Report on Status of SG39/SG46

May, 2018

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Idaho National Laboratory

SG39

SG39 had the final meeting on Tuesday

Final Activities

- Had meeting last November.
- Formulated new adjustment techniques to be passed on to SG46.
- Provided feedback on CIELO and CIELO-2 cross sections and covariance matrices via adjustments and/or analyses of consistency with C/E.
- Concluded work on all chapters of the final deliverable: Methods, Experiment Selection, Adjustment and Covariance Consistency.
- Final deliverable to be sent to NEA by end of September.

CIELO 1 and 2 C/E impact on selected integral experiments and consistency with current covariance matrices

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SG39 Meeting

Novemeber 20-21, 2017

www.inl.gov

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Summary of CIELO – ENDF/B-VII.0

- Regarding experiments, this exercise has shown that the experiments other than critical masses (e. g. spectral indices, irradiation experiments, reactivity coefficients, and neutron propagation) provide extremely useful information.
- Many compensations have been observed among reactions and also energy range (not shown in viewgraphs).
- Regarding the 5 isotopes, the major impacts are related to:
  - ^{16}O: elastic, (n,α), P_1 elastic. Only few experiments are sensitive.
  - ^{56}Fe: elastic, inelastic, capture, P_1 elastic. Propagation experiments are the most sensitive.
  - ^{235}U: inelastic, capture, fission, fission spectrum
  - ^{238}U: inelastic, capture, P_1 elastic, fission, nubar
  - ^{239}Pu: capture, fission, nubar, fission spectrum (in general lesser impact than the other isotopes)

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Summary of CIELO-2 – CIELO

- As general observation from the point of view of an user, one can say that we are far away from reaching a consensus.
- The case of the JEZEBEL critical mass is emblematic. The large compensations among the different reactions (elastic, inelastic, P_1, and fission) yields the same critical mass. The user is disoriented: where is the truth?
- Regarding the 5 isotopes, the major impacts are related to:
  - ^{16}O: elastic, (n,α), P_1 elastic.
  - ^{56}Fe: elastic, inelastic, capture, P_1 elastic.
  - ^{235}U: inelastic, capture, fission, nubar, fission spectrum
  - ^{238}U: inelastic, capture, P_1 elastic, fission, nubar, fission spectrum
  - ^{239}Pu: capture, fission, P_1 elastic, nubar, fission spectrum

Summary of consistency with current covariance matrices

- There are severe differences between the two covariance matrix data.
- In many instances the calculated uncertainties would not cover the C/E spread of the experiments, at least at the one sigma level.
- Of specific interest is the effect of the correlation. In many cases the differences leads to a different sign in the contribution: what can explain this completely different behavior?
- Regarding specific differences between the two covariance matrices related the 5 isotopes, the major impacts are associated to:
  - ^{16}O: elastic, (n,α).
  - ^{56}Fe: elastic, inelastic, capture.
  - ^{235}U: elastic, capture.
  - ^{238}U: elastic, inelastic, capture, fission, nubar, fission spectrum
  - ^{239}Pu: elastic, inelastic, capture, fission.

WPEC SG39 Meeting, Nov. 20-21, 2017
OECD/NEA, Boulogne-Billancourt, France

CIELO-2 Based Cross-section Adjustment by Adding New Experiments on the Basis of the SG33 Benchmark

K. Yokoyama and M. Ishikawa

Japan Atomic Energy Agency

Acknowledgment: The authors express sincere thanks to Mr. T. Jin of NESI incorporation for his many helps of performing the adjustment calculations and pre- and post-processing the results for this presentation.

New Integral Experiments provided by SG39

- PROTEUS
  - HCLWR-PROTEUS
    - Core 7: moderated by water (Vm/Vf=0.48)
      - KINF (k_∞), Void reactivity worth, C28/F49, F28/F49, F25/F49, F41/F49, C42/F49
    - Core 8: not moderated
      - KINF (k_∞), C28/F49, F28/F49, F25/F49, F41/F49, C42/F49
  - Code & Library
    - MCNP6.11 & JEFF-3.1.1
- SNEAK
  - MOX fuel reflected by metallic depleted uranium
    - 7A: PuO2-UO2, graphite
      - KEFF (k_{eff})
    - 7B: PuO2-UO2, ^{nat}UO2
      - KEFF (k_{eff})
  - Code & Library
    - THREEDANT & ENDF/B-VII.1

→ + 15 integral experiments

Based on CIELO-2, the SG33 adjustment benchmark was performed by adding integral experimental data of SNEAK and PROTEUS, which are prepared in SG39. From this benchmark, the followings are found.

- For the original library of CILEO-2, C/E values of ZPPR-9 sodium void reactivity (SVR) are not good (C/E > 1.1). Moreover, the C/E values are not improved well by adjustment.
- In the CIELO-2 based adjustment calculation, C/E values of criticalities of SNEAK-7A, -7B, and PROTEUS 7 are not improved well by adjustment both in CIELO-2 and JENDL-4.0. However, since the application of the new integral experiments prepared by WPEC/SG39 to a nuclear data adjustment is the first attempt, there is still room for the evaluation of the integral experiments from the viewpoint of the nuclear data adjustment. For instance, the correlations of the uncertainties for the new integral experiments were ignored, i.e., set to zero, in this adjustment calculation.
- For the original CIELO-2, reaction rate ratios (spectrum indices) of C28/F49 and F28/F49 are underestimated. Although most of them are improved by adjustment, F28/F49 in PROTEUS 8 is not improved sufficiently.

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Integral data assimilation on U235 and U238 nuclear data and impact on FCA-IX spectral indices.

V. Huy
G. Rimpault, G. Noguère

CEA/DER/SPRC/LEPh

OCTOBER 2017, 21

U235 CAPTURE : SUMMARY

- Results on U235 capture were obtained using critical mass and also PROFIL irradiation experiments.

- At 1-2keV, our assimilation results agrees with recent measurement at RPI (**-30% when compared to JEFF-3.1.1**) $\Rightarrow$ confirm the conclusions of WPEC/SG-29

- From 10keV to 100keV, assimilation results are consistent with DANCE measurements (**+10% from JEFF-3.1.1**) $\Rightarrow$ JEFF-3.3t3 is higher (+20%)

U238 CAPTURE : SUMMARY

- Results on U238 are **highly dependent on fission spectra** :
  -when fission spectra varies through assimilation, trends are included in posterior uncertainties (JEFF-3.1.1 is ok).
  -when fission spectra are constrained**, a -3% to -6% decrease is suggested from 15 keV to 1MeV.**

- Such modifications (decrease from 3 to 6 % from) can have a significant impact on critical mass of fast reactor ! For instance, **modifications suggested by assimilation (fission spectra fixed) results in +500pcm on k_{eff} of a SFR core such as ASTRID.**
  → Further investigation is needed.

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U238 INELASTIC : SUMMARY

- Assimilation results on U238 are highly dependent on fission spectra : **inelastic trends goes from -4% to -8%** (depending on whether fission spectra are varying or not) **in the plateau region**.

- Overall, CIELO and JEFF-3.3t3 both agree with this trend of decreasing U238 inelastic in the plateau region.

Sandro Pelloni :: Senior Scientist :: Paul Scherrer Institut

Consistent adjustment on the basis of TENDL data: Sandro Pelloni and Dimitri Rochman

November 20-21, 2017: WPEC/SG-39 and WPEC/SG-46

Conclusions

- Differently from the other cases, the two APIA simulations using TENDL/TENDL i.e. consistent cross-sections and covariance data in terms of (1) data source, and (2) unified processing on the basis of the Total Monte Carlo method are able to provide similarly adjusted cross-sections by avoiding conflicting effects between incremental steps.
- These characteristics are indicative of reliable adjustments. Correspondingly it turns out that the TENDL inelastic scattering cross-sections of ^{238}U and ^{23}Na would need some reductions essentially due to the assimilation of ZPPR9 experimental data.

- **Key conclusion: reliable adjustments using the APIA methodology require full consistence between expectation values of the nuclear data and their covariances.**

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INFLUENCE OF SYSTEMATIC EXPERIMENTAL UNCERTAINTIES IN THE EVALUATION OF NUCLEAR DATA

Cyrille De Saint Jean, Pascal Archier , Gilles Noguere,
Pierre Leconte, D. Bernard, C. Carmouze and T. Nicol
CEA/DEN/Cadarache

JEFF-CHANDA Joint Winter Meeting
November, 20/24, 2017
JEFFDOC-1880

www.cea.fr

Conclusions

5

- Evaluation of systematic uncertainties is of prime interest for Nuclear Data evaluators
- Microscopic Experiments:
  - Still high Syst. Uncertainties on Fission (Continuum), Capture of Fissile isotopes
  - Mainly related to normalization, background, detectors efficiency, ...
  - Create Evaluated Nuclear Data with long range (and high) correlations
- Integral Experiments:
  - A proper look on Syst. Uncert. for Integral Experiments is paramount

    → Go back to pre-ICSBEP (Experimental reports ?)

    → If no information → be careful in the choice ($\rho = 0$ or 1)
  - Syst. Uncert. will change adjustments results (trends or uncertainty reduction) → SG46
  - Could be positive !!

    → Look at integral experiments such as godiva/flattop

    → Innovative Integral Experiments to be studied

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WPEC SG39 Meeting and SG46 Kickoff Meeting, Nov. 20-21, 2017
OECD/NEA, Boulogne-Billancourt, France

A "Tiny" Adjustment of Nuclear Data and Associated Correlation Factor

K. Yokoyama and M. Ishikawa

Japan Atomic Energy Agency

Exercise with Simple Problem

- For example, let us consider a case where nu-bar of Pu-239 is slightly adjusted/calibrated to improve a Pu-239 criticality experiment.

- Posterior-correlation factors were calculated parametrically with the following condition:

  - σ_1 (parameter): the prior-uncertainty of Pu-239 nu-bar
  - $g_1 = 1.0$ (100%, fixed): the sensitivity of Pu-239 nu-bar
  - $\sigma_2 = 0.01$ (1%, fixed): the prior-uncertainty of the other nuclear data
  - g_2 (parameter): the sensitivity of the other nuclear data (e.g., fission cross-section)
  - v_1 (parameter): the uncertainty of integral data

In the present paper, we investigated the impact on the posterior correlations quantitatively by deriving the explicit solution of a simple problem, in which two nuclear data are adjusted by one integral data. The explicit solution of the simple problem revealed the conditions where the posterior-correlation coefficient becomes significant or negligible in a simple cross-section adjustment case. The results are consistent with the qualitative trends expected from the adjustment equation. Moreover, it enables us to discuss the impact on the posterior correlations systematically and quantitatively.

From the viewpoint of adjusting nuclear data with the use of integral experimental data, we can summarize the results as follows.

- We should carefully judge whether the post-correlation can be ignored when we use an integral experimental data with low uncertainty.
- We should not ignore the post-correlation when we use an integral experimental data which is sensitive to more than two reactions, even if we slightly adjust a nuclear data with high fidelity.

More briefly, we always need to consider the post-correlations in the case where the use of the integral experimental data is effective for adjusting nuclear data. Otherwise, the ignored post-correlation may cause serious overestimations in the uncertainty quantification.

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SG39 Final Deliverable Outline

1 Introduction (M. Salvatores, G. Palmiotti)

2 Methods

- 2.1 Intermediate Report Chapter 1
- 2.2 Intermediate Report Chapter 2
- 2.3 Monte Carlo Sensitivity Coefficients (E. Ivanov)
- 2.4 PIA and REWIND: Two New Methodologies for Cross Section Adjustment (G. Palmiotti, M. Salvatores)
- 2.5 APIA Methodology (S. Pelloni)

3 Experiments

- 3.1 Experiments selection (G. Palmiotti, M. Salvatores)
- 3.2 Stress test (H. Wu)
- 3.3 PROTEUS (M. Hursin)
- 3.4 β_{eff} experiments (I. Kodeli)
- 3.5 Propagation Experiments (I. Kodeli)
- 3.6 FCA (G. Palmiotti, M. Salvatores)

4 Adjustments and covariance data consistency

- 4.1 CIELO-2 adjustment (K. Yokoyama)
- 4.2 TENDL adjustment (S. Pelloni)
- 4.3 CIELO adjustment (G. Palmiotti)
- 4.4 "Impact of New Evaluations of CIELO and CIELO-2 on selected Experiments and Consistency with Current Covariance Matrices" (G. Palmiotti)
- 4.5 "'Tiny' adjustment of nuclear data and associated correlation factor" (K. Yokoyama)
- 4.6 "Integral Experiments Assimilation on U235 and U238 nuclear data in the fast energy range" (V. Huy)

5 Final recommendations and conclusions (G. Palmiotti, M. Salvatores)

SG46

SG46 had the first official meeting on Tuesday and Wednesday

It is proposed a new WPEC subgroup that should have a mandate on formalizing and applying a methodology for:

- Selecting appropriate experiments and in particular those that provide separate effects information on the basis of the findings of Subgroup 39.
- Analyzing C/E by isotope, reaction, and energy range in order to point out compensation effects (based on low uncertainty, sensitivity coefficients, and χ^2). Possibly, all energy range from thermal to fast, should be examined.
- Computing sensitivity coefficients of selected experiments and integral parameters according to the guidelines worked-out in the previous Subgroups 33 and 39. This part of the work should account for and complete the work performed at the Databank by Ian Hill available through the DICE code.
- Performing new generalized adjustments to provide unambiguous feedbacks. Some approaches has been proposed (Yokoyama, Palmiotti, and Ivanov) but not yet finalized or widely used. Other approaches could be proposed and compared. The use of reaction cross correlations and of covariance data for angular distributions, secondary energy distribution from inelastic scattering should be done as far as these data will be made available in the different nuclear data projects.

Moreover the new SG should give guidelines on:

- How to define a general protocol for the use of sensitivity coefficients and covariances in order to provide an improved traceability for safety and design purposes.
- How to systematically quantify impact on a list of selected target power reactors (thermal, epithermal, and fast spectrum reactors). This list of reactors should be defined as far as possible with the help of industry representatives
- How to provide updated target accuracies for nuclear data uncertainty reduction by combining inverse approach and integral experiments (some efforts in this direction have started at ORNL). This last goal should have a significant impact in prioritizing new experiments, both differential and integral and to foster international collaborations for that purpose.

The new subgroup should work in in close contact with the new WPEC Subgroups 44, working on new Covariance Data, and 45 VaNDaL that is supposed to create a database of the selected benchmarks along with the respective decks for calculations.

Current Activities

- **Had a preparatory meeting last November.**
- **Common meeting SG44-SG46.**
- **Choice of integral experiments: criteria and objectives**
- **Toy" calculations and practical examples.**
- **Generalized adjustments**
- **Select a series of applications (power reactors) where perform UQ and quantify improvements due to the use of the information coming from the integral experiments**

Preliminary Feedback on Using CIELO Covariance Matrices

G. Palmiotti, M. Salvatores

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WPEC SG44/46 Meeting

May 15, 2018

Paris

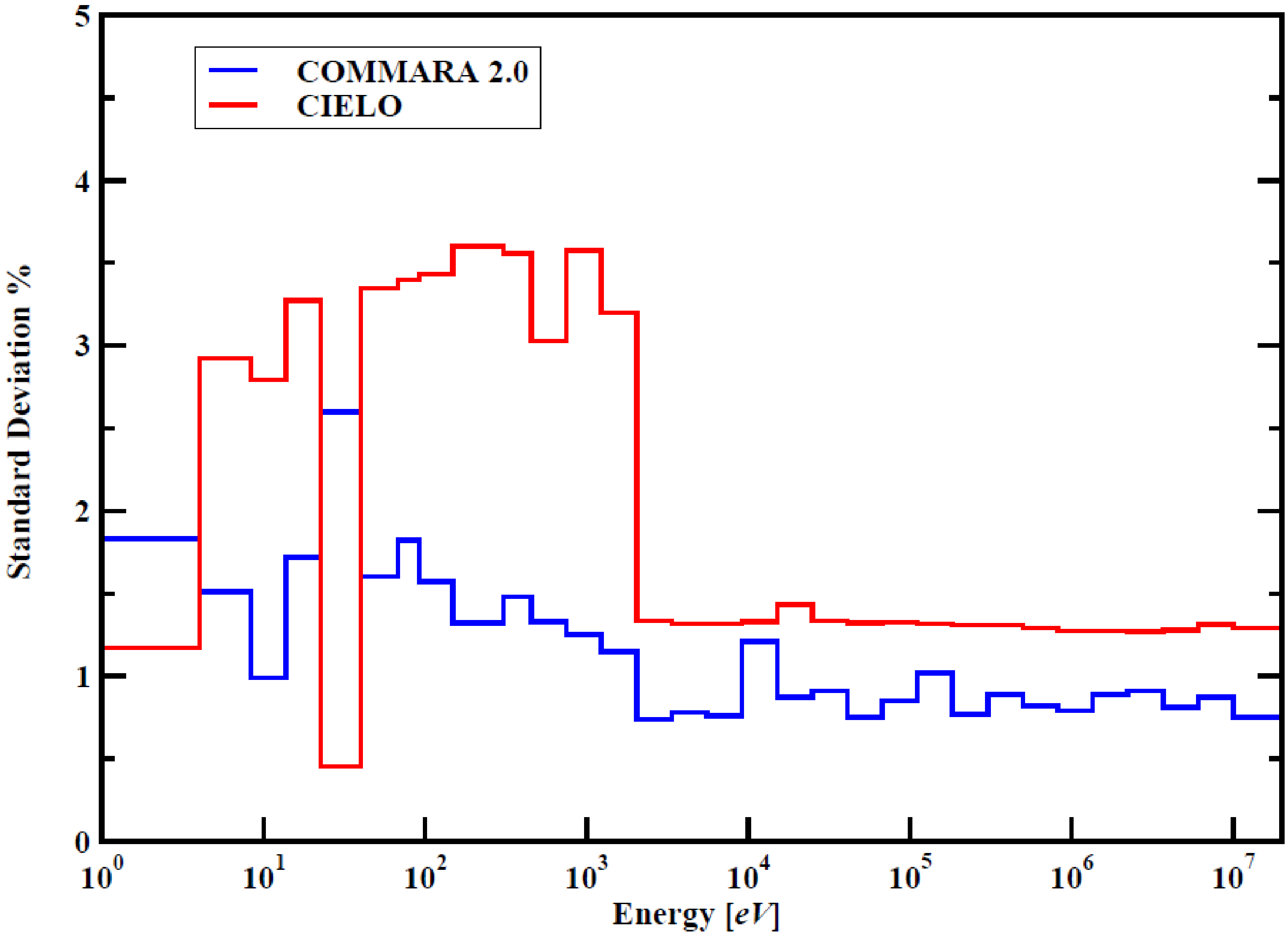
www.inl.gov

Idaho National Laboratory

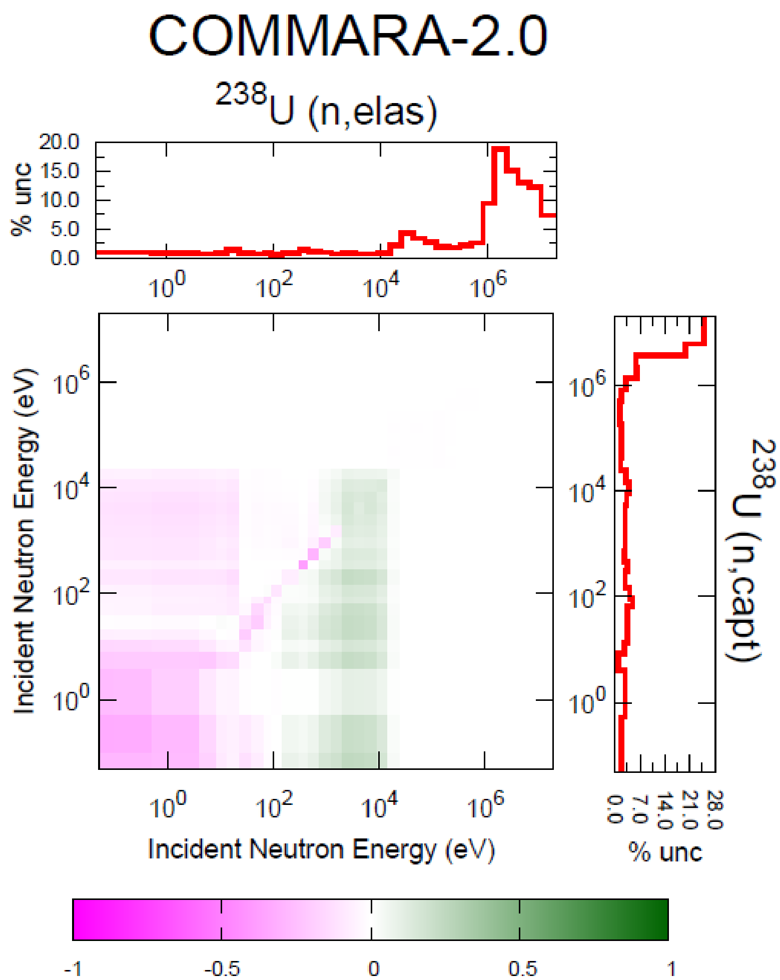
Feedback on CIELO Covariance Matrices Values

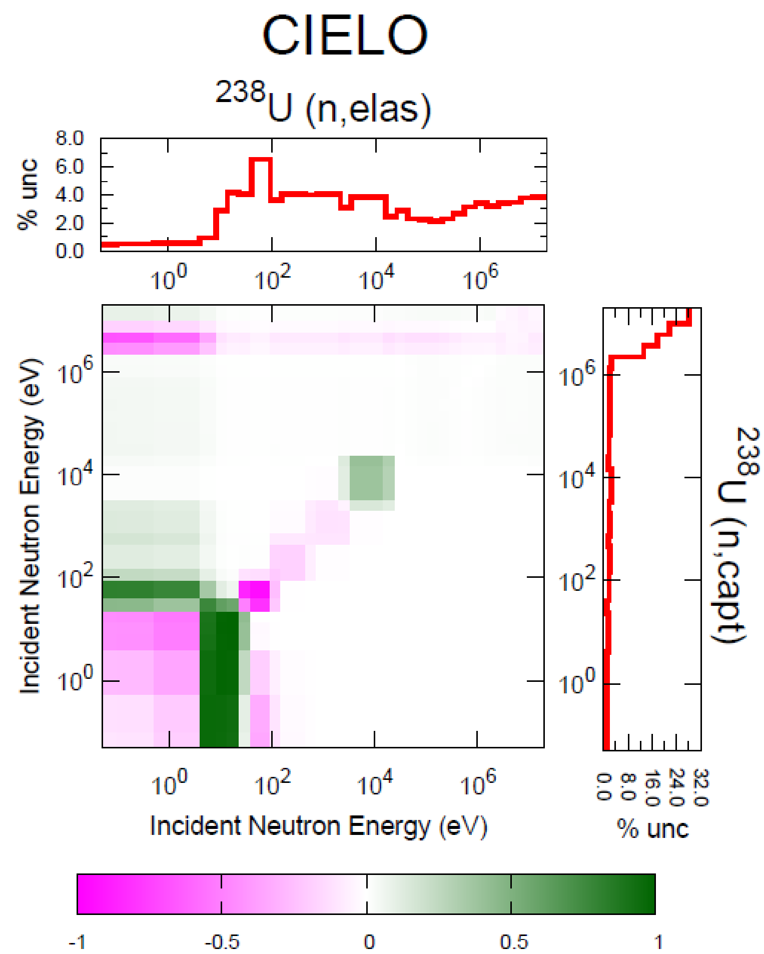
- Missing covariance data for:
  - P_1 of ^{56}Fe, ^{235}U, ^{238}U (Used corresponding JENDL-4 data)
  - Cross correlations for ^{56}Fe reactions that were present in COMMARA 2.0
- Unacceptable values (correlation >1) for:
  - ^{235}U cross correlations: inelastic/ (capture and fission), fission/capture
  - ^{238}U cross correlations: elastic/inelastic, inelastic/ (capture and fission)
  - ^{238}U fission spectrum (very low energy)
- Strange values (>>>>100%) for ^{16}O P_1 values at low energy
- Some difficulties in processing MF35 data (Oscar Cabellos helped)

^{239}Pu σ Fission Standard Deviation %



Correlations





Summary of consistency between covariance

- **Concerning differences observed on the C/E, CIELO does a good job on critical masses that are mostly used in validation, but perform poorly on others not so often used ones (e. g. ZPR/9-34, ZPR3-54) or reactivity variations (e. g. coolant void, rod worth). For quantities of the elementary type there very little improvement and many times worsening. This indicates compensations.**
- **There are severe differences between the two covariance matrix data, and in many instances the calculated uncertainties would not cover the C/E spread of the experiments, at least at the one sigma level.**
- **Of specific interest is the effect of the correlation. In many cases the differences leads to a different sign in the contribution.**
- **Regarding specific differences between the two covariance matrices related to the 5 isotopes, the major impacts are associated to:**
  - **^{56}Fe: elastic, inelastic, capture.**
  - **^{235}U: fission and fission spectrum**
  - **^{238}U: elastic, inelastic, capture, fission, nubar, fission spectrum**
  - **^{239}Pu: capture, fission.**

A Quick Review of Summary Report of the IAEA Consultants Meeting on "Integral Data in Nuclear Data Evaluation"

K. Yokoyama and M. Ishikawa
Japan Atomic Energy Agency

Recommendations by the IAEA Meeting (5/5)

- A General purpose library is expected to faithfully reflect differential data and corresponding uncertainties and correlations (e.g., from cross-section ratio measurements), and is expected to be used as a *prior* to derive application libraries for specific applications.
- Note that in a broad sense typical adjusted libraries correspond to application library #4.
- Uncertainties propagated to integral parameters in applications from a general purpose library are expected to be much larger than those propagated from application libraries to a relevant application.
- Evaluators must provide clear and comprehensive information on which integral experiments have been used, and how those experiments were used in the evaluation process.
- Note that only Class 1-3 type of integral experiments are acceptable for use in the evaluation process.

Summary of ND adjustment exercise
&
Examples of SINBAD shielding benchmarks suitable for ND validation

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WPEC SG46, May 15-16, 2018, OECD/NEA

SINBAD: FISSION NEUTRONICS

Benchmark / quality	Additional information needed on
ASPIS PCA REPLICA ♦♦♦	Supplementary information needed on: - set-up of the activation foils; - rear wall of the ASPIS cave
ASPIS Graphite ♦♦♦	New MCNP model. Additional information needed: - detectors arrangement (dimensions are inconsistent)
ASPIS Water ♦♦♦	New MCNP model. Supplementary information needed on: - NE-213 spectrometer - water tank (container, bowing effects) - experimental room
ASPIS n/γ water/steel arrays ~ ♦♦♦	Supplementary information needed on: - detectors arrangement - bowing of the water tanks - background subtraction - cave walls
EURACOS Na ~ ♦♦	New MCNP model, source model, uncertainty. Supplementary information needed on: source (spectrum, spatial distribution), energy structure of the proton recoil spectra, neutron spectrometers response functions, additional details on the geometry (room return), on geometry and material composition uncertainties. Limited applicability – fast neutron attenuation in iron only.
HARMONIE ♦	too simplified geometry, materials & n.source description

Design of the exercises to combine use trend analysis and reference group method in isotope oriented adjustment

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CHINA NUCLEAR DATA CENTER

1. Motivation

- **Q2 in the previous presentation: what kinds of improvements are expected in Nuclear Data Adjustment ?**
  - One of wish list is to remove the trend of k_{eff} which is made up of testing results of several or dozens of experiments.
- **Trend of C/E values**
  - Sensitive to nuclear data of different isotopes, reactions.
- **The key issue in using NDA to improve evaluation in this situation is *how to avoid compensation.***
  - ***Identify the data of which nuclide should be blamed is in the first place.***
- **Trend analysis and reference group method were used to clarify which sensitive nuclide should be responsible for k_{eff} trend in CENDL Project.**
- **Does this method can be combine used with NDA?**

Mark Chadwick proposal:

“Would the following calculations be of valuable to further understand the issues associated with having a calibrated evaluated file (ie tweaked, as we do now in endf7 and endf8 and in Jeff, Jendl), versus keeping such files uncalibrated to the extent possible?

What I would like to understand is the extent to which it matters, based on how it impacts an adjusted file’s subsequent performance.

So consider two starting evaluates files, say
ENDF-1. (calibrated), and
ENDF-2 (uncalibrated)
(And note these 2 files would be largely the same except say for different nubar values ; their covariance data would be the same)

Run each of these through your adjustment Bayesian approach, based on a suite of integral criticals. These make output files, let’s call them:
Adjusted-1
adjusted-2

Then, assess the extent to which each of these adjusted 1,2 files differ regarding their different predictions for other applications. (I know the definition of “other applications” will perhaps matter, depending on how similar the application is to the criticals that were used in the adjustment process).

If they perform differently in terms of predicted criticality and reaction rates for application problems, then this would highlight the importance of the issue;

if instead they perform in essentially the same way, then it would suggest that calibration is not of practical negative importance for those who make and use adjusted libraries. (Whilst calibration has obvious benefits for those who don’t!).

Is this a calculation worth trying out?

Some answers/comments already, e.g. P.Talou:

The so-called "calibration" or "lucky draw" or "library optimization" or whatever it's called does not account for those post-evaluation correlations. While the mean values are adjusted, there is no "record" of this adjustment in the evaluation process.

I would again point to Kawano et al's paper (NSE 153, 1, 2006) where we played with a toy calculation, adjusting the Pu239 fission cross section and covariance to reproduce Jezebel k_eff within the reported 0.2% experimental uncertainty on the integral data. The result was that the cross section almost did not change, since k_eff was already reproduced by the prior cross section, but the posterior covariance now includes negative correlations, as expected.

This is the main reason why this "calibration" process should not have much of an impact on your post-evaluation adjustment process, *as long as* the evaluated covariance is not modified at the evaluation stage.

Otherwise, it would mean double-counting.

This is the approach proposed recently by Rochman and Bauge. It is somewhat appealing but also confusing, since now part of our knowledge coming from integral data is used *explicitly* in the evaluation process. To avoid double-counting, you would now have to be very careful about which integral data have been used and which have not.

Testing Calibration Effects with SG33 Benchmarks

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1. Background

- ✓ **Mark Chadwick's proposal**
  - **A toy calculation to understand how calibration affects the adjustment results.**

ENDF-1. (calibrated), ENDF-2 (uncalibrated) + *Same covariance* → ***Adjusted-1 Adjusted-2***

- ✓ **Conclusion of stress test**

> ***Different constraints can lead to different, even contrary adjusted results for both integral and differential data. -- Haicheng***

- ✓ **Pino's PIA exercise has shown**

> ***"the succession of experiments to be used in the progressive adjustment will impact significantly the final results both in terms of central values and a posterior covariance." -- Pino***

- ✓ **Qualitative analysis has never been done before.**
  - Play with the SG33 exercises can help to understand how the previous conclusions function in evaluation calibration.

3.3 Summary of phase I

- **Case0 and 1 confirms**
  - Change PIA sequence will affect adjusted results significantly.
    - The priority and correlations of “IPs” were changed when using PIA method.
  - Zero posterior uncertainties were found.

- **Case 1 and 2 show "Calibration” with and without double counting**
  - The adjusted IPs were not affected significantly, if post-evaluation correlations are passed to the following adjustment.
  - However, this kind of calibration cause underestimation of the posterior covariances of nuclear data.

- **Case 0 and 3 show "Calibration" without the evaluated covariance modified.**
  - Adjustment results will not be affect so significant
    - Similar posteriors of integral parameters and nuclear data are obtained.
  - *Keep covariances untouched when you do calibration?*
    - *It looks like double counting will not so harmful if $\Delta\sigma$ is small.*

- **Remind**
  - Different constraints can lead to different, even contrary adjustment results for both integral and differential data.
    - Sequence of adjustment is also a kind of constrain.

3.2 Summary of phase II

- **Case0 and 11 confirms**
  - Even if increasing the number of IPs used in "calibration", change the PIA sequence will affect adjusted results significantly.
    - Zero posterior uncertainties were found again.
- **Case 11 and 12 show "calibration" with and without double coutning**
  - Reusing the same integral parameters will cause underestimating posterior uncertainties of both integral parameters and nuclear data.
- **Case 0 and 13 show the "calibration" without change evaluated covariance**
  - can have none neglectable impact on post-evaluation adjustment process.

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Comparing GLLS with Stochastic Sampling Based Data Assimilation

NEA WPEC Meetings: SG39/SG46
OECD Headquarters, Paris, France

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ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

PAUL SCHERRER INSTITUT

May 14-18, 2018

Approach

- Focus on two stochastic-sampling-based methods:
  1. MOCABA: Monte Carlo Bayesian Analysis
  2. BMC: Bayesian Monte Carlo
- Model the Jezebel-Pu239 benchmark in Serpent2
- Sensitivities calculated with Serpent
- Stochastic sampling done with NUSS code
  1. Uses multigroup covariance data
  2. Perturbations are applied to the ACE files
- 187-energy-group structure
- ENDFB/VII.1 nuclear data and covariances

Conclusions

- Simple test case shows good agreement between GLLS, MOCABA, and BMC
- BMC larger uncertainties than MOCABA
  - Needs more samples to have same accuracy as MOCABA
  - May not be practical for non-academic applications
- For Jezebel-Pu239, supports traditional use of GLLS
- MOCABA could be used complementary to GLLS to verify adjustments
- Provides confidence in stochastic DA, but needs to be tested in larger and more diverse applications

Preliminary Adjustment Using CIELO Isotopes and Their Associated Covariance Matrices

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WPEC SG39/46 Meeting

May 15-16, 2018

Paris

Some General Considerations

- Final χ^2 is satisfactory, 1.2 against starting one at 23. Major contribution after adjustment coming from ZPR9/34 K_{eff} with 0.143 against a starting 6.3, with a starting C/E of 1.03 and final of 1.0007.
- Some cross section adjustment is bigger than the standard deviation:
  - ^{56}Fe inelastic from 10 Mev to 800 Kev and capture from 800Kev to 60 Kev
  - ^{238}U inelastic from 1.3 Mev to 800 Kev
  - ^{239}Pu capture from 15 Kev to 2 Kev and (n,2n) from 10 to 6 MeV
- In general standard deviations are significantly reduced, but some small increase is observed for a few cases of elastic and capture. This could indicate some problem in the cross correlation among reactions.
- MA irradiation experiments have impact also on major actinides.
- FCA experiments impacted by ^{238}U inelastic (i.e. change in spectrum).
- ASPIS-88 and ZPR9/34 impact ^{56}Fe capture, elastic, and inelastic.

Major Findings for the 5 CIELO Isotopes

- **^{16}O: Significant inelastic cross section change and some impact on P_1 scattering. However, no major sensitivity to this isotope, and therefore changes should be ignored.**
- **^{56}Fe: Significant increase of capture at very high energy (up to 50%). Decrease of inelastic (almost 20% at 1 MeV). Some change in P_1 (+10% from 100 KeV to 1MeV).**
- **^{235}U: Increase (~5%) in capture from 5 KeV to 5 MeV. Decrease of χ below 1 MeV and increase above. P_1 elastic decreases between 800 and 100 KeV. Systematic decrease of inelastic of few %.**
- **^{238}U: decrease in capture (~2% average from 25 KeV to 1 KeV). Decrease of inelastic ~5-10%. Change in shape of χ. Significant decrease of P_1 (300 KeV to 5 KeV).**
- **^{239}Pu: Significant increase (~20%) of capture from 10 to 1 KeV; some also at thermal energies. Change in shape of inelastic (significant). Change in χ shape. Large change of n,2n (~+30% from 10 to 6 MeV).**

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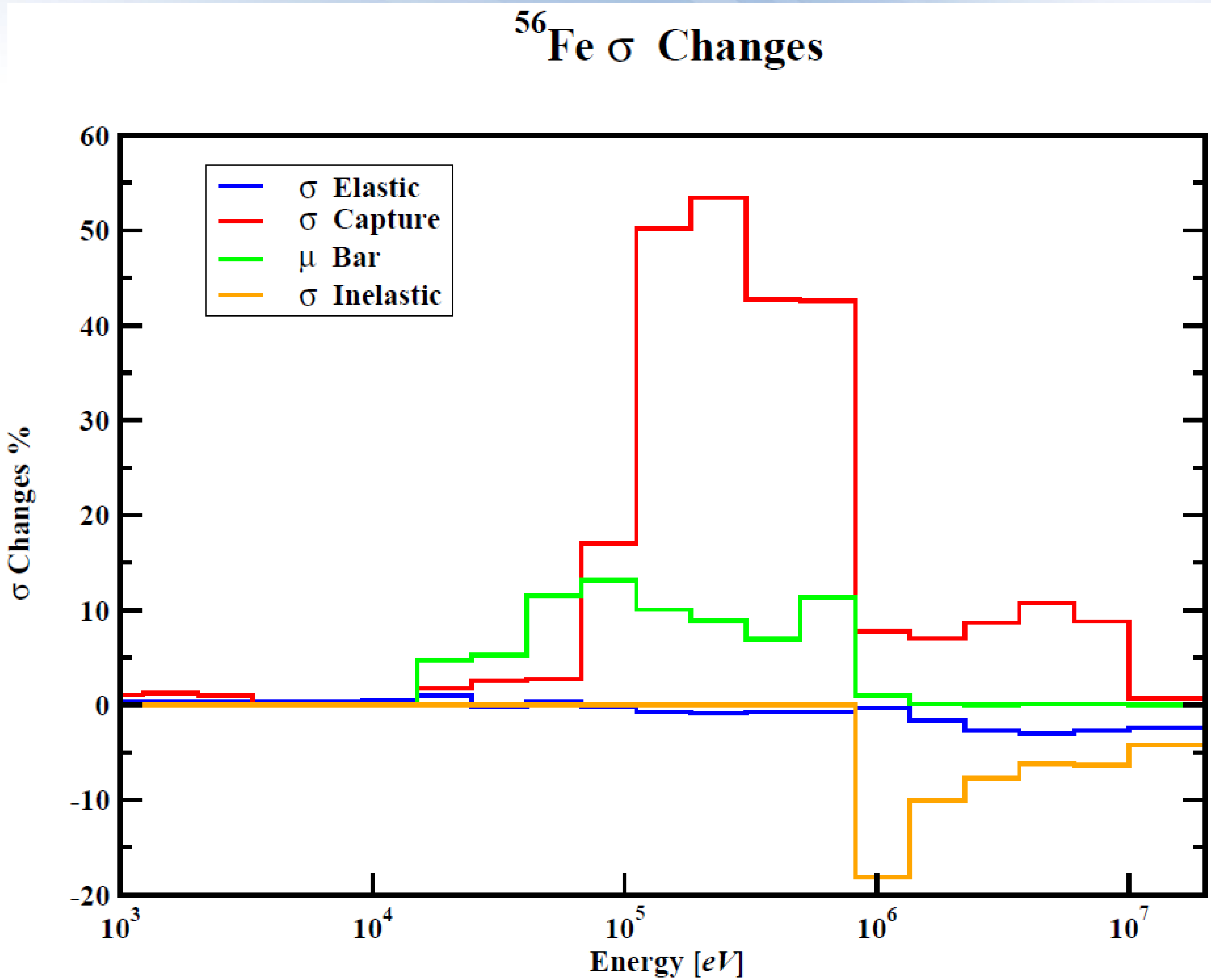
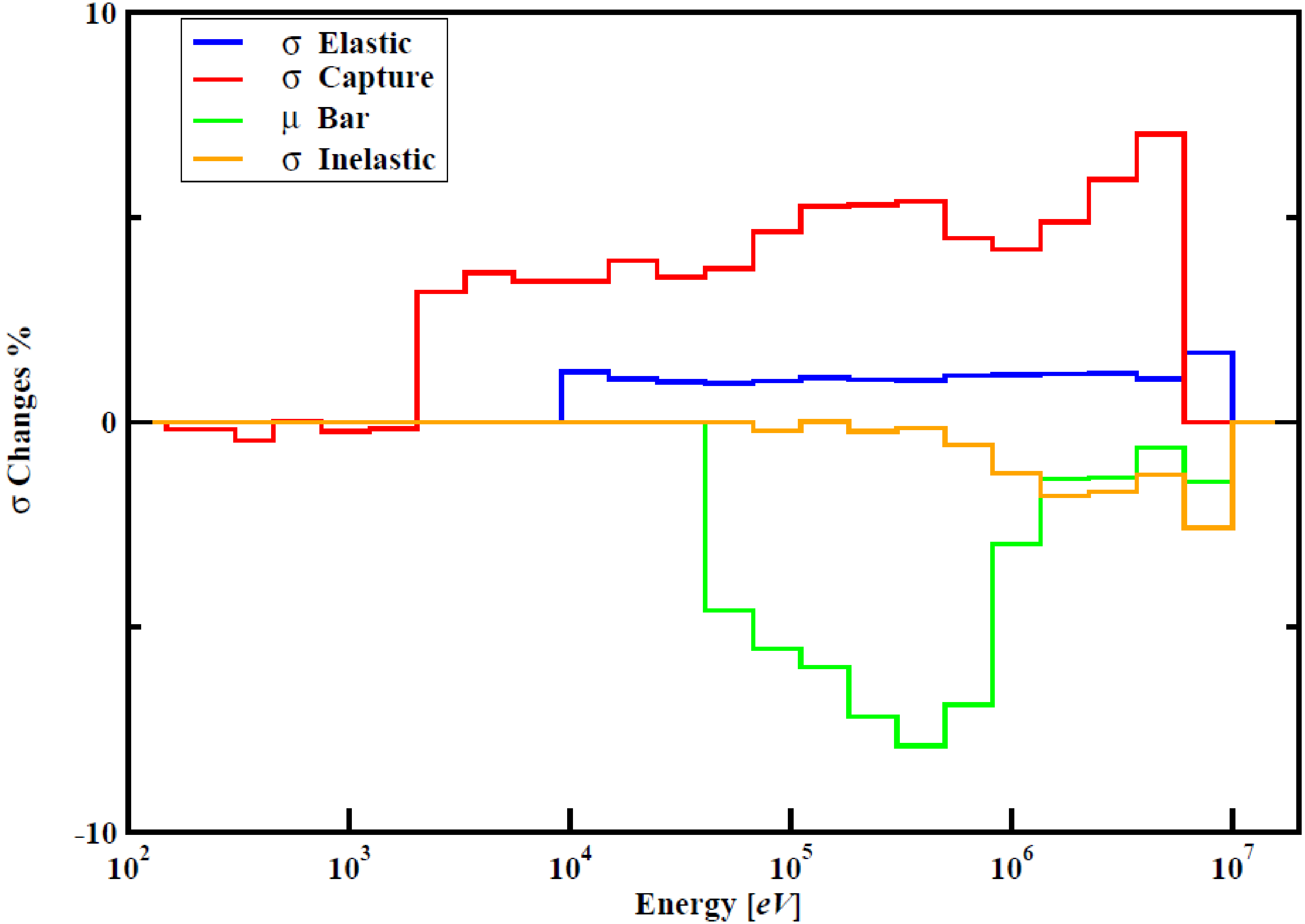
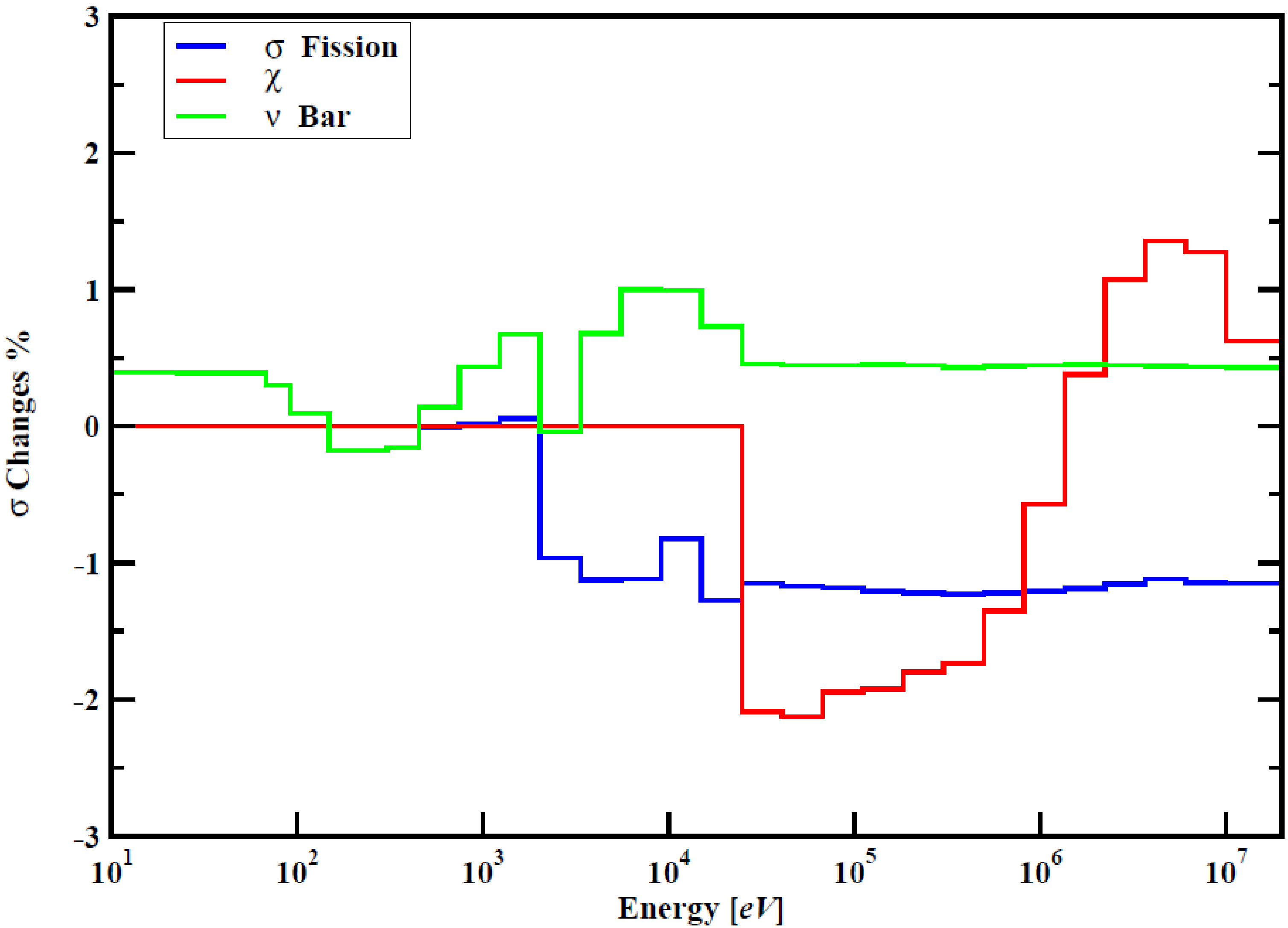


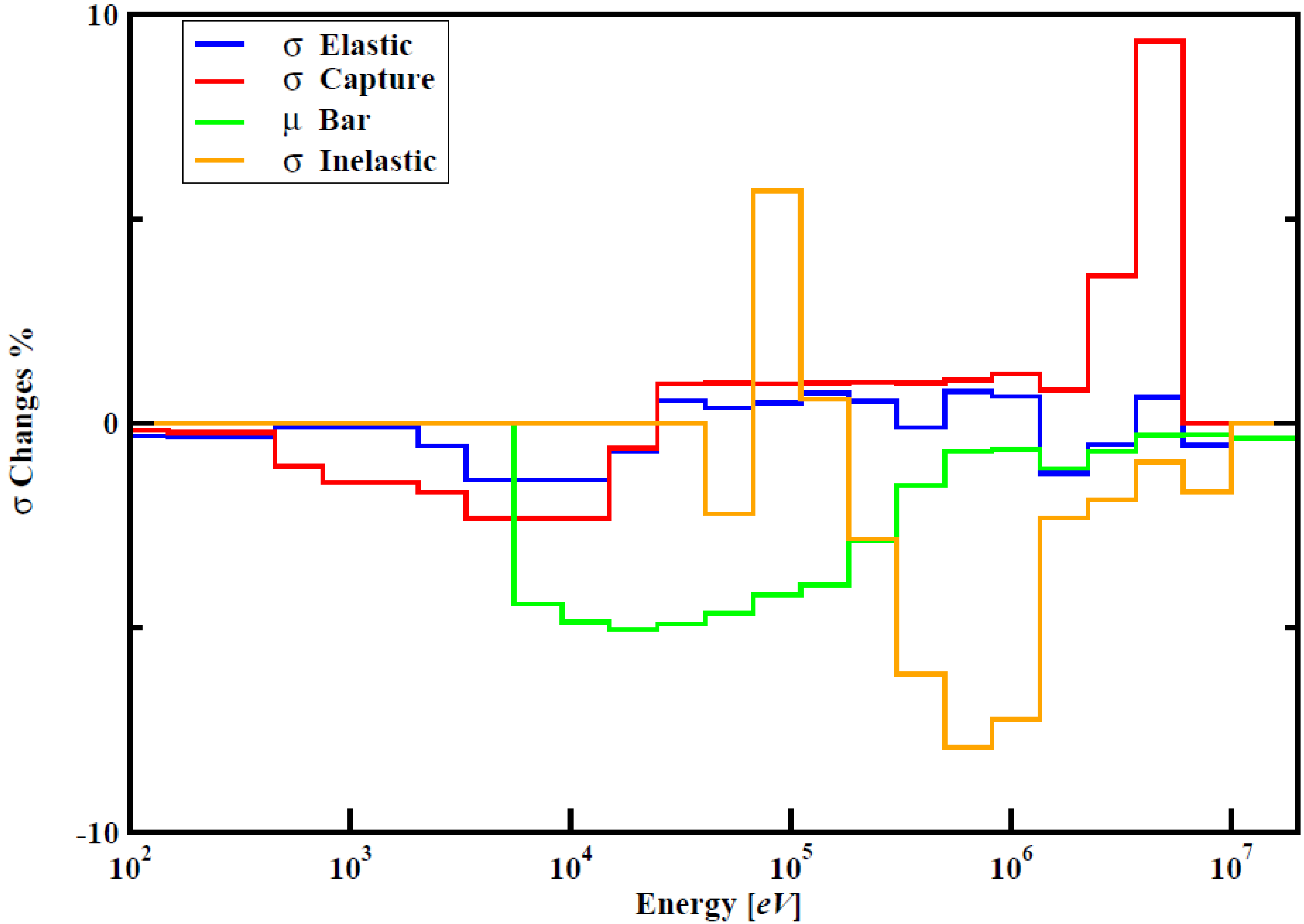
^{235}U σ Changes



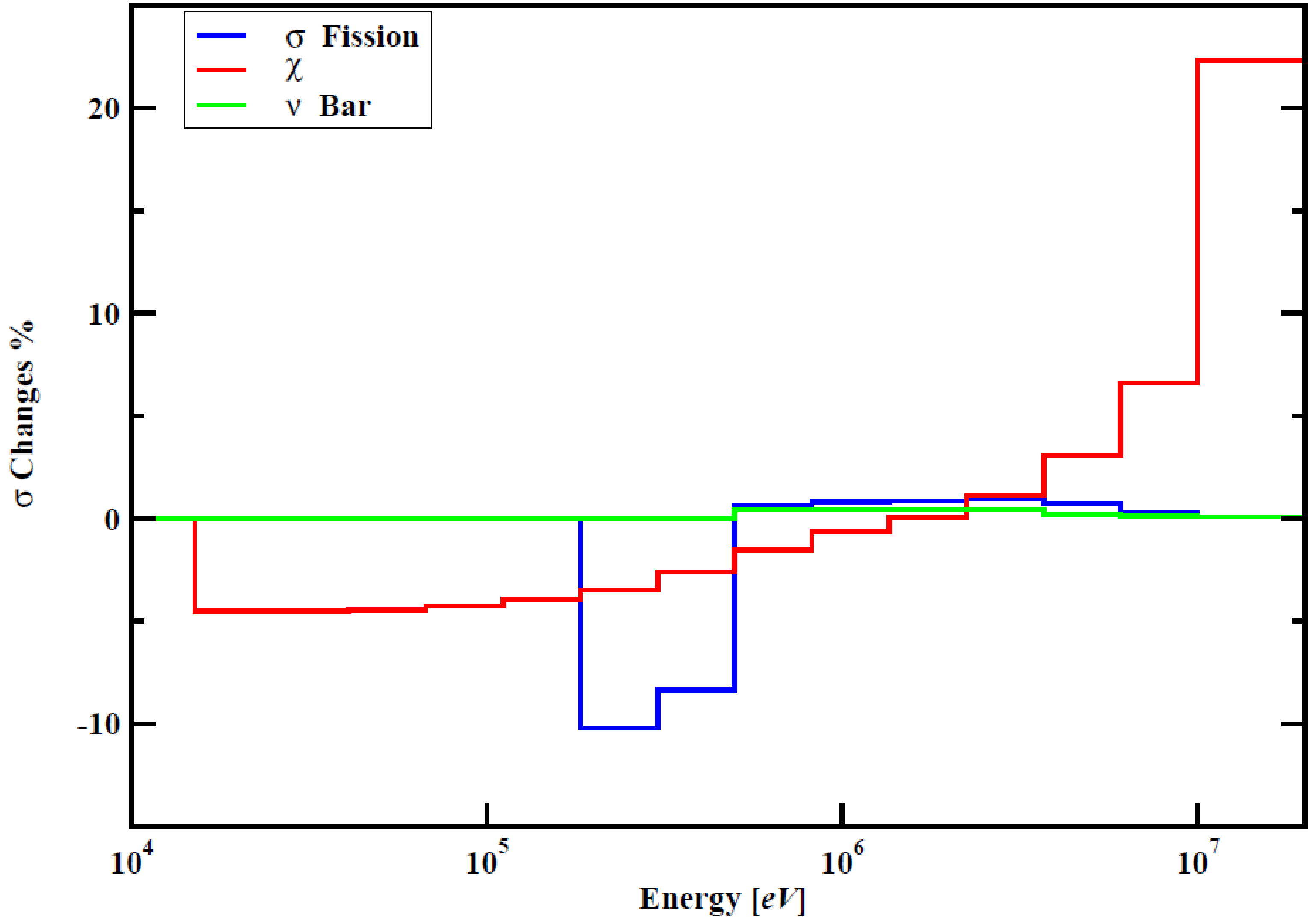
^{235}U σ Changes



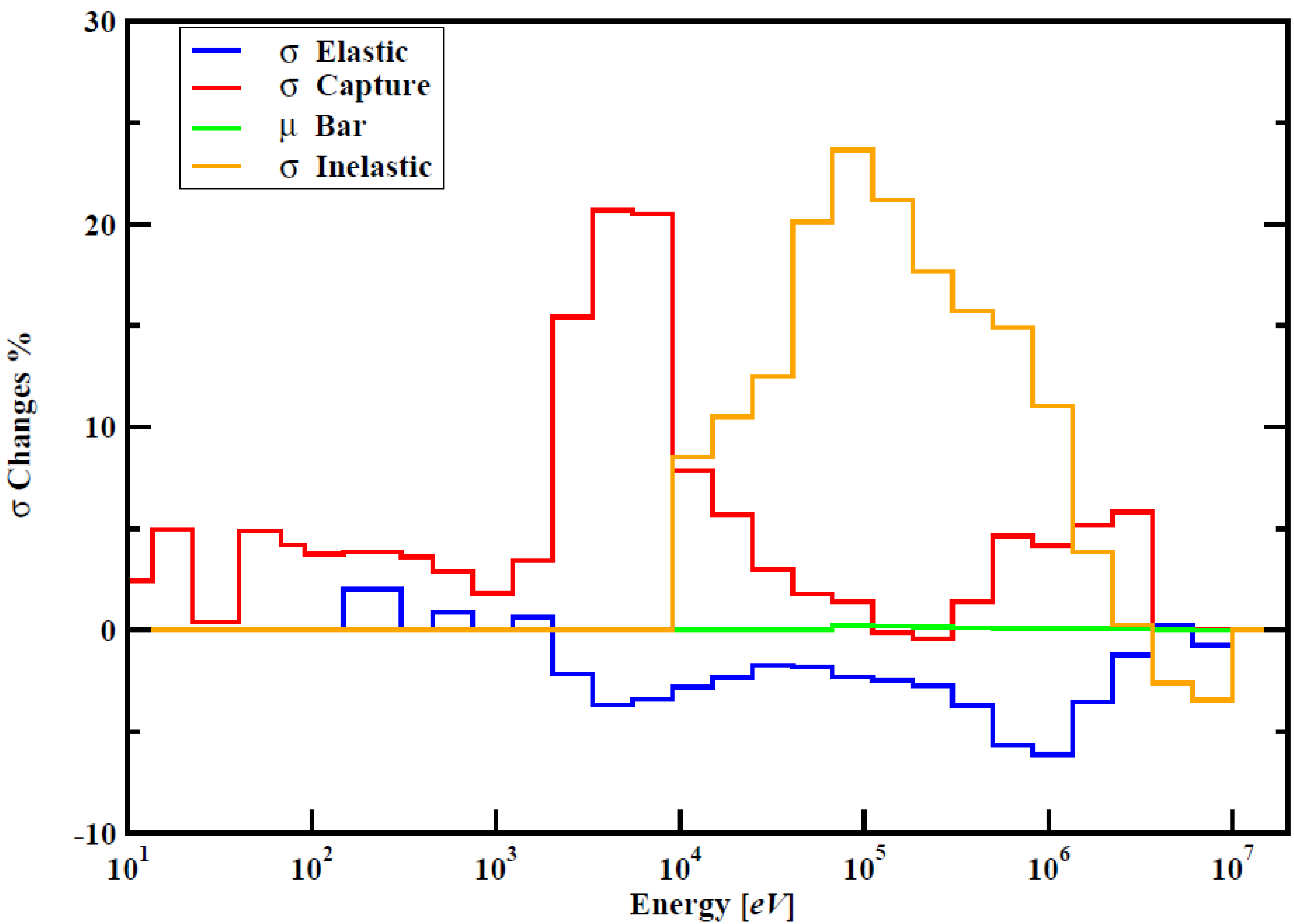
$^{238}U\ \sigma$ Changes



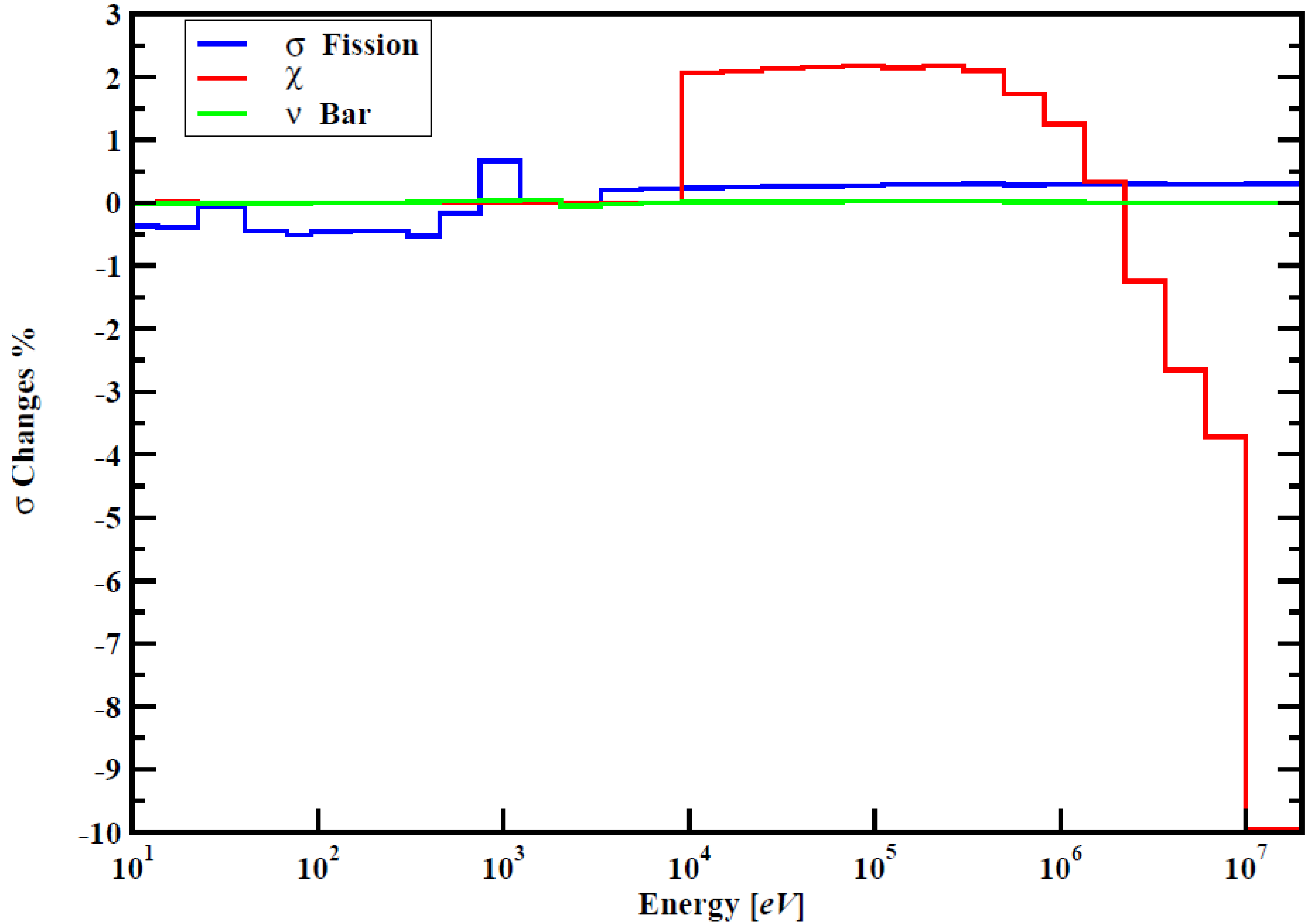
^{238}U σ Changes



^{239}Pu σ Changes



^{239}Pu σ Changes



Future Actions and Conclusions

- **The subgroup is already very active and many, very useful, contributions have been produced by the participants.**
- **Actions will continue on:**
  - **Methodology developments: Experiment Selection and Adjustment**
  - **Selection of existing experiments and adding new experiments**
  - **Toy problem (confirm H. Wu results)**
  - **Performing adjustments**
  - **Applications (power reactors) will be soon defined and models will be provided for exercise of UQ and impact of adjustments**
- **Next meeting at end of November**