Bundesanstalt für Materialforschung und -prüfung (BAM)

ECRM 589-2

Ferro-Titanium

Certification report

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Abstract

This report describes the preparation and certification of reference material ECRM 589-2, Ferro-Titanium (FeTi). The certified mass fractions are listed below.

Element	Mass fraction [1)] in %	Uncertainty *U* in %
C	0.179	0.005
Mn	0.247	0.005
S	0.0101	0.0006
Mo	0.549	0.014
Ni	0.191	0.005
Al	3.172	0.023
Cu	0.0697	0.0018
Co	0.0149	0.0006
Sn	0.166	0.006
Ti	68.94	0.23
Zr	0.260	0.007

[1)] Unweighted mean value of the means of accepted sets of data (consisting of 4 single results), each set being obtained by a different laboratory and/or a different method of measurement.

The mass fractions of the following elements are given for information:

Element	Mass fraction [1)] in %
Si	0.352
Cr	1.060
V	1.336
Ca	0.040
Fe	22.00
Mg	0.101
Pb	0.0061
Zn	0.0113

[1)] Unweighted mean value of the means of accepted sets of data (consisting of 4 single results), each set being obtained by a different laboratory and/or a different method of measurement.

ECRM 589-2 is available as a powder with a particle size in the range of 63 - 125 µm and is supplied in 60 mL glass bottles containing 100 g. The minimum amount of sample to be used for the determination is 0.2 g.

Contents

List of abbreviations

(if not explained elsewhere)

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
XRF	X-Ray fluorescence

1 Introduction

Ferro-titanium (FeTi), a titanium-iron alloy with 65 to 80 % titanium (mass fraction) is used in the steel industry as a master alloy. The deoxidizing capacity of ferrotitanium is much higher than the efficiency of silicon or manganese. Ferrotitanium also improves the mechanical properties of steel – it increases its strength and resistance to corrosion. In steel industry ferrotitanium is most commonly used in tool steel and stainless steel.
Ferro-titanium also improves the properties of alloys. It increases their wear resistance and improves machining properties. The exact knowledge of the titanium-content in ferro-titanium as well as the contents of impurities are important for the correct dosage of titanium and the input of accompanying elements. The CRM 589-2 is used to control the accompanying analysis and to calibrate the analytical methods used. ECRM 589-2 replaces the sold-out ECRM 589-1. The CRM was produced in accordance with the relevant ISO documents [1, 2].

2 Candidate material

About 140 kg of FeTi-powder (nominal < 100 µm) was obtained from Institut für Materialprüfung Glörfeld GmbH, Willich (Germany). This material was sieved over 63 and 125 µm sieves at BAM. A total amount of 100 kg in a particle size range of 63 – 125 µm was taken as candidate material for ECRM 589-2.
The material is stored at ambient temperature in ten containers. From each of these containers one bottle was taken to test the homogeneity of the total batch.
CRM 589-2 will be bottled in 60 mL glass bottles containing 100 g of material.

3 Homogeneity study

A total of 10 bottles of the candidate material were selected from the total batch to give complete coverage of it. From each unit at least six (C, S: nine) independent test portions were analysed using different analytical methods (see Table 1). All measurements were performed in BAM.

Table 1: Analytical methods used for homogeneity testing

Element	Analytical method
C, S	Combustion/Infrared detection
Ti, Fe, Mn, Cr, Mo, Ni, Al, Cu, Co, Sn, Zr	X-ray fluorescence spectrometry

The homogeneity for Si, Mg, Pb, V, and Zn was not tested. The results of the certification ring test showed a wider spread than normal for Si, which maybe resulted from a slight inhomogenity for Si. Therefore, this element is given for information only. For the elements Mg, Pb, V, and Zn there was no hint that the material was not homogeneous, the results af the certification ring test looked normal.
All measurement results from the homogeneity study are given in Annex 2. The estimate of inhomogeneity contribution u_{bb} was calculated according to ISO Guide 35 [2] on the basis of the results of 1-way Analysis of Variance (ANOVA). The maximum of the following equations was used:

$$s_{bb} = \max\left(\sqrt{\frac{MS_{among} - MS_{within}}{n}}, 0\right) \quad (1)$$

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

with:

MS_{among}	mean of squared deviations between bottles (from 1-way ANOVA)
MS_{within}	mean of squared deviations within bottles (from 1-way ANOVA)
n	number of replicate sub-samples per bottle
N	number of bottles selected for homogeneity study

4 Stability

From former batches (e.g. ECRM 589-1) it is well known that the material is stable. Therefore, the CRM will remain stable, provided that the bottle remains sealed and is stored in a cool and dry atmosphere. When the bottle has been opened the lid should be secured immediately after use. If the contents should become discoloured (eg. oxidised) due to atmospheric contamination they should be discarded.

5 Certification study

5.1 Design of the study

The certification study was organised as an interlaboratory comparison. 25 laboratories invited to participate were selected on the basis of their expertise demonstrated in former certification interlabopratory comparisons in the framework of ECRM-certifications.
Most of the laboratories hold an accreditation according to ISO/IEC 17025.
Each participant received one unit of bottled candidate material and was asked to analyse four independent sub-samples for their element contents.
All participants were asked to give information on details of the applied analytical procedures. Table 2 shows the analytical parameters reported by the participating laboratories.

Table 2: Analytical procedures used by the participating laboratories

Lab-No.	Element	Sample mass	Sample pretreatment	Analytical method
1*	all elements	50 mg	Dissolution with aqua regia/HF	ICP-MS, calibration with commercial calibration solutions
2	Mn, Mo, Ni, Cu, Co, Fe, Sn, Ti, Zr	0.1 g	Microwave assisted digestion HF/HCl/HNO_3 (1:1:1)	ICP-OES, calibration with commercial calibration solutions (Merck)
3*	C	0.1 g		Combustion/Infrared detection, calibration with $CaCO_3$ (DIN EN ISO 15350)
	S	0.1 g		Combustion/Infrared detection, calibration with sulphur (DIN EN ISO 15350)
	Cr, Mo, Ni, Al, Cu, Co, Zr	0.5 g	Dissolution in acid	ICP-OES, calibration with different pure chemicals (DIN 11885)
	Mn, Sn, Ti, Fe	0.5 g		XRF, calibration with different pure chemicals (DIN 51418-2)
4*	C	0.25 g		Combustion/Infrared detection, calibration with $NaHCO_3$ (a) or $BaCO_3$ (b)
	S	0.25 g		Combustion/Infrared detection, calibration with K_2SO_4 (a) or $BaSO_4$ (b)
	Si	3 g	Dissolution with HCl/HNO_3	Gravimetry, dehydration with sulfuric acid
	Ti	0.6 g	Dissolution with H_2SO_4/HNO_3/HF/HCl	Titration with ammonium iron(III) sulphate
	Cr, Al	0.6 g	Dissolution with H_2SO_4/HNO_3/HF	FAAS, calibration with commercial calibration solutions (Merck)
	Ni	1 g	Dissolution with HCl/HNO_3	Spectrophotometry, calibration with commercial calibration solutions (Merck)
	Co, Pb, Zn	0.6 g	Dissolution with H_2SO_4/HNO_3/HF	ETAAS, calibration with commercial calibration solutions (Merck)
	Mn, Mo, Ni, Cu, Co, Sn, Pb, Fe, Zr, Mg, V, Zn, Ca	0.6 g	Dissolution with H_2SO_4/HNO_3/HF	ICP-OES, calibration with commercial calibration solutions (Merck)
5*	Si, Cr, Al, Ti, Fe	0.3 g	Fused bead	XRF, calibration with pure substances

*accredited acc. to ISO 17025

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

Lab-No.	Element	Sample mass	Sample pretreatment	Analytical method
6*	Si, Mn, Mo, Ni, Al, Cu, Sn, Mg, V, Ti, Zr, Pb	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-OES, calibration with commercial calibration solutions
	Cr, Co, Fe	0.5 g	Dissolution with HNO_3/HCl/HF, fusion with a mixture of fluxes ($Na_2B_4O_7$+Na_2CO_4)	ICP-OES, calibration with commercial calibration solutions
7	C	1 g		Combustion/Infrared detection, calibration with $CaCO_3$
	S	1 g		Combustion/Infrared detection, calibration with K_2SO_4
	Si, Mn, Cr, Mo, Al, Cu, Co, Pb, Zr, Fe, Mg, V	0.5 g	Microwave assisted digestion	ICP-OES, calibration with commercial calibration solutions (Spectrascan)
8*	C	0.25 g		Combustion/Infrared detection, calibration with WC (DIN EN ISO 15350)
	S	0.15 g		Combustion/Infrared detection, calibration with K_2SO_4 (DIN EN ISO 15350)
	Mn, Cr, Mo, Ni, Al, Cu, Co, Sn, Zr, Fe	0.2 g	Dissolution in acid	ICP-OES, calibration with calibration solutions prepared from pure substances
	Ti	0.5 g	Dissolution in acid	Spectrophotometry with H_2O_2, calibration with Ti-metal
9*	Si, Mn, Cr, Mo, Ni, Al, Cu, Ti, Fe	0.3 g	Dissolution in acid	XRF, calibration with pure substances
10*	Mn, Cr, Mo, Ni, Al, Cu, Co, Ti	0.2 g	Dissolution with H_2SO_4/HNO_3/HF	ICP-OES, calibration with calibration solutions prepared from pure substances
	Sn, Zr, Fe	0.2 g	Dissolution with H_2SO_4/HNO_3	ICP-OES, calibration with calibration solutions prepared from pure substances
11	C	0.3 g		Combustion/Infrared detection, calibration with $CaCO_3$
	S	0.3 g		Combustion/Infrared detection, calibration with $CaSO_4$
	Si, Mn, Cr, Mo, Ni, Al, Cu, Co, Sn, Ti, Zr, Fe, V, Mg, Pb	1 g	Dissolution with aqua regia/HF	ICP-OES, calibration with calibration solutions prepared from pure substances
12*	C			Combustion/Infrared detection, calibration with CO_2
	S			Combustion/Infrared detection, calibration with SO_3
	Si, Mn, Cr, Mo, Ni, Al, Co, Sn, Ti, Fe			ICP-OES, calibration with commercial calibration solutions (NIST traceable)
13	Mn, Cr, Mo, Ni, Al, Cu, Co, Sn, Ti, Zr, Fe	0.1 g	Dissolution with HCl/HNO_3/HF	ICP-OES, calibration with commercial calibration solutions
14	Mn, Cr, Mo, Ni, Al, Cu, Co, Ti, Fe, Mg, V, Pb	0.25 g	Dissolution with HCl/HNO_3 on a hot plate	ICP-OES, calibration with commercial calibration solutions (Accu Standard)
15*	Si, Mn, Cr, Mo, Ni, Al, Cu, Co, Sn, Fe	0.2 g	Decomposition with $K_2S_2O_7$	ICP-OES, calibration with commercial calibration solutions
	Ti	0.2 g	Decomposition with $K_2S_2O_7$	ICP-OES, calibration with TiO_2
	C	0.1 g		Combustion/Infrared detection, calibration with $CaCO_3$ (DIN EN ISO 15350)
	S	0.1 g		Combustion/Infrared detection, calibration with $BaSO_4$ (DIN EN ISO 15350)

*accredited acc. to ISO 17025

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

Lab-No.	Element	Sample mass	Sample pretreatment	Analytical method
16	C	0.25 g	Flux: W/Sn+ Fe	Combustion/Infrared detection, calibration with CO_2
	S	0.25 g	Flux: W/Sn+ Fe	Combustion/Ultraviolet detection, calibration with K_2SO_4
	Si, Mn, Cr, Mo, Ni, Al, Cu, Co, Sn, Ti, Zr, Fe	0.05 g	Microwave assisted HNO_3, HCl, and HF	ICP-OES, calibration with commercial calibration solutions (NIST traceable) or with pure metals (Ni, Cu, Ti, Zr, Fe)
17*	Si, Mn, Cr, Mo, Ni, Al, Cu, Co, Sn, Mg, Ti, Zr, Fe, V, Pb	0.1 g	Microwave assisted acid digestion	ICP-OES, calibration with commercial calibration solutions (Merck)
18*	C	1 g		Combustion/Infrared detection, calibration with $CaCO_3$
	S	1 g		Combustion/Infrared detection, calibration with $BaSO_4$
19	C	0.25 g		Combustion/Infrared detection, calibration with $NaHCO_3$ (ASTM 1019)
	S	0.25 g		Combustion/Infrared detection, calibration with K_2SO_4 (ASTM 1019)
20	Ti, Fe, Si			XRF, calibration with different pure chemicals
	Si	0.5 g	Dissolution with $H_2SO_4/HNO_3/HCl$	Gravimetry, dehydration with hydrochloric acid
23*	C	0.3 g		Combustion/Infrared detection, calibration with $CaCO_3$
	S	0.3 g		Combustion/Infrared detection, calibration with $CsSO_4$
	Si, Mn, Cr, Mo, Ni, Al, Cu, Sn, Ti, Zr, Fe, V	0.3 g		XRF, calibration with different pure chemicals
	Co	0.1 g	Dissolution in acid	ICP-MS, calibration with calibration solutions prepared from pure substances
24*	C	0.2 g		Combustion/Infrared detection, calibration with $CaCO_3$ (ASTM E1019)
	S	0.2 g		Combustion/Infrared detection, calibration with $BaSO_4$ (ASTM E1019)
	Si	0.5 g	Decomposition with Na_2O_2	Gravimetry (IS 13840 (P-2))
	Mn, Cr, Mo, Ni, Al, Cu, Co, Sn	0.5 g	Dissolution with HCl/HF	ICP-OES, calibration with commercial calibration solutions
	Ti	0.5 g	Dissolution with $H_2SO_4/HNO_3/HCl/HF$	Titration with ammonium iron(III) sulphate
	Fe	0.5 g	Decomposition with Na_2O_2	Titration with $K_2Cr_2O_7$
25	C	0.2 g	Flux: 1.5 g W+ 0.8 g Fe	Combustion/Infrared detection, calibration with $BaCO_3$
	S	0.2 g	Flux: 1.5 g W+ 0.8 g Fe	Combustion/Ultraviolet detection, calibration with K_2SO_4
26	C	0.5 g	Flux: W/Sn+ Fe	Combustion/Infrared detection, calibration with $CaCO_3$
	S	0.5 g	Flux: W/Sn+ Fe	Combustion/Infrared detection, calibration with $BaSO_4$
27	C	0.15 g		Combustion/Infrared detection, calibration with $BaCO_3$
	S	0.15 g		Combustion/Ultraviolet detection, calibration with $BaSO_4$

*accredited acc. to ISO 17025

5.2 Participants

Afarak Elektrowerk Weisweiler GmbH, Eschweiler (Germany)
AG der Dillinger Hüttenwerke, Dillingen-Saar (Germany)
Alleima Tube AB, Sandviken (Sweden)
ALS Scandinavia AB, Luleå (Sweden)
ArcelorMittal Eisenhüttenstadt Forschungs- und Qualitätszentrum GmbH, Eisenhüttenstadt (Germany)
ArcelorMittal Maizières Research SAS, Maizières-lès-Metz (France)
Bruker AXS GmbH, Karlsruhe (Germany)
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)
Chemad GmbH, Duisburg (Germany)
CMC POLAND Sp. z o.o., Zawiercie (Poland)
CSIR-National Metallurgical Laboratory, Jamshedpur (India)
Dunaferr Labor Nonprofit Ltd., Dunaújváros (Hungary)
Elementar Analysensysteme GmbH, Langenselbold (Germany)
Eltra GmbH, Haan (Germany)
Höganäs Sweden AB, Höganäs (Sweden)
Horn & Co. Analytics GmbH, Wenden-Hünsborn (Germany)
IFW Dresden e.V., Dresden (Germany)
Inspectorate Griffith India Pvt. Lyd., Bhubaneswar Laboratory, Bhubaneswar (India)
Łukasiewicz Research Network – Upper Silesian Institute of Technology, Gliwice (Poland)
Narema, Närpiö (Finland)
Österreichisches Gießerei-Institut (ÖGI), Leoben (Austria)
Saarstahl AG, Völklingen (Germany)
Salzgitter Flachstahl GmbH, Salzgitter (Germany)
SpectroChem, Turku (Finland)
Tata Steel Limited, Jamshedpur (India)
ThyssenKrupp Steel Europe AG, Duisburg (Germany)

5.3 Analytical results and statistical evaluation

Following the rules of the EURONORM CRM producers' group in a first step, the data obtained were checked for technical errors, miscalculations and typing errors [3, 4]. After that, the mean of all datasets (M) was calculated together with the standard deviation of the laboratories' means (s). All results being outside the interval "$M \pm 3 * s$" (OEV) were removed before testing the whole data for outliers (Grubbs (95%), Cochran (99%)). After removal of outliers the recalculated standard deviation was compared with the data from [5] to evaluate the results of the interlaboratory comparison. OEVs, outliers and results which increases the standard deviation significantly were referred to the laboratories for reanalysis. A second statistical evaluation of the data after inclusion of reanalysed results was performed to detect additional outliers. This data is presented in Annex 1. The bars in the graphic presentations indicate the standard deviation of individual results.

5.4 Calculation of uncertainty

The uncertainty of the certified values considering the uncertainty contributions from the homogeneity-test and the certification interlaboratory comparison was calculated following Equation (3)

$$u_c = \sqrt{u_{char}^2 + u_{bb}^2} \qquad (3)$$

with

$$u_{char} = \frac{s_M}{\sqrt{n}} \qquad (4)$$

n: number of data sets used for calculating the certified mass fractions

In older EURONORM-CRMs as a measure of the uncertainty of the certified values the half-width confidence interval C (95 %) of the certified mass content wass calculated according to Equation (5) and reported in the certificate

$$\mathrm{C}(95\ \%) = \frac{t \times S_{\mathrm{M}}}{\sqrt{\mathrm{n}}} \qquad (5)$$

with
n: number of accepted mean values;
t: the Student's value at the chosen probability with n-1 degrees of freedom.

Table 3 shows the results of both calculations.

Table 3: results of uncertainty calculation

		uncertainty contribution from							
	M	n	s_M	u_{char}	u_{bb}*	$u_{combined}$	U	C(95%)	u_{bb} (rel)
	%		%	%	%	%	%		
C	0.1787	16	0.0075	0.0019	0.0012	0.0022	0.00448	0.00399	0.6918
Mn	0.2471	17	0.0095	0.0023	0.0008	0.0025	0.00491	0.00490	0.3420
S	0.0101	17	0.0011	0.0003	0.0001	0.0003	0.00061	0.00055	1.4172
Cr	1.0600	15	0.0868	0.0224	0.0091	0.0242	0.04836	0.04820	0.8590
Mo	0.5490	15	0.0246	0.0063	0.0016	0.0065	0.01305	0.00955	0.2825
Ni	0.1911	17	0.0080	0.0019	0.0011	0.0022	0.00447	0.00410	0.5896
Al	3.1720	17	0.0440	0.0107	0.0030	0.0111	0.02219	0.02260	0.0957
Cu	0.0697	16	0.0032	0.0008	0.0004	0.0009	0.00177	0.00171	0.5504
Co	0.0149	17	0.0008	0.0002	0.0002	0.0003	0.00058	0.00044	1.3704
Sn	0.1662	14	0.0098	0.0026	0.0011	0.0029	0.00570	0.00565	0.6854
Ti	68.94	17	0.4240	0.1028	0.0452	0.1123	0.22467	0.21790	0.0656
Fe	22.00	18	0.3788	0.0893	0.0227	0.0921	0.18425	0.18838	0.1033
Zr	0.2599	15	0.0117	0.0030	0.0007	0.0031	0.00618	0.00649	0.2559

*calculated from u_{bb}(rel): $u_{bb} = \frac{M \cdot u_{bb}(rel)}{100}$

It can be seen that for Al, Fe, and Zr C(95%) is higher than *U (U* = 2·u_c*).* For all other elements C(95%) is slightly lower than *U*. Certified mass fractions and their respective uncertainties are rounded according to DIN 1333 [6].

For different reasons the mass fractions of some elements are only given for information without reporting any uncertainty:

- Si: no homogeneity data available, spread of results too big.
- Cr, Fe: spread of results too big.
- V, Ca, Mg, Zn, Pb and other traces: no homogeneity data available, number of datasets too low.

6 Information on the proper use of ECRM 589-2

6.1 Shelf life

As mentioned in Chapter 4 ECRM 589-2 is stable. The certificate is valid until there is a revocation from the producer of the material.

6.2 Recommendations for transport, storage and use

Transportation of the bottled sample does not require special precautions. The stability of the material allows the dispatch of the material at ambient temperature. When the bottle has been opened the lid should be secured immediately after use. The bottle should be stored in a cool and dry atmosphere.

6.3 Safety instructions

No hazardous effect is to be expected when the material is used under conditions usually adopted for the analysis of ferro-alloy powders. However, it is strongly recommended to handle and dispose the reference material in accordance with the guidelines for hazardous materials legally in force at the site of end use and disposal.

7 Metrological Traceability

The assigned values for ECRM 589-2 are achieved by inter-laboratory characterization, each laboratory using the method of their choice, details of which are given in Chapter 5. These methods are either stoichiometric analytical techniques or methods which are calibrated against pure metals or stoichiometric compounds. Most methods used were either international or national standard methods or methods which are technically equivalent.

8 References

[1] ISO 17034, General requirements for the competence of reference material producers, 2016

[2] ISO Guide 35, Reference materials - Guidance for characterization and assessment of homogeneity and stability, 2017

[3] ECRM-PG doc 2012-02 (October 2013) Statistical treatment of results of analysis for the certification of European certified reference materials (EURONORM-CRMs)

[4] CEN TR 10317:2020 European certified reference materials (EURONORM-CRMs) for the determination of the chemical composition of iron and steel products

[5] Review of the standard deviation [s(m)] of European certified reference material (EURONORM-CRM) produced between 1980 and 2021

[6] DIN 1333:1992-02 Zahlenangaben

9 Information on and purchase of the CRM

Certified reference material ECRM 589-2 is supplied by

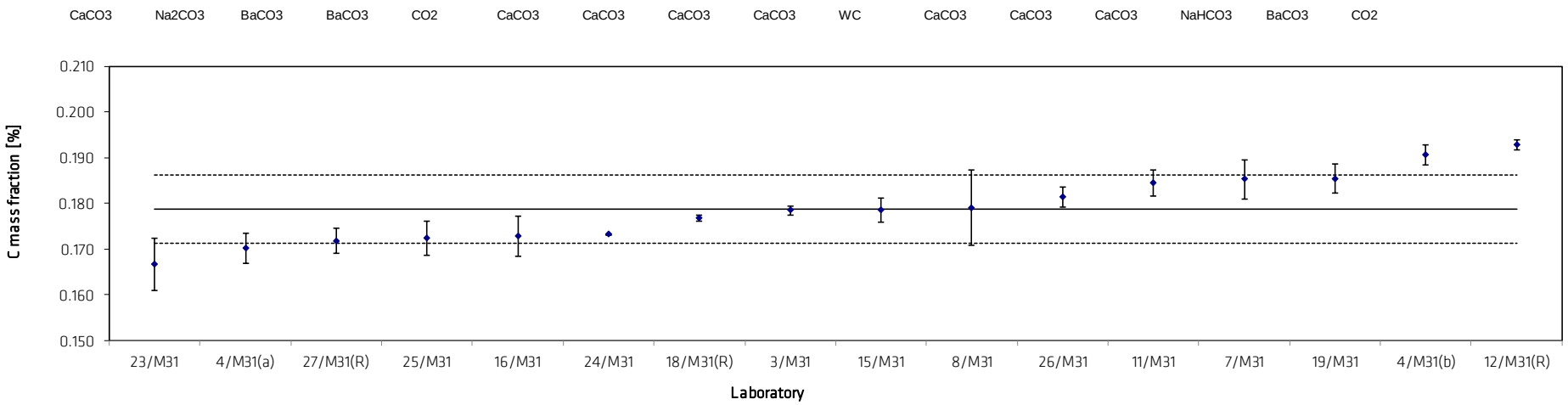
Bundesanstalt für Materialforschung und -prüfung (BAM)
Fachbereich 1.6: Anorganische Referenzmaterialien
Richard-Willstätter-Str. 11, D-12489 Berlin, Germany
Phone +49 (0)30 - 8104 2061
Fax: +49 (0)30 - 8104 72061
Email: sales.crm@bam.de
https://www.webshop.bam.de

Each unit will be distributed together with a detailed certificate containing the certified values and their confidence intervals C(95%), 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.

Annex 1: Certification study

Table A1: Measurement results for carbon

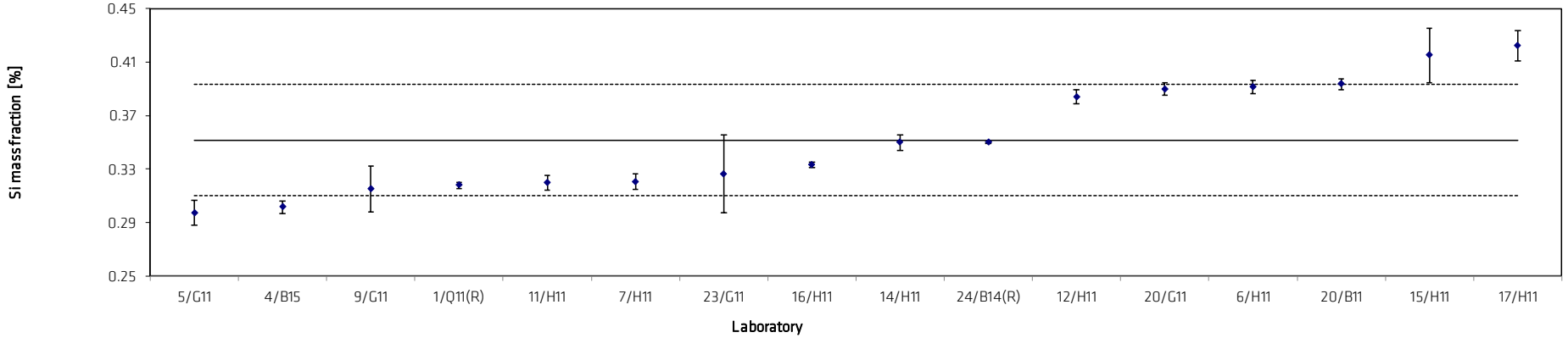
Lab./Meth.	23/M31	4/M31(a)	27/M31(R)	25/M31	16/M31	24/M31	18/M31(R)	3/M31	15/M31	8/M31	26/M31	11/M31	7/M31	19/M31	4/M31(b)	12/M31(R)		
M_i [%]	0.1647	0.1663	0.1700	0.1705	0.1725	0.1731	0.1777	0.1772	0.1750	0.1682	0.1798	0.1843	0.1880	0.1836	0.1915	0.1917		*n*
	0.1741	0.1740	0.1750	0.1733	0.1694	0.1729	0.1763	0.1792	0.1780	0.1779	0.1792	0.1810	0.1880	0.1871	0.1931	0.1939		16
	0.1606	0.1694	0.1690	0.1686	0.1792	0.1732	0.1763	0.1792	0.1810	0.1879	0.1837	0.1880	0.1860	0.1888	0.1881	0.1921		
	0.1675	0.1712	0.1730	0.1770	0.1705	0.1734	0.1768	0.1782	0.1800	0.1822	0.1829	0.1841	0.1790	0.1819	0.1898	0.1936		
***M* [%]**	**0.1667**	**0.1702**	**0.1718**	**0.1723**	**0.1729**	**0.1732**	**0.1768**	**0.1785**	**0.1785**	**0.1791**	**0.1814**	**0.1844**	**0.1853**	**0.1854**	**0.1906**	**0.1928**		**0.1787**
s [%]	0.00567	0.00325	0.00275	0.00366	0.00439	0.00021	0.00066	0.00096	0.00265	0.00831	0.00223	0.00286	0.00427	0.00316	0.00216	0.00109	s_M [%]	0.00748
																	$\bar{s}_i$ [%]	0.00360
s_{rel}	0.03404	0.01908	0.01603	0.02126	0.02540	0.00120	0.00373	0.00537	0.01482	0.04643	0.01230	0.01554	0.02306	0.01704	0.01131	0.00567		0.04186



M31: Combustion/Infrared-detection
(R): reanalysed values

Table A2: Measurement results for silicon

Lab./Meth.	5/G11	4/B15	9/G11	1/Q11(R)	11/H11	7/H11	23/G11	16/H11	14/H11	24/B14(R)	12/H11	20/G11	6/H11	20/B11	15/H11	17/H11		
M_i [%]	0.3062	0.2996	0.3000	0.3171	0.3250	0.3226	0.3473	0.3312	0.3479	0.3492	0.3856	0.3850	0.3964	0.3890	0.396	0.4072		*n*
	0.2905	0.3044	0.3100	0.3169	0.3159	0.3201	0.3528	0.3354	0.3424	0.3498	0.3816	0.3960	0.3856	0.3990	0.399	0.4226		16
	0.3038	0.3060	0.3400	0.3208	0.3244	0.3126	0.3145	0.3313	0.3521	0.3506	0.3902	0.3880	0.3898	0.3940	0.430	0.4250		
	0.2877	0.2957	0.3100	0.3158	0.3144	0.3268	0.2904	0.3337	0.3564	0.3496	0.3784	0.3900	0.3934	0.3920	0.435	0.4342		
M [%]	**0.2971**	**0.3014**	**0.3150**	**0.3177**	**0.3199**	**0.3205**	**0.3263**	**0.3329**	**0.3497**	**0.3498**	**0.3840**	**0.3898**	**0.3913**	**0.3935**	**0.4150**	**0.4223**		**0.3516**
s [%]	0.0093	0.0047	0.0173	0.0022	0.0056	0.0060	0.0293	0.0021	0.0060	0.0006	0.0051	0.0046	0.0047	0.0042	0.0203	0.0112	s_M [%]	0.0415
																	$\bar{s}_i$ [%]	0.0112
s_{rel}	0.03132	0.01555	0.05499	0.00685	0.01736	0.01860	0.08974	0.00619	0.01709	0.00168	0.01331	0.01192	0.01191	0.01068	0.04903	0.02655		0.11795



G11: X-ray fluorescence spectrometry
H11: ICP-OES
B14: Gravimetry, dehydration with nitrosulfuric acid
B11: Gravimetry, dehydration with hydrochloric acid
B15: Gravimetry, dehydration with sulfuric acid
Q11: ICP-MS
(R): reanalysed values

Table A3: Measurement results for manganese

Lab./Meth.	10/H11(R)	14/H11	23/G11	2/H11	24/H11	3/G11	6/H11	1/Q11	13/H11	16/H11	15/H11	4/H11	7/H11(R)	11/H11	17/H11	9/G11	8/H11		
M_i [%]	0.2302	0.2321	0.2419	0.2375	0.2395	0.2381	0.2412	0.2454	0.2499	0.2495	0.2510	0.2630	0.2634	0.2566	0.2550	0.2560	0.2658		*n*
	0.2344	0.2383	0.2362	0.2375	0.2387	0.2488	0.2421	0.2389	0.2428	0.2454	0.2510	0.2480	0.2536	0.2586	0.2584	0.2610	0.2589		17
	0.2378	0.2310	0.2246	0.2345	0.2385	0.2342	0.2429	0.2513	0.2471	0.2422	0.2560	0.2557	0.2547	0.2551	0.2543	0.2610	0.2566		
	0.2327	0.2347	0.2362	0.2405	0.2397	0.2459	0.2415	0.2417	0.2440	0.2598	0.2570	0.2528	0.2517	0.2571	0.2643	0.2600	0.2588		
***M* [%]**	**0.2338**	**0.2340**	**0.2347**	**0.2375**	**0.2391**	**0.2418**	**0.2419**	**0.2443**	**0.2460**	**0.2492**	**0.2538**	**0.2549**	**0.2558**	**0.2569**	**0.2580**	**0.2595**	**0.2600**		**0.2471**
s [%]	0.0032	0.0032	0.0073	0.0024	0.0006	0.0068	0.0008	0.0054	0.0032	0.0077	0.0032	0.0063	0.0052	0.0014	0.0045	0.0024	0.0040	s_M [%]	0.0095
																		$\bar{s}_i$ [%]	0.0045
s_{rel}	0.01374	0.01387	0.03095	0.01017	0.00246	0.02798	0.00310	0.02193	0.01300	0.03084	0.01262	0.02463	0.02023	0.00562	0.01763	0.00917	0.01536		0.03843

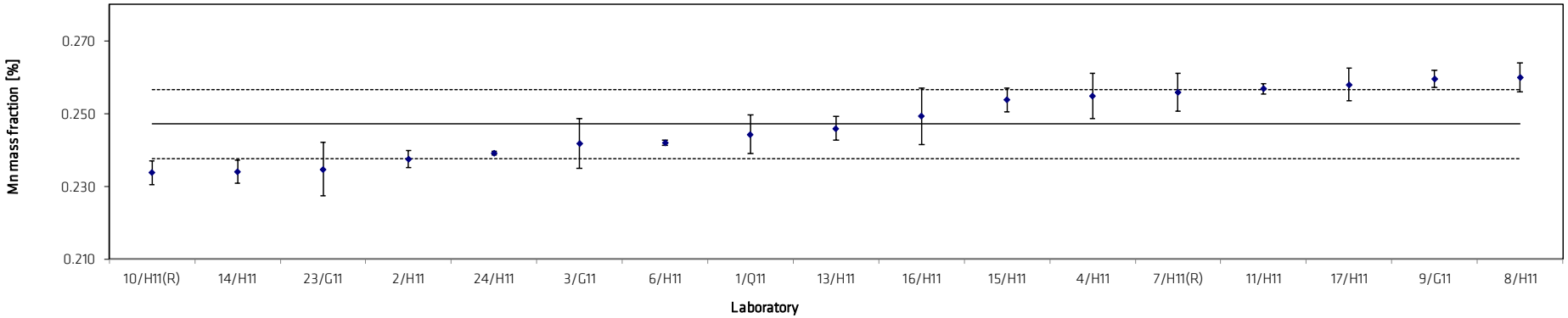
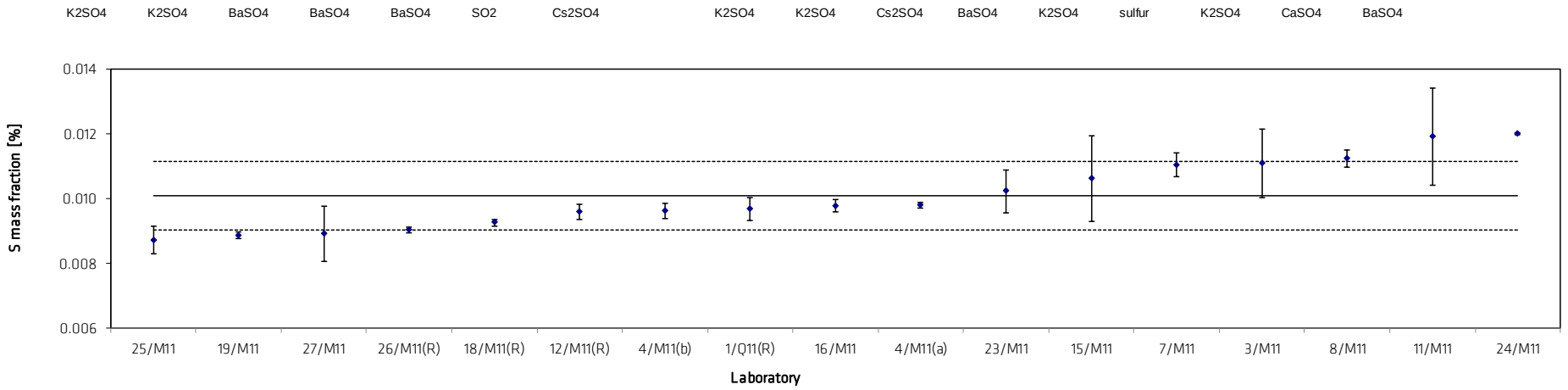


Table A4: Measurement results for sulphur

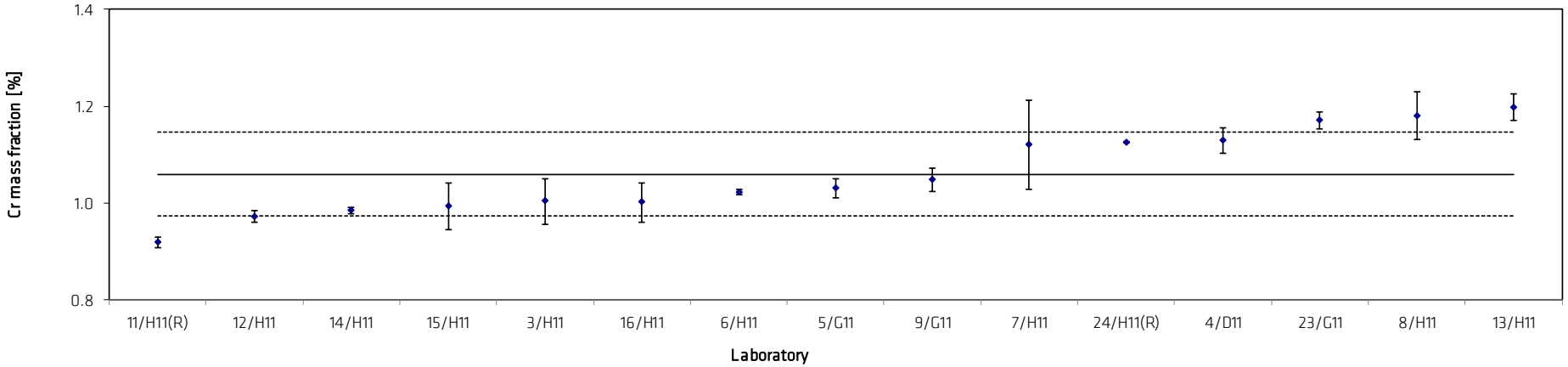
Lab./Meth.	25/M11	19/M11	27/M11	26/M11(R)	18/M11(R)	12/M11(R)	4/M11(b)	1/Q11(R)	16/M11	4/M11(a)	23/M11	15/M11	7/M11	3/M11	8/M11	11/M11	24/M11		
M_i [%]	0.00927	0.00880	0.00920	0.00897	0.00940	0.00989	0.00986	0.00980	0.00957	0.00968	0.01009	0.00920	0.01100	0.00956	0.01130	0.01110	0.01201		*n*
	0.00846	0.00900	0.00820	0.00896	0.00926	0.00932	0.00929	0.00930	0.00978	0.00983	0.01119	0.00990	0.01150	0.01180	0.01100	0.01060	0.01198		17
	0.00885	0.00880	0.00830	0.00914	0.00913	0.00962	0.00968	0.01010	0.00977	0.00989	0.00993	0.01130	0.01060	0.01180	0.01160	0.01200	0.01203		
	0.00831	0.00890	0.01000	0.00910	0.00926	0.00959	0.00965	0.00950	0.01003	0.00981	0.00971	0.01210	0.01110	0.01120	0.01110	0.01400	0.01198		
***M* [%]**	**0.00872**	**0.00888**	**0.00893**	**0.00904**	**0.00926**	**0.00961**	**0.00962**	**0.00968**	**0.00979**	**0.00980**	**0.01023**	**0.01063**	**0.01105**	**0.01109**	**0.01125**	**0.01193**	**0.01200**		**0.01009**
s [%]	0.00043	0.00010	0.00085	0.00009	0.00011	0.00023	0.00024	0.00035	0.00019	0.00009	0.00066	0.00131	0.00037	0.00106	0.00026	0.00150	0.00002	s_M [%]	0.00106
																		$\bar{s}_i$ [%]	0.00064
s_{rel}	0.04931	0.01079	0.09480	0.01007	0.01190	0.02426	0.02447	0.03618	0.01925	0.00920	0.06439	0.12376	0.03346	0.09545	0.02352	0.12576	0.00204		0.10478



M11: Combustion/Infrared-detection

Table A5: Measurement results for chromium

Lab./Meth.	11/H11(R)	12/H11	14/H11	15/H11	3/H11	16/H11	6/H11	5/G11	9/G11	7/H11	24/H11(R)	4/D11	23/G11	8/H11	13/H11		
M_i [%]	0.91110	0.9862	0.9780	1.0356	1.0190	1.0484	1.0225	1.0530	1.0260	1.1537	1.1265	1.1020	1.1802	1.1359	1.2180		*n*
	0.93310	0.9569	0.9940	1.0240	0.9494	1.0151	1.0145	1.0339	1.0360	1.1687	1.1252	1.1140	1.1880	1.2435	1.2030		15
	0.90990	0.9790	0.9820	0.9873	1.0590	0.9537	1.0282	1.0299	1.0520	0.9823	1.1258	1.1580	1.1485	1.1949	1.1570		
	0.92160	0.9679	0.9860	0.9280	0.9860	0.9885	1.0241	1.0068	1.0790	1.1777	1.1262	1.1430	1.1697	1.1477	1.2128		
M [%]	**0.91893**	**0.97249**	**0.98500**	**0.99373**	**1.00335**	**1.00143**	**1.02233**	**1.03090**	**1.04825**	**1.12057**	**1.12593**	**1.12925**	**1.17160**	**1.18050**	**1.19770**		**1.06013**
s [%]	0.01081	0.01284	0.00683	0.04841	0.04674	0.04014	0.00574	0.01897	0.02313	0.09274	0.00056	0.02576	0.01713	0.04913	0.02784	s_M [%]	0.08675
																$\overline{s}_i$ [%]	0.03664
s_{rel}	0.01177	0.01321	0.00694	0.04872	0.04658	0.04008	0.00562	0.01840	0.02206	0.08276	0.00050	0.02281	0.01462	0.04162	0.02324		0.08183



D11: flame atomic absorption spectrometry

Table A6: Measurement results for molybdenum

Lab./Meth.	12/H11	6/H11	14/H11(R)	3/H11	1/Q11	9/G11	10/H11(R)	24/H11(R)	16/H11	7/H11	17/H11	11/H11	8/H11	13/H11	2/H11	4/H11	23/G11		
M_i [%]	0.48588	0.4965	0.5231	0.5268	0.5215	0.5330	0.5237	0.5412	0.5536	0.5421	0.5580	0.5616	0.5664	0.5574	0.5798	0.5709	0.5798		n
	0.48920	0.5090	0.5198	0.5215	0.5312	0.5320	0.5665	0.5406	0.5346	0.5403	0.5531	0.5560	0.5624	0.5593	0.5700	0.5663	0.5828		15
	0.48193	0.5055	0.5208	0.5492	0.5369	0.5230	0.5439	0.5415	0.5534	0.5443	0.5568	0.5696	0.5572	0.5645	0.5667	0.5739	0.5773		
	0.48503	0.4982	0.5224	0.5125	0.5360	0.5440	0.5246	0.5410	0.5251	0.5578	0.5313	0.5548	0.5702	0.5780	0.5585	0.5676	0.5636		
M [%]	**0.4855**	**0.5023**	**0.5215**	**0.5275**	**0.5314**	**0.5330**	**0.5397**	**0.5411**	**0.5417**	**0.5461**	**0.5498**	**0.5605**	**0.5641**	**0.5648**	**0.5687**	**0.5697**	**0.5759**		**0.5490**
s [%]	0.00299	0.00593	0.00150	0.01562	0.00706	0.00860	0.02017	0.00038	0.01420	0.00795	0.01249	0.00675	0.00557	0.00930	0.00879	0.00342	0.00849	s_M [%]	0.01720
																		$\bar{s}_i$ [%]	0.01007
s_{rel}	0.00616	0.01181	0.00288	0.02962	0.01328	0.01614	0.03737	0.00070	0.02621	0.01456	0.02271	0.01205	0.00987	0.01646	0.01545	0.00600	0.01474		0.03133

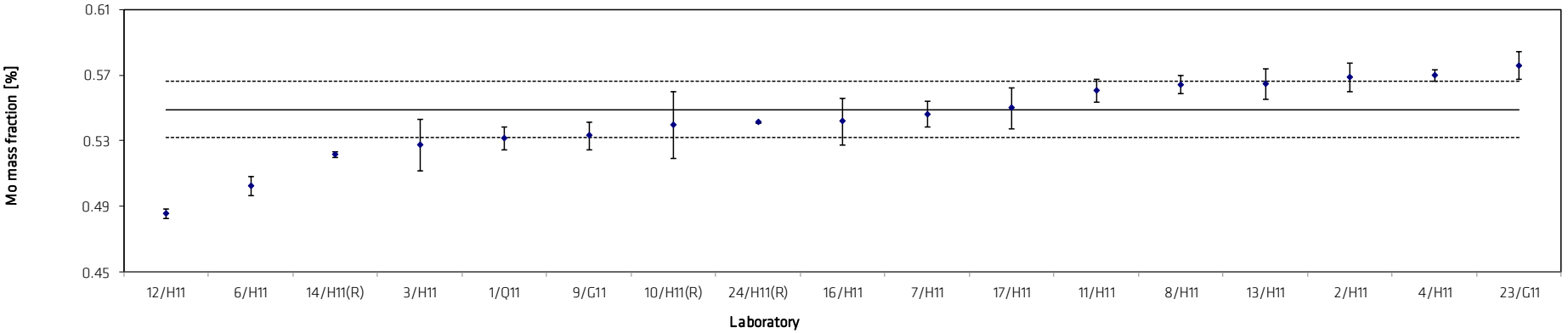
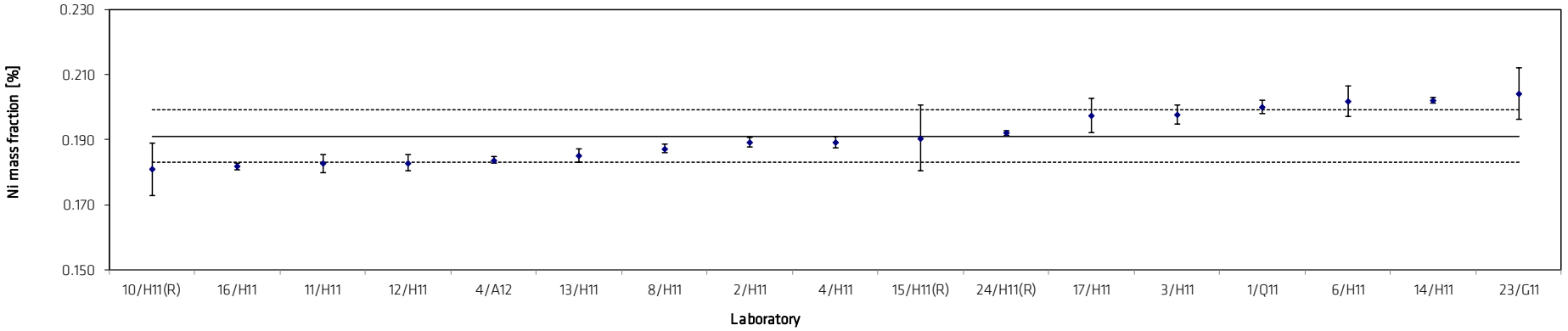


Table A7: Measurement results for nickel

Lab./Meth.	10/H11(R)	16/H11	11/H11	12/H11	4/A12	13/H11	8/H11	2/H11	4/H11	15/H11(R)	24/H11(R)	17/H11	3/H11	1/Q11	6/H11	14/H11	23/G11		
M_i [%]	0.1869	0.1815	0.1864	0.17991	0.1839	0.1868	0.1875	0.1891	0.1913	0.1940	0.1920	0.1990	0.1990	0.1971	0.1976	0.2011	0.2062		*n*
	0.1888	0.1833	0.1834	0.18459	0.1843	0.1843	0.1873	0.1872	0.1892	0.1800	0.1912	0.1971	0.1963	0.2009	0.2081	0.2019	0.2094		17
	0.1733	0.1815	0.1812	0.18164	0.1846	0.1869	0.1887	0.1908	0.1894	0.1850	0.1928	0.2035	0.2011	0.2016	0.2024	0.2033	0.2086		
	0.1746	0.1810	0.1800	0.18523	0.1824	0.1827	0.1856	0.1896	0.1871	0.2030	0.1924	0.1908	0.1945	0.2010	0.1991	0.2021	0.1926		
M [%]	**0.1809**	**0.1818**	**0.1828**	**0.1828**	**0.1838**	**0.1852**	**0.1873**	**0.1892**	**0.1893**	**0.1905**	**0.1921**	**0.1976**	**0.1977**	**0.2002**	**0.2018**	**0.2021**	**0.2042**		**0.1911**
s [%]	0.00810	0.00104	0.00281	0.00250	0.00097	0.00204	0.00128	0.00147	0.00172	0.01015	0.00068	0.00529	0.00291	0.00206	0.00465	0.00091	0.00785	s_M [%]	0.00796
																		$\bar{s}_i$ [%]	0.00411
s_{rel}	0.04476	0.00572	0.01538	0.01369	0.00529	0.01103	0.00682	0.00776	0.00908	0.05328	0.00356	0.02677	0.01473	0.01028	0.02306	0.00450	0.03845		0.04166



A12: Spectrophotometry, dimethylglyoxime, extraction

Table A8: Measurement results for aluminium

Lab./Meth.	11/H11	16/H11	4/D11	15/H11	1/Q11	7/H11	8/H11	23/G11	3/H11(R)	9/G11	10/H11(R)	5/G11	14/H11(R)	6/H11	17/H11	24/H11	12/H11		
M_i [%]	3.1200	3.1373	3.1400	3.130	3.1270	3.1491	3.1573	3.1392	3.0265	3.080	3.2180	3.1718	3.1854	3.2365	3.2012	3.2402	3.2792		*n*
	3.1122	3.1437	3.1520	3.226	3.1807	3.1325	3.1402	3.1484	3.3037	3.023	3.1648	3.1958	3.1921	3.2100	3.2186	3.2259	3.3172		17
	3.0974	3.1085	3.1200	3.120	3.1364	3.1491	3.1739	3.1506	3.0584	3.324	3.1630	3.1809	3.1873	3.2094	3.2432	3.2357	3.2726		
	3.0888	3.1414	3.1270	3.079	3.1224	3.1502	3.1140	3.1502	3.2832	3.253	3.1431	3.1858	3.1804	3.2087	3.2294	3.2624	3.2112		
***M* [%]**	**3.105**	**3.133**	**3.135**	**3.139**	**3.142**	**3.145**	**3.146**	**3.147**	**3.168**	**3.170**	**3.172**	**3.184**	**3.186**	**3.216**	**3.223**	**3.241**	**3.270**		**3.172**
s [%]	0.0141	0.0164	0.0142	0.0622	0.0267	0.0085	0.0256	0.0054	0.1457	0.1418	0.0321	0.0100	0.0048	0.0136	0.0177	0.0154	0.0439	s_M [%]	0.0439
																		$\bar{s}_i$ [%]	0.0549
s_{rel}	0.00454	0.00523	0.00452	0.01982	0.00850	0.00270	0.00813	0.00170	0.04600	0.04473	0.01011	0.00314	0.00152	0.00422	0.00550	0.00476	0.01342		0.01383

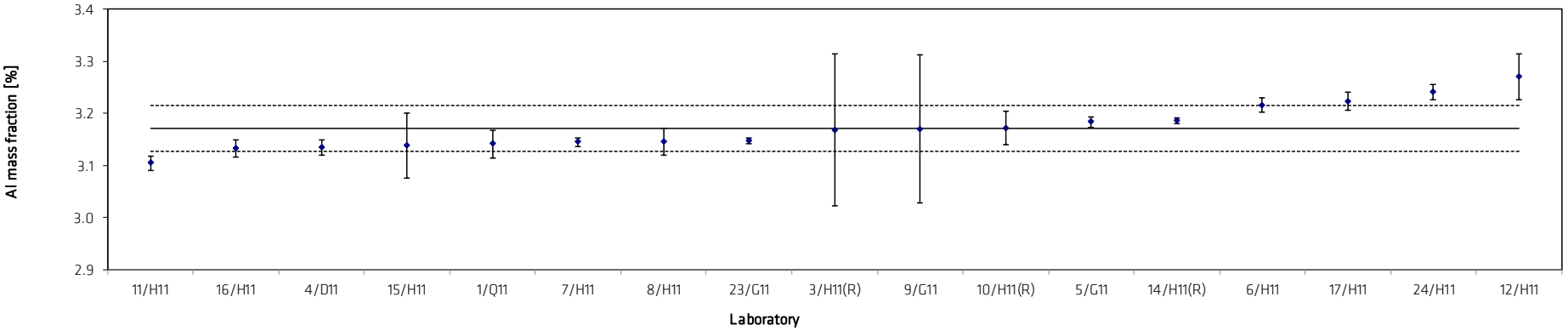


Table A9: Measurement results for copper

Lab./Meth.	10/H11(R)	7/H11	17/H11	11/H11	9/G11(R)	4/H11	24/H11	13/H11	8/H11	15/H11(R)	16/H11	2/H11	6/H11(R)	14/H11(R)	1/Q11	23/G11		
M_i [%]	0.06995	0.0659	0.0667	0.06711	0.0660	0.0684	0.0682	0.0685	0.0721	0.06800	0.06945	0.07122	0.0737	0.0692	0.07380	0.0703		*n*
	0.06034	0.0667	0.0678	0.06612	0.0660	0.0661	0.0679	0.0703	0.0693	0.06800	0.07206	0.07263	0.0707	0.0725	0.07410	0.0763		16
	0.06439	0.0663	0.0650	0.06746	0.0680	0.0668	0.0689	0.0704	0.0696	0.07000	0.07046	0.07073	0.0741	0.0756	0.07500	0.0779		
	0.06417	0.0655	0.0655	0.06730	0.0680	0.0689	0.0684	0.0686	0.0693	0.07500	0.06986	0.07059	0.0726	0.0754	0.07468	0.0780		
***M* [%]**	**0.06471**	**0.06609**	**0.06624**	**0.06700**	**0.06700**	**0.06755**	**0.06835**	**0.06945**	**0.07007**	**0.07025**	**0.07046**	**0.07129**	**0.07278**	**0.07321**	**0.07440**	**0.07563**		**0.06965**
s [%]	0.00396	0.00056	0.00128	0.00060	0.00115	0.00132	0.00042	0.00104	0.00139	0.00330	0.00115	0.00093	0.00152	0.00300	0.00054	0.00362	s_M [%]	0.00320
																	$\bar{s}_i$ [%]	0.00197
s_{rel}	0.06113	0.00840	0.01940	0.00899	0.01723	0.01951	0.00615	0.01499	0.01981	0.04703	0.01626	0.01309	0.02091	0.04104	0.00731	0.04790		0.04592

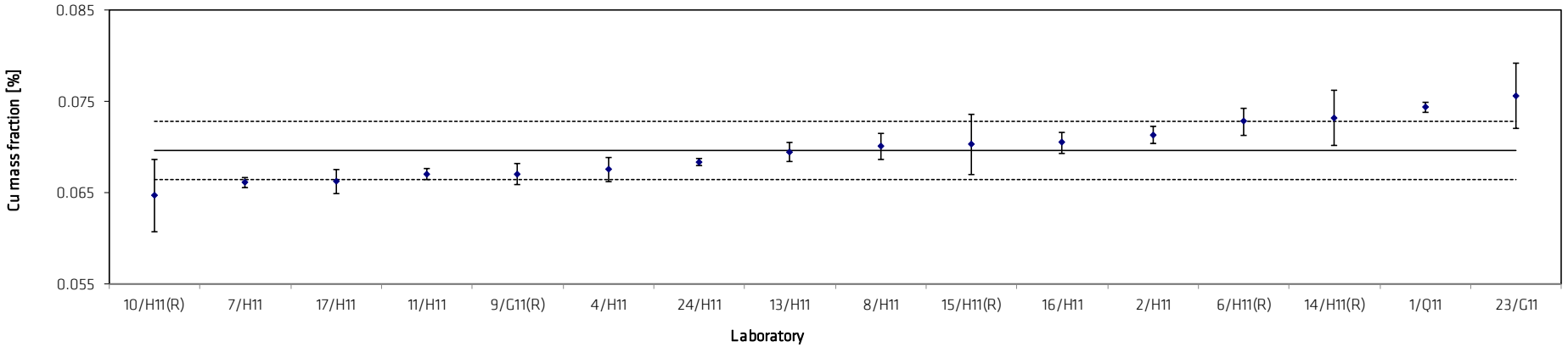


Table A10: Measurement results for cobalt

Lab./Meth.	12/H11	3/H11	23/Q11(R)	14/H11	7/H11(R)	10/H11(R)	16/H11	4/H11	24/H11	11/H11	17/H11	15/H11(R)	8/H11	4/E11	6/H11	1/Q11	13/H11		
M_i [%]	0.01359	0.0135	0.01410	0.01380	0.01599	0.01198	0.01470	0.0150	0.01502	0.01541	0.01518	0.0166	0.01527	0.0155	0.0156	0.0161	0.0161		*n*
	0.01367	0.0138	0.01398	0.01410	0.01351	0.01352	0.01484	0.0149	0.01507	0.01488	0.01503	0.0147	0.01529	0.0158	0.0162	0.0160	0.0168		17
	0.01361	0.0143	0.01355	0.01370	0.01382	0.01518	0.01484	0.0152	0.01503	0.01491	0.01536	0.0148	0.01521	0.0157	0.0169	0.0163	0.0167		
	0.01352	0.0139	0.01434	0.01450	0.01296	0.01568	0.01478	0.0147	0.01501	0.01554	0.01531	0.0148	0.01531	0.0161	0.0152	0.0156	0.0158		
***M* [%]**	**0.01360**	**0.01388**	**0.01399**	**0.01403**	**0.01407**	**0.01409**	**0.01479**	**0.014950**	**0.01503**	**0.01519**	**0.01522**	**0.01523**	**0.01527**	**0.01578**	**0.01598**	**0.01599**	**0.01635**		**0.01491**
s [%]	0.00006	0.00033	0.00033	0.00036	0.00133	0.00168	0.00007	0.00021	0.00003	0.00034	0.00015	0.00092	0.00004	0.00025	0.00074	0.00029	0.00048	s_M [%]	0.00084
																		$\bar{s}_i$ [%]	0.00064
s_{rel}	0.00455	0.02381	0.02364	0.02563	0.09443	0.11942	0.00457	0.01392	0.00175	0.02234	0.00970	0.06029	0.00283	0.01585	0.04639	0.01812	0.02933		0.05650

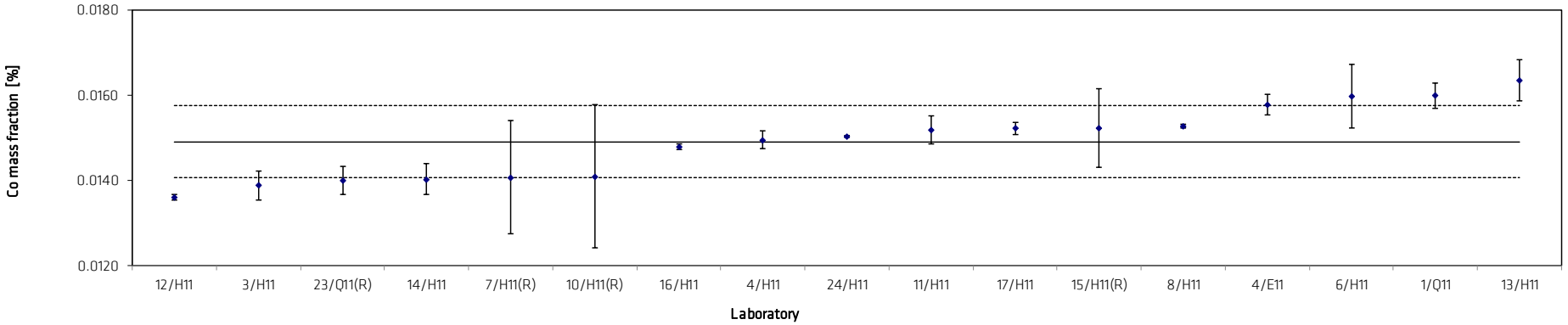


Table A11: Measurement results for tin

Lab./Meth.	10/H11	4/H11	27/H11	24/H11	17/H11	13/H11	15/H11(R)	16/H11	11/H11	8/H11	1/Q11	2/H11	23/G11	14/H11	6/H11		
M_i [%]	0.1521	0.1575	0.1581	0.1562	0.1546	0.1578	0.1570	0.1615	0.1638	0.1679	0.1774	0.1769	0.1815	0.1763	0.1817		*n*
	0.1492	0.1560	0.1549	0.1558	0.1569	0.1584	0.1578	0.1623	0.1614	0.1656	0.1703	0.1765	0.1845	0.1787	0.1829		14
	0.1373	0.1534	0.1520	0.1567	0.1567	0.1594	0.1610	0.1608	0.1650	0.1688	0.1767	0.1719	0.1739	0.1803	0.1815		
	0.1672	0.1552	0.1575	0.1564	0.1616	0.1585	0.1690	0.1622	0.1669	0.1639	0.1699	0.1756	0.1753	0.1842	0.1823		
M [%]	**0.1515**	**0.1555**	**0.1556**	**0.1563**	**0.1574**	**0.1585**	**0.1612**	**0.1617**	**0.1643**	**0.1666**	**0.1736**	**0.1752**	**0.1788**	**0.1799**	**0.1821**		**0.1662**
s [%]	0.01230	0.00171	0.00279	0.00038	0.00296	0.00066	0.00548	0.00071	0.00230	0.00222	0.00403	0.00231	0.00503	0.00332	0.00063	s_M [%]	0.00978
																$\bar{s}_i$ [%]	0.00292
s_{rel}	0.08121	0.01098	0.01792	0.00242	0.01881	0.00416	0.03399	0.00440	0.01402	0.01334	0.02319	0.01319	0.02816	0.01845	0.00347		0.05884

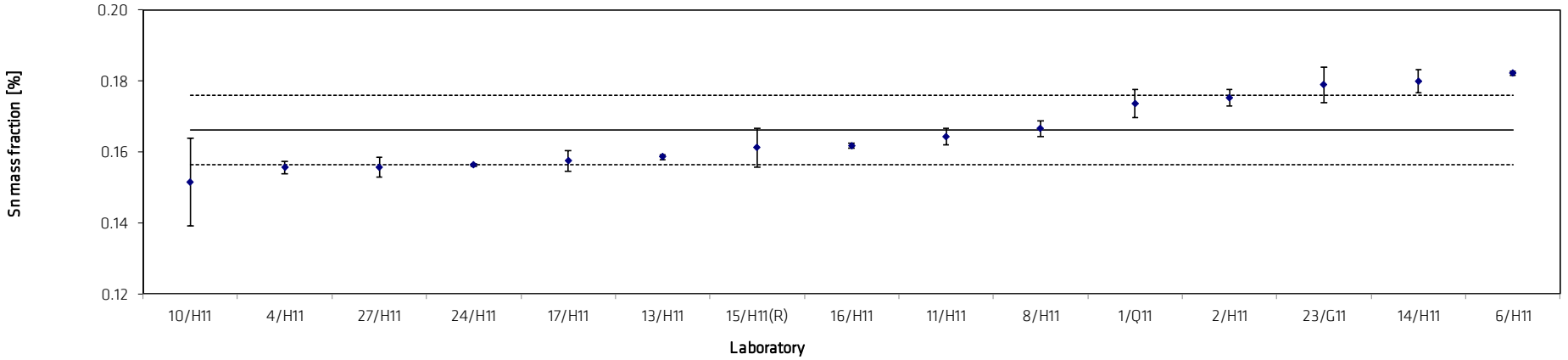
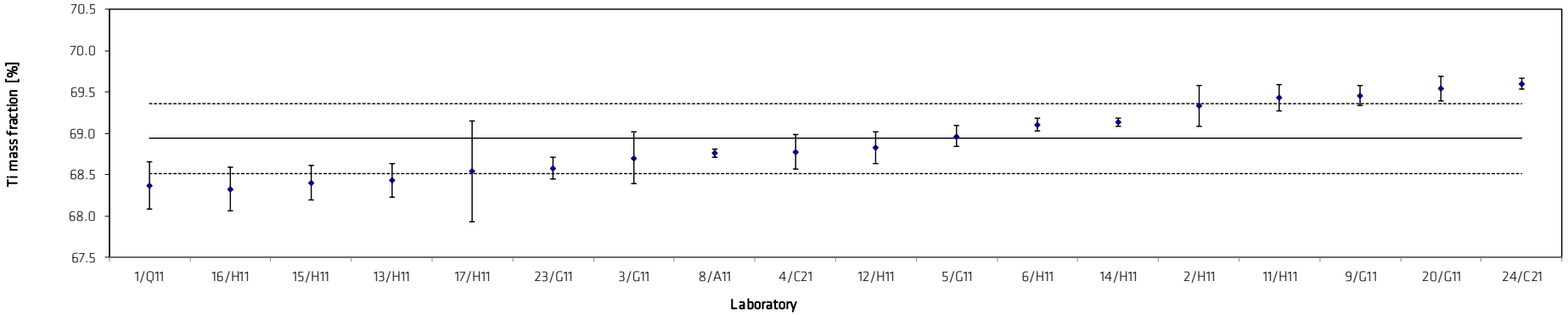


Table A12: Measurement results for titanium

Lab./Meth.	1/Q11	16/H11	15/H11	13/H11	17/H11	23/G11	3/G11	8/A11	4/C21	12/H11	5/G11	6/H11	14/H11	2/H11	11/H11	9/G11	20/G11	24/C21		
M_i [%]	*67.99*	68.08	68.67	68.19	69.37	68.48	68.46	68.71	68.91	68.95	68.84	69.04	69.06	69.43	69.36	69.39	69.55	69.62		*n*
	68.53	68.12	68.21	68.43	68.11	68.72	69.01	68.73	68.95	68.69	68.89	69.04	69.16	69.63	69.66	69.37	69.54	69.54		17
	68.63	68.51	68.27	68.41	68.64	68.67	68.40	68.78	68.74	69.04	69.11	69.18	69.19	69.21	69.30	69.63	69.35	69.69		
	68.33	68.59	68.47	68.69	68.05	68.46	68.94	68.82	68.50	68.63	69.02	69.16	69.12	69.06	69.41	69.45	69.72	69.56		
***M* [%]**	**68.37**	**68.32**	**68.41**	**68.43**	**68.54**	**68.58**	**68.70**	**68.76**	**68.78**	**68.83**	**68.97**	**69.11**	**69.13**	**69.33**	**69.43**	**69.46**	**69.54**	**69.60**		**68.94**
s [%]	0.284	0.261	0.209	0.204	0.610	0.130	0.317	0.050	0.205	0.196	0.125	0.075	0.053	0.247	0.158	0.118	0.151	0.067	s_M [%]	0.424
																			$\bar{s}_i$ [%]	0.22485
s_{rel}	0.00415	0.00382	0.00305	0.00298	0.00890	0.00189	0.00461	0.00072	0.00298	0.00284	0.00181	0.00109	0.00077	0.00356	0.00228	0.00170	0.00217	0.00097		0.00615

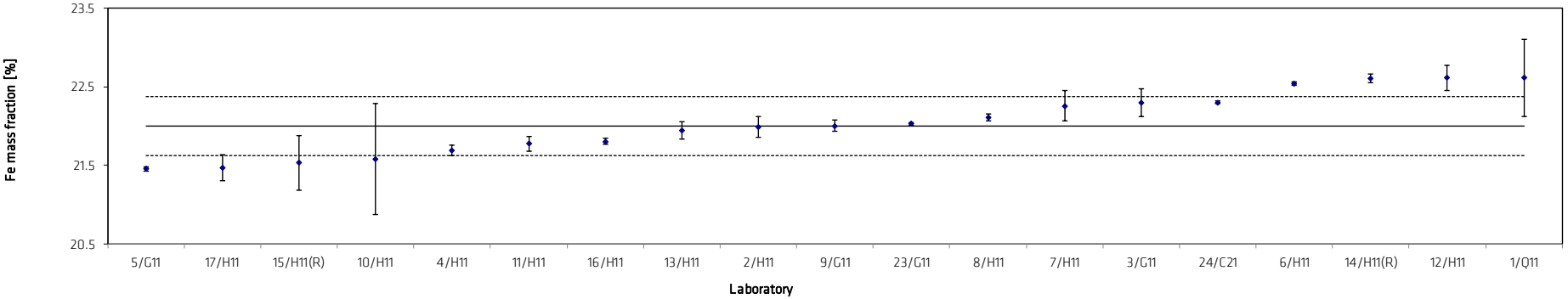


*Dataset 1/Q11 removed for technical reasons

A11: Spectrophotometry, hydrogen peroxide, without separation
C21: Titration with a reducing titrant

Table A13: Measurement results for iron

Lab./Meth.	5/G11	17/H11	15/H11(R)	10/H11	4/H11	11/H11	16/H11	13/H11	2/H11	9/G11	23/G11	8/H11	7/H11	3/G11	24/C21	6/H11	14/H11(R)	12/H11	1/Q11		
M_i [%]	21.46	21.69	21.13	20.87	21.73	21.91	21.76	21.93	21.84	22.00	22.02	22.15	22.53	22.17	22.30	22.53	22.68	22.38	*23.23*		*n*
	21.42	21.30	21.78	22.49	21.60	21.70	21.79	21.92	22.15	21.91	22.02	22.05	22.23	22.47	22.29	22.54	22.56	22.73	*22.35*		18
	21.47	21.49	21.35	21.22	21.75	21.78	21.84	21.85	22.03	22.09	22.03	22.13	22.13	22.12	22.32	22.56	22.57	22.67	*22.75*		
	21.48	21.42	21.87	21.76	21.70	21.71	21.84	22.11	21.95	22.01	22.05	22.10	22.13	22.43	22.29	22.51	22.62	22.67	*22.12*		
M [%]	**21.46**	**21.47**	**21.53**	**21.58**	**21.70**	**21.77**	**21.81**	**21.95**	**21.99**	**22.00**	**22.03**	**22.11**	**22.26**	**22.30**	**22.30**	**22.54**	**22.61**	**22.61**	**22.61**		**22.00**
s [%]	0.025	0.163	0.351	0.704	0.067	0.093	0.041	0.110	0.132	0.074	0.014	0.043	0.190	0.177	0.016	0.023	0.053	0.159	0.488	s_M [%]	0.379
																				$\bar{s}_i$ [%]	0.21016
s_{rel}	0.00118	0.00759	0.01632	0.03264	0.00307	0.00428	0.00190	0.00501	0.00599	0.00335	0.00065	0.00196	0.00852	0.00795	0.00070	0.00101	0.00235	0.00704	0.02157		0.01722



*Dataset 1/Q11 removed for technical reasons

C21: Titration with Cr (VI) after reduction with Sn (II)

Table A14: Measurement results for zirconium

Lab./Meth.	7/H11(R)	10/H11	6/H11	2/H11	14/H11	1/Q11	15/H11(R)	16/H11	4/H11	3/H11	13/H11	11/H11	17/H11	23/G11	8/H11		
M_i [%]	0.2380	0.2441	0.2520	0.2567	0.2496	0.2664	0.2440	0.2643	0.2647	0.2572	0.2697	0.2652	0.2802	0.2775	0.2813		*n*
	0.2453	0.2486	0.2452	0.2477	0.2484	0.2515	0.2510	0.2636	0.2602	0.2664	0.2651	0.2659	0.2720	0.2780	0.2752		15
	0.2359	0.2374	0.2456	0.2453	0.2514	0.2542	0.2610	0.2597	0.2626	0.2744	0.2652	0.2709	0.2730	0.2788	0.2734		
	0.2377	0.2532	0.2475	0.2543	0.2501	0.2521	0.2700	0.2629	0.2659	0.2595	0.2655	0.2741	0.2612	0.2758	0.2805		
M [%]	**0.2392**	**0.2458**	**0.2476**	**0.2510**	**0.2499**	**0.2561**	**0.2565**	**0.2626**	**0.2634**	**0.2644**	**0.2664**	**0.2690**	**0.2716**	**0.2775**	**0.2776**		**0.2599**
s [%]	0.00415	0.00677	0.00312	0.00538	0.00124	0.00700	0.01139	0.00202	0.00250	0.00774	0.00222	0.00423	0.00783	0.00127	0.00390	s_M [%]	0.01168
																$\bar{s}_i$ [%]	0.00550
s_{rel}	0.01734	0.02754	0.01259	0.02145	0.00497	0.02732	0.04439	0.00771	0.00951	0.02929	0.00835	0.01572	0.02882	0.00457	0.01406		0.04494

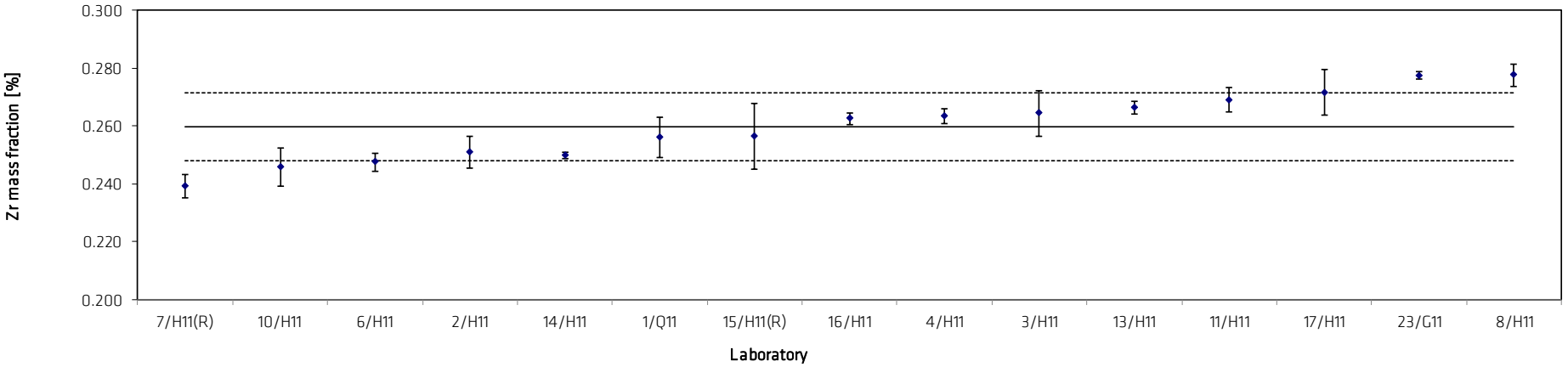


Table A15: Measurement results for magnesium

Lab./Meth.	24/H11	14/H11	1/Q11	11/H11	7/H11	6/H11	4/H11	17/H11		
M_i [%]	0.0862	0.0941	0.0921	0.1011	0.0993	0.1110	0.1095	0.1141		*n*
	0.0855	0.0955	0.0946	0.0975	0.1063	0.1010	0.1101	0.1223		8
	0.0868	0.0897	0.0979	0.0970	0.1002	0.1142	0.1099	0.1153		
	0.0866	0.0932	0.0974	0.0979	0.0940	0.1080	0.1057	0.1196		
M [%]	**0.0863**	**0.0931**	**0.0955**	**0.0984**	**0.0999**	**0.1086**	**0.1088**	**0.1178**		**0.1010**
s [%]	0.0006	0.0025	0.0027	0.0018	0.0050	0.0056	0.0021	0.0038	s_M [%]	0.0101
									$\bar{s}_i$ [%]	0.00341
s_{rel}	0.00665	0.02654	0.02819	0.01874	0.05019	0.05190	0.01913	0.03230		0.10015

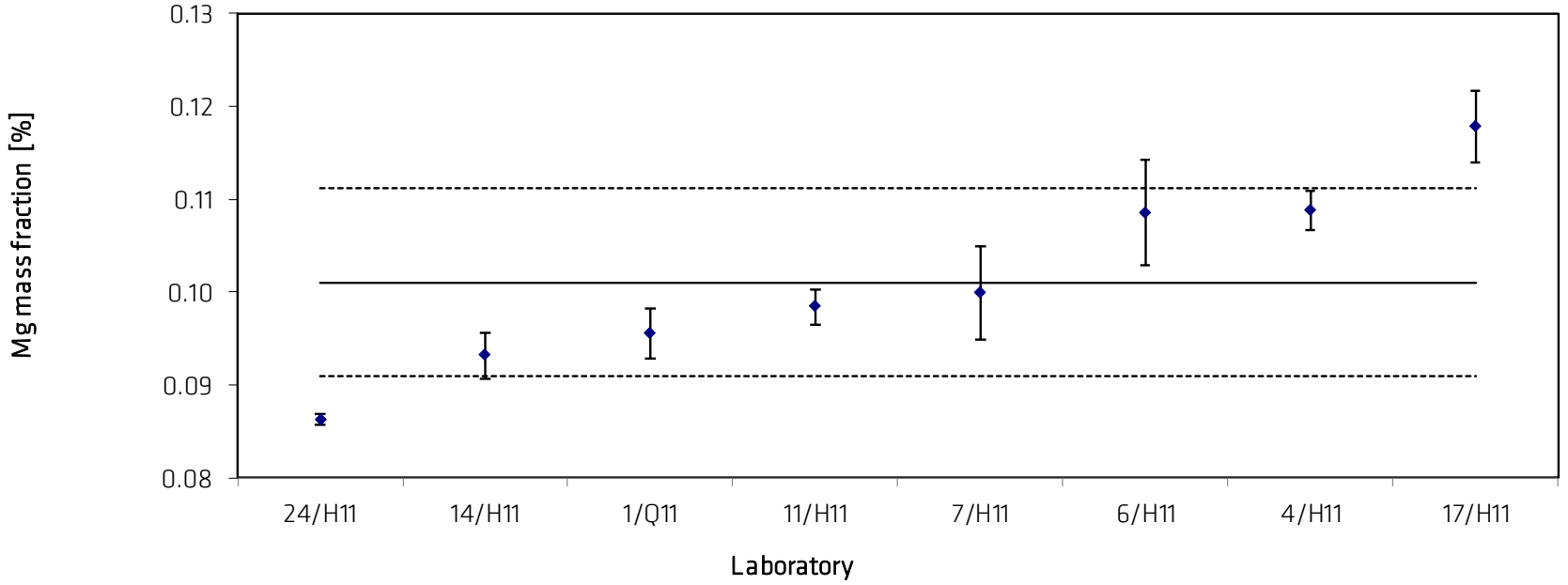


Table A16: Measurement results for lead

Lab./Meth.	14/H11	1/Q11	17/H11	4/E11	4/H11	11/H11	24/H11	7/H11		
M_i [%]	0.00520	0.00545	0.00544	0.00690	0.00730	0.00602	0.00672	0.00751		n
	0.00510	0.00595	0.00555	0.00630	0.00610	0.00688	0.00677	0.00640		8
	0.00490	0.00569	0.00559	0.00550	0.00670	0.00674	0.00675	0.00688		
	0.00480	0.00540	0.00597	0.00580	0.00630	0.00687	0.00670	0.00638		
M [%]	**0.00500**	**0.00562**	**0.00564**	**0.00613**	**0.00660**	**0.00663**	**0.00674**	**0.00679**		**0.00614**
s [%]	0.00018	0.00025	0.00023	0.00061	0.00053	0.00041	0.00003	0.00053	s_M [%]	0.00066
									$\bar{s}_i$ [%]	0.00040
s_{rel}	0.03651	0.04489	0.04090	0.10009	0.08017	0.06186	0.00462	0.07848		0.10749

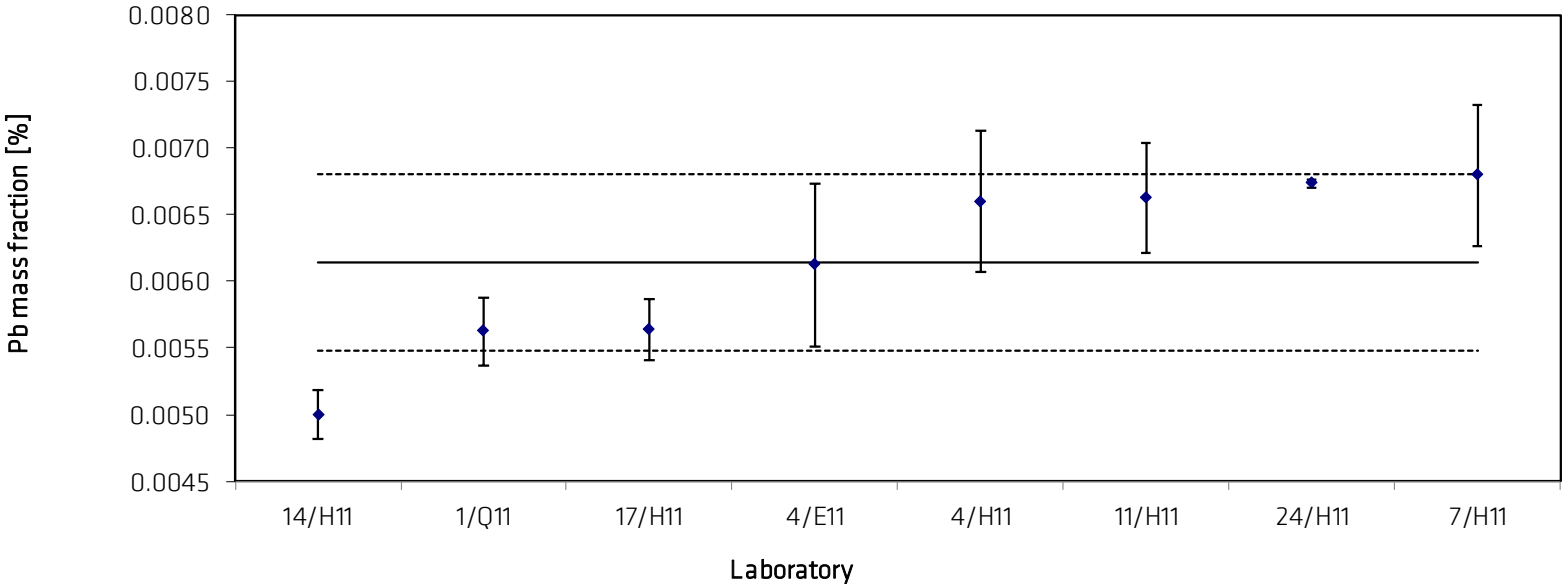


Table A17: Measurement results for vanadium

Lab./Meth.	24/H11	23/G11	6/H11	11/H11	17/H11	7/H11	4/H11	1/Q11	14/H11		
M_i [%]	1.2645	1.2884	1.3022	1.2980	1.3076	1.3183	1.3330	1.4420	1.5070		*n*
	1.2652	1.2885	1.3002	1.3127	1.2808	1.3063	1.3450	1.3907	1.4990		9
	1.2658	1.2830	1.3011	1.3005	1.3206	1.3213	1.3170	1.4069	1.4710		
	1.2648	1.3001	1.3017	1.2966	1.3315	1.3363	1.3140	1.4189	1.4790		
M [%]	**1.2651**	**1.2900**	**1.3013**	**1.3020**	**1.3101**	**1.3205**	**1.3273**	**1.4146**	**1.4890**		**1.3355**
s [%]	0.0006	0.0072	0.0009	0.0073	0.0218	0.0123	0.0145	0.0216	0.0168	s_M [%]	0.0708
										$\bar{s}_i$ [%]	0.0137
s_{rel}	0.0004	0.0056	0.0007	0.0056	0.0167	0.0093	0.0109	0.0153	0.0113		0.0530

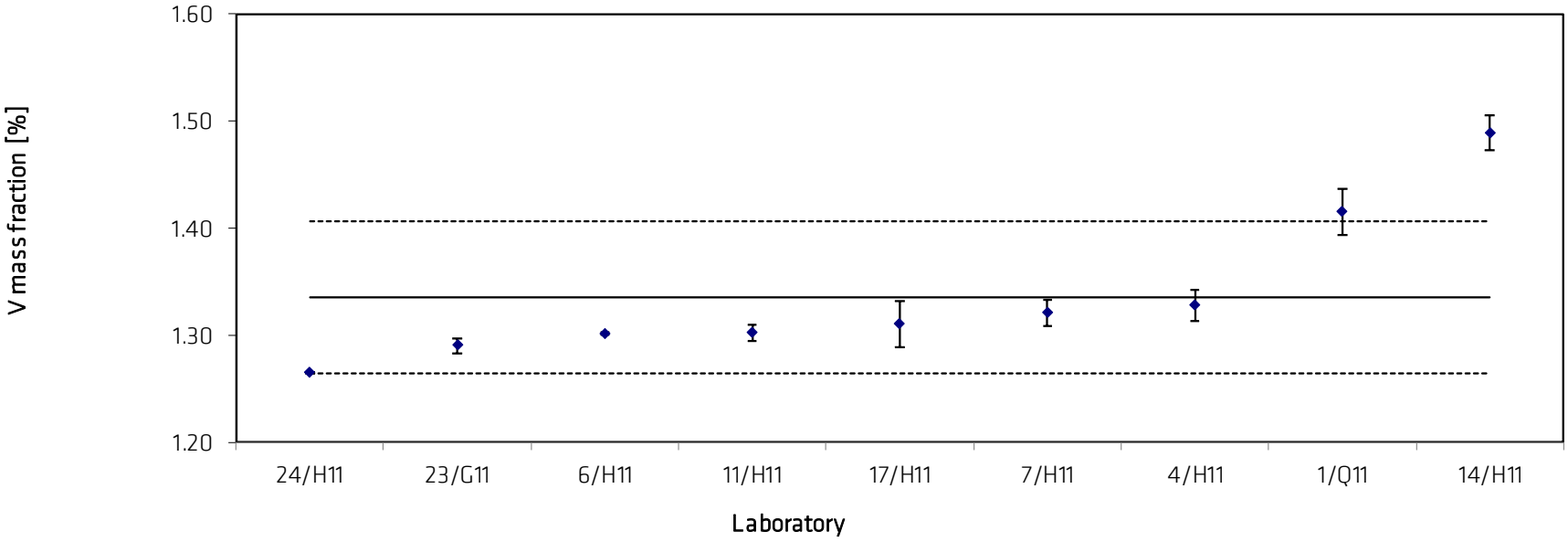


Table A18: Measurement results for zinc

Lab./Meth.	1/Q11	24/H11	4/H11	4/E11		
M_i [%]	0.00836	0.00918	0.01160	0.01760		*n*
	0.00855	0.00924	0.01090	0.01520		4
	0.00891	0.00912	0.01070	0.01620		
	0.00925	0.00920	0.00990	0.01690		
M **[%]**	**0.00877**	**0.00919**	**0.01078**	**0.01648**		**0.01130**
s [%]	0.00039	0.00005	0.00070	0.00102	s_M [%]	0.00356
					$\overline{s}_i$ [%]	0.00065
s_{rel}	0.04498	0.00544	0.06491	0.06217		0.31470

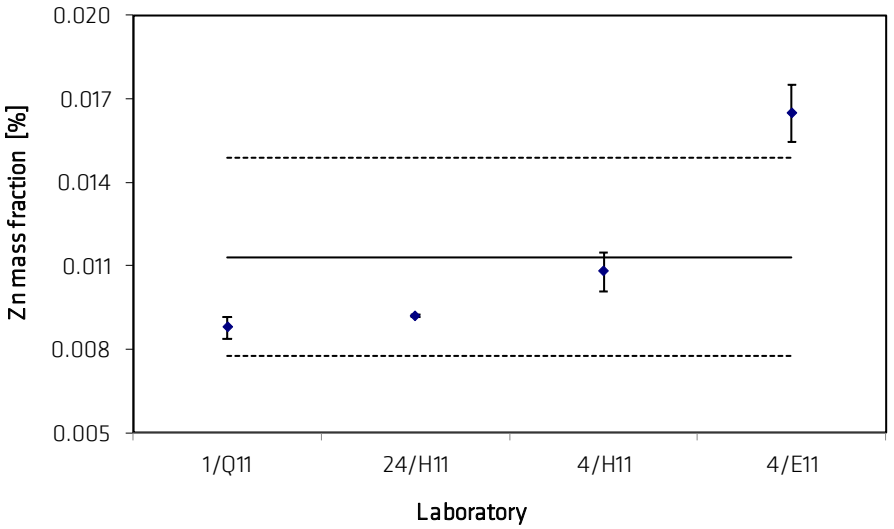


Table A19: results for additional elements

	As	B	Ba	Be	Bi	Ca	Ca	Ca	Ce	Ga	Ge	Hf	Ir	Nb
	0.00258	0.0013	0.00052	0.000010	0.00163	0.0348	0.0377	0.0465	0.00023	0.00106	0.00014	0.00089	0.000010	0.07860
	0.00249	0.0013	0.00054	0.000010	0.00168	0.0343	0.0374	0.0532	0.00024	0.00103	0.00012	0.00093	0.000010	0.08540
	0.00255	0.0013	0.00049	0.000010	0.00169	0.0327	0.0372	0.0497	0.00023	0.00107	0.00014	0.00094	0.000010	0.08430
	0.00274	0.0014	0.00050	0.000010	0.00174	0.0334	0.0379	0.0504	0.00023	0.00105	0.00013	0.00097	0.000010	0.08030
Mean	**0.00259**	**0.00132**	**0.00051**	**0.00001**	**0.00169**	**0.03380**	**0.03755**	**0.04995**	**0.00023**	**0.00105**	**0.00013**	**0.00093**	**0.00001**	**0.08215**
Lab	1/Q11	1/Q11	1/Q11	1/Q11	1/Q11	1/Q11	24/H11	4/H11	1/Q11	1/Q11	1/Q11	1/Q11	1/Q11	1/Q11

Pt	Rb	Re	Sb	Ta	Th	U	W
0.000020	0.00012	0.000010	0.00109	0.00084	0.000010	0.000020	0.08260
0.000020	0.00013	0.000010	0.00117	0.00083	0.000010	0.000020	0.08070
0.000020	0.00012	0.000010	0.00110	0.00085	0.000010	0.000020	0.08220
0.000020	0.00013	0.000010	0.00124	0.00087	0.000010	0.000020	0.08190
0.00002	**0.00013**	**0.00001**	**0.00115**	**0.00085**	**0.00001**	**0.00002**	**0.08185**

Annex 2: Homogeneity study

Carbon:

Bottle A	0.1625	0.1714	0.1746	0.1729	0.1816	0.1810	0.1717	0.1737	0.1641
Bottle B	0.1812	0.1803	0.1623	0.1625	0.1707	0.2068	0.1669	0.1777	0.1712
Bottle C	0.1635	0.1699	0.1705	0.1644	0.1755	0.1621	0.1614	0.1752	0.1672
Bottle D	0.1720	0.1730	0.1695	0.1767	0.1979	0.1816	0.1692	0.1846	0.1597
Bottle E	0.1607	0.1676	0.1822	0.1820	0.1807	0.1787	0.1601	0.1842	0.1607
Bottle F	0.1647	0.1876	0.1721	0.1808	0.1726	0.1804	0.1676	0.1734	0.1715
Bottle G	0.1694	0.1700	0.1751	0.1700	0.1725	0.1824	0.1582	0.1699	0.1688
Bottle H	0.1721	0.1746	0.1770	0.1638	0.1829	0.1658	0.1592	0.1818	0.1730
Bottle I	0.1730	0.1681	0.1713	0.1695	0.1584	0.1761	0.1589	0.1893	0.1740
Bottle J	0.1623	0.1676	0.1759	0.1699	0.1895	0.1719	0.1616	0.1817	0.1753

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000487035	9	5.4115E-05	0.6666671	0.736463	1.999115
Within groups	0.006493791	80	8.11724E-05			
Total	0.006980826	89				
within-sd	0.009009572			status:	homogeneous	
effective n	9.00					
s_bb	0					
s_bb_min	0.001194175					
u_bb	0.001194175	1.19417486				
u_bb(rel.)	0.691809474					

Sulphur:

Bottle A	0.0104	0.0109	0.0110	0.0112	0.0108	0.0108	0.0117	0.0123	0.0115
Bottle B	0.0118	0.0119	0.0118	0.0114	0.0111	0.0120	0.0112	0.0113	0.0108
Bottle C	0.0107	0.0111	0.0117	0.0108	0.0118	0.0112	0.0111	0.0115	0.0115
Bottle D	0.0104	0.0107	0.0102	0.0112	0.0114	0.0114	0.0114	0.0114	0.0110
Bottle E	0.0106	0.0106	0.0110	0.0123	0.0124	0.0124	0.0102	0.0110	0.0105
Bottle F	0.0105	0.0110	0.0107	0.0104	0.0105	0.0108	0.0105	0.0107	0.0108
Bottle G	0.0106	0.0109	0.0110	0.0106	0.0108	0.0109	0.0109	0.0108	0.0115
Bottle H	0.0108	0.0112	0.0122	0.0116	0.0122	0.0114	0.0108	0.0111	0.0114
Bottle I	0.0104	0.0115	0.0108	0.0114	0.0144	0.0116	0.0104	0.0115	0.0108
Bottle J	0.0103	0.0109	0.0108	0.0119	0.0125	0.0122	0.0106	0.0113	0.0109

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.6908E-06	9	6.3231E-07	1.5561881	0.142988	1.999115
Within groups	3.2506E-05	80	4.0632E-07			
Total	3.8196E-05	89				
within-sd	0.00063743			status:	homogeneous	
effective n	9.00					
s_bb	0.00015846					
s_bb_min	8.4489E-05					
u_bb	0.00015846	0.15846147				
u_bb(rel.)	1.41717471					

Manganese:

Bottle A	0.2392	0.2453	0.2299	0.2411	0.2294	0.2350
Bottle B	0.2334	0.2365	0.2385	0.2407	0.2288	0.2357
Bottle C	0.2315	0.2400	0.2349	0.2348	0.2354	0.2348
Bottle D	0.2328	0.2332	0.2331	0.2383	0.2351	0.2329
Bottle E	0.2339	0.2322	0.2369	0.2343	0.2369	0.2393
Bottle F	0.2267	0.2382	0.2373	0.2374	0.2298	0.2315
Bottle G	0.2435	0.2310	0.2357	0.2295	0.2345	0.2354
Bottle H	0.2350	0.2360	0.2390	0.2350	0.2329	0.2363
Bottle I	0.2385	0.2312	0.2378	0.2433	0.2276	0.2267
Bottle J	0.2377	0.2366	0.2312	0.2261	0.2316	0.2375

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.93234E-05	9	6.59149E-06	0.340479	0.956833	2.073351
Within groups	0.000967973	50	1.93595E-05			
Total	0.001027296	59				
within-sd	0.004399938			status:	homogeneous	
effective n	6.00					
s_bb	0					
s_bb_min	0.000803315					
u_bb	0.000803315	0.803315014				
u_bb(rel.)	0.341989222					

Chromium:

Bottle A	0.9624	0.9623	0.9795	0.9799	0.9207	0.9370
Bottle B	0.9179	0.9633	1.0297	1.0400	0.9362	0.9418
Bottle C	0.9339	0.9383	1.0050	0.9677	0.9079	0.8889
Bottle D	0.9240	0.9918	1.0014	1.0059	0.8817	0.9487
Bottle E	1.0163	0.9448	0.9138	1.0066	0.9077	0.9340
Bottle F	1.0023	1.0108	1.0711	1.0196	0.8847	0.9020
Bottle G	0.8893	0.9038	0.9301	0.9360	0.9304	0.9127
Bottle H	0.9514	0.9670	0.9680	0.9875	0.8974	0.9127
Bottle I	0.9402	1.0197	0.9935	0.9616	0.8962	0.8618
Bottle J	0.9550	0.9730	0.9567	0.9513	0.9385	0.9435

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.01655448	9	0.00183939	0.915758	0.519392	2.073351
Within groups	0.1004298	50	0.0020086			
Total	0.11698428	59				
within-sd	0.04481736			status:	homogeneous	
effective n	6.00					
s_bb	0					
s_bb_min	0.00818249					
u_bb	0.00818249	8.18249339				
u_bb(rel.)	0.85895387					

Molybdenum:

Bottle A	0.5621	0.5537	0.5656	0.5599	0.5521	0.5506
Bottle B	0.5503	0.5441	0.5545	0.5663	0.5567	0.5491
Bottle C	0.5477	0.5477	0.5566	0.5682	0.5606	0.5516
Bottle D	0.5522	0.5573	0.5551	0.5537	0.5530	0.5449
Bottle E	0.5671	0.5640	0.5546	0.5656	0.5571	0.5641
Bottle F	0.5677	0.5635	0.5528	0.5631	0.5516	0.5566
Bottle G	0.5578	0.5537	0.5610	0.5540	0.5500	0.5534
Bottle H	0.5670	0.5466	0.5628	0.5613	0.5485	0.5520
Bottle I	0.5484	0.5607	0.5602	0.5489	0.5444	0.5495
Bottle J	0.5491	0.5548	0.5472	0.5647	0.5583	0.5552

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.00050826	9	5.64734E-05	1.355109	0.233748	2.073351
Within groups	0.00208372	50	4.16744E-05			
Total	0.00259198	59				
within-sd	0.00645557			status:	homogeneous	
effective n	6.00					
s_bb	0.00157051					
s_bb_min	0.00117862					
u_bb	0.00157051	1.57050819				
u_bb(rel.)	0.28254732					

Nickel:

Bottle A	0.2252	0.2205	0.2267	0.2251	0.2321	0.2377
Bottle B	0.2396	0.2410	0.2148	0.2274	0.2313	0.2245
Bottle C	0.2305	0.2293	0.2289	0.2369	0.2368	0.2387
Bottle D	0.2320	0.2235	0.2322	0.2226	0.2371	0.2350
Bottle E	0.2286	0.2287	0.2431	0.2306	0.2312	0.2393
Bottle F	0.2326	0.2346	0.2167	0.2181	0.2420	0.2336
Bottle G	0.2254	0.2364	0.2313	0.2221	0.2376	0.2345
Bottle H	0.2315	0.2289	0.2304	0.2161	0.2338	0.2375
Bottle I	0.2341	0.2116	0.2304	0.2364	0.2403	0.2431
Bottle J	0.2295	0.2240	0.2247	0.2250	0.2311	0.2257

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.00028328	9	3.14754E-05	0.568102	0.816518	2.073351
Within groups	0.00277022	50	5.54044E-05			
Total	0.0030535	59				
within-sd	0.00744342			status:	homogeneous	
effective n	6.00					
s_bb	0					
s_bb_min	0.00135898					
u_bb	0.00135898	1.35897561				
u_bb(rel.)	0.58960541					

Aluminium

Bottle A	3.1709	3.1707	3.1575	3.1611	3.1853	3.1846
Bottle B	3.1499	3.1662	3.1717	3.1982	3.1804	3.1880
Bottle C	3.1662	3.1670	3.1718	3.1544	3.1465	3.1819
Bottle D	3.1863	3.1739	3.1648	3.1682	3.1768	3.1750
Bottle E	3.1890	3.1888	3.1945	3.1717	3.1791	3.1949
Bottle F	3.1750	3.1856	3.1664	3.2146	3.1834	3.1751
Bottle G	3.1552	3.1792	3.2033	3.1810	3.1654	3.2079
Bottle H	3.1600	3.1992	3.2013	3.1476	3.1578	3.1751
Bottle I	3.2331	3.1595	3.1832	3.1641	3.1881	3.1726
Bottle J	3.1678	3.1599	3.1691	3.1548	3.1783	3.1845

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.00273602	9	0.000304002	1.097327	0.381843	2.073351
Within groups	0.01385192	50	0.000277038			
Total	0.01658794	59				
within-sd	0.01664447			status:	homogeneous	
effective n	6.00					
s_bb	0.00211988					
s_bb_min	0.00303885					
u_bb	0.00303885	3.03885066				
u_bb(rel.)	0.09567014					

Copper:

Bottle A	0.0985	0.0994	0.0978	0.0991	0.0969	0.0992
Bottle B	0.1005	0.0988	0.0983	0.1002	0.1006	0.0991
Bottle C	0.0981	0.0988	0.0990	0.1002	0.0994	0.0973
Bottle D	0.1006	0.1010	0.1014	0.0997	0.0993	0.0994
Bottle E	0.1003	0.1012	0.0996	0.1006	0.0980	0.1005
Bottle F	0.0988	0.1002	0.0955	0.0985	0.1003	0.1009
Bottle G	0.1019	0.1005	0.0989	0.0987	0.0988	0.0996
Bottle H	0.1001	0.0997	0.1028	0.0991	0.0974	0.0994
Bottle I	0.0984	0.0989	0.0992	0.0988	0.0984	0.0999
Bottle J	0.0982	0.0978	0.0977	0.0981	0.0970	0.0988

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.8764E-05	9	3.19597E-06	2.273433	0.031875	2.073351
Within groups	7.0289E-05	50	1.40579E-06			
Total	9.9053E-05	59				
within-sd	0.00118566			status:	inhomogeneous	
effective n	6.00					
s_bb	0.00054623					
s_bb_min	0.00021647					
u_bb	0.00054623	0.54622615				
u_bb(rel.)	0.55035011					

Cobalt:

Bottle A	0.01462	0.01635	0.01572	0.01579	0.01489	0.01499
Bottle B	0.01536	0.01472	0.01375	0.01465	0.01569	0.01460
Bottle C	0.01506	0.01370	0.01410	0.01581	0.01363	0.01529
Bottle D	0.01482	0.01523	0.01459	0.01422	0.01515	0.01383
Bottle E	0.01414	0.01471	0.01450	0.01471	0.01493	0.01370
Bottle F	0.01452	0.01529	0.01404	0.01460	0.01505	0.01344
Bottle G	0.01537	0.01517	0.01434	0.01563	0.01596	0.01573
Bottle H	0.01490	0.01497	0.01595	0.01432	0.01577	0.01396
Bottle I	0.01432	0.01525	0.01380	0.01674	0.01519	0.01657
Bottle J	0.01511	0.01520	0.01368	0.01476	0.01531	0.01505

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	7.0753E-06	9	7.86149E-07	1.465611	0.18677	2.073351
Within groups	2.682E-05	50	5.36397E-07			
Total	3.3895E-05	59				
within-sd	0.00073239			status:	homogeneous	
effective n	6.00					
s_bb	0.00020402					
s_bb_min	0.00013372					
u_bb	0.00020402	0.20402297				
u_bb(rel.)	1.37044668					

Tin:

Bottle A	0.1721	0.1810	0.1671	0.1709	0.1577	0.1792
Bottle B	0.1805	0.1775	0.1716	0.1807	0.1729	0.1690
Bottle C	0.1768	0.1703	0.1678	0.1784	0.1789	0.1814
Bottle D	0.1773	0.1683	0.1706	0.1815	0.1755	0.1727
Bottle E	0.1914	0.1811	0.1705	0.1844	0.1694	0.1871
Bottle F	0.1765	0.1755	0.1692	0.1702	0.1640	0.1782
Bottle G	0.1866	0.1701	0.1770	0.1672	0.1799	0.1814
Bottle H	0.1745	0.1705	0.1788	0.1717	0.1739	0.1845
Bottle I	0.1727	0.1793	0.1785	0.1773	0.1582	0.1794
Bottle J	0.1736	0.1806	0.1670	0.1693	0.1710	0.1672

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.00042818	9	4.75752E-05	1.104864	0.376704	2.073351
Within groups	0.00215299	50	4.30598E-05			
Total	0.00258117	59				
within-sd	0.00656199			status:	homogeneous	
effective n	6.00					
s_bb	0.00086751					
s_bb_min	0.00119805					
u_bb	0.00119805	1.1980508				
u_bb(rel.)	0.68543211					

Titanium:

Bottle A	69.02	68.80	68.84	68.59	69.12	68.94
Bottle B	69.24	69.14	68.74	68.80	69.05	68.82
Bottle C	68.90	69.00	68.95	68.68	69.07	69.38
Bottle D	69.14	68.89	68.81	68.60	69.15	68.90
Bottle E	68.93	68.91	69.49	69.24	68.98	69.45
Bottle F	69.04	69.10	68.61	68.95	69.48	69.24
Bottle G	69.02	69.14	69.42	68.76	68.91	69.52
Bottle H	68.97	68.86	69.41	68.66	69.13	69.10
Bottle I	69.24	68.68	69.03	69.05	69.48	69.18
Bottle J	68.77	68.68	69.19	69.06	69.29	69.21

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.461035826	9	0.051226203	0.833405	0.58895	2.073351
Within groups	3.073306446	50	0.061466129			
Total	3.534342272	59				
within-sd	0.247923635			status:	homogeneous	
effective n	6.00					
s_bb	0					
s_bb_min	0.045264456					
u_bb	0.045264456	45.26445585				
u_bb(rel.)	0.065572624					

Iron:

Bottle A	21.93	21.99	21.96	21.88	21.94	21.92
Bottle B	22.07	22.14	21.86	21.99	22.05	21.99
Bottle C	21.92	21.98	21.99	22.03	22.05	22.11
Bottle D	22.07	22.00	21.94	21.93	22.01	21.91
Bottle E	22.02	21.99	22.14	22.20	22.06	22.18
Bottle F	22.04	22.10	21.89	22.06	22.03	22.04
Bottle G	22.15	21.99	22.11	21.82	21.95	22.22
Bottle H	22.07	21.94	22.19	21.84	21.97	22.12
Bottle I	22.05	21.88	22.05	21.99	21.96	22.04
Bottle J	21.88	21.87	22.08	22.01	22.00	22.01

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.10065033	9	0.01118337	1.384111	0.220531	2.073351
Within groups	0.40399111	50	0.008079822			
Total	0.50464144	59				
within-sd	0.08988783			status:	homogeneous	
effective n	6.00					
s_bb	0.02274331					
s_bb_min	0.0164112					
u_bb	0.02274331	22.743305				
u_bb(rel.)	0.10333366					

Zirconium:

Bottle A	0.2625	0.2538	0.2536	0.2623	0.2601	0.2555
Bottle B	0.2625	0.2627	0.2609	0.2594	0.2583	0.2636
Bottle C	0.2556	0.2573	0.2647	0.2609	0.2600	0.2597
Bottle D	0.2550	0.2596	0.2557	0.2555	0.2626	0.2628
Bottle E	0.2639	0.2695	0.2573	0.2589	0.2534	0.2618
Bottle F	0.2580	0.2573	0.2600	0.2551	0.2596	0.2597
Bottle G	0.2614	0.2615	0.2659	0.2603	0.2573	0.2612
Bottle H	0.2567	0.2590	0.2618	0.2617	0.2591	0.2591
Bottle I	0.2599	0.2560	0.2564	0.2540	0.2608	0.2661
Bottle J	0.2597	0.2528	0.2571	0.2538	0.2643	0.2630

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	8.3608E-05	9	9.28978E-06	0.702566	0.70346	2.073351
Within groups	0.000661132	50	1.32226E-05			
Total	0.00074474	59				
within-sd	0.003636295			status:	homogeneous	
effective n	6.00					
s_bb	0					
s_bb_min	0.000663894					
u_bb	0.000663894	0.66389368				
u_bb(rel.)	0.255870884					