


^{239}Pu(n,f)
GMA, full GMA database
GMA, combined
Ratio to ENDF/B-VI Evaluation
1.04
1.02
1.00
0.98
10^{-2}
10^{-1}
10^{0}
Neutron energy (MeV)


^{239}Pu(n,f)
Ratio to ENDF/B-VI Evaluation
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
5
10
15
20
Neutron energy (MeV)
GMA, full GMA database
GMA, combined

Cross Section Results (cont.)

- $^{238}U(n,\gamma)$
  - This evaluation is complete.
  - This is not a standard cross section.


^{238}U(n,γ)
Ratio to ENDF/B-VI Evaluation
Neutron energy (MeV)
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.5
1.0
1.5
2.0
GMA, full GMA database
GMA, combined

Uncertainties

Though there is some uncertainty information available at this time, such data will not be released until the investigation has been completed for the entire evaluation. It is anticipated that covariance and variance data will be available early next year. The importance of considering the covariances not just the variances is stressed for any discussion of uncertainties.

Conclusions and Recommendations

The work on the evaluation is approaching completion. However, there is still additional work that must be done to complete the evaluation. Cross sections have been determined for all the standards except $^{3}He(n,p)$, $^{10}B(n,\alpha)$ and $^{10}B(n,\alpha_1\gamma)$. In some cases only limited ranges were provided. These provide an interim library of standard cross sections for the ENDF/B-VII library. The remaining data and detailed uncertainty information will be supplied consistent with the tentative schedule that was given.

These data represent an improvement over previous evaluations of the standards.

Discrepancies in data for the $^{235}U(n,f)$, $^{238}U(n,f)$ and $^{239}Pu(n,f)$ cross sections and their ratios at high energies require new measurements. Such work should be done through an international collaboration, such as a WPEC Subgroup.