BRNO UNIVERSITY OF TECHNOLOGY

FACULTY OF CIVIL ENGINEERING
institute of building testing

ilac-MRA

Z 7008

FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program
Soil Testing
ZZ 2024/1

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

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

Date: January 15, 2025

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Ing. Petr Misák, Ph.D.
Coordinator of PTP results assessment

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1 Introduction and Important Contacts

In the year 2024, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZZ 2024/1 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

doc. Ing. Tomáš Vymazal, Ph.D.
Brno University of Technology
Faculty of Civil Engineering
Institute of Building Testing
Veveří 95, Brno 602 00
Czech Republic
Tel.: +420 603 313 337
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Coordinator of PTP result assessment PrZZ

Ing. Petr Misák, Ph.D.
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Veveří 95, Brno 602 00
Czech Republic
Tel.: +420 774 980 255
Email: Petr.Misak@vut.cz

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.

70 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
25aa05	X	X	X	X	X	X	X	X	X	X
86eb15	X	-	X	X	-	-	-	X	X	X
1357c8	X	X	X	X	X	-	X	X	-	-
01225f	-	X	X	-	-	-	-	-	-	-
ed0ab6	-	-	-	-	-	-	-	-	X	-
33459f	X	X	-	-	-	X	X	-	-	-
fed12a	-	-	-	-	-	-	-	-	X	-
c871a4	X	X	X	X	-	-	-	X	-	-
f8bc7a	X	X	X	X	X	X	X	X	X	X
d1ee17	X	X	X	X	-	-	X	X	X	X
96dae7	X	X	X	X	X	-	-	X	X	X
c0ca45	-	-	X	-	X	-	-	-	-	X
ecf0fd	-	-	X	-	-	-	-	-	-	-
589c5f	X	X	X	X	-	-	-	X	X	X
666124	X	X	X	-	X	X	X	X	-	-
7ac937	X	X	X	X	-	-	-	X	-	-
55e5c0	-	-	-	-	-	-	-	-	X	-
7d0a95	-	-	-	-	-	-	X	-	-	-
3832b5	X	-	-	-	-	-	-	-	X	-
fdd45f	X	-	-	-	-	-	-	-	X	-
4ee2d2	X	-	-	-	-	-	-	-	-	-
ce319a	X	-	X	X	-	-	-	X	X	X
60f194	X	-	-	-	-	-	-	-	X	X
de7330	X	-	-	-	-	-	-	-	X	X
bdbff6	-	-	-	-	-	-	X	-	-	-
22d484	-	-	-	-	X	-	X	-	-	-
1202ed	X	-	X	X	-	-	-	X	-	-
1632e2	X	X	-	X	-	-	-	X	-	-
53a71c	-	-	-	-	-	-	-	-	X	X
7ffaba	X	-	X	X	-	-	-	X	-	-
e81c64	X	-	X	-	-	-	-	-	X	-
cc7904	X	X	X	X	-	-	-	-	X	-
320ee2	-	-	X	X	-	-	-	-	-	-
f03e9c	X	X	-	-	X	-	-	-	-	-
54b338	-	-	-	-	X	-	-	X	-	-
b0c75b	X	X	X	X	X	X	X	X	X	-
33e846	-	-	X	-	-	-	-	X	-	-
390c3b	X	X	X	X	X	X	X	X	-	-
90dd12	X	-	X	-	-	X	X	X	-	-
7f895a	X	-	X	X	-	-	-	X	-	-
3ffebb	-	X	-	X	X	X	-	-	-	-
4a8427	X	X	X	X	-	-	-	X	-	-
779696	X	X	X	X	X	X	X	X	X	X
8aeb2c	X	-	-	-	-	-	-	X	-	X

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ID/Method	1	2	3	4	5	6	7	8	9	10
f2dd88	X	X	X	X	X	X	X	X	X	-
f90fb7	-	-	X	X	X	-	-	-	-	X
5b9821	-	-	-	-	-	-	-	X	-	-
e10589	X	X	X	X	X	X	X	X	-	-
a81bc3	X	-	X	-	-	-	-	X	X	X
9d12b7	-	-	X	X	-	-	-	-	-	-
4dbd08	X	-	-	-	-	-	-	-	-	-
087225	-	-	-	-	-	-	-	X	-	X
1b8e4c	X	X	X	X	-	X	X	X	X	-
2b2ff2	X	X	-	-	-	-	-	-	-	-
3a439b	-	-	-	-	-	-	-	X	X	-
5b2e25	X	X	X	X	-	-	-	X	-	-
3d61b1	X	-	X	-	-	-	-	X	-	-
25e875	X	X	X	X	-	-	-	X	-	-
5633d2	-	-	-	-	-	-	X	X	-	-
4ceca5	X	X	X	-	-	-	-	-	-	-
fc937d	X	-	X	-	-	-	-	X	X	X
f0ee71	X	-	-	-	-	-	-	-	-	-
df7d84	X	X	X	X	X	X	-	X	X	X
8f9b0e	X	-	-	-	-	-	-	-	X	-
1b001e	-	-	-	-	-	-	-	-	X	-
8b3490	X	-	-	-	-	-	-	-	X	X
5c1ea2	-	-	-	X	X	-	X	X	-	-
068f53	-	-	-	-	-	-	-	-	-	X
05920e	X	X	X	X	-	-	-	X	-	-
225f2b	X	X	X	X	X	X	X	X	-	X

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

Laboratory	Address	Accreditation number
4G consite s.r.o.	Šlikova 406/29, Praha 6, 16900, 27624218	1518
ALS Czech Republic s.r.o.	Na Harfě 336/9, Praha 9, 19000, 27407551	-
AZ Consult, spol. s r.o.	Klíšská 1334/12, Ústí nad Labem, 400 01, 44567430	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	-
Banat Inzenjering LBI DOO	Makedonska 15, Zrenjanin, 23000, Republic of Serbia	01-540

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Laboratory	Address	Accreditation number
Bechtel ENKA UK Limited Ogranak Beograd	Jasički put 52đ, Kruševac, 37000, Serbia	-
C.S.R. S.r.l. Centro Sviluppo Ricerche	Via Feltrin, 125, Noale (Venezia), 30033, Italy	-
CONSULTEST s.r.o. - pracoviště Brno	Medkova 974/4, Brno - Tuřany, 62700, ČESKÁ REPUBLIKA	1211
CONSULTEST s.r.o. - pracoviště Napajedla	Medkova 974/4, Brno - Tuřany, 62700, ČESKÁ REPUBLIKA	1211
Civil Engineering Institute IG LLC Banja Luka	Kralja Petra I Karađorđevića 92-98, Banja Luka, 78000, BIH	-
EDAFOMICHANIKI S.A.	19 EMMANUEL PAPADAKI, NEO IRAKLEIO, 14121, GREECE	1269
Estonian Environmental Research Centre	Marja 4d, Tallinn, 10617, Harjumaa	L008
Eurovia Lietuva	Liepkalnio g. 85, Vilnius, 02120, Lithuania	-
GEMATEST s.r.o.	Dr. Janského 954, Černošice, 25228, Česká republika	-
GEODRILL s.r.o.	K Bukovinám 169/45, Brno, 63500, Česká Republika	1596
GEOSTAND AND ASSOCIATES S.A.	KALYMNOU 16, ATHENS, 11251, GREECE	-
GEOtest, a.s.	Šmahova 1244/112, Brno, 627 00, Česká republika	1271
GeoTec-GS, a.s.	Pekárenská 257/81, České Budějovice, 370 04, Česká republika	1772
Geohidroinzenering DOO Skopje	1606 No.8, Gjorce Petrov, Skopje, Skopje, 1000, N Macedonija	LT-096
Geotech d.o.o.	Ciottina 21, Rijeka, 51000, Croatia	1717
Gradezen Institut "Makedonija" AD Skopje	Drezdenska No.52, Skopje, 1000, North Macedonia	LT-014
Gradjevinsko-arhitektonski fakultet Univerziteta u Nišu	Aleksandra Medvedeva 14, Niš, 18000, Serbia	01-202
IGSL	IGSL M7 Business Park Newhall, NAAS, W91 DY93, Ireland	-
INGEO-ENVILAB, s.r.o.	Bytčiská 16, Žilina, 01001, Slovensko	-
Impresa Bacchi S.r.l.	VIA DON DOSSETTI 19, carpiano (MI), 20080, 9BIE	1554L
Innovation Hub/PPC S.A.	Leontariou 9, Kantza Pallini, Athens, 15351, Greece	ed56ac
Labgeo cz s.r.o.	Plzeňská 466/359, Ostrava, 724 00, Česká republika	1789
Labo Devlieger - Van Vooren	Industriepark Rosteyne 1, zelzate, 9060, Oost-Vlaanderen	296-TEST
Laboratoire des Travaux Publics de l'Ouest (LTP-Ouest)	Rond-point des CASTORS, Oran, 31000, ALGERIA	-
Lithuanian geology survey under ministry of environment	S. Konarskio 35, Vilnius, LT-03123, Lithuania	LA.215-01

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Laboratory	Address	Accreditation number
MIRTEC S.A. - Thiva Branch	76th km of Athens-Lamia National Road (Ritsona exit, Schimatari, Boeotia, 32009, Greece	-
Mattest (Ireland) Ltd. Cork Laboratory	Unit 18, University Hall Ind. Park, Sarfield Rd. Wilton, Cork, T12 EV20, ROI	289T
Mega Infrastructure d.o.o., Beograd-Savski Venac, 11000, Belgrade, Serbia	Potez Ružaš, Irig, 22406, Serbia	-
NIEVELT Labor CZ s.r.o.	Za Olomouckou 4184/17, Prostějov, 79601, Česká republika	1716
NeXperta - afdeling Geotechiek	Technologiepark-Zwijnaarde 68, Gent, 9052, België	-
PUDIS a.s.	Podbabská 1014/20, Praha 6, 160 00, Česká republika	1762
Radis d.o.o PJ Radis Institut	Jovana Ducica 16, Istočno Sarajevo, 71123, Bosna i Hercegovina	-
Rina Consulting - GET	Via Albisola 64/66 Genova, genova, 16152, Genova	-
S.C. GEOSTUD S.R.L.	Str. Sîngerului, nr. 11, sector 1, Bucharest, 014617, RO13840425	LI 974
SG Geotechnika a.s.	Geologická 4, Praha 5, 15200, Česká republika	1119
Slovenian national building and civil engineering institute	Dimičeva ulica 12, Ljubljana, 1000, Slovenia	-
Structural Soils Ltd - BRISTOL	Unit 1A, Princess Street, Bedminster, Bristol, BS3 4AG, Bristol	-
Structural Soils Ltd - CASTELFORD	The Potteries, Pottery Street, Castleford, WF10 1NJ, West Yorkshire	-
Structural Soils Ltd - Hemel Hempstead	18 Frogmore Road, Hemel Hempstead, HP3 9RT, Hertfordshire	-
Structural Soils Ltd - TONBRIDGE lab	Structural Soils Ltd, Anerly Court, Half Moon Lane, Hildenborough, Tonbridge, TN11 9HU, Kent	-
Sweco Lietuva UAB	A. Strazdo g 22, Kaunas, LT-48488, Lithuania	-
TESScontrol, s. r. o., organizačná zloška, TESScontrol - Zkušební laboratoř Znojmo	Brněnská 3797/29, 669 02 Znojmo, Praha 8, 182 00, Česká republika	L-1793
TESTLAND SP. Z O.O.	ul. Kasztanowa 14, Łężyce, 84-207, 5862298514	-
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 370 06, Česká republika	1181
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 370 06, Česká republika	1181
TRANSLAB LABORATORIUM	Oeverstraat 21, Lokeren, 9160, Belgium	-
TUV Austria Romania	Calea Plevnei, nr.139B, Bucharest, 060011, Romania	-

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Laboratory	Address	Accreditation number
UAB "GeoFirma"	Sauletelio al. 15-515, Vilnius, 10224, Lithuania	-
UAB "Geoanalizė"	Užnerio g. 1A„ Kaunas, LT-47484, Lithuania	-
UAB Gruntira	Žiogupio g. 37D, Palanga, LT-00177, Lithuania	-
UAB Grunto Laboratorija	Guobų aklg. 1I, Kretinga, LT-97120, Lithuania	-
UAB"Rapasta"	Gedinimo 47- 02, Kaunas, LT-44242, Lithuania	-
UNIGEO a.s.	Místecká 329/258, Ostrava, 70200, Česká republika	1412
University of Belgrade - Faculty of Civil Engineering	Bulevar kralja Aleksandra 73, Belgrade, 11000, Serbia	-
VIALAB CZ s.r.o. - CL07	U Michelského lesa 1581/2, Praha 4, 14000, Česká republika	1112
VIALAB CZ s.r.o. - CL11	U Michelského lesa 1581/2, Praha 4, 14000, Česká republika	1112
VIALAB CZ s.r.o. - Laboratoř Morava, pracoviště LM1-Zlín	MU CODE 1545, PO Box 207, Praha 6, 16041, Česká republika	1170
VIALAB CZ s.r.o. - Laboratoř Morava, pracoviště LM3-Brno	MU CODE 1545, PO Box 207, Praha 6, 16041, Česká republika	1170
VIALAB CZ s.r.o. - Laboratoř Morava, pracoviště LM4-Ostrava	MU CODE 1545, PO Box 207, Praha 6, 16041, Česká republika	1170
Vilnius Gediminas technical university (VILNIUS TECH)	Saulėtekio ave. 11, Vilnius, LT-10223, Lithuania	LA.01.063
České vysoké učení technické v Praze	Thákurova 7, Praha, 16629, Česká republika	1048
České vysoké učení technické v Praze	Thákurova 2077/7, Praha, 16629, Česko	1048
Ředitelství silnic a dálnic s. p.	Na Pankráci 546/56, Praha 4, 145 00, Česká republika	1072
i2 Analytical Ltd. Sp. z o.o. Oddzial w Polsce	Pionierów 39, Ruda Śląska, 41-710, Poland	UKAS 4041

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 ZZ 2024/1(PT Program) organized by the PT Provider at the SZK FAST. 70 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 four 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
25aa05	✓	✓	✓	?	✓	✓	✓	✓	✓	✓
86eb15	✓	-	✓	✓	-	-	-	✓	✓	✓
1357c8	?	✓	✓	✓	✓	-	✓	?	-	-
01225f	-	✓	✓	-	-	-	-	-	-	-
ed0ab6	-	-	-	-	-	-	-	-	?	-
33459f	✓	✓	-	-	-	✓	✓	-	-	-
fed12a	-	-	-	-	-	-	-	-	✓	-
c871a4	✓	✓	✓	✓	-	-	-	✓	-	-
f8bc7a	✓	✓	✓	✓	✓	?	✓	✓	✓	✓
d1ee17	✓	✓	✓	✓	-	-	✓	✓	✓	✓
96dae7	✓	✓	✓	✓	✓	-	-	✓	✓	✓
c0ca45	-	-	✓	-	✓	-	-	-	-	✓
ecf0fd	-	-	✓	-	-	-	-	-	-	-
589c5f	✓	✓	?	✓	-	-	-	✓	✓	✓
666124	✓	✓	✓	-	✓	✓	?	✓	-	-
7ac937	✓	✓	✓	✓	-	-	-	✓	-	-
55e5c0	-	-	-	-	-	-	-	-	✓	-
7d0a95	-	-	-	-	-	-	✓	-	-	-
3832b5	✓	-	-	-	-	-	-	-	?	-
fdd45f	✓	-	-	-	-	-	-	-	✓	-
4ee2d2	✓	-	-	-	-	-	-	-	-	-
ce319a	✓	-	✓	✓	-	-	-	!	✓	✓
60f194	✓	-	-	-	-	-	-	-	✓	✓
de7330	✓	-	-	-	-	-	-	-	✓	✓
bdbff6	-	-	-	-	-	-	?	-	-	-
22d484	-	-	-	-	✓	-	✓	-	-	-
1202ed	✓	-	✓	✓	-	-	-	✓	-	-

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ID / Method	1	2	3	4	5	6	7	8	9	10
1632e2	✓	✓	-	✓	-	-	-	✓	-	-
53a71c	-	-	-	-	-	-	-	-	✓	✓
7ffaba	✓	-	✓	✓	-	-	-	✓	-	-
e81c64	✓	-	✓	-	-	-	-	-	✓	-
cc7904	✓	✓	✓	✓	-	-	-	-	?	-
320ee2	-	-	✓	✓	-	-	-	-	-	-
f03e9c	✓	✓	-	-	✓	-	-	-	-	-
54b338	-	-	-	-	✓	-	-	?	-	-
b0c75b	✓	✓	✓	✓	✓	✓	✓	✓	?	-
33e846	-	-	✓	-	-	-	-	✓	-	-
390c3b	✓	✓	✓	✓	✓	✓	✓	✓	-	-
90dd12	✓	-	✓	-	-	✓	✓	✓	-	-
7f895a	✓	-	✓	✓	-	-	-	✓	-	-
3ffebb	-	✓	-	✓	✓	✓	-	-	-	-
4a8427	✓	✓	✓	✓	-	-	-	✓	-	-
779696	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8aeb2c	✓	-	-	-	-	-	-	!	-	✓
f2dd88	✓	✓	✓	✓	✓	✓	✓	✓	✓	-
f90fb7	-	-	✓	✓	✓	-	-	-	-	✓
5b9821	-	-	-	-	-	-	-	!	-	-
e10589	✓	✓	✓	✓	✓	✓	?	✓	-	-
a81bc3	✓	-	✓	-	-	-	-	?	?	✓
9d12b7	-	-	✓	✓	-	-	-	-	-	-
4dbd08	✓	-	-	-	-	-	-	-	-	-
087225	-	-	-	-	-	-	-	✓	-	✓
1b8e4c	✓	✓	✓	✓	-	✓	✓	✓	✓	-
2b2ff2	✓	✓	-	-	-	-	-	-	-	-
3a439b	-	-	-	-	-	-	-	?	?	-
5b2e25	✓	✓	✓	✓	-	-	-	✓	-	-
3d61b1	✓	-	?	-	-	-	-	✓	-	-
25e875	✓	✓	✓	✓	-	-	-	✓	-	-
5633d2	-	-	-	-	-	-	✓	✓	-	-
4ceca5	✓	✓	✓	-	-	-	-	-	-	-
fc937d	✓	-	✓	-	-	-	-	✓	✓	✓
f0ee71	✓	-	-	-	-	-	-	-	-	-
df7d84	✓	✓	✓	✓	✓	✓	-	✓	✓	✓
8f9b0e	✓	-	-	-	-	-	-	-	✓	-

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ID / Method	1	2	3	4	5	6	7	8	9	10
1b001e	-	-	-	-	-	-	-	-	✓	-
8b3490	✓	-	-	-	-	-	-	-	✓	✓
5c1ea2	-	-	-	✓	✓	-	✓	✓	-	-
068f53	-	-	-	-	-	-	-	-	-	✓
05920e	X	✓	✓	✓	-	-	-	✓	-	-
225f2b	✓	✓	✓	✓	✓	✓	✓	✓	-	✓

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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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[4] EN ISO 17892-5. *Geotechnical investigation and testing - Laboratory testing of soil - Part 5: Incremental loading oedometer test*. 2017.

[5] EN ISO 17892-7. *Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test*. 2018.

[6] EN ISO 17892-10. *Geotechnical investigation and testing - Laboratory testing of soil - Part 10: Direct shear tests*. 2018.

[7] EN ISO 17892-12. *Geotechnical investigation and testing - Laboratory testing of soil - Part 12: Determination of liquid and plastic limits*. 2018.

[8] EN 13286-2. *Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory reference density and water content - Proctor compaction*. 2011.

[9] 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*. 2021.

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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 [%]
1357c8	5.52	5.19	5.32	-	5.34	0.166	3.11
2b2ff2	6.67	5.24	5.06	1.78	5.66	0.882	15.6
f8bc7a	5.6	5.7	5.8	3.8	5.7	0.1	1.75
4ee2d2	5.91	5.93	5.95	0.1	5.93	0.02	0.34
a81bc3	6.1	5.8	5.9	-	5.93	0.153	2.57
f0ee71	5.7	6.0	6.6	0.38	6.1	0.458	7.51
cc7904	6.2	6.05	6.14	0.2	6.13	0.075	1.23
f2dd88	6.1	6.2	6.2	0.1	6.17	0.058	0.94
5b2e25	5.97	6.45	6.37	-	6.26	0.257	4.11
e81c64	6.3	6.4	6.2	0.2	6.3	0.1	1.59
c871a4	6.6	5.9	6.5	3.8	6.33	0.379	5.98
f03e9c	6.4	6.4	6.2	0.04	6.33	0.115	1.82
1632e2	6.4	6.3	6.3	2.0	6.33	0.058	0.91
fdd45f	6.4	6.4	6.3	0.15	6.37	0.058	0.91
1b8e4c	6.4	6.4	6.3	1.28	6.37	0.058	0.91
1202ed	6.48	6.33	6.32	0.13	6.38	0.09	1.41
7ac937	6.2	6.4	6.6	0.9	6.4	0.2	3.12
779696	6.42	6.43	6.42	-	6.42	0.006	0.09
4a8427	6.43	6.42	6.43	0.01	6.43	0.006	0.09
3832b5	6.4	6.4	6.5	0.15	6.43	0.058	0.9
8aeb2c	6.3	6.47	6.61	0.6	6.46	0.155	2.4
86eb15	6.4	6.9	6.1	0.8	6.47	0.404	6.25
b0c75b	6.5	6.1	6.8	0.45	6.47	0.351	5.43
589c5f	6.48	6.48	6.49	0.11	6.48	0.006	0.09
8f9b0e	6.5	6.4	6.6	0.13	6.5	0.1	1.54
25aa05	6.3	6.6	6.6	0.05	6.5	0.173	2.66
33459f	6.49	6.5	6.51	-	6.5	0.01	0.15
de7330	6.5	6.5	6.5	-	6.5	0.0	0.0
8b3490	6.7	6.6	6.3	-	6.53	0.208	3.19
90dd12	6.2	6.2	7.3	-	6.57	0.635	9.67
3d61b1	6.6	6.6	6.6	-	6.6	0.0	0.0
25e875	6.4	6.8	6.6	0.33	6.6	0.2	3.03
60f194	6.8	6.5	6.6	-	6.63	0.153	2.3
ce319a	6.8	6.6	6.5	-	6.63	0.153	2.3
4ceca5	6.6	6.7	6.6	0.1	6.63	0.058	0.87
fc937d	6.7	6.7	6.5	4.0	6.63	0.115	1.74

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ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
96dae7	6.5	6.6	6.8	3.8	6.63	0.153	2.3
390c3b	6.7	6.9	6.4	-	6.67	0.252	3.77
d1ee17	7.0	7.1	5.9	3.8	6.67	0.666	9.99
df7d84	6.5	6.8	6.7	-	6.67	0.153	2.29
7f895a	6.7	6.79	6.69	-	6.73	0.055	0.82
7ffaba	6.8	6.7	6.8	0.8	6.77	0.058	0.85
225f2b	6.8	6.9	6.8	0.2	6.83	0.058	0.84
4dbd08	6.8	6.89	7.01	0.24	6.9	0.105	1.53
666124	6.8	6.9	7.0	0.4	6.9	0.1	1.45
e10589	6.9	7.0	7.0	0.9	6.97	0.058	0.83
05920e	16.1	16.03	16.07	-	16.07	0.035	0.22

1.2 The Numerical Procedure for Determining Outliers

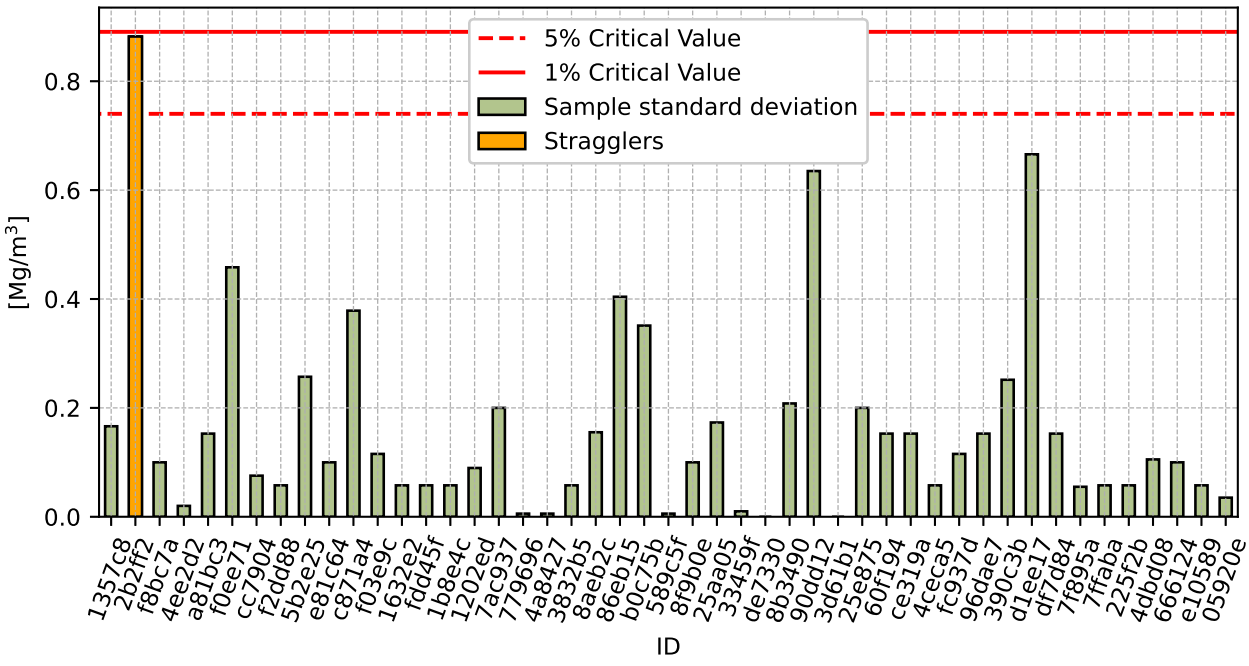

Figure 1: **Cochran's test** - sample standard deviations

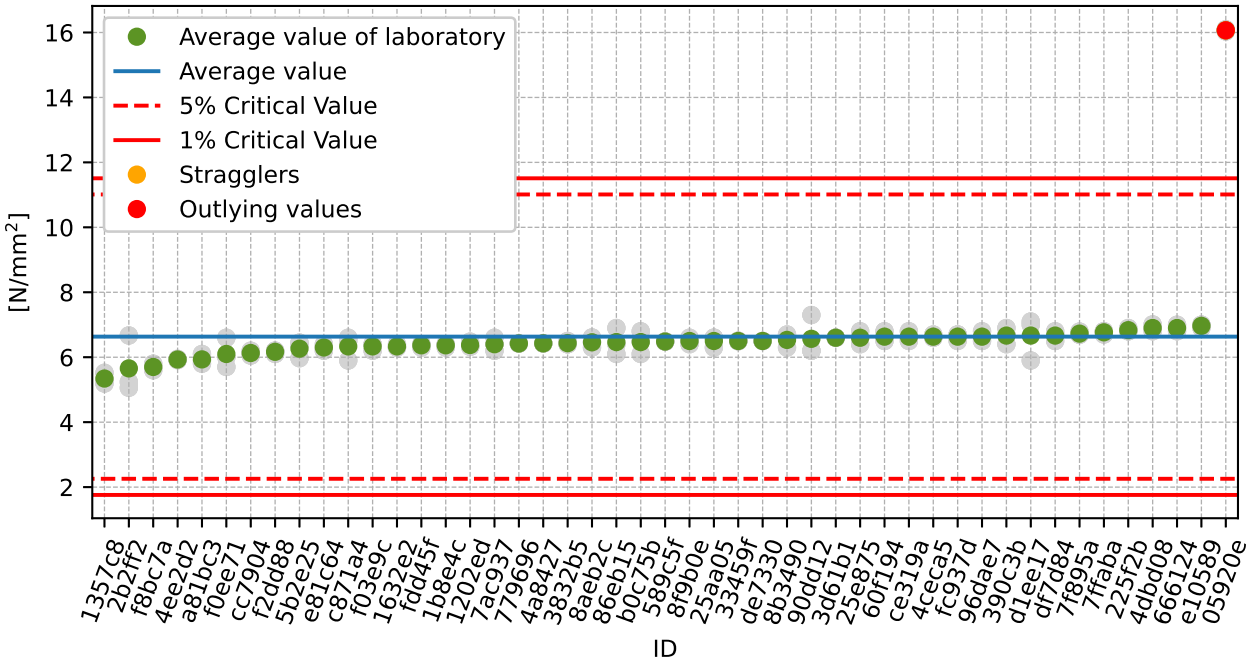

Figure 2: **Grubbs' test** - average values

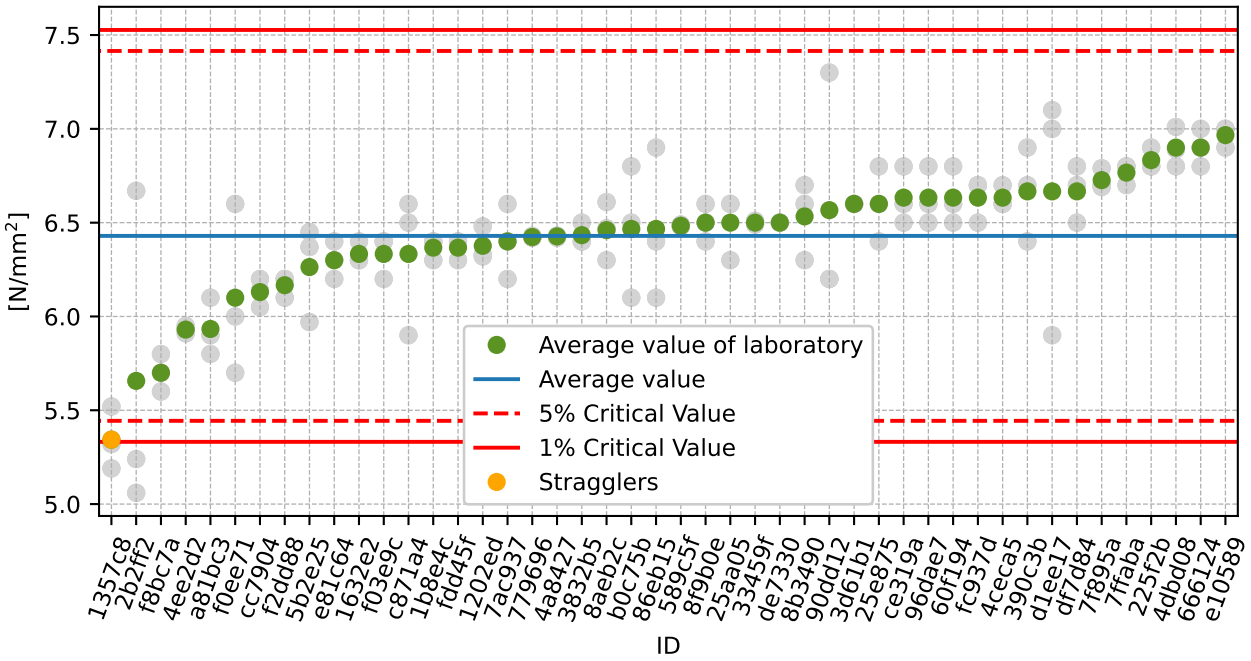

Figure 3: **Grubbs' test** - average values without outliers

1.3 Mandel's Statistics

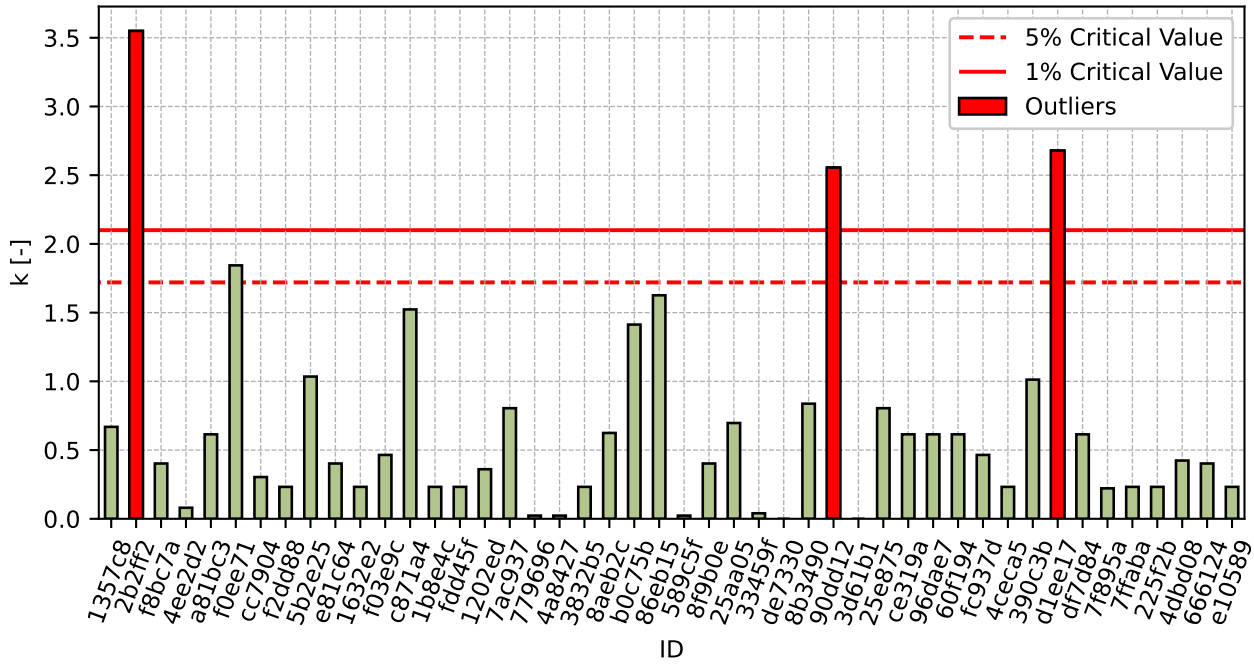

Figure 4: Intralaboratory Consistency Statistic

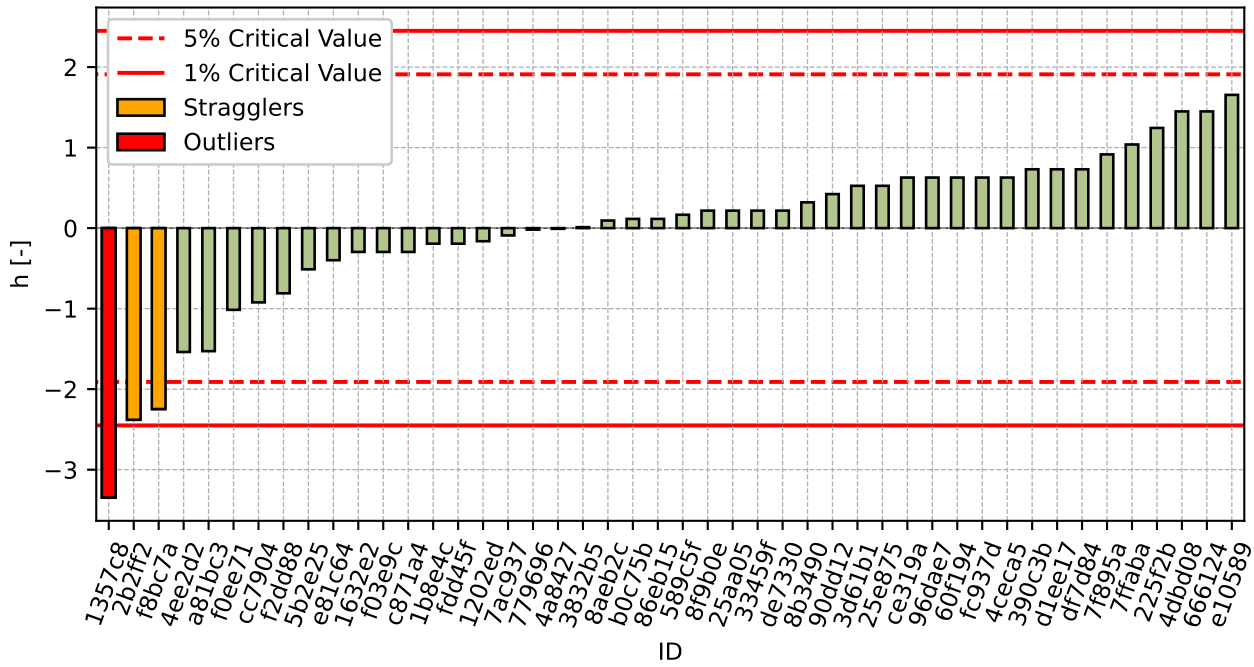

Figure 5: Interlaboratory Consistency Statistic

1.4 Descriptive statistics

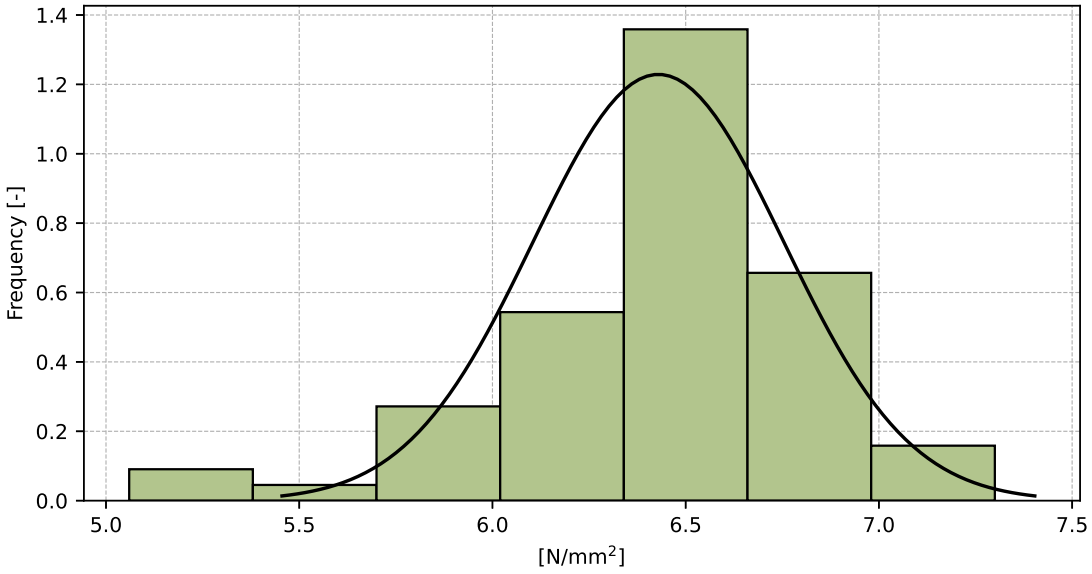

Figure 6: Histogram of all test results

Table 5: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	6.4
Sample standard deviation – s	0.32
Asigned value – x^*	6.4
Robust standard deviation – s^*	0.42
Measurement uncertainty of asigned value – u_X	0.06
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.29
Repeatability standard deviation – s_r	0.25
Reproducibility standard deviation – s_R	0.38
Repeatability – r	0.7
Reproducibility – R	1.1

1.5 Evaluation of Performance Statistics

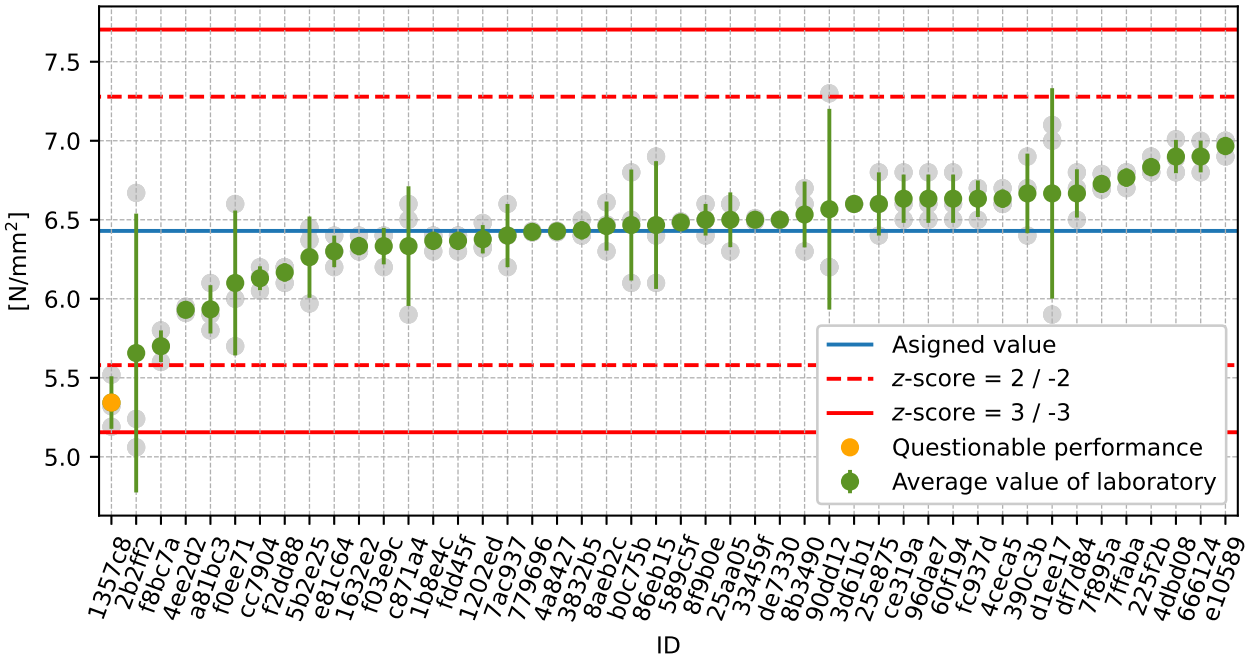

Figure 7: Average values and sample standard deviations

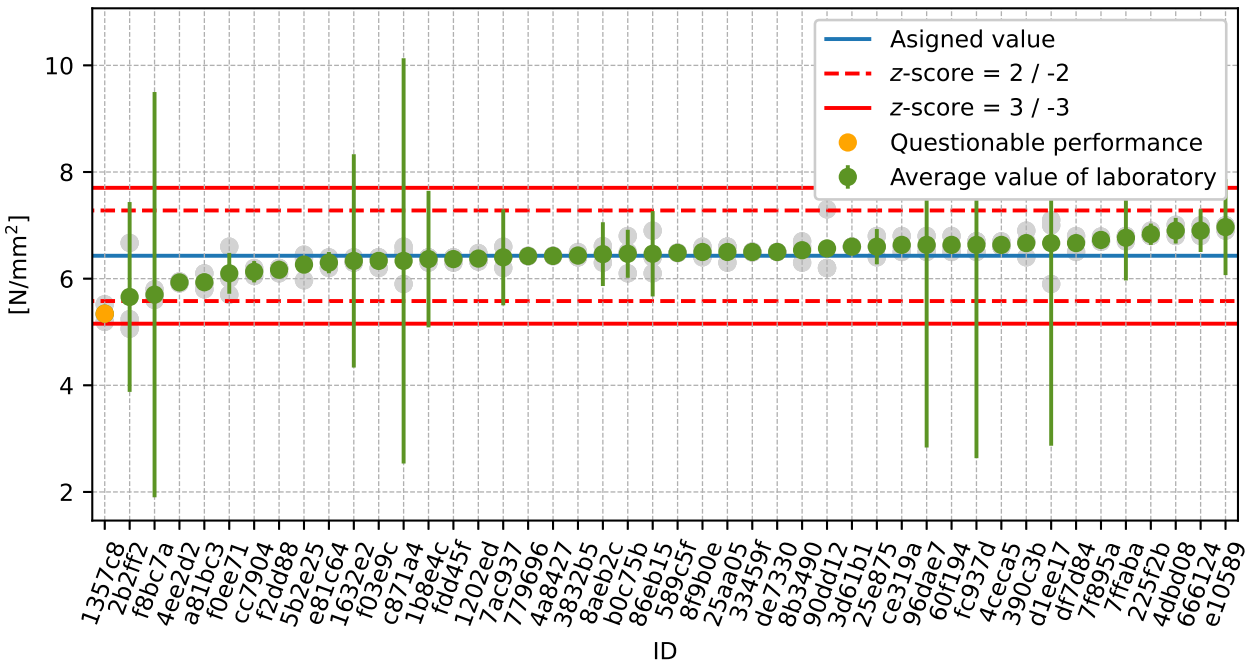

Figure 8: Average values and extended uncertainties of measurement

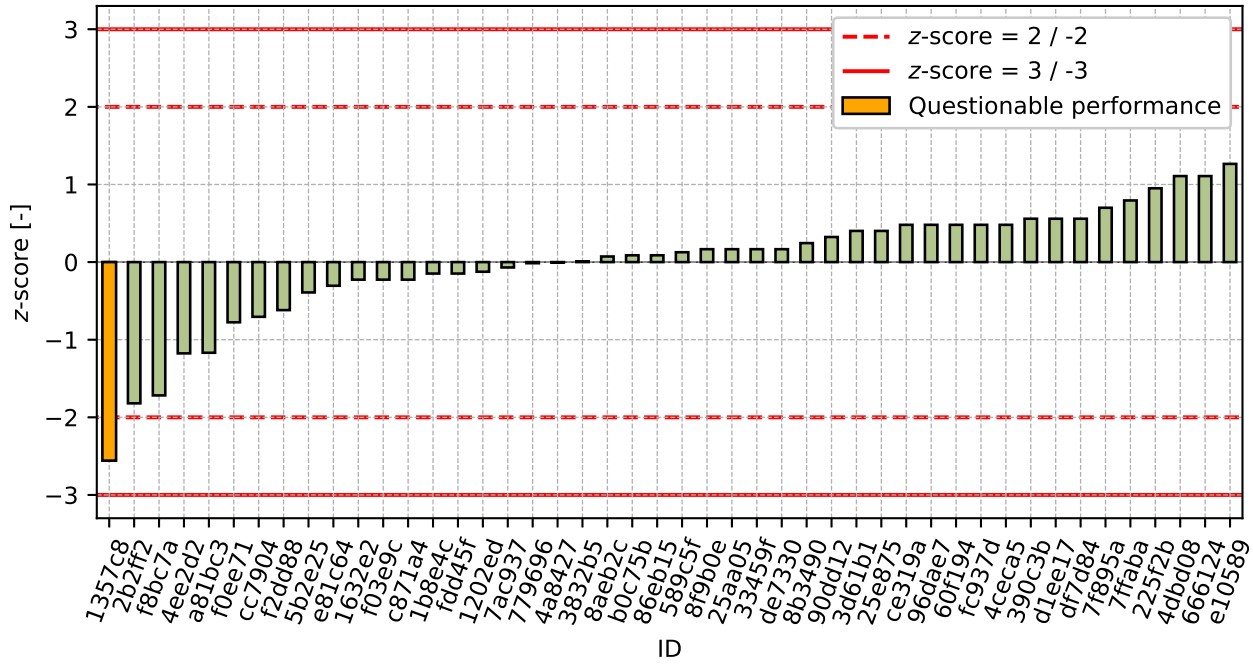

Figure 9: z-score

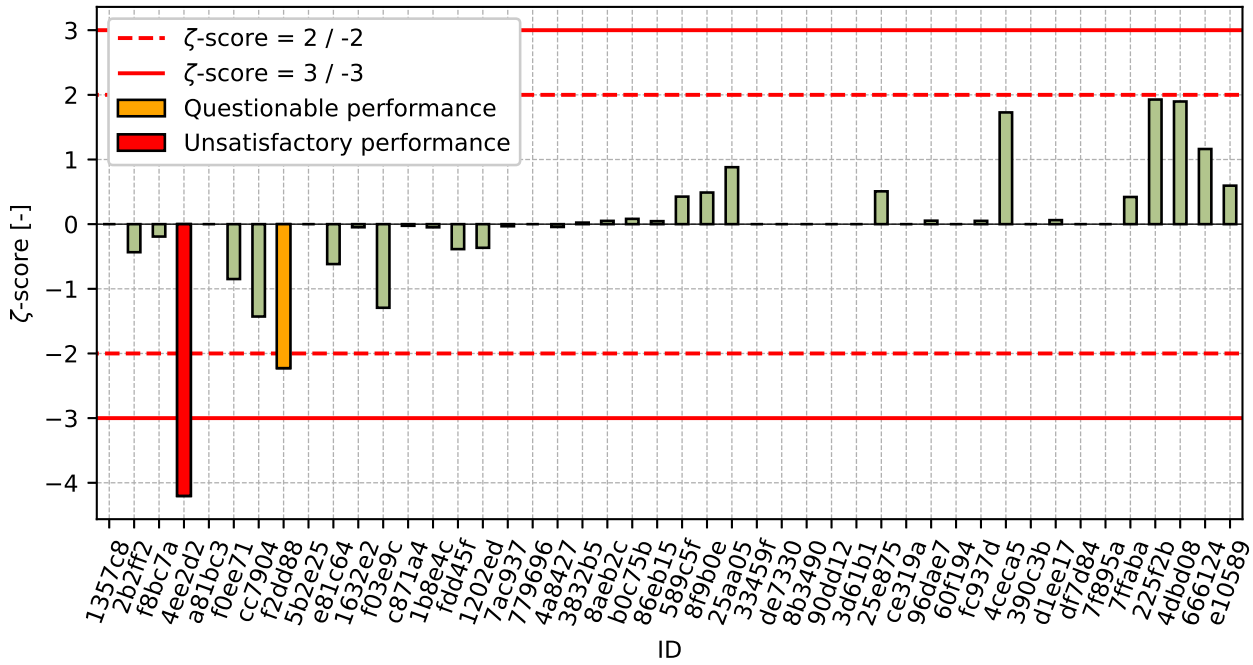

Figure 10: ζ-score

Table 6: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
1357c8	-2.56	-
2b2ff2	-1.82	-0.43
f8bc7a	-1.72	-0.19
4ee2d2	-1.18	-4.2
a81bc3	-1.17	-
f0ee71	-0.78	-0.85
cc7904	-0.71	-1.43
f2dd88	-0.62	-2.23
5b2e25	-0.39	-
e81c64	-0.3	-0.62
1632e2	-0.23	-0.05
f03e9c	-0.23	-1.29
c871a4	-0.23	-0.03
1b8e4c	-0.15	-0.05
fdd45f	-0.15	-0.39
1202ed	-0.12	-0.37
7ac937	-0.07	-0.03
779696	-0.01	-
4a8427	-0.01	-0.04
3832b5	0.01	0.02
8aeb2c	0.07	0.05
b0c75b	0.09	0.08
86eb15	0.09	0.05
589c5f	0.13	0.43
8f9b0e	0.17	0.49
25aa05	0.17	0.88
33459f	0.17	-
de7330	0.17	-
8b3490	0.24	-
90dd12	0.32	-
3d61b1	0.4	-
25e875	0.4	0.51
ce319a	0.48	-
96dae7	0.48	0.05
60f194	0.48	-
fc937d	0.48	0.05
4ceca5	0.48	1.73
390c3b	0.56	-
d1ee17	0.56	0.06
df7d84	0.56	-
7f895a	0.7	-
7ffaba	0.79	0.42
225f2b	0.95	1.93
4dbd08	1.11	1.9

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ID	z-score [-]	ζ-score [-]
666124	1.11	1.16
e10589	1.27	0.6

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 [Mg/m^3]			u_X [Mg/m^3]	$\bar{x}$ [Mg/m^3]	s_0 [Mg/m^3]	V_X [%]
c871a4	2.63	2.63	2.64	0.1	2.63	0.006	0.22
7ac937	2.65	2.63	-	-	2.64	0.014	0.54
cc7904	2.66	2.66	2.66	0.01	2.66	0.001	0.04
225f2b	2.66	2.66	2.67	0.04	2.66	0.006	0.22
f8bc7a	2.67	2.67	2.67	0.1	2.67	0.0	0.0
666124	2.66	2.67	2.68	0.14	2.67	0.01	0.37
33459f	2.68	2.68	2.67	-	2.68	0.005	0.17
1357c8	2.68	2.67	2.68	-	2.68	0.006	0.22
df7d84	2.69	2.69	2.66	0.04	2.68	0.017	0.65
96dae7	2.68	2.68	2.68	0.1	2.68	0.0	0.0
e10589	2.7	2.67	2.68	0.04	2.68	0.014	0.52
5b2e25	2.68	2.69	2.68	-	2.68	0.006	0.22
4a8427	2.68	2.68	2.68	0.01	2.68	0.001	0.04
4ceca5	2.68	2.68	2.7	-	2.69	0.011	0.4
d1ee17	2.69	2.69	2.69	0.1	2.69	0.0	0.0
f2dd88	2.69	2.7	2.69	0.05	2.69	0.006	0.21
b0c75b	2.7	2.69	2.7	0.03	2.7	0.006	0.21
589c5f	2.7	2.7	2.7	0.06	2.7	0.003	0.09
25aa05	2.69	2.7	2.71	0.08	2.7	0.01	0.37
1632e2	2.69	2.71	2.71	0.03	2.7	0.012	0.43
05920e	2.7	2.7	2.7	-	2.7	0.001	0.04
1b8e4c	2.71	2.71	2.7	1.24	2.71	0.006	0.21
3ffebb	2.71	2.71	2.71	0.01	2.71	0.0	0.0
25e875	2.72	2.71	2.72	0.04	2.72	0.006	0.21
779696	2.72	2.72	2.72	-	2.72	0.001	0.04
390c3b	2.73	2.73	2.72	-	2.73	0.004	0.13
2b2ff2	2.73	2.74	2.71	0.0	2.73	0.015	0.56
f03e9c	2.73	2.73	2.73	0.0	2.73	0.003	0.1
01225f	2.73	2.74	2.73	-	2.73	0.006	0.21

2.2 The Numerical Procedure for Determining Outliers

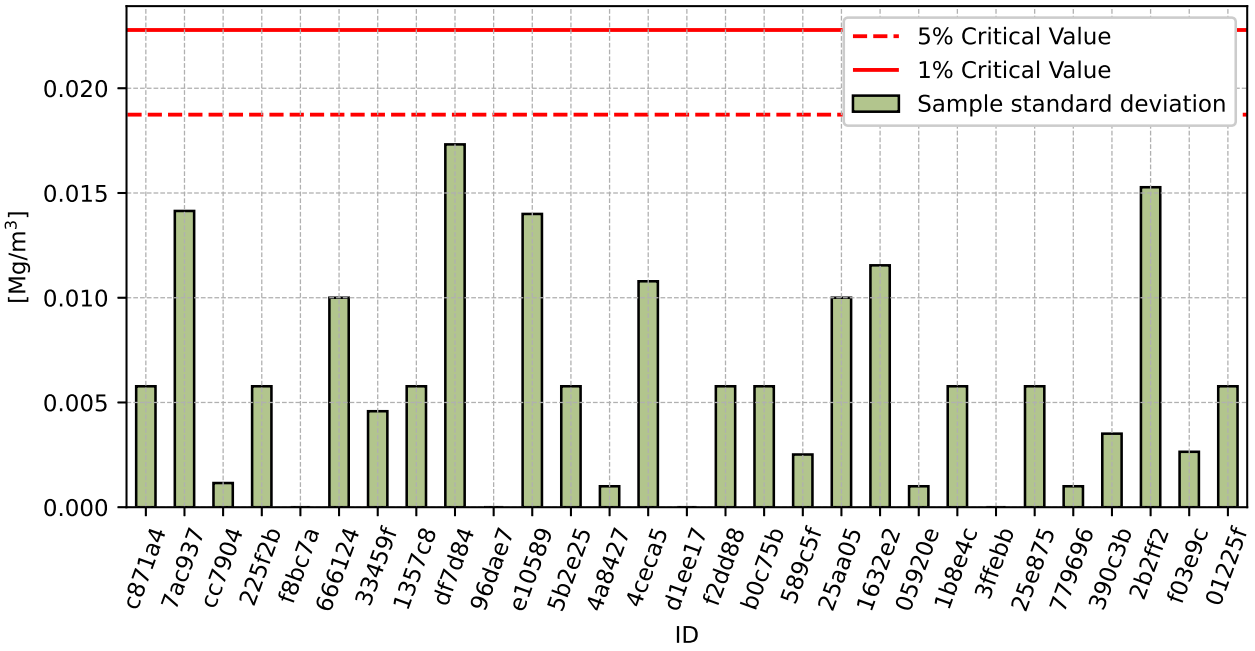

Figure 11: **Cochran's test** - sample standard deviations

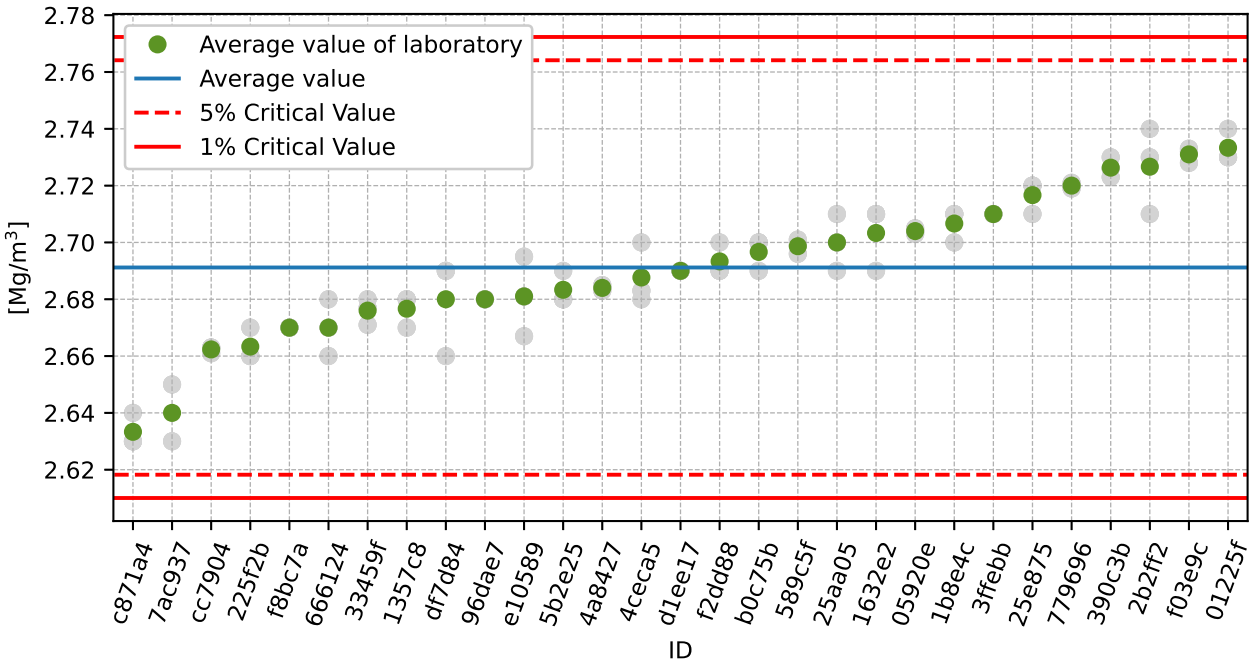

Figure 12: **Grubbs' test** - average values

2.3 Mandel's Statistics

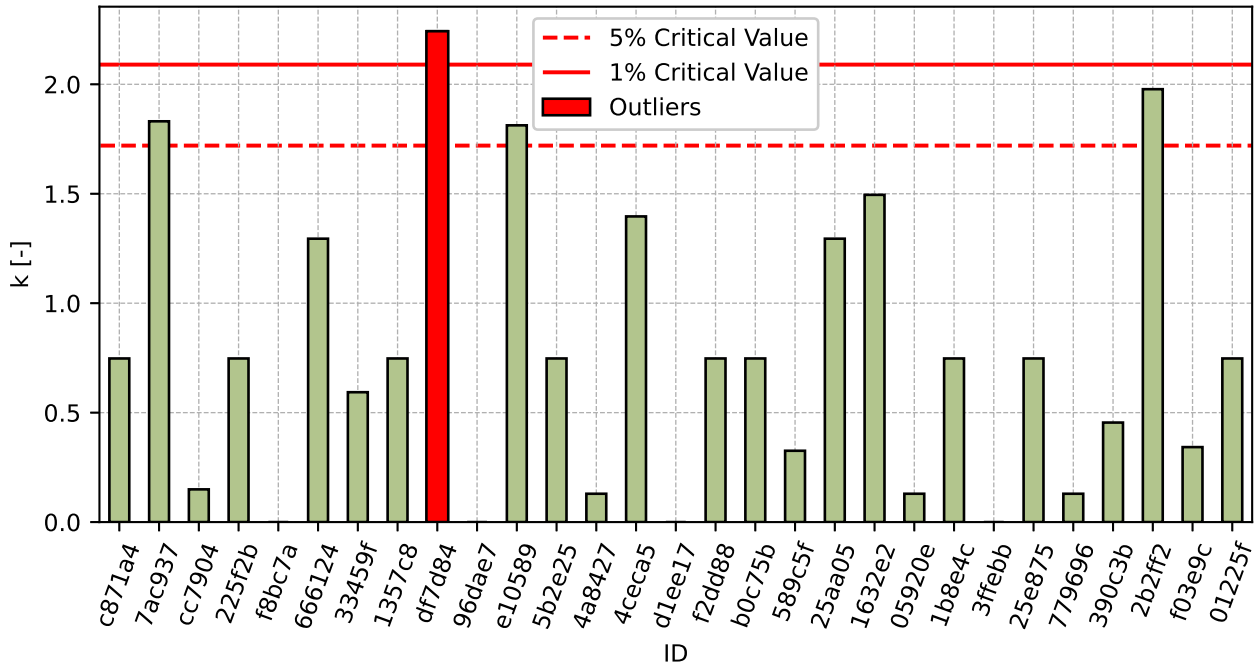

Figure 13: Intralaboratory Consistency Statistic

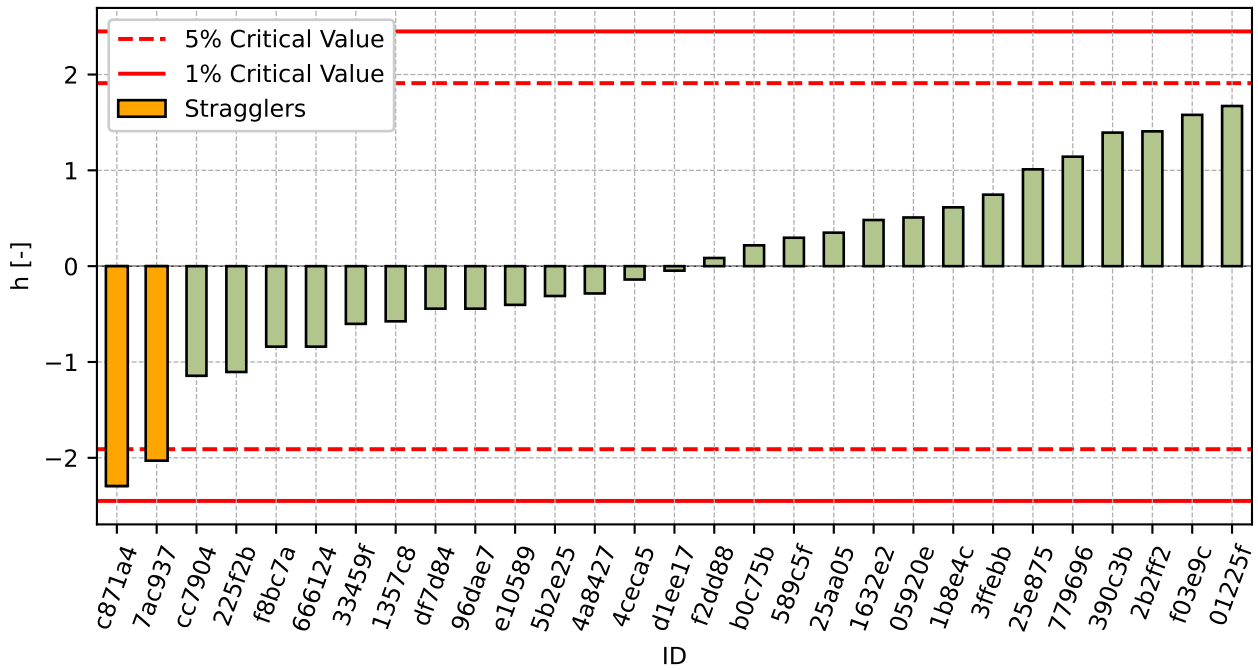

Figure 14: Interlaboratory Consistency Statistic

2.4 Descriptive statistics

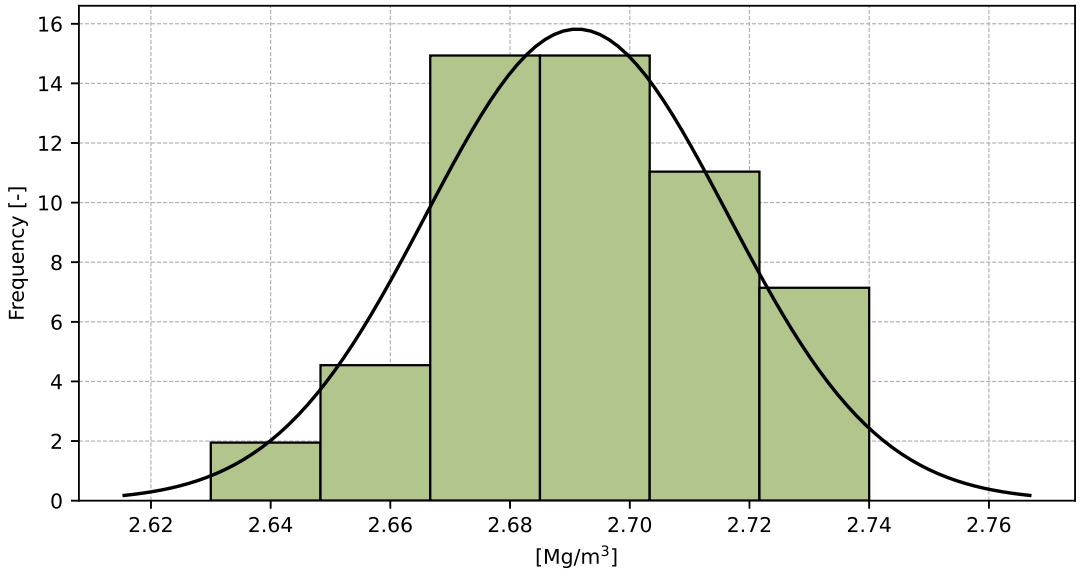

Figure 15: Histogram of all test results

Table 8: Descriptive statistics

Characteristics	[Mg/m³]
Average value – $\bar{x}$	2.69
Sample standard deviation – s	0.025
Asigned value – x^*	2.69
Robust standard deviation – s^*	0.03
Measurement uncertainty of asigned value – u_X	0.005
p-value of normality test	0.751 [-]
Interlaboratory standard deviation – s_L	0.025
Repeatability standard deviation – s_r	0.008
Reproducibility standard deviation – s_R	0.026
Repeatability – r	0.02
Reproducibility – R	0.07

2.5 Evaluation of Performance Statistics

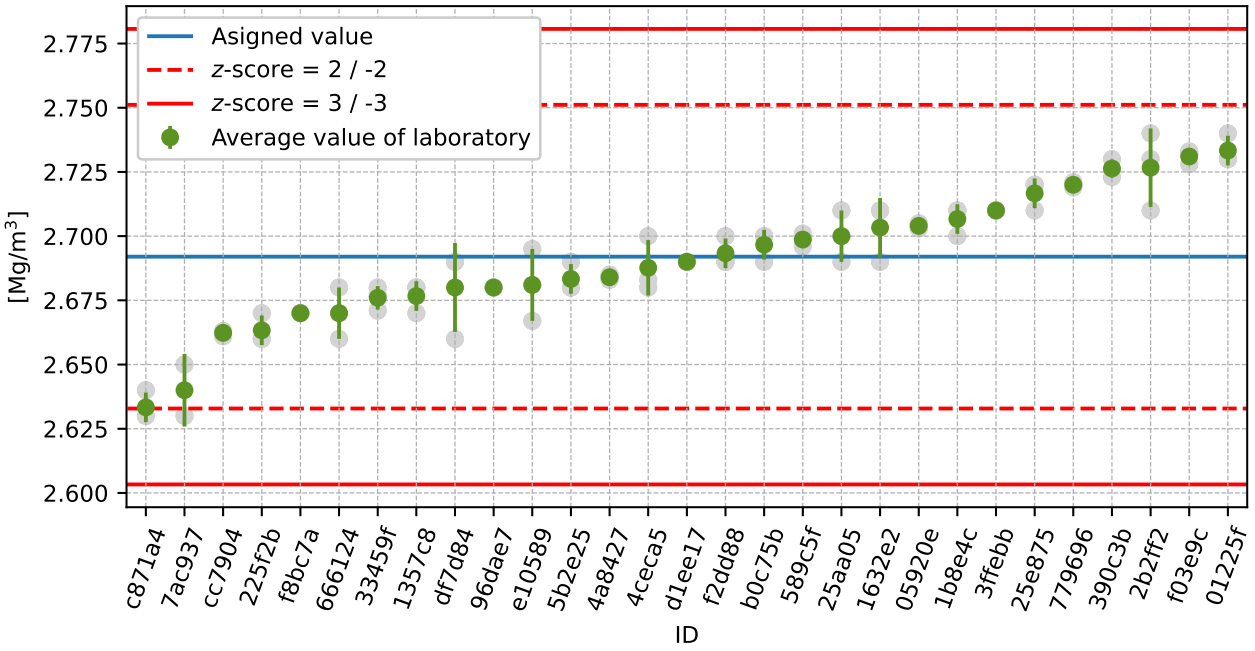

Figure 16: Average values and sample standard deviations

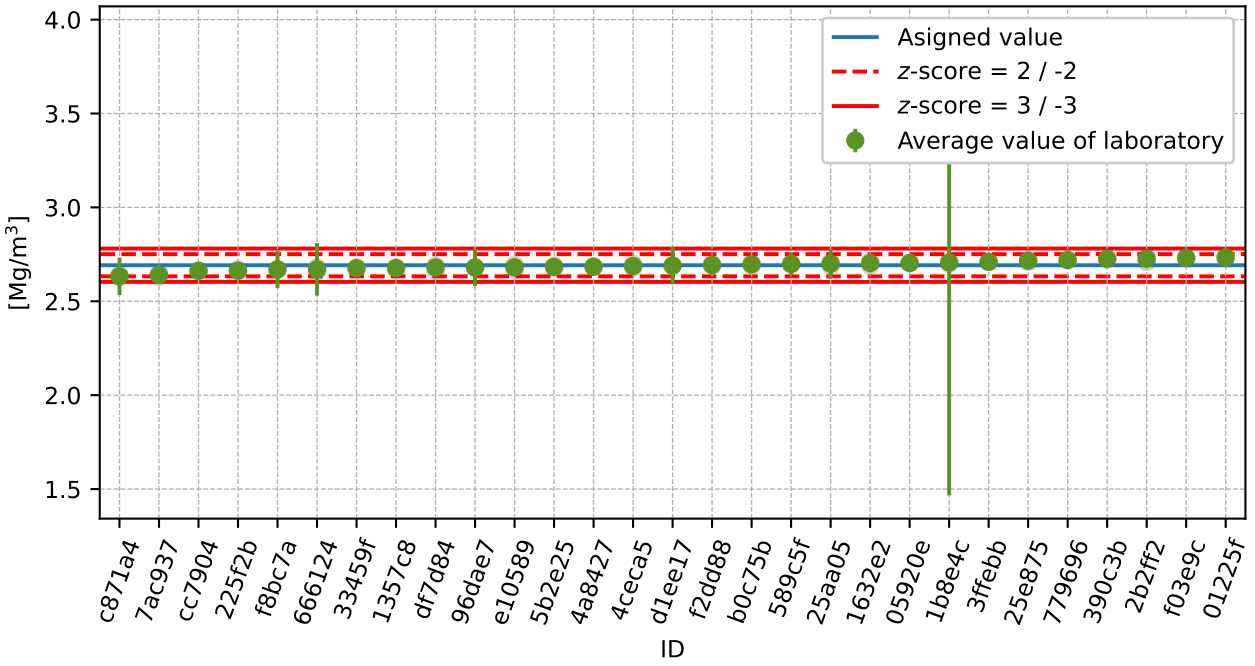

Figure 17: Average values and extended uncertainties of measurement

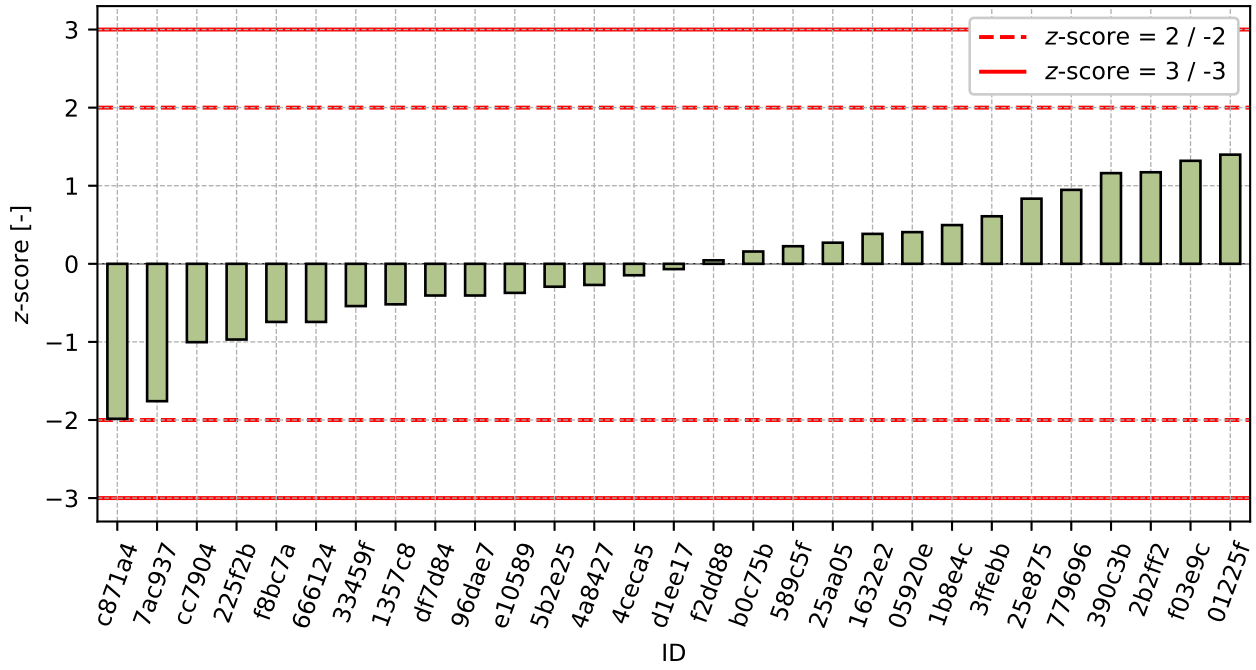

Figure 18: z-score

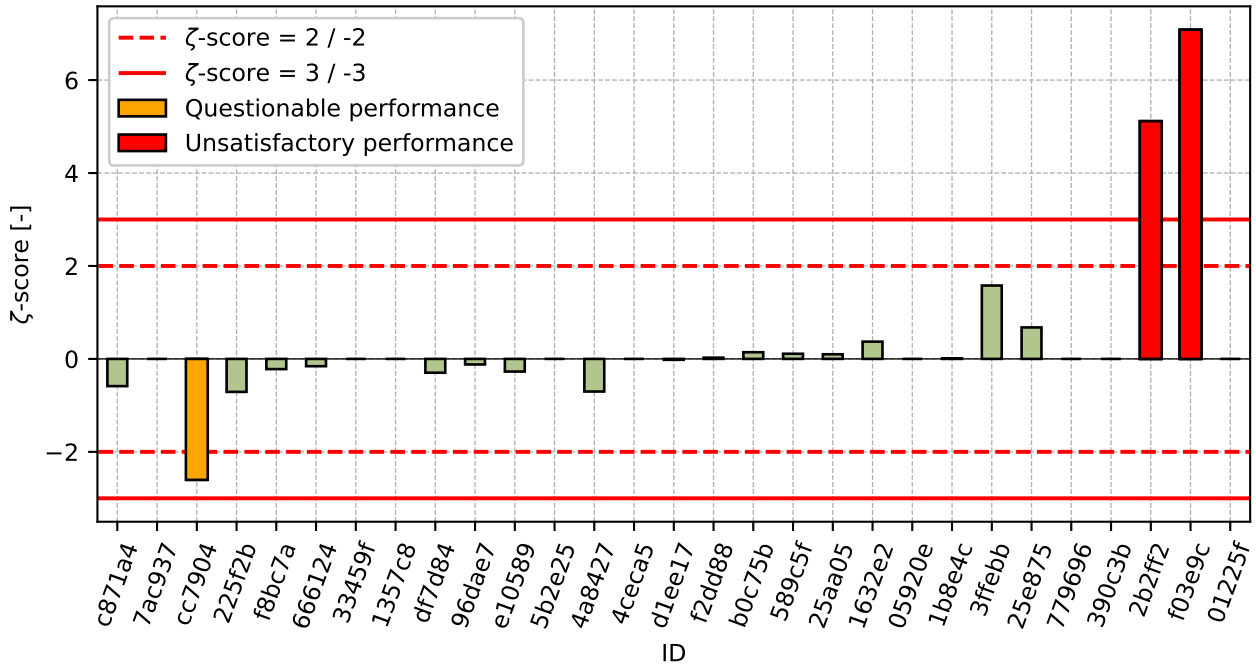

Figure 19: ζ-score

Table 9: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
c871a4	-1.98	-0.59
7ac937	-1.76	-
cc7904	-1.0	-2.6
225f2b	-0.97	-0.71
f8bc7a	-0.74	-0.22
666124	-0.74	-0.16
33459f	-0.54	-
1357c8	-0.52	-
df7d84	-0.41	-0.3
96dae7	-0.41	-0.12
e10589	-0.37	-0.27
5b2e25	-0.29	-
4a8427	-0.27	-0.7
4ceca5	-0.15	-
d1ee17	-0.07	-0.02
f2dd88	0.04	0.03
b0c75b	0.16	0.14
589c5f	0.23	0.11
25aa05	0.27	0.1
1632e2	0.38	0.37
05920e	0.41	-
1b8e4c	0.5	0.01
3ffebb	0.61	1.58
25e875	0.83	0.68
779696	0.95	-
390c3b	1.16	-
2b2ff2	1.17	5.12
f03e9c	1.32	7.08
01225f	1.4	-

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
fc937d	96.3	83.6	58.6	31.9	10.3	1.4	0.6
f90fb7	96.2	83.3	56.1	28.2	8.1	0.9	0.3
f8bc7a	-	85.0	-	-	-	-	1.0
f2dd88	96.8	80.5	54.3	26.6	7.8	1.2	0.5
ecf0fd	97.0	83.5	58.2	31.0	9.9	1.8	0.9
e81c64	97.0	83.7	60.1	32.5	10.4	1.6	0.6
e10589	98.7	86.6	61.8	33.4	11.1	1.6	0.9
df7d84	96.1	82.8	57.0	28.0	11.0	2.0	1.2
d1ee17	-	83.0	-	-	-	-	1.0
ce319a	97.0	83.0	57.0	31.0	10.0	2.0	0.9
cc7904	97.1	82.5	57.7	28.8	8.0	1.2	0.7
c871a4	-	85.0	-	-	-	-	1.0
c0ca45	96.1	82.2	57.2	29.2	12.1	6.8	6.4
b0c75b	96.9	83.6	60.5	34.2	14.8	5.0	1.2
a81bc3	96.6	82.6	57.9	31.9	10.4	1.9	1.2
9d12b7	96.9	82.9	58.3	30.9	7.3	1.2	0.6
96dae7	-	81.0	-	-	-	-	1.0
90dd12	99.0	85.0	61.0	30.0	10.0	5.0	1.0
86eb15	96.8	83.8	59.4	31.8	10.4	1.8	0.9
7ffaba	95.4	78.6	53.5	30.0	9.4	1.3	0.5
7f895a	96.2	79.6	54.4	29.9	9.3	1.3	0.4
7ac937	96.9	81.5	56.2	30.0	9.4	1.4	0.4
779696	95.6	82.8	57.4	29.4	9.2	1.0	0.2
666124	96.7	82.1	57.7	31.4	10.0	1.3	0.6
5b2e25	97.0	84.1	59.3	32.1	9.9	2.5	1.8
589c5f	97.3	86.8	65.8	37.0	12.5	3.8	2.2
4ceca5	96.8	82.4	58.1	31.5	9.4	1.5	0.7
4a8427	97.8	84.5	60.1	32.9	11.8	1.2	0.4
3d61b1	100.0	83.0	65.0	26.0	15.0	2.0	1.0
390c3b	97.0	83.5	58.9	31.3	10.1	1.5	0.5
33e846	96.8	82.5	56.8	36.4	23.7	14.3	6.3
320ee2	96.7	83.2	59.6	31.7	9.1	2.3	0.5
25e875	96.0	85.0	61.4	33.8	12.4	4.6	3.8
25aa05	97.0	84.0	59.0	32.0	10.0	2.0	0.9
225f2b	97.1	83.1	57.6	30.6	9.8	2.0	1.1
1b8e4c	97.1	84.0	58.9	31.2	9.5	1.4	0.7
1357c8	96.8	83.0	57.8	39.0	8.2	0.2	0.0
1202ed	97.1	92.3	63.8	32.0	11.3	3.8	2.8
05920e	96.6	82.9	66.2	31.6	9.9	1.6	0.7
01225f	96.0	82.0	59.3	28.5	7.2	1.2	0.8

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}	1.71	2.219	1.863	2.015	1.165	0.909	0.874
G_{max}	3.533	4.165	2.486	2.905	4.625	4.828	3.767
$G_{0.05}$	2.991	3.036	2.991	2.991	2.991	2.991	3.036
$G_{0.01}$	3.33	3.381	3.33	3.33	3.33	3.33	3.381

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}	1.993	2.828	1.863	2.015	1.67	1.524	2.196
G_{max}	3.09	2.287	2.486	2.905	2.756	2.643	2.986
$G_{0.05}$	2.979	3.025	2.991	2.991	2.979	2.965	2.979
$G_{0.01}$	3.316	3.369	3.33	3.33	3.316	3.301	3.316

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
fc937d	-0.72	0.29	-0.12	0.22	0.09	-0.48	-0.47
f90fb7	-0.86	0.1	-0.97	-1.18	-1.16	-0.92	-1.33
f8bc7a	-	1.16	-	-	-	-	0.68
f2dd88	-0.02	-1.64	-1.59	-1.79	-1.33	-0.66	-0.76
ecf0fd	0.27	0.23	-0.25	-0.12	-0.14	-0.14	0.39
e81c64	0.27	0.35	0.4	0.44	0.15	-0.31	-0.47
e10589	2.67	2.16	0.98	0.79	0.54	-0.31	0.39
df7d84	-1.0	-0.21	-0.66	-1.26	0.49	0.04	1.26
d1ee17	-	-0.08	-	-	-	-	0.68
ce319a	0.27	-0.08	-0.66	-0.12	-0.08	0.04	0.39
cc7904	0.41	-0.4	-0.43	-0.96	-1.22	-0.66	-0.18
c871a4	-	1.16	-	-	-	-	0.68
c0ca45	-1.0	-0.58	-0.6	-0.8	1.11	-	-
b0c75b	0.13	0.29	0.53	1.09	2.64	2.64	1.26
a81bc3	-0.3	-0.33	-0.36	0.22	0.15	-0.05	1.26
9d12b7	0.13	-0.15	-0.22	-0.16	-1.61	-0.66	-0.47
96dae7	-	-1.33	-	-	-	-	0.68
90dd12	3.09	1.16	0.7	-0.5	-0.08	2.64	0.68
86eb15	-0.02	0.42	0.16	0.18	0.15	-0.14	0.39
7ffaba	-1.99	-2.83	-1.86	-0.5	-0.42	-0.57	-0.76
7f895a	-0.86	-2.2	-1.56	-0.54	-0.48	-0.57	-1.04
7ac937	0.13	-1.02	-0.94	-0.5	-0.42	-0.48	-1.04
779696	-1.71	-0.21	-0.53	-0.73	-0.53	-0.83	-1.62
666124	-0.16	-0.64	-0.43	0.03	-0.08	-0.57	-0.47
5b2e25	0.27	0.6	0.12	0.29	-0.14	0.47	2.99
589c5f	0.69	2.29	2.35	2.15	1.34	1.6	-
4ceca5	-0.02	-0.46	-0.29	0.07	-0.42	-0.4	-0.18
4a8427	1.4	0.85	0.4	0.6	0.94	-0.66	-1.04
3d61b1	-	-0.08	2.07	-2.02	2.76	0.04	0.68
390c3b	0.27	0.23	-0.01	-0.01	-0.02	-0.4	-0.76
33e846	-0.02	-0.4	-0.73	1.92	-	-	-
320ee2	-0.16	0.04	0.23	0.14	-0.59	0.3	-0.76
25e875	-1.15	1.16	0.84	0.94	1.28	2.3	-
25aa05	0.27	0.54	0.02	0.26	-0.08	0.04	0.39
225f2b	0.41	-0.02	-0.46	-0.27	-0.19	0.04	0.97
1b8e4c	0.41	0.54	-0.01	-0.05	-0.36	-0.48	-0.18
1357c8	-0.02	-0.08	-0.39	2.9	-1.1	-1.52	-2.2
1202ed	0.41	-	1.66	0.26	0.66	1.6	-
05920e	-0.3	-0.15	2.49	0.1	-0.14	-0.31	-0.18
01225f	-1.15	-0.71	0.12	-1.07	-1.67	-0.66	0.11

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

Table 14: Test results – outliers are marked in red

ID of participant	[%] 0.02 mm	0.01 mm	0.002 mm	0.05 mm	0.005 mm
25aa05	76.4	35.1	27.3	16.6	8.3
86eb15	80.1	56.1	38.0	28.8	21.0
1357c8	88.2	75.1	43.2	25.2	15.8
c871a4	-	57.0	-	34.0	24.0
f8bc7a	-	59.0	-	34.0	25.0
d1ee17	-	58.0	-	32.0	24.0
96dae7	-	56.0	-	31.0	22.0
589c5f	94.4	67.4	49.6	37.8	31.8
7ac937	83.9	53.1	41.3	29.4	25.4
1202ed	69.8	54.1	38.3	27.6	22.1
1632e2	65.0	52.0	38.0	32.0	28.0
7ffaba	88.3	61.2	42.1	31.2	22.1
320ee2	88.6	64.8	44.7	34.7	27.5
b0c75b	86.3	55.2	36.8	27.0	19.5
390c3b	91.0	58.6	41.1	32.5	24.2
7f895a	89.7	64.5	45.0	33.8	23.0
3ffebb	83.8	57.2	40.6	31.2	23.4
4a8427	84.5	57.8	42.3	31.7	26.4
f2dd88	82.5	50.2	33.6	23.4	16.6
f90fb7	80.7	56.0	36.8	28.8	21.4
e10589	63.9	50.0	35.8	25.0	14.1
9d12b7	91.9	67.6	49.2	37.4	23.9
1b8e4c	94.1	65.2	47.5	37.4	27.3
5b2e25	80.2	48.2	40.1	22.3	19.3
25e875	86.4	61.1	44.4	34.6	26.4
779696	86.8	53.0	35.8	24.8	15.4
df7d84	87.5	59.6	42.7	35.0	23.3
5c1ea2	92.3	61.0	45.5	36.5	28.4
cc7904	80.0	50.5	36.5	29.1	18.0
05920e	87.8	60.7	43.8	32.8	24.8
225f2b	90.3	68.5	49.5	40.0	30.2

Table 15: Grubbs' test [%]

Value	0.02 mm	0.01 mm	0.002 mm	0.05 mm	0.005 mm
G_{min}	2.555	3.037	2.632	2.754	2.844
G_{max}	1.277	2.299	1.624	1.755	1.809
$G_{0.05}$	2.859	2.924	2.859	2.924	2.924
$G_{0.01}$	3.178	3.253	3.178	3.253	3.253

Table 16: *z*-score

ID of participant	*z*-score [-] 0.02 mm	0.01 mm	0.002 mm	0.05 mm	0.005 mm
25aa05	-0.98	-3.04	-2.63	-2.75	-2.84
86eb15	-0.52	-0.24	-0.59	-0.4	-0.33
1357c8	0.5	2.3	0.4	-1.1	-1.36
c871a4	-	-0.12	-	0.6	0.26
f8bc7a	-	0.15	-	0.6	0.46
d1ee17	-	0.02	-	0.21	0.26
96dae7	-	-0.25	-	0.02	-0.13
589c5f	1.28	1.27	1.62	1.33	1.81
7ac937	-0.04	-0.64	0.04	-0.29	0.54
1202ed	-1.81	-0.5	-0.53	-0.63	-0.11
1632e2	-2.42	-0.78	-0.59	0.21	1.06
7ffaba	0.51	0.44	0.19	0.06	-0.11
320ee2	0.55	0.93	0.69	0.73	0.96
b0c75b	0.26	-0.36	-0.82	-0.75	-0.63
390c3b	0.85	0.1	0.0	0.31	0.3
7f895a	0.69	0.89	0.75	0.56	0.07
3ffebb	-0.05	-0.09	-0.09	0.06	0.15
4a8427	0.03	-0.01	0.23	0.16	0.74
f2dd88	-0.22	-1.02	-1.43	-1.44	-1.2
f90fb7	-0.44	-0.25	-0.82	-0.4	-0.25
e10589	-2.55	-1.05	-1.01	-1.14	-1.7
9d12b7	0.96	1.3	1.55	1.25	0.24
1b8e4c	1.24	0.98	1.22	1.25	0.92
5b2e25	-0.51	-1.29	-0.19	-1.66	-0.67
25e875	0.27	0.43	0.63	0.71	0.74
779696	0.32	-0.65	-1.01	-1.17	-1.44
df7d84	0.41	0.23	0.31	0.79	0.13
5c1ea2	1.01	0.42	0.84	1.08	1.14
cc7904	-0.53	-0.98	-0.88	-0.34	-0.92
05920e	0.45	0.38	0.52	0.37	0.42
225f2b	0.76	1.42	1.6	1.76	1.49

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

5.1 50 – 100 kPa

5.1.1 Test results

Table 17: 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]
666124	2.82	0.27
22d484	3.82	-
96dae7	3.85	-
f2dd88	4.46	0.22
f90fb7	5.23	0.78
54b338	5.56	0.0
25aa05	5.88	2.62
225f2b	6.0	0.2
b0c75b	7.5	-
e10589	7.89	-
c0ca45	7.9	-
5c1ea2	8.6	0.01
3ffebb	10.6	0.2
779696	10.8	-
390c3b	10.9	-
1357c8	13.19	-
f03e9c	13.34	0.22
f8bc7a	14.49	-
df7d84	14.9	-

5.1.2 The Numerical Procedure for Determining Outliers

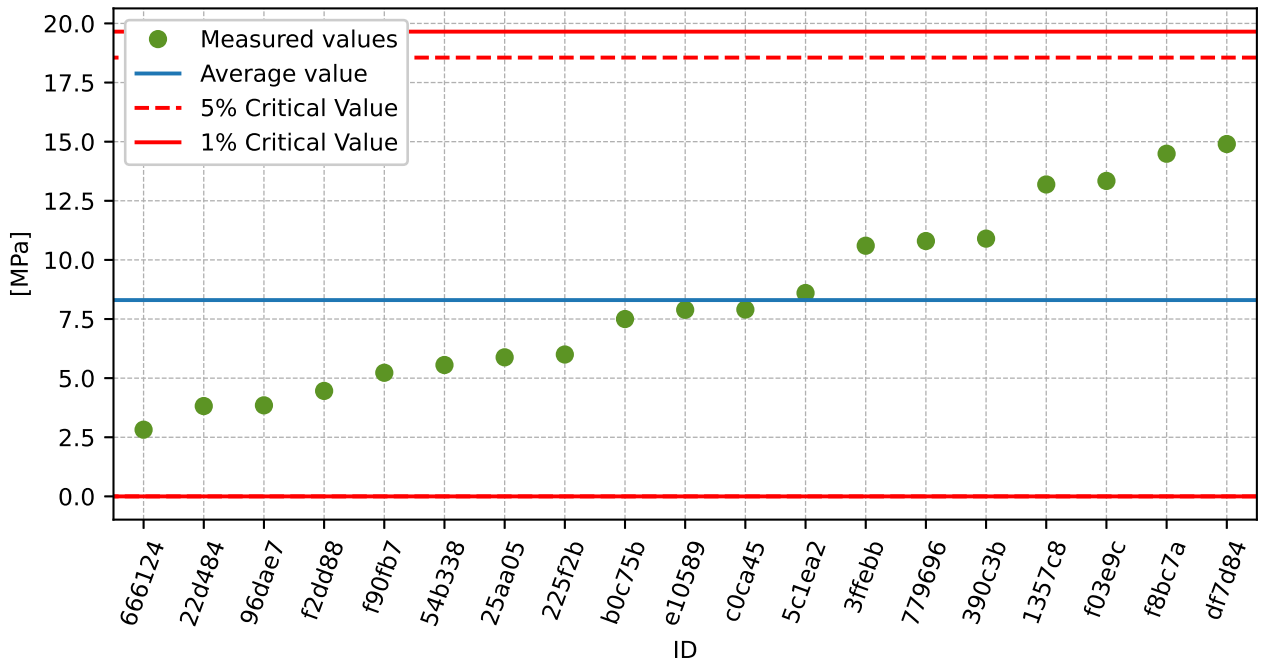

Figure 20: **Grubbs' test** - average values

5.1.3 Mandel's Statistics

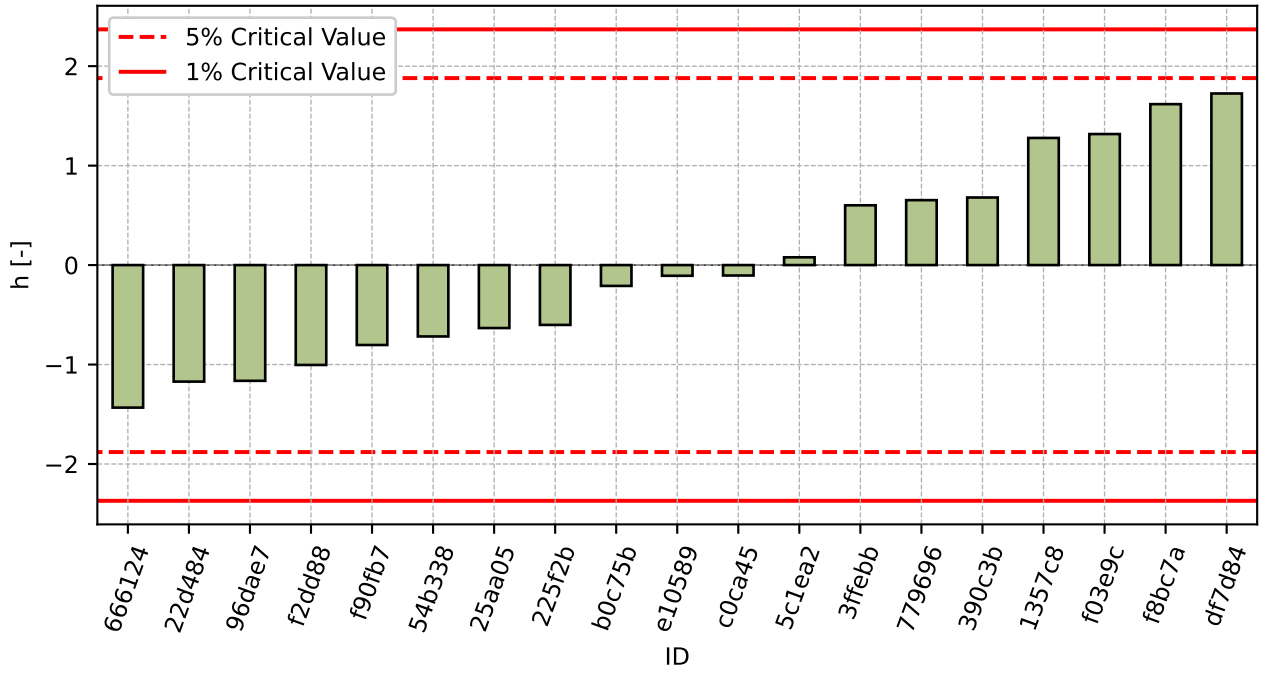

Figure 21: Interlaboratory Consistency Statistic

5.1.4 Descriptive statistics

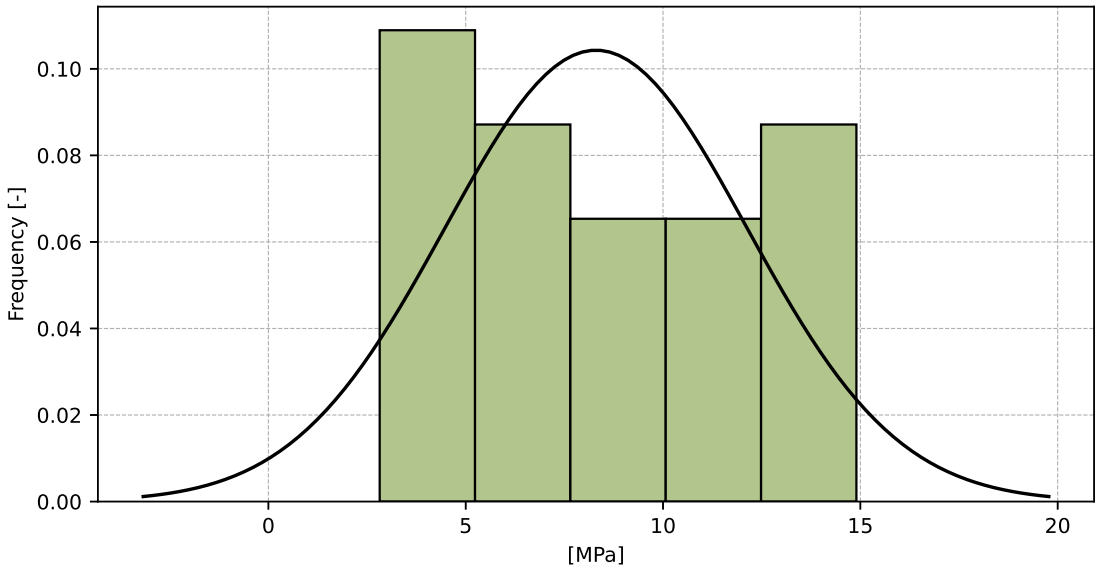

Figure 22: Histogram of all test results

Table 18: Descriptive statistics

Characteristics	**[MPa]**
Average value – $\bar{x}$	8.3
Sample standard deviation – s	3.825
Asigned value – x^*	8.29
Robust standard deviation – s^*	4.209
Measurement uncertainty of asigned value – u_X	1.207
p-value of normality test	0.275 [-]

5.1.5 Evaluation of Performance Statistics

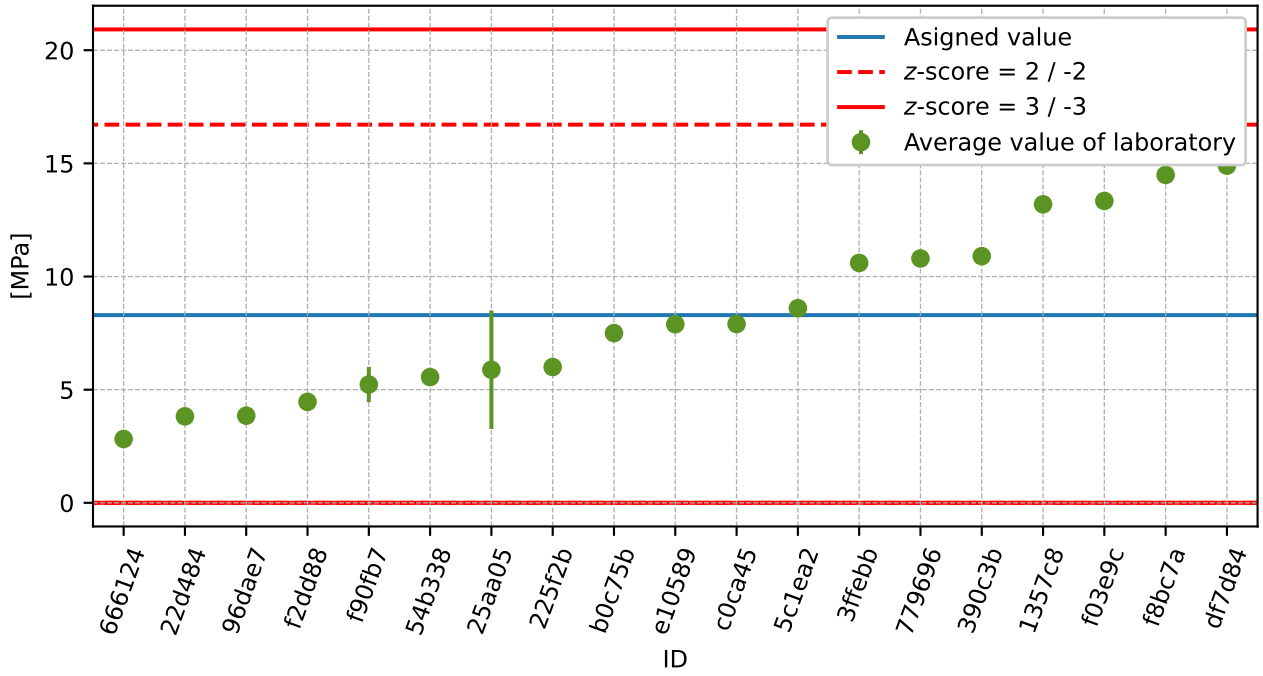

Figure 23: Average values and extended uncertainties of measurement

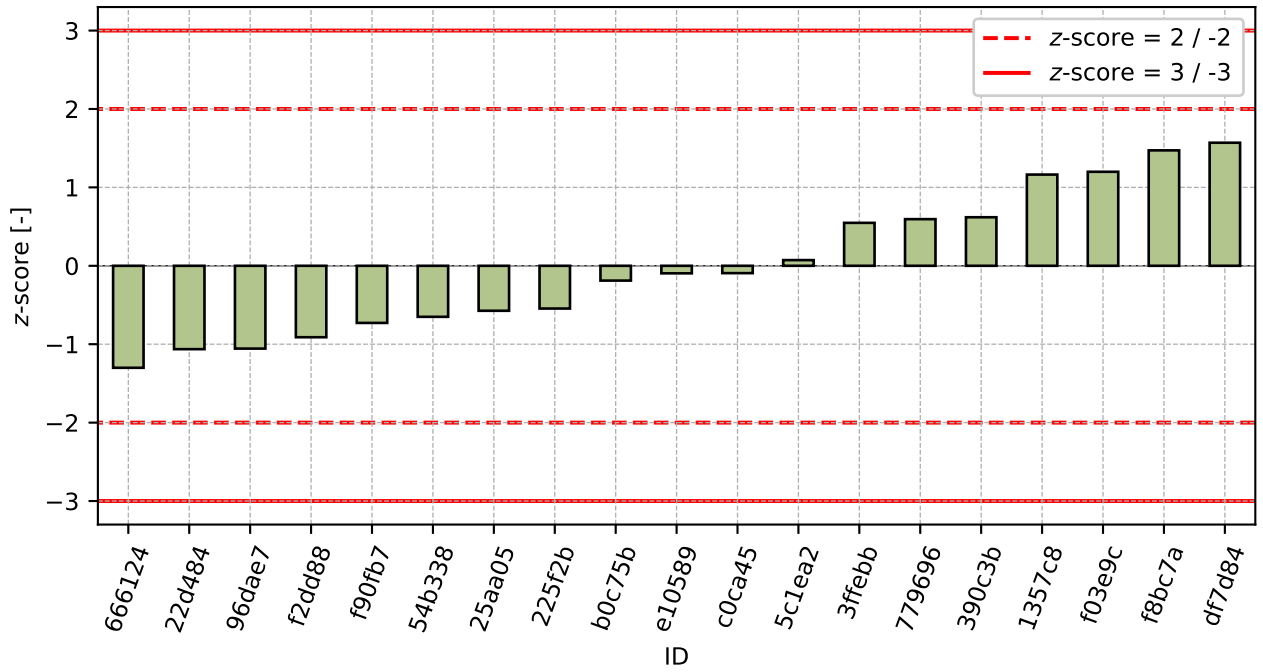

Figure 24: z-score

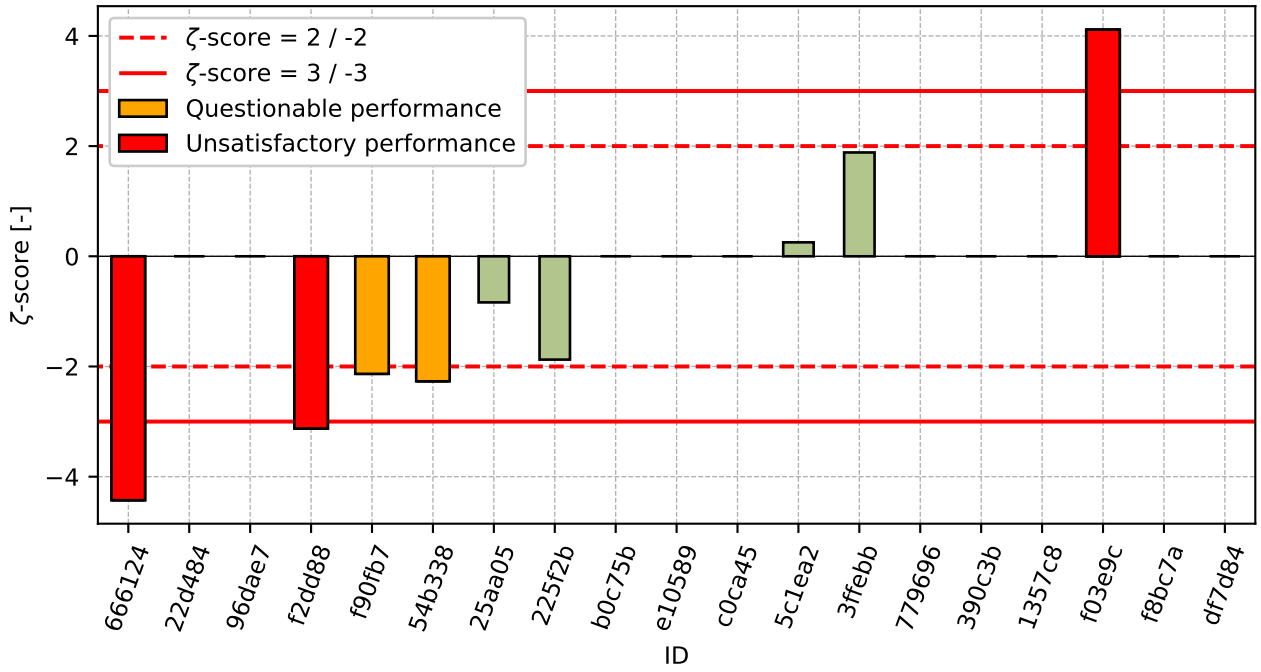

Figure 25: ζ-score

Table 19: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
666124	-1.3	-4.43
22d484	-1.06	-
96dae7	-1.06	-
f2dd88	-0.91	-3.13
f90fb7	-0.73	-2.13
54b338	-0.65	-2.27
25aa05	-0.57	-0.84
225f2b	-0.55	-1.88
b0c75b	-0.19	-
e10589	-0.1	-
c0ca45	-0.09	-
5c1ea2	0.07	0.25
3ffebb	0.55	1.88
779696	0.59	-
390c3b	0.62	-
1357c8	1.16	-
f03e9c	1.2	4.11
f8bc7a	1.47	-
df7d84	1.57	-

5.2 100 – 200 kPa

5.2.1 Test results

Table 20: 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]
666124	3.41	0.33
22d484	4.85	-
f2dd88	6.34	0.32
96dae7	6.67	-
225f2b	7.3	0.2
25aa05	7.34	1.84
54b338	7.41	0.0
f90fb7	8.03	1.2
b0c75b	9.4	-
e10589	10.0	-
5c1ea2	10.71	0.01
c0ca45	10.8	-
3ffebb	11.1	0.2
f03e9c	11.89	0.2
779696	13.58	-
390c3b	14.1	-
f8bc7a	14.71	-
df7d84	15.0	-
1357c8	16.69	-

5.2.2 The Numerical Procedure for Determining Outliers

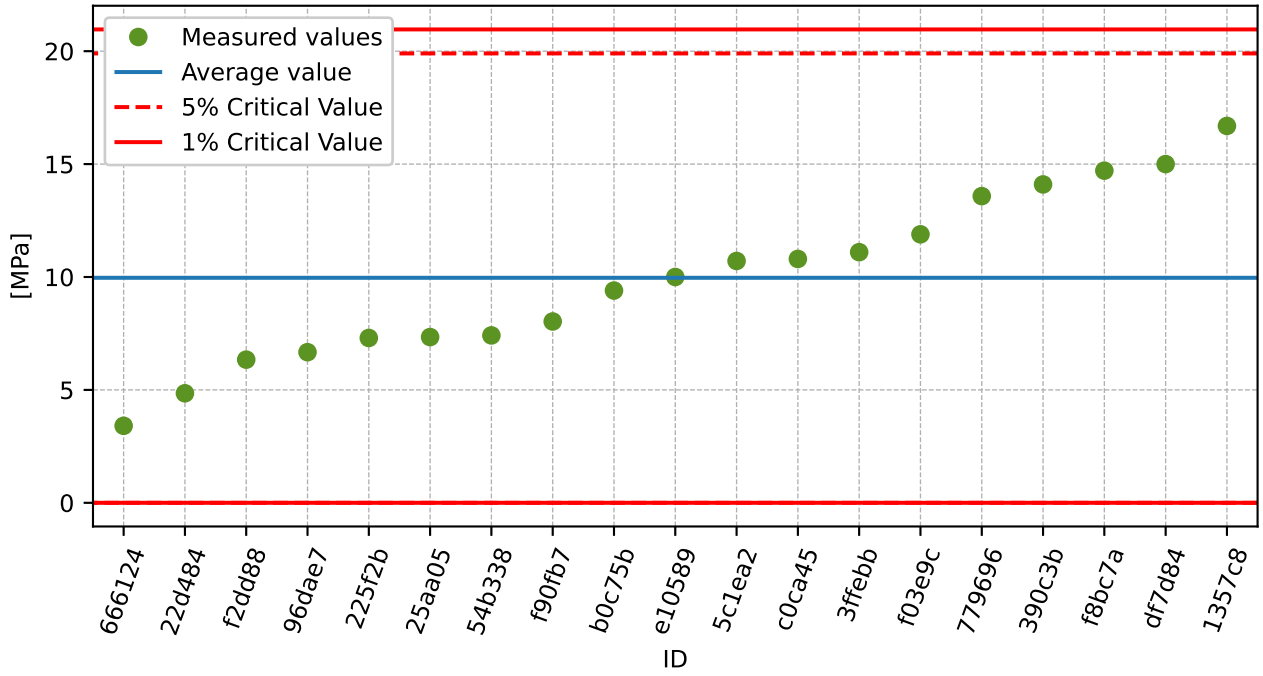

Figure 26: **Grubbs' test** - average values

5.2.3 Mandel's Statistics

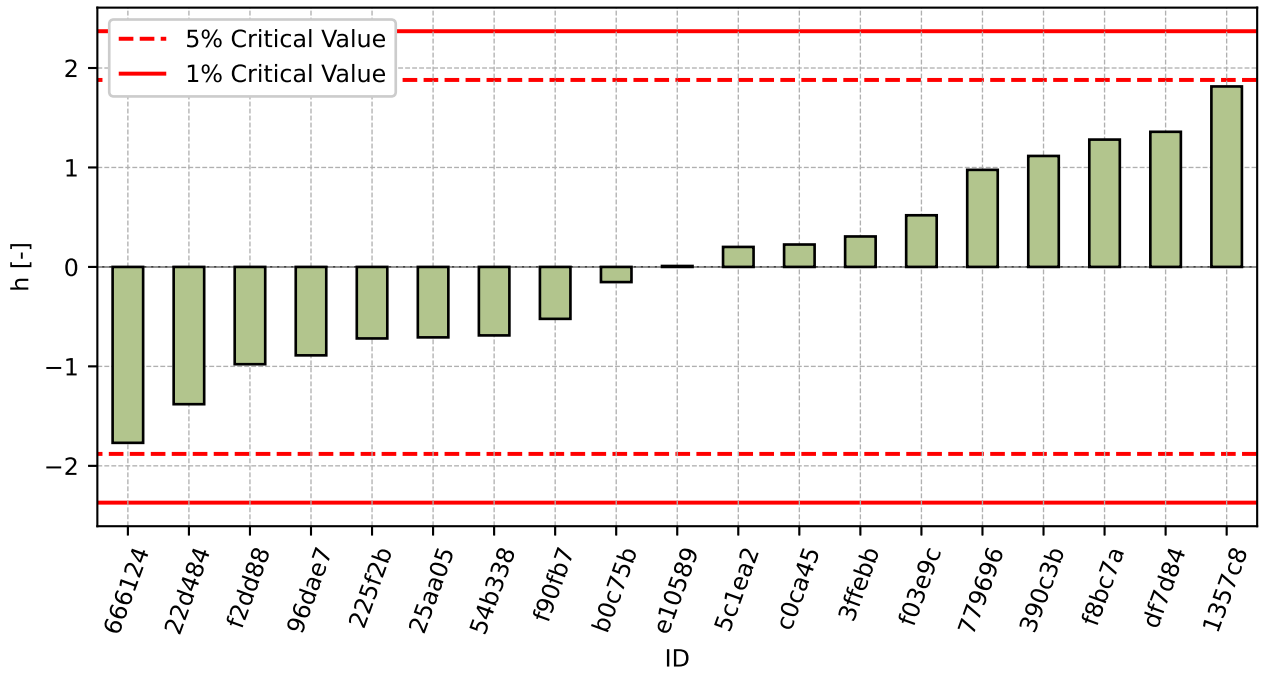

Figure 27: Interlaboratory Consistency Statistic

5.2.4 Descriptive statistics

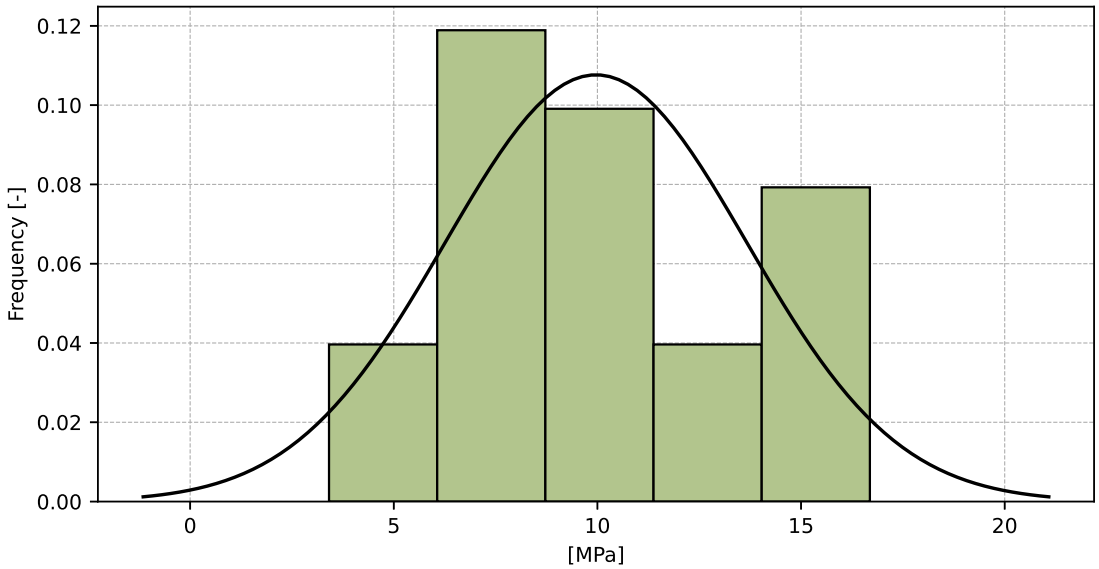

Figure 28: Histogram of all test results

Table 21: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	9.96
Sample standard deviation – s	3.706
Asigned value – x^*	10.0
Robust standard deviation – s^*	4.029
Measurement uncertainty of asigned value – u_X	1.156
p-value of normality test	0.639 [-]

5.2.5 Evaluation of Performance Statistics

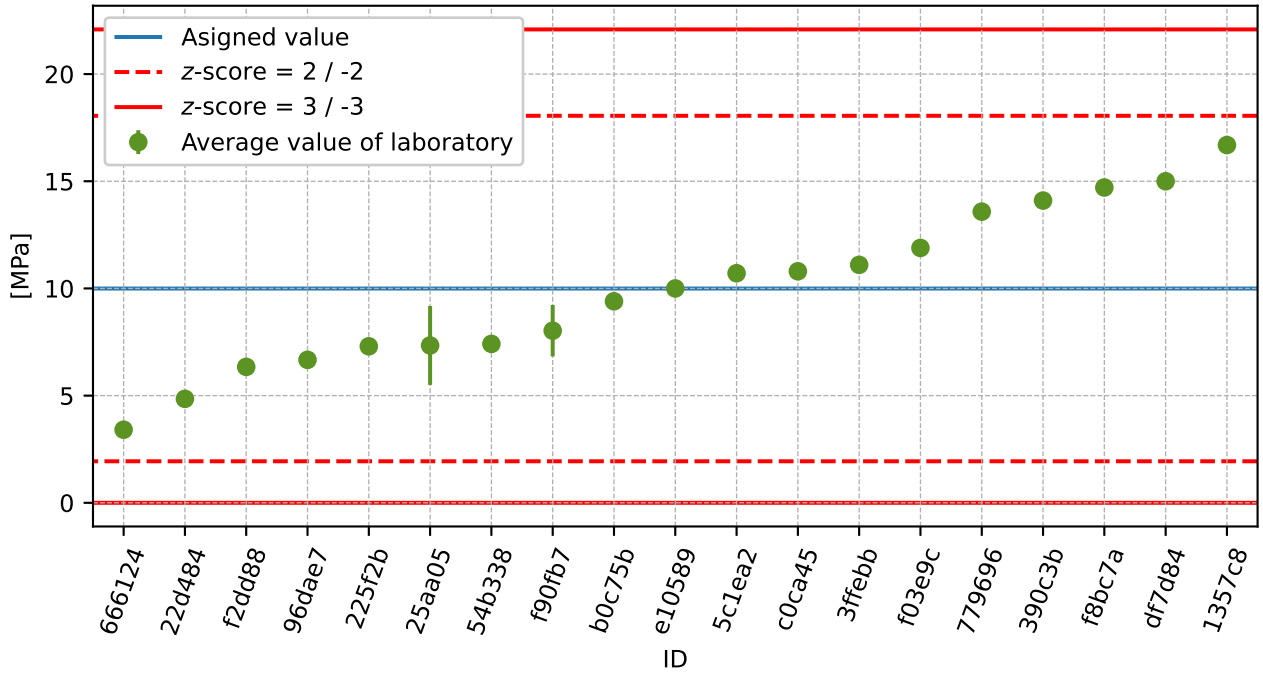

Figure 29: Average values and extended uncertainties of measurement

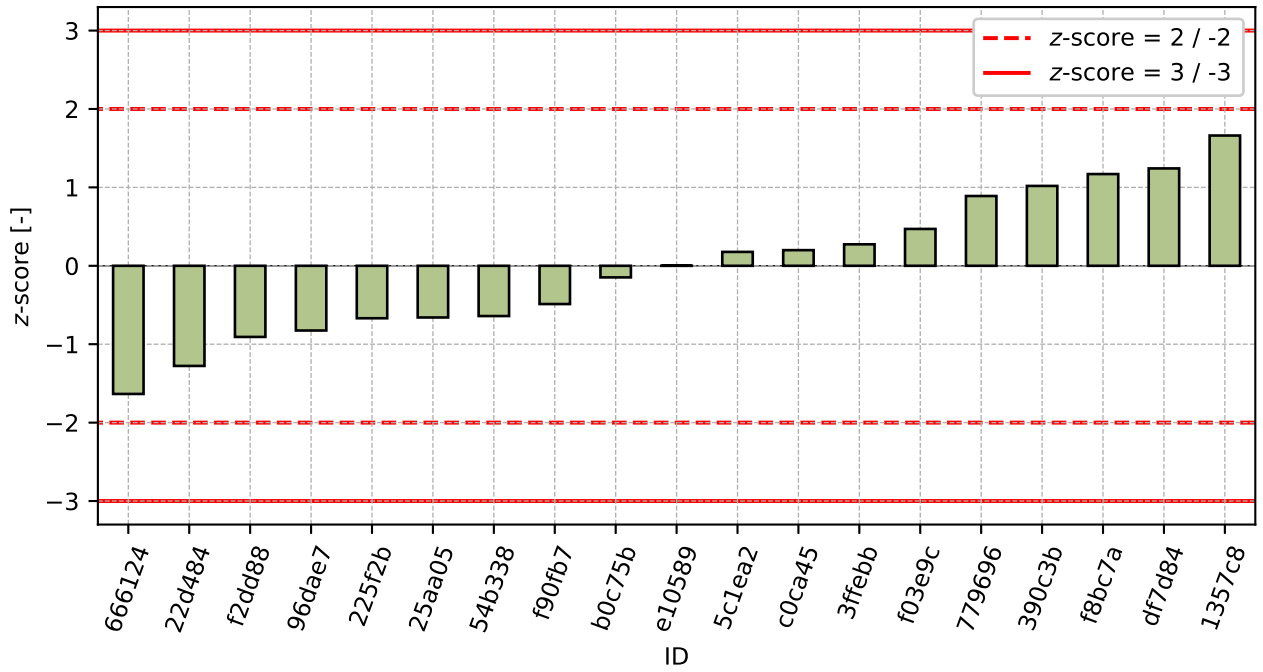

Figure 30: z-score

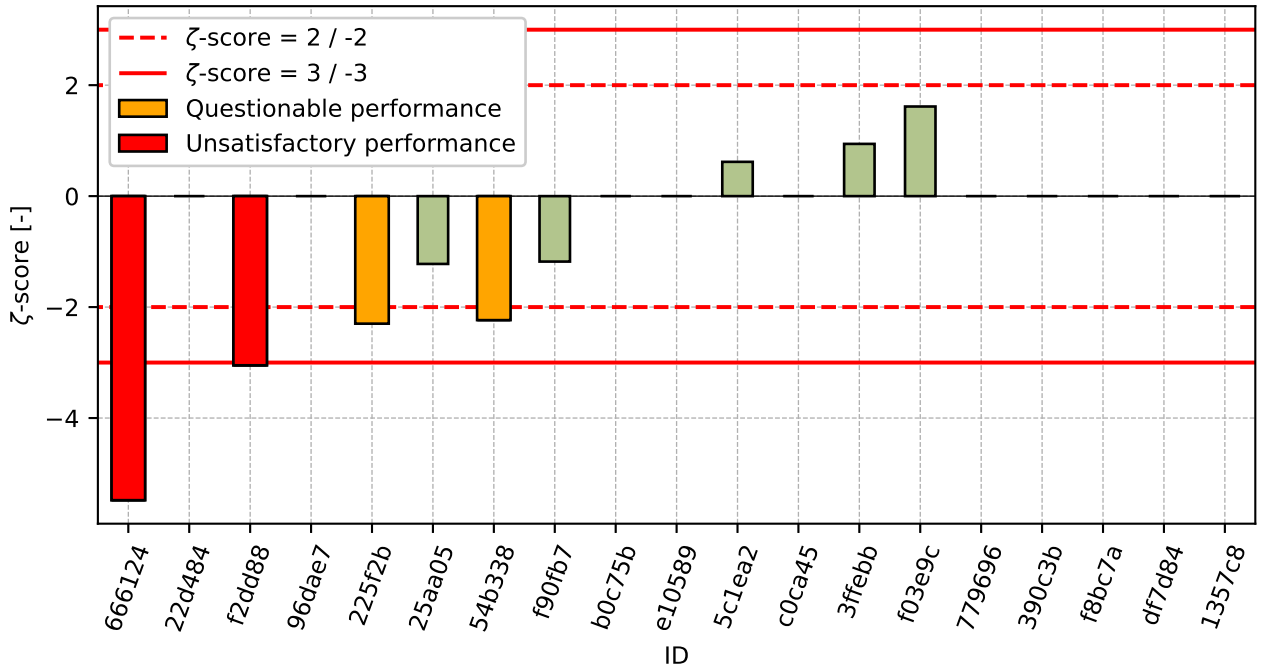

Figure 31: ζ-score

Table 22: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
666124	-1.63	-5.48
22d484	-1.28	-
f2dd88	-0.91	-3.05
96dae7	-0.83	-
225f2b	-0.67	-2.3
25aa05	-0.66	-1.22
54b338	-0.64	-2.24
f90fb7	-0.49	-1.18
b0c75b	-0.15	-
e10589	0.0	-
5c1ea2	0.18	0.62
c0ca45	0.2	-
3ffebb	0.27	0.94
f03e9c	0.47	1.62
779696	0.89	-
390c3b	1.02	-
f8bc7a	1.17	-
df7d84	1.24	-
1357c8	1.66	-

5.3 200 – 400 kPa

5.3.1 Test results

Table 23: 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]
666124	4.39	0.42
22d484	7.55	-
96dae7	7.69	-
54b338	9.09	0.0
f2dd88	10.17	0.51
225f2b	10.2	0.2
f03e9c	11.37	0.19
25aa05	11.58	1.33
f90fb7	13.26	1.33
c0ca45	14.0	-
3ffebb	15.3	0.2
b0c75b	15.7	-
e10589	16.6	-
5c1ea2	16.8	0.01
f8bc7a	19.61	-
390c3b	20.7	-
1357c8	20.76	-
779696	22.18	-
df7d84	23.2	-

5.3.2 The Numerical Procedure for Determining Outliers

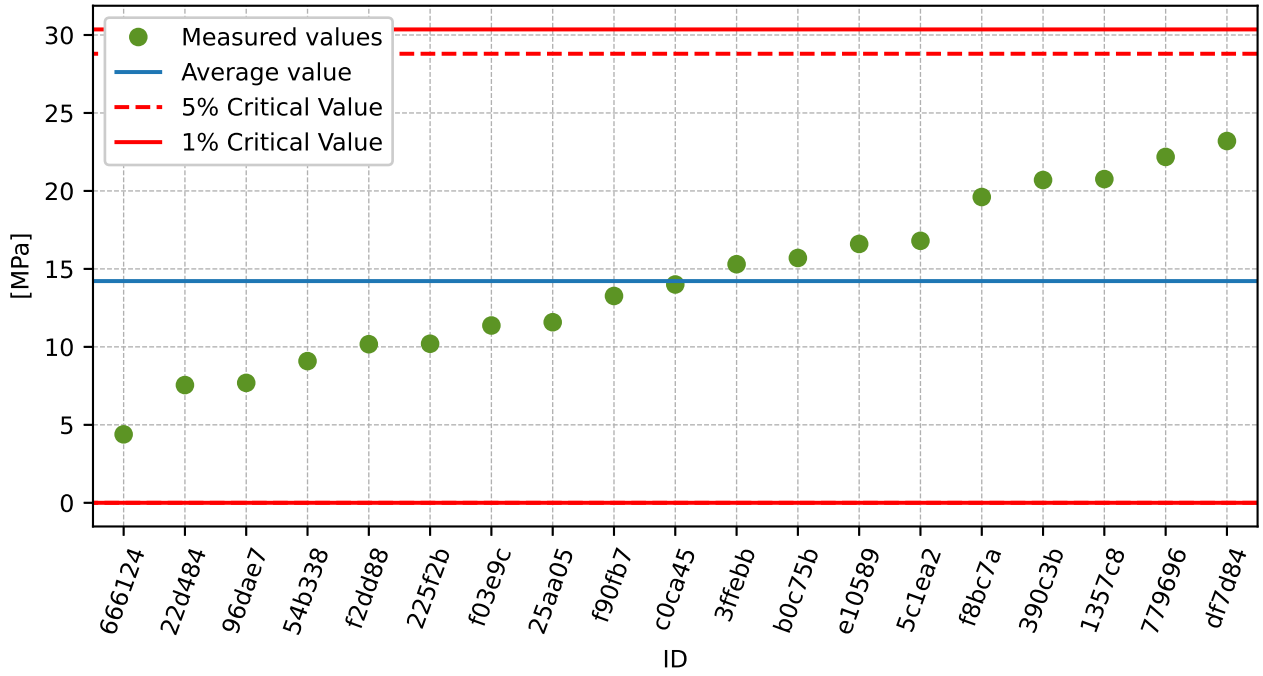

Figure 32: **Grubbs' test** - average values

5.3.3 Mandel's Statistics

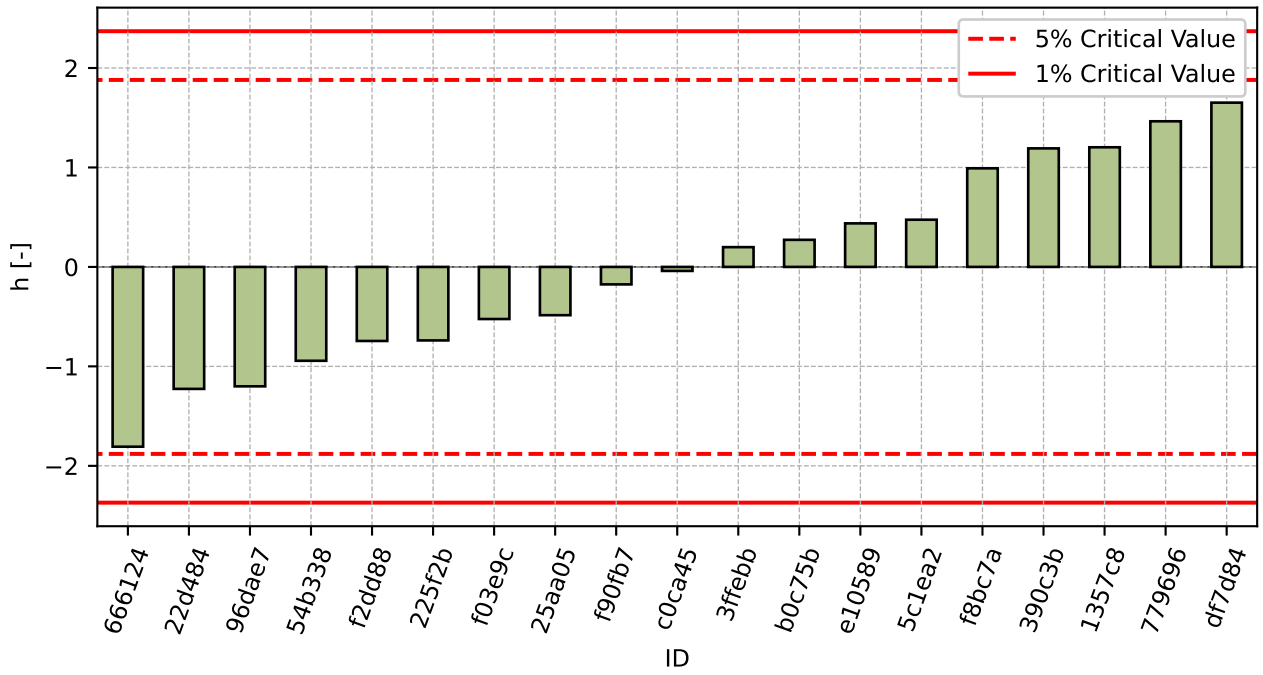

Figure 33: Interlaboratory Consistency Statistic

5.3.4 Descriptive statistics

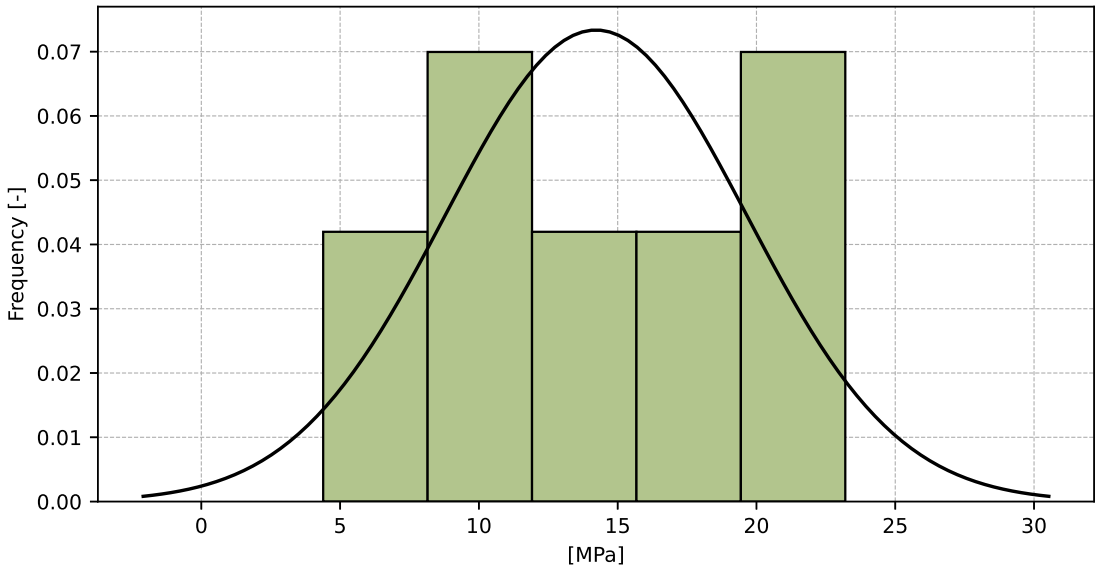

Figure 34: Histogram of all test results

Table 24: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	14.22
Sample standard deviation – s	5.438
Asigned value – x^*	14.28
Robust standard deviation – s^*	5.886
Measurement uncertainty of asigned value – u_X	1.688
p-value of normality test	0.53 [-]

5.3.5 Evaluation of Performance Statistics

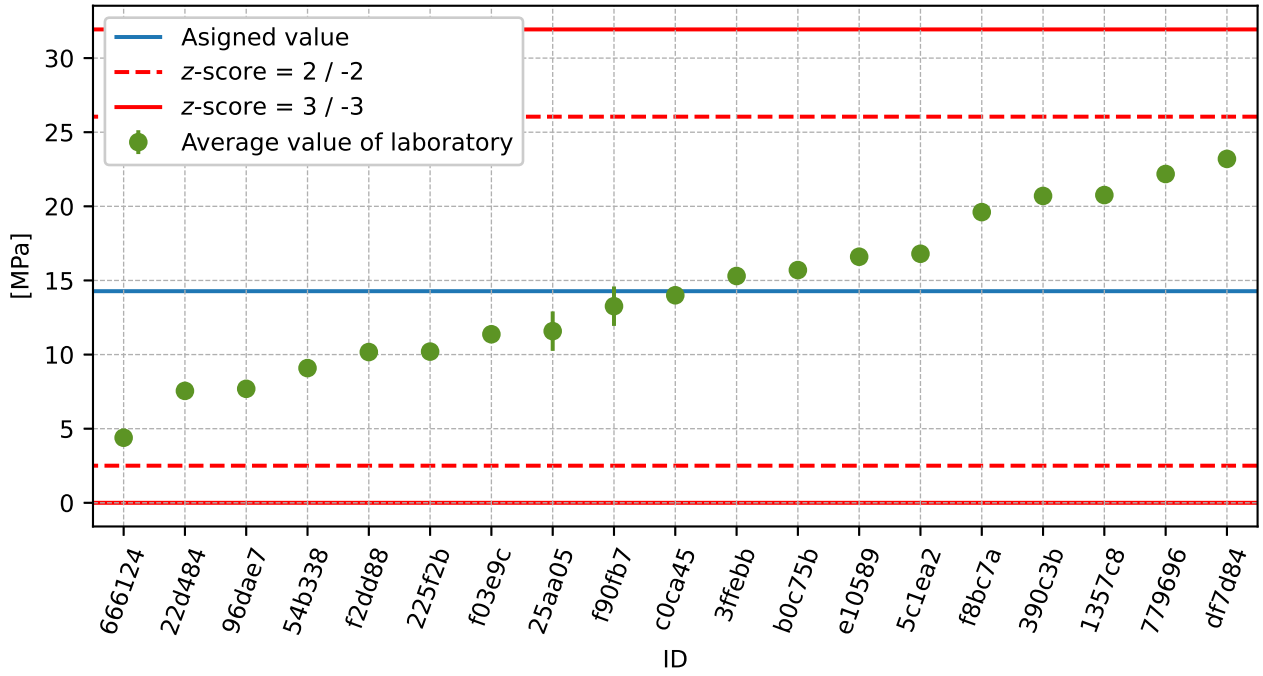

Figure 35: Average values and extended uncertainties of measurement

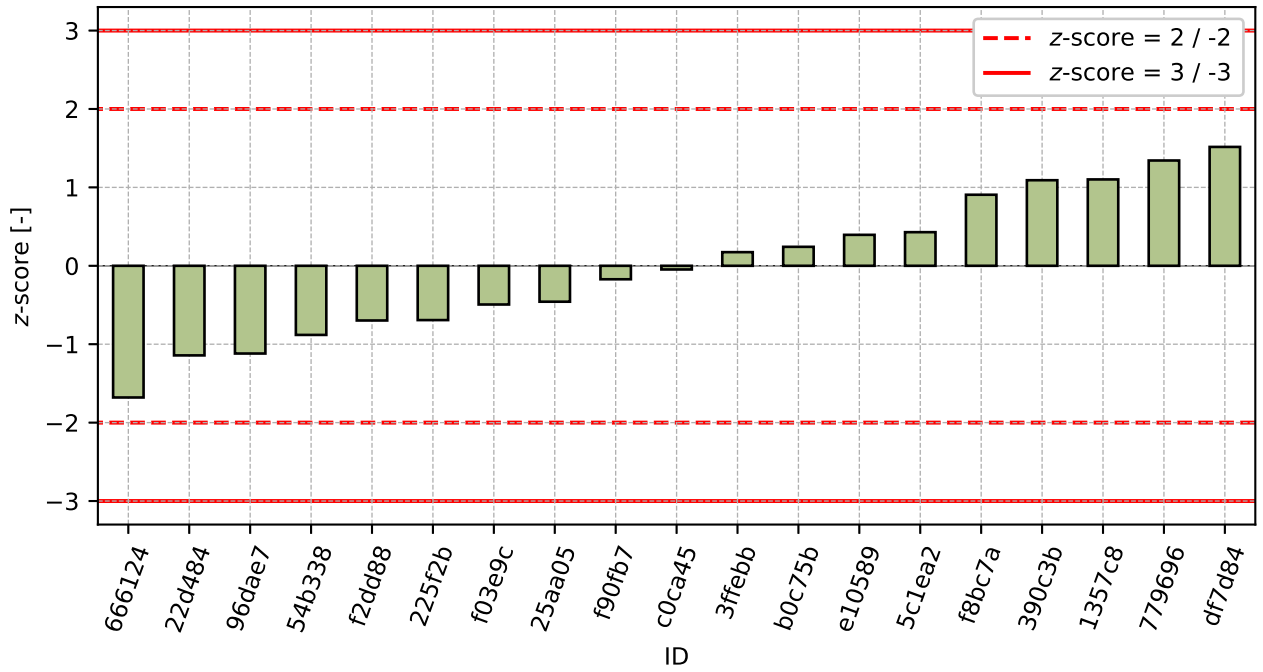

Figure 36: z-score

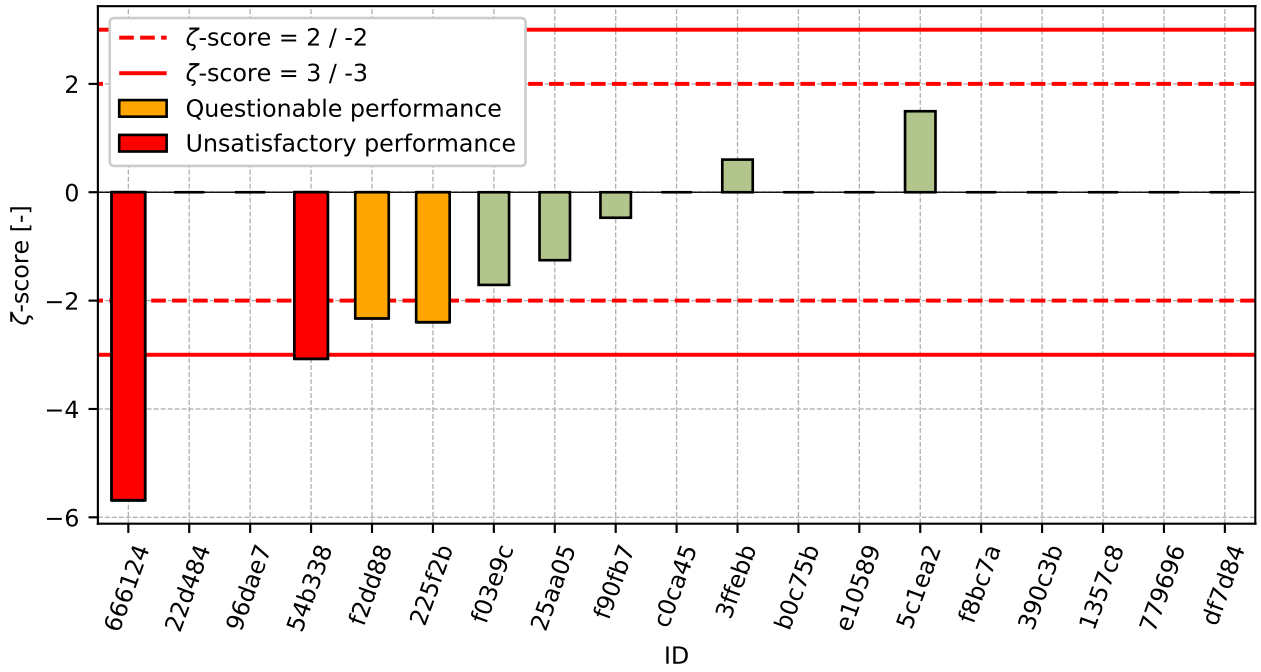

Figure 37: ζ-score

Table 25: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
666124	-1.68	-5.68
22d484	-1.14	-
96dae7	-1.12	-
54b338	-0.88	-3.07
f2dd88	-0.7	-2.33
225f2b	-0.69	-2.4
f03e9c	-0.49	-1.71
25aa05	-0.46	-1.25
f90fb7	-0.17	-0.47
c0ca45	-0.05	-
3ffebb	0.17	0.6
b0c75b	0.24	-
e10589	0.39	-
5c1ea2	0.43	1.5
f8bc7a	0.91	-
390c3b	1.09	-
1357c8	1.1	-
779696	1.34	-
df7d84	1.52	-

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

6.1 Unconfined compressive strength

6.1.1 Test results

Table 26: 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 [MPa]				u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
1b8e4c	0.14	0.145	0.147	0.149	-	0.145	0.0039	2.66
666124	0.15	0.15	0.15	0.15	0.01	0.15	0.0	0.0
b0c75b	0.22	0.21	0.209	0.213	-	0.213	0.005	2.33
779696	0.218	0.2	0.2	0.247	-	0.216	0.0222	10.26
e10589	0.274	0.206	0.226	0.224	0.015	0.232	0.0291	12.51
225f2b	0.231	0.258	0.223	0.232	0.04	0.236	0.0152	6.44
3ffebb	0.216	0.279	0.253	0.227	0.005	0.244	0.0282	11.55
390c3b	0.26	0.257	0.254	0.265	-	0.259	0.0047	1.81
25aa05	0.25	0.27	0.29	0.28	0.007	0.272	0.0171	6.27
f2dd88	0.31	0.33	0.22	0.25	0.01	0.277	0.0512	18.46
df7d84	0.239	0.297	0.297	-	0.019	0.278	0.0335	12.06
90dd12	0.271	0.293	0.305	-	-	0.29	0.0172	5.95
33459f	0.355	0.289	0.344	0.254	-	0.31	0.0475	15.28
f8bc7a	0.53	0.41	0.34	0.53	-	0.452	0.0939	20.76

6.1.2 The Numerical Procedure for Determining Outliers

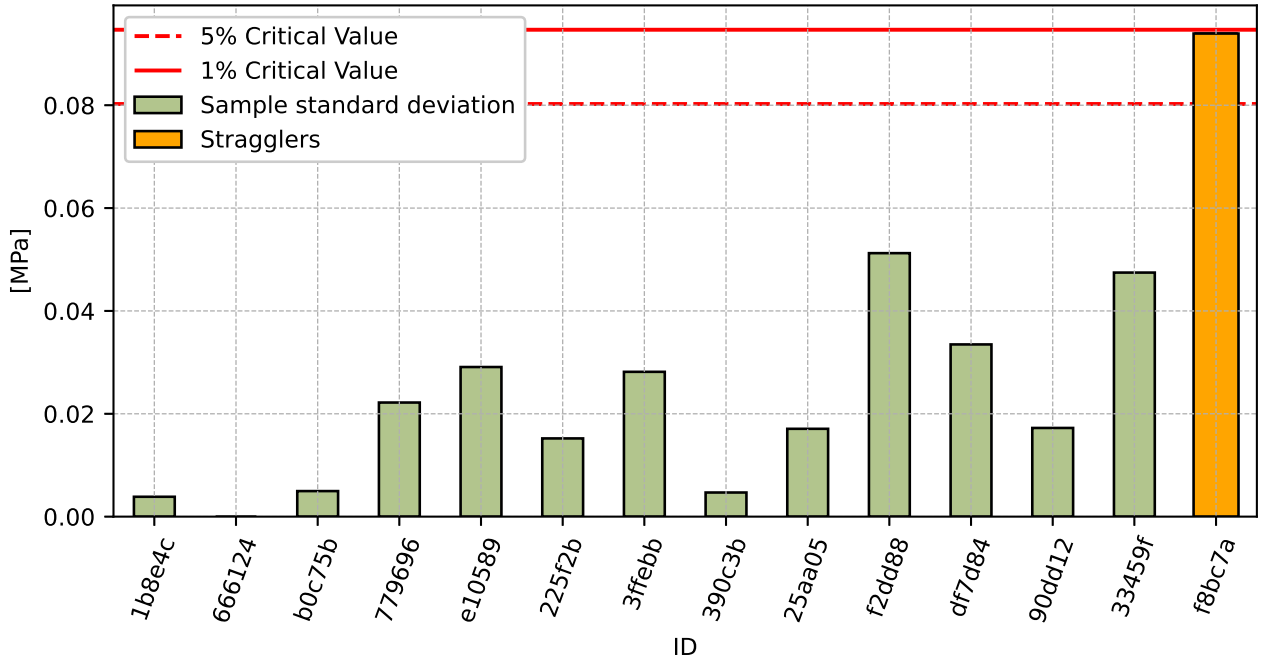

Figure 38: **Cochran's test** - sample standard deviations

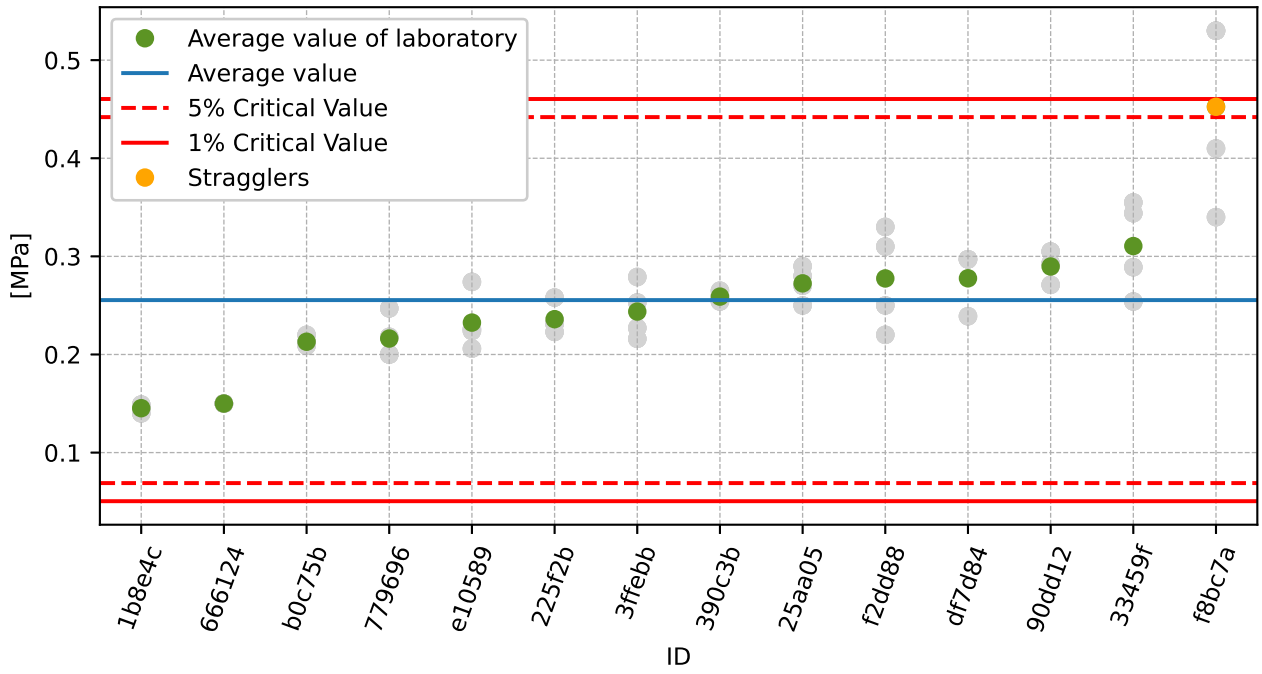

Figure 39: **Grubbs' test** - average values

6.1.3 Mandel's Statistics

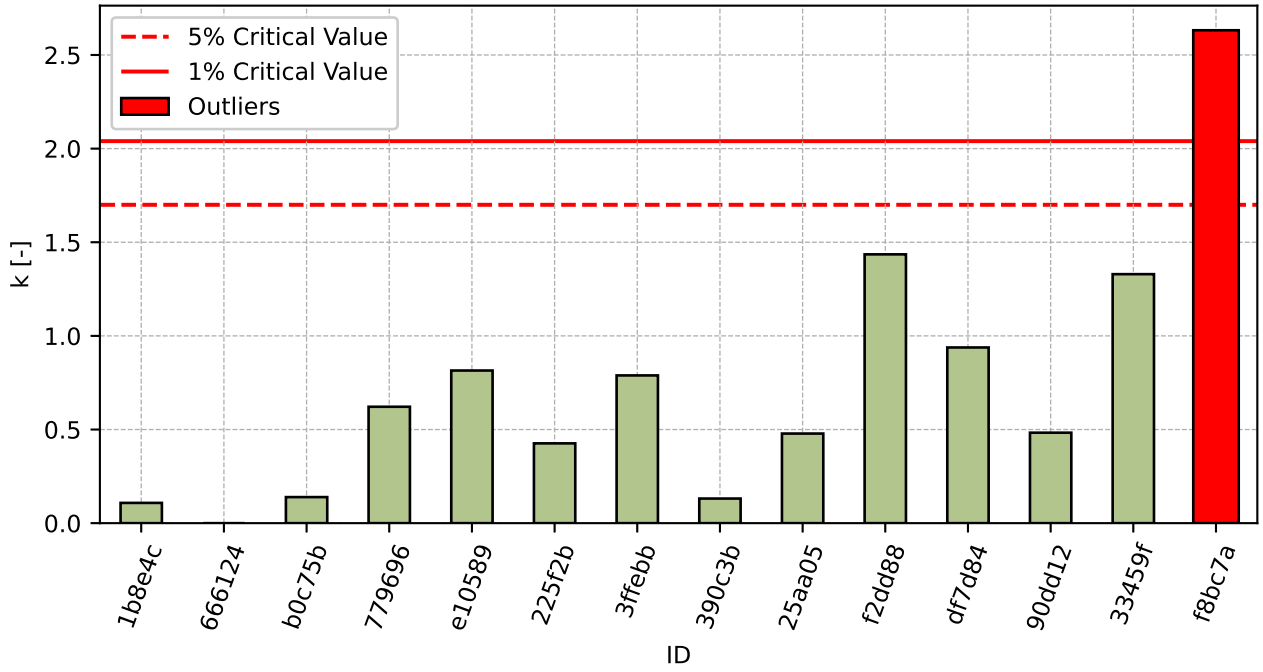

Figure 40: Intralaboratory Consistency Statistic

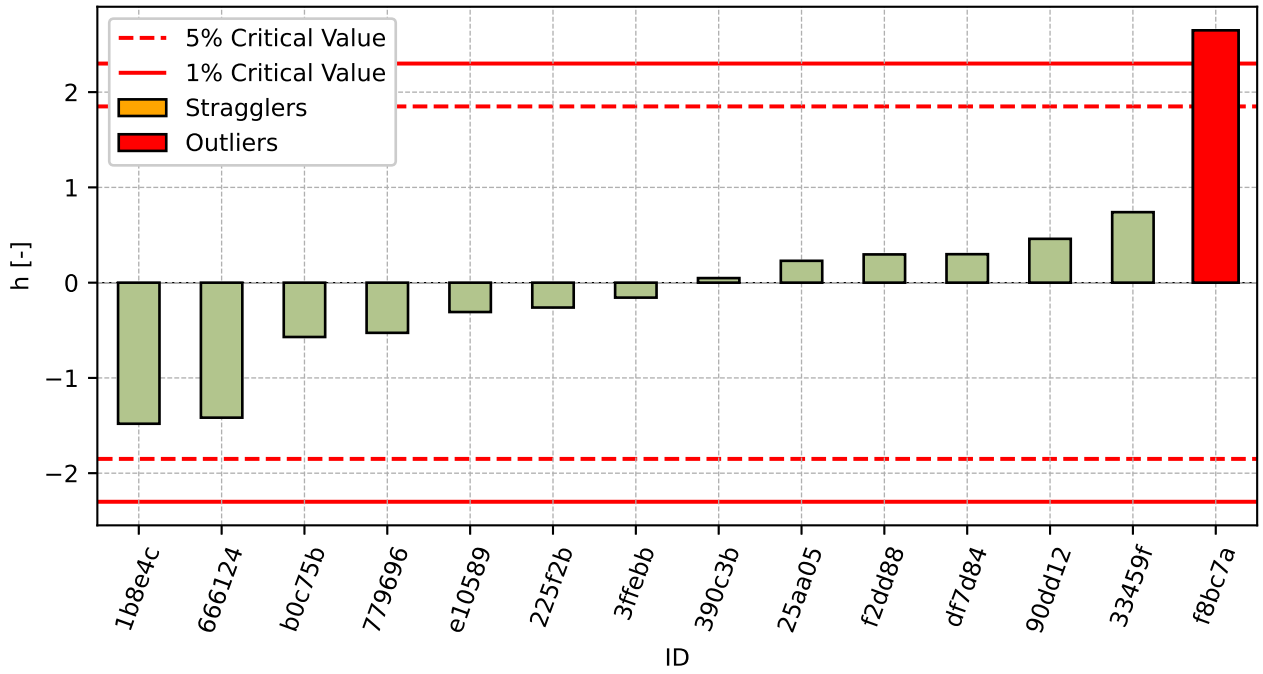

Figure 41: Interlaboratory Consistency Statistic

6.1.4 Descriptive statistics

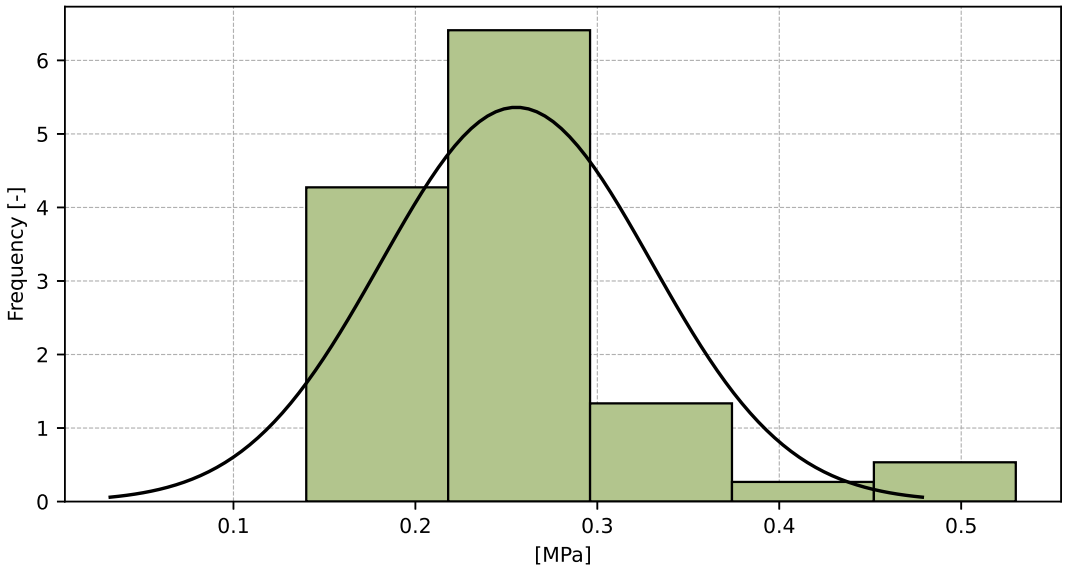

Figure 42: Histogram of all test results

Table 27: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	0.255
Sample standard deviation – s	0.0744
Asigned value – x^*	0.26
Robust standard deviation – s^*	0.0735
Measurement uncertainty of asigned value – u_X	0.0246
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.0722
Repeatability standard deviation – s_r	0.0357
Reproducibility standard deviation – s_R	0.0806
Repeatability – r	0.1
Reproducibility – R	0.226

6.1.5 Evaluation of Performance Statistics

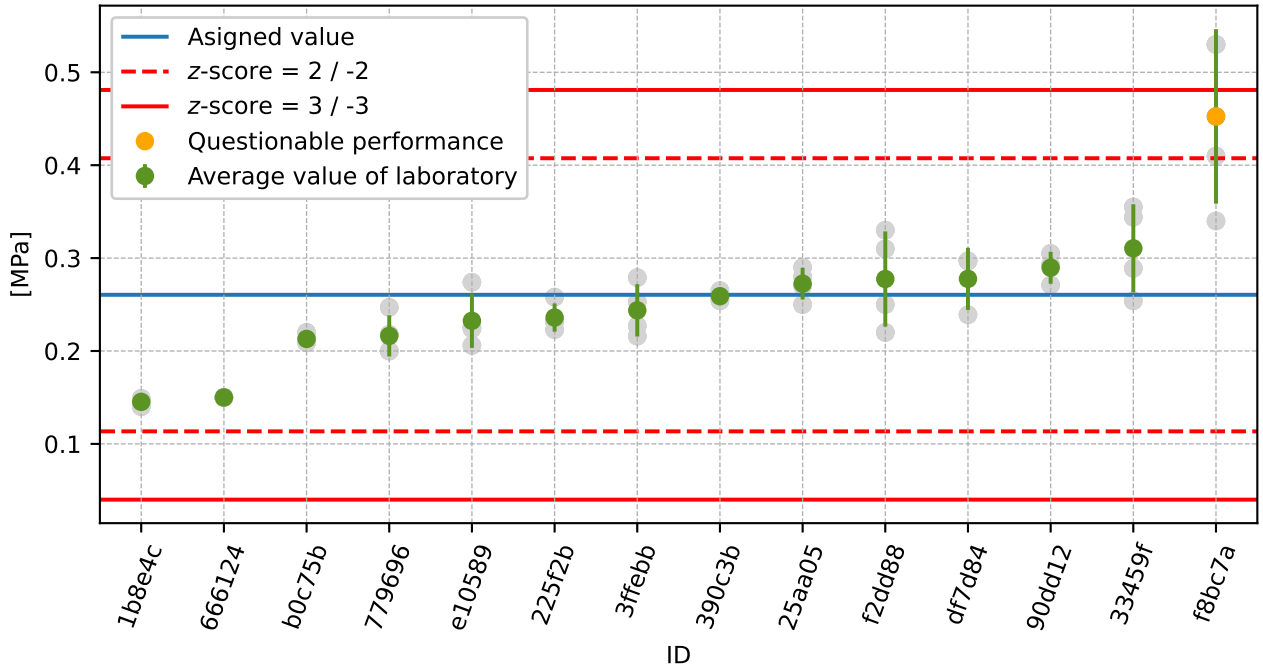

Figure 43: Average values and sample standard deviations

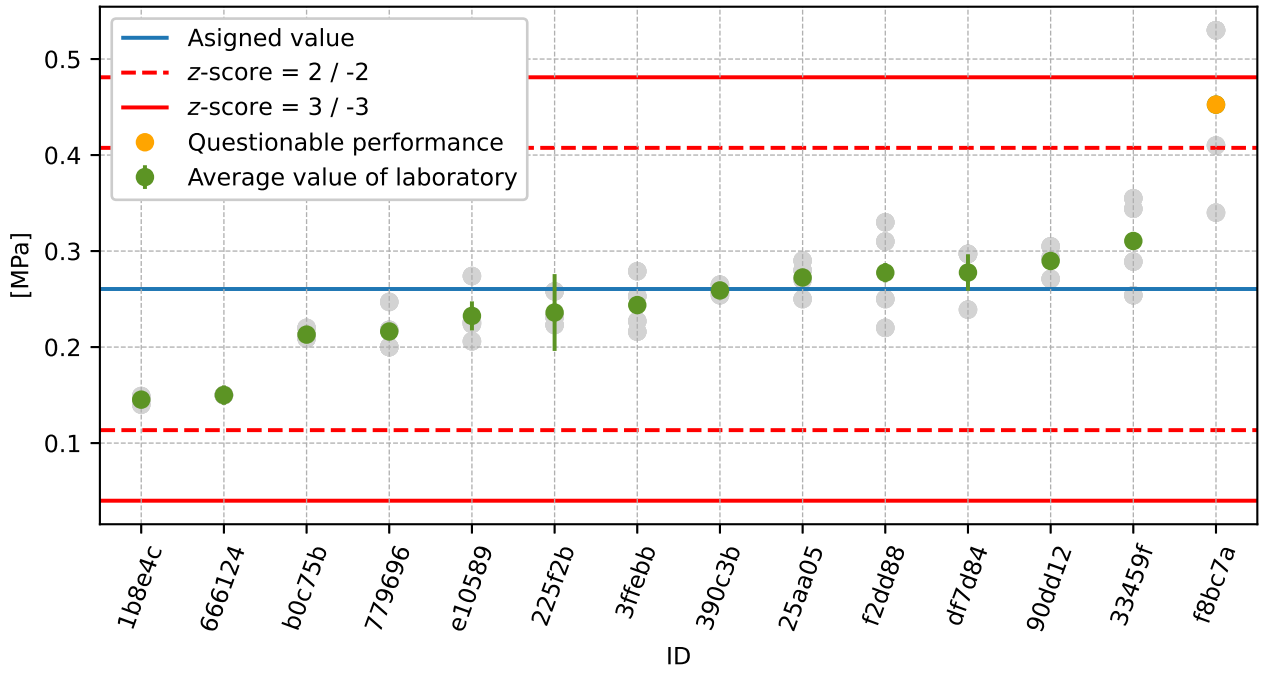

Figure 44: Average values and extended uncertainties of measurement

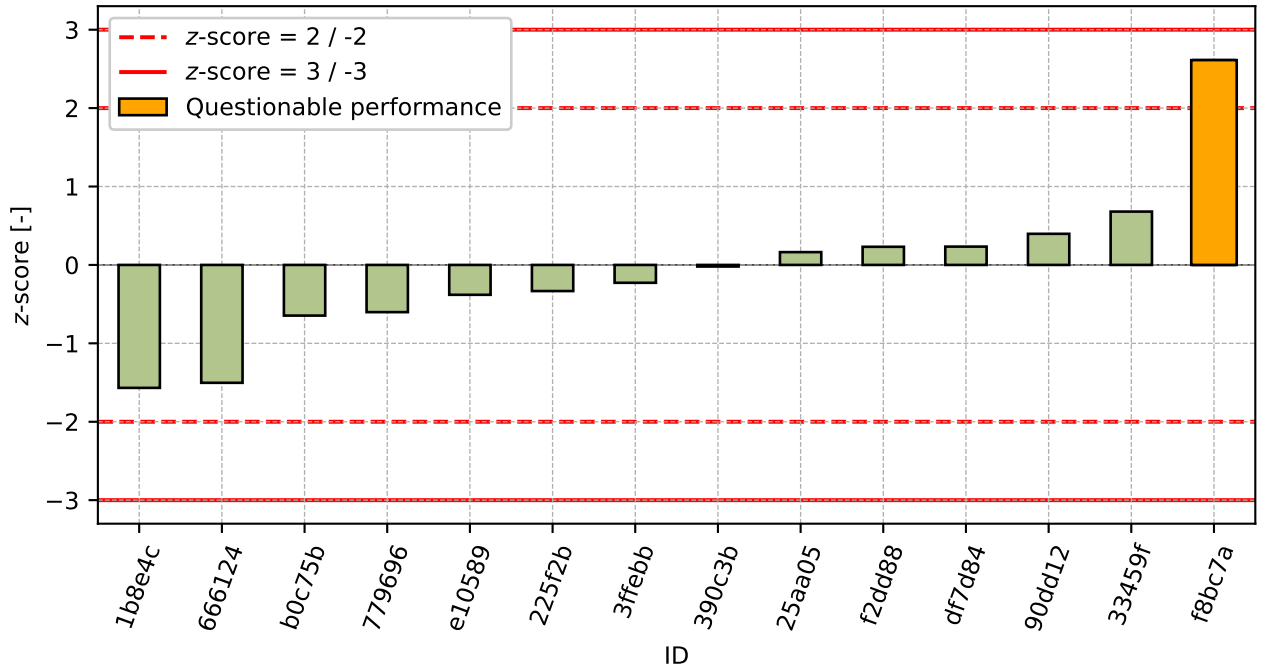

Figure 45: z-score

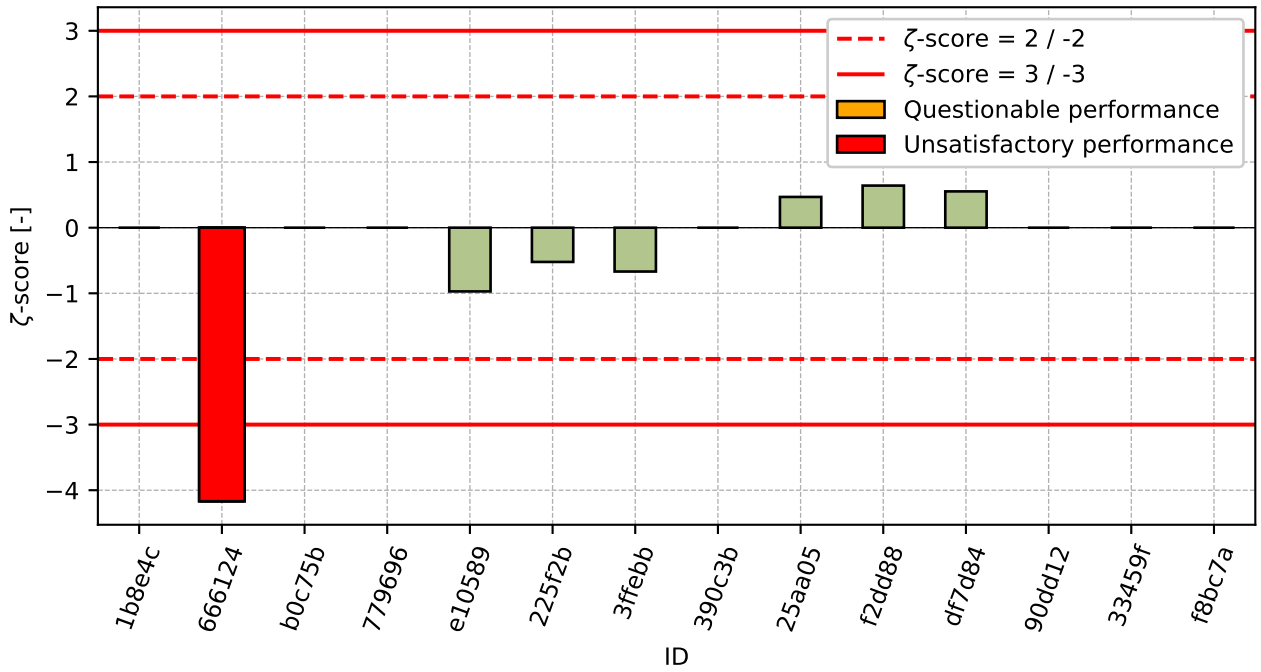

Figure 46: ζ-score

Table 28: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
1b8e4c	-1.57	-
666124	-1.5	-4.17
b0c75b	-0.65	-
779696	-0.6	-
e10589	-0.38	-0.97
225f2b	-0.33	-0.52
3ffebb	-0.23	-0.67
390c3b	-0.02	-
25aa05	0.16	0.47
f2dd88	0.23	0.64
df7d84	0.23	0.55
90dd12	0.4	-
33459f	0.68	-
f8bc7a	2.61	-

6.2 Strain at failure

6.2.1 Test results

Table 29: 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 [%]
df7d84	2.5	3.0	2.7	-	-	2.7	0.25	9.21
225f2b	3.4	3.8	3.3	3.4	0.3	3.5	0.22	6.38
779696	4.6	4.0	4.0	4.9	-	4.4	0.45	10.29
390c3b	4.4	4.8	4.5	4.9	-	4.6	0.24	5.12
666124	6.2	4.7	5.0	3.0	0.4	4.7	1.33	27.96
1b8e4c	5.2	5.8	4.0	4.9	1.2	5.0	0.75	15.08
f8bc7a	6.0	5.1	6.9	4.2	-	5.5	1.19	21.54
3ffebb	4.8	5.9	7.5	6.8	0.0	6.2	1.17	18.68
e10589	7.2	8.2	5.9	7.0	-	7.1	0.94	13.33
f2dd88	7.2	6.6	7.2	7.5	0.5	7.1	0.38	5.3
33459f	6.6	6.6	7.6	7.8	-	7.1	0.66	9.18
b0c75b	7.2	7.6	8.1	7.3	-	7.6	0.4	5.35
90dd12	9.5	8.6	8.9	-	-	9.0	0.46	5.09
25aa05	9.3	9.0	9.0	9.0	-	9.1	0.15	1.65

6.2.2 The Numerical Procedure for Determining Outliers

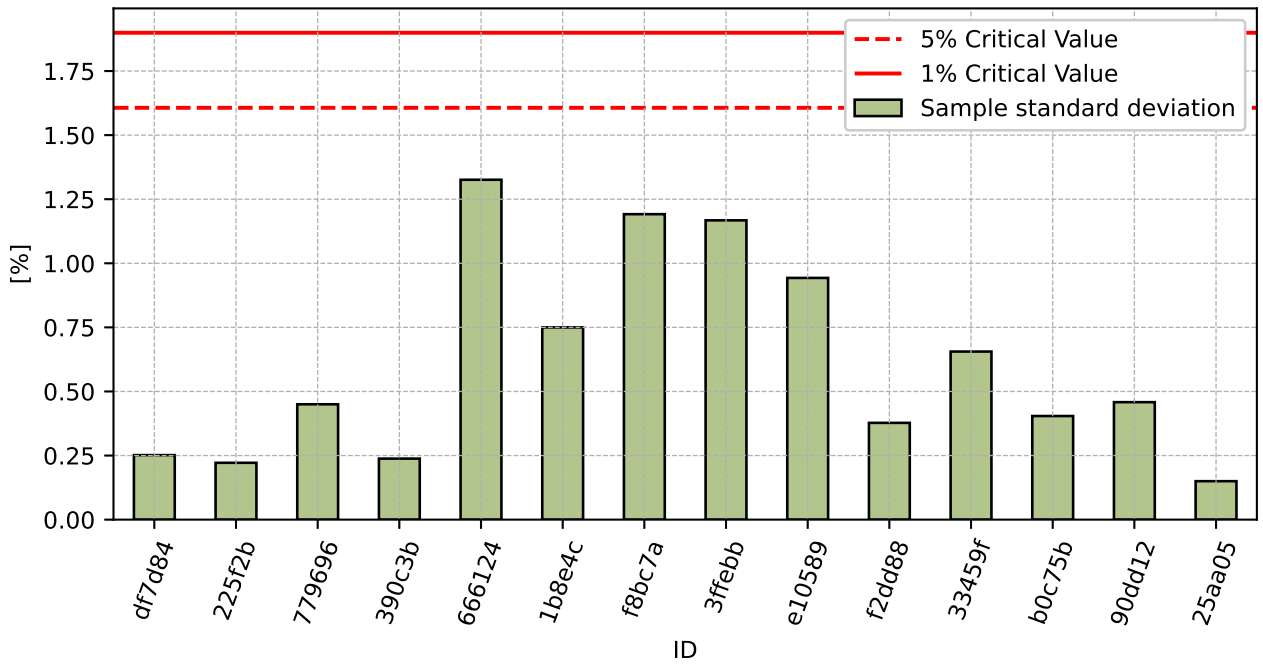

Figure 47: **Cochran's test** - sample standard deviations

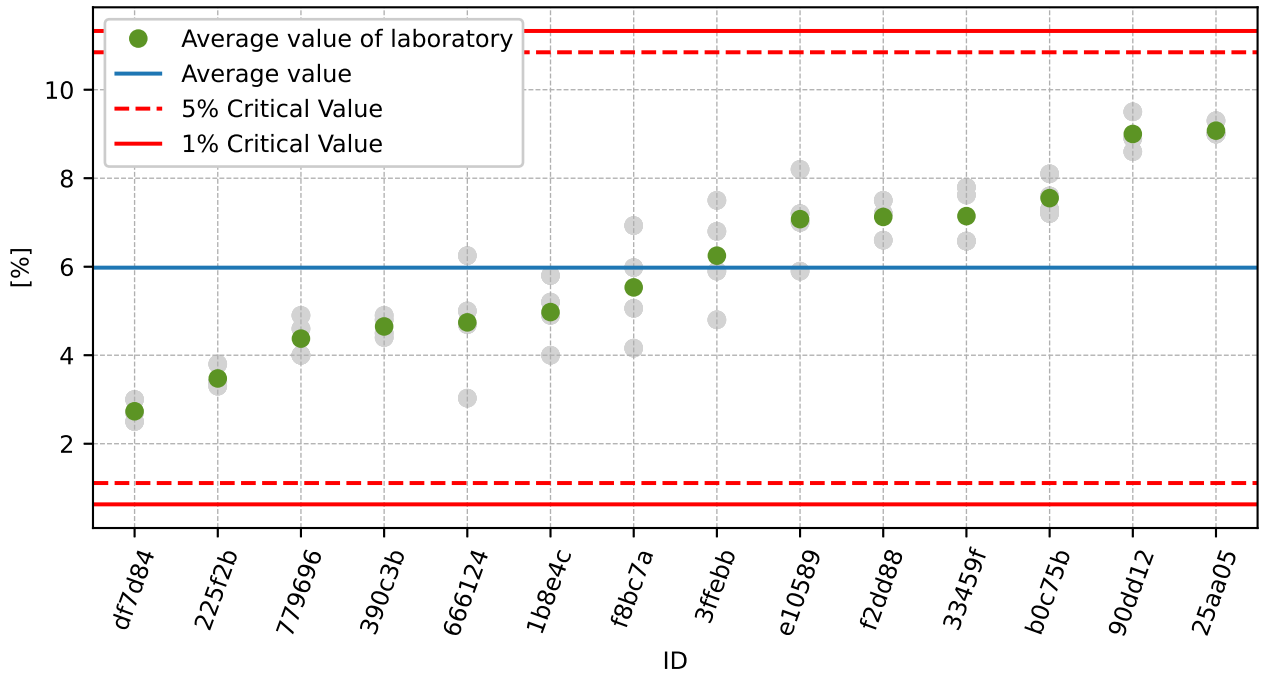

Figure 48: **Grubbs' test** - average values

6.2.3 Mandel's Statistics

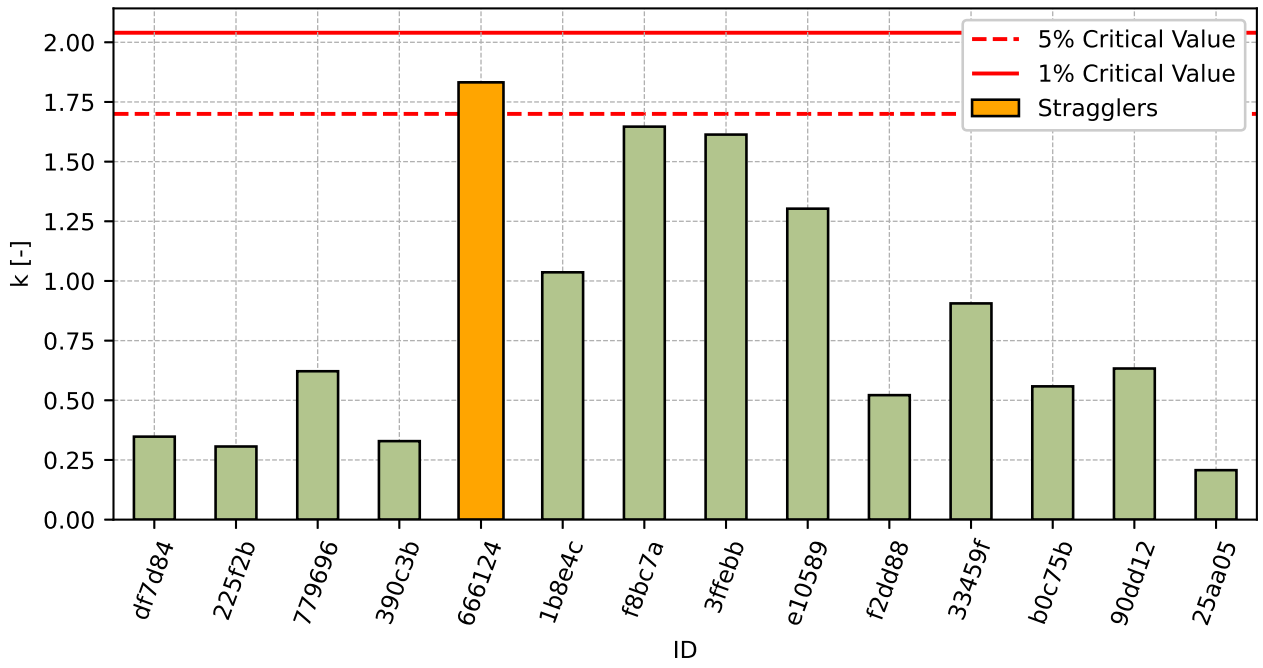

Figure 49: Intralaboratory Consistency Statistic

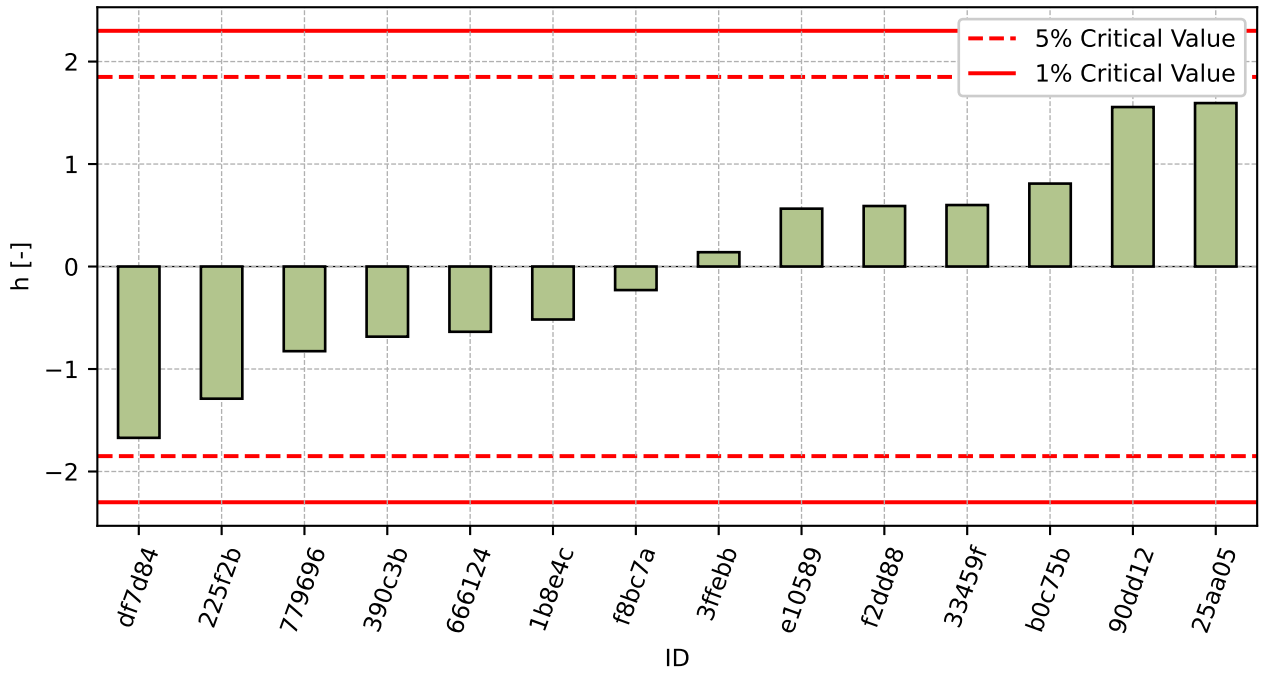

Figure 50: Interlaboratory Consistency Statistic

6.2.4 Descriptive statistics

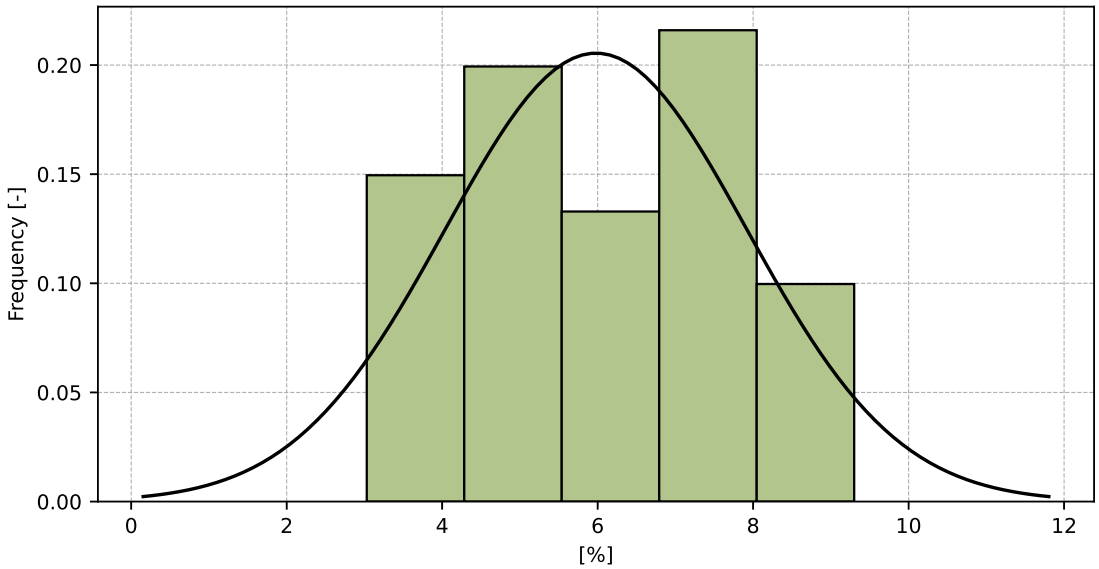

Figure 51: Histogram of all test results

Table 30: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	6.0
Sample standard deviation – s	1.94
Asigned value – x^*	6.0
Robust standard deviation – s^*	2.03
Measurement uncertainty of asigned value – u_X	0.68
p-value of normality test	0.054 [-]
Interlaboratory standard deviation – s_L	1.91
Repeatability standard deviation – s_r	0.72
Reproducibility standard deviation – s_R	2.04
Repeatability – r	2.0
Reproducibility – R	5.7

6.2.5 Evaluation of Performance Statistics

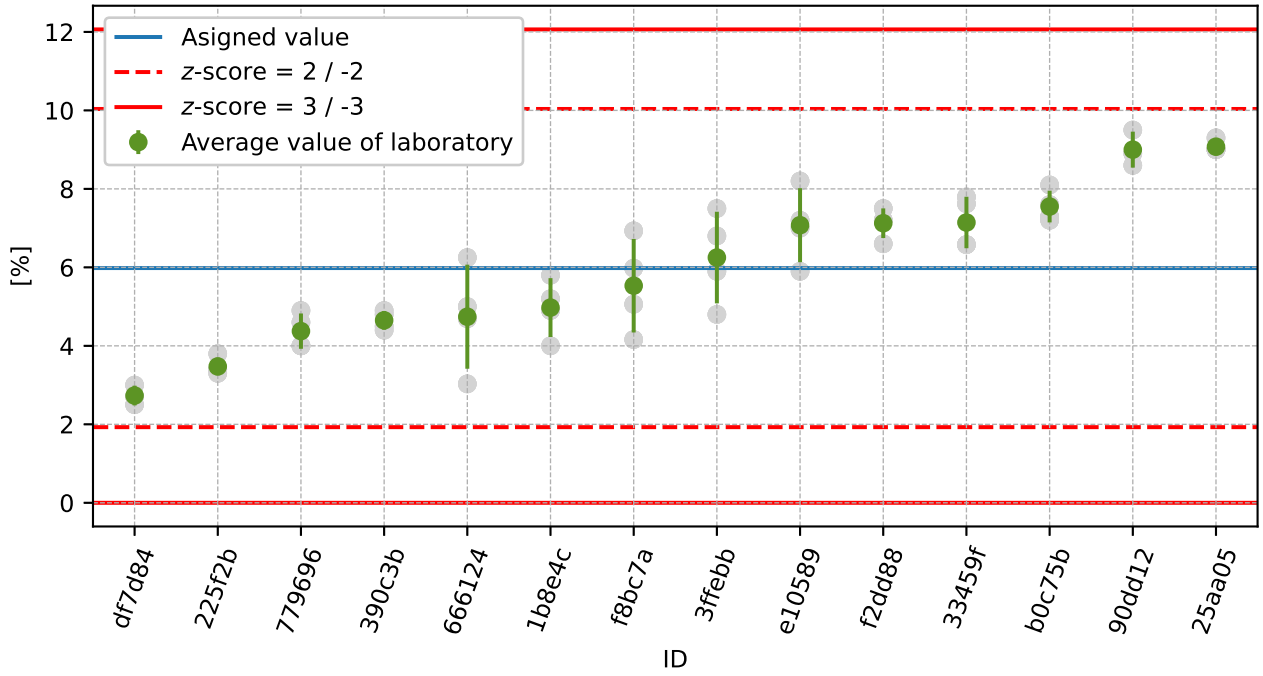

Figure 52: Average values and sample standard deviations

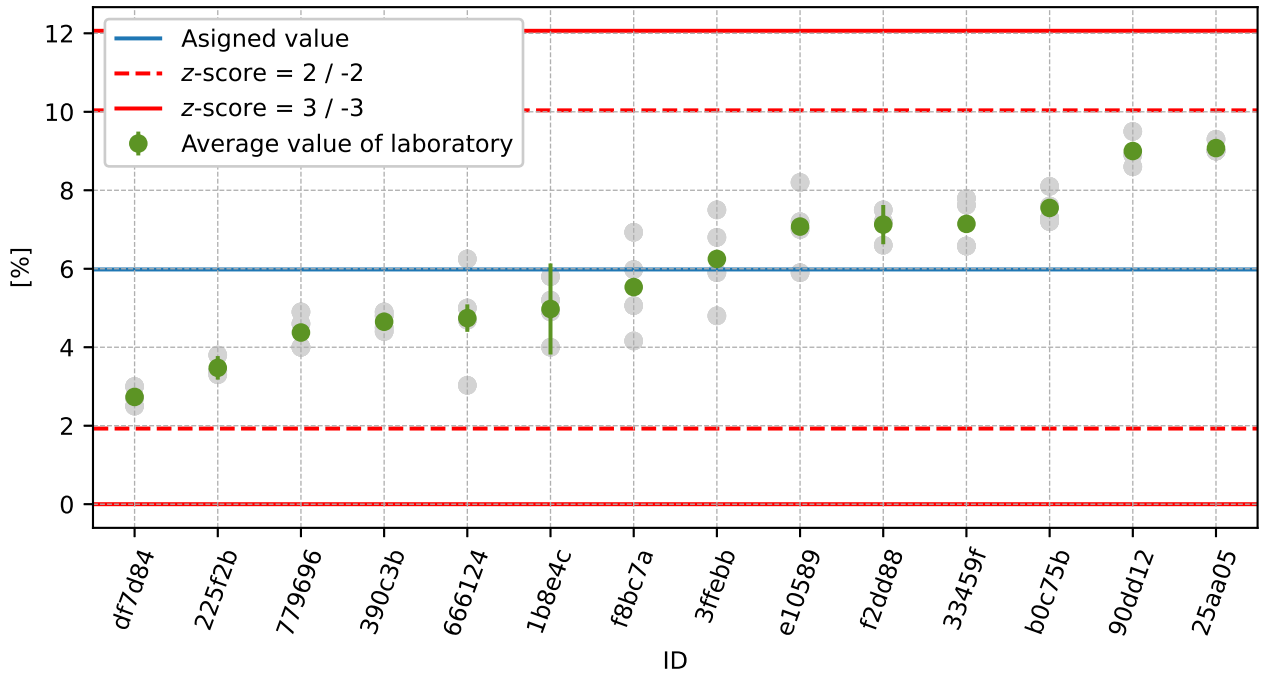

Figure 53: Average values and extended uncertainties of measurement

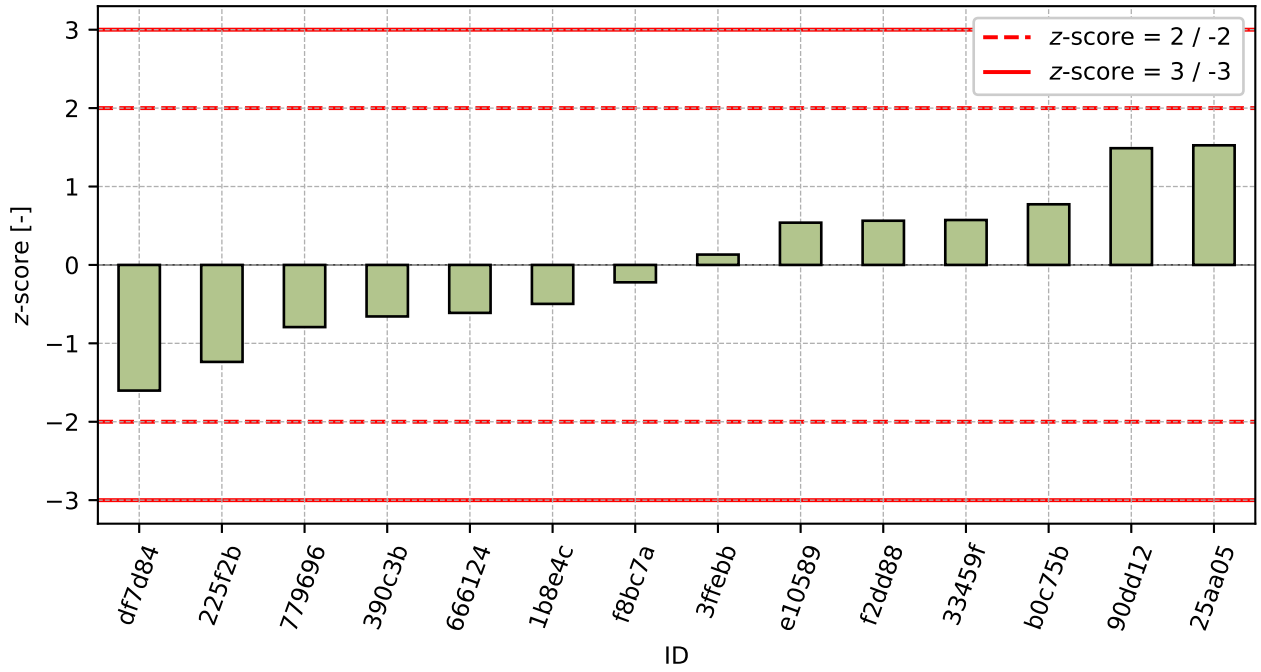

Figure 54: z-score

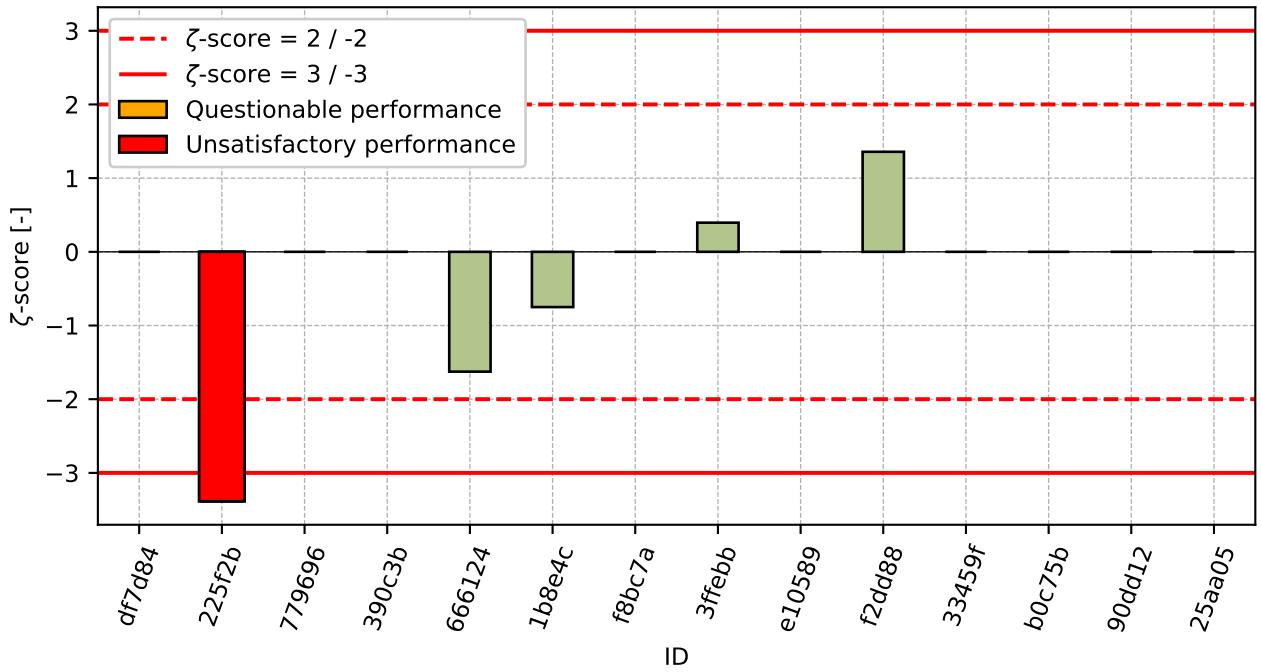

Figure 55: ζ-score

Table 31: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
df7d84	-1.6	-
225f2b	-1.24	-3.38
779696	-0.79	-
390c3b	-0.66	-
666124	-0.61	-1.63
1b8e4c	-0.5	-0.75
f8bc7a	-0.22	-
3ffebb	0.13	0.4
e10589	0.54	-
f2dd88	0.56	1.36
33459f	0.57	-
b0c75b	0.77	-
90dd12	1.49	-
25aa05	1.53	-

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

7.1 50 kPa

7.1.1 Test results

Table 32: 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]
7d0a95	37	1
d1ee17	38	-
90dd12	40	-
225f2b	42	0
5c1ea2	42	0
1357c8	43	-
bdbff6	43	-
22d484	43	-
25aa05	44	1
33459f	45	-
f8bc7a	47	-
390c3b	50	-
b0c75b	52	-
f2dd88	55	3
5633d2	55	-
779696	57	-
e10589	69	4
666124	74	5

7.1.2 The Numerical Procedure for Determining Outliers

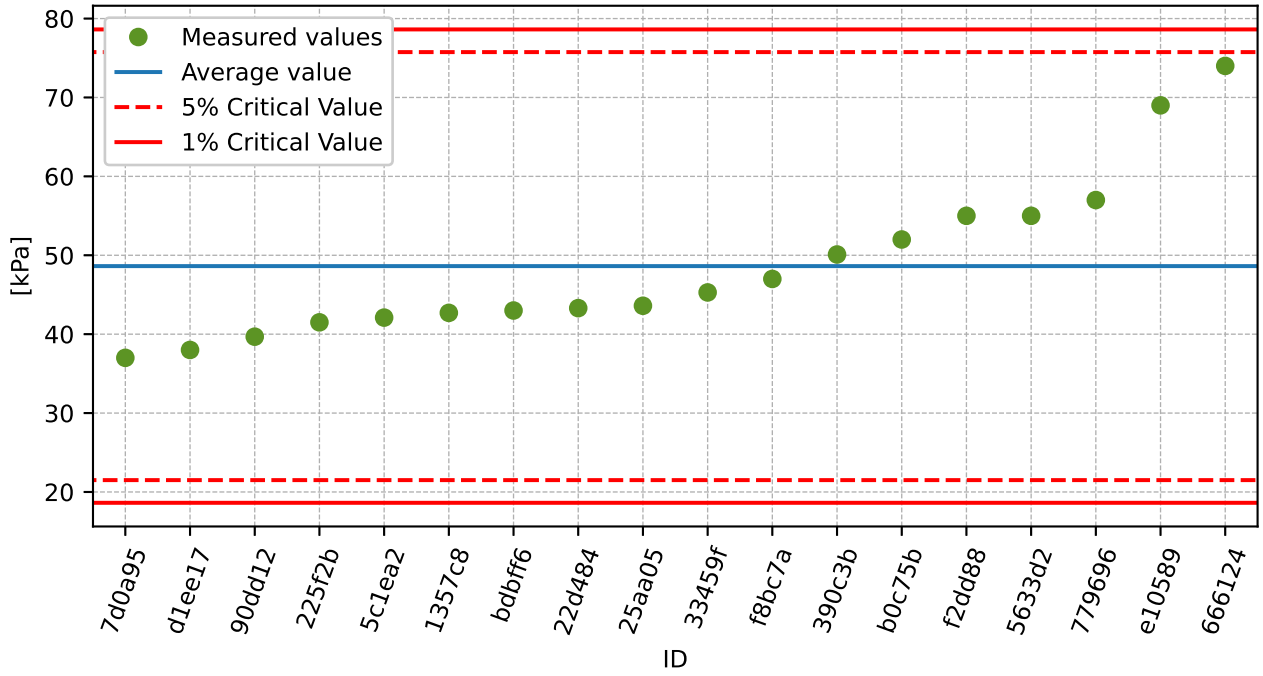

Figure 56: **Grubbs' test** - average values

7.1.3 Mandel's Statistics

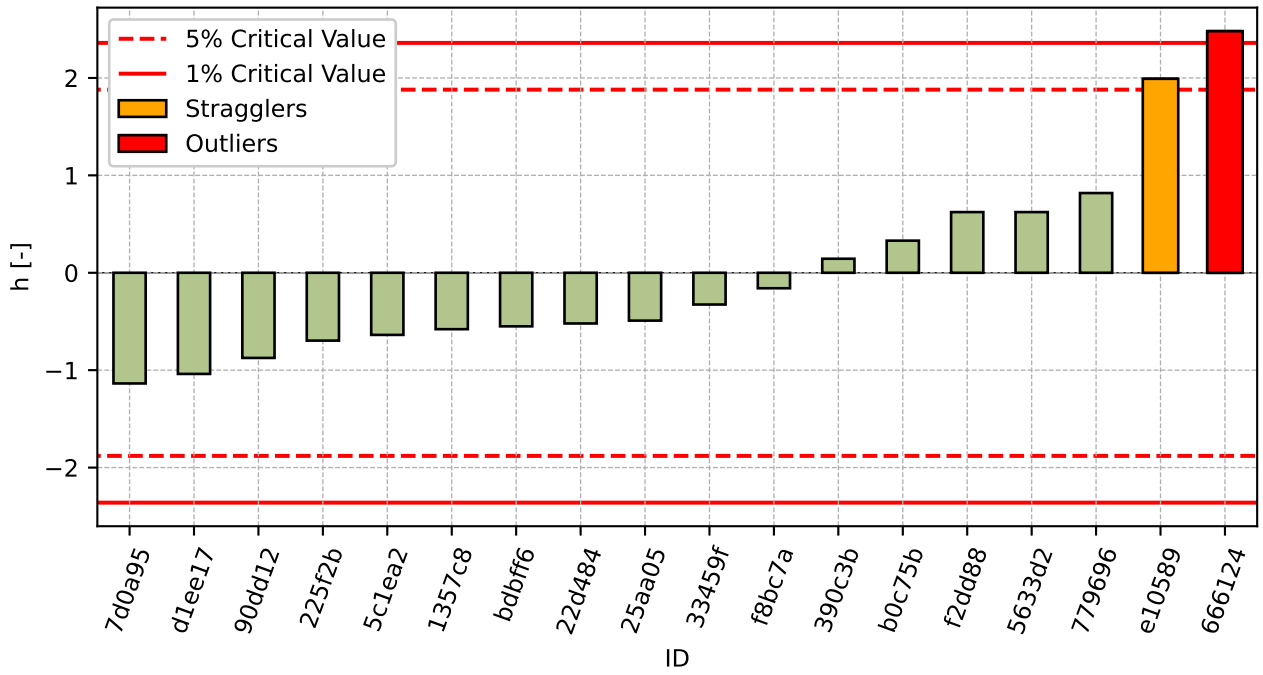

Figure 57: Interlaboratory Consistency Statistic

7.1.4 Descriptive statistics

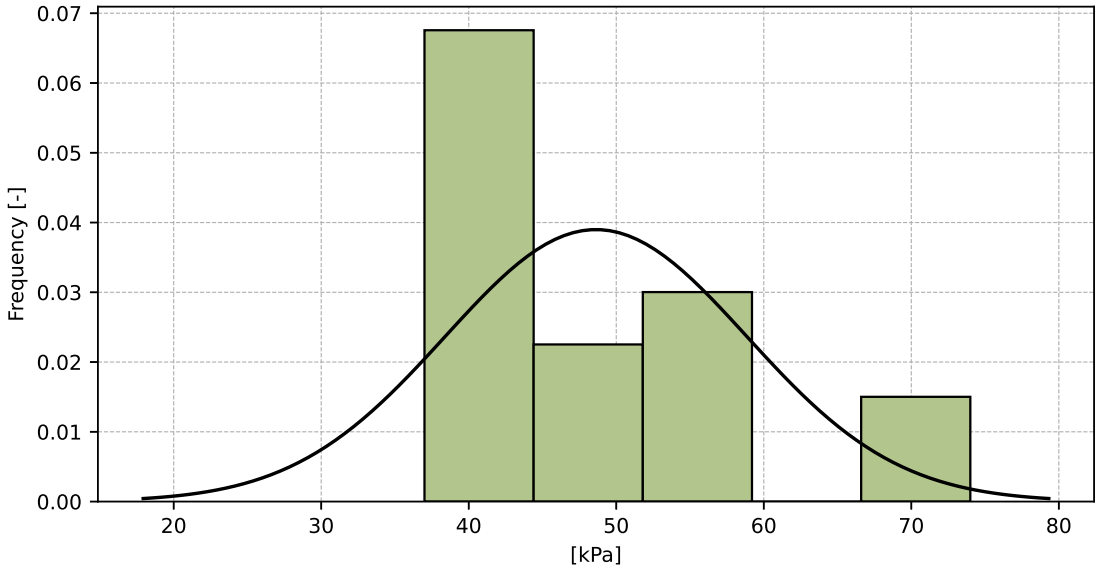

Figure 58: Histogram of all test results

Table 33: Descriptive statistics

Characteristics	[kPa]
Average value – $\bar{x}$	49
Sample standard deviation – s	10.2
Asigned value – x^*	48
Robust standard deviation – s^*	10.0
Measurement uncertainty of asigned value – u_X	2.9
p-value of normality test	0.03 [-]

7.1.5 Evaluation of Performance Statistics

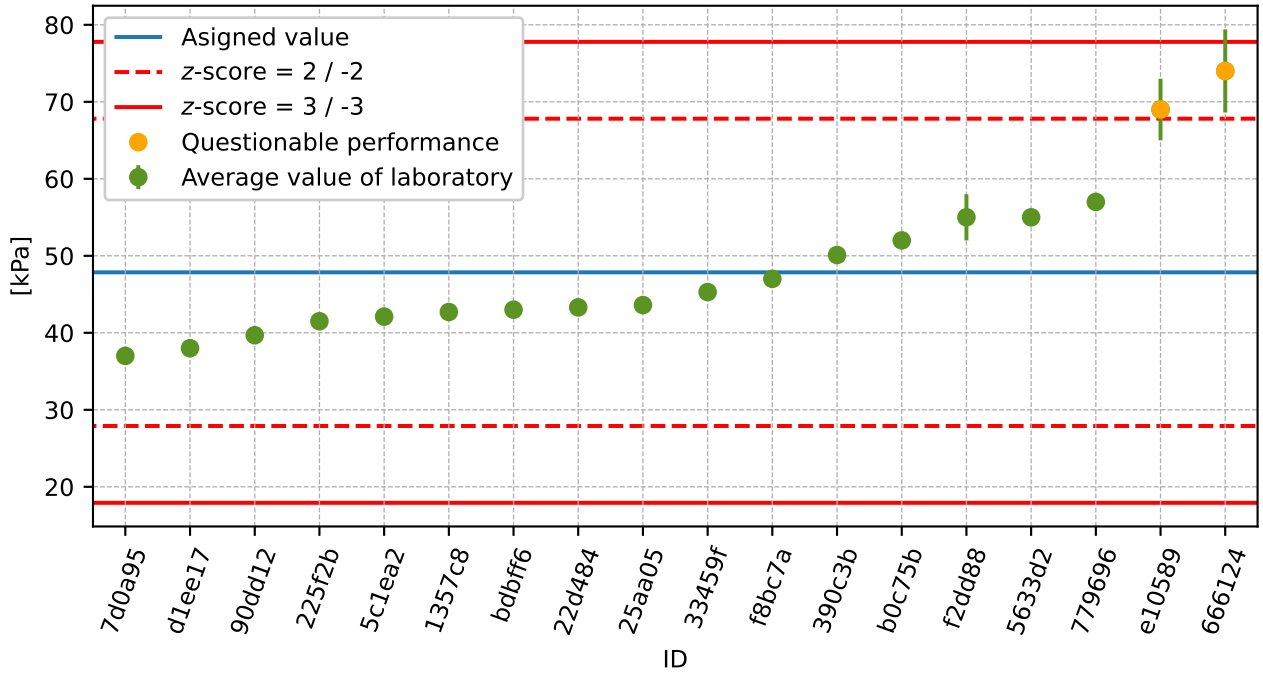

Figure 59: Average values and extended uncertainties of measurement

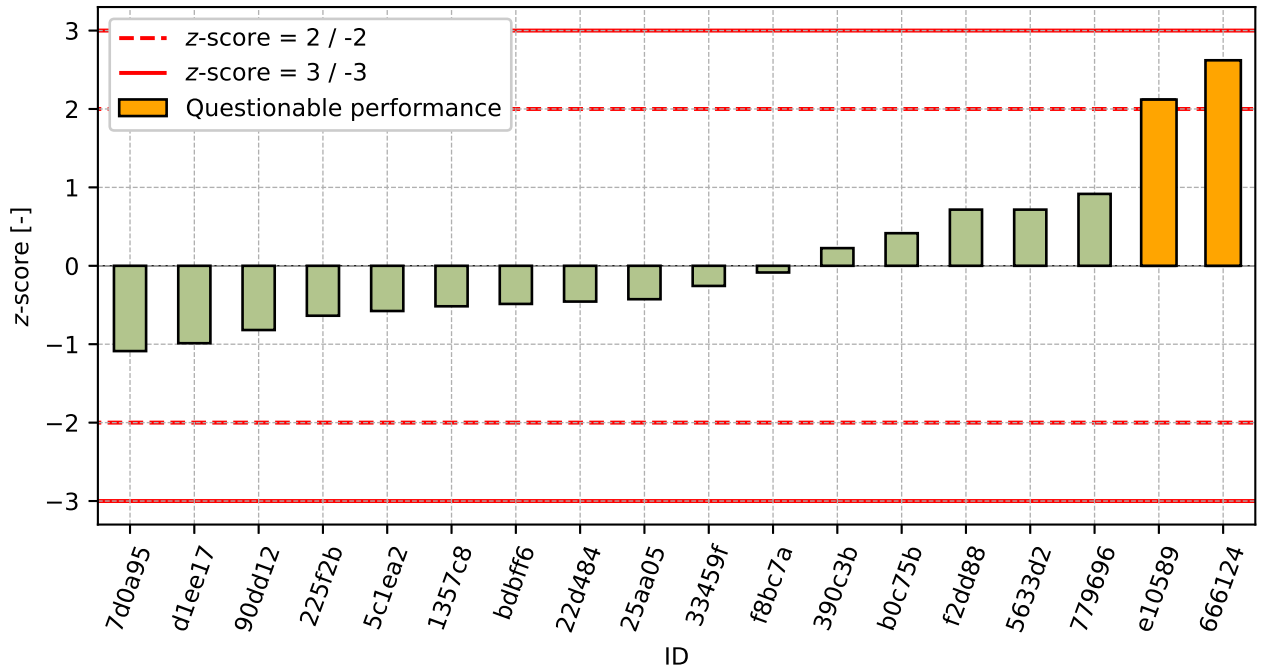

Figure 60: z-score

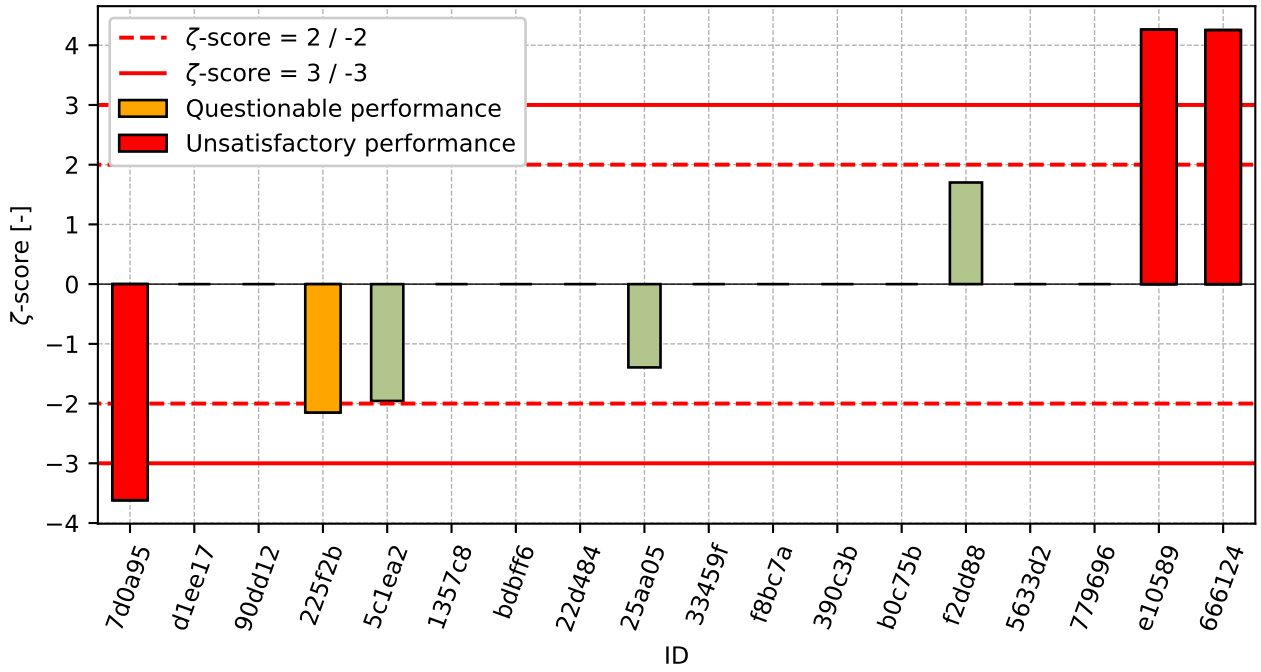

Figure 61: ζ-score

Table 34: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
7d0a95	-1.09	-3.62
d1ee17	-0.99	-
90dd12	-0.82	-
225f2b	-0.64	-2.15
5c1ea2	-0.58	-1.96
1357c8	-0.52	-
bdbff6	-0.49	-
22d484	-0.46	-
25aa05	-0.43	-1.39
33459f	-0.26	-
f8bc7a	-0.09	-
390c3b	0.23	-
b0c75b	0.42	-
f2dd88	0.72	1.7
5633d2	0.72	-
779696	0.92	-
e10589	2.12	4.26
666124	2.62	4.25

7.2 100 kPa

7.2.1 Test results

Table 35: 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]
1357c8	60	-
22d484	64	-
7d0a95	66	1
25aa05	71	1
33459f	72	-
225f2b	73	0
5c1ea2	78	0
bdbff6	79	-
390c3b	80	-
90dd12	82	-
f8bc7a	84	-
b0c75b	85	-
5633d2	86	-
d1ee17	88	-
779696	89	-
e10589	89	5
f2dd88	90	4
666124	108	8

7.2.2 The Numerical Procedure for Determining Outliers

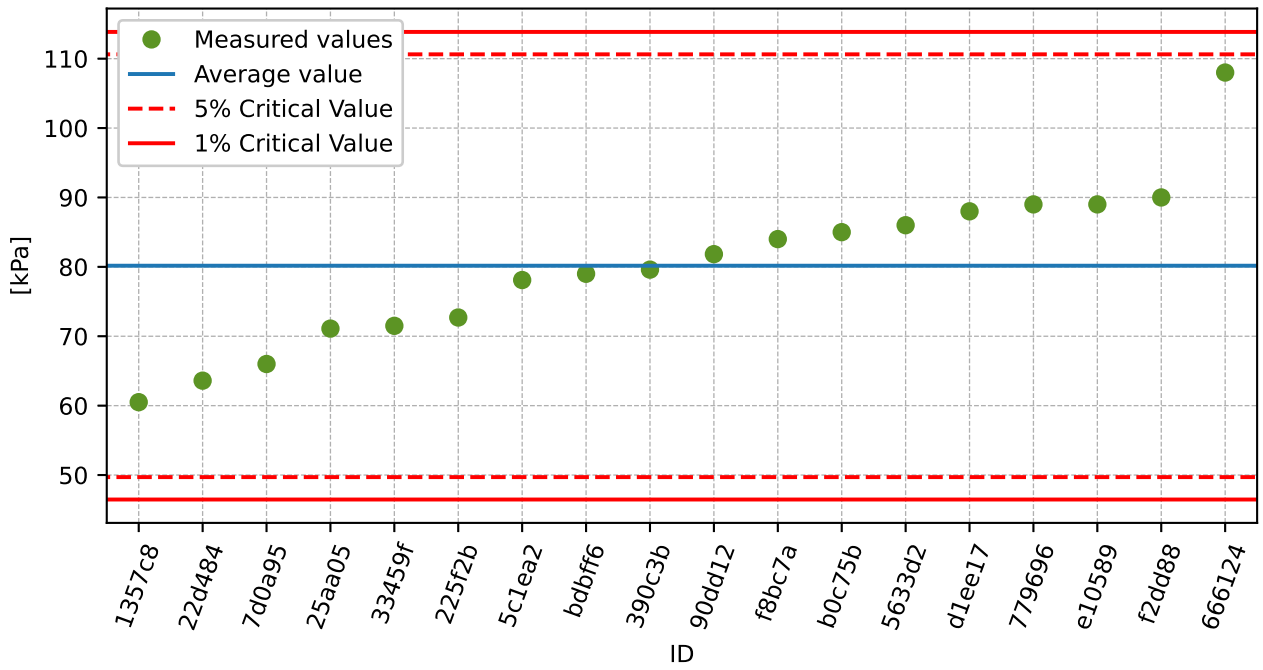

Figure 62: **Grubbs' test** - average values

7.2.3 Mandel's Statistics

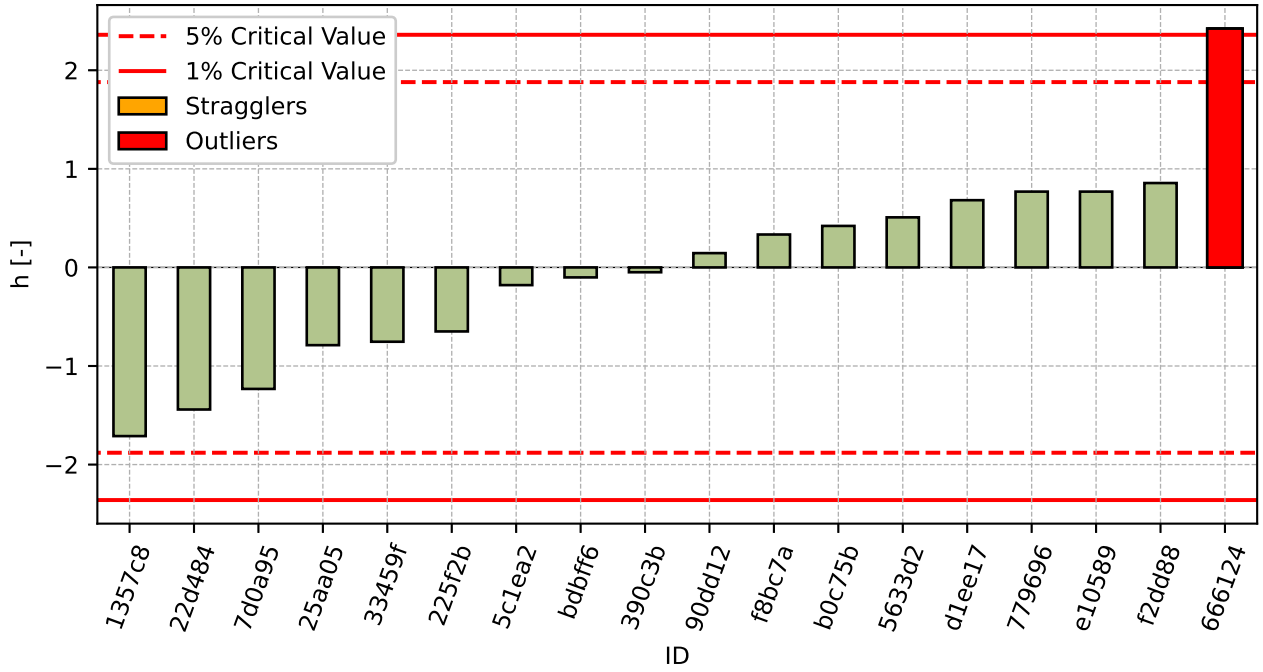

Figure 63: Interlaboratory Consistency Statistic

7.2.4 Descriptive statistics

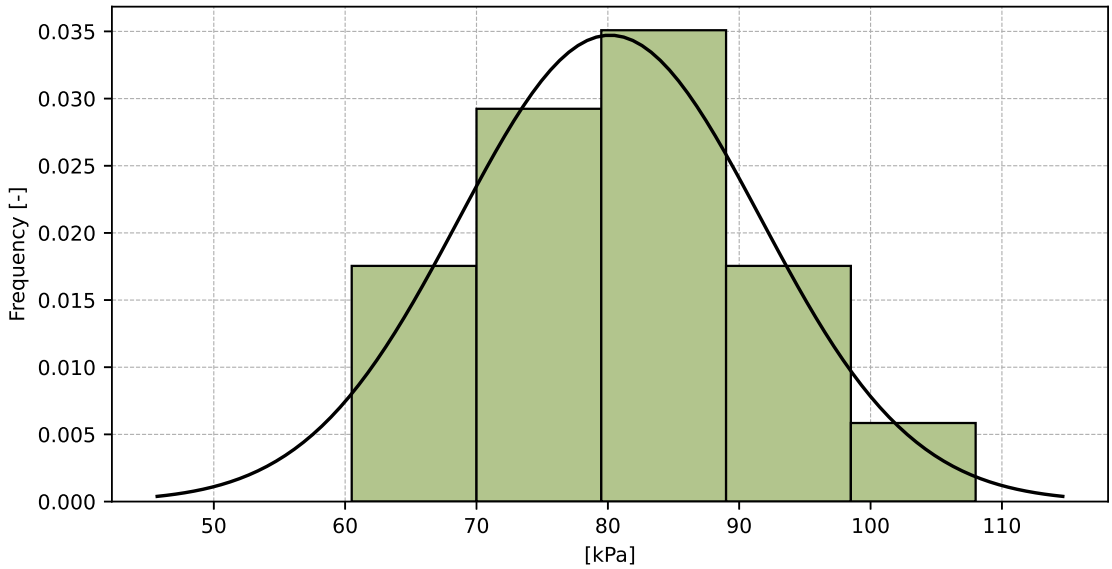

Figure 64: Histogram of all test results

Table 36: Descriptive statistics

Characteristics	**[kPa]**
Average value – $\bar{x}$	80
Sample standard deviation – s	11.5
Asigned value – x^*	80
Robust standard deviation – s^*	12.4
Measurement uncertainty of asigned value – u_X	3.7
p-value of normality test	0.527 [-]

7.2.5 Evaluation of Performance Statistics

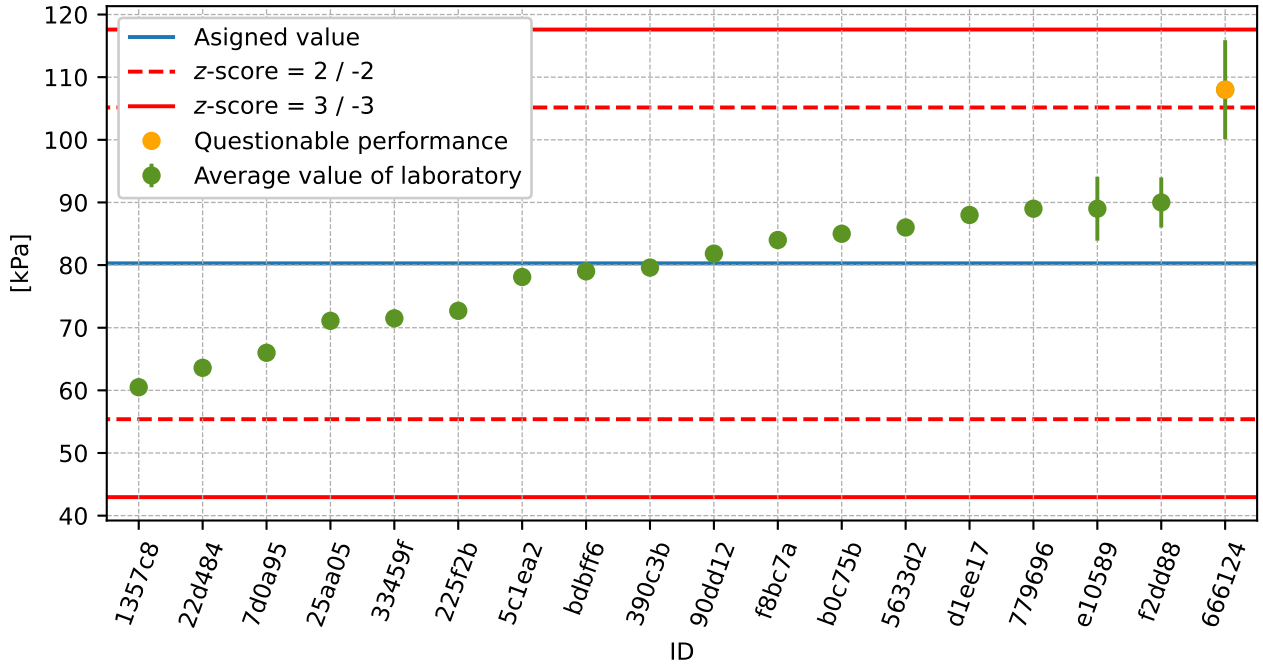

Figure 65: Average values and extended uncertainties of measurement

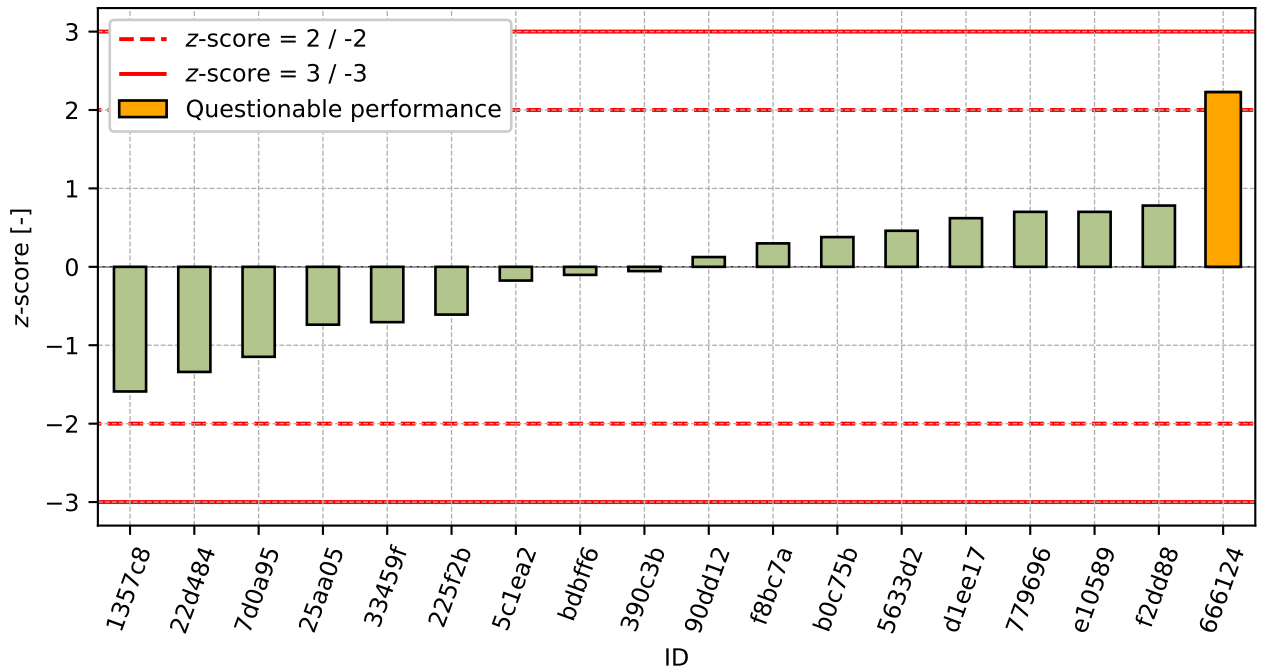

Figure 66: z-score

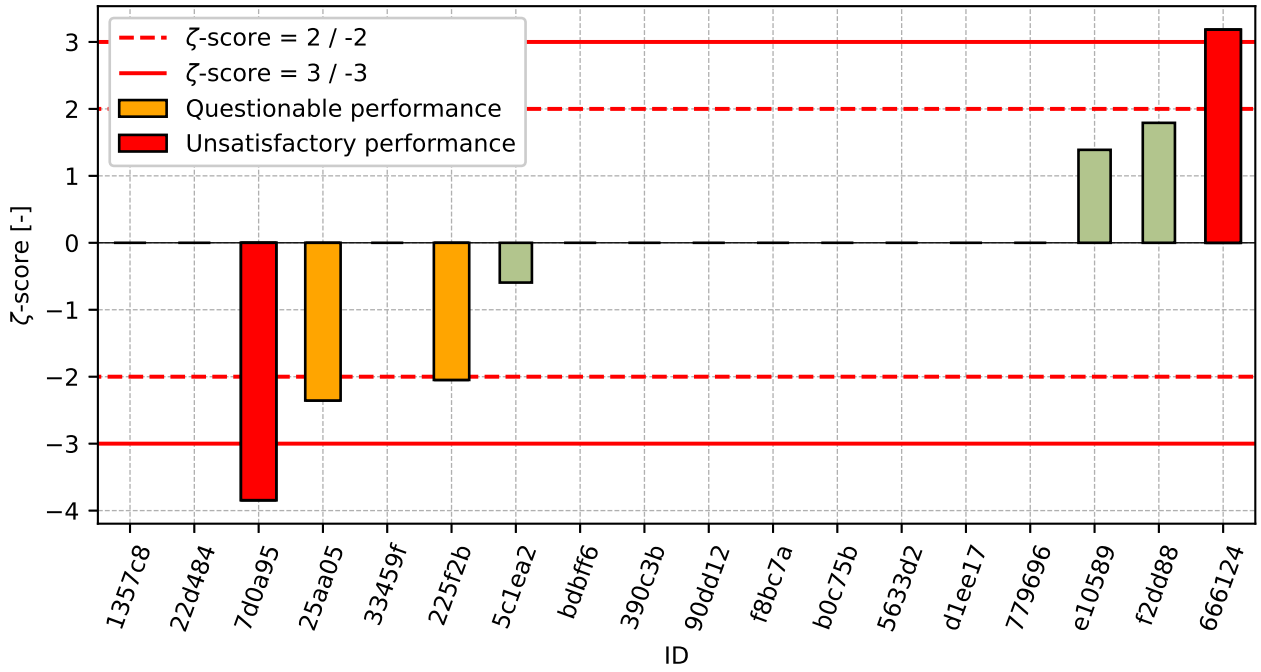

Figure 67: ζ-score

Table 37: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
1357c8	-1.59	-
22d484	-1.34	-
7d0a95	-1.15	-3.84
25aa05	-0.74	-2.36
33459f	-0.71	-
225f2b	-0.61	-2.05
5c1ea2	-0.18	-0.59
bdbff6	-0.1	-
390c3b	-0.05	-
90dd12	0.12	-
f8bc7a	0.3	-
b0c75b	0.38	-
5633d2	0.46	-
d1ee17	0.62	-
779696	0.7	-
e10589	0.7	1.39
f2dd88	0.78	1.79
666124	2.23	3.18

7.3 200 kPa

7.3.1 Test results

Table 38: 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]
22d484	118	-
779696	125	-
225f2b	126	1
33459f	128	-
25aa05	131	1
f8bc7a	136	-
7d0a95	136	1
390c3b	138	-
d1ee17	143	-
5633d2	144	-
5c1ea2	151	0
90dd12	153	-
1357c8	153	-
f2dd88	160	8
666124	166	12
b0c75b	172	-
bdbff6	203	-
e10589	210	8

7.3.2 The Numerical Procedure for Determining Outliers

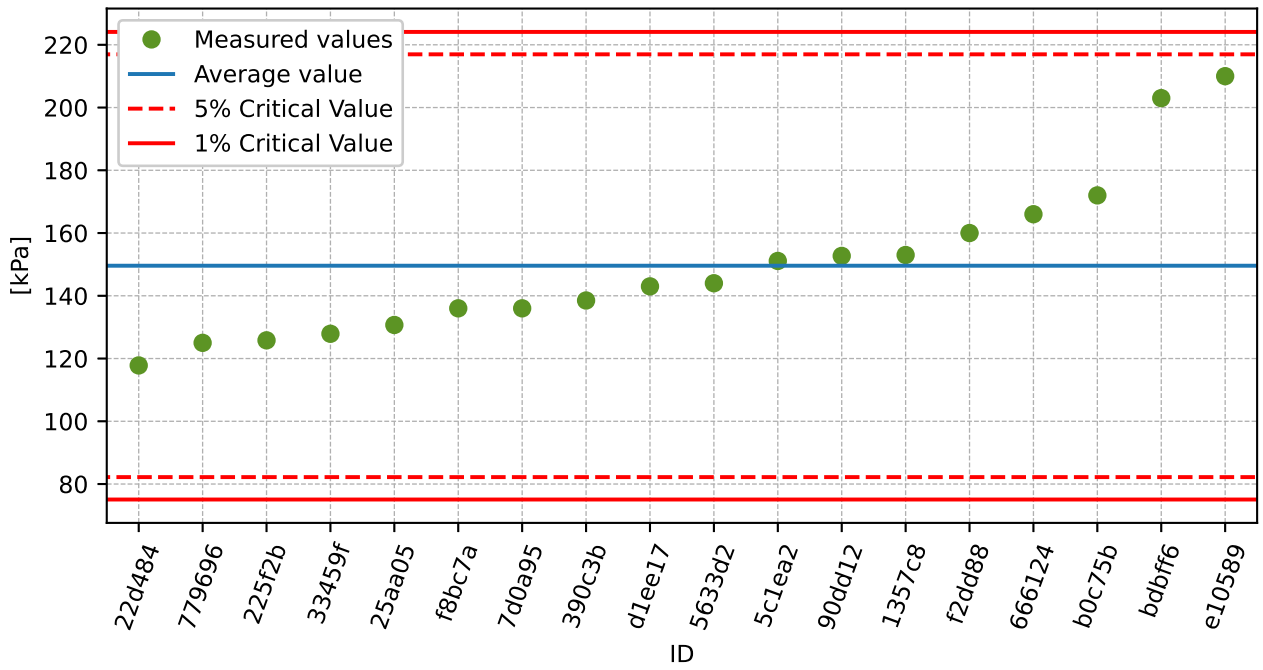

Figure 68: **Grubbs' test** - average values

7.3.3 Mandel's Statistics

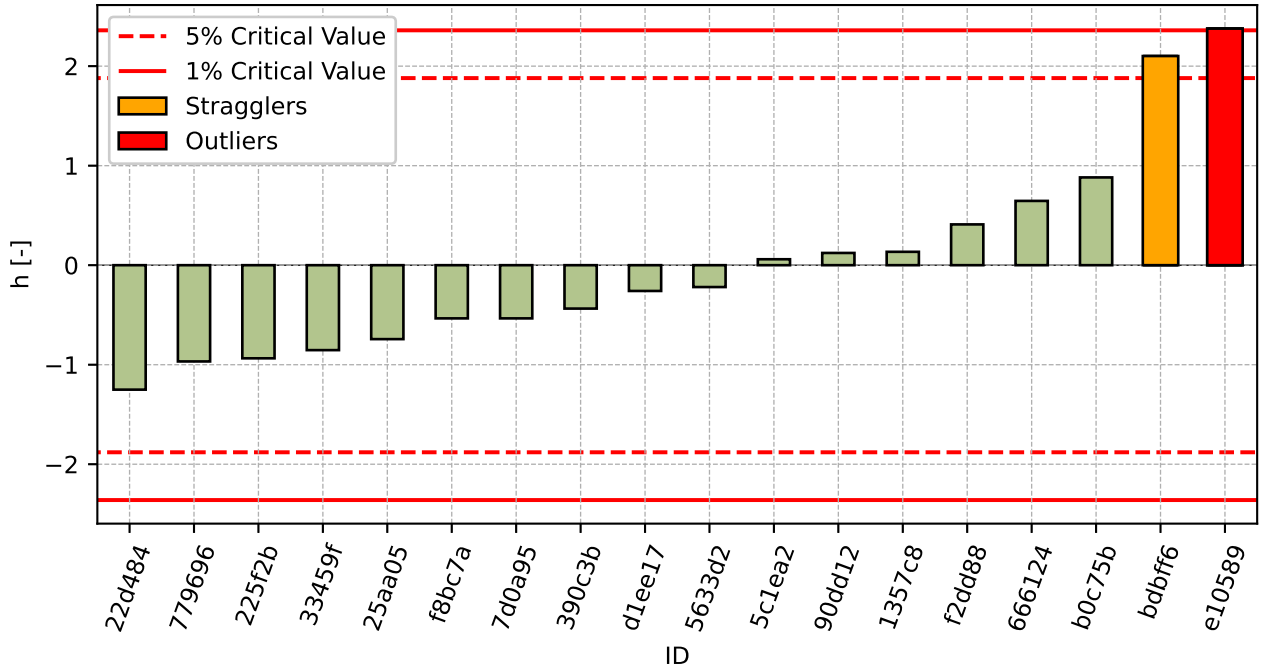

Figure 69: Interlaboratory Consistency Statistic

7.3.4 Descriptive statistics

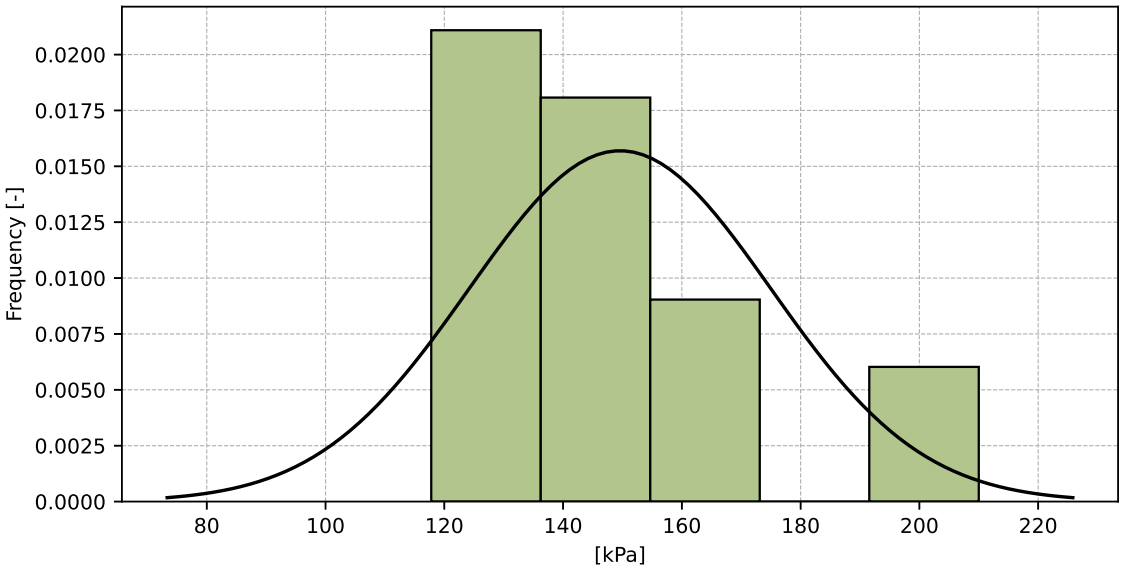

Figure 70: Histogram of all test results

Table 39: Descriptive statistics

Characteristics	**[kPa]**
Average value – $\bar{x}$	150
Sample standard deviation – s	25.4
Asigned value – x^*	148
Robust standard deviation – s^*	25.0
Measurement uncertainty of asigned value – u_X	7.4
p-value of normality test	0.041 [-]

7.3.5 Evaluation of Performance Statistics

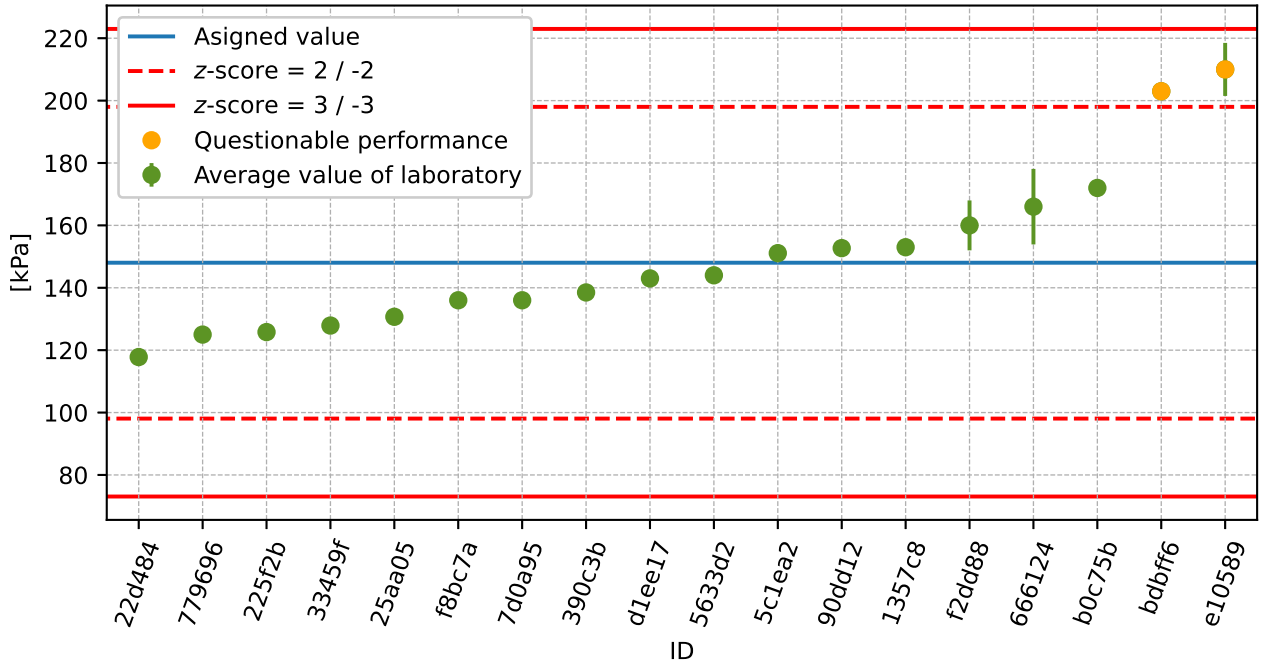

Figure 71: Average values and extended uncertainties of measurement

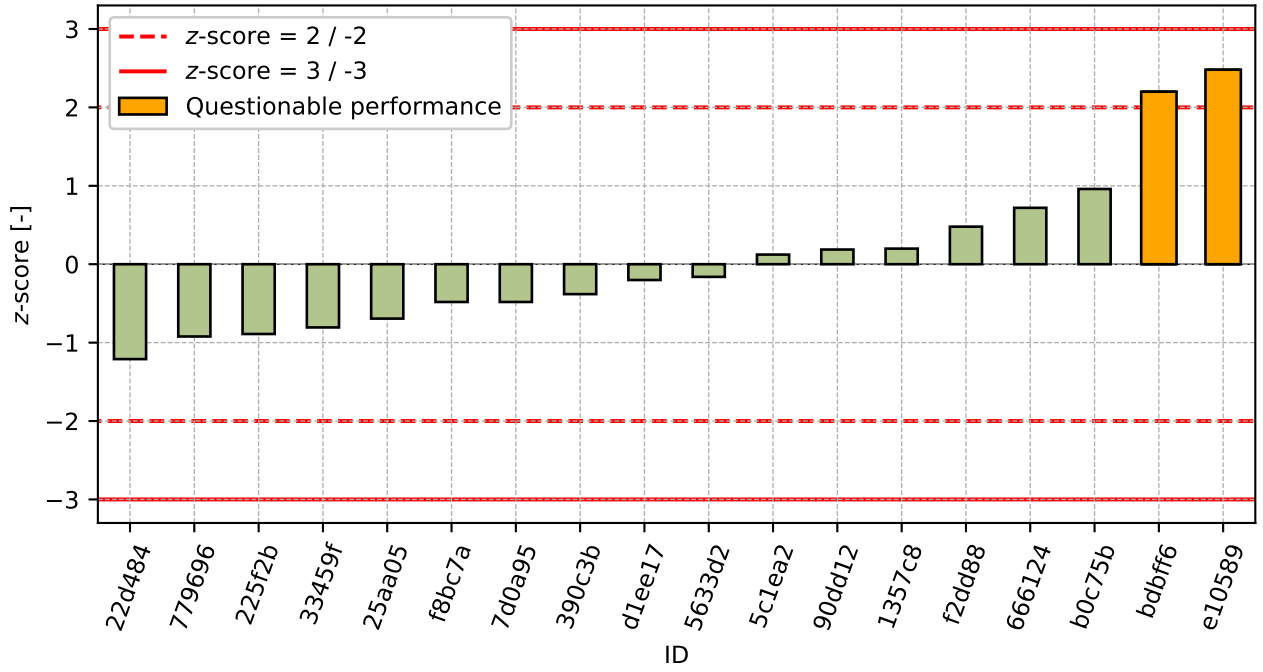

Figure 72: z-score

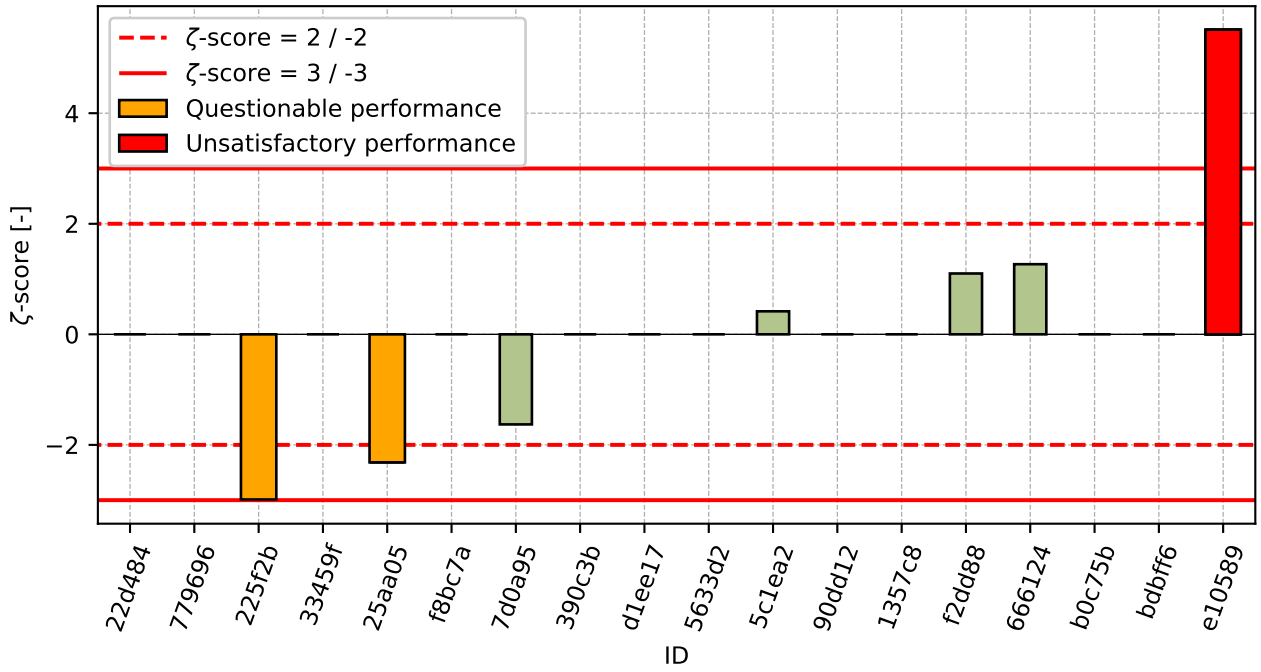

Figure 73: ζ-score

Table 40: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
22d484	-1.21	-
779696	-0.92	-
225f2b	-0.89	-2.99
33459f	-0.81	-
25aa05	-0.69	-2.32
f8bc7a	-0.48	-
7d0a95	-0.48	-1.63
390c3b	-0.38	-
d1ee17	-0.2	-
5633d2	-0.16	-
5c1ea2	0.12	0.42
90dd12	0.19	-
1357c8	0.2	-
f2dd88	0.48	1.1
666124	0.72	1.27
b0c75b	0.96	-
bdbff6	2.2	-
e10589	2.48	5.51

7.4 400 kPa

7.4.1 Test results

Table 41: 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]
666124	212	16
1357c8	229	-
33459f	237	-
779696	243	-
f8bc7a	247	-
25aa05	252	1
22d484	252	-
225f2b	255	2
5633d2	256	-
390c3b	256	-
7d0a95	271	1
b0c75b	272	-
e10589	280	11
5c1ea2	288	0
90dd12	288	-
d1ee17	294	-
f2dd88	320	16
bdbff6	353	-

7.4.2 The Numerical Procedure for Determining Outliers

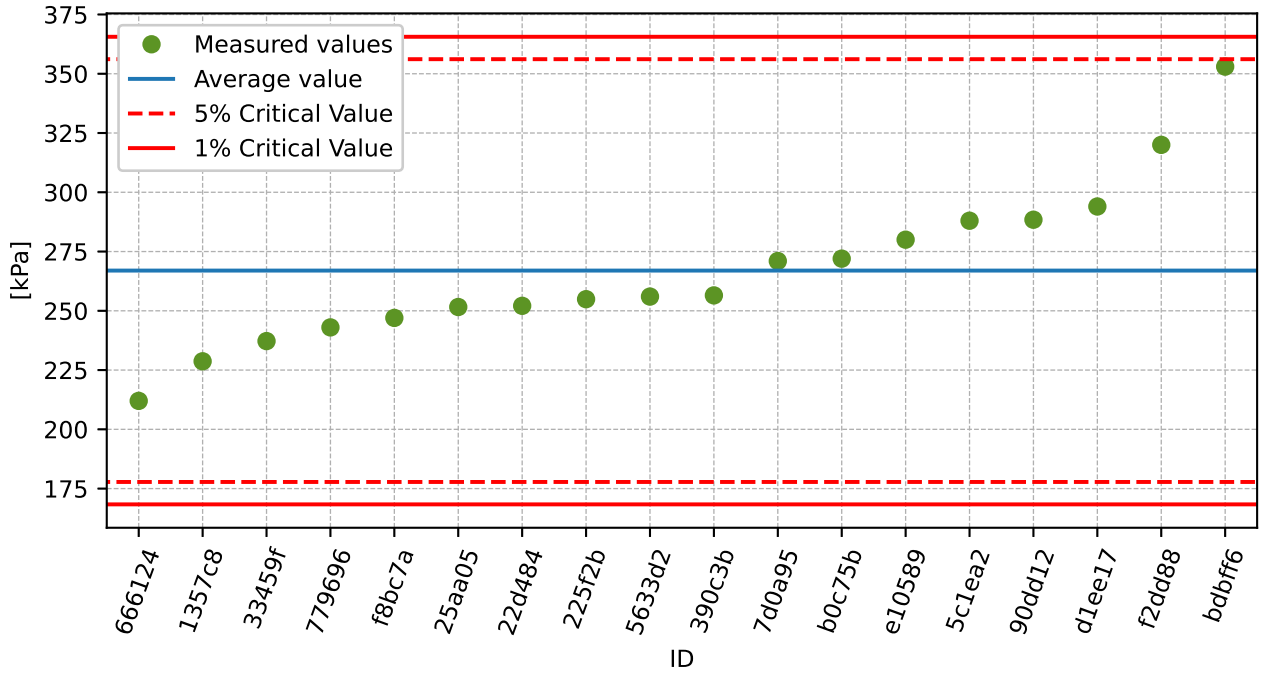

Figure 74: **Grubbs' test** - average values

7.4.3 Mandel's Statistics

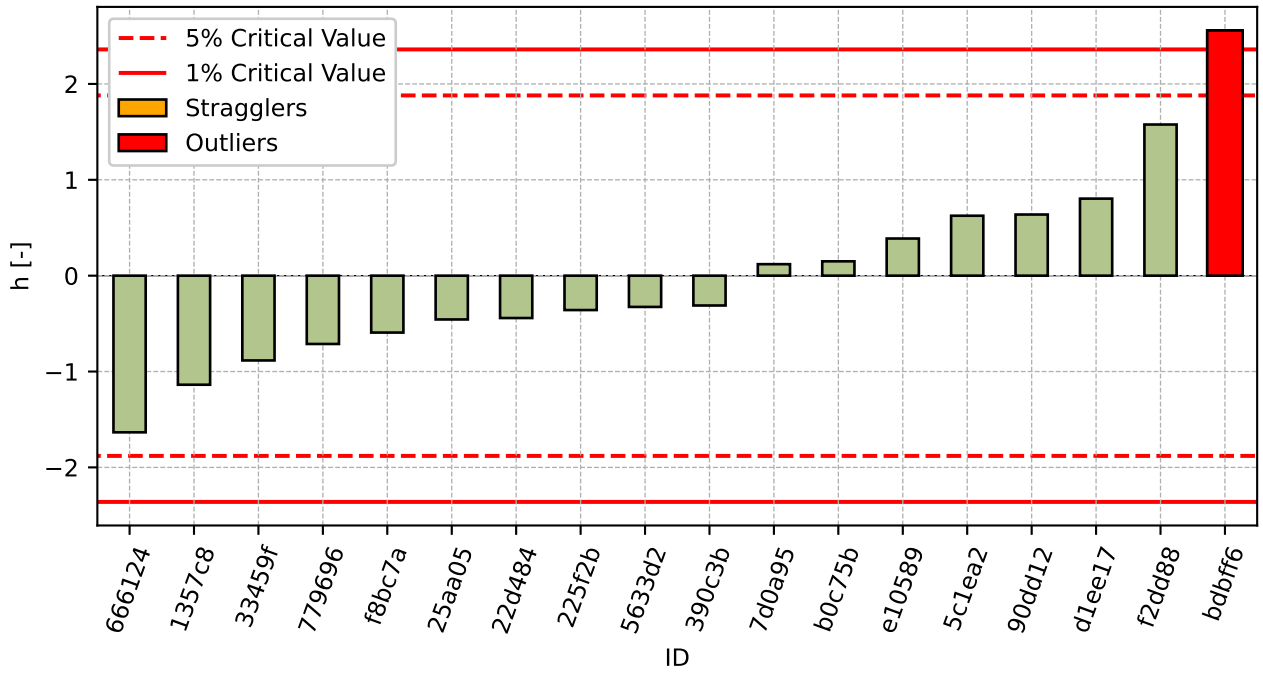

Figure 75: Interlaboratory Consistency Statistic

7.4.4 Descriptive statistics

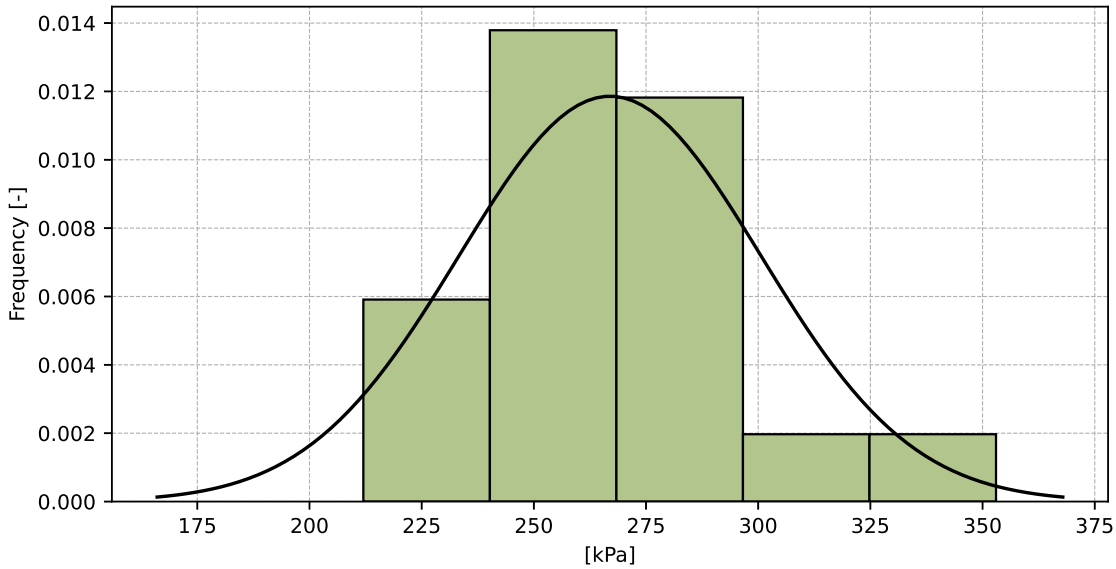

Figure 76: Histogram of all test results

Table 42: Descriptive statistics

Characteristics	[kPa]
Average value – $\bar{x}$	267
Sample standard deviation – s	33.6
Asigned value – x^*	266
Robust standard deviation – s^*	34.4
Measurement uncertainty of asigned value – u_X	10.1
p-value of normality test	0.086 [-]

7.4.5 Evaluation of Performance Statistics

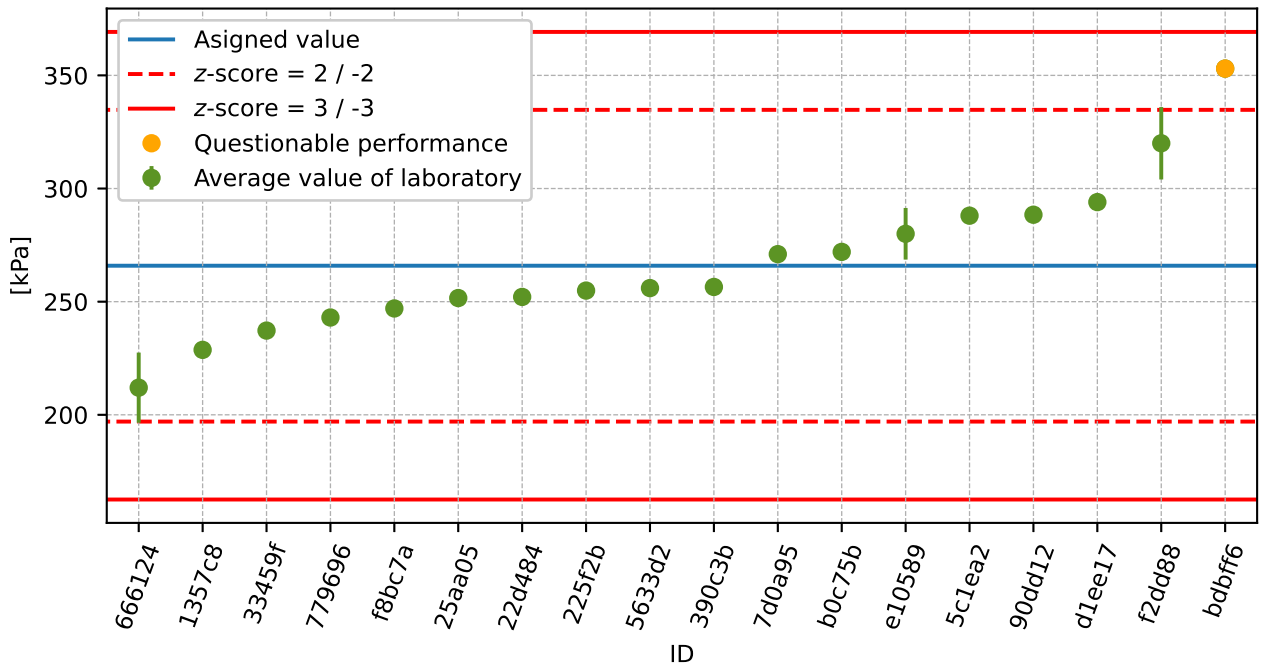

Figure 77: Average values and extended uncertainties of measurement

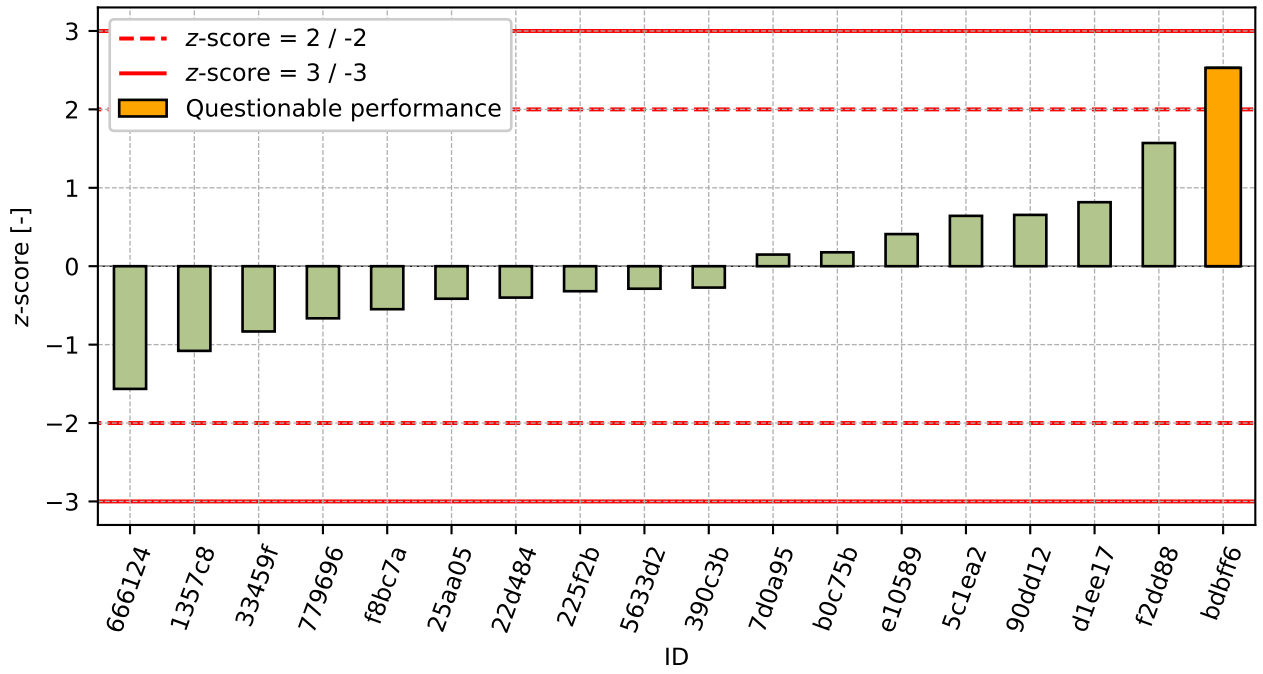

Figure 78: z-score

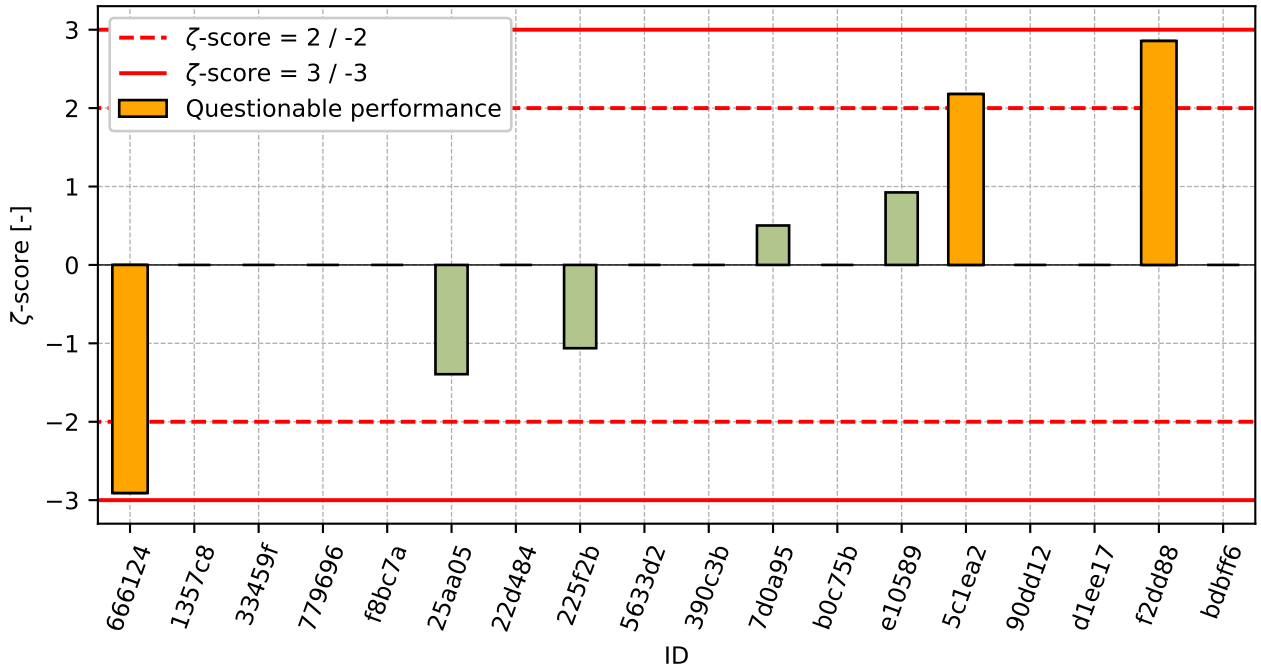

Figure 79: ζ-score

Table 43: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
666124	-1.56	-2.91
1357c8	-1.08	-
33459f	-0.83	-
779696	-0.66	-
f8bc7a	-0.55	-
25aa05	-0.41	-1.39
22d484	-0.4	-
225f2b	-0.32	-1.06
5633d2	-0.29	-
390c3b	-0.27	-
7d0a95	0.15	0.5
b0c75b	0.18	-
e10589	0.41	0.92
5c1ea2	0.64	2.18
90dd12	0.65	-
d1ee17	0.82	-
f2dd88	1.57	2.86
bdbff6	2.53	-

8 Appendix – EN ISO 17892-12 – Atterberg limits

8.1 Liquit limit

8.1.1 Test results

Table 44: 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 [%]
8aeb2c	25.2	25.4	25.5	0.2	25.4	0.15	0.6
54b338	29.4	28.1	30.2	1.1	29.3	1.05	3.6
3a439b	30.5	29.5	30.3	-	30.1	0.53	1.76
1357c8	30.4	30.7	30.3	-	30.5	0.21	0.68
a81bc3	31.5	31.0	30.9	-	31.1	0.32	1.03
666124	31.7	32.3	33.2	3.1	32.4	0.75	2.33
fc937d	32.2	33.0	32.5	10.0	32.6	0.4	1.24
e10589	32.0	33.0	33.0	1.8	32.7	0.58	1.77
25aa05	33.0	33.0	33.0	2.4	33.0	0.0	0.0
5b2e25	33.1	32.5	33.6	-	33.1	0.55	1.67
779696	33.2	33.2	33.2	-	33.2	0.03	0.08
86eb15	33.0	34.0	34.0	1.8	33.7	0.58	1.71
b0c75b	33.7	34.5	33.5	2.3	33.9	0.53	1.56
5633d2	33.9	33.5	34.8	-	34.1	0.67	1.95
25e875	34.3	33.9	34.2	0.8	34.1	0.21	0.61
f2dd88	34.7	34.4	33.6	0.7	34.2	0.57	1.66
4a8427	34.2	34.2	34.5	0.2	34.3	0.17	0.5
390c3b	34.8	34.6	34.2	-	34.5	0.31	0.88
5b9821	34.9	34.6	34.3	1.0	34.6	0.3	0.87
c871a4	35.0	34.0	35.0	2.0	34.7	0.58	1.67
90dd12	34.9	35.1	34.3	-	34.8	0.42	1.2
05920e	34.6	36.0	34.5	-	35.0	0.84	2.39
087225	35.7	35.4	35.6	0.5	35.6	0.17	0.48
5c1ea2	35.6	36.0	35.4	0.2	35.6	0.33	0.91
7f895a	36.0	35.0	36.0	-	35.7	0.58	1.62
d1ee17	37.0	35.0	35.0	2.0	35.7	1.15	3.24
589c5f	35.7	35.9	36.1	0.6	35.9	0.2	0.56
7ffaba	36.1	36.0	35.9	5.0	36.0	0.1	0.28
ce319a	36.0	36.0	36.0	-	36.0	0.0	0.0
3d61b1	36.0	36.0	36.0	-	36.0	0.0	0.0
1b8e4c	36.0	36.0	36.1	4.3	36.0	0.06	0.16
33e846	35.0	37.0	36.5	0.3	36.2	1.04	2.88
1202ed	35.4	35.8	37.3	1.8	36.2	1.02	2.83
1632e2	37.0	37.0	36.0	2.0	36.7	0.58	1.57

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ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
f8bc7a	37.0	37.0	37.0	2.0	37.0	0.0	0.0
df7d84	37.0	37.1	37.7	1.0	37.3	0.38	1.02
96dae7	37.0	37.0	38.0	2.0	37.3	0.58	1.55
225f2b	37.0	38.0	38.0	1.3	37.7	0.58	1.53
7ac937	37.2	38.2	-	-	37.7	0.71	1.88

8.1.2 The Numerical Procedure for Determining Outliers

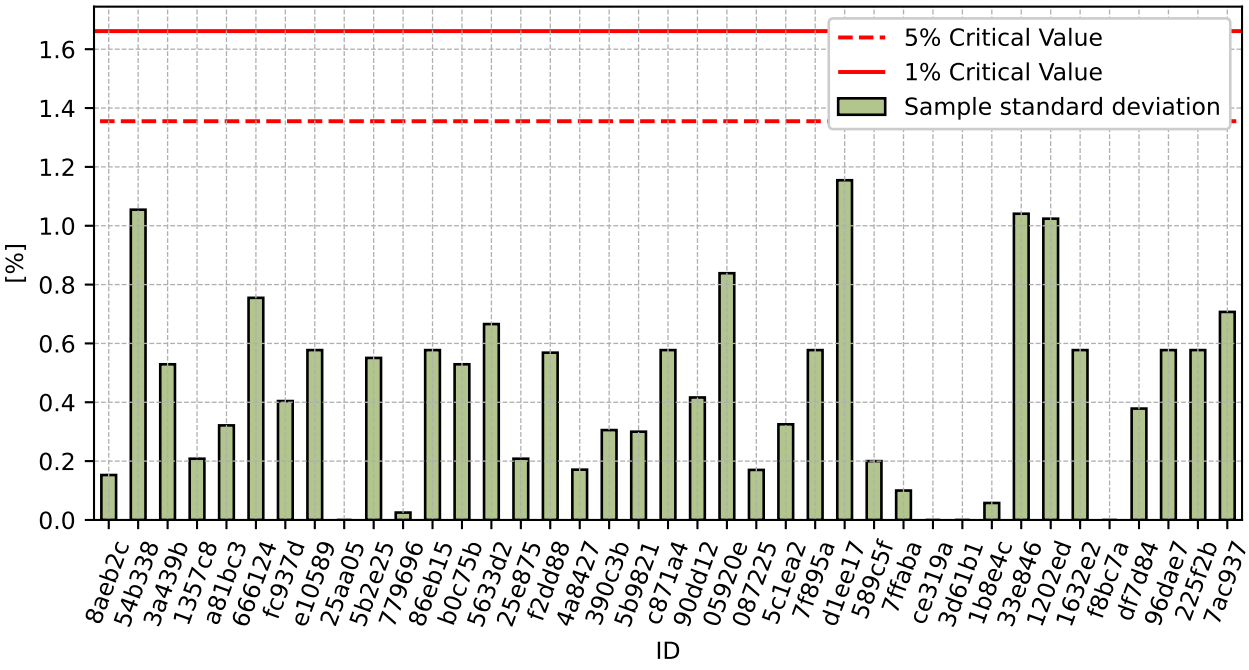

Figure 80: **Cochran's test** - sample standard deviations

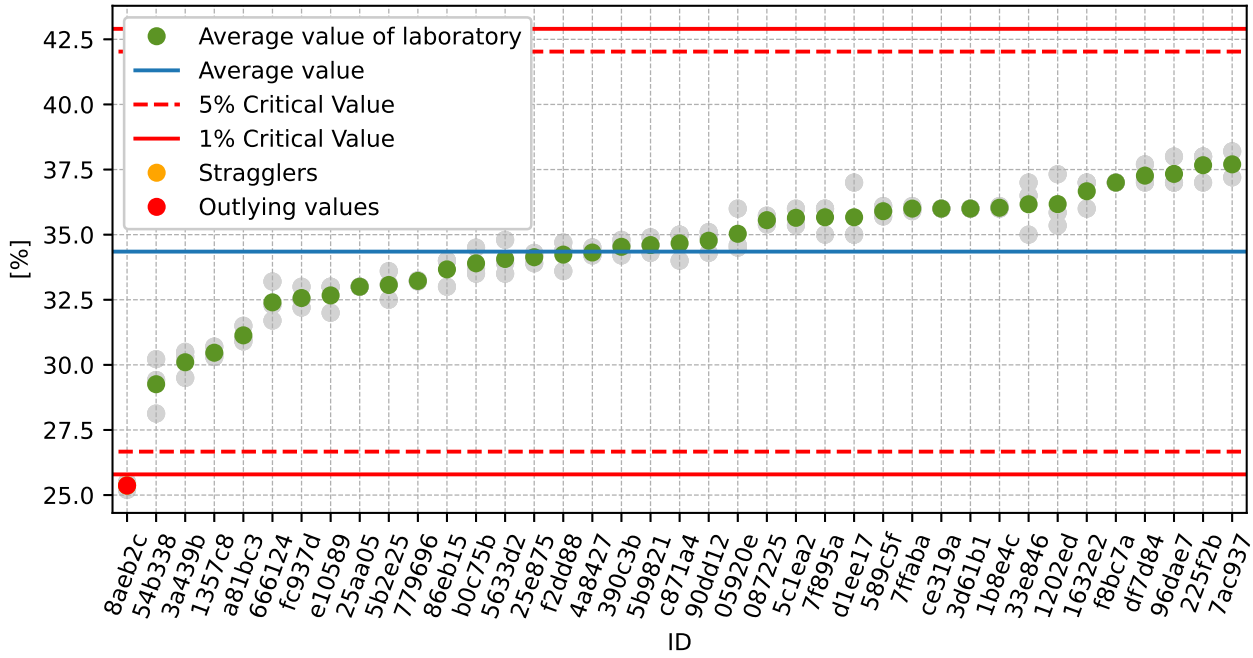

Figure 81: **Grubbs' test** - average values

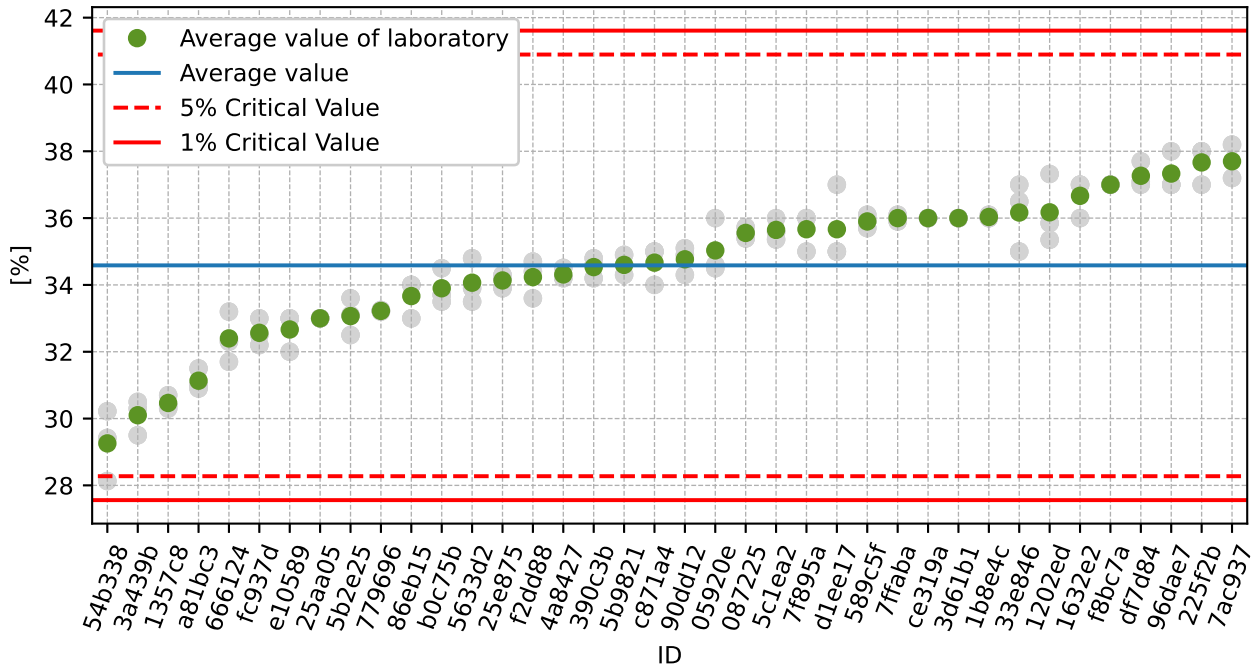

Figure 82: **Grubbs' test** - average values without outliers

8.1.3 Mandel's Statistics

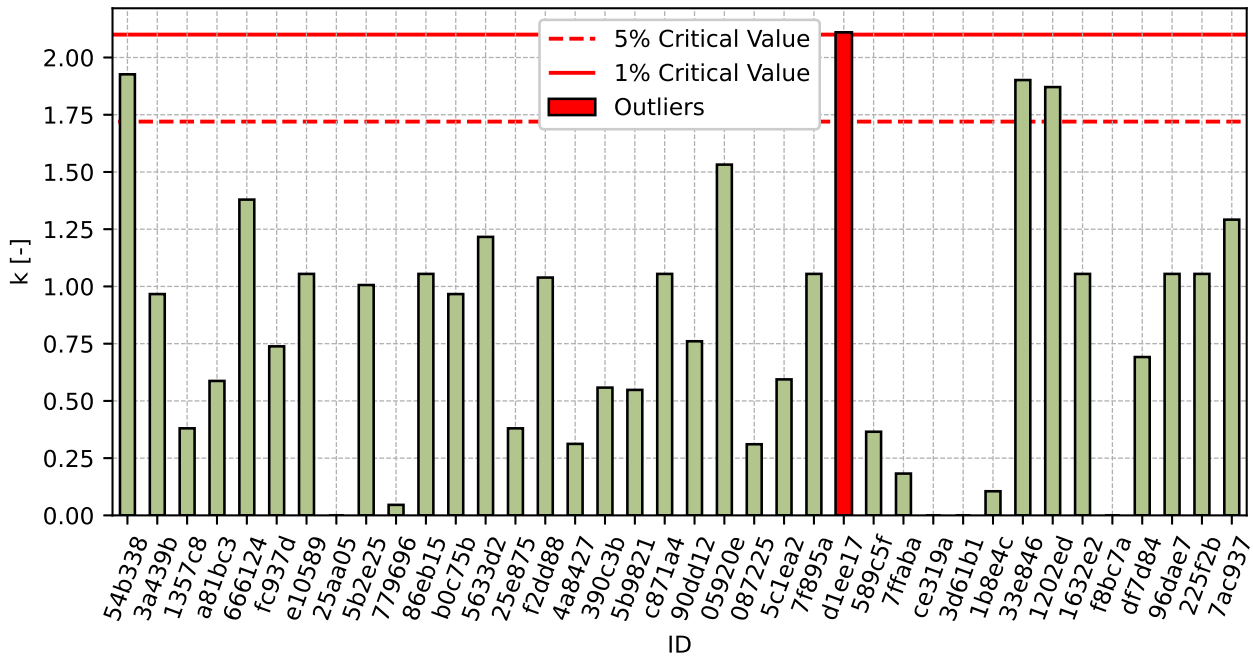

Figure 83: Intralaboratory Consistency Statistic

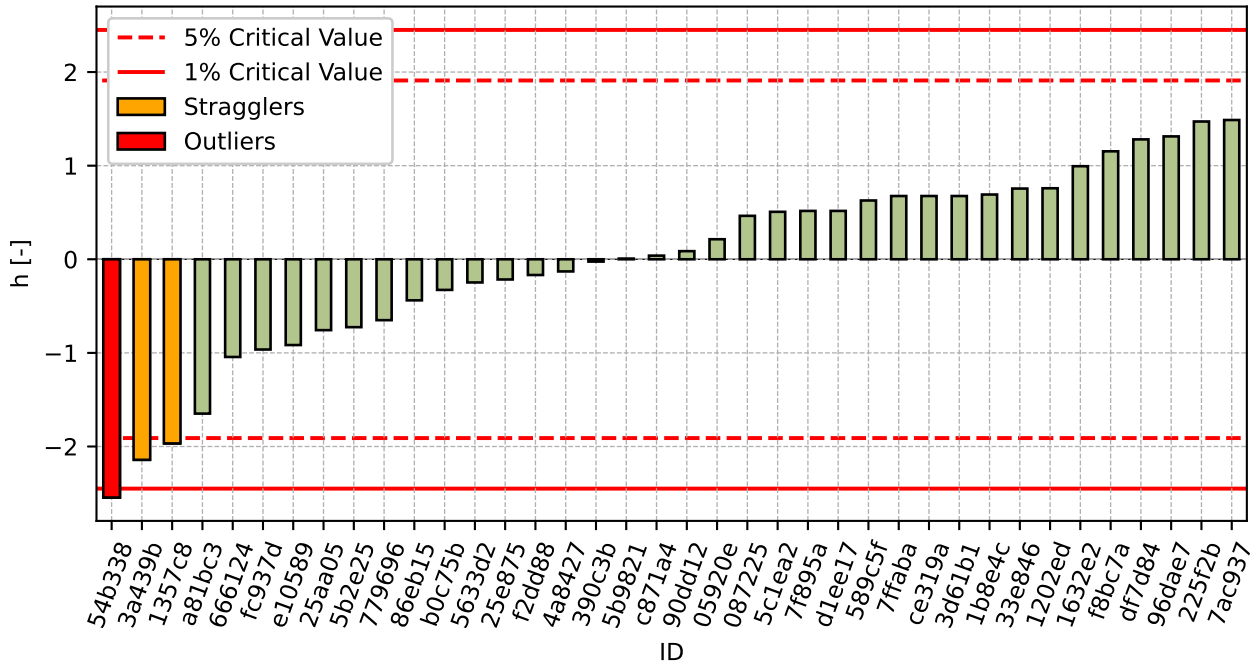

Figure 84: Interlaboratory Consistency Statistic

8.1.4 Descriptive statistics

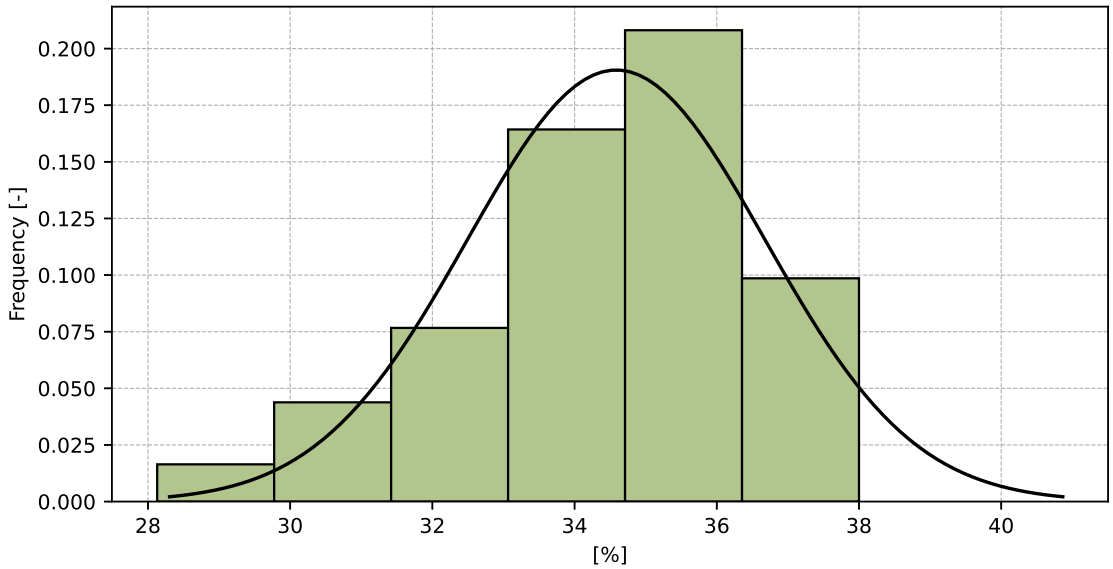

Figure 85: Histogram of all test results

Table 45: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	34.6
Sample standard deviation – s	2.09
Asigned value – x^*	34.8
Robust standard deviation – s^*	1.96
Measurement uncertainty of asigned value – u_X	0.4
p-value of normality test	0.01 [-]
Interlaboratory standard deviation – s_L	2.07
Repeatability standard deviation – s_r	0.55
Reproducibility standard deviation – s_R	2.14
Repeatability – r	1.5
Reproducibility – R	6.0

8.1.5 Evaluation of Performance Statistics

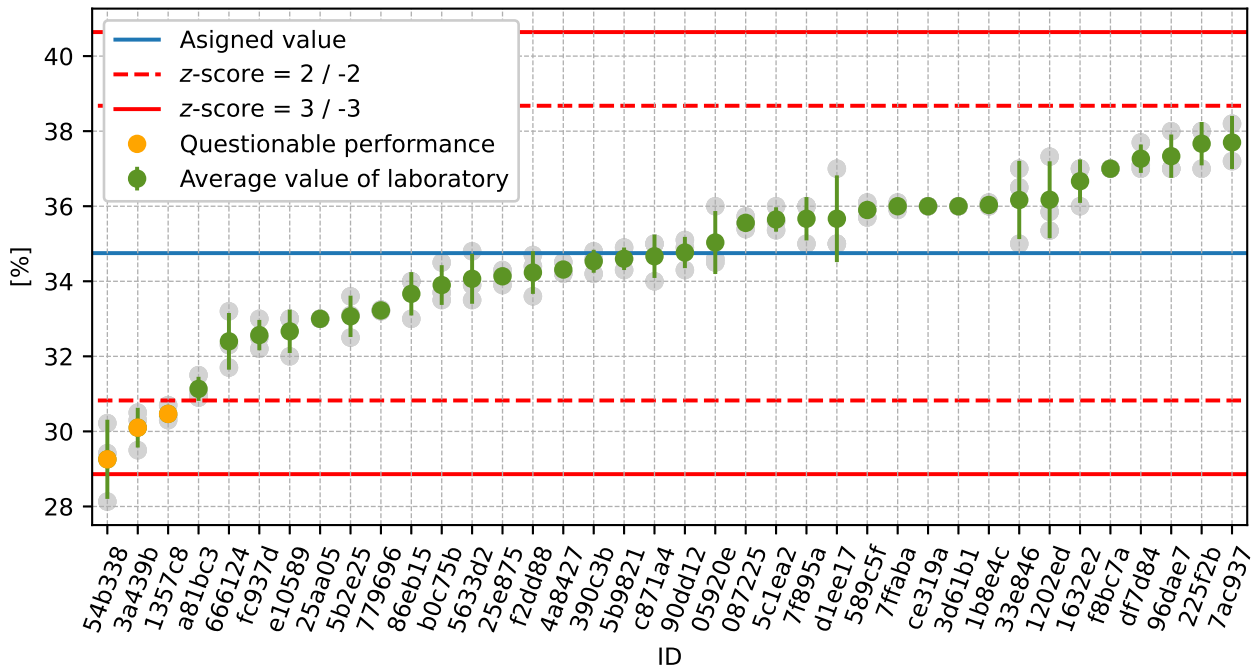

Figure 86: Average values and sample standard deviations

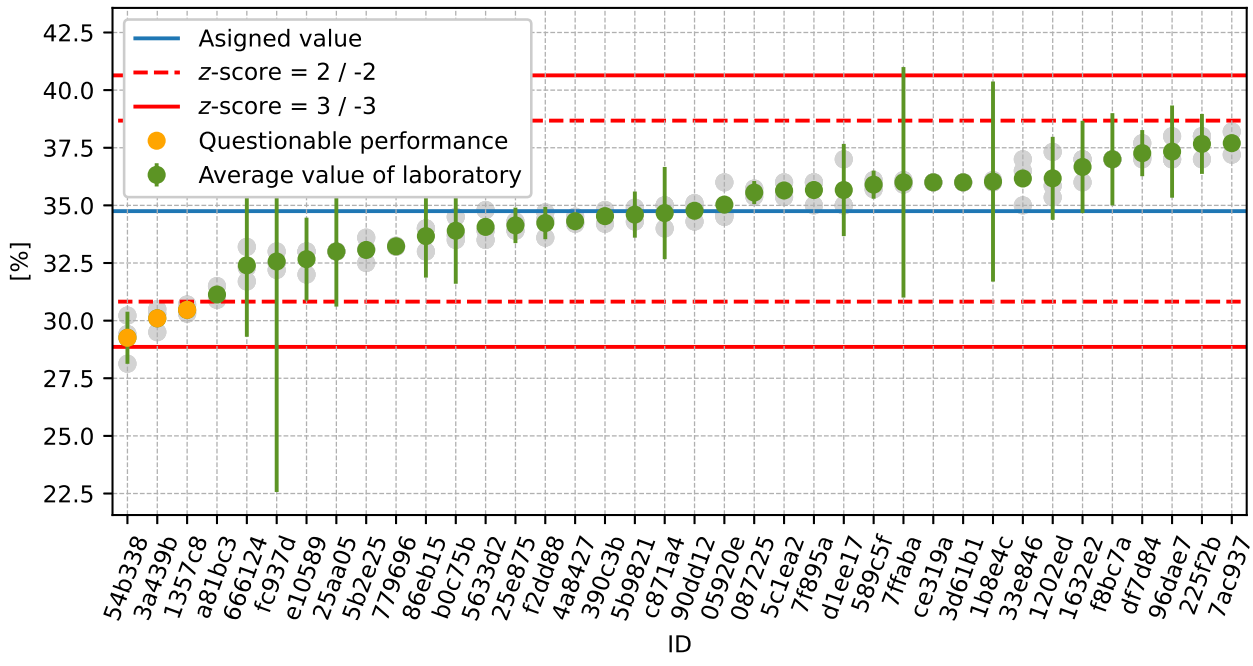

Figure 87: Average values and extended uncertainties of measurement

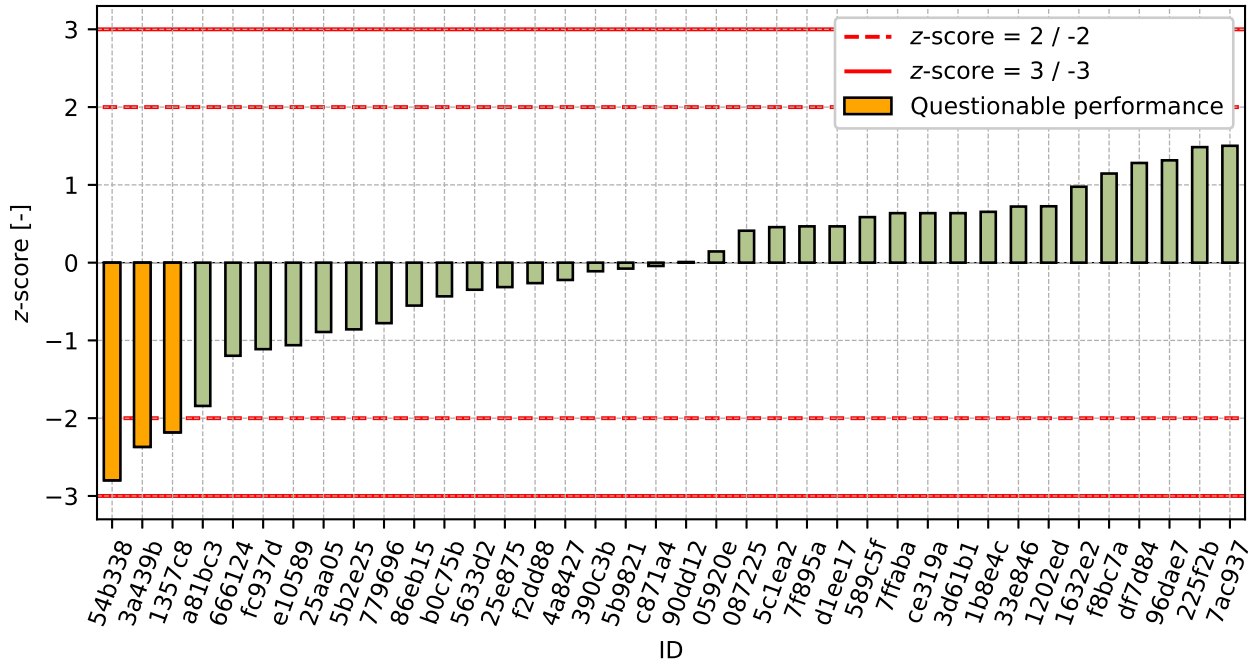

Figure 88: z-score

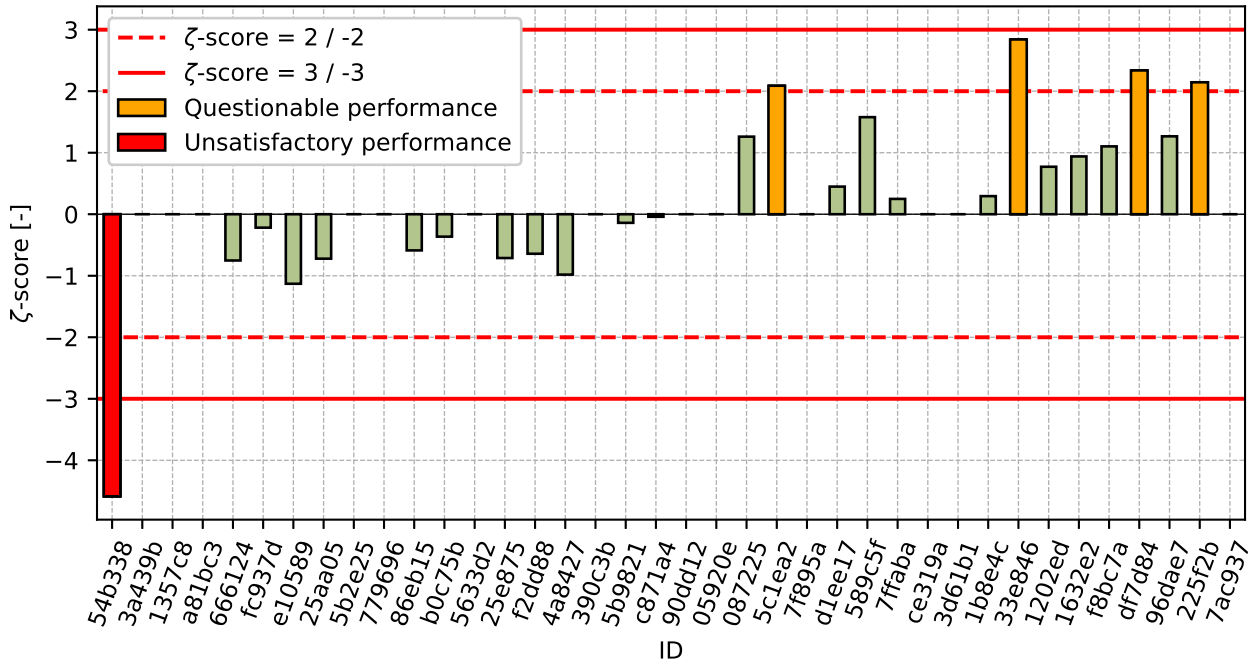

Figure 89: ζ-score

Table 46: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
54b338	-2.8	-4.59
3a439b	-2.37	-
1357c8	-2.18	-
a81bc3	-1.84	-
666124	-1.2	-0.75
fc937d	-1.11	-0.22
e10589	-1.06	-1.13
25aa05	-0.89	-0.72
5b2e25	-0.86	-
779696	-0.78	-
86eb15	-0.55	-0.59
b0c75b	-0.43	-0.36
5633d2	-0.35	-
25e875	-0.31	-0.71
f2dd88	-0.26	-0.64
4a8427	-0.22	-0.98
390c3b	-0.11	-
5b9821	-0.08	-0.14
c871a4	-0.04	-0.04
90dd12	0.01	-
05920e	0.14	-
087225	0.41	1.26
5c1ea2	0.46	2.09
7f895a	0.47	-
d1ee17	0.47	0.45
589c5f	0.59	1.58
7ffaba	0.64	0.25
ce319a	0.64	-
3d61b1	0.64	-
1b8e4c	0.65	0.29
33e846	0.72	2.84
1202ed	0.72	0.77
1632e2	0.98	0.94
f8bc7a	1.15	1.1
df7d84	1.28	2.34
96dae7	1.32	1.27
225f2b	1.49	2.14
7ac937	1.5	-

8.2 Plastic limit

8.2.1 Test results

Table 47: 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 [%]
5b9821	14.1	14.7	14.2	1.1	14.3	0.32	2.24
ce319a	15.0	15.0	15.0	-	15.0	0.0	0.0
8aeb2c	15.2	15.7	15.4	0.2	15.4	0.25	1.63
1357c8	17.2	17.8	17.4	-	17.5	0.31	1.75
05920e	17.7	18.6	18.0	-	18.1	0.43	2.36
779696	18.6	18.6	18.6	-	18.6	0.01	0.05
e10589	19.0	19.0	19.0	2.1	19.0	0.0	0.0
54b338	19.1	18.4	19.9	1.1	19.1	0.73	3.8
390c3b	19.4	19.2	19.5	-	19.4	0.15	0.79
a81bc3	19.6	19.4	19.5	-	19.5	0.1	0.51
5633d2	19.5	19.9	19.3	-	19.6	0.31	1.56
5b2e25	19.5	20.1	19.3	-	19.6	0.42	2.12
7f895a	20.0	19.0	20.0	-	19.7	0.58	2.94
7ac937	19.1	20.3	-	-	19.7	0.85	4.31
90dd12	20.0	20.0	20.0	-	20.0	0.0	0.0
225f2b	20.0	20.0	20.0	1.3	20.0	0.0	0.0
589c5f	20.2	19.9	20.4	0.8	20.2	0.22	1.12
25e875	20.2	20.1	20.2	0.1	20.2	0.06	0.29
5c1ea2	20.0	20.2	20.3	0.2	20.2	0.14	0.69
1632e2	21.0	20.0	20.0	2.0	20.3	0.58	2.84
86eb15	20.0	20.0	21.0	1.8	20.3	0.58	2.84
25aa05	20.0	21.0	20.0	2.3	20.3	0.58	2.84
fc937d	20.2	20.6	20.4	10.0	20.4	0.2	0.98
df7d84	20.3	20.4	20.7	1.0	20.5	0.21	1.02
f8bc7a	21.0	21.0	20.0	2.0	20.7	0.58	2.79
c871a4	20.0	21.0	21.0	2.0	20.7	0.58	2.79
f2dd88	20.5	20.3	21.4	0.4	20.7	0.59	2.83
666124	20.2	21.3	21.0	2.0	20.8	0.57	2.73
7ffaba	20.9	20.8	20.9	2.5	20.9	0.06	0.28
3a439b	21.9	20.7	20.9	-	21.2	0.64	3.04
4a8427	21.3	21.2	21.3	0.1	21.3	0.04	0.19
087225	21.8	21.2	21.0	0.4	21.3	0.43	2.04
96dae7	21.0	22.0	21.0	2.0	21.3	0.58	2.71
d1ee17	22.0	21.0	21.0	2.0	21.3	0.58	2.71
b0c75b	22.2	21.3	21.7	2.4	21.7	0.45	2.07
1202ed	21.1	22.1	22.6	1.1	22.0	0.76	3.45

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ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
33e846	22.2	21.6	22.1	0.3	22.0	0.32	1.46
1b8e4c	22.0	22.0	22.0	4.0	22.0	0.0	0.0
3d61b1	23.0	23.0	23.0	-	23.0	0.0	0.0

8.2.2 The Numerical Procedure for Determining Outliers

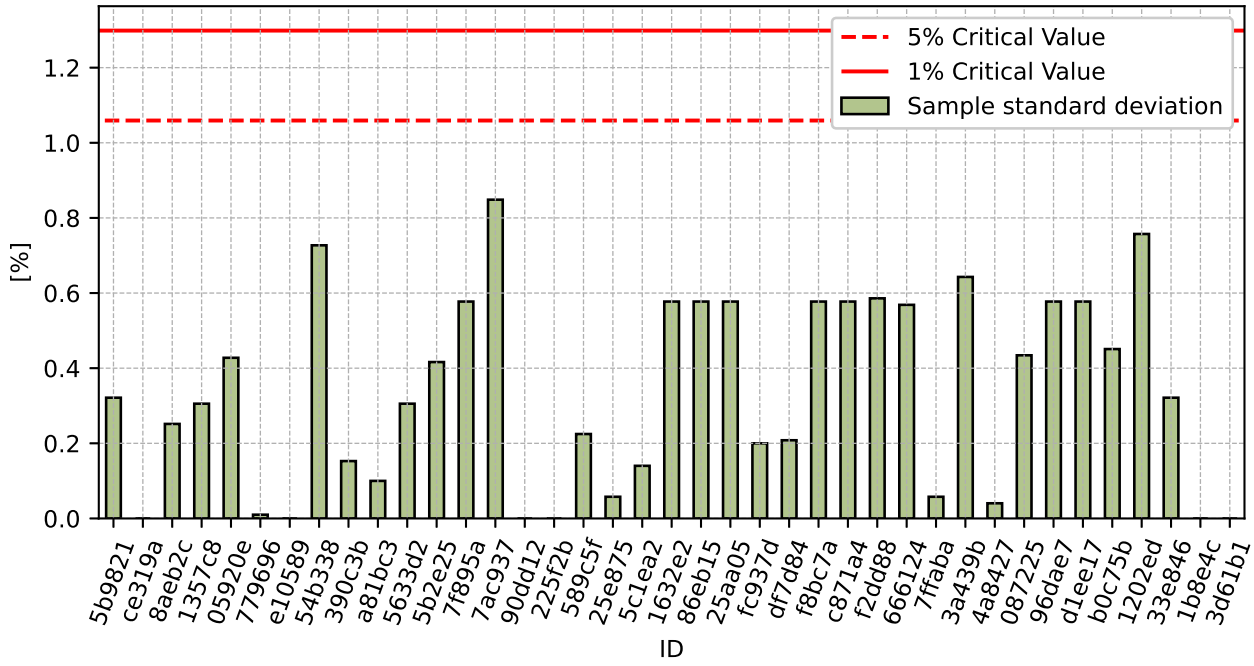

Figure 90: **Cochran's test** - sample standard deviations

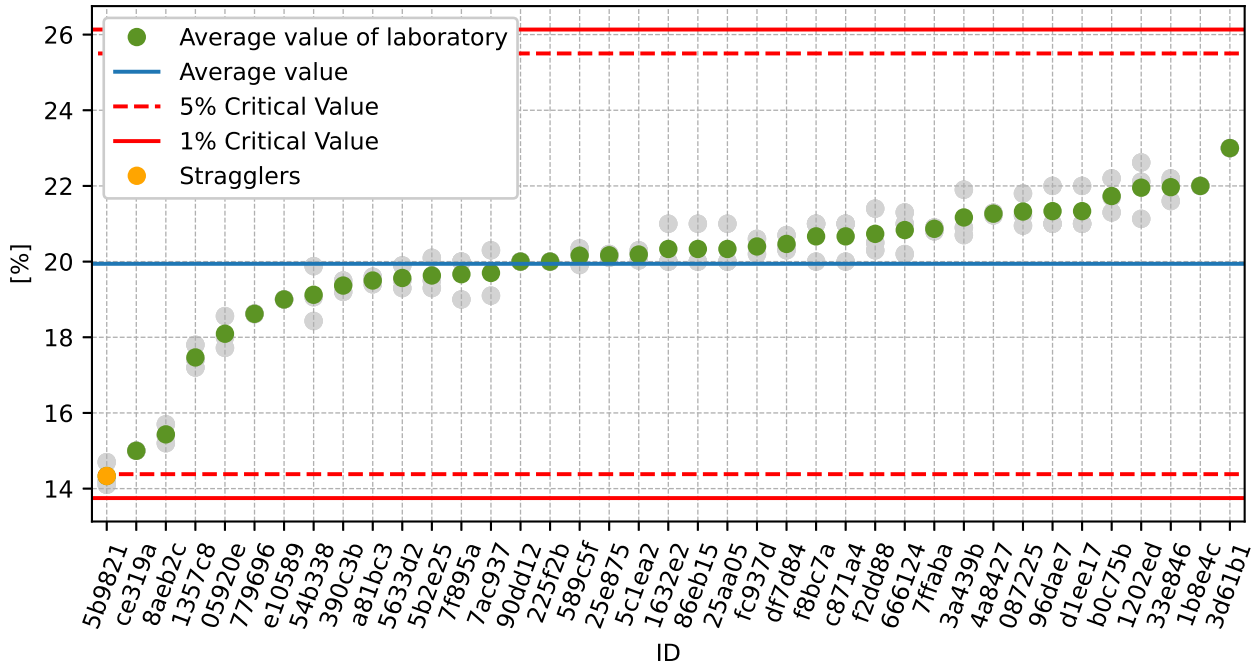

Figure 91: **Grubbs' test** - average values

8.2.3 Mandel's Statistics

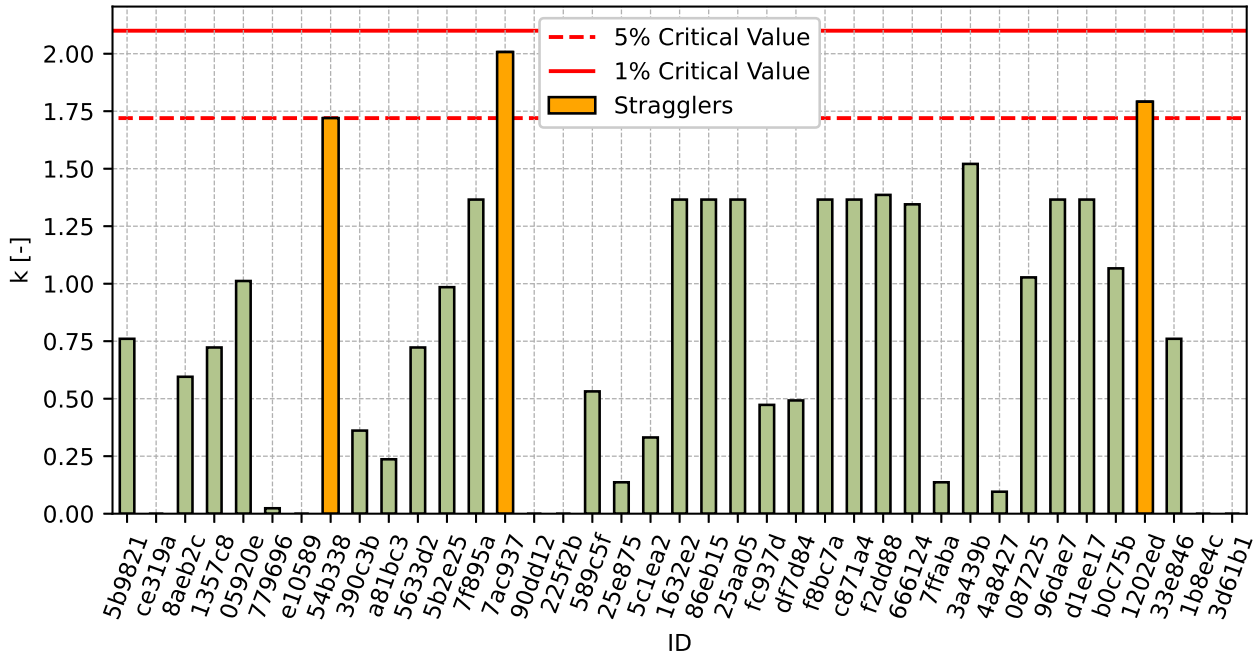

Figure 92: Intralaboratory Consistency Statistic

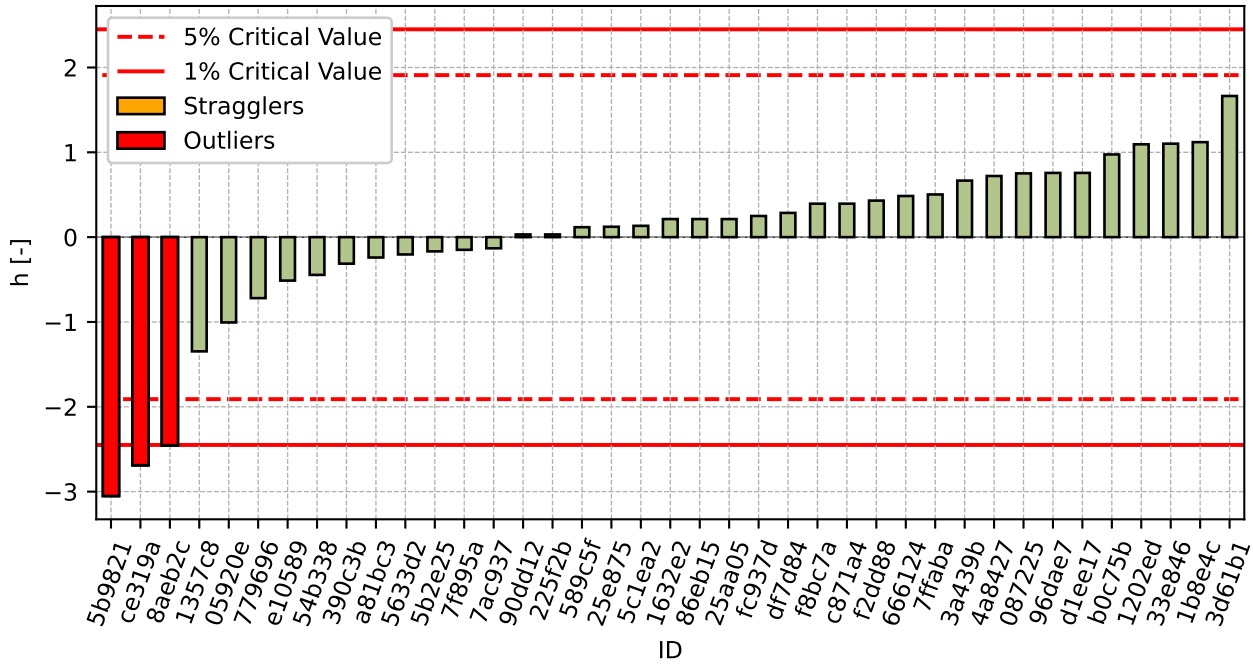

Figure 93: Interlaboratory Consistency Statistic

8.2.4 Descriptive statistics

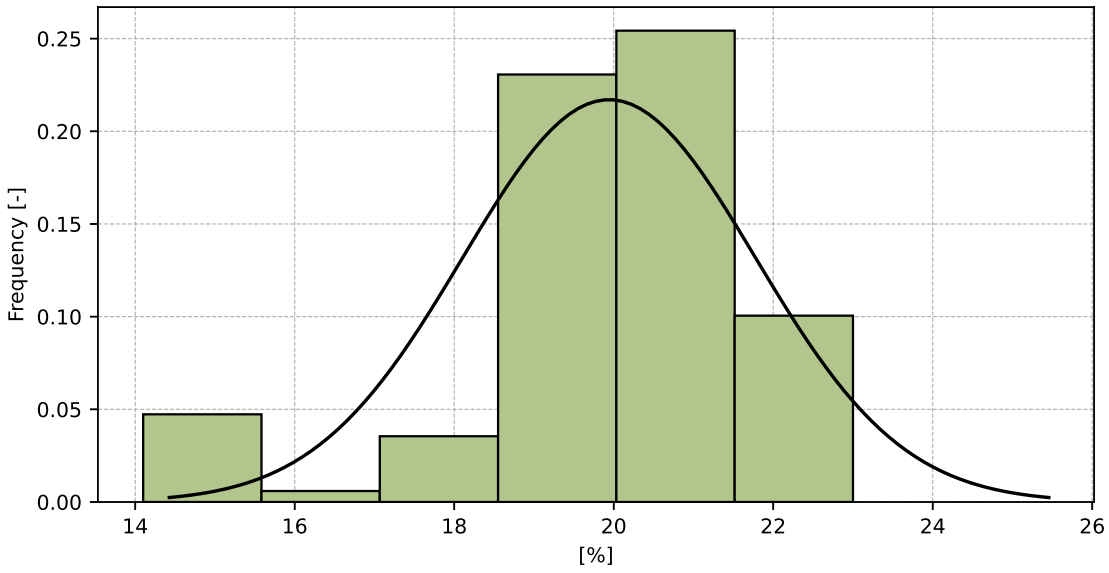

Figure 94: Histogram of all test results

Table 48: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	19.9
Sample standard deviation – s	1.84
Asigned value – x^*	20.3
Robust standard deviation – s^*	1.28
Measurement uncertainty of asigned value – u_X	0.26
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	1.82
Repeatability standard deviation – s_r	0.42
Reproducibility standard deviation – s_R	1.87
Repeatability – r	1.2
Reproducibility – R	5.2

8.2.5 Evaluation of Performance Statistics

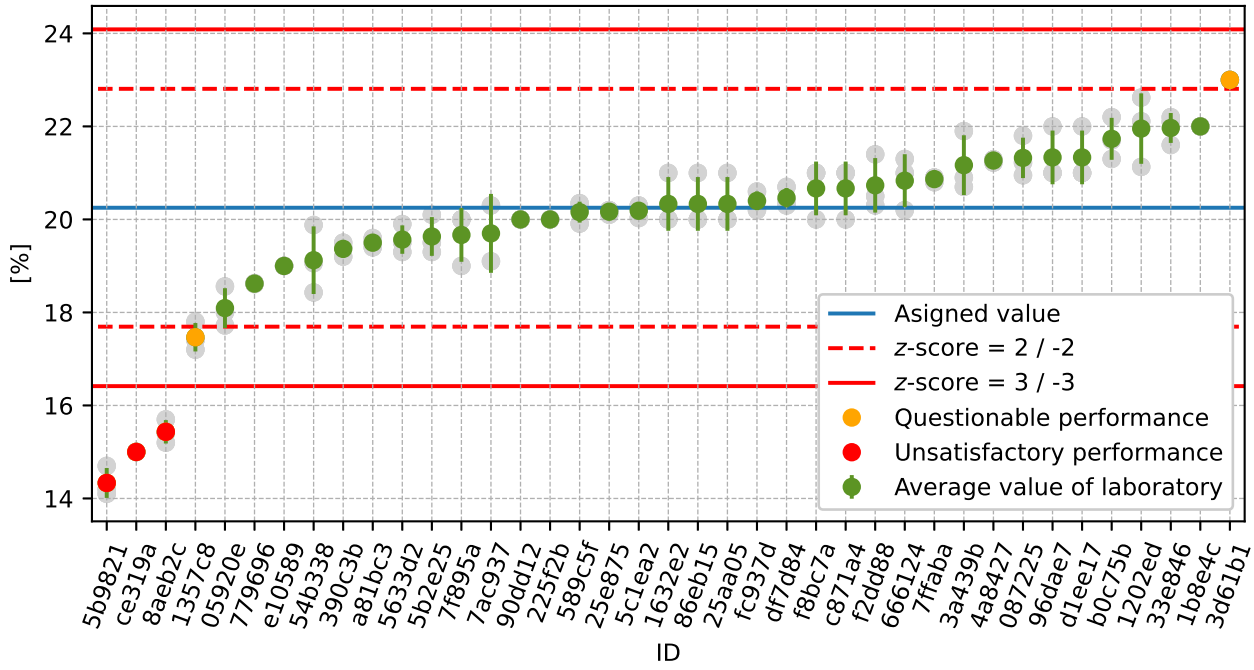

Figure 95: Average values and sample standard deviations

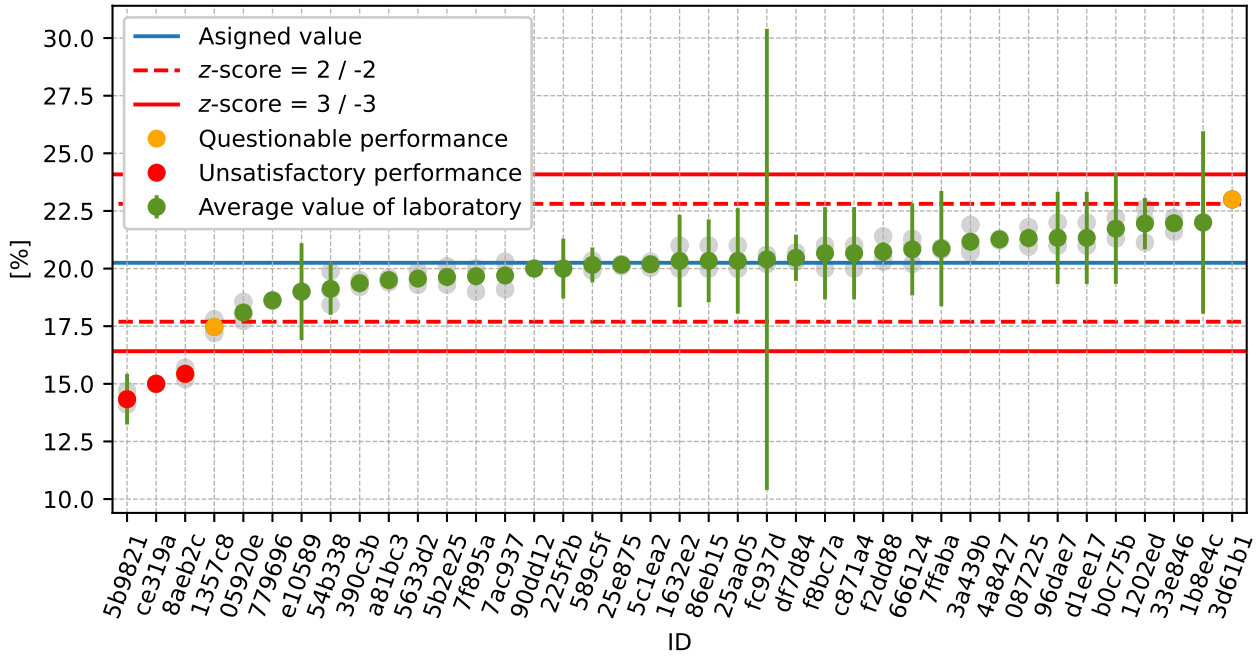

Figure 96: Average values and extended uncertainties of measurement

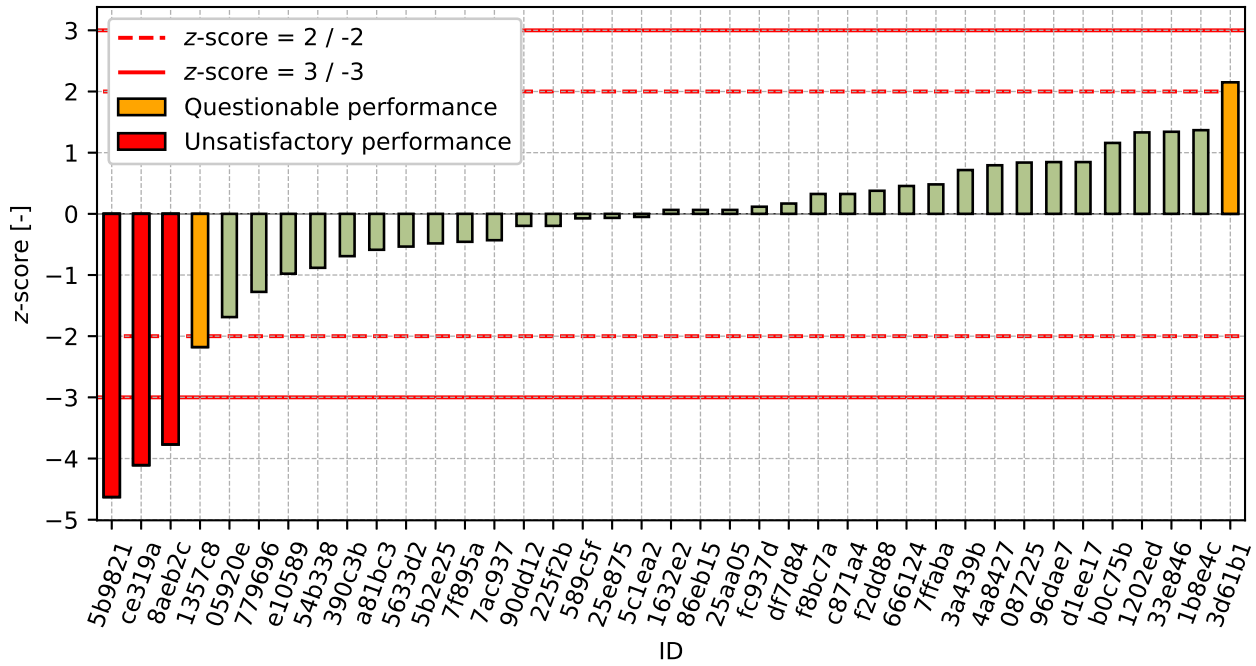

Figure 97: z-score

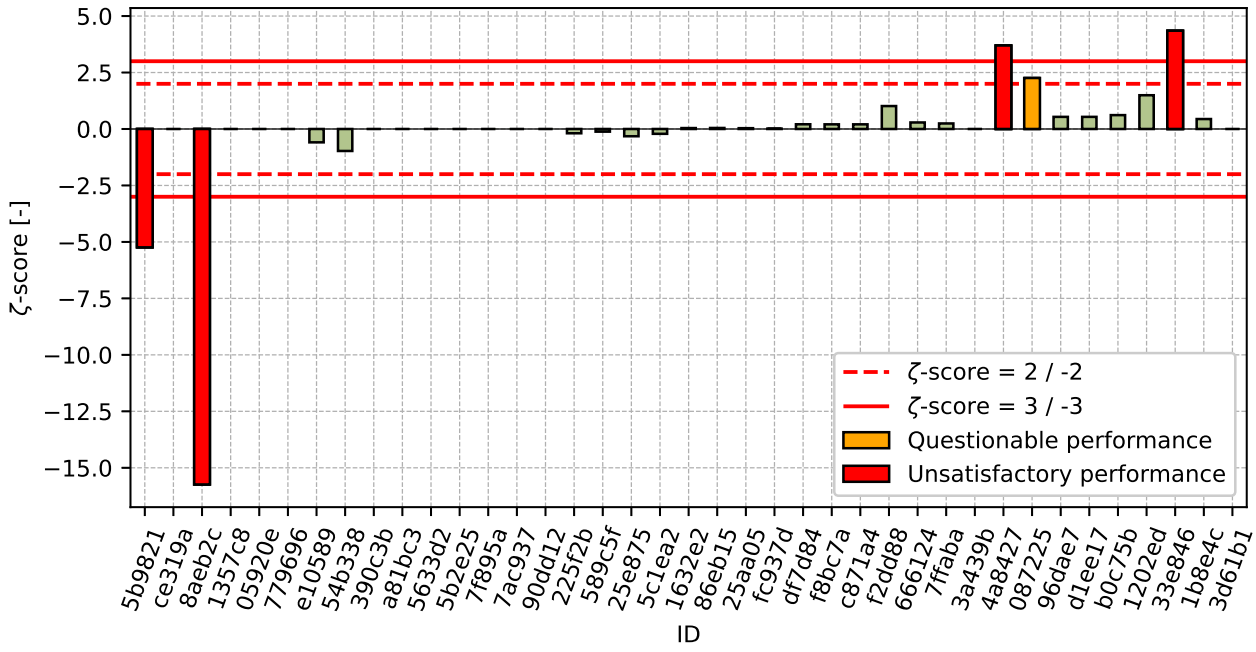

Figure 98: ζ-score

Table 49: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
5b9821	-4.63	-5.24
ce319a	-4.11	-
8aeb2c	-3.77	-15.74
1357c8	-2.18	-
05920e	-1.69	-
779696	-1.28	-
e10589	-0.98	-0.59
54b338	-0.88	-0.97
390c3b	-0.69	-
a81bc3	-0.59	-
5633d2	-0.54	-
5b2e25	-0.48	-
7f895a	-0.46	-
7ac937	-0.43	-
90dd12	-0.2	-
225f2b	-0.2	-0.19
589c5f	-0.07	-0.12
25e875	-0.07	-0.32
5c1ea2	-0.05	-0.21
1632e2	0.06	0.04
86eb15	0.06	0.05
25aa05	0.06	0.04
fc937d	0.12	0.01

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ID	z-score [-]	ζ-score [-]
df7d84	0.17	0.21
f8bc7a	0.32	0.21
c871a4	0.32	0.21
f2dd88	0.38	1.02
666124	0.46	0.29
7ffaba	0.48	0.24
3a439b	0.72	-
4a8427	0.79	3.7
087225	0.84	2.26
96dae7	0.85	0.54
d1ee17	0.85	0.54
b0c75b	1.16	0.61
1202ed	1.33	1.49
33e846	1.34	4.35
1b8e4c	1.37	0.44
3d61b1	2.15	-

9 Appendix – EN 13286-2 – Proctor

9.1 Proctor density

9.1.1 Test results

Table 50: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [kg/m^3]	u_X [kg/m^3]
3832b5	1721	12
fdd45f	1739	12
b0c75b	1749	-
d1ee17	1760	7
8b3490	1770	-
fc937d	1770	1
55e5c0	1770	18
53a71c	1770	0
fed12a	1780	70
f8bc7a	1780	7
f2dd88	1780	0
589c5f	1780	0
e81c64	1790	33
1b001e	1790	-
1b8e4c	1791	-
de7330	1800	-
96dae7	1800	7
779696	1810	-
df7d84	1810	50
25aa05	1810	53
86eb15	1818	23
8f9b0e	1820	17
60f194	1825	-
cc7904	1830	2
ce319a	1840	-
3a439b	1840	-
a81bc3	1850	-
ed0ab6	1892	-

9.1.2 The Numerical Procedure for Determining Outliers

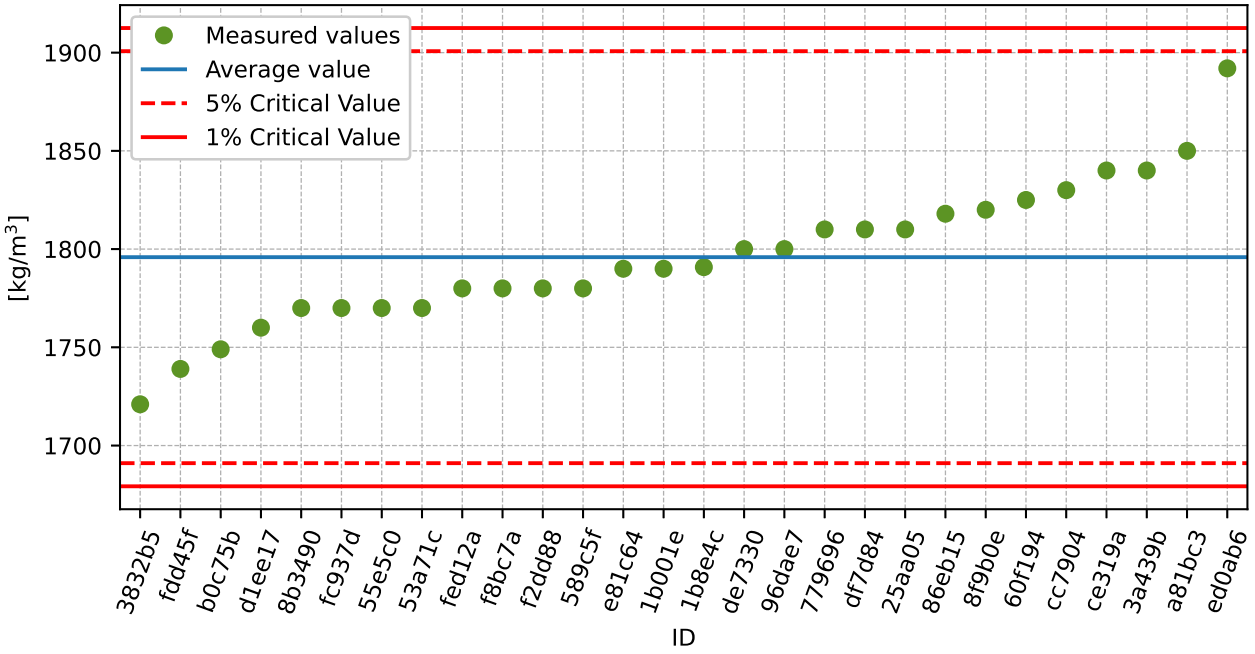

Figure 99: **Grubbs' test** - average values

9.1.3 Mandel's Statistics

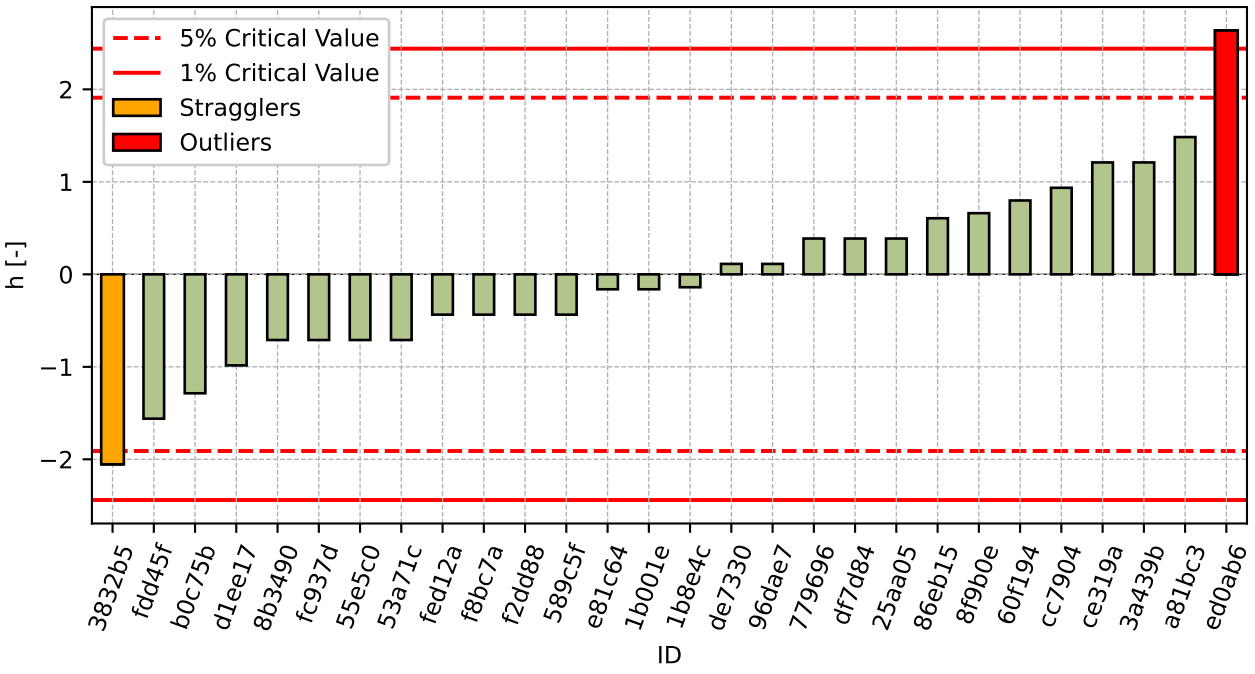

Figure 100: Interlaboratory Consistency Statistic

9.1.4 Descriptive statistics

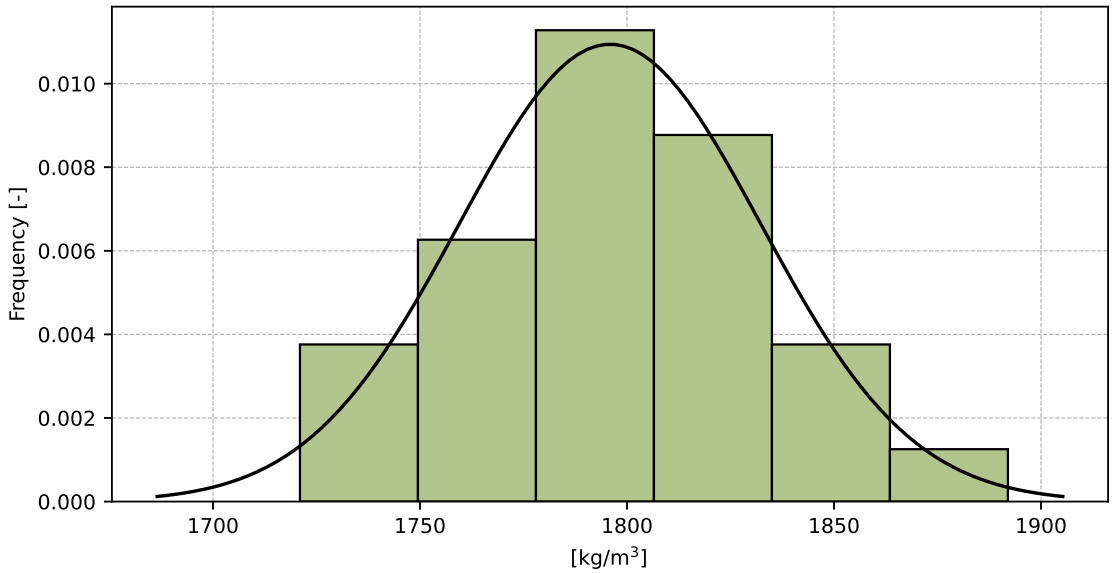

Figure 101: Histogram of all test results

Table 51: Descriptive statistics

Characteristics	[kg/m³]
Average value – $\bar{x}$	1796
Sample standard deviation – s	36.5
Asigned value – x^*	1796
Robust standard deviation – s^*	37.2
Measurement uncertainty of asigned value – u_X	8.8
p-value of normality test	0.408 [-]

9.1.5 Evaluation of Performance Statistics

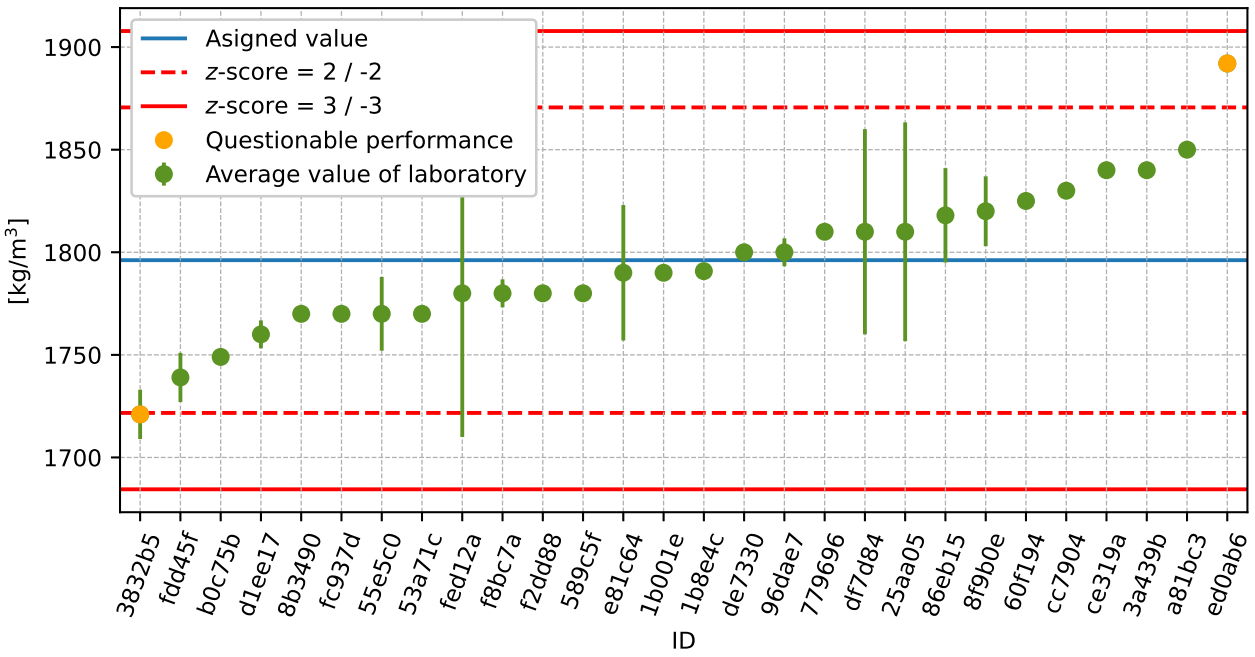

Figure 102: Average values and extended uncertainties of measurement

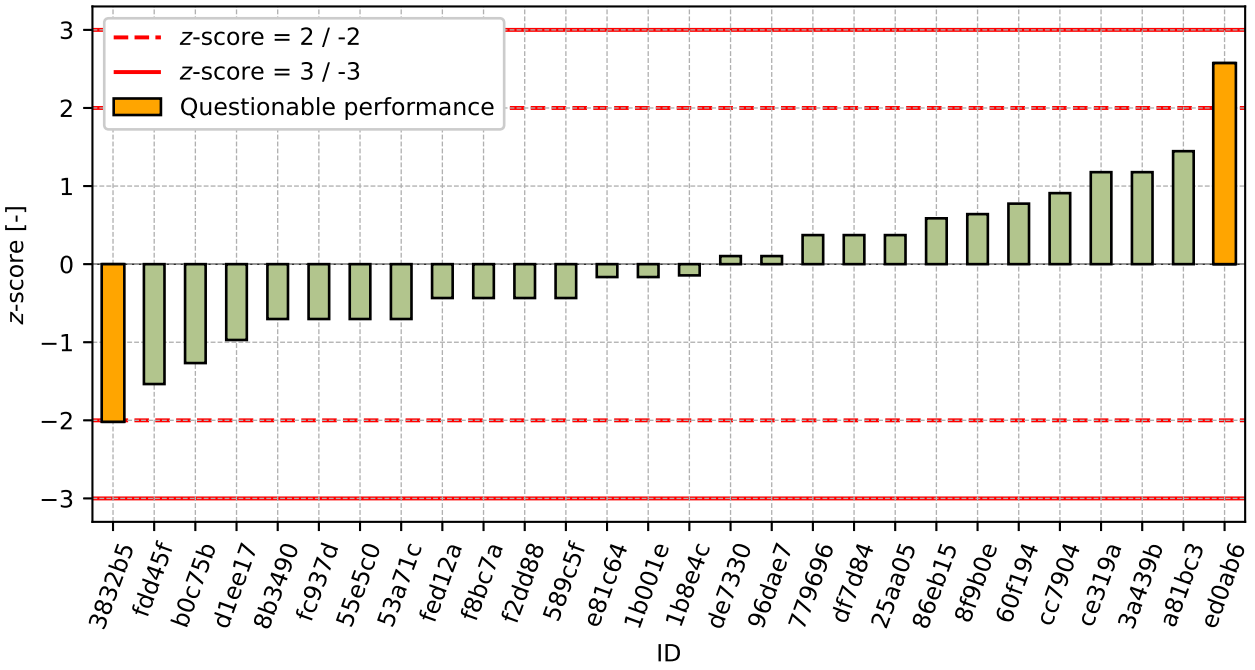

Figure 103: z-score

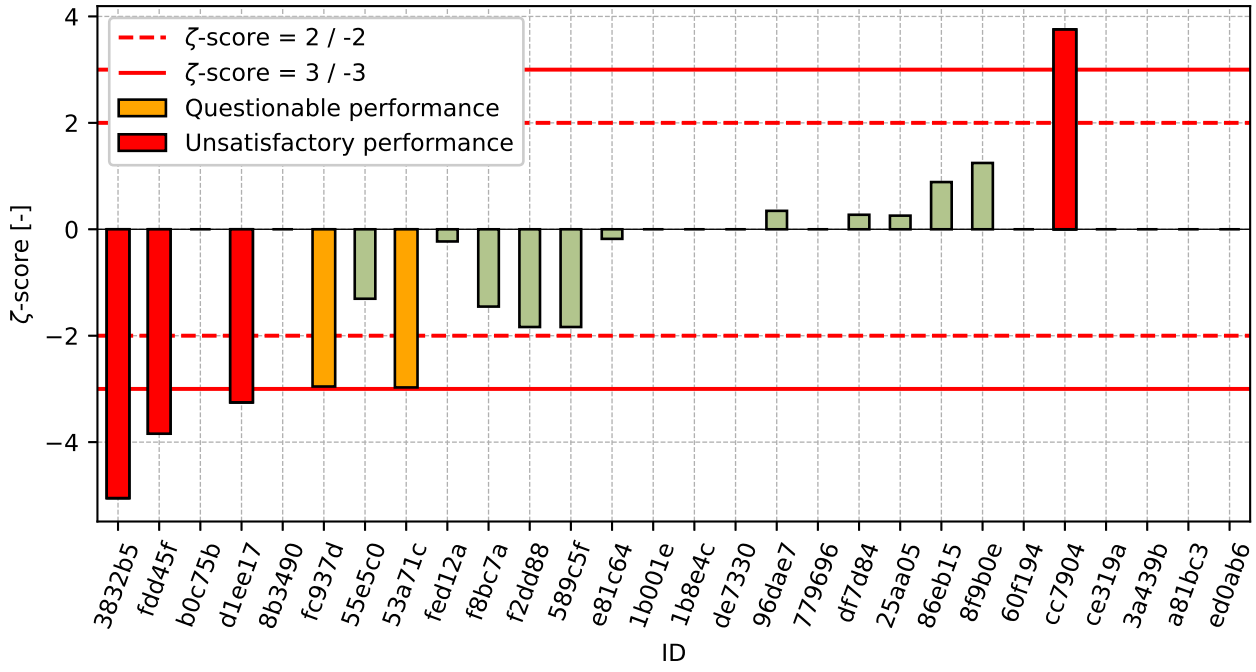

Figure 104: ζ-score

Table 52: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
3832b5	-2.02	-5.05
fdd45f	-1.54	-3.84
b0c75b	-1.27	-
d1ee17	-0.97	-3.25
8b3490	-0.7	-
fc937d	-0.7	-2.95
55e5c0	-0.7	-1.31
53a71c	-0.7	-2.97
fed12a	-0.43	-0.23
f8bc7a	-0.43	-1.45
f2dd88	-0.43	-1.84
589c5f	-0.43	-1.84
e81c64	-0.17	-0.18
1b001e	-0.17	-
1b8e4c	-0.14	-
de7330	0.1	-
96dae7	0.1	0.35
779696	0.37	-
df7d84	0.37	0.27
25aa05	0.37	0.26
86eb15	0.59	0.89
8f9b0e	0.64	1.25

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ID	z-score [-]	ζ-score [-]
60f194	0.78	-
cc7904	0.91	3.75
ce319a	1.18	-
3a439b	1.18	-
a81bc3	1.45	-
ed0ab6	2.57	-

9.2 Optimum water content

9.2.1 Test results

Table 53: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [%]	u_X [%]
ed0ab6	12.7	-
a81bc3	13.4	-
3a439b	13.5	-
cc7904	14.0	0.4
60f194	15.0	-
ce319a	15.0	-
25aa05	15.3	0.2
8b3490	15.4	-
55e5c0	15.5	0.7
86eb15	15.6	0.9
1b8e4c	15.9	-
779696	15.9	-
df7d84	16.0	1.0
fed12a	16.0	1.8
de7330	16.0	-
d1ee17	16.0	3.8
fc937d	16.1	4.0
589c5f	16.2	0.2
8f9b0e	16.2	0.1
3832b5	16.3	0.8
fdd45f	16.4	0.8
e81c64	16.5	0.5
f2dd88	16.7	0.3
f8bc7a	17.0	3.8
96dae7	17.0	3.8
1b001e	17.2	-
53a71c	17.3	0.1
b0c75b	18.0	-

9.2.2 The Numerical Procedure for Determining Outliers

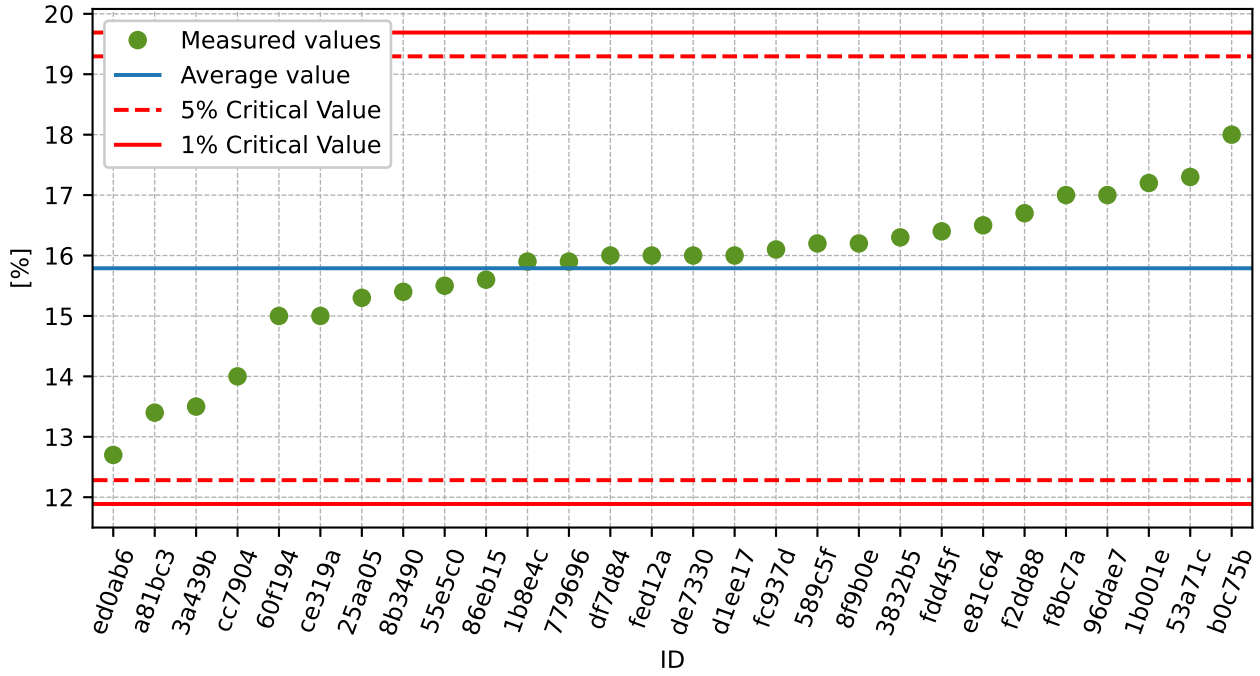

Figure 105: **Grubbs' test** - average values

9.2.3 Mandel's Statistics

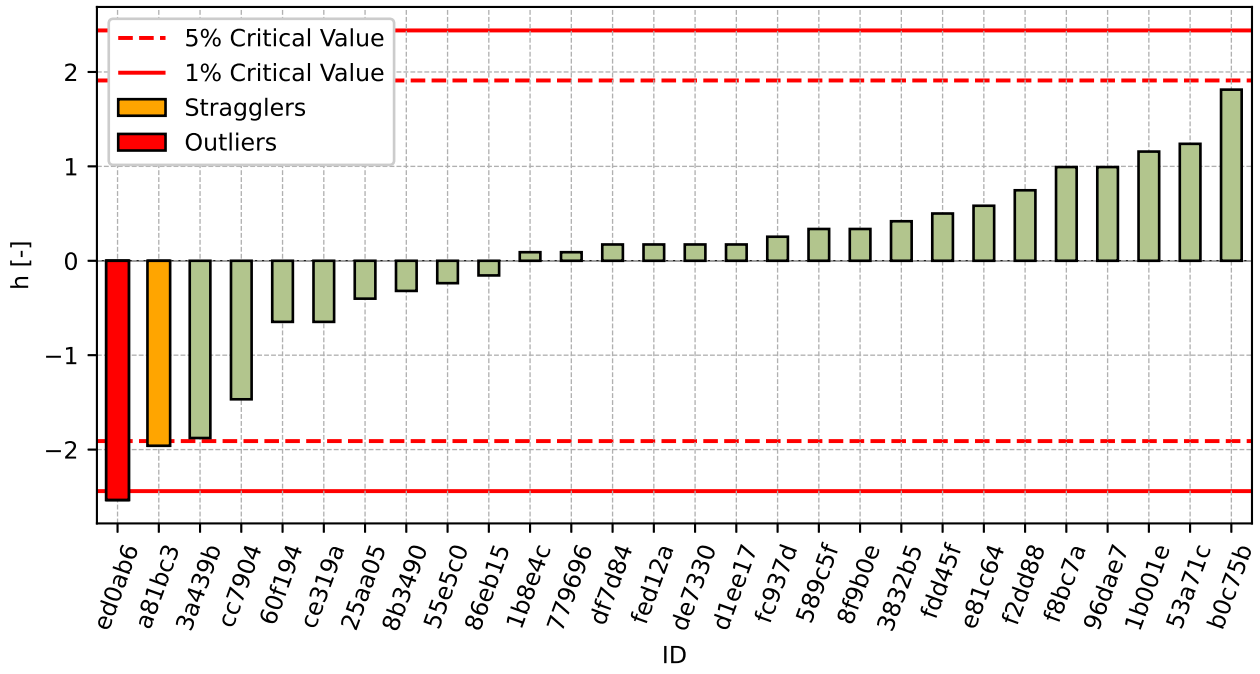

Figure 106: Interlaboratory Consistency Statistic

9.2.4 Descriptive statistics

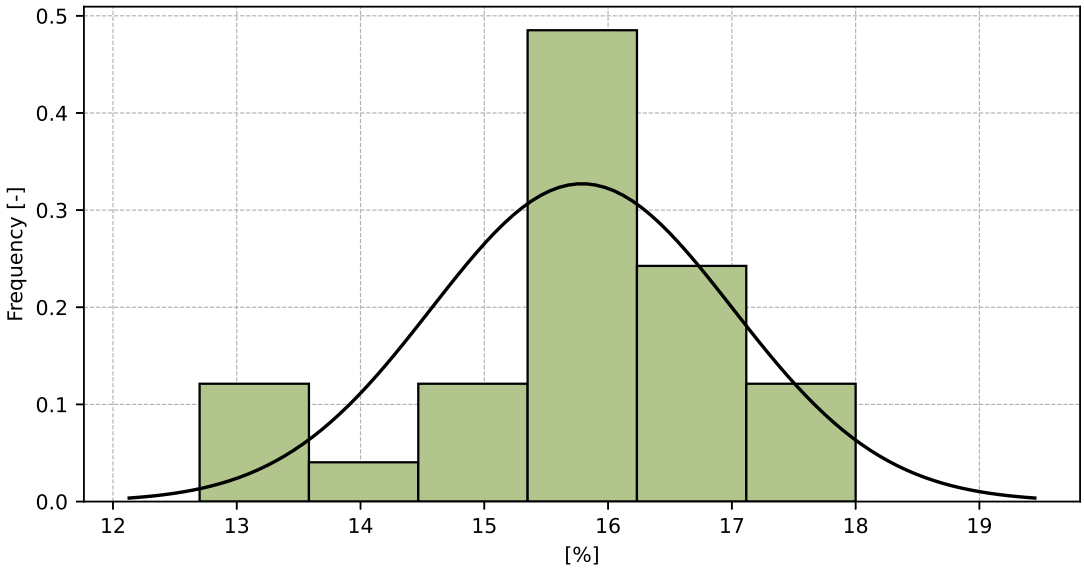

Figure 107: Histogram of all test results

Table 54: Descriptive statistics

Characteristics	**[%]**
Average value – $\bar{x}$	15.8
Sample standard deviation – s	1.22
Asigned value – x^*	16.0
Robust standard deviation – s^*	0.94
Measurement uncertainty of asigned value – u_X	0.22
p-value of normality test	0.081 [-]

9.2.5 Evaluation of Performance Statistics

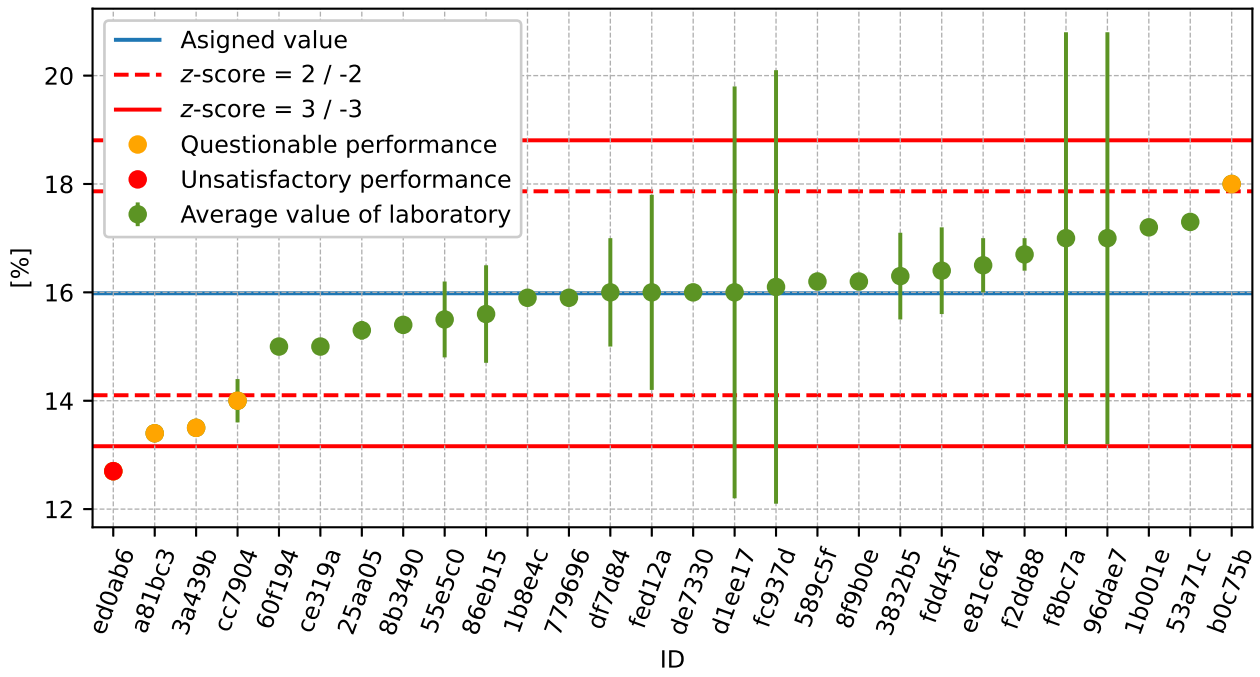

Figure 108: Average values and extended uncertainties of measurement

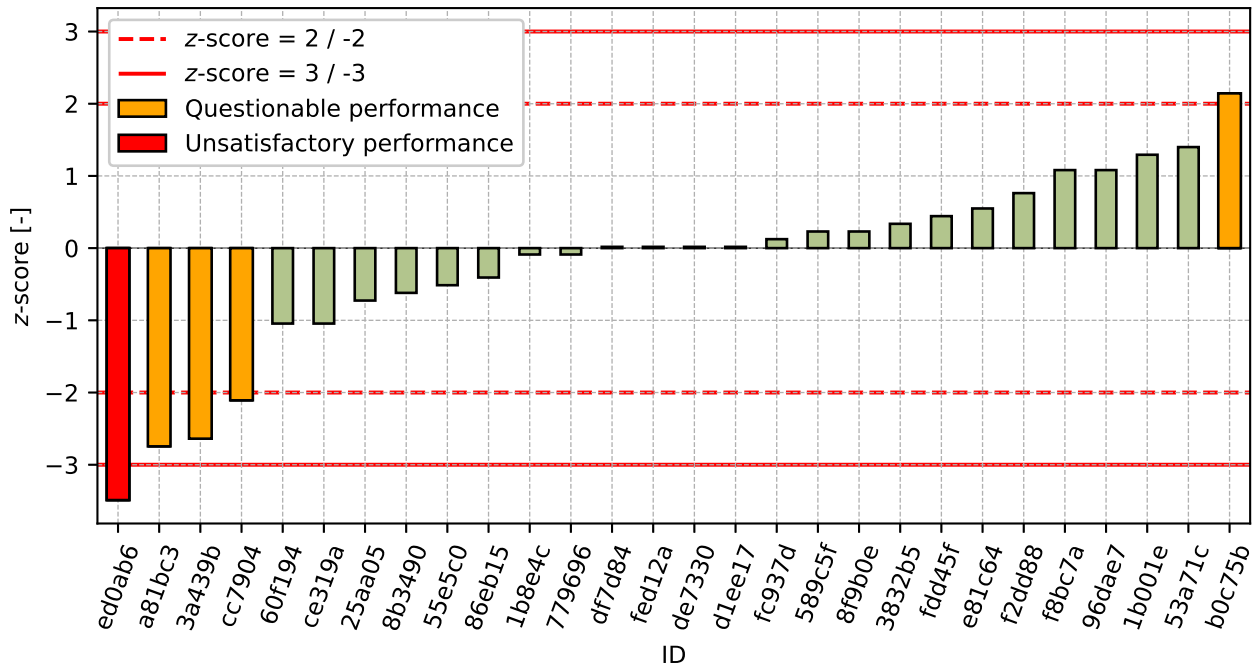

Figure 109: z-score

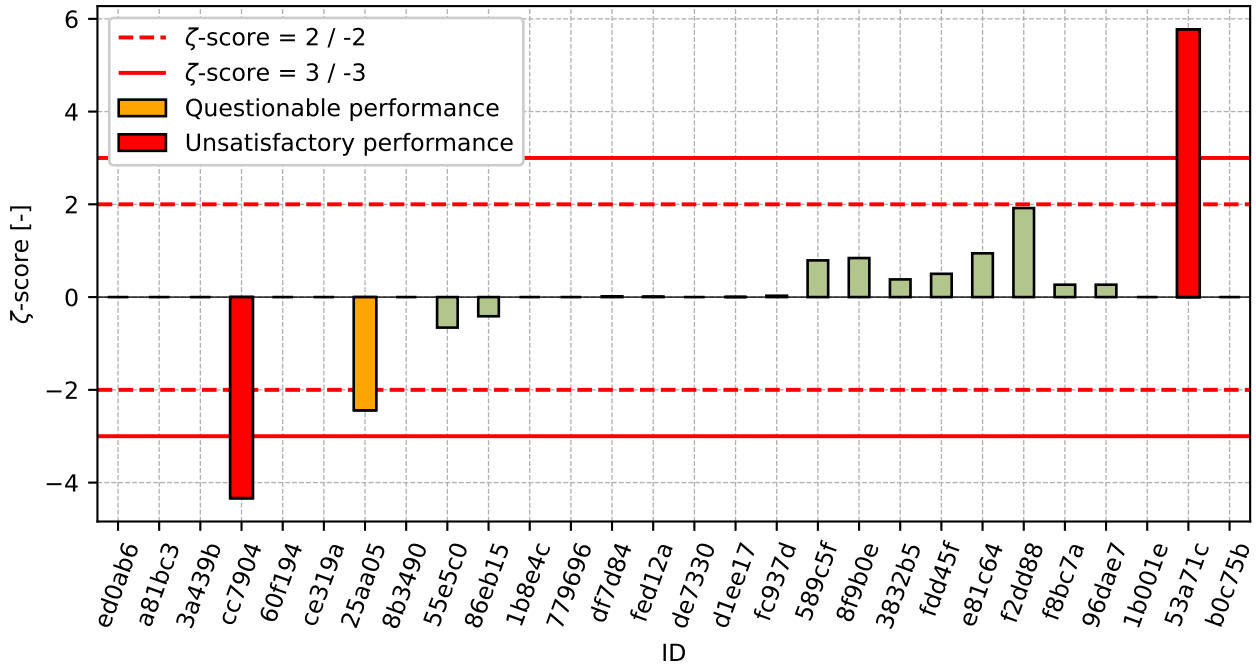

Figure 110: ζ-score

Table 55: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
ed0ab6	-3.49	-
a81bc3	-2.75	-
3a439b	-2.64	-
cc7904	-2.11	-4.33
60f194	-1.04	-
ce319a	-1.04	-
25aa05	-0.73	-2.44
8b3490	-0.62	-
55e5c0	-0.51	-0.66
86eb15	-0.41	-0.41
1b8e4c	-0.09	-
779696	-0.09	-
df7d84	0.02	0.02
fed12a	0.02	0.01
de7330	0.02	-
d1ee17	0.02	0.0
fc937d	0.12	0.03
589c5f	0.23	0.79
8f9b0e	0.23	0.84
3832b5	0.34	0.38
fdd45f	0.44	0.5
e81c64	0.55	0.94

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ID	z-score [-]	ζ-score [-]
f2dd88	0.76	1.92
f8bc7a	1.08	0.27
96dae7	1.08	0.27
1b001e	1.29	-
53a71c	1.4	5.77
b0c75b	2.14	-

10 Appendix – EN 13286-47 – IBI

10.1 Test results

Table 56: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [%]	u_X [%]
fc937d	4.0	13.0
d1ee17	4.3	-
25aa05	4.8	0.9
068f53	5.6	-
86eb15	6.0	2.5
f90fb7	7.0	3.0
8aeb2c	7.2	0.4
96dae7	9.0	-
a81bc3	9.0	-
c0ca45	10.0	2.4
f8bc7a	11.0	-
ce319a	11.0	-
779696	11.0	-
087225	11.5	0.2
53a71c	12.0	-
60f194	12.0	-
de7330	13.0	-
df7d84	14.0	1.0
8b3490	14.0	-
225f2b	14.0	0.1
589c5f	15.8	1.4

10.2 The Numerical Procedure for Determining Outliers

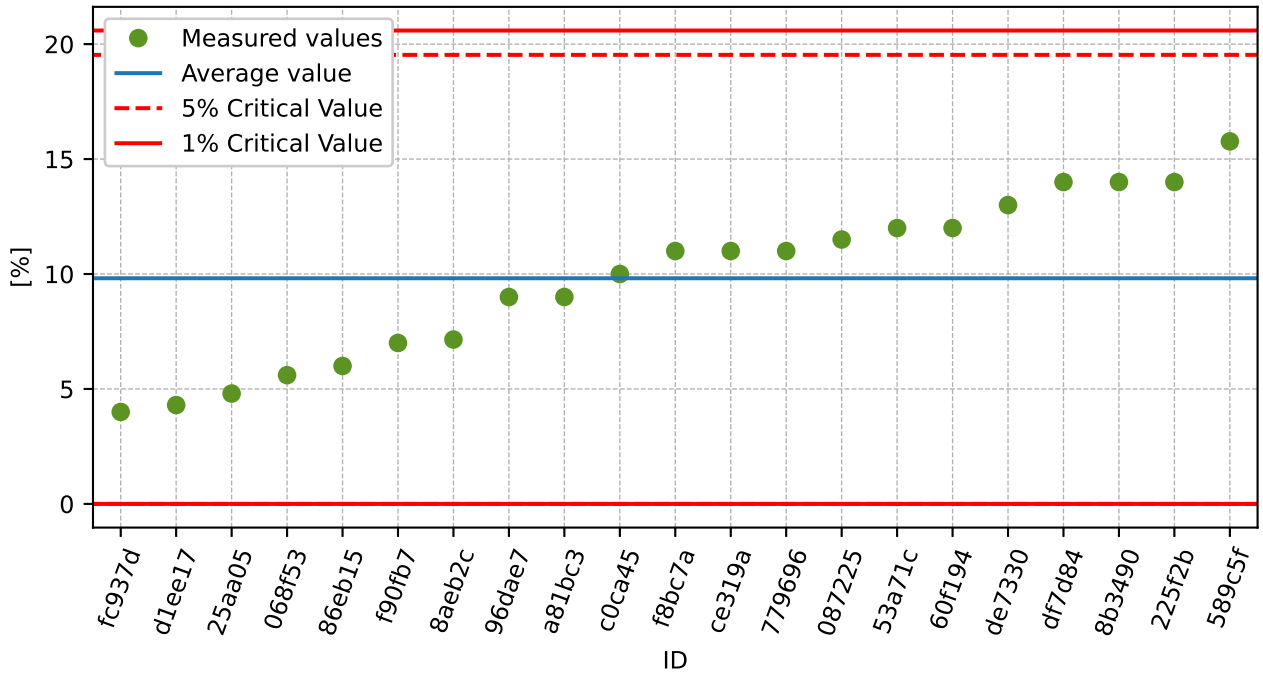

Figure 111: **Grubbs' test** - average values

10.3 Mandel's Statistics

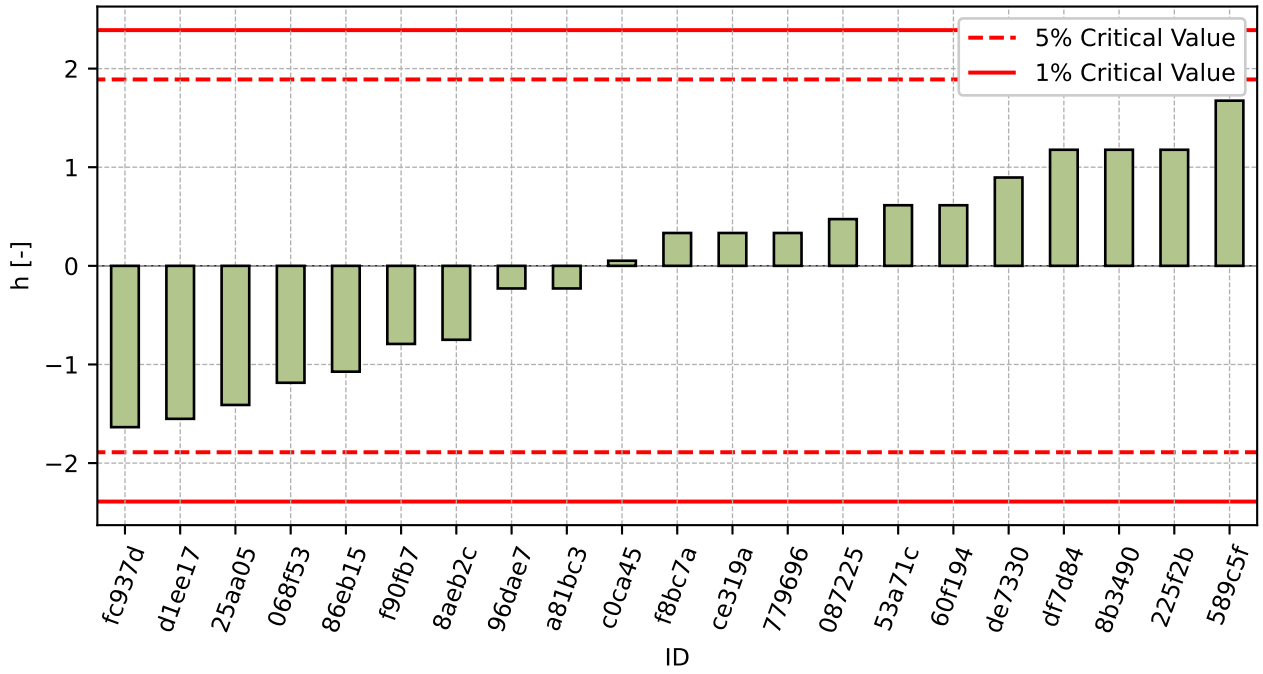

Figure 112: Interlaboratory Consistency Statistic

10.4 Descriptive statistics

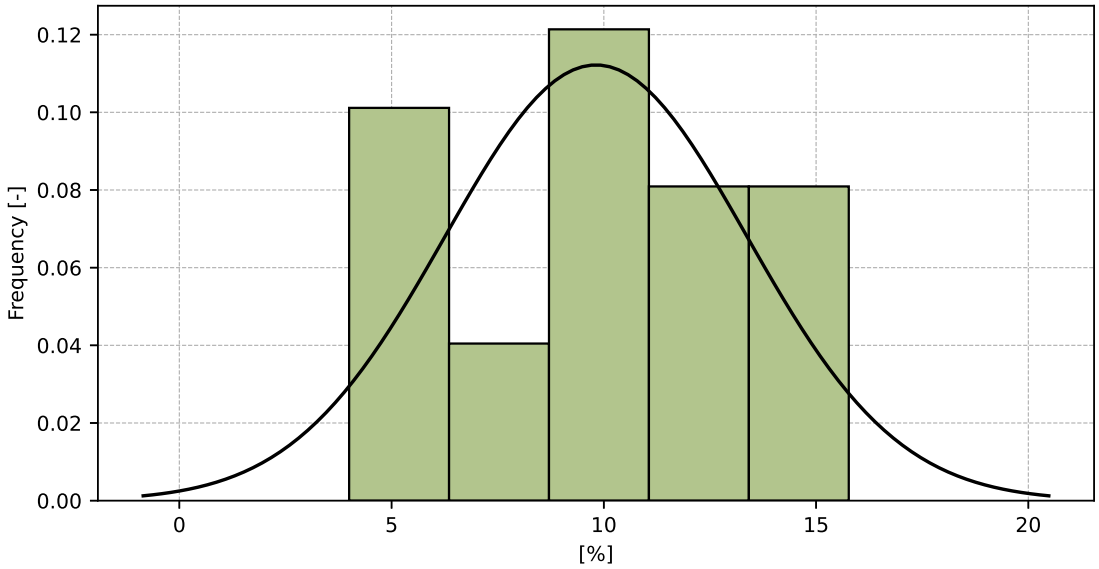

Figure 113: Histogram of all test results

Table 57: Descriptive statistics

Characteristics	**[%]**
Average value – $\bar{x}$	9.8
Sample standard deviation – s	3.56
Asigned value – x^*	9.8
Robust standard deviation – s^*	3.9
Measurement uncertainty of asigned value – u_X	1.06
p-value of normality test	0.276 [-]

10.5 Evaluation of Performance Statistics

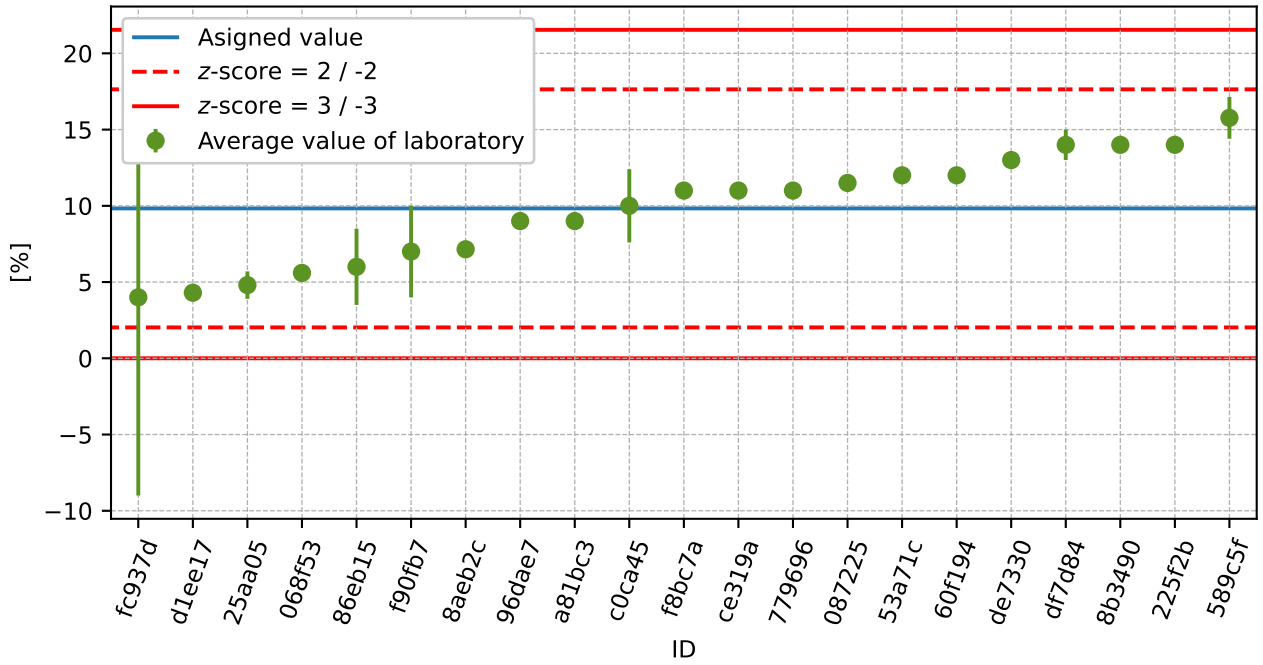

Figure 114: Average values and extended uncertainties of measurement

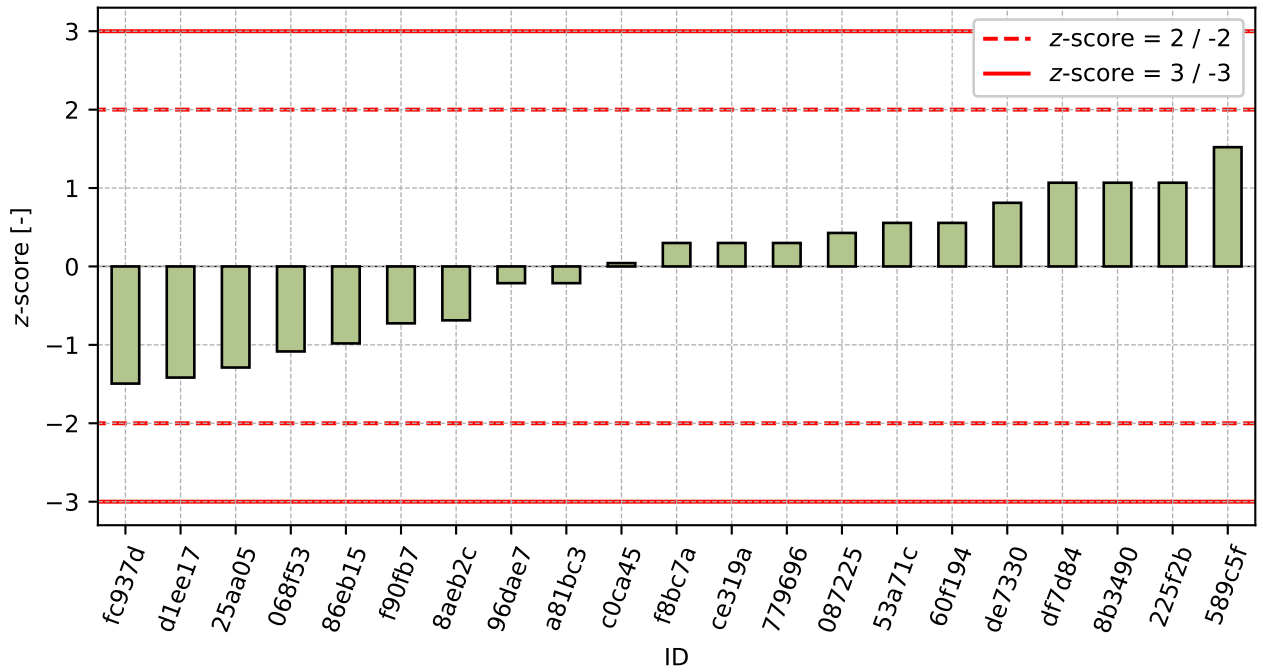

Figure 115: z-score

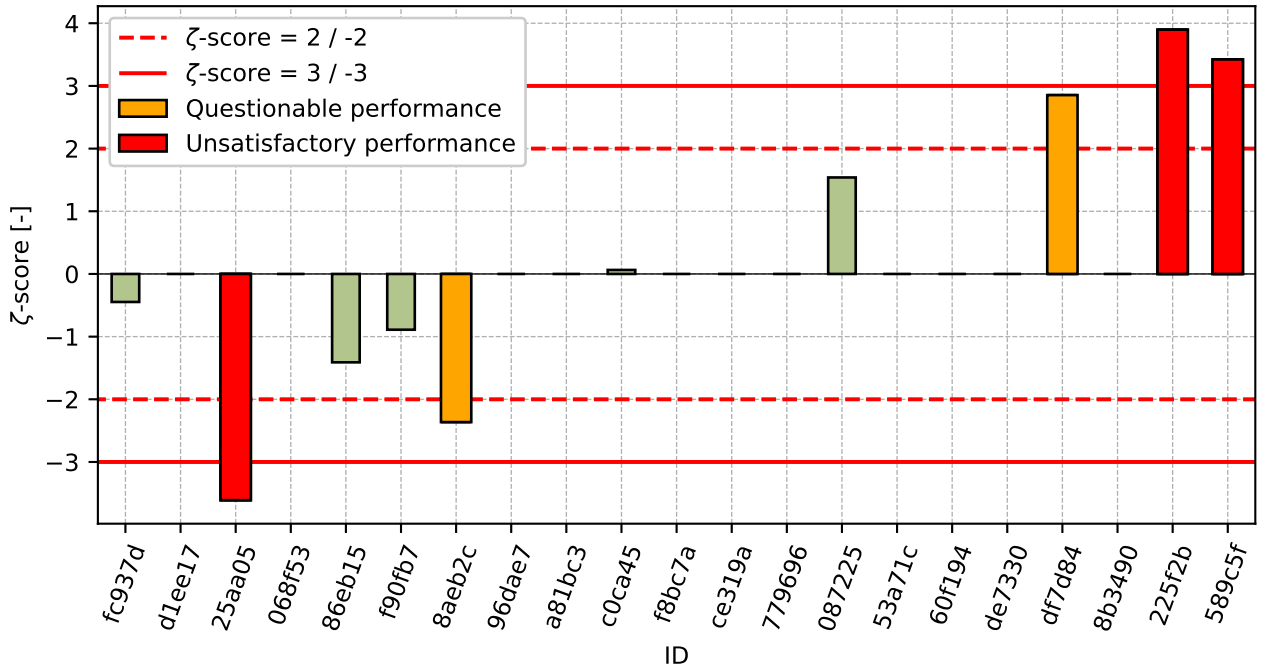

Figure 116: ζ-score

Table 58: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
fc937d	-1.49	-0.45
d1ee17	-1.42	-
25aa05	-1.29	-3.61
068f53	-1.08	-
86eb15	-0.98	-1.41
f90fb7	-0.73	-0.89
8aeb2c	-0.69	-2.36
96dae7	-0.21	-
a81bc3	-0.21	-
c0ca45	0.04	0.06
f8bc7a	0.3	-
ce319a	0.3	-
779696	0.3	-
087225	0.43	1.54
53a71c	0.56	-
60f194	0.56	-
de7330	0.81	-
df7d84	1.07	2.85
8b3490	1.07	-
225f2b	1.07	3.9
589c5f	1.52	3.42