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Test Results for Checking Reliability of Selected ENDF/B-VIII.0 Evaluated Uncertainties

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Contents

Abstract

This report summarizes error messages obtained from counter-checking whether ^{1}H, ^{9}Be, ^{12}C, ^{27}Al, ^{235,238}U and $^{238-242}$Pu relative uncertainties of ENDF/B-VIII.0 are realistic. Large parts of this report were generated automatically by the code CovVal. This code allows to test the reliability of relative uncertainties of any isotope. It gives generic error and warning messages if evaluated relative uncertainties of a particular reaction are likely under- or over-estimated. In addition to these error and warning messages, I added comments whether the flagged uncertainties are truly under- or over-estimated. I call out these uncertainties that should be further investigated and corrected by an evaluator for an upcoming release of ENDF/B-VIII.1.

Chapter 1

Introduction

In Ref. [1], tests were described that check whether evaluated nuclear-data uncertainties are realistic in size. Evaluated uncertainties are not measured (true) quantities but rather represent the communities knowledge of the data at a certain point in time. However, there are certainly physics argument that may indicate whether evaluated uncertainties are unreasonably low or large.

These arguments are cast in Ref. [1] into the following test criteria to counter-check whether evaluated uncertainties are realistic:

- Template tests: Evaluated nuclear data are obtained by model and/ or experimental information. Nuclear models are not of first-principle but rely on approximations like the optical model, etc. Hence, they are often more uncertain than available experimental data. Thus evaluated uncertainties are bounded by the combined experimental knowledge on a quantity of interest (QOI). This combined experimental knowledge can be estimated by templates of experimental uncertainties [2, 3] that give typical uncertainties expected for specific measurement types. Hence, templates of experimental uncertainties are used to establish upper and lower bounds for evaluated uncertainties of a specific QOI.

- PUBs: The "Physical Uncertainty Boundary Method" [4, 5] is similar to the test above in as far as it estimates minimal-realistic and conservative bounds on a QOI based on its available information content. Right now, bounds are given for QOIs that are constrained by experimental data.

- Expert-judgment test: The expert-judgment bounds on uncertainties by D.L. Smith [6] were established based on considering what are typical measurement uncertainties of a QOI. Contrary to the template test, these bounds were obtained without splitting them out in their underlying sources. Due to that, the uncertainty values are more conservative and no upper limits to uncertainties are provided.

- Standard test: A considerable amount of experimental data is measured relative to a standard observable [7]. An example could be a measurement of the ^{237}Np(n,f) cross section relative to ^{235}U(n,f) cross sections. For the evaluation, the ratio data, ^{237}Np(n,f)/^{235}U(n,f), need to be converted to absolute data of the QOI, the ^{237}Np(n,f) cross section. To this end, one multiplies the ratio data with the standard, the ^{235}U(n,f) cross section. It happens frequently that all experimental data of a QOI are measured relative to the same standard reaction. Hence, the evaluated uncertainties are bounded by the uncertainties on that standard. The standard test counter-checks if evaluated uncertainties are above those of it associated standard.

In this report here, these test were applied to relative uncertainties of ^{1}H, ^{9}Be, ^{12}C, ^{27}Al, ^{235,238}U and $^{238-242}$Pu in ENDF/B-VIII.0 [8]. The evaluated covariances were processed by N. Gibson from XCP-5, LANL on a 51-energy-bin grid using NJOY and his own code suite. The resulting covariances

were checked via the code CovVal. The code generates automatic reports which are shown here. These automatic reports are augmented by comments whether the flagged uncertainties are truly under- or over-estimated. These comments are highlighted by using purple color.

The complete report is designed to point evaluator to what covariances of ENDF/B-VIII.0 should be further investigated and corrected by evaluators for the release of ENDF/B-VIII.1. The covariances discussed were chosen as they might be of interest to several LANL programs and the EUCLID LDRD-DR project. If so desired, more covariances can be studied.

Chapter 2

^{242}Pu Covariances

2.1 List of Existing Covariances

Isotope studied: Pu242

- inelastic_09crossSection
- inelastic_continuumcrossSection
- n3ncrossSection
- inelastic_11crossSection
- totalcrossSection
- inelastic_18crossSection
- fissioncrossSection
- nu_promptmultiplicity
- n4ncrossSection
- inelastic_07crossSection
- inelastic_06crossSection
- fissionfissionSpectrum
- inelastic_12crossSection
- elasticcrossSection
- inelastic_01crossSection
- n2ncrossSection
- inelastic_03crossSection
- inelastic_02crossSection
- inelastic_16crossSection
- inelastic_05crossSection

- numultiplicity
- inelastic_15crossSection
- inelastic_08crossSection
- inelastic_17crossSection
- inelastic_10crossSection
- inelastic_20crossSection
- inelasticcrossSection
- inelastic_04crossSection
- inelastic_13crossSection
- inelastic_14crossSection
- capturecrossSection
- inelastic_19crossSection
- nu_delayedmultiplicity

2.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 2.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	Passed	Passed	N/A	N/A
elasticcrossSection	Passed	Failed	Passed	N/A
fissioncrossSection	Passed	Passed	Passed	Failed
fissionfissionSpectrum	Failed	Failed	Failed	Failed
inelastic_01crossSection	Passed	Passed	Passed	N/A
inelastic_02crossSection	Passed	Passed	Passed	N/A
inelastic_03crossSection	Passed	Passed	Passed	N/A
inelastic_04crossSection	Passed	Passed	Passed	N/A
inelastic_05crossSection	Passed	Passed	Passed	N/A
inelastic_06crossSection	Passed	Passed	Passed	N/A
inelastic_07crossSection	Passed	Passed	Passed	N/A
inelastic_08crossSection	Passed	Passed	Passed	N/A
inelastic_09crossSection	Passed	Passed	Passed	N/A
inelastic_10crossSection	Passed	Passed	Passed	N/A
inelastic_11crossSection	Passed	Passed	Passed	N/A
inelastic_12crossSection	Passed	Passed	Passed	N/A
inelastic_13crossSection	Passed	Passed	Passed	N/A
inelastic_14crossSection	Passed	Passed	Passed	N/A
inelastic_15crossSection	Passed	Passed	Passed	N/A
inelastic_16crossSection	Passed	Passed	Passed	N/A

inelastic_17crossSection	Passed	Passed	Passed	N/A
inelastic_18crossSection	Passed	Passed	Passed	N/A
inelastic_19crossSection	Passed	Passed	Passed	N/A
inelastic_20crossSection	Passed	Passed	Passed	N/A
inelastic_continuumcrossSection	Passed	Passed	Passed	N/A
inelasticcrossSection	Passed	Passed	Passed	N/A
n2ncrossSection	Passed	Passed	N/A	N/A
n3ncrossSection	Passed	Passed	N/A	N/A
n4ncrossSection	Passed	Passed	N/A	N/A
nu_delayedmultiplicity	N/A	N/A	N/A	N/A
nu_promptmultiplicity	Failed	Passed	Passed	Failed
numultiplicity	Failed	Passed	Passed	Failed
totalcrossSection	Passed	Passed	N/A	N/A

2.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 2.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
fissioncrossSection	N/A	Failed	N/A	Failed
fissionfissionSpectrum	N/A	Failed	N/A	Passed
inelastic_01crossSection	N/A	Failed	N/A	N/A
inelastic_02crossSection	N/A	Failed	N/A	N/A
inelastic_03crossSection	N/A	Failed	N/A	N/A
inelastic_04crossSection	N/A	Failed	N/A	N/A
inelastic_05crossSection	N/A	Failed	N/A	N/A
inelastic_06crossSection	N/A	Failed	N/A	N/A
inelastic_07crossSection	N/A	Failed	N/A	N/A
inelastic_08crossSection	N/A	Failed	N/A	N/A
inelastic_09crossSection	N/A	Failed	N/A	N/A
inelastic_10crossSection	N/A	Failed	N/A	N/A
inelastic_11crossSection	N/A	Failed	N/A	N/A
inelastic_12crossSection	N/A	Failed	N/A	N/A
inelastic_13crossSection	N/A	Failed	N/A	N/A
inelastic_14crossSection	N/A	Failed	N/A	N/A
inelastic_15crossSection	N/A	Failed	N/A	N/A
inelastic_16crossSection	N/A	Failed	N/A	N/A
inelastic_17crossSection	N/A	Failed	N/A	N/A
inelastic_18crossSection	N/A	Failed	N/A	N/A
inelastic_19crossSection	N/A	Failed	N/A	N/A
inelastic_20crossSection	N/A	Failed	N/A	N/A
inelastic_continuumcrossSection	N/A	Passed	N/A	N/A
inelasticcrossSection	N/A	Passed	N/A	N/A
n2ncrossSection	N/A	Failed	N/A	N/A
n3ncrossSection	N/A	Failed	N/A	N/A
n4ncrossSection	N/A	Passed	N/A	N/A

nu_delayedmultiplicity	N/A	N/A	N/A	N/A
nu_promptmultiplicity	N/A	Failed	N/A	Passed
numultiplicity	N/A	Failed	N/A	Passed
totalcrossSection	N/A	Failed	N/A	N/A

2.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 2.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
capturecrossSection	0 of 2
elasticcrossSection	1 of 3
fissioncrossSection	1 of 4
fissionfissionSpectrum	4 of 4
inelastic_01crossSection	0 of 3
inelastic_02crossSection	0 of 3
inelastic_03crossSection	0 of 3
inelastic_04crossSection	0 of 3
inelastic_05crossSection	0 of 3
inelastic_06crossSection	0 of 3
inelastic_07crossSection	0 of 3
inelastic_08crossSection	0 of 3
inelastic_09crossSection	0 of 3
inelastic_10crossSection	0 of 3
inelastic_11crossSection	0 of 3
inelastic_12crossSection	0 of 3
inelastic_13crossSection	0 of 3
inelastic_14crossSection	0 of 3
inelastic_15crossSection	0 of 3
inelastic_16crossSection	0 of 3
inelastic_17crossSection	0 of 3
inelastic_18crossSection	0 of 3
inelastic_19crossSection	0 of 3
inelastic_20crossSection	0 of 3
inelastic_continuumcrossSection	0 of 3
inelasticcrossSection	0 of 3
n2ncrossSection	0 of 2
n3ncrossSection	0 of 2
n4ncrossSection	0 of 2
nu_delayedmultiplicity	0 of 0
nu_promptmultiplicity	2 of 4
numultiplicity	2 of 4
totalcrossSection	0 of 2

2.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 2.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
capturecrossSection	1 of 1
elasticcrossSection	0 of 1
fissioncrossSection	2 of 2
fissionfissionSpectrum	1 of 2
inelastic_01crossSection	1 of 1
inelastic_02crossSection	1 of 1
inelastic_03crossSection	1 of 1
inelastic_04crossSection	1 of 1
inelastic_05crossSection	1 of 1
inelastic_06crossSection	1 of 1
inelastic_07crossSection	1 of 1
inelastic_08crossSection	1 of 1
inelastic_09crossSection	1 of 1
inelastic_10crossSection	1 of 1
inelastic_11crossSection	1 of 1
inelastic_12crossSection	1 of 1
inelastic_13crossSection	1 of 1
inelastic_14crossSection	1 of 1
inelastic_15crossSection	1 of 1
inelastic_16crossSection	1 of 1
inelastic_17crossSection	1 of 1
inelastic_18crossSection	1 of 1
inelastic_19crossSection	1 of 1
inelastic_20crossSection	1 of 1
inelastic_continuumcrossSection	0 of 1
inelasticcrossSection	0 of 1
n2ncrossSection	1 of 1
n3ncrossSection	1 of 1
n4ncrossSection	0 of 1
nu_delayedmultiplicity	0 of 0
nu_promptmultiplicity	1 of 2
numultiplicity	1 of 2
totalcrossSection	1 of 1

2.6 Covariances that Were Not Tested

- nu_delayedmultiplicity

2.7 Covariances that Should be Counter-checked by Evaluator

- Possible problem in (>= 50% available tests failed): fissioncrossSection (Fig. 2.1) The fission-cross section uncertainties in the thermal and resonance range are very large. However, there are experimental data available for the incident-neutron energy range from 100 eV to 20 MeV. So, uncertainties of 50% are surprisingly high. **An evaluator of fission cross sections in the resonance range should take a look at that.**

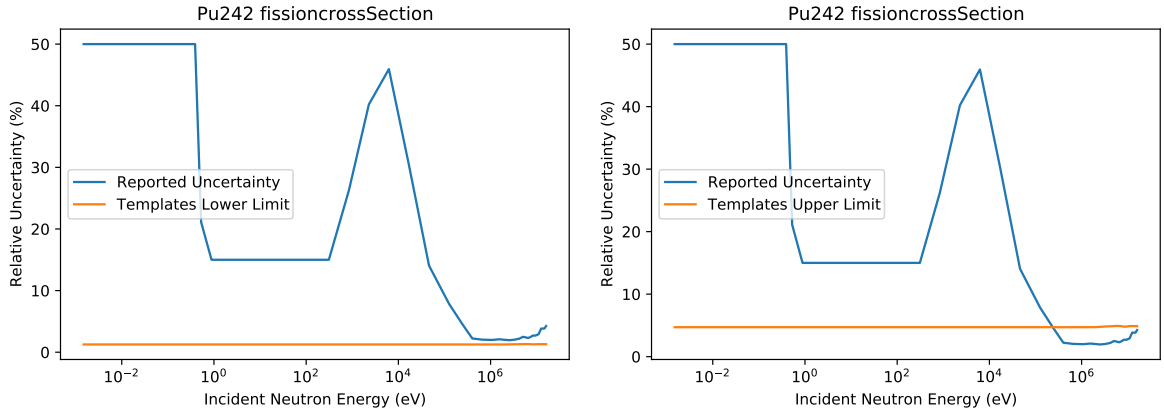

Figure 2.1: Possible problems in uncertainties of fissioncrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): fissionfissionSpectrum (Fig. 2.2). The evaluated ^{242}Pu(n,f)PFNS uncertainties are likely ok. They are lower than the standard uncertainties in the lowest outgoing-neutron energy bin. However, this is a binning issue during processing the data and not an issue in the covariances.

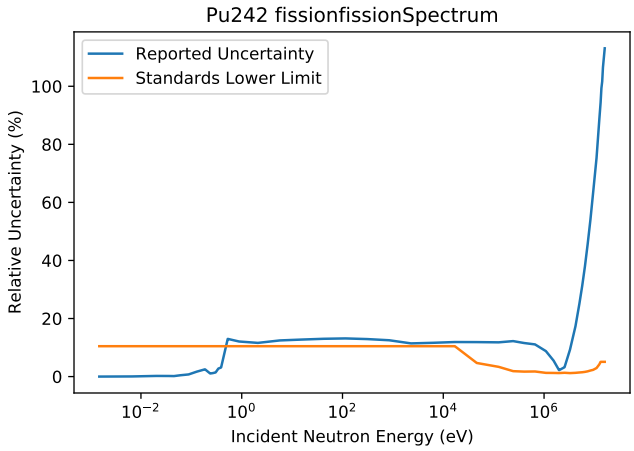

Figure 2.2: Critical problems in uncertainties of fissionfissionSpectrum are illustrated.

- Possible problem in (>= 50% available tests failed): nu_promptmultiplicity (Fig. 2.3). The evaluated ^{242}Pu(n,f) ν_p uncertainties are likely ok. They are higher than upper template bounds at high incident-neutron energies. However, experimental data are very scarce, so these high uncertainties are justified.

- Possible problem in (>= 50% available tests failed): numultiplicity (Fig. 2.4). The evaluated ^{242}Pu(n,f) ν uncertainties are likely ok. They are higher than upper template bounds at high incident-neutron energies. However, experimental data are very scarce, so these high uncertainties are justified.

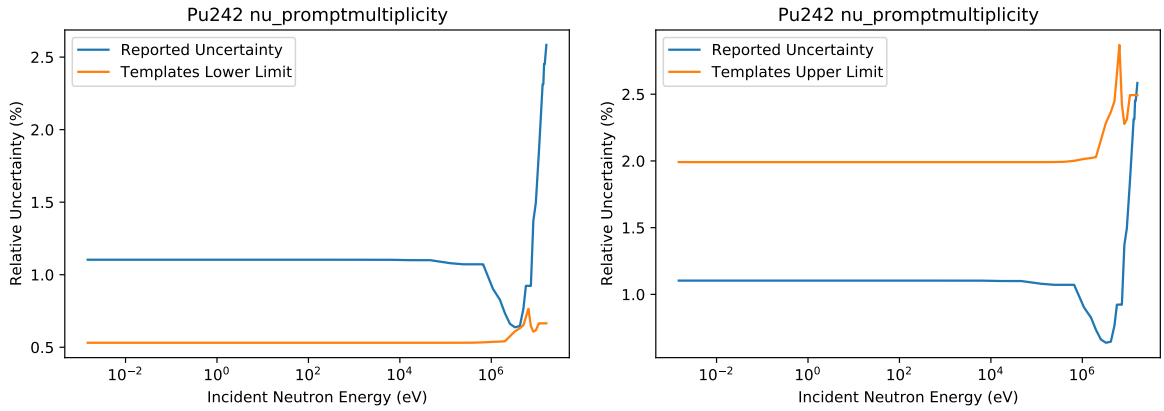

Figure 2.3: Possible problems in uncertainties of nu_promptmultiplicity are illustrated.

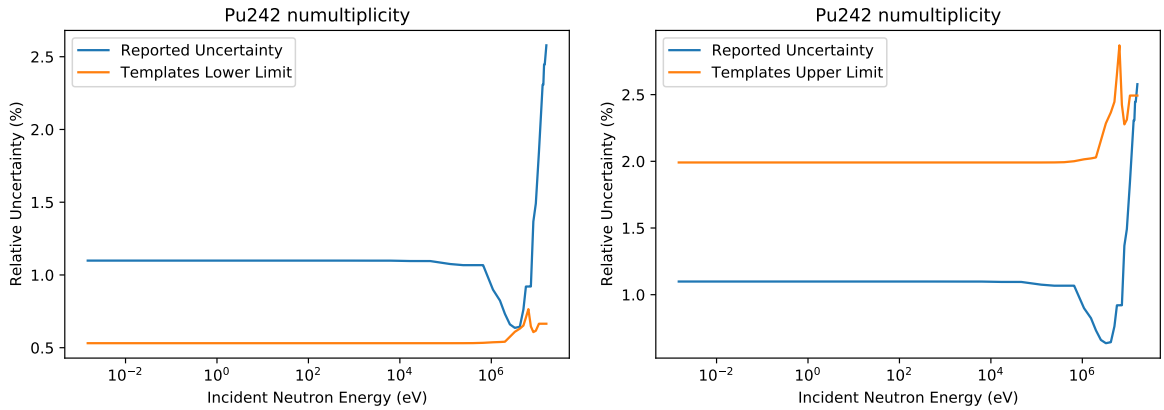

Figure 2.4: Possible problems in uncertainties of numultiplicity are illustrated.

Chapter 3

^{241}Pu Covariances

3.1 List of Existing Covariances

Isotope studied: Pu241

- nu_promptmultiplicity
- inelasticcrossSection
- capturecrossSection
- elasticcrossSection
- n2ncrossSection
- fissioncrossSection

3.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 3.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	Failed	Passed	N/A	N/A
elasticcrossSection	Passed	Passed	Passed	N/A
fissioncrossSection	Failed	Failed	Failed	Failed
inelasticcrossSection	Passed	Passed	Passed	N/A
n2ncrossSection	Passed	Passed	N/A	N/A
nu_promptmultiplicity	Failed	Failed	Failed	Failed

3.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 3.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs

capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
fissioncrossSection	N/A	Passed	N/A	Passed
inelasticcrossSection	N/A	Failed	N/A	N/A
n2ncrossSection	N/A	Failed	N/A	N/A
nu_promptmultiplicity	N/A	Passed	N/A	Passed

3.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 3.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
capturecrossSection	1 of 2
elasticcrossSection	0 of 3
fissioncrossSection	4 of 4
inelasticcrossSection	0 of 3
n2ncrossSection	0 of 2
nu_promptmultiplicity	4 of 4

3.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 3.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
capturecrossSection	1 of 1
elasticcrossSection	0 of 1
fissioncrossSection	0 of 2
inelasticcrossSection	1 of 1
n2ncrossSection	1 of 1
nu_promptmultiplicity	0 of 2

3.6 Covariances that Were Not Tested

- none

3.7 Covariances that Should be Counter-checked by Evaluator

- Possible problem in (>= 50% available tests failed): capturecrossSection (Fig. 3.1) The evaluated capture uncertainties are very low (2%) in the resonance range. But this is justified because we are dealing with a standard here. In the fast range, the evaluated uncertainties are surprisingly large. There is only one experiment there. So, while large this could be ok.

- Critical problem in (uncertainties smaller than relevant standard): fissioncrossSection (Fig. 3.2) **The evaluated neutron-induced fission uncertainties are too low around 100 keV as the update with new standard uncertainties are missing. This needs to be fixed.**

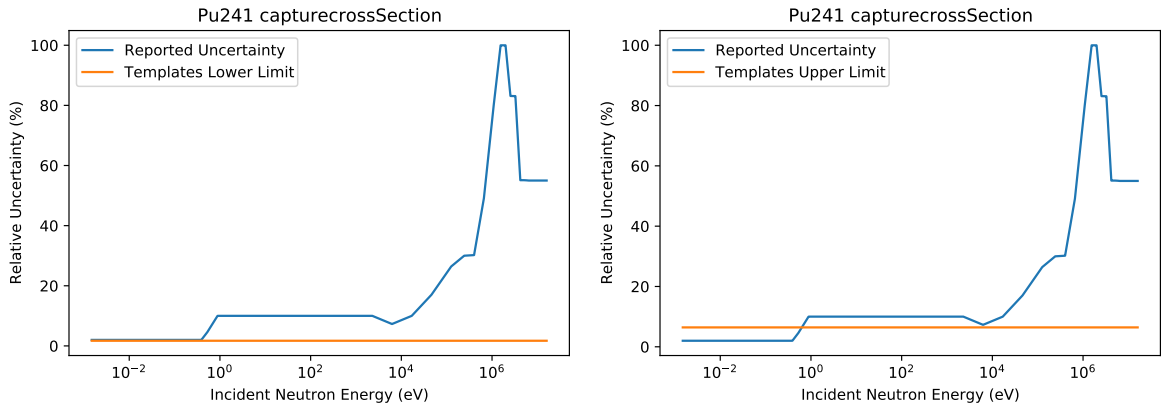

Figure 3.1: Possible problems in uncertainties of capturecrossSection are illustrated.

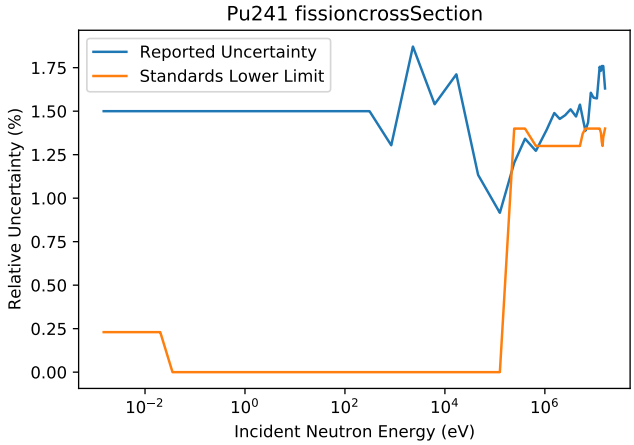

Figure 3.2: Critical problems in uncertainties of fissioncrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): nu_promptmultiplicity (Fig. 3.3) **The evaluated $\overline{\nu}_p$ uncertainties are too low below 5 MeV as the update with new standard uncertainties are missing. This needs to be fixed.**

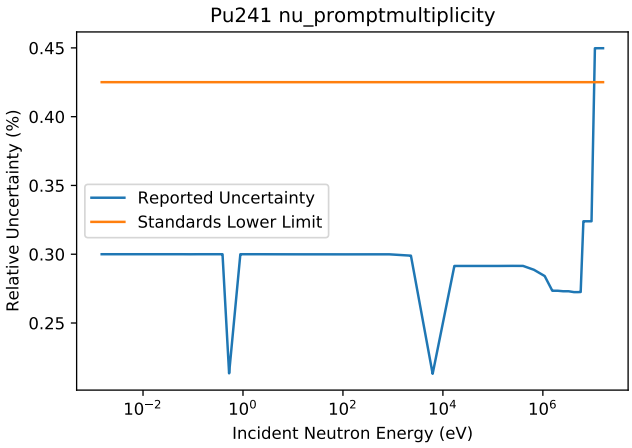

Figure 3.3: Critical problems in uncertainties of nu_promptmultiplicity are illustrated.

Chapter 4

^{240}Pu Covariances

4.1 List of Existing Covariances

Isotope studied: Pu240

- nu_promptmultiplicity
- n3ncrossSection
- fissionfissionSpectrum
- inelasticcrossSection
- capturecrossSection
- totalcrossSection
- elasticcrossSection
- n2ncrossSection
- fissioncrossSection

4.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 4.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	Failed	Failed	N/A	N/A
elasticcrossSection	Passed	Failed	Passed	N/A
fissioncrossSection	Failed	Failed	Failed	Failed
fissionfissionSpectrum	Failed	Failed	Failed	Failed
inelasticcrossSection	Passed	Passed	Passed	N/A
n2ncrossSection	Passed	Passed	N/A	N/A
n3ncrossSection	Passed	Passed	N/A	N/A
nu_promptmultiplicity	Failed	Failed	Failed	Failed
totalcrossSection	Failed	Failed	N/A	N/A

4.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 4.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Failed	N/A	N/A
fissioncrossSection	N/A	Failed	N/A	Failed
fissionfissionSpectrum	N/A	Failed	N/A	Failed
inelasticcrossSection	N/A	Failed	N/A	N/A
n2ncrossSection	N/A	Failed	N/A	N/A
n3ncrossSection	N/A	Failed	N/A	N/A
nu_promptmultiplicity	N/A	Failed	N/A	Failed
totalcrossSection	N/A	Failed	N/A	N/A

4.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 4.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
capturecrossSection	2 of 2
elasticcrossSection	1 of 3
fissioncrossSection	4 of 4
fissionfissionSpectrum	4 of 4
inelasticcrossSection	0 of 3
n2ncrossSection	0 of 2
n3ncrossSection	0 of 2
nu_promptmultiplicity	4 of 4
totalcrossSection	2 of 2

4.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 4.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
capturecrossSection	1 of 1
elasticcrossSection	1 of 1
fissioncrossSection	2 of 2
fissionfissionSpectrum	2 of 2
inelasticcrossSection	1 of 1
n2ncrossSection	1 of 1
n3ncrossSection	1 of 1
nu_promptmultiplicity	2 of 2
totalcrossSection	1 of 1

4.6 Covariances that Were Not Tested

- none

4.7 Covariances that Should be Counter-checked by Evaluator

- Possible problem in (>= 50% available tests failed): capturecrossSection (Fig. 4.1) **The evaluated capture uncertainties are very low (< 1.68%) in the thermal range. This is surprisingly small. An evaluator should take a look at it.**

  In the fast range, the evaluated uncertainties are surprisingly large. There is no experimental data there. So, while large this could be ok.

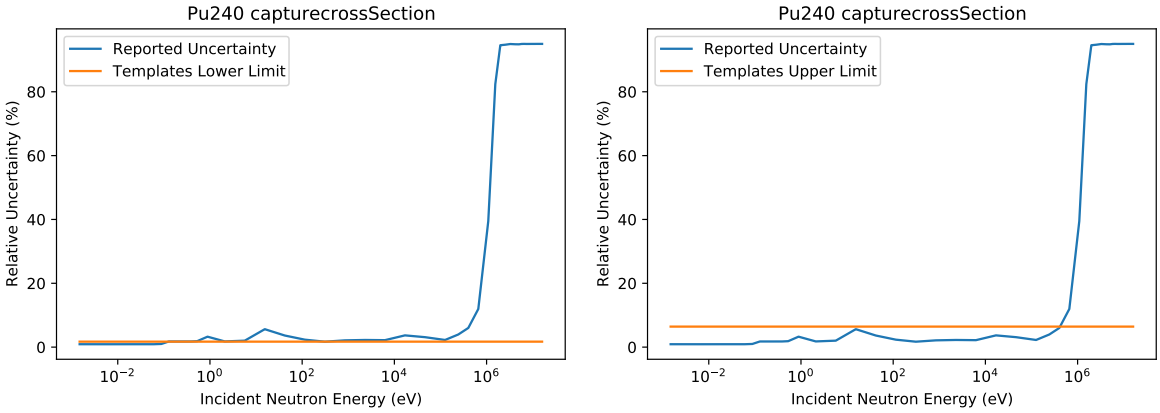

Figure 4.1: Possible problems in uncertainties of capturecrossSection are illustrated.

- Possible problem in (>= 50% available tests failed): elasticcrossSection (Fig. 4.2) **The evaluated elastic uncertainties are very low (< 1.8%) in the resonance range. This is surprisingly small. An evaluator should take a look at it.**

  In the fast range, the evaluated uncertainties are surprisingly large. There are no experimental data there. (n,tot) data exists, but no (n,inl) cross section are available. So, while large this could be ok because there is little information.

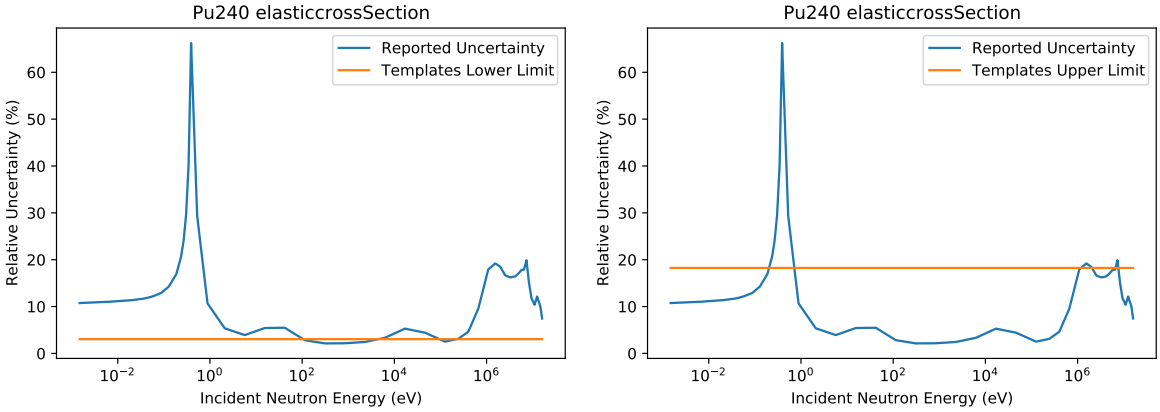

Figure 4.2: Possible problems in uncertainties of elasticcrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): fissioncrossSection (Fig. 4.3) **The evaluated neutron-induced fission uncertainties are too low above 500 keV as an update with new standard uncertainties is missing. This needs to be fixed.**

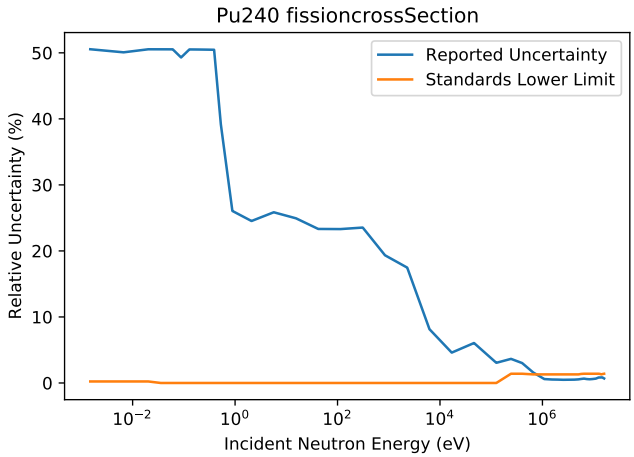

Figure 4.3: Critical problems in uncertainties of fissioncrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): fissionfissionSpectrum (Fig. 4.4)The evaluated ^{240}Pu(n,f) PFNS uncertainties are likely ok. They are lower than the standard uncertainties in the lowest outgoing-neutron energy bin. However, this is a binning issue during processing the data and not an issue in the covariances.

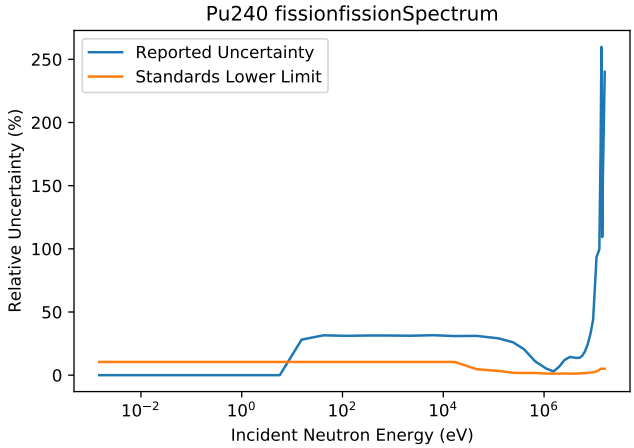

Figure 4.4: Critical problems in uncertainties of fissionfissionSpectrum are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): nu_promptmultiplicity (Fig. 4.5) **The evaluated $\overline{\nu}_p$ uncertainties are too low from 1–5 MeV as the update with new standard uncertainties is missing. This needs to be fixed.**

- Possible problem in (>= 50% available tests failed): totalcrossSection (Fig. 4.6)The evaluated total uncertainties are very low (< 0.9%) in the thermal range. This is surprisingly small. **An evaluator should take a look at it.**

  In the resonance range, the evaluated uncertainties are surprisingly large. There is no experimental data there. So, while large this could be ok.

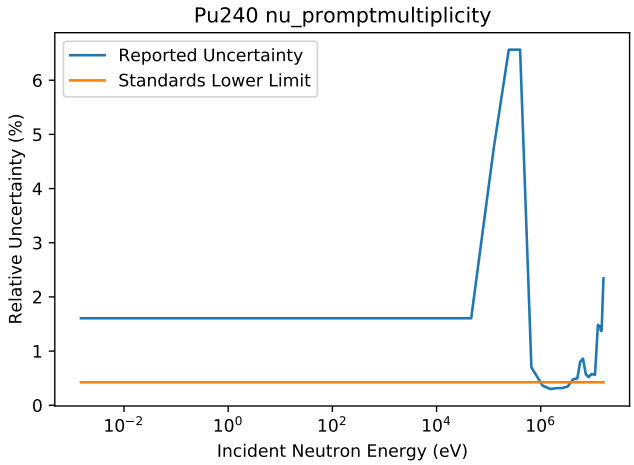

Figure 4.5: Critical problems in uncertainties of nu_promptmultiplicity are illustrated.

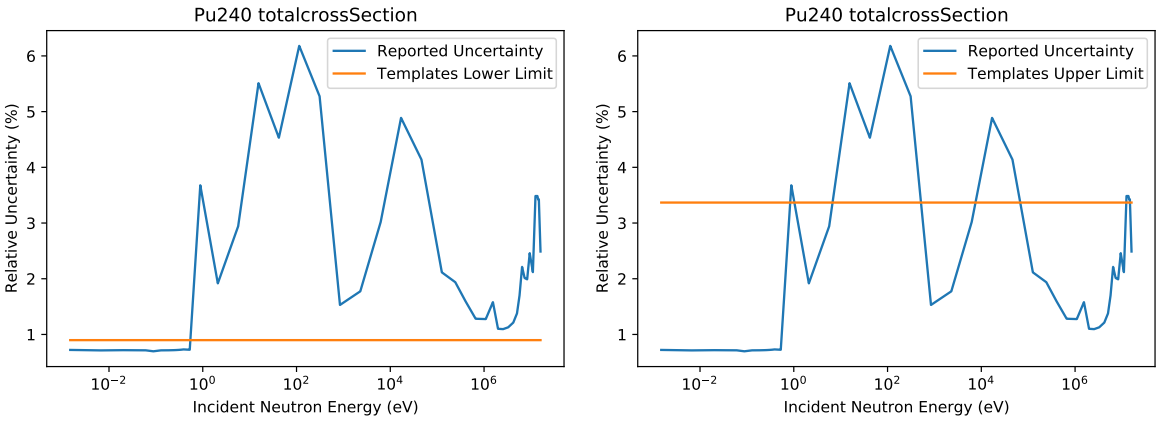

Figure 4.6: Possible problems in uncertainties of totalcrossSection are illustrated.

Chapter 5

^{239}Pu Covariances

5.1 List of Existing Covariances

Isotope studied: Pu239

- nu_promptmultiplicity
- n4ncrossSection
- n3ncrossSection
- fissionfissionSpectrum
- inelasticcrossSection
- capturecrossSection
- totalcrossSection
- elasticcrossSection
- n2ncrossSection
- numultiplicity
- fissioncrossSection

5.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 5.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	Passed	Passed	N/A	N/A
elasticcrossSection	Failed	Failed	Failed	N/A
fissioncrossSection	Failed	Failed	Failed	Failed
fissionfissionSpectrum	Failed	Failed	Failed	Failed
inelasticcrossSection	Passed	Passed	Failed	N/A
n2ncrossSection	Passed	Failed	N/A	N/A
n3ncrossSection	Passed	Passed	N/A	N/A

n4ncrossSection	Passed	Passed	N/A	N/A
nu_promptmultiplicity	Failed	Failed	Failed	Failed
numultiplicity	Failed	Failed	Failed	Failed
totalcrossSection	Failed	Failed	N/A	N/A

5.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 5.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
fissioncrossSection	N/A	Passed	N/A	Failed
fissionfissionSpectrum	N/A	Passed	N/A	Failed
inelasticcrossSection	N/A	Passed	N/A	N/A
n2ncrossSection	N/A	Failed	N/A	N/A
n3ncrossSection	N/A	Failed	N/A	N/A
n4ncrossSection	N/A	Passed	N/A	N/A
nu_promptmultiplicity	N/A	Passed	N/A	Passed
numultiplicity	N/A	Passed	N/A	Passed
totalcrossSection	N/A	Failed	N/A	N/A

5.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 5.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
capturecrossSection	0 of 2
elasticcrossSection	3 of 3
fissioncrossSection	4 of 4
fissionfissionSpectrum	4 of 4
inelasticcrossSection	1 of 3
n2ncrossSection	1 of 2
n3ncrossSection	0 of 2
n4ncrossSection	0 of 2
nu_promptmultiplicity	4 of 4
numultiplicity	4 of 4
totalcrossSection	2 of 2

5.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 5.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed

capturecrossSection	1 of 1
elasticcrossSection	0 of 1
fissioncrossSection	1 of 2
fissionfissionSpectrum	1 of 2
inelasticcrossSection	0 of 1
n2ncrossSection	1 of 1
n3ncrossSection	1 of 1
n4ncrossSection	0 of 1
nu_promptmultiplicity	0 of 2
numultiplicity	0 of 2
totalcrossSection	1 of 1

5.6 Covariances that Were Not Tested

- none

5.7 Covariances that Should be Counter-checked by Evaluator

- Critical problem in (uncertainties smaller than relevant standard): elasticcrossSection (Fig. 5.1)
  The evaluated elastic uncertainties are very low ($< 1.8\%$) in one bin of the resonance range. This is surprisingly small, especially, because there are no experimental data there. But there are a lot of total, (n,γ) and (n,f) cross-section data. So, these uncertainties are mapped out well. So, this could be ok.

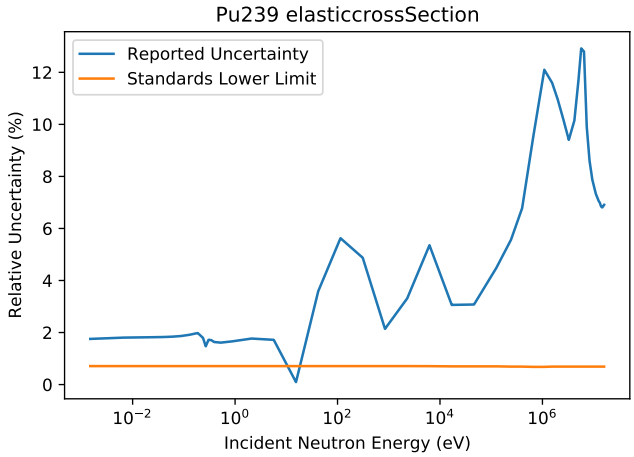

Figure 5.1: Critical problems in uncertainties of elasticcrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): fissioncrossSection (Fig. 5.2)
  The evaluated neutron-induced fission cross-section uncertainties are very low around 100 keV. However, this is coming from the Neutron Data Standards evaluation. So, this is ok.

  The evaluated correlations should be updated to have more USU energy bins.

- Critical problem in (uncertainties smaller than relevant standard): fissionfissionSpectrum (Fig. 5.3)
  The evaluated ^{239}Pu(n,f) PFNS uncertainties are underestimated for this particular evaluation as all relevant data are relative to the standard. So, the evaluated uncertainties should be larger than the standard. The new evaluation, however, will come with new uncertainties.

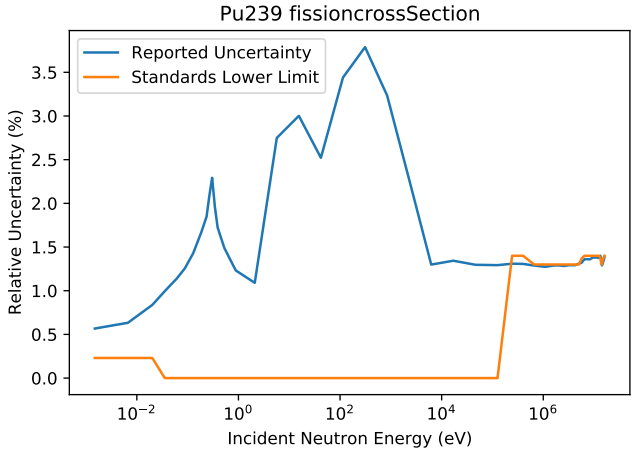

Figure 5.2: Critical problems in uncertainties of fissioncrossSection are illustrated.

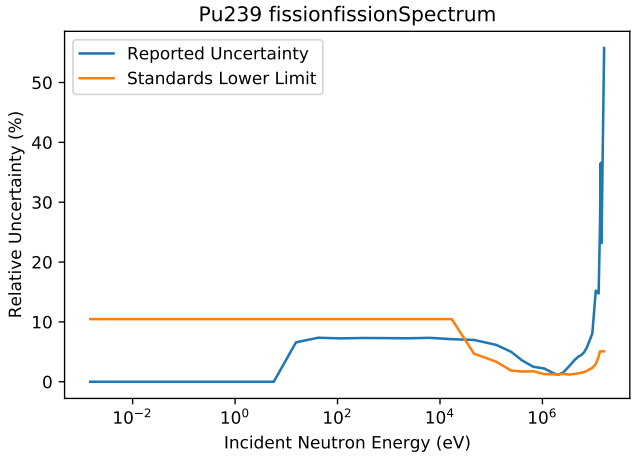

Figure 5.3: Critical problems in uncertainties of fissionfissionSpectrum are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): inelasticcrossSection (Fig. 5.4) The evaluated ^{239}Pu(n,inl) cross-section uncertainties are underestimated in the first energy bin below the threshold. They are actually 0 because of a mistake where the uncertainties start. **This should be fixed.**

- Possible problem in (>= 50% available tests failed): n2ncrossSection (Fig. 5.5)The evaluated ^{239}Pu(n,2n) cross-section uncertainties are underestimated in the first energy bin below the threshold (0.37%). **This should be fixed.**

- Critical problem in (uncertainties smaller than relevant standard): nu_promptmultiplicity (Fig. 5.6) The evaluated $\overline{\nu}_p$ uncertainties are too low below 2 MeV as the update with new standard uncertainties was incomplete. **This needs to be fixed.**

- Critical problem in (uncertainties smaller than relevant standard): numultiplicity (Fig. 5.7)The evaluated $\overline{\nu}$ uncertainties are too low below 2 MeV as the update with new standard uncertainties was incomplete. **This needs to be fixed.**

- Possible problem in (>= 50% available tests failed): totalcrossSection (Fig. 5.8) The evaluated total uncertainties are very low (< 0.9%) in one bin of the resonance range, but there are a lot of total cross-section data. So, these uncertainties are mapped out well. So, this could be ok.

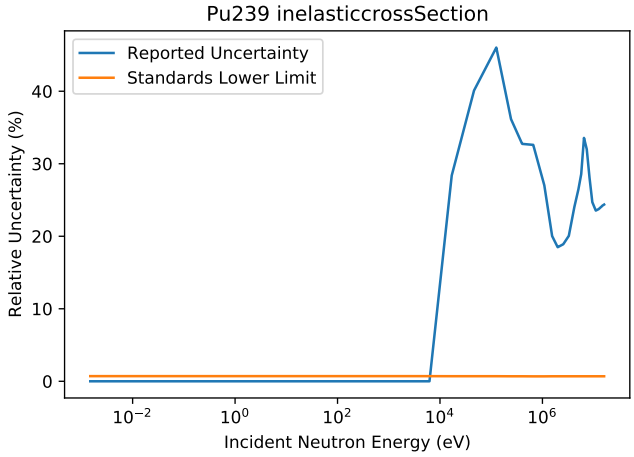

Figure 5.4: Critical problems in uncertainties of inelasticcrossSection are illustrated.

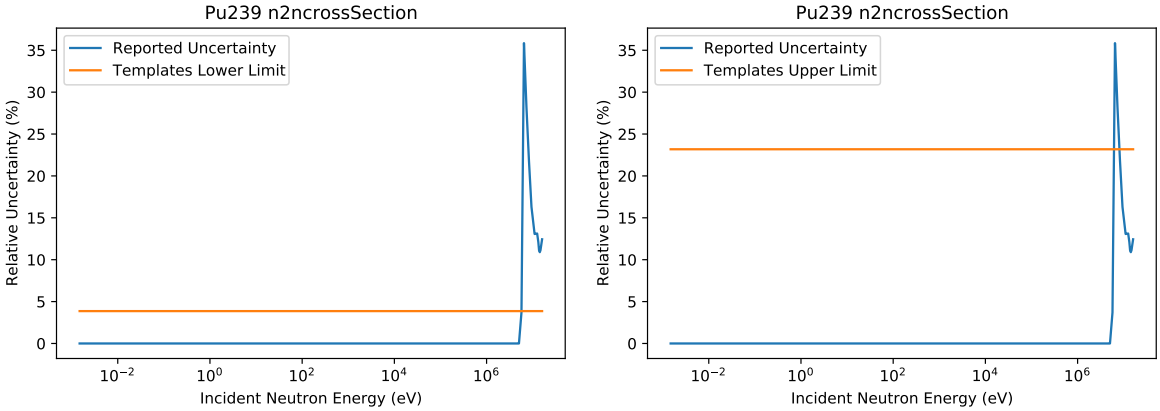

Figure 5.5: Possible problems in uncertainties of n2ncrossSection are illustrated.

They are a bit higher in the resonance range, but likely ok.

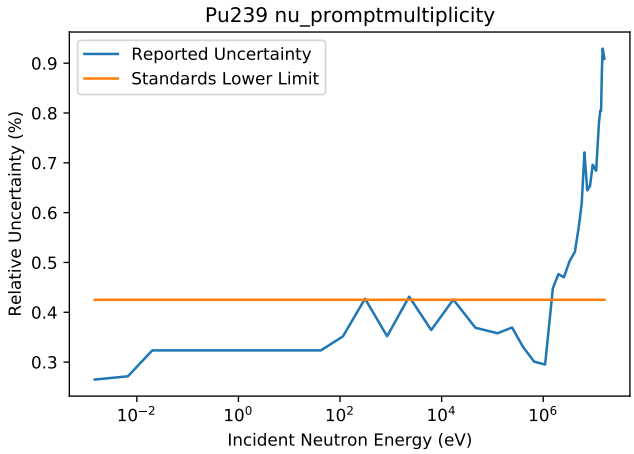

Figure 5.6: Critical problems in uncertainties of nu_promptmultiplicity are illustrated.

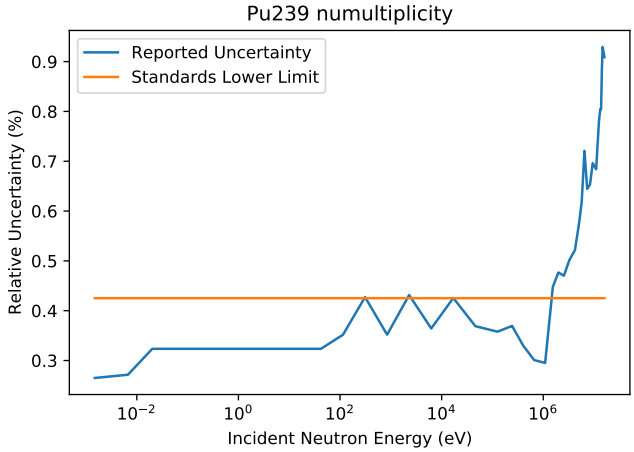

Figure 5.7: Critical problems in uncertainties of numultiplicity are illustrated.

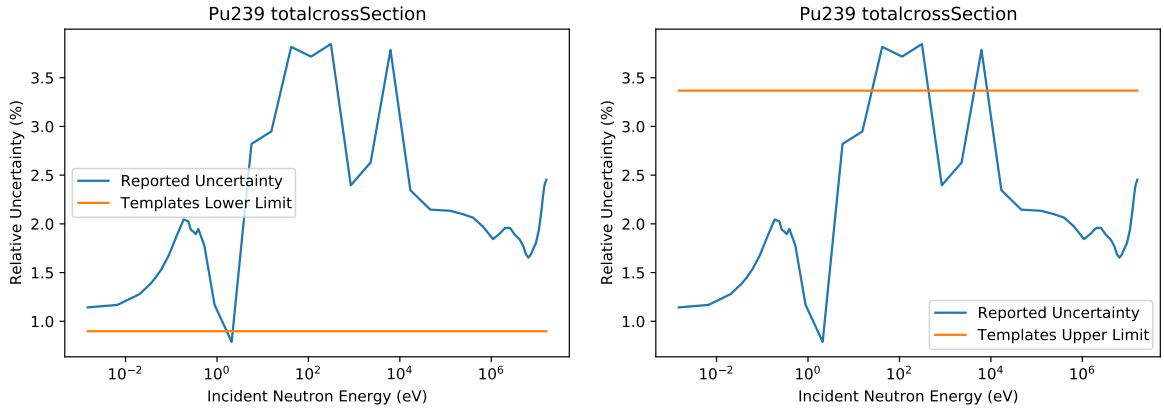

Figure 5.8: Possible problems in uncertainties of totalcrossSection are illustrated.

Chapter 6

^{238}Pu

6.1 List of Existing Covariances

Isotope studied: Pu238

- nu_promptmultiplicity
- n3ncrossSection
- fissionfissionSpectrum
- inelasticcrossSection
- capturecrossSection
- totalcrossSection
- elasticcrossSection
- n2ncrossSection
- numultiplicity
- fissioncrossSection

6.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 6.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	Passed	Passed	N/A	N/A
elasticcrossSection	Passed	Failed	Passed	N/A
fissioncrossSection	Passed	Failed	Failed	Failed
fissionfissionSpectrum	Failed	Failed	Failed	Failed
inelasticcrossSection	Passed	Failed	Passed	N/A
n2ncrossSection	Passed	Passed	N/A	N/A
n3ncrossSection	Passed	Passed	N/A	N/A
nu_promptmultiplicity	Failed	Passed	Passed	Failed
numultiplicity	Failed	Passed	Passed	Failed
totalcrossSection	Passed	Passed	N/A	N/A

6.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 6.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Failed	N/A	N/A
fissioncrossSection	N/A	Failed	N/A	Failed
fissionfissionSpectrum	N/A	Failed	N/A	Failed
inelasticcrossSection	N/A	Passed	N/A	N/A
n2ncrossSection	N/A	Failed	N/A	N/A
n3ncrossSection	N/A	Failed	N/A	N/A
nu_promptmultiplicity	N/A	Failed	N/A	Passed
numultiplicity	N/A	Failed	N/A	Passed
totalcrossSection	N/A	Failed	N/A	N/A

6.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 6.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
capturecrossSection	0 of 2
elasticcrossSection	1 of 3
fissioncrossSection	3 of 4
fissionfissionSpectrum	4 of 4
inelasticcrossSection	1 of 3
n2ncrossSection	0 of 2
n3ncrossSection	0 of 2
nu_promptmultiplicity	2 of 4
numultiplicity	2 of 4
totalcrossSection	0 of 2

6.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 6.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
capturecrossSection	1 of 1
elasticcrossSection	1 of 1
fissioncrossSection	2 of 2
fissionfissionSpectrum	2 of 2
inelasticcrossSection	0 of 1
n2ncrossSection	1 of 1
n3ncrossSection	1 of 1

nu_promptmultiplicity	1 of 2
numultiplicity	1 of 2
totalcrossSection	1 of 1

6.6 Covariances that Were Not Tested

- none

6.7 Covariances that Should be Counter-checked by Evaluator

- Possible problem in (>= 50% available tests failed): elasticcrossSection (Fig. 6.1) The evaluated elastic uncertainties are very low (< 1.8%) in one bin of the resonance range. This is surprisingly small, especially, because there are no experimental data there and only one total cross-section data set. But, there are (n,γ) and (n,f) cross section data. So, this could be ok.

  The evaluated elastic uncertainties in the resonance range are large but likely ok.

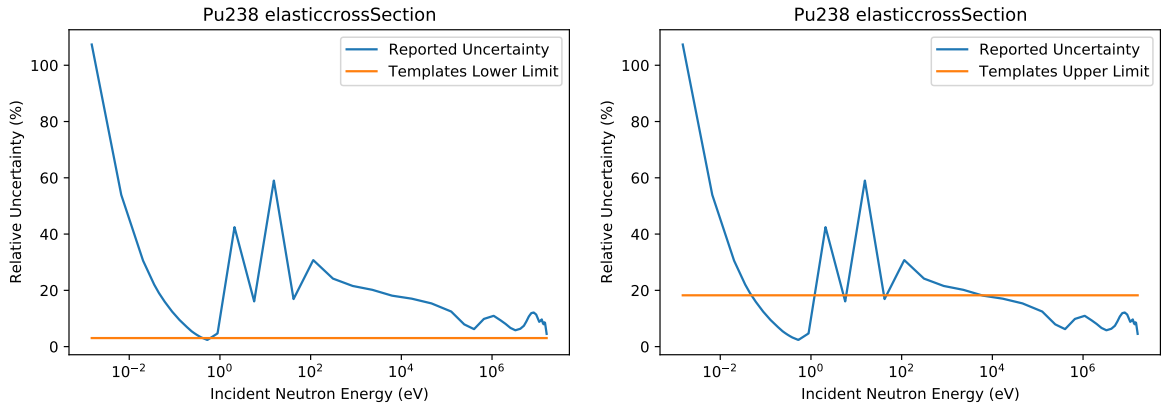

Figure 6.1: Possible problems in uncertainties of elasticcrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): fissioncrossSection (Fig. 6.2) **The evaluated neutron-induced fission cross-section uncertainties are very low from 100 keV to 1 MeV. This needs to be updated with the newest standard uncertainties.**

- Critical problem in (uncertainties smaller than relevant standard): fissionfissionSpectrum (Fig. 6.3) The evaluated ^{238}Pu(n,f) PFNS uncertainties are likely ok. They are lower than the standard uncertainties in the lowest outgoing-neutron energy bin. However, this is a binning issue during processing the data and not an issue in the covariances.

- Possible problem in (>= 50% available tests failed): nu_promptmultiplicity (Fig. 6.4) The evaluated ^{238}Pu(n,f) $\overline{\nu}_p$ uncertainties are likely ok. They are higher than template uncertainties above 5 MeV. That is ok because there are no experimental data.

- Possible problem in (>= 50% available tests failed): numultiplicity (Fig. 6.5) The evaluated ^{238}Pu(n,f) $\overline{\nu}$ uncertainties are likely ok. They are higher than template uncertainties above 5 MeV. That is ok because there are no experimental data.

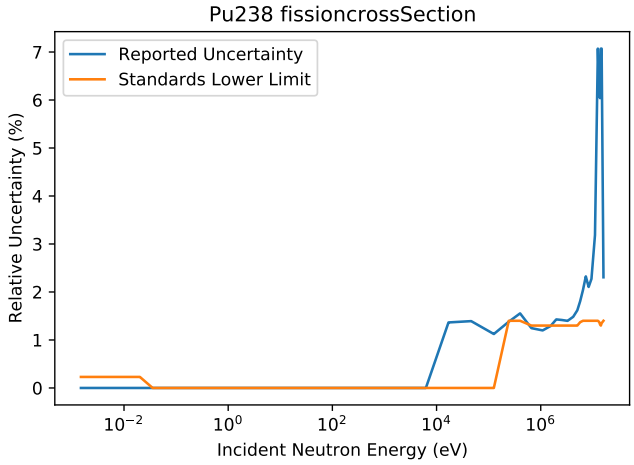

Figure 6.2: Critical problems in uncertainties of fissioncrossSection are illustrated.

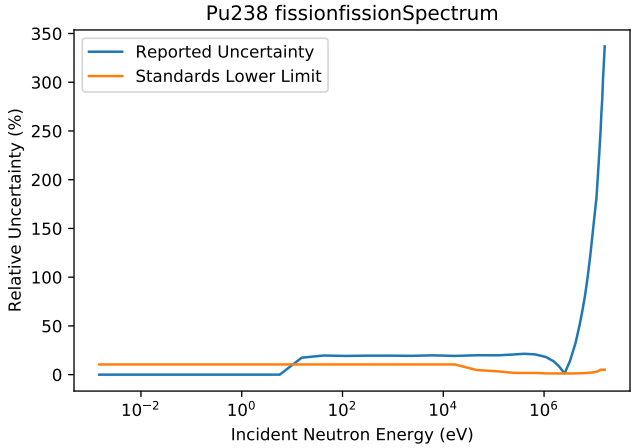

Figure 6.3: Critical problems in uncertainties of fissionfissionSpectrum are illustrated.

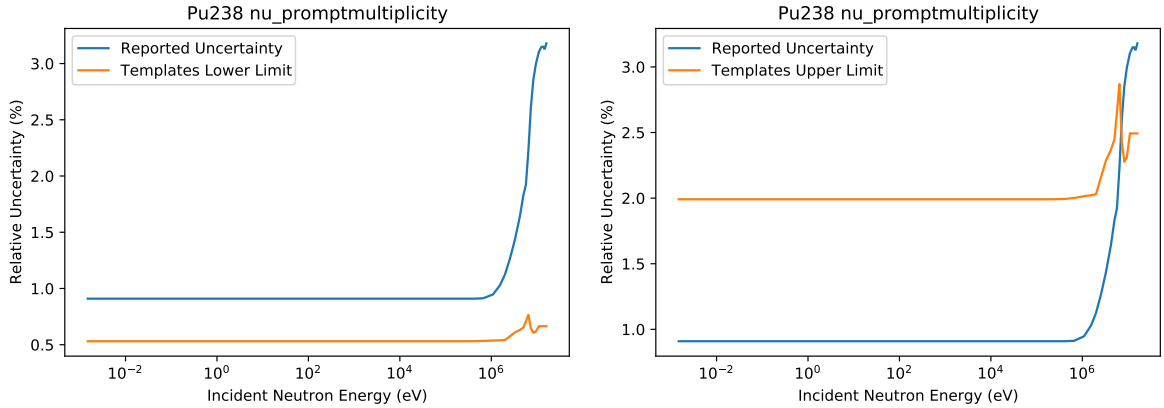

Figure 6.4: Possible problems in uncertainties of nu_promptmultiplicity are illustrated.

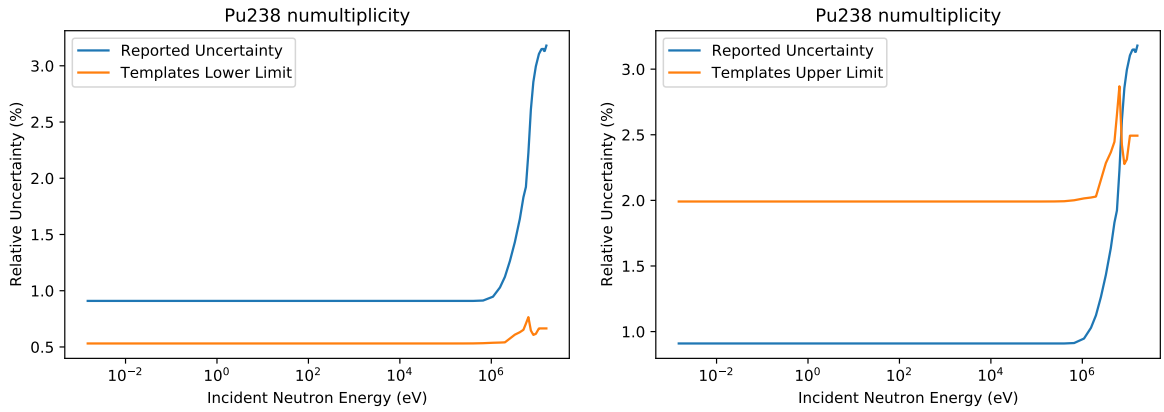

Figure 6.5: Possible problems in uncertainties of numultiplicity are illustrated.

Chapter 7

^{238}U Covariances

7.1 List of Existing Covariances

Isotope studied: U238

- lumped852crossSection
- nu_promptmultiplicity
- n3ncrossSection
- inelastic_01crossSection
- fissionfissionSpectrum
- anythingcrossSection
- inelasticcrossSection
- capturecrossSection
- totalcrossSection
- elasticcrossSection
- n2ncrossSection
- lumped851crossSection
- numultiplicity
- fissioncrossSection
- nu_delayedmultiplicity

7.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 7.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs

anythingcrossSection	N/A	N/A	N/A	N/A
capturecrossSection	Failed	Failed	N/A	N/A
elasticcrossSection	Failed	Failed	Failed	N/A
fissioncrossSection	Passed	Failed	Failed	Passed
fissionfissionSpectrum	Failed	Failed	Failed	Failed
inelastic_01crossSection	Passed	Passed	Passed	N/A
inelasticcrossSection	Passed	Failed	Passed	N/A
lumped851crossSection	N/A	N/A	N/A	N/A
lumped852crossSection	N/A	N/A	N/A	N/A
n2ncrossSection	Passed	Passed	N/A	N/A
n3ncrossSection	Passed	Passed	N/A	N/A
nu_delayedmultiplicity	N/A	N/A	N/A	N/A
nu_promptmultiplicity	Passed	Passed	Passed	Passed
numultiplicity	Passed	Passed	Passed	Passed
totalcrossSection	Failed	Failed	N/A	N/A

7.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 7.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
anythingcrossSection	N/A	N/A	N/A	N/A
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
fissioncrossSection	N/A	Failed	N/A	Failed
fissionfissionSpectrum	N/A	Failed	N/A	Failed
inelastic_01crossSection	N/A	Passed	N/A	N/A
inelasticcrossSection	N/A	Passed	N/A	N/A
lumped851crossSection	N/A	N/A	N/A	N/A
lumped852crossSection	N/A	N/A	N/A	N/A
n2ncrossSection	N/A	Passed	N/A	N/A
n3ncrossSection	N/A	Failed	N/A	N/A
nu_delayedmultiplicity	N/A	N/A	N/A	N/A
nu_promptmultiplicity	N/A	Failed	N/A	Failed
numultiplicity	N/A	Failed	N/A	Failed
totalcrossSection	N/A	Failed	N/A	N/A

7.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 7.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
anythingcrossSection	0 of 0
capturecrossSection	2 of 2
elasticcrossSection	3 of 3

fissioncrossSection	2 of 4
fissionfissionSpectrum	4 of 4
inelastic_01crossSection	0 of 3
inelasticcrossSection	1 of 3
lumped851crossSection	0 of 0
lumped852crossSection	0 of 0
n2ncrossSection	0 of 2
n3ncrossSection	0 of 2
nu_delayedmultiplicity	0 of 0
nu_promptmultiplicity	0 of 4
numultiplicity	0 of 4
totalcrossSection	2 of 2

7.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 7.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
anythingcrossSection	0 of 0
capturecrossSection	1 of 1
elasticcrossSection	0 of 1
fissioncrossSection	2 of 2
fissionfissionSpectrum	2 of 2
inelastic_01crossSection	0 of 1
inelasticcrossSection	0 of 1
lumped851crossSection	0 of 0
lumped852crossSection	0 of 0
n2ncrossSection	0 of 1
n3ncrossSection	1 of 1
nu_delayedmultiplicity	0 of 0
nu_promptmultiplicity	2 of 2
numultiplicity	2 of 2
totalcrossSection	1 of 1

7.6 Covariances that Were Not Tested

- anythingcrossSection
- lumped851crossSection
- lumped852crossSection
- nu_delayedmultiplicity

7.7 Covariances that Should be Counter-checked by Evaluator

- Possible problem in (>= 50% available tests failed): capturecrossSection (Fig. 7.1) The evaluated neutron-induced capture cross-section uncertainties are very low below 1 MeV. However, this is evaluated as part of the Neutron Data Standards project. So, this is ok.

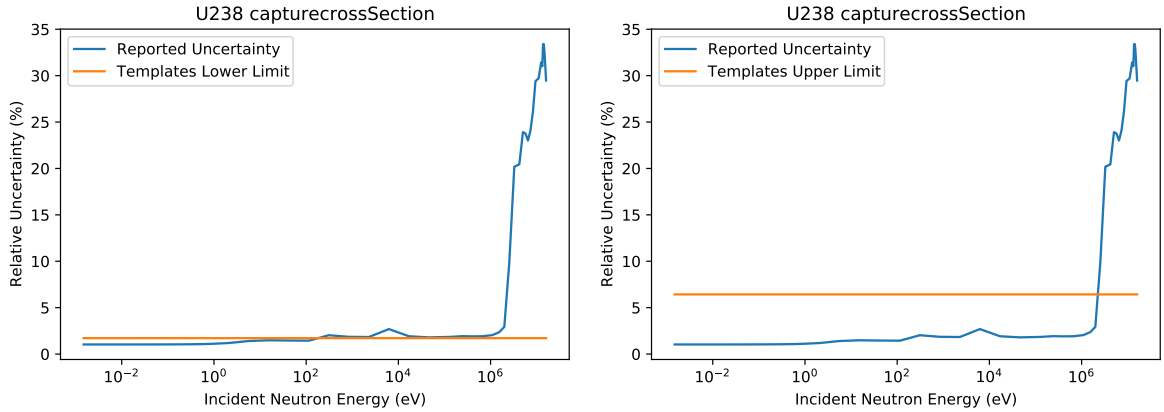

Figure 7.1: Possible problems in uncertainties of capturecrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): elasticcrossSection (Fig. 7.2) The evaluated uncertainties in the resonance range are smaller than the standard at thermal. There are no experimental data for the elastic cross section, only one data set for (n,tot) cross sections and only data right at thermal for (n,γ) cross sections. The evaluated uncertainties seem to be low. **An evaluator of the resonance range should take a look at it.**

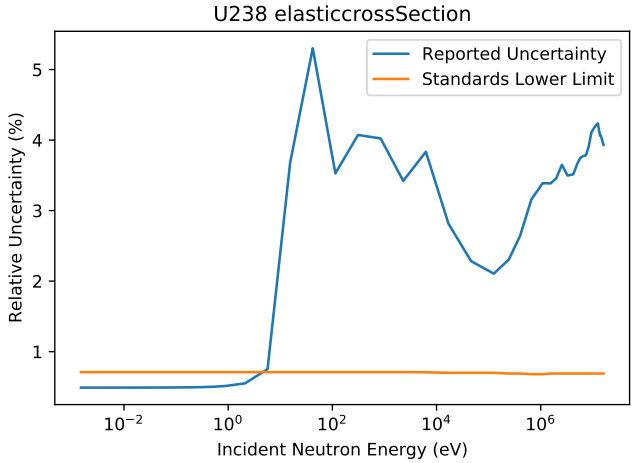

Figure 7.2: Critical problems in uncertainties of elasticcrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): fissioncrossSection (Fig. 7.3) The evaluated neutron-induced fission cross-section uncertainties are very low around 100 keV. However, this is coming from the Neutron Data Standards evaluation. So, this is ok.

  The evaluated correlations should be updated to have more USU energy bins.

- Critical problem in (uncertainties smaller than relevant standard): fissionfissionSpectrum (Fig. 7.4) The evaluated PFNS uncertainties are very low around 10 keV and then there is an issue around 1 eV in the evaluated uncertainties. **An evaluator should fix that.**

- Possible problem in (>= 50% available tests failed): totalcrossSection (Fig. 7.5) The evaluated uncertainties in the resonance range are smaller than expected. There are no experimental data for the elastic cross section, only one data set for (n,tot) cross sections, and only data right at

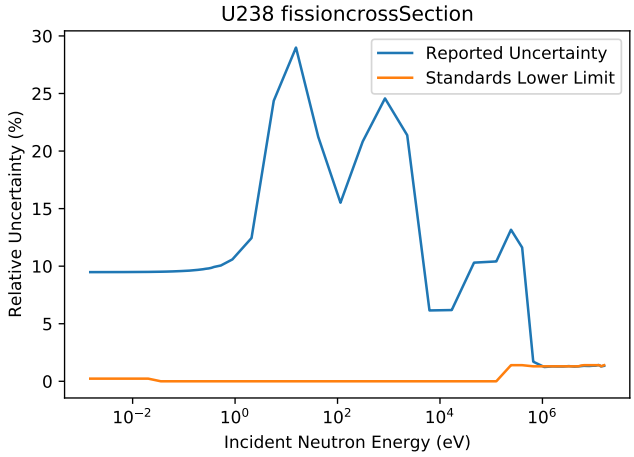

Figure 7.3: Critical problems in uncertainties of fissioncrossSection are illustrated.

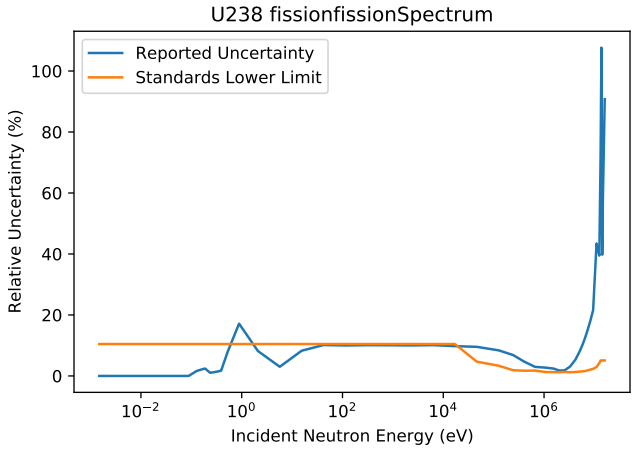

Figure 7.4: Critical problems in uncertainties of fissionfissionSpectrum are illustrated.

thermal for (n,γ) cross sections. The evaluated uncertainties seem to be low. **An evaluator of the resonance range should take a look at it.**

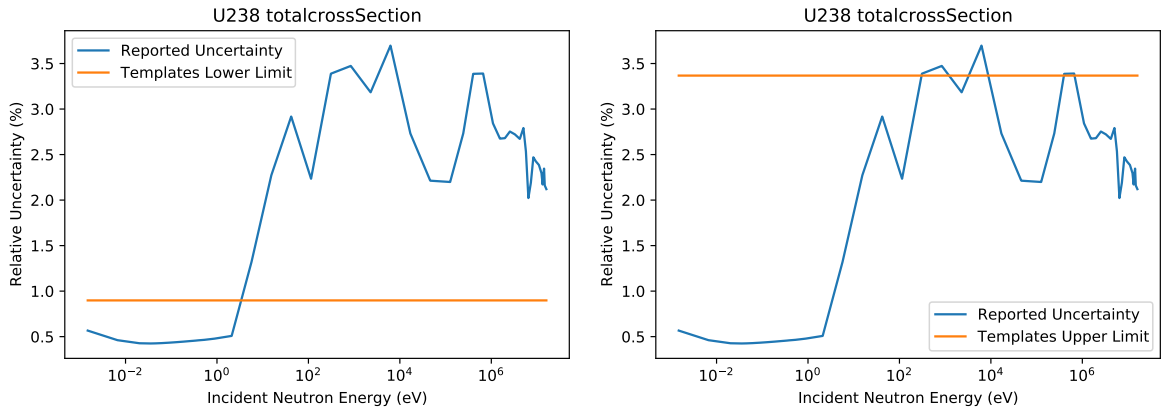

Figure 7.5: Possible problems in uncertainties of totalcrossSection are illustrated.

Chapter 8

^{235}U Covariances

8.1 List of Existing Covariances

Isotope studied: U235

- lumped852crossSection
- nu_promptmultiplicity
- n3ncrossSection
- inelastic_01crossSection
- fissionfissionSpectrum
- anythingcrossSection
- inelasticcrossSection
- capturecrossSection
- totalcrossSection
- elasticcrossSection
- n2ncrossSection
- lumped851crossSection
- numultiplicity
- fissioncrossSection
- nu_delayedmultiplicity

8.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 8.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs

anythingcrossSection	N/A	N/A	N/A	N/A
capturecrossSection	Failed	Failed	N/A	N/A
elasticcrossSection	Failed	Failed	Passed	N/A
fissioncrossSection	Failed	Failed	Failed	Failed
fissionfissionSpectrum	Failed	Failed	Failed	Failed
inelastic_01crossSection	Failed	Failed	Failed	N/A
inelasticcrossSection	Passed	Failed	Passed	N/A
lumped851crossSection	N/A	N/A	N/A	N/A
lumped852crossSection	N/A	N/A	N/A	N/A
n2ncrossSection	Passed	Passed	N/A	N/A
n3ncrossSection	Passed	Passed	N/A	N/A
nu_delayedmultiplicity	N/A	N/A	N/A	N/A
nu_promptmultiplicity	Failed	Failed	Failed	Failed
numultiplicity	Failed	Failed	Failed	Failed
totalcrossSection	Failed	Failed	N/A	N/A

8.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 8.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
anythingcrossSection	N/A	N/A	N/A	N/A
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
fissioncrossSection	N/A	Passed	N/A	Passed
fissionfissionSpectrum	N/A	Passed	N/A	Passed
inelastic_01crossSection	N/A	Failed	N/A	N/A
inelasticcrossSection	N/A	Failed	N/A	N/A
lumped851crossSection	N/A	N/A	N/A	N/A
lumped852crossSection	N/A	N/A	N/A	N/A
n2ncrossSection	N/A	Failed	N/A	N/A
n3ncrossSection	N/A	Failed	N/A	N/A
nu_delayedmultiplicity	N/A	N/A	N/A	N/A
nu_promptmultiplicity	N/A	Passed	N/A	Failed
numultiplicity	N/A	Passed	N/A	Failed
totalcrossSection	N/A	Passed	N/A	N/A

8.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 8.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
anythingcrossSection	0 of 0
capturecrossSection	2 of 2
elasticcrossSection	2 of 3

fissioncrossSection	4 of 4
fissionfissionSpectrum	4 of 4
inelastic_01crossSection	3 of 3
inelasticcrossSection	1 of 3
lumped851crossSection	0 of 0
lumped852crossSection	0 of 0
n2ncrossSection	0 of 2
n3ncrossSection	0 of 2
nu_delayedmultiplicity	0 of 0
nu_promptmultiplicity	4 of 4
numultiplicity	4 of 4
totalcrossSection	2 of 2

8.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 8.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
anythingcrossSection	0 of 0
capturecrossSection	1 of 1
elasticcrossSection	0 of 1
fissioncrossSection	0 of 2
fissionfissionSpectrum	0 of 2
inelastic_01crossSection	1 of 1
inelasticcrossSection	1 of 1
lumped851crossSection	0 of 0
lumped852crossSection	0 of 0
n2ncrossSection	1 of 1
n3ncrossSection	1 of 1
nu_delayedmultiplicity	0 of 0
nu_promptmultiplicity	1 of 2
numultiplicity	1 of 2
totalcrossSection	0 of 1

8.6 Covariances that Were Not Tested

- anythingcrossSection
- lumped851crossSection
- lumped852crossSection
- nu_delayedmultiplicity

8.7 Covariances that Should be Counter-checked by Evaluator

- Possible problem in (>= 50% available tests failed): capturecrossSection (Fig. 8.1) The evaluated uncertainties in the resonance range are small. However, these values are part of the thermal constants from the Neutron Data Standards and are, therefore, low. This is likely ok.

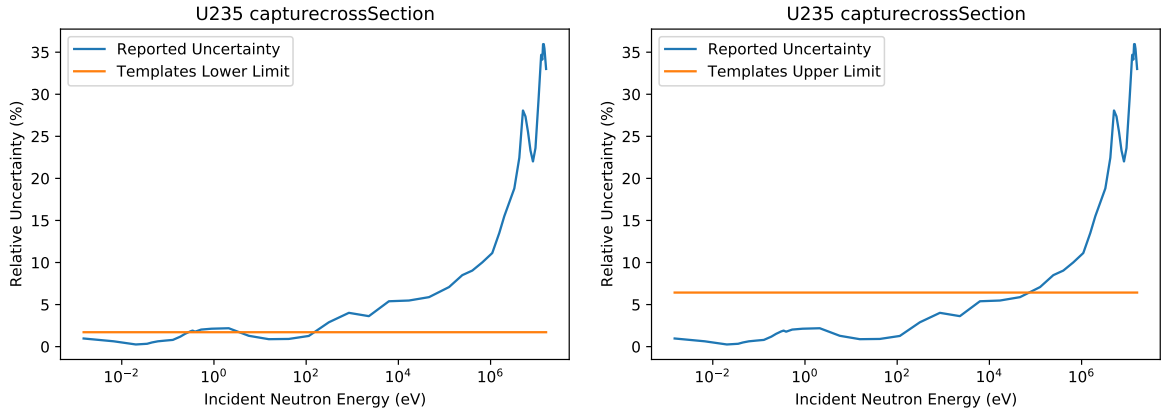

Figure 8.1: Possible problems in uncertainties of capturecrossSection are illustrated.

- Possible problem in (>= 50% available tests failed): elasticcrossSection (Fig. 8.2) The evaluated uncertainties in the resonance range are small. However, these values are part of the thermal constants from the Neutron Data Standards and are, therefore, low. This is likely ok.

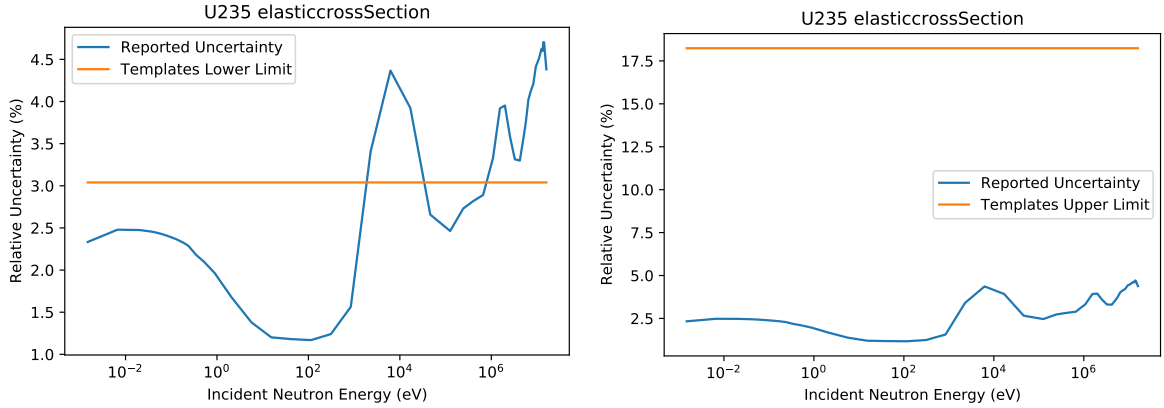

Figure 8.2: Possible problems in uncertainties of elasticcrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): fissioncrossSection (Fig. 8.3) The evaluated uncertainties are coming from the Neutron Data Standards evaluation and are ok.
- Critical problem in (uncertainties smaller than relevant standard): fissionfissionSpectrum (Fig. 8.4) The evaluated PFNS uncertainties are very low around 10 keV and then there is an issue around 1 eV in the evaluated uncertainties. **An evaluator should check if that is what is in ENDF/B-VIII.0 or a binning issue.**
- Critical problem in (uncertainties smaller than relevant standard): inelastic_01crossSection (Fig. 8.5) The evaluated uncertainties seem ok for most energies but there could be underestimated uncertainties in the lowest or highest bins. **An evaluator should check if there is a binning issue for the uncertainties.**
- Possible problem in (>= 50% available tests failed): inelasticcrossSection (Fig. 8.6) The evaluated uncertainties are surprisingly low from 100 keV to 20 MeV. **An evaluator should check if that is ok.**

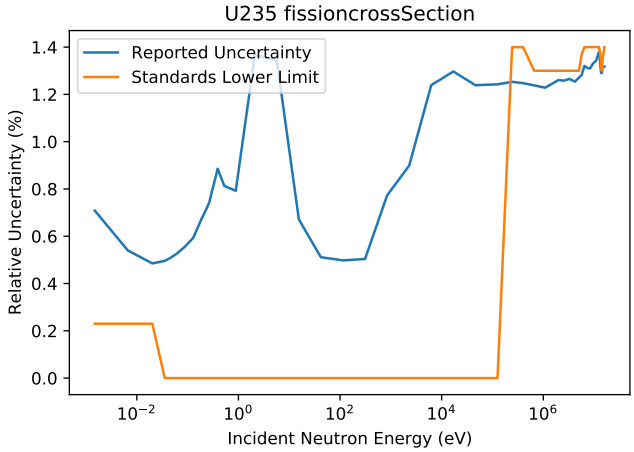

Figure 8.3: Critical problems in uncertainties of fissioncrossSection are illustrated.

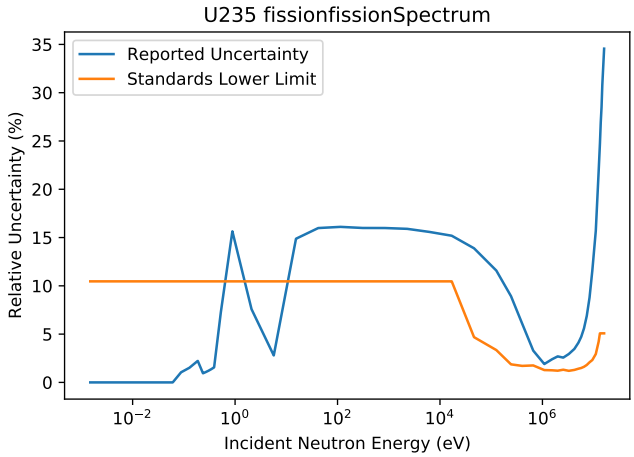

Figure 8.4: Critical problems in uncertainties of fissionfissionSpectrum are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): nu_promptmultiplicity (Fig. 8.7) The evaluated uncertainties are smaller than the standards uncertainties from 100 keV to 1 MeV. **This should be fixed.**
- Critical problem in (uncertainties smaller than relevant standard): numultiplicity (Fig. 8.8) The evaluated uncertainties are smaller than the standards uncertainties from 100 keV to 1 MeV. **This should be fixed.**
- Possible problem in (>= 50% available tests failed): totalcrossSection (Fig. 8.9) The evaluated uncertainties in the resonance range are small. However, these values can be derived from the thermal constants from the Neutron Data Standards and are, therefore, low. This is likely ok.

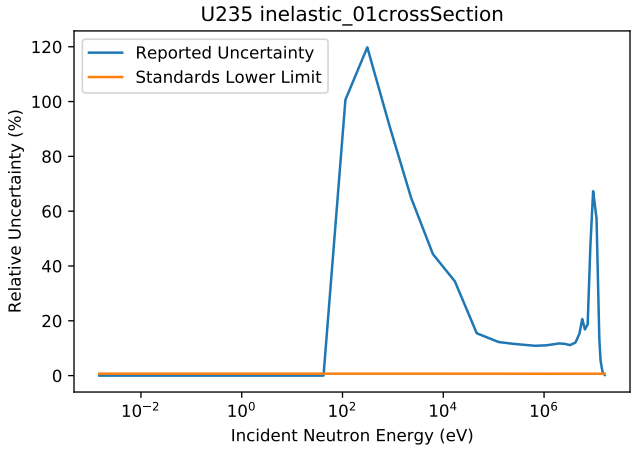

Figure 8.5: Critical problems in uncertainties of inelastic_01crossSection are illustrated.

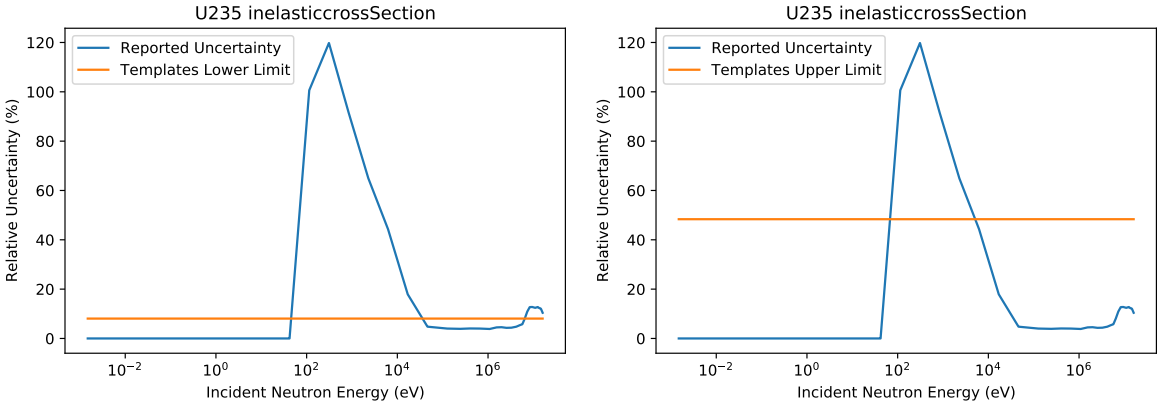

Figure 8.6: Possible problems in uncertainties of inelasticcrossSection are illustrated.

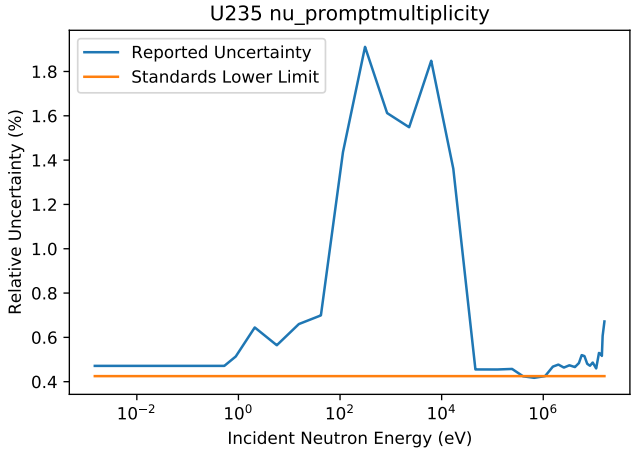

Figure 8.7: Critical problems in uncertainties of nu_promptmultiplicity are illustrated.

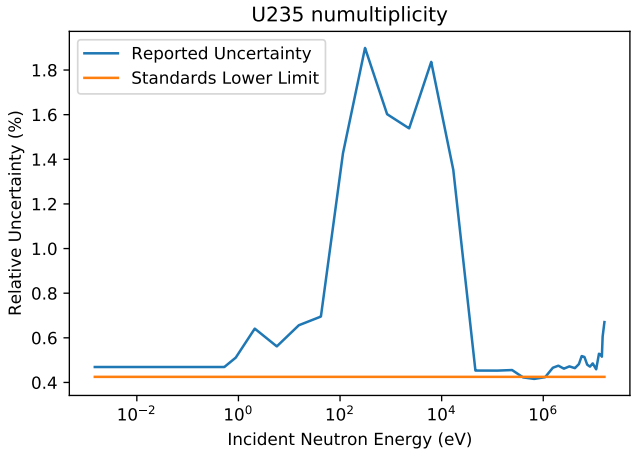

Figure 8.8: Critical problems in uncertainties of numultiplicity are illustrated.

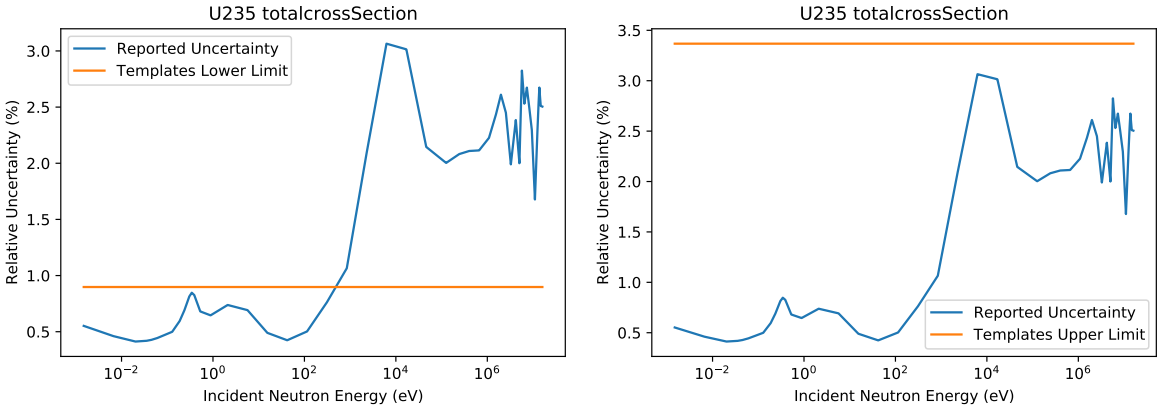

Figure 8.9: Possible problems in uncertainties of totalcrossSection are illustrated.

Chapter 9

^{27}Al Covariances

9.1 List of Existing Covariances

Isotope studied: Al027

- elasticcrossSection
- inelasticcrossSection
- capturecrossSection
- n2ncrossSection
- totalcrossSection

9.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 9.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	Failed	Passed	N/A	N/A
elasticcrossSection	Failed	Failed	Passed	N/A
inelasticcrossSection	Passed	Failed	Passed	N/A
n2ncrossSection	Passed	Passed	N/A	N/A
totalcrossSection	Passed	Passed	N/A	N/A

9.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 9.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
inelasticcrossSection	N/A	Passed	N/A	N/A

n2ncrossSection	N/A	Failed	N/A	N/A
totalcrossSection	N/A	Failed	N/A	N/A

9.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 9.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
capturecrossSection	1 of 2
elasticcrossSection	2 of 3
inelasticcrossSection	1 of 3
n2ncrossSection	0 of 2
totalcrossSection	0 of 2

9.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 9.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
capturecrossSection	1 of 1
elasticcrossSection	0 of 1
inelasticcrossSection	0 of 1
n2ncrossSection	1 of 1
totalcrossSection	1 of 1

9.6 Covariances that Were Not Tested

- none

9.7 Covariances that Should be Counter-checked by Evaluator

- Possible problem in (>= 50% available tests failed): capturecrossSection (Fig. 9.1) The evaluated uncertainties are low in the thermal range. There are few (n,γ) experimental data there. However, there are a lot of (n,tot) data, and (n,γ) is small. While small this could be ok.

  The evaluated uncertainties are large in the fast range. There are few very uncertain and discrepant data sets. The cross section is also very small. I think the uncertainties accurately represent a difficult situation for an evaluator.

- Possible problem in (>= 50% available tests failed): elasticcrossSection (Fig. 9.2) The evaluated uncertainties are low in the thermal range. There are no elastic experimental data there. However, there are a lot of (n,tot) data, and (n,γ) is small. While small this could be ok. **It might be good to discuss this with an evaluator to make sure I did not overlook something.**

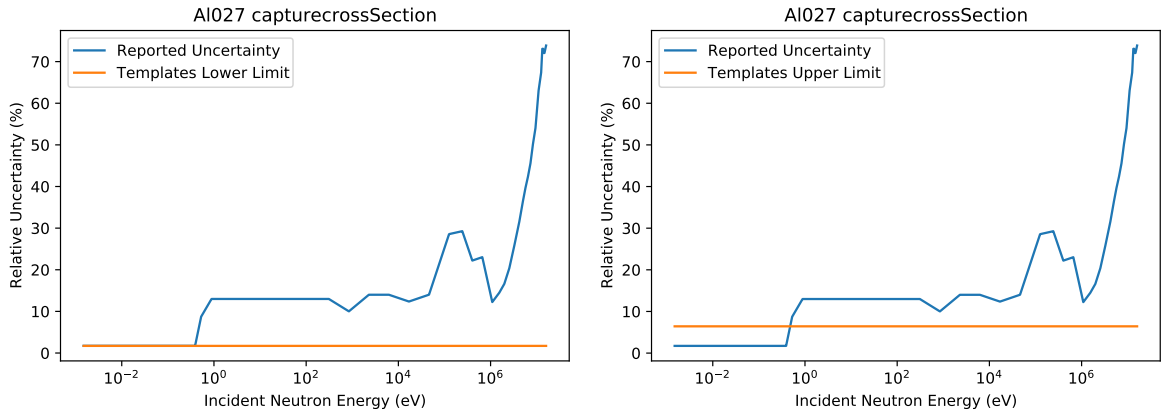

Figure 9.1: Possible problems in uncertainties of capturecrossSection are illustrated.

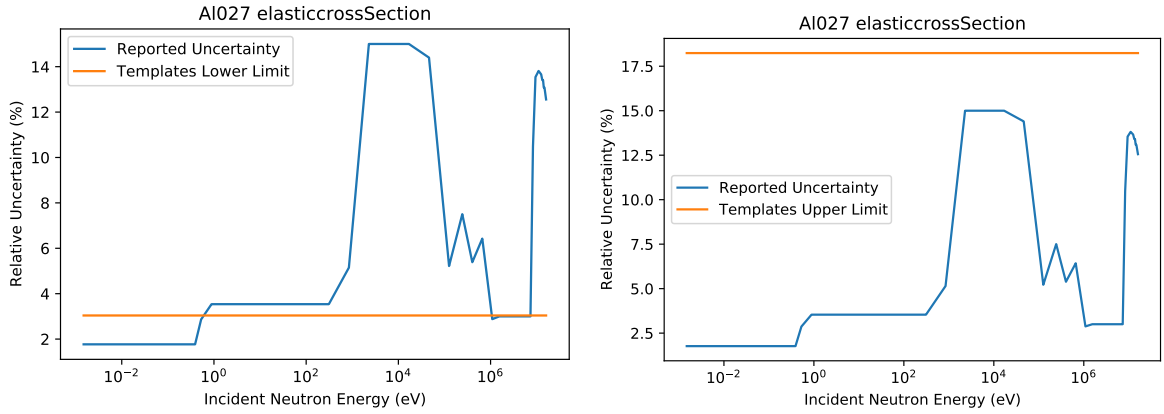

Figure 9.2: Possible problems in uncertainties of elasticcrossSection are illustrated.

Chapter 10

^{12}C

10.1 List of Existing Covariances

Isotope studied: C012

- npcrossSection
- ndcrossSection
- nnpcrossSection
- nacrossSection
- anythingcrossSection
- inelasticcrossSection
- totalcrossSection
- elasticcrossSection
- inelastic_01crossSection
- capturecrossSection

10.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 10.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
anythingcrossSection	N/A	N/A	N/A	N/A
capturecrossSection	Passed	Passed	N/A	N/A
elasticcrossSection	Failed	Failed	Failed	N/A
inelastic_01crossSection	Passed	Failed	Failed	N/A
inelasticcrossSection	Passed	Passed	Passed	N/A
nacrossSection	N/A	N/A	N/A	N/A
ndcrossSection	N/A	N/A	N/A	N/A
nnpcrossSection	N/A	N/A	N/A	N/A
npcrossSection	N/A	N/A	N/A	N/A
totalcrossSection	Failed	Failed	N/A	N/A

10.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 10.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
anythingcrossSection	N/A	N/A	N/A	N/A
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
inelastic_01crossSection	N/A	Passed	N/A	N/A
inelasticcrossSection	N/A	Passed	N/A	N/A
nacrossSection	N/A	N/A	N/A	N/A
ndcrossSection	N/A	N/A	N/A	N/A
nnpcrossSection	N/A	N/A	N/A	N/A
npcrossSection	N/A	N/A	N/A	N/A
totalcrossSection	N/A	Failed	N/A	N/A

10.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 10.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
anythingcrossSection	0 of 0
capturecrossSection	0 of 2
elasticcrossSection	3 of 3
inelastic_01crossSection	2 of 3
inelasticcrossSection	0 of 3
nacrossSection	0 of 0
ndcrossSection	0 of 0
nnpcrossSection	0 of 0
npcrossSection	0 of 0
totalcrossSection	2 of 2

10.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 10.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
anythingcrossSection	0 of 0
capturecrossSection	1 of 1
elasticcrossSection	0 of 1
inelastic_01crossSection	0 of 1
inelasticcrossSection	0 of 1
nacrossSection	0 of 0

ndcrossSection	0 of 0
nnpcrossSection	0 of 0
npcrossSection	0 of 0
totalcrossSection	1 of 1

10.6 Covariances that Were Not Tested

- anythingcrossSection
- nacrossSection
- ndcrossSection
- nnpcrossSection
- npcrossSection

10.7 Covariances that Should be Counter-checked by Evaluator

- Critical problem in (uncertainties smaller than relevant standard): elasticcrossSection (Fig. 10.1) The evaluated uncertainties until 1.8 MeV are coming from the Neutron Data Standards evaluation and are ok.

  However, I wonder if there is a binning issue at higher incident-neutron energies. **An evaluator should take a look if there is an issue in the ENDF/B-VIII.0 covariances or a binning issue.**

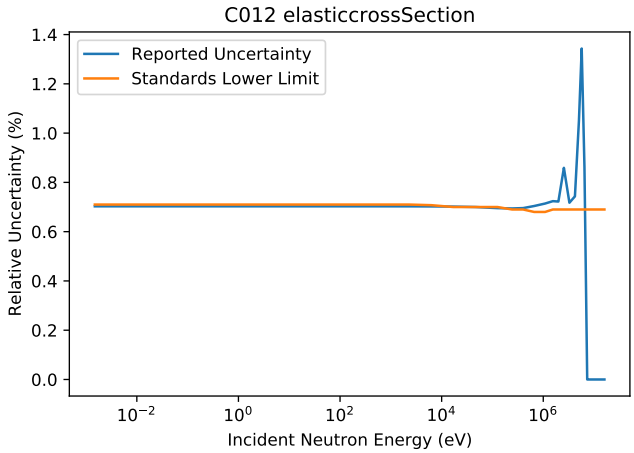

Figure 10.1: Critical problems in uncertainties of elasticcrossSection are illustrated.

- Critical problem in (uncertainties smaller than relevant standard): inelastic_01crossSection (Fig. 10.2) The evaluated uncertainties look ok. However, I wonder if there is a binning issue at higher incident-neutron energies. **An evaluator should take a look if there is an issue in the ENDF/B-VIII.0 covariances or a binning issue.**
- Possible problem in (>= 50% available tests failed): totalcrossSection (Fig. 10.3) The evaluated (n,el) uncertainties until 1.8 MeV are coming from the Neutron Data Standards evaluation and there are a lot of (n,tot) cross-section experimental data. The (n,γ) cross section is small. Hence, this is likely ok.

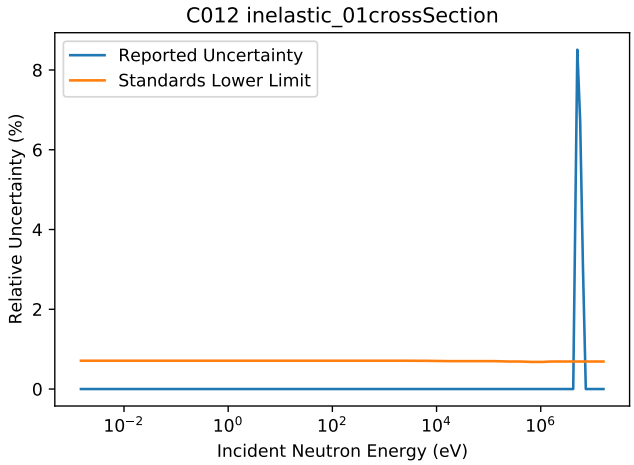

Figure 10.2: Critical problems in uncertainties of inelastic_01crossSection are illustrated.

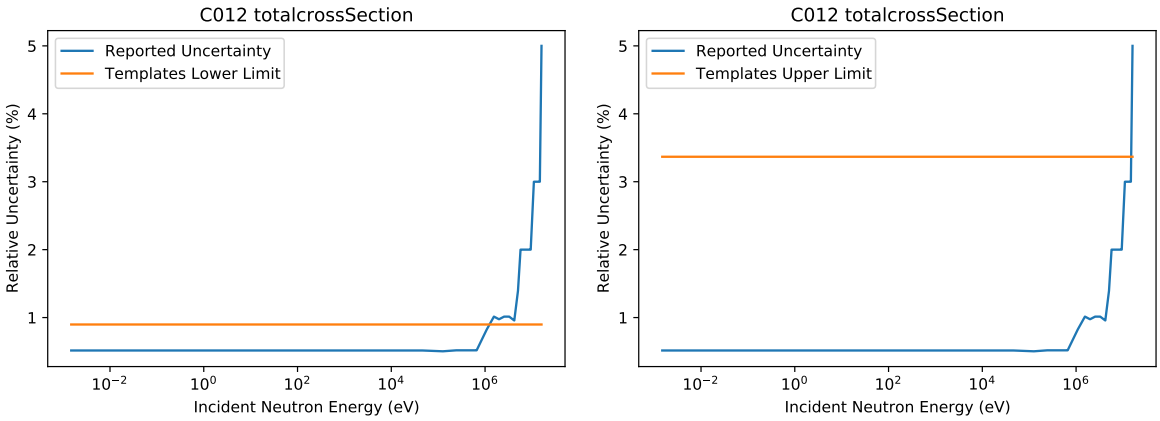

Figure 10.3: Possible problems in uncertainties of totalcrossSection are illustrated.

Chapter 11

^{9}Be Covariances

11.1 List of Existing Covariances

Isotope studied: Be009

- xdcrossSection
- xp_0crossSection
- xt_1crossSection
- xa_0crossSection
- xt_0crossSection
- xtcrossSection
- xpcrossSection
- xacrossSection
- totalcrossSection
- elasticcrossSection
- n2ncrossSection
- xd_0crossSection
- capturecrossSection

11.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 11.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs

capturecrossSection	Passed	Passed	N/A	N/A
elasticcrossSection	Failed	Failed	Failed	N/A
n2ncrossSection	Failed	Failed	N/A	N/A
totalcrossSection	Failed	Failed	N/A	N/A
xa_0crossSection	N/A	N/A	N/A	N/A
xacrossSection	N/A	N/A	N/A	N/A
xd_0crossSection	N/A	N/A	N/A	N/A
xdcrossSection	N/A	N/A	N/A	N/A
xp_0crossSection	N/A	N/A	N/A	N/A
xpcrossSection	N/A	N/A	N/A	N/A
xt_0crossSection	N/A	N/A	N/A	N/A
xt_1crossSection	N/A	N/A	N/A	N/A
xtcrossSection	N/A	N/A	N/A	N/A

11.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 11.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
n2ncrossSection	N/A	Passed	N/A	N/A
totalcrossSection	N/A	Failed	N/A	N/A
xa_0crossSection	N/A	N/A	N/A	N/A
xacrossSection	N/A	N/A	N/A	N/A
xd_0crossSection	N/A	N/A	N/A	N/A
xdcrossSection	N/A	N/A	N/A	N/A
xp_0crossSection	N/A	N/A	N/A	N/A
xpcrossSection	N/A	N/A	N/A	N/A
xt_0crossSection	N/A	N/A	N/A	N/A
xt_1crossSection	N/A	N/A	N/A	N/A
xtcrossSection	N/A	N/A	N/A	N/A

11.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 11.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
capturecrossSection	0 of 2
elasticcrossSection	3 of 3
n2ncrossSection	2 of 2
totalcrossSection	2 of 2
xa_0crossSection	0 of 0
xacrossSection	0 of 0
xd_0crossSection	0 of 0

xdcrossSection	0 of 0
xp_0crossSection	0 of 0
xpcrossSection	0 of 0
xt_0crossSection	0 of 0
xt_1crossSection	0 of 0
xtcrossSection	0 of 0

11.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 11.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
capturecrossSection	1 of 1
elasticcrossSection	0 of 1
n2ncrossSection	0 of 1
totalcrossSection	1 of 1
xa_0crossSection	0 of 0
xacrossSection	0 of 0
xd_0crossSection	0 of 0
xdcrossSection	0 of 0
xp_0crossSection	0 of 0
xpcrossSection	0 of 0
xt_0crossSection	0 of 0
xt_1crossSection	0 of 0
xtcrossSection	0 of 0

11.6 Covariances that Were Not Tested

- xa_0crossSection
- xacrossSection
- xd_0crossSection
- xdcrossSection
- xp_0crossSection
- xpcrossSection
- xt_0crossSection
- xt_1crossSection
- xtcrossSection

11.7 Covariances that Should be Counter-checked by Evaluator

- Critical problem in (uncertainties smaller than relevant standard): elasticcrossSection (Fig. 11.1) The evaluated uncertainties are low in the thermal range. However, there are a lot of (n,tot)

data, and (n,γ) is small. While small, this could be ok. **It might be good to discuss this with an evaluator to make sure I did not overlook something.**

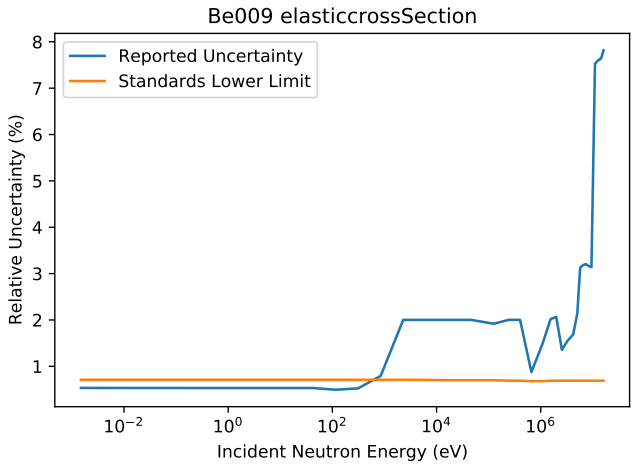

Figure 11.1: Critical problems in uncertainties of elasticcrossSection are illustrated.

- Possible problem in (>= 50% available tests failed): n2ncrossSection (Fig. 11.2) The evaluated uncertainties are smaller than the templates in the fast range. However, there are some (n,2n) measurement. This could be ok, especially considering the rigid R-matrix theory.

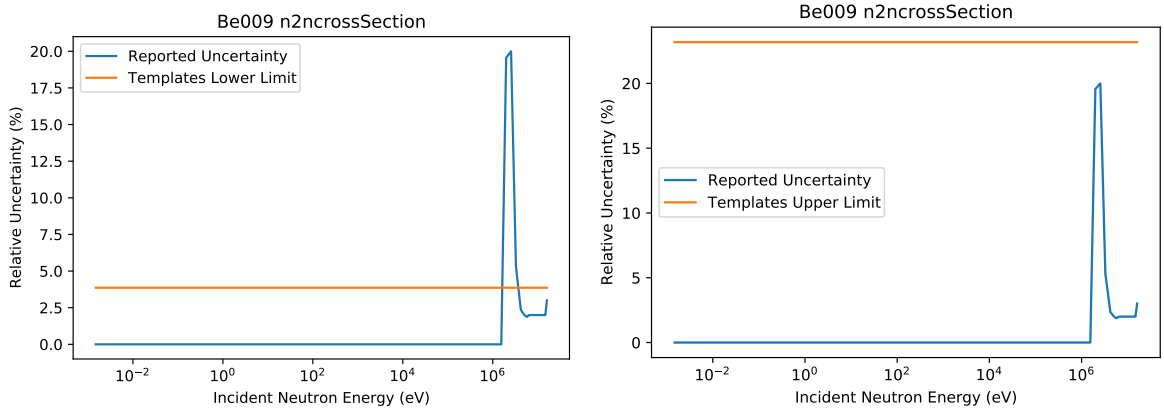

Figure 11.2: Possible problems in uncertainties of n2ncrossSection are illustrated.

- Possible problem in (>= 50% available tests failed): totalcrossSection (Fig. 11.3) The evaluated uncertainties are low in the thermal range. However, there are a lot of (n,tot) data, and (n,γ) is small. While small, this could be ok. **It might be good to discuss this with an evaluator to make sure I did not overlook something.**

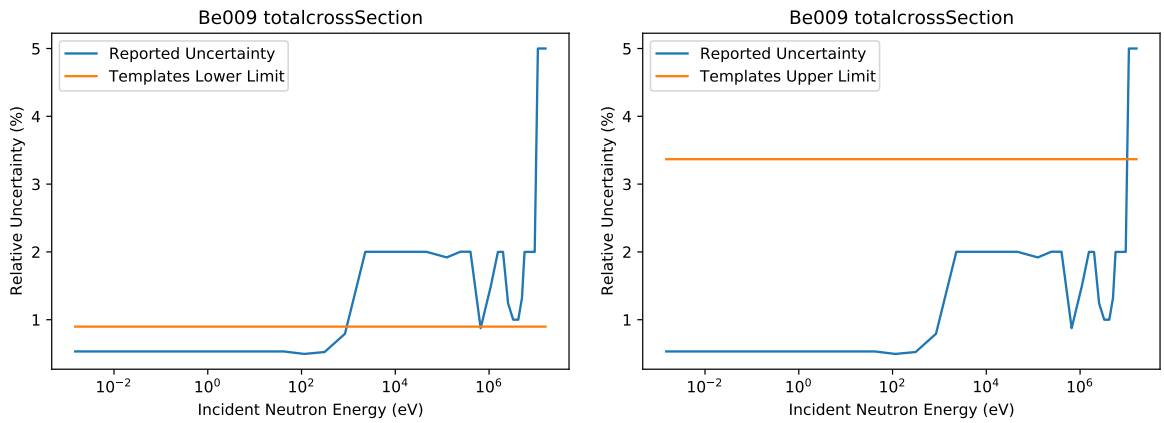

Figure 11.3: Possible problems in uncertainties of totalcrossSection are illustrated.

Chapter 12

^{1}H Covariances

12.1 List of Existing Covariances

Isotope studied: H001

- capturecrossSection
- totalcrossSection
- elasticcrossSection

12.2 Individual Tests to Check for Suspiciously Low Uncertainties

Table 12.1: Table that summarizes which uncertainties were deemed suspiciously low for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	Passed	Passed	N/A	N/A
elasticcrossSection	Failed	Failed	Failed	N/A
totalcrossSection	Failed	Failed	N/A	N/A

12.3 Individual Tests to Check for Suspiciously High Uncertainties

Table 12.2: Table that summarizes which uncertainties were deemed suspiciously high for various observables and various tests.

Observables	Expert-judgment	Templates	Standards	PUBs
capturecrossSection	N/A	Failed	N/A	N/A
elasticcrossSection	N/A	Passed	N/A	N/A
totalcrossSection	N/A	Passed	N/A	N/A

12.4 Summary on Tests to Check for Suspiciously Low Uncertainties

Table 12.3: Table that summarizes which uncertainties were deemed suspiciously low for various observables and summed over all available tests

Observables	Lower-limit Test Failed
capturecrossSection	0 of 2
elasticcrossSection	3 of 3
totalcrossSection	2 of 2

12.5 Summary on Tests to Check for Suspiciously High Uncertainties

Table 12.4: Table that summarizes which uncertainties were deemed suspiciously high for various observables and summed over all available tests

Observables	Upper-limit Test Failed
capturecrossSection	1 of 1
elasticcrossSection	0 of 1
totalcrossSection	0 of 1

12.6 Covariances that Were Not Tested

- none

12.7 Covariances that Should be Counter-checked by Evaluator

- Critical problem in (uncertainties smaller than relevant standard): elasticcrossSection (Fig. 12.1) The evaluated uncertainties are coming from the Neutron Data Standards evaluation and are ok.

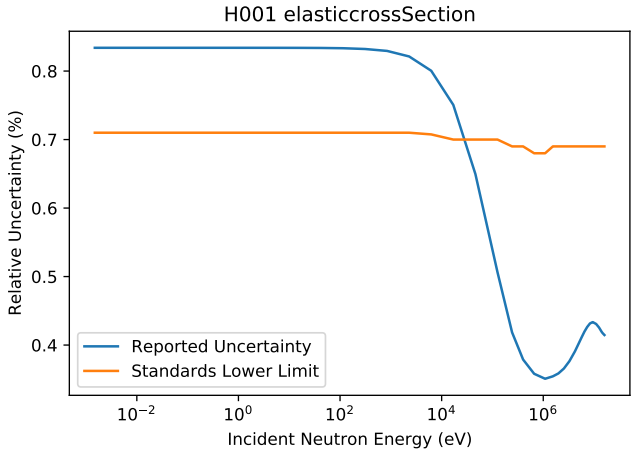

Figure 12.1: Critical problems in uncertainties of elasticcrossSection are illustrated.

- Possible problem in (>= 50% available tests failed): totalcrossSection (Fig. 12.2) The evaluated uncertainties are coming from the Neutron Data Standards evaluation and are ok.

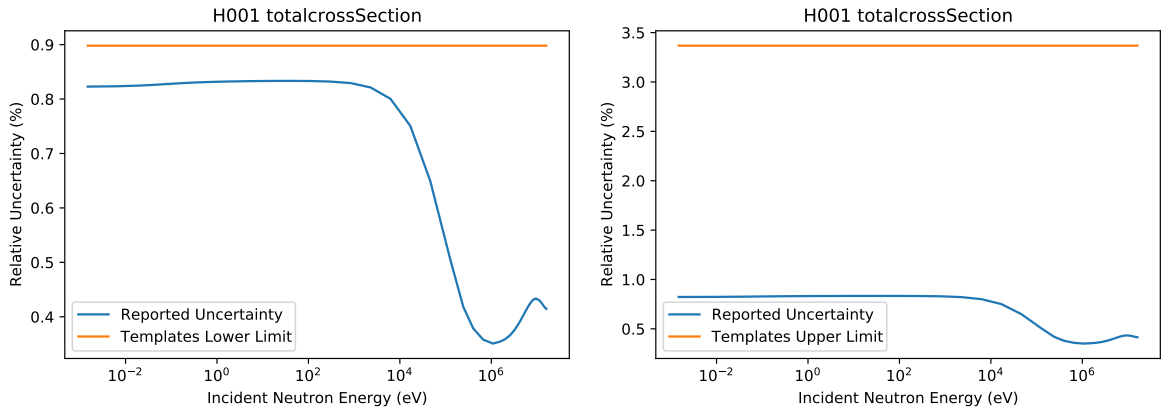

Figure 12.2: Possible problems in uncertainties of totalcrossSection are illustrated.

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