

Round-robin tests for in-house and external measuring stations - results and evaluation

Round-robin test Organic solvents with sampling 07/08 February 2017

Summary of laboratory test results

Sample 1

	Ethylbenzene Z score		Ethanol Z score		1-Methoxy-2-propanole Z score		2-Butoxyethanol Z score		Cumene Z score		1-Methoxy-2-propyl acetate Z score	
Unit	mg/m ³		mg/m ³		mg/m ³		mg/m ³		mg/m ³		mg/m ³	
4	95,20	0,63	400,00	0,47	75,50	0,43	27,00	0,25	47,00	2,22 E	67,10	0,47
7	99,00	1,06	434,62	1,37	81,30	1,23	27,60	0,48	41,26	0,73	76,29	1,91
42	86,60	-0,33	369,00	-0,34	74,10	0,23	26,40	0,02	35,70	-0,72	64,50	0,07
72	125,60	4,03 BE	422,60	1,06	77,00	0,63	33,70	2,79 E	36,40	-0,53	72,50	1,32
78	85,38	-0,46	367,93	-0,37	66,65	-0,80	23,39	-1,12	30,14	-2,16 E	57,79	-0,98
116	91,00	0,16	352,00	-0,79	74,00	0,22	27,00	0,25	38,00	-0,12	68,00	0,61
130	85,10	-0,50	359,20	-0,60	67,10	-0,73	24,10	-0,85	41,80	0,87	59,60	-0,70
175	84,00	-0,62	362,00	-0,53	69,00	-0,47	23,00	-1,27	34,00	-1,16	59,00	-0,79
201	88,90	-0,07	164,00	-5,71 BE	67,50	-0,68	20,10	-2,37 E	35,70	-0,72	57,90	-0,96
232	153,04	7,09 BE	369,60	-0,33	122,92	6,98 BE	120,04	35,56 BE	61,88	6,09 BE	104,36	6,29
244	89,90	0,04	367,30	-0,39	68,10	-0,60	25,00	-0,51	36,40	-0,53	63,70	-0,06
263	90,30	0,09	399,00	0,44	76,30	0,54	32,50	2,34 E	46,60	2,12 E	58,30	-0,90
-	-	--	-	--	-	--	-	--	-	--	-	-
Method	ISO 5725-2		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		Z <=2,00	
Mean	89,54		382,11		72,41		26,34		38,45		64,06	
Reproducibility s.d.	4,73		27,54		4,96		4,00		5,21		6,34	
Rel. reproducibility s.d.	5,28 %		7,21 %		6,85 %		15,19 %		13,54 %		9,90 %	
Reference value	92,90		390,50		71,00		26,80		35,00		60,60	
Target s.d.	8,95		38,21		7,24		2,63		3,85		6,41	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %		10,00 %		10,00 %	
Lower limit of tolerance	71,63		305,69		57,93		21,08		30,76		51,25	
Upper limit of tolerance	107,45		458,54		86,90		31,61		46,15		76,87	
No. of laboratories that submitted results	12		12		12		12		12		12	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	10		11		11		11		11		11	

	Ethylbenzene Z score	Ethanol Z score	1-Methoxy-2-propanole Z score	2-Butoxyethanol Z score	Cumene Z score	1-Methoxy-2-propyl acetate Z score
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						
L: Differing laboratory mean (Grubbs II)		Grubbs für 2				
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232	BE					
-	-					

Summary of laboratory test results

Sample 2

	n-Heptane Z score		m-Xylene Z score		2-Butanol Z score		Ethanol Z score		2-Propanol Z score	
Unit	mg/m ³		mg/m ³		mg/m ³		mg/m ³		mg/m ³	
4	159,50	-0,83	30,40	-0,49	71,70	-0,94	141,80	-0,34	45,50	-0,21
7	201,06	1,56	37,36	1,68	96,51	2,19 E	185,30	2,63 E	60,03	2,91 BE
42	171,00	-0,17	32,10	0,04	76,10	-0,38	149,00	0,15	47,70	0,26
72	172,70	-0,07	33,30	0,41	86,70	0,96	160,10	0,91	48,70	0,48
78	160,53	-0,77	29,83	-0,67	75,43	-0,47	145,70	-0,07	47,04	0,12
116	185,00	0,64	35,00	0,94	78,00	-0,14	142,00	-0,32	46,00	-0,10
130	154,80	-1,10	29,60	-0,74	69,50	-1,22	139,70	-0,48	44,00	-0,53
175	163,00	-0,63	32,00	0,01	71,00	-1,03	150,00	0,22	46,00	-0,10
201	209,00	2,02 E	28,50	-1,09	95,80	2,11 E	164,00	1,18	52,80	1,36
232	312,26	7,95 BE	52,39	6,38 BE	13,61	-8,28 BE	122,10	-1,68	715,44	143,91 BE
244	171,50	-0,14	31,90	-0,03	73,00	-0,78	149,10	0,16	46,10	-0,08
263	165,00	-0,51	31,80	-0,06	76,80	-0,30	112,00	-2,37 E	41,00	-1,18
-	-	--	-	--	-	--	-	--	-	--
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	
Mean	173,92		31,98		79,14		146,73		46,48	
Reproducibility s.d.	17,49		2,54		9,58		18,82		3,06	
Rel. reproducibility s.d.	10,05 %		7,96 %		12,11 %		12,83 %		6,59 %	
Reference value	164,30		31,70		79,50		155,60		45,50	
Target s.d.	17,39		3,20		7,91		14,67		4,65	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %		10,00 %	
Lower limit of tolerance	139,13		25,58		63,31		117,39		37,19	
Upper limit of tolerance	208,70		38,38		94,97		176,08		55,78	
No. of laboratories that submitted results	12		12		12		12		12	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	11		11		11		12		10	

	n-Heptane Z score	m-Xylene Z score	2-Butanol Z score	Ethanol Z score	2-Propanol Z score
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$					
L: Differing laboratory mean (Grubbs II)		Grubbs für 2			

Summary of laboratory test results

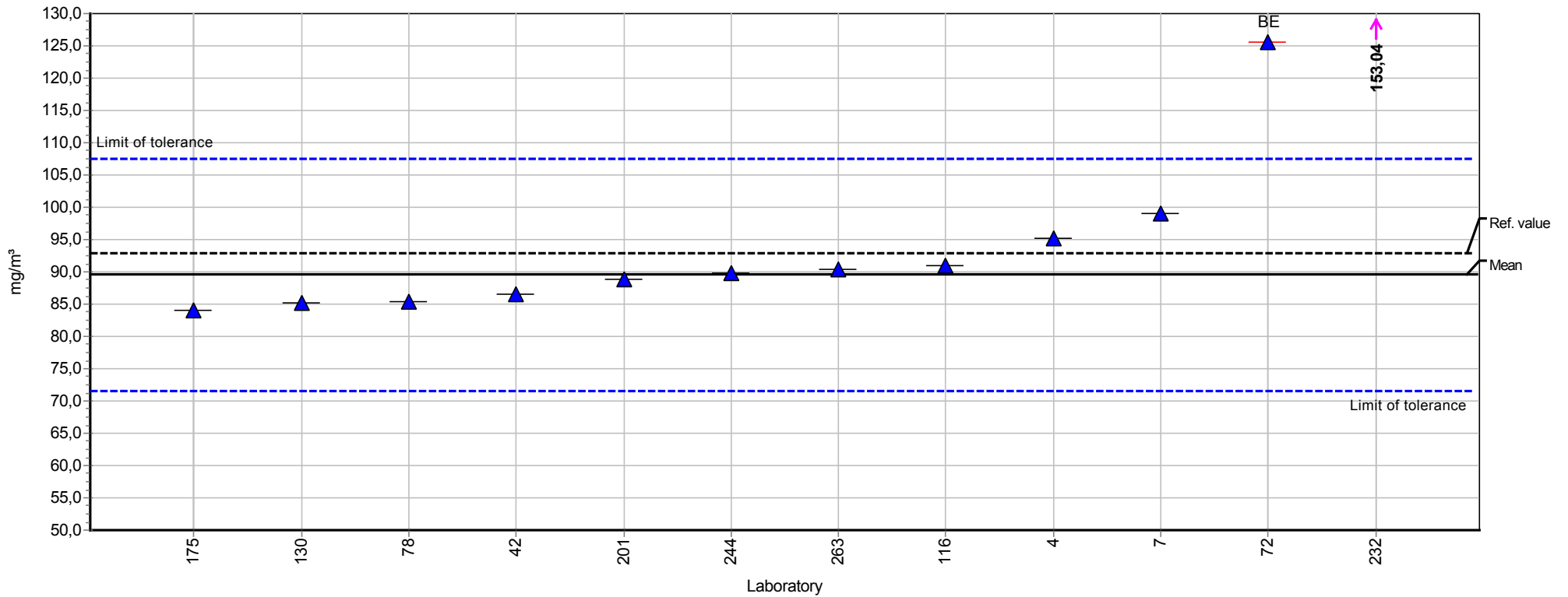
Sample 3

	1-Butylacetate Z score		Toluene Z score		n-Hexane Z score		Ethanol Z score		2-Butoxyethanol Z score	
Unit	mg/m ³		mg/m ³		mg/m ³		mg/m ³		mg/m ³	
4	126,50	0,02	73,20	-0,13	47,60	-0,52	487,50	-0,13	29,60	-0,22
7	135,35	0,72	85,30	1,50	48,06	-0,42	525,22	0,63	34,61	1,43
42	123,00	-0,26	71,00	-0,43	48,30	-0,38	468,00	-0,53	30,10	-0,06
72	123,90	-0,19	76,20	0,27	44,00	-1,23	522,70	0,58	38,20	2,62 E
78	118,78	-0,60	71,42	-0,37	60,67	2,09 E	482,19	-0,24	28,43	-0,61
116	132,00	0,45	77,00	0,38	52,00	0,36	461,00	-0,67	29,00	-0,42
130	120,60	-0,45	69,80	-0,59	44,40	-1,15	450,30	-0,89	28,40	-0,62
175	119,00	-0,58	71,00	-0,43	45,00	-1,03	466,00	-0,57	28,00	-0,75
201	127,00	0,06	72,70	-0,20	62,90	2,53 E	540,00	0,93	22,13	-2,69 E
232	147,26	1,66	132,41	7,85 BE	137,36	17,37 BE	84,56	-8,29 BE	123,75	30,87 BE
244	118,20	-0,64	73,20	-0,13	53,30	0,62	513,90	0,40	28,10	-0,72
263	124,00	-0,18	75,30	0,15	45,80	-0,87	519,00	0,50	36,50	2,05 E
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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	
Mean	126,30		74,19		50,18		494,16		30,28	
Reproducibility s.d.	8,44		4,34		6,46		30,94		4,53	
Rel. reproducibility s.d.	6,69 %		5,85 %		12,87 %		6,26 %		14,98 %	
Reference value	119,60		74,20		49,70		510,50		31,40	
Target s.d.	12,63		7,42		5,02		49,42		3,03	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %		10,00 %	
Lower limit of tolerance	101,04		59,35		40,15		395,33		24,22	
Upper limit of tolerance	151,56		89,03		60,22		593,00		36,33	
No. of laboratories that submitted results	12		12		12		12		12	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	12		11		11		11		11	

	1-Butylacetate Z score	Toluene Z score	n-Hexane Z score	Ethanol Z score	2-Butoxyethanol Z score
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$					
L: Differing laboratory mean (Grubbs II)		Grubbs für 2			

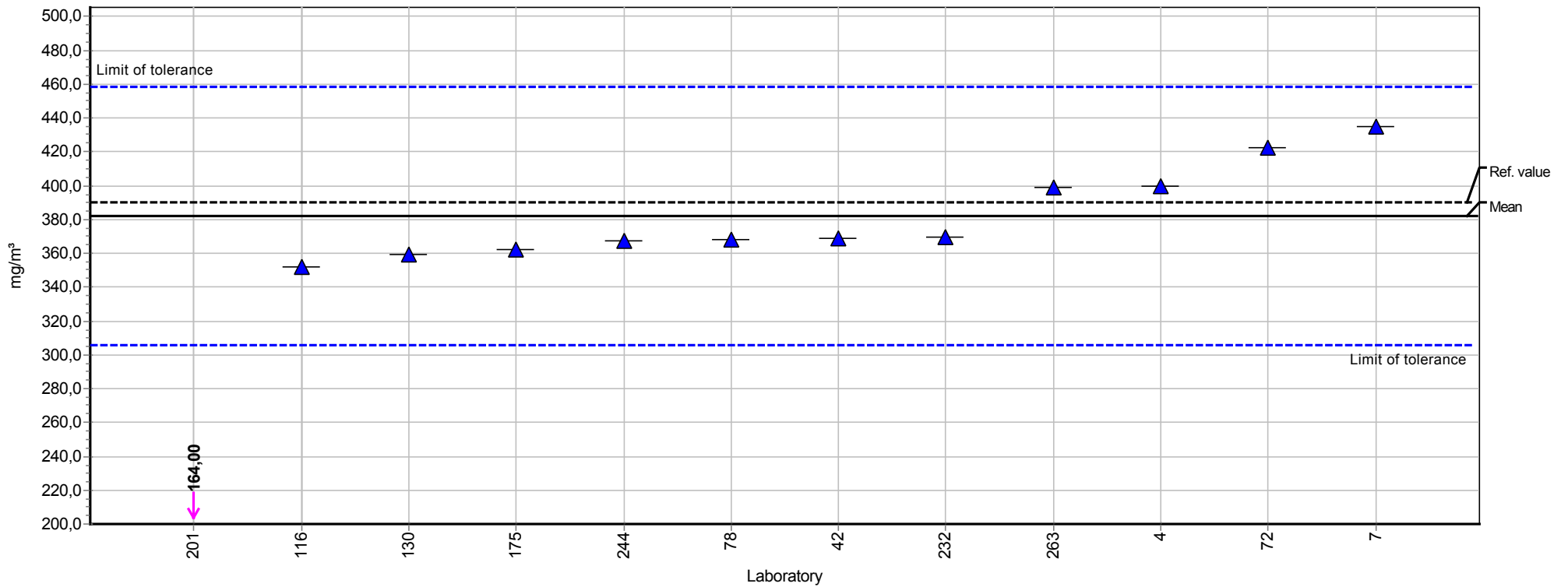
Summary results

Measurand:	Ethylbenzene	Mean:	89,54 mg/m ³
Sample:	1	Reproducibility s.d.:	4,73 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	5,28%
Relative target s.d.:	10,00% (Limited)	Reference value:	92,90 mg/m ³
No. of laboratories:	10	Range of tolerance:	71,63 - 107,45 mg/m ³ (Z-Score <= 2,00)



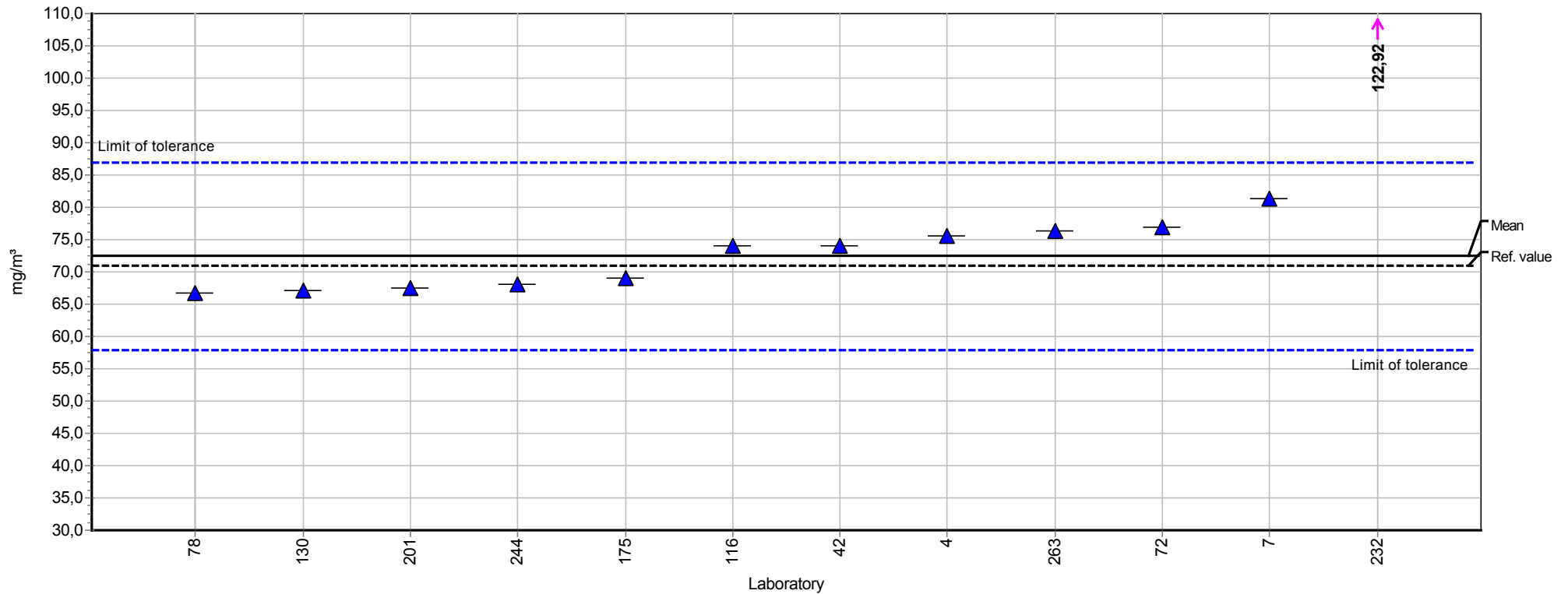
Summary results

Measurand:	Ethanol	Mean:	382,11 mg/m ³
Sample:	1	Reproducibility s.d.:	27,54 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	7,21%
Relative target s.d.:	10,00% (Limited)	Reference value:	390,50 mg/m ³
No. of laboratories:	11	Range of tolerance:	305,69 - 458,54 mg/m ³ (Z-Score <= 2,00)



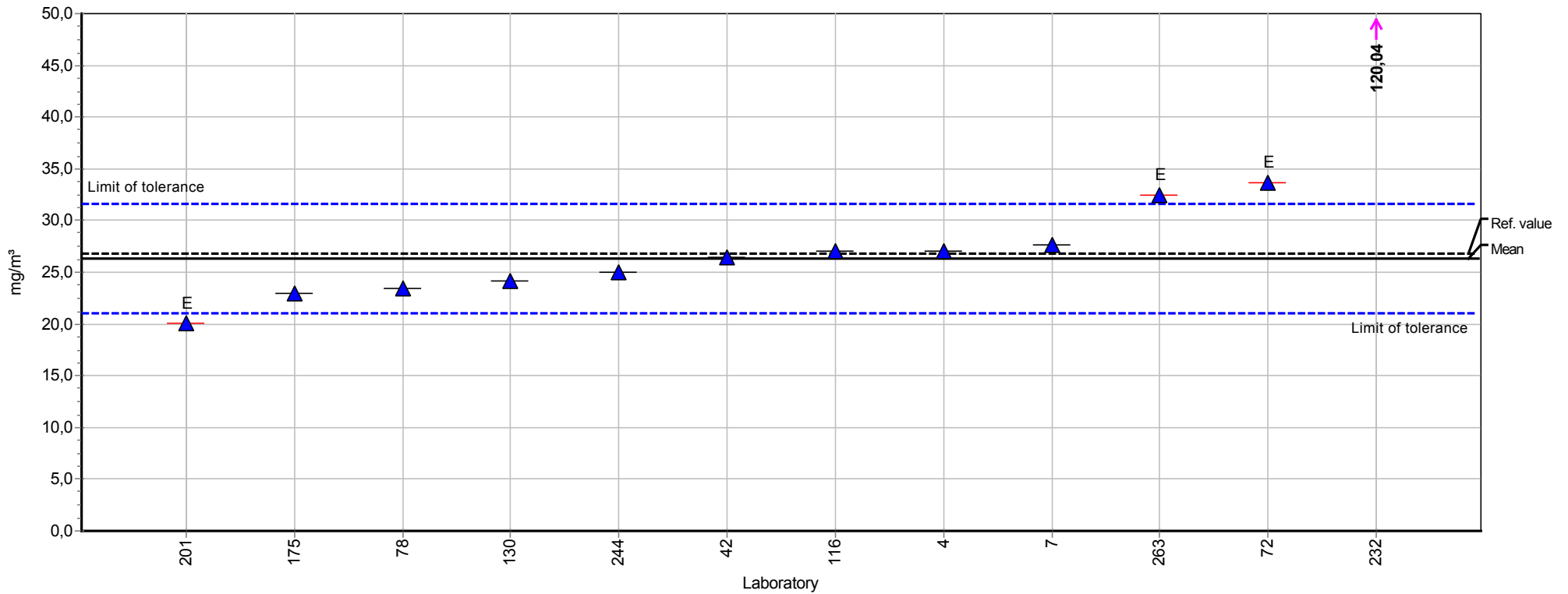
Summary results

Measurand:	1-Methoxy-2-propanol	Mean:	72,41 mg/m ³
Sample:	1	Reproducibility s.d.:	4,96 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	6,85%
Relative target s.d.:	10,00% (Limited)	Reference value:	71,00 mg/m ³
No. of laboratories:	11	Range of tolerance:	57,93 - 86,90 mg/m ³ (Z-Score <= 2,00)



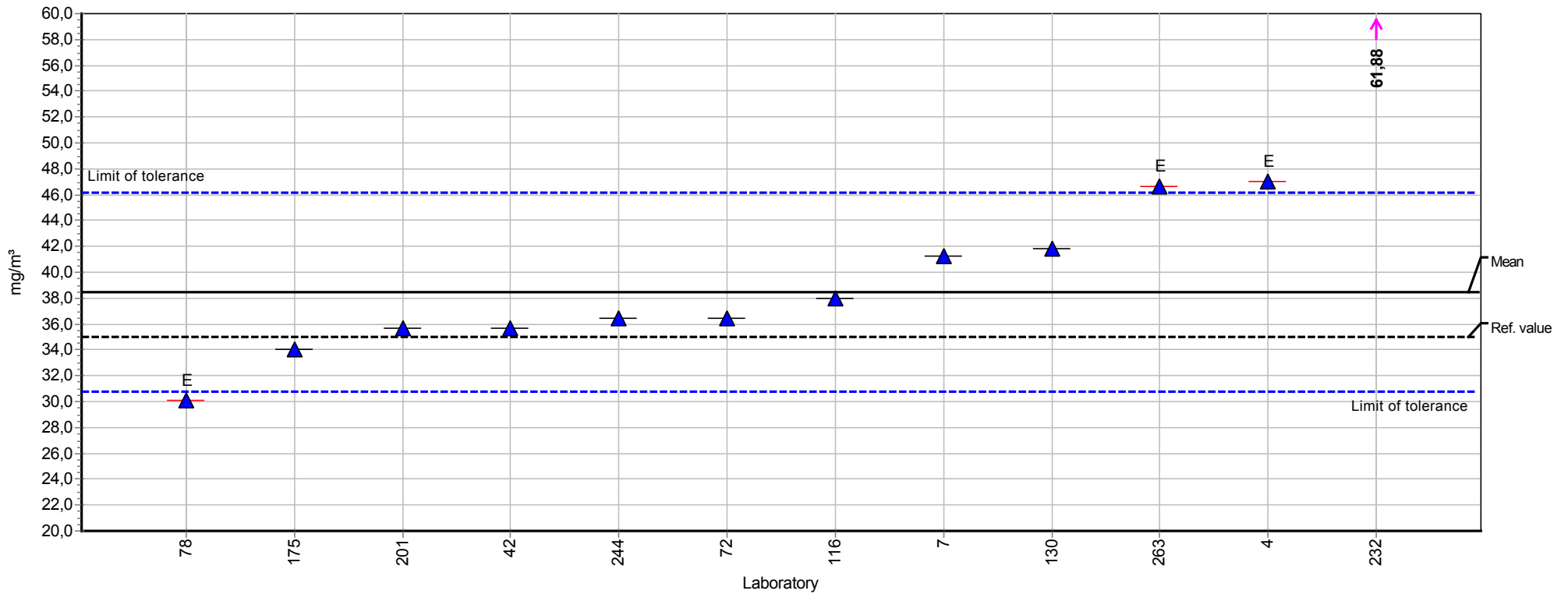
Summary results

Measurand:	2-Butoxyethanol	Mean:	26,34 mg/m ³
Sample:	1	Reproducibility s.d.:	4,00 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	15,19%
Relative target s.d.:	10,00% (Limited)	Reference value:	26,80 mg/m ³
No. of laboratories:	11	Range of tolerance:	21,08 - 31,61 mg/m ³ (Z-Score <= 2,00)



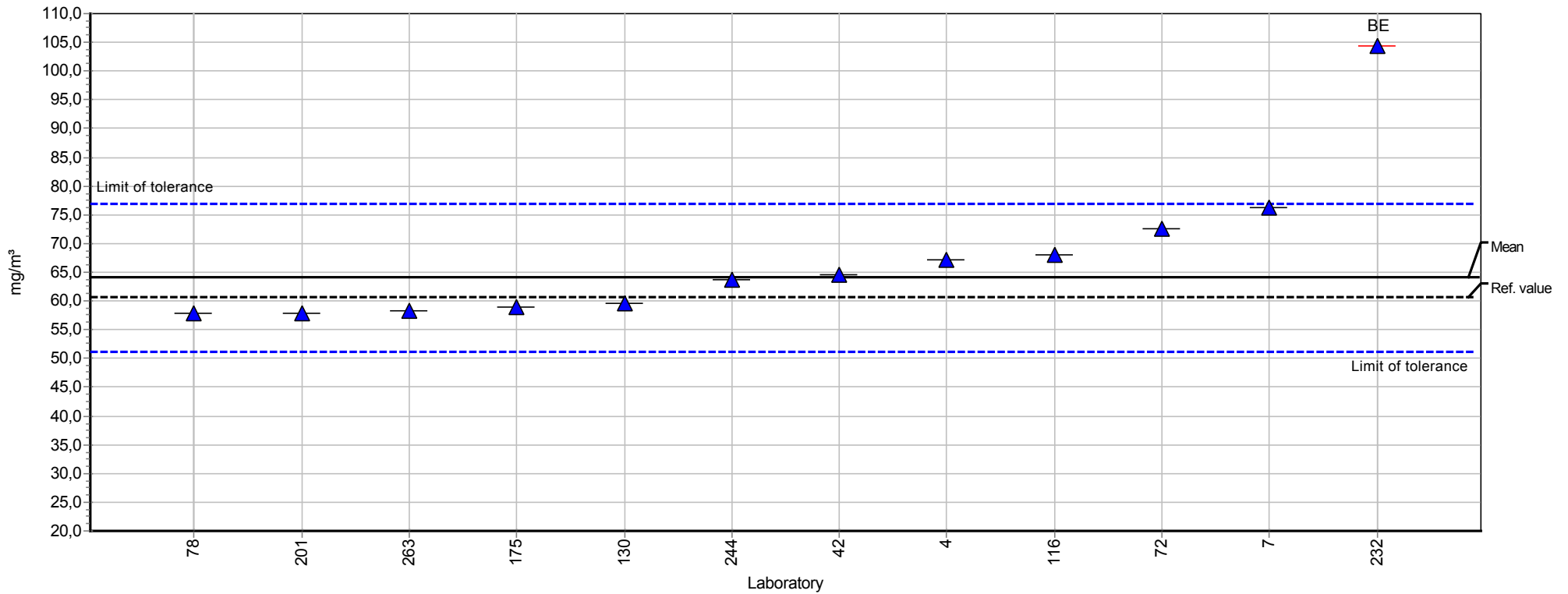
Summary results

Measurand:	Cumene	Mean:	38,45 mg/m ³
Sample:	1	Reproducibility s.d.:	5,21 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	13,54%
Relative target s.d.:	10,00% (Limited)	Reference value:	35,00 mg/m ³
No. of laboratories:	11	Range of tolerance:	30,76 - 46,15 mg/m ³ (Z-Score <= 2,00)



Summary results

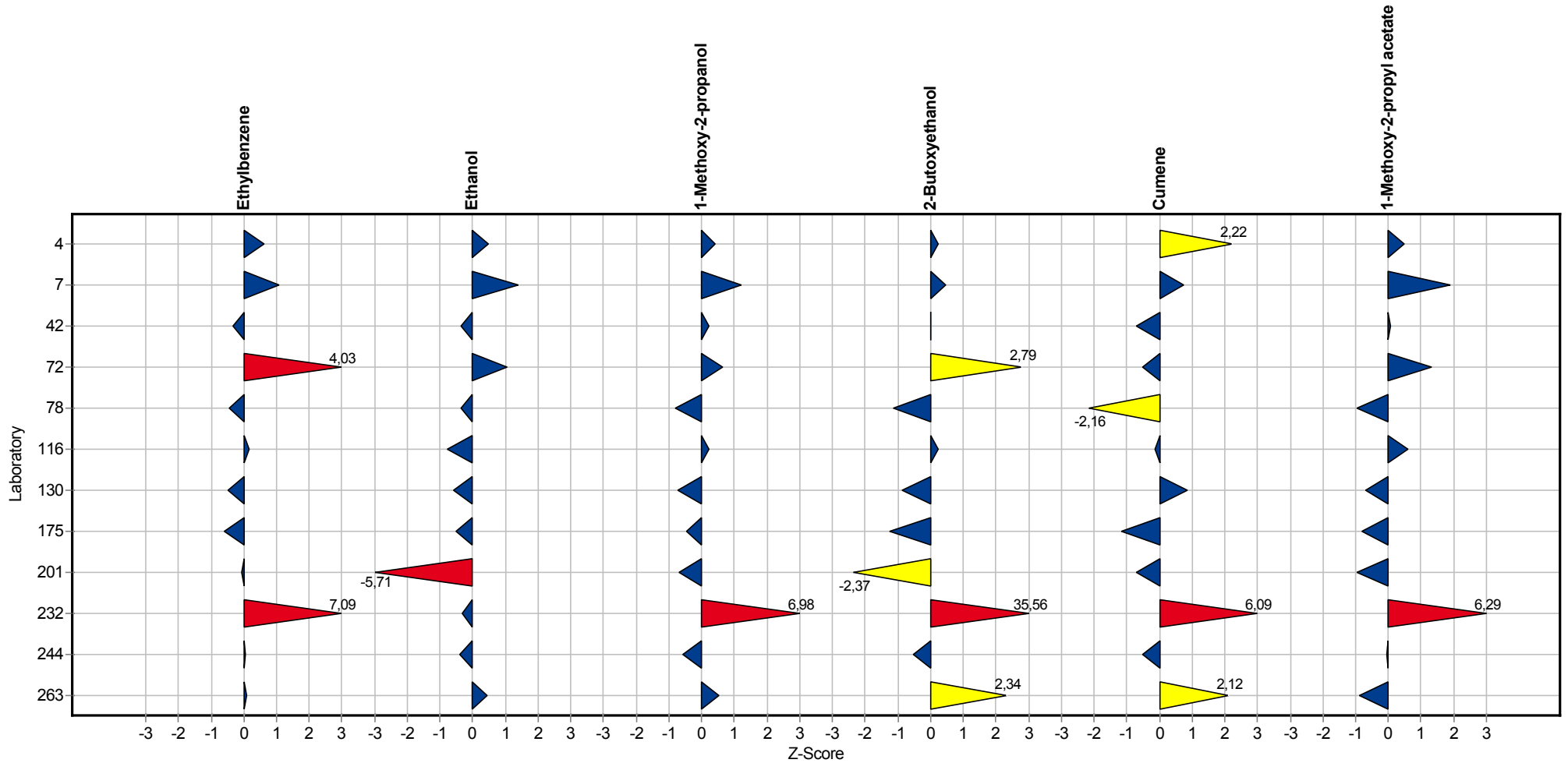
Measurand:	1-Methoxy-2-propyl acetate	Mean:	64,06 mg/m ³
Sample:	1	Reproducibility s.d.:	6,34 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	9,90%
Relative target s.d.:	10,00% (Limited)	Reference value:	60,60 mg/m ³
No. of laboratories:	11	Range of tolerance:	51,25 - 76,87 mg/m ³ (Z-Score <= 2,00)



Sample chart of Z-scores

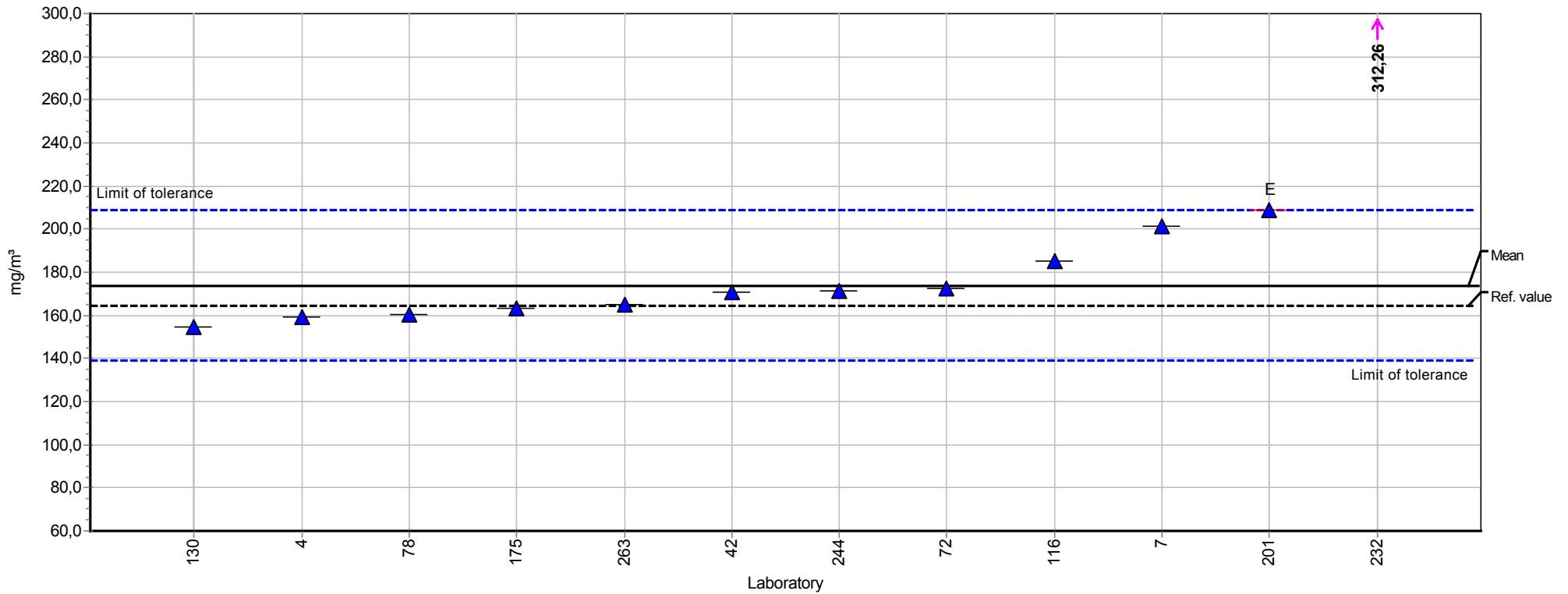
Sample 1

Measurand



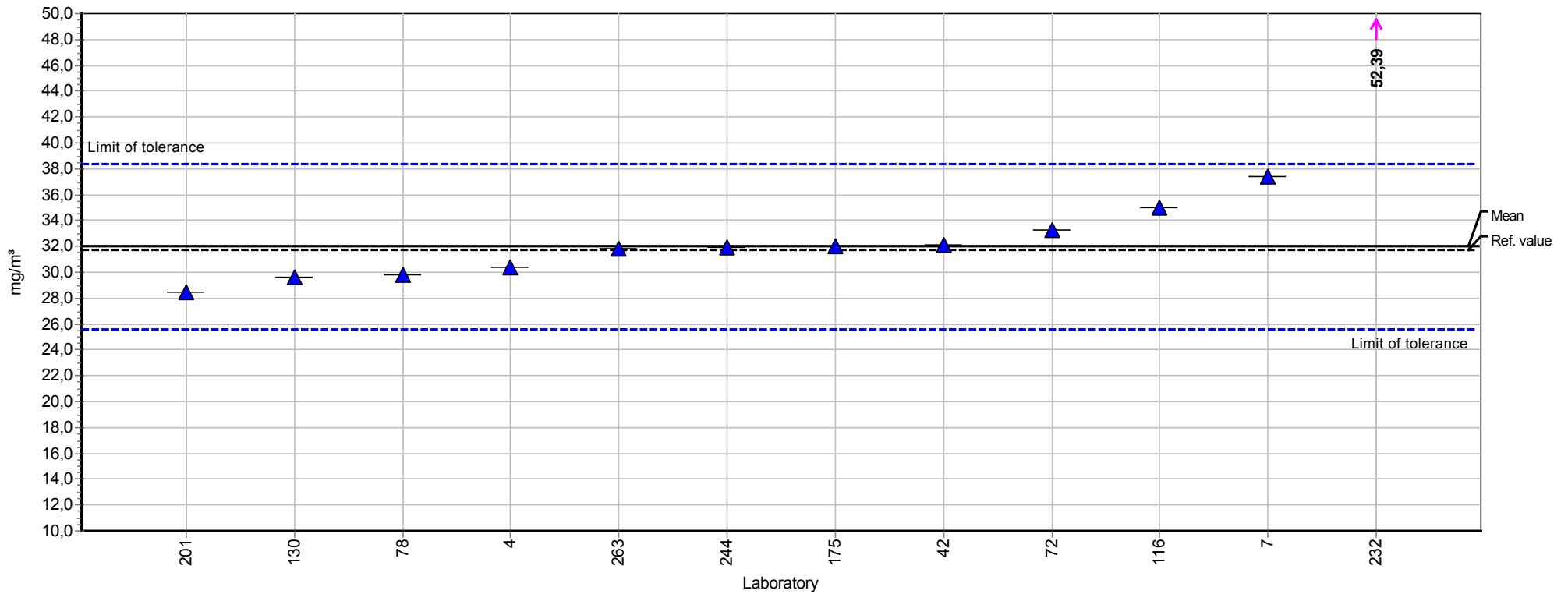
Summary results

Measurand:	n-Heptane	Mean:	173,92 mg/m ³
Sample:	2	Reproducibility s.d.:	17,49 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	10,05%
Relative target s.d.:	10,00% (Limited)	Reference value:	164,30 mg/m ³
No. of laboratories:	11	Range of tolerance:	139,13 - 208,70 mg/m ³ (Z-Score <= 2,00)



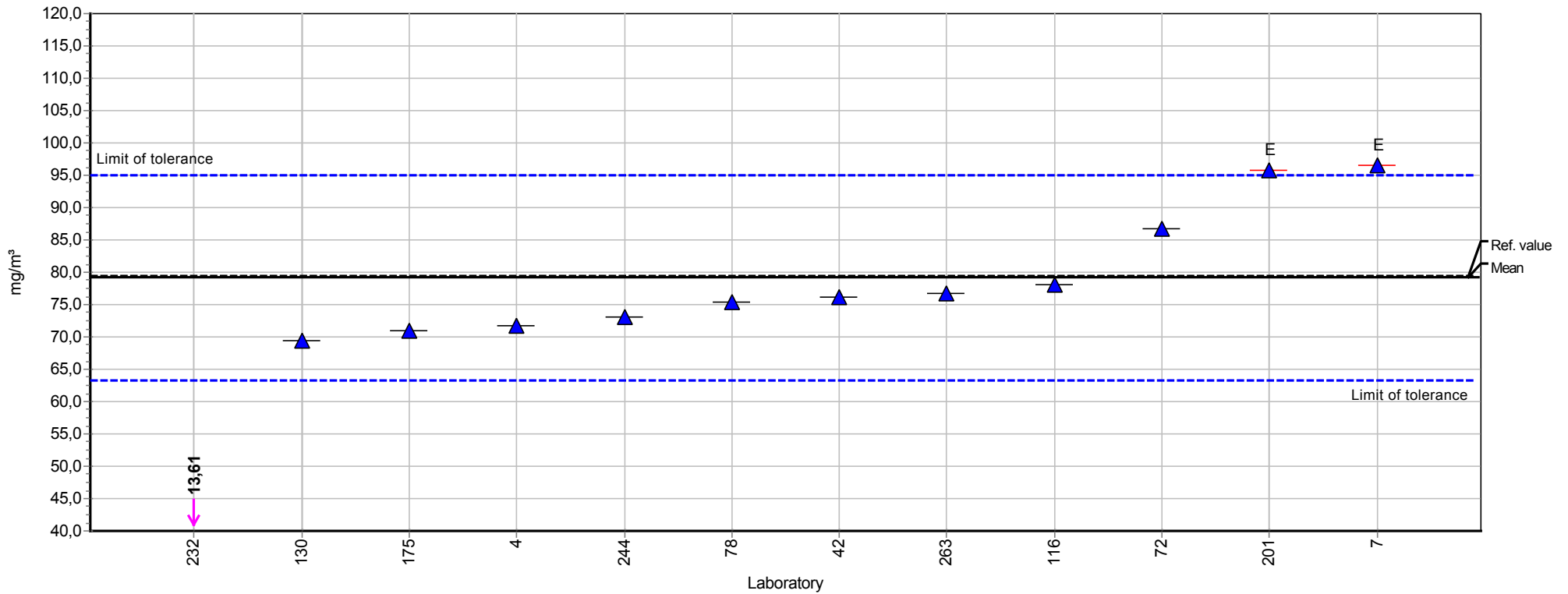
Summary results

Measurand:	m-Xylene	Mean:	31,98 mg/m ³
Sample:	2	Reproducibility s.d.:	2,54 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	7,96%
Relative target s.d.:	10,00% (Limited)	Reference value:	31,70 mg/m ³
No. of laboratories:	11	Range of tolerance:	25,58 - 38,38 mg/m ³ (Z-Score <= 2,00)



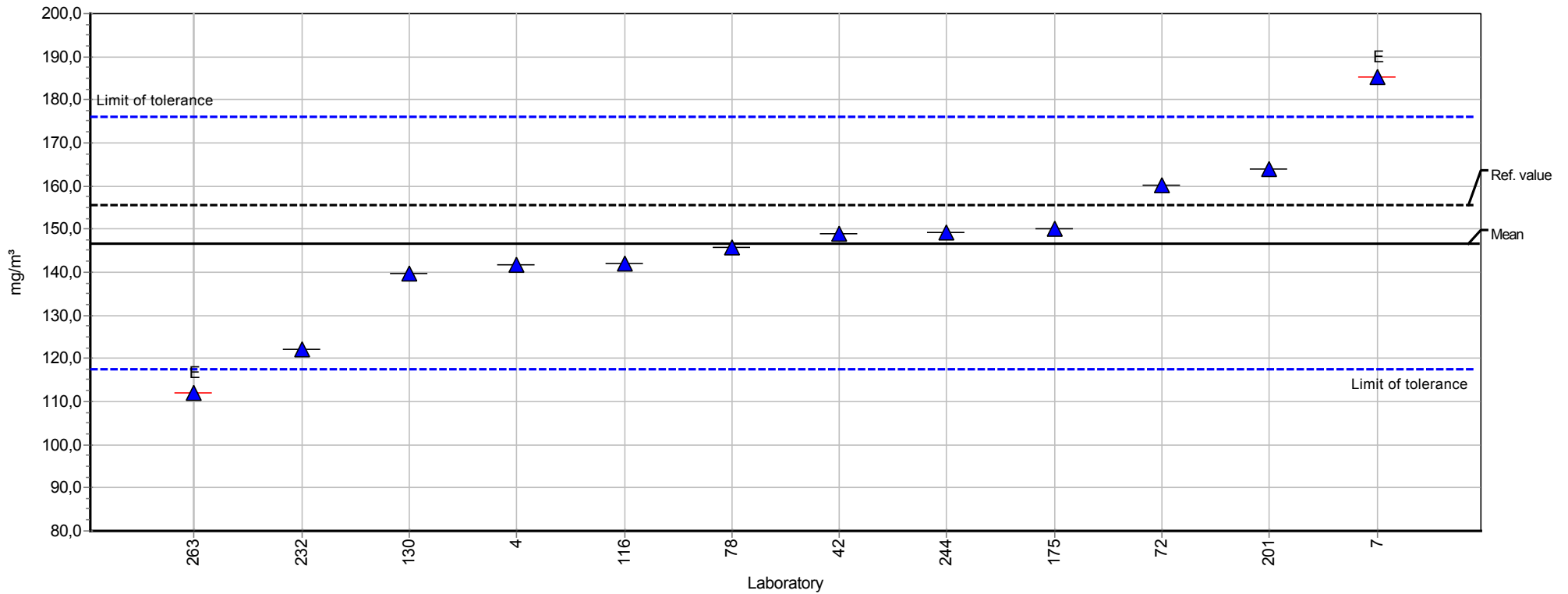
Summary results

Measurand:	2-Butanol	Mean:	79,14 mg/m ³
Sample:	2	Reproducibility s.d.:	9,58 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	12,11%
Relative target s.d.:	10,00% (Limited)	Reference value:	79,50 mg/m ³
No. of laboratories:	11	Range of tolerance:	63,31 - 94,97 mg/m ³ (Z-Score <= 2,00)



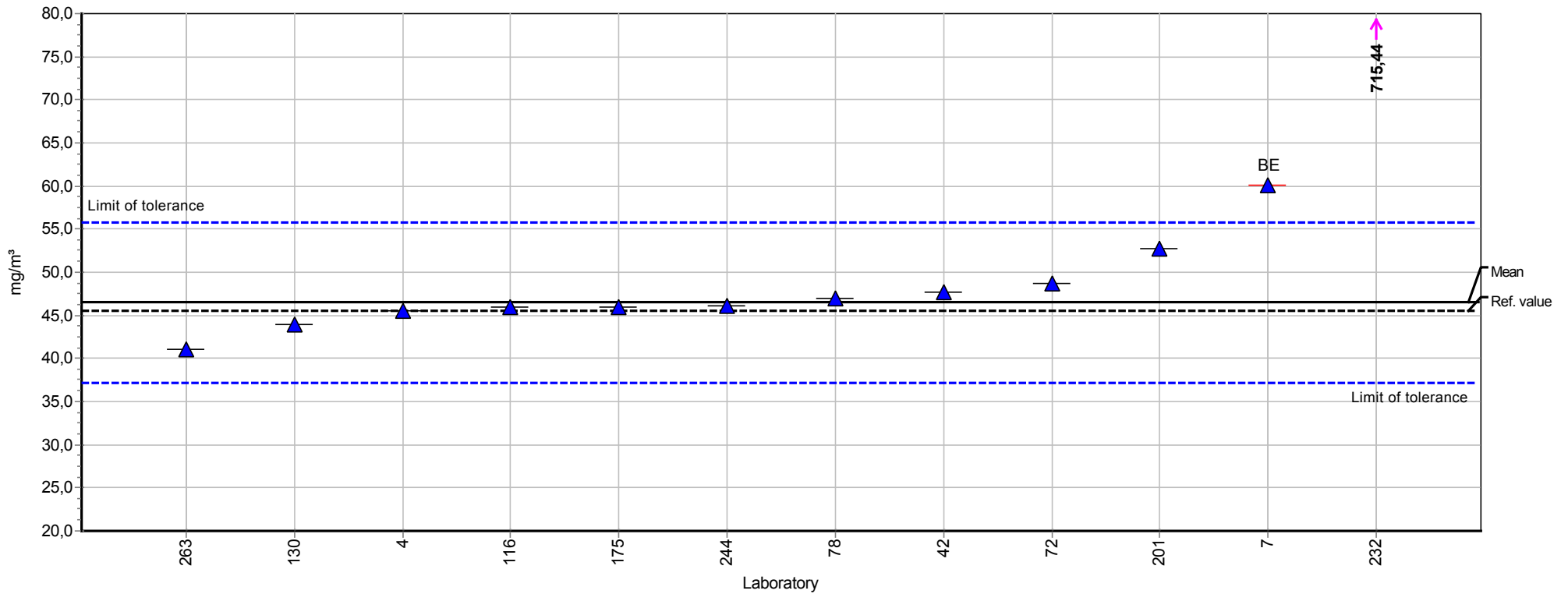
Summary results

Measurand:	Ethanol	Mean:	146,73 mg/m ³
Sample:	2	Reproducibility s.d.:	18,82 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	12,83%
Relative target s.d.:	10,00% (Limited)	Reference value:	155,60 mg/m ³
No. of laboratories:	12	Range of tolerance:	117,39 - 176,08 mg/m ³ (Z-Score <= 2,00)



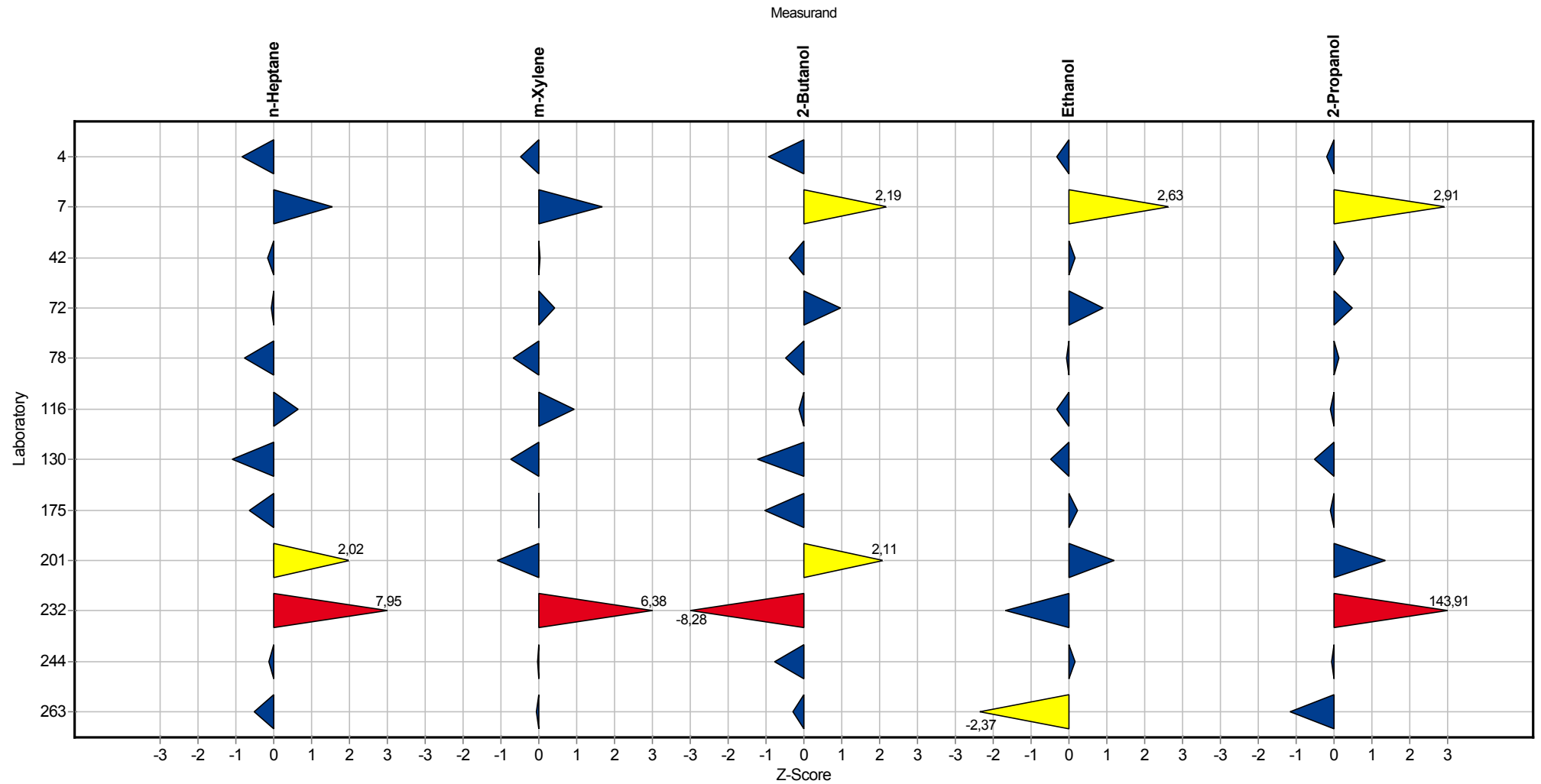
Summary results

Measurand:	2-Propanol	Mean:	46,48 mg/m ³
Sample:	2	Reproducibility s.d.:	3,06 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	6,59%
Relative target s.d.:	10,00% (Limited)	Reference value:	45,50 mg/m ³
No. of laboratories:	10	Range of tolerance:	37,19 - 55,78 mg/m ³ (Z-Score <= 2,00)



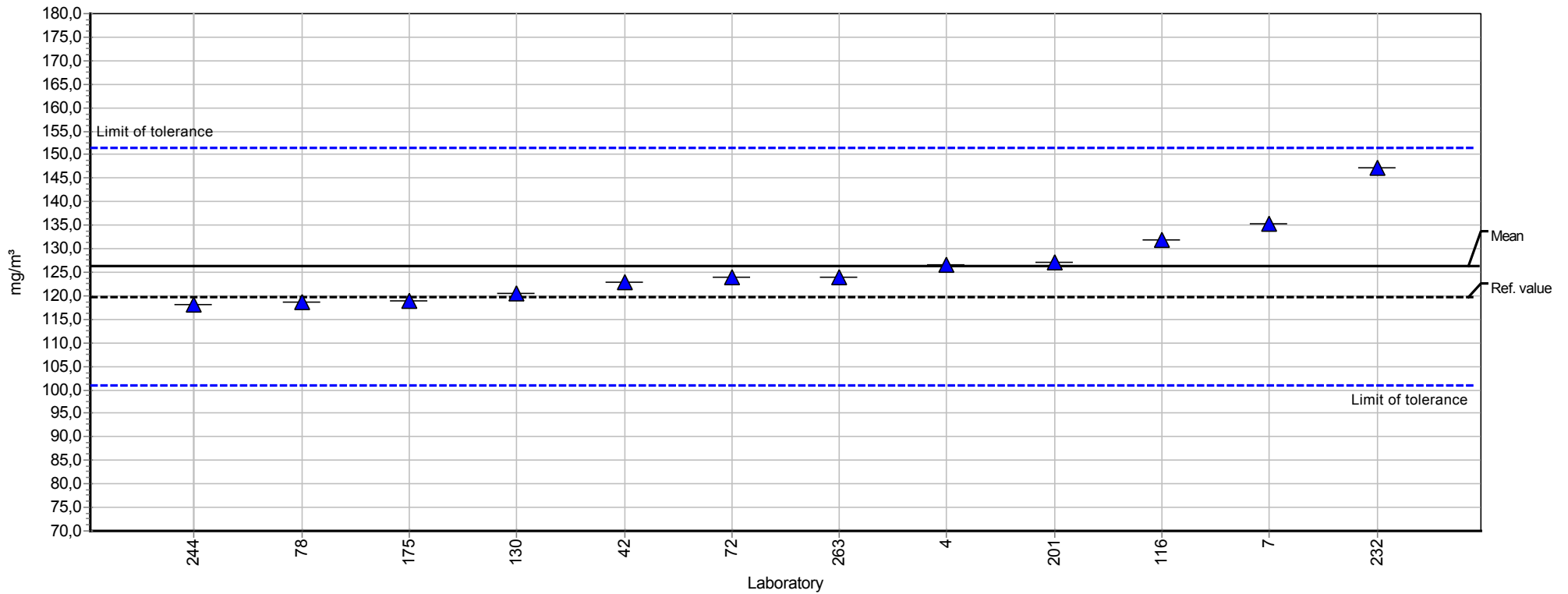
Sample chart of Z-scores

Sample 2



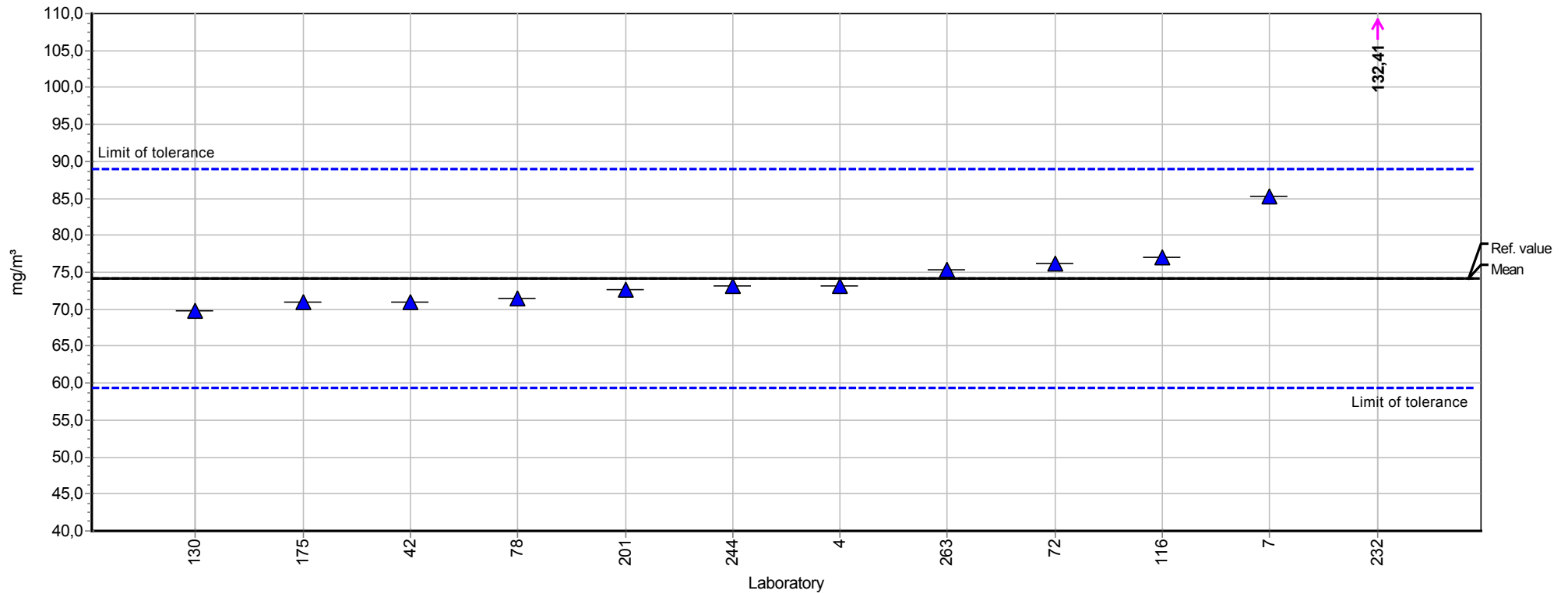
Summary results

Measurand:	1-Butylacetate	Mean:	126,30 mg/m ³
Sample:	3	Reproducibility s.d.:	8,44 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	6,69%
Relative target s.d.:	10,00% (Limited)	Reference value:	119,60 mg/m ³
No. of laboratories:	12	Range of tolerance:	101,04 - 151,56 mg/m ³ (Z-Score <= 2,00)



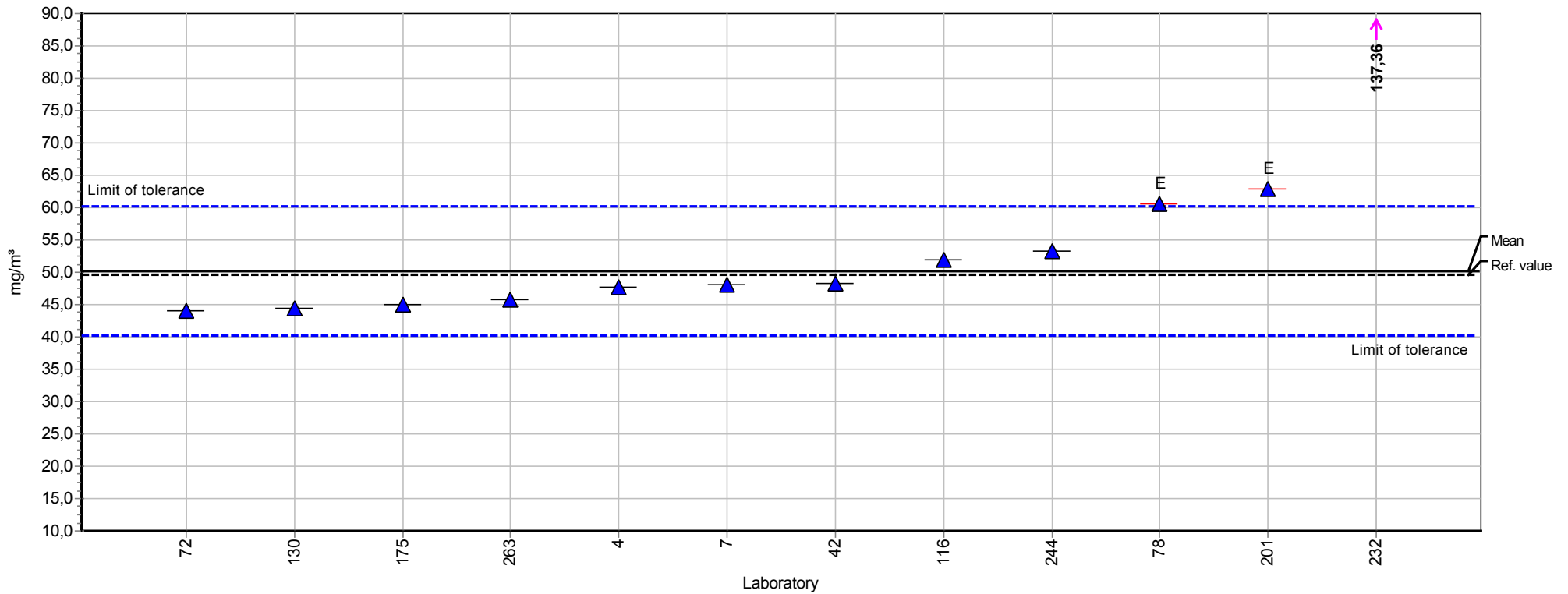
Summary results

Measurand:	Toluene	Mean:	74,19 mg/m ³
Sample:	3	Reproducibility s.d.:	4,34 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	5,85%
Relative target s.d.:	10,00% (Limited)	Reference value:	74,20 mg/m ³
No. of laboratories:	11	Range of tolerance:	59,35 - 89,03 mg/m ³ (Z-Score <= 2,00)



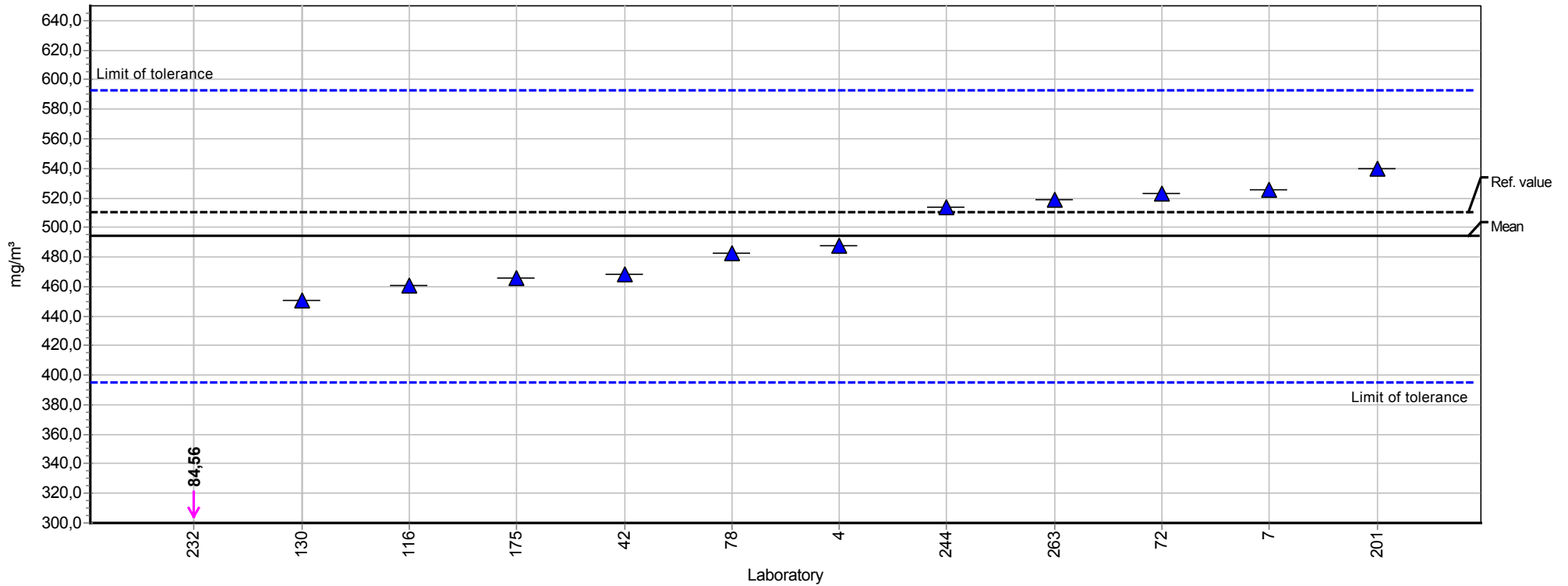
Summary results

Measurand:	n-Hexane	Mean:	50,18 mg/m ³
Sample:	3	Reproducibility s.d.:	6,46 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	12,87%
Relative target s.d.:	10,00% (Limited)	Reference value:	49,70 mg/m ³
No. of laboratories:	11	Range of tolerance:	40,15 - 60,22 mg/m ³ (Z-Score <= 2,00)



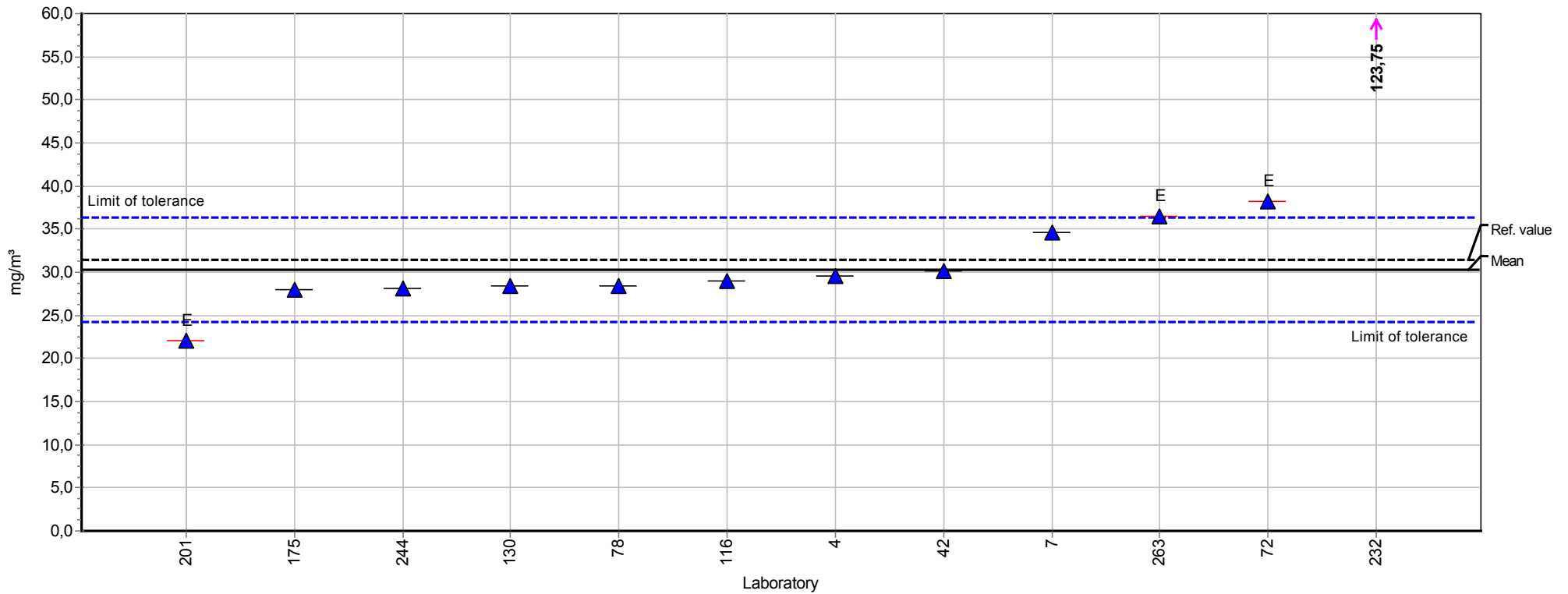
Summary results

Measurand:	Ethanol	Mean:	494,16 mg/m ³
Sample:	3	Reproducibility s.d.:	30,94 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	6,26%
Relative target s.d.:	10,00% (Limited)	Reference value:	510,50 mg/m ³
No. of laboratories:	11	Range of tolerance:	395,33 - 593,00 mg/m ³ (Z-Score ≤ 2,00)



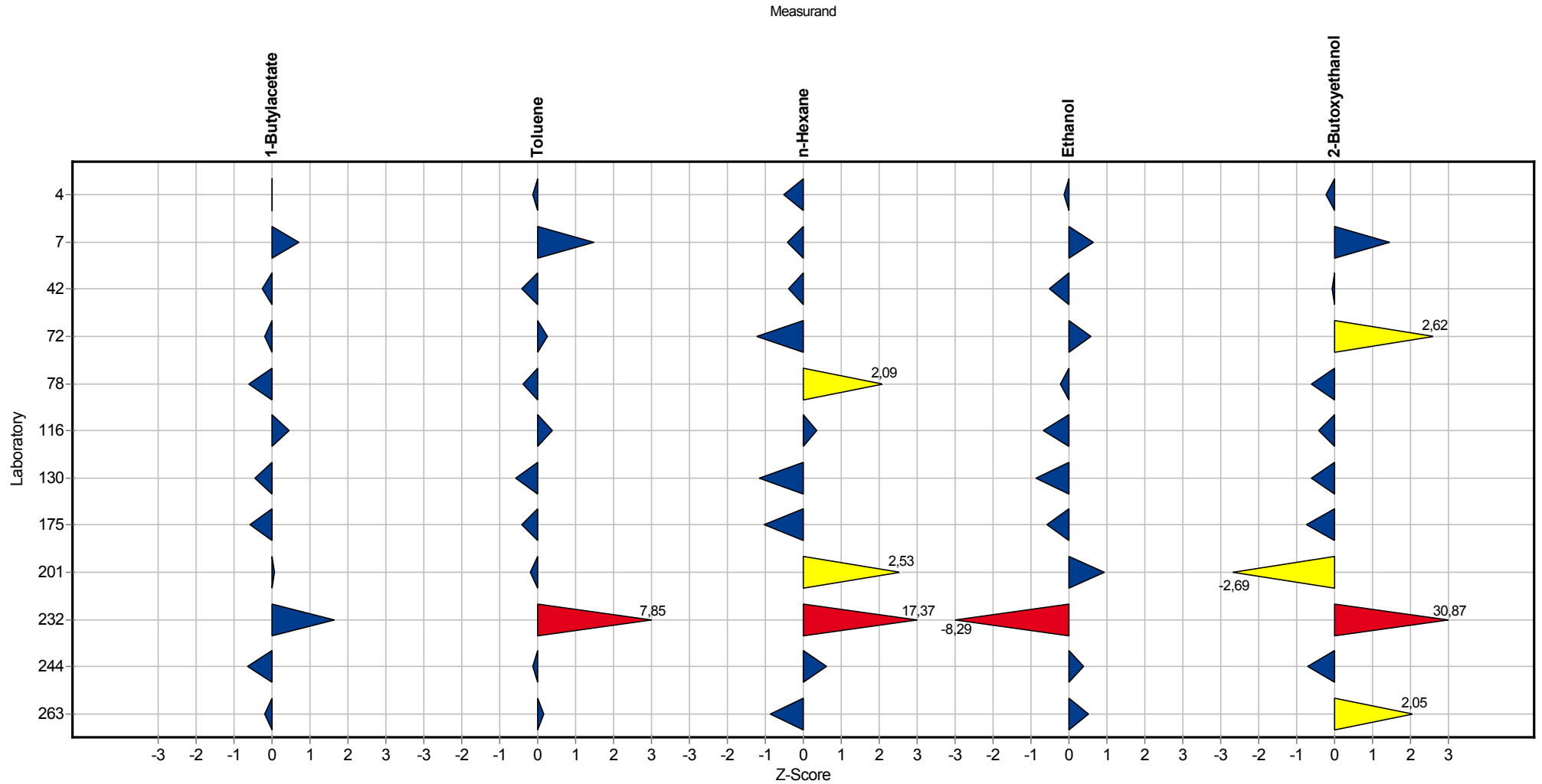
Summary results

Measurand:	2-Butoxyethanol	Mean:	30,28 mg/m ³
Sample:	3	Reproducibility s.d.:	4,53 mg/m ³
Method:	ISO 5725-2	Relative reproducibility s.d.:	14,98%
Relative target s.d.:	10,00% (Limited)	Reference value:	31,40 mg/m ³
No. of laboratories:	11	Range of tolerance:	24,22 - 36,33 mg/m ³ (Z-Score <= 2,00)



Sample chart of Z-scores

Sample 3



Questions and Answers

Participant	Kind of pump	Sample carrier	Volume flow	Volume flow measurement	Sampling time
4	SKC-PCMTX8	Aktivkohle	0,27...0,31	Defender 510	70...90 Minuten
7	2 x SKC / 1 x GilAir 5	Dräger Aktivkohle Typ BIA	0,083 bzw. 0,33 l/min	digitaler Massendurchflußmesser	120 Min
42	GSA, SG350	Aktivkohle Typ B	0,333 l/min	TSI 4146	120min
72	Aktivkohle	SG350	333 ml/min	Defender 520 (50-5000 ml/min)	1 h bzw . 2 h
78	GilAir 5 (Fa. Sensidyne) und SG 5100 (Fa. GSA)	Aktivkohne, Typ B	ca. 300 mL/Minute	Gilibrator	ca. 60 Minuten
116	LfS 113	AK Dräger Typ B	0,33 l/min	BIOS Defender	120 min
130	Gilian LFS 113	A-Kohle Typ BIA	0,3 l/min	Gilian Gilibrator I	30 - 120 min
175	SKC Pocket Pump 210-1002	SKC 226-01	50 ml - 200 ml/min	TSI 4100	15 min - 85 min
201	GSA, SG 5100 und SG 4000	Aktivkohle, Typ G, Fa. Dräger	0,341 - 0,363 l/min	Defender 510, 50 - 5000 ml/min, Fa, BIOS	2 Stunden
244	SKC Pocket Pump Model Nr. 210-1002MTX	Aktivkohle Typ NIOSH Fa. Draeger	50 ml / min	Bios Defender 510	ca. 70 min
263	GilAirPlus von der Firma Sensidyne	Aktivkohle Typ G von Dräger	ca. 0,33 l/min	Massflowmeter TSI 4146 und Gilibrator.	jeweils 30 Minuten

Participant	Analytical method	Desorption solution
4	"DFG - Analytische Methoden- Luftanalysen- Band 1, Seite 1, Methode 3, LM-Gemische"	Ternäres Gemisch (60/35/5, Dichlormethan/ Schwefelkohlenstoff/ Methanol)
7	IFA 6368, IFA 7330, IFA 7322 , IFA7569, IFA 7732, IFA 7733, IFA 8415	Ternäres Gemisch
42	IFA-Arbeitsmappe	Ternäres Gemisch (60%Dichlormethan / 35%Schwefelkohlenstoff / 5%Methanol)
72	validierte eigene SOP in Anlehnung an IFA Arbeitsmappe	Benzylalkohol (Lsm.) / Gemisch Dichlormethan - Schwefelkohlenstoff - Methanol (Glykole)
78	IFA-Arbeitsmappe	ternäres Gemisch
130	DFG-Luftanalysenband 1	ternäres Gemisch
175	modifiziertes NIOSH	CS2 + 2%DMF
201	7569, 7733, 7330, 7732, 7322,	Glykolether: DCM/MeOH; Alkohole + KW: DMF; Aromaten: Ternäres Gemisch
244	eigene Methode	Benzylalkohol
263	IFA 7732, 7733, 7322, 7569, QMA	diverse: Ternäres Gemisch, CS2, CS2 + 1% 1-Prop.

Participant	Volume of desorption solution	Carrier gas	Injection
4		Stickstoff 5.0	Split 10/ 3 ml
7		Helium	split
42		Helium	1µl, Split 1:10

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Participant	Volume of desorption solution	Carrier gas	Injection
72		Helium 6.0	split
78		Stickstoff	split
130		Stickstoff	split
175		Helium	2 µl
201		Helium	Glykolether: splitless; Alkohole + KW: split, Aromaten: split
244		Helium	Split
263	diverse : 5 mL und 3 mL	Stickstoff	split

Participant	Analytical column
4	ZB-5 (60 x 0,32 m x 1 µm)
7	RTX5 Amine
42	HP-FFAP / HP- ULTRA2 (je 50m; 0,32mm; 0,52µm)
72	Phenomenex Zebron ZB-WAX, 30 m x 0,25 mm x 0,25 mm
78	J+W (DB-1)
130	ZB-5 (60 m x 0,32 mm x 1 µm)
175	DB-1 60m id 0,25 mm, 1µm
201	Glykolether: DB Innowax; 60 m; 0,25 mm ID, 0,25 µm Film; Alkohole + KW: Restek, RTX Volantiles, 30 m, 0,25 mm ID, 1,0 µm Film, Aromaten: DB-XLB, 30 m x 0,25 mm x 0,5 µm
244	Zebron ZB-5MSi 30m x 0.25mm x 0.25µm
263	Säule A: Fused Silica-Kapillarsäule 007-5-50-2.5F (5%Phenyl Methyl Silicon) / Säule B: Fused Silica-Kapillarsäule 007-1701-50W-1.OF (Methyl 7%, Cyanopropyl 7%, Phenylsilicon)

Participant	Detector	Data evaluation
4	FID	Messung mit externen Standard gegen Kontrollstandard
7	5975 C inert XL MSD	interner Standard
42	FID / FID	Interner Standard
72	FID	externer Standard, 4 und 6 Pkt. Kalibrierung
78	FID	interner Standard
130	FID	externer Standard
175	FID	Interner Standard
201	Glykolether: GC/MS HP 5972; Alkohole + KW: GC/MS HP 5972; Aromaten: GC/MS HP 5975 C	Externer Standard
244	Shimadzu MSD QP2020	externer Standard
263	FID	interner Standard, externe Kalibrierung

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Participant	Recovery rate
4	Wiederfindungsstandards wurden gemessen und mit einer Toleranz von +/- 10 % eingehalten,. Eine Rückrechnung wurde nicht durchgeführt
7	nein
42	Ja
72	ja (0,86 bis 0,95)
78	ja
130	nein
175	nein
201	nein
244	Ja
263	nein

Participant	Date of analysis
4	1.Prüfgas: 15./16.02.2017, 2. Prüfgas: 20./21.02.2017, 3. Prüfgas: 02./03.03.2017
7	21.02. und 24.02.2017
42	10.02.2017
72	09.-14.02.2017
78	- - -
130	16.02. - 03.03.2017
175	21 - 22 Feb 2017
201	Glykolether:26.02.2017; Alkohole + KW: 20.02.2017; Aromaten: 27.02.2017
244	20. - 27.02.2017
263	15.02.2017
