

Final Report Proficiency Test LS BAM-5.5-2021: Measurement of the particle size distribution of ceramic powders by laser diffraction in accordance with ISO 13320

1. General remarks

The proficiency test (PT) „Measurement of the particle size distribution of ceramic powders by laser diffraction” was organized by the Federal Institute for Materials Research and Testing (BAM), division 5.5 “Advanced technical ceramics”. The measurements took place from 12/2021 to 03/2022. The aim of the interlaboratory comparison was the proficiency assessment of the participating laboratories.

Management and realization of PT were performed in accordance with DIN EN ISO/IEC 17043:2010.

The basis of the harmonized measuring procedure and the instructions for the interlaboratory comparison was the standard ISO 13320:2020. The organizer is accredited in accordance with DIN EN ISO IEC 17025:2018 for measurement of the particle size distribution by laser diffraction.

The statistical analysis was performed in accordance with DIN ISO 13528:2020 by use of the software PROLab Plus (QuoData GmbH, Dresden, Germany).

A group of 45 laboratories from 17 countries participated in the PT. One laboratory (L30) had to cancel due to the pandemic, so that 44 results were included in the evaluation. Five other participants requested an extended processing time, so that the total period for the measurements extended to a total of 3 months.

Laser diffraction analyzers produced by 7 different manufacturers were used.

2. Test objects

The three test materials were commercial products. The median particle size of the powders was about 0.8 μm , 4 μm and 15 μm . Overall, the measured characteristic values of the particle distributions (d_{10} , d_{50} and d_{90}) were in the size range between 0.5 and 25 μm .

Table 1 shows an overview of the test materials and their properties.

Table 1: Characterization of the test samples

	Sample 1	Sample 2	Sample 3
Material	Al ₂ O ₃ -Powder	SiC-Powder	BaTiO ₃ -Powder
mean particle size /μm	4	15	0.8
Density / g/cm³	3.70	3.21	5.87
Specific surface / m²/g	0.10	0.33	2.67
Particle shape	spherical	irregular	irregular

Figures 1 to 3 show microscopic images of the samples.

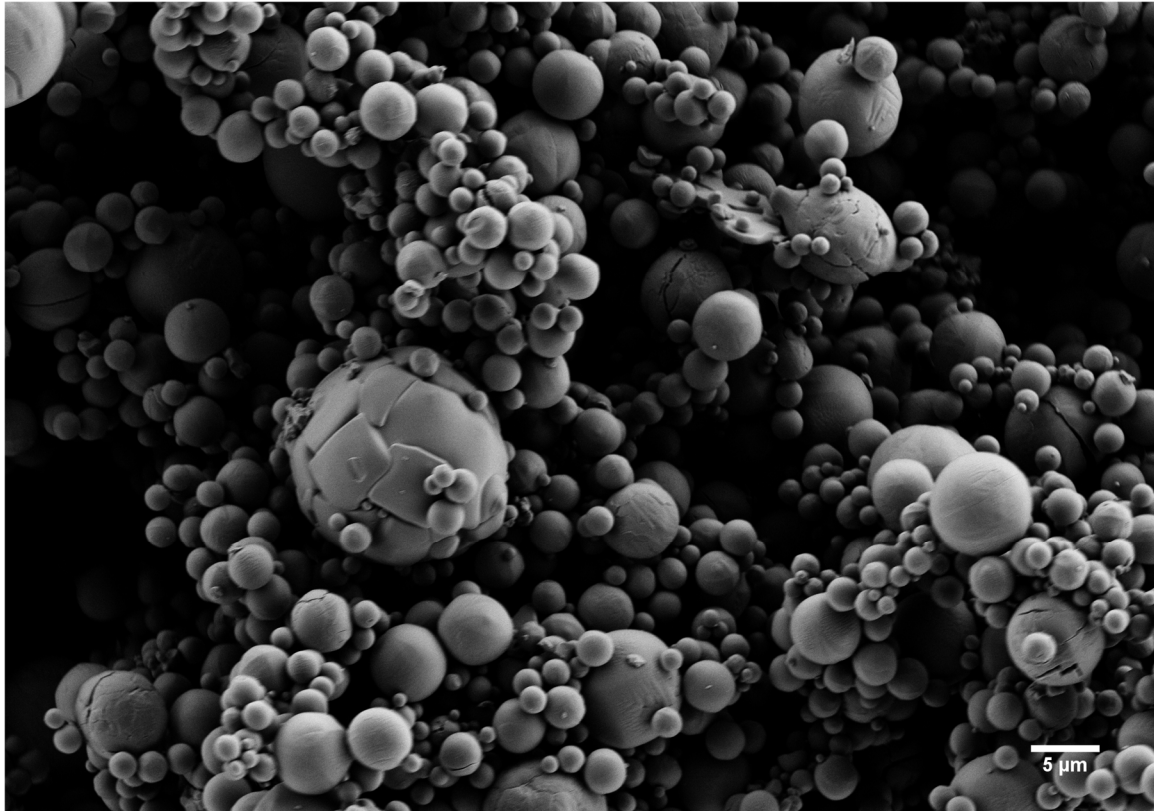


Fig. 1: SEM image of sample 1 (Al₂O₃)

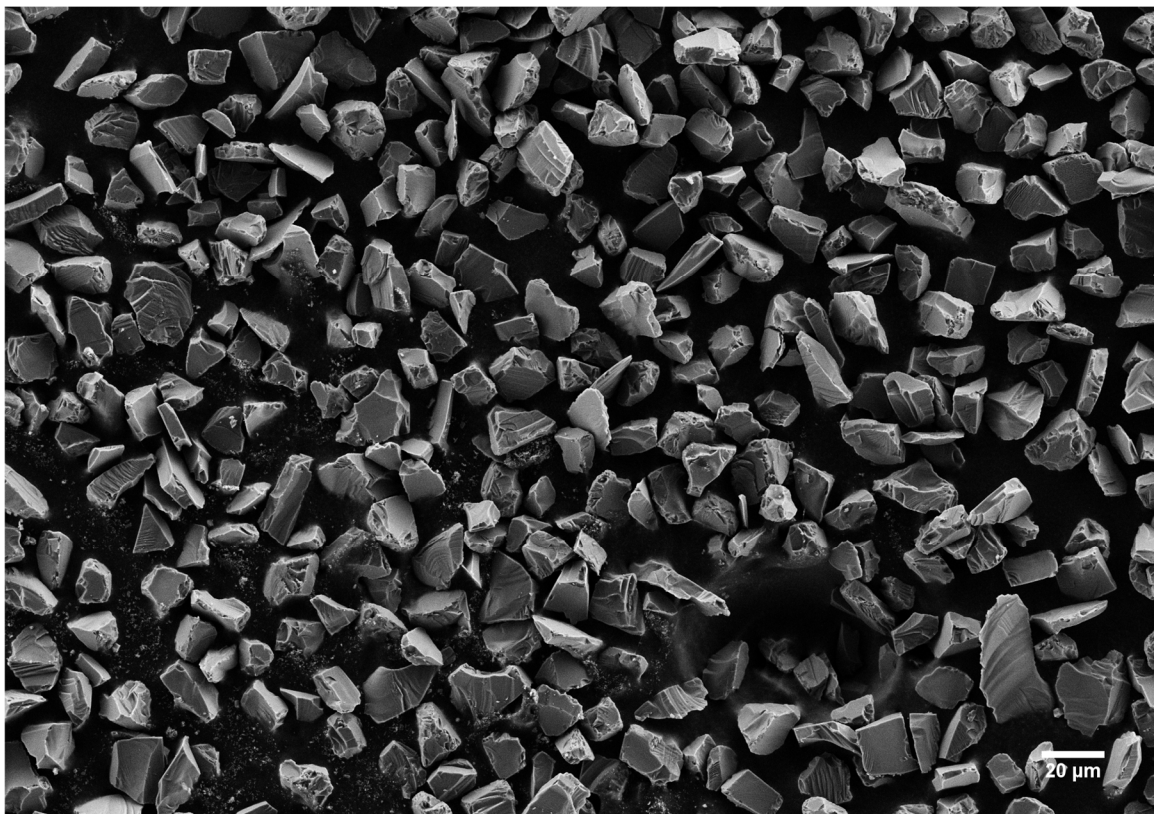


Fig. 2: SEM image of sample 2 (SiC)

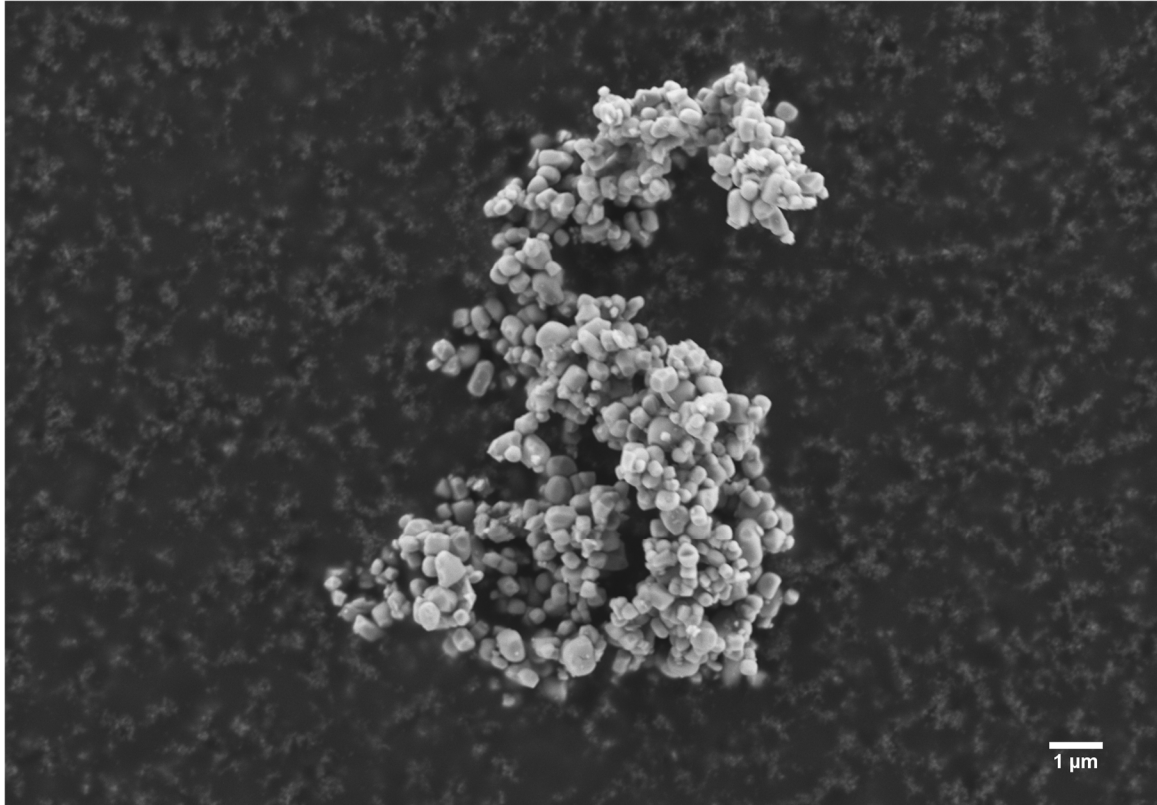


Fig. 3: SEM image of sample 3 (BaTiO₃)

Sub-sampling was done by use of a rotary cone sample divider with 8 channels (Laborette 27, Fritsch) and a v-shaped vibratory feeder (Laborette 24, Fritsch).

The homogeneity analysis was done in accordance with DIN ISO 13528 for all 9 measurands (d_{10} , d_{50} and d_{90} for each of the 3 samples) by use of the software PROLab Plus. All samples showed homogeneity for its measurands and were suitable for the PT without any restrictions.

3. Test procedure

All participants obtained a randomly chosen bottle of each sample material labeled with a unique number, as well as a detailed instruction for the sample preparation, performance of the measurements and for analysis of the raw data in accordance with ISO 13320. Each participating laboratory also receives a unique code number for the laboratory (lab-code).

Anonymity was also maintained in the context of all e-mail contacts.

The participants should analyze the measured data by use of Mie calculation. Therefore, the optical data and the particle shape category were given by the organizers within the analysis instructions. In the case of measurement wavelengths not listed, the participants were asked to determine the corresponding refractive index themselves via a link on www.refractiveindex.info.

The participants were asked to transfer the measuring results and if applicable comments or deviations from the measuring procedure, by use of the program RingDat (QuoData). The program RingDat and the anonymized data files, based on the lab-code, were provided by the organizers. The organizers of the PT used the received data files to import the measured data automatically into the software PROLab Plus.

The measured values of all participants are tabulated in *attachment 1*.

The standard deviation within the laboratories ("repeatability") is not a subject of performance evaluation within the framework of DIN ISO 13528.

4. Statistical Evaluation

The statistical evaluation was performed in accordance with DIN ISO 13528 by use of the software PROLab Plus. Since the assigned values are determined from the results of all participants, the proficiency test corresponds to a comparison of the participants under intermediate conditions of precision according to ISO 13320:2020, chapter 6.5.

At first the 'assigned value' and the 'standard deviation for proficiency assessment' of each measurand were determined by use of a robust analysis, the so-called algorithm A+S (DIN ISO 13528, annex C). These calculated values of all measurands are registered in Table 2.

Table 2: List of the assigned values, the standard deviation for proficiency assessment and the repeatability standard deviation

Sample	Measurand	Assigned value µm	Standard deviation for proficiency assessment		Repeatability standard deviation	
			µm	%	µm	%
Al ₂ O ₃ (P1)	d ₁₀	2.103	0.229	10.87	0.022	1.06
	d ₅₀	4.296	0.391	9.09	0.058	1.35
	d ₉₀	9.561	1.180	12.34	0.257	2.69
SiC (P2)	d ₁₀	10.321	0.467	4.53	0.042	0.40
	d ₅₀	15.545	0.231	1.48	0.047	0.30
	d ₉₀	23.160	0.832	3.59	0.122	0.53
BaTiO ₃ (P3)	d ₁₀	0.468	0.085	18.27	0.006	1.36
	d ₅₀	0.805	0.169	21.06	0.014	1.79
	d ₉₀	1.536	0.431	28.07	0.040	2.63

The assessment criterion z-score was calculated in accordance with DIN ISO 13528:

$$z = \frac{\text{average of the laboratory} - \text{assigned average value}}{\text{standard deviation for proficiency assessment}}$$

Analogous to the procedure in chapter 6.5.2 of ISO 13320:2020, where the extension factor $CF = 3$ is recommended for calculating the tolerance limit, all $|z\text{-scores}| \leq 3$ are considered "acceptable". Z-score smaller -3 and larger $+3$ stand for unacceptable deviations.

A general overview of all averages of the laboratories and their z-scores for each measurand is listed in *attachment 2*.

The diagrams in Figs. 4 to 12 show the following data of each measurand:

- Measured values, average and standard deviation of each laboratory
- Assigned value ("mean")
- Limits of the tolerance for $|z\text{-score}| \leq 3.00$.

The Figs. 13 to 15 show the z-scores for all measurands of each sample for all laboratories.

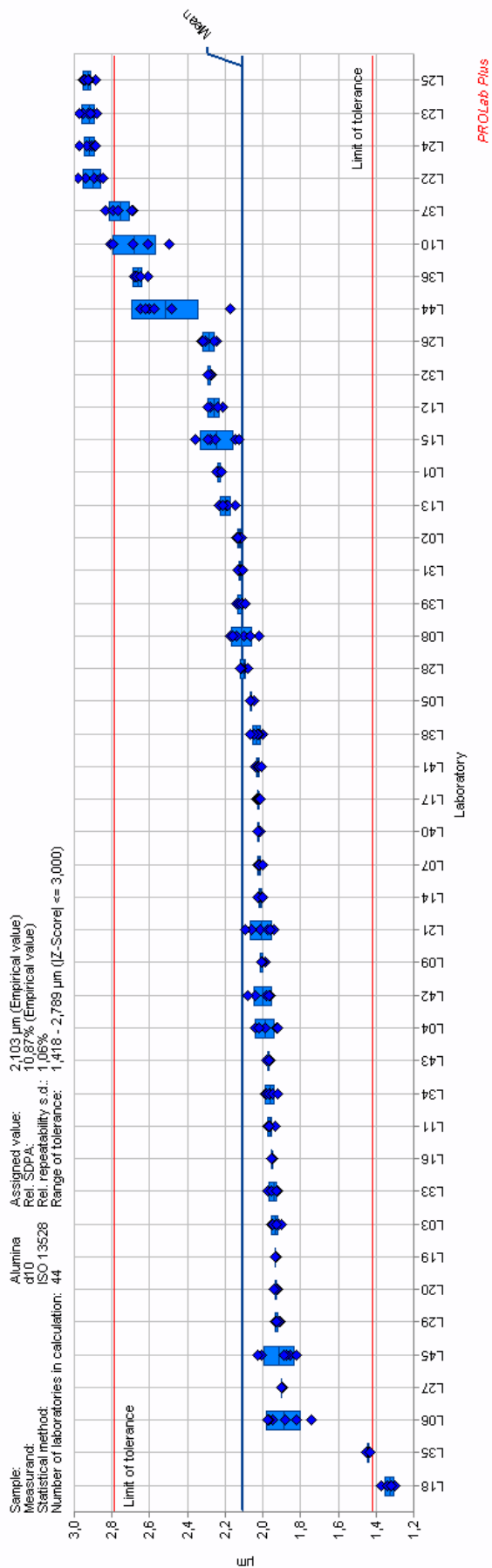


Fig. 4: Measured values, average and standard deviation of the laboratories (blue), assigned value (blue line) and limits of tolerance range (red lines) for d₁₀ sample 1 (Al₂O₃)

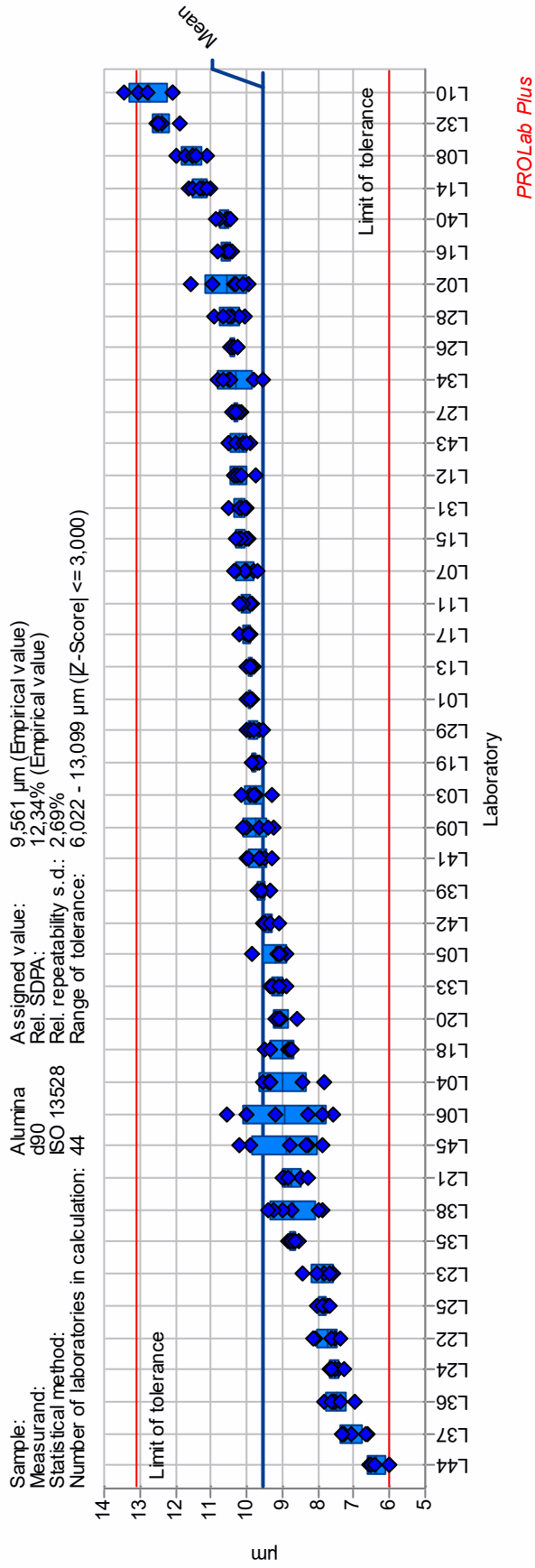


Fig. 6: Measured values, average and standard deviation of the laboratories (blue), assigned value (blue line) and limits of tolerance range (red lines) for d₉₀ sample 1 (Al₂O₃)

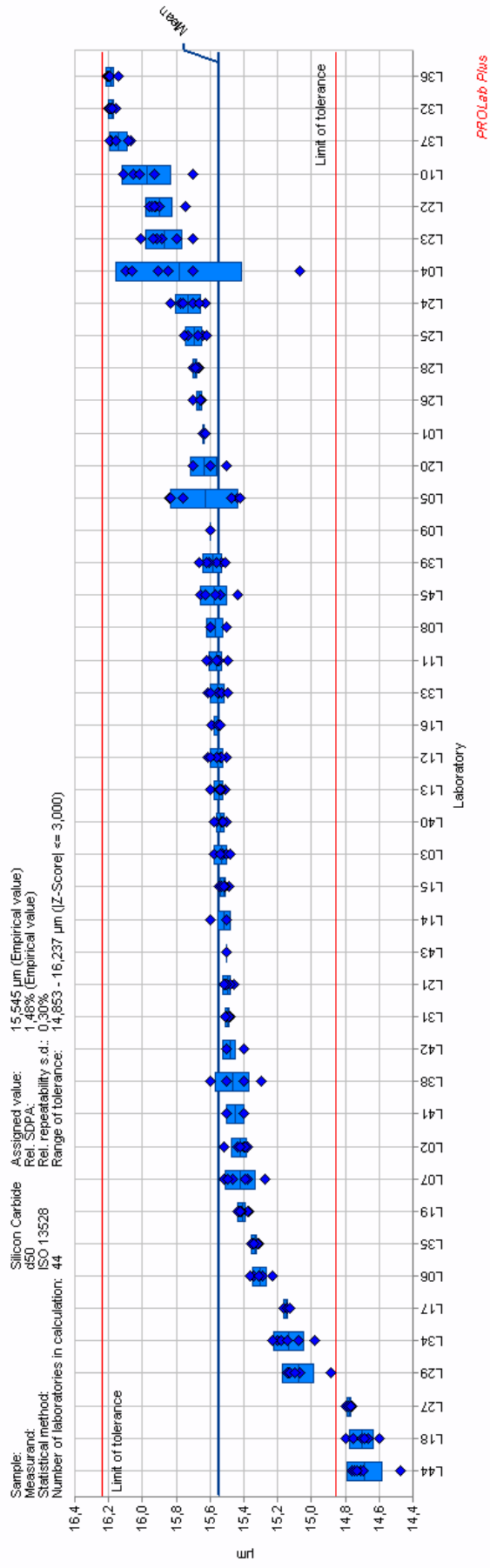


Fig. 8: Measured values, average and standard deviation of the laboratories (blue), assigned value (blue line) and limits of tolerance range (red lines) for d₅₀ sample 2 (SiC)

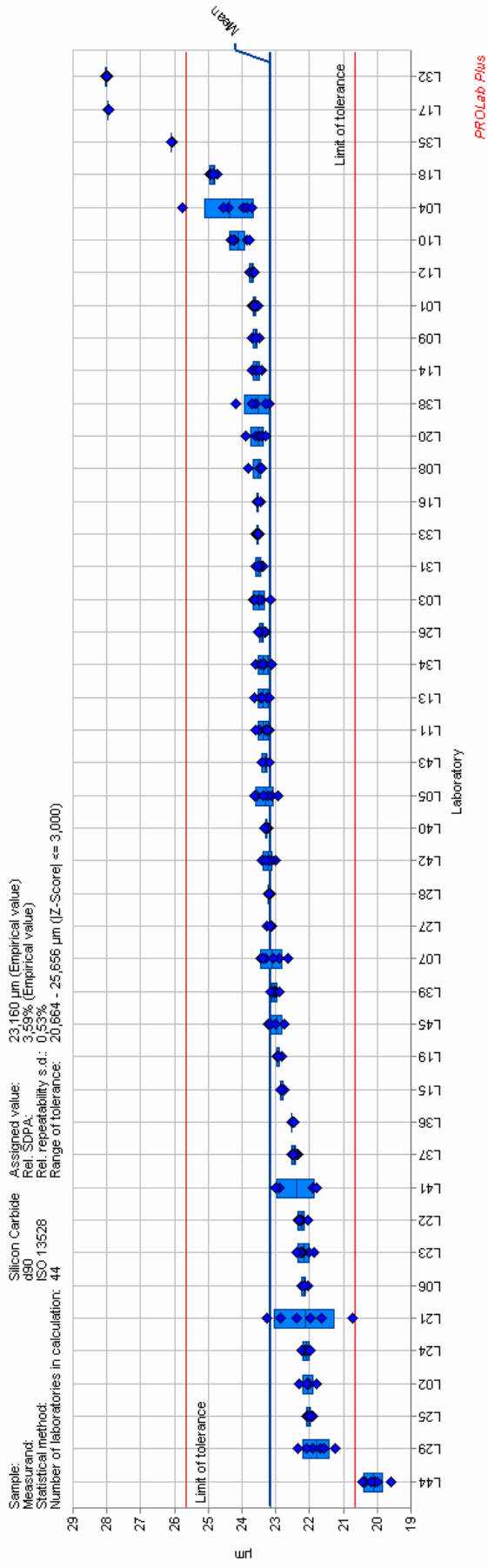


Fig. 9: Measured values, average and standard deviation of the laboratories (blue), assigned value (blue line) and limits of tolerance range (red lines) for d₉₀ sample 2 (SiC)

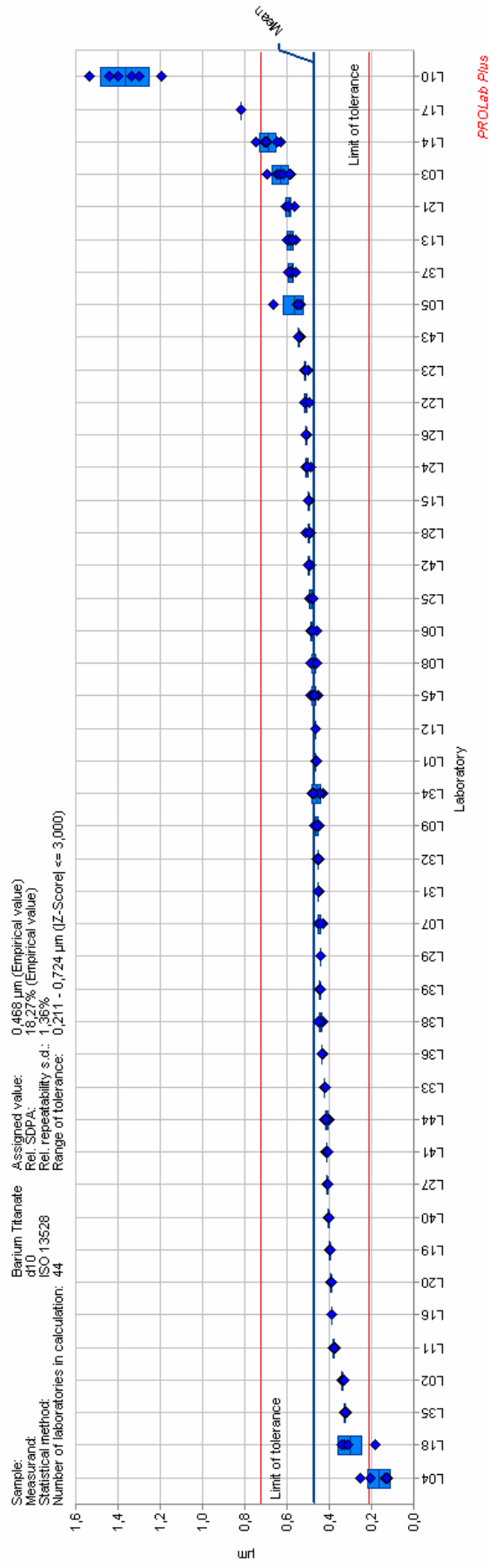


Fig. 10: Measured values, average and standard deviation of the laboratories (blue), assigned value (blue line) and limits of tolerance range (red lines) for d_{10} sample 3 (BaTiO_3)

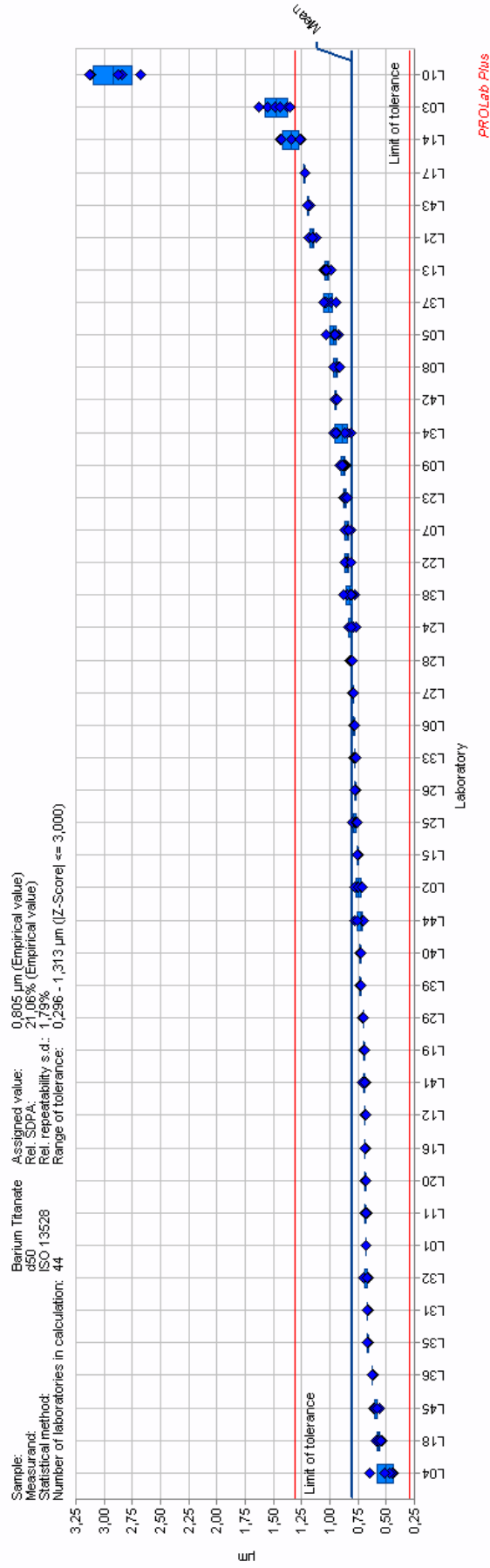


Fig. 11: Measured values, average and standard deviation of the laboratories (blue), assigned value (blue line) and limits of tolerance range (red lines) for d₅₀ sample 3 (BaTiO₃)

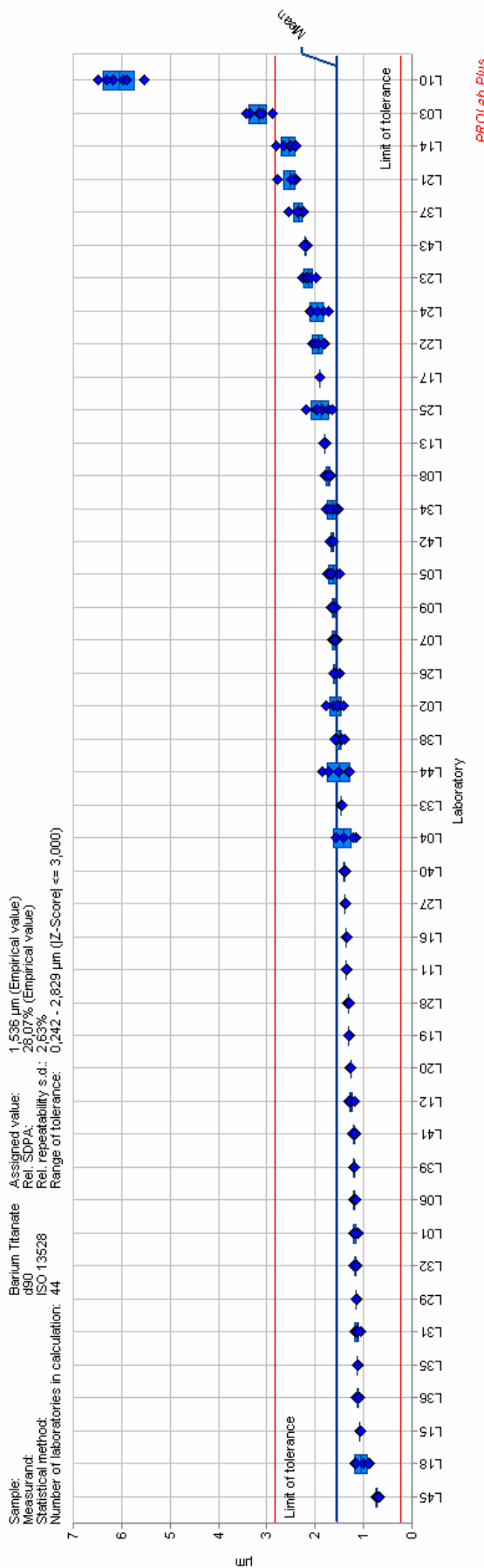


Fig. 12: Measured values, average and standard deviation of the laboratories (blue line), assigned value (blue line) and limits of tolerance range (red lines) for d₉₀ sample 3 (BaTiO₃)

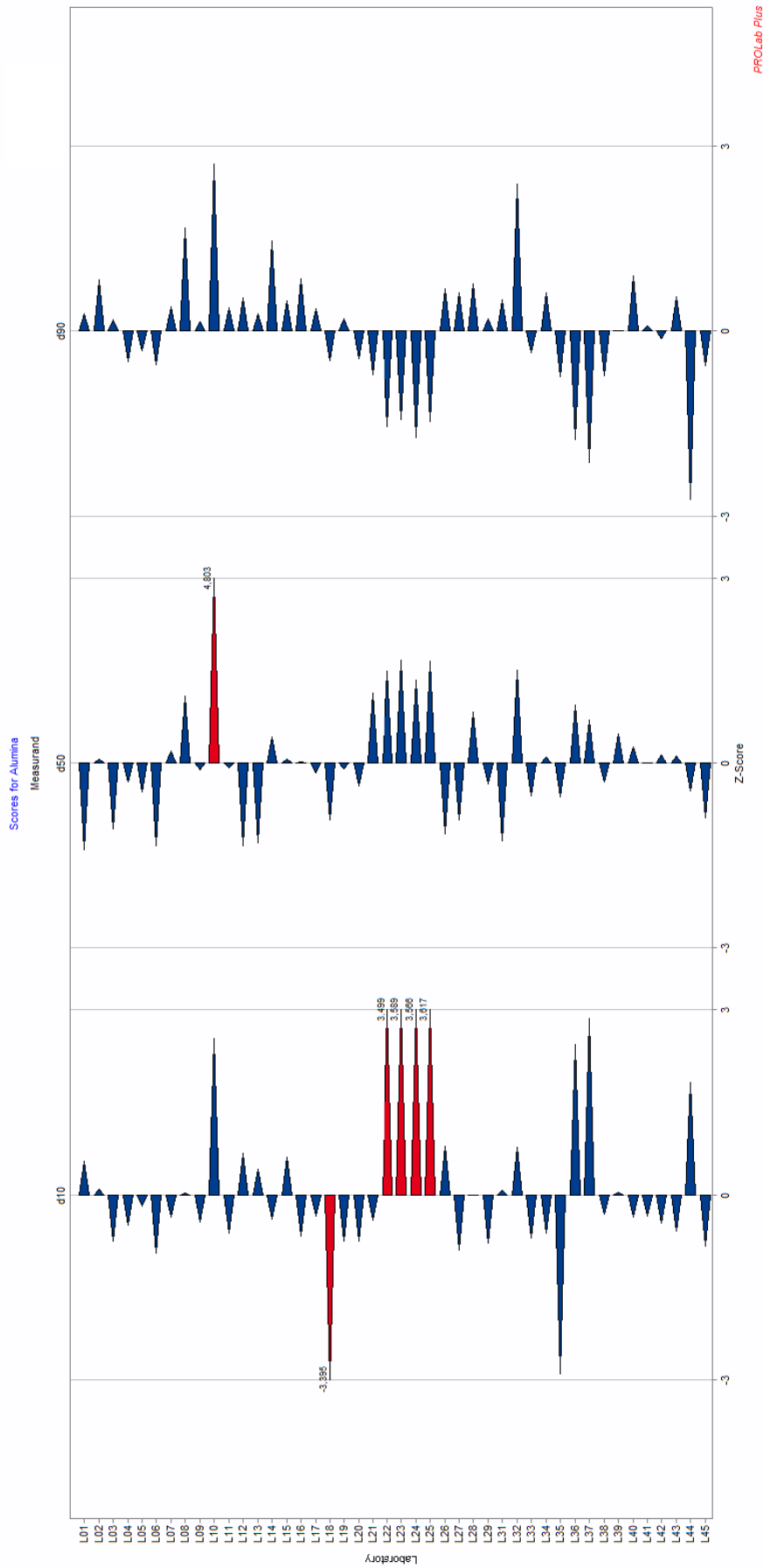


Fig. 13: Scheme of the z-scores of all laboratories for the 3 measurands of sample 1 (Al_2O_3) ($|z| \leq 3$: blue; $|z| > 3$: red)

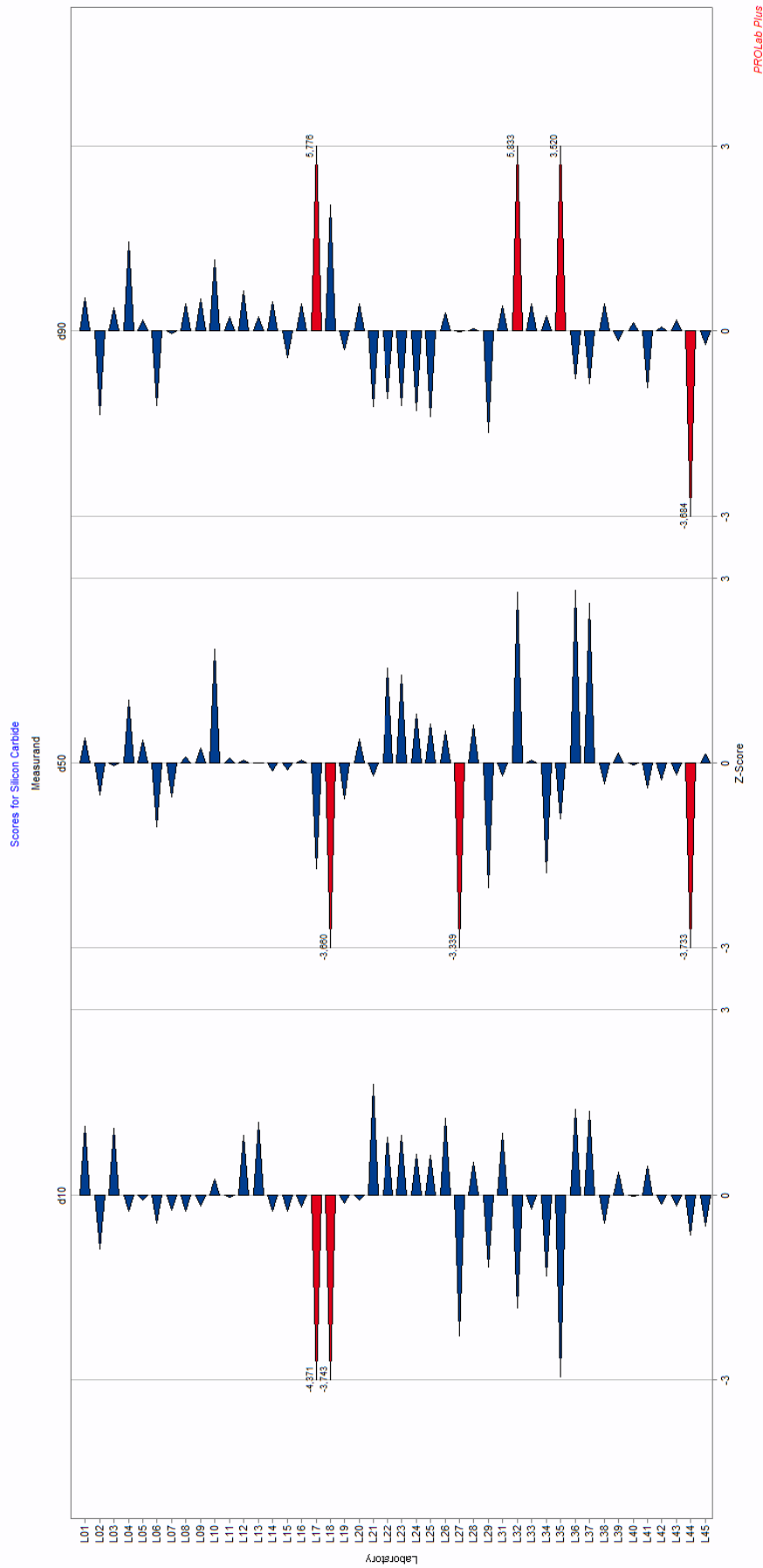


Fig. 14: Scheme of the z-scores of all laboratories for the 3 measurands of sample 2 (SIC)

($|z| \leq 3$: blue; $|z| > 3$: red)

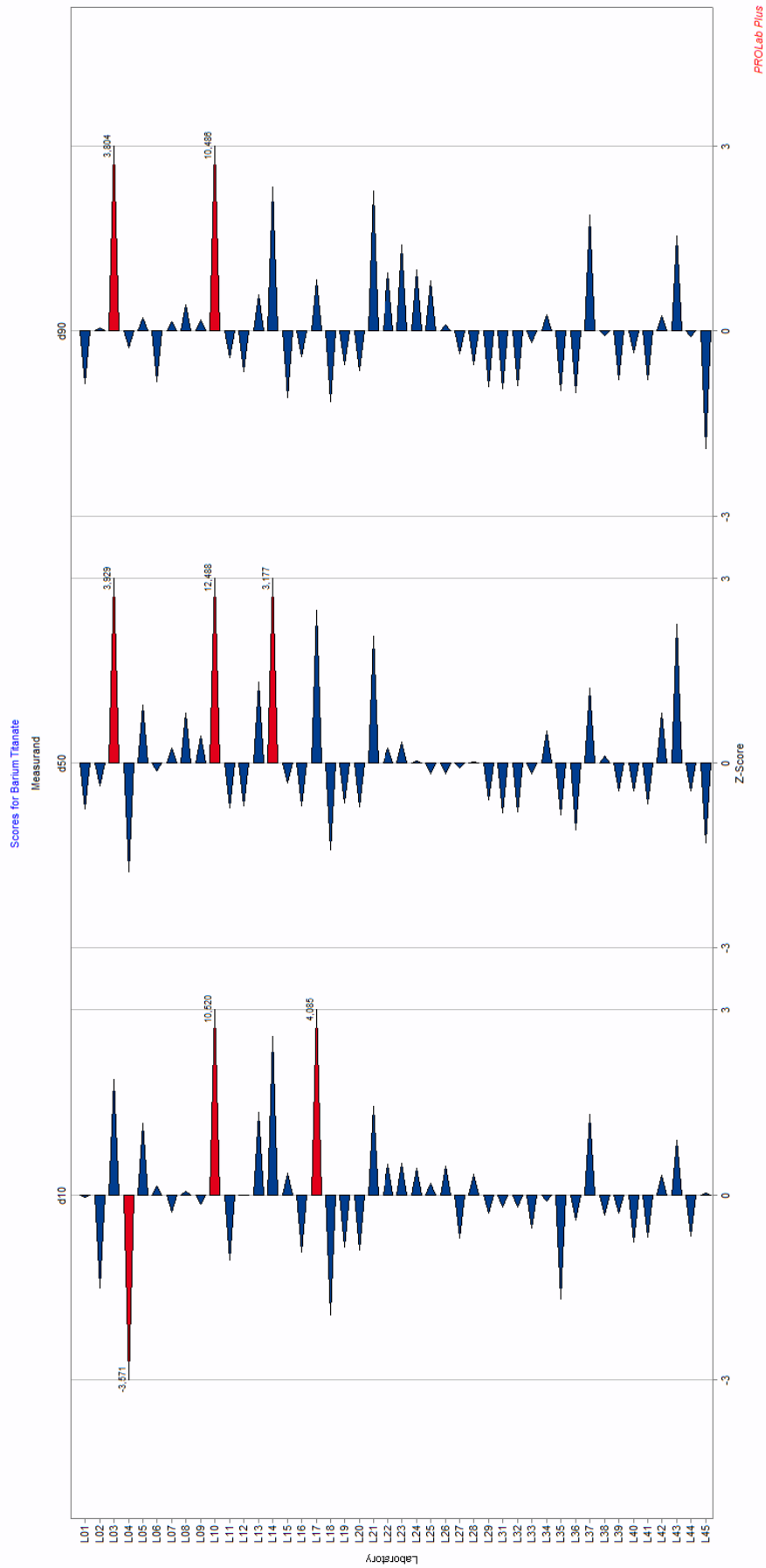


Fig. 15: Scheme of the z-scores of all laboratories for the 3 measurands of sample 3 (BaTiO₃) ($|z| \leq 3$: blue; $|z| > 3$: red)

5. Assessment of the laboratories

The assessment method of the BAM for proficiency tests evaluates the participation as successfully if at least 80 % of the measured values of the laboratory were found within the tolerance range of $|z|$. Thus, in this PT 8 of 9 measurands had to be measured with a $|z\text{-score}| \leq 3$ to receive the status of a successful participation.

As a result of the evaluation, 39 laboratories successfully participated in the proficiency assessment, while 5 laboratories failed this test.

An overview is given in *attachment 3*.

Each laboratory obtains this report, an evaluative certificate of participation with an attachment, including the assigned values of the measurands, the standard deviations for proficiency assessment, the measured values and the specific z-scores of this laboratory.

The standard deviation within the labs (repeatability standard deviation) is not subject of the proficiency assessment in accordance with DIN ISO 13528.

6. Remarks

Deviations from the assigned value

All laboratories with $|z\text{-scores}| > 3$ (see figs. 13 -15; marked red) should find out the cause for their deviations. According to DIN ISO 13528, chapter 9.4, $|z\text{-scores}| > 2$ are also a warning signal that a check is advisable (cf. *appendix 2*).

Standard deviations within the laboratories

Standard deviation within the laboratories is not subject of the proficiency assessment in accordance with DIN ISO 13528. However, ISO 13320, chapter 6.4.2, provides a guide for the repeatability of the measurements of a reference material or internal standard.

The few laboratories with very high laboratory standard deviation (compare Fig. 4 to 12 and *attachment 2*) should control their measuring procedure.

Survey of test results



Laboratory	Test item code	Measurand	M1	M2	M3	M4	M5	M6
L01	1/178	D10	2,236	2,220	2,222	2,230	2,246	2,216
L01	1/178	D50	3,730	3,750	3,760	3,760	3,760	3,710
L01	1/178	D90	9,840	9,880	10,020	9,890	9,850	9,890
L01	2/165	D10	10,810	10,850	10,860	10,860	10,820	10,820
L01	2/165	D50	15,640	15,640	15,640	15,630	15,640	15,630
L01	2/165	D90	23,700	23,610	23,550	23,530	23,670	23,630
L01	3/147	D10	0,466	0,465	0,464	0,462	0,466	0,461
L01	3/147	D50	0,682	0,679	0,677	0,678	0,675	0,676
L01	3/147	D90	1,203	1,192	1,130	1,195	1,100	1,190
L02	1/154	D10	2,120	2,139	2,124	2,126	2,112	2,133
L02	1/154	D50	4,307	4,404	4,301	4,357	4,241	4,318
L02	1/154	D90	10,355	11,555	10,315	10,954	9,940	10,131
L02	2/161	D10	9,961	9,898	9,916	9,916	9,870	9,891
L02	2/161	D50	15,516	15,381	15,401	15,435	15,396	15,421
L02	2/161	D90	22,317	21,778	22,000	22,053	22,002	22,094
L02	3/225	D10	0,340	0,344	0,335	0,338	0,338	0,332
L02	3/225	D50	0,756	0,780	0,727	0,741	0,744	0,708
L02	3/225	D90	1,611	1,778	1,473	1,525	1,556	1,408
L03	1/156	D10	1,917	1,951	1,900	1,952	1,950	1,930
L03	1/156	D50	3,842	3,868	3,834	3,945	3,888	3,910
L03	1/156	D90	9,740	9,926	9,294	9,738	9,812	10,150
L03	2/213	D10	10,812	10,794	10,814	10,873	10,858	10,810
L03	2/213	D50	15,528	15,500	15,480	15,580	15,574	15,540
L03	2/213	D90	23,508	23,422	23,158	23,500	23,656	23,620
L03	3/178	D10	0,584	0,648	0,694	0,636	0,620	0,587
L03	3/178	D50	1,379	1,549	1,626	1,484	1,436	1,351
L03	3/178	D90	3,172	3,333	3,435	3,083	3,152	2,879
L04	1/164	D10	1,989	1,931	2,041	2,038	2,018	1,922
L04	1/164	D50	4,241	4,054	4,134	4,357	4,327	3,954
L04	1/164	D90	9,407	8,419	9,527	9,325	9,334	7,843
L04	2/187	D10	10,490	10,480	10,550	10,360	9,288	10,010
L04	2/187	D50	16,100	15,910	16,060	15,850	15,070	15,700
L04	2/187	D90	25,750	23,960	24,410	23,860	24,540	23,690
L04	3/122	D10	0,126	0,134	0,125	0,131	0,253	0,206
L04	3/122	D50	0,438	0,512	0,448	0,473	0,518	0,648
L04	3/122	D90	1,582	1,565	1,576	1,415	1,163	1,211
L05	1/112	D10	2,057	2,067	2,060	2,067	2,046	2,068
L05	1/112	D50	4,089	4,092	4,087	4,138	4,164	4,107
L05	1/112	D90	8,869	9,020	9,071	9,170	9,867	9,082
L05	2/176	D10	10,106	10,164	10,096	10,446	10,431	10,426
L05	2/176	D50	15,440	15,476	15,424	15,842	15,762	15,834
L05	2/176	D90	23,110	23,210	22,938	23,576	23,640	23,380
L05	3/128	D10	0,549	0,536	0,548	0,552	0,550	0,667
L05	3/128	D50	0,962	0,928	0,945	0,961	0,959	1,033
L05	3/128	D90	1,739	1,540	1,636	1,709	1,669	1,502
L06	1/127	D10	1,744	1,882	1,946	1,821	1,967	1,973
L06	1/127	D50	3,188	3,720	4,006	3,565	4,129	4,023
L06	1/127	D90	7,593	8,270	9,181	7,905	10,010	10,570
L06	2/118	D10	10,120	10,110	10,140	10,090	10,060	10,100

Ring test PT Laserscattering 2021

Laboratory	Test item code	Measurand	M1	M2	M3	M4	M5	M6
L06	2/118	D50	15,340	15,310	15,360	15,290	15,230	15,310
L06	2/118	D90	22,220	22,150	22,230	22,140	22,040	22,150
L06	3/175	D10	0,480	0,460	0,483	0,486	0,488	0,483
L06	3/175	D50	0,780	0,785	0,780	0,783	0,786	0,779
L06	3/175	D90	1,173	1,212	1,172	1,177	1,182	1,168
L07	1/116	D10	2,020	2,028	2,025	2,017	2,020	2,003
L07	1/116	D50	4,380	4,354	4,381	4,384	4,388	4,340
L07	1/116	D90	10,290	9,782	10,029	10,031	10,376	9,698
L07	2/136	D10	10,204	10,218	10,210	10,192	10,210	10,201
L07	2/136	D50	15,274	15,376	15,520	15,463	15,392	15,493
L07	2/136	D90	22,624	22,901	23,439	23,310	23,063	23,392
L07	3/117	D10	0,432	0,451	0,443	0,444	0,452	0,439
L07	3/117	D50	0,816	0,869	0,848	0,842	0,868	0,840
L07	3/117	D90	1,550	1,651	1,609	1,575	1,623	1,606
L08	1/225	D10	2,020	2,100	2,070	2,170	2,140	2,160
L08	1/225	D50	4,520	4,670	4,600	4,870	4,780	4,870
L08	1/225	D90	12,000	11,500	11,100	11,700	11,500	11,400
L08	2/163	D10	10,200	10,200	10,200	10,200	10,200	10,200
L08	2/163	D50	15,600	15,500	15,600	15,600	15,600	15,500
L08	2/163	D90	23,500	23,500	23,800	23,500	23,500	23,400
L08	3/151	D10	0,472	0,468	0,470	0,478	0,489	0,457
L08	3/151	D50	0,948	0,926	0,924	0,970	0,968	0,915
L08	3/151	D90	1,810	1,680	1,660	1,760	1,700	1,710
L09	1/172	D10	1,990	2,010	2,000	2,000	2,010	2,010
L09	1/172	D50	4,160	4,310	4,230	4,200	4,300	4,320
L09	1/172	D90	9,270	10,100	9,630	9,390	10,000	10,100
L09	2/125	D10	10,200	10,300	10,200	10,200	10,200	10,300
L09	2/125	D50	15,600	15,600	15,600	15,600	15,600	15,600
L09	2/125	D90	23,600	23,700	23,600	23,600	23,500	23,600
L09	3/163	D10	0,451	0,451	0,468	0,450	0,446	0,458
L09	3/163	D50	0,870	0,862	0,913	0,866	0,874	0,889
L09	3/163	D90	1,610	1,570	1,660	1,580	1,650	1,640
L10	1/158	D10	2,689	2,808	2,496	2,691	2,793	2,611
L10	1/158	D50	6,319	6,048	6,036	6,230	6,051	6,351
L10	1/158	D90	13,045	12,084	13,039	12,782	12,078	13,464
L10	2/112	D10	10,516	10,464	10,413	10,281	10,413	10,538
L10	2/112	D50	16,057	15,930	16,018	15,700	16,018	16,111
L10	2/112	D90	24,204	23,857	24,325	23,769	24,325	24,257
L10	3/134	D10	1,194	1,398	1,333	1,301	1,442	1,533
L10	3/134	D50	2,678	2,876	2,844	2,876	3,122	3,133
L10	3/134	D90	5,534	5,966	5,887	6,170	6,479	6,303
L11	1/214	D10	1,972	1,967	1,958	1,933	1,966	1,967
L11	1/214	D50	4,266	4,255	4,265	4,221	4,299	4,300
L11	1/214	D90	9,837	9,899	10,116	9,902	10,091	10,189
L11	2/222	D10	10,292	10,332	10,299	10,261	10,313	10,337
L11	2/222	D50	15,603	15,558	15,498	15,622	15,549	15,561
L11	2/222	D90	23,481	23,282	23,189	23,614	23,300	23,283
L11	3/217	D10	0,370	0,379	0,381	0,379	0,380	0,376
L11	3/217	D50	0,673	0,683	0,689	0,683	0,688	0,676
L11	3/217	D90	1,340	1,355	1,362	1,336	1,362	1,357
L12	1/151	D10	2,210	2,279	2,290	2,292	2,238	2,242
L12	1/151	D50	3,590	3,810	3,810	3,860	3,790	3,770

Ring test PT Laserscattering 2021

Laboratory	Test item code	Measurand	M1	M2	M3	M4	M5	M6
L12	1/151	D90	9,760	10,290	10,380	10,370	10,280	10,140
L12	2/158	D10	10,800	10,740	10,750	10,770	10,800	10,780
L12	2/158	D50	15,610	15,500	15,540	15,530	15,560	15,600
L12	2/158	D90	23,790	23,700	23,790	23,680	23,640	23,620
L12	3/187	D10	0,467	0,466	0,466	0,467	0,466	0,467
L12	3/187	D50	0,690	0,690	0,685	0,689	0,688	0,685
L12	3/187	D90	1,265	1,300	1,231	1,271	1,254	1,196
L13	1/133	D10	2,194	2,145	2,212	2,231	2,188	2,213
L13	1/133	D50	3,800	3,760	3,790	3,810	3,790	3,800
L13	1/133	D90	9,820	9,910	9,920	10,030	9,840	9,880
L13	2/148	D10	10,900	10,840	10,910	10,860	10,870	10,850
L13	2/148	D50	15,600	15,550	15,540	15,510	15,530	15,540
L13	2/148	D90	23,460	23,620	23,280	23,190	23,180	23,430
L13	3/223	D10	0,588	0,573	0,561	0,595	0,601	0,577
L13	3/223	D50	1,019	1,027	0,989	1,053	1,041	1,028
L13	3/223	D90	1,779	1,800	1,772	1,798	1,763	1,823
L14	1/126	D10	2,020	2,010	2,010	2,030	2,000	2,000
L14	1/126	D50	4,490	4,480	4,440	4,490	4,420	4,440
L14	1/126	D90	11,600	11,500	11,000	11,200	11,300	11,100
L14	2/226	D10	10,200	10,200	10,200	10,200	10,200	10,200
L14	2/226	D50	15,500	15,500	15,600	15,500	15,500	15,500
L14	2/226	D90	23,400	23,600	23,700	23,500	23,600	23,500
L14	3/112	D10	0,703	0,630	0,746	0,697	0,699	0,650
L14	3/112	D50	1,440	1,250	1,430	1,340	1,340	1,260
L14	3/112	D90	2,800	2,410	2,660	2,510	2,500	2,390
L15	1/162	D10	2,279	2,250	2,359	2,149	2,292	2,129
L15	1/162	D50	4,428	4,459	4,358	4,147	4,397	4,150
L15	1/162	D90	9,944	10,010	10,220	10,230	10,170	10,320
L15	2/122	D10	10,150	10,210	10,190	10,200	10,220	10,200
L15	2/122	D50	15,490	15,550	15,530	15,520	15,510	15,520
L15	2/122	D90	22,740	22,830	22,840	22,810	22,740	22,850
L15	3/144	D10	0,493	0,499	0,497	0,498	0,495	0,500
L15	3/144	D50	0,745	0,751	0,751	0,751	0,750	0,754
L15	3/144	D90	1,074	1,066	1,067	1,067	1,075	1,066
L16	1/216	D10	1,951	1,948	1,954	1,945	1,952	1,956
L16	1/216	D50	4,314	4,297	4,313	4,273	4,303	4,325
L16	1/216	D90	10,603	10,455	10,577	10,388	10,527	10,817
L16	2/142	D10	10,308	10,205	10,209	10,208	10,209	10,202
L16	2/142	D50	15,594	15,544	15,557	15,552	15,553	15,541
L16	2/142	D90	23,440	23,524	23,560	23,542	23,555	23,531
L16	3/166	D10	0,388	0,387	0,389	0,386	0,390	0,390
L16	3/166	D50	0,687	0,686	0,686	0,684	0,686	0,687
L16	3/166	D90	1,368	1,365	1,347	1,363	1,347	1,349
L17	1/228	D10	2,033	2,027	2,026	2,023	2,020	2,014
L17	1/228	D50	4,259	4,242	4,250	4,225	4,218	4,210
L17	1/228	D90	9,999	9,938	10,193	9,889	9,914	9,949
L17	2/134	D10	8,277	8,273	8,284	8,288	8,279	8,266
L17	2/134	D50	15,146	15,141	15,162	15,168	15,146	15,127
L17	2/134	D90	27,960	27,957	27,989	27,985	27,959	27,938
L17	3/138	D10	0,817	0,817	0,817	0,816	0,817	0,817
L17	3/138	D50	1,226	1,226	1,226	1,225	1,226	1,226
L17	3/138	D90	1,894	1,894	1,894	1,892	1,894	1,894

Ring test PT Laserscattering 2021

Laboratory	Test item code	Measurand	M1	M2	M3	M4	M5	M6
L18	1/137	D10	1,301	1,371	1,340	1,298	1,337	1,317
L18	1/137	D50	3,896	4,012	3,962	3,895	3,946	3,912
L18	1/137	D90	8,839	9,481	9,361	8,717	8,792	8,760
L18	2/146	D10	8,511	8,473	8,666	8,626	8,593	8,558
L18	2/146	D50	14,598	14,666	14,800	14,756	14,702	14,684
L18	2/146	D90	24,743	24,863	24,970	24,916	24,853	24,837
L18	3/152	D10	0,331	0,327	0,339	0,184	0,310	0,313
L18	3/152	D50	0,567	0,579	0,593	0,537	0,565	0,552
L18	3/152	D90	0,994	1,157	1,193	0,871	1,157	0,896
L19	1/135	D10	1,927	1,933	1,937	1,927	1,930	1,936
L19	1/135	D50	4,229	4,263	4,271	4,262	4,246	4,282
L19	1/135	D90	9,694	9,827	9,861	9,812	9,661	9,878
L19	2/144	D10	10,248	10,248	10,270	10,270	10,263	10,262
L19	2/144	D50	15,374	15,377	15,431	15,435	15,417	15,421
L19	2/144	D90	22,826	22,838	22,953	22,962	22,928	22,939
L19	3/136	D10	0,395	0,397	0,395	0,398	0,393	0,394
L19	3/136	D50	0,698	0,701	0,692	0,694	0,693	0,695
L19	3/136	D90	1,284	1,317	1,288	1,289	1,310	1,313
L20	1/163	D10	1,920	1,930	1,930	1,930	1,930	1,940
L20	1/163	D50	4,120	4,170	4,150	4,130	4,160	4,170
L20	1/163	D90	9,050	9,130	9,210	8,600	9,080	9,080
L20	2/181	D10	10,200	10,300	10,300	10,300	10,300	10,300
L20	2/181	D50	15,500	15,700	15,700	15,700	15,600	15,600
L20	2/181	D90	23,500	23,600	23,500	23,900	23,400	23,300
L20	3/142	D10	0,391	0,390	0,391	0,390	0,393	0,388
L20	3/142	D50	0,680	0,681	0,684	0,685	0,690	0,681
L20	3/142	D90	1,260	1,250	1,260	1,260	1,280	1,250
L21	1/187	D10	2,016	1,943	2,061	1,975	2,094	1,964
L21	1/187	D50	4,750	4,710	4,850	4,760	4,650	4,710
L21	1/187	D90	8,930	8,510	8,830	8,980	8,280	8,820
L21	2/178	D10	10,870	11,330	10,860	11,570	11,180	11,120
L21	2/178	D50	15,460	15,510	15,520	15,480	15,500	15,520
L21	2/178	D90	22,850	21,630	23,280	20,740	21,970	22,370
L21	3/133	D10	0,592	0,593	0,594	0,603	0,563	0,593
L21	3/133	D50	1,140	1,155	1,152	1,192	1,119	1,156
L21	3/133	D90	2,393	2,494	2,448	2,772	2,489	2,501
L22	1/146	D10	2,941	2,979	2,897	2,896	2,858	2,847
L22	1/146	D50	5,012	5,051	4,855	4,816	4,830	4,720
L22	1/146	D90	8,089	8,138	7,640	7,547	7,645	7,392
L22	2/124	D10	10,778	10,777	10,762	10,658	10,803	10,775
L22	2/124	D50	15,925	15,947	15,899	15,742	15,960	15,927
L22	2/124	D90	22,282	22,235	22,256	22,043	22,341	22,308
L22	3/148	D10	0,511	0,509	0,513	0,514	0,518	0,496
L22	3/148	D50	0,855	0,849	0,855	0,836	0,867	0,814
L22	3/148	D90	2,002	2,066	2,015	1,803	1,942	1,818
L23	1/128	D10	2,895	2,882	2,927	2,951	2,975	2,912
L23	1/128	D50	4,823	4,880	4,942	5,013	5,143	4,883
L23	1/128	D90	7,568	7,701	7,826	8,033	8,441	7,657
L23	2/211	D10	10,679	10,734	10,777	10,800	10,804	10,846
L23	2/211	D50	15,701	15,794	15,884	15,918	15,940	16,008
L23	2/211	D90	21,867	22,017	22,184	22,227	22,280	22,373
L23	3/162	D10	0,502	0,513	0,517	0,516	0,513	0,511

Ring test PT Laserscattering 2021

Laboratory	Test item code	Measurand	M1	M2	M3	M4	M5	M6
L23	3/162	D50	0,844	0,871	0,878	0,873	0,863	0,849
L23	3/162	D90	2,174	2,261	2,188	2,171	2,084	1,972
L24	1/132	D10	2,918	2,907	2,933	2,895	2,886	2,972
L24	1/132	D50	4,859	4,777	4,888	4,793	4,709	4,905
L24	1/132	D90	7,617	7,437	7,676	7,507	7,275	7,653
L24	2/121	D10	10,658	10,649	10,685	10,618	10,561	10,596
L24	2/121	D50	15,774	15,757	15,835	15,703	15,629	15,667
L24	2/121	D90	22,151	22,123	22,235	22,050	21,967	21,993
L24	3/221	D10	0,512	0,513	0,504	0,503	0,488	0,506
L24	3/221	D50	0,840	0,836	0,818	0,793	0,772	0,809
L24	3/221	D90	2,115	2,074	2,084	1,734	1,820	1,957
L25	1/218	D10	2,890	2,954	2,920	2,941	2,945	2,930
L25	1/218	D50	4,914	5,012	4,939	4,926	4,954	4,902
L25	1/218	D90	7,839	8,040	7,857	7,744	7,861	7,689
L25	2/175	D10	10,600	10,624	10,649	10,583	10,663	10,609
L25	2/175	D50	15,644	15,730	15,728	15,623	15,750	15,675
L25	2/175	D90	21,937	22,105	22,039	21,905	22,066	21,989
L25	3/211	D10	0,494	0,474	0,480	0,494	0,481	0,478
L25	3/211	D50	0,783	0,764	0,771	0,806	0,763	0,755
L25	3/211	D90	1,841	1,984	2,177	1,955	1,720	1,657
L26	1/185	D10	2,246	2,261	2,256	2,303	2,324	2,317
L26	1/185	D50	3,860	3,900	3,870	3,820	3,820	3,820
L26	1/185	D90	10,430	10,450	10,470	10,360	10,270	10,270
L26	2/141	D10	10,870	10,890	10,860	10,990	10,920	10,850
L26	2/141	D50	15,650	15,650	15,660	15,700	15,660	15,660
L26	2/141	D90	23,440	23,350	23,460	23,310	23,340	23,510
L26	3/143	D10	0,507	0,507	0,503	0,510	0,509	0,509
L26	3/143	D50	0,772	0,776	0,772	0,772	0,773	0,777
L26	3/143	D90	1,585	1,620	1,604	1,498	1,551	1,615
L27	1/212	D10	1,899	1,900	1,900	1,900	1,892	1,901
L27	1/212	D50	3,927	3,947	3,942	3,948	3,924	3,942
L27	1/212	D90	10,170	10,360	10,320	10,400	10,200	10,300
L27	2/111	D10	9,261	9,251	9,252	9,254	9,253	9,255
L27	2/111	D50	14,800	14,760	14,780	14,770	14,770	14,770
L27	2/111	D90	23,250	23,110	23,170	23,130	23,140	23,150
L27	3/184	D10	0,412	0,410	0,407	0,406	0,404	0,404
L27	3/184	D50	0,796	0,796	0,791	0,789	0,789	0,785
L27	3/184	D90	1,394	1,400	1,373	1,366	1,374	1,357
L28	1/175	D10	2,082	2,112	2,100	2,083	2,114	2,121
L28	1/175	D50	4,500	4,615	4,593	4,661	4,654	4,680
L28	1/175	D90	10,065	10,391	10,225	10,923	10,536	10,671
L28	2/168	D10	10,581	10,574	10,560	10,562	10,580	10,569
L28	2/168	D50	15,699	15,689	15,668	15,669	15,704	15,685
L28	2/168	D90	23,210	23,183	23,163	23,154	23,221	23,185
L28	3/137	D10	0,509	0,494	0,493	0,495	0,491	0,493
L28	3/137	D50	0,826	0,811	0,799	0,802	0,800	0,803
L28	3/137	D90	1,329	1,321	1,288	1,291	1,297	1,296
L29	1/161	D10	1,935	1,911	1,913	1,927	1,928	1,926
L29	1/161	D50	4,201	4,119	4,133	4,190	4,180	4,175
L29	1/161	D90	9,988	9,672	9,562	9,916	9,896	9,790
L29	2/221	D10	9,689	10,089	9,772	9,595	9,906	9,568
L29	2/221	D50	14,883	15,137	15,145	15,070	15,125	15,101

Ring test PT Laserscattering 2021

Laboratory	Test item code	Measurand	M1	M2	M3	M4	M5	M6
L29	2/221	D90	21,225	21,906	21,699	22,076	21,560	22,330
L29	3/185	D10	0,444	0,443	0,442	0,443	0,442	0,443
L29	3/185	D50	0,708	0,706	0,701	0,704	0,703	0,706
L29	3/185	D90	1,160	1,157	1,139	1,146	1,138	1,153
L31	1/117	D10	2,118	2,109	2,129	2,116	2,131	2,108
L31	1/117	D50	3,740	3,860	3,780	3,800	3,850	3,800
L31	1/117	D90	10,010	10,490	10,030	10,180	10,200	10,060
L31	2/131	D10	10,780	10,750	10,780	10,830	10,780	10,800
L31	2/131	D50	15,510	15,490	15,480	15,500	15,490	15,510
L31	2/131	D90	23,590	23,610	23,420	23,390	23,490	23,540
L31	3/113	D10	0,450	0,451	0,450	0,451	0,453	0,451
L31	3/113	D50	0,666	0,665	0,663	0,670	0,669	0,669
L31	3/113	D90	1,150	1,124	1,192	1,166	1,057	1,098
L32	1/152	D10	2,289	2,272	2,281	2,273	2,278	2,292
L32	1/152	D50	4,906	4,815	4,895	4,876	4,885	4,915
L32	1/152	D90	12,539	11,884	12,395	12,467	12,476	12,477
L32	2/162	D10	9,469	9,491	9,457	9,491	9,435	9,455
L32	2/162	D50	16,198	16,181	16,186	16,197	16,156	16,180
L32	2/162	D90	28,048	27,958	28,036	28,025	27,990	28,018
L32	3/182	D10	0,450	0,448	0,448	0,459	0,451	0,451
L32	3/182	D50	0,666	0,657	0,658	0,700	0,672	0,669
L32	3/182	D90	1,144	1,134	1,139	1,200	1,157	1,148
L33	1/157	D10	1,927	1,954	1,977	1,919	1,957	1,929
L33	1/157	D50	4,055	4,159	4,099	4,001	4,159	4,069
L33	1/157	D90	9,246	9,333	8,996	8,878	9,289	9,114
L33	2/138	D10	10,258	10,210	10,212	10,207	10,248	10,145
L33	2/138	D50	15,616	15,544	15,553	15,534	15,599	15,498
L33	2/138	D90	23,581	23,491	23,529	23,475	23,556	23,515
L33	3/155	D10	0,424	0,420	0,425	0,422	0,419	0,419
L33	3/155	D50	0,782	0,775	0,786	0,778	0,769	0,764
L33	3/155	D90	1,459	1,469	1,473	1,455	1,446	1,429
L34	1/153	D10	1,987	1,983	1,961	1,967	1,945	1,921
L34	1/153	D50	4,442	4,385	4,342	4,375	4,290	4,186
L34	1/153	D90	10,808	10,490	10,476	10,687	9,782	9,533
L34	2/182	D10	9,692	9,834	9,847	9,595	9,707	9,543
L34	2/182	D50	15,198	15,178	15,228	15,075	15,144	14,982
L34	2/182	D90	23,603	23,327	23,447	23,388	23,371	23,101
L34	3/161	D10	0,483	0,429	0,442	0,472	0,450	0,477
L34	3/161	D50	0,962	0,810	0,843	0,934	0,871	0,944
L34	3/161	D90	1,770	1,526	1,565	1,702	1,611	1,709
L35	1/176	D10	1,448	1,438	1,440	1,438	1,450	1,430
L35	1/176	D50	4,106	4,056	4,084	4,104	4,080	4,070
L35	1/176	D90	8,832	8,524	8,688	8,770	8,724	8,620
L35	2/173	D10	8,916	8,956	8,952	8,908	8,956	8,944
L35	2/173	D50	15,312	15,346	15,348	15,320	15,354	15,342
L35	2/173	D90	26,058	26,094	26,098	26,076	26,108	26,098
L35	3/212	D10	0,332	0,320	0,318	0,322	0,320	0,324
L35	3/212	D50	0,672	0,654	0,658	0,664	0,658	0,668
L35	3/212	D90	1,124	1,112	1,120	1,122	1,118	1,126
L36	1/155	D10	2,678	2,675	2,682	2,613	2,669	2,650
L36	1/155	D50	4,709	4,783	4,704	4,450	4,724	4,605
L36	1/155	D90	7,566	7,848	7,543	6,976	7,632	7,358

Ring test PT Laserscattering 2021

Laboratory	Test item code	Measurand	M1	M2	M3	M4	M5	M6
L36	2/218	D10	10,993	10,990	10,976	10,974	10,961	10,929
L36	2/218	D50	16,208	16,197	16,200	16,199	16,192	16,146
L36	2/218	D90	22,526	22,508	22,536	22,530	22,535	22,472
L36	3/174	D10	0,434	0,433	0,434	0,431	0,428	0,436
L36	3/174	D50	0,621	0,626	0,624	0,616	0,615	0,625
L36	3/174	D90	1,094	1,151	1,119	1,080	1,089	1,108
L37	1/143	D10	2,768	2,692	2,832	2,792	2,693	2,770
L37	1/143	D50	4,675	4,382	4,666	4,619	4,398	4,677
L37	1/143	D90	7,326	6,632	7,275	7,093	6,660	7,331
L37	2/115	D10	10,897	10,900	10,989	10,996	10,968	10,947
L37	2/115	D50	16,067	16,083	16,190	16,191	16,156	16,157
L37	2/115	D90	22,350	22,384	22,520	22,508	22,465	22,500
L37	3/224	D10	0,575	0,586	0,575	0,584	0,559	0,596
L37	3/224	D50	0,988	1,048	0,994	1,036	0,946	1,050
L37	3/224	D90	2,331	2,334	2,536	2,260	2,240	2,380
L38	1/224	D10	2,020	2,000	2,020	2,030	2,050	2,070
L38	1/224	D50	4,200	4,010	4,230	4,020	4,280	4,320
L38	1/224	D90	8,760	7,880	8,990	7,960	9,250	9,400
L38	2/155	D10	9,630	10,200	10,300	10,000	10,300	10,200
L38	2/155	D50	15,400	15,500	15,500	15,300	15,500	15,600
L38	2/155	D90	24,200	23,600	23,200	23,200	23,300	23,700
L38	3/115	D10	0,443	0,427	0,432	0,441	0,440	0,452
L38	3/115	D50	0,819	0,778	0,806	0,841	0,817	0,878
L38	3/115	D90	1,540	1,400	1,470	1,570	1,450	1,590
L39	1/114	D10	2,113	2,137	2,127	2,107	2,110	2,094
L39	1/114	D50	4,475	4,532	4,512	4,481	4,442	4,427
L39	1/114	D90	9,552	9,607	9,535	9,723	9,371	9,598
L39	2/214	D10	10,452	10,474	10,512	10,519	10,540	10,435
L39	2/214	D50	15,531	15,563	15,609	15,619	15,664	15,508
L39	2/214	D90	22,966	23,002	23,058	23,072	23,168	22,914
L39	3/157	D10	0,444	0,442	0,441	0,445	0,441	0,442
L39	3/157	D50	0,730	0,727	0,724	0,731	0,724	0,725
L39	3/157	D90	1,198	1,193	1,189	1,200	1,190	1,192
L40	1/148	D10	2,021	2,018	2,011	2,015	2,025	2,029
L40	1/148	D50	4,396	4,377	4,378	4,367	4,416	4,439
L40	1/148	D90	10,567	10,444	10,579	10,483	10,756	10,855
L40	2/184	D10	10,305	10,293	10,330	10,290	10,307	10,334
L40	2/184	D50	15,529	15,533	15,561	15,504	15,528	15,573
L40	2/184	D90	23,265	23,301	23,295	23,230	23,256	23,320
L40	3/125	D10	0,404	0,406	0,405	0,399	0,400	0,399
L40	3/125	D50	0,725	0,734	0,736	0,730	0,721	0,723
L40	3/125	D90	1,359	1,383	1,399	1,407	1,372	1,397
L41	1/173	D10	2,040	2,030	2,020	2,030	2,020	2,010
L41	1/173	D50	4,360	4,340	4,290	4,280	4,250	4,270
L41	1/173	D90	9,990	9,970	9,580	9,480	9,300	9,630
L41	2/123	D10	10,600	10,700	10,700	10,400	10,400	10,400
L41	2/123	D50	15,400	15,400	15,400	15,500	15,500	15,500
L41	2/123	D90	21,900	21,900	21,800	22,900	22,900	23,000
L41	3/123	D10	0,410	0,408	0,406	0,416	0,409	0,408
L41	3/123	D50	0,697	0,693	0,682	0,716	0,684	0,688
L41	3/123	D90	1,210	1,200	1,180	1,230	1,170	1,180
L42	1/168	D10	1,980	1,960	1,960	2,040	1,970	2,080

Ring test PT Laserscattering 2021

Laboratory	Test item code	Measurand	M1	M2	M3	M4	M5	M6
L42	1/168	D50	4,330	4,280	4,280	4,420	4,290	4,490
L42	1/168	D90	9,480	9,480	9,570	9,480	9,340	9,120
L42	2/116	D10	10,300	10,200	10,300	10,200	10,300	10,200
L42	2/116	D50	15,400	15,500	15,500	15,500	15,500	15,500
L42	2/116	D90	23,000	23,400	23,300	23,100	23,200	23,300
L42	3/183	D10	0,489	0,496	0,501	0,487	0,499	0,499
L42	3/183	D50	0,932	0,935	0,945	0,938	0,959	0,935
L42	3/183	D90	1,630	1,610	1,630	1,670	1,690	1,610
L43	1/226	D10	1,970	1,960	1,980	1,970	1,970	1,970
L43	1/226	D50	4,360	4,320	4,360	4,350	4,340	4,320
L43	1/226	D90	10,500	9,890	10,500	10,300	10,100	10,000
L43	2/145	D10	10,200	10,200	10,200	10,300	10,300	10,200
L43	2/145	D50	15,500	15,500	15,500	15,500	15,500	15,500
L43	2/145	D90	23,400	23,400	23,300	23,200	23,200	23,400
L43	3/145	D10	0,542	0,542	0,537	0,546	0,544	0,546
L43	3/145	D50	1,190	1,180	1,180	1,190	1,180	1,200
L43	3/145	D90	2,220	2,180	2,200	2,200	2,170	2,230
L44	1/122	D10	2,484	2,604	2,171	2,650	2,624	2,577
L44	1/122	D50	3,952	4,215	3,845	4,288	4,237	4,167
L44	1/122	D90	5,997	6,529	6,018	6,590	6,521	6,424
L44	2/152	D10	10,008	10,114	9,927	10,118	9,977	9,934
L44	2/152	D50	14,471	14,758	14,711	14,742	14,694	14,729
L44	2/152	D90	19,596	20,074	20,344	19,984	20,159	20,416
L44	3/168	D10	0,401	0,408	0,407	0,421	0,407	0,416
L44	3/168	D50	0,716	0,707	0,706	0,779	0,706	0,760
L44	3/168	D90	1,519	1,301	1,298	1,842	1,299	1,730
L45	1/145	D10	2,006	2,025	1,856	1,878	1,820	1,886
L45	1/145	D50	4,356	4,403	3,753	3,762	3,700	3,722
L45	1/145	D90	9,928	10,190	8,809	8,303	8,315	7,904
L45	2/227	D10	10,280	10,060	9,772	10,230	9,924	10,220
L45	2/227	D50	15,630	15,540	15,440	15,660	15,570	15,630
L45	2/227	D90	22,990	22,740	22,760	23,210	23,150	22,990
L45	3/165	D10	0,452	0,487	0,467	0,479	0,468	0,469
L45	3/165	D50	0,559	0,610	0,584	0,598	0,581	0,579
L45	3/165	D90	0,680	0,750	0,709	0,730	0,705	0,701

Summary of laboratory means

Sample Alumina

	D10	Z score	D50	Z score	D90	Z score
Unit	µm		µm		µm	
L01	2,228	0,547	3,745	-1,412	9,895	0,283
L02	2,126	0,098	4,321	0,064	10,542	0,832
L03	1,933	-0,744	3,881	-1,063	9,777	0,183
L04	1,990	-0,497	4,178	-0,303	8,976	-0,496
L05	2,061	-0,186	4,113	-0,470	9,180	-0,323
L06	1,889	-0,939	3,772	-1,343	8,921	-0,542
L07	2,019	-0,370	4,371	0,192	10,034	0,402
L08	2,110	0,029	4,718	1,080	11,533	1,672
L09	2,003	-0,438	4,253	-0,110	9,748	0,159
L10	2,681	2,529	6,173	4,803	12,749	2,703
L11	1,961	-0,625	4,268	-0,073	10,006	0,377
L12	2,258	0,679	3,772	-1,343	10,203	0,545
L13	2,197	0,410	3,792	-1,292	9,900	0,288
L14	2,012	-0,401	4,460	0,419	11,283	1,460
L15	2,243	0,611	4,323	0,069	10,149	0,499
L16	1,951	-0,667	4,304	0,020	10,561	0,848
L17	2,024	-0,348	4,234	-0,160	9,980	0,356
L18	1,327	-3,395	3,937	-0,920	8,992	-0,482
L19	1,932	-0,751	4,259	-0,096	9,789	0,193
L20	1,930	-0,758	4,150	-0,375	9,025	-0,454
L21	2,009	-0,414	4,738	1,132	8,725	-0,708
L22	2,903	3,499	4,881	1,496	7,742	-1,542
L23	2,924	3,589	4,947	1,667	7,871	-1,432
L24	2,918	3,566	4,822	1,345	7,527	-1,724
L25	2,930	3,617	4,941	1,651	7,838	-1,460
L26	2,284	0,793	3,848	-1,147	10,375	0,690
L27	1,899	-0,896	3,938	-0,917	10,292	0,620
L28	2,102	-0,006	4,617	0,821	10,468	0,770
L29	1,923	-0,788	4,166	-0,333	9,804	0,206
L31	2,119	0,066	3,805	-1,258	10,162	0,510
L32	2,281	0,776	4,882	1,499	12,373	2,384
L33	1,944	-0,698	4,090	-0,527	9,143	-0,354
L34	1,961	-0,624	4,337	0,103	10,296	0,623
L35	1,441	-2,899	4,083	-0,545	8,693	-0,736
L36	2,661	2,440	4,662	0,937	7,487	-1,758
L37	2,758	2,863	4,569	0,699	7,053	-2,126
L38	2,032	-0,314	4,177	-0,306	8,707	-0,724
L39	2,115	0,049	4,478	0,465	9,564	0,003
L40	2,020	-0,365	4,396	0,254	10,614	0,893
L41	2,025	-0,343	4,298	0,005	9,658	0,083
L42	1,998	-0,459	4,348	0,133	9,412	-0,126
L43	1,970	-0,583	4,342	0,116	10,215	0,555
L44	2,518	1,816	4,117	-0,458	6,346	-2,725
L45	1,912	-0,838	3,949	-0,888	8,908	-0,553
-	-	-	-	-	-	-
Statistical method	ISO 13528		ISO 13528		ISO 13528	
Assessment	Z <=3,000		Z <=3,000		Z <=3,000	

	D10	Z score	D50	Z score	D90	Z score
No. of laboratories that submitted results	44		44		44	
Assigned value	2,103		4,296		9,561	
SDPA	0,229		0,391		1,180	
Repeatability s.d.	0,022		0,058		0,257	
Rel. SDPA	10,87 %		9,09 %		12,34 %	
Rel. repeatability s.d.	1,06 %		1,35 %		2,69 %	
Percentage of satisfactory scores	79,55 %		97,73 %		90,91 %	

Summary of laboratory means



Sample Silicon Carbide

Unit	D10		D50		D90	
	µm	Z score	µm	Z score	µm	Z score
L01	10,837	1,104	15,637	0,397	23,615	0,547
L02	9,909	-0,882	15,425	-0,521	22,041	-1,345
L03	10,827	1,082	15,534	-0,050	23,477	0,381
L04	10,196	-0,266	15,782	1,026	24,368	1,453
L05	10,278	-0,091	15,630	0,367	23,309	0,179
L06	10,103	-0,465	15,307	-1,034	22,155	-1,208
L07	10,206	-0,246	15,420	-0,544	23,121	-0,046
L08	10,200	-0,259	15,567	0,094	23,533	0,449
L09	10,233	-0,187	15,600	0,238	23,600	0,529
L10	10,438	0,250	15,972	1,853	24,123	1,157
L11	10,306	-0,032	15,565	0,087	23,358	0,238
L12	10,773	0,968	15,557	0,050	23,703	0,653
L13	10,872	1,178	15,545	0,000	23,360	0,240
L14	10,200	-0,259	15,517	-0,123	23,550	0,469
L15	10,195	-0,269	15,520	-0,109	22,802	-0,431
L16	10,223	-0,208	15,557	0,051	23,525	0,439
L17	8,278	-4,371	15,148	-1,721	27,965	5,776
L18	8,571	-3,743	14,701	-3,660	24,864	2,048
L19	10,260	-0,130	15,409	-0,589	22,908	-0,303
L20	10,283	-0,080	15,633	0,383	23,533	0,449
L21	11,155	1,785	15,498	-0,203	22,140	-1,226
L22	10,759	0,937	15,900	1,539	22,244	-1,101
L23	10,773	0,968	15,874	1,427	22,158	-1,204
L24	10,628	0,657	15,727	0,791	22,087	-1,290
L25	10,621	0,643	15,692	0,636	22,007	-1,386
L26	10,897	1,232	15,663	0,513	23,402	0,291
L27	9,254	-2,282	14,775	-3,339	23,158	-0,002
L28	10,571	0,535	15,686	0,610	23,186	0,031
L29	9,770	-1,179	15,077	-2,031	21,799	-1,636
L31	10,787	0,997	15,497	-0,210	23,507	0,417
L32	9,466	-1,828	16,183	2,766	28,012	5,833
L33	10,213	-0,230	15,557	0,053	23,524	0,438
L34	9,703	-1,322	15,134	-1,782	23,373	0,256
L35	8,939	-2,957	15,337	-0,902	26,089	3,520
L36	10,970	1,390	16,190	2,798	22,518	-0,772
L37	10,950	1,345	16,141	2,583	22,454	-0,848
L38	10,105	-0,462	15,467	-0,340	23,533	0,449
L39	10,489	0,359	15,582	0,161	23,030	-0,156
L40	10,310	-0,024	15,538	-0,031	23,278	0,142
L41	10,533	0,455	15,450	-0,412	22,400	-0,914
L42	10,250	-0,152	15,483	-0,268	23,217	0,068
L43	10,233	-0,187	15,500	-0,196	23,317	0,188
L44	10,013	-0,659	14,684	-3,733	20,096	-3,684
L45	10,081	-0,513	15,578	0,144	22,973	-0,224
-	-	-	-	-	-	-
Statistical method	ISO 13528		ISO 13528		ISO 13528	
Assessment	Z <=3,000		Z <=3,000		Z <=3,000	

	D10	Z score	D50	Z score	D90	Z score
No. of laboratories that submitted results	44		44		44	
Assigned value	10,321		15,545		23,160	
SDPA	0,467		0,231		0,832	
Repeatability s.d.	0,042		0,047		0,122	
Rel. SDPA	4,53 %		1,48 %		3,59 %	
Rel. repeatability s.d.	0,40 %		0,30 %		0,53 %	
Percentage of satisfactory scores	90,91 %		84,09 %		88,64 %	

Summary of laboratory means



Sample Barium Titanate

	D10	Z score	D50	Z score	D90	Z score
Unit	µm		µm		µm	
L01	0,464	-0,043	0,678	-0,749	1,168	-0,852
L02	0,338	-1,519	0,743	-0,367	1,559	0,053
L03	0,628	1,877	1,471	3,929	3,176	3,804
L04	0,163	-3,571	0,506	-1,762	1,419	-0,272
L05	0,567	1,162	0,965	0,943	1,633	0,224
L06	0,480	0,144	0,782	-0,134	1,181	-0,824
L07	0,444	-0,283	0,847	0,250	1,602	0,154
L08	0,472	0,054	0,942	0,808	1,720	0,427
L09	0,454	-0,160	0,879	0,437	1,618	0,192
L10	1,367	10,520	2,921	12,488	6,056	10,486
L11	0,378	-1,055	0,682	-0,725	1,352	-0,426
L12	0,467	-0,014	0,688	-0,690	1,253	-0,656
L13	0,583	1,343	1,026	1,306	1,789	0,588
L14	0,688	2,572	1,343	3,177	2,545	2,341
L15	0,497	0,343	0,750	-0,322	1,069	-1,082
L16	0,388	-0,929	0,686	-0,701	1,357	-0,416
L17	0,817	4,085	1,226	2,484	1,894	0,830
L18	0,301	-1,954	0,566	-1,412	1,045	-1,139
L19	0,395	-0,847	0,696	-0,645	1,300	-0,547
L20	0,391	-0,903	0,683	-0,716	1,260	-0,640
L21	0,590	1,427	1,152	2,050	2,516	2,274
L22	0,510	0,497	0,846	0,243	1,941	0,940
L23	0,512	0,518	0,863	0,343	2,142	1,405
L24	0,504	0,429	0,811	0,038	1,964	0,993
L25	0,483	0,185	0,774	-0,184	1,889	0,819
L26	0,508	0,466	0,774	-0,184	1,579	0,100
L27	0,407	-0,708	0,791	-0,082	1,377	-0,368
L28	0,496	0,329	0,807	0,012	1,304	-0,538
L29	0,443	-0,291	0,705	-0,591	1,149	-0,898
L31	0,451	-0,195	0,667	-0,813	1,131	-0,939
L32	0,451	-0,193	0,670	-0,794	1,154	-0,886
L33	0,421	-0,541	0,776	-0,172	1,455	-0,187
L34	0,459	-0,104	0,894	0,526	1,647	0,258
L35	0,323	-1,697	0,662	-0,841	1,120	-0,964
L36	0,432	-0,412	0,621	-1,082	1,107	-0,995
L37	0,579	1,304	1,010	1,212	2,347	1,881
L38	0,439	-0,334	0,823	0,108	1,503	-0,075
L39	0,443	-0,295	0,727	-0,460	1,194	-0,794
L40	0,402	-0,767	0,728	-0,453	1,386	-0,347
L41	0,409	-0,681	0,693	-0,658	1,195	-0,790
L42	0,495	0,321	0,941	0,801	1,640	0,242
L43	0,543	0,879	1,187	2,252	2,200	1,541
L44	0,410	-0,675	0,729	-0,448	1,498	-0,087
L45	0,470	0,031	0,585	-1,296	0,713	-1,910
-	-	-	-	-	-	-
Statistical method	ISO 13528		ISO 13528		ISO 13528	
Assessment	Z <=3,000		Z <=3,000		Z <=3,000	

	D10	Z score	D50	Z score	D90	Z score
No. of laboratories that submitted results	44		44		44	
Assigned value	0,468		0,805		1,536	
SDPA	0,085		0,169		0,431	
Repeatability s.d.	0,006		0,014		0,040	
Rel. SDPA	18,27 %		21,06 %		28,07 %	
Rel. repeatability s.d.	1,36 %		1,79 %		2,63 %	
Percentage of satisfactory scores	90,91 %		86,36 %		90,91 %	



Results of laboratory evaluation

Laboratory	Number	Within tolerance	Percentage	Successful
L01	9	9	100,00	Yes
L02	9	9	100,00	Yes
L03	9	7	77,78	No
L04	9	8	88,89	Yes
L05	9	9	100,00	Yes
L06	9	9	100,00	Yes
L07	9	9	100,00	Yes
L08	9	9	100,00	Yes
L09	9	9	100,00	Yes
L10	9	5	55,56	No
L11	9	9	100,00	Yes
L12	9	9	100,00	Yes
L13	9	9	100,00	Yes
L14	9	8	88,89	Yes
L15	9	9	100,00	Yes
L16	9	9	100,00	Yes
L17	9	6	66,67	No
L18	9	6	66,67	No
L19	9	9	100,00	Yes
L20	9	9	100,00	Yes
L21	9	9	100,00	Yes
L22	9	8	88,89	Yes
L23	9	8	88,89	Yes
L24	9	8	88,89	Yes
L25	9	8	88,89	Yes
L26	9	9	100,00	Yes
L27	9	8	88,89	Yes
L28	9	9	100,00	Yes
L29	9	9	100,00	Yes
L31	9	9	100,00	Yes
L32	9	8	88,89	Yes
L33	9	9	100,00	Yes
L34	9	9	100,00	Yes
L35	9	8	88,89	Yes
L36	9	9	100,00	Yes
L37	9	9	100,00	Yes
L38	9	9	100,00	Yes
L39	9	9	100,00	Yes
L40	9	9	100,00	Yes
L41	9	9	100,00	Yes
L42	9	9	100,00	Yes
L43	9	9	100,00	Yes
L44	9	7	77,78	No
L45	9	9	100,00	Yes