

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

## Proficiency testing scheme

## Volatile organic compounds (VOC) with thermal desorption

**October 2021**



































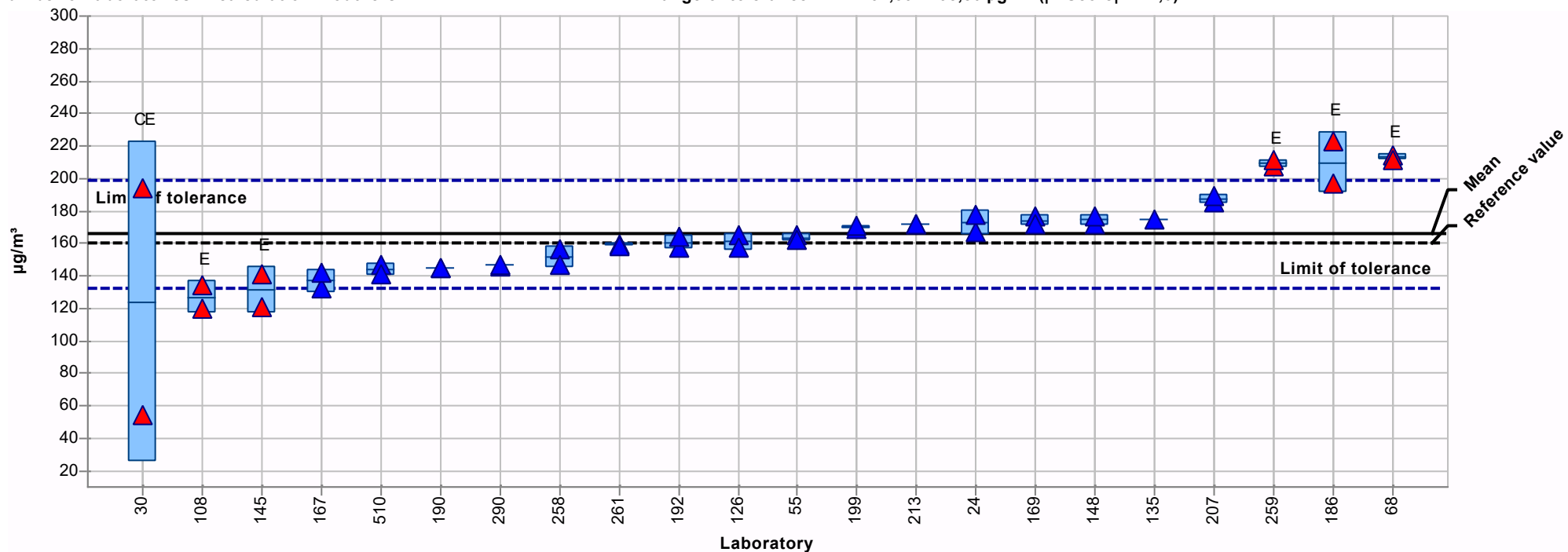






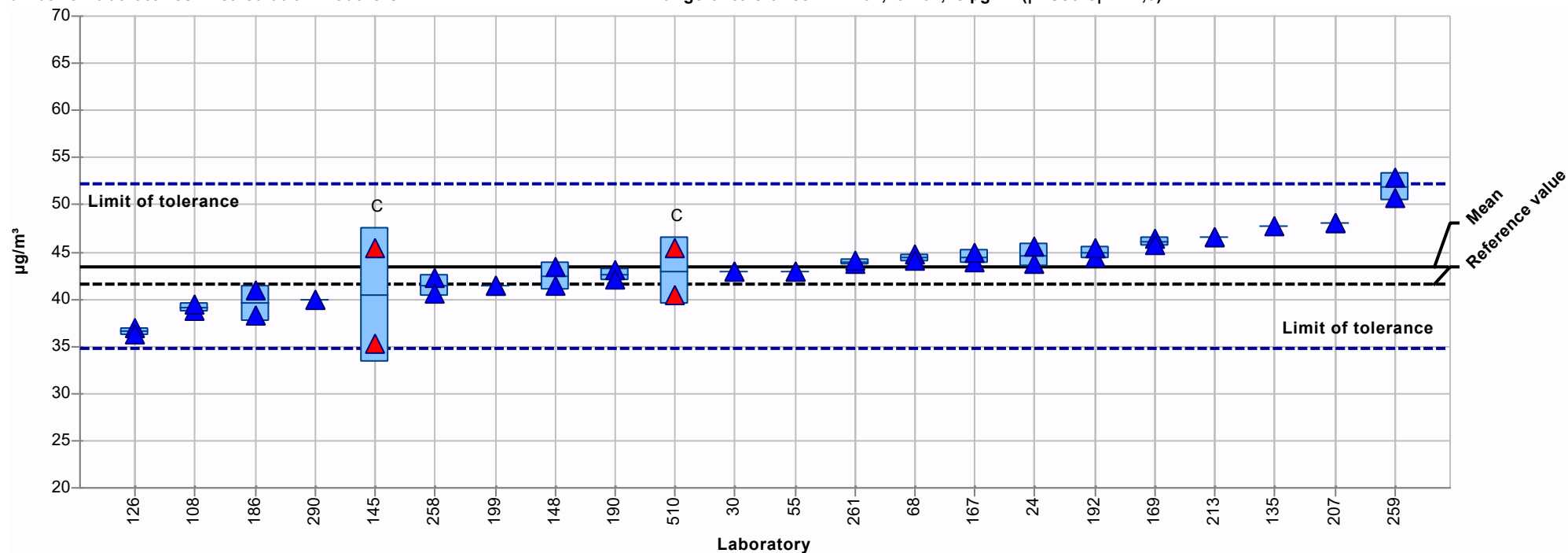
## Summary results

<b>Sample:</b>	2	<b>Mean:</b>	165,66 µg/m³
<b>Measurand:</b>	1-Butanol	<b>Reproducibility s.d.:</b>	25,13 µg/m³
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	15,17%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	160,70 µg/m³
<b>Number of laboratories in calculation + outliers:</b>	22	<b>Range of tolerance:</b>	132,53 - 198,80 µg/m³ ( Z-Score  ≤ 2,0)



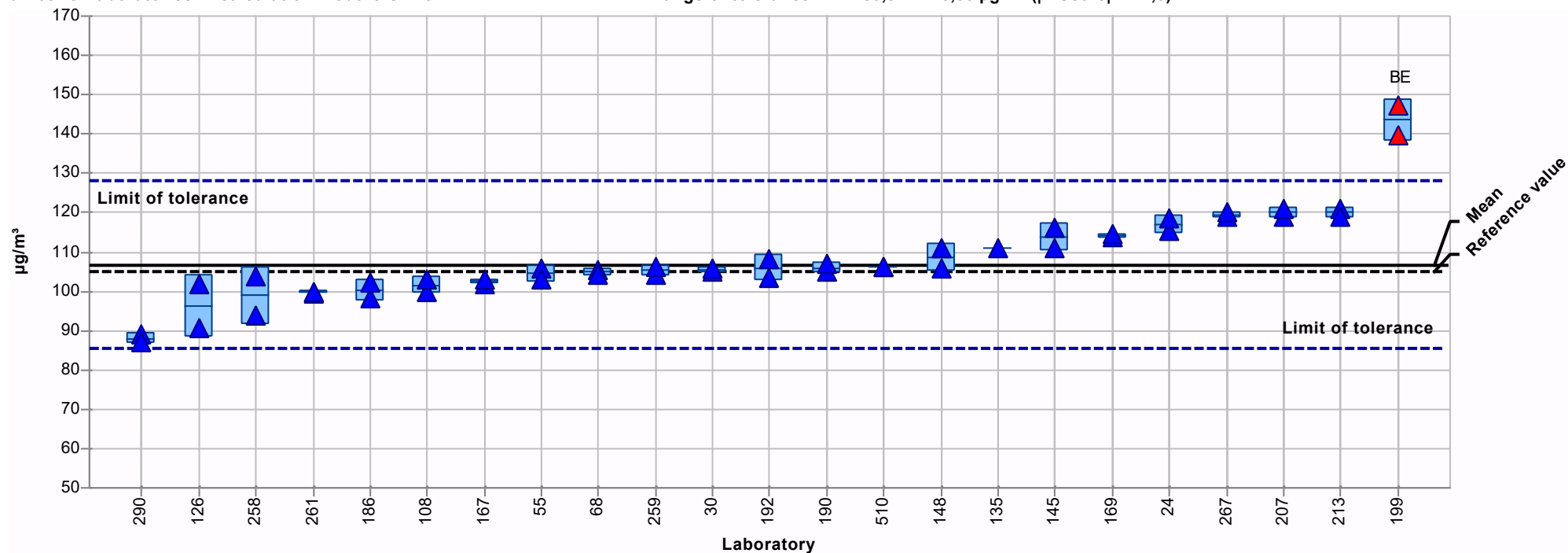
## Summary results

<b>Sample:</b>	2	<b>Mean:</b>	43,49 µg/m³
<b>Measurand:</b>	4-Methyl-2-pentanone	<b>Reproducibility s.d.:</b>	3,55 µg/m³
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	8,17%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	41,60 µg/m³
<b>Number of laboratories in calculation + outliers:</b>	22	<b>Range of tolerance:</b>	34,79 - 52,18 µg/m³ ( Z-Score  ≤ 2,0)



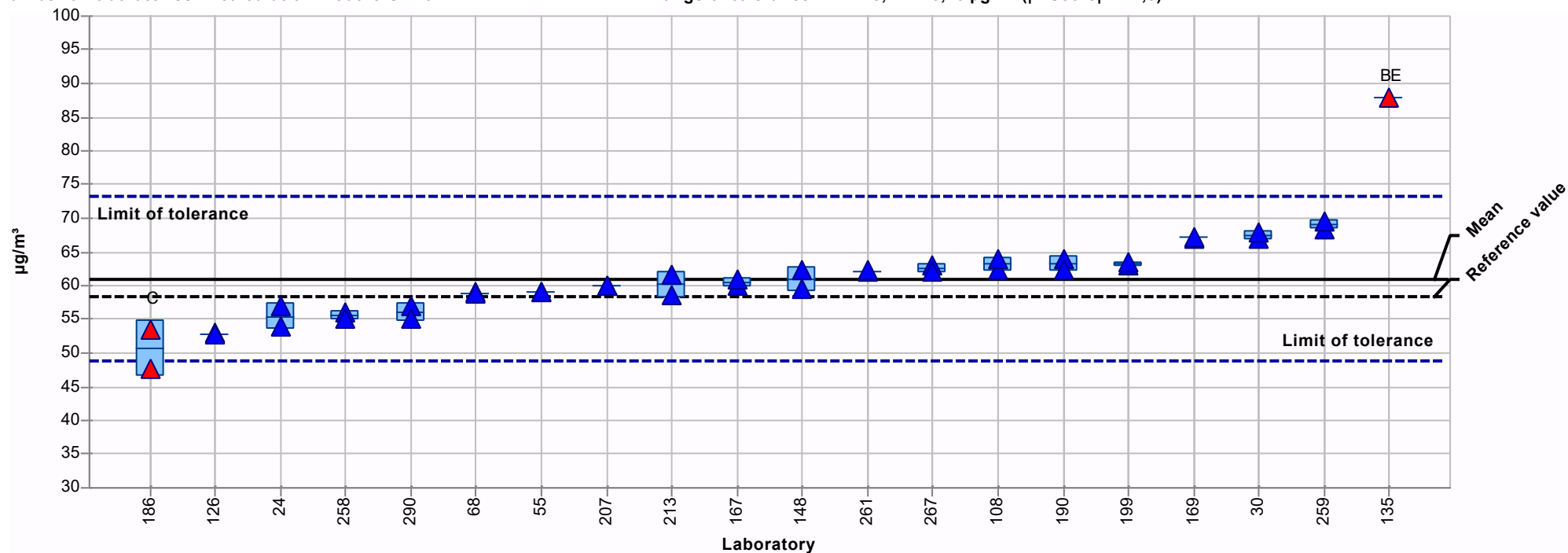
## Summary results

<b>Sample:</b>	2	<b>Mean:</b>	106,67 µg/m³
<b>Measurand:</b>	Benzene	<b>Reproducibility s.d.:</b>	8,53 µg/m³
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	8,00%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	105,20 µg/m³
<b>Number of laboratories in calculation + outliers:</b>	23	<b>Range of tolerance:</b>	85,34 - 128,00 µg/m³ ( Z-Score  ≤ 2,0)



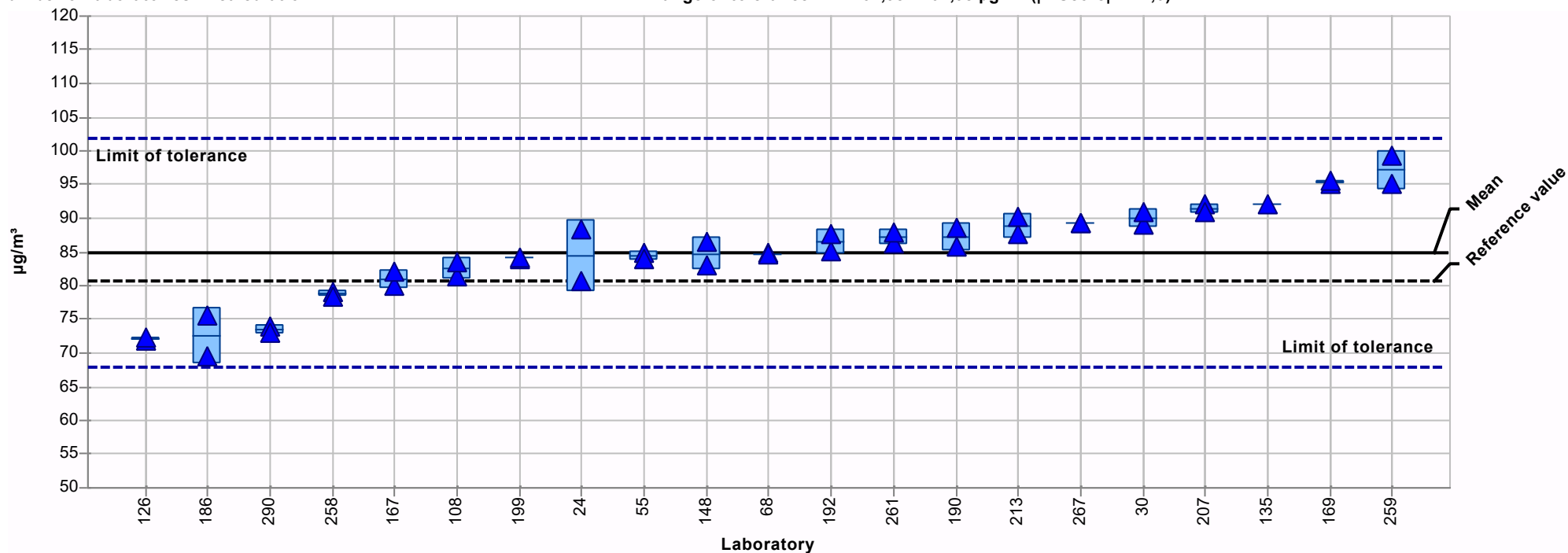
## Summary results

<b>Sample:</b>	2	<b>Mean:</b>	60,96 µg/m³
<b>Measurand:</b>	Cumene	<b>Reproducibility s.d.:</b>	4,42 µg/m³
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	7,25%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	58,30 µg/m³
<b>Number of laboratories in calculation + outliers:</b>	20	<b>Range of tolerance:</b>	48,77 - 73,16 µg/m³ ( Z-Score  <= 2,0)



## Summary results

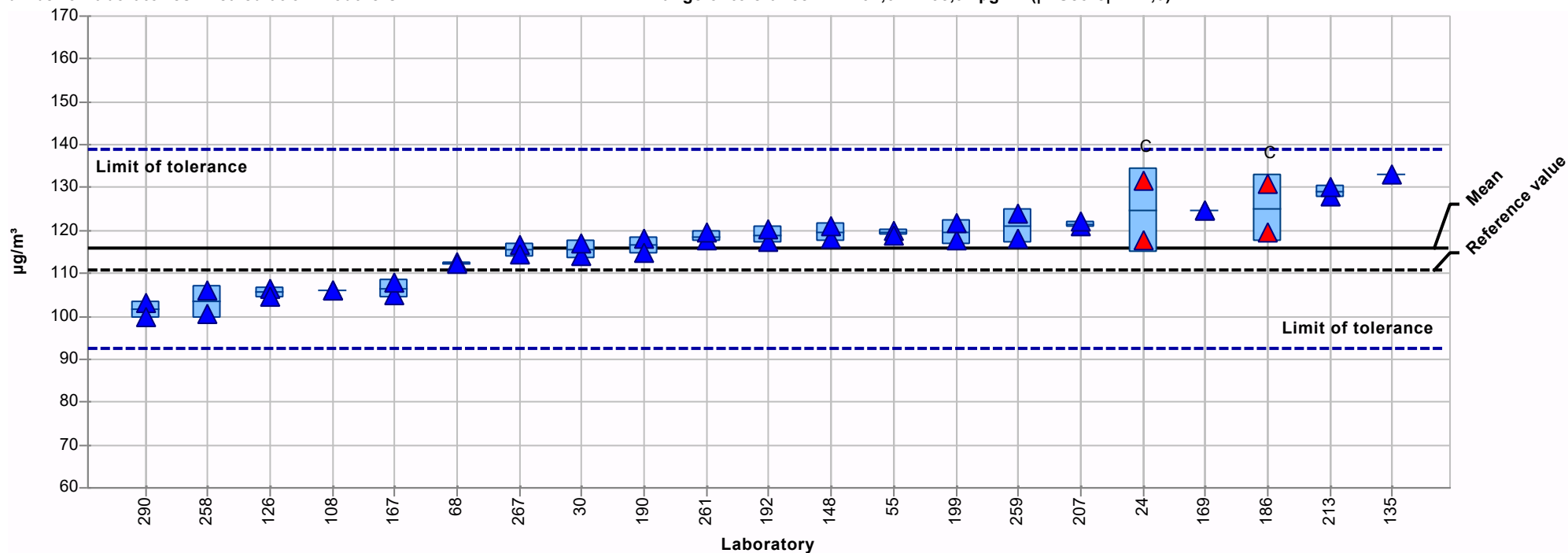
<b>Sample:</b>	2	<b>Mean:</b>	84,98 µg/m <sup>3</sup>
<b>Measurand:</b>	m-Xylene	<b>Reproducibility s.d.:</b>	6,97 µg/m <sup>3</sup>
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	8,20%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	80,80 µg/m <sup>3</sup>
<b>Number of laboratories in calculation:</b>	21	<b>Range of tolerance:</b>	67,98 - 101,98 µg/m <sup>3</sup> ( Z-Score  ≤ 2,0)





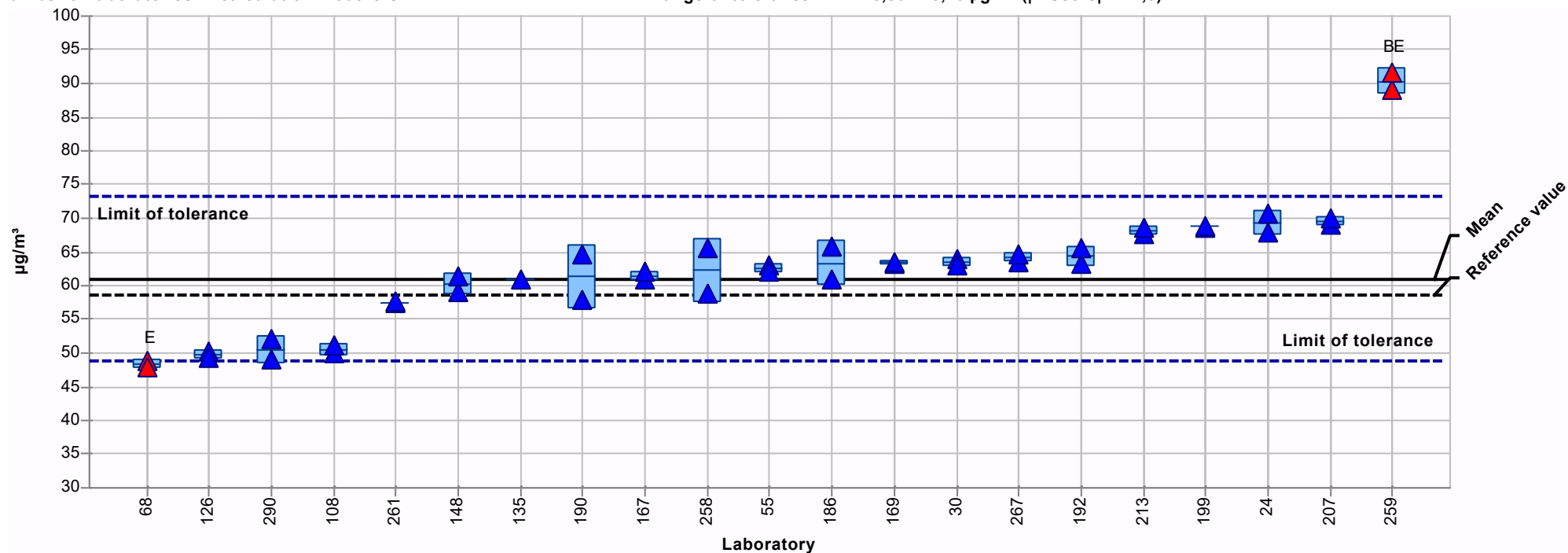
## Summary results

<b>Sample:</b>	2	<b>Mean:</b>	115,76 µg/m³
<b>Measurand:</b>	n-Butyl acetate	<b>Reproducibility s.d.:</b>	8,33 µg/m³
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	7,20%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	110,80 µg/m³
<b>Number of laboratories in calculation + outliers:</b>	21	<b>Range of tolerance:</b>	92,61 - 138,91 µg/m³ ( Z-Score  ≤ 2,0)



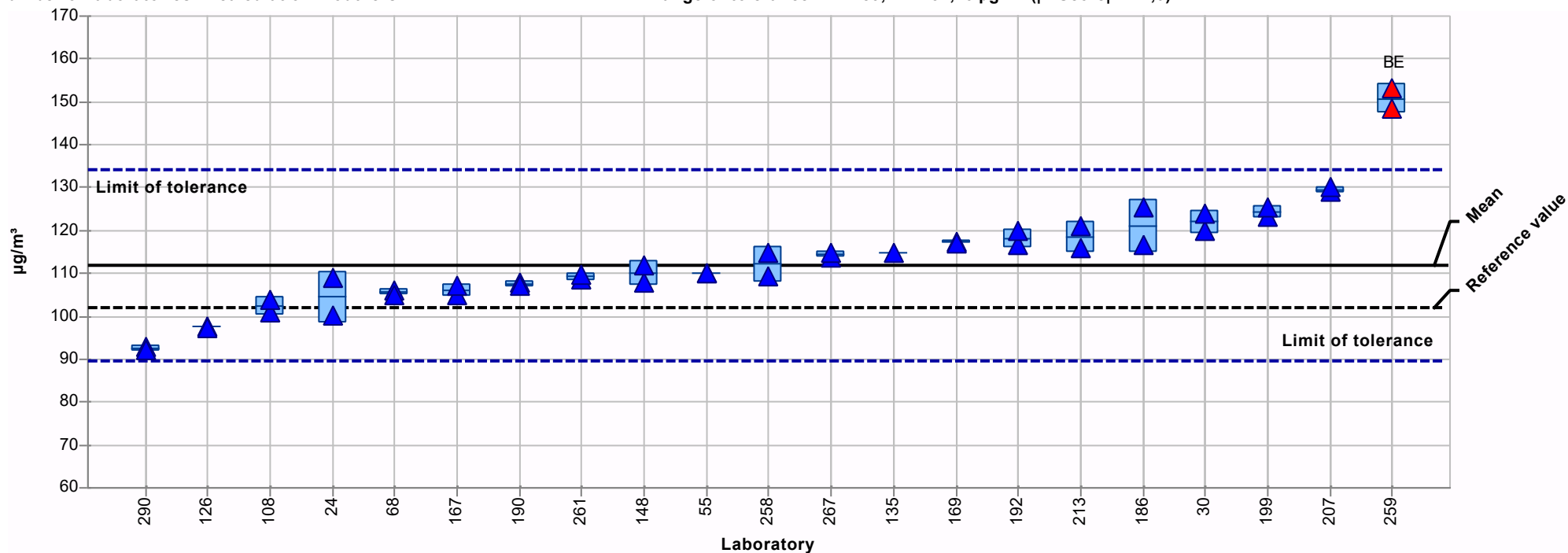
## Summary results

<b>Sample:</b>	2	<b>Mean:</b>	61,00 µg/m³
<b>Measurand:</b>	n-Heptane	<b>Reproducibility s.d.:</b>	6,78 µg/m³
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	11,11%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	58,70 µg/m³
<b>Number of laboratories in calculation + outliers:</b>	21	<b>Range of tolerance:</b>	48,80 - 73,20 µg/m³ ( Z-Score  <= 2,0)



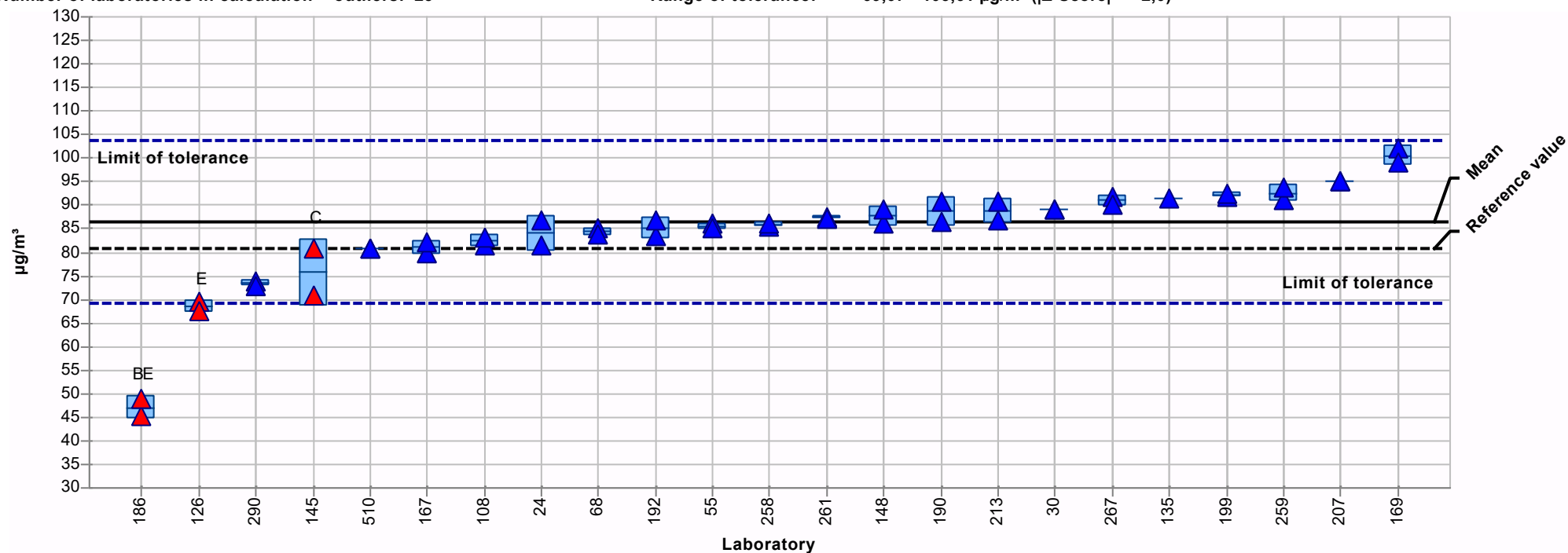
## Summary results

<b>Sample:</b>	2	<b>Mean:</b>	111,80 µg/m³
<b>Measurand:</b>	n-Octane	<b>Reproducibility s.d.:</b>	9,51 µg/m³
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	8,51%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	101,90 µg/m³
<b>Number of laboratories in calculation + outliers:</b>	21	<b>Range of tolerance:</b>	89,44 - 134,16 µg/m³ ( Z-Score  ≤ 2,0)



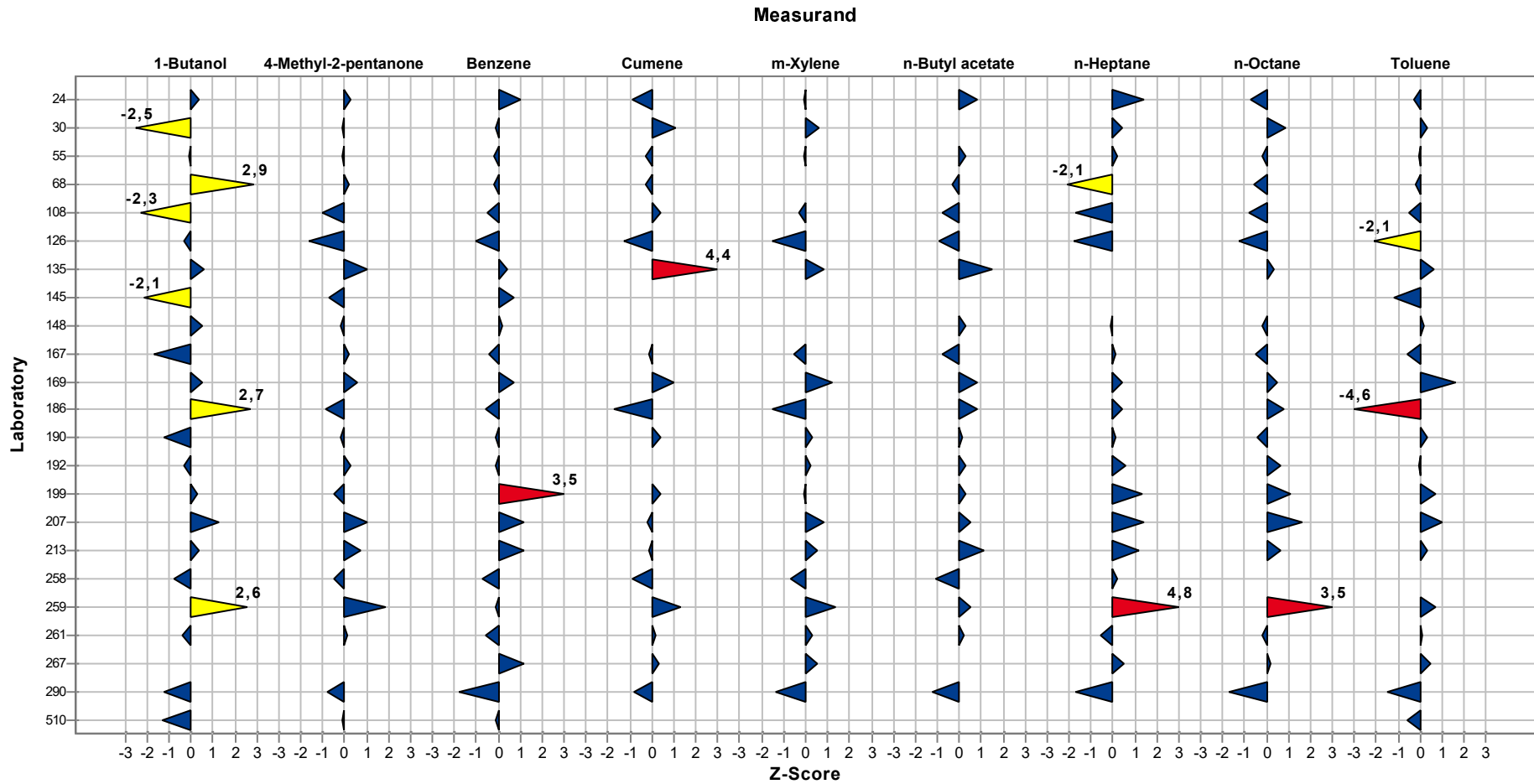
## Summary results

<b>Sample:</b>	2	<b>Mean:</b>	86,34 µg/m³
<b>Measurand:</b>	Toluene	<b>Reproducibility s.d.:</b>	7,16 µg/m³
<b>Method:</b>	ISO 5725-2	<b>Rel. reproducibility s.d.:</b>	8,30%
<b>Rel. target s.d.:</b>	10,00% (Limited)	<b>Reference value:</b>	80,80 µg/m³
<b>Number of laboratories in calculation + outliers:</b>	23	<b>Range of tolerance:</b>	69,07 - 103,61 µg/m³ ( Z-Score  ≤ 2,0)



# Sample chart of Z-Scores

Sample: 2



## Summary of laboratory test results

### Sample Blank Value 1

Laboratory	1-Butanol	4-Methyl-2-pentanone	Benzene	Cumene	m-Xylene	n-Butylacetate	n-Heptane	n-Octane	Toluene
Unit	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>
24	6,69	0,00	4,80	0,47	1,00	0,00	0,00	2,95	2,33
30	4,80	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00
55	5,00	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00
68	< 0,10	< 0,10	1,50	< 0,10	1,10	1,00	< 0,10	0,50	1,00
108					0,80				1,30
135	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	2,30
145	0,00	0,00	0,00						0,00
148	< 1,00	< 1,00	1,00	< 1,00	< 1,00	< 1,00	< 1,00	< 1,00	1,30
167	1,00	0,00	3,00	0,00	1,00	1,00	1,00	1,00	3,00
169	6,30		3,60	3,90	4,40	2,20	3,40		6,50
186	3,80	0,50	5,90	0,10	1,60	1,00	2,60	1,60	1,70
190			1,26	0,05	0,57	0,11	0,30	0,34	1,35
192	0,60	0,11	0,89		1,08	0,28	0,28	0,39	1,57
199	1,10	0,10	0,90	0,10	1,80	0,30	0,30	0,40	1,30
207	1,00		1,00						3,00
213	0,00	0,00	1,90	0,00	0,00	0,00	0,00	0,50	1,50
261	0,00	0,00	0,80	0,80	0,90	0,80	0,00	0,00	1,50
267			< 2,50	< 2,50	< 2,50	< 2,50	< 2,50	< 2,50	< 2,50
290	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
510	0,00	0,00	0,00						0,00
-	-	-	-	-	-	-	-	-	-
No. of laboratories that submitted results	17	15	19	15	17	16	16	15	20

## Summary of laboratory test results

### Sample Blank Value 2

Laboratory	1-Butanol	4-Methyl-2-pentanone	Benzene	Cumene	m-Xylene	n-Butylacetate	n-Heptane	n-Octane	Toluene
Unit	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>
24	9,31	0,00	4,80	0,00	1,74	0,00	2,61	1,97	4,15
30	3,30	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	2,70
55	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00	< 5,00
68	< 0,10	< 0,10	1,60	< 0,10	2,70	0,90	< 0,10	0,90	2,50
108					1,20	0,60	0,60	0,70	2,30
135	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	< 2,00	3,10
145	0,00	0,00	0,00						0,00
148	< 1,00	< 1,00	1,70	< 1,00	1,10	< 1,00	< 1,00	1,10	2,30
167	1,00	0,00	2,00	0,00	1,00	0,00	0,00	0,00	2,00
169	4,90		3,90	5,20	4,40	2,40	3,50		6,70
186	4,60	0,60	7,50	0,40	3,60	2,40	3,70	3,70	2,80
190			1,27	0,11	1,06	0,50	0,80	0,67	2,40
192	0,92	0,16	1,29		1,41	0,71	0,56	0,52	2,39
199	1,50	0,20	2,10	0,20	1,60	0,90	0,80	0,80	2,50
207	4,00		2,00			3,00			4,00
213	14,40	0,00	1,90	0,00	1,10	0,70	1,10	0,70	3,40
261	0,00	0,00	1,80	0,40	1,40	1,10	0,70	0,00	3,20
267			< 2,50	< 2,50	< 2,50	< 2,50	< 2,50	< 2,50	3,40
290	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
510	0,00	0,00	0,00						0,00
-	-	-	-	-	-	-	-	-	-
No. of laboratories that submitted results	17	15	19	15	17	18	17	16	20

## Questions and Answers

Participant	Sample carrier	Analytical method
24	Glas, Tenax TA, Gerstel	DIN ISO 16000-6
30	Tenax TA	ISO 16000-6
55	Tenax TA	EN ISO 16017-1
68	Tenax TA	Auf Basis von EN ISO 16000-5 und ISO 16000-6 wurde eigene Labormethode entwickelt
108	Tenax Markes	DIN ISO 16000-6:2012-11
126	Tenax TA	DIN ISO 16000-6
135	Tenax TA Supelco	DIN ISO 16000-6
145	Gerstel Tenax TA + Carbosieve S3	Hausmethode
148	Tenax TA (Markes)	DIN ISO 16000-6, DIN EN 16516
167	Markes stainless steel material emission tubes. Quartz wool, Tenax TA, Carbograph 5TD	EN 16516
169	TenaxTA, Fa. Gerstel	16000-6
186	Tenax TA	DIN ISO 16000-6
190	Tenax von Supelco	DIN ISO 16000-6
192	TenaxTA	ISO 16000-6
199		in Anlehnung an DIN ISO 16000-6:2012-11
207	Tenax, Markes Röhrchen	DIN ISO 16000-6
213	TDS-Röhrchen, Tenax TA, Gerstel	DIN ISO 16000-6
258	Tenax TA, Markes	ISO 16000-6
259	Tenax	DIN ISO 16000-6
261	Edelstahl Adsorptionsröhrchen gefüllt mit Tenax TA, Firma Camsco	DIN ISO 16000-6
267	Stainless Steel tubes filled with Tenax TA (ref. C1-AXXX-5003, Markes International)	ISO 16000-6
290	Perkin Elmer Tenax TA	ISO 16000-6:2021-08
510	Gerstel Tenax TA + Carbosieve S3	Hausmethode

Participant	Gas chromatograph	Thermal desorber	Desorption temperature	Desorption flow	Desorption time
24	7890B von Agilent	TDS-3 von Gerstel	280°C	82,3 mL/min	10 Min
30	GC 7890 Agilent	TD 650 Perkin Elmer	260	50	30
55	HP6890	Markes TD-100	300°C	30	10



## VOC 2021

Participant	Gas chromatograph	Thermal desorber	Desorption temperature	Desorption flow	Desorption time
68	Agilent 7890B Series GC Custom	TD100-xr (ATD) von Markes	300°C		
108	GC 2010 QP2010	TD-20	240°C	60	7
126	Thermo Trace GC Ultra mit MSD ISQ 7000	Markes TD100XR	260°C	15	5
135	Agilent 7890A	Perkin Elmer TurboMatrix 650	250°C		
145	Agilent 6890N	Gerstel TDS2	260°C	50	21
148	Agilent GC 7890B	Markes TD100	280°C	50	10
167	Agilent 6890N	Markes ATD 100XR	320 °C	40	10
169	GC 6890 Fa. Agilent	TDS2 Fa. Gestel	280°C	100 ml/min	5 Minuten
186	Perkin Elmer Gold	Perkin Elmer Turbomatrix 650	280°C	50 mL/min	20 min
190	Shimadzu GC-MS-QP 2020 NX	PerkinElmer TurboMatrix 650	260 °C	20	15
192	Agilent technologies	Markes International	270degC	30mL/min	10min
199	Agilent 7890B	TD-100 Markes	250 °C	50 mL/min	5 min
207	Agilent 7890	Markes Unity TD 100	300		
213	Agilent GC 7890 / MS5977	Gerstel TDS 3	260°	29,3	5
258	Agilent 7890A	Markes TD100	280°C	20 ml/min	15 min
259	GC-MS Q2010plus , Shimadzu	TD 30 Fa. Shimadzu	250 °C	60 ml/min	5
261	Perkin Elmer Clarus 680	Perkin Elmer ATD 350	270 °C	30	15
267	Agilent 8890	Markes Unity-xr	280°C		
290	Agilent 7890B (G3440B)	Perkin Elmer TurboMatrix 350	280°C	40	20
510	Agilent 7890B	Gerstel TDS3C	260°C	57	21

Participant	Cryo-trap	Carrier gas	Carrier gas flow	Analytical column
24	-150°C und 280°C	Helium	1,3 mL/min	Agilent Ultra 2
30	-30°C / 280°C	He	1	RTX-5 MS
55	10-350°C maximal heating rate	He	1.5	Rxi-5 Sil-MS 60m x 0.25 mm ID x 1 µm fd
68	-20°C / 300°C	Helium	15 ml/min	Vocol von Supelco
108	Kühlfalle: -10°C, Heiztemperatur: 250°C	Helium	1,0 ml/min	rtx5 60m/1µm/0,25mm
126	-20°C / 280°C	Helium	1	TG-624SiIMS, 60 m, 0,25 mm (ID), 1,4 µm Filmstärke
135		Helium	28	RTX-200
145	-150°C	Helium	2	

## VOC 2021

Participant	Cryo-trap	Carrier gas	Carrier gas flow	Analytical column
148	-25 /315	Helium	0,5	Restek Rxi-5Sil MS, 20m x 0,18mm id x 0,36µm df
167	5 to 320 oC	Helium	1,5	Agilent DB-5MS UI
169	-100°C	Helium	1 ml/min	
186	30°C to 280°C at 45°C/sec	Helium	2 mL/min	HP-5MS
190	-20 °C und 280 °C	Helium	1,6	DB-VRX 60m lang
192	Cryo trap at 5degC and desorb at 280degC	helium	1.3mL/min	InertCap 1 (60ml length, 0.25mm daim., 1.5um film)
199	25-300 °C	Helium	0,7 mL/min	DB-5.625MS
207	-25	Helium	1,2	DB 5
213	-150°C / 280°C	He	1,3	HP Ultra 2
258	-30°C, 300°C	Helium	1.3 ml/min	HP-ULTRA 2, 50m x 0.32mm, 0.52µm (Agilent 19091B-115)
259	-15 °C, 250 °C	Helium	1,18	VF-624ms, Fa. Agilent
261	-8 °C / 275 °C	Helium	1	Perkin Elmer Elite-VMS
267	-5°C - 300°C	Helium	1.77 mL/min	HP™ Innowax 60 m x 0.32 mm x 0.5 µm, Agilent™ Technologies (réf : 19091N-216)
290	-30°C bis 280°C	Helium	44 ml/min	HP Ultra 2 (50m x 0,32mm 0,52µm)
510	-150°C	Helium	2	

Participant	Detector
24	MSD 5977B von Agilent
30	FID for all substances (MS for benzene)
55	Agilent MS
68	7000D Quadrupol MS/MS von Agilent
108	QP2010 Quadrupol
126	Thermo MSD ISQ 7000
135	MSD
145	FID / MSD
148	Agilent 5977B MSD
167	Agilent 5975
169	Massenspektrometer
186	MS
190	MS

## VOC 2021

Participant	Detector
192	MSD
199	Massendetektor (5977A MSD)
207	MS Agilent 5975
213	MSD
258	Agilent HP5975C
259	MS
261	Massenspektrometer Perkin Elmer Clarus SQ8
267	Mass spectrometer (scan mode for acquisition)
290	Agilent MSD 5977B G7077BA
510	FID / MSD

Participant	Data evaluation
24	Quantifizierung: 4-Punkt-Kalibrierung mit externen Standards, Identifikation: Massenspektrum und Retentionsindex
30	External
55	7 point calibration curve with external standards
108	NIST Ms, Retentionszeit
145	Quantifizierung: FID, Qualifizierung MSD
148	Identifizierung und Quantifizierung mittels GC-MSD und Toluol d8 als Interner Standard
167	Quantification from standard mixture, 10-600 ng/ $\mu$ L with toluene d8 as internal standard. Identification using Masshunter Qualitative Analysis with NIST spectral library. Quantification using Masshunter Quantitative Analysis.
186	Internal calibration
190	Die Verbindungen wurden anhand der entsprechenden Standardverbindungen mit Sech-Punkt-Kalibrierung quantifiziert und identifiziert.
192	Absolute calibration curve
199	Standards externe Kalibrierung, Korrektur über interne Standards
207	EIC Originalreferenzen, eigene und kommerzielle Bibliotheken
213	Einzelsubstanz, Massenspektrum / Retentionszeit
258	External standards and NIST library
259	externe Kalibrierung
261	Quantifiziert nach charakteristischer Ionenspur mit internem Standard und 6-Punkt Kalibrierung, Identifikation erfolgt nach Spektrum
267	Acquisition in scan mode, quantification with one m/z quantifier and confirmation of identification with specific ratios of the qualifiers (if a doubt, mass spectrum is compared with available databases)
290	Qualitative Auswertung über das Total-Ionen-Chromatogramm mit dem ChemStation Integrator und das NIST-Bibliothek / Quantitative Auswertung über den entsprechenden Substanz-Kalibration

## VOC 2021

---

Participant	Data evaluation
510	Quantifizierung: FID Qualifizierung: MSD

---

Participant	Recovery rates	Date of analysis
24	nein	15.11. und 16.11. und 17.11.
30	No	19/10 and 19/11/2021
55		25/10/2021
68	Nein	08./09.11.2021
108	Nein	30.10.2021
126	Nein	04.11.2021
135	ja	02.11.2021
145	nein	21.10.2021
148	Nein	15.10.2021
167	Yes	29.Oct.2021
169	nein	15.10.2021
186	No	10/11/2021
190	nein	22.10. - 23.10.2021
192	No	2,3 Nov 2021
199	nein	27.10.2021
207	nein	19.10.2021
213	nein	12.11.2021
258	No	October 25, 2021
259	nein	15.10.2021
261	Nein	25.11.2021
267	No	03/11/2021
290	Nein	22.10.2021
510	nein	21.10.2021