

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

Test-Proficiency testing scheme

Higher molecular weight polycyclic aromatic hydrocarbons (PAH) on filters

February 2024

Summary of laboratory means

Sample L 1

Laboratory	5-Methylchrysene	Z score	Anthanthrene	Z score	Benzo[a]pyrene	Z score	Coronene	Z score	Dibenz[a,h]anthracene	Z score
Unit	µg abs./Filter		µg abs./Filter		µg abs./Filter		µg abs./Filter		µg abs./Filter	
1	0.0457	1.52					0.0473	2.75 CE	0.0327	-1.34 C
13	0.0327	-1.76	0.0327	-0.92	0.0400	-0.19	0.0350	-0.57	0.0367	-0.28
33	0.0365	-0.78	0.0346	-0.40	0.0423	0.38	0.0374	0.08	0.0381	0.10
52					0.0452	1.10			0.0409	0.83
130					0.0288	-2.94 CE			0.0301	-2.02 CE
150	0.0471	1.89	0.0398	1.05	0.0446	0.94	0.0324	-1.28	0.0365	-0.33
200	0.0370	-0.68 C	0.0328	-0.89	0.0399	-0.21	0.0374	0.06	0.0380	0.08
203	0.0360	-0.92	0.0197	-4.54 FE	0.0380	-0.68	0.0400	0.77	0.0330	-1.25
231	0.0376	-0.52	0.0560	5.56 FE	0.0436	0.69	0.0406	0.93	0.0412	0.92
238					0.0380	-0.69			0.0386	0.22 C
248					0.0353	-1.33			0.0347	-0.81
266					0.0384	-0.57			0.0437	1.59
267					0.0398	-0.24			0.0339	-1.01
519	0.0419	0.58	0.0402	1.16	0.0440	0.80	0.0415	1.18 C	0.0383	0.16
-	-	--	-	--	-	--	-	--	-	--
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	8		7		13		8		14	
Mean	0.0396		0.0360		0.0408		0.0371		0.0377	
Reprod. s.d.	0.0054		0.0039		0.0033		0.0031		0.0034	
Rel. reproducibility s.d.	13.7 %		10.8 %		8.1 %		8.5 %		8.9 %	
Reference value	0.0392		0.0394		0.0441		0.0393		0.0406	
Target s.d.	0.0040		0.0036		0.0041		0.0037		0.0038	
Rel. target s.d.	10.0 %		10.0 %		10.0 %		10.0 %		10.0 %	
Lower limit of tolerance	0.0317		0.0288		0.0326		0.0297		0.0302	
Upper limit of tolerance	0.0476		0.0432		0.0489		0.0446		0.0453	
Type C outliers	1				1		2		3	
No. of measurement values outside of tolerance limits	1		6		1		2		2	
Type F outliers			2							
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only	7		5		12		6		11	

Higher molecular weight polycyclic aromatic hydrocarbons (PAH) 2024

Sample L 1

Laboratory	5-Methylchrysene Z score	Anthanthrene Z score	Benzo[a]pyrene Z score	Coronene Z score	Dibenz[a,h]anthracene Z score
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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: $|Z\text{-Score}| > 3.50$

Higher molecular weight polycyclic aromatic hydrocarbons (PAH) 2024

Sample L 1

Laboratory	Dibenzo[a,l]pyrene	Z score	Indeno[1,2,3-cd]pyrene	Z score	Dibenzo[a,h]pyrene	Z score	Dibenzo[a,i]pyrene	Z score	Dibenzo[a,e]pyrene	Z score
Unit	µg abs./Filter		µg abs./Filter		µg abs./Filter		µg abs./Filter		µg abs./Filter	
13	0.0337	-0.63	0.0363	-0.76	0.0327	-1.26	0.0320	-1.21	0.0367	-0.76
33	0.0317	-1.18	0.0408	0.38	0.0322	-1.37	0.0363	-0.02	0.0409	0.32
52			0.0417	0.61						
130			0.0324	-1.75 C						
150	0.0340	-0.53	0.0383	-0.25	0.0441	1.81	0.0385	0.59	0.0390	-0.17
200	0.0378	0.53 C	0.0386	-0.19	0.0398	0.66	0.0336	-0.76	0.0385	-0.29 C
203	0.0377	0.48	0.0393	0.00	0.0147	-6.08 FE	0.0357	-0.20	0.0400	0.08
231	0.0349	-0.28	0.0403	0.26	0.0372	-0.05 C	0.0403	1.06	0.0384	-0.31
238			0.0393	-0.02						
248			0.0373	-0.51						
266	0.0422	1.73	0.0431	0.96						
267			0.0369	-0.61						
519	0.0374	0.41	0.0398	0.13	0.0380	0.17	0.0384	0.54	0.0430	0.83
-	-	--	-	--	-	--	-	--	-	--
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	8		13		7		7		7	
Mean	0.0359		0.0393		0.0374		0.0364		0.0397	
Reprod. s.d.	0.0035		0.0022		0.0051		0.0031		0.0025	
Rel. reproducibility s.d.	9.8 %		5.7 %		13.6 %		8.5 %		6.3 %	
Reference value	0.0371		0.0394		0.0364		0.0382		0.0390	
Target s.d.	0.0036		0.0039		0.0037		0.0036		0.0040	
Rel. target s.d.	10.0 %		10.0 %		10.0 %		10.0 %		10.0 %	
Lower limit of tolerance	0.0287		0.0315		0.0299		0.0291		0.0317	
Upper limit of tolerance	0.0431		0.0472		0.0449		0.0437		0.0476	
Type C outliers	1		1		1				1	
No. of measurement values outside of tolerance limits	1		1		3					
Type F outliers					1					
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	7		12		5		7		6	

Summary of laboratory means

Sample L 2

Laboratory	5-Methylchrysene	Z score	Anthanthrene	Z score	Benzo[a]pyrene	Z score	Coronene	Z score	Dibenz[a,h]anthracene	Z score
Unit	µg abs./Filter		µg abs./Filter		µg abs./Filter		µg abs./Filter		µg abs./Filter	
1	0.0900	1.28					0.0863	1.10		
13	0.0677	-1.52	0.0647	-0.99	0.0827	0.10	0.0703	-0.96	0.0750	-0.23
33	0.0731	-0.83	0.0695	-0.32	0.0851	0.40	0.0828	0.64	0.0771	0.05
52					0.0876	0.70			0.0744	-0.30
130					0.0919	1.24 C			0.0864	1.25 C
150	0.0917	1.50	0.0731	0.19	0.0872	0.66	0.0639	-1.78	0.0772	0.06
200	0.0778	-0.25	0.0663	-0.77	0.0813	-0.07	0.0755	-0.29	0.0770	0.03
203	0.0727	-0.89	0.0353	-5.08 FE	0.0747	-0.87	0.0783	0.07	0.0657	-1.44
231	0.0771	-0.33	0.1093	5.24 FE	0.0910	1.13	0.0849	0.91	0.0894	1.64
238					0.0742	-0.93			0.0724	-0.56 C
248					0.0720	-1.20			0.0697	-0.92
266					0.0746	-0.88			0.0886	1.54
267					0.0828	0.13			0.0702	-0.86
519	0.0880	1.04	0.0853	1.89	0.0887	0.84	0.0802	0.31	0.0800	0.43
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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	
No. of laboratories that submitted results	8		7		13		8		13	
Mean	0.0798		0.0718		0.0818		0.0778		0.0767	
Reprod. s.d.	0.0096		0.0084		0.0067		0.0083		0.0074	
Rel. reproducibility s.d.	12.0 %		11.7 %		8.2 %		10.7 %		9.6 %	
Reference value	0.0785		0.0784		0.0880		0.0793		0.0814	
Target s.d.	0.0080		0.0072		0.0082		0.0078		0.0077	
Rel. target s.d.	10.0 %		10.0 %		10.0 %		10.0 %		10.0 %	
Lower limit of tolerance	0.0638		0.0574		0.0655		0.0622		0.0614	
Upper limit of tolerance	0.0957		0.0861		0.0982		0.0934		0.0921	
Type B outliers										
Type C outliers					1		2			
No. of measurement values outside of tolerance limits	1		7		1		1			
Type F outliers	2									

Higher molecular weight polycyclic aromatic hydrocarbons (PAH) 2024

Sample L 2

Laboratory	5-Methylchrysene Z score	Anthanthrene Z score	Benzo[a]pyrene Z score	Coronene Z score	Dibenz[a,h]anthracene Z score
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	8	5	12	8	11
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} > 3.50$					

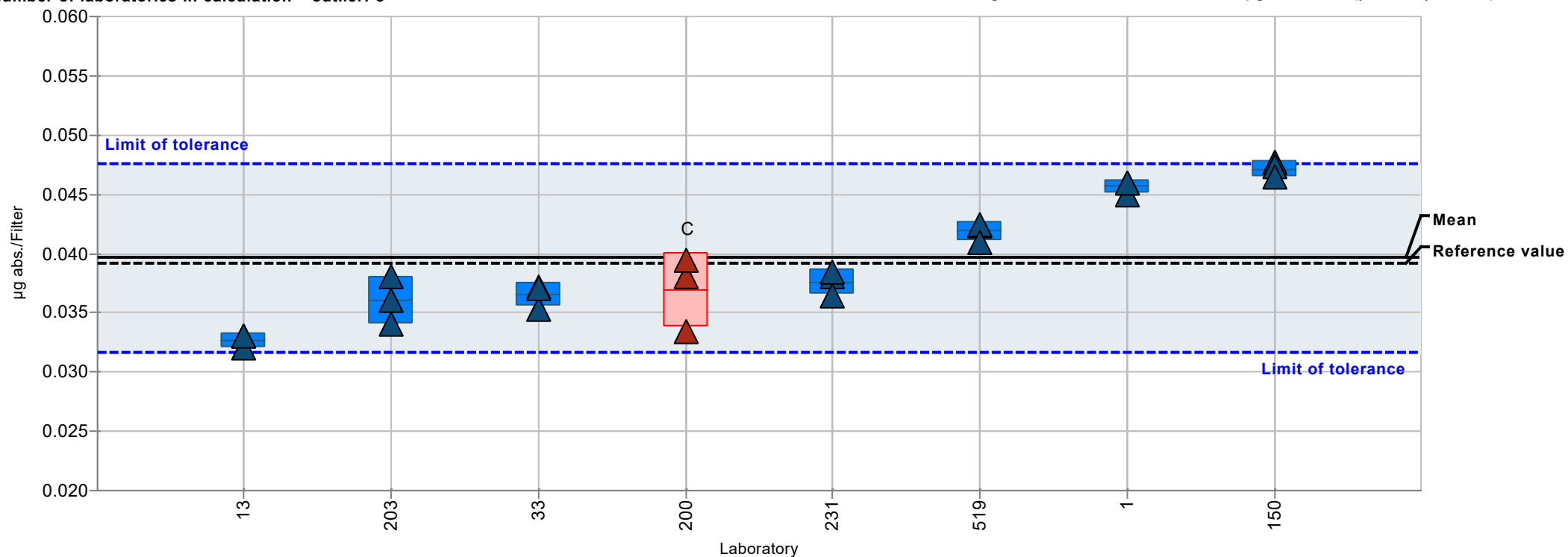
Higher molecular weight polycyclic aromatic hydrocarbons (PAH) 2024

Sample L 2

Laboratory	Dibenzo[a,l]pyrene	Z score	Indeno[1,2,3-cd]pyrene	Z score	Dibenzo[a,h]pyrene	Z score	Dibenzo[a,i]pyrene	Z score	Dibenzo[a,e]pyrene	Z score
Unit	µg abs./Filter		µg abs./Filter		µg abs./Filter		µg abs./Filter		µg abs./Filter	
1									0.0653	-1.74
13	0.0677	-0.75	0.0757	-0.35	0.0750	-0.49	0.0677	-0.88	0.0757	-0.43
33	0.0749	0.23 C	0.0811	0.34	0.0695	-1.19	0.0765	0.30	0.0848	0.72
52			0.0747	-0.47						
130			0.0885	1.29 C						
150	0.0686	-0.63	0.0740	-0.56	0.0863	0.94	0.0739	-0.05	0.0749	-0.54
200	0.0805	1.00	0.0793	0.12	0.0849	0.77	0.0681	-0.83	0.0815	0.30
203	0.0733	0.02	0.0787	0.04	0.0260	-6.74 BE	0.0697	-0.61	0.0790	-0.01
231	0.0733	0.01	0.0872	1.13	0.0792	0.05	0.0837	1.27	0.0851	0.76
238			0.0698	-1.10						
248			0.0790	0.08						
266	0.0737	0.07 C	0.0862	1.00						
267			0.0741	-0.54						
519	0.0758	0.36	0.0809	0.32	0.0781	-0.09	0.0801	0.80	0.0866	0.95
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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	
No. of laboratories that submitted results	8		13		7		7		8	
Mean	0.0732		0.0784		0.0788		0.0742		0.0791	
Reprod. s.d.	0.0049		0.0054		0.0066		0.0065		0.0075	
Rel. reproducibility s.d.	6.6 %		6.9 %		8.4 %		8.8 %		9.5 %	
Reference value	0.0754		0.0795		0.0718		0.0780		0.0785	
Target s.d.	0.0073		0.0078		0.0079		0.0074		0.0079	
Rel. target s.d.	10.0 %		10.0 %		10.0 %		10.0 %		10.0 %	
Lower limit of tolerance	0.0585		0.0627		0.0631		0.0594		0.0633	
Upper limit of tolerance	0.0878		0.0941		0.0946		0.0891		0.0949	
Type B outliers					1					
Type C outliers	2		1							
No. of measurement values outside of tolerance limits					3				1	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	6		12		6		7		8	

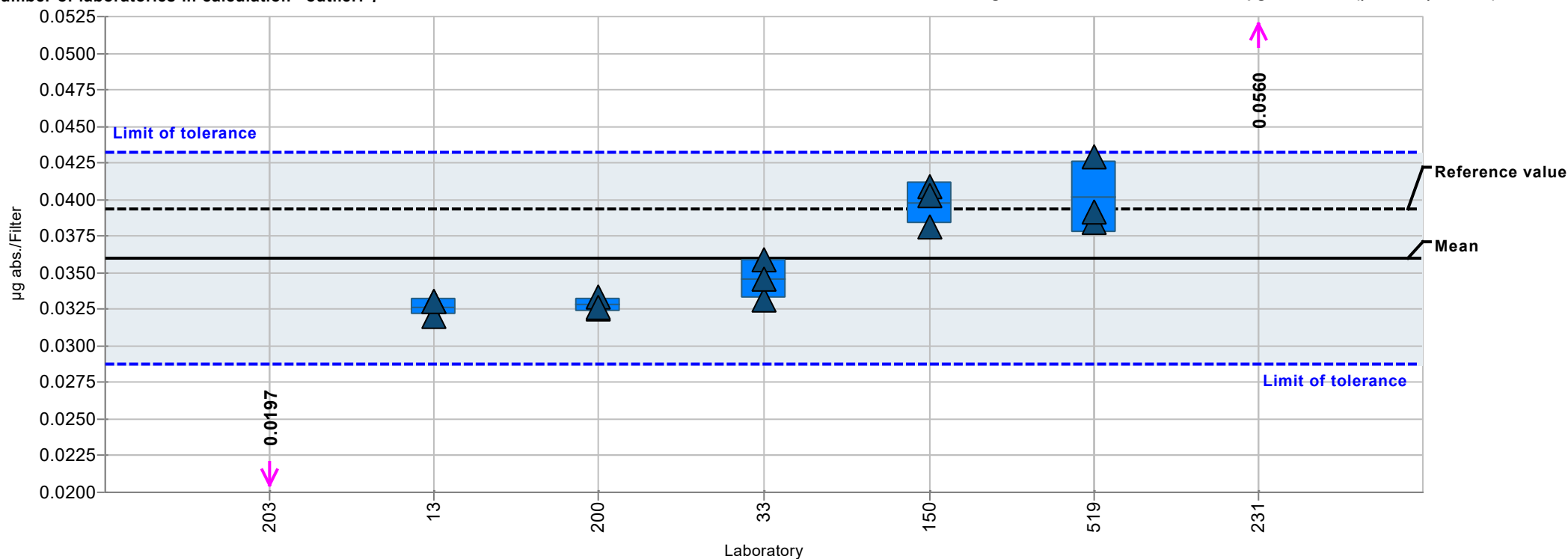
Summary results

Sample:	L 1	Mean:	0.0396 µg abs./Filter
Measurand:	5-Methylchrysene	Reprod. s.d.:	0.0054 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	13.7%
Rel.target s.d.:	10.0%	Reference value:	0.0392 µg abs./Filter
Number of laboratories in calculation + outlier: 8		Range of tolerance: 0.0317 - 0.0476 µg abs./Filter (Z-Score <= 2.00)	



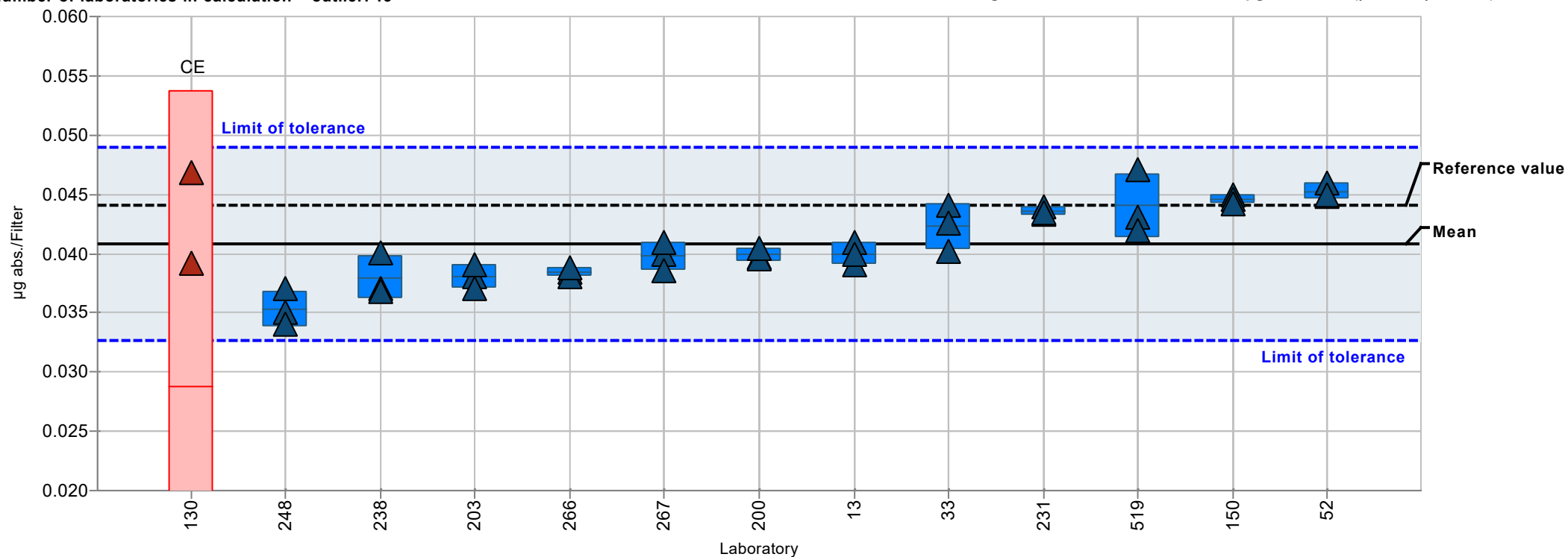
Summary results

Sample:	L 1	Mean:	0.0360 µg abs./Filter
Measurand:	Anthanthrene	Reprod. s.d.:	0.0039 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	10.8%
Rel.target s.d.:	10.0%	Reference value:	0.0394 µg abs./Filter
Number of laboratories in calculation+ outlier: 7		Range of tolerance: 0.0288 - 0.0432 µg abs./Filter (Z-Score <= 2.00)	



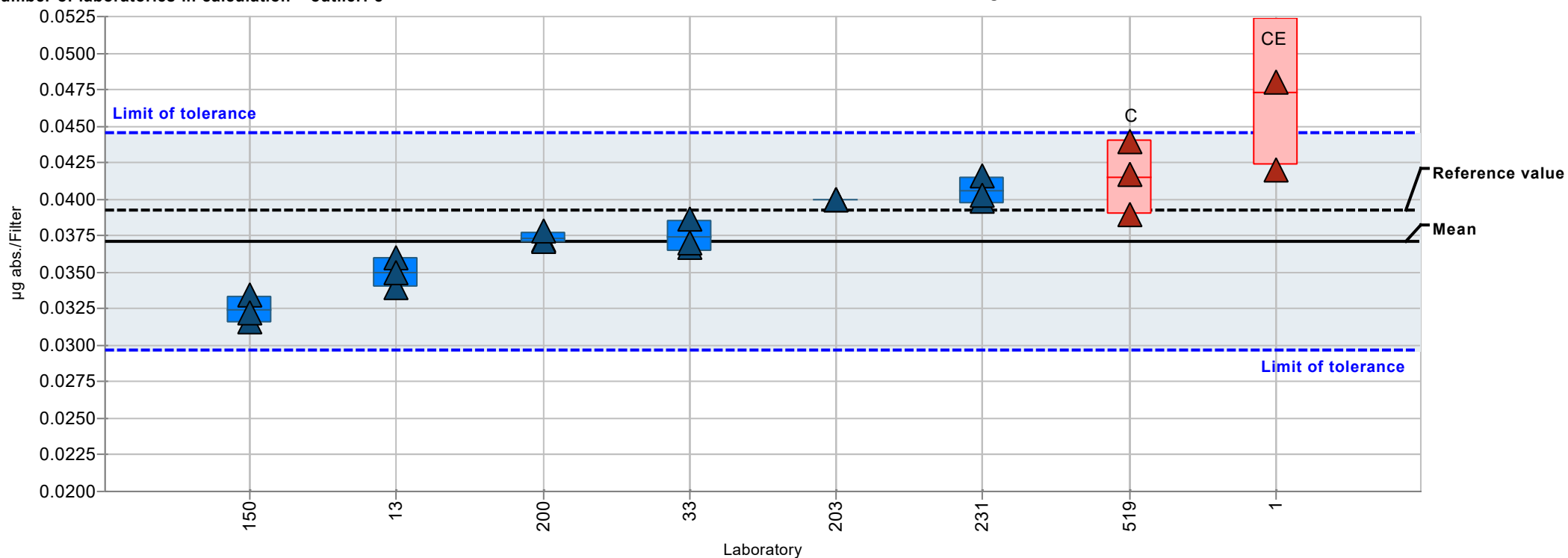
Summary results

Sample:	L 1	Mean:	0.0408 µg abs./Filter
Measurand:	Benzo[a]pyrene	Reprod. s.d.:	0.0033 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	8.1%
Rel.target s.d.:	10.0%	Reference value:	0.0441 µg abs./Filter
Number of laboratories in calculation + outlier: 13		Range of tolerance:	0.0326 - 0.0489 µg abs./Filter (Z-Score ≤ 2.00)



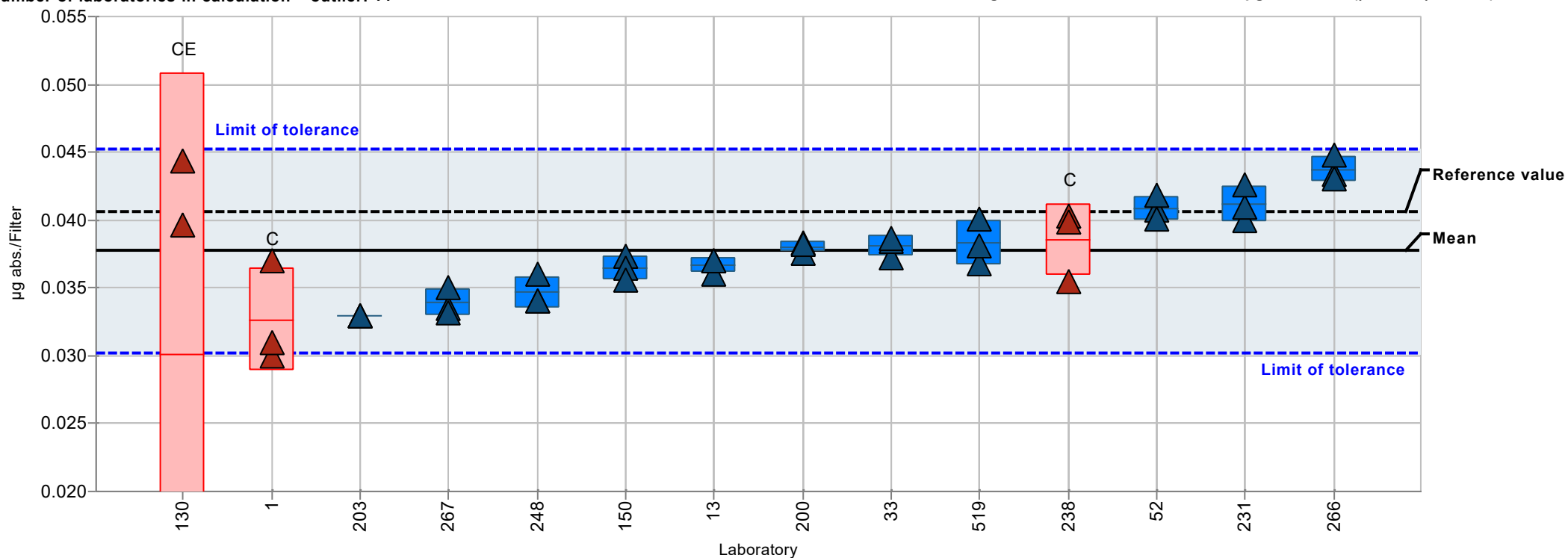
Summary results

Sample:	L 1	Mean:	0.0371 µg abs./Filter
Measurand:	Coronene	Reprod. s.d.:	0.0031 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	8.5%
Rel.target s.d.:	10.0%	Reference value:	0.0393 µg abs./Filter
Number of laboratories in calculation + outlier: 8		Range of tolerance:	0.0297 - 0.0446 µg abs./Filter (Z-Score <= 2.00)



Summary results

Sample:	L 1	Mean:	0.0377 µg abs./Filter
Measurand:	Dibenz[a,h]anthracene	Reprod. s.d.:	0.0034 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	8.9%
Rel.target s.d.:	10.0%	Reference value:	0.0406 µg abs./Filter
Number of laboratories in calculation + outlier: 14		Range of tolerance:	0.0302 - 0.0453 µg abs./Filter (Z-Score ≤ 2.00)



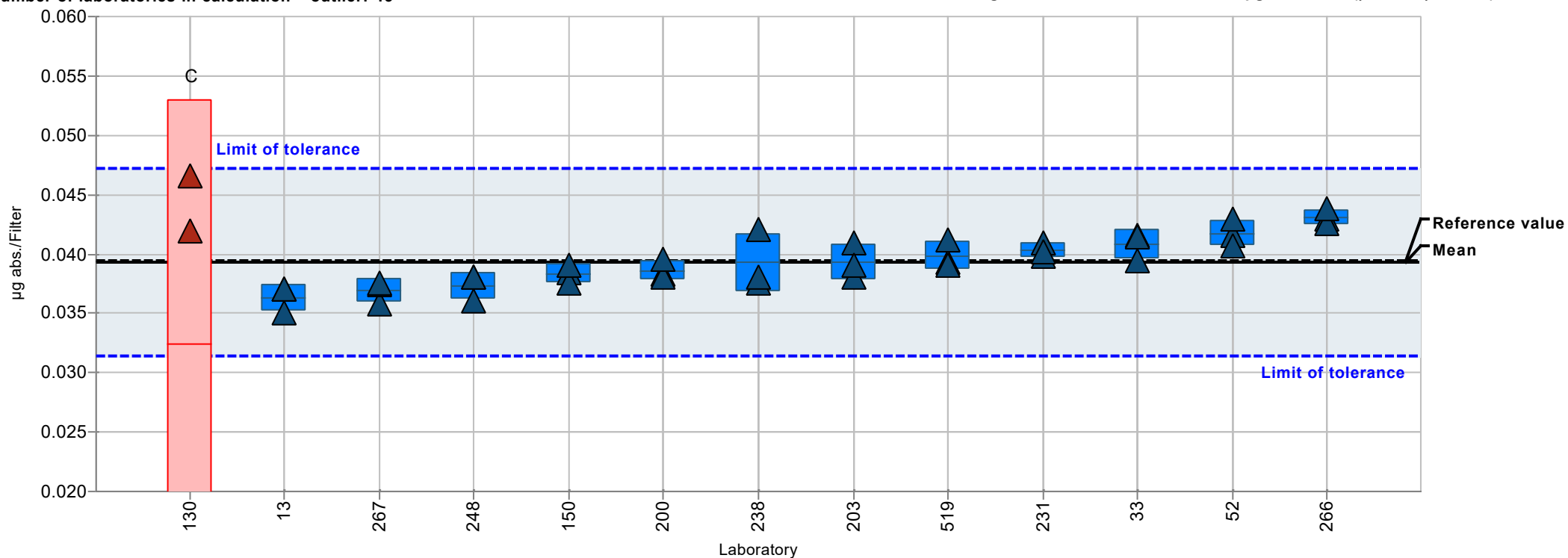
Summary results

Sample:	L 1	Mean:	0.0359 µg abs./Filter
Measurand:	Dibenzo[a,l]pyrene	Reprod. s.d.:	0.0035 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	9.8%
Rel.target s.d.:	10.0%	Reference value:	0.0371 µg abs./Filter
Number of laboratories in calculation + outlier: 8		Range of tolerance:	0.0287 - 0.0431 µg abs./Filter (Z-Score <= 2.00)



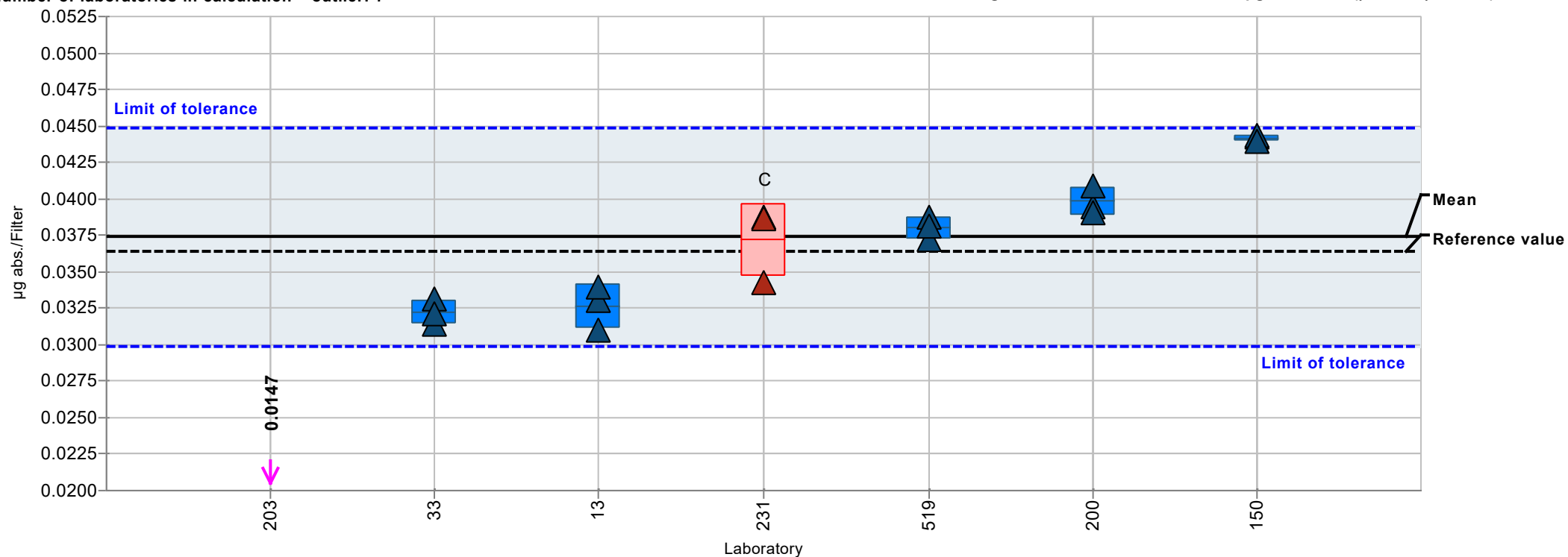
Summary results

Sample:	L 1	Mean:	0.0393 µg abs./Filter
Measurand:	Indeno[1,2,3-cd]pyrene	Reprod. s.d.:	0.0022 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	5.7%
Rel.target s.d.:	10.0%	Reference value:	0.0394 µg abs./Filter
Number of laboratories in calculation + outlier: 13		Range of tolerance: 0.0315 - 0.0472 µg abs./Filter (Z-Score <= 2.00)	



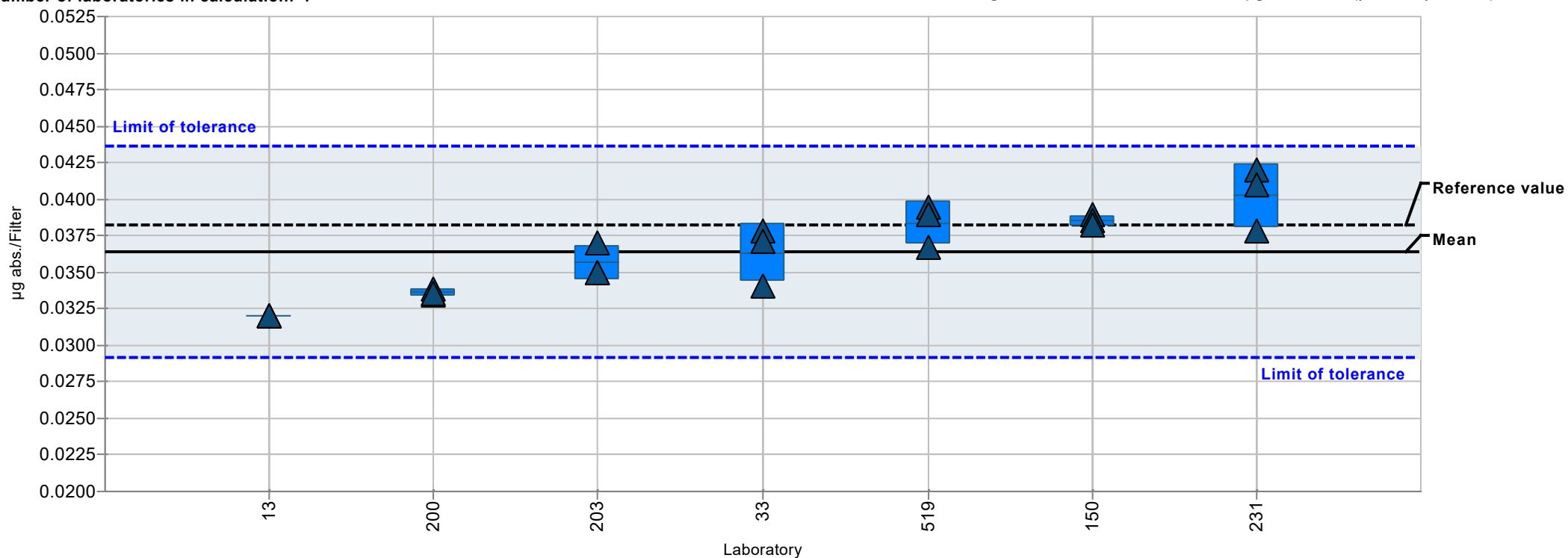
Summary results

Sample:	L 1	Mean:	0.0374 µg abs./Filter
Measurand:	Dibenzo[a,h]pyrene	Reprod. s.d.:	0.0051 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	13.6%
Rel.target s.d.:	10.0%	Reference value:	0.0364 µg abs./Filter
Number of laboratories in calculation + outlier: 7		Range of tolerance: 0.0299 - 0.0449 µg abs./Filter (Z-Score <= 2.00)	



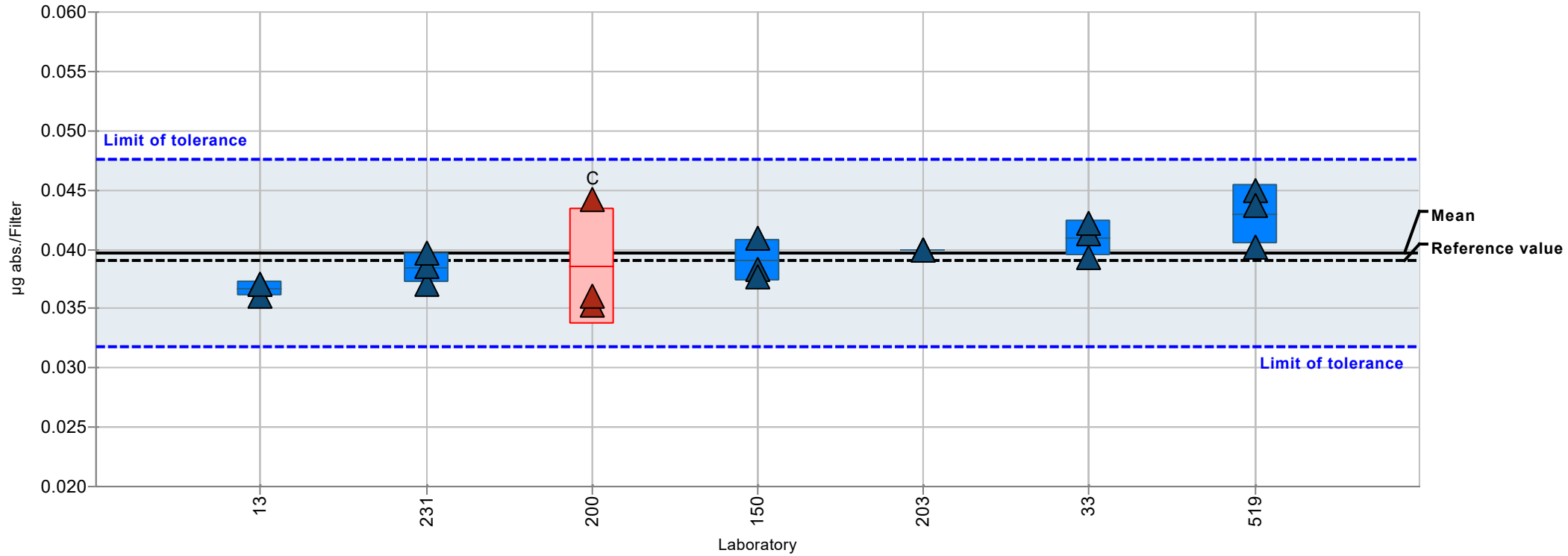
Summary results

Sample:	L 1	Mean:	0.0364 µg abs./Filter
Measurand:	Dibenzo[a,i]pyrene	Reprod. s.d.:	0.0031 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	8.5%
Rel.target s.d.:	10.0%	Reference value:	0.0382 µg abs./Filter
Number of laboratories in calculation:	7	Range of tolerance:	0.0291 - 0.0437 µg abs./Filter (Z-Score ≤ 2.00)



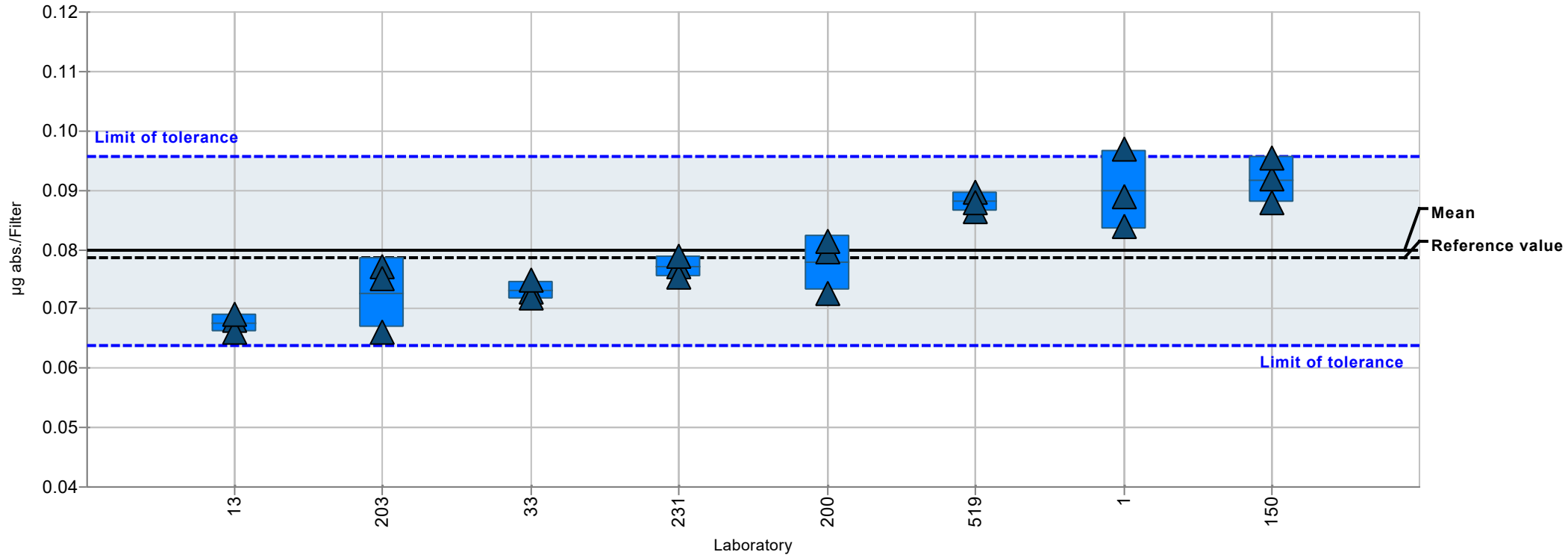
Summary results

Sample:	L 1	Mean:	0.0397 µg abs./Filter
Measurand:	Dibenzo[a,e]pyrene	Reprod. s.d.:	0.0025 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	6.3%
Rel.target s.d.:	10.0%	Reference value:	0.0390 µg abs./Filter
Number of laboratories in calculation + outlier:	7	Range of tolerance:	0.0317 - 0.0476 µg abs./Filter (Z-Score <= 2.00)



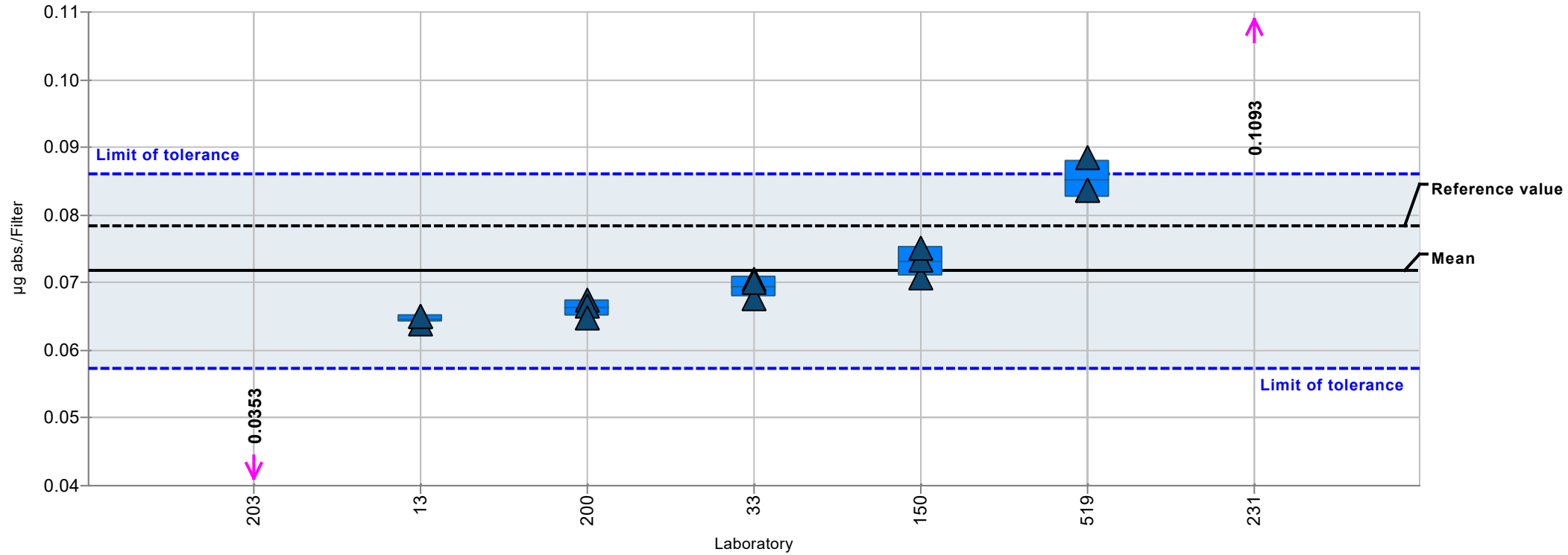
Summary results

Sample:	L 2	Mean:	0.0798 µg abs./Filter
Measurand:	5-Methylchrysene	Reprod. s.d.:	0.0096 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	12.0%
Rel.target s.d.:	10.0%	Reference value:	0.0785 µg abs./Filter
Number of laboratories in calculation:	8	Range of tolerance:	0.0638 - 0.0957 µg abs./Filter (Z-Score <= 2.00)



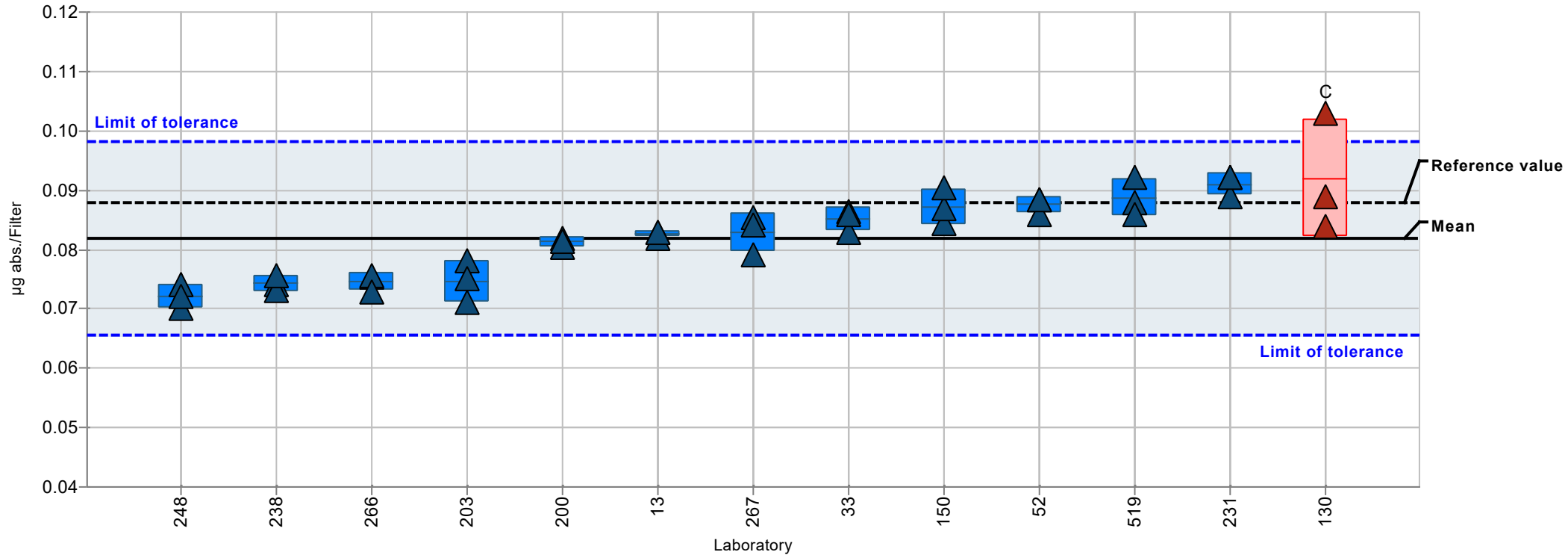
Summary results

Sample:	L 2	Mean:	0.0718 µg abs./Filter
Measurand:	Anthanthrene	Reprod. s.d.:	0.0084 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	11.7%
Rel.target s.d.:	10.0%	Reference value:	0.0784 µg abs./Filter
Number of laboratories in calculation + outlier: 7		Range of tolerance: 0.0574 - 0.0861 µg abs./Filter (Z-Score <= 2.00)	



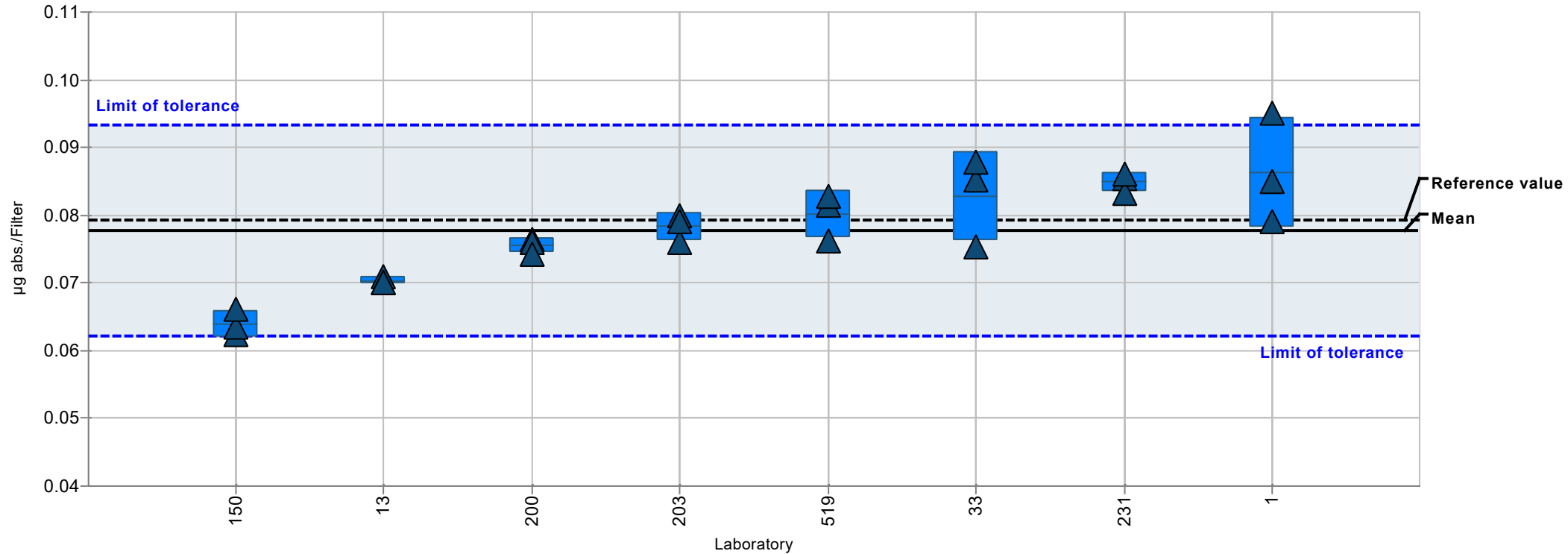
Summary results

Sample:	L 2	Mean:	0.0818 µg abs./Filter
Measurand:	Benzo[a]pyrene	Reprod. s.d.:	0.0067 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	8.2%
Rel.target s.d.:	10.0%	Reference value:	0.0880 µg abs./Filter
Number of laboratories in calculation + outlier:	13	Range of tolerance:	0.0655 - 0.0982 µg abs./Filter (Z-Score ≤ 2.00)



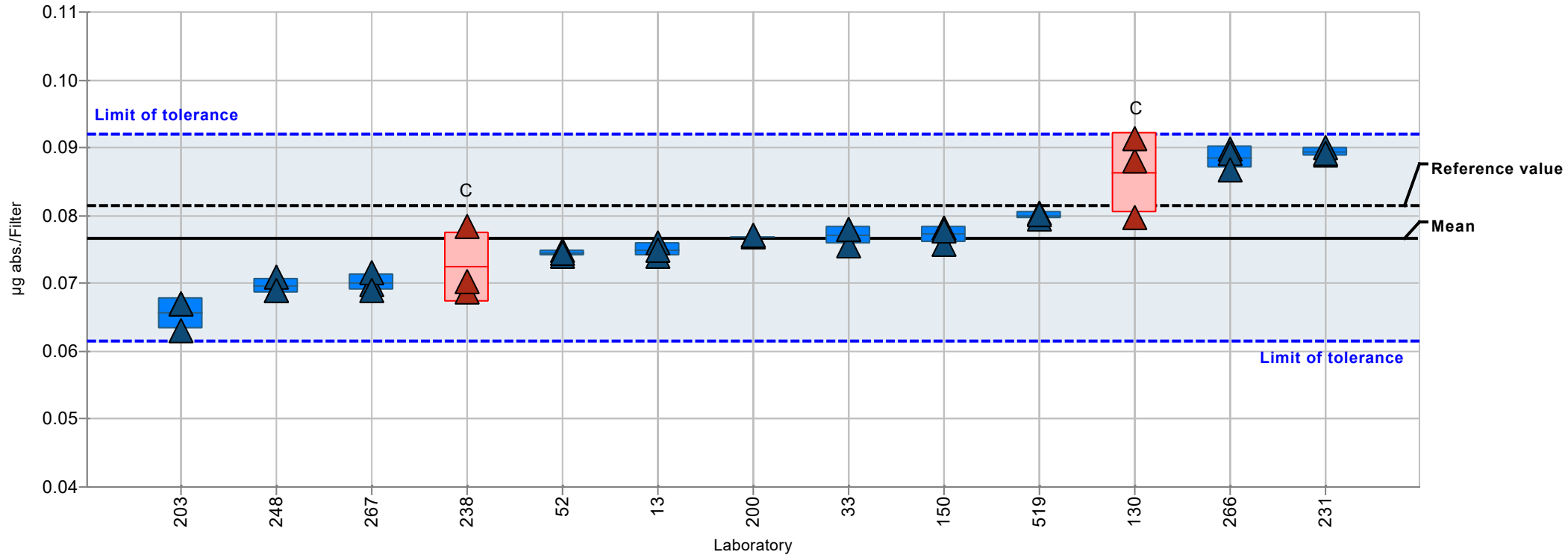
Summary results

Sample:	L 2	Mean:	0.0778 µg abs./Filter
Measurand:	Coronene	Reprod. s.d.:	0.0083 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	10.7%
Rel.target s.d.:	10.0%	Reference value:	0.0793 µg abs./Filter
Number of laboratories in calculation:	8	Range of tolerance:	0.0622 - 0.0934 µg abs./Filter (Z-Score <= 2.00)



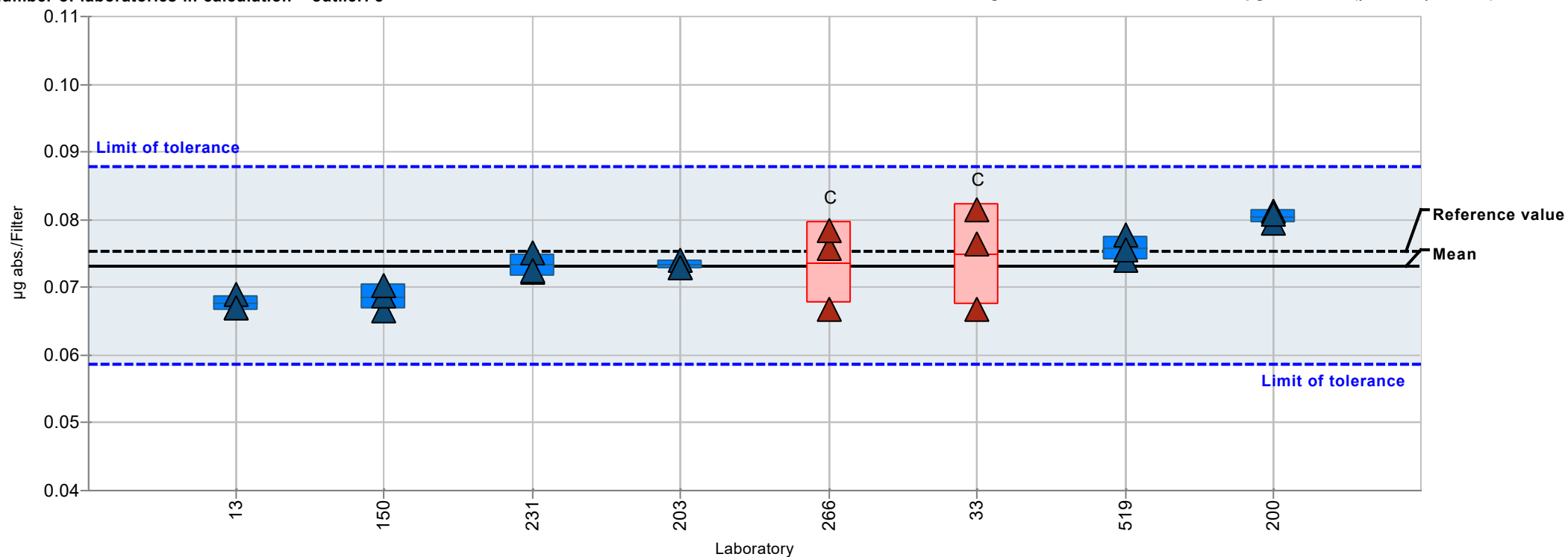
Summary results

Sample:	L 2	Mean:	0.0767 µg abs./Filter
Measurand:	Dibenz[a,h]anthracene	Reprod. s.d.:	0.0074 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	9.6%
Rel.target s.d.:	10.0%	Reference value:	0.0814 µg abs./Filter
Number of laboratories in calculation + outlier: 13		Range of tolerance:	0.0614 - 0.0921 µg abs./Filter (Z-Score <= 2.00)



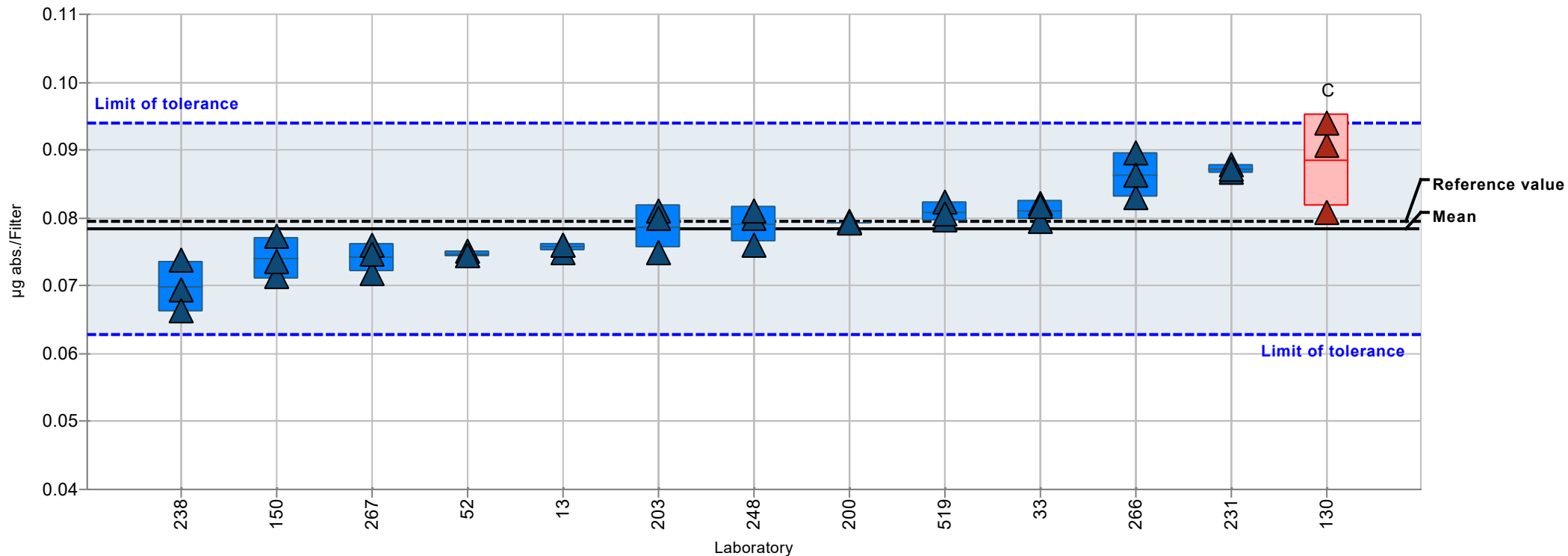
Summary results

Sample:	L 2	Mean:	0.0732 µg abs./Filter
Measurand:	Dibenzo[a,l]pyrene	Reprod. s.d.:	0.0049 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	6.6%
Rel.target s.d.:	10.0%	Reference value:	0.0754 µg abs./Filter
Number of laboratories in calculation + outlier: 8		Range of tolerance:	0.0585 - 0.0878 µg abs./Filter (Z-Score <= 2.00)



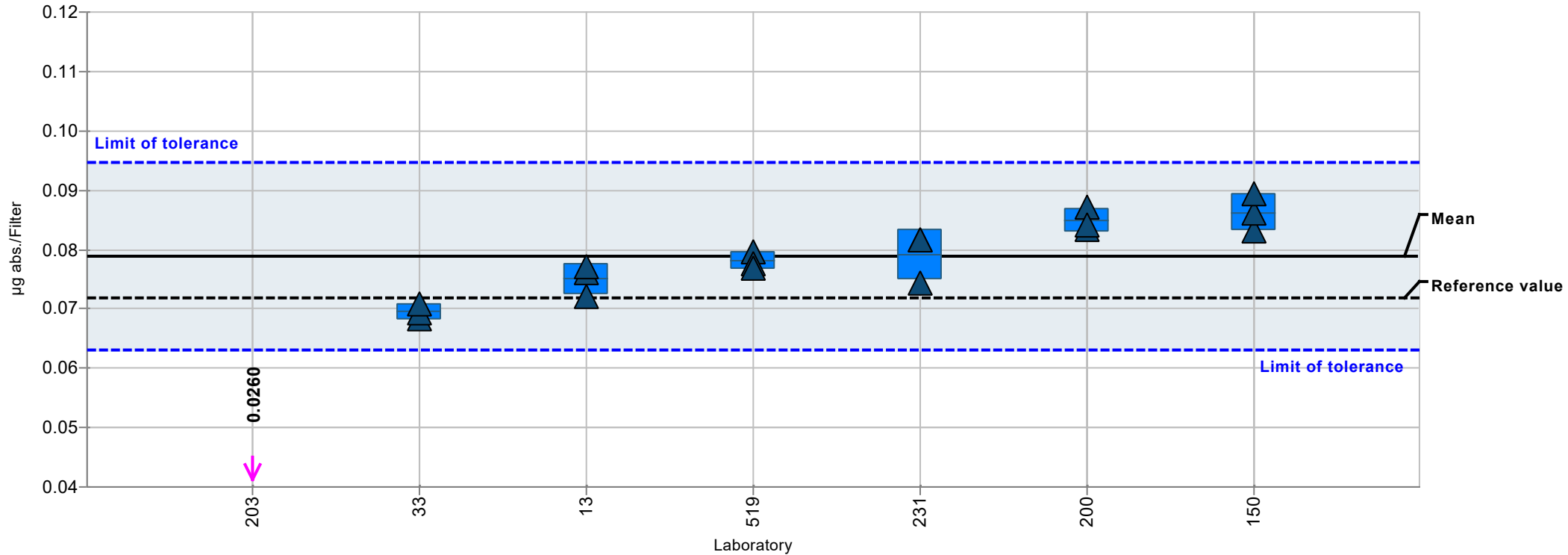
Summary results

Sample:	L 2	Mean:	0.0784 µg abs./Filter
Measurand:	Indeno[1,2,3-cd]pyrene	Reprod. s.d.:	0.0054 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	6.9%
Rel.target s.d.:	10.0%	Reference value:	0.0795 µg abs./Filter
Number of laboratories in calculation + outlier: 13		Range of tolerance:	0.0627 - 0.0941 µg abs./Filter (Z-Score ≤ 2.00)



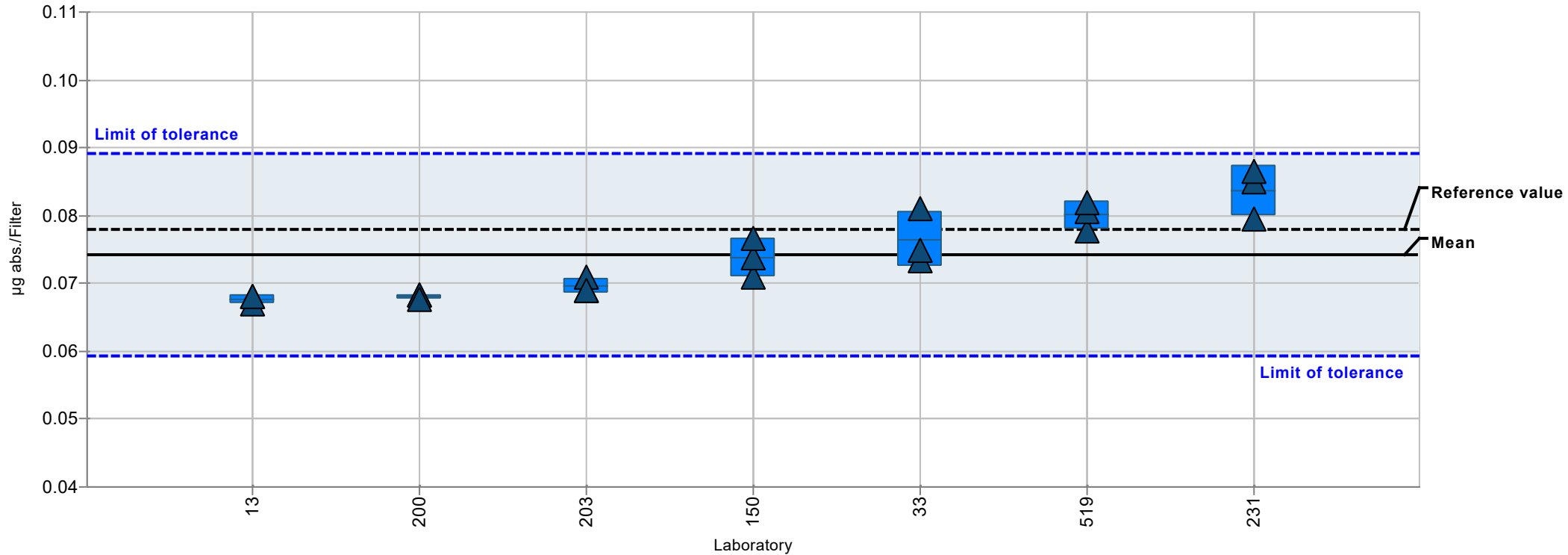
Summary results

Sample:	L 2	Mean:	0.0788 µg abs./Filter
Measurand:	Dibenzo[a,h]pyrene	Reprod. s.d.:	0.0066 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	8.4%
Rel.target s.d.:	10.0%	Reference value:	0.0718 µg abs./Filter
Number of laboratories in calculation + outlier: 7		Range of tolerance: 0.0631 - 0.0946 µg abs./Filter (Z-Score <= 2.00)	



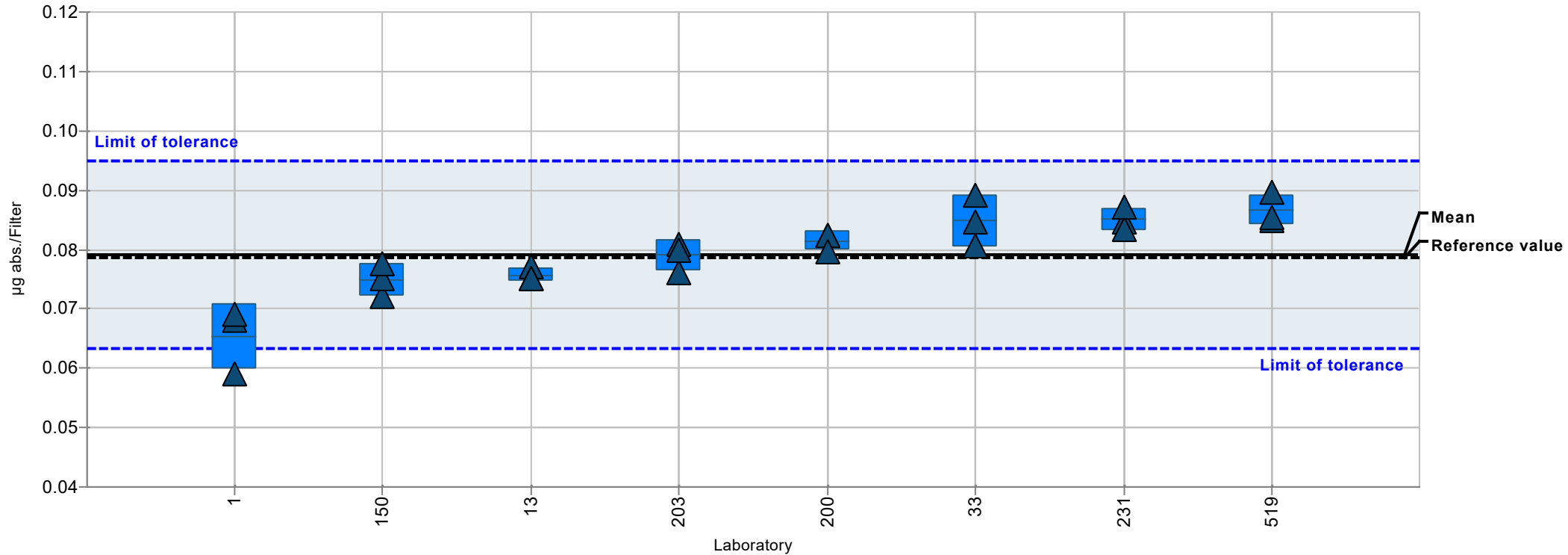
Summary results

Sample:	L 2	Mean:	0.0742 µg abs./Filter
Measurand:	Dibenzo[a,i]pyrene	Reprod. s.d.:	0.0065 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	8.8%
Rel.target s.d.:	10.0%	Reference value:	0.0780 µg abs./Filter
Number of laboratories in calculation: 7		Range of tolerance:	0.0594 - 0.0891 µg abs./Filter (Z-Score ≤ 2.00)



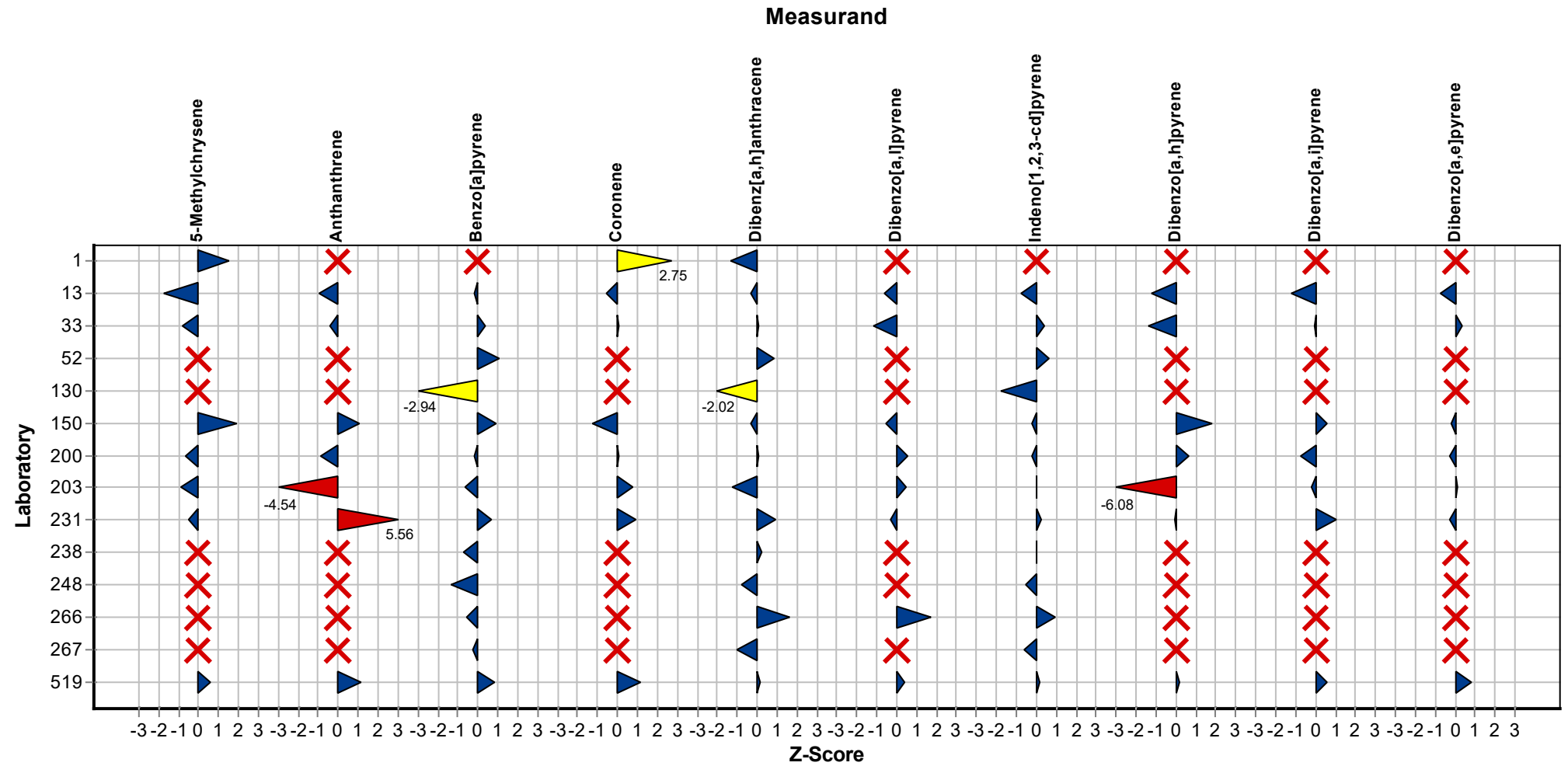
Summary results

Sample:	L 2	Mean:	0.0791 µg abs./Filter
Measurand:	Dibenzo[a,e]pyrene	Reprod. s.d.:	0.0075 µg abs./Filter
Method:	ISO 5725-2	Rel.reprod. s.d.:	9.5%
Rel.target s.d.:	10.0%	Reference value:	0.0785 µg abs./Filter
Number of laboratories in calculation:	8	Range of tolerance:	0.0633 - 0.0949 µg abs./Filter (Z-Score ≤ 2.00)



Sample chart of Z-scores

Sample L 1



Sample chart of Z-scores

Sample L 2

