BRNO UNIVERSITY OF TECHNOLOGY

FACULTY OF CIVIL ENGINEERING
institute of building testing

ilac-MRA

Z 7008

FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program
Mechanical Properties of Plastics
ZVP 2026/1

Brno University of Technology
Proficiency testing provider at the SZK FAST
Veveří 95, Brno 602 00
Czech Republic

www.szk.fce.vutbr.cz
www.ptprovider.cz

Date: August 24, 2026

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1 Introduction and Important Contacts

At the beginning of the year 2026, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZVP 2026/1 whose aim was to verify and assess the conformity of test results across laboratories when testing plastics. The assessment of the results of the Proficiency Testing Program was carried out by a committee consisting of the following PT Provider employees:

Head of the PT Provider, PTP coordinator

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The subjects of proficiency testing were the following testing procedures:

1. EN ISO 527-1, 2 (Tensile modulus) [1, 2]
2. EN ISO 527-1, 2 (Stress at yield, Strain at yield) [1, 2]
3. EN ISO 527-1, 2 (Stress at yield) [1, 2]
4. EN ISO 178 (Flexural modulus) [3]
5. EN ISO 178 (Flexural strength, Flexural strain at flexural strength) [3]
6. EN ISO 179-1 (Charpy unnotched impact strength) [4]
7. EN ISO 179-1 (Charpy notched impact strength (note: notch made by distributor)) [4]
8. EN ISO 179-1 (Charpy notched impact strength (note: notch made by laboratory)) [4]
9. EN ISO 868 (Shore hardness D) [5]
10. EN ISO 306 (Vicat softening temperature VST/A/50) [6]
11. EN ISO 306 (Vicat softening temperature VST/B/50) [6]
12. EN ISO 75-1, -2 (Temperature of deflection under load, method A) [7, 8]
13. EN ISO 75-1, -2 (Temperature of deflection under load, method B) [7, 8]
14. EN ISO 1183-1 (Density) [9]
15. EN ISO 11357-1, -3 (Melting temperature T_{m1}, Enthalpy of fusion ΔH_{m1}) [10, 11]
16. EN ISO 1133-1 (Melt mass-flow rate) [12]
17. EN ISO 1628-1, -5 (Viscosity) [13, 14]
18. EN ISO 11358-1 (Filler content) [15]
19. ISO 3795 (Burning Rate) [16]

Due to the low number of participants, only testing procedures **No 1, 4, 5, 9, 12, 14, 15, 16, 17 and 18** were opened.

The supplier, UNIPETROL RPA, s.r.o. – POLYMER INSTITUTE BRNO, odštěpný závod, was responsible for the preparation of testing samples for the PTP. The supplier was also responsible for the homogeneity and stability of the testing samples, which were distributed among the individual PTP participants in such a way that their properties could not be affected.

The test results from individual PTP participants were compared via a method involving the statistical analysis of all their results in a manner complying with ISO 5725-2 [17], ISO 13528 [18] and EN ISO/IEC 17043 [19]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

10 laboratories took part in PTP. In order to maintain the anonymity of the PTP, each laboratory was given an identification number that will be used henceforth in this document. An integral part of the present final report is a Certificate of Participation in the Proficiency Testing Program. It is unique for each participant and includes the participant's ID used in this report. The following table shows the participation of laboratories in individual parts of the PTP.

Table 1: Participation of individual laboratories in the PTP

ID / Method	1	4	5	9	12	14	15	16	17	18
d6aa79	X	-	X	-	-	-	-	-	X	-
b81fb0	X	X	X	X	X	X	X	X	-	X
d4fccc	-	-	-	-	-	-	-	X	-	-
d2396a	-	X	X	X	X	X	X	X	X	-
8d26a1	-	-	-	-	-	-	-	-	-	X
dfdd55	X	X	X	X	X	X	X	X	X	X
fbf170	-	-	-	-	-	-	-	X	-	-
1875c4	X	-	-	X	-	-	-	-	-	-
d5e138	-	-	-	-	-	-	X	-	-	X
26616b	X	X	X	X	X	X	X	X	X	X

Table 2: List of participants (laboratories) – the order in the table does not correspond to the identification number in the previous table

Laboratory	Address	Accr. No
Centexbel	Technologiepark 70, ZWIJNAARDE, 9052, Belgium	-
John von Neumann University	10. Izsáki Street, Kecskemét, H-6000, Hungary	NAH-1-1958/2026
KTI Építésügyi Minőségellenőrző Vizsgáló és Műszaki Értékelő Főosztály Vizsgálati Munkacsoport	Than Károly u. 3-5., Budapest, 1119, Magyarország	NAH-1-1110/2023/K
ORLEN Unipetrol RPA s.r.o. - POLYMER INSTITUTE BRNO, odštěpný závod	Tkalcovská 36/2, Brno, 602 00, Česká republika	1380
ORLEN Unipetrol RPA s.r.o. - POLYMER INSTITUTE BRNO, odštěpný závod	Tkalcovská 36/2, Brno, 602 00, Česká republika	-

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Laboratory	Address	Accr. No
Research and Certification Center for Building Materials Ltd	district "Druzhba 1" , 14 Asen Yordanov Blvd., Sofia, 1592, Bulgaria	-
Sieć Badawcza Łukasiewicz - Instytut Materiałów Polimerowych	ul. Chorzowska 50A, Gliwice, 44-100, Polska	AB 163
Testing Laboratory for Construction Products	Ilia Beshkov str., No. 1, Sofia, 1528, Sofia	-
UAB "Jungtinės sistemos"	Linkmenu st. 25, Vilnius, 08217, Lithuania	-
VÚSAPL a.s.	Novozámocká 5154/179 C, Nitra, 949 05, Slovensko	-

2 Procedures used in the Statistical Analysis of Laboratory Results

The statistical analysis is based on the following steps:

1. Evaluation of intralaboratory variabilities by Cochran's C test: If 5% or 1% critical value is exceeded, the effect of the individual observations is first considered. If the results indicate that high participant variability is caused by a single observation, this value is excluded from the experiment, but the participant is not excluded as outlying. By overcoming 1% of the critical value, the participant's results can be marked as outlying and excluded from the experiment (symbol **X**).
2. The numerical critical evaluation of the test results using Grubbs' test: By overcoming 1% critical value, the participant's results can be marked as outlying and excluded from the experiment (symbol **X**).
3. Graphical determination of the consistency of laboratories (Mandel's statistics): The exceedance of the critical values of Mandel's statistics does not indicate that the results of the laboratories concerned are wrong; it only suggests minor inconsistencies.
4. Evaluation of descriptive statistics and, if possible, taking into account the number of observations, the repeatability and reproducibility.
5. Evaluation of the assigned value.
6. The performance evaluation: The most significant outcome of the PT Program is the so-called z-score and ζ-score (zeta-score). These characteristics assess the performance of individual participants by comparing it with the assigned value and measurement uncertainties. z-score and ζ-score are compared with limit values. The resulting ζ-score values are not taken into account during the final evaluation of the performance of participants as they are to a considerable degree dependent on the values of the measurement uncertainties of the assessed institutions. The following scales are applied for the z-score values:
   - $|z\text{-score}| < 2 \Rightarrow$ shows that the laboratory performance is **satisfactory** and generates no signal – ✓.
   - $2 \leq |z\text{-score}| < 3 \Rightarrow$ shows that the laboratory performance is **questionable** and generates an action signal – **?**.
   - $|z\text{-score}| \geq 3 \Rightarrow$ shows that the laboratory performance is **unsatisfactory** and generates an action signal – **!**.

Procedures used in the statistical analysis of proficiency testing programs can be found here: http://ptprovider.cz/?lang=en.

3 Conclusions of the Statistical Analysis

The present report summarizes the results of the Proficiency Testing Program ZVP 2026/1 (PT Program) organized by the PT Provider at the SZK FAST. 10 participants (laboratories) took part in the PT Program. PT program focused on ordinary standardized testing of plastics. The test results are evaluated separately for each observed test procedure and sample. An evaluation of statistical characteristics is included in the Appendix, as well as test results and graphic presentations. The designation of the test procedures is given in the section 1 of this report.

Legend to Table 3:
✓ – satisfactory performance; ? – questionable performance; ! – unsatisfactory performance, X – outlier

Table 3: Evaluation of participants performance

ID / Method	1	4	5	9	12	14	15	16	17	18
1875c4	✓	-	-	✓	-	-	-	-	-	-
26616b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8d26a1	-	-	-	-	-	-	-	-	-	X
b81fb0	✓	✓	✓	✓	✓	✓	✓	✓	-	✓
d2396a	-	✓	✓	✓	✓	✓	✓	✓	✓	-
d4fccc	-	-	-	-	-	-	-	✓	-	-
d5e138	-	-	-	-	-	-	✓	-	-	✓
d6aa79	✓	-	✓	-	-	-	-	-	✓	-
dfdd55	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
fbf170	-	-	-	-	-	-	-	✓	-	-

References

[1] EN ISO 527-1. *Plastics - Determination of tensile properties - Part 1: General principles*. 2019.

[2] EN ISO 527-2. *Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics*. 2012.

[3] EN ISO 178. *Plastics - Determination of flexural properties*. 2019.

[4] EN ISO 179-1. *Plastics - Determination of Charpy impact properties - Part 1: Non-instrumented impact test*. 2010.

[5] EN ISO 868. *Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)*. 2003.

[6] EN ISO 306. *Plastics - Thermoplastic materials - Determination of Vicat softening temperature (VST)*. 2014.

[7] EN ISO 75-1. *Plastics - Determination of temperature of deflection under load - Part 1: General test method*. 2013.

[8] EN ISO 75-2. *Plastics - Determination of temperature of deflection under load - Part 2: Plastics and ebonite*. 2013.

[9] EN ISO 1183-1. *Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pyknometer method and titration method*. 2019.

[10] EN ISO 11357-1. *Plastics - Differential scanning calorimetry (DSC) - Part 1: General principles*. 2017.

[11] EN ISO 11357-3. *Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization*. 2018.

[12] EN ISO 1133-1. *Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics - Part 1: Standard method*. 2012.

[13] EN ISO 1628-1. *Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscometers - Part 1: General principles*. 2009.

[14] EN ISO 1628-5. *Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscometers - Part 5: Thermoplastic polyester (TP) homopolymers and copolymers*. 2015.

[15] EN ISO 11358-1. *Plastics - Thermogravimetry (TG) of polymers - Part 1: General principles*. 2014.

[16] ISO 3795. *Road vehicles and tractors and machinery for agriculture and foresty. Determination of burning behaviour of interior materials*. 1994.

[17] ISO 5725-2. *Accuracy (trueness and precision) of measurement methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*. 2019.

[18] ISO 13 528. *Statistical methods for use in proficiency testing by interlaboratory comparisons*. 2022.

[19] EN ISO/IEC 17043. *Conformity assessment - General requirements for proficiency testing*. 2010.

1 Appendix – EN ISO 527-1, 2 (Tensile modulus)

1.1 Sample A

1.1.1 Test results

Table 4: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [MPa]	2 [MPa]	3 [MPa]	4 [MPa]	5 [MPa]	u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
1875c4	993	1460	1320	1320	1040	22.0	1367	80.8	5.91
26616b	1379	1385	1358	1392	1393	28.0	1381	14.3	1.03
dfdd55	1466	1407	1472	1526	1432	88.0	1461	45.1	3.09
b81fb0	1563	1567	1552	1440	1582	150.0	1541	57.4	3.72
d6aa79	1630	1620	1590	1650	-	21.7	1622	25.0	1.54

1.1.2 The Numerical Procedure for Determining Outliers

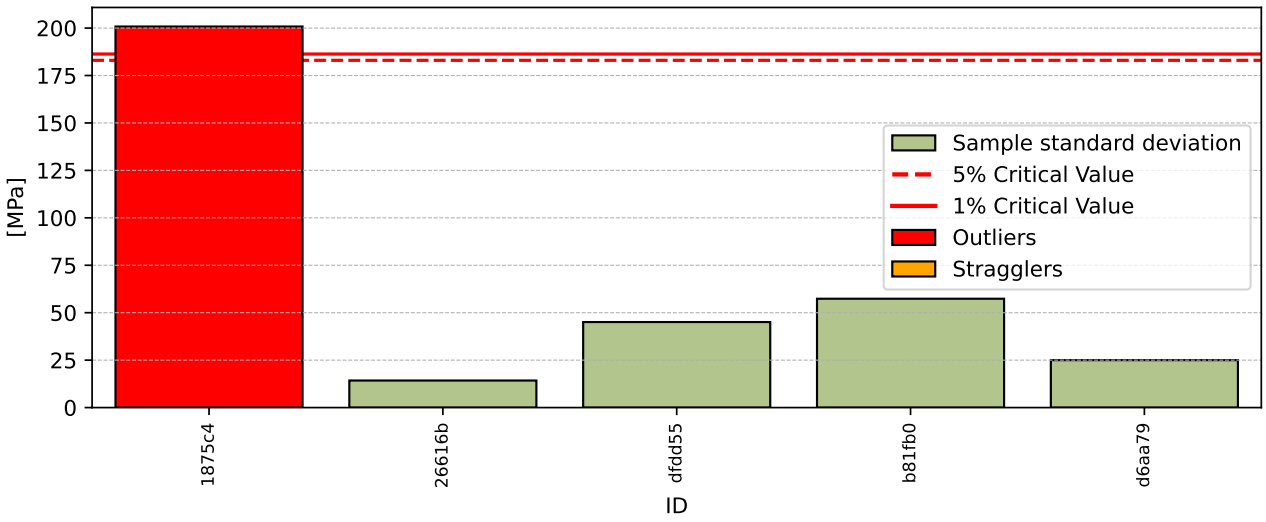

Figure 1: **Cochran's test** - sample standard deviations

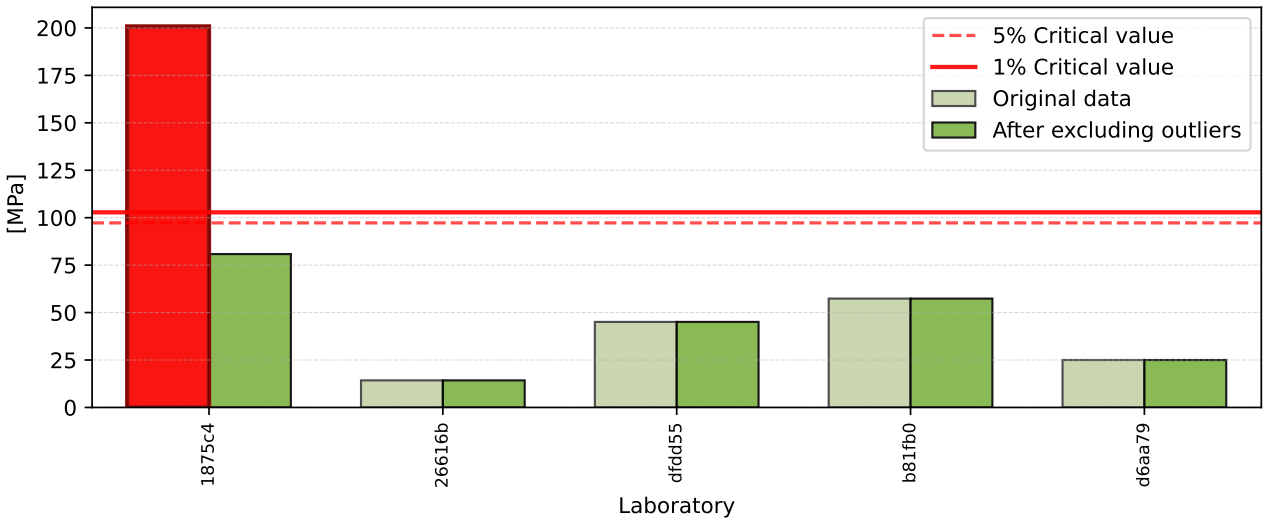

Figure 2: **Cochran's test** - sample standard deviations without outliers

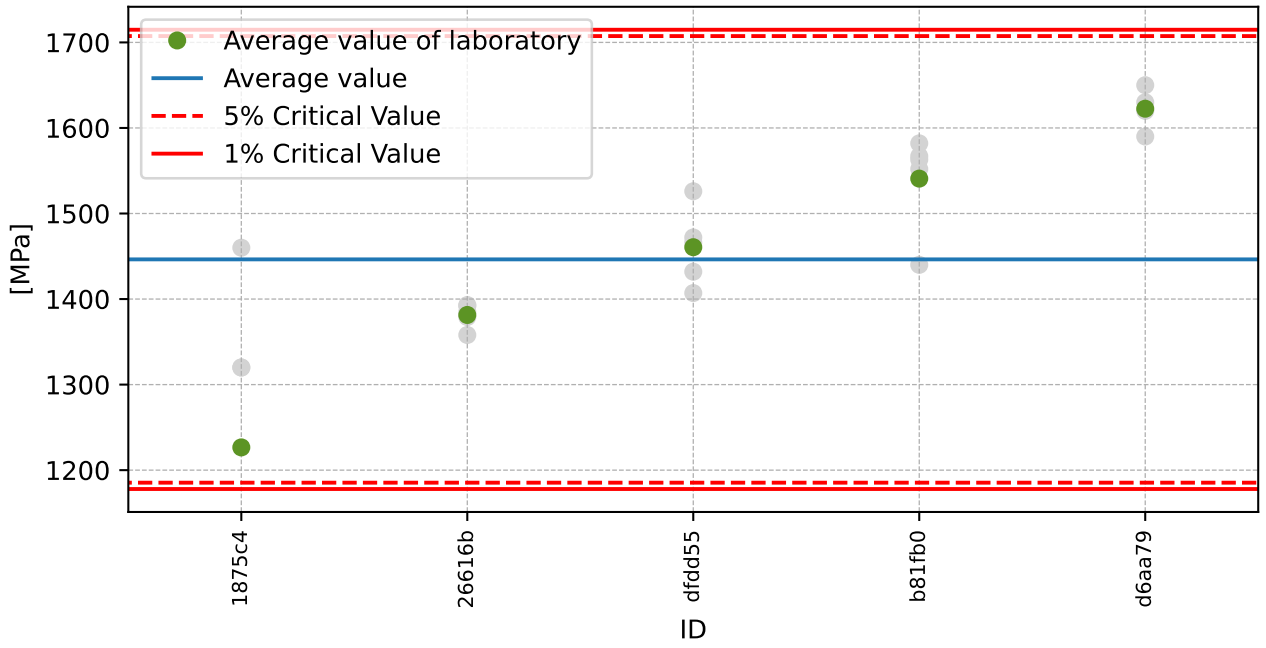

Figure 3: **Grubbs' test** - average values

1.1.3 Mandel's Statistics

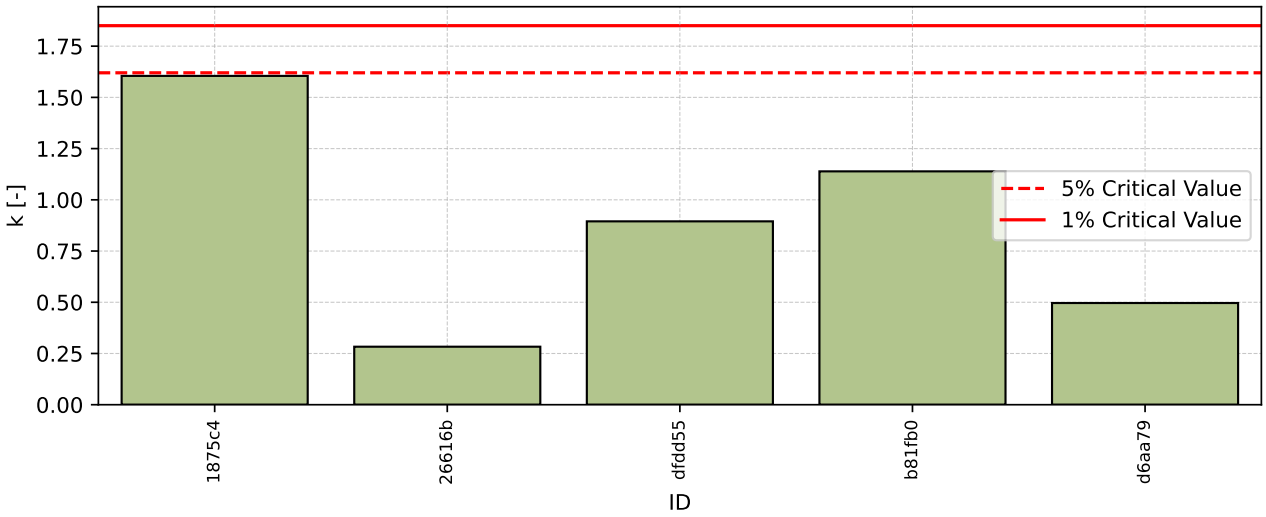

Figure 4: Intralaboratory Consistency Statistic

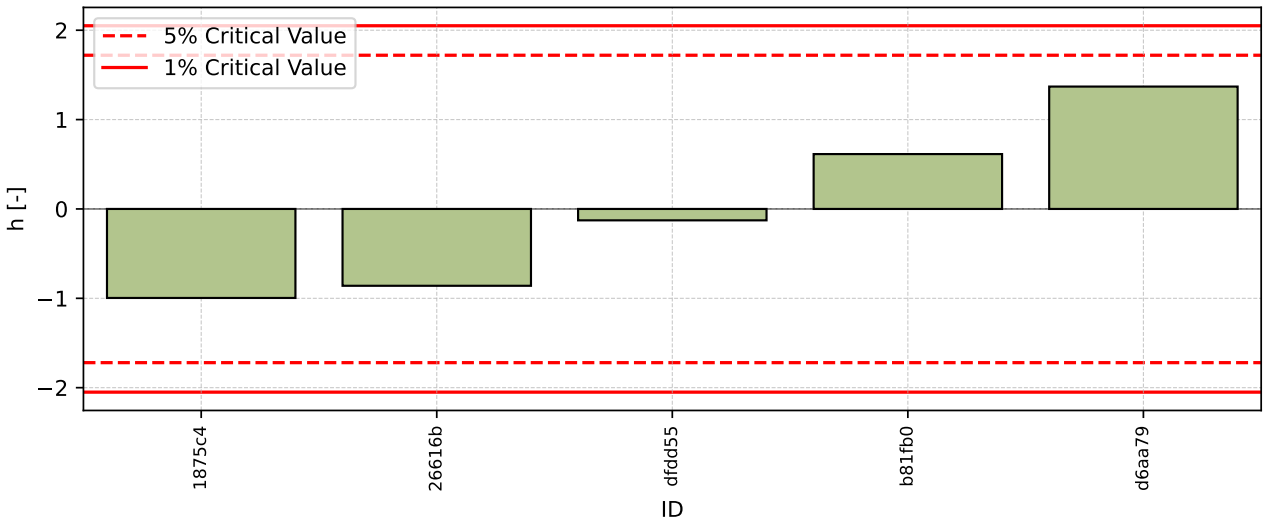

Figure 5: Interlaboratory Consistency Statistic

1.1.4 Descriptive statistics

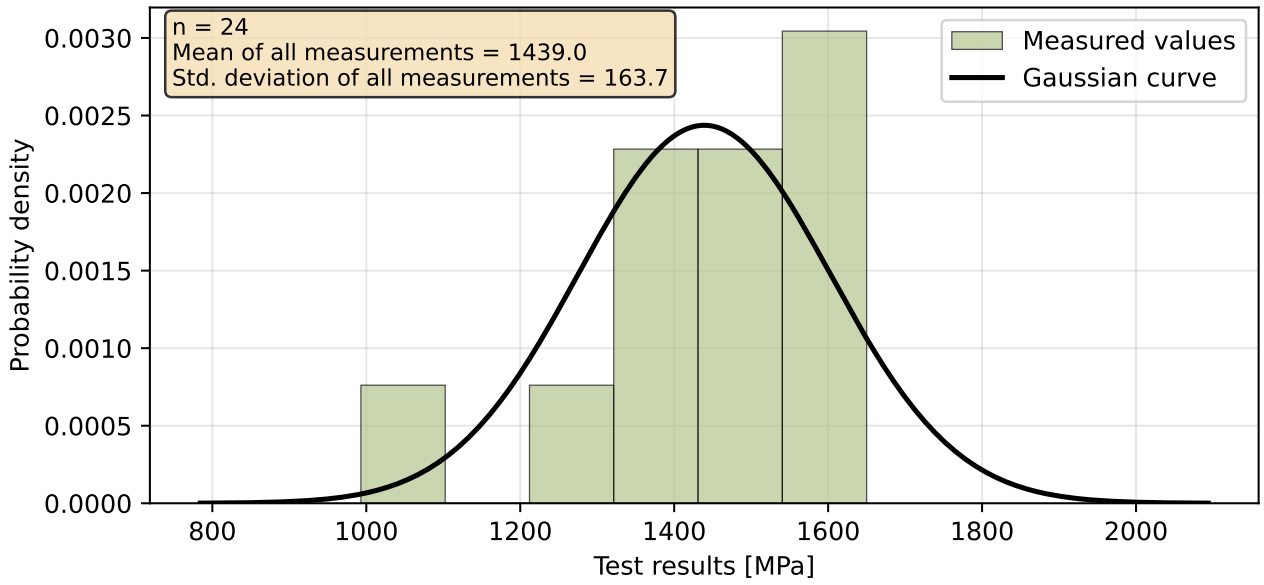

Figure 6: Histogram of all test results

Table 5: Descriptive statistics

Characteristics	**[MPa]**
Average value – $\bar{x}$	1474.4
Sample standard deviation – s	108.2
Assigned value – x^*	1474.4
Robust standard deviation – s^*	108.2
Measurement uncertainty of assigned value – u_X	48.4
p-value of normality test [-]	0.007
Interlaboratory standard deviation – s_L	105.8
Repeatability standard deviation – s_r	50.4
Reproducibility standard deviation – s_R	117.2
Repeatability – r	141.0
Reproducibility – R	328.0

1.1.5 Evaluation of Performance Statistics

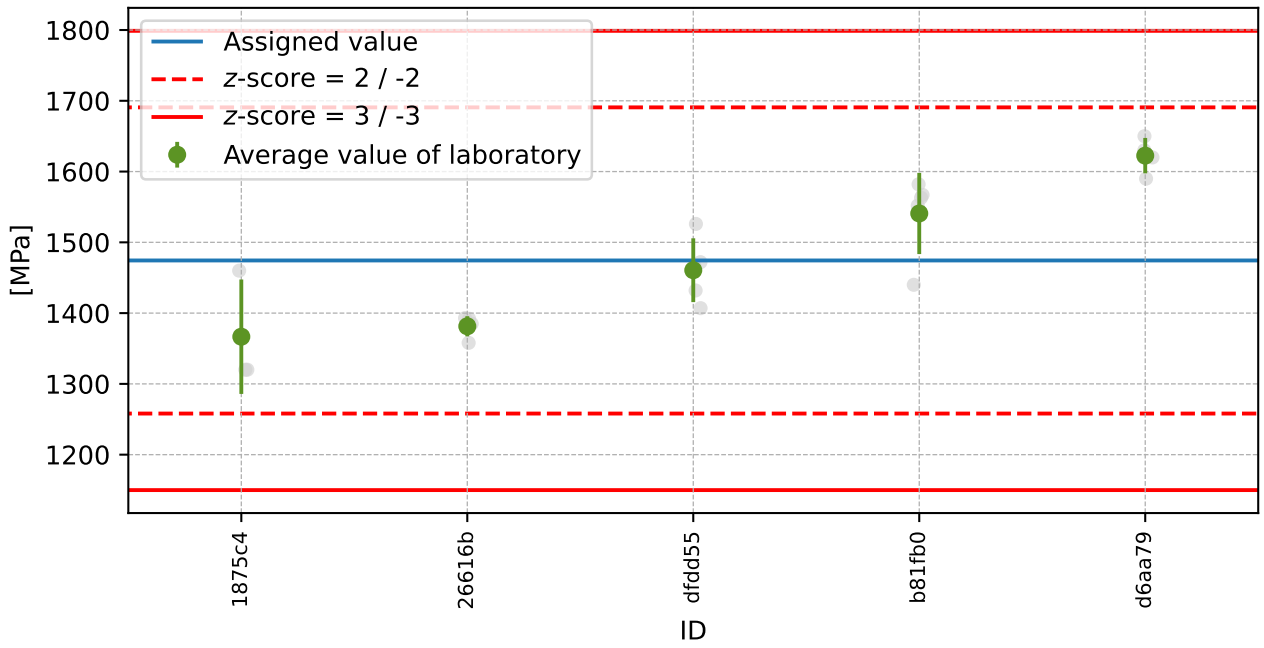

Figure 7: Average values and sample standard deviations

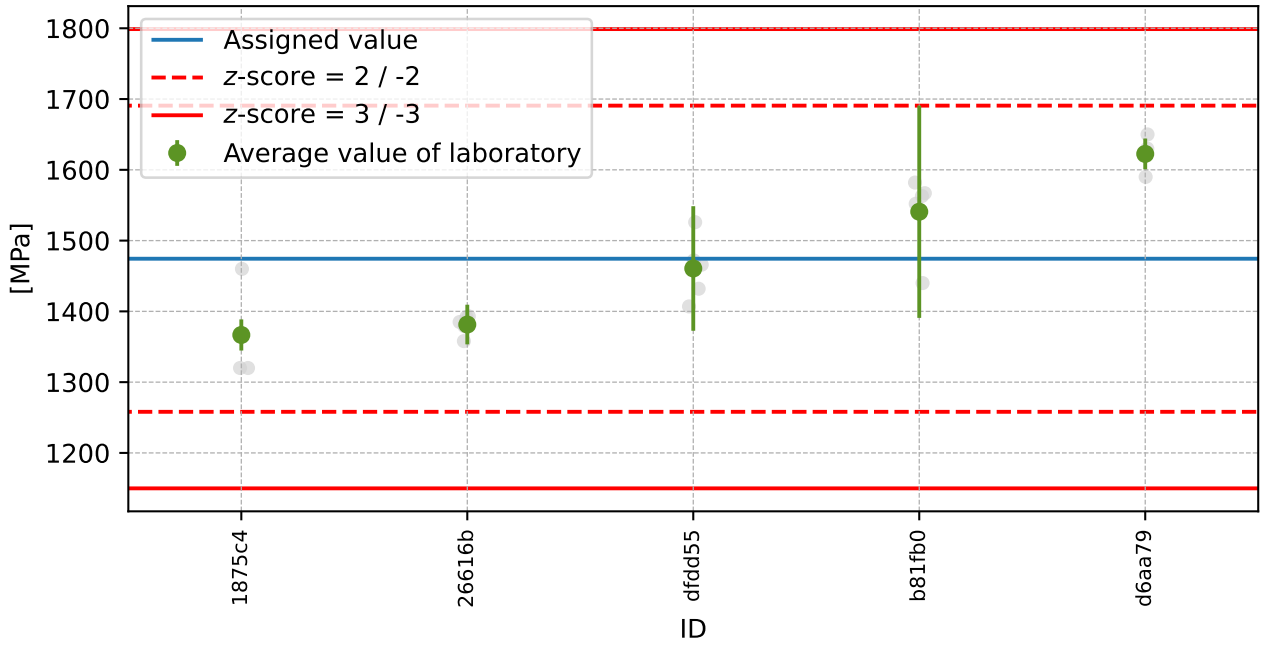

Figure 8: Average values and extended uncertainties of measurement

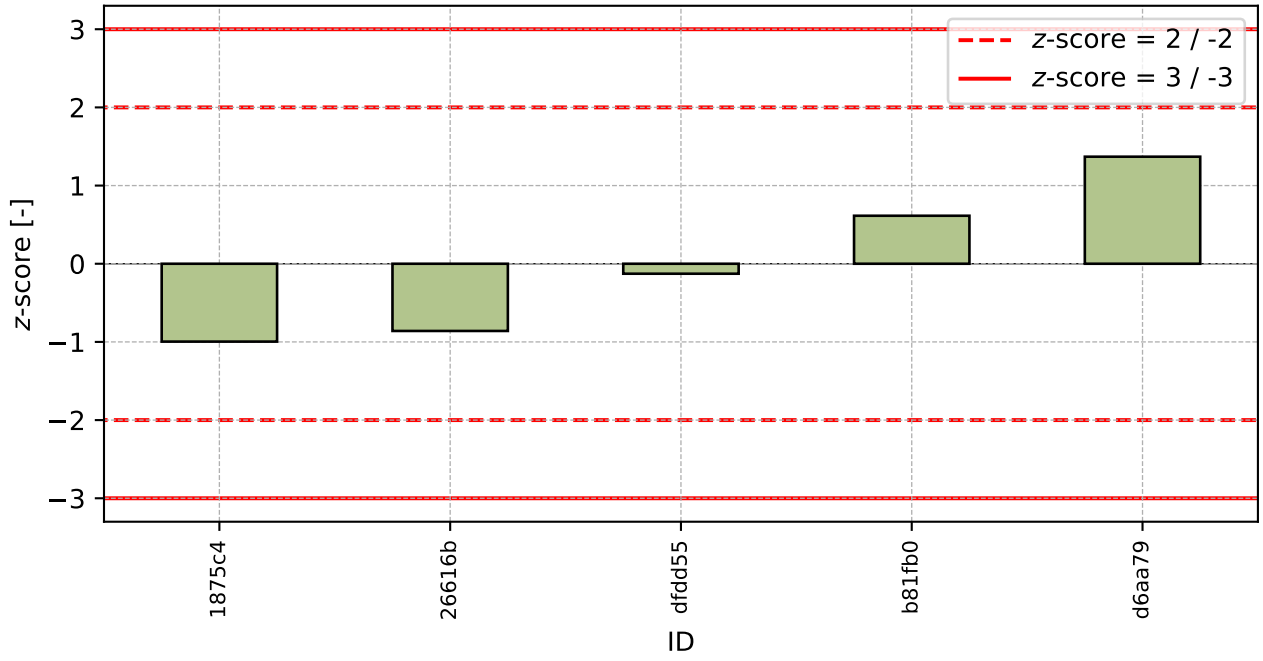

Figure 9: z-score

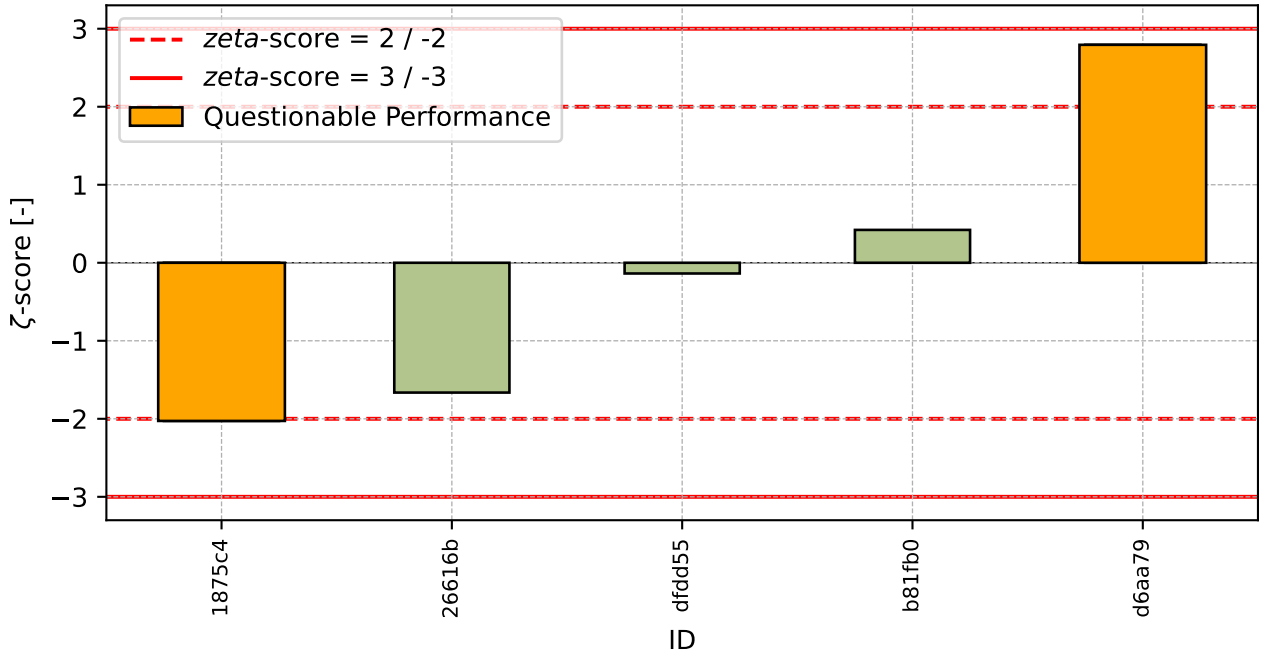

Figure 10: ζ-score

Table 6: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
1875c4	-1.00	-2.03
26616b	-0.86	-1.66
dfdd55	-0.13	-0.14
b81fb0	0.61	0.42
d6aa79	1.37	2.79

1.2 Sample B

1.2.1 Test results

Table 7: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [MPa]	2 [MPa]	3 [MPa]	4 [MPa]	5 [MPa]	u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
1875c4	1410	1810	1470	1380	2030	29.0	1420	45.8	3.23
26616b	1631	1638	1590	1546	1587	74.0	1598	37.3	2.34
b81fb0	1571	1627	1543	1676	1595	150.0	1602	51.5	3.21
dfdd55	1674	1748	1705	1720	1703	54.0	1710	27.0	1.58
d6aa79	1880	1900	1830	1920	1870	35.0	1880	33.9	1.80

1.2.2 The Numerical Procedure for Determining Outliers

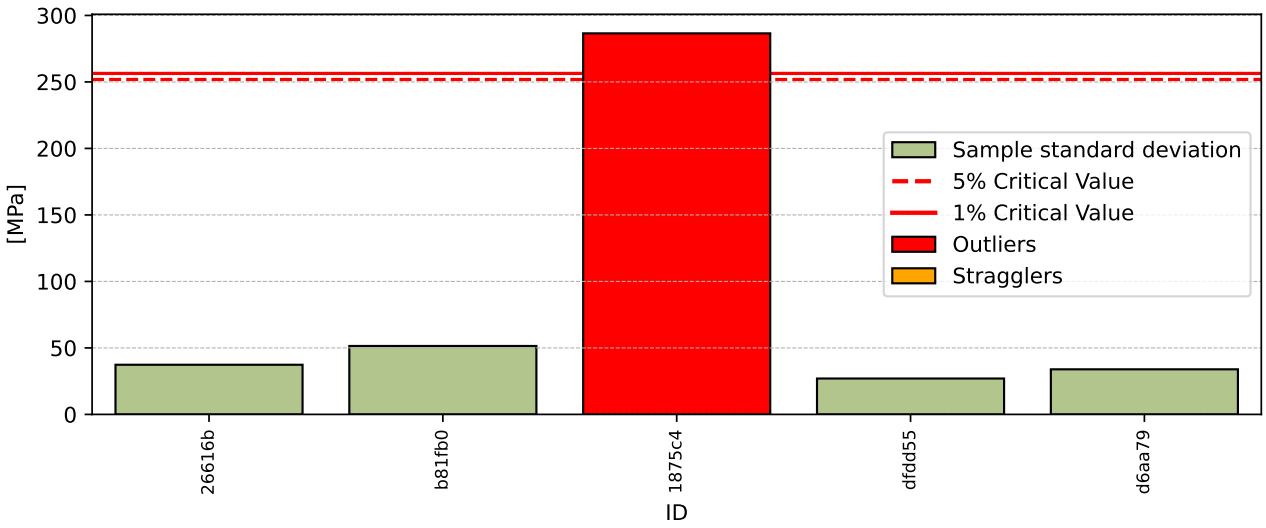

Figure 11: **Cochran's test** - sample standard deviations

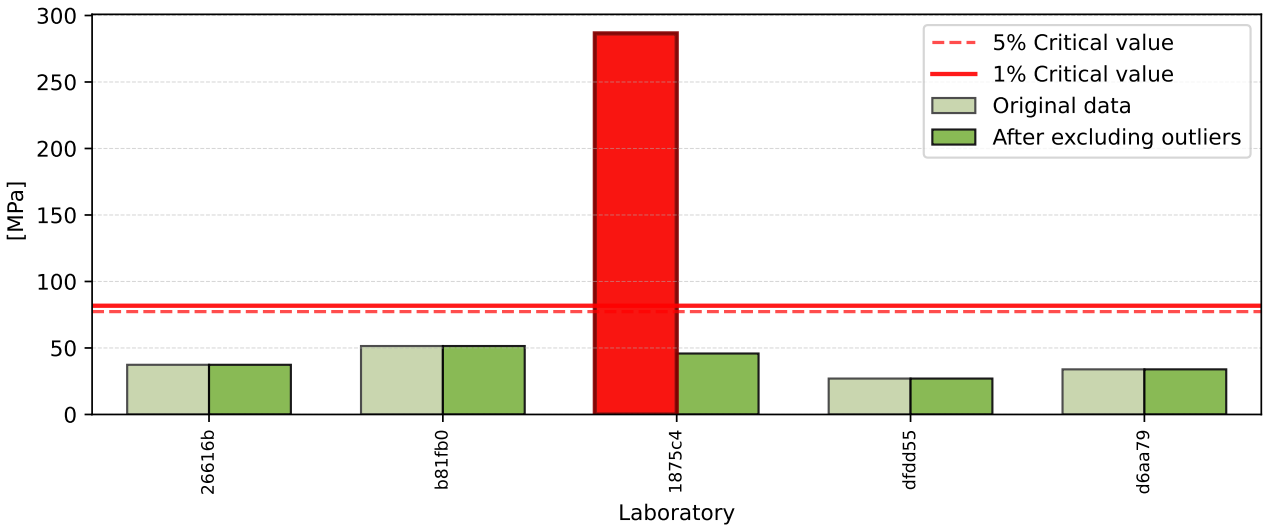

Figure 12: **Cochran's test** - sample standard deviations without outliers

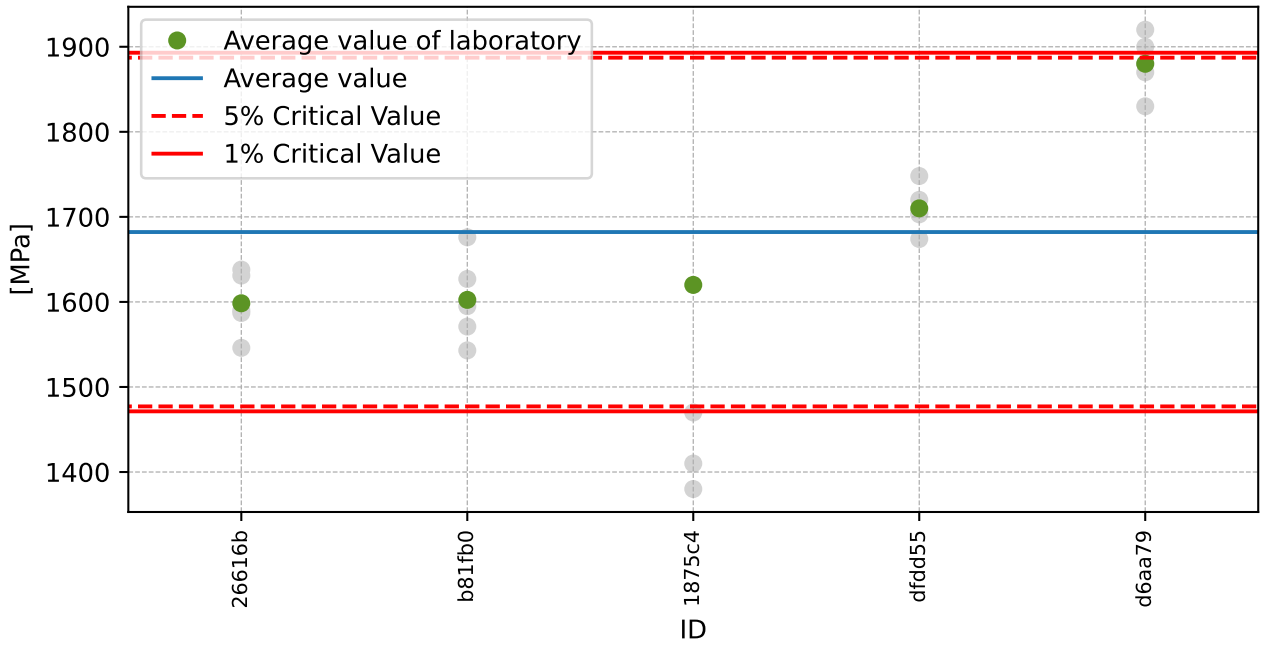

Figure 13: **Grubbs' test** - average values

1.2.3 Mandel's Statistics

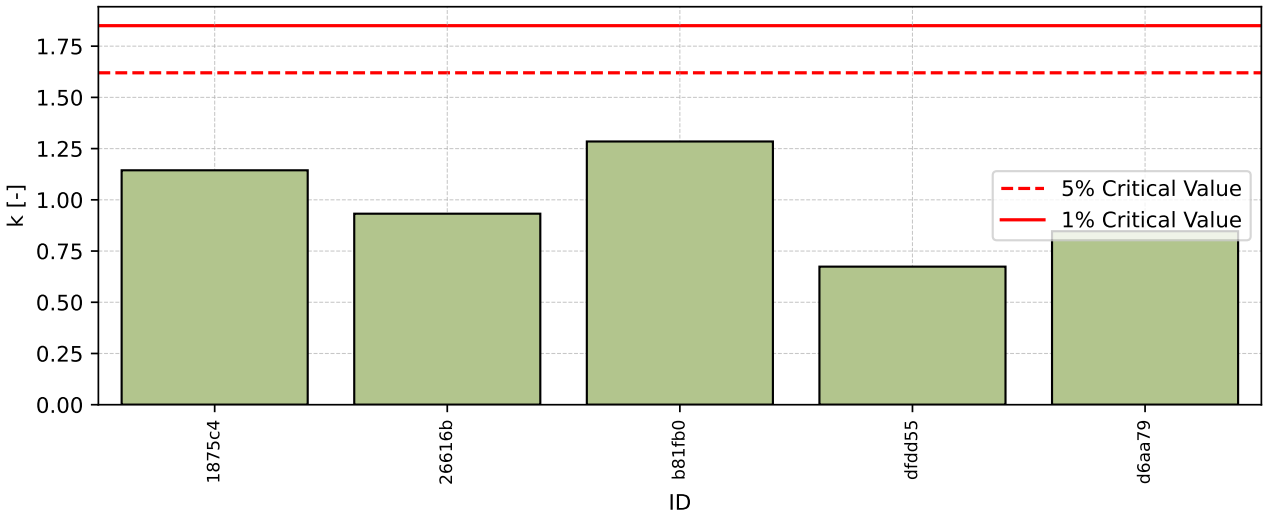

Figure 14: Intralaboratory Consistency Statistic

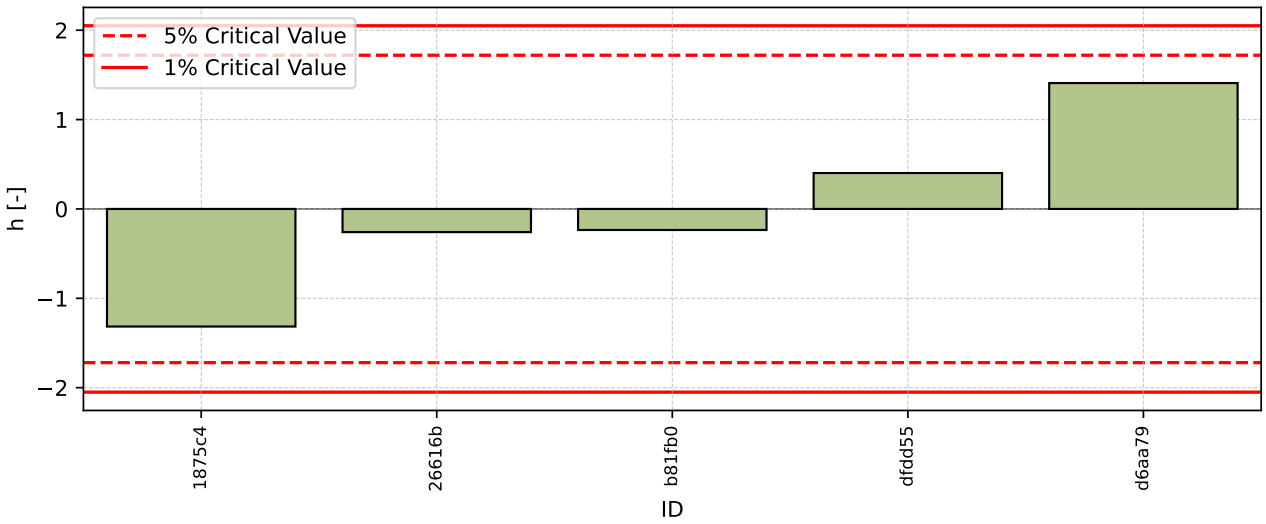

Figure 15: Interlaboratory Consistency Statistic

1.2.4 Descriptive statistics

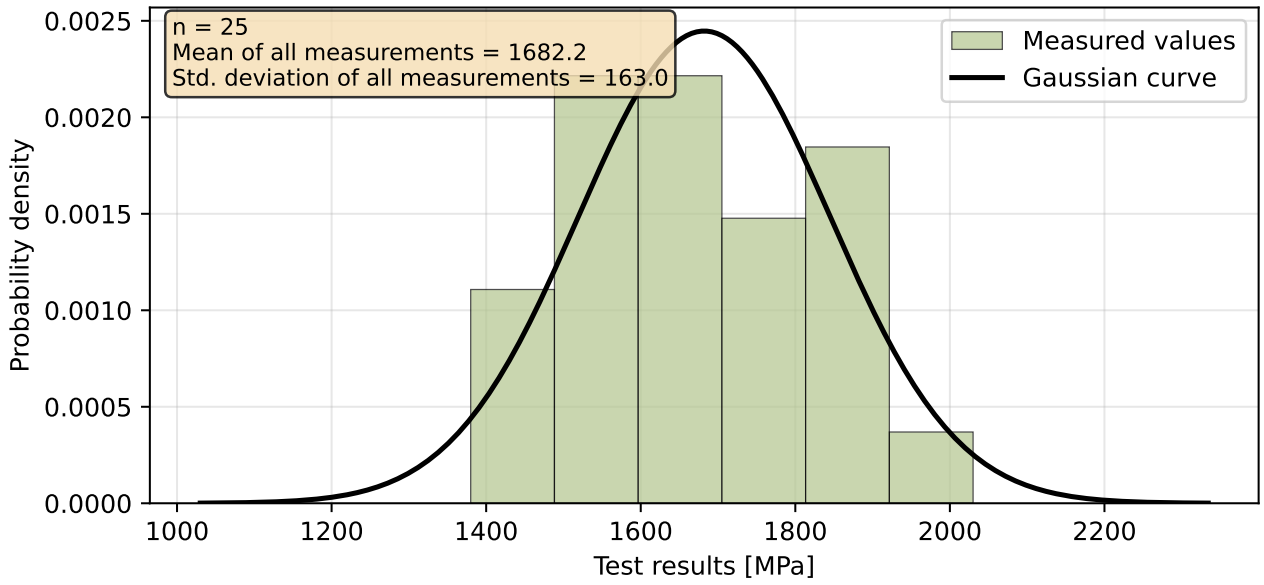

Figure 16: Histogram of all test results

Table 8: Descriptive statistics

Characteristics	**[MPa]**
Average value – $\bar{x}$	1642.2
Sample standard deviation – s	168.8
Assigned value – x^*	1642.2
Robust standard deviation – s^*	168.8
Measurement uncertainty of assigned value – u_X	75.5
p-value of normality test [-]	0.886
Interlaboratory standard deviation – s_L	167.9
Repeatability standard deviation – s_r	40.1
Reproducibility standard deviation – s_R	172.6
Repeatability – r	112.1
Reproducibility – R	483.3

1.2.5 Evaluation of Performance Statistics

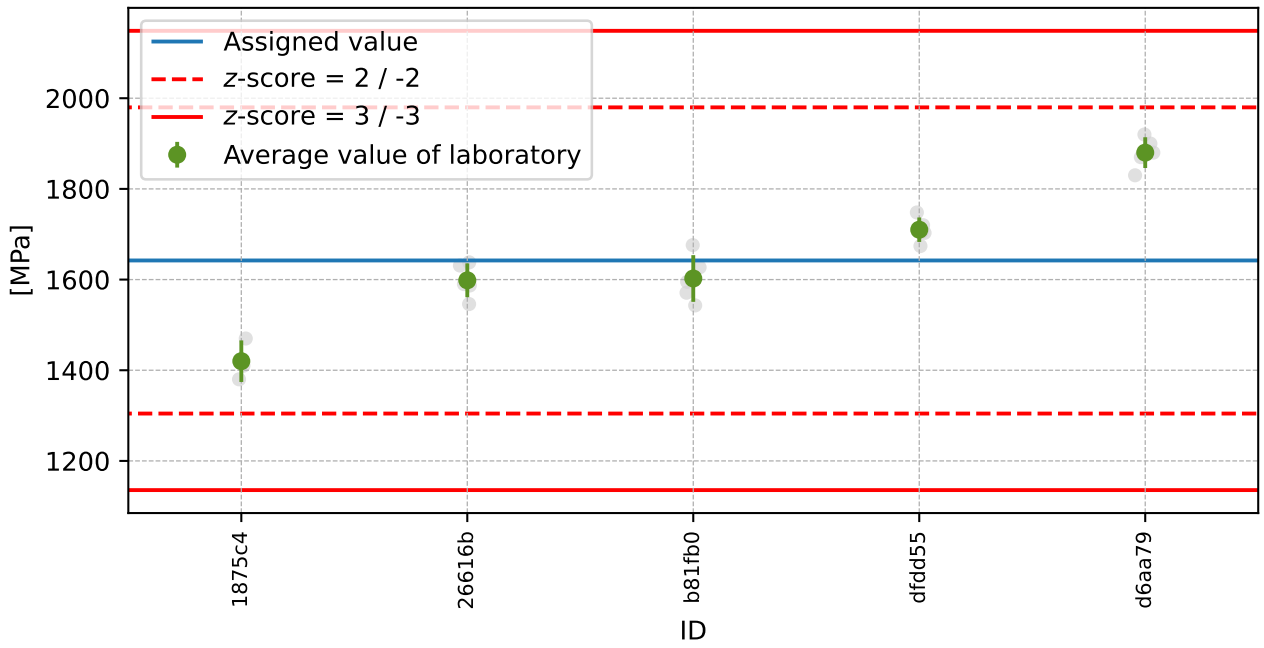

Figure 17: Average values and sample standard deviations

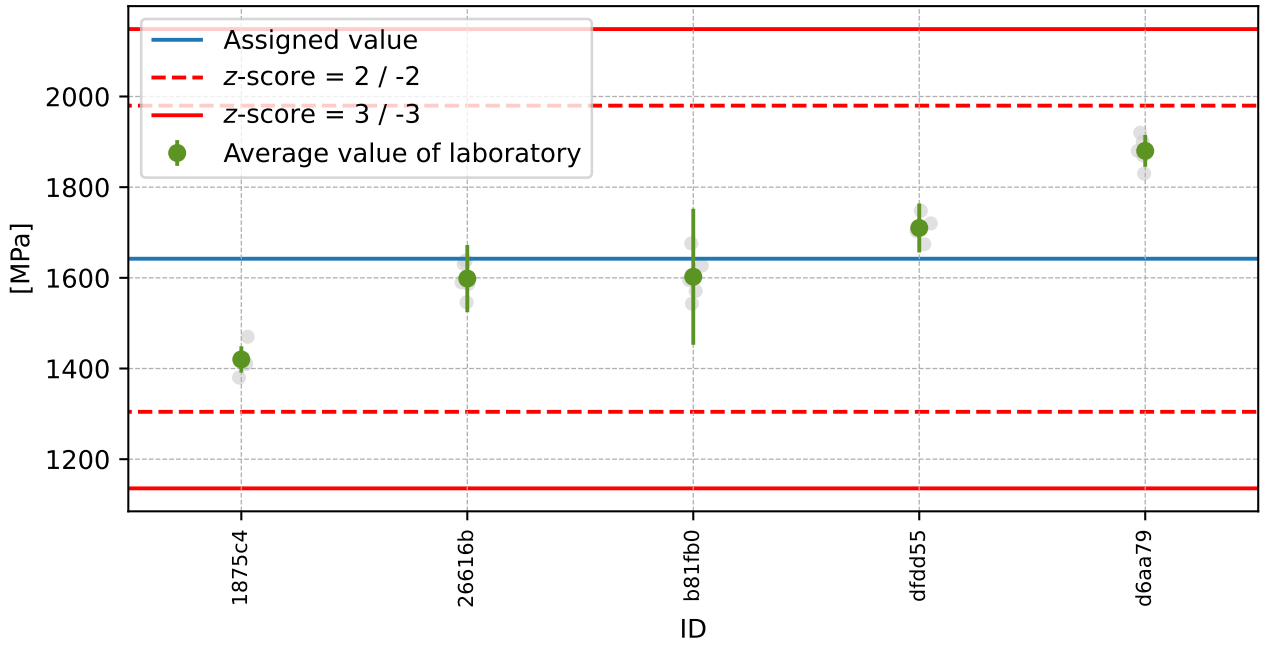

Figure 18: Average values and extended uncertainties of measurement

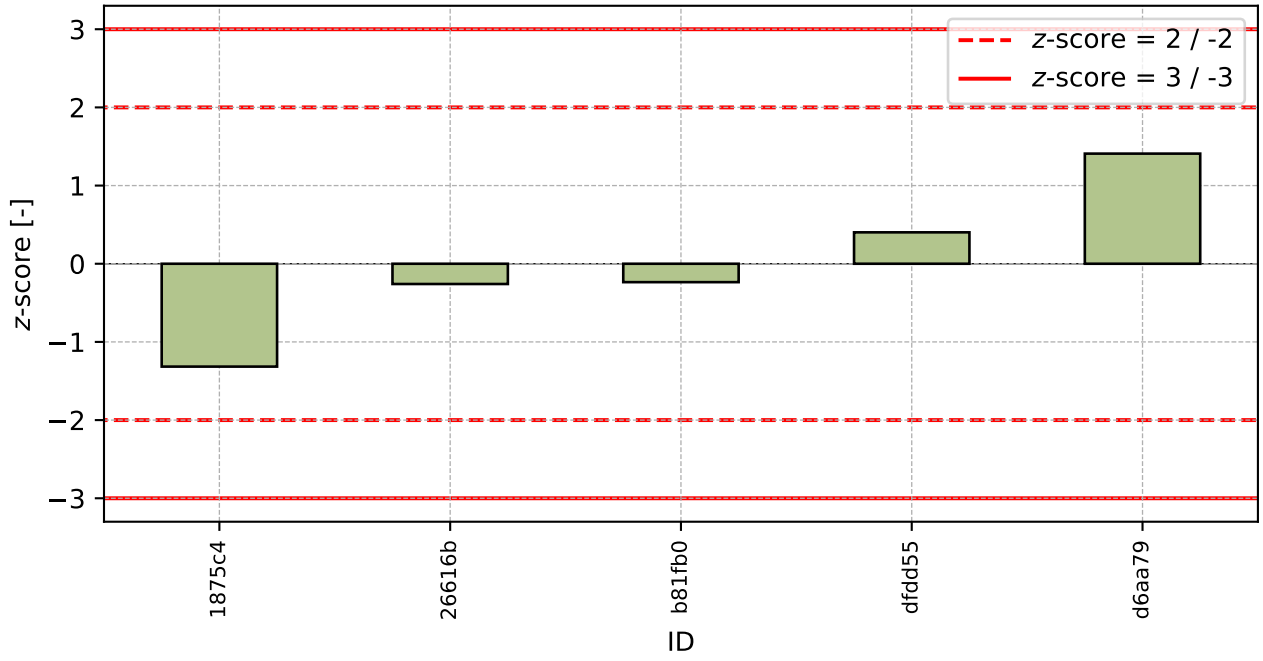

Figure 19: z-score

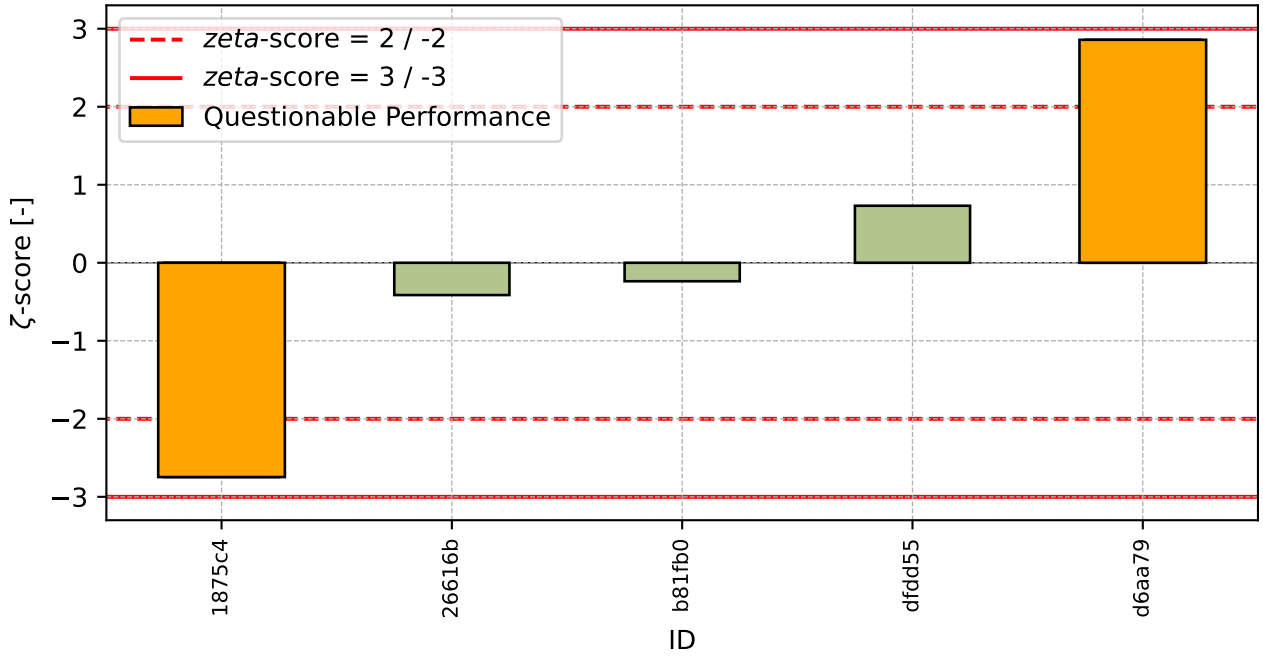

Figure 20: ζ-score

Table 9: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
1875c4	-1.32	-2.75
26616b	-0.26	-0.41
b81fb0	-0.24	-0.24
dfdd55	0.40	0.73
d6aa79	1.41	2.86

2 Appendix – EN ISO 527-1, 2 (Stress at yield, Strain at yield)

The test method was not opened due to the low number of participants.

3 Appendix – EN ISO 527-1, 2 (Stress at yield)

The test method was not opened due to the low number of participants.

4 Appendix – EN ISO 178 (Flexural modulus)

4.1 Sample A

4.1.1 Test results

Table 10: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [MPa]	2 [MPa]	3 [MPa]	4 [MPa]	5 [MPa]	u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
dfdd55	1330	1320	1330	1330	1330	12.0	1328	4.5	0.34
26616b	1420	1410	1400	1410	1410	12.0	1410	7.1	0.50
d2396a	1467	1423	1446	1430	1376	15.3	1428	33.8	2.37
b81fb0	1592	1623	1608	1573	1468	155.0	1573	61.5	3.91

4.1.2 The Numerical Procedure for Determining Outliers

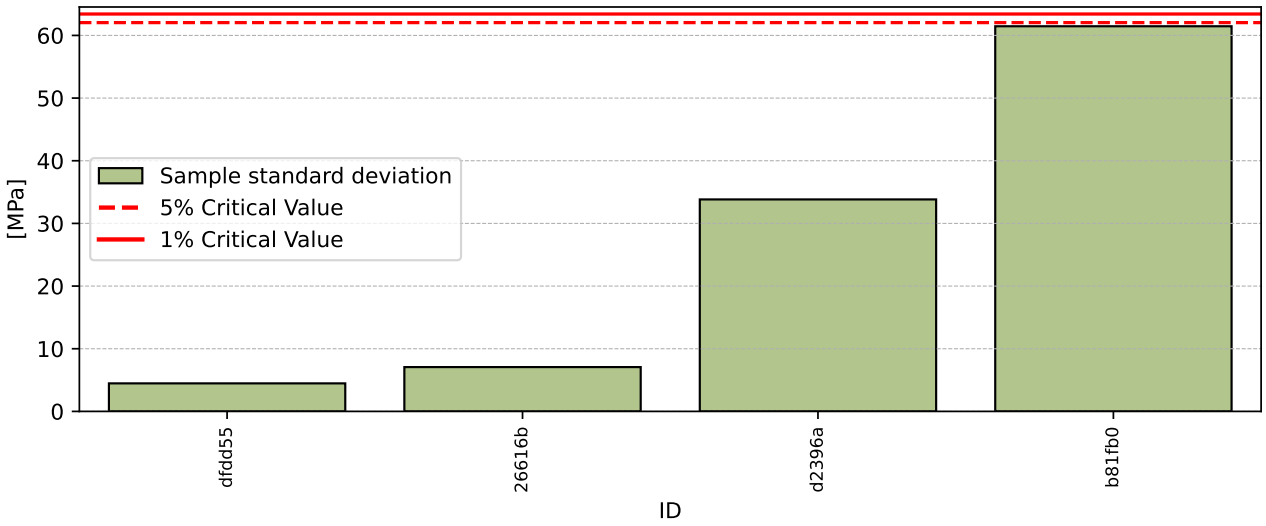

Figure 21: **Cochran's test** - sample standard deviations

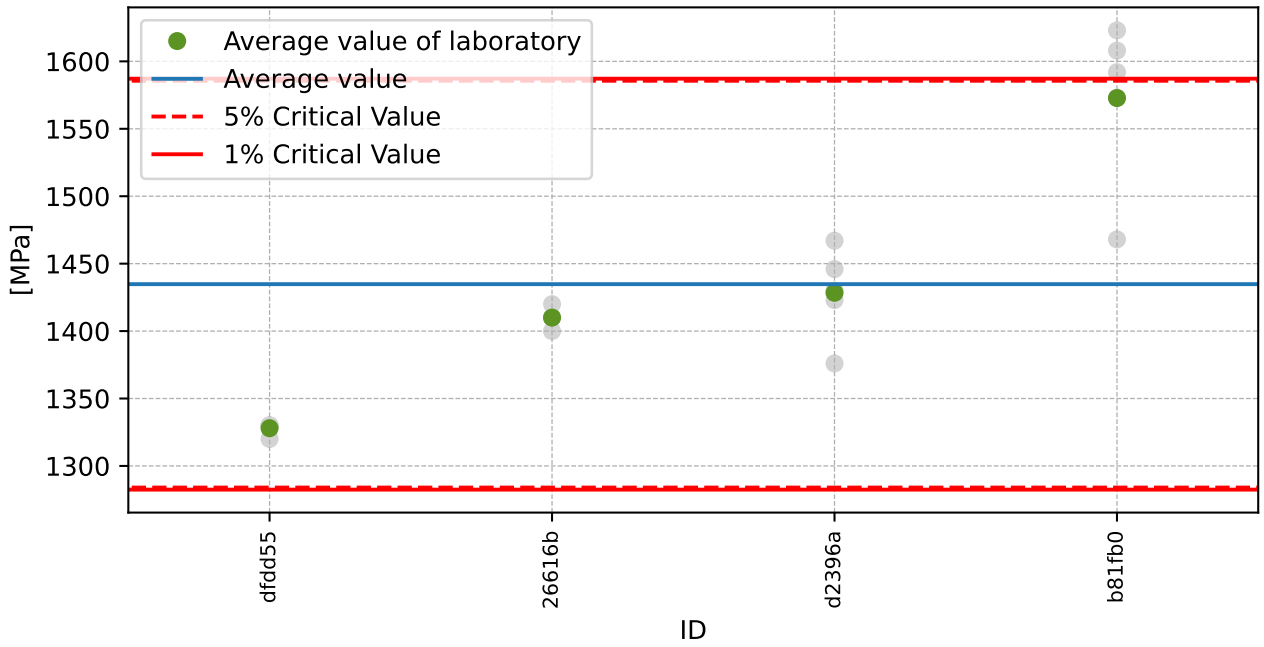

Figure 22: **Grubbs' test** - average values

4.1.3 Mandel's Statistics

Figure 23: Intralaboratory Consistency Statistic

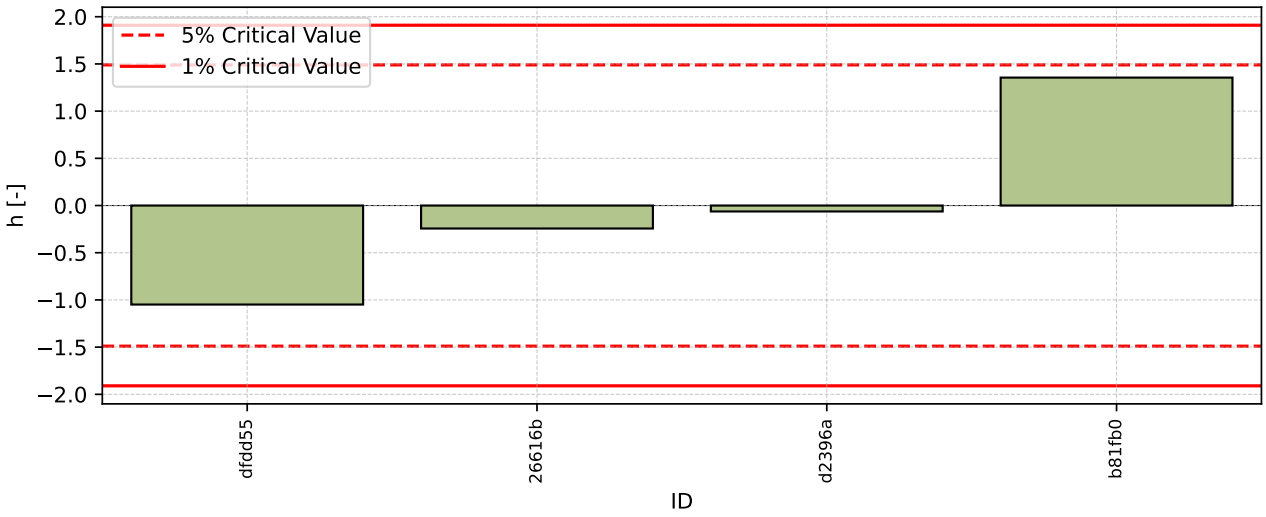

Figure 24: Interlaboratory Consistency Statistic

4.1.4 Descriptive statistics

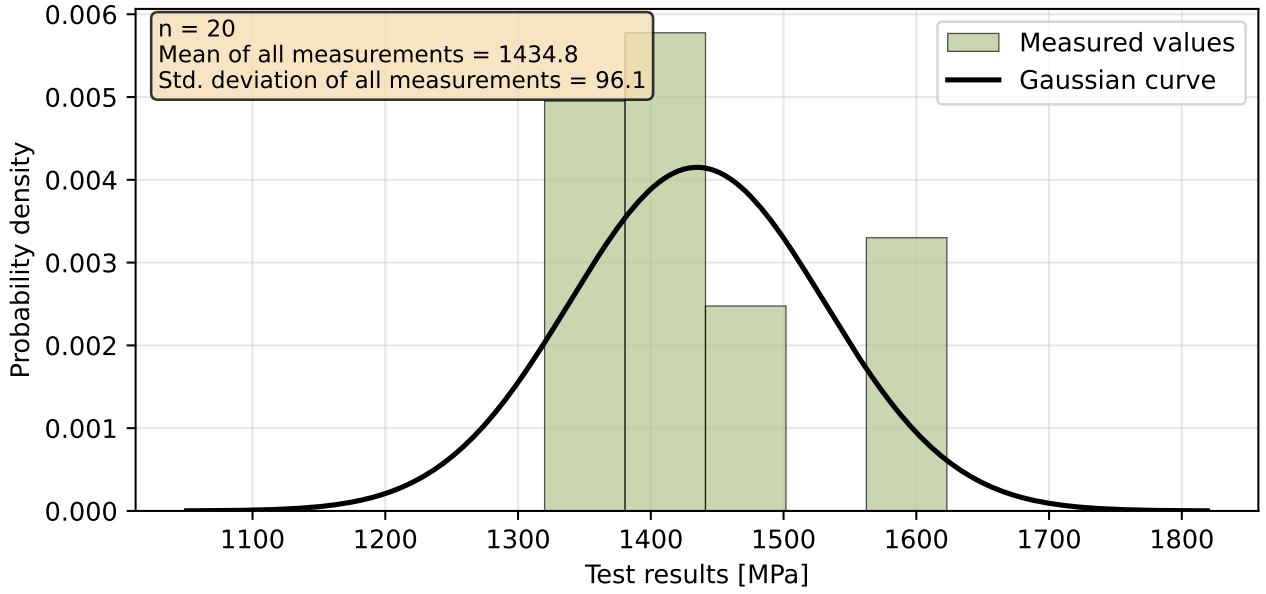

Figure 25: Histogram of all test results

Table 11: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	1434.8
Sample standard deviation – s	101.8
Assigned value – x^*	1434.8
Robust standard deviation – s^*	101.8
Measurement uncertainty of assigned value – u_X	50.9
p-value of normality test [-]	0.017
Interlaboratory standard deviation – s_L	100.6
Repeatability standard deviation – s_r	35.3
Reproducibility standard deviation – s_R	106.6
Repeatability – r	98.9
Reproducibility – R	298.5

4.1.5 Evaluation of Performance Statistics

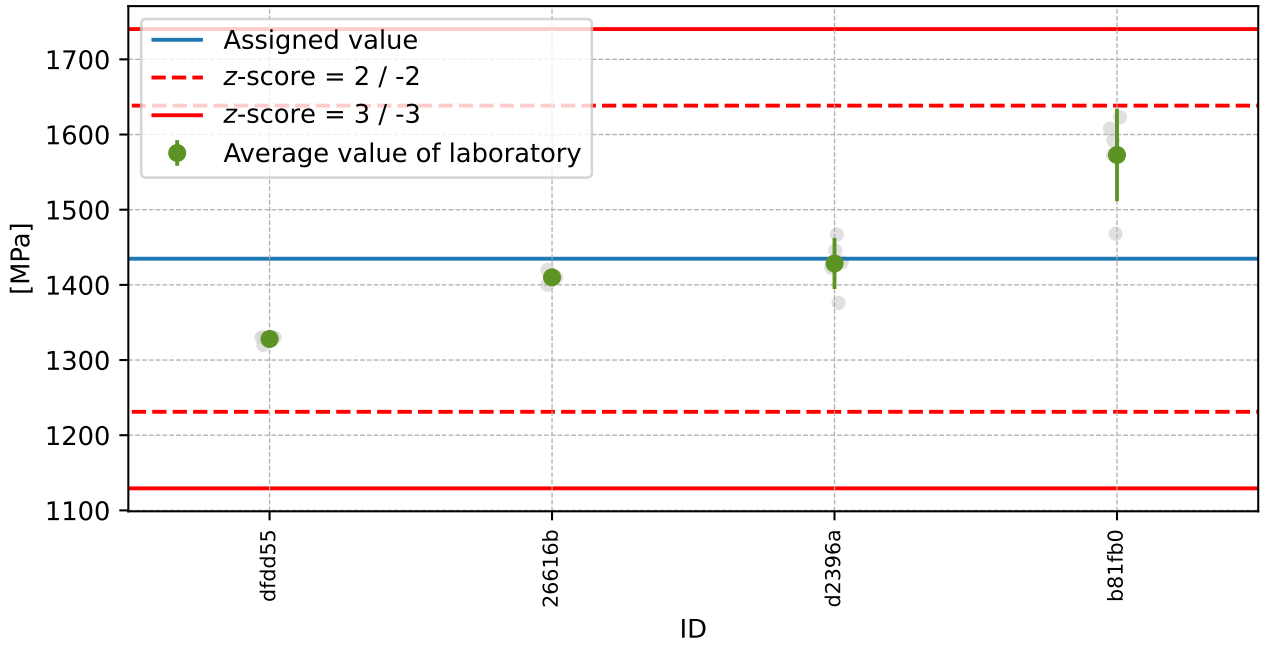

Figure 26: Average values and sample standard deviations

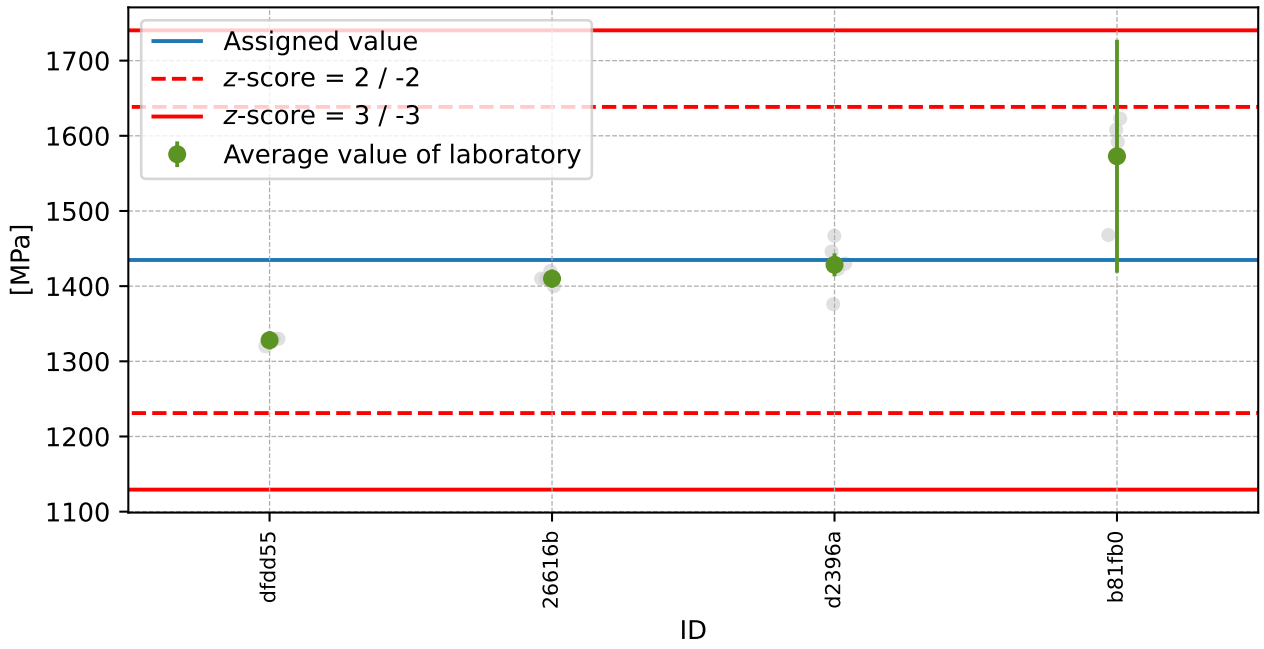

Figure 27: Average values and extended uncertainties of measurement

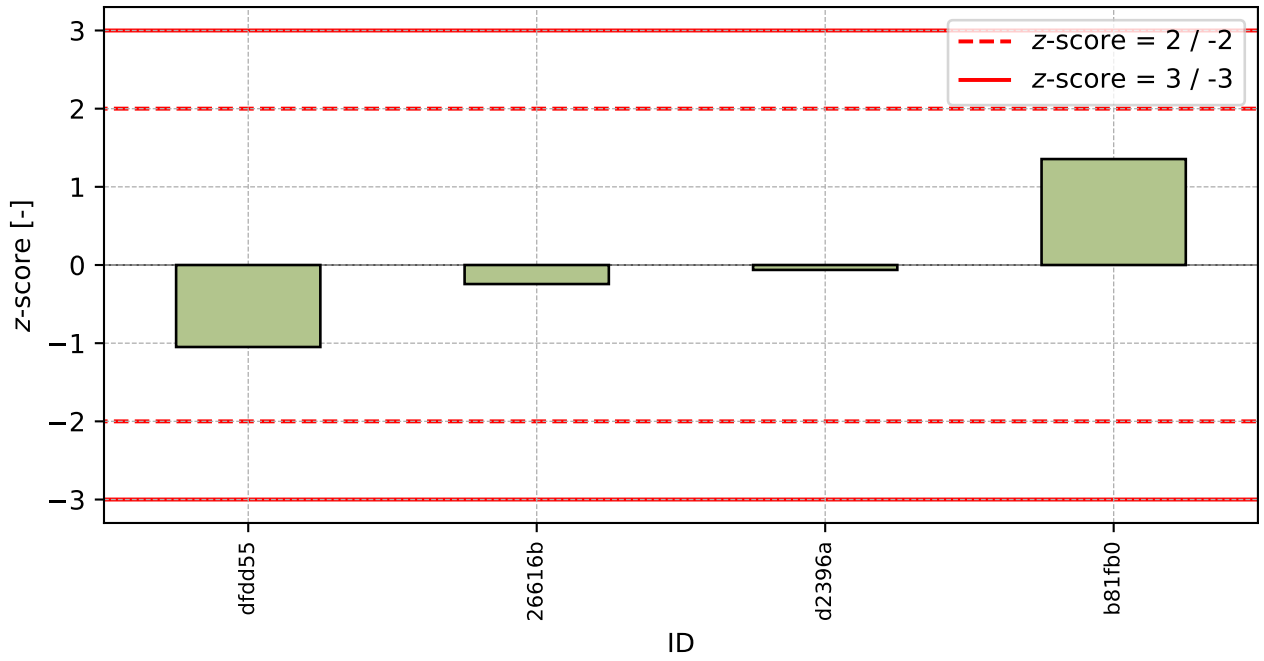

Figure 28: z-score

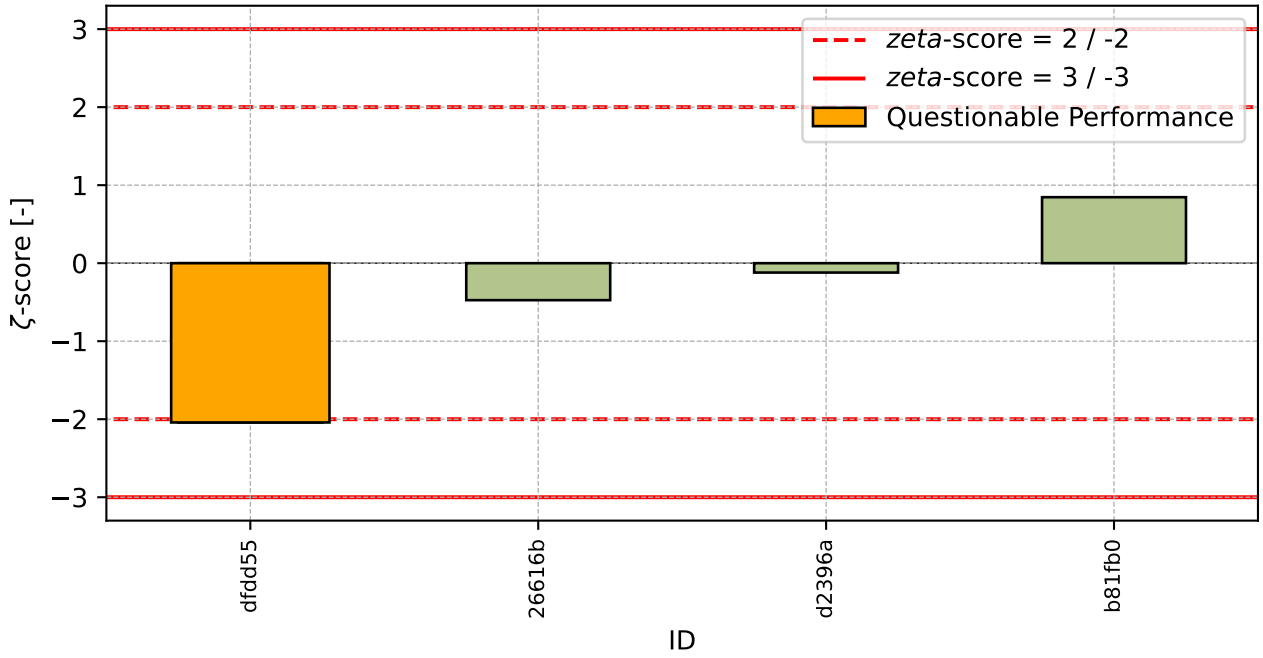

Figure 29: ζ-score

Table 12: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dfdd55	-1.05	-2.04
26616b	-0.24	-0.47
d2396a	-0.06	-0.12
b81fb0	1.36	0.85

4.2 Sample B

4.2.1 Test results

Table 13: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [MPa]	2 [MPa]	3 [MPa]	4 [MPa]	5 [MPa]	u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
dfdd55	1540	1540	1550	1540	1550	10.0	1544	5.5	0.35
d2396a	1630	1629	1606	1588	1639	9.3	1618	20.9	1.29
26616b	1630	1630	1640	1630	1630	4.0	1632	4.5	0.27
b81fb0	1833	1777	1784	1843	1796	180.0	1807	29.7	1.64

4.2.2 The Numerical Procedure for Determining Outliers

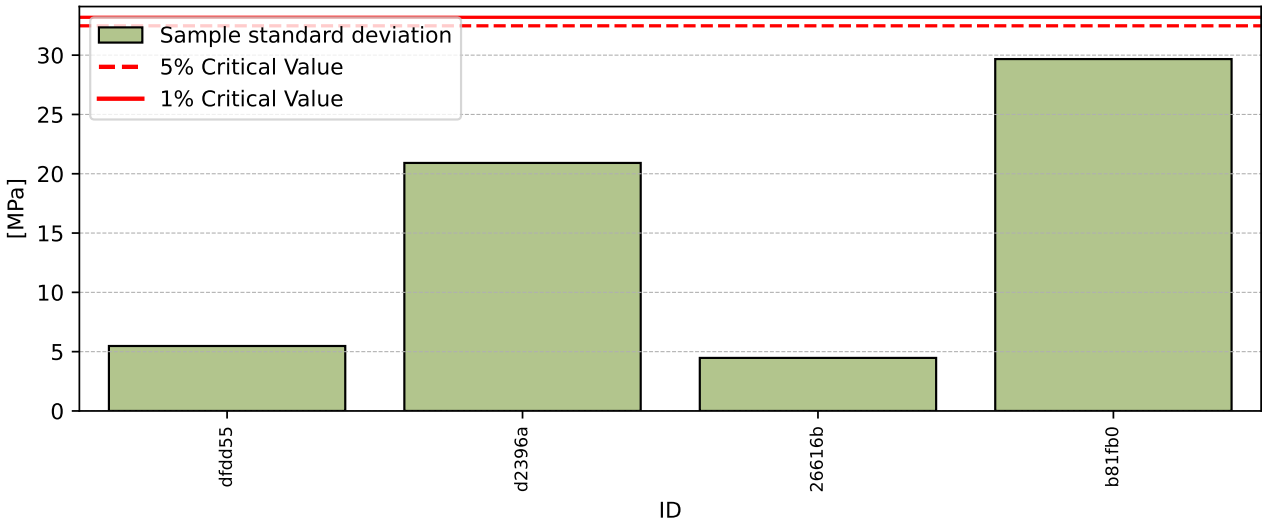

Figure 30: **Cochran's test** - sample standard deviations

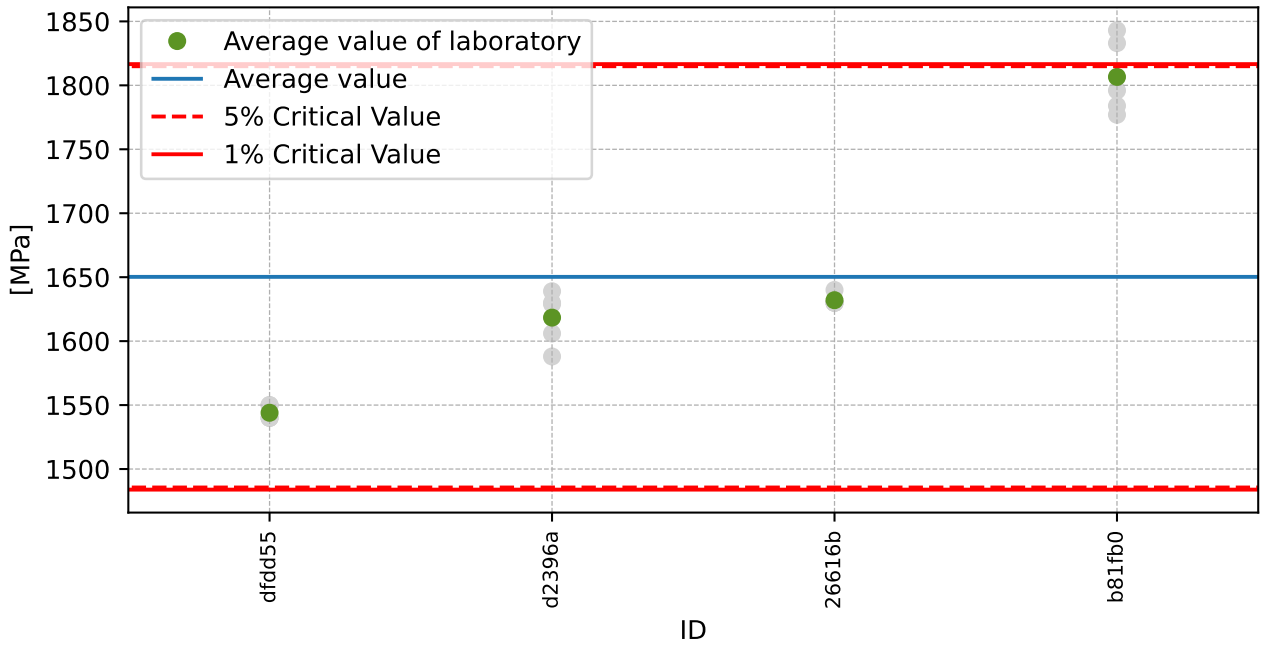

Figure 31: **Grubbs' test** - average values

4.2.3 Mandel's Statistics

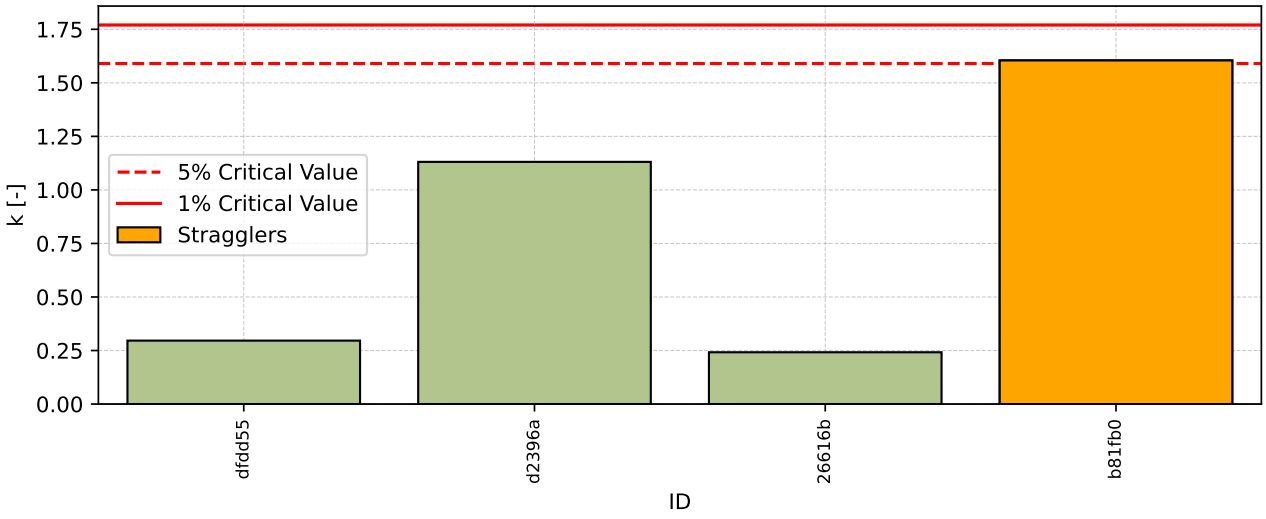

Figure 32: Intralaboratory Consistency Statistic

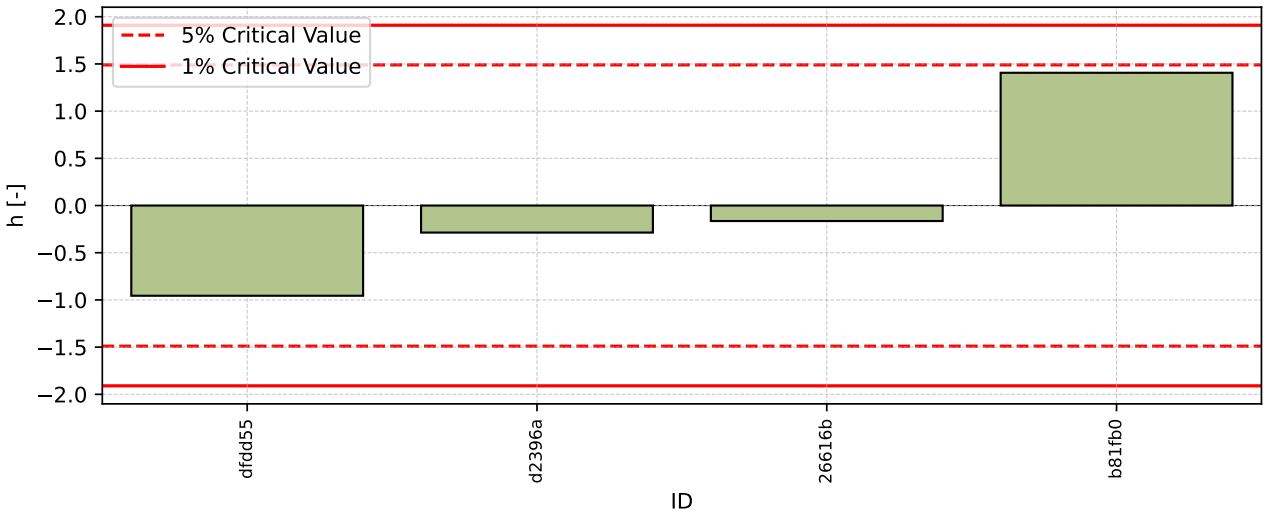

Figure 33: Interlaboratory Consistency Statistic

4.2.4 Descriptive statistics

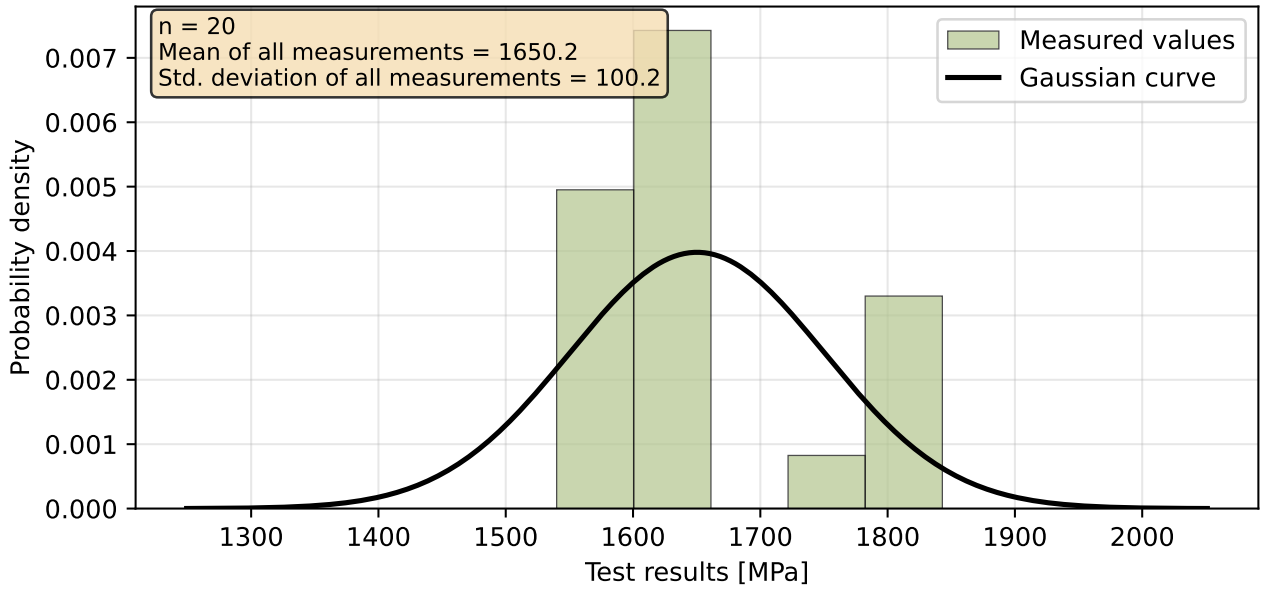

Figure 34: Histogram of all test results

Table 14: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	1650.2
Sample standard deviation – s	111.2
Assigned value – x^*	1650.2
Robust standard deviation – s^*	111.2
Measurement uncertainty of assigned value – u_X	55.6
p-value of normality test [-]	0.004
Interlaboratory standard deviation – s_L	110.9
Repeatability standard deviation – s_r	18.5
Reproducibility standard deviation – s_R	112.4
Repeatability – r	51.8
Reproducibility – R	314.7

4.2.5 Evaluation of Performance Statistics

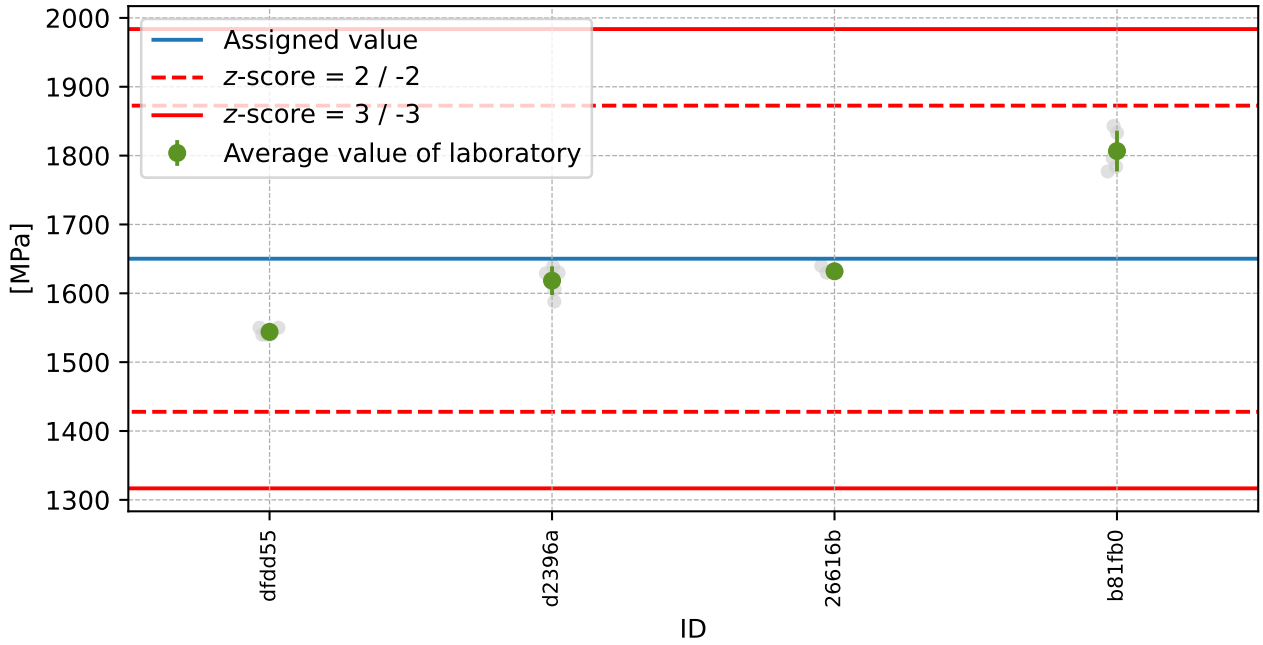

Figure 35: Average values and sample standard deviations

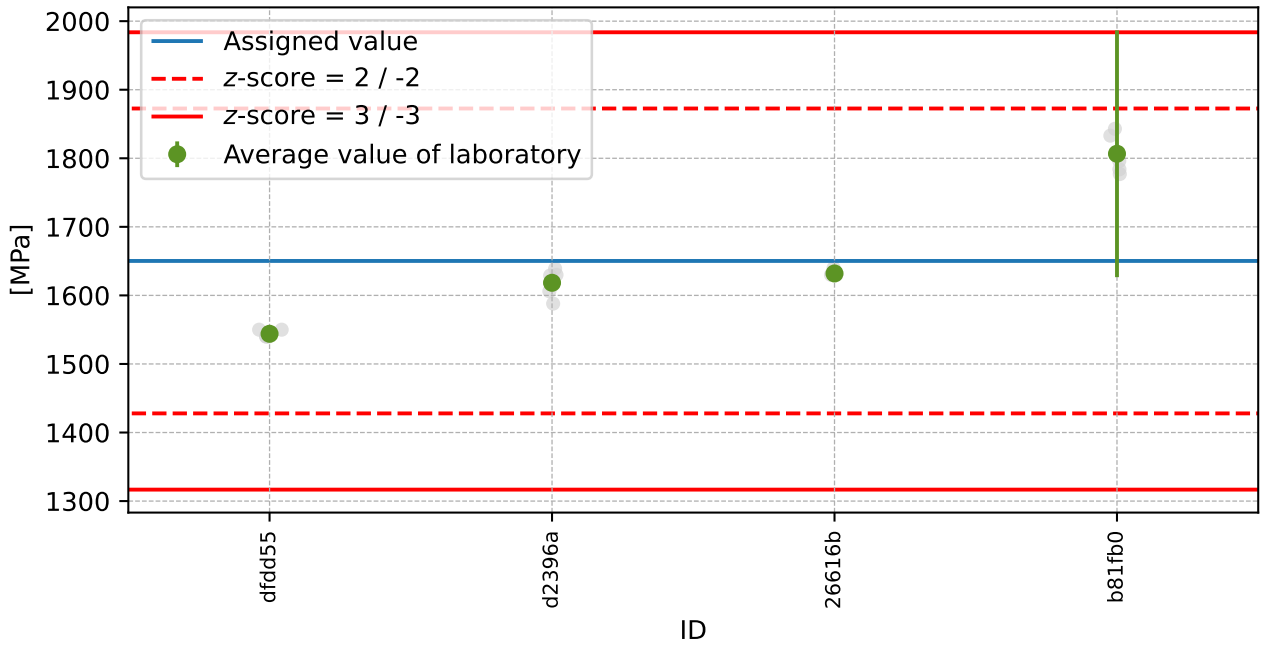

Figure 36: Average values and extended uncertainties of measurement

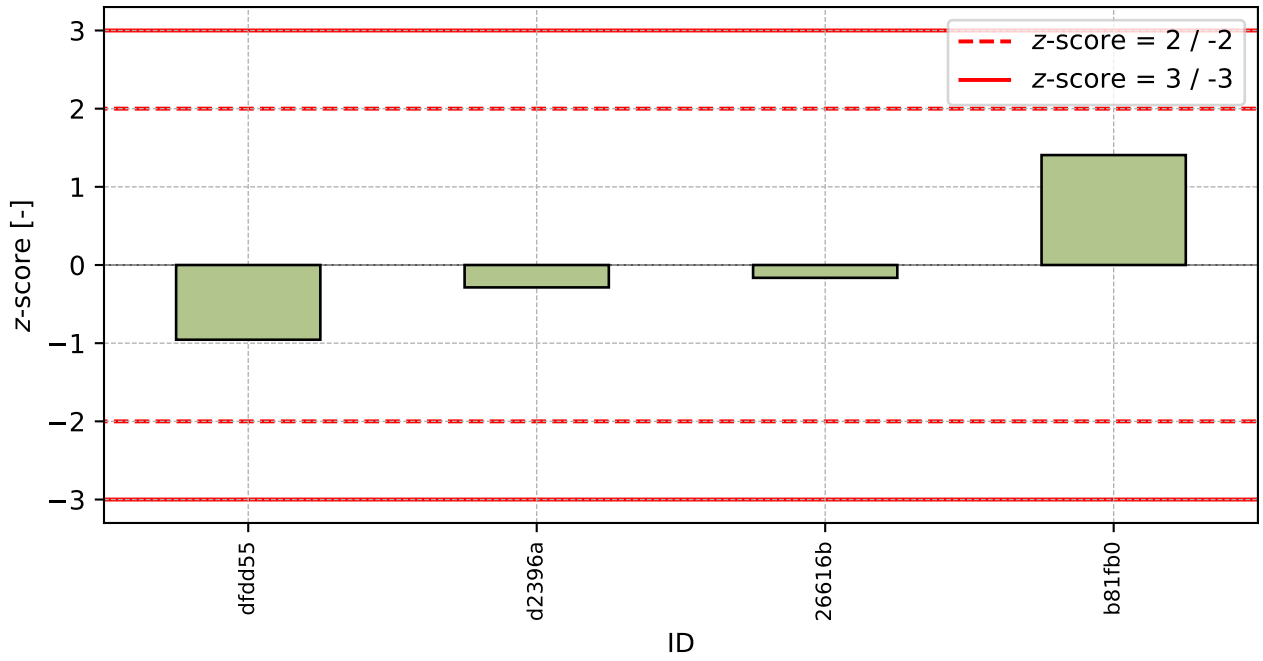

Figure 37: z-score

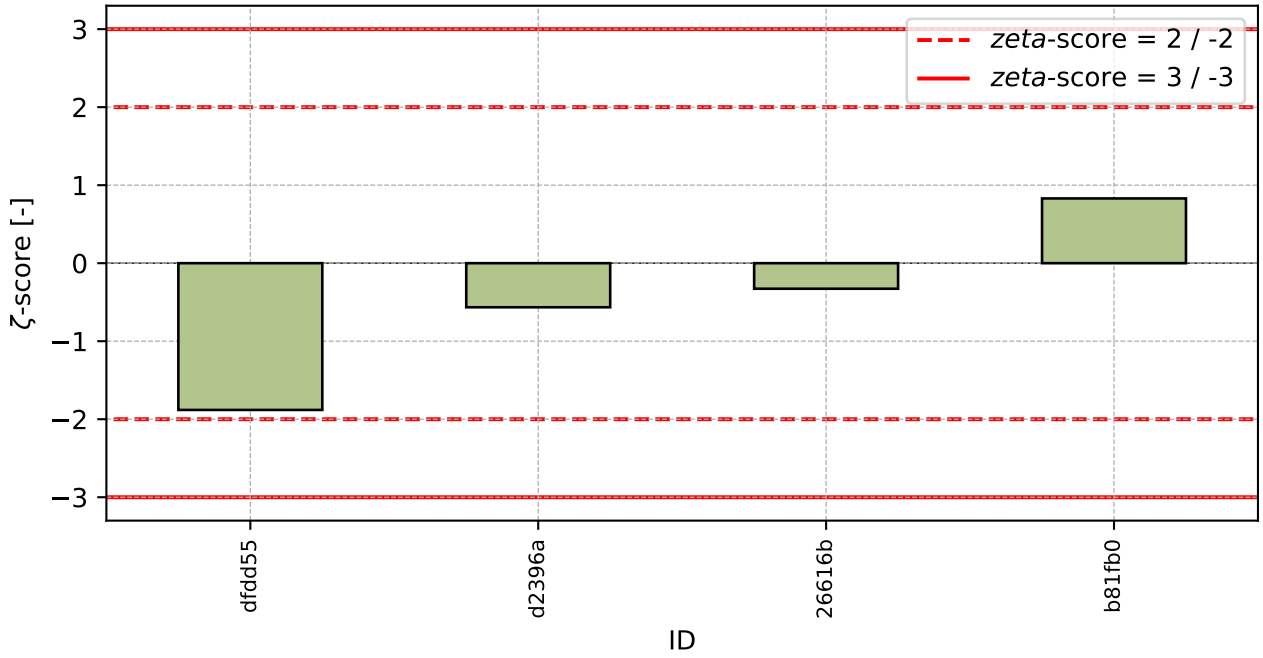

Figure 38: ζ-score

Table 15: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dfdd55	-0.96	-1.88
d2396a	-0.29	-0.57
26616b	-0.16	-0.33
b81fb0	1.41	0.83

5 Appendix – EN ISO 178 (Flexural strength, Flexural strain at flexural strength)

5.1 Flexural strain at flexural strength

5.1.1 Sample A

Test results

Table 16: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [%]	2 [%]	3 [%]	4 [%]	5 [%]	u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
26616b	33.1	32.8	33.0	32.8	32.7	0.30	32.9	0.16	0.50
dfdd55	33.5	33.1	33.0	32.9	32.7	0.60	33.0	0.30	0.90
d2396a	39.3	39.6	38.9	39.2	38.9	0.10	39.2	0.29	0.75
b81fb0	41.9	41.7	41.5	41.6	41.8	2.00	41.7	0.16	0.38
d6aa79	42.5	43.1	42.7	42.5	43.3	0.35	42.8	0.36	0.85

The Numerical Procedure for Determining Outliers

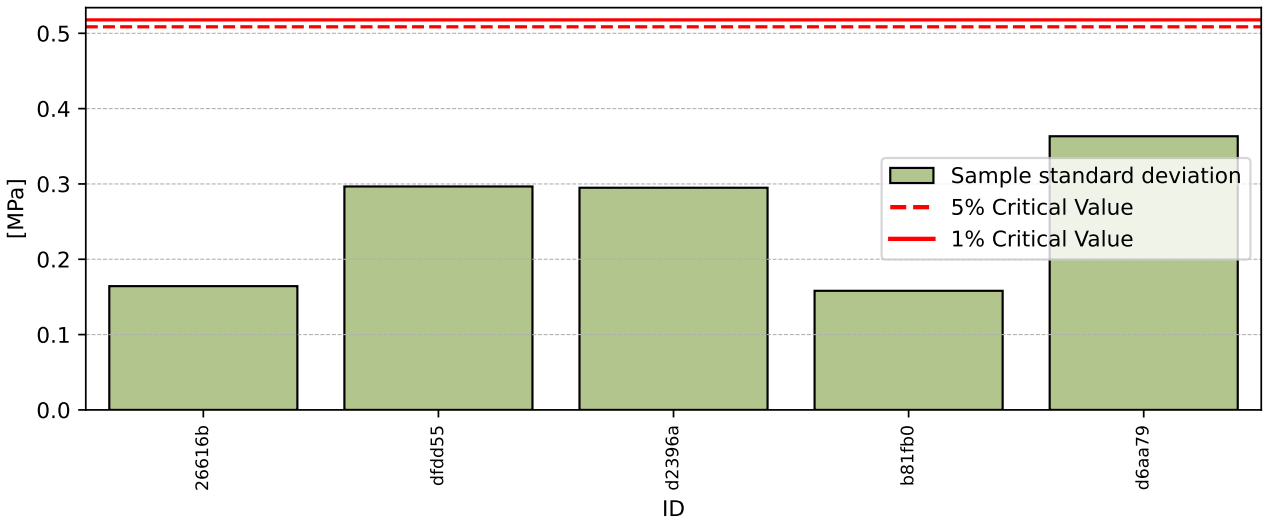

Figure 39: **Cochran's test** - sample standard deviations

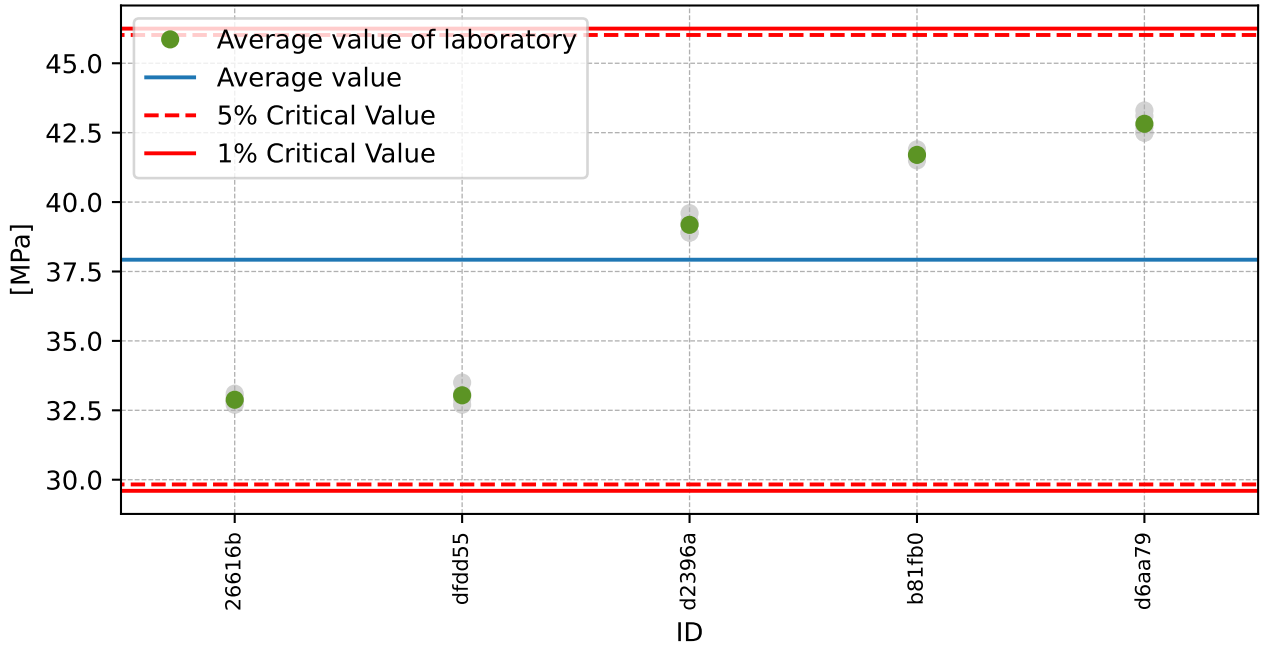

Figure 40: **Grubbs' test** - average values

Mandel's Statistics

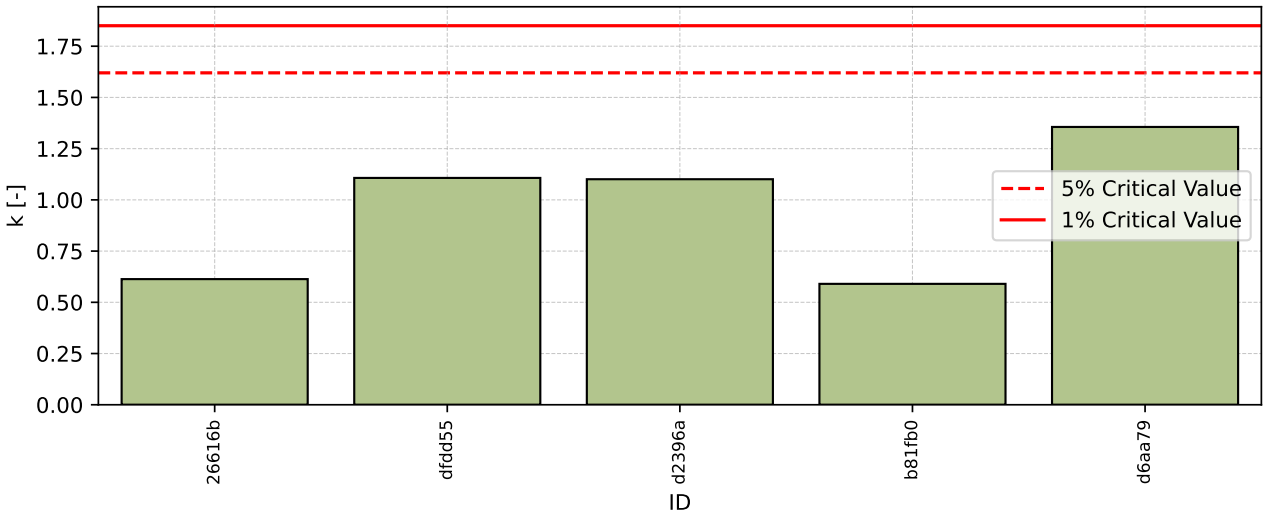

Figure 41: Intralaboratory Consistency Statistic

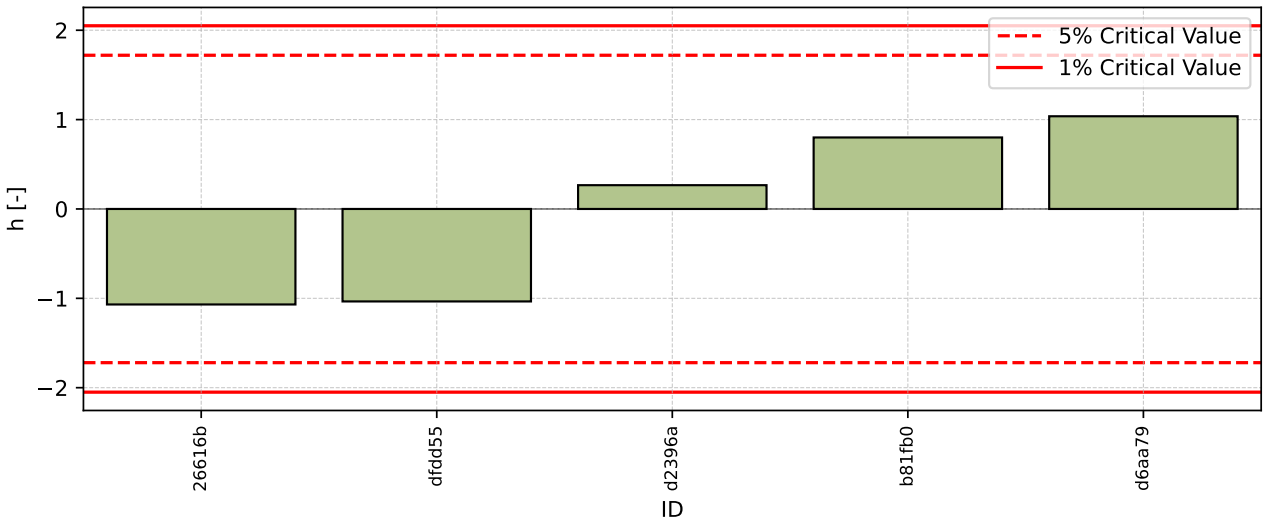

Figure 42: Interlaboratory Consistency Statistic

Descriptive statistics

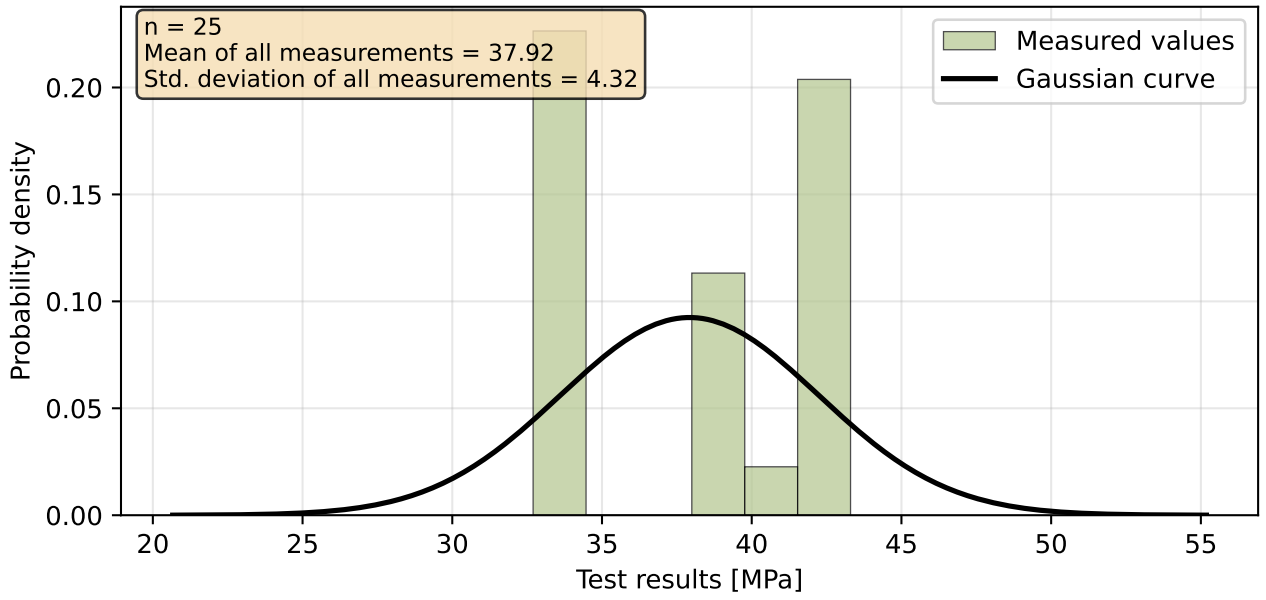

Figure 43: Histogram of all test results

Table 17: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	37.92
Sample standard deviation – s	4.72
Assigned value – x^*	37.92
Robust standard deviation – s^*	4.72
Measurement uncertainty of assigned value – u_X	2.11
p-value of normality test [-]	< 0.001
Interlaboratory standard deviation – s_L	4.72
Repeatability standard deviation – s_r	0.27
Reproducibility standard deviation – s_R	4.73
Repeatability – r	0.75
Reproducibility – R	13.23

Evaluation of Performance Statistics

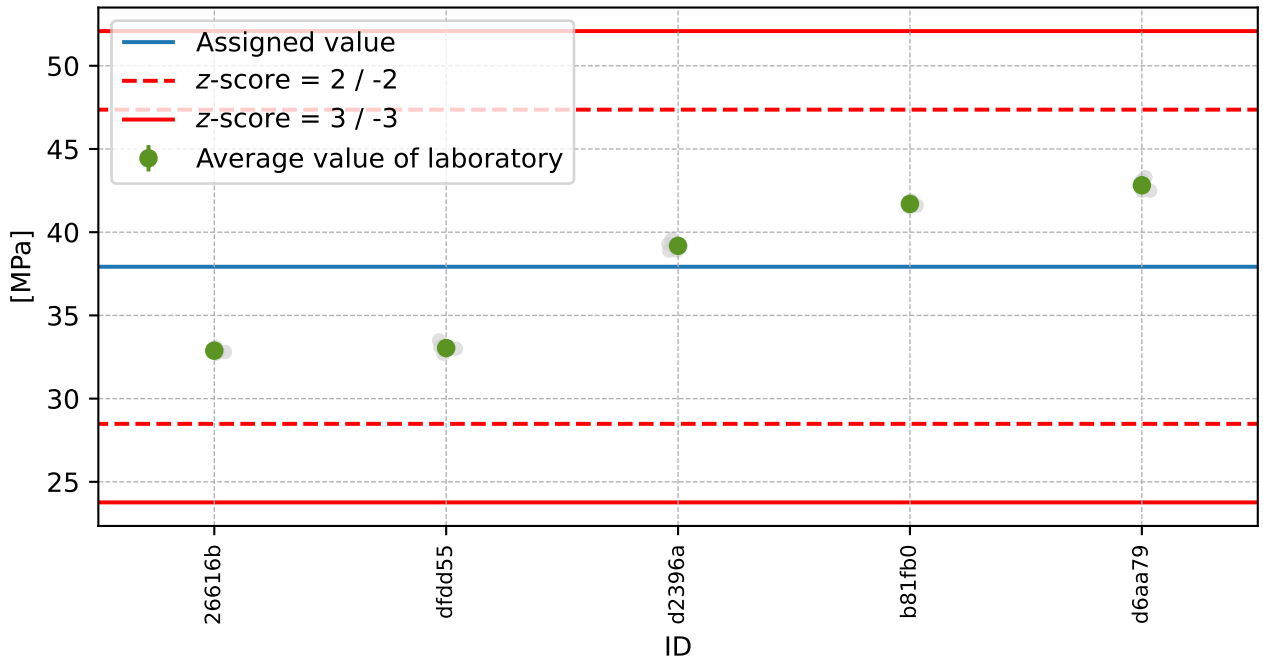

Figure 44: Average values and sample standard deviations

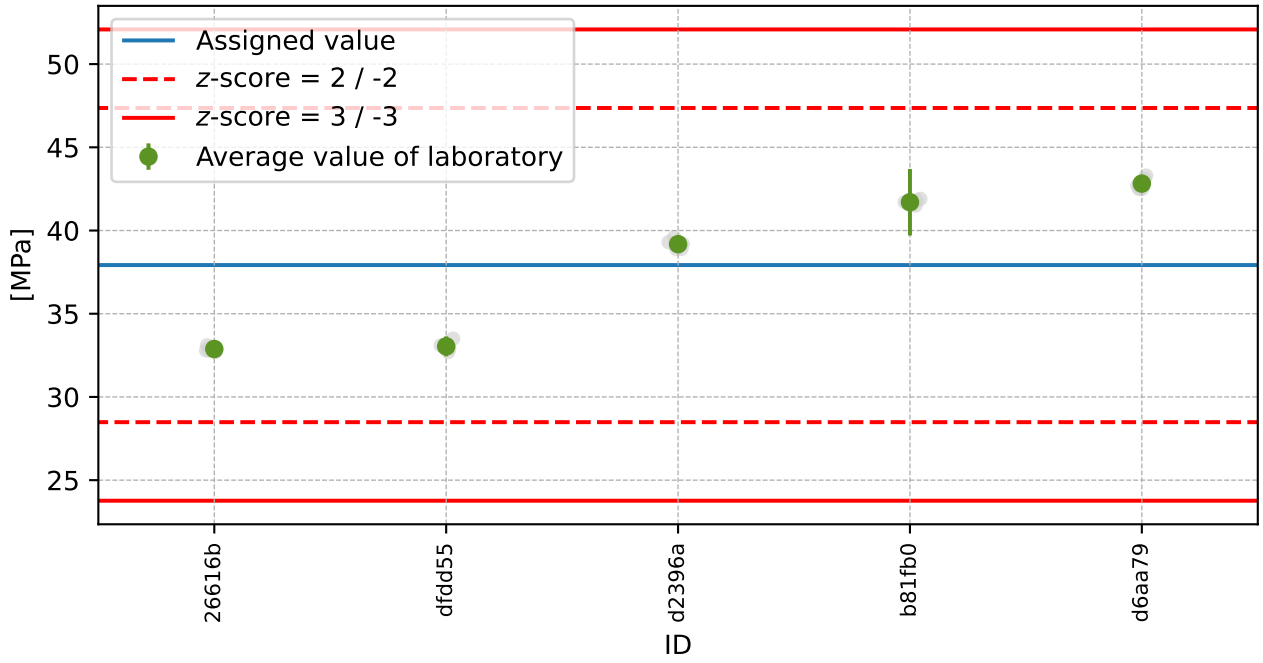

Figure 45: Average values and extended uncertainties of measurement

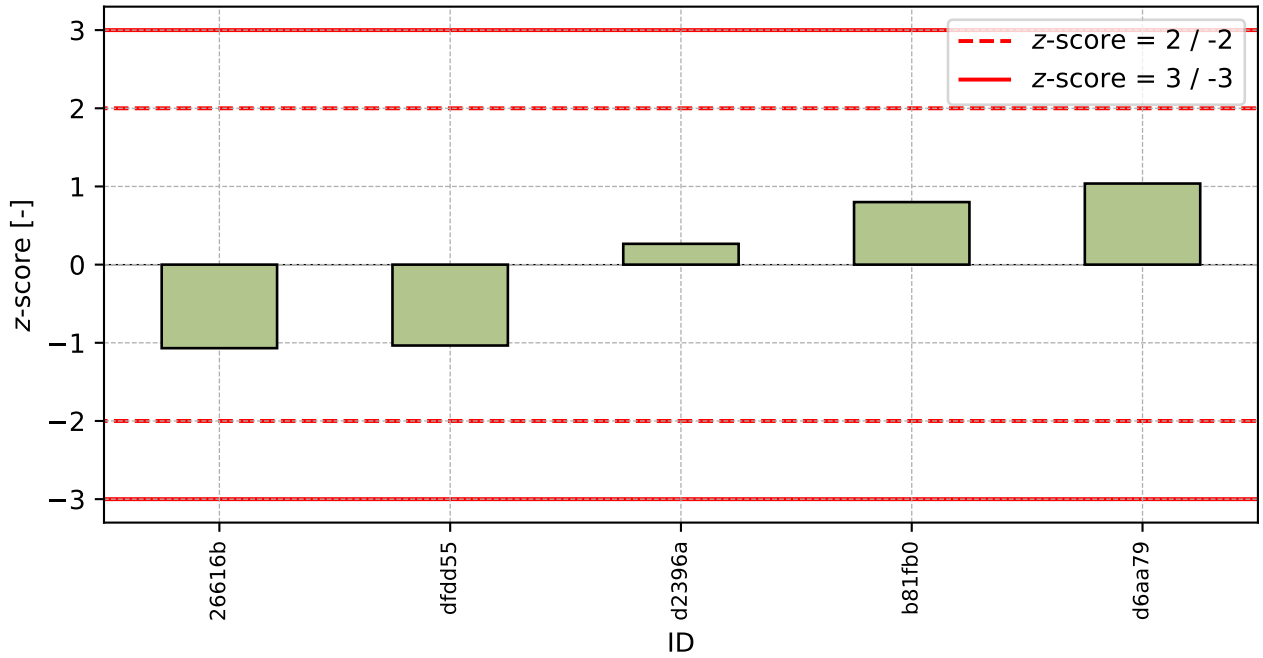

Figure 46: z-score

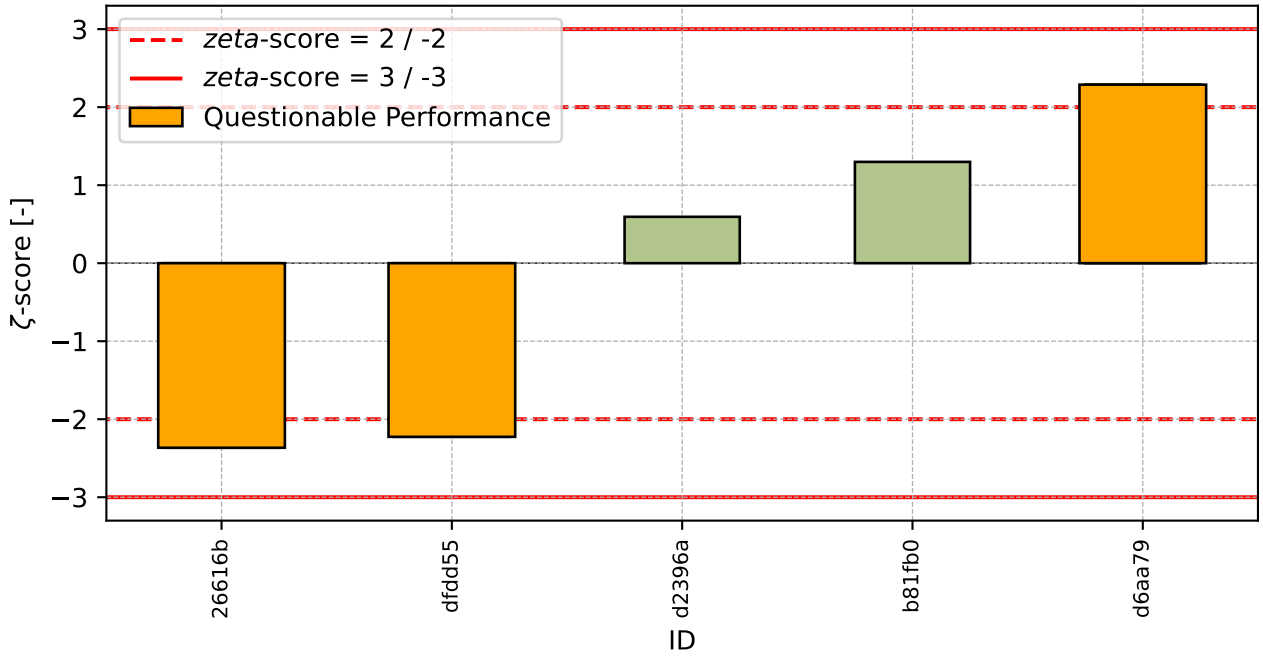

Figure 47: ζ-score

Table 18: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
26616b	-1.07	-2.37
dfdd55	-1.03	-2.23
d2396a	0.27	0.59
b81fb0	0.80	1.30
d6aa79	1.04	2.29

5.1.2 Sample B

Test results

Table 19: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [%]	2 [%]	3 [%]	4 [%]	5 [%]	u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d6aa79	6.3	6.4	6.1	6.1	6.1	0.15	6.2	0.14	2.28
dfdd55	6.5	6.2	6.3	6.2	6.2	0.30	6.3	0.13	2.08
26616b	6.2	6.0	6.5	6.5	6.2	0.40	6.3	0.22	3.45
b81fb0	6.7	6.6	6.2	6.5	6.3	1.20	6.5	0.21	3.21
d2396a	6.5	6.3	6.7	6.4	6.5	0.08	6.5	0.15	2.29

The Numerical Procedure for Determining Outliers

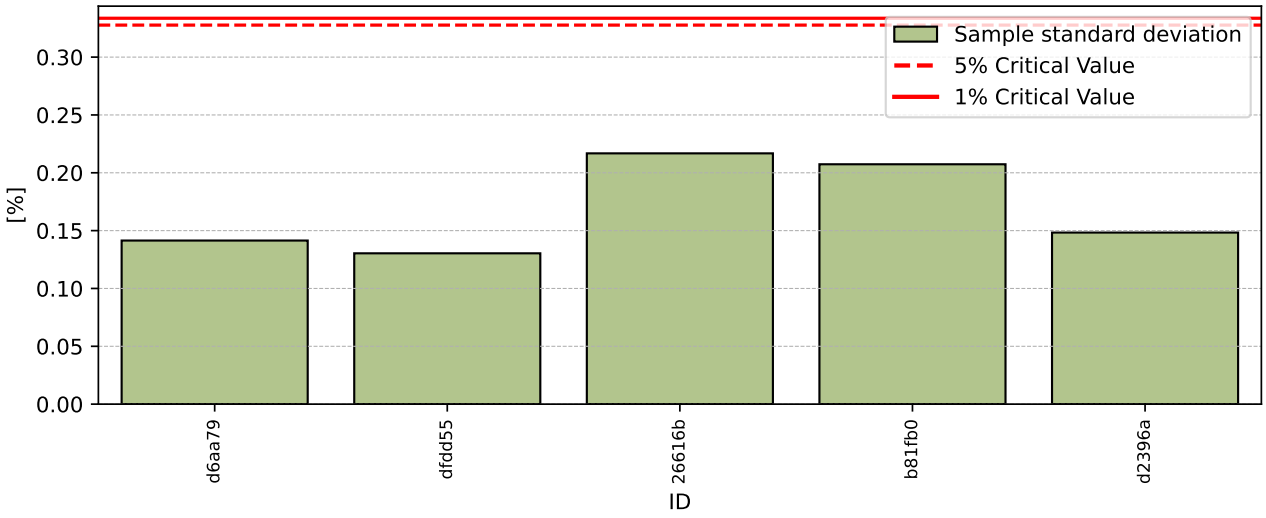

Figure 48: **Cochran's test** - sample standard deviations

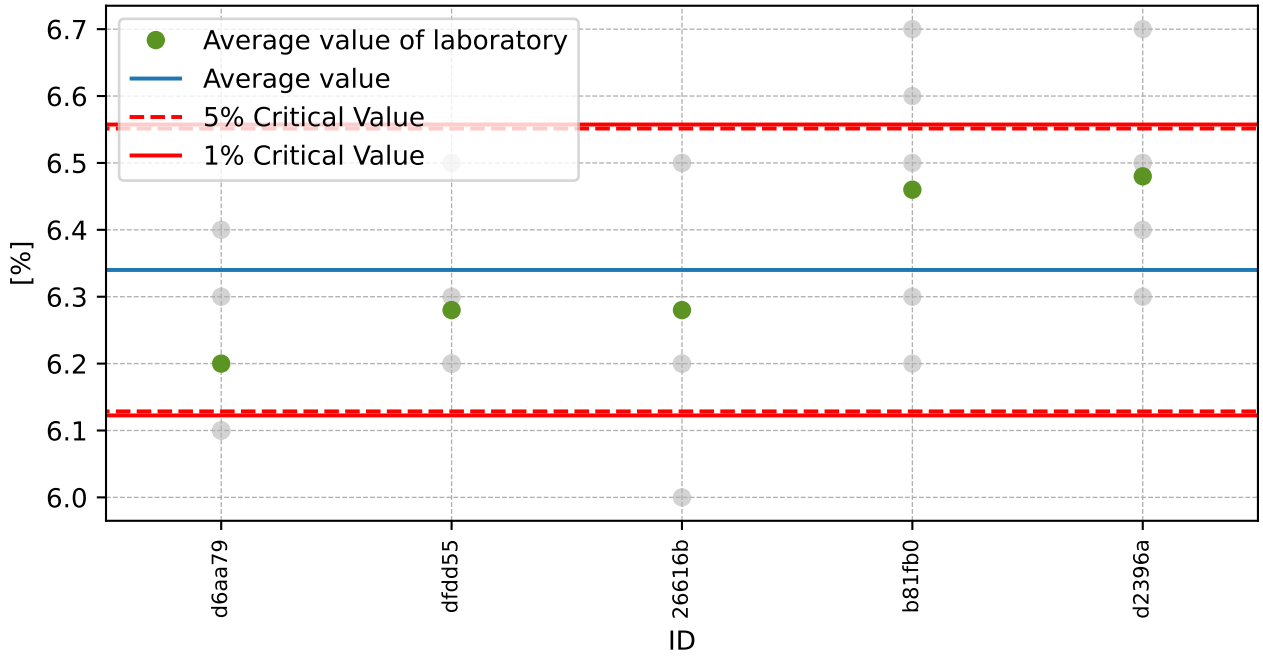

Figure 49: **Grubbs' test** - average values

Mandel's Statistics

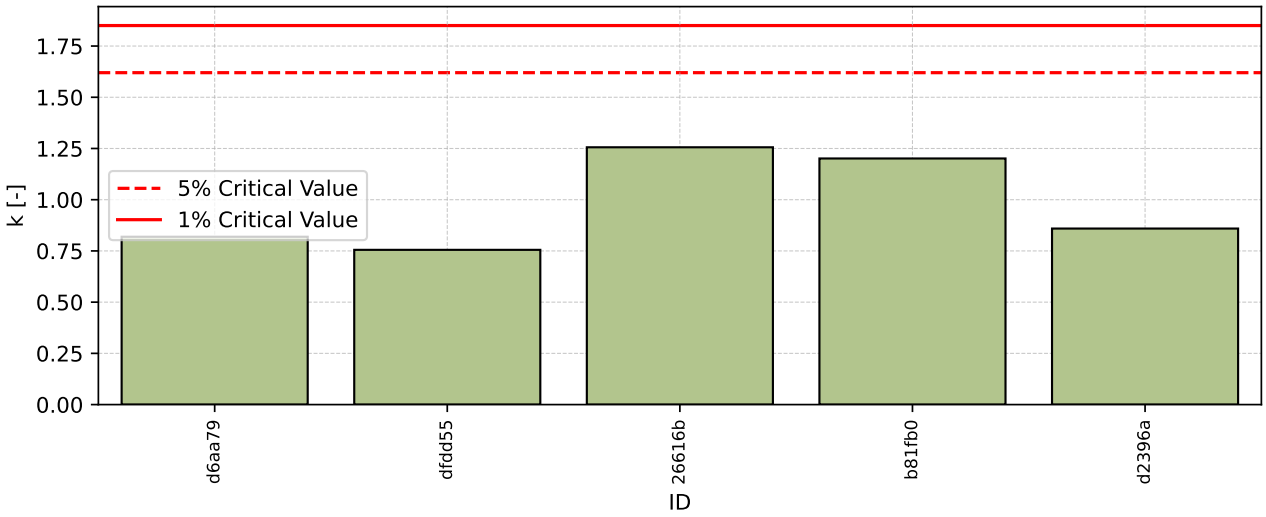

Figure 50: Intralaboratory Consistency Statistic

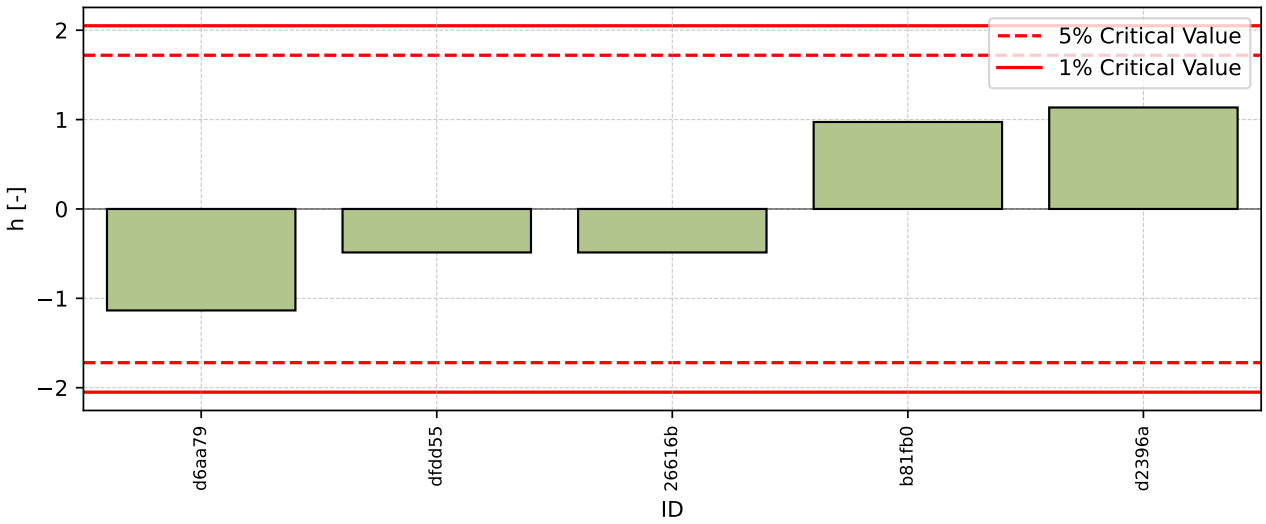

Figure 51: Interlaboratory Consistency Statistic

Descriptive statistics

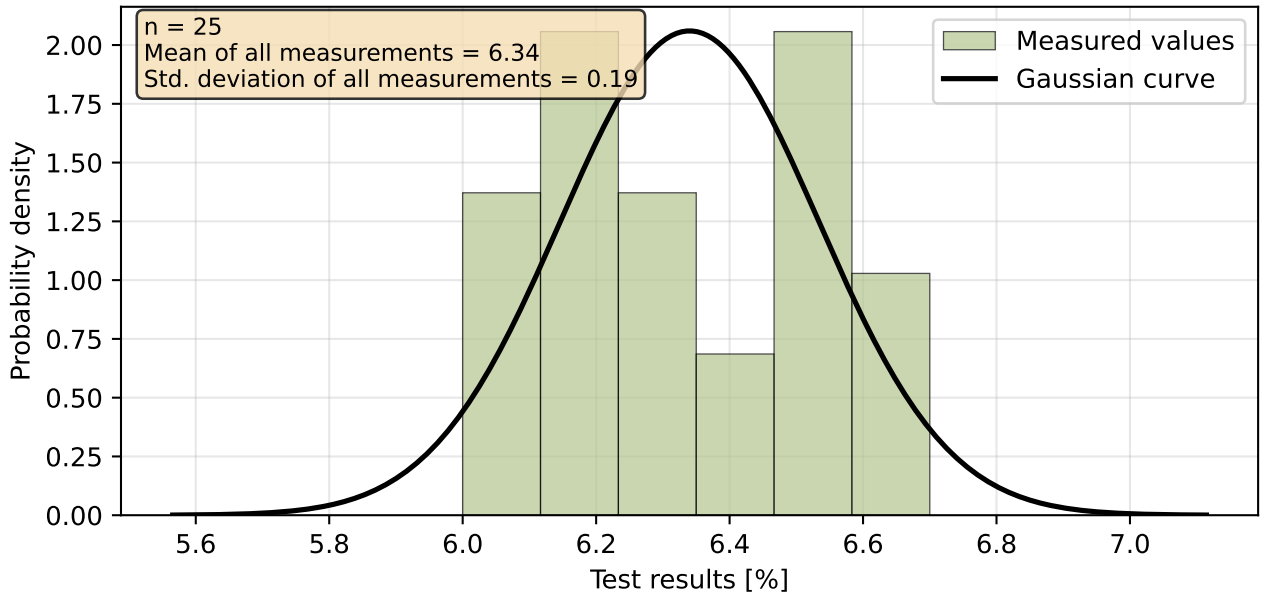

Figure 52: Histogram of all test results

Table 20: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	6.34
Sample standard deviation – s	0.12
Assigned value – x^*	6.34
Robust standard deviation – s^*	0.12
Measurement uncertainty of assigned value – u_X	0.06
p-value of normality test [-]	0.170
Interlaboratory standard deviation – s_L	0.10
Repeatability standard deviation – s_r	0.17
Reproducibility standard deviation – s_R	0.20
Repeatability – r	0.48
Reproducibility – R	0.55

Evaluation of Performance Statistics

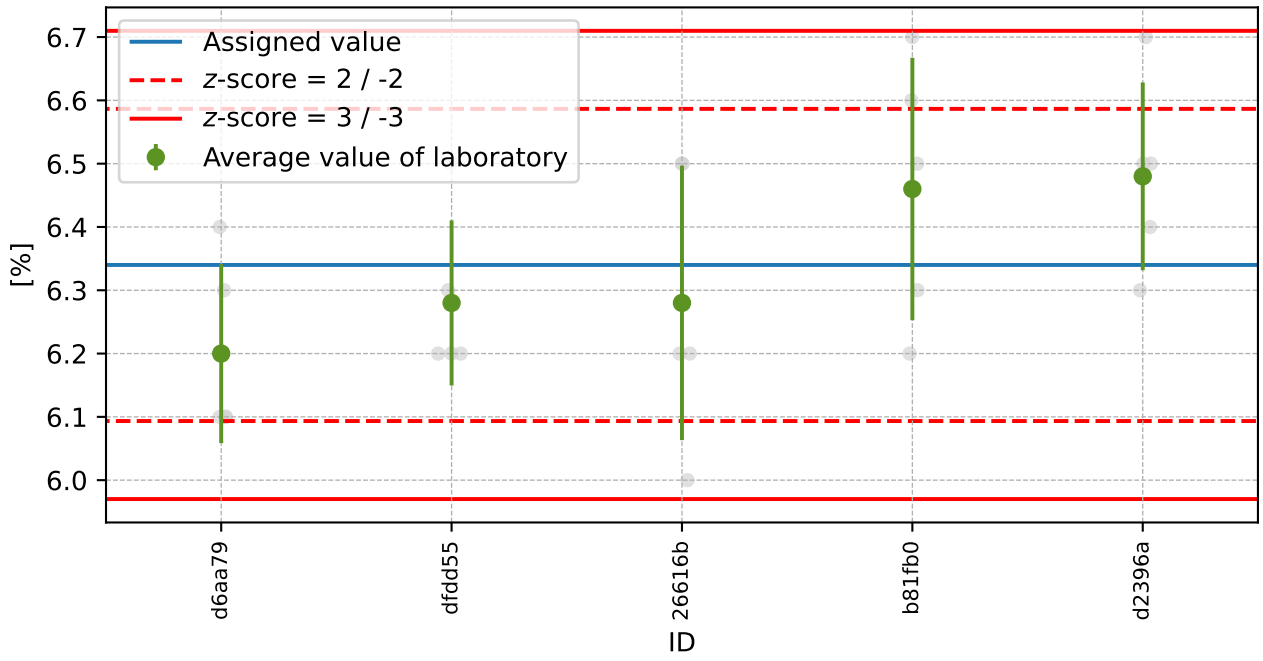

Figure 53: Average values and sample standard deviations

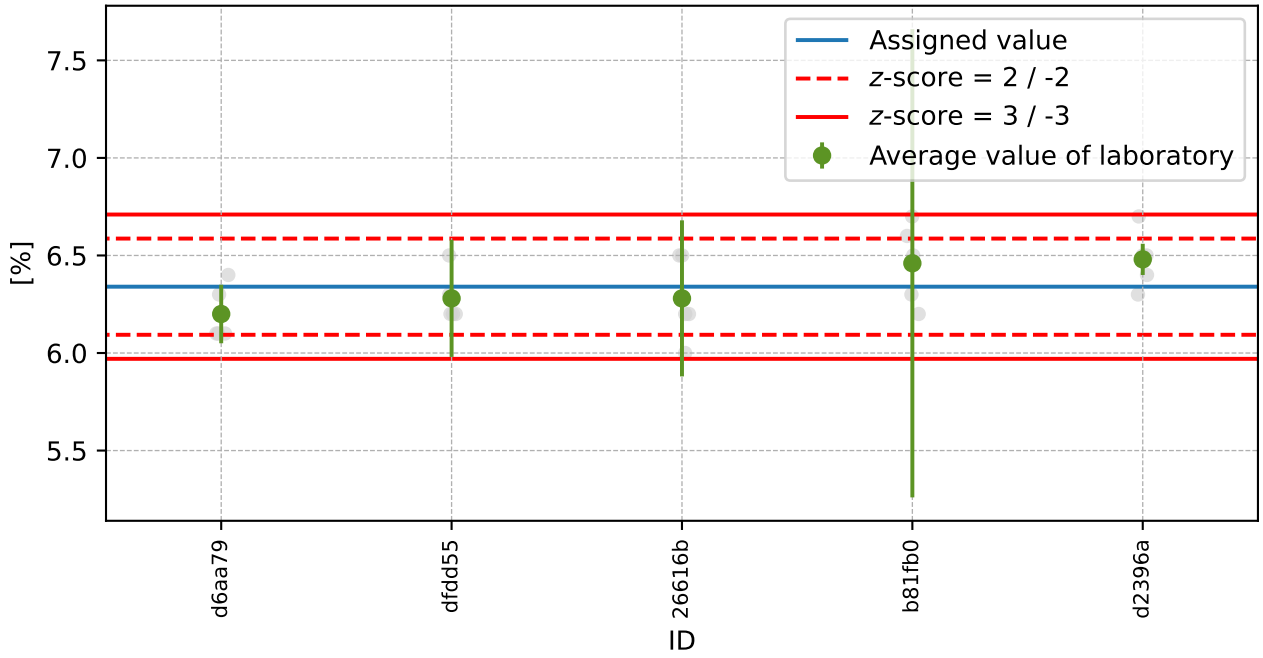

Figure 54: Average values and extended uncertainties of measurement

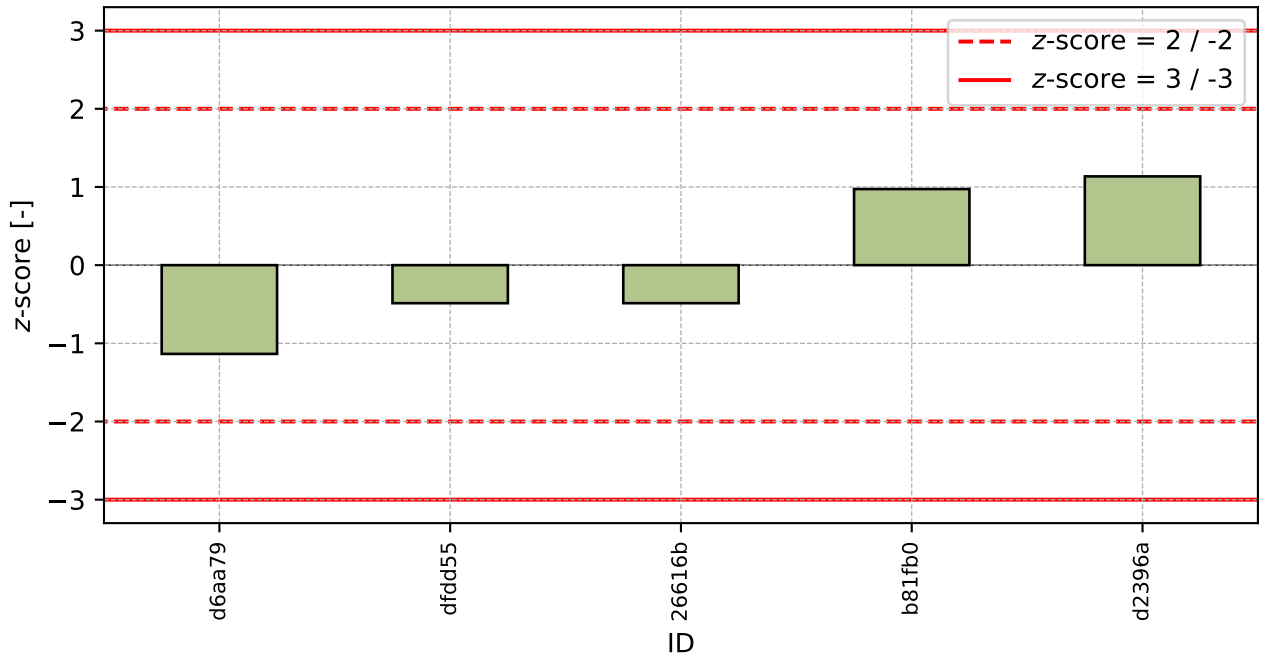

Figure 55: z-score

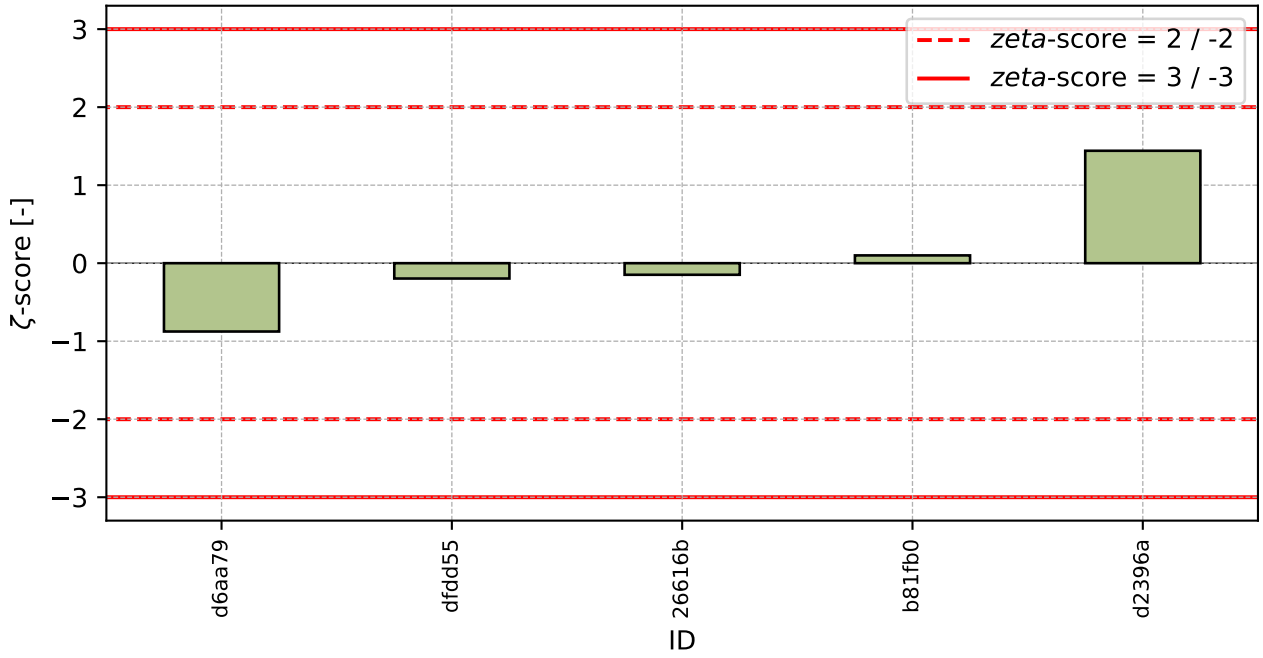

Figure 56: ζ-score

Table 21: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d6aa79	-1.14	-0.88
dfdd55	-0.49	-0.20
26616b	-0.49	-0.15
b81fb0	0.97	0.10
d2396a	1.14	1.44

5.2 Flexural strength

5.2.1 Sample A

Test results

Table 22: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [MPa]	2 [MPa]	3 [MPa]	4 [MPa]	5 [MPa]	u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
dfdd55	40.3	40.3	40.4	40.1	40.0	0.30	40.2	0.16	0.41
26616b	40.5	40.1	40.3	40.3	40.4	0.30	40.3	0.15	0.37
d2396a	48.4	47.7	47.3	47.1	46.4	0.30	47.4	0.74	1.56
b81fb0	50.5	52.4	51.2	50.8	51.2	2.50	51.2	0.72	1.41
d6aa79	52.7	52.5	52.8	52.8	52.8	0.12	52.7	0.13	0.25

The Numerical Procedure for Determining Outliers

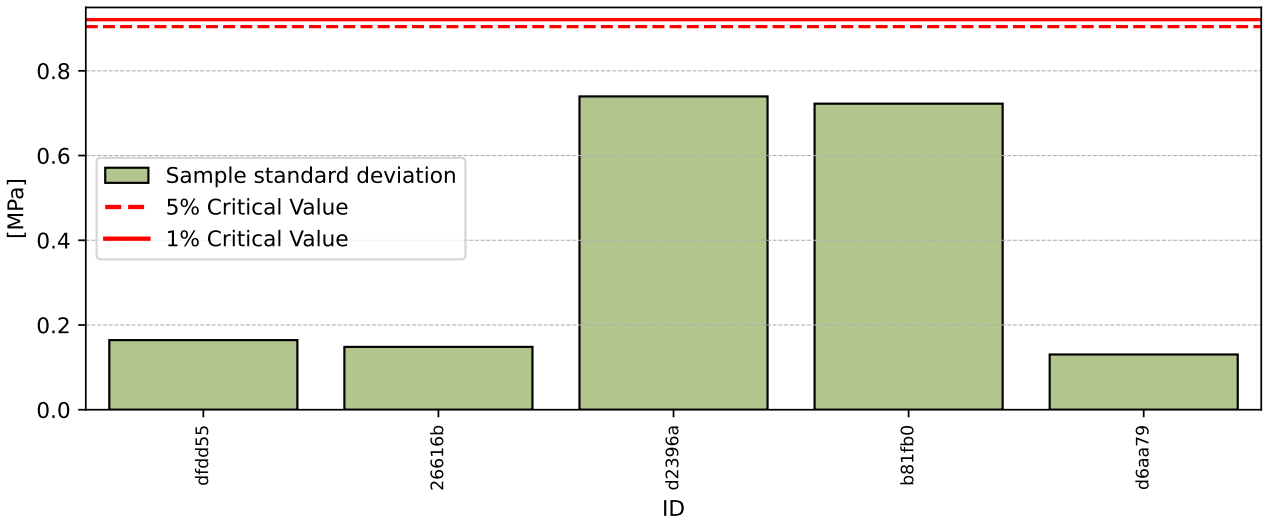

Figure 57: **Cochran's test** - sample standard deviations

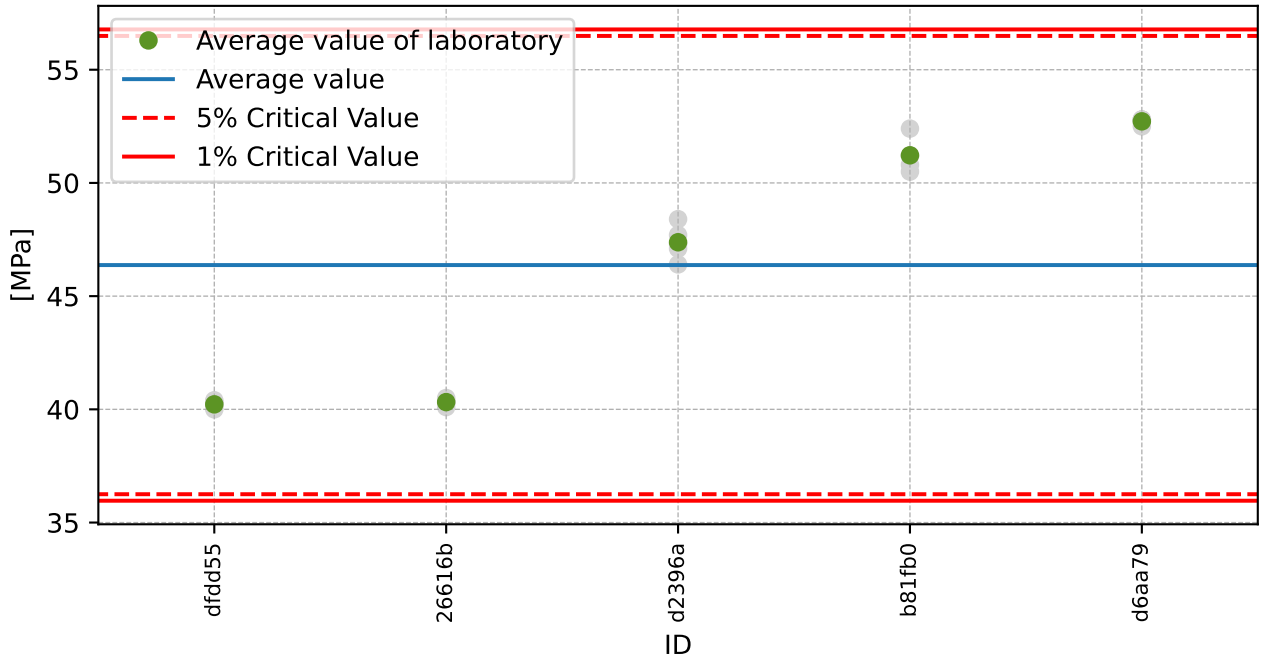

Figure 58: **Grubbs' test** - average values

Mandel's Statistics

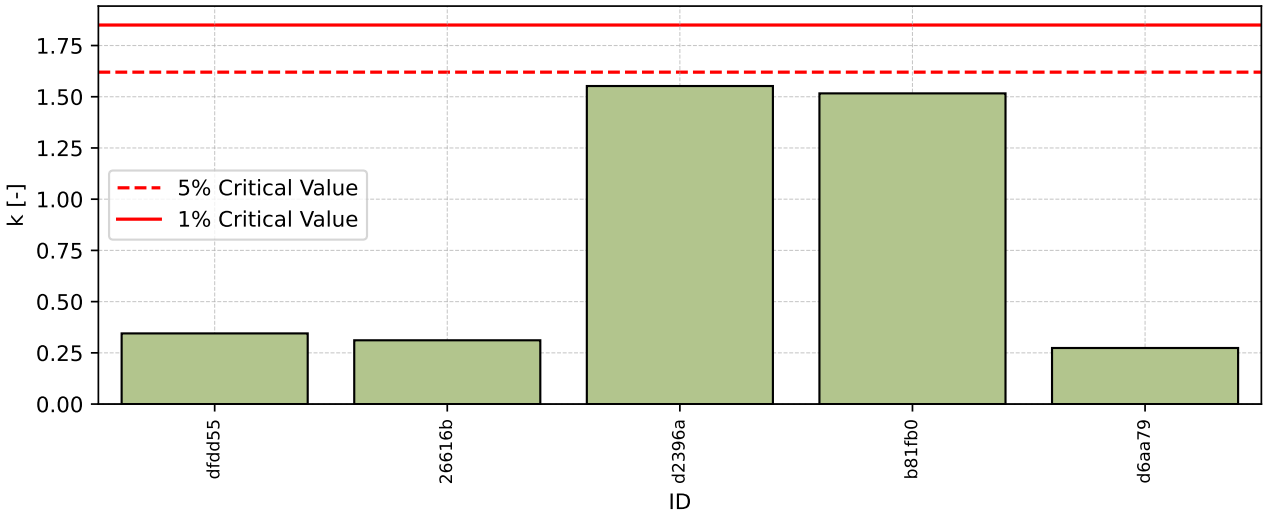

Figure 59: Intralaboratory Consistency Statistic

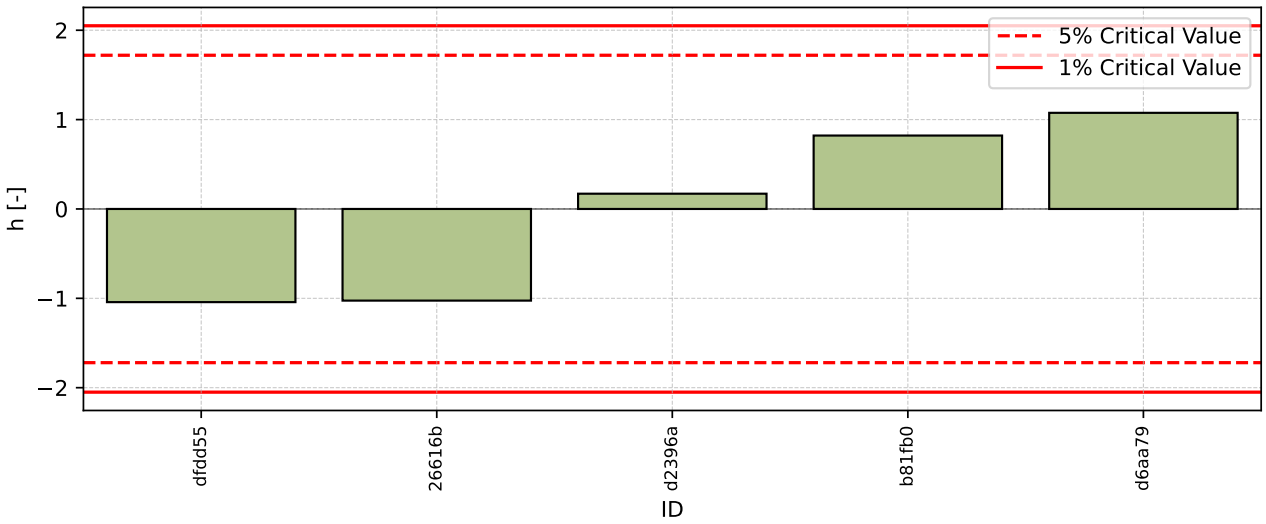

Figure 60: Interlaboratory Consistency Statistic

Descriptive statistics

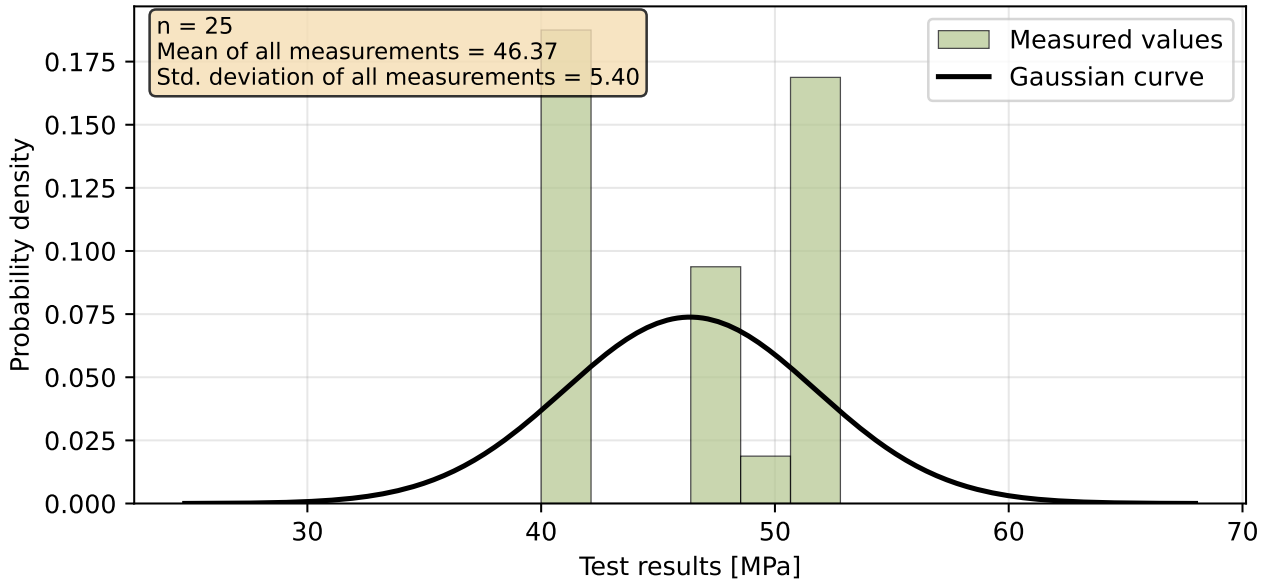

Figure 61: Histogram of all test results

Table 23: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	46.37
Sample standard deviation – s	5.90
Assigned value – x^*	46.37
Robust standard deviation – s^*	5.90
Measurement uncertainty of assigned value – u_X	2.64
p-value of normality test [-]	< 0.001
Interlaboratory standard deviation – s_L	5.90
Repeatability standard deviation – s_r	0.48
Reproducibility standard deviation – s_R	5.92
Repeatability – r	1.33
Reproducibility – R	16.57

Evaluation of Performance Statistics

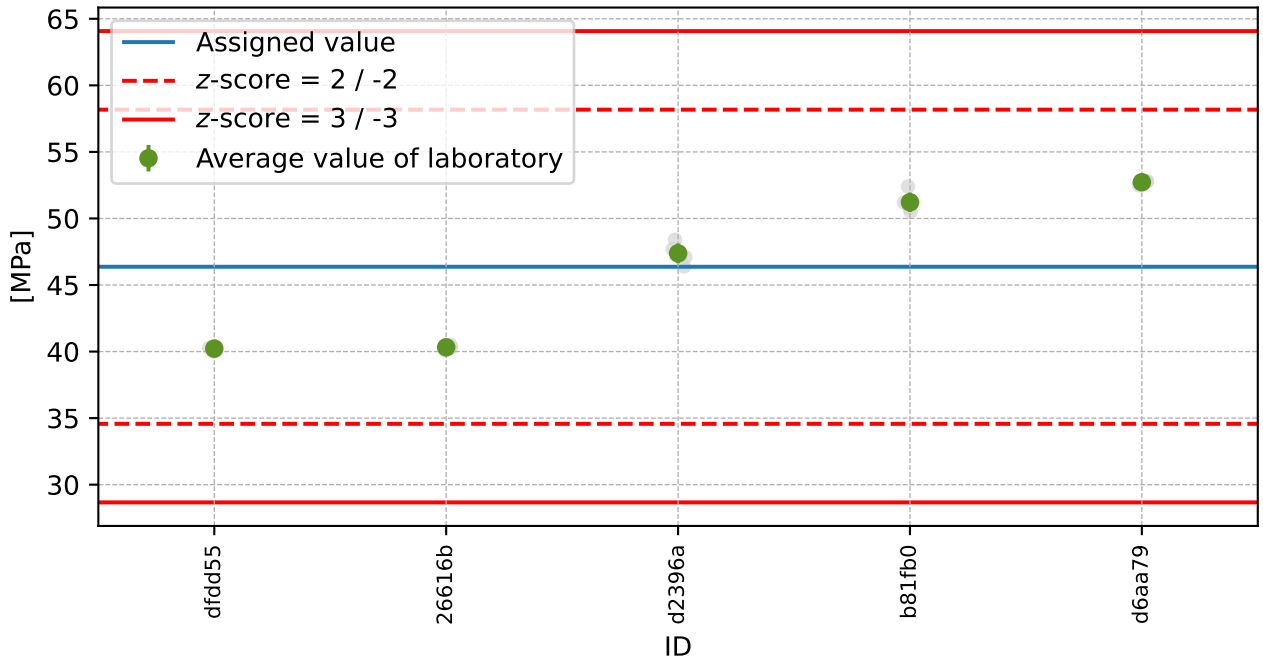

Figure 62: Average values and sample standard deviations

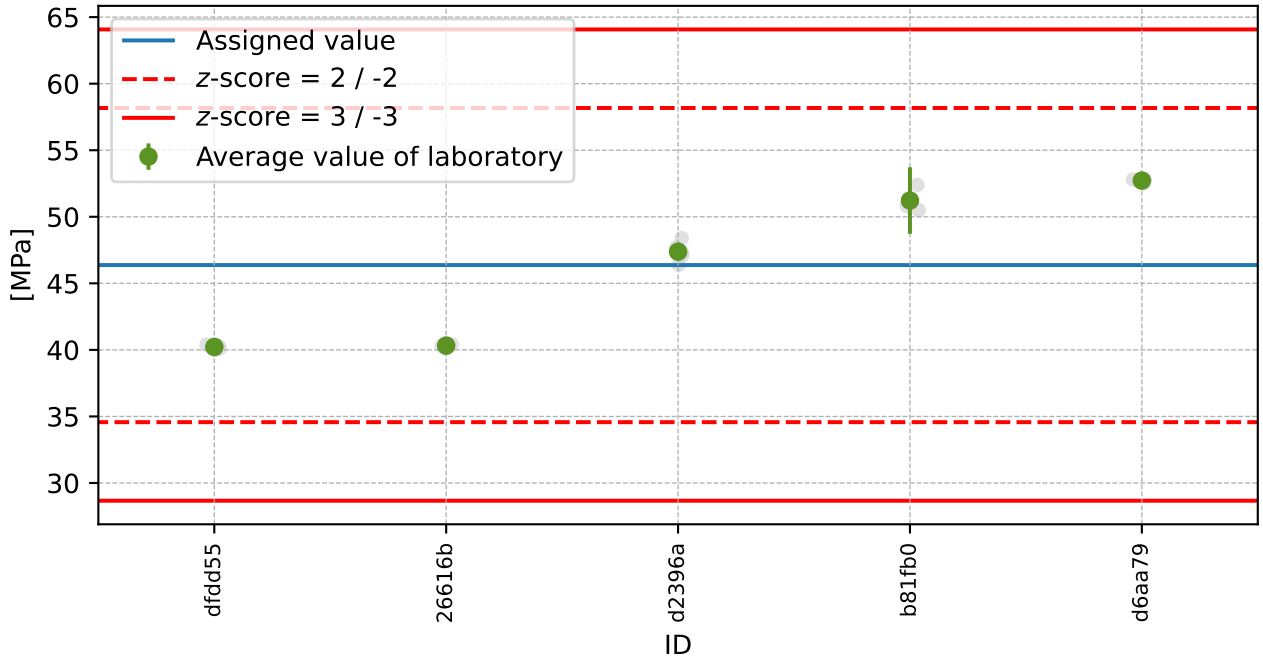

Figure 63: Average values and extended uncertainties of measurement

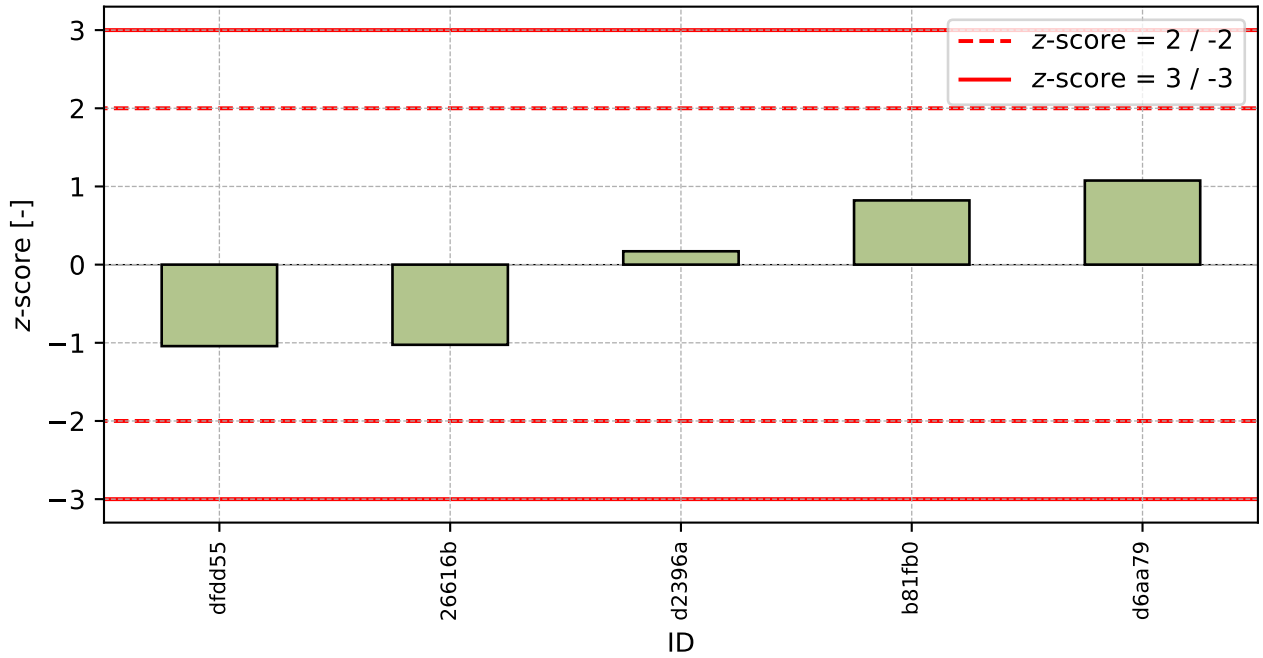

Figure 64: z-score

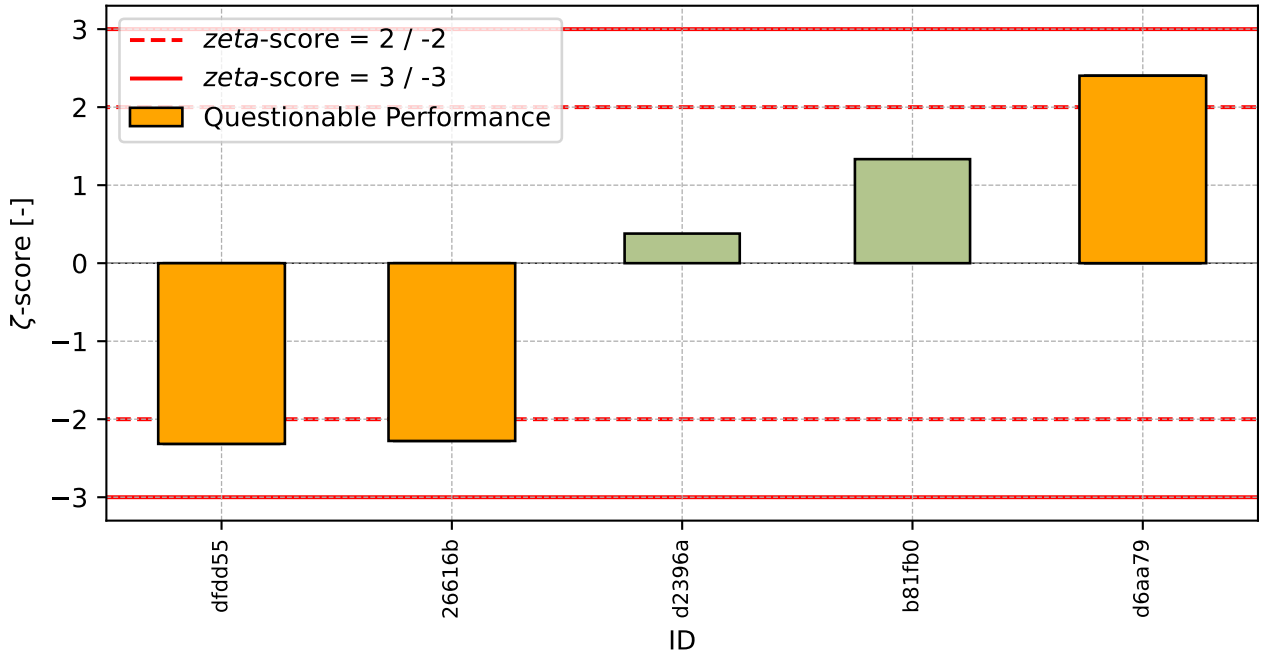

Figure 65: ζ-score

Table 24: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dfdd55	-1.04	-2.32
26616b	-1.03	-2.28
d2396a	0.17	0.38
b81fb0	0.82	1.33
d6aa79	1.08	2.40

5.2.2 Sample B

Test results

Table 25: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [MPa]	2 [MPa]	3 [MPa]	4 [MPa]	5 [MPa]	u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
26616b	6.6	6.7	6.6	6.6	6.6	0.10	6.6	0.04	0.68
dfdd55	6.6	6.8	6.7	6.7	6.8	0.20	6.7	0.08	1.25
d6aa79	6.7	6.6	7.1	7.2	6.7	0.26	6.9	0.27	3.94
b81fb0	7.0	7.0	6.9	7.1	7.1	1.20	7.0	0.08	1.19
d2396a	7.0	7.5	7.2	7.2	7.3	0.10	7.2	0.18	2.51

The Numerical Procedure for Determining Outliers

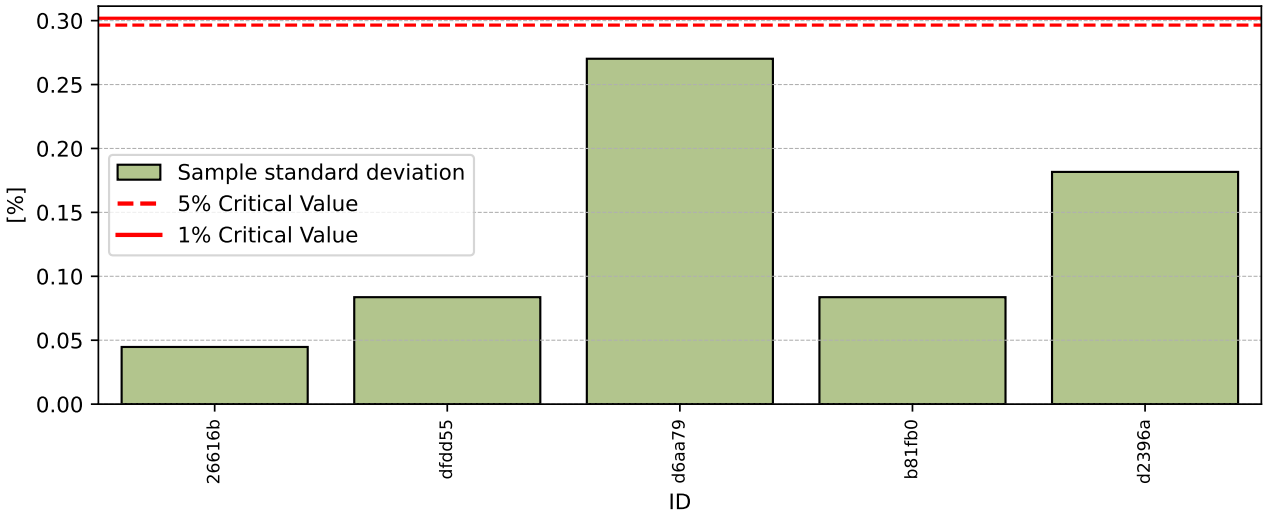

Figure 66: **Cochran's test** - sample standard deviations

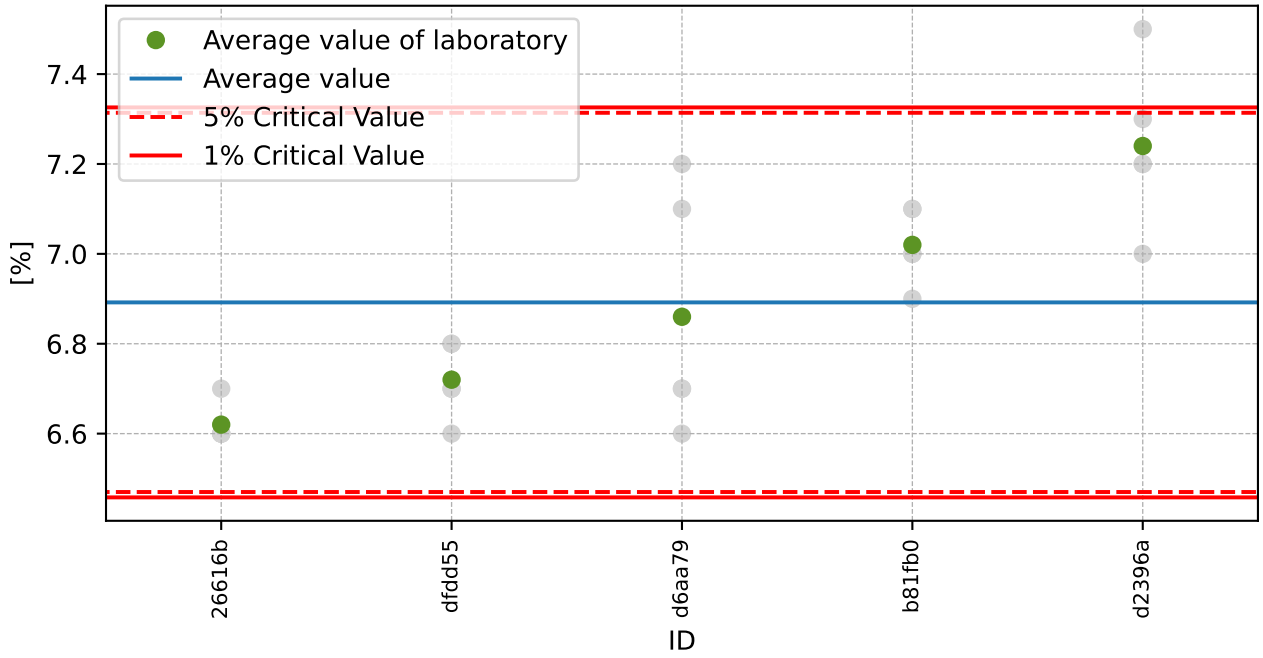

Figure 67: **Grubbs' test** - average values

Mandel's Statistics

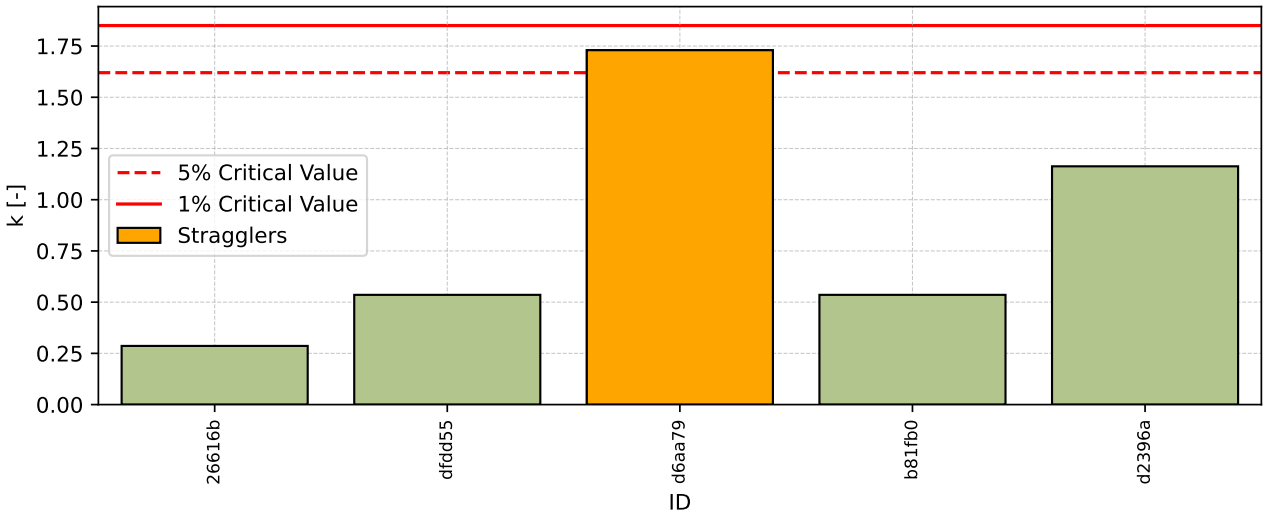

Figure 68: Intralaboratory Consistency Statistic

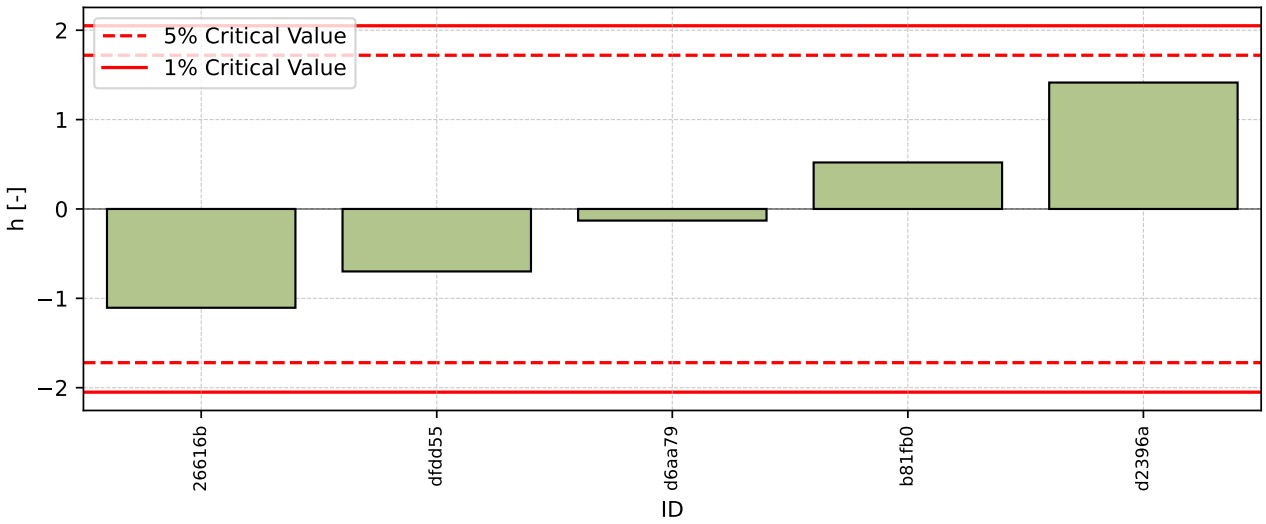

Figure 69: Interlaboratory Consistency Statistic

Descriptive statistics

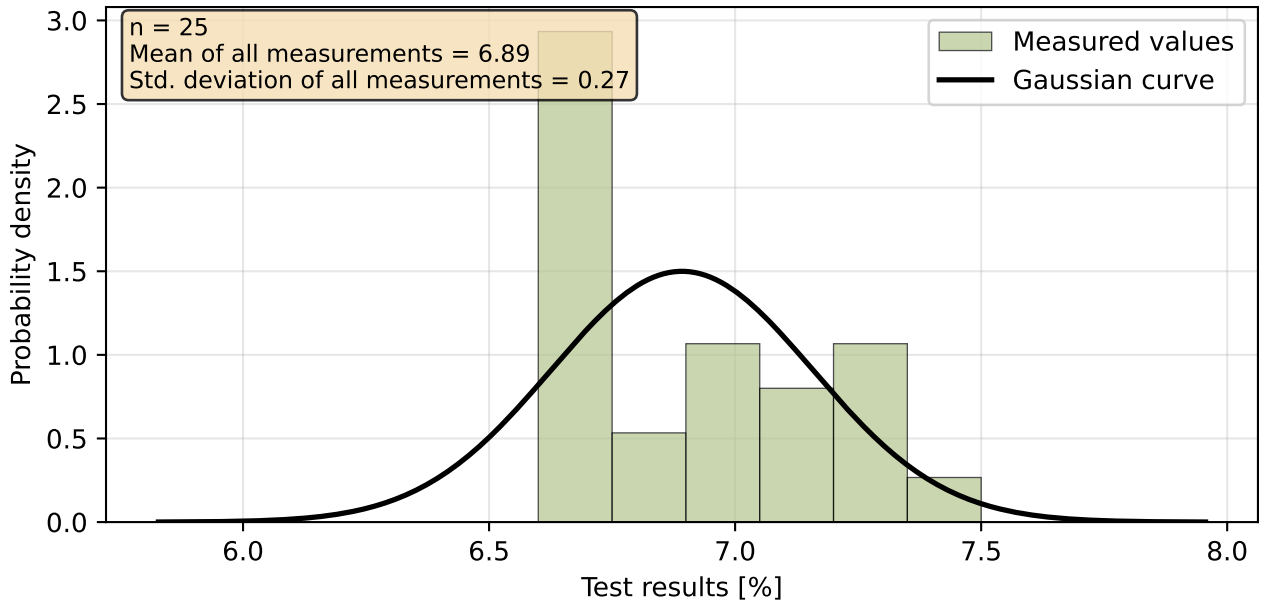

Figure 70: Histogram of all test results

Table 26: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	6.89
Sample standard deviation – s	0.25
Assigned value – x^*	6.89
Robust standard deviation – s^*	0.25
Measurement uncertainty of assigned value – u_X	0.11
p-value of normality test [-]	0.016
Interlaboratory standard deviation – s_L	0.24
Repeatability standard deviation – s_r	0.16
Reproducibility standard deviation – s_R	0.28
Repeatability – r	0.44
Reproducibility – R	0.79

Evaluation of Performance Statistics

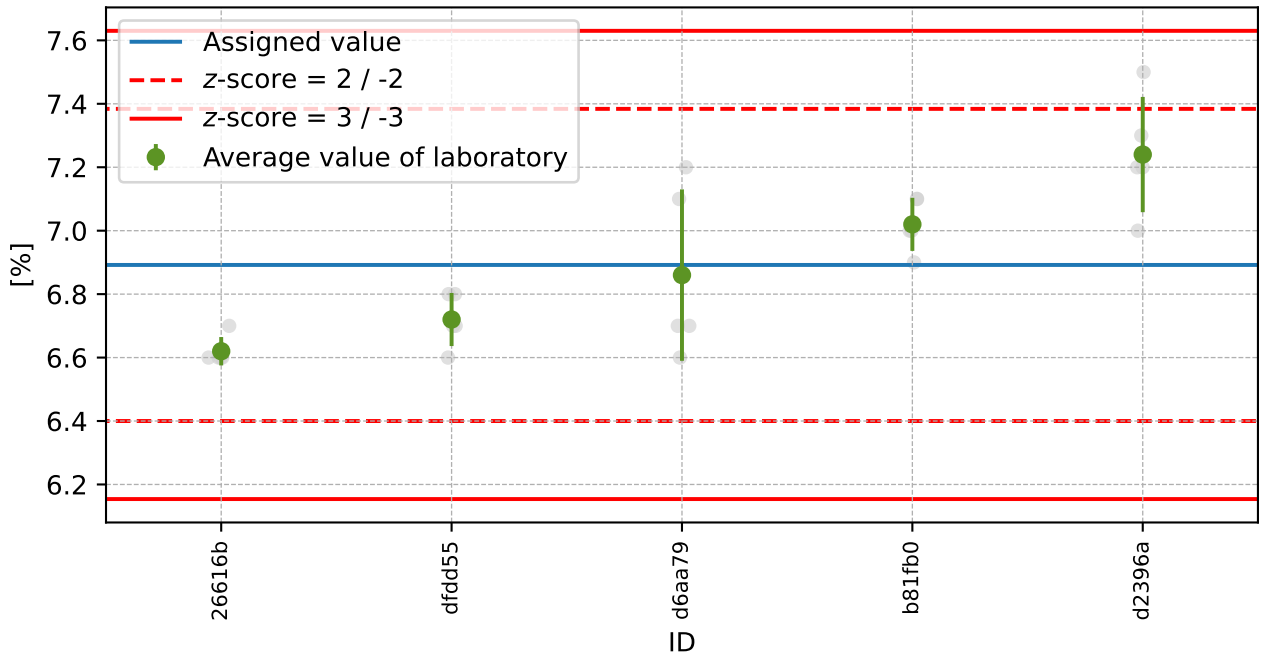

Figure 71: Average values and sample standard deviations

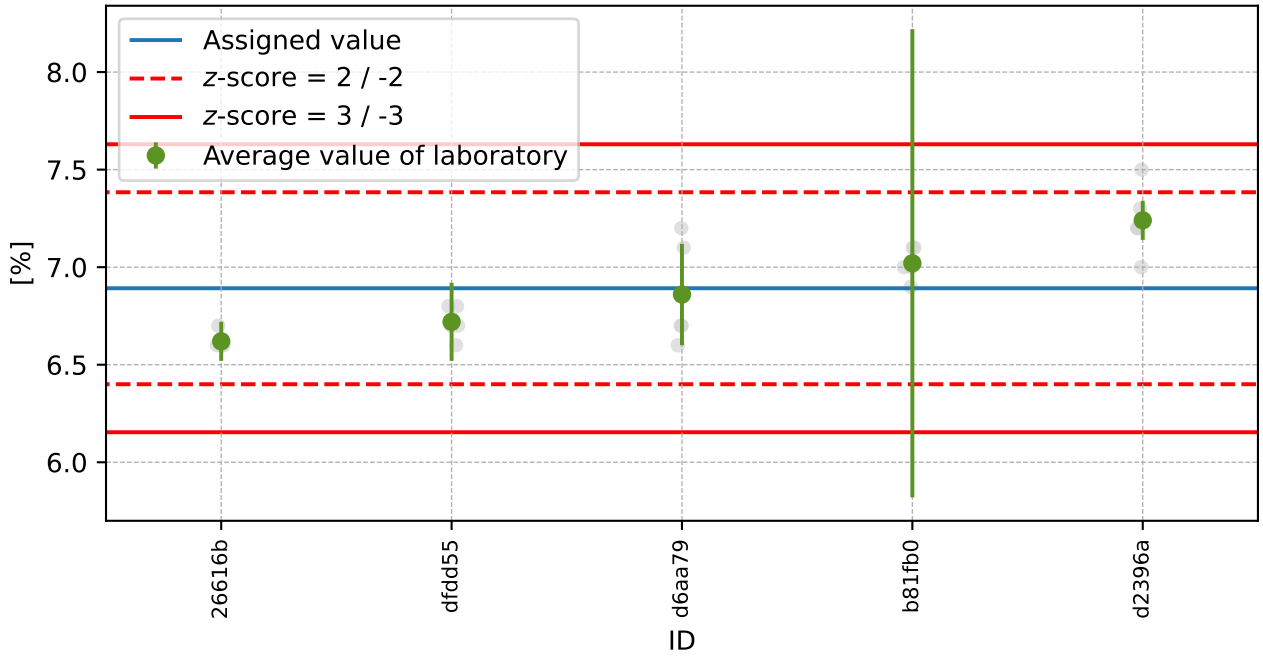

Figure 72: Average values and extended uncertainties of measurement

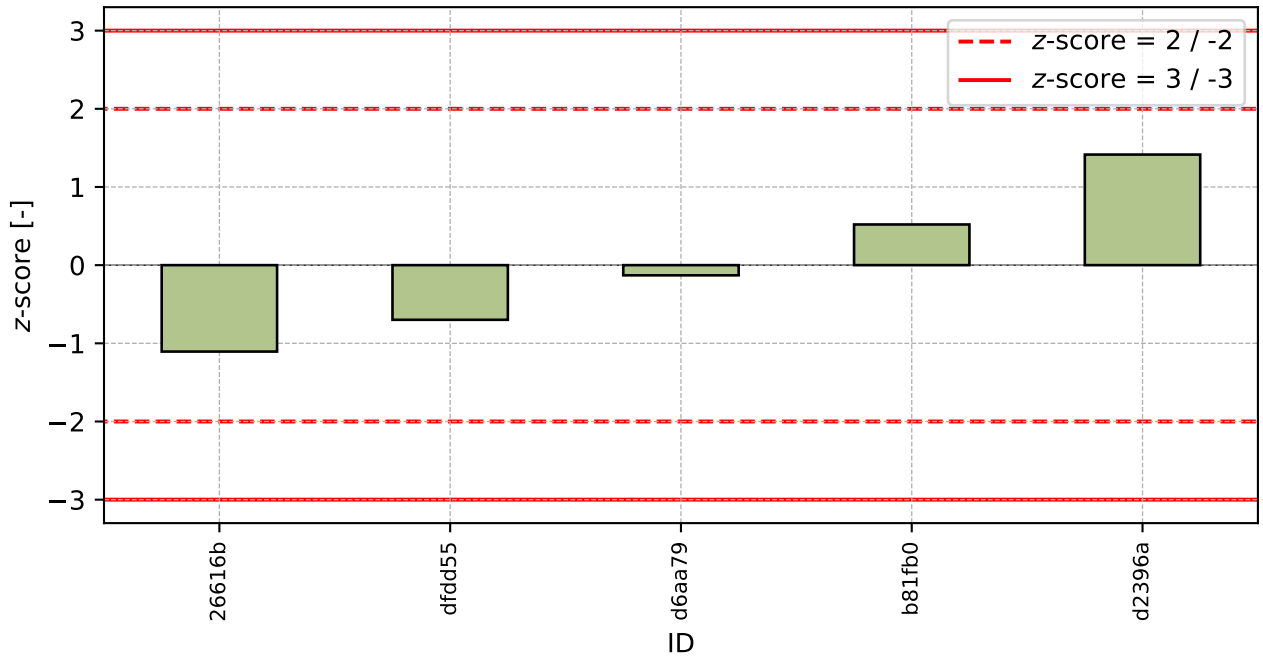

Figure 73: z-score

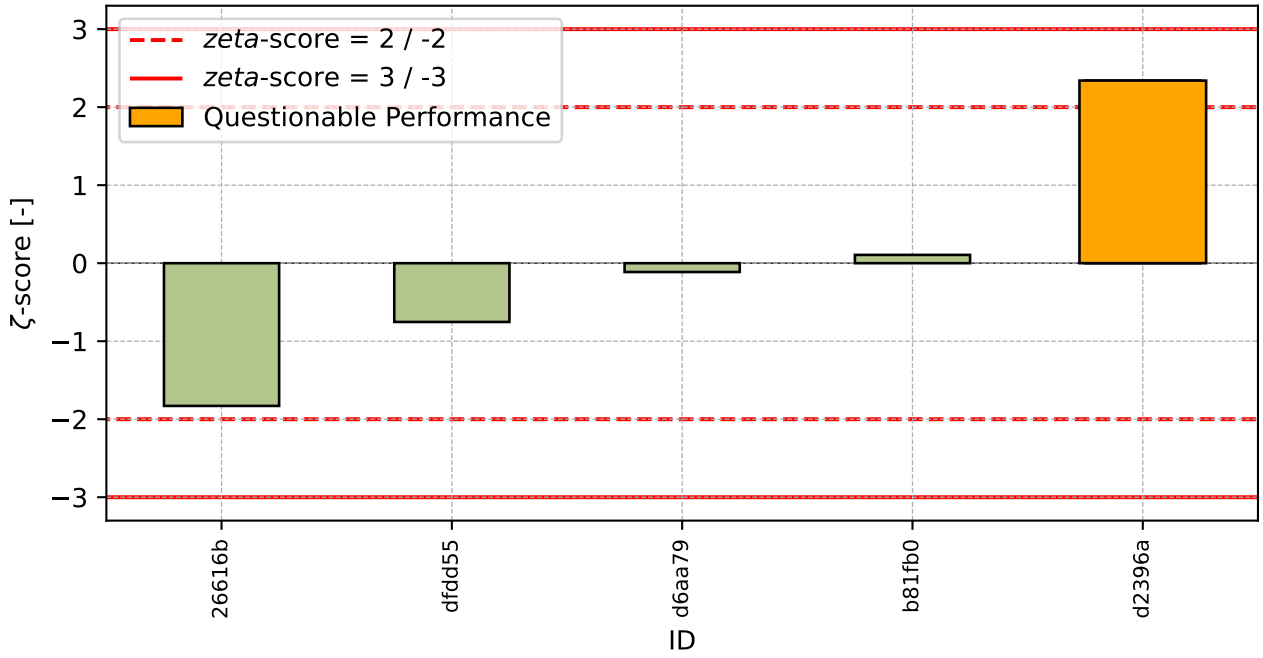

Figure 74: ζ-score

Table 27: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
26616b	-1.11	-1.83
dfdd55	-0.70	-0.75
d6aa79	-0.13	-0.11
b81fb0	0.52	0.11
d2396a	1.41	2.34

6 Appendix – EN ISO 179-1 (Charpy unnotched impact strength)

The test method was not opened due to the low number of participants.

7 Appendix – EN ISO 179-1 (Charpy notched impact strength (note: notch made by distributor))

The test method was not opened due to the low number of participants.

8 Appendix – EN ISO 179-1 (Charpy notched impact strength (note: notch made by laboratory))

The test method was not opened due to the low number of participants.

9 Appendix – EN ISO 868 (Shore hardness D)

9.1 Sample A

9.1.1 Test results

Table 28: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [°]	2 [°]	3 [°]	4 [°]	5 [°]	u_X [°]	$\bar{x}$ [°]	s_0 [°]	V_X [%]
d2396a	62.3	61.0	61.2	61.5	61.1	0.20	61.4	0.53	0.86
1875c4	65.0	64.0	64.0	65.0	65.0	0.93	64.6	0.55	0.85
b81fb0	66.9	66.7	67.3	67.2	67.0	0.30	67.0	0.24	0.36
dfdd55	67.0	67.2	67.0	67.3	66.9	0.40	67.1	0.16	0.24
26616b	67.9	67.8	68.0	68.3	68.3	0.40	68.1	0.23	0.34

9.1.2 The Numerical Procedure for Determining Outliers

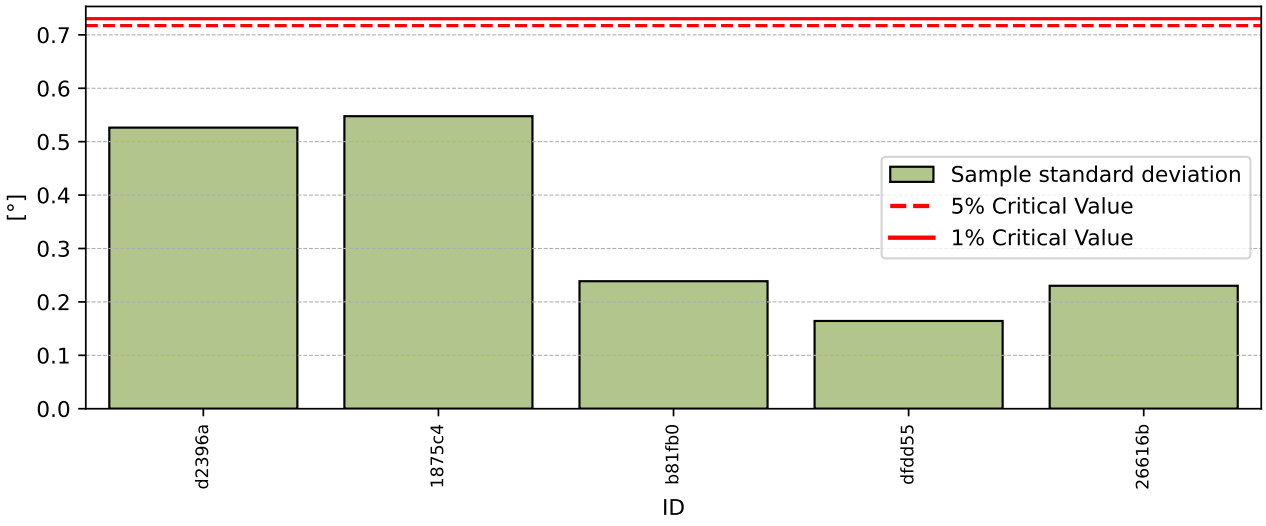

Figure 75: **Cochran's test** - sample standard deviations

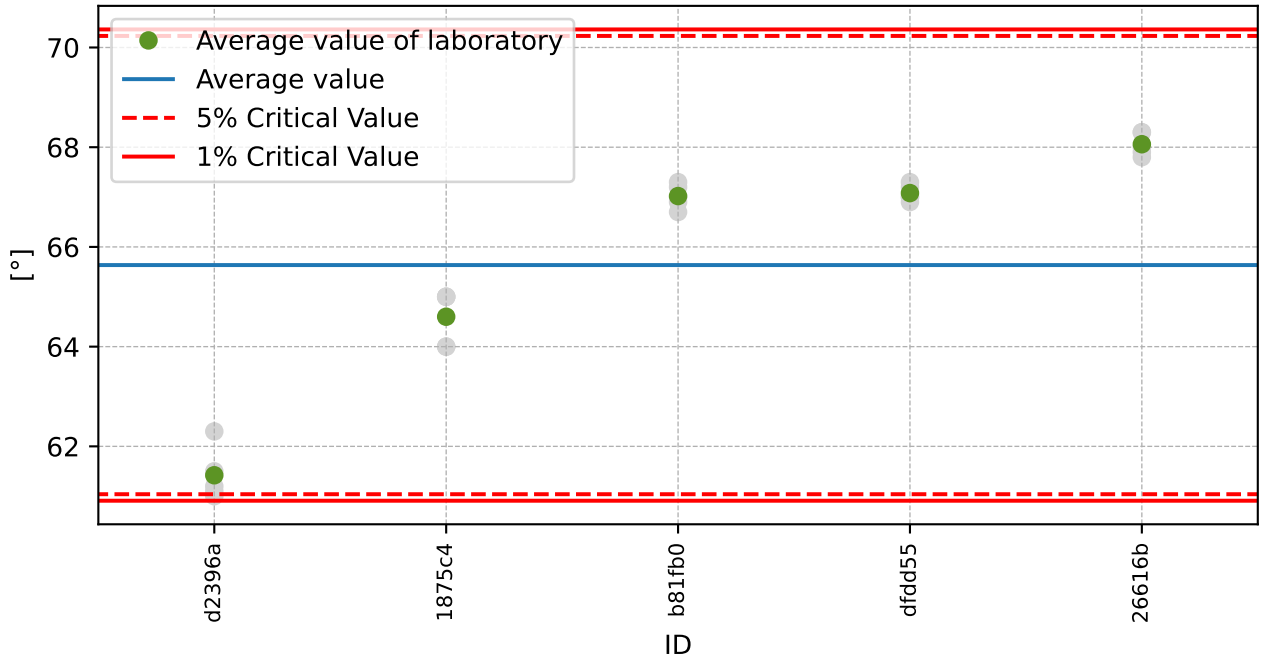

Figure 76: **Grubbs' test** - average values

9.1.3 Mandel's Statistics

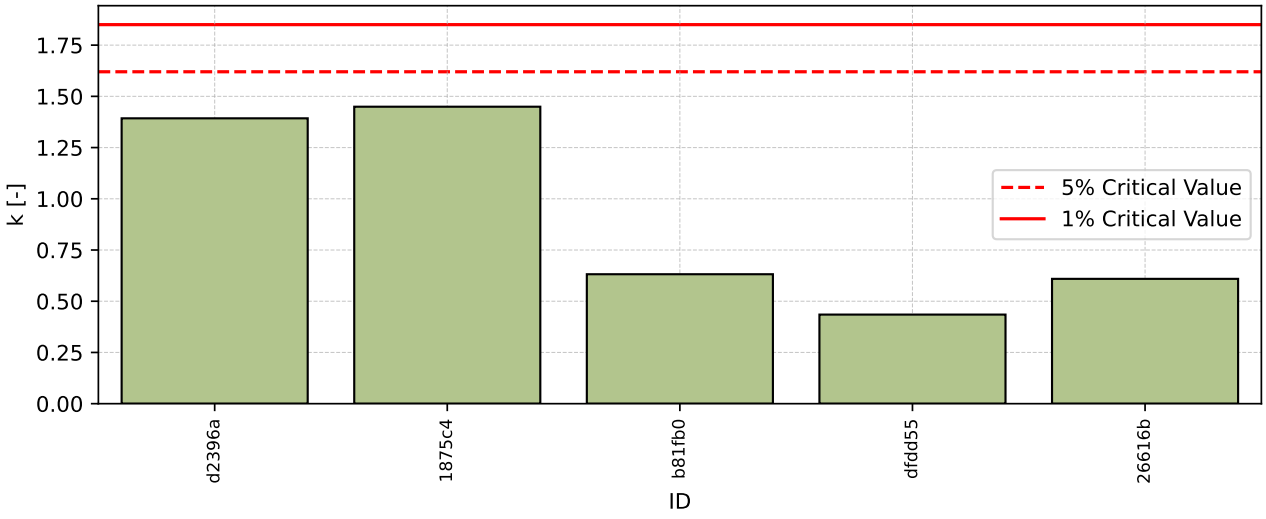

Figure 77: Intralaboratory Consistency Statistic

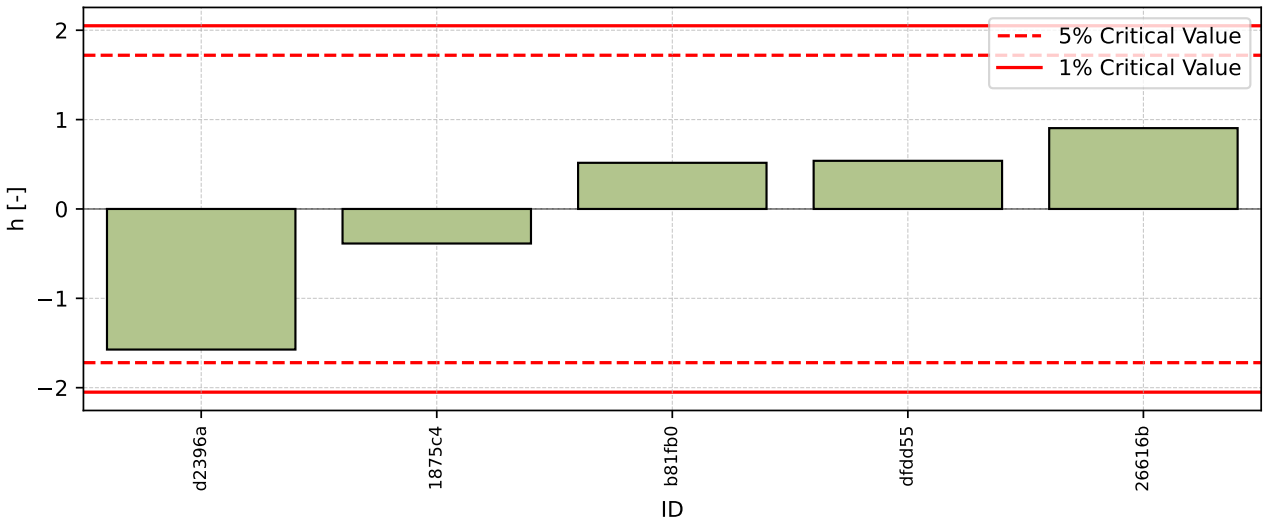

Figure 78: Interlaboratory Consistency Statistic

9.1.4 Descriptive statistics

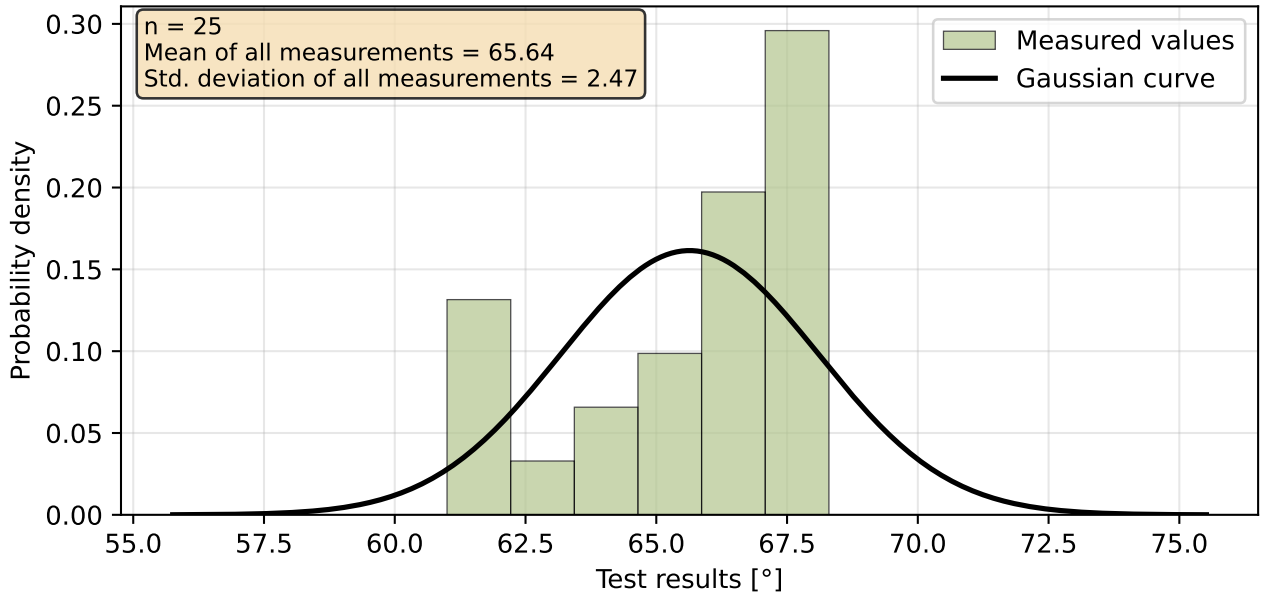

Figure 79: Histogram of all test results

Table 29: Descriptive statistics

Characteristics	[°]
Average value – $\bar{x}$	65.64
Sample standard deviation – s	2.68
Assigned value – x^*	65.64
Robust standard deviation – s^*	2.68
Measurement uncertainty of assigned value – u_X	1.20
p-value of normality test [-]	< 0.001
Interlaboratory standard deviation – s_L	2.67
Repeatability standard deviation – s_r	0.38
Reproducibility standard deviation – s_R	2.70
Repeatability – r	1.06
Reproducibility – R	7.56

9.1.5 Evaluation of Performance Statistics

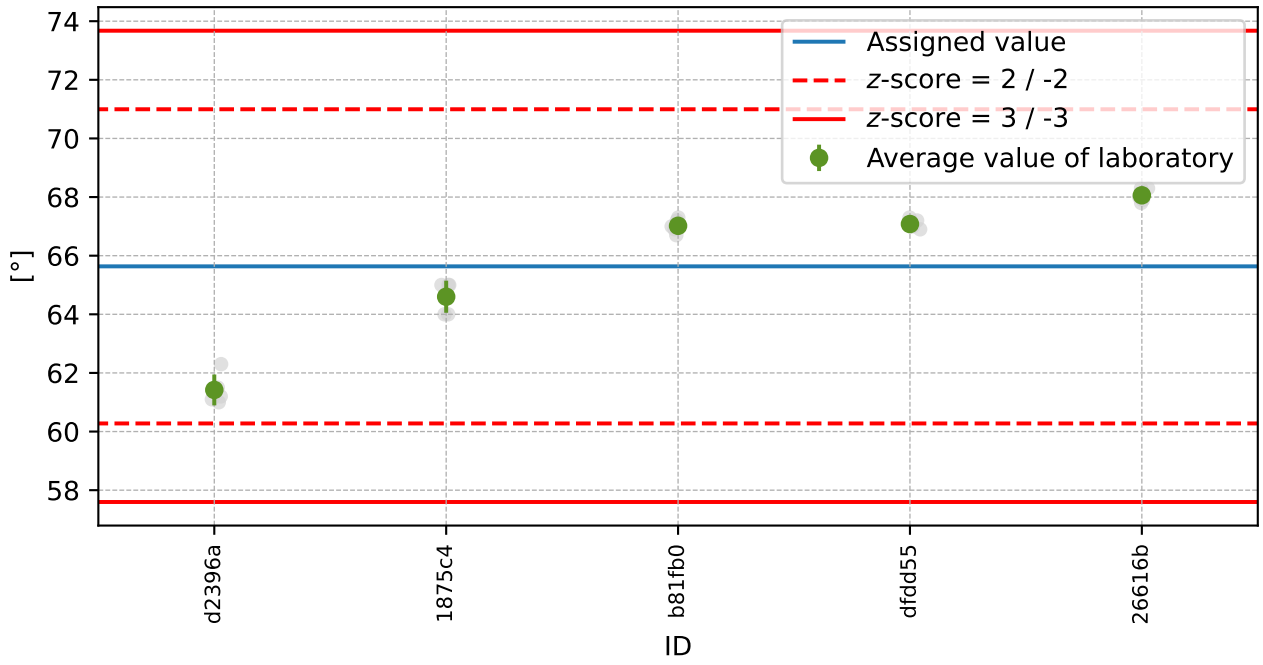

Figure 80: Average values and sample standard deviations

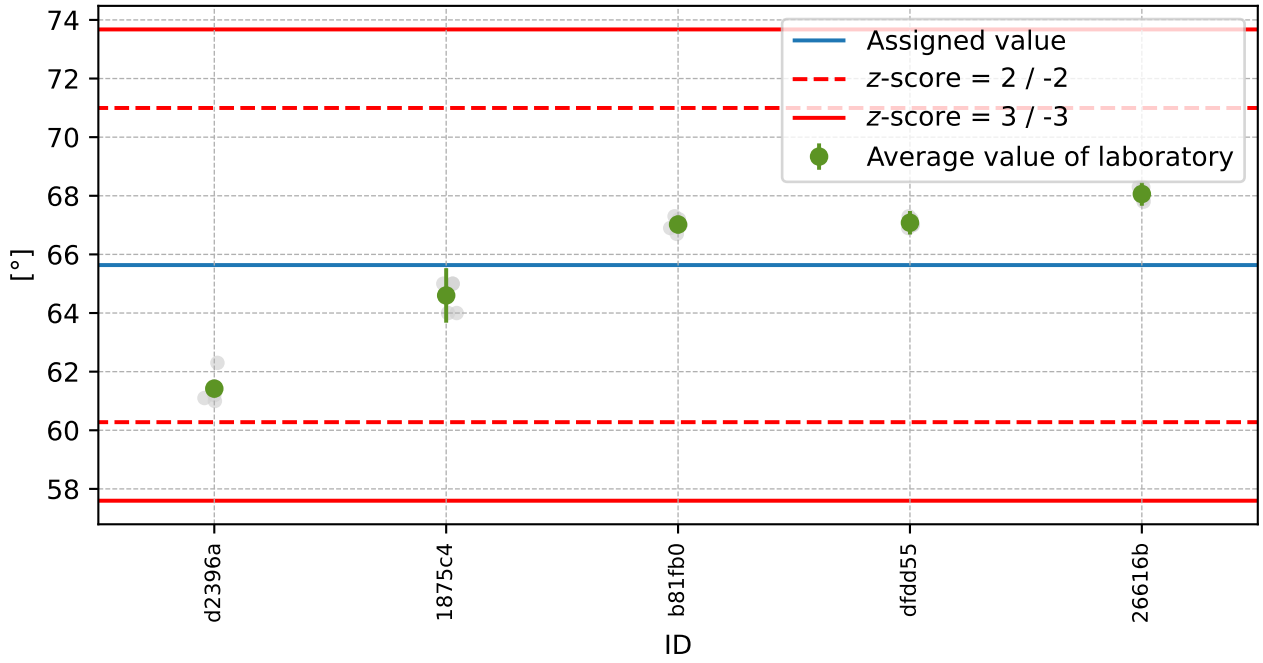

Figure 81: Average values and extended uncertainties of measurement

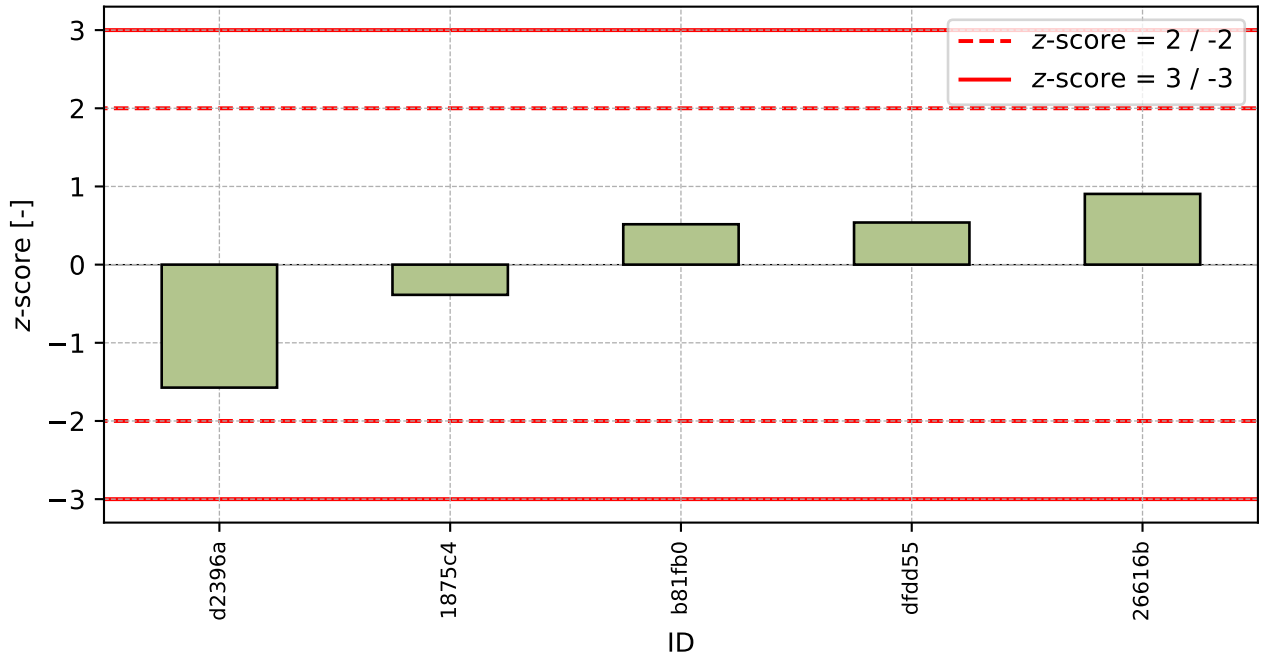

Figure 82: z-score

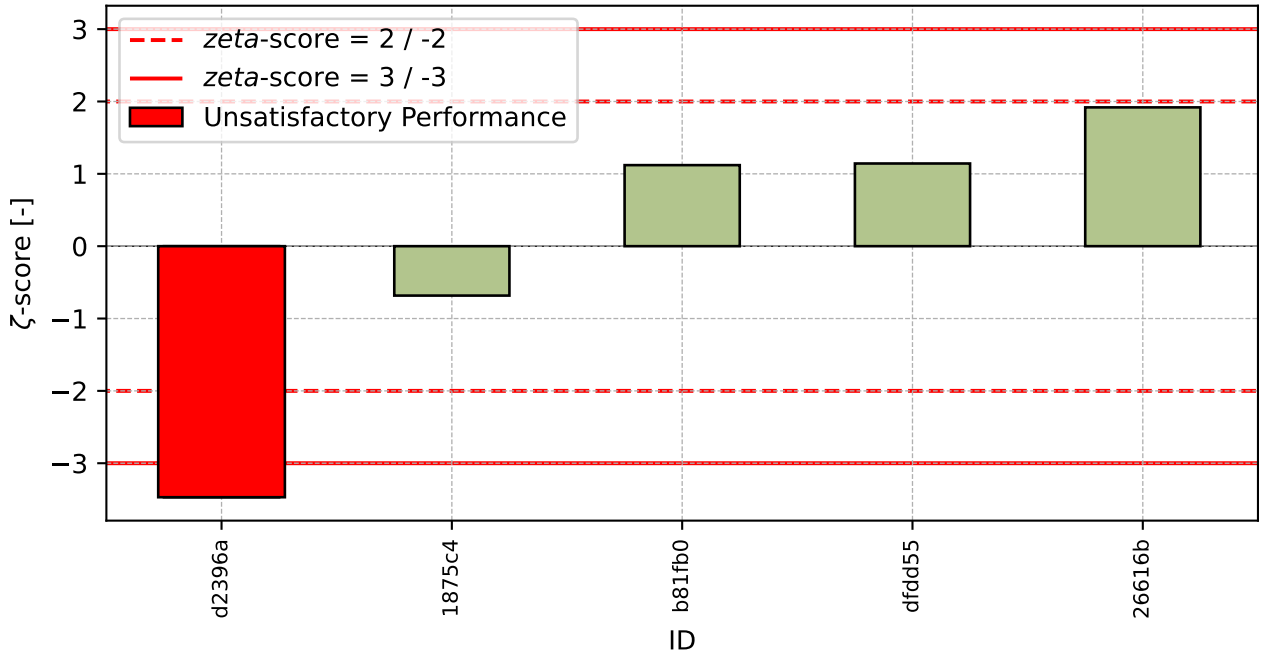

Figure 83: ζ-score

Table 30: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d2396a	-1.57	-3.47
1875c4	-0.39	-0.68
b81fb0	0.52	1.12
dfdd55	0.54	1.14
26616b	0.90	1.92

9.2 Sample B

9.2.1 Test results

Table 31: Test results – ordered by average value. Outliers are marked by red color. Columns 1–5 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [°]	2 [°]	3 [°]	4 [°]	5 [°]	u_X [°]	$\bar{x}$ [°]	s_0 [°]	V_X [%]
d2396a	65.2	65.8	66.4	66.3	66.5	0.20	66.0	0.54	0.82
1875c4	69.0	69.0	69.0	68.0	68.0	0.93	68.6	0.55	0.80
b81fb0	69.7	70.2	69.5	69.8	70.4	0.30	69.9	0.37	0.53
dfdd55	70.4	70.2	69.8	70.1	70.3	0.40	70.2	0.23	0.33
26616b	71.5	71.8	72.3	72.1	72.1	0.60	72.0	0.31	0.44

9.2.2 The Numerical Procedure for Determining Outliers

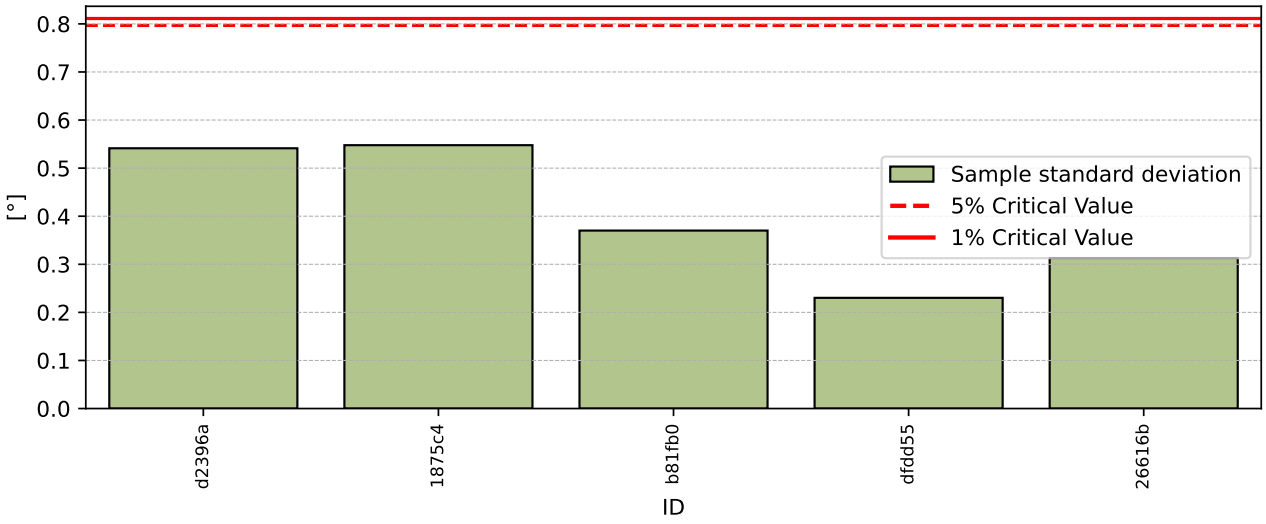

Figure 84: **Cochran's test** - sample standard deviations

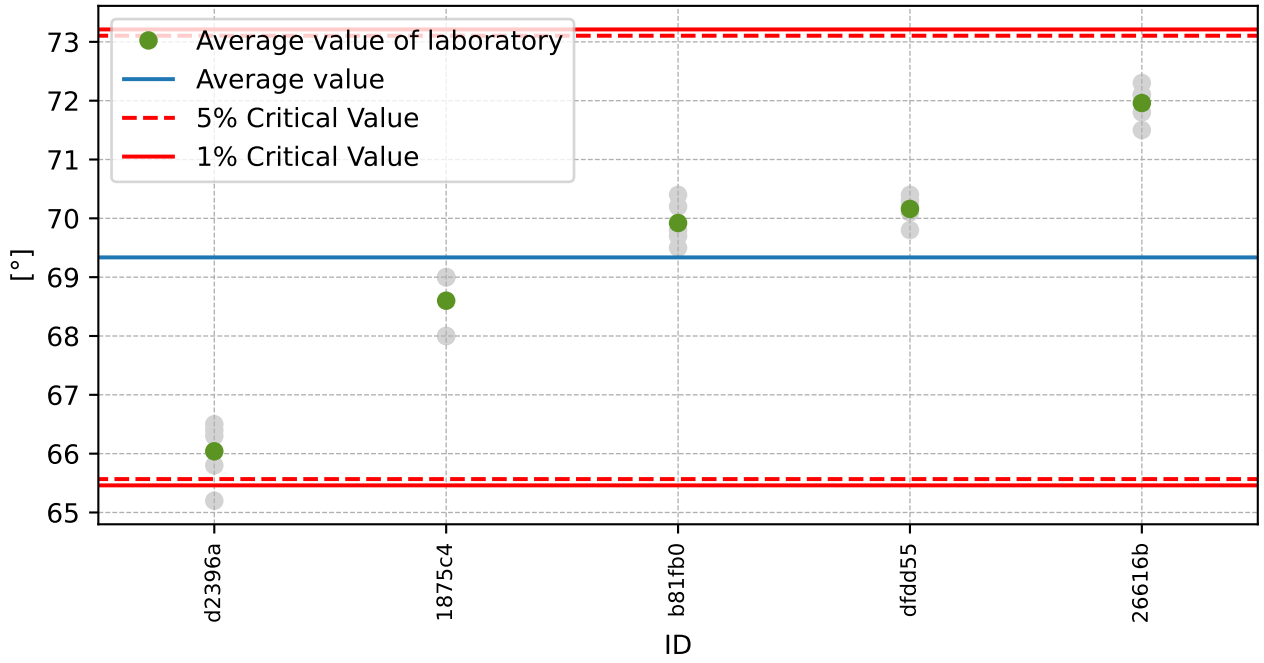

Figure 85: **Grubbs' test** - average values

9.2.3 Mandel's Statistics

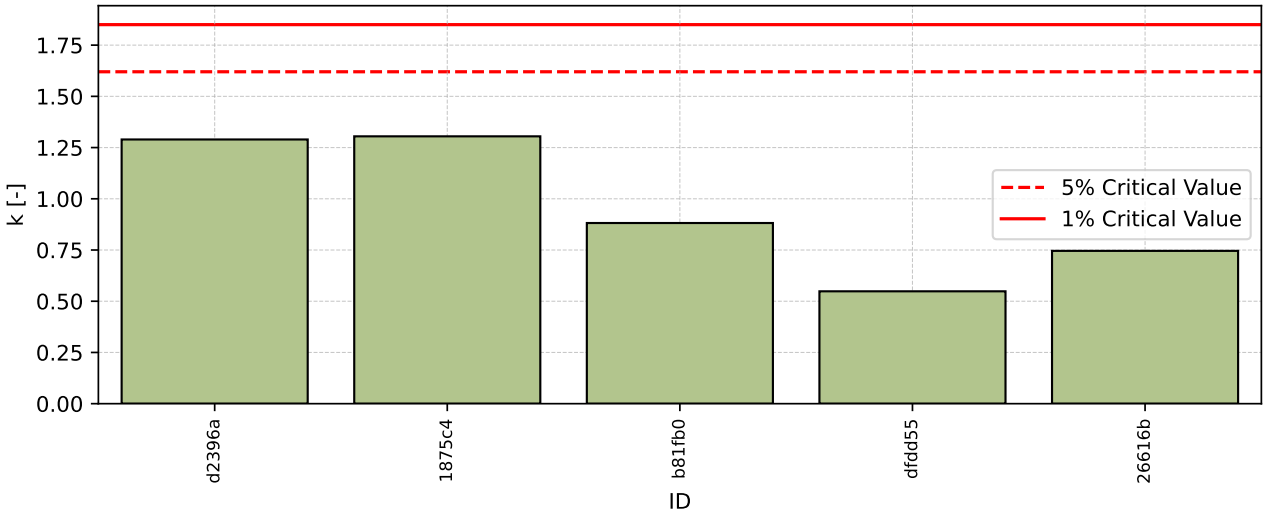

Figure 86: Intralaboratory Consistency Statistic

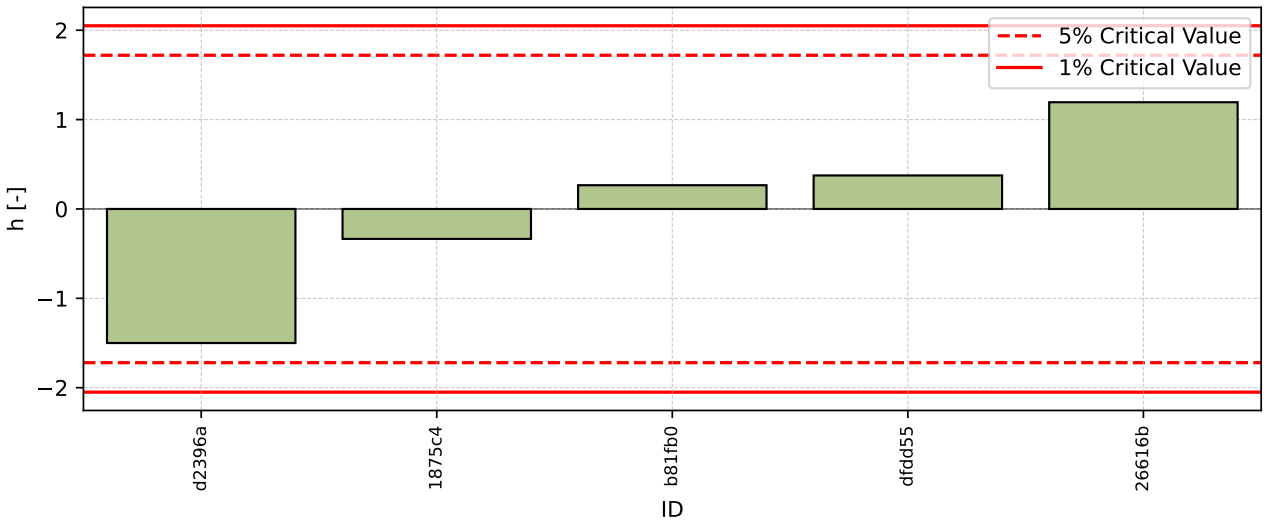

Figure 87: Interlaboratory Consistency Statistic

9.2.4 Descriptive statistics

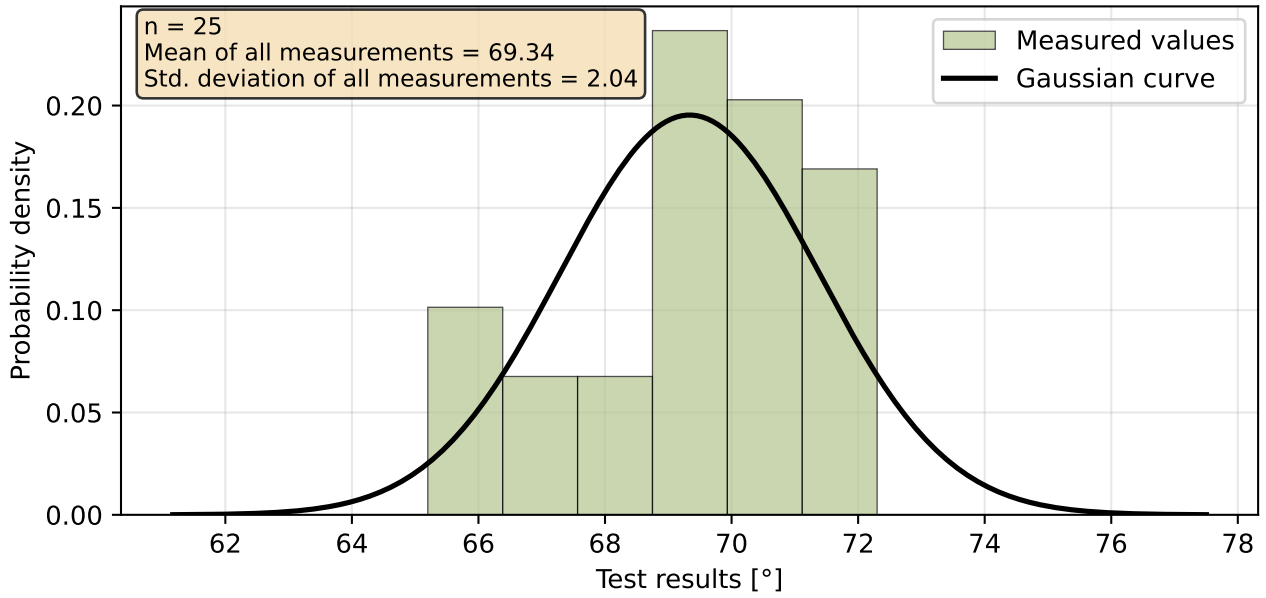

Figure 88: Histogram of all test results

Table 32: Descriptive statistics

Characteristics	[°]
Average value – $\bar{x}$	69.34
Sample standard deviation – s	2.20
Assigned value – x^*	69.34
Robust standard deviation – s^*	2.20
Measurement uncertainty of assigned value – u_X	0.98
p-value of normality test [-]	0.097
Interlaboratory standard deviation – s_L	2.19
Repeatability standard deviation – s_r	0.42
Reproducibility standard deviation – s_R	2.23
Repeatability – r	1.18
Reproducibility – R	6.24

9.2.5 Evaluation of Performance Statistics

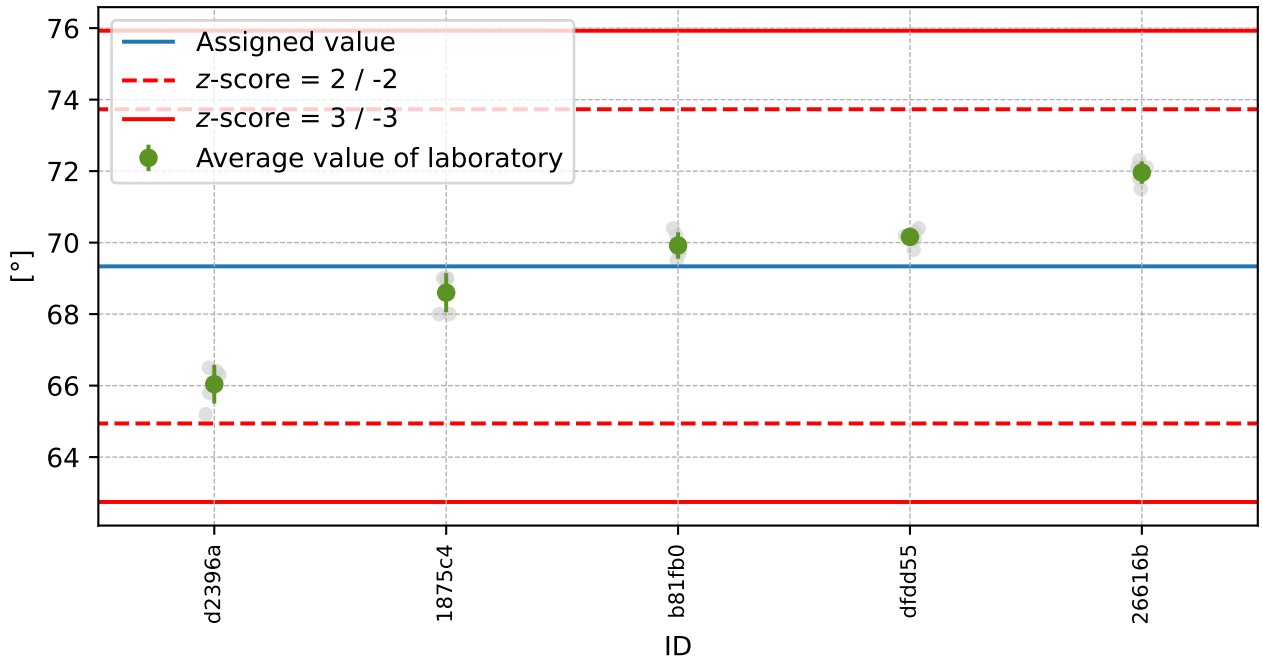

Figure 89: Average values and sample standard deviations

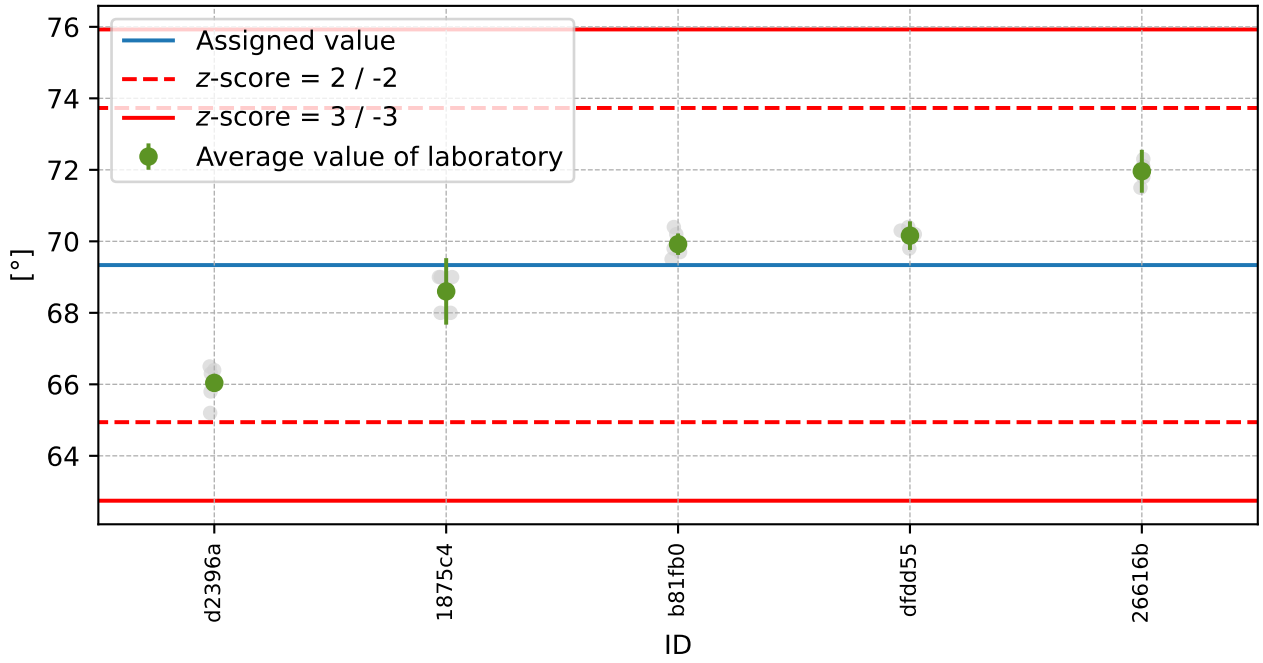

Figure 90: Average values and extended uncertainties of measurement

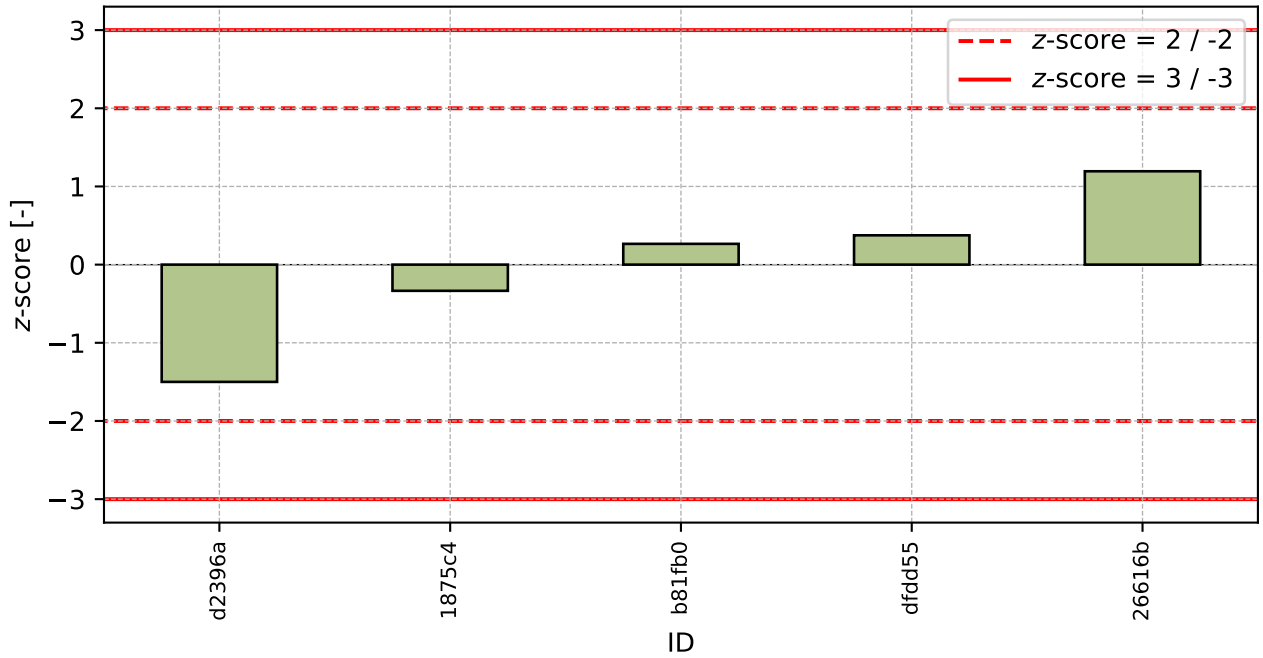

Figure 91: z-score

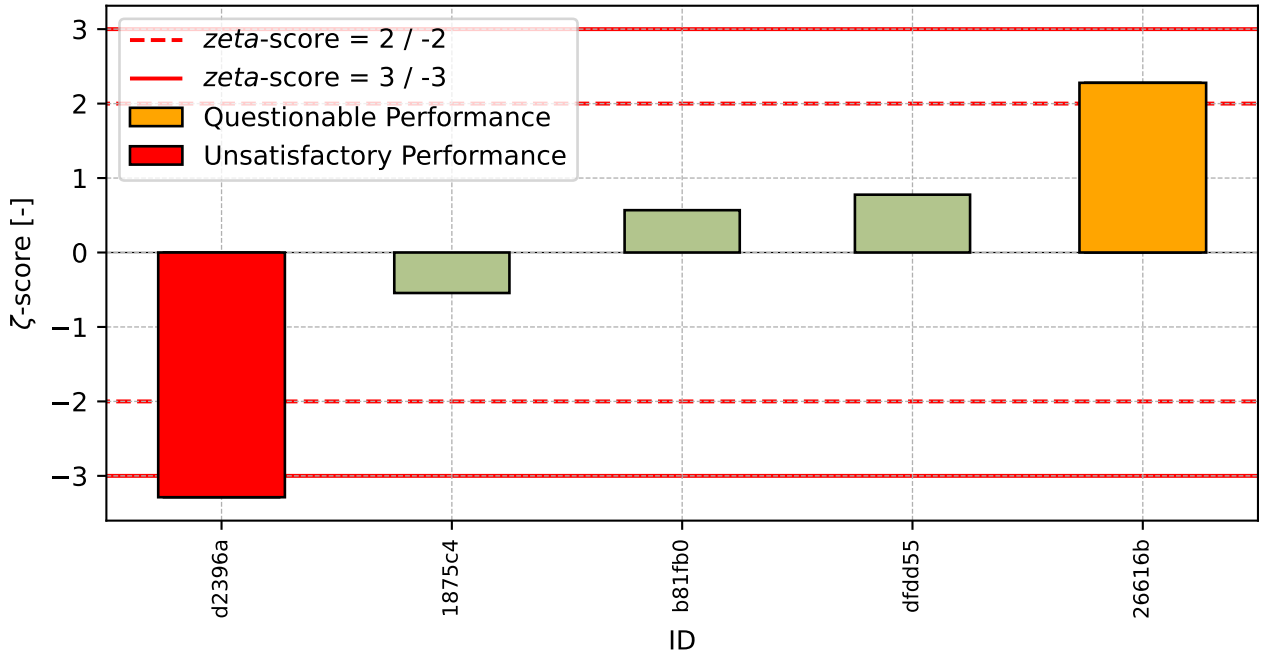

Figure 92: ζ-score

Table 33: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d2396a	-1.50	-3.29
1875c4	-0.33	-0.54
b81fb0	0.27	0.57
dfdd55	0.38	0.78
26616b	1.19	2.28

10 Appendix – EN ISO 306 (Vicat softening temperature VST/A/50)

The test method was not opened due to the low number of participants.

11 Appendix – EN ISO 306 (Vicat softening temperature VST/B/50)

The test method was not opened due to the low number of participants.

12 Appendix – EN ISO 75-1, -2 (Temperature of deflection under load, method A)

12.1 Sample A

12.1.1 Test results

Table 34: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [°C]	2 [°C]	3 [°C]	u_X [°C]	$\bar{x}$ [°C]	s_0 [°C]	V_X [%]
d2396a	59.7	57.8	57.9	0.60	58.5	1.07	1.83
b81fb0	59.1	59.0	58.9	2.00	59.0	0.10	0.17
26616b	59.8	59.4	59.5	0.40	59.6	0.21	0.35
dfdd55	62.9	59.4	59.4	4.00	60.6	2.02	3.34

12.1.2 The Numerical Procedure for Determining Outliers

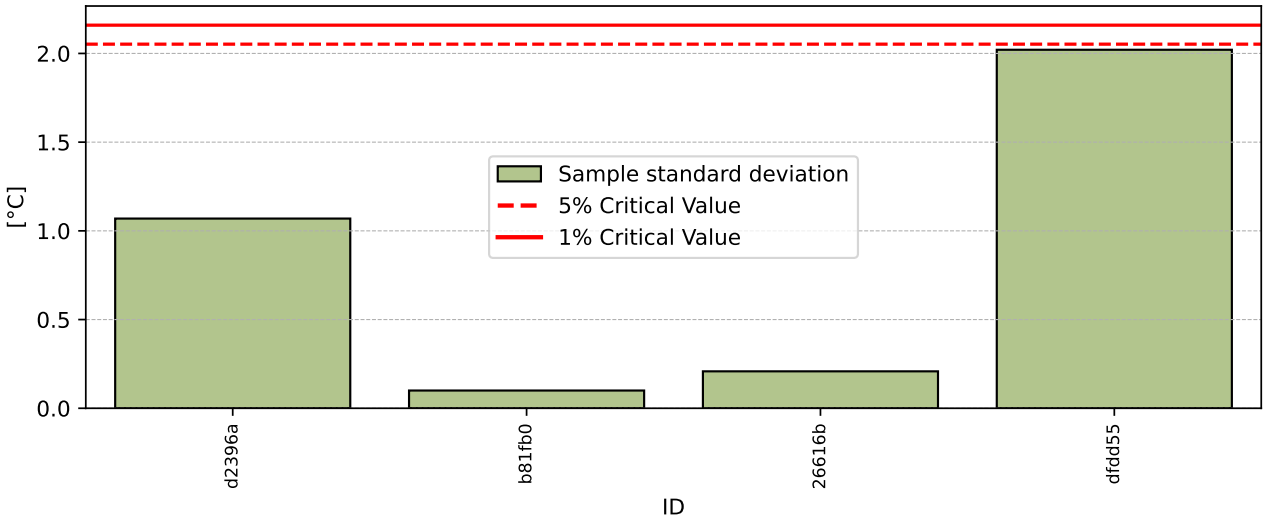

Figure 93: **Cochran's test** - sample standard deviations

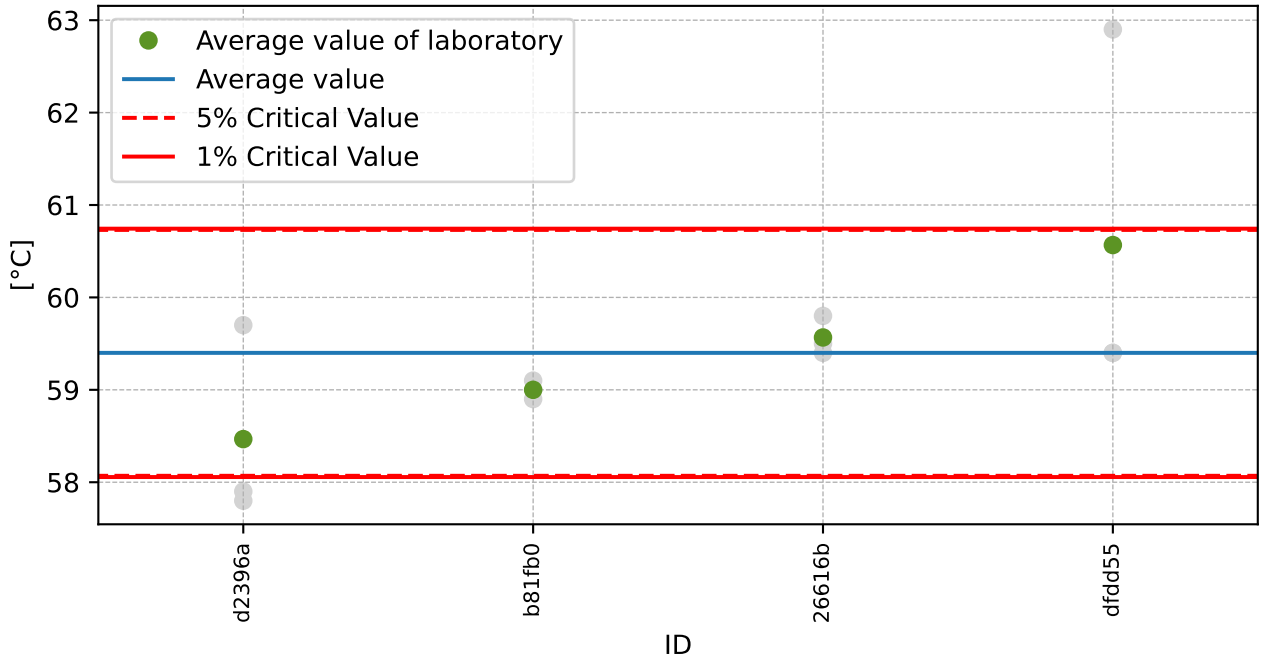

Figure 94: **Grubbs' test** - average values

12.1.3 Mandel's Statistics

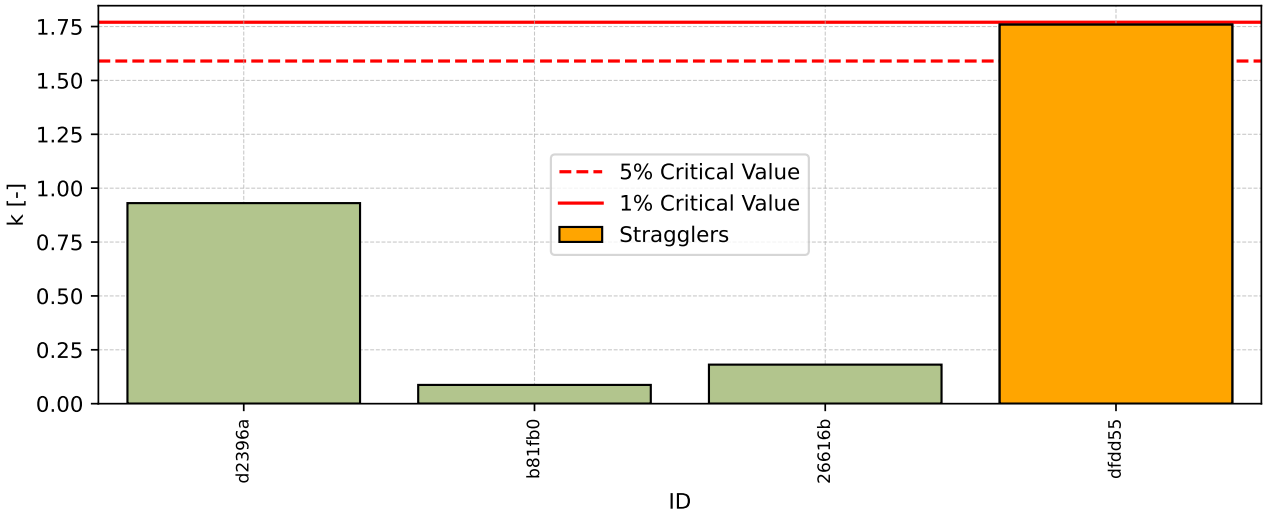

Figure 95: Intralaboratory Consistency Statistic

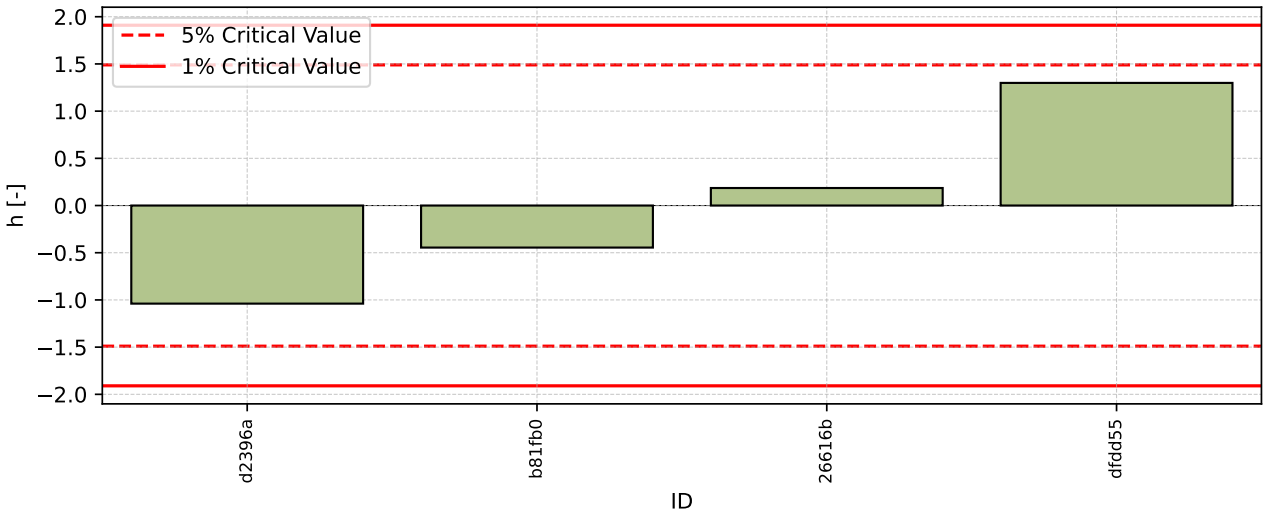

Figure 96: Interlaboratory Consistency Statistic

12.1.4 Descriptive statistics

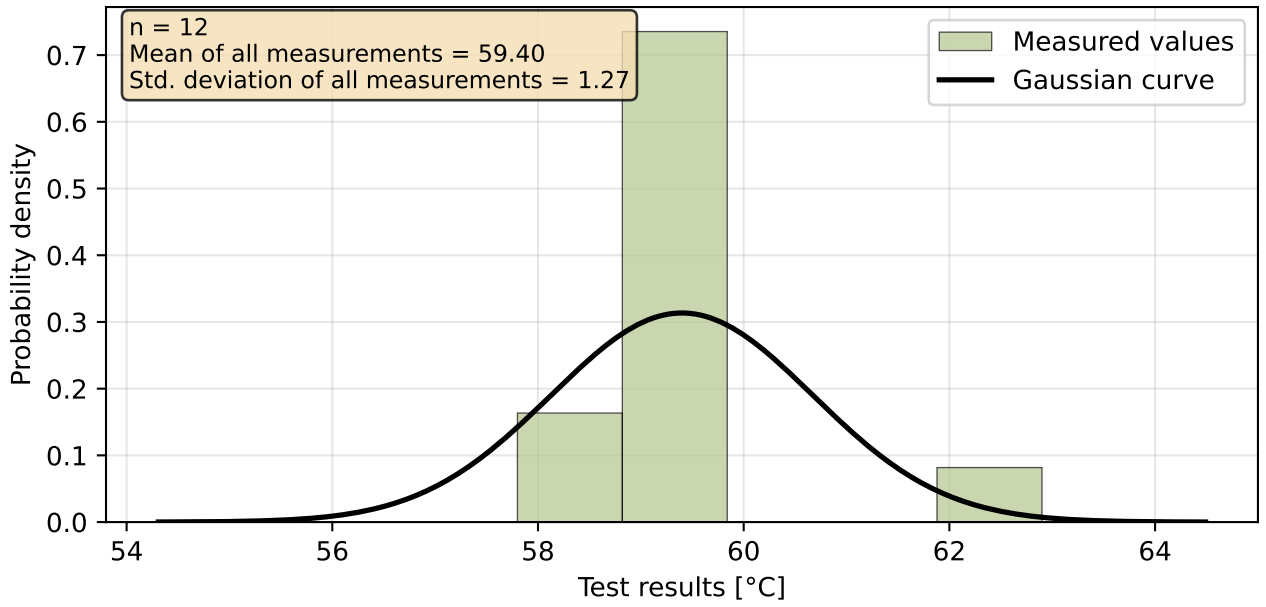

Figure 97: Histogram of all test results

Table 35: Descriptive statistics

Characteristics	[°C]
Average value – $\bar{x}$	59.40
Sample standard deviation – s	0.90
Assigned value – x^*	59.40
Robust standard deviation – s^*	0.90
Measurement uncertainty of assigned value – u_X	0.45
p-value of normality test [-]	0.005
Interlaboratory standard deviation – s_L	0.61
Repeatability standard deviation – s_r	1.15
Reproducibility standard deviation – s_R	1.30
Repeatability – r	3.22
Reproducibility – R	3.64

12.1.5 Evaluation of Performance Statistics

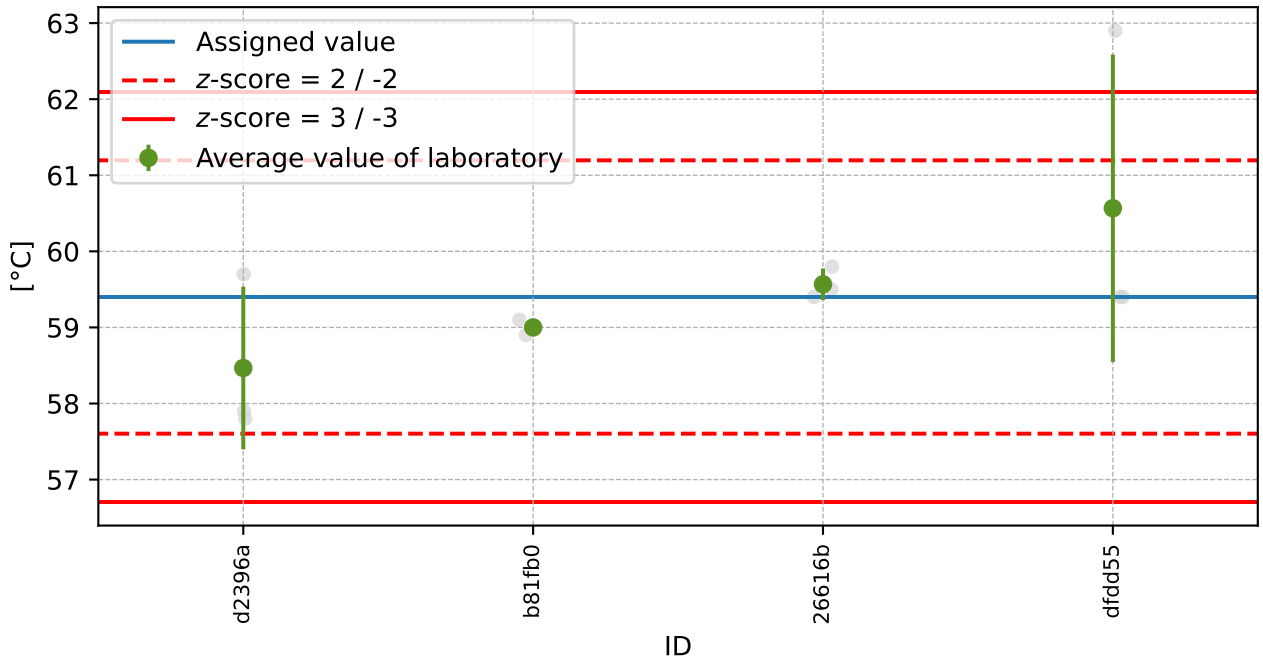

Figure 98: Average values and sample standard deviations

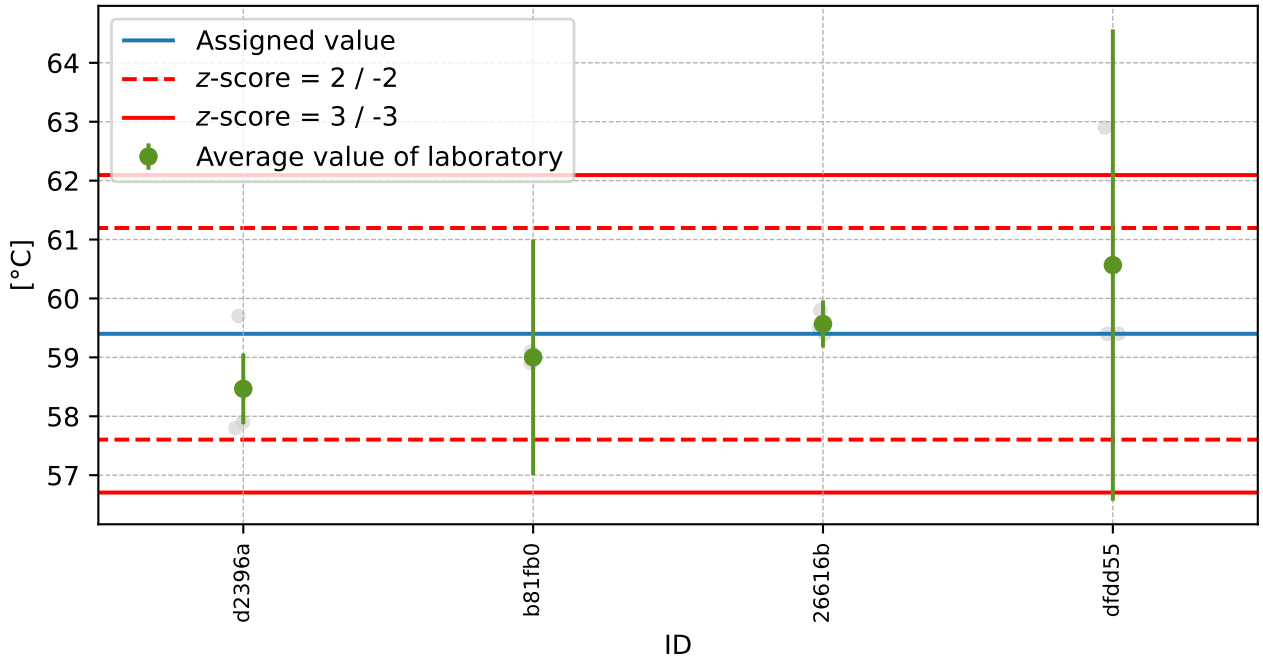

Figure 99: Average values and extended uncertainties of measurement

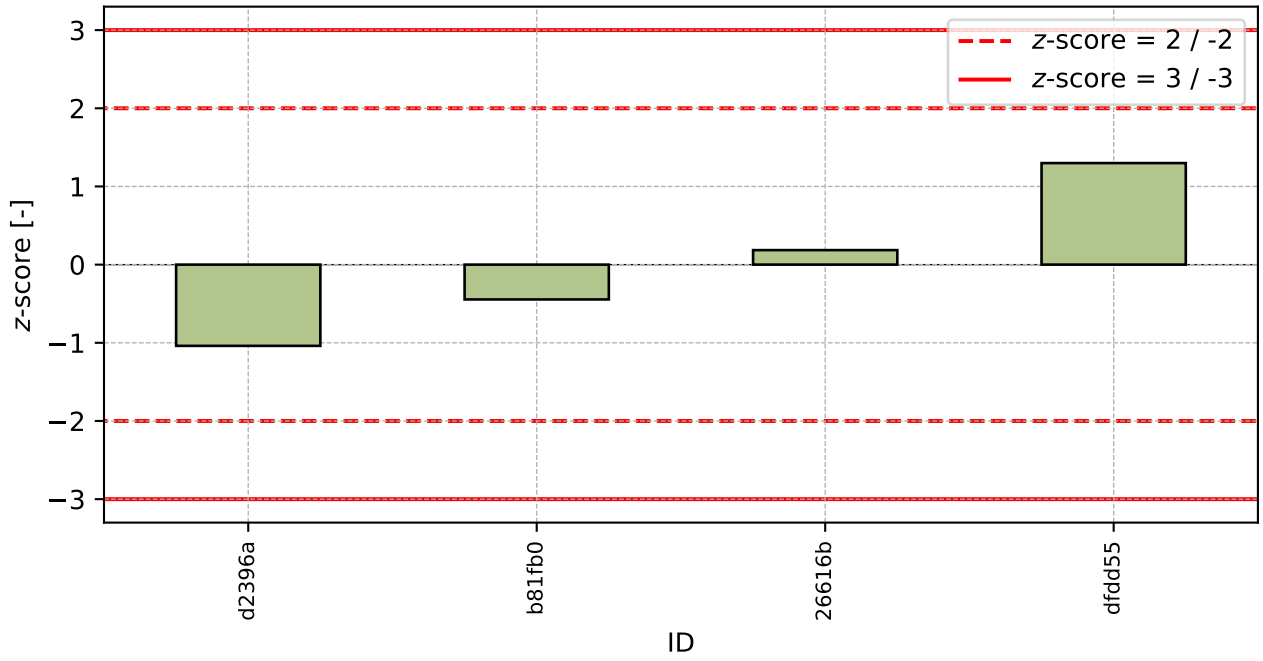

Figure 100: z-score

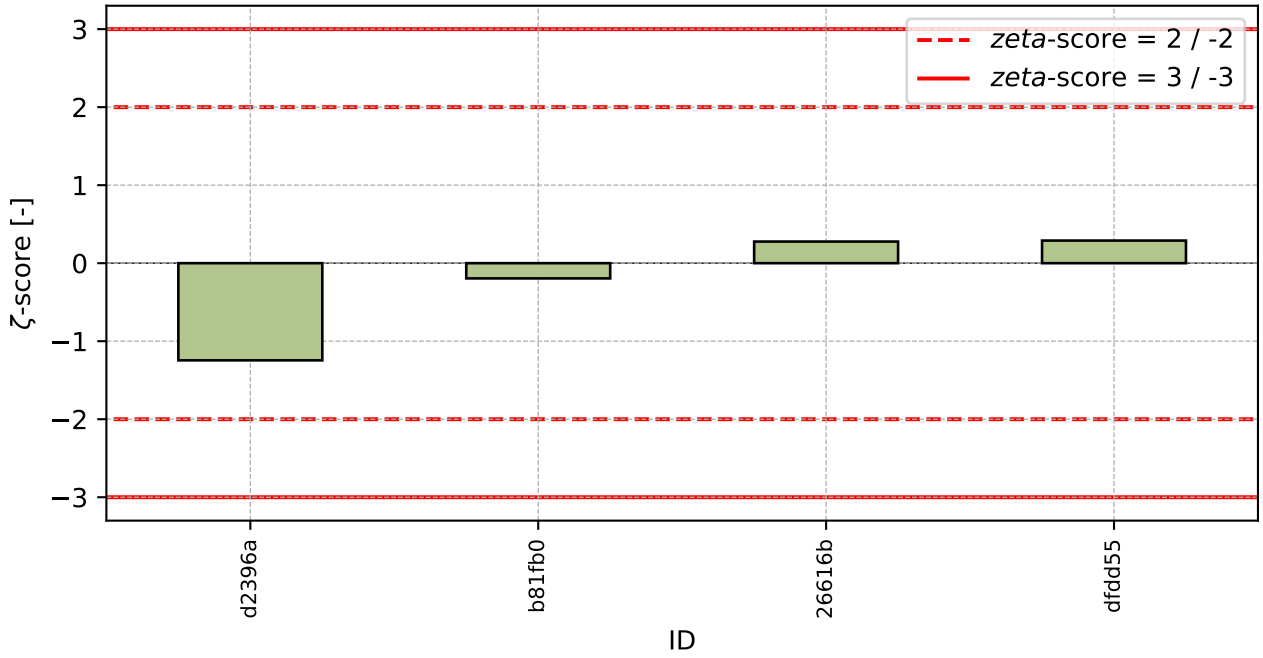

Figure 101: ζ-score

Table 36: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d2396a	-1.04	-1.25
b81fb0	-0.45	-0.20
26616b	0.19	0.28
dfdd55	1.30	0.29

12.2 Sample B

12.2.1 Test results

Table 37: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [°C]	2 [°C]	3 [°C]	u_X [°C]	$\bar{x}$ [°C]	s_0 [°C]	V_X [%]
d2396a	60.3	59.5	59.1	0.40	59.6	0.61	1.02
b81fb0	60.4	60.2	60.2	2.00	60.3	0.12	0.19
26616b	61.3	60.9	61.1	0.40	61.1	0.20	0.33
dfdd55	62.7	60.8	60.5	2.40	61.3	1.19	1.95

12.2.2 The Numerical Procedure for Determining Outliers

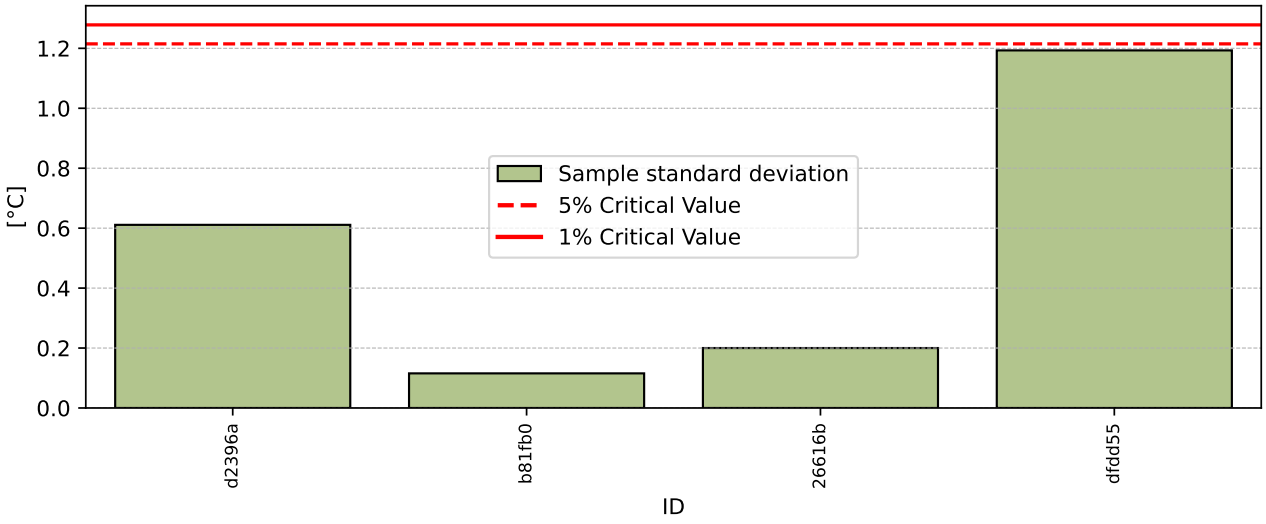

Figure 102: **Cochran's test** - sample standard deviations

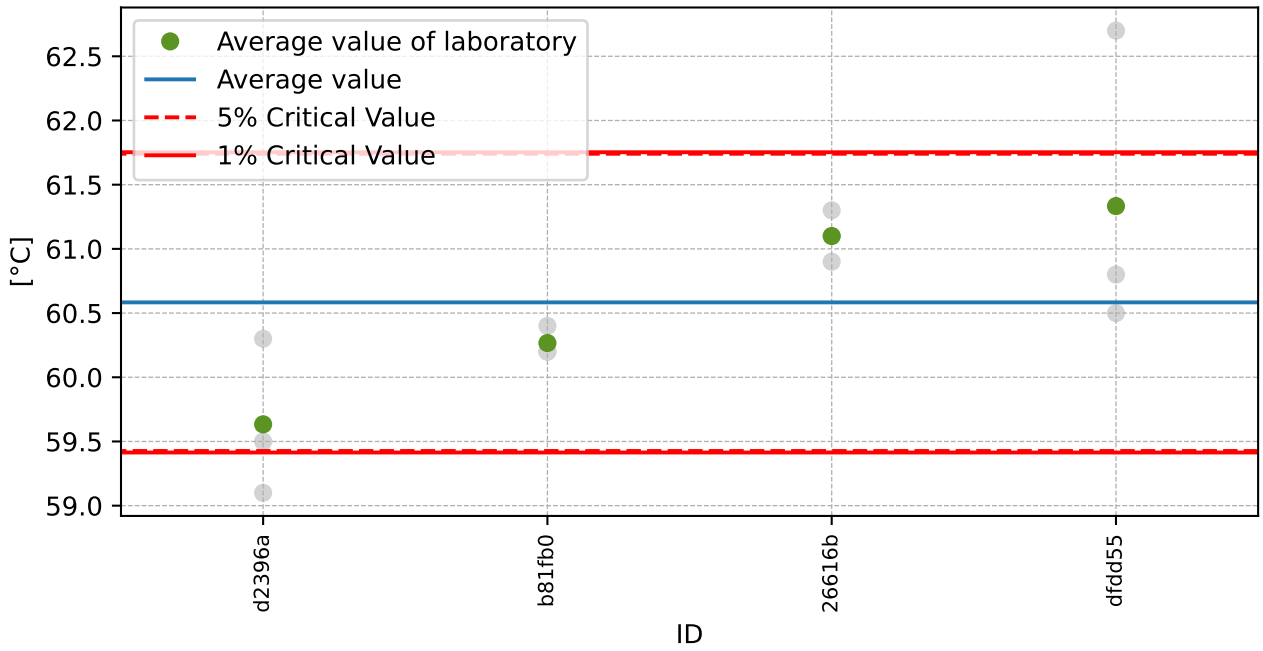

Figure 103: **Grubbs' test** - average values

12.2.3 Mandel's Statistics

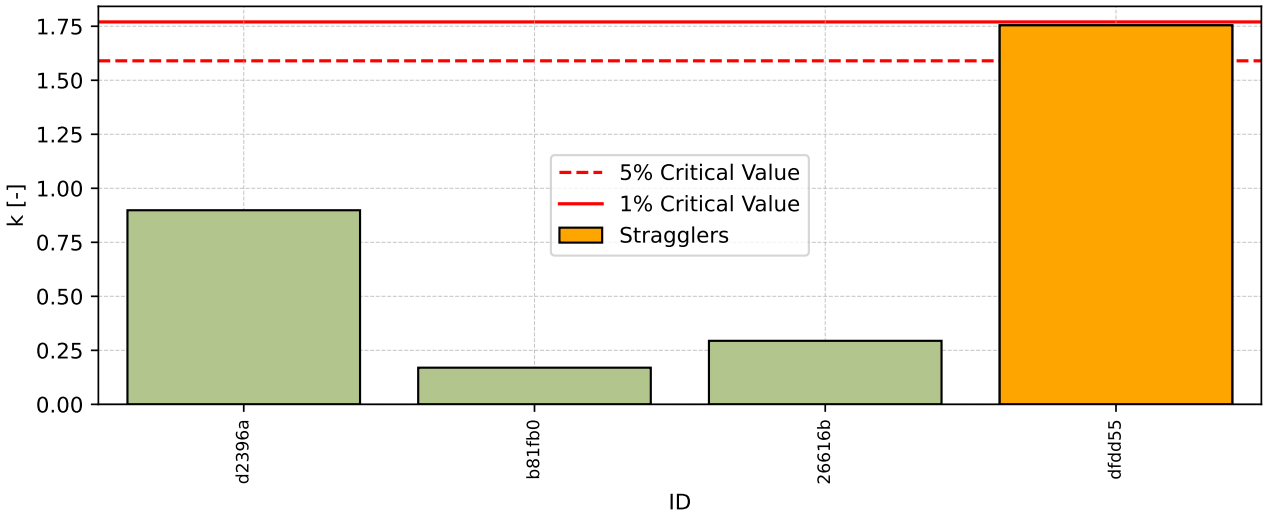

Figure 104: Intralaboratory Consistency Statistic

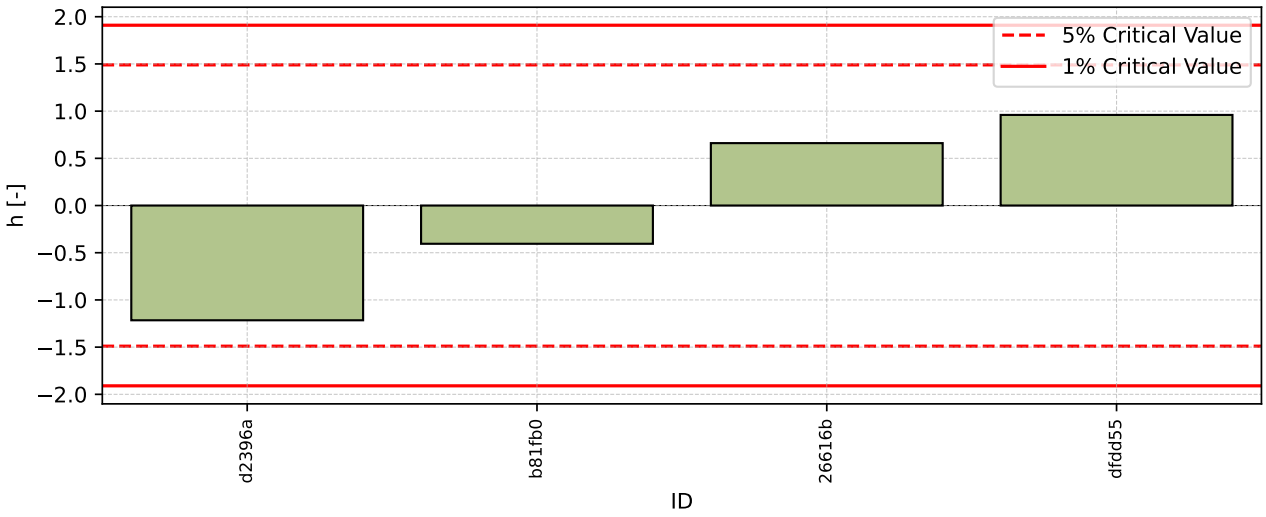

Figure 105: Interlaboratory Consistency Statistic

12.2.4 Descriptive statistics

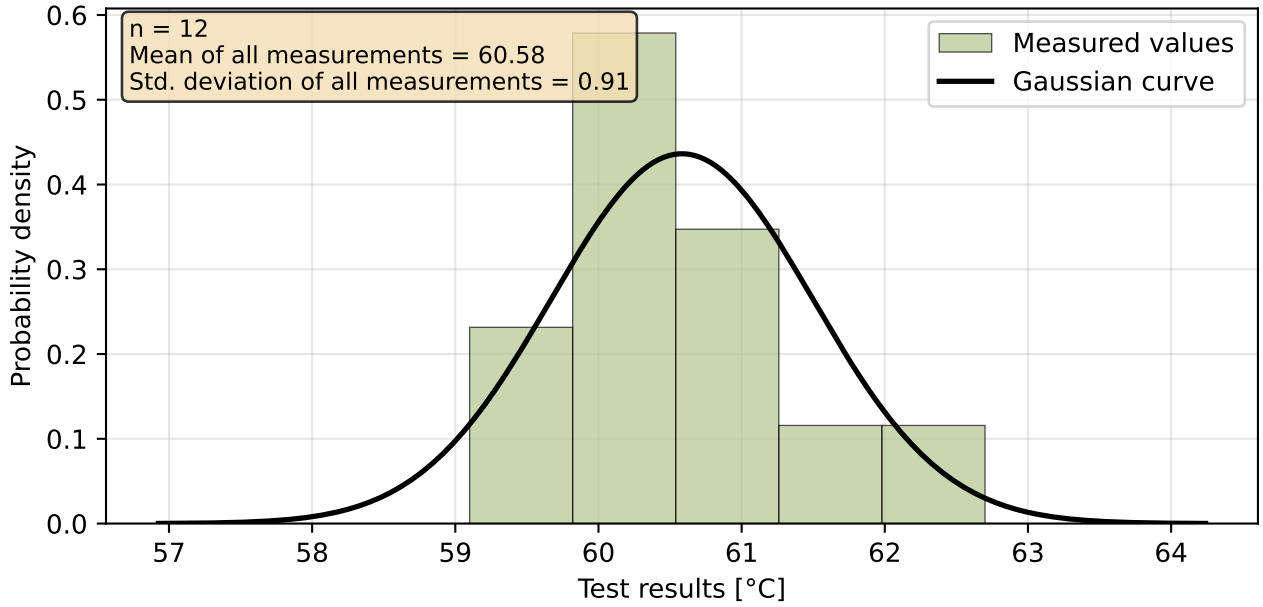

Figure 106: Histogram of all test results

Table 38: Descriptive statistics

Characteristics	[°C]
Average value – $\bar{x}$	60.58
Sample standard deviation – s	0.78
Assigned value – x^*	60.58
Robust standard deviation – s^*	0.78
Measurement uncertainty of assigned value – u_X	0.39
p-value of normality test [-]	0.504
Interlaboratory standard deviation – s_L	0.68
Repeatability standard deviation – s_r	0.68
Reproducibility standard deviation – s_R	0.96
Repeatability – r	1.90
Reproducibility – R	2.68

12.2.5 Evaluation of Performance Statistics

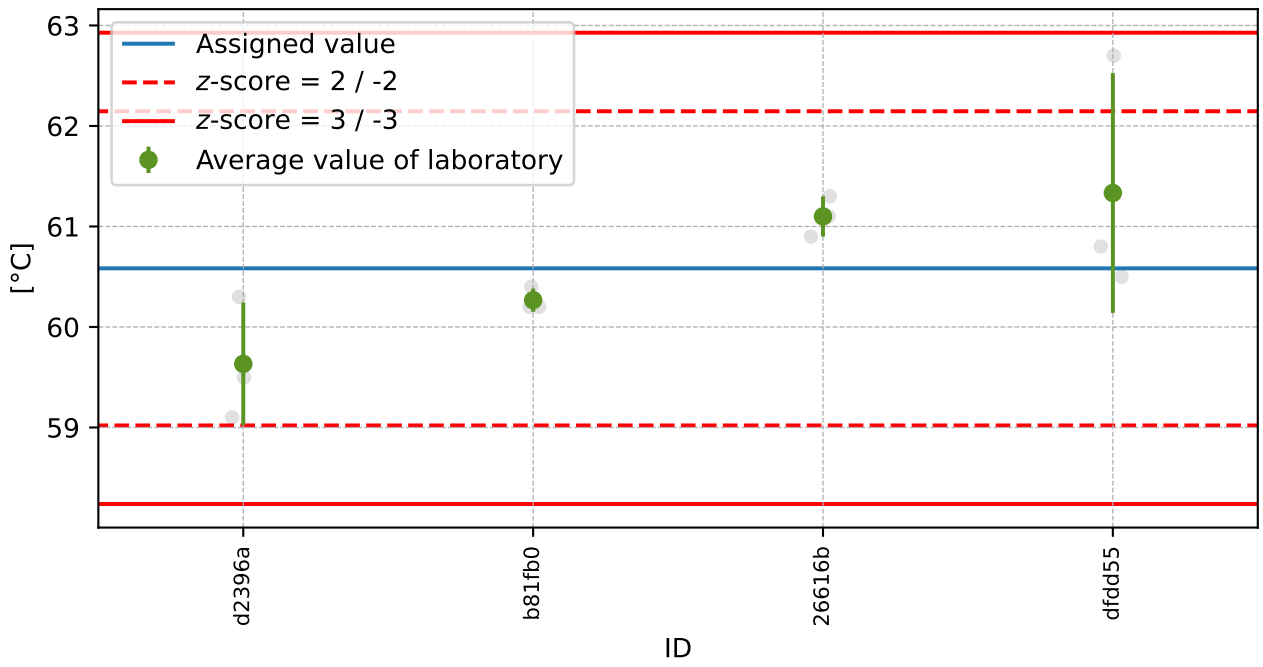

Figure 107: Average values and sample standard deviations

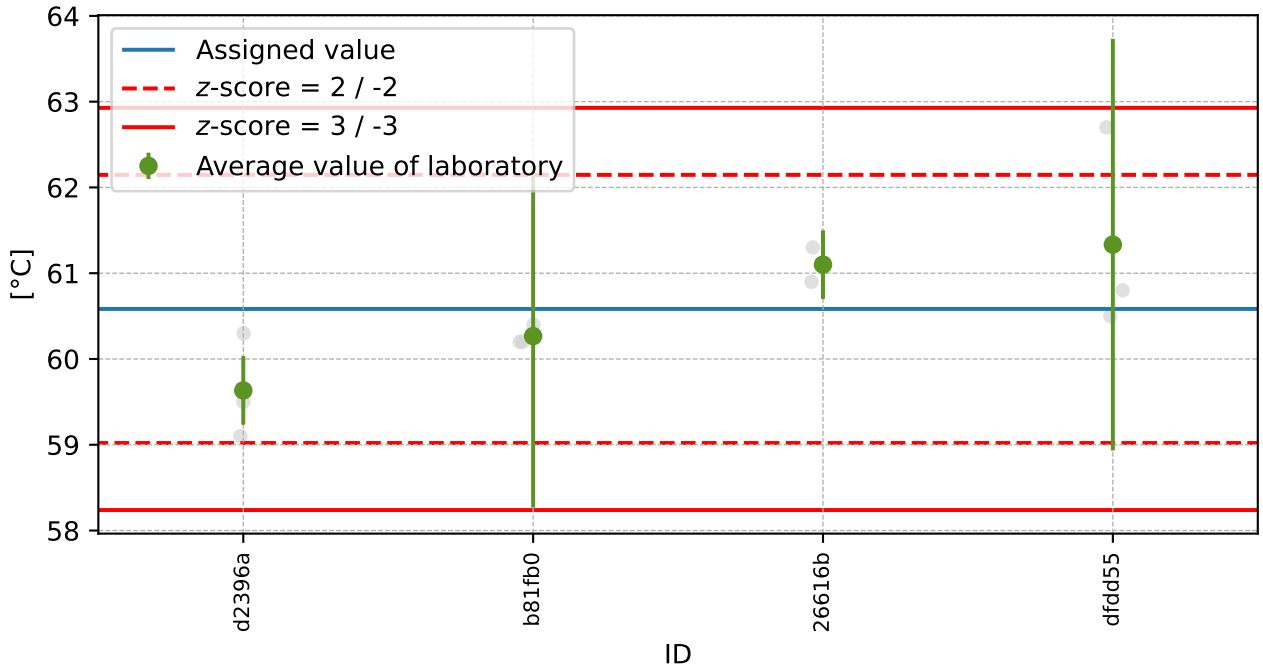

Figure 108: Average values and extended uncertainties of measurement

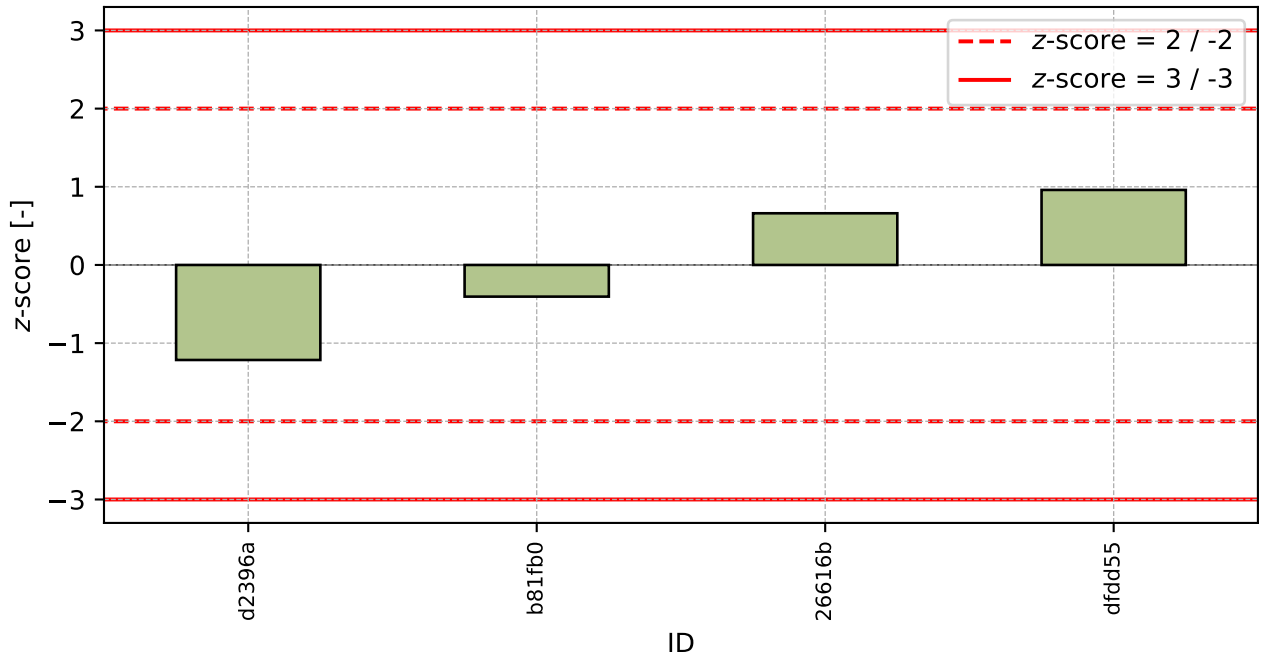

Figure 109: z-score

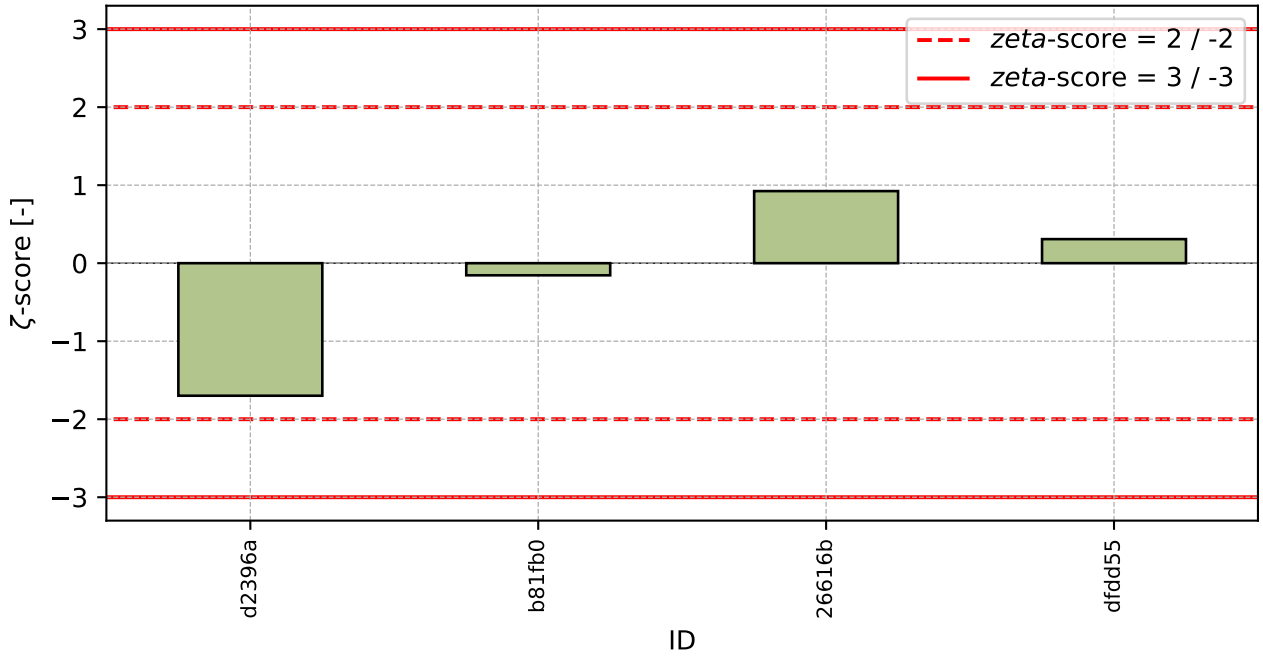

Figure 110: ζ-score

Table 39: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d2396a	-1.22	-1.70
b81fb0	-0.41	-0.16
26616b	0.66	0.92
dfdd55	0.96	0.31

13 Appendix – EN ISO 75-1, -2 (Temperature of deflection under load, method B)

The test method was not opened due to the low number of participants.

14 Appendix – EN ISO 1183-1 (Density)

14.1 Sample A

14.1.1 Test results

Table 40: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [kg/m³]	2 [kg/m³]	3 [kg/m³]	u_X [kg/m³]	$\bar{x}$ [kg/m³]	s_0 [kg/m³]	V_X [%]
b81fb0	906	899	902	11.0	900	2.1	0.24
dfdd55	903	903	903	0.8	903	0.0	0.00
26616b	903	903	903	0.8	903	0.0	0.00
d2396a	903	904	903	0.3	903	0.6	0.06

14.1.2 The Numerical Procedure for Determining Outliers

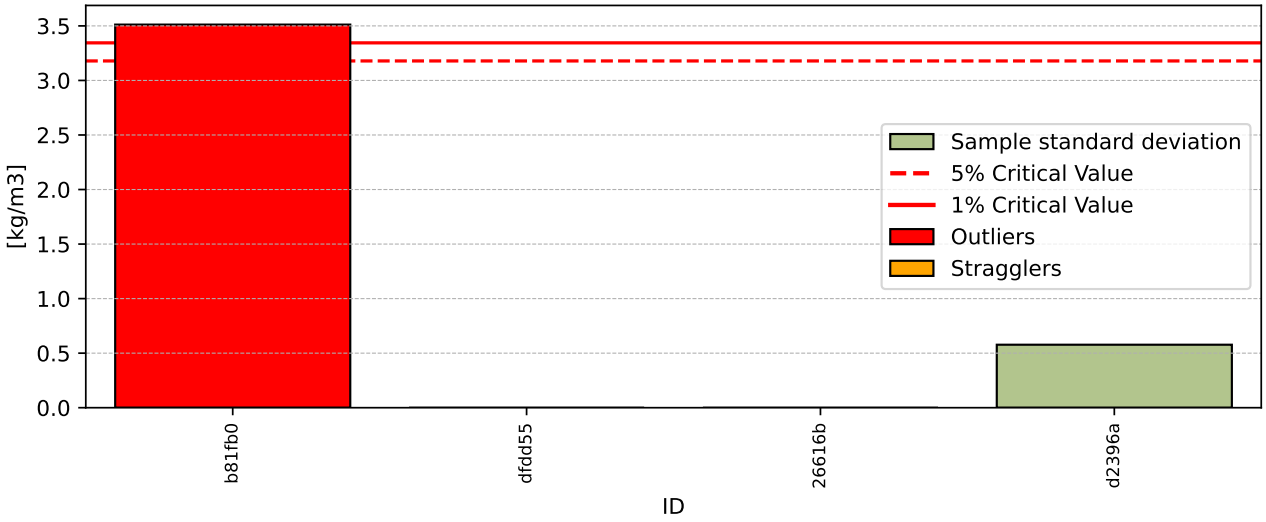

Figure 111: **Cochran's test** - sample standard deviations

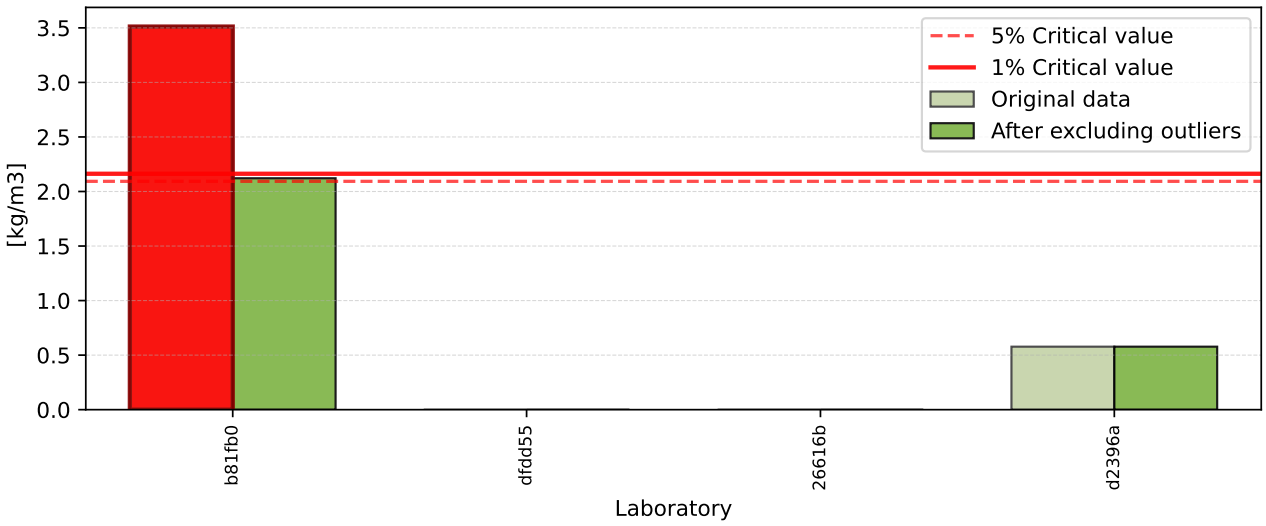

Figure 112: **Cochran's test** - sample standard deviations without outliers

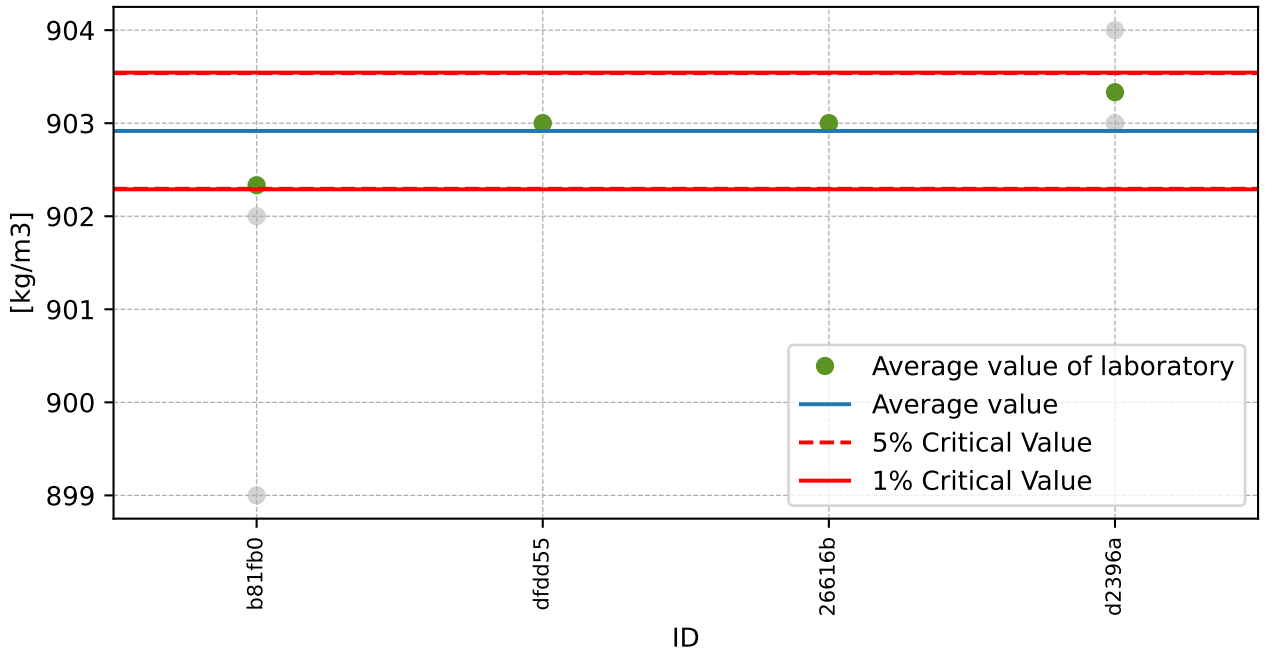

Figure 113: **Grubbs' test** - average values

14.1.3 Mandel's Statistics

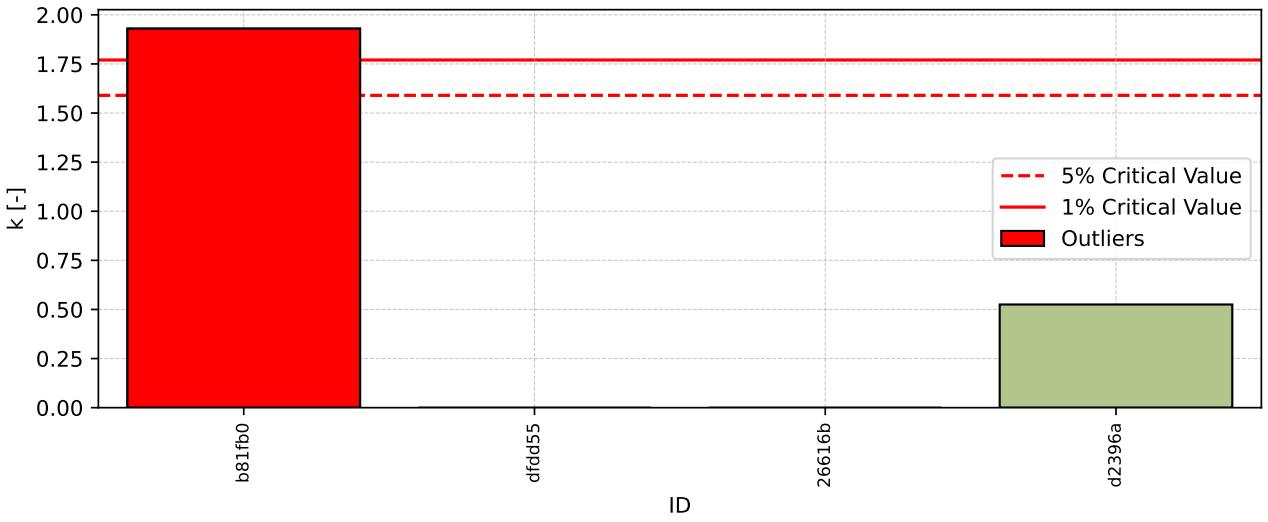

Figure 114: Intralaboratory Consistency Statistic

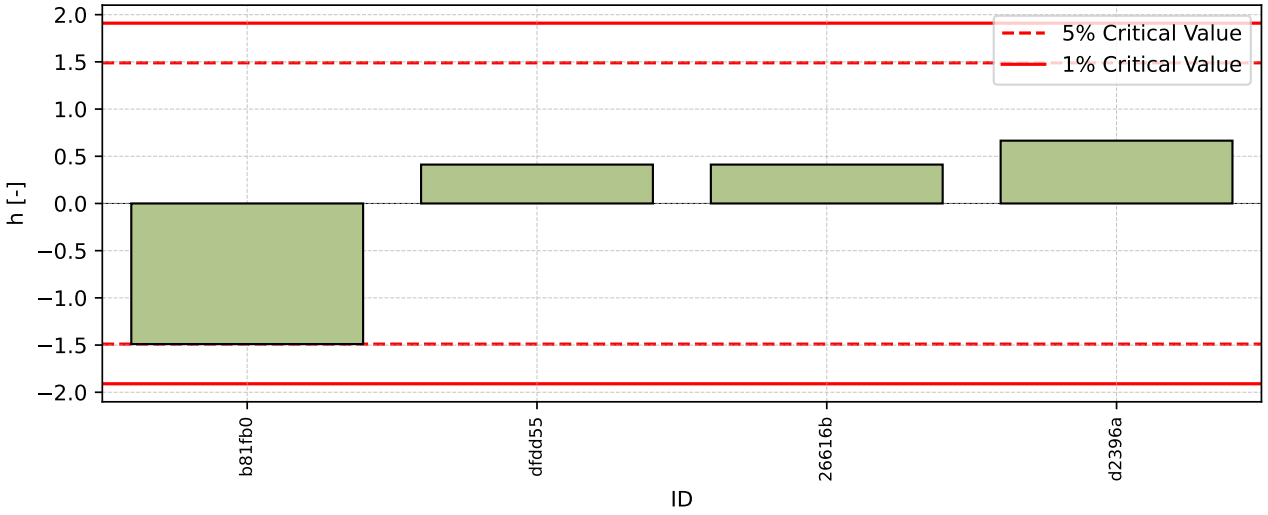

Figure 115: Interlaboratory Consistency Statistic

14.1.4 Descriptive statistics

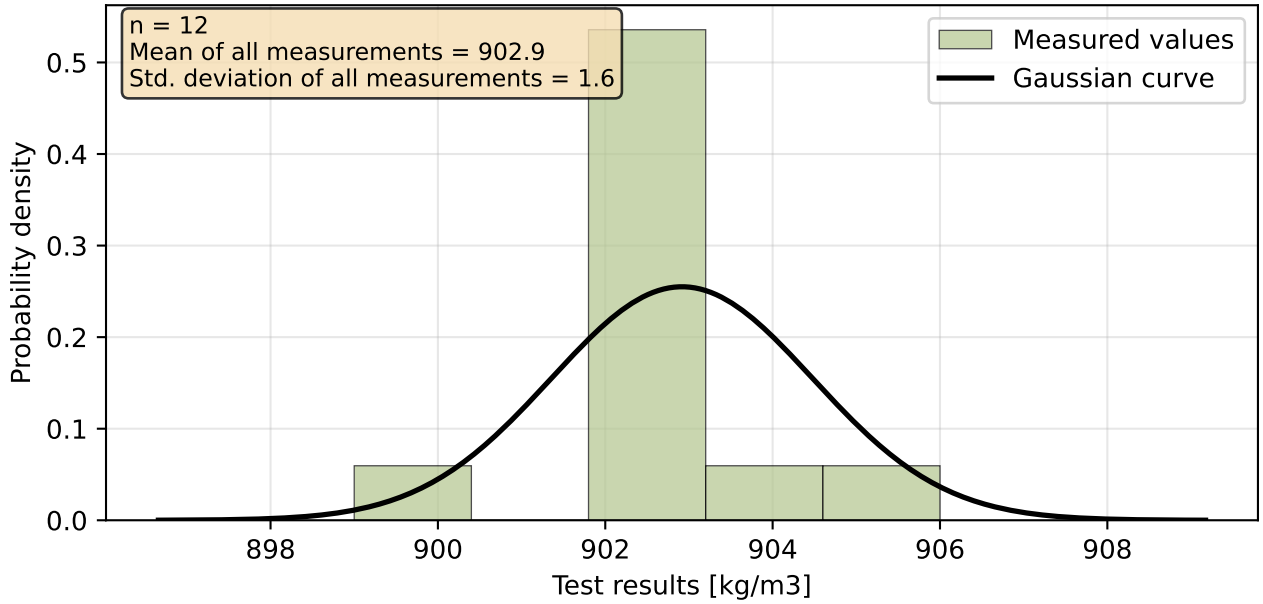

Figure 116: Histogram of all test results

Table 41: Descriptive statistics

Characteristics	[kg/m³]
Average value – $\bar{x}$	902.5
Sample standard deviation – s	1.3
Assigned value – x^*	902.5
Robust standard deviation – s^*	1.3
Measurement uncertainty of assigned value – u_X	0.7
p-value of normality test [-]	0.003
Interlaboratory standard deviation – s_L	1.2
Repeatability standard deviation – s_r	1.1
Reproducibility standard deviation – s_R	1.6
Repeatability – r	3.1
Reproducibility – R	4.5

14.1.5 Evaluation of Performance Statistics

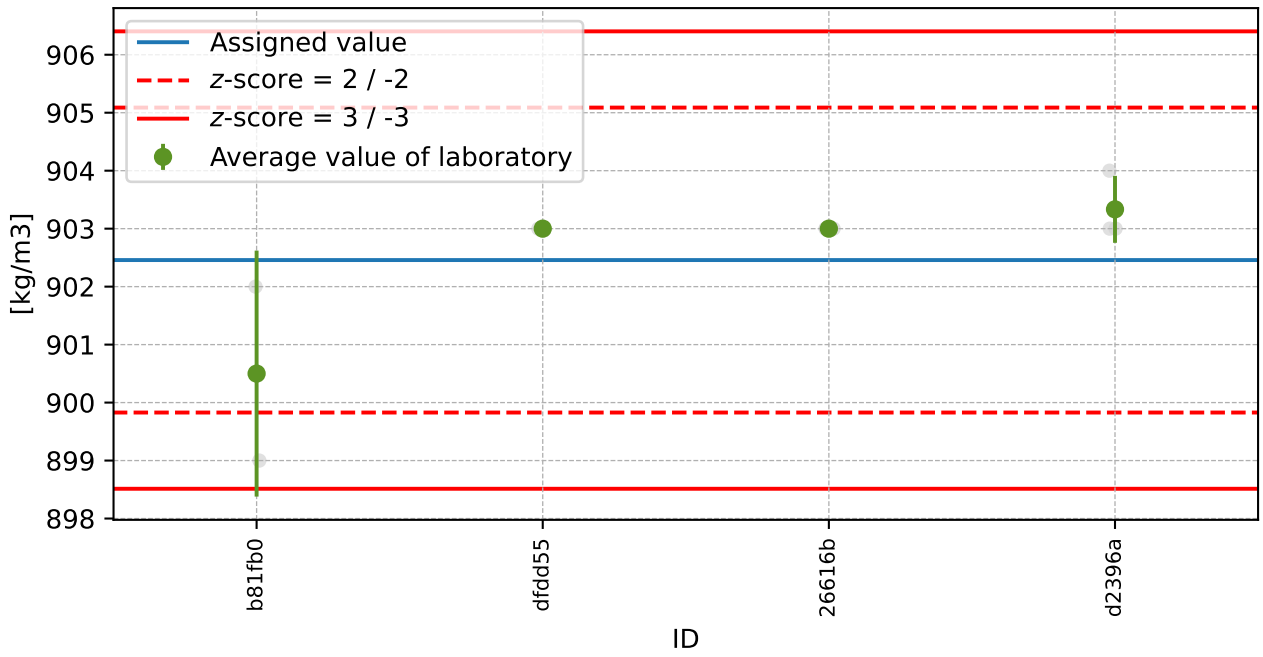

Figure 117: Average values and sample standard deviations

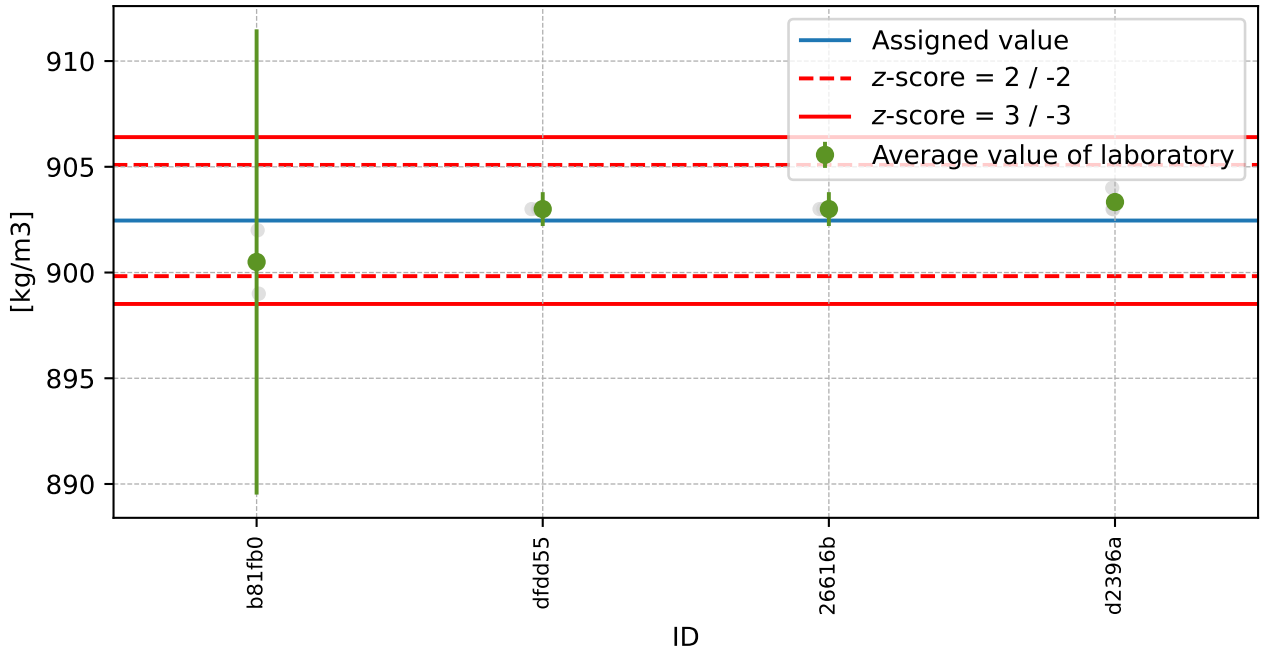

Figure 118: Average values and extended uncertainties of measurement

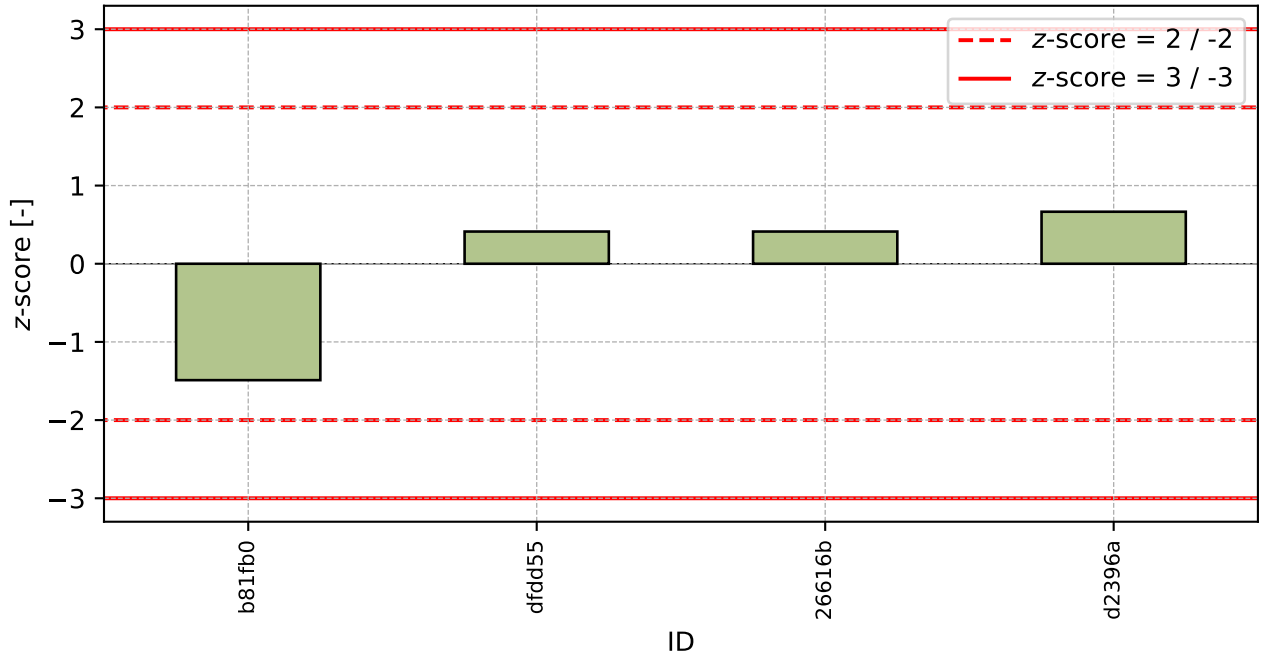

Figure 119: z-score

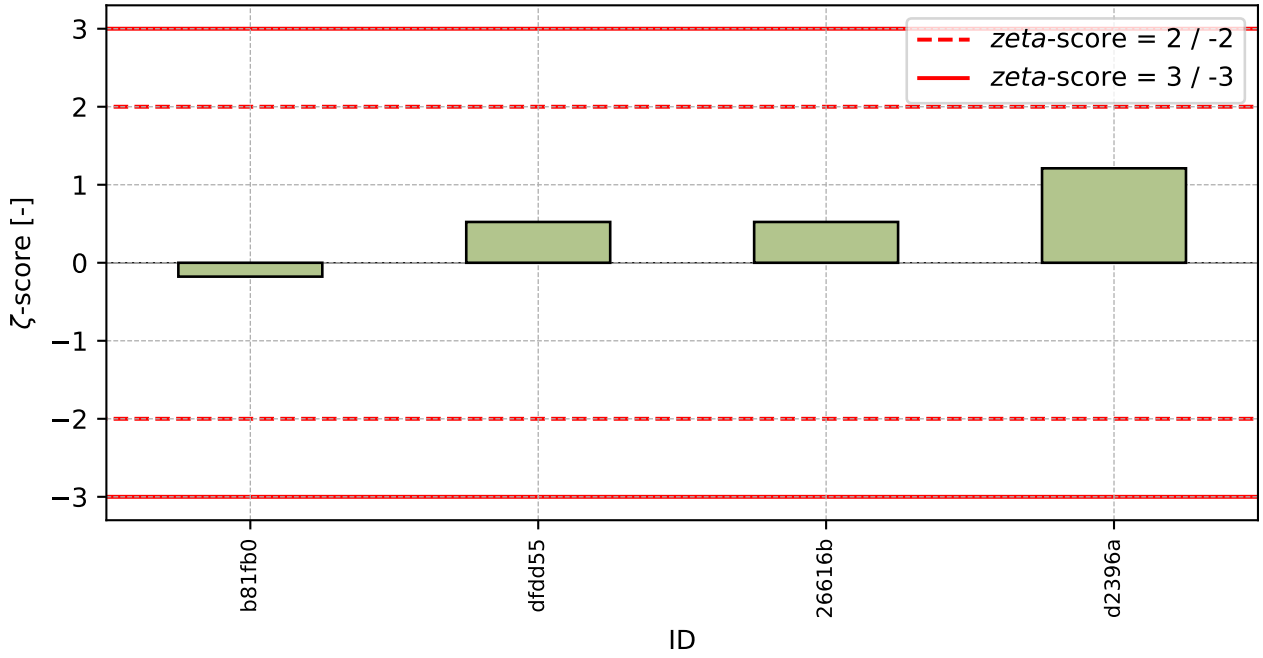

Figure 120: ζ-score

Table 42: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
b81fb0	-1.49	-0.18
dfdd55	0.41	0.52
26616b	0.41	0.52
d2396a	0.67	1.21

14.2 Sample B

14.2.1 Test results

Table 43: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [kg/m³]	2 [kg/m³]	3 [kg/m³]	u_X [kg/m³]	$\bar{x}$ [kg/m³]	s_0 [kg/m³]	V_X [%]
b81fb0	905	905	911	11.0	905	0.0	0.00
d2396a	907	906	906	0.3	906	0.0	0.00
dfdd55	906	906	906	0.8	906	0.0	0.00
26616b	906	906	906	0.8	906	0.0	0.00

14.2.2 The Numerical Procedure for Determining Outliers

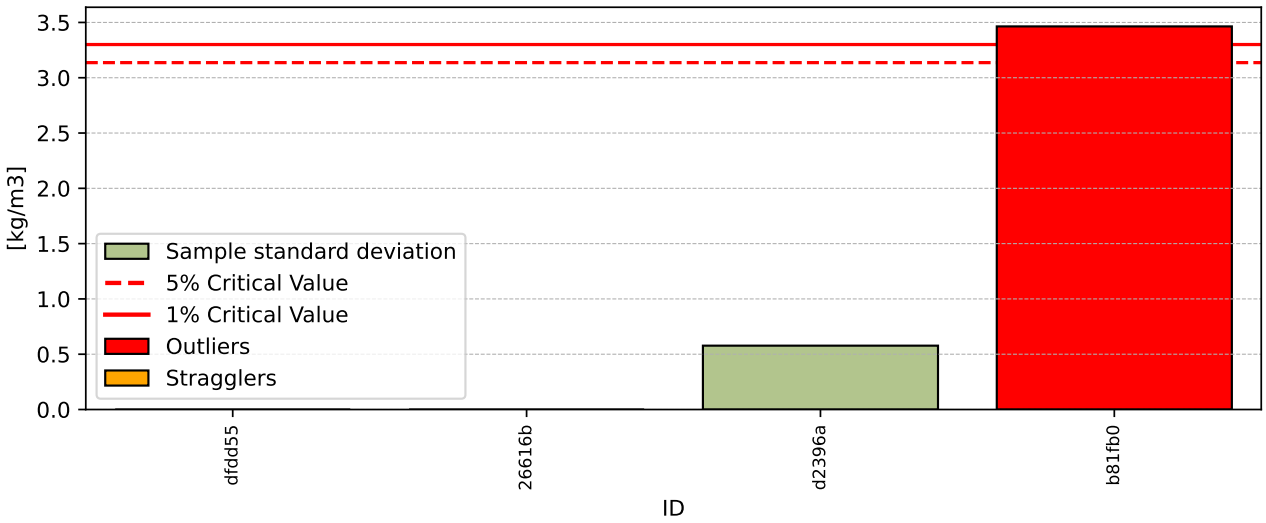

Figure 121: **Cochran's test** - sample standard deviations

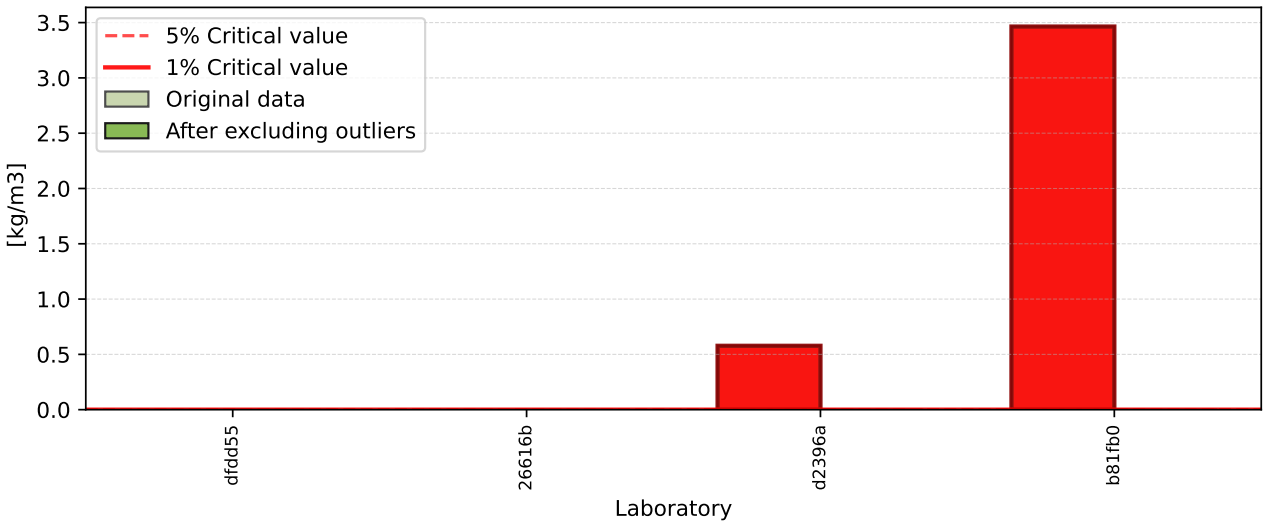

Figure 122: **Cochran's test** - sample standard deviations without outliers

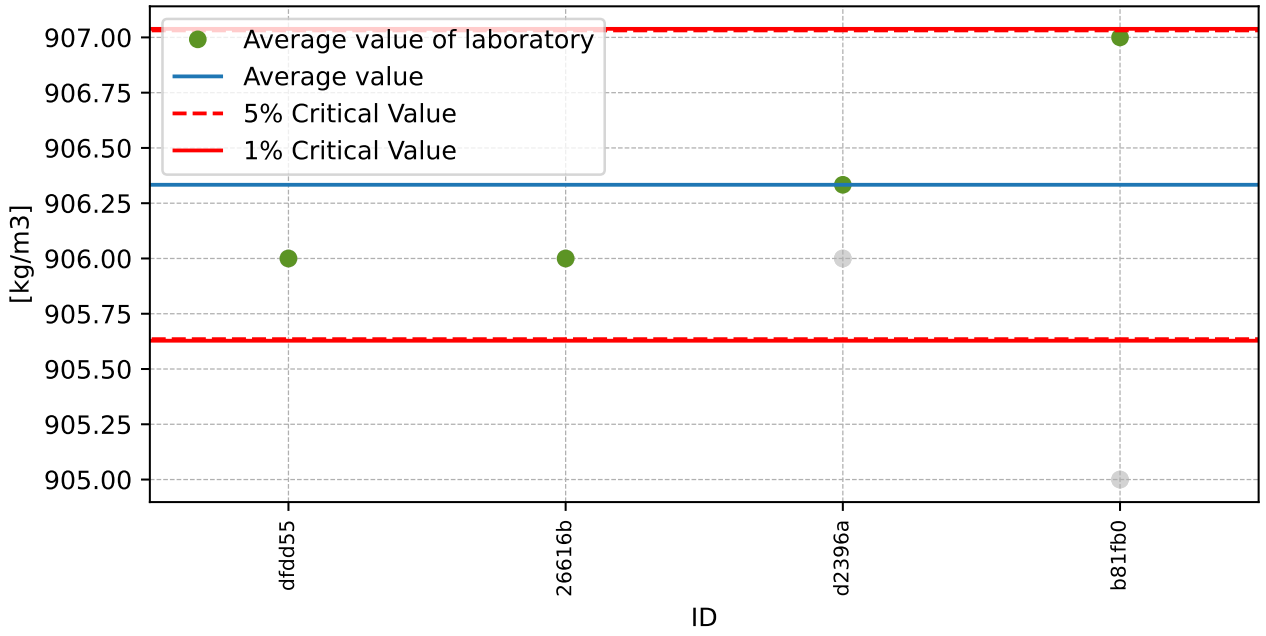

Figure 123: **Grubbs' test** - average values

14.2.3 Mandel's Statistics

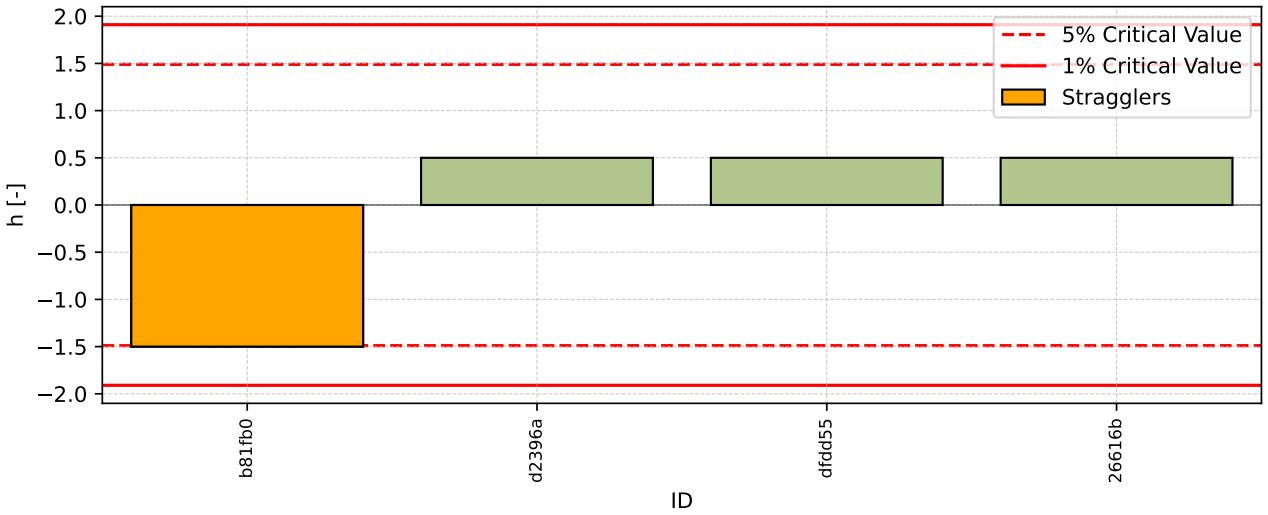

Figure 124: Interlaboratory Consistency Statistic

14.2.4 Descriptive statistics

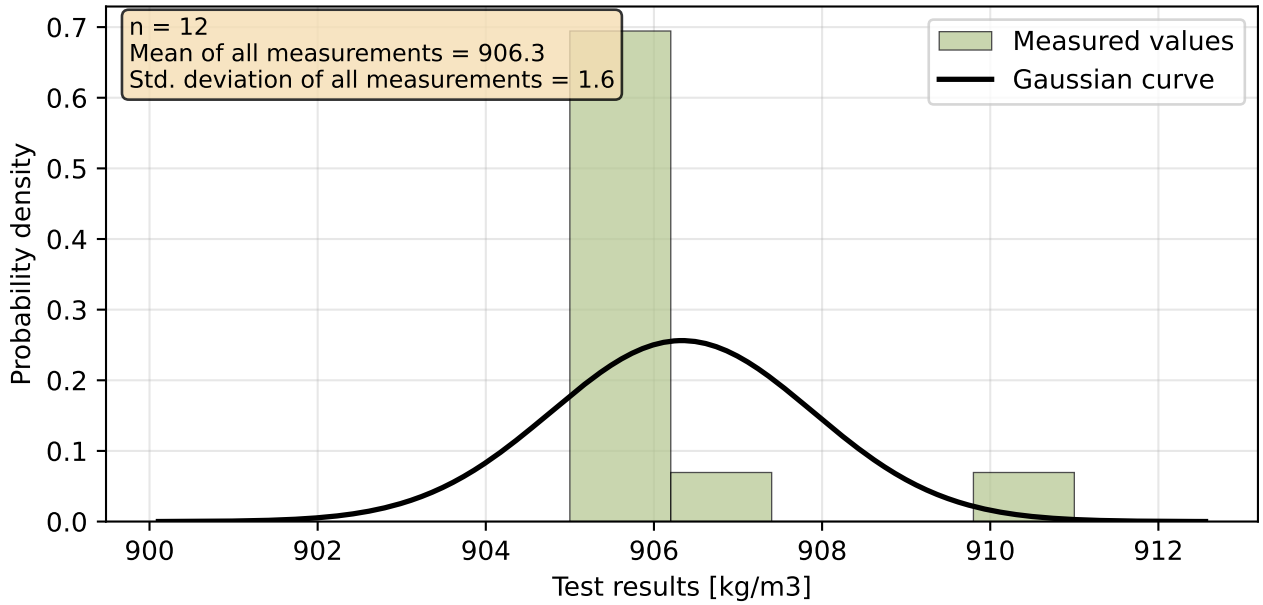

Figure 125: Histogram of all test results

Table 44: Descriptive statistics

Characteristics	[kg/m³]
Average value – $\bar{x}$	905.8
Sample standard deviation – s	0.5
Assigned value – x^*	905.8
Robust standard deviation – s^*	0.5
Measurement uncertainty of assigned value – u_X	0.2
p-value of normality test [-]	< 0.001
Interlaboratory standard deviation – s_L	0.5
Repeatability standard deviation – s_r	0.0
Reproducibility standard deviation – s_R	0.5
Repeatability – r	0.0
Reproducibility – R	1.4

14.2.5 Evaluation of Performance Statistics

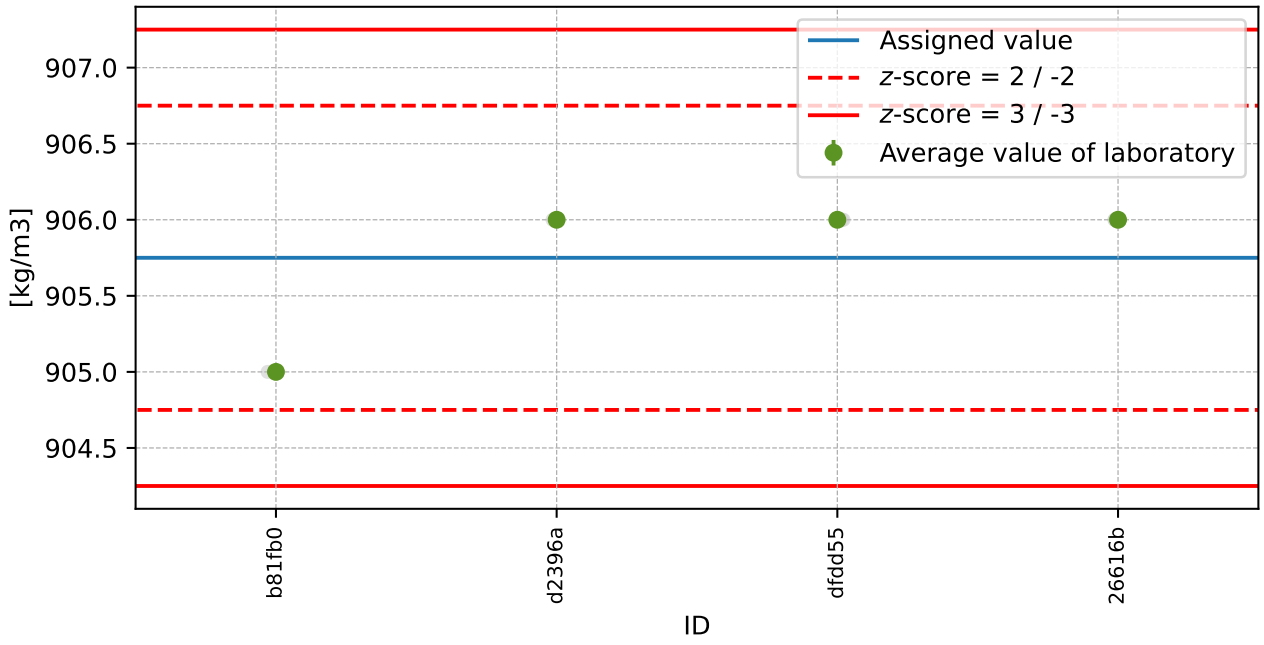

Figure 126: Average values and sample standard deviations

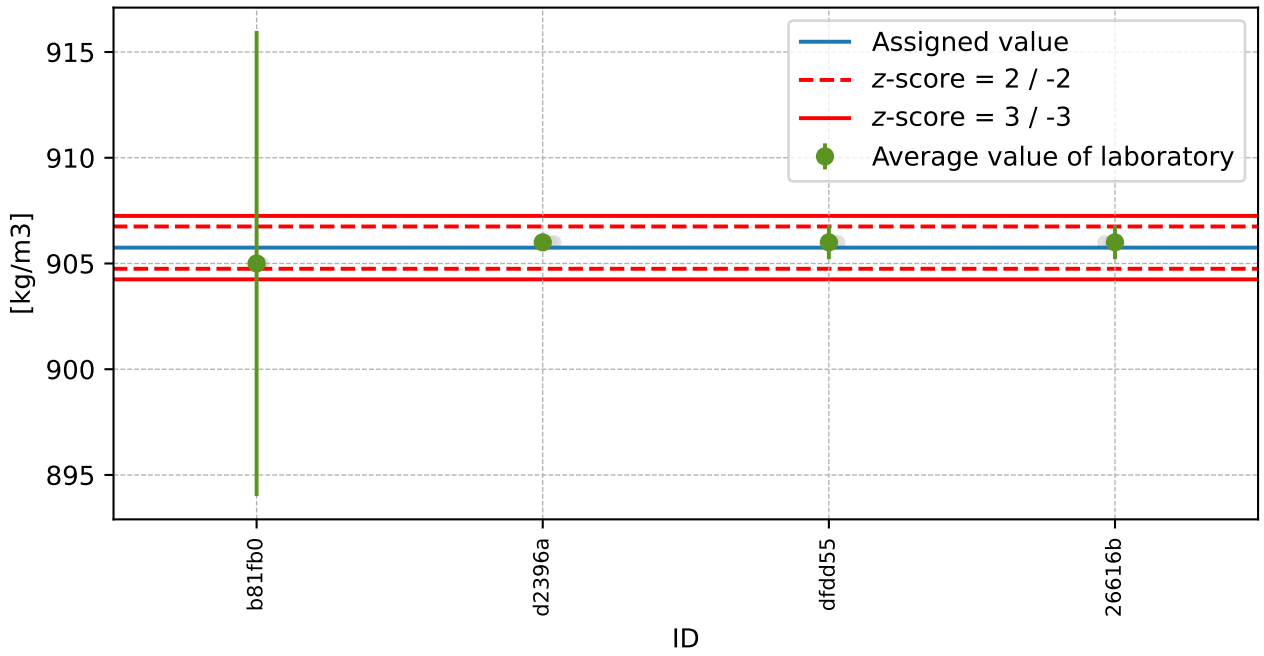

Figure 127: Average values and extended uncertainties of measurement

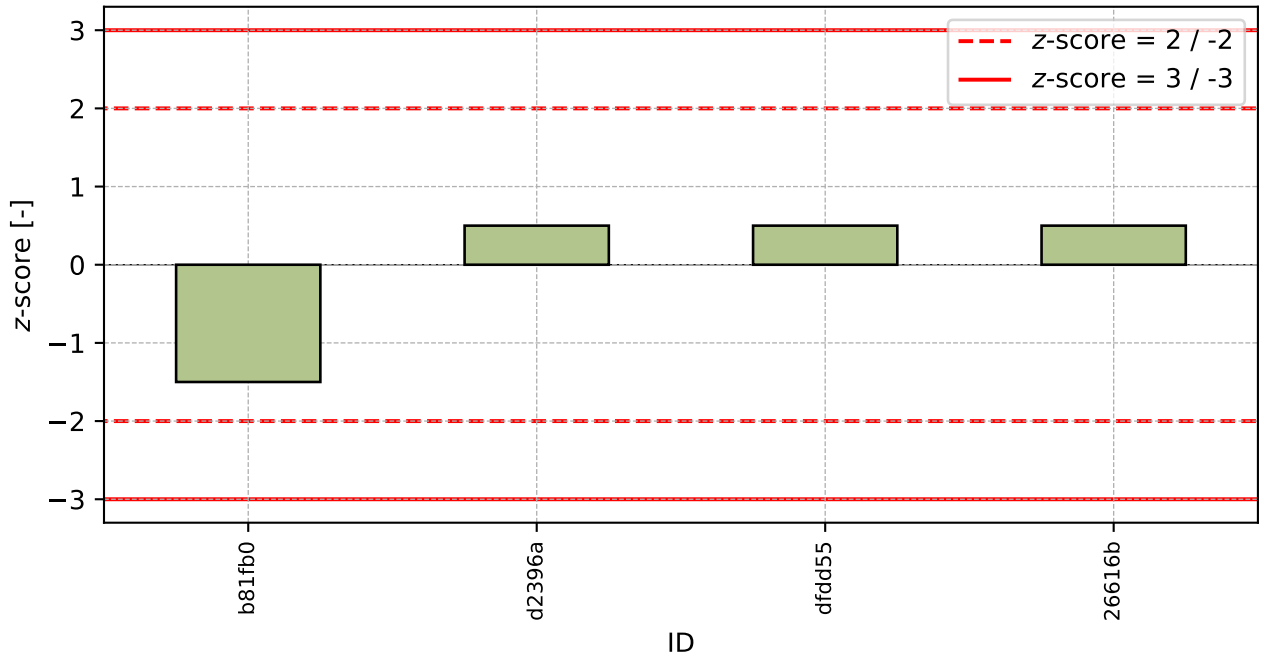

Figure 128: z-score

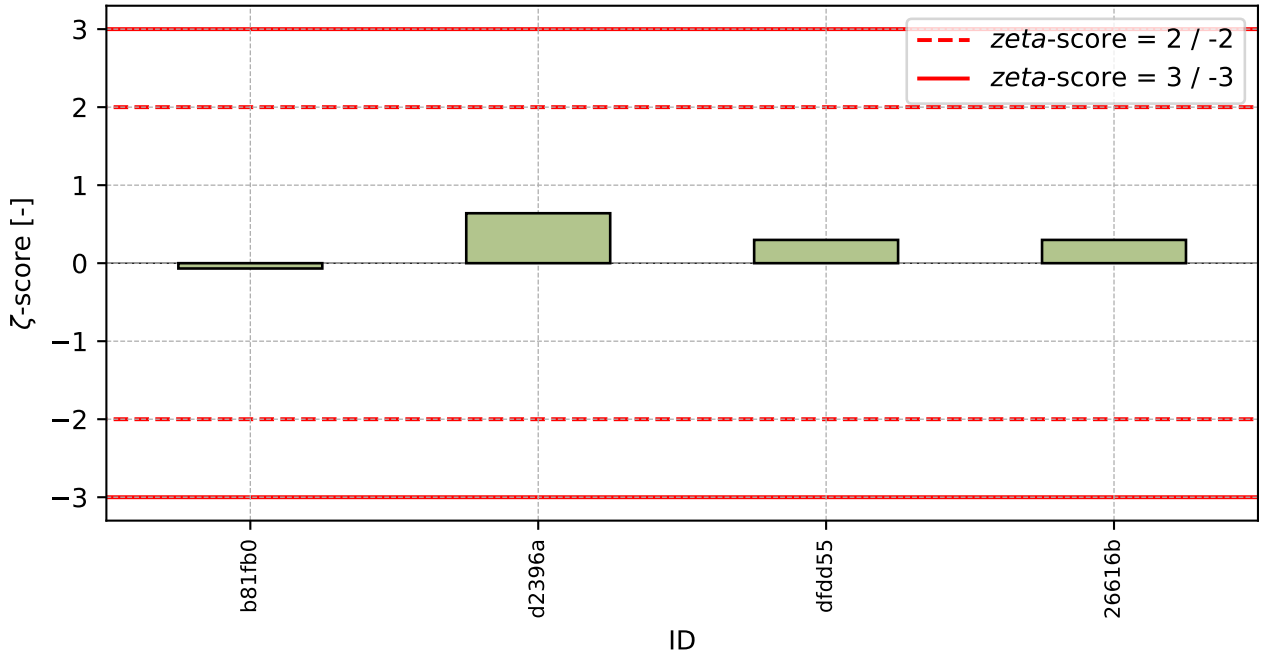

Figure 129: ζ-score

Table 45: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
b81fb0	-1.50	-0.07
d2396a	0.50	0.64
dfdd55	0.50	0.30
26616b	0.50	0.30

15 Appendix – EN ISO 11357-1, -3 (Melting temperature T_{m1}, Enthalpy of fusion ΔH_{m1})

15.1 Sample A

15.1.1 Melting temperature T_{m1}

Test results

Table 46: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [°C]	2 [°C]	3 [°C]	u_X [°C]	$\bar{x}$ [°C]	s_0 [°C]	V_X [%]
d5e138	133.7	133.4	133.4	0.20	133.5	0.17	0.13
b81fb0	134.4	134.2	133.4	0.30	134.0	0.53	0.39
dfdd55	134.3	134.4	134.0	0.20	134.2	0.21	0.16
26616b	136.1	136.0	136.3	0.10	136.1	0.15	0.11
d2396a	136.0	137.0	135.8	0.38	136.3	0.64	0.47

The Numerical Procedure for Determining Outliers

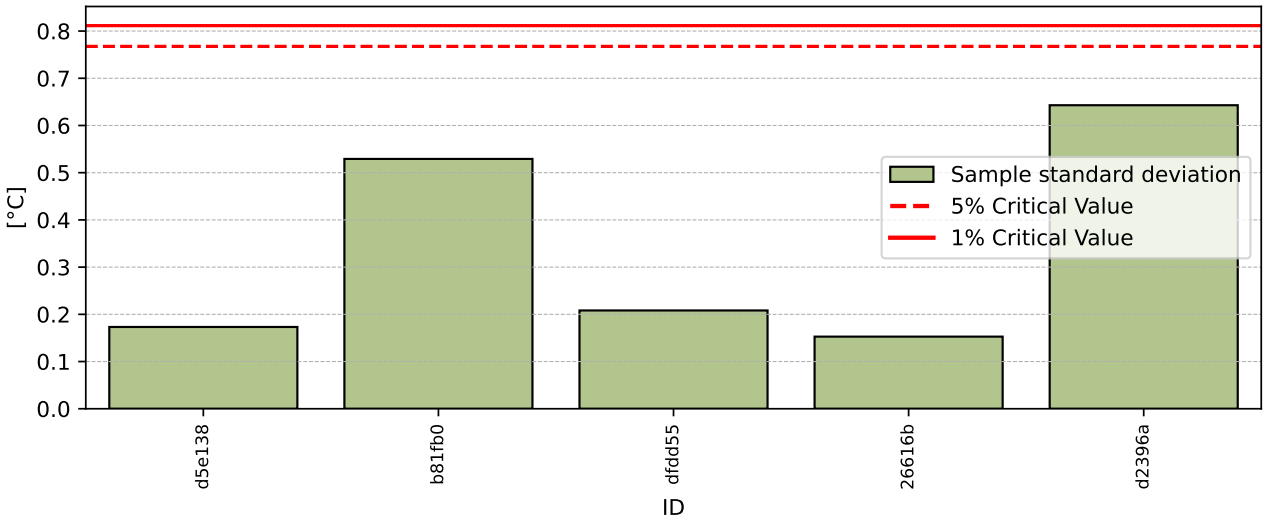

Figure 130: **Cochran's test** - sample standard deviations

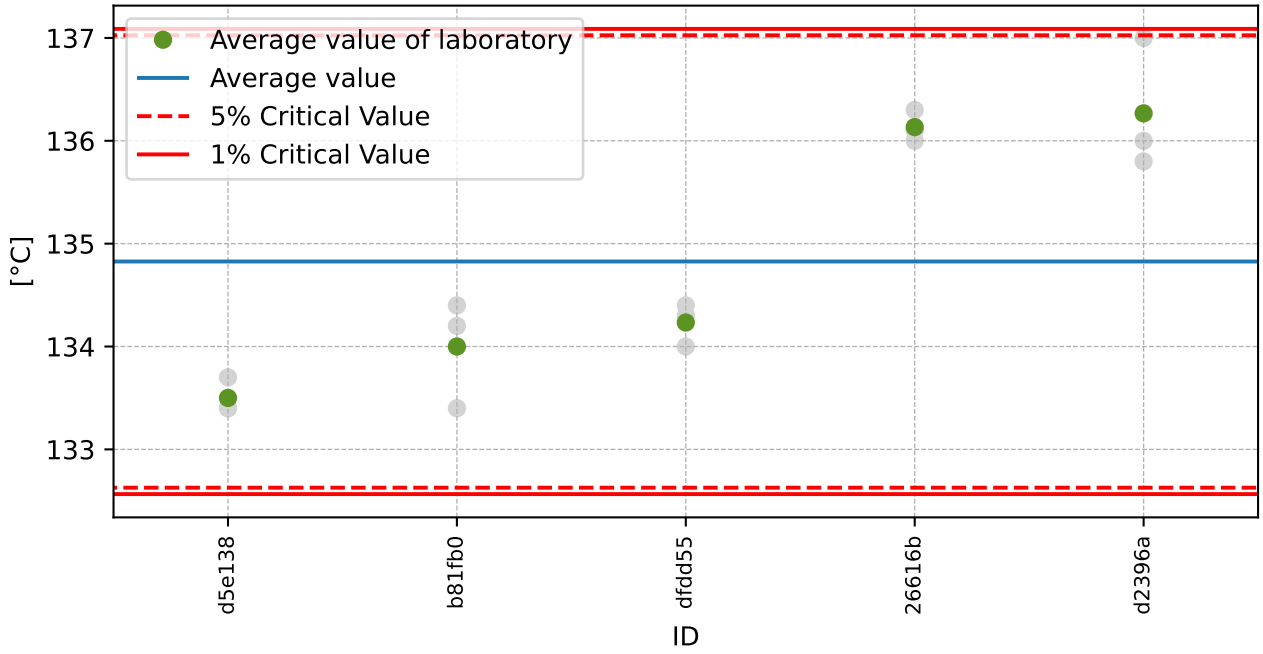

Figure 131: **Grubbs' test** - average values

Mandel's Statistics

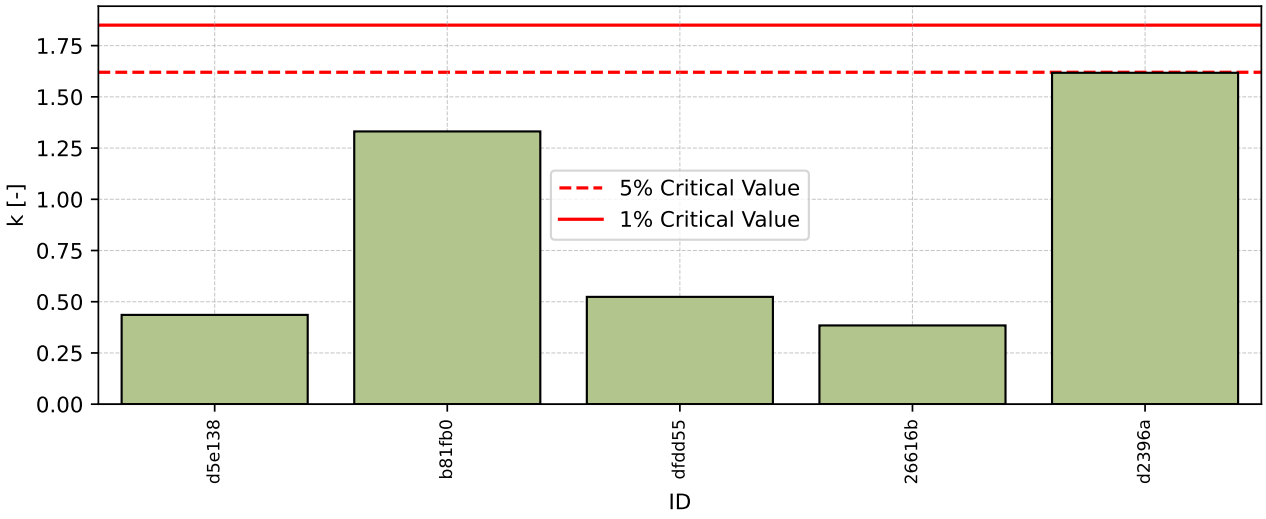

Figure 132: Intralaboratory Consistency Statistic

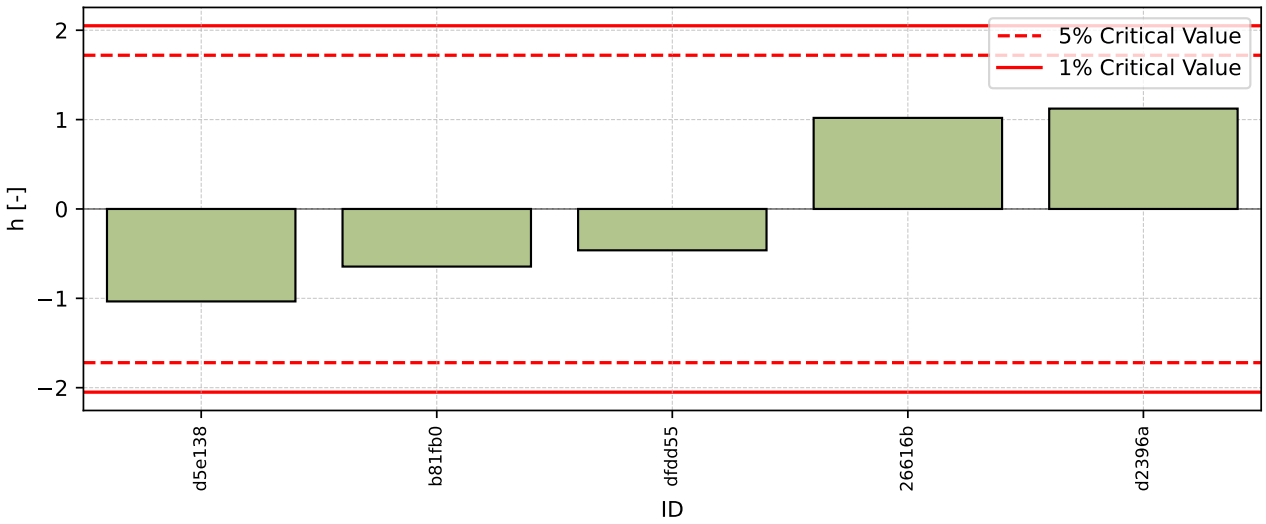

Figure 133: Interlaboratory Consistency Statistic

Descriptive statistics

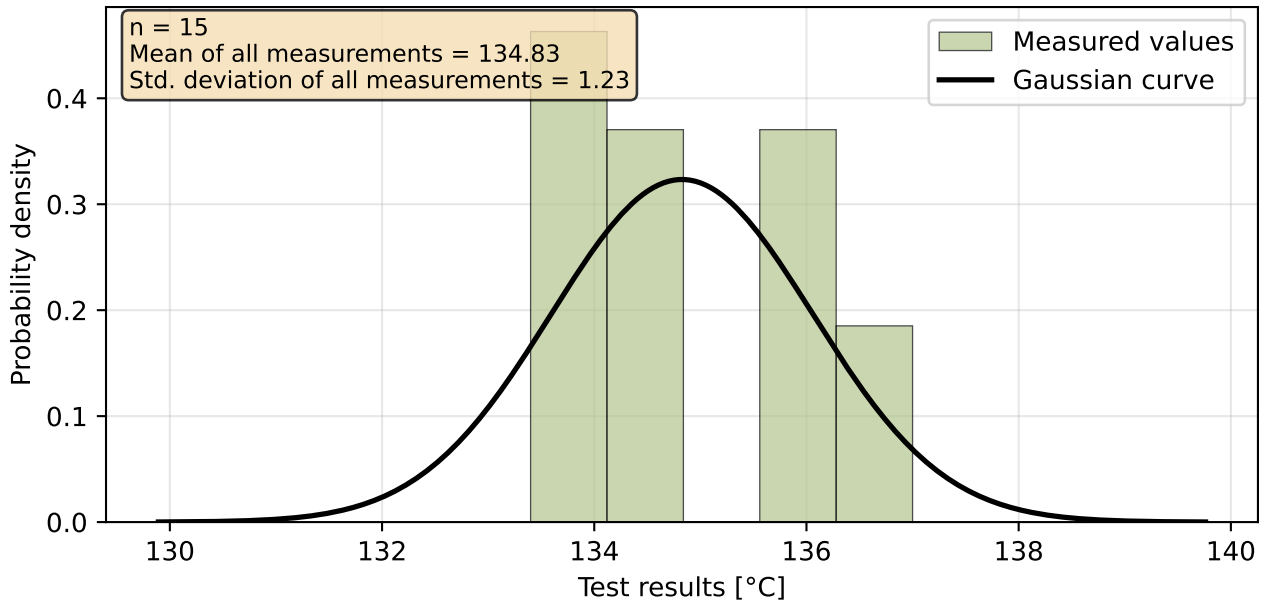

Figure 134: Histogram of all test results

Table 47: Descriptive statistics

Characteristics	[°C]
Average value – $\bar{x}$	134.83
Sample standard deviation – s	1.28
Assigned value – x^*	134.83
Robust standard deviation – s^*	1.28
Measurement uncertainty of assigned value – u_X	0.57
p-value of normality test [-]	0.050
Interlaboratory standard deviation – s_L	1.26
Repeatability standard deviation – s_r	0.40
Reproducibility standard deviation – s_R	1.32
Repeatability – r	1.11
Reproducibility – R	3.70

Evaluation of Performance Statistics

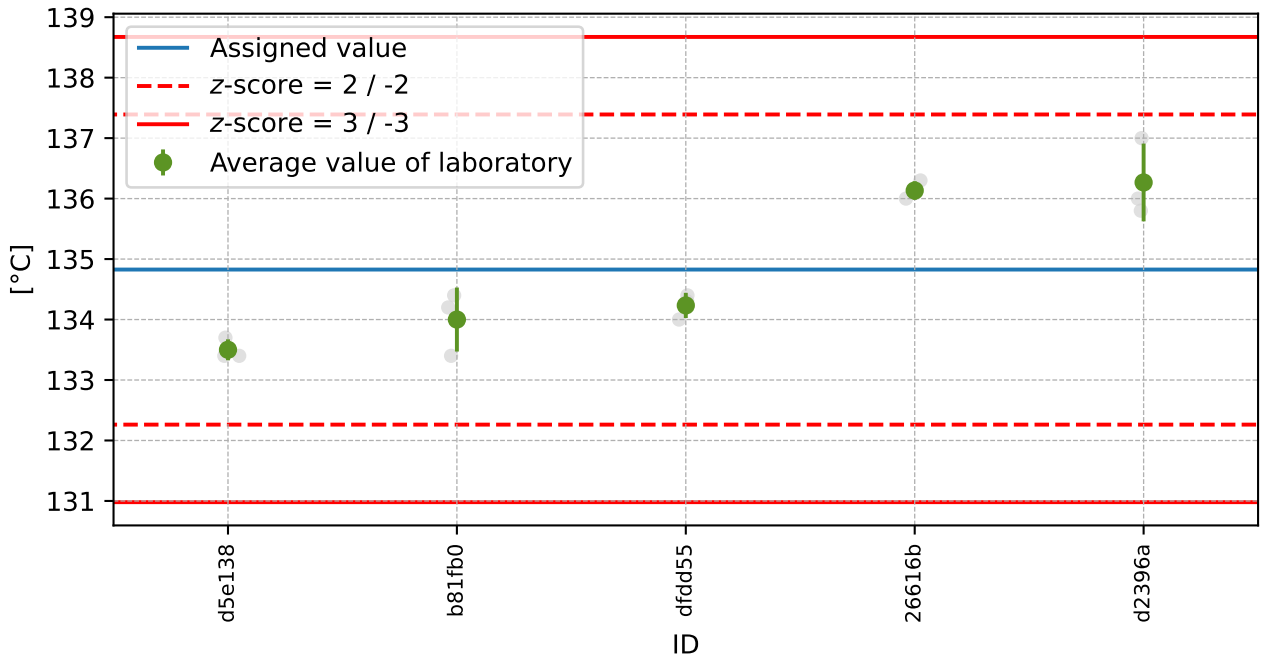

Figure 135: Average values and sample standard deviations

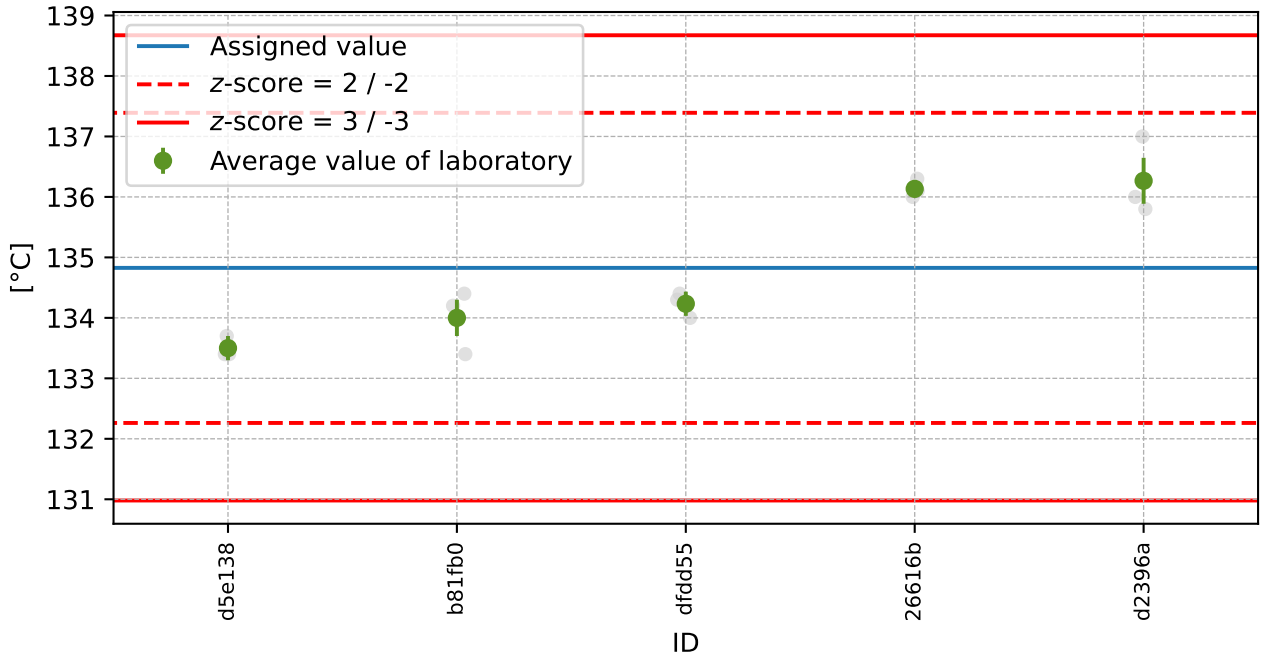

Figure 136: Average values and extended uncertainties of measurement

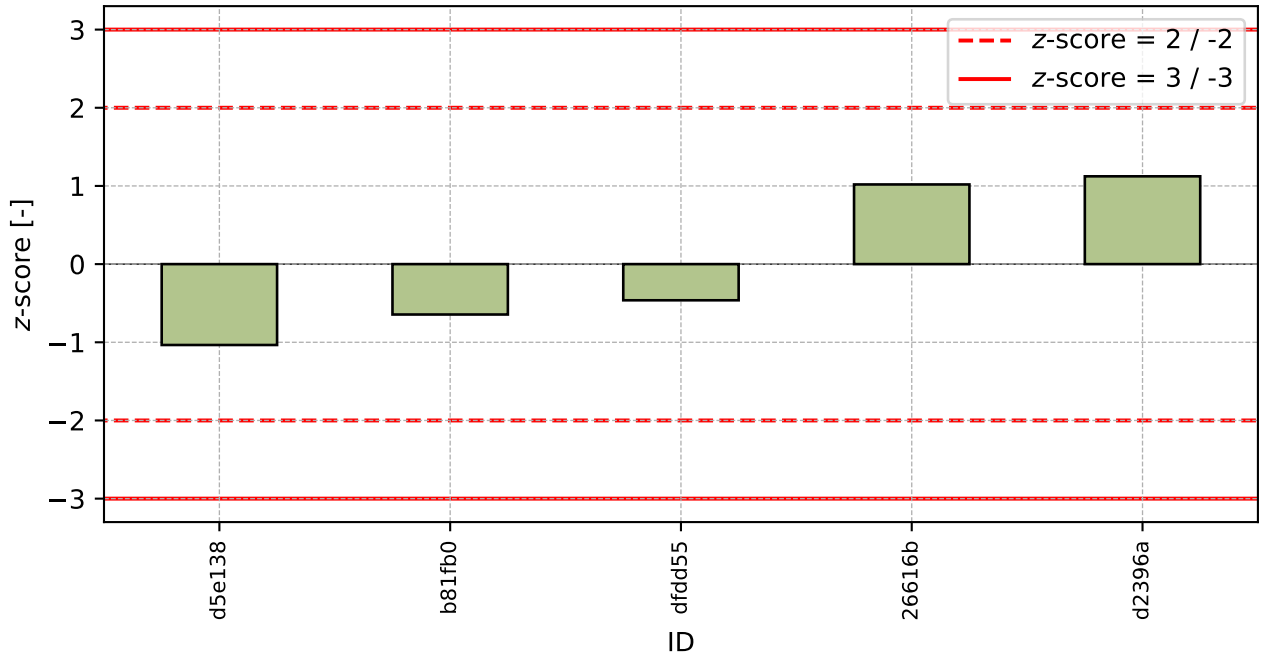

Figure 137: z-score

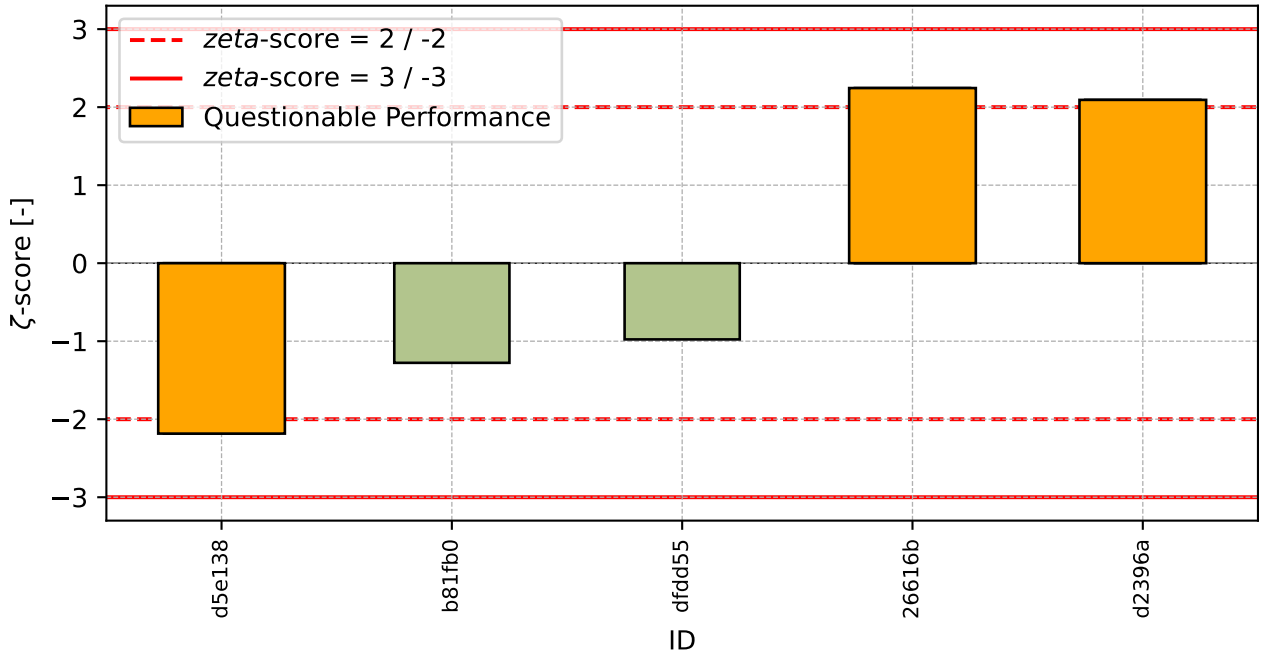

Figure 138: ζ-score

Table 48: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d5e138	-1.03	-2.18
b81fb0	-0.64	-1.28
dfdd55	-0.46	-0.98
26616b	1.02	2.24
d2396a	1.12	2.09

15.1.2 Enthalpy of fusion ΔH_{m1}

Test results

Table 49: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [J/g]	2 [J/g]	3 [J/g]	u_X [J/g]	$\bar{x}$ [J/g]	s_0 [J/g]	V_X [%]
b81fb0	206.1	209.4	206.8	1.00	207.4	1.74	0.84
dfdd55	222.8	224.3	223.0	1.00	223.4	0.81	0.36
26616b	224.2	225.6	226.2	1.10	225.3	1.03	0.46
d5e138	237.6	234.5	234.4	3.50	235.5	1.82	0.77
d2396a	295.9	269.8	288.1	7.73	292.0	5.52	1.89

The Numerical Procedure for Determining Outliers

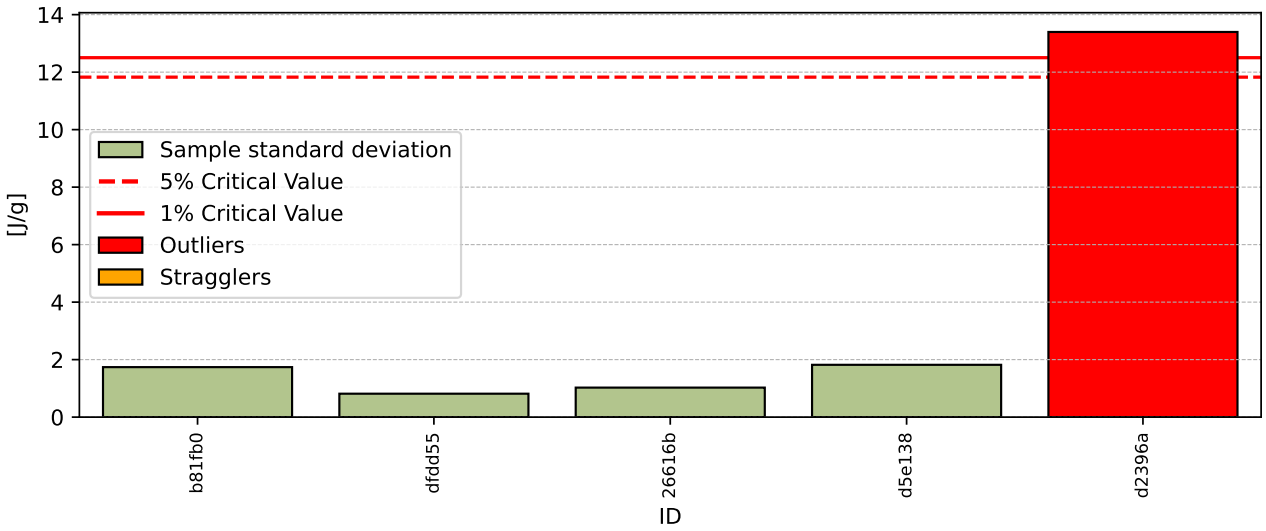

Figure 139: **Cochran's test** - sample standard deviations

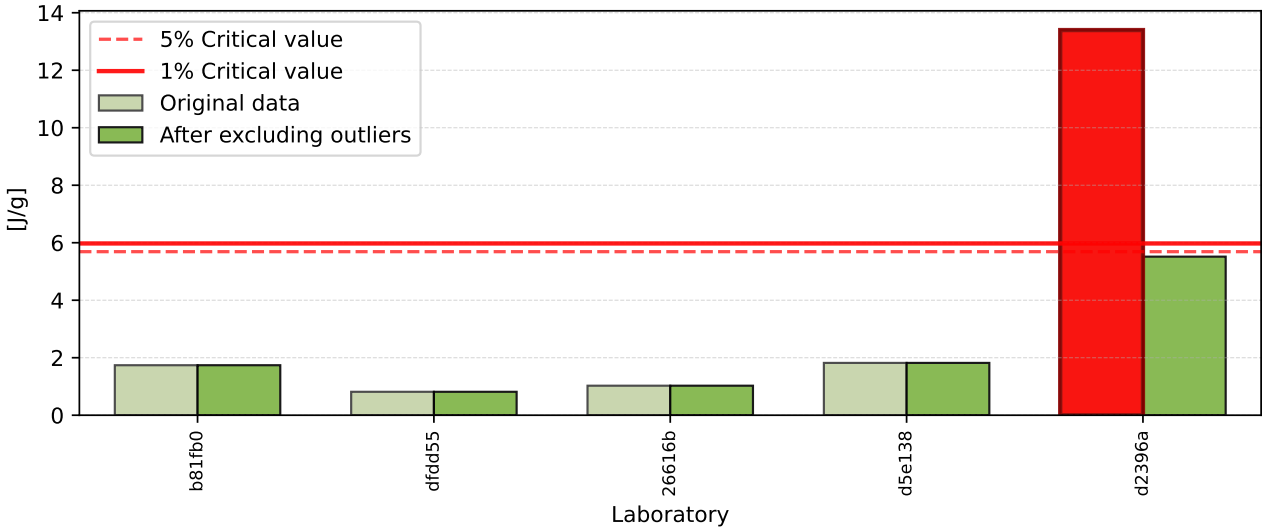

Figure 140: **Cochran's test** - sample standard deviations without outliers

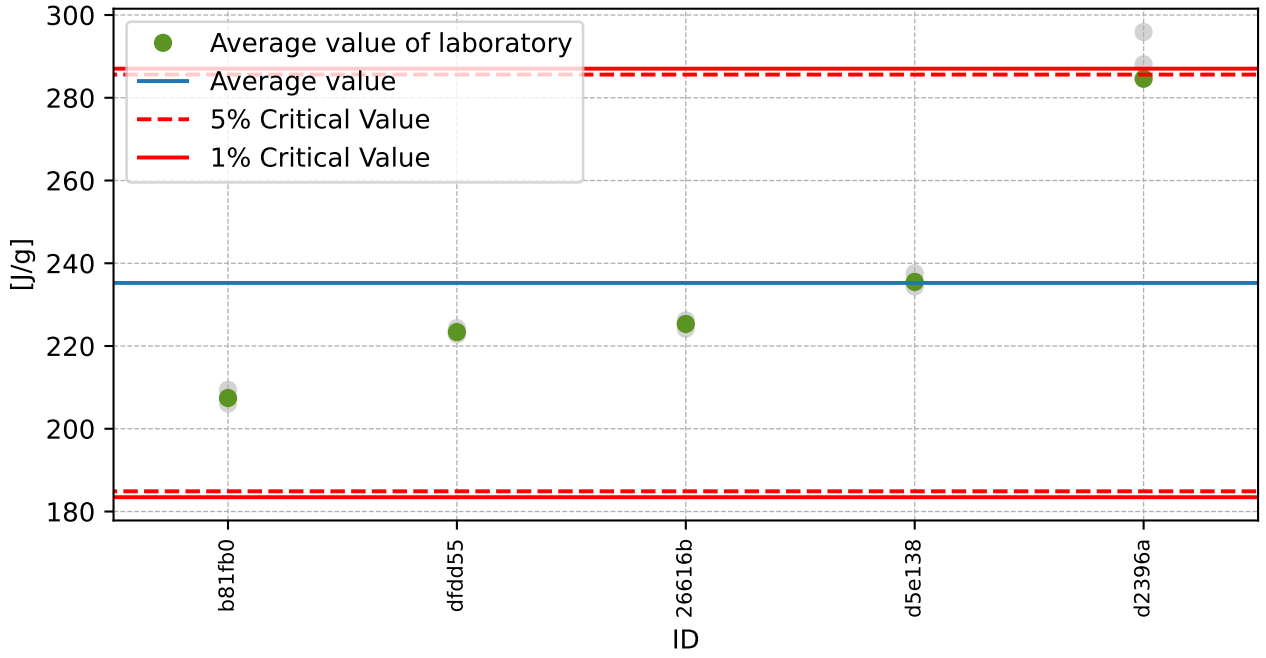

Figure 141: **Grubbs' test** - average values

Mandel's Statistics

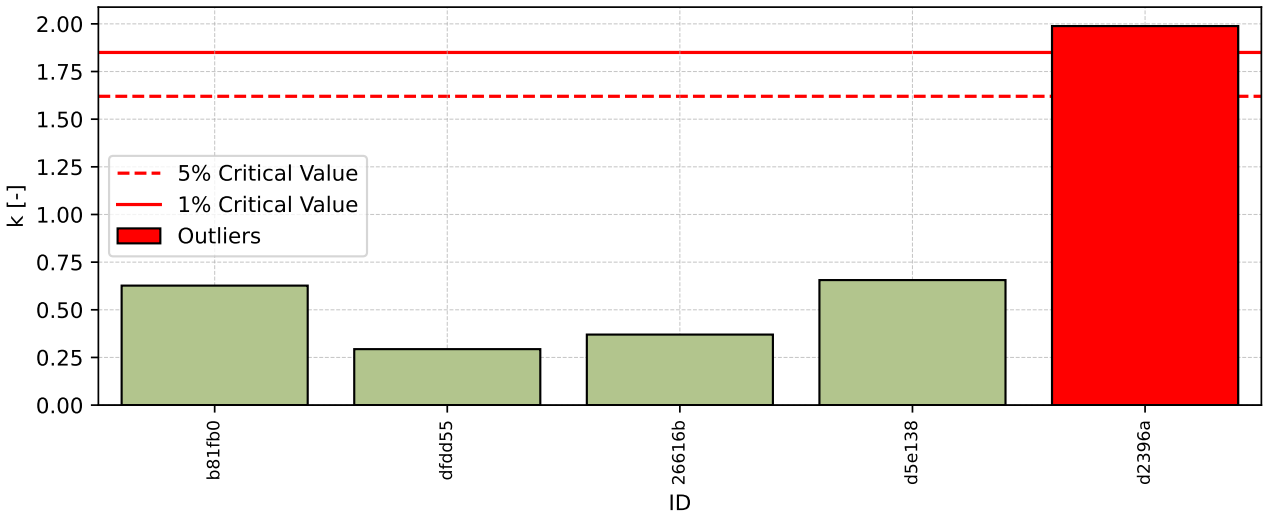

Figure 142: Intralaboratory Consistency Statistic

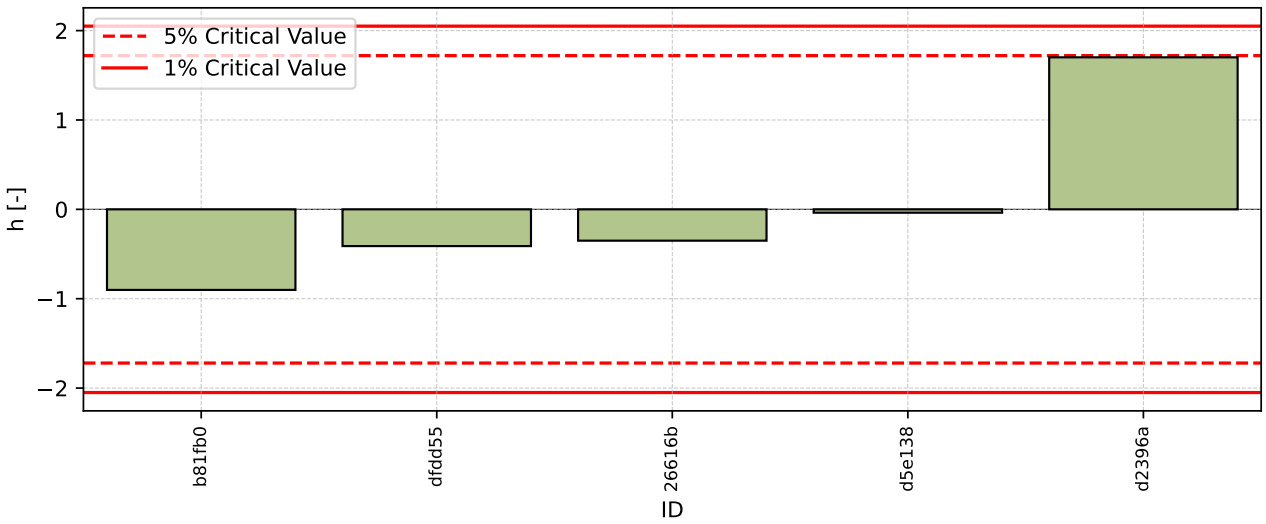

Figure 143: Interlaboratory Consistency Statistic

Descriptive statistics

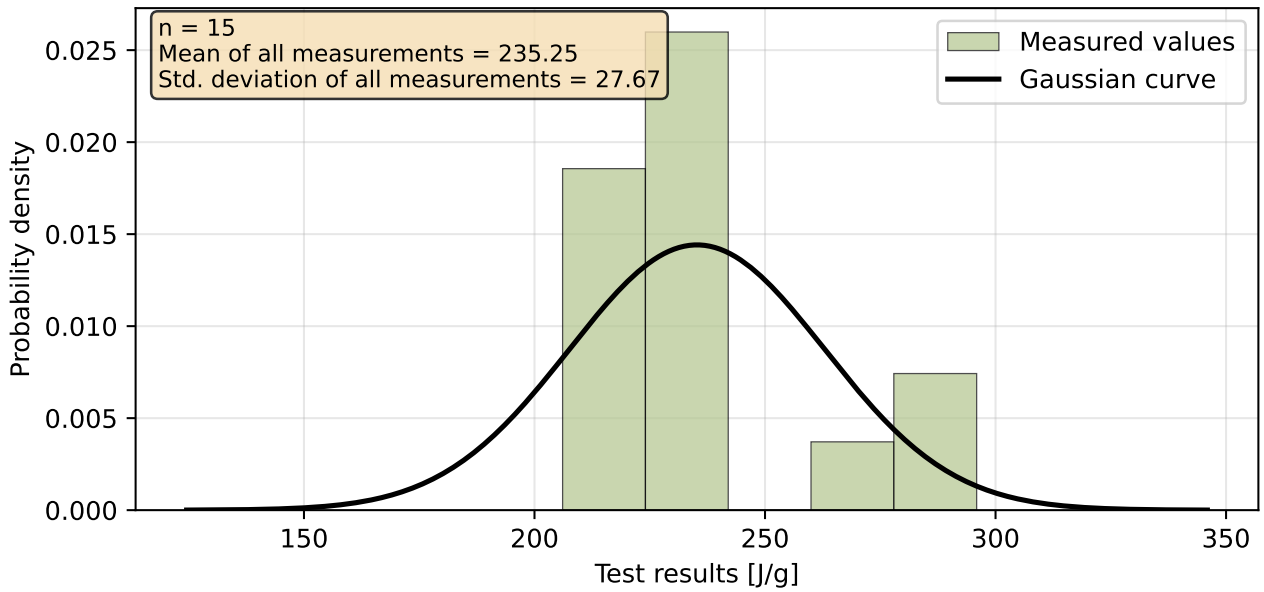

Figure 144: Histogram of all test results

Table 50: Descriptive statistics

Characteristics	**[J/g]**
Average value – $\bar{x}$	236.73
Sample standard deviation – s	32.49
Assigned value – x^*	236.73
Robust standard deviation – s^*	32.49
Measurement uncertainty of assigned value – u_X	14.53
p-value of normality test [-]	0.006
Interlaboratory standard deviation – s_L	32.45
Repeatability standard deviation – s_r	2.77
Reproducibility standard deviation – s_R	32.57
Repeatability – r	7.77
Reproducibility – R	91.20

Evaluation of Performance Statistics

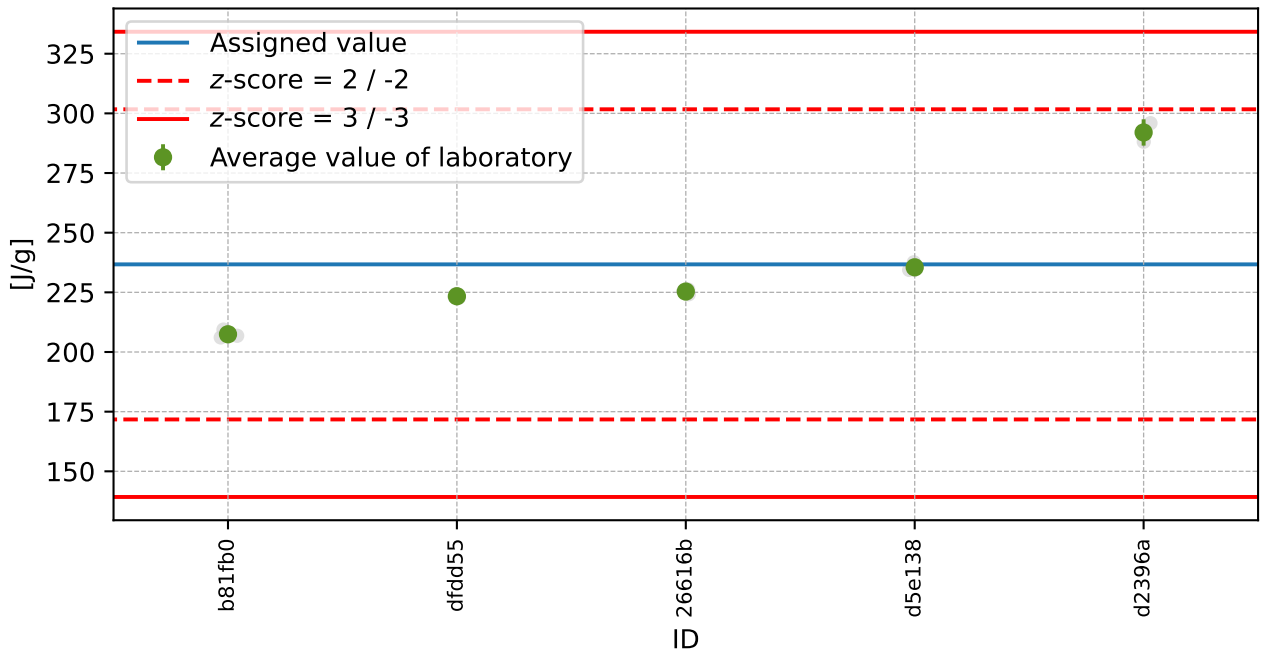

Figure 145: Average values and sample standard deviations

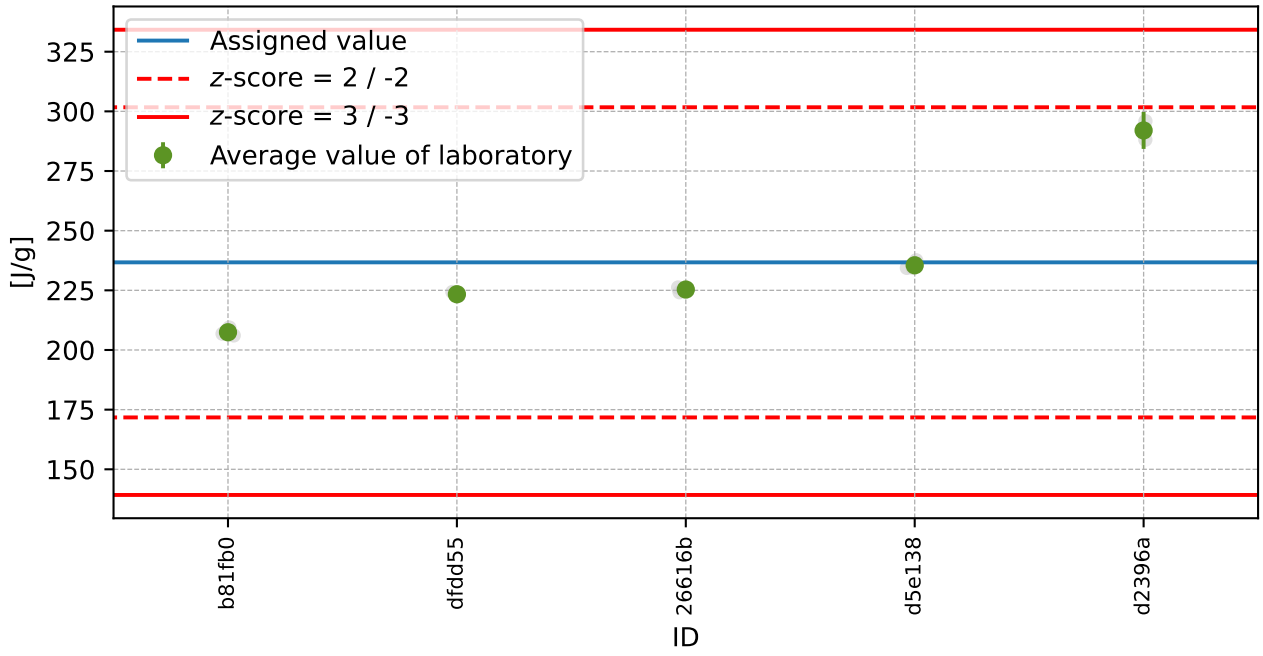

Figure 146: Average values and extended uncertainties of measurement

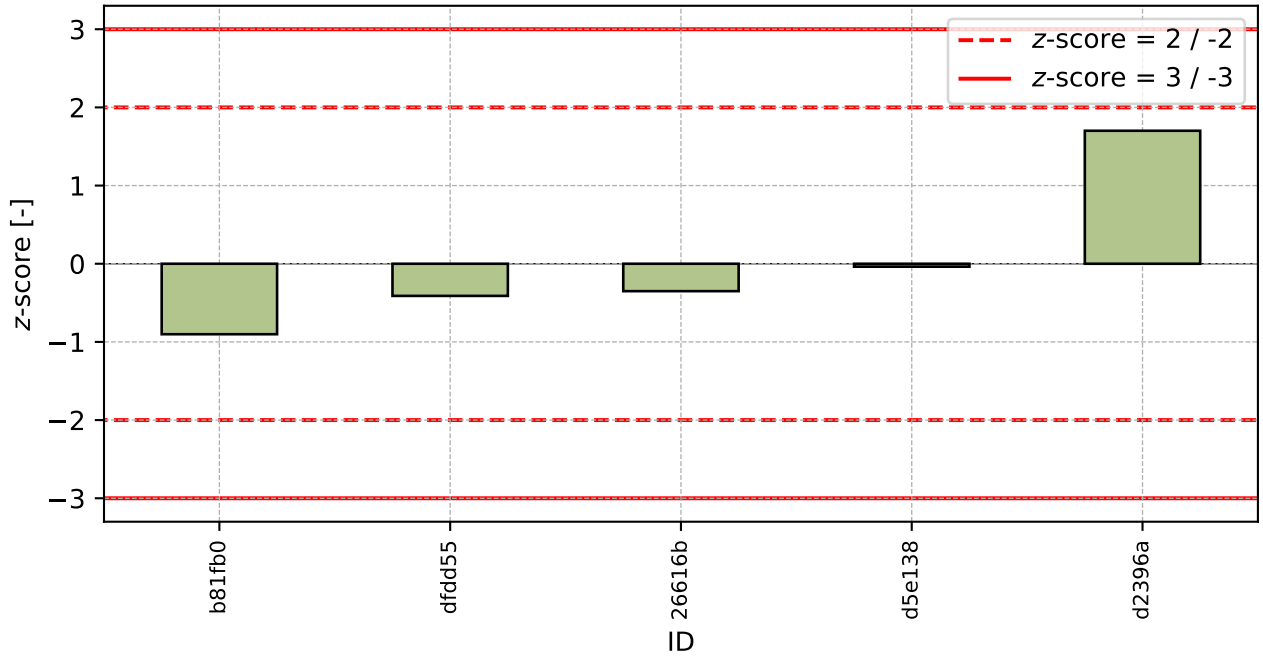

Figure 147: z-score

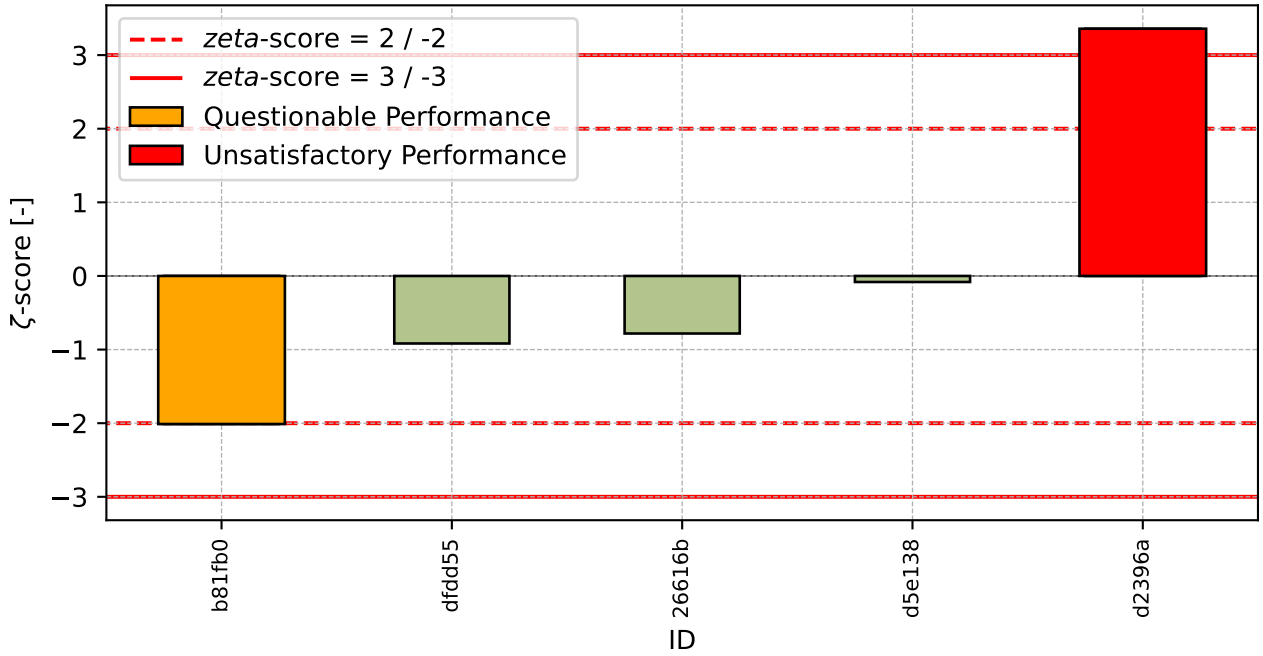

Figure 148: ζ-score

Table 51: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
b81fb0	-0.90	-2.01
dfdd55	-0.41	-0.92
26616b	-0.35	-0.78
d5e138	-0.04	-0.08
d2396a	1.70	3.36

15.2 Sample B

15.2.1 Melting temperature T_{m1}

Test results

Table 52: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [°C]	2 [°C]	3 [°C]	u_X [°C]	$\bar{x}$ [°C]	s_0 [°C]	V_X [%]
d5e138	103.3	103.0	103.1	0.20	103.1	0.15	0.15
dfdd55	103.7	103.4	103.4	0.20	103.5	0.17	0.17
26616b	103.5	103.3	103.7	0.20	103.5	0.20	0.19
b81fb0	103.7	103.7	103.7	0.00	103.7	0.00	0.00
d2396a	104.5	104.3	104.2	0.10	104.3	0.15	0.15

The Numerical Procedure for Determining Outliers

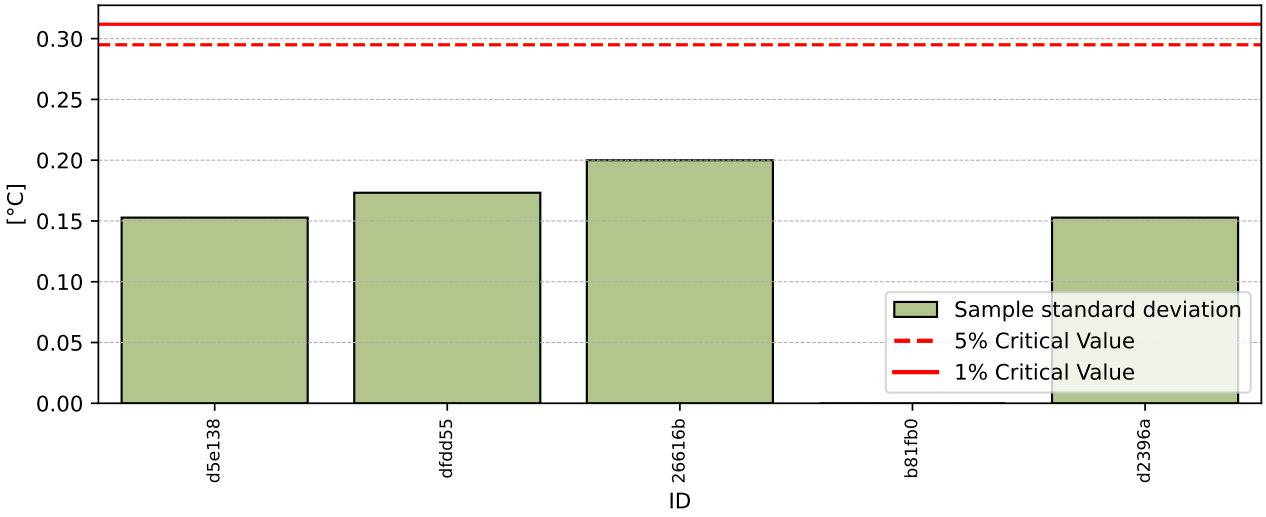

Figure 149: **Cochran's test** - sample standard deviations

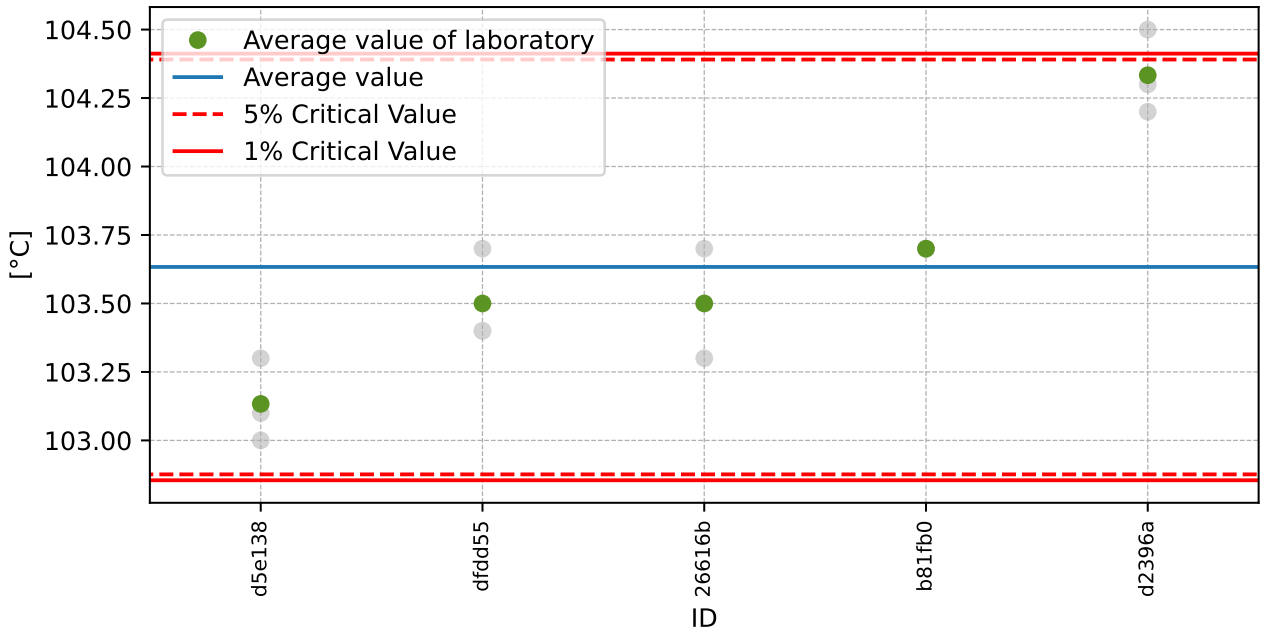

Figure 150: **Grubbs' test** - average values

Mandel's Statistics

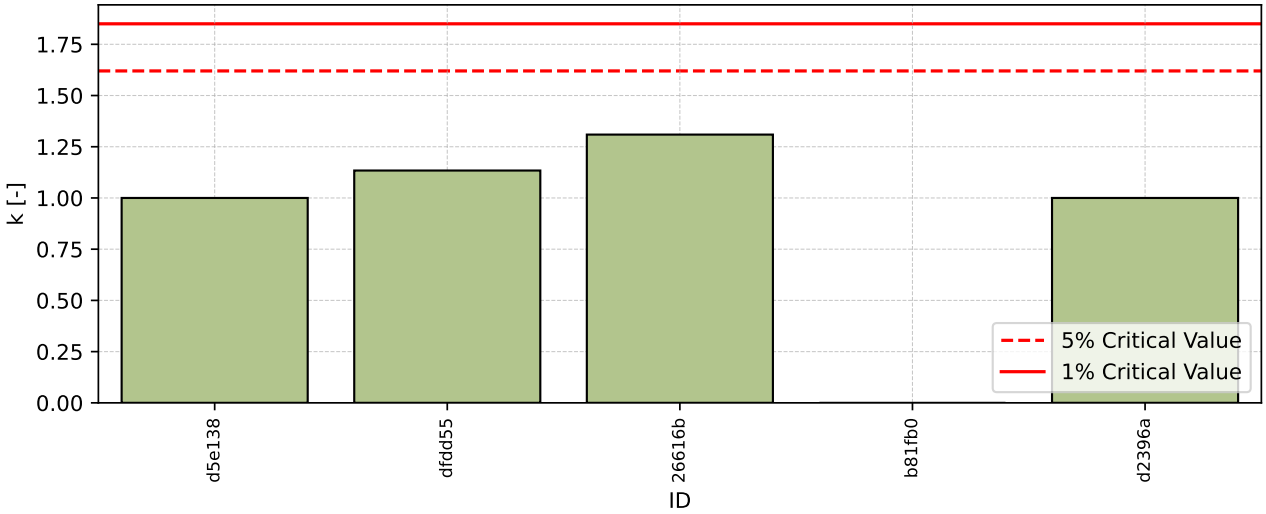

Figure 151: Intralaboratory Consistency Statistic

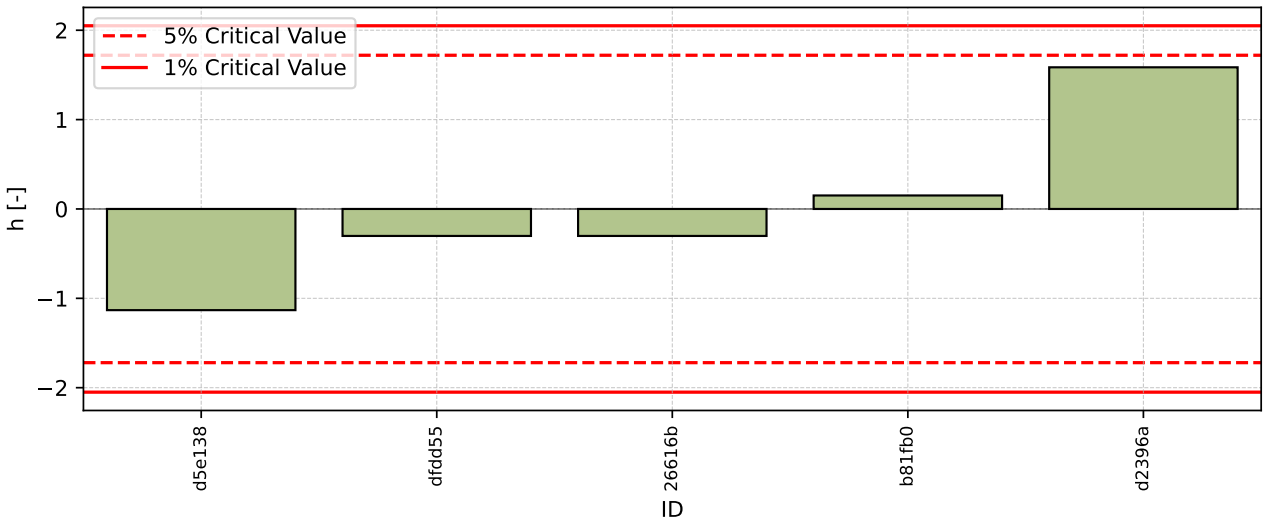

Figure 152: Interlaboratory Consistency Statistic

Descriptive statistics

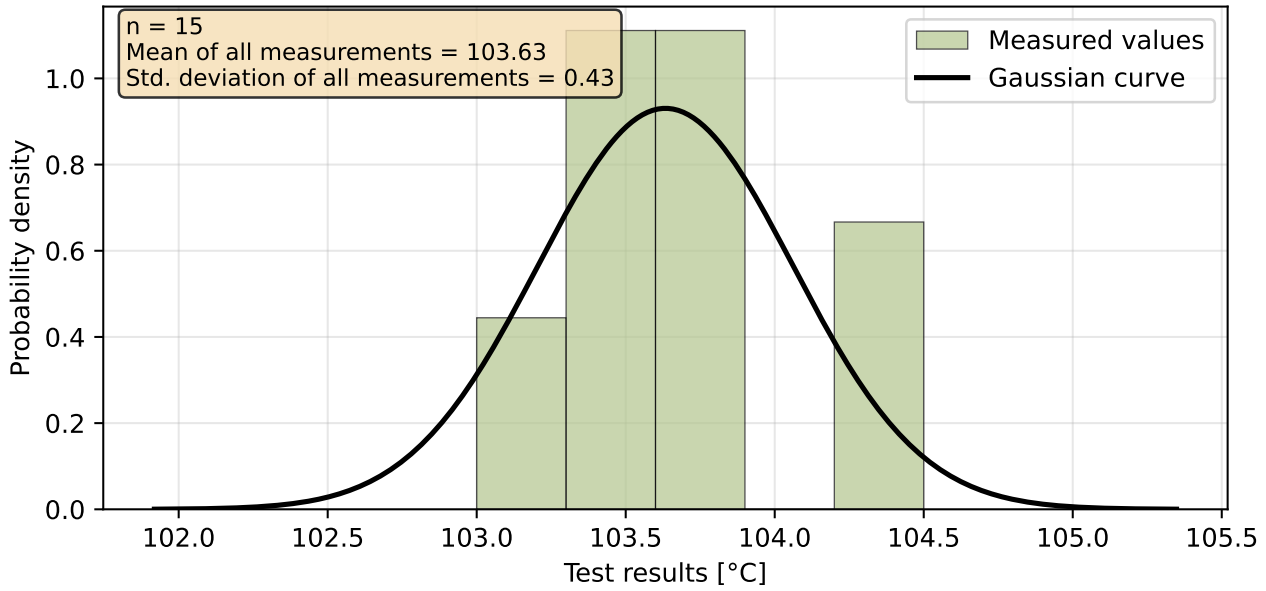

Figure 153: Histogram of all test results

Table 53: Descriptive statistics

Characteristics	[°C]
Average value – $\bar{x}$	103.63
Sample standard deviation – s	0.44
Assigned value – x^*	103.63
Robust standard deviation – s^*	0.44
Measurement uncertainty of assigned value – u_X	0.20
p-value of normality test [-]	0.247
Interlaboratory standard deviation – s_L	0.43
Repeatability standard deviation – s_r	0.15
Reproducibility standard deviation – s_R	0.46
Repeatability – r	0.43
Reproducibility – R	1.28

Evaluation of Performance Statistics

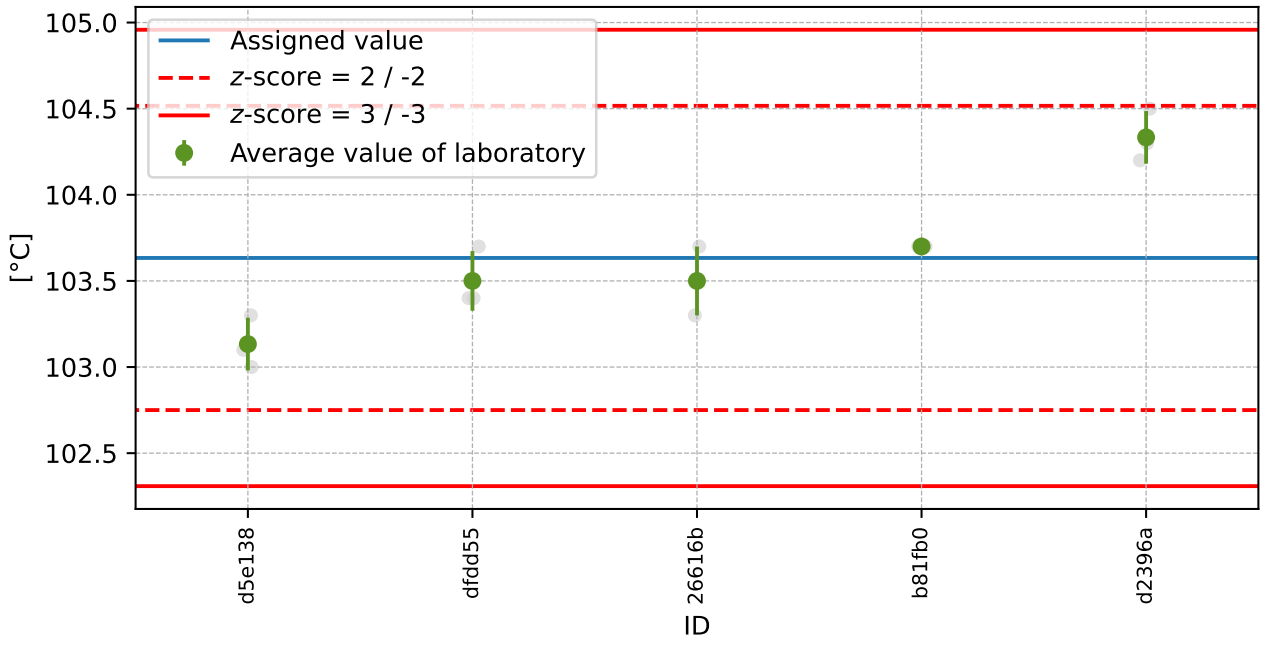

Figure 154: Average values and sample standard deviations

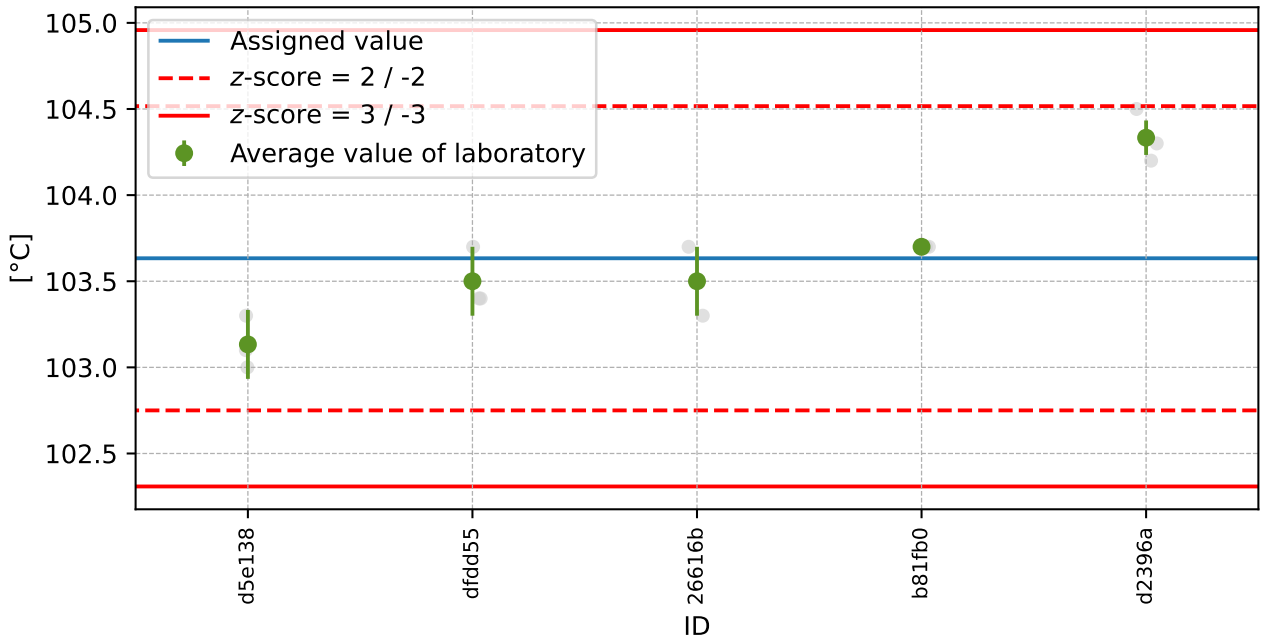

Figure 155: Average values and extended uncertainties of measurement

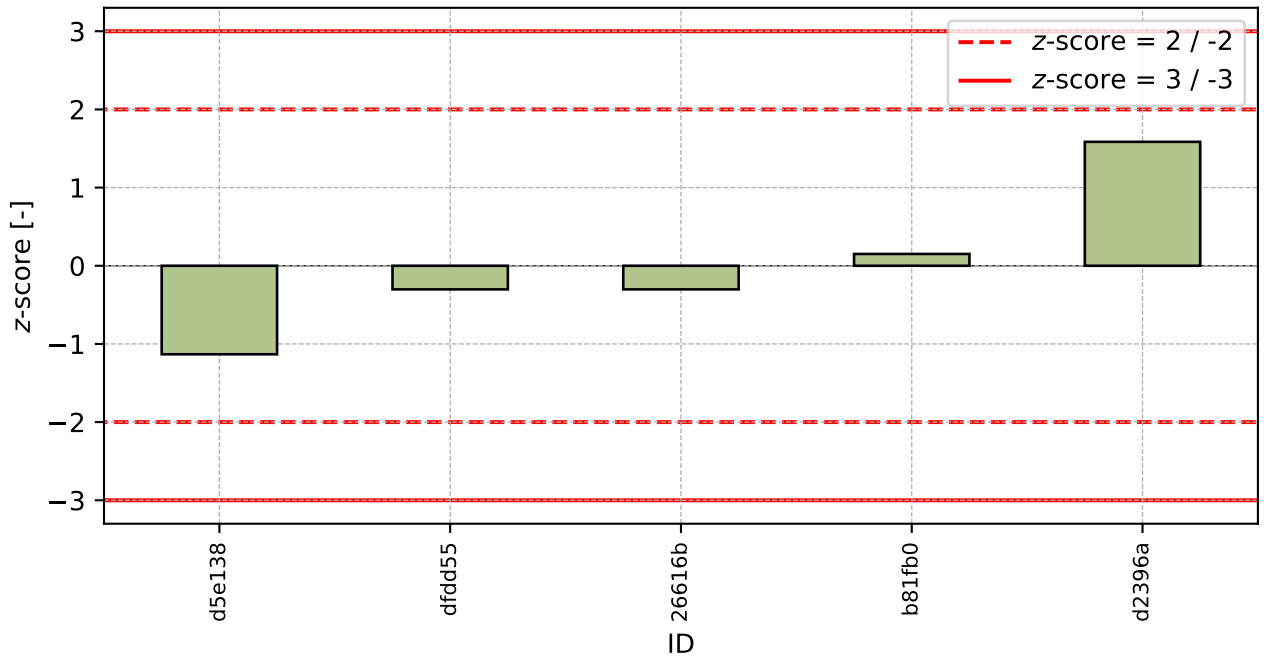

Figure 156: z-score

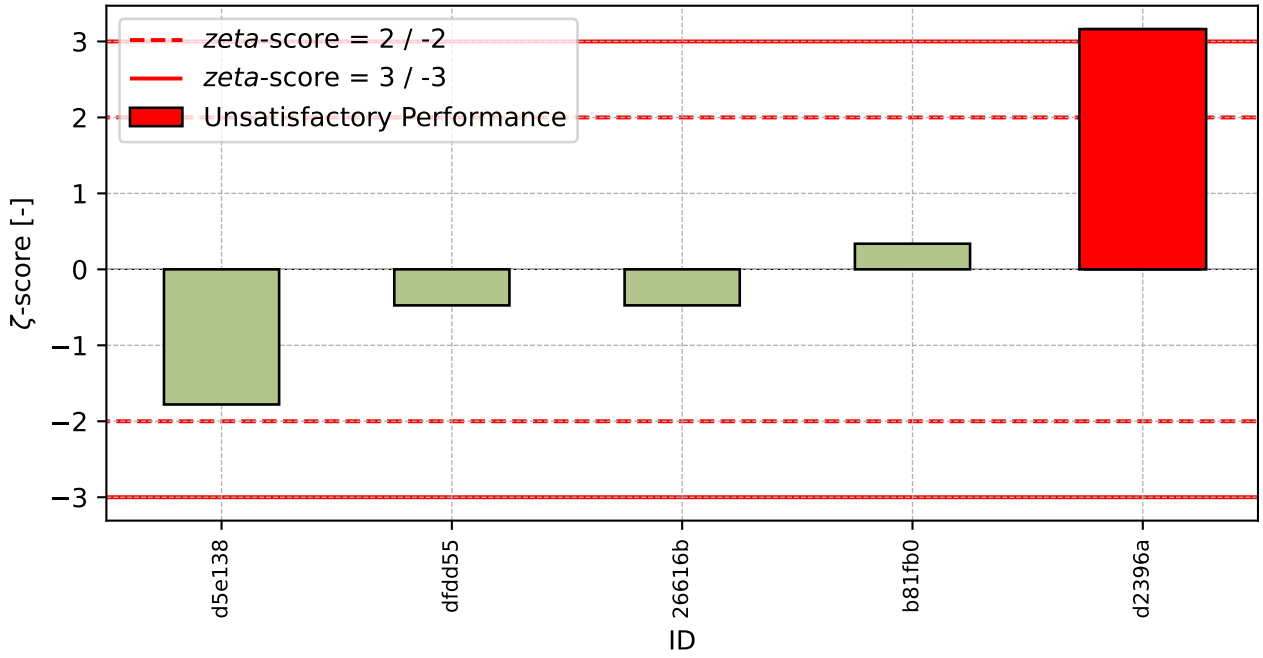

Figure 157: ζ-score

Table 54: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d5e138	-1.13	-1.78
dfdd55	-0.30	-0.47
26616b	-0.30	-0.47
b81fb0	0.15	0.34
d2396a	1.59	3.16

15.2.2 Enthalpy of fusion ΔH_{m1}

Test results

Table 55: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [J/g]	2 [J/g]	3 [J/g]	u_X [J/g]	$\bar{x}$ [J/g]	s_0 [J/g]	V_X [%]
d5e138	71.5	68.6	70.8	1.90	70.3	1.51	2.15
dfdd55	74.4	74.8	74.4	0.20	74.5	0.23	0.31
b81fb0	74.2	76.2	76.0	0.60	75.5	1.10	1.46
26616b	77.2	77.7	77.7	0.30	77.5	0.29	0.37
d2396a	93.5	98.4	100.9	2.20	97.6	3.76	3.86

The Numerical Procedure for Determining Outliers

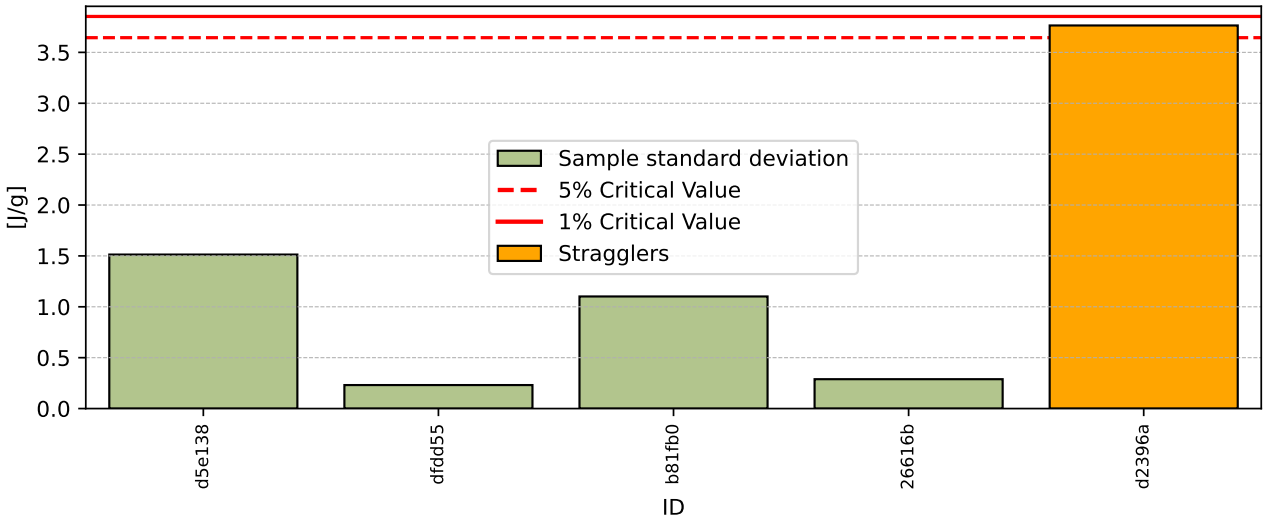

Figure 158: **Cochran's test** - sample standard deviations

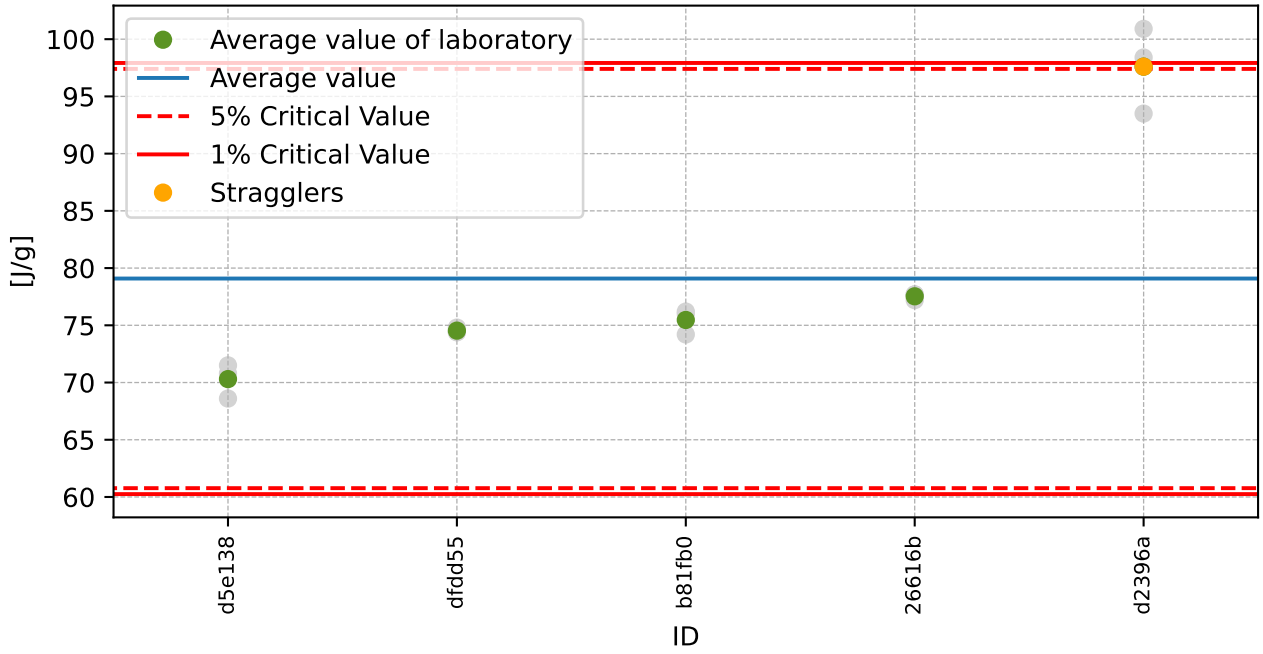

Figure 159: **Grubbs' test** - average values

Mandel's Statistics

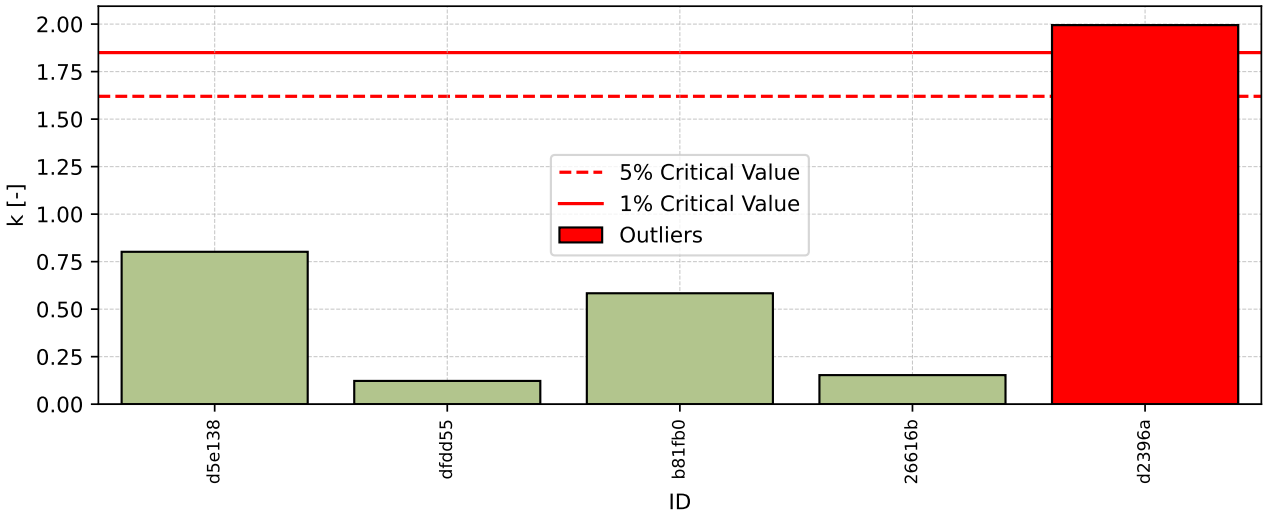

Figure 160: Intralaboratory Consistency Statistic

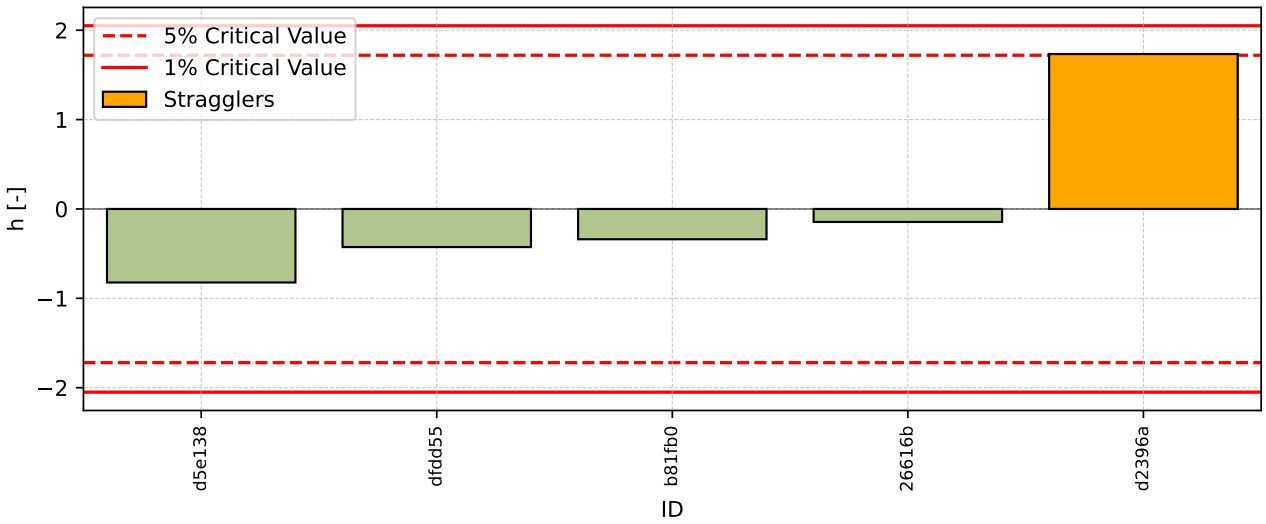

Figure 161: Interlaboratory Consistency Statistic

Descriptive statistics

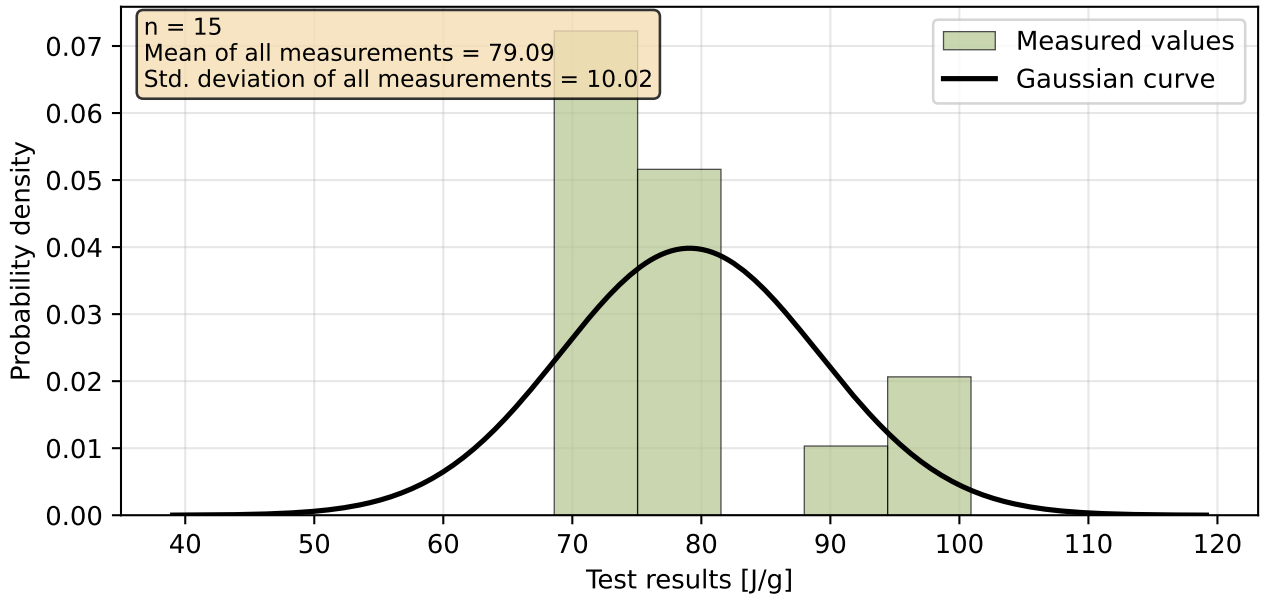

Figure 162: Histogram of all test results

Table 56: Descriptive statistics

Characteristics	[J/g]
Average value – $\bar{x}$	79.09
Sample standard deviation – s	10.68
Assigned value – x^*	79.09
Robust standard deviation – s^*	10.68
Measurement uncertainty of assigned value – u_X	4.78
p-value of normality test [-]	0.001
Interlaboratory standard deviation – s_L	10.62
Repeatability standard deviation – s_r	1.89
Reproducibility standard deviation – s_R	10.79
Repeatability – r	5.28
Reproducibility – R	30.21

Evaluation of Performance Statistics

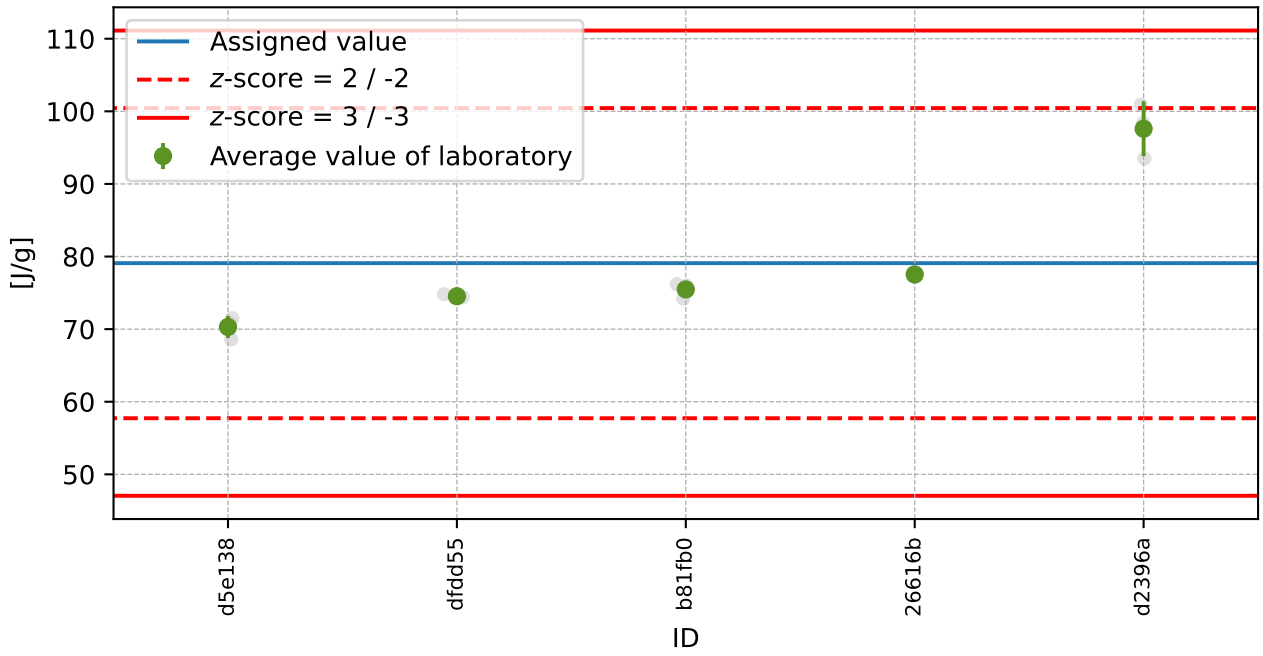

Figure 163: Average values and sample standard deviations

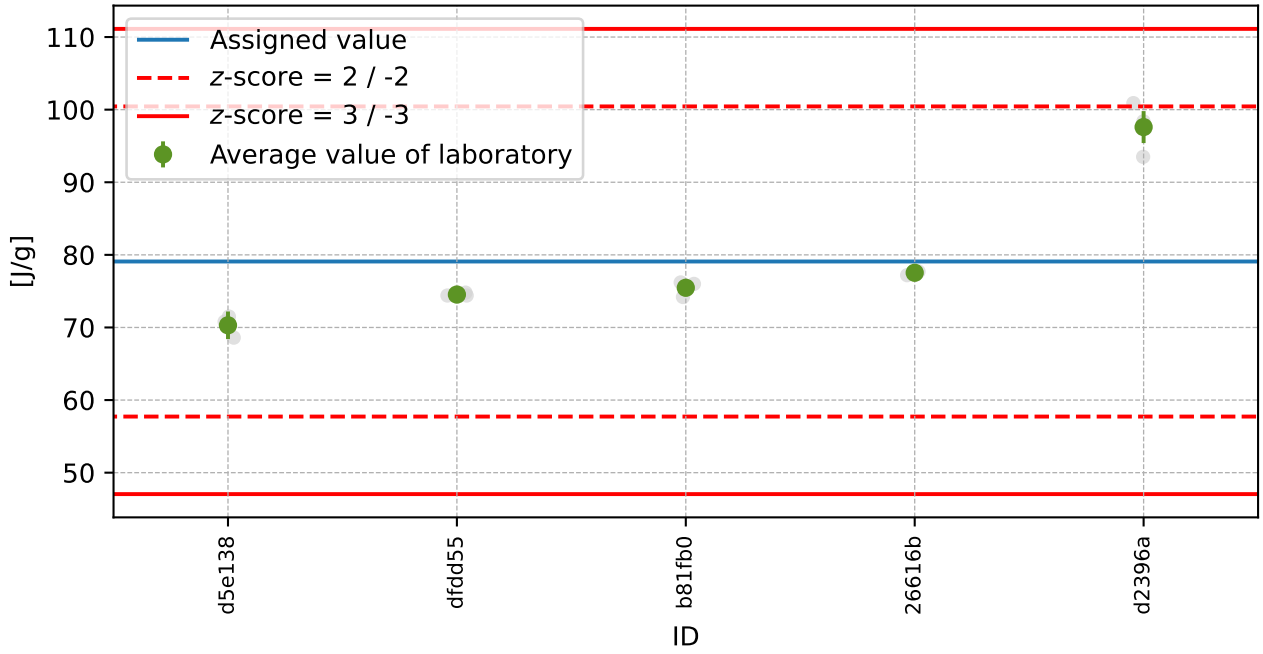

Figure 164: Average values and extended uncertainties of measurement

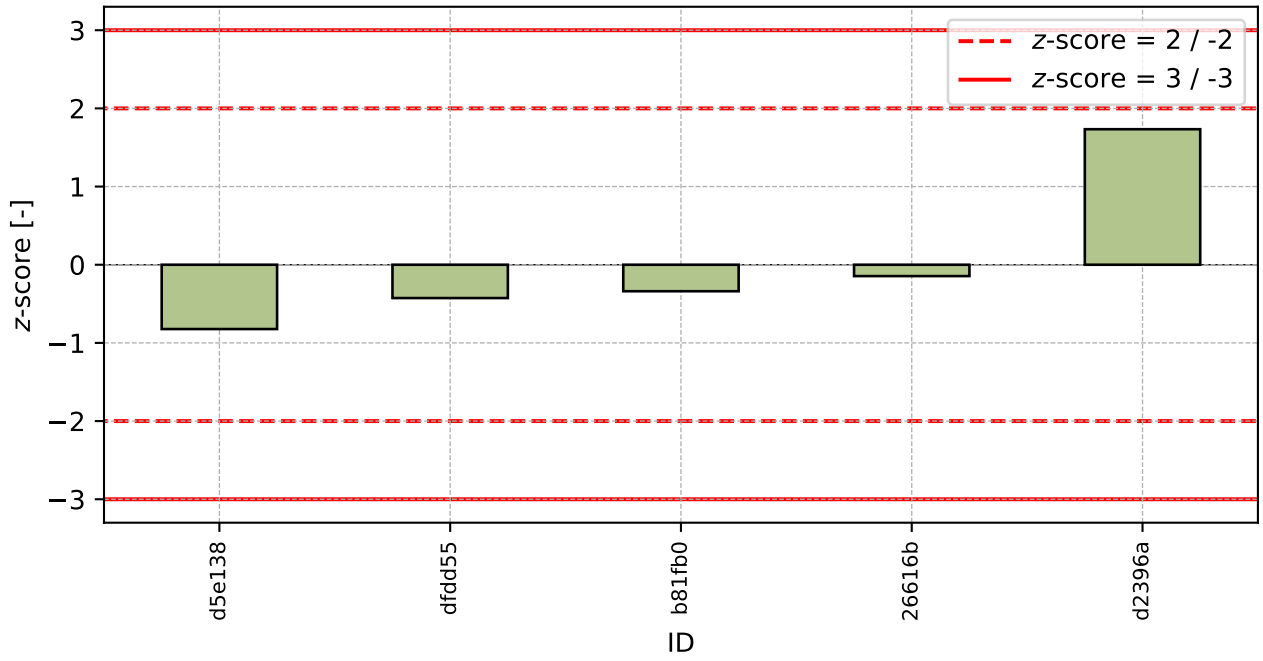

Figure 165: z-score

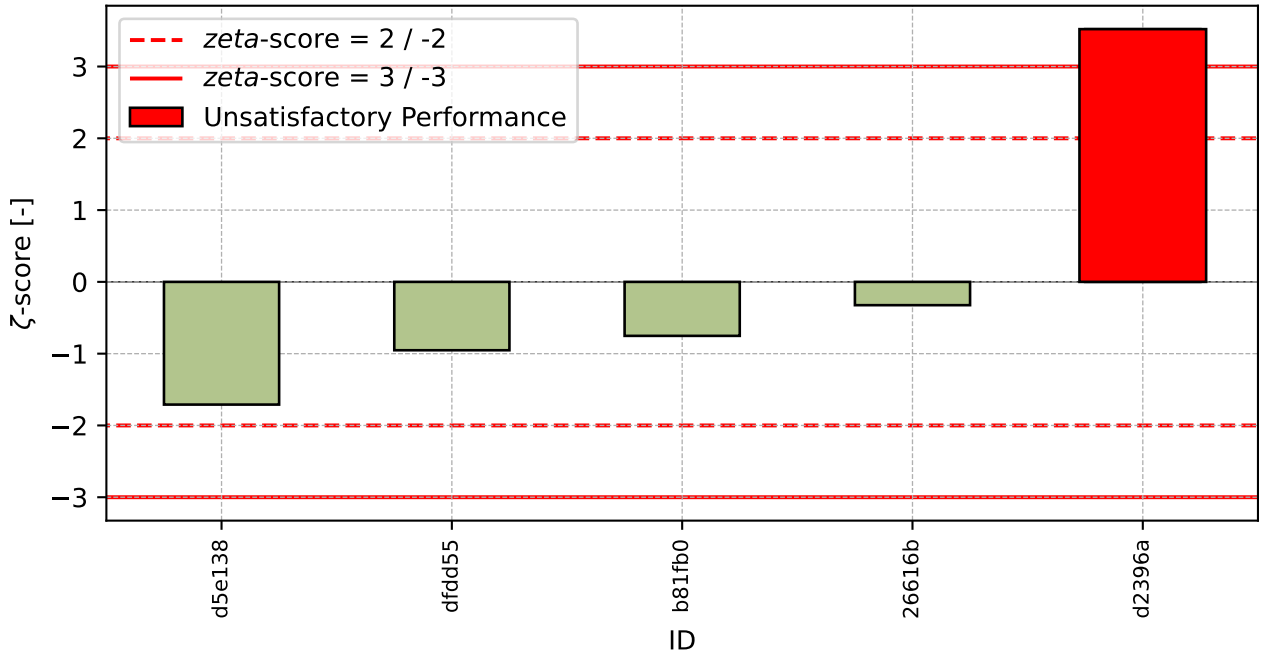

Figure 166: ζ-score

Table 57: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d5e138	-0.82	-1.71
dfdd55	-0.43	-0.95
b81fb0	-0.34	-0.75
26616b	-0.15	-0.32
d2396a	1.73	3.52

16 Appendix – EN ISO 1133-1 (Melt mass-flow rate)

16.1 Sample A

16.1.1 Test results

Table 58: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [g/10min]	2 [g/10min]	3 [g/10min]	u_X [g/10min]	$\bar{x}$ [g/10min]	s_0 [g/10min]	V_X [%]
dfdd55	7.06	7.09	7.03	0.060	7.06	0.030	0.42
d2396a	7.10	7.00	7.20	0.060	7.10	0.100	1.41
26616b	7.28	7.21	7.34	0.130	7.28	0.065	0.89
fbf170	7.38	7.08	8.16	1.520	7.54	0.557	7.39
d4fccc	7.58	7.41	8.04	0.690	7.68	0.326	4.25
b81fb0	7.64	7.83	7.58	0.750	7.68	0.131	1.70

16.1.2 The Numerical Procedure for Determining Outliers

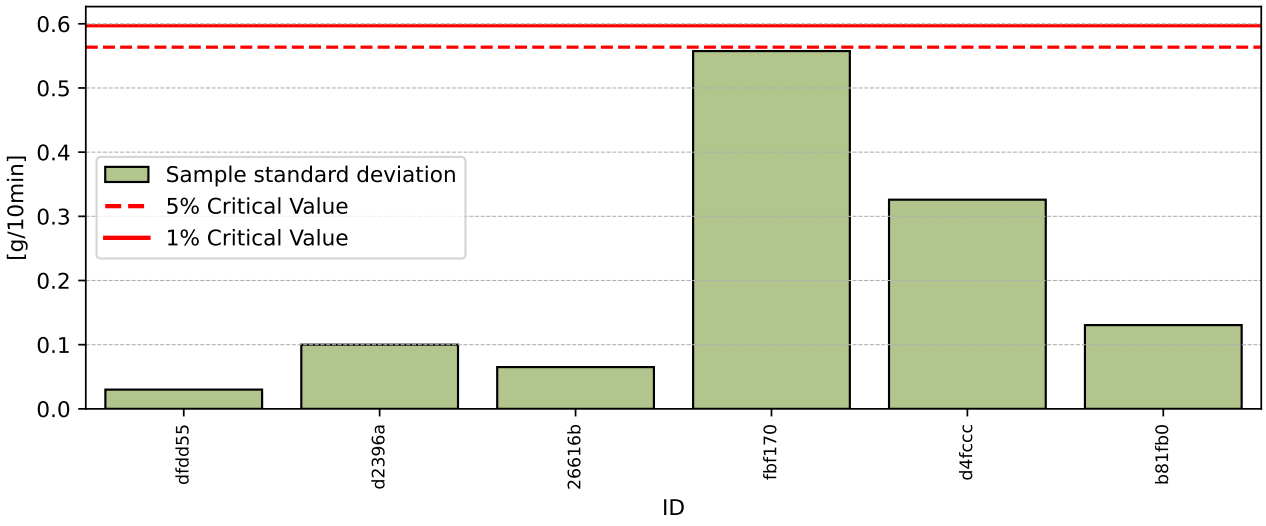

Figure 167: **Cochran's test** - sample standard deviations

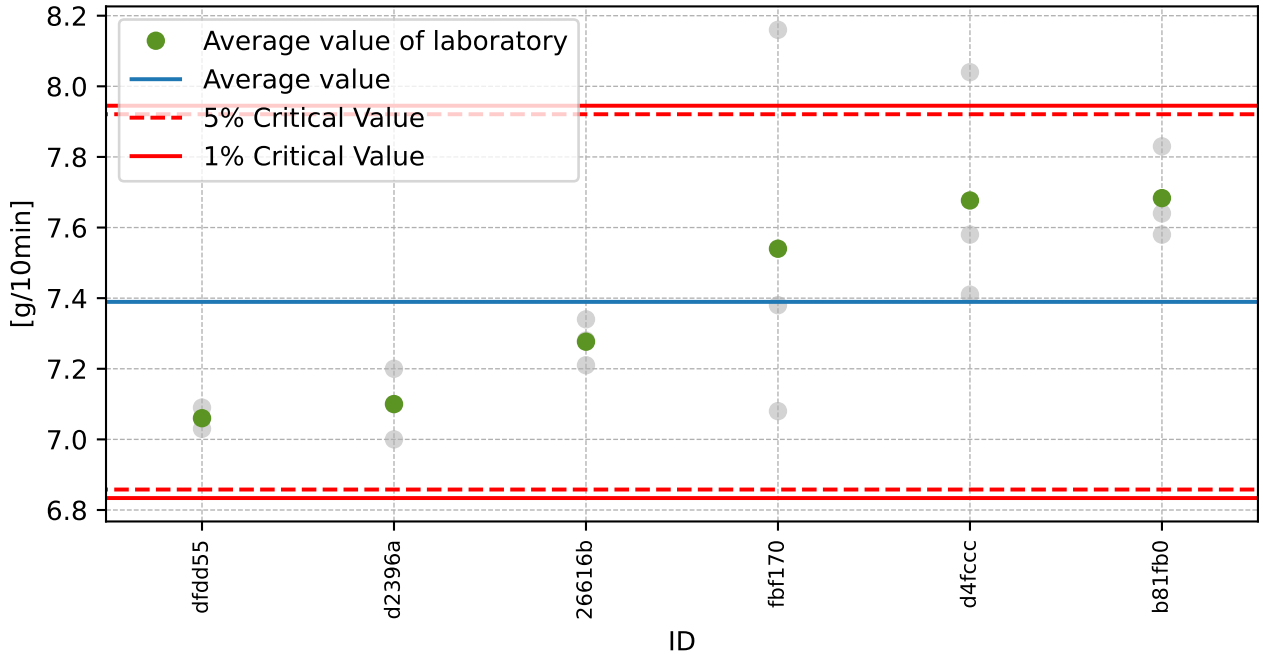

Figure 168: **Grubbs' test** - average values

16.1.3 Mandel's Statistics

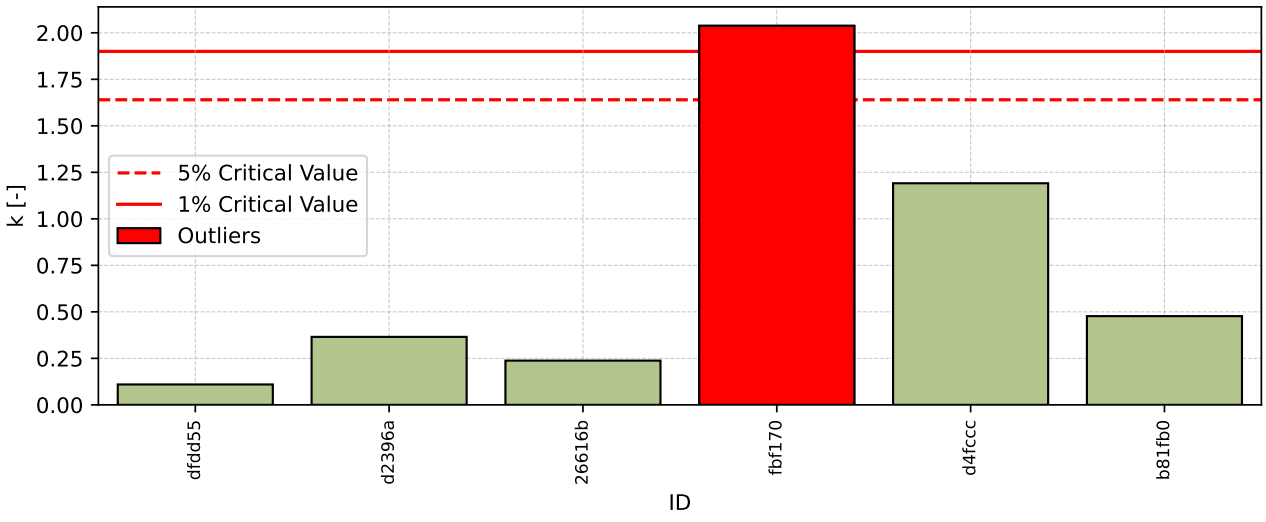

Figure 169: Intralaboratory Consistency Statistic

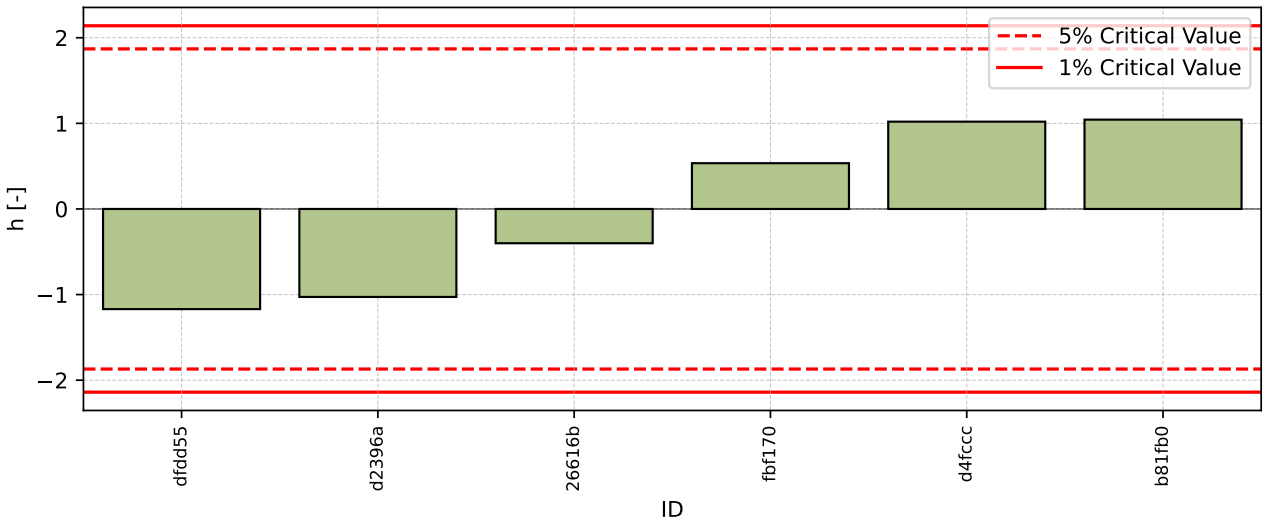

Figure 170: Interlaboratory Consistency Statistic

16.1.4 Descriptive statistics

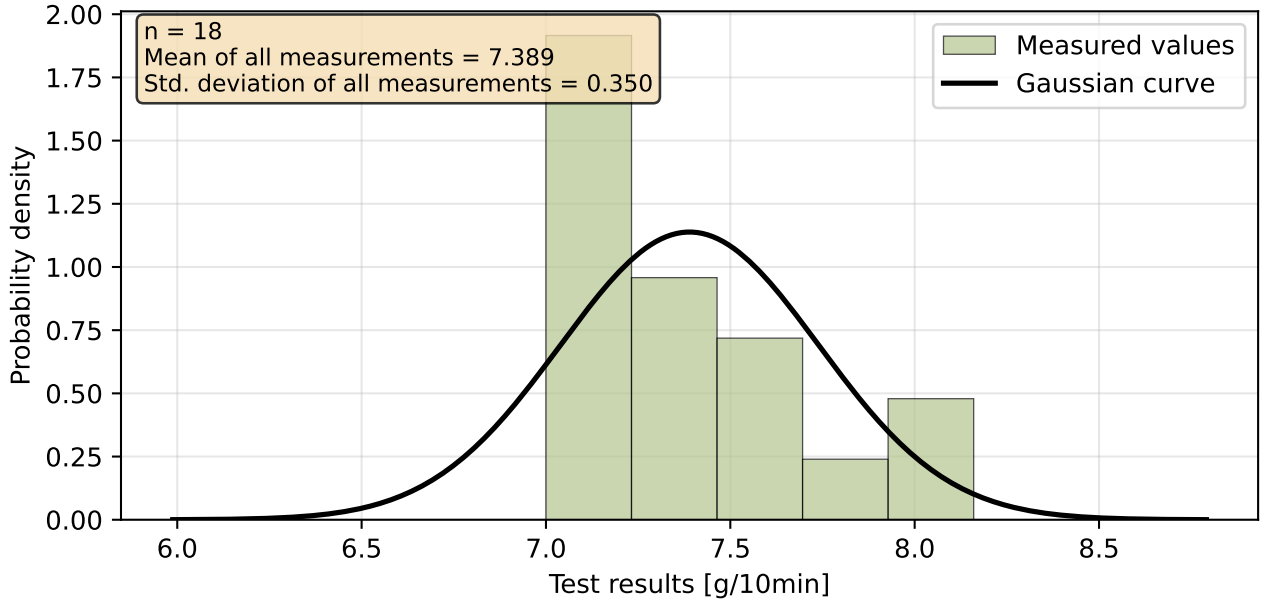

Figure 171: Histogram of all test results

Table 59: Descriptive statistics

Characteristics	[g/10min]
Average value – $\bar{x}$	7.389
Sample standard deviation – s	0.282
Assigned value – x^*	7.389
Robust standard deviation – s^*	0.282
Measurement uncertainty of assigned value – u_X	0.115
p-value of normality test [-]	0.048
Interlaboratory standard deviation – s_L	0.233
Repeatability standard deviation – s_r	0.274
Reproducibility standard deviation – s_R	0.359
Repeatability – r	0.766
Reproducibility – R	1.007

16.1.5 Evaluation of Performance Statistics

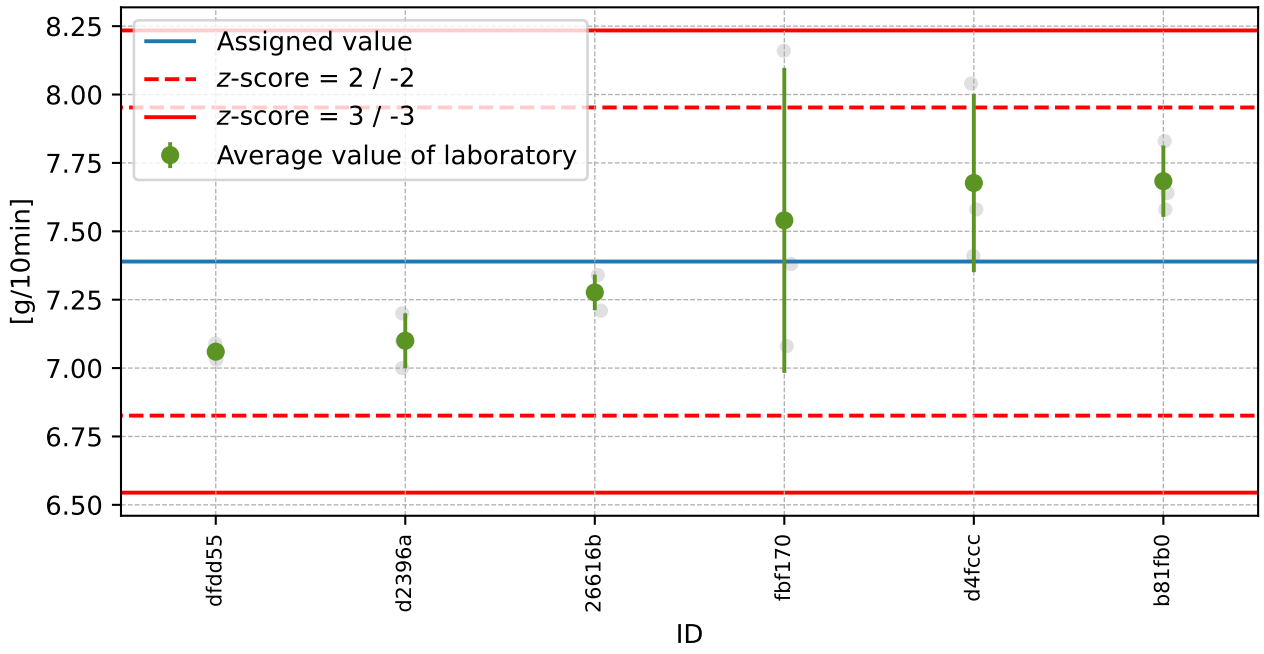

Figure 172: Average values and sample standard deviations

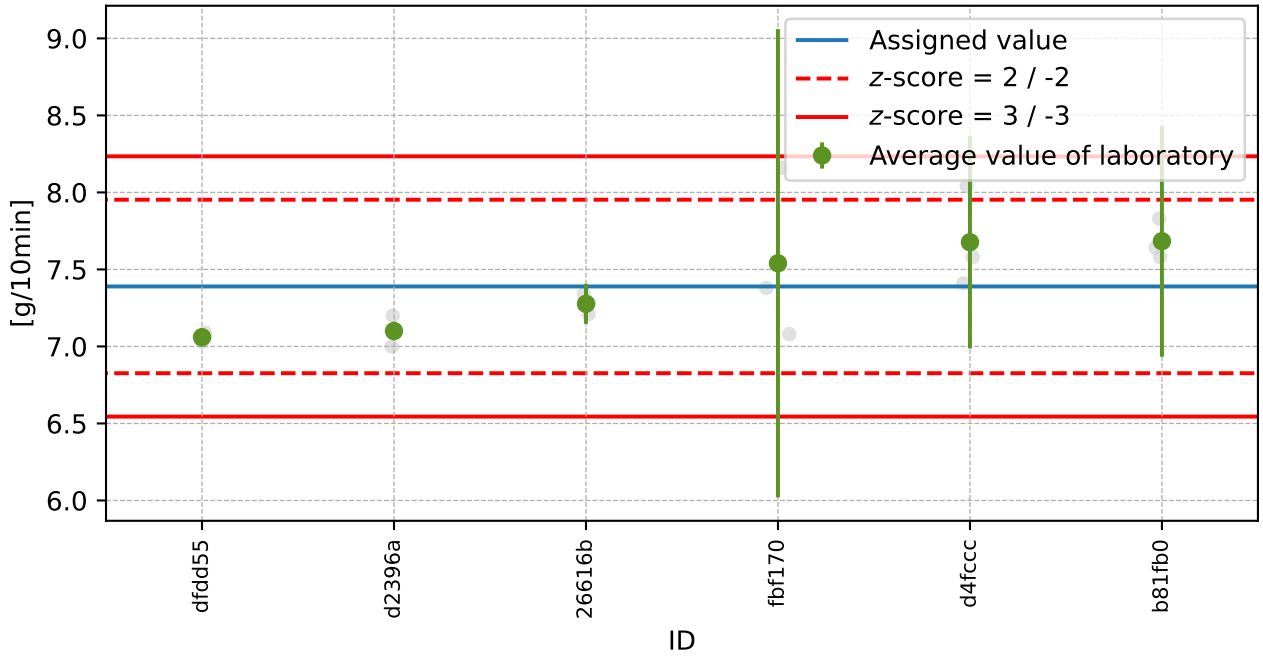

Figure 173: Average values and extended uncertainties of measurement

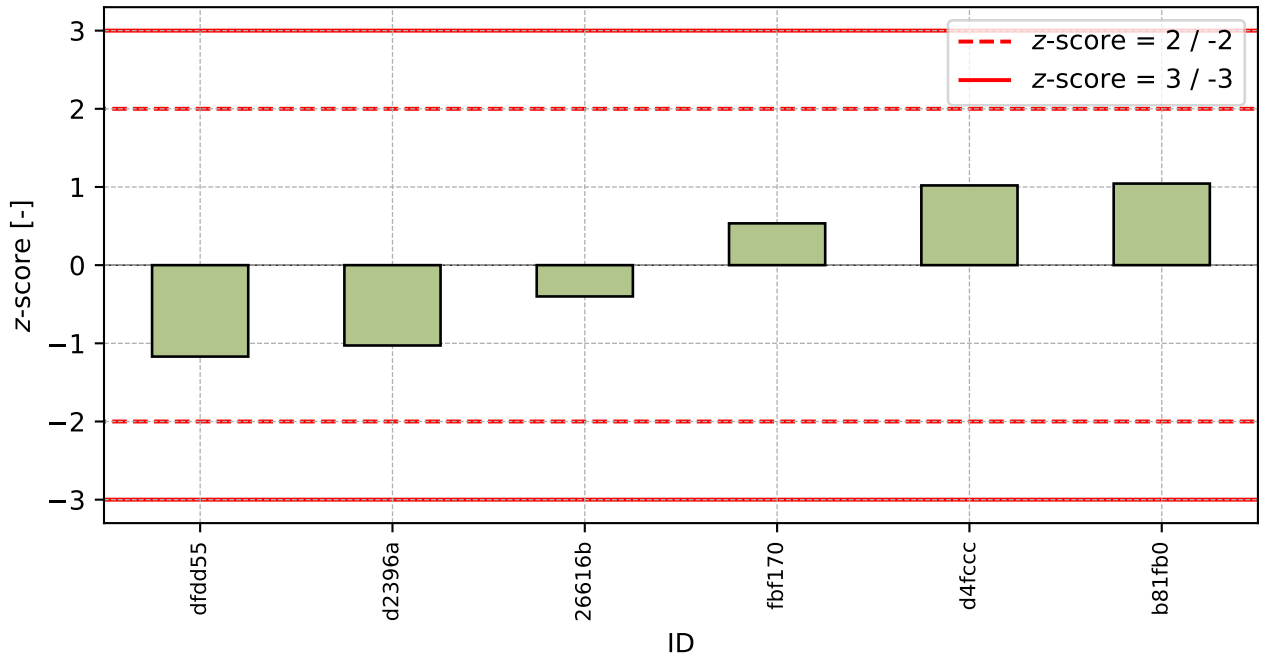

Figure 174: z-score

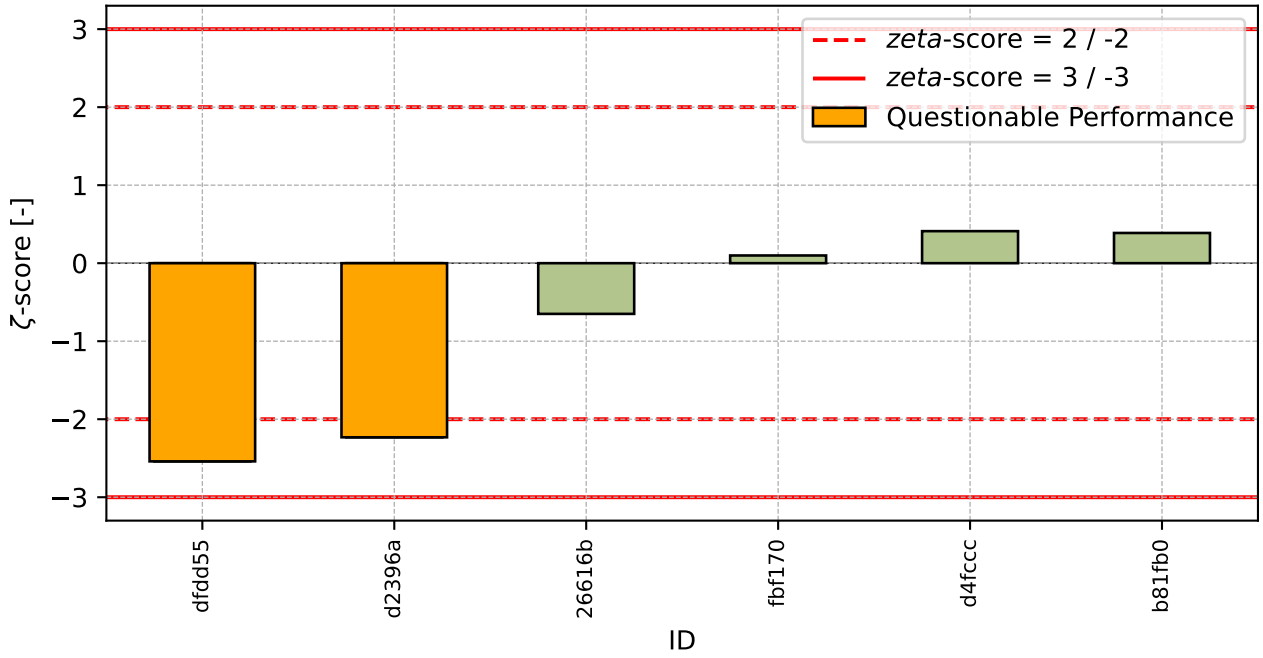

Figure 175: ζ-score

Table 60: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dfdd55	-1.17	-2.54
d2396a	-1.03	-2.23
26616b	-0.40	-0.65
fbf170	0.53	0.10
d4fccc	1.02	0.41
b81fb0	1.04	0.39

16.2 Sample B

16.2.1 Test results

Table 61: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [g/10min]	2 [g/10min]	3 [g/10min]	u_X [g/10min]	$\bar{x}$ [g/10min]	s_0 [g/10min]	V_X [%]
d2396a	8.40	8.40	8.20	0.070	8.33	0.115	1.39
b81fb0	8.42	8.52	8.23	0.850	8.39	0.147	1.76
dfdd55	8.63	8.22	8.32	0.430	8.39	0.214	2.55
26616b	8.51	8.64	8.36	0.280	8.50	0.140	1.65
fbf170	8.88	9.24	8.46	1.120	8.86	0.390	4.41
d4fccc	8.55	9.55	9.02	0.960	9.04	0.500	5.53

16.2.2 The Numerical Procedure for Determining Outliers

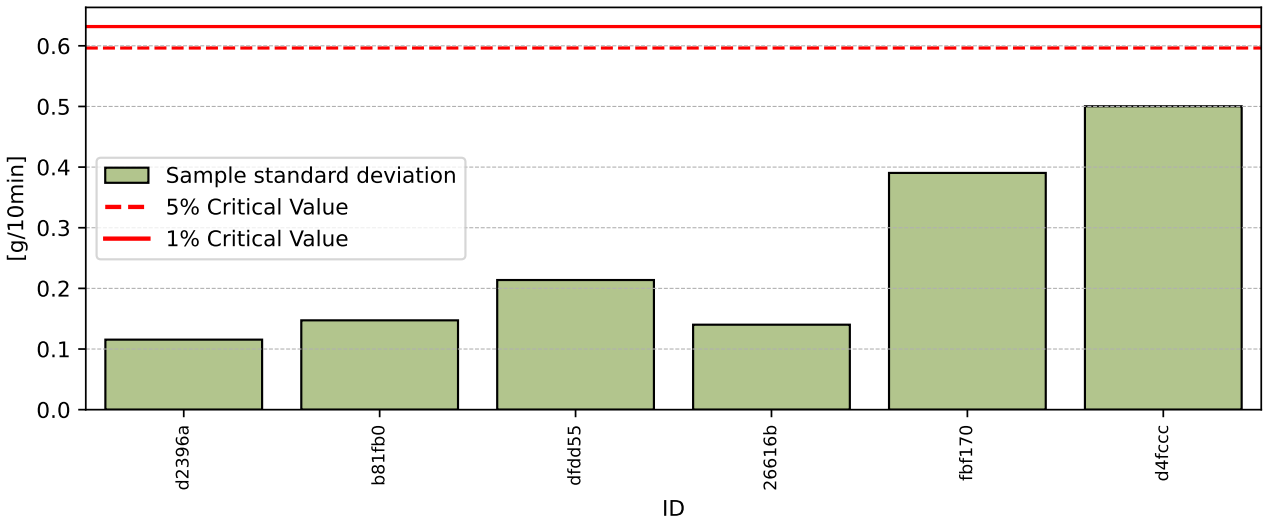

Figure 176: **Cochran's test** - sample standard deviations

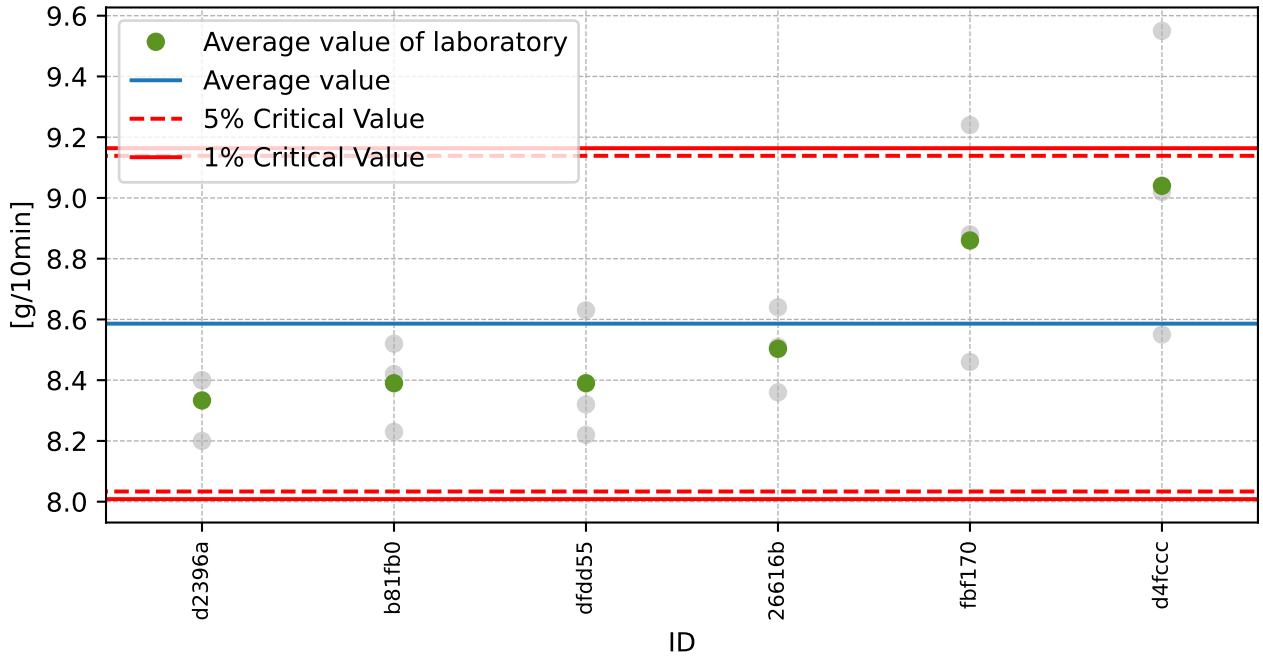

Figure 177: **Grubbs' test** - average values

16.2.3 Mandel's Statistics

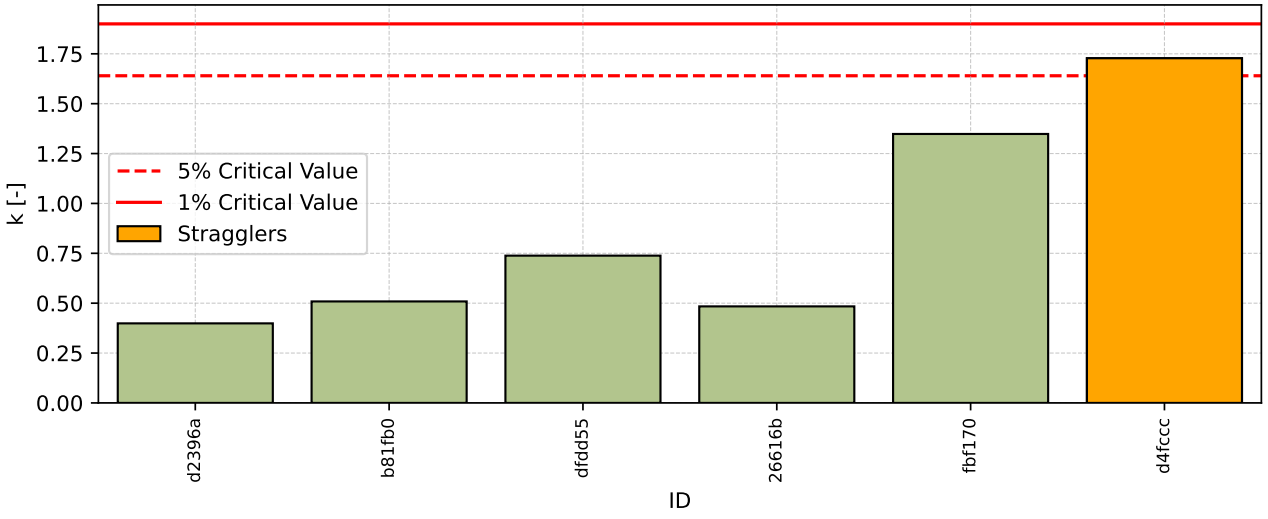

Figure 178: Intralaboratory Consistency Statistic

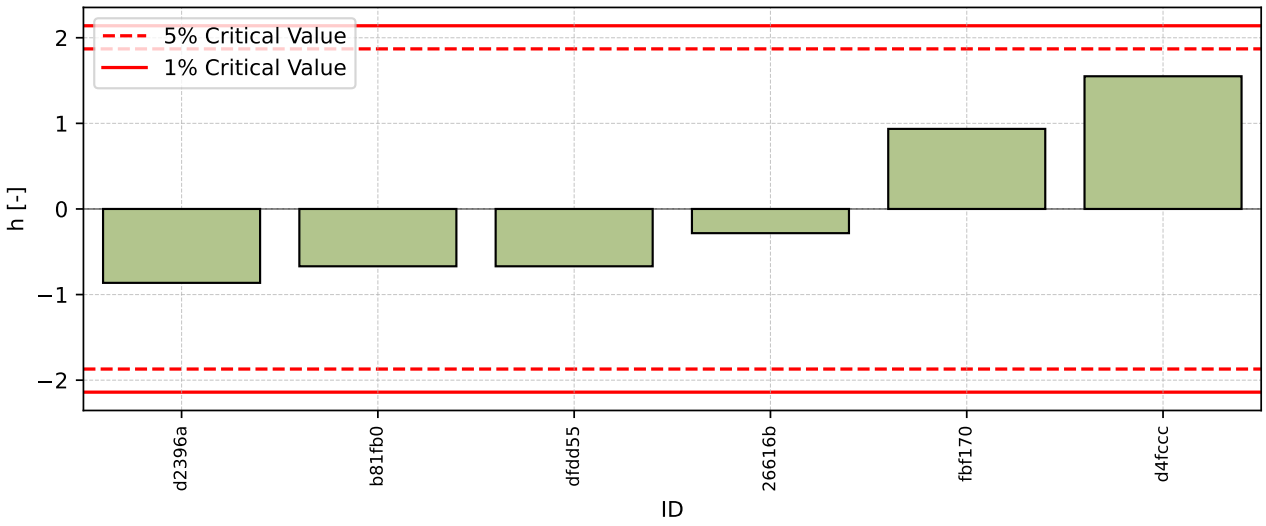

Figure 179: Interlaboratory Consistency Statistic

16.2.4 Descriptive statistics

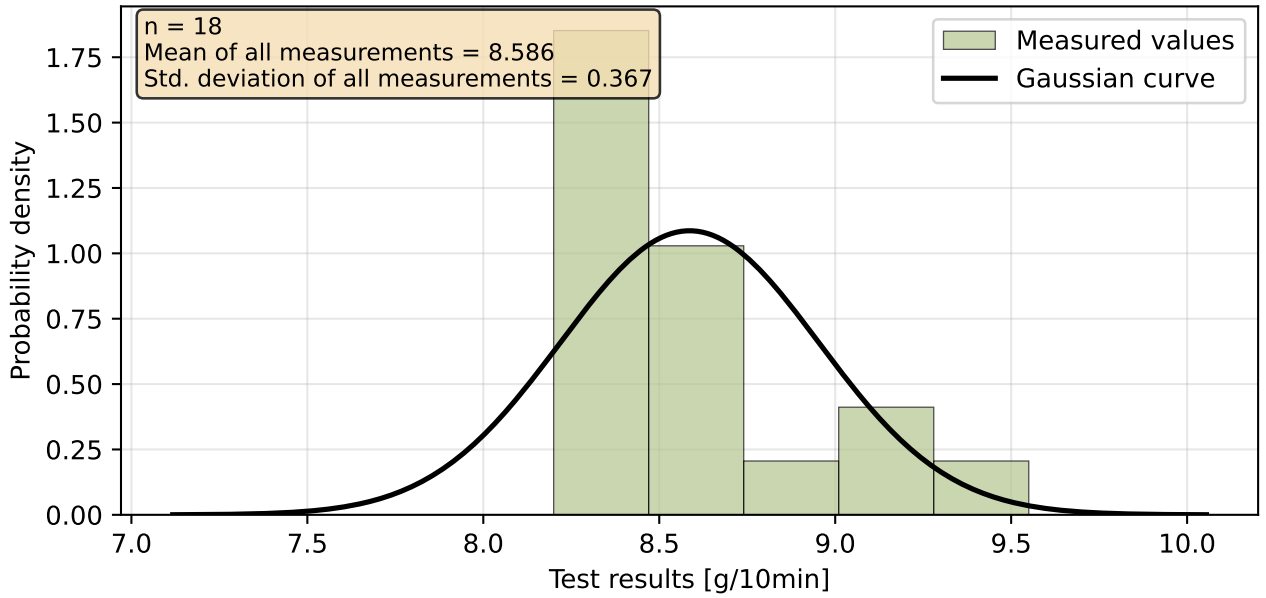

Figure 180: Histogram of all test results

Table 62: Descriptive statistics

Characteristics	[g/10min]
Average value – $\bar{x}$	8.586
Sample standard deviation – s	0.293
Assigned value – x^*	8.586
Robust standard deviation – s^*	0.293
Measurement uncertainty of assigned value – u_X	0.120
p-value of normality test [-]	0.009
Interlaboratory standard deviation – s_L	0.240
Repeatability standard deviation – s_r	0.290
Reproducibility standard deviation – s_R	0.376
Repeatability – r	0.811
Reproducibility – R	1.054

16.2.5 Evaluation of Performance Statistics

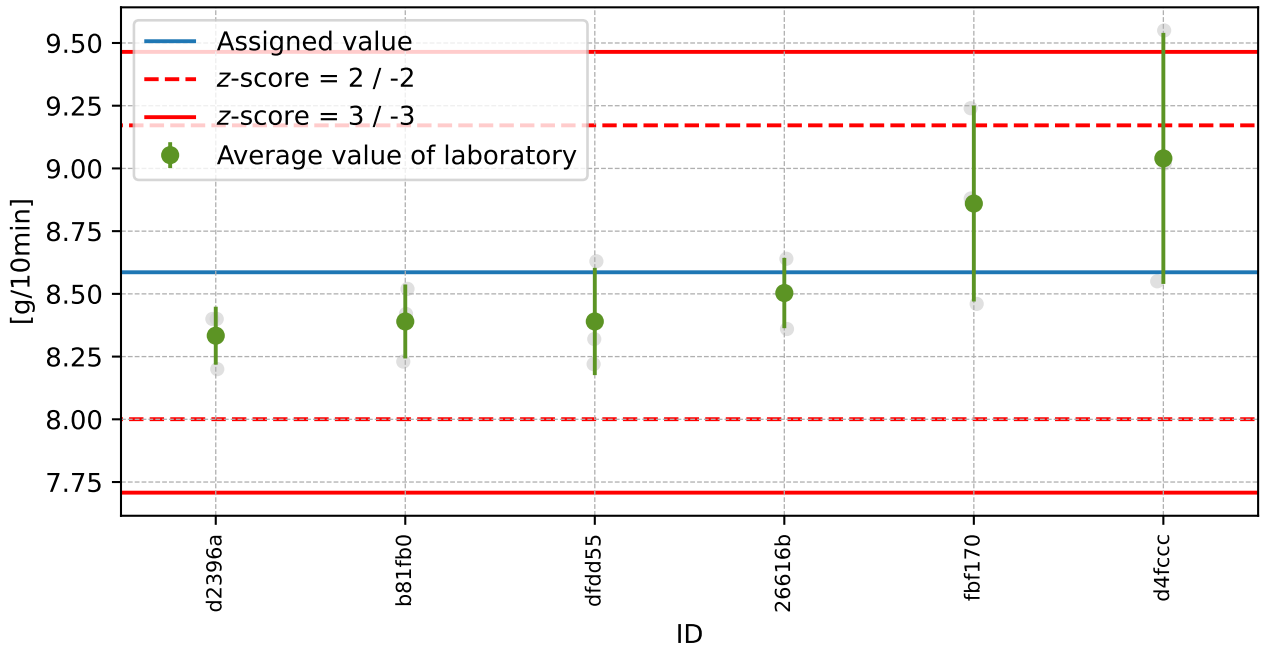

Figure 181: Average values and sample standard deviations

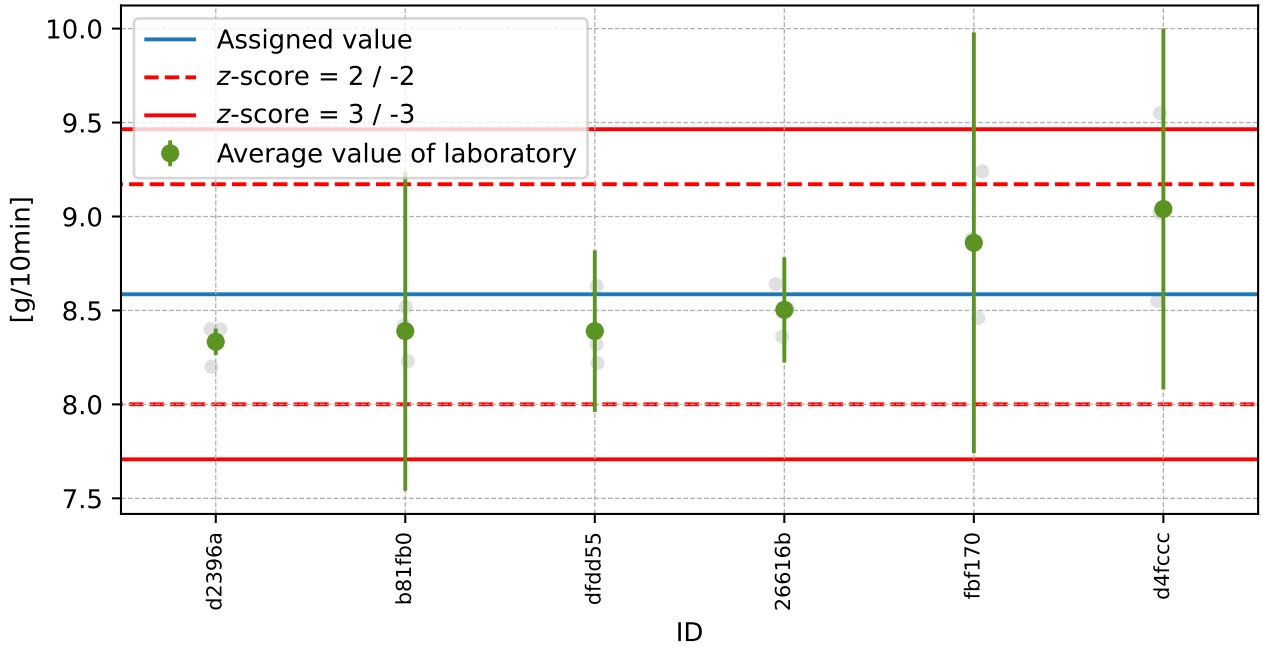

Figure 182: Average values and extended uncertainties of measurement

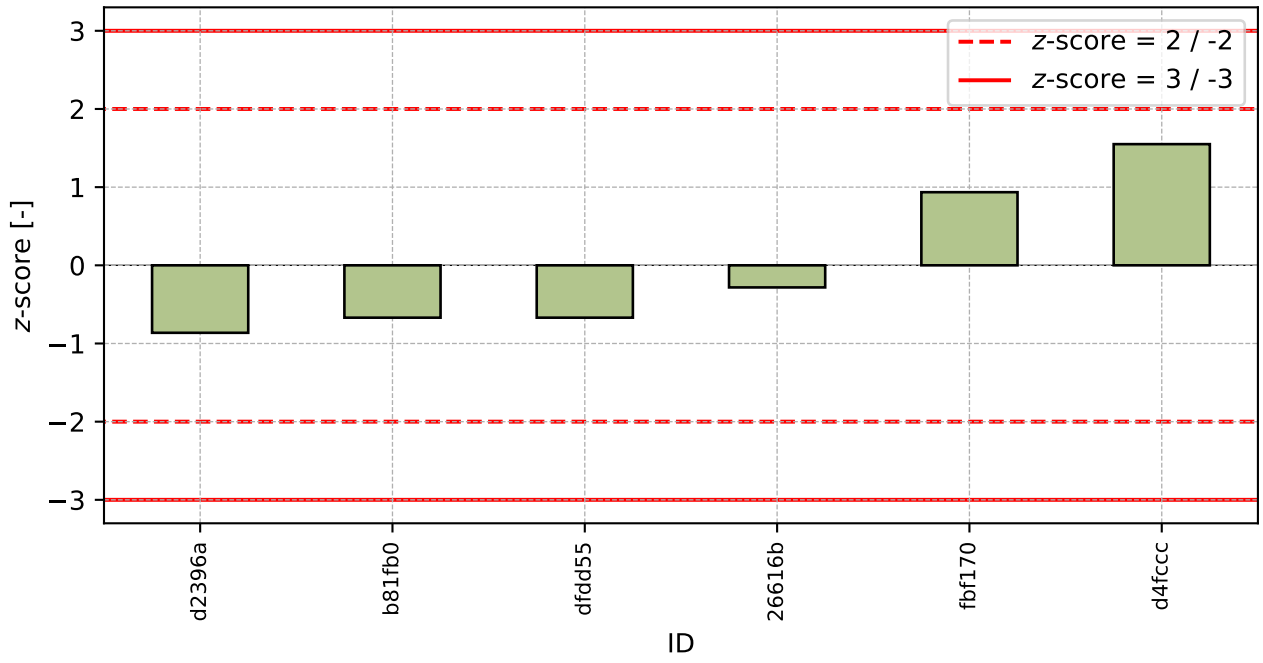

Figure 183: z-score

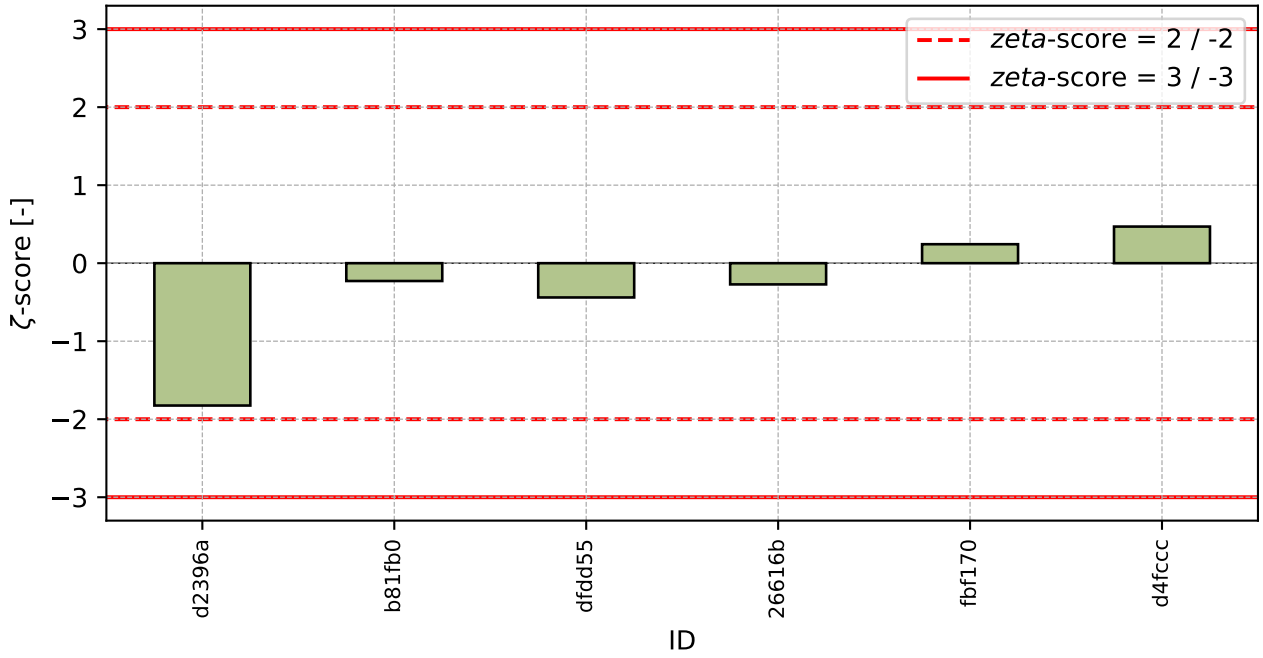

Figure 184: ζ-score

Table 63: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
d2396a	-0.86	-1.82
b81fb0	-0.67	-0.23
dfdd55	-0.67	-0.44
26616b	-0.28	-0.27
fbf170	0.94	0.24
d4fccc	1.55	0.47

17 Appendix – EN ISO 1628-1, -5 (Viscosity)

17.1 Sample A

17.1.1 Test results

Table 64: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [ml/g]	2 [ml/g]	3 [ml/g]	u_X [ml/g]	$\bar{x}$ [ml/g]	s_0 [ml/g]	V_X [%]
dfdd55	87.9	87.7	87.9	0.20	87.8	0.12	0.13
26616b	88.7	88.2	88.9	0.70	88.6	0.36	0.41
d2396a	89.8	93.6	91.9	1.10	91.8	1.90	2.07
d6aa79	91.2	92.7	91.9	2.00	91.9	0.75	0.82

17.1.2 The Numerical Procedure for Determining Outliers

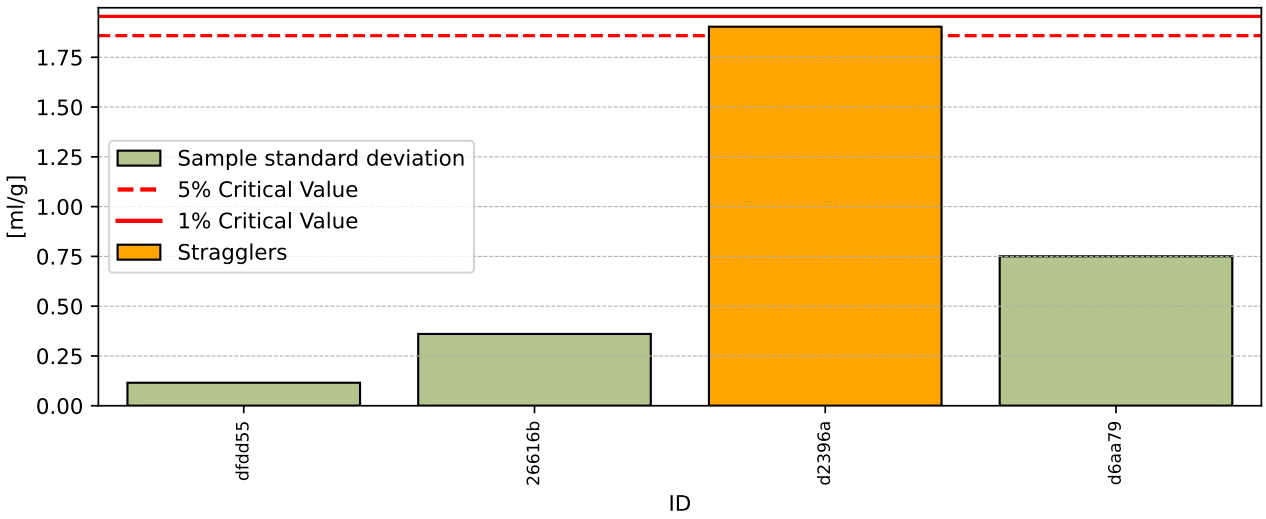

Figure 185: **Cochran's test** - sample standard deviations

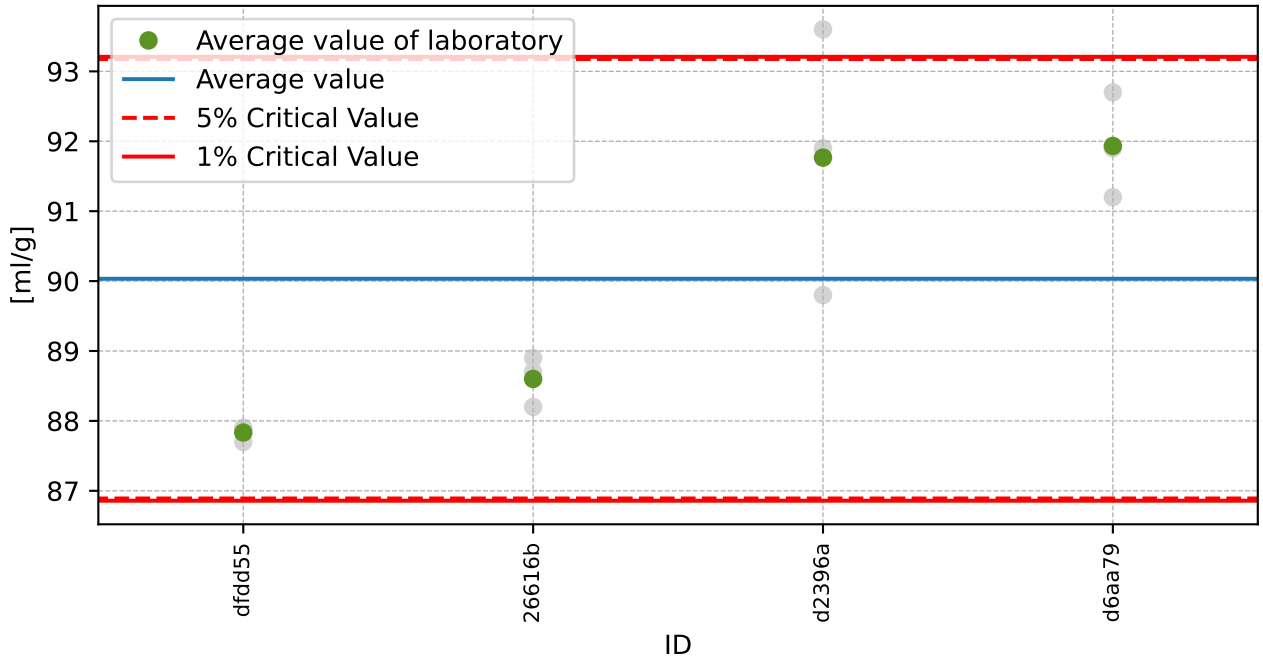

Figure 186: **Grubbs' test** - average values

17.1.3 Mandel's Statistics

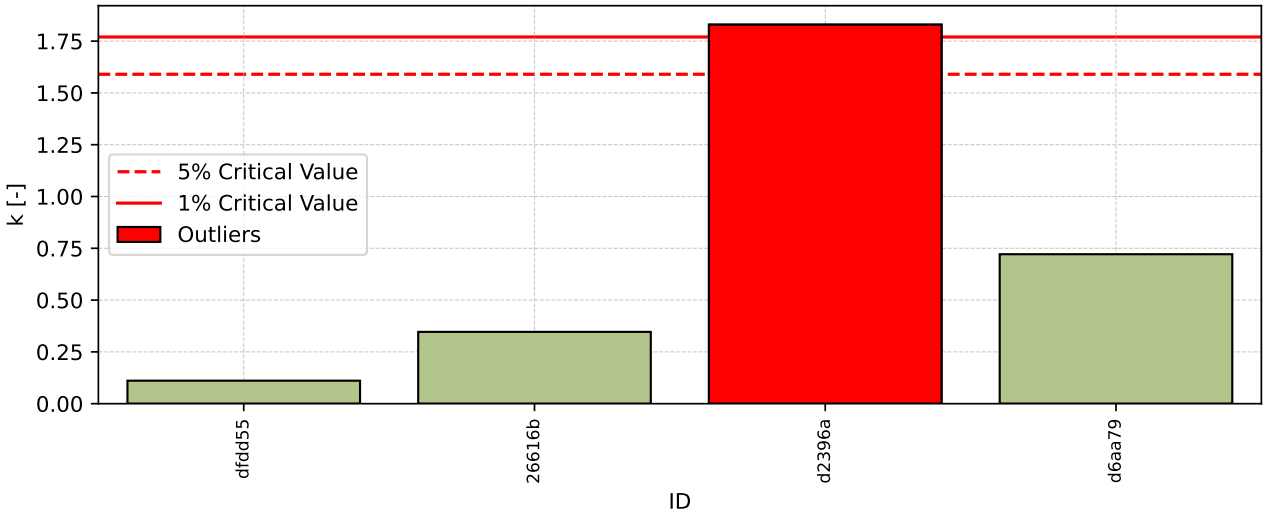

Figure 187: Intralaboratory Consistency Statistic

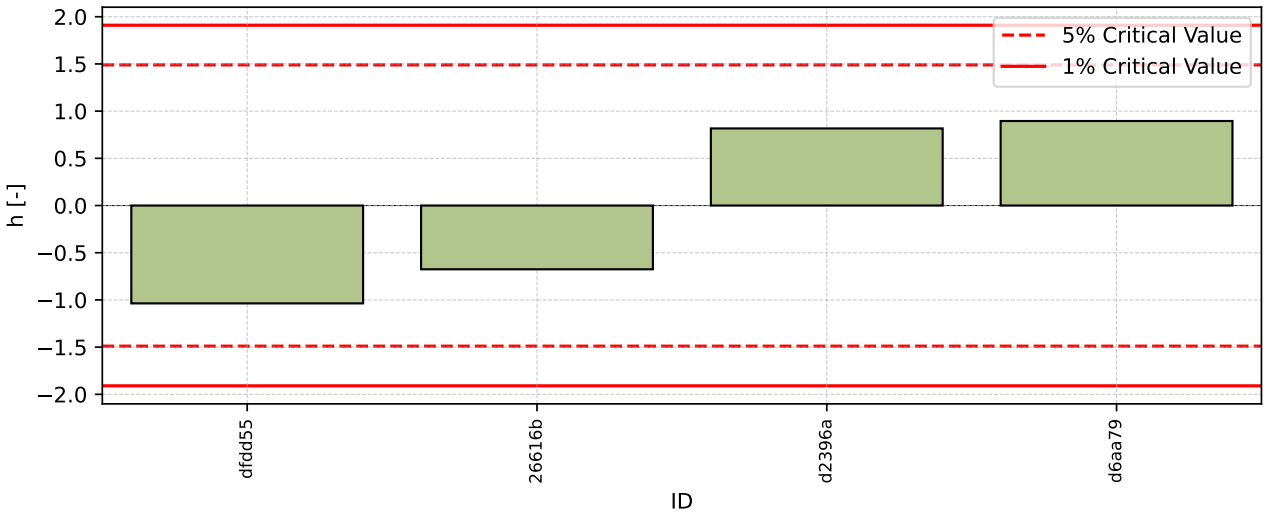

Figure 188: Interlaboratory Consistency Statistic

17.1.4 Descriptive statistics

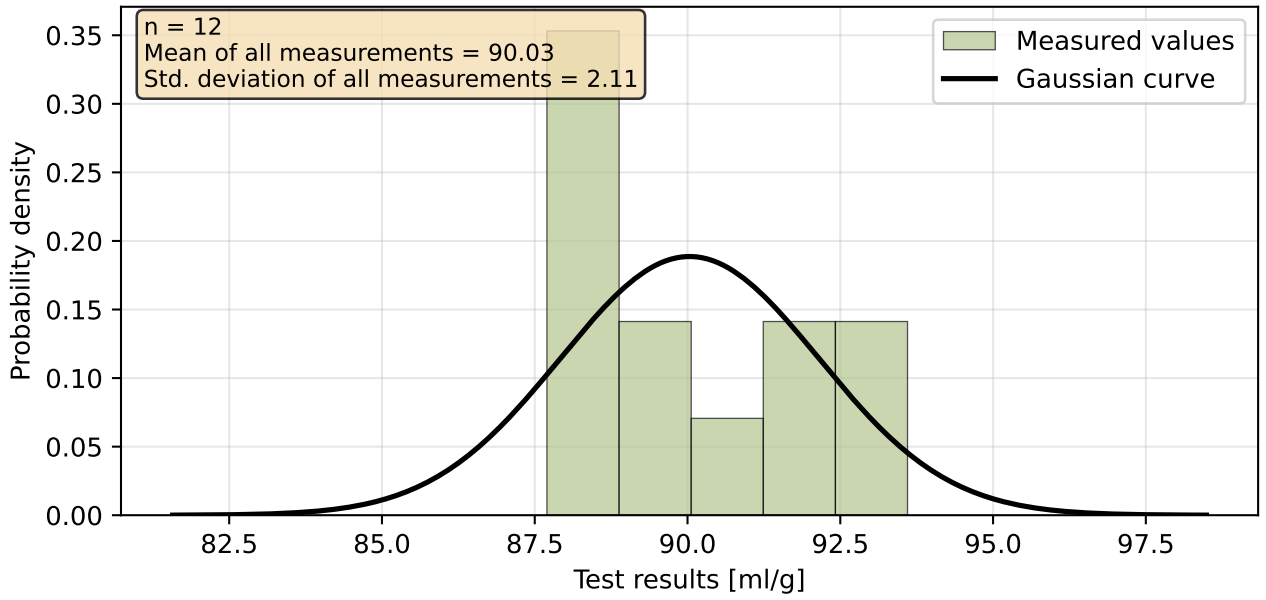

Figure 189: Histogram of all test results

Table 65: Descriptive statistics

Characteristics	[ml/g]
Average value – $\bar{x}$	90.03
Sample standard deviation – s	2.12
Assigned value – x^*	90.03
Robust standard deviation – s^*	2.12
Measurement uncertainty of assigned value – u_X	1.06
p-value of normality test [-]	0.112
Interlaboratory standard deviation – s_L	2.04
Repeatability standard deviation – s_r	1.04
Reproducibility standard deviation – s_R	2.29
Repeatability – r	2.91
Reproducibility – R	6.40

17.1.5 Evaluation of Performance Statistics

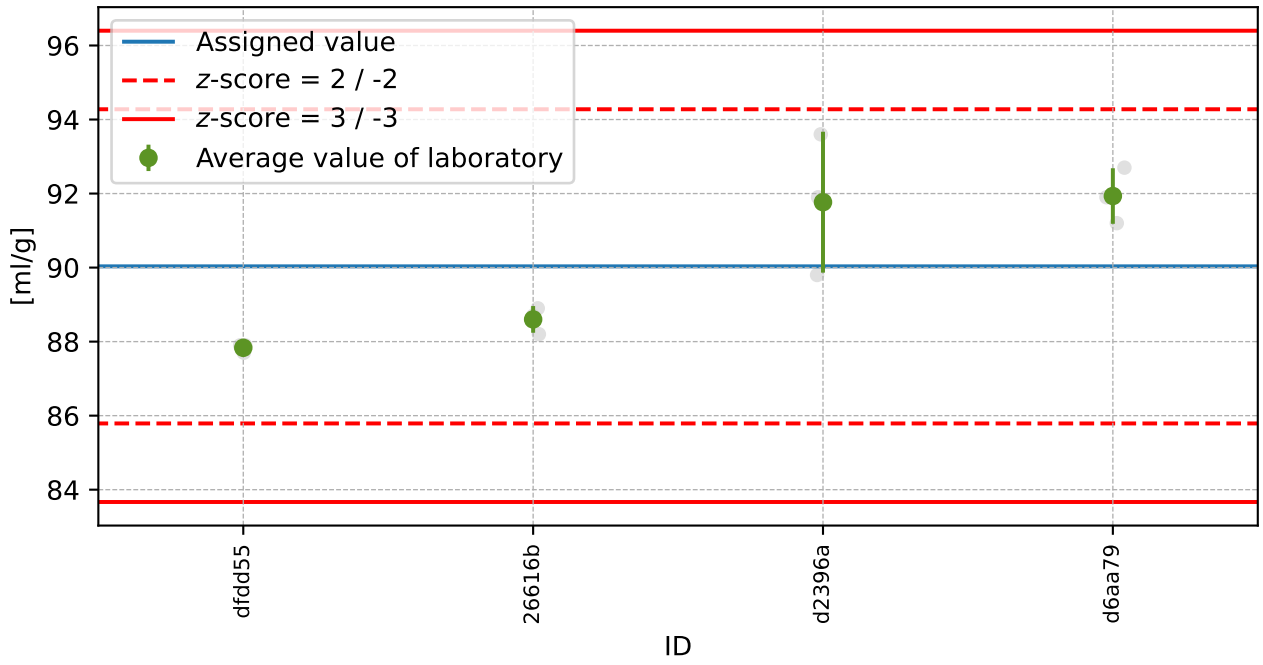

Figure 190: Average values and sample standard deviations

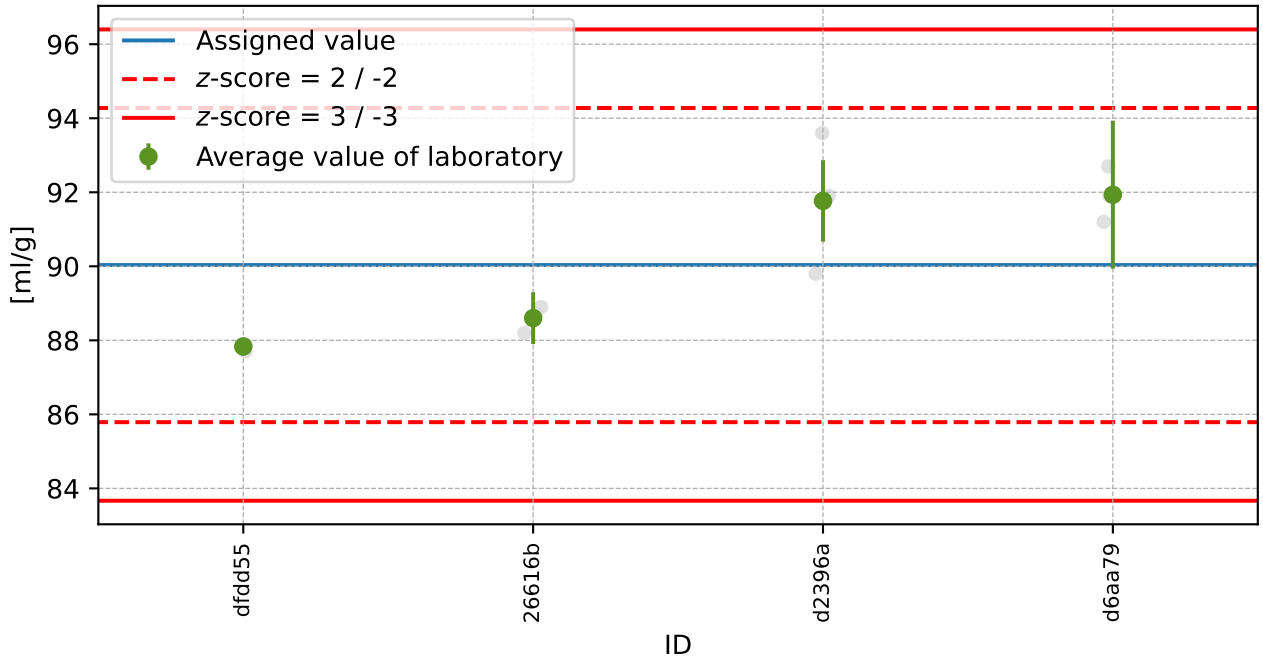

Figure 191: Average values and extended uncertainties of measurement

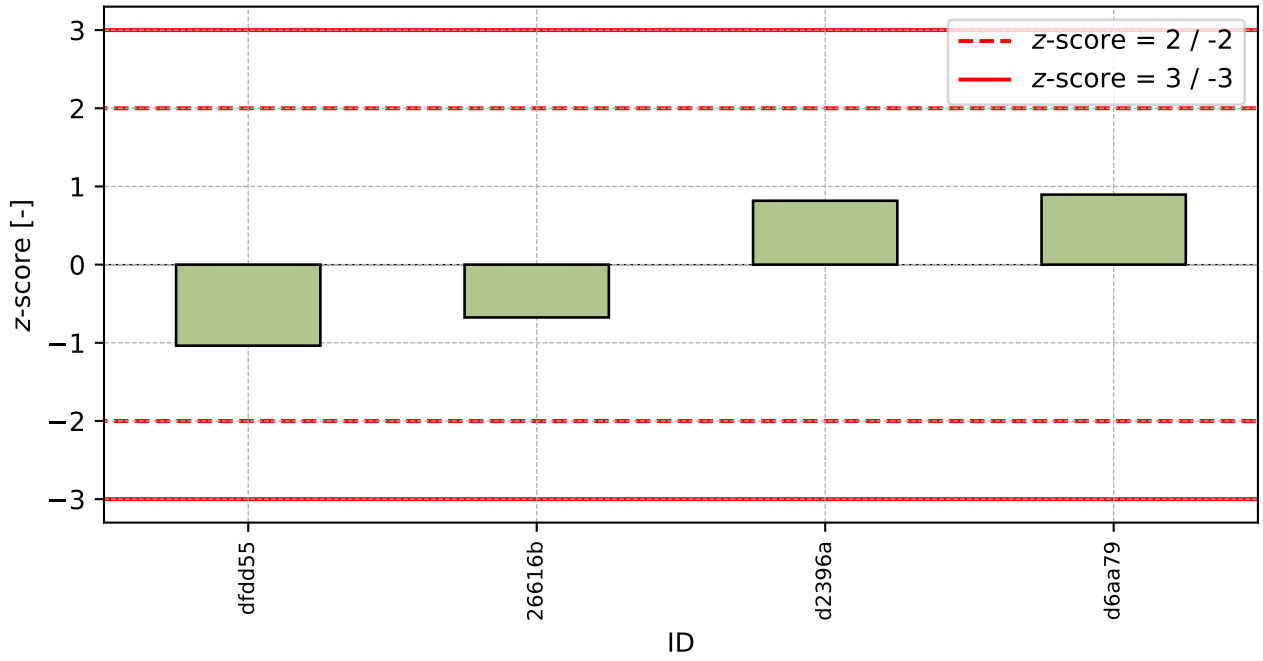

Figure 192: z-score

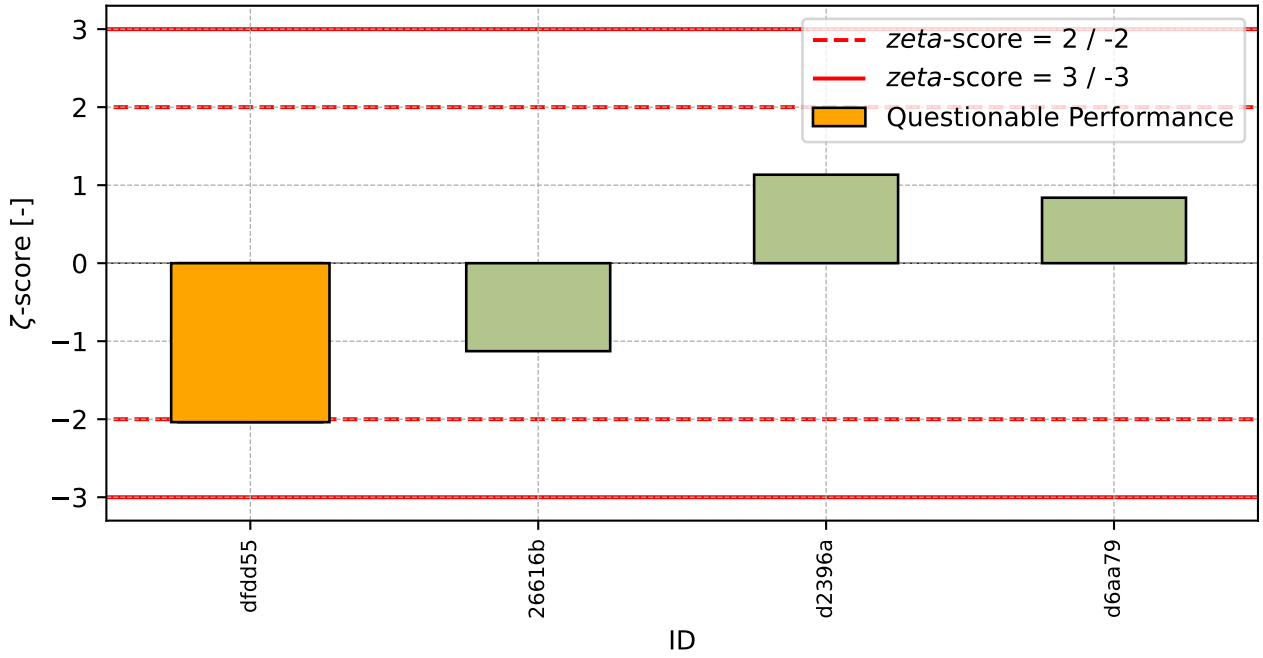

Figure 193: ζ-score

Table 66: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dfdd55	-1.04	-2.04
26616b	-0.68	-1.13
d2396a	0.82	1.13
d6aa79	0.90	0.84

17.2 Sample B

17.2.1 Test results

Table 67: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [ml/g]	2 [ml/g]	3 [ml/g]	u_X [ml/g]	$\bar{x}$ [ml/g]	s_0 [ml/g]	V_X [%]
26616b	84.7	84.9	84.8	0.20	84.8	0.10	0.12
dfdd55	85.6	85.9	85.9	0.30	85.8	0.17	0.20
d6aa79	87.5	87.4	87.4	2.00	87.4	0.06	0.07
d2396a	91.0	92.1	92.3	0.40	92.2	0.14	0.15

17.2.2 The Numerical Procedure for Determining Outliers

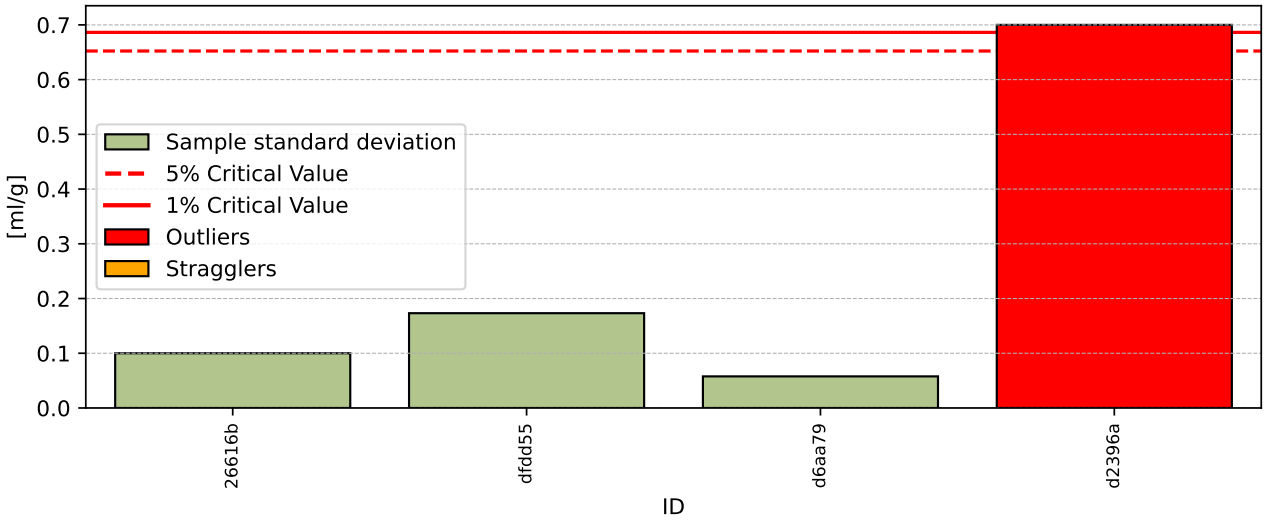

Figure 194: **Cochran's test** - sample standard deviations

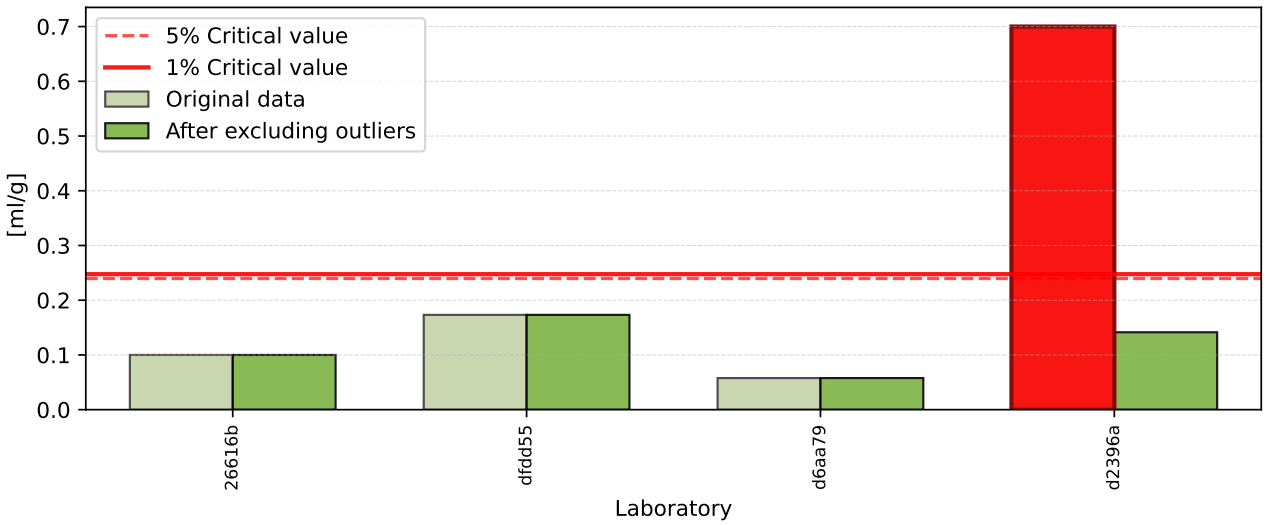

Figure 195: **Cochran's test** - sample standard deviations without outliers

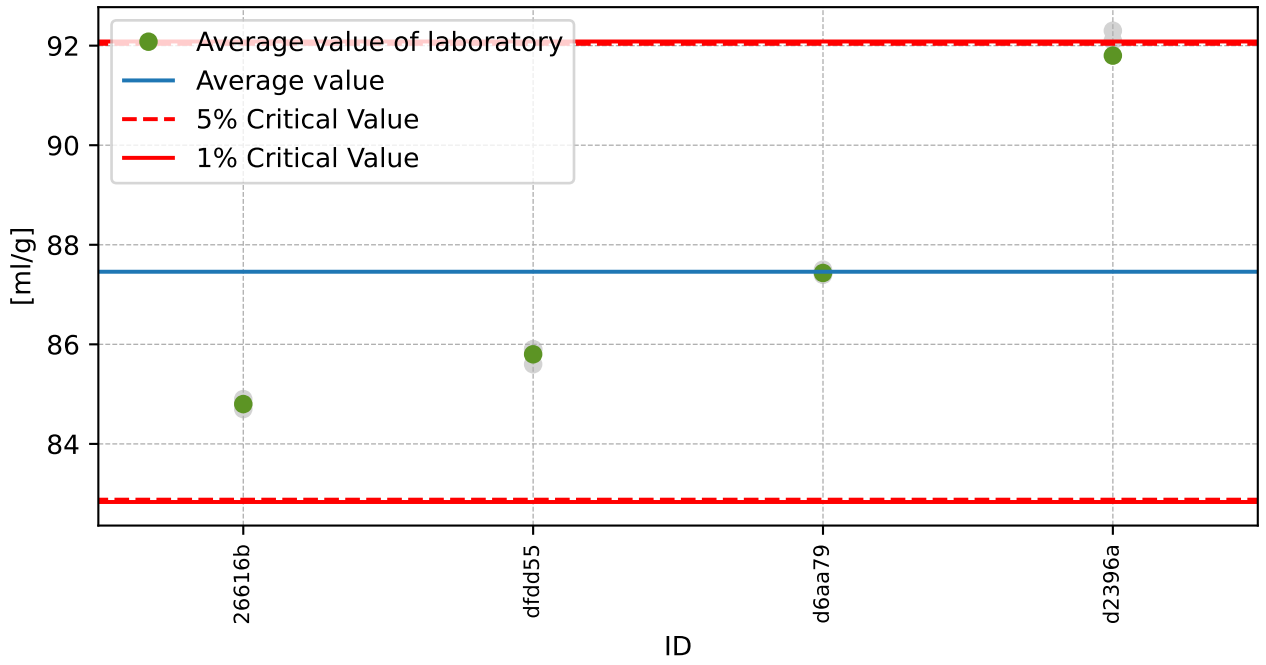

Figure 196: **Grubbs' test** - average values

17.2.3 Mandel's Statistics

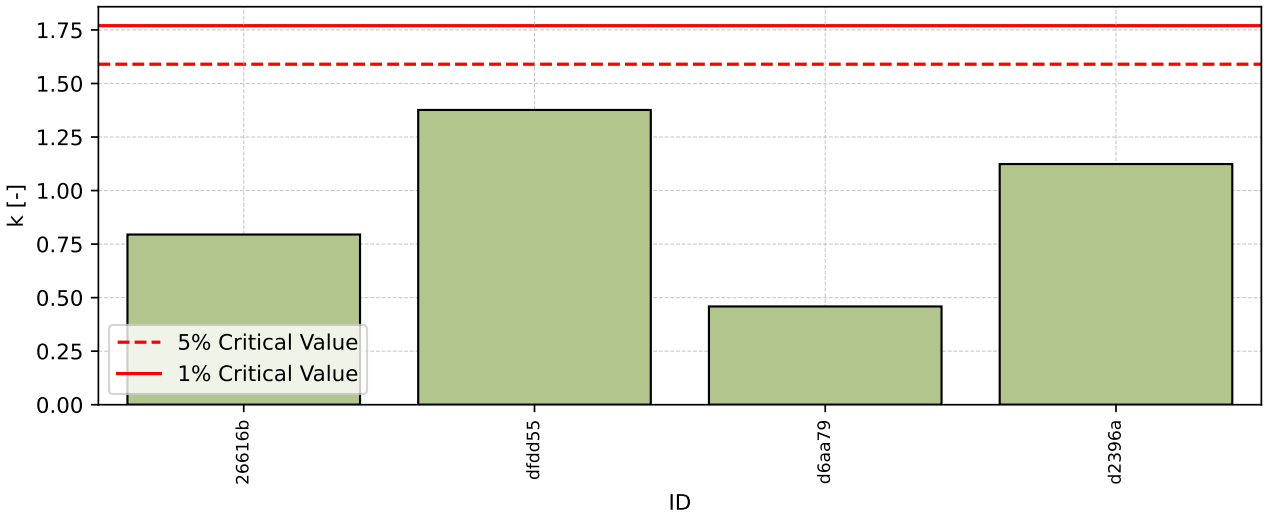

Figure 197: Intralaboratory Consistency Statistic

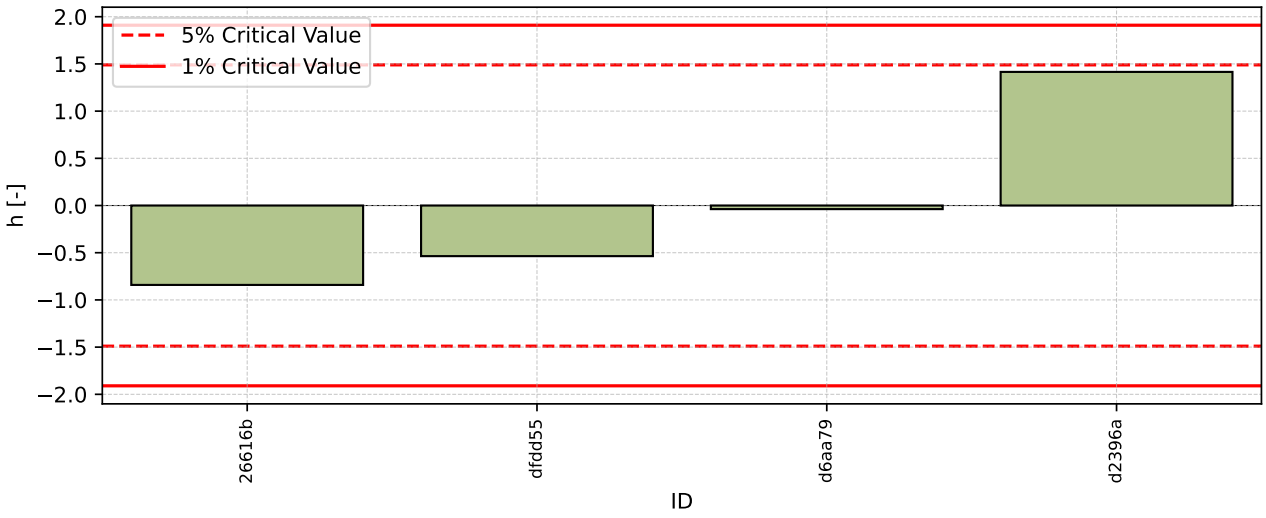

Figure 198: Interlaboratory Consistency Statistic

17.2.4 Descriptive statistics

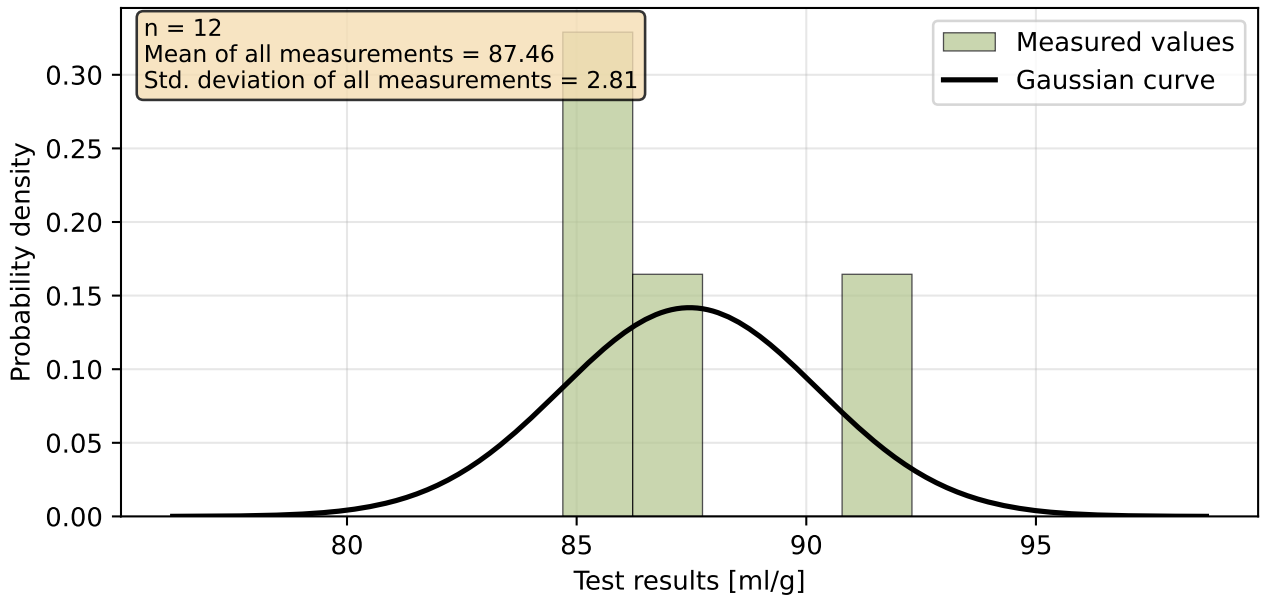

Figure 199: Histogram of all test results

Table 68: Descriptive statistics

Characteristics	[ml/g]
Average value – $\bar{x}$	87.56
Sample standard deviation – s	3.28
Assigned value – x^*	87.56
Robust standard deviation – s^*	3.28
Measurement uncertainty of assigned value – u_X	1.64
p-value of normality test [-]	0.021
Interlaboratory standard deviation – s_L	3.28
Repeatability standard deviation – s_r	0.13
Reproducibility standard deviation – s_R	3.28
Repeatability – r	0.35
Reproducibility – R	9.19

17.2.5 Evaluation of Performance Statistics

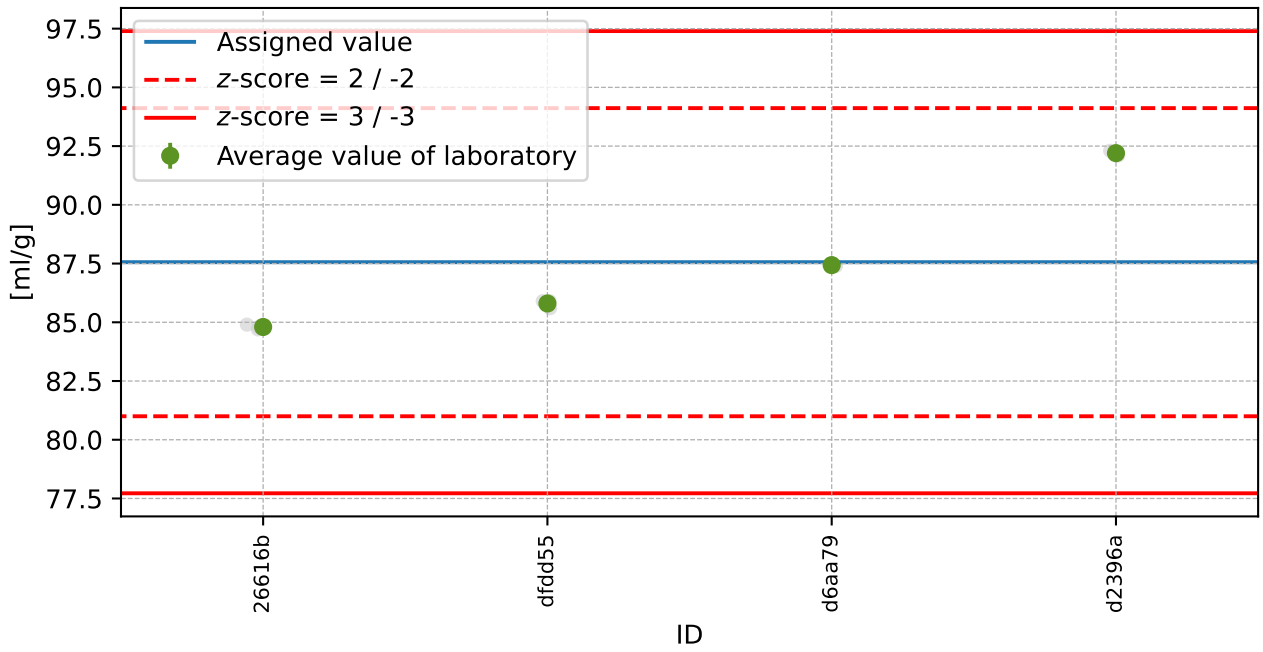

Figure 200: Average values and sample standard deviations

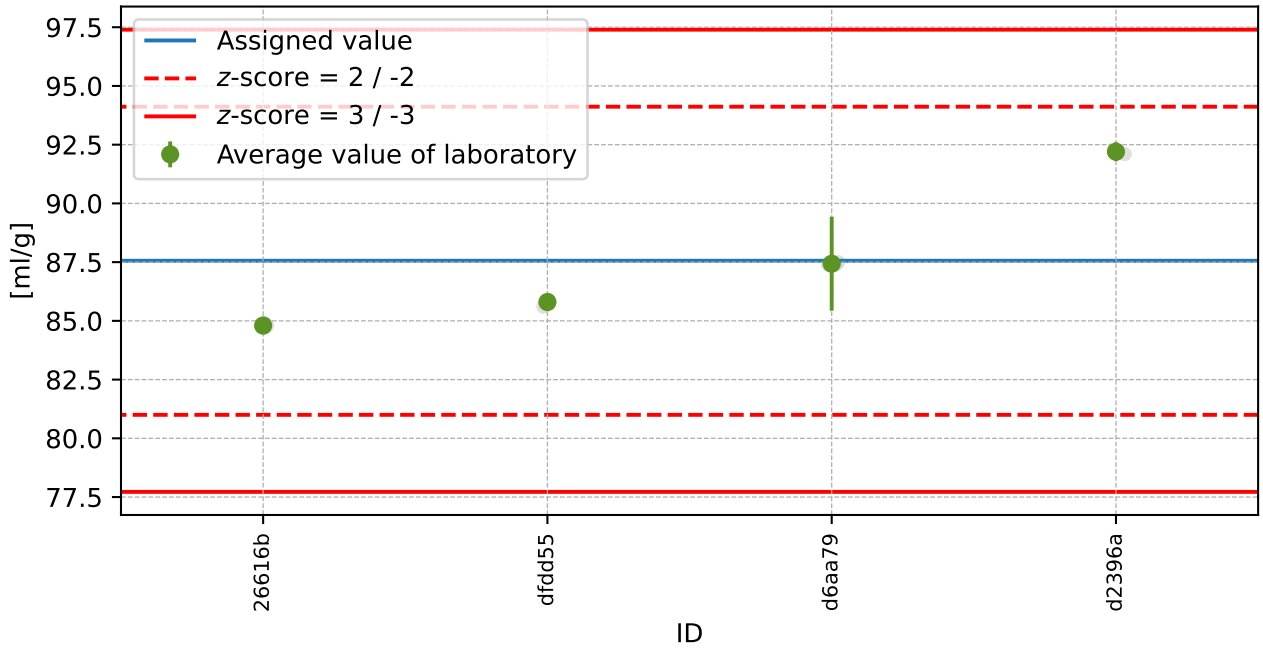

Figure 201: Average values and extended uncertainties of measurement

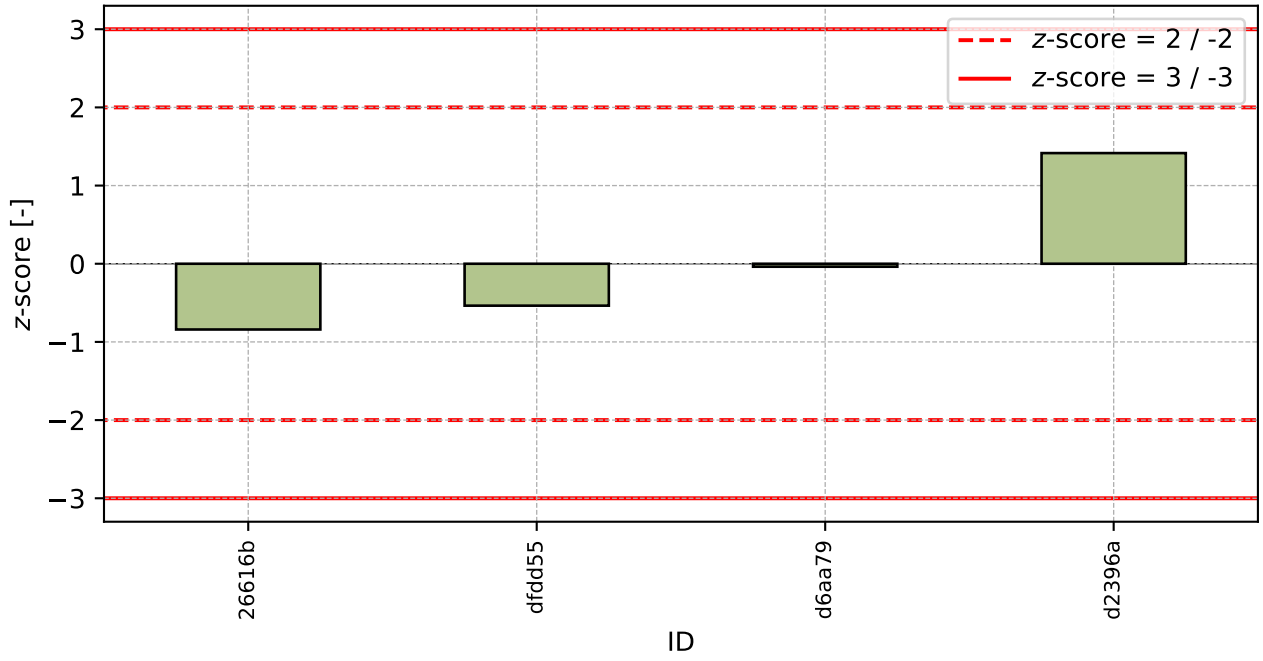

Figure 202: z-score

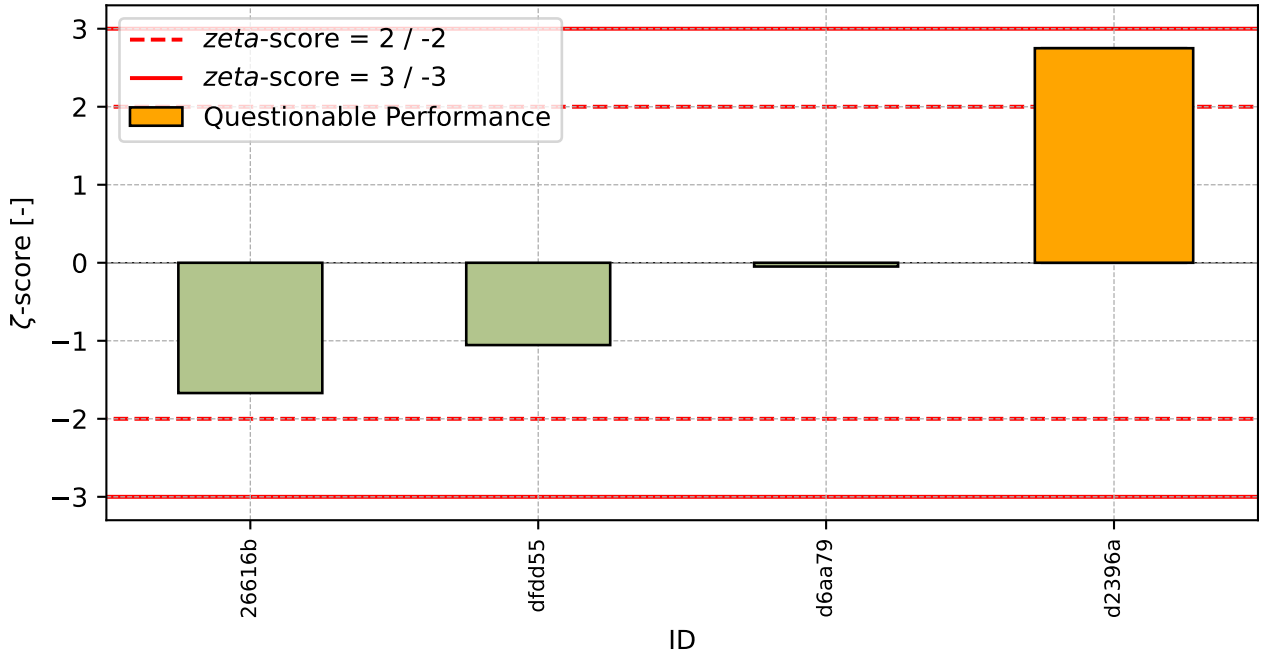

Figure 203: ζ-score

Table 69: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
26616b	-0.84	-1.67
dfdd55	-0.54	-1.05
d6aa79	-0.04	-0.05
d2396a	1.42	2.75

18 Appendix – EN ISO 11358-1 (Filler content)

18.1 Sample A

18.1.1 Test results

Table 70: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [%]	2 [%]	3 [%]	u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d5e138	31.31	31.31	31.35	0.030	31.32	0.023	0.07
b81fb0	31.30	31.40	31.30	0.100	31.33	0.058	0.18
dfdd55	32.22	32.21	32.05	0.110	32.22	0.007	0.02
26616b	32.37	32.93	32.60	0.300	32.60	-	-
8d26a1	67.64	-	-	-	67.64	-	-

18.1.2 The Numerical Procedure for Determining Outliers

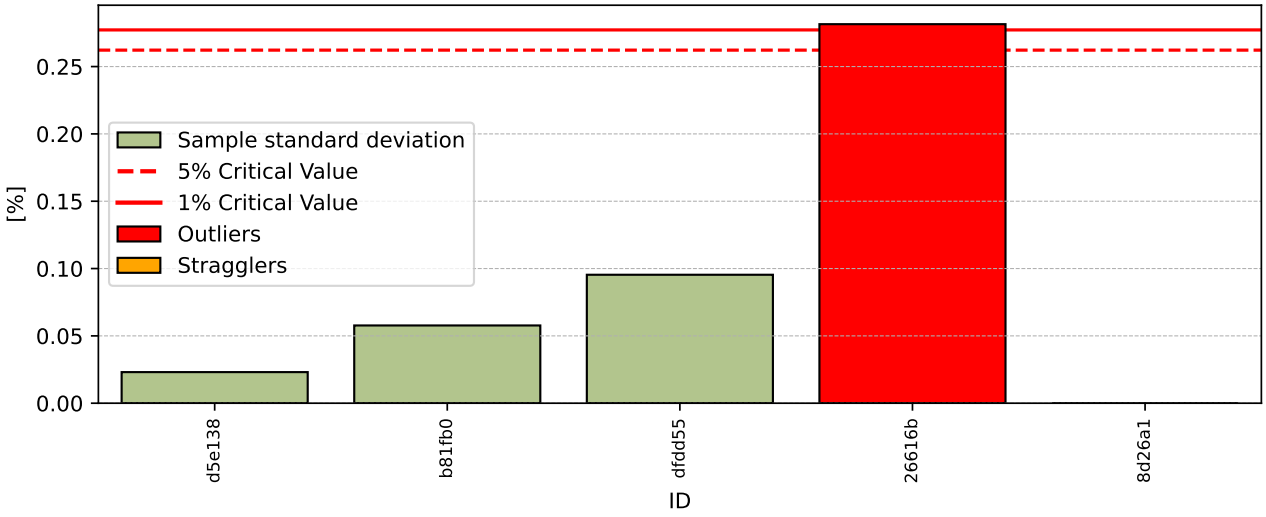

Figure 204: **Cochran's test** - sample standard deviations

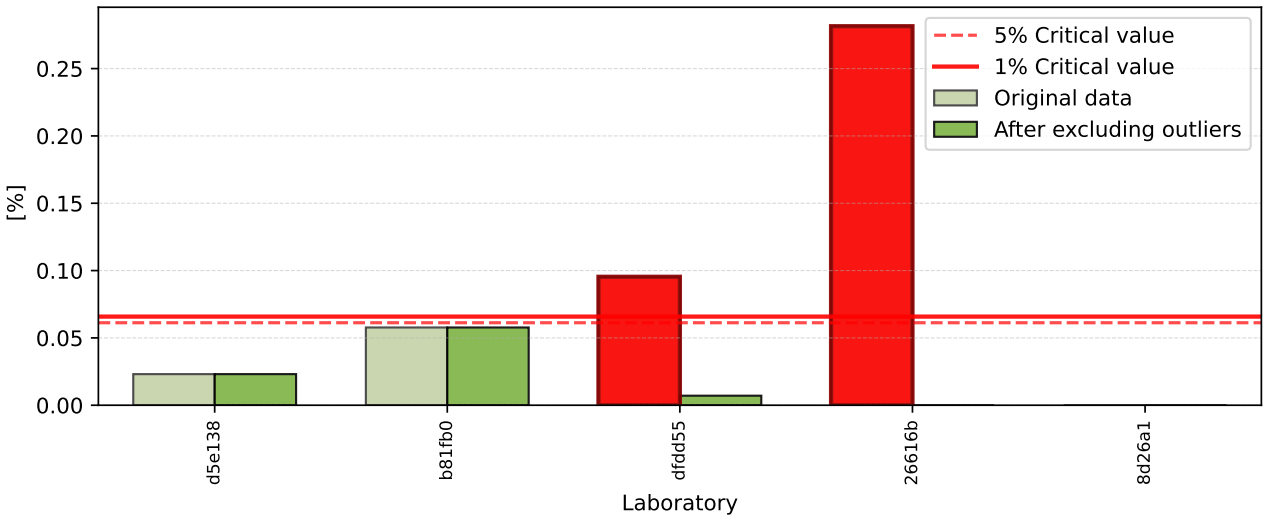

Figure 205: **Cochran's test** - sample standard deviations without outliers

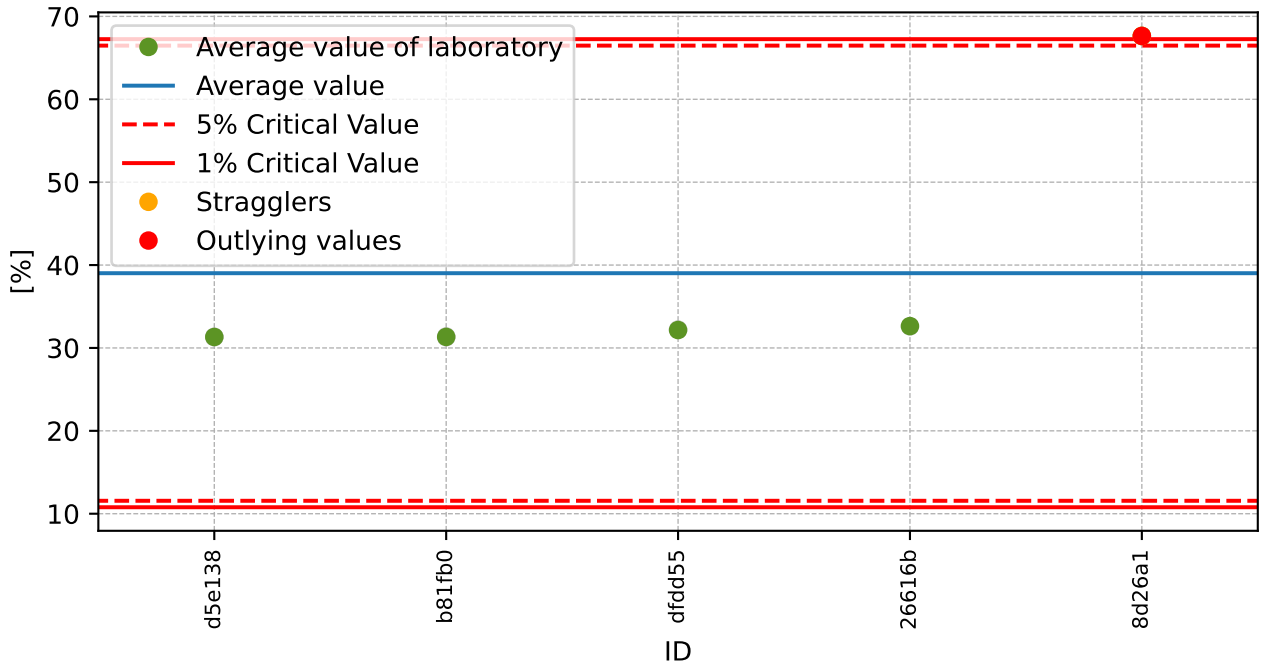

Figure 206: **Grubbs' test** - average values

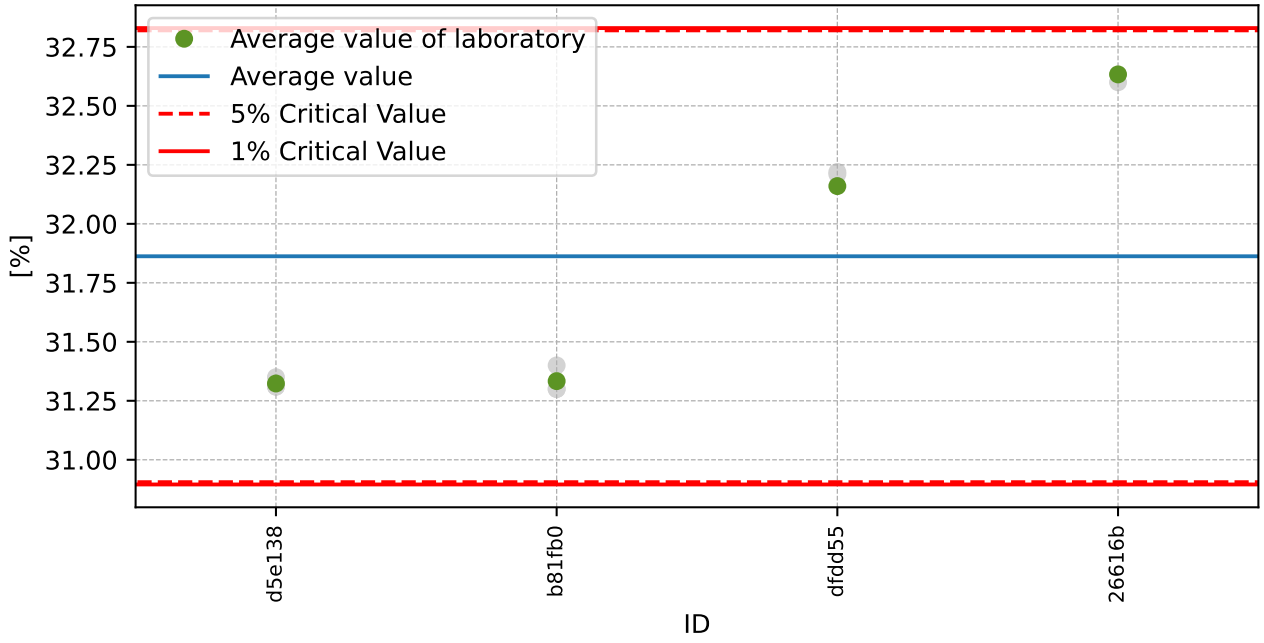

Figure 207: **Grubbs' test** - average values without outliers

18.1.3 Mandel's Statistics

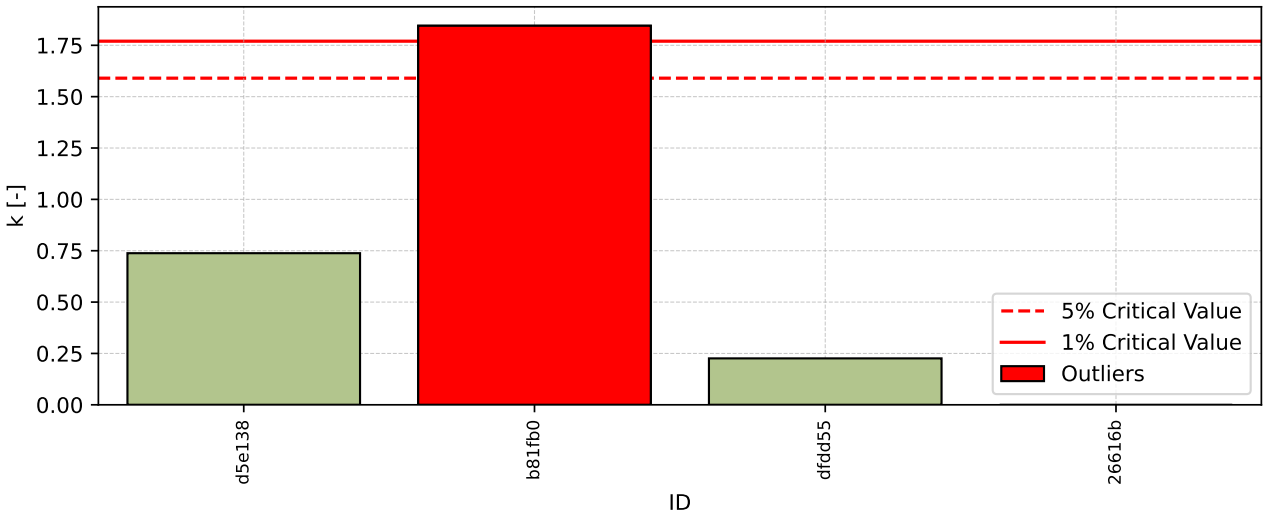

Figure 208: Intralaboratory Consistency Statistic

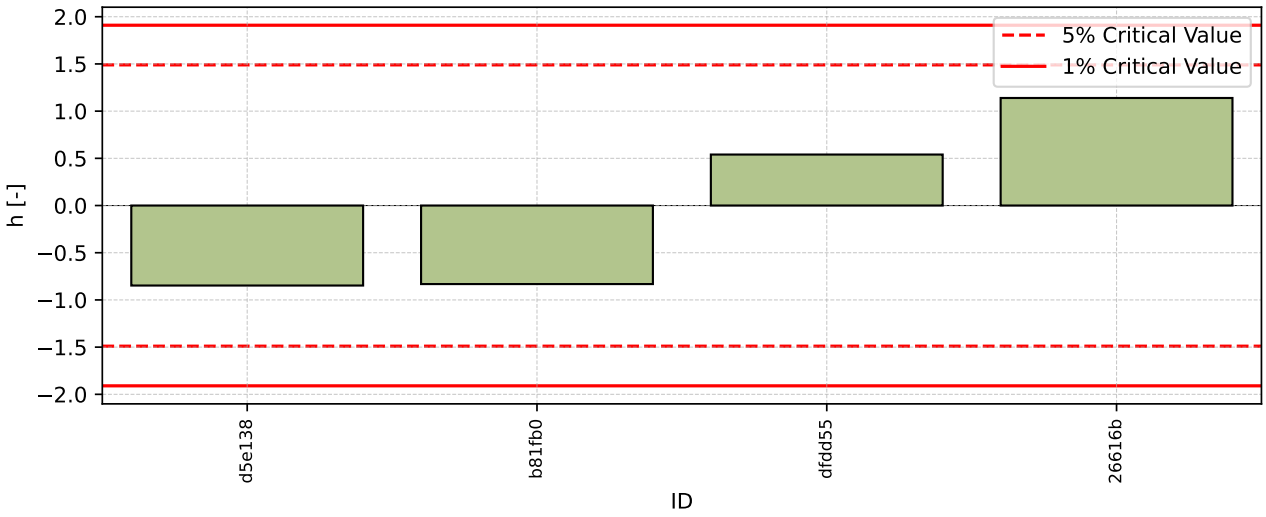

Figure 209: Interlaboratory Consistency Statistic

18.1.4 Descriptive statistics

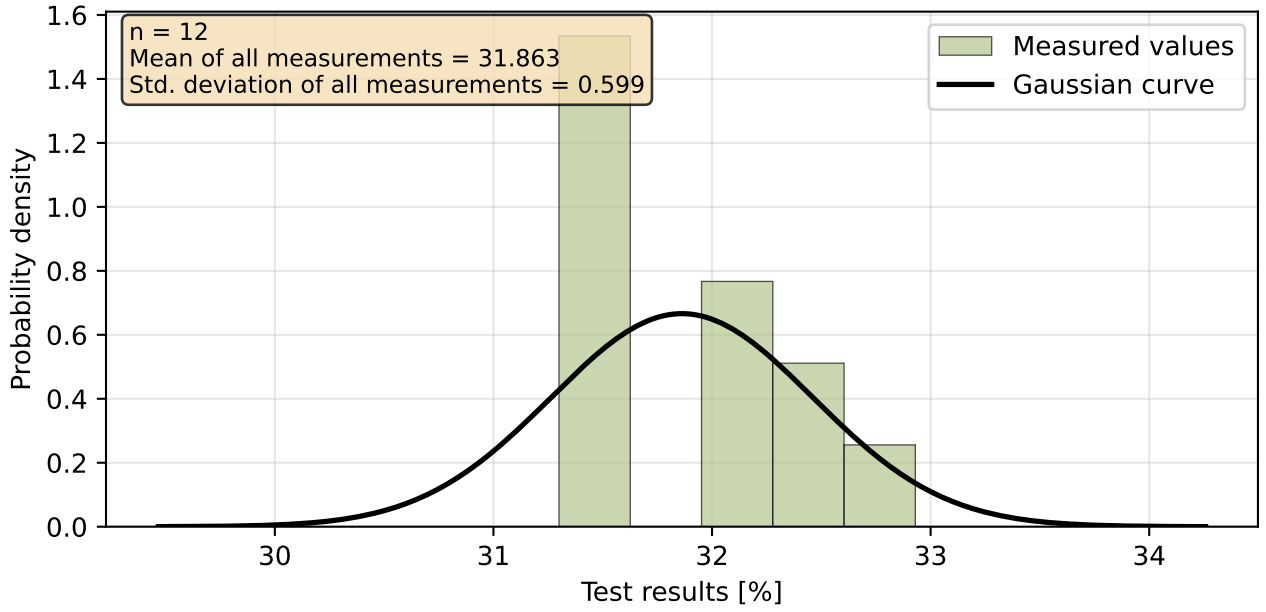

Figure 210: Histogram of all test results

Table 71: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	31.868
Sample standard deviation – s	0.643
Assigned value – x^*	31.868
Robust standard deviation – s^*	0.643
Measurement uncertainty of assigned value – u_X	0.321
p-value of normality test [-]	0.025

18.1.5 Evaluation of Performance Statistics

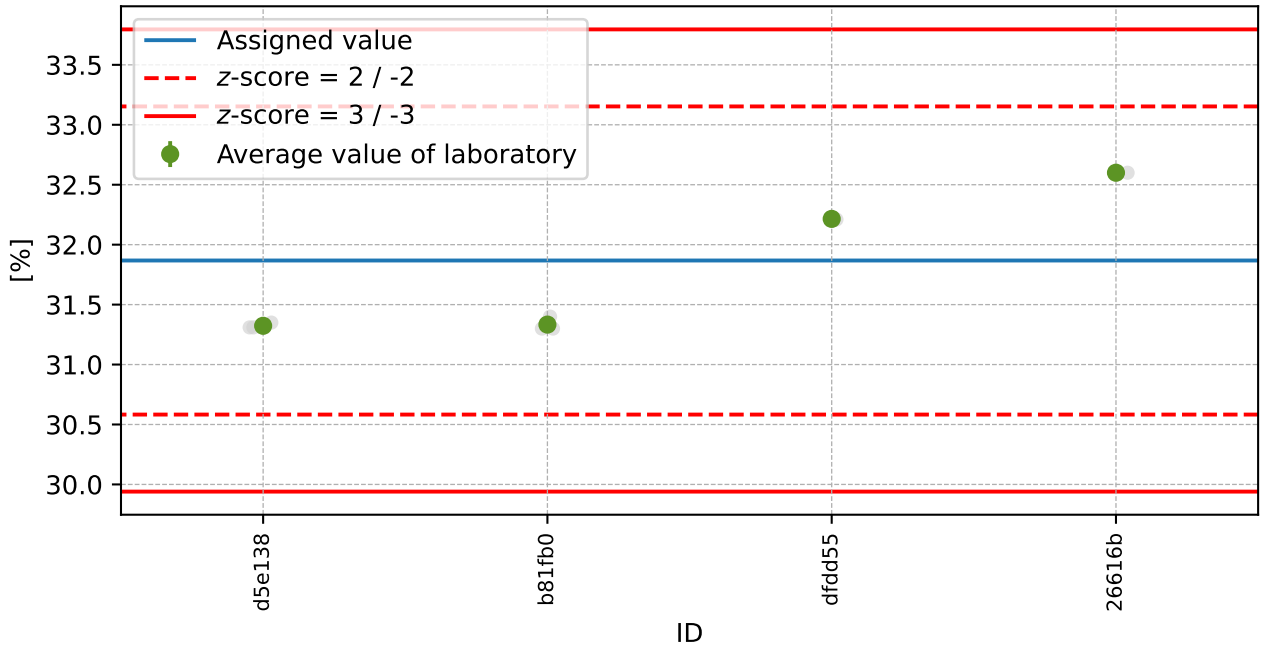

Figure 211: Average values and sample standard deviations

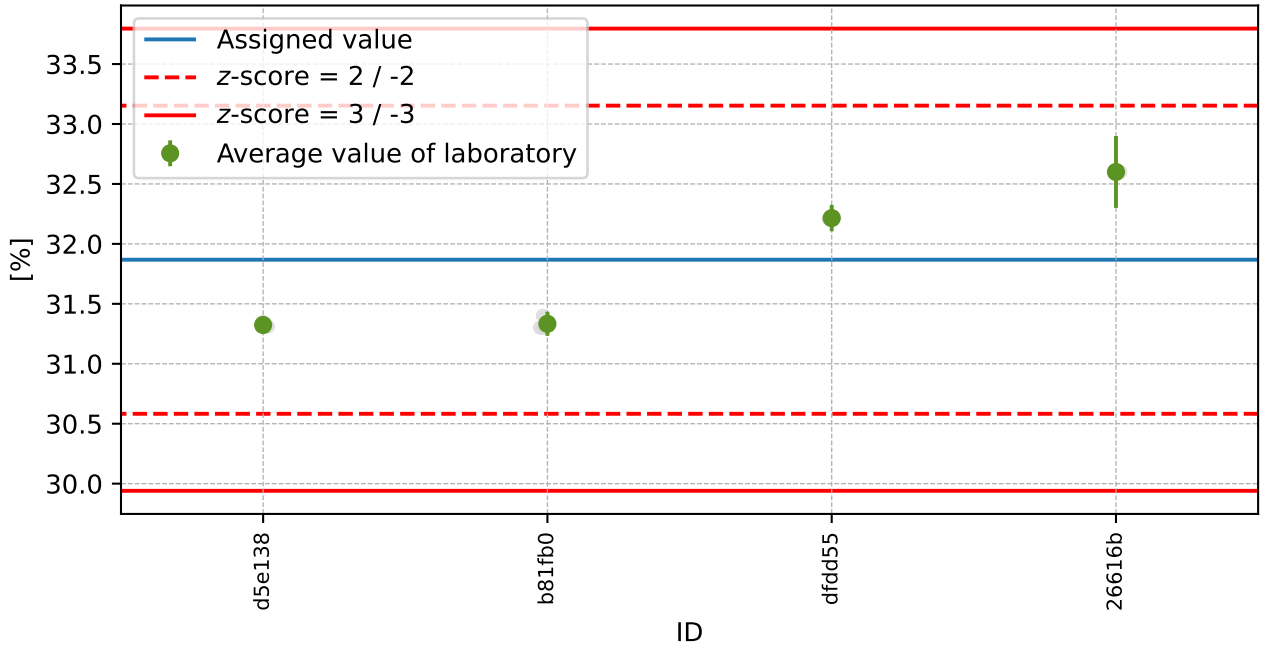

Figure 212: Average values and extended uncertainties of measurement

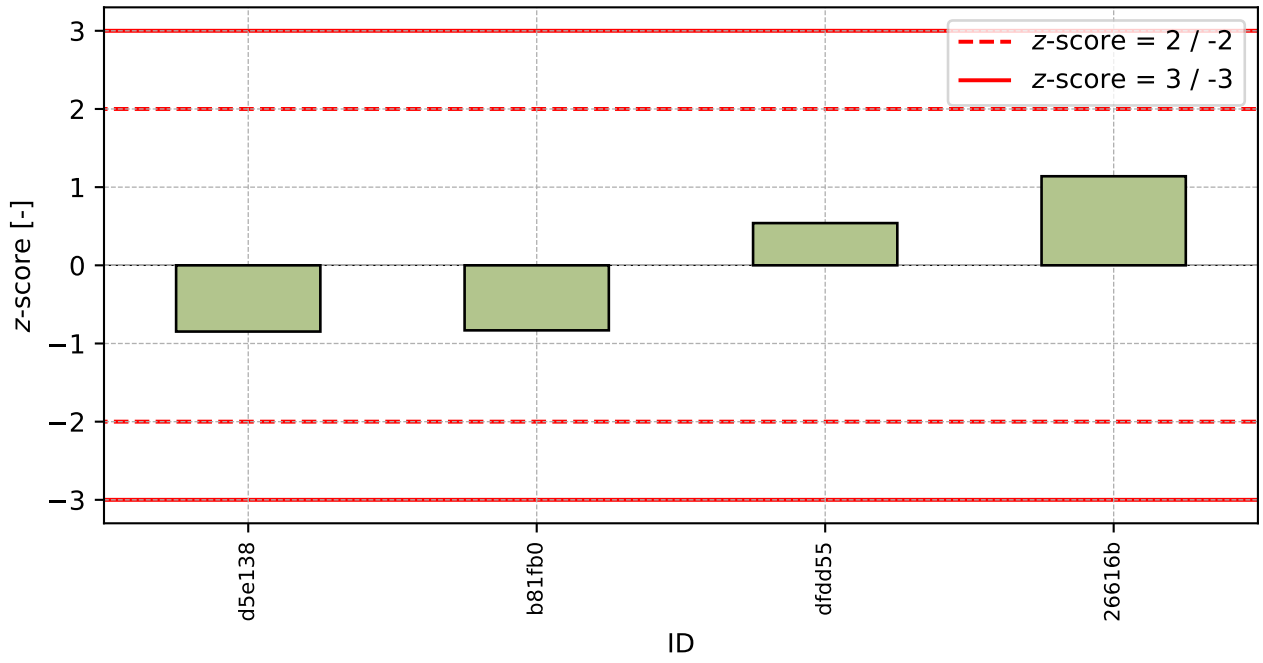

Figure 213: z-score

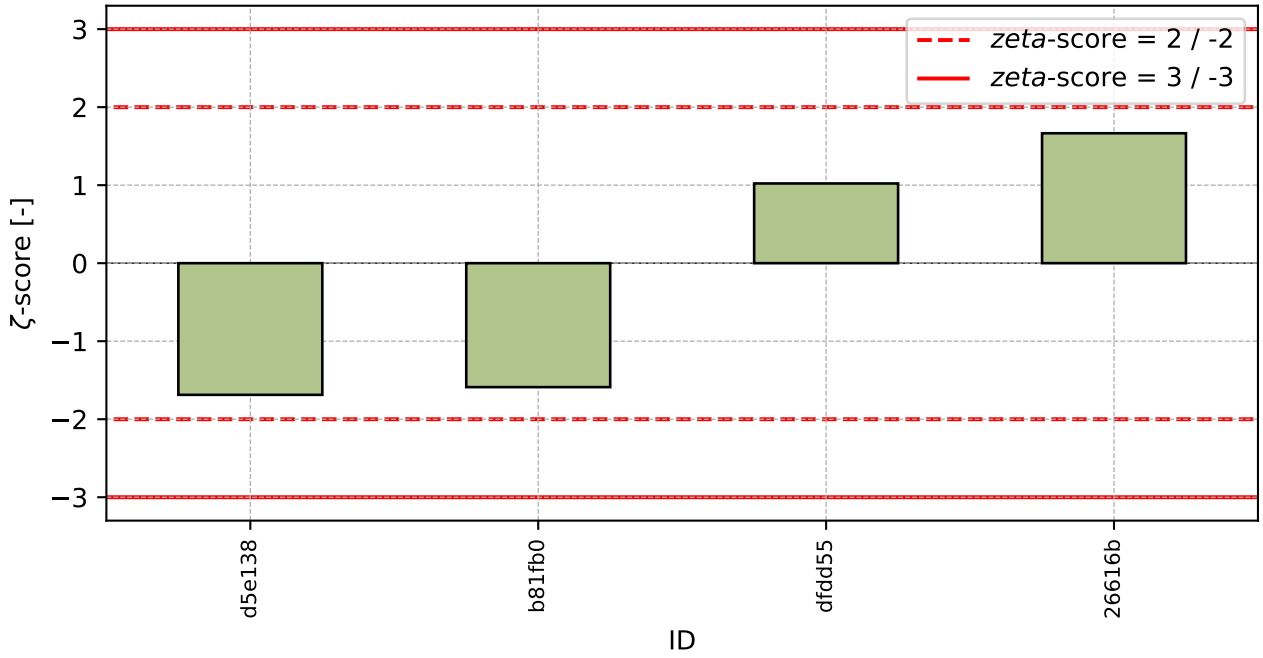

Figure 214: ζ-score

Table 72: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d5e138	-0.85	-1.69
b81fb0	-0.83	-1.59
dfdd55	0.54	1.02
26616b	1.14	1.67

18.2 Sample B

18.2.1 Test results

Table 73: Test results – ordered by average value. Outliers are marked by red color. Columns 1–3 are individual determinations; u_X – extended uncertainty of measurement; $\bar{x}$ – average value; s_0 – sample standard deviation; V_X – variation coefficient

ID	1 [%]	2 [%]	3 [%]	u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
8d26a1	49.46	-	-	-	49.46	-	-
b81fb0	50.30	50.30	50.20	0.200	50.27	0.058	0.11
d5e138	50.36	50.43	50.10	0.200	50.30	0.174	0.35
26616b	51.19	51.01	50.76	0.200	50.99	0.216	0.42
dfdd55	50.95	51.07	51.07	0.080	51.03	0.069	0.14

18.2.2 The Numerical Procedure for Determining Outliers

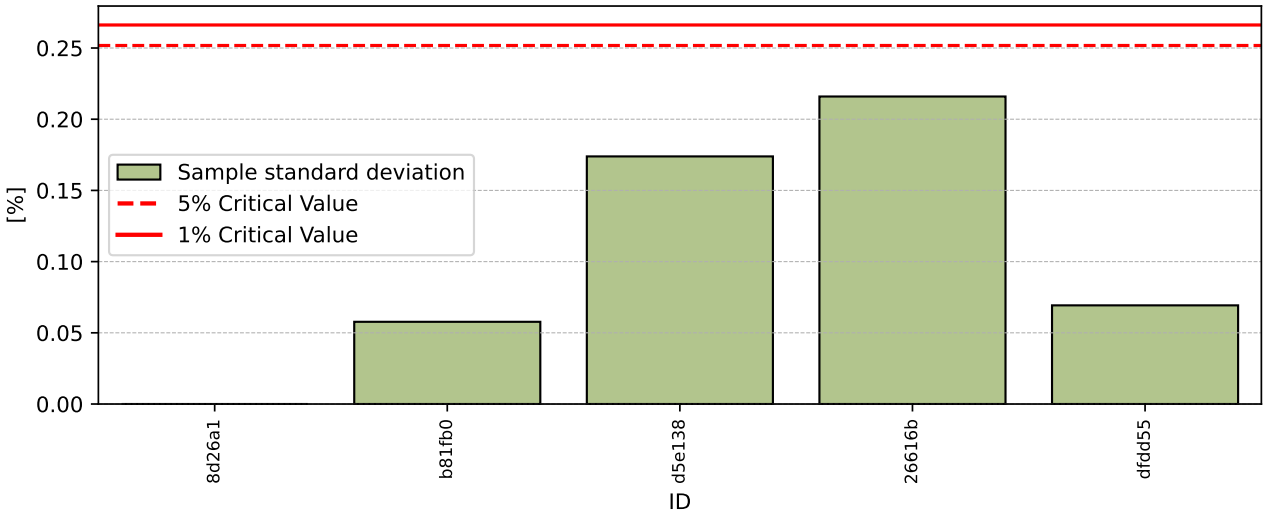

Figure 215: **Cochran's test** - sample standard deviations

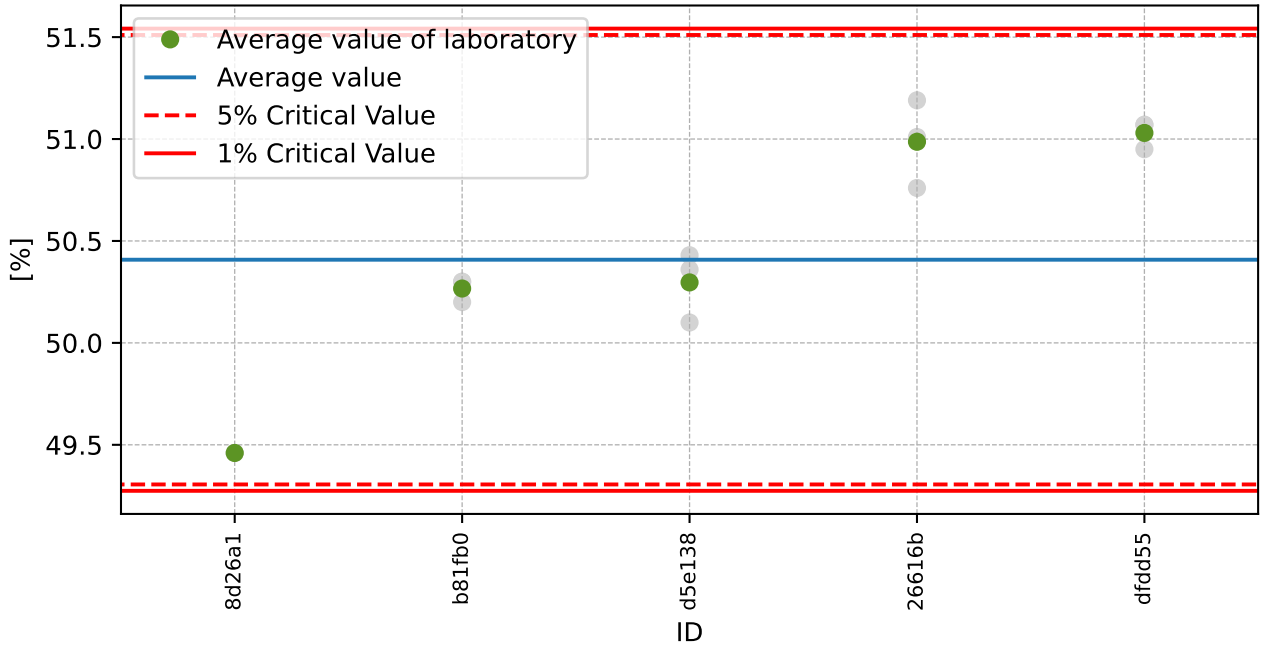

Figure 216: **Grubbs' test** - average values

18.2.3 Mandel's Statistics

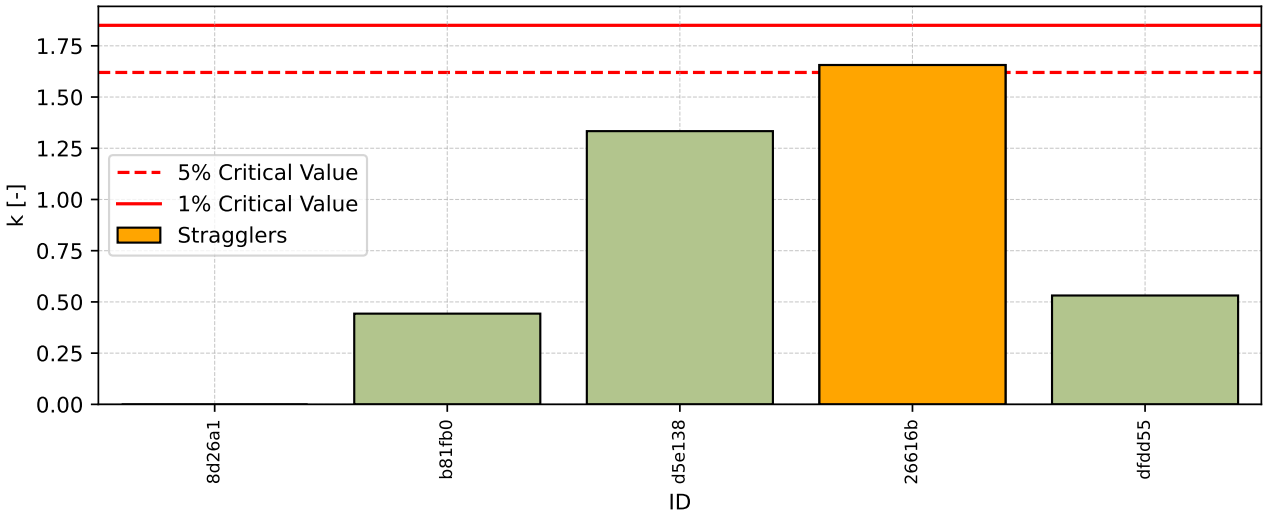

Figure 217: Intralaboratory Consistency Statistic

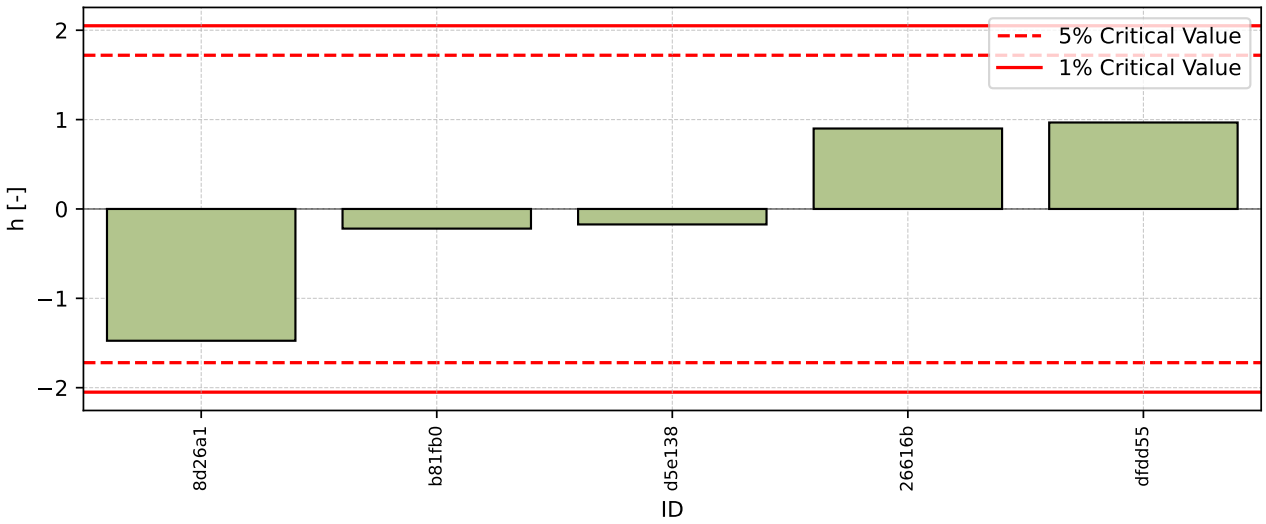

Figure 218: Interlaboratory Consistency Statistic

18.2.4 Descriptive statistics

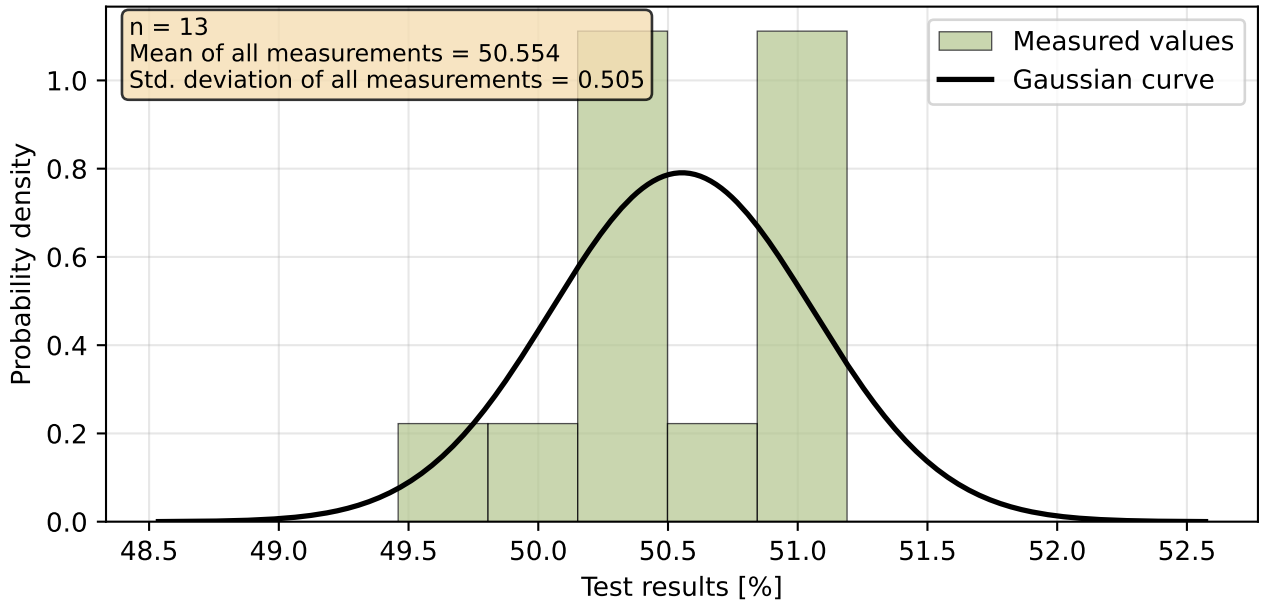

Figure 219: Histogram of all test results

Table 74: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	50.408
Sample standard deviation – s	0.643
Assigned value – x^*	50.408
Robust standard deviation – s^*	0.643
Measurement uncertainty of assigned value – u_X	0.287
p-value of normality test [-]	0.229
Interlaboratory standard deviation – s_L	0.638
Repeatability standard deviation – s_r	0.130
Reproducibility standard deviation – s_R	0.652
Repeatability – r	0.365
Reproducibility – R	1.824

18.2.5 Evaluation of Performance Statistics

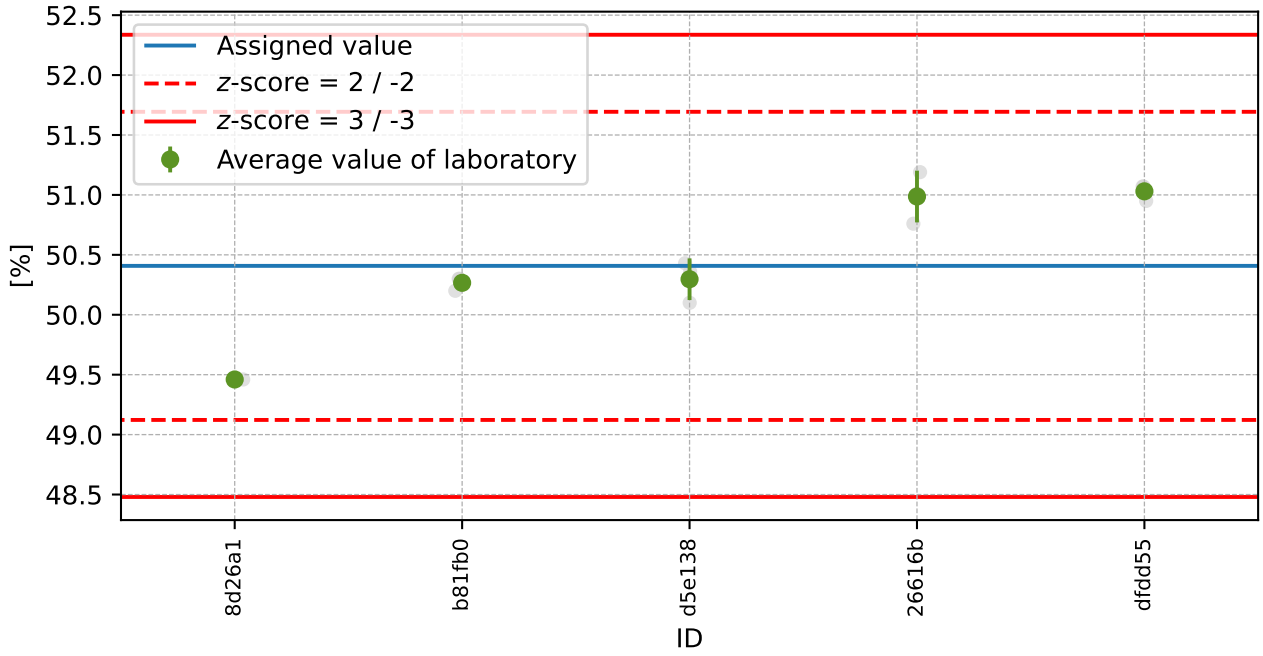

Figure 220: Average values and sample standard deviations

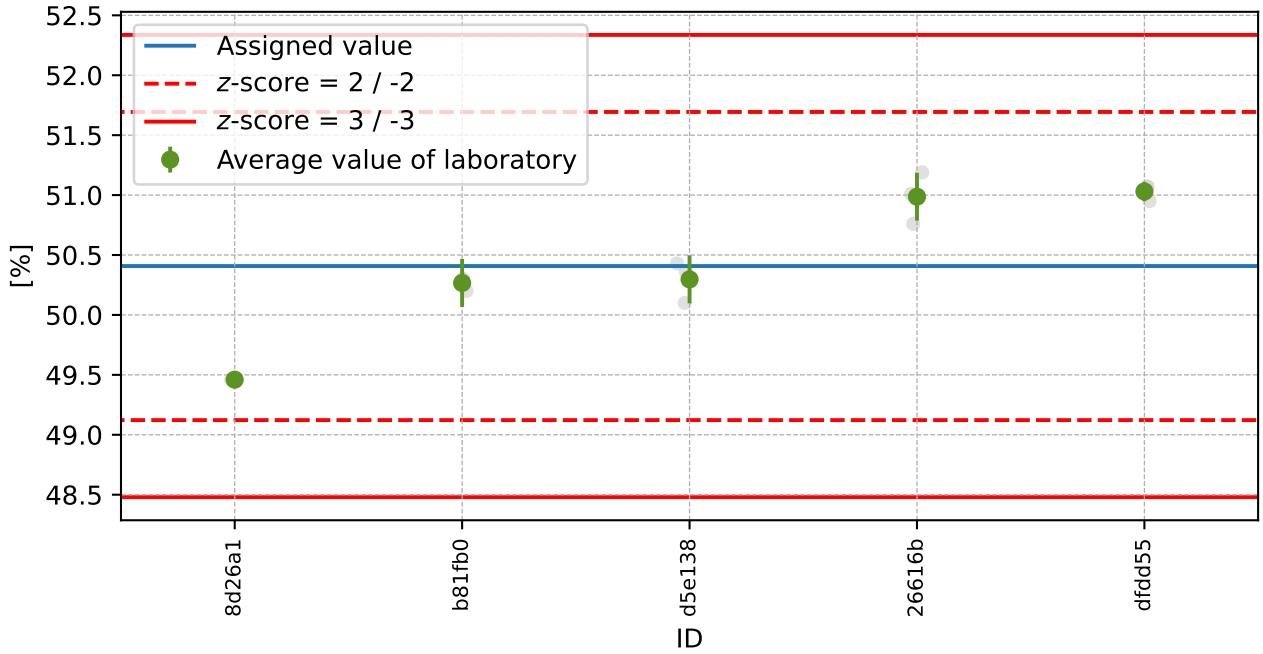

Figure 221: Average values and extended uncertainties of measurement

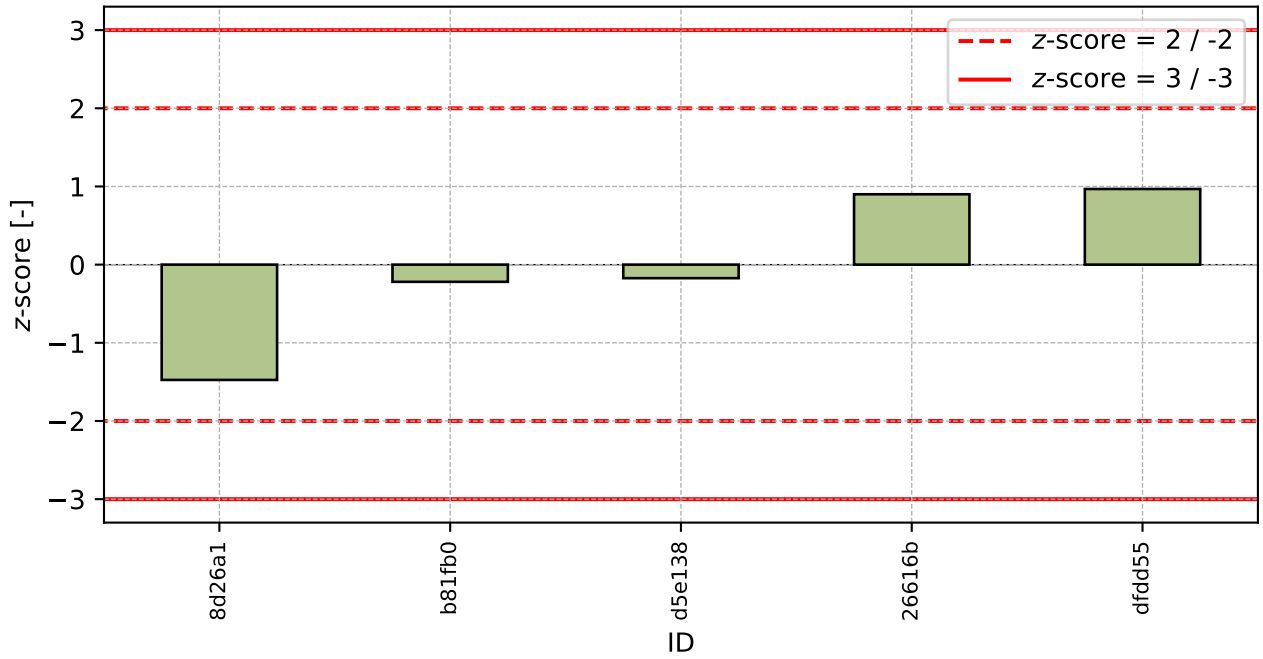

Figure 222: z-score

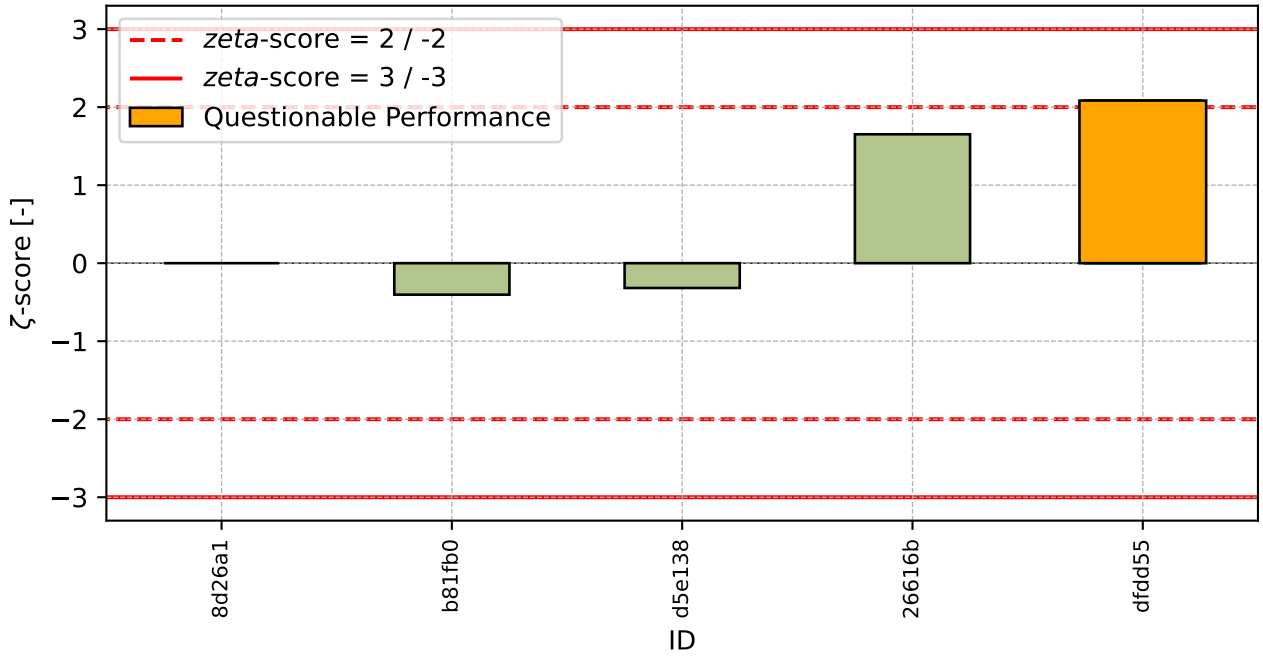

Figure 223: ζ-score

Table 75: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8d26a1	-1.47	-
b81fb0	-0.22	-0.40
d5e138	-0.17	-0.32
26616b	0.90	1.65
dfdd55	0.97	2.08

19 Appendix – ISO 3795 (Burning Rate)

The test method was not opened due to the low number of participants.