International Seminar

Mathematics, statistics and computation to support measurement quality

30.06.2009-02.07.2009, Sankt Petersburg, Russia

Critical overview of the quality of numerical measured data reported in physics e-publications and in physics data Internet-resources

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Семинар ИФВЭ 10.09.2009

“The current doubtful practice guide”

CERN-LEP-OPAL

1. **Physics Letters B288 (1992) 373, “Measurement of the Tau Topological Branching Ratios at LEP”**

   - Uncertainties of the main result presented in the paper are incomplete. The correlation matrix is questionable. It could not be reproduced from the other pertinent data presented in the text. An attempt to reproduce the published matrix resulted in different matrix.

CESR-CLEO

1. **Physical Review D55 (1997) 2259; D58 (1998) 119904E, “Experimental Test of Lepton Universality in Tau Decay”**

   - Represented uncertainties of the main result are incorrect. Correlation matrices presented in the paper and in the Erratum are non positive semi-definite. It seems that an Erratum to the published Erratum is needed.

CERN-LEP-ALEPH

1. **European Physical Journal C4 (1998) 409, Measurement of the axial-vector τ *spectral functions* and determination of $\alpha_s(M_\tau^2)$ *from hadronic* τ *decays***

   - WARNING: Correlation matrix for parameter uncertainties presented in Table 9.1 is badly over-rounded, it has one negative eigenvalue..

2. **European Physical Journal C11 (1999) 599, ``Study of τ decays involving kaons, spectral functions and determination of the strange quark mass"**

   - WARNING: Correlation matrix for parameter uncertainties presented in Table 8 is badly over-rounded, it has one negative eigenvalue..

3. **Physics Reports 421 (2005) 191, ``Branching ratios and spectral functions of tau decays: Final ALEPH measurements and physics implications"**

   - WARNING: Correlation matrices presented in Table 24 are non positive semi-definite probably due to over-rounding.

CERN-LEP-L3

1. Physics Letters B519 (2001) 189, "Measurement of the topological branching fractions of the τ lepton at LEP"

- Uncertainties of the main result presented in the paper are incomplete. The correlation matrix is questionable. It could not be reproduced from the other pertinent data presented in the text. An attempt to restore published matrix resulted in different matrix.

2. Physics Letters B598 (2004) 15, "Measurement of the atmospheric muon spectrum from 20-GeV to 3000-GeV"

- WARNING: Correlation matrix presented in Table 1 is badly over-rounded. Non degenerate 6×6-symmetric submatrix has one negative eigenvalue..

CERN-LEP-DELPHI

1. **European Physical Journal C20 (2001) 617, "A measurement of the τ topological branching ratios"**
   - Uncertainties of the main result presented in the paper are incomplete. The correlation matrix is questionable. It could not be reproduced from the other pertinent data presented in the text. An attempt to restore published matrix resulted in different matrix.

2. **European Physical Journal C45 (2006) 35, "Determination of heavy quark non-perturbative parameters from spectral moments in semileptonic B decays"**
   - Warning: Uncertainties of the main result presented in the paper are incorrect. Correlation matrices for hadronic mass moments (stat., syst., and total) have negative eigenvalues (See comment to the reference **1.**).

3. **European Physical Journal C46 (2006) 1, "A measurement of the tau hadronic branching ratios"**
   - *WARNING:* Uncertainties of the main result presented in the paper are incorrect. Correlation matrix has two negative eigenvalues (See comments to the references **1.** , **2.**).

BaBar Collaboration Home Page

SLAC-PEP2-BABAR

1. **Physical Review D70 (2005) 072004, "Study of $e^+ e^- \to \pi^+ \pi^- \pi^0$ process using initial state radiation with BaBar,"**
   - WARNING: Data on observables describing properties of resonances ω(782), φ(1020), ω(1420), ω(1650) are obtained from fit of the background subtracted $(\pi^+ \pi^0 \pi^-)$ mass distribution by VMD model and could be highly correlated. There are no information on the confidence region of the fitted parameters so the presented results are, most probably, unreliable.

2. **Physical Review D72 (2005) 052004, "Measurements of the $B \to X(s)\, \gamma$ branching fraction and photon spectrum from a sum of exclusive final states"**
   - WARNING: Correlation matrices presented in Tables IX and X are ambiguous, most probably by mistake in data presentation: 10×10 correlation matrices in Tables IX and X are presented in three 5×5-upper triangle blocks each. If correlation blocks between first and second moments are treated as symmetric matrices, the both 10x10-matrices turned to be not the positive definite matrices. If correlation blocks between first and second moments are treated as matrices with zero value lower triangle, the both10×10-matrices also have negative eigenvalues.

BABAR

Collaboration Home Page

SLAC-PEP2-BABAR

3. Physical Review D73 (2006) 012005, "A Study of e+ e- ---> p anti-p using initial state radiation with BABAR"

- Representation of the final results is incomplete. Correlations of statistical errors are not negligible, but there is no information on the correlator there. The consistency of the resonance parameters reported and their scatter region could not be assessed.

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Electronic Physics Auxiliary Publication Service (EPAPS)

Collaboration Home Page

SLAC-PEP2-BABAR, EPAPS

4. Physical Review D69 (2004) 111103R, "Measurements of moments of the hadronic mass distribution in semileptonic B decays"

ftp://ftp.aip.org/epaps/phys_rev_d/E-PRVDAQ-69-R02411/

- WARNING: Correlation 28×28 matrix is badly over-rounded (has 6 negative eigenvalues). The consistency of the values reported and their scatter regions could not be assessed.

5. Physical Review D69 (2004) 111104R, "Measurement of the electron energy spectrum and its moments in inclusive *B* → *X e v* decays"

ftp://ftp.aip.org/epaps/phys_rev_d/E-PRVDAQ-69-R03411/

- WARNING: Correlation 20×20 matrix is badly over-rounded (has negative eigenvalues). The consistency of the values reported and their scatter regions could not be assessed.

6. Physical Review Letters 97 (2006) 171803, "Measurement of the Branching Fraction and Photon Energy Moments of B → X_s γ and A_{CP}(B →X_{s+d} γ)"

ftp://ftp.aip.org/epaps/phys_rev_lett/E-PRLTAO-97-045644/

- WARNING: 8×8 correlation matrices presented in Tables I and II (see EPAPS URL) are not the positive definite matrices (Each of them has one negative eigenvalue).

Collaboration Home Page

SLAC-PEP2-BABAR, EPAPS

7. Physical Review D77 (2008) 051103, "Measurement of the $B \to X_s \gamma$ branching fraction and photon energy spectrum using the recoil method"

ftp://ftp.aip.org/epaps/phys_rev_d/E-PRVDAQ-77-R06805/ /

■ WARNING: Correlation 8×8-matrices presented in the Tables III and IV (see EPAPS URL) are not the positive definite matrices (T. III has one negative eigenvalue, T. IV has two negative eigenvalues).

KEK-BF-BELLE

1. Physical Review D78 (2008) 032016, "Measurement of the moments of the photon energy spectrum in *B* →*X_s γ* decays and determination of *V_{cb}* and *m_{b}* at Belle"

■ WARNING. Correlation matrix between first and second moments of the photon energy spectrum in B --> STRANGE GAMMA decays as it is presented in Tables V, VI, and VIII is badly over-rounded (it has one non negligible negative eigenvalue).

Miscellaneous Experiments

1. **Physical Review D67(2003) 072004, *BNL-E865*, "High statistics measurement of K(e4) decay properties"**
   - WARNING: Presentation of the fit results for the form-factors is incomplete. Uncertainties of the fit parameters are correlated. The correlations are not given.

2. **Physical Review D73 (2006) 052008, *BEPC-BES*, "Measurement of the Branching Fractions for $J/\psi \to \gamma\, \pi 0$, $J/\psi \to \gamma\, \eta$, $J/\psi \to \gamma\, \eta'$"**
   - WARNING: Branching fractions quoted with uncertainties (combined statistical and correlated systematic), but correlations of the final total uncertainties not given;

3. **Physical Review D74 (2006) 014016, *BINP-VEPP-2M-SND*, *"Study of the e+ e- → $\eta\, \gamma$ process with Spherical Neutral Detector at the VEPP-2M e+ e- collider"***
   - Representation of the final results on the physics parameters evaluation is incomplete. Correlation matrix for uncertainties of the resonance parameters is not reported.

4. **Astroparticle Physics 29 (2008) 257, CERN-PS-214, "Measurement of the production cross-sections of pi+- in p - C and pi+- - C interactions at 12-GeV/c"**
   - WARNING: Correlation matrix for parameter uncertainties presented in part of Table 7(pi+) is badly over-rounded, it has one negative eigenvalue.

Data summarization and evaluation working groups

1. **European Physical Journal C41 (2005) 1,** ***CKMFitter-WG,*** **"*CP* violation and the CKM matrix: assessing the impact of the asymmetric *B* factories"**
   - WARNING: Matrix elements of the correlation matrix presented in Table 10. are badly over rounded. Correlator has 1 negative eigenvalue.

2. **Physics Reports 427 (2006) 257,** ***ADLO-SLD-WZ, "Precision electroweak measurements on the Z resonance"***
   - WARNING: Matrix elements of the correlation matrix presented in Table F.6 are badly over-rounded. Correlator has one negative eigenvalue.

3. **Physical Review D73 (2006) 073008,** ***O.L.Buchmuller and H.U.Flacher,*** **"Fits to moment measurements from B → X/c l *v* and B → X/s *γ* decays using heavy quark expansions in the kinetic scheme"**
   - WARNING: 8×8 correlation matrix presented in the Table II is badly over-rounded. It has one negative eigenvalue.

4. **Physical Review C73 (2006) 044603,** ***ORELA,*** **R-matrix analysis of *Cl* neutron cross sections up to 1.2-MeV**
   - Representation of the final results on the physics parameters evaluations is incomplete. Correlation matrix for uncertainties of the resonance parameters is not reported.

OPAL

Physics Letters B288 (1992) 373

Experiment CERN-LEP-OPAL

Measurement of the τ topological branching ratios at LEP

"5. Summary and discussion

The inclusive branching ratios of the τ lepton to one, three and five charged particle final states are measured to be

B_1 = 84.48 +- 0.27 (stat) +- 0.23 (sys) %,
B_3 = 15.26 +- 0.26 +- 0.22 % and
B_5 = 0.26 +- 0.06 +- 0.05 % respectively.

These measurements have been obtained from a fit where **$B_1 + B_3 + B_5$ is constrained to equal one.**

The correlations between the fitted branching ratios are given by the matrix

$$\rho = \begin{pmatrix} 1. & -0.97 & -0.15 \\ -0.97 & 1. & -0.07 \\ -0.15 & -0.07 & 1. \end{pmatrix}."$$

Eigenvalues of this matrix are

{ **1.9677, 1.0118, 0.0205** }

Rounding Threshould = 2

If $\rho = \rho$(stat), it should be degenerate, but it is positive definite!

It is possible to restore the "true" statistical correlator from data on statistical errors, if they were obtained by the constrained fit :

$(B_1 + B_3 + B_5 = 1)$.

Indeed, in this case

$$\rho^{(stat)}_{mn} = (\sigma_k^2 - \sigma_m^2 - \sigma_n^2) / (2 \sigma_m \sigma_n), \ (k \neq m \neq n) = (1,3,5).$$

Inserting data on the statistical errors we will obtain a "true" correlator

$$\rho^{(stat)} = \begin{pmatrix} 1 & -0.975071 & -0.274691 \\ -0.975071 & 1 & 0.054487 \\ -0.274691 & 0.054487 & 1 \end{pmatrix}$$

with eigenvalues 2.02838, 0.97617, 3.46132E-17, where the minimal eigenvalue should be treated as zero (it is close to "default precision" which is 16 "significant digits").

Thus, the obtained matrix is degenerate and differs strongly out of the OPAL matrix.

From the systematic errors budget, taken from Table 7 of the paper

	Observables		
Sources	0.14	0.13	0.35
	0.12	0.12	0.12
	0.10	0.10	0.027
	0.10	0.10	0.00

we can calculate the covariance matrix of systematic uncertainties

Covariance matrix		
0.054	0.0526	0.00904
0.0526	0.0513	0.00869
0.00904	0.00869	0.002098

Adding it to the "true" statistical covariance matrix we will obtain the covariance matrix for the combined stat. and syst. errors

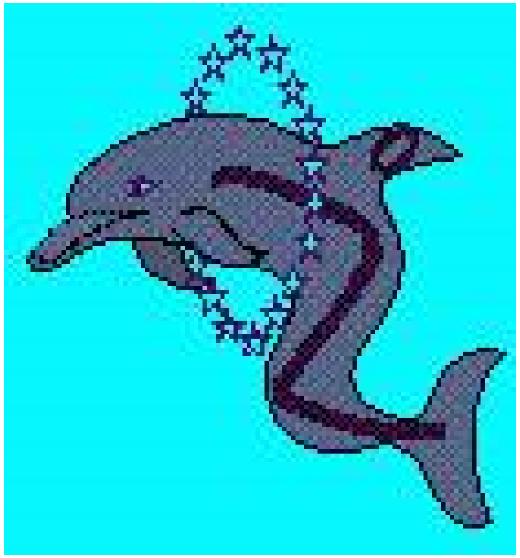
Total covariance matrix		
0.1269	-0.01585	0.00459
-0.01585	0.1189	0.00954
0.00459	0.00954	0.005698

Total correlation matrix		
1.	-0.129035	0.170695
-0.129035	1.	0.366519
0.170695	0.366519	1.

Eigenvalues of the total correlator are as follows
{ 1.36933, 1.09429, 0.536376 }

Now, it seems, we have complete presentation of OPAL result:

- **estimates of mean values,**
- **estimates of statistical and systematic covariances with true properties;**
- **estimates of the total covariances and correlations with quoting the data quality parameters (precision of calculations and rounding thresholds).**



European Physical Journal C20 (2001) 617
Experiment CERN-LEP-DELPHI

A Measurement of the τ Topological Branching Ratios

$$\begin{bmatrix} B_1 \\ B_3 \\ B_5 \end{bmatrix} = \left(\begin{bmatrix} 0.85316 \pm 0.000929_{stat} \pm 0.000492_{syst} \\ 0.14569 \pm 0.000929_{stat} \pm 0.000477_{syst} \\ 0.00115 \pm 0.000126_{stat} \pm 0.000059_{syst} \end{bmatrix}, \begin{bmatrix} 1.00 & -0.98 & -0.08 \\ -0.98 & 1.00 & -0.08 \\ -0.08 & -0.08 & 1.00 \end{bmatrix} \right)$$

Unreliable !!!

Published correlator is incorrect and over-rounded.

Our calculations, based on data presented in the paper give the "correct" safely rounded correlator:

$$\begin{bmatrix} 1. & -0.9924 & -0.0848 \\ -0.9924 & 1. & -0.0335 \\ -0.0848 & -0.0335 & 1. \end{bmatrix}$$

It seems that an Erratum to the paper is needed, because of the over-rounding and improper uncertainty propagation

European Physical Journal C46 (2006) 1
Experiment CERN-LEP-DELPHI

A measurement of the tau hadronic branching ratios

Table10. Measured branching ratios in percent.The uncertainties are statistical followed by systematic

Decay mode		BranchingRatio(%)
$\tau^- \to h^-$	$\geq 0K^0\ \nu_\tau$	12.780 ± 0.120 ± 0.103
$\tau^- \to h^-\ \pi^o$	$\geq 0K^0\ \nu_\tau$	26.291 ± 0.201 ± 0.130
$\tau^- \to h^-\ 2\pi^o$	$\geq 0K^0\ \nu_\tau$	9.524 ± 0.320 ± 0.274
$\tau^- \to h^-\ \geq 1\pi^o$	$\geq 0K^0\ \nu_\tau$	37.218 ± 0.155 ± 0.116
$\tau^- \to h^-\ \geq 2\pi^o$	$\geq 0K^0\ \nu_\tau$	10.927 ± 0.173 ± 0.116
$\tau^- \to h^-\ \geq 3\pi^o$	$\geq 0K^0\ \nu_\tau$	1.403 ± 0.214 ± 0.224
$\tau^- \to 3h^\pm$	$\geq 0K^0\ \nu_\tau$	9.340 ± 0.090 ± 0.079
$\tau^- \to 3h^\pm\ \pi^o$	$\geq 0K^0\ \nu_\tau$	4.545 ± 0.106 ± 0.103
$\tau^- \to 3h^\pm\ \geq 1\pi^o$	$\geq 0K^0\ \nu_\tau$	5.106 ± 0.083 ± 0.103
$\tau^- \to 3h^\pm\ \geq 2\pi^o$	$\geq 0K^0\ \nu_\tau$	0.561 ± 0.068 ± 0.095
$\tau^- \to 5h^\pm$	$\geq 0K^0\ \nu_\tau$	0.097 ± 0.015 ± 0.005
$\tau^- \to 5h^\pm\ \geq 1\pi^o$	$\geq 0K^0\ \nu_\tau$	0.016 ± 0.012 ± 0.006

Table 11.Correlation matrix of the combined statistical and systematic uncertainties.The last three rows show the correlation with the topological branching ratios presented in [16].

$h^-\nu_\tau$	1.00											
$h^-\pi^0\nu_\tau$	−0.34	1.00										
$h^- \geq 1\pi^0\nu_\tau$	−0.47	0.56										
$h^- 2\pi^0\nu_\tau$	0.06	−0.66	0.15	1.00								
$h^- \geq 2\pi^0\nu_\tau$	−0.03	−0.74	0.15	0.81	1.00							
$h^- \geq 3\pi^0\nu_\tau$	−0.06	0.38	0.11	−0.86	−0.36	1.00						
$3h^\pm\nu_\tau$	−0.07	−0.08	0.15	0.00	−0.03	−0.02	1.00					
$3h^\pm\pi^0\nu_\tau$	−0.02	−0.01	−0.05	−0.03	−0.02	0.03	−0.53	1.00				
$3h^\pm \geq 1\pi^0\nu_\tau$	−0.04	−0.04	−0.13	−0.04	−0.06	−0.02	−0.56	0.75	1.00			
$3h^\pm \geq 2\pi^0\nu_\tau$	−0.01	−0.01	−0.04	0.03	−0.02	−0.06	0.26	−0.78	−0.16	1.00		
$5h^\pm\nu_\tau$	−0.01	−0.01	0.01	0.00	0.00	0.00	−0.02	−0.03	−0.01	0.03	1.00	
$5h^\pm \geq 1\pi^0\nu_\tau$	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	−0.05	−0.05	−0.57	1.00
B1	0.09	0.10	0.26	0.04	0.11	0.03	−0.50	−0.25	−0.39	−0.06	−0.03	0.00
B2	−0.09	−0.10	−0.26	−0.04	−0.11	−0.03	0.50	0.25	0.39	0.06	0.03	0.00
B3	−0.02	0.00	0.00	0.00	0.00	0.00	−0.03	0.03	0.00	0.00	0.72	0.40

Table 11. Correlation matrix of the combined statistical and systematic uncertainties as it is reproduced in **pdgLive-2007(8).**

$h^- \nu_\tau$	1.00											
$h^- \pi^0 \nu_\tau$	-0.34	1.00										
$h^- \geq 1\pi^0 \nu_\tau$	-0.47	0.56										
$h^- 2\pi^0 \nu_\tau$	0.06	-0.66	0.15	1.00								
$h^- \geq 2\pi^0 \nu_\tau$	-0.03	-0.74	0.15	0.81	1.00							
$h^- \geq 3\pi^0 \nu_\tau$	-0.06	0.38	0.11	-0.86	-0.36	1.00						
$3h^\pm \nu_\tau$	-0.07	-0.08	0.15	0.00	-0.03	-0.02	1.00					
$3h^\pm \pi^0 \nu_\tau$	-0.02	-0.01	-0.05	-0.03	-0.02	0.03	-0.53	1.00				
$3h^\pm \geq 1\pi^0 \nu_\tau$	-0.04	-0.04	-0.13	-0.04	-0.06	-0.02	-0.56	0.75	1.00			
$3h^\pm \geq 2\pi^0 \nu_\tau$	-0.01	-0.01	-0.04	0.03	-0.02	-0.06	0.26	-0.78	-0.16	1.00		
$5h^\pm \nu_\tau$	-0.01	-0.01	0.01	0.00	0.00	0.00	-0.02	-0.03	-0.01	0.03	1.00	
$5h^\pm \geq 1\pi^0 \nu_\tau$	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.05	0.05	-0.57	1.00

Omitted in RPP

-0.05

In original text

This matrix is assigned in the RPP data block to the observables of Table 12 not to the observables of Table 10 as it is in the original paper.

*"Using the world averages [18] for the channels involving **K^0** and neglecting this contribution for channels with more than three charged pions or kaons, we can derive the branching ratios shown in Table 12. In this subtraction, the total error on the world average was added in quadrature to the systematic error of these measurements."*

Table 12. Measured branching ratios in percent after subtraction of the contributions of channels including K^0. The uncertainties are statistical followed by systematic

Decay mode	Branching Ratio (%)
$\tau^- \to h^- \nu_\tau$	11.571 ± 0.120 ± 0.114
$\tau^- \to h^- \pi^o \nu_\tau$	25.740 ± 0.201 ± 0.138
$\tau^- \to h^- 2\pi^o \nu_\tau$	9.498 ± 0.320 ± 0.275
$\tau^- \to h^- \geq 1\pi^o \nu_\tau$	36.641 ± 0.155 ± 0.127
$\tau^- \to h^- \geq 2\pi^o \nu_\tau$	10.901 ± 0.173 ± 0.118
$\tau^- \to h^- \geq 3\pi^o \nu_\tau$	1.403 ± 0.214 ± 0.224
$\tau^- \to 3h^\pm \nu_\tau$	9.317 ± 0.090 ± 0.082
$\tau^- \to 3h^\pm \pi^o \nu_\tau$	4.545 ± 0.106 ± 0.103
$\tau^- \to 3h^\pm \geq 1\pi^o \nu_\tau$	5.106 ± 0.083 ± 0.103
$\tau^- \to 3h^\pm \geq 2\pi^o \nu_\tau$	0.561 ± 0.068 ± 0.095
$\tau^- \to 5h^\pm \nu_\tau$	0.097 ± 0.015 ± 0.005
$\tau^- \to 5h^\pm \geq 1\pi^o \nu_\tau$	0.016 ± 0.012 ± 0.006

But it is impossible to do this evaluation reliably simply because there are no proper correlator of the corresponding “world averaged” tau branchings.

As a rule, PDG shows correlators in % for the pure informational purposes – to show highly correlated observables under study. ⟶ **The PDG correlators for branchings are badly over-rounded.**

There is another problem with DELPHI correlators – both “correlation” matrices, original and presented in RPP, have two negative eigenvalues.

Such papers should be returned by referees to the senders for corrections.

Such “data” should not pass to the RPP repository without comments on the data corruption in spite of being published in journals with high impact factor.


L3
HOME
PAGE

Physics Letters B519 (2001) 191

Experiment CERN-LEP-L3

Measurement of the topological branching fractions of the *τ* lepton at LEP

“After combination of the systematic uncertainties the results for the branching fractions of the *τ* lepton decays into one, three and five charged particle final states are:

$$B(\tau \to (1\text{-prong})) = 85.274 \pm 0.105 \pm 0.073\%,$$
$$B(\tau \to (3\text{-prong})) = 14.556 \pm 0.105 \pm 0.076\%,$$
$$B(\tau \to (5\text{-prong})) = 0.170 \pm 0.022 \pm 0.026\%,$$

where the first uncertainty is statistical and the second is systematic.”

Unfrortunately, there are no comments on the properties of the stat., or syst., or combined uncertainty matrices in the section describing the final results.

But in **pdgLive(2008)** we have some indication that there might be further comments from “L3-verifier”

From the footnotes to the measurements in the corresponding data blocks it is possible to form the correlation matrix

Source	*B(*1-prong*)*	*B(*3-prong*)*	*B(*5-prong*)*
*B(*1-prong*)*	**1.0**	**−0.978**	**−0.082**
*B(*3-prong*)*		**1.0**	**−0.19**
*B(*5-prong*)*			**1.0**

that is named as "correlations between measurements" there, and can be interpreted as the correlations of the total uncertainties. It does not coinside with the statistical correlator presented in the paper (Table 4).

"In the fit the constraint ***B(*1*)* + *B(*3*)* + *B(*5*)* = 1** is applied and the sum of N^{i}_{exp} is constrained to the number of observed τ decays. The following results are obtained:….."

"Table 4

The correlation coefficients obtained from a fit of the topological branching fractions

Source	*B(*1-prong*)*	*B(*3-prong*)*	*B(*5-prong*)*
*B(*1-prong*)*	**1.0**	**−0.978**	**−0.082**
*B(*3-prong*)*		**1.0**	**−0.127**
*B(*5-prong*)*			**1.0**

"

It turns out that both above “correlators” are “wrong” !

The “correlator” encoded in RPP and named as “correlations between measurements” has passed through L3-verifier, but it is not positive semi definite. Its eigenvalues are as follows:

{1.98404, 1.03052, -0.0145664}

The statistical correlator from Table 4 is positive definite with eigenvalues {1.97905, 1.02081, 0.00014514} and rounding threshold = **4.**
But it should be degenerate if obtained from the constrained fit.
(It looks as over-rounded matrix.)

Calculations analogous to the OPAL case give matrices with correct properties and in accordance with raw data presented in the paper (if we properly understand and interpret it).

Our calculations, analogous to OPAL case based on the statistical errors from constrained fit presented in the paper give the "correct" safely rounded statistical correlator:

$$\rho^{(stat)} = \begin{pmatrix} 1 & -0.97805 & -0.104762 \\ -0.97805 & 1 & -0.104762 \\ -0.104762 & -0.104762 & 1 \end{pmatrix}$$

With eigenvalues: 1.97805, 1.02195, -1.01856E-17

From the systematic errors budget, taken from Table 5 of the paper

	Observables		
	0.048	0.052	0.024
	0.01	0.01	0.001
	0.01	0.01	0.001
Sources	0.011	0.011	0.001
	0.035	0.035	0.003
	0.012	0.012	0.001
	0.017	0.017	0.004
	0.032	0.032	0.007

Systematic covariance matrix		
0.005307	0.005499	0.001592
0.005499	0.005707	0.001688
0.001592	0.001688	0.000654

With systematic errors as in the paper
0.0728492, 0.0755447, 0.0255734

Adding it to the "true" statistical covariance matrix we will obtain the covariance matrix for the combined stat. and syst. errors

Total covariance matrix		
0.016332	-0.005284	0.001350
-0.005284	0.016732	0.001446
0.001350	0.001446	0.001138

Total correlation matrix		
1.	-0.319646	0.313143
-0.319646	1.	0.331378
0.313143	0.331378	1.

Eigenvalues of the total correlator are as follows

{ 1.33208, 1.31076, 0.357163}

Now we have complete presentation of L3 result:

- **estimates of mean values;**
- **statistical and systematic covariances with true properties;**
- **estimates of the total covariances and correlations with quoting the data quality parameters (precision of calculations and rounding thresholds).**

JCGM 100:2008
GUM 1995 with minor corrections

Evaluation of measurement data — Guide to the expression of uncertainty in measurement

Évaluation des données de mesure — Guide pour l'expression de l'incertitude de Mesure

First edition September 2008

ISO GUM, ISO GUM-JCGM

1. **Guide to the Expression of Uncertainty in Measurement (*1995*)**

   - Correlation matrix presented in the section "Annex H: Examples" Tables H.3 and H.4 is non positive semi-definite. Formula for non-linear uncertainty propagation in clause 5.1.2 is incorrect. Recommendation in clause 7.2.6 on rounding correlation matrix is incorrect (see details in DSJ.,**IHEP_2006-28**)

2. **Guide to the Expression of Uncertainty in Measurement (*2008*)**

   - Correlation matrix presented in the section "Annex H: Examples" Tables H.3 and H.4 is non positive semi-definite. Formula for non-linear uncertainty propagation in clause 5.1.2 is incorrect. Recommendation in clause 7.2.6 on rounding correlation matrix is incorrect (see details in presentation at June IHEP seminar)

ICSU CODATA

The NIST Reference on
Constants, Units, and Uncertainty

CODATA FPC

1. **Reviews of Modern Physics 72 (2000) 351, "CODATA recommended values of the fundamental physical constants: 1998"**

   - Represented uncertainties of the main result are incorrect. Some of correlation sub-matrices presented in the paper and on the CODATA FPC site are non positive semi-definite.

2. **Reviews of Modern Physics 77 (2005) 1, "CODATA recommended values of the fundamental physical constants: 2002"**

   - Resulted values and uncertainties of some of the derived constants are incorrect. Some of correlation sub-matrices presented in the paper and on the CODATA FPC site are non positive semi-definite.

     In this version the complete computer readable outputs (LSA files) for the basic constants were presented for the first time. On the basis of that LSA files it is possible to check the overall consistency of the basic constants, and from the other hand to reveal that values of some derived constants and their correlations are incorrect. Most probably, the origin of this incorrectness is the application of the linear uncertainty propagation law and badly over-rounding of the central values of the derived constants presented in publication and on the pages of the CODATA FPC site.

3. Reviews of Modern Physics 80 (2008) 633, "CODATA recommended values of the fundamental physical constants: 2006"

■ Resulted values and uncertainties of some of the derived constants are incorrect. Some of correlation sub-matrices presented in the paper and on the CODATA FPC site are non positive semi-definite. In this version the complete computer readable outputs (LSA files) are absent.

Message from NIST FPC site for the versions 5.0 (Mar 2007), 5.1 (Dec 2007), 5.2 (Jun 2008):

*"*Data from the least-squares adjustment of the values of the constants*"*

*"***Data from the CODATA 2002 least-squares adjustment of the values of the constants** (Data from the 2006 adjustment will be available here at a future date.)*"*

AMDC

Atomic Mass Data Center

1. **Nuclear Physics A729 (2003) 337, "The AME2003 Atomic Mass Evaluation (II). Tables, Graphs and References"**
   - Uncertainties of the main result presented in the paper are incomplete. Small fragments of the correlation matrix are presented with argumentation: "…A complete representation would require reproduction of a matrix of correlation coefficients. Since this matrix contains N(N+1)/2 elements in which N=847, this is not very attractive. …" (See page 341).

The computer readable data presented on the pages of AMDC site is questioned: data in the file mass.mass03 (containing non-rounded nuclide masses) are scrambled, probably due to the bug in the output block (see column “beta-decay energy”). It is impossible to assess the consistency of the published data on the rounded masses and corresponding scatter region without knowing the minimal eigenvalue of the 847×847 correlation matrix and without the corrected mass.mass03 file.

AMDC
Atomic Mass Data Center

?

mass.mas03

-1 1 2 3 He 14931.21475 0.00242 2572.681 0.001 B- -13736# 2000# **3 016029.31914** 0.00260

mass.mas03round

1 2 He 14931.2148 0.0024 2572.681 0.001 * **3 016029.3191** 0.0026

Previous estimates

mass_rmd.mas95

-1 1 2 3 He 14931.204 0.001 7718.058 0.002 B- * **3 016029.310** 0.001

mass_rmd.mas93

-1 1 2 3 He 14931.203 0.002 7718.058 0.003 B- * **3 016029.309** 0.001

Table B. Correlation matrices for the most precisely known very light nuclei (in squared nano atomic mass units).

covariance

	n	H	D	^{4}He	^{13}C	^{14}N	^{15}N	^{16}O	^{28}Si
n	0.316817								
H	−0.007978	0.010689							
D	0.124508	0.002709	0.127243						
^{4}He	0.000000	0.000000	0.000000	0.004011					
^{13}C	0.125909	−0.007584	0.118352	0.000000	0.954145				
^{14}N	−0.008911	0.012558	0.003645	0.000000	−0.008470	0.384729			
^{15}N	0.094981	0.016262	0.111262	0.000000	0.090285	0.019496	0.558755		
^{16}O	−0.001022	0.001377	0.000355	0.000000	−0.000972	0.005718	0.002100	0.027039	
^{28}Si	0.227453	0.008282	0.235786	0.000000	0.216210	0.010584	0.653732	0.001078	3.761099

	n	H	D	^{3}H	^{3}He	^{16}O	^{20}Ne	^{23}Na	^{28}Si
n	0.316817								
H	−0.007978	0.010689							
D	0.124508	0.002709	0.127243						
^{3}H	0.008197	0.000942	0.009139	6.116907					
^{3}He	0.009704	0.001116	0.010822	5.694194	6.743975				
^{16}O	−0.001022	0.001377	0.000355	0.000122	0.000144	0.027039			
^{20}Ne	0.326227	0.014358	0.340650	0.024965	0.029563	0.001866	3.687126		
^{23}Na	−0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	8.587458	
^{28}Si	0.227453	0.008282	0.235786	0.017163	0.020325	0.001078	0.633419	0.000000	3.761099

?

4. Nuclear-reaction and separation energies

The result of the least-squares adjustment of experimental data (reaction and decay energies and mass-spectrometric data) determining atomic masses of nuclides, as described in Part I, is not represented completely by the adjusted values of the input data given there and the resulting values of the atomic masses given in the Table I. A com-

plete representation would require reproduction of a matrix of correlation coefficents. Since this matrix contains $\frac{1}{2}N(N+1)$ elements in which $N = 847$, this is not very attractive.

The main use of the correlation matrix is in obtaining errors in linear combinations of atomic masses. In practice, the correlations are important only for combinations involving two neighbouring nuclides with small differences in mass number and particles such as n, p, d, t, ^{3}He and α. Such combinations, consisting of various kinds

Conclusions on the AME-2003

Independent evaluations of nuclide and nuclear masses are urgently needed.

This statement (if shared) should be officially transferred by Russian CODATA Committee to all relevant Russian agencies that supported national metrology system and atomic, nuclear, particle, and astroparticle physics research projects.

Report on the Meeting of the CODATA Task Group on Fundamental Constants
14 June 2008, Broomfield, Colorado, USA
Prepared by David Newell
National Institute of Standards and Technology

■ ■ ■

11. Other topics

a. A Freedom Of Information Act (FOIA) was issued to NIST wanting all of our code and data for the 2006 LSA, and we complied.

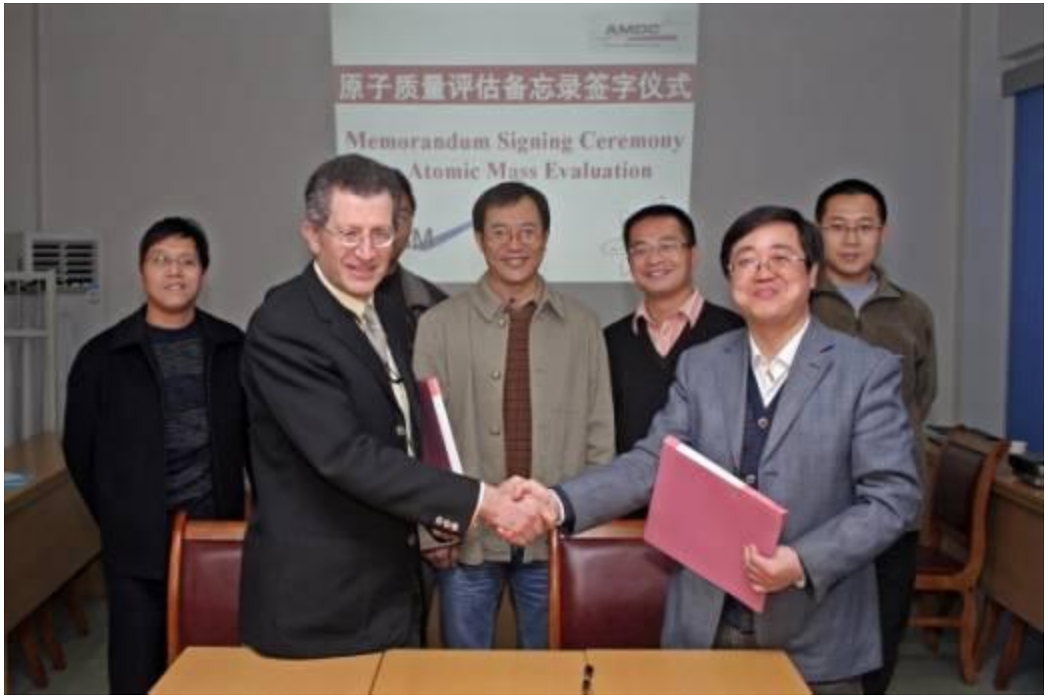
b. Atomic Mass Data Center - *Wapstra* has died and *Audi* has closed the AMDC. It was recommended that CODATA Task Group issue the following statement:

> **"The CODATA Task Group on Fundamental Constants urges IUPAP to officially recommend to relevant agencies that support for an atomic mass evaluation program similar to the past activities of the AMDC, is vital for the determination of the fundamental constants and highly important to physics in general."**

■ ■ ■

Memorandum Signing Ceremony on Transfer of Atomic Mass Evaluation to IMP held in Lanzhou
(November 25, 2008)

On 17 November 2008, Professor XIAO Guoqing, Director of the Institute of Modern Physics (IMP), CAS and Dr. Georges Audi, Head of the Atomic Mass Evaluation (AME) and the Atomic Mass Data Center (AMDC) signed a memorandum on transfer of the AME from the CNSMS (Orsay, France) to IMP.
The signing ceremony was held at IMP in Lanzhou.



According to the memorandum, IMP will be responsible for the AME in future. IMP will first assign one person to learn and get trained at CNSMS and then focus on the AME in full time.
After the preparation of two or three years, CSNSM will transfer all of the relevant materials to IMP and IMP will host the AMDC as well. IMP will establish a core group for the AME and attach importance to the collaboration with institutes and universities around the world accordingly.

All of the data of AME will be open to the whole nuclear physics community.

International Atomic Energy Agency

Nuclear Data Services

RIPL-2
Reference Input Parameter Library

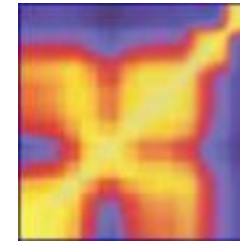
Release Date: April 20, 2003

RIPL-2 library contains input parameters for theoretical calculations of nuclear reactions involving light particles such as *n, p, d, t*, ^{3}He, ^{4}He, and γ at incident energies up to about 100 MeV. The library contains **nuclear masses, deformations, matter densities, discrete levels and decay schemes, spacings of neutron resonances, optical model potentials, level density parameters, Giant Resonance parameters, gamma-ray strength-functions, and fission barriers**. It also includes extensive database of level densities, γ-ray strength-functions and fission barriers calculated with microscopic approaches. Several computer codes are provided in order to facilitate use of the library.

WARNING-1: Nuclide masses are based on the AME-1995 evaluation.
Theoretical calculations also adjusted to the AME-1995 data. The AME-2003 evaluation is not assimilated yet into RIPL

WARNING-2: In the whole RIPL the description of the parameters scatter regions is incomplete.
In the “*Handbook for calculations of nuclear reaction data, RIPL-2”,* IAEA-TEC-DOC-1506, June 2006 there are no words covariance matrix or correlation matrix

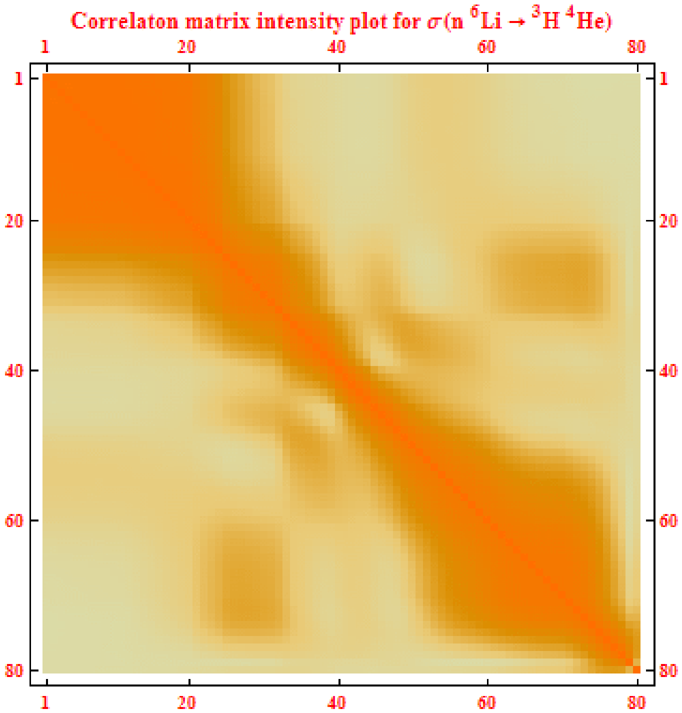
NNDC

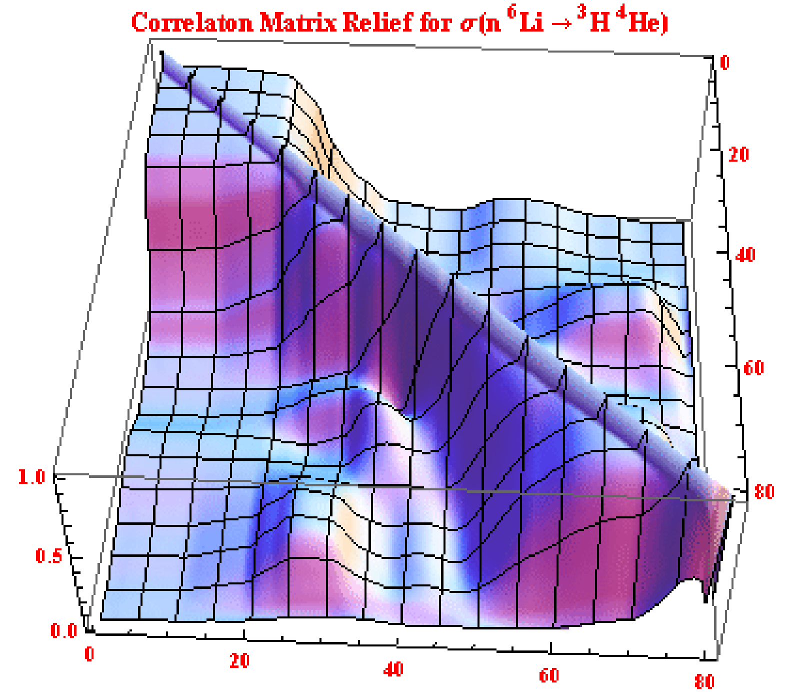


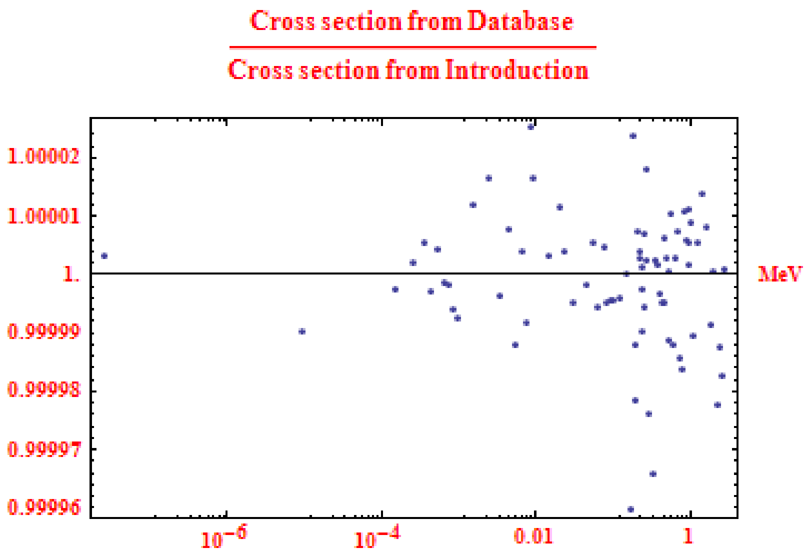
The current situation on the quality of data presentation in ENDF-IV data library is discussed in recent paper:
R.C. Little *et al.*, "Low-Fidelity Covariance Project", Nuclear Data Sheets **109** (2008) 2828.

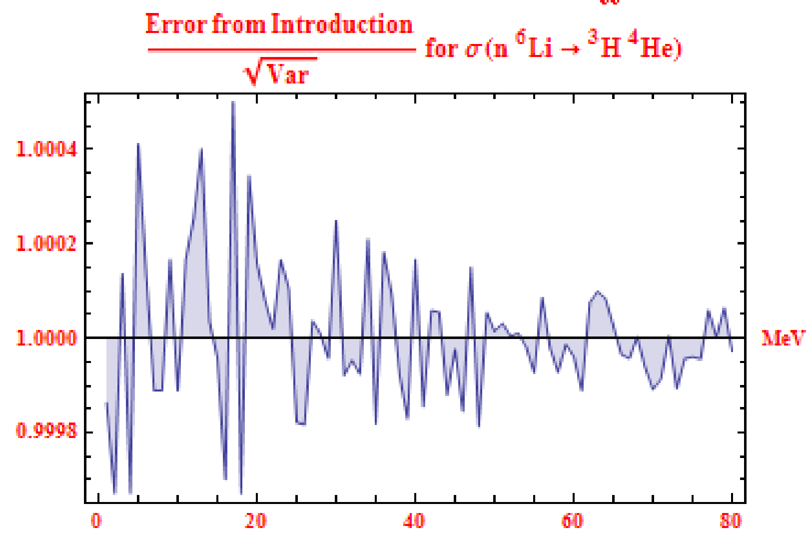
> "… An eigenvalue analysis of each of the symmetric LB-5 sub-subsections identified that forty of the materials have significant negative eigenvalues, beyond what is normally attributed to round-off [15]. All issues uncovered during this phase will be communicated and resolved.
>
> The processing and review of these files by both PUFF and NJOY (ERRORJ) at several of the labs has already led to improvements not only in the Low-Fi files but also in the processing codes for the covariance data. …"

Neutron cross section standards: Li6

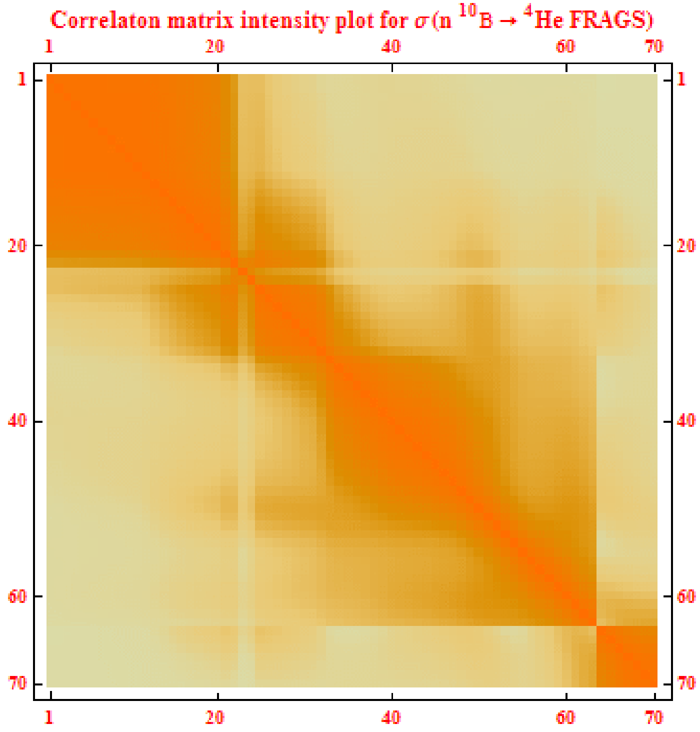


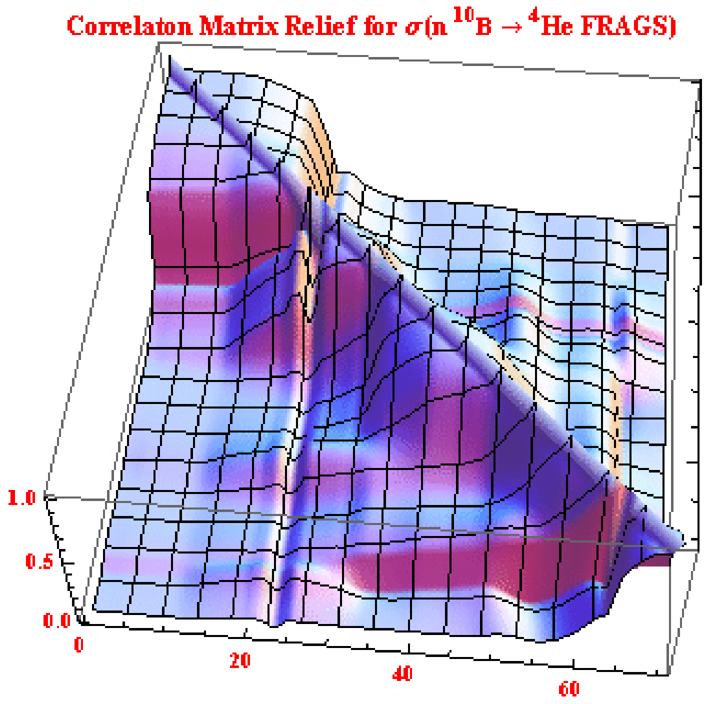


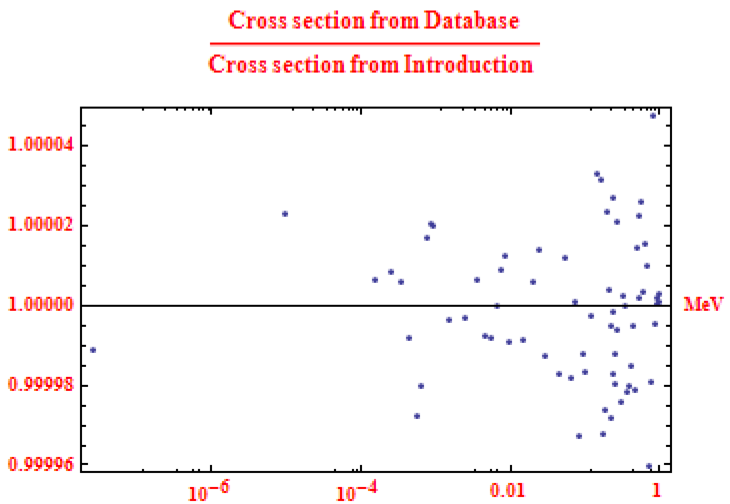


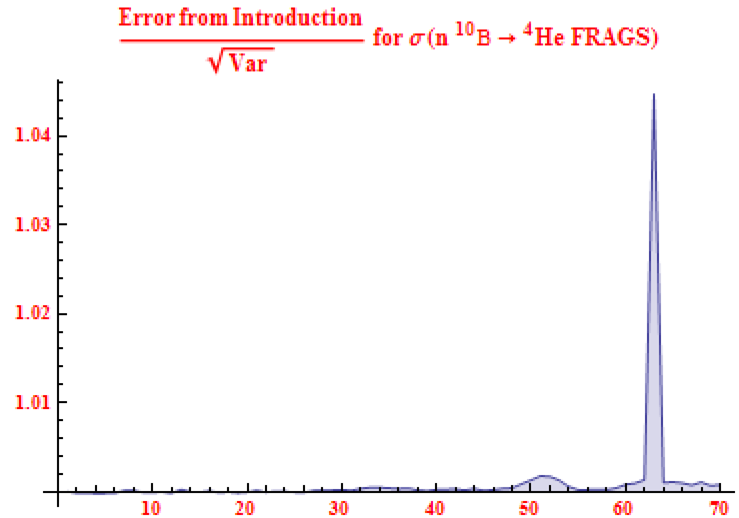


Neutron cross section standards: B10, A0

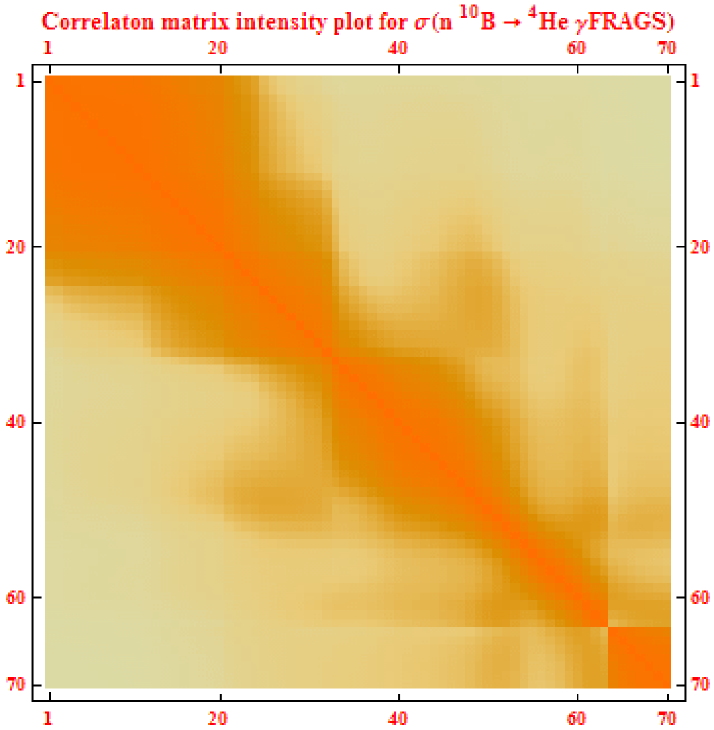


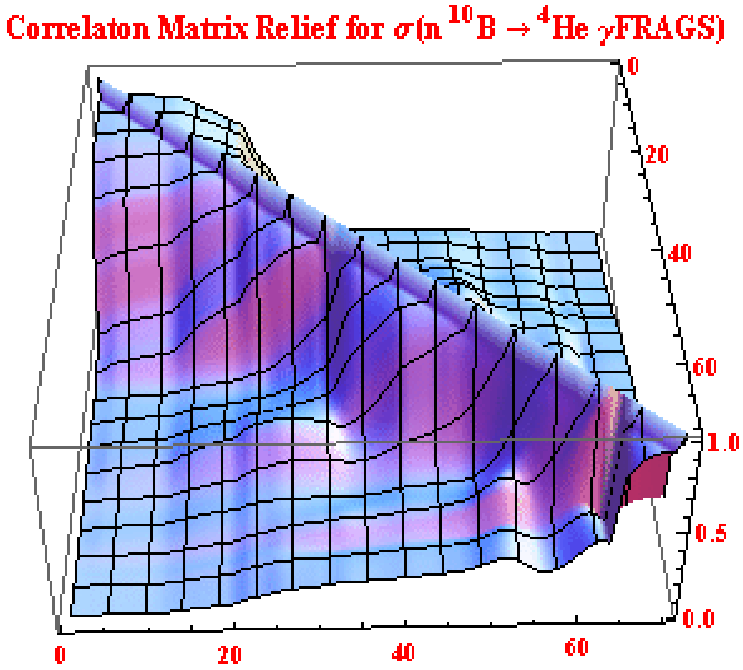


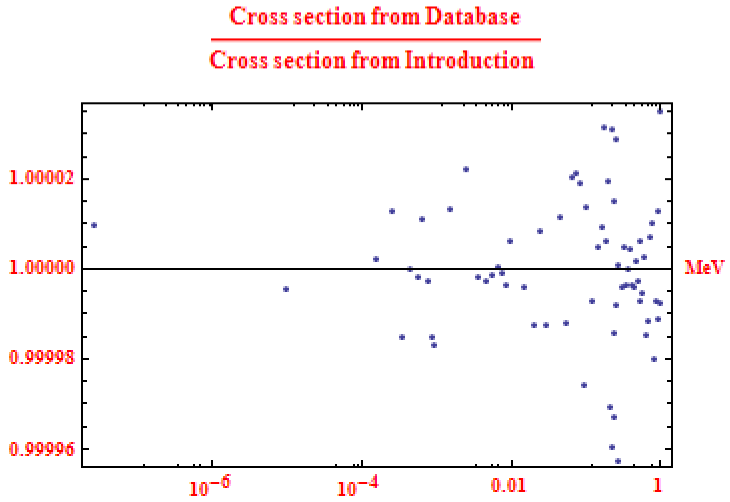


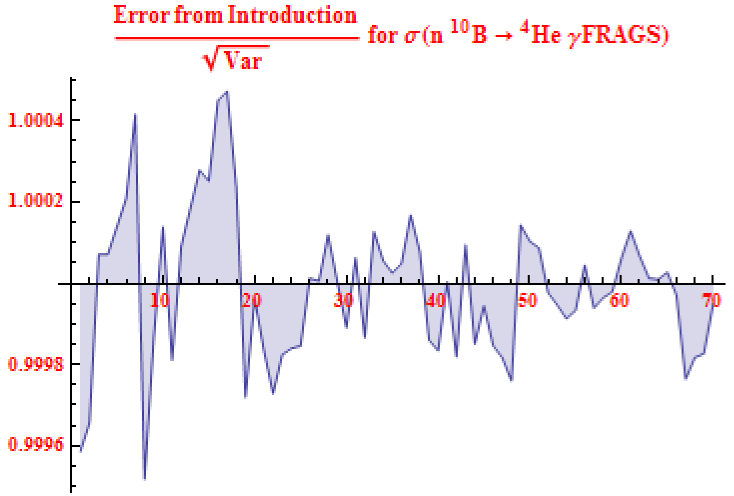


Neutron cross section standards: B10, A1

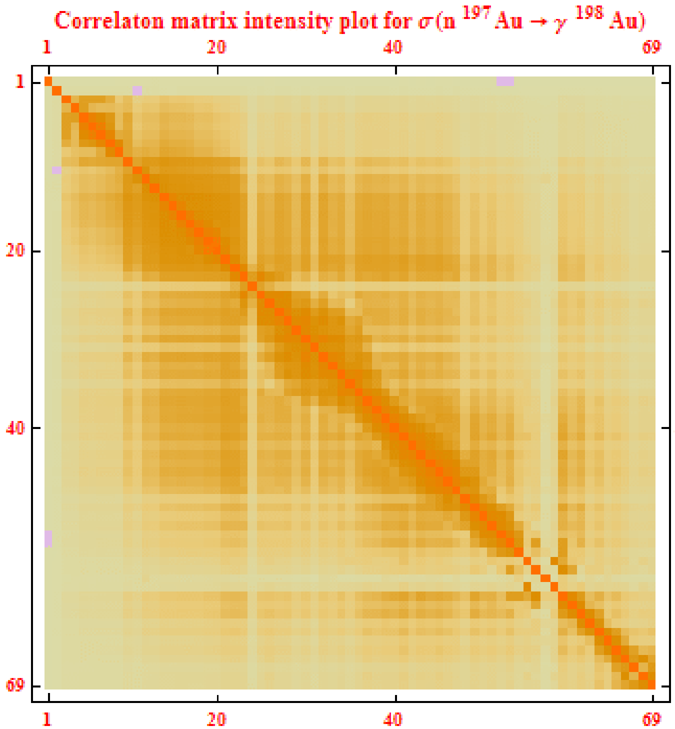


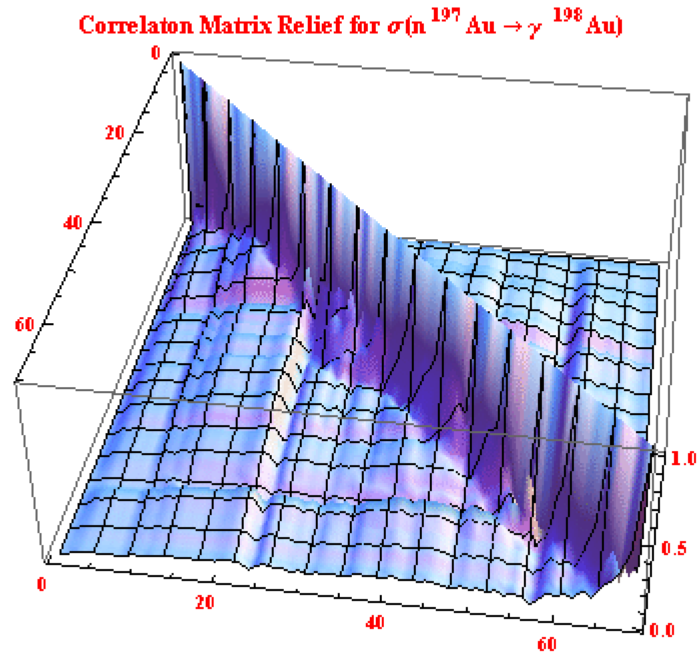


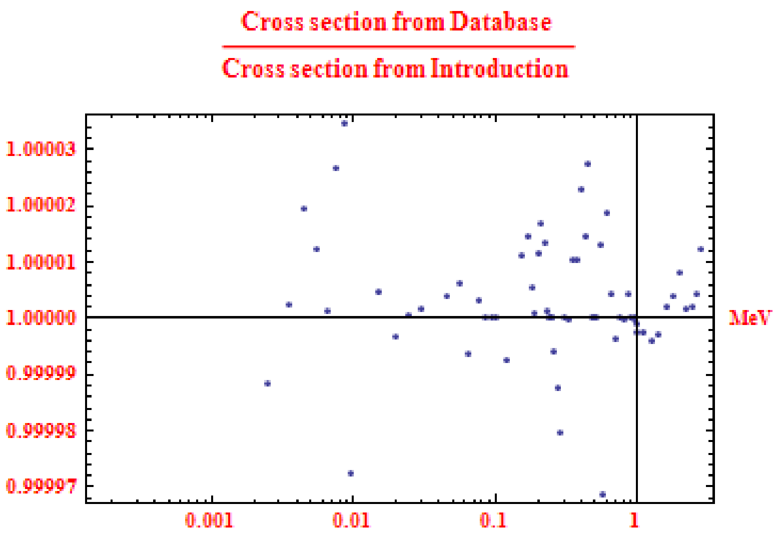


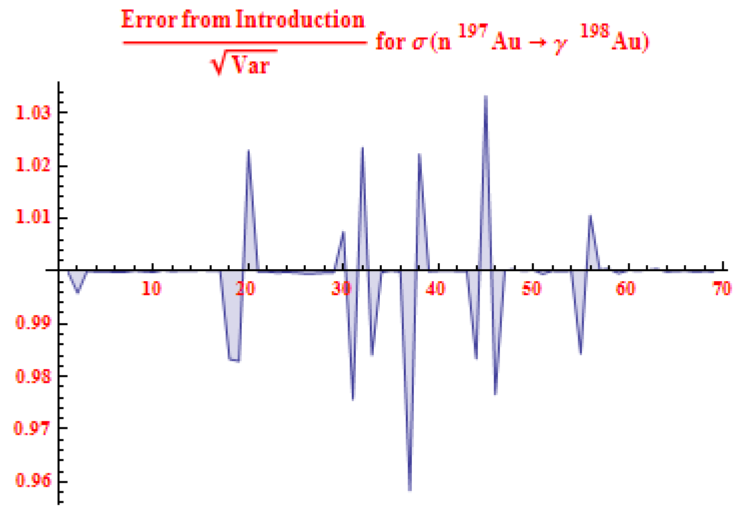


Neutron cross section standards: Au197

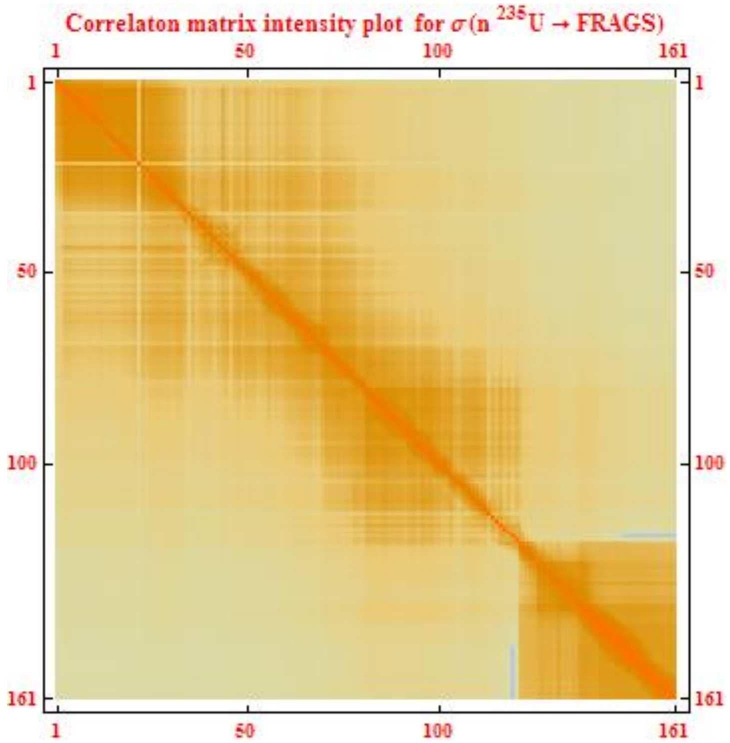


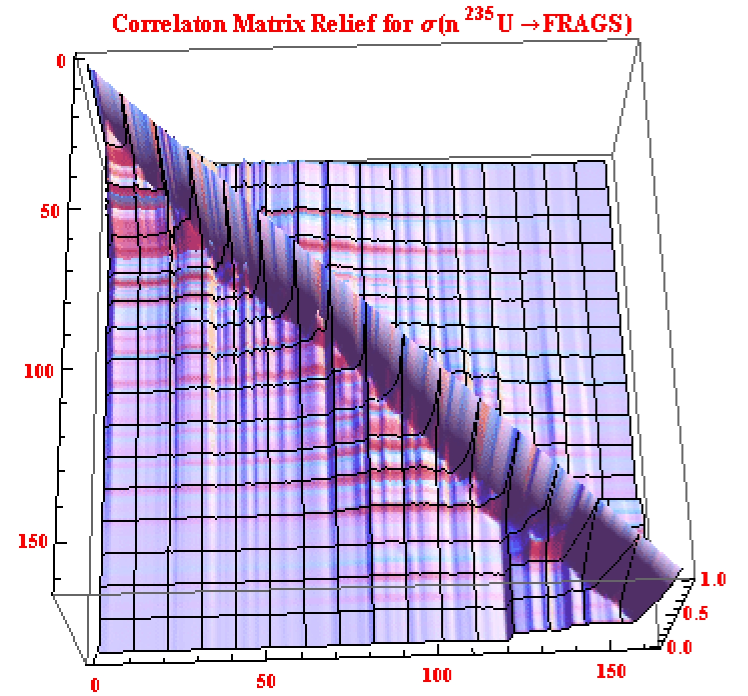


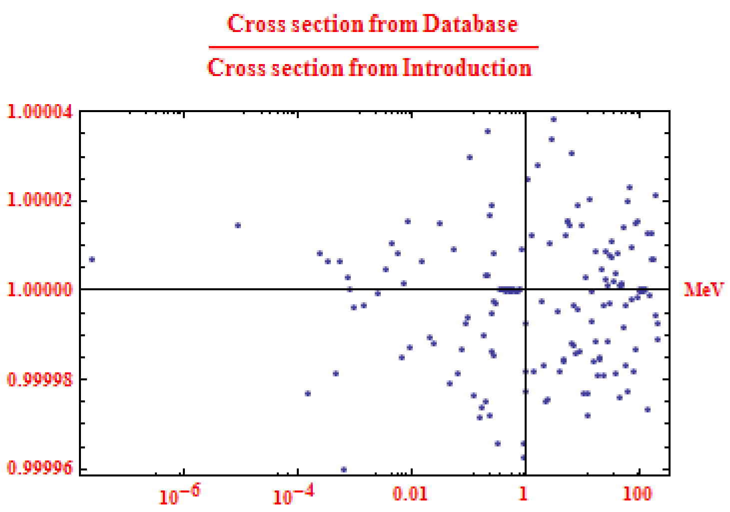


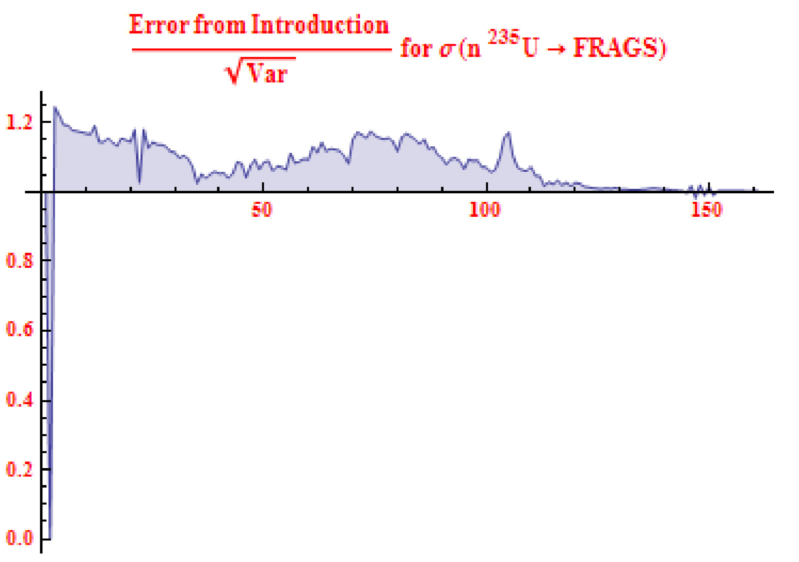


Neutron cross section standards: U235

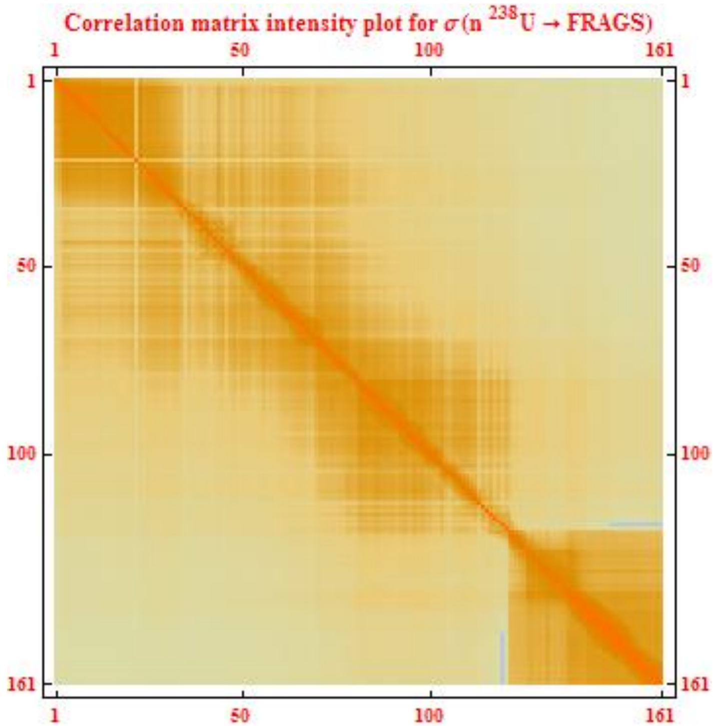


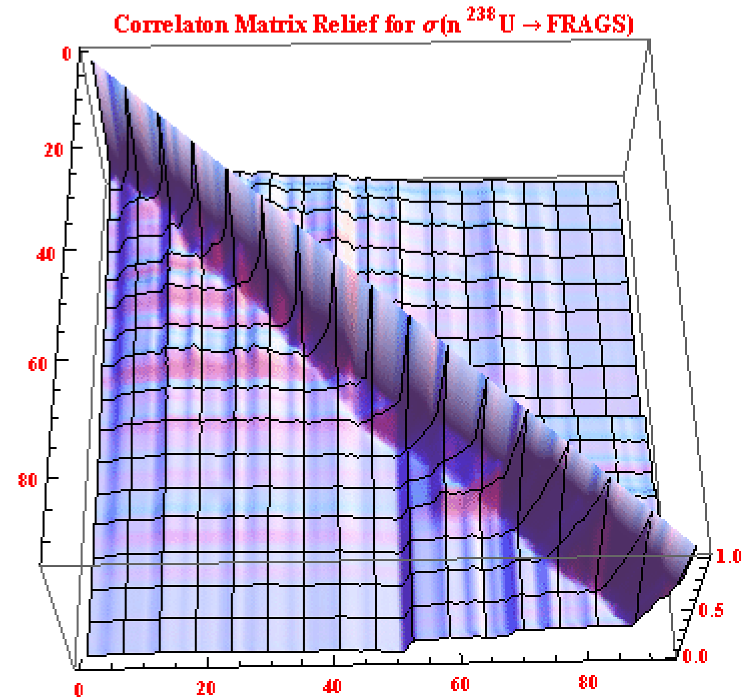


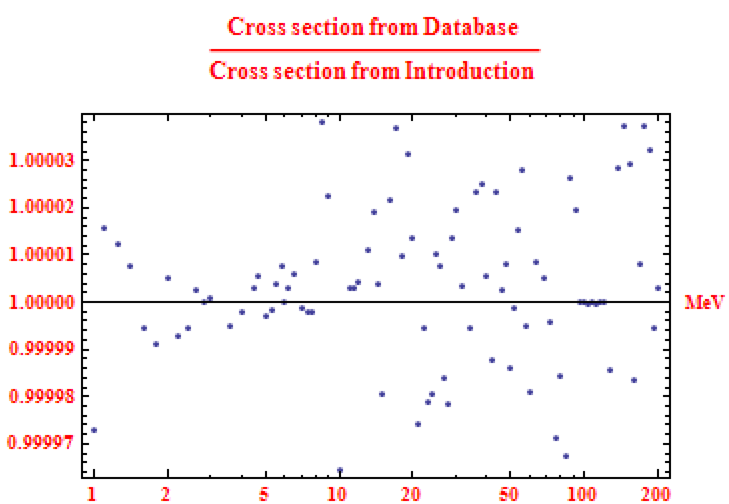


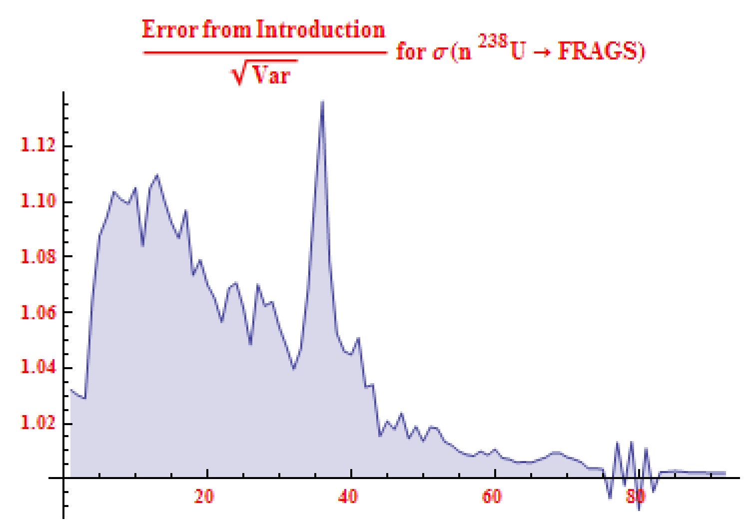


Neutron cross section standards: U238









PDG Live

particle data group

PDG COLLABORATION

1. Journal of Physics G33 (2006) 1, "Review of Particle Physics

■ WARNING: Representation of the final results on the physics parameters evaluations in some reviews is incomplete. Correlation matrices for uncertainties of the parameters are not reported. The consistency of the parameters reported and their scatter regions could not be assessed. ■

2. Physics Letters B667 (2008) 1, "Review of Particle Physics"

■ Representation of the final results on the physics parameter evaluations in some reviews is incomplete. Correlation matrices for uncertainties of the parameters are not reported. The consistency of the parameters reported and their scatter regions could not be assessed. http://pdg.lbl.gov/

RPP evaluated data from reviews and mini-reviews

In majority of the reviews and mini-reviews the evaluated particle physics parameters (the best current values) did not supported by the properly organized computer readable data files with input data and results of evaluations

CONSTRAINED FIT INFORMATION π^0 DECAY MODES

An overall fit to 2 branching ratios uses 4 measurements and one constraint to determine 3 parameters.
The overall fit has a $\chi^2 = 1.9$ for 2 degrees of freedom.
The following *off-diagonal* array elements are the correlation coefficients $<\delta x_i \delta x_j> / (\delta x_i \cdot \delta x_j)$, in percent, from the fit to x_i, including the branching fractions, $x_i = \Gamma_i / \Gamma_{total}$.
The fit constrains the x_i whose labels appear in this array to sum to one.

x_1	100		
x_2	–100	100	
x_4	–1	–0	100
	x_1	x_2	x_4

Eigenvalues of the rounded correlator
{2.00005, 1., -0.00005}

	x1	x2	x4
x1	1.00		
x2	-0.999958	1.00	
x4	-0.005585791	-0.003579367	1.00

Eigenvalues of the "URL-rounded correlator"
{1.99996, 1.00004, -1.02849×10^-10}

“5.2.3. ***Constrained fits:***

… In the Particle Listings, we give the complete correlation matrix; we also calculate the fitted value of each ratio, for comparison with the input data, and list it above the relevant input, along with a simple unconstrained average of the same input. ….”

Excerpt from page 17 of the RPP-2008

We see that there are no “complete correlation matrix” neither in the book nor on the pdgLive pages. We have over-rounded correlators instead (see the CONSTRAINED FIT INFORMATION pages).

Moreover, it seems, that both correlation matrices have another problem. It turns out that if we have three random quantities x1, x2, x4 such that they obey the relation

$$x1 + x2 + x4 = 1,$$

then their covariance matrix is degenerate 3×3 matrix and its non-diagonal matrix elements completely determined by the diagonal ones $\sigma_{mn} = 2\,\rho_{mn}\cdot\sigma_m\cdot\sigma_n$, where

$$\rho_{mn} = (\,\sigma_k^2 - \sigma_m^2 - \sigma_n^2\,) / (\,2\,\sigma_m\,\sigma_n\,)\ ,\ (k \neq m \neq n) = (1,2,4)$$

are the correlations. Inserting corresponding σ_m data from pdgLive we obtain: →

	Rounded Correlator		
x1	1	**-0.999956**	**-0.0046875**
x2	**-0.999956**	1	**-0.0046875**
x4	**-0.0046875**	**-0.0046875**	1

Eigenvalues. Rounded correlator: {**1.99996, 1.00004, 5.46851×10^{-8}**}

Eigenvalues. Non-rounded correlator: {**1.99996, 1.00004, -1.21385×10^{-16}**}

We have no explanations why the obtained estimates of the correlator differs from that of presented in the RPP and propose slightly modified procedure for the constrained fit

Ratio R	R-Value xi	R-Uncertainty δ(xi)	Formula (F)
$\Gamma(e^+ e^- \gamma)/\Gamma(2\gamma)$	0.0125	0.0004	x2/x1
$\Gamma(e^+ e^- \gamma)/\Gamma(2\gamma)$	0.01166	0.00047	x2/x1
$\Gamma(e^+ e^- \gamma)/\Gamma(2\gamma)$	0.0117	0.0015	x2/x1
$\Gamma(\gamma\ \text{Atom}(e^+e^-)/\Gamma(2\gamma)$	1.84×10^{-9}	0.29×10^{-9}	x3/x1
$\Gamma(2e^+ 2e^-)/\Gamma(2\gamma)$	0.0000318	3.0×10^{-6}	x4/x1
$\Gamma(e^+ e^-)/\Gamma(\text{total})$	6.46×10^{-8}	0.33×10^{-8}	x5
Γ(*undetected*)/Γ(total)	0.0	6.0×10^{-4}	1-x1-x2-x3-x4-x5

7 measurements, 5 parameters

Proposal for "new" forms of constrained fits

$$\chi^2 = \Sigma\, (R - F)_i\, W_{ij}\, (R - F)_j + (10^8/36) \cdot \text{UnitStep}[x1+x2+x3+x4+x5-1] \cdot (1-x1-x2-x3-x4-x5)^2$$

1/δ(xU)^2

	Value		Error		Rounded correlator				
x1	0.98798	±	0.00066	;	1.00	-0.42	0.00	0.00	0.00
x2	0.01198	±	0.00029	;	-0.42	1.00	-0.00	-0.00	0.00
x3	1.82×10^{-9}	±	0.29×10^{-9}	;	0.00	-0.00	1.00	0.00	0.00
x4	31.4×10^{-6}	±	3.0×10^{-6}	;	0.00	-0.00	0.00	1.00	0.00
x5	6.46×10^{-8}	±	0.33×10^{-8}	;	0.00	0.00	0.00	0.00	1.00

Eigenvalues. Non rounded correlator: {1.41895,1.00000,0.99999,0.99993,0.58113}

Eigenvalues. Rounded correlator: {1.42, 1.00, 1.00, 1.00, 0.58}

Minimum(χ^2) = 1.94 for 7- 5 = 2 degrees of freedom

In addition we can obtain the estimate for the fraction of the sum of possible undetected decays xU = 1-x1-x2-x3-x4-x5. Our calculations give:

	Value		Error		Rounded correlator					
x1	0.98798	±	0.00066	;	1.00	-0.42	0.00	0.00	0.00	-0.90
x2	0.01198		0.00029		-0.42	1.00	-0.00	-0.00	0.00	-0.02
x3	1.82×10^{-9}		0.29×10^{-9}		0.00	-0.00	1.00	0.00	0.00	-0.00
x4	31.4×10^{-6}		3.0×10^{-6}		0.00	-0.00	0.00	1.00	0.00	-0.00
x5	6.46×10^{-8}		0.33×10^{-8}		0.00	0.00	0.00	0.00	1.00	0.00
xU	4.92×10^{-6}		600.0×10^{-6}		-0.90	-0.02	-0.00	-0.00	0.00	1.00

Eigenvalues. Non rounded correlator: {1.98, 1.02, 1.00, 1.00, 1.00, 7.08×10^{-17}}

Eigenvalues. Rounded correlator: {1.98563, 1.01533, 1.00, 1.00, 1.00, -0.00095}

Now we have complete information to formulate the result:

1. For the vector {x1,x2,x3,x4,x5} we have correct estimates for the adjusted values of components, their standard deviations and positive definite correlation matrix which may be uniformly rounded to be presented in integers % ;

2. For the extended vector {x1,x2,x3,x4,x5,xU} we have correct estimates for the adjusted values of components, their standard deviations and positive semi-definite correlation matrix expressed with 16 digits to the right of decimal point.

To express results in a more compact forms the directed rounding procedures should be designed and implemented to preserve the properties of the correlator.

CONSTRAINED FIT INFORMATION π^0 DECAY MODES

2009

An overall fit to 2 branching ratios uses 4 measurements and one constraint to determine 3 parameters.
The overall fit has a $\chi^2 = 1.9$ for 2 degrees of freedom.
The following *off-diagonal* array elements are the correlation coefficients $\langle\delta x_i \delta x_j\rangle / (\delta x_i \cdot \delta x_j)$, in percent, from the fit to x_i, including the branching fractions, $x_i = \Gamma_i / \Gamma_{total}$.
The fit constrains the x_i whose labels appear in this array to sum to one.

x_1	100		
x_2	−100	100	
x_4	0	−1	100
	x_1	x_2	x_4

Eigenvalues of the rounded correlator
{2.00005, 1., -0.00005}

	x1	x2	x4
x1	1.00		
x2	-0.9999895	1.00	
x4	0.002807028	-0.007404748	1.00

Eigenvalues of the "URL-rounded correlator"
{2.00004, 0.999958, - 6.97894×10^{-8}}

CONCLUSION: Numerical Peer Review is urgently needed !

Historically it turns out that traditional chain to assure the quality of the published scientific data:

Authors → Journal peer reviewers → Editorial boards

and evolved publishing standards are insufficient to express and transfer multidimensional correlated data with metrological quality needed for applications

CAUTION : even the more powerful chain:

Authors → Journal peer reviewers → Journal editors →
→ RPP article finders → RPP data encoders →
RPP overseers → Verifiers(Authors) → RPP peer reviewers
→ RPP editors → Journal peer reviewers → Journal editors

used by PDG collaboration is insufficient to represent RPP data with metrological quality needed for different applications.

Summary & Plea to Russian CODATA Committee

The problems with numerical expression and presentation of correlated multidimensional data in publications and in computer readable files are common in the whole scientific community.

These problems originated in the absence of the widely accepted standard to express numerically the multidimensional correlated data and the absence of the numerical peer review in traditional and electronic publishing.

NUMERICAL PEER REVIEW is impossible without uniformity in multidimensional data expression and exchange in computer readable and "computer understandable" forms.

STANDARDS for multidimensional measured data expression and publication in electronic media in computer readable and computer understandable forms are urgently needed

As metrologists move too slow, we apply to Russian CODATA Committee to organize workout a draft of the standard and officially transfer it to Russian authoritative metrology organizations for expertise and implementation in Russian metrology system.

Conclusion

- Scientific measured data to prove the discovery of a phenomenon and data needed to use the phenomenon in practice are the data of different quality.
- Current practice to select scientific papers for publication is not enough to assure the scientific data to be of metrological quality.
- Current practice of selecting measured data from publications to assess them as the reference data for scientific and industrial applications is too soft to prevent proliferation of incomplete or corrupted data.
- Necessity of the special standardized procedures and means to “sieve and seal” the measured scientific data to be qualified as data of metrological quality and recommended for publication is argued.
- It is time to think on the extended form of the scientific publication, namely: any paper, reporting measured (or evaluated) data, should be accompanied by data files where data are completely presented in computer readable form of sufficient numeric precision to preserve the results obtained.