

Proficiency testing for in-house and external measuring stations - results and evaluation

Proficiency testing scheme Organic solvents with sampling on 14/15 February 2018

Summary of laboratory test results

Sample 1

	1-Butanol	Z score	1-Propanol	Z score	2-Butanol	Z score	i-Butanol	Z score
Unit	mg/m ³		mg/m ³		mg/m ³		mg/m ³	
39	70,90	1,02	428,20	0,34	90,40	0,41	123,30	0,42
47	64,50	0,02	407,10	-0,17	105,20	2,12 E	119,30	0,09
72	64,10	-0,04	401,20	-0,31	96,90	1,16	119,20	0,08
78	55,70	-1,35	380,63	-0,81	76,95	-1,14	107,92	-0,88
136	66,90	0,39	424,90	0,26	88,80	0,23	125,30	0,59
150	66,90	0,39	425,00	0,27	88,30	0,17	126,00	0,65
158	63,70	-0,10	396,30	-0,43	81,40	-0,62	113,30	-0,42
212	63,40	-0,15	413,40	-0,01	81,00	-0,67	117,10	-0,10
222	65,90	0,24	422,50	0,21	82,30	-0,52	112,80	-0,46
231	68,30	0,61	475,36	1,48	90,19	0,39	126,05	0,66
245	55,70	-1,35	346,20	-1,64	71,80	-1,73	101,60	-1,41
259	71,07	1,04	451,69	0,91	92,75	0,68	127,85	0,81
271	64,69	0,05	409,21	-0,12	88,37	0,18	121,12	0,24
283	59,30	-0,79	287,00	-3,07 BE	80,90	-0,68	115,00	-0,28
-	-	--	-	--	-	--	-	--
Method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	Z <=2,00		Z <=2,00		Z <=2,00		Z <=2,00	
No. of laboratories that submitted results	14		14		14		14	
Mean	64,36		413,98		86,80		118,27	
Reproducibility s.d.	4,77		31,57		8,54		7,59	
Rel. reproducibility s.d.	7,41 %		7,63 %		9,84 %		6,42 %	
Reference value	61,10		397,80		85,50		119,10	
Target s.d.	6,44		41,40		8,68		11,83	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %	
Lower limit of tolerance	51,49		331,18		69,44		94,62	
Upper limit of tolerance	77,23		496,77		104,16		141,93	
Type B outliers			1					
No. of laboratories after elimination of	14		13		14		14	

1- Butanol	Z score	1-Propanol	Z score	2-Butanol	Z score	i-Butanol	Z score
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outliers type A-D and F (w ithout laboratories that only gave states but no measured values)

Explanation of outlier types

A: Single outlier Grubbs

B: Differing laboratory mean Grubbs

C: Excessive laboratory s.d. Cochran

D: Excluded manually

E: mean outside tolerance limits

F: $|Z\text{-Score}| > 3,5$

Summary of laboratory test results

Sample 2

	Cumene	Z score	Ethyl acetate	Z score	Ethylbenzene	Z score	p-Xylene	Z score	Toluene	Z score
Unit	mg/m ³		mg/m ³		mg/m ³		mg/m ³		mg/m ³	
39	17,00	-0,28	299,70	0,42	39,20	0,39	110,80	0,33	66,20	0,03
47	16,10	-0,79	270,80	-0,58	38,40	0,18	110,60	0,31	66,60	0,09
72	15,10	-1,36	257,60	-1,04	36,10	-0,43	98,80	-0,79	60,00	-0,91
78	16,71	-0,44	295,05	0,26	39,92	0,58	113,89	0,62	67,12	0,17
136	18,90	0,81	291,90	0,15	40,80	0,82	118,30	1,03	72,60	1,00
150	16,20	-0,73	309,00	0,75	36,30	-0,38	109,00	0,16	65,00	-0,15
158	16,20	-0,73	271,40	-0,56	36,30	-0,38	101,80	-0,51	65,00	-0,15
212	17,40	-0,05	286,10	-0,05	37,60	-0,03	109,10	0,17	67,70	0,26
222	15,90	-0,91	298,50	0,38	36,30	-0,38	109,20	0,18	65,20	-0,12
231	20,89	1,95	281,82	-0,20	35,83	-0,50	96,53	-1,00	60,87	-0,78
245	18,30	0,47	306,90	0,67	41,60	1,03	120,90	1,27	72,10	0,93
259	16,46	-0,59	300,18	0,44	39,25	0,41	114,83	0,70	70,32	0,66
271	21,62	2,37 E	274,31	-0,46	36,24	-0,39	100,77	-0,61	62,12	-0,59
283	18,00	0,29	282,00	-0,19	34,20	-0,93	87,50	-1,84	63,00	-0,45
-	-	--	-	--	-	--	-	--	-	--
Method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	Z <=2,00		Z <=2,00		Z <=2,00		Z <=2,00		Z <=2,00	
No. of laboratories that submitted results	14		14		14		14		14	
Mean	17,48		287,52		37,72		107,29		65,99	
Reproducibility s.d.	1,90		15,23		2,17		9,16		3,85	
Rel. reproducibility s.d.	10,87 %		5,30 %		5,75 %		8,54 %		5,84 %	
Reference value	17,10		297,10		38,40		113,20		67,20	
Target s.d.	1,75		28,75		3,77		10,73		6,60	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %		10,00 %	
Lower limit of tolerance	13,99		230,01		30,17		85,83		52,79	
Upper limit of tolerance	20,98		345,02		45,26		128,74		79,19	
No. of laboratories after elimination of outliers type A-D and F (without)	14		14		14		14		14	

	Cumene	Z score	Ethyl acetate	Z score	Ethylbenzene	Z score	p-Xylene	Z score	Toluene	Z score
laboratories that only gave states but no measured values)										
Explanation of outlier types										
A: Single outlier				Grubbs						
B: Differing laboratory mean				Grubbs						
C: Excessive laboratory s.d.				Cochran						
D: Excluded manually										
E: mean outside tolerance limits										
F: Z-Score >3,5										

Summary of laboratory test results

Sample 3

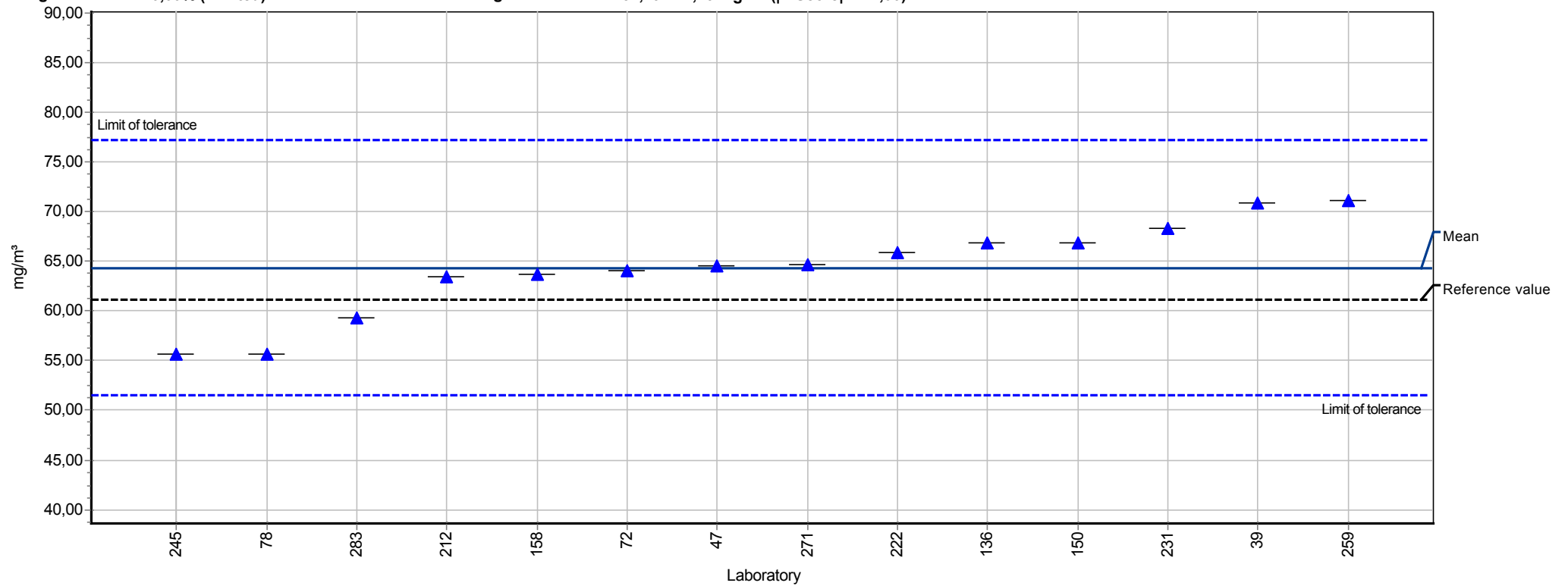
	Cyclohexane	Z score	Methylcyclohexane	Z score	n-Decane	Z score	n-Heptane	Z score
Unit	mg/m ³		mg/m ³		mg/m ³		mg/m ³	
39	65,70	0,22	57,70	-0,09	34,30	0,03	308,30	0,16
47	65,60	0,21	59,80	0,27	35,20	0,30	315,20	0,38
72	66,80	0,39	60,20	0,34	38,30	1,20	316,60	0,43
78	61,74	-0,40	55,43	-0,48	34,30	0,03	294,13	-0,31
136	72,50	1,28	67,60	1,61	39,50	1,55	344,20	1,34
150	65,90	0,25	59,40	0,21	39,70	1,61	311,00	0,24
158	67,10	0,44	56,70	-0,26	34,40	0,06	303,90	0,01
212	68,10	0,59	63,40	0,89	37,50	0,97	317,50	0,46
222	61,60	-0,42	56,40	-0,31	29,80	-1,28	307,90	0,14
231	60,66	-0,56	55,05	-0,54	29,56	-1,35	276,91	-0,88
245	51,60	-1,97	45,50	-2,18 E	26,30	-2,31 E	236,60	-2,21 E
259	73,00	1,36	66,39	1,41	35,57	0,40	336,21	1,08
271	56,22	-1,25	52,40	-1,00	31,24	-0,86	272,51	-1,02
283	63,40	-0,14	58,90	0,12	33,00	-0,35	309,00	0,18
-	-	--	-	--	-	--	-	--
Method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	Z <=2,00		Z <=2,00		Z <=2,00		Z <=2,00	
No. of laboratories that submitted results	14		14		14		14	
Mean	64,28		58,21		34,19		303,57	
Reproducibility s.d.	5,77		5,61		3,95		27,16	
Rel. reproducibility s.d.	8,97 %		9,64 %		11,54 %		8,95 %	
Reference value	62,60		59,80		35,20		310,20	
Target s.d.	6,43		5,82		3,42		30,36	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %	
Lower limit of tolerance	51,42		46,56		27,35		242,85	
Upper limit of tolerance	77,14		69,85		41,03		364,28	
No. of laboratories after elimination of outliers type A-D and F (without)	14		14		14		14	

	Cyclohexane	Z score	Methylcyclohexane	Z score	n-Decane	Z score	n-Heptane	Z score
laboratories that only gave states but no measured values)								
Explanation of outlier types								
A: Single outlier	Grubbs							
B: Differing laboratory mean	Grubbs							
C: Excessive laboratory s.d.	Cochran							
D: Excluded manually								
E: mean outside tolerance limits								
F: $ Z\text{-Score} > 3,5$								
	n-Hexane	Z score	n-Octane	Z score				
Unit	mg/m ³		mg/m ³					
39	29,20	-0,05	263,60	0,07				
47	29,40	0,02	267,90	0,24				
72	29,20	-0,05	270,40	0,33				
78	35,18	1,98	260,59	-0,04				
136	33,40	1,38	300,70	1,49				
150	31,70	0,80	268,00	0,24				
158	30,20	0,29	243,90	-0,68				
212	30,50	0,39	275,60	0,53				
222	27,10	-0,77	268,10	0,25				
231	26,68	-0,91	237,75	-0,91				
245	23,70	-1,93	201,40	-2,30 E				
259	33,12	1,28	299,89	1,46				
271	25,39	-1,35	241,70	-0,76				
283	26,20	-1,07	264,00	0,09				
-	-	--	-	--				
Method	ISO 5725-2		ISO 5725-2					
Assessment	$ Z \leq 2,00$		$ Z \leq 2,00$					
No. of laboratories that submitted results	14		14					
Mean	29,35		261,68					

	n-Hexane	Z score	n-Octane	Z score
Reproducibility s.d.	3,30		25,27	
Rel. reproducibility s.d.	11,26 %		9,66 %	
Reference value	30,50		270,60	
Target s.d.	2,94		26,17	
Rel. target s.d.	10,00 %		10,00 %	
Lower limit of tolerance	23,48		209,34	
Upper limit of tolerance	35,23		314,02	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	14		14	

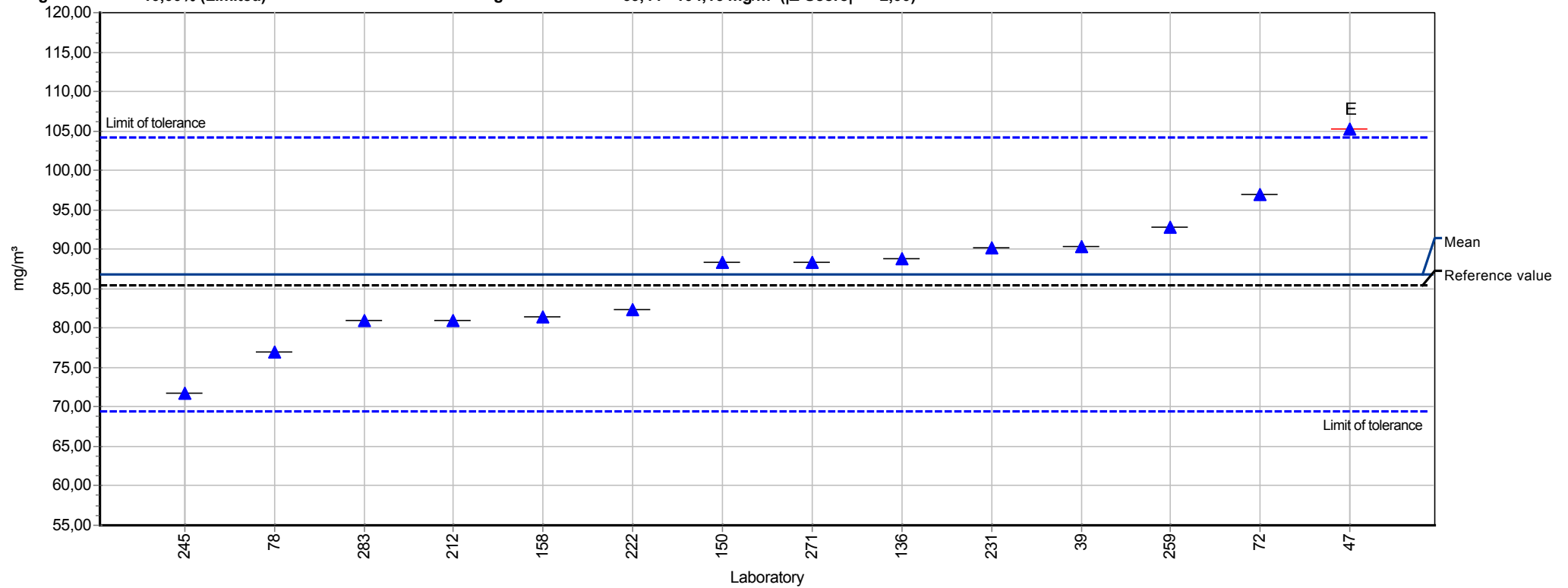
Summary results

Measurand: 1- Butanol Mean: 64,36 mg/m³
Sample: 1 Reprod. s.d.: 4,77 mg/m³
Method: ISO 5725-2 Rel.reprod. s.d.: 7,41%
No. of laboratories: 14 Reference value: 61,10 mg/m³
Rel.target s.d.: 10,00% (Limited) Range of tolerance: 51,49 - 77,23 mg/m³ (|Z-Score| <= 2,00)



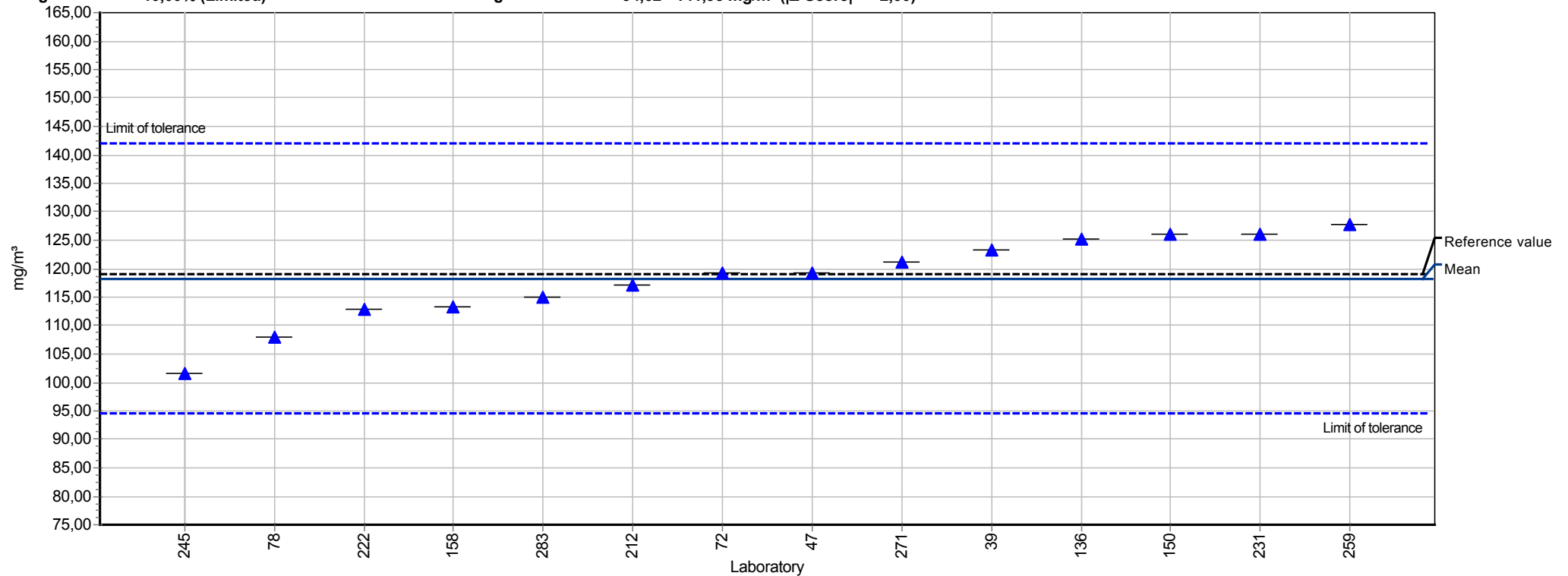
Summary results

Measurand:	2-Butanol	Mean:	86,80 mg/m ³
Sample:	1	Reprod. s.d.:	8,54 mg/m ³
Method:	ISO 5725-2	Rel.reprod. s.d.:	9,84%
No. of laboratories:	14	Reference value:	85,50 mg/m ³
Rel.target s.d.:	10,00% (Limited)	Range of tolerance:	69,44 - 104,16 mg/m ³ (Z-Score <= 2,00)



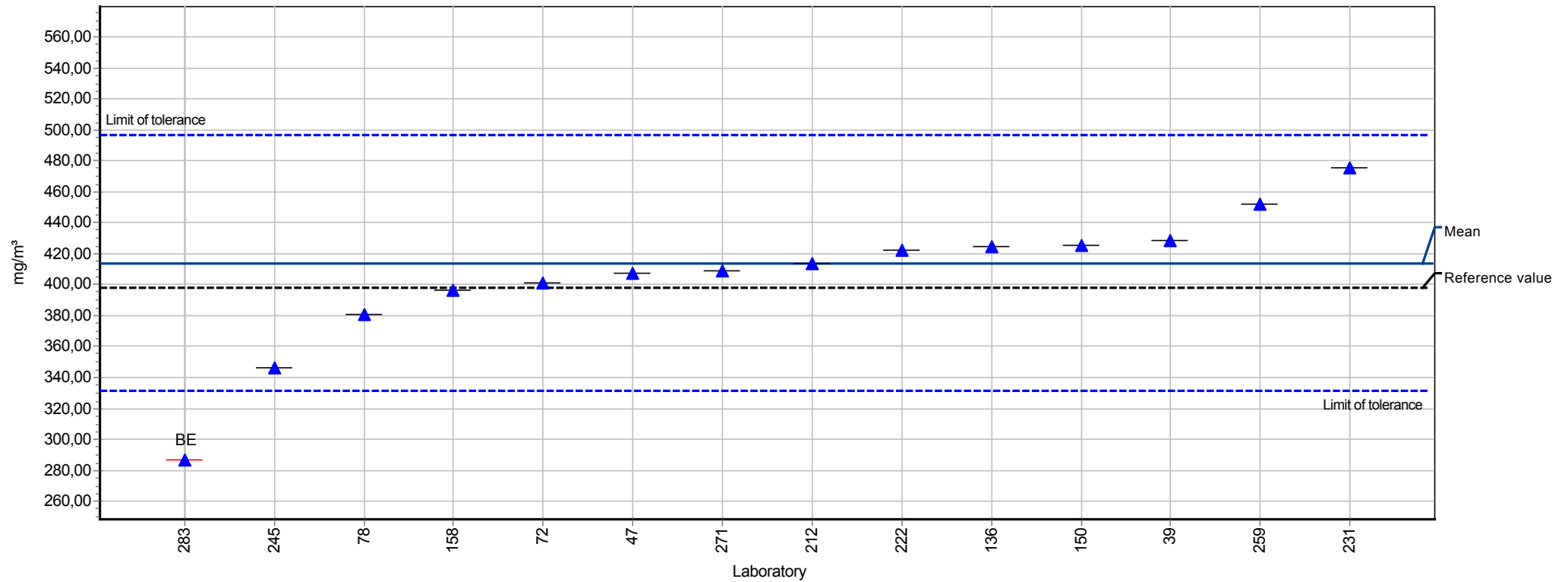
Summary results

Measurand: i-Butanol Mean: 118,27 mg/m³
Sample: 1 Reprod. s.d.: 7,59 mg/m³
Method: ISO 5725-2 Rel.reprod. s.d.: 6,42%
No. of laboratories: 14 Reference value: 119,10 mg/m³
Rel.target s.d.: 10,00% (Limited) Range of tolerance: 94,62 - 141,93 mg/m³ (|Z-Score| <= 2,00)



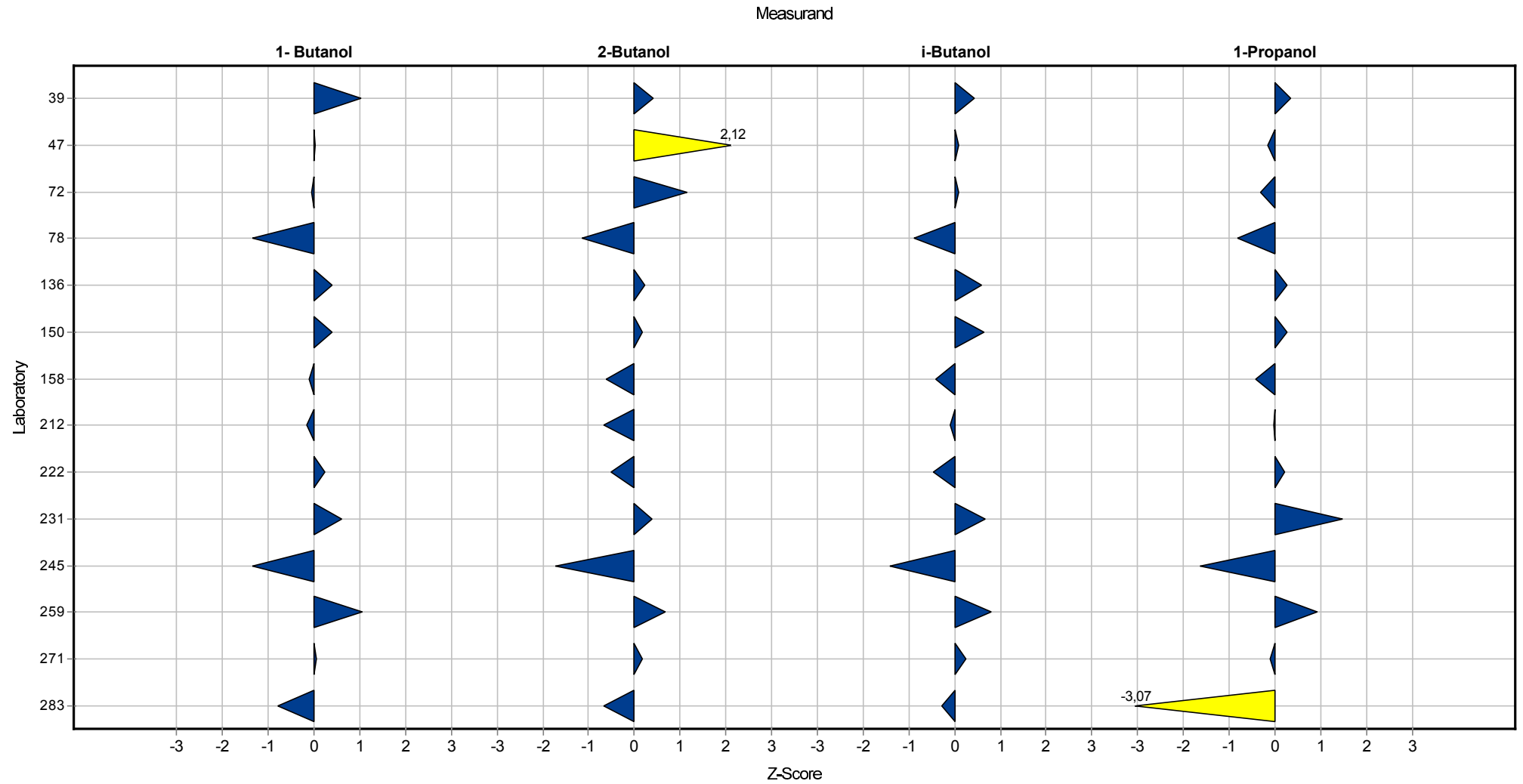
Summary results

Measurand: 1-Propanol Mean: 413,98 mg/m³
Sample: 1 Reprod. s.d.: 31,57 mg/m³
Method: ISO 5725-2 Rel.reprod. s.d.: 7,63%
No. of laboratories: 13 Reference value: 397,80 mg/m³
Rel.target s.d.: 10,00% (Limited) Range of tolerance: 331,18 - 496,77 mg/m³ (|Z-Score| <= 2,00)



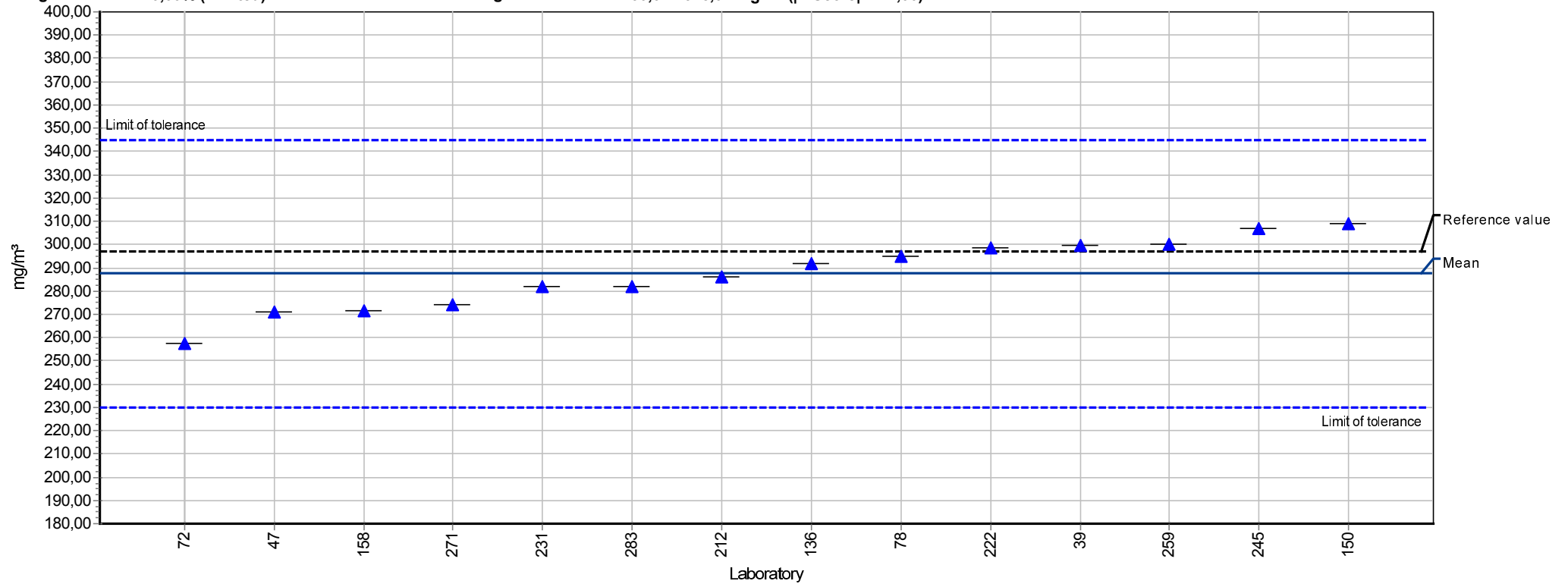
Sample chart of Z-scores

Sample 1



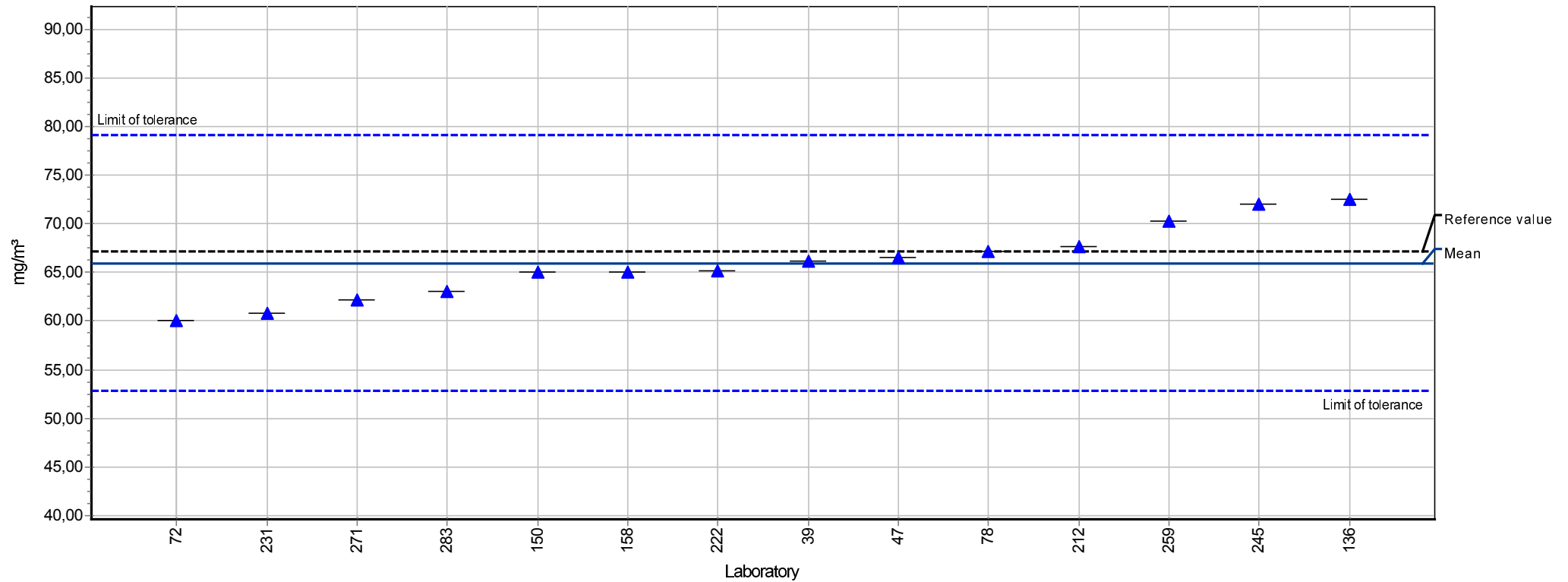
Summary results

Measurand: Ethyl acetate Mean: 287,52 mg/m³
Sample: 2 Reprod. s.d.: 15,23 mg/m³
Method: ISO 5725-2 Rel.reprod. s.d.: 5,30%
No. of laboratories: 14 Reference value: 297,10 mg/m³
Rel.target s.d.: 10,00% (Limited) Range of tolerance: 230,01 - 345,02 mg/m³ (|Z-Score| <= 2,00)



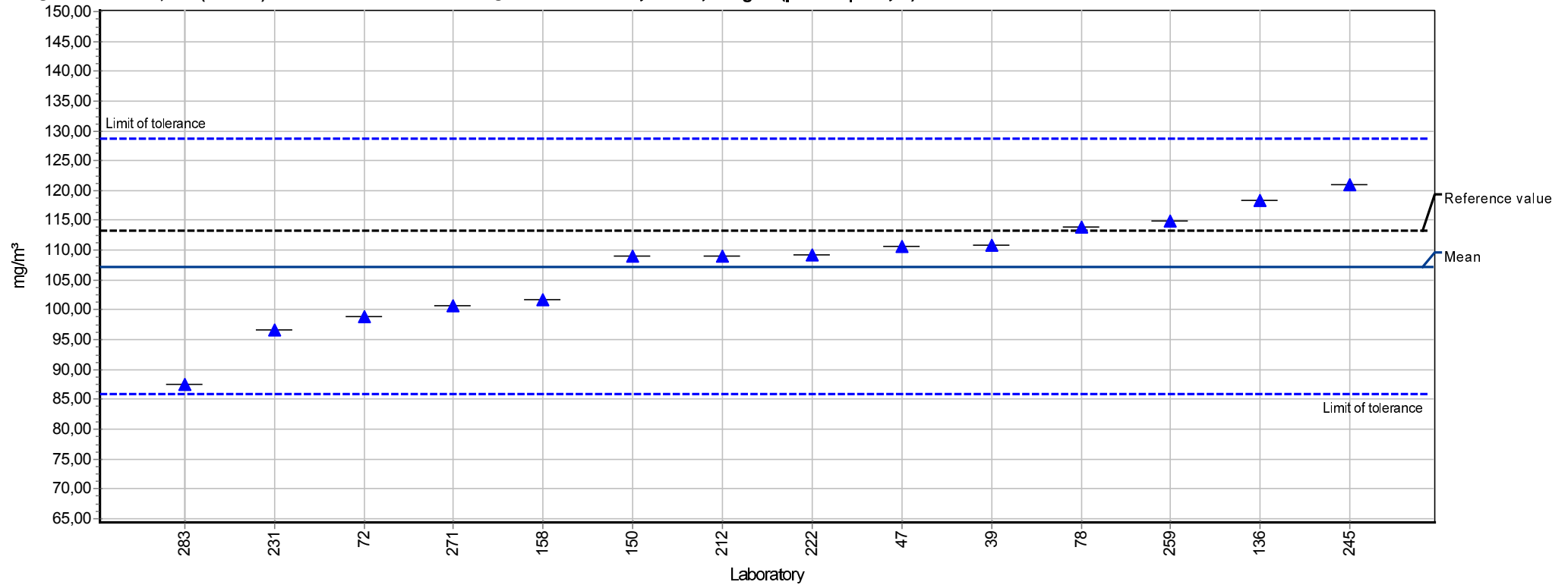
Summary results

Measurand:	Toluene	Mean:	65,99 mg/m ³
Sample:	2	Reprod. s.d.:	3,85 mg/m ³
Method:	ISO 5725-2	Rel.reprod. s.d.:	5,84%
No. of laboratories:	14	Reference value:	67,20 mg/m ³
Rel.target s.d.:	10,00% (Limited)	Range of tolerance:	52,79 - 79,19 mg/m ³ (Z-Score <= 2,00)



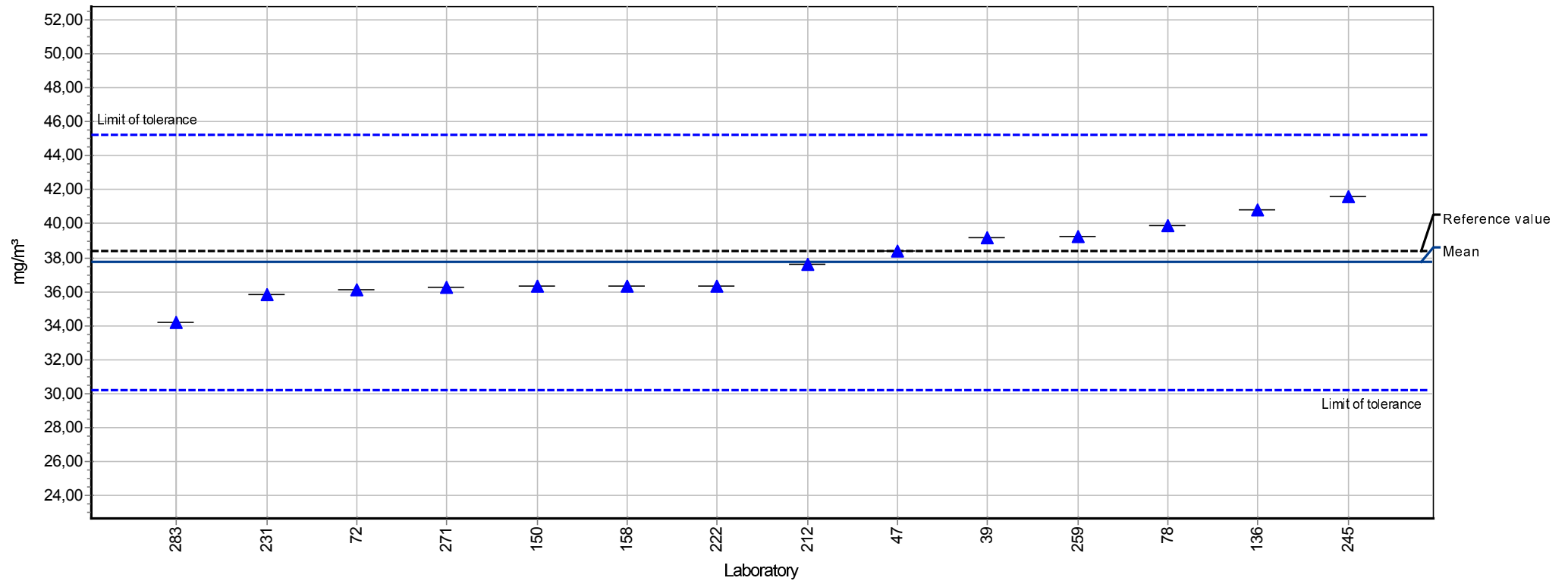
Summary results

Measurand:	p-Xylene	Mean:	107,29 mg/m ³
Sample:	2	Reprod. s.d.:	9,16 mg/m ³
Method:	ISO 5725-2	Rel.reprod. s.d.:	8,54%
No. of laboratories:	14	Reference value:	113,20 mg/m ³
Rel.target s.d.:	10,00% (Limited)	Range of tolerance:	85,83 - 128,74 mg/m ³ (Z-Score <= 2,00)



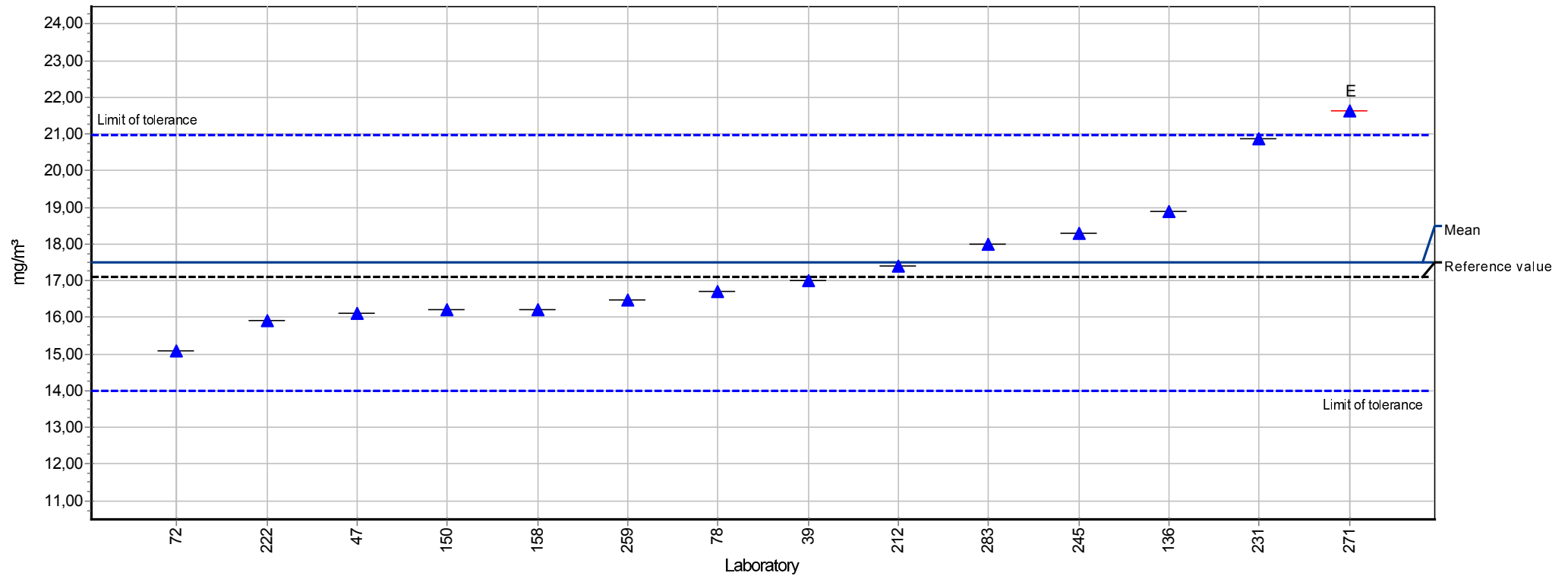
Summary results

Measurand: Ethylbenzene Mean: 37,72 mg/m³
Sample: 2 Reprod. s.d.: 2,17 mg/m³
Method: ISO 5725-2 Rel.reprod. s.d.: 5,75%
No. of laboratories: 14 Reference value: 38,40 mg/m³
Rel.target s.d.: 10,00% (Limited) Range of tolerance: 30,17 - 45,26 mg/m³ (|Z-Score| <= 2,00)



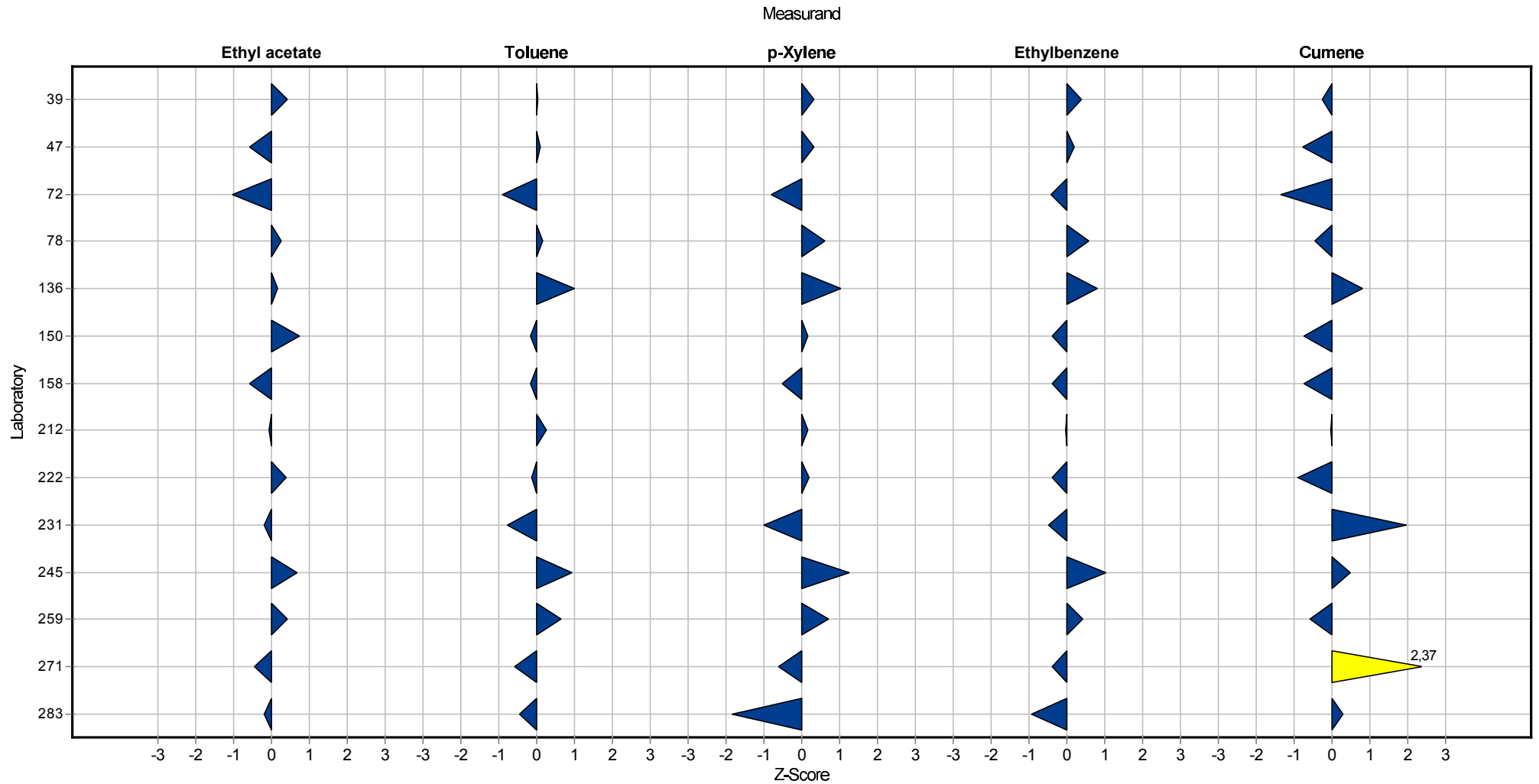
Summary results

Measurand:	Cumene	Mean:	17,48 mg/m ³
Sample:	2	Reprod. s.d.:	1,90 mg/m ³
Method:	ISO 5725-2	Rel.reprod. s.d.:	10,87%
No. of laboratories:	14	Reference value:	17,10 mg/m ³
Rel.target s.d.:	10,00% (Limited)	Range of tolerance:	13,99 - 20,98 mg/m ³ (Z-Score <= 2,00)



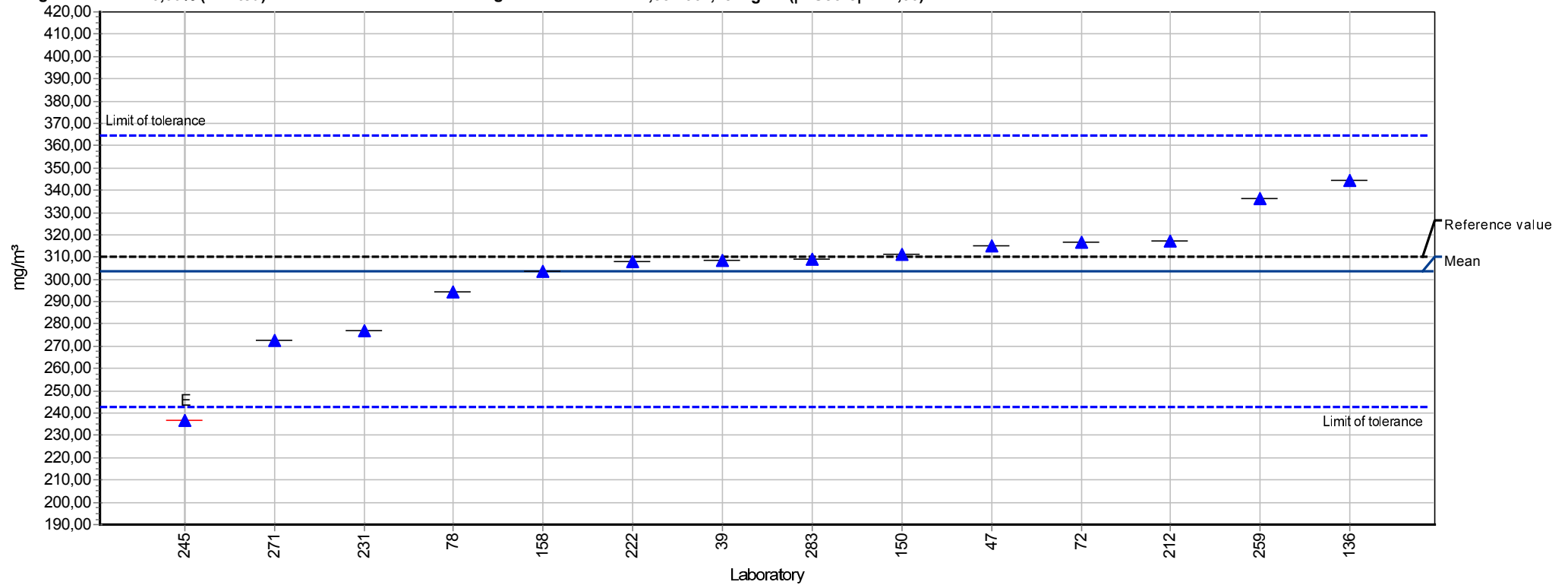
Sample chart of Z-scores

Sample 2



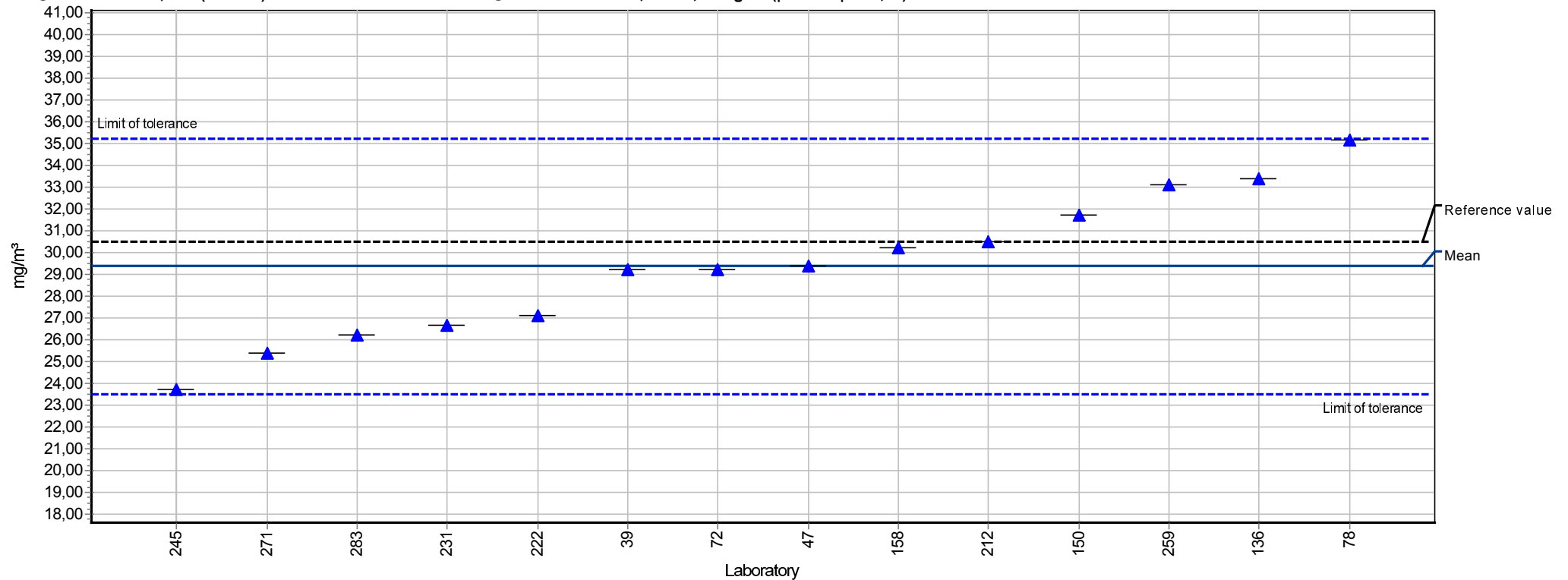
Summary results

Measurand:	n-Heptane	Mean:	303,57 mg/m ³
Sample:	3	Reprod. s.d.:	27,16 mg/m ³
Method:	ISO 5725-2	Rel.reprod. s.d.:	8,95%
No. of laboratories:	14	Reference value:	310,20 mg/m ³
Rel.target s.d.:	10,00% (Limited)	Range of tolerance:	242,85 - 364,28 mg/m ³ (Z-Score <= 2,00)



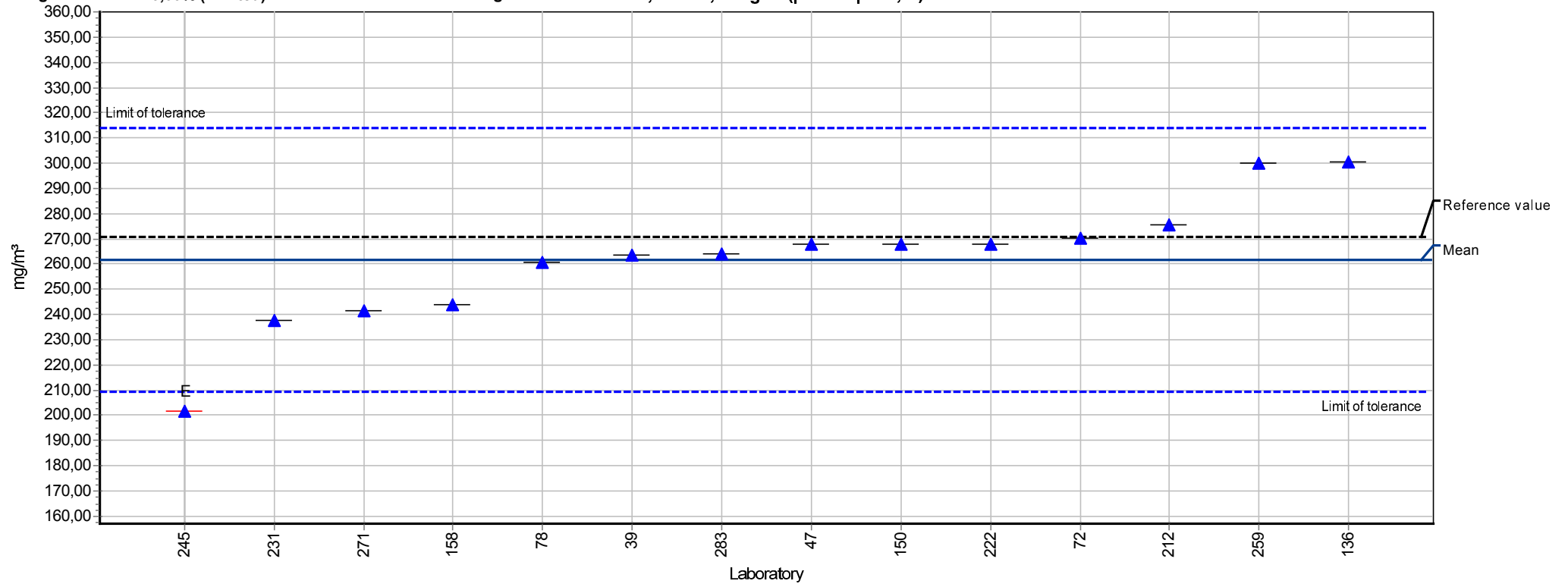
Summary results

Measurand: n-Hexane Mean: 29,35 mg/m³
Sample: 3 Reprod. s.d.: 3,30 mg/m³
Method: ISO 5725-2 Rel.reprod. s.d.: 11,26%
No. of laboratories: 14 Reference value: 30,50 mg/m³
Rel.target s.d.: 10,00% (Limited) Range of tolerance: 23,48 - 35,23 mg/m³ (|Z-Score| <= 2,00)



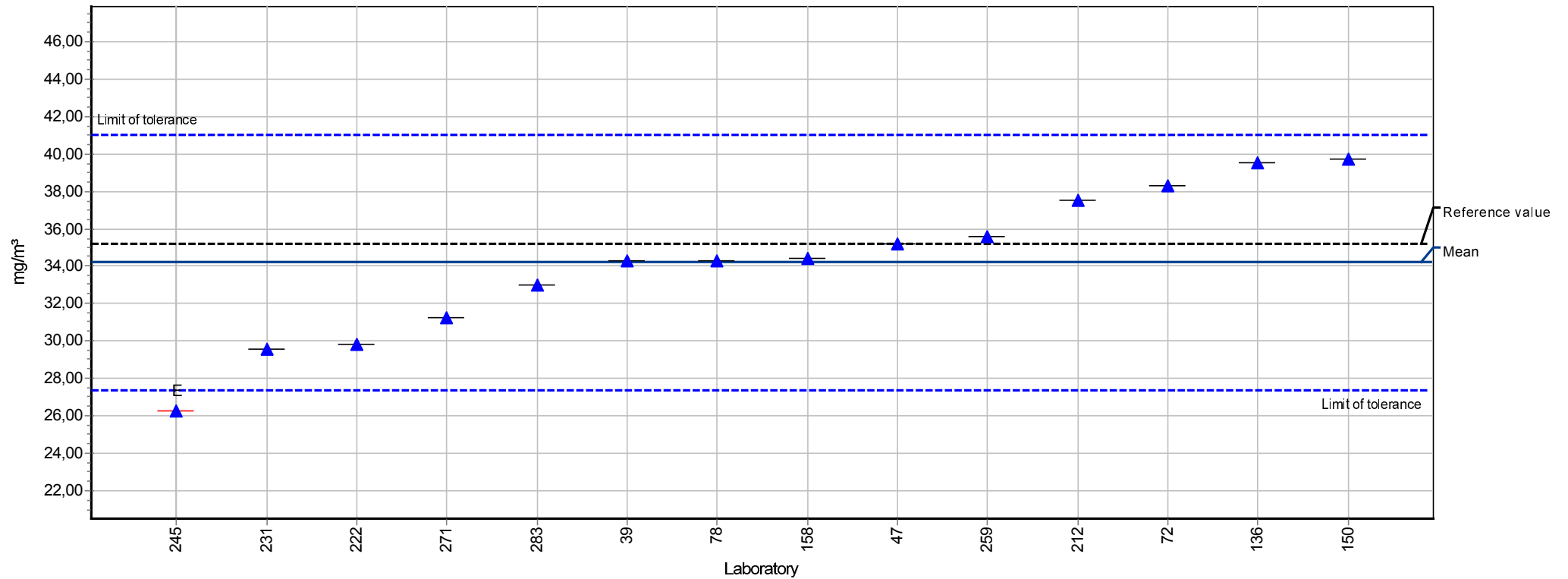
Summary results

Measurand:	n-Octane	Mean:	261,68 mg/m ³
Sample:	3	Reprod. s.d.:	25,27 mg/m ³
Method:	ISO 5725-2	Rel.reprod. s.d.:	9,66%
No. of laboratories:	14	Reference value:	270,60 mg/m ³
Rel.target s.d.:	10,00% (Limited)	Range of tolerance:	209,34 - 314,02 mg/m ³ (Z-Score <= 2,00)



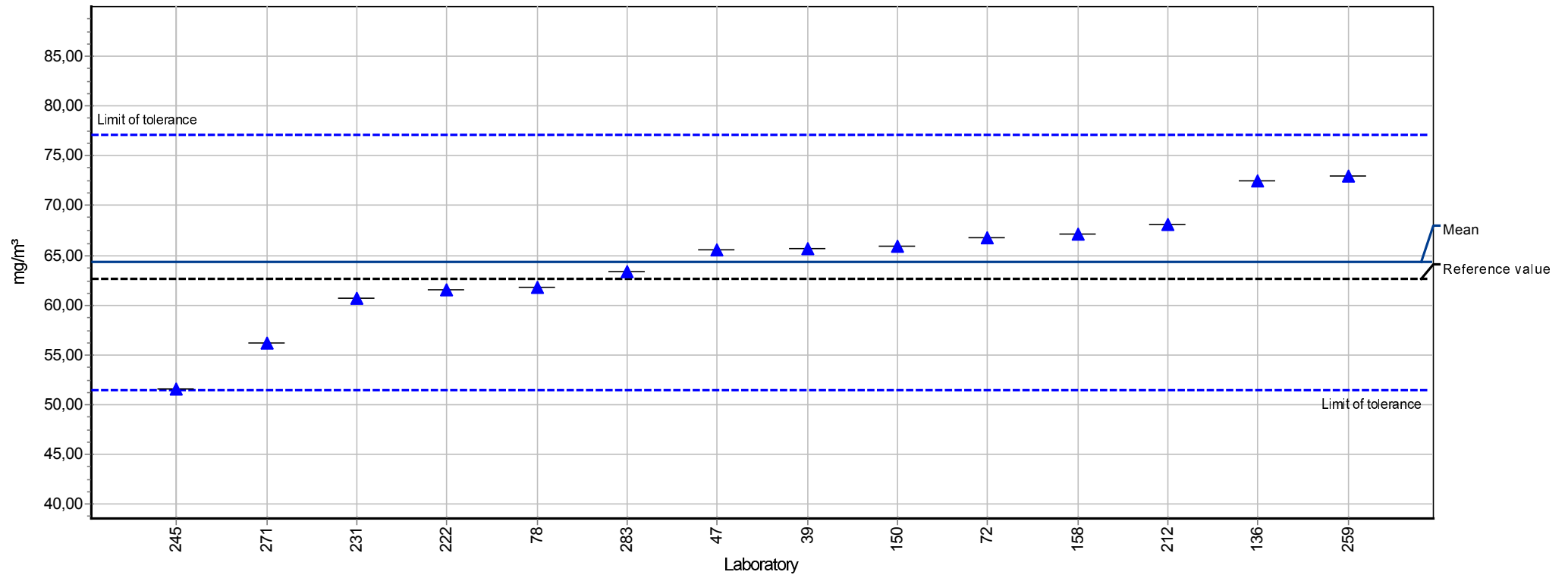
Summary results

Measurand: n-Decane Mean: 34,19 mg/m³
Sample: 3 Reprod. s.d.: 3,95 mg/m³
Method: ISO 5725-2 Rel.reprod. s.d.: 11,54%
No. of laboratories: 14 Reference value: 35,20 mg/m³
Rel.target s.d.: 10,00% (Limited) Range of tolerance: 27,35 - 41,03 mg/m³ (|Z-Score| <= 2,00)



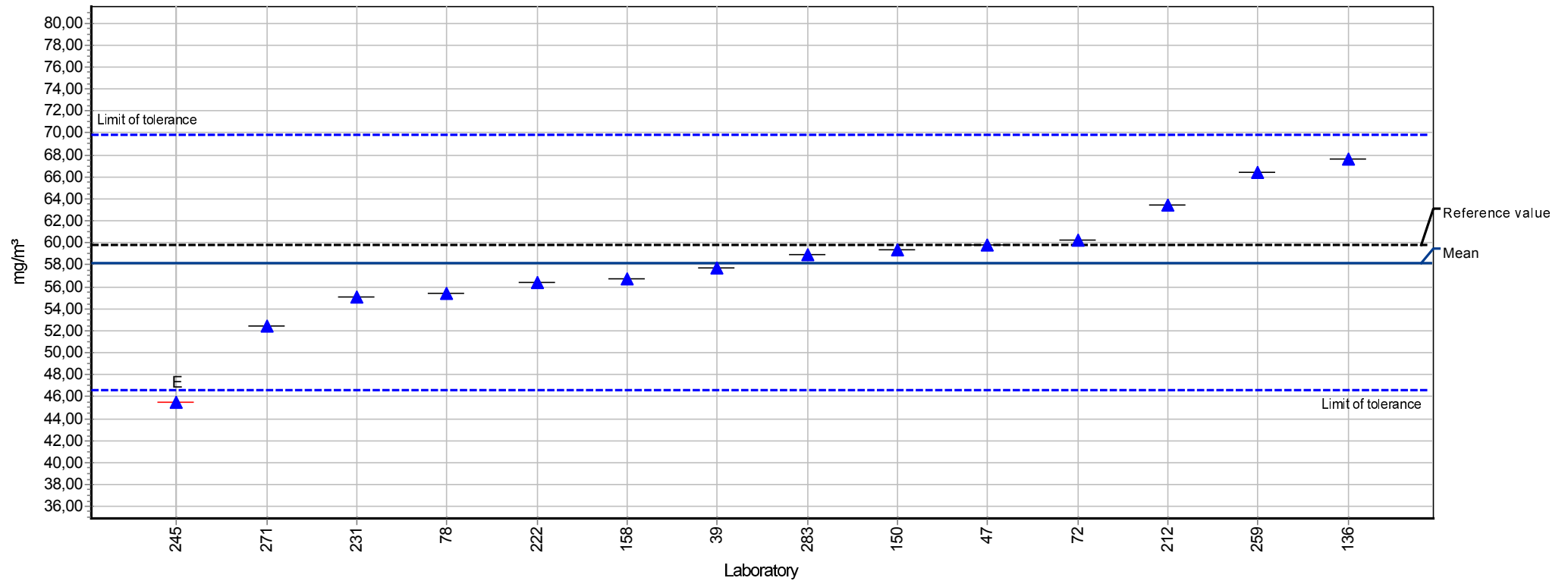
Summary results

Measurand: Cyclohexane Mean: 64,28 mg/m³
Sample: 3 Reprod. s.d.: 5,77 mg/m³
Method: ISO 5725-2 Rel.reprod. s.d.: 8,97%
No. of laboratories: 14 Reference value: 62,60 mg/m³
Rel.target s.d.: 10,00% (Limited) Range of tolerance: 51,42 - 77,14 mg/m³ (|Z-Score| <= 2,00)



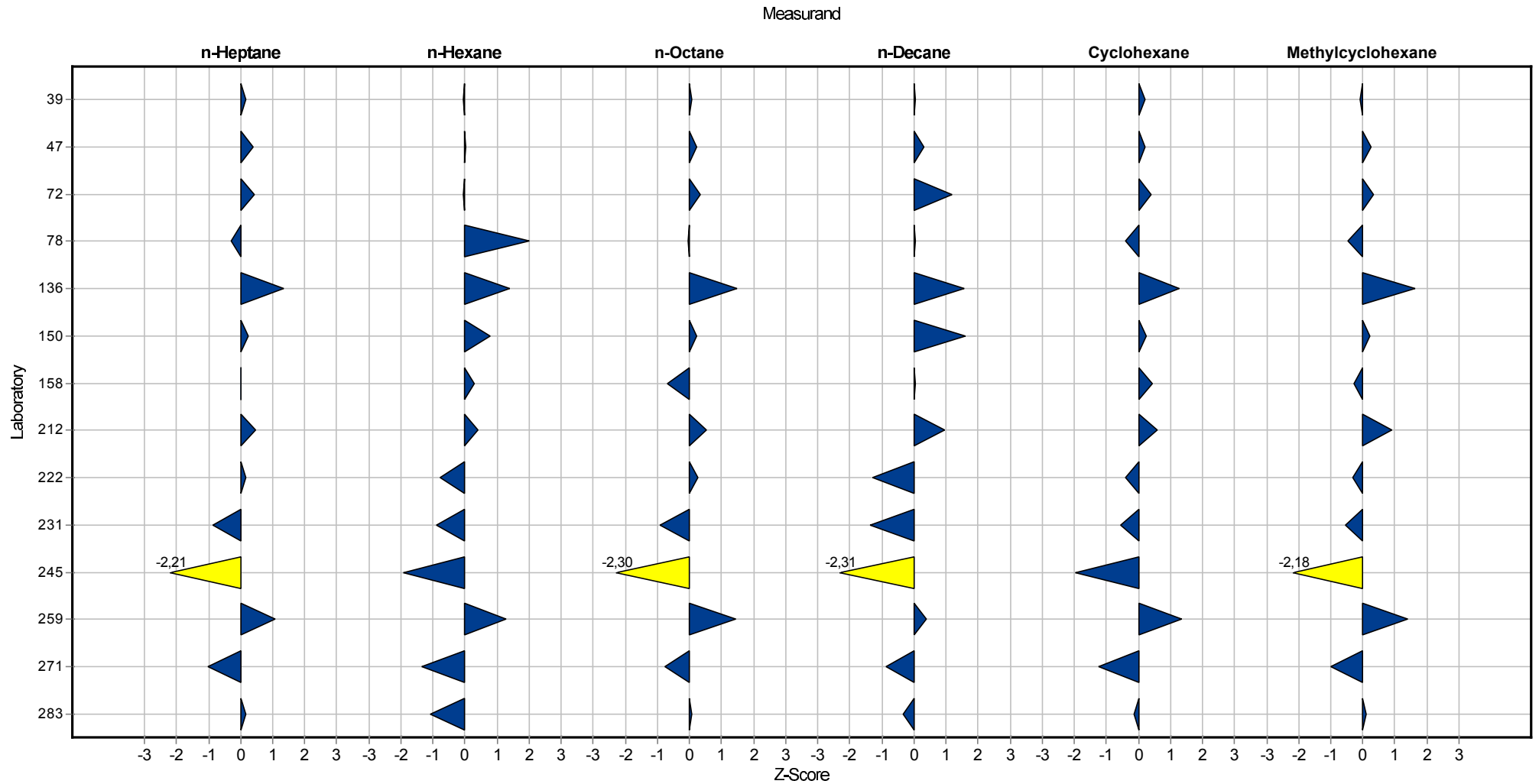
Summary results

Measurand: **Methylcyclohexane** Mean: **58,21 mg/m³**
Sample: **3** Reprod. s.d.: **5,61 mg/m³**
Method: **ISO 5725-2** Rel.reprod. s.d.: **9,64%**
No. of laboratories: **14** Reference value: **59,80 mg/m³**
Rel.target s.d.: **10,00% (Limited)** Range of tolerance: **46,56 - 69,85 mg/m³ (|Z-Score| <= 2,00)**



Sample chart of Z-scores

Sample 3



Questions and Answers

Participant	Sample carrier	Kind of pump	Volume flow	Volume flow measurement
39	Aktivkohle 226-36 Lot. 10325	Gilian Air Plus	320 bis 330 mL/min	Defender 530-L
47	Aktivkohle, Supelco Orbo 32	Compur 4903	ca. 3 lt/Std	keines
72	Aktivkohle	GilAir3	333 ml/min	Defender 520 (50-5000 ml/min)
78	A-Kohle (Typ B)	Gil-Air	300 mL/Minute	Gilibrator
136	Dräger AK, type G	Casella, TUFF 4 Plus	20l/h	MesaLabs, Defender 520 Medium
150	A-Kohle Typ B/G	GSA 2500	0,33 l/min	BIOS DryCal DC-Lite
158	Tenax TA und Carbotrap 300	Gilian LFS-113 DC Low Flow Sampler	10 ml/min	Bios Int. Corp. Defender 510-L Rev C1
212	Active coal draeger type BIA	GSA SG350ex, 5100ex, SKC AIRLITE	0,333 L/min	TSI 4146
222	Dräger Aktivkohleröhrchen Typ BIA	Sensidyne GilAir PLUS	0,335 l/min.	Defender 530 - Low
231	Aktivkohle Dräger Typ G	GilAir Plus	0,33 l/min bis 1,0 l/min	TSI Massflow
245	Aktivkohle Typ BIA	GilAir+ bzw . GS350	0,333 l/min	MDM von TSI
259	Aktivkohle Dräger Typ G	Gillian AirPlus, Gillian 5000	0,335 l/min / 0,8 l/min / 1,0 l/min	Rotameter
271	Aktivkohleröhrchen	SG 350	0,333 l/min	DryCal DC Lite
283	Aktivkohle TYP B	GSA, SG 4000 Ex	0,33 L/Min	Massenflussmesser SKC, 0-1 L/Min

Participant	Sampling time	Analytical method
39	110 bis 120 Minuten	IFA-Arbeitsmappe 7732; 7733; 7322
47	120 min	Niosh Method 1400, 1500, 1501
72	1 h	validierte eigene SOP in Anlehnung an IFA Arbeitsmappe
78	60 Minuten	IFA-Arbeitsmappe
136	2h	according to IFA methods
150	1,0 h	IFA 6385, 7322, 7732, 7733
158	5, 15 und 30 min	VOC in Luft mittels Thermodesorption
212	2h	GC
222	120 Minuten	
231	15 min bis 120 min	NIOSH 1501; BIA 7322; BIA 6385; BIA 6387; BIA 7732; BIA 8414
245	120 min	IFA 7732, IFA 7733, IFA 7322
259	120 min / 60 min / 15 min	
271	120 min	IFA 7733, , IFA 7732, IFA 7322, IFA 6385, IFA 6387, IFA 8414, NIOSH 1501

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Participant	Sampling time	Analytical method
283	120 Minuten	IFA 7732/ IFA 7733/ IFA 7322

Participant	Desorption solution
39	Ternäres Gemisch (600ml Dichlormethan, 350 ml Schwefelkohlenstoff, 50 ml Methanol)
47	Schwefelkohlenstoff
72	Benzylalkohol
78	ternäres Gemisch
136	DCM/CS ₂ /MeOH 60/35/5
150	tern. Gemisch, CS ₂
158	kein LM, da Thermodesorption
212	ternary mixture
222	Schwefelkohlenstoff
231	Schwefelkohlenstoff; ternäres Gemisch(Dichlormethan65%,Schwefelkohlenstoff30%,Methanol5%)
245	Ternäres Gemisch
271	tern. Gemisch (65% Dichlormethan, 30% Schwefelkohlenstoff, 5% Methanol) Schwefelkohlenstoff
283	ternäres Gemisch: DCM/CS ₂ /MeOH (60:35:5)

Participant	Volume of desorption solution	Carrier gas	Injection
39	3 ml	Helium	split
47	1 ml	Helium	split
72	5 ml	Helium 6.0	split
78	20 mL	Stickstoff	split
136	2 ml	helium	split
150	2 ml	Helium	split
158	keins, da Thermodesorption	Helium	Mittels Markes TD100 im 1:4000 Splitmodus
212	2 ml	helium	split
231	3 ml	Helium	split
245	10 ml je Phase	keine Angabe	Split: 10 / 3 ml
271	je 3ml für die Hauptphase und 3ml für die Sicherheitsphase	Helium	Split
283	3 mL	Helium	split

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Participant	Analytical column
39	J&W 122-5563UI; DB 5 MS; 60 m
47	Rxi-5ms
72	Phenomenex Zebron ZB-WAX, 30 m x 0,25 mm x0,25 mm
78	DB-1 (J+W)
136	SE54
150	CP Sil 8 CB, 50 m x 0,32mm, 5 µm Film
158	Resteck RTX-1 60m, ID 0,25 x 1µm
212	SE54/Stabilw ax
231	MN Optima XLB(30m*0,25mm*0,25µm); ThermoTG-1301MS (30m*0,25mm*1µm)
245	ZB-5 (60 m x 0,32 mm x 1 µm)
271	Machery Nagel Optima XLB, 30m*0,25mm, 0,25µm Filmdicke Thermo TG-1301 MS, 30m*0,5mm, 1 µm Filmdicke
283	VF-5-MS 60m*0,25mm*0,25µm

Participant	Detector	Data evaluation
39	FID	externer Standard
47	MSD, FID	externer Standard
72	FID	externer Standard, 4 und 6 Pkt. Kalibrierung
78	FID	interner Standard
136	MS	internal
150	MSD und FID	interner Standard
158	MSD Agilent 5975C	Mittels internem Standard
212	MS and FID	internal
222	FID	
231	Thermo ISQ Massenspektrometer; Thermo ISQ LT Massenspektrometer	intern mit Chlorbenzol ; intern mit Undecan
245	FID 250 °C	externer Standard
271	Thermo ISQ Massenspektrometer Thermo ISQ LT Massenspektrometer	intern: Chlorbenzol und Undecan
283	MS	externer Standard

Participant	Recovery rate	Date of analysis
39	nicht berücksichtigt	07.03.2018 bis 11.03.2018
47	ja	20.02.2018 bis 09.03.2018

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Participant	Recovery rate	Date of analysis
72	ja (0,77 bis 0,98)	19.02.2018
78	ja	9. KW
136	yes	26.02.-14.03.2018
150	Ja (BTEX'e und Decan)	20.02. - 01.03.2018
158	Ja, es w urde ein Kontrollstandard eingesetzt	16.02.2018 bis 20.02.2018
212	yes	01.-12.03.2018
231	nein	19.02.2018; 23.02.2018; 27.02.2018
245	nein	Mehrfachbestimmungen vom 27.02.-02.03.2018
271	Nein.	22.02.2018
283	ja	22.02.2018