



# FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

## Proficiency Testing Program Soil Testing ZZ 2022/1

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Proficiency testing provider at the SZK FAST  
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## 1 Introduction and Important Contacts

In the year 2022, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZZ 2022/1 whose aim was to verify and assess the conformity of test results across laboratories when testing soils.

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

Head of the PT Provider, PTP coordinator

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The subjects of proficiency testing were the following testing procedures:

1. EN ISO 17892-1 Geotechnical investigation and testing - Laboratory testing of soil - Part 1: Determination of water content [1],
2. EN ISO 17892-3 Geotechnical investigation and testing - Laboratory testing of soil - Part 3: Determination of particle density [2],
3. EN ISO 17892-4 Geotechnical investigation and testing - Laboratory testing of soil - Part 4: Determination of particle size distribution, art. 5.2 (Sieving) [3],
4. EN ISO 17892-4 Geotechnical investigation and testing - Laboratory testing of soil - Part 4: Determination of particle size distribution, art. 5.3 (Densimetric analysis),
5. EN ISO 17892-5 Geotechnical investigation and testing - Laboratory testing of soil - Part 5: Incremental loading oedometer test [4],
6. EN ISO 17892-7 Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test [5],
7. CEN ISO/TS 17892-10 Geotechnical investigation and testing - Laboratory testing of soil - Part 10: Direct shear tests [6],
8. EN ISO 17892-12 Geotechnical investigation and testing - Laboratory testing of soil - Part 12: Determination of liquid and plastic limits [7],
9. EN 13286-2 Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory reference density and water content - Proctor compaction [8],
10. EN 13286-47 Unbound and hydraulically bound mixtures - Part 47: Test method for the determination of California Bearing ratio, immediate bearing index and linear swelling [9].

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 [10] and with EN ISO/IEC 17043 [11]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

49 laboratories from Europe 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/Method	1	2	3	4	5	6	7	8	9	10
1ecd1c	-	X	-	-	-	X	X	-	-	-
16fb0c	X	X	X	-	-	-	-	X	-	-
9b4e48	X	X	X	-	X	X	-	X	-	-
5555ce	X	X	-	-	X	X	X	X	X	X
47751a	X	X	X	-	X	-	-	X	-	-
8e4fed	X	X	X	X	X	X	X	X	X	-
642748	X	-	-	-	-	-	X	X	-	-
c743cd	-	-	-	-	-	-	-	-	X	-
b225ca	-	-	-	-	-	-	-	-	X	-
be2d81	-	-	-	-	-	-	-	X	-	-
130a69	-	-	-	X	-	-	-	-	-	-
9dabfd	X	-	X	-	-	-	-	X	-	-
01ba46	X	-	-	-	-	-	-	-	X	-
f28265	X	X	X	X	-	-	-	X	X	-
61f5d3	X	X	X	X	-	X	-	X	X	X
da393e	X	X	X	X	X	X	X	X	X	X
ae69e8	X	-	-	X	-	-	-	-	-	-
6af0a4	X	-	X	X	-	-	-	-	-	-
831b65	X	-	X	X	-	-	-	X	-	-
26de55	X	-	X	-	-	-	-	-	-	-
ebadb1	X	X	X	X	-	-	-	-	X	-
f21137	X	X	X	X	X	-	-	X	X	X
c6d3ea	-	-	-	-	-	-	-	-	-	X
db964b	-	X	X	X	-	-	-	X	-	-
8955b7	X	-	X	-	-	-	-	-	-	-
1b1360	X	X	X	X	-	-	-	X	-	-
2c3ca2	X	-	-	-	-	-	-	-	X	X
9d7c2f	-	-	-	-	-	-	-	X	-	-
22d9d4	-	-	-	-	-	X	-	-	-	-
05275d	-	-	-	-	-	-	-	-	-	X
d26722	-	-	-	-	-	-	-	X	X	X
43691e	-	X	X	-	-	-	-	-	-	-
128432	-	-	-	-	X	-	X	-	-	-
386032	X	-	-	-	-	-	-	X	X	-
16b837	-	X	-	-	X	-	-	-	-	-
899306	X	X	X	X	X	X	X	X	X	X
3ab650	X	X	X	X	X	X	X	X	X	X
c388be	X	-	-	-	-	X	-	-	-	-
dcf124	X	X	X	X	X	X	X	X	X	X
d4807a	X	-	X	-	-	-	-	X	X	X
55818f	X	-	X	-	-	-	-	-	X	-
fc2b3	X	X	X	X	X	-	-	X	-	-
8bbad3	X	X	X	X	X	-	X	X	X	X
5c4e92	X	-	-	X	-	-	-	X	-	X

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ID/Method	1	2	3	4	5	6	7	8	9	10
e0f6cc	-	-	-	X	-	-	-	X	-	-
225baf	-	-	-	-	-	-	-	X	-	-
c87702	X	-	X	-	-	-	-	-	X	X
276b77	X	X	X	-	-	-	-	X	X	X
18338d	X	X	X	-	-	-	-	X	X	X

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

Laboratory	Address	Accreditation number
"Hidrozavod dtd" ad Novi Sad	Petra Drapsina 56, Novi Sad, 21100, Serbia	01-405
4G consite s.r.o.	Šlikova 406/29, Praha 6, 16900, 27624218	1518
AG Institut doo Novi Sad, Laboratorija za ispitivanje AGI - Novi Sad	Đorđa Zličića 53A, Novi Sad, 21000, Republika Srbija	01-457
AZ Consult, spol. s r.o.	Klíšská 1334/12, Ústí nad Labem, 400 01, Česká republika	L1740
AZ GEO, s.r.o.	Chittussiho 1186/14, Ostrava – Slezská Ostrava, 71000, Česká republika	1768
A&A MACEDONIA LAB TEST LTD	10, Moisi Street, Chlroraka, Paphos, 8220, Cyprus	-
B-PROJEKTY Teplice s.r.o.	Kollárova 1879/11, Teplice, 415 01, Česká republika	AZL 1428
Bautechnische Versuch- und Forschungsanstalt	Alpenstr. 157, Salzburg, 5020, Austria	-
Centrum dopravního výzkumu, v. v. i.	Líšeňská 33a, Brno, 63600, Česká republika	1506
EDAFOMICHIANI S.A.	19 EMMANUEL PAPADAKI, NEO IRAKLEIO, 14121, Greece	-
FUGRO BELGIUM	Rue du Bosquet 9, Louvain-la-Neuve, 1348, Ottignies Belgium	UKAS0919
Fugro	Veurse Achterweg 10, Leidschendam, 2264SG, Netherlands	L034 (RvA nummer NL)
Fugro GB Marine Limited	Fugro House, Hithercroft Road, Wallingford, OX10 9RB, Oxfordshire	UKAS0919
GEMATEST s.r.o.	Dr.Janského 954, Černošice, 25228, Česká republika	1291
GEOSTAR, spol. s r.o. - pracoviště Brno	Tuřanka 240/111, Brno, 627 00, Česká republika	1373
GEOSTAR, spol. s r.o. - pracoviště Hranice	Tuřanka 240/111, Brno, 627 00, Česká republika	1373

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Laboratory	Address	Accreditation number
GEOTECHNICAL LABORATORY OF OFFSHORE GEOTECHNICS DEPARTMENT IN MARITIME INSTITUTE (GDYNIA MARITIME UNIVERSITY)	311A Grunwaldzka St., Gdansk, 80-309, Poland	AB 1770
GEOtest, a.s.	Šmahova, 1244/112, BRNO, 627 00, Česká republika	1271.2
GIM-TEST D.O.O. BANJA LUKA	Palih boraca 55, local No. 2, Banja Luka, 78000, RS, BiH	LI-152-01
Geo-Test d.o.o.	Vojina Đurašinića Kostje 11, Beograd, 11000, Srbija	01-466
GeoLab	Tvaika iela 39, Rīga, LV1034, Latvia	-
INGEO-ENVILAB s.r.o.	Bytčická 16, Žilina, 010 01, Slovenská republika	S-008
Institut za građevinarstvo "IG"	Kralja Petra I Karađorđevića 92-98, Banja Luka, 78000, Bosna i Hercegovina	LI-71-01
Klaipeda University	Herkaus Manto str. 84, Klaipeda, 92294, Lithuania	LT119511515
Labo Devlieger - Van Vooren	Industriepark Rosteyne 1, zezate, 9060, België	296-TEST
Laboratorium Drogowe Szczecin Sp. z o.o.	Tama Pomorzańska 13L, Szczecin, 70-030, Poland	AB1806
Lithuanian Geological Survey under the Ministry of Environment, Laboratory	S. Konarskio str. 35, Vilnius, LT-03123, Lithuania	-
Mattest Ireland Ltd	Unit 2, Site 9, Northwest Business park, Ballycoolin, D15 EF1H, Ireland	-
Mining and Metallurgy Institute Bor	Zeleni bulevar 35, Bor, 19210, Serbia	01-308, ATS Serbia
Národná diaľničná spoločnosť a.s.	Dúbravská cesta 14, Bratislava, 841 04, Slovenská republika	456/S-328
Ogranak Instituta za građevinarstvo "IG" d.o.o. Banja Luka Beograd	Kosovska 17, Beograd, 11000, Republika Srbija	ATS 01-493
PUDIS a.s.	Podbabská 1014/20, Praha 6, 16000, Česká republika	1762
QUALIFORM SLOVAKIA s.r.o. - Svit	Pasienková 9 D, Bratislava, 82016, Slovenská republika	S-301
QUALIFORM SLOVAKIA s.r.o. - Bratislava	Pasienková 9 D, Bratislava, 82106, Slovenská republika	S-301
QUALIFORM, a.s. - pracoviště Brno	Mlaty 672/8, Brno, 64200, Česká republika	1008
QUALIFORM, a.s. - pracoviště Praha	Mlaty 672/8, Brno, 64200, Česká republika	1008
RUDARSKI INSTITUT D.O.O BEOGRAD - ZEMUN	Batajnički put br.2, Beograd, 11080, Serbia	01-309
Rina Consulting - GET Srl	Via Albisola 64/66, Genova, 16162, Italy	-
S.C. GEOSTUD S.R.L.	Str. Sîngerului, nr. 11, sector 1, Bucharest, 014617, Romania	LI 974

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Laboratory	Address	Accreditation number
SQZ, s.r.o.	U Místní Dráhy 939/5, Olomouc, 77900, Česká republika	1135.2
Sibotec cvba	Industriepark Oost 6, Beernem, 8730, West - Vlaanderen	BELAC 637-TEST
Sweco Lietuva UAB	A. Strazdo g. 22, Kaunas, LT-48488, Lithuania	-
TESTSTAV, spol. s r.o.	Orlovská 347/160, Ostrava-Heřmanice, 71300, Česká republika	1290
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 37006, Česká republika	1181
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 370 06, Česká republika	1181
TUV Austria Romania	Calea Plevnei, nr. 139B, Corp A, sector 6, 060011, București, România, Bucharest, 060011, Romania	-
i2 Analytical Limited Sp. z o o Oddział w Polsce	Pionierów 39, Ruda Śląska, 41-711, Polska	-
Ředitelství silnic a dálnic ČR	Rebešovická 40, Brno-Chrlice, 643 00, Česká republika	1072
"ЦЕНТЪР ЗА ИЗПИТВАНЕ И ЕВРОПЕЙСКА СЕРТИФИКАЦИЯ" ЕООД/Center for Testing and European Certification Ltd.	2, Industrialna street, Stara Zagora, 6006, Bulgaria	252 LI

## 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  $\zeta$ -score (zeta-score). These characteristics assess the performance of individual participants by comparing it with the assigned value and measurement uncertainties. z-score and  $\zeta$ -score are compared with limit values. The resulting  $\zeta$ -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 Soil Testing (PT Program) organized by the PT Provider at the SZK FAST. 49 participants (laboratories) took part in the PT Program. The program focused on ordinary standardized testing of soil. 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.

The testing methods 3 and 4 were evaluated as a multilevel experiment. Laboratory performance was classified as problematic or unsatisfactory if critical values were exceeded on at least three levels of the experiment.

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
1ecd1c	-	✓	-	-	-	✓	✓	-	-	-
16fb0c	✓	✓	✓	-	-	-	-	✓	-	-
9b4e48	✓	✓	✓	-	✓	✓	-	!	-	-
5555ce	✓	✓	-	-	✓	✓	✓	?	✓	✓
47751a	✓	✓	?	-	✓	-	-	✓	-	-
8e4fed	✓	✓	✓	✓	✓	✓	✓	✓	✓	-
642748	✓	-	-	-	-	-	✓	?	-	-
c743cd	-	-	-	-	-	-	-	-	✓	-
b225ca	-	-	-	-	-	-	-	-	✓	-
be2d81	-	-	-	-	-	-	-	X	-	-
130a69	-	-	-	✓	-	-	-	-	-	-
9dabfd	✓	-	✓	-	-	-	-	?	-	-
01ba46	✓	-	-	-	-	-	-	-	✓	-
f28265	✓	✓	✓	?	-	-	-	✓	X	-
61f5d3	✓	✓	✓	✓	-	✓	-	✓	✓	✓
da393e	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ae69e8	✓	-	-	✓	-	-	-	-	-	-
6af0a4	✓	-	✓	✓	-	-	-	-	-	-
831b65	?	-	?	✓	-	-	-	✓	-	-
26de55	✓	-	✓	-	-	-	-	-	-	-
ebadb1	✓	✓	✓	✓	-	-	-	-	✓	-
f21137	✓	✓	✓	?	✓	-	-	✓	✓	✓
c6d3ea	-	-	-	-	-	-	-	-	-	✓
db964b	-	✓	✓	✓	-	-	-	✓	-	-
8955b7	✓	-	✓	-	-	-	-	-	-	-
1b1360	✓	✓	✓	✓	-	-	-	✓	-	-
2c3ca2	✓	-	-	-	-	-	-	-	!	✓

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ID / Method	1	2	3	4	5	6	7	8	9	10
9d7c2f	-	-	-	-	-	-	-	?	-	-
22d9d4	-	-	-	-	-	✓	-	-	-	-
05275d	-	-	-	-	-	-	-	-	-	✓
d26722	-	-	-	-	-	-	-	✓	✓	✓
43691e	-	✓	✓	-	-	-	-	-	-	-
128432	-	-	-	-	✓	-	✓	-	-	-
386032	✓	-	-	-	-	-	-	✓	✓	-
16b837	-	✓	-	-	✓	-	-	-	-	-
899306	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3ab650	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
c388be	✓	-	-	-	-	✓	-	-	-	-
dcf124	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
d4807a	?	-	✓	-	-	-	-	✓	✓	✓
55818f	✓	-	✓	-	-	-	-	-	✓	-
fc2b3	✓	✓	✓	✓	✓	-	-	✓	-	-
8bbad3	✓	✓	✓	✓	✓	-	?	✓	✓	✓
5c4e92	✓	-	-	✓	-	-	-	✓	-	✓
e0f6cc	-	-	-	✓	-	-	-	✓	-	-
225baf	-	-	-	-	-	-	-	✓	-	-
c87702	✓	-	✓	-	-	-	-	-	✓	✓
276b77	✓	✓	✓	-	-	-	-	✓	✓	✓
18338d	✓	✓	✓	-	-	-	-	?	✓	✓

## References

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- [2] EN ISO 17892-3. *Geotechnical investigation and testing - Laboratory testing of soil - Part 3: Determination of particle density*. 2016.
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- [5] EN ISO 17892-7. *Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test*. 2018.
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- [10] 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.
- [11] EN ISO/IEC 17043. *Conformity assessment - General requirements for proficiency testing*. 2010.

## 1 Appendix – EN ISO 17892-1 – Water content

### 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			$u_X$ [%]	$\bar{x}$ [%]	$s_0$ [%]	$V_X$ [%]
	[%]	[%]	[%]				
d4807a	4.2	4.2	4.2	-	4.2	0.0	0.0
fc2b3	4.3	4.3	4.5	-	4.4	0.09	2.04
16fb0c	4.4	4.3	4.6	0.2	4.4	0.17	3.72
f21137	4.4	4.5	4.5	-	4.5	0.04	0.84
01ba46	4.5	-	-	-	4.5	0.0	0.0
ebadb1	4.5	4.4	4.6	0.1	4.5	0.1	2.22
61f5d3	4.6	4.6	4.6	0.1	4.6	0.0	0.0
dcf124	4.6	4.6	4.6	0.2	4.6	0.0	0.0
9dabfd	4.6	4.6	4.7	-	4.6	0.07	1.56
5555ce	4.7	4.7	4.6	0.2	4.7	0.06	1.24
c87702	4.8	4.8	4.7	0.2	4.8	0.06	1.21
c388be	4.7	4.8	4.8	-	4.8	0.06	1.21
5c4e92	4.8	4.8	4.7	0.5	4.8	0.06	1.21
f28265	4.9	4.7	4.8	0.6	4.8	0.1	2.08
da393e	4.7	4.9	4.9	-	4.8	0.12	2.39
642748	4.8	4.9	4.8	0.4	4.8	0.03	0.66
3ab650	5.0	4.8	4.8	0.2	4.9	0.12	2.37
9b4e48	4.9	4.9	4.9	0.0	4.9	0.03	0.57
6af0a4	4.9	4.9	4.8	0.0	4.9	0.05	1.03
47751a	4.8	4.9	5.0	0.1	4.9	0.1	2.04
8e4fed	5.0	4.9	4.9	-	4.9	0.06	1.17
1b1360	5.0	5.0	4.9	0.0	5.0	0.06	1.16
18338d	5.1	4.9	4.9	-	5.0	0.12	2.32
26de55	5.0	5.0	5.0	0.1	5.0	0.0	0.0
2c3ca2	5.0	5.0	5.1	0.1	5.0	0.06	1.15
55818f	5.0	5.1	5.0	0.2	5.0	0.06	1.15
899306	5.1	5.0	5.1	-	5.1	0.06	1.14
ae69e8	5.0	5.2	-	0.1	5.1	0.14	2.77
276b77	5.1	5.0	5.2	-	5.1	0.1	1.96
8bbad3	5.2	5.1	5.1	-	5.1	0.03	0.49
8955b7	5.2	5.1	5.1	0.1	5.1	0.06	1.12
386032	5.2	5.2	5.2	0.1	5.2	0.03	0.58
831b65	5.6	5.4	5.4	0.1	5.5	0.15	2.73

## 1.2 The Numerical Procedure for Determining Outliers

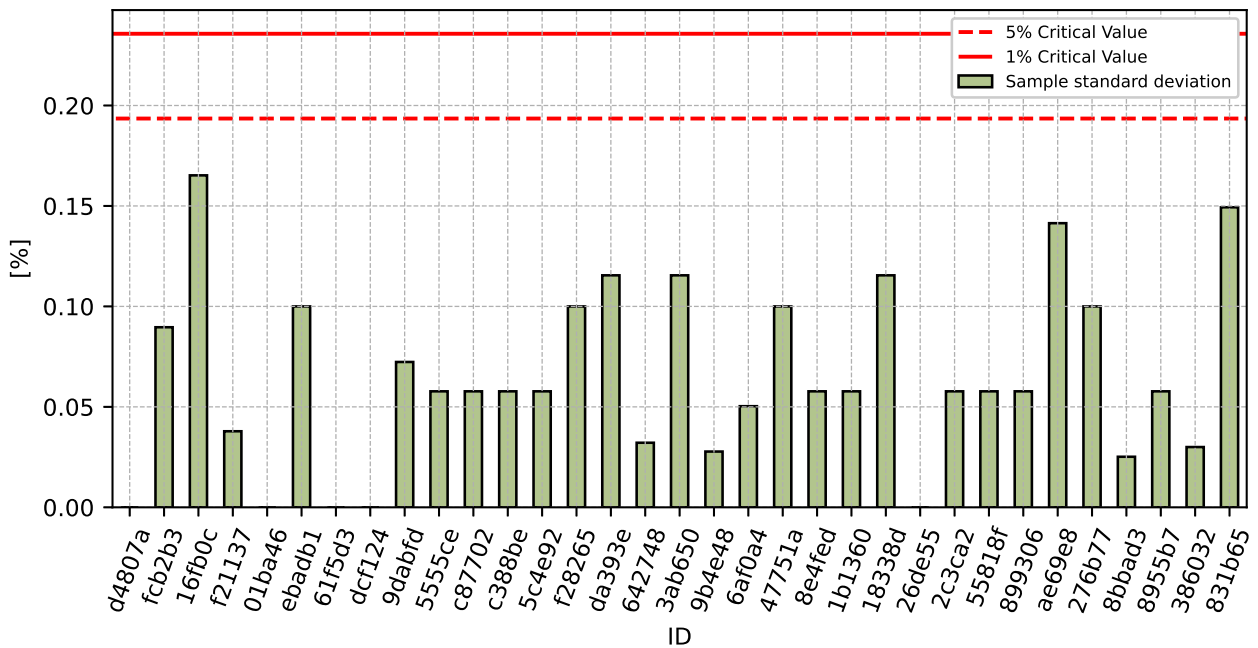


Figure 1: **Cochran's test** - sample standard deviations

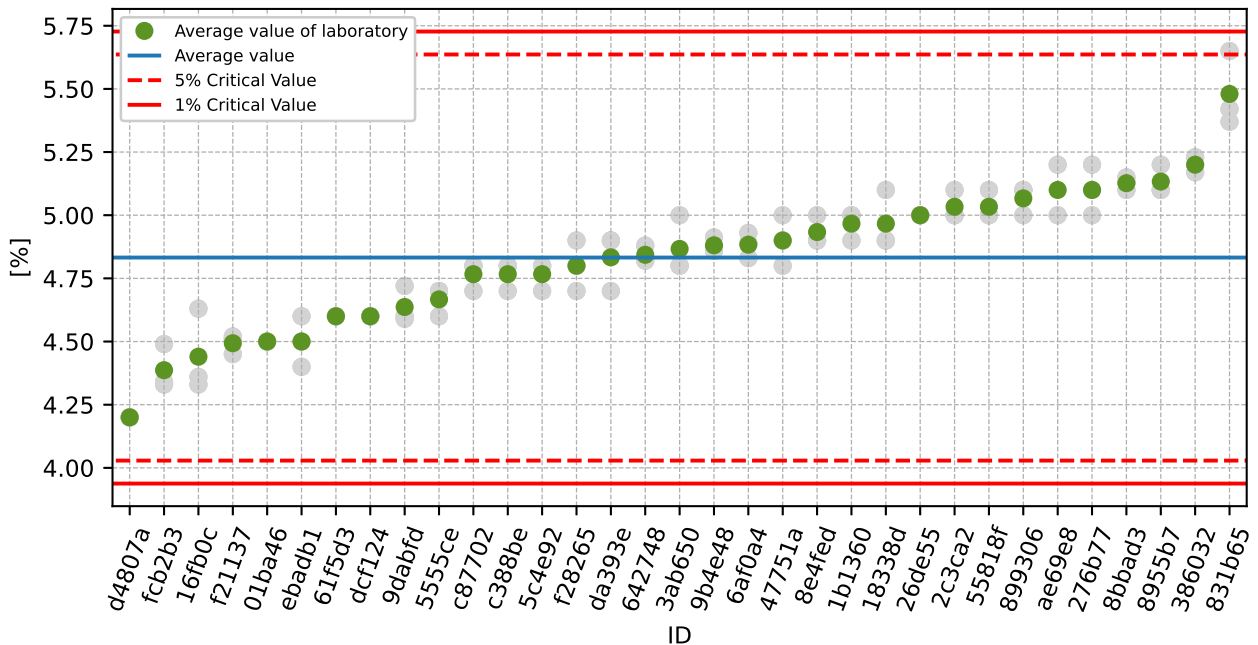


Figure 2: **Grubbs' test** - average values

### 1.3 Mandel’s Statistics

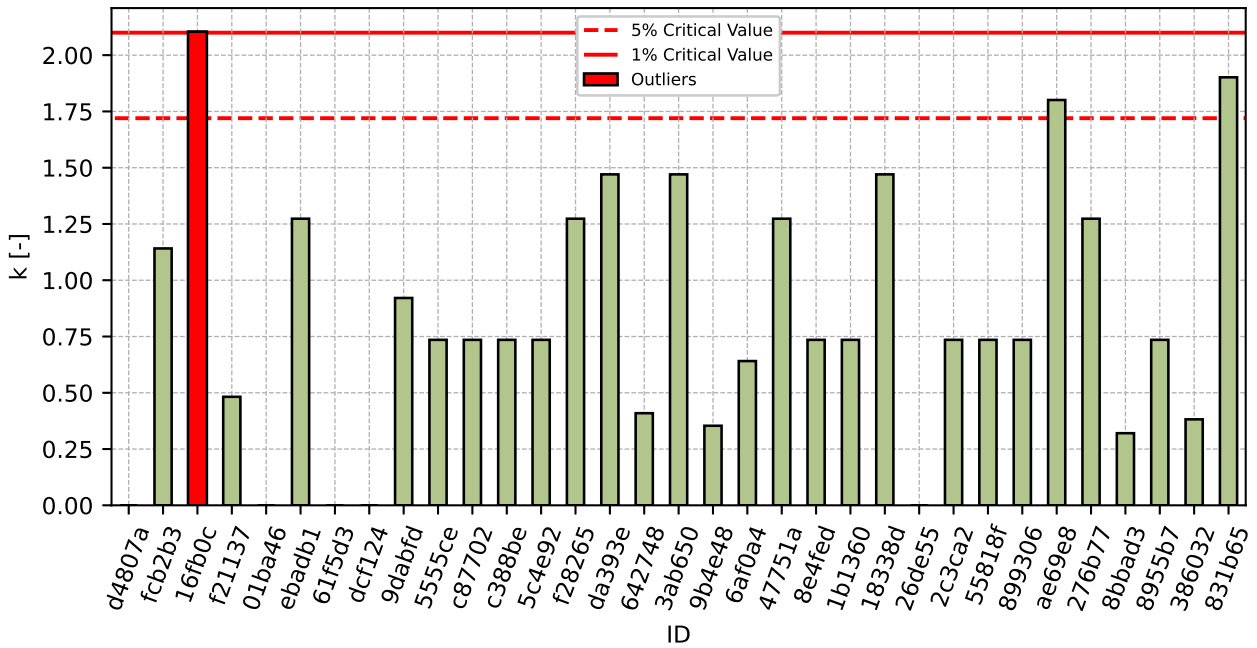


Figure 3: Intralaboratory Consistency Statistic

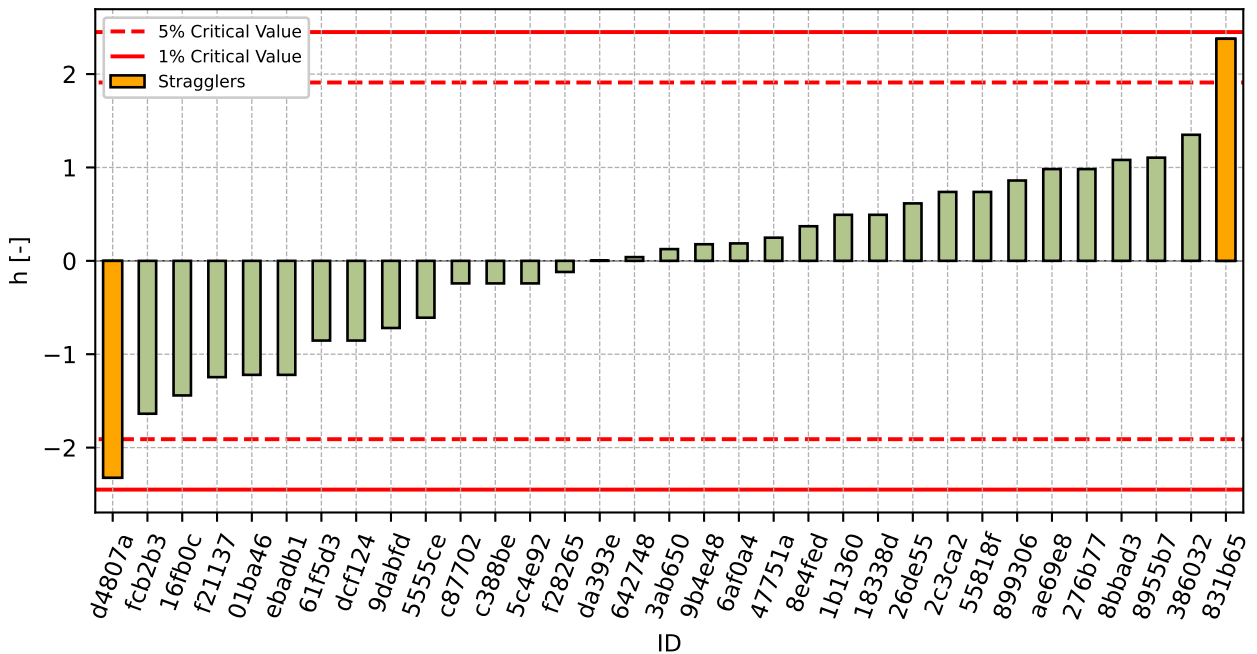


Figure 4: Interlaboratory Consistency Statistic



## 1.4 Descriptive statistics

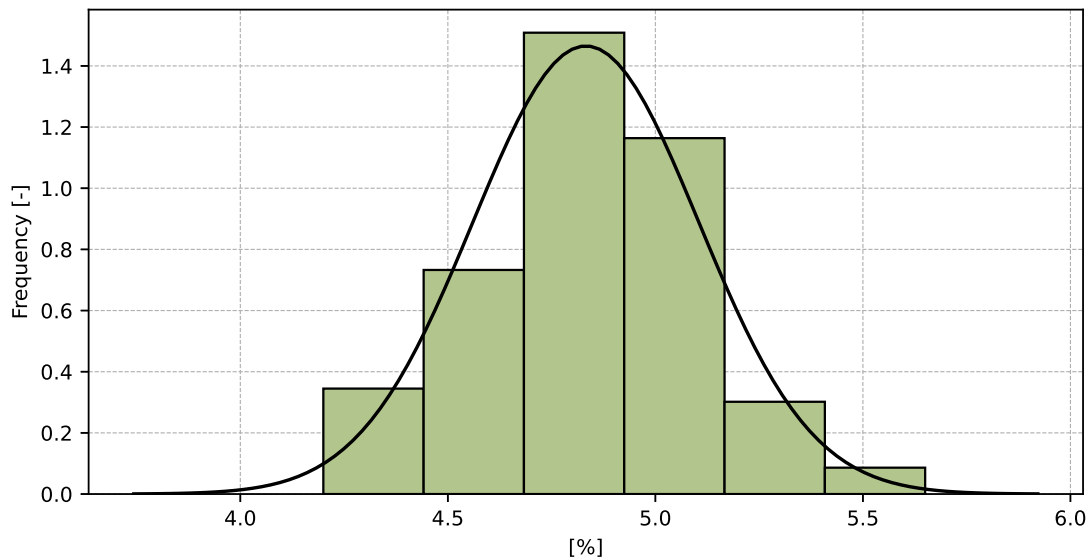


Figure 5: Histogram of all test results

Table 5: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	4.8
Sample standard deviation – $s$	0.27
Assigned value – $x^*$	4.8
Robust standard deviation – $s^*$	0.29
Measurement uncertainty of assigned value – $u_X$	0.06
$p$ -value of normality test	1.0 [-]
Interlaboratory standard deviation – $s_L$	0.27
Repeatability standard deviation – $s_r$	0.08
Reproducibility standard deviation – $s_R$	0.28
Repeatability – $r$	0.2
Reproducibility – $R$	0.8

### 1.5 Evaluation of Performance Statistics

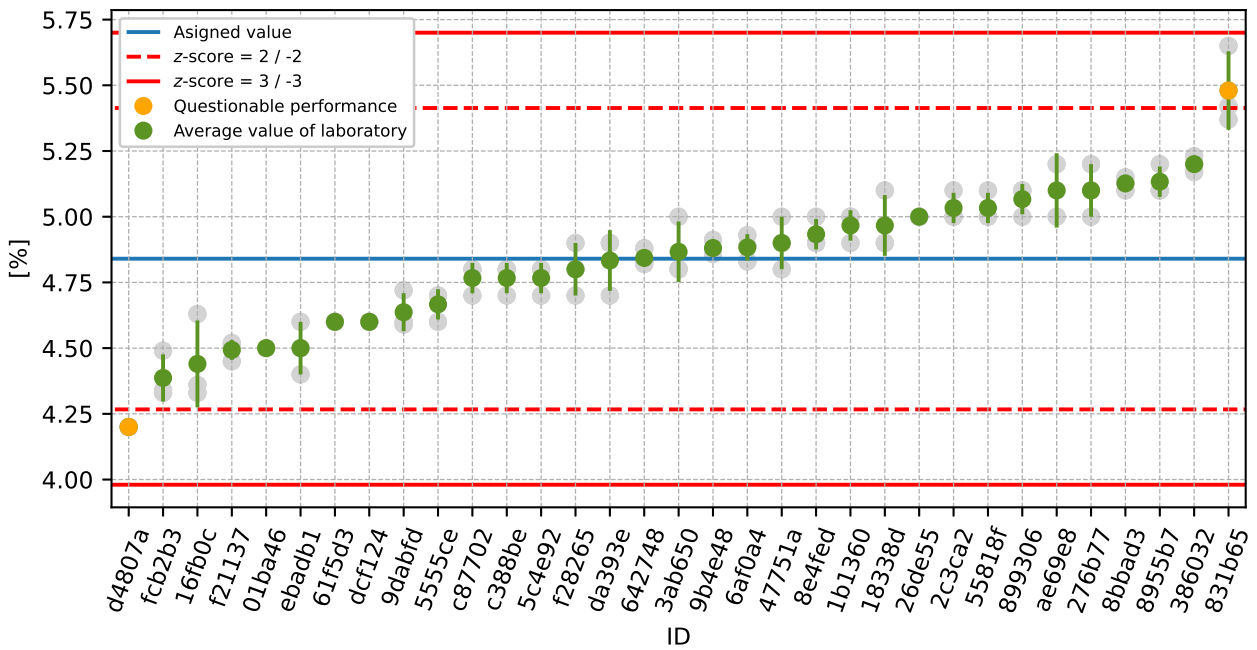


Figure 6: Average values and sample standard deviations

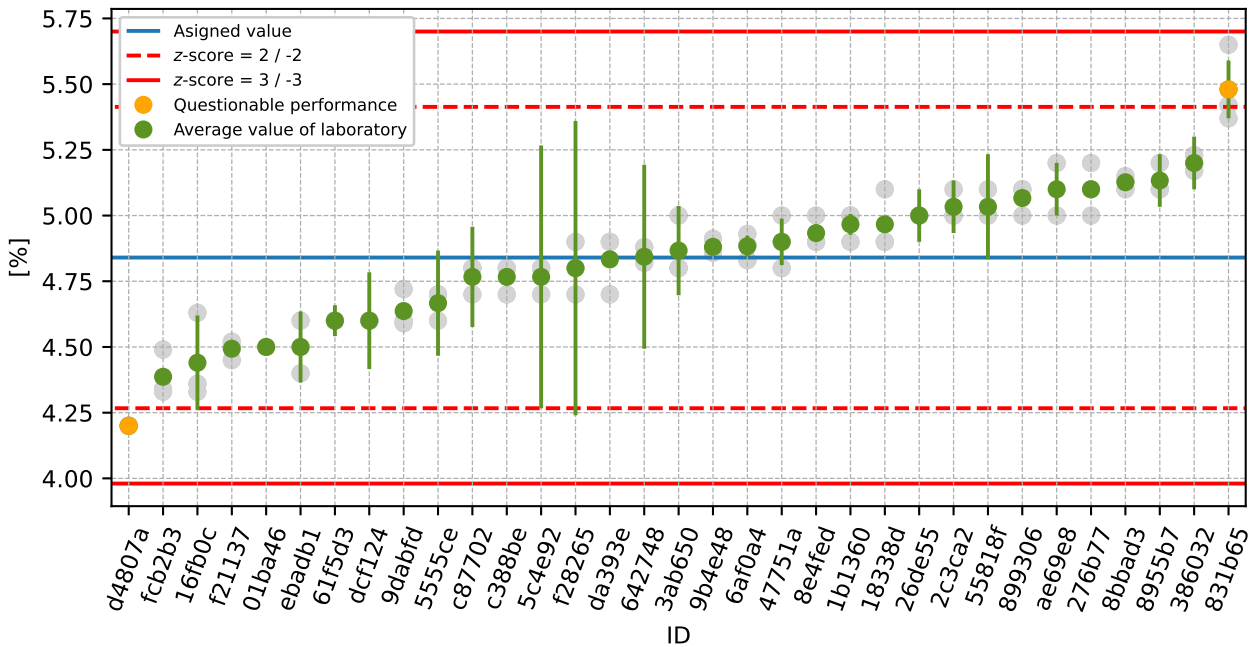


Figure 7: Average values and extended uncertainties of measurement

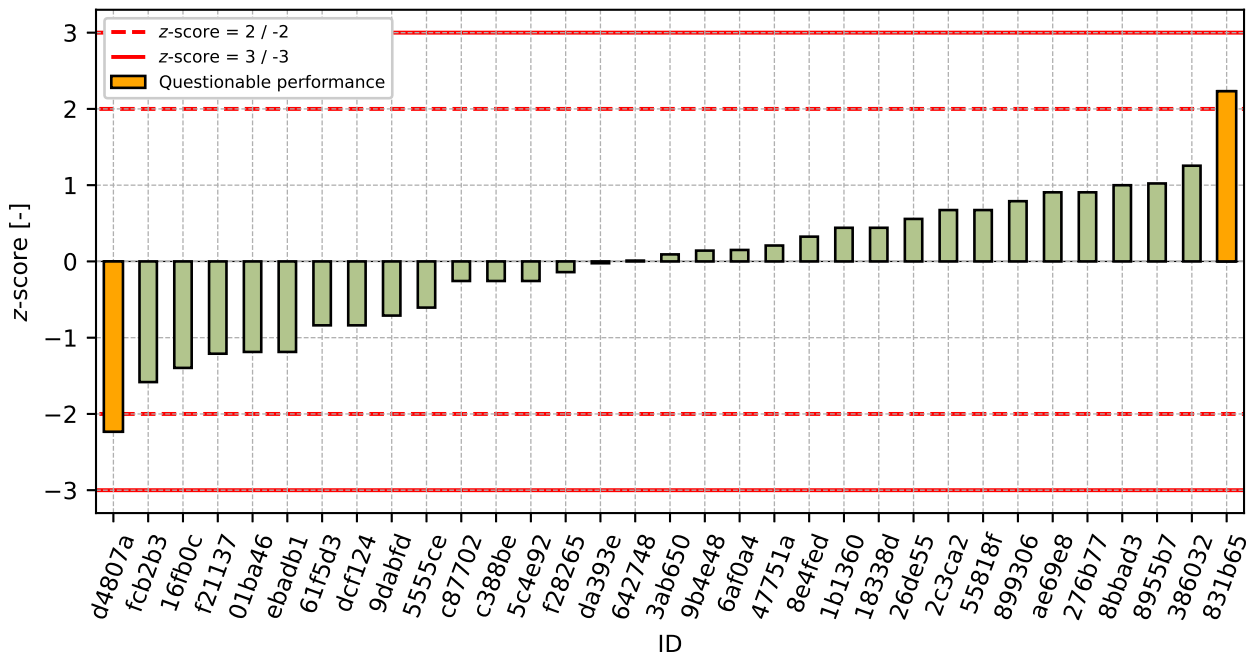


Figure 8: z-score

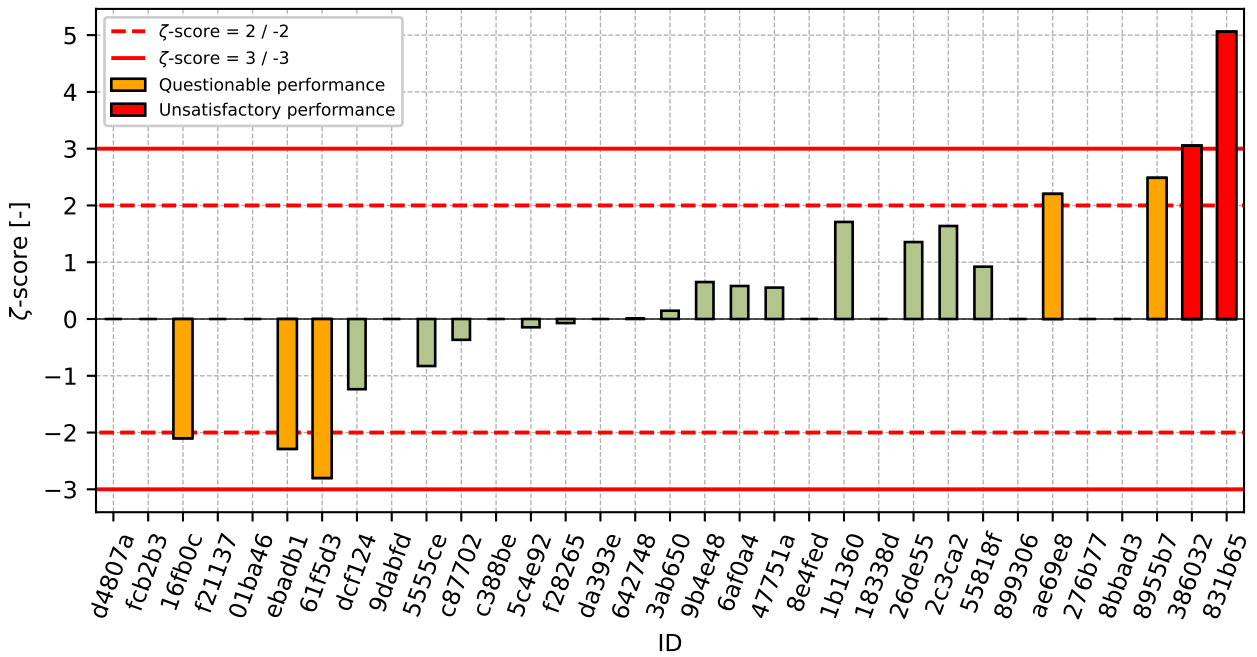


Figure 9: zeta-score

Table 6: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
d4807a	-2.23	-
fc2b3	-1.58	-
16fb0c	-1.4	-2.1
f21137	-1.21	-
01ba46	-1.19	-
ebadb1	-1.19	-2.29
61f5d3	-0.84	-2.8
dcf124	-0.84	-1.24
9dabfd	-0.71	-
5555ce	-0.61	-0.83
c87702	-0.26	-0.37
c388be	-0.26	-
5c4e92	-0.26	-0.15
f28265	-0.14	-0.07
da393e	-0.02	-
642748	0.01	0.01
3ab650	0.09	0.15
9b4e48	0.14	0.65
6af0a4	0.15	0.58
47751a	0.21	0.55
8e4fed	0.32	-
1b1360	0.44	1.71
18338d	0.44	-
26de55	0.56	1.36
2c3ca2	0.67	1.64
55818f	0.67	0.92
899306	0.79	-
ae69e8	0.91	2.2
276b77	0.91	-
8bbad3	1.0	-
8955b7	1.02	2.49
386032	1.26	3.05
831b65	2.23	5.06

## 2 Appendix – EN ISO 17892-3 – Particle density

### 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			$u_x$ [Mg/m <sup>3</sup> ]	$\bar{x}$ [Mg/m <sup>3</sup> ]	$s_0$ [Mg/m <sup>3</sup> ]	$V_x$ [%]
	[Mg/m <sup>3</sup> ]	[Mg/m <sup>3</sup> ]	[Mg/m <sup>3</sup> ]				
18338d	2.64	2.65	2.63	-	2.64	0.01	0.38
276b77	2.63	2.66	2.64	-	2.64	0.015	0.58
f28265	2.64	2.64	2.65	0.04	2.64	0.006	0.22
dcf124	2.65	2.65	2.65	0.1	2.65	0.0	0.0
f21137	2.65	2.65	2.66	-	2.65	0.003	0.12
47751a	2.65	2.66	2.65	0.01	2.65	0.006	0.22
5555ce	2.66	2.67	2.66	0.01	2.66	0.006	0.24
61f5d3	2.67	2.67	2.67	1.24	2.67	0.0	0.0
43691e	2.68	2.67	2.67	0.04	2.67	0.006	0.22
3ab650	2.7	2.68	2.64	0.04	2.67	0.031	1.14
1ecd1c	2.68	2.67	2.68	-	2.68	0.006	0.22
16b837	2.68	2.7	2.69	0.04	2.69	0.01	0.37
9b4e48	2.69	2.69	2.69	0.0	2.69	0.002	0.07
ebadb1	2.69	2.7	2.68	3.0	2.69	0.01	0.37
da393e	2.69	2.71	2.68	-	2.69	0.015	0.57
fc2b3	2.71	2.69	2.69	-	2.7	0.012	0.43
8e4fed	2.7	2.71	2.7	-	2.7	0.006	0.21
1b1360	2.7	2.7	2.71	0.11	2.7	0.006	0.21
db964b	2.71	2.7	2.7	0.01	2.7	0.003	0.11
899306	2.71	2.7	2.71	-	2.71	0.006	0.21
16fb0c	2.73	2.72	2.7	0.11	2.72	0.015	0.56
8bbad3	2.73	2.73	2.73	-	2.73	0.0	0.0

## 2.2 The Numerical Procedure for Determining Outliers

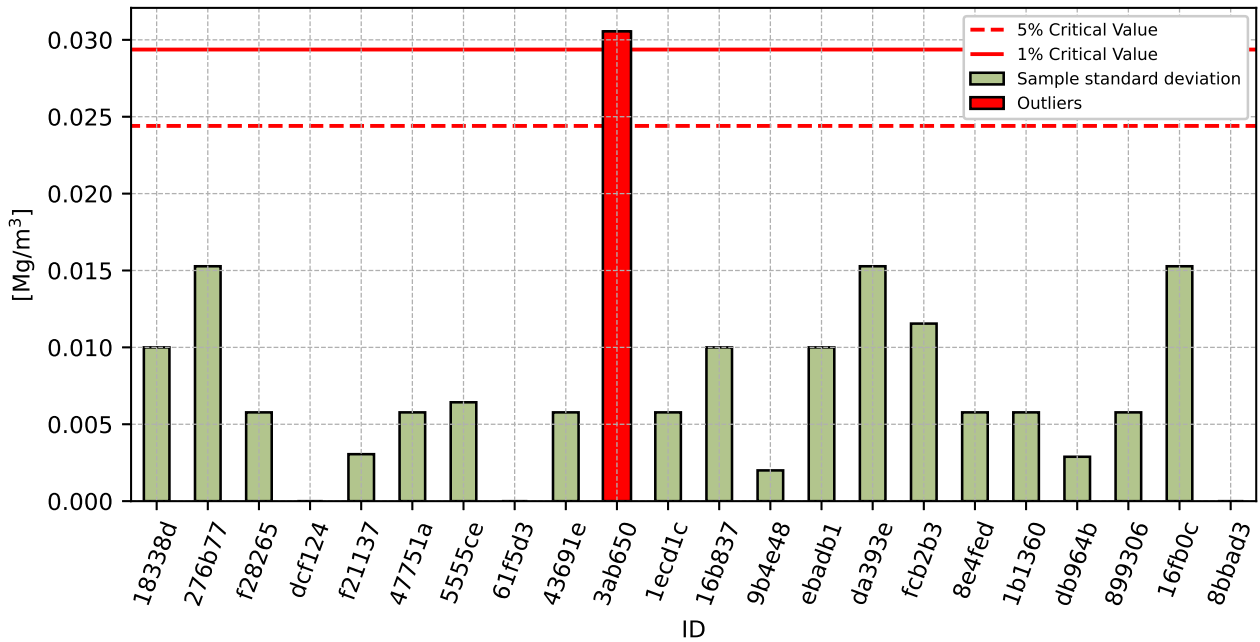


Figure 10: Cochran's test - sample standard deviations

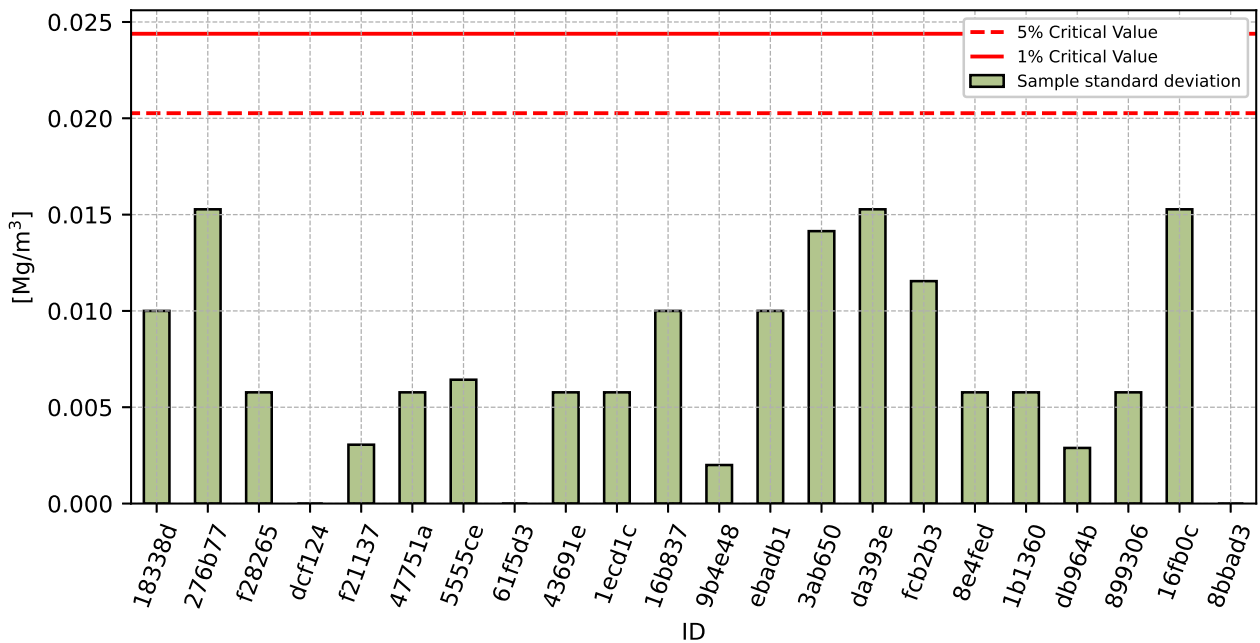


Figure 11: Cochran's test - sample standard deviations without outliers

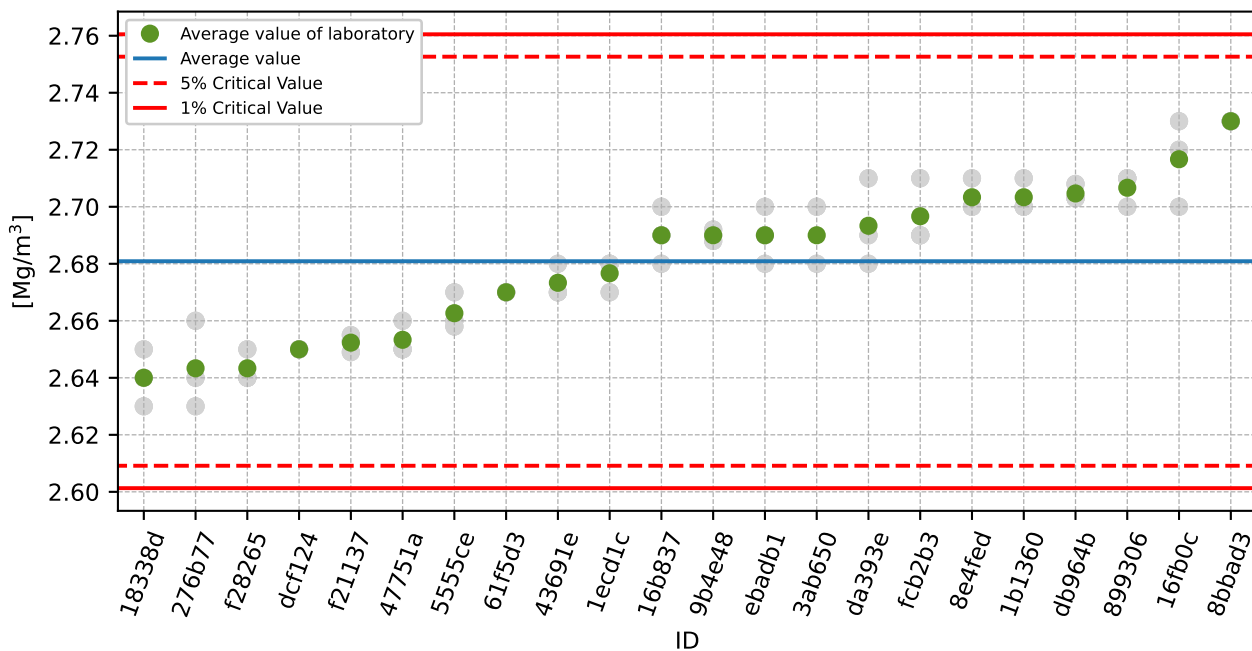


Figure 12: Grubbs' test - average values

### 2.3 Mandel's Statistics

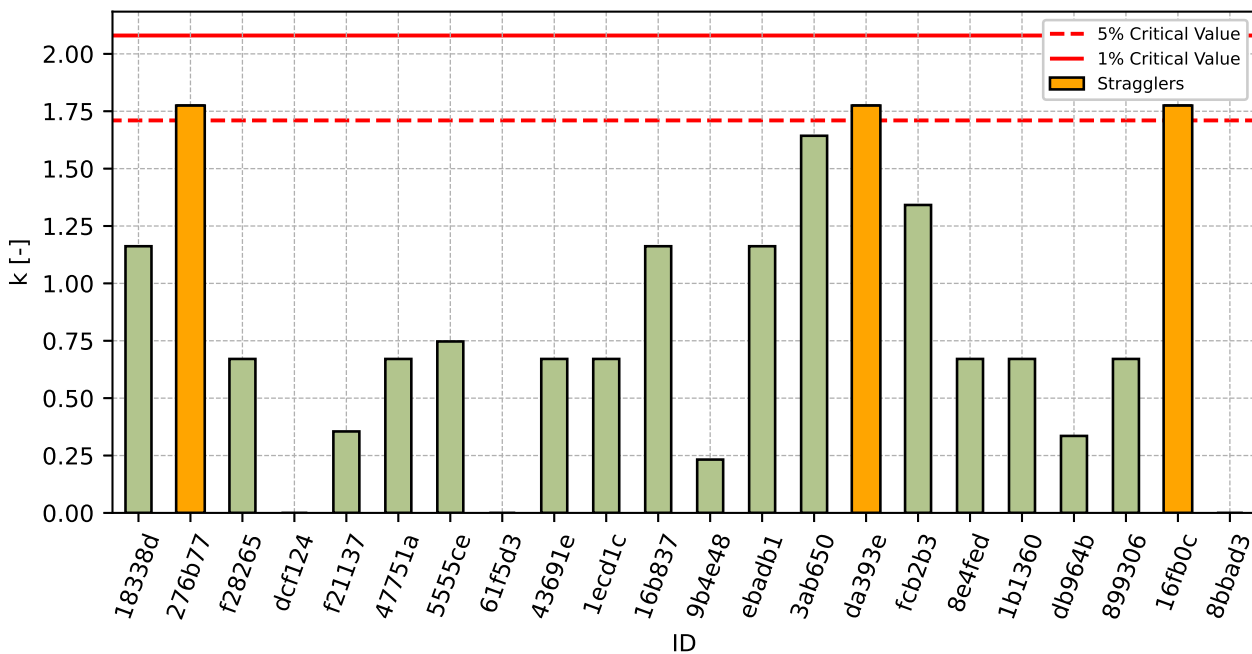


Figure 13: Intralaboratory Consistency Statistic

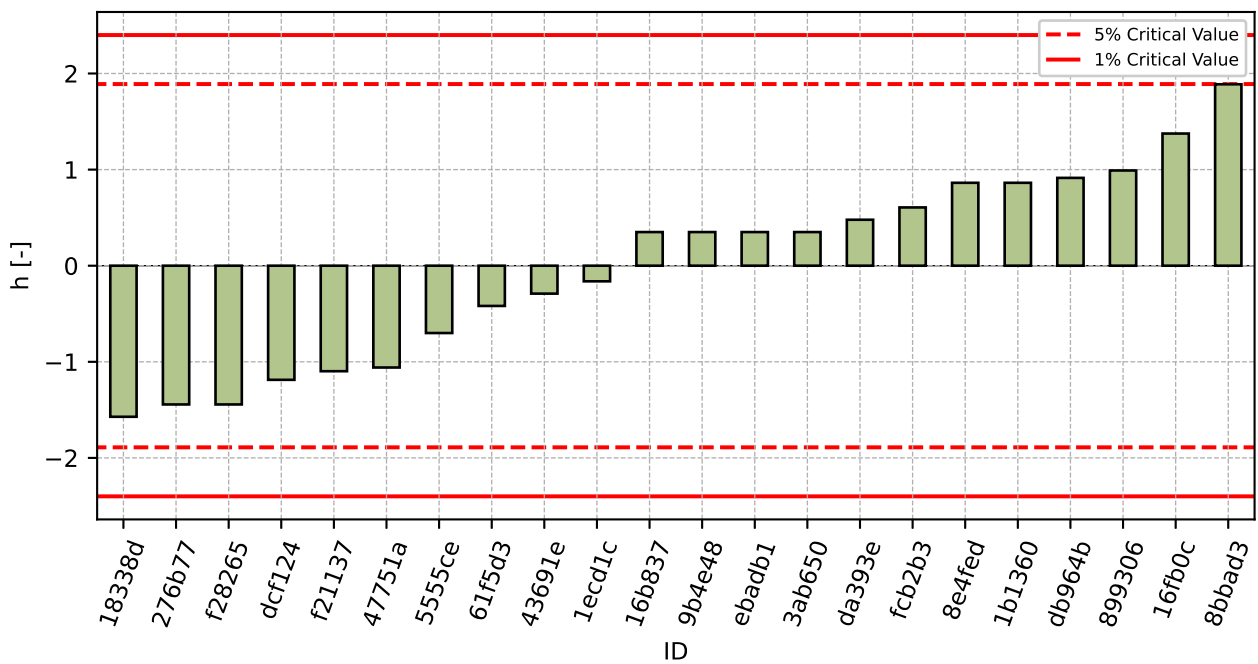


Figure 14: Interlaboratory Consistency Statistic

## 2.4 Descriptive statistics

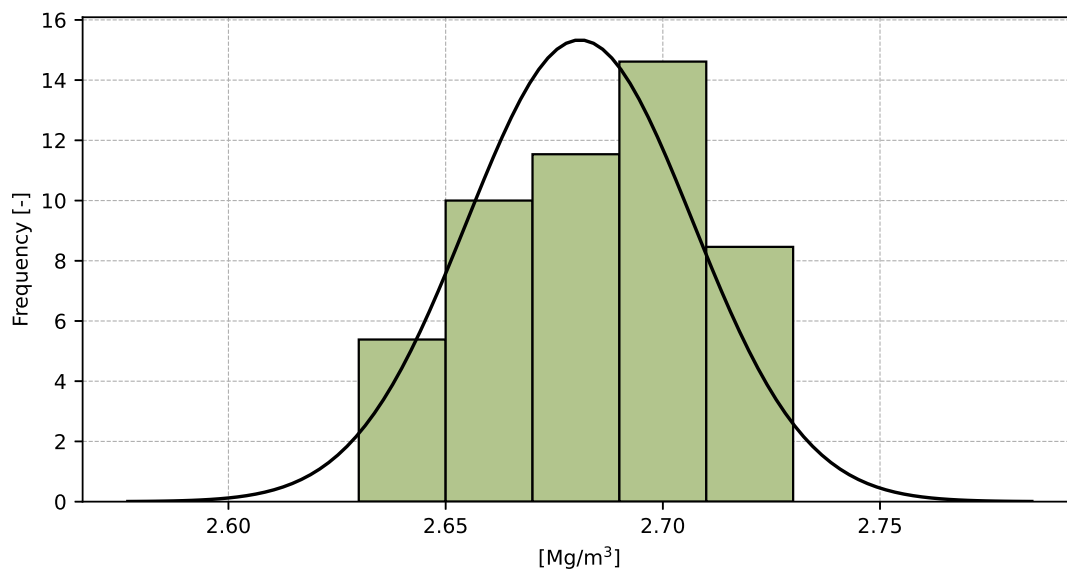


Figure 15: Histogram of all test results



Table 8: Descriptive statistics

Characteristics	[Mg/m <sup>3</sup> ]
Average value – $\bar{x}$	2.68
Sample standard deviation – $s$	0.026
Assigned value – $x^*$	2.68
Robust standard deviation – $s^*$	0.026
Measurement uncertainty of assigned value – $u_X$	0.007
$p$ -value of normality test	1.0 [-]
Interlaboratory standard deviation – $s_L$	0.026
Repeatability standard deviation – $s_r$	0.009
Reproducibility standard deviation – $s_R$	0.027
Repeatability – $r$	0.02
Reproducibility – $R$	0.08

## 2.5 Evaluation of Performance Statistics

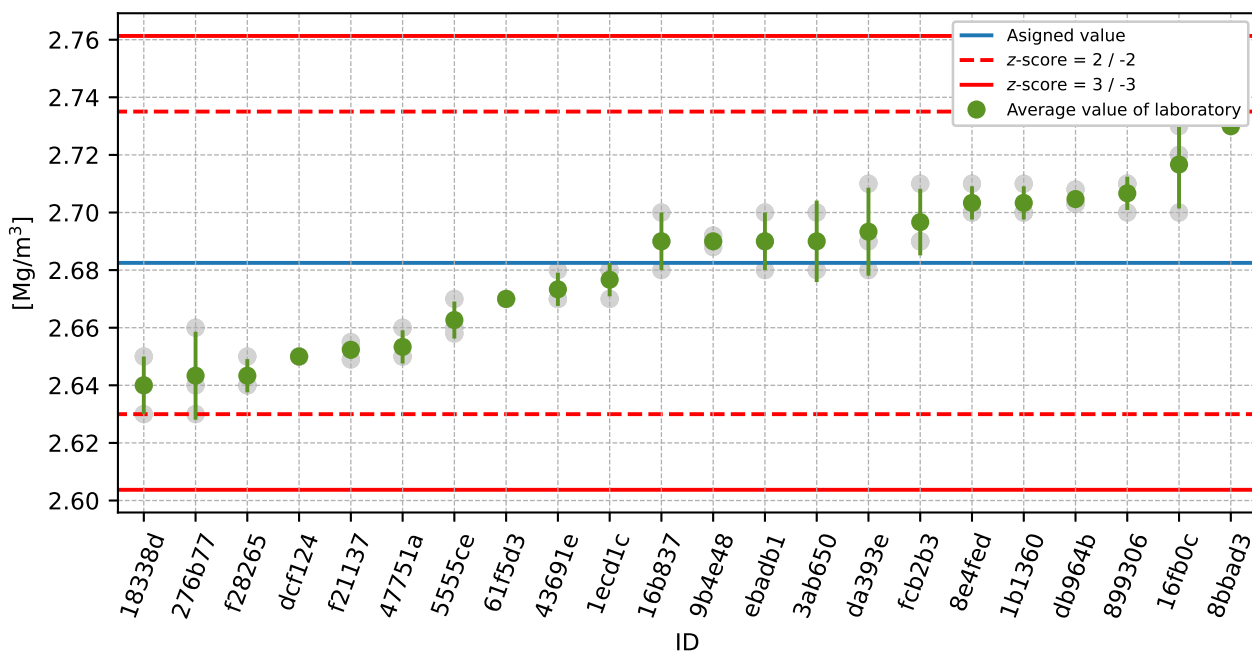


Figure 16: Average values and sample standard deviations

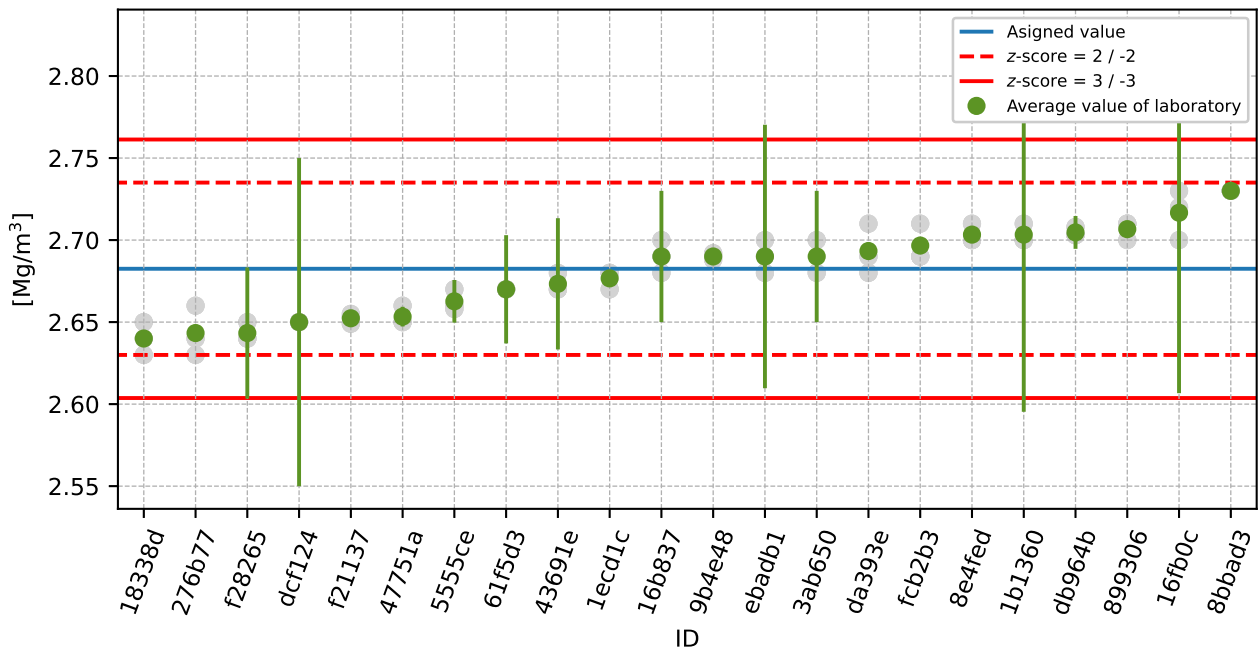


Figure 17: Average values and extended uncertainties of measurement

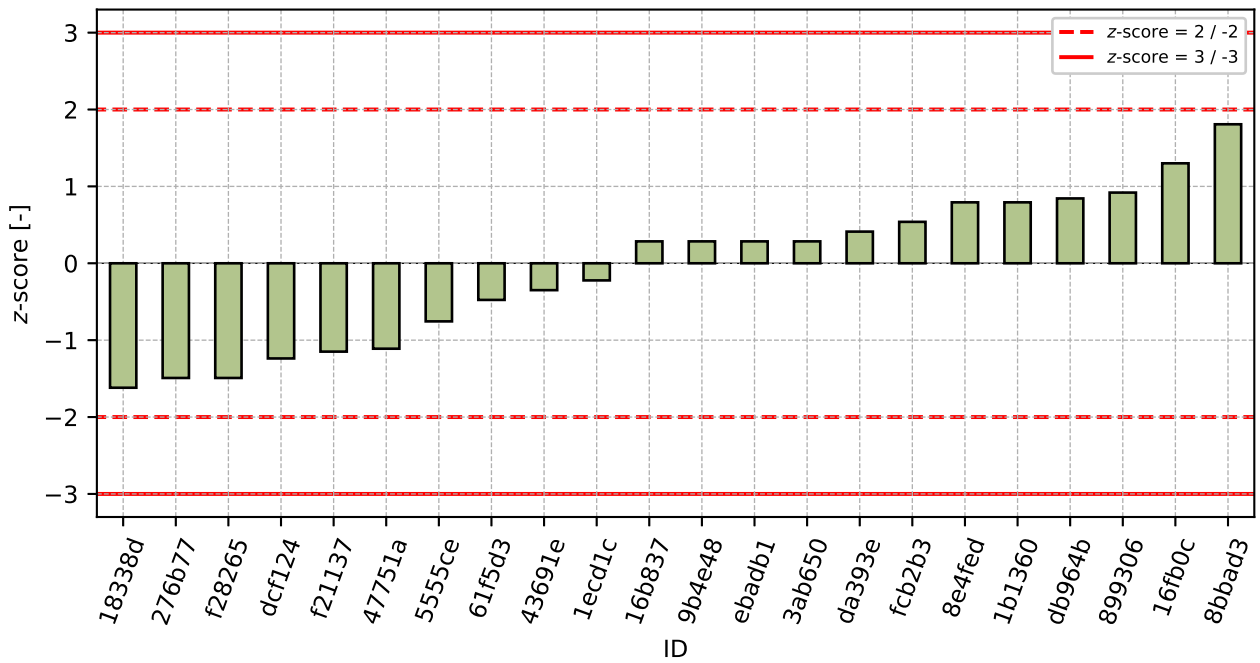


Figure 18: z-score

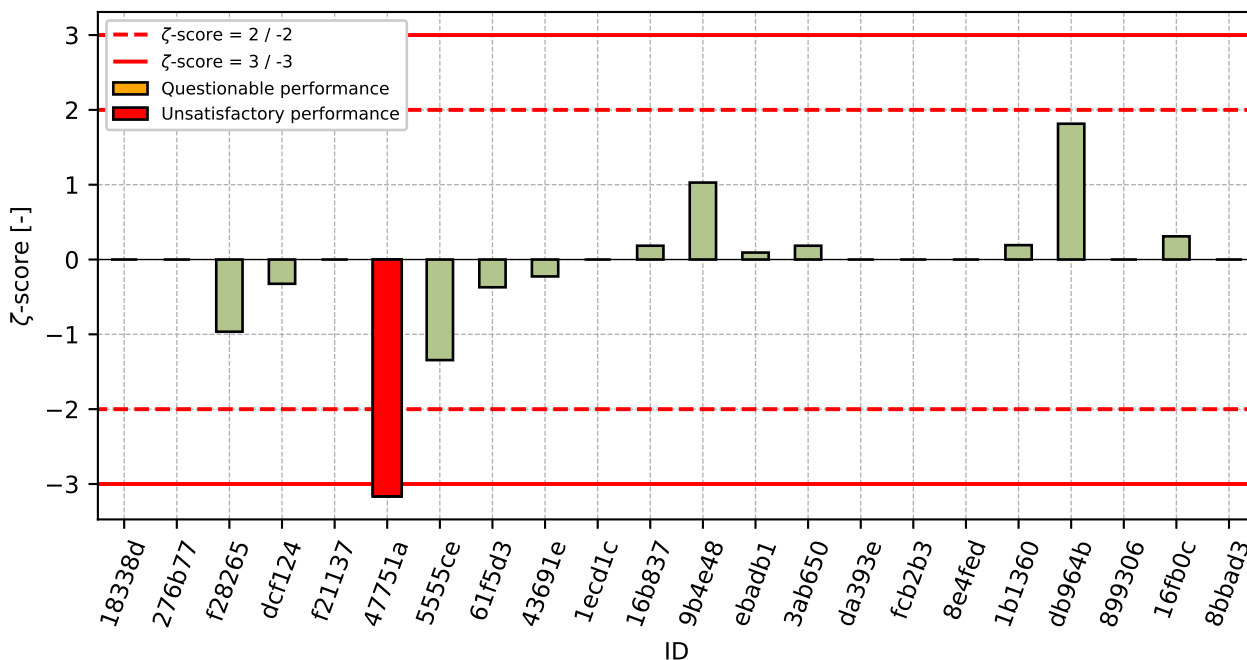


Figure 19: ζ-score

Table 9: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
18338d	-1.62	-
276b77	-1.49	-
f28265	-1.49	-0.96
dcf124	-1.24	-0.32
f21137	-1.15	-
47751a	-1.11	-3.17
5555ce	-0.76	-1.34
61f5d3	-0.48	-0.37
43691e	-0.35	-0.23
1ecd1c	-0.22	-
16b837	0.29	0.18
9b4e48	0.29	1.03
ebadb1	0.29	0.09
3ab650	0.29	0.18
da393e	0.41	-
fc2b2b3	0.54	-
8e4fed	0.79	-
1b1360	0.79	0.19
db964b	0.84	1.81
899306	0.92	-
16fb0c	1.3	0.31
8bbad3	1.81	-

### 3 Appendix – EN ISO 17892-4 – Particle size distribution, art. 5.2 (Sieving)

Table 10: Test results - Sieve through [%]

ID of participant	Sieve through [%]						
	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
16fb0c	96.9	84.5	61.0	33.6	12.2	3.2	1.7
9b4e48	96.8	83.7	60.0	32.4	10.4	1.6	0.4
47751a	94.0	80.0	54.0	27.0	7.0	1.0	0.0
8e4fed	96.1	84.2	61.5	34.3	12.8	3.4	2.0
9dabfd	95.0	82.0	59.0	32.0	10.5	1.0	-
f28265	96.2	85.5	61.1	33.9	9.8	1.1	0.1
61f5d3	94.9	83.4	58.9	32.0	11.2	3.5	2.2
da393e	96.0	83.8	59.9	33.6	12.4	3.6	2.4
6af0a4	96.0	83.0	59.0	33.0	12.0	3.0	1.3
831b65	96.1	85.4	61.9	35.8	14.9	6.6	5.4
26de55	98.2	84.0	60.4	33.1	11.8	3.0	1.8
ebadb1	96.5	83.0	59.6	32.9	12.3	2.9	1.5
f21137	95.3	81.3	56.6	30.7	10.4	2.1	0.9
db964b	96.1	84.1	60.5	33.2	11.9	3.1	1.7
8955b7	96.3	84.1	60.1	33.3	12.1	3.0	1.5
1b1360	94.7	79.9	55.2	32.0	10.3	1.7	0.4
43691e	94.8	83.0	59.6	33.5	12.2	3.3	1.8
899306	97.9	83.7	58.9	31.0	8.6	0.9	0.2
3ab650	95.0	85.0	44.0	30.0	10.0	5.0	2.0
dcf124	95.5	83.5	60.6	33.7	11.9	3.3	2.1
d4807a	95.6	83.4	59.6	31.8	8.3	1.1	0.2
55818f	95.5	82.8	60.3	33.7	12.0	3.0	1.4
fc2b3	93.0	81.2	57.2	31.3	12.1	4.1	2.4
8bbad3	96.4	83.4	60.3	32.1	10.8	2.7	1.4
c87702	96.2	85.1	60.7	30.4	12.2	2.7	1.4
276b77	96.3	84.0	60.2	33.2	9.7	2.6	1.6
18338d	96.1	82.8	60.9	33.9	11.8	2.7	1.4

Table 11: Grubbs' test [%]

Value	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
$G_{min}$	2.62	2.381	4.264	3.215	2.585	1.475	1.402
$G_{max}$	2.195	1.511	0.85	1.932	2.312	2.985	3.62
$G_{0.05}$	2.859	2.859	2.859	2.859	2.859	2.859	2.841
$G_{0.01}$	3.178	3.178	3.178	3.178	3.178	3.178	3.157

Table 12: Grubbs' test - without outliers [%]

Value	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
$G_{min}$	2.62	2.381	2.945	2.027	2.585	1.475	1.827
$G_{max}$	2.195	1.511	1.285	2.315	2.312	2.985	1.416
$G_{0.05}$	2.859	2.859	2.841	2.841	2.859	2.859	2.822
$G_{0.01}$	3.178	3.178	3.157	3.157	3.178	3.178	3.135

Table 13: z-score

ID of participant	z-score [-] / sieve						
	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
16fb0c	0.99	0.82	0.8	0.67	0.64	0.32	0.47
9b4e48	0.9	0.26	0.27	-0.23	-0.48	-0.93	-1.29
47751a	-1.69	-2.31	-2.94	-	-2.58	-1.4	-1.83
8e4fed	0.25	0.61	1.07	1.19	1.01	0.48	0.88
9dabfd	-0.77	-0.92	-0.27	-0.53	-0.42	-1.4	-
f28265	0.34	1.51	0.86	0.89	-0.85	-1.32	-1.69
61f5d3	-0.86	0.05	-0.32	-0.53	0.02	0.56	1.15
da393e	0.16	0.33	0.21	0.67	0.76	0.64	1.42
6af0a4	0.16	-0.23	-0.27	0.22	0.51	0.17	-0.07
831b65	0.25	1.44	1.28	2.31	2.31	2.99	-
26de55	2.2	0.47	0.48	0.29	0.39	0.17	0.61
ebadb1	0.62	-0.23	0.05	0.14	0.7	0.09	0.2
f21137	-0.49	-1.41	-1.55	-1.5	-0.48	-0.54	-0.61
db964b	0.25	0.54	0.54	0.37	0.45	0.25	0.47
8955b7	0.44	0.54	0.32	0.44	0.58	0.17	0.2
1b1360	-1.05	-2.38	-2.3	-0.53	-0.54	-0.85	-1.29
43691e	-0.95	-0.23	0.05	0.59	0.64	0.4	0.61
899306	1.92	0.26	-0.32	-1.28	-1.59	-1.48	-1.56
3ab650	-0.77	1.16	-	-2.03	-0.73	1.73	0.88
dcf124	-0.31	0.12	0.59	0.74	0.45	0.4	1.01
d4807a	-0.21	0.05	0.05	-0.68	-1.78	-1.32	-1.56
55818f	-0.31	-0.37	0.43	0.74	0.51	0.17	0.06
fc2b2b3	-2.62	-1.48	-1.23	-1.05	0.58	1.03	1.42
8bbad3	0.53	0.05	0.43	-0.45	-0.23	-0.07	0.06
c87702	0.34	1.23	0.64	-1.73	0.64	-0.07	0.06
276b77	0.44	0.47	0.37	0.37	-0.91	-0.14	0.34
18338d	0.25	-0.37	0.75	0.89	0.39	-0.07	0.06

#### 4 Appendix – EN ISO 17892-4 – Particle size distribution, art. 5.3 (Densimetric analysis)

Table 14: Test results – outliers are marked in red

ID of participant	[%]				
	0.002 mm	0.005 mm	0.010 mm	0.020 mm	0.050 mm
8e4fed	17.5	23.6	33.1	46.1	75.5
130a69	26.0	32.0	41.0	56.0	82.0
f28265	3.2	3.2	6.5	12.7	7.0
61f5d3	21.3	29.8	40.8	64.4	96.8
da393e	25.2	32.8	56.2	67.7	89.5
ae69e8	20.5	27.7	30.7	44.1	87.1
6af0a4	29.0	38.0	45.0	61.0	88.0
831b65	20.6	26.4	32.2	39.6	81.4
ebadb1	11.1	18.8	40.8	48.9	81.8
f21137	0.0	0.0	0.0	37.1	76.3
db964b	18.5	24.9	31.2	46.5	78.6
1b1360	20.7	29.6	40.3	63.3	91.2
899306	7.2	14.5	25.8	47.5	81.3
3ab650	15.0	-	40.0	50.0	85.0
dcf124	18.0	29.0	36.0	52.0	80.0
fc2b3	15.5	15.9	16.6	47.7	75.3
8bbad3	16.1	21.4	31.3	45.9	76.0
5c4e92	17.9	26.8	35.8	51.5	82.8
e0f6cc	13.3	21.2	30.0	49.2	81.8

Table 15: Grubbs' test [%]

Value	0.002 mm	0.005 mm	0.010 mm	0.020 mm	0.050 mm
$G_{min}$	2.255	2.346	2.456	3.021	3.922
$G_{max}$	1.67	1.515	1.82	1.555	0.982
$G_{0.05}$	2.681	2.651	2.681	2.681	2.681
$G_{0.01}$	2.968	2.932	2.968	2.968	2.968

Table 16: Grubbs' test - without outliers [%]

Value	0.002 mm	0.005 mm	0.010 mm	0.020 mm	0.050 mm
$G_{min}$	2.255	2.346	2.456	1.652	1.271
$G_{max}$	1.67	1.515	1.82	1.977	2.372
$G_{0.05}$	2.681	2.651	2.681	2.651	2.651
$G_{0.01}$	2.968	2.932	2.968	2.932	2.932

Table 17: z-score

ID of participant	0.002 mm	0.005 mm	0.010 mm	0.020 mm	0.050 mm
8e4fed	0.11	0.05	0.06	-0.58	-1.24
130a69	1.26	0.91	0.66	0.59	-0.14
f28265	-1.82	-2.02	-1.96	-	-
61f5d3	0.63	0.68	0.65	1.59	2.37
da393e	1.16	0.99	1.82	1.98	1.14
ae69e8	0.52	0.47	-0.12	-0.82	0.73
6af0a4	1.67	1.51	0.97	1.18	0.88
831b65	0.53	0.34	-0.01	-1.36	-0.24
ebadb1	-0.75	-0.44	0.65	-0.25	-0.17
f21137	-2.26	-2.35	-2.46	-1.65	-1.1
db964b	0.25	0.18	-0.08	-0.54	-0.71
1b1360	0.55	0.66	0.61	1.46	1.42
899306	-1.28	-0.87	-0.49	-0.42	-0.25
3ab650	-0.23	-	0.59	-0.12	0.37
dcf124	0.18	0.6	0.28	0.12	-0.47
fc2b3	-0.16	-0.73	-1.19	-0.39	-1.27
8bbad3	-0.08	-0.17	-0.07	-0.61	-1.15
5c4e92	0.17	0.38	0.27	0.06	0.0
e0f6cc	-0.46	-0.19	-0.17	-0.22	-0.17



## 5 Appendix – EN ISO 17892-5 – Incremental loading oedometer test

### 5.1 50 – 100 kPa

#### 5.1.1 Test results

Table 18: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [MPa]	$u_x$ [MPa]
da393e	3.93	-
9b4e48	4.81	0.19
16b837	6.2	0.7
fc2b3	6.29	-
3ab650	6.3	0.2
5555ce	6.34	0.37
47751a	6.4	0.2
8e4fed	7.0	-
899306	7.55	-
128432	9.77	-
8bbad3	9.89	-
f21137	11.94	-

#### 5.1.2 The Numerical Procedure for Determining Outliers

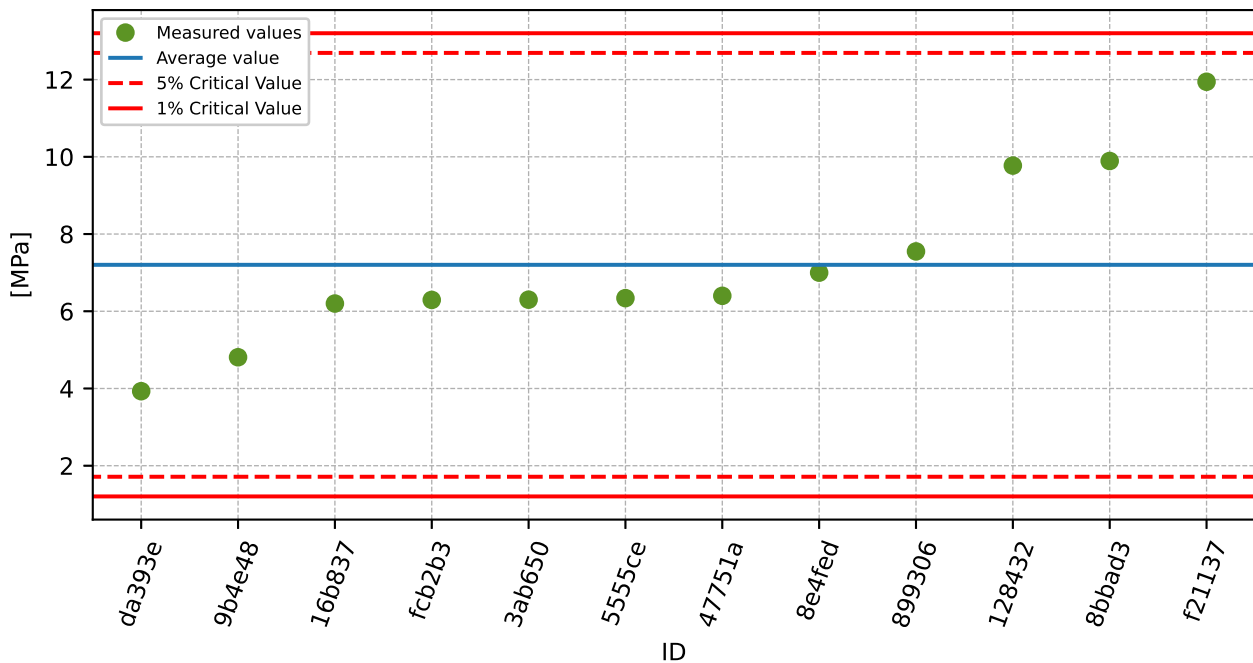


Figure 20: **Grubbs' test** - average values

### 5.1.3 Mandel’s Statistics

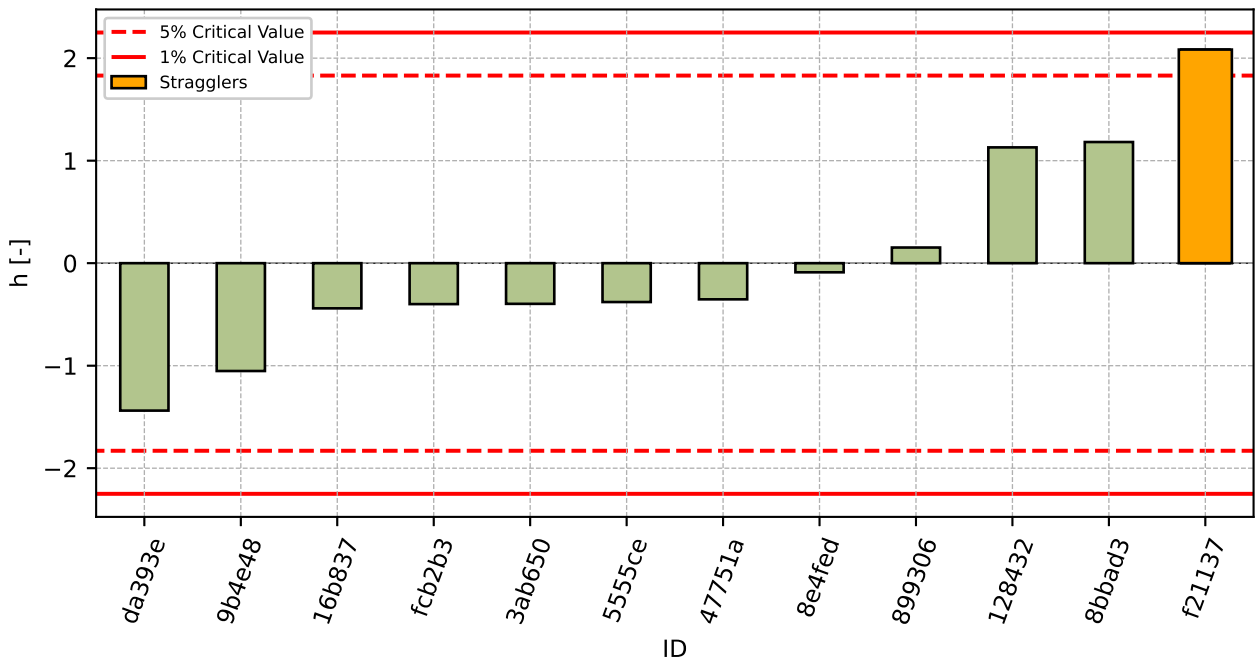


Figure 21: Interlaboratory Consistency Statistic

### 5.1.4 Descriptive statistics

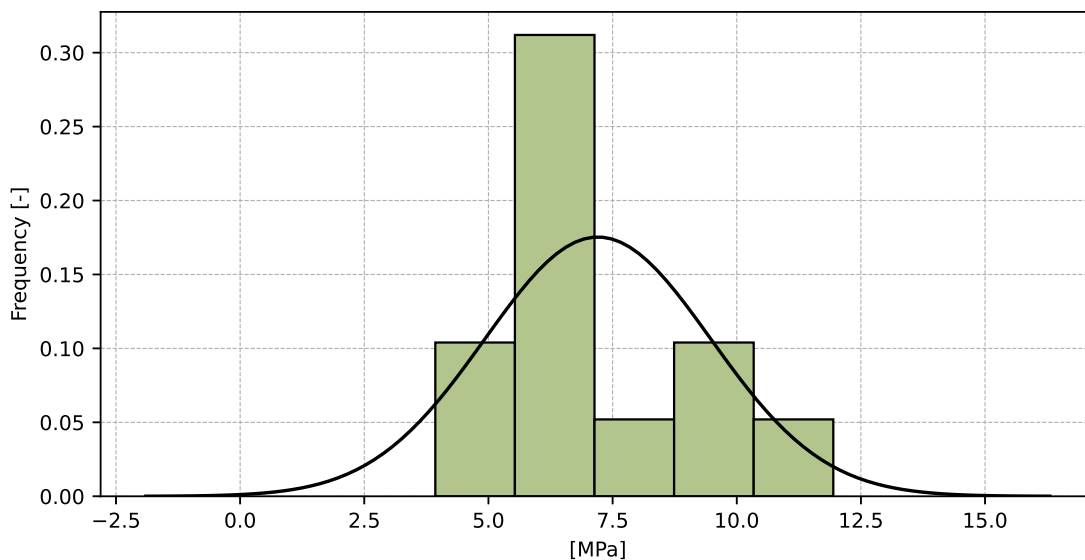


Figure 22: Histogram of all test results

Table 19: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	7.2
Sample standard deviation – $s$	2.275
Assigned value – $x^*$	7.0
Robust standard deviation – $s^*$	2.141
Measurement uncertainty of assigned value – $u_x$	0.773
$p$ -value of normality test	0.187 [-]

### 5.1.5 Evaluation of Performance Statistics

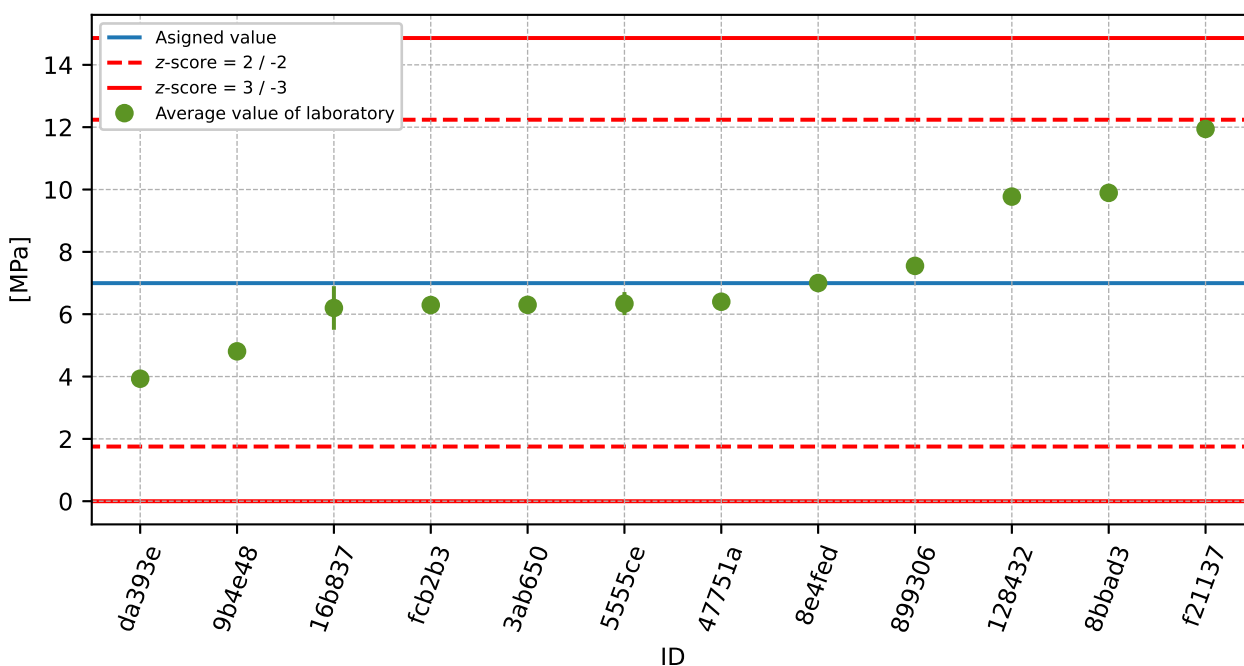


Figure 23: Average values and extended uncertainties of measurement

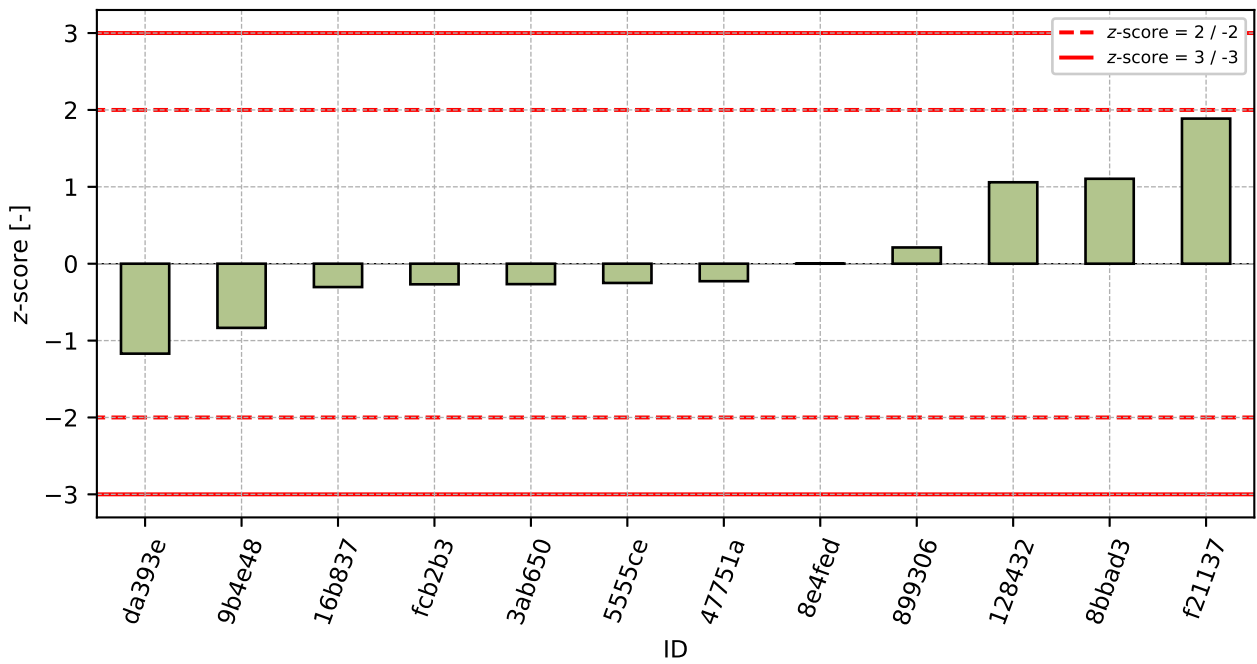


Figure 24: z-score

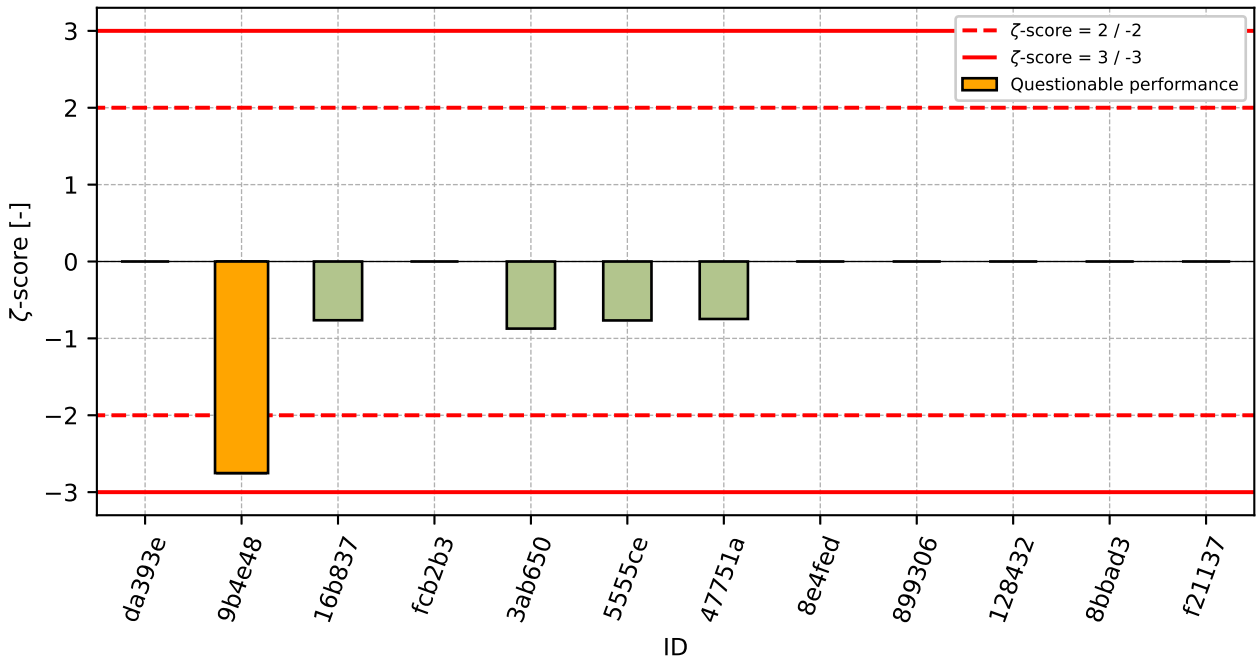


Figure 25: ζ-score

Table 20: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
da393e	-1.17	-
9b4e48	-0.83	-2.75
16b837	-0.3	-0.76
fc2b3	-0.27	-
3ab650	-0.27	-0.87
5555ce	-0.25	-0.77
47751a	-0.23	-0.75
8e4fed	0.0	-
899306	0.21	-
128432	1.06	-
8bbad3	1.1	-
f21137	1.89	-

## 5.2 100 – 200 kPa

### 5.2.1 Test results

Table 21: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [MPa]	$u_x$ [MPa]
da393e	5.16	-
9b4e48	7.1	0.22
3ab650	8.0	0.2
5555ce	8.33	0.44
47751a	8.7	0.2
fc2b3	8.73	-
16b837	8.8	1.1
128432	10.12	-
dcf124	11.0	-
899306	11.69	-
8e4fed	13.0	-
f21137	13.02	-
8bbad3	13.51	-

### 5.2.2 The Numerical Procedure for Determining Outliers

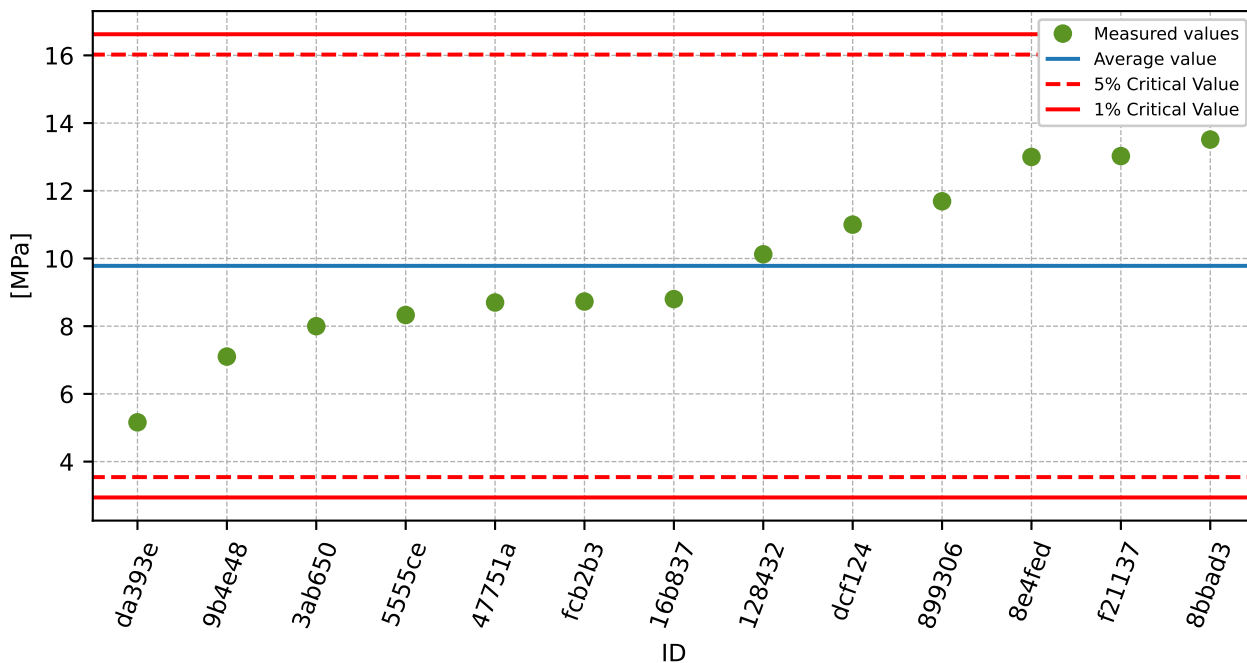


Figure 26: **Grubbs' test** - average values

### 5.2.3 Mandel's Statistics

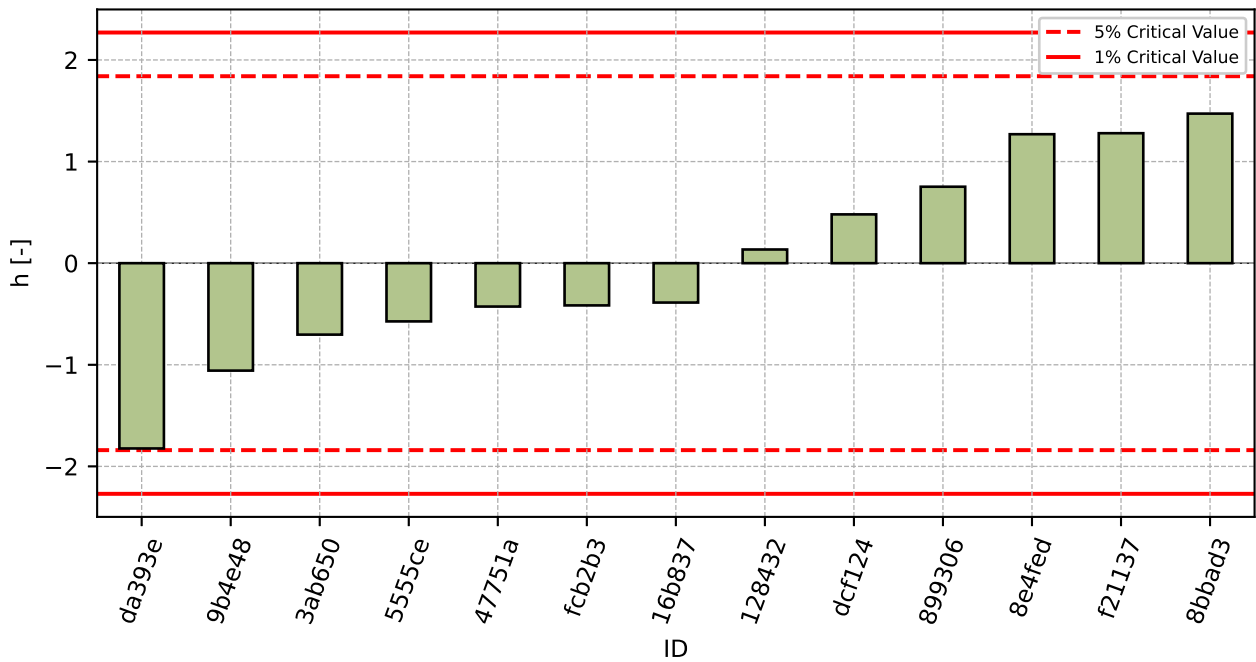


Figure 27: Interlaboratory Consistency Statistic

### 5.2.4 Descriptive statistics

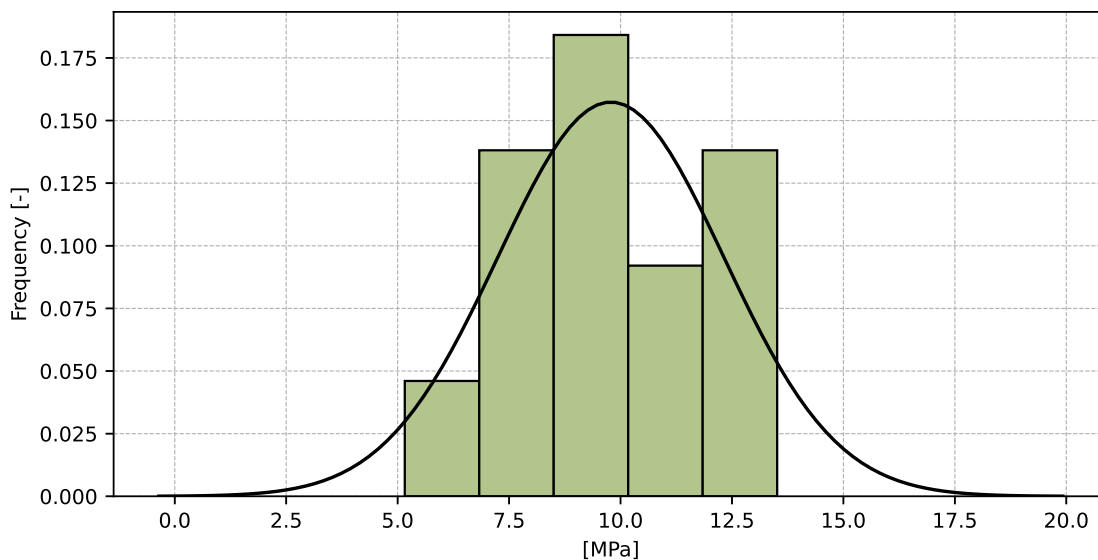


Figure 28: Histogram of all test results

Table 22: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	9.78
Sample standard deviation – $s$	2.535
Assigned value – $x^*$	9.78
Robust standard deviation – $s^*$	3.036
Measurement uncertainty of assigned value – $u_x$	0.879
$p$ -value of normality test	0.579 [-]

### 5.2.5 Evaluation of Performance Statistics

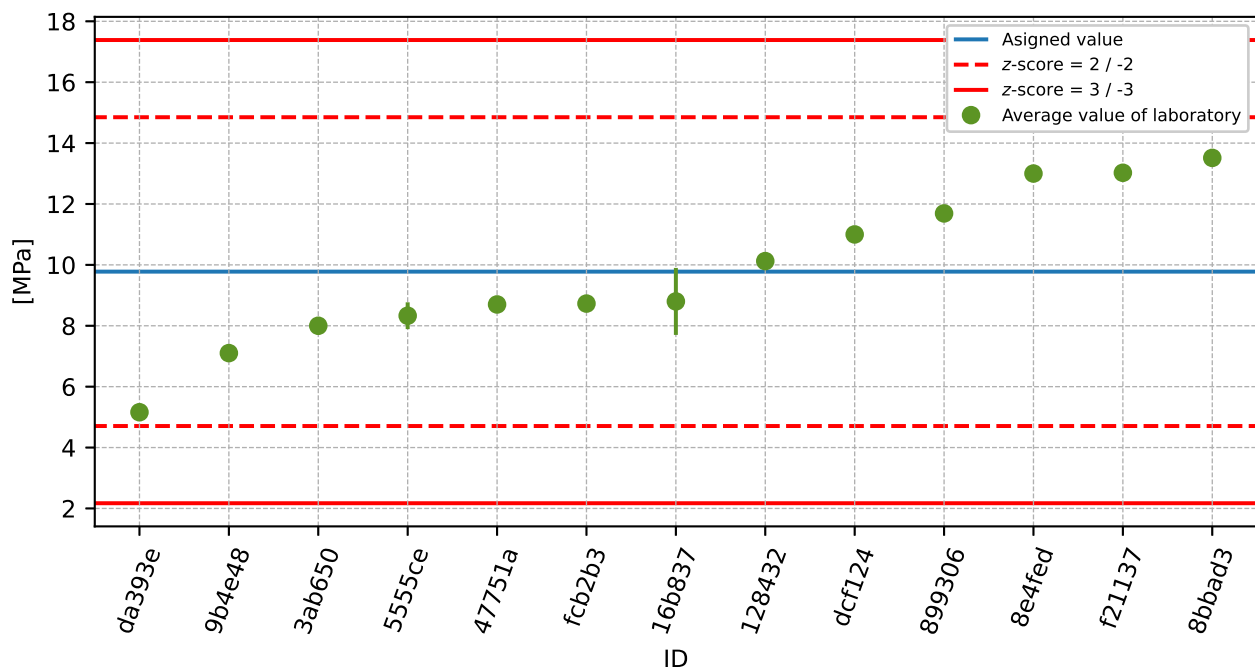


Figure 29: Average values and extended uncertainties of measurement



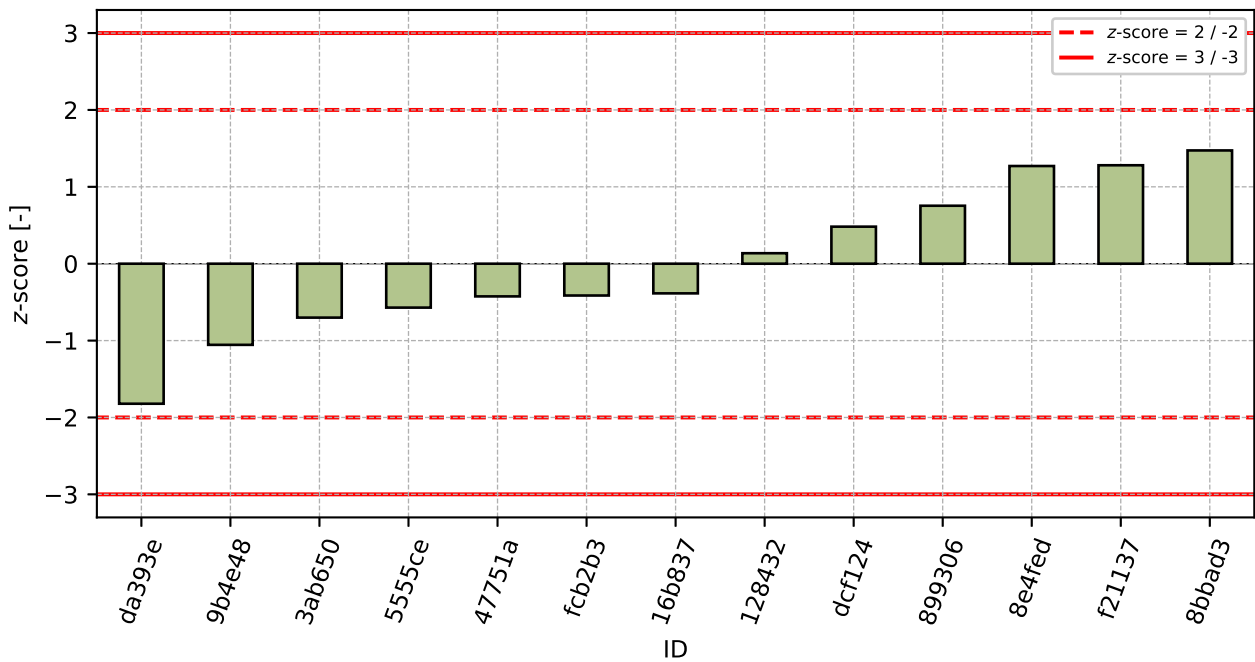


Figure 30: z-score

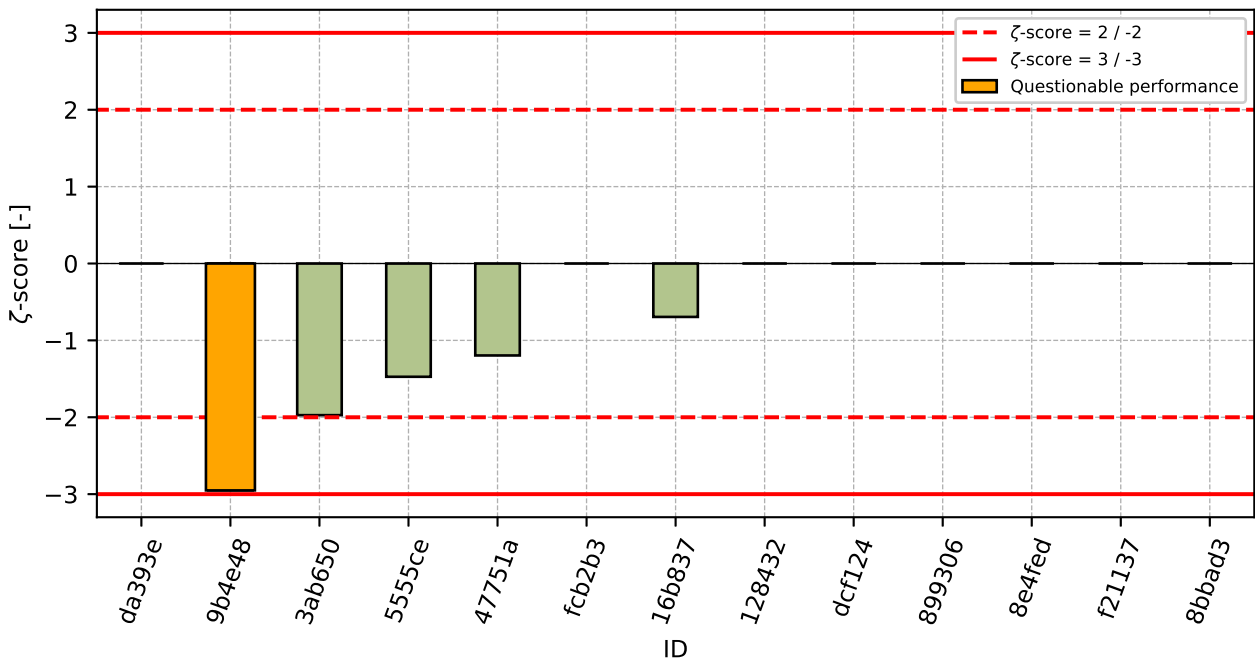


Figure 31: zeta-score

Table 23: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
da393e	-1.82	-
9b4e48	-1.06	-2.95
3ab650	-0.7	-1.97
5555ce	-0.57	-1.47
47751a	-0.43	-1.2
fc2b3	-0.41	-
16b837	-0.39	-0.69
128432	0.14	-
dcf124	0.48	-
899306	0.75	-
8e4fed	1.27	-
f21137	1.28	-
8bbad3	1.47	-

### 5.3 200 – 400 kPa

#### 5.3.1 Test results

Table 24: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [MPa]	$u_x$ [MPa]
da393e	8.43	-
9b4e48	9.44	0.23
fc2b2b3	9.65	-
5555ce	11.14	0.56
47751a	12.8	0.2
16b837	13.0	1.6
3ab650	13.2	0.4
dcf124	14.0	-
128432	15.25	-
8bbad3	16.17	-
8e4fed	16.4	-
899306	17.23	-
f21137	18.24	-

#### 5.3.2 The Numerical Procedure for Determining Outliers

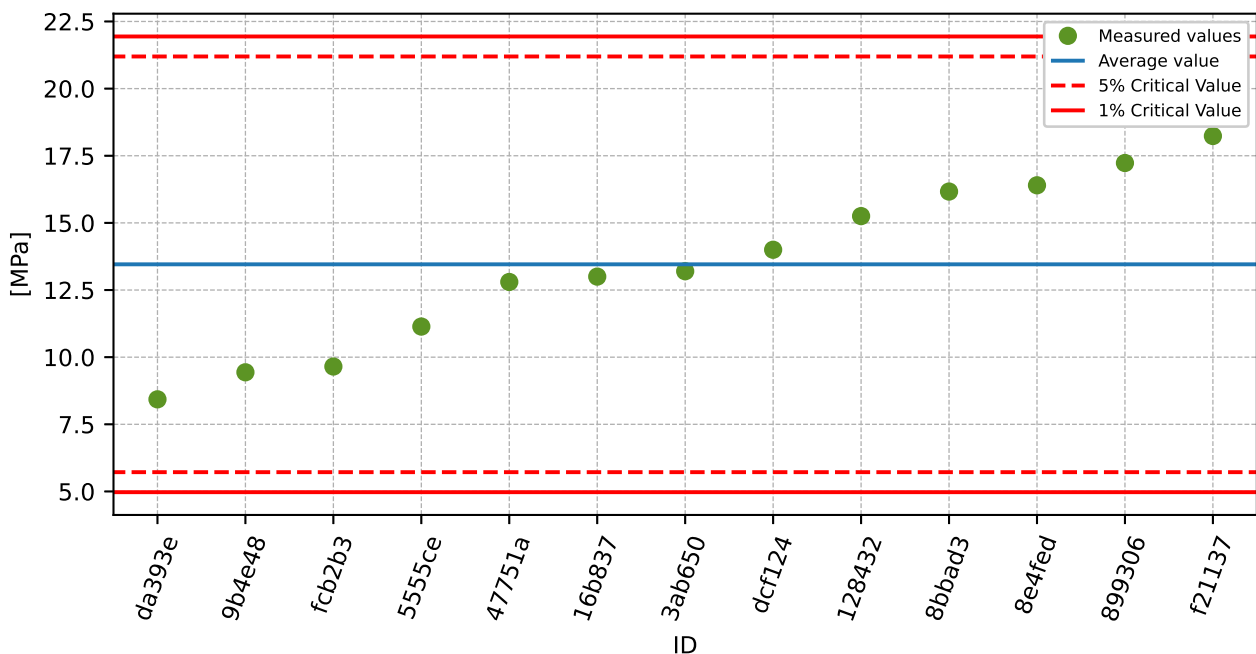


Figure 32: **Grubbs' test** - average values

### 5.3.3 Mandel's Statistics

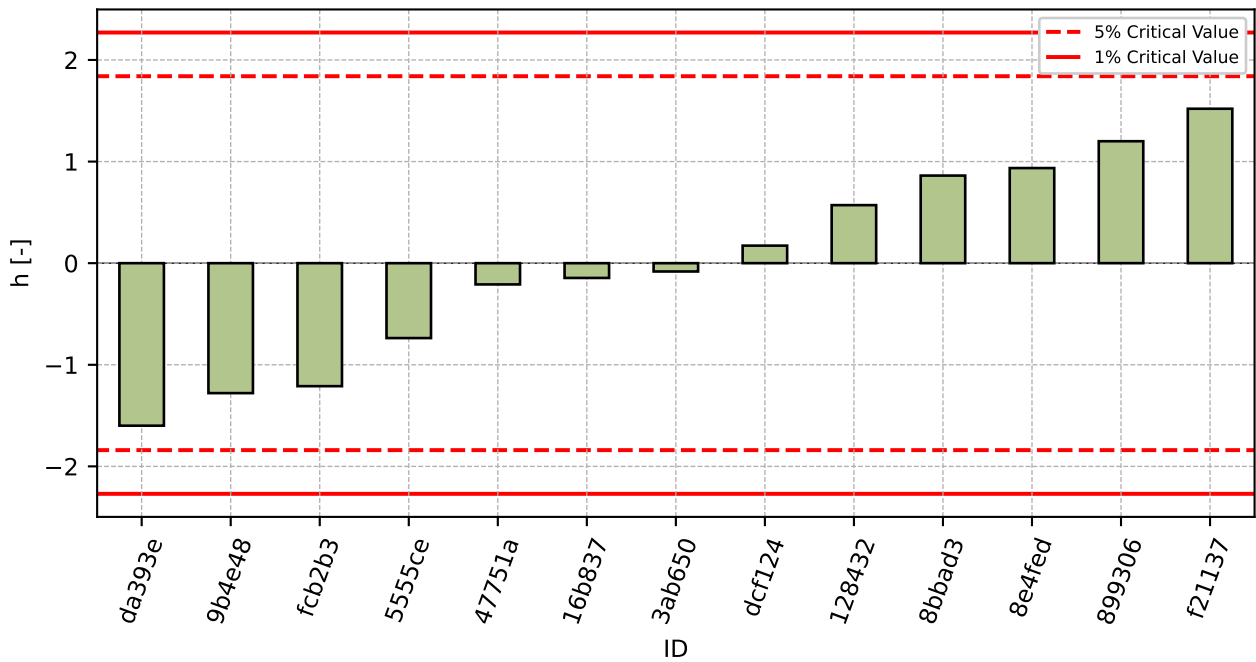


Figure 33: Interlaboratory Consistency Statistic

### 5.3.4 Descriptive statistics

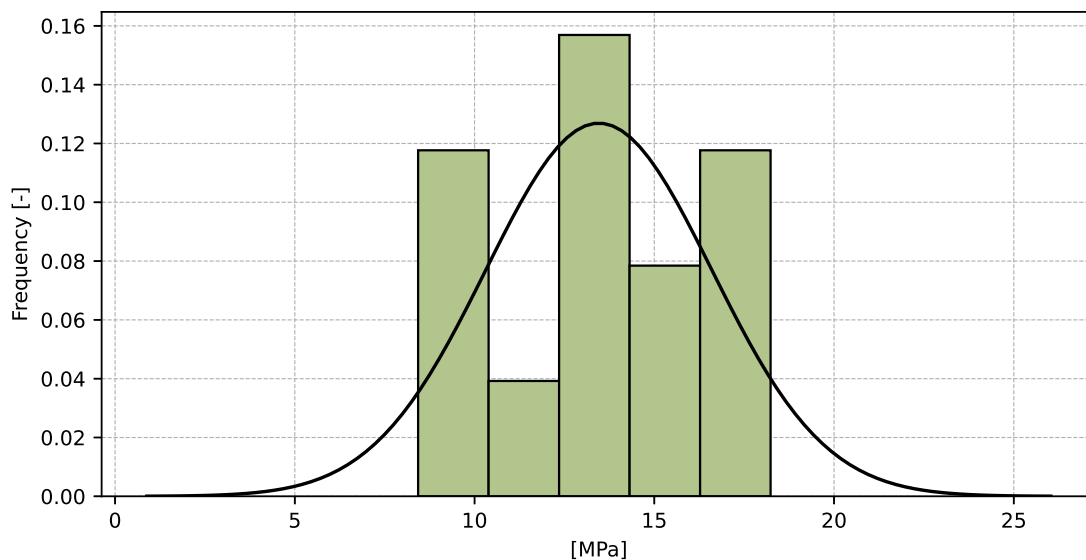


Figure 34: Histogram of all test results

Table 25: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	13.46
Sample standard deviation – $s$	3.143
Assigned value – $x^*$	13.46
Robust standard deviation – $s^*$	3.425
Measurement uncertainty of assigned value – $u_x$	1.187
$p$ -value of normality test	0.712 [-]

### 5.3.5 Evaluation of Performance Statistics

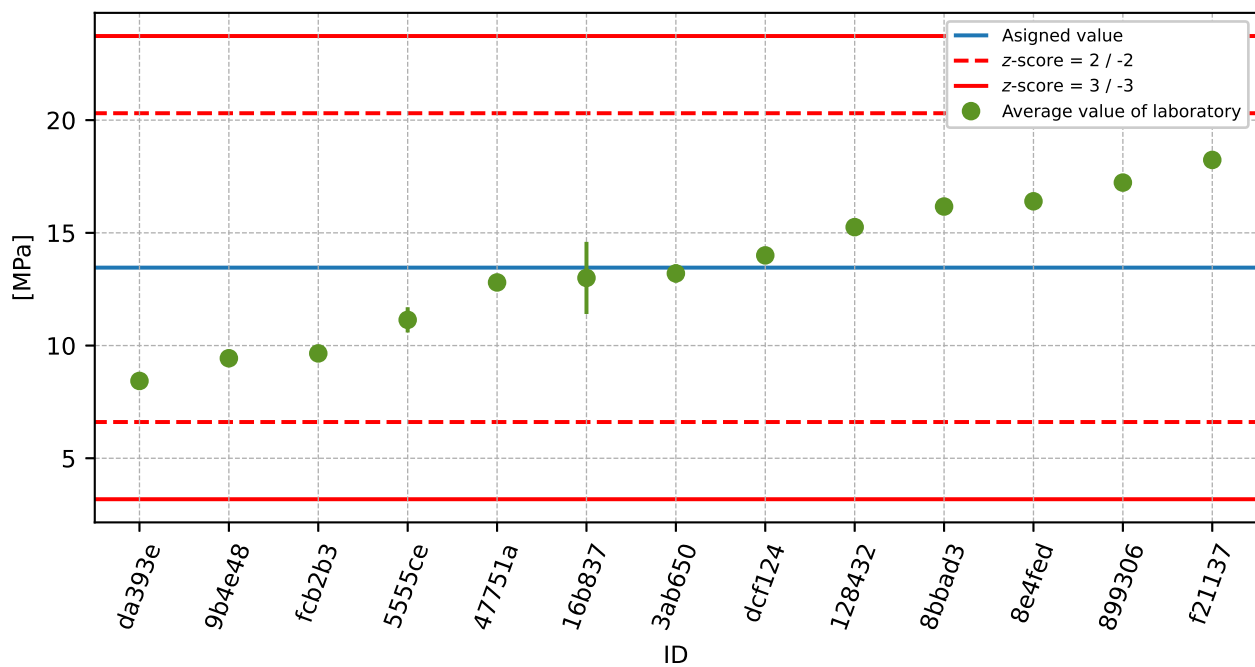


Figure 35: Average values and extended uncertainties of measurement

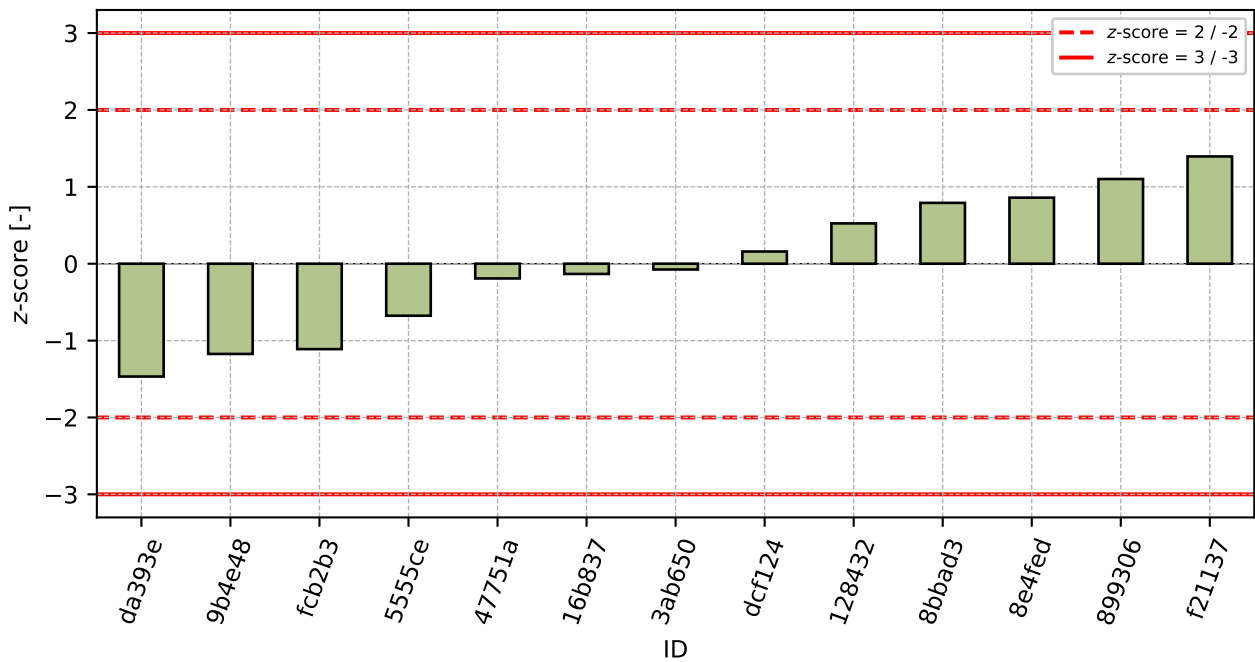


Figure 36: z-score

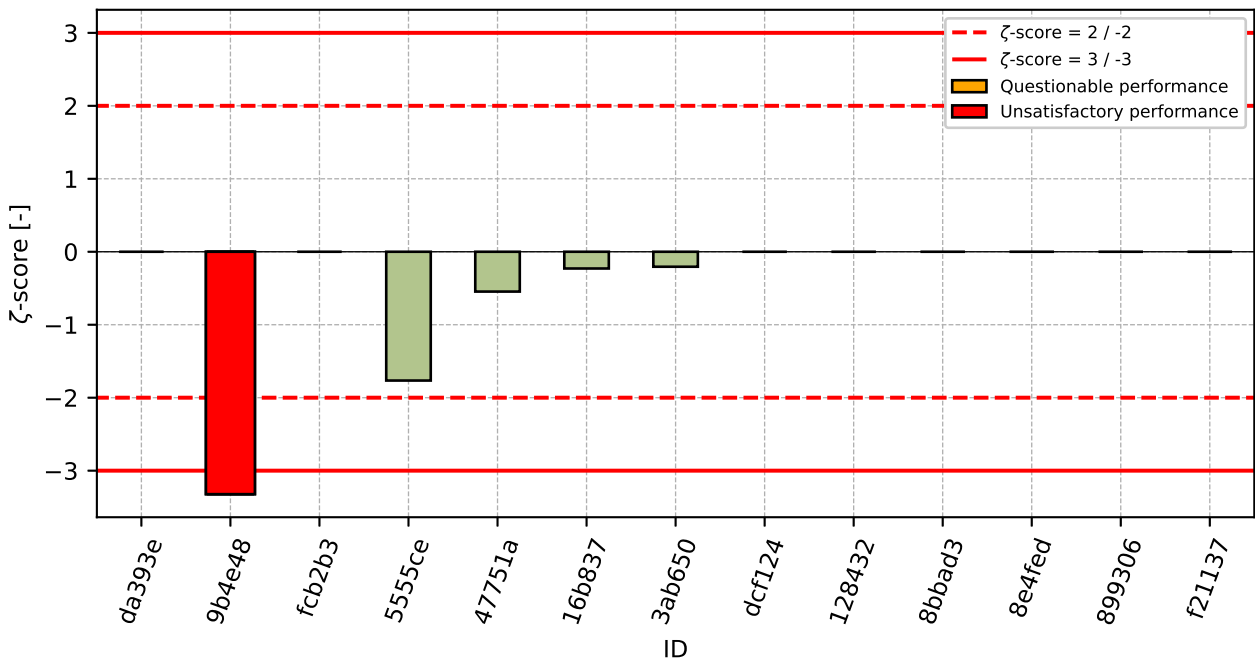


Figure 37: zeta-score

Table 26: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
da393e	-1.47	-
9b4e48	-1.17	-3.32
fc2b2b3	-1.11	-
5555ce	-0.68	-1.77
47751a	-0.19	-0.55
16b837	-0.13	-0.23
3ab650	-0.08	-0.21
dcf124	0.16	-
128432	0.52	-
8bbad3	0.79	-
8e4fed	0.86	-
899306	1.1	-
f21137	1.4	-

## 6 Appendix – EN ISO 17892-7 – Unconfined compressive strength, Strain at failure

### 6.1 Unconfined compressive strength

#### 6.1.1 Test results

Table 27: 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				$u_x$ [MPa]	$\bar{x}$ [MPa]	$s_0$ [MPa]	$V_x$ [%]
	[MPa]							
61f5d3	0.12	0.124	0.135	0.127	0.001	0.126	0.0064	5.02
9b4e48	0.15	0.14	0.151	0.144	0.002	0.146	0.0052	3.55
22d9d4	0.216	0.234	0.183	0.186	-	0.205	0.0245	11.99
da393e	0.21	0.254	0.168	0.206	-	0.21	0.0352	16.8
8e4fed	0.222	0.22	0.186	0.224	-	0.213	0.0178	8.38
3ab650	0.249	0.25	0.255	0.247	0.006	0.25	0.0034	1.36
dcf124	0.253	0.255	0.266	0.243	-	0.254	0.0094	3.71
5555ce	0.3	0.35	0.28	0.32	0.06	0.312	0.0299	9.56
1ecd1c	0.356	0.304	0.315	0.325	-	0.325	0.0224	6.88
c388be	0.32	0.33	0.32	0.34	-	0.328	0.0096	2.92
899306	0.338	0.333	0.34	0.345	-	0.339	0.005	1.47

#### 6.1.2 The Numerical Procedure for Determining Outliers

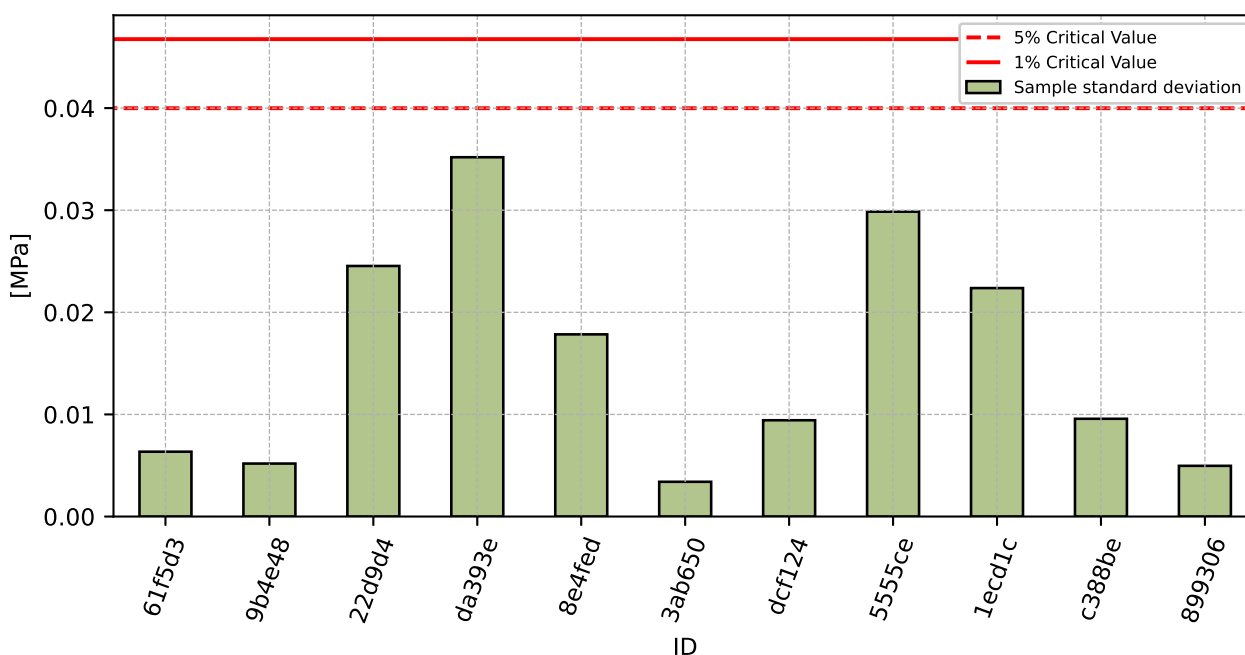


Figure 38: Cochran's test - sample standard deviations



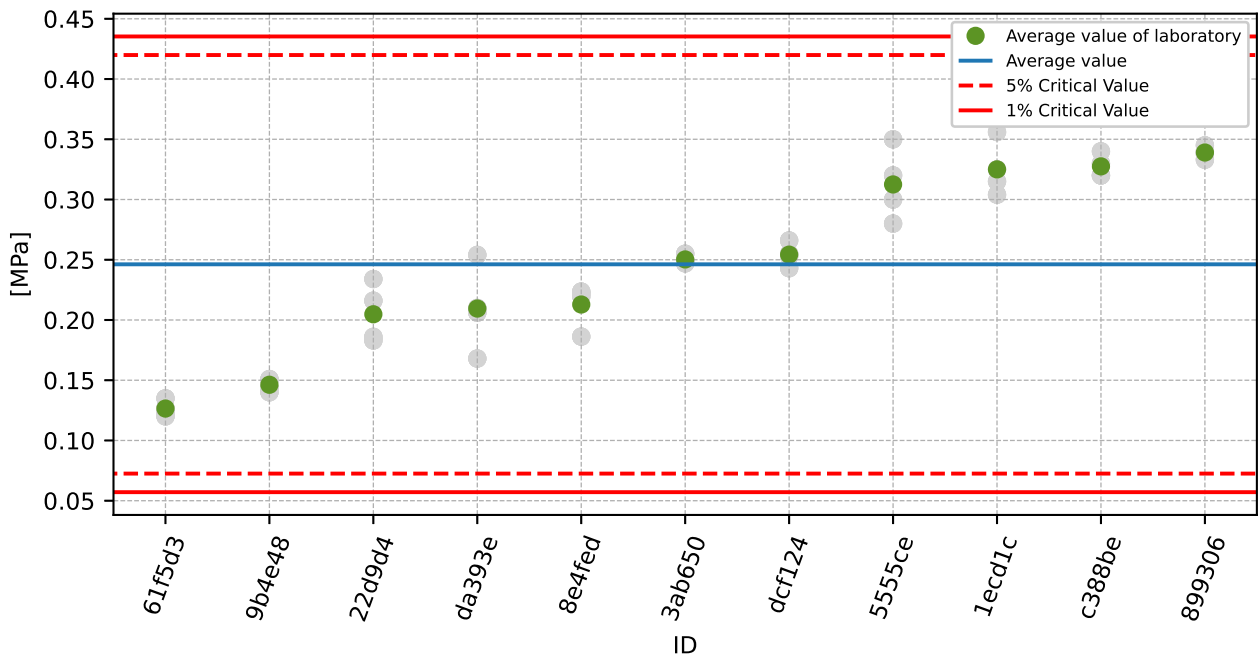


Figure 39: Grubbs' test - average values

### 6.1.3 Mandel's Statistics

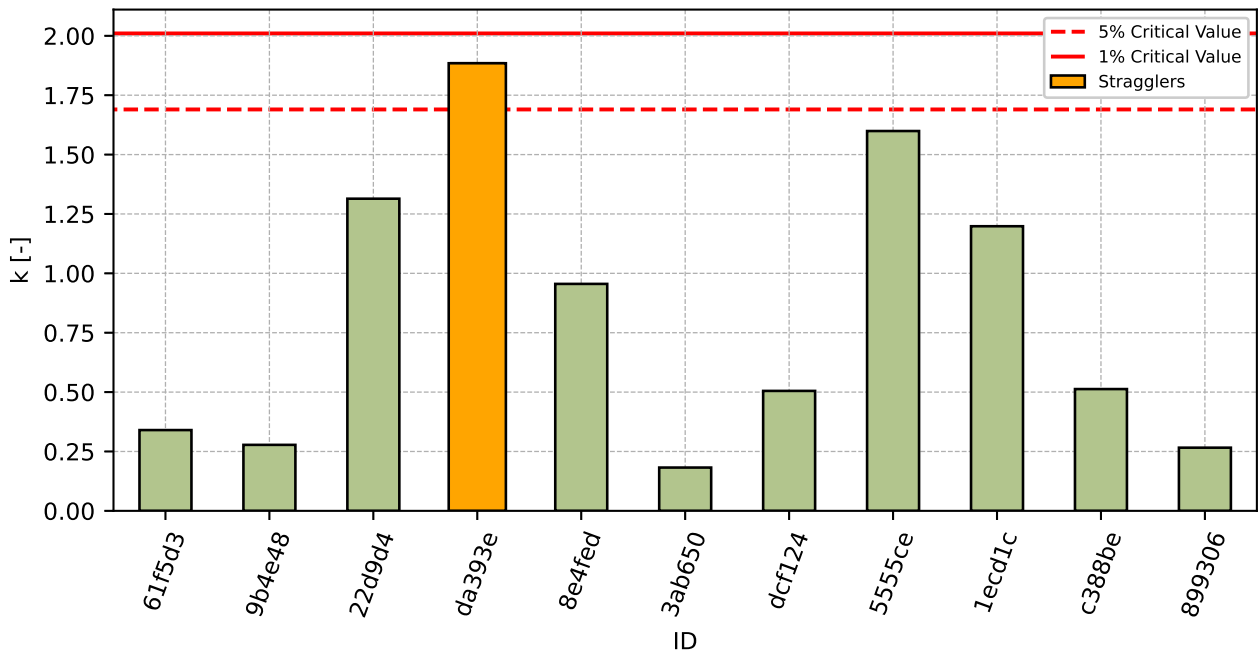


Figure 40: Intralaboratory Consistency Statistic

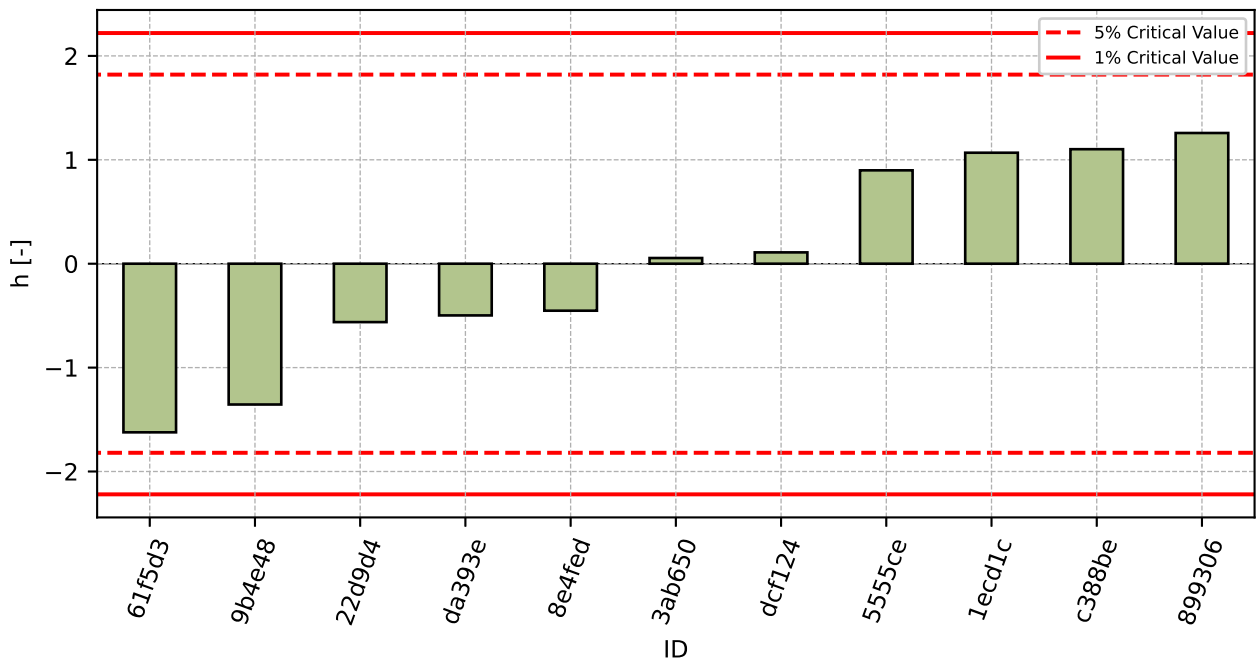


Figure 41: Interlaboratory Consistency Statistic

### 6.1.4 Descriptive statistics

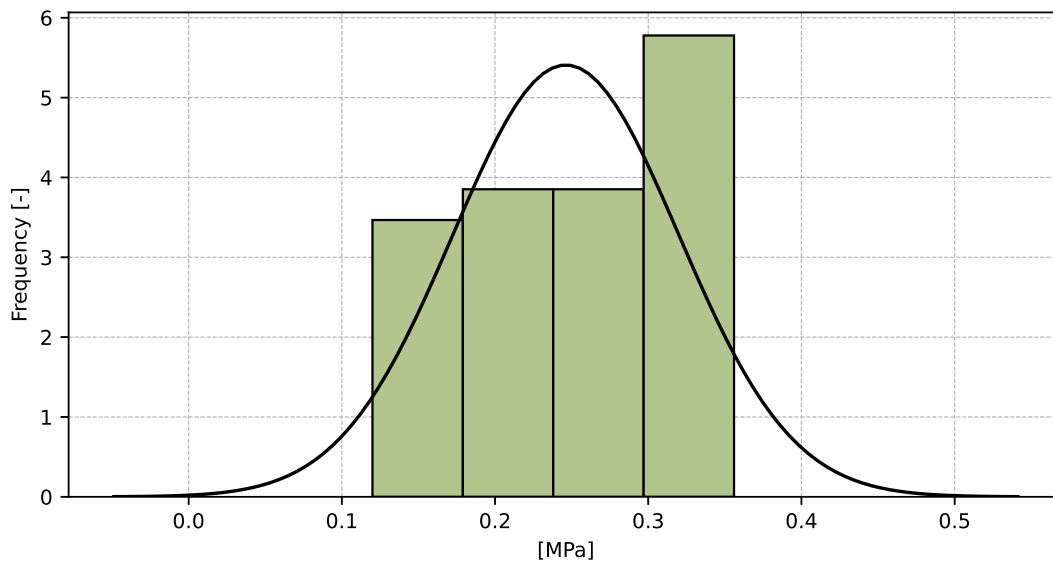


Figure 42: Histogram of all test results

Table 28: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	0.246
Sample standard deviation – $s$	0.0738
Assigned value – $x^*$	0.246
Robust standard deviation – $s^*$	0.0797
Measurement uncertainty of assigned value – $u_X$	0.03
$p$ -value of normality test	0.019 [-]
Interlaboratory standard deviation – $s_L$	0.0732
Repeatability standard deviation – $s_r$	0.0187
Reproducibility standard deviation – $s_R$	0.0755
Repeatability – $r$	0.052
Reproducibility – $R$	0.211

### 6.1.5 Evaluation of Performance Statistics

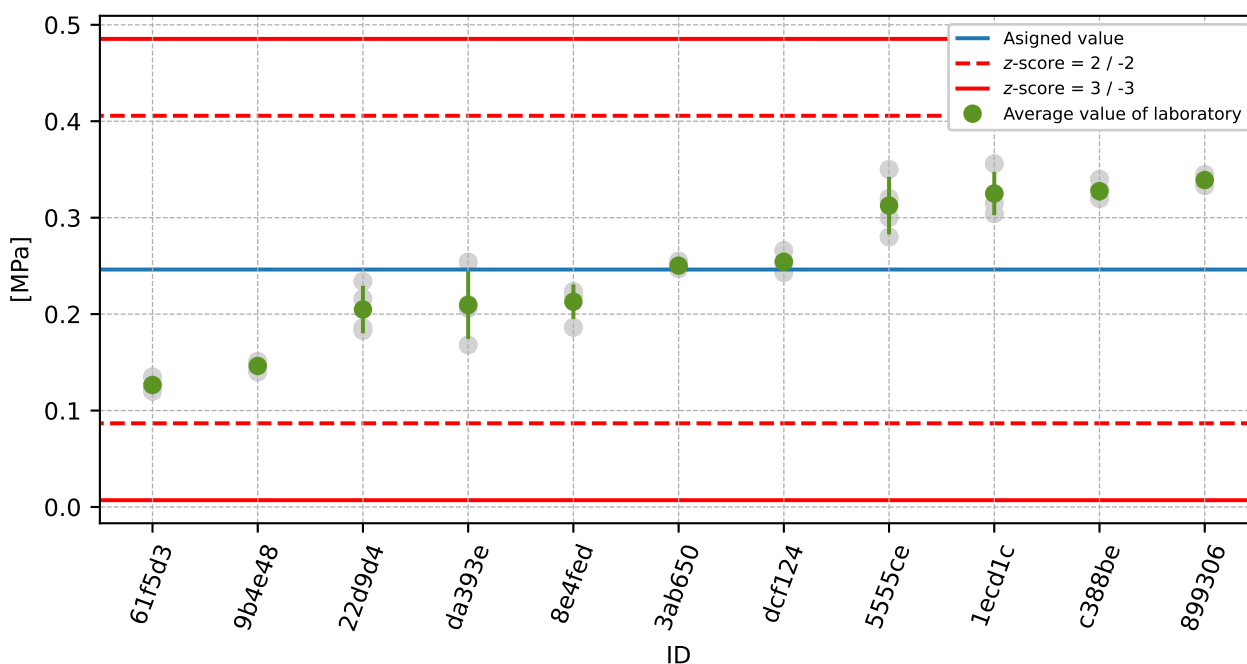


Figure 43: Average values and sample standard deviations

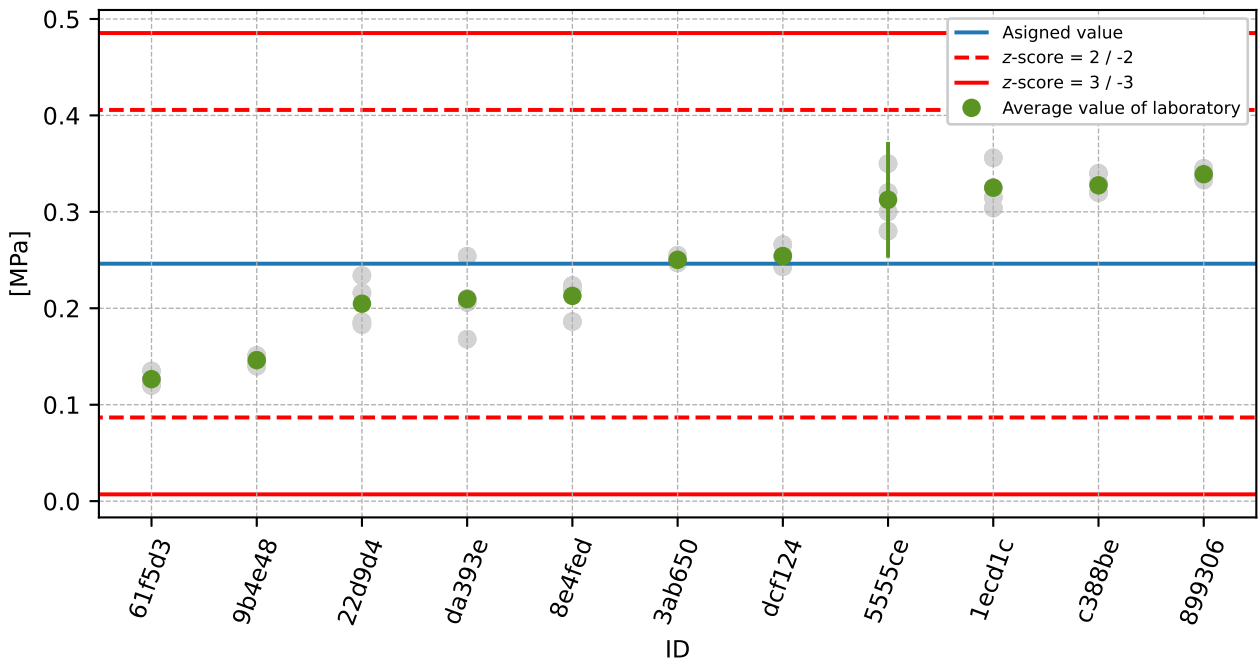


Figure 44: Average values and extended uncertainties of measurement

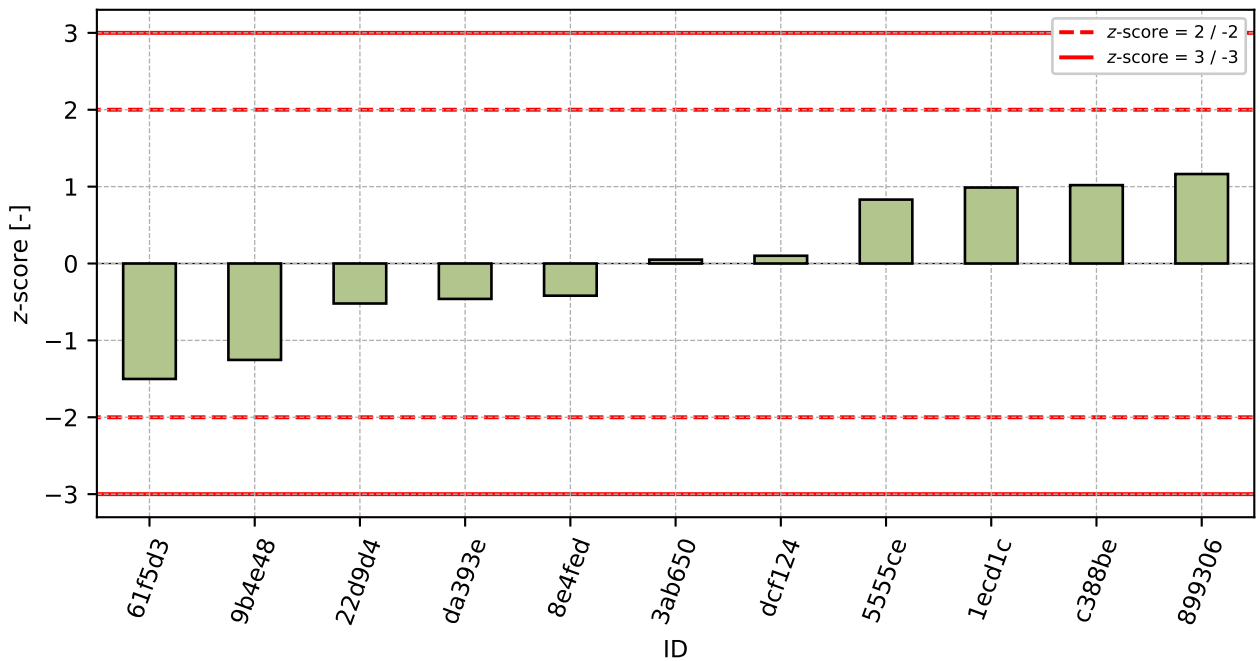


Figure 45: z-score

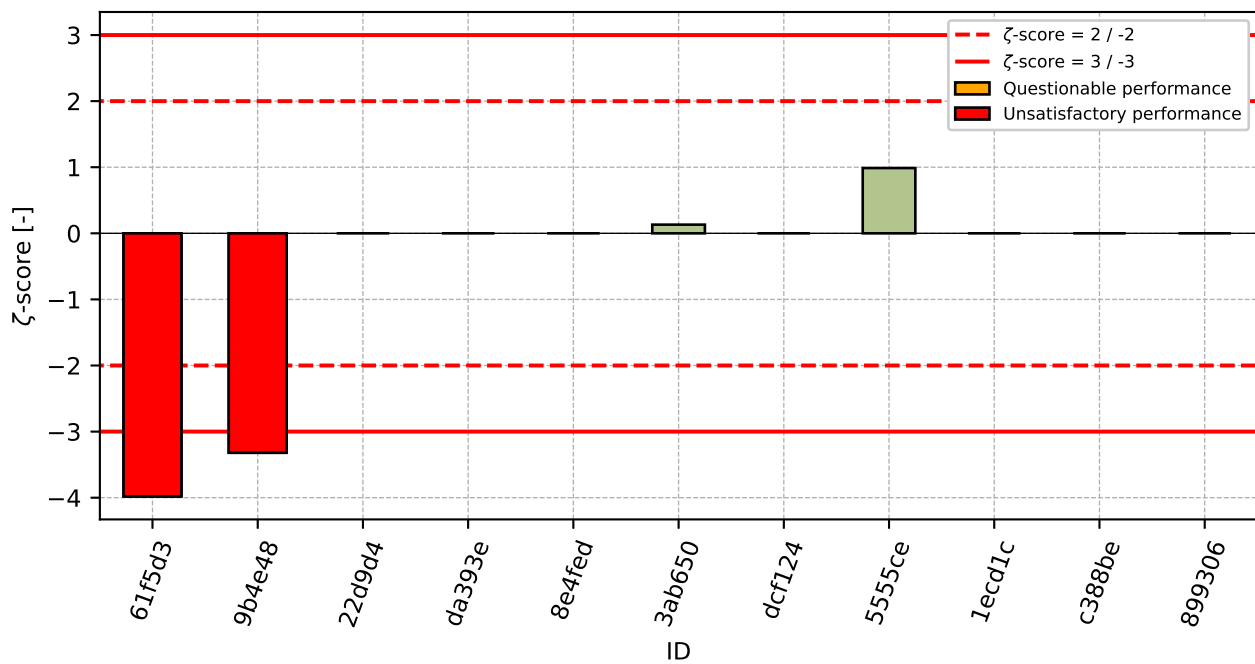


Figure 46: z-score

Table 29: z-score and z-score

ID	z-score [-]	z-score [-]
61f5d3	-1.5	-3.98
9b4e48	-1.25	-3.32
22d9d4	-0.52	-
da393e	-0.46	-
8e4fed	-0.42	-
3ab650	0.05	0.13
dcf124	0.1	-
5555ce	0.83	0.99
1ecd1c	0.99	-
c388be	1.02	-
899306	1.16	-

## 6.2 Strain at failure

### 6.2.1 Test results

Table 30: 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 [%]				$u_X$ [%]	$\bar{x}$ [%]	$s_0$ [%]	$V_X$ [%]
22d9d4	3.7	4.2	4.1	4.2	-	4.0	0.24	5.88
5555ce	4.3	4.3	4.1	4.4	0.2	4.3	0.12	2.89
3ab650	4.3	4.3	4.4	4.5	0.2	4.4	0.1	2.19
dcf124	5.0	3.8	5.2	5.1	-	4.8	0.66	13.72
c388be	5.1	4.9	5.2	5.3	-	5.1	0.17	3.33
8e4fed	6.2	5.2	4.6	5.3	-	5.3	0.66	12.4
899306	6.7	6.3	6.2	6.8	-	6.5	0.29	4.37
da393e	6.4	7.3	6.9	6.8	-	6.8	0.39	5.63
61f5d3	7.3	8.1	9.0	8.5	1.2	8.2	0.72	8.73
1ecd1c	9.0	9.0	9.0	9.0	-	9.0	0.0	0.0
9b4e48	10.1	10.1	10.3	10.9	0.0	10.4	0.39	3.81

### 6.2.2 The Numerical Procedure for Determining Outliers

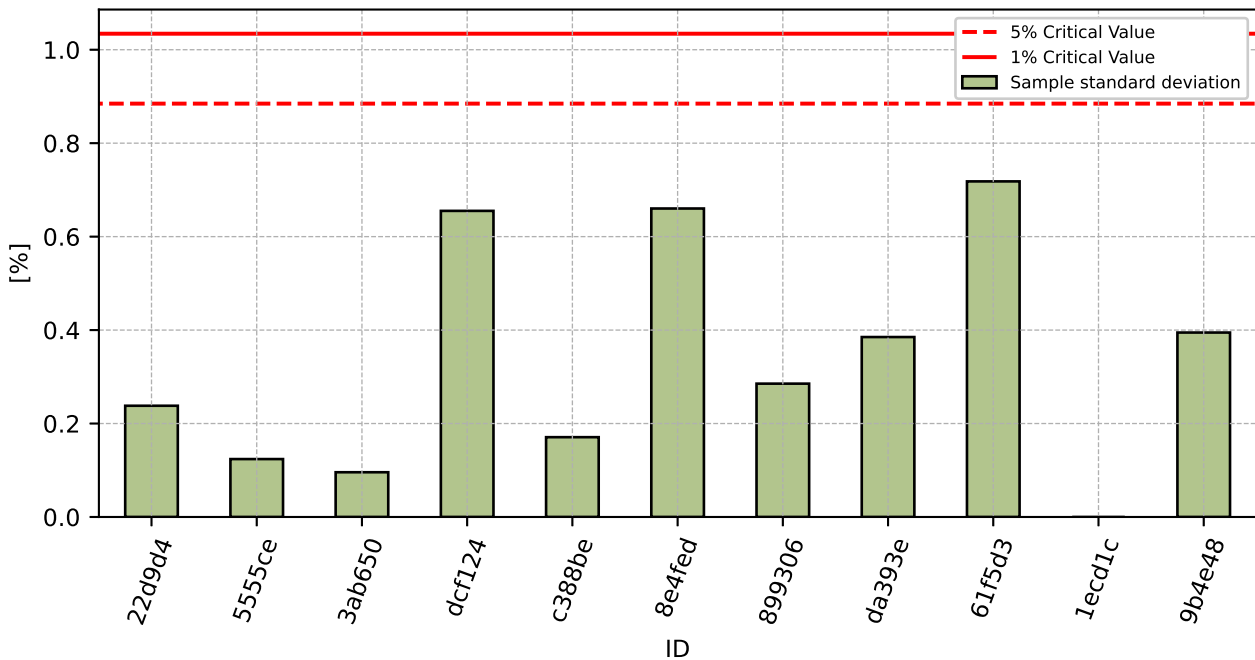


Figure 47: Cochran's test - sample standard deviations

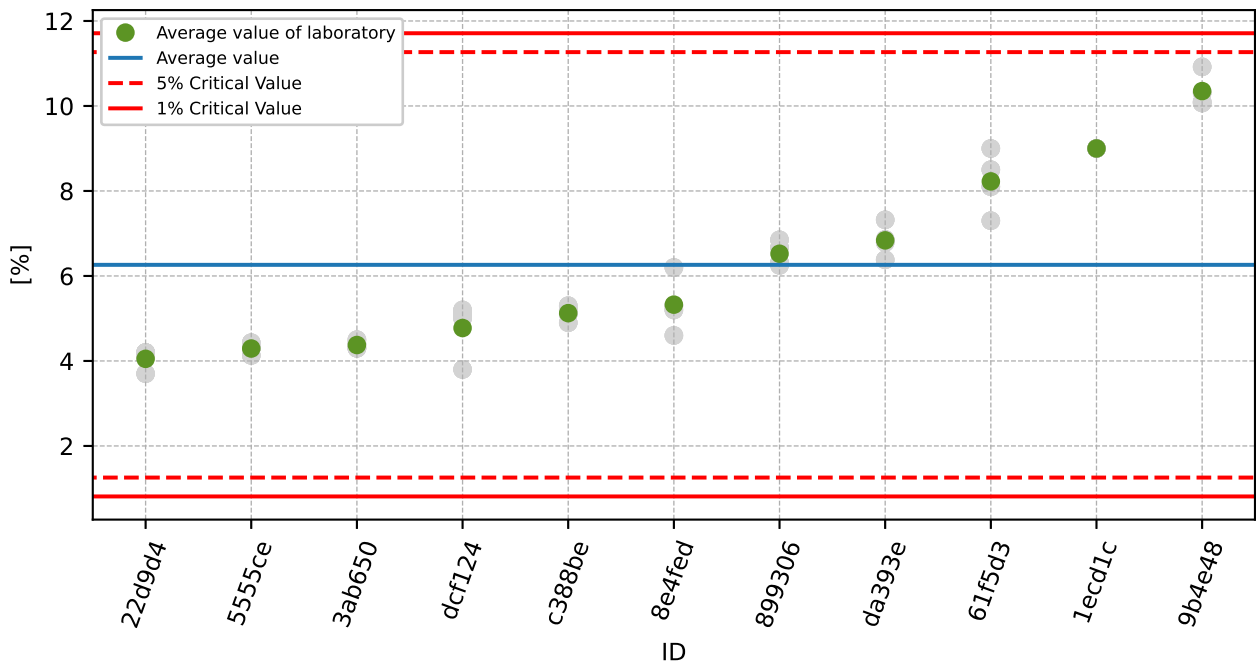


Figure 48: **Grubbs' test** - average values

### 6.2.3 Mandel's Statistics

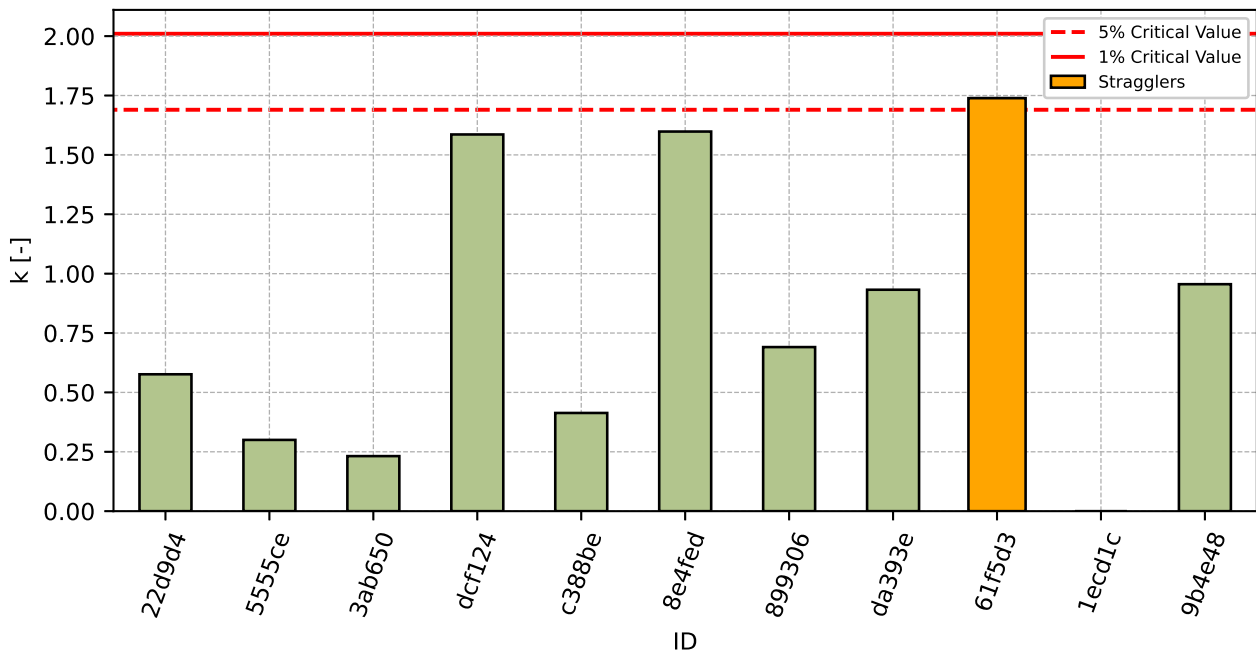


Figure 49: Intralaboratory Consistency Statistic

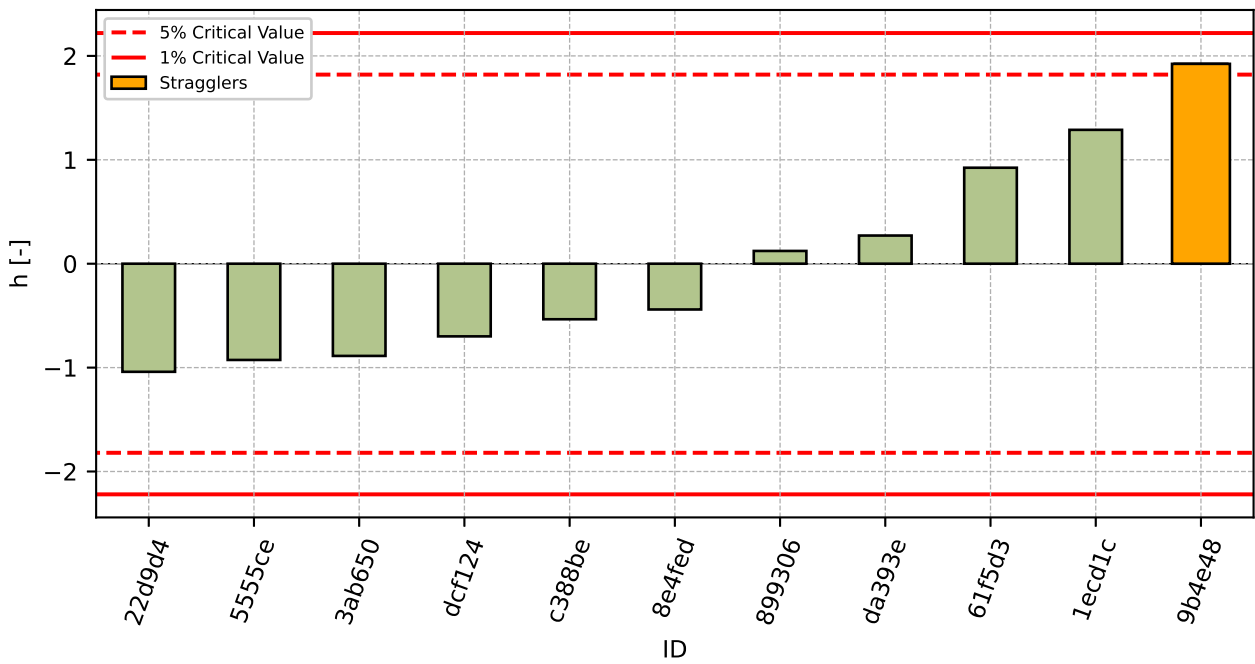


Figure 50: Interlaboratory Consistency Statistic

### 6.2.4 Descriptive statistics

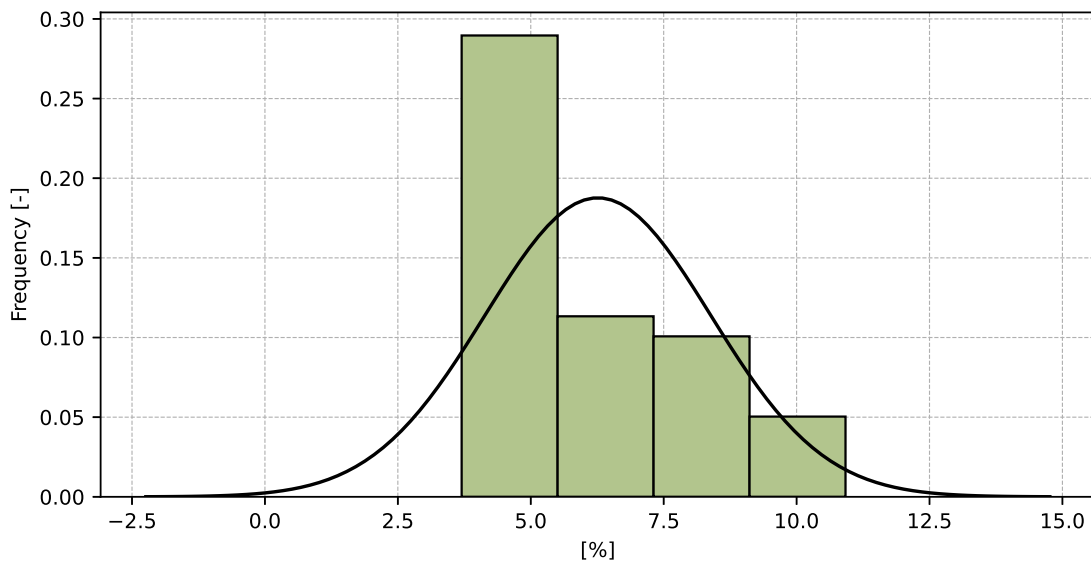


Figure 51: Histogram of all test results



Table 31: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	6.3
Sample standard deviation – $s$	2.13
Assigned value – $x^*$	6.1
Robust standard deviation – $s^*$	2.15
Measurement uncertainty of assigned value – $u_X$	0.81
$p$ -value of normality test	0.001 [-]
Interlaboratory standard deviation – $s_L$	2.12
Repeatability standard deviation – $s_r$	0.41
Reproducibility standard deviation – $s_R$	2.16
Repeatability – $r$	1.2
Reproducibility – $R$	6.0

### 6.2.5 Evaluation of Performance Statistics

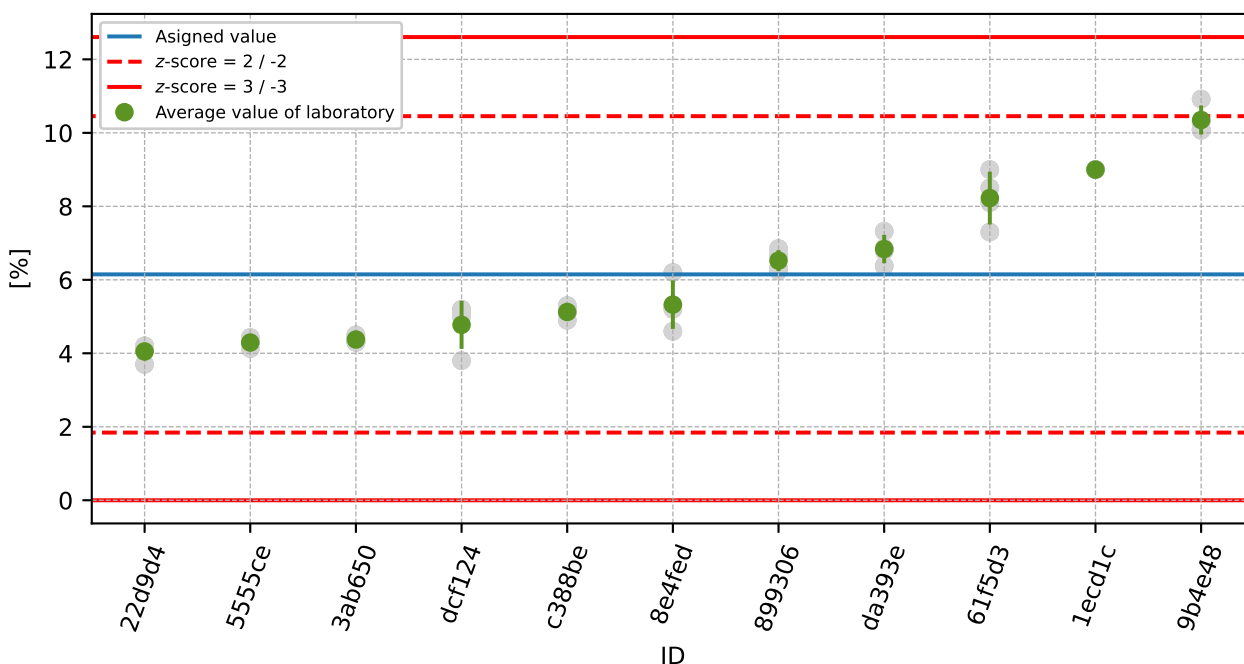


Figure 52: Average values and sample standard deviations

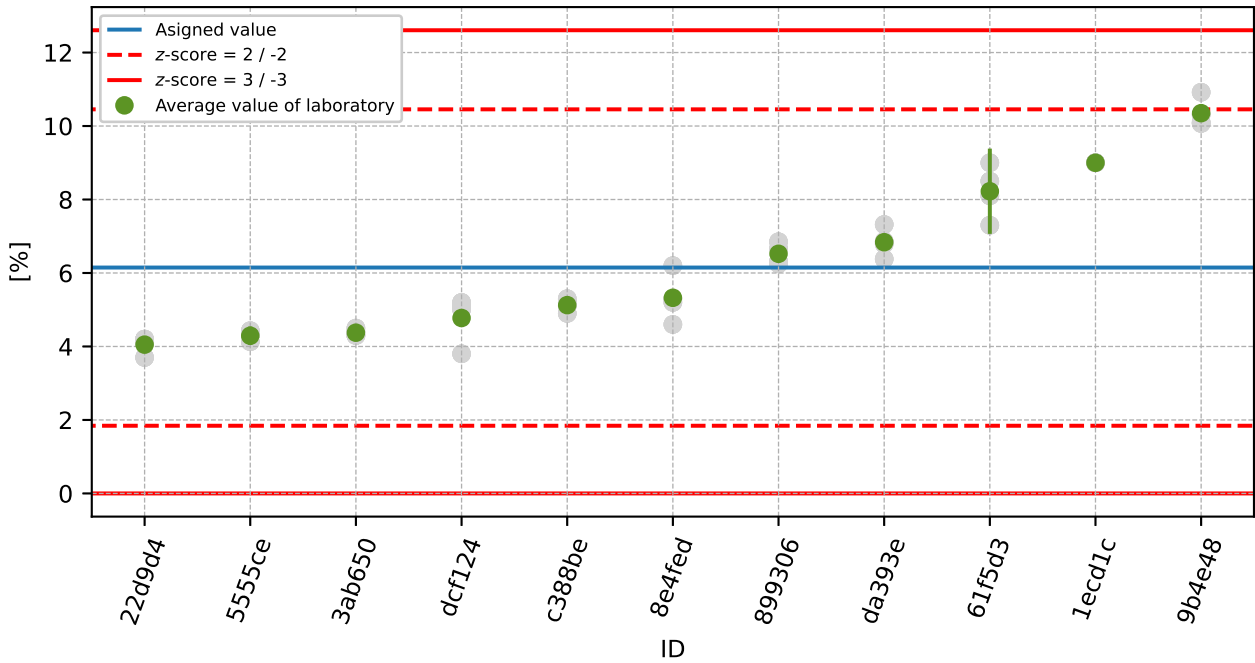


Figure 53: Average values and extended uncertainties of measurement

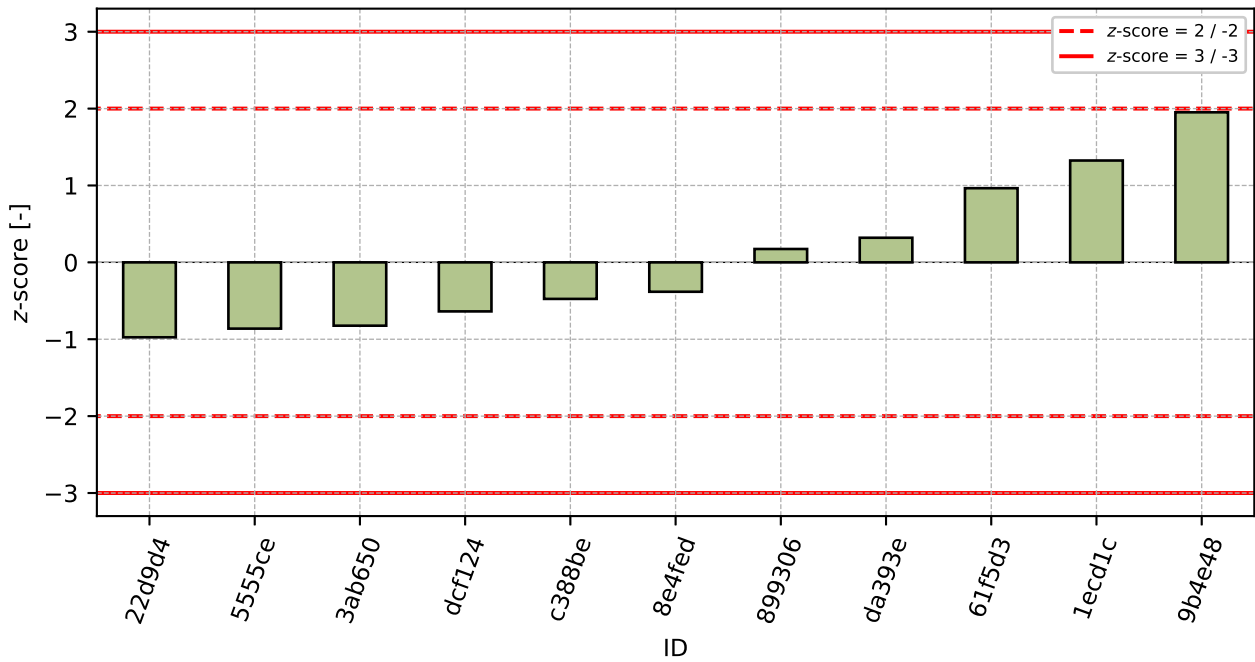


Figure 54: z-score

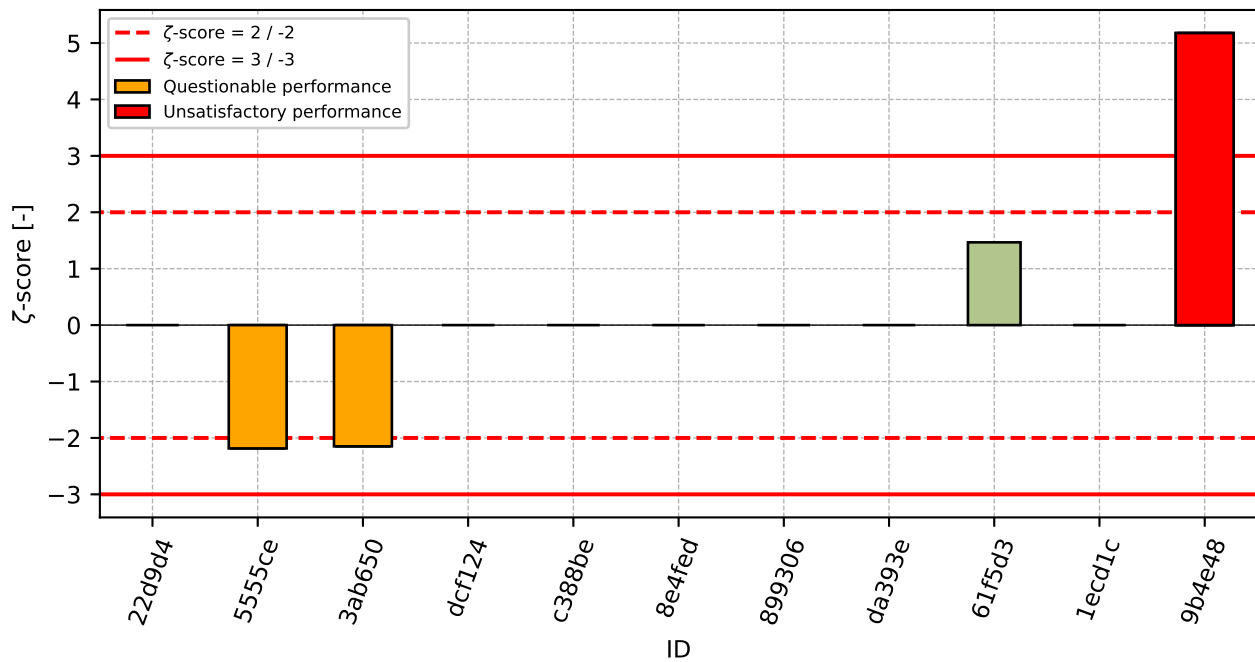


Figure 55: ζ-score

Table 32: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
22d9d4	-0.97	-
5555ce	-0.86	-2.19
3ab650	-0.82	-2.15
dcf124	-0.64	-
c388be	-0.48	-
8e4fed	-0.38	-
899306	0.17	-
da393e	0.32	-
61f5d3	0.96	1.47
1ecd1c	1.32	-
9b4e48	1.95	5.18

## 7 Appendix – CEN ISO/TS 17892-10 – Effective shear parameters

### 7.1 50 kPa

#### 7.1.1 Test results

Table 33: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [kPa]	$u_x$ [kPa]
8bbad3	22.0	-
da393e	24.0	-
5555ce	35.6	5.0
3ab650	37.5	0.3
899306	44.0	-
642748	46.0	8.0
8e4fed	47.9	-
1ecd1c	48.5	-
128432	50.0	-

#### 7.1.2 The Numerical Procedure for Determining Outliers

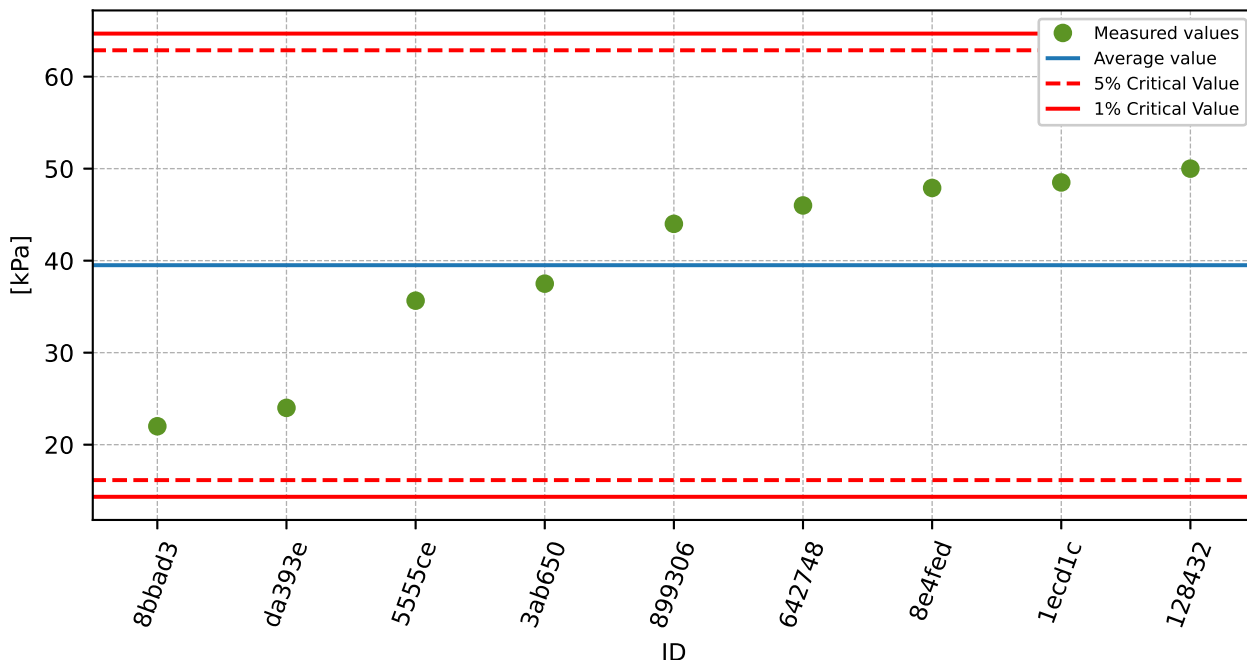


Figure 56: **Grubbs' test** - average values

### 7.1.3 Mandel’s Statistics

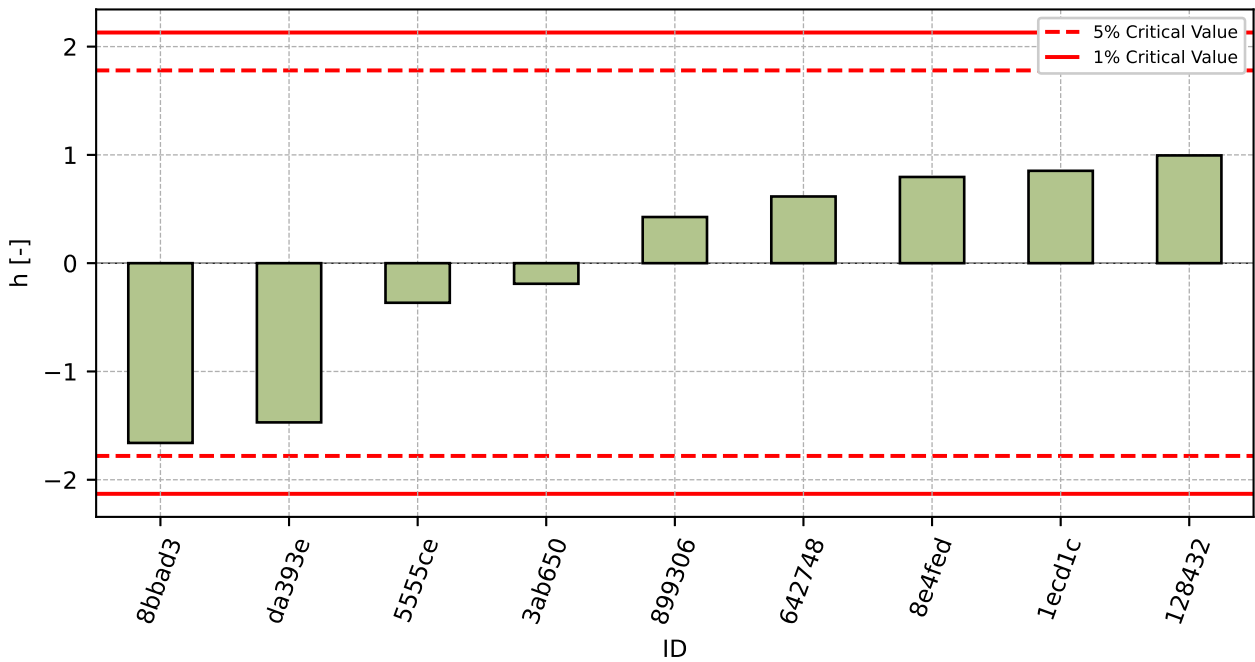


Figure 57: Interlaboratory Consistency Statistic

### 7.1.4 Descriptive statistics

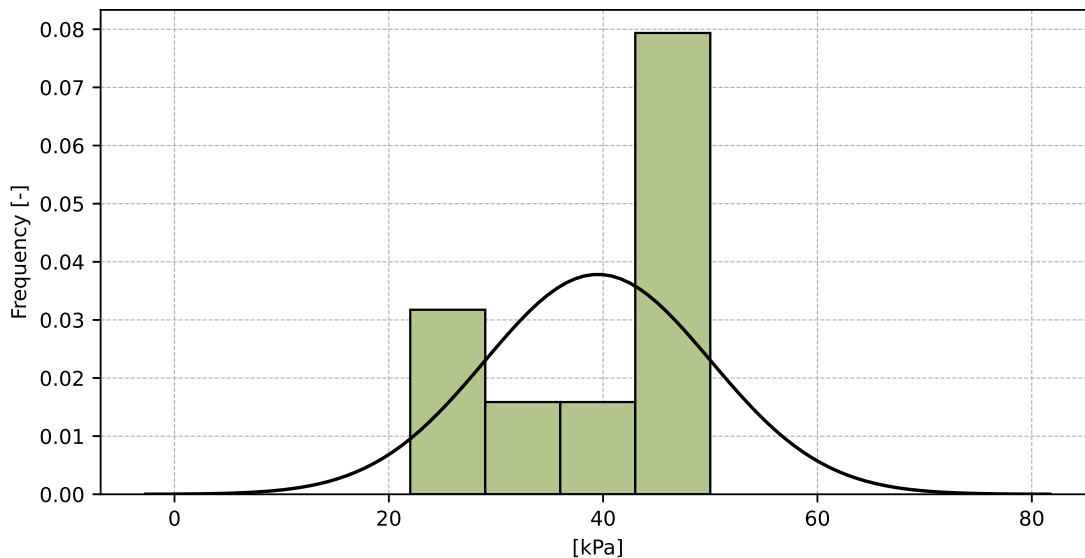


Figure 58: Histogram of all test results

Table 34: Descriptive statistics

Characteristics	[kPa]
Average value – $\bar{x}$	39.5
Sample standard deviation – $s$	10.55
Assigned value – $x^*$	39.5
Robust standard deviation – $s^*$	10.55
Measurement uncertainty of assigned value – $u_x$	3.52
$p$ -value of normality test	0.096 [-]

### 7.1.5 Evaluation of Performance Statistics

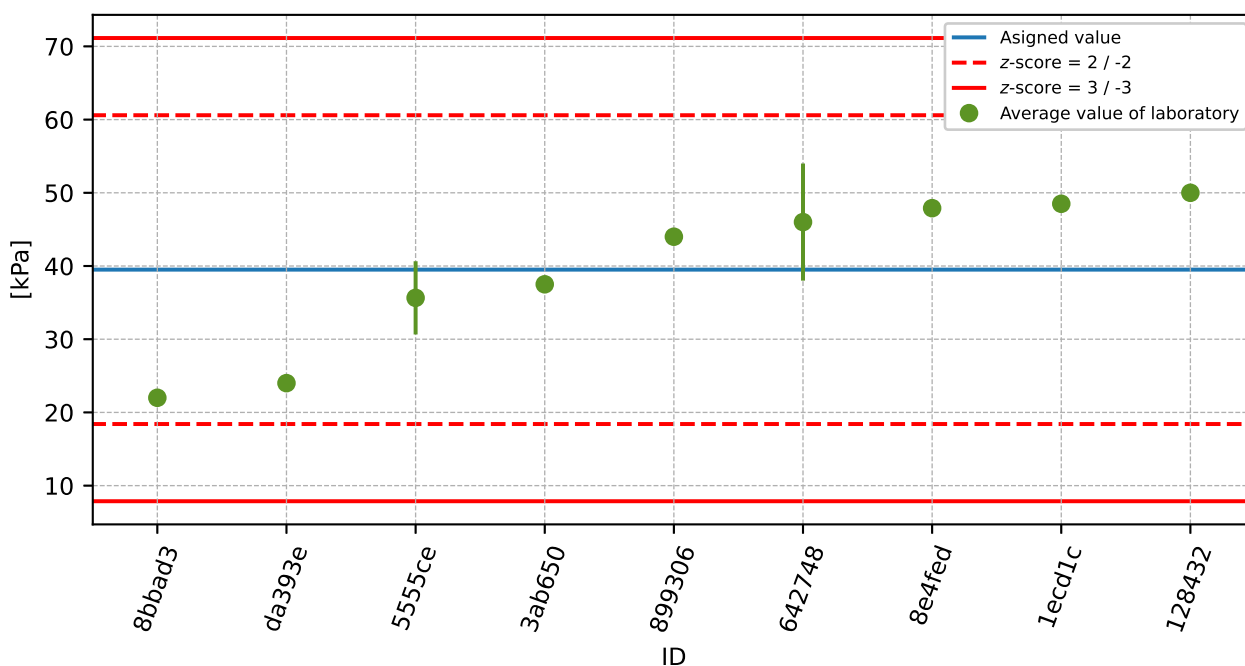


Figure 59: Average values and extended uncertainties of measurement

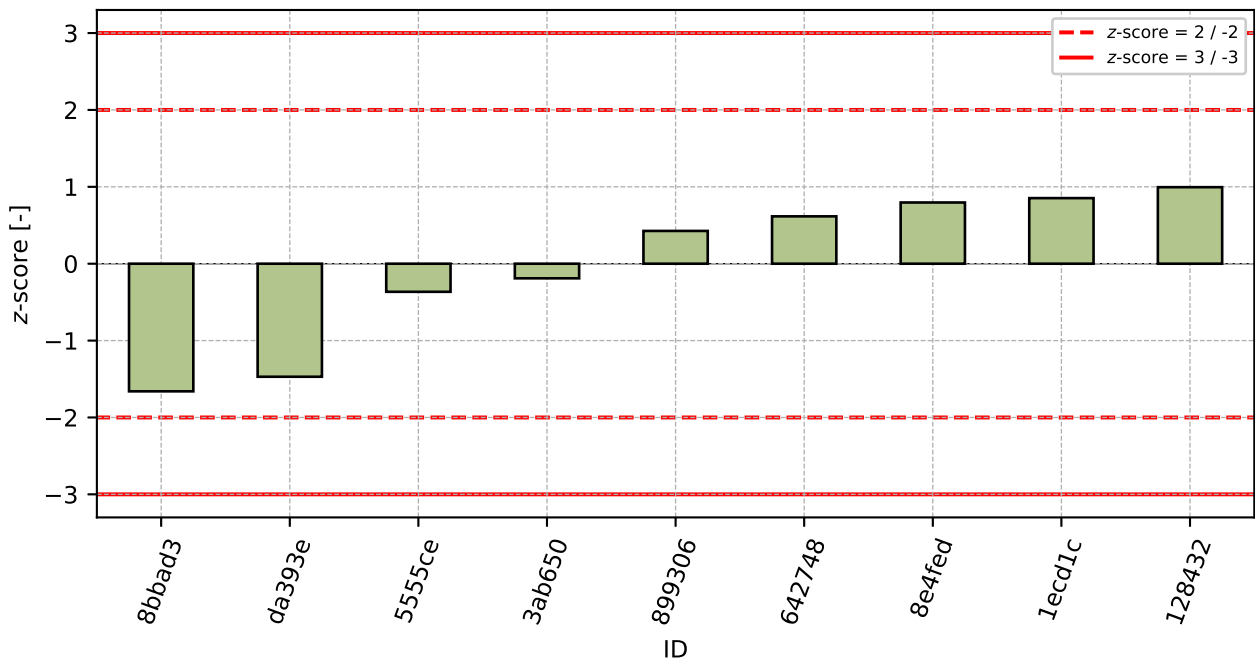


Figure 60: z-score

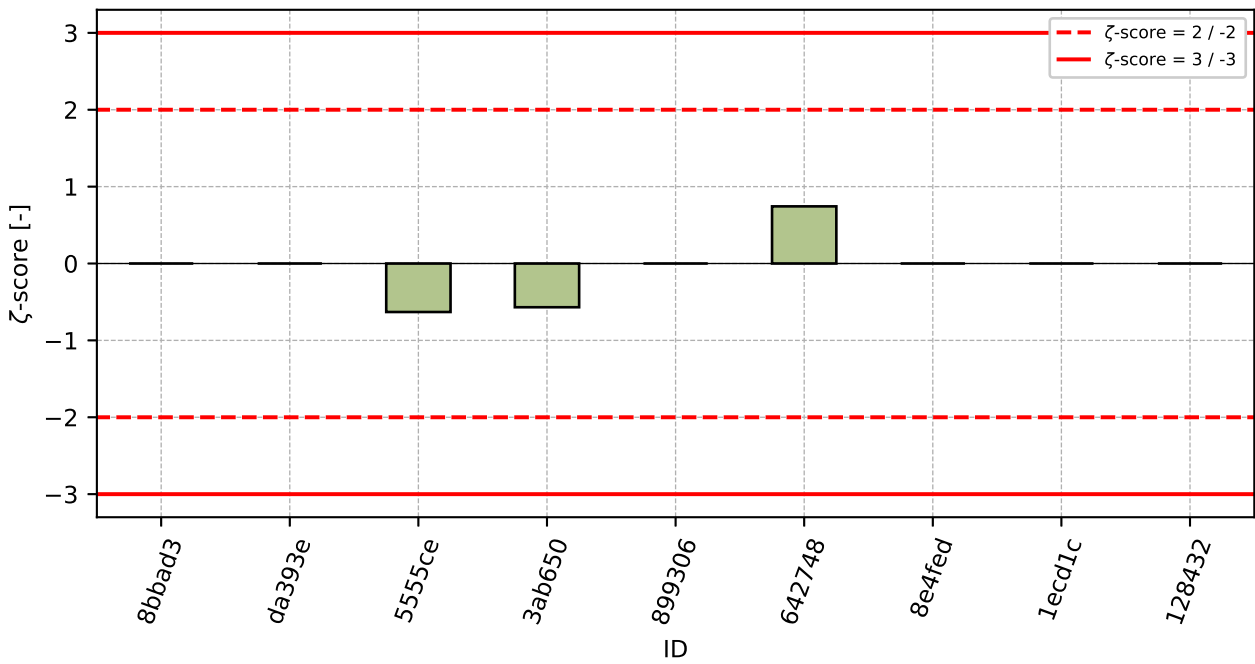


Figure 61: zeta-score

Table 35: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
8bbad3	-1.66	-
da393e	-1.47	-
5555ce	-0.37	-0.63
3ab650	-0.19	-0.57
899306	0.43	-
642748	0.62	0.74
8e4fed	0.8	-
1ecd1c	0.85	-
128432	1.0	-



## 7.2 100 kPa

### 7.2.1 Test results

Table 36: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [kPa]	$u_x$ [kPa]
8bbad3	28.0	-
da393e	46.0	-
899306	68.0	-
5555ce	70.0	10.0
3ab650	74.2	0.5
1ecd1c	75.6	-
642748	78.0	8.0
128432	83.0	-
8e4fed	85.3	-

### 7.2.2 The Numerical Procedure for Determining Outliers

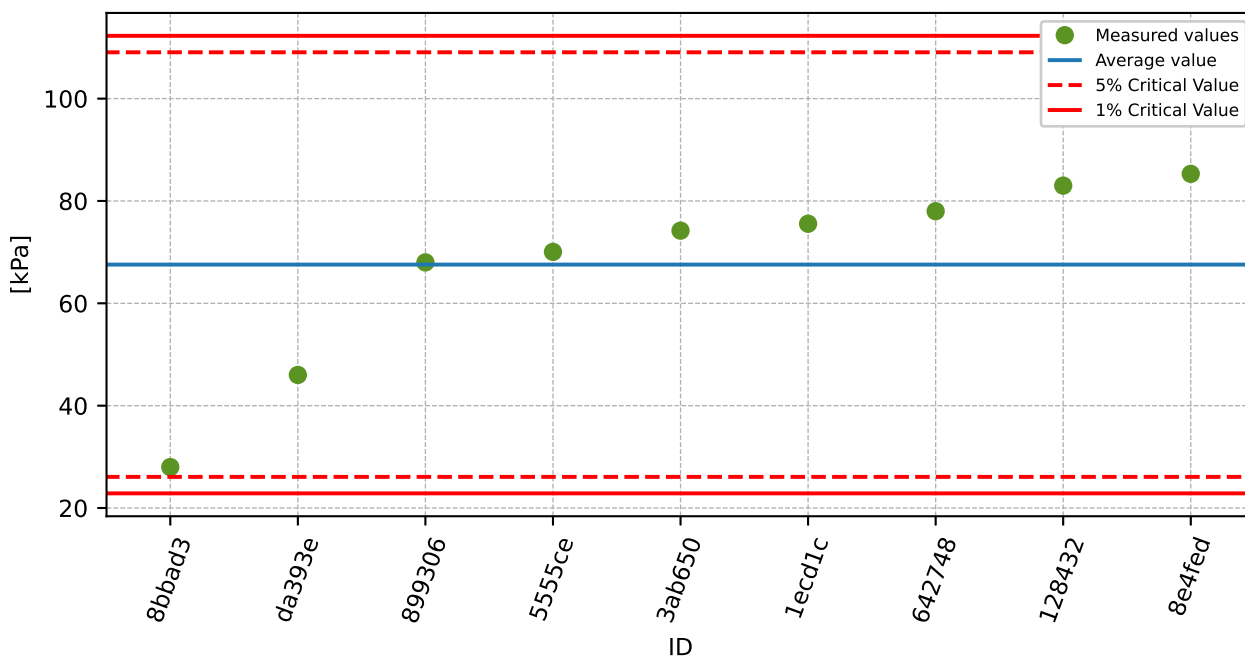


Figure 62: **Grubbs' test** - average values

### 7.2.3 Mandel's Statistics

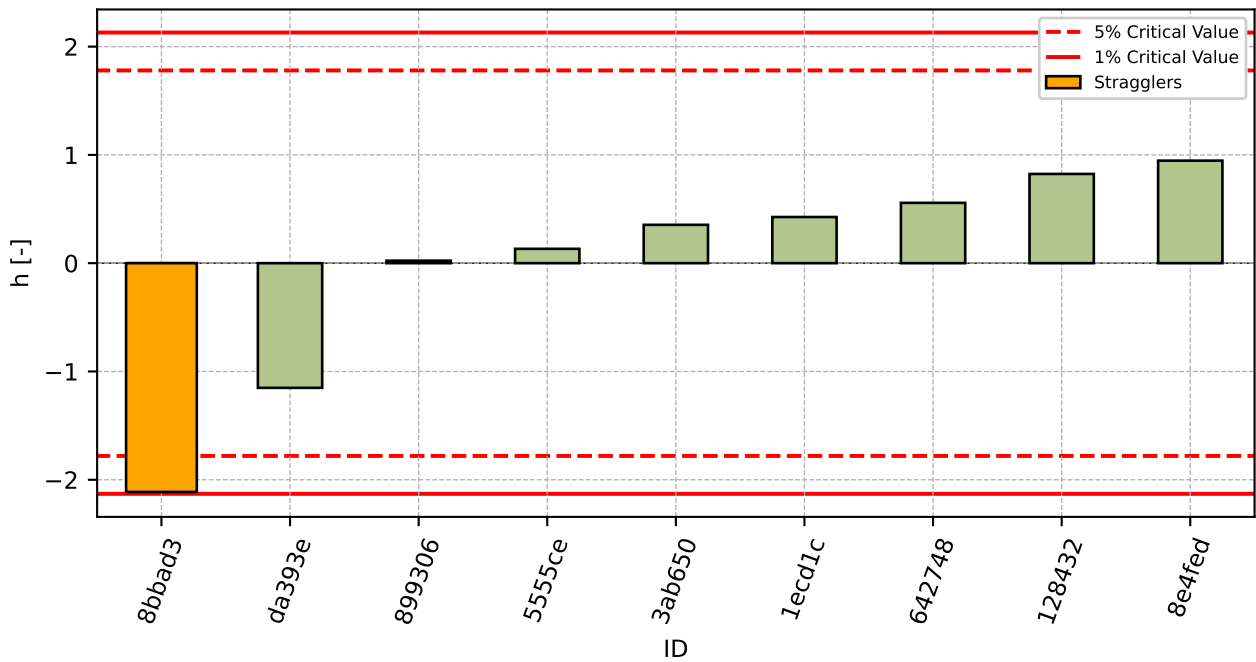


Figure 63: Interlaboratory Consistency Statistic

### 7.2.4 Descriptive statistics

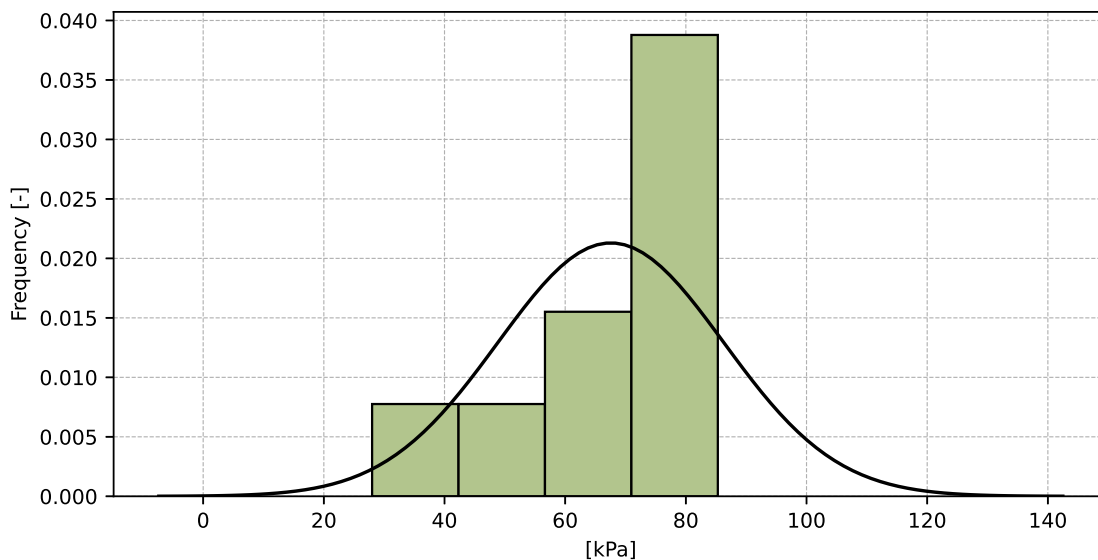


Figure 64: Histogram of all test results

Table 37: Descriptive statistics

Characteristics	[kPa]
Average value – $\bar{x}$	67.6
Sample standard deviation – $s$	18.73
Assigned value – $x^*$	67.6
Robust standard deviation – $s^*$	18.73
Measurement uncertainty of assigned value – $u_x$	6.24
$p$ -value of normality test	0.044 [-]

### 7.2.5 Evaluation of Performance Statistics

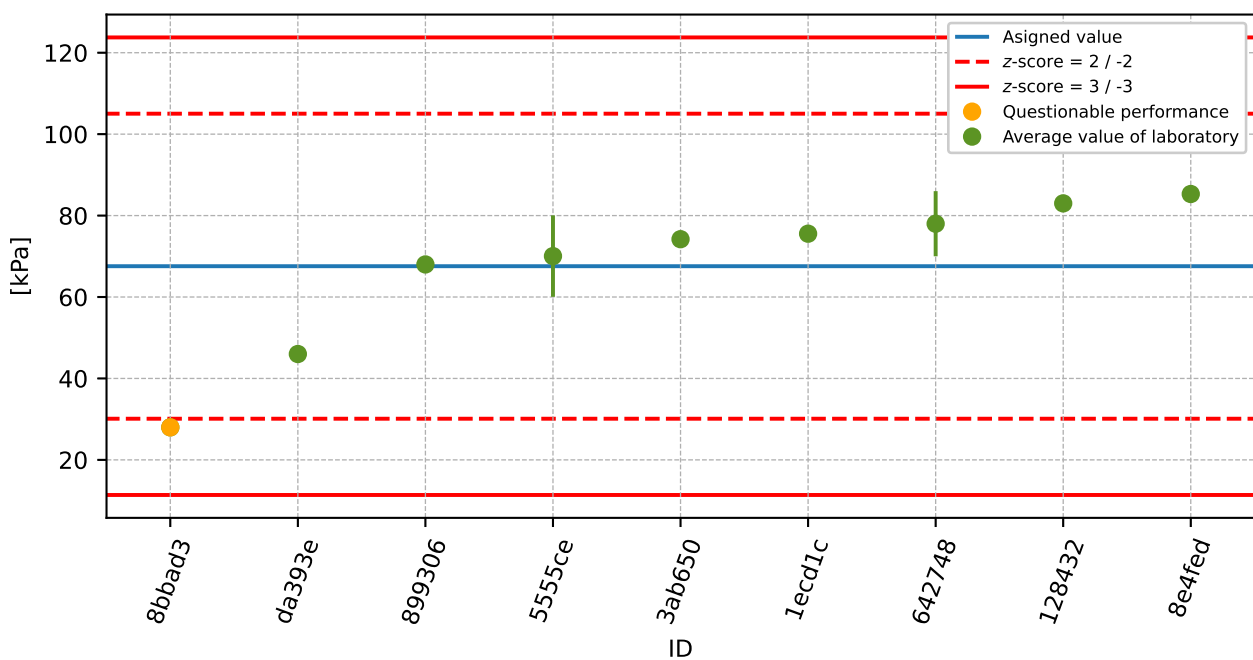


Figure 65: Average values and extended uncertainties of measurement

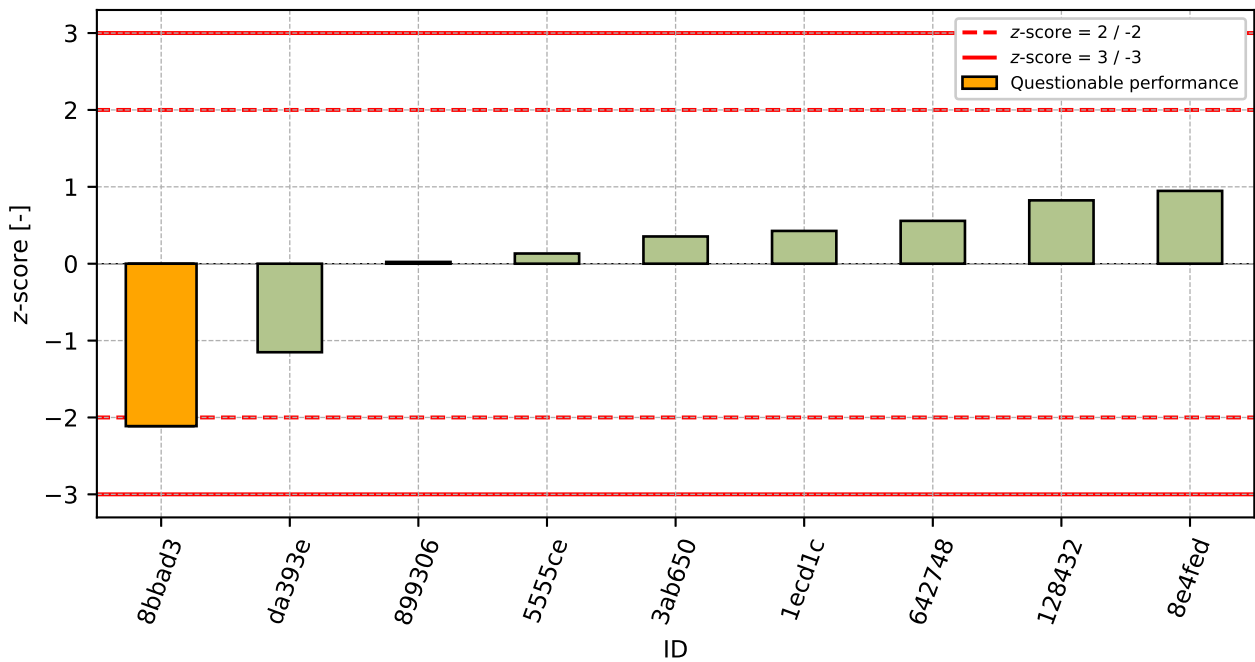


Figure 66: z-score

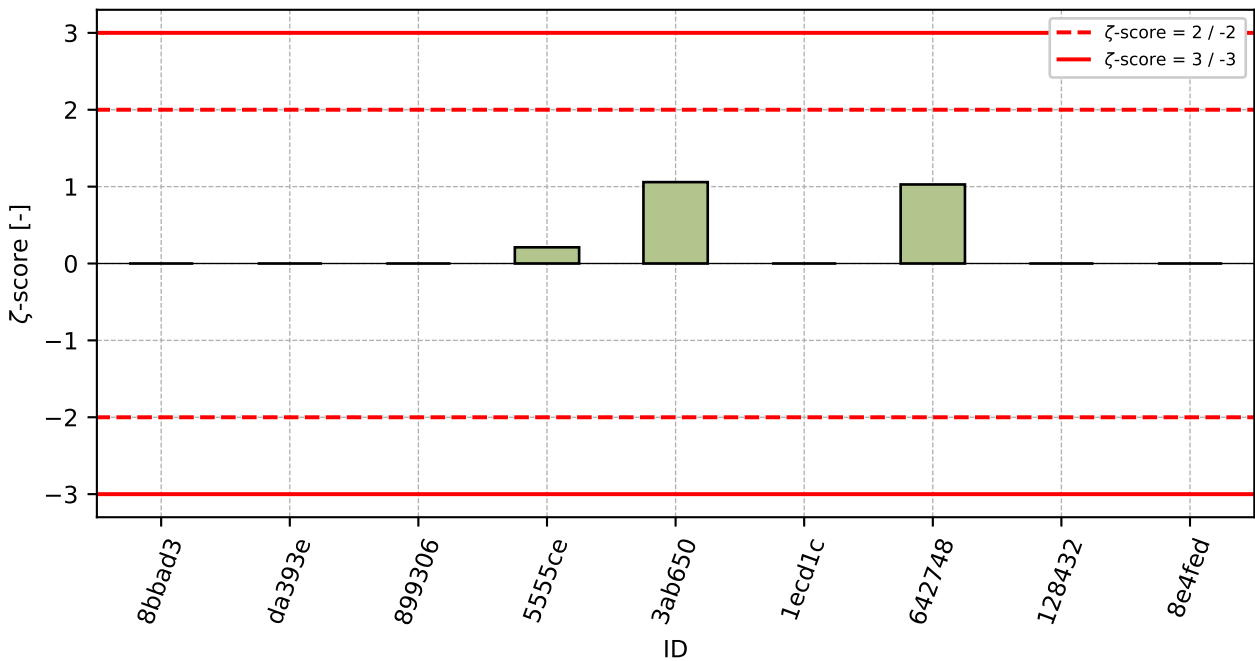


Figure 67: zeta-score

Table 38: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
8bbad3	-2.11	-
da393e	-1.15	-
899306	0.02	-
5555ce	0.13	0.21
3ab650	0.35	1.06
1ecd1c	0.43	-
642748	0.56	1.03
128432	0.82	-
8e4fed	0.95	-

### 7.3 200 kPa

#### 7.3.1 Test results

Table 39: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [kPa]	$u_x$ [kPa]
8bbad3	30.0	-
da393e	87.0	-
128432	102.4	-
899306	114.0	-
3ab650	132.7	1.1
1ecd1c	135.4	-
642748	138.0	8.0
5555ce	138.8	10.0
8e4fed	140.3	-

#### 7.3.2 The Numerical Procedure for Determining Outliers

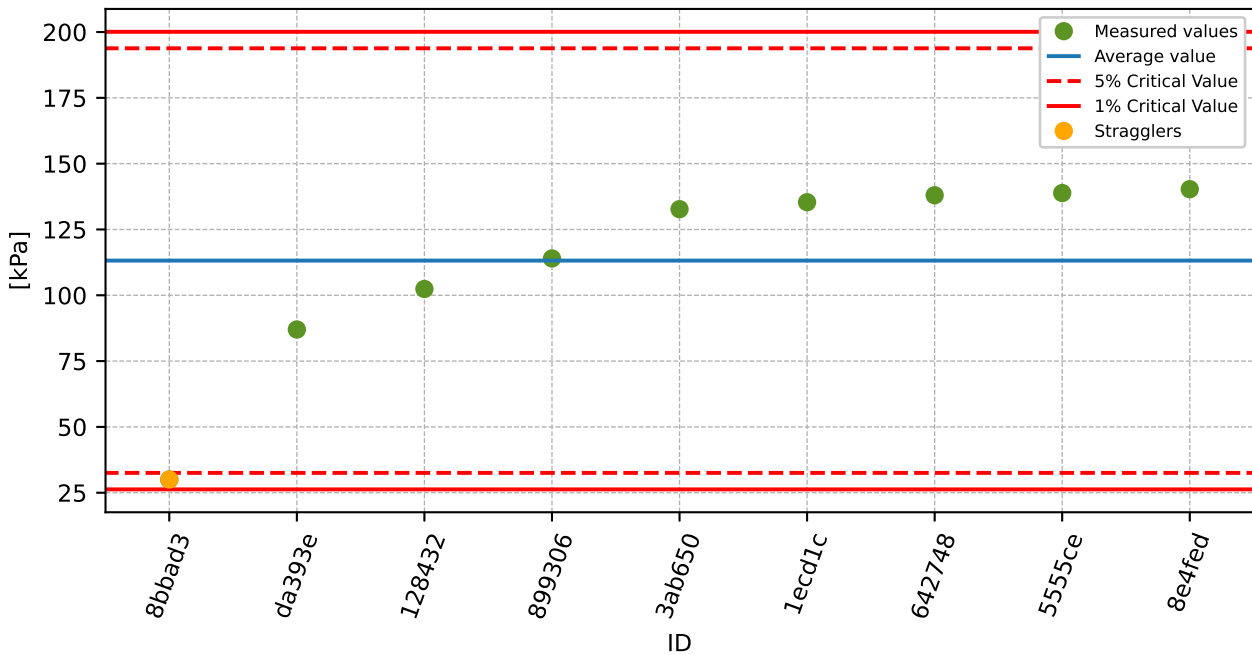


Figure 68: **Grubbs' test** - average values

### 7.3.3 Mandel's Statistics

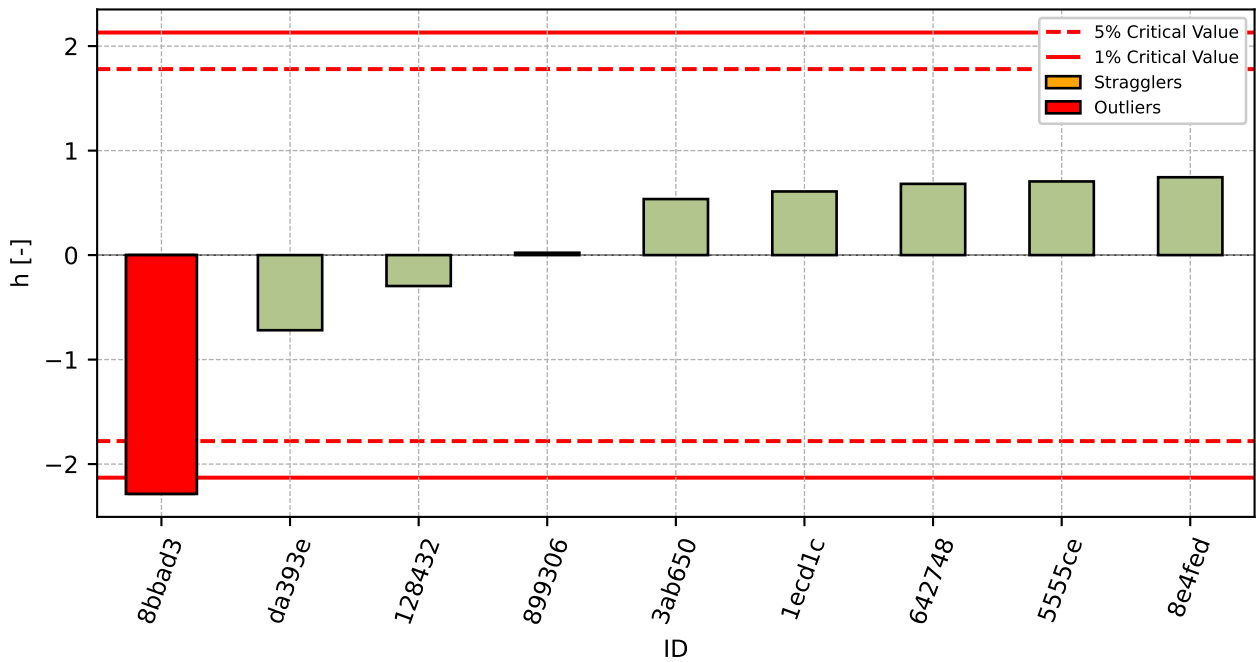


Figure 69: Interlaboratory Consistency Statistic

### 7.3.4 Descriptive statistics

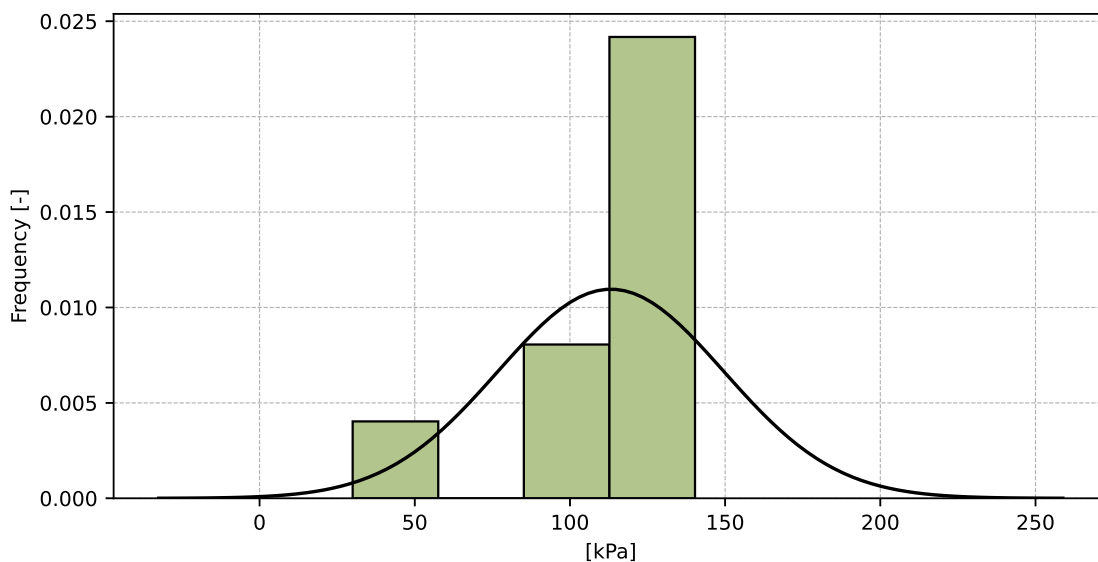


Figure 70: Histogram of all test results

Table 40: Descriptive statistics

Characteristics	[kPa]
Average value – $\bar{x}$	113.2
Sample standard deviation – $s$	36.41
Assigned value – $x^*$	113.2
Robust standard deviation – $s^*$	36.41
Measurement uncertainty of assigned value – $u_x$	12.14
$p$ -value of normality test	0.011 [-]

### 7.3.5 Evaluation of Performance Statistics

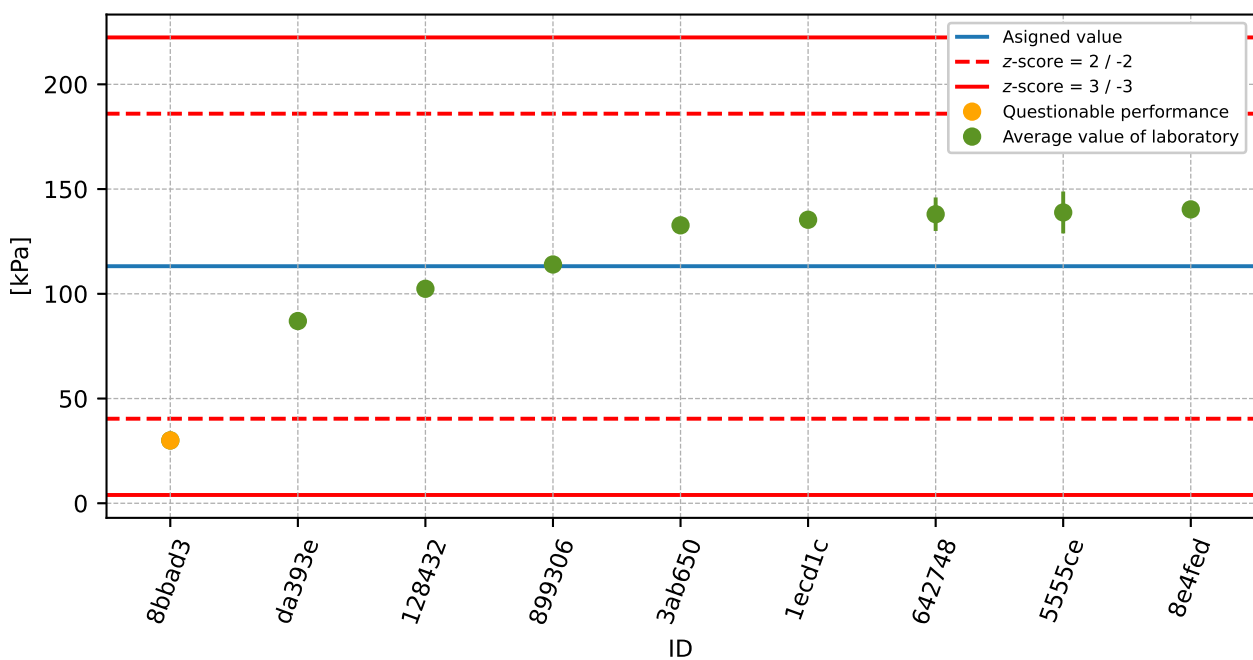


Figure 71: Average values and extended uncertainties of measurement



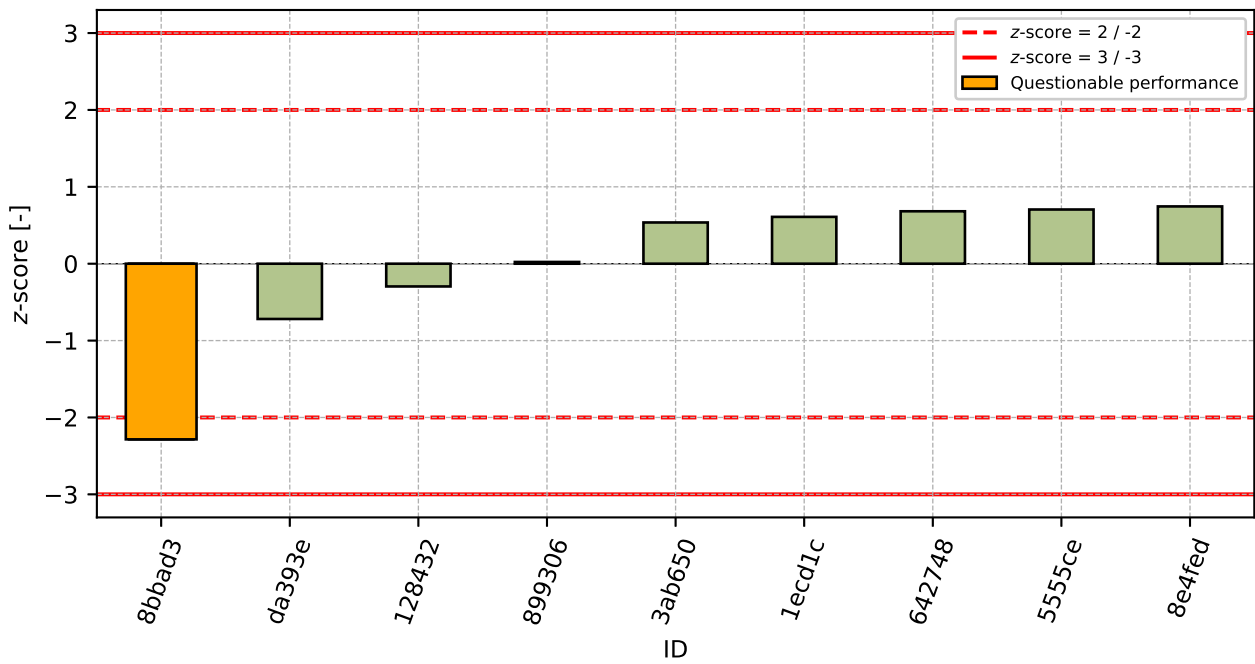


Figure 72: z-score

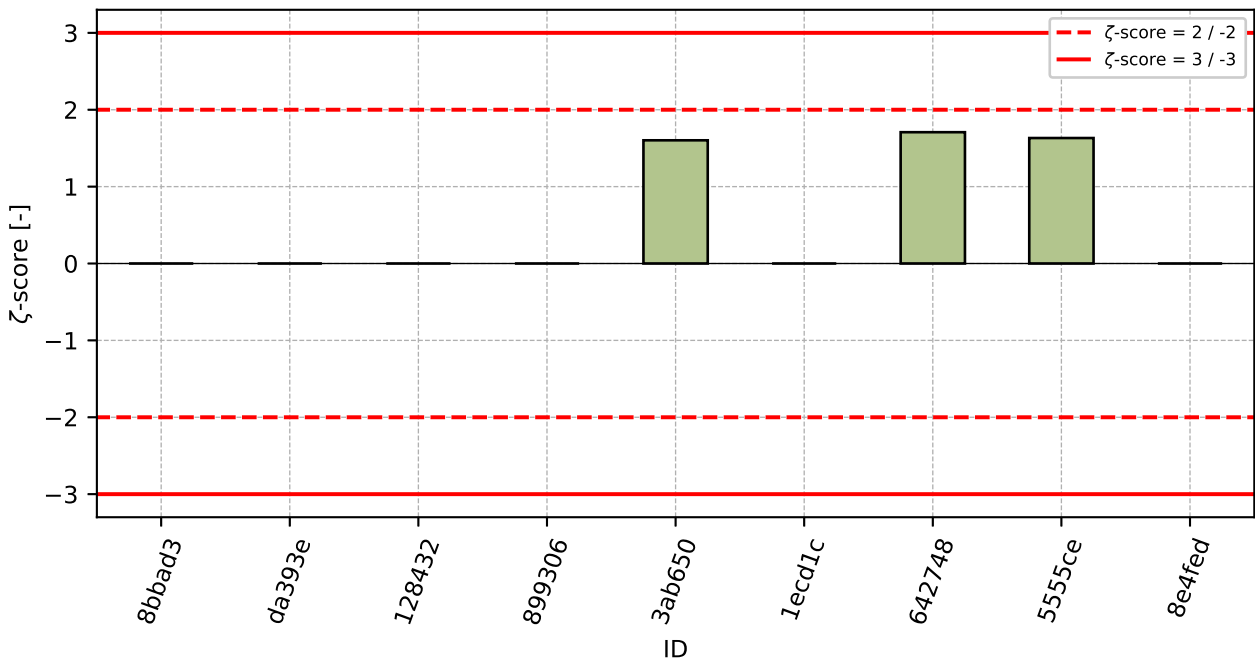


Figure 73: zeta-score

Table 41: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
8bbad3	-2.28	-
da393e	-0.72	-
128432	-0.3	-
899306	0.02	-
3ab650	0.54	1.6
1ecd1c	0.61	-
642748	0.68	1.71
5555ce	0.7	1.63
8e4fed	0.75	-

## 7.4 400 kPa

### 7.4.1 Test results

Table 42: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [kPa]	$u_x$ [kPa]
8bbad3	70.0	-
128432	178.3	-
da393e	191.0	-
899306	208.0	-
1ecd1c	247.4	-
642748	261.0	8.0
8e4fed	265.8	-
3ab650	266.7	2.7
5555ce	276.4	10.0

### 7.4.2 The Numerical Procedure for Determining Outliers

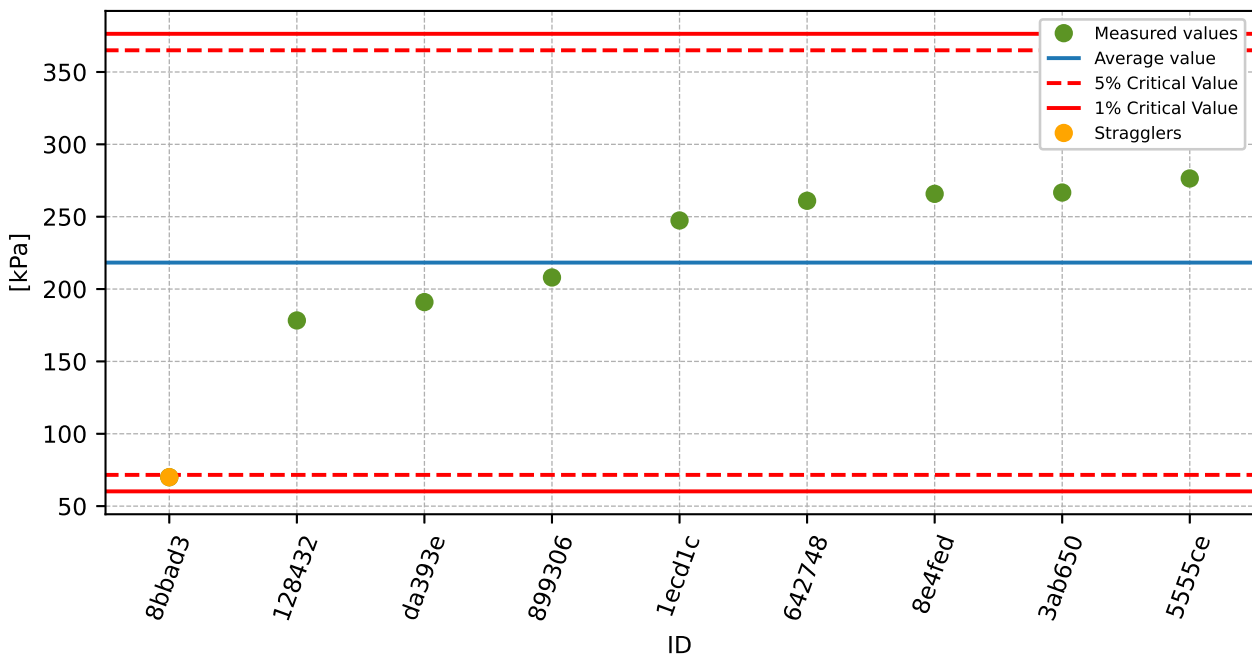


Figure 74: **Grubbs' test** - average values

### 7.4.3 Mandel's Statistics

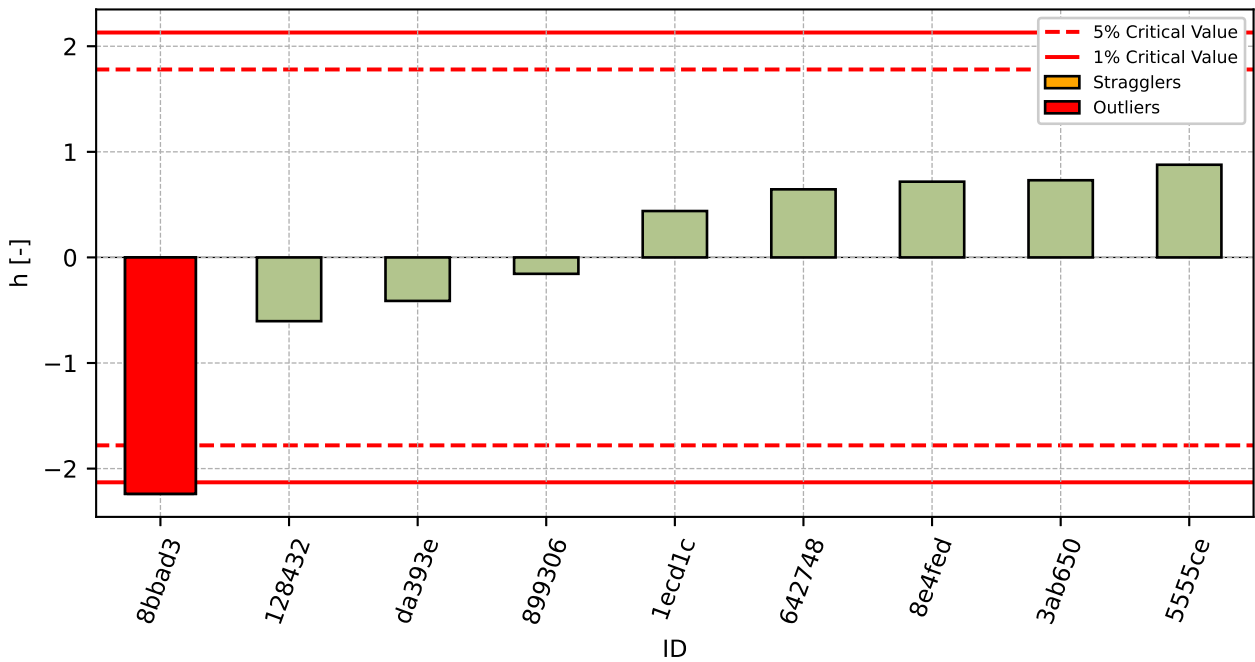


Figure 75: Interlaboratory Consistency Statistic

### 7.4.4 Descriptive statistics

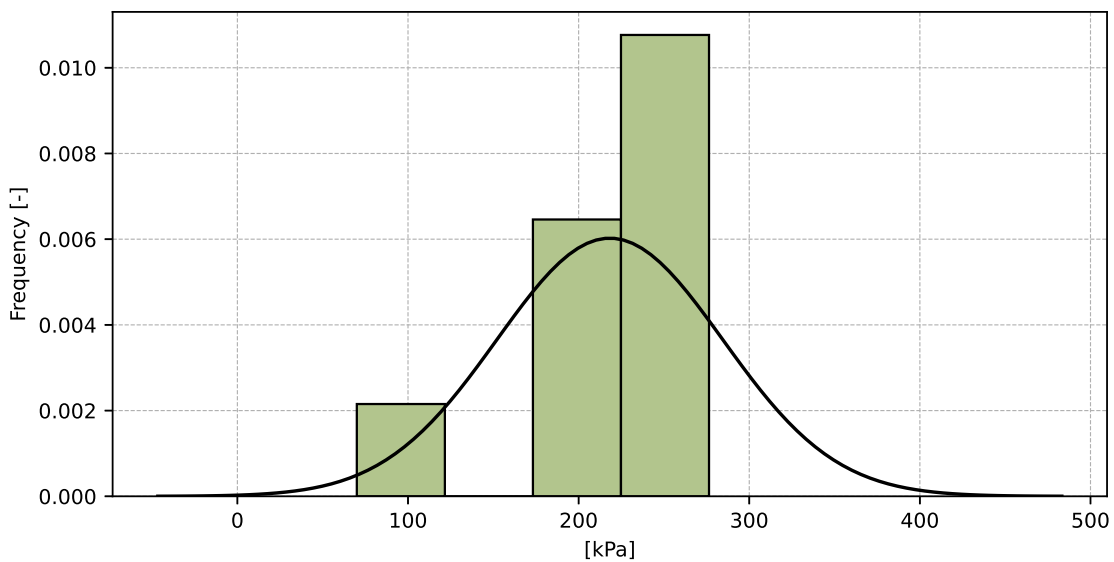


Figure 76: Histogram of all test results

Table 43: Descriptive statistics

Characteristics	[kPa]
Average value – $\bar{x}$	218.3
Sample standard deviation – $s$	66.23
Assigned value – $x^*$	218.3
Robust standard deviation – $s^*$	66.23
Measurement uncertainty of assigned value – $u_x$	22.08
$p$ -value of normality test	0.038 [-]

### 7.4.5 Evaluation of Performance Statistics

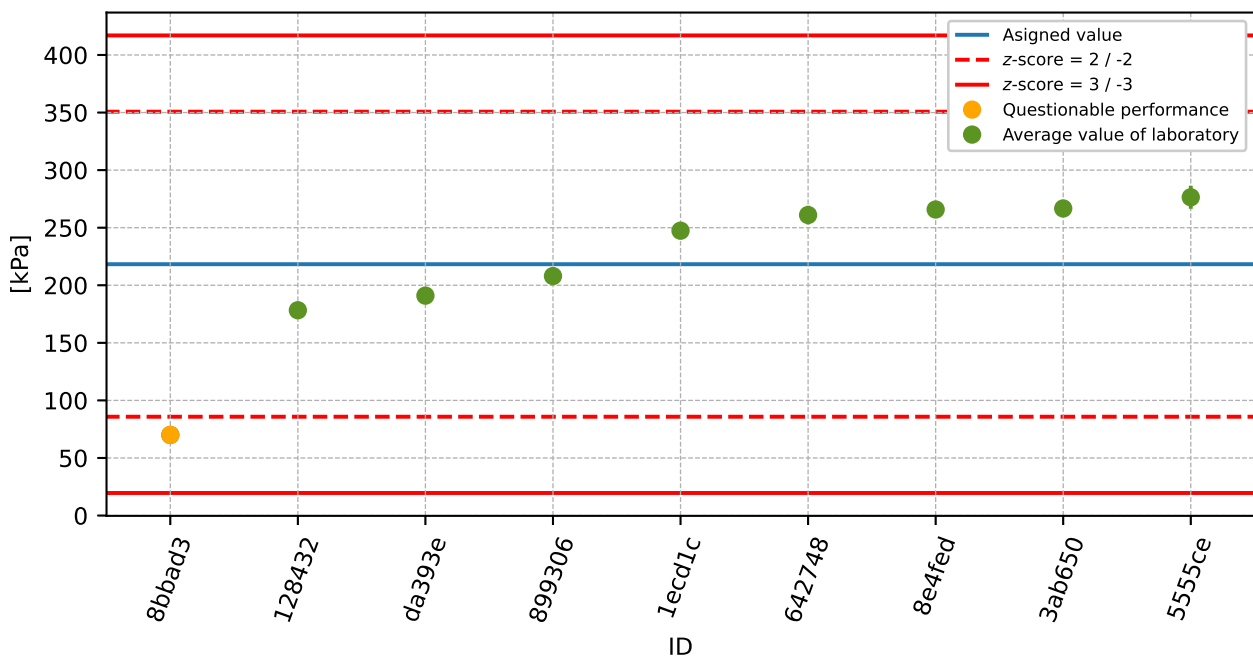


Figure 77: Average values and extended uncertainties of measurement

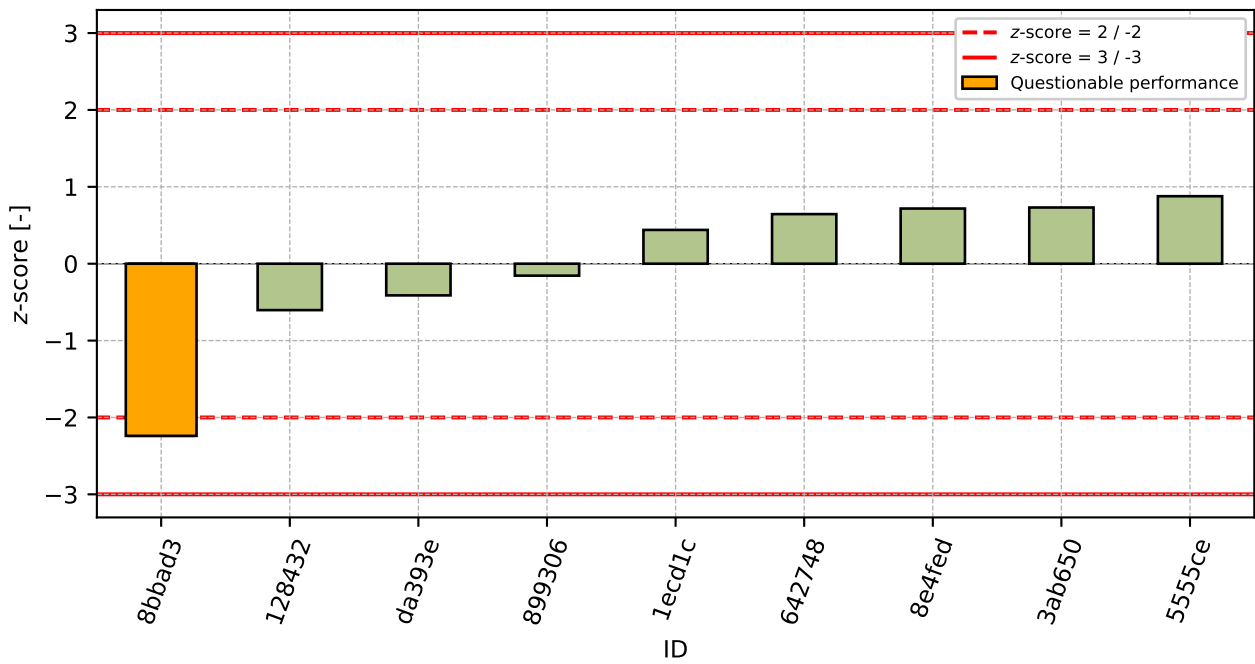


Figure 78: z-score

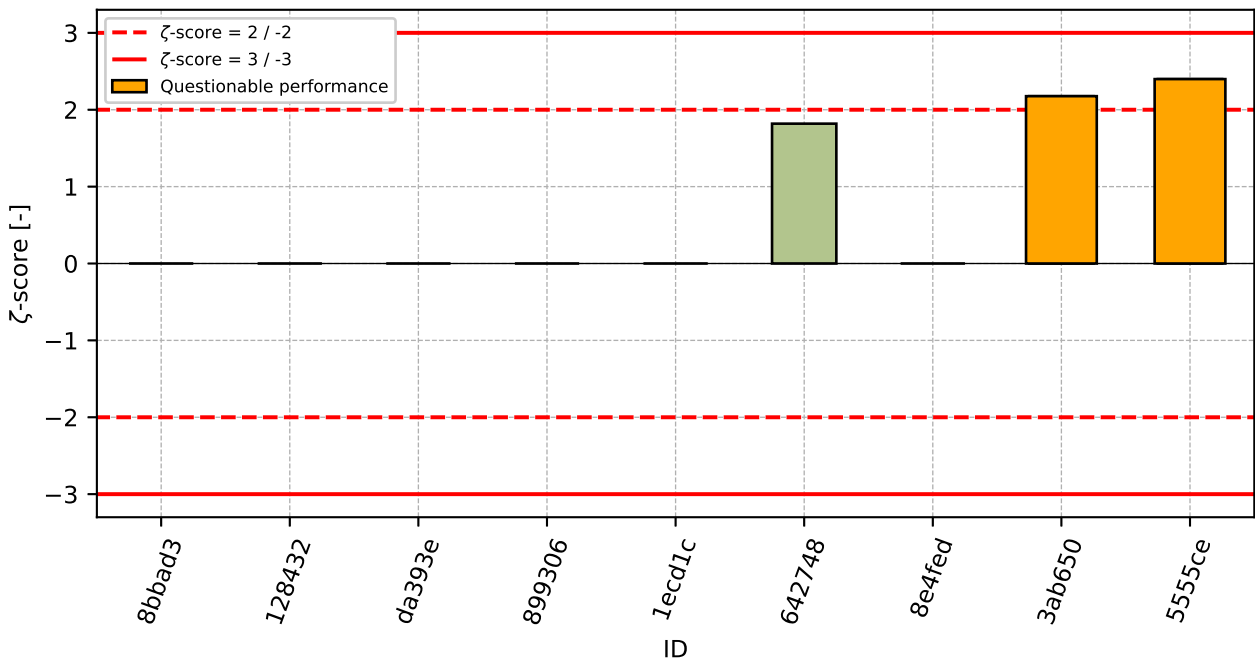


Figure 79: ζ-score

Table 44: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
8bbad3	-2.24	-
128432	-0.6	-
da393e	-0.41	-
899306	-0.16	-
1ecd1c	0.44	-
642748	0.64	1.82
8e4fed	0.72	-
3ab650	0.73	2.18
5555ce	0.88	2.4

## 8 Appendix – EN ISO 17892-12 – Atterberg limits

### 8.1 Liquit limit

#### 8.1.1 Test results

Table 45: 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			$u_X$ [%]	$\bar{x}$ [%]	$s_0$ [%]	$V_X$ [%]
	[%]	[%]	[%]				
9b4e48	25.3	26.0	25.6	0.3	25.6	0.35	1.37
18338d	27.8	28.1	28.3	-	28.1	0.25	0.9
9dabfd	30.7	31.2	30.5	-	30.8	0.36	1.17
e0f6cc	31.1	31.3	31.4	-	31.3	0.15	0.49
899306	32.0	32.0	33.0	-	32.3	0.58	1.79
d4807a	32.6	32.5	32.7	0.7	32.6	0.1	0.31
5555ce	32.7	31.6	34.0	2.4	32.8	1.2	3.67
276b77	33.0	33.2	33.5	-	33.2	0.25	0.76
f28265	33.2	33.4	33.2	1.0	33.3	0.12	0.35
5c4e92	33.5	33.7	33.6	0.5	33.6	0.1	0.3
9d7c2f	33.7	33.1	34.9	1.3	33.9	0.92	2.7
386032	33.2	34.5	34.0	0.4	33.9	0.67	1.97
225baf	34.6	34.4	34.0	1.7	34.3	0.31	0.89
16fb0c	33.8	35.2	35.4	2.1	34.8	0.85	2.45
1b1360	35.0	35.0	35.0	5.0	35.0	0.0	0.0
be2d81	34.4	35.6	35.1	1.0	35.0	0.6	1.72
8e4fed	35.3	35.2	34.9	-	35.1	0.21	0.59
d26722	37.0	36.0	35.0	-	36.0	1.0	2.78
61f5d3	36.0	36.0	36.0	4.3	36.0	0.0	0.0
fc2b2b3	36.0	36.0	36.0	-	36.0	0.0	0.0
da393e	36.5	35.8	36.3	-	36.2	0.36	1.0
47751a	36.0	37.0	36.0	2.4	36.3	0.58	1.59
f21137	39.2	37.6	33.2	-	36.6	3.11	8.47
db964b	37.0	37.0	36.7	1.6	36.9	0.17	0.47
3ab650	37.0	36.0	38.0	1.4	37.0	1.0	2.7
8bbad3	37.0	39.0	37.0	-	37.7	1.15	3.07
dcf124	40.0	39.0	38.0	-	39.0	1.0	2.56
831b65	40.0	40.1	40.1	2.0	40.1	0.06	0.14
642748	41.3	40.9	41.1	0.4	41.1	0.19	0.45



### 8.1.2 The Numerical Procedure for Determining Outliers

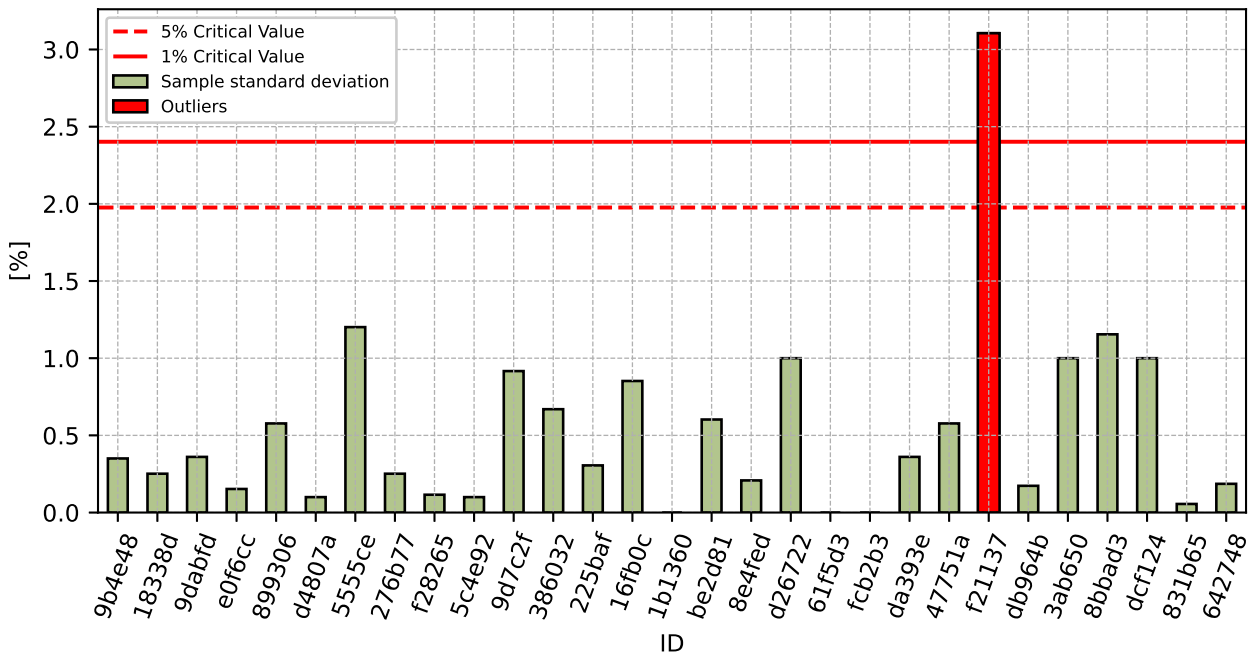


Figure 80: **Cochran's test** - sample standard deviations

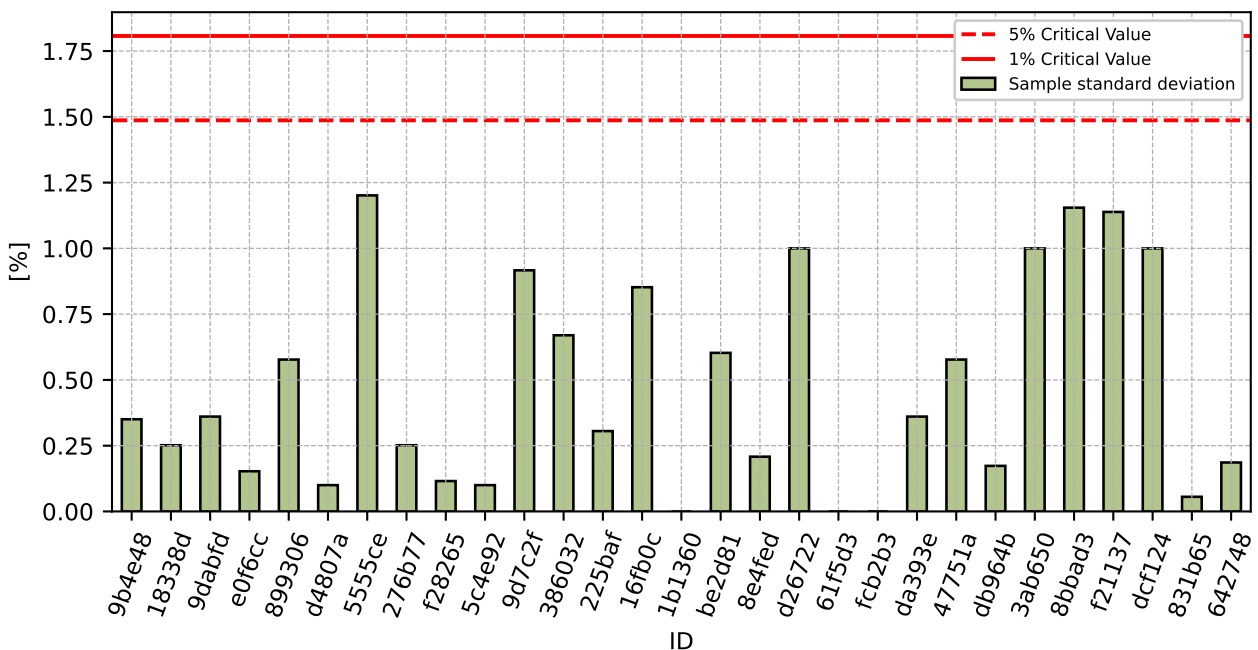


Figure 81: **Cochran's test** - sample standard deviations without outliers

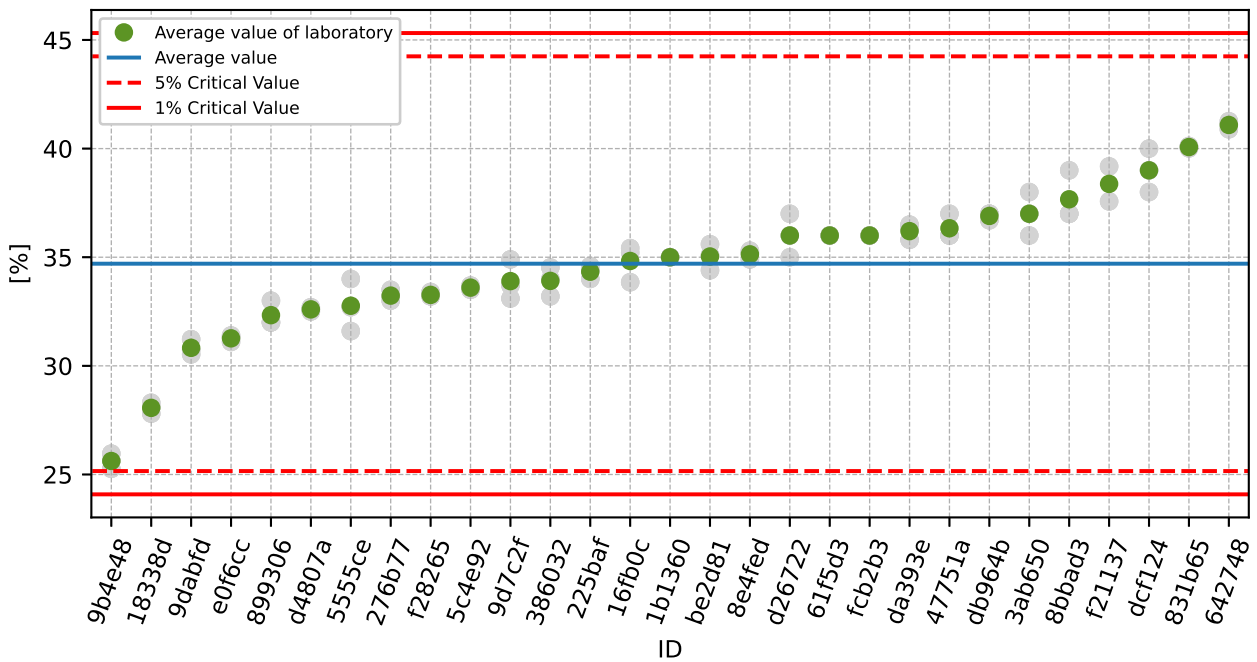


Figure 82: **Grubbs' test** - average values

### 8.1.3 Mandel's Statistics

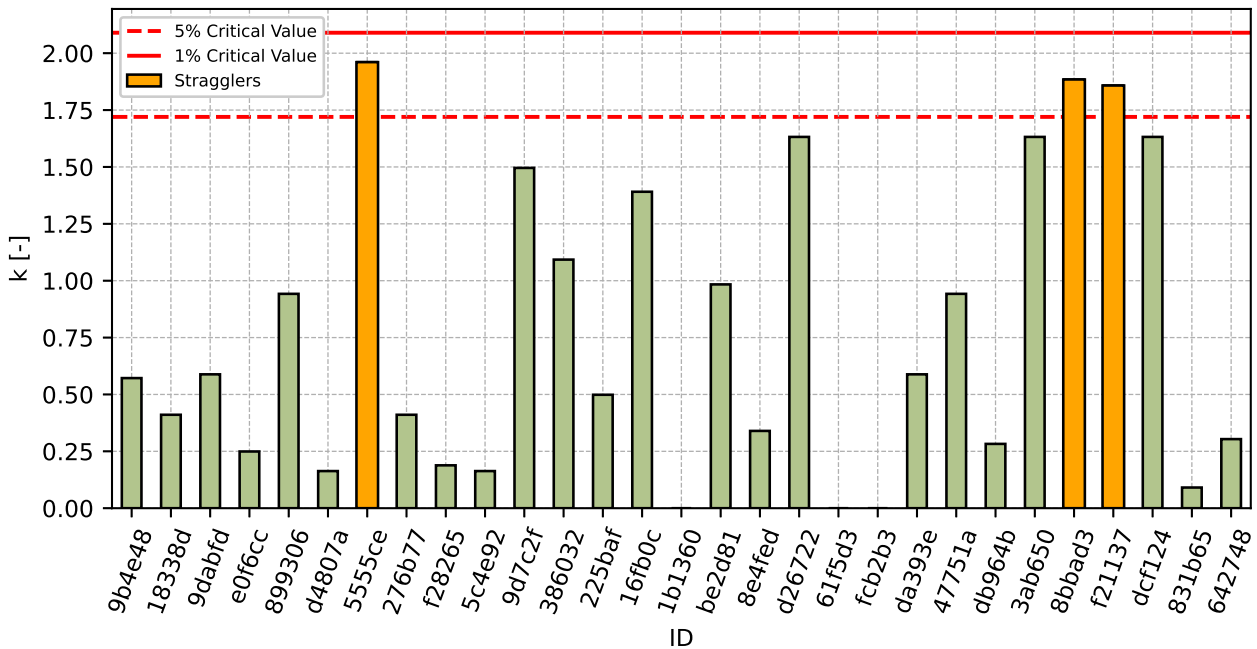


Figure 83: Intralaboratory Consistency Statistic

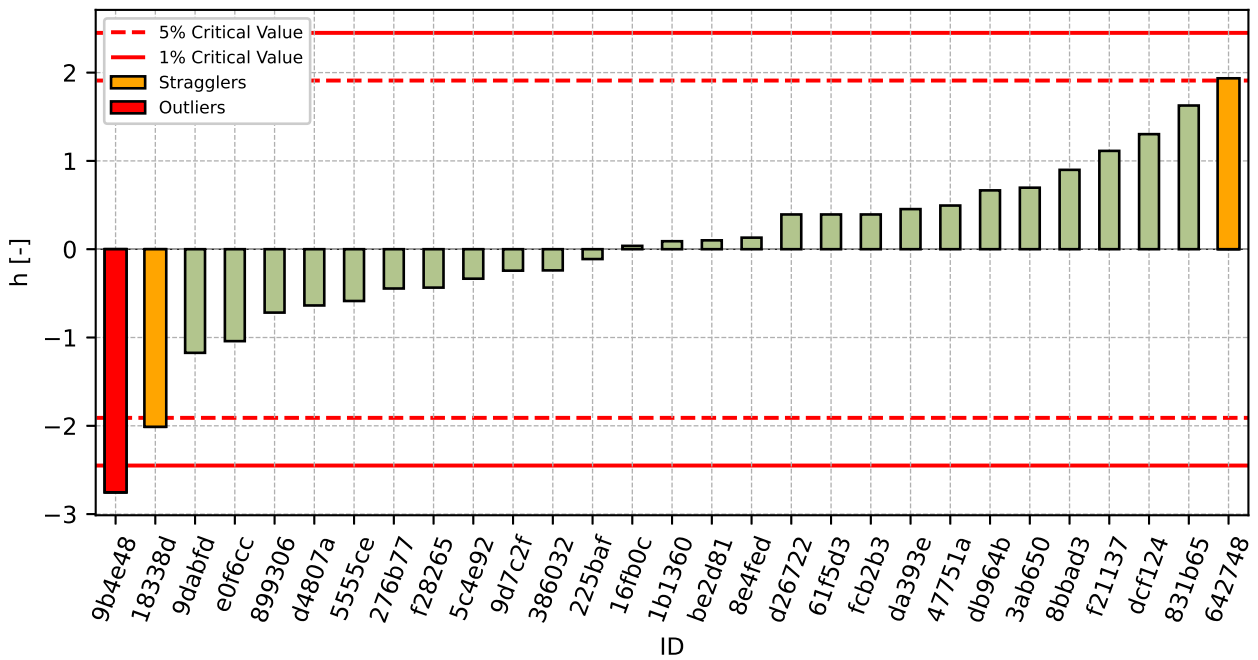


Figure 84: Interlaboratory Consistency Statistic

### 8.1.4 Descriptive statistics

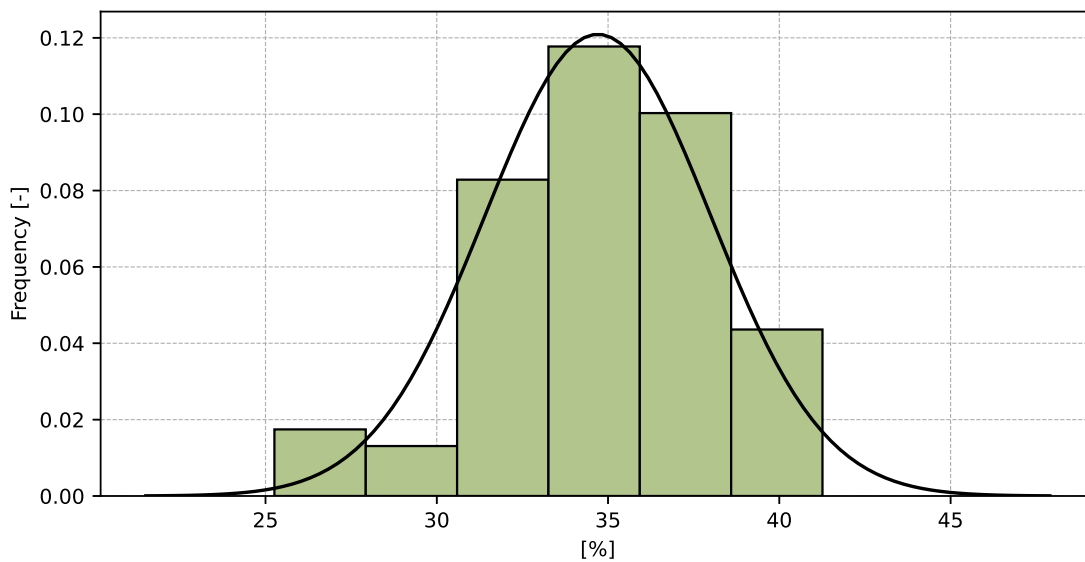


Figure 85: Histogram of all test results

Table 46: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	34.7
Sample standard deviation – $s$	3.3
Assigned value – $x^*$	35.0
Robust standard deviation – $s^*$	2.9
Measurement uncertainty of assigned value – $u_X$	0.67
$p$ -value of normality test	1.0 [-]
Interlaboratory standard deviation – $s_L$	3.28
Repeatability standard deviation – $s_r$	0.61
Reproducibility standard deviation – $s_R$	3.34
Repeatability – $r$	1.7
Reproducibility – $R$	9.3

### 8.1.5 Evaluation of Performance Statistics

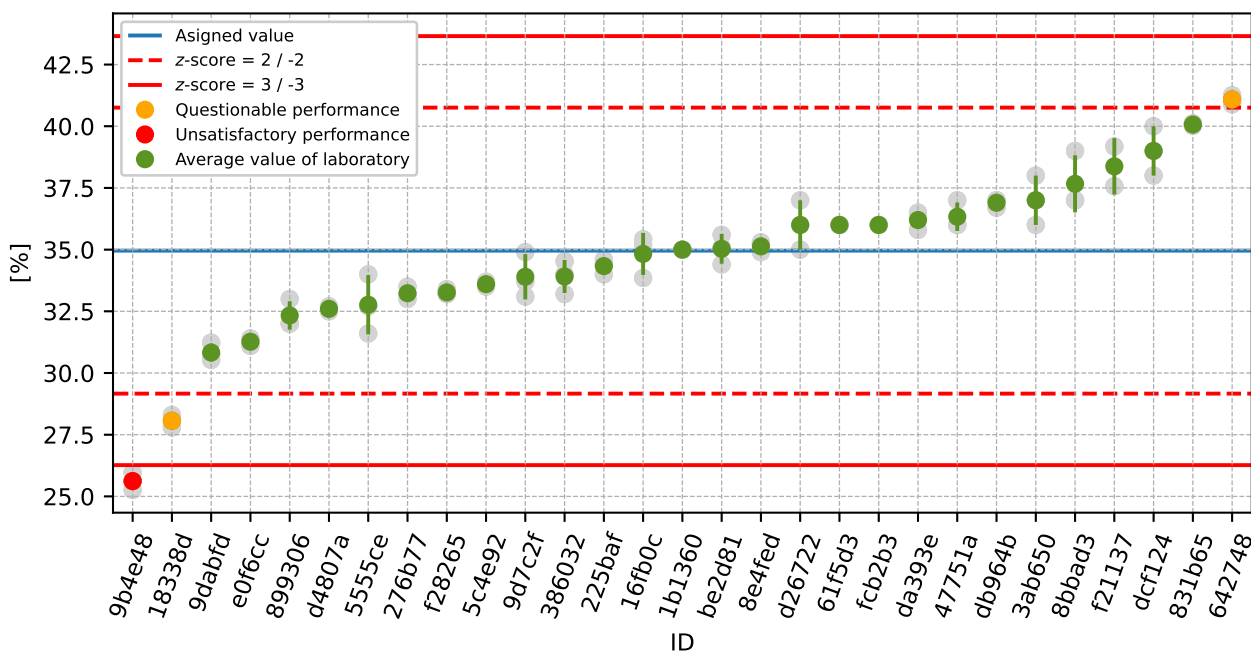


Figure 86: Average values and sample standard deviations

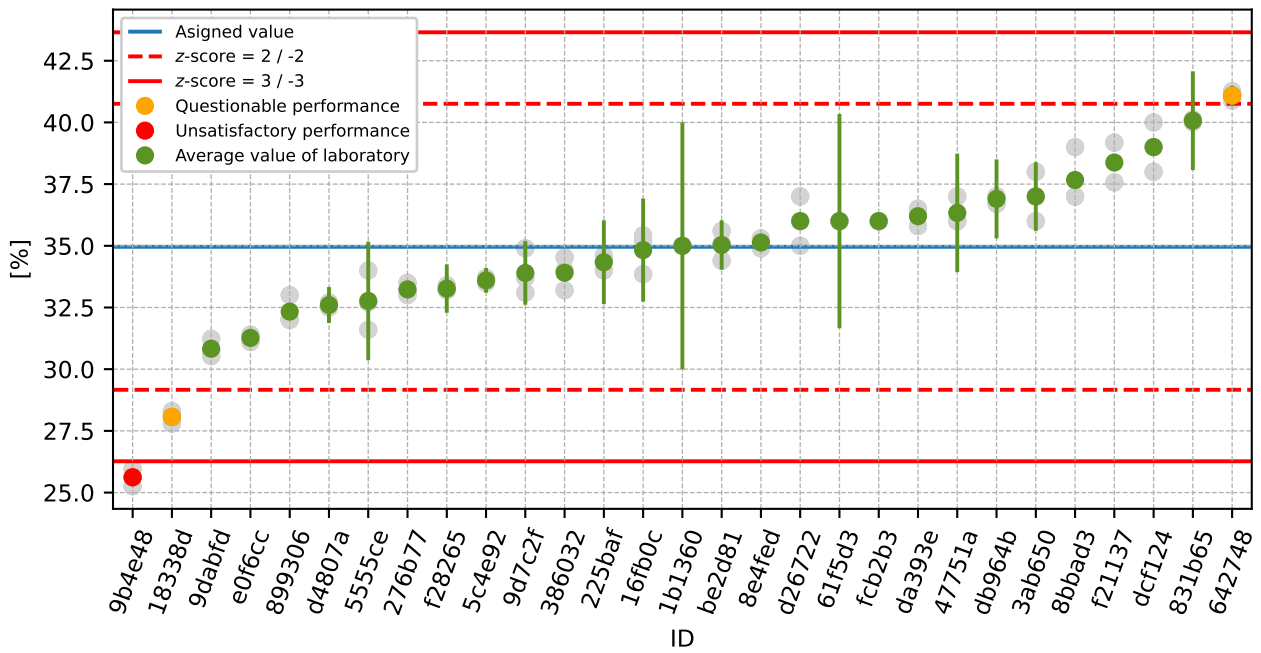


Figure 87: Average values and extended uncertainties of measurement

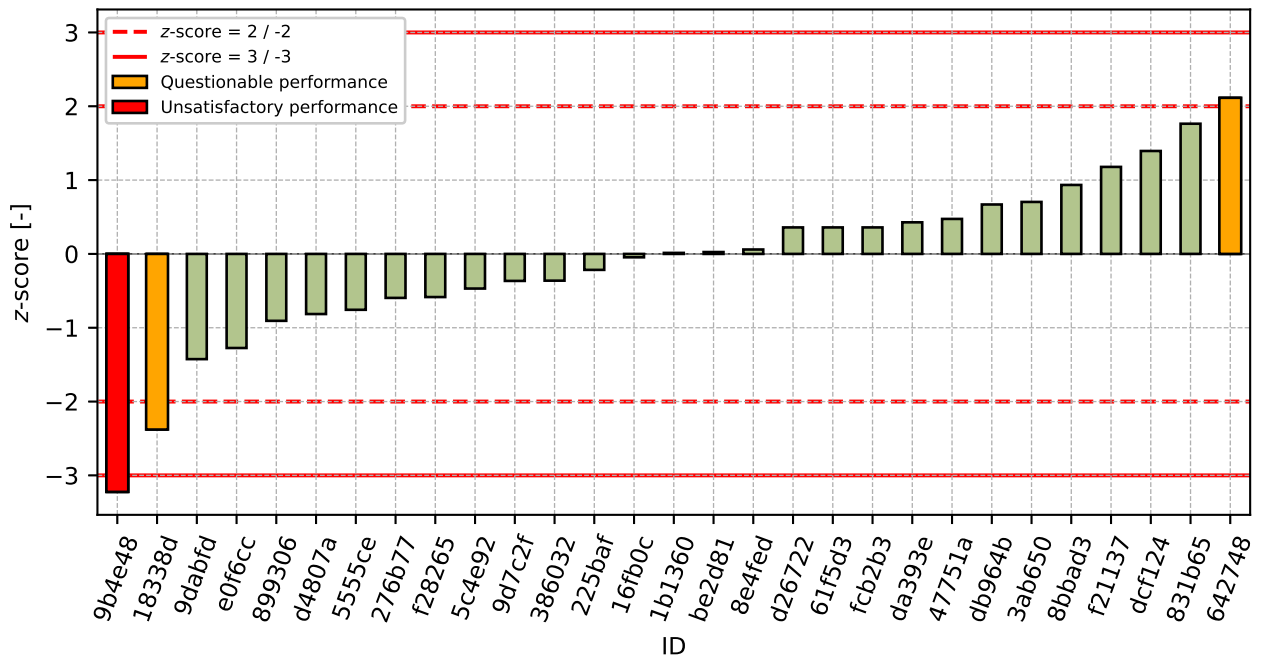


Figure 88: z-score

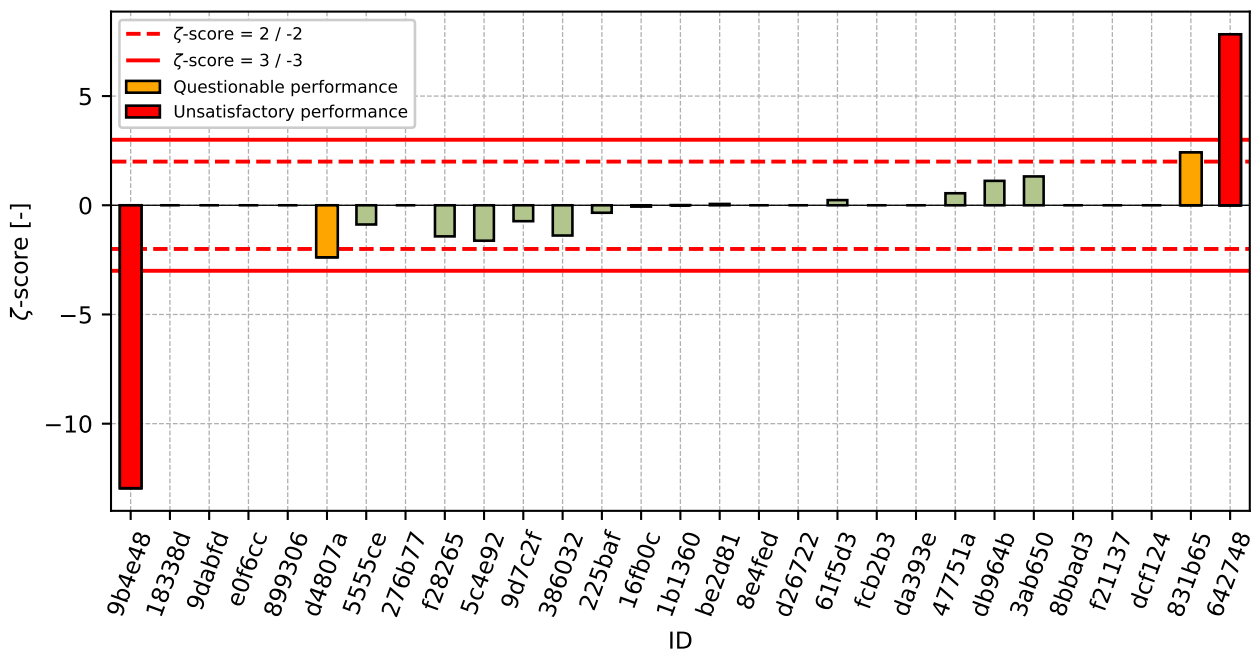


Figure 89: zeta-score

Table 47: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
9b4e48	-3.22	-12.95
18338d	-2.38	-
9dabfd	-1.43	-
e0f6cc	-1.27	-
899306	-0.91	-
d4807a	-0.81	-2.38
5555ce	-0.76	-0.88
276b77	-0.6	-
f28265	-0.58	-1.42
5c4e92	-0.47	-1.62
9d7c2f	-0.37	-0.73
386032	-0.36	-1.38
225baf	-0.22	-0.34
16fb0c	-0.05	-0.06
1b1360	0.01	0.01
be2d81	0.03	0.06
8e4fed	0.06	-
d26722	0.36	-
61f5d3	0.36	0.24
fc2b2b3	0.36	-
da393e	0.43	-
47751a	0.47	0.55
db964b	0.67	1.12
3ab650	0.7	1.32
8bbad3	0.93	-
f21137	1.18	-
dcf124	1.39	-
831b65	1.76	2.42
642748	2.11	7.83

## 8.2 Plastic limit

### 8.2.1 Test results

Table 48: 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			$u_x$	$\bar{x}$	$s_0$	$V_x$
	[%]						
be2d81	5.5	5.5	5.4	0.5	5.5	0.06	1.06
5555ce	14.7	15.3	15.3	0.6	15.1	0.35	2.29
9dabfd	15.9	16.6	-	-	16.2	0.5	3.09
9b4e48	17.6	17.7	17.4	0.4	17.6	0.18	1.03
fc2b3	18.0	19.0	18.0	-	18.3	0.58	3.15
dcf124	18.0	18.0	19.0	-	18.3	0.58	3.15
225baf	18.0	18.5	19.0	2.5	18.5	0.5	2.7
f28265	18.6	19.1	18.9	1.3	18.9	0.25	1.33
899306	19.0	19.0	19.0	-	19.0	0.0	0.0
d4807a	19.1	19.3	19.0	0.7	19.1	0.16	0.81
da393e	19.6	19.9	19.0	-	19.5	0.46	2.35
db964b	19.8	19.8	19.6	1.5	19.7	0.12	0.59
e0f6cc	19.9	19.6	19.7	-	19.7	0.15	0.77
642748	19.2	20.2	20.5	0.5	20.0	0.72	3.59
d26722	20.0	20.0	20.0	-	20.0	0.0	0.0
276b77	20.9	20.4	20.0	-	20.4	0.45	2.21
386032	20.5	20.3	20.6	0.2	20.5	0.19	0.91
f21137	20.5	20.6	20.6	-	20.6	0.08	0.4
3ab650	21.0	21.0	20.0	1.4	20.7	0.58	2.79
1b1360	21.0	21.0	21.0	2.5	21.0	0.0	0.0
16fb0c	19.6	21.4	22.1	1.3	21.0	1.28	6.07
5c4e92	21.3	21.1	21.2	0.5	21.2	0.1	0.47
61f5d3	21.0	21.0	22.0	4.0	21.3	0.58	2.71
831b65	21.4	21.6	21.5	1.1	21.5	0.09	0.43
8e4fed	21.7	20.9	22.1	-	21.6	0.61	2.83
47751a	22.0	22.0	21.0	1.4	21.7	0.58	2.66
8bbad3	23.0	23.0	22.0	-	22.7	0.58	2.55
18338d	22.7	23.5	24.0	-	23.4	0.66	2.8
9d7c2f	24.8	24.5	23.2	0.9	24.2	0.85	3.52



### 8.2.2 The Numerical Procedure for Determining Outliers

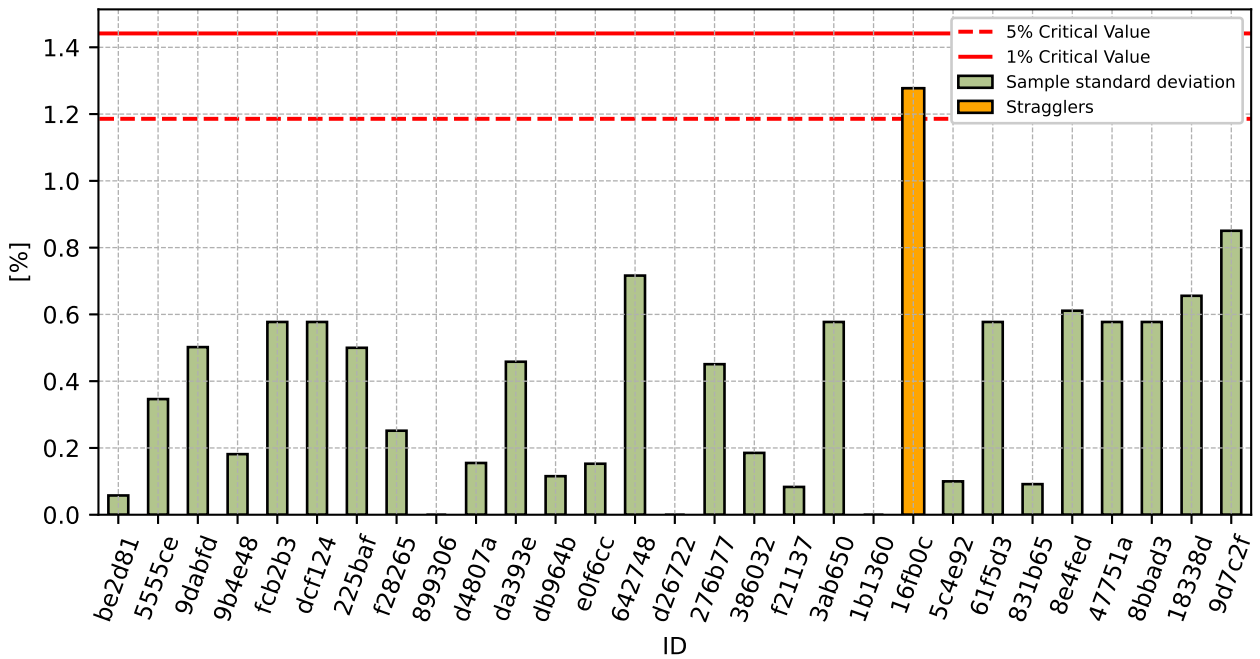


Figure 90: **Cochran's test** - sample standard deviations

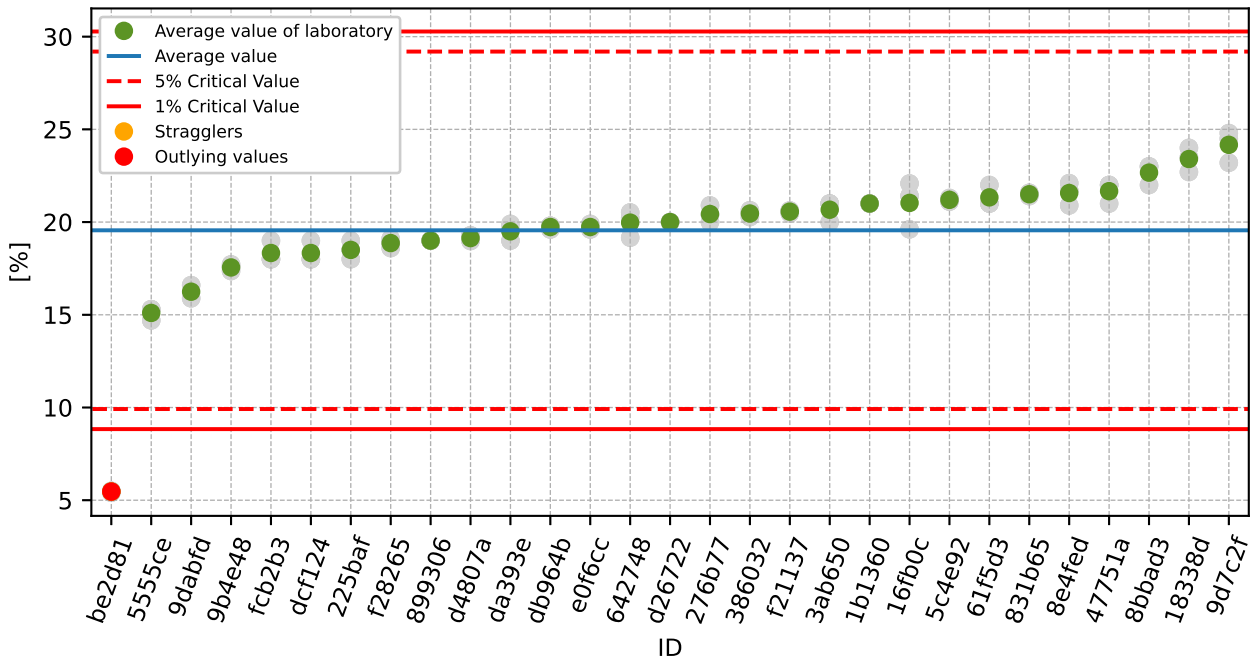


Figure 91: **Grubbs' test** - average values

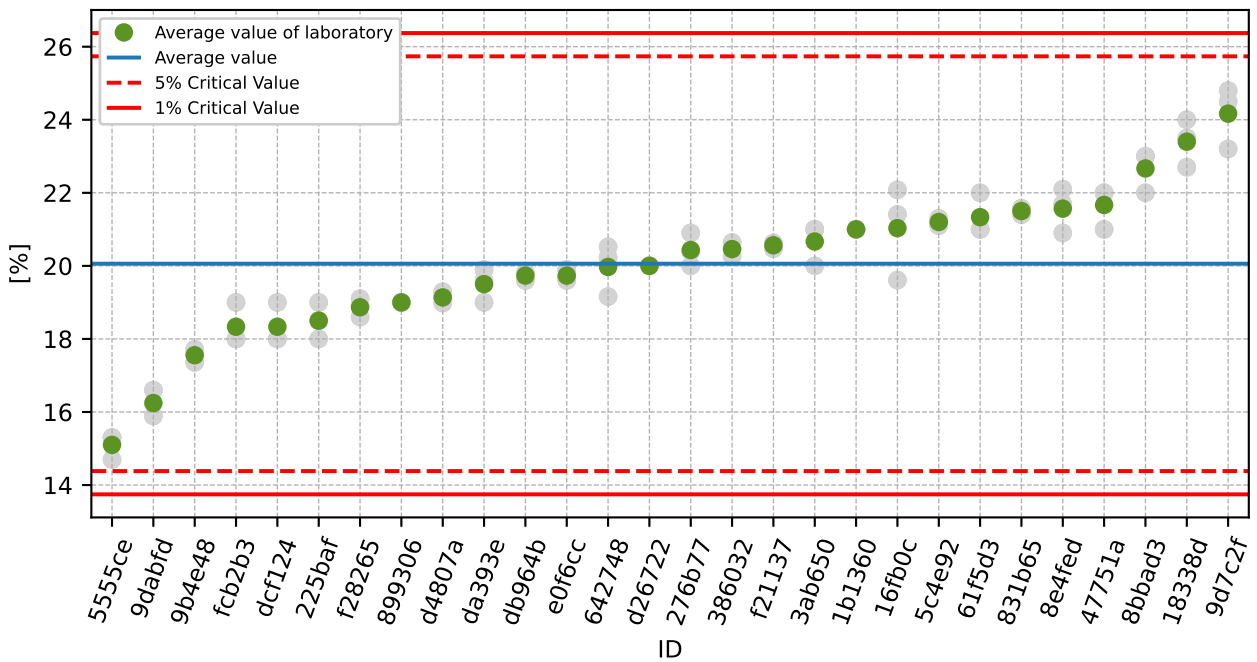


Figure 92: **Grubbs' test** - average values without outliers

### 8.2.3 Mandel's Statistics

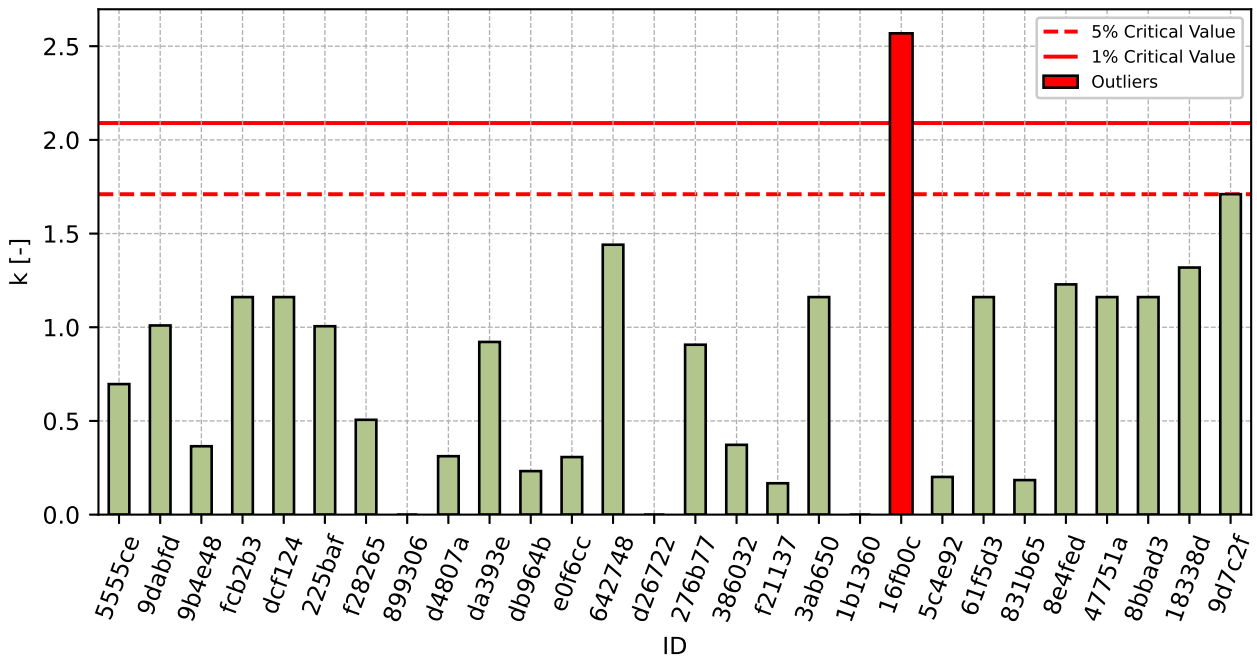


Figure 93: Intralaboratory Consistency Statistic

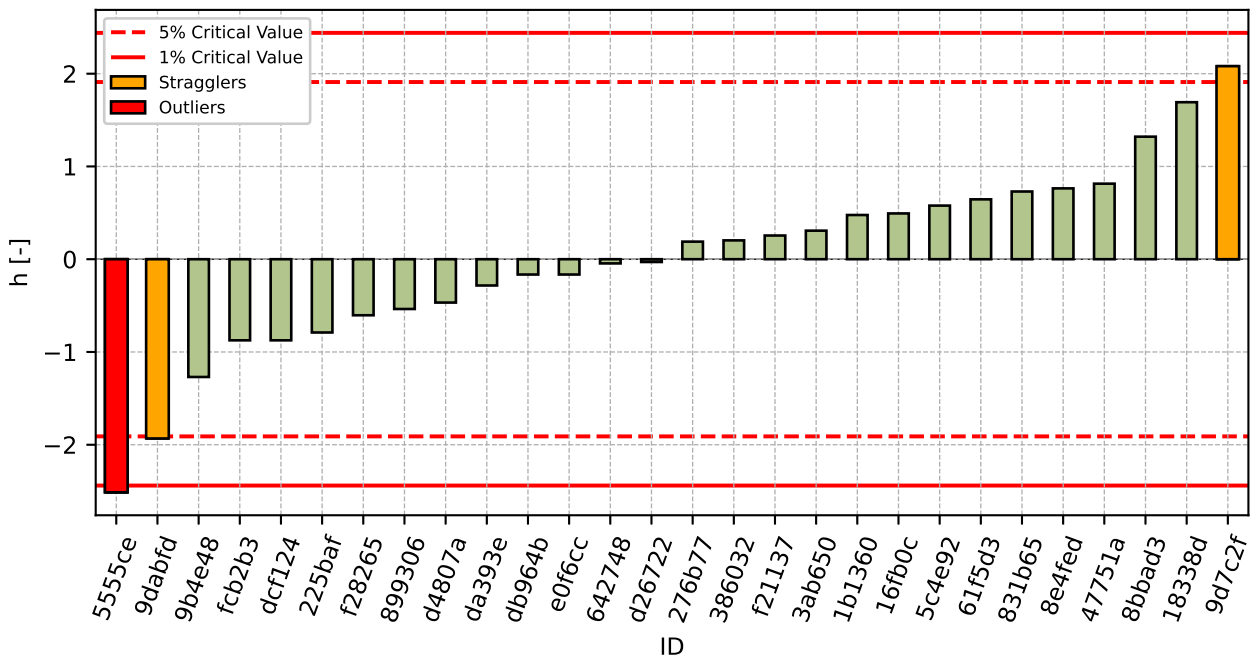


Figure 94: Interlaboratory Consistency Statistic

### 8.2.4 Descriptive statistics

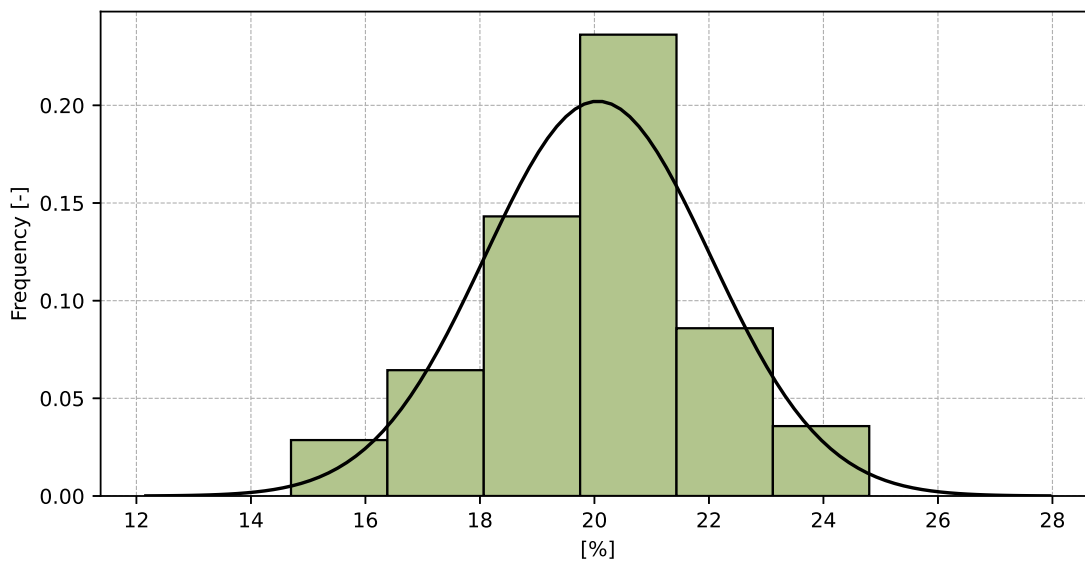


Figure 95: Histogram of all test results

Table 49: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	20.1
Sample standard deviation – $s$	1.97
Assigned value – $x^*$	20.2
Robust standard deviation – $s^*$	1.84
Measurement uncertainty of assigned value – $u_X$	0.43
$p$ -value of normality test	1.0 [-]
Interlaboratory standard deviation – $s_L$	1.95
Repeatability standard deviation – $s_r$	0.5
Reproducibility standard deviation – $s_R$	2.02
Repeatability – $r$	1.4
Reproducibility – $R$	5.6

### 8.2.5 Evaluation of Performance Statistics

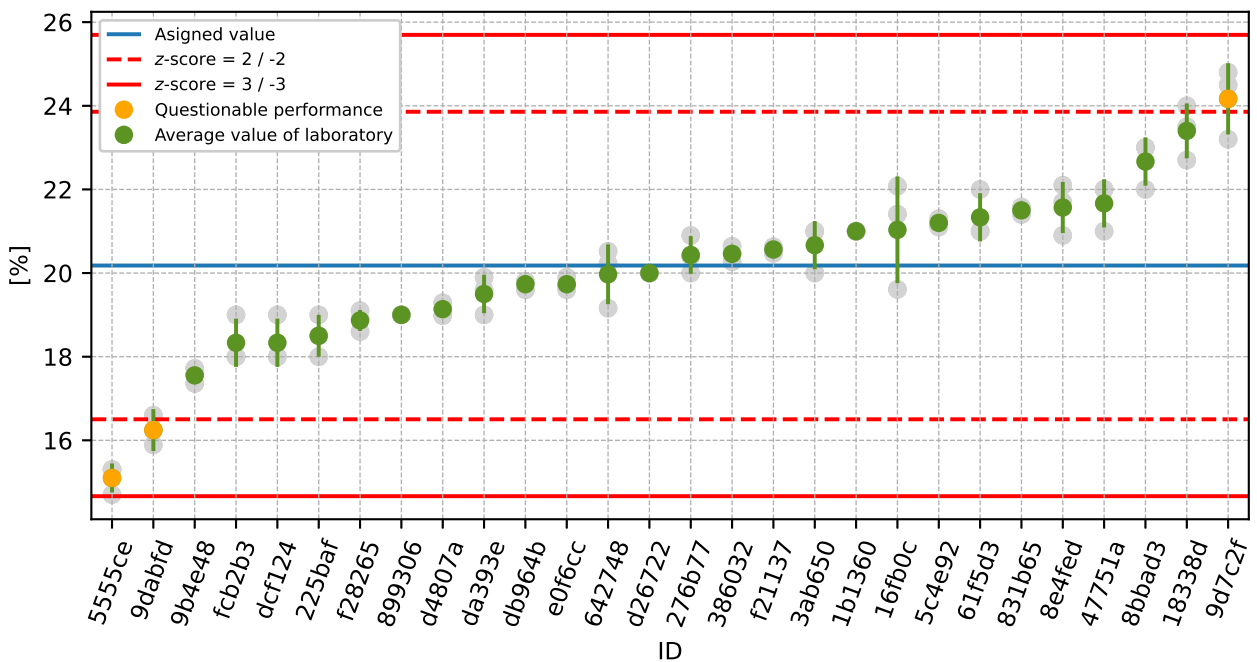


Figure 96: Average values and sample standard deviations

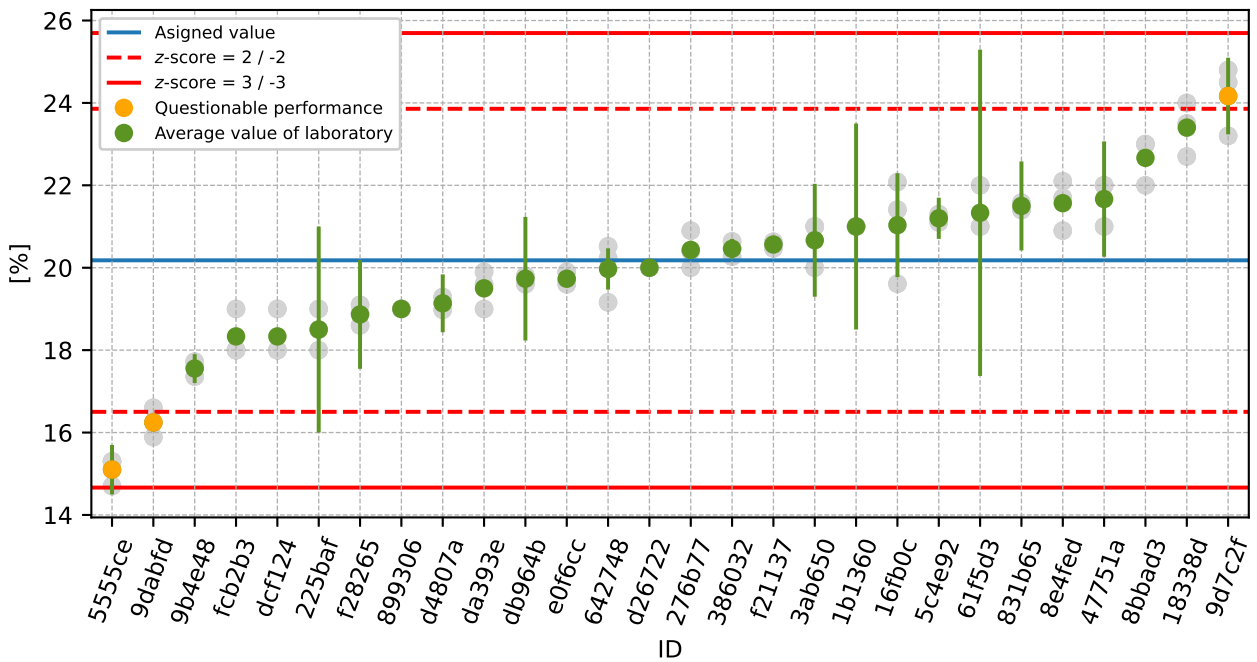


Figure 97: Average values and extended uncertainties of measurement

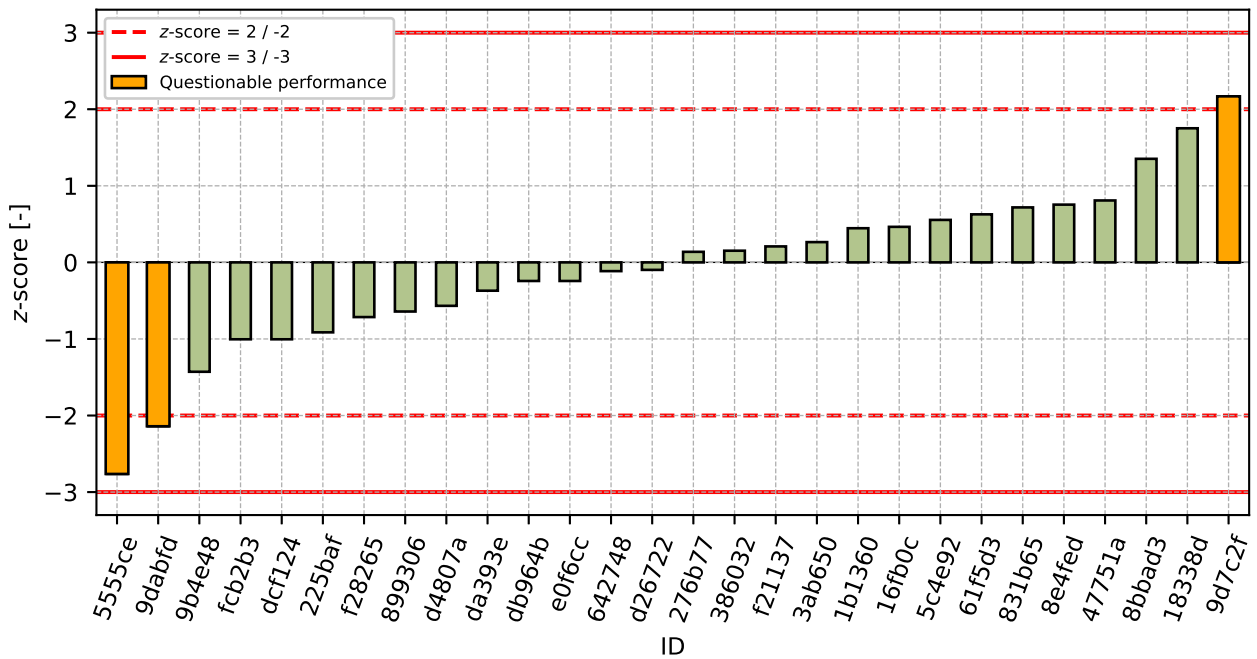


Figure 98: z-score

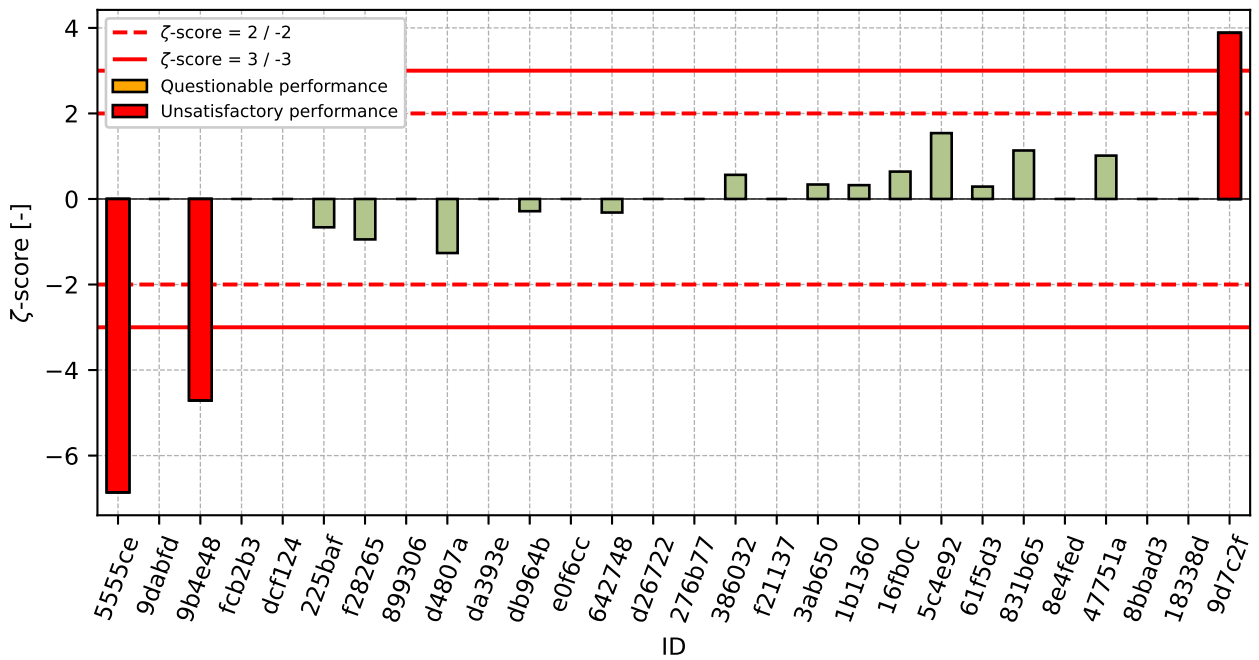


Figure 99:  $\zeta$ -score

Table 50: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
5555ce	-2.76	-6.86
9dabfd	-2.14	-
9b4e48	-1.43	-4.71
fc2b3	-1.0	-
dcf124	-1.0	-
225baf	-0.91	-0.66
f28265	-0.71	-0.95
899306	-0.64	-
d4807a	-0.57	-1.26
da393e	-0.37	-
db964b	-0.24	-0.29
e0f6cc	-0.24	-
642748	-0.11	-0.32
d26722	-0.1	-
276b77	0.14	-
386032	0.15	0.56
f21137	0.21	-
3ab650	0.26	0.34
1b1360	0.45	0.32
16fb0c	0.46	0.64
5c4e92	0.55	1.54
61f5d3	0.63	0.29
831b65	0.72	1.13
8e4fed	0.75	-
47751a	0.81	1.01
8bbad3	1.35	-
18338d	1.75	-
9d7c2f	2.17	3.88

## 9 Appendix – EN 13286-2 – Proctor

### 9.1 Proctor density

#### 9.1.1 Test results

Table 51: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [kg/m <sup>3</sup> ]	$u_x$ [kg/m <sup>3</sup> ]
f28265	1560	0.0
386032	1750	30.0
8e4fed	1755	-
c87702	1755	18.0
d4807a	1772	0.0
5555ce	1774	20.0
da393e	1775	-
8bbad3	1777	-
dcf124	1780	38.0
3ab650	1780	13.7
2c3ca2	1780	43.0
18338d	1780	-
d26722	1790	-
ebadb1	1790	4.0
f21137	1792	-
899306	1792	-
61f5d3	1800	-
276b77	1800	-
55818f	1810	40.0
b225ca	1810	36.2
c743cd	1820	36.4
01ba46	1830	-



### 9.1.2 The Numerical Procedure for Determining Outliers

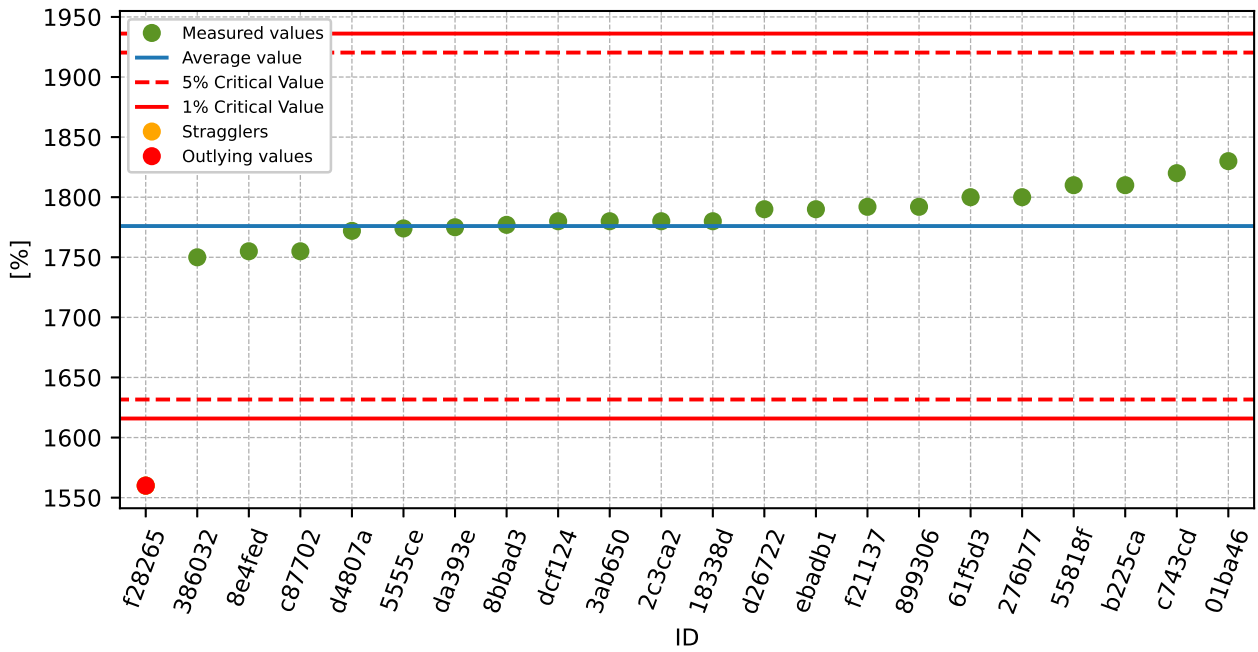


Figure 100: **Grubbs' test** - average values

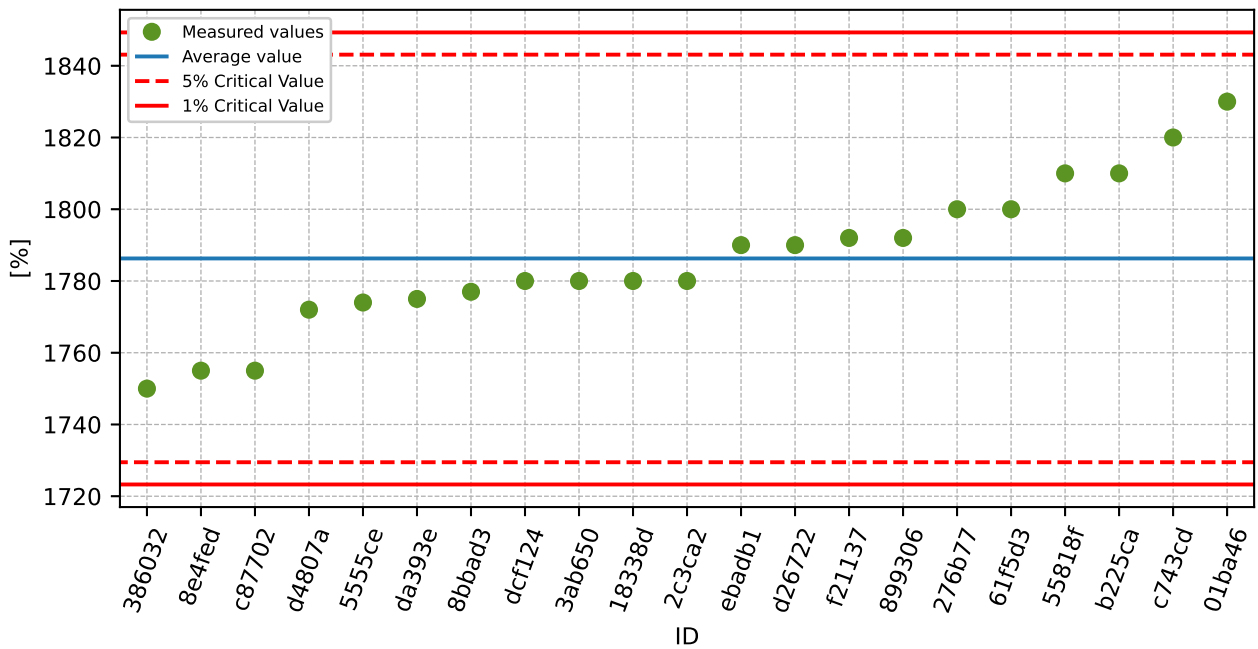


Figure 101: **Grubbs' test** - average values without outliers

### 9.1.3 Mandel's Statistics

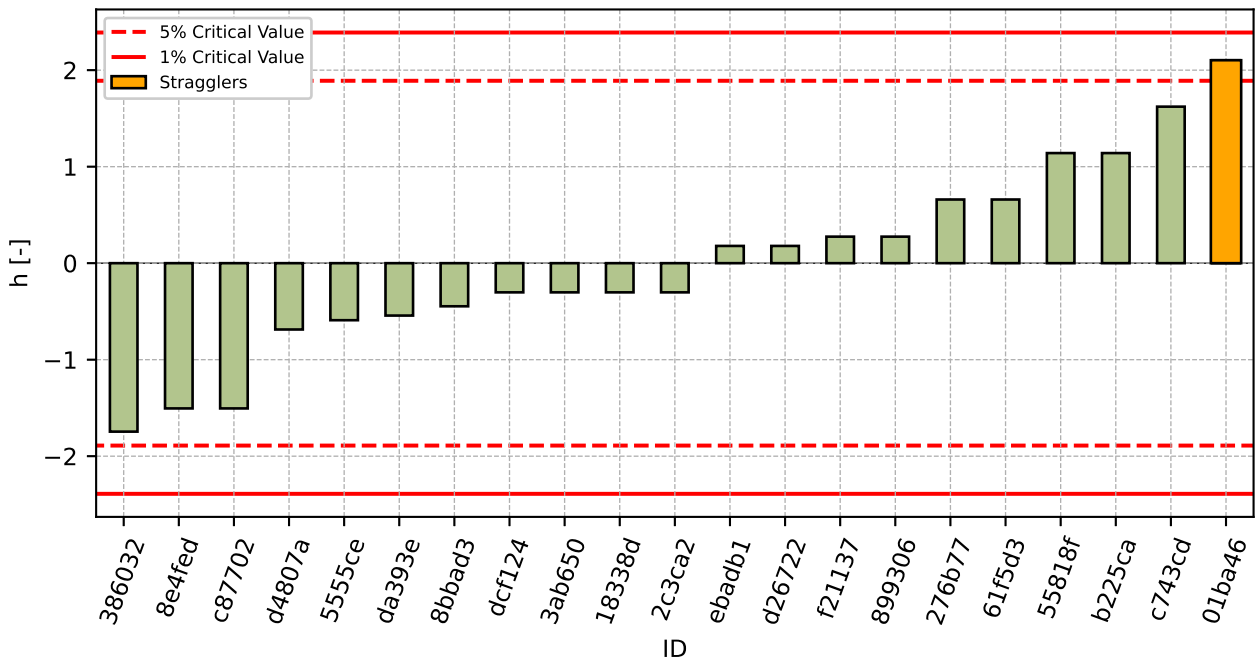


Figure 102: Interlaboratory Consistency Statistic

### 9.1.4 Descriptive statistics

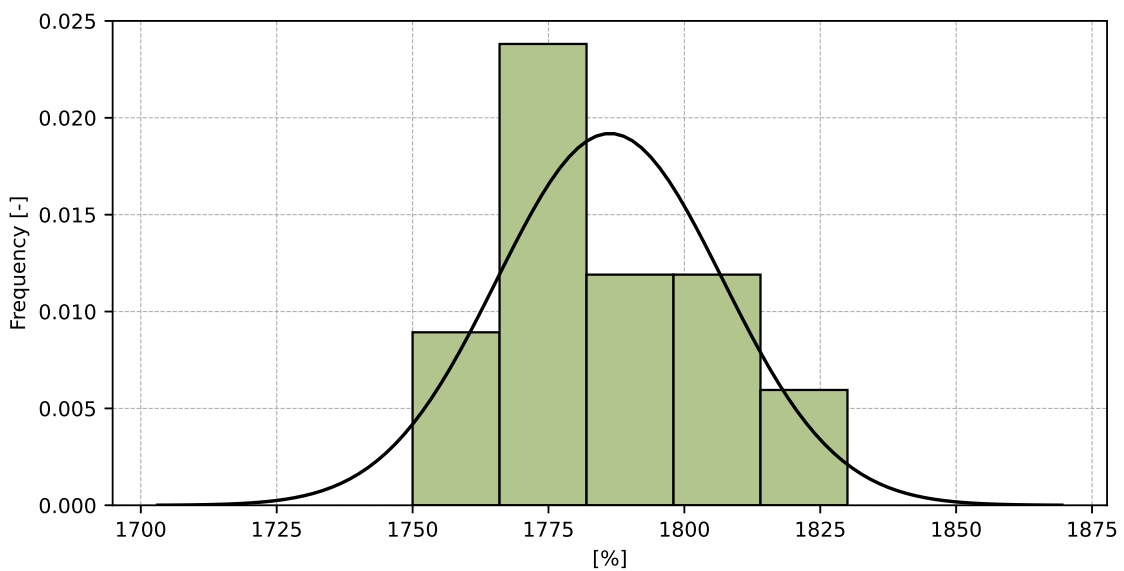


Figure 103: Histogram of all test results

Table 52: Descriptive statistics

Characteristics	[kg/m <sup>3</sup> ]
Average value – $\bar{x}$	1786.3
Sample standard deviation – $s$	20.79
Assigned value – $x^*$	1785.5
Robust standard deviation – $s^*$	22.44
Measurement uncertainty of assigned value – $u_x$	5.79
$p$ -value of normality test	0.695 [-]

### 9.1.5 Evaluation of Performance Statistics

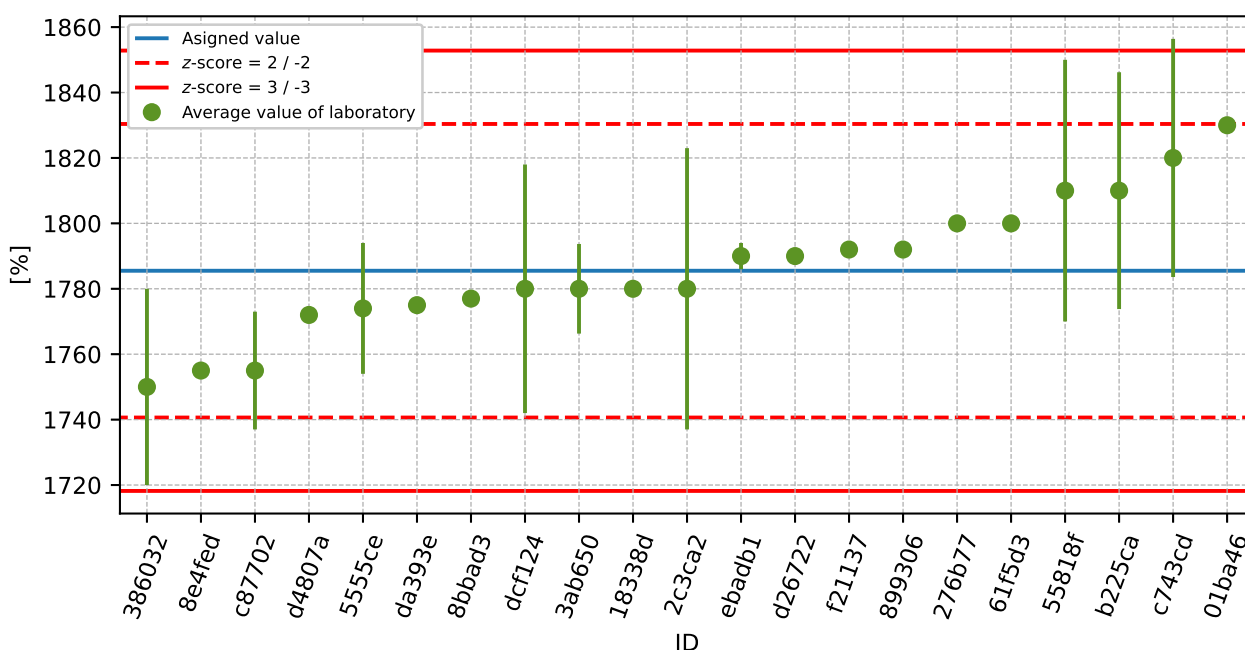


Figure 104: Average values and extended uncertainties of measurement

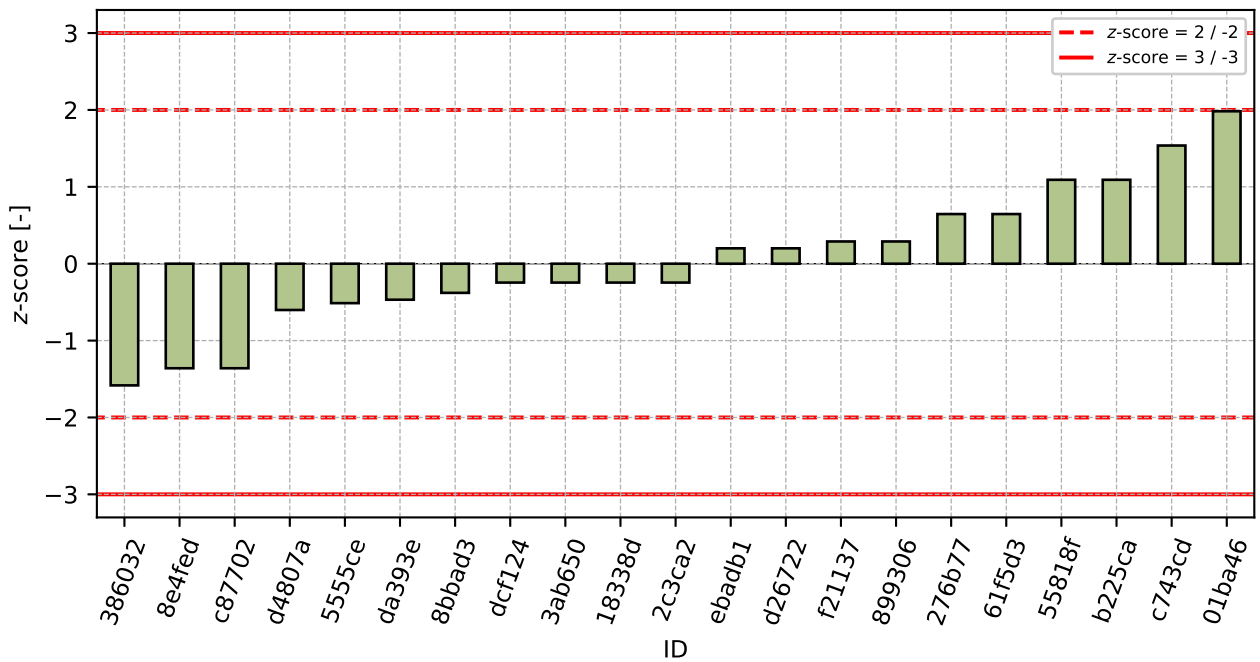


Figure 105: z-score

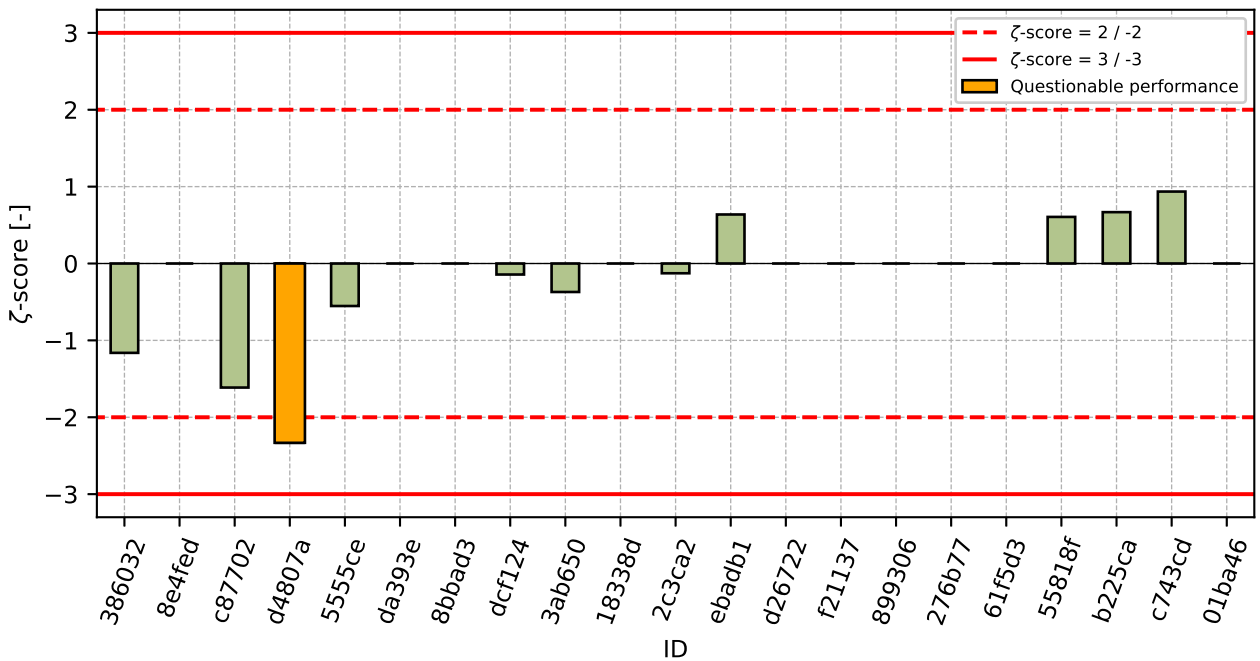


Figure 106: ζ-score

Table 53: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
386032	-1.58	-1.16
8e4fed	-1.36	-
c87702	-1.36	-1.61
d4807a	-0.6	-2.33
5555ce	-0.51	-0.55
da393e	-0.47	-
8bbad3	-0.38	-
dcf124	-0.25	-0.14
3ab650	-0.25	-0.37
18338d	-0.25	-
2c3ca2	-0.25	-0.13
ebadb1	0.2	0.64
d26722	0.2	-
f21137	0.29	-
899306	0.29	-
276b77	0.65	-
61f5d3	0.65	-
55818f	1.09	0.61
b225ca	1.09	0.67
c743cd	1.54	0.94
01ba46	1.98	-

## 9.2 Optimum water content

### 9.2.1 Test results

Table 54: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results [%]	$u_x$ [%]
2c3ca2	13.0	0.1
61f5d3	14.5	-
01ba46	14.8	-
8e4fed	15.0	-
c743cd	15.0	1.2
b225ca	15.0	1.2
55818f	15.3	1.0
d4807a	15.5	0.6
276b77	15.5	-
da393e	15.6	-
899306	15.9	-
dcf124	16.0	1.6
18338d	16.0	-
f21137	16.2	-
5555ce	16.2	0.3
c87702	16.3	0.7
386032	16.5	1.7
d26722	16.6	-
ebadb1	16.7	0.7
3ab650	17.0	0.1
8bbad3	17.5	-
<b>f28265</b>	<b>23.6</b>	<b>0.6</b>

### 9.2.2 The Numerical Procedure for Determining Outliers

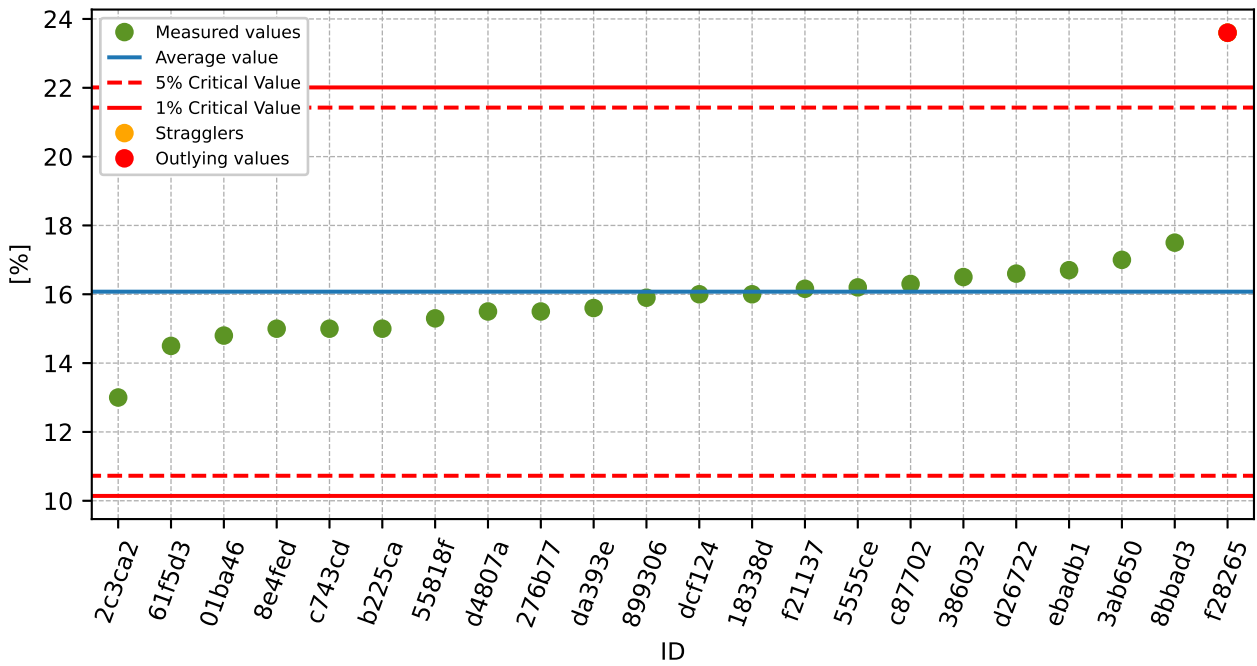


Figure 107: **Grubbs' test** - average values

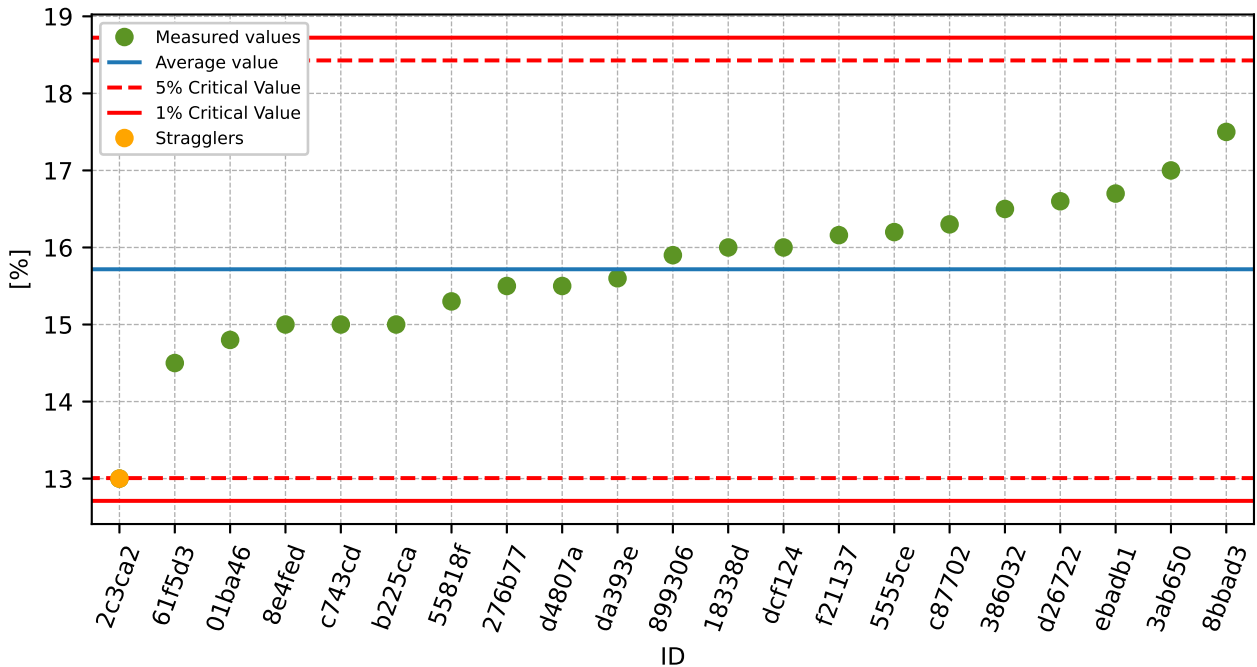


Figure 108: **Grubbs' test** - average values without outliers

### 9.2.3 Mandel's Statistics

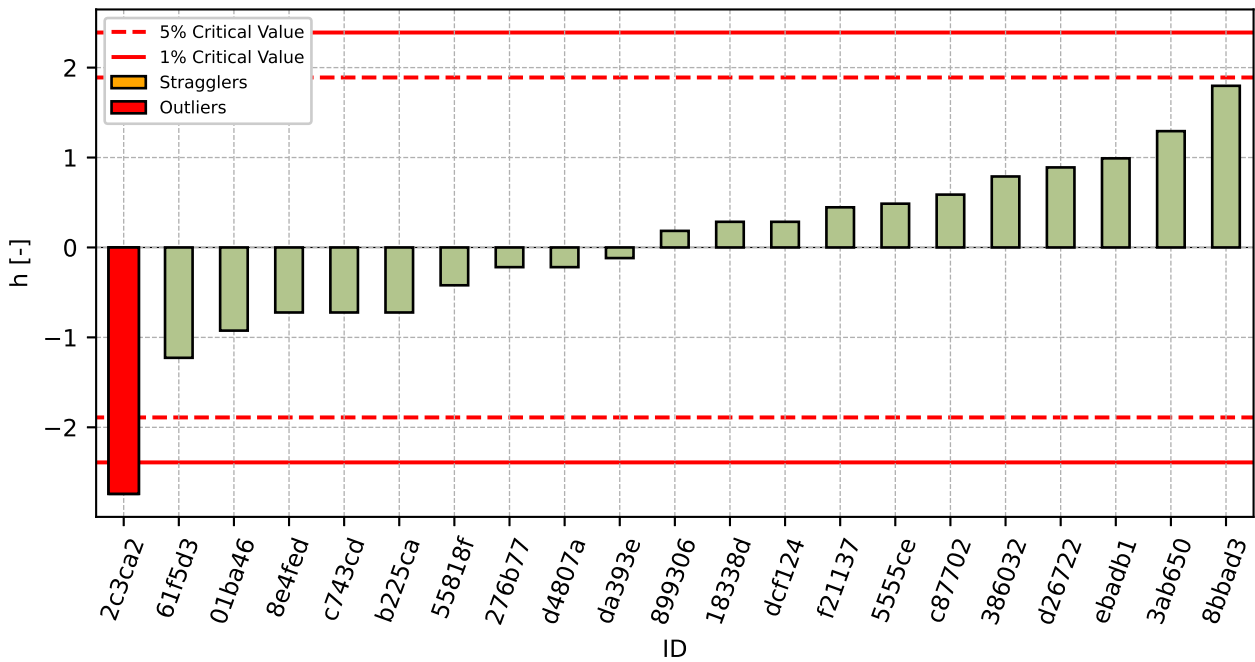


Figure 109: Interlaboratory Consistency Statistic

### 9.2.4 Descriptive statistics

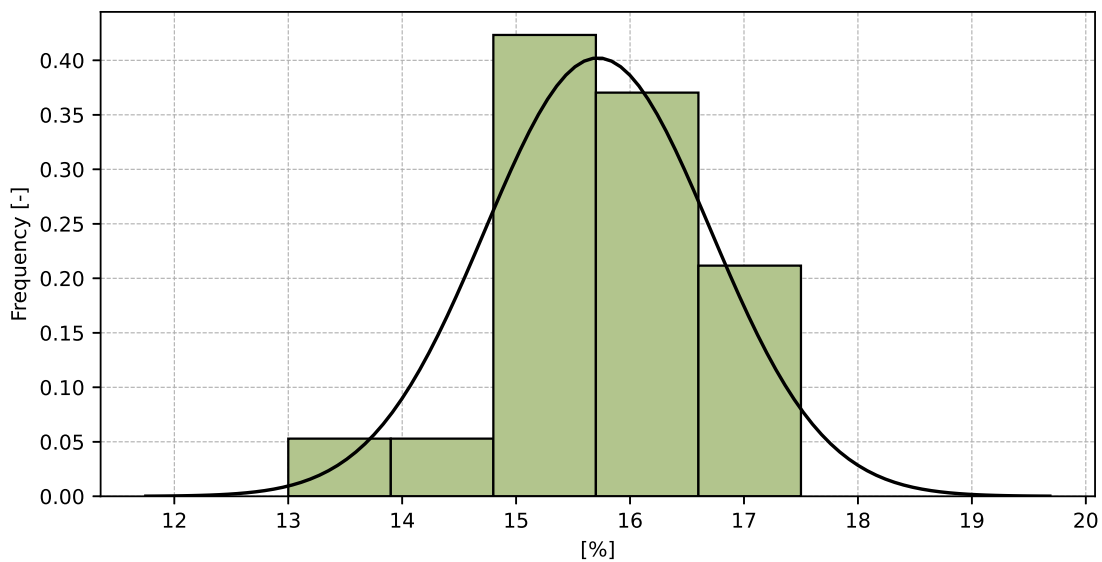


Figure 110: Histogram of all test results



Table 55: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	15.7
Sample standard deviation – $s$	0.99
Assigned value – $x^*$	15.8
Robust standard deviation – $s^*$	0.9
Measurement uncertainty of assigned value – $u_x$	0.25
$p$ -value of normality test	0.523 [-]

### 9.2.5 Evaluation of Performance Statistics

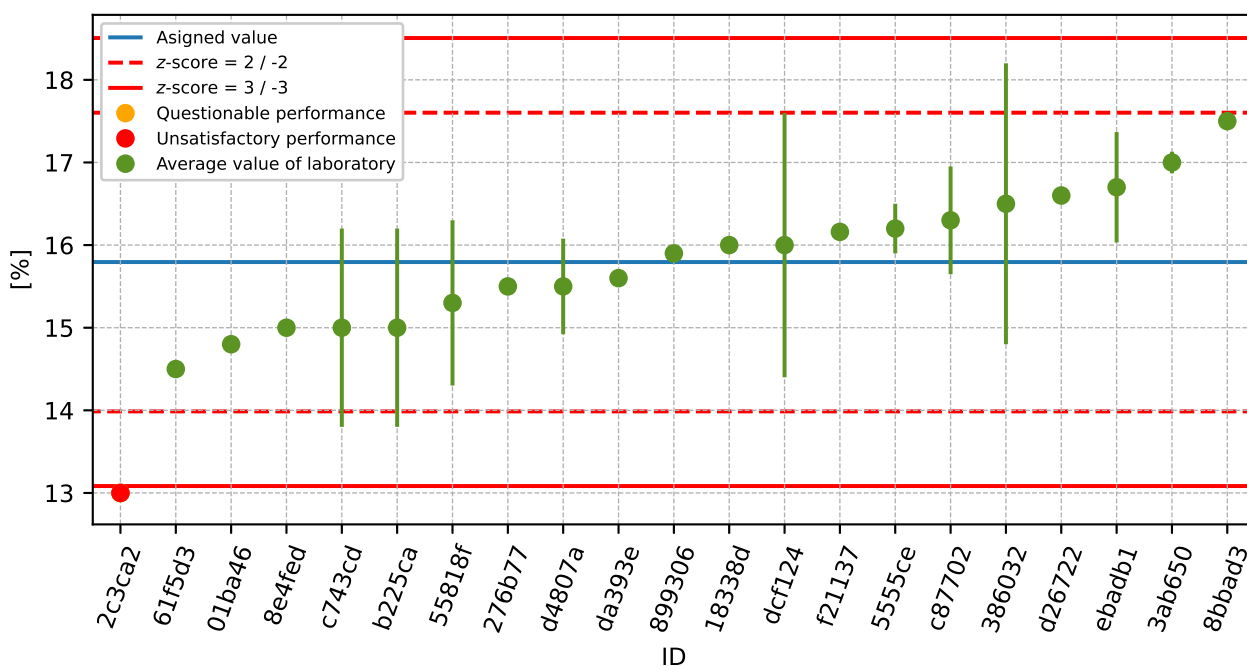


Figure 111: Average values and extended uncertainties of measurement

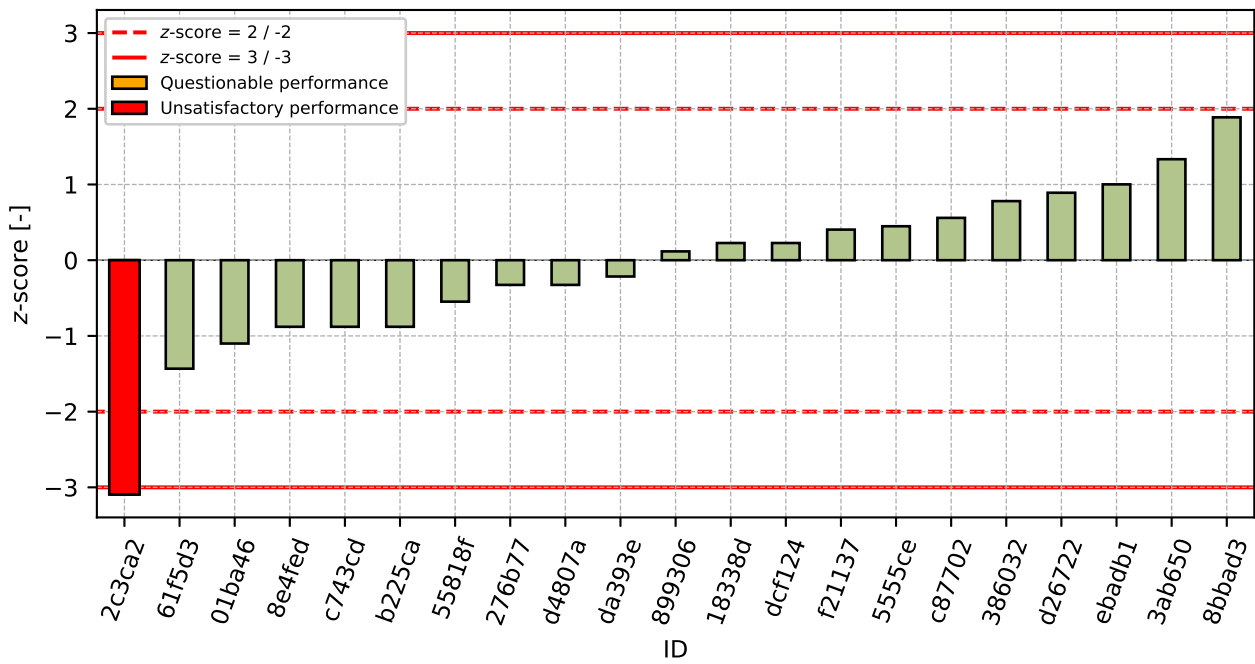


Figure 112: z-score

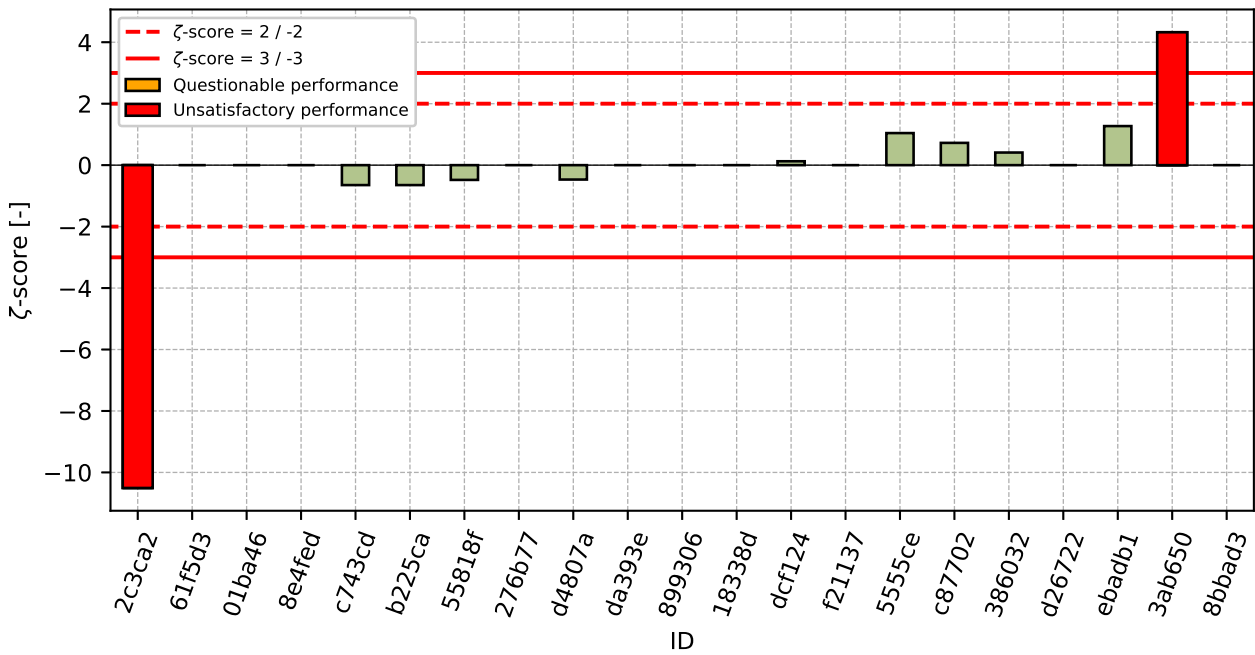


Figure 113: zeta-score

Table 56: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
2c3ca2	-3.09	-10.51
61f5d3	-1.43	-
01ba46	-1.1	-
8e4fed	-0.88	-
c743cd	-0.88	-0.65
b225ca	-0.88	-0.65
55818f	-0.55	-0.48
276b77	-0.33	-
d4807a	-0.33	-0.47
da393e	-0.22	-
899306	0.12	-
18338d	0.23	-
dcf124	0.23	0.13
f21137	0.4	-
5555ce	0.45	1.04
c87702	0.56	0.72
386032	0.78	0.41
d26722	0.89	-
ebadb1	1.0	1.27
3ab650	1.33	4.32
8bbad3	1.89	-

## 10 Appendix – EN 13286-47 – IBI

### 10.1 Test results

Table 57: Test results - ordered by average value. Outliers are marked by red color.  $u_x$  - extended uncertainty of measurement.

ID	Test results	$u_x$
	[%]	[%]
c6d3ea	3.0	0.5
2c3ca2	4.0	1.0
da393e	4.0	-
c87702	4.5	0.6
3ab650	6.5	1.3
5c4e92	8.0	0.5
18338d	9.0	-
8bbad3	9.5	-
61f5d3	11.0	-
899306	12.0	-
05275d	12.0	-
276b77	12.0	-
f21137	13.0	-
d4807a	13.2	0.2
d26722	15.0	-
dcf124	15.1	2.4
5555ce	16.0	1.0

### 10.2 The Numerical Procedure for Determining Outliers

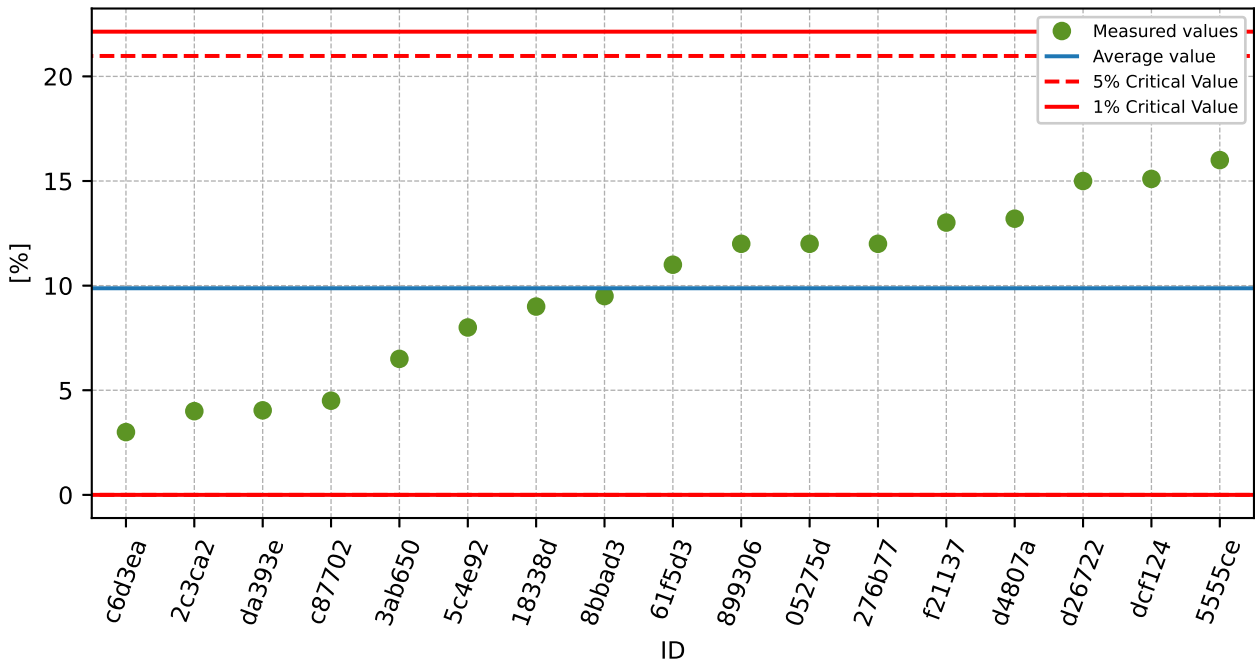


Figure 114: Grubbs' test - average values

### 10.3 Mandel's Statistics

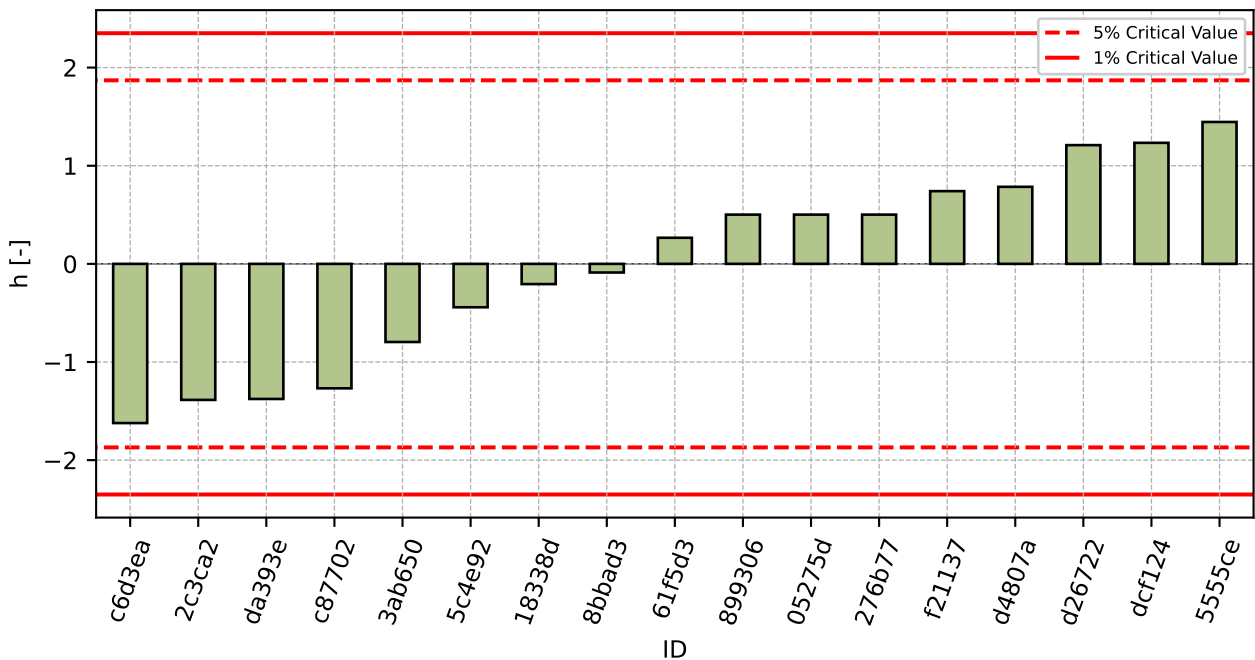


Figure 115: Interlaboratory Consistency Statistic

## 10.4 Descriptive statistics

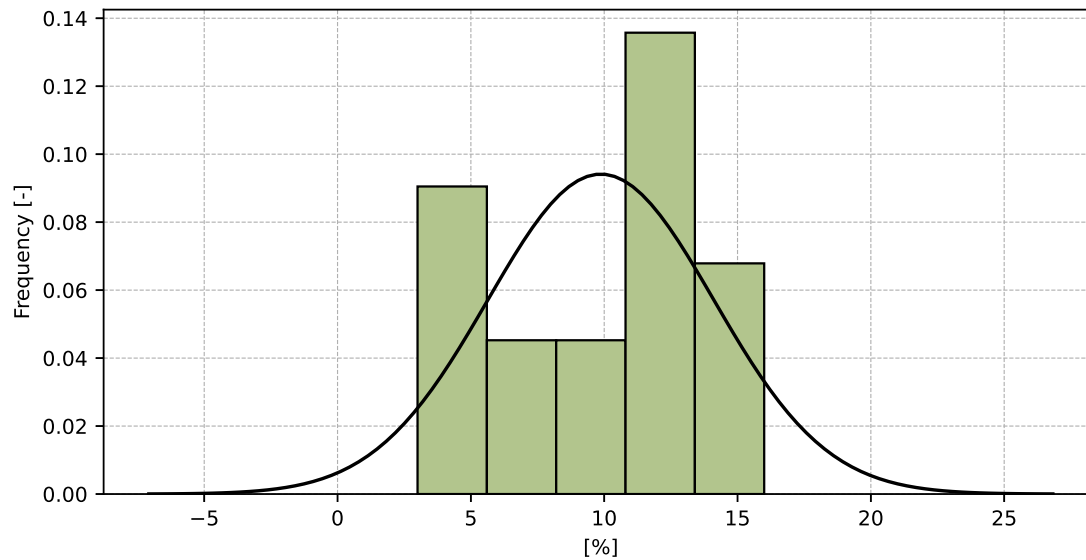


Figure 116: Histogram of all test results

Table 58: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	9.9
Sample standard deviation – $s$	4.24
Assigned value – $x^*$	10.0
Robust standard deviation – $s^*$	4.47
Measurement uncertainty of assigned value – $u_x$	1.35
$p$ -value of normality test	0.217 [-]

### 10.5 Evaluation of Performance Statistics

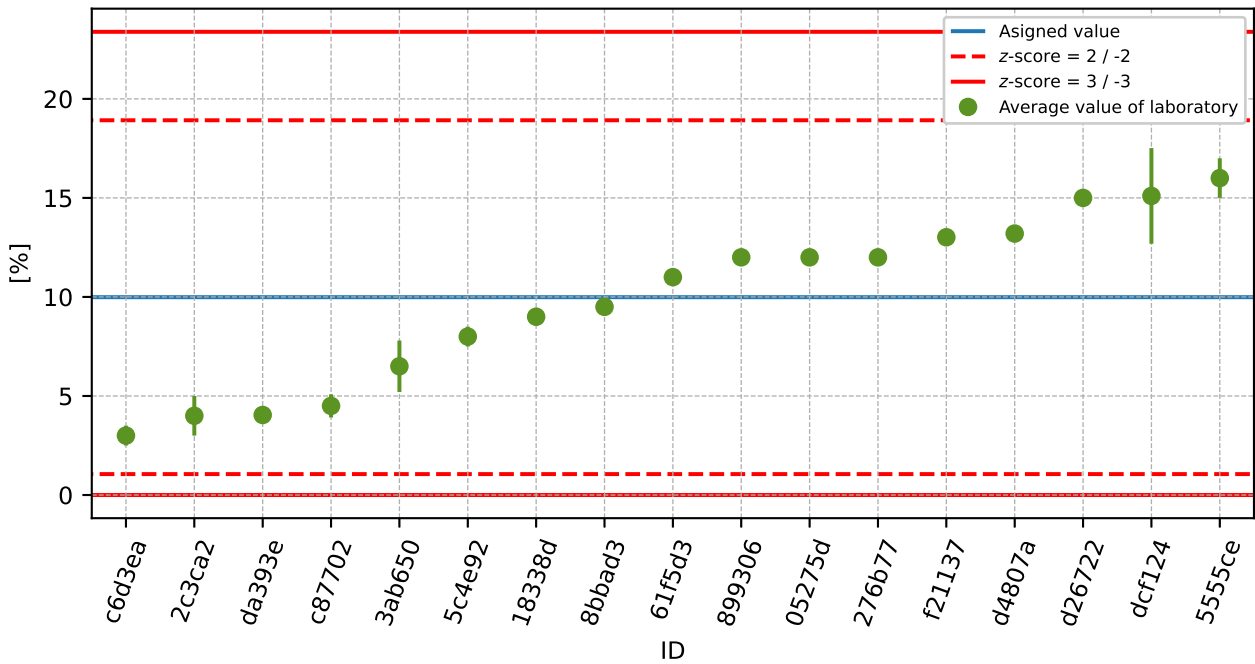


Figure 117: Average values and extended uncertainties of measurement

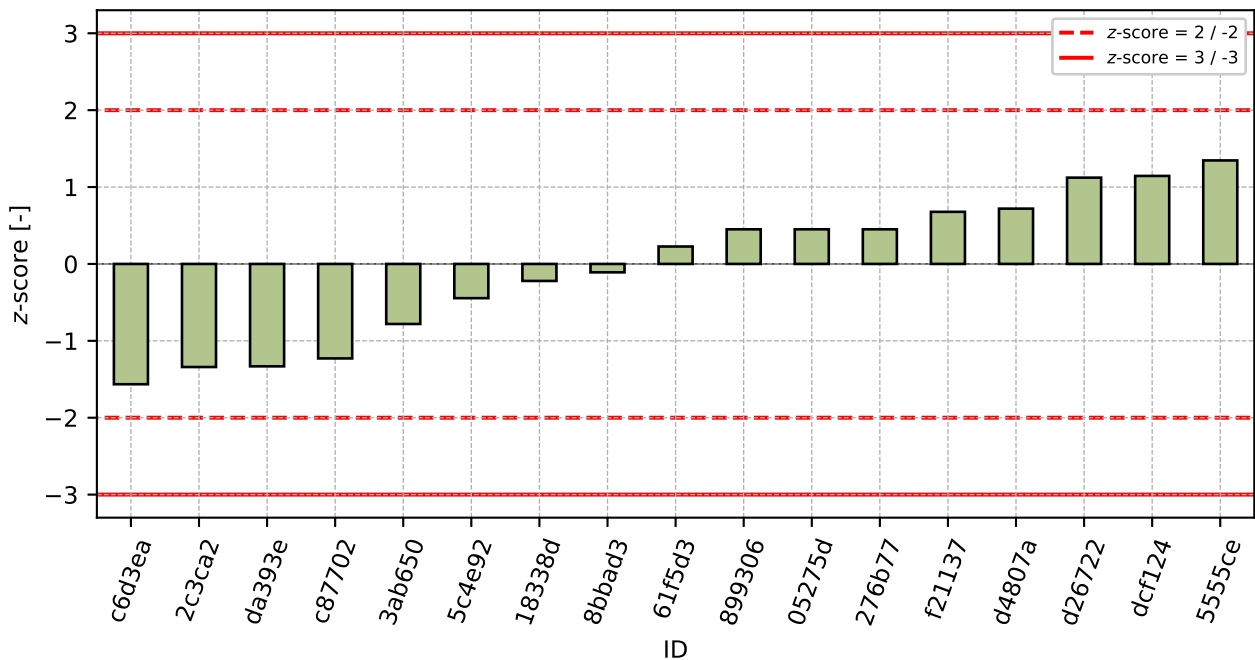
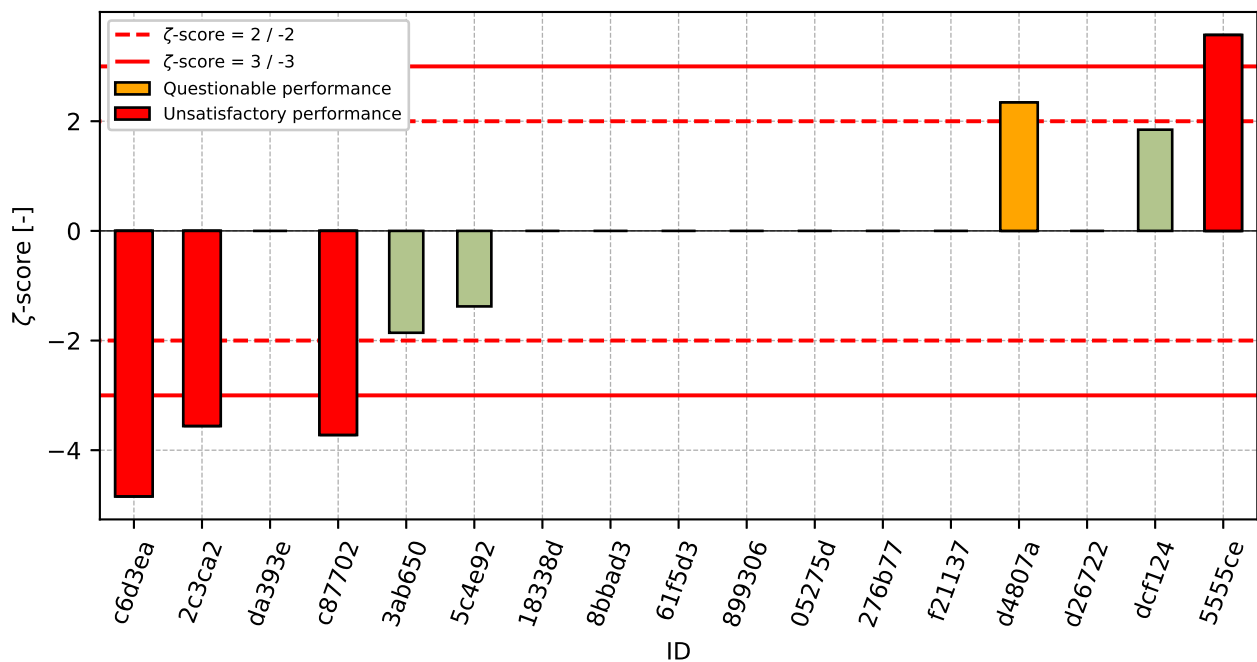


Figure 118: z-score

Figure 119:  $\zeta$ -scoreTable 59: z-score and  $\zeta$ -score

ID	z-score [-]	$\zeta$ -score [-]
c6d3ea	-1.56	-4.84
2c3ca2	-1.34	-3.56
da393e	-1.33	-
c87702	-1.23	-3.72
3ab650	-0.78	-1.86
5c4e92	-0.45	-1.38
18338d	-0.22	-
8bbad3	-0.11	-
61f5d3	0.23	-
899306	0.45	-
05275d	0.45	-
276b77	0.45	-
f21137	0.68	-
d4807a	0.72	2.34
d26722	1.12	-
dcf124	1.14	1.85
5555ce	1.35	3.57