

Development of Web Tool for constructing a covariance matrix from EXFOR uncertainties

V.Zerkin, IAEA-NDS, 13/04/2012 (revised 26/04/2012)

Introduction

During the last few years there is a growing interest and usage of covariance data in the nuclear data community. Covariance data in evaluated data files have been available for a very long time, have well defined formats (ENDF-6) and well developed software tool of different types. The experimental nuclear reaction database EXFOR contains almost no covariance data because most experimentalists provide experimental data only with uncertainties (total, statistical, systematic, partial uncertainties of different types).

The tool described here was developed mostly for evaluators who want to construct an “experimental” covariance matrix from the uncertainties given in EXFOR. When uncertainty information given in EXFOR is poor or even absent, an evaluator can introduce some assumptions to produce the matrix. The tool is publically available through the Internet as part of the IAEA EXFOR Web retrieval system and can be used remotely. It includes Web plotting and several types of output convenient for users.

General approach

The procedure for usage of the tools consists of four steps:

1. The tool starts by converting an EXFOR file to computational format “C5” (including systematic and statistical uncertainties) and presenting to the user a report with full relevant information:
 - data points (energy, central values of cross sections)
 - data uncertainties: total, systematic, statistical
 - all uncertainties given in EXFOR file
 - information from EXFOR file given in ERR-ANALYS and METHOD sections.
2. Setup uncertainties: the user can change (or confirm) existing values of uncertainties, introduce new (additional) uncertainties, e.g. by splitting systematic uncertainties into parts, by uploading his (her) own array of uncertainties, etc. All these uncertainties can be used in the next step as a component to calculate the fractional covariance matrix.
3. The user defines how to use existing and newly introduced uncertainties for constructing the covariance matrix: correlation type (uncorrelated, fully correlated and partially correlated) and energy intervals. For partially correlated uncertainties the user defines the algorithm of calculation and additional parameters.
4. The user submits the calculation and gets final results as numerical data, data in ENDF-6 format (MF33), EXFOR, interactive plot and text input for Fortran codes including a subroutine for reading data in a Fortran program.

3 Detailed description

3.1 EXFOR to C5 conversion

Translation of EXFOR file to computational format C5 is performed by a Java program “x4toc5”. Format C5 has a similar structure to the C4 format [2] based on ENDF MF/MT definition of reaction, but extended by bibliographical information, systematic and statistical uncertainties. The translation program uses three types of dictionaries: EXFOR dictionaries, X4TOC4 dictionaries and universal X4ENDF dictionary [3].

Approximately 86% of all EXFOR datasets are now converted to C5 (X4TOC4 converts ~56%). Approximately 15% of datasets converted to C5 file have statistical and/or systematic uncertainties. C5 for the full EXFOR database can be easily used for construction of experimental covariance matrices (for example, in large packages like EMPIRE and TALYS) without any further interactive procedures and without any additional assumptions.

3.2 Algorithms and parameters

3.2.1 Setting up uncertainties

For the calculation of the fractional covariance matrices the user can use uncertainties given in EXFOR, generalized uncertainties calculated in C5 and his (her) own uncertainties (see Appendix-1). The user can modify values of total, systematic and statistical uncertainties setting them in per-cents of data or by splitting total uncertainties. The user can define his own (artificial) uncertainties setting them either as a fraction of the data or by splitting into parts the total or systematic uncertainties. User can also input own array of uncertainties.

3.2.2 Grouping, energy intervals, gaps in data

If the dimension of the final matrix is greater than 100×100 , uncertainties are grouped for neighbouring energies. Uncorrelated uncertainties became smaller (square averaging), fully correlated remain the same (averaging), total - recalculated from systematic and statistical.

Sometimes EXFOR files have empty fields in the uncertainty columns. In these cases the user defines how to fill in existing gaps.

The user can also define energy intervals where a fractional covariance matrix has to be calculated with a given algorithm. This allows, for example, easy construction of fractional covariance matrices if different samples are used for different energy intervals.

3.2.3 Types of correlations

Four types of the data correlation are available in the tool (first three correspond to the classification given in [4]):

- uncorrelated data (short energy range correlations - **SERC**),
example: statistical uncertainties;
- fully correlated data (long energy range correlations - **LERC**),
example: uncertainties in the determination of mass of the sample;
- partially correlated data (medium energy range correlations - **MERC**),
example: detector efficiency;
- partially correlated data with coefficients given by user (user defined energy range correlations – **UDERC**),
example: correlations taken from the monitor data from an external source.

In the Web tool, all four types of correlations can be used energy intervals for calculations.

The fractional covariance matrix is calculated as following:

$$Cov[i,j] = a[i,j] \times Err[i] \times Err[j]$$

where:

$Cov[i,j]$ – element of the matrix

$a[i,j]$ – coefficient of correlation

$Err[i]$ – relative uncertainty of given type for given energy $E[i]$

For fully correlated data the coefficient of correlation $a=1$ for all the correlation matrix; for uncorrelated data $a=1$ for diagonal elements only (rest of elements $a=0$); for the medium energy range correlations (MERC), the coefficient of correlation $a[i,j]$ is a function of energies $E[i]$, $E[j]$, “scale type” and “length of correlation” – the last two parameters are defined by the user.

3.2.4 MERC parameters

The general ideas and algorithms of calculation of the fractional covariance matrices of MERC type are based on the relevant part of the methodology used in the work under IAEA Coordinated Research Project "Neutron Cross-section Standards" [5].

The two energy dependent parameters are [6]:

1. “correlation length”: energy range beyond which the correlations between data in two energy ranges disappear
2. “type of the energy scale”: functional dependence on the difference between energies is defined either in logarithmic or linear scale:
 - logarithmic scale for energy-energy correlations is more common for time of flight measurements;
 - linear scale – mostly for measurements with discrete incident energy beams

3.3 Output results and intermediate control

Finally the user starts the calculation and receives intermediate and final results in the following forms: raw data, data in ENDF-6 (MF33) format, EXFOR covariance section, interactive 2D/3D plot and data formatted for input to a Fortran program including an example of Fortran code with subroutine for reading energy grid and correlation matrix.

Intermediate results present all the steps of calculation, covariance matrix, variances, Gaussian matrix and test for positive definiteness of the final matrix. User can also plot partial uncertainties and fractional matrices with Web-ZVView (see Appendix-4).

3.3 Save and reuse recipe in XML format

User can save recipe in XML format and re-use it supplying the XML-recipe back to the form using [restore-recipe] function of the Web tool. Examples of such a recipe for EXFOR Entry#23114 are shown in Appendix-1 and -3.

4 Example and test

The test case below presents the experimental energy-energy correlation matrix for the $^{241}\text{Am}(n,2n)$ reaction cross section from EXFOR Entry#23114 [7-8] in comparison with a matrix constructed from uncertainties given in the same Entry.

4.1 Testing default parameters

Figure 1 shows result of the construction using only statistical and systematic uncertainties given in C5. The large difference between constructed and original matrices is clearly visible. (See Appendix-1 with XML recipe.)

Figure 2 shows result of construction done with very general assumptions: using statistical uncertainties as given in C5, and splitting systematic uncertainties 50/50 to (a) fully correlated and (b) MERC correlated uncertainties with parameters: “correlation scale”=linear, “correlation length”=0.5 of the whole energy range of this experiment (~6MeV). (See Appendix-1 with XML recipe.)

Comparing figures 1 and 2 it can be seen that applying the interactive tool even with very general assumptions can produce a correlation matrix very similar to the original matrix provided by experimentalists – which is a result of a very careful analysis and calculations considering all the components of correlation.

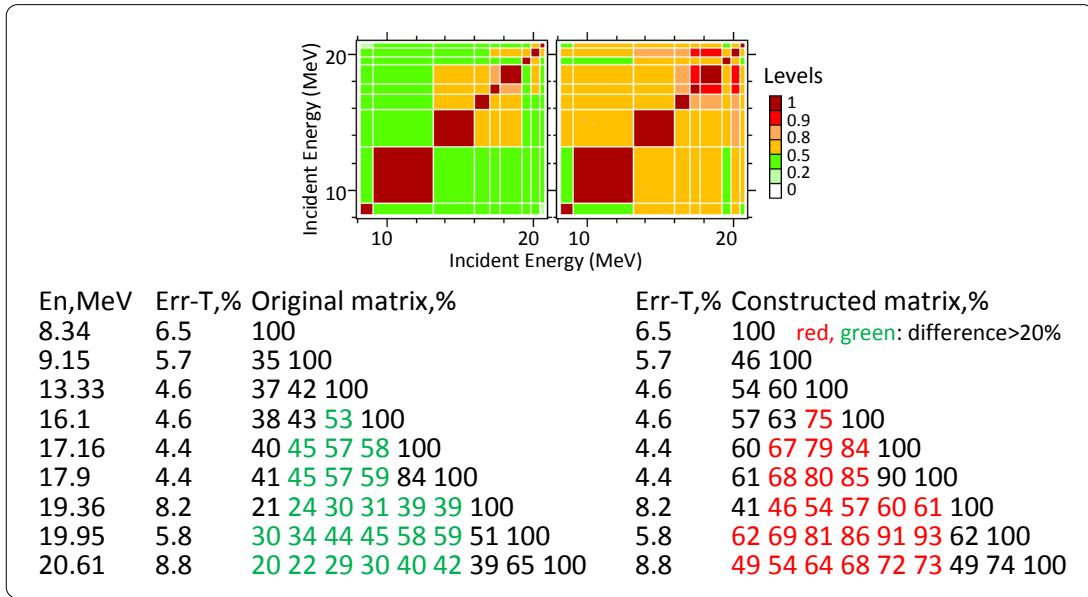


Fig. 1. Correlation matrices: experimental reported by authors (left) and constructed using only C5 uncertainties (right)

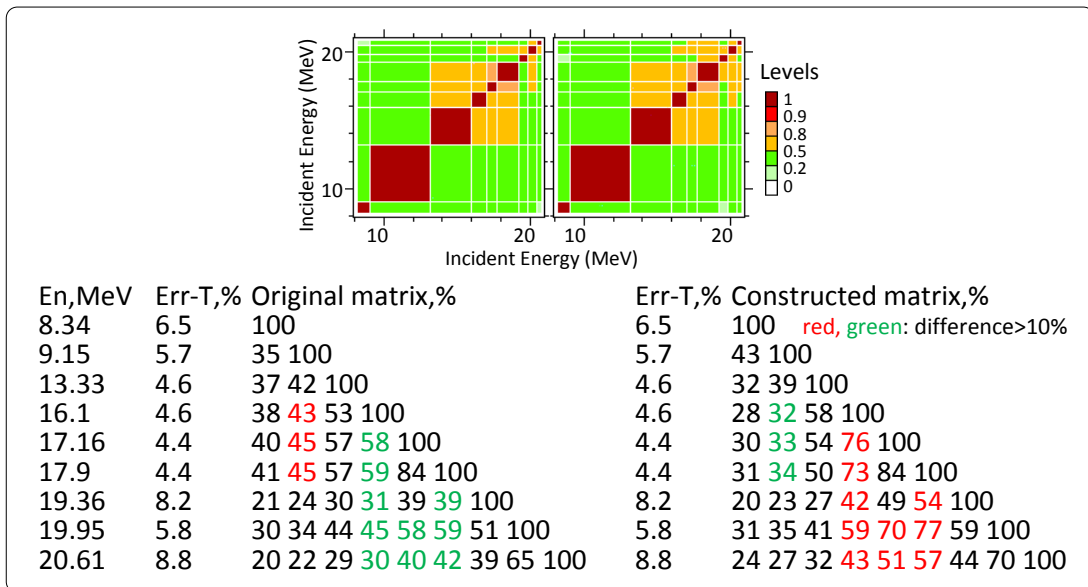


Fig. 2. Correlation matrices: experimental (left) and constructed using C5 uncertainties split to fully- and MERC-correlated uncertainties with default parameters (right)

4.2 Reconstruction of the full correlation matrix using complete “recipe” reported by the authors

Having detailed description of partial uncertainties and types of their correlations presented Web tool can be used to build the full correlation matrix – exactly as experimentalists calculate their final correlation matrices. In the case of Entry#23114, all analysis done by the authors was available [9], and therefore complete testing and comparison final results were possible. Two UDERC-type (user’s defined energy range correlation) matrices were used: correlation between energy points of the monitor data and correlation between energy points due to the usage of four samples in the different energy intervals (see Appendix-2 and -3).

Result of the reconstruction of the full matrix (Fig.3, Appendix-5) is different from reported by the authors only in one point. (Total reconstructed uncertainties are systematically lower than authors' values, probably because of different rounding – this needs further checking.)

En, MeV	Err-T,%	Original matrix,%	Err-T,%	Constructed matrix, %
8.34	6.5	100	6.4	100
9.15	5.7	35 100	5.6	35 100
13.33	4.6	37 42 100	4.5	37 42 100
16.1	4.6	38 43 53 100	4.5	38 43 53 100
17.16	4.4	40 45 57 58 100	4.3	40 45 57 58 100
17.9	4.4	41 45 57 59 84 100	4.3	41 45 57 59 84 100
19.36	8.2	21 24 30 31 39 39 100	8.1	21 24 30 31 39 39 100
19.95	5.8	30 34 44 45 58 59 51 100	5.7	30 34 44 45 58 59 51 100
20.61	8.8	20 22 29 30 40 42 39 65 100	8.8	20 22 29 30 40 42 39 66 100

Fig. 3. Experimental (left) and constructed correlation matrices using full “recipe” provided by the authors (right).

Concluding remarks

The Web tool has two parts: translation of EXFOR files to C5 and interactive construction of a correlation matrix.

The first part allows construction of a rough estimation of the covariance matrix on the basis of statistical and systematic uncertainties without any assumptions, and it can be directly used by some program packages. Although this part does not use additional knowledge about specific partial uncertainties, it leads to significant progress in covariance data.

The second (interactive) part of the tool relies on the experience of evaluators and their assumptions about correlations. This part is intuitive and therefore subjective. It can help in individual evaluations, but probably not as a routine part in large packages.

Such a tool may be the only practical way to construct covariance matrices for old data stored in the EXFOR database.

Discussion

Practicing with such a tool can improve understanding and formulation of recipes for constructing covariance matrices based on providing partial errors and correlation components for different cases. It can also help in the development of the EXFOR format via formalization of parameters from these recipes.

After comprehensive testing and discussion in the nuclear data community, it can be recommended to experimentalists for calculation of the final correlation matrices from partial uncertainties [10] and supply the recipe for reconstruction of the matrices to the EXFOR compilers to store them in the EXFOR database.

Acknowledgment

I thank to V. Pronyaev and D. Smith for useful discussions.

References

1. IAEA Nuclear Data Services, EXFOR Web Retrieval System: <http://www-nds.iaea.org/exfor/>
2. D.E. Cullen, A. Trkov, "Program X4TOC4", report IAEA-NDS-80, Rev.1, (March 2001)
3. V.Pronyaev, Priv.Comm. (2007)
4. ENDF-6 Formats Manual. CSEWG Document ENDF-102. Report BNL-90365-2009, p.249 (2009).
5. V.G. Pronyaev, S.A. Badikov, A.D. Carlson, Chen Zhenpeng, E.V. Gai, G.M. Hale, F.-J. Hamsch, H.M. Hofmann, T. Kawano, N.M. Larson, D.L. Smith, Soo-Youl Oh, S. Tagesen, H. Vonach, "International Evaluation of Neutron Cross-Section Standards", STI/PUB/1291, pp.10-12, IAEA (2007)
6. V.Pronyaev, Priv.Comm. (2010)
7. <http://www-nds.iaea.org/EXFOR/23114>
8. C.Sage, V.Semkova, O.Bouland, P.Dessagne, A.Fernandez, F.Gunsing, C.Nastren, G.Noguere, H.Ottmar, A.J.M.Plompen, P.Romain, G.Rudolf, J.Somers, F.Wastin. High resolution measurements of the $^{241}\text{Am}(n,2n)$ reaction cross section, Physical Review, Part C, Vol.81, p.064604 (2010), DOI: 10.1103/PhysRevC.81.064604
9. V.Semkova, Priv.Comm. (2011)
10. D. Smith, Priv.Comm. (2011)

Entry#23114: correlation matrix construction.

Summary of uncertainties and form with parameters

Request: #10
Dataset: 23114002 LX=9 Set default: [1] [2] Examples: [1] [2] → →

Restore your previous Recipe /test-version/
Reaction: 95-AM-241(N,2N)95-AM-240,,SIG
C4Referer: C.Sage,ET.AL. (10)
Data and uncertainties (data points: 9)

Data									
No.	1	2	3	4	5	6	7	8	9
Energy (eV) *0.001	8340.9150	13330.16100	17160.17900	19360.19950	20610.20610				
Data (B) *1000.	96.8	162.9	241.8	152.4	116.1	105.7	89.5	102.1	77.9

Uncertainties defined in C5 (C4++)									
Total (%)	6.5	5.7	4.6	4.6	4.4	4.4	8.2	5.8	8.8
Statistical (%)	5.0	4.0	2.5	2.1	1.5	1.3	6.3	1.4	5.7
Systematic (%) empty	-	-	-	-	-	-	-	-	-

Uncertainties given in EXFOR									
ERR-T (%)	6.5	5.7	4.6	4.6	4.4	4.4	8.2	5.8	8.8
ERR-S (%)	5.0	4.0	2.5	2.1	1.5	1.3	6.3	1.4	5.7
ERR-1 (%)	1.0	1.0	1.0	1.0	1.0	0.7	2.0	1.0	1.6
ERR-2 (%) const	1.2	=	=	=	=	=	=	=	=
ERR-3 (%) const	0.1	=	=	=	=	=	=	=	=
ERR-4 (%) const	0.3	=	=	=	=	=	=	=	=
ERR-5 (%) const	3.0	=	=	=	=	=	=	=	=
ERR-6 (%)	0.9	0.6	0.4	0.6	0.6	0.7	0.6	0.6	0.6
ERR-7 (%)	-	-	0.3	0.3	0.3	0.3	1.3	1.4	1.4
MONIT-ERR (%)	1.9	1.9	1.6	2.0	2.0	2.2	3.1	4.1	5.4

Default [1]: recipe based on C4 total uncertainties

```

http://www.nds.iaea.org/exfor/servlet/X4sShowData?db=x4&op=cov_rcp&file=X4R727_tdat.x4.par.xml&req=727 - Original Source
File Edit Format
1 <?xml version="1.0" encoding="UTF-8" ?>
2 <CovRecipe DatasetID="23114002"
3   Created="2012-04-13 11:47:59"
4   Software="Web-tool:2012.03.16">
5   <Subent id="23114002" x4upd="20100924" />
6   <Reacode code="95-AM-241(N,2N)95-AM-240,,SIG" />
7
8   <defineErr name="Systematic" type="C5" cmd="Setup" src="Auto" ></defineErr>
9
10  <addCovFraction errName="Statistical" errType="C5" corrType="SERC" fracType="Uncorrelated" ></addCovFraction>
11  <addCovFraction errName="Systematic" errType="C5" corrType="LERC" fracType="Fully-correlated" >
12 </addCovFraction>
13 </CovRecipe>

```

Default [2] recipe:

- 1) uncorrelated: C4 statistical +
- 2) fully correlated: 50% of C4 systematic +
- 3) MERC correlated: 50% of C4 systematic

```

http://www.nds.iaea.org/exfor/servlet/X4sShowData?db=x4&op=cov_rcp&file=X4R727_tdat.x4.par.xml&req=727 - Original Source
File Edit Format
1 <?xml version="1.0" encoding="UTF-8" ?>
2 <CovRecipe DatasetID="23114002"
3   Created="2012-04-13 11:43:54"
4   Software="Web-tool:2012.03.16">
5   <Subent id="23114002" x4upd="20100924" />
6   <Reacode code="95-AM-241(N,2N)95-AM-240,,SIG" />
7
8   <defineErr name="myErr-1" type="myErr" cmd="Setup" src="Systematic" coeff="0.5" ></defineErr>
9   <defineErr name="myErr-2" type="myErr" cmd="Setup" src="Systematic" coeff="0.5" ></defineErr>
10
11  <addCovFraction errName="Statistical" errType="C5" corrType="SERC" fracType="Uncorrelated" ></addCovFraction>
12  <addCovFraction errName="myErr-1" errType="myErr" corrType="LERC" fracType="Fully-correlated" ></addCovFraction>
13  <addCovFraction errName="myErr-2" errType="myErr" corrType="MERC" fracType="MERC-correlated" MercType="Lin"
14  MercInterval="0.5" MercEnMin="8.34e6" MercEnMax="2.061e7" EnUnits="eV" ></addCovFraction>
15 </CovRecipe>

```


Entry#23114: full correlation matrix reconstruction

Example [1] on the Web-page: Appendix-1.

X4Covar - Mozilla Firefox

File Edit View History Bookmarks Tools Help

www.nds.iaea.org/exfor/servlet/X4sShowX4err?File=db&db=x4&op=c4b&req=500&Da

X4Covar

Summary: available uncertainties L=13
Text in EXFOR under keywords "ERR-ANALYS" and "METHOD"

```
#ENTRY 23114 L=2
METHOD (ACTIV) Activation technique
(GSPEC) Of-line standard gamma-ray spectrometry.
#/ENTRY 23114
#SUBENT 23114002 L=12
ERR-ANALYS (ERR-T) Total uncertainty.
(MONIT-ERR) Uncertainty of monitor cross section.
(ERR-S) Counting statistics uncertainty for Am .
(ERR-1) Counting statistics uncertainty for Al.
(ERR-2) Uncertainty of gamma-rays intensities .
(ERR-3) Uncertainty of Al target nuclei number
(ERR-4) Uncertainty of Am target nuclei number
(ERR-5) Uncertainty of ratio of detection efficiency
for Al to Am one.
(ERR-6) Uncertainty of time factors for Am.
(ERR-7) Uncertainty due to correction for presence of
low-energy breakup neutrons.
#/SUBENT 23114002
```

...Method Time-Of-Flight: **No**

Set/Add uncertainties (%) More myErr: [+] [-] Input parameters and run calculation

Request Submit Reset Submit in new Window Include uncertainty arrays to the Recipe-report

Grouping Factor: 1 data points (required if final covariance matrix is too large)

No.	Name	Apply	Correlation-type	Parameters	<input type="checkbox"/> Use energy intervals (default: 8.34 20.61 MeV)
1	MONIT-ERR	<input checked="" type="checkbox"/>	My-Matrix	Correlation Matrix: <pre>1 .43 1 0 0 1 0 0 .06 1 0 0 .09 .12 1 0 0 .09 .12 1 1 0 0 .11 .11 .4 .4 1 0 0 .11 .11 .4 .4 1 1 0 0 .11 .11 .4 .4 1 1 1</pre>	[clean] examples: [1] [2] [3] [4] [help]
2	ERR-S	<input checked="" type="checkbox"/>	Uncorrelated		
3	ERR-1	<input checked="" type="checkbox"/>	Uncorrelated		
4	ERR-2	<input checked="" type="checkbox"/>	Fully-correlated		
5	ERR-3	<input checked="" type="checkbox"/>	Uncorrelated		
6	ERR-4	<input checked="" type="checkbox"/>	My-Matrix	Correlation Matrix: <pre>1 0 1 0 1 1 0 1 1 1 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 1 0 0 0 0 1 0 0 1</pre>	[clean] examples: [1] [2] [3] [4] [help]
7	ERR-5	<input checked="" type="checkbox"/>	Fully-correlated		
8	ERR-6	<input checked="" type="checkbox"/>	Fully-correlated		
9	ERR-7	<input checked="" type="checkbox"/>	Uncorrelated		

Page generated: 2012/04/12,20:49:04 by X4-Servlet on www.nds.iaea.org
Project: "Multi-platform EXFOR-CINDA-ENDF", V.Zerkin, IAEA-NDS, 1999-2012

XML-Recipe for full covariance matrix reconstruction

```

http://www-nds.iaea.org/exfor/servlet/X4sShowData?db=x4&op=cov_rcp&File=X4R500_tdat.x4.par.xml&req=500 - Original Source
File Edit Format
1 <?xml version="1.0" encoding="UTF-8" ?>
2 <CovRecipe DatasetID="23114002"
3   Created="2012-04-12 20:54:47"
4   Software="Web-tool:2012.03.16">
5   <Subent id="23114002" x4upd="20100924" />
6   <Reacode code="95-AM-241(N,2N)95-AM-240,,SIG" />
7
8   <addCovarFraction errName="MONIT-ERR" errType="EXFOR" corrType="UDERC" fracType="My-Matrix" >
9     <dataArray2 what="CorrMatrix" LX="9" LY="9" LL="45" type="triangle" units="NO-DIM">
10 1
11 .43 1
12 0 0 1
13 0 0 .06 1
14 0 0 .09 .12 1
15 0 0 .09 .12 1 1
16 0 0 .11 .11 .4 .4 1
17 0 0 .11 .11 .4 .4 1 1
18 0 0 .11 .11 .4 .4 1 1 1
19   </dataArray2>
20 </addCovarFraction>
21 <addCovarFraction errName="ERR-5" errType="EXFOR" corrType="SERC" fracType="Uncorrelated" ></addCovarFraction>
22 <addCovarFraction errName="ERR-1" errType="EXFOR" corrType="SERC" fracType="Uncorrelated" ></addCovarFraction>
23 <addCovarFraction errName="ERR-2" errType="EXFOR" corrType="LERC" fracType="Fully-correlated" ></addCovarFraction>
24 <addCovarFraction errName="ERR-3" errType="EXFOR" corrType="SERC" fracType="Uncorrelated" ></addCovarFraction>
25 <addCovarFraction errName="ERR-4" errType="EXFOR" corrType="UDERC" fracType="My-Matrix" >
26   <dataArray2 what="CorrMatrix" LX="9" LY="9" LL="45" type="triangle" units="NO-DIM">
27 1
28 0 1
29 0 1 1
30 0 1 1 1
31 0 0 0 0 1
32 1 0 0 0 0 1
33 0 0 0 0 1 0 1
34 0 0 0 0 0 0 0 1
35 1 0 0 0 0 1 0 0 1
36   </dataArray2>
37 </addCovarFraction>
38 <addCovarFraction errName="ERR-5" errType="EXFOR" corrType="LERC" fracType="Fully-correlated" ></addCovarFraction>
39 <addCovarFraction errName="ERR-6" errType="EXFOR" corrType="LERC" fracType="Fully-correlated" ></addCovarFraction>
40 <addCovarFraction errName="ERR-7" errType="EXFOR" corrType="SERC" fracType="Uncorrelated" ></addCovarFraction>
41 <myStamp>EXFOR-Web-Covariance-Recipe, V.Zerkin, IAEA-NDS, 2012-03-19.</myStamp>
42 </CovRecipe>
43

```

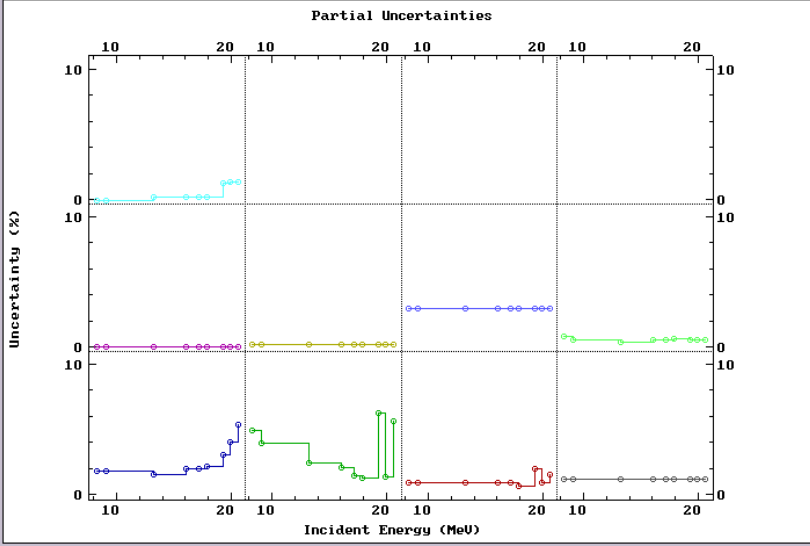
Intermediate output for controlling correctness of calculations

```

#...Result:CorrelationMatrix
En(MeV): L=9
8.34 9.15 13.33 16.1 17.16 17.9
19.36 19.95 20.61
Variance(%): L=9
6.4 5.6 4.5 4.5 4.3 4.3 8.1 5.7 8.8
Correlation(%): 9*9
100
35 100
37 42 100
38 43 53 100
40 45 57 58 100
41 45 57 59 84 100
21 24 30 31 39 39 100
30 34 44 45 58 59 51 100
20 22 29 30 40 42 39 66 100
#Covariance: 9*9 (*1e+4)
40.96 12.5323 10.8 10.98 10.98 11.16 10.98 10.98 11.07
12.5323 31.51 10.77 10.89 10.8 10.86 10.8 10.8 10.8
10.8 10.77 20.6 10.962 10.968 11.0368 11.2256 11.4016 11.6304
10.98 10.89 10.962 20.4 11.28 11.388 11.482 11.702 11.988
10.98 10.8 10.968 11.28 18.24 15.26 13.37 14.08 15.12
11.16 10.86 11.0368 11.388 15.26 18.14 13.588 14.468 15.702
10.98 10.8 11.2256 11.482 13.37 13.588 65.89 23.51 27.54
10.98 10.8 11.4016 11.702 14.08 14.468 23.51 32.63 32.94
11.07 10.8 11.6304 11.988 15.12 15.702 27.54 32.94 77.06999
#/Covariance

#Covariance-Gauss: 9*9 (*1e+4)
40.95999989658594 12.53229915164411 10.800000745803118 10.9799999788105488 10.9799999788105488 11.1599999994561076
0.0 27.67556120622796 7.465584301308186 7.5305119276734125 7.4405124065222275 7.445438055675269
0.0 0.0 15.738473093205988 6.035499056422442 6.065776803552377 6.085787387311698
0.0 0.0 0.0 13.093047459937967 13.093047459937967 3.9859232585121376 4.036656843654093
0.0 0.0 0.0 0.0 0.0 9.74501397412001 6.92278834373098
0.0 0.0 0.0 0.0 0.0 0.0 4.9026852014871976
0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0
#/Covariance-Gauss

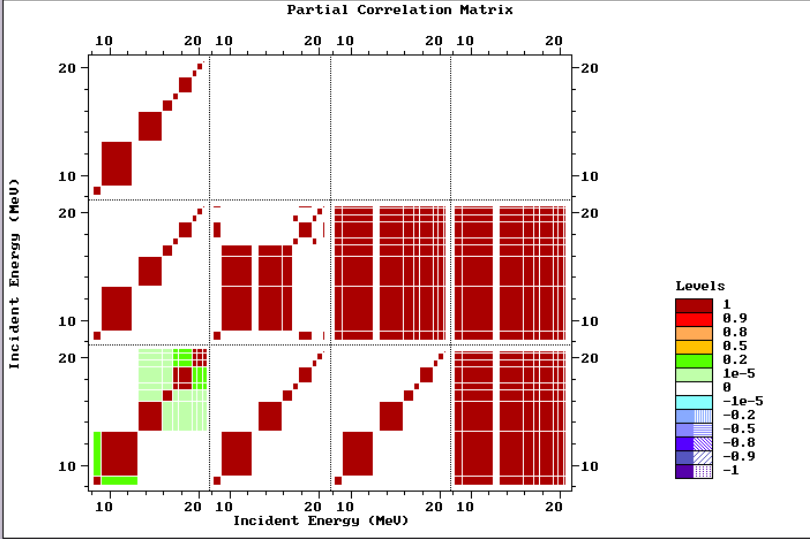
#Covariance-Gauss-Diagonal-Elements: 9*9 (*1e+4)
1 40.95999989658594
2 27.67556120622796
3 15.738473093205988
4 13.093047459937967
5 9.74501397412001
6 4.9026852014871976
7 54.276405521421374
8 17.515276396838885
9 43.405813162206464
#/Covariance-Gauss-Diagonal-Elements
#Positive-Definite: true
    
```



- 1) MONIT-ERR:My-Matrix
- 2) ERR-S:Uncorrelated
- 3) ERR-1:Uncorrelated
- 4) ERR-2:Fully-correlated
- 5) ERR-3:Uncorrelated
- 6) ERR-4:My-Matrix
- 7) ERR-5:Fully-correlated
- 8) ERR-6:Fully-correlated
- 9) ERR-7:Uncorrelated

10) Use my data [example]

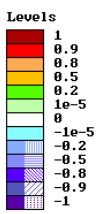
See: [plotted data \(5Kb\)](#)



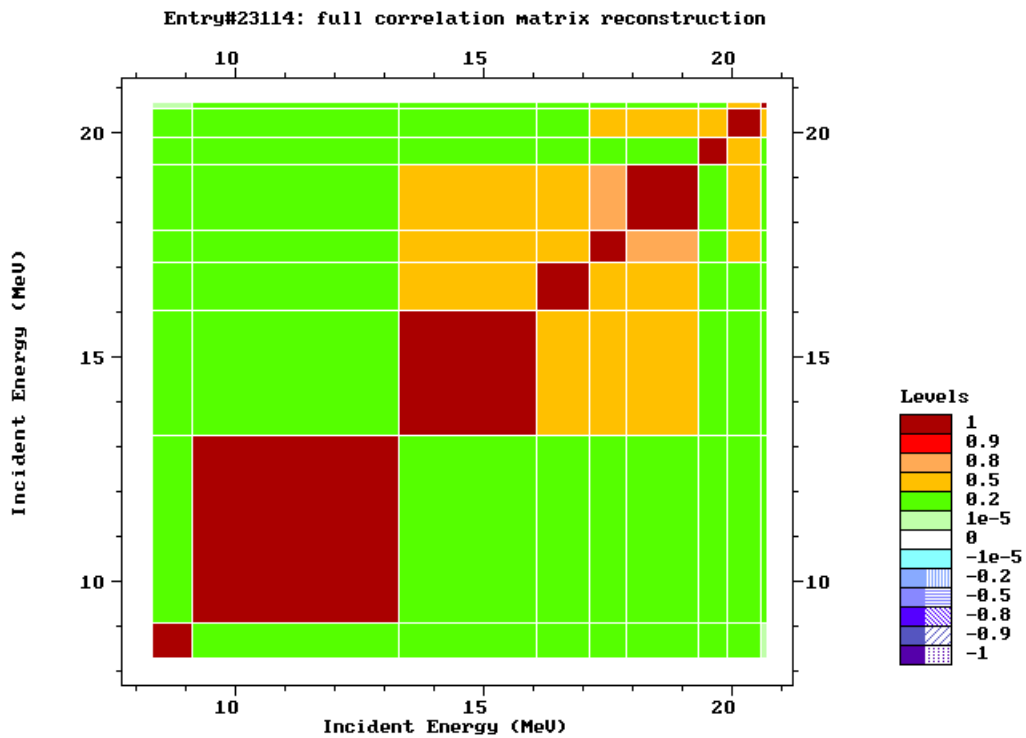
- 1) MONIT-ERR:My-Matrix
- 2) ERR-S:Uncorrelated
- 3) ERR-1:Uncorrelated
- 4) ERR-2:Fully-correlated
- 5) ERR-3:Uncorrelated
- 6) ERR-4:My-Matrix
- 7) ERR-5:Fully-correlated
- 8) ERR-6:Fully-correlated
- 9) ERR-7:Uncorrelated

10) Use my data [example]

See: [plotted data \(25Kb\)](#)
out:x4,T,F,e6



Plotting final data with Web-ZVView



Mozilla Firefox

File Edit View History Bookmarks Tools Help

www.nds.iaea.org/ex

http://www.nds.i...V24.zvd.dat.htm

#ZVView-data-copy: 13-Apr-2012 12:04:39

#

#ENDF Am-241 MT16:2n

Z(10x10): $Z_{i,j} = \text{Cor}(\sigma_{X_i}, \sigma_{Y_j}) * 100$

	X (MeV)										
Y (MeV)	8.34	9.15	13.33	16.1	17.16	17.9	19.36	19.95	20.61	20.61	j
8.34	100	34.88	37.18	37.98	40.17	40.94	21.14	30.03	19.7	19.7	1
9.15	34.88	100	42.27	42.95	45.05	45.42	23.7	33.68	21.92	21.92	2
13.33	37.18	42.27	100	53.47	56.58	57.09	30.47	43.98	29.19	29.19	3
16.1	37.98	42.95	53.47	100	58.48	59.2	31.32	45.36	30.23	30.23	4
17.16	40.17	45.05	56.58	58.48	100	83.89	38.57	57.71	40.33	40.33	5
17.9	40.94	45.42	57.09	59.2	83.89	100	39.3	59.47	41.99	41.99	6
19.36	21.14	23.7	30.47	31.32	38.57	39.3	100	50.7	38.65	38.65	7
19.95	30.03	33.68	43.98	45.36	57.71	59.47	50.7	100	65.69	65.69	8
20.61	19.7	21.92	29.19	30.23	40.33	41.99	38.65	65.69	100	65.69	9
20.61	19.7	21.92	29.19	30.23	40.33	41.99	38.65	65.69	65.69	100	10
i	1	2	3	4	5	6	7	8	9	10	