



FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program Mortar, Cement and Fine-grained Cement Composites ZMC 2023/1

Brno University of Technology
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1 Introduction and Important Contacts

In the year 2023, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZMC 2023/1 whose aim was to verify and assess the conformity of test results across laboratories when testing mortar, cement and fine-grained cement composites.

The assessment of the results of the Proficiency Testing Program was carried out by a committee consisting of the following PT Provider employees:

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The subjects of proficiency testing were the following testing procedures:

1. EN 196-1 – Strength [1]
2. EN 196-2 (art. 4.4.1) – Determination of loss on ignition [2]
3. EN 196-2 (art. 4.4.2) – Determination of sulphate content [2]
4. EN 196-2 (art. 4.4.3) – Determination of the residue insoluble in hydrochloric acid and sodium carbonate [2]
5. EN 196-2 (art. 4.4.4) – Determination of the residue insoluble in hydrochloric acid and potassium hydroxide [2]
6. EN 196-2 (art. 4.4.5) – Determination of sulphite content [2]
7. EN 196-2 (art. 4.4.6) – Determination of manganese content [2]
8. EN 196-3 – Setting time, Soundness [3]
9. EN 196-10 – Determination of the water-soluble chromium (Cr^{6+}) [4]
10. EN 1015-1 – Granularity [5]
11. EN 1015-3 – Consistency [6]
12. EN 1015-6 – Density of fresh mortar [7]
13. EN 1015-10 – Density of hardened mortar [8]
14. EN 1015-11 – Strength [9]
15. EN 1015-12 – Adhesion [10]
16. EN 1015-18 – Capillary absorption coefficient (C_m) [11]
17. EN 1015-19 – Water vapor flow [12]
18. EN 13892-2 – Determination of flexural and compressive strength [13]
19. EN 12004-2 (art. 8.1) – Open time [14]
20. EN 12004-2 (art. 8.2) – Slippage [14]
21. EN 12004-2 (art. 8.3.3.2) – Adhesion [14]

22. EN 12004-2 (art. 8.3.3.3) – Adhesion [14]

Testing procedures No **1, 2, 8, 13, 14, 15, 18, 19 and 21** were open. Other test methods were not opened due to low number of participants (interested laboratories).

The specimens were taken from the same production with the same production date. 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 [15] and with EN ISO/IEC 17043 [16]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

28 laboratories took part in the program. 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 chart shows the participation of laboratories in individual parts of the PTP.

Table 1: Participation of individual laboratories in the PTP

ID/Part	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
453085	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0498be	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-
09b3b4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-
5bd8de	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
91a9fc	X	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	X	X	-	-	-
daa375	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
503a6a	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
724b20	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	-	-	-	-
a3354e	-	X	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	X	-	-	X	-
3db6ff	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26b832	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0b215e	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-
37ab14	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
e66cd8	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37784e	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	X	X	-	X	-
d09c92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
d04726	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
a83ef3	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
07138b	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
fec653	X	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
124fe6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-
aebfde	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
8c23d8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-
12a5f5	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-
257269	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3e3e5b	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b810f7	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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

Laboratory	Address	Accreditation number
"Център за изпитване и европейска сертификация" ЕООД	2 Industrialna street, Stara Zagora, 6000, Bulgaria	-
BETONTEST, spol. s r. o.	Trnkova 3083/162, Brno - Líšeň, 62800, Česká republika	1116
BETOTECH, s.r.o. - Pracoviště Beroun	Beroun 660, Beroun, 26601, Česká Republika	AZL 1195
BETOTECH, s.r.o. - pracoviště Ostrava	Beroun 660, Beroun, 26601, ČR	1195.2
CIPC INCERC TEST LLC	16/1 Varnita street (Laboratory), Chisinau, MD-2023 Chisinau, Republic of Moldova	-
Cement Hranice, akciová společnost	Bělotínská 288, Hranice I - Město, 75301, Česká republika	-
Cement Hranice, akciová společnost	Bělotínská 288, Hranice I - Město, 75301, Česká republika	1284
Ghent University	Technologiepark-Zwijnaarde 60, Zwijnaarde, 9052, Belgium	220-TEST
Institut technologie a testování betonu, s.r.o., Zkušební laboratoř ITTB Brno	K Babě 609/9, Brno, 62100, Česká republika	L1778
Institut za Beton doo	Ugrinovački put, 31 deo, br 50, Beograd, 11283, Srbija	-
Kloknerův ústav ČVUT v Praze	Šolínova 1903/7, Praha 6, 166 08, Česká republika	1061
LABKONSULT PLUS Ltd.	"Simeonovsko shousse"18A, Sofia, 1700, BULGARIA	-
Laboratoire Central des Travaux Publics - Laboratoire Matériaux Hussein dey- LCTP	1. rue Kaddour RAHIM- HUSSEIN DEY, ALGER, 16005, Algérie	-
MAIN LABORATORY SASSUOLO srl	Via Fratelli Setti, 7, Scandiano (RE), 42019, ITALY	-
Mattest (Ireland) Ltd. Dublin	Unit 2, Northwest Business Park, Ballycoolin, Dublin 15., Dublin, D15EF1H, Ireland	286T
NORD COMAT shpk	Rruga: "Muhamet Deliu", Pallati i Firmes "DODAJ" ,KATI 1, TIRANE, 1000, ALBANIA	-
QCONTROL s.r.o., odštěpný závod - pracoviště Děčín	Lesní 693, Bílovice nad Svitavou, 66401, Česká republika	1737
Stachema CZ s.r.o. - zkušební laboratoř - pracoviště 2	Hasičská 1, Zibohlavý, Kolín, 28002, Česká republika	1433
TESTSTAV, spol. s r. o.	Orlovská 347/160, Ostrava-Heřmanice, 71300, Česká republika	1290
TPA EOOD CTC SOFIA	Rezbarska str. №7, SOFIA, 1510, BULGARIA	-

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Laboratory	Address	Accreditation number
Technický a skúšobný ústav stavebný, n. o., Pobočka Bratislava	Studená, 967/3, Bratislava, 82104, Slovensko	S-045
Technický a skúšobný ústav stavebný, n.o.	Bellova 72/24, Tatranská Štrba, 05941, Slovenská republika	004/S-045
UAB Heidelberg Materials Lietuva Cementas	Švėpelių st. 5, Klaipėda, LT-95101, Lithuania	-
Vysoké učení technické v Brně, Fakulta stavební, Zkušební laboratoř při ÚTHD FAST VUT v Brně	Veveří 331/95, Brno, 60200, Česká republika	L1396
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.	Dózsa György út 26, Szentendre, 2000, Magyarország	NAH-1-1011/2023/K
Ústav stavebního zkušebnictví s.r.o.	Jiřího Potůčka 115, Trnová, Pardubice, 53009, Česká republika	1115
Ředitelství silnic a dálnic ČR	Rebešovická 40, Brno-Chrlice, 643 00, Česká republika	1072

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 Mortar, Cement and Fine-grained Cement Composites (PT Program) organized by the PT Provider at the SZK FAST. 28 participants (laboratories) took part in the PT Program. The program focused on ordinary standardized testing of mortar, cement, fine-grained cement composites. The test results are evaluated separately for each testing procedure examined. An evaluation of statistical characteristics is included in the Appendix, as well as test results and graphic presentations. Testing methods can be found in part 1 of this report.

Table 4: Evaluation of overall performance and outliers.

✓ – satisfactory performance; ? – questionable performance; ! – unsatisfactory performance; X – outlier;

ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
453085	✓	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0498be	✓	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-
09b3b4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-
5bd8de	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-
91a9fc	✓	-	-	-	-	-	-	✓	-	-	-	-	-	✓	✓	-	-	✓	✓	-	-	-
daa375	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
503a6a	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
724b20	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	✓	-	-	-	-
a3354e	-	✓	-	-	-	-	-	-	-	-	-	-	✓	✓	✓	-	-	✓	-	-	✓	-
3db6ff	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26b832	✓	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0b215e	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-
37ab14	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
e66cd8	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37784e	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓	✓	-	-	✓	✓	-	✓	-
d09c92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
d04726	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-
a83ef3	✓	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
07138b	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
fec653	✓	!	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
124fe6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	✓	-
aebfde	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
8c23d8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	✓	-
12a5f5	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
257269	-	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3e3e5b	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b810f7	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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- [2] EN 196-2. *Method of testing cement - Part 2: Chemical analysis of cement*. 2013.
- [3] EN 196-3. *Methods of testing cement - Part 3: Determination of setting times and soundness*. 2017.
- [4] EN 196-10. *Methods of testing cement - Part 10: Determination of the water-soluble chromium (VI) content of cement*. 2017.
- [5] EN 1015-1. *Methods of test for mortar for masonry - Part 1: Determination of particle size distribution (by sieve analysis)*. 1999.
- [6] EN 1015-3. *Methods of test for mortar for masonry - Part 3: Determination of consistence of fresh mortar (by flow table)*. 2000.
- [7] EN 1015-6. *Methods of test for mortar for masonry - Part 6: Determination of bulk density of fresh mortar*. 1999.
- [8] EN 1015-10. *Methods of test for mortar for masonry - Part 10: Determination of dry bulk density of hardened mortar*. 2000.
- [9] EN 1015-11. *Methods of test for mortar for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar*. 2000.
- [10] EN 1015-12. *Methods of test for mortar for masonry - Part 12: Determination of adhesive strength of hardened rendering and plastering mortars on substrates*. 2000.
- [11] EN 1015-18. *Methods of test for mortar for masonry - Part 18: Determination of water absorption coefficient due to capillarity action of hardened mortar*. 2003.
- [12] EN 1015-19. *Methods of test for mortar for masonry - Part 19: Determination of water vapour permeability of hardened rendering and plastering mortars*. 1999.
- [13] EN 13892-2. *Methods of test for screed materials - Part 2: Determination of flexural and compressive strength*. 2003.
- [14] EN 12004-2. *Adhesives for ceramic tiles - Part 2: Test methods*. 2017.
- [15] 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*. 1997.
- [16] EN ISO/IEC 17043. *Conformity assessment - General requirements for proficiency testing*. 2010.

1 Appendix – EN 196-1 – Strength

1.1 Flexural Strength after 2 days of ageing

1.1.1 Test results

Table 4: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]			u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
453085	4.4	4.2	4.1	-	4.3	0.17	3.91
0498be	4.7	4.8	4.4	0.2	4.6	0.21	4.49
3e3e5b	5.1	4.7	4.9	0.5	4.9	0.2	4.08
07138b	4.7	5.1	5.0	0.2	4.9	0.21	4.22
37ab14	5.2	5.1	4.6	0.4	5.0	0.32	6.47
a83ef3	5.0	5.3	4.8	0.3	5.0	0.25	5.0
b810f7	5.5	5.7	5.5	0.5	5.6	0.12	2.07
91a9fc	5.9	5.6	5.9	0.5	5.8	0.17	2.99
26b832	5.9	5.9	6.3	0.3	6.0	0.23	3.83
fec653	7.5	7.2	6.8	0.8	7.2	0.35	4.9

1.1.2 The Numerical Procedure for Determining Outliers

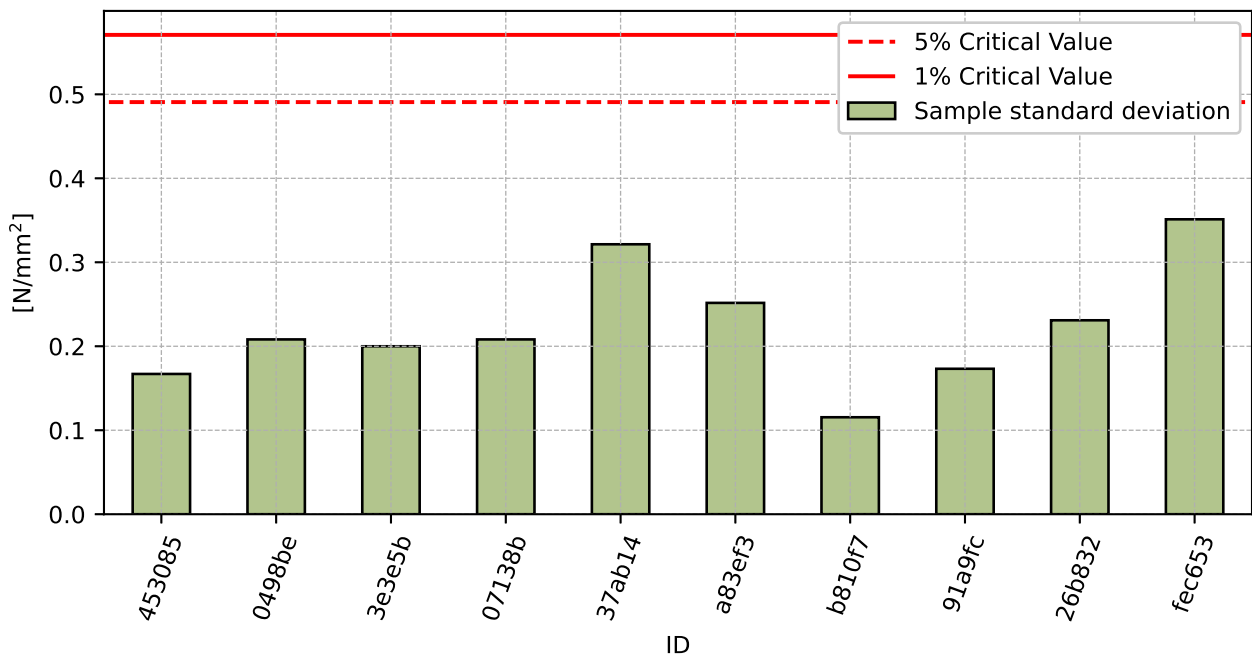


Figure 1: **Cochran's test** - sample standard deviations

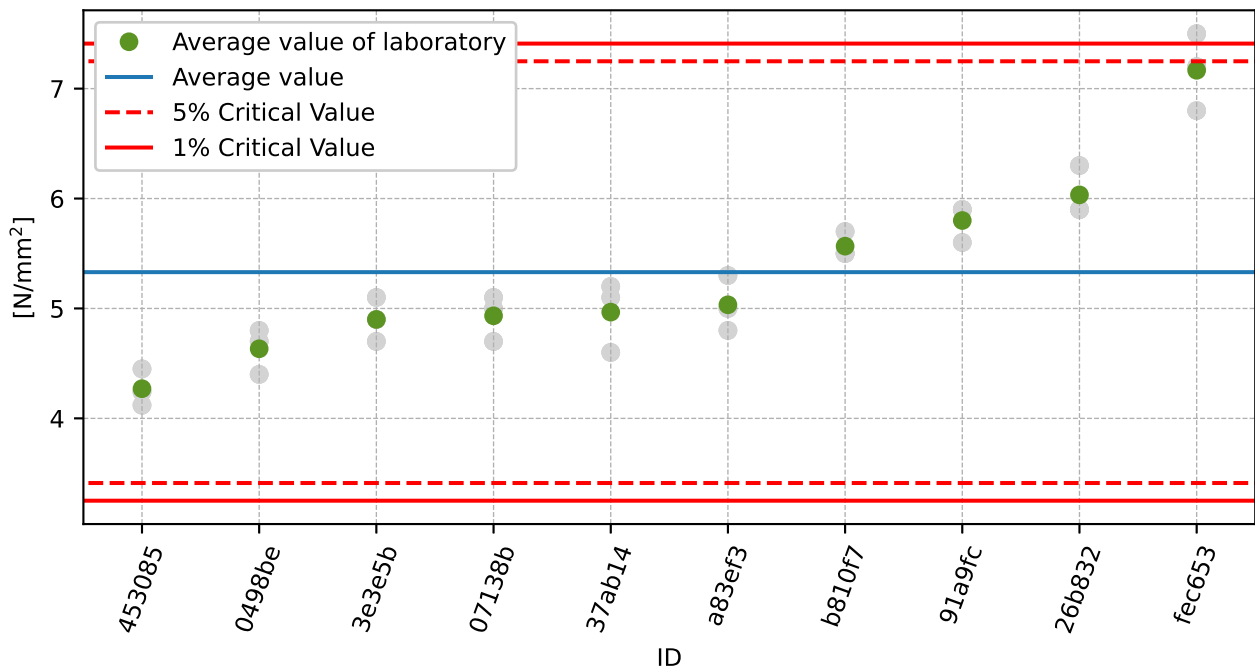


Figure 2: **Grubbs' test** - average values

1.1.3 Mandel's Statistics

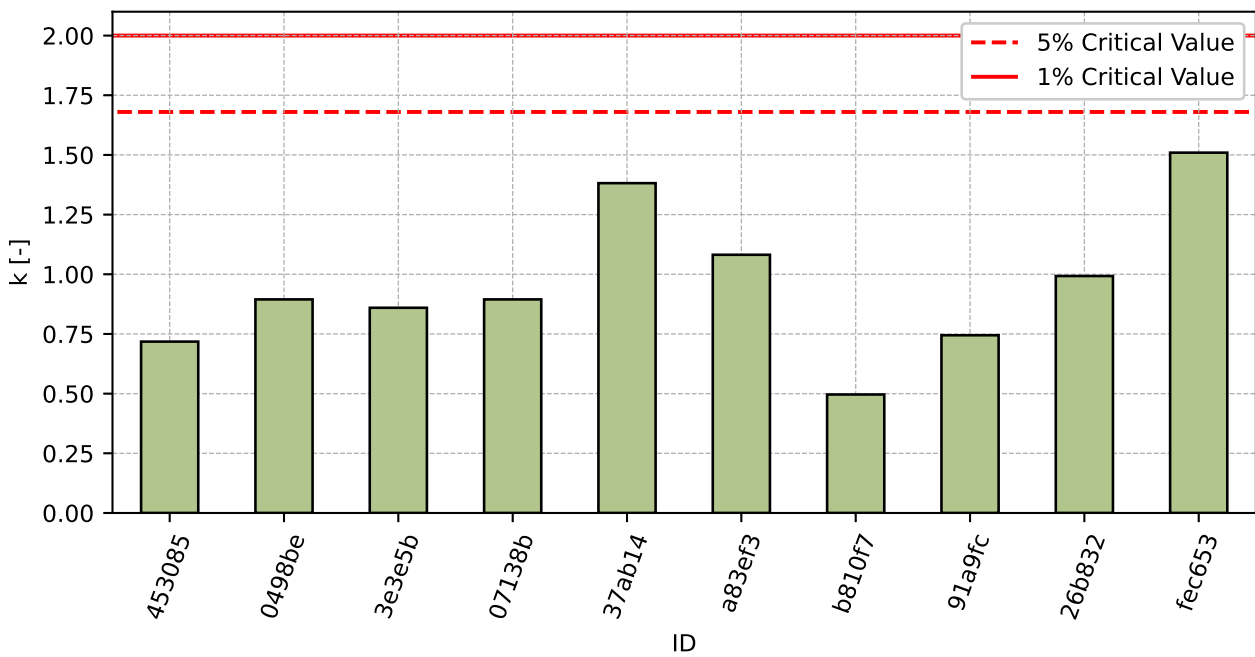


Figure 3: Intralaboratory Consistency Statistic

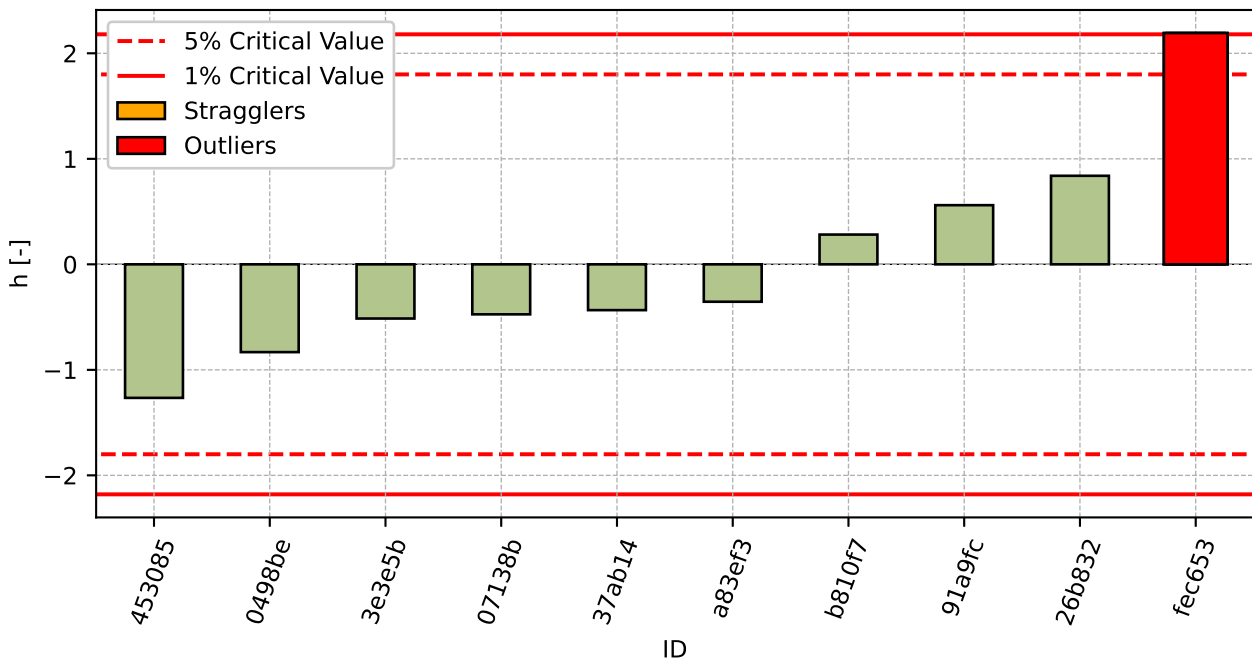


Figure 4: Interlaboratory Consistency Statistic

1.1.4 Descriptive statistics

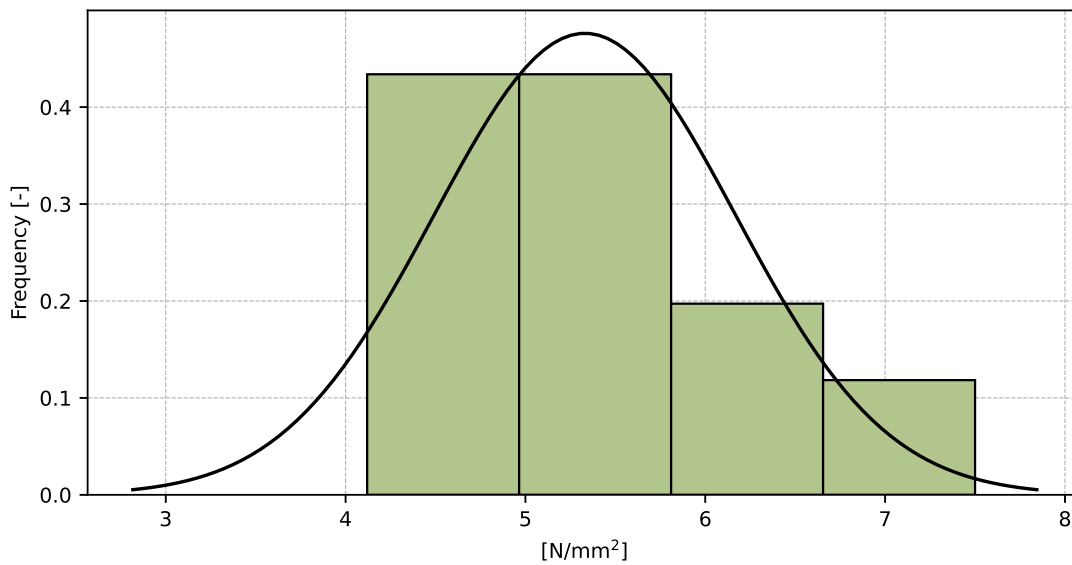


Figure 5: Histogram of all test results

Table 5: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	5.3
Sample standard deviation – s	0.84
Assigned value – x^*	5.3
Robust standard deviation – s^*	0.95
Measurement uncertainty of assigned value – u_X	0.36
p -value of normality test	0.039 [-]
Interlaboratory standard deviation – s_L	0.83
Repeatability standard deviation – s_r	0.23
Reproducibility standard deviation – s_R	0.86
Repeatability – r	0.7
Reproducibility – R	2.4

1.1.5 Evaluation of Performance Statistics

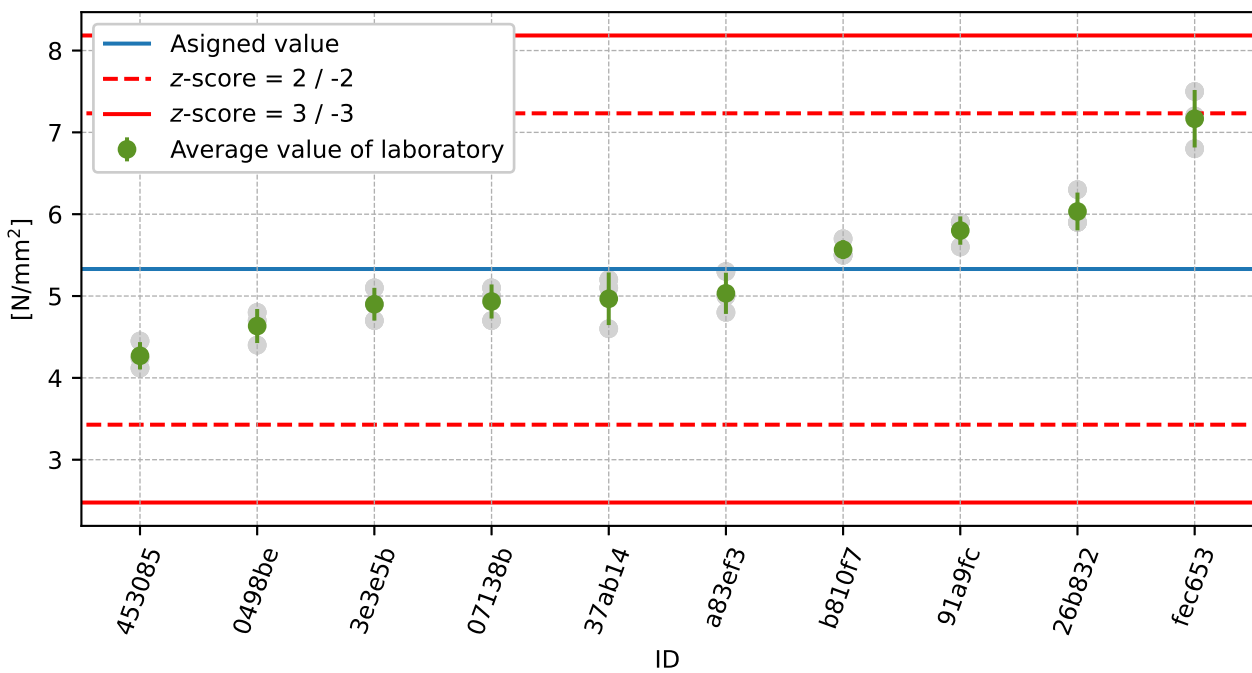


Figure 6: Average values and sample standard deviations

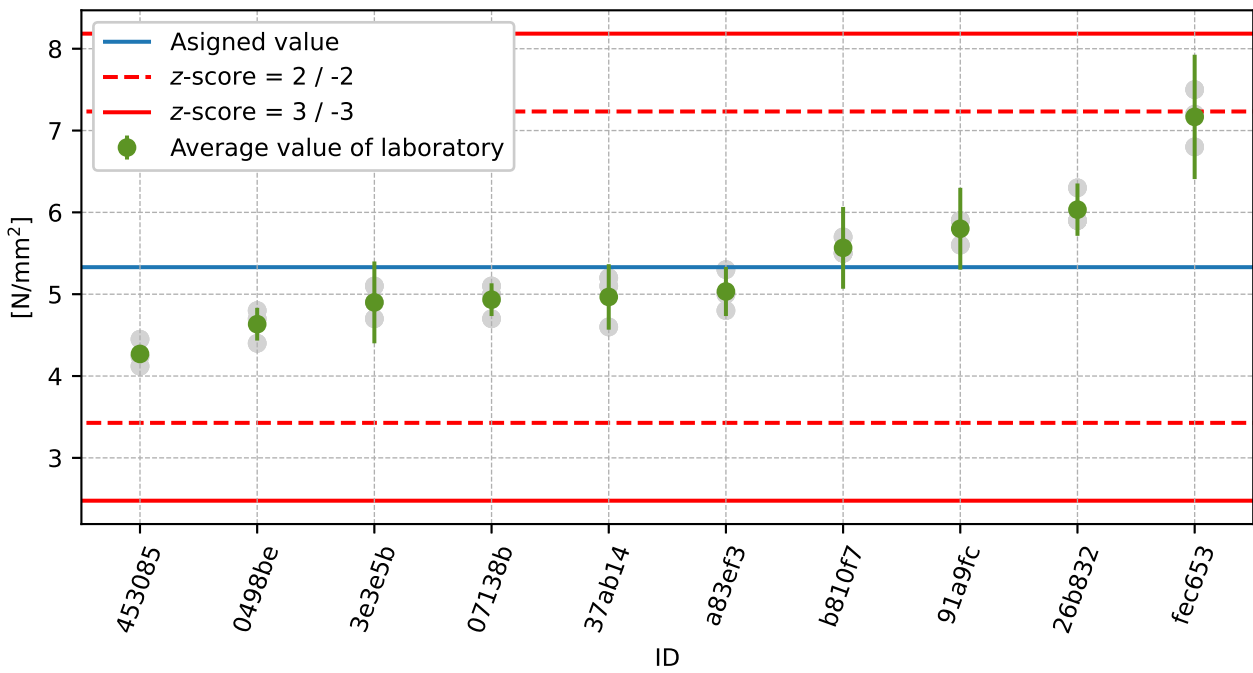


Figure 7: Average values and extended uncertainties of measurement

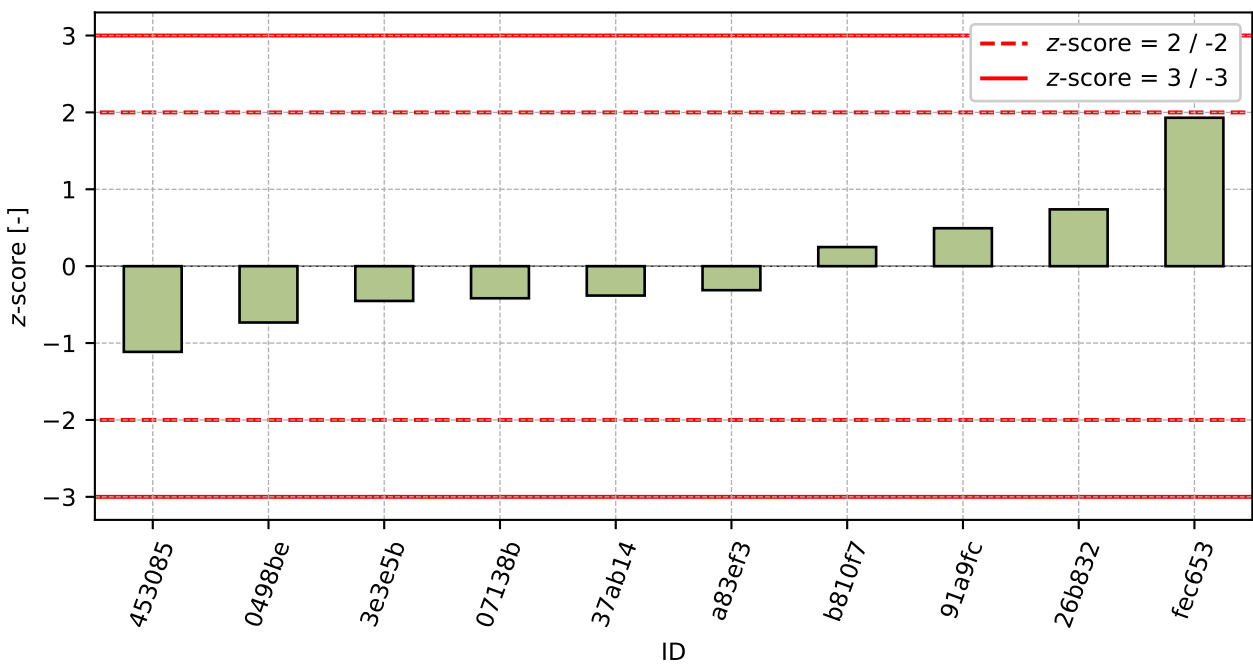


Figure 8: z-score

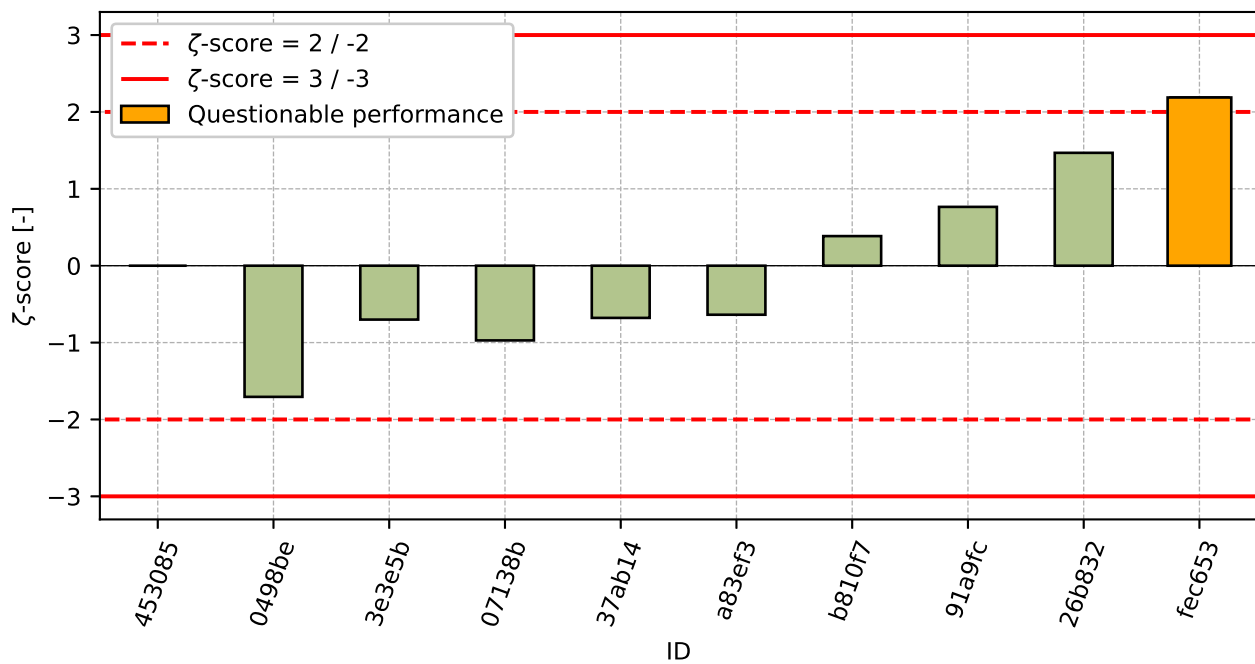


Figure 9: z-score

Table 6: z-score and zeta-score

ID	z-score [-]	zeta-score [-]
453085	-1.11	-
0498be	-0.73	-1.71
3e3e5b	-0.45	-0.7
07138b	-0.42	-0.97
37ab14	-0.38	-0.68
a83ef3	-0.31	-0.64
b810f7	0.25	0.38
91a9fc	0.49	0.77
26b832	0.74	1.47
fec653	1.93	2.19

1.2 Compressive Strength after 2 days of ageing

1.2.1 Test results

Table 7: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]						u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
fec653	22.8	22.5	21.5	21.7	20.9	20.5	2.3	21.7	0.89	4.11
b810f7	22.2	22.5	22.0	22.3	21.3	22.2	0.9	22.1	0.42	1.89
26b832	22.5	23.1	23.1	22.5	23.8	22.5	1.1	22.9	0.52	2.28
3e3e5b	23.9	23.5	24.8	26.1	22.3	23.0	2.0	23.9	1.35	5.66
a83ef3	25.5	25.2	24.4	24.6	24.1	24.2	1.8	24.7	0.56	2.29
453085	25.2	25.0	26.9	24.1	24.0	25.4	-	25.1	1.06	4.21
37ab14	27.1	25.3	26.9	26.2	26.6	27.5	1.0	26.6	0.77	2.91
91a9fc	26.6	27.3	27.4	26.9	26.9	27.9	0.9	27.2	0.46	1.71
0498be	28.1	26.7	28.0	27.2	26.2	27.2	1.4	27.2	0.73	2.67
07138b	33.1	30.9	31.6	29.7	31.6	30.0	1.2	31.2	1.24	3.98

1.2.2 The Numerical Procedure for Determining Outliers

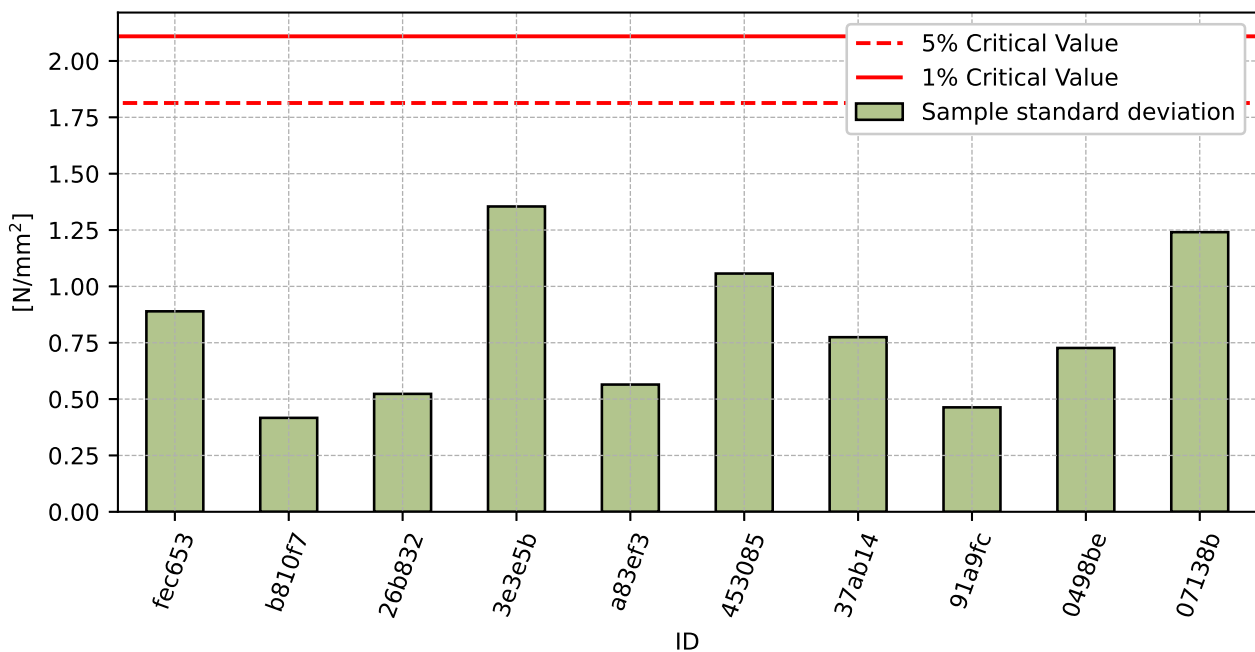


Figure 10: Cochran's test - sample standard deviations

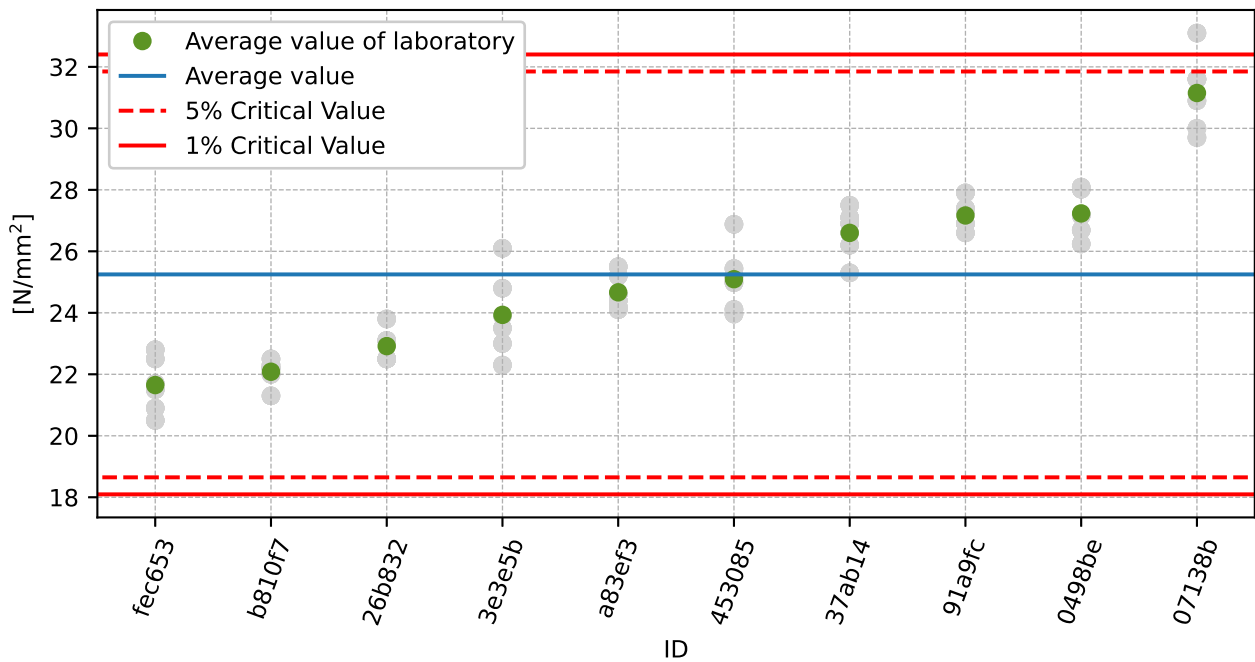


Figure 11: **Grubbs' test** - average values

1.2.3 Mandel's Statistics

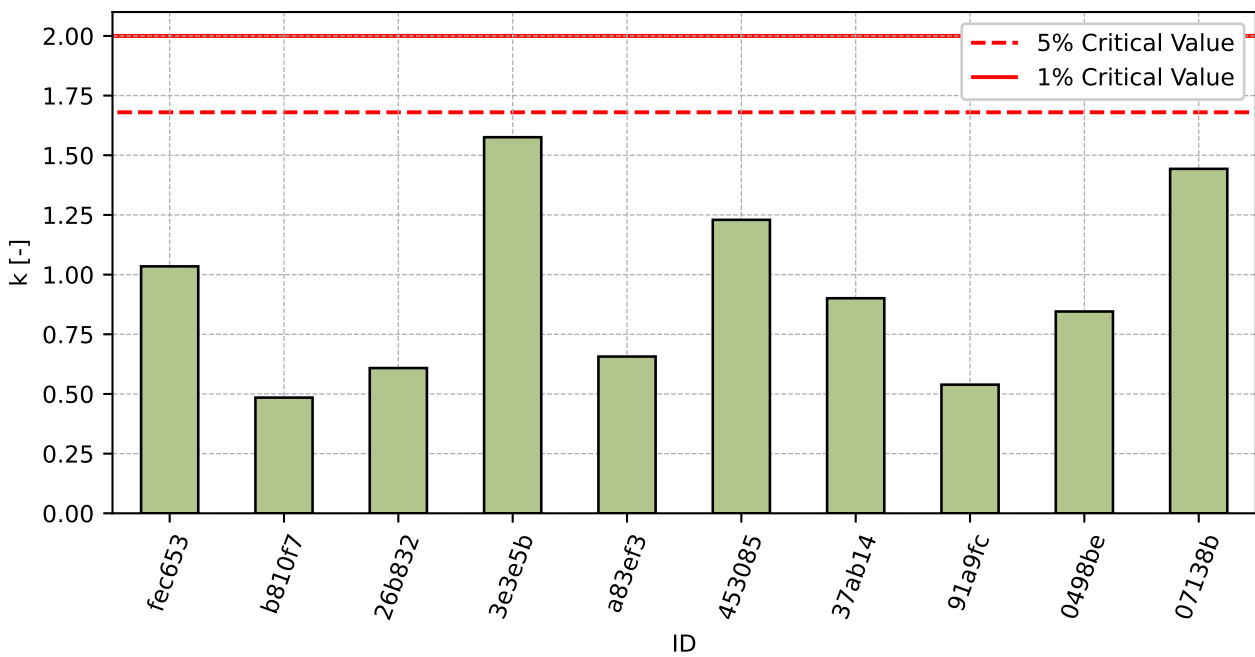


Figure 12: Intralaboratory Consistency Statistic

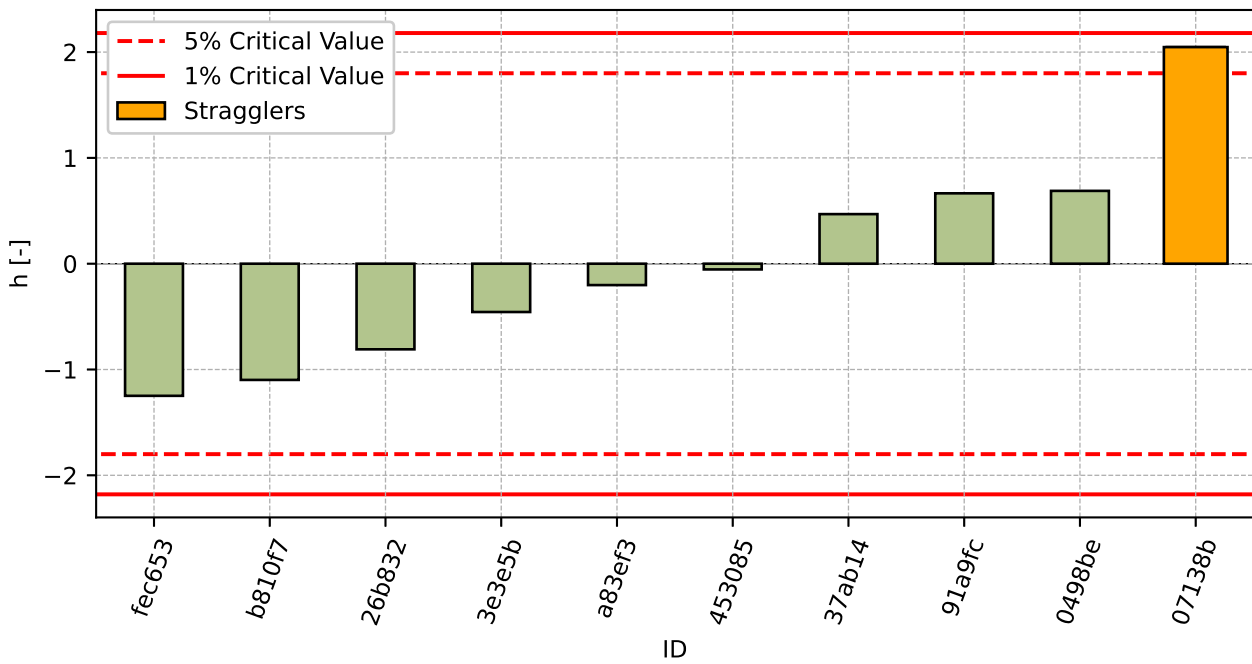


Figure 13: Interlaboratory Consistency Statistic

1.2.4 Descriptive statistics

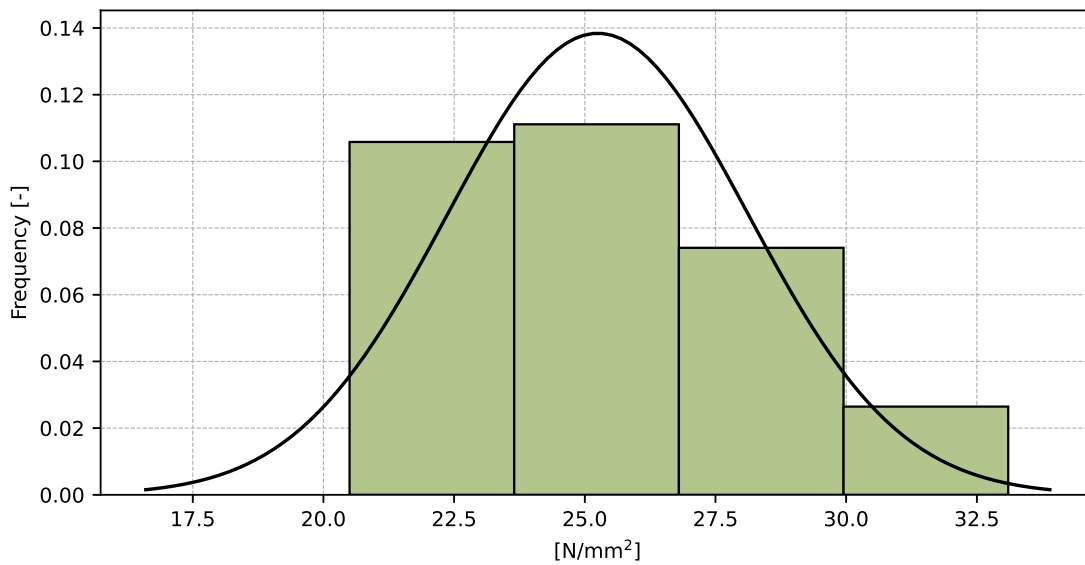


Figure 14: Histogram of all test results

Table 8: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	25.2
Sample standard deviation – s	2.88
Assigned value – x^*	25.2
Robust standard deviation – s^*	3.1
Measurement uncertainty of assigned value – u_X	1.23
p -value of normality test	0.026 [-]
Interlaboratory standard deviation – s_L	2.86
Repeatability standard deviation – s_r	0.86
Reproducibility standard deviation – s_R	2.99
Repeatability – r	2.4
Reproducibility – R	8.4

1.2.5 Evaluation of Performance Statistics

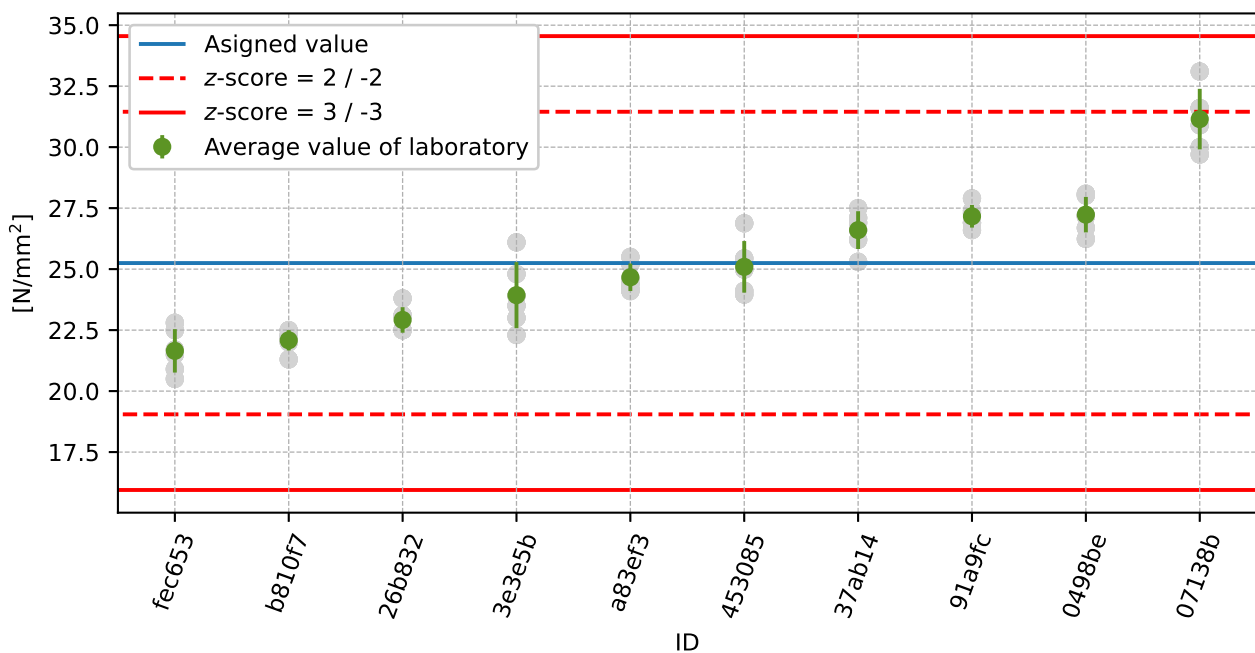


Figure 15: Average values and sample standard deviations

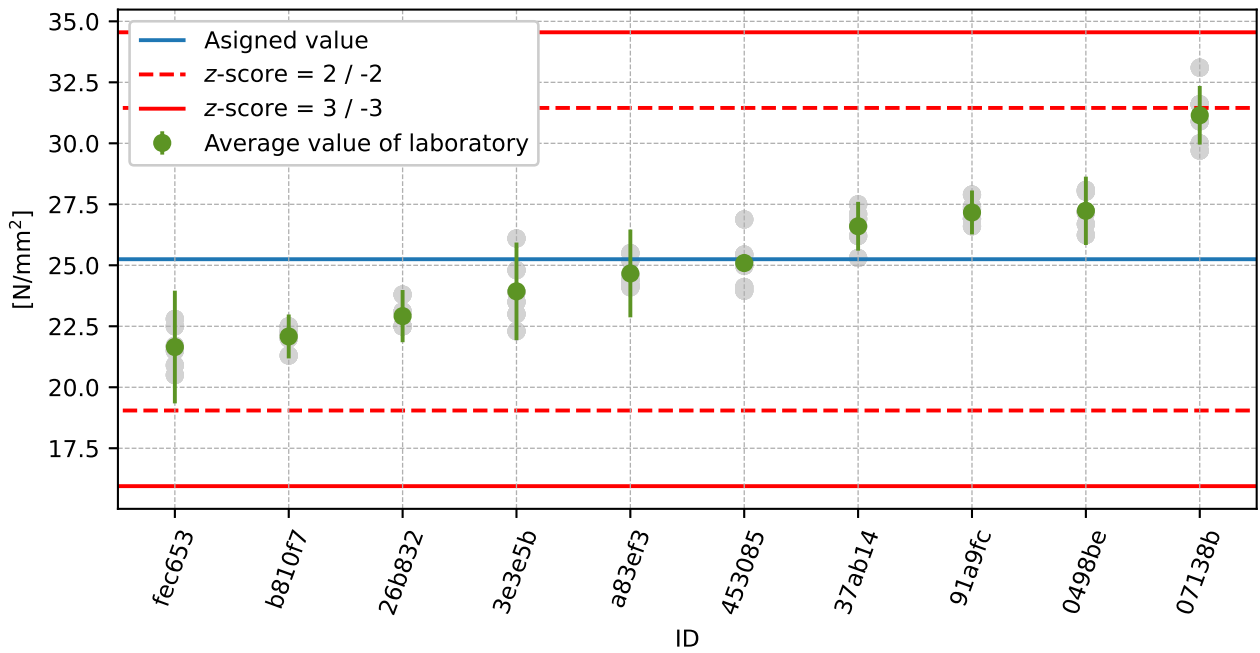


Figure 16: Average values and extended uncertainties of measurement

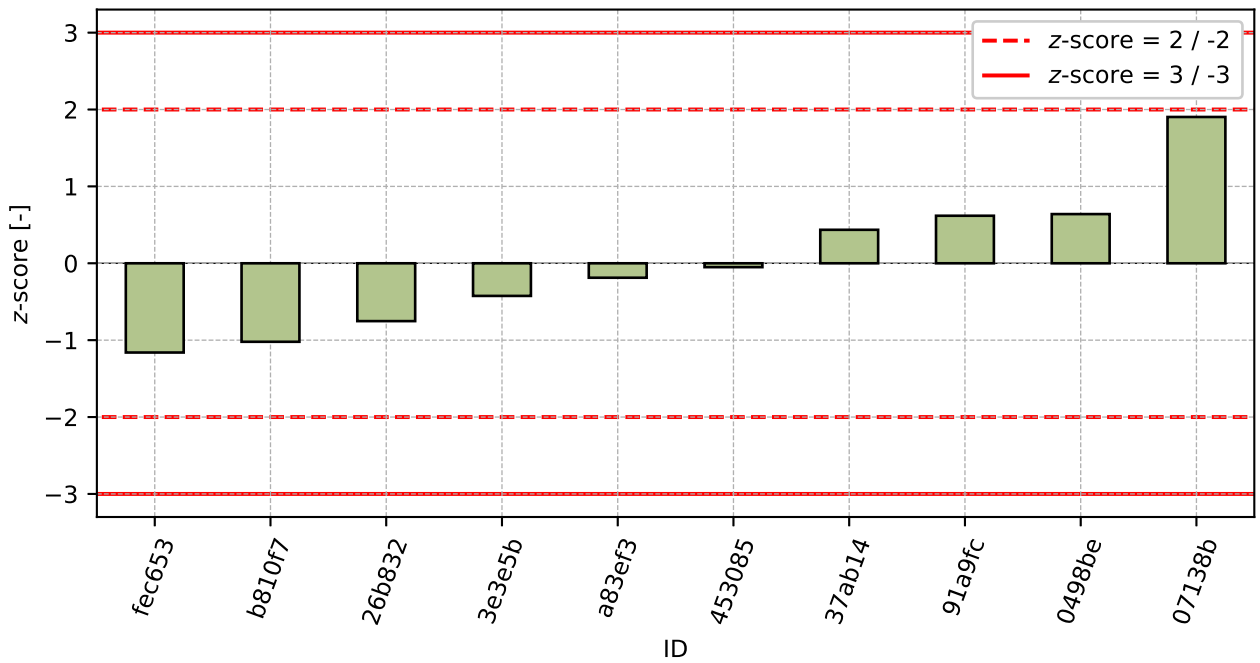


Figure 17: z-score

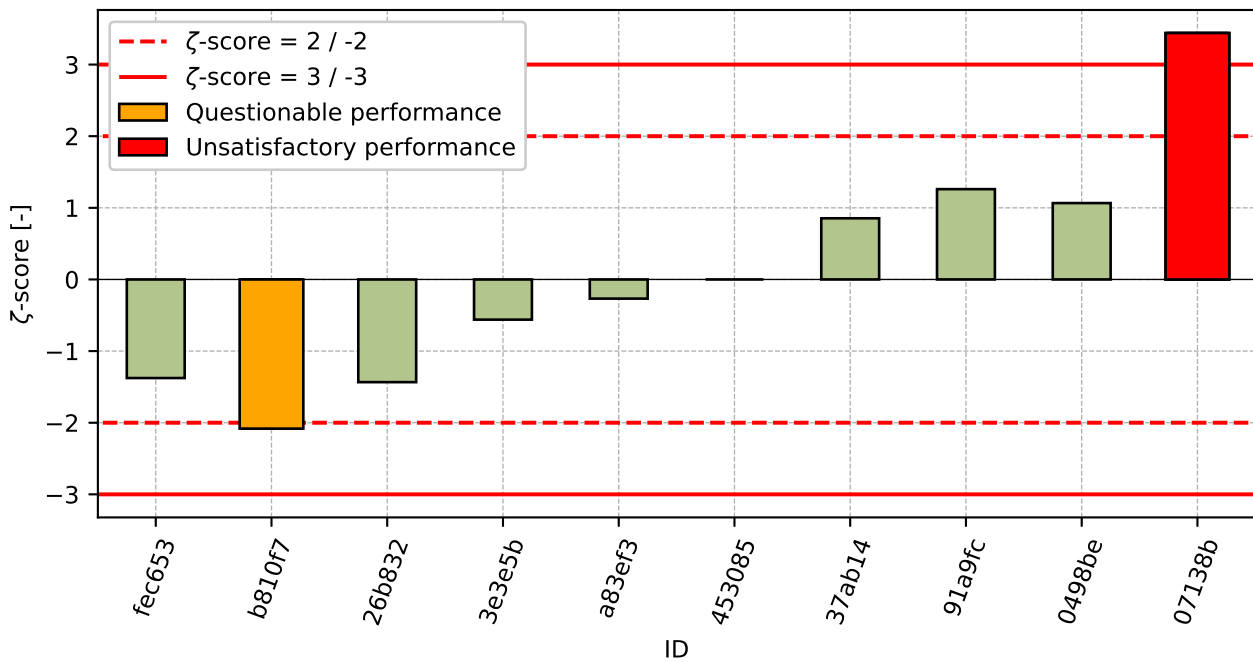


Figure 18: z-score

Table 9: z-score and zeta-score

ID	z-score [-]	zeta-score [-]
fec653	-1.16	-1.38
b810f7	-1.02	-2.08
26b832	-0.75	-1.43
3e3e5b	-0.42	-0.56
a83ef3	-0.19	-0.27
453085	-0.05	-
37ab14	0.44	0.85
91a9fc	0.62	1.26
0498be	0.64	1.07
07138b	1.9	3.44

1.3 Flexural Strength after 7 days of ageing

1.3.1 Test results

Table 10: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]			u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
453085	6.2	6.5	6.1	-	6.2	0.2	3.21
07138b	6.4	6.6	6.4	0.2	6.5	0.12	1.79
0498be	6.7	7.0	6.7	0.3	6.8	0.17	2.55
37ab14	6.8	6.9	7.5	0.5	7.1	0.38	5.36
3e3e5b	7.1	7.1	7.4	0.4	7.2	0.17	2.41
b810f7	7.9	7.9	8.3	0.5	8.0	0.23	2.87
26b832	7.5	8.4	8.4	0.6	8.1	0.52	6.42
a83ef3	7.8	8.7	8.3	0.4	8.3	0.45	5.45
fec653	8.5	8.0	8.3	0.9	8.3	0.25	3.04
91a9fc	8.5	8.2	8.9	0.6	8.5	0.35	4.12

1.3.2 The Numerical Procedure for Determining Outliers

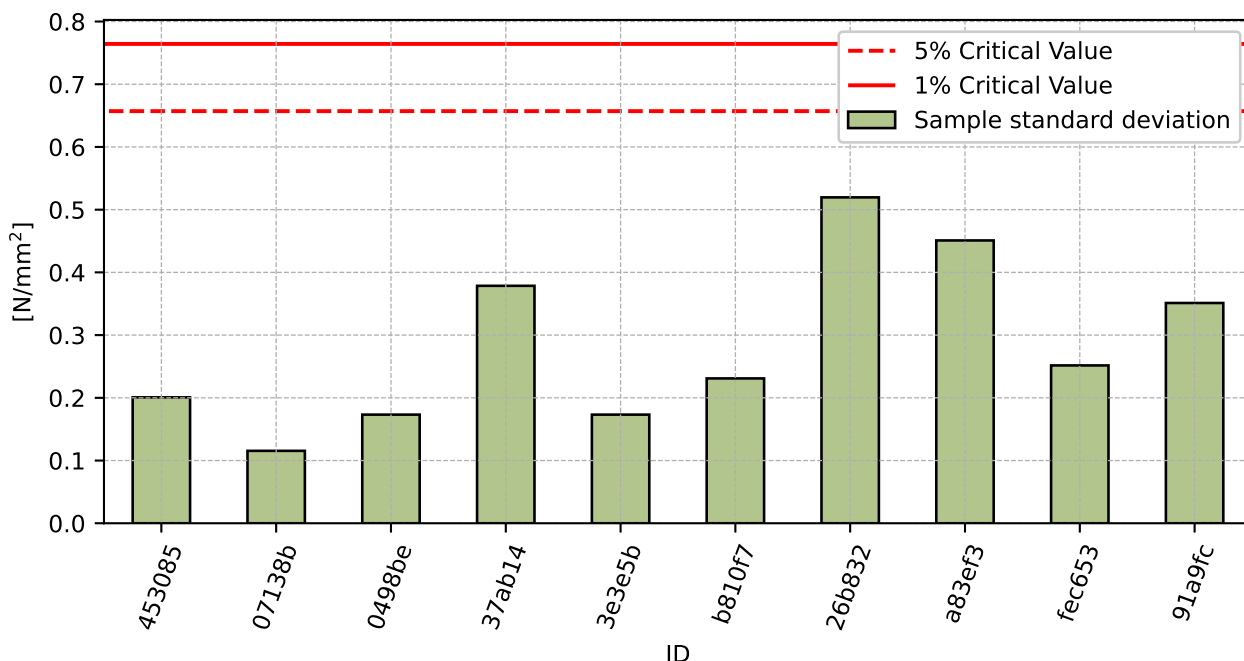


Figure 19: Cochran's test - sample standard deviations

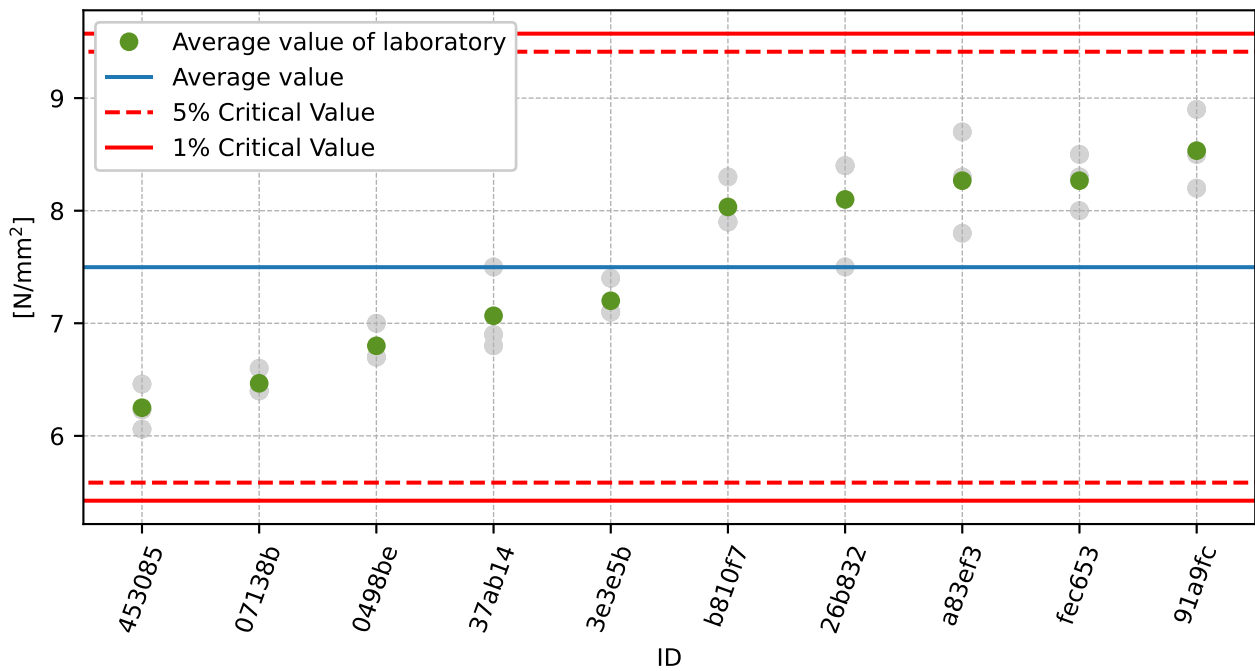


Figure 20: **Grubbs' test** - average values

1.3.3 Mandel's Statistics

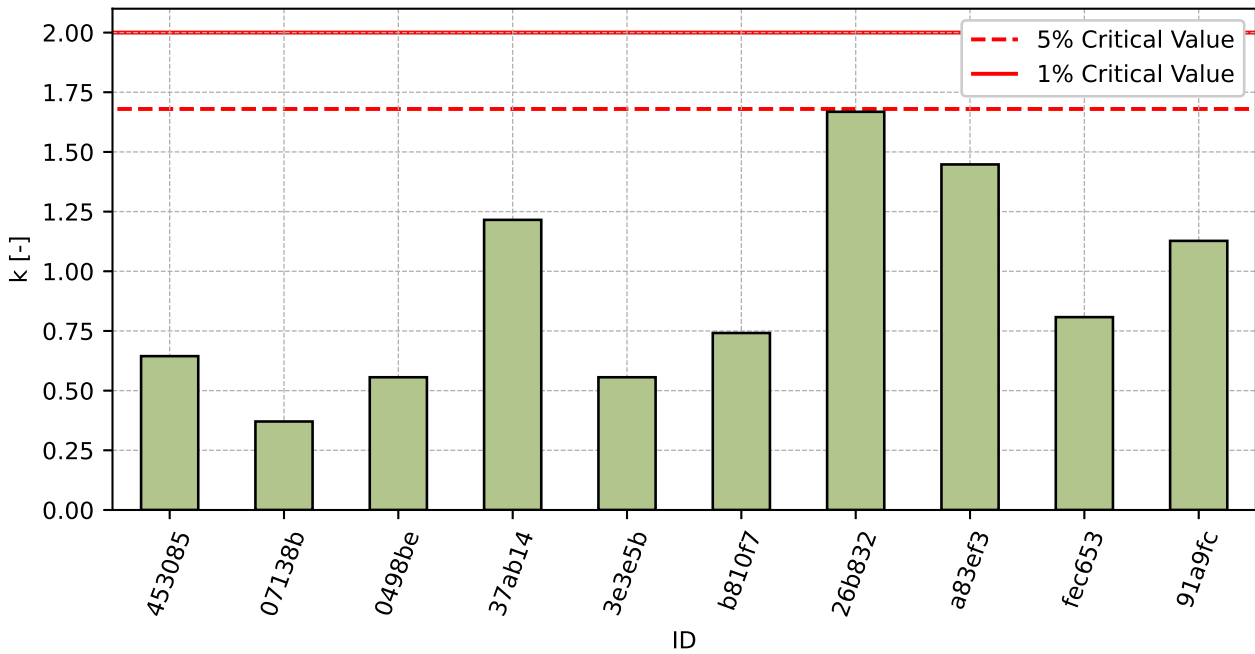


Figure 21: Intralaboratory Consistency Statistic

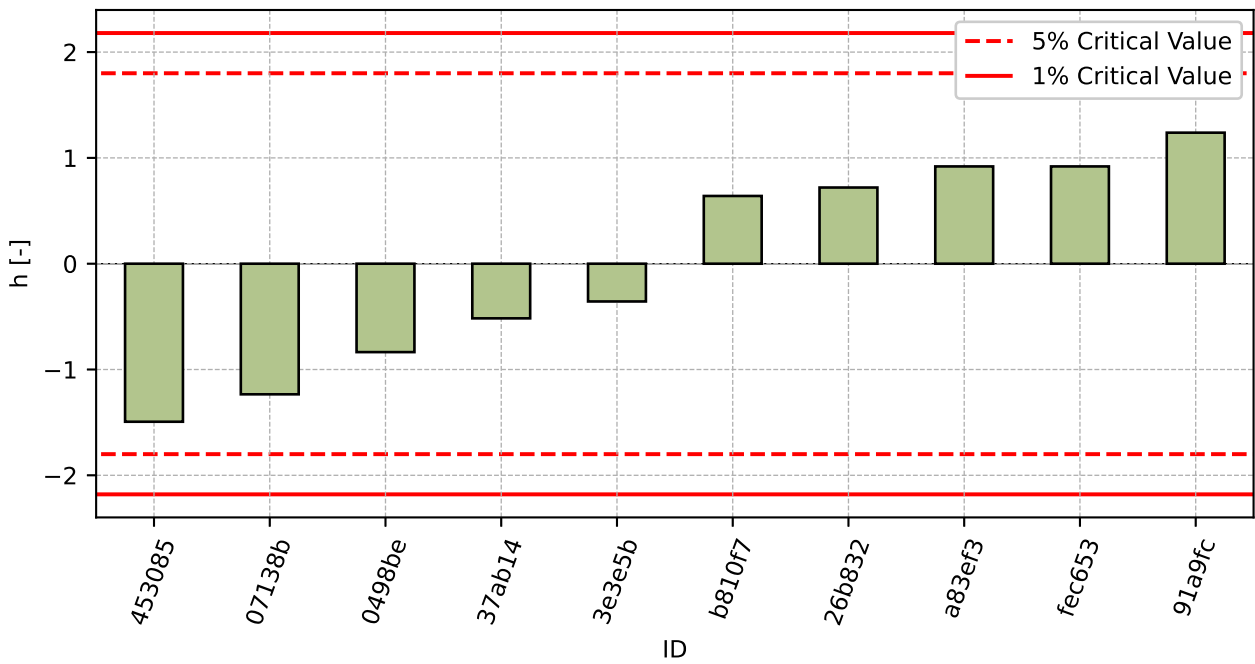


Figure 22: Interlaboratory Consistency Statistic

1.3.4 Descriptive statistics

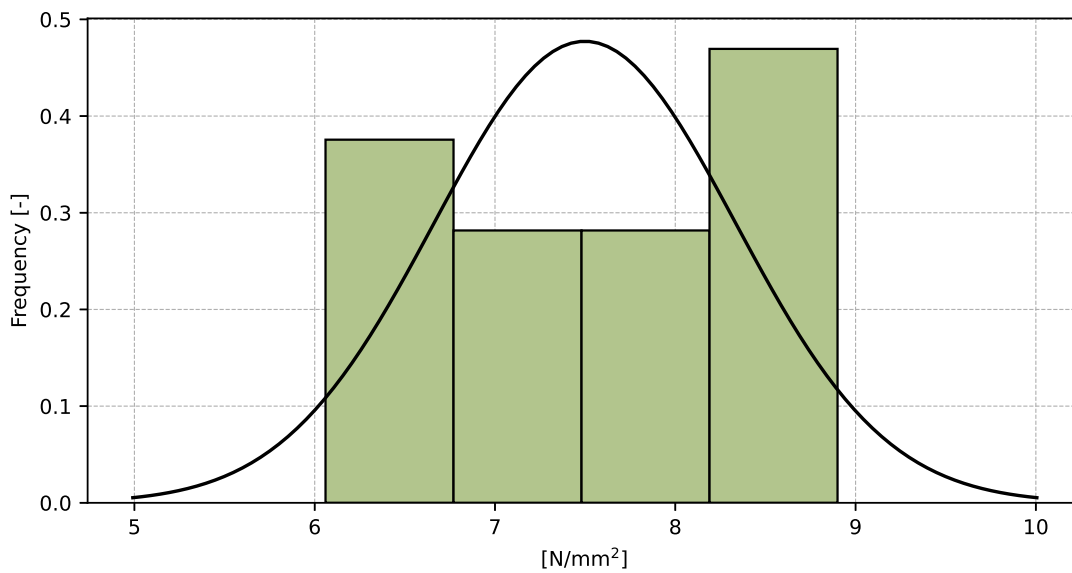


Figure 23: Histogram of all test results

Table 11: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	7.5
Sample standard deviation – s	0.84
Assigned value – x^*	7.5
Robust standard deviation – s^*	0.9
Measurement uncertainty of assigned value – u_X	0.36
p -value of normality test	0.08 [-]
Interlaboratory standard deviation – s_L	0.82
Repeatability standard deviation – s_r	0.31
Reproducibility standard deviation – s_R	0.87
Repeatability – r	0.9
Reproducibility – R	2.4

1.3.5 Evaluation of Performance Statistics

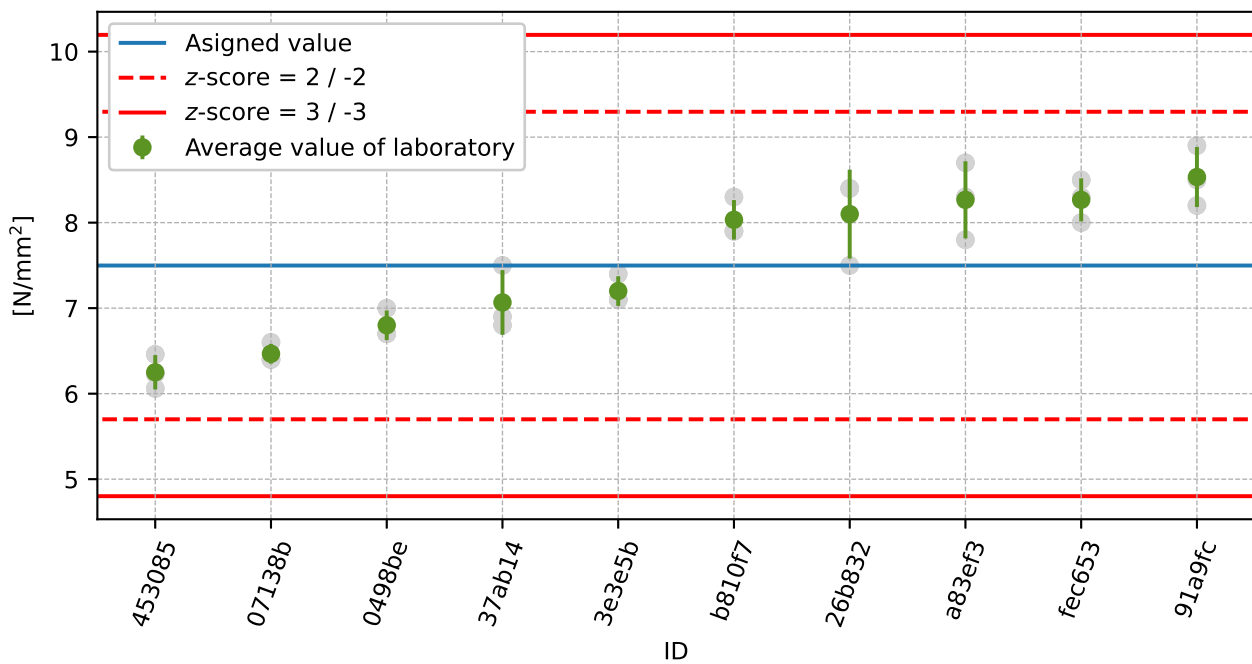


Figure 24: Average values and sample standard deviations

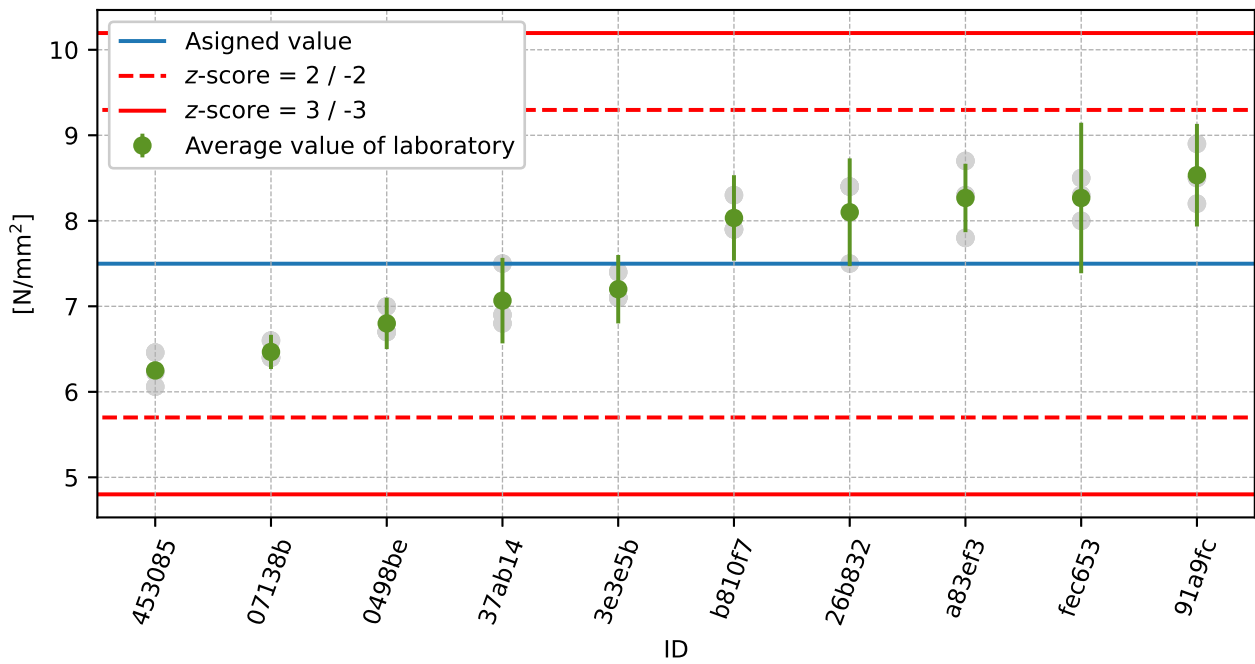


Figure 25: Average values and extended uncertainties of measurement

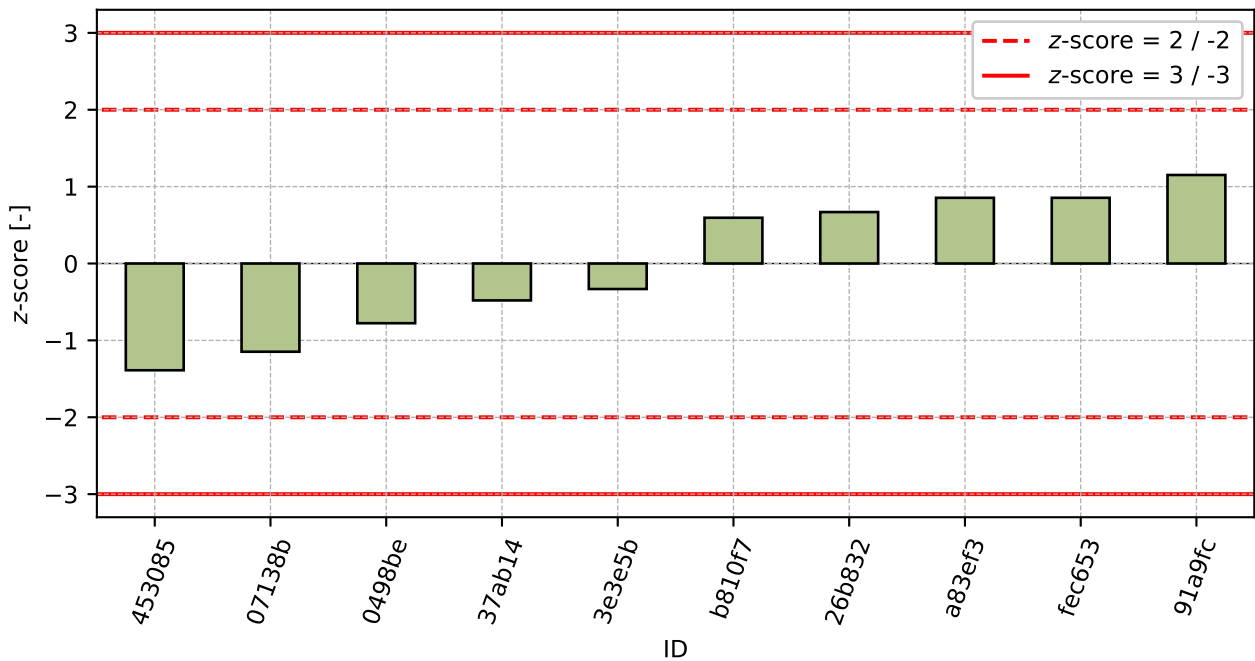
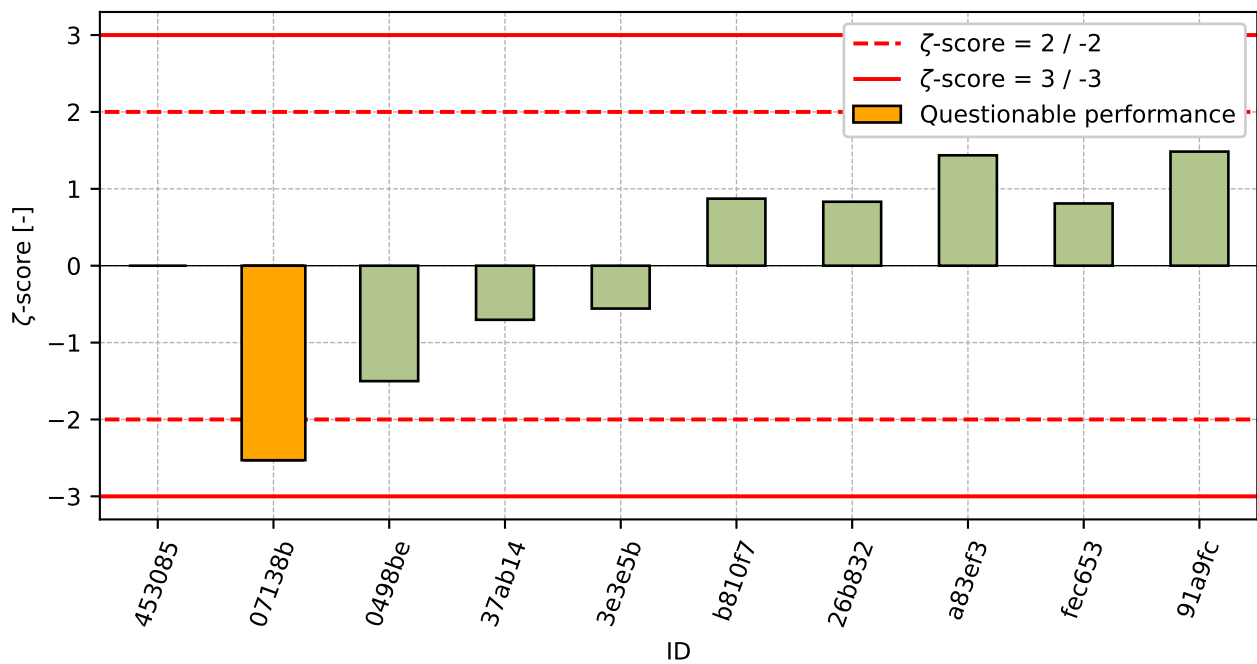


Figure 26: z-score

Figure 27: ζ -scoreTable 12: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
453085	-1.39	-
07138b	-1.15	-2.53
0498be	-0.78	-1.5
37ab14	-0.48	-0.7
3e3e5b	-0.33	-0.56
b810f7	0.6	0.87
26b832	0.67	0.83
a83ef3	0.85	1.44
fec653	0.85	0.81
91a9fc	1.15	1.48

1.4 Compressive Strength after 7 days of ageing

1.4.1 Test results

Table 13: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]						u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
fec653	32.5	31.9	33.4	33.0	31.9	32.0	3.5	32.4	0.63	1.96
3e3e5b	35.3	33.8	34.4	35.9	34.7	35.0	1.5	34.8	0.73	2.09
b810f7	39.1	37.2	37.8	38.1	38.1	38.8	1.4	38.2	0.69	1.79
26b832	38.8	39.4	38.8	40.0	39.4	40.6	1.5	39.5	0.7	1.78
453085	41.6	39.7	42.9	40.0	44.3	41.7	-	41.7	1.73	4.15
a83ef3	45.0	45.2	45.4	44.6	45.2	43.8	3.2	44.9	0.59	1.31
37ab14	44.8	44.5	46.4	43.4	44.7	46.3	2.0	45.0	1.15	2.55
07138b	45.0	45.0	45.3	45.9	45.9	43.8	1.2	45.2	0.78	1.72
0498be	44.4	45.8	49.1	48.4	46.2	46.2	2.3	46.7	1.73	3.7
91a9fc	49.0	48.9	49.1	49.1	48.9	49.1	0.8	49.0	0.1	0.2

1.4.2 The Numerical Procedure for Determining Outliers

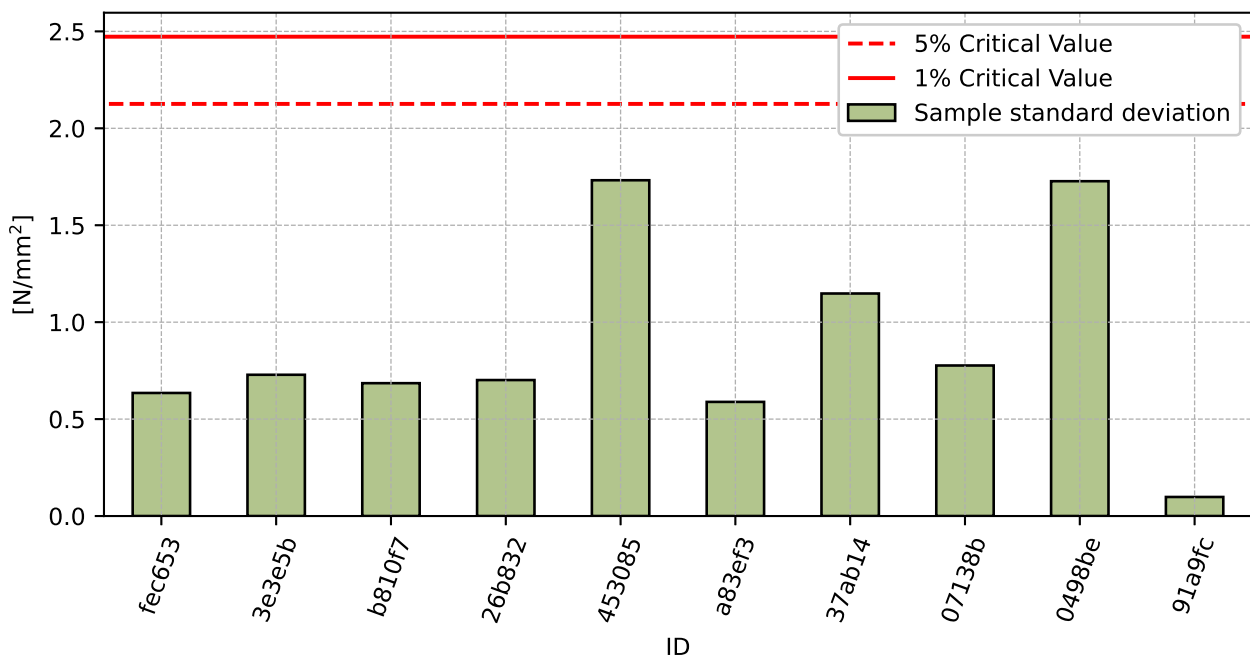


Figure 28: **Cochran's test** - sample standard deviations

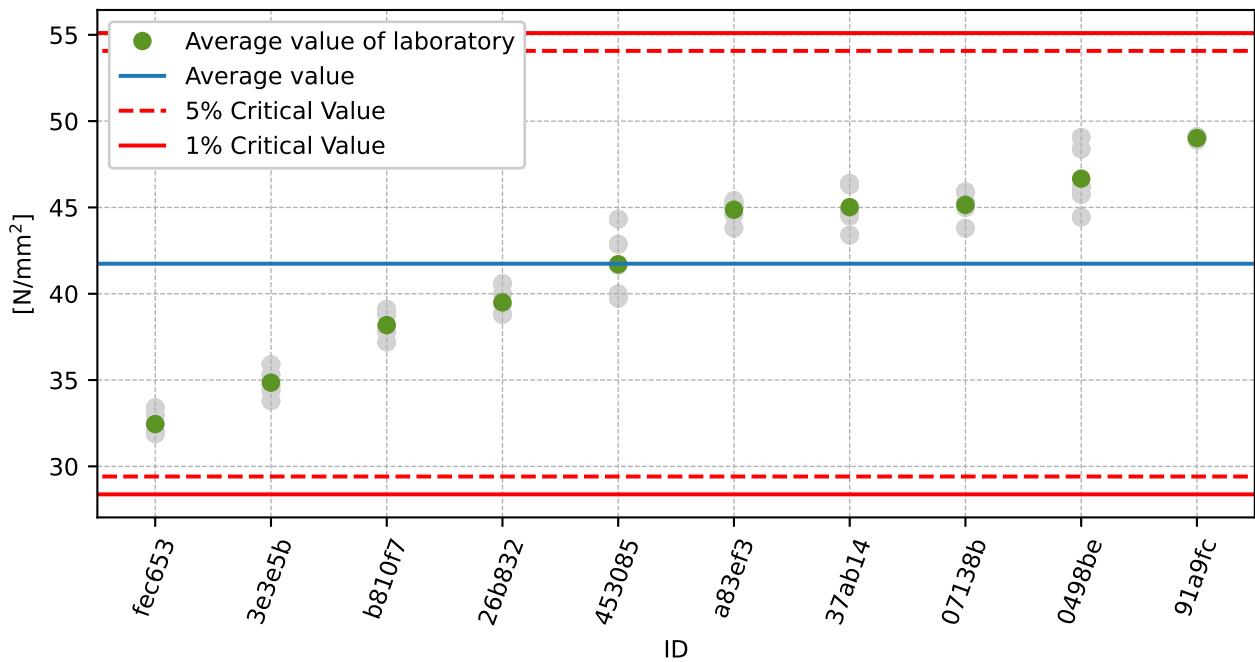


Figure 29: **Grubbs' test** - average values

1.4.3 Mandel's Statistics

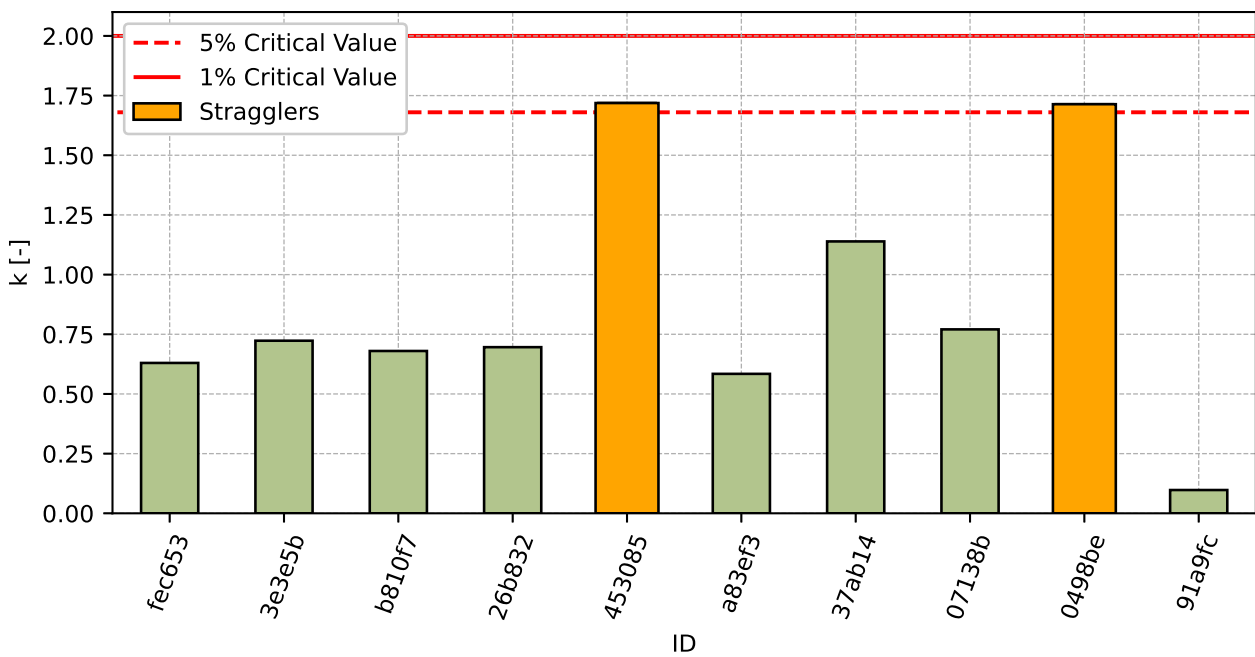


Figure 30: Intralaboratory Consistency Statistic

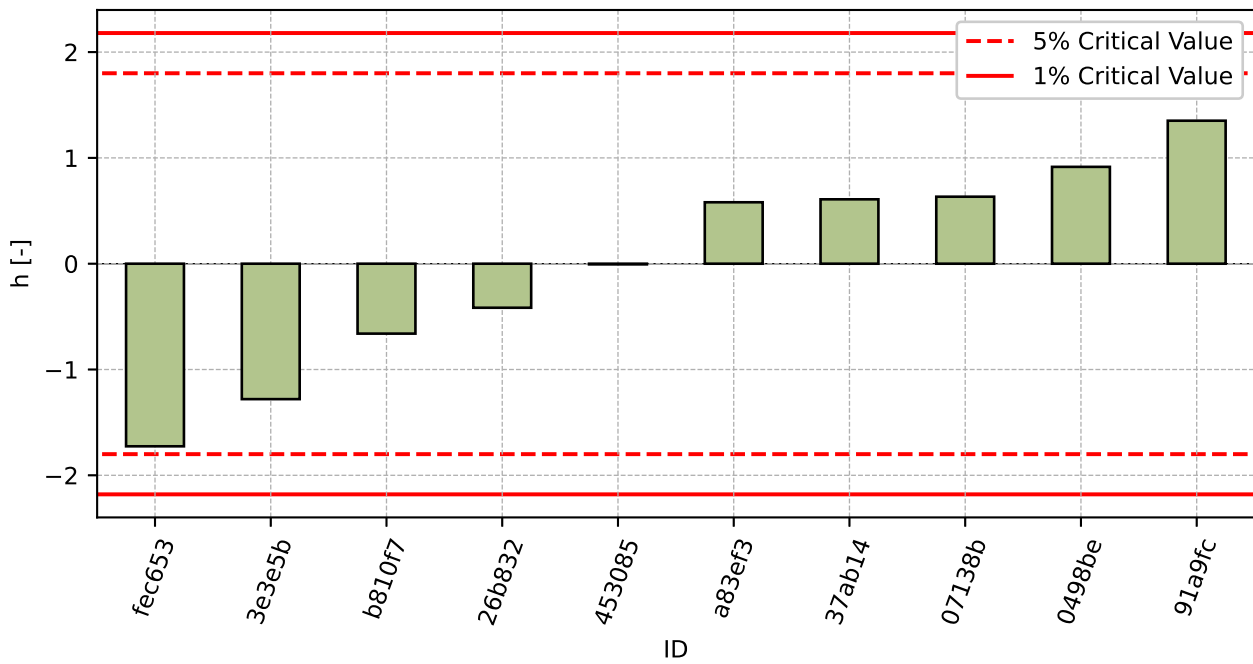


Figure 31: Interlaboratory Consistency Statistic

1.4.4 Descriptive statistics

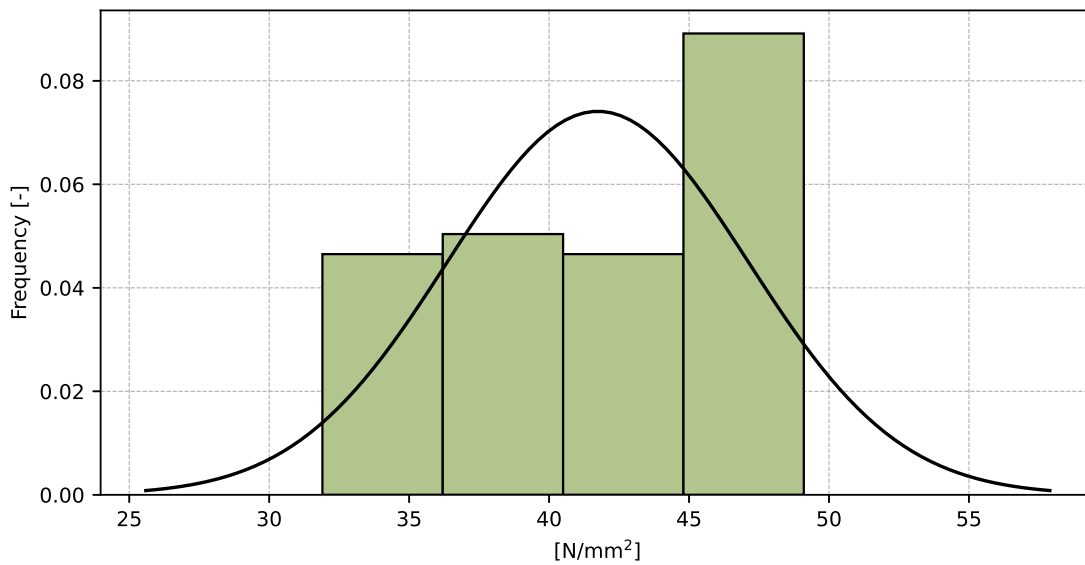


Figure 32: Histogram of all test results

Table 14: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	41.7
Sample standard deviation – s	5.38
Assigned value – x^*	42.1
Robust standard deviation – s^*	5.18
Measurement uncertainty of assigned value – u_X	2.05
p -value of normality test	0.002 [-]
Interlaboratory standard deviation – s_L	5.37
Repeatability standard deviation – s_r	1.01
Reproducibility standard deviation – s_R	5.46
Repeatability – r	2.8
Reproducibility – R	15.3

1.4.5 Evaluation of Performance Statistics

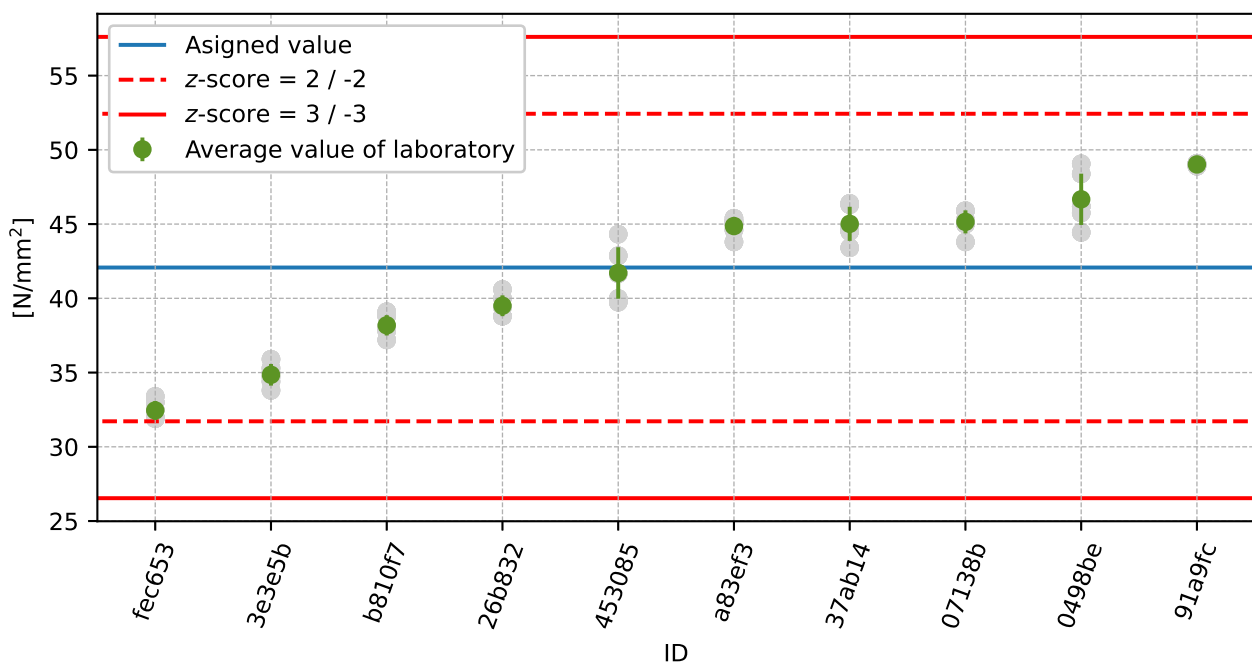


Figure 33: Average values and sample standard deviations

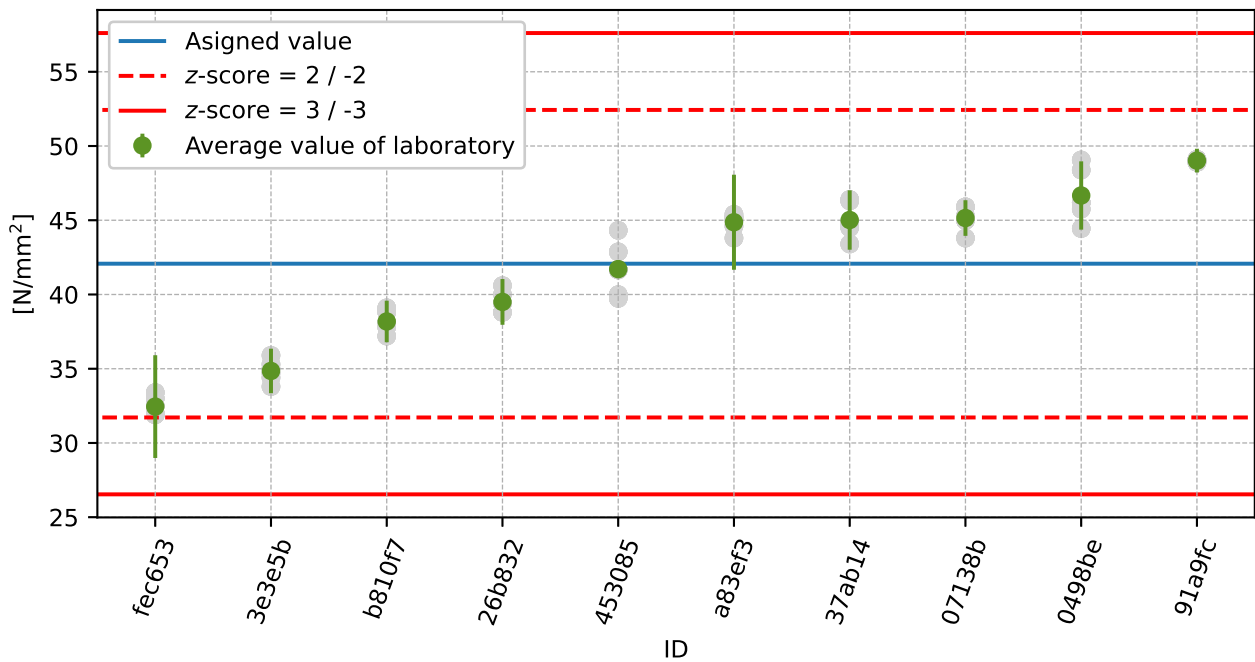


Figure 34: Average values and extended uncertainties of measurement

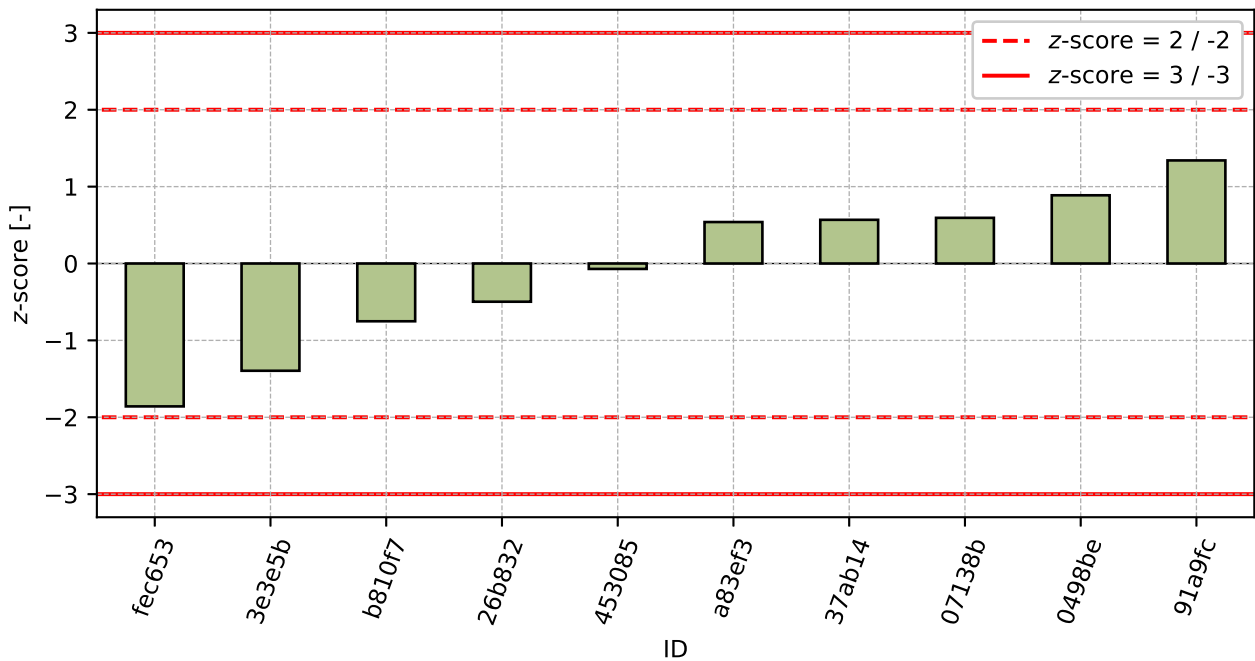


Figure 35: z-score

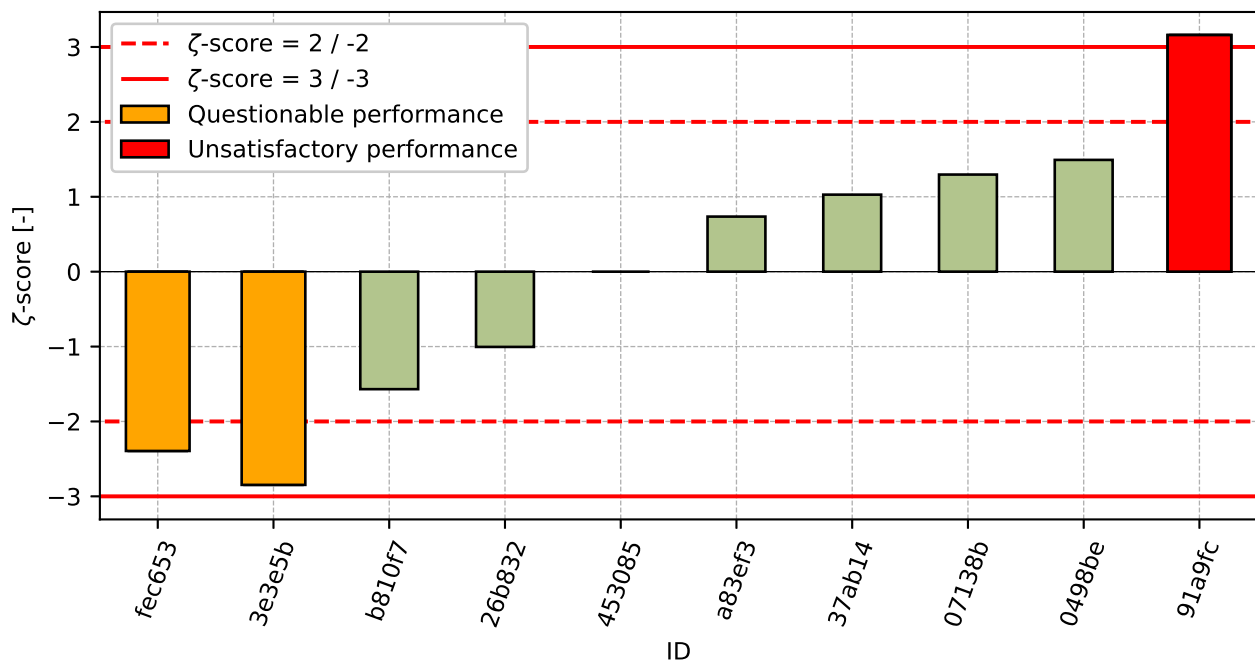


Figure 36: ζ -score

Table 15: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
fec653	-1.86	-2.39
3e3e5b	-1.4	-2.85
b810f7	-0.75	-1.57
26b832	-0.5	-1.0
453085	-0.07	-
a83ef3	0.54	0.74
37ab14	0.57	1.03
07138b	0.59	1.3
0498be	0.89	1.49
91a9fc	1.34	3.16

1.5 Flexural Strength after 28 days of ageing

1.5.1 Test results

Table 16: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]			u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
0498be	7.1	8.0	7.6	0.3	7.6	0.45	5.96
37ab14	7.5	8.0	7.2	0.5	7.6	0.4	5.34
453085	7.8	7.7	7.4	-	7.7	0.22	2.84
3e3e5b	8.3	8.0	8.3	0.4	8.2	0.17	2.11
b810f7	8.6	8.9	9.1	0.5	8.9	0.25	2.84
a83ef3	9.0	9.2	9.2	0.5	9.1	0.12	1.26
91a9fc	10.6	10.5	10.3	0.5	10.5	0.15	1.46
26b832	10.5	10.1	10.8	0.4	10.5	0.35	3.36
fec653	12.0	11.0	12.9	1.3	12.0	0.95	7.94
07138b	30.5	29.5	32.6	0.2	30.9	1.58	5.13

1.5.2 The Numerical Procedure for Determining Outliers

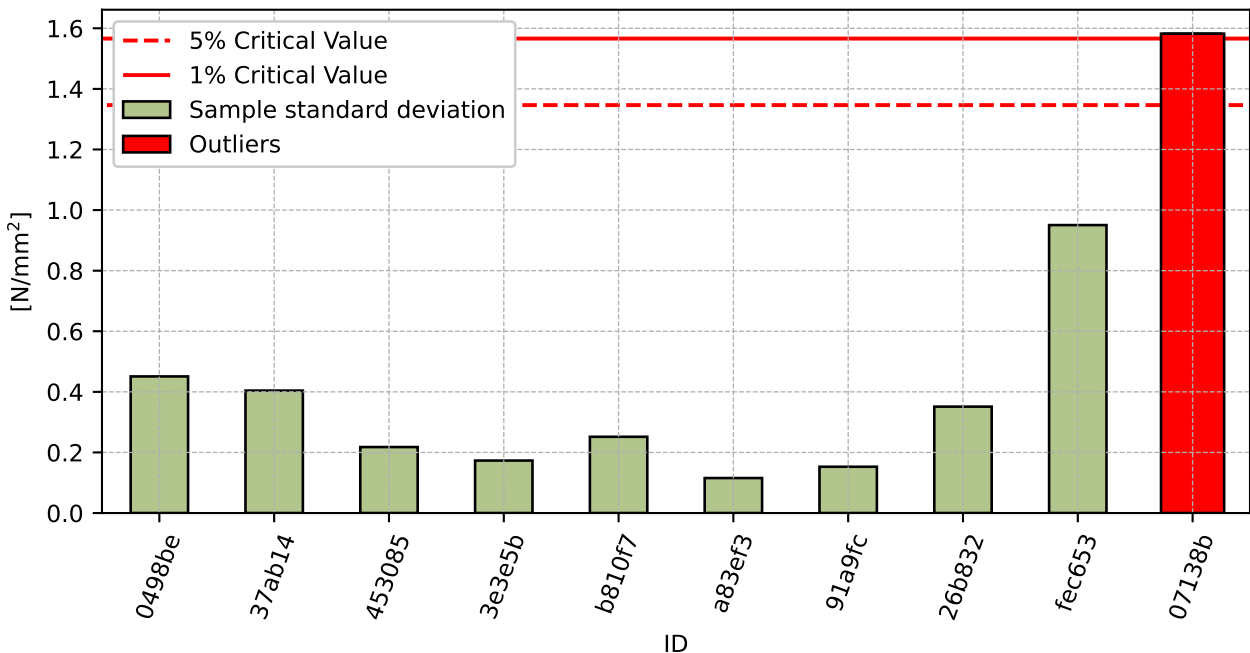


Figure 37: Cochran's test - sample standard deviations

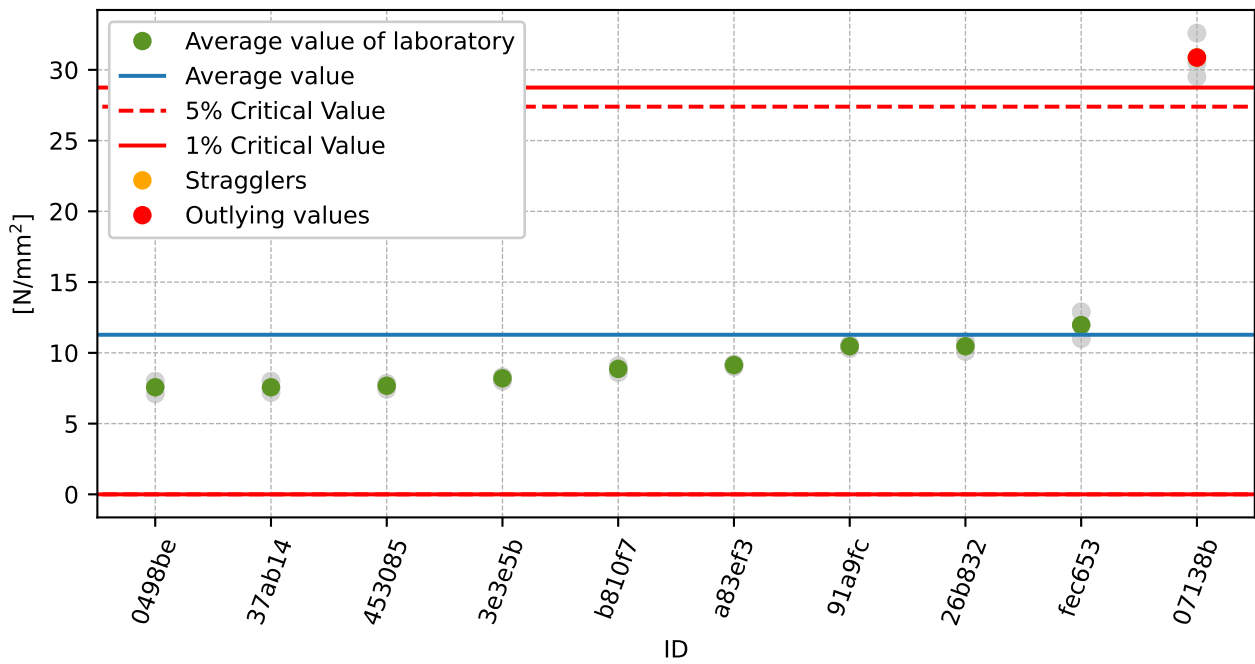


Figure 38: **Grubbs' test** - average values

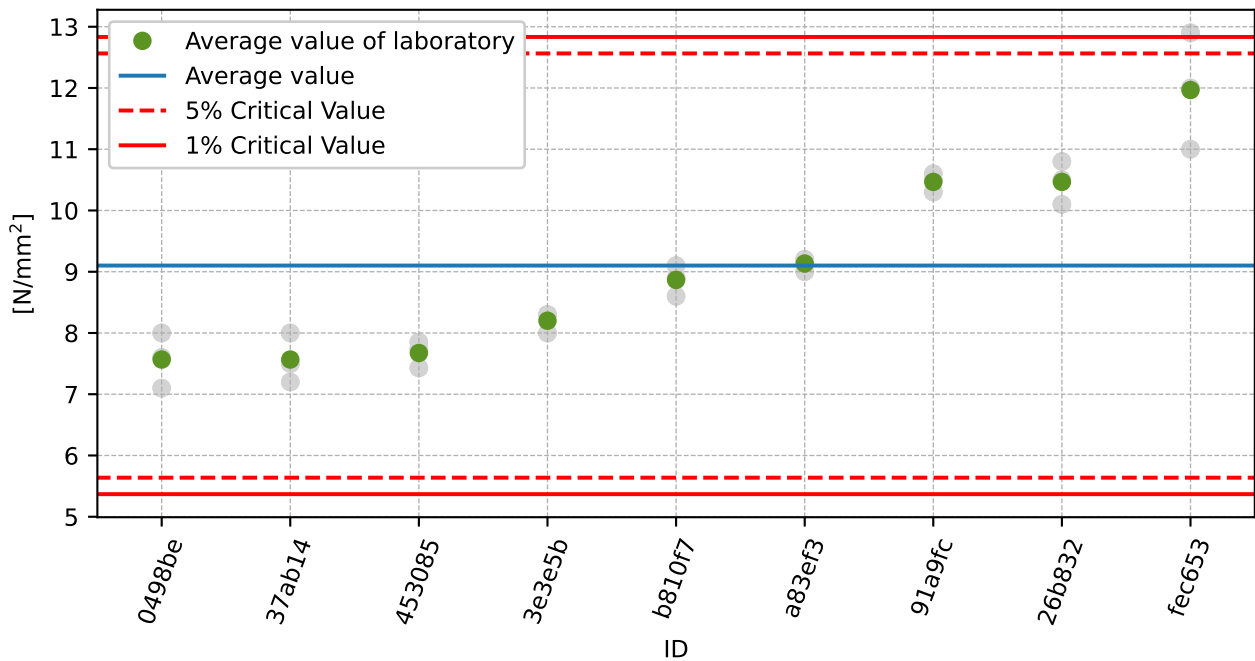


Figure 39: **Grubbs' test** - average values without outliers

1.5.3 Mandel’s Statistics

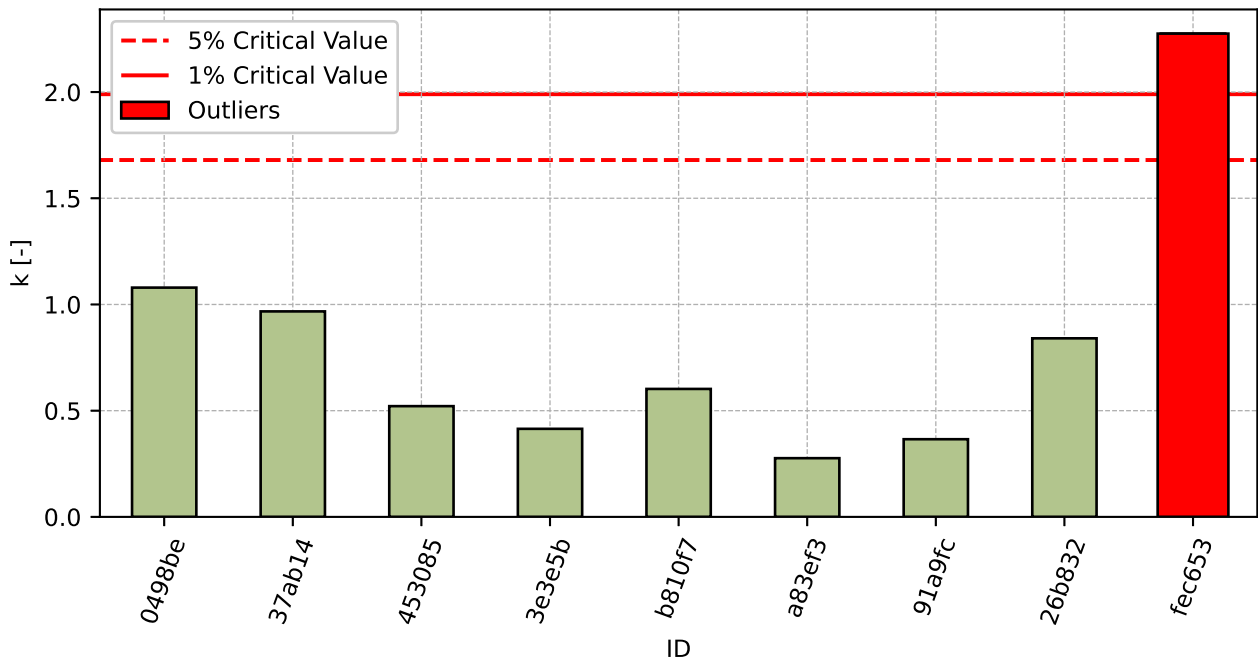


Figure 40: Intralaboratory Consistency Statistic

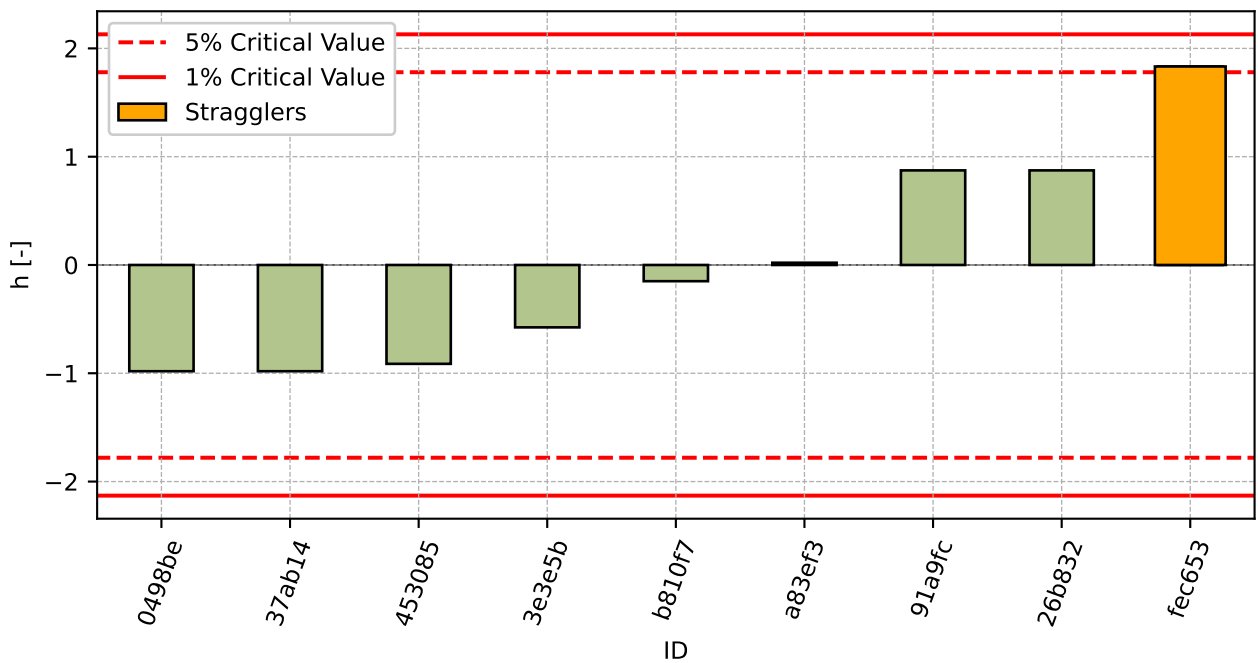


Figure 41: Interlaboratory Consistency Statistic

1.5.4 Descriptive statistics

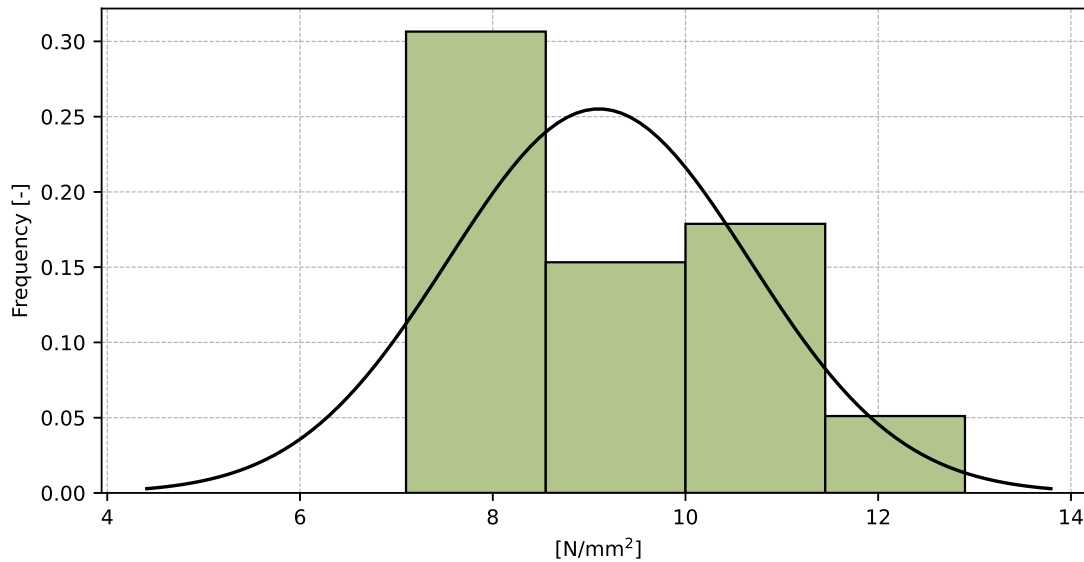


Figure 42: Histogram of all test results

Table 17: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	9.1
Sample standard deviation – s	1.56
Assigned value – x^*	9.1
Robust standard deviation – s^*	1.67
Measurement uncertainty of assigned value – u_X	0.7
p -value of normality test	0.059 [-]
Interlaboratory standard deviation – s_L	1.54
Repeatability standard deviation – s_r	0.42
Reproducibility standard deviation – s_R	1.6
Repeatability – r	1.2
Reproducibility – R	4.5

1.5.5 Evaluation of Performance Statistics

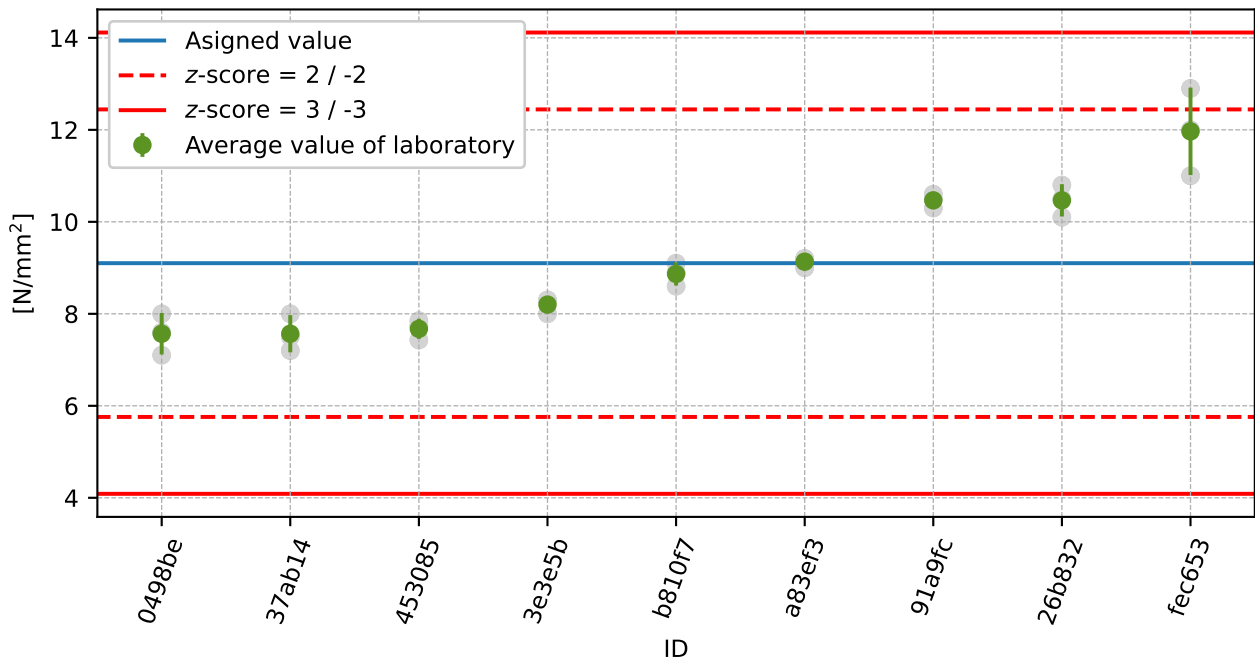


Figure 43: Average values and sample standard deviations

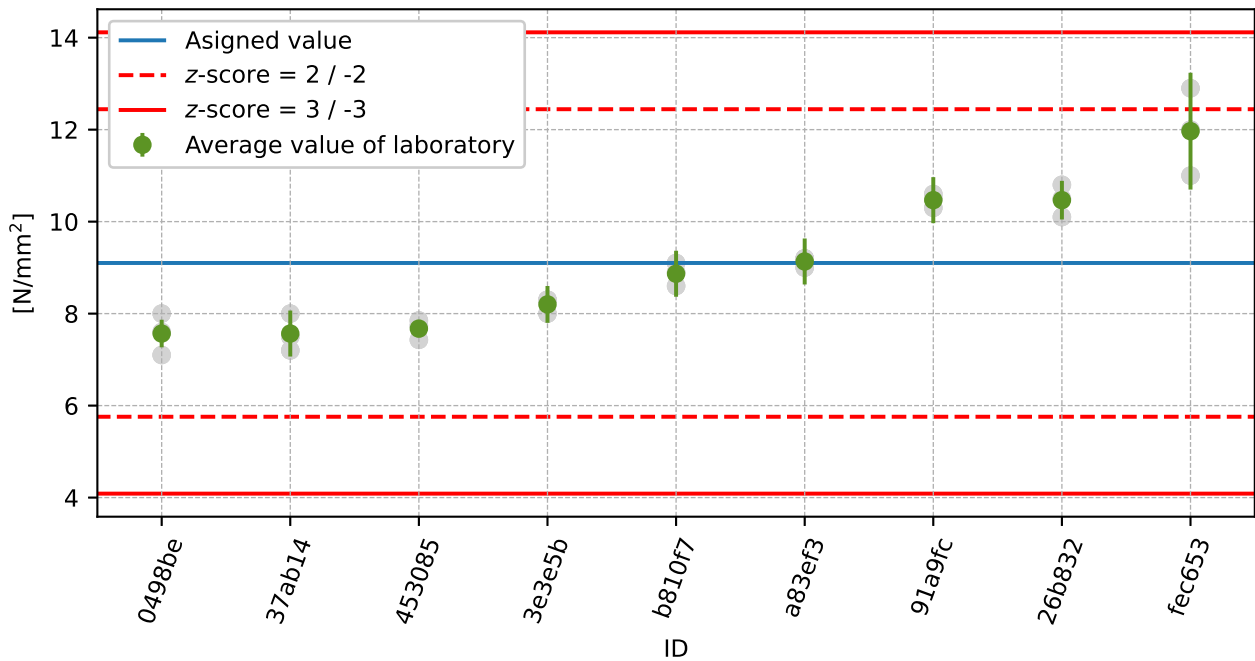


Figure 44: Average values and extended uncertainties of measurement

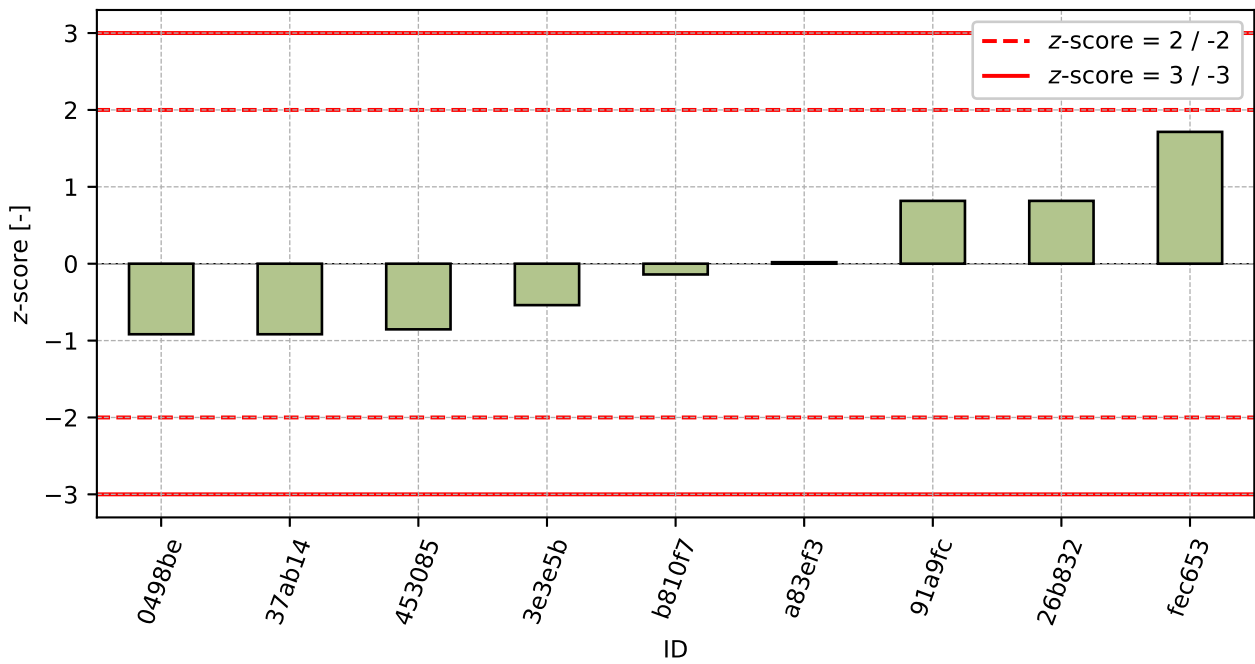


Figure 45: z-score

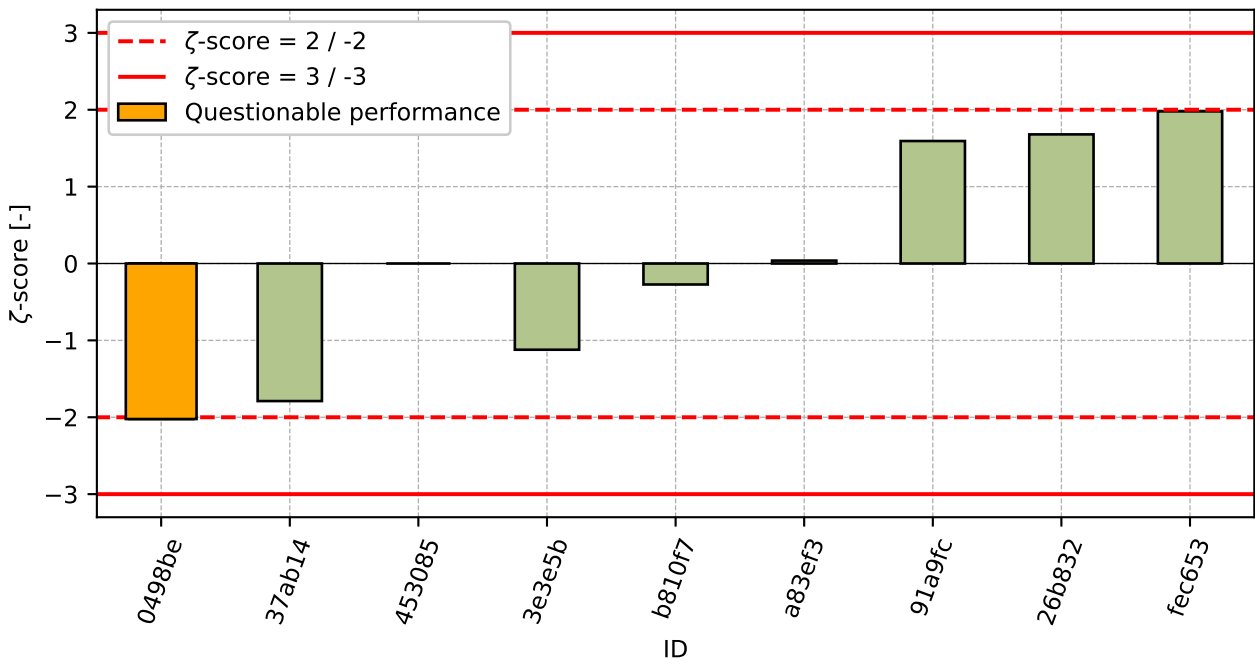


Figure 46: ζ-score

Table 18: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
0498be	-0.92	-2.02
37ab14	-0.92	-1.79
453085	-0.85	-
3e3e5b	-0.54	-1.12
b810f7	-0.14	-0.27
a83ef3	0.02	0.04
91a9fc	0.82	1.59
26b832	0.82	1.68
fec653	1.71	1.98

1.6 Compressive Strength after 28 days of ageing

1.6.1 Test results

Table 19: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results						u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
	[N/mm ²]									
b810f7	47.8	48.8	48.1	49.4	46.9	49.4	1.9	48.4	0.99	2.04
26b832	50.0	50.6	49.4	50.0	48.8	50.0	1.4	49.8	0.62	1.24
3e3e5b	49.0	48.4	50.1	50.1	52.5	52.1	2.2	50.4	1.64	3.25
453085	52.3	47.9	50.6	48.9	53.9	52.1	-	50.9	2.24	4.39
37ab14	53.4	50.2	54.8	57.7	52.5	53.9	3.0	53.7	2.49	4.63
fec653	53.0	52.9	55.1	55.4	54.6	54.2	5.8	54.2	1.05	1.94
503a6a	55.1	54.9	53.3	54.4	55.9	53.1	2.0	54.5	1.08	1.99
a83ef3	54.2	54.5	55.4	54.6	55.3	55.2	4.0	54.9	0.5	0.91
07138b	57.5	55.9	57.8	56.3	57.5	56.3	1.2	56.9	0.81	1.42
0498be	61.5	61.8	58.1	60.2	59.7	60.1	2.9	60.2	1.34	2.22
91a9fc	62.2	62.4	60.0	61.6	61.9	60.6	1.4	61.4	0.95	1.55

1.6.2 The Numerical Procedure for Determining Outliers

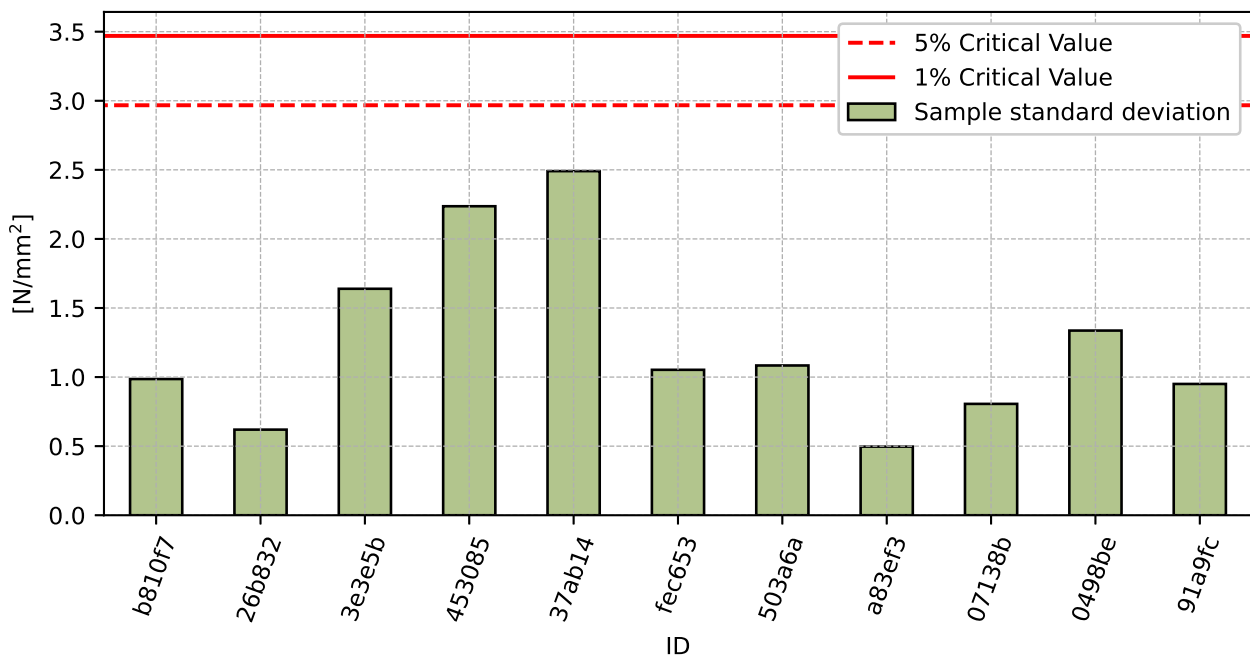


Figure 47: Cochran's test - sample standard deviations

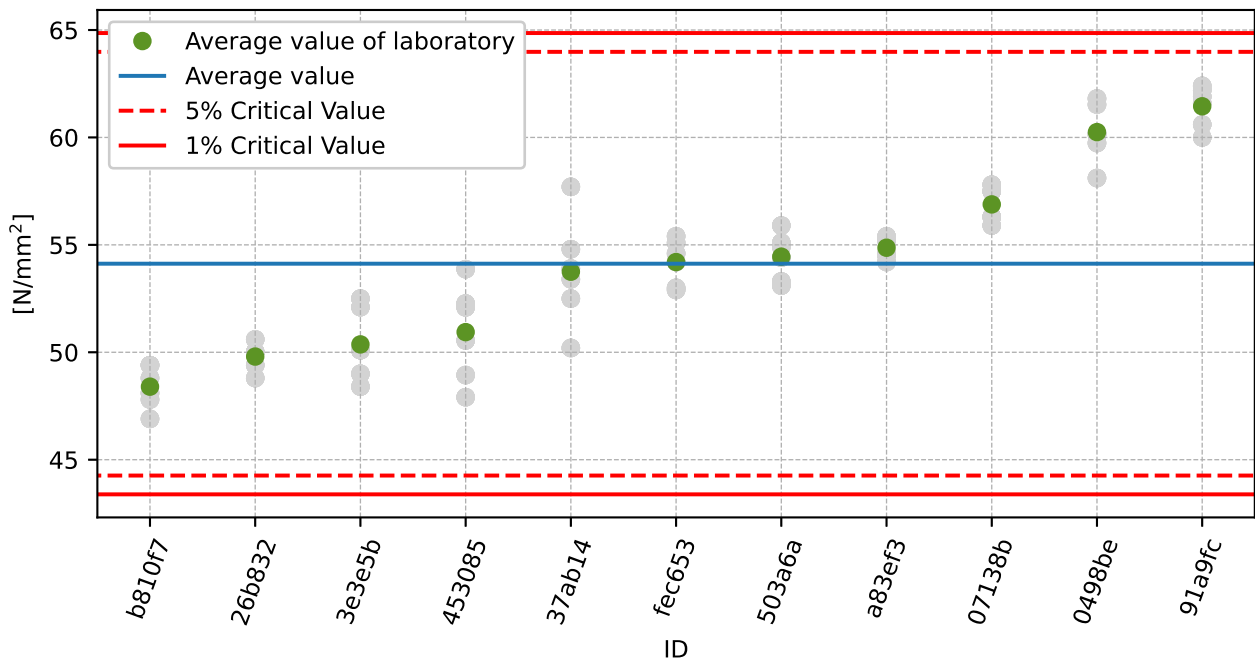


Figure 48: **Grubbs' test** - average values

1.6.3 Mandel's Statistics

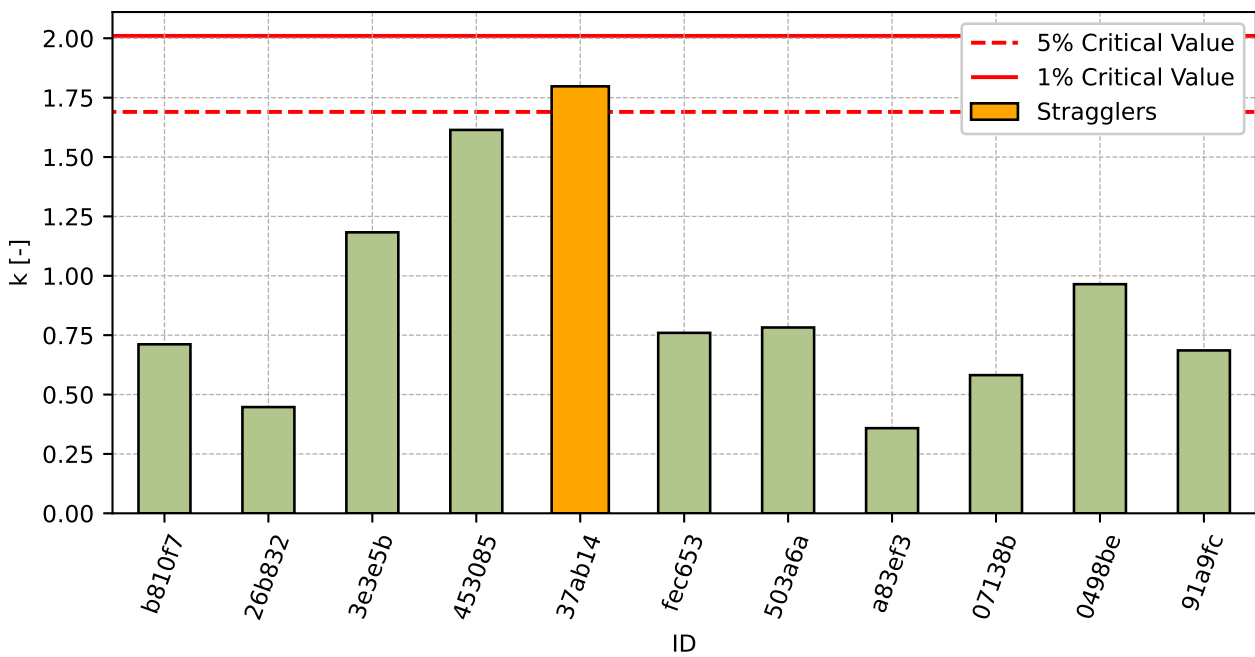


Figure 49: Intralaboratory Consistency Statistic

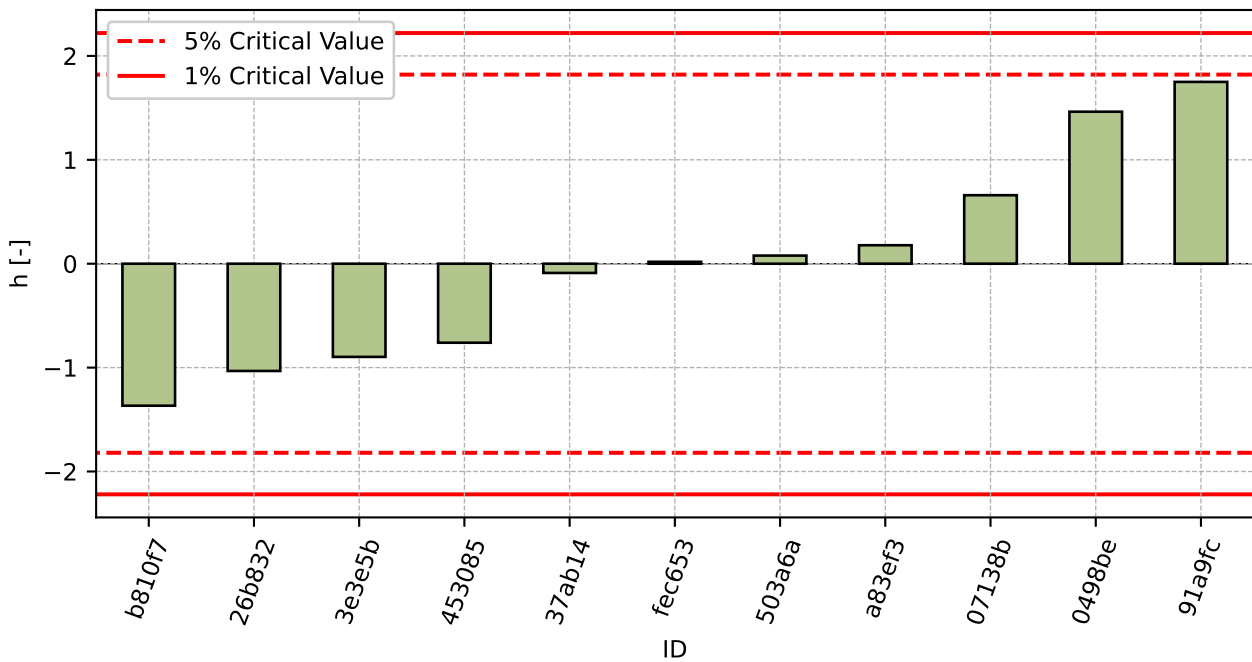


Figure 50: Interlaboratory Consistency Statistic

1.6.4 Descriptive statistics

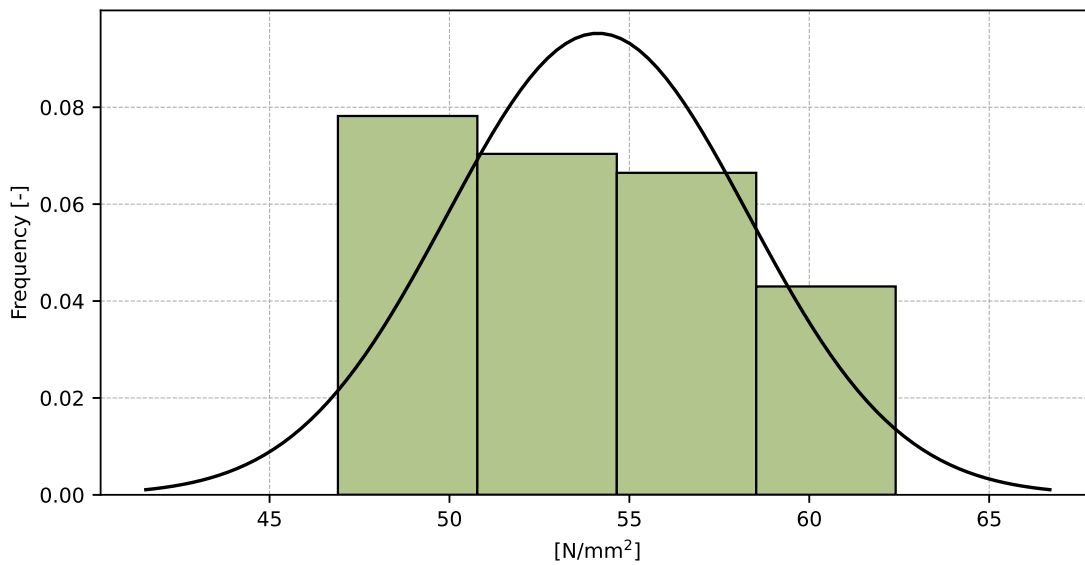


Figure 51: Histogram of all test results

Table 20: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	54.1
Sample standard deviation – s	4.19
Assigned value – x^*	54.1
Robust standard deviation – s^*	4.53
Measurement uncertainty of assigned value – u_X	1.71
p -value of normality test	0.018 [-]
Interlaboratory standard deviation – s_L	4.15
Repeatability standard deviation – s_r	1.39
Reproducibility standard deviation – s_R	4.37
Repeatability – r	3.9
Reproducibility – R	12.2

1.6.5 Evaluation of Performance Statistics

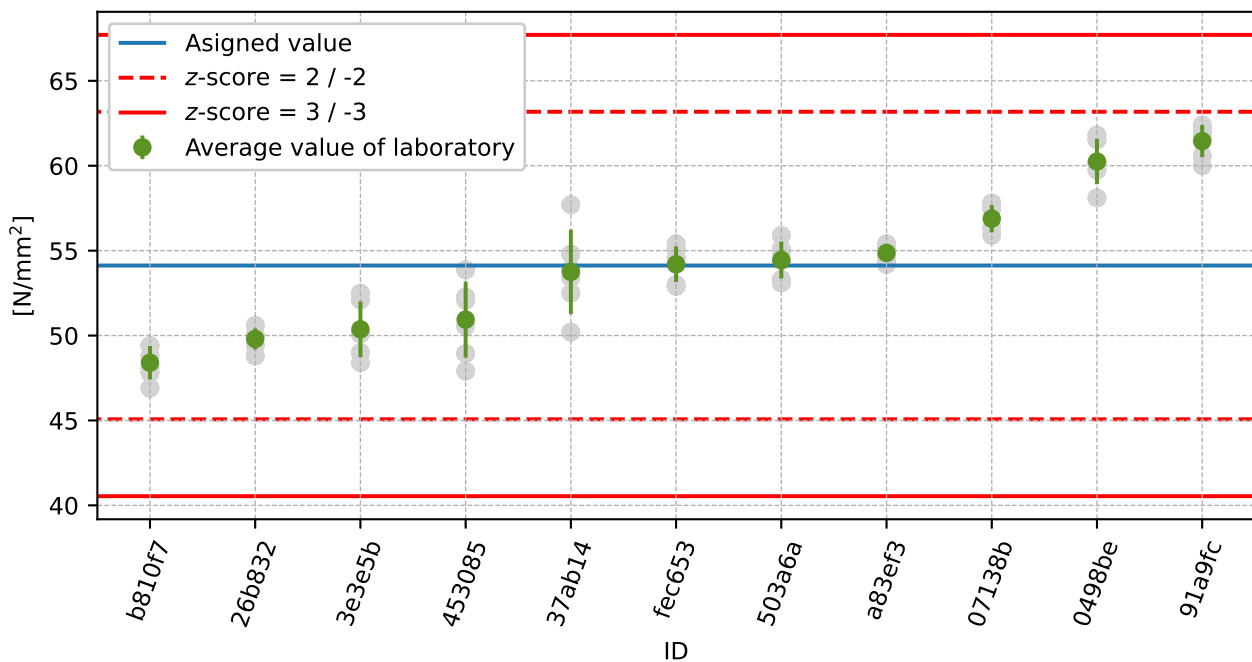


Figure 52: Average values and sample standard deviations

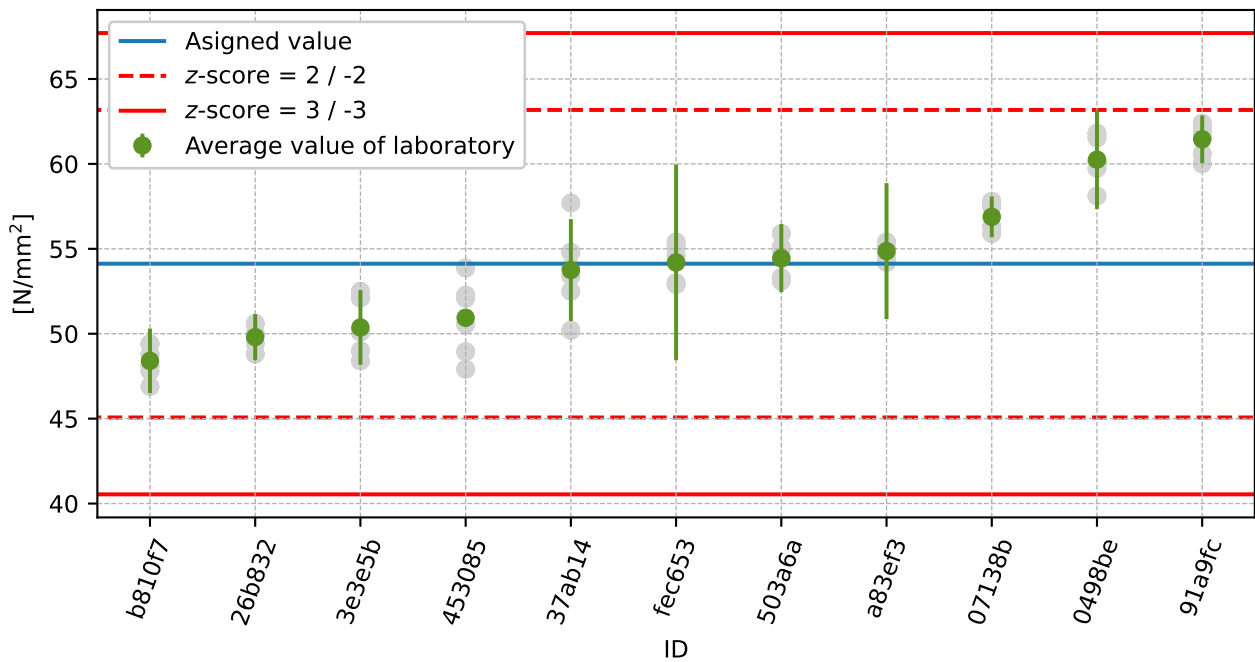


Figure 53: Average values and extended uncertainties of measurement

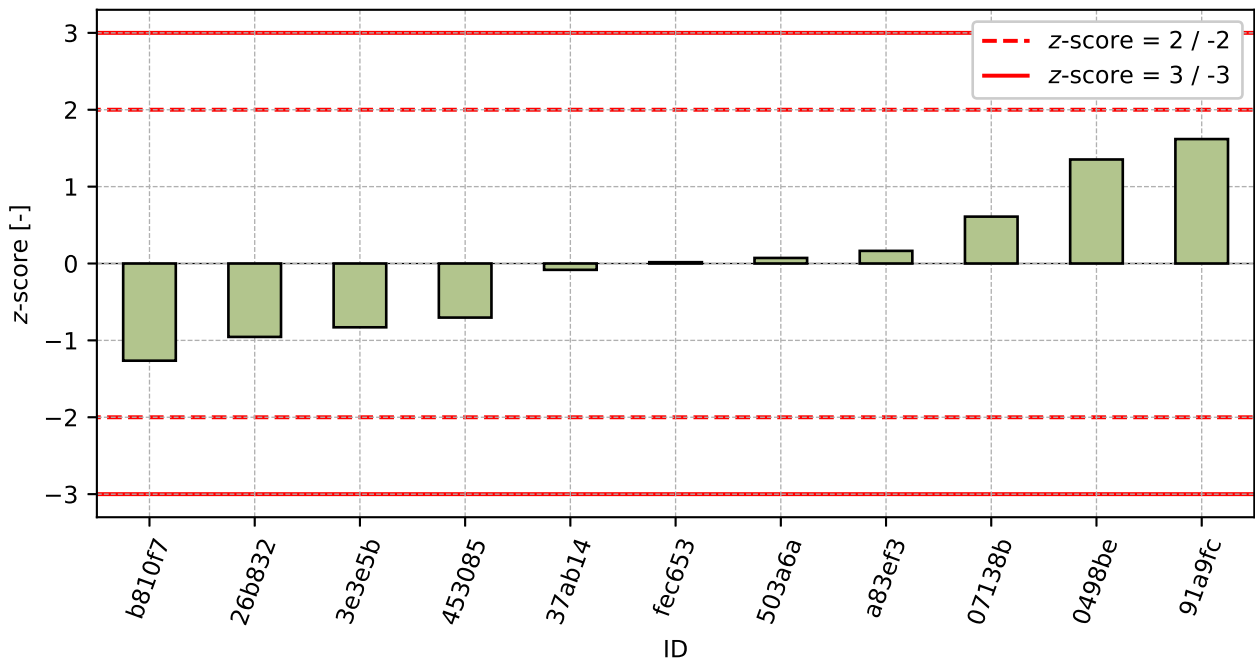


Figure 54: z-score

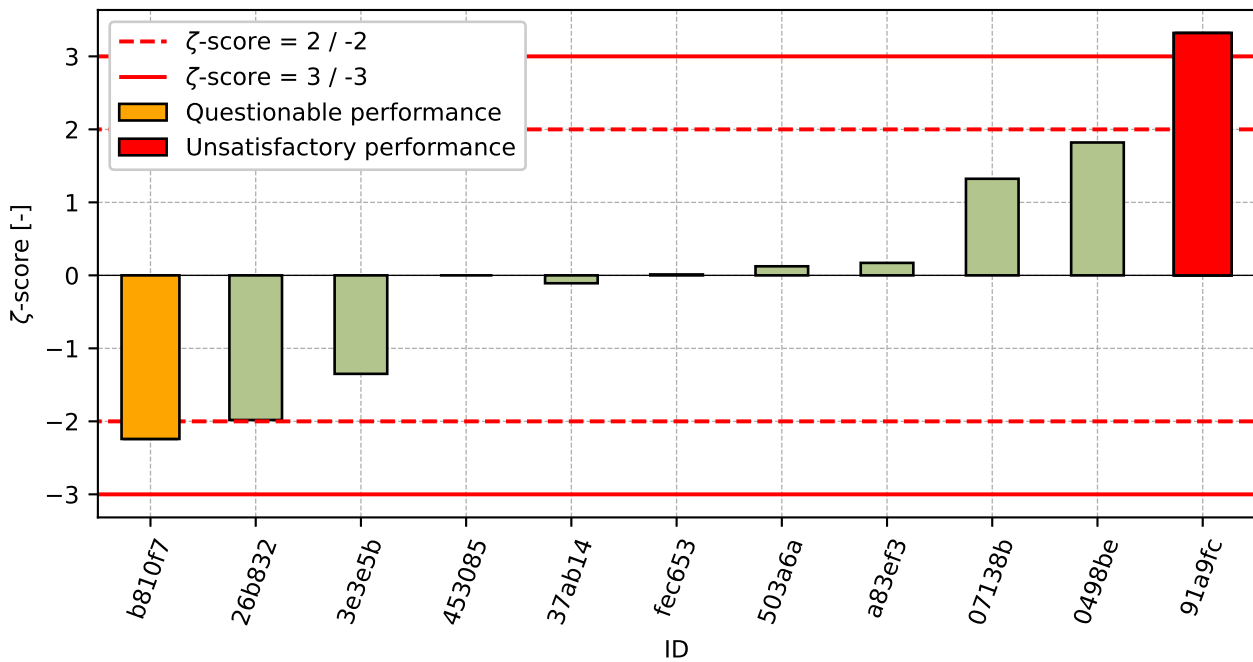


Figure 55: z-score

Table 21: z-score and zeta-score

ID	z-score [-]	zeta-score [-]
b810f7	-1.26	-2.24
26b832	-0.95	-1.98
3e3e5b	-0.83	-1.35
453085	-0.7	-
37ab14	-0.08	-0.11
fec653	0.02	0.01
503a6a	0.07	0.12
a83ef3	0.16	0.17
07138b	0.61	1.32
0498be	1.35	1.82
91a9fc	1.62	3.32

2 Appendix – EN 196-2 (art. 4.4.1) – Determination of loss on ignition

2.1 Test results

Table 22: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results			u_x [%]	\bar{x} [%]	s_0 [%]	V_x [%]
	[%]	[%]	[%]				
fec653	0.6	0.5	0.4	0.05	0.5	0.1	20.0
d04726	3.38	3.36	3.4	0.07	3.38	0.02	0.59
257269	3.4	3.39	3.38	0.06	3.39	0.01	0.29
a3354e	3.53	3.84	3.78	0.44	3.72	0.164	4.42
e66cd8	4.27	4.3	4.36	0.28	4.31	0.046	1.06

2.2 The Numerical Procedure for Determining Outliers

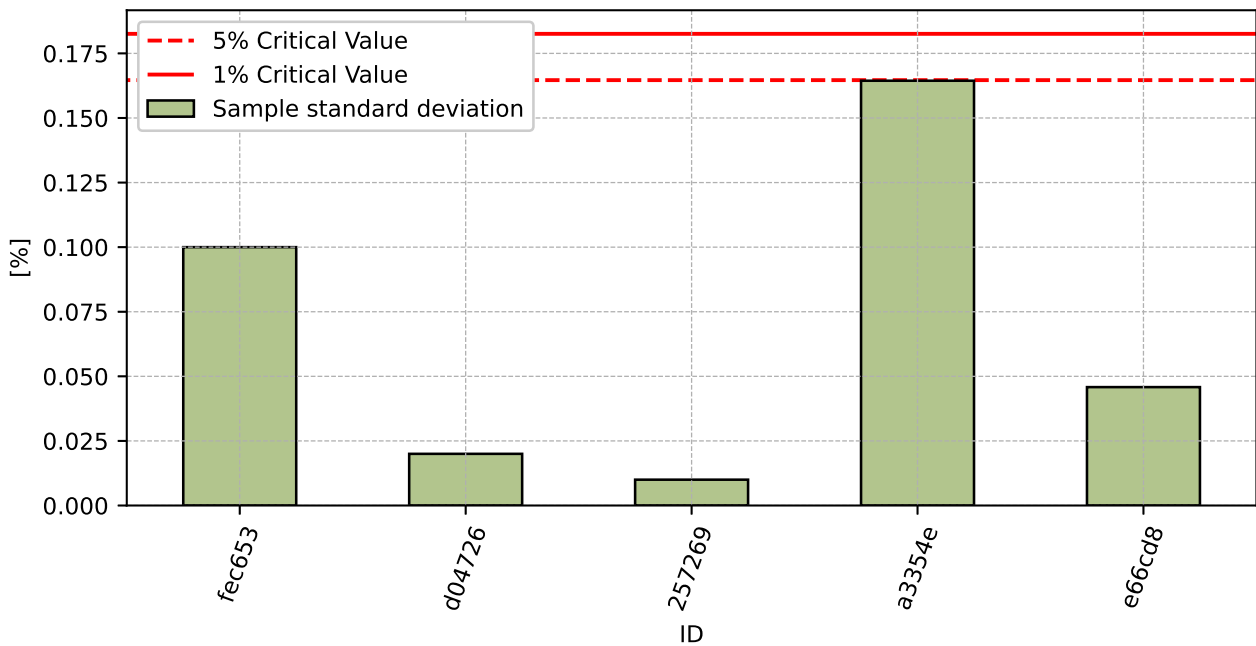


Figure 56: Cochran's test - sample standard deviations

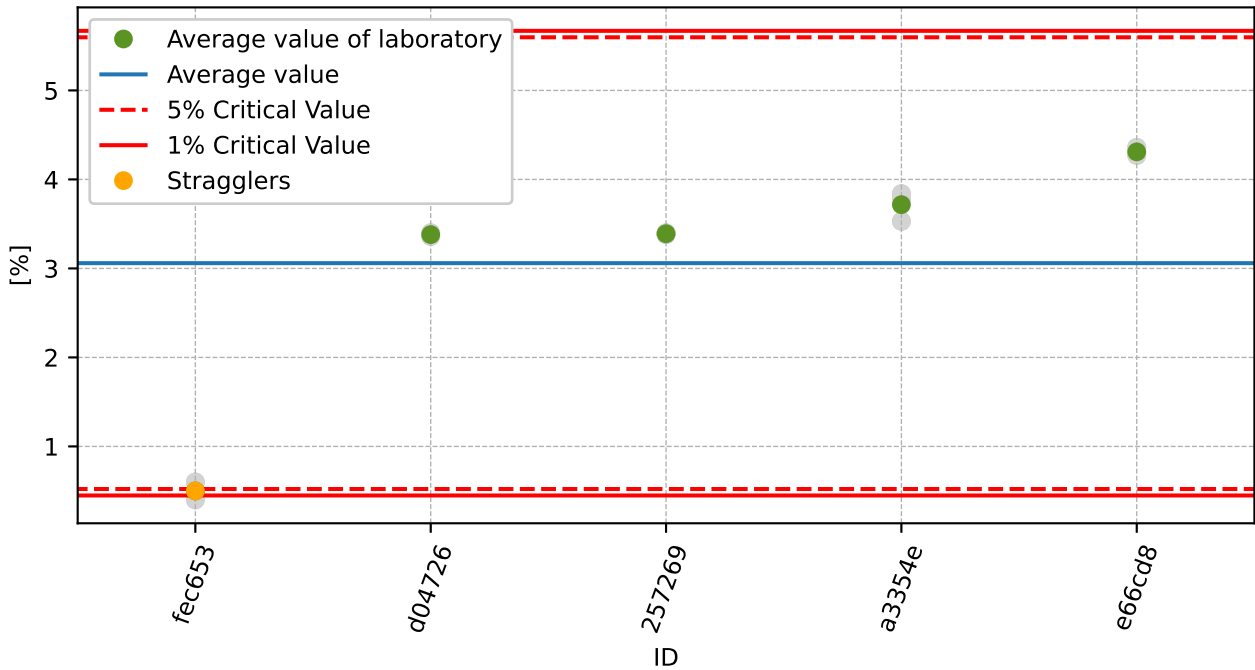


Figure 57: Grubbs' test - average values

2.3 Mandel's Statistics

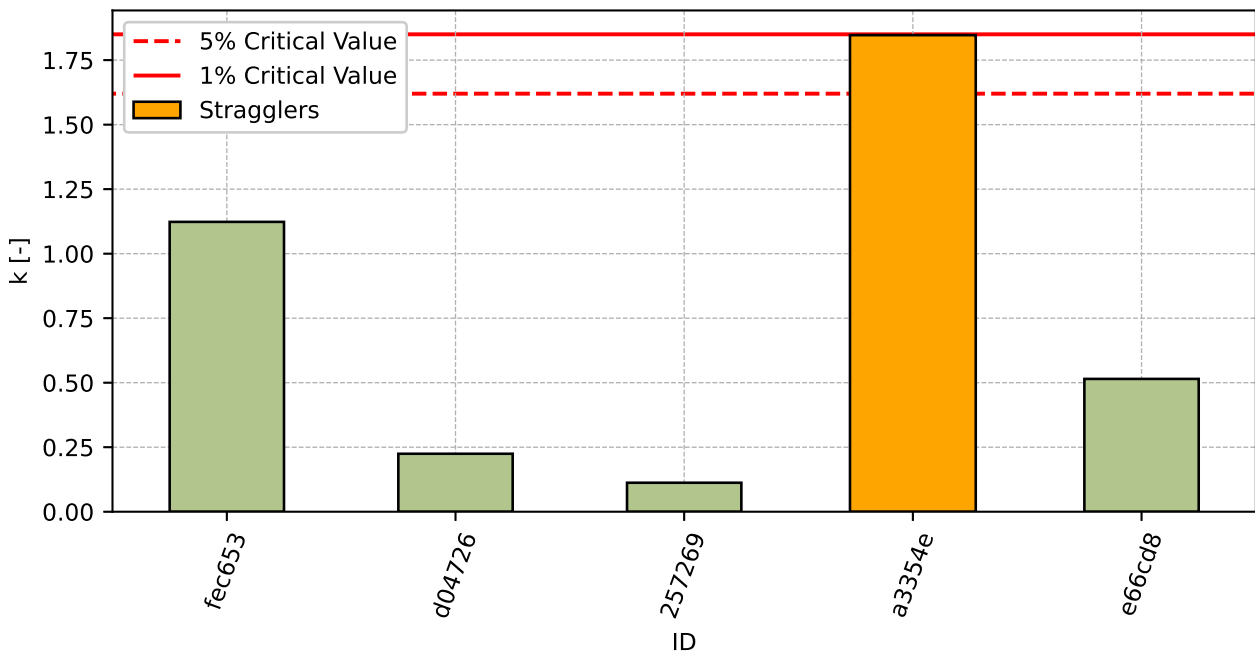


Figure 58: Intralaboratory Consistency Statistic

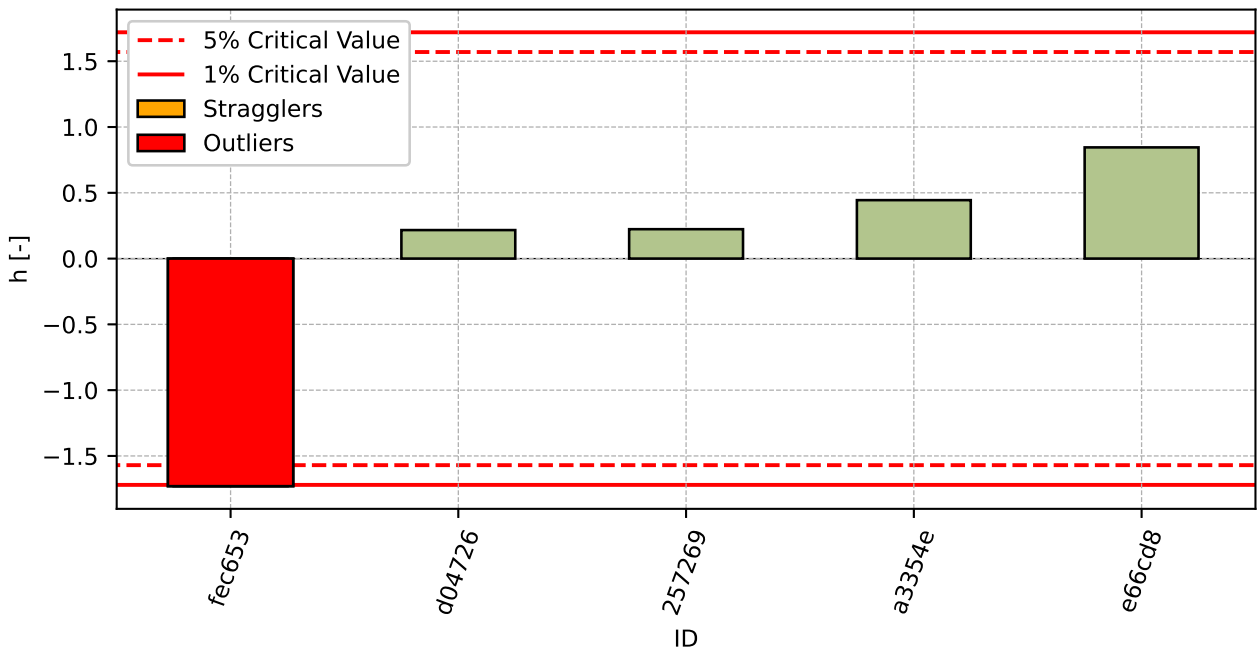


Figure 59: Interlaboratory Consistency Statistic

2.4 Descriptive statistics

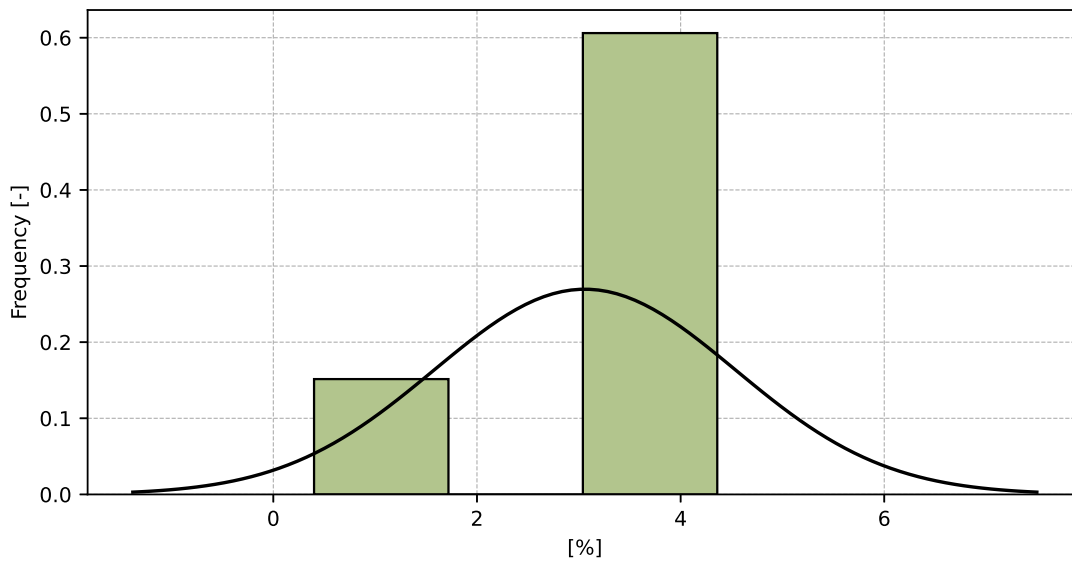


Figure 60: Histogram of all test results

Table 23: Descriptive statistics

Characteristics	[%]
Average value – \bar{x}	3.06
Sample standard deviation – s	1.48
Assigned value – x^*	3.49
Robust standard deviation – s^*	0.606
Measurement uncertainty of assigned value – u_X	0.339
p -value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	1.479
Repeatability standard deviation – s_r	0.089
Reproducibility standard deviation – s_R	1.482
Repeatability – r	0.25
Reproducibility – R	4.15

2.5 Evaluation of Performance Statistics

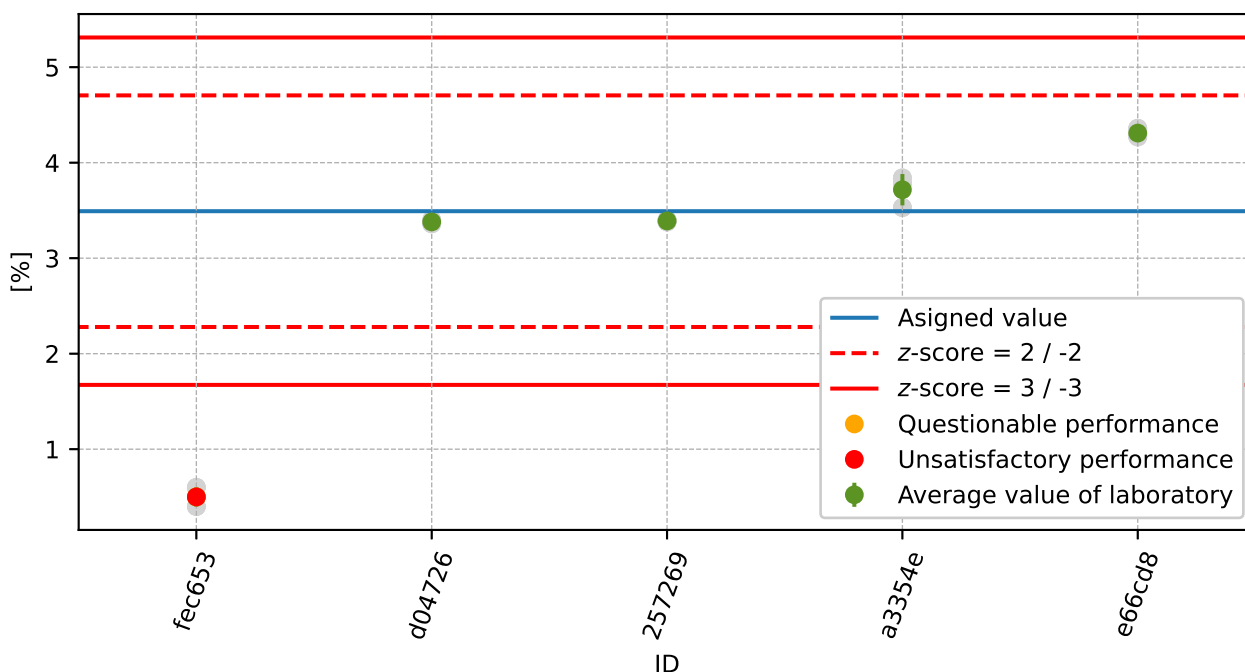


Figure 61: Average values and sample standard deviations

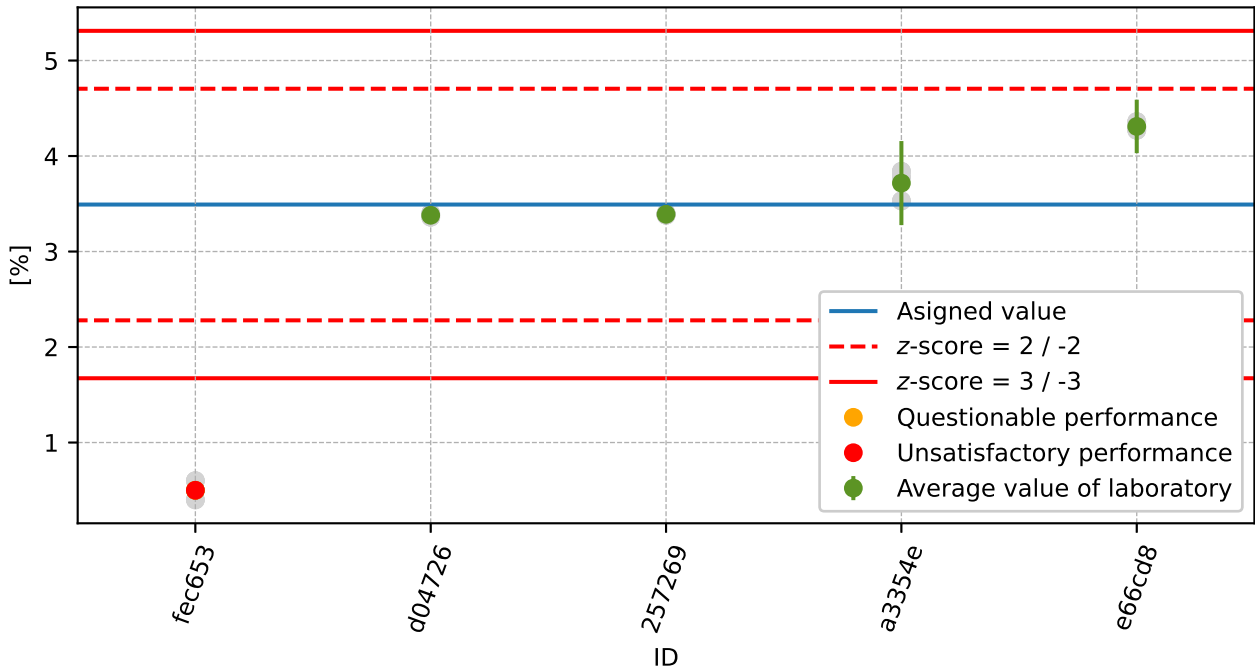


Figure 62: Average values and extended uncertainties of measurement

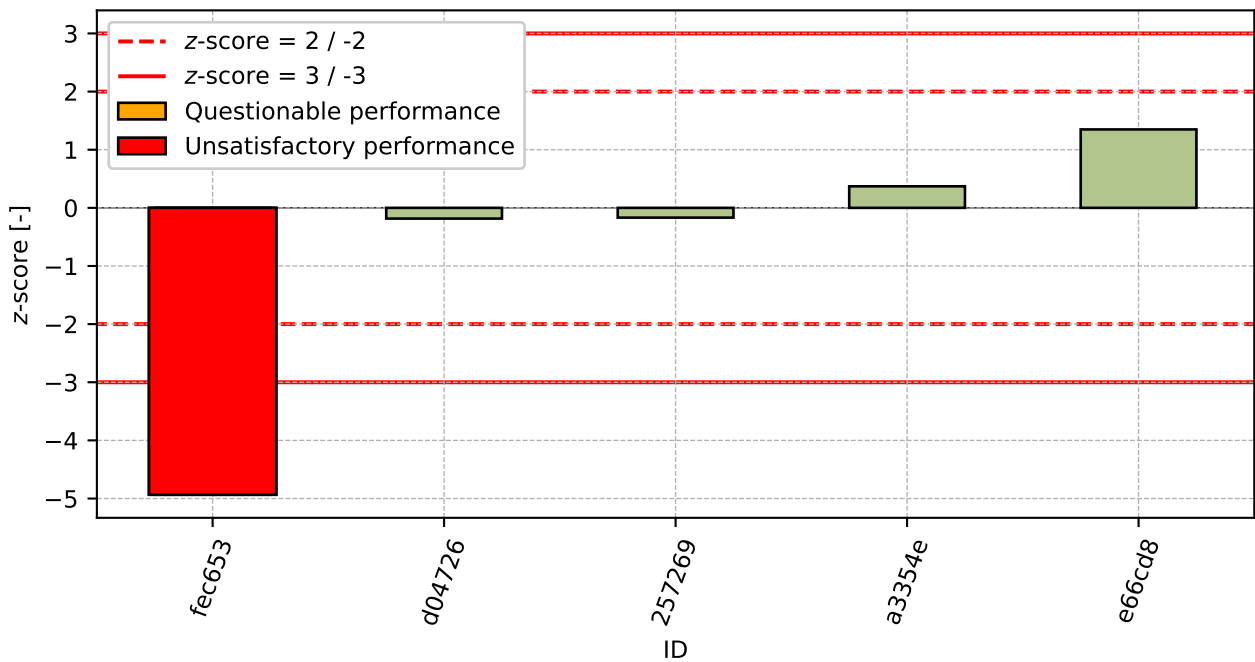


Figure 63: z-score

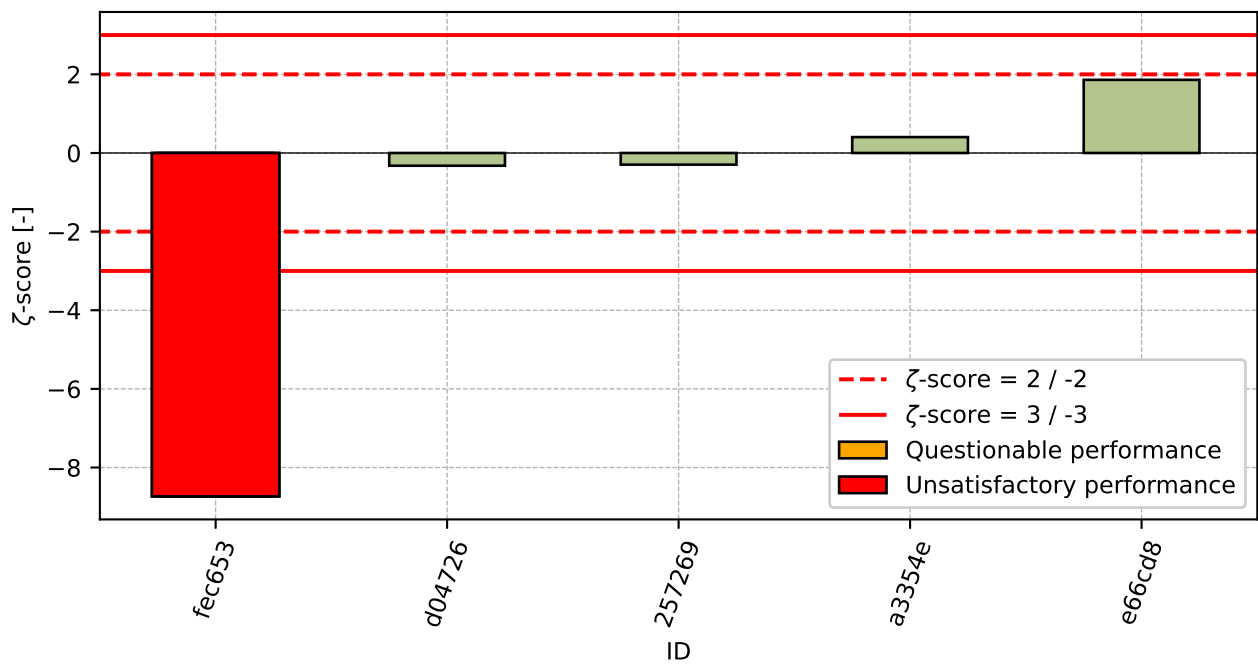


Figure 64: ζ -score

Table 24: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
fec653	-4.93	-8.73
d04726	-0.18	-0.32
257269	-0.17	-0.3
a3354e	0.37	0.4
e66cd8	1.35	1.86

This part of PT program was not open according to the low number of participants.

3 Appendix – EN 196-2 (art. 4.4.2) – Determination of sulphate content

This part of PT program was not open according to the low number of participants.

4 Appendix – EN 196-2 (art. 4.4.3) – Determination of the residue insoluble in hydrochloric acid and sodium carbonate

This part of PT program was not open due to low number of participants.

5 Appendix – EN 196-2 (art. 4.4.4) – Determination of the residue insoluble in hydrochloric acid and potassium hydroxide

This part of PT program was not open due to low number of participants.

6 Appendix – EN 196-2 (art. 4.4.5) – Determination of sulphite content

This part of PT program was not open due to low number of participants.

7 Appendix – EN 196-2 (art. 4.4.6) – Determination of manganese content

This part of PT program was not open due to low number of participants.

8 Appendix – EN 196-3 – Setting time, Soundness

8.1 Initial setting time

8.1.1 Test results

Table 25: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [min.]			u_x [min.]	\bar{x} [min.]	s_0 [min.]	V_x [%]
453085	165	157	150	-	157	7.5	4.77
257269	185	185	185	1	185	0.0	0.0
fec653	190	185	191	14	189	3.2	1.7
91a9fc	196	200	211	8	202	7.8	3.84
26b832	210	210	190	13	203	11.5	5.68
3db6ff	230	220	230	-	227	5.8	2.55

8.1.2 The Numerical Procedure for Determining Outliers

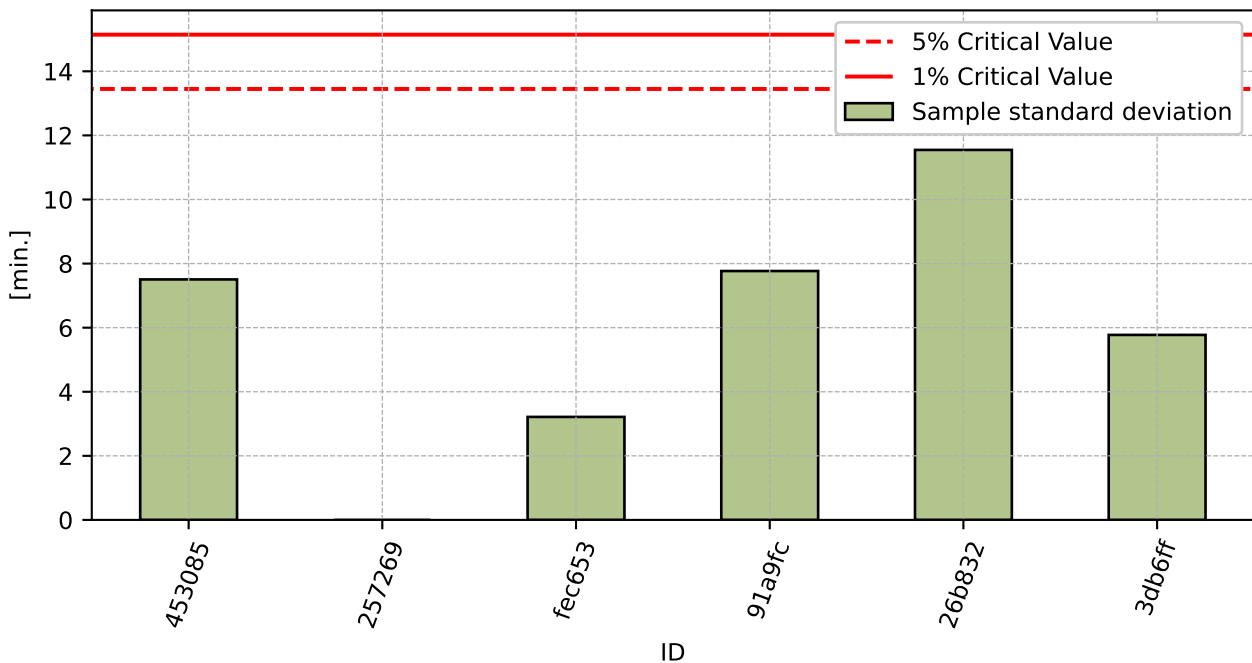


Figure 65: **Cochran's test** - sample standard deviations

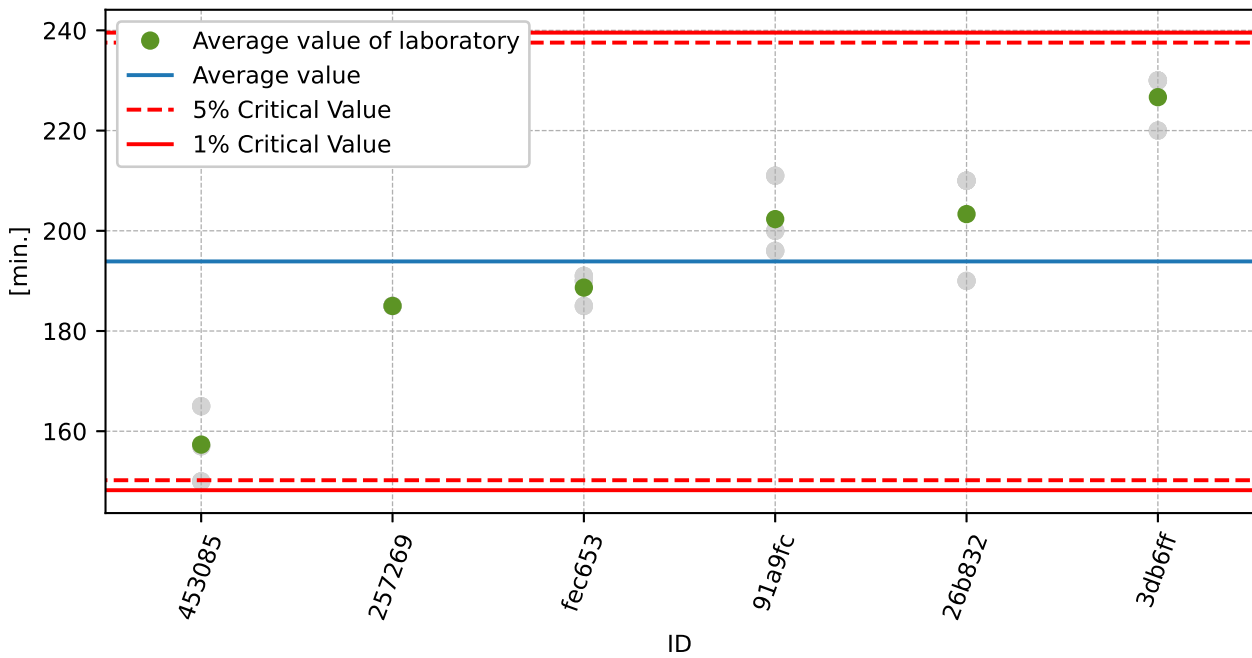


Figure 66: **Grubbs' test** - average values

8.1.3 Mandel's Statistics

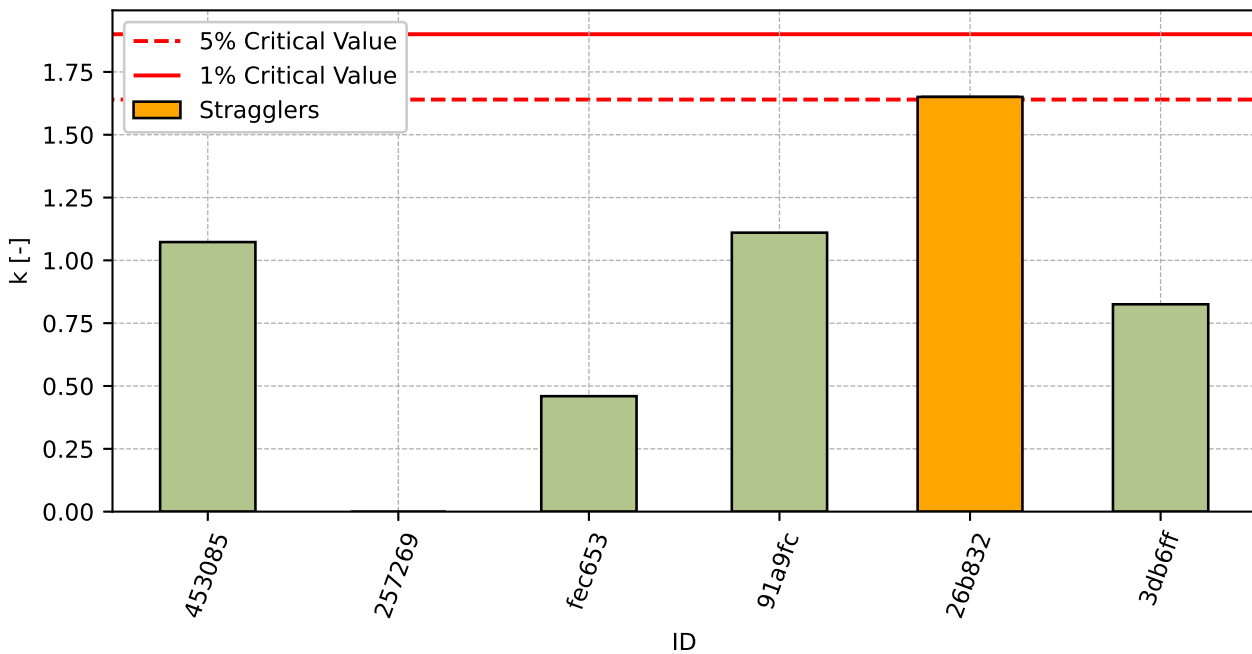


Figure 67: Intralaboratory Consistency Statistic

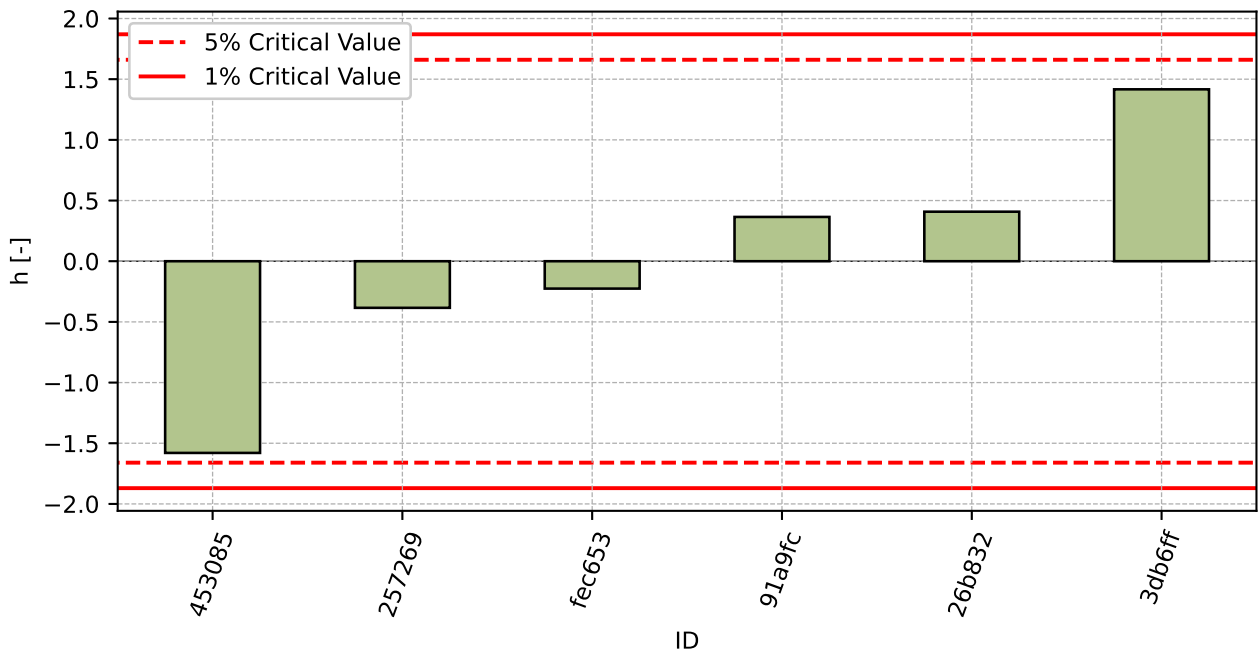


Figure 68: Interlaboratory Consistency Statistic

8.1.4 Descriptive statistics

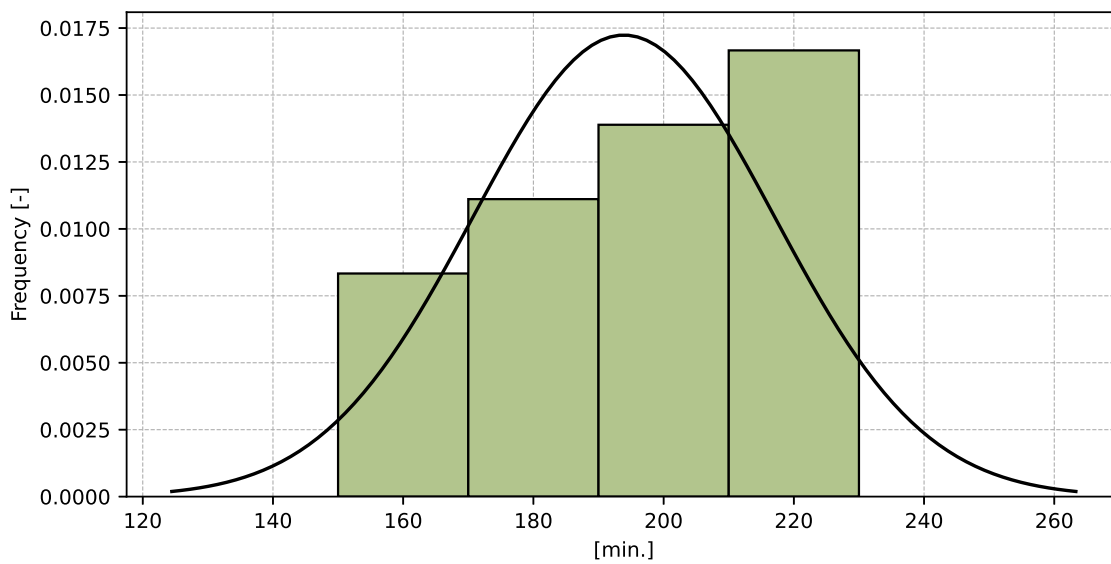


Figure 69: Histogram of all test results

Table 26: Descriptive statistics

Characteristics	[min.]
Average value – \bar{x}	194
Sample standard deviation – s	23.1
Assigned value – x^*	194
Robust standard deviation – s^*	23.1
Measurement uncertainty of assigned value – u_X	9.4
p -value of normality test	0.487 [-]
Interlaboratory standard deviation – s_L	22.8
Repeatability standard deviation – s_r	7.0
Reproducibility standard deviation – s_R	23.8
Repeatability – r	20
Reproducibility – R	67

8.1.5 Evaluation of Performance Statistics

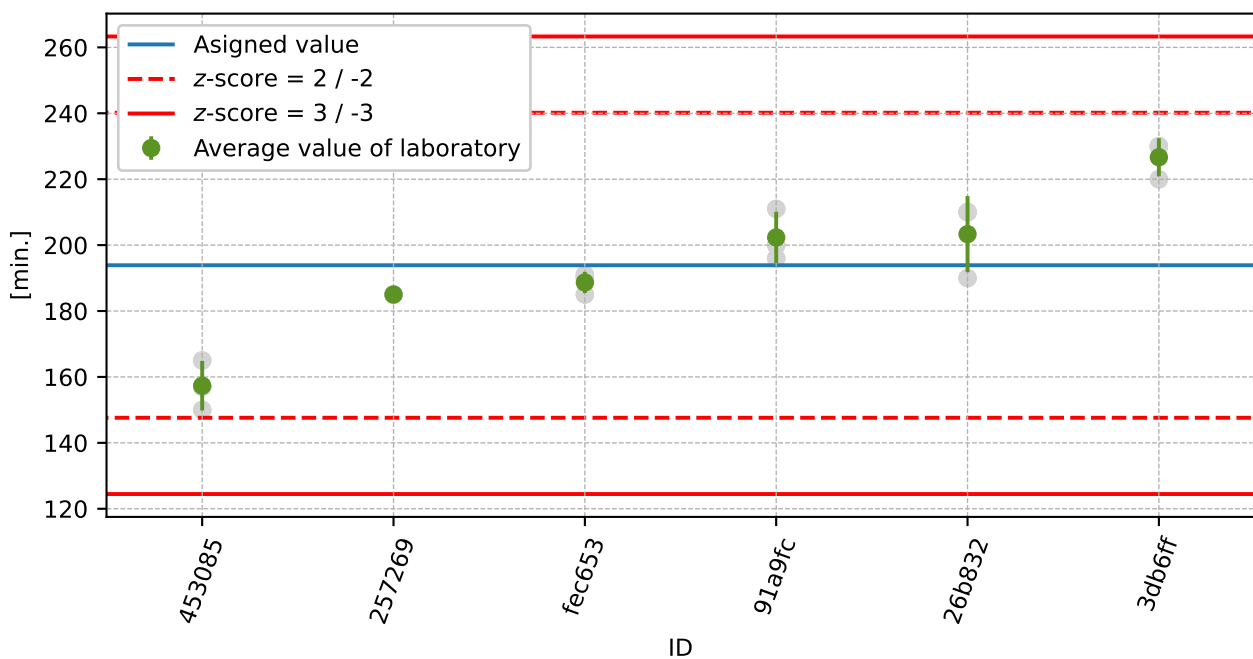


Figure 70: Average values and sample standard deviations

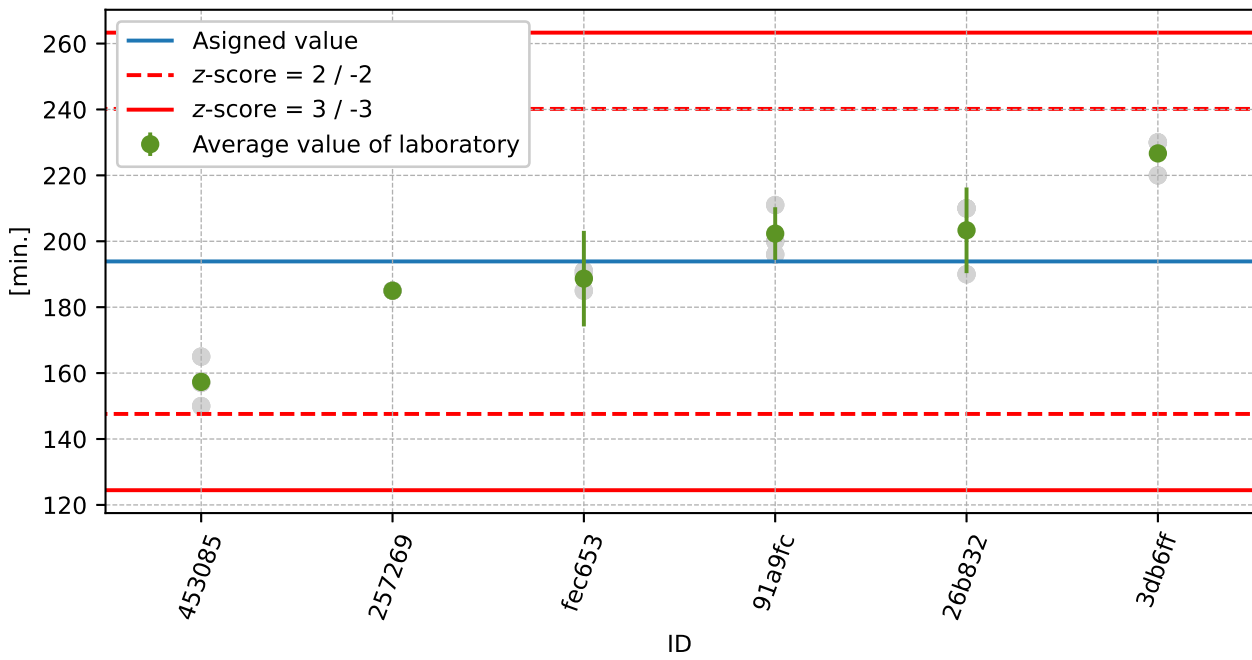


Figure 71: Average values and extended uncertainties of measurement

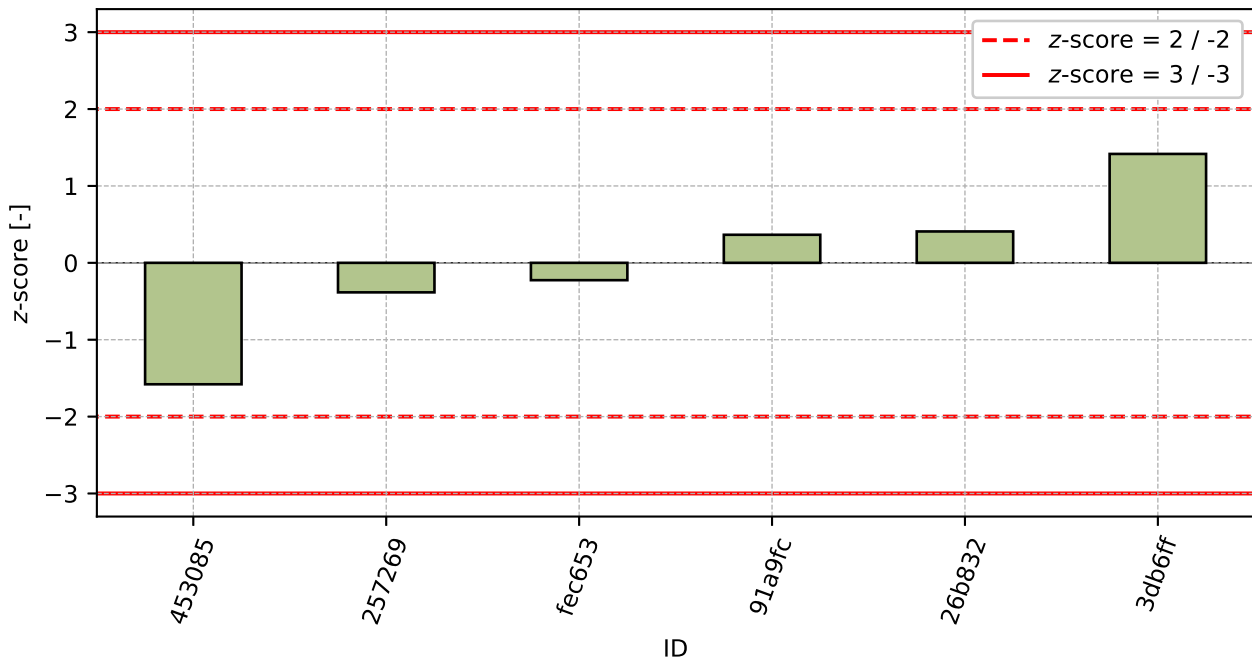


Figure 72: z-score

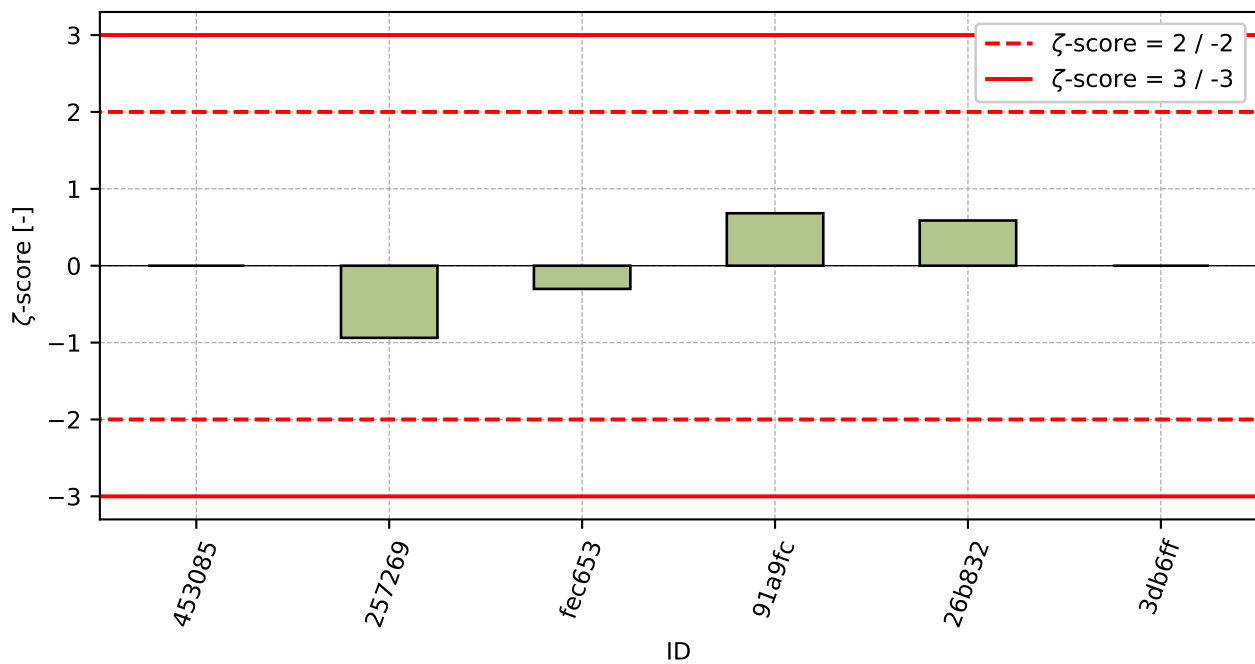


Figure 73: z-score

Table 27: z-score and z-score

ID	z-score [-]	z-score [-]
453085	-1.58	-
257269	-0.38	-0.94
fec653	-0.23	-0.3
91a9fc	0.36	0.68
26b832	0.41	0.59
3db6ff	1.42	-

8.2 Final setting time

8.2.1 Test results

Table 28: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [min.]			u_x [min.]	\bar{x} [min.]	s_0 [min.]	V_x [%]
26b832	240	240	250	7	243	5.8	2.37
257269	265	265	265	1	265	0.0	0.0
453085	270	290	255	-	272	17.6	6.46
91a9fc	291	295	300	5	295	4.5	1.53
3db6ff	300	290	300	-	297	5.8	1.95

8.2.2 The Numerical Procedure for Determining Outliers

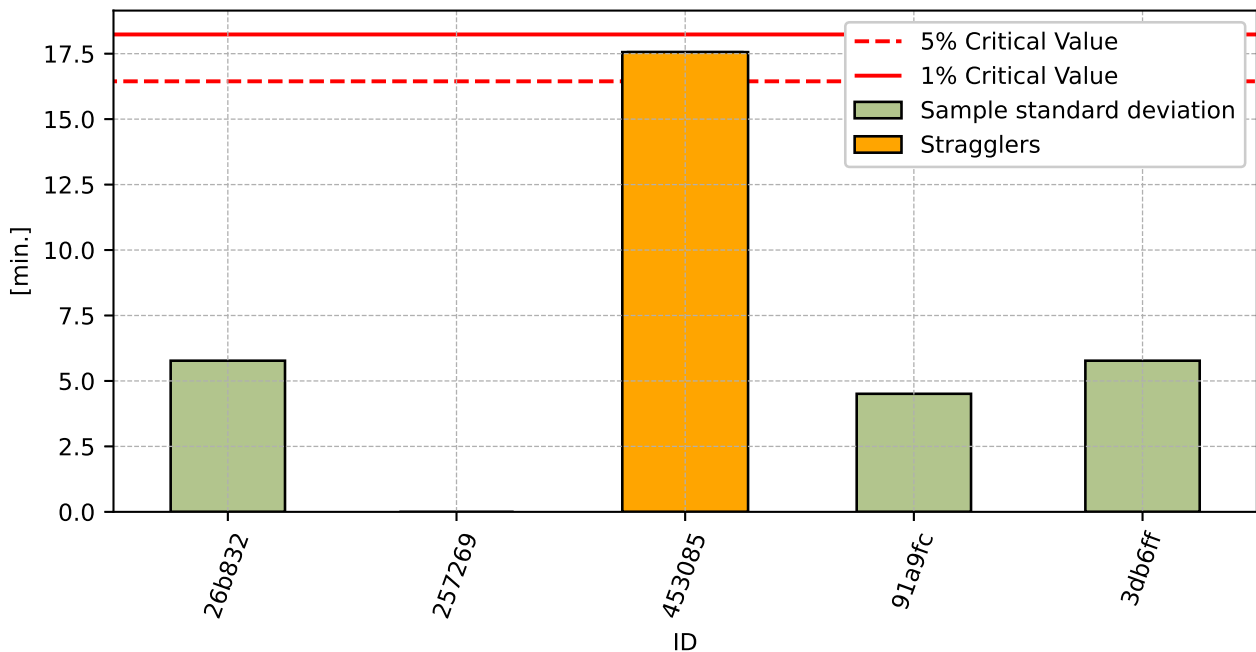


Figure 74: Cochran's test - sample standard deviations

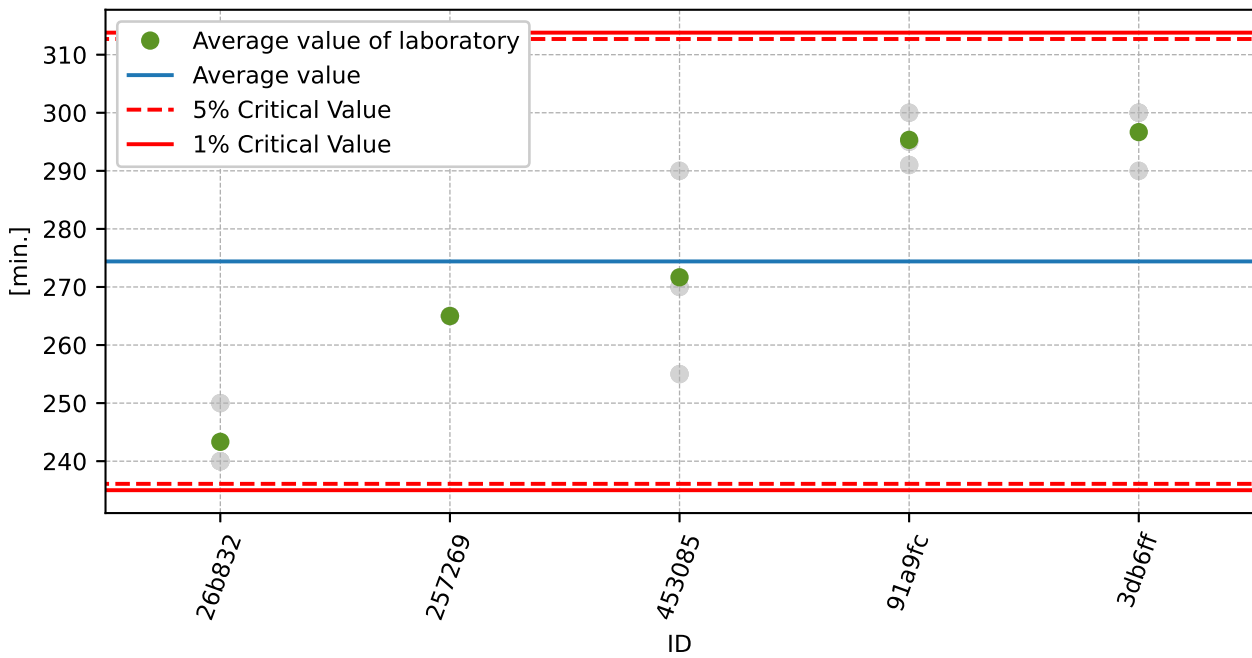


Figure 75: **Grubbs' test** - average values

8.2.3 Mandel's Statistics

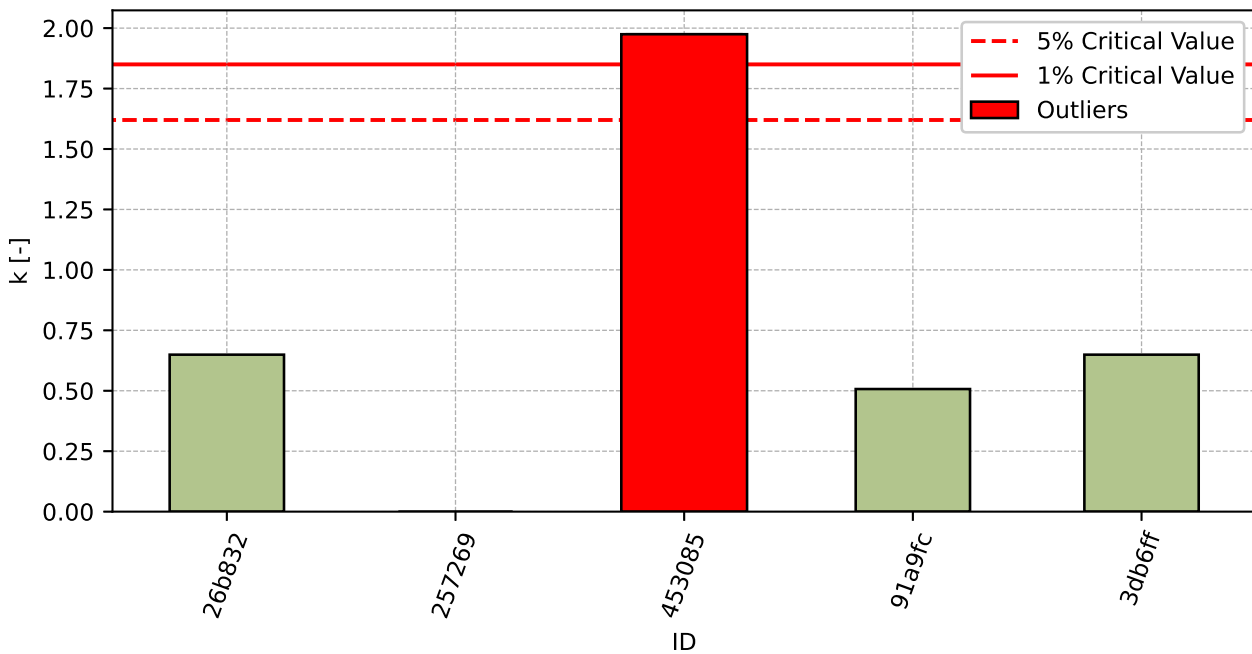


Figure 76: Intralaboratory Consistency Statistic

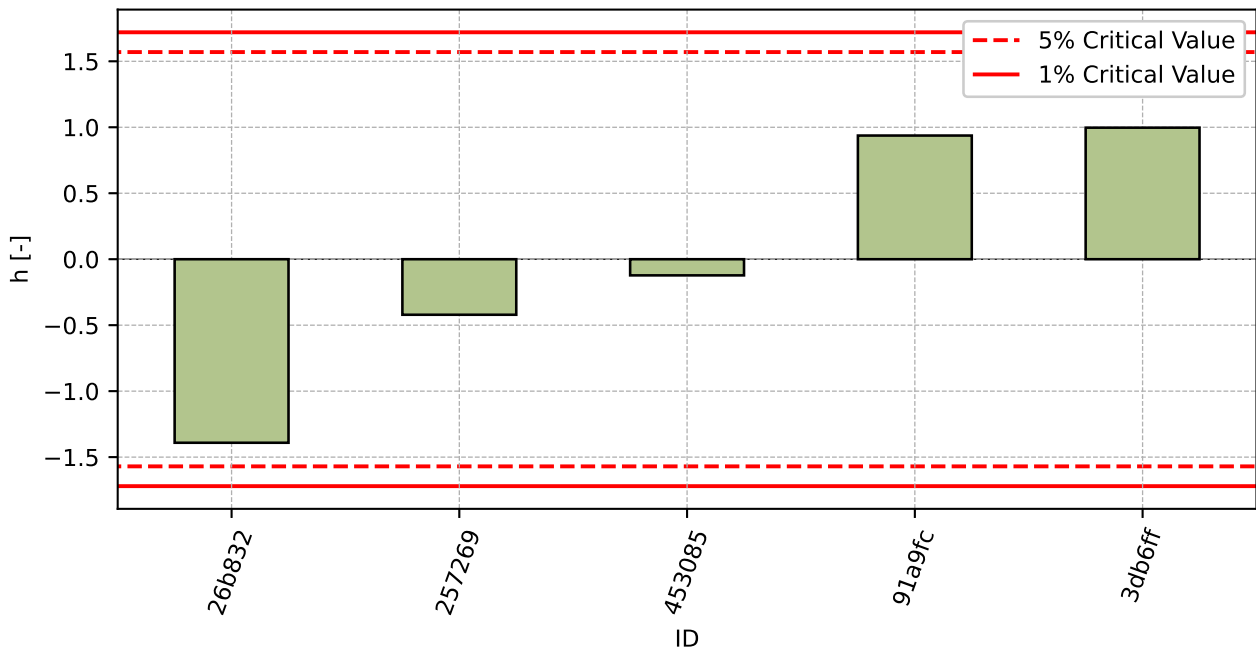


Figure 77: Interlaboratory Consistency Statistic

8.2.4 Descriptive statistics

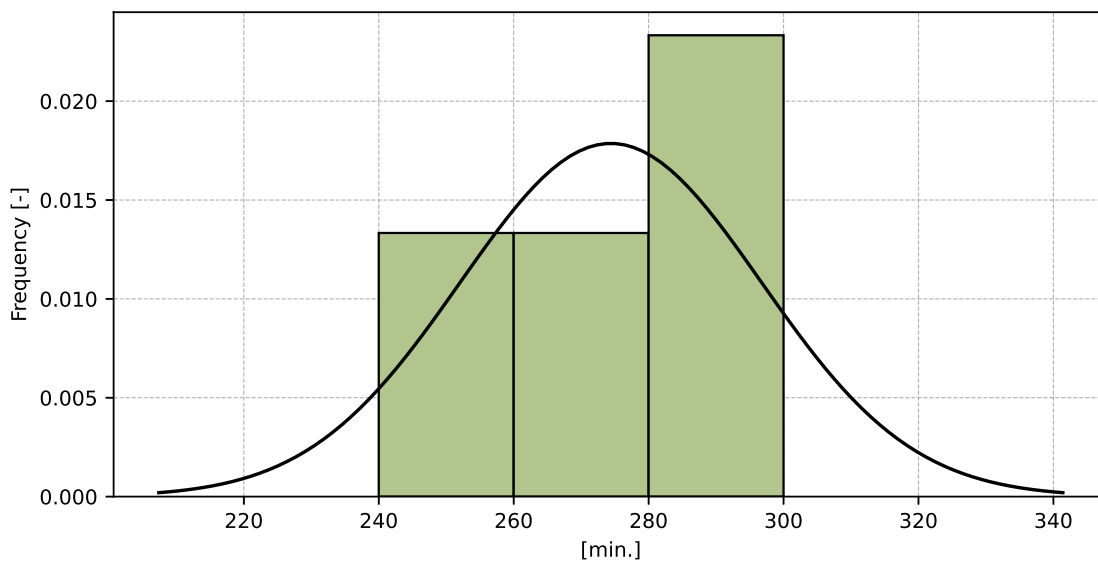


Figure 78: Histogram of all test results

Table 29: Descriptive statistics

Characteristics	[min.]
Average value – \bar{x}	274
Sample standard deviation – s	22.3
Assigned value – x^*	274
Robust standard deviation – s^*	22.3
Measurement uncertainty of assigned value – u_X	10.0
p -value of normality test	0.061 [-]
Interlaboratory standard deviation – s_L	21.7
Repeatability standard deviation – s_r	8.9
Reproducibility standard deviation – s_R	23.5
Repeatability – r	25
Reproducibility – R	66

8.2.5 Evaluation of Performance Statistics

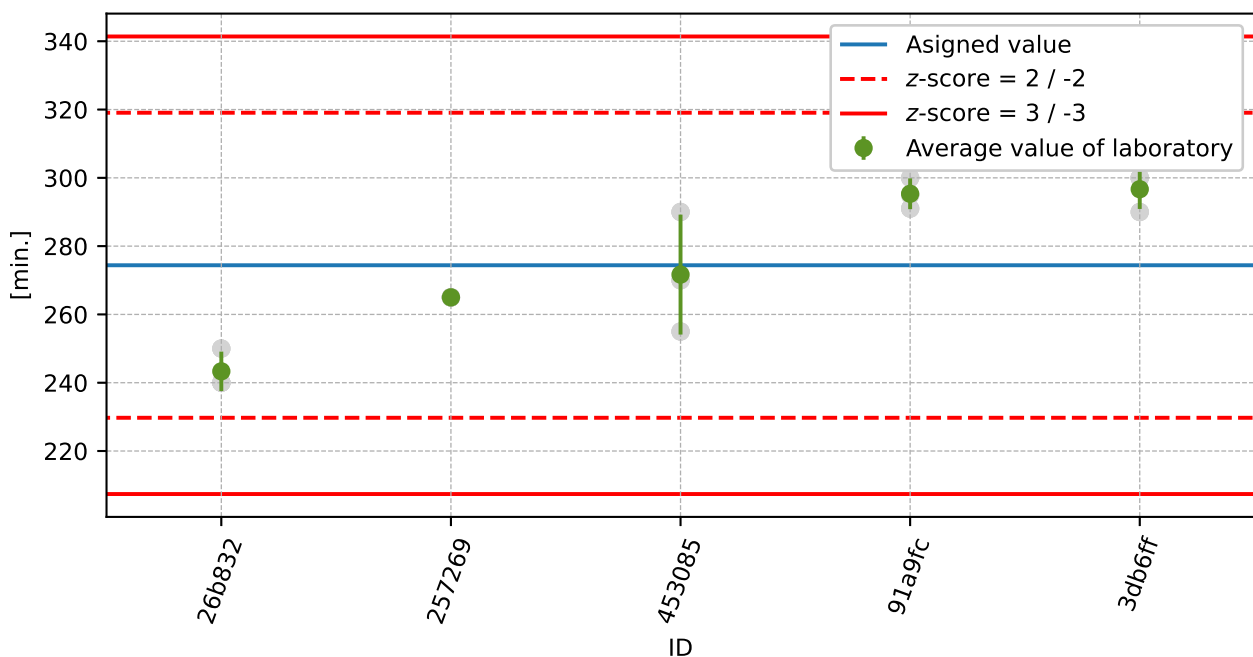


Figure 79: Average values and sample standard deviations

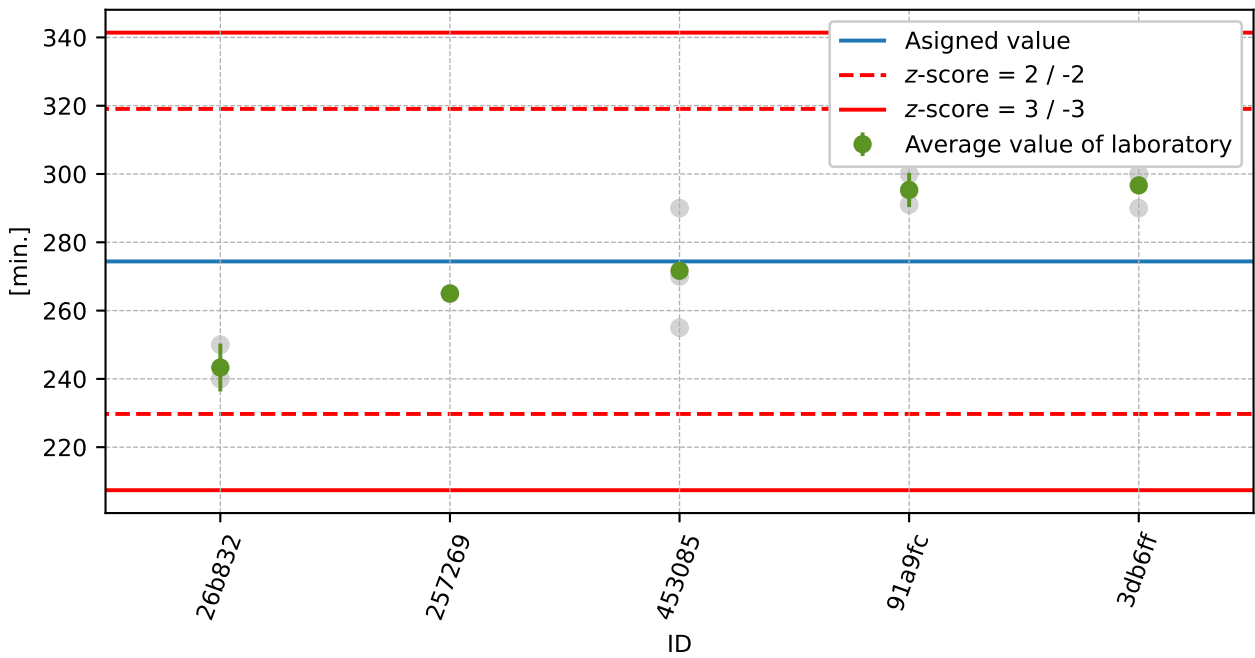


Figure 80: Average values and extended uncertainties of measurement

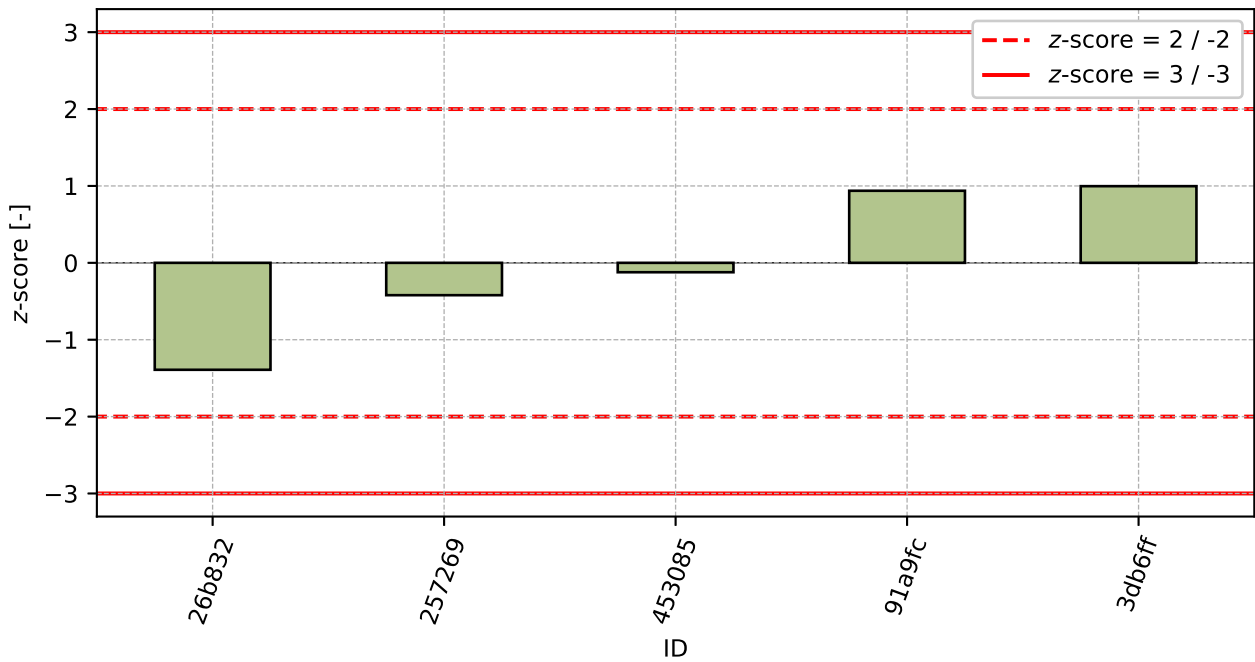


Figure 81: z-score

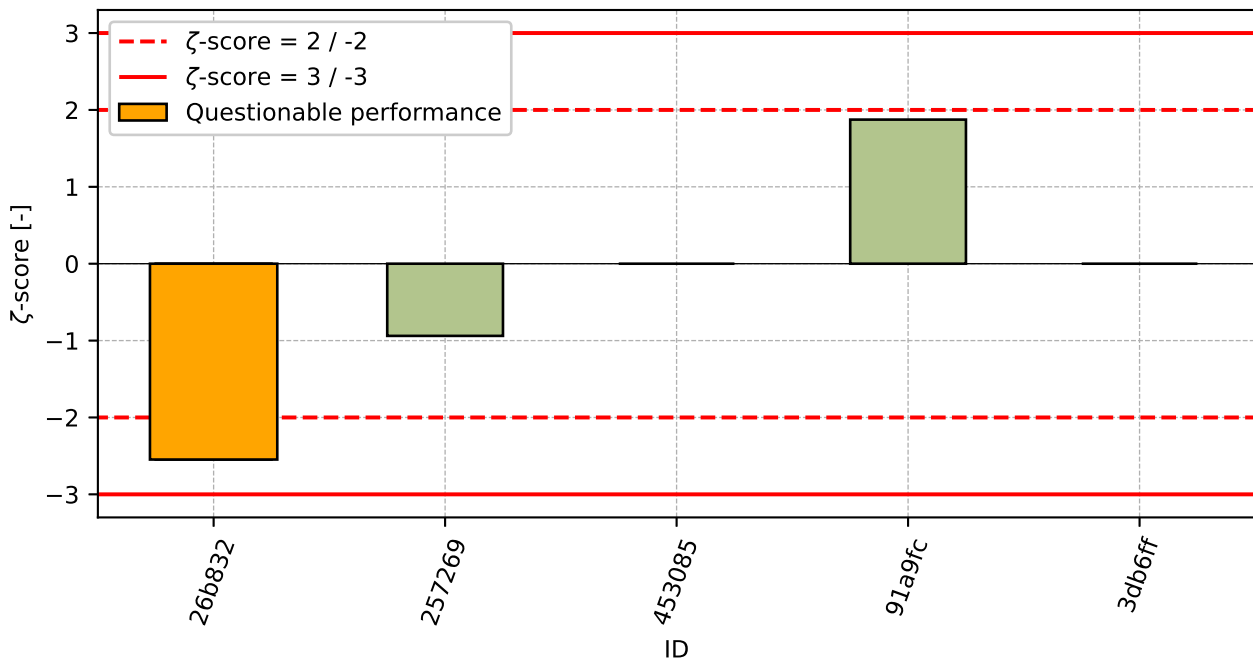


Figure 82: ζ -score

Table 30: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
26b832	-1.39	-2.55
257269	-0.42	-0.94
453085	-0.12	-
91a9fc	0.94	1.87
3db6ff	1.0	-

8.3 Soundness

8.3.1 Test results

Table 31: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [mm]			u_x [mm]	\bar{x} [mm]	s_0 [mm]	V_x [%]
26b832	0.0	0.0	0.0	0.5	0.0	0.0	-
453085	1.0	0.5	1.5	1.0	1.0	0.5	50.0
3db6ff	1.0	1.0	1.0	-	1.0	0.0	0.0
fec653	1.0	1.0	1.0	0.0	1.0	0.0	0.0
257269	1.0	1.0	1.0	0.1	1.0	0.0	0.0
91a9fc	1.0	2.0	1.0	1.2	1.3	0.58	43.3

8.3.2 The Numerical Procedure for Determining Outliers

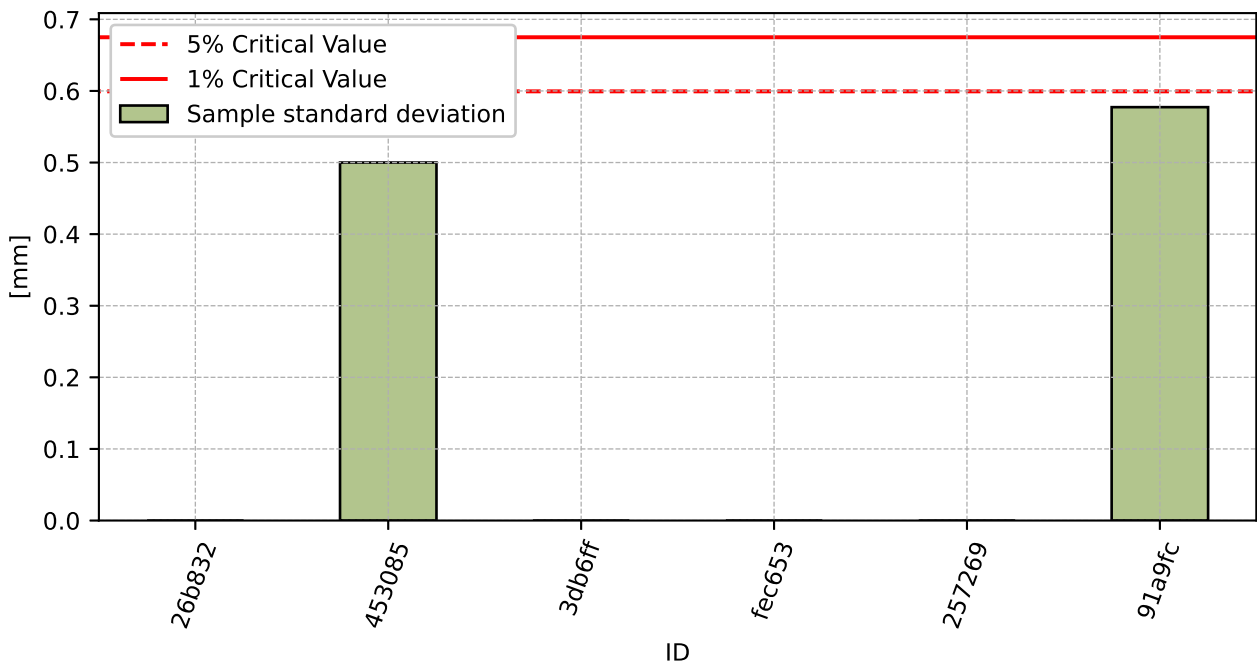


Figure 83: Cochran's test - sample standard deviations

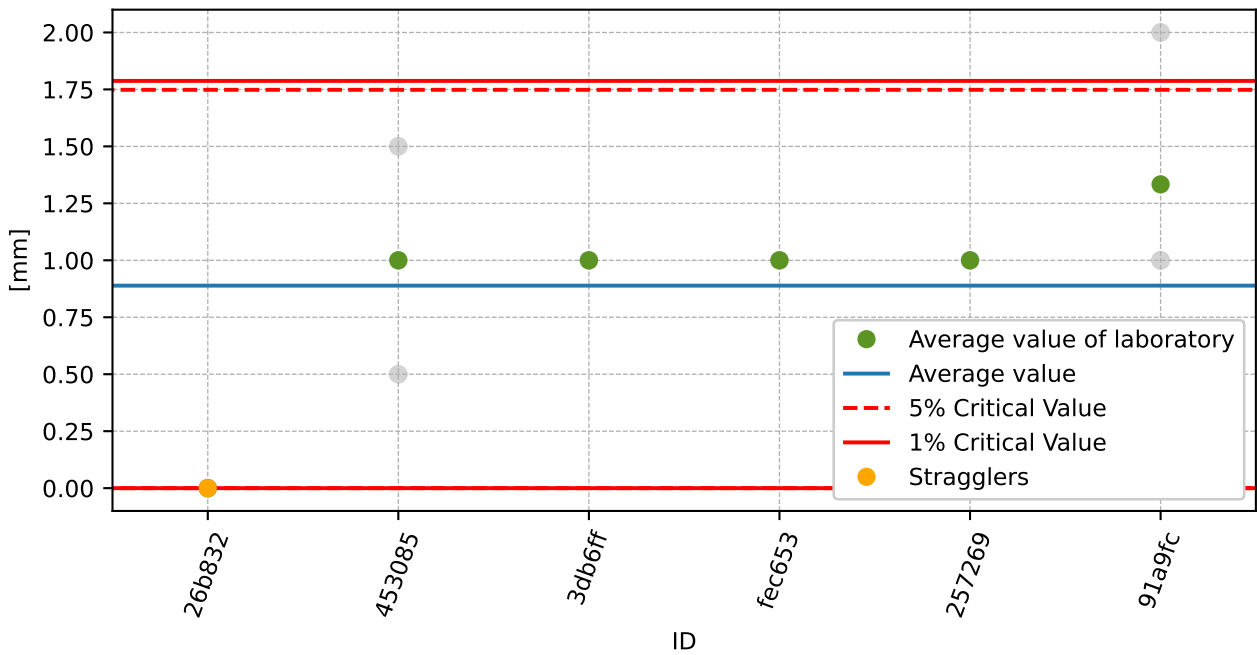


Figure 84: **Grubbs' test** - average values

8.3.3 Mandel's Statistics

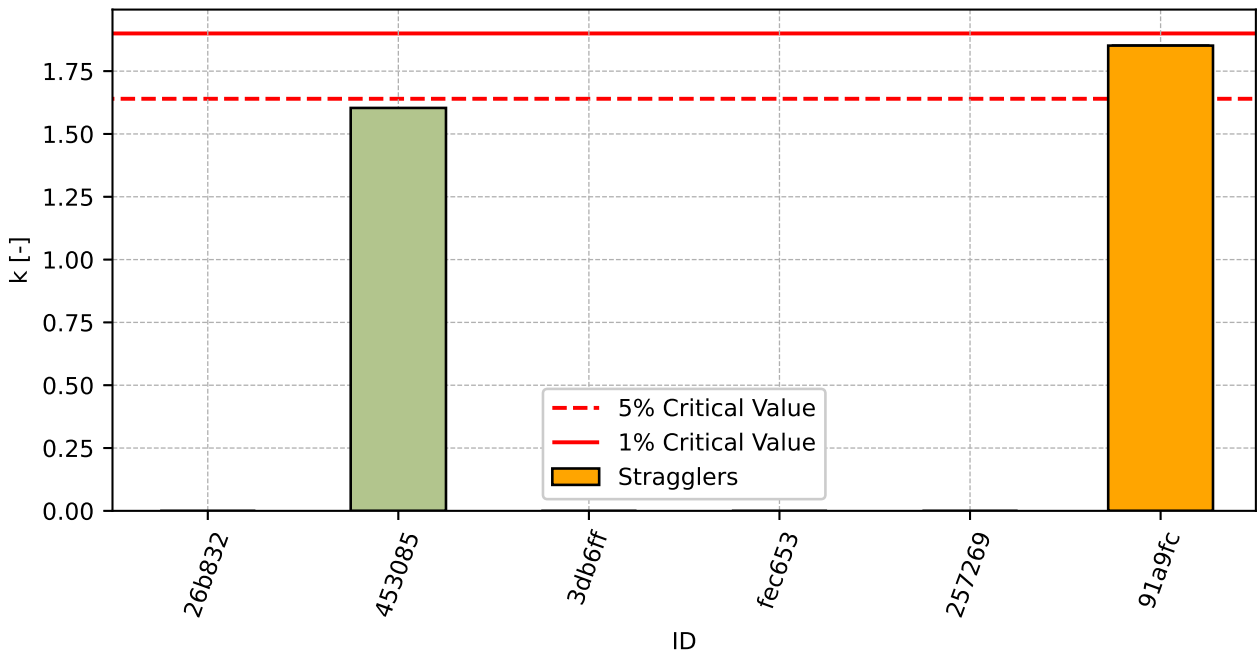


Figure 85: Intralaboratory Consistency Statistic

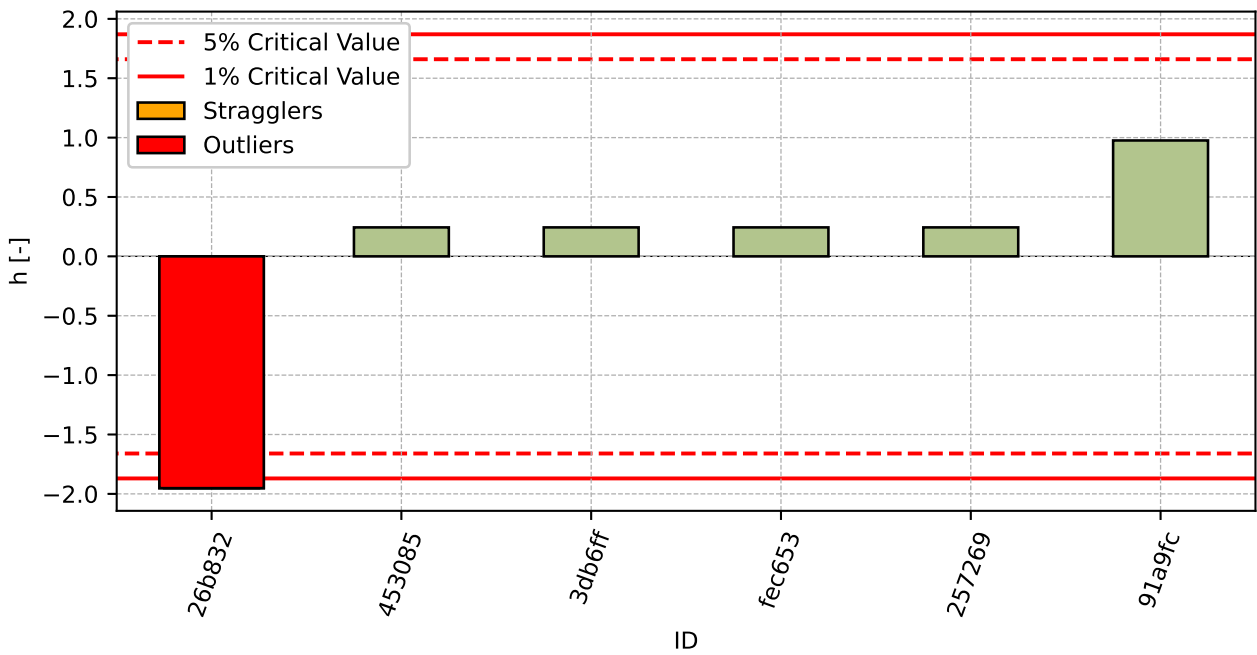


Figure 86: Interlaboratory Consistency Statistic

8.3.4 Descriptive statistics

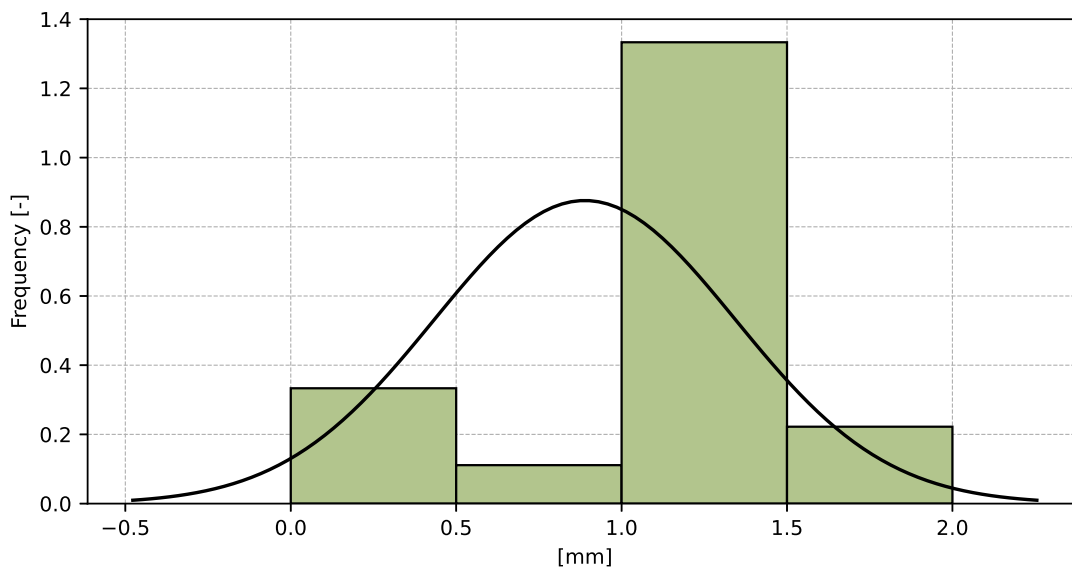


Figure 87: Histogram of all test results

Table 32: Descriptive statistics

Characteristics	[mm]
Average value – \bar{x}	0.9
Sample standard deviation – s	0.46
Assigned value – x^*	0.9
Robust standard deviation – s^*	0.46
Measurement uncertainty of assigned value – u_X	0.19
p -value of normality test	0.001 [-]
Interlaboratory standard deviation – s_L	0.42
Repeatability standard deviation – s_r	0.31
Reproducibility standard deviation – s_R	0.52
Repeatability – r	0.9
Reproducibility – R	1.5

8.3.5 Evaluation of Performance Statistics

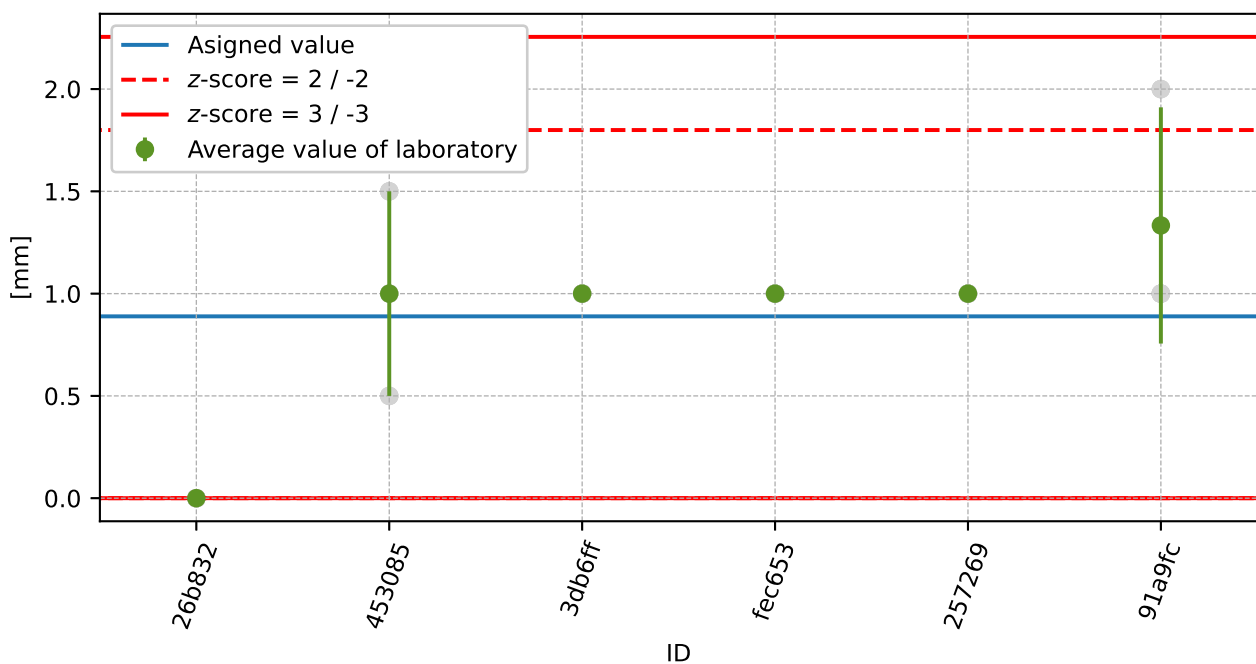


Figure 88: Average values and sample standard deviations

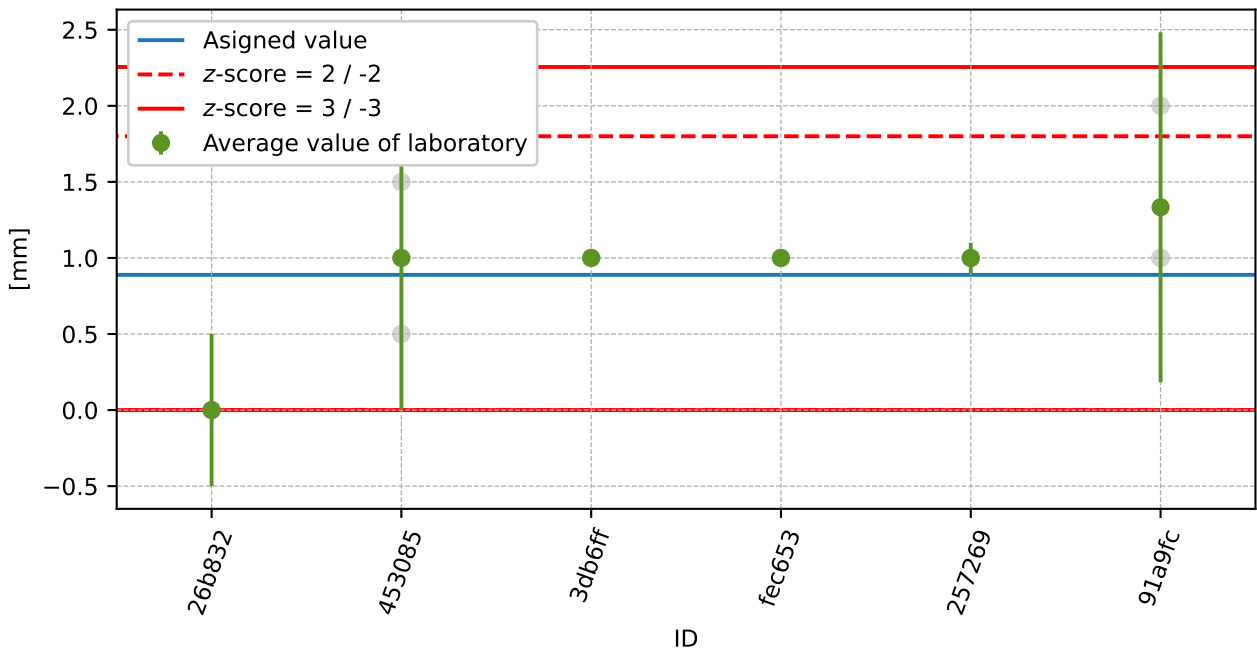


Figure 89: Average values and extended uncertainties of measurement

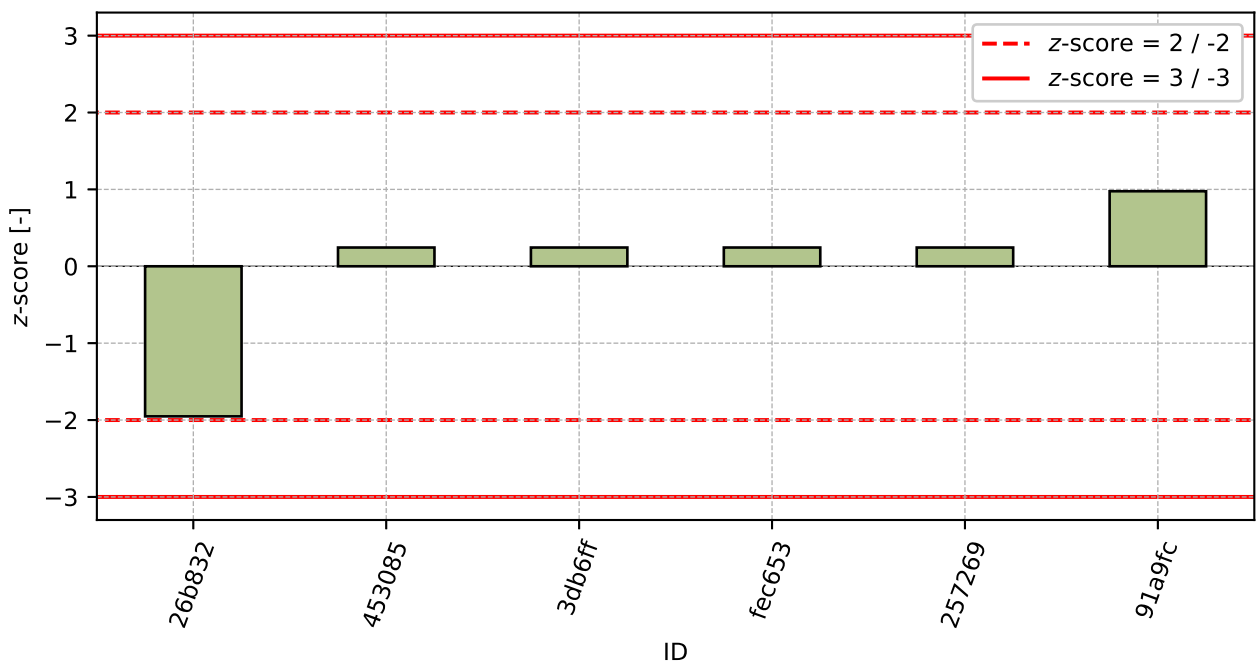


Figure 90: z-score

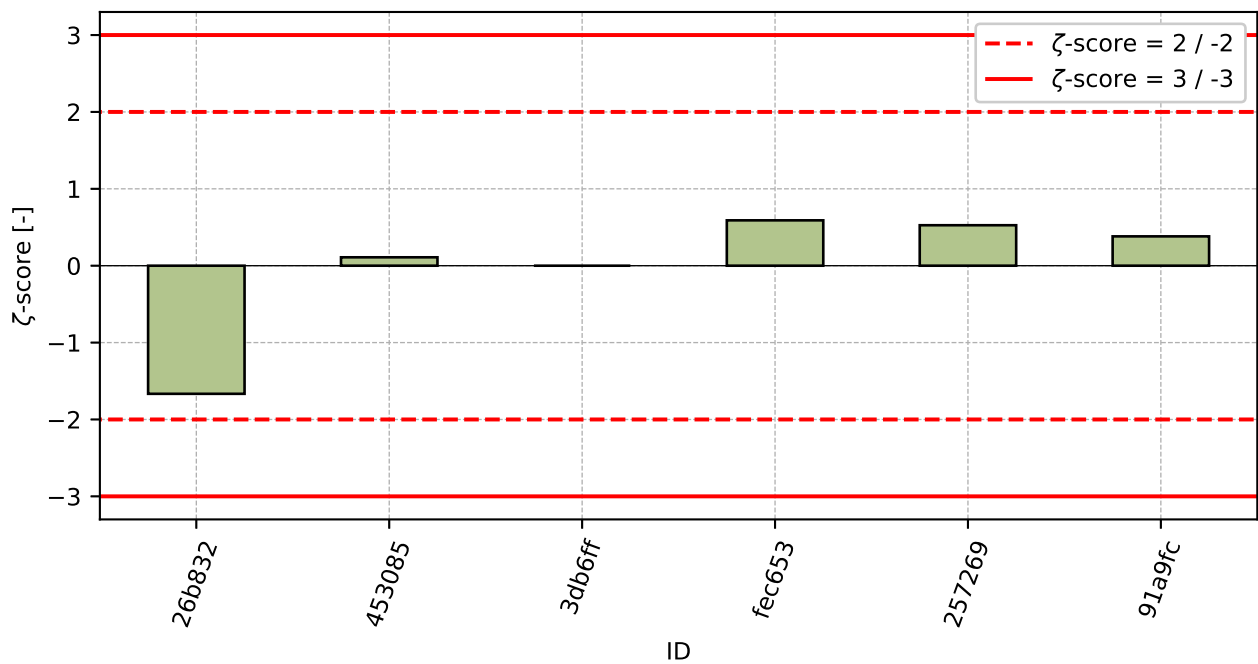


Figure 91: ζ-score

Table 33: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
26b832	-1.95	-1.67
453085	0.24	0.11
3db6ff	0.24	-
fec653	0.24	0.59
257269	0.24	0.53
91a9fc	0.98	0.38

9 Appendix – EN 196-10 – Determination of the water-soluble chromium (Cr^{6+})

This part of PT program was not open according to the low number of participants.

10 Appendix – EN 1015-1 – Granularity

This part of PT program was not open due to low number of participants.

11 Appendix – EN 1015-3 – Consistency

This part of PT program was not open due to low number of participants.

12 Appendix – EN 1015-6 – Density of fresh mortar

This part of PT program was not open according to the low number of participants.

13 Appendix – EN 1015-10 – Density of hardened mortar

13.1 Test results

Table 34: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [kg/m ³]			u_x [kg/m ³]	\bar{x} [kg/m ³]	s_0 [kg/m ³]	V_x [%]
12a5f5	1850	1840	1850	19	1847	5.8	0.31
37784e	1850	1860	1850	151	1853	5.8	0.31
37ab14	1910	1890	1900	10	1900	10.0	0.53
a3354e	1916	1922	1920	14	1919	3.1	0.16
daa375	1996	2018	2010	60	2008	11.1	0.55

13.2 The Numerical Procedure for Determining Outliers

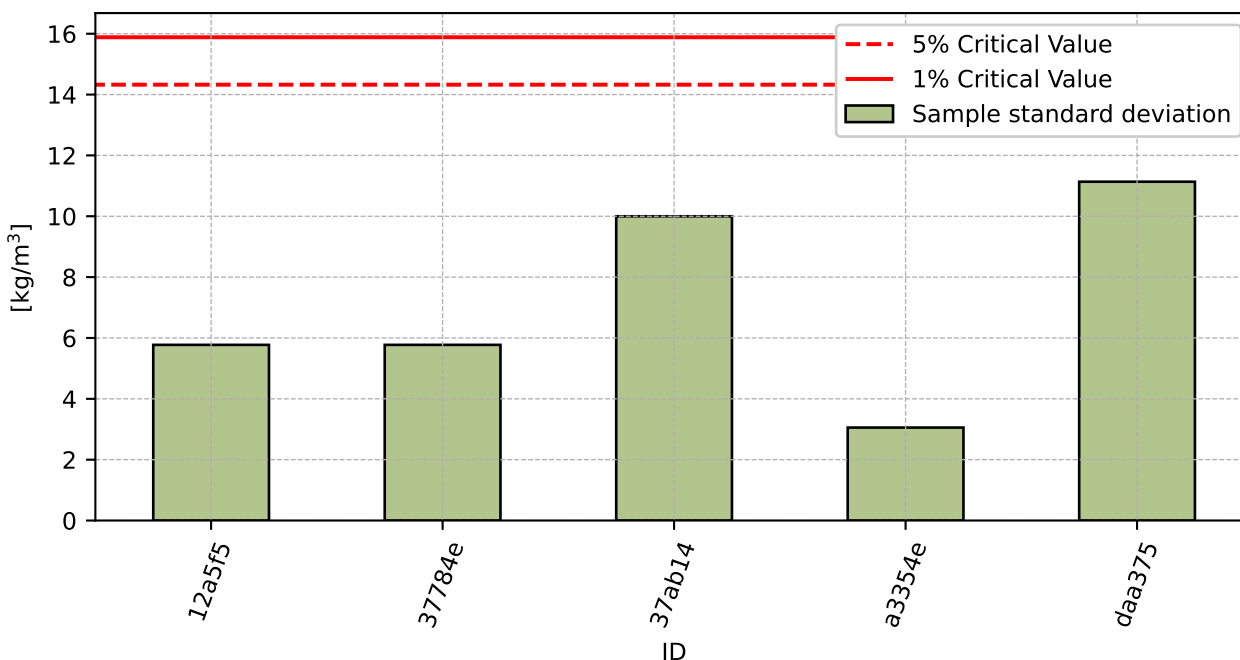


Figure 92: Cochran's test - sample standard deviations

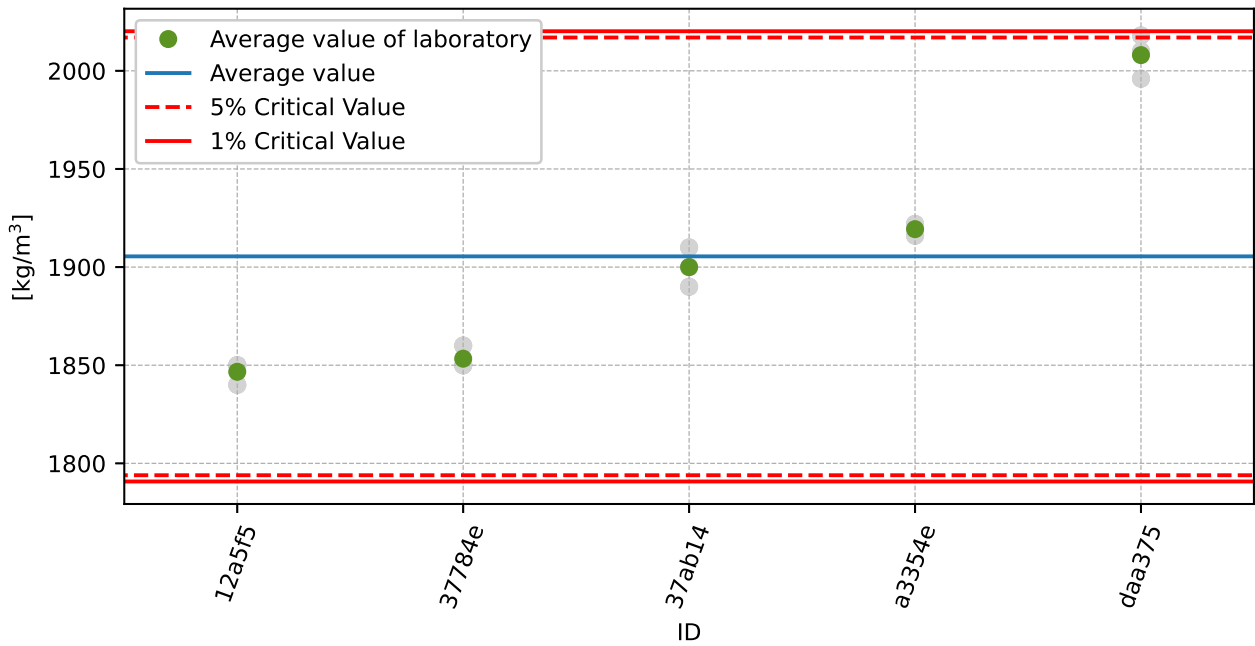


Figure 93: **Grubbs' test** - average values

13.3 Mandel's Statistics

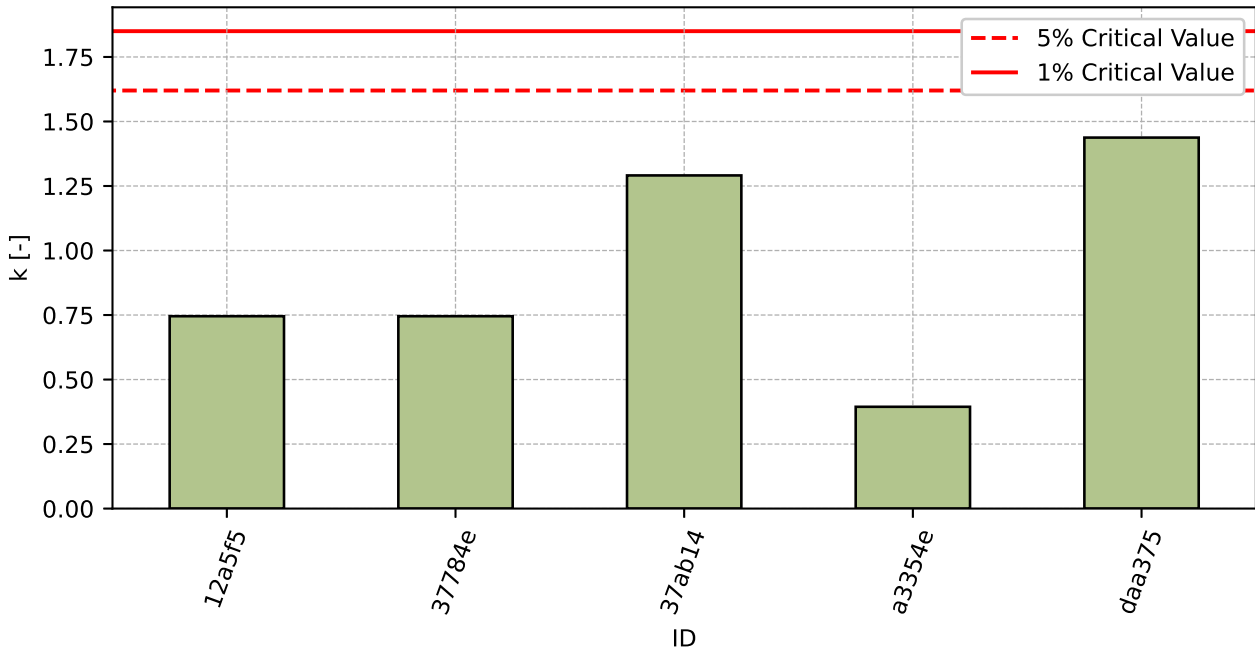


Figure 94: Intralaboratory Consistency Statistic

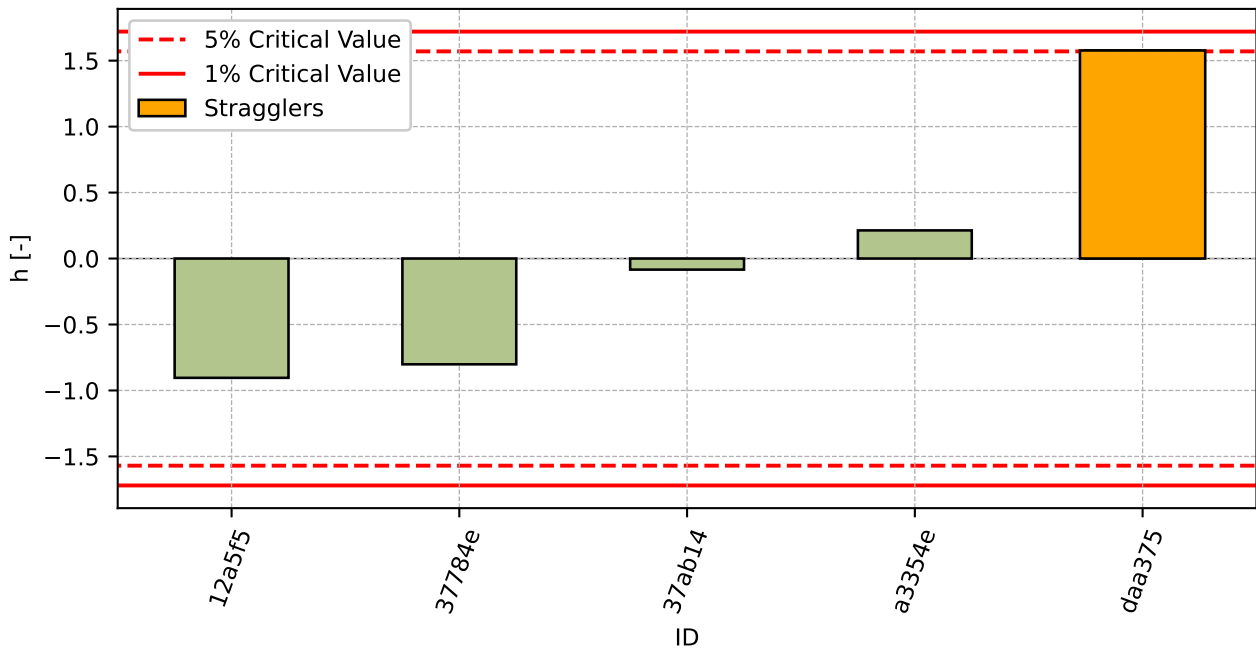


Figure 95: Interlaboratory Consistency Statistic

13.4 Descriptive statistics

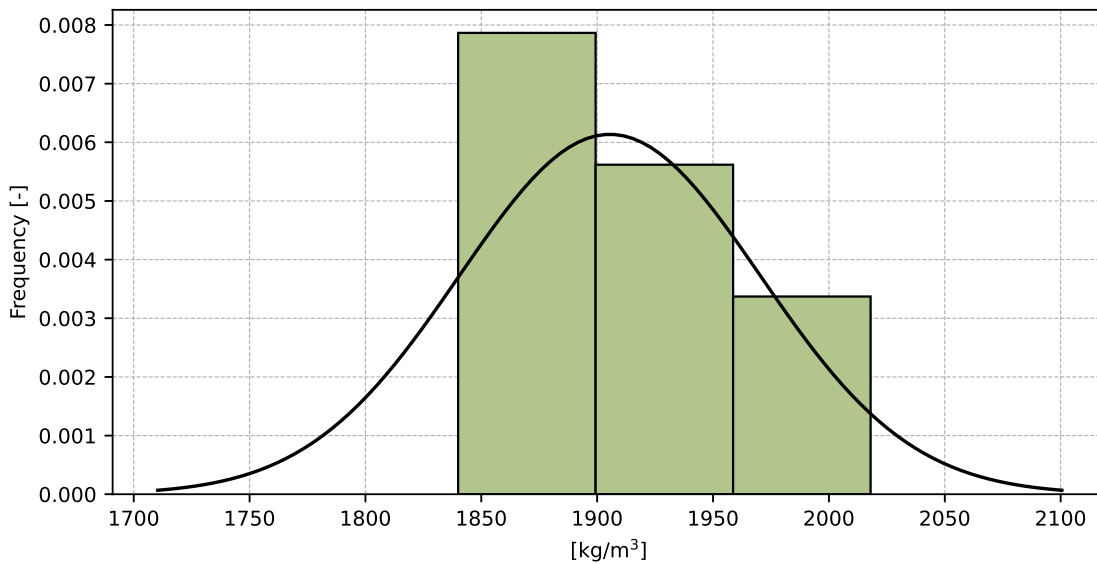


Figure 96: Histogram of all test results

Table 35: Descriptive statistics

Characteristics	[kg/m ³]
Average value – \bar{x}	1905
Sample standard deviation – s	65.0
Assigned value – x^*	1905
Robust standard deviation – s^*	65.0
Measurement uncertainty of assigned value – u_X	29.1
p -value of normality test	0.022 [-]
Interlaboratory standard deviation – s_L	64.9
Repeatability standard deviation – s_r	7.7
Reproducibility standard deviation – s_R	65.3
Repeatability – r	22
Reproducibility – R	183

13.5 Evaluation of Performance Statistics

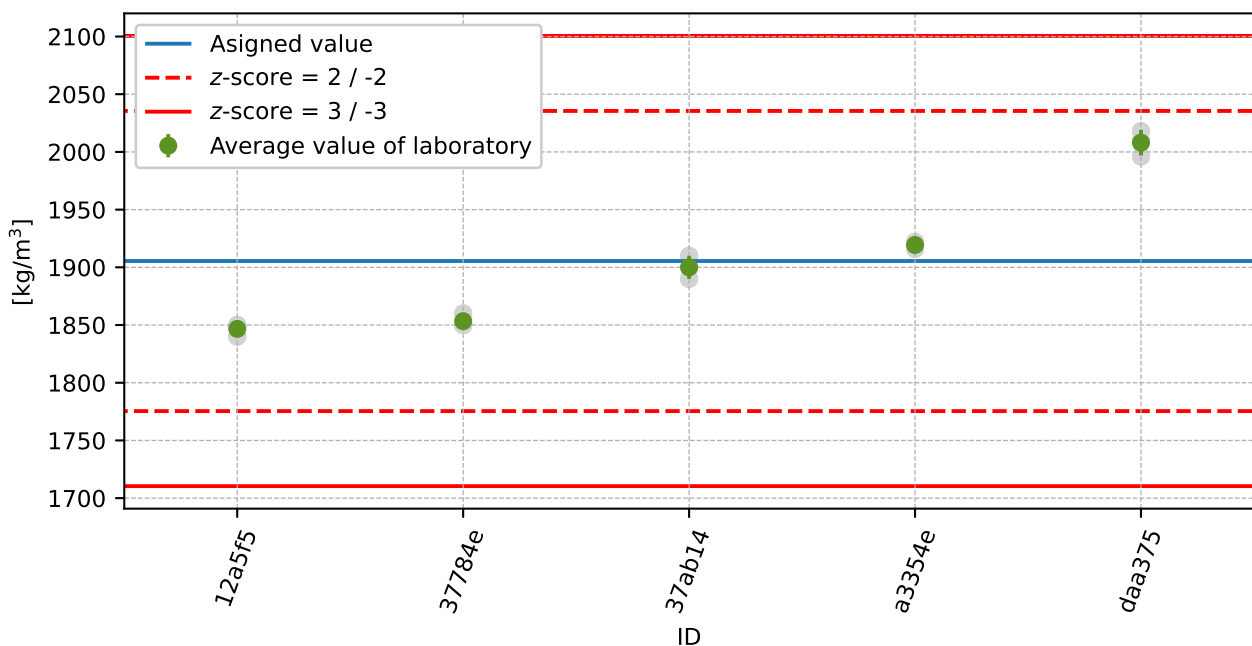


Figure 97: Average values and sample standard deviations

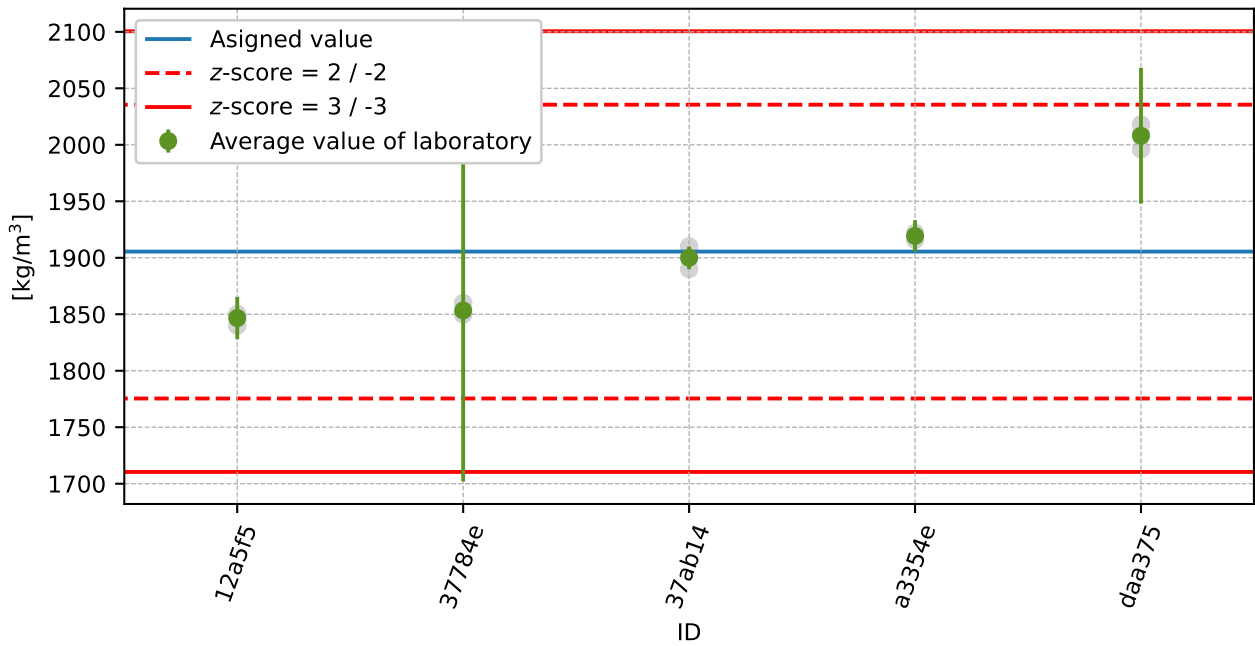


Figure 98: Average values and extended uncertainties of measurement

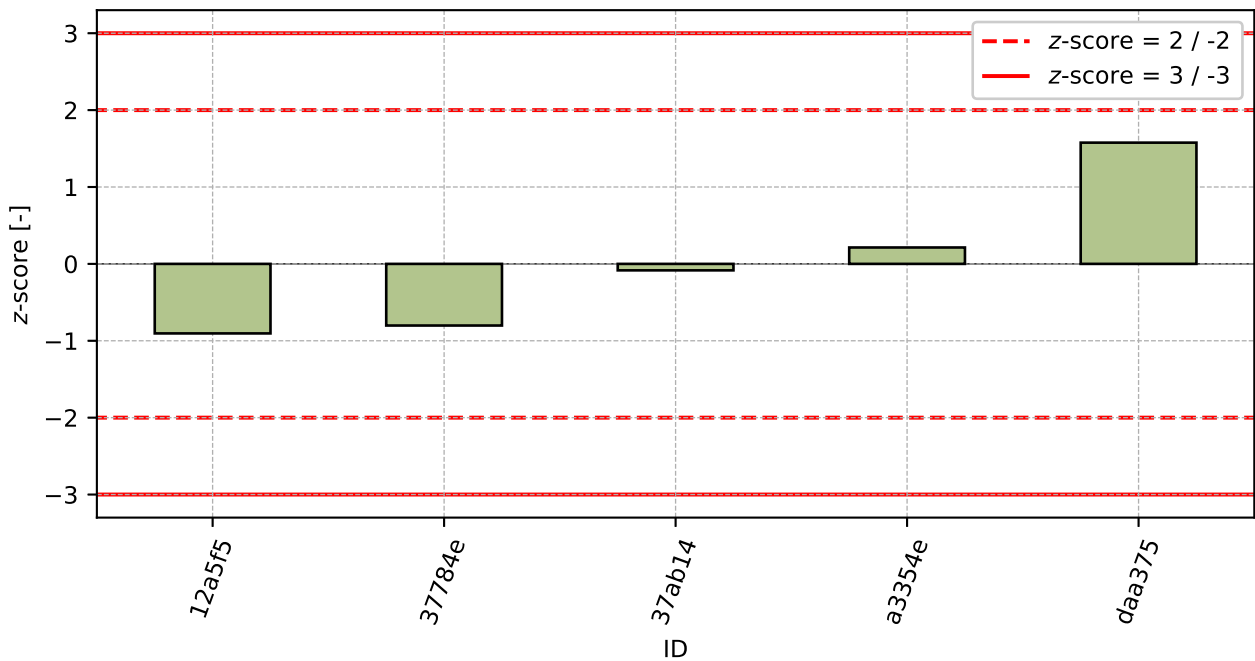


Figure 99: z-score

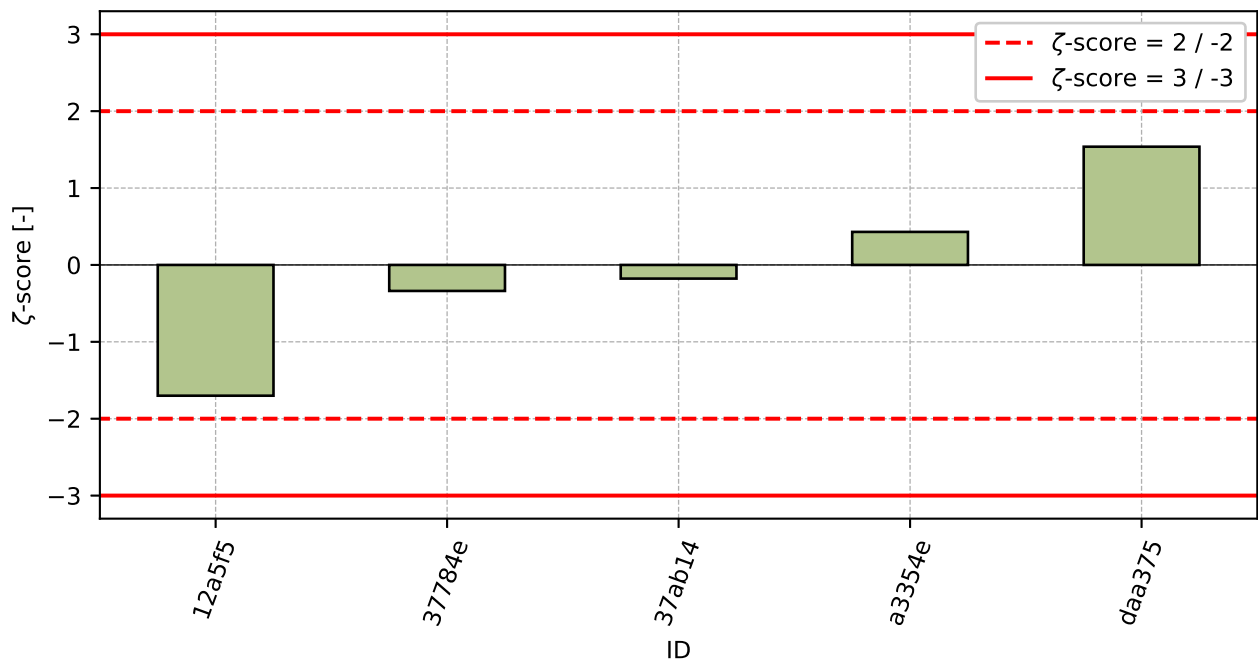


Figure 100: z-score

Table 36: z-score and z-score

ID	z-score [-]	z-score [-]
12a5f5	-0.9	-1.7
37784e	-0.8	-0.34
37ab14	-0.08	-0.18
a3354e	0.21	0.43
daa375	1.58	1.54

14 Appendix – EN 1015-11 – Strength

14.1 Flexural Strength

14.1.1 Test results

Table 37: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]			u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
0b215e	2.5	2.3	2.3	0.3	2.4	0.12	4.88
91a9fc	2.4	2.3	2.4	0.1	2.4	0.09	3.61
0498be	2.2	2.4	3.0	0.2	2.5	0.42	16.43
aebfde	2.6	2.8	2.4	-	2.6	0.19	7.2
a83ef3	2.8	2.8	2.4	0.2	2.6	0.2	7.67
724b20	3.1	3.1	3.0	0.1	3.1	0.06	1.88
37784e	3.4	3.7	3.2	0.2	3.5	0.25	7.25
a3354e	3.8	3.9	3.6	0.3	3.8	0.15	4.06
12a5f5	4.0	3.9	3.7	0.2	3.8	0.13	3.44

14.1.2 The Numerical Procedure for Determining Outliers

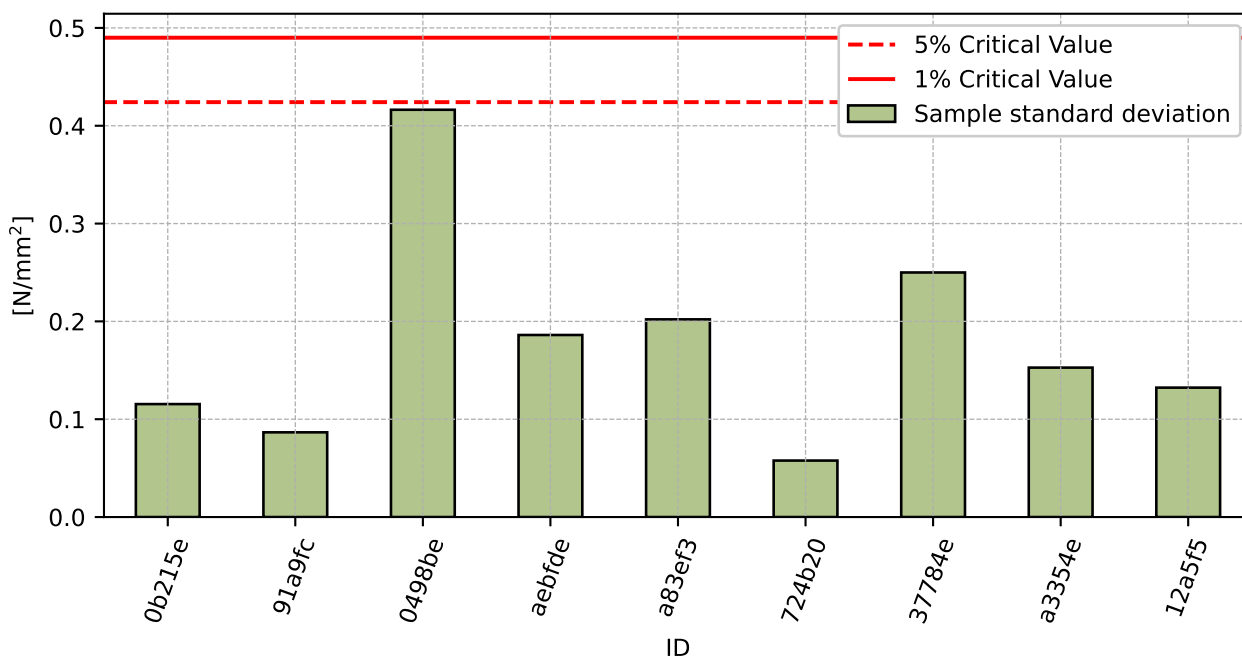


Figure 101: Cochran's test - sample standard deviations

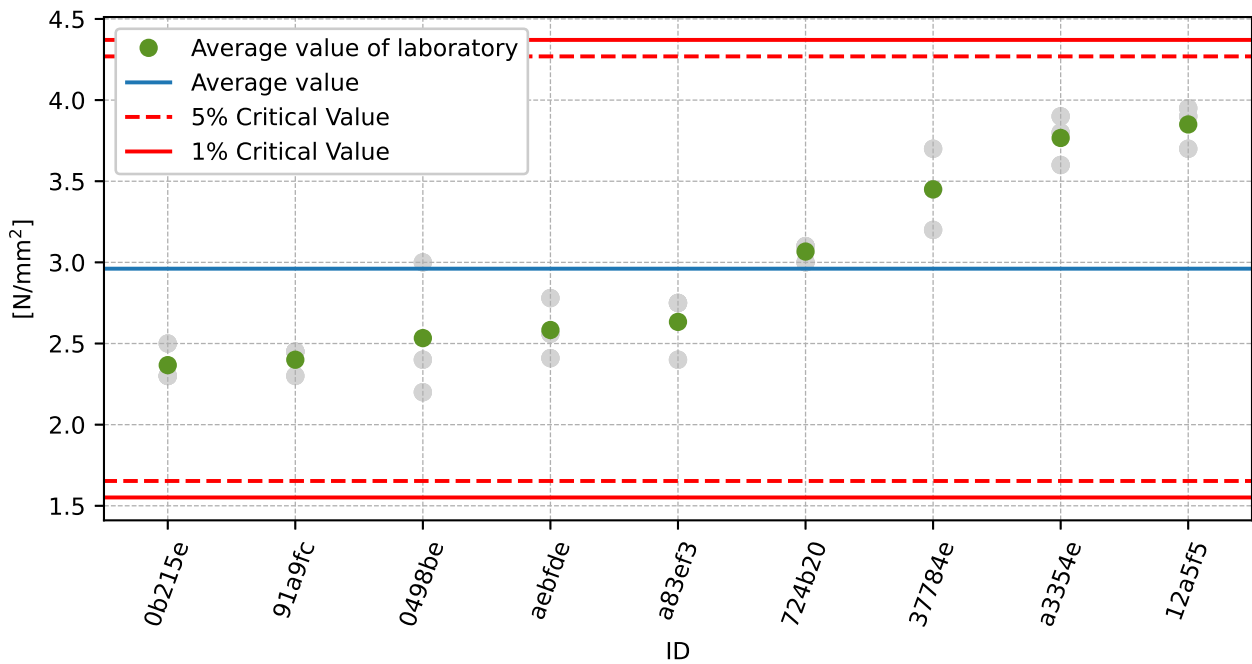


Figure 102: Grubbs' test - average values

14.1.3 Mandel's Statistics

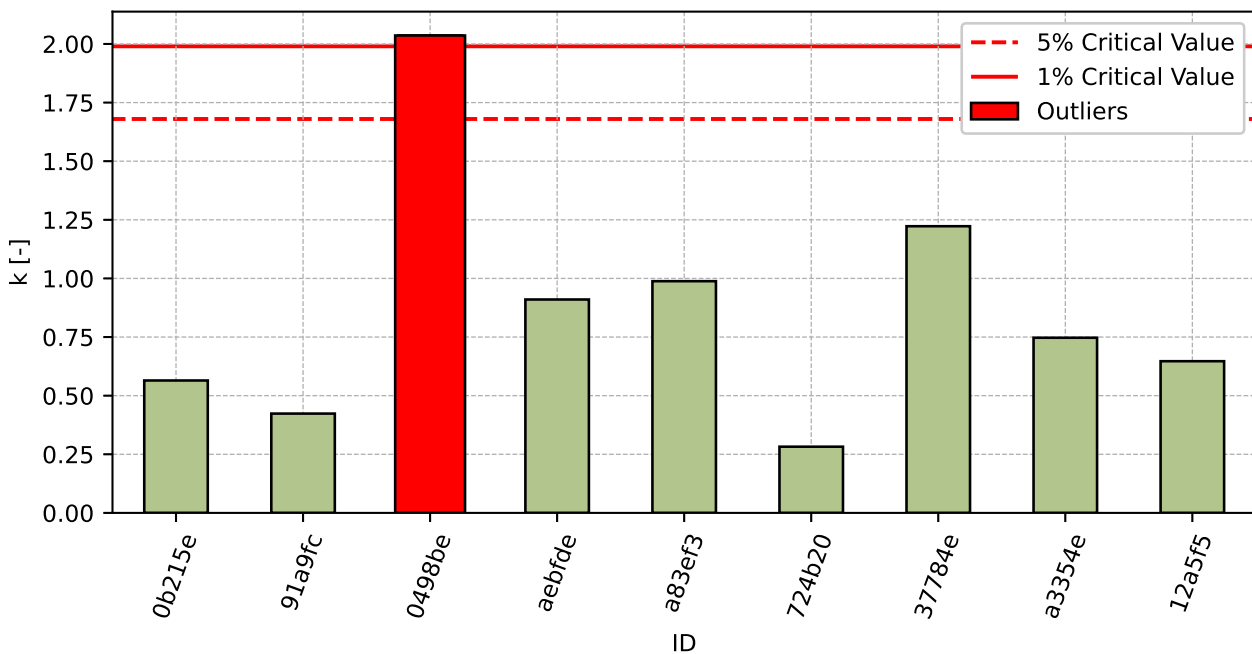


Figure 103: Intralaboratory Consistency Statistic

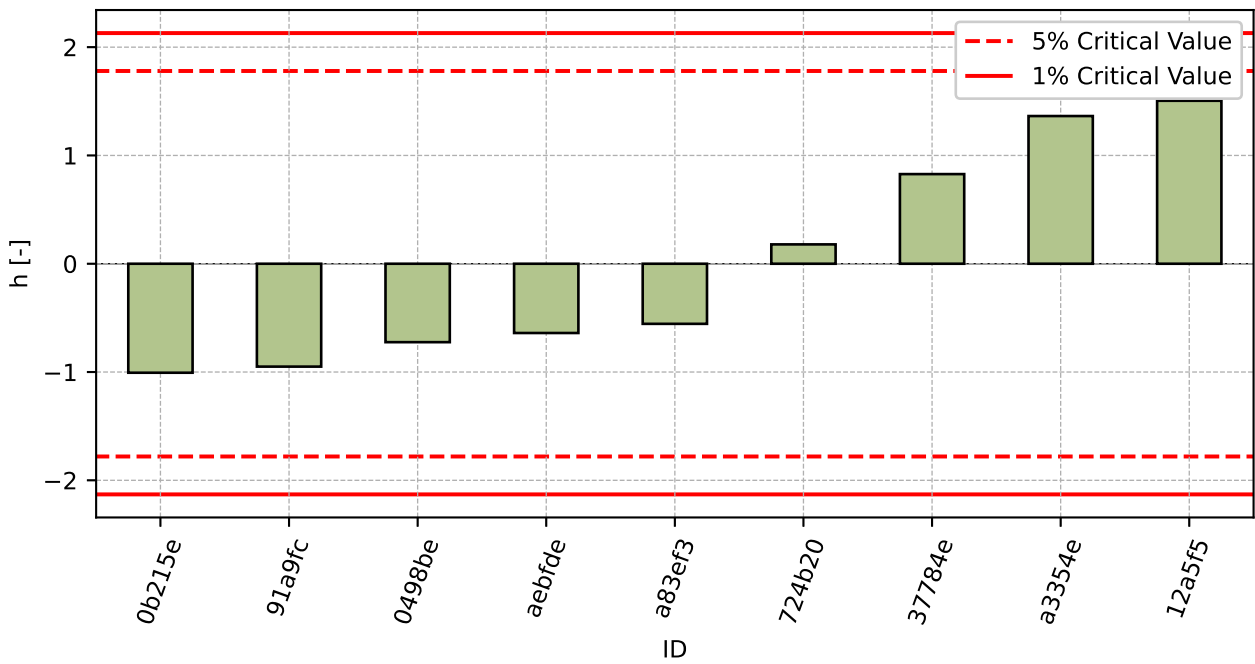


Figure 104: Interlaboratory Consistency Statistic

14.1.4 Descriptive statistics

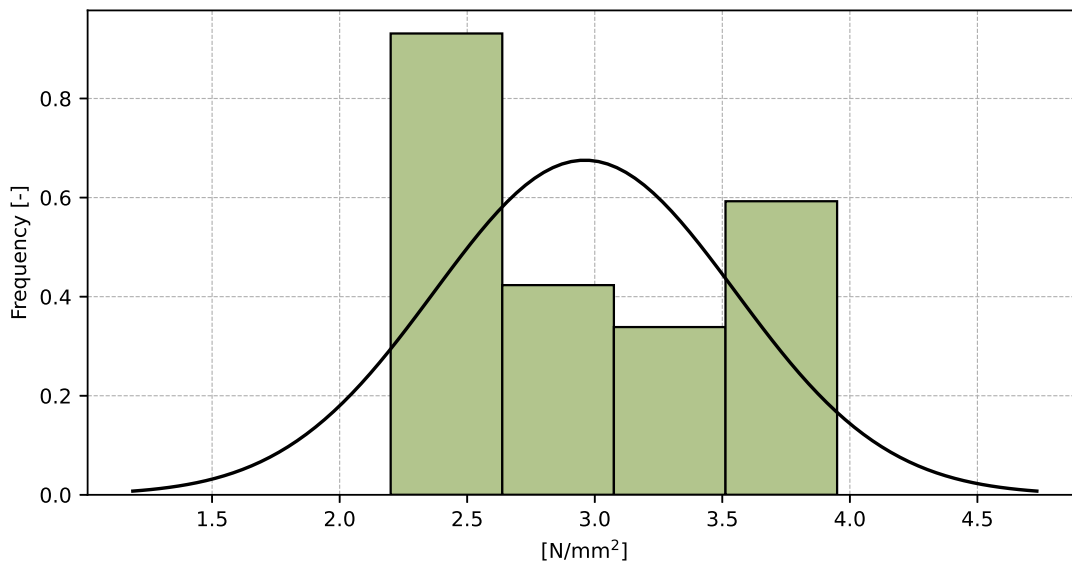


Figure 105: Histogram of all test results

Table 38: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	3.0
Sample standard deviation – s	0.59
Assigned value – x^*	2.9
Robust standard deviation – s^*	0.53
Measurement uncertainty of assigned value – u_X	0.22
p -value of normality test	0.009 [-]
Interlaboratory standard deviation – s_L	0.58
Repeatability standard deviation – s_r	0.2
Reproducibility standard deviation – s_R	0.61
Repeatability – r	0.6
Reproducibility – R	1.7

14.1.5 Evaluation of Performance Statistics

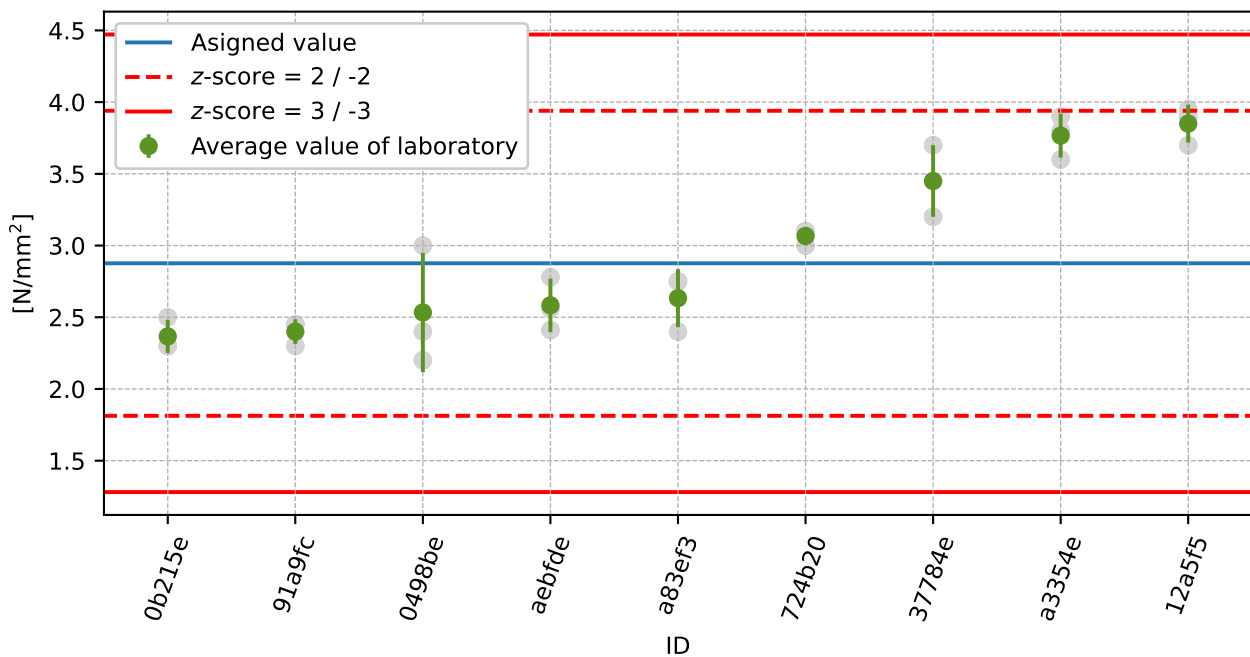


Figure 106: Average values and sample standard deviations

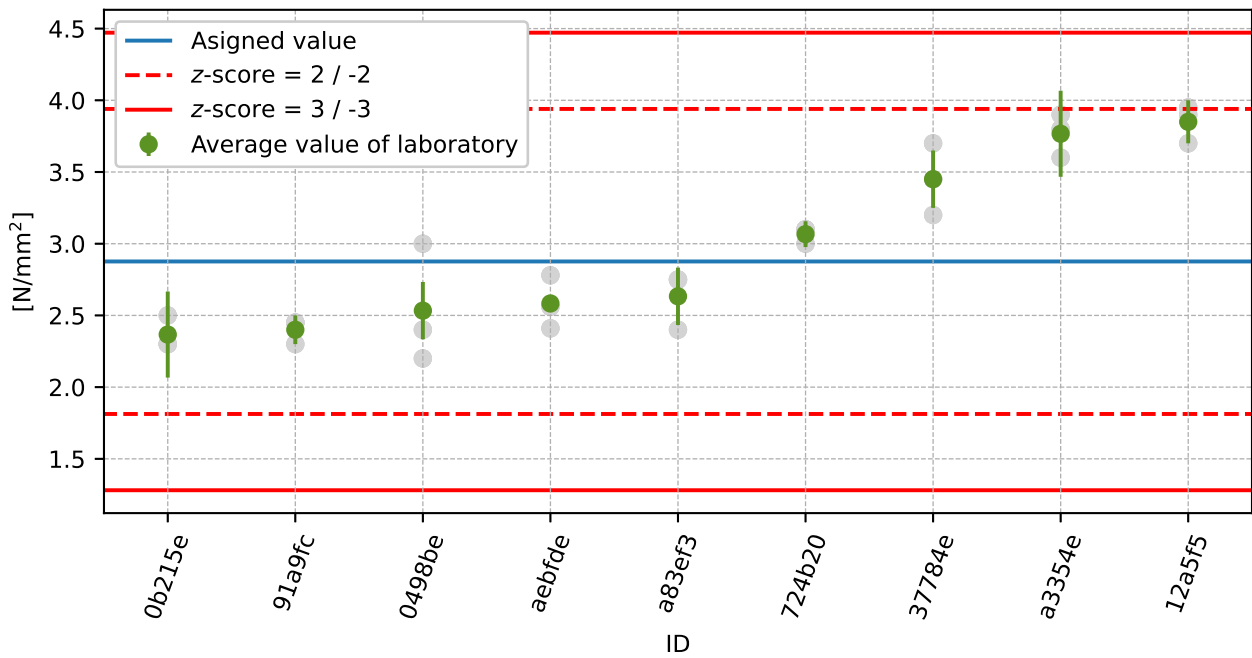


Figure 107: Average values and extended uncertainties of measurement

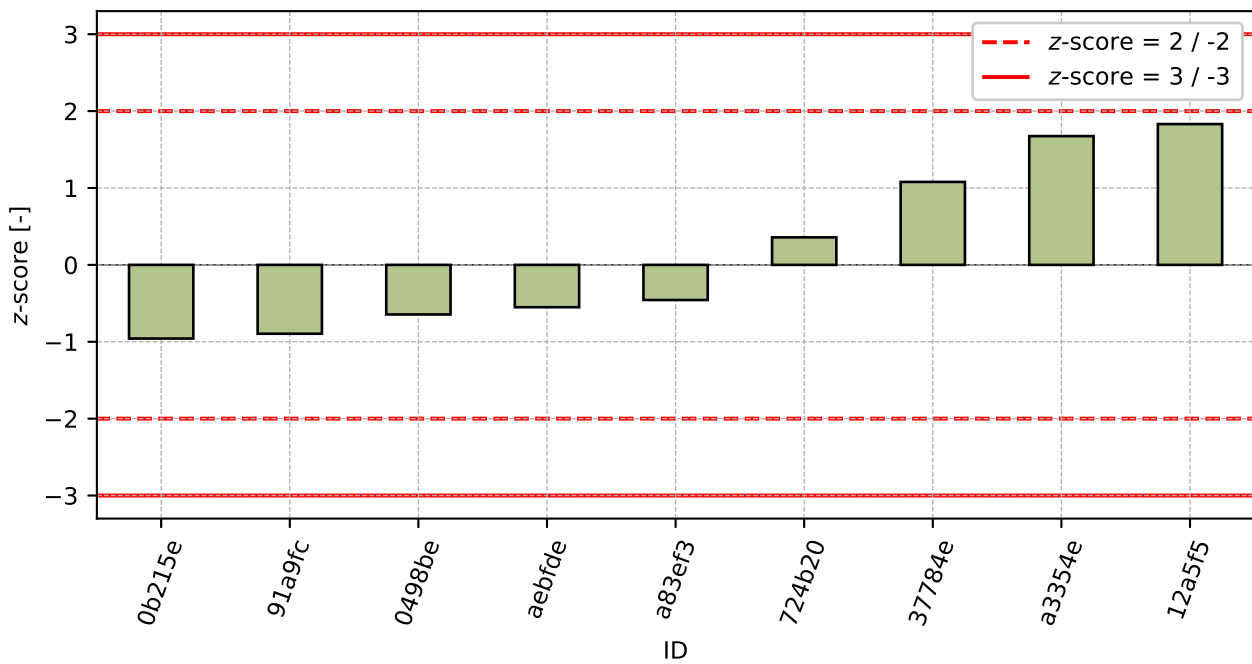


Figure 108: z-score

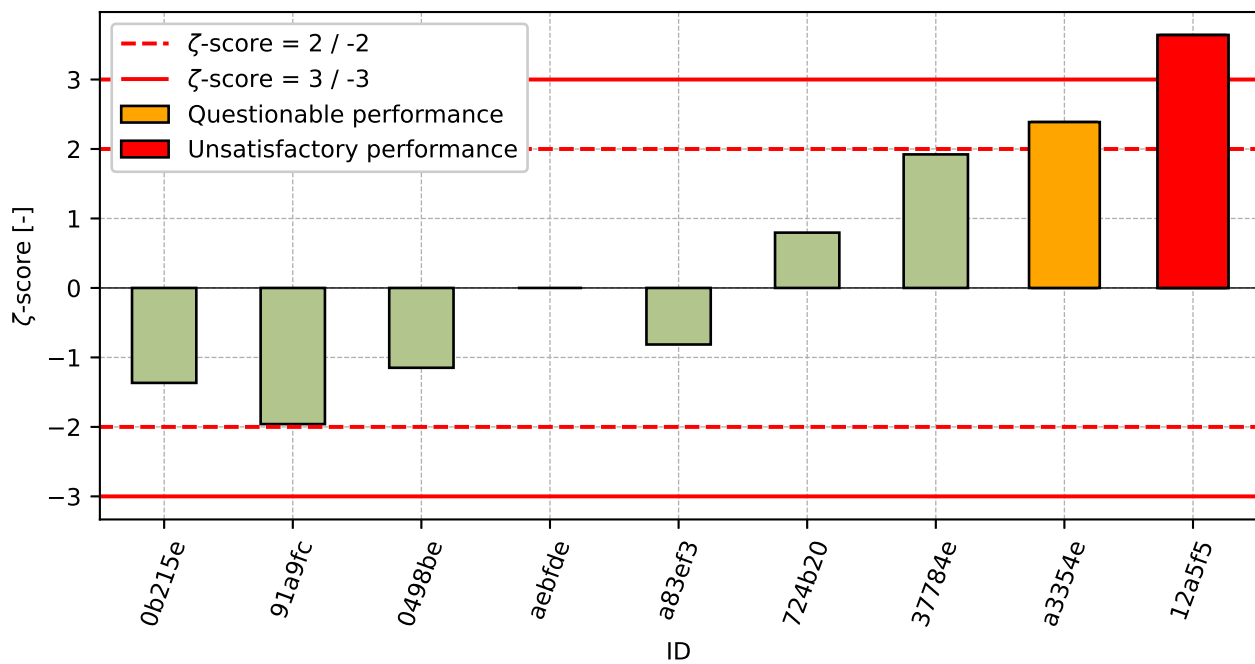


Figure 109: ζ -score

Table 39: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
0b215e	-0.96	-1.37
91a9fc	-0.9	-1.96
0498be	-0.64	-1.15
aebfde	-0.55	-
a83ef3	-0.46	-0.81
724b20	0.36	0.8
37784e	1.08	1.92
a3354e	1.67	2.39
12a5f5	1.83	3.64

14.2 Compressive Strength

14.2.1 Test results

Table 40: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]						u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
0b215e	8.9	8.6	8.1	7.9	7.9	8.4	0.8	8.3	0.4	4.88
91a9fc	9.0	9.0	8.4	8.4	9.0	9.0	0.3	8.8	0.32	3.63
724b20	11.2	11.0	10.4	10.8	10.4	10.4	0.3	10.7	0.38	3.52
aebfde	11.9	11.4	10.0	10.7	10.6	10.6	-	10.9	0.7	6.41
a83ef3	12.4	12.0	12.1	11.4	11.6	11.5	0.9	11.8	0.4	3.41
0498be	13.3	12.8	13.7	13.3	13.7	12.9	0.7	13.3	0.4	2.98
37784e	14.8	13.5	13.0	14.0	13.8	14.6	0.8	13.9	0.68	4.87
12a5f5	13.7	14.5	13.0	14.1	14.0	14.8	0.4	14.0	0.63	4.53
a3354e	15.8	15.5	15.6	15.7	15.4	15.6	1.2	15.6	0.14	0.91

14.2.2 The Numerical Procedure for Determining Outliers

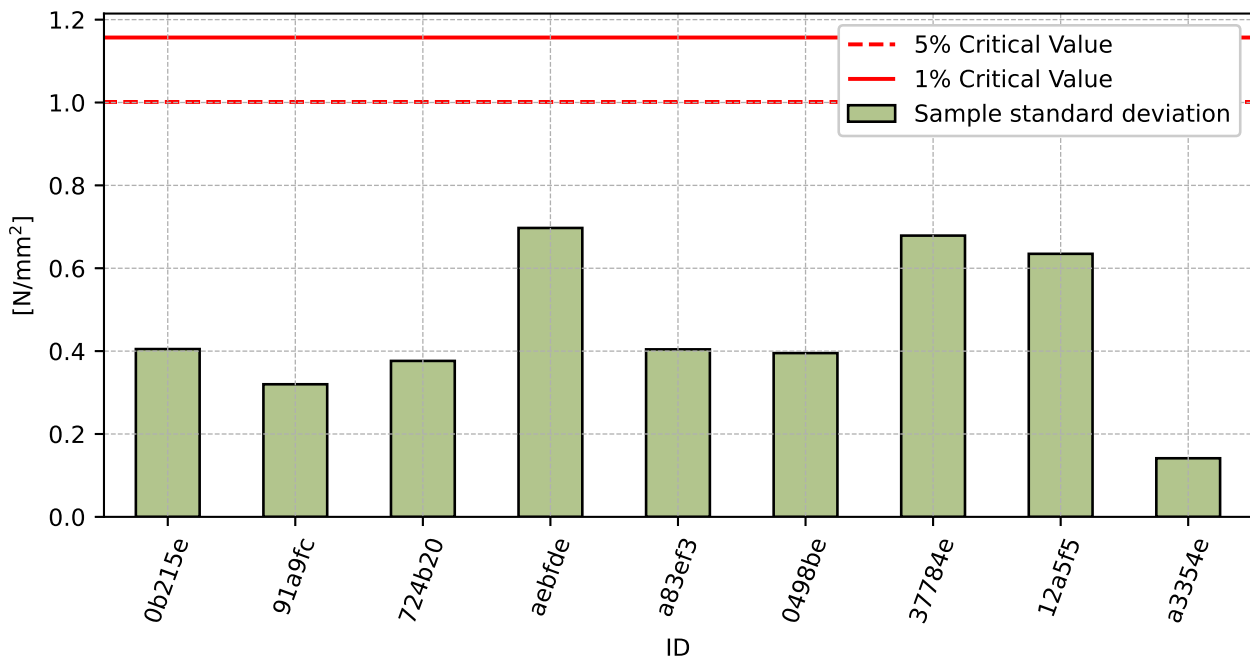


Figure 110: Cochran's test - sample standard deviations

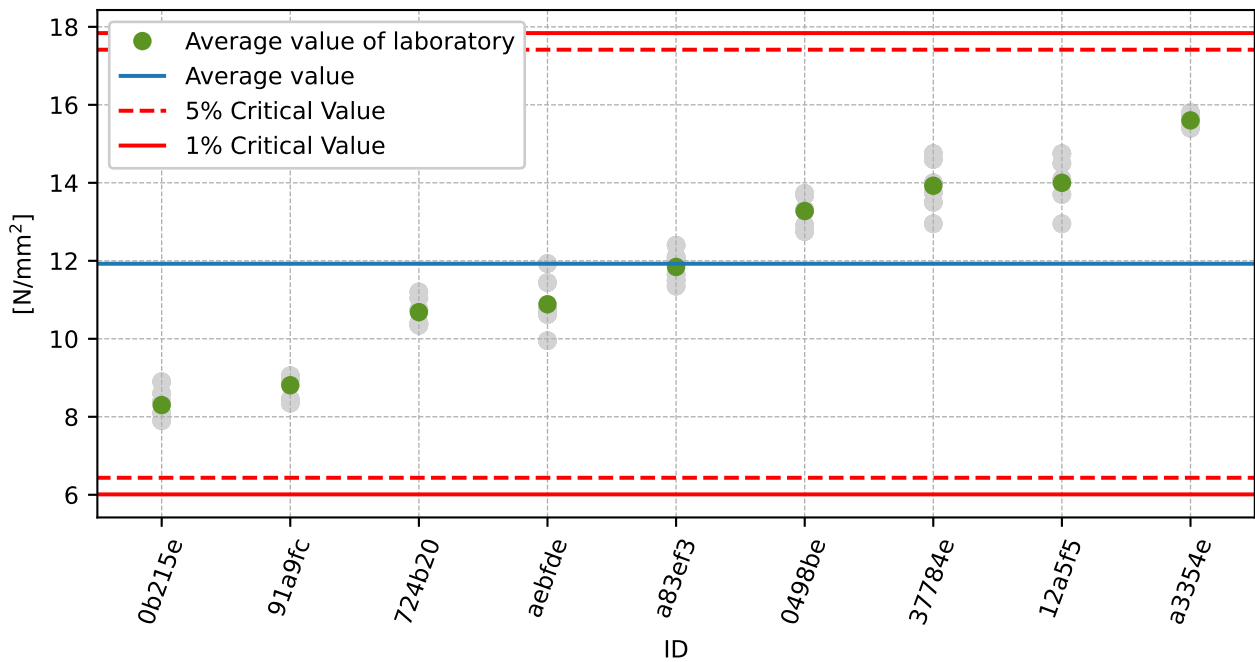


Figure 111: Grubbs' test - average values

14.2.3 Mandel's Statistics

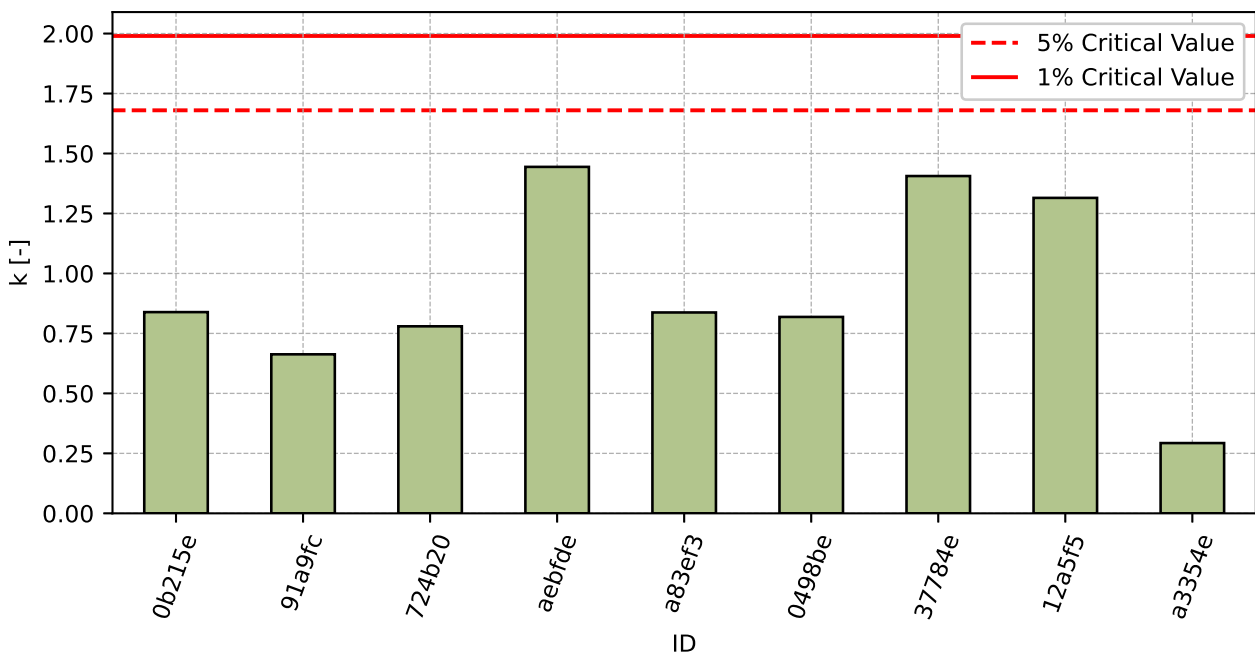


Figure 112: Intralaboratory Consistency Statistic

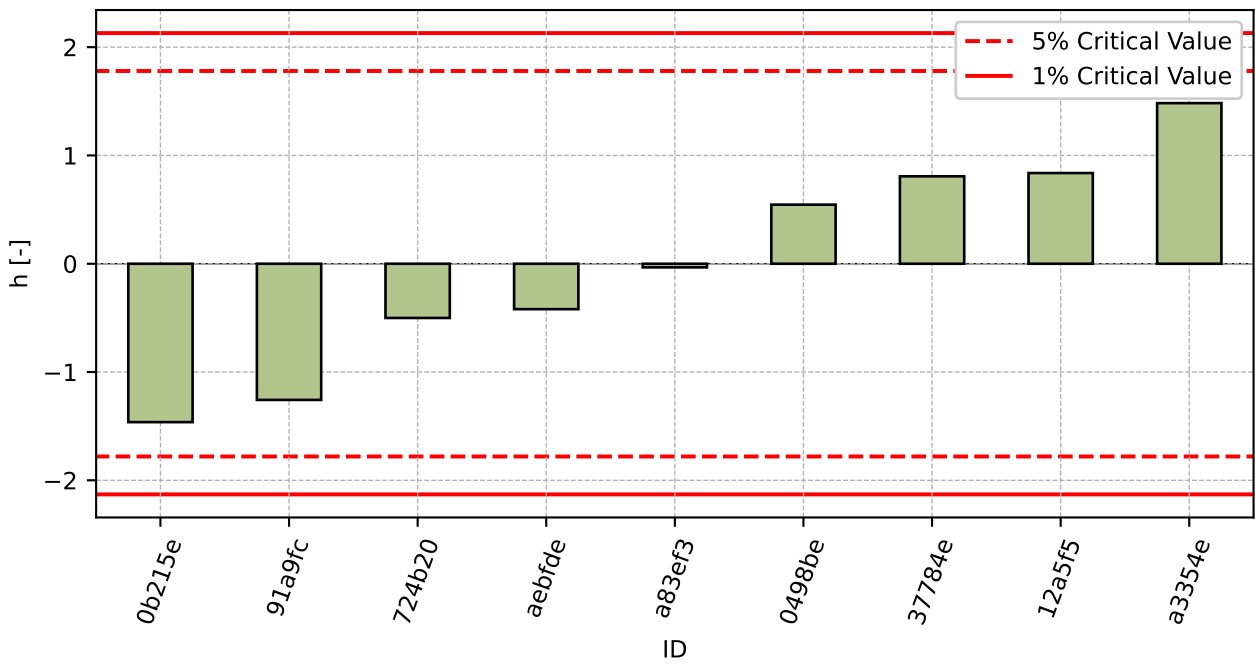


Figure 113: Interlaboratory Consistency Statistic

14.2.4 Descriptive statistics

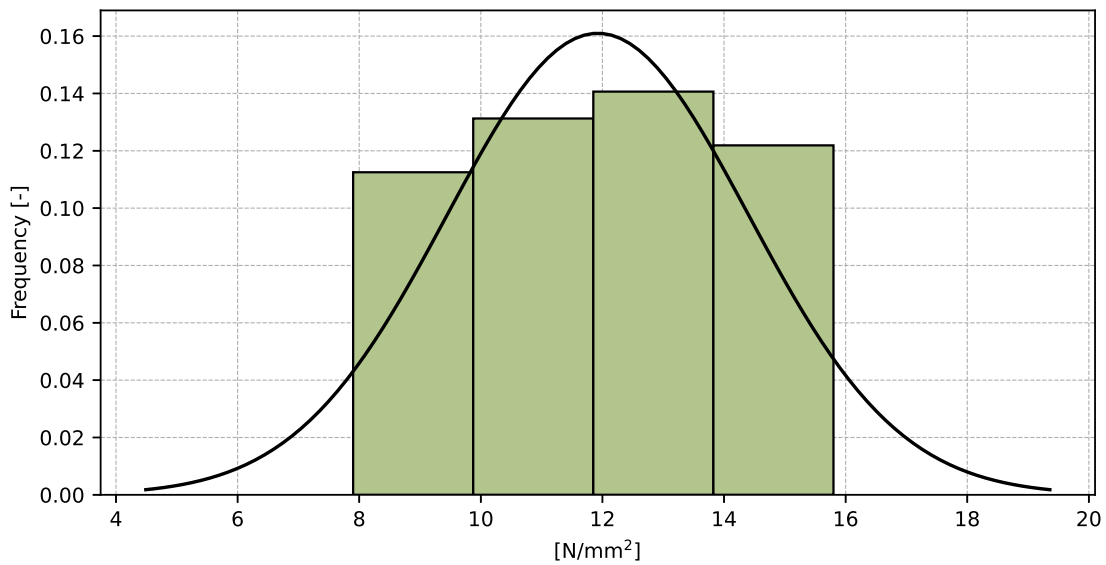


Figure 114: Histogram of all test results

Table 41: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	11.9
Sample standard deviation – s	2.48
Assigned value – x^*	11.9
Robust standard deviation – s^*	2.65
Measurement uncertainty of assigned value – u_X	1.1
p -value of normality test	0.024 [-]
Interlaboratory standard deviation – s_L	2.47
Repeatability standard deviation – s_r	0.48
Reproducibility standard deviation – s_R	2.52
Repeatability – r	1.4
Reproducibility – R	7.0

14.2.5 Evaluation of Performance Statistics

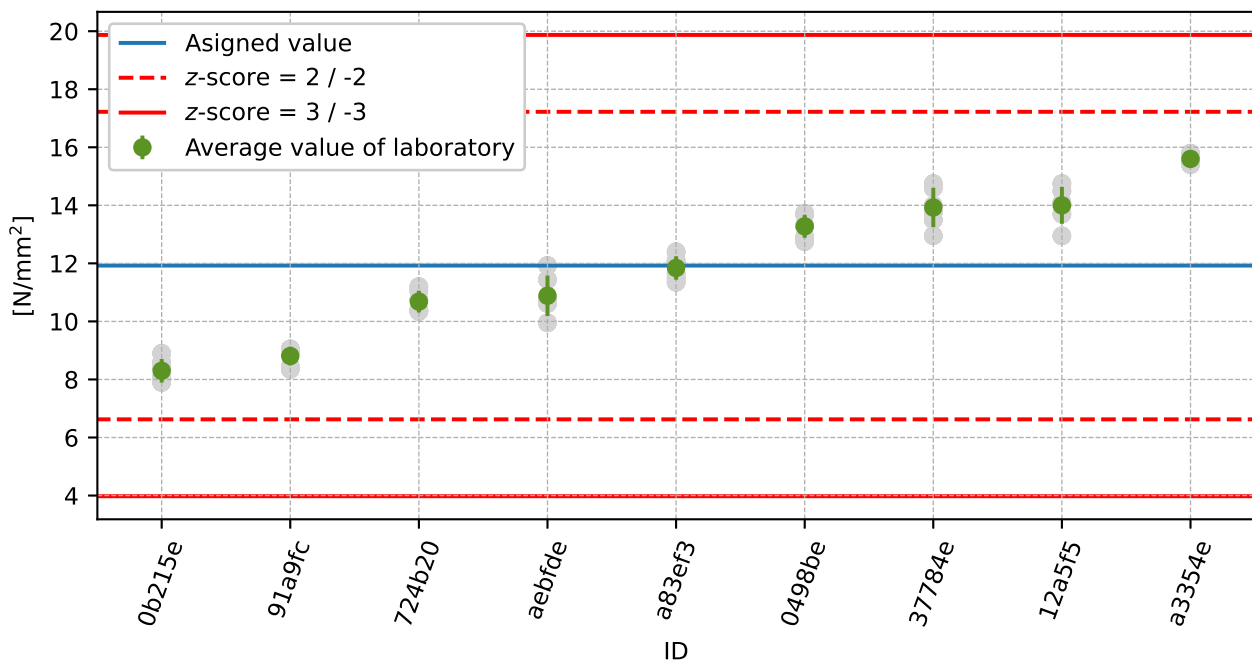


Figure 115: Average values and sample standard deviations

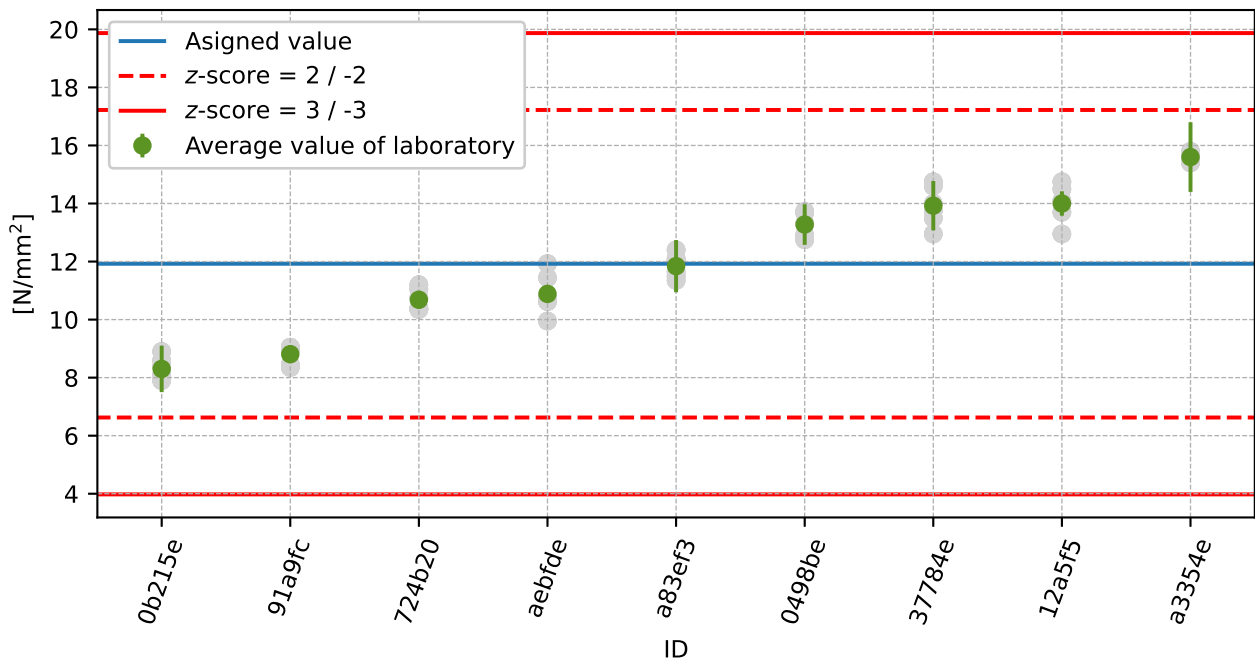


Figure 116: Average values and extended uncertainties of measurement

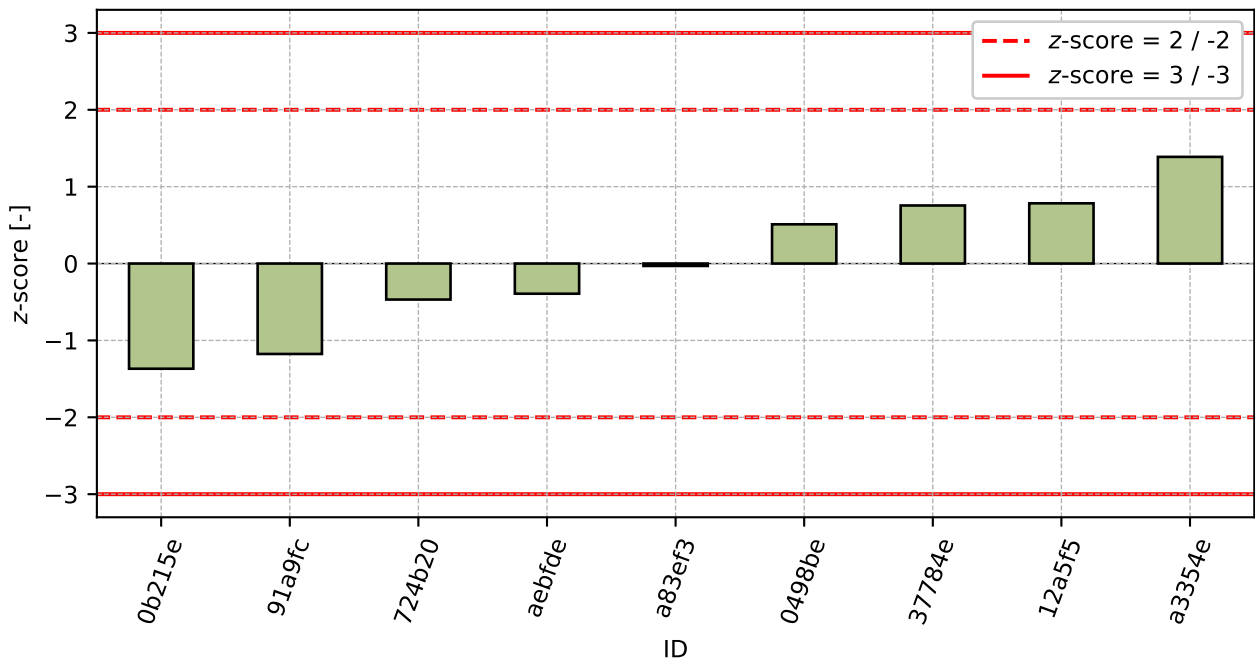


Figure 117: z-score

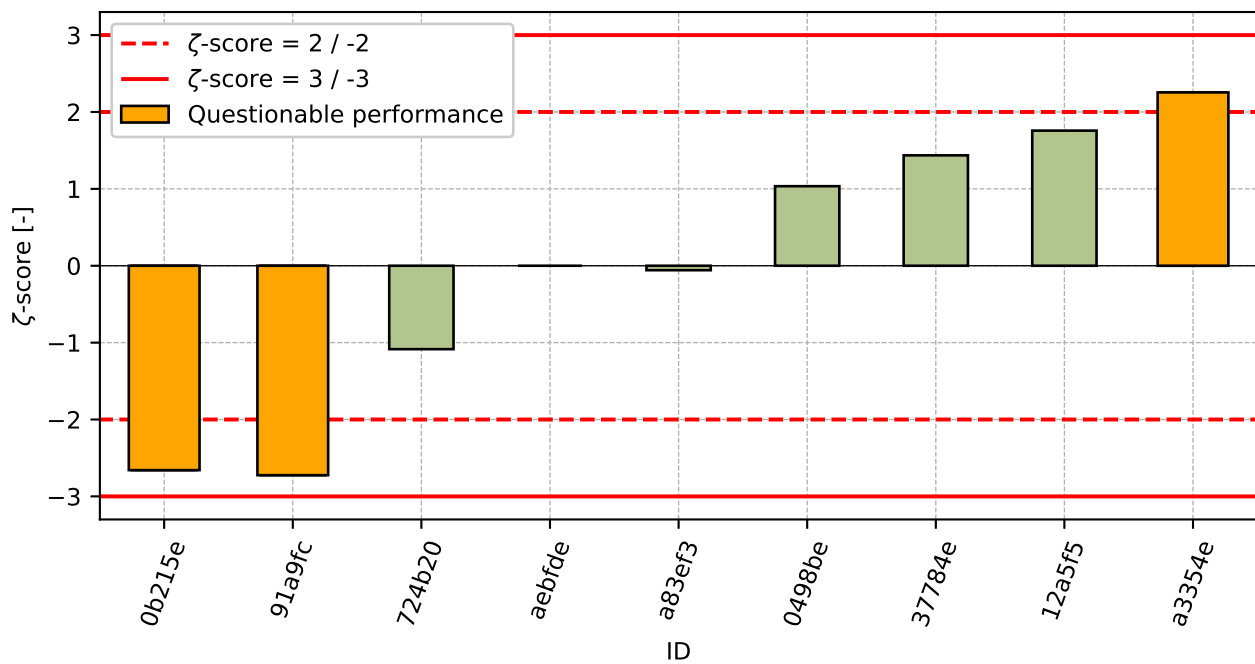


Figure 118: ζ -score

Table 42: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
0b215e	-1.37	-2.66
91a9fc	-1.18	-2.72
724b20	-0.47	-1.08
aebfde	-0.39	-
a83ef3	-0.03	-0.06
0498be	0.51	1.03
37784e	0.76	1.44
12a5f5	0.78	1.76
a3354e	1.39	2.25

15 Appendix – EN 1015-12 – Adhesion

15.1 Test results

Table 43: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]					u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
724b20	0.35	0.3	0.35	0.35	0.3	0.01	0.33	0.027	8.3
91a9fc	0.38	0.32	0.35	0.36	0.34	0.02	0.35	0.022	6.39
37784e	0.45	0.5	0.45	0.4	0.6	0.1	0.48	0.076	15.8
a3354e	0.46	0.51	0.53	0.48	0.52	0.1	0.5	0.029	5.83

15.2 The Numerical Procedure for Determining Outliers

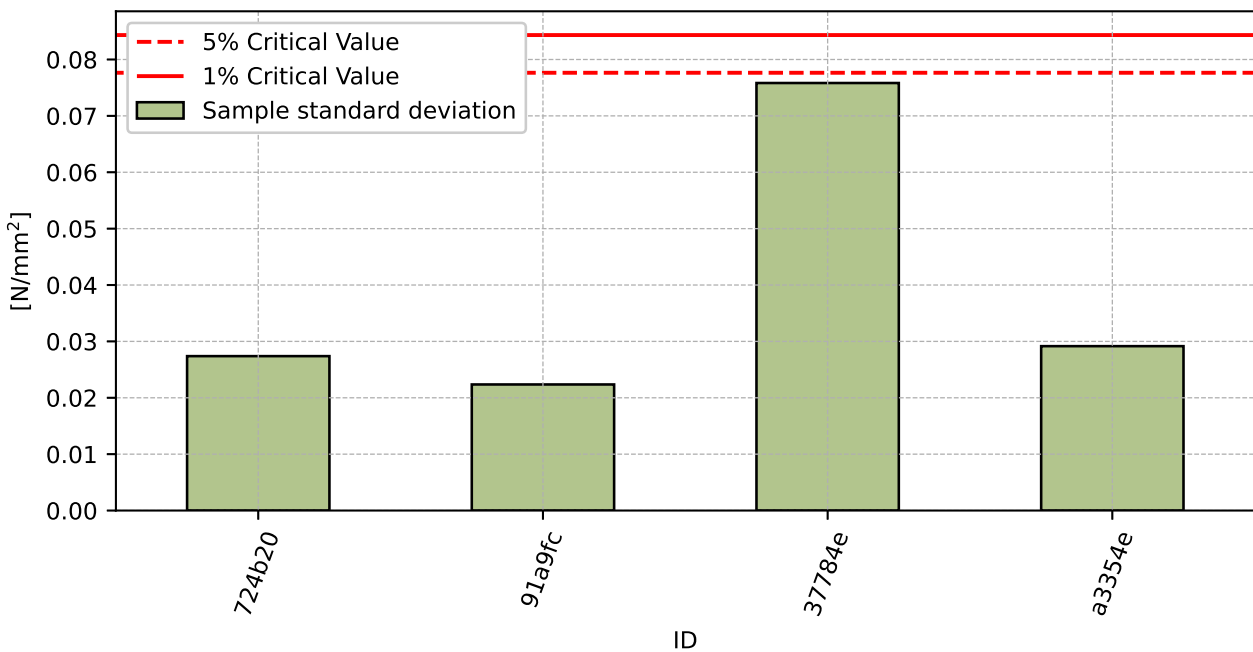


Figure 119: Cochran's test - sample standard deviations

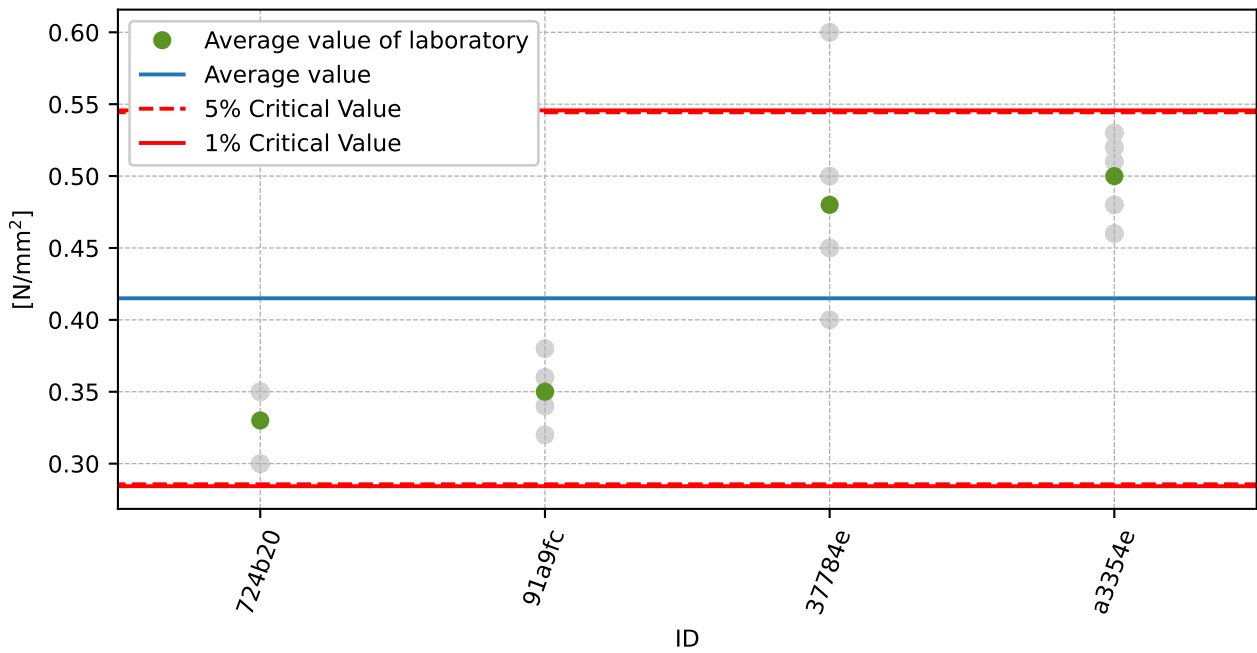


Figure 120: Grubbs' test - average values

15.3 Mandel's Statistics

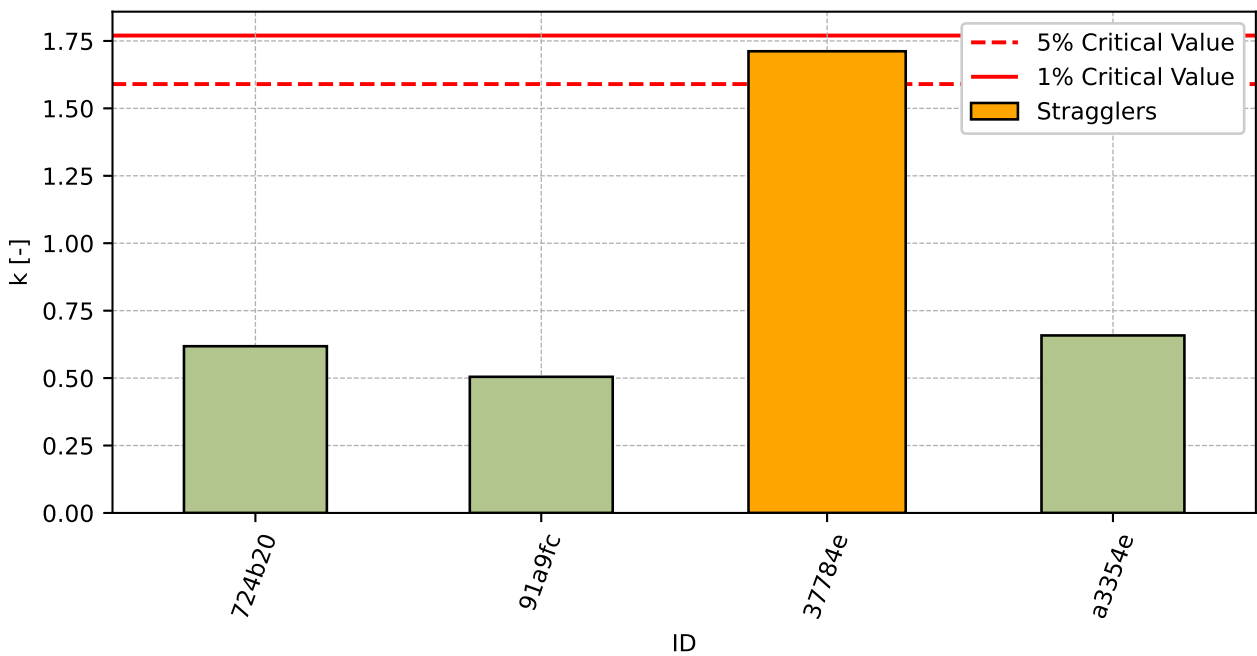


Figure 121: Intralaboratory Consistency Statistic

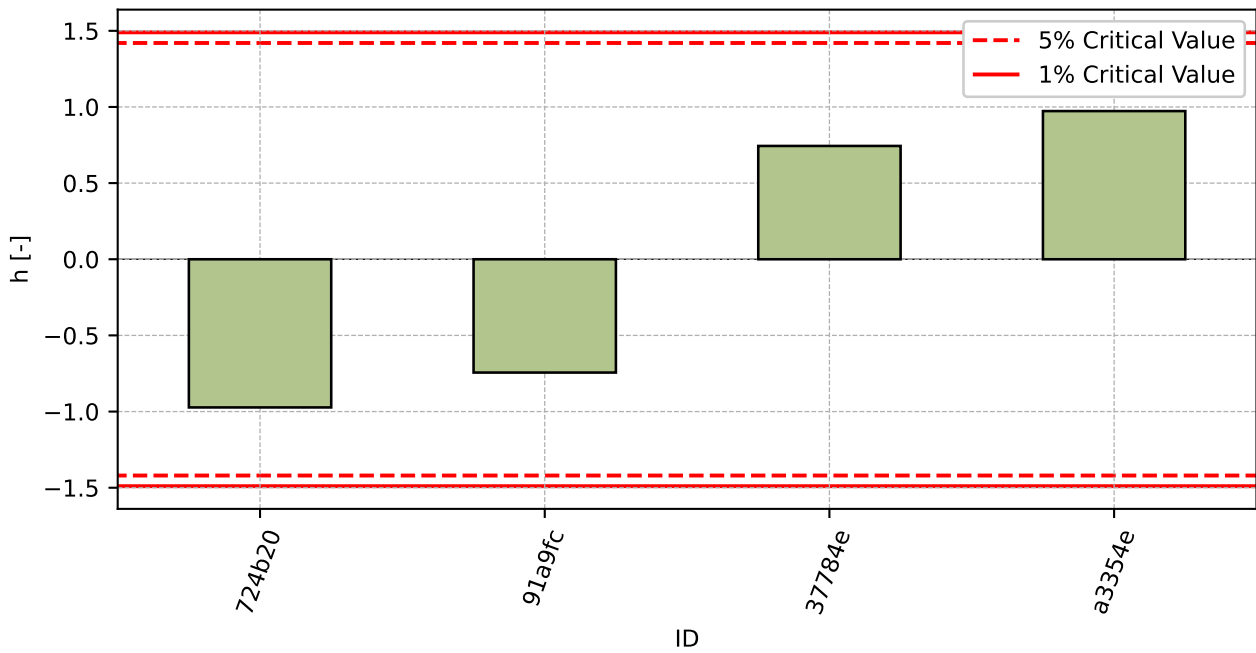


Figure 122: Interlaboratory Consistency Statistic

15.4 Descriptive statistics

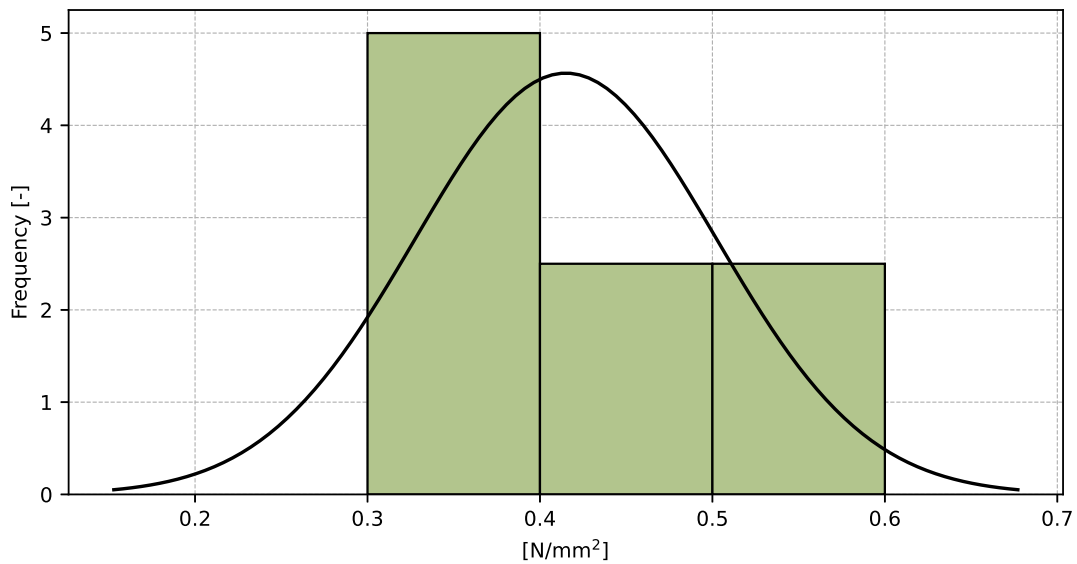


Figure 123: Histogram of all test results

Table 44: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	0.42
Sample standard deviation – s	0.087
Assigned value – x^*	0.42
Robust standard deviation – s^*	0.086
Measurement uncertainty of assigned value – u_X	0.054
p -value of normality test	0.13 [-]
Interlaboratory standard deviation – s_L	0.085
Repeatability standard deviation – s_r	0.044
Reproducibility standard deviation – s_R	0.096
Repeatability – r	0.12
Reproducibility – R	0.27

15.5 Evaluation of Performance Statistics

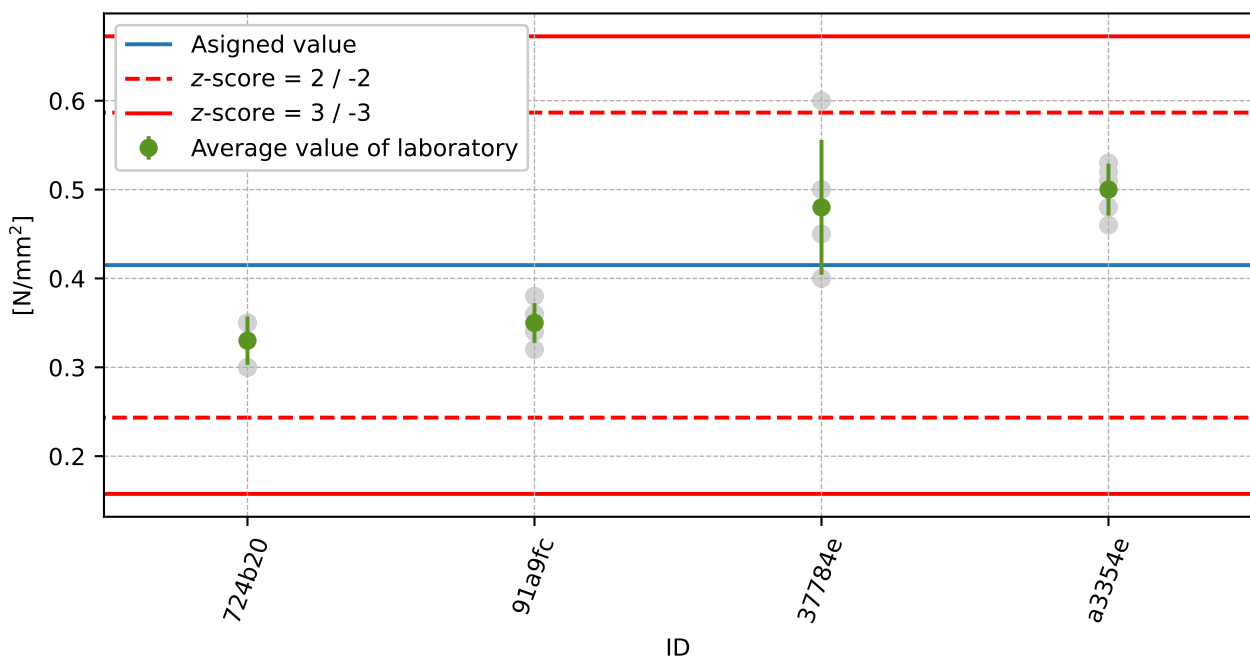


Figure 124: Average values and sample standard deviations

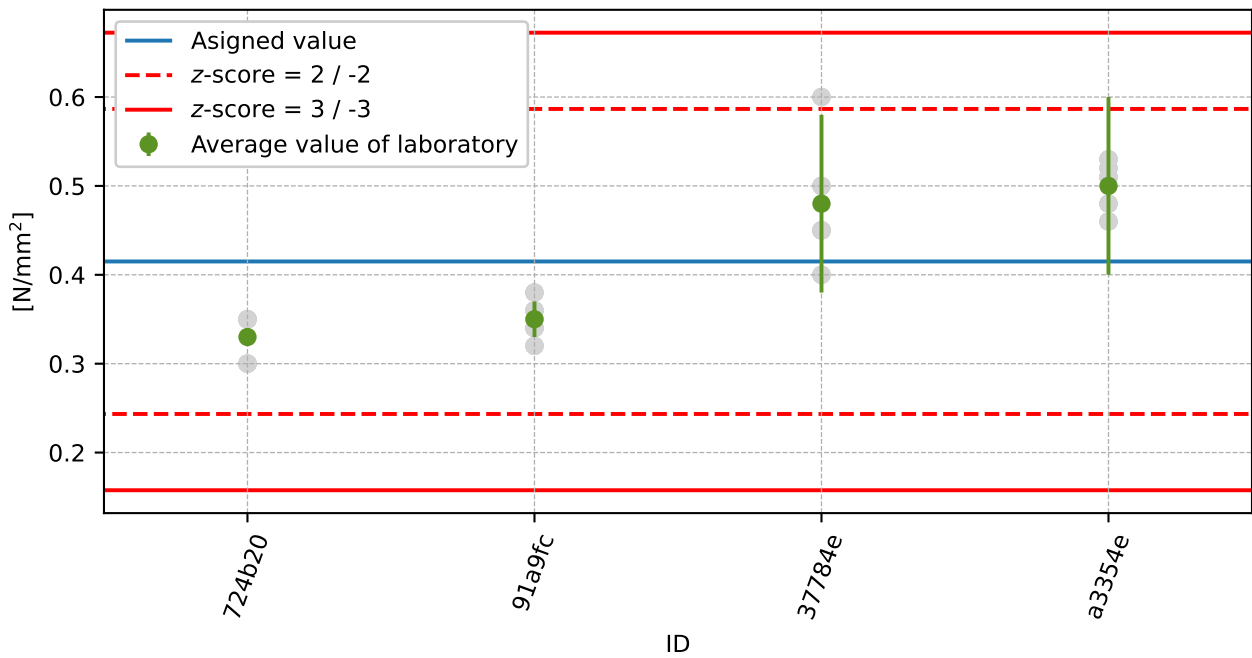


Figure 125: Average values and extended uncertainties of measurement

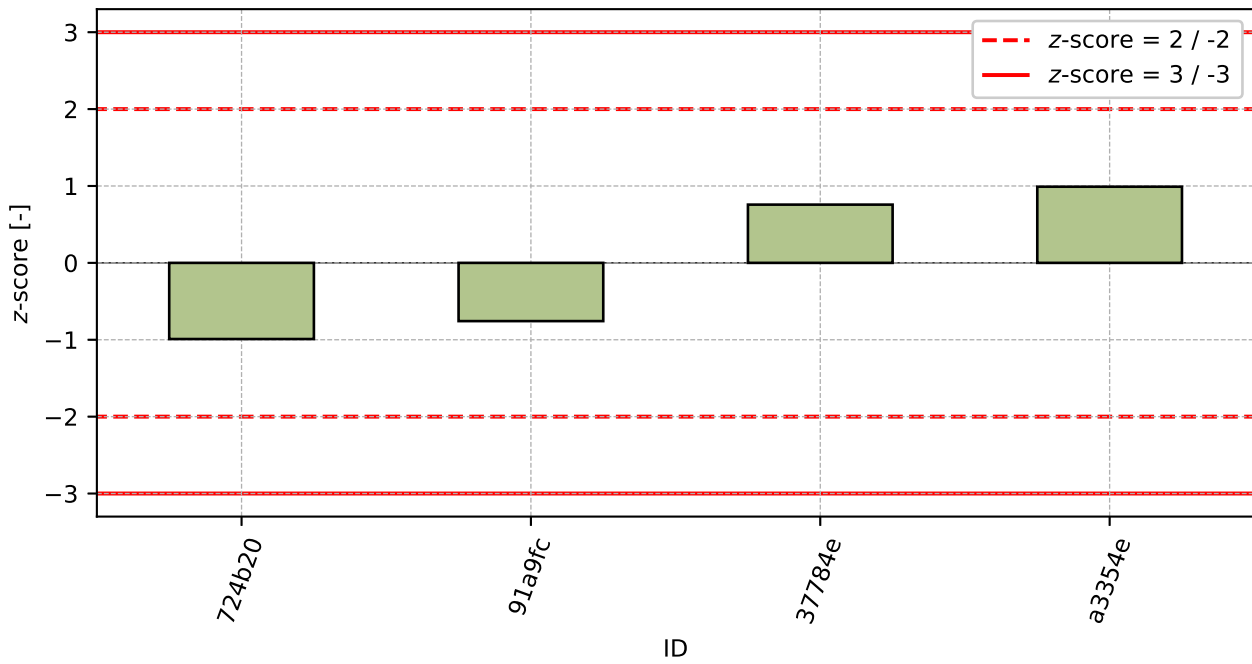


Figure 126: z-score

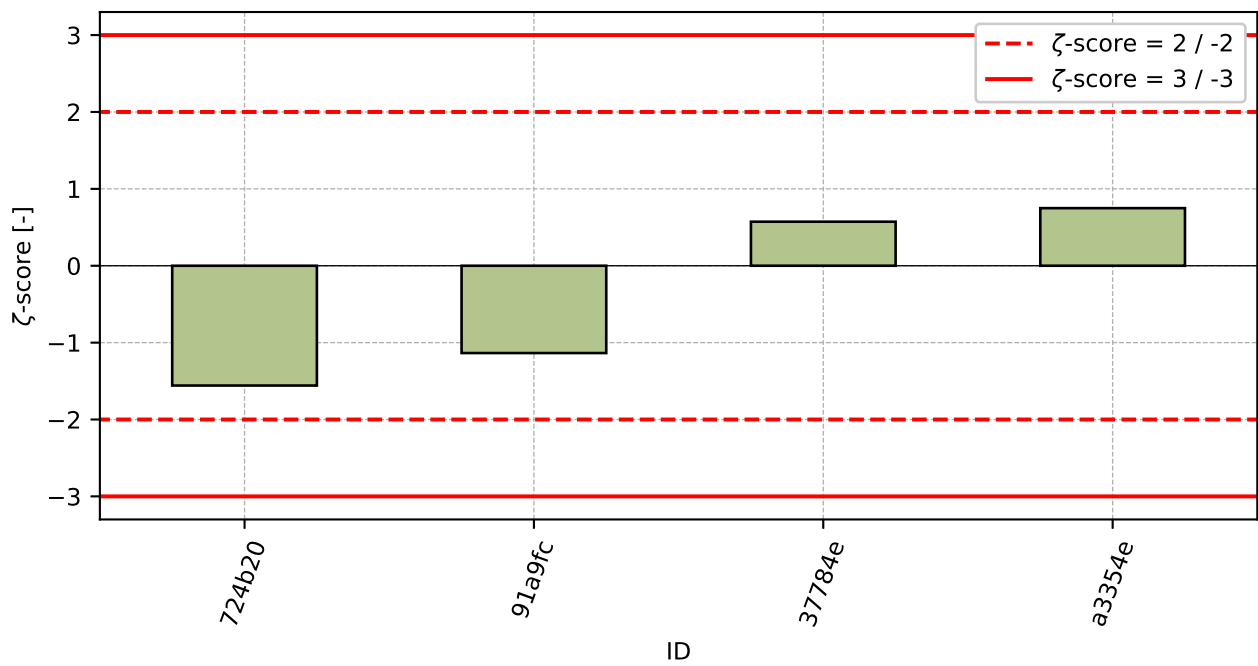


Figure 127: z-score

Table 45: z-score and zeta-score

ID	z-score [-]	zeta-score [-]
724b20	-0.99	-1.56
91a9fc	-0.76	-1.14
37784e	0.76	0.57
a3354e	0.99	0.75

16 Appendix – EN 1015-18 – Capillary absorption coefficient (C_m)

This part of PT program was not open due to low number of participants.

17 Appendix – EN 1015-19 – Water vapor flow

This part of PT program was not open due to low number of participants.

18 Appendix – EN 13892-2 – Determination of flexural and compressive strength

18.1 Flexural Strength

18.1.1 Test results

Table 46: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results			u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
	[N/mm ²]	[N/mm ²]	[N/mm ²]				
0b215e	4.6	5.3	5.3	1.0	5.07	0.404	7.98
8c23d8	5.05	5.0	5.2	0.2	5.08	0.104	2.05
91a9fc	5.65	4.9	5.05	0.4	5.2	0.397	7.63
0498be	5.3	6.1	6.3	0.5	5.9	0.529	8.97
37784e	6.3	6.3	6.3	0.15	6.3	0.0	0.0
09b3b4	6.75	6.4	6.9	0.3	6.68	0.257	3.84
724b20	7.0	6.4	6.75	0.2	6.72	0.301	4.49
d09c92	7.1	7.2	6.45	1.2	6.92	0.407	5.89
a3354e	7.0	7.34	7.45	0.3	7.26	0.235	3.23

18.1.2 The Numerical Procedure for Determining Outliers

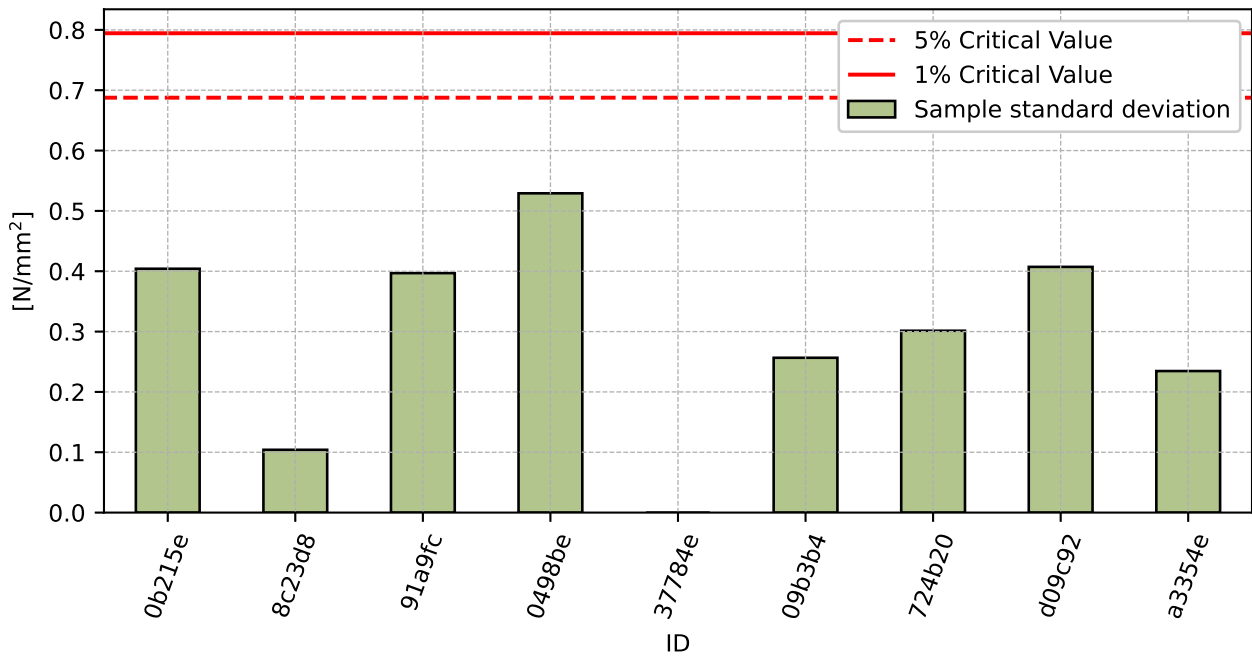


Figure 128: **Cochran's test** - sample standard deviations

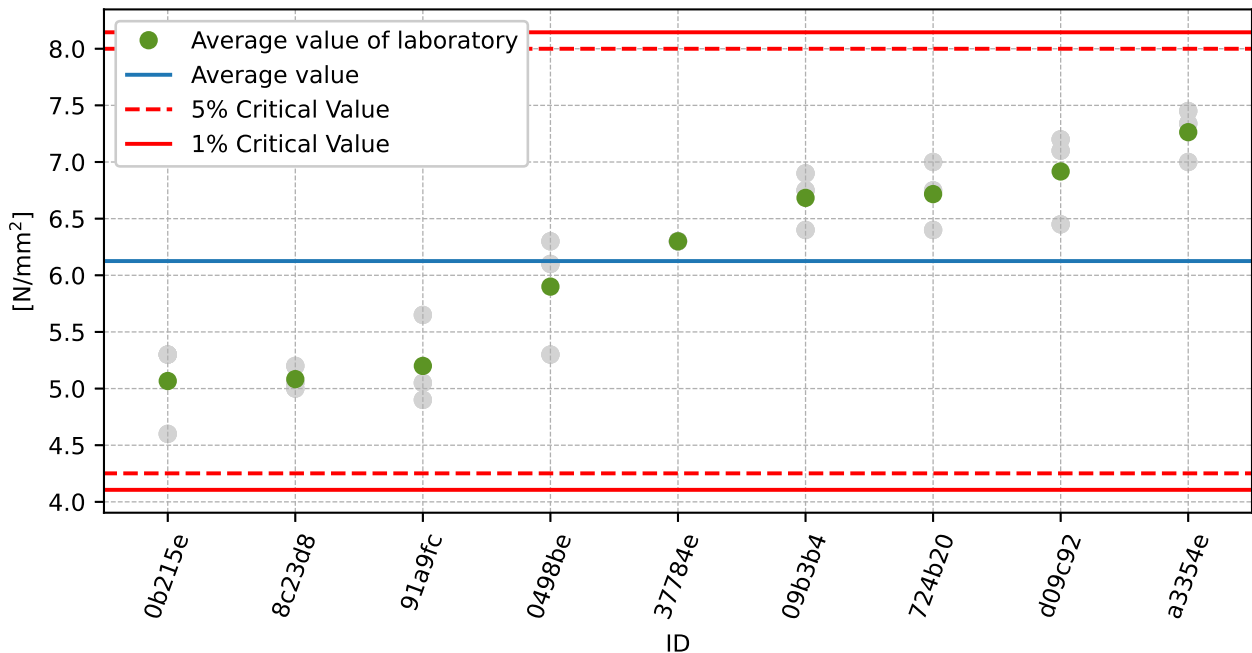


Figure 129: **Grubbs' test** - average values

18.1.3 Mandel’s Statistics

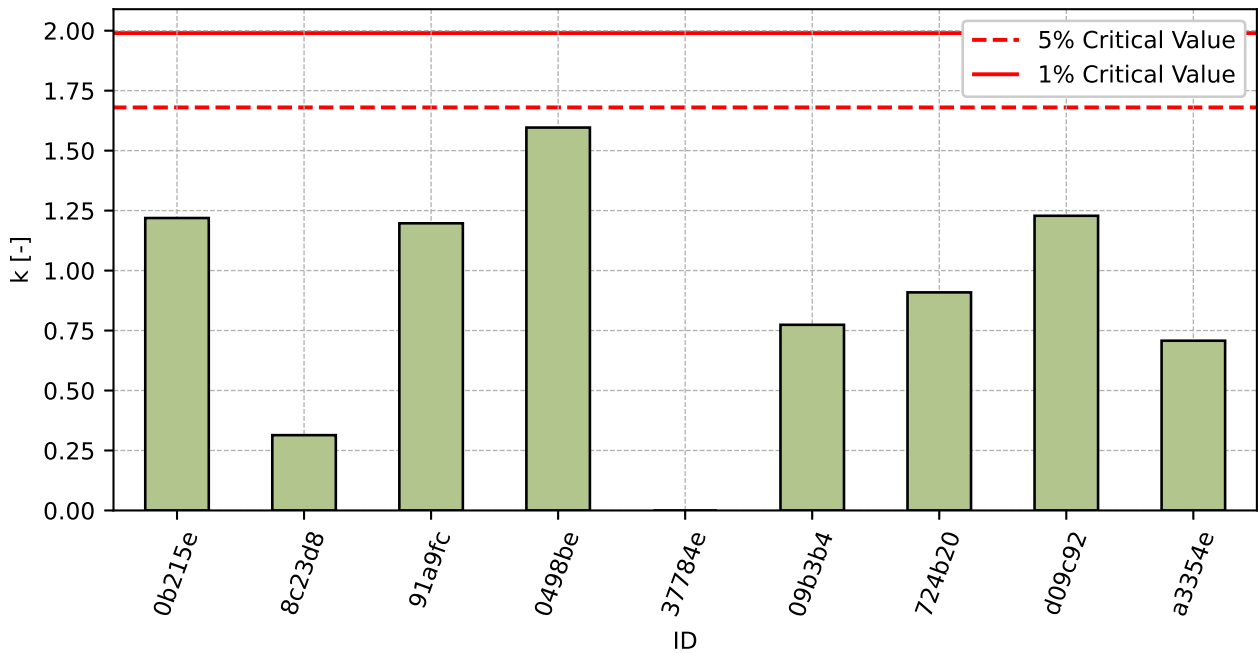


Figure 130: Intralaboratory Consistency Statistic

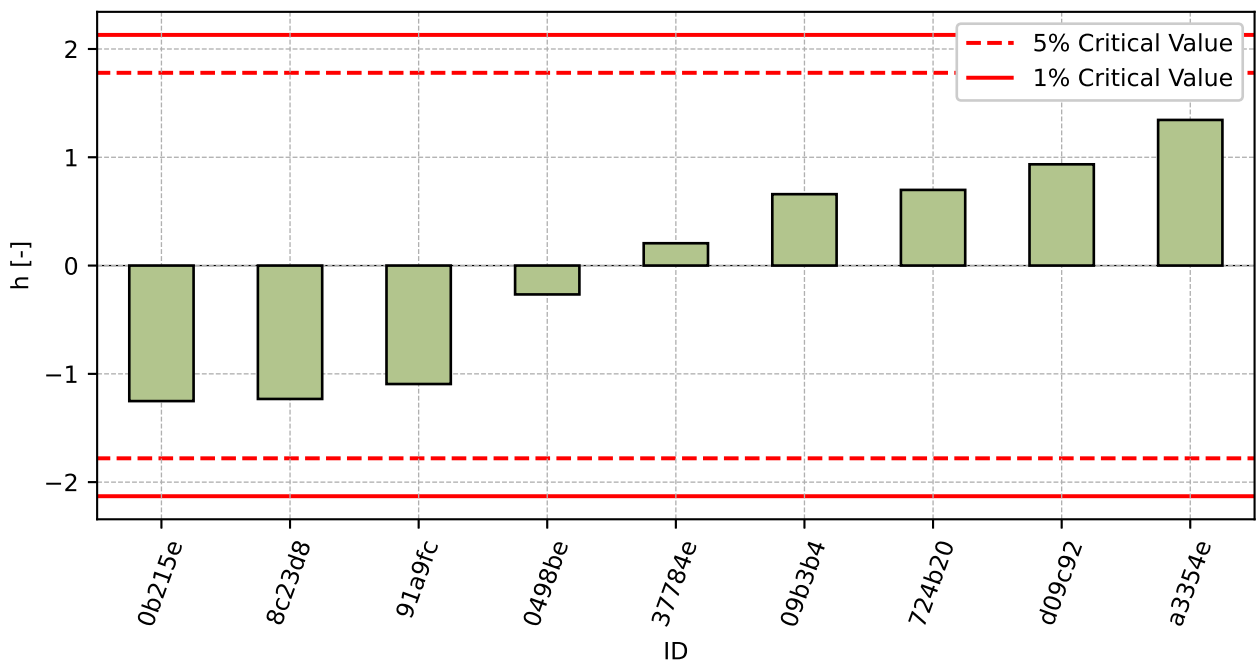


Figure 131: Interlaboratory Consistency Statistic

18.1.4 Descriptive statistics

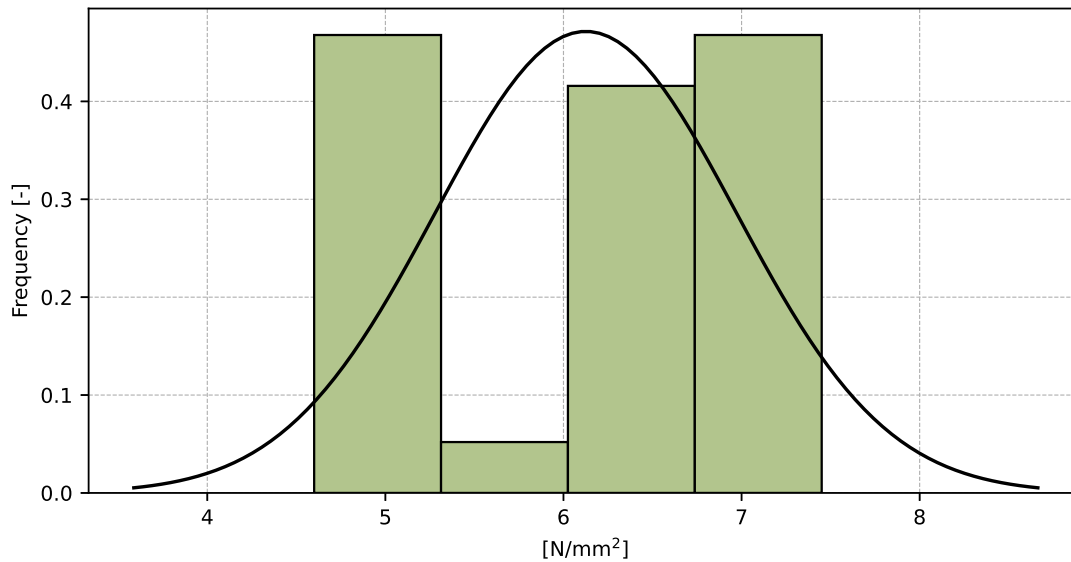


Figure 132: Histogram of all test results

Table 47: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	6.13
Sample standard deviation – s	0.846
Assigned value – x^*	6.13
Robust standard deviation – s^*	0.905
Measurement uncertainty of assigned value – u_X	0.377
p -value of normality test	0.065 [-]
Interlaboratory standard deviation – s_L	0.824
Repeatability standard deviation – s_r	0.332
Reproducibility standard deviation – s_R	0.888
Repeatability – r	0.93
Reproducibility – R	2.49

18.15 Evaluation of Performance Statistics

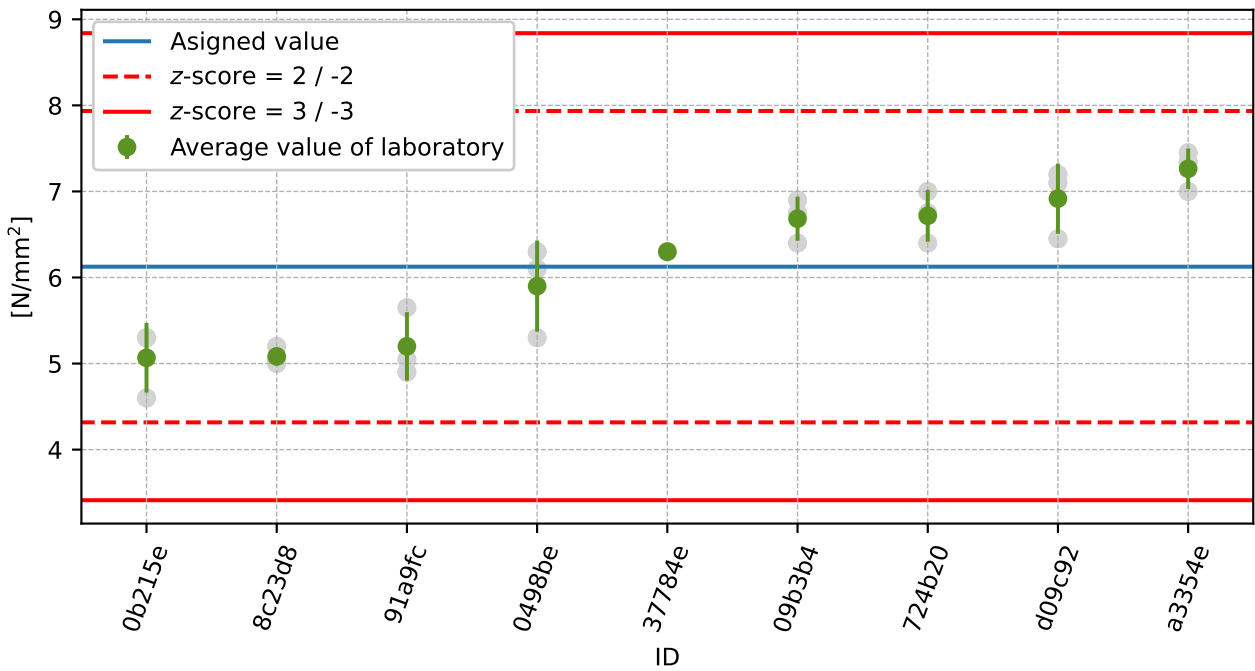


Figure 133: Average values and sample standard deviations

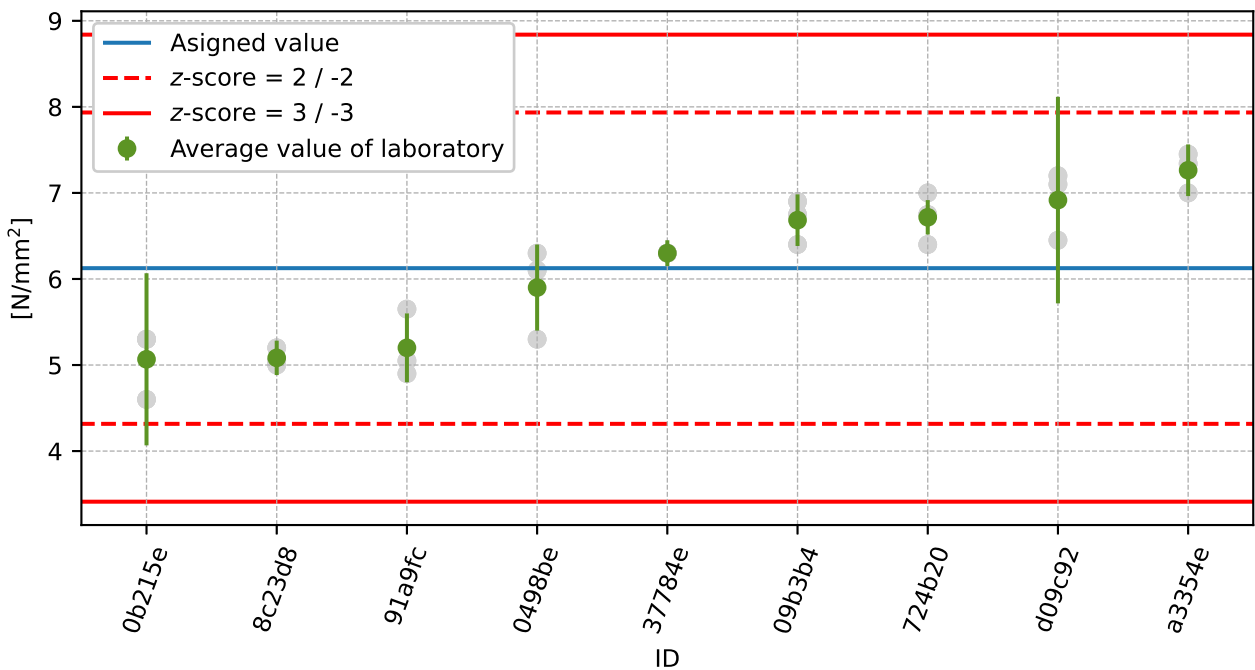


Figure 134: Average values and extended uncertainties of measurement

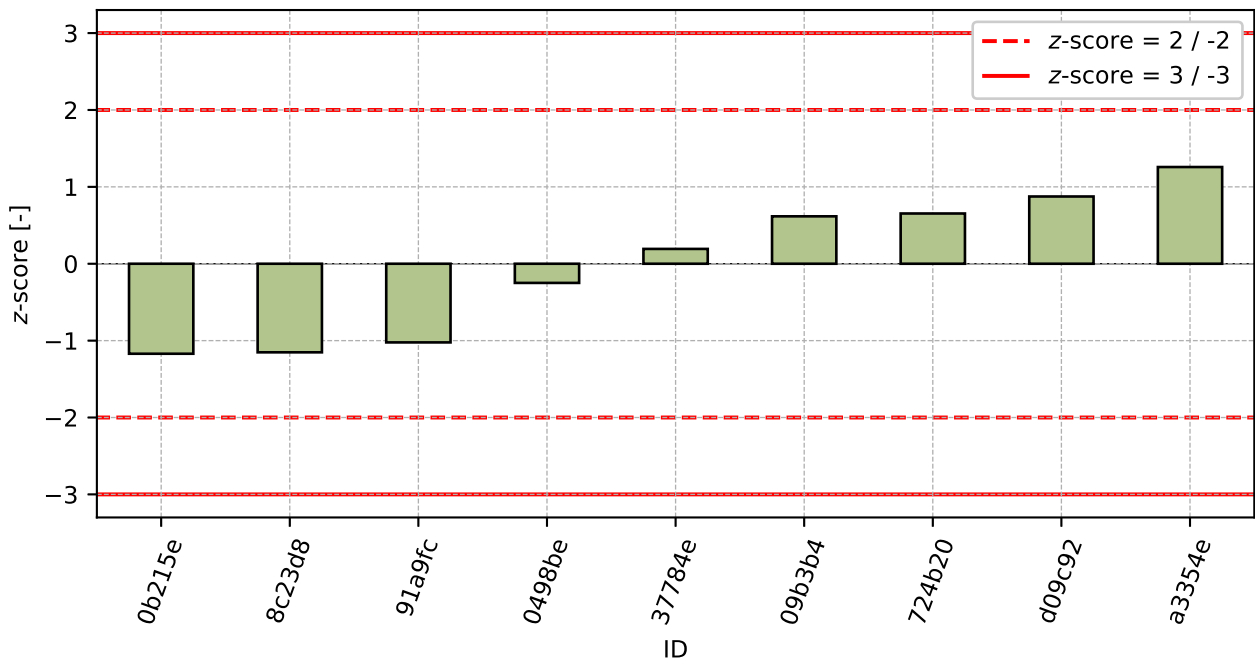


Figure 135: z-score

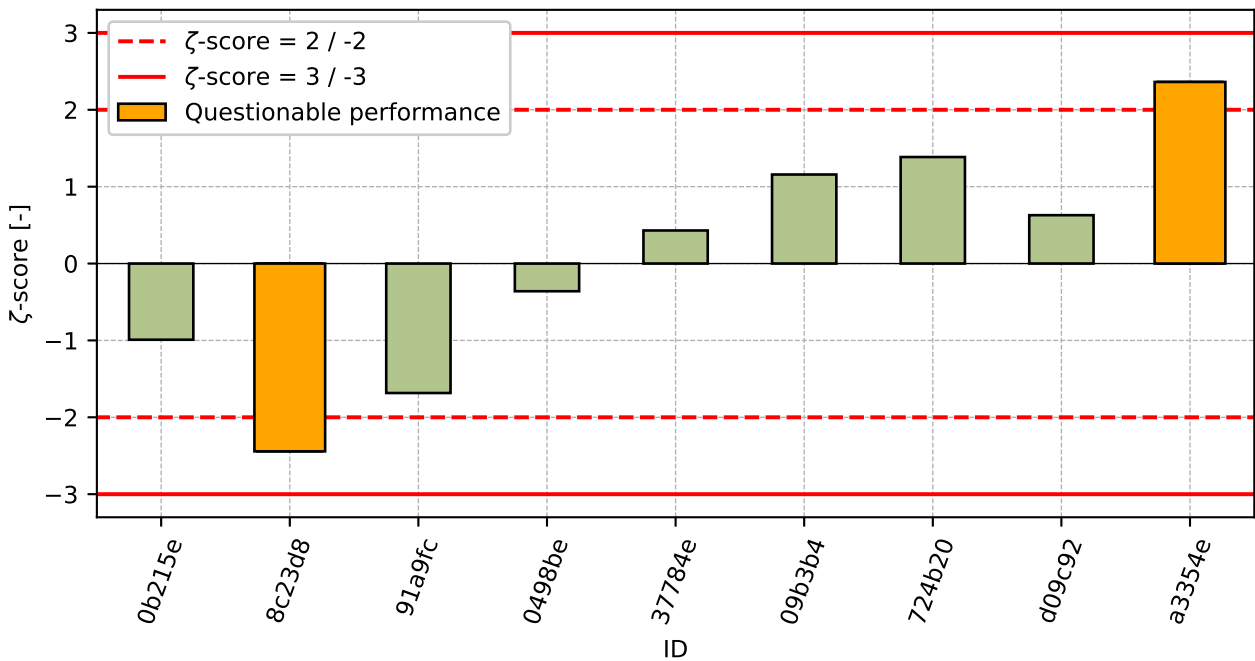


Figure 136: ζ-score

Table 48: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
0b215e	-1.17	-0.99
8c23d8	-1.15	-2.44
91a9fc	-1.02	-1.68
0498be	-0.25	-0.36
37784e	0.19	0.43
09b3b4	0.62	1.16
724b20	0.65	1.39
d09c92	0.87	0.63
a3354e	1.26	2.36

18.2 Compressive Strength

18.2.1 Test results

Table 49: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]						u_x	\bar{x}	s_0	V_x
							[N/mm ²]	[N/mm ²]	[N/mm ²]	[%]
0b215e	30.1	29.9	27.9	30.3	30.3	29.7	1.8	29.7	0.912	3.07
8c23d8	31.45	31.65	32.4	32.4	33.75	33.25	0.8	32.48	0.891	2.74
724b20	31.2	32.7	31.55	31.55	35.0	33.9	0.9	32.65	1.524	4.67
91a9fc	35.45	35.75	31.45	31.05	33.0	33.2	2.0	33.32	1.96	5.88
a3354e	33.9	35.1	34.4	34.6	34.3	33.6	0.8	34.32	0.527	1.54
0498be	35.09	32.99	33.88	33.68	36.17	34.24	1.7	34.34	1.131	3.29
09b3b4	33.8	35.4	36.2	36.4	34.9	37.0	1.8	35.62	1.16	3.26
d09c92	38.45	37.7	38.95	37.1	37.0	36.0	1.4	37.53	1.068	2.84
37784e	37.85	38.35	37.7	37.6	38.5	37.55	1.3	37.93	0.403	1.06

18.2.2 The Numerical Procedure for Determining Outliers

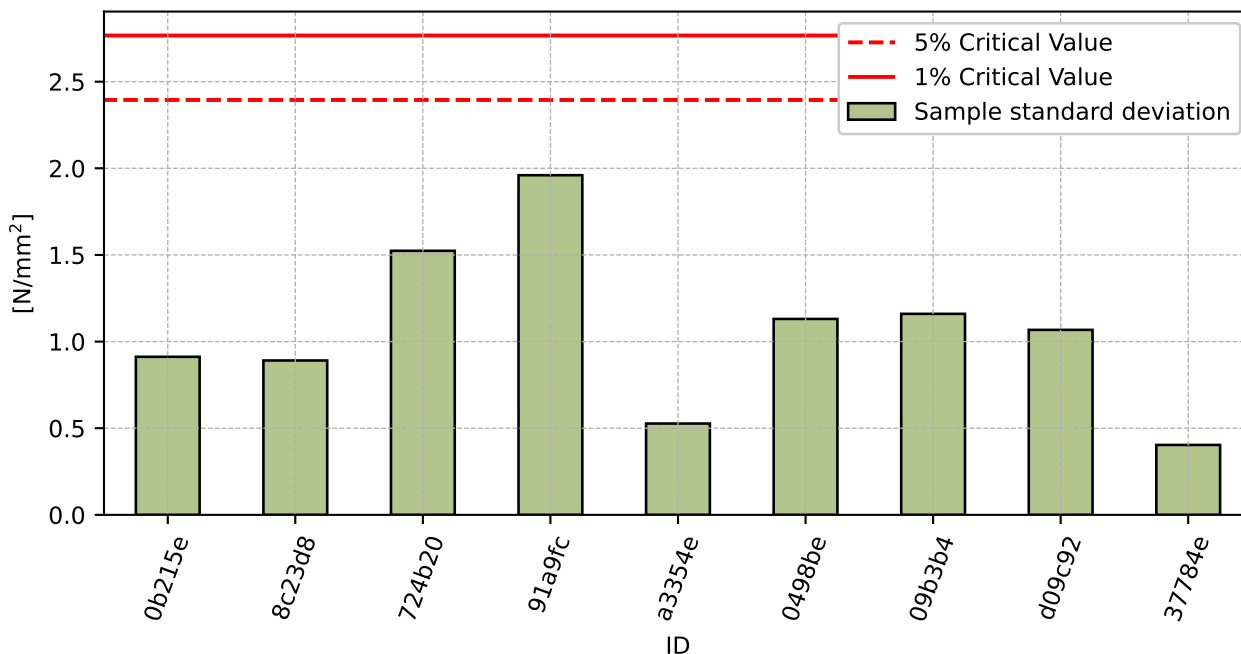


Figure 137: Cochran's test - sample standard deviations

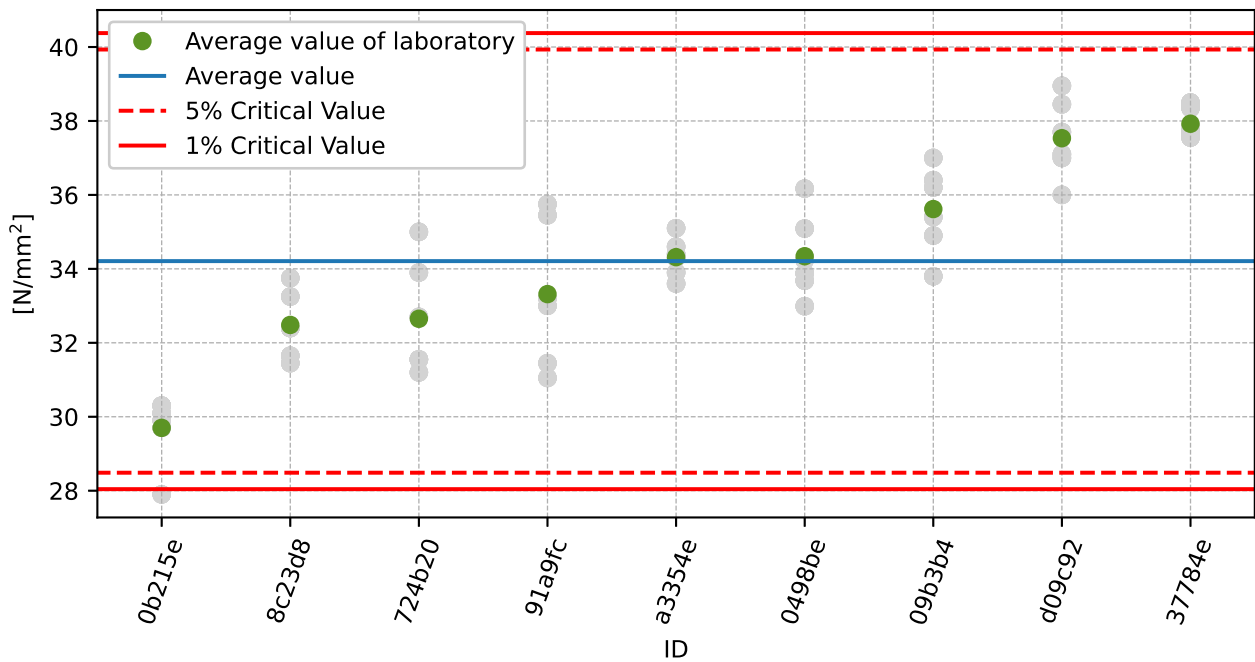


Figure 138: Grubbs' test - average values

18.2.3 Mandel's Statistics

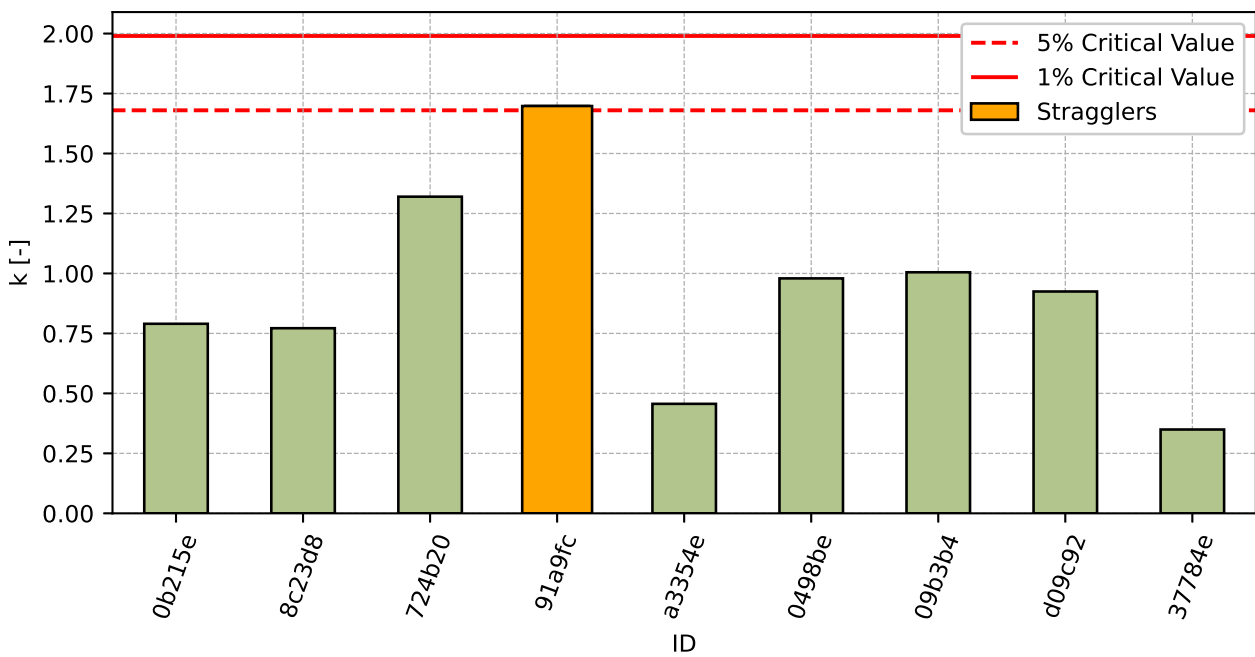


Figure 139: Intralaboratory Consistency Statistic

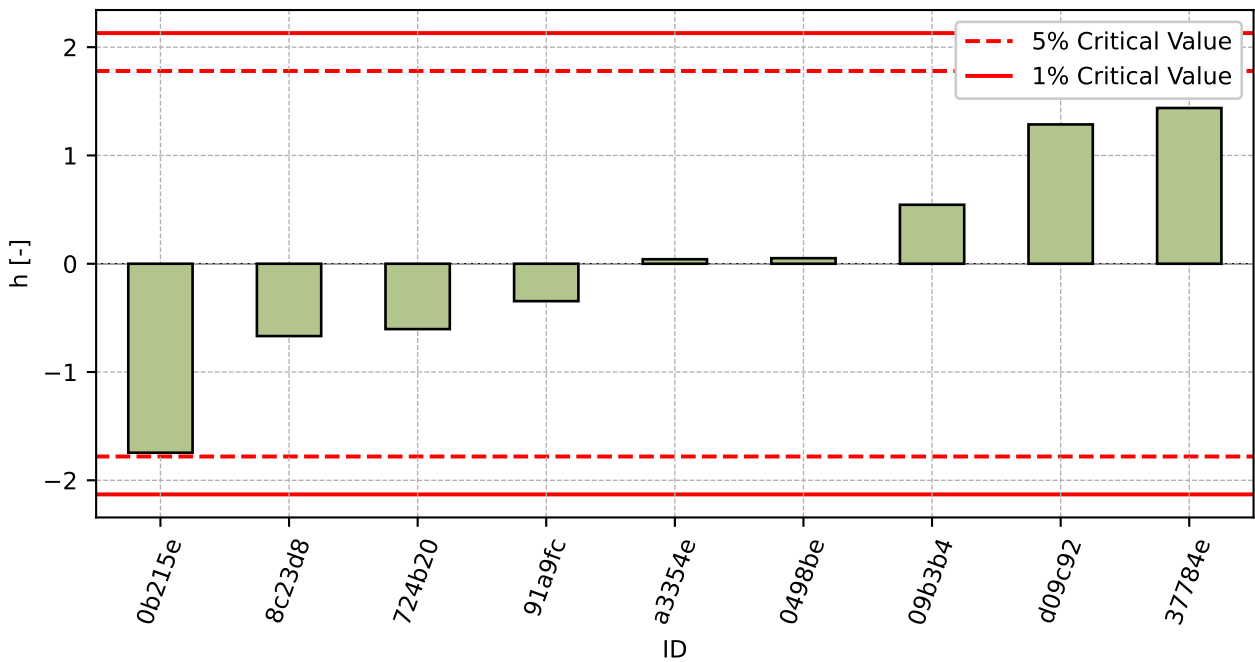


Figure 140: Interlaboratory Consistency Statistic

18.2.4 Descriptive statistics

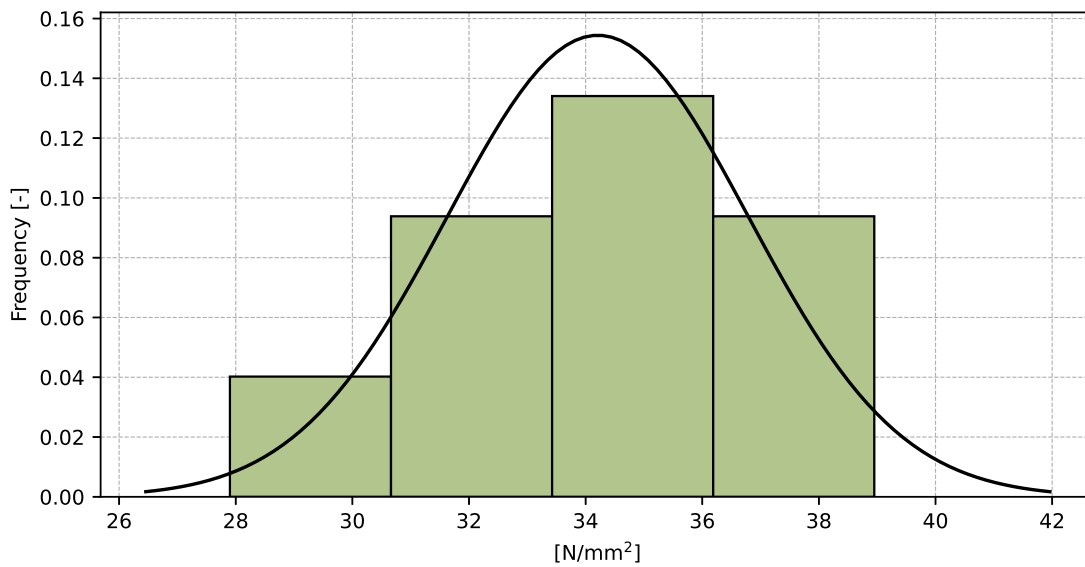


Figure 141: Histogram of all test results

Table 50: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	34.21
Sample standard deviation – s	2.584
Assigned value – x^*	34.31
Robust standard deviation – s^*	2.562
Measurement uncertainty of assigned value – u_X	1.068
p -value of normality test	0.408 [-]
Interlaboratory standard deviation – s_L	2.54
Repeatability standard deviation – s_r	1.154
Reproducibility standard deviation – s_R	2.79
Repeatability – r	3.23
Reproducibility – R	7.81

18.2.5 Evaluation of Performance Statistics

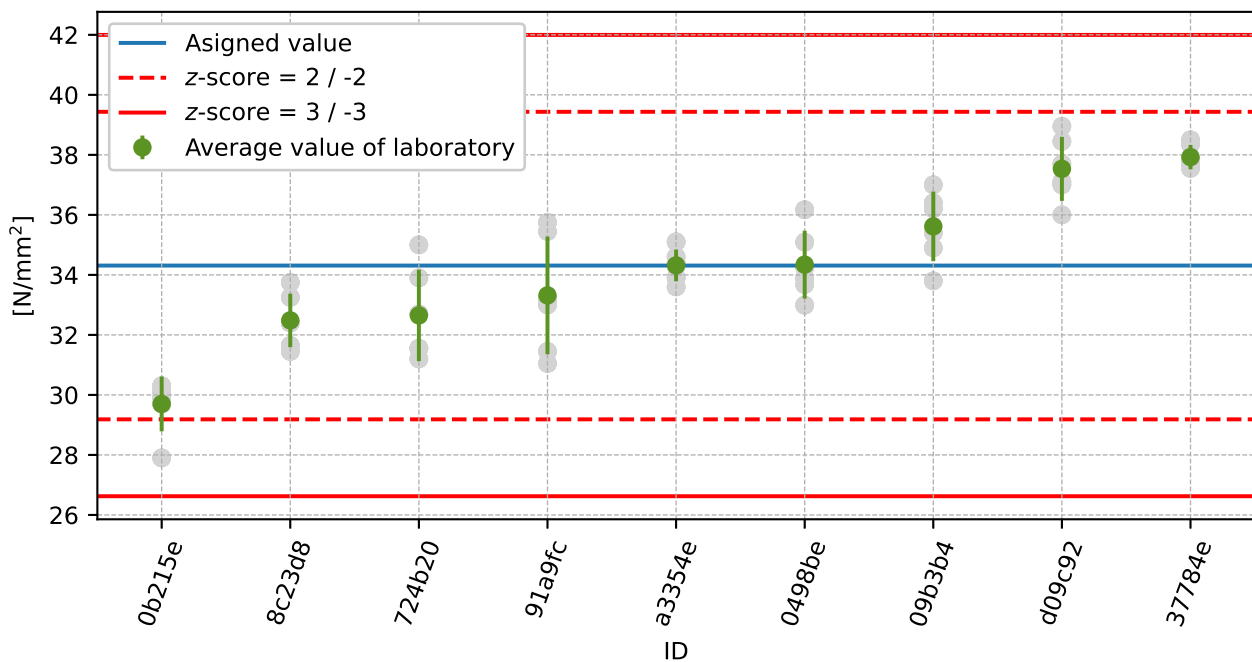


Figure 142: Average values and sample standard deviations

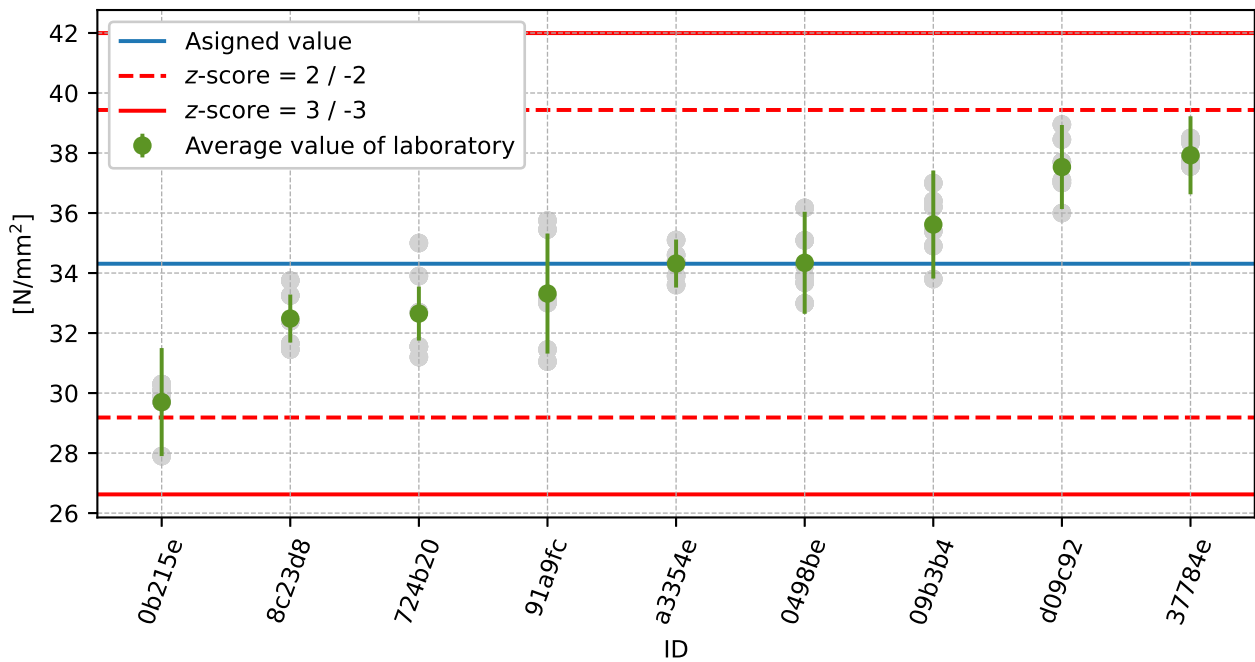


Figure 143: Average values and extended uncertainties of measurement

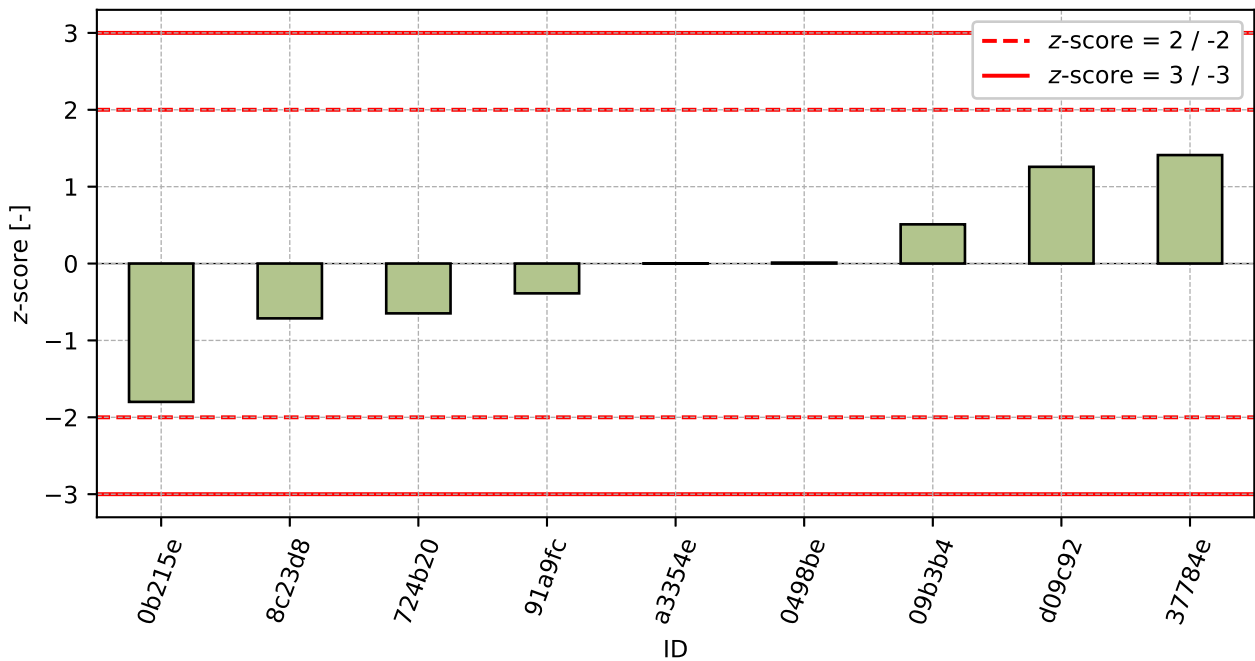
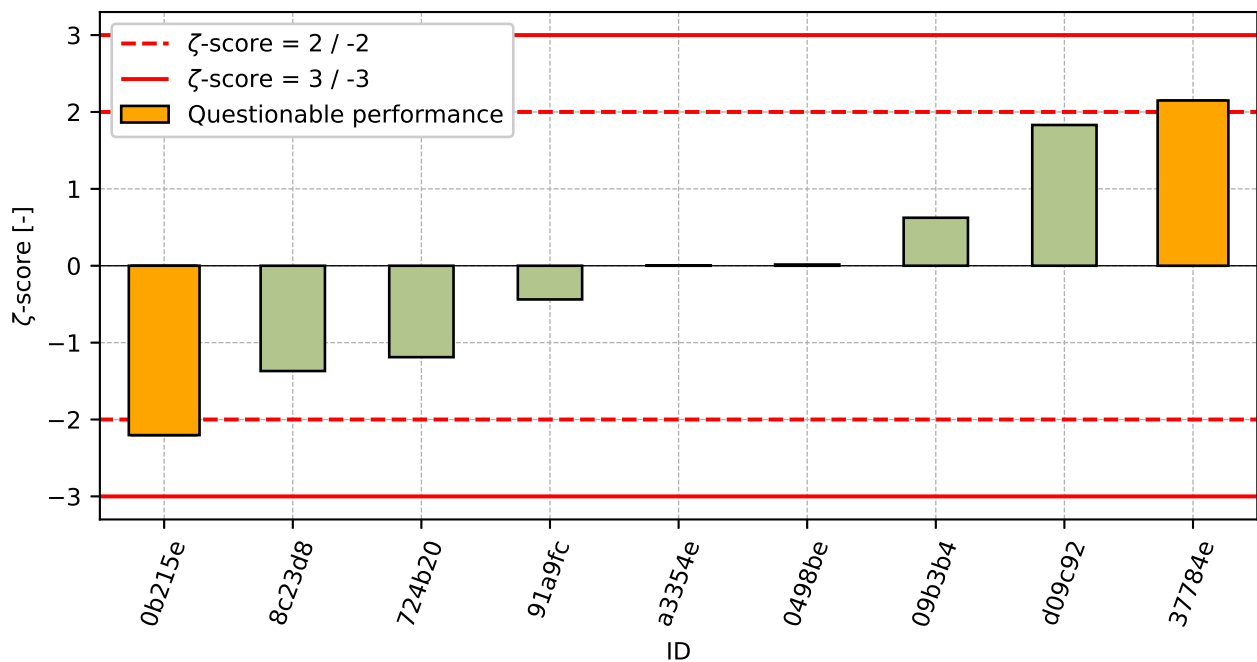


Figure 144: z-score

Figure 145: ζ -scoreTable 51: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
0b215e	-1.8	-2.2
8c23d8	-0.71	-1.37
724b20	-0.65	-1.19
91a9fc	-0.39	-0.44
a3354e	0.0	0.0
0498be	0.01	0.02
09b3b4	0.51	0.62
d09c92	1.26	1.83
37784e	1.41	2.15

19 Appendix – EN 12004-2 (art. 8.1) – Open time

19.1 10 min.

19.1.1 Test results

Table 52: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]										u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
09b3b4	0.08	0.07	0.08	0.08	0.09	0.08	0.09	0.1	0.08	0.09	0.01	0.08	0.008	10
d04726	0.18	0.5	0.0	0.12	0.19	0.21	0.0	0.14	0.18	0.0	-	0.15	0.148	97
124fe6	0.19	0.15	0.23	0.16	0.19	0.19	0.16	0.17	0.11	0.15	-	0.17	0.032	19
91a9fc	0.37	0.43	0.39	0.38	0.33	0.27	0.32	0.33	0.34	0.29	0.05	0.34	0.048	13
37784e	0.5	0.5	0.4	0.6	0.5	0.4	0.6	0.4	0.4	0.6	0.1	0.49	0.088	17

19.1.2 The Numerical Procedure for Determining Outliers

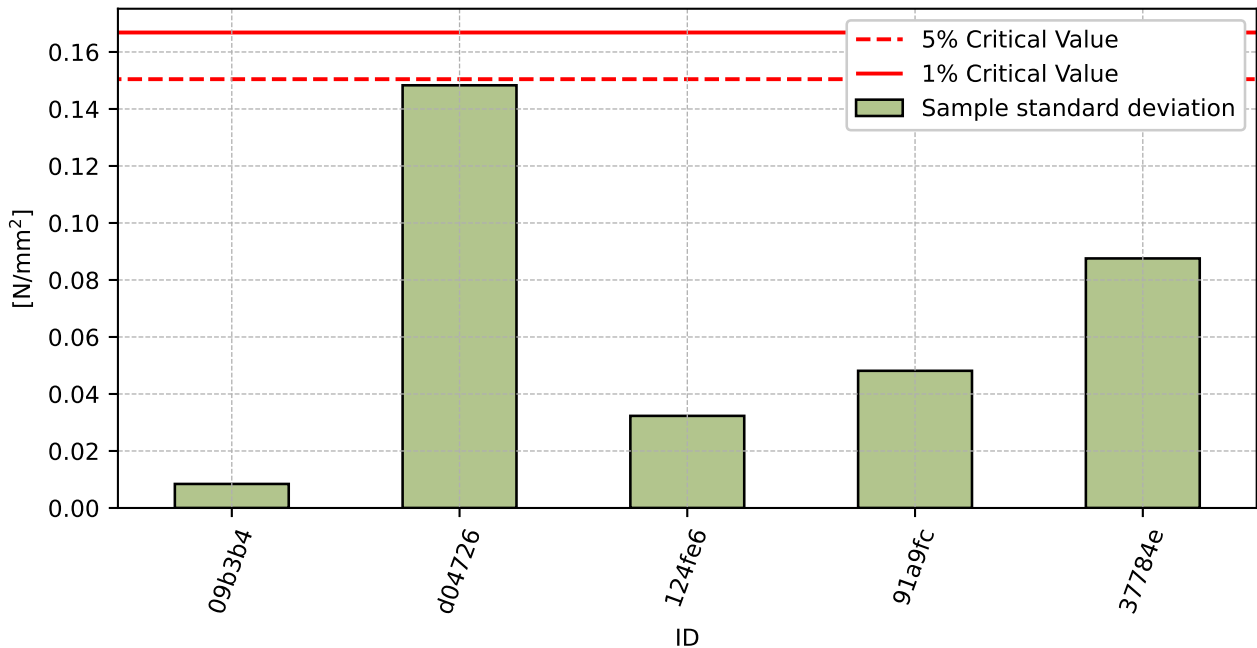


Figure 146: Cochran's test - sample standard deviations

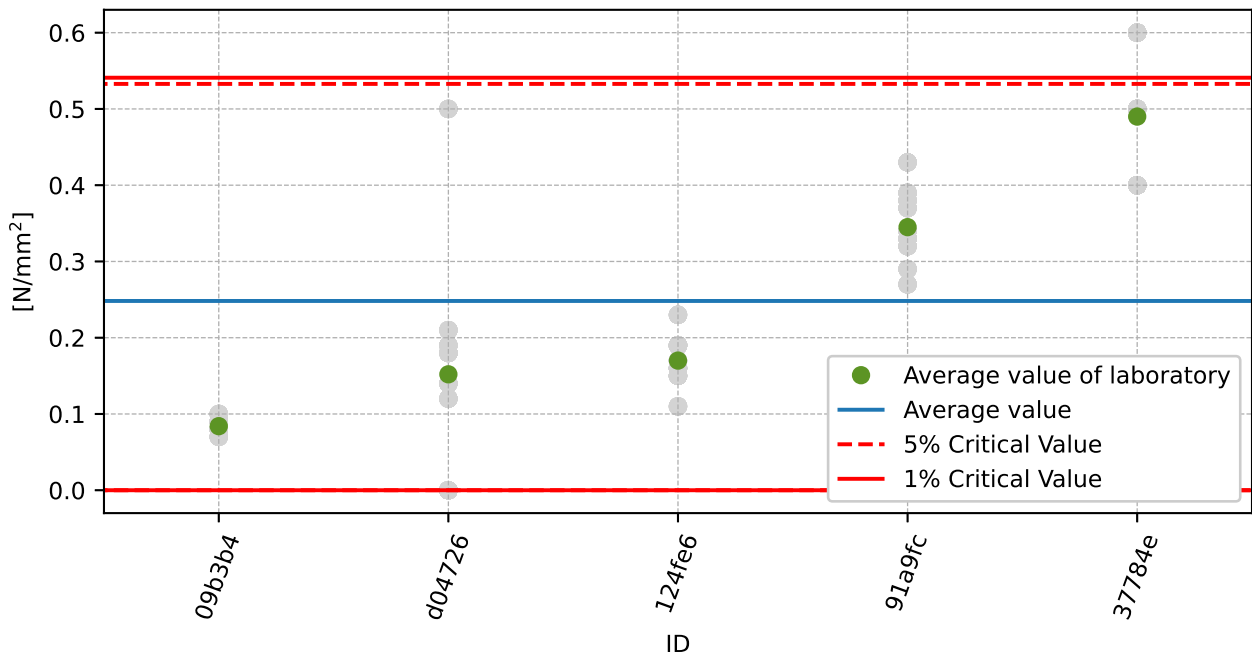


Figure 147: Grubbs' test - average values

19.1.3 Mandel's Statistics

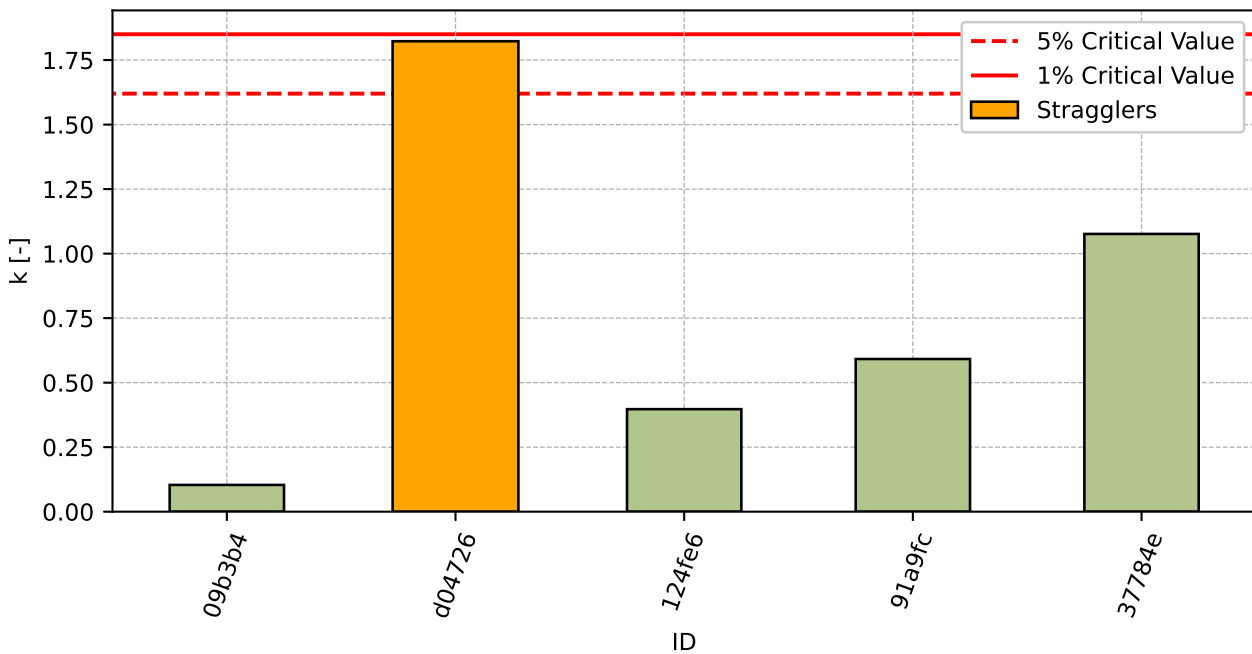


Figure 148: Intralaboratory Consistency Statistic

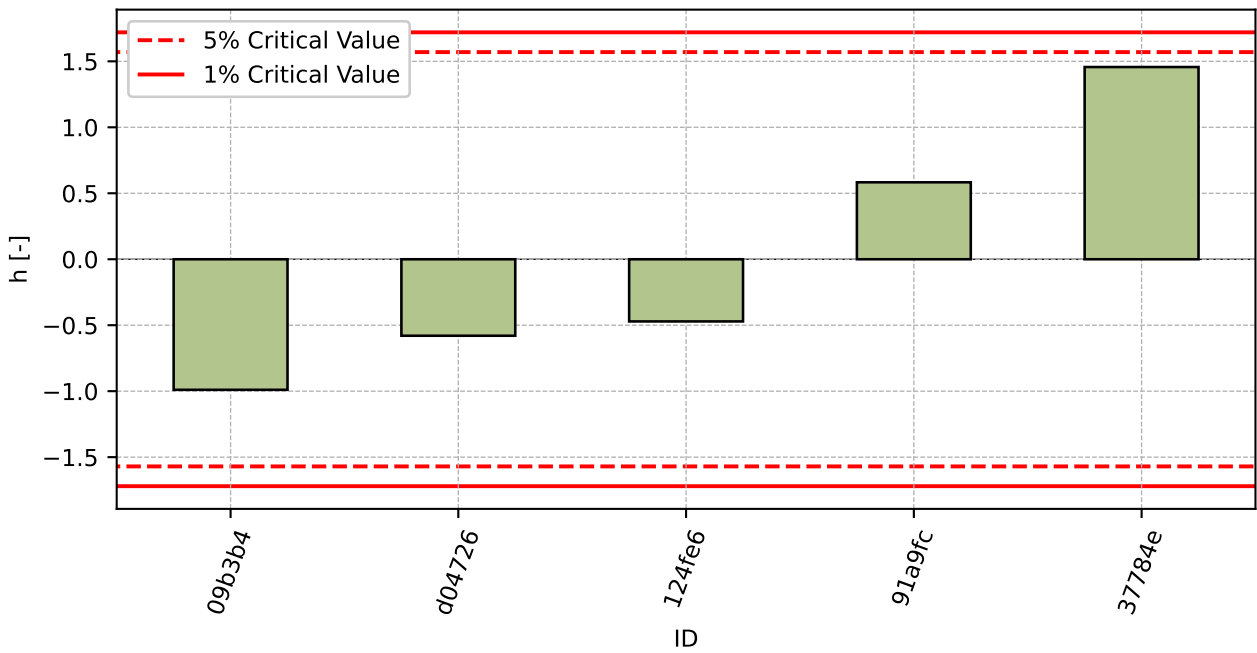


Figure 149: Interlaboratory Consistency Statistic

19.1.4 Descriptive statistics

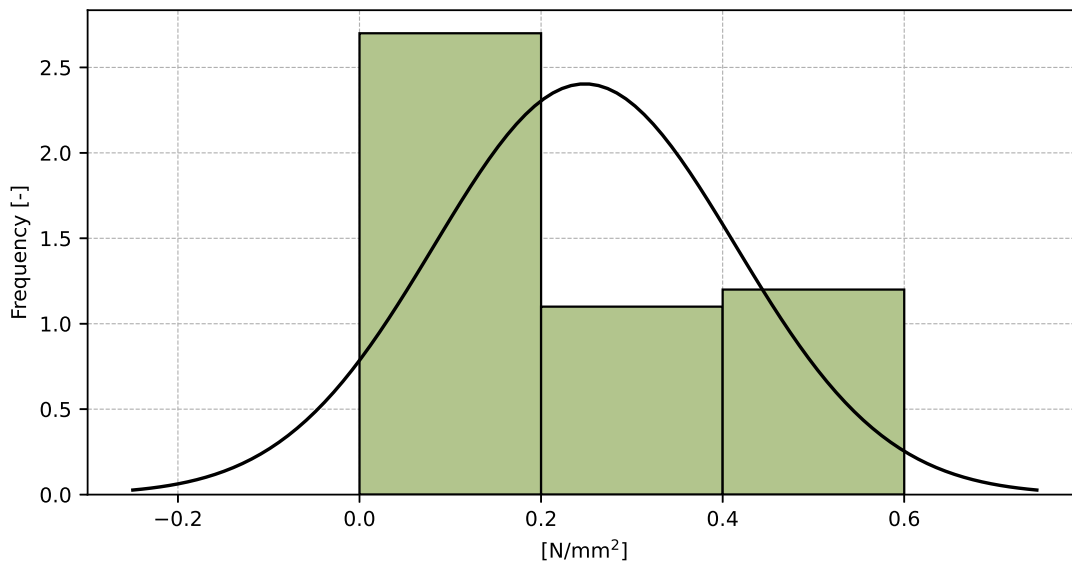


Figure 150: Histogram of all test results

Table 53: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	0.25
Sample standard deviation – s	0.166
Assigned value – x^*	0.25
Robust standard deviation – s^*	0.168
Measurement uncertainty of assigned value – u_X	0.094
p -value of normality test	0.005 [-]
Interlaboratory standard deviation – s_L	0.164
Repeatability standard deviation – s_r	0.081
Reproducibility standard deviation – s_R	0.183
Repeatability – r	0.23
Reproducibility – R	0.51

19.1.5 Evaluation of Performance Statistics

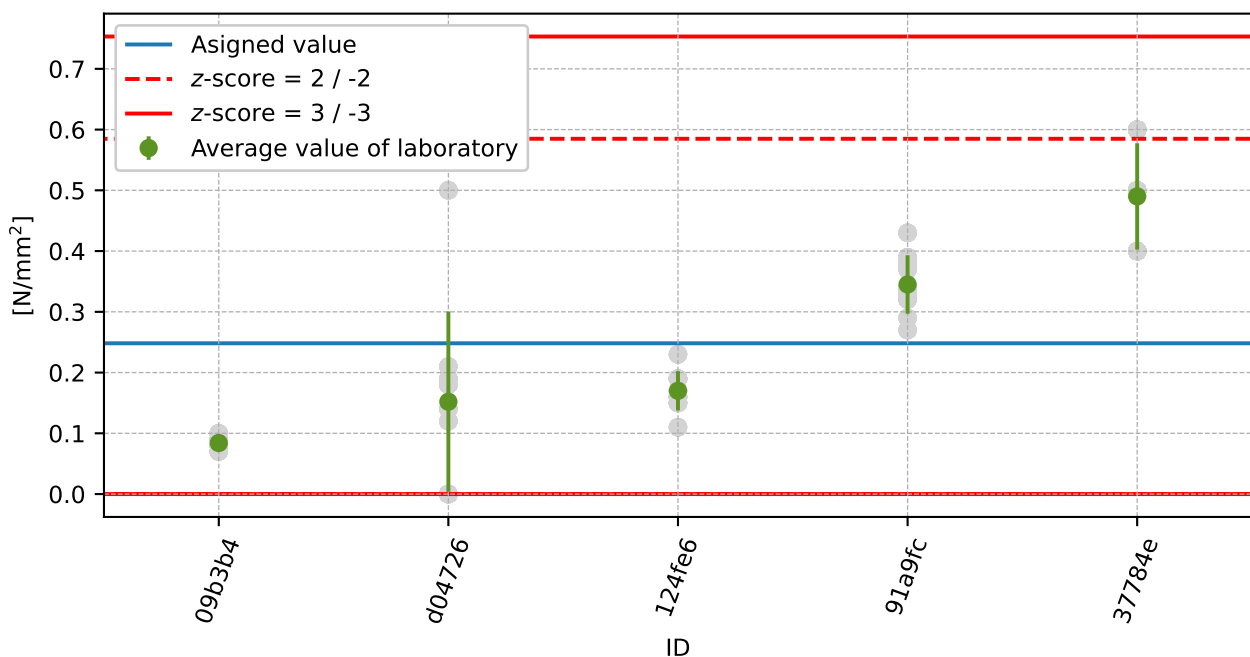


Figure 151: Average values and sample standard deviations

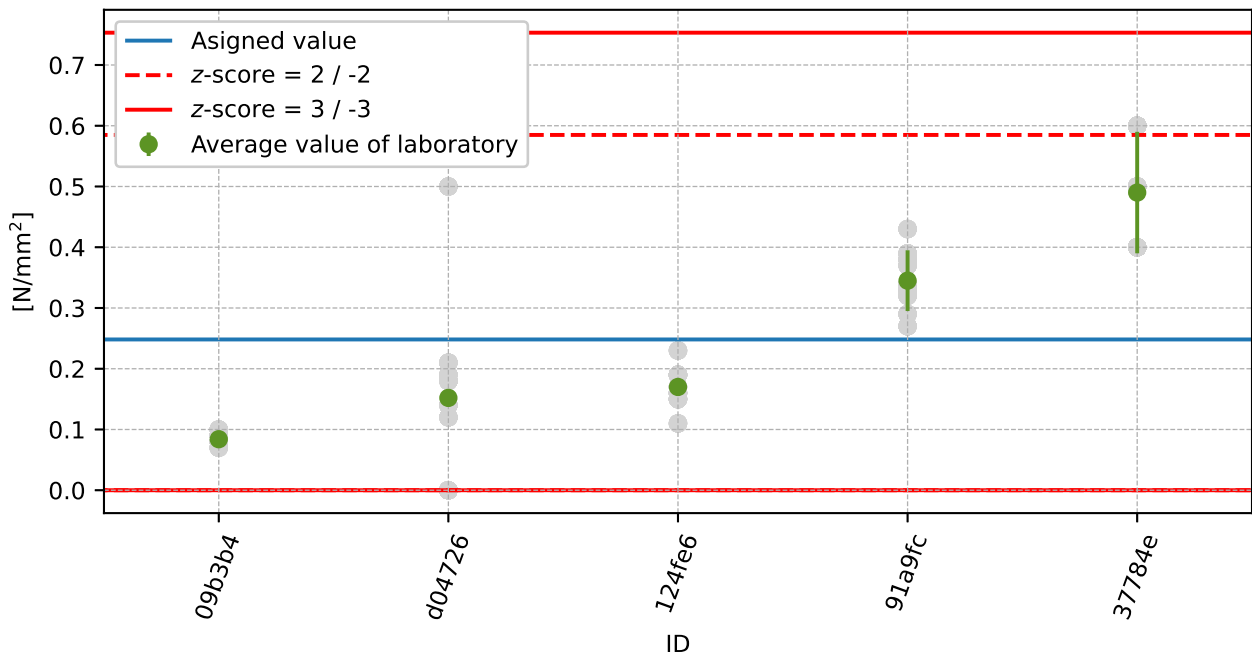


Figure 152: Average values and extended uncertainties of measurement

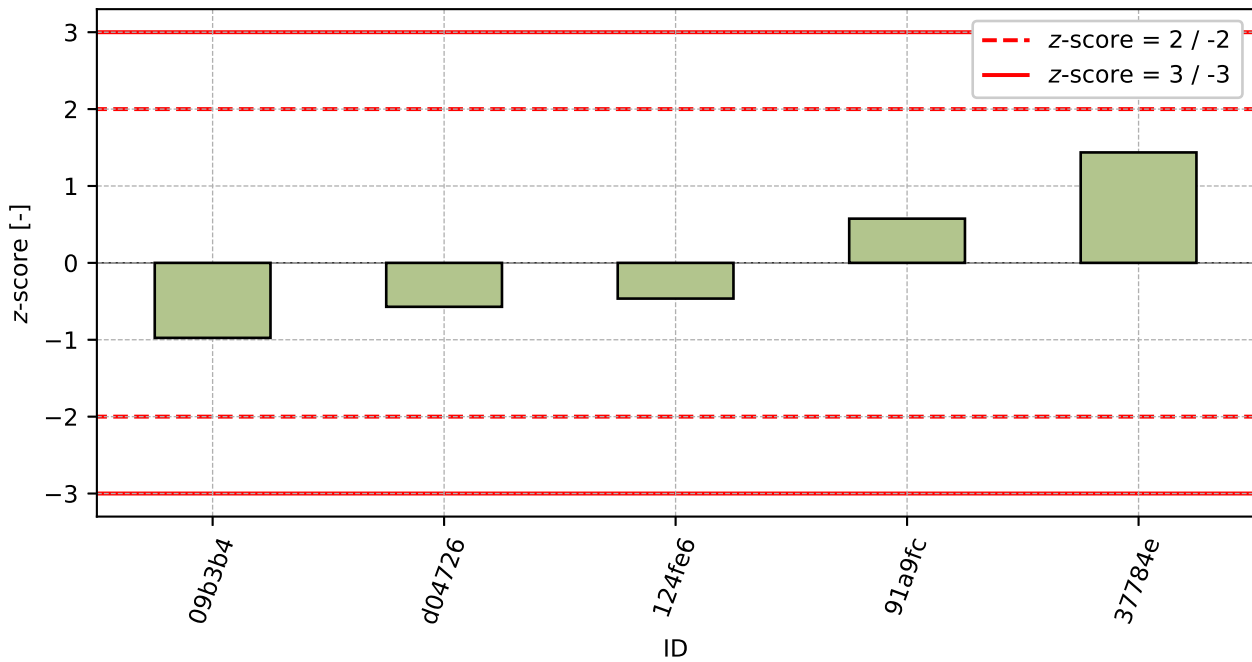


Figure 153: z-score

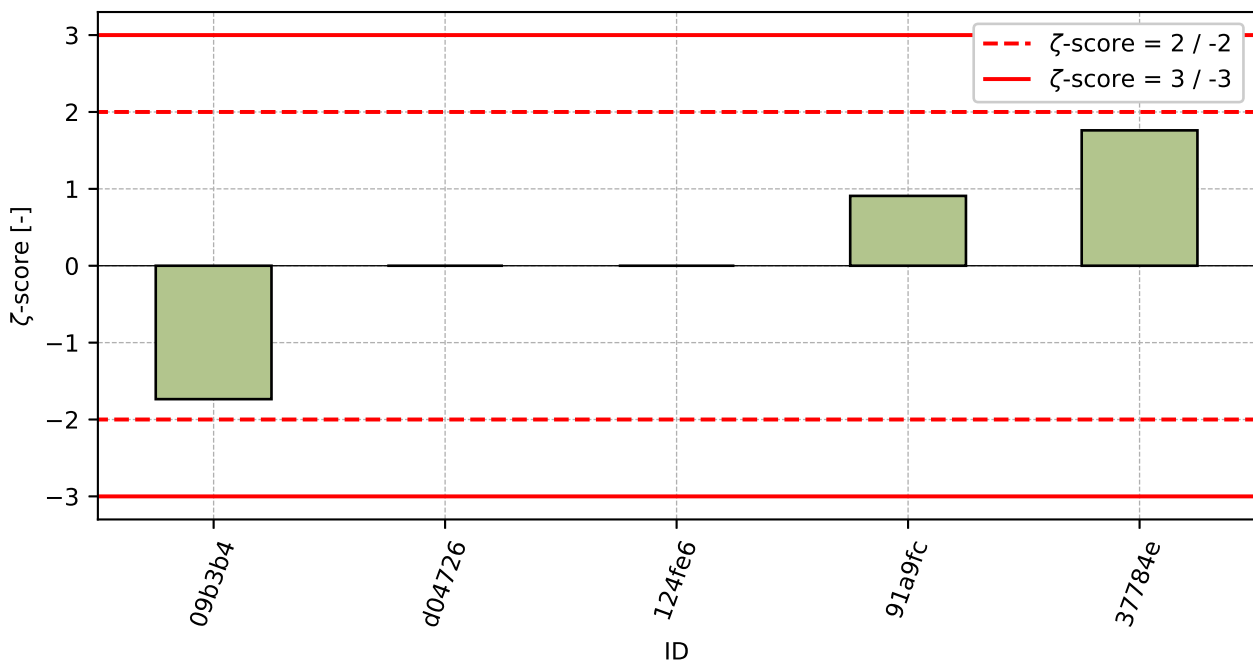


Figure 154: z-score

Table 54: z-score and zeta-score

ID	z-score [-]	zeta-score [-]
09b3b4	-0.98	-1.74
d04726	-0.57	-
124fe6	-0.46	-
91a9fc	0.58	0.91
37784e	1.44	1.76

19.2 30 min.

19.2.1 Test results

Table 55: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]										u_x	\bar{x}	s_0	V_x	
												[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
91a9fc	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0
d04726	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0
124fe6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0
09b3b4	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.0	0.02	0.004	0.20
37784e	0.3	0.4	0.3	0.4	0.3	0.3	0.2	0.3	0.4	0.4	0.4	0.1	0.33	0.067	0.20

19.2.2 The Numerical Procedure for Determining Outliers

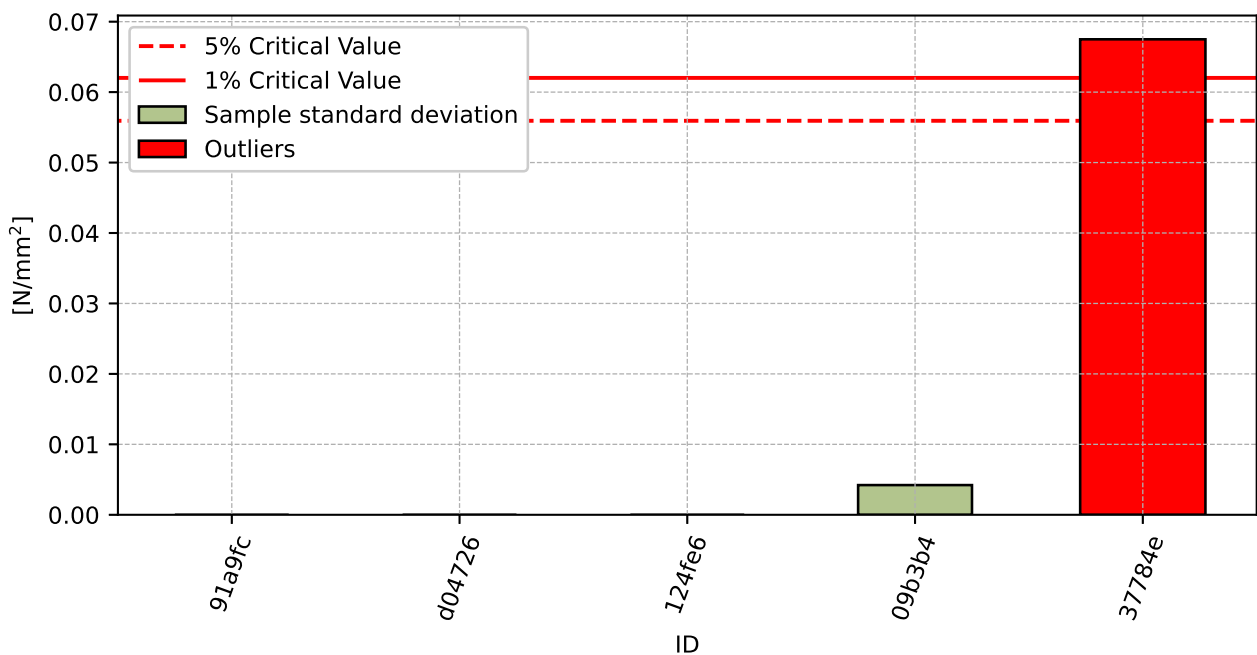


Figure 155: Cochran's test - sample standard deviations

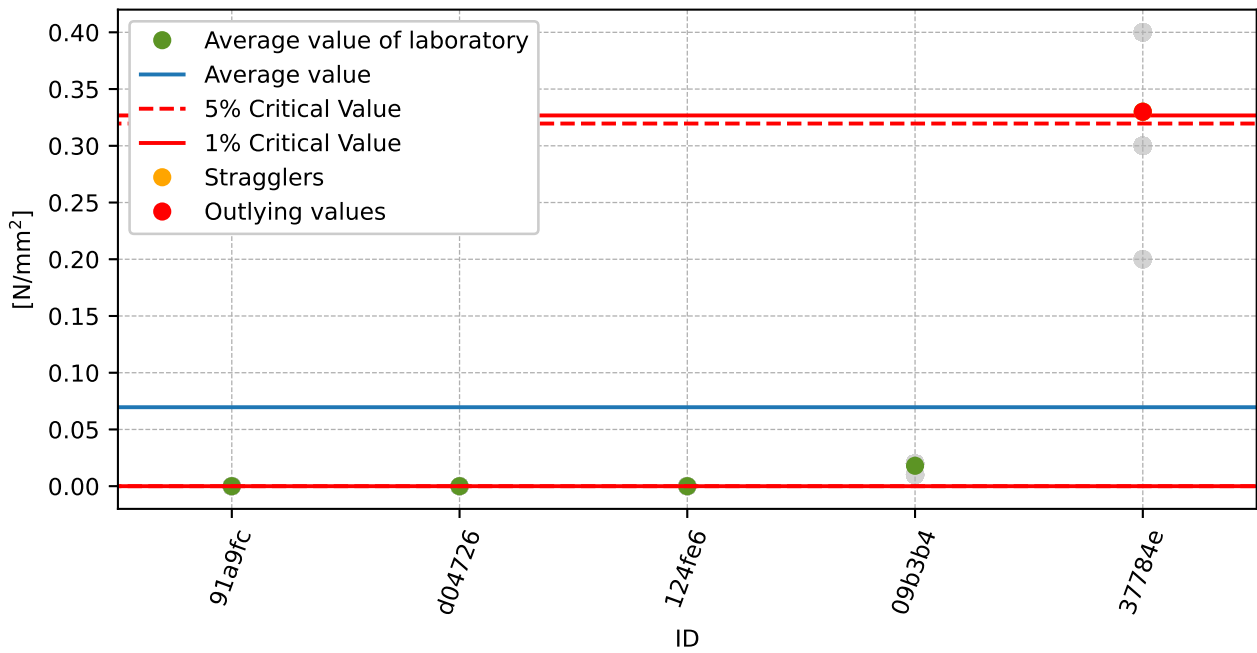


Figure 156: Grubbs' test - average values

19.2.3 Mandel's Statistics

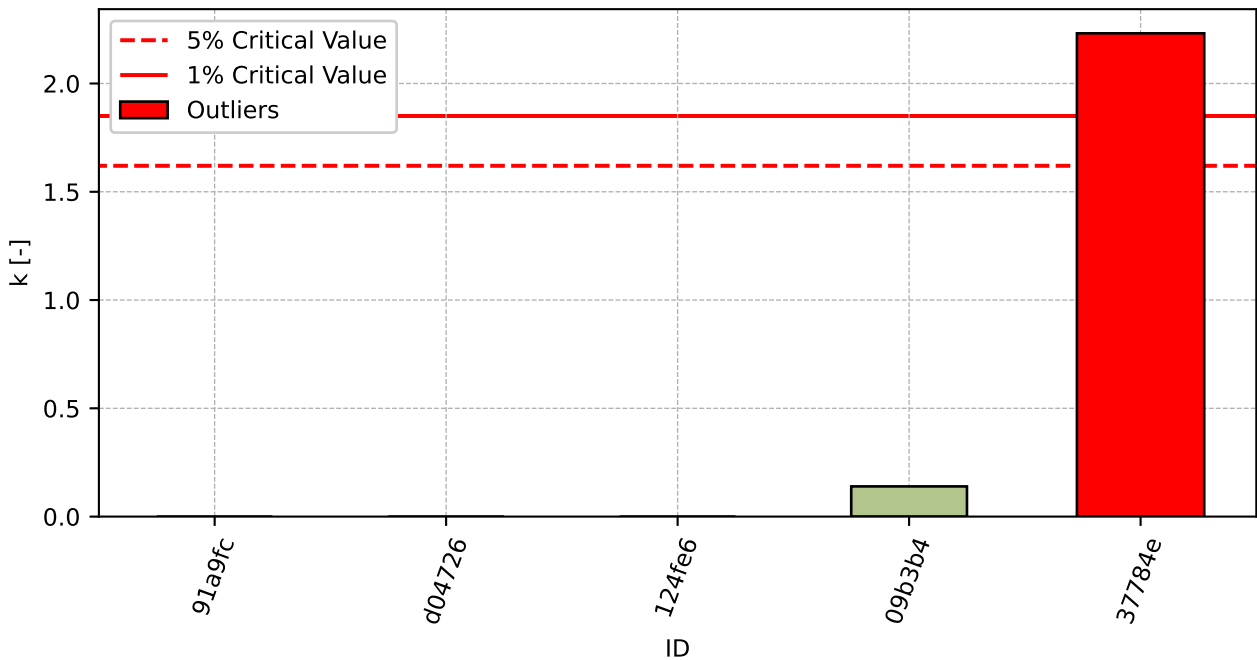


Figure 157: Intralaboratory Consistency Statistic

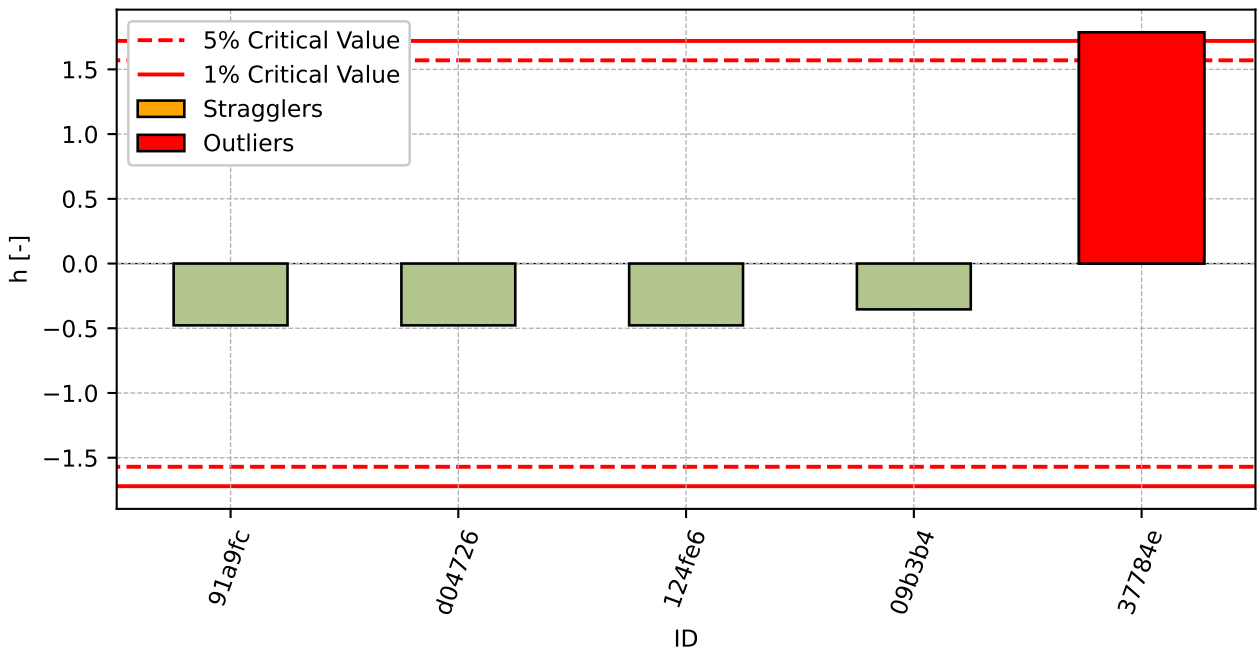


Figure 158: Interlaboratory Consistency Statistic

19.2.4 Descriptive statistics

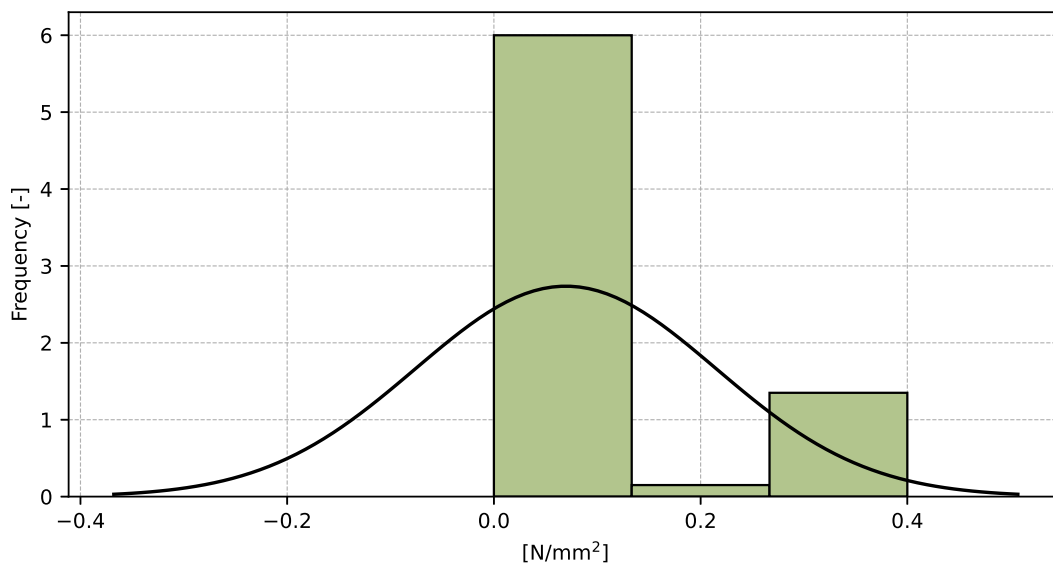


Figure 159: Histogram of all test results

Table 56: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	0.07
Sample standard deviation – s	0.146
Assigned value – x^*	0.07
Robust standard deviation – s^*	0.15
Measurement uncertainty of assigned value – u_X	0.084
p -value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.145
Repeatability standard deviation – s_r	0.03
Reproducibility standard deviation – s_R	0.149
Repeatability – r	0.08
Reproducibility – R	0.42

19.2.5 Evaluation of Performance Statistics

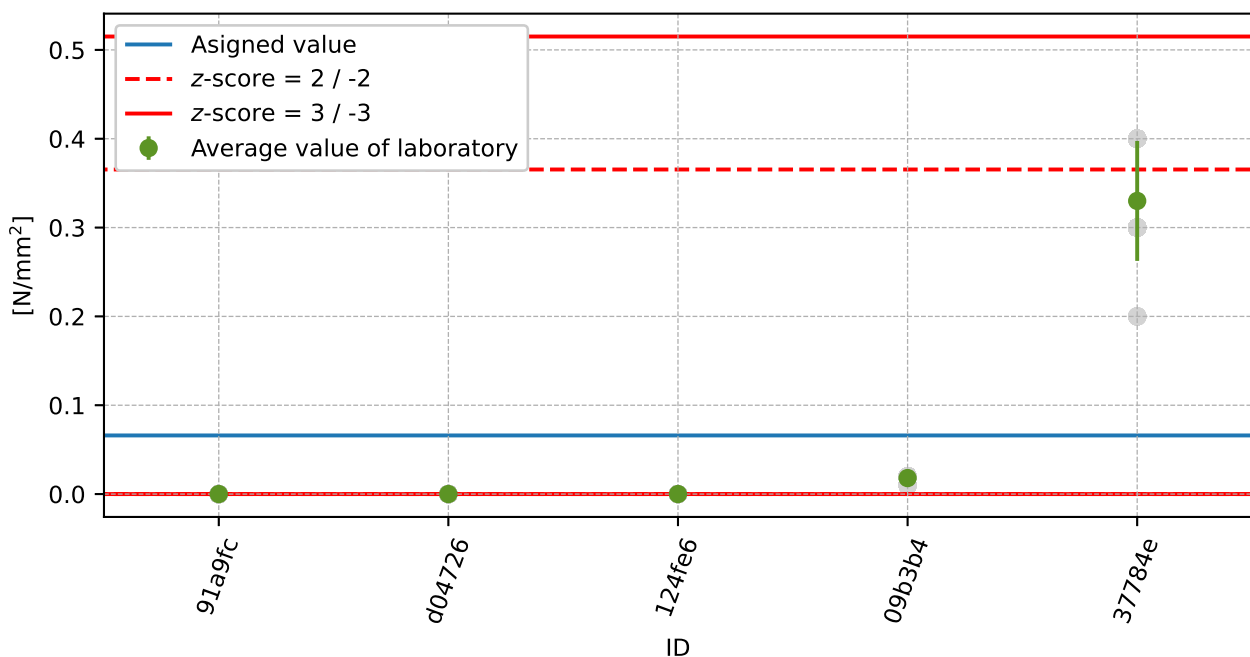


Figure 160: Average values and sample standard deviations

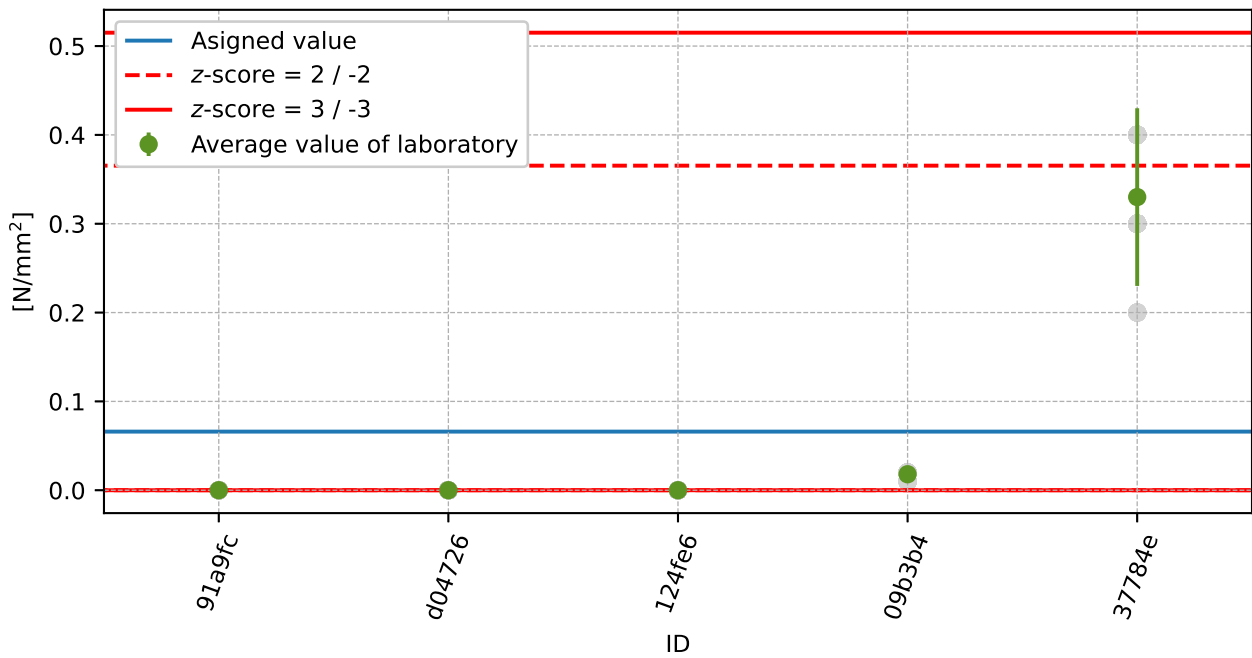


Figure 161: Average values and extended uncertainties of measurement

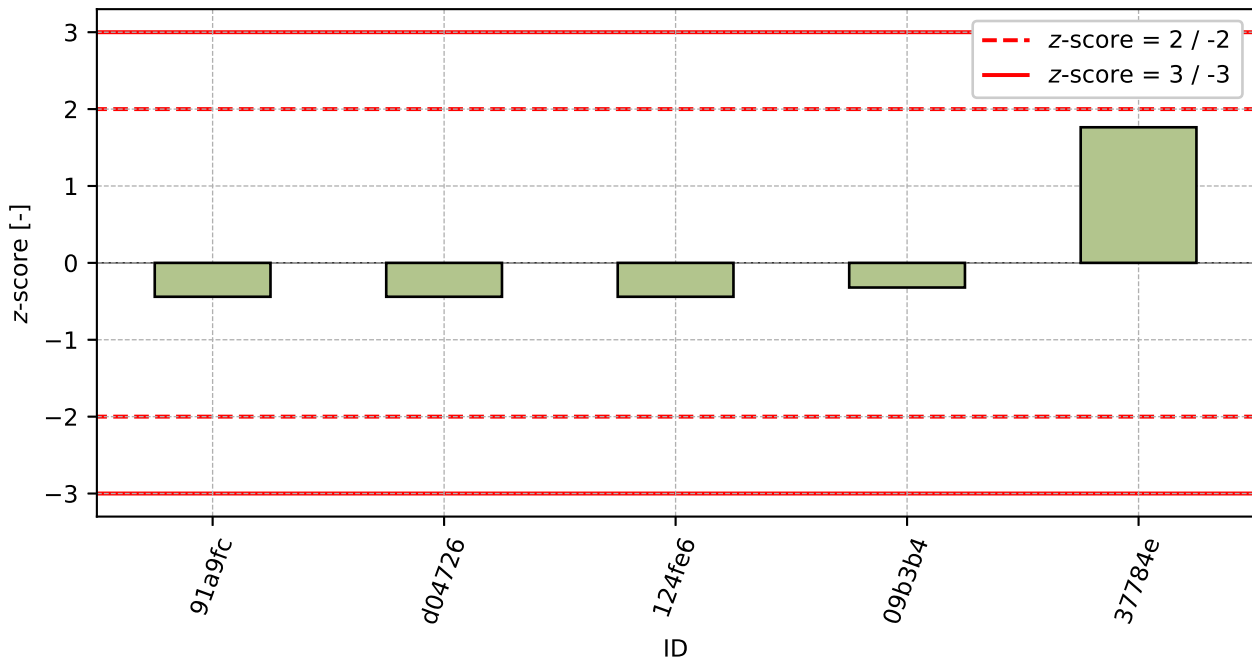


Figure 162: z-score

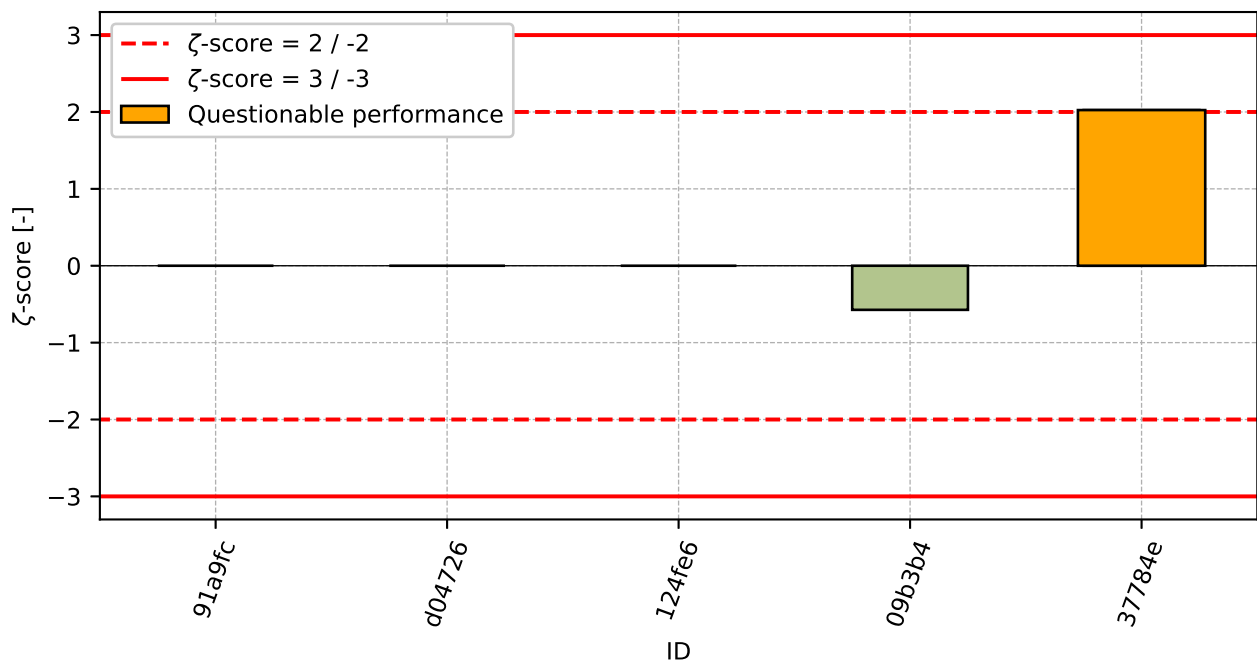


Figure 163: ζ-score

Table 57: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
91a9fc	-0.44	-
d04726	-0.44	-
124fe6	-0.44	-
09b3b4	-0.32	-0.57
37784e	1.76	2.02

20 Appendix – EN 12004-2 (art. 8.2) – Slippage

This part of PT program was not open according to the low number of participants.

21 Appendix – EN 12004-2 (art. 8.3.3.2) – Adhesion

21.1 Test results

Table 58: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; \bar{x} - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]										u_x [N/mm ²]	\bar{x} [N/mm ²]	s_0 [N/mm ²]	V_x [%]
37784e	0.5	0.4	0.5	0.6	0.5	0.4	0.7	0.4	0.5	0.5	0.1	0.5	0.094	18
124fe6	0.6	0.53	0.5	0.79	0.54	0.61	0.78	0.66	0.58	0.5	-	0.61	0.106	17
5bd8de	0.7	0.5	0.6	0.5	0.6	0.7	0.7	0.6	-	-	0.1	0.61	0.083	13
a3354e	0.78	0.73	0.77	0.81	0.78	0.76	0.81	0.87	0.72	0.79	0.07	0.78	0.043	5
8c23d8	0.8	0.93	0.86	0.77	0.93	0.89	0.83	0.94	-	-	0.1	0.87	0.064	7

21.2 The Numerical Procedure for Determining Outliers

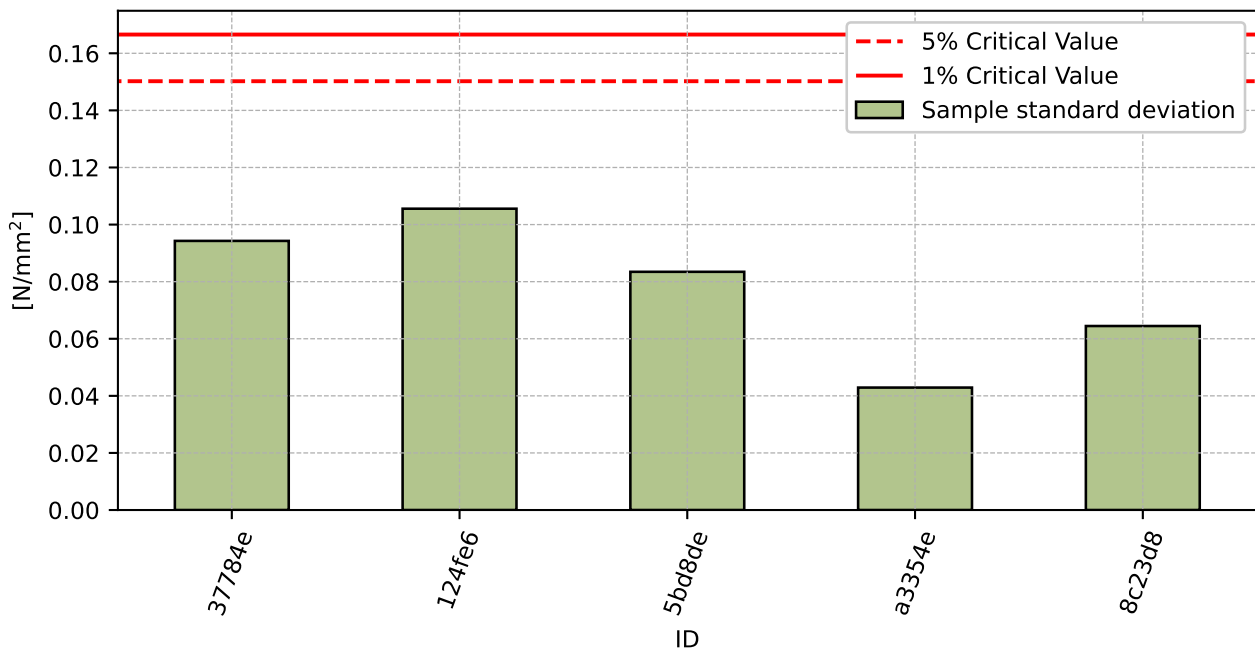


Figure 164: Cochran's test - sample standard deviations

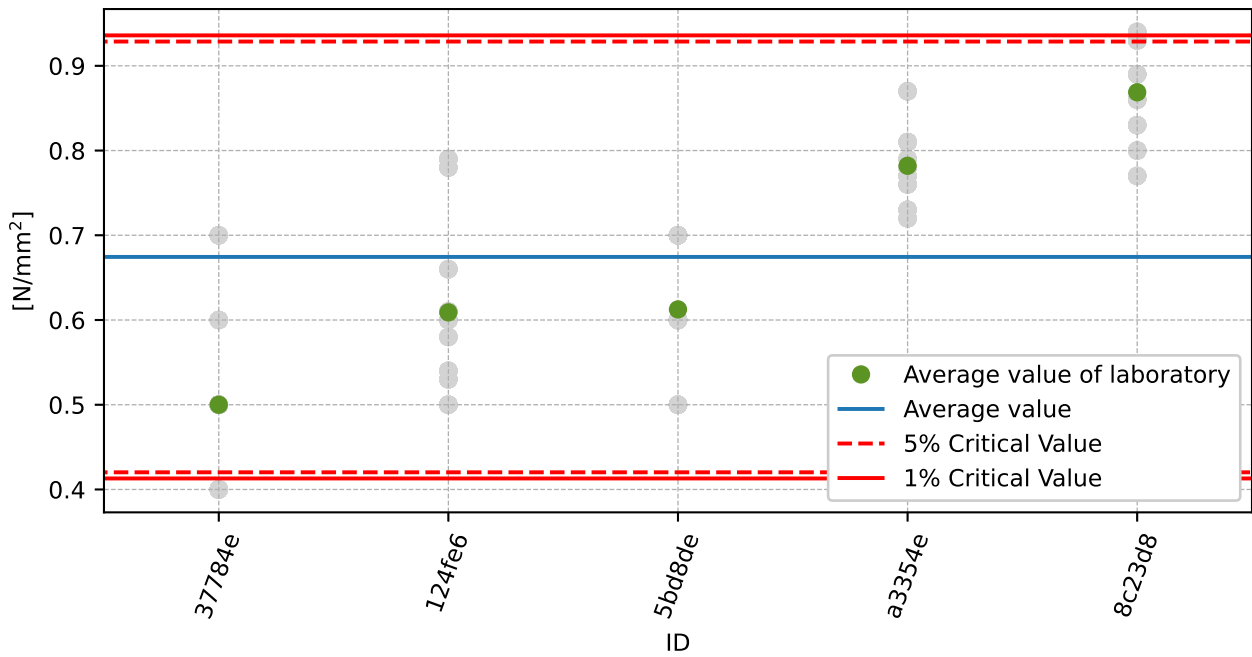


Figure 165: Grubbs' test - average values

21.3 Mandel's Statistics

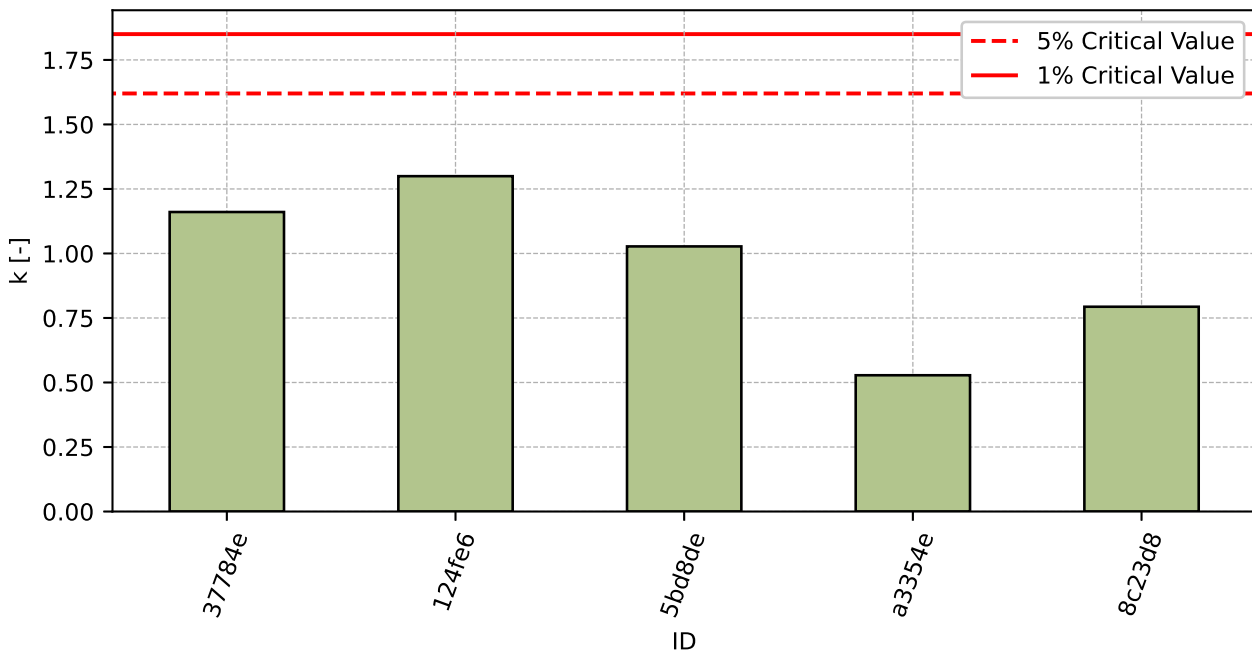


Figure 166: Intralaboratory Consistency Statistic

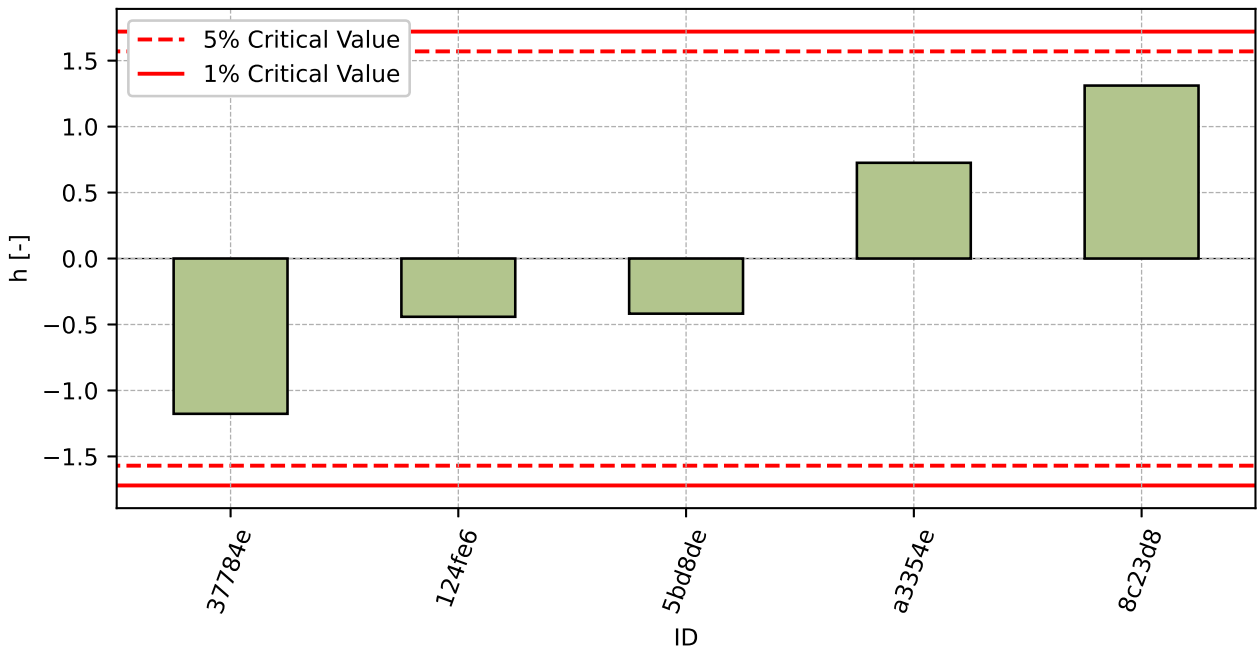


Figure 167: Interlaboratory Consistency Statistic

21.4 Descriptive statistics

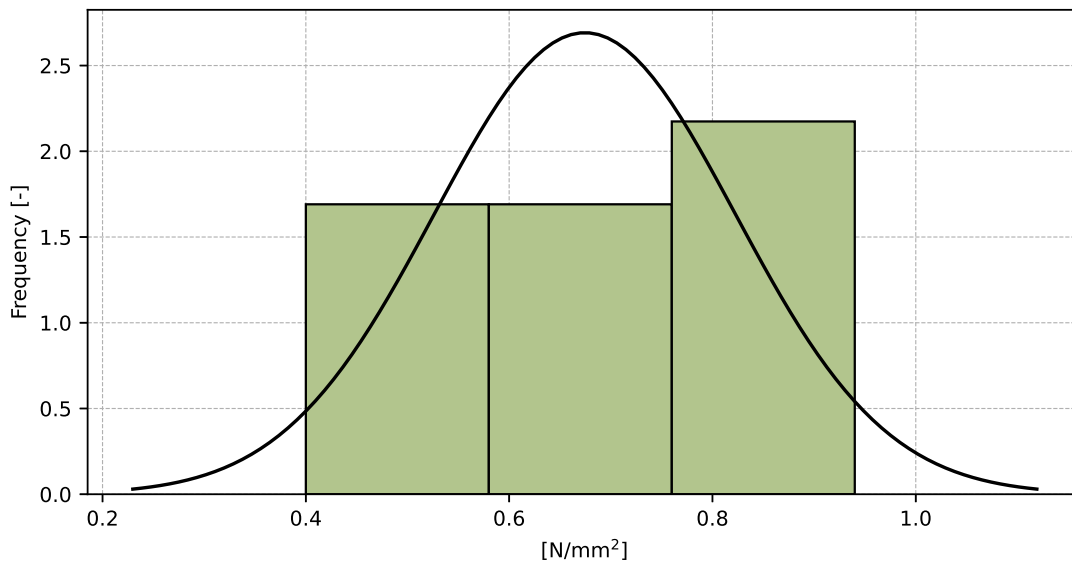


Figure 168: Histogram of all test results

Table 59: Descriptive statistics

Characteristics	[N/mm ²]
Average value – \bar{x}	0.67
Sample standard deviation – s	0.148
Assigned value – x^*	0.67
Robust standard deviation – s^*	0.15
Measurement uncertainty of assigned value – u_X	0.084
p -value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	0.146
Repeatability standard deviation – s_r	0.081
Reproducibility standard deviation – s_R	0.167
Repeatability – r	0.23
Reproducibility – R	0.47

21.5 Evaluation of Performance Statistics

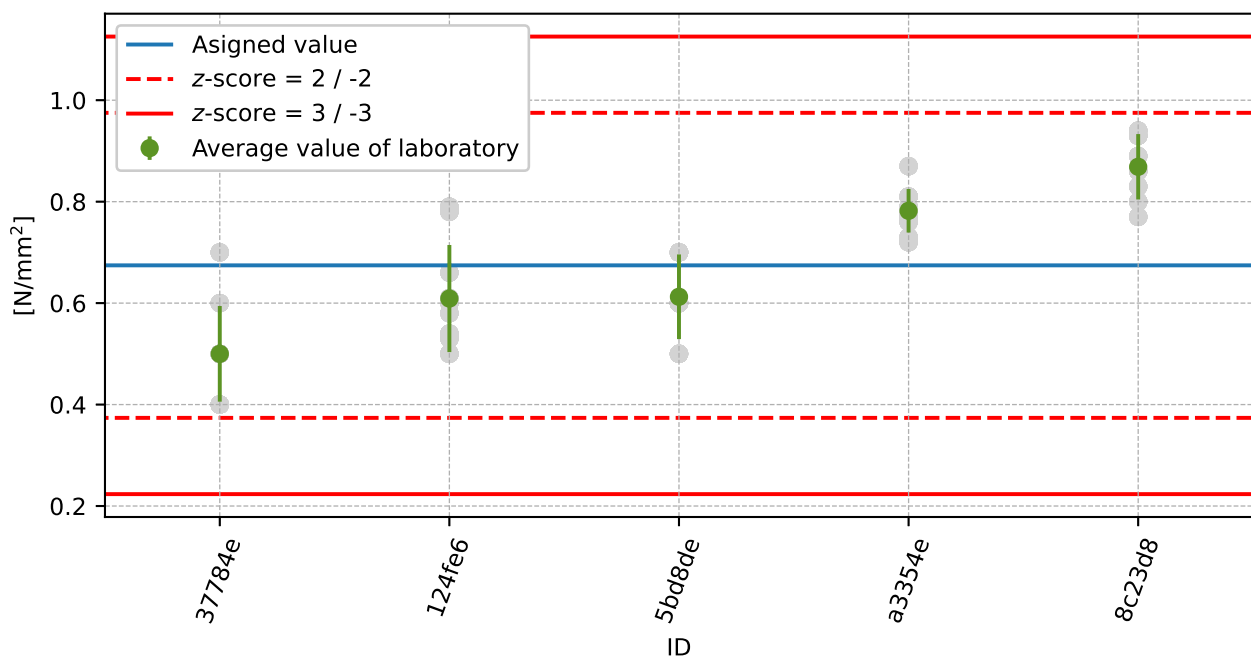


Figure 169: Average values and sample standard deviations

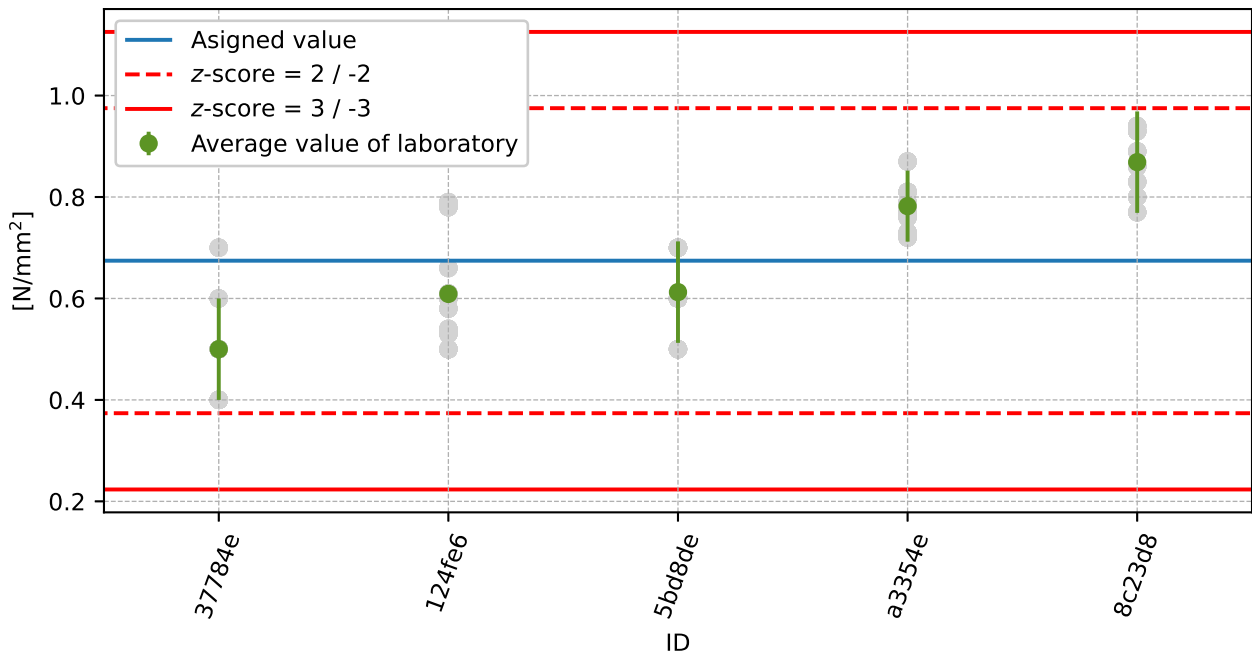


Figure 170: Average values and extended uncertainties of measurement

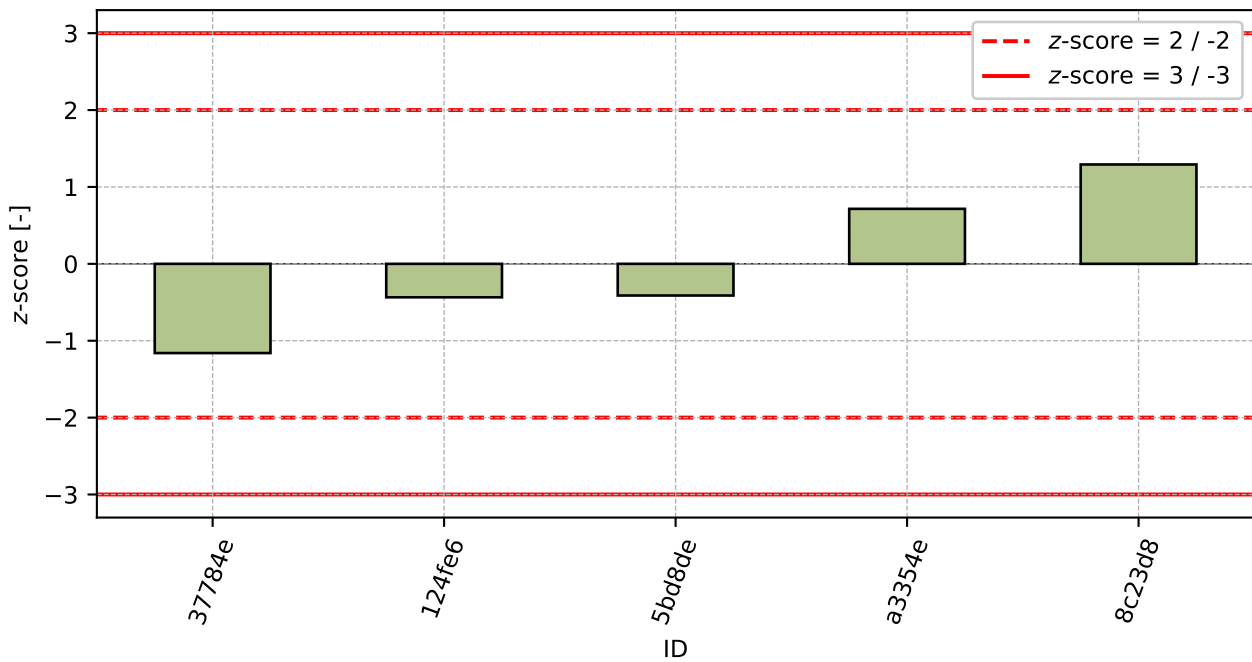


Figure 171: z-score

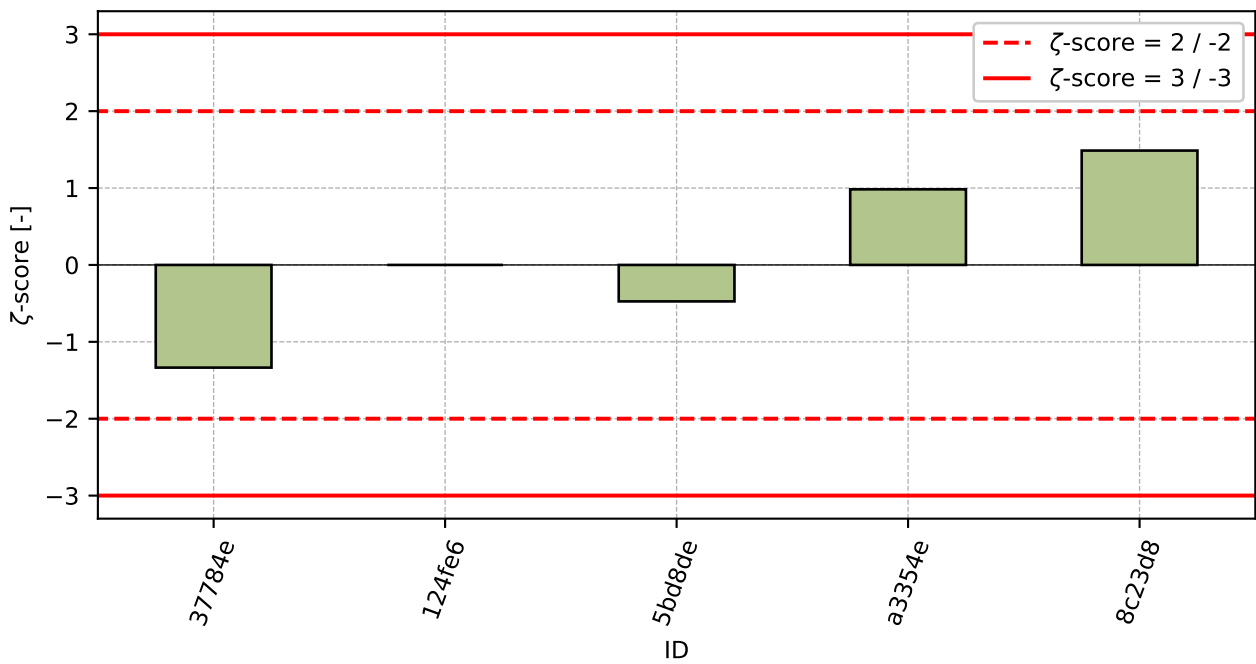


Figure 172: ζ -score

Table 60: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
37784e	-1.16	-1.34
124fe6	-0.44	-
5bd8de	-0.41	-0.47
a3354e	0.72	0.98
8c23d8	1.29	1.49

22 Appendix – EN 12004-2 (art. 8.3.3.3) – Adhesion

This part of PT program was not open due to low number of participants.