Certification Report

Certified Reference Material

ERM®-EB602

ZnAl4Cu1

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Coordinator: Dr. Sebastian Recknagel
BAM Federal Institute for Materials Research and Testing
Richard-Willstätter-Straße 11
12489 Berlin
Tel.: ++49/30/8104 1111
Fax.: ++49/30/8104 1117
Email: sebastian.recknagel@bam.de

Division 1.6 “Inorganic Reference Materials“

Summary

This report describes preparation, analysis and certification of the zinc alloy reference material ERM®-EB602. It can serve as a replacement of BCR-358.
The certified reference material is available in the form of discs (39 mm diameter and 39 mm height). It is intended for establishing and checking the calibration of optical emission and X-ray spectrometers (excluding micro-analysis) for the analysis of samples of similar matrix composition.

The following mass fractions and uncertainties have been certified:

Element	**Mass fraction** in %	**Uncertainty** in %
Al	4.08	0.11
Cu	0.812	0.017
Mg	0.0415	0.0020
	in mg/kg	in mg/kg
Pb	19.5	3.0
Cd	1.1	0.5
Fe	7.3	1.6
Sn	1.0	0.5
Ni	2.5	0.4
Si	11.4	1.9
Ti	4.8	0.4

This report contains detailed information on the preparation of the CRM as well as on homogeneity investigations and on the analytical methods used for certification analysis.
The certified values are based on the results of 12 laboratories which participated in the certification interlaboratory comparison.

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List of abbreviations
(if not explained elsewhere)

CRM	certified reference material
ERM	European reference material
FAAS	flame atomic absorption spectrometry
ICP-OES	inductively coupled plasma optical emission spectrometry
ICP-MS	inductively coupled plasma mass spectrometry
IDMS	isotopic dilution mass spectrometry
SOES	spark optical emission spectrometry
XRF	X-ray fluorescence spectrometry
M	mean value
n	number of accepted data sets
s	standard deviation of an individual data set
s_M	standard deviation of mean of means of data sets
s_{rel}	relative standard deviation
$\bar{s}$	mean of standard deviations of data sets under repeatability conditions
M_i	single result
I	ICP-OES (Tables 14 – 23)
I(R)	ICP-OES, revised value (Tables 14 – 23)
IMS	ICP-MS (Tables 14 – 23)
A	FAAS (Tables 14 – 23)
A(R)	FAAS, revised value (Tables 14 – 23)
P	spectrophotometry (Tables 14 – 23)
EA	electrothermal atomic absorption spectrometry (Tables 14 – 23)
T	titration (Tables 14 – 23)
r_0	measure from spark emission of the center of the disc (see Annex 2)
r_in	measure from spark emission of the inner circle of the disc (see Annex 2)
r_out	measure from spark emission of the outer circle of the disc (see Annex 2)

1. Introduction

In the metal-producing and metal-working industry mainly spark emission spectrometry (SOES) and X-ray fluorescence spectrometry (XRF) are used for reception inspection of raw materials, e.g. scrap, for quality control of end products and production control. These time saving analytical techniques require suitable reference materials for calibration and recalibration. The certified reference material ERM®-EB602 is based on a ZnAl4Cu1 alloy (Zamak Z410).

The idea to produce a reference material of this alloy type, which can serve as a replacement of the exhausted CRM BCR-358, was the outcome of discussions within the German Gesellschaft für Bergbau, Metallurgie, Rohstoff- und Umwelttechnik (GDMB), especially the working group „Lead/Zinc“ of the Committee of Chemists within GDMB. From this working group the needs were defined, since the members are potential users of the prepared CRMs. Secondly from this group the participating laboratories are recruited as well as from CEN TC 209/WG 6 “Zinc and zinc alloys – Methods of analysis and testing”. Since all of the laboratories are highly experienced with zinc alloy analysis and participated in earlier interlaboratory comparisons, there was no preceding round robin test for qualification.

Certification of reference materials is carried out on the basis of the relevant ISO-Guides [1-3], the „Guidelines for the production of BAM Reference Materials“ [4] and the “Technical Guidelines for the Production and Acceptance of a European Reference Material” [5].

2. Companies/laboratories involved

Preparation of the material:

Grillo-Werke AG, Duisburg
SUS Nell, Oberhausen, Germany

Test for homogeneity:

SUS Nell, Oberhausen, Germany
BAM Bundesanstalt für Materialforschung und -prüfung, Division 1.6

Participants in the certification interlaboratory comparison:

Allgemeine Gold- und Silberscheideanstalt, Pforzheim, Germany
AMCO united, Duisburg, Germany
Asturiana de Zinc, S.A., Avilés-Asturias, Spain
BAM Bundesanstalt für Materialforschung und -prüfung, Berlin, Germany
Boliden Odda AS, Odda, Norway
Boliden Kokkola AS, Kokkola, Finland
CHEMAD GmbH, Duisburg, Germany
GfE Fremat GmbH, Freiberg, Germany
Grillo-Werke AG, Goslar, Germany
ThyssenKrupp Steel AG, Duisburg, Germany
Umicore AG & Co KG., Hanau, Germany
Weser-Metall GmbH, Nordenham, Germany

Statistical evaluation of the data

BAM Bundesanstalt für Materialforschung und -prüfung, Division 1.4 and 1.6

3. Candidate material

A commercially available zinc alloy ZnAl4Cu1 was used as basic material for the preparation of the candidate material. 250 kg of this alloy were delivered by Grillo-Werke AG, Duisburg. This material was grinded, melted and casted to ca. 400 discs (9 sub-batches A – I) with a diameter of ca. 40 mm and 39 - 45 mm height by SUS Nell, Oberhausen.

4. Homogeneity testing

Possible reasons for an inhomogeneous distribution of elements in the raw material may be a change of the composition of the melt during the casting procedure because some elements may volatise or segregate during the solidification of the material.
Homogeneity testing of the raw material was performed on the discs listed in Table 1 using spark emission spectrometry and initially X-ray fluorescence spectrometry for a first overview, which is only suitable for elements present in higher concentrations, here Cu and Al. The total number of 45 discs used for homogeneity testing is higher than the recommended number of 8 % of the total number of discs according to ASTM standard E 826-90 [6]. All tests were carried out with a Spectrolab spark emission spectrometer.

Tab. 1: Discs analysed for homogeneity testing of ERM®-EB602

A2	B3	C11	D4	E3	F3	G2	H5	I3
A12	B12	C20	D22	E12	F17	G17	H11	I11
A22	B21	C29	D27	E17	F22	G24	H21	I24
A32	B31	C38	D32	E31	F32	G29	H38	I29
A37	B47	C46	D43	E42	F44	G40	H42	I43

Another disc, G35 was used as drift control sample

All samples were analysed 5 times (2 sparks per run) in a randomly chosen order.
The estimates of inhomogeneity contributions u_{bb} potentially hidden by the measurement uncertainty and to be included into the total uncertainty budget were estimated according to ISO Guide 35 [3] as the maximum of the values obtained from Eq. (1) and (2).

$$s_{bb} = \sqrt{\frac{MS_{among} - MS_{within}}{n}} \qquad (1)$$

$$s_{bb\min} = \sqrt{\frac{MS_{within}}{n}} \times \sqrt[4]{\frac{2}{N(n-1)}} \qquad (2)$$

where

MS_{among} mean of squared deviations between discs (from 1-way ANOVA)
MS_{within} mean of squared deviations within discs (from 1-way ANOVA)
n number of replicate analyses per disc
N number of discs selected for homogeneity study

s_{bb} signifies either the between-disc standard deviation (inhomogeneities within the total batch) or the within-disc standard deviation (inhomogeneities over the area of one disc), whereas $s_{bb'min}$ denotes the maximum heterogeneity that can potentially be hidden by an insufficient repeatability of the applied measurement method (which has to be considered as the minimum uncertainty contribution). In any case the larger of the two values was used as u_{bb}. Eq. (1) does not apply if MS_{within} is larger than MS_{among}.

The results of the statistical evaluation of the inhomogeneity data over the total batch can be seen in Annex 1.

One disc (D22) was tested for homogeneity over the area (possible segregation from the outer part to the centre) and over the height of each cylinder (possible segregation from the top to the bottom). To perform this test the cylinder was cut in the middle. SOES analysis was then carried out on top, on the bottom and on the middle area of the cylinder (outer circle: 11 sparks, inner circle: 7 sparks; centre: 1 spark; copper: XRF, 2x centre, 4x inner circle, 4x outer circle).

The estimates of inhomogeneity contributions were calculated in the same way as for the total batch. To calculate the necessary data an unbalanced ANOVA was carried out taking into account that the number of single measurements is different for the center, the inner and the outer circle. For technical reasons, at r_0 (centre) only one measurement per height position is possible. An ANOVA requires minimum two measurements per factor value. Thus, the value for r_0 should be replaced by a dummy. This dummy is defined as follows:

The two values replacing the one measured have a mean equal to the value measured, and a standard deviation equal to the average within-variation. This resembles the situation were one could take two independent measurements at the same place, with values deviating by the average standard deviation (non-destructive testing method). A first guess for the average standard deviation may be calculated from the data for r_in (inner circle) and r_out (outer circle). As results from these calculations an inhomogeneity factor for the radius and one for the height of the disc is obtained. From these values a combined inhomogeneity factor is calculated. This factor is compared with the within standard deviation calculated from the ANOVA-data. The larger factor is used for uncertainty calculation.

Annex 2 shows the results of the calculations.

5. Characterisation study

5.1 Analytical methods

12 laboratories participated in the certification interlaboratory comparison. For some elements part of the laboratories used more than one analytical method reporting more than one dataset. 9 laboratories received a randomly chosen disc; two outside laboratories received chips prepared in BAM.

The laboratories were asked to analyse six subsamples. They were free to choose any suitable analytical method for analysis. Table 2 shows the analytical methods used by the participating laboratories.

For all analytical methods where a calibration was necessary this calibration was performed using liquid standard solutions. All participating laboratories were asked to use only standard solutions prepared from pure metals or stoichiometric compounds or well checked commercial calibration solutions.

Table 2: Analytical procedures used by the participating laboratories

Lab-No.	Element.	Sample mass	Sample pretreatment	Analytical method
1	Ti, Pb, Sn	0.5 g	Dissolution with 3mL HNO_3 and 2mL HCl	ICP-MS, calibration with commercial solutions (Merck)
	Fe, Ni, Cd	0.5 g	Dissolution with 3mL HNO_3 and 2mL HCl	ETAAS, calibration with commercial solutions (Merck)
	Fe		Dissolution with HCl/H_2O_2, Separation of Fe	IDMS (HR-ICP-MS)
	Mg	2 g	Dissolution with acid mixture HCl/HNO_3 (180+4) (DIN EN12441-2)	FAAS, calibration with commercial solutions (Merck)
	Al	0.5 g	Dissolution with HCl (DIN EN12441-1)	Titration
	Cu	0.15 g	Dissolution with HCl	FAAS, calibration with pure metal
2	Al, Cd, Cu, Fe, Mg, Ni, Pb, Sn, Ti	1 g	Dissolution with HCl/H_2O_2	ICP-OES, calibration with commercial solutions (Merck, NIST-traceable), matrix matching with high-purity zinc
3	Al, Cd, Cu, Fe, Mg, Ni, Pb, Sn, Ti, Si			ICP-OES
4	Cd, Fe, Mg, Ni, Pb, Sn, Ti, Si	1 g	Dissolution with HCl/H_2O_2	ICP-OES with matrix matched standards (Zn 5N)
	Al	0.5 g	Dissolution with HCl/H_2O_2	ICP-OES with matrix matched standards (Zn 5N)
	Cu	3x 0.5 g 3x 1 g	Dissolution with HCl/H_2O_2	ICP-OES with matrix matched standards (Zn 5N)
5	Al, Cu, Fe, Mg, Ni	1 g	Dissolution with HCl/HNO_3	ICP-OES calibration with commercial solutions
	Cd, Pb	5 g	Dissolution with HCl/HNO_3	FAAS calibration with commercial solutions (standard addition)
6	Al, Cd, Cu, Fe, Mg, Ni, Pb, Sn, Ti	1 g	Dissolution with HCl	ICP-OES with matrix matched standards (Zn, Al, Cu)
	Al, Cu, Mg	80 g	Dissolution with HCl	ICP-OES with matrix matched standards (Zn, Al, Cu)
7	Ni	10 g	Dissolution with HNO_3 (EN12441-9)	FAAS, calibration with pure metal
	Pb, Cu, Cd	10 g	Dissolution with HCl/HNO_3 (EN12441-3)	FAAS, calibration with pure metal
	Mg	5 g	Dissolution with acid mixture HCl/HNO_3 (180+4) (EN12441-2)	FAAS, calibration with pure metal
	Fe	10 g	Dissolution with HCl/H_2O_2 (EN12441-4)	Spectrophotometry, calibration with pure metal
	Al	5 g	Dissolution with HCl (DIN EN12441-1)	Titration
8	Al, Cd, Cu, Fe, Mg, Ni, Pb, Sn, Ti, Si	1 g	Dissolution with HNO_3	ICP-OES, calibration with pure metal
9	Al, Cd, Cu, Mg, Ni, Pb, Sn, Ti, Si	5 g	Dissolution with HCl/HNO_3	ICP-OES calibration with commercial solutions

Table 2 (cont.): Analytical procedures used by the participating laboratories

10	Al, Cd, Cu, Fe, Mg, Ni, Pb, Sn, Ti, Si			ICP-OES
11	Al, Sn, Ti	1 g	Dissolution with HCl	ICP-OES calibration with commercial solutions
	Cd, Cu, Fe, Mg, Ni, Pb	1 g	Dissolution with HCl	FAAS calibration with commercial solutions
	Si	250 mg	Dissolution with HCl/HNO_3	Spectrophotometry, calibration with commercial solution
12	Al, Cd, Cu, Fe, Mg, Ni, Pb, Ti	1 g	Dissolution with HNO_3	ICP-OES, calibration with commercial solutions
	Sn	1 g	Dissolution with HCl	ICP-OES, calibration with commercial solutions

5.2 Analytical results and statistical evaluation

The analytical results of the certification interlaboratory comparison are listed in Tables 14 to 23. These tables show the single results (M_i) of each laboratory, the resp. laboratories' mean values (M) together with the intralaboratory standard deviation (s) and in addition the mean standard deviation ($\overline{s}$) of all laboratories. The continuous line marks the certified value (mean of the laboratories' means), the broken lines mark the standard deviation, calculated from the laboratories' means.
In the related figures for each laboratory its mean value and single standard deviation is given.

The statistical evaluation of the data was performed using the software program SoftCRM 1.2.2. [7]. The following results were received:

Table 3: Outcome of statistical tests of results obtained for Al

Number of data sets	13
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	Lab. 11
Dixon (α = 0.01)	Lab. 11
Nalimov (α = 0.05)	Lab. 11
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: not normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

The outlying value (Lab. 11) was not removed.

Table 4: Outcome of statistical tests of results obtained for Cu

Number of data sets	13
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Laboratory 5
Nalimov (α = 0.01)	Laboratory 5
Grubbs (α = 0.05)	Laboratory 5
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

The outlying value (Lab. 5) was removed.

Table 4a: Outcome of statistical tests of results obtained for Cu (after removal of outlier)

Number of data sets	12
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	---
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: not normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

Table 5: Outcome of statistical tests of results obtained for Fe

Number of data sets	12
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	---
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: not normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

For Fe two populations of data exist. For this reason a new determination was performed using the primary method IDMS. The results of this investigation support the lower results which were finally used to calculate the certified value.

Table 6: Outcome of statistical tests of results obtained for Mg

Number of data sets	13
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	---
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

Table 7: Outcome of statistical tests of results obtained for Ni

Number of data sets	11 (12*)
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	Laboratory 11
Dixon (α = 0.01)	Laboratory 11
Nalimov (α = 0.05)	Laboratory 11**
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: not normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: not normal
Skewness & Kurtosis test (α = 0.05)	Distribution: not normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

*One laboratory reported 6 times < 5, these values were not included into the statistical evaluation.

**Laboratories 7 and 11 were detected as Grubbs Pair outliers and removed.

Table 7a: Outcome of statistical tests of results obtained for Ni (after removal of outliers)

Number of data sets	9
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Laboratory 10
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

The outlying value (Lab. 10) was not removed.

Table 8: Outcome of statistical tests of results obtained for Cd

Number of data sets	9 (11*)
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon ($\alpha = 0.05$)	---
Dixon ($\alpha = 0.01$)	---
Nalimov ($\alpha = 0.05$)	Laboratory 3
Nalimov ($\alpha = 0.01$)	Laboratory 3
Grubbs ($\alpha = 0.05$)	Laboratory 3
Grubbs ($\alpha = 0.01$)	---
Grubbs Pair ($\alpha = 0.05$)	---
Grubbs Pair ($\alpha = 0.01$)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test ($\alpha = 0.05$)	Distribution: not normal
Kolmogorov-Smirnov-Lilliefors Test ($\alpha = 0.01$)	Distribution: normal
Skewness & Kurtosis test ($\alpha = 0.05$)	Distribution: not normal
Skewness & Kurtosis test ($\alpha = 0.01$)	Distribution: normal

*One laboratory reported 6 times < 5, another lab reported 6 times < 2, these values were not included into the statistical evaluation.

The outlying value (Lab. 3) was removed.

Table 8a: Outcome of statistical tests of results obtained for Cd (after removal of outlier)

Number of data sets	8
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon ($\alpha = 0.05$)	---
Dixon ($\alpha = 0.01$)	---
Nalimov ($\alpha = 0.05$)	---
Nalimov ($\alpha = 0.01$)	---
Grubbs ($\alpha = 0.05$)	---
Grubbs ($\alpha = 0.01$)	---
Grubbs Pair ($\alpha = 0.05$)	---
Grubbs Pair ($\alpha = 0.01$)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test ($\alpha = 0.05$)	Distribution: normal
Kolmogorov-Smirnov-Lilliefors Test ($\alpha = 0.01$)	Distribution: normal
Skewness & Kurtosis test ($\alpha = 0.05$)	Distribution: normal
Skewness & Kurtosis test ($\alpha = 0.01$)	Distribution: normal

Table 9: Outcome of statistical tests of results obtained for Ti

Number of data sets	8
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	---
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: not normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

Table 10: Outcome of statistical tests of results obtained for Si

Number of data sets	7
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	---
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

Table 11: Outcome of statistical tests of results obtained for Pb

Number of data sets	11
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	Laboratory 4
Dixon (α = 0.01)	Laboratory 4
Nalimov (α = 0.05)	Laboratory 4
Nalimov (α = 0.01)	Laboratory 4
Grubbs (α = 0.05)	Laboratory 4
Grubbs (α = 0.01)	Laboratory 4
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: not normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: not normal
Skewness & Kurtosis test (α = 0.05)	Distribution: not normal
Skewness & Kurtosis test (α = 0.01)	Distribution: not normal

The outlying value (Lab. 4) was removed.

Table 11a: Outcome of statistical tests of results obtained for Pb (after removal of outlier)

Number of data sets	10
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	---
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Distribution: normal
Skewness & Kurtosis test (α = 0.01)	Distribution: normal

Table 12: Outcome of statistical tests of results obtained for Sn

Number of data sets	6 (9*)
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	---
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran	---
Kolmogorov-Smirnov-Lilliefors Test (α = 0.05)	Distribution: normal
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: normal
Skewness & Kurtosis test (α = 0.05)	Insufficient data
Skewness & Kurtosis test (α = 0.01)	Insufficient data

*Three laboratories reported 6 times < 5, these values were not included into the statistical evaluation.

The certified mass fractions of all elements were calculated as mean of the accepted data sets. These values are given in Table 13.
The respective combined uncertainties were calculated from the spread resulting from the certification interlaboratory comparison (s_{ilc}) and the uncertainty contributions from possible inhomogeneity of the material using Equation (3). An uncertainty contribution resulting from the purity of the used calibration substances could be neglected.

$$u_{\text{combined}} = \sqrt{\frac{s_{\text{M}}^2}{n} + u_{bb}^2(1) + u_{bb}^2(2)} \qquad (3)$$

where

$\frac{s_{\text{M}}^2}{n}$: spread resulting from interlaboratory comparison

n : number of data sets used for calculating the certified mass fraction of each element

Table 13: Uncertainty calculation

	M	***n***	s_M	u_{bb} (1)*	u_{bb} (2)**	$u_{combined}$
Al	4.082 %	13	0.054 %	0.0037 %	0.050 %	0.052 %
Cu	0.812 %	12	0.012 %	0.0016 %	0.0071 %	0.0081 %
Mg	415.3 mg/kg	13	18.6 mg/kg	3.76 mg/kg	7.18 mg/kg	9.70 mg/kg
Pb	19.5 mg/kg	10	2.50 mg/kg	0.204 mg/kg	1.21 mg/kg	1.46 mg/kg
Cd	1.06 mg/kg	8	0.08 mg/kg	0.034 mg/kg	0.20 mg/kg	0.21 mg/kg
Fe	7.34 mg/kg	5	0.202 mg/kg	0.096 mg/kg	0.49 mg/kg	0.51 mg/kg
Sn	1.03 mg/kg	6	0.365 mg/kg	0.023 mg/kg	0.15 mg/kg	0.22 mg/kg
Ni	2.51 mg/kg	9	0.49 mg/kg	0.032 mg/kg	0.073 mg/kg	0.19 mg/kg
Si	11.4 mg/kg	7	2.28 mg/kg	0.169 mg/kg	0.22 mg/kg	0.91 mg/kg
Ti	4.81 mg/kg	8	0.175 mg/kg	0.0043 mg/kg	0.175 mg/kg	0.19 mg/kg

* Inhomogeneity contribution from batch
** Inhomogeneity contribution from area (Cu: XRF)

The expanded uncertainties U are calculated by multiplication of u_{combined} with a coverage factor of k = 2 using Equation (4).

$$U = k \cdot u_{\text{combined}} \qquad (4)$$

The calculated mass fractions and their resp. expanded uncertainties are given on Page 3 of this report.

Lab./Meth.	9/I	1/T	6/I-1	7/T	3/I	10/I	4/I	6/I-2	2/I	12/I	8/I	5/I(R)	11/I(R)		$N_{acc.}$
M_i [%]	4.052	4.010	4.110	4.057	4.057	4.062	4.092	4.082	4.092	4.010	4.089	4.150	4.213		
	4.073	4.050	4.099	4.057	4.056	4.068	4.204	4.084	4.071	4.160	4.111	4.130	4.219		13
	3.922	4.030	4.104	4.057	4.076	4.072	4.087	4.087	4.074	4.170	4.091	4.180	4.222		
	3.950	4.010	3.972	4.071	4.043	4.069	4.013	4.085	4.084	4.090	4.097	4.190	4.199		
	3.915	4.050	4.095	4.057	4.076	4.074	4.049	4.086	4.104	4.050	4.091	4.190	4.203		
	4.008	4.030	3.963	4.071	4.082	4.072	3.987	4.082	4.095	4.070	4.085		4.157		
M [%]	**3.987**	**4.030**	**4.057**	**4.061**	**4.065**	**4.070**	**4.072**	**4.084**	**4.087**	**4.092**	**4.094**	**4.168**	**4.202**		**4.082**
s[%]	0.068	0.018	0.070	0.007	0.015	0.004	0.077	0.002	0.013	0.063	0.009	0.027	0.024		0.054
$\bar{s}$ [%]															0.0406
s_{rel}	0.017	0.004	0.017	0.002	0.004	0.001	0.019	0.001	0.003	0.015	0.002	0.006	0.006		0.013

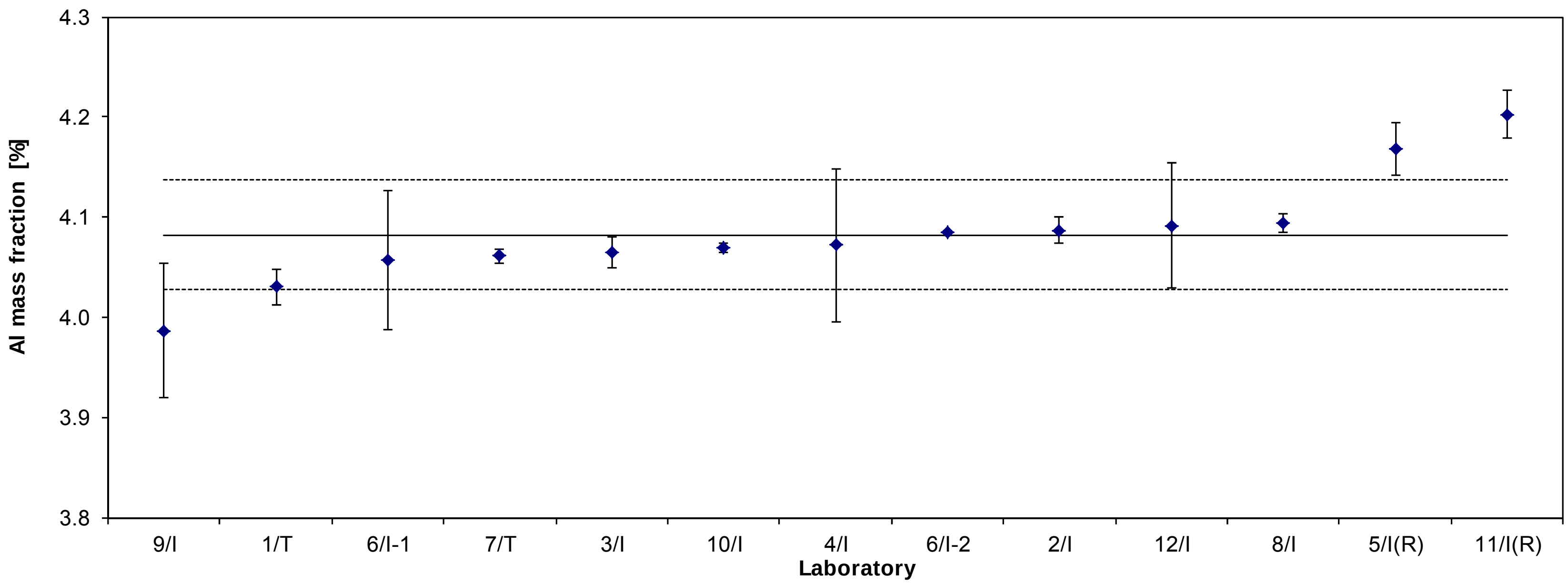

Table 14: Results for Al

Lab./Meth.	5/I(R)	9/I	11/A	7/A	1/A	4/I	2/I	3/I	8/I	10/I	12/I	6/I	6/I-1		$N_{acc.}$
M_i [%]	0.769	0.795	0.796	0.802	0.809	0.823	0.811	0.807	0.810	0.812	0.833	0.830	0.837		
	0.765	0.807	0.805	0.798	0.781	0.813	0.808	0.810	0.810	0.816	0.835	0.830	0.832		12
	0.774	0.791	0.802	0.806	0.814	0.808	0.810	0.816	0.809	0.805	0.842	0.832	0.831		
	0.771	0.791	0.797	0.806	0.806	0.805	0.815	0.806	0.809	0.812	0.826	0.831	0.831		
	0.766	0.804	0.797	0.803	0.812	0.795	0.802	0.806	0.811	0.817	0.816	0.830	0.829		
		0.796	0.800	0.806	0.806	0.793	0.804	0.807	0.807	0.811	0.820	0.830	0.833		
M [%]	**0.769**	**0.797**	**0.799**	**0.804**	**0.805**	**0.806**	**0.808**	**0.809**	**0.809**	**0.812**	**0.829**	**0.831**	**0.832**		**0.812**
s[%]	0.004	0.007	0.004	0.003	0.012	0.011	0.005	0.004	0.001	0.004	0.010	0.001	0.003		0.012
$\bar{s}$ [%]															0.0065
s_{rel}	0.005	0.008	0.004	0.004	0.015	0.014	0.006	0.005	0.002	0.005	0.012	0.001	0.003		0.015

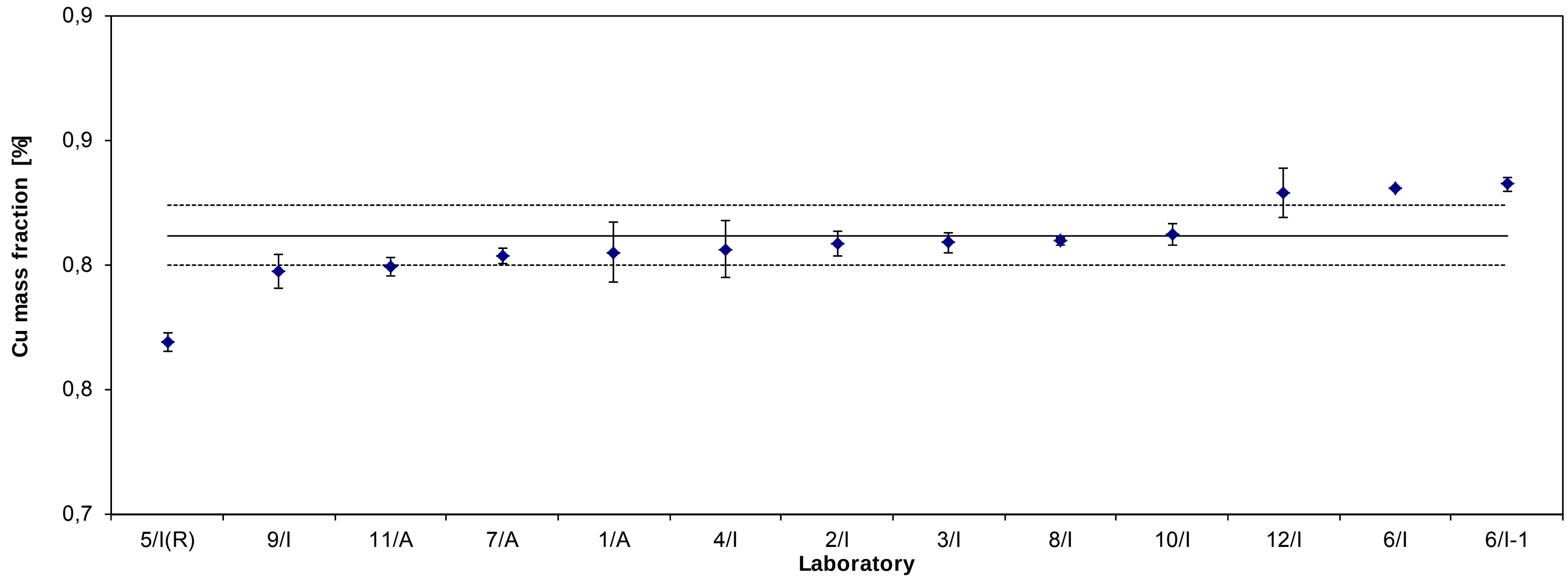

Table 15: Results for Cu

Lab./Meth.	9/I	10/I	4/I	12/I	3/I	6/I-1	11/A	6/I-2	1/A(R)	8/I	7/A	2/I	5/I		$N_{acc.}$
M_i [µg/g]	390.0	388.0	405.0	410.7	414.0	422.0	411.0	416.0	422.0	427.9	429.3	447.0	440.0		
	390.0	390.0	383.0	400.7	410.0	420.0	416.0	416.0	415.0	428.1	429.4	439.0	450.0		13
	390.0	394.0	395.0	409.6	405.0	421.0	409.0	416.0	416.0	427.8	429.4	443.0	450.0		
	380.0	392.0	396.0	405.6	411.0	397.0	411.0	416.0	419.0	427.0	429.3	443.0	440.0		
	400.0	389.0	393.0	402.9	410.0	410.0	416.0	416.0	417.0	427.8	429.3	451.0	450.0		
	390.0	393.0	393.0	402.4	413.0	396.0	413.0	416.0	416.0	427.1	429.4	446.0	460.0		
M [µg/g]	**390.00**	**391.00**	**394.17**	**405.32**	**410.50**	**411.00**	**412.67**	**416.00**	**417.50**	**427.62**	**429.35**	**444.83**	**448.33**		**415.25**
s[µg/g]	6.325	2.366	7.055	4.076	3.146	12.033	2.875	0.000	2.588	0.454	0.055	4.119	7.528		18.581
$\bar{s}$ [µg/g]															5.0619
s_{rel}	0.016	0.006	0.018	0.010	0.008	0.029	0.007	0.000	0.006	0.001	0.000	0.009	0.017		0.045

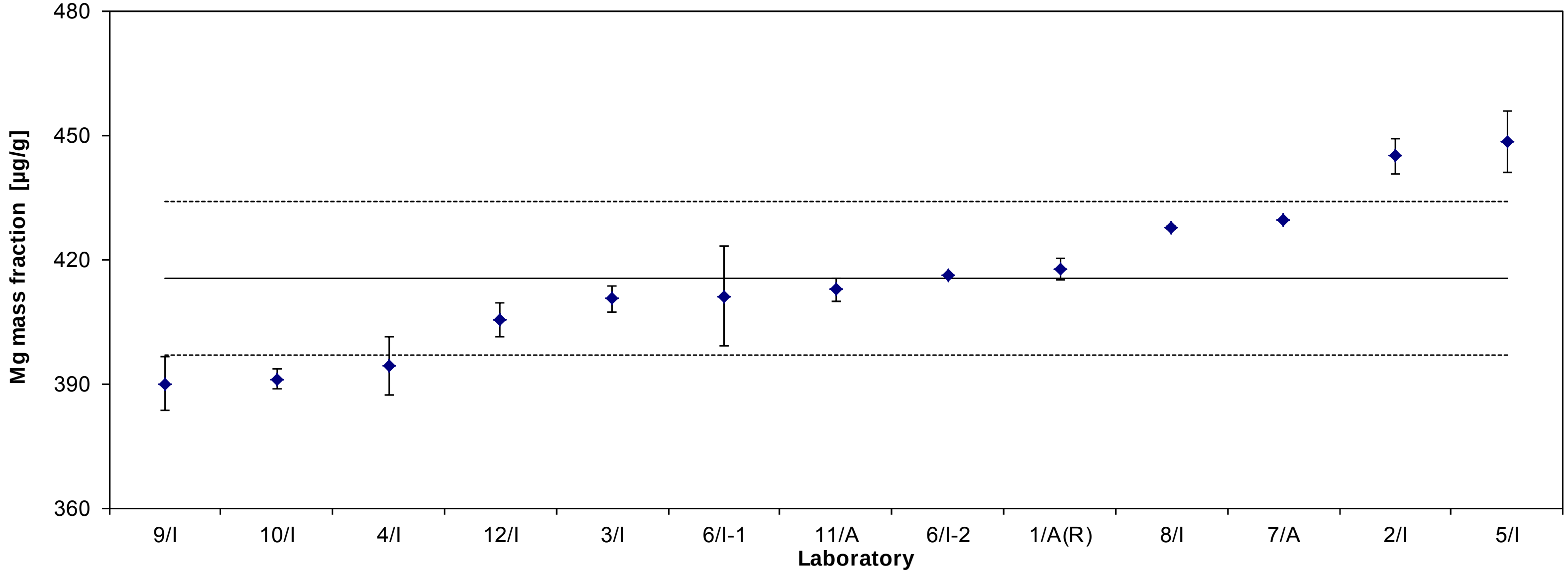

Table 16: Results for Mg

Lab./Meth.	7/A	8/I	3/I	10/I	6/I	2/I	9/I	1/IMS	11/A	5/A	4/I		$N_{acc.}$
M_i [µg/g]	16.0	17.2	17.4	18.4	18.8	20.0	21.0	20.0	21.8	23.0	33.0		
	15.0	16.8	17.4	18.8	18.3	17.0	20.0	20.1	21.8	24.0	32.0		10
	15.0	16.7	17.5	18.6	19.1	17.0	21.0	21.2	23.5	24.0	36.0		
	16.0	16.9	17.0	19.2	20.4	22.0	22.0	21.4	24.8	23.0	36.0		
	16.0	17.0	17.3	19.0	18.5	23.0	20.0	21.0	22.4	23.0	35.0		
	16.0	17.1	16.7	19	19.0	16.0	21.0	21.7	22.2	23.0	35.0		
M [µg/g]	**15.67**	**16.96**	**17.22**	**18.80**	**19.02**	**19.17**	**20.83**	**20.88**	**22.75**	**23.33**	**34.50**		**19.46**
s[µg/g]	0.516	0.192	0.306	0.283	0.741	2.927	0.753	0.699	1.183	0.516	1.643		2.497
$\bar{s}$ [µg/g]													1.1097
s_{rel}	0.033	0.011	0.018	0.015	0.039	0.153	0.036	0.033	0.052	0.022	0.048		0.128

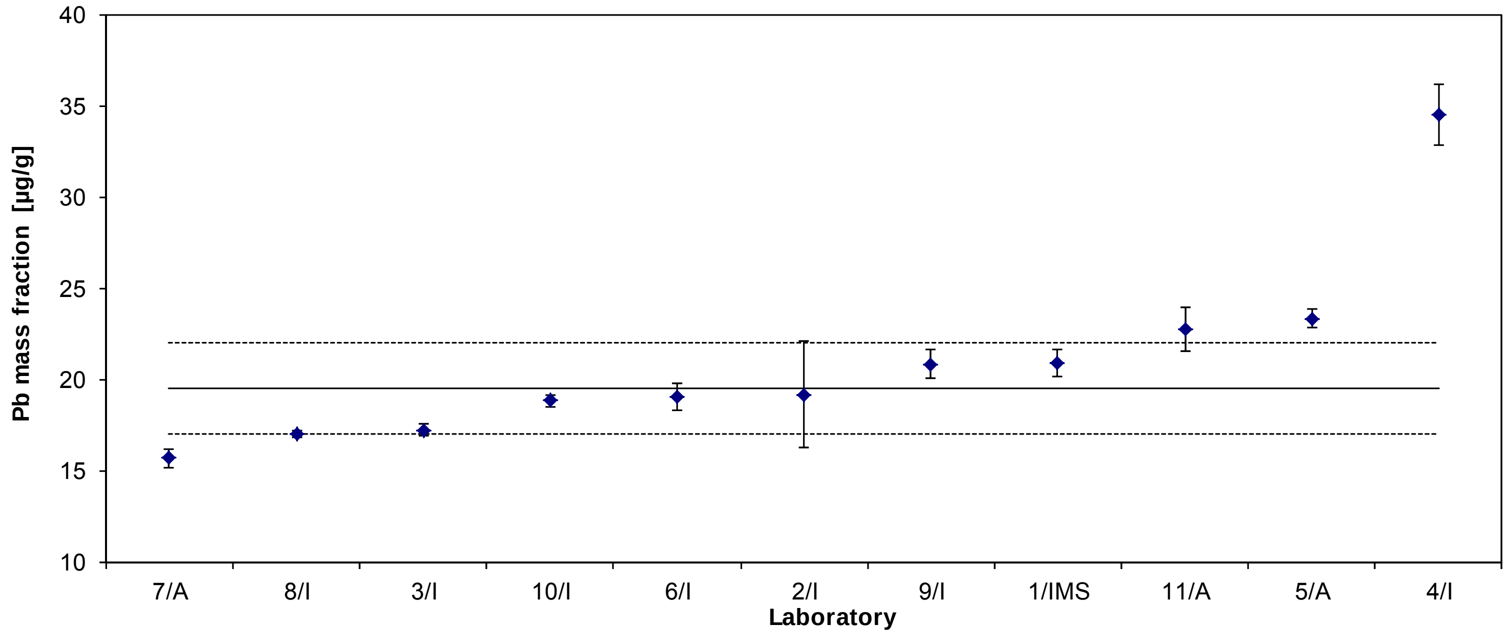

Table 17: Results for Pb

Lab./Meth.	3/I	8/I	5/A	6/I	7/A	1/EA	10/I	11/A	9/I	2/I	4/I		$N_{acc.}$
M_i [µg/g]	0.69	0.93	1	1.0	1.1	1.05	1.0	1.2	1.2	< 2	< 5		
	0.70	0.93	1	1.0	0.9	1.08	1.1	1.4	1.1	< 2	< 5		8
	0.71	0.93	1	1.0	0.9	1.05	1.3	1.2	1.2	< 2	< 5		
	0.68	0.92	1	1.0	1.0	1.07	1.0	0.9	1.1	< 2	< 5		
	0.68	0.93	1	1.1	1.2	1.06	1.1	0.9	1.2	< 2	< 5		
	0.70	0.93	1	1.1	1.1	1.06	1.0	1.2	1.2	< 2	< 5		
M [µg/g]	**0.69**	**0.93**	**1.00**	**1.03**	**1.03**	**1.06**	**1.08**	**1.13**	**1.17**	**< 2**	**< 5**		**1.06**
s[µg/g]	0.012	0.004	0.000	0.052	0.121	0.012	0.117	0.197	0.052				0.075
$\bar{s}$ [µg/g]													0.0952
s_{rel}	0.017	0.004	0.000	0.050	0.117	0.011	0.108	0.174	0.044				0.071

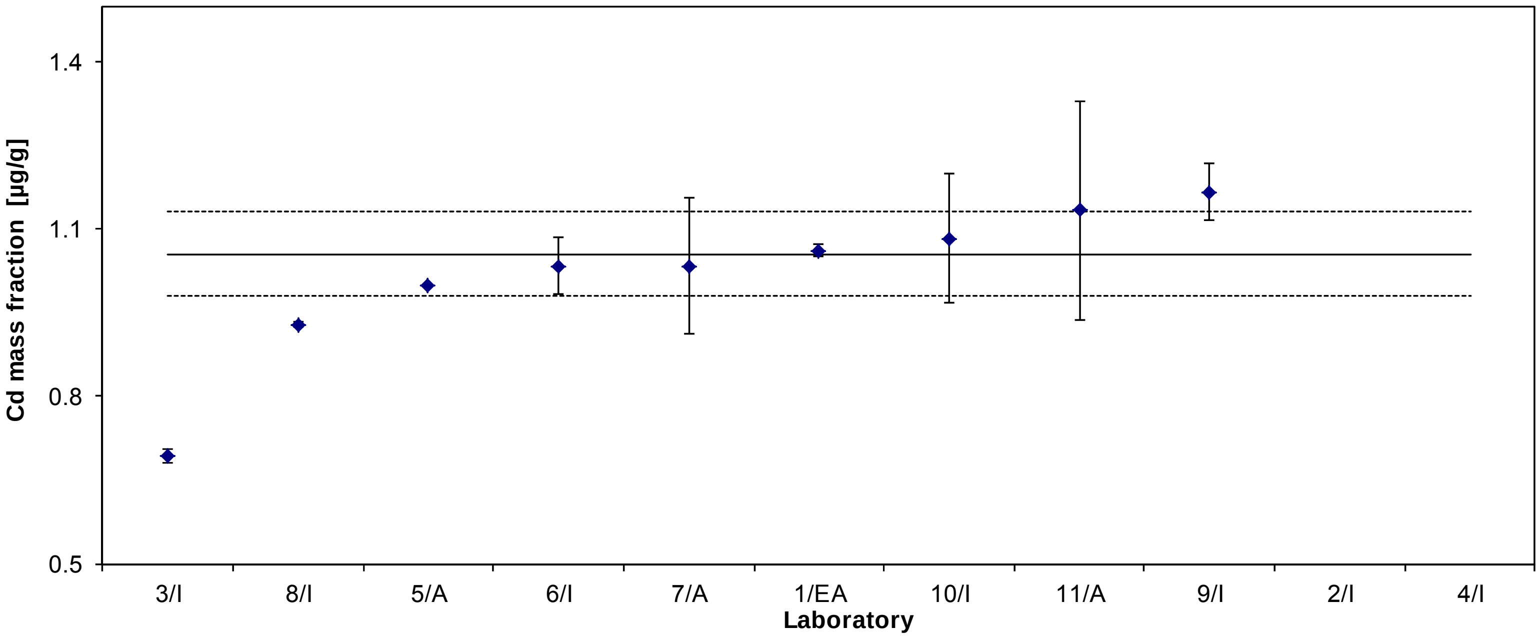

Table 18: Results for Cd

Lab./Meth.	1/IDMS	3/I	6/I	10/I	12/I	1/EA	11/A	2/I	4/I	7/P	5/I	8/I		$N_{acc.}$
M_i [µg/g]	7.18	7.40	7.30	7.30	7.70	9.00	9.70	10.00	13.00	10.30	8.00	10.40		
	7.20	7.60	7.30	7.80	7.30	9.40	9.70	11.00	10.00	10.30	10.00	11.00		5
	7.18	7.00	7.30	7.60	7.60	9.30	10.60	9.00	9.00	10.10	12.00	11.10		
	6.97	7.10	7.20	7.90	7.80	10.00	9.40	9.00	10.00	10.50	9.00	10.40		
		7.10	7.30	7.10	7.60	9.40	10.10	11.00	9.00	10.30	8.00	9.80		
		6.90	7.30	7.30	7.60	9.20	9.90	10.00	9.00	10.30	15.00	10.90		
M [µg/g]	**7.13**	**7.18**	**7.28**	**7.50**	**7.60**	**9.38**	**9.90**	**10.00**	**10.00**	**10.30**	**10.33**	**10.60**		**7.34**
s[µg/g]	0.109	0.264	0.041	0.316	0.167	0.337	0.415	0.894	1.549	0.126	2.733	0.494		0.202
$\bar{s}$ [µg/g]														0.2232
s_{rel}	0.015	0.037	0.006	0.042	0.022	0.036	0.042	0.089	0.155	0.012	0.264	0.047		0.028

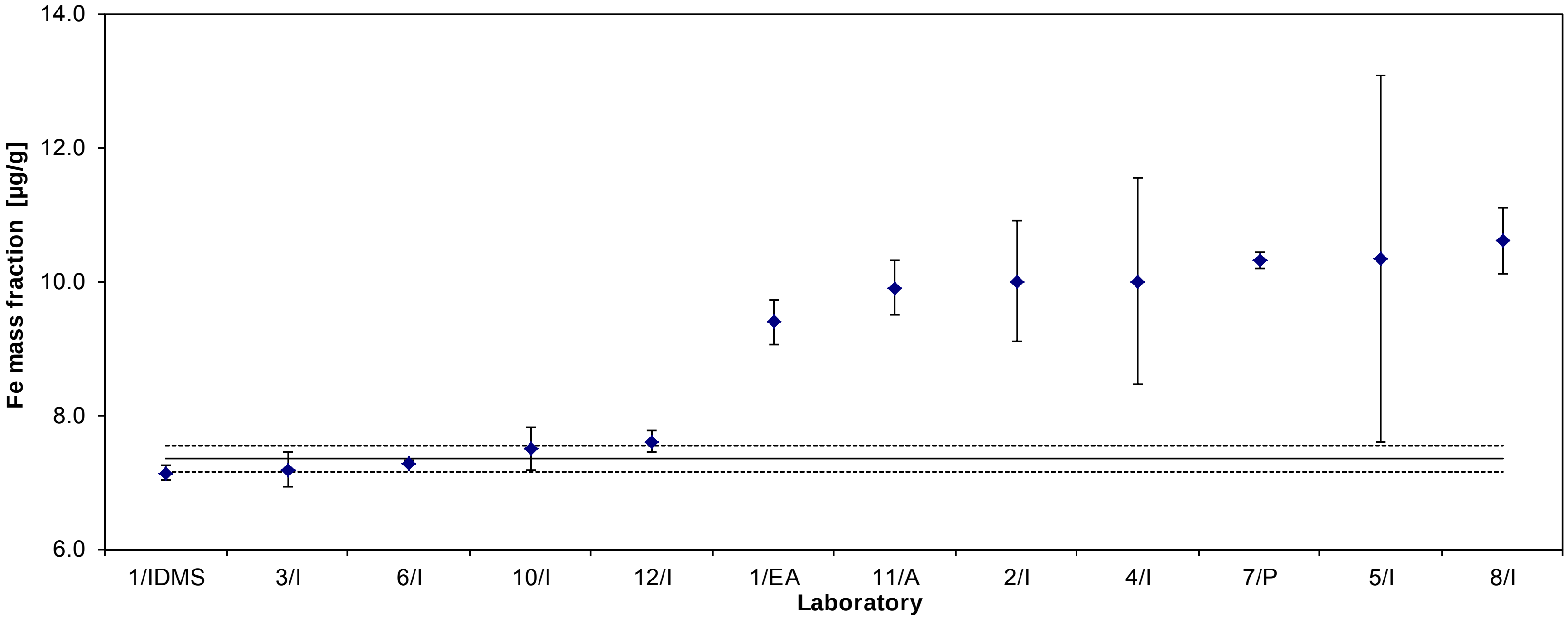

Table 19: Results for Fe

Lab./Meth.	8/I	3/I	6/I	10/I(R)	1/IMS	2/I	4/I	9/I	11/I	12/I		$N_{acc.}$
M_i [µg/g]	0.40	0.70	1.40	1.00	1.50	1.70	< 5	< 5	< 5	15.50		
	0.40	0.70	1.10	1.00	1.50	1.00	< 5	< 5	< 5	9.50		6
	0.50	0.80	0.80	1.00	1.40	1.00	< 5	< 5	< 5	15.70		
	0.50	0.80	1.00	1.00	1.30	2.00	< 5	< 5	< 5	12.60		
	0.60	0.70	1.00	1.00	1.20	2.00	< 5	< 5	< 5	15.90		
	0.70	0.70	1.00	1.00	1.50	1.00	< 5	< 5	< 5	11.50		
M [µg/g]	**0.52**	**0.73**	**1.05**	**1.00**	**1.40**	**1.45**	**< 5**	**< 5**	**< 5**	**13.45**		**1.03**
s[µg/g]	0.117	0.052	0.197	0.000	0.126	0.505				2.661		0.365
$\bar{s}$ [µg/g]												0.2332
s_{rel}	0.226	0.070	0.188	0.000	0.090	0.348				0.198		0.356

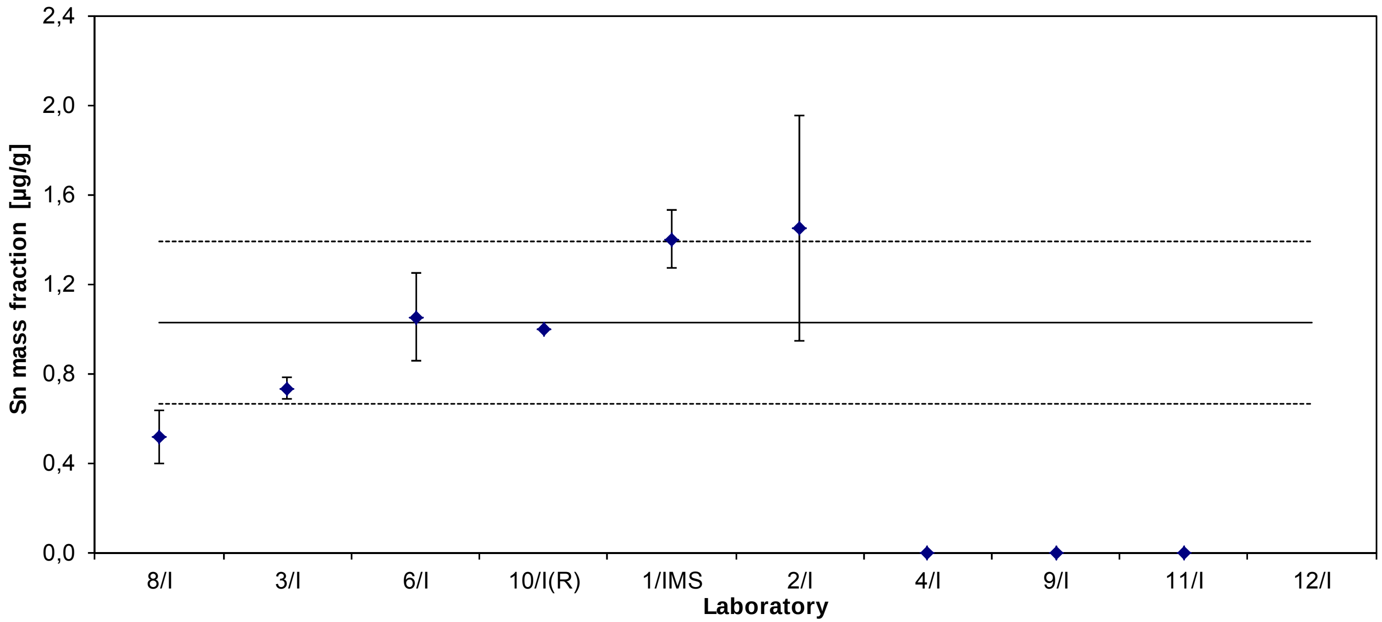

Table 20: Results for Sn

Lab./Meth.	10/I(R)	5/I	12/I	2/I	8/I	1/EA	9/I	6/I	3/I	7/A	11/A	4/I		$N_{acc.}$
M_i [µg/g]	1.60	2.00	2.40	2.60	2.60	2.50	2.70	3.60	3.20	4.60	5.10	< 5		
	1.60	2.00	2.30	2.50	2.60	2.60	2.80	3.00	3.10	4.60	5.60	< 5		9
	1.50	2.00	2.40	2.50	2.60	2.70	3.00	2.80	3.00	4.50	4.60	< 5		
	1.50	2.00	2.40	2.50	2.50	2.70	3.10	2.80	2.80	4.60	4.90	< 5		
	1.60	2.00	2.40	2.50	2.60	2.50	3.10	2.80	3.10	4.70	5.70	< 5		
	1.60	2.00	2.40	2.50	2.60	2.50	3.00	2.80	3.10	4.60	5.40	< 5		
M [µg/g]	**1.57**	**2.00**	**2.38**	**2.52**	**2.58**	**2.58**	**2.95**	**2.97**	**3.05**	**4.60**	**5.22**	**< 5**		**2.51**
s[µg/g]	0.052	0.000	0.041	0.041	0.041	0.098	0.164	0.320	0.138	0.063	0.426			0.484
$\bar{s}$ [µg/g]														0.1358
s_{rel}	0.033	0.000	0.017	0.016	0.016	0.038	0.056	0.108	0.045	0.014	0.082			0.193

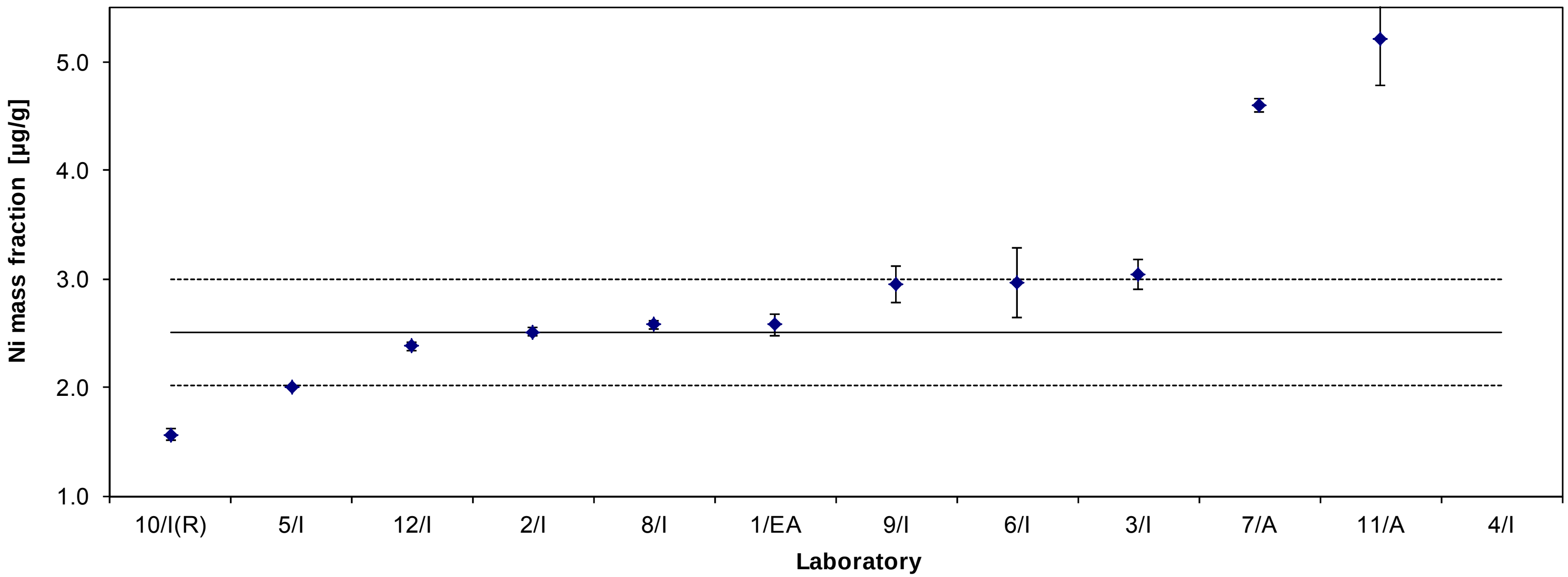

Table 21: Results for Ni

Lab./Meth.	4/I	3/I	10/I	9/I	11/I	8/I	11/P		$N_{acc.}$
M_i [µg/g]	7.0	9.6	10.3	12.0	11.5	11.5	20.0		
	9.0	10.1	10.6	10.0	10.7	14.1	20.0		7
	7.0	11.1	10.3	13.0	11.4	13.7	10.0		
	11.0	10.2	10.0	11.0	11.2	16.4	20.0		
	8.0	10.1	11.0	10.0	11.1	13.5	10.0		
	7.0	9.6	11.0	9.0	11.2	12.6	10.0		
M [µg/g]	**8.17**	**10.12**	**10.53**	**10.83**	**11.18**	**13.63**	**15.00**		**11.35**
s[µg/g]	1.602	0.549	0.408	1.472	0.279	1.644	5.477		2.279
$\bar{s}$ [µg/g]									2.3294
s_{rel}	0.196	0.054	0.039	0.136	0.025	0.121	0.365		0.201

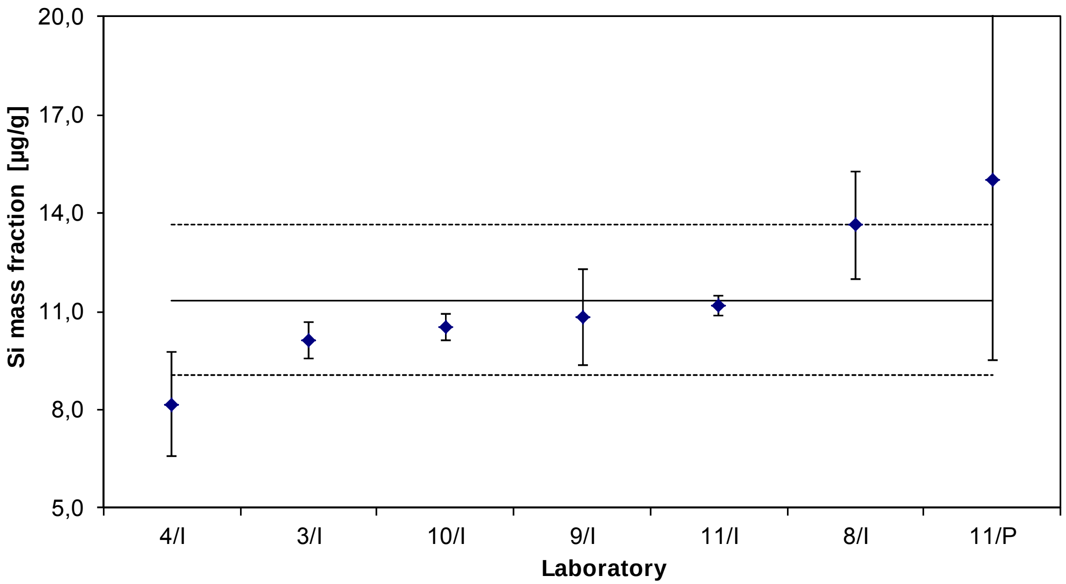

Table 22: Results for Si

Lab./Meth.	12/I	8/I	3/I	1/IMS	9/I	2/I	11/I	6/I		$N_{acc.}$
M_i [µg/g]	4.7	4.6	4.6	4.8	4.8	5.0	6.0	5.0		
	4.5	4.7	4.7	4.8	4.8	5.0	4.0	5.0		8
	4.7	4.7	4.8	4.8	4.9	4.5	5.0	5.0		
	4.4	4.6	4.7	4.8	4.8	5.0	6.0	5.1		
	4.3	4.7	4.8	4.8	4.9	5.0	4.0	5.0		
	4.5	4.6	4.8	4.8	5.0	5.0	5.0	5.0		
M [µg/g]	**4.52**	**4.65**	**4.73**	**4.78**	**4.87**	**4.92**	**5.00**	**5.02**		**4.81**
s[µg/g]	0.160	0.055	0.082	0.030	0.082	0.204	0.894	0.041		0.174
$\bar{s}$ [µg/g]										0.3328
s_{rel}	0.035	0.012	0.017	0.006	0.017	0.042	0.179	0.008		0.036

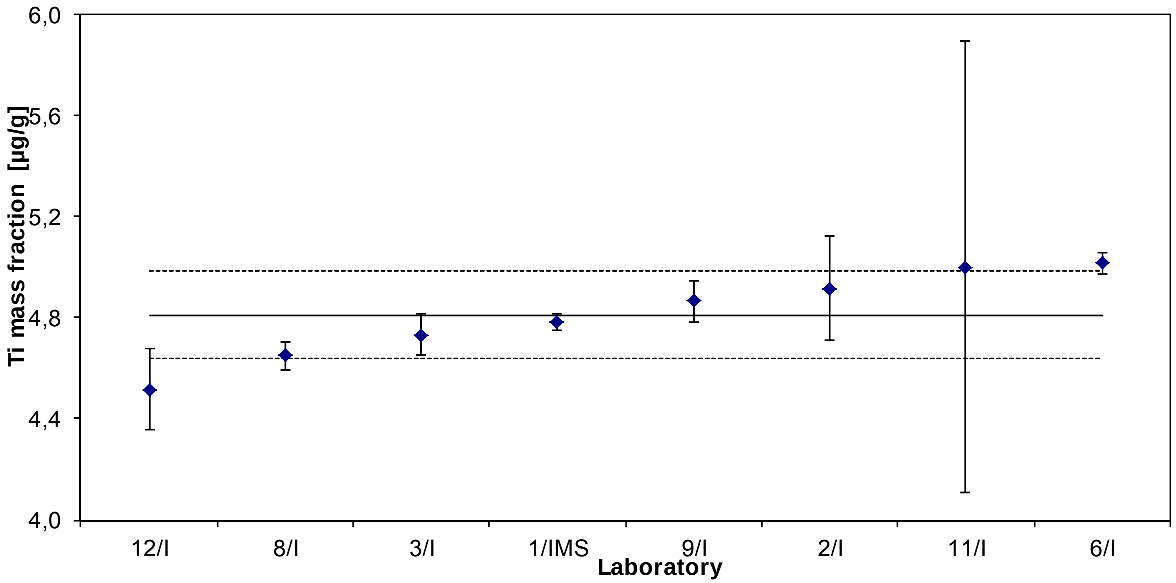

Table 23: Results for Ti

6. Instructions for users and stability

The certified reference material ERM®-EB602 is intended for the calibration and quality control of spark emission and X-ray fluorescence spectrometer used for the analysis of similar materials.
Before analysis the surface of the material should be cleaned by turning or milling.

If chips prepared from the compact material are used for wet chemical analysis, a minimum sample intake of 0.5 g has to be used.
The material will remain stable provided that it is not subjected to excessive heat (eg, during preparation of the working surface).

7. Literature

[1] ISO Guide 31, Contents of certificates of reference materials, 1981

[2] ISO Guide 34, General requirements for the competence of reference material producers, 2009

[3] ISO Guide 35, Reference materials - General and statistical principles for certification. Third edition, 2006

[4] Guidelines for the production of BAM Reference Materials, 2006

[5] Technical Guidelines for the Production and Acceptance of a European Reference Material (www.erm-crm.org)

[6] ASTM Designation E 826-90, Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

[7] Bonas G, Zervou M, Papaeoannou T, Lees M: Accred Qual Assur (2003) 8:101-107

[8] ISO/IEC Guide 98-1:2009, Uncertainty of measurement -- Part 1: Introduction to the expression of uncertainty in measurement

8. Information on and purchase of the CRM

Certified reference material ERM®-EB602 is supplied by

BAM Bundesanstalt für Materialforschung und -prüfung
Fachbereich 1.6: Anorganische Referenzmaterialien
Richard-Willstätter-Straße 11, 12489 Berlin
Phone +49 (0)30 - 8104 2061 or 1119
Fax: +49 (0)30 - 8104 1117
E-Mail: sales.crm@bam.de

Each disc of ERM®-EB602 will be distributed together with a detailed certificate containing the certified values and their uncertainties, the mean values and standard deviations of all accepted data sets and information on the analytical methods used and the names of the participating laboratories.
Information on certified reference materials can be obtained from BAM,

http://www.bam.de/en/fachthemen/referenzmaterialien/index.htm
www.webshop.bam.de

Annex 1: Calc. of uncertainty contribution of potential inhomogeneity (batch)

Aluminium:

3.748278	3.752306	3.733668	3.753483	3.725993
3.747361	3.733725	3.72053	3.761571	3.718842
3.75764	3.751093	3.714986	3.745288	3.718404
3.751478	3.756843	3.714754	3.717489	3.728183
3.764222	3.774595	3.73083	3.747325	3.717077
3.779468	3.7407	3.722113	3.726061	3.70641
3.770608	3.736097	3.695142	3.738239	3.729932
3.752347	3.754993	3.703415	3.723776	3.704807
3.781517	3.746636	3.76429	3.759998	3.731606
3.77945	3.74699	3.730382	3.694727	3.712714
3.793712	3.760951	3.697605	3.724011	3.726155
3.75651	3.758996	3.753525	3.690734	3.675488
3.753987	3.75543	3.734991	3.723523	3.721704
3.732624	3.76167	3.711802	3.720174	3.71831
3.776197	3.737263	3.702984	3.709286	3.698856
3.751459	3.716978	3.728842	3.745866	3.696135
3.769324	3.766716	3.720912	3.738819	3.701378
3.784507	3.758695	3.747146	3.7365	3.714571
3.758302	3.740784	3.71727	3.731168	3.718862
3.758549	3.754172	3.741108	3.760382	3.704463
3.738234	3.749052	3.720972	3.736069	3.733884
3.781331	3.768982	3.72919	3.718813	3.729321
3.745072	3.773019	3.754046	3.698627	3.702192
3.768356	3.741898	3.716906	3.729138	3.682856
3.766489	3.75648	3.707686	3.717757	3.723462
3.745136	3.789469	3.754285	3.745297	3.733963
3.782189	3.721884	3.717555	3.692691	3.698917
3.753039	3.732237	3.714534	3.737718	3.711455
3.776376	3.741365	3.709474	3.716089	3.714482
3.761751	3.759875	3.72794	3.698405	3.733528
3.77275	3.741292	3.734929	3.728022	3.731633
3.78753	3.719997	3.69358	3.723605	3.705818
3.743945	3.748701	3.68994	3.732534	3.705374
3.75477	3.756832	3.718634	3.713577	3.732089
3.746839	3.739275	3.741506	3.724184	3.706707
3.774881	3.770113	3.762131	3.710697	3.722765
3.721447	3.784904	3.755695	3.737923	3.720331
3.717419	3.750647	3.725789	3.704442	3.719593
3.774698	3.769759	3.734705	3.758705	3.716044
3.752876	3.746281	3.723493	3.722798	3.717821
3.776476	3.739268	3.717256	3.733504	3.721671
3.762479	3.738032	3.724371	3.725999	3.697754
3.75247	3.752839	3.717275	3.764074	3.683648
3.767561	3.733357	3.751437	3.718954	3.747835
3.722679	3.755186	3.727414	3.709086	3.759518
			Mean	3.7361219

	abs.	rel.
s^2_{bb}	-6.021E-05	
u_{bb}	0.0037	0.10 %

Copper

0.830833	0.831083	0.807908	0.811528	0.801308
0.826336	0.832042	0.824388	0.806801	0.813625
0.829318	0.834074	0.810911	0.812858	0.820696
0.821221	0.82924	0.814147	0.816566	0.797569
0.825195	0.844907	0.816003	0.811595	0.814439
0.824121	0.83285	0.817711	0.816905	0.818957
0.825787	0.824491	0.816353	0.808846	0.80487
0.834181	0.822786	0.815849	0.813868	0.810291
0.82045	0.840549	0.812613	0.817668	0.815255
0.821885	0.824455	0.81106	0.822915	0.807075
0.840083	0.821165	0.81083	0.810198	0.807624
0.813403	0.829672	0.809145	0.823947	0.815533
0.834988	0.823282	0.814839	0.817806	0.803542
0.829632	0.828894	0.810228	0.812815	0.796667
0.817074	0.839985	0.820825	0.809489	0.811733
0.823302	0.824991	0.813684	0.80529	0.81216
0.832558	0.829053	0.811291	0.807122	0.81177
0.829112	0.843756	0.810567	0.816798	0.813669
0.819593	0.833405	0.812564	0.812148	0.805601
0.824489	0.823536	0.817314	0.808282	0.818197
0.820972	0.828732	0.81508	0.809896	0.801071
0.828156	0.822774	0.819831	0.80512	0.812937
0.8145	0.821	0.814858	0.8202	0.811898
0.817814	0.831485	0.816723	0.820971	0.821918
0.826747	0.834901	0.821304	0.824861	0.802806
0.812772	0.827781	0.817168	0.812231	0.806734
0.826855	0.827086	0.822592	0.823983	0.806199
0.819147	0.823585	0.816266	0.817563	0.81939
0.831134	0.834864	0.814447	0.817419	0.8204
0.821568	0.819997	0.814236	0.822774	0.809893
0.832281	0.831277	0.816474	0.814855	0.811507
0.819287	0.840266	0.815512	0.820168	0.815554
0.817876	0.82955	0.818625	0.814079	0.807424
0.833947	0.825703	0.819098	0.818482	0.806446
0.828854	0.845531	0.820672	0.816991	0.806633
0.823267	0.835521	0.807806	0.824844	0.815241
0.813787	0.826152	0.833621	0.820689	0.820552
0.811671	0.83745	0.822456	0.826381	0.820098
0.811096	0.821504	0.813083	0.810139	0.806875
0.830579	0.812021	0.809022	0.814357	0.808688
0.827183	0.835688	0.824382	0.809472	0.803942
0.823929	0.824006	0.816198	0.814723	0.798617
0.83448	0.832411	0.821856	0.81487	0.807033
0.822446	0.846437	0.811902	0.814047	0.808266
0.818883	0.851885	0.821911	0.80323	0.828283
			Mean	0.81934553

	abs.	rel.
s^2_{bb}	-1.308E-05	
u_{bb}	0.0016	0.19 %

Cadmium

0.000154	0.000163	0.000186	0.000143	0.000153
0.00016	0.000174	0.000148	0.000171	0.00017
0.000194	0.000145	0.000143	0.000165	0.000177
0.000173	0.000168	0.000188	0.000167	0.000146
0.000147	0.000188	0.00018	0.000148	0.000177
0.000176	0.000149	0.000166	0.000183	0.000171
0.000167	0.000178	0.00017	0.000139	0.000144
0.000139	0.000167	0.000163	0.000173	0.000147
0.000147	0.00016	0.000142	0.000135	0.000171
0.000176	0.000174	0.00014	0.000163	0.00017
0.000182	0.000142	0.00018	0.000179	0.00015
0.000152	0.00018	0.000156	0.000156	0.000154
0.000151	0.000149	0.000166	0.000174	0.000109
0.000147	0.00013	0.00017	0.000184	0.000134
0.000159	0.000184	0.000174	0.000172	0.000175
0.000183	0.000153	0.000178	0.000166	0.000169
0.000155	0.000132	0.000153	0.000133	0.00013
0.000162	0.000134	0.000142	0.00013	0.000167
0.000174	0.00018	0.000171	0.000133	0.000175
0.000137	0.00014	0.000142	0.000153	0.00015
0.000142	0.000162	0.000161	0.00019	0.000173
0.000163	0.000149	0.00017	0.000151	0.000129
0.00017	0.000161	0.000159	0.000141	0.000132
0.000169	0.000145	0.000158	0.000161	0.000142
0.000161	0.000171	0.000178	0.000167	0.000122
0.000164	0.00014	0.000176	0.000164	0.000149
0.000126	0.000132	0.000174	0.000147	0.000148
0.000147	0.000147	0.000178	0.000147	0.000145
0.000151	0.000162	0.000159	0.000161	0.000156
0.000171	0.000149	0.000166	0.000146	0.000162
0.000146	0.000153	0.000172	0.000174	0.000158
0.000172	0.000178	0.000159	0.00017	0.000177
0.000124	0.000169	0.000176	0.000145	0.000159
0.000176	0.000171	0.000137	0.000151	0.000178
0.00018	0.000174	0.000163	0.000183	0.000144
0.000164	0.00013	0.000156	0.000159	0.000139
0.000176	0.000177	0.00014	0.000174	0.000167
0.000146	0.00014	0.000158	0.000168	0.000156
0.000171	0.00017	0.000167	0.000163	0.000149
0.00016	0.00014	0.000161	0.000154	0.000167
0.000156	0.000189	0.000191	0.000164	0.000178
0.000171	0.000173	0.00018	0.000156	0.000146
0.000184	0.000152	0.000167	0.00017	0.000151
0.00015	0.000159	0.000133	0.000157	0.000172
0.000131	0.000202	0.000132	0.000165	0.000118
			Mean	0.00015943

	abs.	rel.
s^2_{bb}	1.680E-11	
s_{bb}	4.10E-06	3.47 %
u_{bb}	2.319E-06	

Iron

0.000957	0.000884	0.001019	0.001091	0.00099
0.000954	0.000868	0.000966	0.000971	0.001108
0.000945	0.000902	0.000938	0.000979	0.000977
0.000928	0.000854	0.000959	0.000982	0.001107
0.000952	0.000885	0.000969	0.000981	0.000994
0.000978	0.000876	0.000977	0.00098	0.00099
0.000946	0.00087	0.000974	0.000959	0.00099
0.000949	0.000885	0.000967	0.000979	0.001007
0.000963	0.000898	0.001034	0.000994	0.000982
0.000966	0.00088	0.00096	0.000988	0.001045
0.001001	0.000869	0.000958	0.000967	0.000955
0.000956	0.000858	0.001002	0.000978	0.000927
0.000987	0.000833	0.000963	0.00102	0.00106
0.000913	0.000853	0.000961	0.000963	0.001022
0.000926	0.000847	0.000972	0.000965	0.000942
0.000945	0.000854	0.001026	0.000984	0.000934
0.000992	0.000828	0.000981	0.001041	0.000958
0.000989	0.000848	0.00093	0.001152	0.000934
0.00096	0.000874	0.001057	0.00097	0.00099
0.000942	0.000885	0.001018	0.000926	0.001
0.000963	0.000854	0.000963	0.00098	0.000964
0.00093	0.000853	0.000947	0.000944	0.00102
0.000964	0.000867	0.000971	0.001225	0.000964
0.000931	0.000851	0.000962	0.000976	0.000989
0.000959	0.000894	0.001009	0.000994	0.001133
0.00094	0.000834	0.000983	0.001072	0.000953
0.000927	0.000847	0.000937	0.00095	0.000999
0.000958	0.000835	0.001	0.000988	0.001131
0.000972	0.000841	0.000964	0.001023	0.000997
0.000952	0.000886	0.000968	0.001008	0.001037
0.001072	0.000877	0.000943	0.001066	0.000939
0.000971	0.000882	0.000966	0.000984	0.000971
0.000955	0.000898	0.000936	0.000987	0.000939
0.00097	0.000846	0.000972	0.000956	0.001062
0.000956	0.000874	0.000964	0.000962	0.000955
0.000916	0.000836	0.000981	0.001044	0.000929
0.000993	0.000847	0.000974	0.00097	0.000968
0.000953	0.000826	0.000981	0.000959	0.000977
0.000909	0.00091	0.000993	0.000964	0.00096
0.000998	0.00083	0.00095	0.000965	0.000995
0.000948	0.000894	0.000957	0.000988	0.001029
0.000993	0.000861	0.000967	0.000984	0.000962
0.000945	0.000856	0.001089	0.000995	0.000971
0.000983	0.000856	0.00096	0.000992	0.000974
0.000908	0.000907	0.001175	0.000952	0.001071
			Mean	0.00095898

	abs.	rel.
s^2_{bb}	-6.704E-10	
u_{bb}	1.011E-05	1.05 %

Magnesium

0.039205	0.034721	0.041351	0.040048	0.040747
0.039326	0.034775	0.042101	0.04031	0.041391
0.039685	0.034977	0.040528	0.040159	0.040525
0.038885	0.034979	0.041053	0.039899	0.040815
0.039132	0.035141	0.041815	0.04012	0.041013
0.039246	0.034751	0.04155	0.040206	0.041232
0.03895	0.03487	0.041561	0.039698	0.041014
0.039702	0.034702	0.041436	0.040153	0.040653
0.039304	0.034594	0.041722	0.040097	0.041011
0.038992	0.034662	0.040867	0.039576	0.04044
0.039969	0.034728	0.041494	0.039983	0.040863
0.038824	0.03538	0.041001	0.040155	0.040589
0.039023	0.034806	0.041531	0.039958	0.040681
0.038881	0.035138	0.041899	0.039679	0.040496
0.039077	0.03465	0.04061	0.039413	0.040523
0.038977	0.034466	0.04202	0.040087	0.041077
0.039504	0.035279	0.04108	0.040322	0.041162
0.039504	0.034962	0.041223	0.039859	0.040854
0.039083	0.035159	0.040909	0.040129	0.040975
0.039077	0.034756	0.041391	0.040178	0.040783
0.039615	0.034942	0.041291	0.039976	0.040533
0.039181	0.035052	0.04213	0.039701	0.041531
0.038923	0.034742	0.041765	0.040149	0.040913
0.038867	0.034589	0.04156	0.03967	0.040703
0.039501	0.035094	0.041567	0.040351	0.04067
0.038865	0.035397	0.041552	0.039863	0.041037
0.039409	0.034807	0.041256	0.040172	0.040944
0.03924	0.034503	0.040887	0.040335	0.040782
0.039451	0.034807	0.041448	0.040144	0.041062
0.039052	0.035101	0.041662	0.040088	0.040893
0.039364	0.034581	0.041687	0.04007	0.041183
0.039627	0.034956	0.041744	0.040238	0.040716
0.039039	0.035192	0.041608	0.04013	0.040512
0.038988	0.034853	0.041498	0.04009	0.040762
0.039423	0.035355	0.041422	0.040057	0.040451
0.039343	0.034996	0.041277	0.039975	0.040762
0.040933	0.039448	0.034996	0.041256	0.039954
0.038477	0.035065	0.041282	0.039754	0.041483
0.039118	0.035012	0.04126	0.04006	0.040848
0.039325	0.034784	0.041525	0.040445	0.040886
0.039596	0.034996	0.040878	0.040124	0.040848
0.039642	0.034865	0.041383	0.04026	0.040303
0.039708	0.035116	0.041456	0.040379	0.040642
0.039211	0.035171	0.041196	0.039899	0.041
0.038434	0.03531	0.040786	0.040431	0.040417
			Mean	0.03928663

	abs.	rel.
s^2_{bb}	-1.317E-06	
u_{bb}	0.00038	0.96 %

Nickel

0.00053	0.000513	0.000473	0.000449	0.000413
0.000508	0.000524	0.000467	0.000443	0.000426
0.000505	0.000529	0.000457	0.000471	0.000424
0.000504	0.000515	0.000471	0.000447	0.000412
0.000505	0.000528	0.000467	0.000446	0.000436
0.000528	0.000516	0.000447	0.000449	0.000437
0.000498	0.000534	0.000465	0.000457	0.000425
0.00051	0.000503	0.000459	0.000459	0.00044
0.000527	0.000526	0.000463	0.000461	0.000446
0.000495	0.000514	0.000467	0.000468	0.000414
0.000507	0.000499	0.000453	0.000467	0.000427
0.000504	0.000538	0.000456	0.000453	0.000433
0.000527	0.000512	0.000451	0.000455	0.000407
0.000501	0.000507	0.000459	0.000448	0.0004
0.000513	0.000531	0.000472	0.000436	0.00043
0.000498	0.000503	0.000476	0.000446	0.00043
0.000508	0.000502	0.000467	0.000436	0.000439
0.000518	0.000547	0.000458	0.000462	0.000429
0.000496	0.000534	0.000461	0.000448	0.000423
0.000532	0.000502	0.000448	0.000457	0.000422
0.000514	0.000547	0.000479	0.000457	0.000399
0.000506	0.000526	0.00046	0.000448	0.000431
0.000491	0.00053	0.000464	0.000465	0.000445
0.000504	0.000518	0.000476	0.000462	0.000445
0.000494	0.00054	0.000463	0.000453	0.000406
0.000507	0.000514	0.000451	0.000463	0.000413
0.000496	0.000511	0.000471	0.000466	0.000419
0.000529	0.000505	0.000458	0.000457	0.000409
0.000509	0.000514	0.00046	0.000462	0.000411
0.00051	0.000486	0.000458	0.000465	0.000422
0.000497	0.000517	0.000491	0.000452	0.000453
0.000517	0.000542	0.000448	0.00047	0.00043
0.000495	0.000523	0.000479	0.000478	0.000412
0.000522	0.000512	0.000464	0.00044	0.000424
0.000503	0.000526	0.000471	0.000438	0.00043
0.000511	0.000531	0.000453	0.00046	0.000423
0.000439	0.000504	0.00053	0.000473	0.000447
0.000485	0.000539	0.000477	0.000467	0.000436
0.000504	0.000518	0.000461	0.000454	0.000419
0.000519	0.000504	0.000455	0.000455	0.00042
0.00052	0.000527	0.000468	0.000469	0.00043
0.000505	0.00051	0.000444	0.00046	0.000404
0.000519	0.000509	0.000448	0.000462	0.000421
0.000496	0.00053	0.000476	0.00045	0.00043
0.000498	0.000536	0.000446	0.000405	0.000474
			Mean	0.00047441

	abs.	rel.
s^2_{bb}	-3.191E-10	
u_{bb}	6.002E-06	1.27 %

Titanium

0.000391	0.000395	0.00035	0.000346	0.00032
0.000379	0.0004	0.000356	0.000338	0.000334
0.000396	0.0004	0.00034	0.000349	0.000345
0.000364	0.000375	0.000357	0.00035	0.000319
0.000387	0.000403	0.000346	0.000339	0.000326
0.000395	0.000398	0.00034	0.000344	0.000338
0.000373	0.000398	0.000348	0.000337	0.000326
0.000387	0.000381	0.000349	0.000346	0.000336
0.000372	0.000393	0.000346	0.000344	0.000328
0.000359	0.000377	0.000336	0.000348	0.000338
0.000391	0.00038	0.000339	0.000321	0.000316
0.000378	0.000406	0.000352	0.000346	0.00033
0.000368	0.000398	0.000346	0.000328	0.000312
0.00038	0.000396	0.000342	0.000344	0.000311
0.000375	0.000405	0.00034	0.000336	0.000341
0.000376	0.000379	0.000339	0.000345	0.000321
0.000388	0.000391	0.000334	0.000328	0.000326
0.00037	0.0004	0.000339	0.000347	0.000328
0.000369	0.000395	0.000339	0.000334	0.00032
0.000367	0.000388	0.000342	0.00035	0.000328
0.000378	0.000386	0.000338	0.000332	0.000329
0.000369	0.000387	0.000347	0.000328	0.000338
0.000364	0.000396	0.000343	0.00035	0.000325
0.000379	0.000393	0.000357	0.000338	0.000333
0.000386	0.000396	0.000337	0.000352	0.000308
0.000362	0.000408	0.000352	0.000351	0.000319
0.000387	0.000385	0.000347	0.00034	0.000325
0.000388	0.000383	0.000345	0.000348	0.000322
0.000403	0.000398	0.000343	0.000336	0.000335
0.00038	0.00038	0.000342	0.000328	0.000343
0.000385	0.000381	0.000356	0.000344	0.000332
0.00038	0.000402	0.000338	0.000331	0.000343
0.000372	0.000399	0.000342	0.000352	0.000318
0.00039	0.000385	0.000343	0.000348	0.000317
0.000387	0.000399	0.000362	0.000333	0.000346
0.000379	0.000405	0.000344	0.000338	0.000322
0.000335	0.00038	0.000391	0.000345	0.000343
0.000366	0.000402	0.00036	0.000337	0.000316
0.00036	0.000392	0.000358	0.000343	0.000344
0.000393	0.0004	0.000351	0.000344	0.000327
0.000381	0.000397	0.000337	0.000338	0.00032
0.000393	0.000391	0.000334	0.000347	0.00032
0.000377	0.000394	0.000344	0.000343	0.000321
0.000374	0.000395	0.000357	0.000344	0.000333
0.000384	0.000401	0.00034	0.00032	0.00035
			Mean	0.00035733

	abs.	rel.
s^2_{bb}	-1.542E-10	
u_{bb}	4.223E-06	1.18 %

Silicium

0.002223	0.002121	0.002093	0.00214	0.002079
0.002191	0.002151	0.002134	0.00215	0.002113
0.002191	0.002161	0.002082	0.002149	0.002117
0.002983	0.002085	0.002137	0.00216	0.002031
0.002329	0.002368	0.002076	0.002139	0.00212
0.002215	0.002152	0.002093	0.002135	0.002083
0.002977	0.002132	0.002152	0.002096	0.002119
0.002148	0.002143	0.002126	0.002159	0.002105
0.00226	0.002178	0.002112	0.002156	0.002129
0.002933	0.002108	0.00207	0.002156	0.002112
0.002221	0.002128	0.002085	0.002079	0.002045
0.002999	0.002159	0.002117	0.002154	0.002083
0.002268	0.00216	0.002112	0.00212	0.002041
0.002152	0.002146	0.002127	0.002155	0.002071
0.002938	0.002195	0.002101	0.002138	0.002208
0.002212	0.00209	0.002112	0.002185	0.002052
0.002233	0.002126	0.002044	0.002144	0.002083
0.002858	0.002175	0.002037	0.002152	0.002067
0.003001	0.002153	0.002079	0.002128	0.002083
0.002325	0.002141	0.002131	0.002186	0.002073
0.002182	0.002131	0.002056	0.002143	0.002139
0.002753	0.002154	0.002107	0.002137	0.002123
0.003046	0.002155	0.002098	0.002179	0.002315
0.002384	0.002119	0.002154	0.002169	0.00209
0.002154	0.002157	0.002074	0.002143	0.002066
0.003029	0.002157	0.002108	0.002163	0.002099
0.00243	0.002153	0.002063	0.00208	0.002104
0.002266	0.002141	0.002109	0.002134	0.00209
0.002241	0.002117	0.002066	0.002119	0.002086
0.002226	0.002134	0.002108	0.002114	0.002131
0.002764	0.00209	0.002082	0.002162	0.002115
0.002231	0.002153	0.002086	0.002112	0.002105
0.003026	0.002144	0.002079	0.002162	0.002048
0.002238	0.002116	0.002105	0.002177	0.002089
0.002186	0.002165	0.002095	0.002087	0.002133
0.002491	0.002103	0.00207	0.002134	0.002083
0.002147	0.00225	0.002143	0.002088	0.002117
0.003075	0.002151	0.00211	0.002173	0.002028
0.00261	0.002131	0.002112	0.002168	0.002151
0.002207	0.002197	0.002106	0.002177	0.00209
0.00223	0.002132	0.002057	0.002103	0.002042
0.002232	0.002128	0.002024	0.002188	0.002146
0.002202	0.002166	0.002068	0.002112	0.00209
0.002478	0.002146	0.002122	0.002149	0.002106
0.003092	0.002164	0.002107	0.002099	0.00215
			Mean	0.00219349

	abs.	rel.
s^2_{bb}	-4.631E-09	
u_{bb}	3.252E-05	1.48 %

Lead:

0.000957	0.000884	0.001019	0.001091	0.00099
0.000954	0.000868	0.000966	0.000971	0.001108
0.000945	0.000902	0.000938	0.000979	0.000977
0.000928	0.000854	0.000959	0.000982	0.001107
0.000952	0.000885	0.000969	0.000981	0.000994
0.000978	0.000876	0.000977	0.00098	0.00099
0.000946	0.00087	0.000974	0.000959	0.00099
0.000949	0.000885	0.000967	0.000979	0.001007
0.000963	0.000898	0.001034	0.000994	0.000982
0.000966	0.00088	0.00096	0.000988	0.001045
0.001001	0.000869	0.000958	0.000967	0.000955
0.000956	0.000858	0.001002	0.000978	0.000927
0.000987	0.000833	0.000963	0.00102	0.00106
0.000913	0.000853	0.000961	0.000963	0.001022
0.000926	0.000847	0.000972	0.000965	0.000942
0.000945	0.000854	0.001026	0.000984	0.000934
0.000992	0.000828	0.000981	0.001041	0.000958
0.000989	0.000848	0.00093	0.001152	0.000934
0.00096	0.000874	0.001057	0.00097	0.00099
0.000942	0.000885	0.001018	0.000926	0.001
0.000963	0.000854	0.000963	0.00098	0.000964
0.00093	0.000853	0.000947	0.000944	0.00102
0.000964	0.000867	0.000971	0.001225	0.000964
0.000931	0.000851	0.000962	0.000976	0.000989
0.000959	0.000894	0.001009	0.000994	0.001133
0.00094	0.000834	0.000983	0.001072	0.000953
0.000927	0.000847	0.000937	0.00095	0.000999
0.000958	0.000835	0.001	0.000988	0.001131
0.000972	0.000841	0.000964	0.001023	0.000997
0.000952	0.000886	0.000968	0.001008	0.001037
0.001072	0.000877	0.000943	0.001066	0.000939
0.000971	0.000882	0.000966	0.000984	0.000971
0.000955	0.000898	0.000936	0.000987	0.000939
0.00097	0.000846	0.000972	0.000956	0.001062
0.000956	0.000874	0.000964	0.000962	0.000955
0.000916	0.000836	0.000981	0.001044	0.000929
0.000993	0.000847	0.000974	0.00097	0.000968
0.000953	0.000826	0.000981	0.000959	0.000977
0.000909	0.00091	0.000993	0.000964	0.00096
0.000998	0.00083	0.00095	0.000965	0.000995
0.000948	0.000894	0.000957	0.000988	0.001029
0.000993	0.000861	0.000967	0.000984	0.000962
0.000945	0.000856	0.001089	0.000995	0.000971
0.000983	0.000856	0.00096	0.000992	0.000974
0.000908	0.000907	0.001175	0.000952	0.001071
			Mean	0.00095898

	abs.	rel.
s^2_{bb}	-6.704E-10	
u_{bb}	1.011E-05	1.05 %

Tin

0.000635	0.000582	0.000569	0.000564	0.000425
0.000577	0.000785	0.000559	0.000514	0.000577
0.000665	0.000698	0.000456	0.000592	0.000618
0.000602	0.000609	0.000539	0.000593	0.000423
0.000615	0.000747	0.000519	0.000547	0.000537
0.000657	0.000692	0.000542	0.000577	0.0005
0.000519	0.00071	0.000509	0.000563	0.000458
0.000629	0.000648	0.000501	0.000549	0.000546
0.000608	0.000692	0.000458	0.000553	0.000673
0.000587	0.000685	0.000463	0.00061	0.000479
0.000598	0.000632	0.000509	0.000519	0.000466
0.000589	0.000734	0.000484	0.000575	0.000509
0.000624	0.000619	0.000573	0.000513	0.000434
0.000637	0.000711	0.000574	0.000574	0.000371
0.000602	0.00071	0.00055	0.000549	0.000494
0.000642	0.000602	0.000524	0.00047	0.000532
0.000607	0.000635	0.000472	0.000536	0.000551
0.000655	0.000756	0.000479	0.00058	0.000516
0.000524	0.000737	0.000519	0.000543	0.000495
0.000618	0.000627	0.0005	0.000524	0.000534
0.000676	0.000679	0.000533	0.000523	0.000455
0.000577	0.000709	0.000531	0.000517	0.000561
0.000581	0.000717	0.000508	0.000568	0.000536
0.000581	0.000675	0.000558	0.00057	0.000535
0.000563	0.000719	0.0005	0.000546	0.000434
0.000592	0.00062	0.00049	0.000559	0.000377
0.000529	0.000655	0.000605	0.000636	0.00043
0.000603	0.000616	0.000525	0.000541	0.000529
0.000548	0.000704	0.000533	0.000569	0.000534
0.000598	0.000587	0.000513	0.000646	0.000498
0.000524	0.000613	0.000601	0.000493	0.000537
0.000576	0.000747	0.000544	0.000573	0.000443
0.000572	0.000726	0.000571	0.000613	0.000405
0.000631	0.000664	0.000567	0.000533	0.000462
0.000669	0.000736	0.000472	0.000574	0.000471
0.000519	0.000752	0.000467	0.000608	0.00046
0.000464	0.000634	0.000702	0.00059	0.000614
0.000527	0.000801	0.000518	0.00053	0.000512
0.000605	0.000658	0.000504	0.000535	0.000479
0.000627	0.000599	0.000544	0.000551	0.000458
0.000596	0.000699	0.000605	0.000588	0.000459
0.000618	0.000633	0.000498	0.000572	0.00045
0.000654	0.000631	0.000534	0.000537	0.000564
0.000567	0.000667	0.000621	0.000566	0.000498
0.000518	0.000742	0.000469	0.000441	0.000561
			Mean	0.00057127

	abs.	rel.
s^2_{bb}	-1.251E-09	
u_{bb}	1.283E-05	2.24 %

Annex 2: Calc. of uncertainty contribution of potential inhomogeneity (area)

Aluminium

summary on radius and height effects:							
	u_bb	within-sd	status		F matrix	crit	2.403447071
bottom	0.005856084	0.018723194	homogeneous		1		
middle	0.011649703	0.037796628	homogeneous		0.245388236	1	
top	0.021969657	0.072199661	homogeneous		14.86998259	3.648918803	1
r_0	0.039982816	0.020200676	inhomogeneous		1		
r_in	0.015624052	0.059897283	homogeneous		8.791893652	1	
r_out	0.004218008	0.02518263	homogeneous		0.643472017	5.657337545	1
				rel			
	max inhom factor radius		0.021969657	0.59%			
	max inhom factor height		0.039982816	1.07%			
	combined inhom		0.045621173	1.22%			
	average within-sd		0.04401108	1.18%			
	overall mean		3.739219982				

Copper (XRF)

summary on radius and height effects:							
	u_bb	within-sd	status		F matrix	crit	2,403447071
bottom	0,003925466	0,009604686	homogeneous		1		
middle	0,002654324	0,006494503	homogeneous		2,187129551	1	
top	0,00359982	0,005532372	homogeneous		0,331784746	0,725656224	1
r_0	0,00530746	0,008306624	homogeneous		1		
r_in	0,001333671	0,004758034	homogeneous		0,328099839	1	
r_out	0,001882832	0,009095176	homogeneous		0,834116857	0,273673606	1

			rel	
	max inhom factor radius	0,003925466	0,46%	
	max inhom factor height	0,00530746	0,62%	
	combined inhom	0,006601395	0,77%	
	average within-sd	0,007521046	0,88%	
	overall mean	0,856033333		

Copper (XRF)

summary on radius and height effects:

	u_bb	within-sd	status		F matrix	crit	2,403447071
bottom	0,003925466	0,009604686	homogeneous		1		
middle	0,002654324	0,006494503	homogeneous		2,187129551	1	
top	0,00359982	0,005532372	homogeneous		0,331784746	0,725656224	1
r_0	0,00530746	0,008306624	homogeneous		1		
r_in	0,001333671	0,004758034	homogeneous		0,328099839	1	
r_out	0,001882832	0,009095176	homogeneous		0,834116857	0,273673606	1

			rel			
	max inhom factor radius	0,003925466	0,46%			
	max inhom factor height	0,00530746	0,62%			
	combined inhom	0,006601395	0,77%			
	average within-sd	0,007521046	0,88%			
	overall mean	0,856033333				

Cadmium

summary on radius and height effects:							
	u_bb	within-sd	status		F matrix	crit	2.403447071
bottom	1.29349E-05	2.11054E-05	homogeneous		1		
middle	1.09006E-05	2.03485E-05	homogeneous		1.075780015	1	
top	5.86172E-06	1.92636E-05	homogeneous		0.833080544	0.896211401	1
r_0	2.43557E-05	5.53836E-06	inhomogeneous		1		
r_in	1.18518E-05	1.31085E-05	inhomogeneous		5.602032108	1	
r_out	3.40452E-06	2.03259E-05	homogeneous		0.074244036	0.415917473	1
				rel			
	max inhom factor radius		1.29349E-05	9.61%			
	max inhom factor height		2.43557E-05	18.10%			
	combined inhom		2.75774E-05	20.49%			
	average within-sd		1.75415E-05	13.03%			
	overall mean		0.000134596				

Iron

summary on radius and height effects:							
	u_bb	within-sd	status		F matrix	crit	2.403447071
bottom	1.1092E-05	4.14984E-05	homogeneous		1		
middle	1.64225E-05	2.59009E-05	homogeneous		2.567054517	1	
top	7.91539E-06	3.14068E-05	homogeneous		0.57277509	1.470344882	1
r_0	2.15355E-05	3.37049E-05	homogeneous		1		
r_in	8.8319E-06	3.5801E-05	homogeneous		1.128247449	1	
r_out	1.27158E-05	3.19898E-05	homogeneous		1.110104127	1.252472149	1

			rel			
	max inhom factor radius	1.64225E-05	2.62%			
	max inhom factor height	2.15355E-05	3.43%			
	combined inhom	2.70828E-05	4.32%			
	average within-sd	3.37156E-05	5.38%			
	overall mean	0.000627018				

Magnesium

summary on radius and height effects:							
	u_bb	within-sd	status		F matrix	crit	2,403447071
bottom	6,65385E-05	0,000248941	homogeneous		1		
middle	0,00044016	0,000303949	inhomogeneous		0,670796092	1	
top	0,000201641	0,000800074	homogeneous		10,32926361	6,928829661	1
r_0	2,05694E-05	3,21929E-05	homogeneous		1		
r_in	0,000499209	0,000578268	inhomogeneous		322,6541052	1	
r_out	0,000263842	0,000525063	inhomogeneous		0,003759217	1,2129268	1
				rel			
	max inhom factor radius		0,00044016	1,14%			
	max inhom factor height		0,000499209	1,30%			
	combined inhom		0,000665545	1,73%			
	average within-sd		0,00048401	1,26%			
	overall mean		0,038541947				

Nickel

summary on radius and height effects:							
	u_bb	within-sd	status		F matrix	crit	2.403447071
bottom	3.52339E-06	1.31821E-05	homogeneous		1		
middle	8.46491E-06	1.31199E-05	homogeneous		1.009496664	1	
top	3.4359E-06	1.3633E-05	homogeneous		1.069585587	1.079743082	1
r_0	8.53861E-06	1.33636E-05	homogeneous		1		
r_in	5.66471E-06	1.43419E-05	homogeneous		1.151757784	1	
r_out	1.95786E-06	1.27791E-05	homogeneous		1.093579081	1.259538219	1
				rel			
	max inhom factor radius		8.46491E-06	1.83%			
	max inhom factor height		8.53861E-06	1.85%			
	combined inhom		1.20234E-05	2.60%			
	average within-sd		1.34123E-05	2.90%			
	overall mean		0.000461789				

Titanium

summary on radius and height effects:

	u_bb	within-sd	status		F matrix	crit	2.403447071
bottom	9.98439E-06	1.13213E-05	inhomogeneous		1		
middle	5.98363E-06	1.33585E-05	homogeneous		0.718256975	1	
top	5.63631E-06	1.01268E-05	homogeneous		0.800118183	0.574690466	1
r_0	7.47896E-06	1.17052E-05	homogeneous		1		
r_in	4.62041E-06	1.1887E-05	homogeneous		1.0312972	1	
r_out	6.40855E-06	1.15334E-05	inhomogeneous		1.030006725	1.062243052	1

			rel	
	max inhom factor radius	9.98439E-06	2.89%	
	max inhom factor height	7.47896E-06	2.16%	
	combined inhom	1.24749E-05	3.61%	
	average within-sd	1.16941E-05	3.38%	
	overall mean	0.000345877		

Silicium

summary on radius and height effects:

	u_bb	within-sd	status		F matrix	crit	2,403447071
bottom	3,65651E-05	4,55833E-05	inhomogeneous		1		
middle	2,83191E-05	5,10964E-05	homogeneous		0,795851701	1	
top	1,14032E-05	4,5246E-05	homogeneous		0,985252696	0,784115035	1
r_0	3,03089E-05	4,7436E-05	homogeneous		1		
r_in	4,37377E-05	4,53408E-05	inhomogeneous		0,913613345	1	
r_out	7,40888E-06	4,83584E-05	homogeneous		0,962215433	0,87909286	1

			rel			
	max inhom factor radius	3,65651E-05	1,22%			
	max inhom factor height	4,37377E-05	1,46%			
	combined inhom	5,70087E-05	1,91%			
	average within-sd	4,72235E-05	1,58%			
	overall mean	0,002988561				

Lead

summary on radius and height effects:							
	u_bb	within-sd	status		F matrix	crit	2,403447071
bottom	8,26022E-06	3,0904E-05	homogeneous		1		
middle	4,31278E-05	2,91482E-05	inhomogeneous		1,124103953	1	
top	2,92181E-05	3,72885E-05	inhomogeneous		1,455861229	1,636539362	1
r_0	2,05694E-05	3,21929E-05	homogeneous		1		
r_in	3,95767E-05	2,6163E-05	inhomogeneous		0,660469581	1	
r_out	2,53543E-05	3,56746E-05	inhomogeneous		0,814332933	0,537842131	1

			rel	
	max inhom factor radius	4,31278E-05	4,54%	
	max inhom factor height	3,95767E-05	4,17%	
	combined inhom	5,85348E-05	6,17%	
	average within-sd	3,21161E-05	3,38%	
	overall mean	0,000949421		

Tin

summary on radius and height effects:							
	u_bb	within-sd	status		F matrix	crit	2,403447071
bottom	1,29751E-05	4,85438E-05	homogeneous		1		
middle	3,96615E-05	4,87512E-05	inhomogeneous		0,991509073	1	
top	4,26955E-05	4,33715E-05	inhomogeneous		0,79825271	0,791474805	1
r_0	2,86576E-05	4,48516E-05	homogeneous		1		
r_in	4,80174E-05	4,71806E-05	inhomogeneous		1,106552228	1	
r_out	2,38826E-05	4,66697E-05	inhomogeneous		0,923603975	1,022016036	1
				rel			
	max inhom factor radius		4,26955E-05	9,83%			
	max inhom factor height		4,80174E-05	11,06%			
	combined inhom		6,4254E-05	14,80%			
	average within-sd		4,66011E-05	10,73%			
	overall mean		0,000434211				