Certification Report

Certified Reference Material

ERM®-EB315a

AlSi9Cu3

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Summary

This report describes preparation, analysis and certification of the aluminium alloy reference material ERM®-EB315a.
The certified reference material (CRM) is available in the form of discs (65 mm diameter and 30 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. It is also suitable for wet chemical analysis.

The following mass fractions and uncertainties have been certified:

Element	**Mass fraction**[1] in %	**Uncertainty**[2] in %
Si	9.88	0.18
Fe	0.621	0.014
Cu	2.46	0.08
Mn	0.311	0.009
Mg	0.446	0.023
Cr	0.0274	0.0004
Ni	0.0955	0.0022
Zn	0.801	0.010
Ti	0.142	0.006
Ga	0.0089	0.0003
Pb	0.077	0.003
Sn	0.0764	0.0020
	in mg/kg	in mg/kg
Be	4.33	0.16
Bi	36	4
Cd	7.9	1.2
Sb	51	10
V	47.0	2.3
Zr	31.0	1.9

1 Unweighted mean value of the means of accepted sets of data, each set being obtained by at least 5 laboratories and/or with different methods of measurement. The values are traceable to the SI (Système International d'Unités) by the use of pure substances of known stoichiometry for calibration.

2 Estimated expanded uncertainty *U* with a coverage factor of $k = 2$ corresponding to a level of confidence of about 95%, as defined in the ISO/IEC Guide 98-3:2008 [Uncertainty of measurement -- Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)].

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 9 laboratories which participated in the certification inter-laboratory comparison.

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List of abbreviations
(if not explained elsewhere)

CRM	certified reference material
CVAFS	cold vapour atomic fluorescence spectrometry
ERM	European reference material
ETAAS	electrothermal atomic absorption spectrometry
FAAS	flame atomic absorption spectrometry
ICP-OES	inductively coupled plasma optical emission spectrometry
ICP-MS	inductively coupled plasma 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 laboratory means
s_{rel}	relative standard deviation
$\bar{s}_i$	square root of mean of variances of data sets under repeatability conditions
M_i	single result
I	ICP-OES (Tables 2 – 23)
I(R)	ICP-OES, revised value (Tables 2 – 23)
IMS	ICP-MS (Tables 2 – 23)
A	FAAS (Tables 2 – 23)
EA	ETAAS (Tables 2 – 23)
P	spectrophotometry (Tables 2 – 23)
G	gravimetry (Tables 2 – 23)
XRF(R)	X-ray fluorescence spectrometry, revised value (Tables 2 – 23)
-s	dissolution in acid (Tables 2 – 23)
-a	dissolution in base (Tables 2 – 23)

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®-EB315a is based on the aluminium alloy AlSi9Cu3. It replaces the sold out CRM BAM-315.

The CRM was produced in close cooperation with the working group „Aluminium“ of the Committee of Chemists of GDMB Society of Metallurgists und Miners. Since all the laboratories participating in this certification project are highly experienced with aluminium analysis and had already participated in earlier inter-laboratory comparisons, there was no preceding round robin for qualification.

Certification was carried out on the basis of the relevant ISO-Guides [1-3], the „Guidelines for the development and 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

Manufacturing of the material:

- Constellium, Centre de Recherches de Voreppe, Voreppe, France

Test for homogeneity:

- Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
- Constellium, Centre de Recherches de Voreppe, Voreppe, France

Participants in the certification inter-laboratory comparison:

AMAG Austria Metall AG, Ranshofen, Austria
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
Hydro Aluminium Rolled Products GmbH, R&D, Bonn, Germany
Hydro Aluminium Rolled Products GmbH, Hamburg, Germany
Institute of Non-Ferrous Metals, Gliwice, Poland
Leichtmetall Aluminium Giesserei Hannover GmbH, Hannover, Germany
Otto Fuchs KG, Meinerzhagen, Germany
Suisse Technology Partners AG, Neuhausen, Switzerland
TRIMET Aluminium SE, Essen, Germany

Statistical evaluation of the data:

- Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany

3. Candidate material

The candidate material was produced by Constellium, Centre de Recherches de Voreppe, Voreppe, France. About 500 kg of an aluminium melt were doped with the desired elements. The melt was casted into six rods (A – F) with a length of 3775 mm each. 250 mm on both ends of each rod were discarded. The rods were cut into segments of 800 mm length (A1, A2, A3, A4, B1, B2, ..., F3, F4). Between the segments 15-mm discs (AA, AB, AC, AD, AE, BA, BB, ..., FD, FE) were taken for homogeneity testing (see Fig. 1).

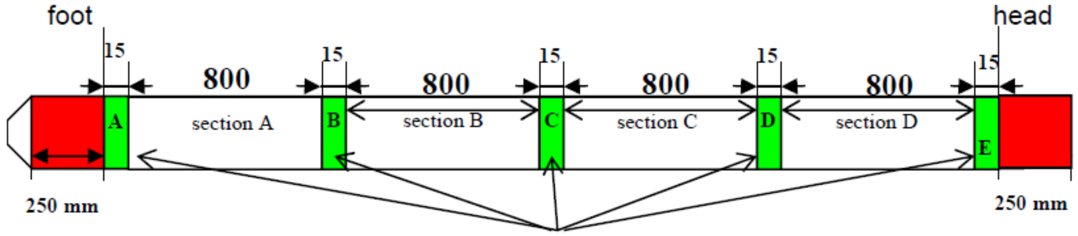

Fig.1: Preparation of the rods casted

In total, approx. 500 discs with a diameter of ca. 65 mm and 30 mm height were obtained.

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 because of possible segregation during the solidification of the material. Since the raw material was produced by casting of a rod, concentration gradients can occur over the length of the rod (axial) as well as over the area of the rod (radial, see Figures 2 and 3):

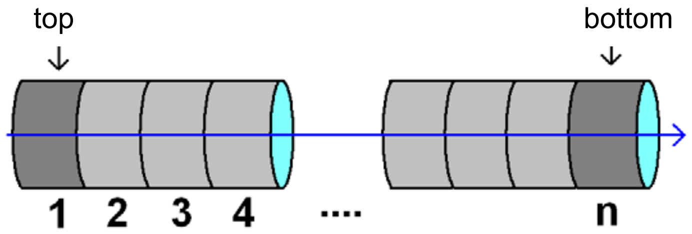

Fig. 2: Axial composition gradient

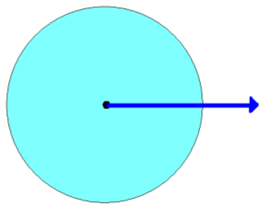

Fig. 3: Radial composition gradient

Therefore, it is necessary to investigate the raw material for both axial and radial inhomogeneities. Radial homogeneity testing of the candidate material using spark emission spectrometry was performed by Constellium, Centre de Recherches de Voreppe on the discs taken from the rods as shown in Fig. 1. In total 30 discs were investigated, this corresponds to 6 % of the whole batch.

In addition, 24 discs were cut from the 800-mm-segments (identification: name of segment together with position: food (F) or head (H), e.g. A1F). These discs were analysed with XRF using a wavelength dispersive MagiX Pro instrument (Panalytical, Almelo, The Netherlands). Before measuring the disc its surface was milled.

Since the measured spread of results in all cases contains contributions from both inhomogeneity and the analytical method it is necessary to distinguish between them and to separate the contribution due to the inhomogeneity. This is done by subtracting the variance of the instrumental spread, determined by repeated measurement of the same disc, from the variances resulting from inhomogeneities. This approach is only suitable in case of non-destructive analysis. Therefore, no ANOVA-calculation was performed. XRF is not as sensitive as SOES, therefore not all elements could be determined with this method. For uncertainty calculation, the lower value (XRF vs. SOES) was used (see Annex 1).

The estimate of analyte-specific inhomogeneity contribution u_{bb} to be included into the total uncertainty budget was calculated according to ISO Guide 35 [4] using Eq. (1) and Eq. (2):

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

$$u_{bb}^{*} = \sqrt{\frac{MS_{within}}{n}} \sqrt[4]{\frac{2}{N(n-1)}} \qquad (2)$$

where:

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

s_{bb} signifies the between-discs standard deviation whereas u_{bb}^{*} 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 $u_{bb}(1)$. Eq. (1) does not apply if MS_{within} is larger than MS_{among}.

In addition to the tests performed over the length of the rods two discs were tested for homogeneity over the area (possible segregation from the outer part to the centre). To perform this test SOES analysis was carried out in circles (outer circle: 16 sparks, mean circle: 11 sparks, inner circle: 8 sparks; centre: 1 spark).

The analyte-specific within-disc uncertainty component $u_{bb}(2)$ was 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 centre, the inner and the outer circle. For technical reasons, at r_0 (centre) only one measurement is possible. An ANOVA requires a minimum of 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), r_mean (mean circle) and r_out (outer circle). As results from these calculations an inhomogeneity component for the radius of the disc is obtained. From these values a combined inhomogeneity component is calculated. This component is compared with the within standard deviation calculated from the ANOVA-data. The higher component is used for uncertainty calculation.

Annex 2 shows the results of the calculations.

5. Characterisation study

5.1 Analytical methods

9 laboratories participated in the certification inter-laboratory comparison. For some elements part of the laboratories used more than one analytical method reporting more than one data set.
The laboratories were asked to analyse six subsamples. They were free to choose any suitable analytical method. Table 1 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 1: Analytical procedures used by the participating laboratories

Lab-No.	Element.	Sample mass	Sample pretreatment	Analytical method
2	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Pb, Sn, Ti	0.5 g	Dissolution with NaOH	ICP-OES, calibration with pure metals or pure chemicals, matrix matching with pure Al (5N5)
	P	1 g	Dissolution with HNO_3/HCl/HF	ICP-OES, calibration with pure chemicals, matrix matching with pure Al (5N5)
	B, Be, Bi, Cd, Co, V, Zr	0.5 g	Dissolution with HNO_3/HF	ICP-MS, calibration with pure metals or pure chemicals, matrix matching with pure Al (5N5)
	Hg	1 g	Dissolution with HNO_3/HCl/HF	ICP-MS, calibration with pure metal, matrix matching with pure Al (5N5)
	Ga, Sb	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-MS, calibration with pure metals or pure chemicals, matrix matching with pure Al (5N5)
4	Si	0.2 g	Dissolution with NaOH	Spectrophotometry, commercial mono-element solutions
	Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Pb, Sn, Ga	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-OES, commercial mono-element solutions
	B, Be, Bi, Cd, Co, Sb, Hg, V, Zr, P	1 g	Dissolution with HNO_3/HCl/HF/H_2O_2/H_2SO_4	ICP-OES, commercial mono-element solutions
5	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Pb, Sn, Ga, Be, Cd, Co, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (NIST)

Table 1 (cont.): Analytical procedures used by the participating laboratories

6	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Pb, Sn, Ga, Be, Cd, Co, Hg, V, Zr, P	0.5 g	Dissolution with NaOH	ICP-OES, calibration with pure substance
	B, Bi, Sb	0.5 g	Dissolution with HNO_3/HF	ICP-OES, calibration with pure substance
7	Be, Bi, Cd, Co, Ni, Sb, Pb, V, Zr	0.5 g	Dissolution with HNO_3/HF	ICP-MS with matrix matched standards (pure Al), commercial multi-element standard solutions
	Bi, Cd, Sb	0.5 g	Dissolution with HCl/ HNO3/HF	ICP-OES with matrix matched standards (pure Al), commercial multi-element standard solutions
	Fe, Cu, Mg, Zn	0.5 g	Dissolution with HCl/H_2O_2/HF	FAAS, with matrix matched standards, commercial mono-element solutions
	Si, Fe, Mn, Zn, Ti, Sn, Pb, Ni, Zr	0.5 g	Dissolution with HCl/ HNO_3/HF	ICP-OES with matrix matched standards (pure Al), commercial multi-element standard solutions
8	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Pb, Sn, Ga	0.5 g	Dissolution with NaOH	ICP-OES with matrix matched standards, commercial mono-element solutions
	Be, Cd, Co, Sb, V, Zr	0.5 g	Dissolution with HCl	ICP-OES with matrix matched standards, commercial mono-element solutions
	Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Pb, Sn, V, Zr, Co			XRF, calibration with BAM-CRMs
9	Si	0.25 g	Dissolution with NaOH	Spectrophotometry
	Fe	0.5 g	Dissolution with HCl/H_2O_2	Spectrophotometry, calibration with pure metals or pure chemicals
	Zr, V	0.5 g	Dissolution with NaOH,	Spectrophotometry, calibration with pure metals or pure chemicals
	Fe, Cr, Ni, Ga, Pb, Sn, B, Be, Bi, Cd, Co, Sb, V, Zr	0.1 g	Dissolution with HCl/HNO_3/HF	ICP-MS, calibration with commercial mono-element solutions
	Fe, Cu, Mn, Mg, Cr, Zn, Ti, Ga, Bi, Cd, Pb, Sb, V, Zr, P	1 g	Dissolution with HCl/HNO_3	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions (Merck)
	Fe, Cu, Mn, Mg, Ni, Zn, Ti, Ga, Pb	0.5 g	Dissolution with NaOH	ICP-OES, calibration with commercial mono-element solution
	Mn, Ni			XRF, reconstitution
	Ni, Pb, Be, Bi, Cd	0.3 g	Dissolution with HCl/H_2O_2/HF	ETAAS, calibration with commercial solution (Merck)
	Hg			CVAES
10	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Pb, Sn, Ga, Zr, Be, Cd, Sb, V	0.5 g	Dissolution with NaOH	ICP-OES, calibration with pure chemicals

5.2 Analytical results and statistical evaluation

The analytical results of the certification inter-laboratory comparison are listed in Tables 2 to 23. These tables show the single results (M_i) of each laboratory, the respective laboratories' mean values (M), absolute and relative intra-laboratory standard deviation (s and s_{rel}, respectively), the standard

deviation of laboratory means (s_M), and in addition the square root of mean of variances of data sets under repeatability conditions ($\overline{s}_i$) where *n* is the number of accepted data sets. 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. Outliers which have been excluded are highlighted in yellow. In case of Cr one single value was excluded as Grubbs-Outlier.

Lab./Meth.	4/P	11/P	9/I-a	7/I-s	10/I-a	5/I-a	8/I-a	2/I-a	9/P	6/I-a		
M_i [%]	9.63	9.760	9.821	9.806	9.85	9.940	9.747	10.030	9.979	9.99		n
	9.79	9.843	9.748	9.809	9.88	9.955	10.028	9.896	9.979	10.09		10
	9.74	9.769	9.816	9.806	9.87	9.933	9.933	9.918	9.921	10.05		
	9.78	9.742	9.880	9.808	9.88	9.957	9.978	9.961	9.995	9.92		
	9.72	9.888	9.725	9.810	9.78	9.946	10.024	9.992	9.987	9.99		
	9.69	9.746		9.805	9.90	9.942	9.984	9.974	9.947	9.91		
M [%]	**9.725**	**9.791**	**9.798**	**9.807**	**9.860**	**9.946**	**9.949**	**9.962**	**9.968**	**9.992**		**9.880**
s [%]	0.0596	0.0602	0.0621	0.0020	0.0424	0.0092	0.1049	0.0488	0.0282	0.0705	s_M [%]	0.0944
											$\bar{s}_i$ [%]	0.0566
s_{rel}	0.00613	0.00614	0.00633	0.00020	0.00430	0.00092	0.01054	0.00490	0.00283	0.00706		0.00956

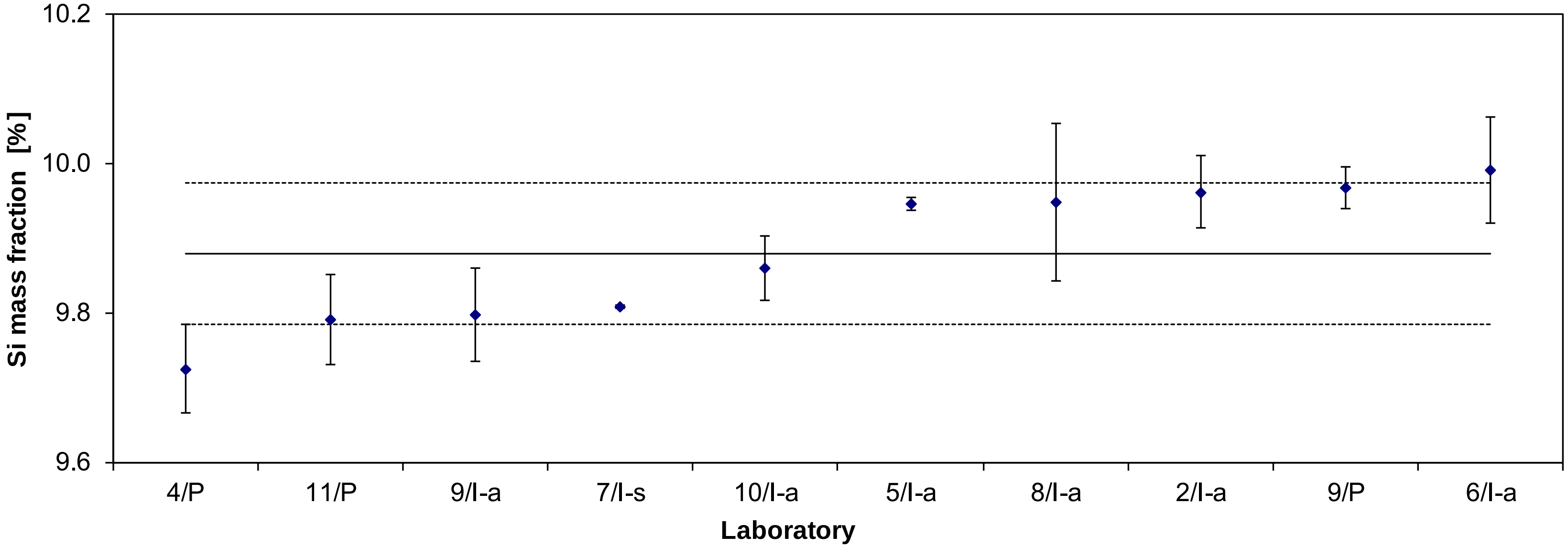

Table 2: Results for Si

Lab./Meth.	6/I-a	9/I-a	9/I-s	11/A-s	8/I-a	10/I-a	8/XRF	7/A-a(R)	7/I-s	5/I-a	2/I-a	9/P	9/IMS	4/I-s(R)		
M i [%]	0.599	0.5814	0.612	0.6115	0.6058	0.622	0.6223	0.6280	0.6241	0.6282	0.6343	0.6311	0.6186	0.639		*n*
	0.603	0.5897	0.596	0.6180	0.6154	0.623	0.6217	0.6133	0.6239	0.6290	0.6259	0.6344	0.6243	0.639		14
	0.603	0.6114	0.603	0.6076	0.6078	0.618	0.6217	0.6132	0.6249	0.6290	0.6244	0.6416	0.6335	0.639		
	0.600	0.5977	0.612	0.6060	0.6194	0.618	0.6216	0.6324	0.6239	0.6283	0.6313	0.6363	0.6415			
	0.599	0.6337	0.617	0.6200	0.6184	0.620	0.6216	0.6201	0.6235	0.6297	0.6328	0.6390	0.6377			
	0.600		0.600	0.6071	0.6160	0.623	0.6215	0.6299	0.6240	0.6306	0.6326	0.6098	0.6662			
***M* [%]**	**0.6007**	**0.6028**	**0.6067**	**0.6117**	**0.6138**	**0.6207**	**0.6217**	**0.6228**	**0.6241**	**0.6291**	**0.6302**	**0.6320**	**0.6370**	**0.6390**		**0.6209**
s [%]	0.0019	0.0205	0.0082	0.0060	0.0057	0.0023	0.0003	0.0085	0.0005	0.0009	0.0041	0.0115	0.0166	0.0000	s_M [%]	0.0123
															$\bar{s}_i$ [%]	0.0087
s_{rel}	0.00310	0.03404	0.01350	0.00978	0.00921	0.00377	0.00047	0.01361	0.00074	0.00146	0.00645	0.01816	0.02613	0.00000		0.01975

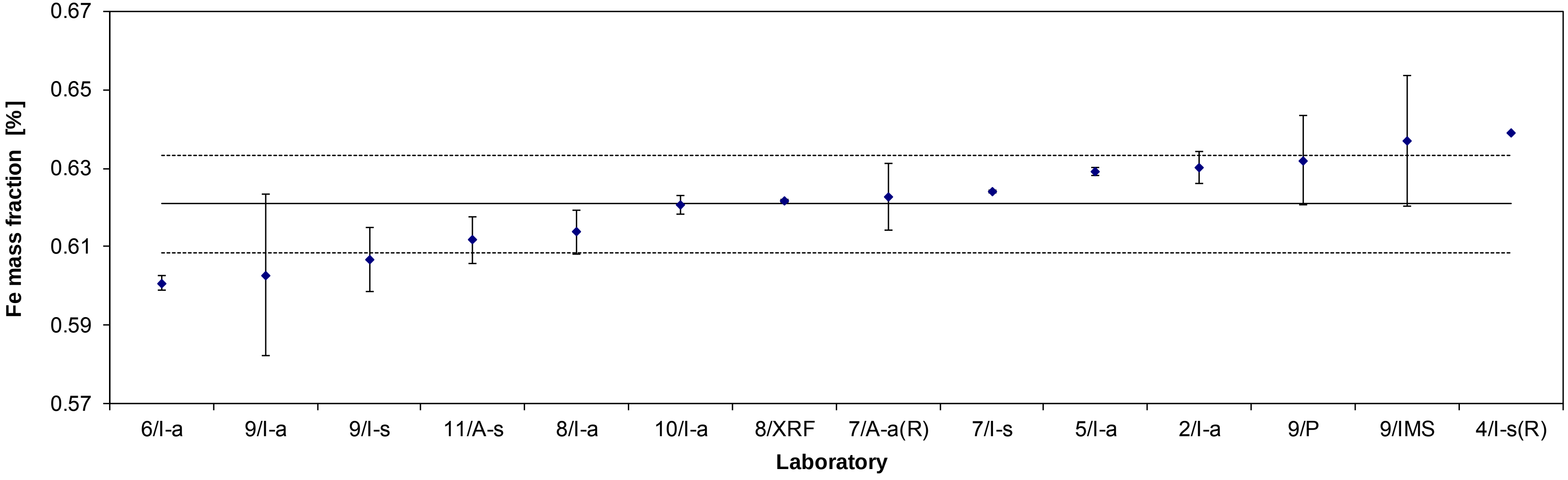

Table 3: Results for Fe

Lab./Meth.	11/A-s	9/I-s	8/I-a	4/I-s	6/I-a	8/XRF	2/I-a	5/I-a	10/I-a	7/A-s(R)	9/I-a		
M_i [%]	2.327	2.408	2.388	2.47	2.442	2.468	2.501	2.474	2.492	2.532	2.54		*n*
	2.278	2.374	2.469	2.48	2.467	2.469	2.474	2.475	2.491	2.545	2.51		11
	2.293	2.373	2.443	2.47	2.453	2.468	2.465	2.465	2.494	2.557	2.62		
	2.318	2.399	2.458	2.43	2.480	2.467	2.455	2.479	2.494	2.542	2.52		
	2.312	2.387	2.465	2.39	2.466	2.470	2.466	2.483	2.483	2.549			
		2.370	2.454	2.44	2.475	2.467	2.469	2.478	2.488	2.555			
***M* [%]**	**2.306**	**2.385**	**2.446**	**2.447**	**2.464**	**2.468**	**2.472**	**2.475**	**2.490**	**2.547**	**2.548**		**2.459**
s [%]	0.0196	0.0156	0.0298	0.0339	0.0141	0.0012	0.0154	0.0060	0.0042	0.0092	0.0499	s_M [%]	0.0681
												$\bar{s}_i$ [%]	0.0228
s_{rel}	0.00850	0.00655	0.01219	0.01384	0.00573	0.00049	0.00625	0.00244	0.00170	0.00360	0.01959		0.02769

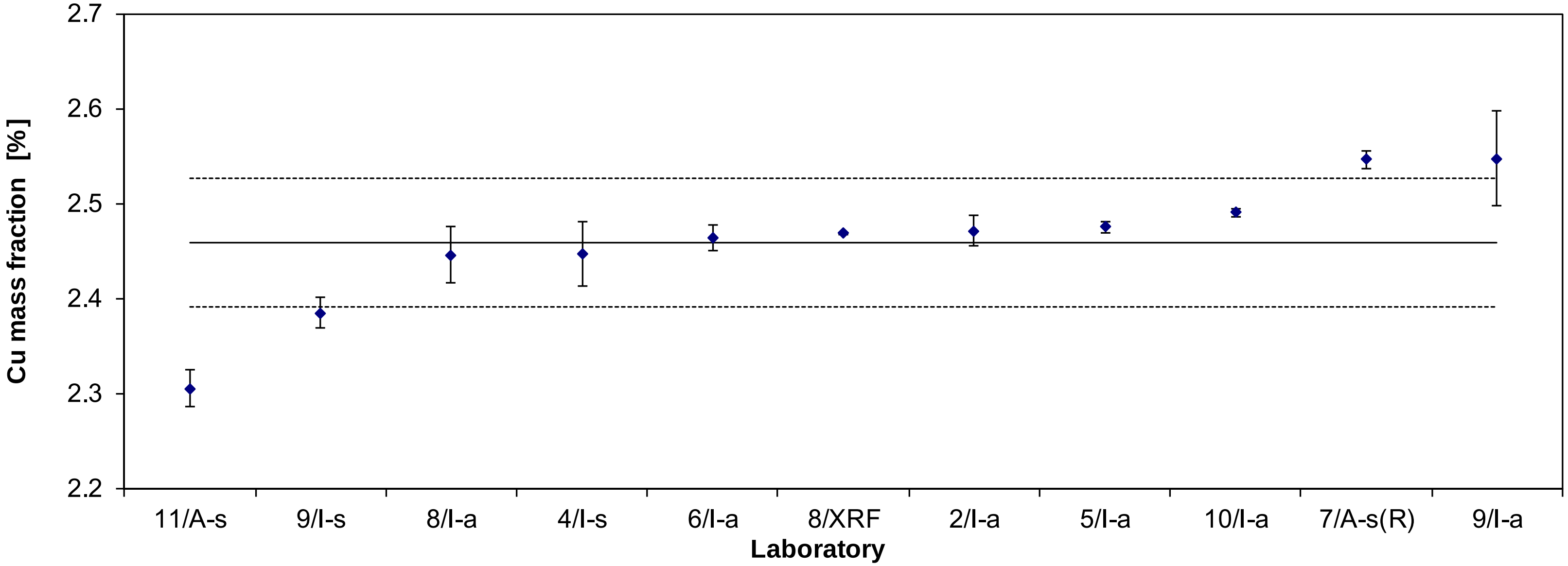

Table 4: Results for Cu

Lab./Meth.	7/A-s	7/I-s	9/XRF	9/I-a	11/A-s	6/I-a	9/I-s	8/I-a	5/I-a	8/XRF	2/I-a	4/I-s	10/I-a		
M_i [%]	0.297	0.2992	0.3261	0.2931	0.3040	0.307	0.3168	0.3092	0.3154	0.3188	0.3257	0.3240	0.320		n
	0.296	0.2999	0.3102	0.3011	0.3016	0.309	0.3118	0.3188	0.3164	0.3181	0.3245	0.3180	0.325		13
	0.297	0.3005	0.2763	0.3054	0.3045	0.309	0.3118	0.3150	0.3157	0.3181	0.3197	0.3220	0.321		
	0.295	0.2995	0.2946	0.3019	0.3079	0.308	0.3168	0.3169	0.3160	0.3186	0.3197	0.3210	0.321		
	0.298	0.3002	0.3078	0.3142	0.3058	0.309	0.3168	0.3166	0.3169	0.3184	0.3202	0.3220	0.323		
	0.290	0.2990	0.2894		0.3006	0.309	0.3138	0.3148	0.3168	0.3184	0.3197	0.3240	0.322		
M [%]	**0.2955**	**0.2997**	**0.3007**	**0.3031**	**0.3041**	**0.3085**	**0.3147**	**0.3152**	**0.3162**	**0.3184**	**0.3216**	**0.3218**	**0.3220**		**0.3109**
s [%]	0.0029	0.0006	0.0176	0.0076	0.0027	0.0008	0.0025	0.0033	0.0006	0.0003	0.0028	0.0022	0.0018	s_M [%]	0.0094
														$\bar{s}_i$ [%]	0.0057
s_{rel}	0.00975	0.00195	0.05847	0.02523	0.00882	0.00271	0.00789	0.01043	0.00188	0.00083	0.00856	0.00692	0.00556		0.03012

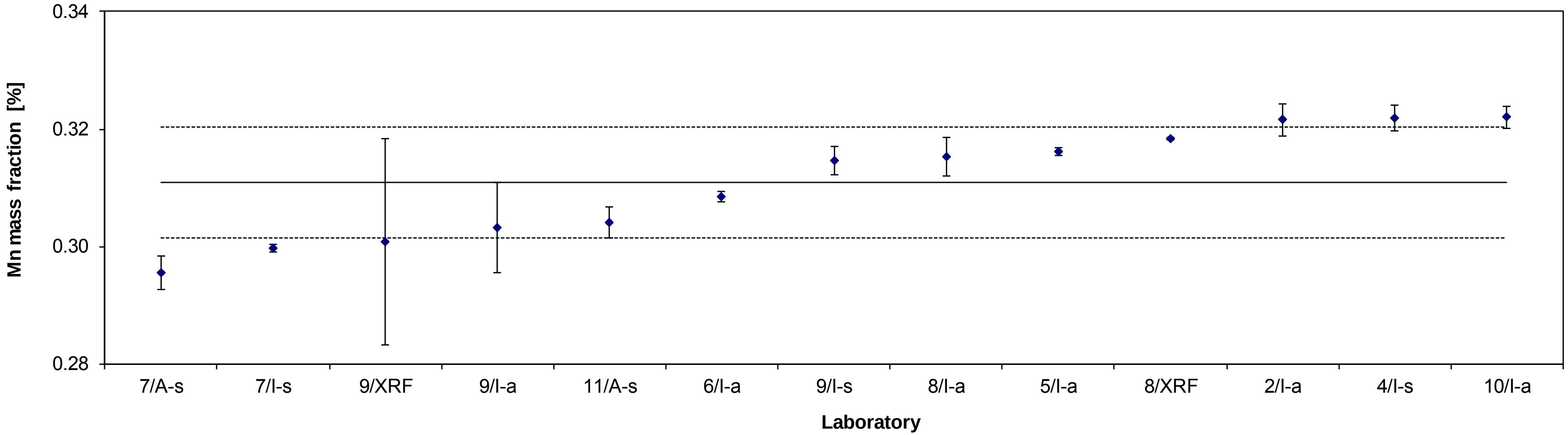

Table 5: Results for Mn

Lab./Meth.	9/I-a	9/I-s	8/I-a	8/XRF	4/I-s	5/I-a	7/A-s(R)	7/I-s	11/A-s	6/I-a(R)	10/I-a	2/I-a		
M_i [%]	0.417	0.442	0.435	0.444	0.448	0.446	0.448	0.451	0.457	0.446	0.451	0.459		*n*
	0.433	0.428	0.447	0.443	0.442	0.450	0.452	0.450	0.446	0.451	0.453	0.454		12
	0.435	0.435	0.439	0.444	0.447	0.446	0.447	0.451	0.446	0.455	0.448	0.451		
	0.430	0.439	0.441	0.443	0.445	0.449	0.451	0.450	0.452	0.449	0.449	0.448		
	0.449	0.446	0.441	0.443	0.446	0.449	0.449	0.450	0.454	0.453	0.454	0.450		
		0.433	0.434	0.444	0.447	0.448	0.448	0.451	0.449	0.453	0.452	0.450		
***M* [%]**	**0.4326**	**0.4372**	**0.4394**	**0.4436**	**0.4458**	**0.4481**	**0.4492**	**0.4504**	**0.4506**	**0.4512**	**0.4512**	**0.4521**		**0.4459**
s [%]	0.0115	0.0065	0.0048	0.0004	0.0021	0.0016	0.0019	0.0003	0.0044	0.0033	0.0023	0.0039	s_M [%]	0.0064
													$\bar{s}_i$ [%]	0.0046
s_{rel}	0.02657	0.01485	0.01085	0.00093	0.00479	0.00351	0.00428	0.00074	0.00978	0.00720	0.00513	0.00871		0.01440

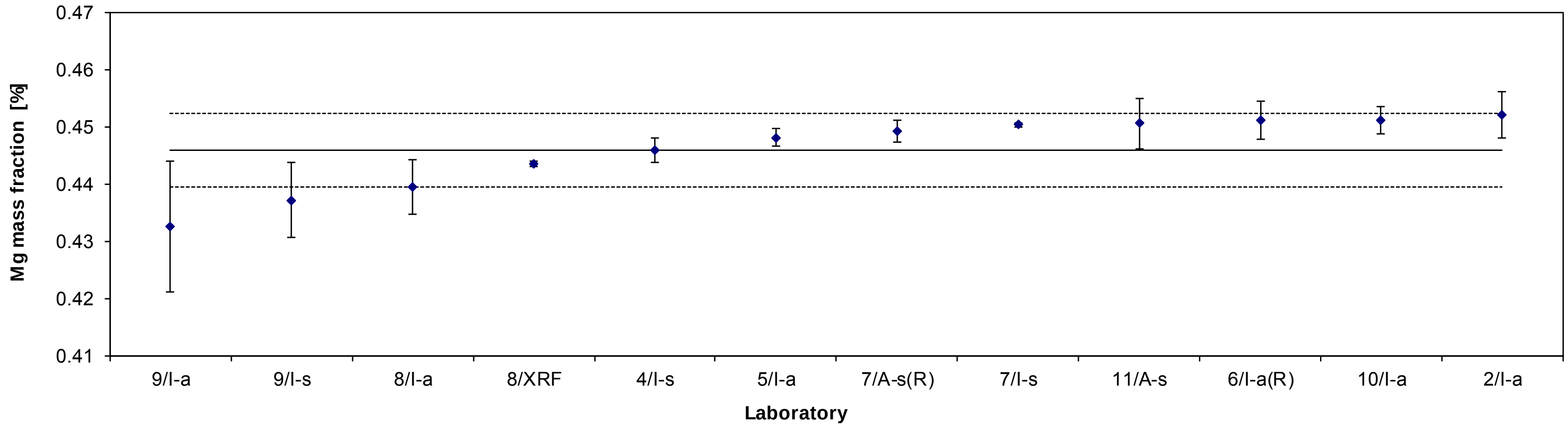

Table 6: Results for Mg

Lab./Meth.	8/I-a	8/XRF	9/I-s	6/I-a	5/I-a	9/IMS	2/I-a	10/I-a	11/A-s(R)	4/I-s		
M_i [%]	0.0265	0.0271	0.0276	0.027	0.0275	0.0271	0.0280	0.0280	0.0277	0.028		*n*
	0.0267	0.0271	0.0256	0.027	0.0274	0.0274	0.0277	0.0280	0.0278	0.028		10
	0.0264	0.0269	0.0276	0.027	0.0273	0.0276	0.0276	0.0279	0.0284	0.028		
	0.0271	0.0273	0.0276	0.028	0.0275	0.0278	0.0276	0.0277	0.0273	0.028		
	0.0269	0.0271	0.0276	0.028	0.0273	0.0273	0.0276	0.0275	0.0275	0.027		
	0.0269	0.0271	[0.0326]	0.027	0.0274	0.0286	0.0276	0.0270	0.0280	0.028		
***M* [%]**	**0.0268**	**0.0271**	**0.0272**	**0.0273**	**0.0274**	**0.0277**	**0.0277**	**0.0277**	**0.0278**	**0.0278**		**0.0274**
s [%]	0.0003	0.0001	0.0009	0.0005	0.0001	0.0005	0.0002	0.0004	0.0004	0.0004	s_M [%]	0.00035
											$\bar{s}_i$ [%]	0.00044
s_{rel}	0.00996	0.00530	0.03288	0.01889	0.00205	0.01915	0.00578	0.01397	0.01392	0.01467		0.01274

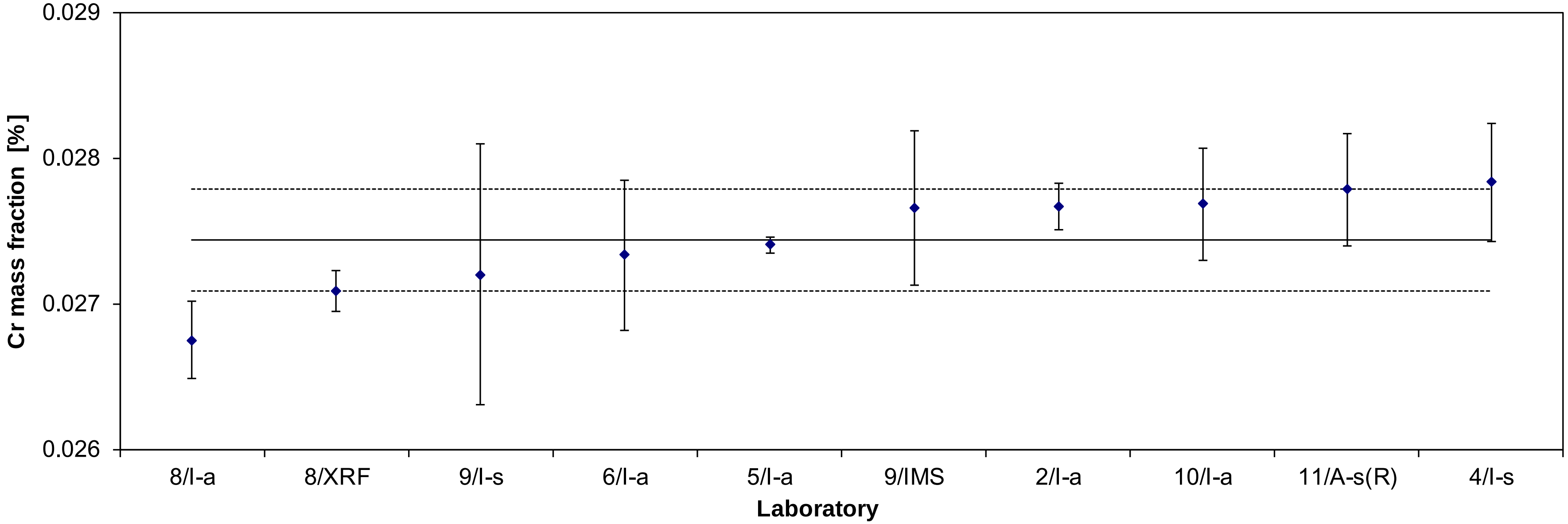

Table 7: Results for Cr

Lab./Meth.	9/I-a	9/I-s	9/XRF	11/A-s	9/IMS	8/I-a	6/I-a	5/I-a	9/EA	2/I-a	10/I-a	4/I-s	8/XRF	7/IMS	7/I-s		
M_i [%]	0.0858	0.091	0.0931	0.0935	0.0959	0.0938	0.094	0.0960	0.0973	0.0984	0.0969	0.098	0.0987	0.1011	0.1040		*n*
	0.0851	0.089	0.0989	0.0932	0.0959	0.0954	0.095	0.0962	0.0965	0.0972	0.0976	0.098	0.0987	0.0999	0.1001		15
	0.0912	0.090	0.0856	0.0936	0.0956	0.0944	0.095	0.0962	0.0966	0.0976	0.0964	0.099	0.0988	0.1019	0.1029		
	0.0873	0.090	0.0899	0.0946	0.0949	0.0959	0.095	0.0966	0.0968	0.0958	0.0964	0.099	0.0990	0.1018	0.1004		
	0.0947	0.090	0.0841	0.0912	0.0911	0.0950	0.096	0.0965	0.0973	0.0964	0.0971	0.097	0.0988	0.1011	0.1010		
		0.088		0.0923	0.0932	0.0953	0.095	0.0967		0.0959	0.0975	0.099	0.0986	0.1015	0.0996		
***M* [%]**	**0.0888**	**0.0897**	**0.0903**	**0.0931**	**0.0944**	**0.0950**	**0.0950**	**0.0964**	**0.0969**	**0.0969**	**0.0970**	**0.0983**	**0.0988**	**0.1012**	**0.1013**		**0.0955**
s [%]	0.0040	0.0010	0.0060	0.0012	0.0019	0.0008	0.0006	0.0003	0.0004	0.0010	0.0005	0.0008	0.0001	0.0007	0.0017	s_M [%]	0.0038
																$\bar{s}_i$ [%]	0.0021
s_{rel}	0.04556	0.01152	0.06608	0.01263	0.02040	0.00795	0.00666	0.00277	0.00369	0.01069	0.00535	0.00830	0.00116	0.00719	0.01713		0.04007

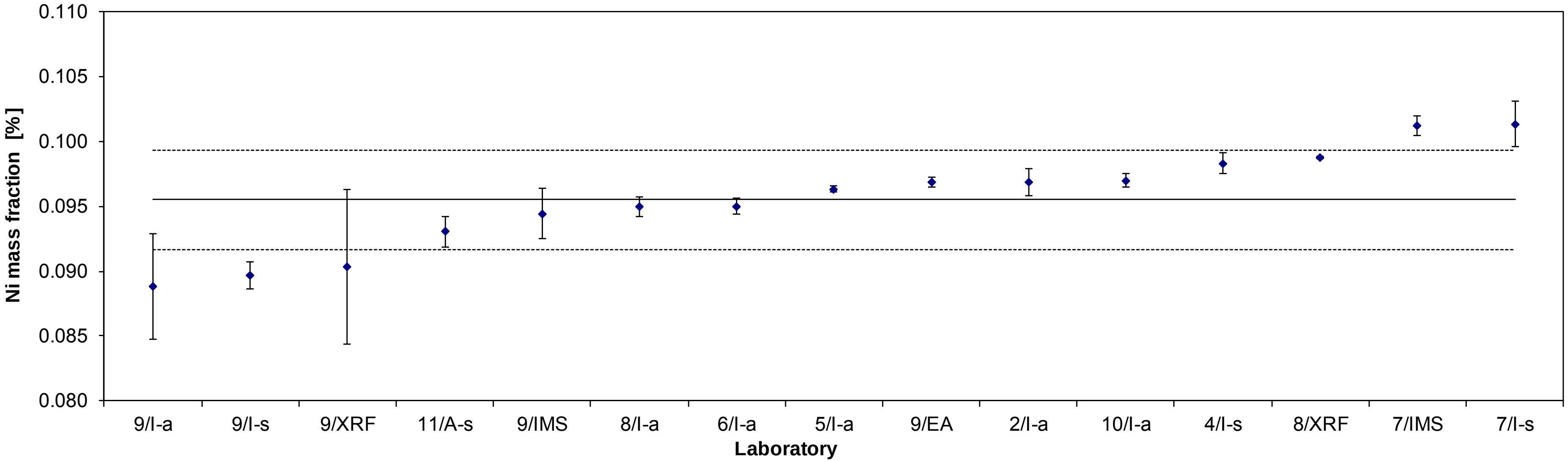

Table 8: Results for Ni

Lab./Meth.	**8/XRF**	**10/I-a**	**9/I-a**	**9/I-s**	**8/I-a**	**7/I-s**	**6/I-a**	**4/I-s**	**7/A-s(R)**	**11/A-s**	**2/I-a**	**5/I-a**		
M_i [%]	0.782	0.791	0.767	0.808	0.7826	0.802	0.805	0.808	0.806	0.7993	0.822	0.8144		*n*
	0.782	0.797	0.819	0.782	0.8047	0.803	0.801	0.806	0.807	0.8148	0.811	0.8130		12
	0.782	0.793	0.783	0.794	0.7966	0.802	0.802	0.802	0.804	0.8039	0.809	0.8100		
	0.781	0.789	0.802	0.801	0.8003	0.802	0.808	0.799	0.805	0.8390	0.806	0.8123		
	0.781	0.795	0.791	0.809	0.8017	0.802	0.800	0.808	0.807	0.8144	0.809	0.8139		
	0.781	0.788		0.785	0.7992	0.802	0.801	0.800	0.807	0.7743	0.809	0.8142		
***M* [%]**	**0.7815**	**0.7922**	**0.7923**	**0.7965**	**0.7975**	**0.8023**	**0.8028**	**0.8038**	**0.8059**	**0.8076**	**0.8110**	**0.8130**		**0.8005**
s [%]	0.0006	0.0035	0.0194	0.0115	0.0078	0.0003	0.0031	0.0040	0.0011	0.0213	0.0057	0.0017	s_M [%]	0.0090
													$\bar{s}_i$ [%]	0.0096
s_{rel}	0.00082	0.00440	0.02452	0.01440	0.00976	0.00042	0.00381	0.00500	0.00138	0.02641	0.00703	0.00204		0.01124

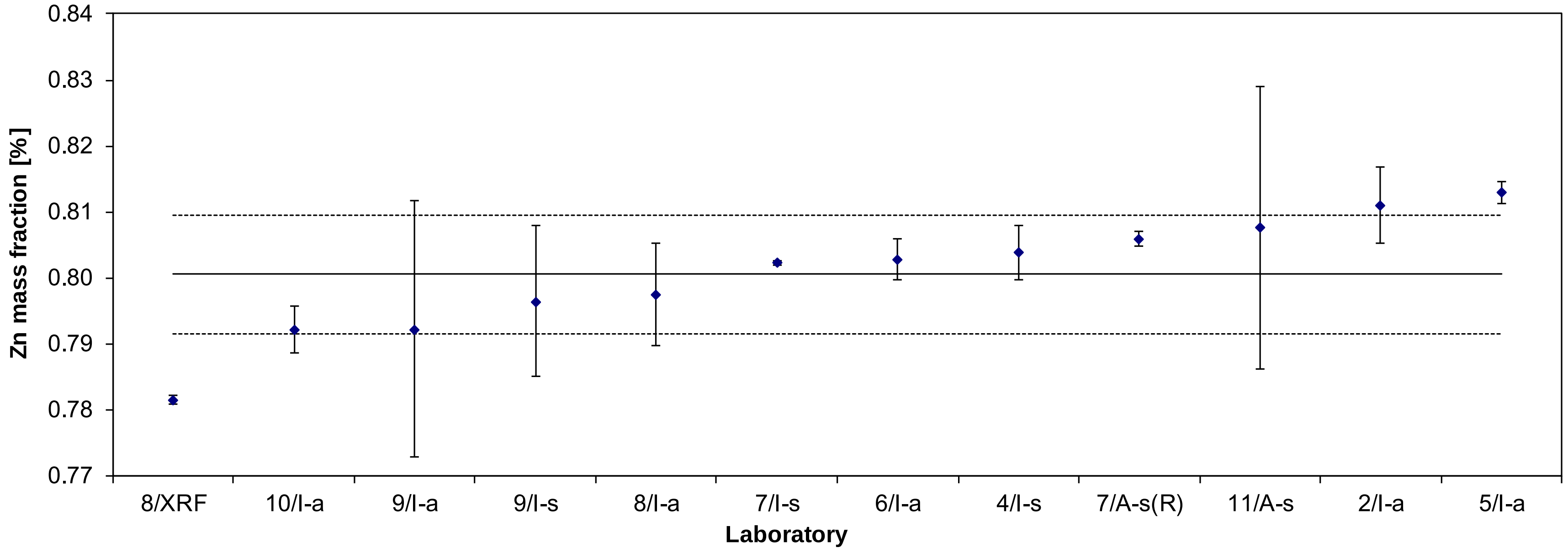

Table 9: Results for Zn

Lab./Meth.	9/I-s	6/I-a	7/I-s	8/I-a	5/I-a	9/I-a	10/I-a	8/XRF	2/I-a	9/P	4/I-s		
M_i [%]	0.138	0.138	0.1391	0.1373	0.1412	0.1366	0.1430	0.1430	0.1465	0.1442	0.148		*n*
	0.135	0.138	0.1393	0.1424	0.1413	0.1434	0.1418	0.1435	0.1452	0.1458	0.146		11
	0.136	0.138	0.1406	0.1407	0.1410	0.1411	0.1420	0.1434	0.1445	0.1426	0.148		
	0.138	0.138	0.1396	0.1417	0.1415	0.1422	0.1418	0.1433	0.1423	0.1457	0.148		
	0.138	0.138	0.1414	0.1417	0.1414	0.1439	0.1415	0.1435	0.1421	0.1446	0.146		
	0.135	0.138	0.1404	0.1411	0.1411		0.1421	0.1432	0.1418	0.1444	0.148		
***M* [%]**	**0.1367**	**0.1380**	**0.1401**	**0.1408**	**0.1412**	**0.1414**	**0.1420**	**0.1433**	**0.1437**	**0.1446**	**0.1473**		**0.1417**
s [%]	0.0015	0.0000	0.0009	0.0018	0.0002	0.0029	0.0005	0.0002	0.0019	0.0012	0.0010	s_M [%]	0.0030
												$\bar{s}_i$ [%]	0.0014
s_{rel}	0.01102	0.00000	0.00632	0.01291	0.00142	0.02062	0.00364	0.00133	0.01346	0.00807	0.00701		0.02111

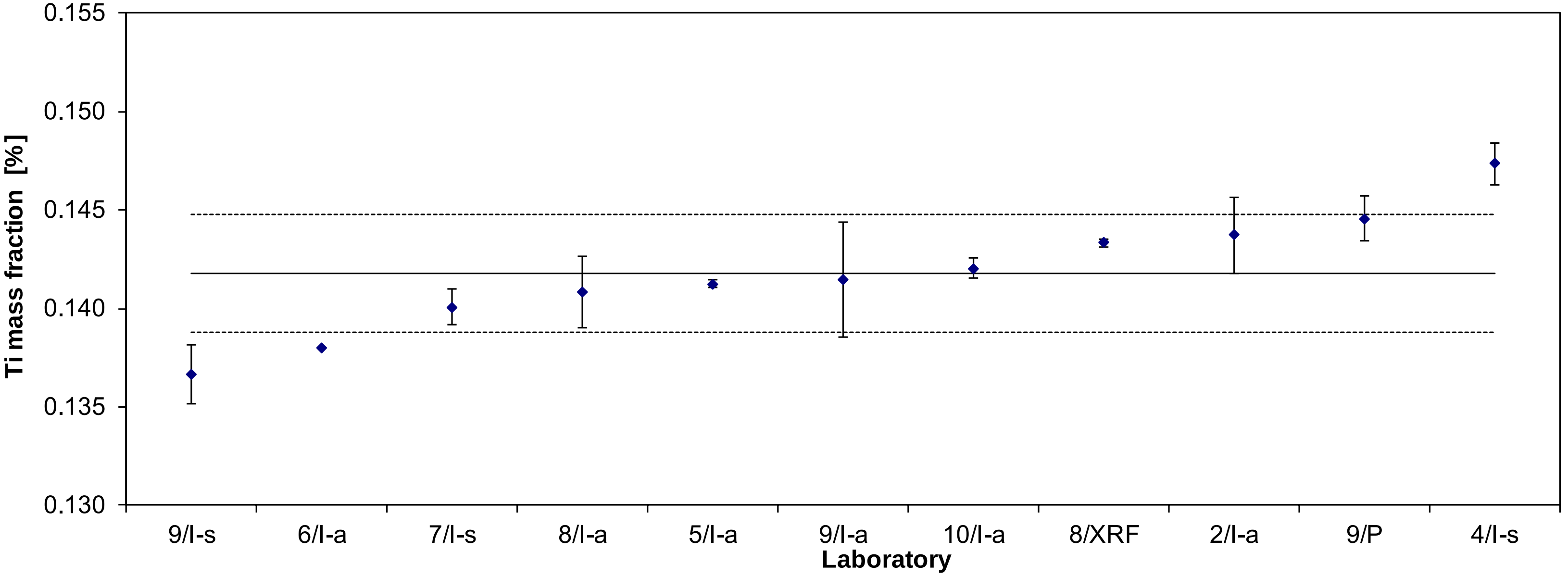

Table 10: Results for Ti

Lab./Meth.	9/I-s	9/IMS	2/IMS	8/I-a	9/I-a	5/I-a	6/I-a	4/I-s(R)	10/I-a		
M_i [%]	0.009	0.0087	0.0088	0.0086	0.0086	0.0091	0.009	0.0089	0.0091		*n*
	0.008	0.0087	0.0089	0.0088	0.0096	0.0090	0.009	0.0091	0.0088		9
	0.008	0.0087	0.0089	0.0086	0.0085	0.0089	0.009	0.0090	0.0090		
	0.009	0.0088	0.0088	0.0091	0.0090	0.0091	0.009		0.0095		
	0.009	0.0086	0.0088	0.0086	0.0086	0.0089	0.009		0.0089		
	0.008	0.0089	0.0087	0.0095		0.0090	0.009		0.0094		
***M* [%]**	**0.0085**	**0.0087**	**0.0088**	**0.0089**	**0.0089**	**0.0090**	**0.0090**	**0.0090**	**0.0091**		**0.0089**
s [%]	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	s_M [%]	0.0002
										$\bar{s}_i$ [%]	0.0003
s_{rel}	0.064	0.012	0.009	0.041	0.051	0.006	0.000	0.011	0.031		0.021

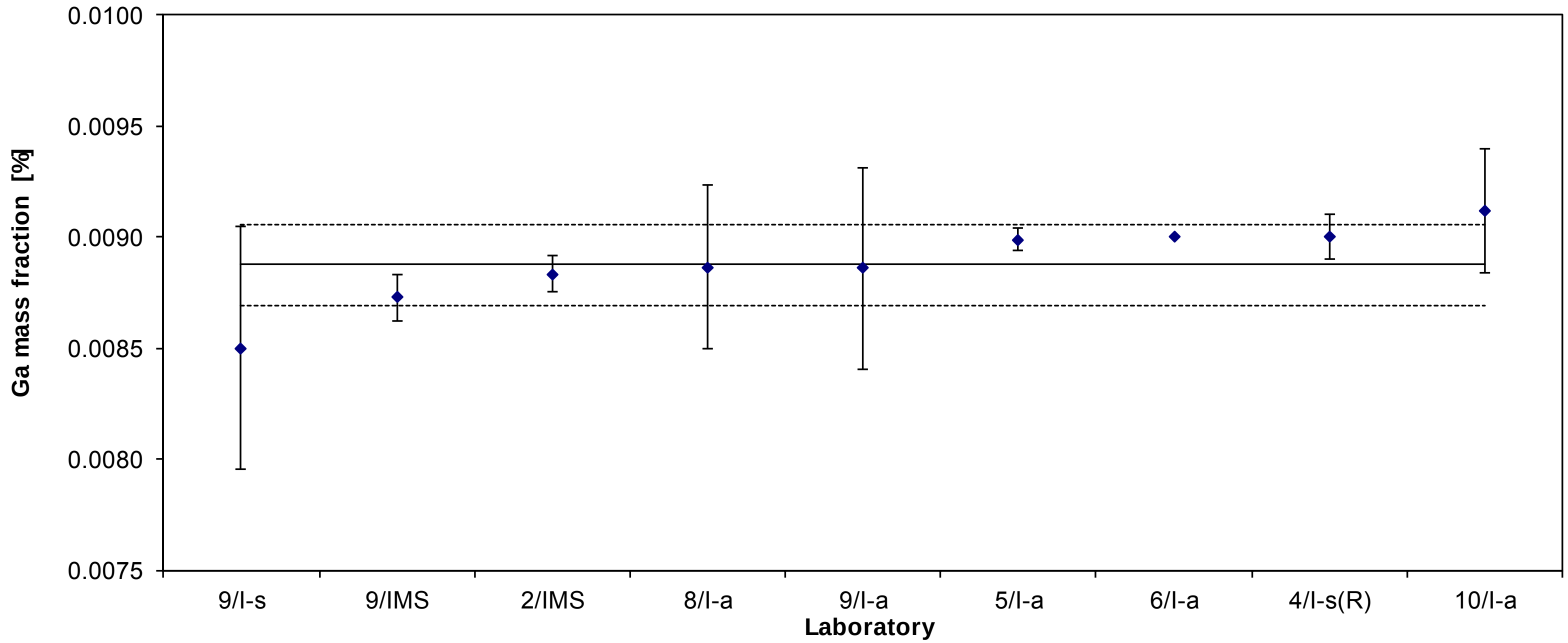

Table 11: Results for Ga

Lab./Meth.	9/I-a	11/A-s	9/I-s	4/I-s	6/I-a	10/I-a(R)	5/I-a	2/I-s	8/I-a	9/IMS	7/IMS	7/I-s	9/EA	8/XRF		
M_i [%]	0.0684	0.0741	0.073	0.075	0.075	0.0796	0.0769	0.0774	0.0767	0.0782	0.0791	0.0802	0.0815	0.0846		*n*
	0.0692	0.0730	0.072	0.074	0.075	0.0815	0.0768	0.0766	0.0796	0.0791	0.0823	0.0798	0.0816	0.0845		14
	0.0721	0.0741	0.072	0.074	0.076	0.0793	0.0765	0.0766	0.0770	0.0785	0.0800	0.0809	0.0815	0.0845		
	0.0691	0.0736	0.073	0.073	0.076	0.0731	0.0770	0.0767	0.0800	0.0799	0.0783	0.0798	0.0809	0.0843		
	0.0742	0.0675	0.074	0.071	0.076	0.0728	0.0776	0.0777	0.0785	0.0787	0.0807	0.0795	0.0818	0.0846		
		0.0735	0.073	0.073	0.077	0.0729	0.0775	0.0772	0.0789	0.0811	0.0801	0.0804	0.0814	0.0844		
***M* [%]**	**0.0706**	**0.0726**	**0.0728**	**0.0733**	**0.0758**	**0.0765**	**0.0770**	**0.0770**	**0.0785**	**0.0793**	**0.0801**	**0.0801**	**0.0814**	**0.0845**		**0.0771**
s [%]	0.0025	0.0026	0.0008	0.0014	0.0008	0.0040	0.0004	0.0005	0.0013	0.0011	0.0014	0.0005	0.0003	0.0001	s_M [%]	0.0039
															$\bar{s}_i$ [%]	0.0016
s_{rel}	0.03488	0.03517	0.01034	0.01863	0.00993	0.05248	0.00512	0.00603	0.01719	0.01326	0.01717	0.00632	0.00381	0.00138		0.05012

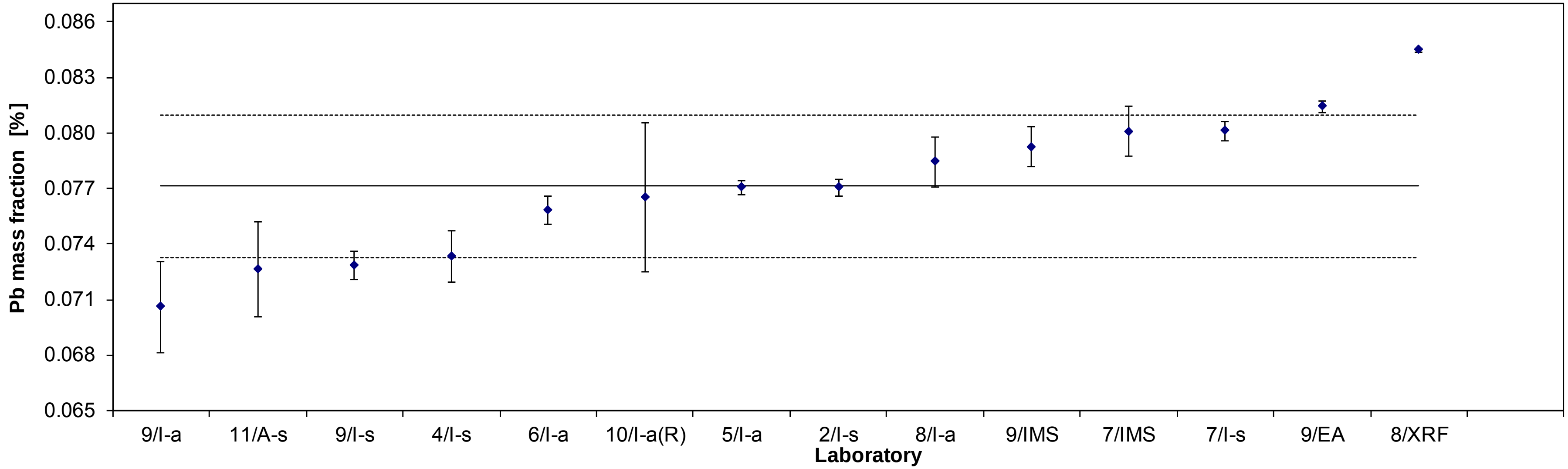

Table 12: Results for Pb

Lab./Meth.	8/XRF	6/I-a	9/I-s	8/I-a	2/I-a	5/I-a	10/I-a	4/I-s	7/I-s	9/IMS		
M_i [%]	0.0730	0.074	0.075	0.0747	0.0772	0.0764	0.0797	0.079	0.0795	0.0788		*n*
	0.0728	0.073	0.072	0.0753	0.0761	0.0765	0.0763	0.078	0.0795	0.0797		10
	0.0730	0.074	0.074	0.0750	0.0764	0.0764	0.0775	0.079	0.0796	0.0801		
	0.0729	0.073	0.075	0.0755	0.0754	0.0769	0.0787	0.078	0.0801	0.0805		
	0.0729	0.073	0.075	0.0755	0.0752	0.0768	0.0760	0.077	0.0795	0.0784		
	0.0727	0.073	0.073	0.0744	0.0755	0.0767	0.0793	0.078	0.0796	0.0827		
***M* [%]**	**0.0729**	**0.0733**	**0.0740**	**0.0751**	**0.0760**	**0.0766**	**0.0779**	**0.0782**	**0.0796**	**0.0800**		**0.0764**
s [%]	0.0001	0.0005	0.0013	0.0005	0.0008	0.0002	0.0016	0.0008	0.0002	0.0015	s_M [%]	0.0026
											$\bar{s}_i$ [%]	0.0009
s_{rel}	0.00179	0.00704	0.01709	0.00600	0.00991	0.00258	0.02002	0.00963	0.00294	0.01890		0.03342

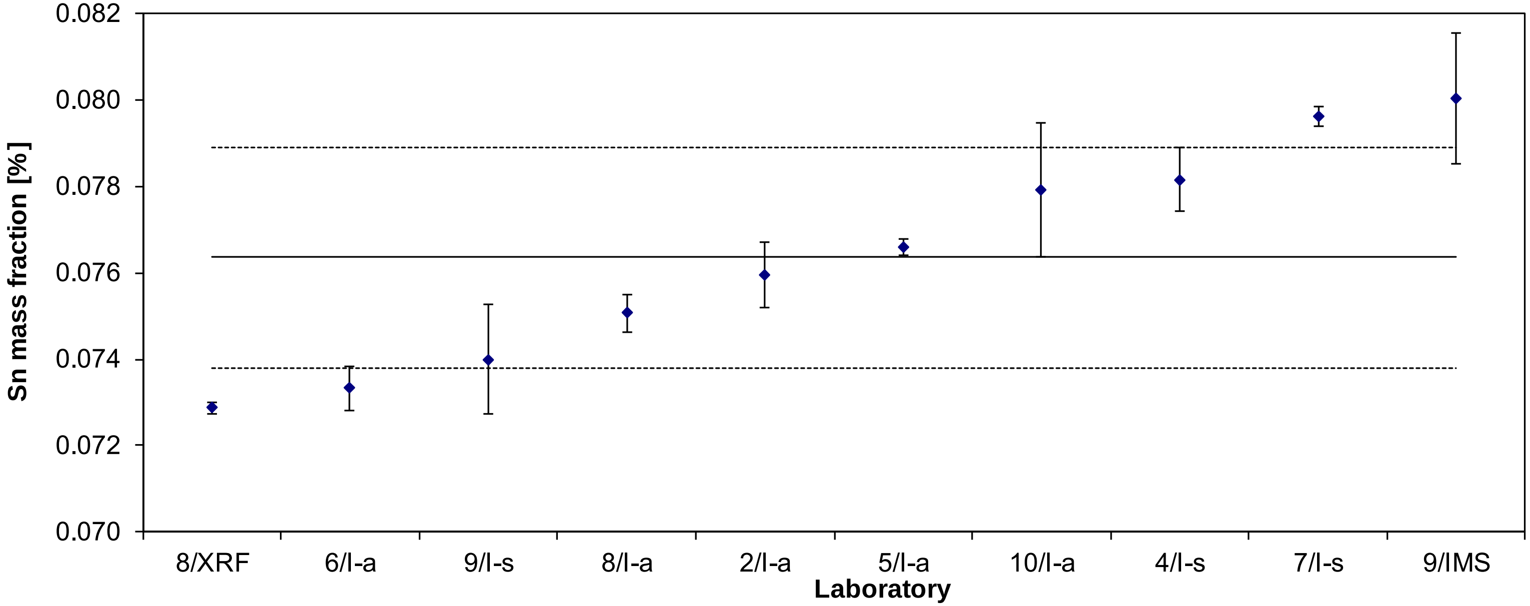

Table 13: Results for Sn

Lab./Meth.	8/I-s	10/I-a	6/I-a	7/IMS	2/IMS	4/I-s	9/EA	5/I-a	9/IMS		
M_i [mg/kg]	4.0	4.1	4.3	4.2	4.2	4.3	4.5	4.6	4.6		n
	4.0	4.1	4.3	4.5	4.1	4.4	4.5	4.5	4.4		9
	4.0	4.2	4.3	4.2	4.4	4.3	4.5	4.5	4.6		
	4.0	4.2	4.4	4.2	4.3	4.2	4.4	4.5	4.7		
	4.0	4.1	4.3	4.3	4.5	4.4	4.4	4.5	4.5		
	4.0	4.1	4.2	4.3	4.3	4.3	4.5	4.5	4.6		
M [mg/kg]	**4.00**	**4.13**	**4.29**	**4.29**	**4.31**	**4.33**	**4.47**	**4.52**	**4.59**		**4.33**
s [mg/kg]	0.000	0.052	0.061	0.116	0.143	0.072	0.040	0.041	0.107	s_M [mg/kg]	0.185
										$\bar{s}_i$ [mg/kg]	0.082
s_{rel}	0.000	0.012	0.014	0.027	0.033	0.017	0.009	0.009	0.023		0.043

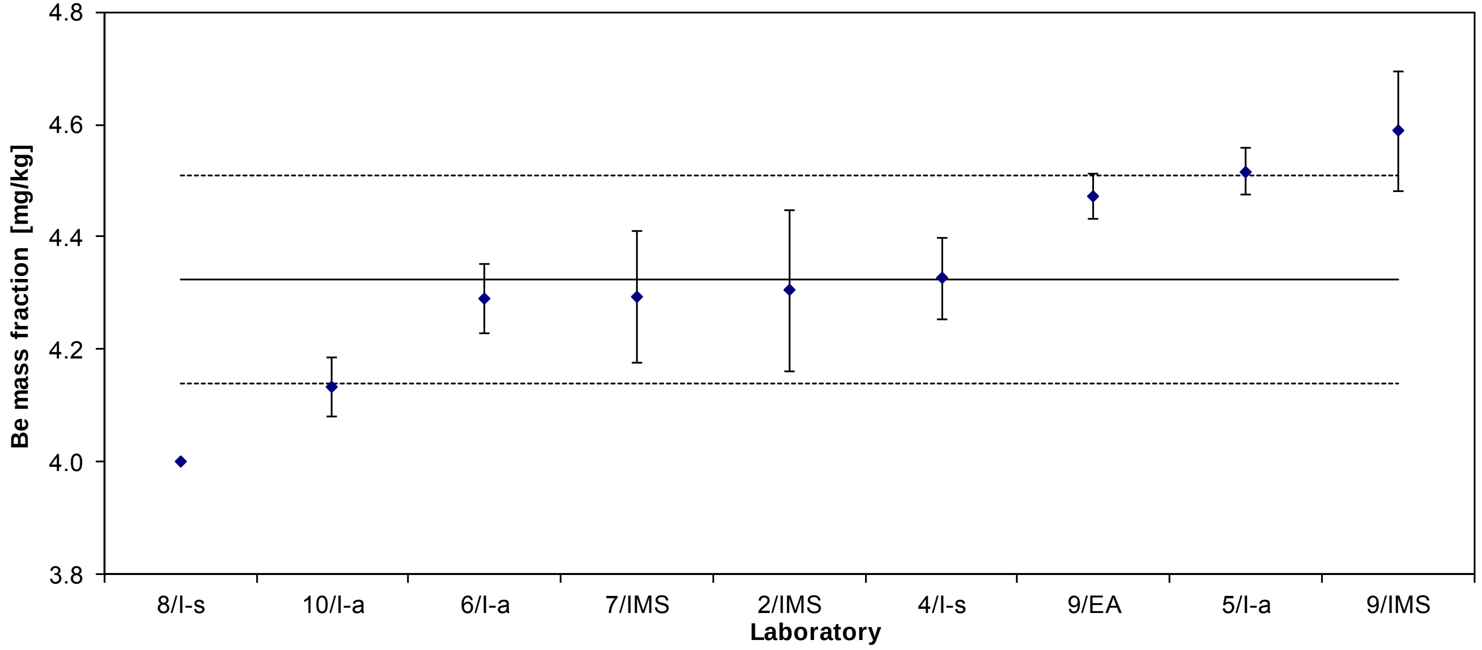

Table 14: Results for Be

Lab./Meth.	9/I-s	4/I-s	5/I-a	9/IMS	2/IMS	6/I-s	9/EA	7/I-s(R)	7/IMS		
M_i [mg/kg]	32.0	32.4	35.8	34.3	36.3	38.5	39.2	37.4	40.8		*n*
	31.7	33.4	32.6	34.4	36.4	39.8	39.7	40.6	41.0		9
	32.0	33.4	35.2	34.5	36.3	37.9	38.6	39.6	39.2		
	34.2	33.4	35.1	34.9	37.1	36.7	38.6	38.8	38.7		
	33.4	33.0	33.8	33.9	36.4	37.7	40.4	41.4	38.8		
	34.8	33.3	32.6	34.4	36.2	36.2		39.7	39.7		
***M* [mg/kg]**	**33.01**	**33.15**	**34.18**	**34.41**	**36.46**	**37.80**	**39.31**	**39.58**	**39.71**		**36.40**
s [mg/kg]	1.293	0.383	1.389	0.336	0.330	1.287	0.772	1.407	1.009	s_M [mg/kg]	2.794
										$\bar{s}_i$ [mg/kg]	1.012
s_{rel}	0.039	0.012	0.041	0.010	0.009	0.034	0.020	0.036	0.025		0.077

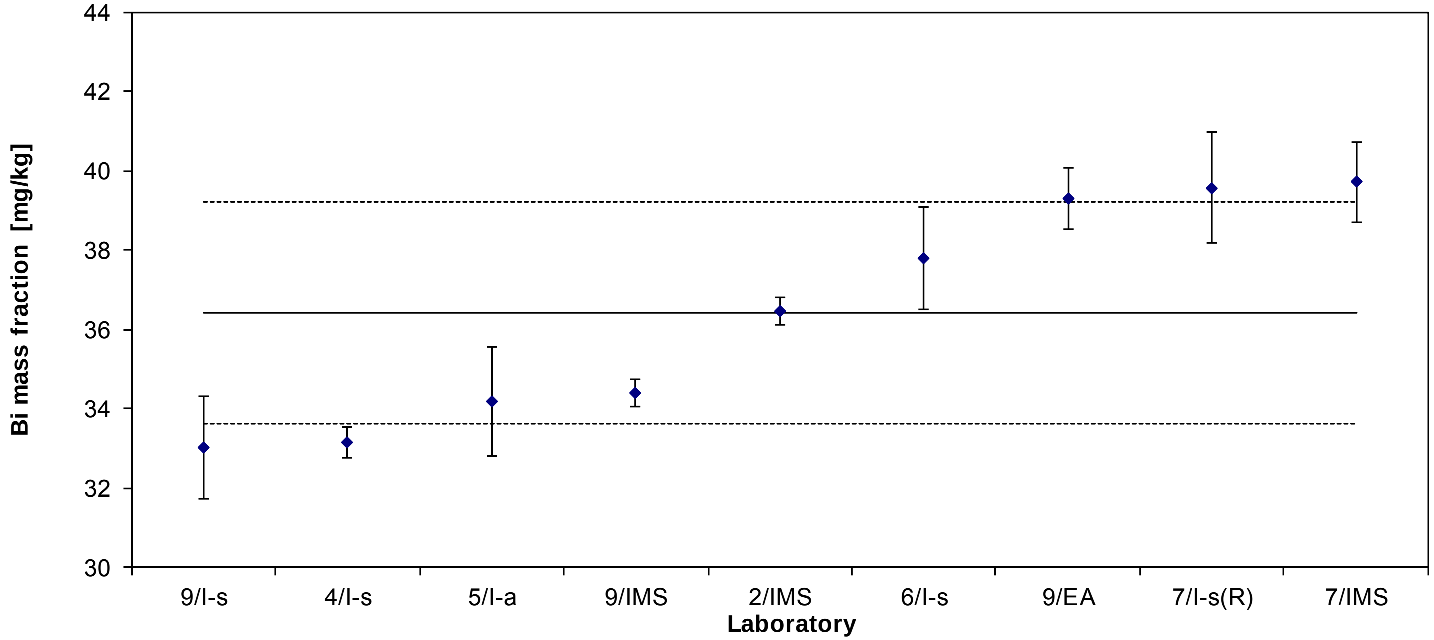

Table 15: Results for Bi

Lab./Meth.	11/A-s	2/IMS	4/I-s	9/EA	9/I-s	9/IMS	8/I-s	5/I-a	7/IMS	7/I-s(R)	6/I-a	10/I-a		
M_i [mg/kg]	7.1	7.25	7.2	7.79	7.9	7.7	8.0	8.3	8.1	8.3	8.8	11.1		*n*
	7.2	7.39	7.6	7.57	7.6	7.7	8.0	8.1	8.6	8.0	8.9	11.4		11
	7.3	7.26	7.3	7.60	7.6	7.7	8.0	8.0	8.2	8.2	8.9	10.8		
	7.2	7.57	7.3	7.48	7.7	7.9	8.0	8.1	8.1	8.2	8.9	10.4		
	6.7	7.20	7.5	7.62	7.9	7.6	8.0	8.0	8.5	8.5	9.1	10.9		
	7.1	7.29	7.5	7.66	7.7	7.9	8.0	8.1	8.9	9.5	8.9	10.9		
M [mg/kg]	**7.08**	**7.33**	**7.38**	**7.62**	**7.72**	**7.75**	**8.00**	**8.10**	**8.40**	**8.43**	**8.93**	**10.92**		**7.88**
s [mg/kg]	0.207	0.133	0.166	0.103	0.118	0.112	0.000	0.110	0.338	0.545	0.116	0.331	s_M [mg/kg]	0.551
													$\bar{s}_i$ [mg/kg]	0.226
s_{rel}	0.029	0.018	0.022	0.014	0.015	0.014	0.000	0.014	0.040	0.065	0.013	0.030		0.070

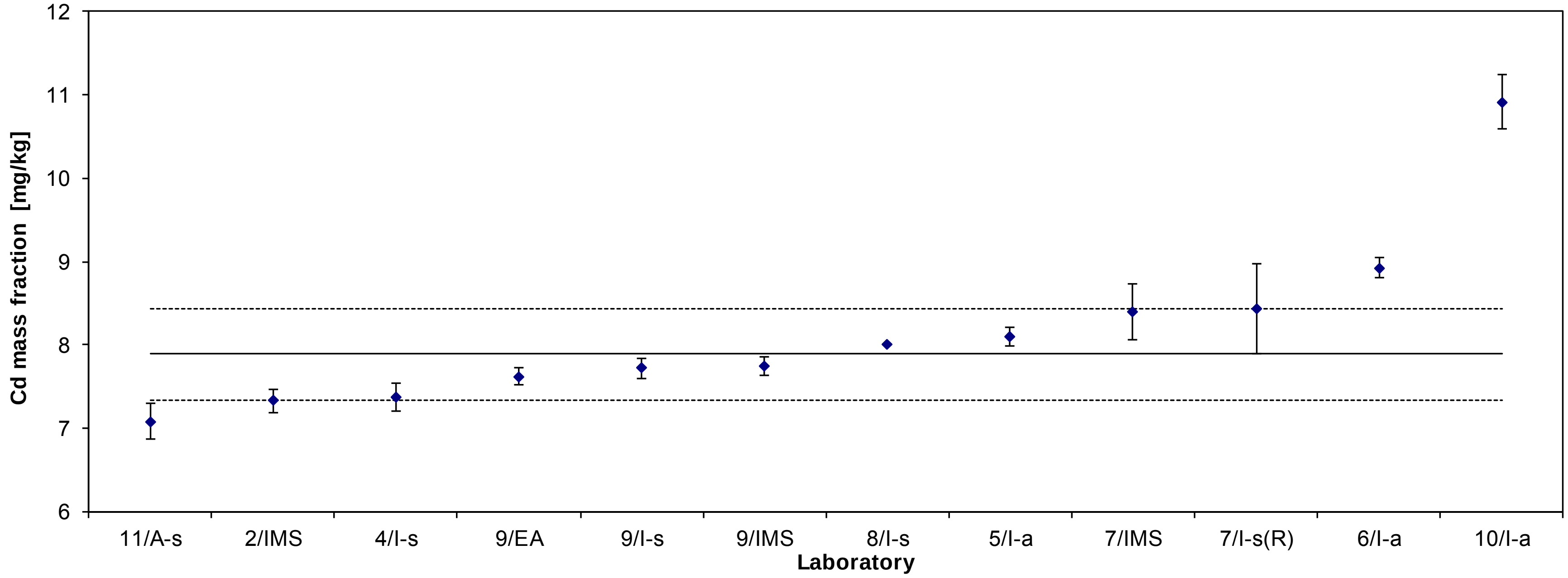

Table 16: Results for Cd

Lab./Meth.	9/I-s	10/I-a	8/I-s(R)	4/I-s	9/IMS	2/IMS	7/I-s(R)	7/IMS	6/I-s		
M_i [mg/kg]	42.5	43.7	47.0	50.1	54.2	55.6	51.7	54.1	57.4		*n*
	43.5	42.7	50.0	48.7	54.3	55.3	57.6	57.1	57.5		9
	43.7	42.5	37.0	47.7	54.3	55.5	56.8	54.8	56.1		
	44.4	45.1	48.0	48.0	55.3	53.8	56.6	56.4	58.6		
	42.0	44.7	42.0	48.9	53.3	54.4	53.3	56.8	56.7		
	40.5	45.7	49.0	47.2	55.4	54.0	55.1	56.9	54.4		
***M* [mg/kg]**	**42.77**	**44.07**	**45.50**	**48.42**	**54.47**	**54.74**	**55.20**	**56.02**	**56.78**		**50.88**
s [mg/kg]	1.386	1.311	5.010	1.023	0.782	0.777	2.288	1.254	1.439	s_M [mg/kg]	5.643
										$\bar{s}_i$ [mg/kg]	2.178
s_{rel}	0.032	0.030	0.110	0.021	0.014	0.014	0.041	0.022	0.025		0.111

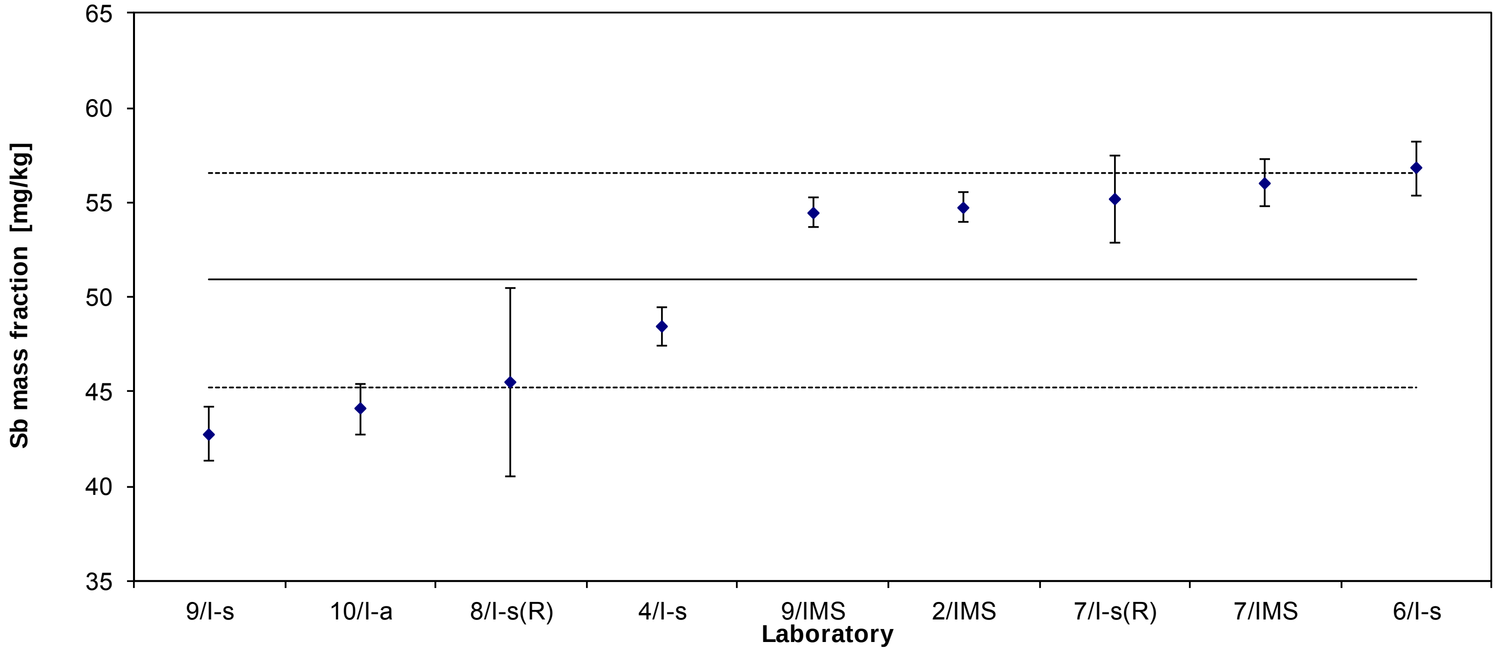

Table 17: Results for Sb

Lab./Meth.	**7/I-s**	**9/IMS**	**10/I-a(R)**	**2/IMS**	**4/I-s**	**9/I-s**	**6/I-a**	**8/I-s**	**5/I-a**	**8/XRF**	**9/P**	**7/IMS**		
M_i [mg/kg]	44.1	44.2	46.3	46.4	47.7	47.9	47.4	47.0	48.6	49.7	48.5	51.2		*n*
	44.0	44.4	47.1	46.1	47.6	46.5	47.3	48.0	48.5	51.1	48.5	50.0		12
	43.9	44.4	46.6	46.6	46.7	47.3	47.4	47.0	48.6	49.1	49.2	50.7		
	44.0	44.8	46.9	47.4	46.4	47.6	47.7	48.0	48.7	48.0	48.6	49.6		
	43.9	43.5	46.0	46.9	47.3	47.7	47.6	47.0	48.7	47.8	49.8	49.5		
	44.1	44.7	45.8	47.2	46.2	46.6	47.4	48.0	48.5	48.7	49.9	49.8		
***M* [mg/kg]**	**44.0**	**44.3**	**46.5**	**46.8**	**47.0**	**47.3**	**47.5**	**47.5**	**48.6**	**49.1**	**49.1**	**50.1**		**47.3**
s [mg/kg]	0.072	0.489	0.509	0.487	0.659	0.566	0.151	0.548	0.089	1.218	0.674	0.677	s_M [mg/kg]	1.83
													$\bar{s}_i$ [mg/kg]	0.59
s_{rel}	0.002	0.011	0.011	0.010	0.014	0.012	0.003	0.012	0.002	0.025	0.014	0.014		0.039

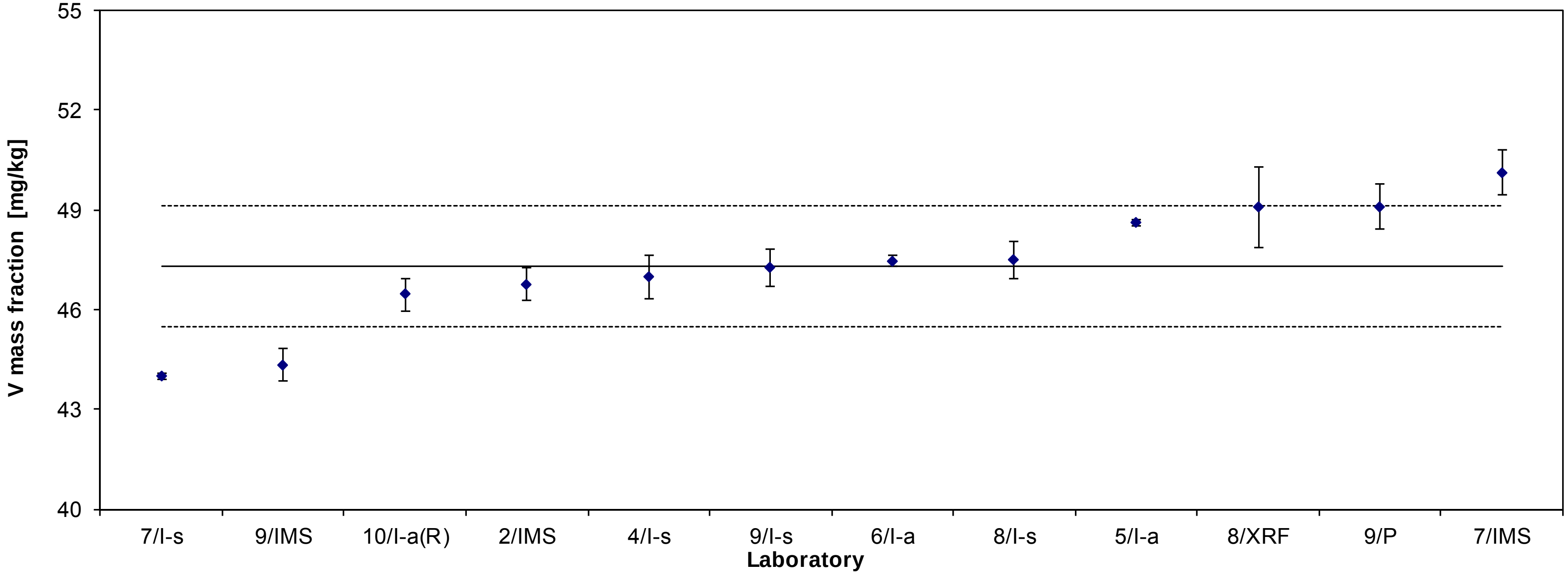

Table 18: Results for V

Lab./Meth.	9/IMS	6/I-a	8/XRF(R)	7/I-s	9/P	10/I-a(R)	5/I-a	2/I-s	7/IMS	9/I-s	8/I-s	4/I-s		
M_i [mg/kg]	28.5	29.9	30	30.1	30.4	31.0	31.0	31.0	30.2	34.9	32.0	34.0		*n*
	30.1	29.8	30	29.9	30.1	31.5	31.0	31.0	31.8	32.3	31.0	35.5		12
	28.7	30.2	30	29.9	30.3	31.8	31.2	31.3	30.9	31.0	32.0	33.9		
	28.5	29.9	30	29.9	30.6	30.6	31.1	31.1	30.5	31.0	32.0	33.5		
	27.4	29.8	30	30.1	30.8	29.6	31.0	31.3	31.4	31.0	32.0	36.1		
	28.9	29.9	30	30.2	30.6	30.3	30.9	31.1	32.0	30.3	32.0	35.0		
***M* [mg/kg]**	**28.7**	**29.9**	**30.0**	**30.0**	**30.5**	**30.8**	**31.0**	**31.1**	**31.1**	**31.7**	**31.8**	**34.7**		**31.0**
s [mg/kg]	0.86	0.16	0.00	0.12	0.25	0.81	0.10	0.13	0.72	1.68	0.41	1.04	s_M [mg/kg]	1.46
													$\bar{s}_i$ [mg/kg]	0.71
s_{rel}	0.030	0.005	0.000	0.004	0.008	0.026	0.003	0.004	0.023	0.053	0.013	0.030		0.047

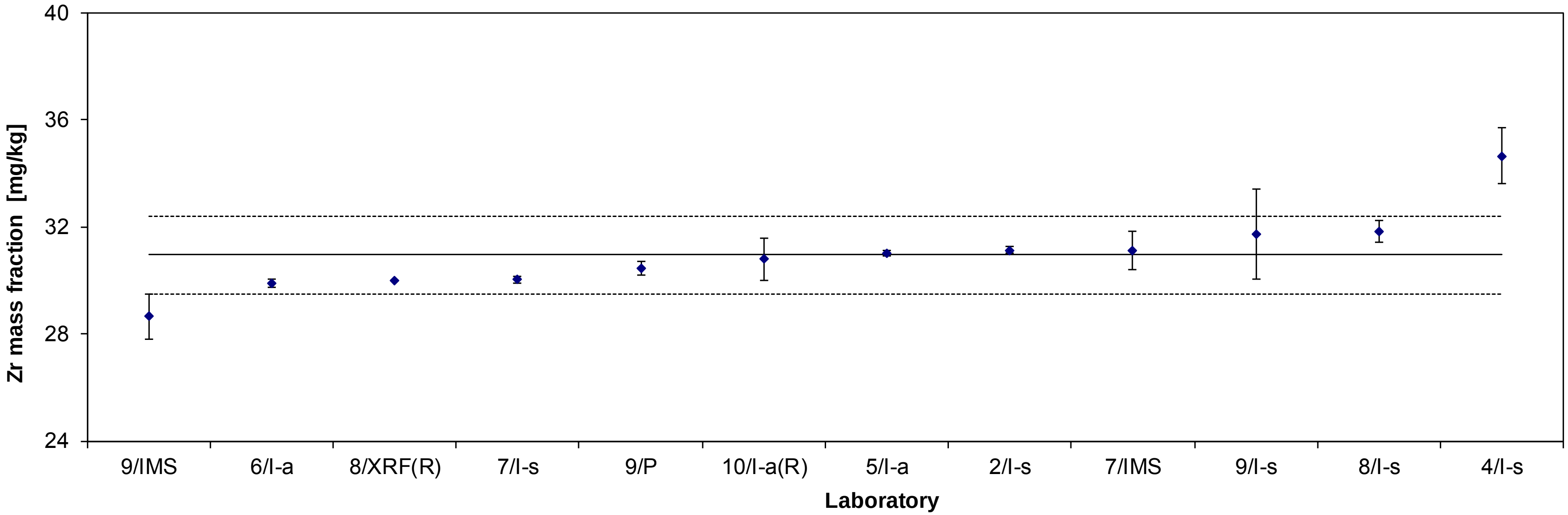

Table 19: Results for Zr

Lab./Meth.	2/IMS	5/I-a	9/IMS	6/I-s	4/I-s		
M_i [mg/kg]	0.2	2.4	2.6	3.7	<1		*n*
	0.2	1.9	2.0	2.7	<1		4
	0.2	2.2	3.1	4.2	<1		
	0.5	1.9	4.4	3.1	<1		
	0.4	2.4	3.0	2.2	<1		
	0.5	2.3	2.8	2.5	<1		
M [mg/kg]	**0.30**	**2.18**	**2.99**	**3.07**	**<1**		**2.14**
s [mg/kg]	0.142	0.232	0.794	0.761		s_M [mg/kg]	1.285
						$\bar{s}_i$ [mg/kg]	0.566
s_{rel}	0.467	0.106	0.265	0.248			0.602

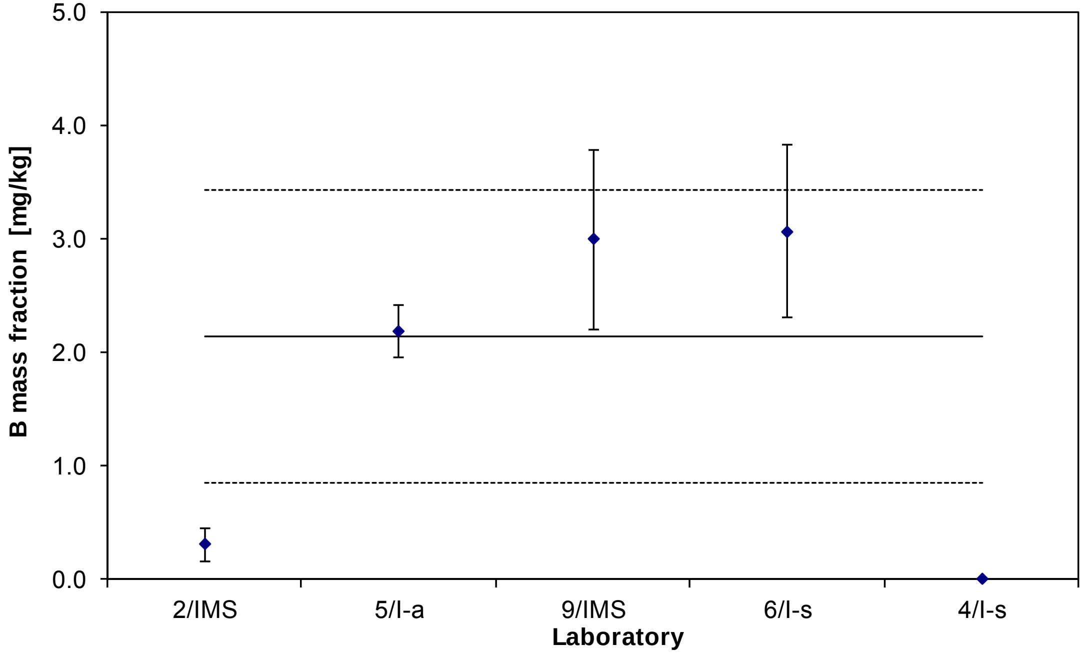

Table 20: Results for B

Lab./Meth.	2/IMS	9/IMS	7/IMS	8/I-s	4/I-s(R)	8/XRF	6/I-a	5/I-a		
M_i [mg/kg]	0.76	0.9	0.8	1.0	1.3	1.6	2.4	2.7		*n*
	0.84	0.8	0.9	1.0	1.3	1.5	2.4	2.7		8
	0.83	0.9	0.8	1.0	1.3	1.6	2.4	2.7		
	0.79	0.8	0.8	1.0		1.6	2.6	2.7		
	0.76	0.8	0.9	1.0		1.5	2.4	2.7		
	0.78	0.8	0.9	1.0		1.5	2.6	2.7		
***M* [mg/kg]**	**0.79**	**0.85**	**0.85**	**1.00**	**1.30**	**1.54**	**2.46**	**2.70**		**1.44**
s [mg/kg]	0.035	0.029	0.019	0.000	0.000	0.046	0.090	0.000	s_M [mg/kg]	0.753
									$\bar{s}_i$ [mg/kg]	0.040
s_{rel}	0.044	0.034	0.023	0.000	0.000	0.030	0.037	0.000		0.525

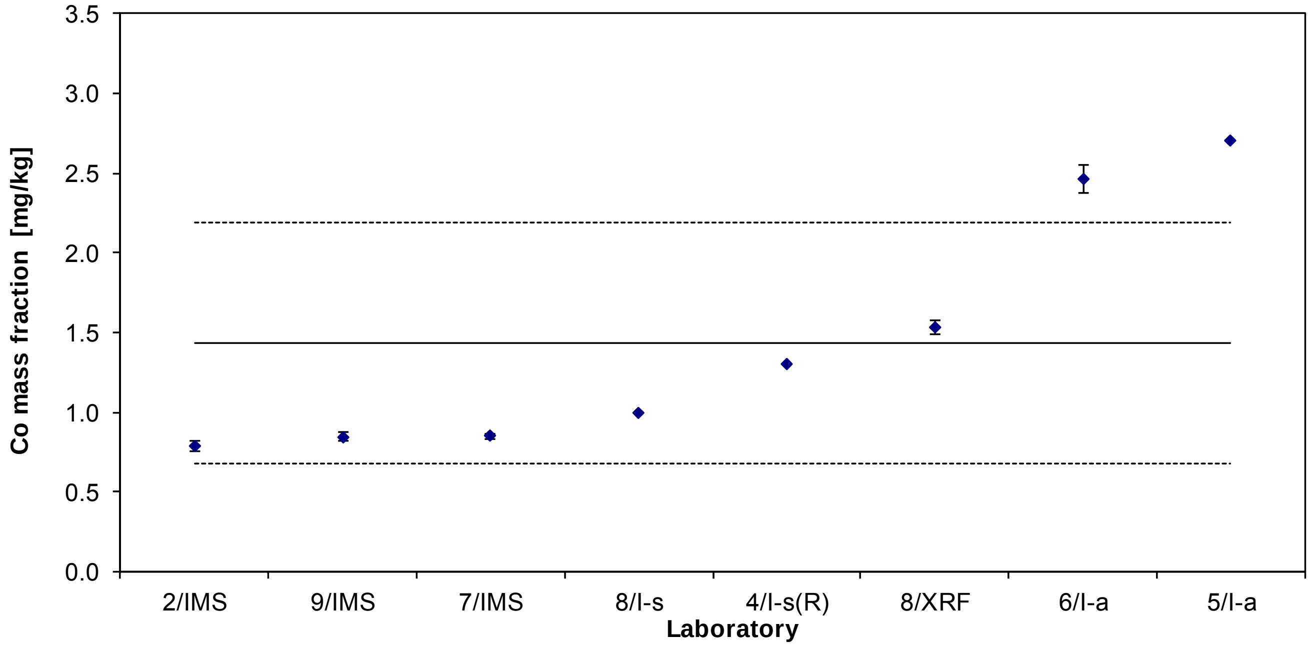

Table 21: Results for Co

Lab./Meth.	2/IMS	9/CVAFS	6/I-a		
M_i [mg/kg]	20.3	20.7	26.1		*n*
	20.3	20.8	25.2		3
	20.0	20.6	24.8		
	20.3	20.7	25.9		
	20.2	20.5	27.4		
	19.8	20.3	26.5		
M [mg/kg]	**20.15**	**20.63**	**25.98**		**22.25**
s [mg/kg]	0.185	0.175	0.928	s_M [mg/kg]	3.240
				$\bar{s}_i$ [mg/kg]	0.556
s_{rel}	0.009	0.008	0.036		0.146

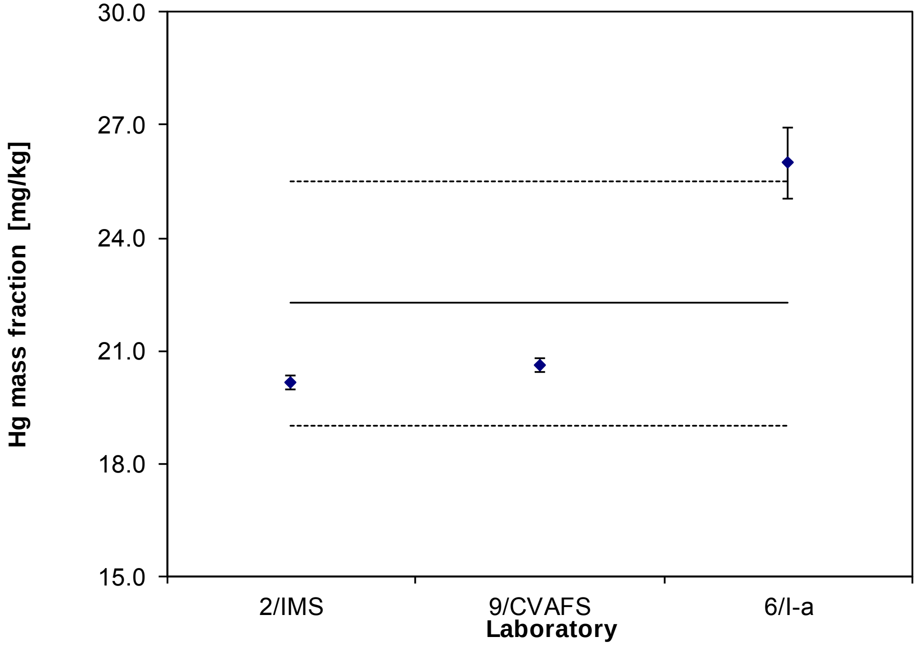

Table 22: Results for Hg

Lab./Meth.	5/I-a	6/I-s	9/I-s	2/I-s		
M_i [mg/kg]	6.2	6.4	6.3	8.6		*n*
	6.1	6.4	6.4	8.8		4
	6.1	6.3	6.4	9.2		
	6.1	6.4	6.3	7.9		
	6.2	6.3	6.3	9.5		
	6.0	6.3	6.4	8.7		
***M* [mg/kg]**	**6.12**	**6.35**	**6.35**	**8.77**		**6.90**
s [mg/kg]	0.075	0.055	0.030	0.553	s_M [mg/kg]	1.253
					$\bar{s}_i$ [mg/kg]	0.281
s_{rel}	0.012	0.009	0.005	0.063		0.182

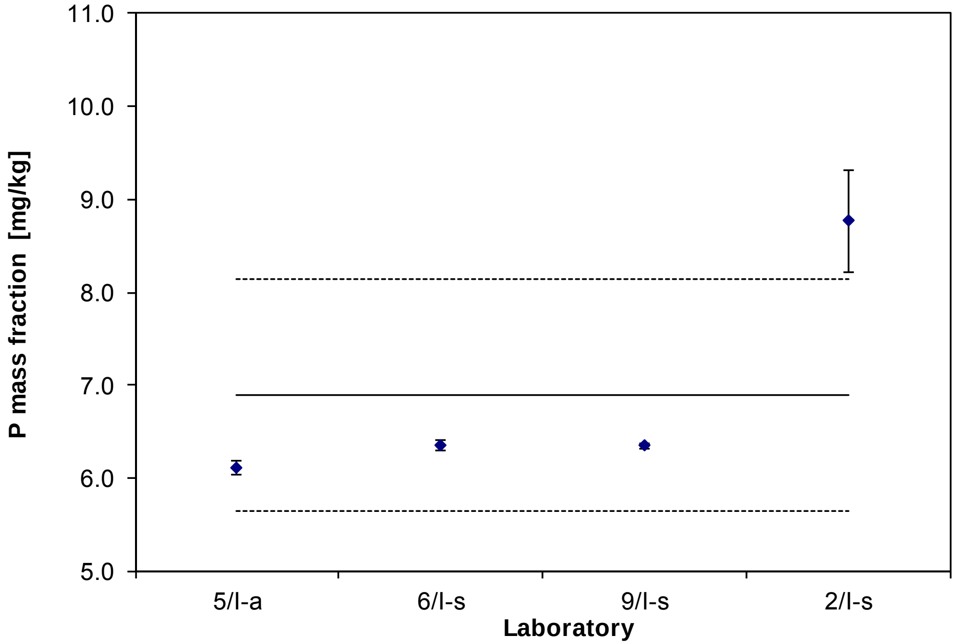

Table 23: Results for P

The statistical evaluation of the data was performed using the software program SoftCRM 1.2.2. [6]. The following results were obtained:

Table 24: Outcome of statistical tests of results obtained for Si

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 25: Outcome of statistical tests of results obtained for Fe

Number of data sets	14
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 26: Outcome of statistical tests of results obtained for Cu

Number of data sets	11
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	Lab. 11
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Lab. 11
Nalimov (α = 0.01)	Lab. 11
Grubbs (α = 0.05)	Lab. 11
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 straggler (Lab. 11) was not removed.

Table 27: Outcome of statistical tests of results obtained for Mn

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 28: Outcome of statistical tests of results obtained for Mg

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)	Lab 9/I-a
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 straggler (Lab. 9/I-a) was not removed.

Table 29: Outcome of statistical tests of results obtained for Cr

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)	Lab. 8/I
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: not normal
Skewness & Kurtosis Test (α = 0.01)	Distribution: normal

The straggler (Lab. 8/I) was not removed.

Table 30: Outcome of statistical tests of results obtained for Ni

Number of data sets	15
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Lab 9/I-a
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 straggler (Lab. 9/I-a) was not removed.

Table 31: Outcome of statistical tests of results obtained for Zn

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)	Lab. 8/XRF
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 straggler (Lab. 8/XRF) was not removed.

Table 32: Outcome of statistical tests of results obtained for Ti

Number of data sets	11
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Lab. 4
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 straggler (Lab. 4) was not removed.

Table 33: Outcome of statistical tests of results obtained for Ga

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)	Lab. 9/I-s
Nalimov (α = 0.01)	Lab. 9/I-s
Grubbs (α = 0.05)	Lab. 9/I-s
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 straggler (Lab. 9/I-s) was not removed.

Table 34: Outcome of statistical tests of results obtained for Pb

Number of data sets	14
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 35: Outcome of statistical tests of results obtained for Sn

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 36: Outcome of statistical tests of results obtained for Be

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)	---
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 37: Outcome of statistical tests of results obtained for Bi

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)	---
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	---
Grubbs (α = 0.01)	---
Grubbs Pair (α = 0.05)	---
Grubbs Pair (α = 0.01)	---
Cochran (α = 0.01)	---
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 38a: Outcome of statistical tests of results obtained for Cd

Number of data sets	12
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	Lab. 10
Dixon (α = 0.01)	Lab. 10
Nalimov (α = 0.05)	Lab. 10
Nalimov (α = 0.01)	Lab. 10
Grubbs (α = 0.05)	Lab. 10
Grubbs (α = 0.01)	Lab. 10
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: not normal
Skewness & Kurtosis Test (α = 0.01)	Distribution: not normal

The outlier (Lab. 10) was removed.

Table 38b: Outcome of statistical tests of results obtained for Cd (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)	Lab. 6
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: not normal
Skewness & Kurtosis Test (α = 0.01)	Distribution: not normal

The straggler (Lab. 6) was not removed.

Table 39: Outcome of statistical tests of results obtained for Sb

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)	---
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 40: Outcome of statistical tests of results obtained for V

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: 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 41: Outcome of statistical tests of results obtained for Zr

Number of data sets	12
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	Lab. 4
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Lab. 4
Nalimov (α = 0.01)	Lab. 4
Grubbs (α = 0.05)	Lab. 4
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: not normal
Skewness & Kurtosis Test (α = 0.01)	Distribution: normal

The straggler (Lab. 4) was not removed.

Table 42: Outcome of statistical tests of results obtained for B

Number of data sets	4
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Lab. 2
Nalimov (α = 0.01)	---
Grubbs (α = 0.05)	Lab. 2
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: insufficient data
Skewness & Kurtosis Test (α = 0.01)	Distribution: insufficient data

The straggler (Lab. 2) was not removed.

Table 43: Outcome of statistical tests of results obtained for Co

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: 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 44: Outcome of statistical tests of results obtained for Hg

Number of data sets	3
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	---
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Lab. 6
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: insufficient data
Kolmogorov-Smirnov-Lilliefors Test (α = 0.01)	Distribution: insufficient data
Skewness & Kurtosis Test (α = 0.05)	Distribution: insufficient data
Skewness & Kurtosis Test (α = 0.01)	Distribution: insufficient data

The straggler (Lab. 6) was not removed.

Table 45: Outcome of statistical tests of results obtained for P

Number of data sets	4
Snedecor-F-Test and Bartlett-Test	Pooling not allowed
Dixon (α = 0.05)	Lab. 2
Dixon (α = 0.01)	---
Nalimov (α = 0.05)	Lab. 2
Nalimov (α = 0.01)	Lab. 2
Grubbs (α = 0.05)	Lab. 2
Grubbs (α = 0.01)	Lab. 2
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: insufficient data
Skewness & Kurtosis Test (α = 0.01)	Distribution: insufficient data

The outlier (Lab. 2) was not removed.

The certified mass fractions of all elements were calculated as mean of the accepted data sets. These values are given in Table 46.
The resp. combined uncertainties were calculated from the spread resulting from the certification inter-laboratory comparison (u_{ilc}) and the uncertainty contributions from possible inhomogeneity over the length ($u_{bb}(1)$) and over area ($u_{bb}(2)$) of the material using Equation 3.

$$u_{\text{combined}} = \sqrt{u_{ilc}^2 + u_{bb}^2(1) + u_{bb}^2(2)} \qquad (3)$$

with

$u_{ilc} = \sqrt{\frac{s_M^2}{n}}$: uncertainty contribution resulting from inter-laboratory comparison

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

Table 46: Uncertainty calculation

	uncertainty contribution from									u_{bb} (rel)		
	M	n	s_M	u_{ilc}	u_{bb} (1) Length	u_{bb} (2) Area	u(comb)	U		Length	Area	
	%		%	%	%	%	%	%				
Si	9.8800	10	0.0944	0.0299	0.0793	0.0263	0.0887	0.17740		0.8024	0.2662	
Fe	0.6209	14	0.0123	0.0033	0.0057	0.0013	0.0067	0.01340		0.9173	0.2047	
Cu	2.4590	11	0.0681	0.0205	0.0053	0.0325	0.0388	0.07762		0.2172	1.3216	
Mn	0.3109	13	0.0094	0.0026	0.0030	0.0005	0.0040	0.00806		0.9779	0.1455	XRD-data
Mg	0.4459	12	0.0064	0.0018	0.0104	0.0032	0.0110	0.02207		2.3325	0.7175	XRD-data
Cr	0.0274	10	0.0004	0.0001	0.0001	0.0001	0.0002	0.00036		0.4160	0.3159	
Ni	0.0955	15	0.0038	0.0010	0.0003	0.0003	0.0011	0.00217		0.3537	0.3270	
Zn	0.8005	12	0.0090	0.0026	0.0005	0.0039	0.0047	0.00939		0.0627	0.4845	XRD-data
Ti	0.1417	11	0.0030	0.0009	0.0009	0.0027	0.0030	0.00592		0.6145	1.8905	
Pb	0.0771	14	0.0039	0.0010	0.0002	0.0011	0.0015	0.0030		0.3140	1.3751	XRD-data
Ga	0.0089	9	0.0002	0.0001	0.0001	0.0001	0.0001	0.00021		0.5931	0.6290	
Sn	0.0764	10	0.0026	0.0008	0.0001	0.0005	0.0010	0.00194		0.1444	0.6632	XRD-data
	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				
Be	4.3300	9	0.1850	0.0617	0.0441	0.0188	0.0781	0.1563		1.0196	0.4335	
B	2.1400	4	1.2850	0.6425	0.0709	0.0207	0.6467	1.9402		3.3117	0.9650	
Bi	36.4000	9	2.7940	0.9313	0.2610	1.3099	1.6283	3.2566		0.7171	3.5987	
Cd	7.8800	11	0.5510	0.1661	0.3164	0.3483	0.4990	0.9980		4.0150	4.4200	
Co	1.4400	8	0.7530	0.2662	0.0000	0.0000	0.2662	0.6656				
Sb	50.8800	9	5.6430	1.8810	3.1788	3.0732	4.8049	9.6098		6.2476	6.0400	
Hg	22.2500	3	3.2400	1.8706	0.2405	0.2455	1.9019	5.7057		1.0807	1.1032	
V	47.3000	12	1.8300	0.5283	0.2616	0.9720	1.1368	2.2736		0.5530	2.0550	
Zr	31.0000	12	1.4600	0.4215	0.1494	0.7848	0.9032	1.8065		0.4820	2.5315	XRD-data
P	6.9000	4	1.2530	0.6265	0.0651	1.4607	1.5907	3.1814		0.9439	21.1695	

The expanded uncertainties U are calculated by multiplication of $u_{combined}$ with a coverage factor of k = 2 (B, Hg: k = 3; Co: k = 2.5) 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.

In addition to the wet chemical characterization some of the laboratories analysed the material with spark emission to check if there is agreement between SOES and wet chemistry. Tab. 47 shows the mean values of wet chemical and spark emission results as well as their standard deviations. The agreement between wet chemistry and SOES is good for all elements.

Tab. 47: Comparison wet chemistry (incl. XRF) vs. SOES

Element	Wet chemical analysis			Spark emission		
	Mass fraction in %	Std.-dev. in %	*n*	Mass fraction in %	Std.-dev. in %	*n*
Si	9.88	0.10	10	9.95	0.08	9
Fe	0.621	0.013	14	0.630	0.0172	9
Cu	2.459	0.069	11	2.456	0.049	9
Mn	0.311	0.010	13	0.316	0.006	9
Mg	0.446	0.007	12	0.449	0.010	9
Cr	0.0274	0.0004	10	0.0277	0.0006	9
Ni	0.0955	0.0038	15	0.0965	0.0026	9
Zn	0.801	0.009	12	0.821	0.015	8
Ti	0.142	0.003	11	0.140	0.002	8
Ga	0.0089	0.0002	9	0.0087	0.0007	9
Pb	0.0771	0.0039	14	0.0770	0.0028	9
Sn	0.0764	0.0026	10	0.0761	0.0015	8
	in mg/kg	in mg/kg		in mg/kg	in mg/kg	
B	2.1	1.3	4	2.40	0.51	4
Be	4.3	0.2	9	4.15	0.18	9
Bi	36.4	2.8	9	34.9	8.3	9
Cd	7.9	0.6	11	8.4	1.4	7
Co	1.44	0.76	8	1.70	1.08	3
Hg	22.3	3.3	3	21.3	4.4	6
P	6.9	1.3	4	9.4	3.0	8
Sb	50.9	5.7	9	45.1	13.6	6
V	47.3	1.9	12	47.9	2.6	7
Zr	31.0	1.5	12	30.2	2.5	9

6. Instructions for users and stability

The certified reference material ERM®-EB315a is intended for the calibration and quality control of spark emission and X-ray fluorescence spectrometers used for the analysis of similar materials. It is also suitable for wet chemical analysis.
The surface of the material should be cleaned by turning or milling before analysis.
If chips prepared from the compact material are used for wet chemical analysis, a minimum sample intake of 0.2 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. References

[1] ISO Guide 31, Reference materials - Contents of certificates, labels and accompanying documentation, 2015

[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 development and production of BAM Reference Materials, 2016

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

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

8. Information on and purchase of the CRM

Certified reference material ERM®-EB315a is supplied by

Bundesanstalt für Materialforschung und -prüfung (BAM)
Fachbereich 1.6: Anorganische Referenzmaterialien
Richard-Willstätter-Str. 11, D-12489 Berlin, Germany
Phone +49 (0)30 - 8104 2061
Fax: +49 (0)30 – 8104 72061
E-Mail: sales.crm@bam.de

Each disc of ERM®-EB315a 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, https://www.bam.de.
www.webshop.bam.de
Tel. +49 30 8104 1111.

Annex 1: Calculation of uncertainty contribution of potential inhomogeneity (length), XRF

	Mg	Mn	Pb	Sn	V	Zn	Zr
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Sample							
A1F	0.48396	0.296	0.07973	0.07979	0.00594	0.79911	0.00298
A3F	0.49103	0.29857	0.07991	0.0799	0.00593	0.79935	0.00299
A4F	0.49864	0.29982	0.07985	0.07995	0.00607	0.7999	0.00302
A4H	0.5012	0.30033	0.07962	0.0797	0.00607	0.79877	0.00299
B1F	0.50841	0.30184	0.07973	0.07987	0.00608	0.79879	0.00298
B2F	0.50735	0.30084	0.07999	0.07983	0.00603	0.79935	0.00296
B4F	0.50802	0.30146	0.07954	0.07996	0.00605	0.7996	0.00301
B4H	0.50762	0.30205	0.07987	0.07986	0.00603	0.79898	0.00298
C2F	0.50649	0.30143	0.07988	0.07978	0.00602	0.79925	0.00299
C3F	0.50922	0.30233	0.08003	0.0799	0.006	0.79967	0.00298
C3H	0.51171	0.30309	0.08006	0.0798	0.00594	0.79908	0.00298
C4F	0.51339	0.30232	0.07971	0.07984	0.00613	0.80013	0.00302
D2F	0.51708	0.30341	0.08029	0.08002	0.00621	0.80031	0.00298
D4F	0.5111	0.30288	0.07979	0.07984	0.00604	0.79986	0.00301
D4H	0.50976	0.30307	0.07979	0.07957	0.00608	0.7998	0.003
E1F	0.51626	0.30282	0.0794	0.07981	0.00599	0.79969	0.003
E3F	0.51542	0.30486	0.08013	0.07991	0.00607	0.8004	0.00299
E4F	0.51216	0.3043	0.07978	0.07983	0.00603	0.79941	0.00299
E4H	0.51475	0.30482	0.07988	0.07988	0.00604	0.79975	0.00298
F1F	0.51872	0.30456	0.08002	0.07987	0.006	0.79999	0.00297
F2F	0.51611	0.30392	0.07988	0.08002	0.00605	0.79996	0.00299
F3F	0.51883	0.30494	0.08041	0.07984	0.00604	0.79994	0.00301
F4F	0.52208	0.30555	0.07984	0.07963	0.00597	0.7987	0.003
D1F	0.52133	0.30507	0.08027	0.07989	0.00605	0.80011	0.00299
M	0.50719259	0.30180852	0.07985111	0.07986407	0.00603259	0.79963704	0.00299185
s	0.0118304	0.00295126	0.00025074	0.00011533	6.0294E-05	0.00050113	1.4421E-05
s(rel.)	2.33252581	0.97785759	0.31401252	0.14441321	0.99946544	0.06266944	0.48202303

Annex 2: Calculation of uncertainty contribution of potential inhomogeneity (length), SOES

Silicon:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	50.3227	10.06454	0.00191732		
AB	5	51.1264	10.22528	0.00558599		
AC	5	50.9215	10.1843	0.00357792		
AD	5	50.3241	10.06482	0.00067653		
AE	5	50.5602	10.11204	0.00280189		
BA	5	50.2525	10.0505	0.00089532		
BB	5	50.3118	10.06236	0.00081613		
BC	5	50.3058	10.06116	0.00979941		
BD	5	50.525	10.105	0.00158909		
BE	5	50.8158	10.16316	0.00126544		
CA	5	50.6632	10.13264	0.00531144		
CB	5	50.0251	10.00502	0.00122862		
CC	5	50.3331	10.06662	0.00229348		
CD	5	51.2747	10.25494	0.00401656		
CE	5	50.2583	10.05166	0.0057136		
DA	5	50.4087	10.08174	0.00104473		
DB	5	50.9857	10.19714	0.00062499		
DC	5	49.7537	9.95074	0.00111491		
DD	5	51.177	10.2354	0.00296145		
DE	5	50.278	10.0556	0.00140465		
EA	5	50.4017	10.08034	0.00123565		
EB	5	50.902	10.1804	0.0022123		
EC	5	50.7784	10.15568	0.00929996		
ED	5	49.9505	9.9901	0.00244054		
EE	5	50.2707	10.05414	0.00278569		
FA	5	50.8392	10.16784	0.00186258		
FB	5	50.944	10.1888	0.00324116		
FC	5	50.5825	10.1165	0.00089827		
FD	5	50.2179	10.04358	0.0018445		
FE	5	50.1762	10.03524	0.00157313		
			10.104576			

ANOVA

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.84184439	29	0.02902912	10.6161017	1.9142E-21	1.56207098
Within groups	0.32813307	120	0.00273444			
Total	1.16997745	149				
within-sd	0.052292					
effective n	4.00					
s_bb	0.081078					
s_bb_min	0.009394					
u_bb	0.081078	81.07816				
u_bb(rel.)	0.80239056					

Iron:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	3.0792	0.61584	3.383E-06		
AB	5	3.1506	0.63012	1.0472E-05		
AC	5	3.1457	0.62914	1.8683E-05		
AD	5	3.1067	0.62134	7.933E-06		
AE	5	3.1301	0.62602	4.252E-06		
BA	5	3.1029	0.62058	9.847E-06		
BB	5	3.104	0.6208	2.11E-06		
BC	5	3.0906	0.61812	9.037E-06		
BD	5	3.1162	0.62324	2.5883E-05		
BE	5	3.16	0.632	2.53E-06		
CA	5	3.1232	0.62464	7.683E-06		
CB	5	3.1094	0.62188	2.057E-06		
CC	5	3.0826	0.61652	2.497E-06		
CD	5	3.1489	0.62978	1.447E-06		
CE	5	3.0848	0.61696	3.23E-07		
DA	5	3.1264	0.62528	1.097E-06		
DB	5	3.1243	0.62486	1.1073E-05		
DC	5	3.0581	0.61162	2.887E-06		
DD	5	3.159	0.6318	8.635E-06		
DE	5	3.1162	0.62324	1.903E-06		
EA	5	3.0844	0.61688	2.3927E-05		
EB	5	3.1092	0.62184	1.578E-06		
EC	5	3.1148	0.62296	2.5928E-05		
ED	5	3.0774	0.61548	2.2412E-05		
EE	5	3.0858	0.61716	8.448E-06		
FA	5	3.1107	0.62214	1.813E-06		
FB	5	3.1361	0.62722	8.232E-06		
FC	5	3.1224	0.62448	8.787E-06		
FD	5	3.1003	0.62006	4.698E-06		
FE	5	3.0794	0.61588	1.1117E-05		
			0.62226267			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.00402186	29	0.00013868	16.5975772	1.0572E-29	1.56207098
Within groups	0.00100269	120	8.3557E-06			
Total	0.00502455	149				
within-sd	0.002891					
effective n	4.00					
s_bb	0.005708					
s_bb_min	0.000519					
u_bb	0.005708	5.708091				
u_bb(rel.)	0.91731209					

Copper:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	14.2946	2.85892	0.00019171		
AB	5	14.4711	2.89422	0.00028561		
AC	5	14.4425	2.8885	0.00069026		
AD	5	14.2597	2.85194	0.00045247		
AE	5	14.4497	2.88994	0.00101832		
BA	5	14.346	2.8692	0.00065131		
BB	5	14.4129	2.88258	0.0003178		
BC	5	14.42	2.884	0.00054378		
BD	5	14.3271	2.86542	0.00095464		
BE	5	14.4099	2.88198	0.00029915		
CA	5	14.4659	2.89318	0.00021092		
CB	5	14.3457	2.86914	0.00053345		
CC	5	14.361	2.8722	0.0006608		
CD	5	14.3398	2.86796	0.00017935		
CE	5	14.3591	2.87182	0.00014899		
DA	5	14.4394	2.88788	0.00030937		
DB	5	14.3628	2.87256	6.5683E-05		
DC	5	14.3846	2.87692	0.00073337		
DD	5	14.378	2.8756	0.00033218		
DE	5	14.4304	2.88608	0.00054078		
EA	5	14.4061	2.88122	0.00066014		
EB	5	14.3219	2.86438	0.00040451		
EC	5	14.3723	2.87446	0.00078485		
ED	5	14.3941	2.87882	0.00040629		
EE	5	14.2935	2.8587	0.00011714		
FA	5	14.3047	2.86094	0.00056302		
FB	5	14.3343	2.86686	0.00012327		
FC	5	14.3556	2.87112	0.00018841		
FD	5	14.3968	2.87936	0.00023001		
FE	5	14.346	2.8692	0.00016511		
			2.87483667			

ANOVA

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.01685853	29	0.00058133	1.36647187	0.12393955	1.56207098
Within groups	0.05105076	120	0.00042542			
Total	0.06790929	149				

within-sd	0.020626	
effective n	4.00	
s_bb	0.006243	
s_bb_min	0.003705	
u_bb	0.006243	6.243107
u_bb(rel.)	0.2171639	

Manganese:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	1.6018	0.32036	3.58E-07		
AB	5	1.638	0.3276	1.355E-06		
AC	5	1.6475	0.3295	1.99E-06		
AD	5	1.6138	0.32276	4.78E-07		
AE	5	1.623	0.3246	3.85E-07		
BA	5	1.6118	0.32236	1.553E-06		
BB	5	1.6195	0.3239	2.65E-07		
BC	5	1.5986	0.31972	2.852E-06		
BD	5	1.6225	0.3245	3.11E-06		
BE	5	1.6507	0.33014	1.258E-06		
CA	5	1.6281	0.32562	1.997E-06		
CB	5	1.6196	0.32392	7.67E-07		
CC	5	1.5947	0.31894	1.003E-06		
CD	5	1.6475	0.3295	4.55E-07		
CE	5	1.5921	0.31842	4.52E-07		
DA	5	1.6272	0.32544	9.88E-07		
DB	5	1.6304	0.32608	2.302E-06		
DC	5	1.5727	0.31454	6.93E-07		
DD	5	1.6461	0.32922	5.92E-07		
DE	5	1.6191	0.32382	5.02E-07		
EA	5	1.6032	0.32064	2.173E-06		
EB	5	1.6237	0.32474	4.88E-07		
EC	5	1.6282	0.32564	3.723E-06		
ED	5	1.5855	0.3171	3.47E-06		
EE	5	1.6028	0.32056	1.683E-06		
FA	5	1.6241	0.32482	5.17E-07		
FB	5	1.6451	0.32902	9.57E-07		
FC	5	1.6283	0.32566	5.33E-07		
FD	5	1.6034	0.32068	9.17E-07		
FE	5	1.5904	0.31808	1.337E-06		
			0.323596			

ANOVA

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.00236945	29	8.1705E-05	62.604414	2.9827E-59	1.56207098
Within groups	0.00015661	120	1.3051E-06			
Total	0.00252606	149				

within-sd	0.001142	
effective n	4.00	
s_bb	0.004483	
s_bb_min	0.000205	
u_bb	0.004483	4.4833
u_bb(rel.)	1.38546216	

Magnesium:

Sample	*Number*	*Sum*	*Mean*	*Variance*
AA	5	2.6356	0.52712	0.00010713
AB	5	2.4104	0.48208	0.00018543
AC	5	2.5559	0.51118	0.00027074
AD	5	2.5981	0.51962	6.7532E-05
AE	5	2.6617	0.53234	0.00019559
BA	5	2.6462	0.52924	5.1298E-05
BB	5	2.6736	0.53472	9.1967E-05
BC	5	2.796	0.5592	0.00011981
BD	5	2.6348	0.52696	0.00023077
BE	5	2.5448	0.50896	0.00013251
CA	5	2.6504	0.53008	7.7017E-05
CB	5	2.6559	0.53118	7.2922E-05
CC	5	2.8108	0.56216	0.00017402
CD	5	2.3087	0.46174	0.0001977
CE	5	2.7304	0.54608	0.0001955
DA	5	2.6481	0.52962	0.00013874
DB	5	2.6614	0.53228	3.8752E-05
DC	5	2.7633	0.55266	0.00011152
DD	5	2.3525	0.4705	0.00024125
DE	5	2.6632	0.53264	4.2283E-05
EA	5	2.6924	0.53848	9.9932E-05
EB	5	2.6267	0.52534	7.2503E-05
EC	5	2.6804	0.53608	0.00028854
ED	5	2.7736	0.55472	1.3737E-05
EE	5	2.6469	0.52938	8.2207E-05
FA	5	2.617	0.5234	0.00041569
FB	5	2.4216	0.48432	0.00012833
FC	5	2.6377	0.52754	1.4083E-05
FD	5	2.705	0.541	3.2675E-05
FE	5	2.79	0.558	6.1625E-05
			0.52662067	

ANOVA

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.08779941	29	0.00302757	22.9836383	2.2681E-36	1.56207098
Within groups	0.01580724	120	0.00013173			
Total	0.10360665	149				

within-sd	0.011477	
effective n	4.00	
s_bb	0.026906	
s_bb_min	0.002062	
u_bb	0.026906	26.9065
u_bb(rel.)	5.10927515	

Chromium:

Sample	Number	Sum	Mean	Variance		
AA	5	0.1428	0.02856	1.8E-08		
AB	5	0.1454	0.02908	6.2E-08		
AC	5	0.1454	0.02908	6.7E-08		
AD	5	0.1429	0.02858	1.7E-08		
AE	5	0.1442	0.02884	2.3E-08		
BA	5	0.1434	0.02868	2E-09		
BB	5	0.1437	0.02874	2.3E-08		
BC	5	0.1452	0.02904	1.03E-07		
BD	5	0.1435	0.0287	2E-08		
BE	5	0.1449	0.02898	3.7E-08		
CA	5	0.1442	0.02884	2.8E-08		
CB	5	0.1431	0.02862	2E-09		
CC	5	0.1445	0.0289	0.00000017		
CD	5	0.1429	0.02858	2.2E-08		
CE	5	0.1441	0.02882	1.7E-08		
DA	5	0.1438	0.02876	1.3E-08		
DB	5	0.144	0.0288	3.5E-08		
DC	5	0.1437	0.02874	6.8E-08		
DD	5	0.1439	0.02878	3.7E-08		
DE	5	0.1436	0.02872	8.7E-08		
EA	5	0.1447	0.02894	5.3E-08		
EB	5	0.1439	0.02878	3.7E-08		
EC	5	0.1446	0.02892	7.2E-08		
ED	5	0.1434	0.02868	7E-09		
EE	5	0.1433	0.02866	2.3E-08		
FA	5	0.1437	0.02874	1.23E-07		
FB	5	0.144	0.0288	3E-08		
FC	5	0.1433	0.02866	1.3E-08		
FD	5	0.1437	0.02874	8E-09		
FE	5	0.1438	0.02876	4.3E-08		
			0.028784			
ANOVA						
Source of variation	sums of squares (SS)	degrees of freedom (df)	Mean squares (MS)	F-value	P-value	critical F-value
Between groups	2.8816E-06	29	9.9366E-08	2.36584565	0.0006143	1.56207098
Within groups	0.00000504	120	4.2E-08			
Total	7.9216E-06	149				
within-sd	0.000205			status:	inhomogeneous	
effective n	4.00					
s_bb	0.00012					
s_bb_min	3.68E-05					
u_bb	0.00012	0.119755				
u_bb(rel.)	0.41604884					

Nickel:

Sample	Number	Sum	Mean	Variance		
AA	5	0.4966	0.09932	2.67E-07		
AB	5	0.5048	0.10096	5.23E-07		
AC	5	0.5025	0.1005	1.175E-06		
AD	5	0.4946	0.09892	6.57E-07		
AE	5	0.502	0.1004	1.295E-06		
BA	5	0.4982	0.09964	1.208E-06		
BB	5	0.5008	0.10016	6.68E-07		
BC	5	0.4998	0.09996	8.43E-07		
BD	5	0.4979	0.09958	1.292E-06		
BE	5	0.5014	0.10028	3.97E-07		
CA	5	0.5041	0.10082	3.17E-07		
CB	5	0.4969	0.09938	4.92E-07		
CC	5	0.4981	0.09962	1.062E-06		
CD	5	0.4994	0.09988	4.27E-07		
CE	5	0.4979	0.09958	3.77E-07		
DA	5	0.5019	0.10038	2.92E-07		
DB	5	0.5005	0.1001	5.5E-08		
DC	5	0.4968	0.09936	1.133E-06		
DD	5	0.5012	0.10024	3.58E-07		
DE	5	0.501	0.1002	5.95E-07		
EA	5	0.4998	0.09996	1.328E-06		
EB	5	0.4984	0.09968	8.27E-07		
EC	5	0.4992	0.09984	1.103E-06		
ED	5	0.4981	0.09962	4.22E-07		
EE	5	0.4956	0.09912	1.67E-07		
FA	5	0.4977	0.09954	1.103E-06		
FB	5	0.4993	0.09986	2.48E-07		
FC	5	0.5001	0.10002	2.37E-07		
FD	5	0.4994	0.09988	2.47E-07		
FE	5	0.4968	0.09936	2.48E-07		
			0.099872			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	3.319E-05	29	1.1445E-06	1.77322195	0.01704443	1.56207098
Within groups	7.7452E-05	120	6.4543E-07			
Total	0.00011064	149				
within-sd	0.000803					
effective n	4.00					
s_bb	0.000353					
s_bb_min	0.000144					
u_bb	0.000353	0.353222				
u_bb(rel.)	0.35367474					

Zinc:

Sample	*Number*	*Sum*	*Mean*	*Variance*
AA	5	3.8757	0.77514	6.753E-06
AB	5	3.9602	0.79204	1.0903E-05
AC	5	3.9329	0.78658	1.1942E-05
AD	5	3.8778	0.77556	1.1778E-05
AE	5	3.9086	0.78172	1.1717E-05
BA	5	3.8862	0.77724	2.8613E-05
BB	5	3.9019	0.78038	6.067E-06
BC	5	3.8725	0.7745	7.51E-06
BD	5	3.9026	0.78052	1.7002E-05
BE	5	3.9296	0.78592	2.3782E-05
CA	5	3.924	0.7848	1.639E-05
CB	5	3.8905	0.7781	1.676E-05
CC	5	3.8578	0.77156	6.963E-06
CD	5	3.9871	0.79742	9.082E-06
CE	5	3.8746	0.77492	8.277E-06
DA	5	3.906	0.7812	3E-06
DB	5	3.9176	0.78352	5.792E-06
DC	5	3.8431	0.76862	8.077E-06
DD	5	3.9662	0.79324	7.023E-06
DE	5	3.9009	0.78018	1.0337E-05
EA	5	3.88	0.776	8.805E-06
EB	5	3.903	0.7806	9.695E-06
EC	5	3.9141	0.78282	1.0937E-05
ED	5	3.8677	0.77354	6.478E-06
EE	5	3.8761	0.77522	1.1987E-05
FA	5	3.9168	0.78336	1.1313E-05
FB	5	3.9505	0.7901	1.785E-06
FC	5	3.9082	0.78164	6.613E-06
FD	5	3.8783	0.77566	2.1253E-05
FE	5	3.8648	0.77296	4.103E-06
			0.780502	

ANOVA

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.00659704	29	0.00022748	21.2776374	9.5216E-35	1.56207098
Within groups	0.00128295	120	1.0691E-05			
Total	0.00787999	149				

within-sd	0.00327	
effective n	4.00	
s_bb	0.007362	
s_bb_min	0.000587	
u_bb	0.007362	7.361945
u_bb(rel.)	0.94323208	

Titanium:

Sample	Number	Sum	Mean	Variance		
AA	5	0.6974	0.13948	2.37E-07		
AB	5	0.7016	0.14032	5.7E-08		
AC	5	0.7025	0.1405	2.25E-07		
AD	5	0.7034	0.14068	5.7E-08		
AE	5	0.7075	0.1415	2.5E-08		
BA	5	0.6964	0.13928	4.7E-08		
BB	5	0.6991	0.13982	1.17E-07		
BC	5	0.7005	0.1401	2.85E-07		
BD	5	0.7058	0.14116	2.3E-08		
BE	5	0.7086	0.14172	4.7E-08		
CA	5	0.6997	0.13994	2.13E-07		
CB	5	0.6991	0.13982	1.97E-07		
CC	5	0.7006	0.14012	1.77E-07		
CD	5	0.7101	0.14202	3.32E-07		
CE	5	0.7084	0.14168	1.82E-07		
DA	5	0.6979	0.13958	2.32E-07		
DB	5	0.7007	0.14014	3.18E-07		
DC	5	0.6998	0.13996	6.3E-08		
DD	5	0.7084	0.14168	1.87E-07		
DE	5	0.7062	0.14124	6.3E-08		
EA	5	0.6959	0.13918	1.7E-08		
EB	5	0.7002	0.14004	3.3E-08		
EC	5	0.7027	0.14054	1.83E-07		
ED	5	0.7049	0.14098	2.22E-07		
EE	5	0.7064	0.14128	2.22E-07		
FA	5	0.7011	0.14022	3.7E-08		
FB	5	0.7011	0.14022	1.22E-07		
FC	5	0.703	0.1406	0.00000014		
FD	5	0.7024	0.14048	9.2E-08		
FE	5	0.708	0.1416	5.5E-08		
			0.14052933			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	9.0583E-05	29	3.1235E-06	22.2739441	1.0441E-35	1.56207098
Within groups	1.6828E-05	120	1.4023E-07			
Total	0.00010741	149				
within-sd	0.000374					
effective n	4.00					
s_bb	0.000864					
s_bb_min	6.73E-05					
u_bb	0.000864	0.863614				
u_bb(rel.)	0.61454353					

Gallium:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	0.0511	0.01022	7E-09		
AB	5	0.0523	0.01046	8E-09		
AC	5	0.0524	0.01048	7E-09		
AD	5	0.0512	0.01024	8E-09		
AE	5	0.0521	0.01042	2.2E-08		
BA	5	0.0515	0.0103	5E-09		
BB	5	0.0519	0.01038	1.2E-08		
BC	5	0.0519	0.01038	7E-09		
BD	5	0.0517	0.01034	8E-09		
BE	5	0.052	0.0104	5E-09		
CA	5	0.0517	0.01034	3E-09		
CB	5	0.0519	0.01038	7E-09		
CC	5	0.0518	0.01036	8E-09		
CD	5	0.0522	0.01044	8E-09		
CE	5	0.0514	0.01028	1.2E-08		
DA	5	0.0518	0.01036	1.3E-08		
DB	5	0.0516	0.01032	7E-09		
DC	5	0.051	0.0102	5E-09		
DD	5	0.0521	0.01042	7E-09		
DE	5	0.0518	0.01036	1.8E-08		
EA	5	0.052	0.0104	5E-09		
EB	5	0.0516	0.01032	7E-09		
EC	5	0.0519	0.01038	2.2E-08		
ED	5	0.0514	0.01028	7E-09		
EE	5	0.0513	0.01026	1.3E-08		
FA	5	0.0517	0.01034	3E-09		
FB	5	0.052	0.0104	5E-09		
FC	5	0.0516	0.01032	7E-09		
FD	5	0.0515	0.0103	5E-09		
FE	5	0.0516	0.01032	2E-09		
			0.01034667			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	6.8133E-07	29	2.3494E-08	2.78587979	5.1778E-05	1.56207098
Within groups	1.012E-06	120	8.4333E-09			
Total	1.6933E-06	149				
within-sd	9.18E-05					
effective n	4.00					
s_bb	6.14E-05					
s_bb_min	1.65E-05					
u_bb	6.14E-05	0.061361				
u_bb(rel.)	0.59305544					

Lead:

Sample	Number	Sum	Mean	Variance		
AA	5	0.362	0.0724	6E-07		
AB	5	0.3822	0.07644	6.28E-07		
AC	5	0.3724	0.07448	7.87E-07		
AD	5	0.3629	0.07258	1.067E-06		
AE	5	0.367	0.0734	5.65E-07		
BA	5	0.3633	0.07266	1.738E-06		
BB	5	0.3648	0.07296	8.8E-08		
BC	5	0.3573	0.07146	6.83E-07		
BD	5	0.3634	0.07268	1.387E-06		
BE	5	0.3727	0.07454	1.193E-06		
CA	5	0.3697	0.07394	7.73E-07		
CB	5	0.3619	0.07238	5.87E-07		
CC	5	0.3551	0.07102	7.72E-07		
CD	5	0.3811	0.07622	4.67E-07		
CE	5	0.3575	0.0715	5.6E-07		
DA	5	0.3661	0.07322	1.047E-06		
DB	5	0.3654	0.07308	3.12E-07		
DC	5	0.3559	0.07118	8.47E-07		
DD	5	0.3812	0.07624	6.88E-07		
DE	5	0.3666	0.07332	1.112E-06		
EA	5	0.3651	0.07302	8.52E-07		
EB	5	0.3637	0.07274	8.18E-07		
EC	5	0.3659	0.07318	1.587E-06		
ED	5	0.355	0.071	6.4E-07		
EE	5	0.3623	0.07246	1.013E-06		
FA	5	0.3647	0.07294	7.3E-08		
FB	5	0.3768	0.07536	4.28E-07		
FC	5	0.3653	0.07306	2.78E-07		
FD	5	0.3632	0.07264	7.08E-07		
FE	5	0.3531	0.07062	9.7E-08		
			0.07309067			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.00033487	29	1.1547E-05	15.4683666	2.5138E-28	1.56207098
Within groups	8.958E-05	120	7.465E-07			
Total	0.00042445	149				
within-sd	0.000864					
effective n	4.00					
s_bb	0.001643					
s_bb_min	0.000155					
u_bb	0.001643	1.643216				
u_bb(rel.)	2.24818859					

Tin:

Sample	*Number*	*Sum*	*Mean*	*Variance*
AA	5	0.4318	0.08636	4.68E-07
AB	5	0.443	0.0886	4.75E-07
AC	5	0.44	0.088	0.00000113
AD	5	0.4317	0.08634	8.28E-07
AE	5	0.4383	0.08766	1.933E-06
BA	5	0.4355	0.0871	0.00000127
BB	5	0.4372	0.08744	4.63E-07
BC	5	0.4347	0.08694	1.008E-06
BD	5	0.434	0.0868	1.855E-06
BE	5	0.4393	0.08786	4.88E-07
CA	5	0.4415	0.0883	5E-07
CB	5	0.4341	0.08682	9.47E-07
CC	5	0.4344	0.08688	1.227E-06
CD	5	0.4356	0.08712	3.87E-07
CE	5	0.432	0.0864	3.8E-07
DA	5	0.439	0.0878	8.15E-07
DB	5	0.4366	0.08732	2.32E-07
DC	5	0.4351	0.08702	1.297E-06
DD	5	0.4381	0.08762	6.12E-07
DE	5	0.4388	0.08776	1.138E-06
EA	5	0.4366	0.08732	1.012E-06
EB	5	0.4347	0.08694	9.63E-07
EC	5	0.4379	0.08758	1.312E-06
ED	5	0.4343	0.08686	9.58E-07
EE	5	0.4314	0.08628	2.17E-07
FA	5	0.4337	0.08674	7.48E-07
FB	5	0.4354	0.08708	2.37E-07
FC	5	0.4368	0.08736	3.63E-07
FD	5	0.436	0.0872	6.1E-07
FE	5	0.4316	0.08632	2.97E-07
			0.087194	

ANOVA

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.1005E-05	29	1.7588E-06	2.18301114	0.00176658	1.56207098
Within groups	0.00009668	120	8.0567E-07			
Total	0.00014768	149				

within-sd	0.000898	
effective n	4.00	
s_bb	0.000488	
s_bb_min	0.000161	
u_bb	0.000488	0.488137
u_bb(rel.)	0.55982916	

Beryllium:

Sample	Number	Sum	Mean	Variance		
AA	5	0.0025	0.0005	0		
AB	5	0.0025	0.0005	0		
AC	5	0.0025	0.0005	0		
AD	5	0.0025	0.0005	0		
AE	5	0.0025	0.0005	0		
BA	5	0.0025	0.0005	0		
BB	5	0.0025	0.0005	0		
BC	5	0.0025	0.0005	0		
BD	5	0.0025	0.0005	0		
BE	5	0.0025	0.0005	0		
CA	5	0.0025	0.0005	0		
CB	5	0.0025	0.0005	0		
CC	5	0.0025	0.0005	0		
CD	5	0.0025	0.0005	0		
CE	5	0.0025	0.0005	0		
DA	5	0.0025	0.0005	0		
DB	5	0.0025	0.0005	0		
DC	5	0.0025	0.0005	0		
DD	5	0.0025	0.0005	0		
DE	5	0.0025	0.0005	0		
EA	5	0.0023	0.00046	3E-09		
EB	5	0.0025	0.0005	0		
EC	5	0.0024	0.00048	2E-09		
ED	5	0.0025	0.0005	0		
EE	5	0.0024	0.00048	2E-09		
FA	5	0.0024	0.00048	2E-09		
FB	5	0.0025	0.0005	0		
FC	5	0.0025	0.0005	0		
FD	5	0.0025	0.0005	0		
FE	5	0.0024	0.00048	2E-09		
			0.000496			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.36E-08	29	4.6897E-10	1.27899687	0.17934884	1.56207098
Within groups	4.4E-08	120	3.6667E-10			
Total	5.76E-08	149				
within-sd	1.91E-05					
effective n	4.00					
s_bb	5.06E-06					
s_bb_min	3.44E-06					
u_bb	5.06E-06	0.005057				
u_bb(rel.)	1.01958563					

Bismuth:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	0.0199	0.00398	2E-09		
AB	5	0.0206	0.00412	2E-09		
AC	5	0.0204	0.00408	7E-09		
AD	5	0.02	0.004	5E-09		
AE	5	0.0202	0.00404	8E-09		
BA	5	0.0199	0.00398	2E-09		
BB	5	0.0201	0.00402	7E-09		
BC	5	0.0201	0.00402	2E-09		
BD	5	0.0202	0.00404	8E-09		
BE	5	0.0202	0.00404	8E-09		
CA	5	0.0202	0.00404	3E-09		
CB	5	0.0202	0.00404	3E-09		
CC	5	0.0202	0.00404	3E-09		
CD	5	0.0205	0.0041	0		
CE	5	0.02	0.004	5E-09		
DA	5	0.0202	0.00404	8E-09		
DB	5	0.0202	0.00404	3E-09		
DC	5	0.0196	0.00392	2E-09		
DD	5	0.0204	0.00408	2E-09		
DE	5	0.0201	0.00402	7E-09		
EA	5	0.0203	0.00406	3E-09		
EB	5	0.0201	0.00402	2E-09		
EC	5	0.0202	0.00404	8E-09		
ED	5	0.02	0.004	5E-09		
EE	5	0.02	0.004	5E-09		
FA	5	0.0202	0.00404	3E-09		
FB	5	0.0204	0.00408	2E-09		
FC	5	0.0201	0.00402	7E-09		
FD	5	0.0201	0.00402	2E-09		
FE	5	0.0201	0.00402	2E-09		
			0.00403133			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.1873E-07	29	7.5425E-09	1.79584018	0.01511898	1.56207098
Within groups	5.04E-07	120	4.2E-09			
Total	7.2273E-07	149				
within-sd	6.48E-05					
effective n	4.00					
s_bb	2.89E-05					
s_bb_min	1.16E-05					
u_bb	2.89E-05	0.028907				
u_bb(rel.)	0.71706557					

Cadmium:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	0.0045	0.0009	0		
AB	5	0.005	0.001	0		
AC	5	0.0048	0.00096	3E-09		
AD	5	0.0045	0.0009	0		
AE	5	0.0045	0.0009	0		
BA	5	0.0045	0.0009	0		
BB	5	0.0045	0.0009	0		
BC	5	0.0045	0.0009	0		
BD	5	0.0045	0.0009	0		
BE	5	0.0046	0.00092	2E-09		
CA	5	0.0045	0.0009	0		
CB	5	0.0045	0.0009	0		
CC	5	0.0045	0.0009	0		
CD	5	0.005	0.001	0		
CE	5	0.0045	0.0009	0		
DA	5	0.0045	0.0009	0		
DB	5	0.0045	0.0009	0		
DC	5	0.0045	0.0009	0		
DD	5	0.005	0.001	0		
DE	5	0.0045	0.0009	0		
EA	5	0.0045	0.0009	0		
EB	5	0.0045	0.0009	0		
EC	5	0.0046	0.00092	2E-09		
ED	5	0.0045	0.0009	0		
EE	5	0.0045	0.0009	0		
FA	5	0.0045	0.0009	0		
FB	5	0.0049	0.00098	2E-09		
FC	5	0.0045	0.0009	0		
FD	5	0.0045	0.0009	0		
FE	5	0.0045	0.0009	0		
			0.000916			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.656E-07	29	5.7103E-09	19.0344828	1.8936E-32	1.56207098
Within groups	3.6E-08	120	3E-10			
Total	2.016E-07	149				
within-sd	1.73E-05					
effective n	4.00					
s_bb	3.68E-05					
s_bb_min	3.11E-06					
u_bb	3.68E-05	0.036778				
u_bb(rel.)	4.01501344					

Mercury:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	0.0307	0.00614	3E-09		
AB	5	0.0316	0.00632	2E-09		
AC	5	0.0313	0.00626	3E-09		
AD	5	0.0309	0.00618	2E-09		
AE	5	0.031	0.0062	0		
BA	5	0.031	0.0062	0		
BB	5	0.0315	0.0063	0		
BC	5	0.0309	0.00618	2E-09		
BD	5	0.0311	0.00622	2E-09		
BE	5	0.0314	0.00628	2E-09		
CA	5	0.0311	0.00622	2E-09		
CB	5	0.0314	0.00628	2E-09		
CC	5	0.0309	0.00618	2E-09		
CD	5	0.0317	0.00634	3E-09		
CE	5	0.0311	0.00622	2E-09		
DA	5	0.0314	0.00628	2E-09		
DB	5	0.0313	0.00626	3E-09		
DC	5	0.0304	0.00608	2E-09		
DD	5	0.0319	0.00638	2E-09		
DE	5	0.0311	0.00622	2E-09		
EA	5	0.0308	0.00616	3E-09		
EB	5	0.0311	0.00622	2E-09		
EC	5	0.0312	0.00624	3E-09		
ED	5	0.0309	0.00618	2E-09		
EE	5	0.0308	0.00616	3E-09		
FA	5	0.031	0.0062	0		
FB	5	0.0314	0.00628	2E-09		
FC	5	0.0312	0.00624	3E-09		
FD	5	0.031	0.0062	0		
FE	5	0.0309	0.00618	2E-09		
			0.00622667			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.8133E-07	29	2.0046E-08	10.3686088	4.8377E-21	1.56207098
Within groups	2.32E-07	120	1.9333E-09			
Total	8.1333E-07	149				
within-sd	4.4E-05					
effective n	4.00					
s_bb	6.73E-05					
s_bb_min	7.9E-06					
u_bb	6.73E-05	0.067292				
u_bb(rel.)	1.08070039					

Phosphor:

Sample	Number	Sum	Mean	Variance
AA	5	39.83	7.966	0.01753
AB	5	39.85	7.97	0.07105
AC	5	39.52	7.904	0.08183
AD	5	40.58	8.116	0.15213
AE	5	39.62	7.924	0.06663
BA	5	40.46	8.092	0.19187
BB	5	40.81	8.162	0.20137
BC	5	41.25	8.25	0.17175
BD	5	39.91	7.982	0.21957
BE	5	40.13	8.026	0.12948
CA	5	38.18	7.636	0.16888
CB	5	38.51	7.702	0.11737
CC	5	41.37	8.274	0.07008
CD	5	40.64	8.128	0.51287
CE	5	40.45	8.09	0.1041
DA	5	38.96	7.792	0.07612
DB	5	41.15	8.23	0.13045
DC	5	40.94	8.188	0.42477
DD	5	38.53	7.706	0.09153
DE	5	39.65	7.93	0.14675
EA	5	41.64	8.328	0.04457
EB	5	38.38	7.676	0.26073
EC	5	39.84	7.968	0.44757
ED	5	40.69	8.138	0.10707
EE	5	40.69	8.138	0.33967
FA	5	39.57	7.914	0.02158
FB	5	39.82	7.964	0.03748
FC	5	40.33	8.066	0.40493
FD	5	41.4	8.28	0.07075
FE	5	42.04	8.408	0.46117
			8.0316	

ANOVA

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.760216	29	0.19862814	1.11554372	0.33144384	1.56207098
Within groups	21.3666	120	0.178055			
Total	27.126816	149				
within-sd	0.421966					
effective n	4.00					
s_bb	0.071717					
s_bb_min	0.075807					
u_bb	0.075807	75.80699				
u_bb(rel.)	0.94385919					

Antimony:

Sample	Number	Sum	Mean	Variance
AA	5	0.0205	0.0041	0
AB	5	0.023	0.0046	5E-09
AC	5	0.0234	0.00468	7E-09
AD	5	0.0216	0.00432	1.7E-08
AE	5	0.0222	0.00444	8E-09
BA	5	0.021	0.0042	1E-08
BB	5	0.0224	0.00448	7E-09
BC	5	0.0214	0.00428	1.7E-08
BD	5	0.0224	0.00448	1.7E-08
BE	5	0.0234	0.00468	1.2E-08
CA	5	0.0223	0.00446	1.3E-08
CB	5	0.0217	0.00434	3E-09
CC	5	0.0208	0.00416	1.3E-08
CD	5	0.0238	0.00476	1.8E-08
CE	5	0.0208	0.00416	1.3E-08
DA	5	0.0222	0.00444	8E-09
DB	5	0.0225	0.0045	5E-09
DC	5	0.0192	0.00384	3E-09
DD	5	0.0236	0.00472	7E-09
DE	5	0.0218	0.00436	8E-09
EA	5	0.0206	0.00412	7E-09
EB	5	0.0226	0.00452	2E-09
EC	5	0.022	0.0044	5E-09
ED	5	0.0196	0.00392	1.7E-08
EE	5	0.0208	0.00416	1.3E-08
FA	5	0.0219	0.00438	1.2E-08
FB	5	0.0241	0.00482	2.7E-08
FC	5	0.0225	0.0045	1.5E-08
FD	5	0.0209	0.00418	1.2E-08
FE	5	0.02	0.004	5E-09
			0.00436667	

ANOVA

Source of variation	sums of squares (SS)	degrees of freedom (df)	Mean squares (MS)	F-value	P-value	critical F-value
Between groups	8.9293E-06	29	3.0791E-07	30.1870633	2.6984E-42	1.56207098
Within groups	1.224E-06	120	1.02E-08			
Total	1.0153E-05	149				

within-sd	0.000101	
effective n	4.00	
s_bb	0.000273	
s_bb_min	1.81E-05	
u_bb	0.000273	0.272813
u_bb(rel.)	6.24762925	

Vanadium:

Sample	*Number*	*Sum*	*Mean*	*Variance*		
AA	5	0.0281	0.00562	2E-09		
AB	5	0.0287	0.00574	3E-09		
AC	5	0.0289	0.00578	7E-09		
AD	5	0.0283	0.00566	3E-09		
AE	5	0.0284	0.00568	2E-09		
BA	5	0.0284	0.00568	2E-09		
BB	5	0.0284	0.00568	2E-09		
BC	5	0.0286	0.00572	2E-09		
BD	5	0.0284	0.00568	2E-09		
BE	5	0.0285	0.0057	5E-09		
CA	5	0.0283	0.00566	3E-09		
CB	5	0.0284	0.00568	2E-09		
CC	5	0.0286	0.00572	2E-09		
CD	5	0.0288	0.00576	3E-09		
CE	5	0.0283	0.00566	3E-09		
DA	5	0.0284	0.00568	2E-09		
DB	5	0.0283	0.00566	3E-09		
DC	5	0.0281	0.00562	2E-09		
DD	5	0.0284	0.00568	2E-09		
DE	5	0.0282	0.00564	3E-09		
EA	5	0.0287	0.00574	3E-09		
EB	5	0.0284	0.00568	2E-09		
EC	5	0.0284	0.00568	2E-09		
ED	5	0.0283	0.00566	3E-09		
EE	5	0.0282	0.00564	8E-09		
FA	5	0.0284	0.00568	7E-09		
FB	5	0.0285	0.0057	0		
FC	5	0.0284	0.00568	2E-09		
FD	5	0.0283	0.00566	3E-09		
FE	5	0.0285	0.0057	5E-09		
			0.005684			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.016E-07	29	6.9517E-09	2.31724138	0.0008149	1.56207098
Within groups	0.00000036	120	3E-09			
Total	5.616E-07	149				
within-sd	5.48E-05					
effective n	4.00					
s_bb	3.14E-05					
s_bb_min	9.84E-06					
u_bb	3.14E-05	0.031431				
u_bb(rel.)	0.55297977					

Zirconium:

Sample	Number	Sum	Mean	Variance		
AA	5	0.0168	0.00336	3E-09		
AB	5	0.0169	0.00338	2E-09		
AC	5	0.0169	0.00338	2E-09		
AD	5	0.0167	0.00334	3E-09		
AE	5	0.0168	0.00336	3E-09		
BA	5	0.0168	0.00336	3E-09		
BB	5	0.0168	0.00336	3E-09		
BC	5	0.0171	0.00342	2E-09		
BD	5	0.0168	0.00336	3E-09		
BE	5	0.0168	0.00336	3E-09		
CA	5	0.0167	0.00334	3E-09		
CB	5	0.0168	0.00336	3E-09		
CC	5	0.017	0.0034	2.351E-37		
CD	5	0.0168	0.00336	3E-09		
CE	5	0.017	0.0034	2.351E-37		
DA	5	0.0169	0.00338	2E-09		
DB	5	0.0168	0.00336	3E-09		
DC	5	0.017	0.0034	2.351E-37		
DD	5	0.0168	0.00336	3E-09		
DE	5	0.0168	0.00336	3E-09		
EA	5	0.0168	0.00336	3E-09		
EB	5	0.0167	0.00334	3E-09		
EC	5	0.0167	0.00334	3E-09		
ED	5	0.0171	0.00342	2E-09		
EE	5	0.0168	0.00336	3E-09		
FA	5	0.0167	0.00334	3E-09		
FB	5	0.0166	0.00332	2E-09		
FC	5	0.0165	0.0033	0		
FD	5	0.017	0.0034	2.351E-37		
FE	5	0.0171	0.00342	2E-09		
			0.00336667			
ANOVA						
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.2133E-07	29	4.1839E-09	1.84584178	0.0115687	1.56207098
Within groups	2.72E-07	120	2.2667E-09			
Total	3.9333E-07	149				
within-sd	4.76E-05					
effective n	4.00					
s_bb	2.19E-05					
s_bb_min	8.55E-06					
u_bb	2.19E-05	0.021893				
u_bb(rel.)	0.65029181					

Annex 3: Calculation of uncertainty contribution of potential inhomogeneity (area)

Silicon:

r_0	10.05082489	10.34917511														
r_in	10.35	10.27	10.27	10.23	10.32	10.29	10.34	10.38								
r_middle	10.31	10.3	10.3	10.34	10.3	10.29	10.3	10.3	10.32	10.28	10.35	10.37				
r_out	10.3	10.37	10.33	10.26	10.26	10.28	10.24	10.28	10.18	10.26	10.3	10.28	10.29	10.32	10.22	10.24
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	0.028152083	3	0.009384028	3.17298018	0.036537734	2.882604204										
Within groups	0.100554345	34	0.002957481													
Total	0.128706429	37														
within-sd	0.054382725															
effective n	8.56															
s_bb	0.027397842															
s_bb_min	0.009153269															
u_bb	0.027397842			10.29264706												
u_bb(rel.)	0.266188495															

Iron:

r_0	0.495508623	0.524491377														
r_in	0.51	0.51	0.51	0.52	0.51	0.51	0.51	0.51								
r_middle	0.51	0.51	0.51	0.52	0.51	0.51	0.5	0.5	0.51	0.51	0.51	0.52				
r_out	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.52	0.51	0.5	0.51	0.5	0.51	0.52	0.51	0.51
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	9.86842E-06	3	3.28947E-06	0.085538895	0.967480422	2.882604204										
Within groups	0.0013075	34	3.84559E-05													
Total	0.001317368	37														
within-sd	0.006201281															
effective n	8.56															
s_bb	0															
s_bb_min	0.00104375															
u_bb	0.00104375			0.51												
u_bb(rel.)	0.204656951															

Copper:

r_0	2.584139843	2.695860157														
r_in	2.66	2.69	2.71	2.7	2.68	2.71	2.68	2.69								
r_middle	2.66	2.67	2.69	2.68	2.69	2.67	2.7	2.67	2.67	2.66	2.69	2.69				
r_out	2.6	2.6	2.62	2.64	2.61	2.64	2.62	2.61	2.6	2.62	2.62	2.65	2.65	2.61	2.63	2.65
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	0.033029057	3	0.011009686	24.70636113	1.14637E-08	2.882604204										
Within groups	0.015151131	34	0.000445621													
Total	0.048180188	37														
within-sd	0.021109749															
effective n	8.56															
s_bb	0.035127159															
s_bb_min	0.003553026															
u_bb	0.035127159			2.657941176												
u_bb(rel.)	1.321592809															

Manganese:

r_0	0.341532658	0.350467342														
r_in	0.348	0.35	0.348	0.349	0.35	0.347	0.347	0.351								
r_middle	0.349	0.35	0.348	0.349	0.348	0.348	0.348	0.349	0.351	0.348	0.349	0.35				
r_out	0.35	0.348	0.35	0.35	0.347	0.351	0.347	0.35	0.347	0.348	0.348	0.348	0.349	0.35	0.347	0.348
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	1.49123E-05	3	4.97076E-06	1.796387512	0.166443651	2.882604204										
Within groups	9.4081E-05	34	2.76709E-06													
Total	0.000108993	37														
within-sd	0.001663456															
effective n	8.56															
s_bb	0.000507342															
s_bb_min	0.00027998															
u_bb	0.000507342			0.348617647												
u_bb(rel.)	0.145529744															

Magnesium:

r_0	0.472097838	0.493902162														
r_in	0.49	0.498	0.497	0.497	0.492	0.493	0.493	0.49								
r_middle	0.496	0.496	0.5	0.5	0.5	0.497	0.499	0.495	0.495	0.494	0.497	0.497				
r_out	0.493	0.491	0.5	0.494	0.494	0.497	0.496	0.492	0.489	0.491	0.487	0.495	0.494	0.487	0.496	0.496
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	0.000371728	3	0.000123909	7.606179831	0.000506741	2.882604204										
Within groups	0.000553881	34	1.62906E-05													
Total	0.000925609	37														
within-sd	0.004036164															
effective n	8.56															
s_bb	0.003545451															
s_bb_min	0.000679335															
u_bb	0.003545451			0.494147059												
u_bb(rel.)	0.717489012															

Chromium:

r_0	0.028606136	0.031393864														
r_in	0.029	0.031	0.03	0.03	0.03	0.03	0.03	0.03								
r_middle	0.031	0.03	0.03	0.03	0.03	0.03	0.029	0.03	0.031	0.03	0.03	0.03				
r_out	0.03	0.03	0.03	0.03	0.03	0.031	0.03	0.03	0.03	0.029	0.03	0.03	0.03	0.03	0.03	0.03
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	5.70175E-08	3	1.90058E-08	0.059820037	0.980505518	2.882604204										
Within groups	1.08024E-05	34	3.17717E-07													
Total	1.08594E-05	37														
within-sd	0.000563664															
effective n	8.56															
s_bb	0															
s_bb_min	9.48715E-05															
u_bb	9.48715E-05			0.030029412												
u_bb(rel.)	0.315928458															

Nickel:

r_0	0.083566967	0.090433033														
r_in	0.086	0.088	0.088	0.088	0.087	0.088	0.087	0.088								
r_middle	0.086	0.088	0.087	0.088	0.086	0.088	0.086	0.085	0.089	0.087	0.089	0.087				
r_out	0.086	0.087	0.089	0.086	0.085	0.085	0.085	0.086	0.086	0.087	0.088	0.085	0.087	0.088	0.087	0.085
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	8.16228E-06	3	2.72076E-06	1.340895812	0.277361752	2.882604204										
Within groups	6.89881E-05	34	2.02906E-06													
Total	7.71504E-05	37														
within-sd	0.001424451															
effective n	8.56															
s_bb	0.000284241															
s_bb_min	0.000239752															
u_bb	0.000284241			0.086911765												
u_bb(rel.)	0.327044914															

Zinc:

r_0	0.709362227	0.790637773														
r_in	0.74	0.75	0.75	0.74	0.74	0.8	0.75	0.75								
r_middle	0.74	0.74	0.75	0.74	0.74	0.74	0.74	0.75	0.74	0.75	0.74	0.75				
r_out	0.74	0.74	0.74	0.74	0.74	0.74	0.75	0.73	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	0.000909649	3	0.000303216	1.581305173	0.21187532	2.882604204										
Within groups	0.006519524	34	0.000191751													
Total	0.007429173	37														
within-sd	0.013847408															
effective n	8.56															
s_bb	0.003608262															
s_bb_min	0.002330686															
u_bb	0.003608262			0.744705882												
u_bb(rel.)	0.484521782															

Titanium:

r_0	0.15062183	0.18737817														
r_in	0.171	0.174	0.166	0.166	0.164	0.16	0.169	0.169								
r_middle	0.185	0.168	0.171	0.169	0.176	0.172	0.172	0.178	0.166	0.174	0.162	0.169				
r_out	0.173	0.169	0.17	0.176	0.189	0.188	0.175	0.177	0.174	0.169	0.172	0.181	0.178	0.167	0.174	0.184

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000435958	3	0.000145319	2.657725877	0.063914078	2.882604204
Within groups	0.001859056	34	5.46781E-05			
Total	0.002295014	37				
within-sd	0.007394465					
effective n	8.56					
s_bb	0.003253798					
s_bb_min	0.001244578					
u_bb	0.003253798			0.172117647		
u_bb(rel.)	1.890450224					

Gallium:

r_0	75.35602945	90.64397055														
r_in	83.3	81.3	80.3	81.4	84.9	85.3	84.8	85.4								
r_middle	84.4	81	83.7	86.1	87.9	83.4	88.2	82.7	85.4	81.1	84.5	79.1				
r_out	81.8	84.7	86.4	79.5	86.5	82.7	80.9	85.2	84.8	81.3	87.2	87.3	88.6	82.8	82.7	84.6

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.488267544	3	1.829422515	0.186605208	0.904777274	2.882604204
Within groups	333.3259881	34	9.803705532			
Total	338.8142556	37				
within-sd	3.131086957					
effective n	8.56					
s_bb	0					
s_bb_min	0.526999758					
u_bb	0.526999758			83.77941176		
u_bb(rel.)	0.629032535					

Lead:

r_0	689.8744273	736.9255727														
r_in	714.9	727	724	715.5	720.3	732.5	733.7	729.7								
r_middle	741.2	710.9	723	735.1	740.4	731.3	742	732.3	737.9	732.4	727.8	719.1				
r_out	708.4	696.2	709.8	704.8	706.4	718.3	707.6	718.4	713.8	710.4	700	720.9	720.3	715.1	719.7	717.9

Source of variation	sums of squares (SS)	degrees of freedom (df)	Mean squares (MS)	F-value	P-value	critical F-value
Between groups	2818.286491	3	939.4288304	9.585773117	9.91066E-05	2.882604204
Within groups	3332.08181	34	98.00240616			
Total	6150.368301	37				

within-sd	9.899616465			
effective n	8.56			
s_bb	9.913695836			
s_bb_min	1.666225036			
u_bb	9.913695836			720.9647059
u_bb(rel.)	1.375059799			

Tin:

r_0	484.0847808	592.7152192														
r_in	540.5	532.9	520.4	526.5	559.6	563.8	556	563.6								
r_middle	544.1	523	542.9	562.7	567.8	540	573.6	540.5	554.7	535.9	554.7	516.2				
r_out	527.8	545.8	554.4	510.9	561	535.2	523.2	544.7	549.4	526.5	563.7	557.3	574.1	533.9	536.3	552.7

Source of variation	sums of squares (SS)	degrees of freedom (df)	Mean squares (MS)	F-value	P-value	critical F-value
Between groups	135.9166557	3	45.3055519	0.098615154	0.96024609	2.882604204
Within groups	15620.20336	34	459.417746			
Total	15756.12002	37				

within-sd	21.43403242			
effective n	8.56			
s_bb	0			
s_bb_min	3.607606576			
u_bb	3.607606576			544.0029412
u_bb(rel.)	0.663159388			

Beryllium:

r_0	5.058380175	5.361619825														
r_in	5.21	5.27	5.29	5.35	5.36	5.28	5.34	5.35								
r_middle	5.38	5.27	5.31	5.33	5.35	5.3	5.37	5.39	5.31	5.29	5.29	5.33				
r_out	5.36	5.34	5.31	5.31	5.25	5.38	5.26	5.31	5.29	5.3	5.34	5.36	5.38	5.26	5.27	5.26

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.023468202	3	0.007822734	2.383135455	0.08649855	2.882604204
Within groups	0.11160631	34	0.003282539			
Total	0.135074511	37				
within-sd	0.057293442					
effective n	8.56					
s_bb	0.023028454					
s_bb_min	0.009643178					
u_bb	0.023028454			5.311764706		
u_bb(rel.)	0.433536793					

Bismuth:

r_0	13.07240356	50.42759644														
r_in	39.07	31.02	30.73	34.05	41.85	45.72	42.11	45.03								
r_middle	38.69	28.71	34.14	40.9	46.66	34.08	47.35	31.74	41.84	30.1	40.82	23.82				
r_out	30.68	35.9	42.91	25.93	39.28	34.39	25.6	38.32	36.35	28.85	42.59	41.81	42.98	31.61	32.45	36.52

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	101.6020909	3	33.86736363	0.561918214	0.643824905	2.882604204
Within groups	2049.213453	34	60.27098392			
Total	2150.815544	37				
within-sd	7.763438924					
effective n	8.56					
s_bb	0					
s_bb_min	1.306680552					
u_bb	1.306680552			36.31		
u_bb(rel.)	3.598679569					

Cadmium:

r_0	8.131351195	17.48864881														
r_in	15.27	16.76	18.89	15.07	15.9	17.27	17.81	16.49								
r_middle	16.48	14.61	16.33	13.93	14.69	18.17	15.85	17.85	20.57	16.33	14.69	14.88				
r_out	14.89	13.25	17.14	18.21	16.86	16.12	16.87	14.94	16.23	14.15	14.73	15.49	16.96	16.77	19.72	16.18
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	24.52967906	3	8.176559686	2.084121811	0.120615684	2.882604204										
Within groups	133.3909697	34	3.923263815													
Total	157.9206488	37														
within-sd	1.980723054															
effective n	8.56															
s_bb	0.704839629															
s_bb_min	0.333379617															
u_bb	0.704839629			15.95117647												
u_bb(rel.)	4.418731311															

Mercury:

r_0	81.09876641	89.90123359														
r_in	88.3	89	87.3	86.9	90.4	88	85.8	88.3								
r_middle	87.3	88.6	85.4	86.9	88.9	85.5	88.2	88.1	84.6	84.6	88	87.8				
r_out	88.2	90.4	90.1	87.9	91.2	89.5	88.8	87.2	88.3	90.8	89.8	88.9	86.9	86.8	87.6	88
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	33.72951754	3	11.24317251	3.530335754	0.024973571	2.882604204										
Within groups	108.280881	34	3.184731793													
Total	142.0103985	37														
within-sd	1.784581686															
effective n	8.56															
s_bb	0.97018158															
s_bb_min	0.300366655															
u_bb	0.97018158			87.94117647												
u_bb(rel.)	1.103216512															

Phosphor

r_0	6.561700147	23.75829985														
r_in	9.24	19.4	12.22	12.25	15.28	14.39	13.81	17.75								
r_middle	8.47	13.04	9.86	12.13	15.26	13.21	10.05	14.15	14.91	9.82	13.62	13.48				
r_out	11	9.13	4.97	8.16	6.26	10.42	7.54	6.89	11.26	5.91	9.83	10.9	8.62	10.96	12.6	11.74

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	186.7686738	3	62.2562246	5.934951554	0.00227761	2.882604204
Within groups	356.6518811	34	10.48976121			
Total	543.4205549	37				

within-sd	3.238790084			
effective n	8.56			
s_bb	2.458961702			
s_bb_min	0.545127495			
u_bb	2.458961702			11.61558824
u_bb(rel.)	21.16949785			

Antimony

at:		D2						
r_0	0.002597188	0.011602812						
r_in	0.0072	0.0063	0.0072	0.0075	0.0067	0.0053	0.0061	0.0064
r_middle	0.0089	0.0074	0.0089	0.0035	0.0066	0.0063	0.0064	0.0061
r_out	0.0078	0.0064	0.0061	0.0049	0.0069	0.0066	0.0054	0.0076

reuungsursac	*dratsummen (*	*heitsgrade (*	*e Quadratsum*	*rüfgröße (F)*	*P-Wert*	*tischer F-Wert*
Unterschiede	8.17212E-07	3	2.72404E-07	0.083053535	0.968561316	3.049124989
Innerhalb de	7.21569E-05	22	3.27986E-06			
Gesamt	7.29741E-05	25				

within-sd	0.001811038			
This data set now can be handled according to ISO G35. The result for u_bb is:				
effective n	6.15			
s_bb	0			
s_bb_min	0.000400872			
u_bb	0.000400872			0.006642308
u_bb(rel.)	6.035136232			

Vanadium

r_0	67.91251118	81.88748882														
r_in	76.3	79.6	73.6	80.2	79.4	79.2	82.7	78.9								
r_middle	74.6	74.6	76	78.4	76	79	75.2	78.5	77.2	77.4	79.3	76.7				
r_out	76.7	74.2	75.6	73	77.9	75.5	74.3	73.3	74.9	72.9	79.1	75.5	75.9	73.2	73.7	73.9
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	83.77576754	3	27.92525585	4.163417551	0.012926436	2.882604204										
Within groups	228.0479167	34	6.707291667													
Total	311.8236842	37														
within-sd	2.589843946															
effective n	8.56															
s_bb	1.574270556															
s_bb_min	0.435902021															
u_bb	1.574270556			76.63235294												
u_bb(rel.)	2.054315828															

Zirconium:

r_0	23.18866494	28.51133506														
r_in	26.81	28.39	26.46	28.61	28.4	27.99	29.17	27.55								
r_middle	26.02	26.48	26.77	26.83	26.33	28.34	25.65	28.31	26.73	28.29	27.5	27.73				
r_out	26.89	26.72	25.85	26.36	28.03	26.79	26.42	25.57	26.26	25.93	27.98	25.58	26.49	25.6	25.92	25.55
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	15.4372557	3	5.145751901	4.504717342	0.009139932	2.882604204										
Within groups	38.83830024	34	1.142302948													
Total	54.27555594	37														
within-sd	1.068785735															
effective n	8.56															
s_bb	0.683824512															
s_bb_min	0.17988955															
u_bb	0.683824512			27.01294118												
u_bb(rel.)	2.531470038															