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
Aggregate Testing
ZK 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: July 12, 2024

Poskytovatel zkoušení způsobilosti při SZK FAST
Proficiency testing provider at the SZK FAST
Z 7008
Veveří 95
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Assoc. Prof. Ing. Tomáš Vymazal, Ph.D.
Head of the PT Provider, PTP coordinator

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

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1 Introduction and Important Contacts

At the beginning of 2024, the Proficiency Testing Provider at SZK FAST (PoZZ) launched a Proficiency Testing Programme (PrZZ), designated ZK 2024/1, to verify and assess the consistency of aggregate test results. The assessment of the results of the proficiency testing programme was carried out by a committee consisting of the following PT Provider employees:

Head of the PT Provider, PTP coordinator

Assoc. Prof. 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
Email: Tomas.Vymazal@vut.cz

Coordinator of PTP result assessment PTP

Ing. Petr Misák, Ph.D.
Brno University of Technology
Faculty of Civil Engineering
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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 933-1 Determination of particle size distribution - Sieving method [1],
2. EN 933-3 Determination of particle shape - Flakiness index [2],
3. EN 933-4 Determination of particle shape - Shape index [3],
4. EN 933-8 Assessment of fines - Sand equivalent test [4],
5. EN 933-9 Assessment of fines - Methylene blue test [5],
6. EN 933-10 Assessment of fines - Grading of filler aggregates (air jet sieving) [6],
7. EN 1097-1 Determination of the resistance to wear (micro-Deval) [7],
8. EN 1097-2 Methods for the determination of resistance to fragmentation - chapter 5 [8],
9. EN 1097-2 Methods for the determination of resistance to fragmentation - chapter 6 [8],
10. EN 1097-3 Determination of loose bulk density and voids [9],
11. EN 1097-5 Determination of the water content by drying in a ventilated oven [10],
12. EN 1097-6 Determination of particle density and water absorption [11],
13. EN 1097-7 Determination of the particle density of filer - Pyknometer method [12],
14. EN 1367-1 Determination of resistance to freezing and thawing [13],
15. EN 1367-2 Magnesium sulfate test [14],
16. EN 1367-3 Boiling test for "Sonnenbrand basalt" [15],
17. TP 137 - Appendix 1 and 2 – Determination of reactivity of aggregates in connection with alkalies [16],
18. ČSN 72 1179 Determination of reactivity of aggregates in connection with alkalies – chapter B [17].

Test procedures 13, 16, 17 and 18 were not opened due to low interest of participants.

The supplier, BETOTECH s. r. o. (L 1195.3), was responsible for the preparation of testing samples for the PTP. The supplier is responsible for homogeneity and stability of testing samples.

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 [18] and with EN ISO/IEC 17043 [19].

The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

82 laboratories took part in PTP. In order to maintain the anonymity of the PTP, each laboratory was given an identification number that will be used henceforth in this document. An integral part of the present final report is a Certificate of Participation in the Proficiency Testing Program. It is unique for each participant and includes the participant's ID used in this report. The following 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	11	12	13	14	15	16	17	18
2831cc	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-	-
a2426d	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-
6a65da	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7f9471	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
363174	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
692075	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
f9906c	-	X	X	-	X	-	X	X	-	-	X	X	-	-	X	-	-	-
978abc	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1cf882	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
ae026d	X	X	X	X	-	X	-	X	-	-	X	X	-	-	-	-	-	-
91d1d4	X	-	X	-	X	-	-	-	-	-	X	X	-	-	-	-	-	-
9facaf	X	X	-	-	X	-	X	X	-	-	-	X	-	-	-	-	-	-
cce71a	-	-	X	X	X	-	-	X	-	-	-	-	-	-	X	-	-	-
1cf584	-	-	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-
943aff	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
e1ed78	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44e8e8	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
2968bc	X	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
1300a8	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
82a501	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
02a56a	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-
c2ab58	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
c429d1	X	-	X	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-
8541f2	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
f26927	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
22edc2	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
801460	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
1ae021	-	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-
ba0755	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
b4912c	X	X	X	X	X	X	X	X	-	X	X	X	-	X	-	-	-	-
f56670	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b5b225	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13fdf1	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d6b7ab	-	X	X	-	X	-	X	X	-	X	-	-	-	X	X	-	-	-
d0d741	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
fc3f32	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
f7e2f2	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65eb6d	X	-	X	X	-	-	-	-	-	-	X	X	-	X	-	-	-	-

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ID/Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
178148	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d3cb2f	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
615698	-	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-
5648cb	-	-	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-
d34bb3	-	X	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
d2edc0	-	-	-	X	-	-	-	X	-	-	-	-	-	-	X	-	-	-
25dbc8	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-
bf5ab5	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
144321	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
9db03c	X	-	X	X	-	-	-	-	-	-	X	-	-	X	-	-	-	-
bf844c	-	X	-	-	-	-	-	-	X	-	X	-	-	-	X	-	-	-
c07cfc	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
99772d	-	-	-	-	X	X	-	X	-	-	X	-	-	X	-	-	-	-
25e37d	X	-	X	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
6ec30c	X	-	X	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-
56e681	X	-	-	-	-	-	X	X	-	-	X	X	-	-	-	-	-	-
31f9a0	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
a493e8	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
5dfeee	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
597047	-	X	X	-	X	-	X	X	-	-	-	X	-	X	-	-	-	-
66c90a	X	-	X	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-
320f41	X	-	X	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-
fb2fb1	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
7f555e	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4471dc	X	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
feef67	X	-	X	-	X	-	X	X	-	X	X	X	-	X	X	-	-	-
566efb	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
b0263e	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
34c434	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
f7250c	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0c2972	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
414fc6	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d69d0e	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
442491	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
5b59a2	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
ed0789	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
c01d65	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
3524eb	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74d791	X	-	-	-	-	-	X	X	-	X	X	X	-	-	X	-	-	-
e8f59c	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1420b6	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
63d8e1	X	X	X	-	-	-	X	X	-	X	X	X	-	-	X	-	-	-
2dc09c	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
c54811	-	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
”STROYCONTROL 2003”LTD	Kostenec str 12, Sofia, 1612, Bulgaria	-
AB „KLOVAINIŲ SKALDA” 167901031	BERŽINIŲ km. GAMYKLOS g. 2, PAKRUOJO raj., LT-83209, LITHUANIA	LA.01.047
AQ TESTING BT SRL	PICULINEI 5A SECTOR 1, BUCURESTI, 012601, ROMANIA	-
ARP GmbH	Johann-Sackl-Gasse 65-67, Leoben, 8700, Austria	-
AsChem	Strada Requaglia 13, Ovada, 15076, italy	-
BETOTECH, s.r.o. - pracoviště Beroun	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Jindřichův Hradec	Jarošovská 2217/II, Jindřichův Hradec, 377 01, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Most	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Trutnov	Beroun 660, Beroun, 26601, Česká republika	1195
BHP Laboratories Limited	New Road Thomandgate, Limerick, V94P9X4, Ireland	-
BTI Bautechnisches Institut GmbH	Karl-Leitl-Strasse 2, Puchenau bei Linz, A 4048, Austria	-
Banat Inzenjering LBI DOO	Makedonska 15, Zrenjanin, 23000, Republic of Serbia	01-540
Bechtel ENKA UK Limited Ogranak Beograd	Jasički put 52đ, Kruševac, 37000, Serbia	-
Betotech s.r.o., laboratoř Mokrá	Beroun 660, Beroun, 266 01, Česká republika	1195.3
Building Research Institute NISI	86 Nikola Petkov Blvd., Sofia, 1618, Bulgaria	88 ЛИ
C.N.A.I.R S.A	BD. IULIU MANIU 401A, SECTOR 6, BUCURESTI, 061101, ROMANIA	LI220/19.08.2022
CEMEX Czech Republic, s.r.o.	Laurinova 2800/4, Praha 5, 15500, Česká republika	1302
CSS d.o.o.	Savska cesta 144a, Zagreb, 10000, Croatia	HR1106
Civil Engineering Institute IG LLC Banja Luka	Kralja Petra I Karađorđevića 92-98, Banja Luka, 78000, Bosnia and Herzegovi	-
DSP a.s.	Kostěnice 111, Kostěnice, 53002, Česká republika	1782
DUNAFERR LABOR Nonprofit Kft.	Vasmu ter 1-3., Dunaujvaros, H-2400, Hungary	NAH-1-1798/2021
Danucem Slovensko a.s., Skúšobné laboratórium Bratislava	Pestovateľská 2, Bratislava, 82104, Slovenská republika	426/S-313
EUROCERT TESTING IKE ATHANASIADIS STATHIS	89 Chlois St., Metamorphosi, GR 14452, Greece	-

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Laboratory	Address	Accreditation number
Ferriere Nord S.p.A.	Zona Industriale Rivoli di Osoppo, Osoppo (Udine), 33010, Italy	-
GEOTEST SHPK	AUTOSTRADA TIRANE -DURRES, KM 2, MEZEZ, KASHAR ,TIRANE, TIRANE, 1051, ALBANIA	-
GEOtest, a.s.	Šmahova 1244/112, Brno, 627 00, Česká republika	L 1271
GUBT GmbH	Gewerbeparkstraße 5, Markgrafneusiedl, A-2282, Austria	-
Heidelberg Materials Research Lab LT	Švepelių g. 5, Klaip4da, LT95101, Lithuania	-
Holcim (Hrvatska) d.o.o.	Koromačno 7b, Koromačno, 52 222, Croatia	-
Holcim Česko, a.s.	Čížkovice 27, Čížkovice, 411 12, Česká republika	1426
IDICOL SAS	CALLE 70A 52-27, BOGOTA, 111221, BOGOTA	-
INSTITUTUL DE CERCETARI IN TRANSPORTURI-INCERTRANS S.A.	Băneasa Business & Technology Park, Road București–Ploiești no. 42-44, building B, wing B1, floor 2, sector 1, Bucharest, Bucharest, 015011, Romania	LI1106
Impresa Bacchi	VIA DON DOSSETTI 19, carpiano (MI), 20080, 9BIE	1554L
LABORATOIRE DES TRAVAUX PUBLICS DU SUD	Zone des activités Bouhraoua- PB 332 GHARDAIA, GHARDAIA, 47000, ALGERIA	-
Labo Devlieger - Van Vooren - Monnikenwerve	Industriepark Rosteyne 1, zelzate, 9060, Oost-Vlaanderen	296-TEST
Labo Devlieger - Van Vooren - Zelzate	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	099931010352443
Labos d.o.o.	Pavlinska ulica 5, Varazdin, 42000, Croatia	1395
Mega Infrastructure d.o.o., Beograd-Savski Venac, 11000, Belgrade, Serbia	Potez Ružaš, Irig, 22406, Serbia	-
Mining and Metallurgy Institute Bor	Zeleni bulevar 35, Bor, 19210, Serbia	01-308, ATS Serbia
NAMALAB S.A.	Asimakopoulou 7, Athens, 115 24, Attiki	-
PUDIS a.s.	Podbabská 1014/20, Praha 6, 160 00, Česká republika	1762
QUALIFORM SLOVAKIA s.r.o.	Pasienková 9D, Bratislava, 821 06, Slovenská republika	S-301
QUALIFORM, a.s. - pracoviště Brno	Mlaty 672/8, Brno, 642 00, Czech Republik	1008
QUALIFORM, a.s. - pracoviště Olomouc	Mlaty 672/8, Bosonohy, Brno, 642 00, Jihomoravský	1008

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Laboratory	Address	Accreditation number
QUALIFORM, a.s. - pracoviště Praha	Mlaty 672/8, Bosonohy, Brno, 642 00, Jihomoravský	1008
Radis d.o.o PJ Radis Institut	Jovana Ducica 16, Istocno Sarajevo, 71123, Bosna i Hercegovina	-
SIBOTEC	Industriepark Oost 6, Beernem, 8730, West - Vlaanderen	-
SQZ, s.r.o. - organizačná zložka Bratislava	Mlynské Nivy 68, Bratislava, 82105, Slovensko	S-376
SRL CIPC INCERC TEST	Bd. Dacia 38, ap. 336, Chisinau, MD 2060, Republic of Moldova	LÎ 125
STACHEMA Bratislava a.s.	Železničná, 714/180, Rovinka, 90041, Slovenská republika	S-275
Skanska a.s.	Křižíkova 682/34a, Praha 8- Karlín, 186 00, Česká republika	1355
Slovenian national building and civil engineering institute	Dimičeva ulica 12, Ljubljana, 1000, Slovenia	-
Structural Soils Ltd	Structural Soils Ltd, The Potteries, Pottery Street, Castleford, WF10 1NJ, West Yorkshire, UK	-
TEPVERAM, s.r.o.	Třibřichy 13, Třibřichy, 53701, Česká republika	1759
TESScontrol, s. r. o., organizačná zloška, TESScontrol - Zkušební laboratoř Znojmo	efakturycz@tesscontrol.sk, Praha 8, 182 00, ČR	L-1793
TESScontrol, s.r.o., Oblastné laboratórium Bratislava, Laboratórium Bratislava,	Hronská 3211/1, Zvolen, 960 93, Slovenská republika	S-375
TIQU-Tiroler Qualitätszentrum für Umwelt, Bau und Rohstoffe GmbH	Gewerbestrasse 4, Ötztal Bahnhof, 6430, Austria	-
TPA Spoločnosť pre zabezpečenie kvality a inovácie s.r.o. - pracovisko Geča	Neresnická cesta 3, Zvolen, 96001, Slovenská republika	211/S-176
TPA Spoločnosť pre zabezpečenie kvality a inovácie s.r.o. - pracovisko K2	Neresnická cesta 3, Zvolen, 96001, Slovenská republika	211/S-176
TPA Spoločnosť pre zabezpečenie kvality a inovácie s.r.o. - pracovisko Podunajské Biskupice	Neresnická cesta 3, Zvolen, 96001, Slovenská republika	211/S-176
TPA Spoločnosť pre zabezpečenie kvality a inovácie s.r.o. - pracovisko Zvolen	Neresnická cesta 3, Zvolen, 96001, Slovenská republika	211/S-176
TPA za obezbeđenje kvaliteta i inovacije d.o.o. Beograd	MIilutina Milankovica 3B, Beograd, 11070, Srbija	01-280
TRA EOOD CTC BURGAS	Rezbarska str. № 7, SOFIA, 1000, BULGARIA	-
TRA EOOD CTC KREPOST, 6410 village of Krepost, territory “Dolna cheshma”, municipality of Dimitrovgrad	Rezbarska str. № 7, SOFIA, 1000, BULGARIA	-

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Laboratory	Address	Accreditation number
Technický a zkušební ústav stavební Praha, s.p.	Nemanická 441/8, České Budějovice, 37010, Česká republika	1018.3
Technický a zkušební ústav stavební Praha, s.p., Pobočka Teplice	Tolstého 447, Teplice, 41503, Česká republika	1018.3
Technický a zkušební ústav stavební, s.p., pobočka Praha	Prosecká 76a, Praha 9, 190 00, Česká republika	1018.3
TesTec	Max Hermanlei 35, Brasschaat, 2930, Antwerpen	-
Tino Braeckman	Oeverstraat 21, Lokeren, 9160, Belgium	-
VIALAB CZ s.r.o. - laboratoř oblast LOMY, pracoviště LL1/Těškov	MUCODE 1593, PO Box 207, Praha 6, 16041, Česká republika	1771
VIALAB CZ s.r.o. - laboratoř oblast LOMY, pracoviště LL3/Jakubčovice	MUCODE 1593, PO Box 207, Praha 6, 16041, Česká republika	1771
Výzkumný ústav pro hnědé uhlí a.s.	tř. Budovatelů 2830/3, Most, 43401, Česká republika	1078
Zavod za gradbeništvo Slovenije/ Slovenian National Building and Civil Engineering Institute	Dimičeva ulica 12, Ljubljana, 1000, Slovenija	LP-005
Zkušebna kamene a kameniva, s.r.o.	Husova 2274, Hořice, 508 01, Česká republika	1046
i2 Analytical Ltd. Sp. z o.o. Oddział w Polsce	Pionierów 39, Ruda Śląska, 41-711, Polska	-
iTER solutions	Rue du Tronquoy, 24, Fernelmont - Belgique, 5380, Hainaut	BELAC 422-TEST
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. - Központi Vizsgáló Laboratórium	Dózsa György út 26, Szentendre, 2000, Hungary	NAH-1-1110/2023/K
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. - Közép-magyarországi Anyagvizsgáló Kirendeltség	Dózsa György út 26, Szentendre, 2000, Hungary	-
Ústav stavebního zkušebnictví s.r.o.	Jiřího Potůčka 115, Trnová, Pardubice, 53009, Česká republika	1115
Ředitelství silnic a dálnic s. p.	Na Pankráci 546/56, Praha 4, 145 00, Česká republika	1072
Ředitelství silnic a dálnic s. p., Samostatné oddělení zkušebnictví Praha, Laboratoř Praha	Na Pankráci 546/56, Praha, 140 00, Česká republika	1734

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 ZK 2024/1 (PT Program) organized by the PT Provider at the SZK FAST. 82 participants (laboratories) took part in the PT Program. The PT program focused on ordinary standardized testing of aggregates. 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. In some cases, overcoming the critical values of the Cochran test due to incorrect rounding of test results by laboratories was not taken into account.

3.1 EN 933-1 Determination of Particle Size Distribution - Sieving Method

The test results were evaluated as multilevel experiment according to the sieve size: 4 mm, 2 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm and 0.063 mm. The outliers elimination and evaluation of statistical characteristics were carried out in every level of experiment. The test results are shown together with graphic presentation and evaluated statistical characteristics in part 1 of the Appendix. The test results were rated as outlying, questionable or unsatisfactory only if the limit values were exceeded in four levels at least.

The assigned value and its uncertainty was determined using the A algorithm (ISO 13528 [20]). Table 3 shows the performance evaluation and outliers.

Table 3: Evaluation of performance and outliers – testing method EN 933-1 [1].
✓ – satisfactory performance; ? – questionable performance; ! – unsatisfactory performance, X – outlier

ID	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
6a65da	✓	✓	✓	✓	✓	✓	✓
7f9471	✓	✓	✓	✓	✓	✓	✓
692075	✓	✓	✓	✓	?	✓	✓
978abc	✓	✓	✓	✓	✓	✓	✓
1cf882	✓	✓	✓	✓	✓	✓	✓
ae026d	✓	✓	✓	✓	✓	✓	✓
91d1d4	✓	✓	✓	✓	✓	✓	✓
9facaf	✓	✓	✓	✓	✓	✓	✓
e1ed78	?	✓	✓	✓	✓	✓	✓
44e8e8	✓	✓	✓	✓	✓	✓	✓
2968bc	✓	✓	✓	✓	✓	✓	✓
c429d1	✓	✓	✓	✓	✓	✓	✓
8541f2	✓	✓	✓	✓	✓	✓	✓
f26927	✓	?	✓	✓	✓	✓	✓
22edc2	✓	✓	✓	✓	✓	✓	✓
801460	X	✓	✓	✓	✓	✓	✓
b4912c	✓	✓	✓	✓	✓	✓	✓
13fdf1	✓	✓	?	?	✓	✓	✓
d0d741	✓	✓	✓	✓	✓	✓	✓
fc3f32	✓	✓	✓	✓	✓	✓	✓

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ID	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
f7e2f2	X	✓	✓	?	?	✓	✓
65eb6d	✓	✓	✓	✓	✓	✓	✓
d3cb2f	✓	✓	✓	✓	✓	✓	✓
144321	✓	?	✓	✓	✓	✓	✓
9db03c	✓	✓	✓	✓	✓	✓	✓
25e37d	✓	✓	✓	✓	✓	✓	✓
6ec30c	✓	✓	✓	✓	✓	✓	✓
56e681	✓	✓	✓	✓	✓	✓	✓
31f9a0	✓	✓	✓	✓	✓	✓	✓
a493e8	✓	✓	✓	✓	✓	✓	✓
5dfeee	✓	✓	✓	✓	✓	✓	✓
66c90a	✓	!	✓	✓	✓	✓	✓
320f41	✓	✓	✓	✓	✓	✓	✓
7f555e	?	X	X	✓	✓	✓	✓
4471dc	?	X	X	X	X	X	✓
feef67	?	✓	✓	✓	✓	✓	✓
0c2972	✓	✓	?	✓	✓	✓	✓
d69d0e	✓	✓	✓	✓	✓	✓	✓
442491	✓	✓	✓	✓	✓	✓	✓
5b59a2	✓	✓	✓	✓	✓	✓	✓
3524eb	?	X	?	X	X	?	✓
74d791	✓	✓	✓	✓	✓	✓	✓
e8f59c	✓	✓	✓	✓	✓	✓	✓
1420b6	✓	✓	✓	✓	✓	✓	✓
63d8e1	✓	✓	✓	?	?	✓	✓
2dc09c	✓	✓	✓	✓	✓	✓	✓

3.2 Overall Performance Evaluation

Testing methods can be found in part 1 of this report.

Table 4: Evaluation of overall performance and outliers.
✓ – satisfactory performance; ? – questionable performance; ! – unsatisfactory performance, X – outlier

ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2831cc	-	-	-	-	-	-	-	✓	-	✓	-	-	-	-	-	-	-	-
a2426d	-	-	-	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
6a65da	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
7f9471	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
363174	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
692075	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
f9906c	-	✓	✓	-	✓	-	✓	?	-	-	✓	✓	-	-	✓	-	-	-
978abc	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1cf882	✓	-	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-
ae026d	✓	✓	✓	✓	-	✓	-	✓	-	-	✓	✓	-	-	-	-	-	-
91d1d4	✓	-	✓	-	✓	-	-	-	-	-	✓	✓	-	-	-	-	-	-
9facaf	✓	?	-	-	✓	-	✓	✓	-	-	-	✓	-	-	-	-	-	-
cce71a	-	-	✓	✓	✓	-	-	✓	-	-	-	-	-	-	✓	-	-	-
1cf584	-	-	✓	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
943aff	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
e1ed78	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44e8e8	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
2968bc	✓	-	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
1300a8	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
82a501	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
02a56a	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-
c2ab58	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
c429d1	✓	-	✓	-	-	-	-	✓	-	-	-	✓	-	-	-	-	-	-
8541f2	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
f26927	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
22edc2	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
801460	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
1ae021	-	-	-	-	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-
ba0755	-	-	-	-	-	-	-	✓	-	-	-	-	-	✓	-	-	-	-
b4912c	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	-	✓	-	-	-	-
f56670	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b5b225	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13fdf1	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d6b7ab	-	✓	✓	-	✓	-	✓	✓	-	✓	-	-	-	✓	✓	-	-	-
d0d741	✓	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
fc3f32	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
f7e2f2	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65eb6d	✓	-	✓	✓	-	-	-	-	-	-	?	?	-	✓	-	-	-	-
178148	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d3cb2f	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
615698	-	-	-	-	-	-	-	-	✓	-	✓	-	-	-	-	-	-	-
5648cb	-	-	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
d34bb3	-	✓	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
d2edc0	-	-	-	✓	-	-	-	✓	-	-	-	-	-	-	✓	-	-	-
25dbc8	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-
bf5ab5	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
144321	✓	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
9db03c	✓	-	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-	-	-
bf844c	-	✓	-	-	-	-	-	-	✓	-	✓	-	-	-	✓	-	-	-
c07cfc	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
99772d	-	-	-	-	✓	✓	-	✓	-	-	✓	-	-	✓	-	-	-	-
25e37d	✓	-	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	-	-	-
6ec30c	✓	-	✓	-	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-
56e681	✓	-	-	-	-	-	✓	✓	-	-	✓	?	-	-	-	-	-	-
31f9a0	✓	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
a493e8	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
5dfeee	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
597047	-	✓	✓	-	!	-	✓	✓	-	-	-	✓	-	✓	-	-	-	-
66c90a	✓	-	✓	-	-	-	-	-	-	✓	✓	✓	-	-	-	-	-	-
320f41	✓	-	✓	-	-	-	-	-	-	✓	✓	✓	-	-	-	-	-	-
fb2fb1	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
7f555e	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4471dc	X	-	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
feef67	✓	-	✓	-	✓	-	✓	✓	-	✓	✓	✓	-	✓	✓	-	-	-
566efb	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
b0263e	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-
34c434	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
f7250c	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0c2972	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
414fc6	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d69d0e	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
442491	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
5b59a2	✓	✓	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-
ed0789	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
c01d65	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
3524eb	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74d791	✓	-	-	-	-	-	✓	✓	-	✓	?	✓	-	-	✓	-	-	-

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ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
e8f59c	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1420b6	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
63d8e1	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	✓	-	-	✓	-	-	-
2dc09c	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
c54811	-	✓	!	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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1 Appendix – EN 933-1 Determination of particle size distribution - Sieving method

1.1 4 mm

1.1.1 Test results

Table 5: 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 [%]
3524eb	98.0	98.0	97.9	1.0	97.9	0.02	0.02
feef67	98.0	98.0	98.0	1.0	98.0	0.0	0.0
65eb6d	99.0	98.0	98.0	-	98.3	0.58	0.59
63d8e1	99.0	98.0	98.0	1.0	98.3	0.58	0.59
f7e2f2	98.6	98.7	98.2	0.7	98.5	0.26	0.27
b4912c	98.6	98.4	98.6	0.8	98.5	0.12	0.12
442491	98.9	98.6	98.4	2.0	98.6	0.24	0.24
d3cb2f	99.0	99.0	98.0	-	98.7	0.58	0.59
e8f59c	99.0	98.0	99.0	-	98.7	0.58	0.59
13fdf1	98.7	98.7	98.8	4.0	98.7	0.06	0.06
66c90a	98.4	98.9	98.9	-	98.7	0.29	0.29
1420b6	99.0	98.7	98.9	3.0	98.9	0.15	0.15
978abc	98.8	98.9	98.9	1.7	98.9	0.06	0.06
f26927	99.0	98.9	98.8	2.0	98.9	0.1	0.1
1cf882	98.9	98.9	98.9	0.6	98.9	0.0	0.0
7f9471	99.0	99.2	98.6	3.5	98.9	0.31	0.31
320f41	99.1	98.9	98.8	-	98.9	0.15	0.15
a493e8	99.0	99.0	99.0	0.4	99.0	0.0	0.0
56e681	99.0	99.0	99.0	0.0	99.0	0.0	0.0
6ec30c	99.0	99.0	99.0	0.4	99.0	0.0	0.0
0c2972	99.0	99.0	99.0	0.2	99.0	0.0	0.0
74d791	99.0	99.0	99.0	-	99.0	0.0	0.0
31f9a0	99.0	99.0	99.0	0.4	99.0	0.0	0.0
25e37d	99.0	99.0	99.0	0.4	99.0	0.0	0.0
2dc09c	99.0	99.0	99.0	-	99.0	0.0	0.0
144321	99.0	99.0	99.0	3.0	99.0	0.0	0.0
ae026d	99.0	99.0	99.0	0.8	99.0	0.0	0.0
91d1d4	99.0	99.0	99.0	-	99.0	0.0	0.0
9facaf	99.0	99.0	99.0	1.0	99.0	0.0	0.0
44e8e8	99.0	99.0	99.0	-	99.0	0.0	0.0
9db03c	99.0	99.0	99.0	2.5	99.0	0.0	0.0
2968bc	99.0	99.0	99.0	1.4	99.0	0.0	0.0
22edc2	99.0	99.0	99.0	2.4	99.0	0.0	0.0
801460	99.0	99.0	99.0	0.2	99.0	0.0	0.0

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ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d0d741	99.0	99.0	99.0	6.8	99.0	0.0	0.0
fc3f32	99.0	99.0	99.0	-	99.0	0.0	0.0
8541f2	99.0	99.0	99.0	5.1	99.0	0.0	0.0
c429d1	99.0	99.0	99.1	12.2	99.0	0.06	0.06
6a65da	99.2	99.0	99.1	1.0	99.1	0.1	0.1
5b59a2	99.0	99.4	99.0	-	99.1	0.23	0.23
d69d0e	99.3	99.2	99.2	0.6	99.2	0.06	0.06
5dfeee	100.0	99.0	99.0	0.1	99.3	0.58	0.58
692075	99.1	99.4	99.6	0.1	99.4	0.25	0.25
7f555e	100.0	100.0	100.0	1.4	100.0	0.0	0.0
4471dc	100.0	100.0	100.0	-	100.0	0.0	0.0
e1ed78	100.0	100.0	100.0	-	100.0	0.0	0.0

1.1.2 The Numerical Procedure for Determining Outliers

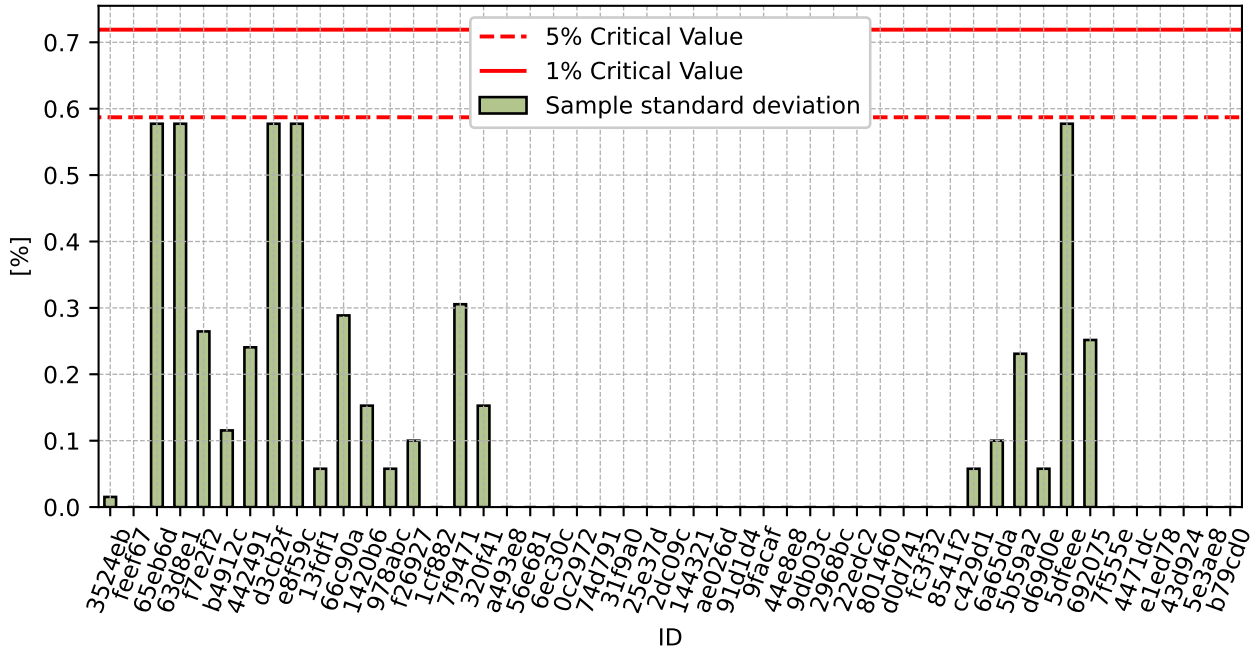

Figure 1: **Cochran's test** - sample standard deviations

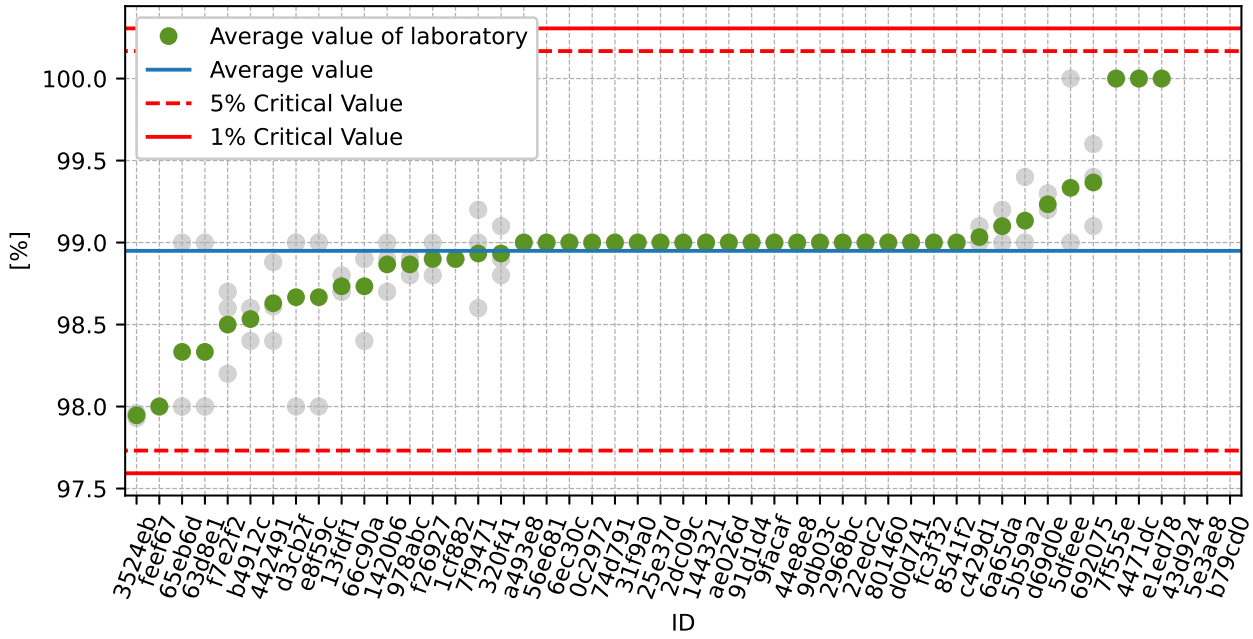

Figure 2: **Grubbs' test** - average values

1.1.3 Mandel's Statistics

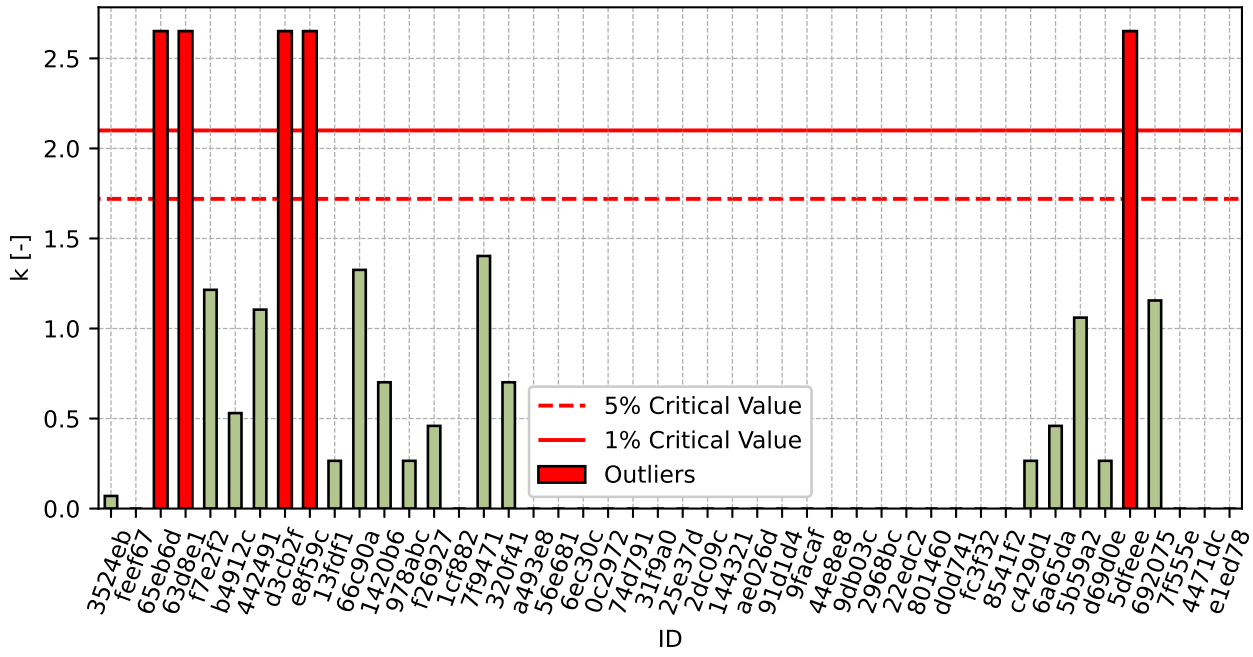

Figure 3: Intralaboratory Consistency Statistic

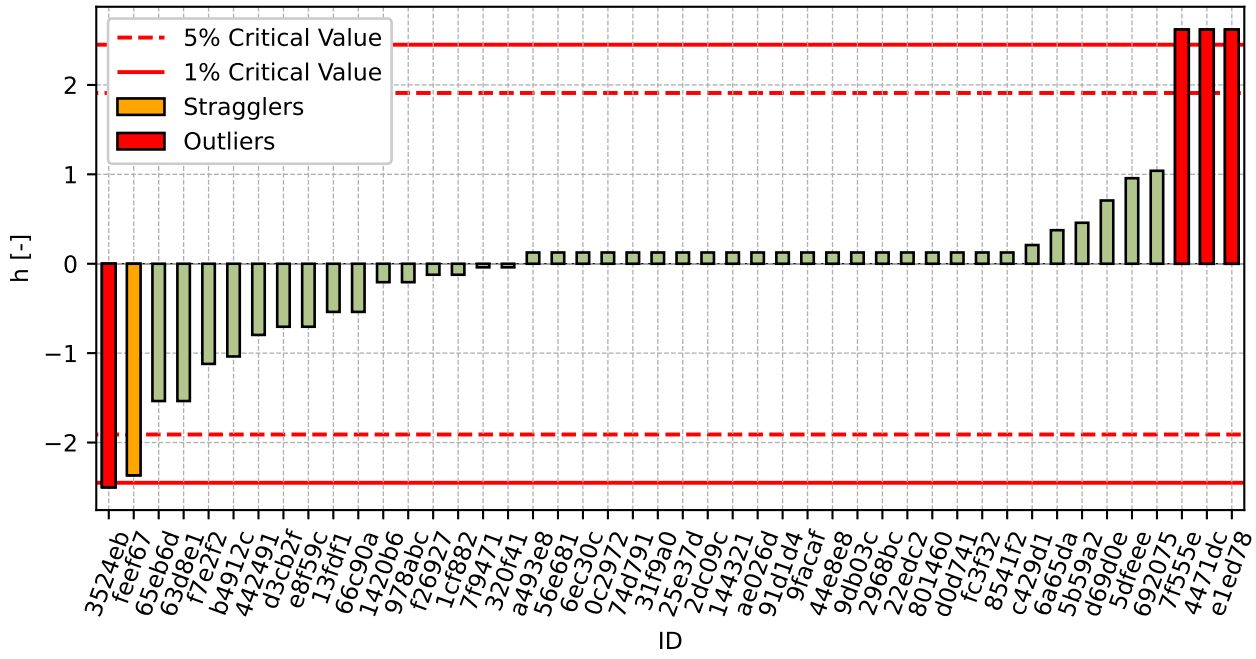

Figure 4: Interlaboratory Consistency Statistic

1.1.4 Descriptive statistics

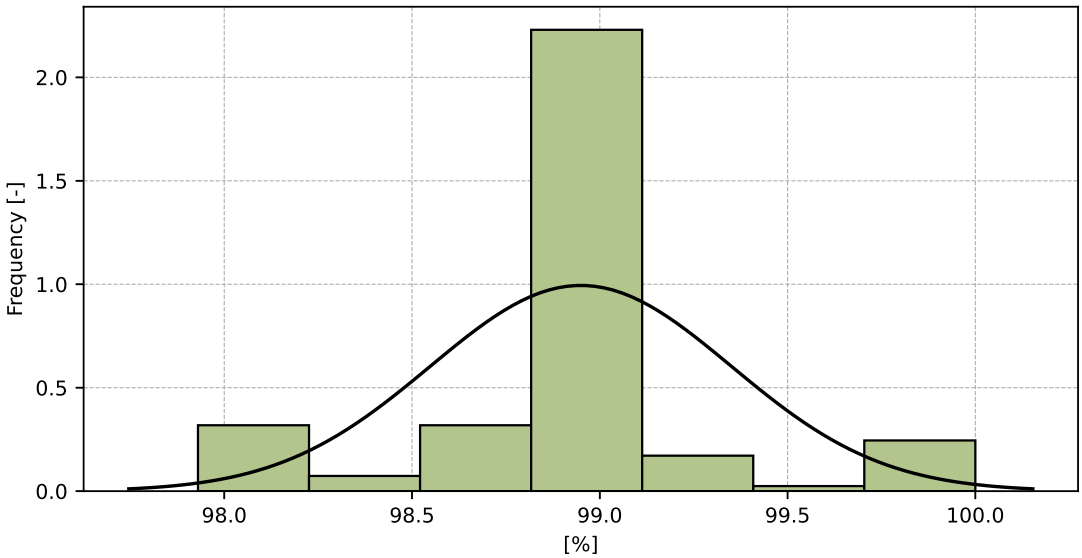

Figure 5: Histogram of all test results

Table 6: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	98.9
Sample standard deviation – s	0.4
Asigned value – x^*	98.9
Robust standard deviation – s^*	0.4
Measurement uncertainty of asigned value – u_X	0.06
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.38
Repeatability standard deviation – s_r	0.22
Reproducibility standard deviation – s_R	0.44
Repeatability – r	0.6
Reproducibility – R	1.2

1.1.5 Evaluation of Performance Statistics

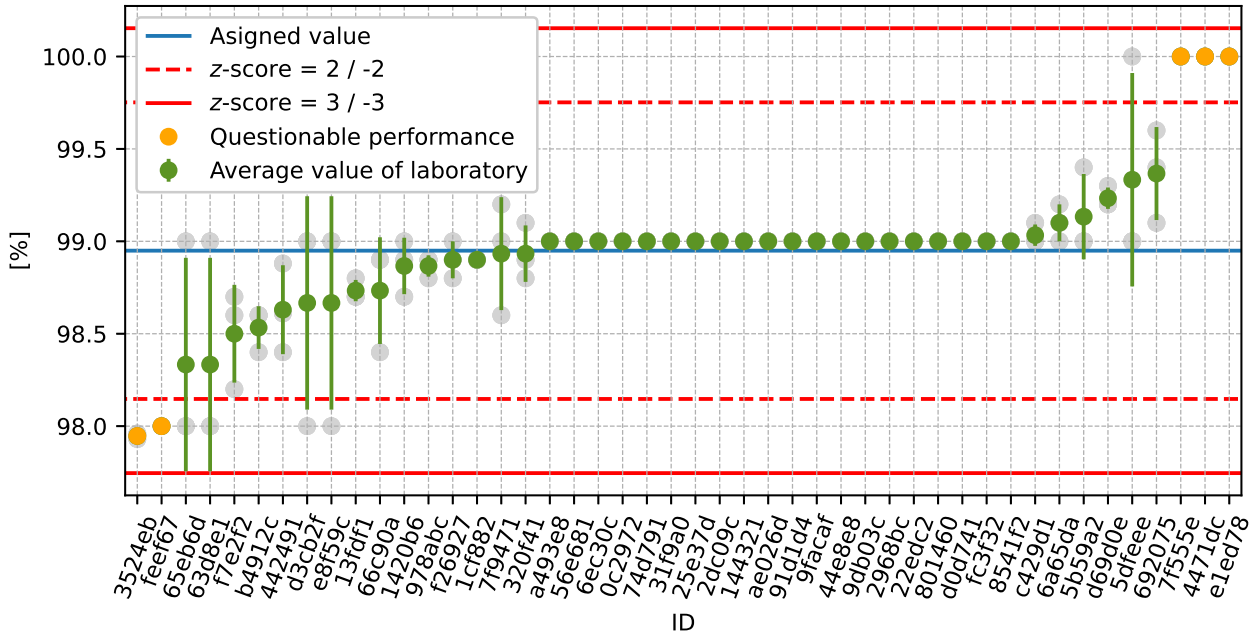

Figure 6: Average values and sample standard deviations

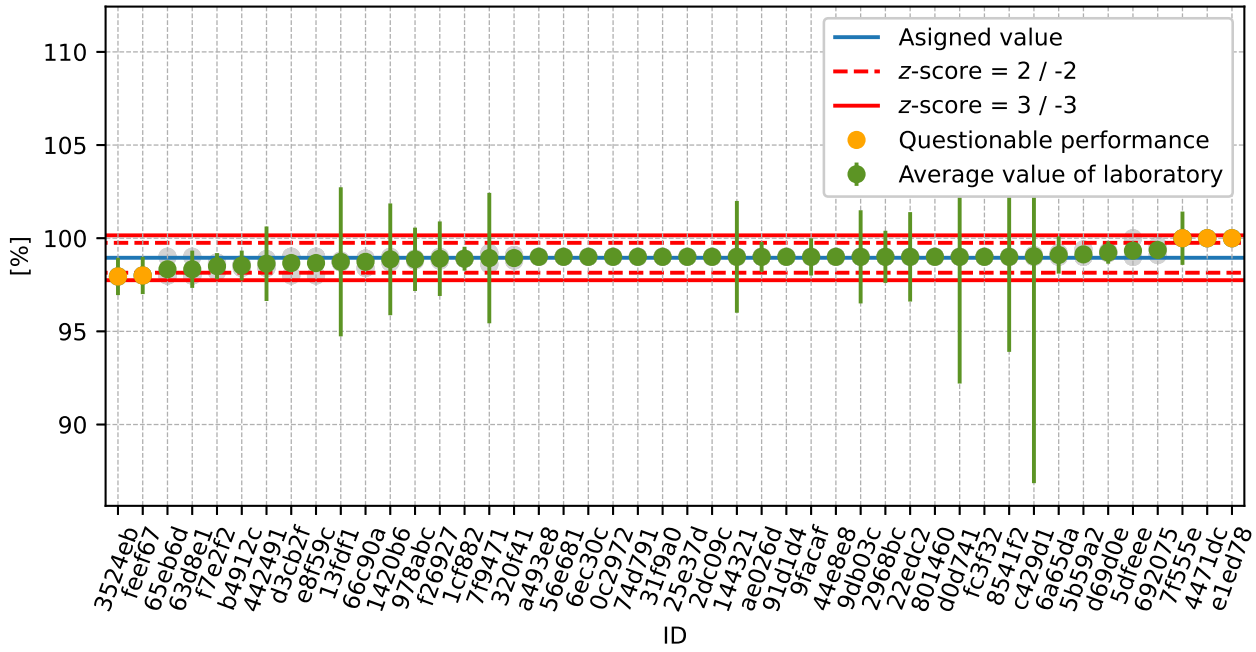

Figure 7: Average values and extended uncertainties of measurement

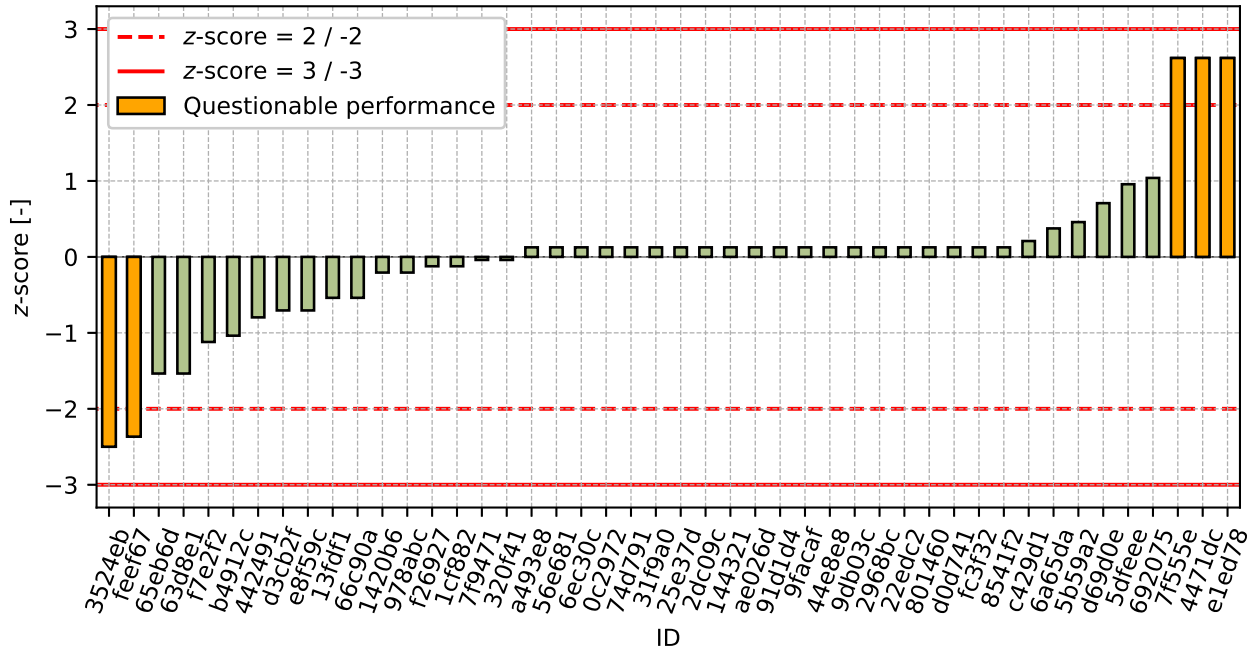

Figure 8: z-score

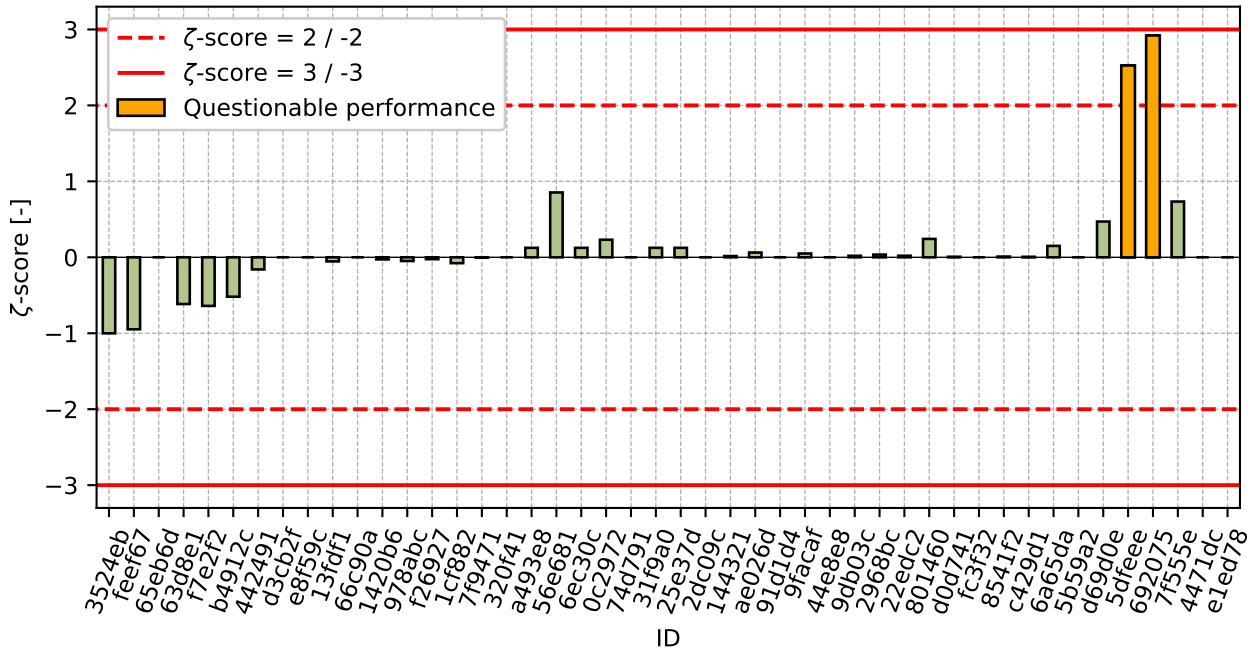

Figure 9: ζ-score

Table 7: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
3524eb	-2.5	-1.0
feef67	-2.37	-0.95
65eb6d	-1.54	-
63d8e1	-1.54	-0.62
f7e2f2	-1.12	-0.64
b4912c	-1.04	-0.52
442491	-0.8	-0.16
d3cb2f	-0.7	-
e8f59c	-0.7	-
13fdf1	-0.54	-0.05
66c90a	-0.54	-
1420b6	-0.21	-0.03
978abc	-0.21	-0.05
f26927	-0.12	-0.02
1cf882	-0.12	-0.08
7f9471	-0.04	-0.0
320f41	-0.04	-
a493e8	0.13	0.12
56e681	0.13	0.85
6ec30c	0.13	0.12
0c2972	0.13	0.23
74d791	0.13	-
31f9a0	0.13	0.12

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ID	z-score [-]	ζ-score [-]
25e37d	0.13	0.12
2dc09c	0.13	-
144321	0.13	0.02
ae026d	0.13	0.06
91d1d4	0.13	-
9facaf	0.13	0.05
44e8e8	0.13	-
9db03c	0.13	0.02
2968bc	0.13	0.04
22edc2	0.13	0.02
801460	0.13	0.24
d0d741	0.13	0.01
fc3f32	0.13	-
8541f2	0.13	0.01
c429d1	0.21	0.01
6a65da	0.38	0.15
5b59a2	0.46	-
d69d0e	0.71	0.47
5dfeee	0.96	2.53
692075	1.04	2.92
7f555e	2.62	0.73
4471dc	2.62	-
e1ed78	2.62	-

1.2 2 mm

1.2.1 Test results

Table 8: 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 [%]
3524eb	80.4	80.4	80.3	1	80.3	0.03	0.04
66c90a	81.8	82.2	82.5	-	82.2	0.35	0.43
320f41	84.1	83.6	83.5	-	83.7	0.32	0.38
feef67	84.0	84.0	84.0	1	84.0	0.0	0.0
44e8e8	85.0	83.0	85.0	-	84.3	1.15	1.37
b4912c	84.1	84.5	85.0	3.0	84.5	0.45	0.53
63d8e1	85.0	85.0	84.0	1	84.7	0.58	0.68
442491	84.9	83.5	85.7	2	84.7	1.11	1.31
f7e2f2	84.9	84.8	85.1	0.41	84.9	0.15	0.18
fc3f32	85.0	85.0	85.0	-	85.0	0.0	0.0
d0d741	85.0	86.0	84.0	5.7	85.0	1.0	1.18
801460	85.0	85.0	85.0	0.26	85.0	0.0	0.0
9facaf	86.0	85.0	84.0	1	85.0	1.0	1.18
ae026d	85.0	85.0	85.0	0.8	85.0	0.0	0.0
e1ed78	85.3	85.3	85.3	-	85.3	0.0	0.0
65eb6d	87.0	84.0	85.0	-	85.3	1.53	1.79
31f9a0	85.0	85.0	86.0	0.4	85.3	0.58	0.68
6ec30c	85.0	85.0	86.0	0.4	85.3	0.58	0.68
e8f59c	86.0	84.0	86.0	-	85.3	1.15	1.35
0c2972	87.0	82.0	87.0	0.19	85.3	2.89	3.38
d3cb2f	87.0	85.0	84.0	-	85.3	1.53	1.79
91d1d4	83.0	86.0	87.0	-	85.3	2.08	2.44
a493e8	86.0	86.0	84.0	0.4	85.3	1.15	1.35
2968bc	86.0	86.0	84.0	1.2	85.3	1.15	1.35
1cf882	85.4	85.7	85.4	0.84	85.5	0.17	0.2
7f9471	85.9	85.6	85.1	3.5	85.5	0.4	0.47
978abc	85.6	85.6	85.6	0.23	85.6	0.0	0.0
22edc2	85.0	86.0	86.0	1.7	85.7	0.58	0.67
d69d0e	86.1	85.3	85.7	0.6	85.7	0.4	0.47
c429d1	85.5	86.0	86.1	10.48	85.9	0.32	0.37
74d791	86.0	87.0	85.0	-	86.0	1.0	1.16
2dc09c	86.0	87.0	85.0	-	86.0	1.0	1.16
56e681	86.0	86.0	86.0	0	86.0	0.0	0.0
25e37d	86.0	86.0	86.0	0.4	86.0	0.0	0.0
8541f2	86.0	86.0	86.0	4.8	86.0	0.0	0.0
1420b6	85.6	85.9	86.8	2.6	86.1	0.62	0.73

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ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
5b59a2	84.6	88.4	85.9	-	86.3	1.93	2.24
13fdf1	87.6	86.7	85.6	4	86.6	1.0	1.16
5dfeee	87.0	87.0	86.0	0.14	86.7	0.58	0.67
9db03c	86.0	87.0	88.0	2.5	87.0	1.0	1.15
6a65da	87.5	86.8	87.4	1.0	87.2	0.38	0.43
692075	86.1	86.8	89.1	0.13	87.3	1.57	1.8
144321	87.0	88.0	88.0	3	87.7	0.58	0.66
f26927	87.5	88.1	88.4	2	88.0	0.46	0.52
7f555e	93.0	89.0	88.0	2.33	90.0	2.65	2.94
4471dc	99.0	99.2	99.2	-	99.1	0.12	0.12

1.2.2 The Numerical Procedure for Determining Outliers

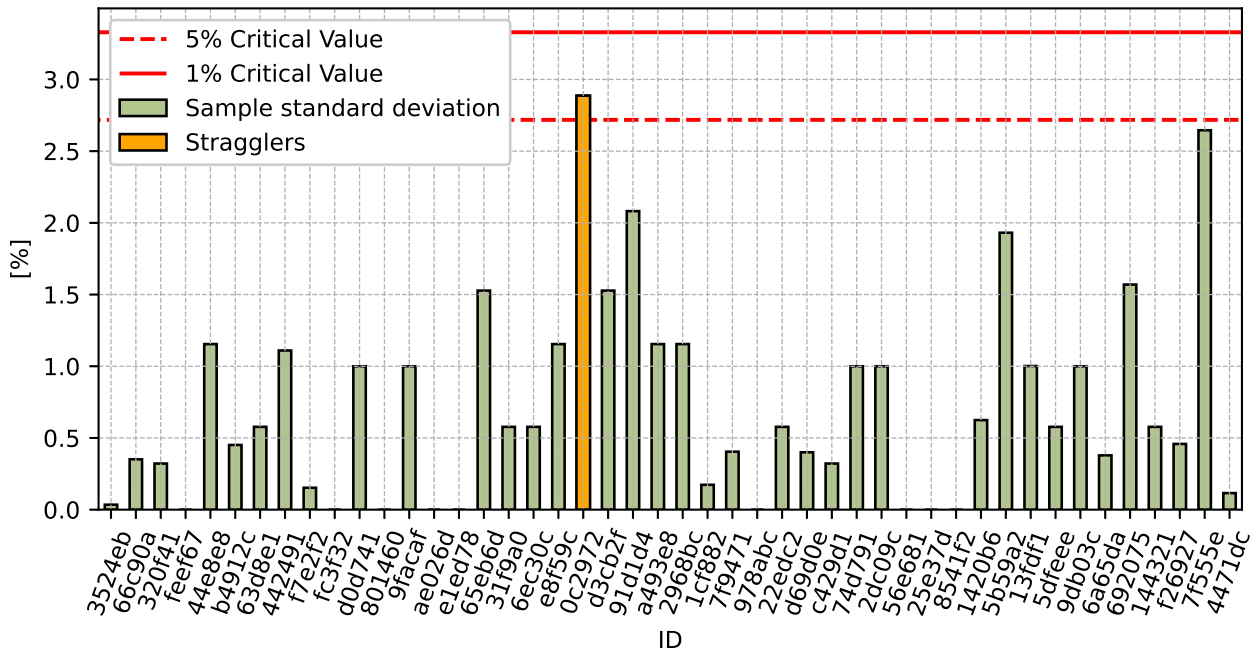

Figure 10: **Cochran's test** - sample standard deviations

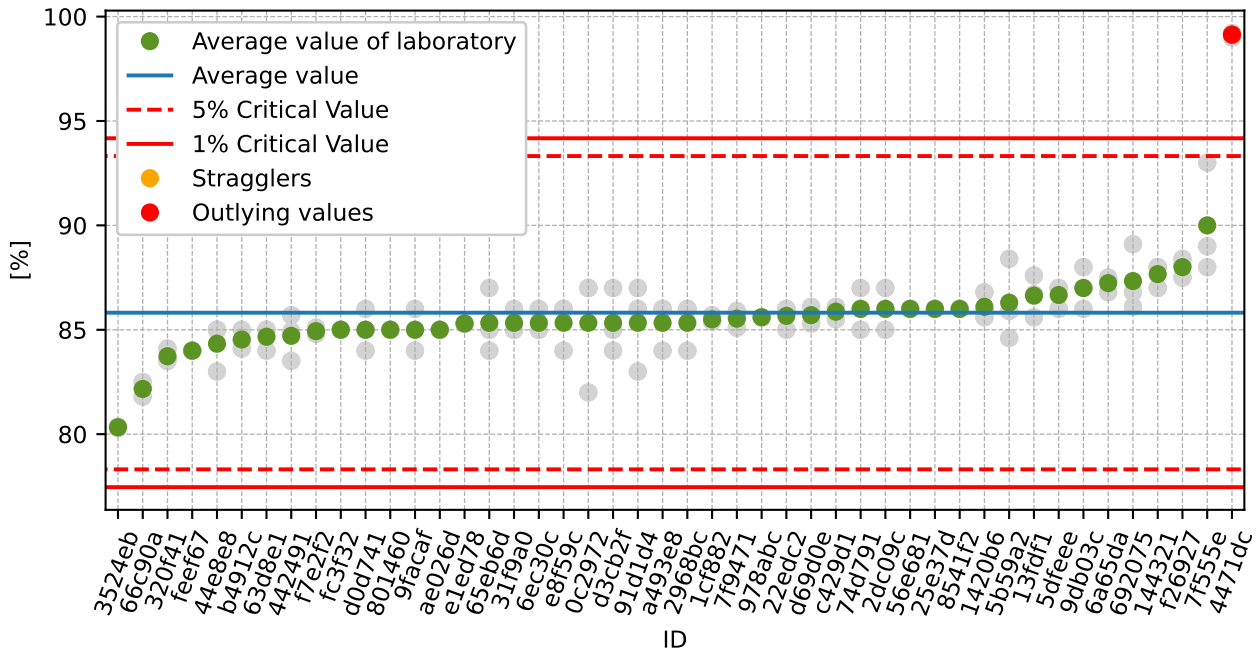

Figure 11: **Grubbs' test** - average values

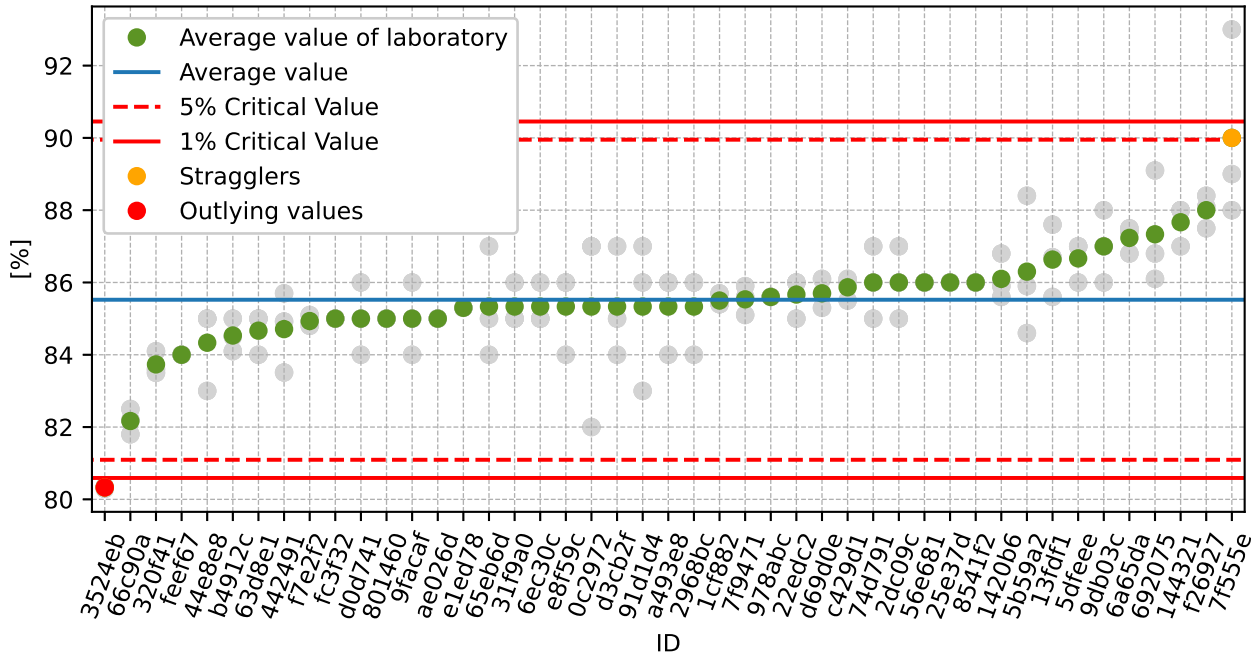

Figure 12: **Grubbs' test** - average values without outliers

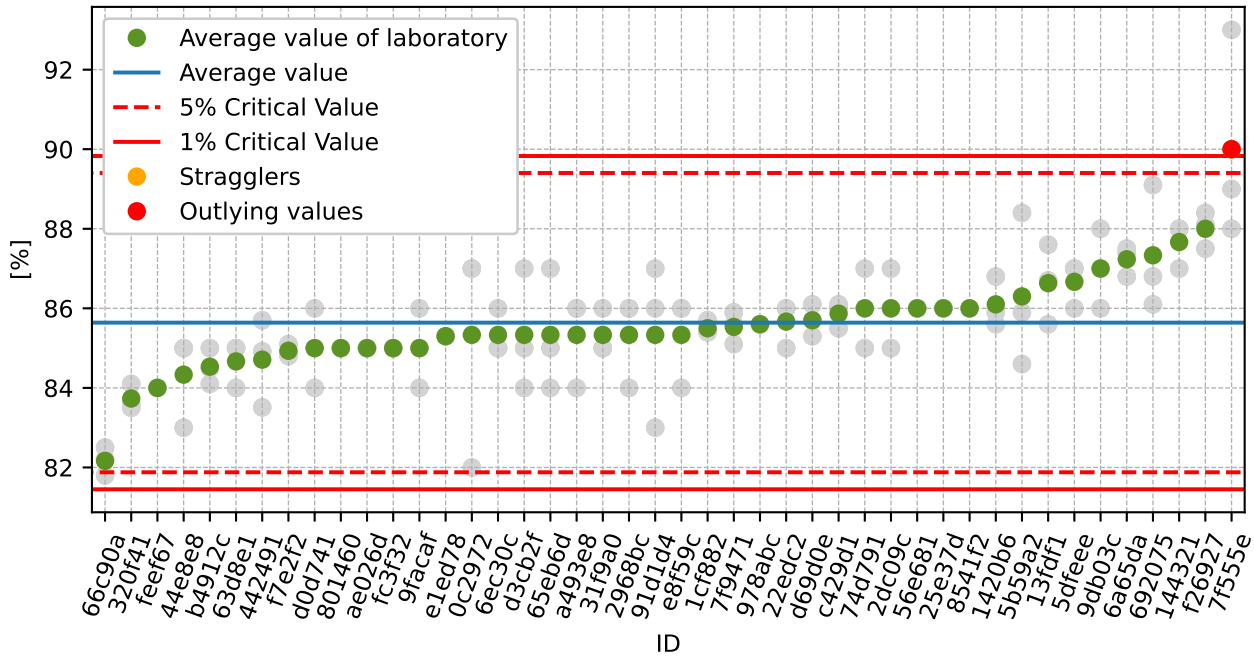

Figure 13: **Grubbs' test** - average values without outliers

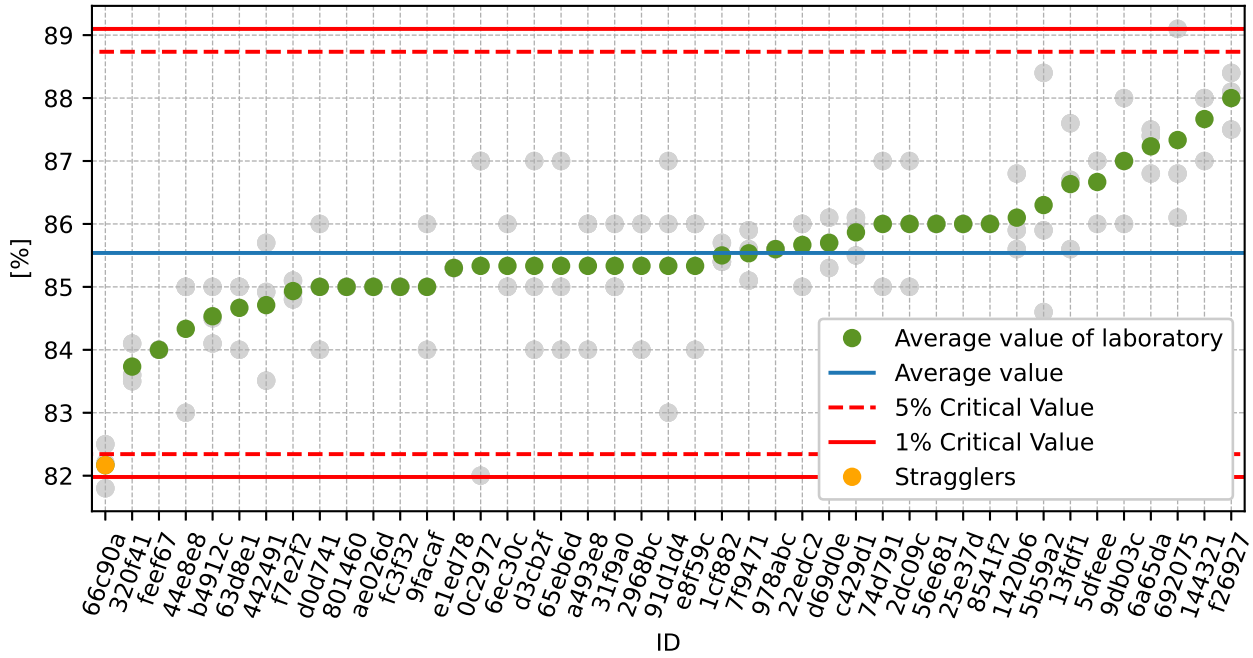

Figure 14: **Grubbs' test** - average values without outliers

1.2.3 Mandel's Statistics

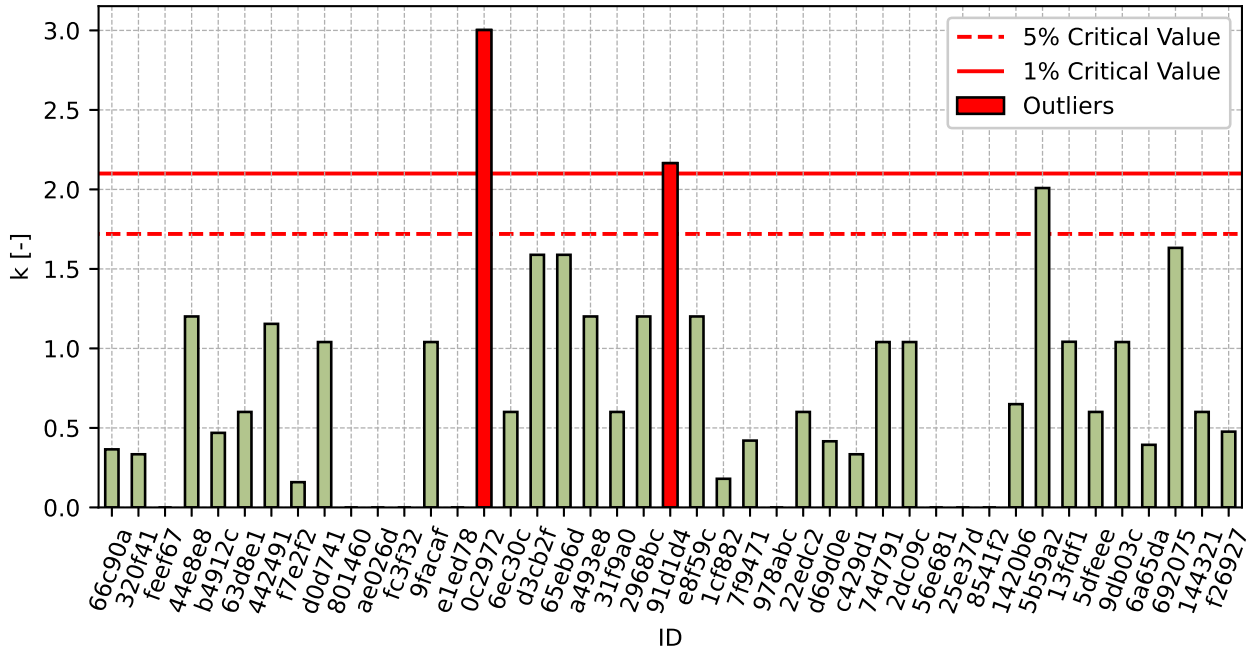

Figure 15: Intralaboratory Consistency Statistic

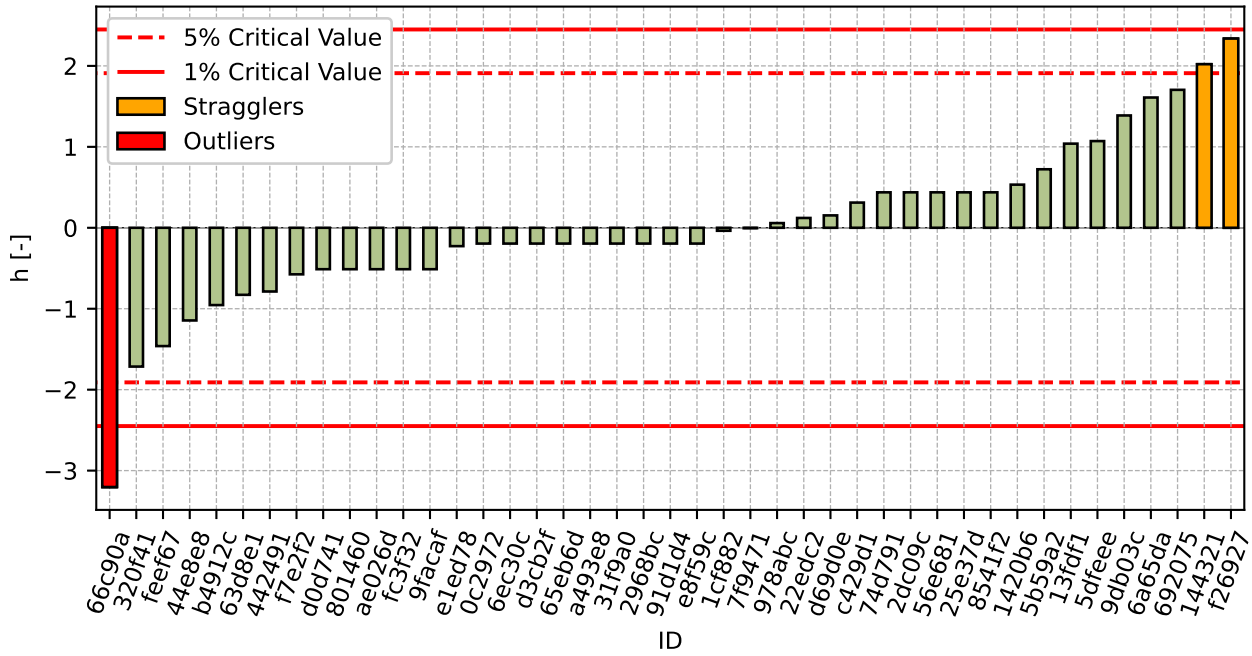

Figure 16: Interlaboratory Consistency Statistic

1.2.4 Descriptive statistics

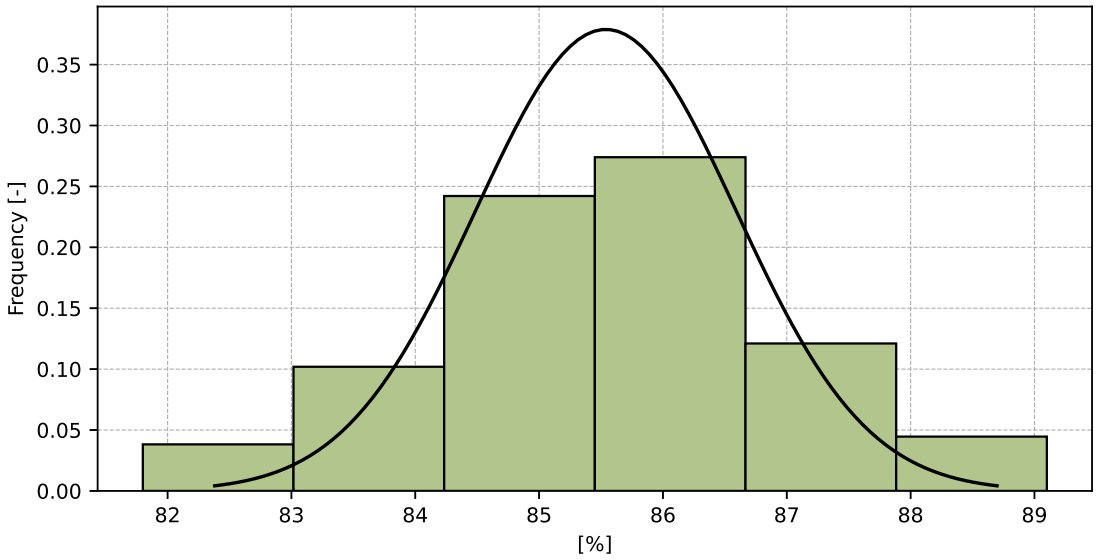

Figure 17: Histogram of all test results

Table 9: Descriptive statistics

Characteristics	**[%]**
Average value – $\bar{x}$	85.5
Sample standard deviation – s	1.05
Asigned value – x^*	85.5
Robust standard deviation – s^*	0.87
Measurement uncertainty of asigned value – u_X	0.17
p-value of normality test	0.004 [-]
Interlaboratory standard deviation – s_L	0.89
Repeatability standard deviation – s_r	0.96
Reproducibility standard deviation – s_R	1.31
Repeatability – r	2.7
Reproducibility – R	3.7

1.2.5 Evaluation of Performance Statistics

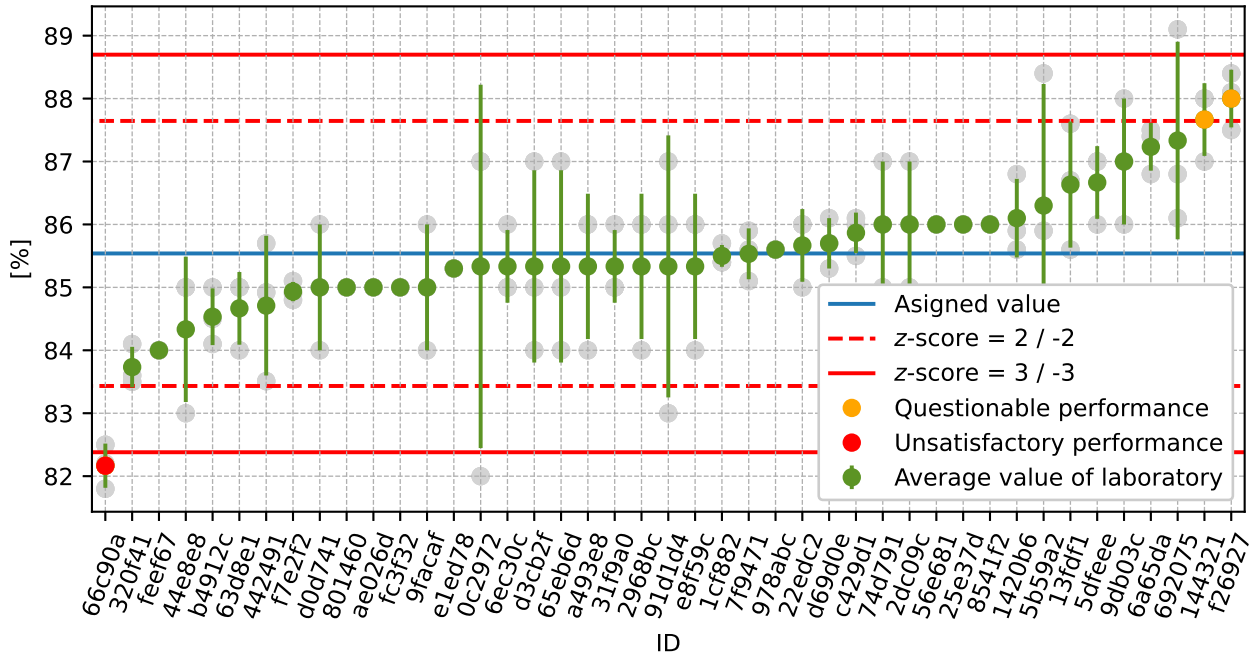

Figure 18: Average values and sample standard deviations

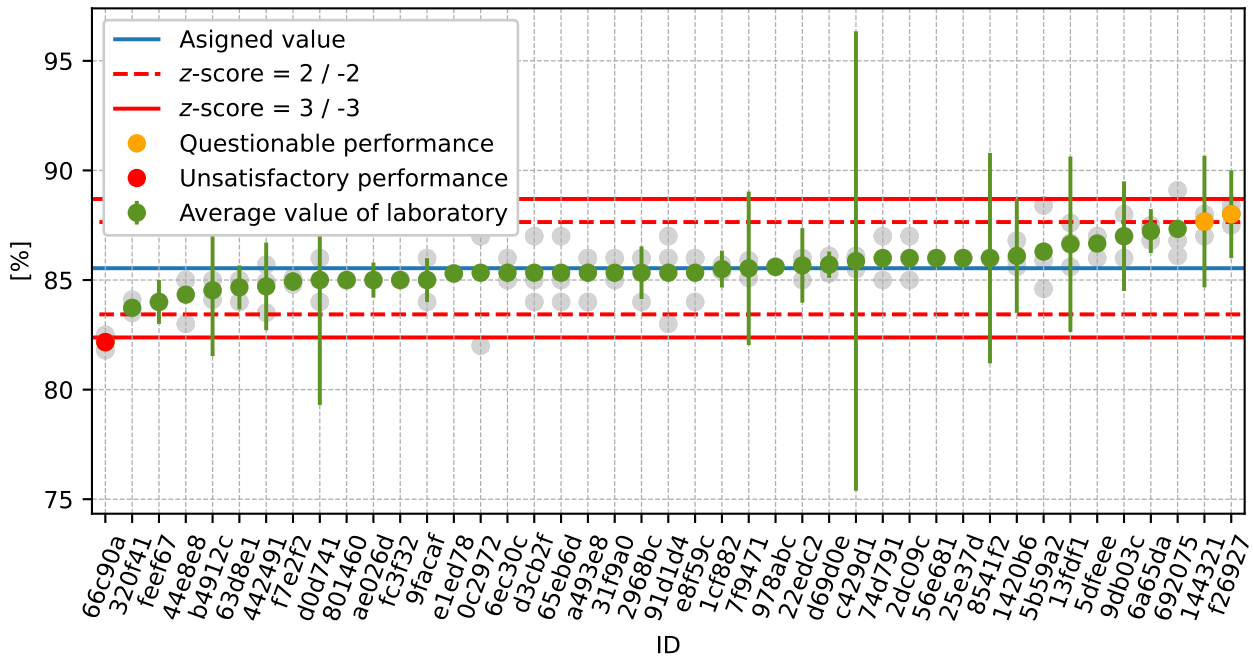

Figure 19: Average values and extended uncertainties of measurement

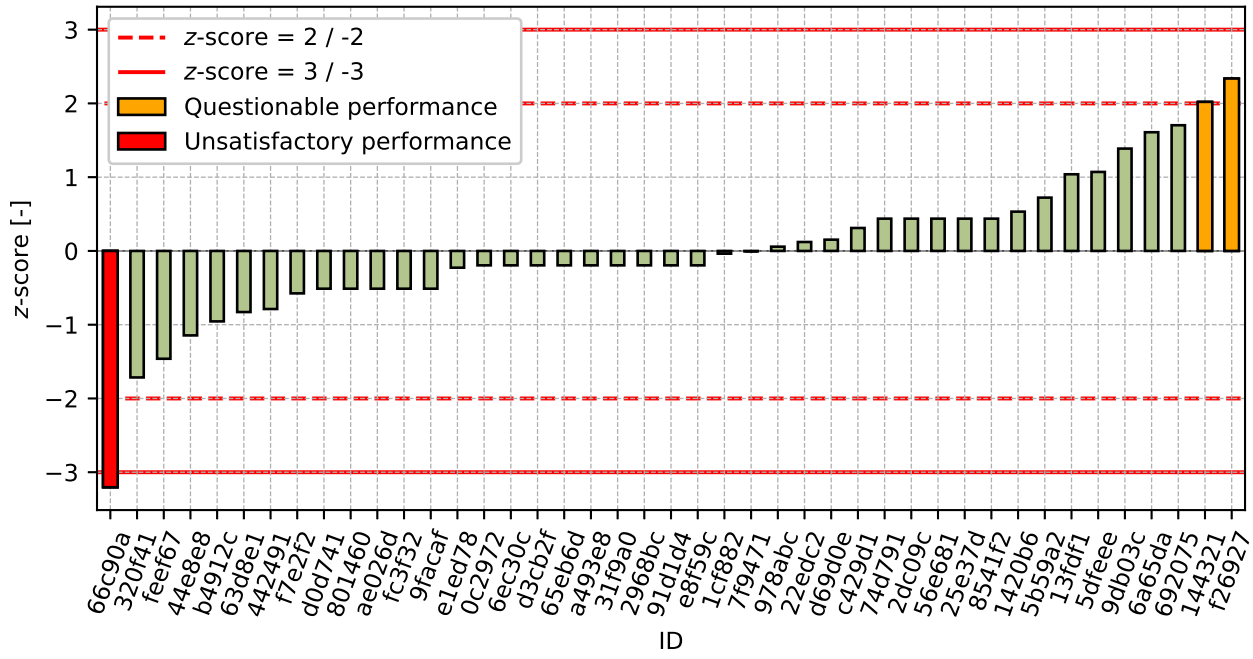

Figure 20: z-score

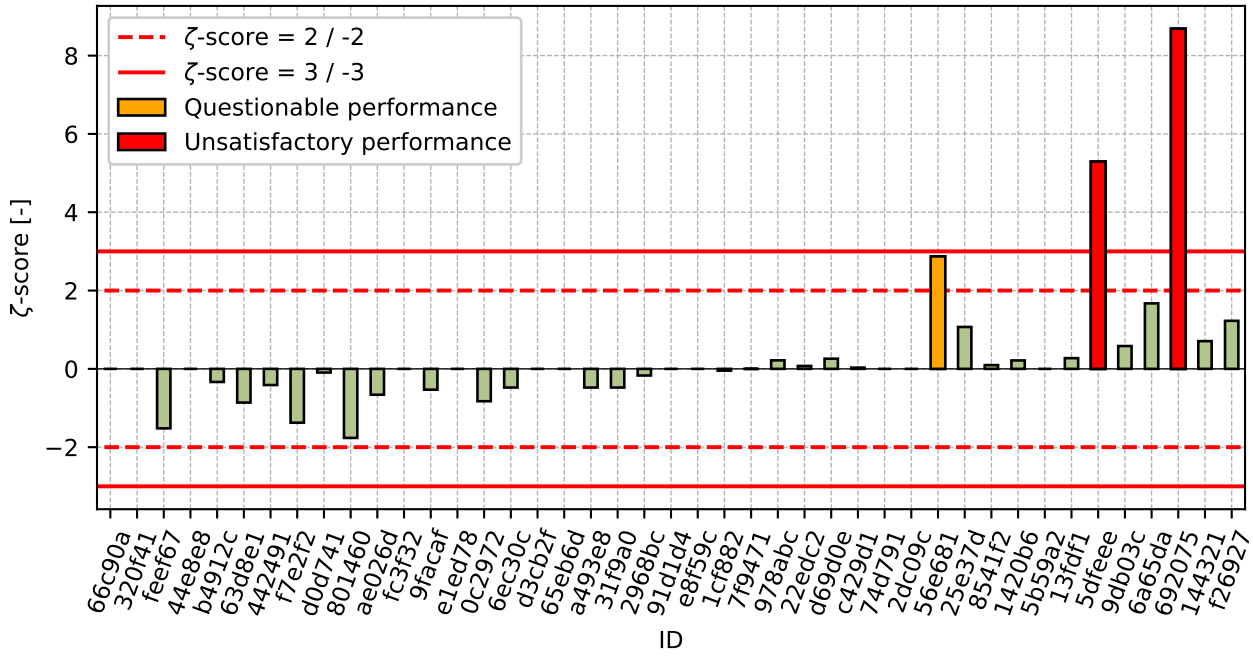

Figure 21: ζ-score

Table 10: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
66c90a	-3.2	-
320f41	-1.71	-
feef67	-1.46	-1.52
44e8e8	-1.15	-
b4912c	-0.96	-0.33
63d8e1	-0.83	-0.86
442491	-0.79	-0.41
f7e2f2	-0.58	-1.38
d0d741	-0.51	-0.09
801460	-0.51	-1.76
ae026d	-0.51	-0.66
fc3f32	-0.51	-
9facaf	-0.51	-0.53
e1ed78	-0.23	-
0c2972	-0.2	-0.83
6ec30c	-0.2	-0.48
d3cb2f	-0.2	-
65eb6d	-0.2	-
a493e8	-0.2	-0.48
31f9a0	-0.2	-0.48
2968bc	-0.2	-0.17
91d1d4	-0.2	-
e8f59c	-0.2	-
1cf882	-0.04	-0.05
7f9471	-0.01	-0.0
978abc	0.06	0.22
22edc2	0.12	0.07
d69d0e	0.15	0.26
c429d1	0.31	0.03
74d791	0.44	-
2dc09c	0.44	-
56e681	0.44	2.87
25e37d	0.44	1.07
8541f2	0.44	0.1
1420b6	0.53	0.22
5b59a2	0.72	-
13fdf1	1.04	0.27
5dfeee	1.07	5.29
9db03c	1.39	0.58
6a65da	1.61	1.67
692075	1.7	8.69
144321	2.02	0.71
f26927	2.34	1.23

1.3 1 mm

1.3.1 Test results

Table 11: 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 [%]
3524eb	55.4	55.4	55.4	0.5	55.4	0.03	0.05
d3cb2f	61.0	57.0	54.0	-	57.3	3.51	6.13
63d8e1	59.0	57.0	56.0	1.0	57.3	1.53	2.66
1cf882	57.5	57.5	57.1	1.0	57.4	0.23	0.4
f7e2f2	57.5	57.9	57.6	0.6	57.7	0.21	0.36
6ec30c	58.0	57.0	58.0	0.4	57.7	0.58	1.0
8541f2	58.0	58.0	58.0	3.1	58.0	0.0	0.0
9facaf	59.0	57.0	58.0	1.0	58.0	1.0	1.72
a493e8	59.0	57.0	58.0	0.4	58.0	1.0	1.72
44e8e8	59.0	57.0	58.0	-	58.0	1.0	1.72
fc3f32	58.0	58.0	58.0	-	58.0	0.0	0.0
442491	57.6	59.1	57.9	2.0	58.2	0.81	1.39
e8f59c	59.0	57.0	59.0	-	58.3	1.15	1.98
91d1d4	55.0	59.0	61.0	-	58.3	3.06	5.24
feef67	59.0	58.0	58.0	1.0	58.3	0.58	0.99
22edc2	59.0	58.0	59.0	1.4	58.7	0.58	0.98
66c90a	58.7	58.6	58.7	-	58.7	0.06	0.1
5dfeee	58.0	60.0	58.0	0.2	58.7	1.15	1.97
65eb6d	61.0	58.0	57.0	-	58.7	2.08	3.55
e1ed78	58.8	58.7	58.7	-	58.7	0.06	0.1
320f41	59.1	58.8	58.7	-	58.9	0.21	0.35
b4912c	59.7	57.0	60.0	4.2	58.9	1.65	2.81
978abc	58.9	59.0	58.9	0.2	58.9	0.06	0.1
1420b6	58.3	58.8	59.7	1.7	58.9	0.71	1.2
31f9a0	59.0	59.0	59.0	0.4	59.0	0.0	0.0
0c2972	63.0	53.0	61.0	0.2	59.0	5.29	8.97
2dc09c	58.0	62.0	57.0	-	59.0	2.65	4.48
ae026d	59.0	59.0	59.0	0.8	59.0	0.0	0.0
801460	59.0	59.0	59.0	0.4	59.0	0.0	0.0
2968bc	60.0	60.0	57.0	1.1	59.0	1.73	2.94
25e37d	59.0	59.0	59.0	0.4	59.0	0.0	0.0
74d791	60.0	60.0	58.0	-	59.3	1.15	1.95
c429d1	58.7	59.6	59.8	7.4	59.4	0.59	0.99
7f9471	60.0	59.2	59.1	3.5	59.4	0.49	0.83
5b59a2	57.0	63.7	58.2	-	59.6	3.57	5.99
f26927	59.7	59.8	59.7	2.0	59.7	0.06	0.1

Continued on next page

Continued from previous page

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
144321	60.0	60.0	60.0	3.0	60.0	0.0	0.0
d69d0e	60.3	59.8	60.3	0.6	60.1	0.29	0.48
56e681	61.0	60.0	60.0	0.3	60.3	0.58	0.96
d0d741	60.0	61.0	60.0	3.8	60.3	0.58	0.96
6a65da	61.8	61.5	61.2	1.0	61.5	0.3	0.49
692075	59.1	59.8	65.8	0.1	61.6	3.68	5.98
9db03c	61.0	61.0	63.0	2.5	61.7	1.15	1.87
13fdf1	63.4	63.1	63.0	3.0	63.2	0.21	0.33
7f555e	68.0	63.0	65.0	1.8	65.3	2.52	3.85
4471dc	84.0	87.9	85.7	-	85.9	1.96	2.28

1.3.2 The Numerical Procedure for Determining Outliers

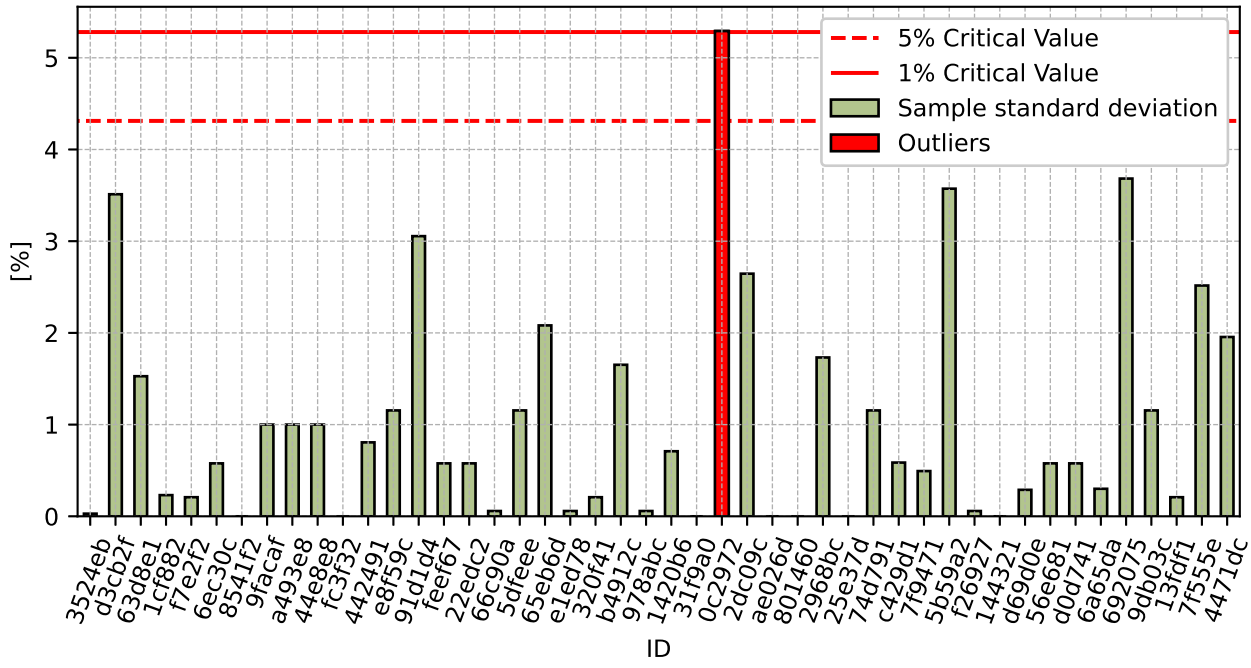

Figure 22: **Cochran's test** - sample standard deviations

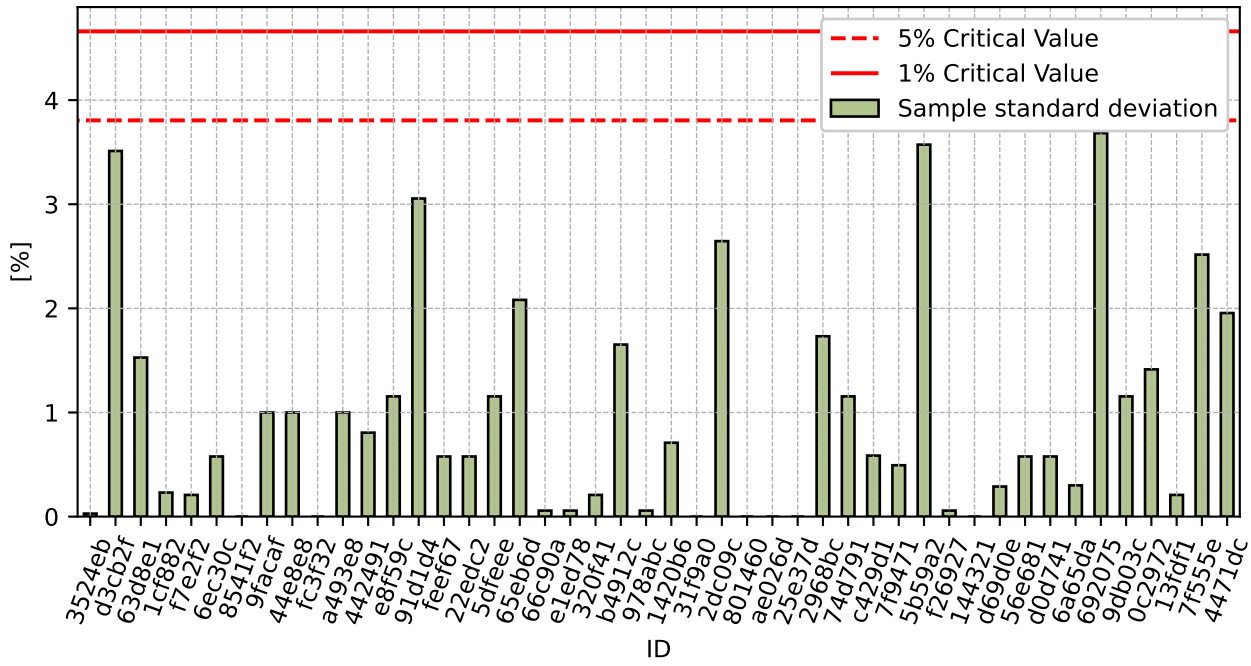

Figure 23: **Cochran's test** - sample standard deviations without outliers

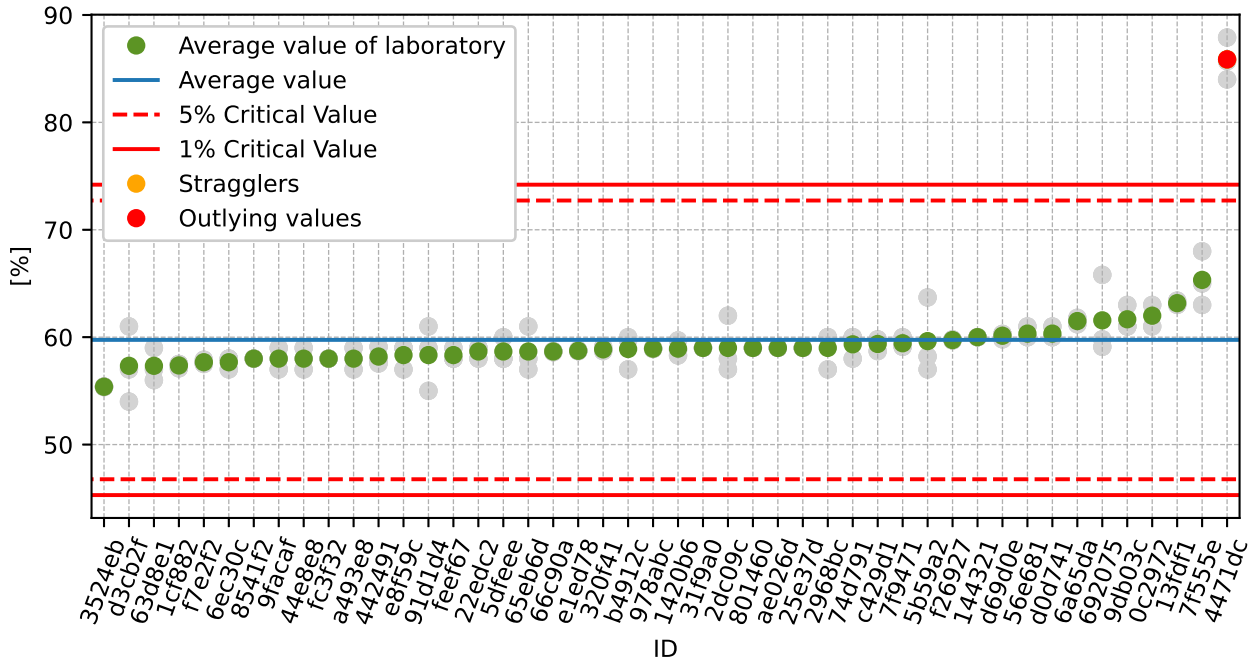

Figure 24: **Grubbs' test** - average values

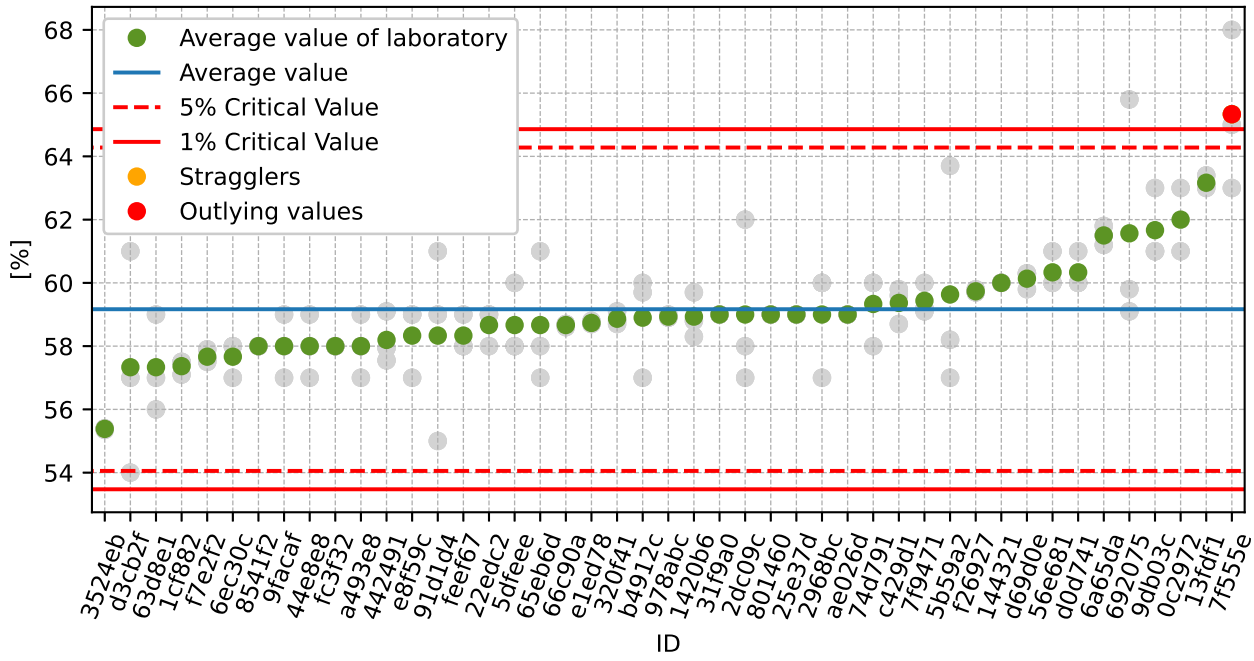

Figure 25: **Grubbs' test** - average values without outliers

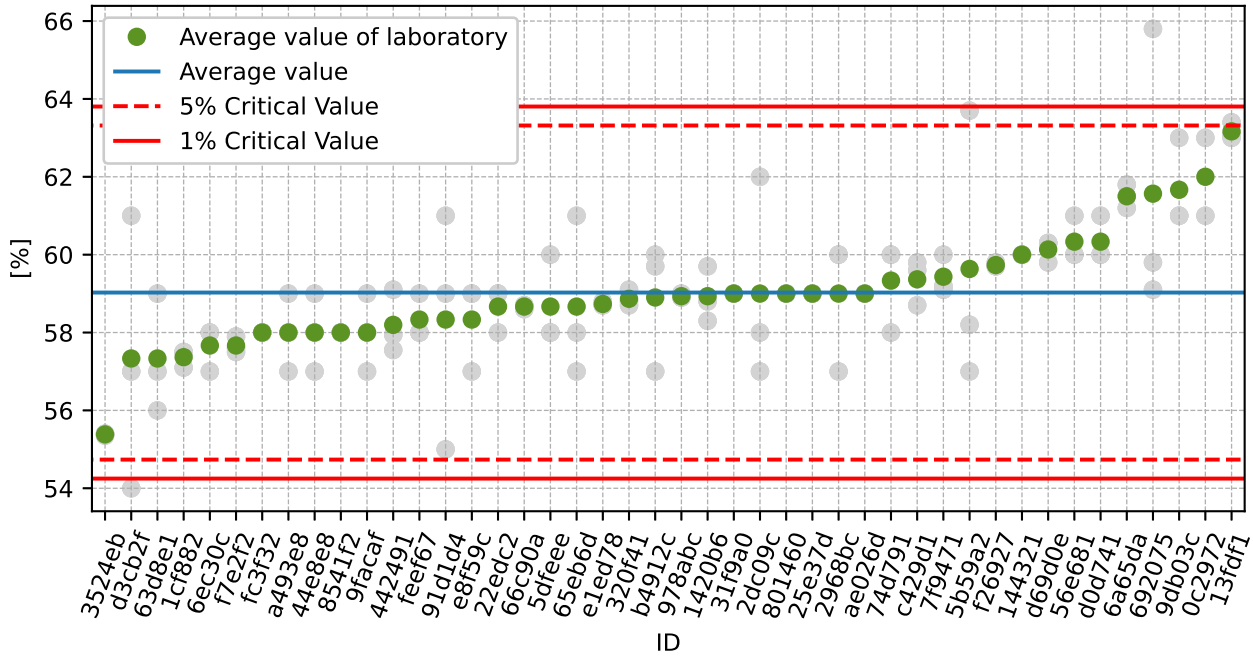

Figure 26: **Grubbs' test** - average values without outliers

1.3.3 Mandel's Statistics

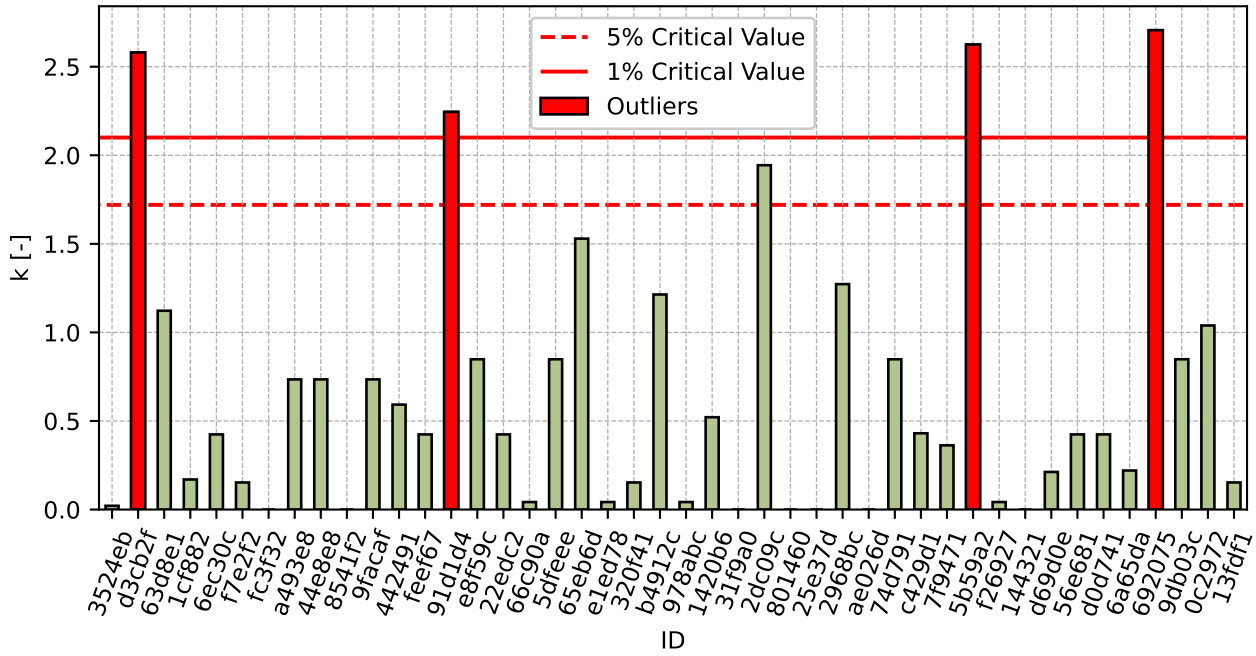

Figure 27: Intralaboratory Consistency Statistic

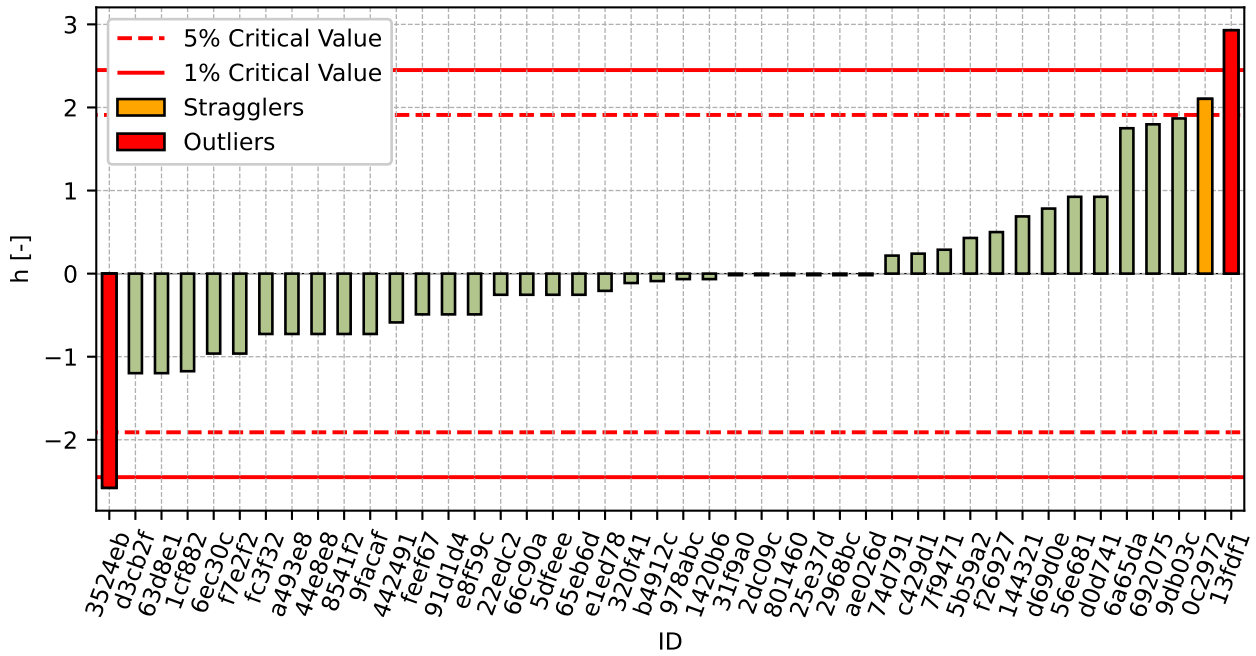

Figure 28: Interlaboratory Consistency Statistic

1.3.4 Descriptive statistics

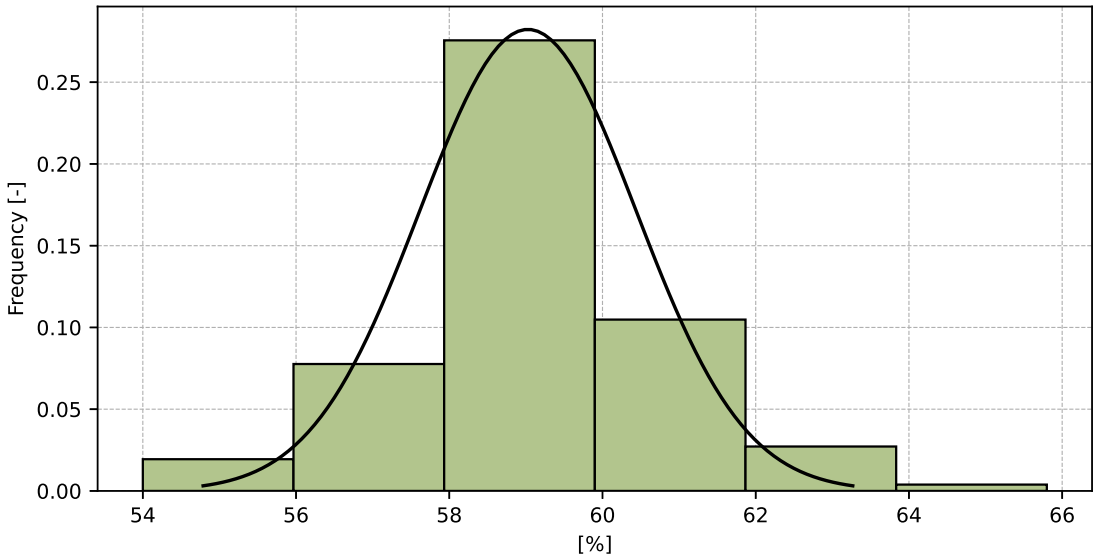

Figure 29: Histogram of all test results

Table 12: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	59.0
Sample standard deviation – s	1.41
Asigned value – x^*	59.0
Robust standard deviation – s^*	1.41
Measurement uncertainty of asigned value – u_X	0.21
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	1.17
Repeatability standard deviation – s_r	1.36
Reproducibility standard deviation – s_R	1.8
Repeatability – r	3.8
Reproducibility – R	5.0

1.3.5 Evaluation of Performance Statistics

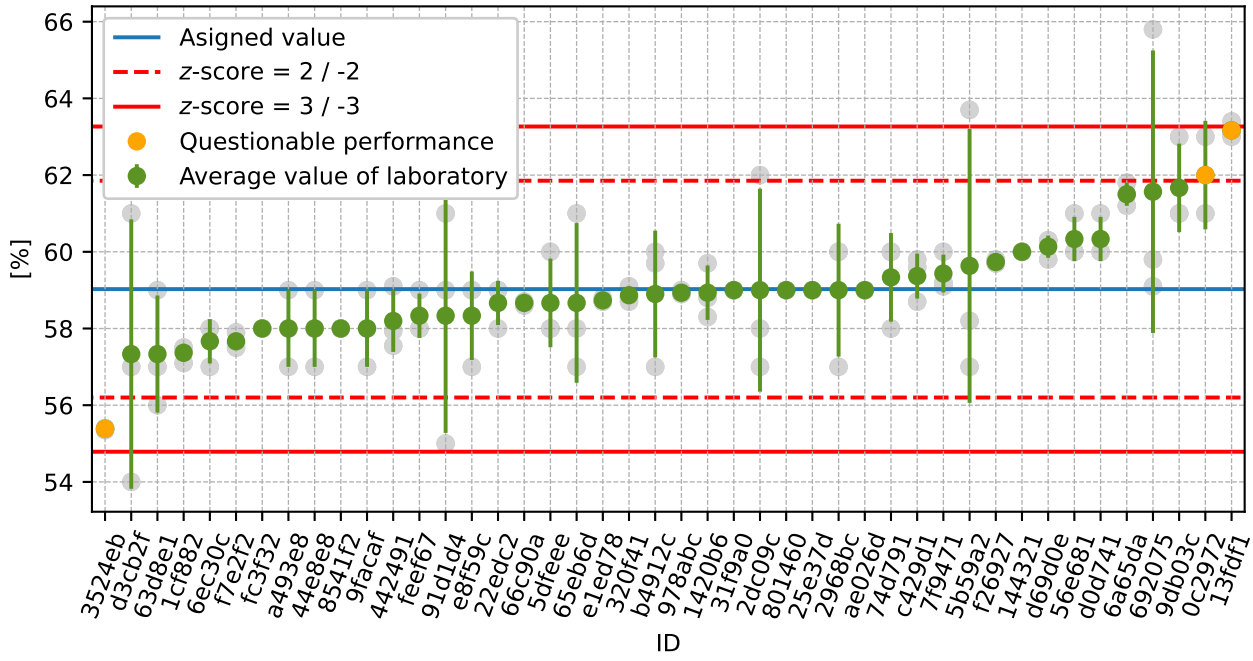

Figure 30: Average values and sample standard deviations

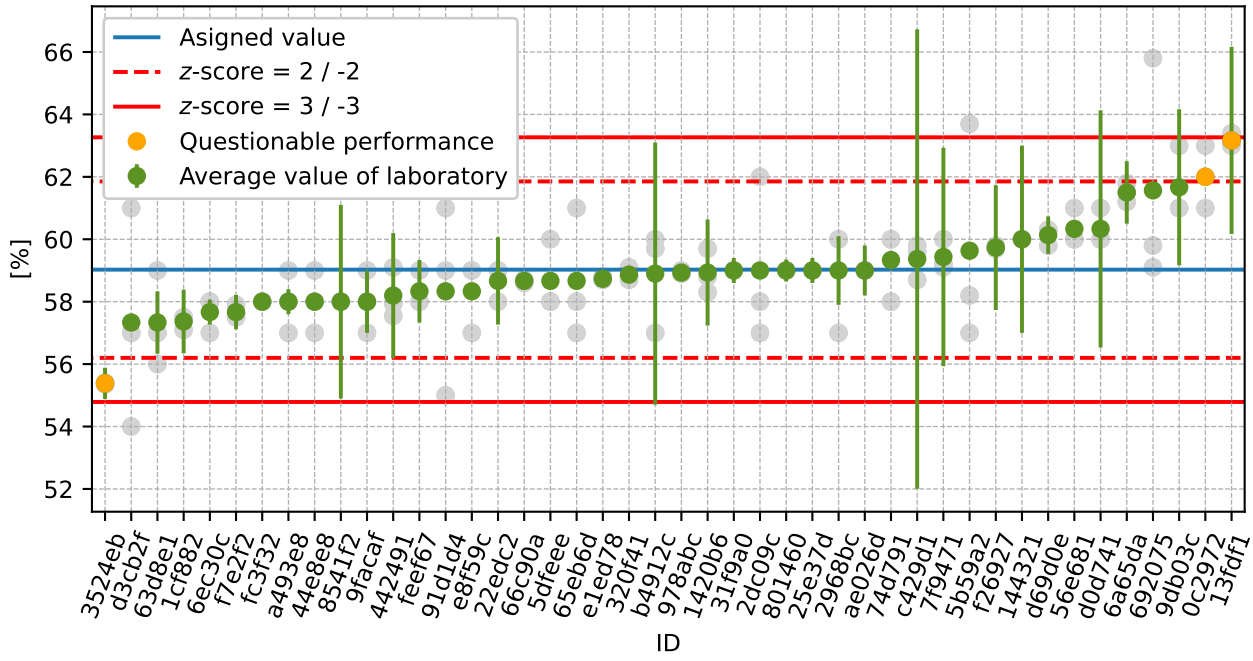

Figure 31: Average values and extended uncertainties of measurement

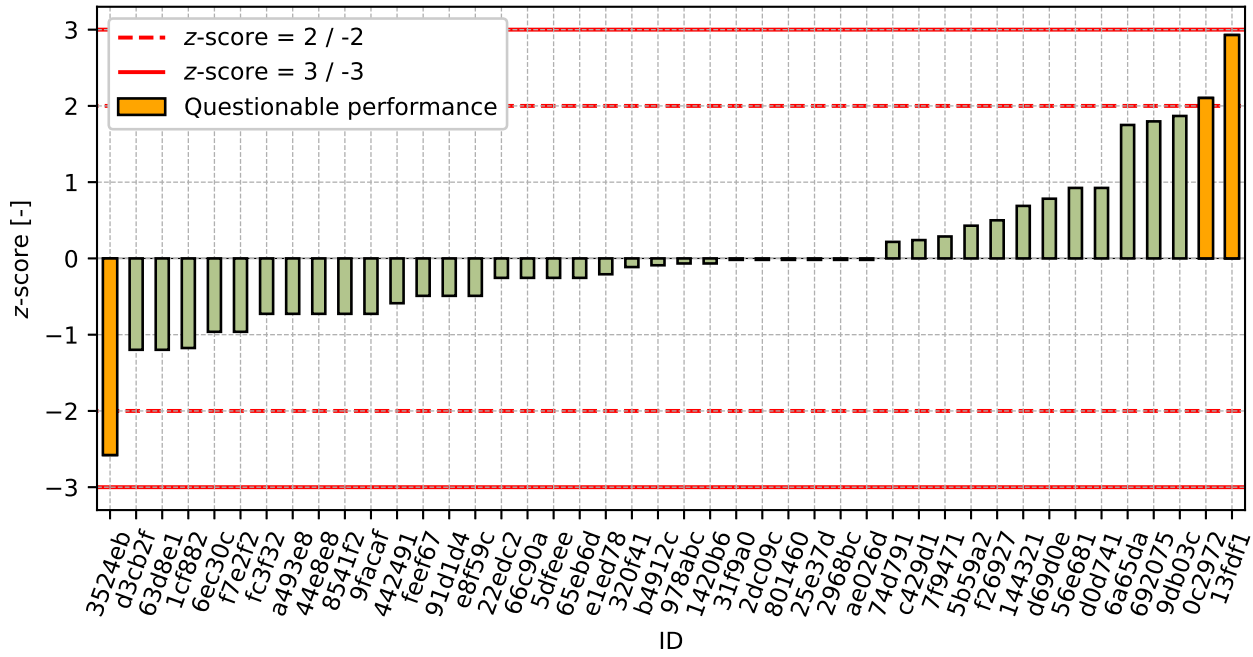

Figure 32: z-score

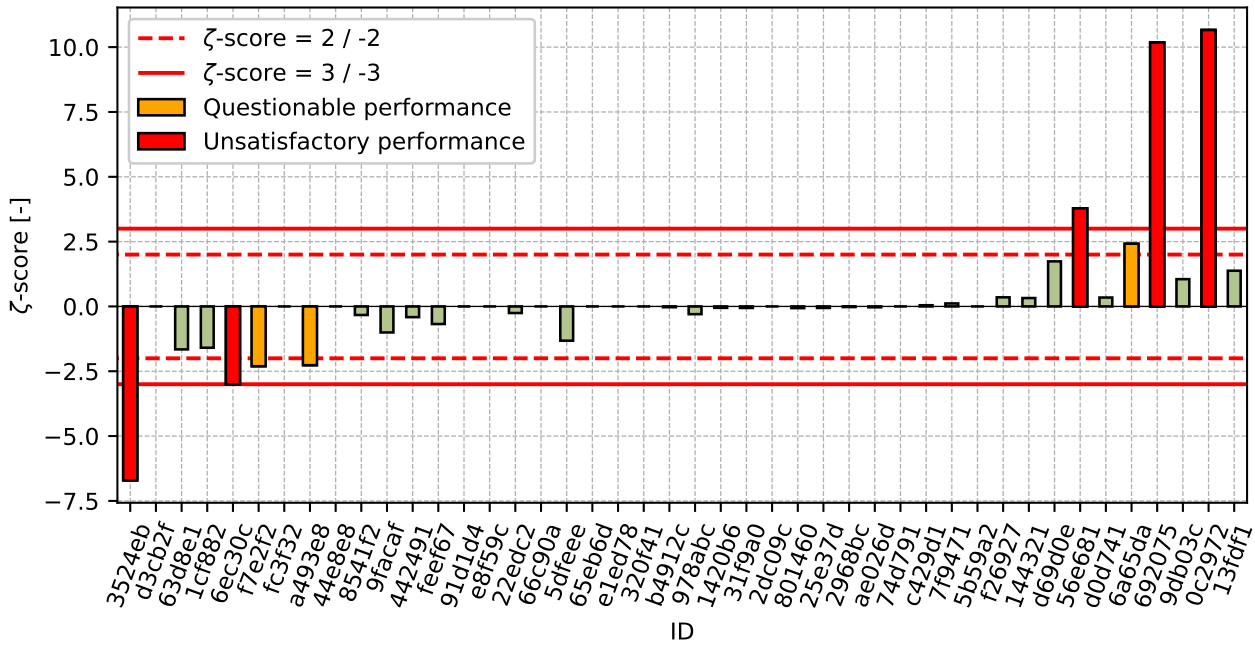

Figure 33: ζ-score

Table 13: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
3524eb	-2.58	-6.7
d3cb2f	-1.2	-
63d8e1	-1.2	-1.66
1cf882	-1.17	-1.59
6ec30c	-0.96	-3.0
f7e2f2	-0.96	-2.31
fc3f32	-0.73	-
a493e8	-0.73	-2.27
44e8e8	-0.73	-
8541f2	-0.73	-0.33
9facaf	-0.73	-1.0
442491	-0.59	-0.41
feef67	-0.49	-0.68
91d1d4	-0.49	-
e8f59c	-0.49	-
22edc2	-0.25	-0.25
66c90a	-0.25	-
5dfeee	-0.25	-1.32
65eb6d	-0.25	-
e1ed78	-0.21	-
320f41	-0.11	-
b4912c	-0.09	-0.03
978abc	-0.07	-0.3
1420b6	-0.07	-0.05
31f9a0	-0.02	-0.06
2dc09c	-0.02	-
801460	-0.02	-0.07
25e37d	-0.02	-0.06
2968bc	-0.02	-0.02
ae026d	-0.02	-0.03
74d791	0.22	-
c429d1	0.24	0.05
7f9471	0.29	0.12
5b59a2	0.43	-
f26927	0.5	0.35
144321	0.69	0.32
d69d0e	0.78	1.74
56e681	0.92	3.78
d0d741	0.92	0.34
6a65da	1.75	2.42
692075	1.8	10.18
9db03c	1.87	1.05
0c2972	2.1	10.66
13fdf1	2.93	1.38

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ID	z-score [-]	ζ-score [-]

1.4 0.5 mm

1.4.1 Test results

Table 14: 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 [%]
3524eb	22.6	22.6	22.8	0.2	22.7	0.06	0.27
f7e2f2	26.6	26.9	27.0	0.6	26.8	0.21	0.78
63d8e1	28.0	27.0	27.0	1.0	27.3	0.58	2.11
66c90a	27.6	28.4	27.8	-	27.9	0.42	1.49
978abc	28.3	28.3	28.1	0.5	28.2	0.12	0.41
5dfeee	28.0	28.0	30.0	0.2	28.7	1.15	4.03
feef67	29.0	29.0	28.0	1.0	28.7	0.58	2.01
8541f2	29.0	30.0	29.0	1.6	29.3	0.58	1.97
a493e8	30.0	28.0	31.0	0.4	29.7	1.53	5.15
1420b6	29.8	29.3	29.9	0.9	29.7	0.32	1.08
b4912c	30.2	28.2	30.7	3.9	29.7	1.32	4.45
22edc2	31.0	30.0	29.0	0.7	30.0	1.0	3.33
44e8e8	31.0	30.0	30.0	-	30.3	0.58	1.9
6ec30c	30.0	30.0	31.0	0.4	30.3	0.58	1.9
fc3f32	29.0	31.0	31.0	-	30.3	1.15	3.81
442491	30.0	29.7	31.3	2.0	30.4	0.86	2.83
0c2972	33.0	27.0	32.0	0.2	30.7	3.21	10.48
d3cb2f	34.0	30.0	28.0	-	30.7	3.06	9.96
e8f59c	32.0	29.0	31.0	-	30.7	1.53	4.98
1cf882	30.8	30.6	30.6	0.9	30.7	0.12	0.38
31f9a0	31.0	31.0	30.0	0.4	30.7	0.58	1.88
c429d1	30.5	30.8	30.9	4.2	30.7	0.21	0.68
320f41	31.1	30.6	30.8	-	30.8	0.25	0.82
ae026d	31.0	31.0	31.0	0.8	31.0	0.0	0.0
25e37d	31.0	31.0	31.0	0.4	31.0	0.0	0.0
801460	31.0	31.0	31.0	0.4	31.0	0.0	0.0
5b59a2	30.2	33.0	30.0	-	31.1	1.68	5.4
7f9471	31.4	31.0	30.9	3.5	31.1	0.26	0.85
74d791	32.0	32.0	30.0	-	31.3	1.15	3.69
2dc09c	30.0	34.0	30.0	-	31.3	2.31	7.37
65eb6d	32.0	32.0	30.0	-	31.3	1.15	3.69
91d1d4	30.0	31.0	33.0	-	31.3	1.53	4.88
f26927	30.9	32.0	31.3	1.0	31.4	0.56	1.77
e1ed78	31.5	31.5	31.5	-	31.5	0.0	0.0
2968bc	32.0	33.0	30.0	0.8	31.7	1.53	4.82
d69d0e	31.9	31.7	31.9	0.6	31.8	0.12	0.36

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ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
6a65da	32.2	31.8	31.7	1.0	31.9	0.26	0.83
d0d741	32.0	32.0	32.0	2.0	32.0	0.0	0.0
9facaf	32.0	33.0	31.0	1.0	32.0	1.0	3.12
144321	32.0	33.0	32.0	3.0	32.3	0.58	1.79
9db03c	32.0	33.0	33.0	2.5	32.7	0.58	1.77
56e681	33.0	32.0	33.0	0.3	32.7	0.58	1.77
692075	31.5	32.2	37.8	0.1	33.8	3.45	10.21
7f555e	36.0	31.0	35.0	2.0	34.0	2.65	7.78
13fdf1	33.3	35.4	35.6	3.0	34.8	1.27	3.66
4471dc	56.6	62.4	58.9	-	59.3	2.92	4.93

1.4.2 The Numerical Procedure for Determining Outliers

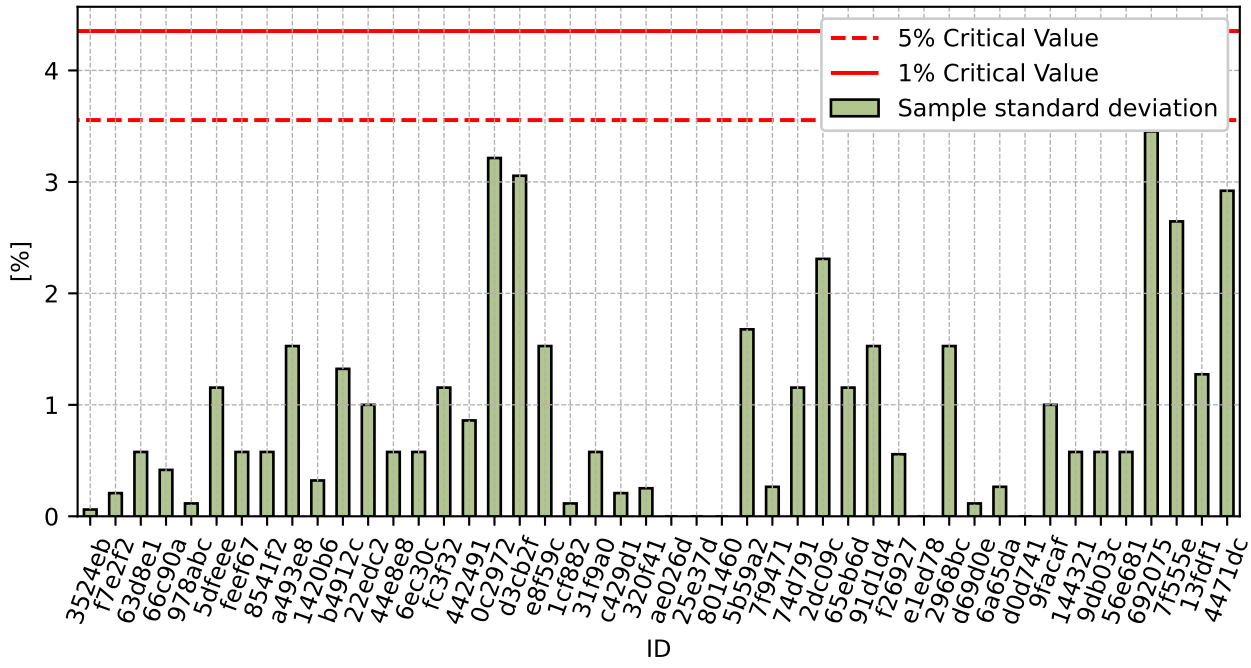

Figure 34: **Cochran's test** - sample standard deviations

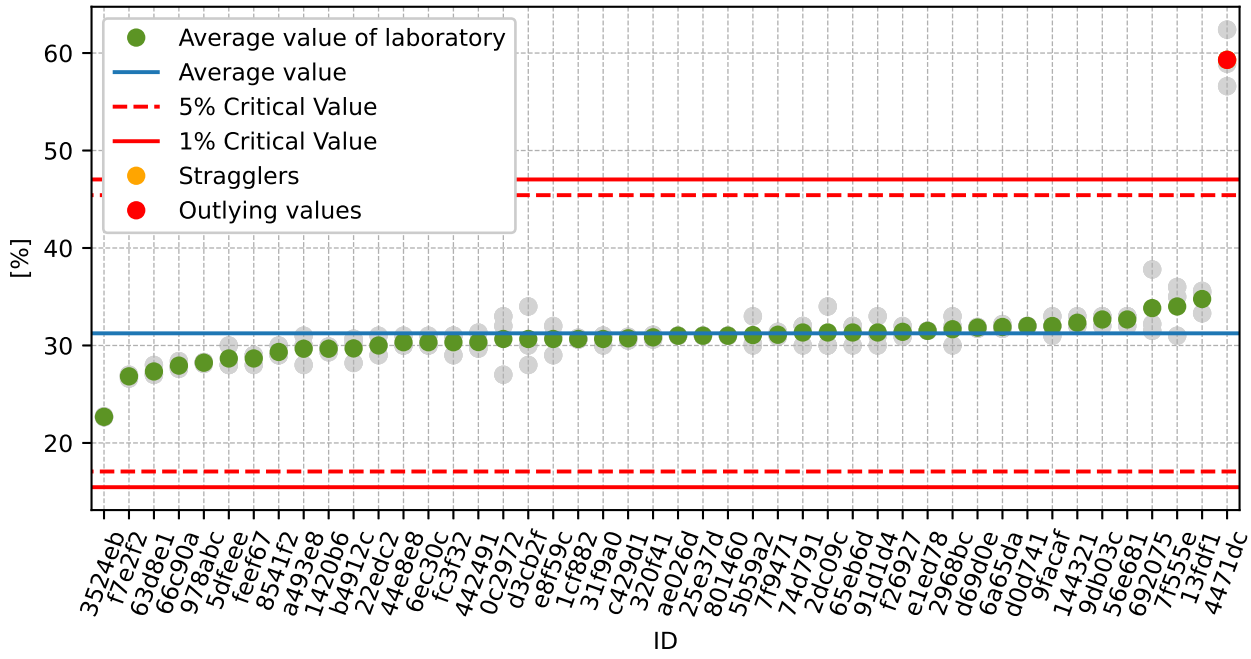

Figure 35: **Grubbs' test** - average values

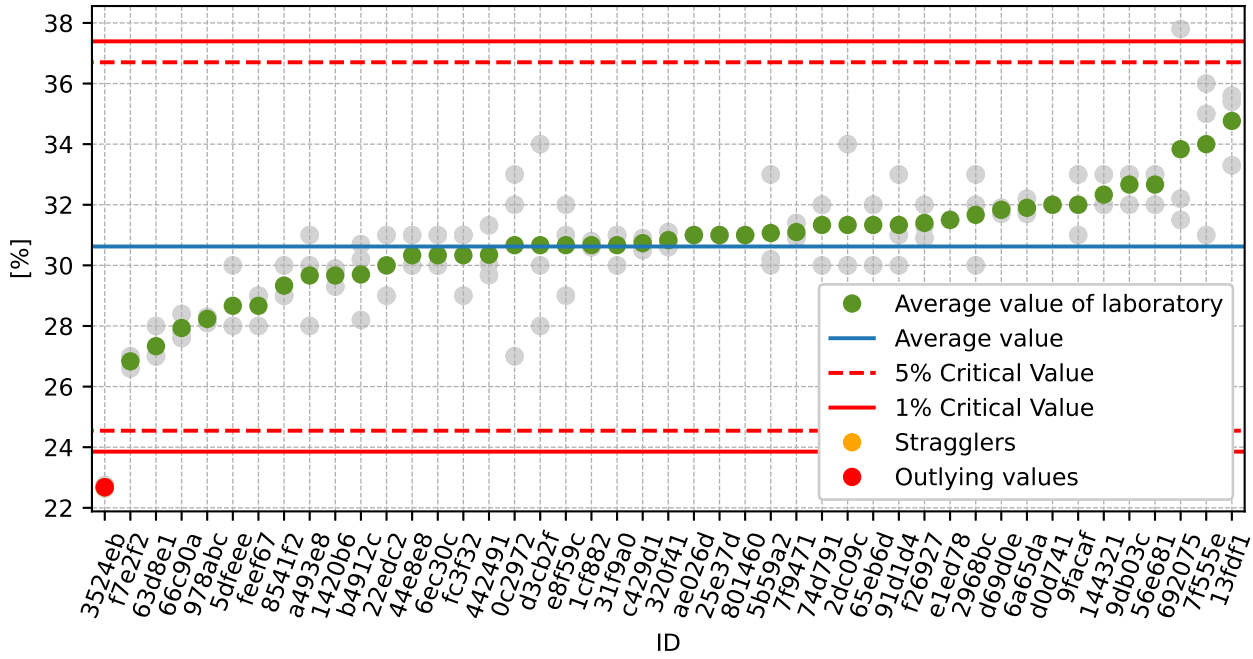

Figure 36: **Grubbs' test** - average values without outliers

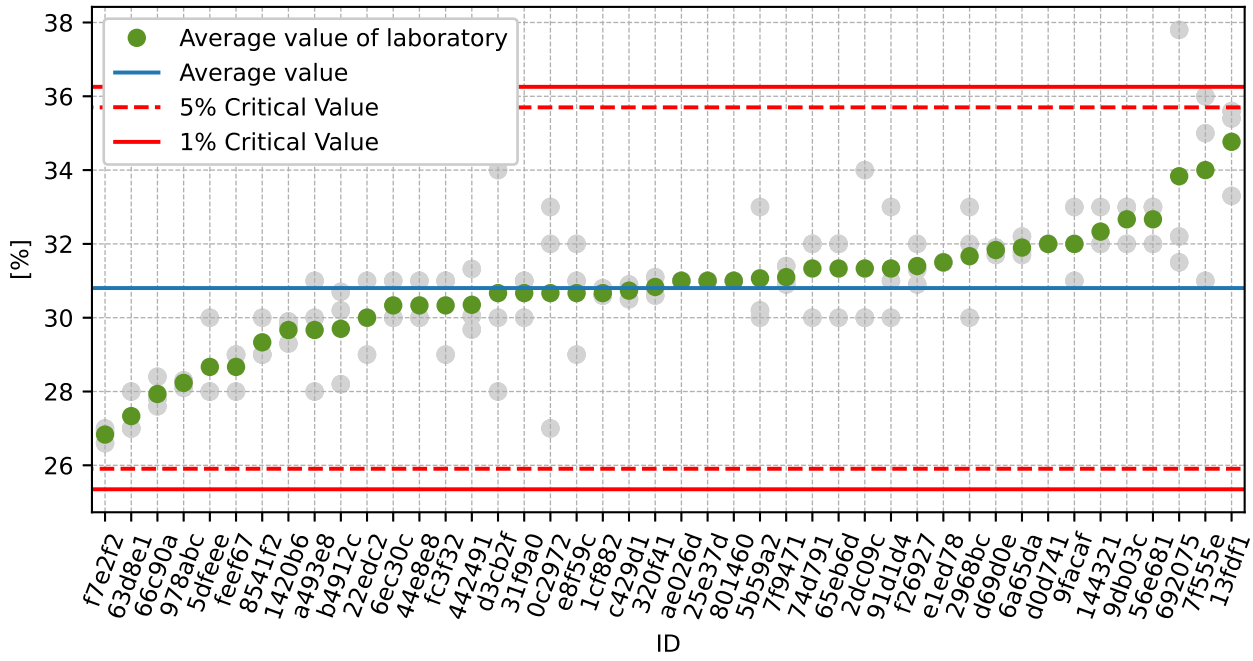

Figure 37: **Grubbs' test** - average values without outliers

1.4.3 Mandel's Statistics

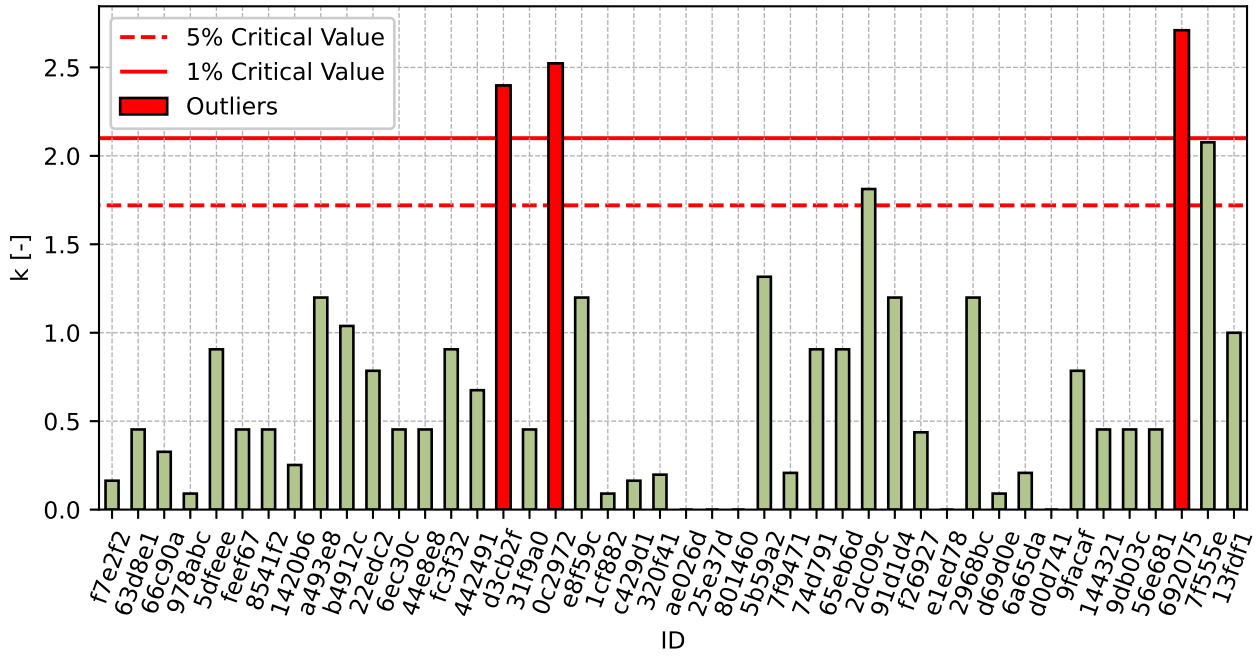

Figure 38: Intralaboratory Consistency Statistic

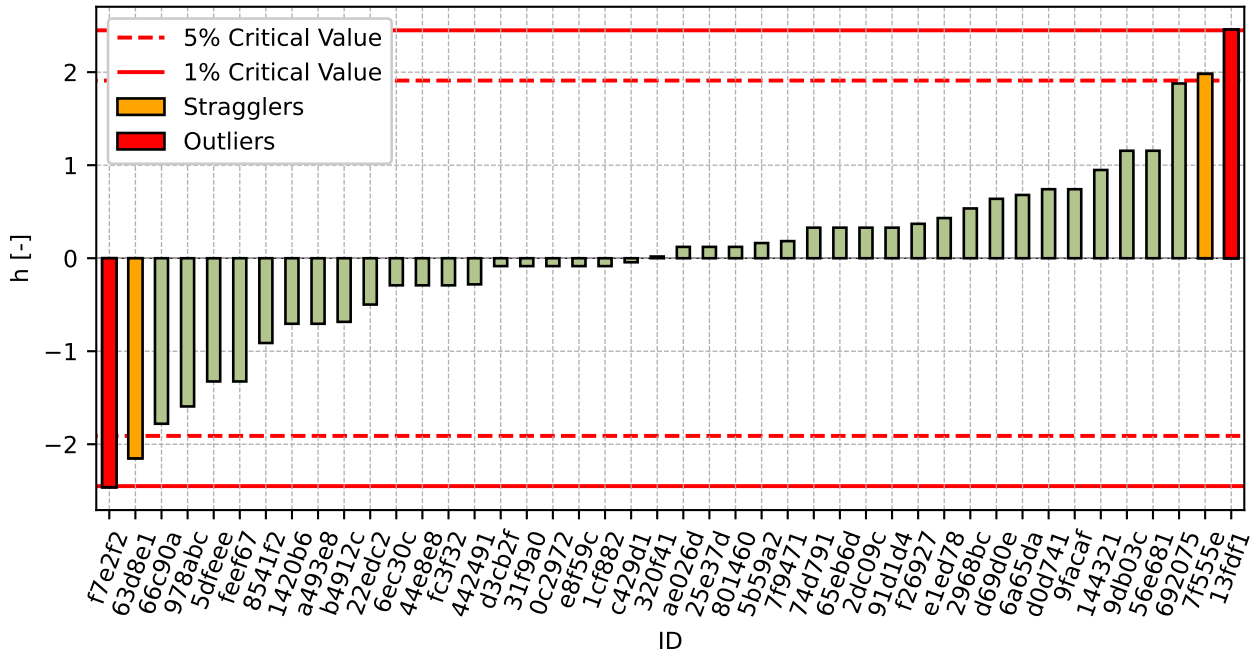

Figure 39: Interlaboratory Consistency Statistic

1.4.4 Descriptive statistics

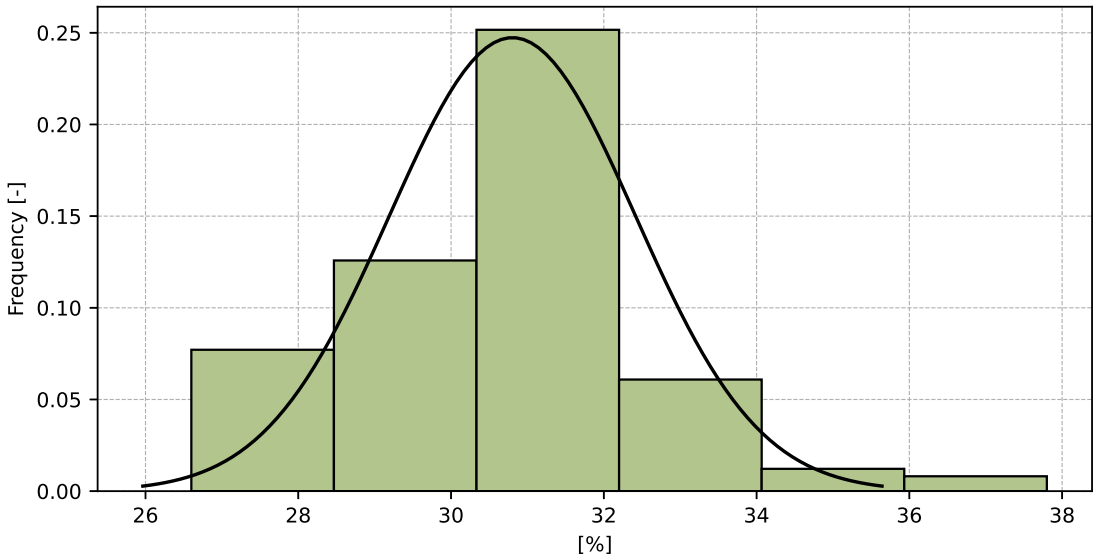

Figure 40: Histogram of all test results

Table 15: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	30.8
Sample standard deviation – s	1.61
Asigned value – x^*	30.8
Robust standard deviation – s^*	1.61
Measurement uncertainty of asigned value – u_X	0.24
p-value of normality test	0.001 [-]
Interlaboratory standard deviation – s_L	1.44
Repeatability standard deviation – s_r	1.27
Reproducibility standard deviation – s_R	1.92
Repeatability – r	3.6
Reproducibility – R	5.4

1.4.5 Evaluation of Performance Statistics

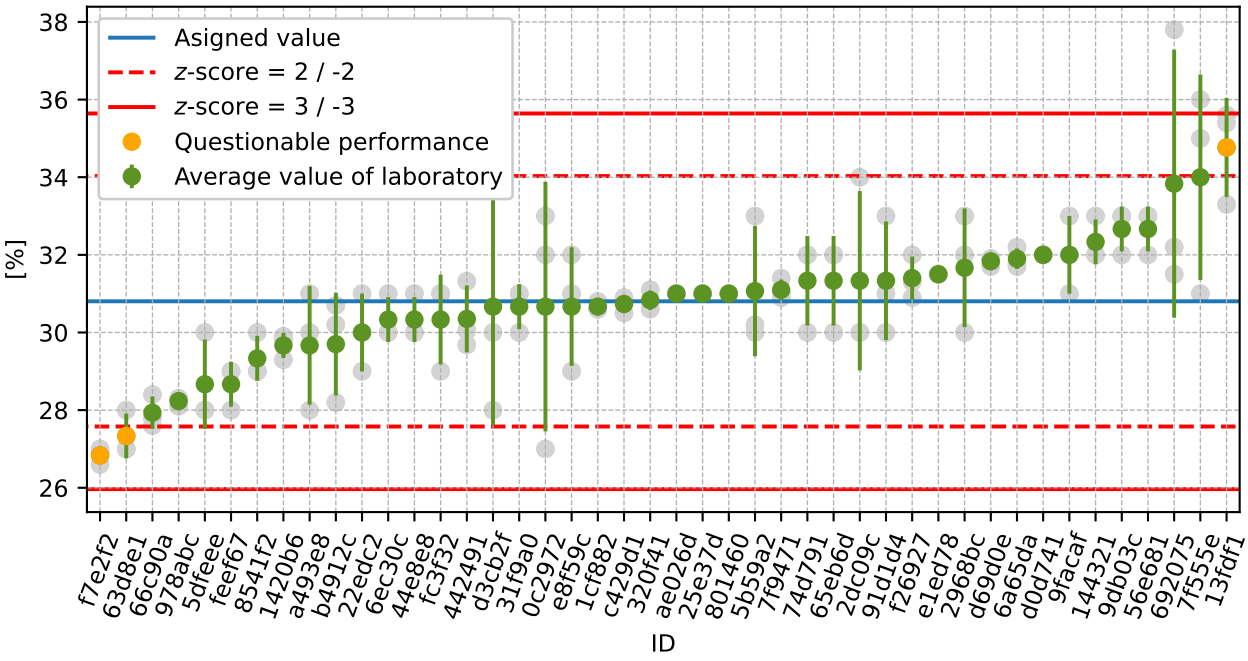

Figure 41: Average values and sample standard deviations

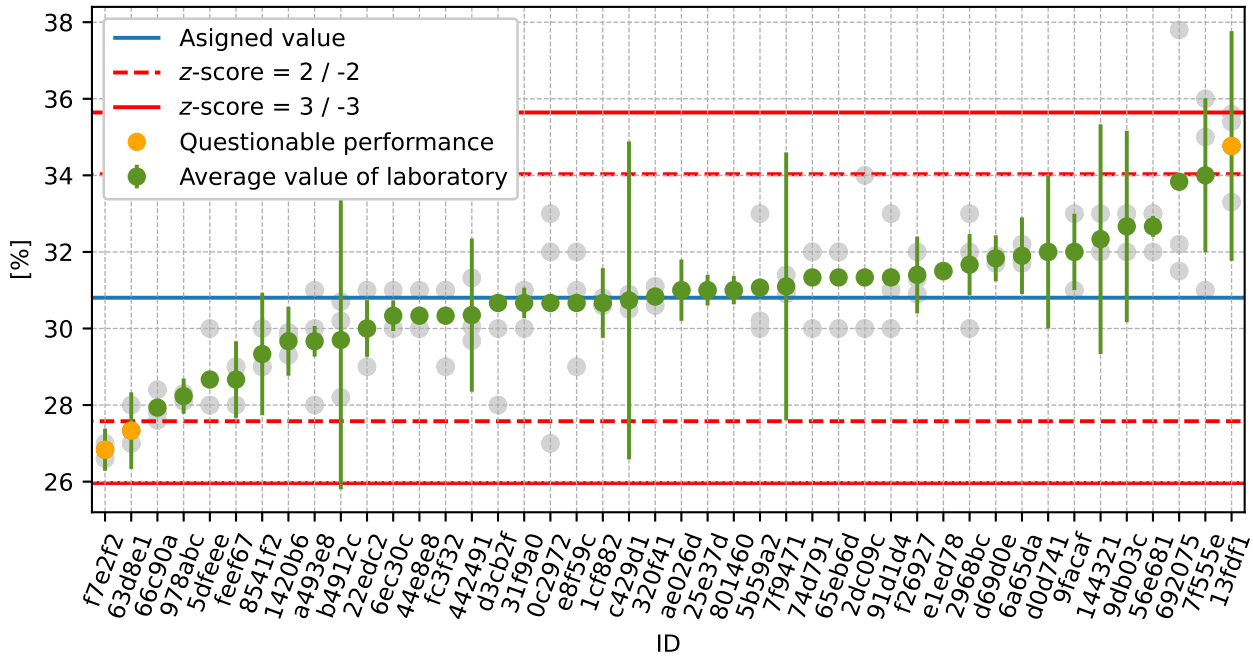

Figure 42: Average values and extended uncertainties of measurement

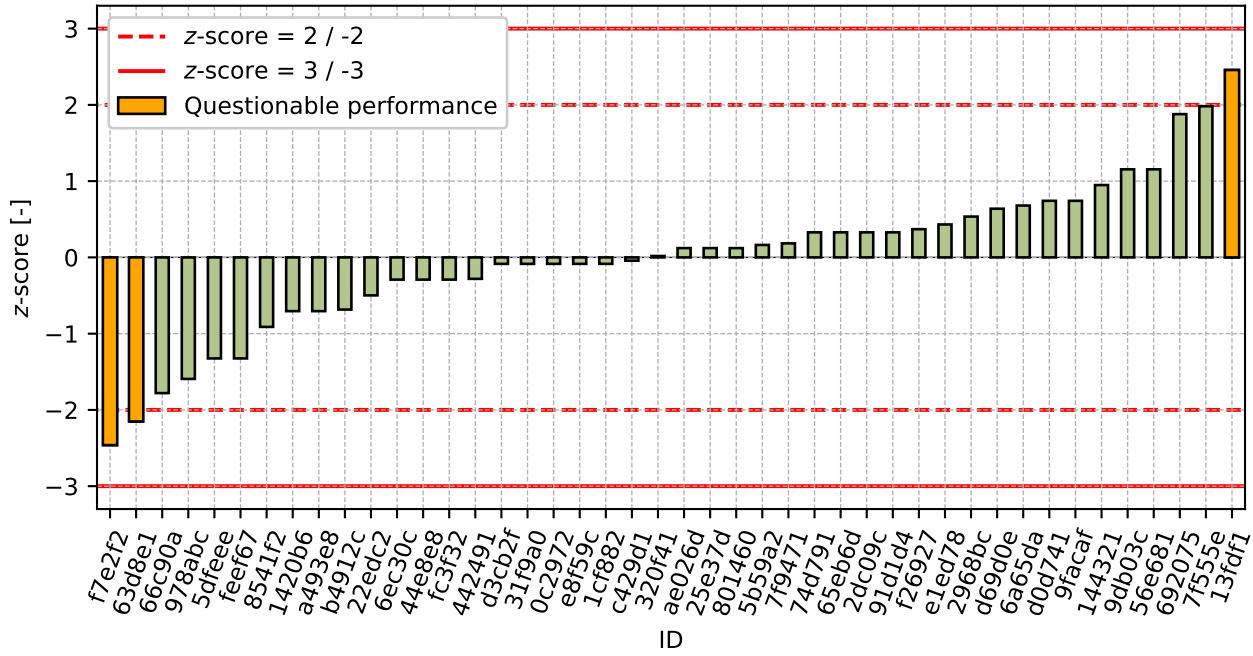

Figure 43: z-score

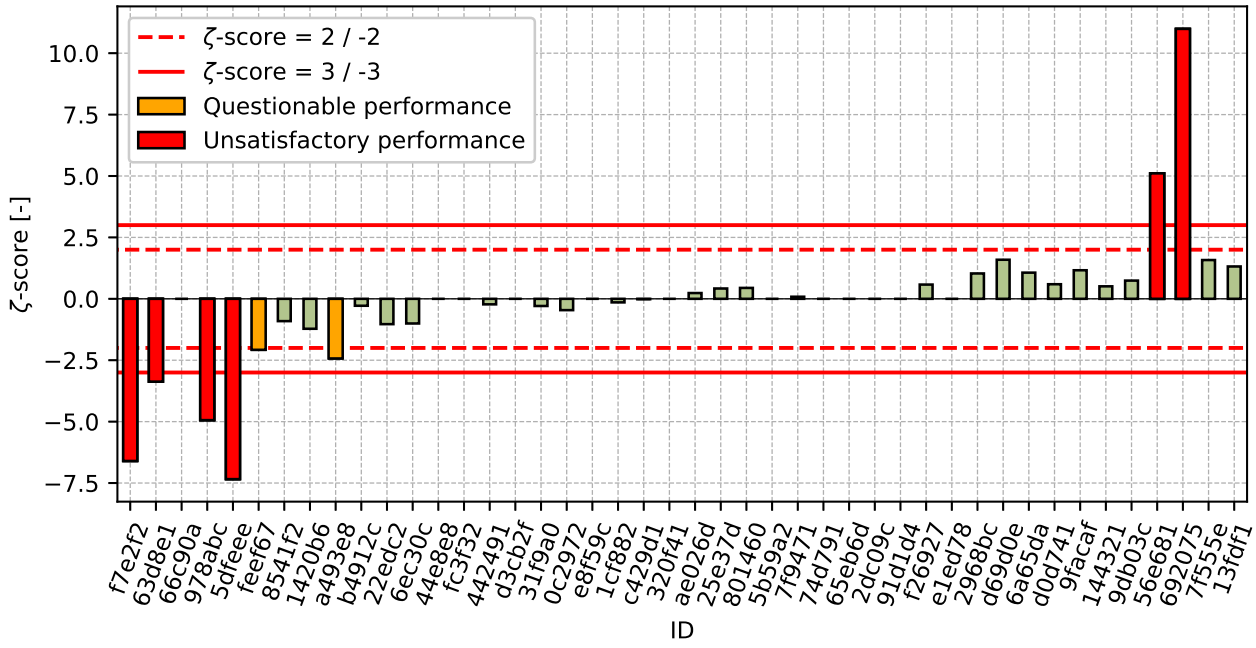

Figure 44: ζ-score

Table 16: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f7e2f2	-2.46	-6.6
63d8e1	-2.15	-3.37
66c90a	-1.78	-
978abc	-1.59	-4.94
5dfeee	-1.32	-7.34
feef67	-1.32	-2.08
8541f2	-0.91	-0.91
1420b6	-0.7	-1.22
a493e8	-0.7	-2.43
b4912c	-0.68	-0.28
22edc2	-0.5	-1.03
6ec30c	-0.29	-1.0
44e8e8	-0.29	-
fc3f32	-0.29	-
442491	-0.28	-0.23
d3cb2f	-0.08	-
31f9a0	-0.08	-0.29
0c2972	-0.08	-0.46
e8f59c	-0.08	-
1cf882	-0.08	-0.15
c429d1	-0.04	-0.02
320f41	0.02	-
ae026d	0.12	0.24

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ID	z-score [-]	ζ-score [-]
25e37d	0.12	0.42
801460	0.12	0.44
5b59a2	0.16	-
7f9471	0.18	0.08
74d791	0.33	-
65eb6d	0.33	-
2dc09c	0.33	-
91d1d4	0.33	-
f26927	0.37	0.58
e1ed78	0.43	-
2968bc	0.54	1.03
d69d0e	0.64	1.59
6a65da	0.68	1.07
d0d741	0.74	0.59
9facaf	0.74	1.16
144321	0.95	0.51
9db03c	1.16	0.74
56e681	1.16	5.11
692075	1.88	10.99
7f555e	1.98	1.58
13fdf1	2.46	1.32

1.5 0.25 mm

1.5.1 Test results

Table 17: 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 [%]
3524eb	5.1	5.1	5.1	0.0	5.1	0.03	0.5
f7e2f2	6.5	6.9	6.8	0.6	6.7	0.21	3.09
63d8e1	7.0	7.0	7.0	1.0	7.0	0.0	0.0
978abc	7.5	7.5	7.4	0.2	7.5	0.06	0.77
5dfeee	7.0	8.0	9.0	0.2	8.0	1.0	12.5
8541f2	8.0	8.0	8.0	0.6	8.0	0.0	0.0
66c90a	7.8	8.3	8.2	-	8.1	0.26	3.27
1cf882	8.6	8.5	8.7	0.6	8.6	0.1	1.16
e8f59c	9.0	8.0	9.0	-	8.7	0.58	6.66
0c2972	9.0	9.0	8.0	0.1	8.7	0.58	6.66
b4912c	8.7	8.5	8.9	2.5	8.7	0.2	2.3
5b59a2	9.2	8.5	8.5	-	8.7	0.4	4.63
feef67	8.7	9.2	9.0	0.5	9.0	0.25	2.81
22edc2	9.0	9.0	9.0	0.2	9.0	0.0	0.0
d3cb2f	10.0	9.0	8.0	-	9.0	1.0	11.11
25e37d	9.0	9.0	9.0	0.4	9.0	0.0	0.0
fc3f32	9.0	9.0	9.0	-	9.0	0.0	0.0
442491	9.1	9.6	8.8	2.0	9.2	0.43	4.69
6ec30c	9.0	9.0	10.0	0.4	9.3	0.58	6.19
2dc09c	9.0	10.0	9.0	-	9.3	0.58	6.19
9facaf	10.0	9.0	9.0	0.5	9.3	0.58	6.19
1420b6	9.7	9.4	9.4	0.3	9.5	0.17	1.82
320f41	10.0	9.5	9.2	-	9.6	0.4	4.22
c429d1	9.6	9.6	9.7	1.3	9.6	0.06	0.6
144321	10.0	10.0	9.0	1.0	9.7	0.58	5.97
56e681	9.0	10.0	10.0	0.3	9.7	0.58	5.97
a493e8	10.0	9.0	10.0	0.4	9.7	0.58	5.97
2968bc	10.0	10.0	9.0	0.4	9.7	0.58	5.97
7f9471	9.9	10.0	9.7	3.5	9.9	0.15	1.55
801460	10.0	10.0	10.0	0.2	10.0	0.0	0.0
74d791	10.0	10.0	10.0	-	10.0	0.0	0.0
31f9a0	10.0	10.0	10.0	0.4	10.0	0.0	0.0
44e8e8	10.0	10.0	10.0	-	10.0	0.0	0.0
d0d741	10.0	10.0	10.0	0.6	10.0	0.0	0.0
ae026d	10.0	10.0	10.0	0.8	10.0	0.0	0.0
6a65da	10.2	10.5	9.9	1.0	10.2	0.3	2.94

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ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d69d0e	10.3	10.2	10.2	0.6	10.2	0.06	0.56
91d1d4	11.0	10.0	10.0	-	10.3	0.58	5.59
65eb6d	10.0	12.0	9.0	-	10.3	1.53	14.78
e1ed78	10.3	10.4	10.3	-	10.3	0.06	0.56
f26927	10.0	11.0	10.2	1.0	10.4	0.53	5.09
7f555e	12.0	10.0	10.0	2.1	10.7	1.15	10.83
9db03c	11.0	11.0	11.0	2.0	11.0	0.0	0.0
13fdf1	10.6	11.7	10.9	2.0	11.1	0.57	5.14
692075	10.9	11.2	13.0	0.1	11.7	1.14	9.71
4471dc	28.7	34.2	31.9	-	31.6	2.76	8.74

1.5.2 The Numerical Procedure for Determining Outliers

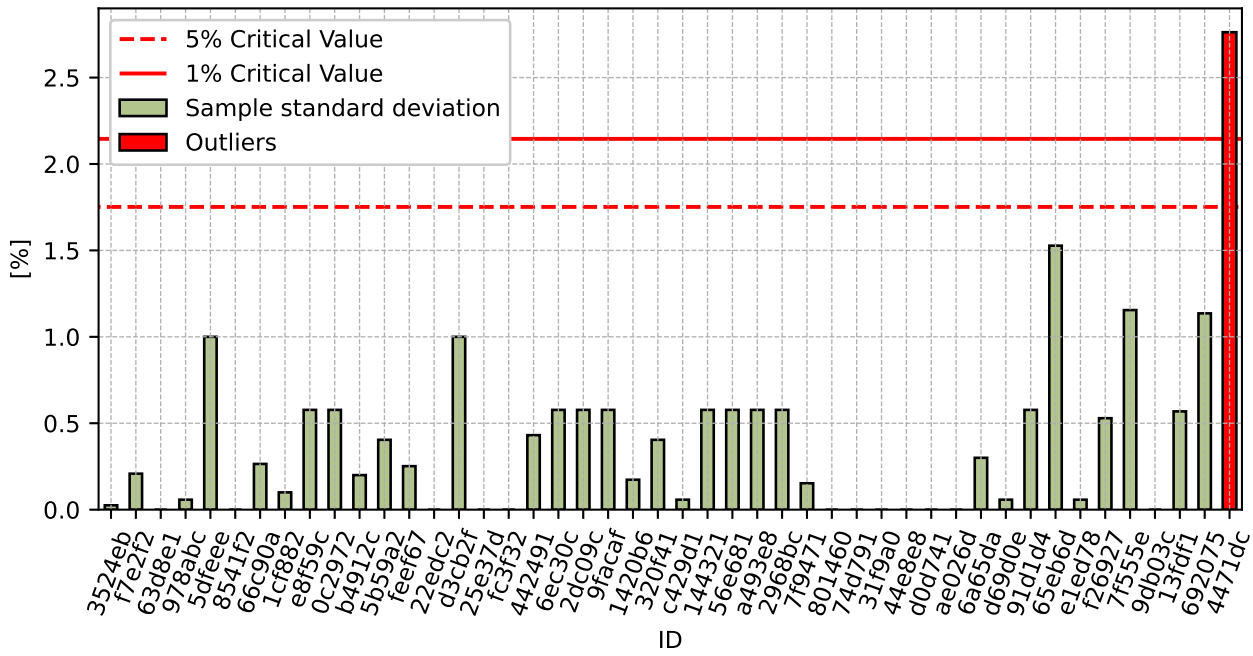

Figure 45: **Cochran's test** - sample standard deviations

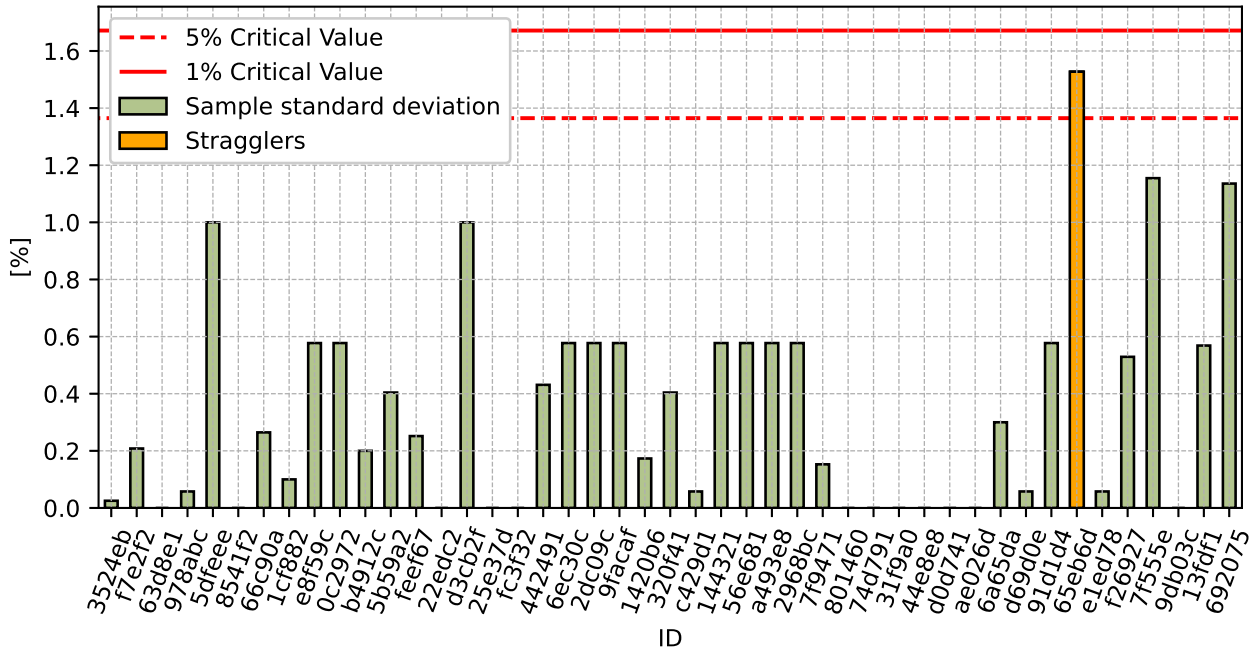

Figure 46: **Cochran's test** - sample standard deviations without outliers

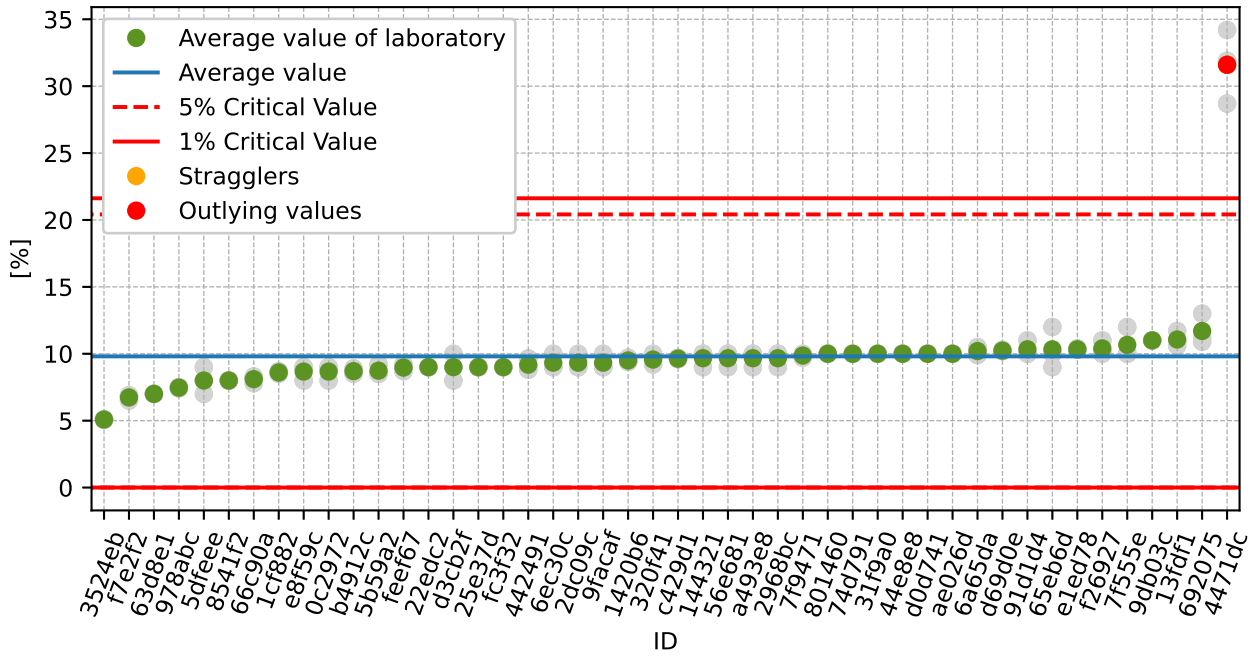

Figure 47: **Grubbs' test** - average values

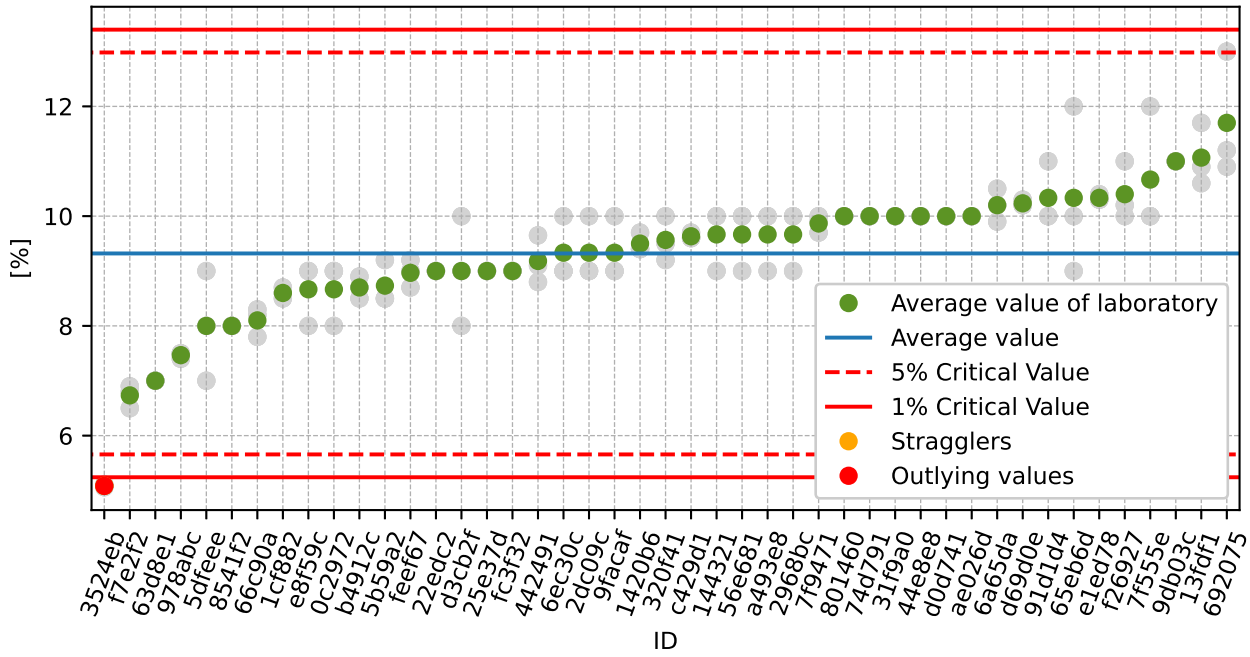

Figure 48: **Grubbs' test** - average values without outliers

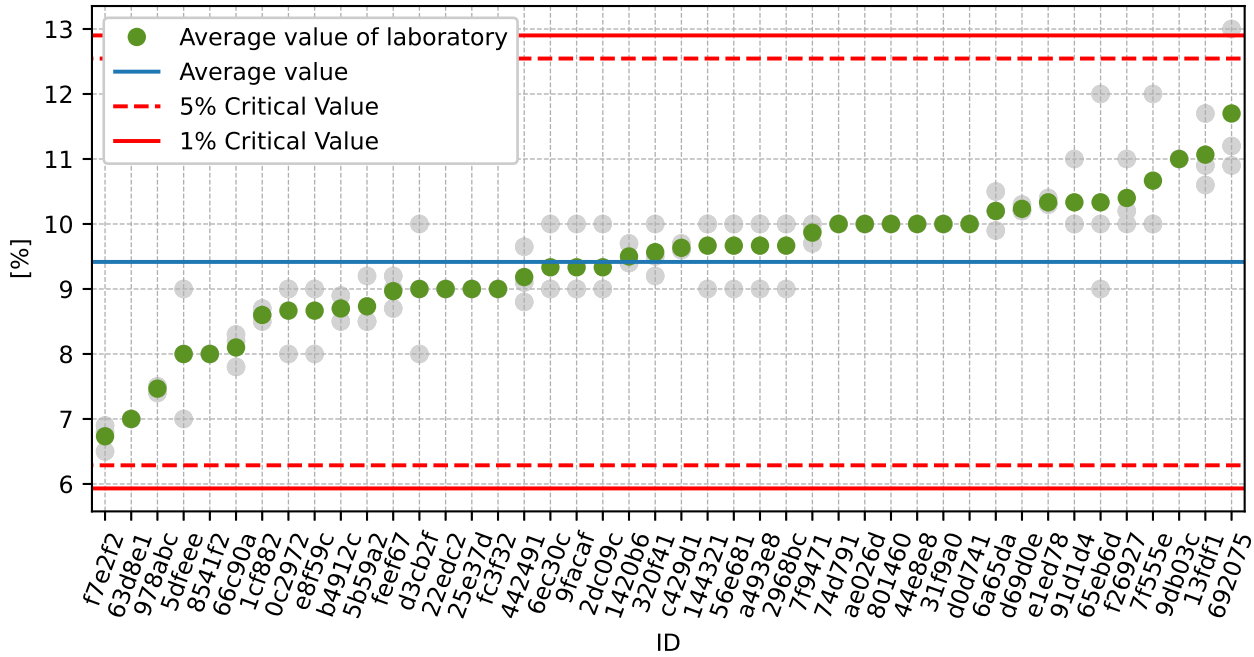

Figure 49: **Grubbs' test** - average values without outliers

1.5.3 Mandel's Statistics

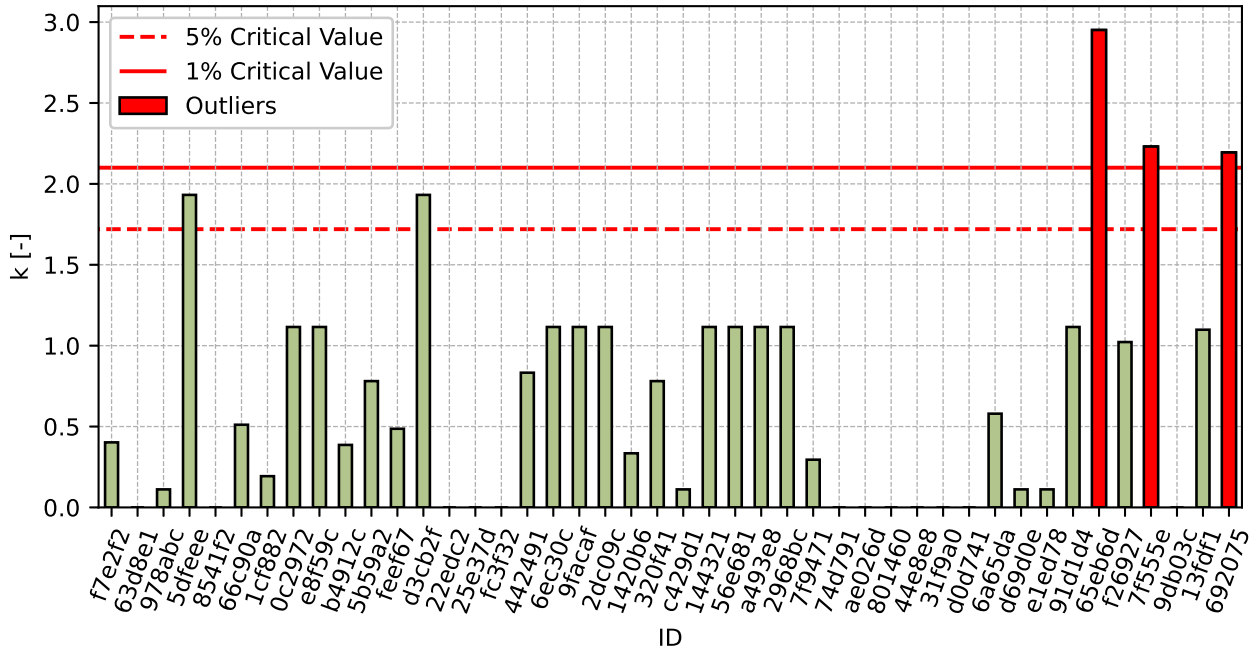

Figure 50: Intralaboratory Consistency Statistic

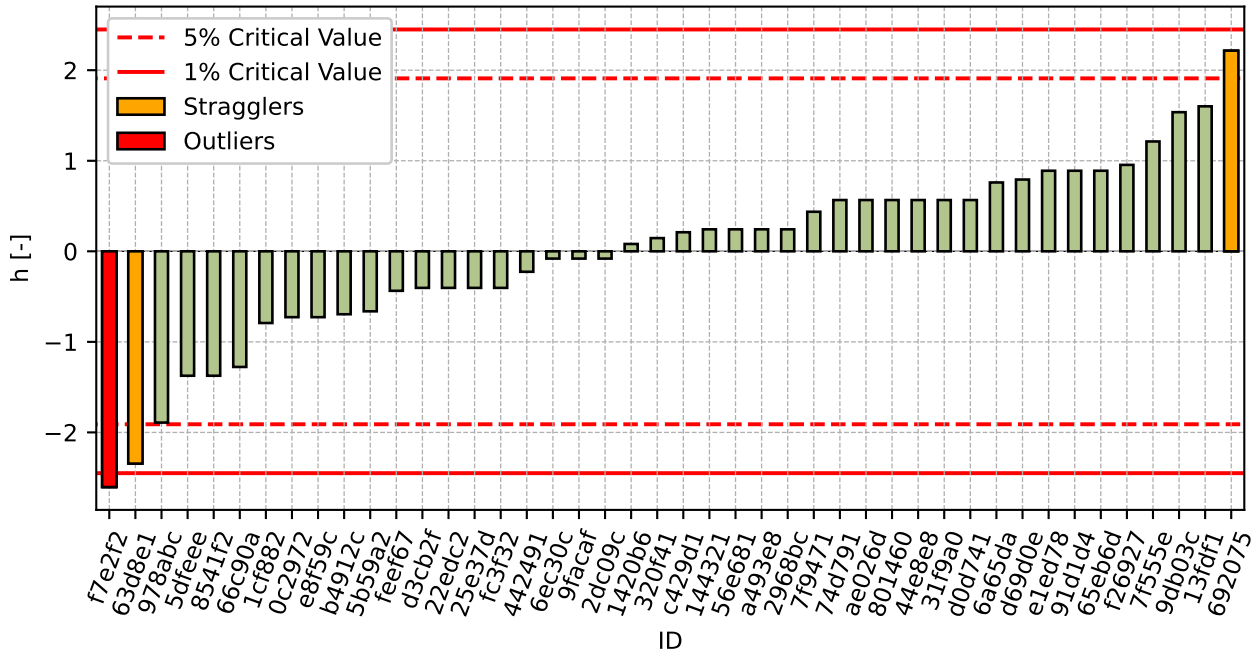

Figure 51: Interlaboratory Consistency Statistic

1.5.4 Descriptive statistics

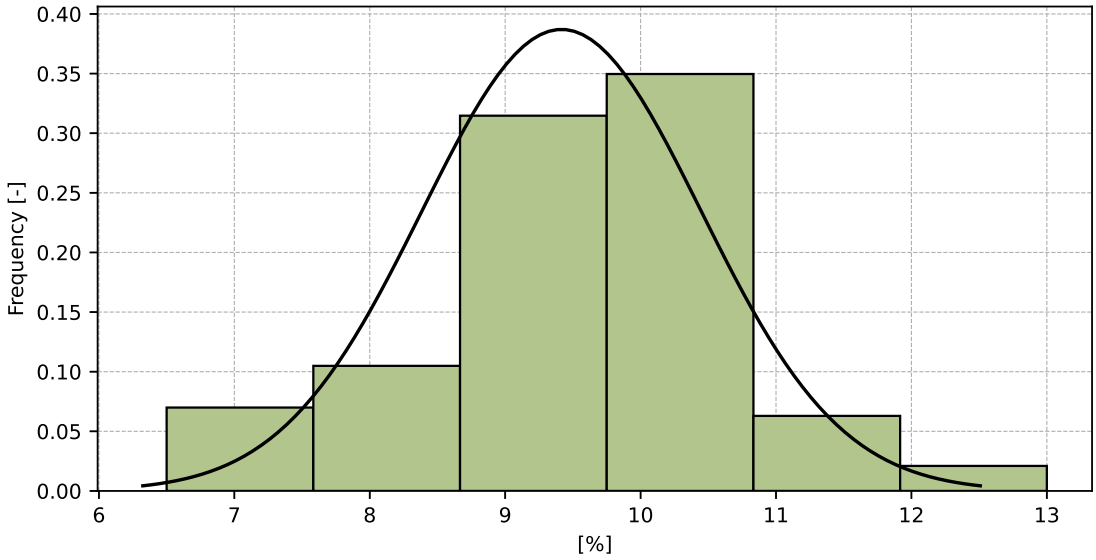

Figure 52: Histogram of all test results

Table 18: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	9.4
Sample standard deviation – s	1.03
Asigned value – x^*	9.4
Robust standard deviation – s^*	1.03
Measurement uncertainty of asigned value – u_X	0.16
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.99
Repeatability standard deviation – s_r	0.52
Reproducibility standard deviation – s_R	1.11
Repeatability – r	1.4
Reproducibility – R	3.1

1.5.5 Evaluation of Performance Statistics

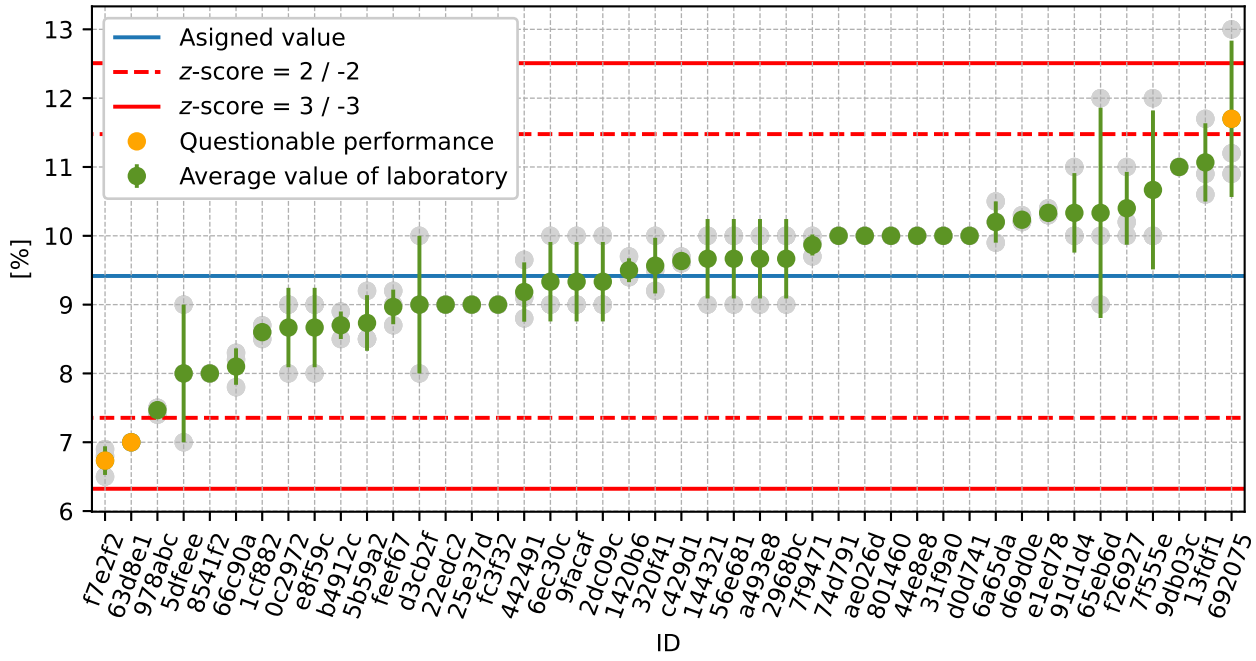

Figure 53: Average values and sample standard deviations

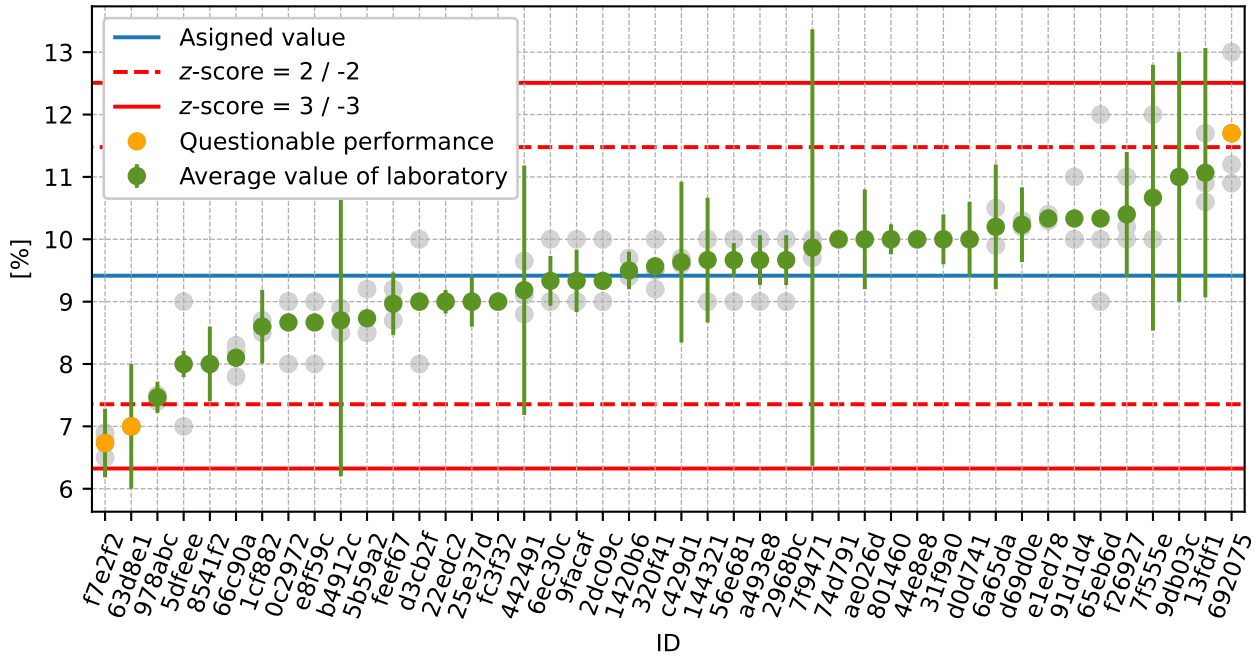

Figure 54: Average values and extended uncertainties of measurement

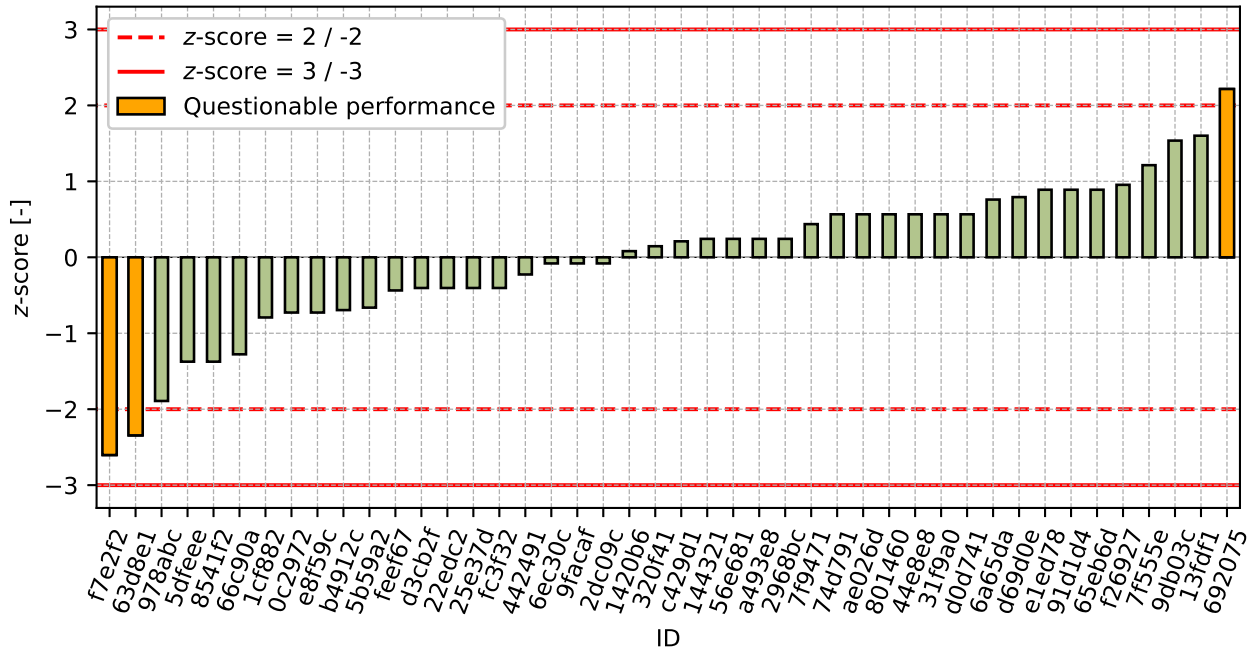

Figure 55: z-score

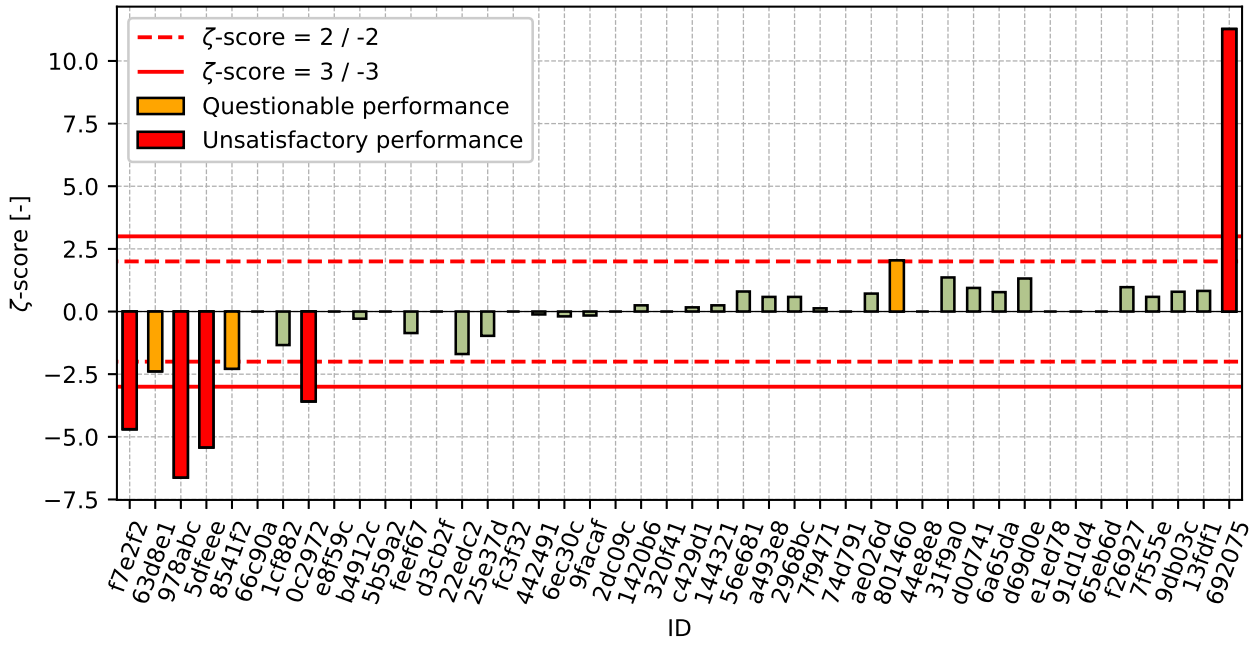

Figure 56: ζ-score

Table 19: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f7e2f2	-2.6	-4.69

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ID	*z*-score [-]	ζ-score [-]
63d8e1	-2.34	-2.39
978abc	-1.89	-6.62
5dfeee	-1.37	-5.42
8541f2	-1.37	-2.29
66c90a	-1.28	-
1cf882	-0.79	-1.34
0c2972	-0.73	-3.58
e8f59c	-0.73	-
b4912c	-0.69	-0.29
5b59a2	-0.66	-
feef67	-0.44	-0.86
d3cb2f	-0.4	-
22edc2	-0.4	-1.7
25e37d	-0.4	-0.97
fc3f32	-0.4	-
442491	-0.23	-0.12
6ec30c	-0.08	-0.19
9facaf	-0.08	-0.16
2dc09c	-0.08	-
1420b6	0.08	0.25
320f41	0.15	-
c429d1	0.21	0.17
144321	0.24	0.25
56e681	0.24	0.8
a493e8	0.24	0.58
2968bc	0.24	0.58
7f9471	0.44	0.13
74d791	0.57	-
ae026d	0.57	0.72
801460	0.57	2.04
44e8e8	0.57	-
31f9a0	0.57	1.36
d0d741	0.57	0.94
6a65da	0.76	0.77
d69d0e	0.79	1.32
e1ed78	0.89	-
91d1d4	0.89	-
65eb6d	0.89	-
f26927	0.95	0.97
7f555e	1.21	0.59
9db03c	1.54	0.79
13fdf1	1.6	0.82
692075	2.22	11.27

1.6 0.125 mm

1.6.1 Test results

Table 20: 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 [%]
3524eb	0.5	0.5	0.5	0.0	0.5	0.02	3.1
f7e2f2	0.7	1.0	0.8	0.4	0.8	0.15	18.33
978abc	0.9	0.9	1.0	0.2	0.9	0.06	6.19
2dc09c	1.0	1.0	1.0	-	1.0	0.0	0.0
144321	1.0	1.0	1.0	1.0	1.0	0.0	0.0
63d8e1	1.0	1.0	1.0	1.0	1.0	0.0	0.0
5dfeee	1.0	1.0	1.0	0.0	1.0	0.0	0.0
7f555e	1.0	1.0	1.0	1.6	1.0	0.0	0.0
25e37d	1.0	1.0	1.0	0.4	1.0	0.0	0.0
0c2972	1.0	1.0	1.0	0.1	1.0	0.0	0.0
e8f59c	1.0	1.0	1.0	-	1.0	0.0	0.0
5b59a2	1.5	0.9	1.3	-	1.2	0.31	24.77
c429d1	1.3	1.2	1.3	0.2	1.3	0.06	4.56
66c90a	1.3	1.4	1.3	-	1.3	0.06	4.33
442491	1.3	1.5	1.8	2.0	1.5	0.24	15.69
320f41	1.9	1.3	1.4	-	1.5	0.32	20.96
b4912c	1.6	1.5	1.6	1.2	1.6	0.06	3.69
7f9471	1.7	1.5	1.5	3.5	1.6	0.12	7.37
feef67	1.6	1.6	1.7	0.5	1.6	0.06	3.53
9facaf	2.0	2.0	1.0	0.5	1.7	0.58	34.64
8541f2	2.0	1.0	2.0	0.2	1.7	0.58	34.64
1420b6	1.8	1.8	1.8	0.1	1.8	0.0	0.0
1cf882	1.7	1.8	2.0	0.4	1.8	0.15	8.33
74d791	2.0	2.0	2.0	-	2.0	0.0	0.0
a493e8	2.0	2.0	2.0	0.4	2.0	0.0	0.0
31f9a0	2.0	2.0	2.0	0.4	2.0	0.0	0.0
56e681	2.0	2.0	2.0	0.0	2.0	0.0	0.0
d3cb2f	2.0	2.0	2.0	-	2.0	0.0	0.0
9db03c	2.0	2.0	2.0	1.0	2.0	0.0	0.0
ae026d	2.0	2.0	2.0	0.8	2.0	0.0	0.0
fc3f32	2.0	2.0	2.0	-	2.0	0.0	0.0
d0d741	2.0	2.0	2.0	0.2	2.0	0.0	0.0
91d1d4	2.0	2.0	2.0	-	2.0	0.0	0.0
801460	2.0	2.0	2.0	0.1	2.0	0.0	0.0
e1ed78	2.0	2.0	2.0	-	2.0	0.0	0.0
22edc2	2.0	2.0	2.0	0.1	2.0	0.0	0.0

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ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
6ec30c	2.0	2.0	2.0	0.4	2.0	0.0	0.0
44e8e8	2.0	2.0	2.0	-	2.0	0.0	0.0
2968bc	2.0	2.0	2.0	0.2	2.0	0.0	0.0
6a65da	2.0	2.1	2.0	1.0	2.0	0.06	2.84
d69d0e	2.1	2.0	2.0	0.6	2.0	0.06	2.84
f26927	1.8	2.9	2.1	1.0	2.3	0.57	25.09
13fdf1	2.4	2.2	2.3	2.0	2.3	0.1	4.35
65eb6d	2.0	3.0	2.0	-	2.3	0.58	24.74
692075	2.4	2.4	2.5	0.1	2.4	0.06	2.37
4471dc	8.4	11.0	10.0	-	9.8	1.31	13.38

1.6.2 The Numerical Procedure for Determining Outliers

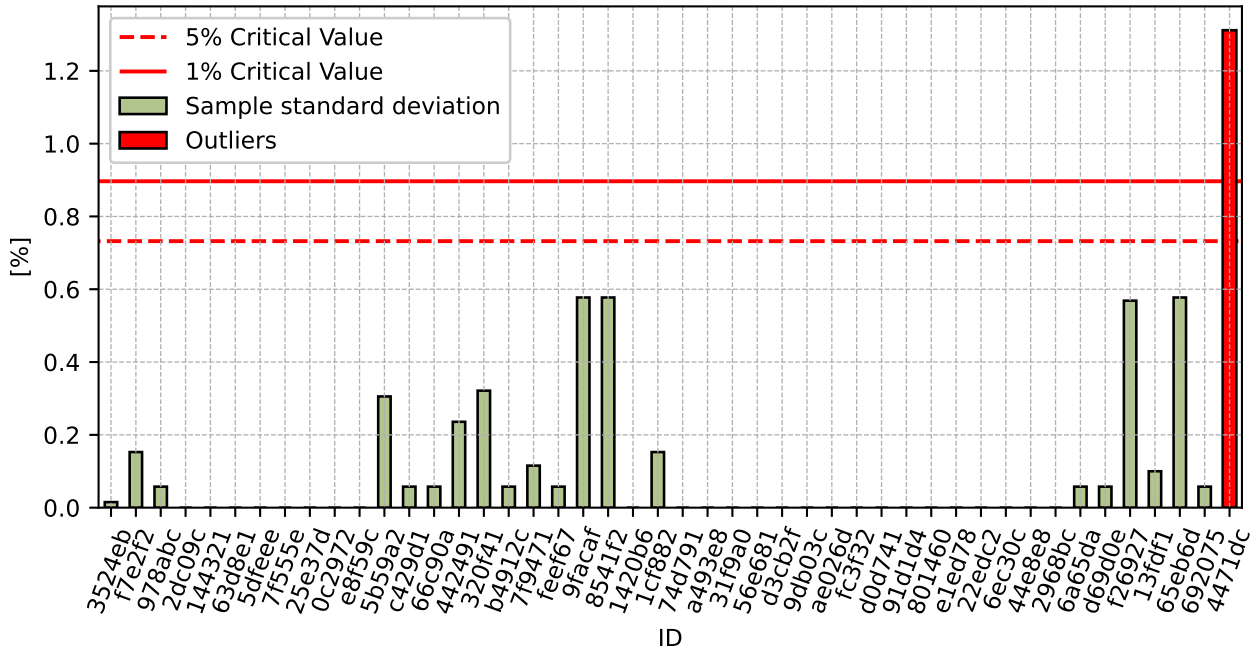

Figure 57: **Cochran's test** - sample standard deviations

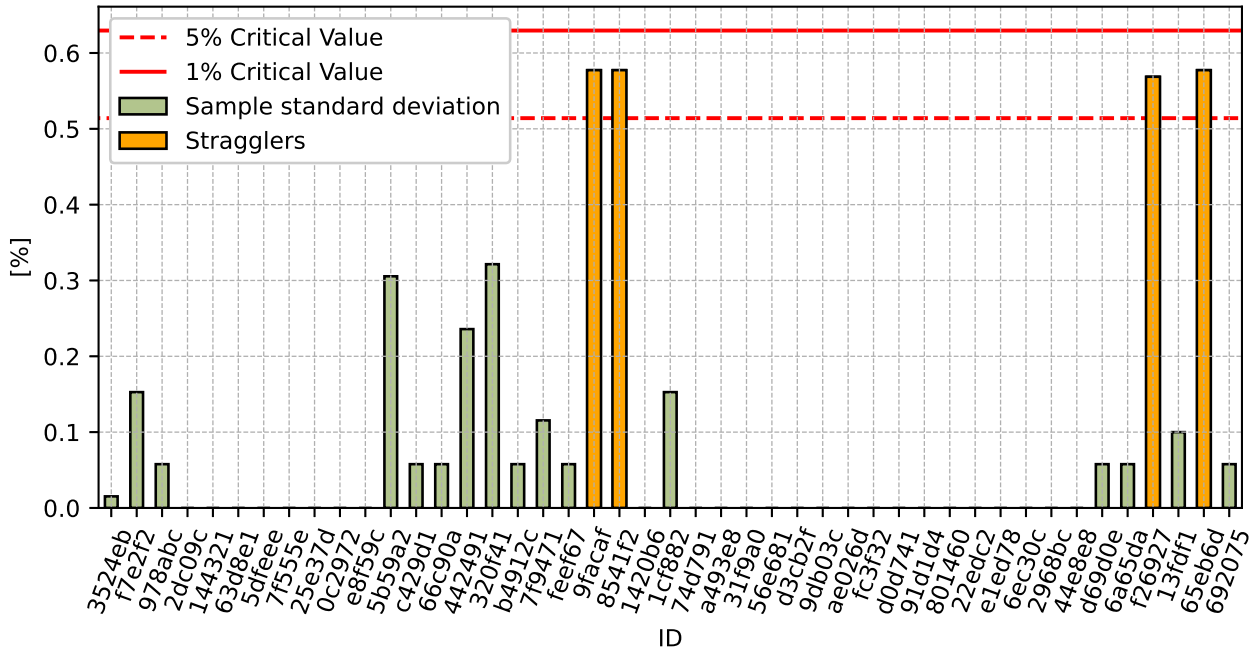

Figure 58: **Cochran's test** - sample standard deviations without outliers

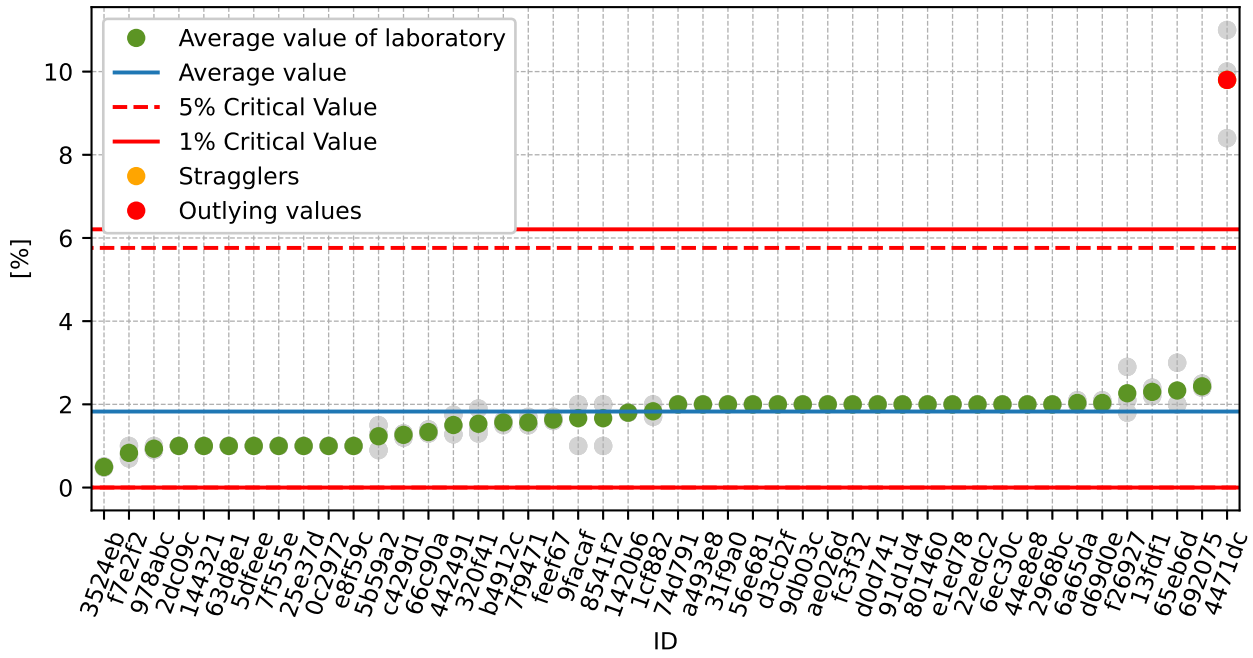

Figure 59: **Grubbs' test** - average values

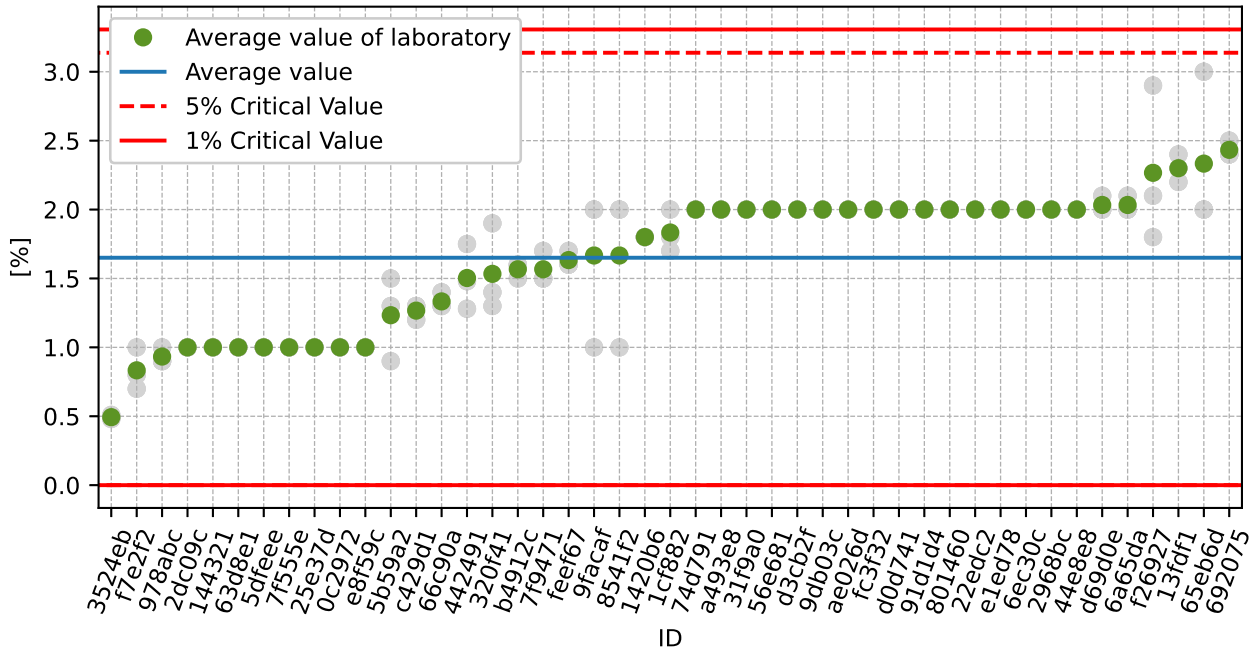

Figure 60: **Grubbs' test** - average values without outliers

1.6.3 Mandel's Statistics

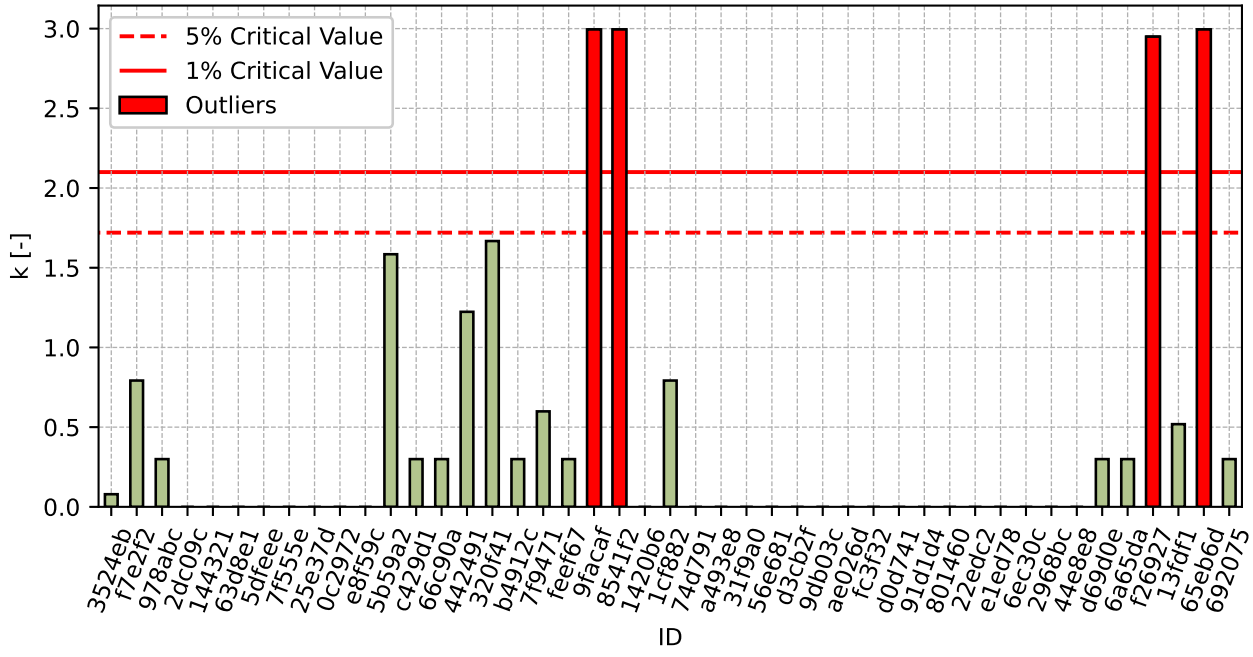

Figure 61: Intralaboratory Consistency Statistic

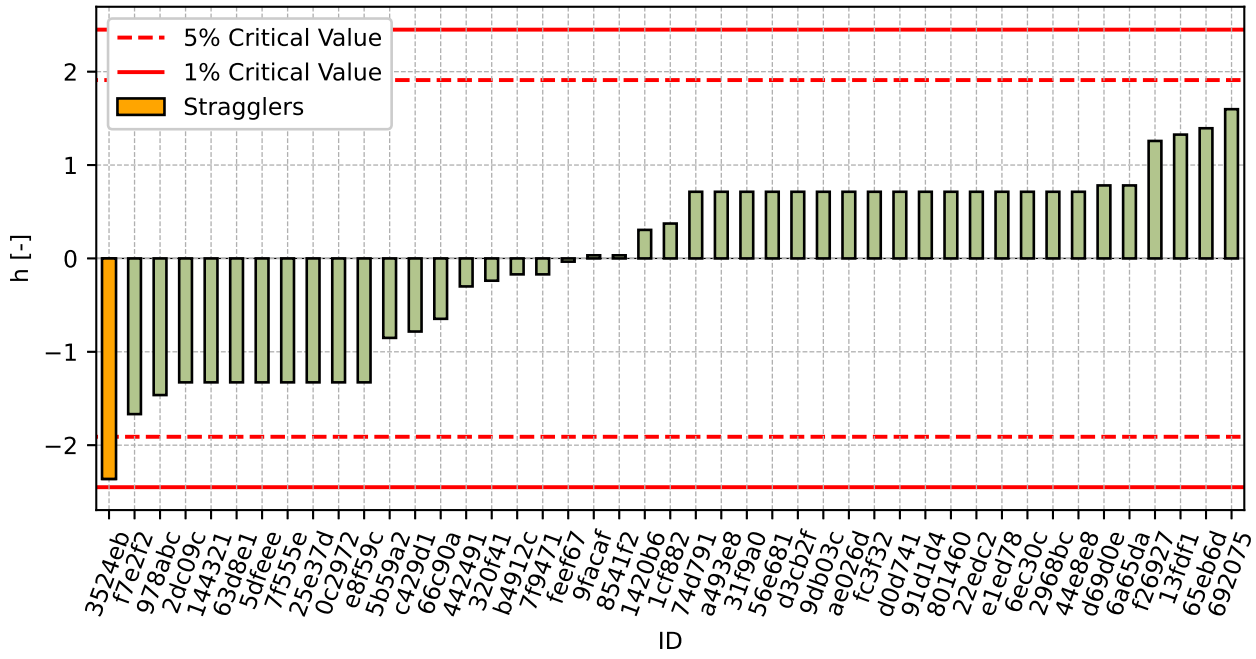

Figure 62: Interlaboratory Consistency Statistic

1.6.4 Descriptive statistics

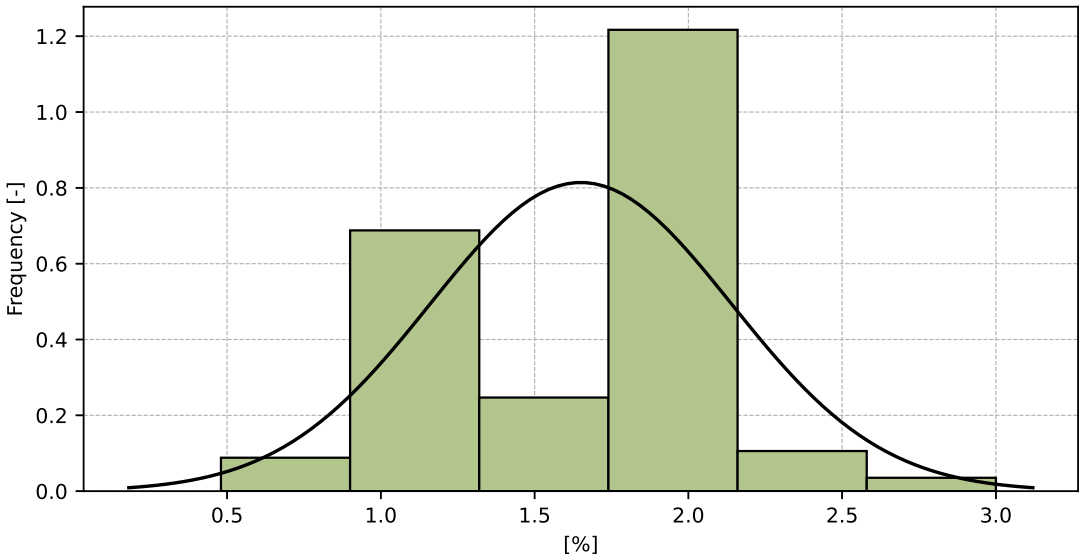

Figure 63: Histogram of all test results

Table 21: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	1.7
Sample standard deviation – s	0.49
Asigned value – x^*	1.7
Robust standard deviation – s^*	0.49
Measurement uncertainty of asigned value – u_X	0.07
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.48
Repeatability standard deviation – s_r	0.19
Reproducibility standard deviation – s_R	0.51
Repeatability – r	0.5
Reproducibility – R	1.4

1.6.5 Evaluation of Performance Statistics

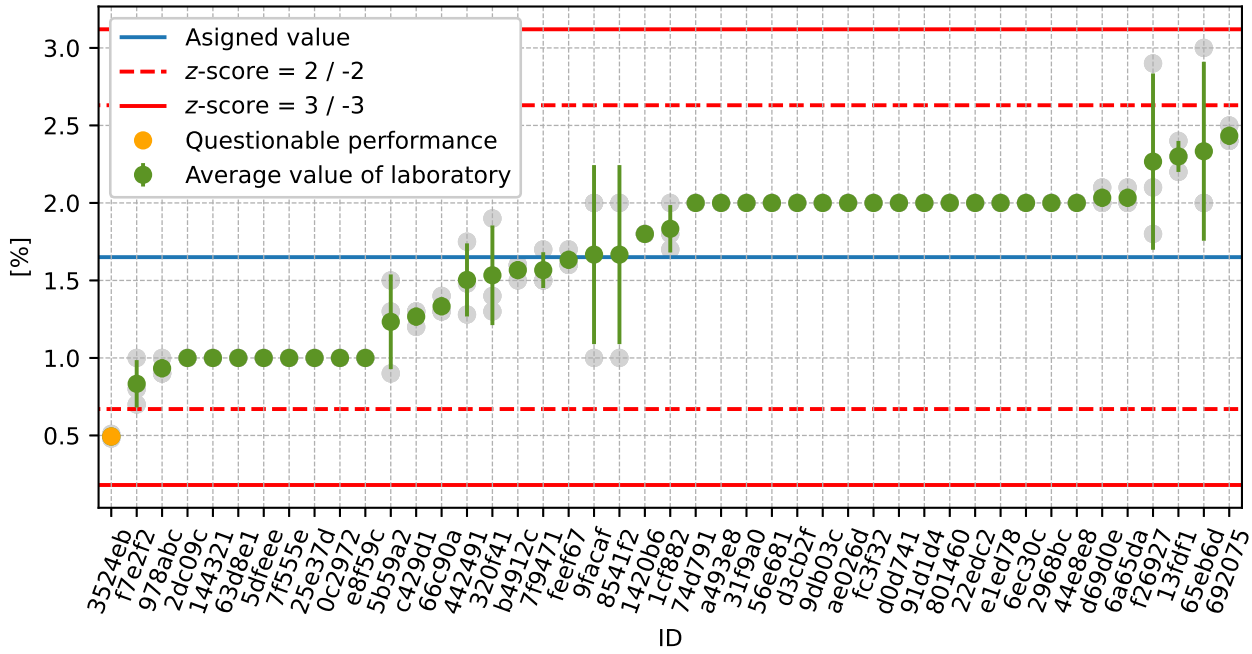

Figure 64: Average values and sample standard deviations

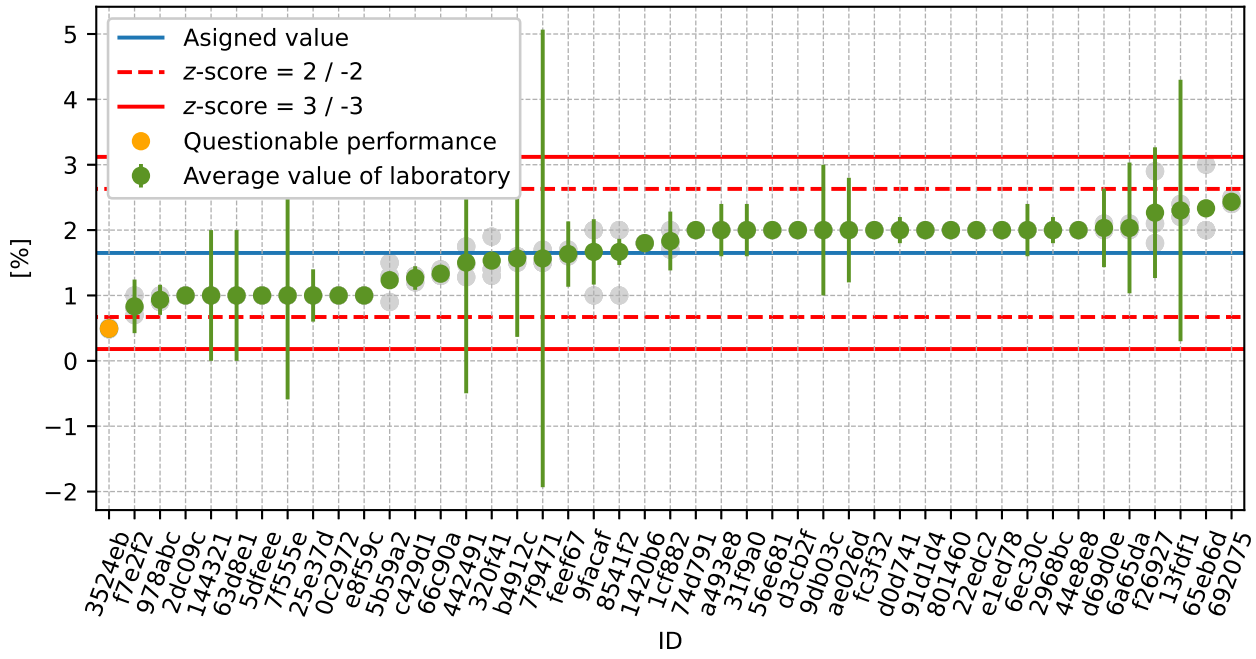

Figure 65: Average values and extended uncertainties of measurement

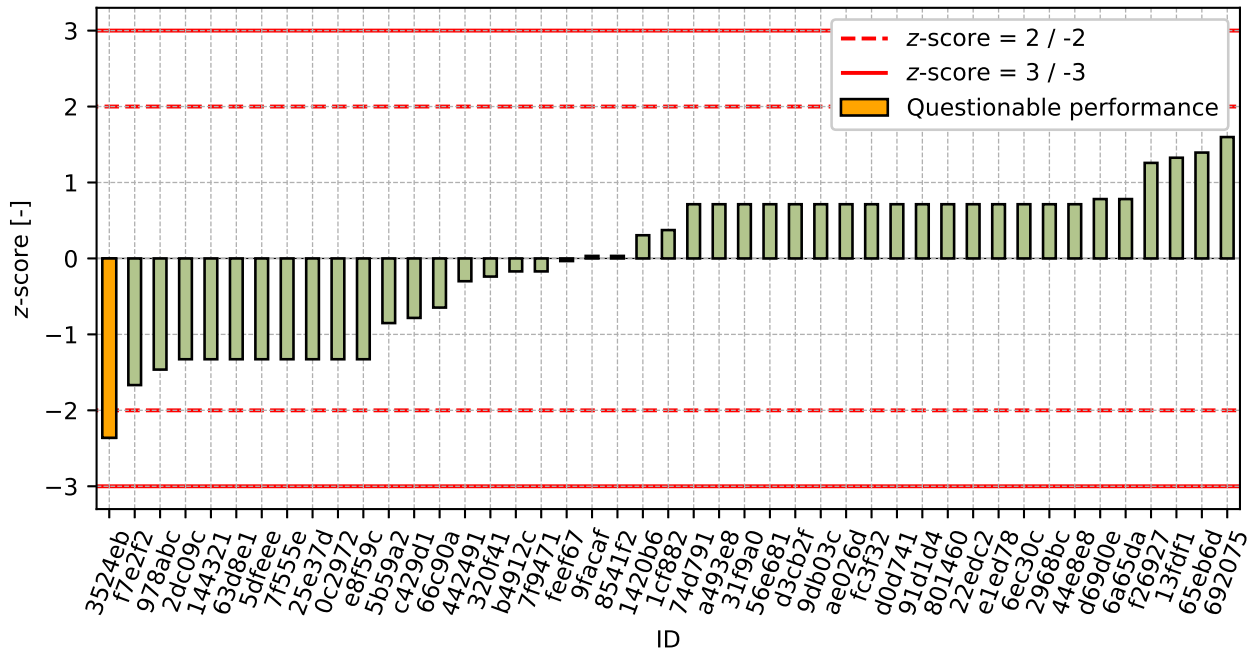

Figure 66: z-score

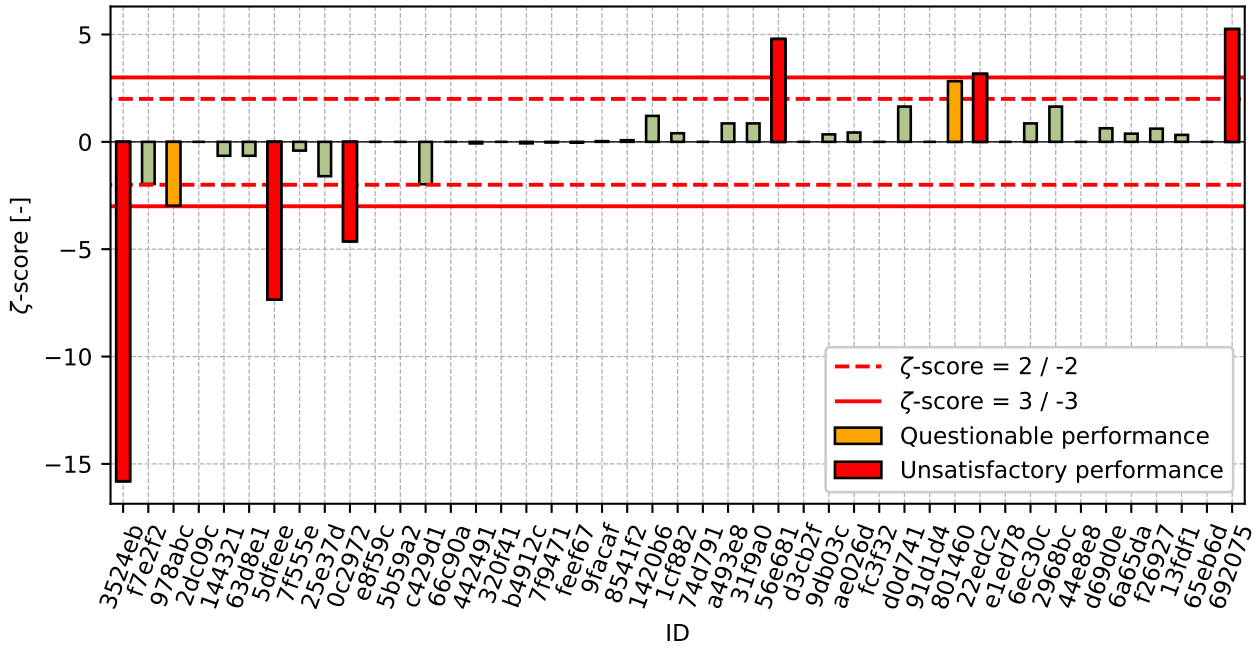

Figure 67: ζ-score

Table 22: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
3524eb	-2.36	-15.8
f7e2f2	-1.67	-1.96
978abc	-1.46	-2.97
2dc09c	-1.33	-
144321	-1.33	-0.65
63d8e1	-1.33	-0.65
5dfeee	-1.33	-7.35
7f555e	-1.33	-0.41
25e37d	-1.33	-1.6
0c2972	-1.33	-4.63
e8f59c	-1.33	-
5b59a2	-0.85	-
c429d1	-0.78	-1.97
66c90a	-0.65	-
442491	-0.3	-0.07
320f41	-0.24	-
b4912c	-0.17	-0.07
7f9471	-0.17	-0.02
feef67	-0.03	-0.03
9facaf	0.03	0.03
8541f2	0.03	0.08
1420b6	0.31	1.21
1cf882	0.37	0.4

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ID	z-score [-]	ζ-score [-]
74d791	0.71	-
a493e8	0.71	0.86
31f9a0	0.71	0.86
56e681	0.71	4.79
d3cb2f	0.71	-
9db03c	0.71	0.35
ae026d	0.71	0.44
fc3f32	0.71	-
d0d741	0.71	1.64
91d1d4	0.71	-
801460	0.71	2.82
22edc2	0.71	3.16
e1ed78	0.71	-
6ec30c	0.71	0.86
2968bc	0.71	1.64
44e8e8	0.71	-
d69d0e	0.78	0.63
6a65da	0.78	0.38
f26927	1.26	0.61
13fdf1	1.33	0.32
65eb6d	1.39	-
692075	1.6	5.25

1.7 0.063 mm

1.7.1 Test results

Table 23: 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 [%]
f7e2f2	0.1	0.1	0.1	0.0	0.1	0.02	19.25
3524eb	0.1	0.1	0.1	0.0	0.1	0.01	6.19
2dc09c	0.2	0.2	0.1	-	0.2	0.06	34.64
144321	0.2	0.2	0.2	0.1	0.2	0.0	0.0
978abc	0.2	0.2	0.2	0.0	0.2	0.0	0.0
e8f59c	0.2	0.2	0.2	-	0.2	0.0	0.0
25e37d	0.3	0.3	0.3	0.4	0.3	0.0	0.0
7f555e	0.3	0.4	0.2	1.0	0.3	0.1	33.33
c429d1	0.3	0.3	0.3	0.1	0.3	0.0	0.0
5b59a2	0.5	0.1	0.3	-	0.3	0.2	66.67
1cf882	0.3	0.3	0.3	0.4	0.3	0.0	0.0
feef67	0.4	0.4	0.3	0.1	0.4	0.01	2.86
63d8e1	0.2	0.6	0.3	0.1	0.4	0.21	56.77
0c2972	0.3	0.5	0.4	0.1	0.4	0.1	25.0
b4912c	0.6	0.5	0.5	0.6	0.5	0.06	10.83
442491	0.6	0.8	0.5	2.0	0.6	0.15	23.06
8541f2	0.7	0.5	0.7	0.1	0.6	0.12	18.23
7f9471	0.8	0.6	0.6	3.5	0.7	0.12	17.32
66c90a	0.6	0.7	0.7	-	0.7	0.06	8.66
9facaf	0.6	0.8	0.7	0.2	0.7	0.1	14.29
801460	0.7	0.7	0.7	0.1	0.7	0.0	0.0
22edc2	0.7	0.9	0.8	0.1	0.8	0.1	12.5
1420b6	0.9	0.8	0.8	0.0	0.8	0.06	6.93
2968bc	0.8	1.0	0.8	0.2	0.9	0.12	13.32
6ec30c	0.9	0.8	0.9	0.4	0.9	0.06	6.66
ae026d	1.0	0.7	0.9	0.1	0.9	0.15	17.63
74d791	1.0	0.8	0.9	-	0.9	0.1	11.11
a493e8	0.9	0.9	0.9	0.4	0.9	0.0	0.0
d3cb2f	1.0	1.0	0.7	-	0.9	0.17	19.25
d0d741	0.9	0.8	1.0	0.1	0.9	0.1	11.11
d69d0e	1.0	0.9	0.9	0.6	0.9	0.06	6.19
31f9a0	1.0	0.9	0.9	0.4	0.9	0.06	6.19
320f41	1.1	0.8	0.9	-	0.9	0.15	16.37
fc3f32	1.0	1.0	0.9	-	1.0	0.06	5.97
9db03c	0.8	1.1	1.0	1.0	1.0	0.15	15.8
5dfeee	1.0	1.0	1.0	0.0	1.0	0.0	0.0

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ID	Test results			u_X	$\bar{x}$	s_0	V_X
		[%]		[%]	[%]	[%]	[%]
e1ed78	1.0	1.0	1.0	-	1.0	0.0	0.0
56e681	1.0	1.1	1.0	0.0	1.0	0.06	5.59
6a65da	1.0	1.1	1.0	1.0	1.0	0.06	5.59
65eb6d	1.2	1.1	1.1	-	1.1	0.06	5.09
91d1d4	1.2	1.1	1.1	-	1.1	0.06	5.09
44e8e8	1.2	1.3	1.1	-	1.2	0.1	8.33
13fdf1	1.3	1.3	1.1	1.0	1.2	0.12	9.36
f26927	0.9	2.0	1.1	1.0	1.3	0.59	43.95
4471dc	1.2	1.5	1.3	-	1.3	0.15	11.46
692075	1.5	1.4	1.3	0.1	1.4	0.1	7.14

1.7.2 The Numerical Procedure for Determining Outliers

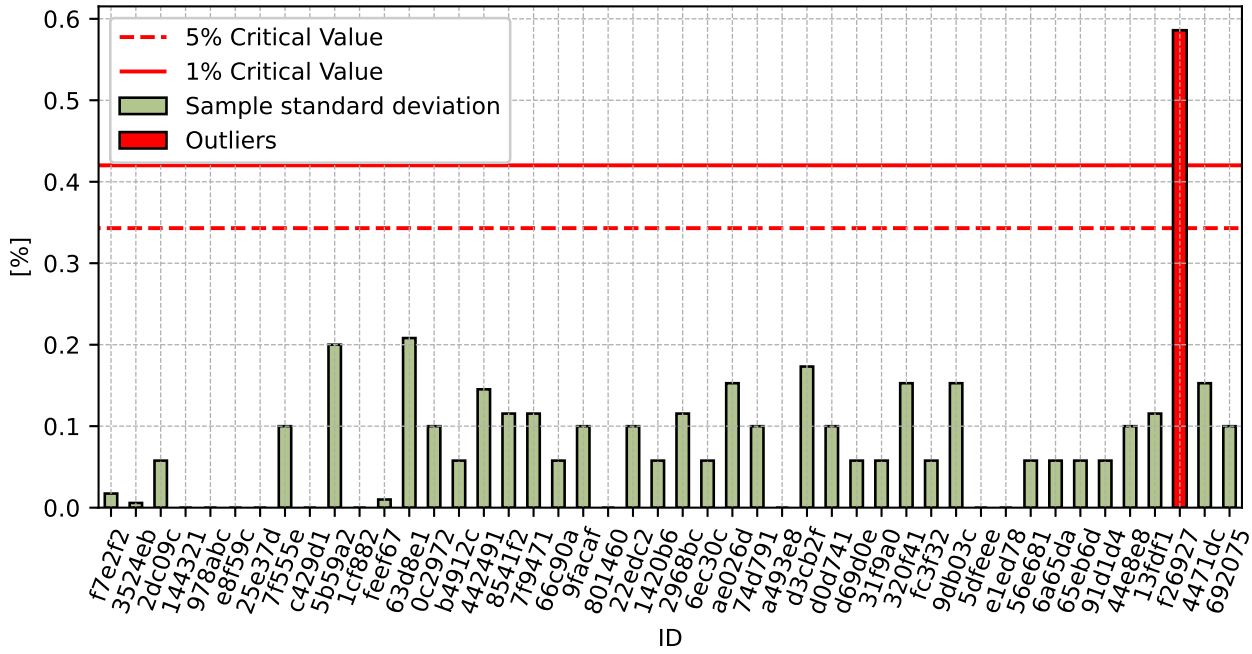

Figure 68: **Cochran's test** - sample standard deviations

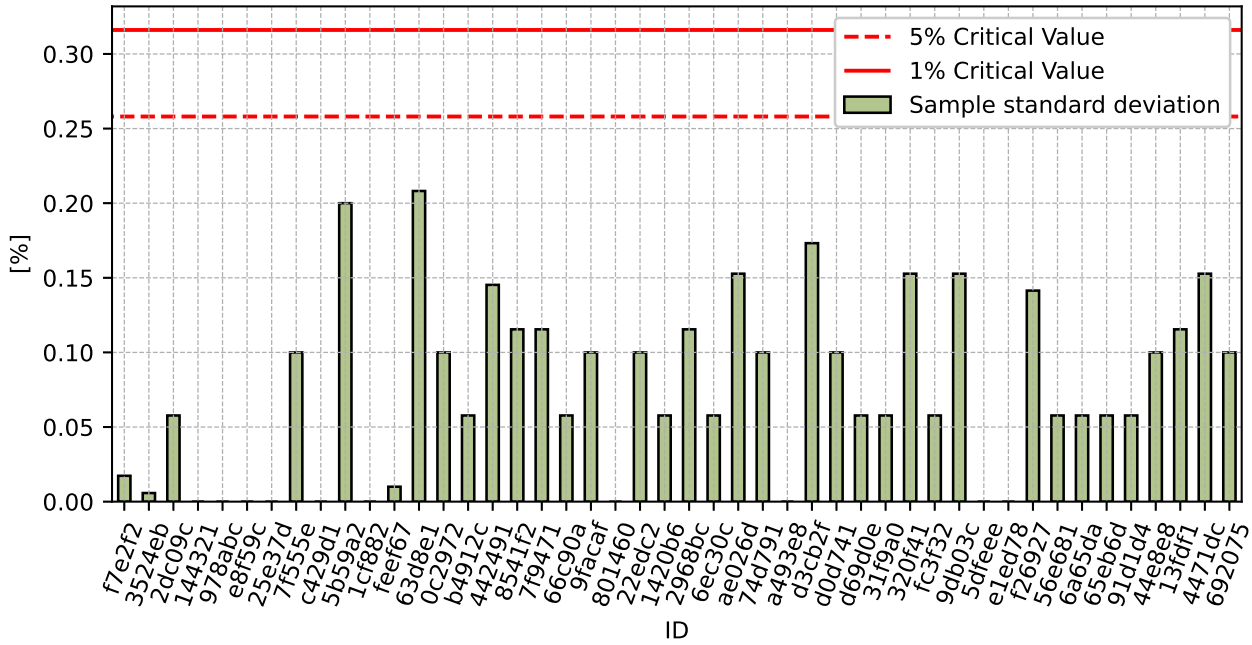

Figure 69: **Cochran's test** - sample standard deviations without outliers

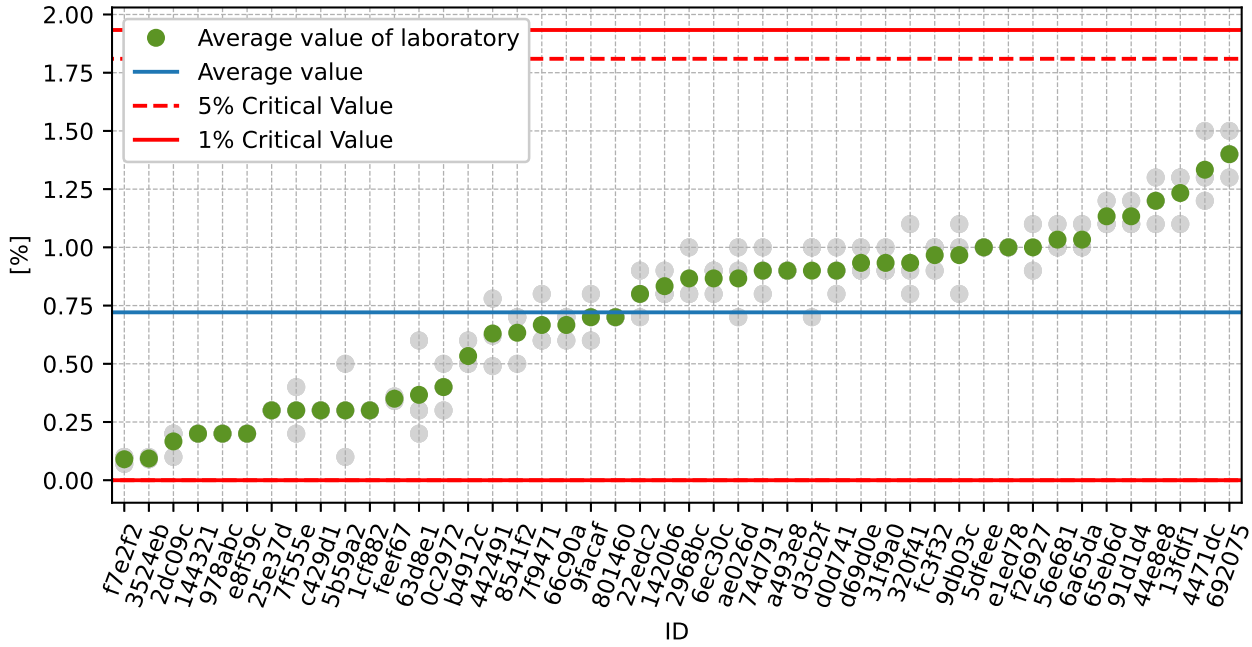

Figure 70: **Grubbs' test** - average values

1.7.3 Mandel's Statistics

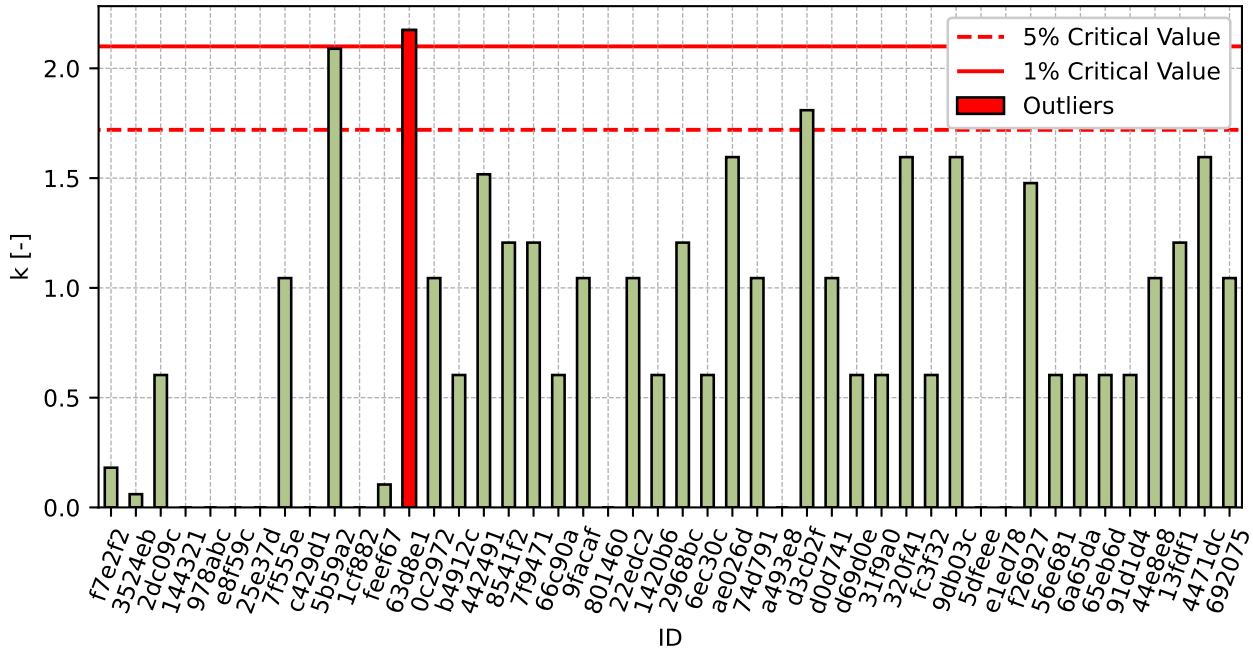

Figure 71: Intralaboratory Consistency Statistic

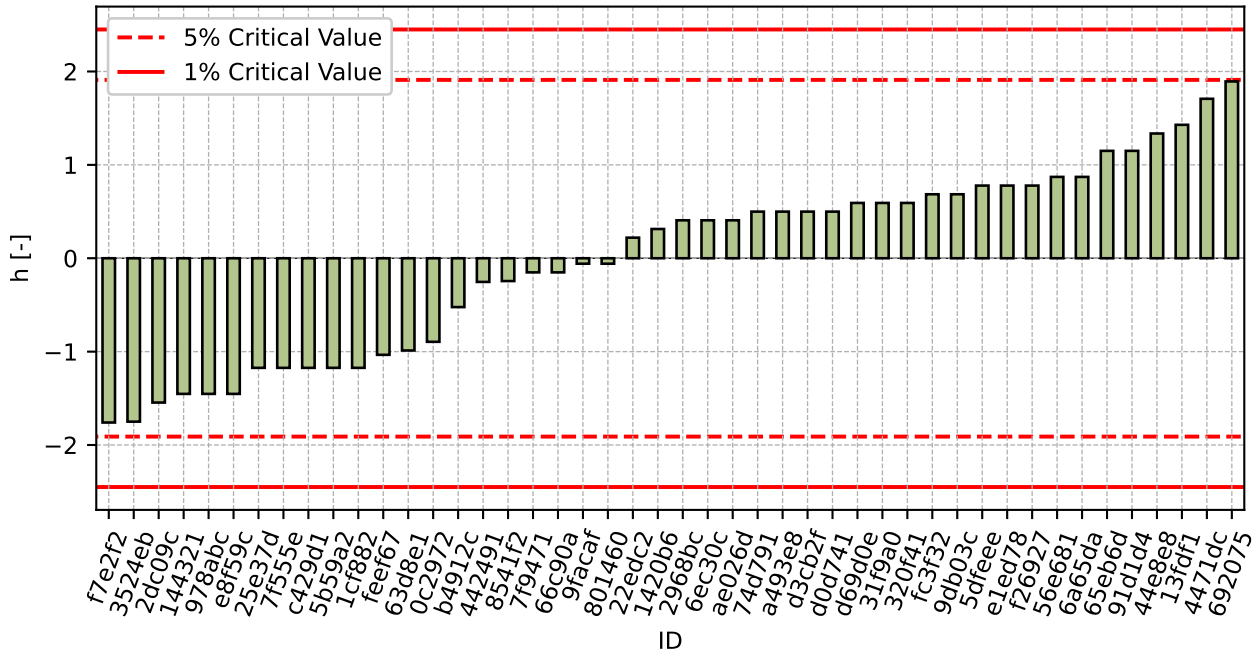

Figure 72: Interlaboratory Consistency Statistic

1.7.4 Descriptive statistics

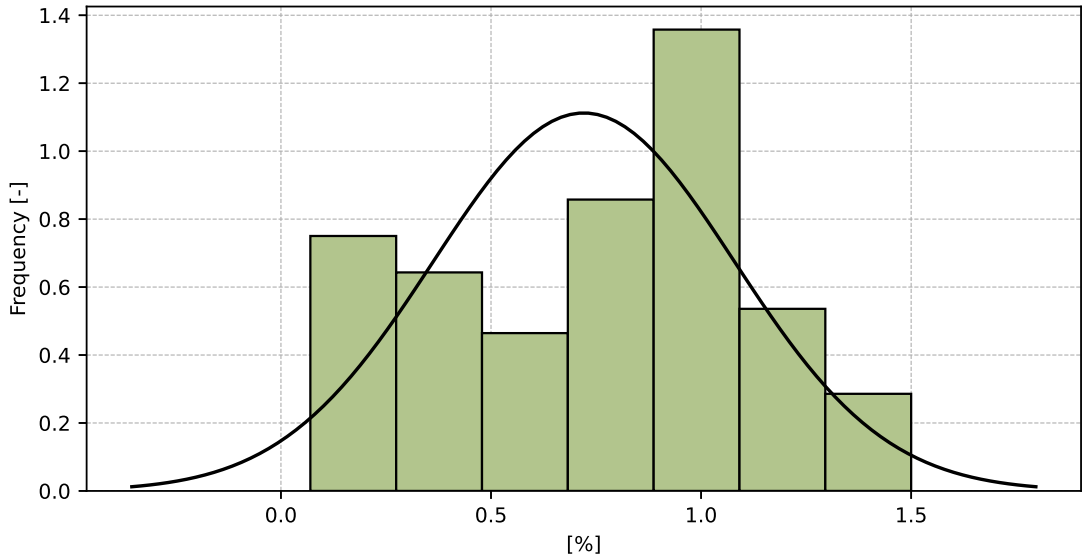

Figure 73: Histogram of all test results

Table 24: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	0.7
Sample standard deviation – s	0.36
Asigned value – x^*	0.7
Robust standard deviation – s^*	0.36
Measurement uncertainty of asigned value – u_X	0.05
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	0.35
Repeatability standard deviation – s_r	0.1
Reproducibility standard deviation – s_R	0.37
Repeatability – r	0.3
Reproducibility – R	1.0

1.7.5 Evaluation of Performance Statistics

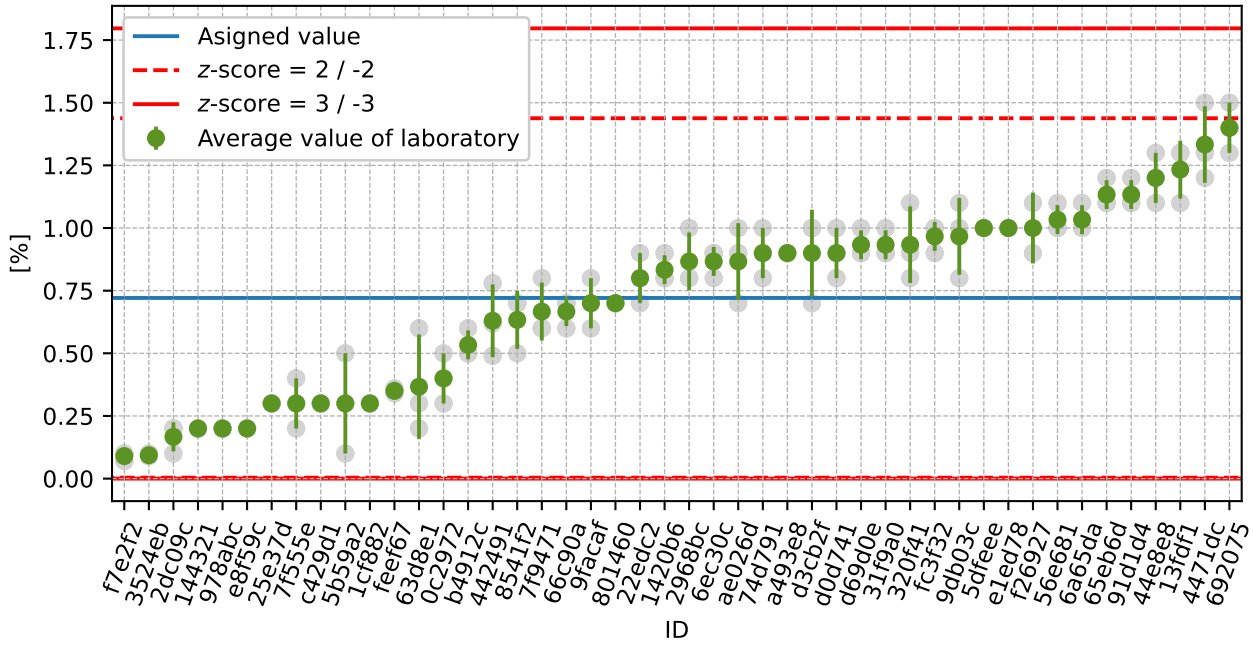

Figure 74: Average values and sample standard deviations

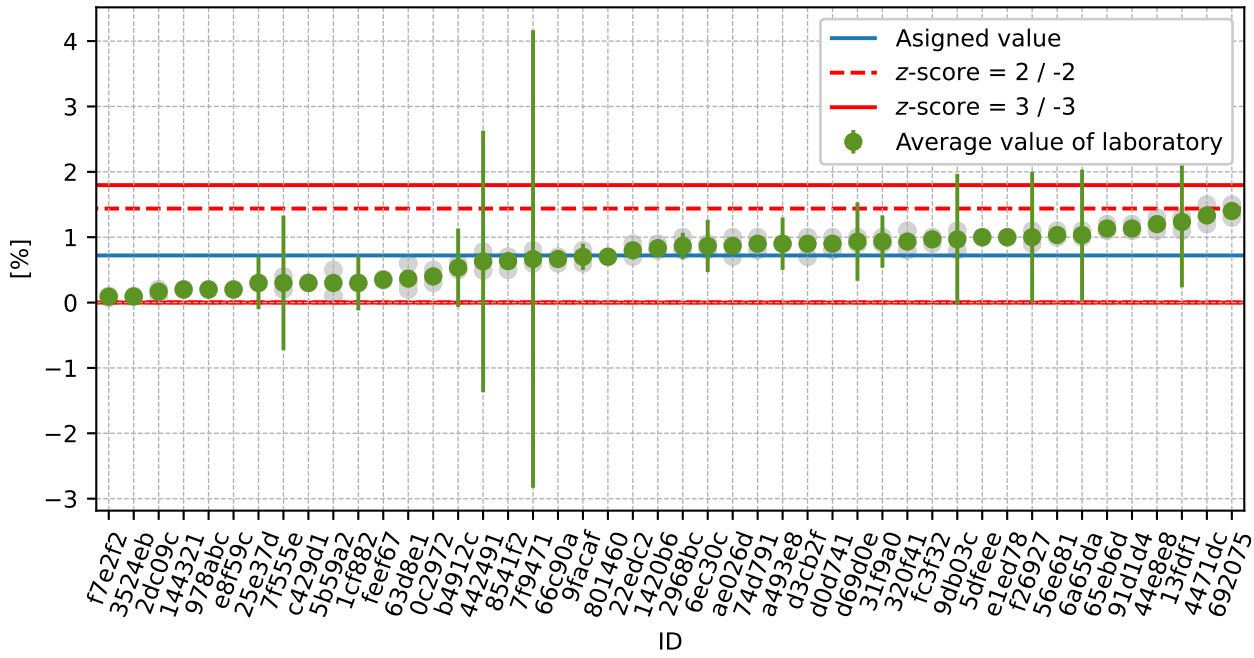

Figure 75: Average values and extended uncertainties of measurement

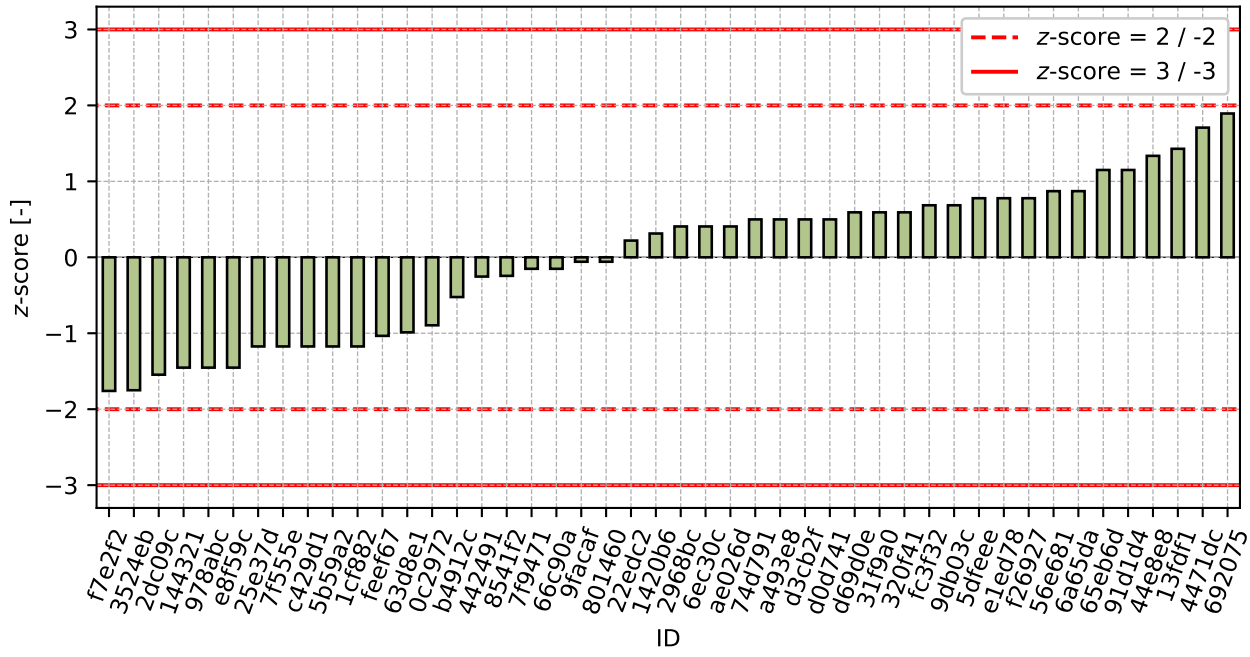

Figure 76: z-score

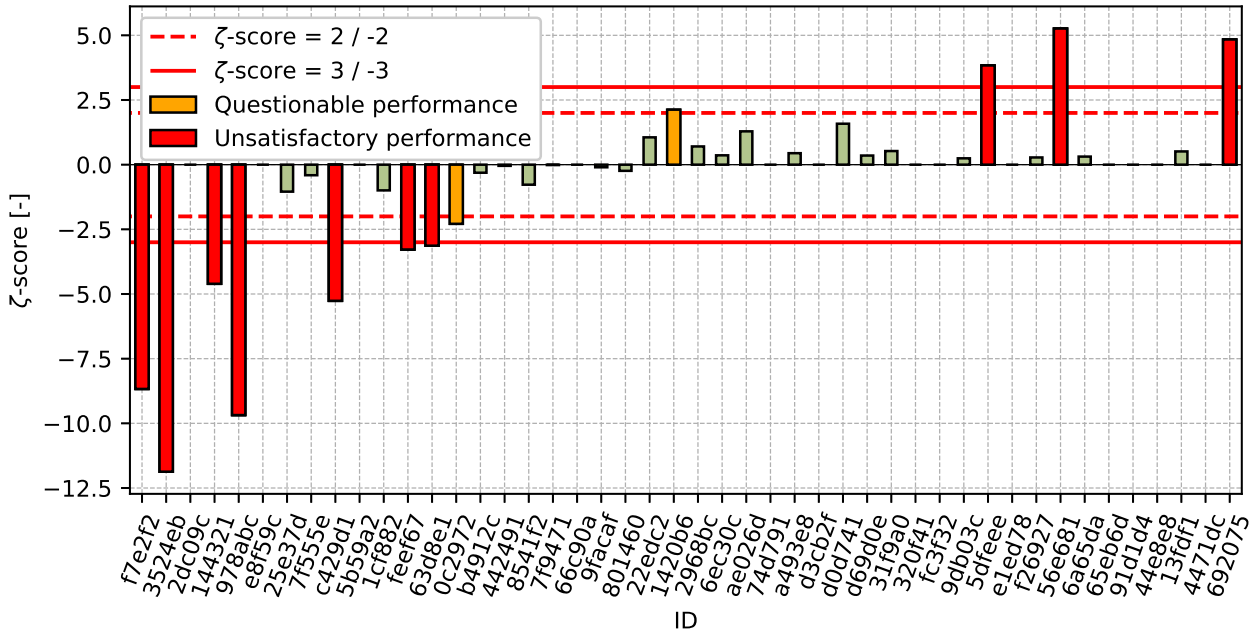

Figure 77: ζ-score

Table 25: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f7e2f2	-1.76	-8.67

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ID	*z*-score [-]	*ζ*-score [-]
3524eb	-1.75	-11.87
2dc09c	-1.55	-
144321	-1.45	-4.61
978abc	-1.45	-9.68
e8f59c	-1.45	-
25e37d	-1.17	-1.04
7f555e	-1.17	-0.41
c429d1	-1.17	-5.26
5b59a2	-1.17	-
1cf882	-1.17	-0.99
feef67	-1.03	-3.28
63d8e1	-0.99	-3.13
0c2972	-0.89	-2.29
b4912c	-0.52	-0.31
442491	-0.25	-0.05
8541f2	-0.24	-0.77
7f9471	-0.15	-0.02
66c90a	-0.15	-
9facaf	-0.06	-0.1
801460	-0.06	-0.24
22edc2	0.22	1.06
1420b6	0.31	2.13
2968bc	0.41	0.7
6ec30c	0.41	0.36
ae026d	0.41	1.29
74d791	0.5	-
a493e8	0.5	0.44
d3cb2f	0.5	-
d0d741	0.5	1.58
d69d0e	0.59	0.35
31f9a0	0.59	0.53
320f41	0.59	-
fc3f32	0.69	-
9db03c	0.69	0.25
5dfeee	0.78	3.83
e1ed78	0.78	-
f26927	0.78	0.28
56e681	0.87	5.26
6a65da	0.87	0.31
65eb6d	1.15	-
91d1d4	1.15	-
44e8e8	1.34	-
13fdf1	1.43	0.51
4471dc	1.71	-
692075	1.89	4.84

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ID	z-score [-]	ζ-score [-]

2 Appendix – EN 933-3 Determination of particle shape - Flakiness index

2.1 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 [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
9facaf	17.4	16.2	16.5	1.0	16.7	0.62	3.74
0c2972	22.0	21.0	21.0	1.4	21.3	0.58	2.71
5b59a2	22.1	22.5	22.6	0.6	22.4	0.26	1.18
b4912c	22.9	22.7	22.6	4.3	22.7	0.15	0.67
d34bb3	24.0	24.0	24.0	1.0	24.0	0.0	0.0
63d8e1	24.0	24.0	24.0	0.5	24.0	0.0	0.0
f9906c	25.0	24.0	24.0	2.0	24.3	0.58	2.37
bf844c	24.0	24.0	25.0	2.0	24.3	0.58	2.37
2dc09c	24.0	24.0	25.0	-	24.3	0.58	2.37
597047	24.0	25.0	26.0	1.8	25.0	1.0	4.0
d3cb2f	26.0	25.0	25.0	-	25.3	0.58	2.28
414fc6	28.0	27.0	28.0	-	27.7	0.58	2.09
c54811	28.3	27.4	28.6	-	28.1	0.62	2.22
ae026d	31.0	30.0	31.0	1.0	30.7	0.58	1.88
d6b7ab	31.0	29.0	33.0	0.2	31.0	2.0	6.45

2.2 The Numerical Procedure for Determining Outliers

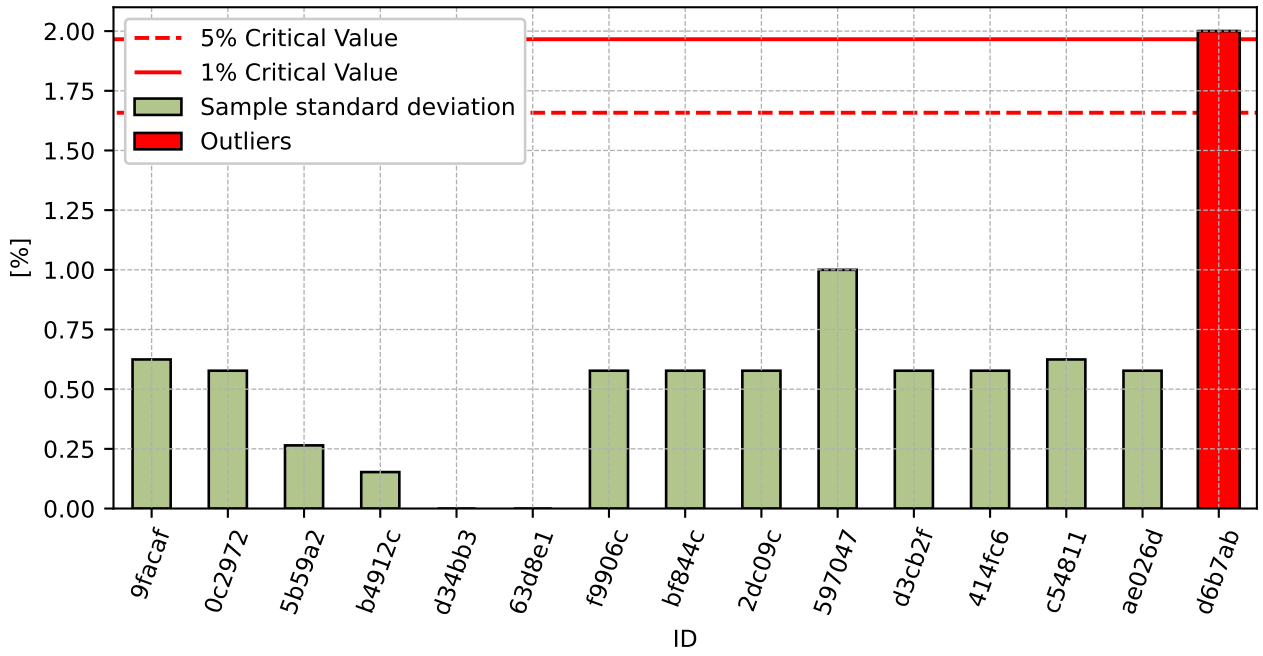

Figure 78: **Cochran's test** - sample standard deviations

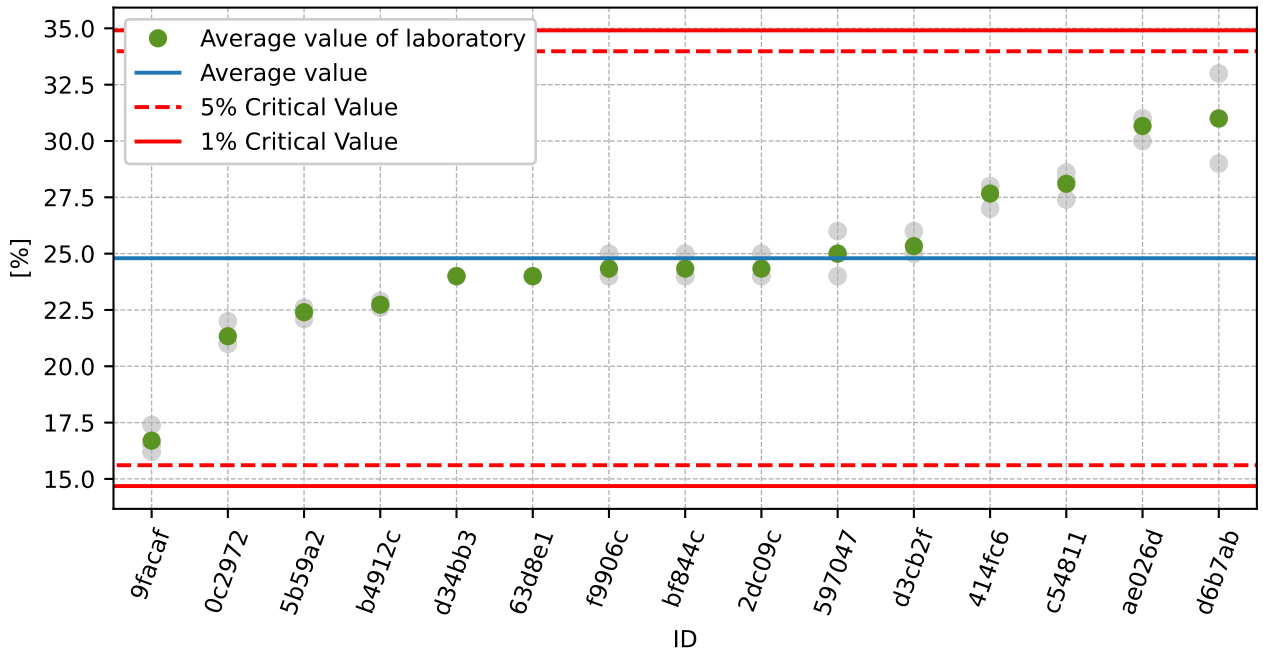

Figure 79: **Grubbs' test** - average values

2.3 Mandel's Statistics

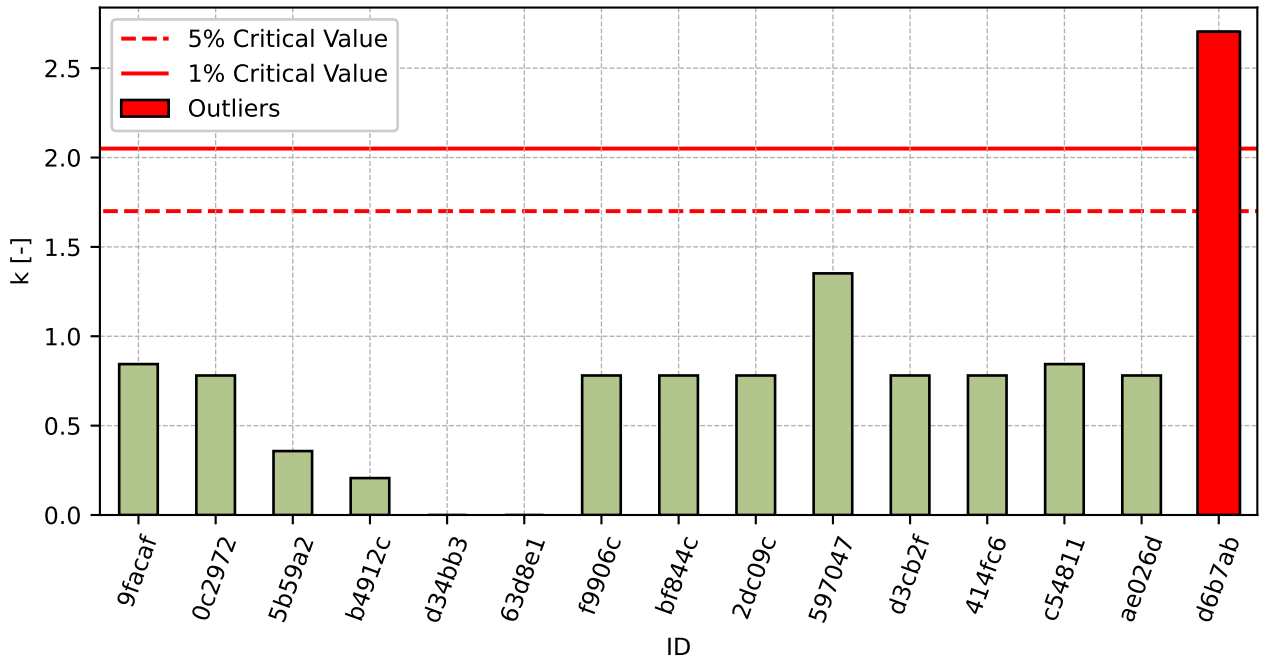

Figure 80: Intralaboratory Consistency Statistic

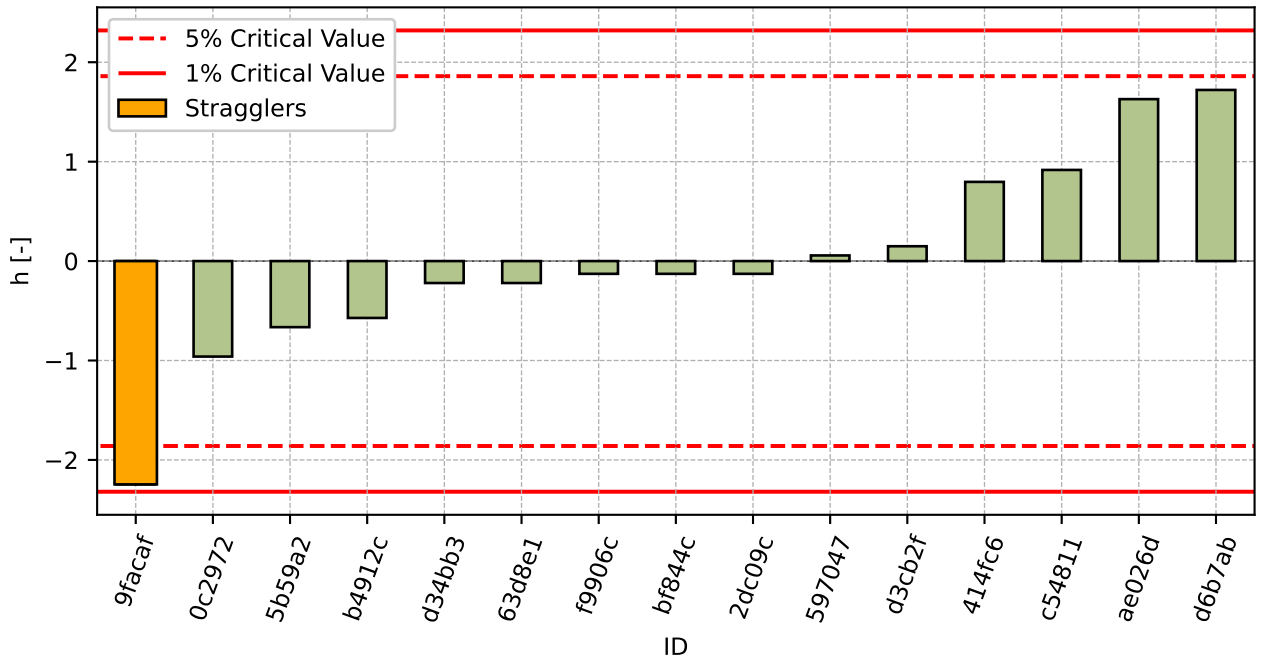

Figure 81: Interlaboratory Consistency Statistic

2.4 Descriptive statistics

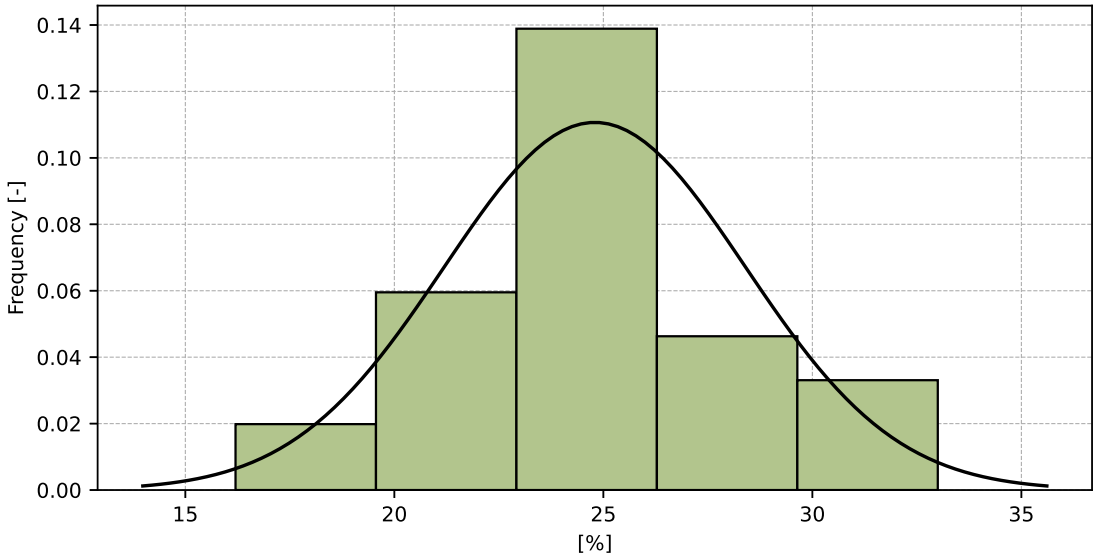

Figure 82: Histogram of all test results

Table 27: Descriptive statistics

Characteristics	**[%]**
Average value – $\bar{x}$	24.8
Sample standard deviation – s	3.6
Asigned value – x^*	24.8
Robust standard deviation – s^*	3.6
Measurement uncertainty of asigned value – u_X	0.93
p-value of normality test	0.033 [-]
Interlaboratory standard deviation – s_L	3.58
Repeatability standard deviation – s_r	0.74
Reproducibility standard deviation – s_R	3.65
Repeatability – r	2.1
Reproducibility – R	10.2

2.5 Evaluation of Performance Statistics

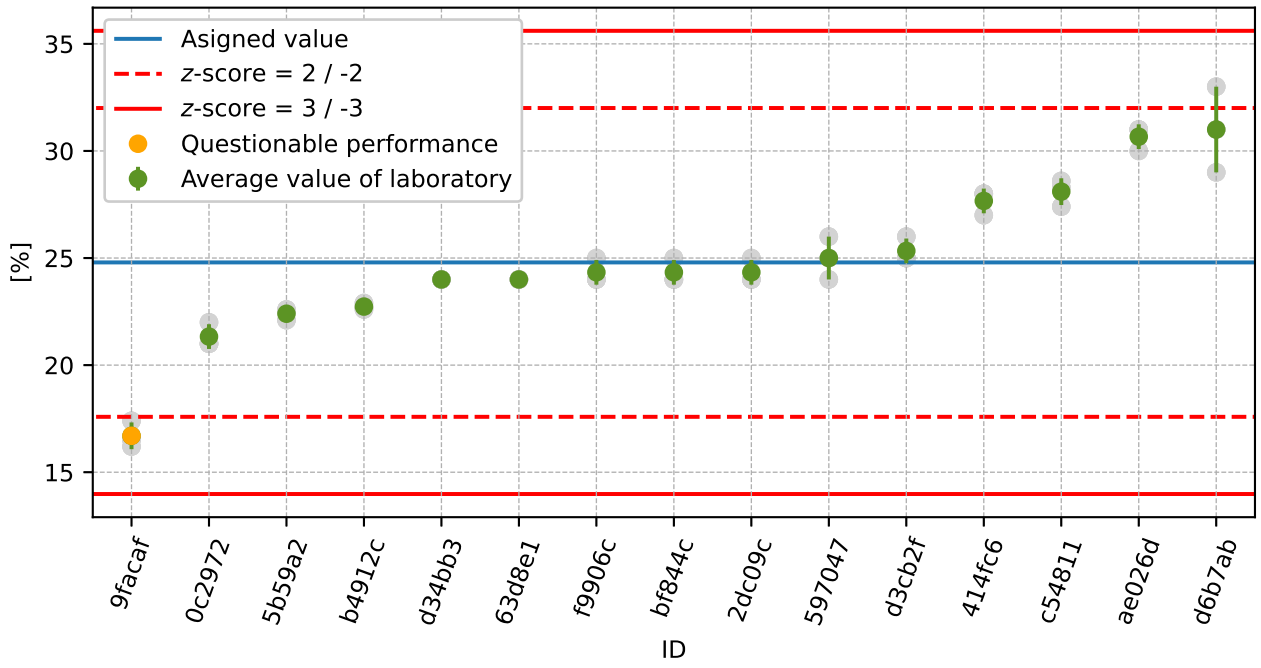

Figure 83: Average values and sample standard deviations

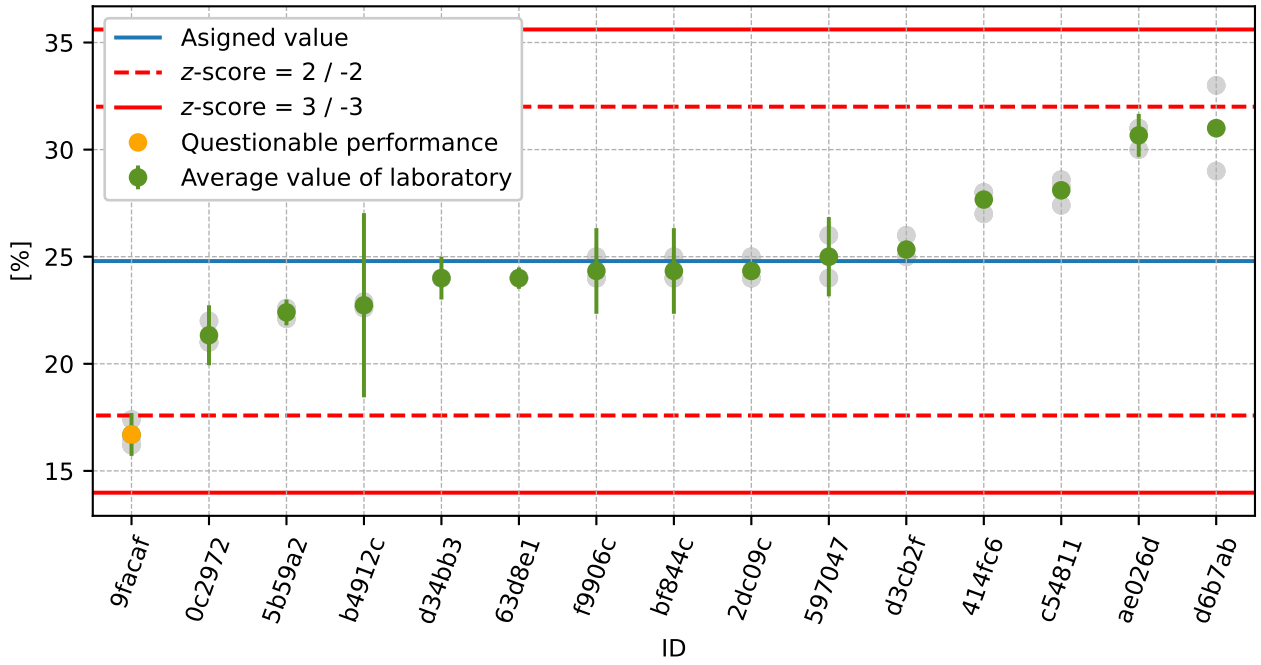

Figure 84: Average values and extended uncertainties of measurement

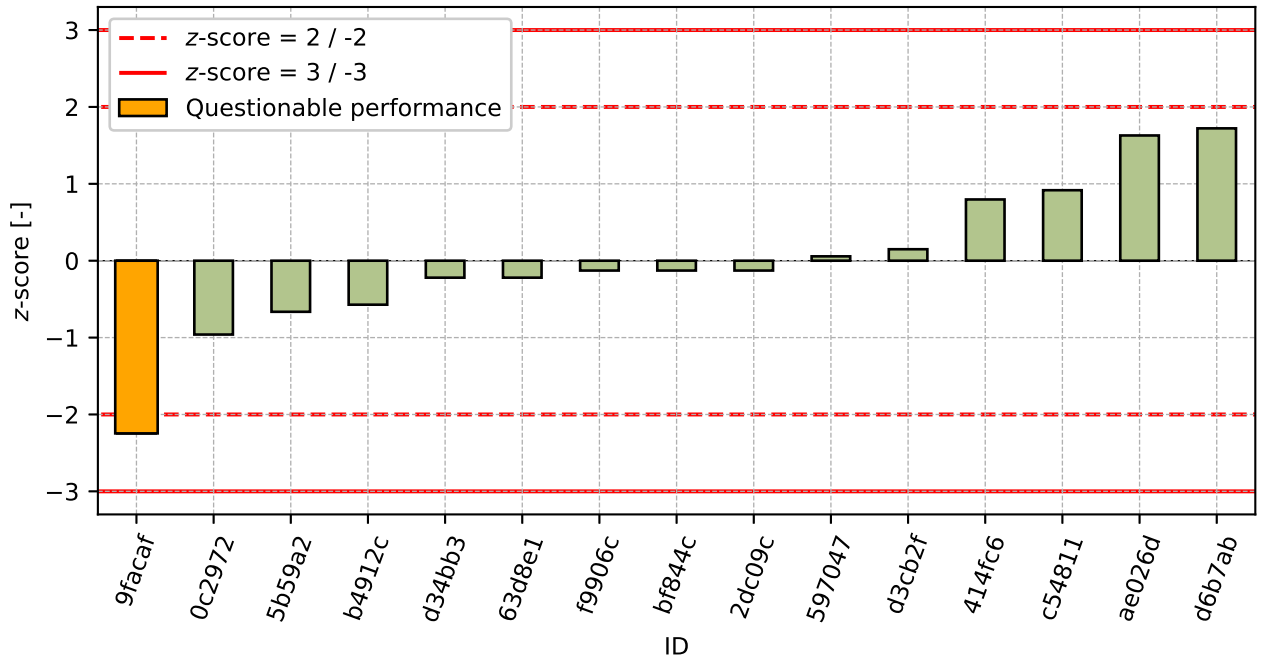

Figure 85: z-score

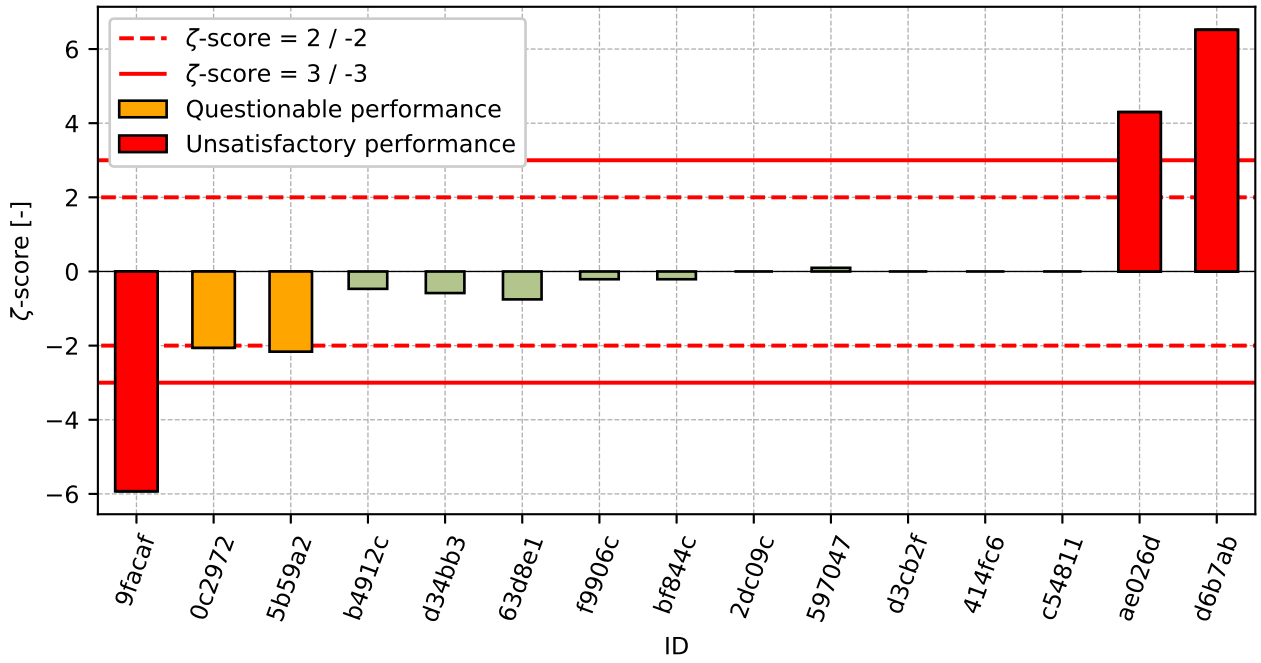

Figure 86: ζ-score

Table 28: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
9facaf	-2.25	-5.93
0c2972	-0.96	-2.06
5b59a2	-0.66	-2.16
b4912c	-0.57	-0.47
d34bb3	-0.22	-0.58
63d8e1	-0.22	-0.75
f9906c	-0.13	-0.21
bf844c	-0.13	-0.21
2dc09c	-0.13	-
597047	0.06	0.1
d3cb2f	0.15	-
414fc6	0.8	-
c54811	0.92	-
ae026d	1.63	4.3
d6b7ab	1.72	6.52

3 Appendix – EN 933-4 Determination of particle shape - Shape index

3.1 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 [%]
f9906c	27.0	28.0	30.0	2.0	28.3	1.53	5.39
ae026d	28.0	30.0	28.0	1.0	28.7	1.15	4.03
b4912c	29.4	29.0	29.2	0.6	29.2	0.2	0.68
66c90a	30.0	30.0	29.0	-	29.7	0.58	1.95
7f9471	31.0	32.0	32.0	2.3	31.7	0.58	1.82
5648cb	31.5	32.3	31.8	0.6	31.9	0.4	1.27
320f41	33.0	32.0	33.0	-	32.7	0.58	1.77
8541f2	35.5	35.5	35.5	2.6	35.5	0.0	0.0
d0d741	35.0	36.0	36.0	2.0	35.7	0.58	1.62
c429d1	36.0	35.0	36.0	11.2	35.7	0.58	1.62
6ec30c	36.3	36.2	36.5	0.2	36.3	0.15	0.42
597047	36.0	37.0	36.0	1.7	36.3	0.58	1.59
25e37d	36.2	37.5	35.7	0.2	36.5	0.93	2.55
22edc2	37.0	36.0	37.0	2.0	36.7	0.58	1.57
f26927	38.0	36.0	36.0	1.0	36.7	1.15	3.15
2dc09c	36.7	36.5	36.8	-	36.7	0.15	0.42
65eb6d	37.0	36.0	37.0	-	36.7	0.58	1.57
31f9a0	41.7	35.8	32.9	0.2	36.8	4.48	12.19
2968bc	36.0	37.0	38.0	1.2	37.0	1.0	2.7
cce71a	38.0	37.0	38.0	3.0	37.7	0.58	1.53
1cf584	38.0	38.0	39.0	3.0	38.3	0.58	1.51
d34bb3	37.0	39.0	39.0	4.0	38.3	1.15	3.01
91d1d4	38.3	38.9	38.7	-	38.6	0.31	0.79
801460	39.0	39.0	40.0	4.7	39.3	0.58	1.47
f7e2f2	38.6	39.6	40.2	2.2	39.5	0.81	2.05
9db03c	39.0	40.0	40.0	3.5	39.7	0.58	1.46
d6b7ab	41.0	39.0	40.0	0.9	40.0	1.0	2.5
63d8e1	41.0	41.0	41.0	0.4	41.0	0.0	0.0
4471dc	44.0	44.0	44.0	-	44.0	0.0	0.0
feef67	45.0	45.0	45.0	4.0	45.0	0.0	0.0
c54811	51.0	50.0	51.0	-	50.7	0.58	1.14

3.2 The Numerical Procedure for Determining Outliers

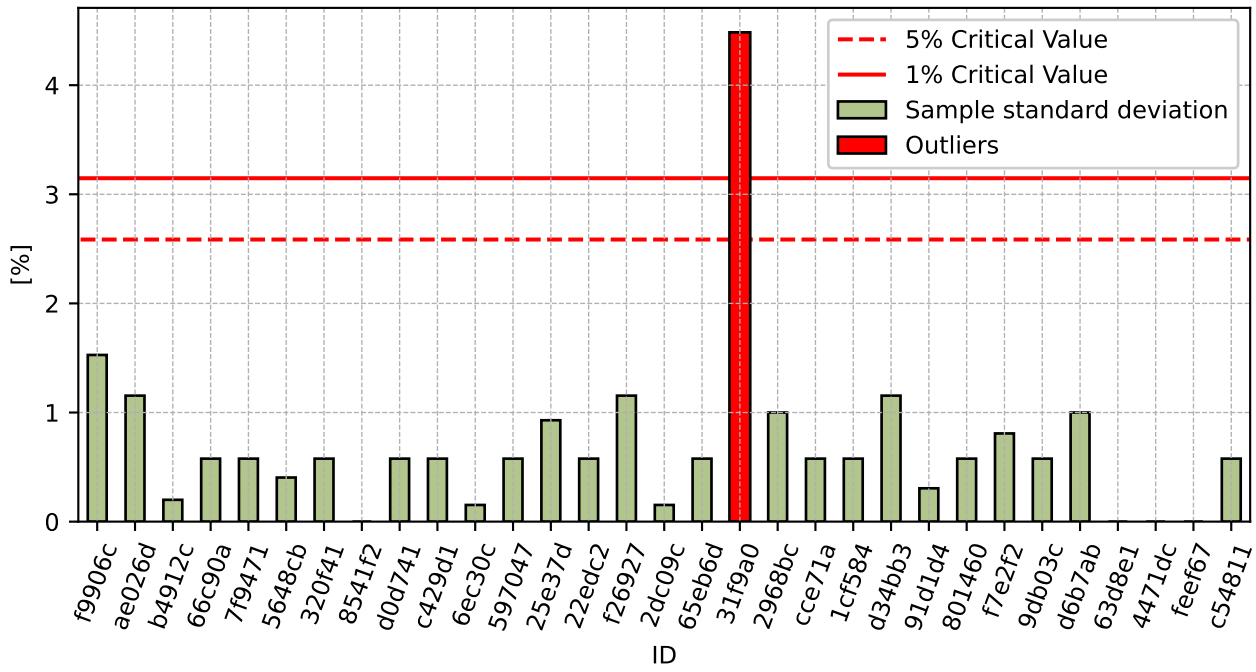

Figure 87: **Cochran's test** - sample standard deviations

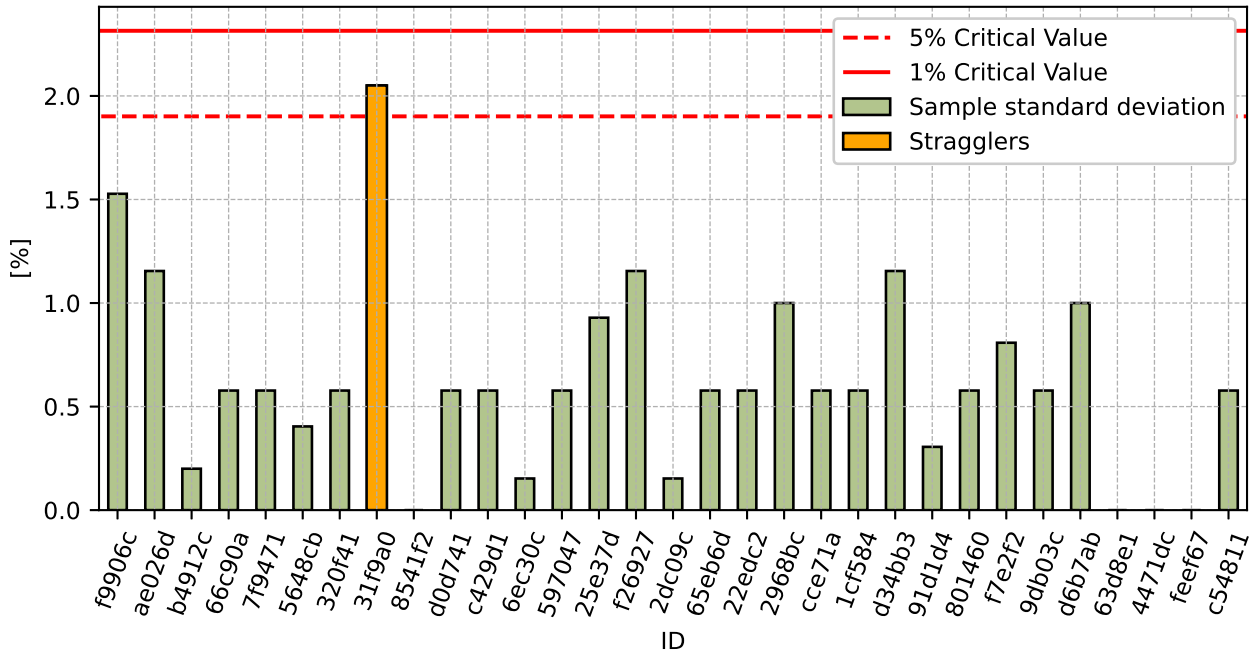

Figure 88: **Cochran's test** - sample standard deviations without outliers

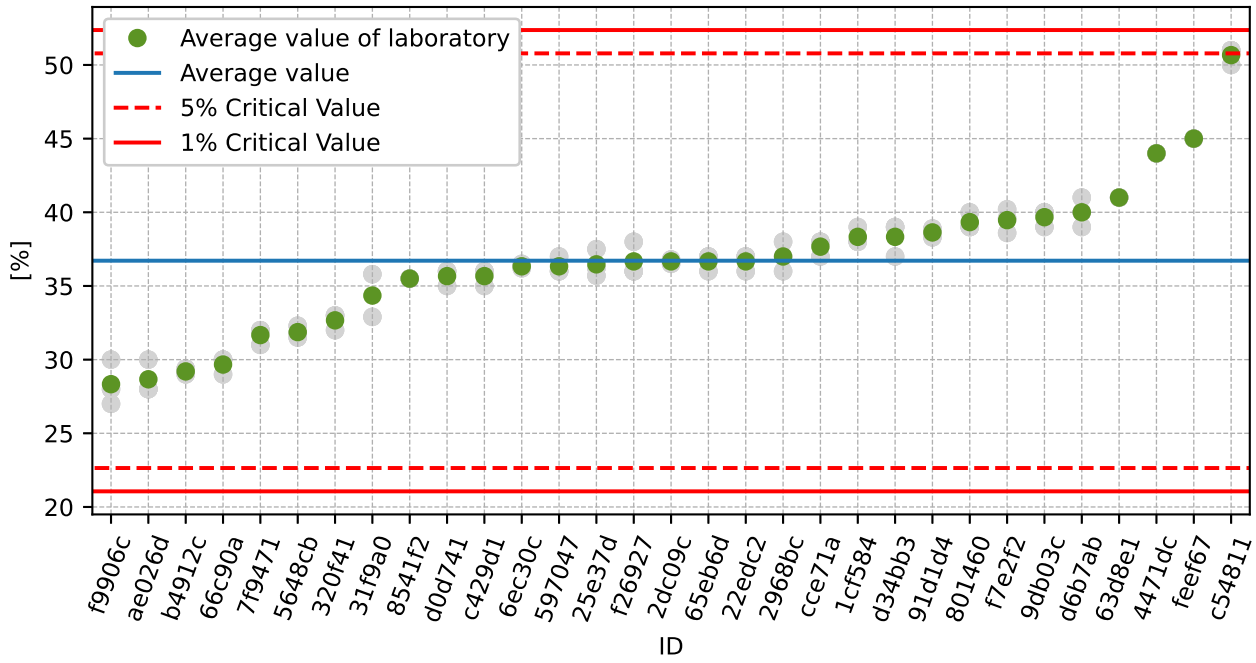

Figure 89: **Grubbs' test** - average values

3.3 Mandel's Statistics

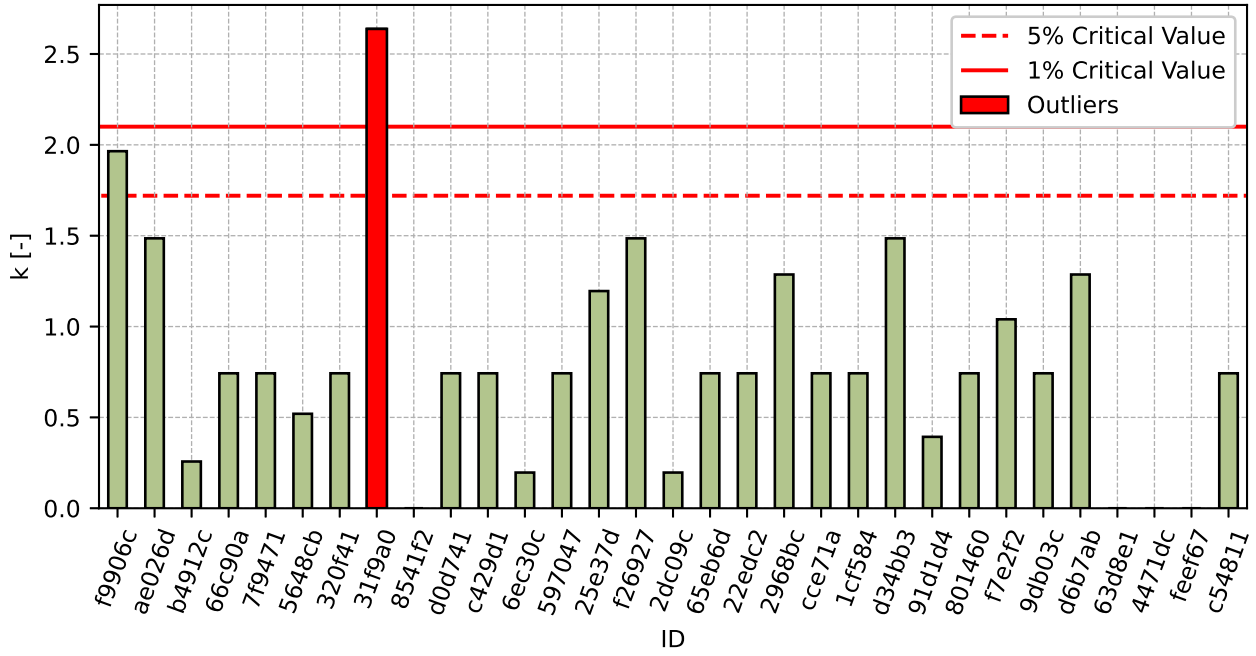

Figure 90: Intralaboratory Consistency Statistic

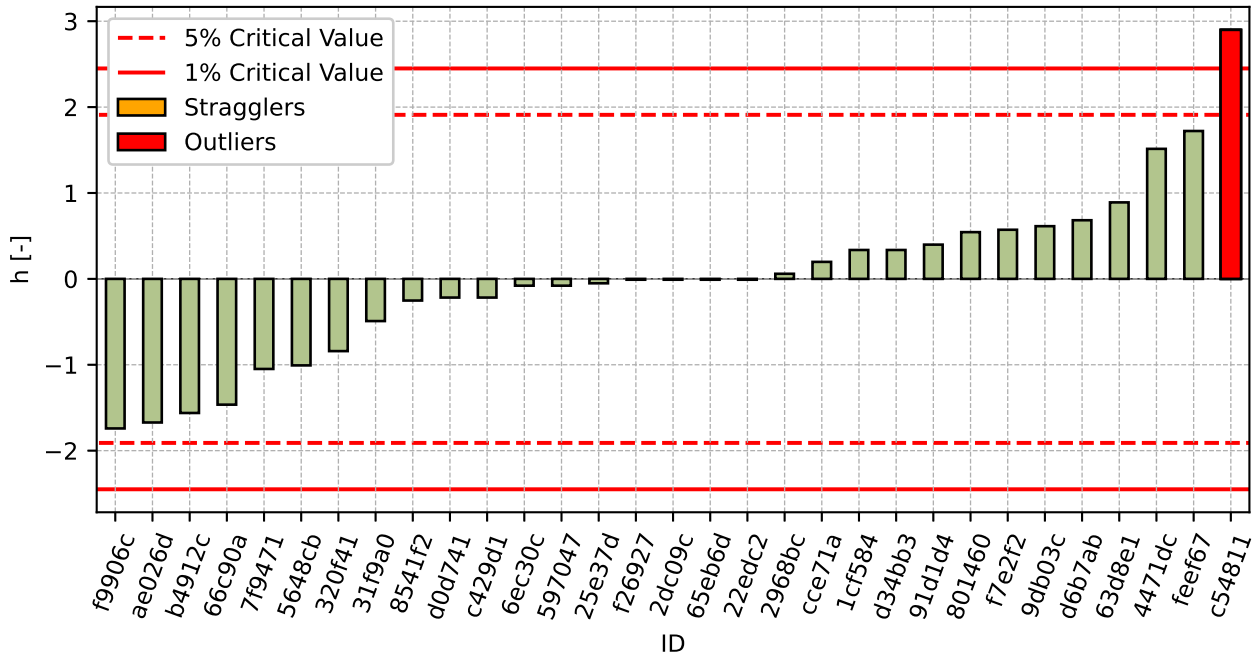

Figure 91: Interlaboratory Consistency Statistic

3.4 Descriptive statistics

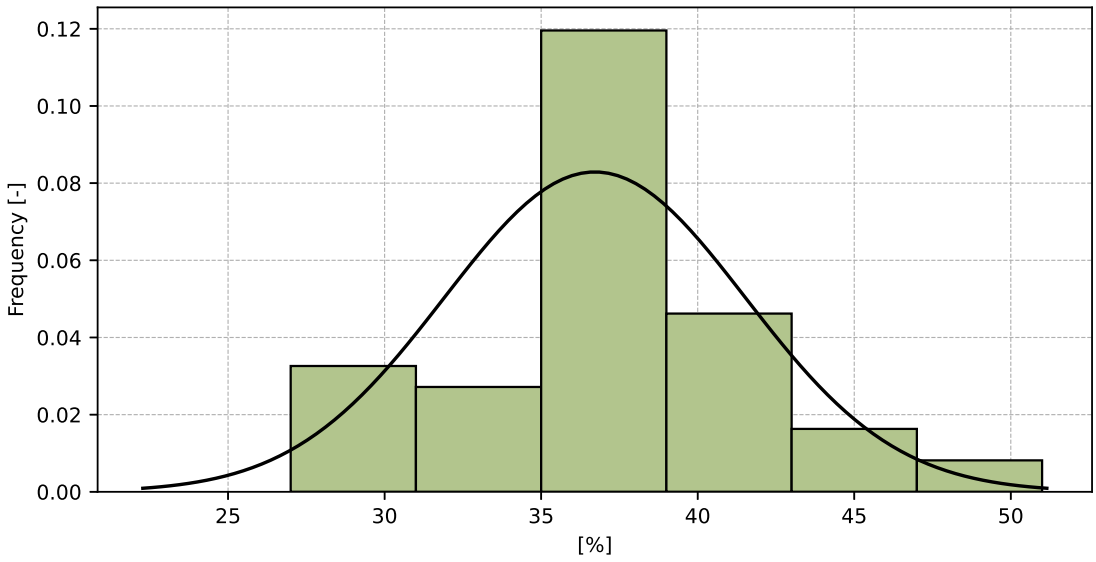

Figure 92: Histogram of all test results

Table 30: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	36.7
Sample standard deviation – s	4.81
Asigned value – x^*	36.9
Robust standard deviation – s^*	4.52
Measurement uncertainty of asigned value – u_X	1.01
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	4.79
Repeatability standard deviation – s_r	0.78
Reproducibility standard deviation – s_R	4.85
Repeatability – r	2.2
Reproducibility – R	13.6

3.5 Evaluation of Performance Statistics

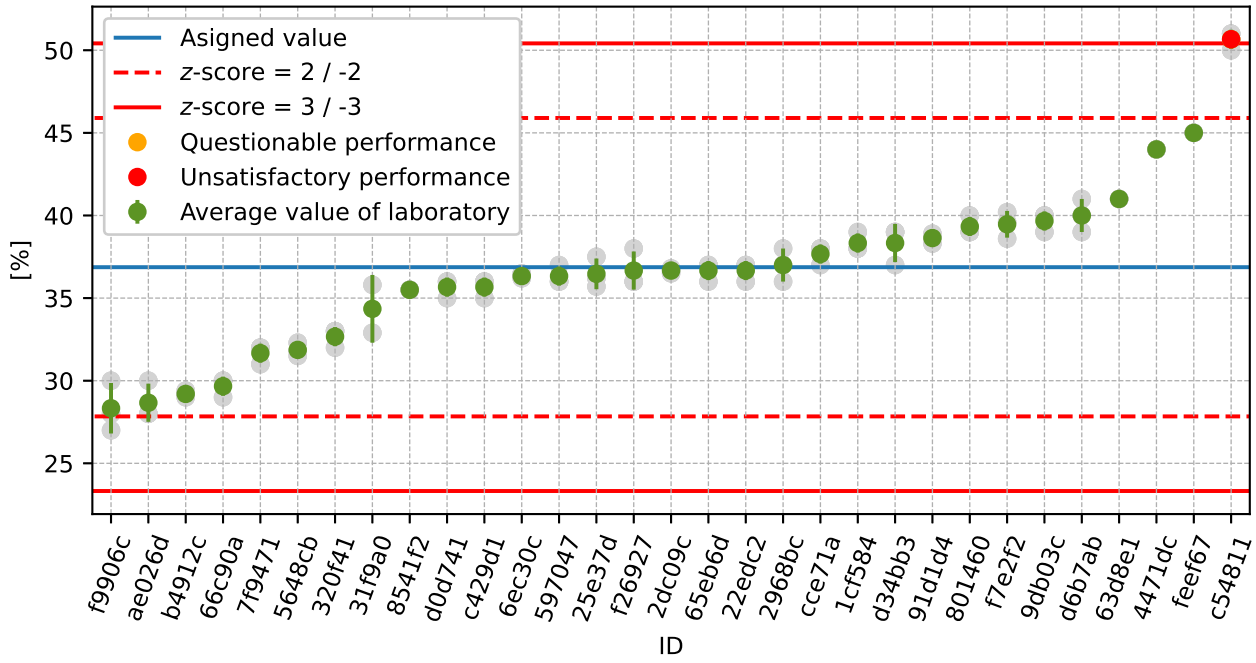

Figure 93: Average values and sample standard deviations

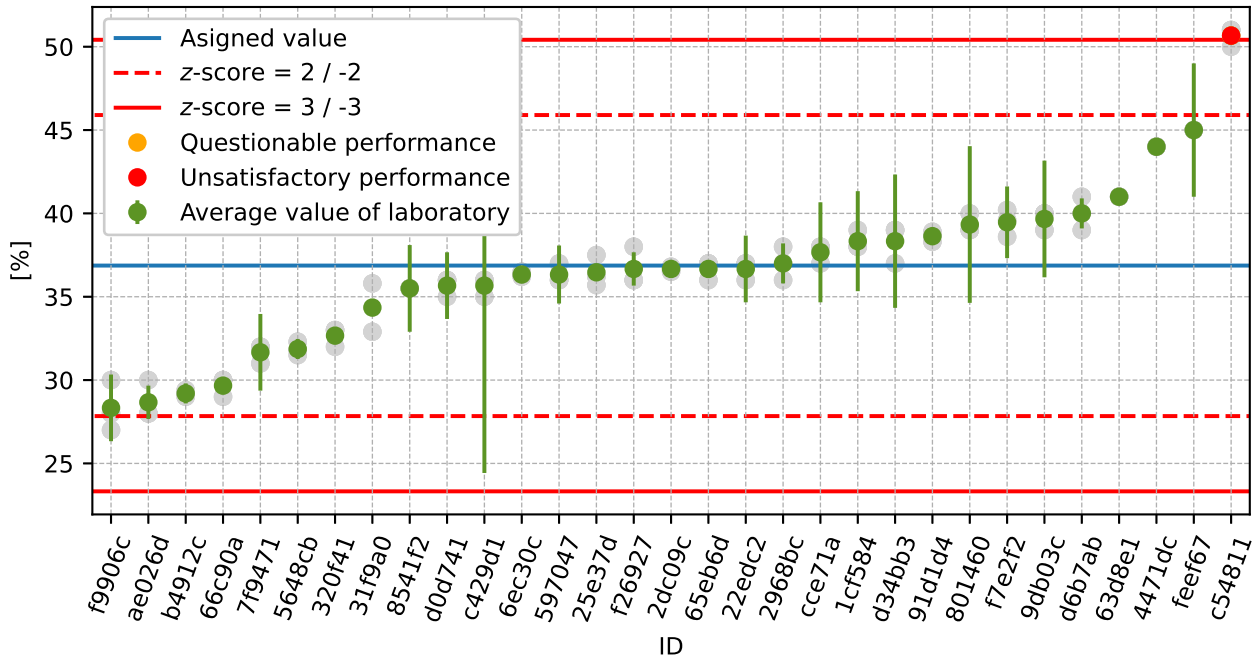

Figure 94: Average values and extended uncertainties of measurement

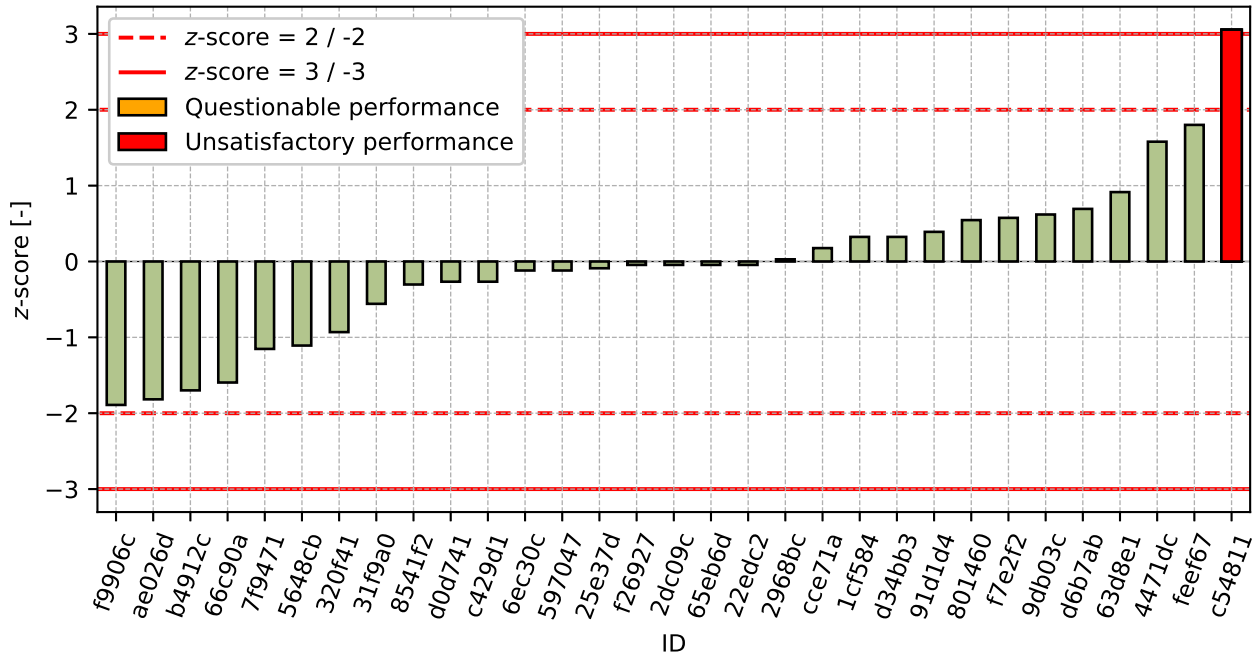

Figure 95: z-score

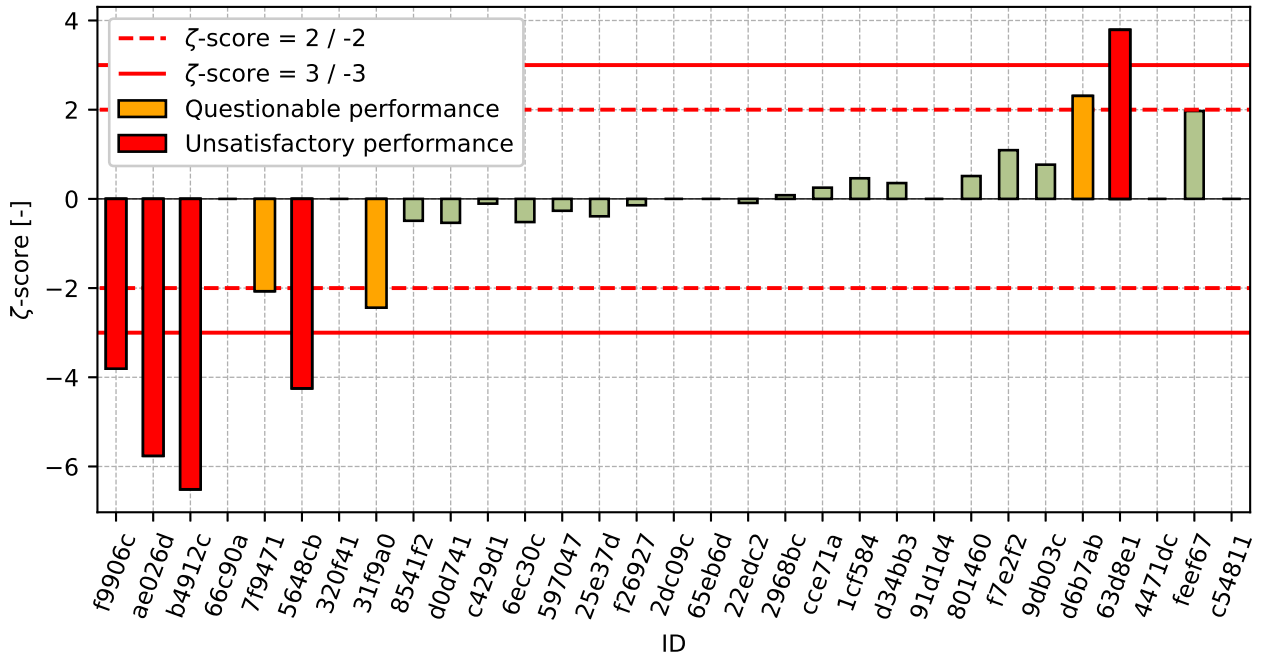

Figure 96: ζ-score

Table 31: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f9906c	-1.89	-3.81
ae026d	-1.82	-5.76
b4912c	-1.7	-6.51
66c90a	-1.6	-
7f9471	-1.15	-2.07
5648cb	-1.11	-4.25
320f41	-0.93	-
31f9a0	-0.56	-2.44
8541f2	-0.3	-0.49
d0d741	-0.27	-0.54
c429d1	-0.27	-0.11
6ec30c	-0.12	-0.52
597047	-0.12	-0.27
25e37d	-0.09	-0.39
f26927	-0.05	-0.14
2dc09c	-0.05	-
65eb6d	-0.05	-
22edc2	-0.05	-0.09
2968bc	0.03	0.08
cce71a	0.18	0.25
1cf584	0.32	0.46
d34bb3	0.32	0.35

Continued on next page

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ID	z-score [-]	ζ-score [-]
91d1d4	0.39	-
801460	0.55	0.51
f7e2f2	0.58	1.09
9db03c	0.62	0.77
d6b7ab	0.69	2.31
63d8e1	0.91	3.79
4471dc	1.58	-
feef67	1.8	1.97
c54811	3.06	-

4 Appendix – EN 933-8 Assessment of fines - Sand equivalent test

4.1 Test results

Table 32: 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 [%]
cce71a	56.0	55.0	55.0	2.0	55.3	0.58	1.04
d2edc0	55.5	56.3	56.5	1.3	56.1	0.53	0.94
ae026d	54.0	59.0	56.0	1.0	56.3	2.52	4.47
9db03c	57.4	56.1	56.3	7.0	56.6	0.7	1.24
b5b225	57.0	57.0	58.0	1.0	57.3	0.58	1.01
f56670	58.0	57.0	58.0	1.0	57.7	0.58	1.0
2968bc	58.0	56.0	61.0	1.8	58.3	2.52	4.31
a2426d	62.0	61.0	60.0	4.0	61.0	1.0	1.64
178148	60.0	63.0	61.0	2.0	61.3	1.53	2.49
1cf584	61.0	62.0	62.0	2.0	61.7	0.58	0.94
2dc09c	63.4	62.2	61.2	-	62.3	1.1	1.77
7f555e	62.0	63.0	62.0	8.1	62.3	0.58	0.93
f7250c	64.1	63.3	63.5	-	63.6	0.42	0.65
5648cb	65.0	63.9	64.7	1.0	64.5	0.57	0.88
65eb6d	66.0	64.0	64.0	-	64.7	1.15	1.79
b4912c	66.4	66.9	66.6	1.7	66.6	0.25	0.38

4.2 The Numerical Procedure for Determining Outliers

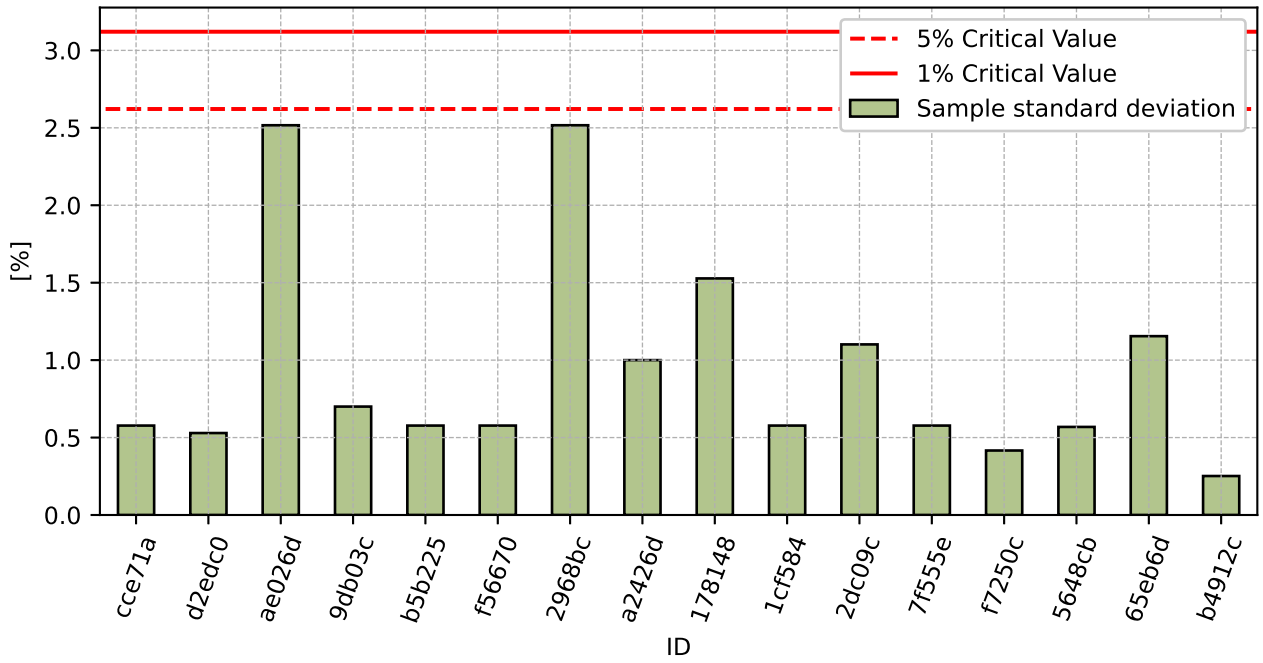

Figure 97: **Cochran's test** - sample standard deviations

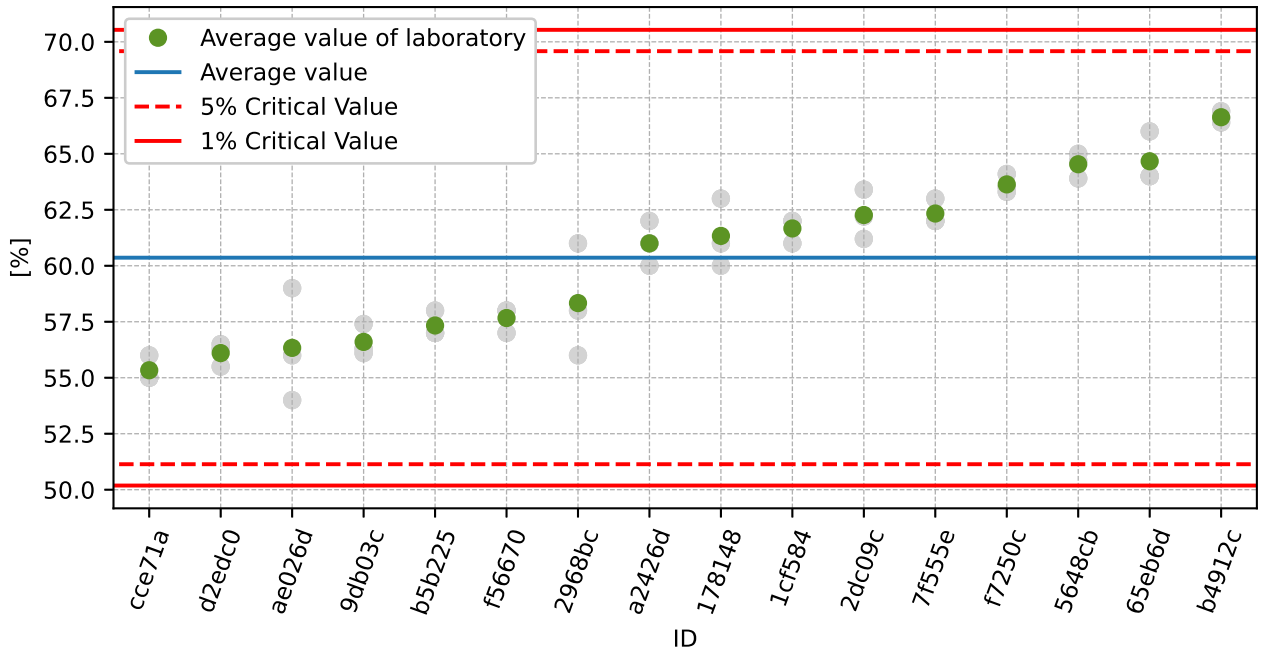

Figure 98: **Grubbs' test** - average values

4.3 Mandel's Statistics

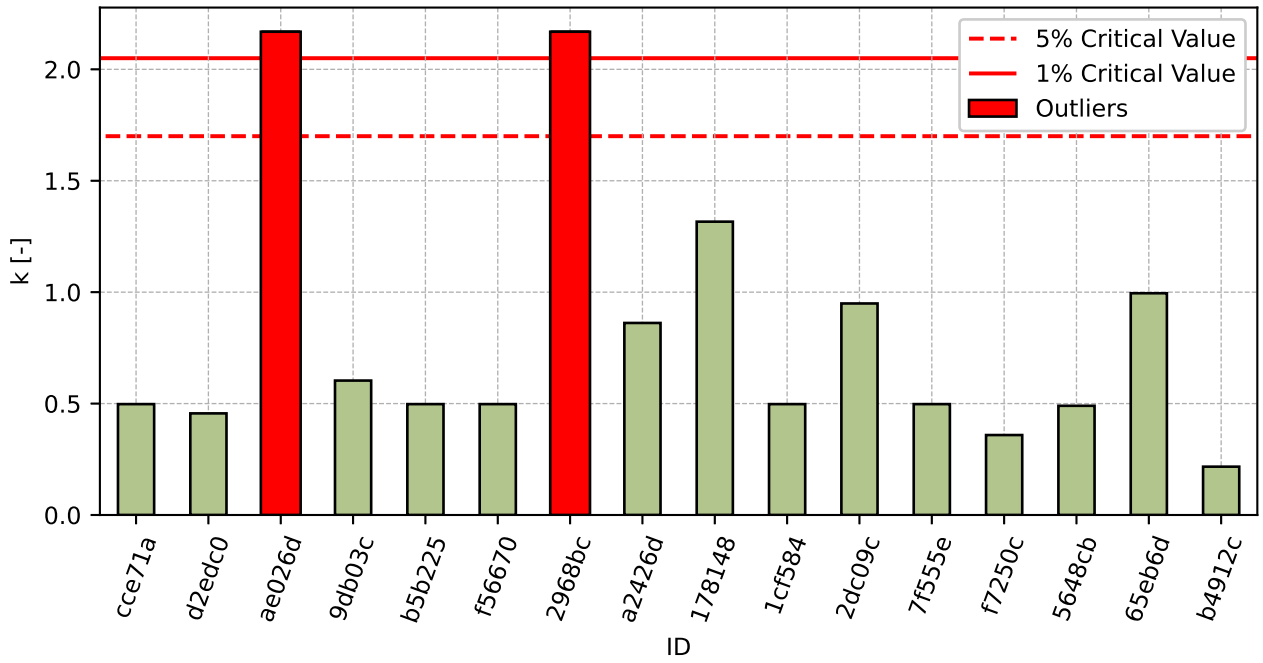

Figure 99: Intralaboratory Consistency Statistic

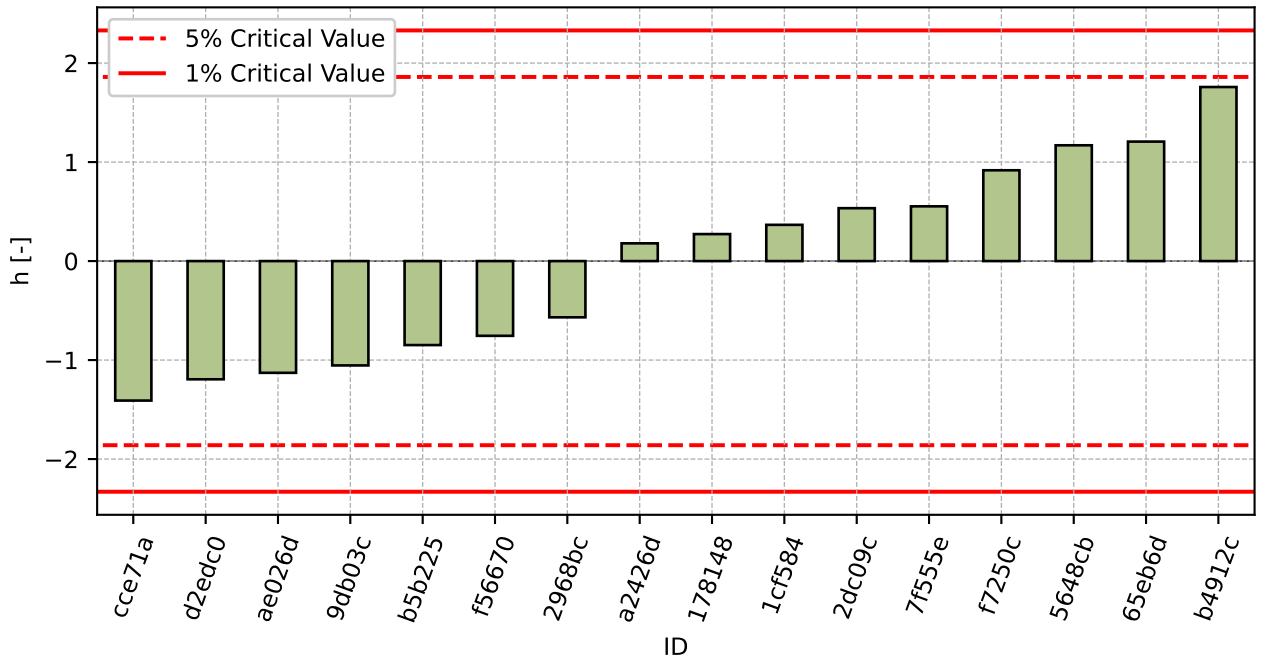

Figure 100: Interlaboratory Consistency Statistic

4.4 Descriptive statistics

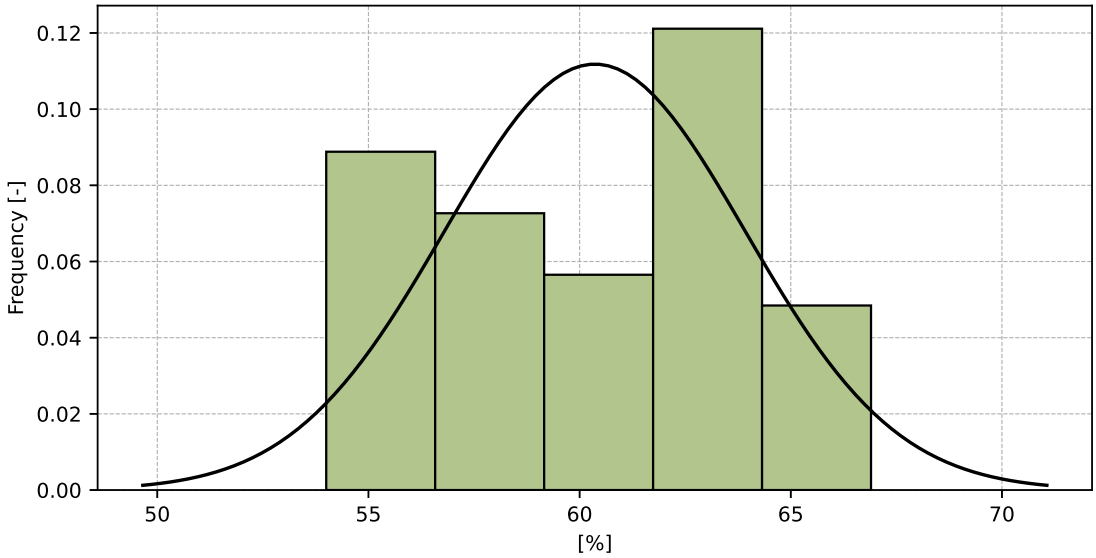

Figure 101: Histogram of all test results

Table 33: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	60.4
Sample standard deviation – s	3.57
Asigned value – x^*	60.4
Robust standard deviation – s^*	3.92
Measurement uncertainty of asigned value – u_X	1.22
p-value of normality test	0.031 [-]
Interlaboratory standard deviation – s_L	3.5
Repeatability standard deviation – s_r	1.16
Reproducibility standard deviation – s_R	3.69
Repeatability – r	3.2
Reproducibility – R	10.3

4.5 Evaluation of Performance Statistics

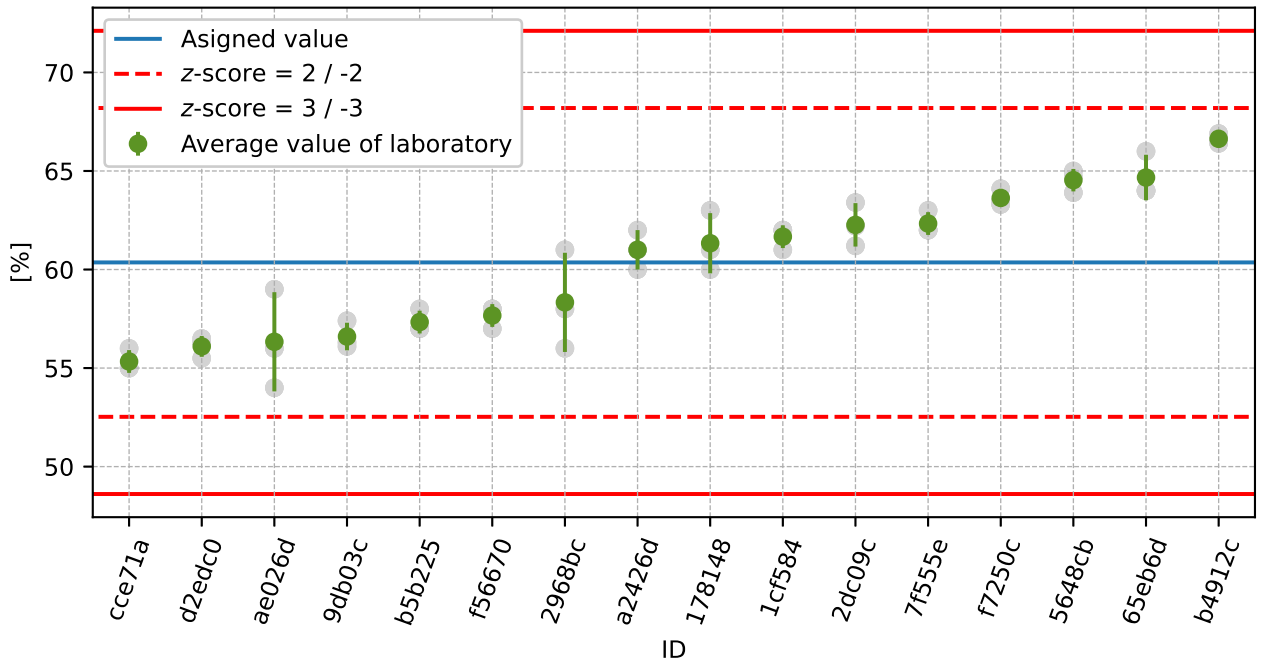

Figure 102: Average values and sample standard deviations

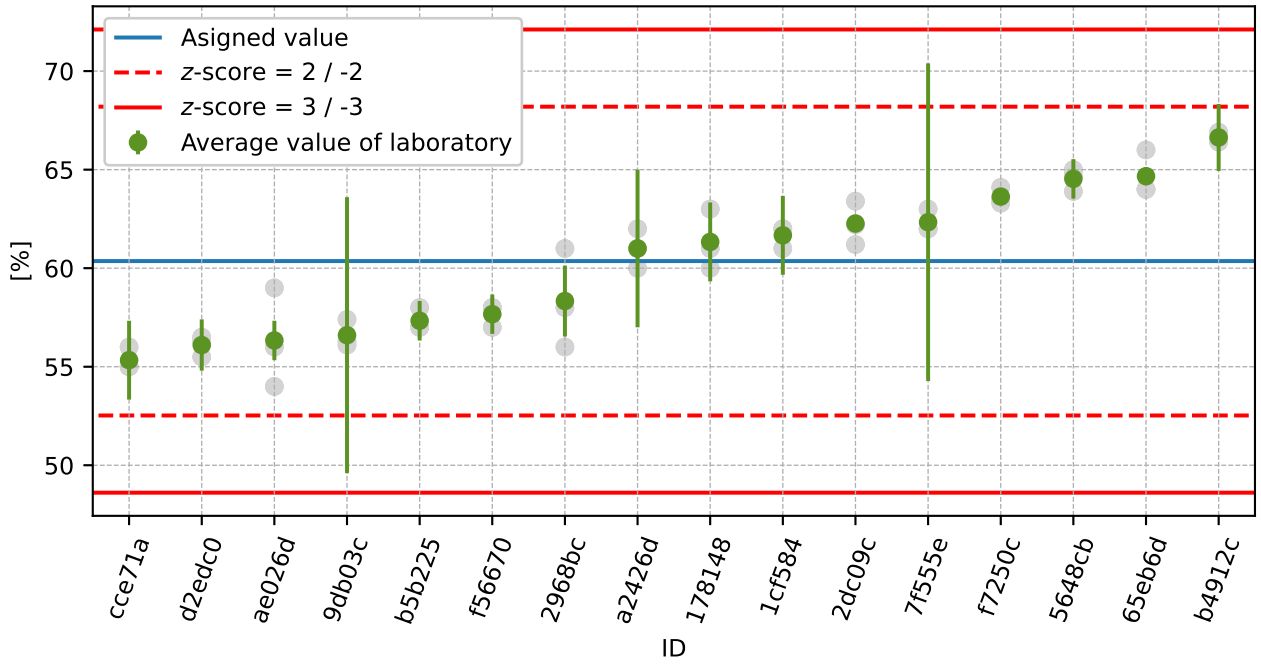

Figure 103: Average values and extended uncertainties of measurement

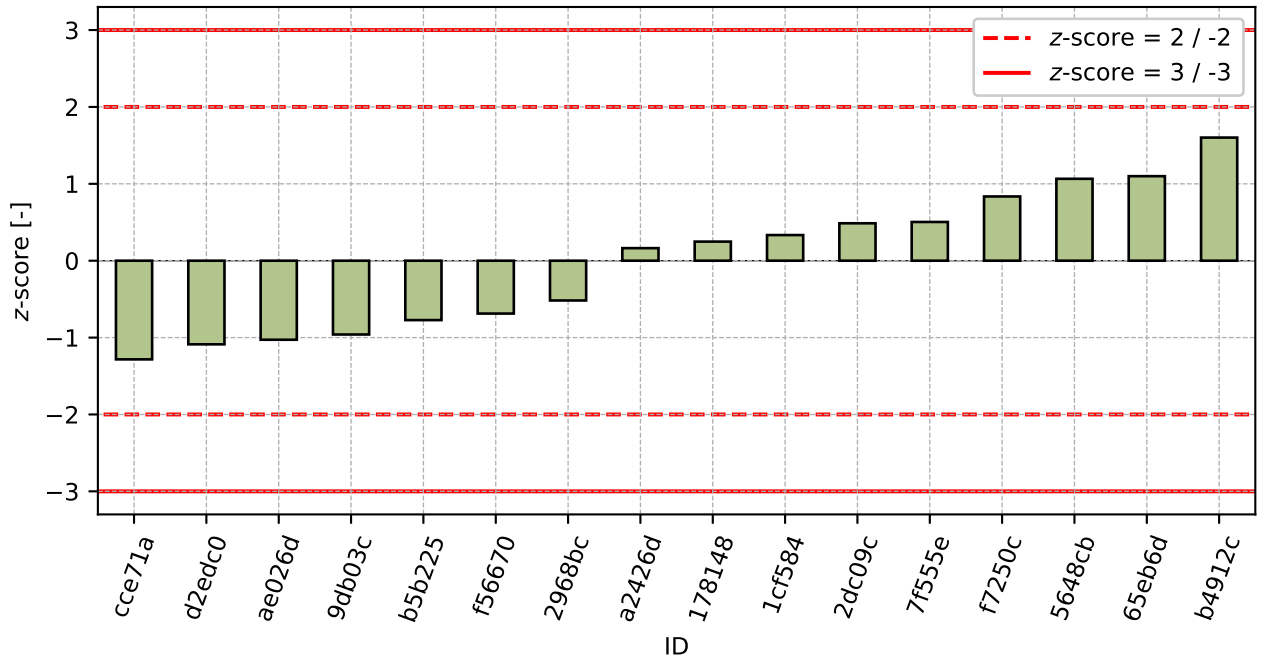

Figure 104: z-score

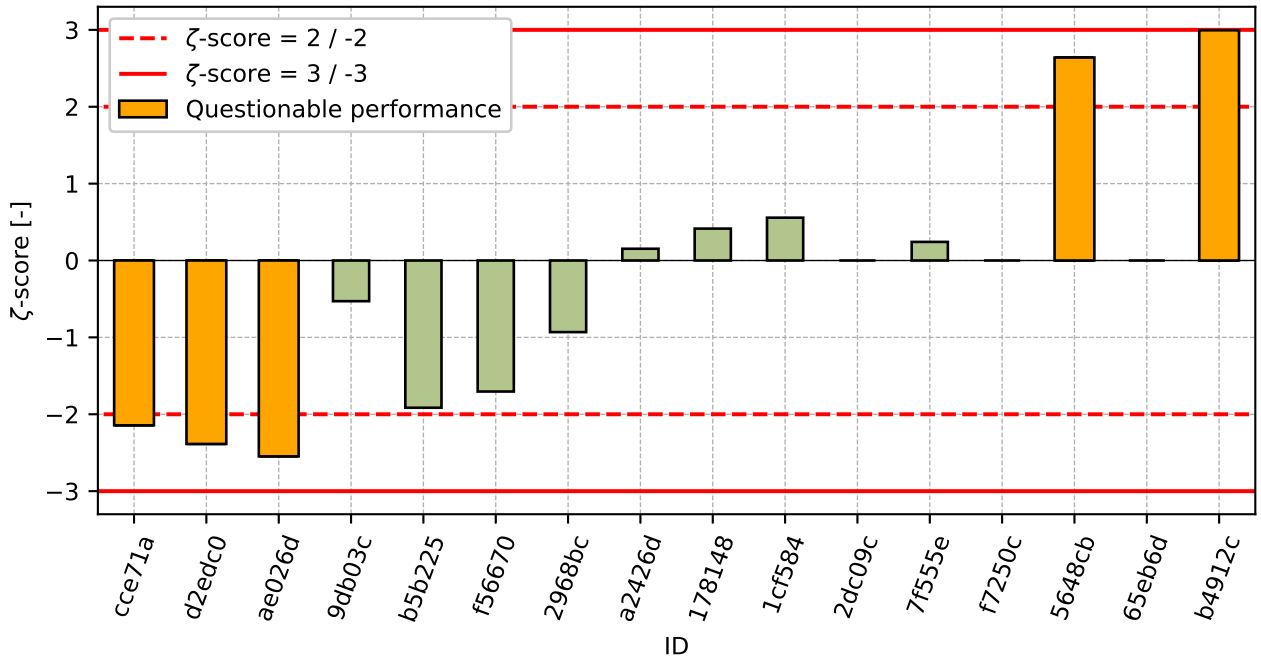

Figure 105: ζ-score

Table 34: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
cce71a	-1.28	-2.14
d2edc0	-1.09	-2.39
ae026d	-1.03	-2.55
9db03c	-0.96	-0.53
b5b225	-0.77	-1.92
f56670	-0.69	-1.7
2968bc	-0.52	-0.93
a2426d	0.16	0.15
178148	0.25	0.41
1cf584	0.33	0.56
2dc09c	0.49	-
7f555e	0.5	0.24
f7250c	0.84	-
5648cb	1.07	2.64
65eb6d	1.1	-
b4912c	1.6	2.99

5 Appendix – EN 933-9 Assessment of fines - Methylene blue test

5.1 Test results

Table 35: 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 [g/kg]			u_X [g/kg]	$\bar{x}$ [g/kg]	s_0 [g/kg]	V_X [%]
597047	0.2	0.2	0.2	0.0	0.2	0.0	0.0
99772d	1.1	1.0	1.3	0.5	1.1	0.15	13.48
feef67	1.3	1.2	1.3	0.2	1.3	0.06	4.56
b4912c	1.4	1.4	1.4	0.3	1.4	0.0	0.0
d6b7ab	1.5	1.5	1.5	0.2	1.5	0.0	0.0
9facaf	1.8	2.0	1.8	0.2	1.9	0.12	6.19
f9906c	1.7	2.0	2.0	0.2	1.9	0.17	9.12
2968bc	1.9	2.0	1.9	0.4	1.9	0.06	2.99
bf5ab5	2.0	2.0	2.0	0.6	2.0	0.0	0.0
2dc09c	2.0	2.0	2.0	-	2.0	0.02	1.04
1ae021	1.9	2.1	2.2	0.0	2.1	0.15	7.39
82a501	2.1	2.1	2.0	0.1	2.1	0.06	2.79
ed0789	1.9	2.2	2.4	-	2.2	0.25	11.62
144321	2.2	2.2	2.3	0.7	2.2	0.06	2.59
cce71a	2.3	2.3	2.3	0.2	2.3	0.0	0.0
1cf584	2.3	2.4	2.3	0.2	2.3	0.06	2.47
6ec30c	2.4	2.4	2.4	0.2	2.4	0.0	0.0
34c434	2.5	2.5	2.5	0.1	2.5	0.0	0.0
91d1d4	2.7	2.6	2.7	-	2.6	0.03	1.0
5b59a2	3.3	3.3	4.0	-	3.5	0.4	11.44

5.2 The Numerical Procedure for Determining Outliers

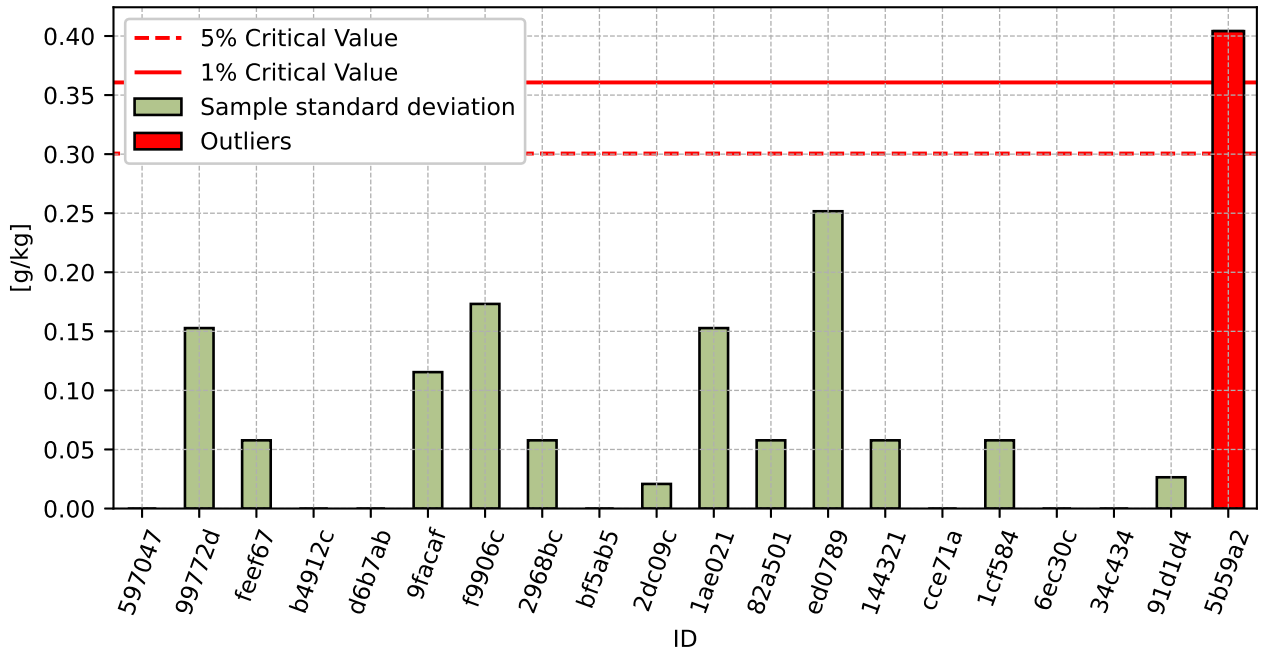

Figure 106: **Cochran's test** - sample standard deviations

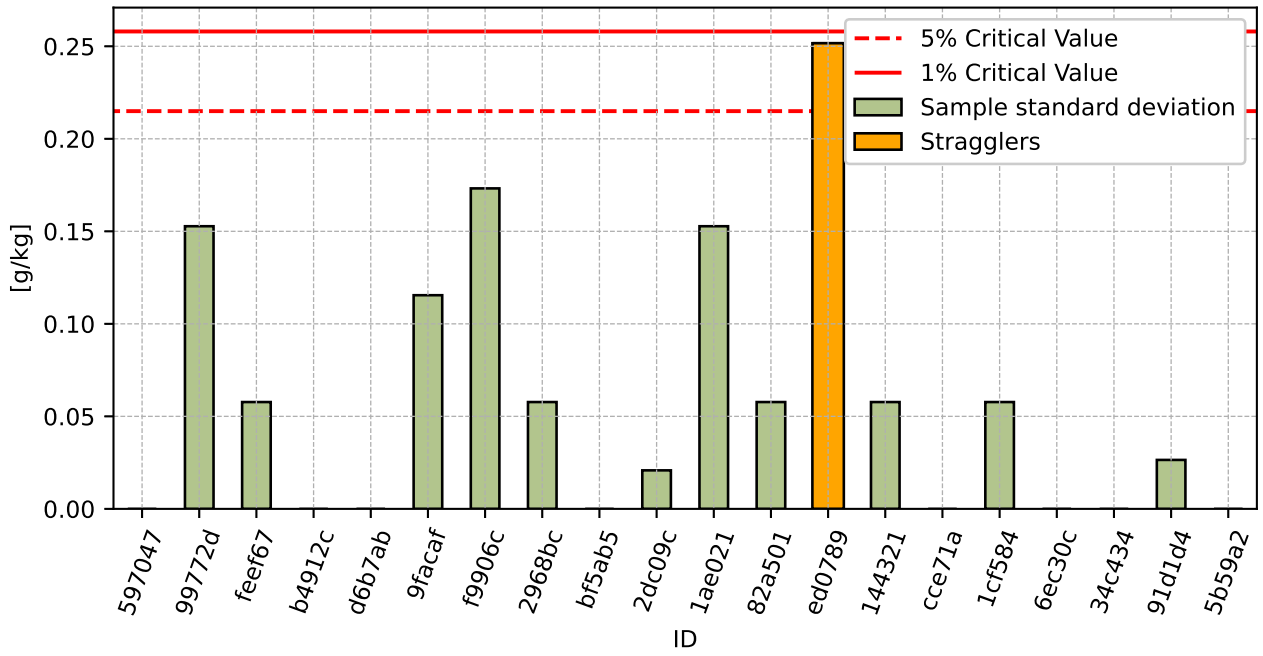

Figure 107: **Cochran's test** - sample standard deviations without outliers

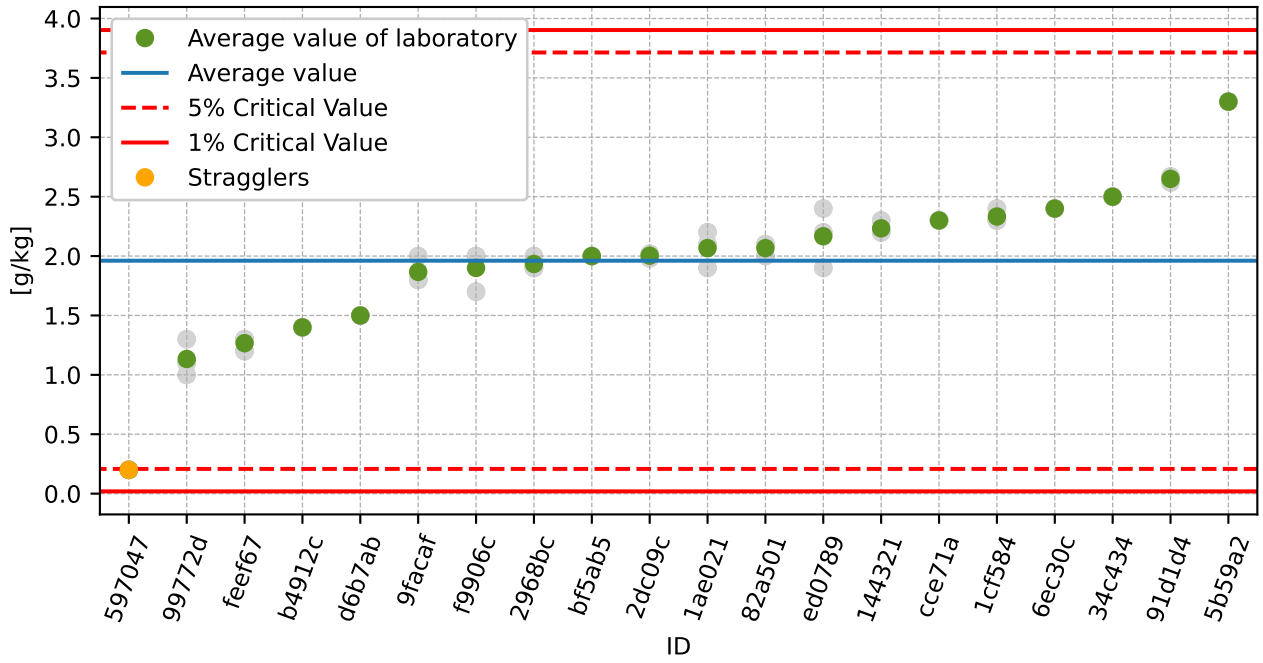

Figure 108: **Grubbs' test** - average values

5.3 Mandel's Statistics

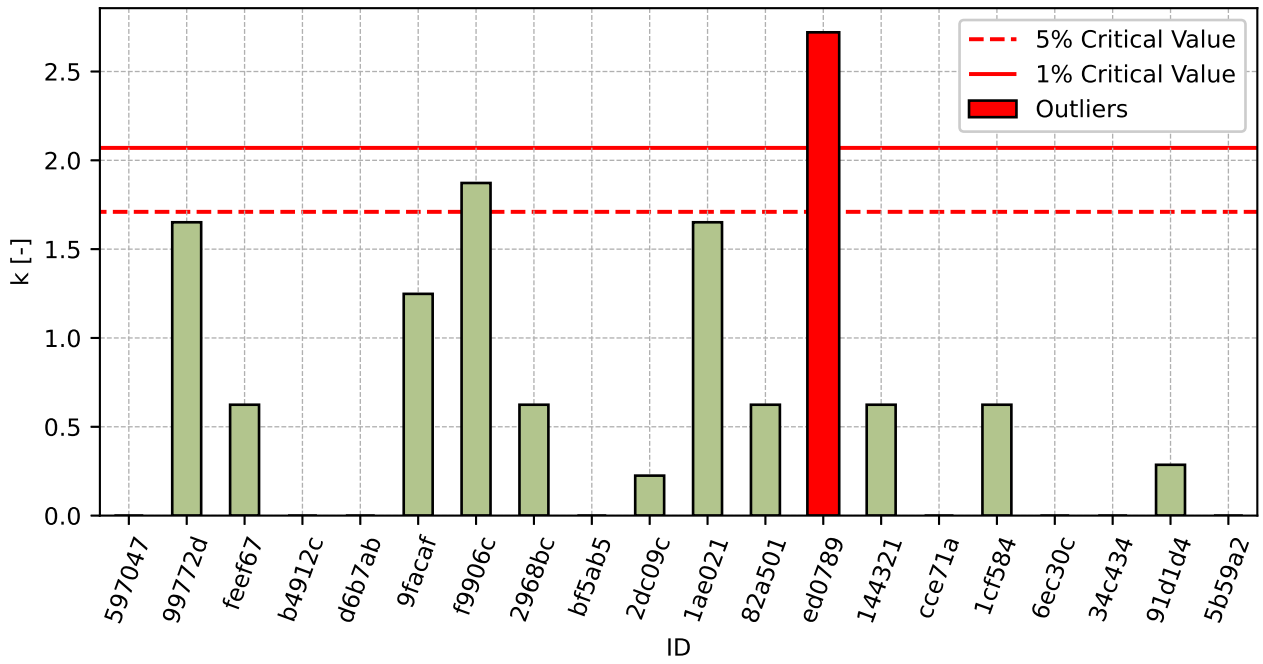

Figure 109: Intralaboratory Consistency Statistic

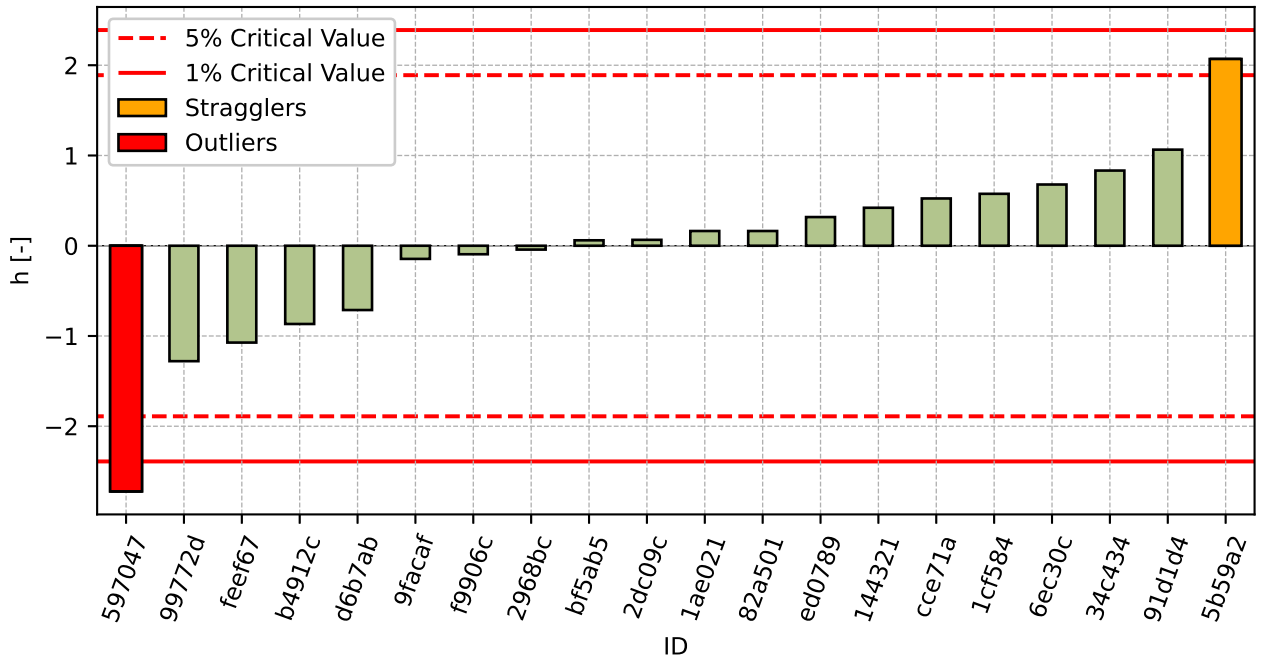

Figure 110: Interlaboratory Consistency Statistic

5.4 Descriptive statistics

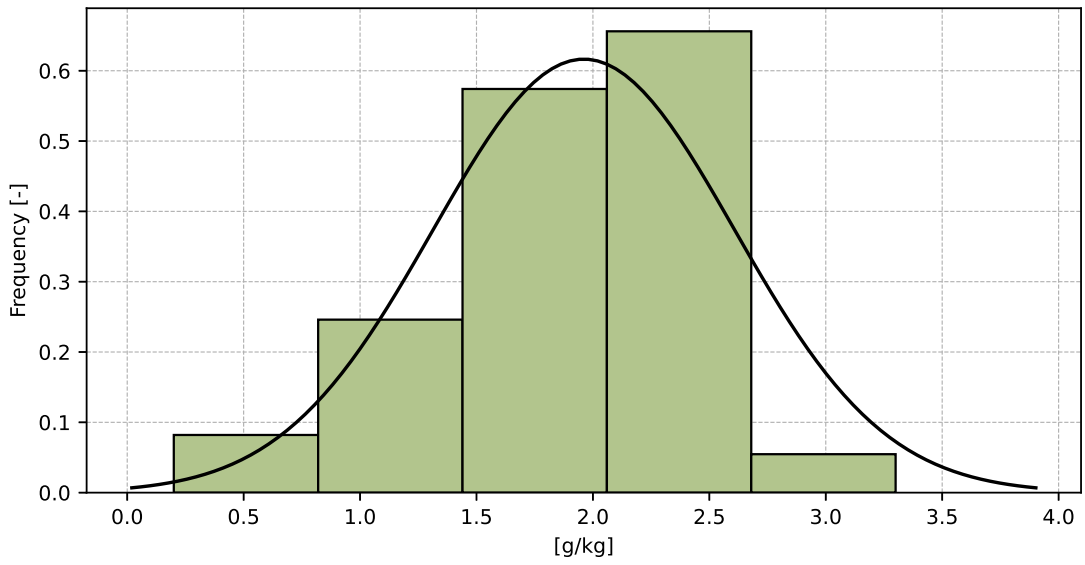

Figure 111: Histogram of all test results

Table 36: Descriptive statistics

Characteristics	[g/kg]
Average value – $\bar{x}$	2.0
Sample standard deviation – s	0.65
Asigned value – x^*	2.0
Robust standard deviation – s^*	0.54
Measurement uncertainty of asigned value – u_X	0.15
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	0.64
Repeatability standard deviation – s_r	0.09
Reproducibility standard deviation – s_R	0.65
Repeatability – r	0.3
Reproducibility – R	1.8

5.5 Evaluation of Performance Statistics

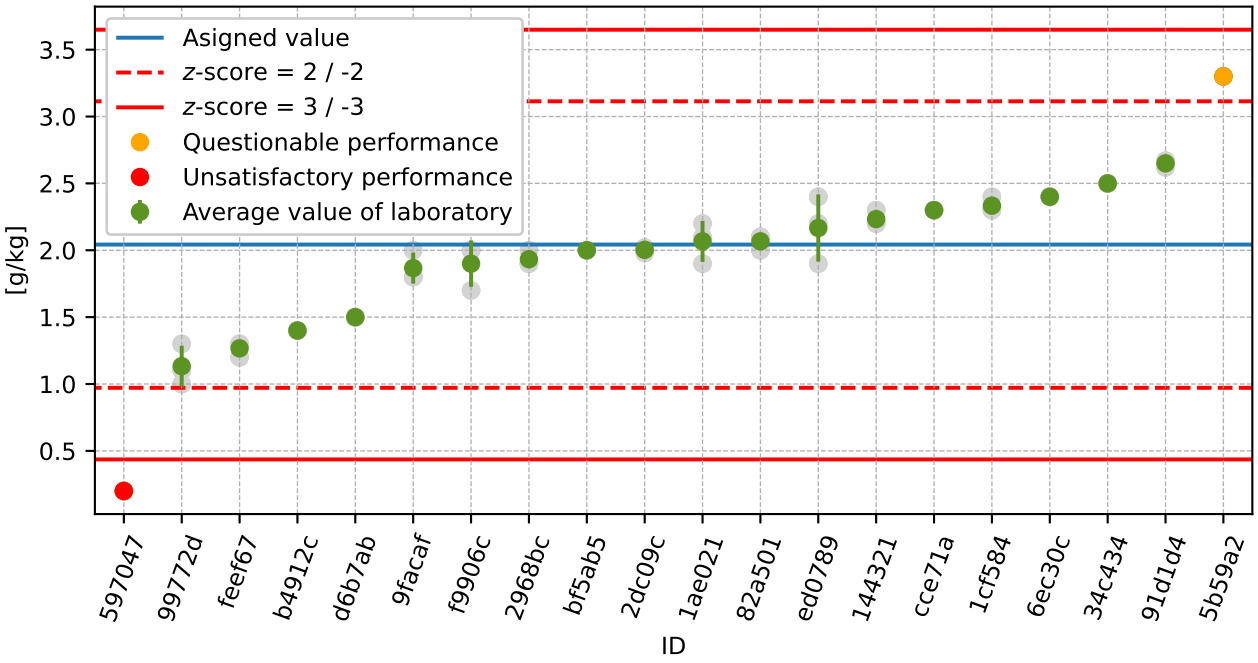

Figure 112: Average values and sample standard deviations

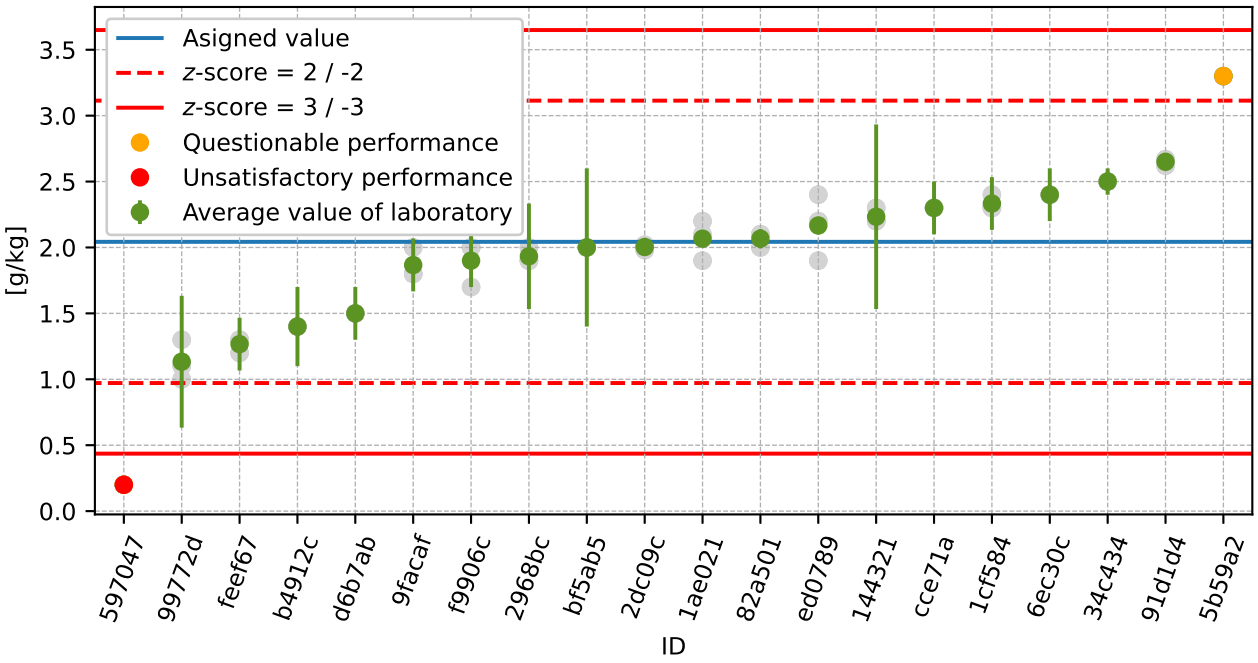

Figure 113: Average values and extended uncertainties of measurement

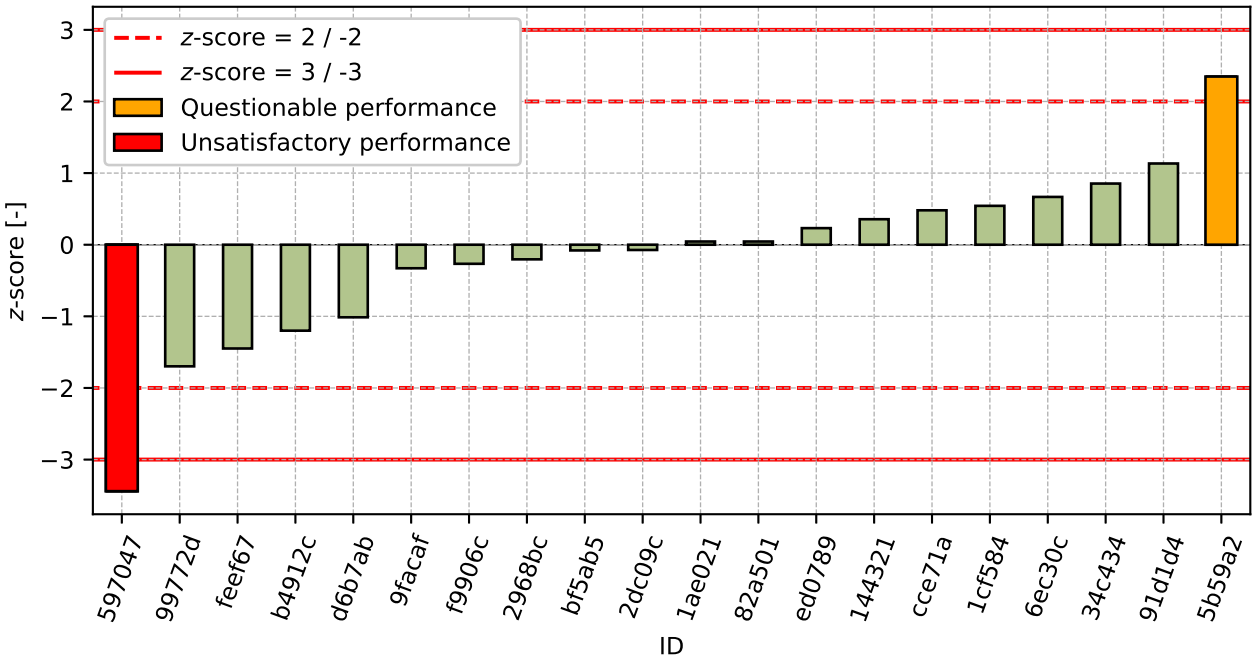

Figure 114: z-score

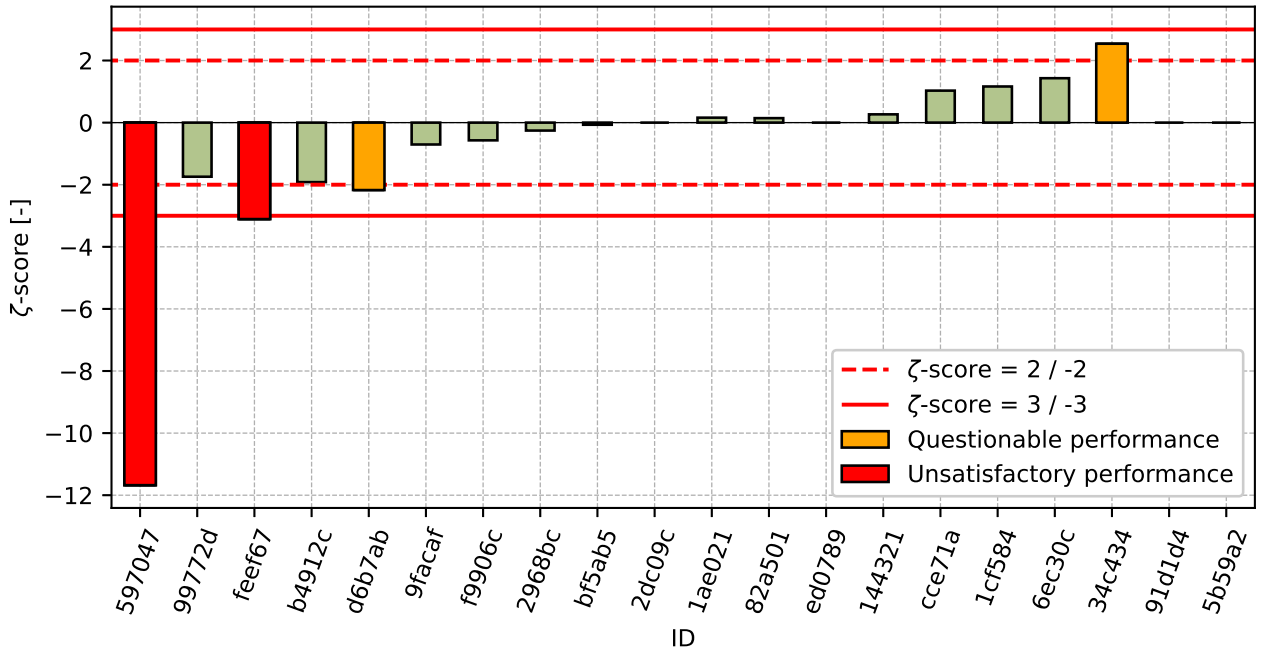

Figure 115: ζ-score

Table 37: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
597047	-3.44	-11.68
99772d	-1.7	-1.74
feef67	-1.45	-3.11
b4912c	-1.2	-1.92
d6b7ab	-1.01	-2.17
9facaf	-0.33	-0.7
f9906c	-0.27	-0.57
2968bc	-0.2	-0.26
bf5ab5	-0.08	-0.07
2dc09c	-0.07	-
1ae021	0.04	0.16
82a501	0.04	0.14
ed0789	0.23	-
144321	0.36	0.27
cce71a	0.48	1.03
1cf584	0.54	1.16
6ec30c	0.67	1.43
34c434	0.85	2.54
91d1d4	1.13	-
5b59a2	2.35	-

6 Appendix – EN 933-10 Assessment of fines - Grading of filler aggregates (air jet sieving)

6.1 Sieve 2 mm

6.1.1 Test results

Table 38: 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 [%]
ae026d	100	100	100	1	100	0.0	0.0
b4912c	100	100	100	3	100	0.0	0.0
99772d	100	100	100	-	100	0.0	0.0
25e37d	100	100	100	4	100	0.0	0.0
2dc09c	100	100	100	-	100	0.0	0.0
943aff	100	100	100	3	100	0.0	0.0

6.2 Sieve 0.125 mm

6.2.1 Test results

Table 39: 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 [%]
ae026d	95	95	95	1	95	0.1	0.06
99772d	95	95	96	9	95	0.6	0.61
b4912c	96	96	96	3	96	0.0	0.0
25e37d	96	96	96	4	96	0.0	0.0
2dc09c	96	96	96	-	96	0.0	0.0
943aff	96	96	96	3	96	0.0	0.0

6.2.2 The Numerical Procedure for Determining Outliers

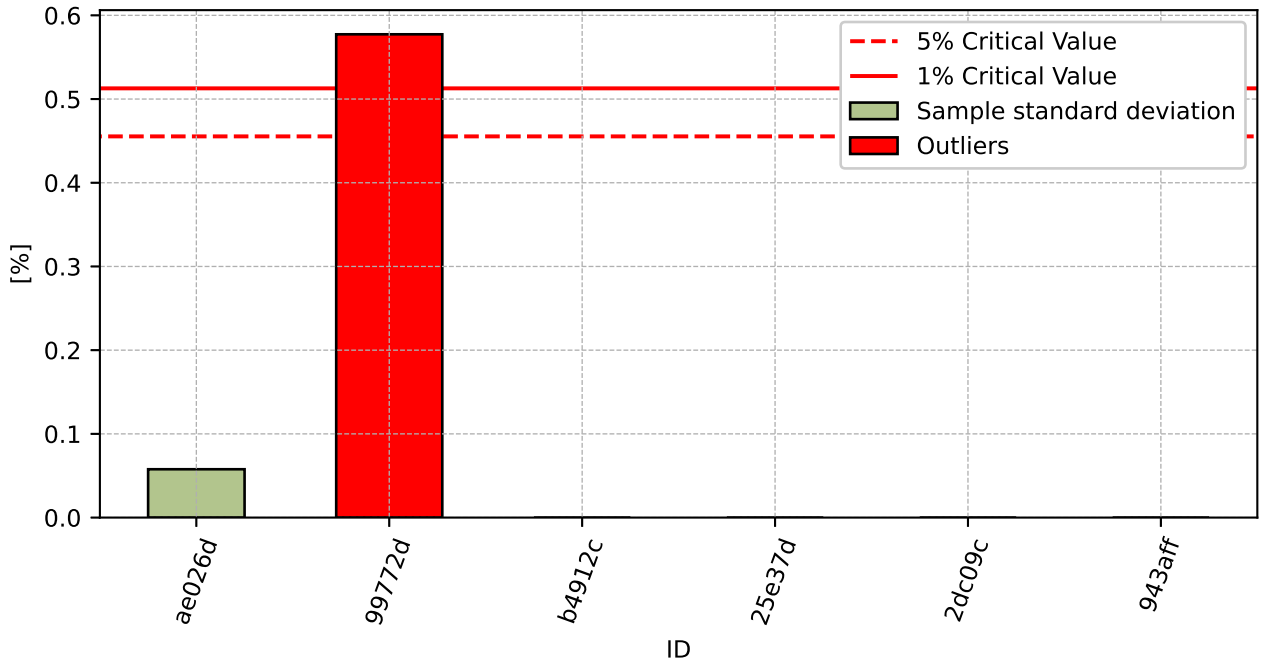

Figure 116: **Cochran's test** - sample standard deviations

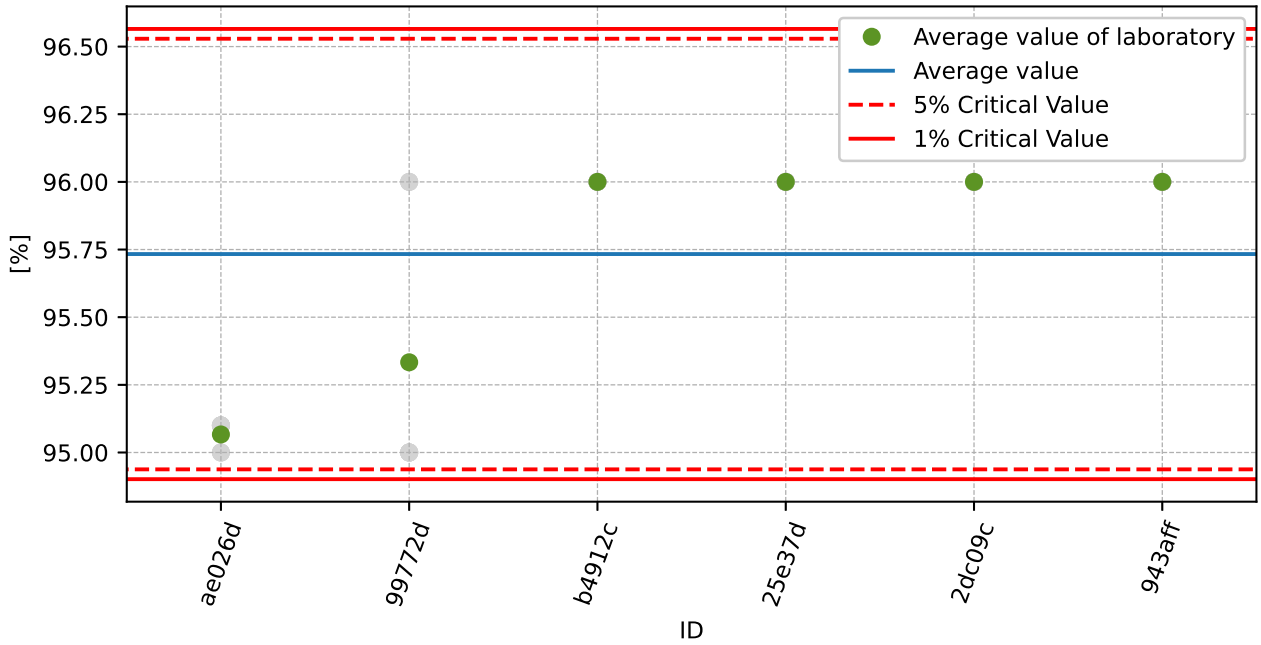

Figure 117: **Grubbs' test** - average values

6.2.3 Mandel's Statistics

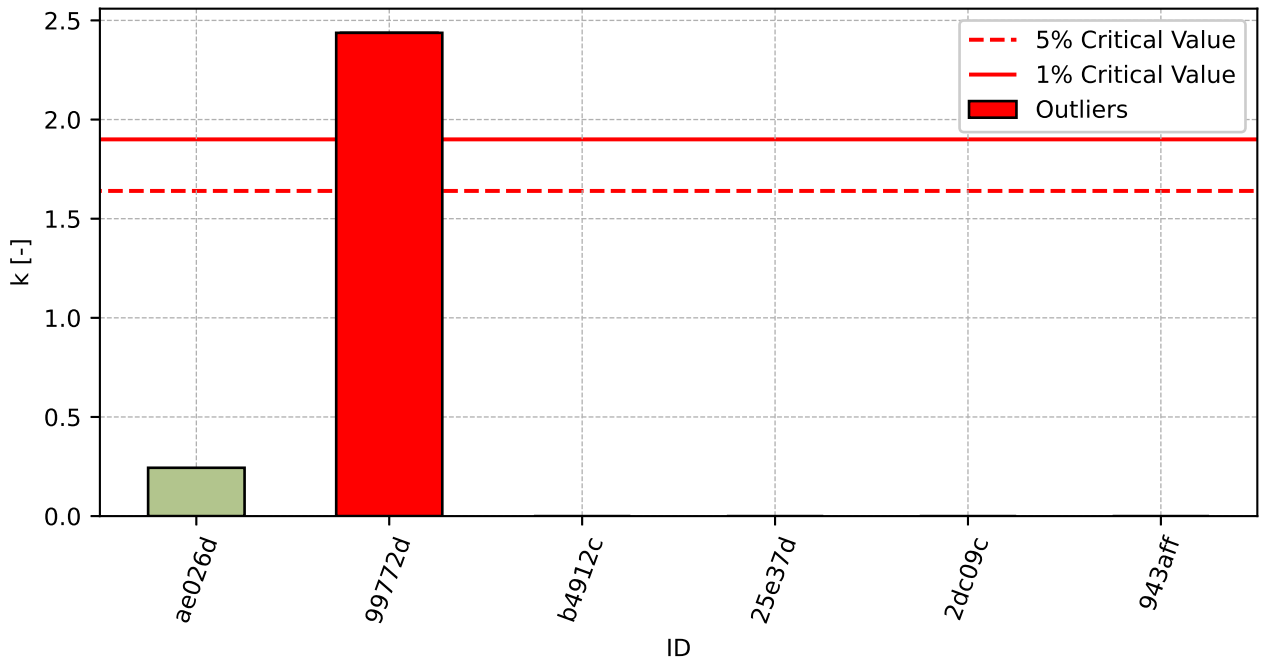

Figure 118: Intralaboratory Consistency Statistic

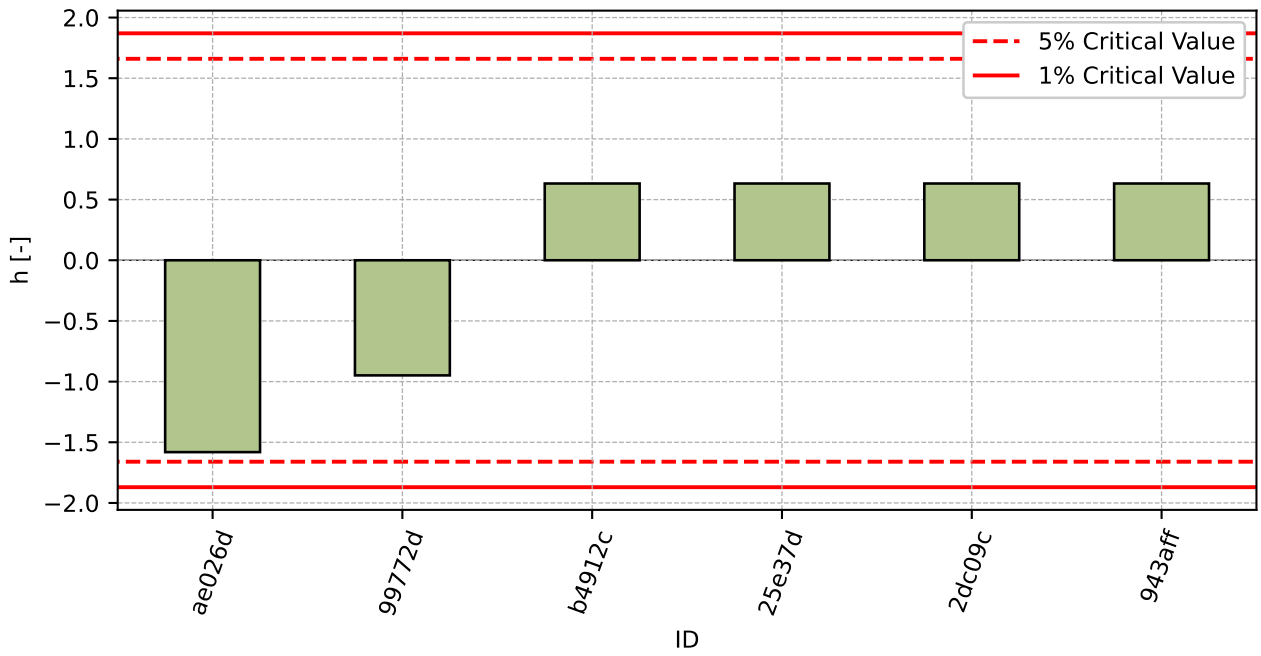

Figure 119: Interlaboratory Consistency Statistic

6.2.4 Descriptive statistics

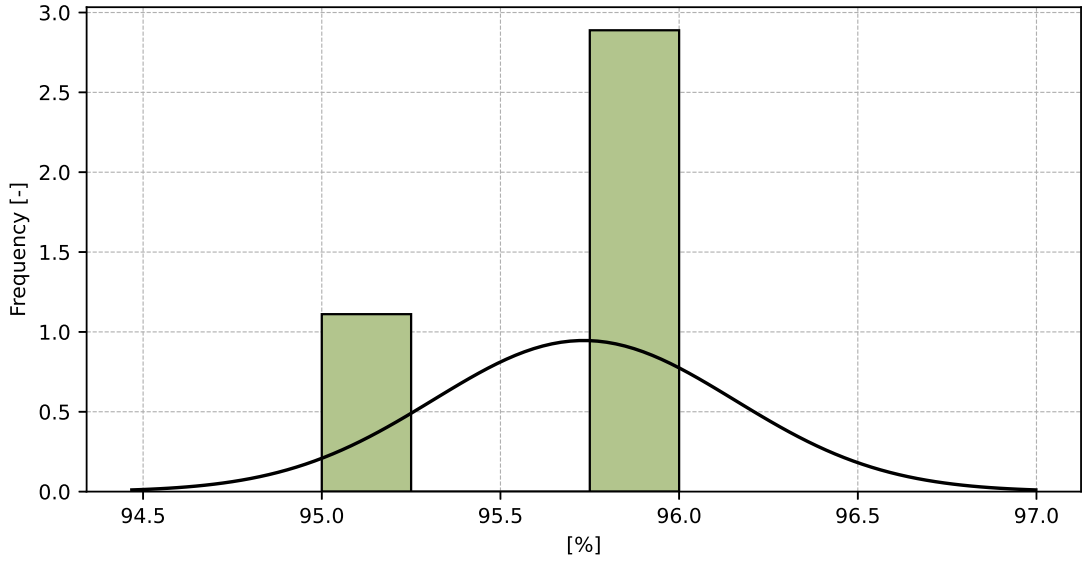

Figure 120: Histogram of all test results

Table 40: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	96
Sample standard deviation – s	0.4
Asigned value – x^*	96
Robust standard deviation – s^*	0.4
Measurement uncertainty of asigned value – u_X	0.2
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.4
Repeatability standard deviation – s_r	0.2
Reproducibility standard deviation – s_R	0.5
Repeatability – r	1
Reproducibility – R	1

6.2.5 Evaluation of Performance Statistics

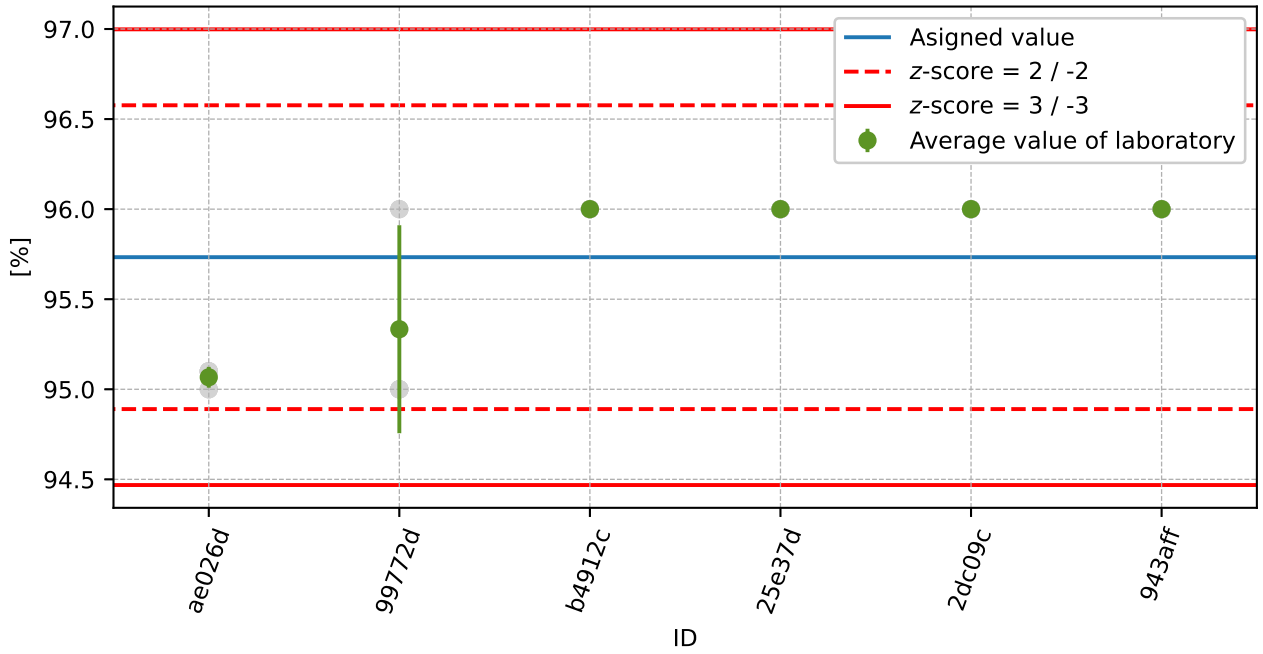

Figure 121: Average values and sample standard deviations

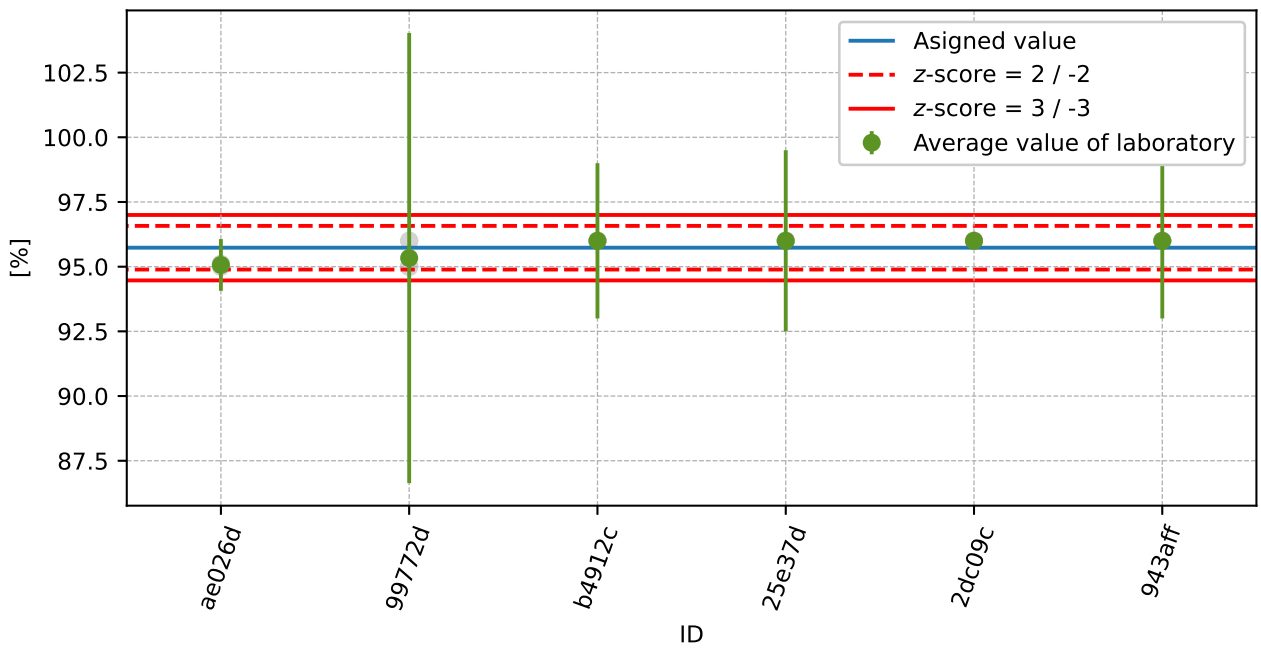

Figure 122: Average values and extended uncertainties of measurement

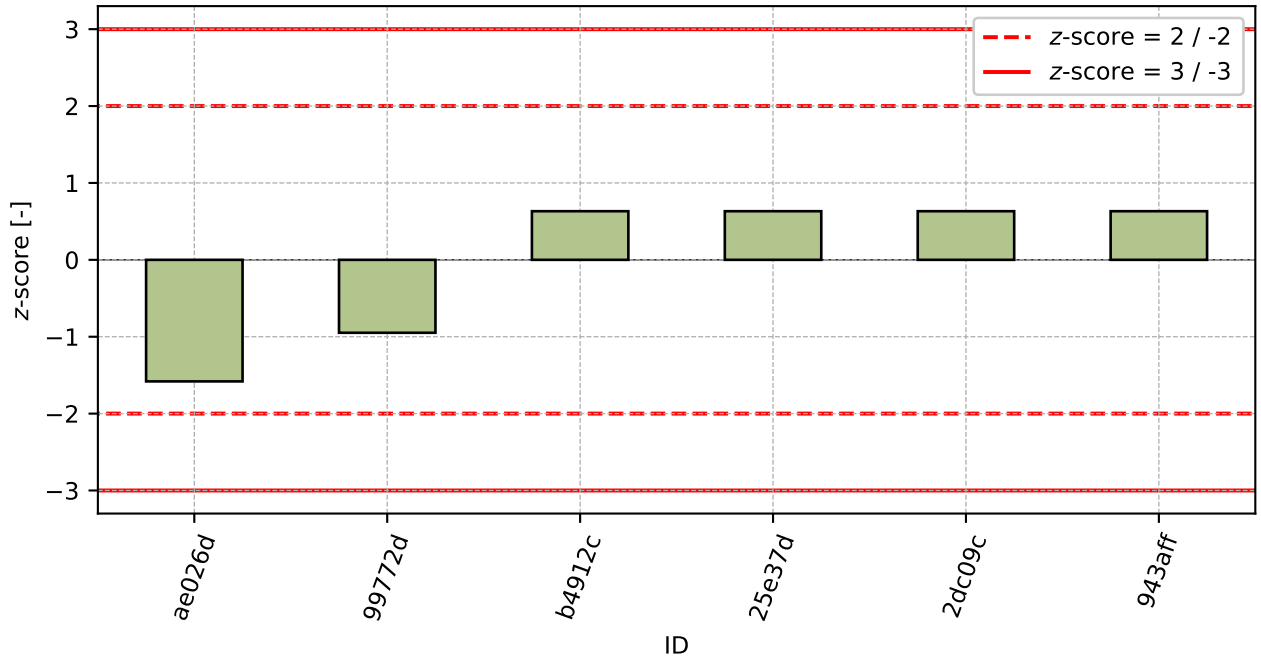

Figure 123: z-score

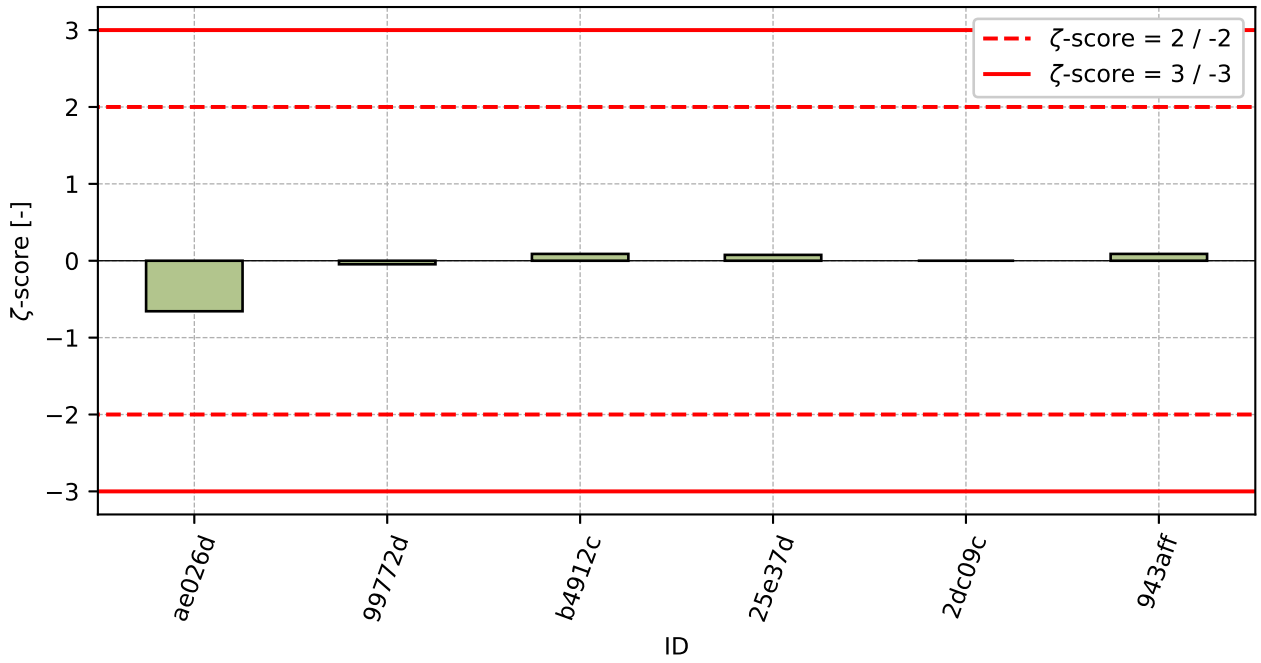

Figure 124: ζ-score

Table 41: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
ae026d	-1.58	-0.66
99772d	-0.95	-0.05
b4912c	0.63	0.09
25e37d	0.63	0.08
2dc09c	0.63	-
943aff	0.63	0.09

6.3 Sieve 0.063 mm

6.3.1 Test results

Table 42: 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 [%]
99772d	76	77	79	2	77	1.5	1.98
2dc09c	80	81	80	-	80	0.6	0.72
ae026d	85	85	85	1	85	0.2	0.2
943aff	85	85	85	3	85	0.0	0.0
b4912c	86	86	86	3	86	0.0	0.0
25e37d	86	86	86	4	86	0.0	0.0

6.3.2 The Numerical Procedure for Determining Outliers

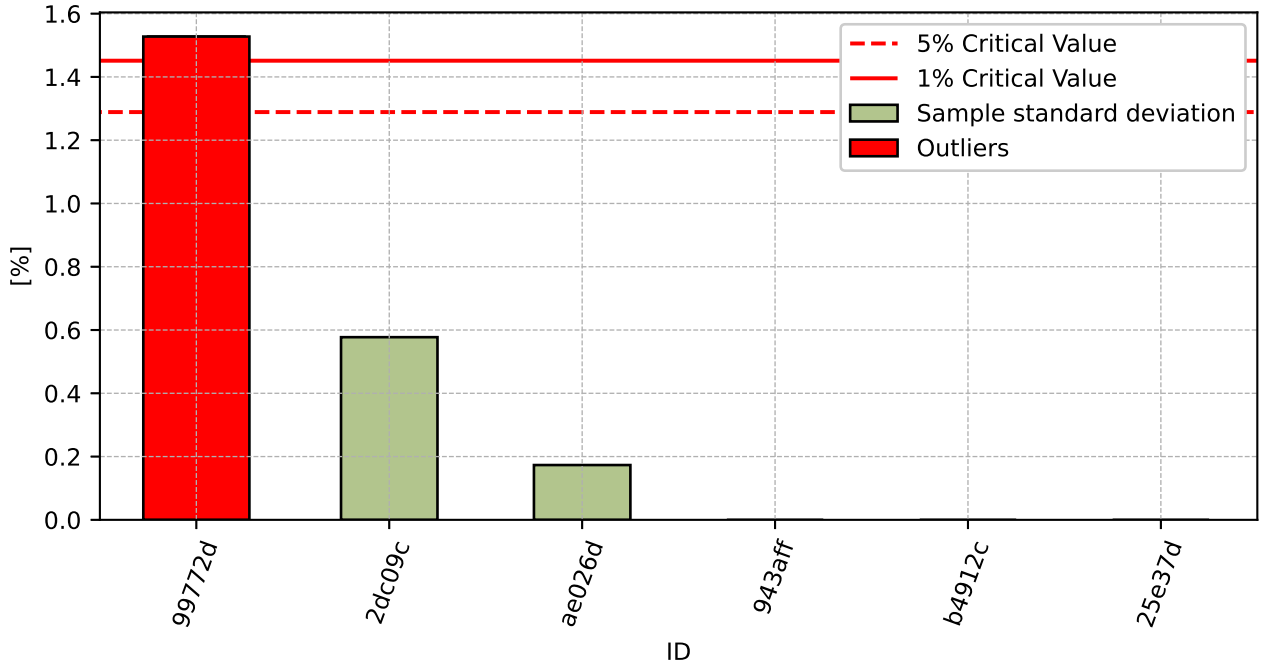

Figure 125: **Cochran's test** - sample standard deviations

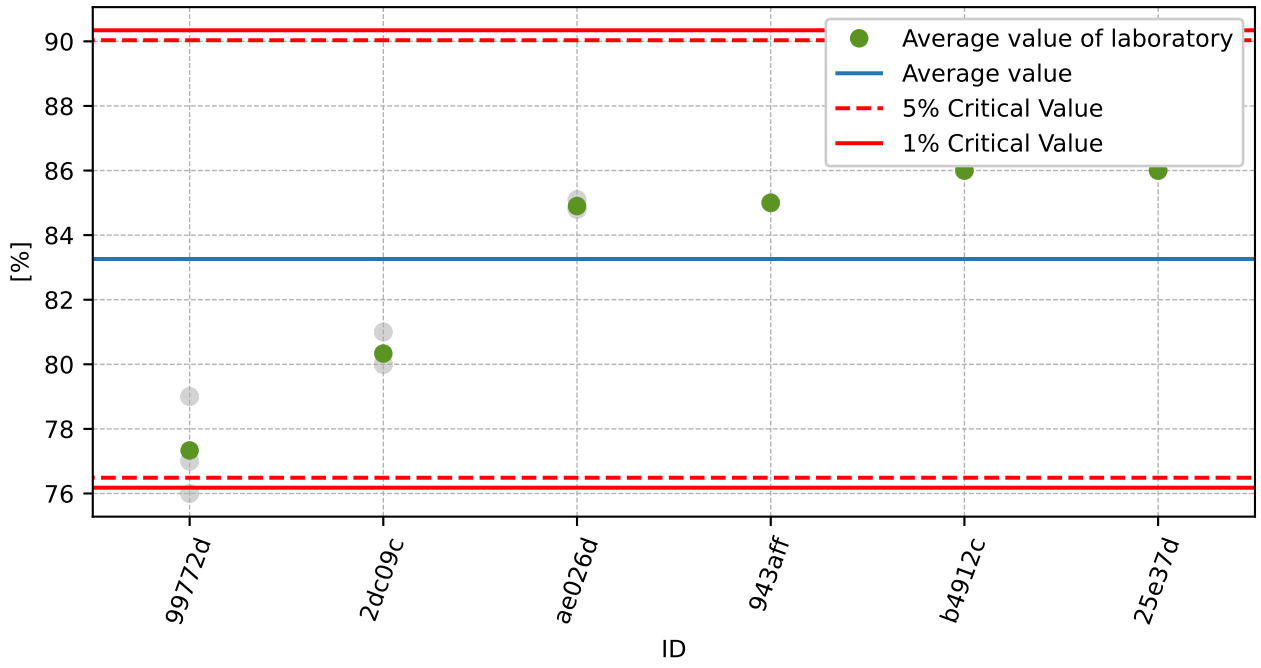

Figure 126: **Grubbs' test** - average values

6.3.3 Mandel's Statistics

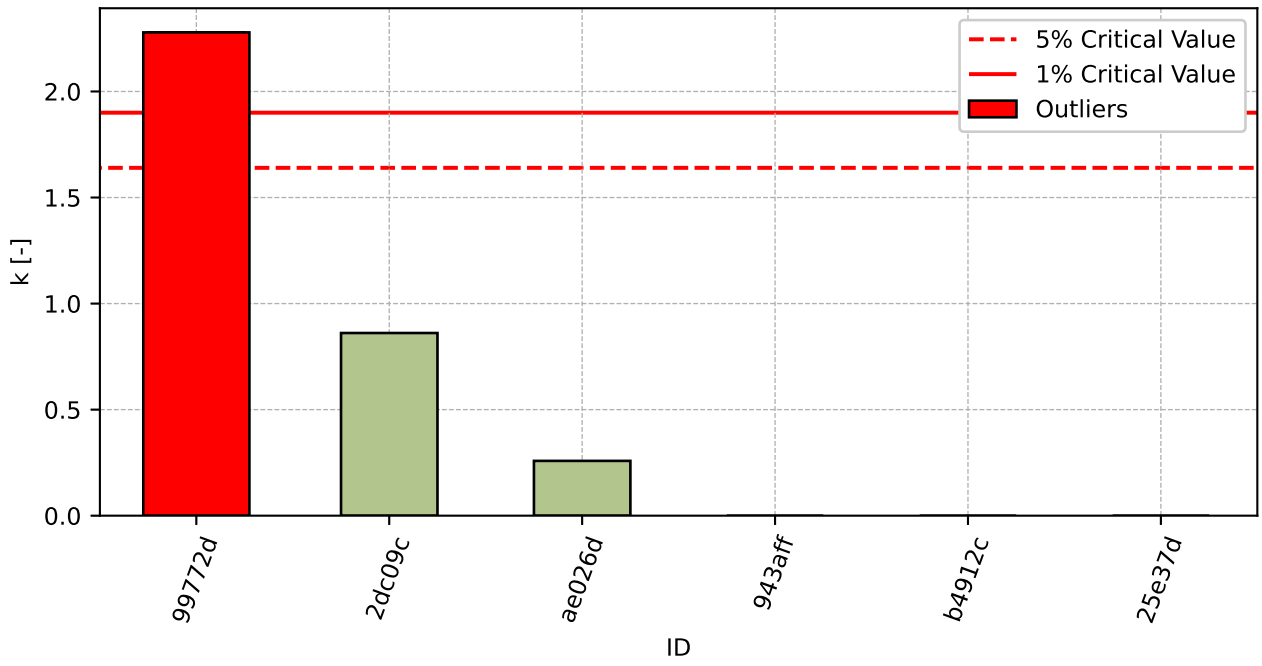

Figure 127: Intralaboratory Consistency Statistic

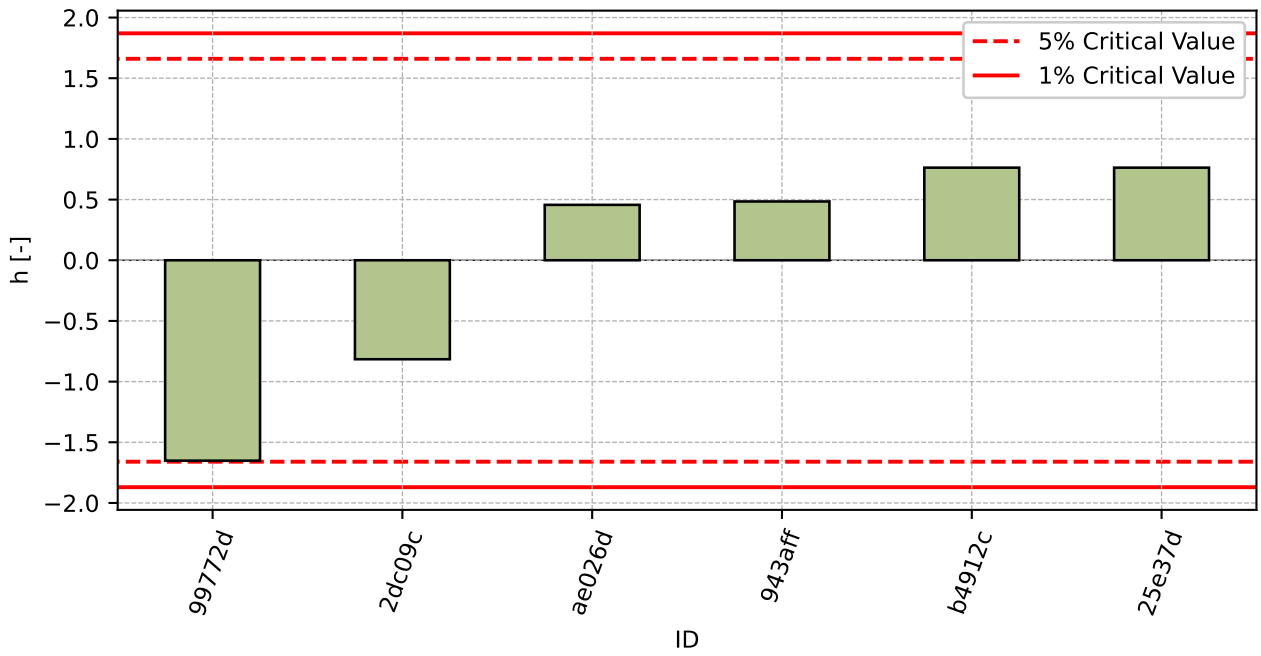

Figure 128: Interlaboratory Consistency Statistic

6.3.4 Descriptive statistics

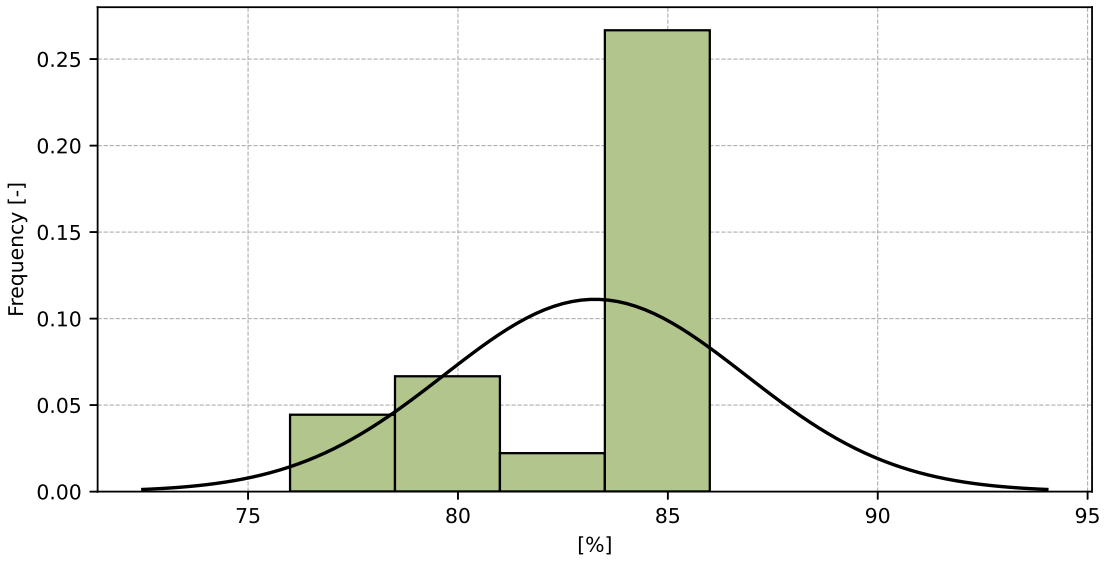

Figure 129: Histogram of all test results

Table 43: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	83
Sample standard deviation – s	3.6
Asigned value – x^*	83
Robust standard deviation – s^*	3.6
Measurement uncertainty of asigned value – u_X	1.5
p-value of normality test	0.001 [-]
Interlaboratory standard deviation – s_L	3.6
Repeatability standard deviation – s_r	0.7
Reproducibility standard deviation – s_R	3.6
Repeatability – r	2
Reproducibility – R	10

6.3.5 Evaluation of Performance Statistics

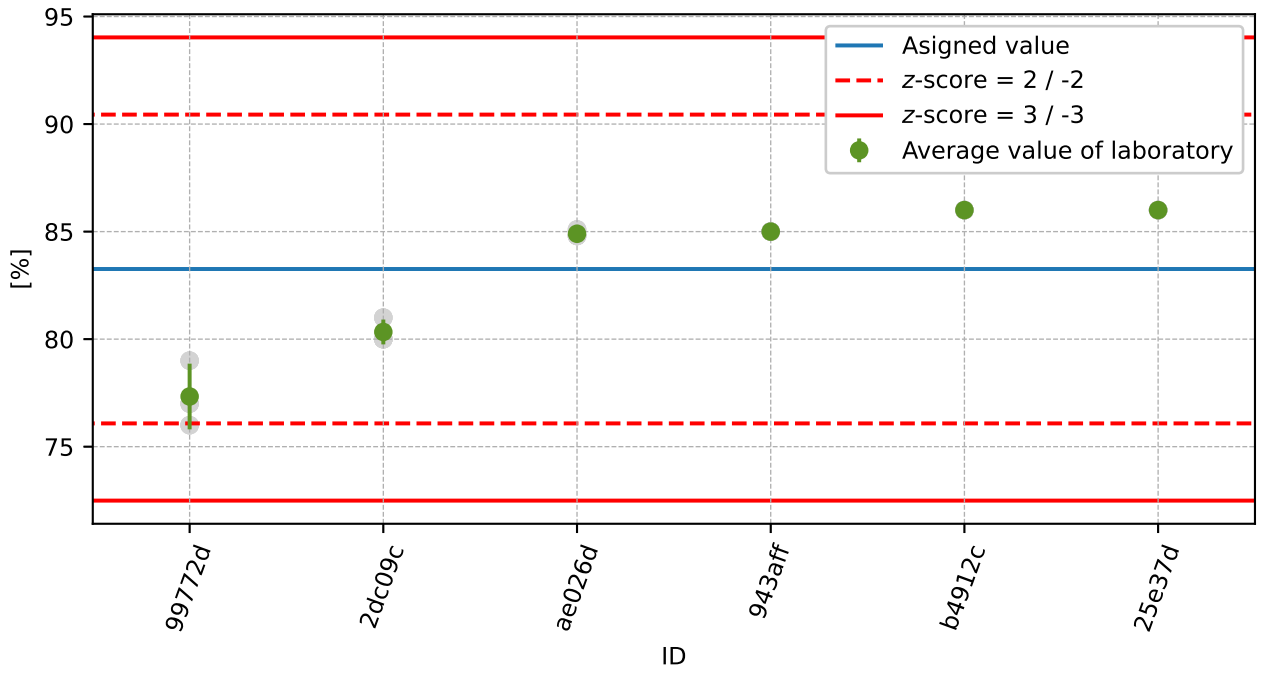

Figure 130: Average values and sample standard deviations

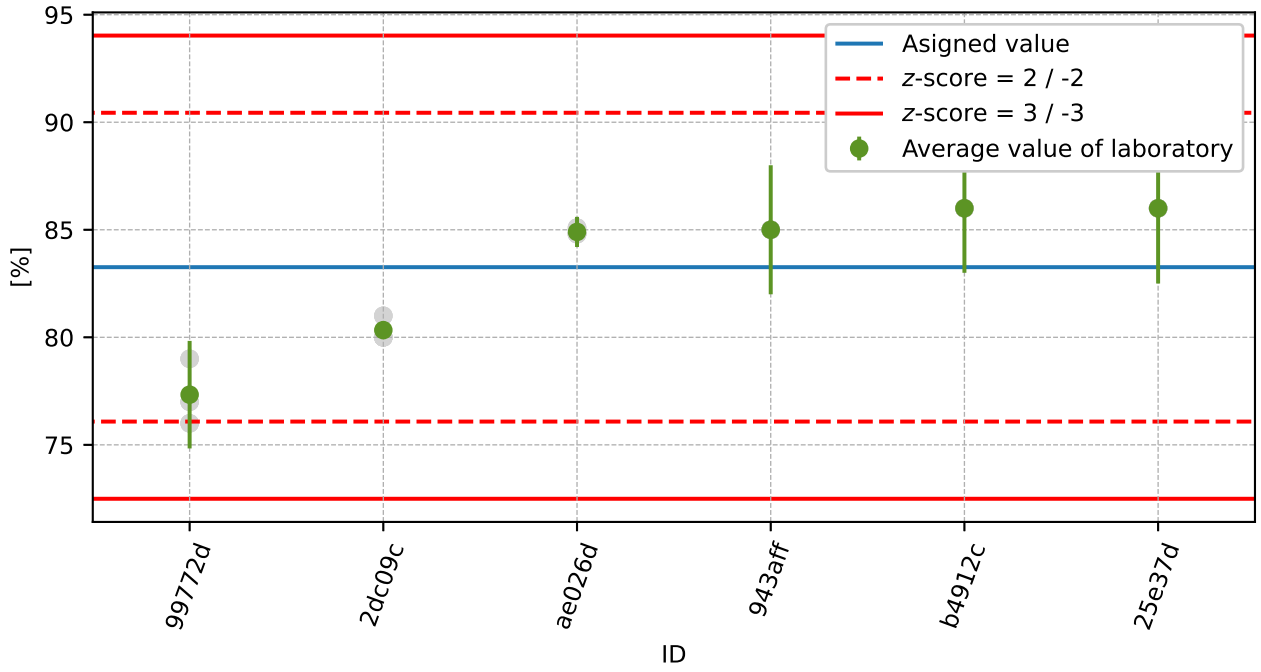

Figure 131: Average values and extended uncertainties of measurement

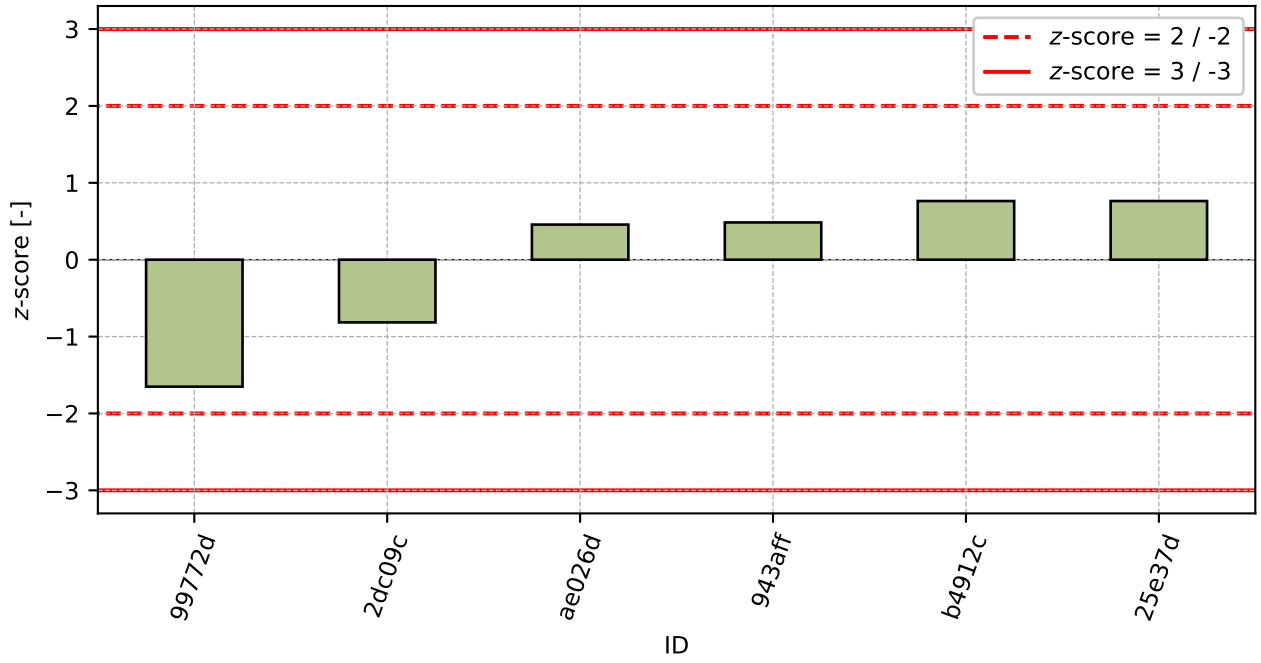

Figure 132: z-score

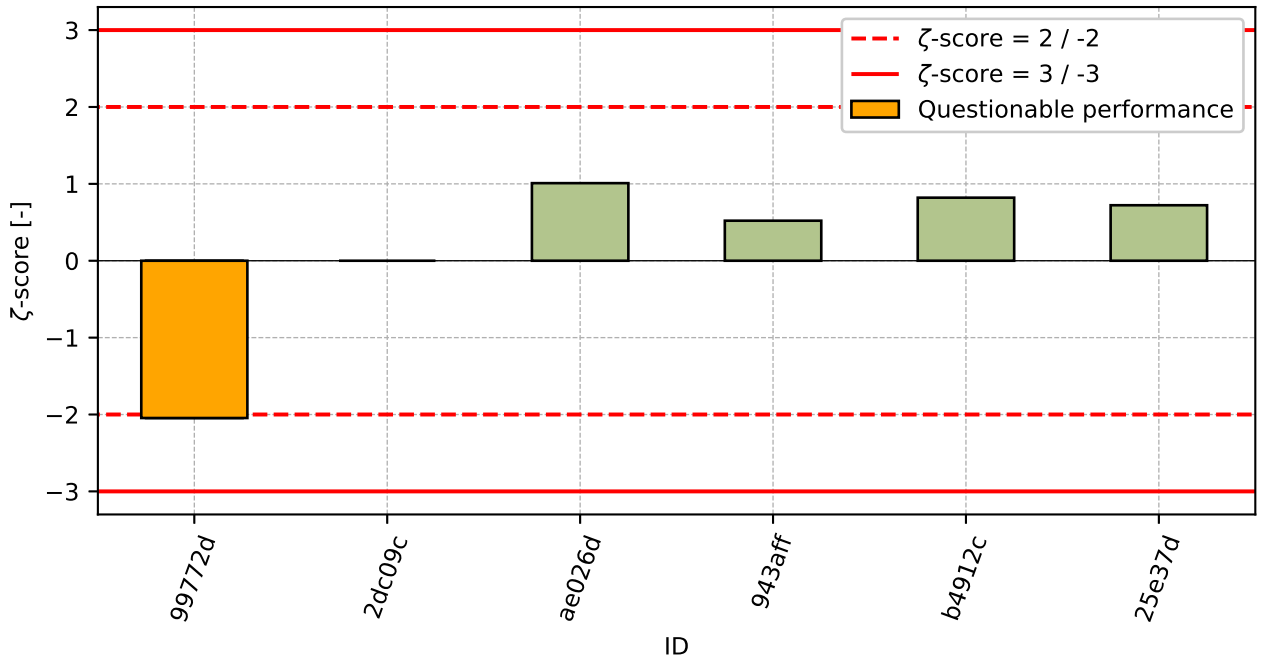

Figure 133: ζ-score

Table 44: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
99772d	-1.65	-2.05
2dc09c	-0.82	-
ae026d	0.46	1.01
943aff	0.48	0.52
b4912c	0.76	0.82
25e37d	0.76	0.72

7 Appendix – EN 1097-1 Determination of the resistance to wear (micro-Deval)

7.1 Test results

Table 45: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [-]	u_X [-]
a2426d	11	2
02a56a	11	1
d6b7ab	11	1
f9906c	12	2
b4912c	12	2
63d8e1	12	0
feef67	12	1
74d791	12	-
9facaf	13	0
5648cb	13	1
56e681	13	0
597047	13	2
1300a8	14	0

7.2 The Numerical Procedure for Determining Outliers

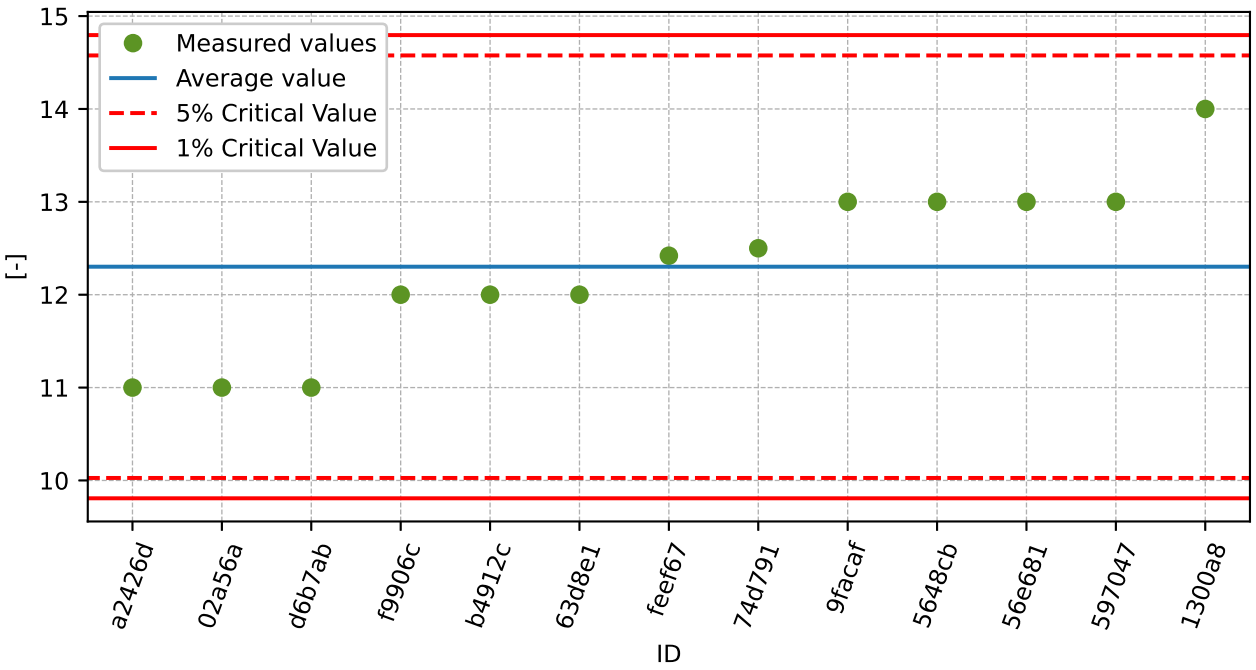

Figure 134: **Grubbs' test** - average values

7.3 Mandel's Statistics

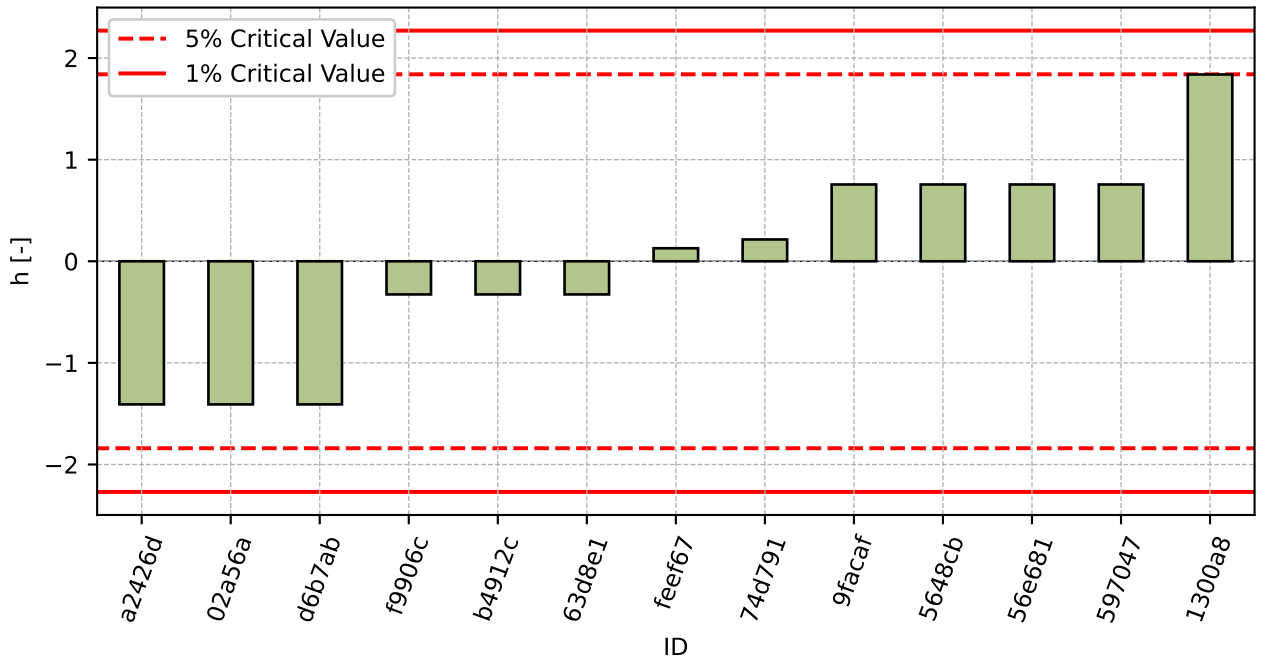

Figure 135: Interlaboratory Consistency Statistic

7.4 Descriptive statistics

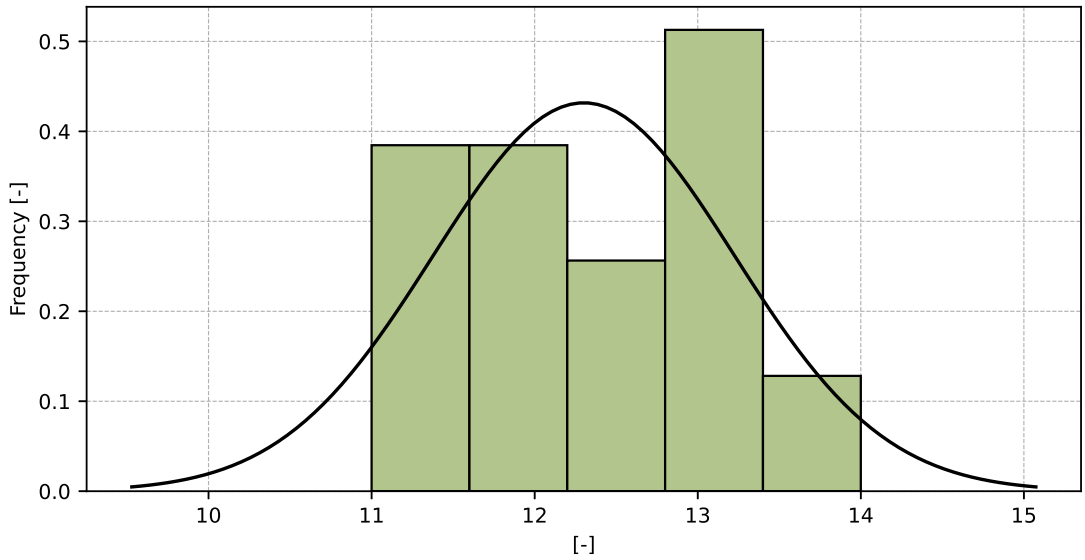

Figure 136: Histogram of all test results

Table 46: Descriptive statistics

Characteristics	[-]
Average value – $\bar{x}$	12
Sample standard deviation – s	0.9
Asigned value – x^*	12
Robust standard deviation – s^*	1.0
Measurement uncertainty of asigned value – u_X	0.3
p-value of normality test	0.218 [-]

7.5 Evaluation of Performance Statistics

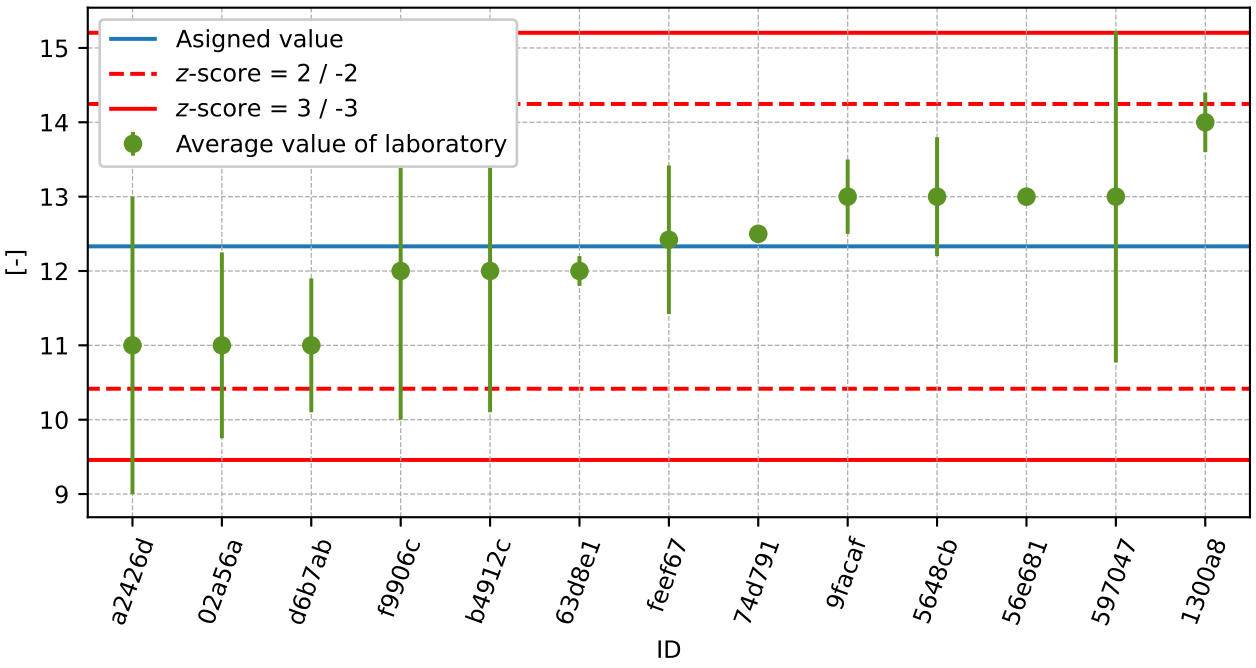

Figure 137: Average values and extended uncertainties of measurement

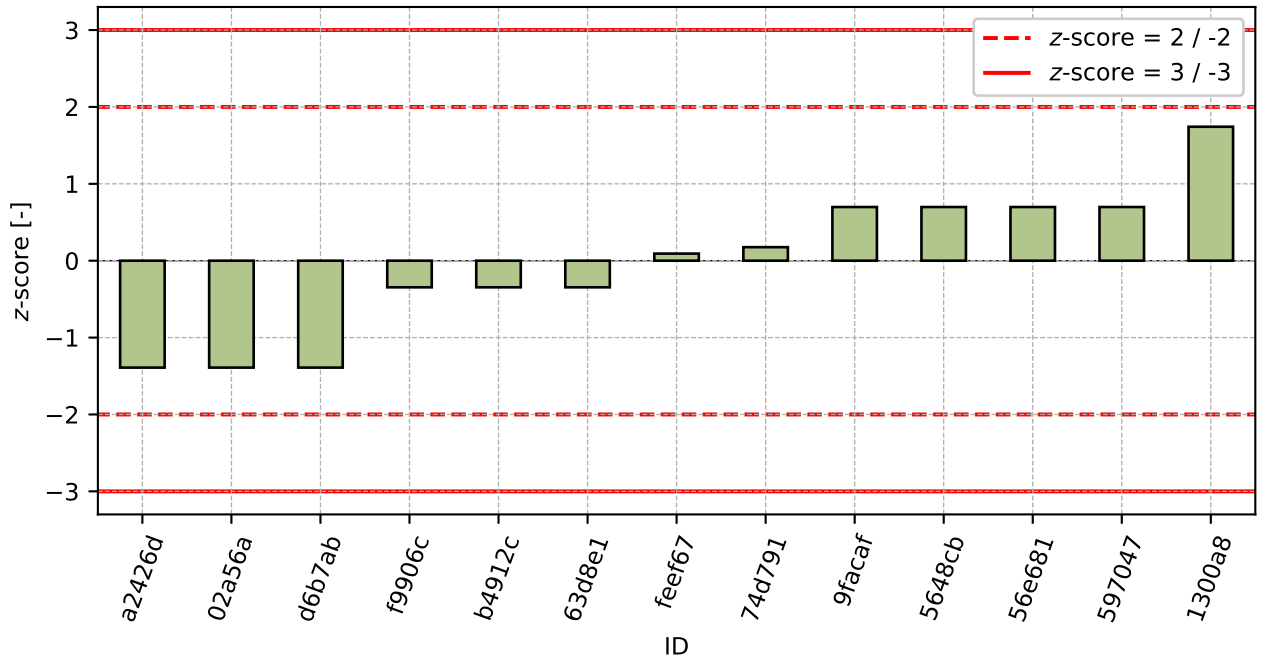

Figure 138: z-score

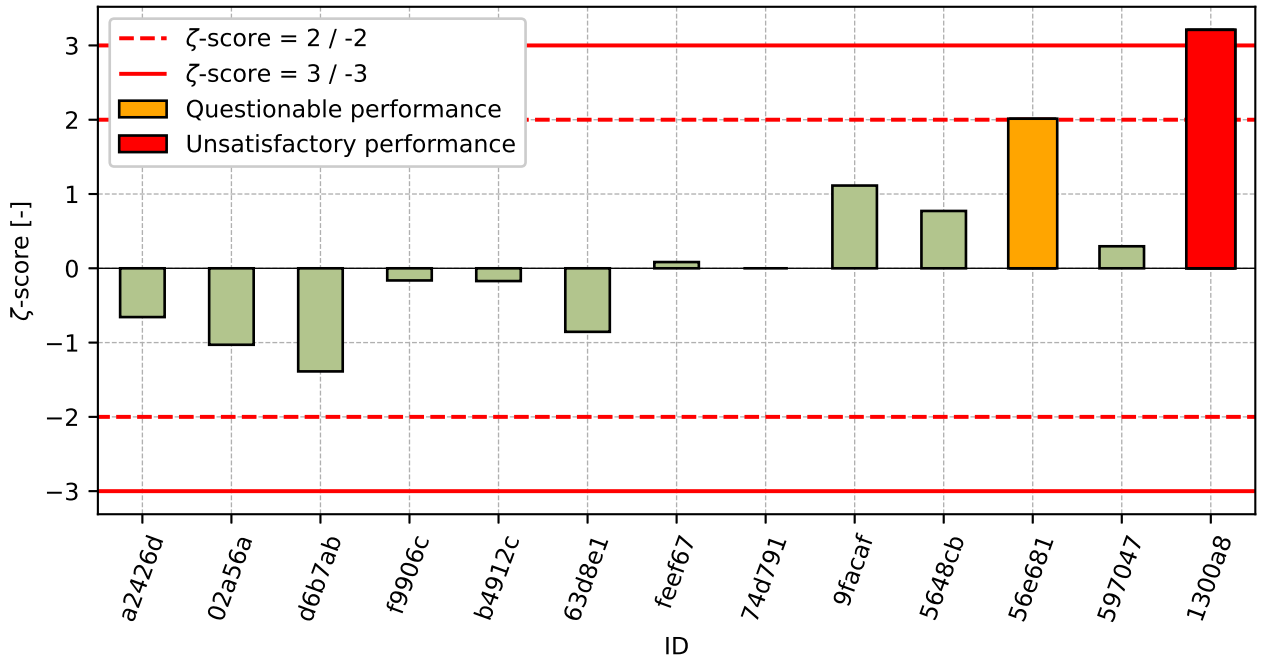

Figure 139: ζ-score

Table 47: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a2426d	-1.39	-0.66
02a56a	-1.39	-1.03
d6b7ab	-1.39	-1.39
f9906c	-0.35	-0.16
b4912c	-0.35	-0.17
63d8e1	-0.35	-0.86
feef67	0.09	0.08
74d791	0.18	-
9facaf	0.7	1.11
5648cb	0.7	0.77
56e681	0.7	2.01
597047	0.7	0.3
1300a8	1.74	3.21

8 Appendix – EN 1097-2 Methods for the determination of resistance to fragmentation - chapter 5

8.1 Test results

Table 48: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [-]	u_X [-]
f9906c	12	2
9facaf	13	1
c01d65	15	0
597047	15	3
56e681	15	0
63d8e1	15	1
b4912c	15	2
ba0755	16	1
74d791	16	-
99772d	16	5
d6b7ab	16	0
feef67	16	-
1cf584	16	2
cce71a	16	2
c429d1	16	2
d2edc0	17	2
02a56a	17	1
ae026d	18	1
2831cc	18	-
1cf882	20	2

8.2 The Numerical Procedure for Determining Outliers

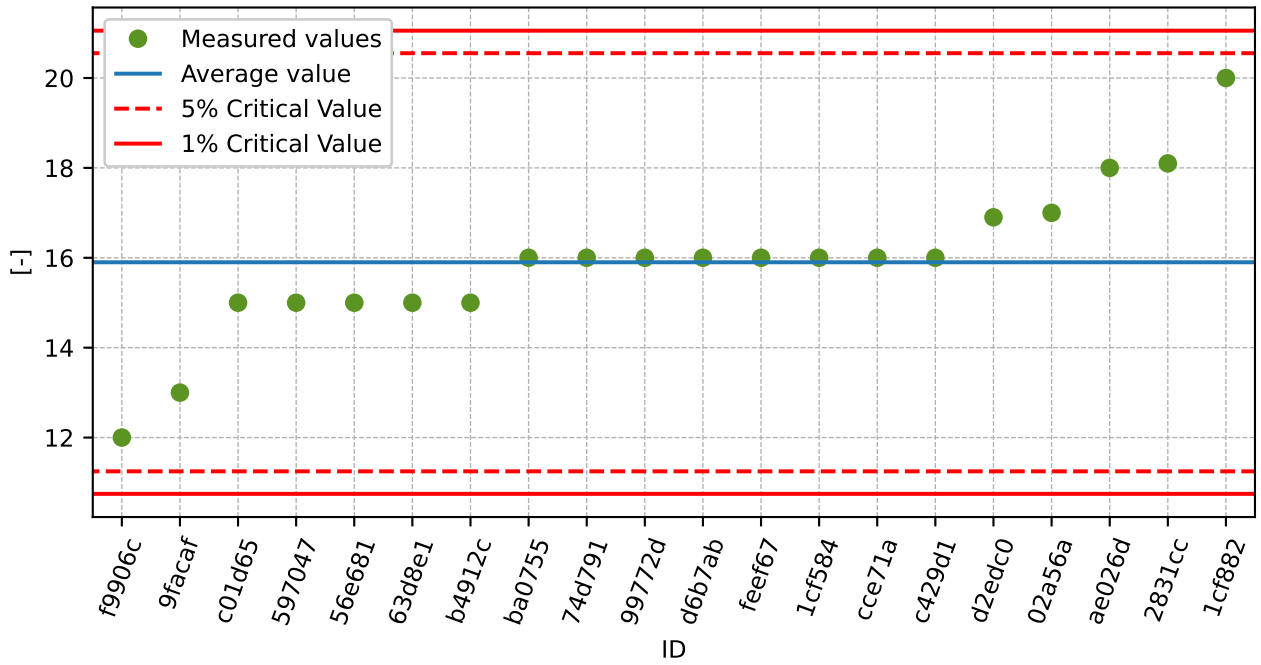

Figure 140: **Grubbs' test** - average values

8.3 Mandel's Statistics

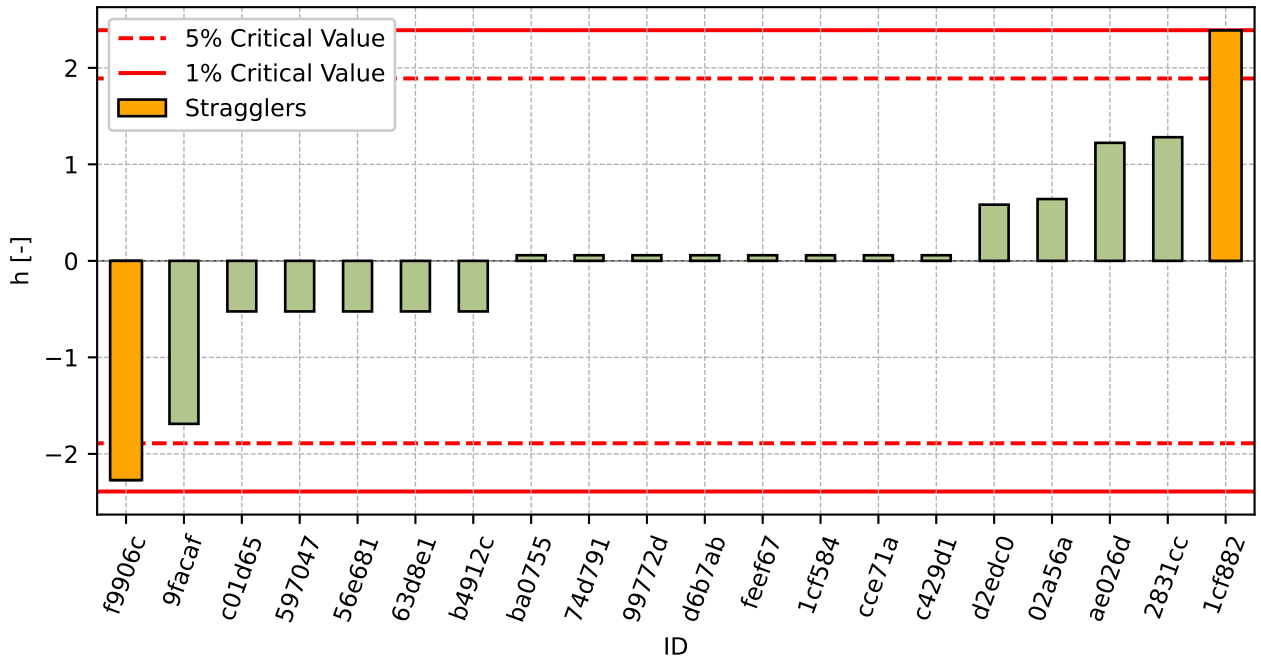

Figure 141: Interlaboratory Consistency Statistic

8.4 Descriptive statistics

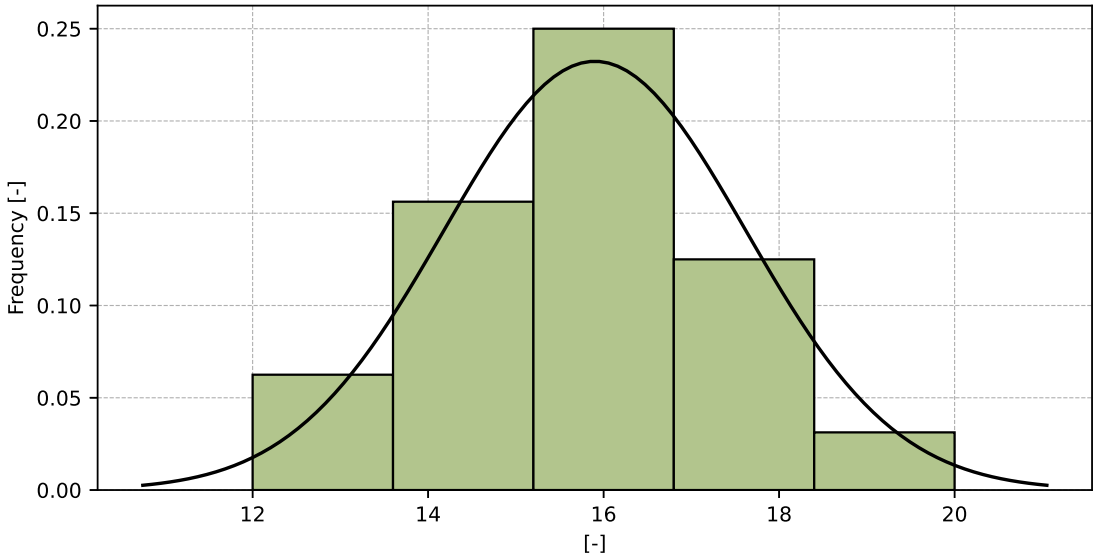

Figure 142: Histogram of all test results

Table 49: Descriptive statistics

Characteristics	**[-]**
Average value – $\bar{x}$	16
Sample standard deviation – s	1.7
Asigned value – x^*	16
Robust standard deviation – s^*	1.6
Measurement uncertainty of asigned value – u_X	0.5
p-value of normality test	0.086 [-]

8.5 Evaluation of Performance Statistics

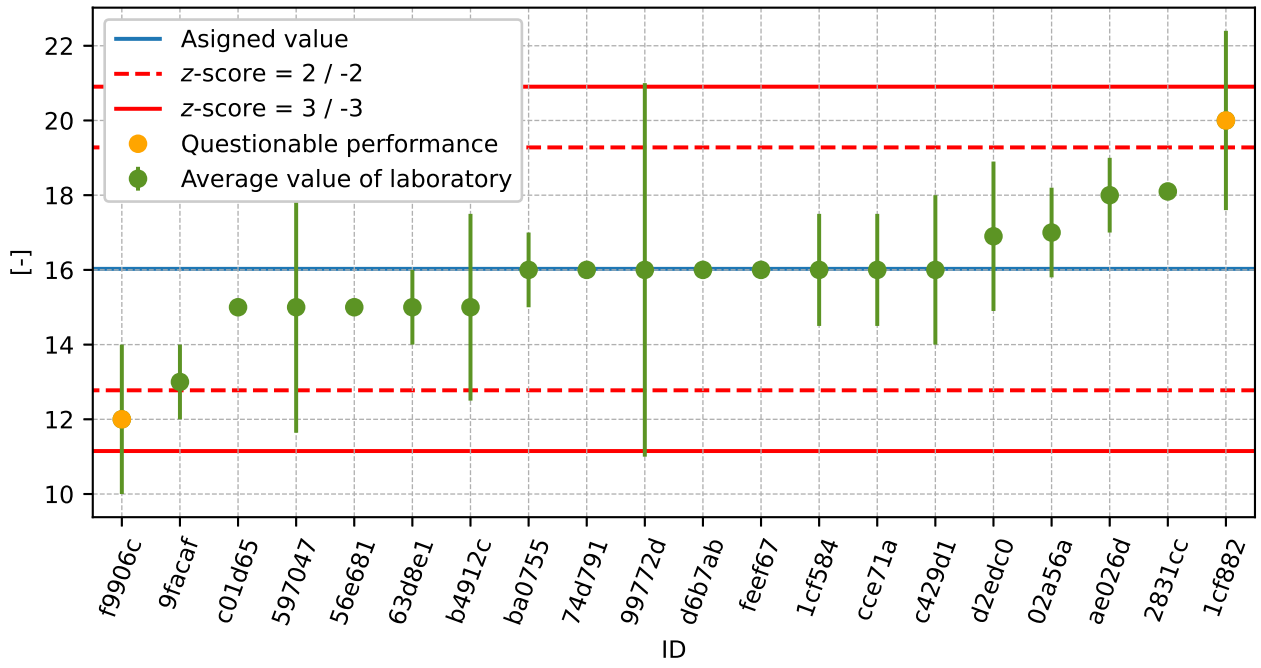

Figure 143: Average values and extended uncertainties of measurement

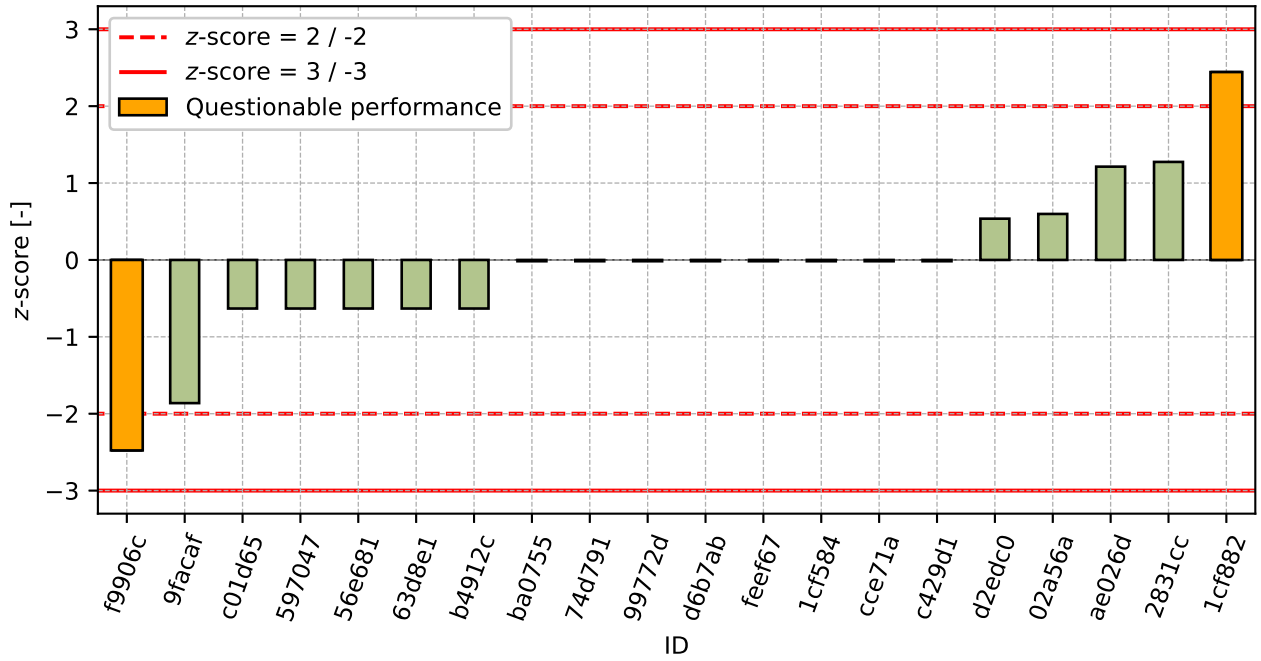

Figure 144: z-score

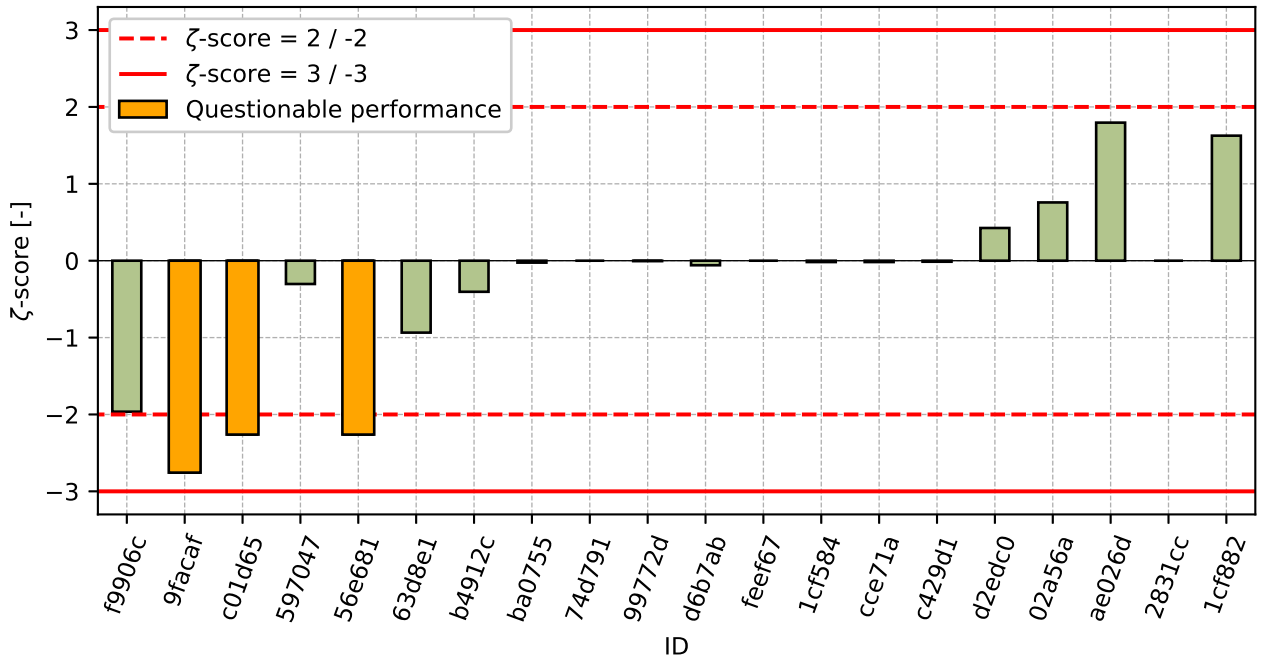

Figure 145: ζ-score

Table 50: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f9906c	-2.48	-1.96
9facaf	-1.86	-2.76
c01d65	-0.63	-2.26
597047	-0.63	-0.3
56e681	-0.63	-2.26
63d8e1	-0.63	-0.94
b4912c	-0.63	-0.4
ba0755	-0.02	-0.03
74d791	-0.02	-
99772d	-0.02	-0.01
d6b7ab	-0.02	-0.06
feef67	-0.02	-
1cf584	-0.02	-0.02
cce71a	-0.02	-0.02
c429d1	-0.02	-0.01
d2edc0	0.54	0.43
02a56a	0.6	0.76
ae026d	1.21	1.8
2831cc	1.27	-
1cf882	2.44	1.63

9 Appendix – EN 1097-2 Methods for the determination of resistance to fragmentation - chapter 6

9.1 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 [-]	u_X [-]
615698	16	0
bf844c	16	1

9.2 Evaluation of Performance Statistics

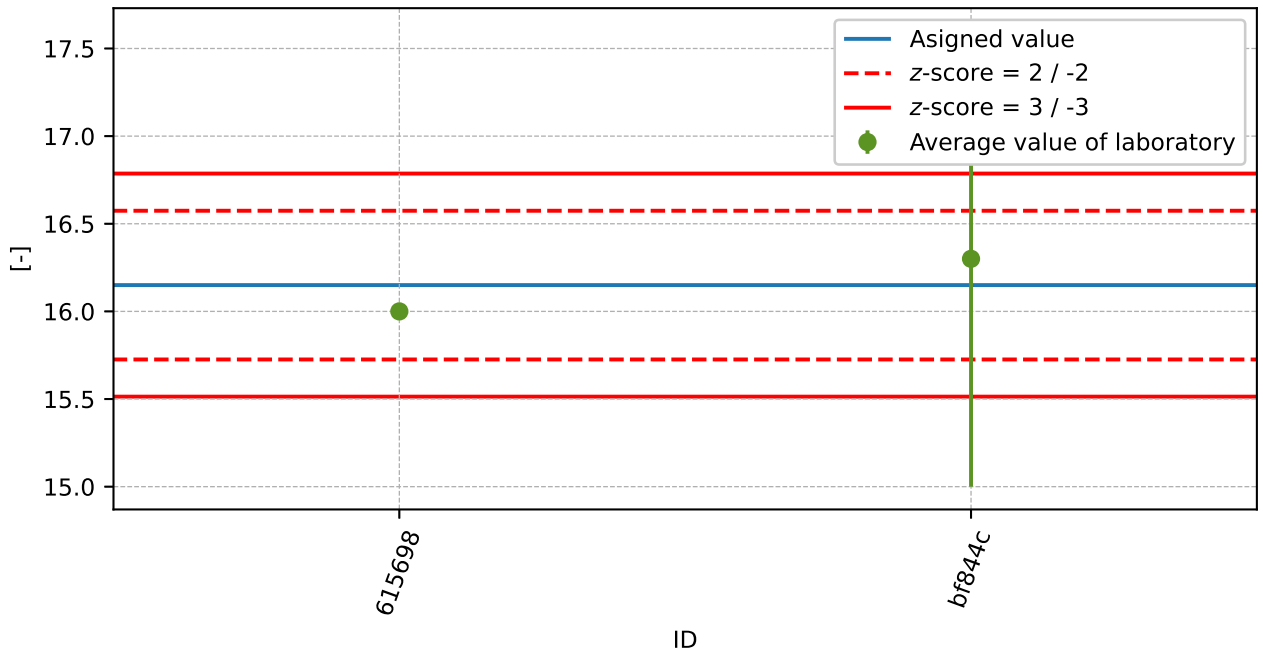

Figure 146: Average values and extended uncertainties of measurement

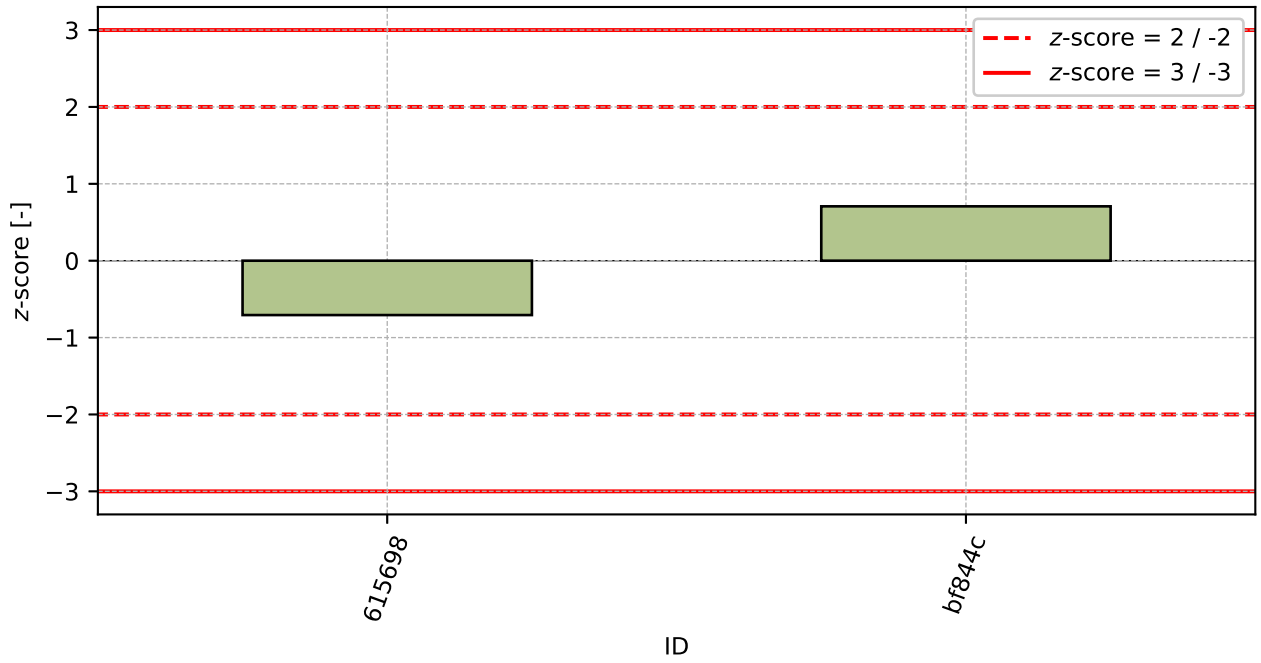

Figure 147: z-score

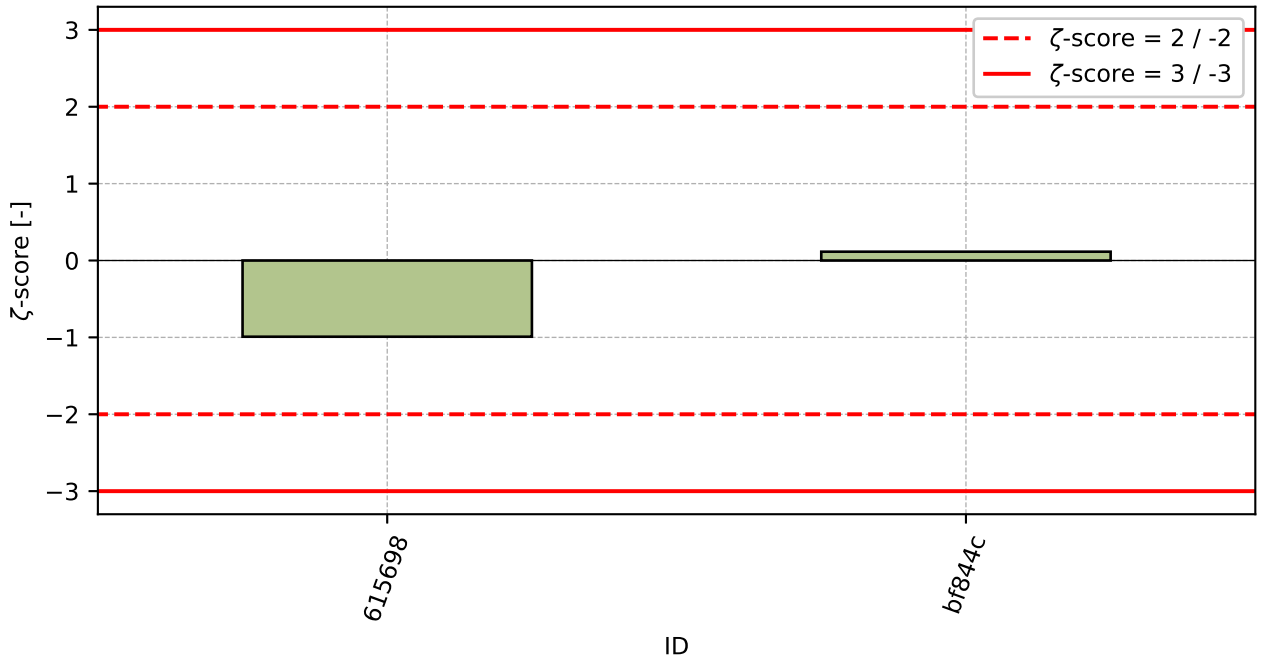

Figure 148: ζ-score

Table 52: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
615698	-0.71	-0.99
bf844c	0.71	0.11

10 Appendix – EN 1097-3 Determination of loose bulk density and voids

10.1 Loose bulk density

10.1.1 Test results

Table 53: 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/m³]			u_X [Mg/m³]	$\bar{x}$ [Mg/m³]	s_0 [Mg/m³]	V_X [%]
2831cc	1.32	1.32	1.32	-	1.32	0.001	0.09
320f41	1.38	1.39	1.4	-	1.39	0.01	0.72
66c90a	1.4	1.38	1.4	-	1.39	0.012	0.83
fb2fb1	1.4	1.39	1.39	-	1.39	0.006	0.41
b4912c	1.43	1.43	1.43	0.16	1.43	0.001	0.04
d6b7ab	1.45	1.45	1.47	0.01	1.46	0.012	0.79
63d8e1	1.46	1.46	1.46	0.02	1.46	0.0	0.0
74d791	1.48	1.48	1.48	-	1.48	0.0	0.0
feef67	1.5	1.49	1.49	0.05	1.49	0.006	0.39
c07cfc	1.51	1.51	1.5	0.01	1.51	0.006	0.38

10.1.2 The Numerical Procedure for Determining Outliers

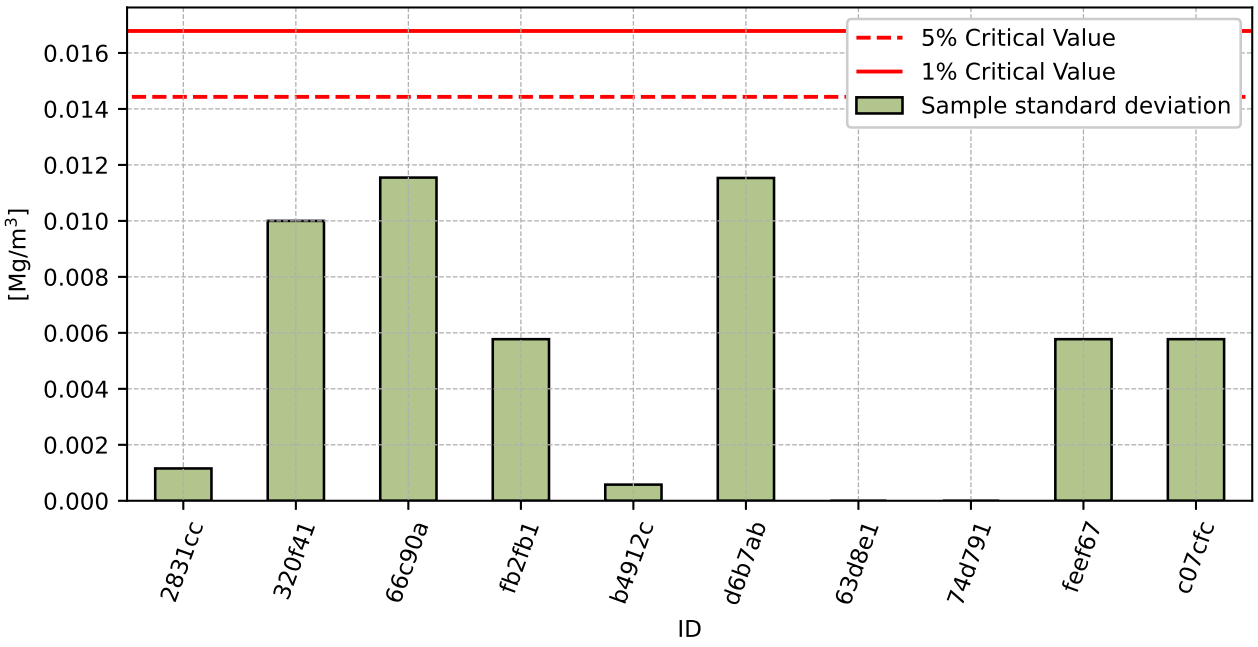

Figure 149: **Cochran's test** - sample standard deviations

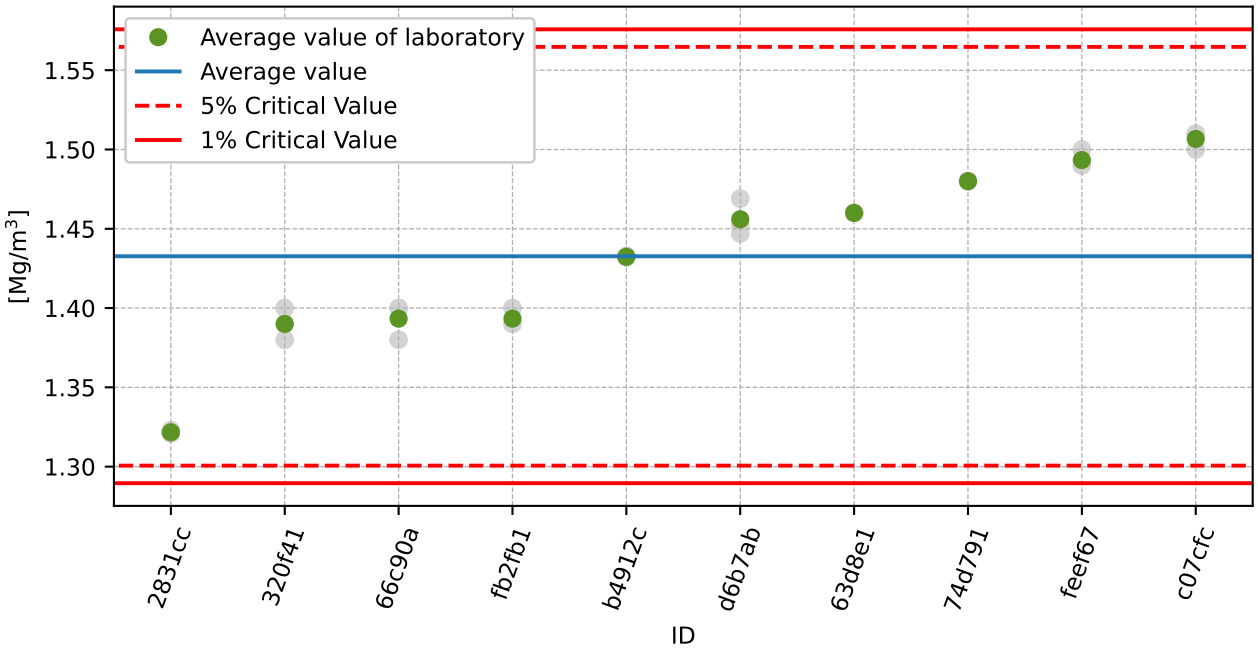

Figure 150: **Grubbs' test** - average values

10.1.3 Mandel's Statistics

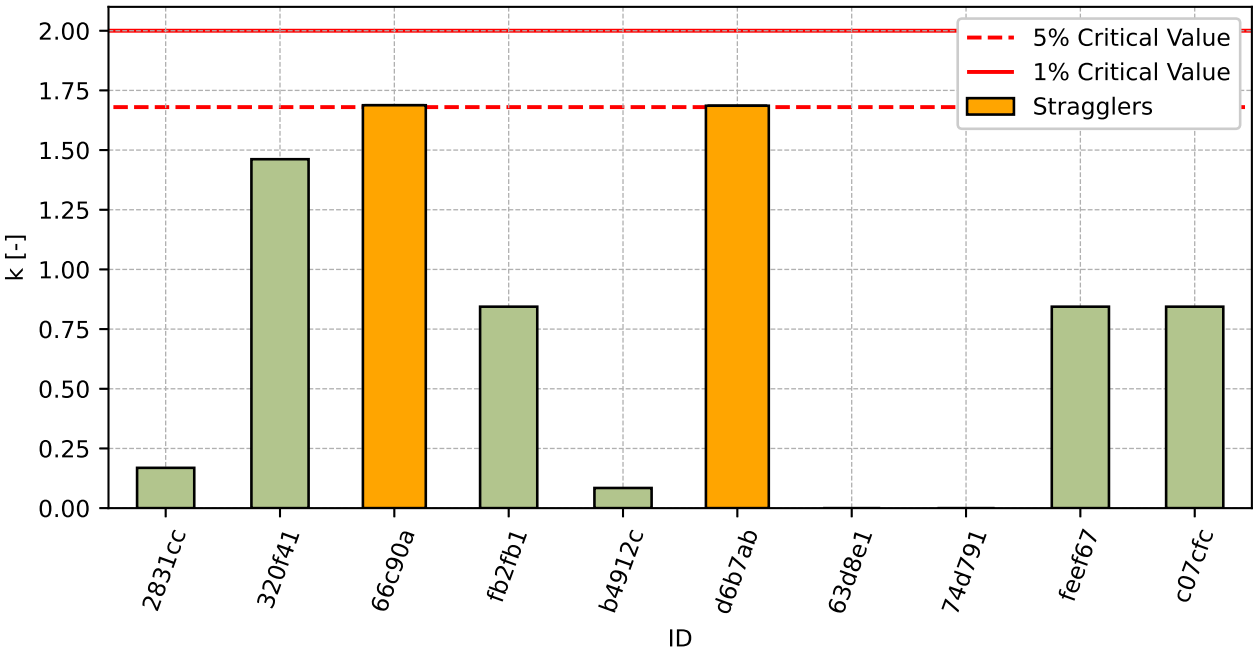

Figure 151: Intralaboratory Consistency Statistic

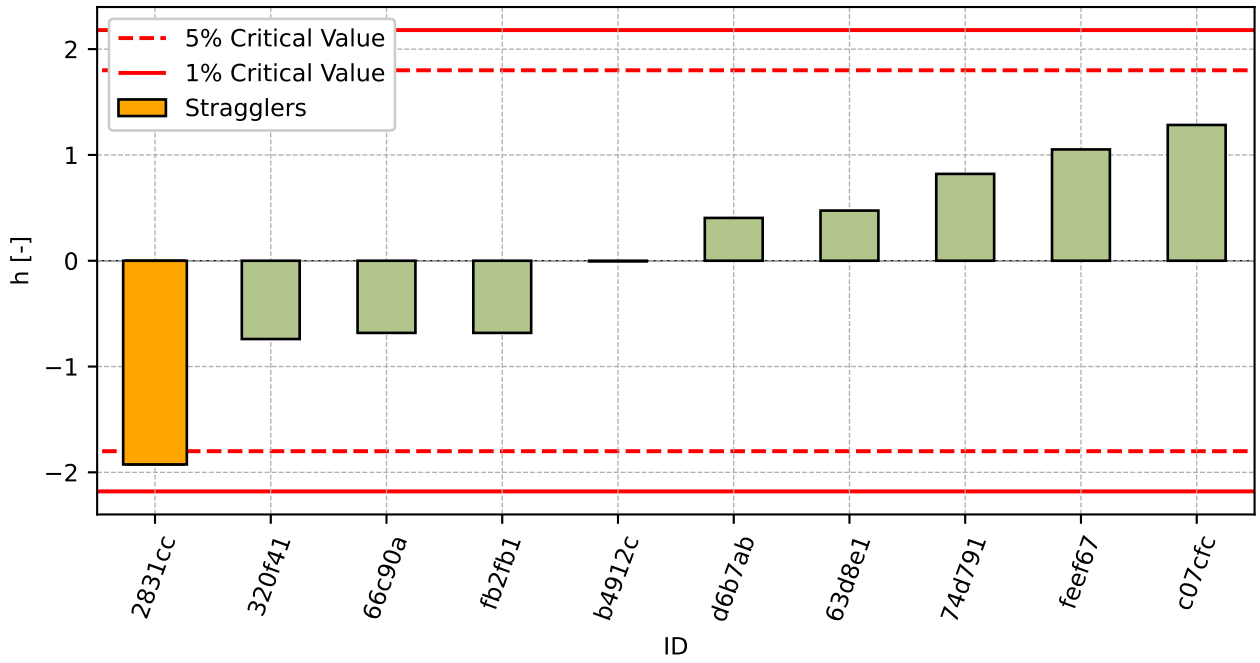

Figure 152: Interlaboratory Consistency Statistic

10.1.4 Descriptive statistics

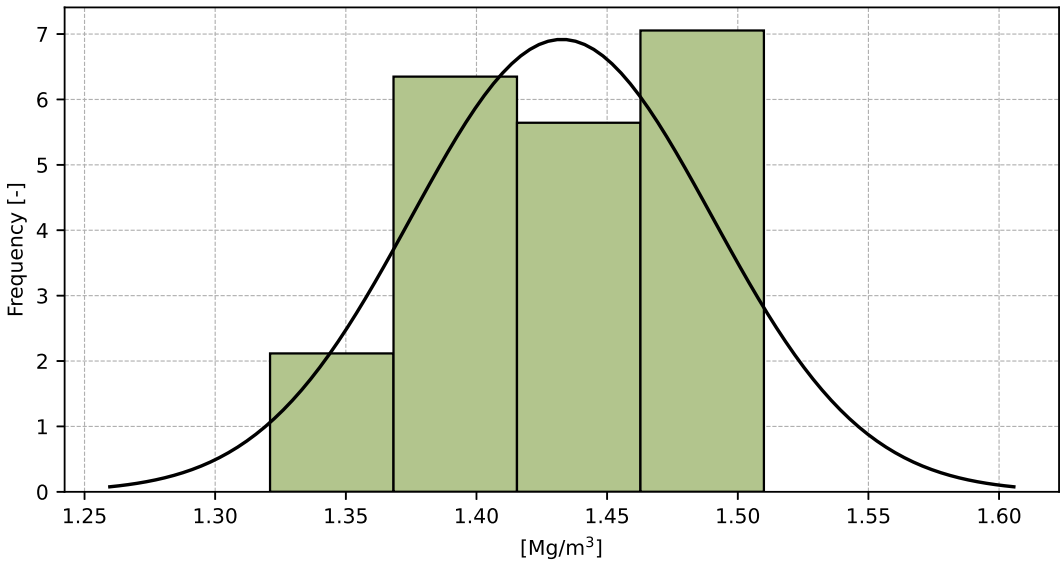

Figure 153: Histogram of all test results

Table 54: Descriptive statistics

Characteristics	[Mg/m^3]
Average value – $\bar{x}$	1.43
Sample standard deviation – s	0.058
Asigned value – x^*	1.43
Robust standard deviation – s^*	0.058
Measurement uncertainty of asigned value – u_X	0.018
p-value of normality test	0.049 [-]
Interlaboratory standard deviation – s_L	0.058
Repeatability standard deviation – s_r	0.007
Reproducibility standard deviation – s_R	0.058
Repeatability – r	0.02
Reproducibility – R	0.16

10.1.5 Evaluation of Performance Statistics

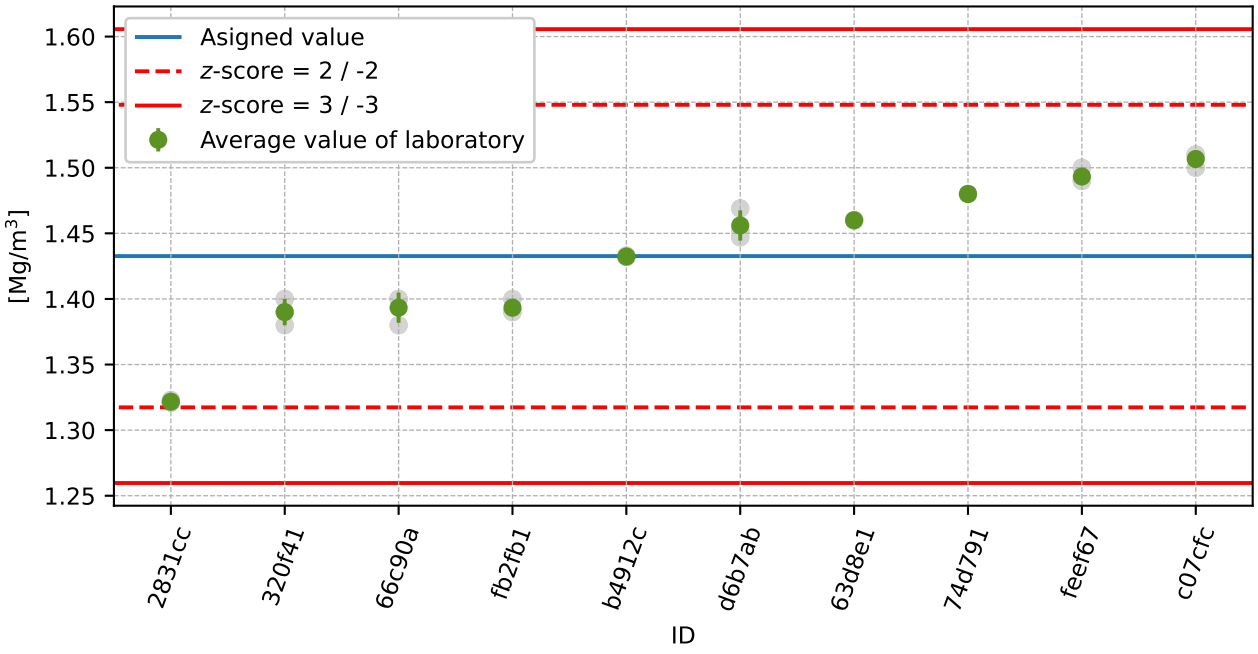

Figure 154: Average values and sample standard deviations

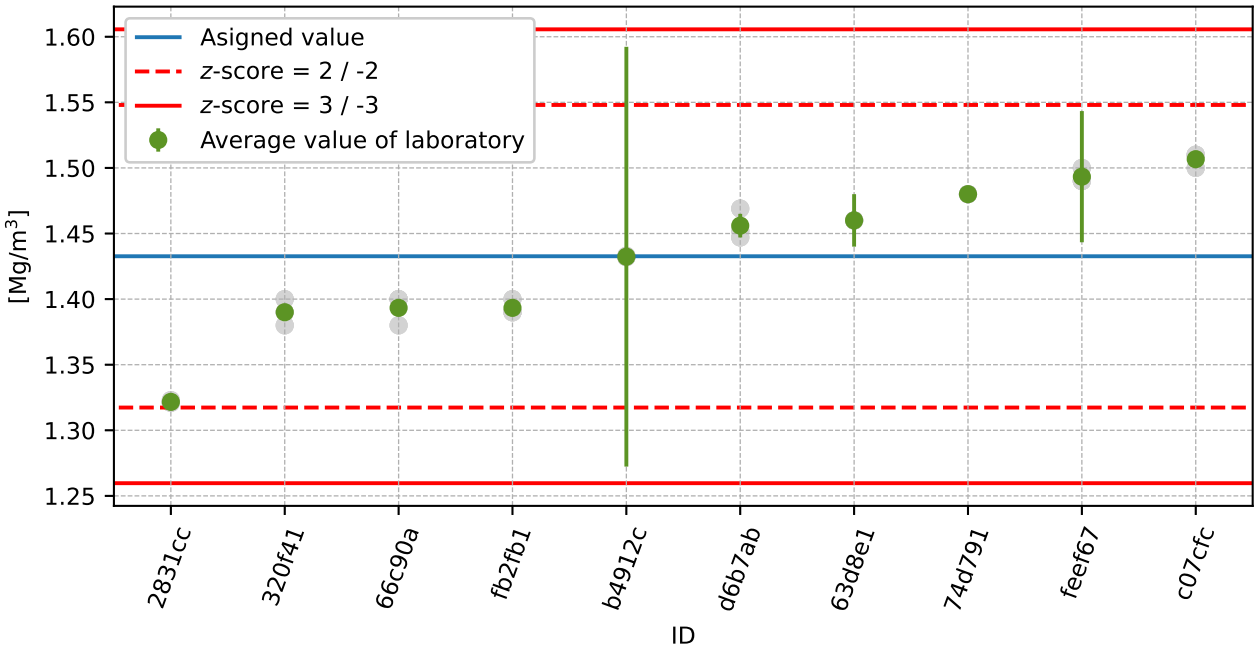

Figure 155: Average values and extended uncertainties of measurement

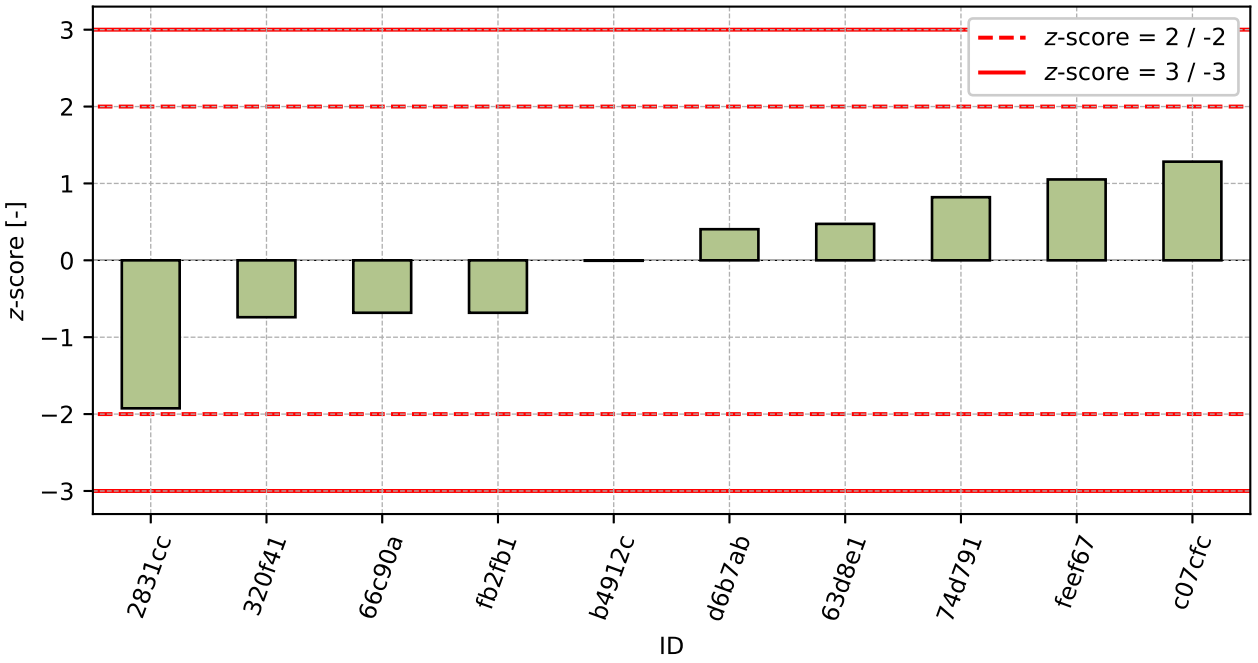

Figure 156: z-score

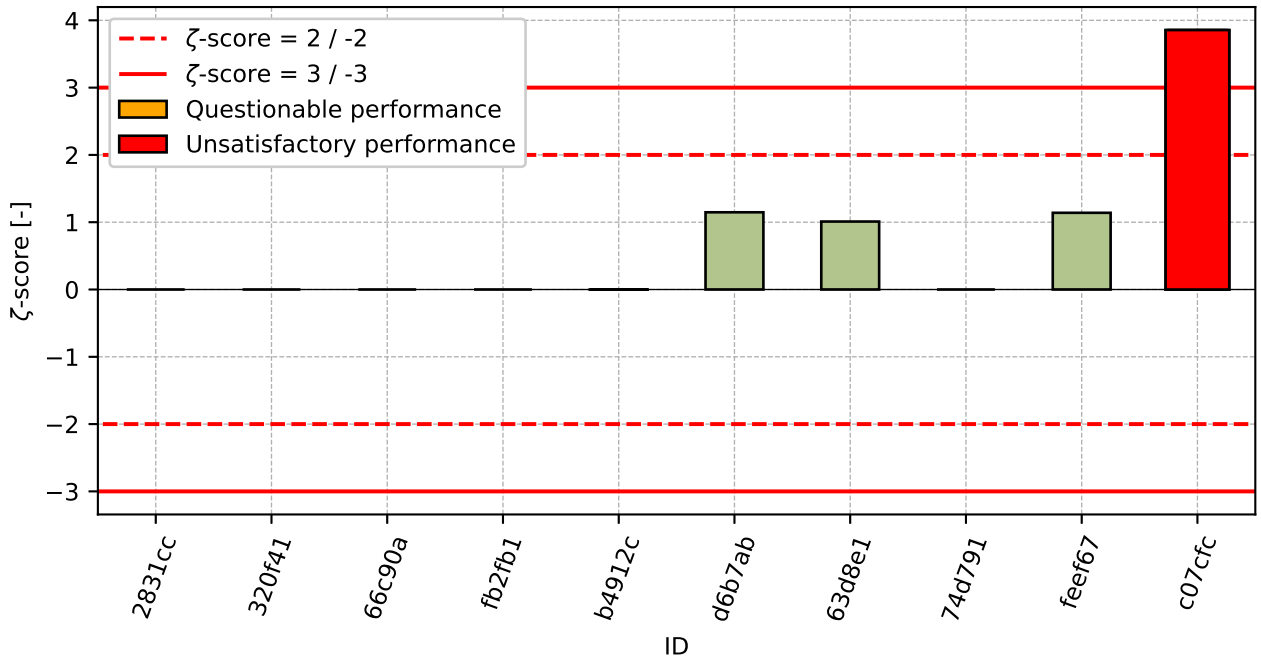

Figure 157: ζ-score

Table 55: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
2831cc	-1.93	-
320f41	-0.74	-
66c90a	-0.68	-
fb2fb1	-0.68	-
b4912c	-0.01	-0.0
d6b7ab	0.4	1.15
63d8e1	0.47	1.01
74d791	0.82	-
feef67	1.05	1.14
c07cfc	1.28	3.85

10.2 Voids

10.2.1 Test results

Table 56: 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 [%]
c07cfc	34.6	34.6	34.9	-	34.7	0.17	0.5
320f41	39.9	38.9	38.8	-	39.2	0.61	1.55
66c90a	39.7	40.0	39.4	-	39.7	0.3	0.76
fb2fb1	40.2	39.8	40.5	-	40.2	0.35	0.87
d6b7ab	40.7	40.5	40.0	0.3	40.4	0.36	0.89
b4912c	42.2	42.2	42.2	2.1	42.2	0.0	0.0
63d8e1	43.5	43.4	43.5	0.4	43.5	0.06	0.13
74d791	44.0	44.0	44.0	-	44.0	0.0	0.0
feef67	43.8	44.2	44.2	2.0	44.1	0.23	0.52
2831cc	50.0	51.0	50.0	-	50.3	0.58	1.15

10.2.2 The Numerical Procedure for Determining Outliers

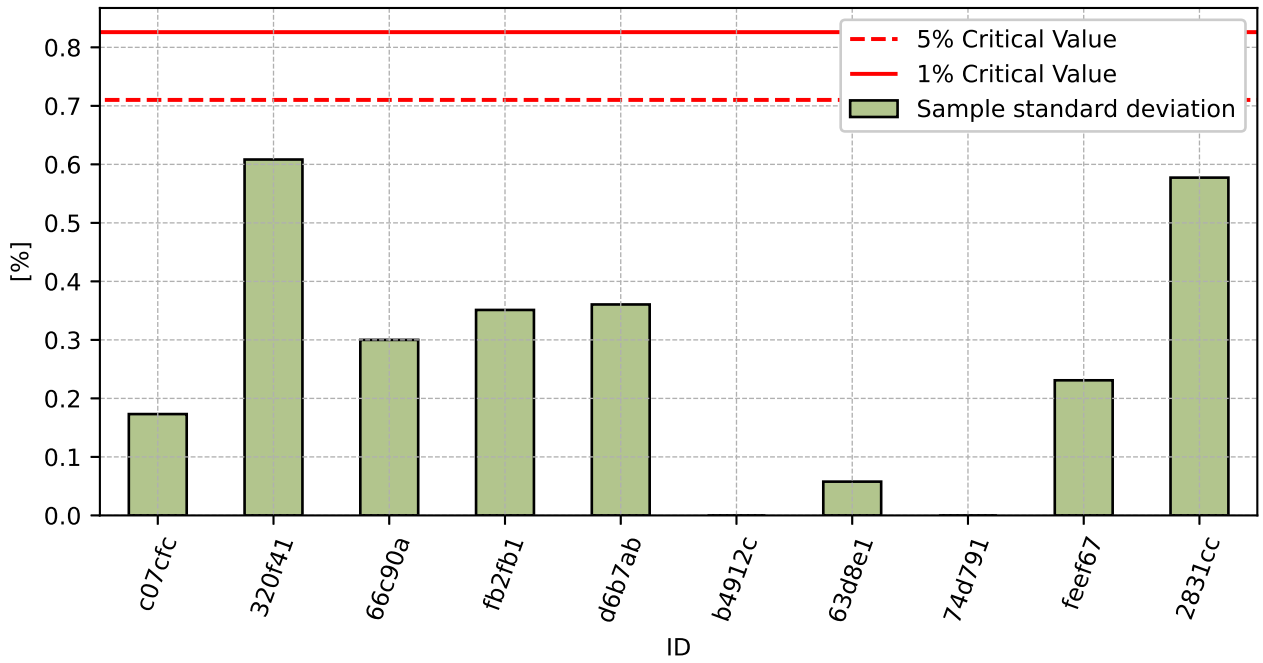

Figure 158: **Cochran's test** - sample standard deviations

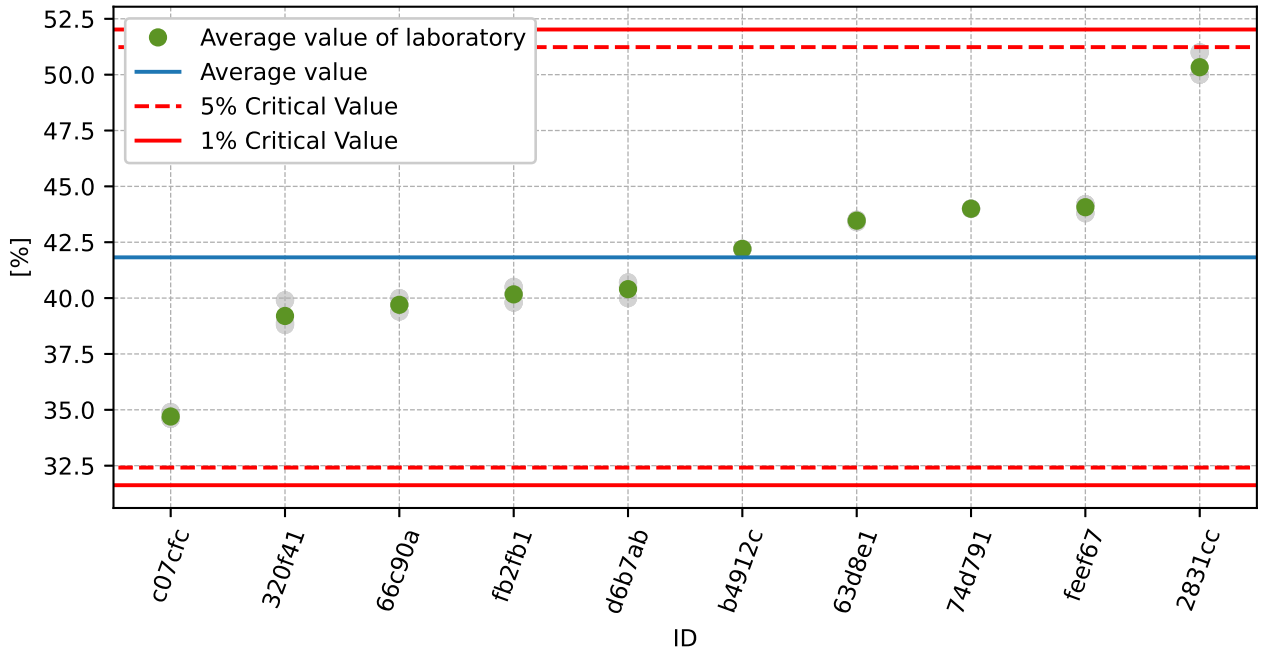

Figure 159: **Grubbs' test** - average values

10.2.3 Mandel's Statistics

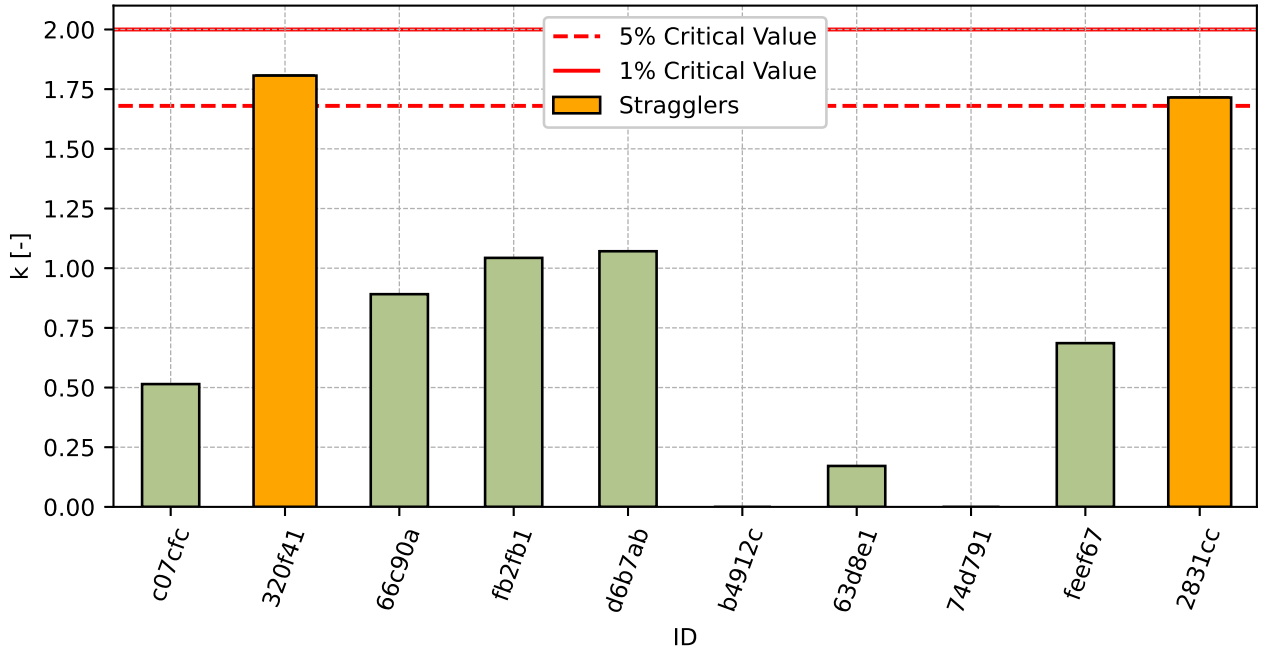

Figure 160: Intralaboratory Consistency Statistic

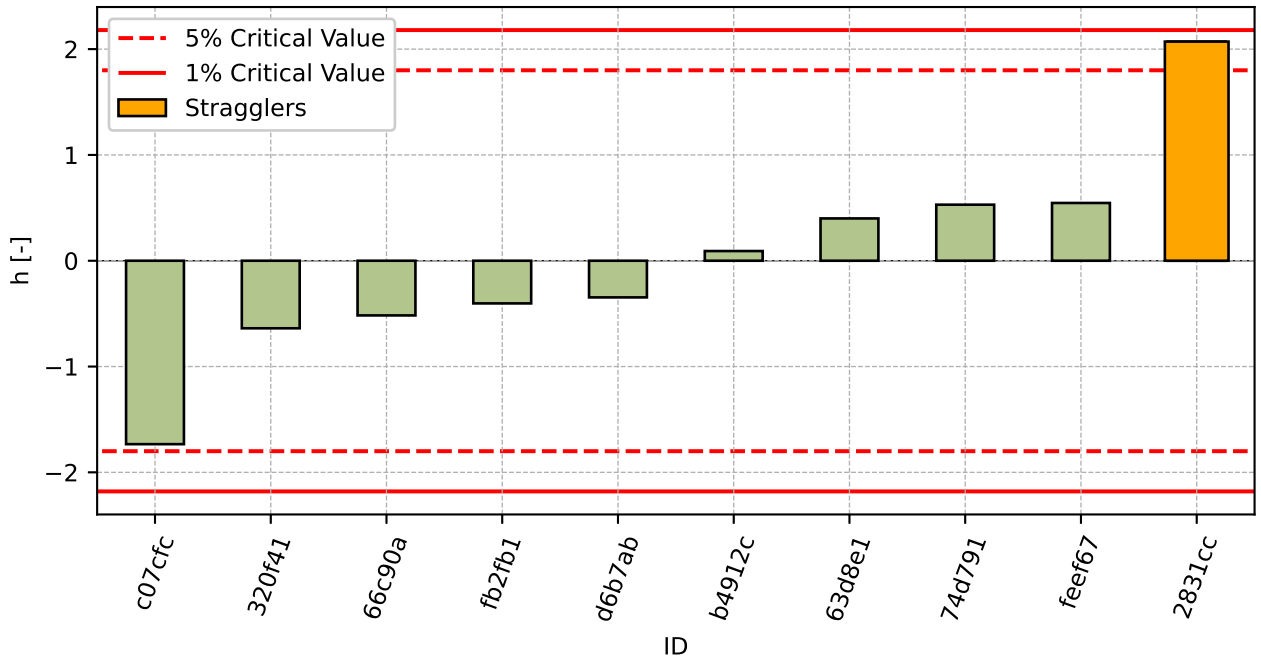

Figure 161: Interlaboratory Consistency Statistic

10.2.4 Descriptive statistics

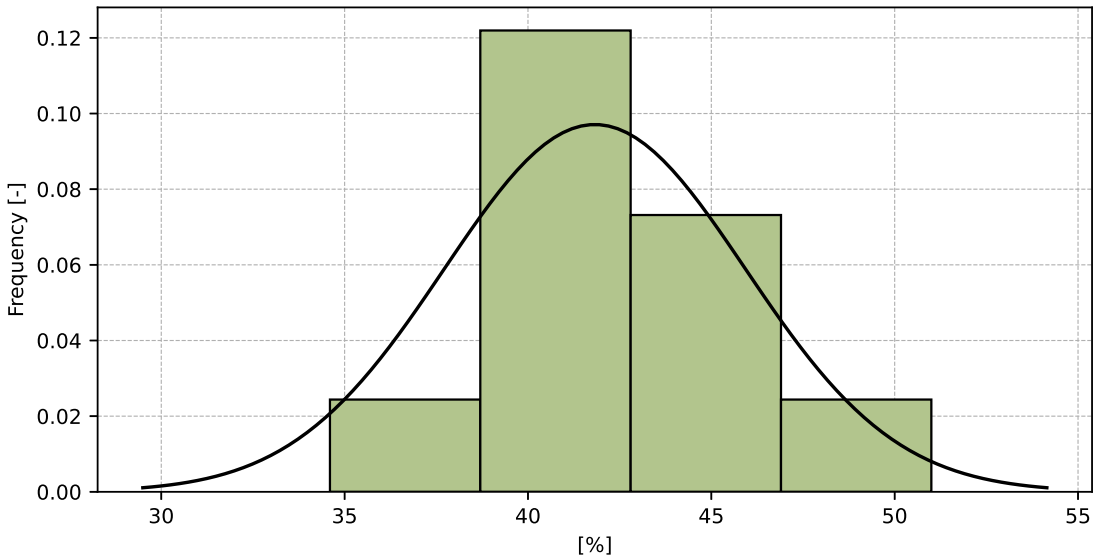

Figure 162: Histogram of all test results

Table 57: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	41.8
Sample standard deviation – s	4.11
Asigned value – x^*	41.8
Robust standard deviation – s^*	4.31
Measurement uncertainty of asigned value – u_X	1.36
p-value of normality test	0.029 [-]
Interlaboratory standard deviation – s_L	4.1
Repeatability standard deviation – s_r	0.34
Reproducibility standard deviation – s_R	4.12
Repeatability – r	0.9
Reproducibility – R	11.5

10.2.5 Evaluation of Performance Statistics

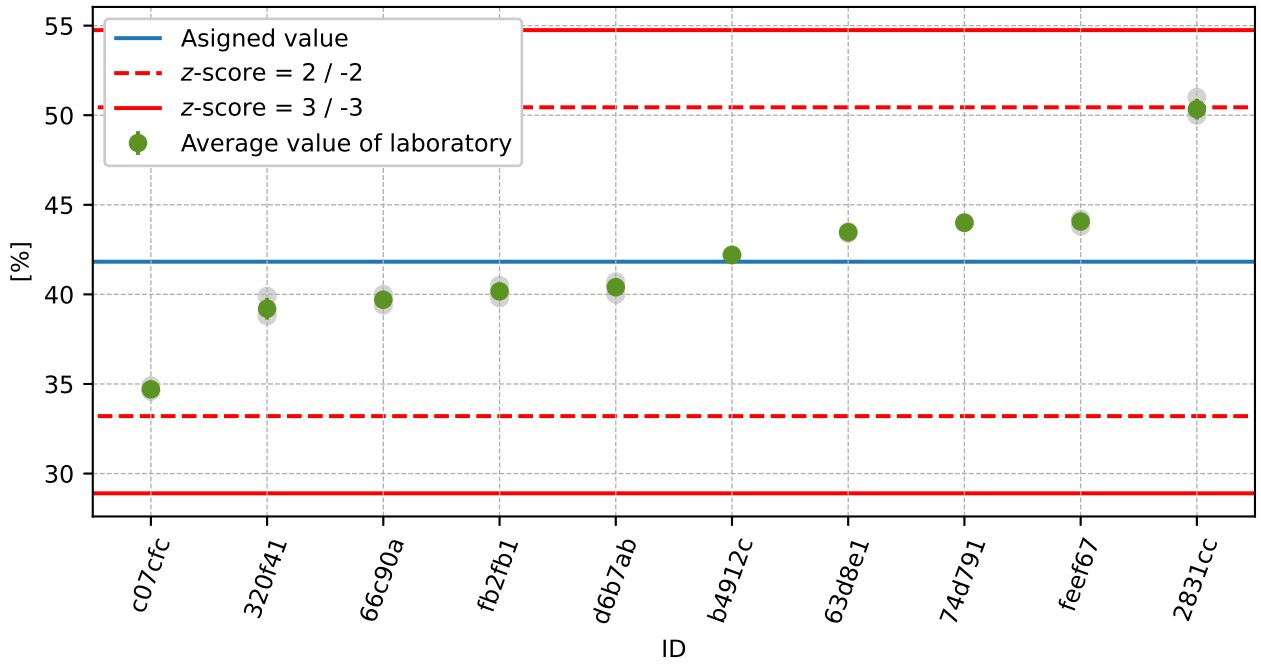

Figure 163: Average values and sample standard deviations

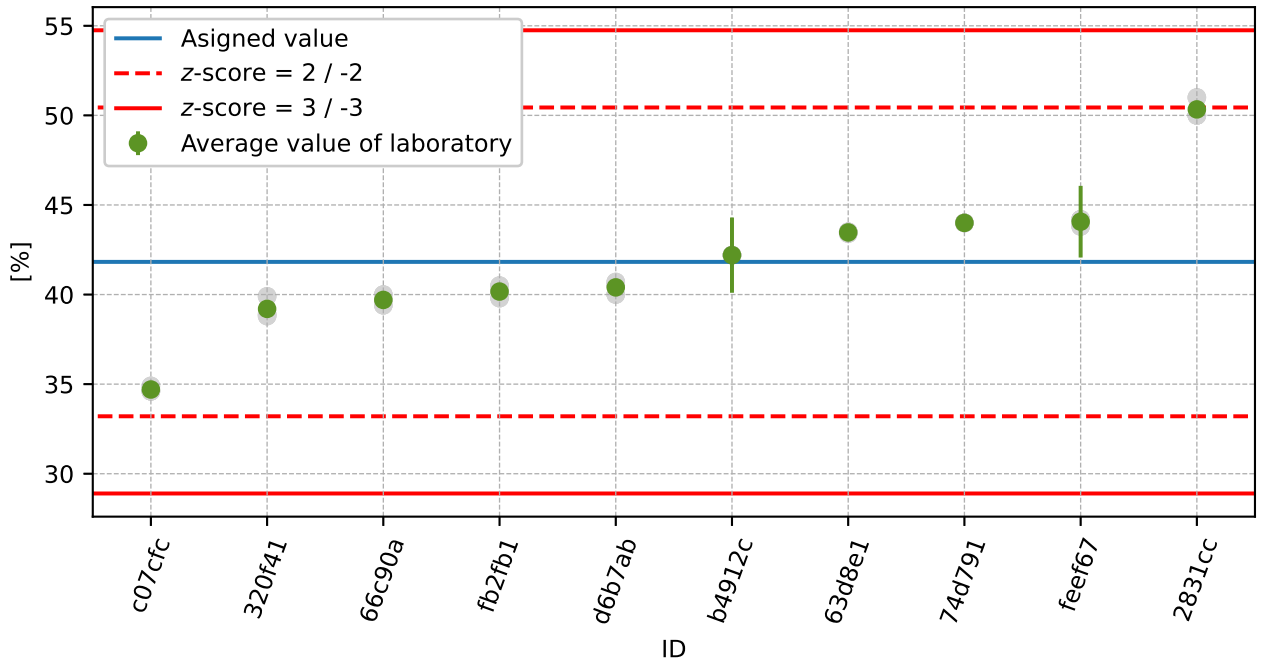

Figure 164: Average values and extended uncertainties of measurement

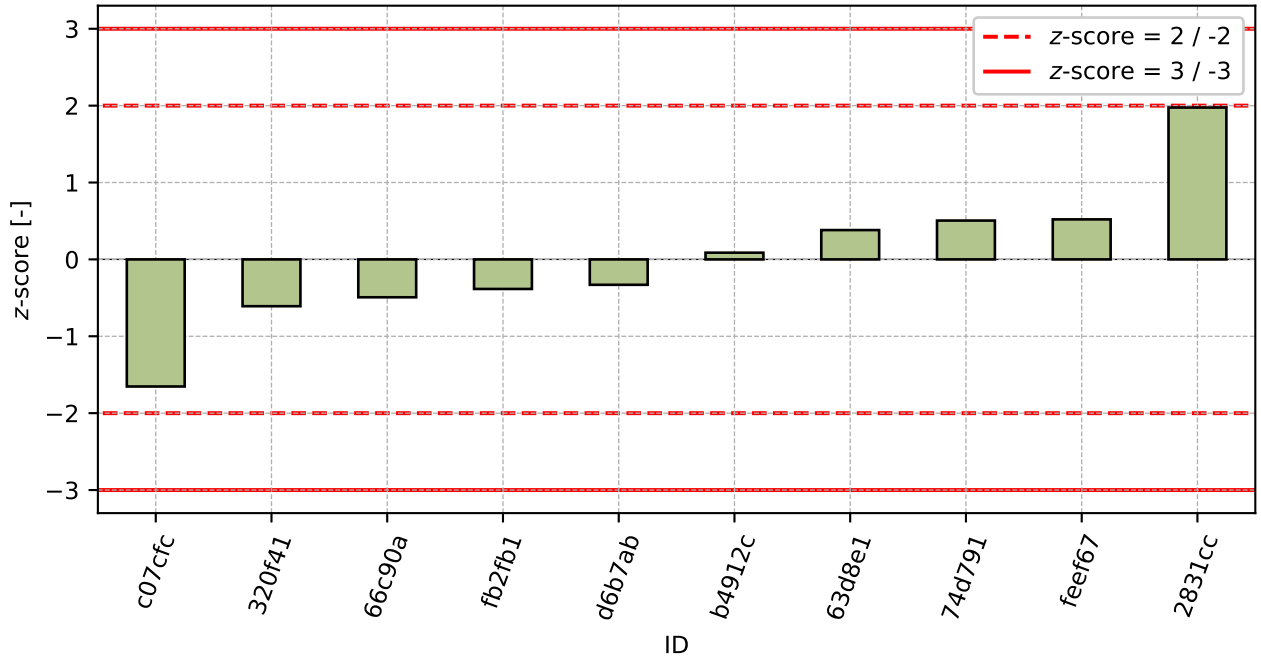

Figure 165: z-score

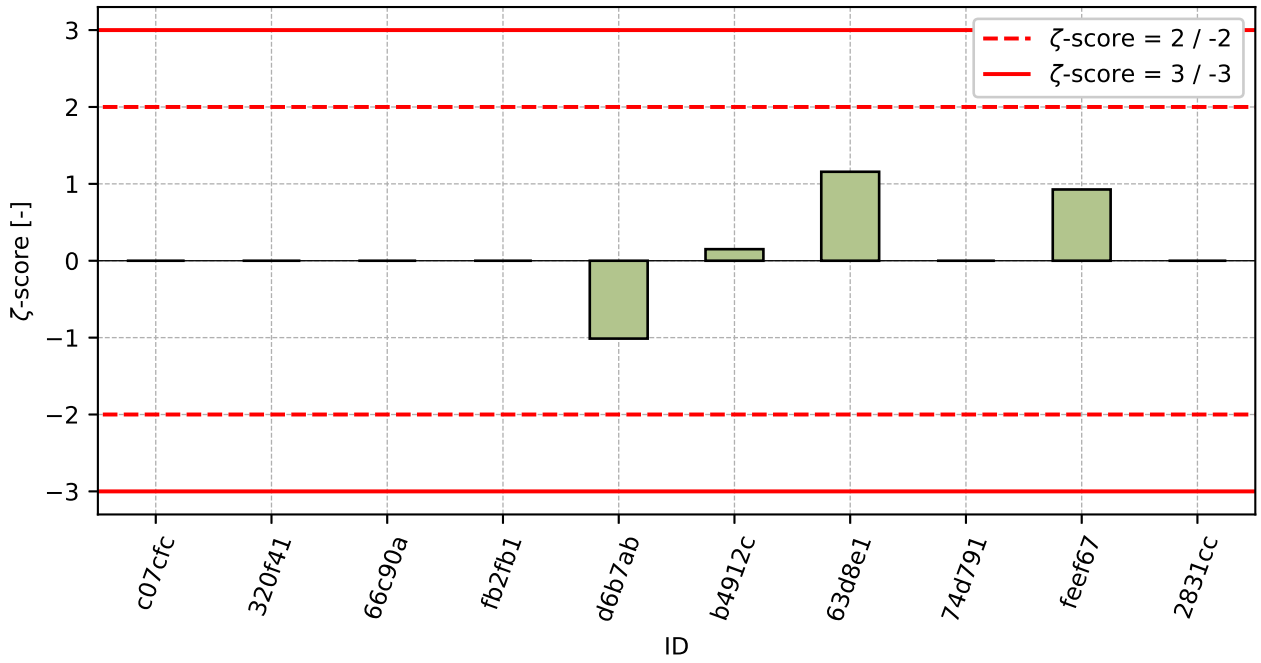

Figure 166: ζ-score

Table 58: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
c07cfc	-1.65	-
320f41	-0.61	-
66c90a	-0.49	-
fb2fb1	-0.38	-
d6b7ab	-0.33	-1.01
b4912c	0.09	0.15
63d8e1	0.38	1.16
74d791	0.51	-
feef67	0.52	0.93
2831cc	1.98	-

11 Appendix – EN 1097-5 Determination of the water content by drying in a ventilated oven

11.1 Test results

Table 59: 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 [%]
65eb6d	4.7	4.4	5.1	-	4.7	0.35	7.42
320f41	4.7	5.0	5.2	-	5.0	0.25	5.07
66c90a	4.7	5.2	5.4	-	5.1	0.36	7.07
44e8e8	5.1	5.3	5.5	-	5.3	0.2	3.77
801460	5.2	5.3	5.7	0.2	5.4	0.26	4.9
56e681	5.4	5.4	5.4	0	5.4	0.0	0.0
1420b6	5.4	5.4	5.5	0.1	5.4	0.06	1.06
feef67	5.5	5.5	5.4	0.3	5.5	0.02	0.37
b4912c	5.5	5.5	5.4	0.5	5.5	0.06	1.06
63d8e1	5.5	5.5	5.5	0.2	5.5	0.0	0.0
566efb	5.4	5.5	5.6	0.1	5.5	0.1	1.82
99772d	5.7	5.5	5.5	0.2	5.6	0.12	2.07
615698	5.7	5.6	5.4	±0.01	5.6	0.15	2.74
31f9a0	5.5	5.6	5.6	1.0	5.6	0.07	1.25
25e37d	5.7	5.6	5.5	1.0	5.6	0.07	1.22
91d1d4	5.6	5.6	5.6	-	5.6	0.0	0.0
bf844c	5.6	5.7	5.5	0.4	5.6	0.1	1.79
f9906c	5.3	5.9	5.7	0.3	5.6	0.31	5.42
8541f2	5.7	5.4	5.8	0.5	5.6	0.21	3.7
9db03c	4.9	5.7	6.3	0.8	5.6	0.7	12.47
a493e8	5.7	5.6	5.6	1.0	5.7	0.03	0.47
6ec30c	5.8	5.7	5.7	1.0	5.7	0.05	0.79
ae026d	5.5	5.9	5.8	-	5.7	0.22	3.83
d0d741	5.8	5.7	5.8	0.2	5.8	0.06	1.0
f26927	5.3	5.7	6.3	0.5	5.8	0.5	8.73
442491	5.8	5.7	5.8	0.3	5.8	0.06	1.0
d69d0e	6.1	5.7	5.7	0.6	5.8	0.23	3.96
22edc2	5.8	5.9	5.9	0.09	5.9	0.06	0.98
692075	6.0	5.9	5.9	6.0	5.9	0.06	0.97
363174	5.9	6.0	6.1	0.8	6.0	0.1	1.67
74d791	6.5	6.6	6.6	0.2	6.6	0.06	0.88

11.2 The Numerical Procedure for Determining Outliers

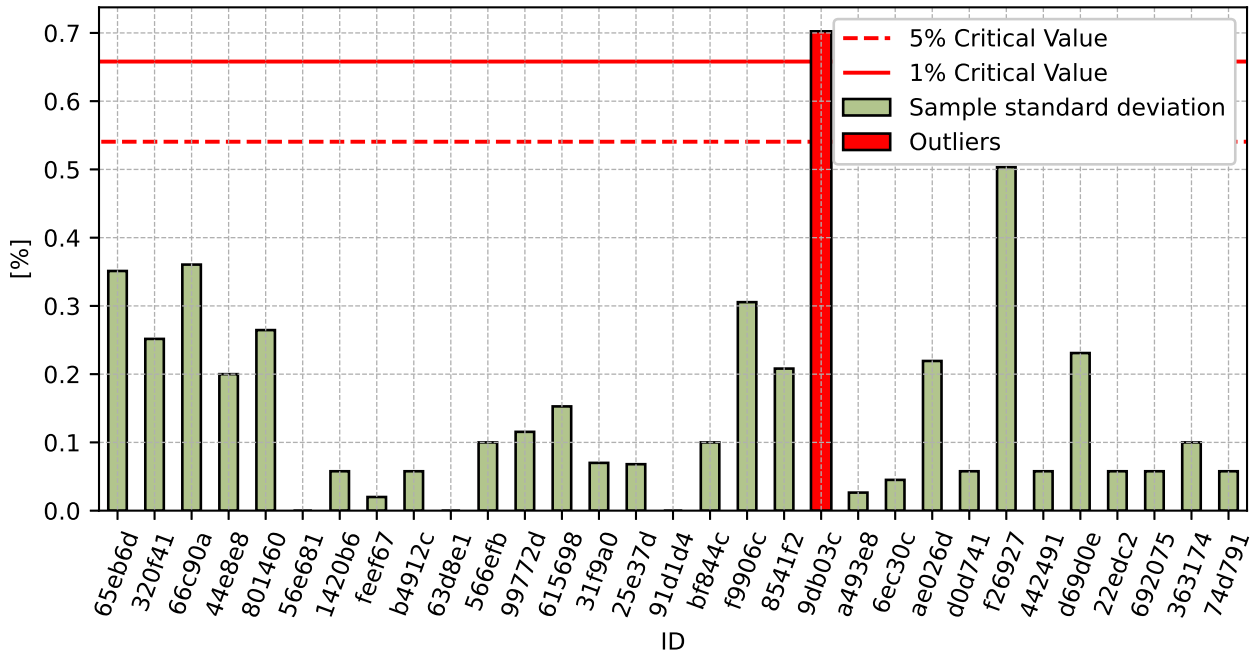

Figure 167: **Cochran's test** - sample standard deviations

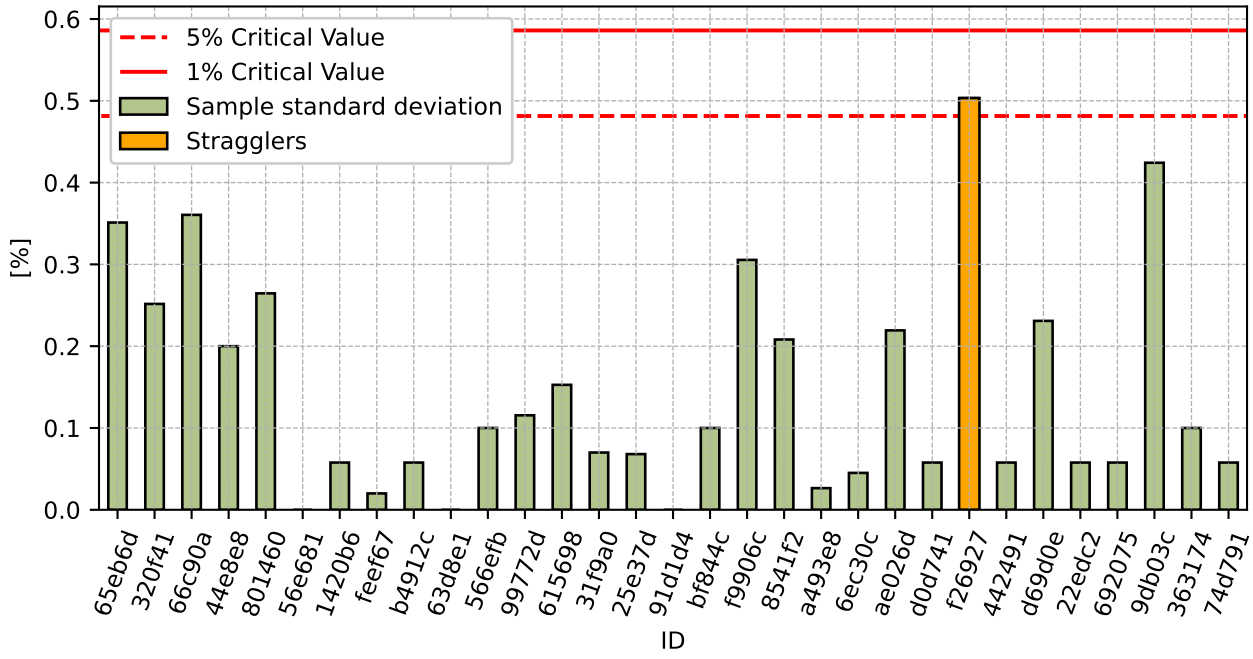

Figure 168: **Cochran's test** - sample standard deviations without outliers

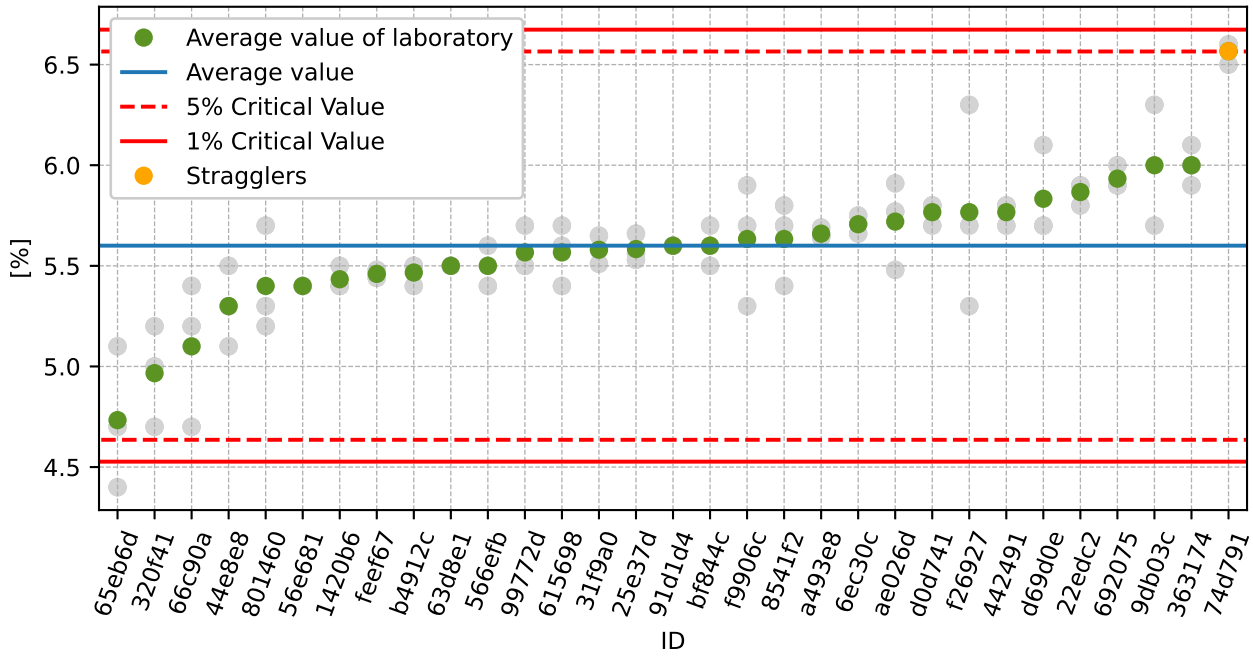

Figure 169: **Grubbs' test** - average values

11.3 Mandel's Statistics

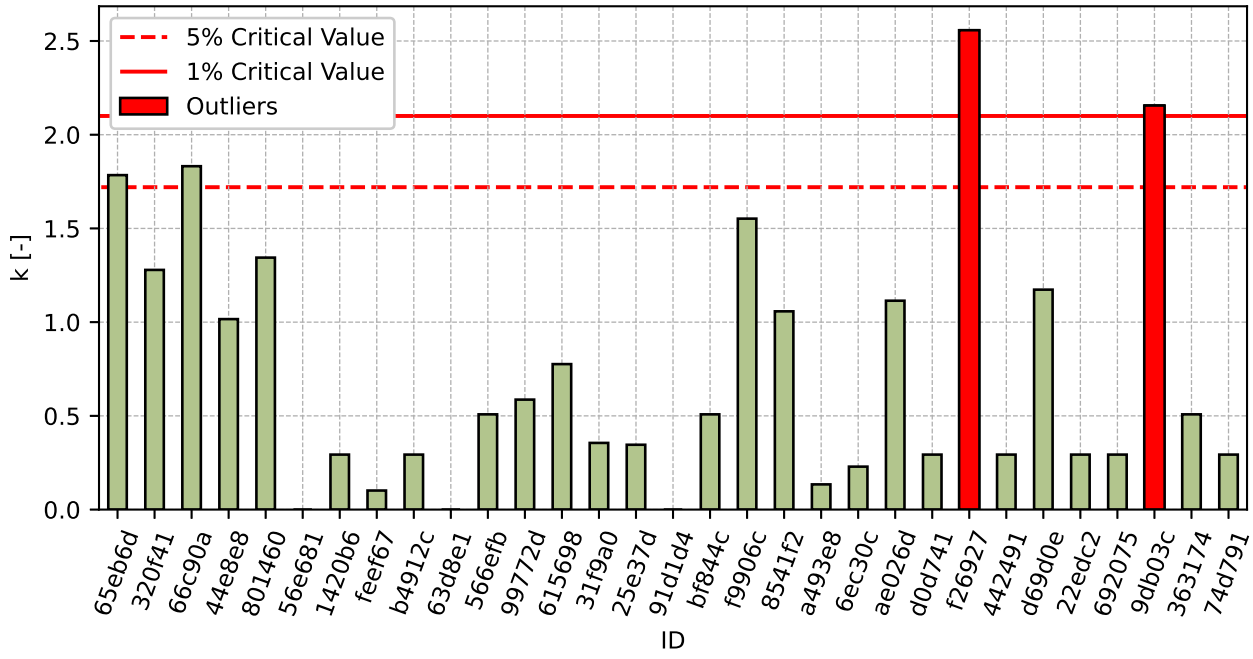

Figure 170: Intralaboratory Consistency Statistic

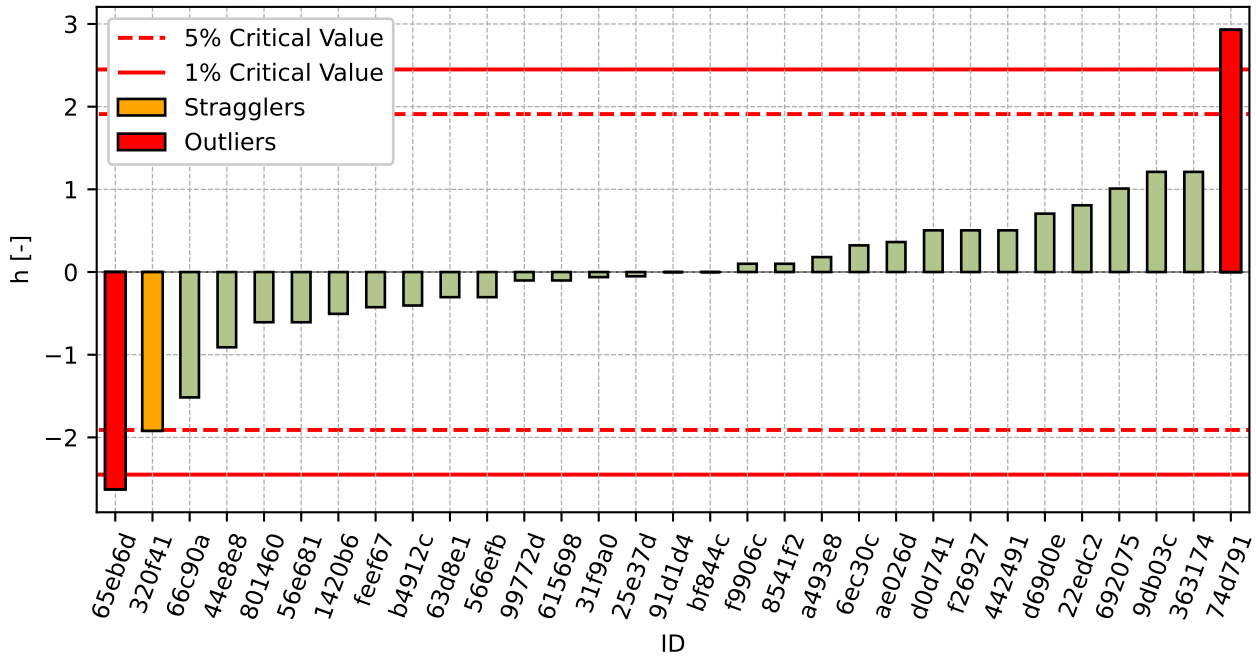

Figure 171: Interlaboratory Consistency Statistic

11.4 Descriptive statistics

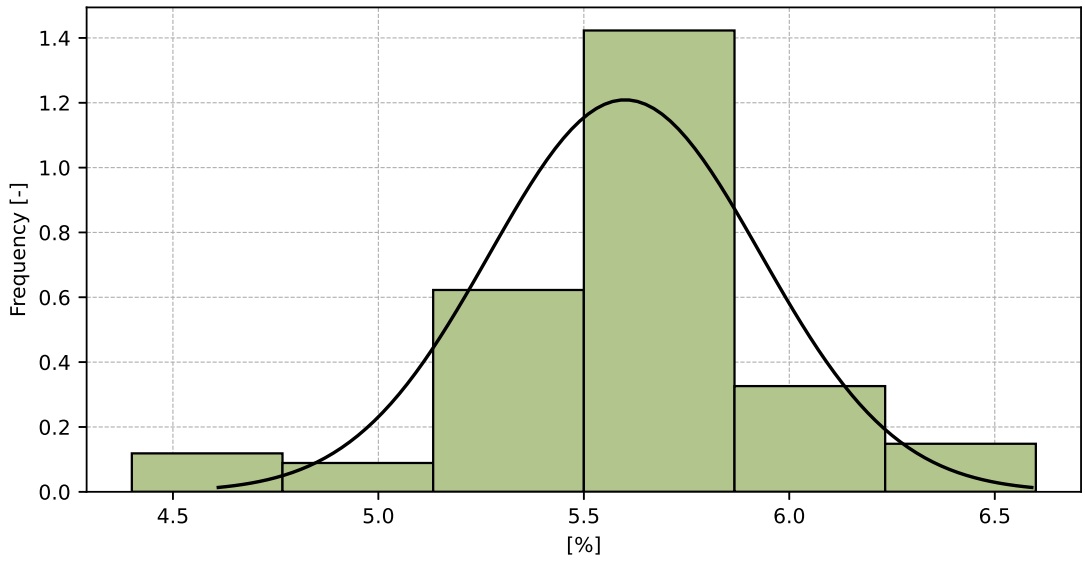

Figure 172: Histogram of all test results

Table 60: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	5.6
Sample standard deviation – s	0.33
Asigned value – x^*	5.6
Robust standard deviation – s^*	0.33
Measurement uncertainty of asigned value – u_X	0.06
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	0.31
Repeatability standard deviation – s_r	0.2
Reproducibility standard deviation – s_R	0.37
Repeatability – r	0.6
Reproducibility – R	1.0

11.5 Evaluation of Performance Statistics

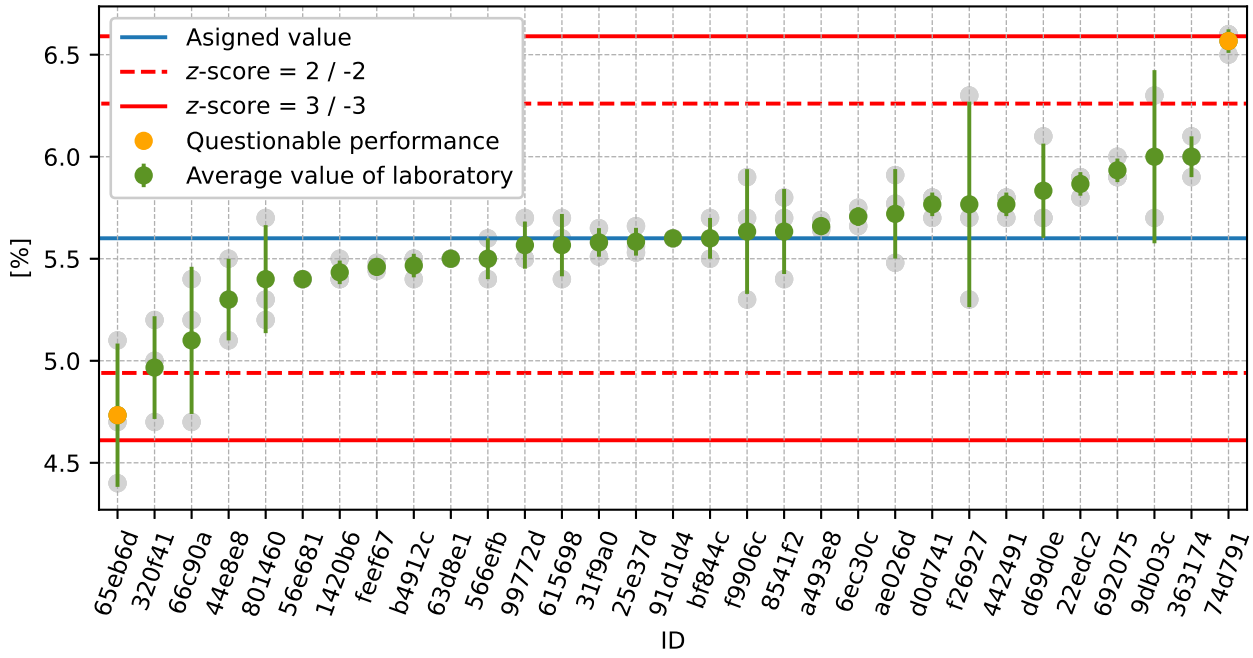

Figure 173: Average values and sample standard deviations

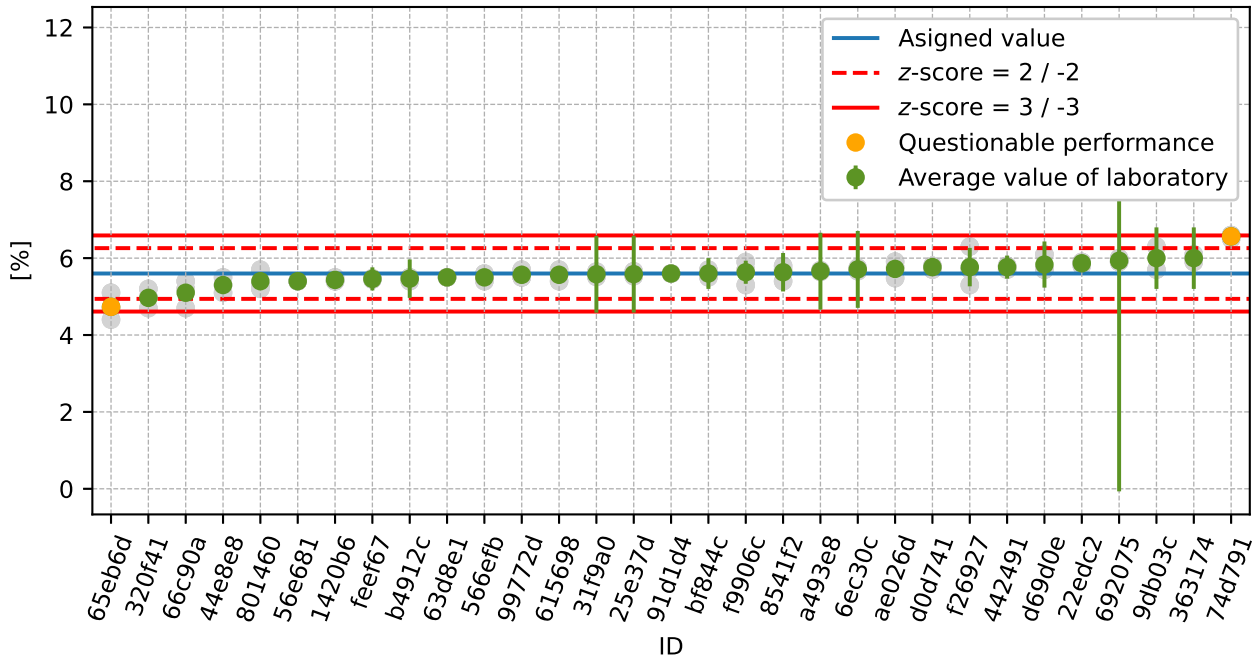

Figure 174: Average values and extended uncertainties of measurement

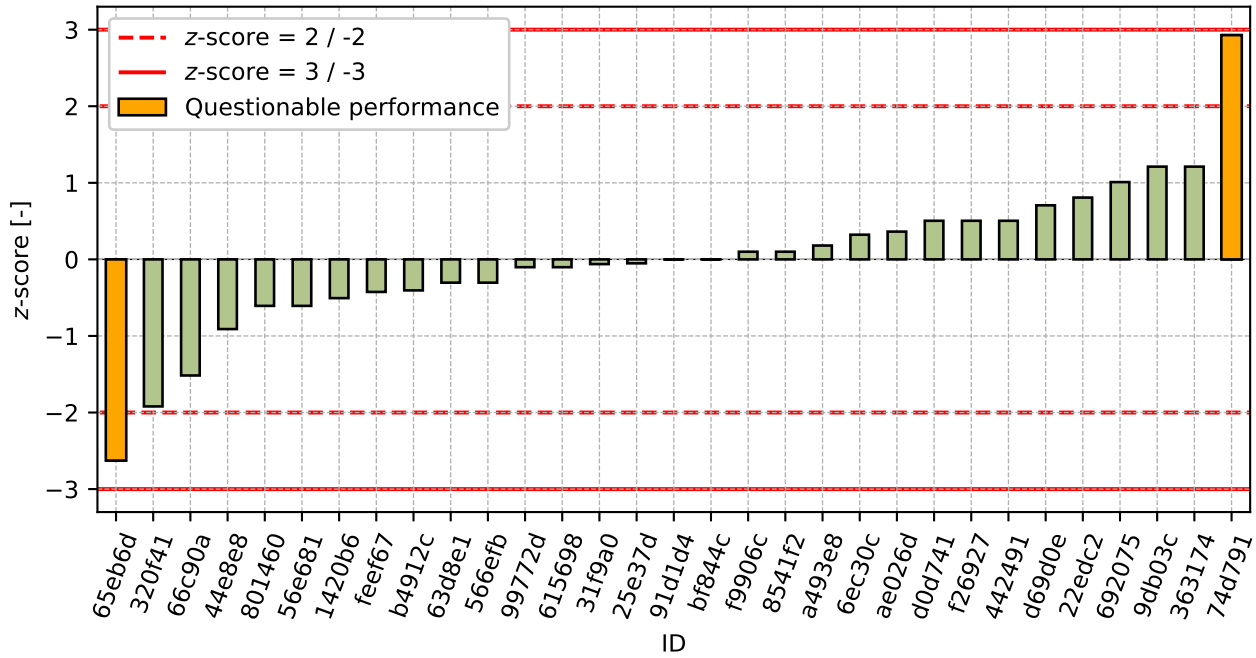

Figure 175: z-score

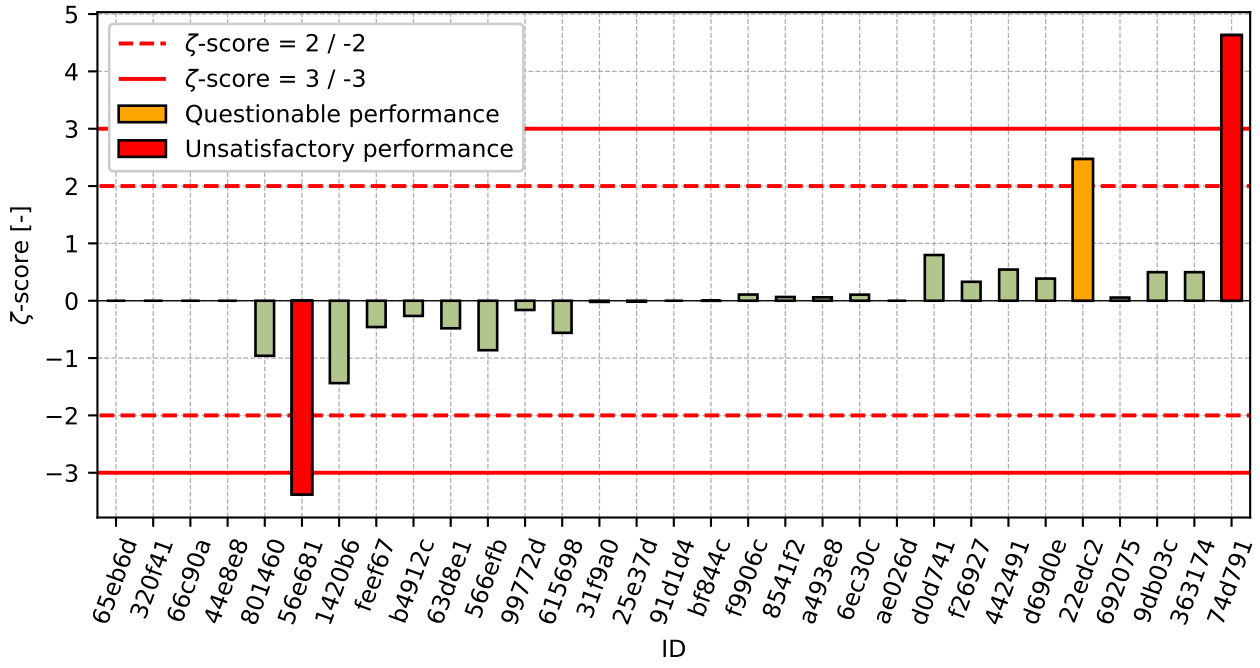

Figure 176: ζ-score

Table 61: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
65eb6d	-2.63	-
320f41	-1.92	-
66c90a	-1.52	-
44e8e8	-0.91	-
801460	-0.61	-0.96
56e681	-0.61	-3.38
1420b6	-0.51	-1.44
feef67	-0.43	-0.46
b4912c	-0.41	-0.27
63d8e1	-0.3	-0.48
566efb	-0.3	-0.86
99772d	-0.1	-0.16
615698	-0.1	-0.56
31f9a0	-0.06	-0.02
25e37d	-0.05	-0.02
91d1d4	-0.0	-
bf844c	-0.0	-0.0
f9906c	0.1	0.11
8541f2	0.1	0.07
a493e8	0.18	0.06
6ec30c	0.32	0.11
ae026d	0.36	-

Continued on next page

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ID	*z*-score [-]	ζ-score [-]
d0d741	0.5	0.8
f26927	0.5	0.33
442491	0.5	0.54
d69d0e	0.71	0.39
22edc2	0.81	2.47
692075	1.01	0.06
9db03c	1.21	0.5
363174	1.21	0.5
74d791	2.93	4.63

12 Appendix – EN 1097-6 Determination of particle density and water absorption

12.1 Particle density

12.1.1 Test results

Table 62: 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 [%]
65eb6d	2.67	2.55	2.52	-	2.58	0.079	3.08
56e681	2.6	2.59	2.6	0.0	2.6	0.006	0.22
8541f2	2.62	2.63	2.63	0.11	2.63	0.006	0.22
22edc2	2.64	2.63	2.64	0.05	2.64	0.006	0.22
f9906c	2.66	2.65	2.63	0.06	2.65	0.015	0.58
feef67	2.67	2.66	2.65	0.15	2.66	0.01	0.38
b4912c	2.66	2.66	2.66	0.07	2.66	0.002	0.08
801460	2.67	2.67	2.65	0.15	2.66	0.012	0.43
4471dc	2.66	2.66	2.67	-	2.66	0.002	0.06
9facaf	2.67	2.67	2.67	0.02	2.67	0.0	0.0
91d1d4	2.67	2.67	2.67	-	2.67	0.0	0.0
c2ab58	2.63	2.75	2.64	-	2.67	0.067	2.49
d34bb3	2.67	2.68	2.68	0.02	2.68	0.006	0.22
74d791	2.68	2.68	2.68	-	2.68	0.0	0.0
66c90a	2.68	2.68	2.68	-	2.68	0.0	0.0
320f41	2.68	2.68	2.68	-	2.68	0.0	0.0
63d8e1	2.68	2.68	2.68	0.03	2.68	0.0	0.0
c429d1	2.68	2.68	2.69	0.03	2.68	0.006	0.22
597047	2.69	2.68	2.69	0.21	2.69	0.006	0.21
f26927	2.74	2.69	2.67	0.03	2.7	0.036	1.34
ae026d	2.74	2.7	2.71	0.01	2.72	0.024	0.9

12.1.2 The Numerical Procedure for Determining Outliers

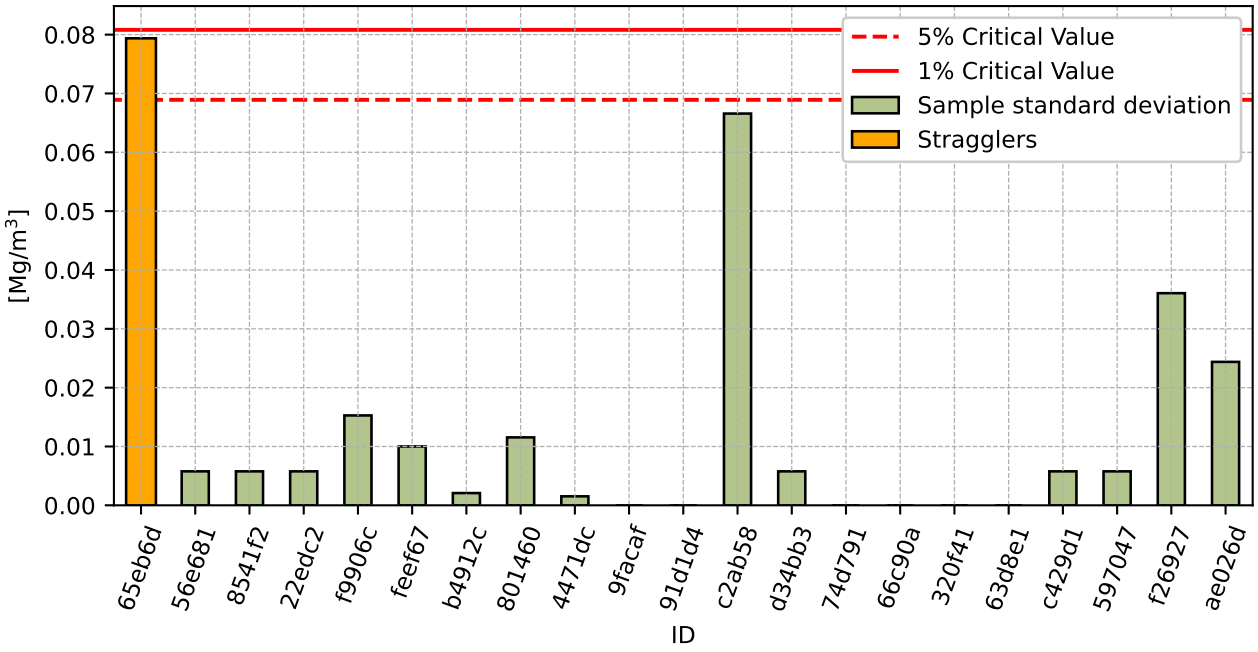

Figure 177: **Cochran's test** - sample standard deviations

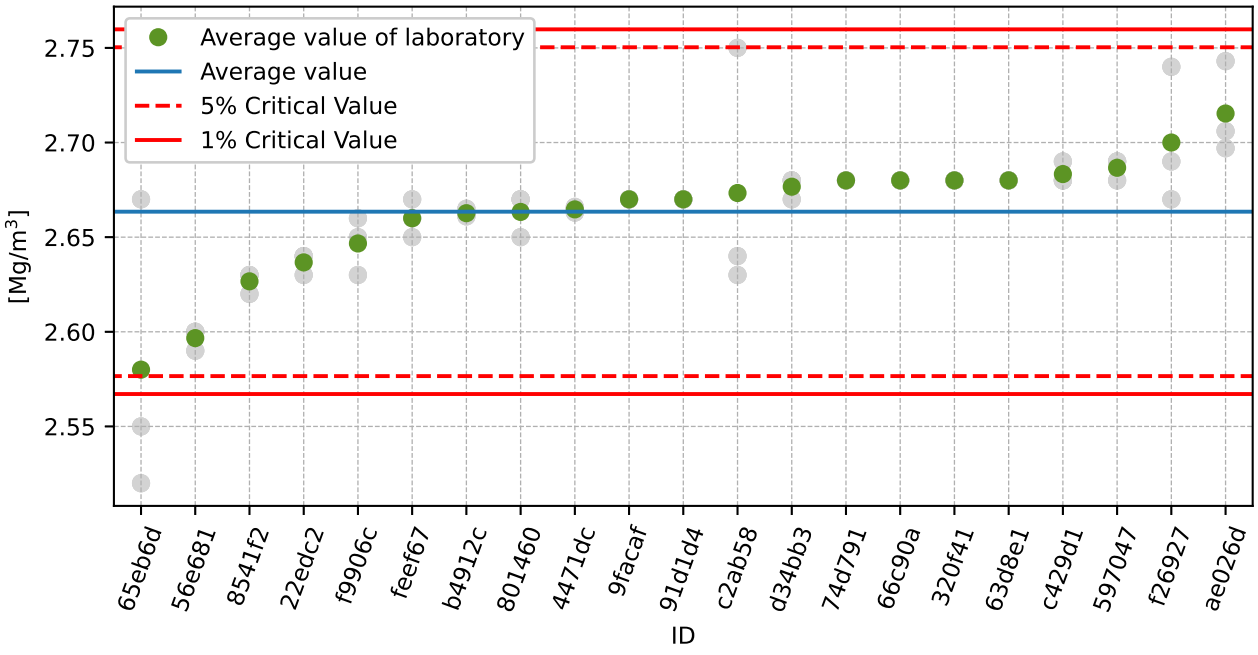

Figure 178: **Grubbs' test** - average values

12.1.3 Mandel's Statistics

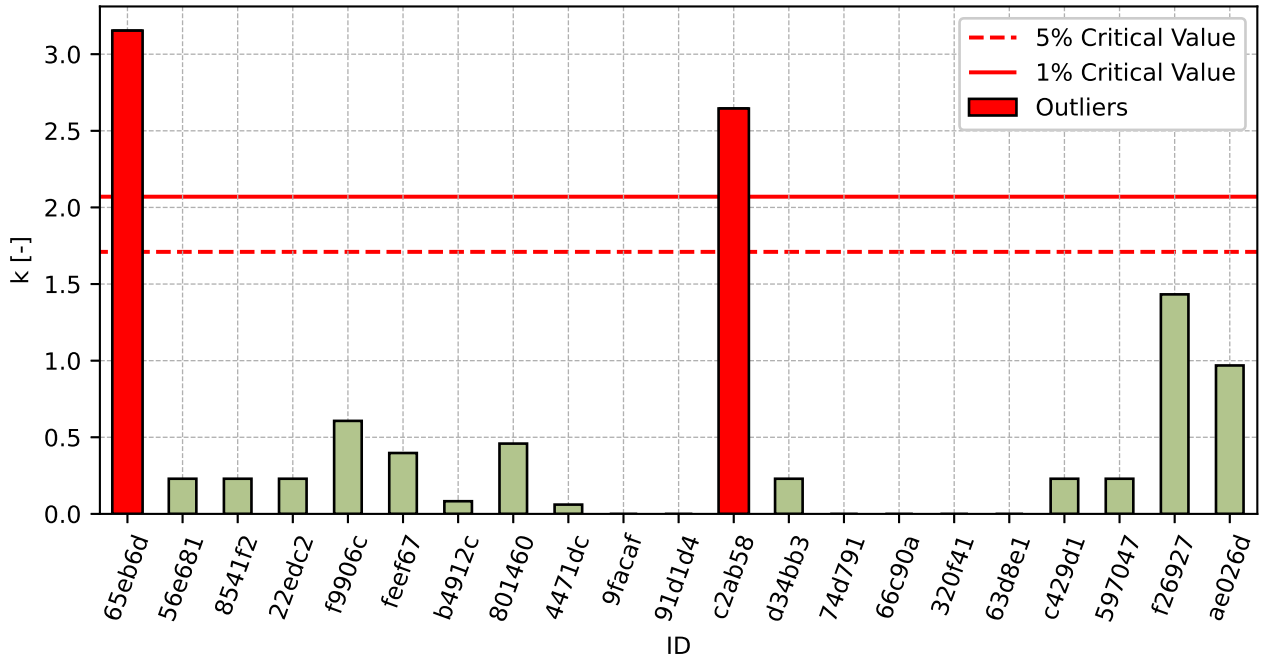

Figure 179: Intralaboratory Consistency Statistic

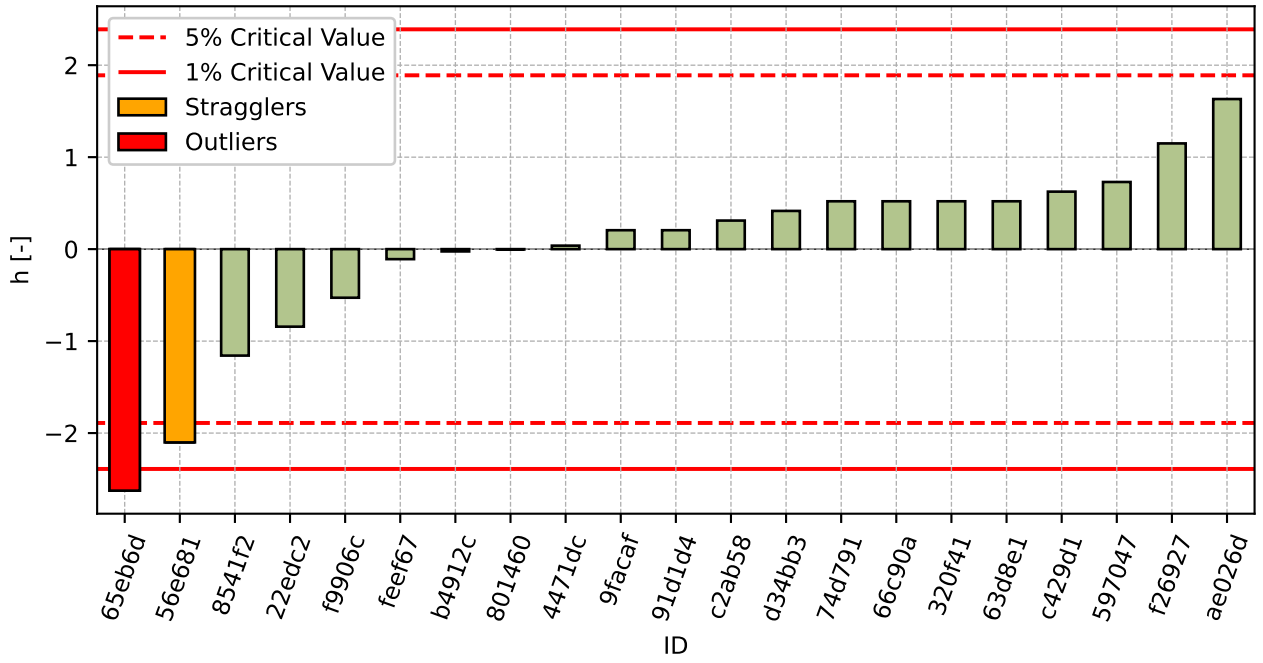

Figure 180: Interlaboratory Consistency Statistic

12.1.4 Descriptive statistics

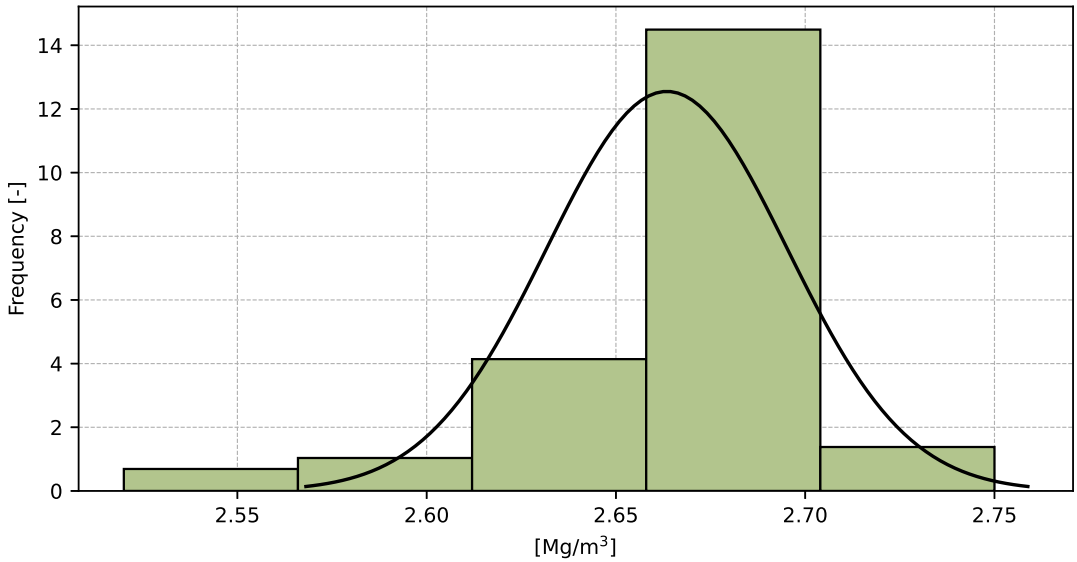

Figure 181: Histogram of all test results

Table 63: Descriptive statistics

Characteristics	[Mg/m³]
Average value – $\bar{x}$	2.66
Sample standard deviation – s	0.032
Asigned value – x^*	2.66
Robust standard deviation – s^*	0.032
Measurement uncertainty of asigned value – u_X	0.007
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.028
Repeatability standard deviation – s_r	0.025
Reproducibility standard deviation – s_R	0.038
Repeatability – r	0.07
Reproducibility – R	0.11

12.1.5 Evaluation of Performance Statistics

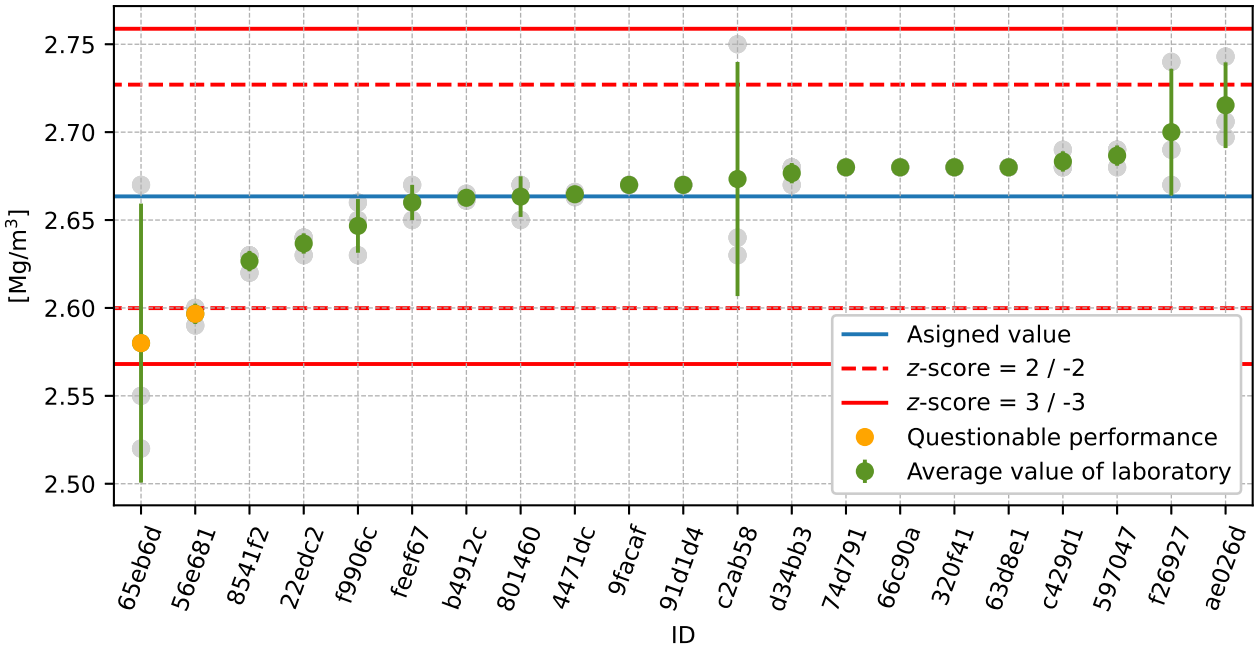

Figure 182: Average values and sample standard deviations

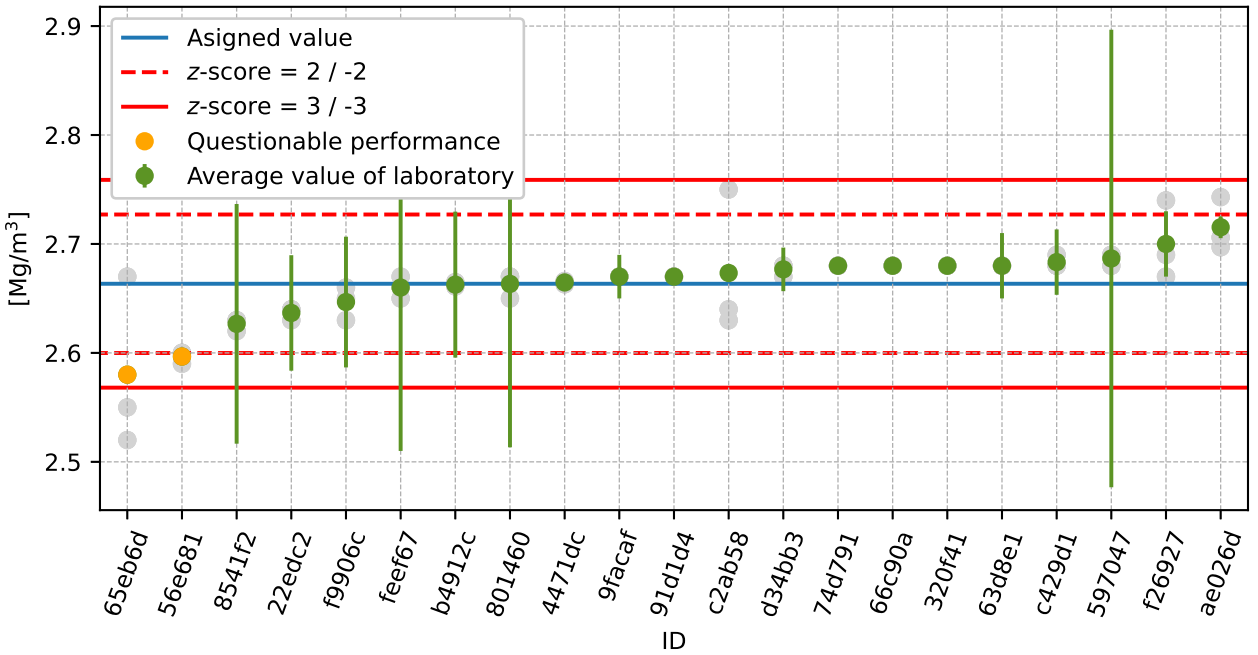

Figure 183: Average values and extended uncertainties of measurement

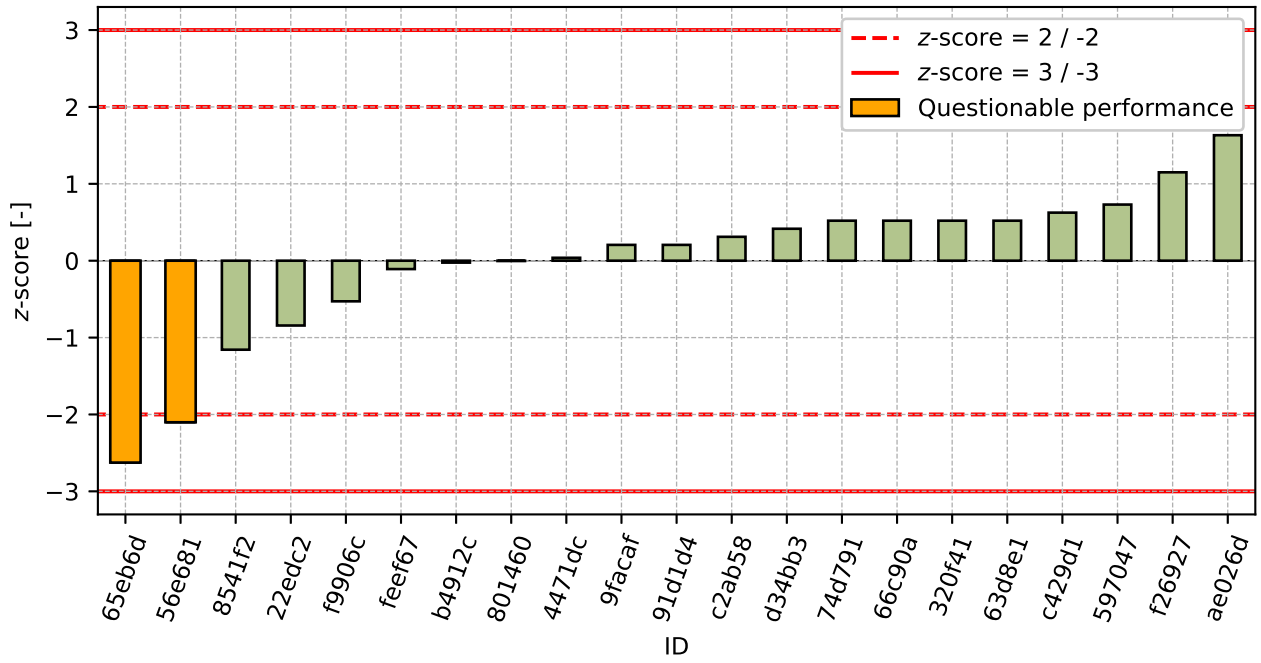

Figure 184: z-score

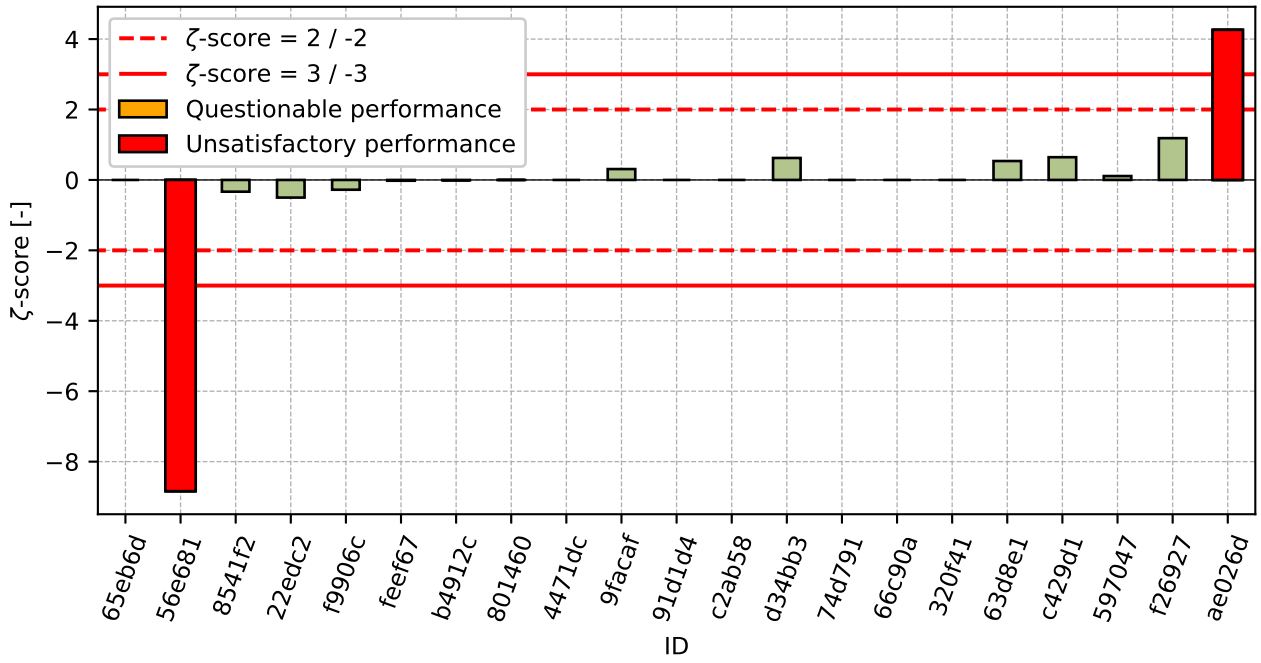

Figure 185: ζ-score

Table 64: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
65eb6d	-2.63	-
56e681	-2.1	-8.84
8541f2	-1.16	-0.33
22edc2	-0.84	-0.5
f9906c	-0.53	-0.28
feef67	-0.11	-0.02
b4912c	-0.02	-0.01
801460	-0.0	-0.0
4471dc	0.04	-
9facaf	0.21	0.31
91d1d4	0.21	-
c2ab58	0.31	-
d34bb3	0.42	0.62
74d791	0.52	-
66c90a	0.52	-
320f41	0.52	-
63d8e1	0.52	0.54
c429d1	0.63	0.65
597047	0.73	0.11
f26927	1.15	1.19
ae026d	1.63	4.26

12.2 Water absorption

12.2.1 Test results

Table 65: 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 [%]
320f41	0.7	0.8	0.8	-	0.8	0.06	7.53
8541f2	0.7	0.8	0.8	0.3	0.8	0.06	7.53
feef67	1.0	1.0	1.0	0.1	1.0	0.01	1.0
91d1d4	1.0	1.0	1.0	-	1.0	0.0	0.0
9facaf	1.2	0.9	1.1	0.2	1.1	0.15	14.32
b4912c	1.1	1.1	1.2	-	1.2	0.08	7.01
22edc2	1.2	1.1	1.2	0.1	1.2	0.06	4.95
4471dc	1.2	1.3	1.2	-	1.2	0.05	3.77
66c90a	1.2	1.3	1.3	-	1.3	0.06	4.56
63d8e1	1.3	1.3	1.3	0.1	1.3	0.0	0.0
801460	1.3	1.4	1.2	0.1	1.3	0.1	7.69
d34bb3	1.3	1.4	1.4	0.1	1.4	0.06	4.22
f9906c	1.4	1.5	1.4	0.2	1.4	0.06	4.03
f26927	1.4	1.6	1.6	0.1	1.5	0.12	7.53
597047	1.6	1.6	1.5	0.5	1.6	0.06	3.69
74d791	1.7	1.7	1.7	-	1.7	0.0	0.0
ae026d	1.7	1.7	1.7	-	1.7	0.02	1.02
c429d1	1.9	1.7	1.7	0.4	1.8	0.12	6.54
c2ab58	2.0	1.8	2.0	-	1.9	0.12	5.97
65eb6d	2.1	2.0	2.4	-	2.2	0.21	9.61
56e681	2.4	2.6	2.5	0.0	2.5	0.1	4.0

12.2.2 The Numerical Procedure for Determining Outliers

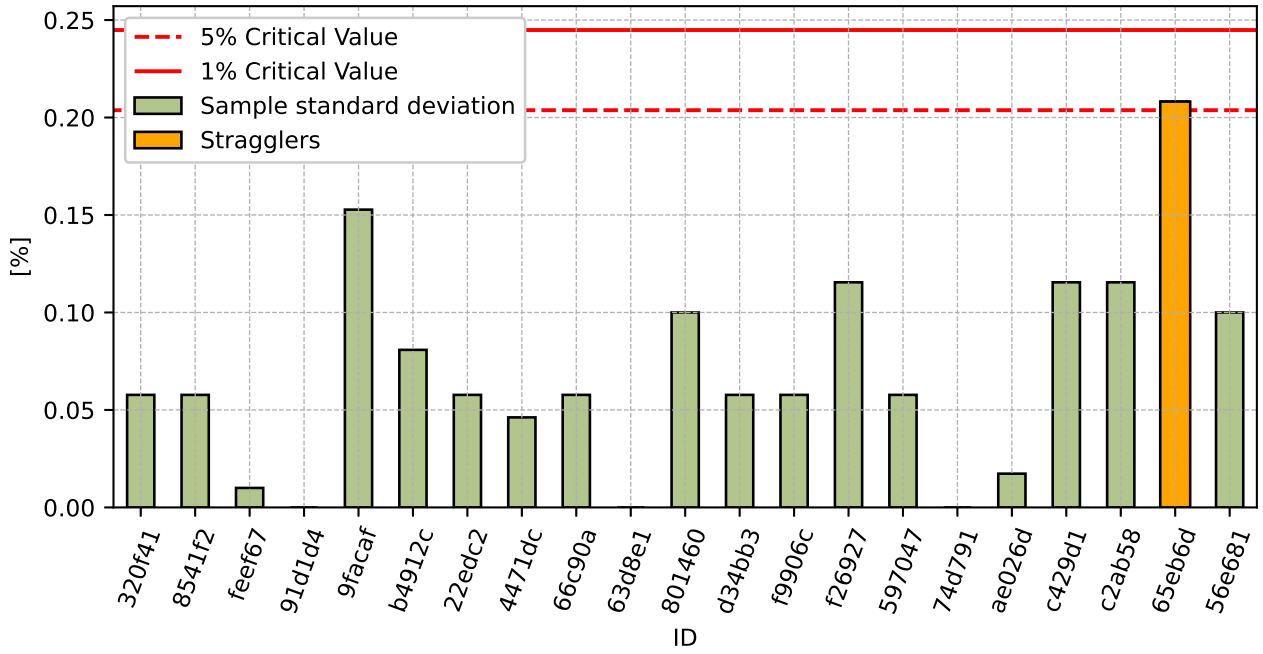

Figure 186: **Cochran's test** - sample standard deviations

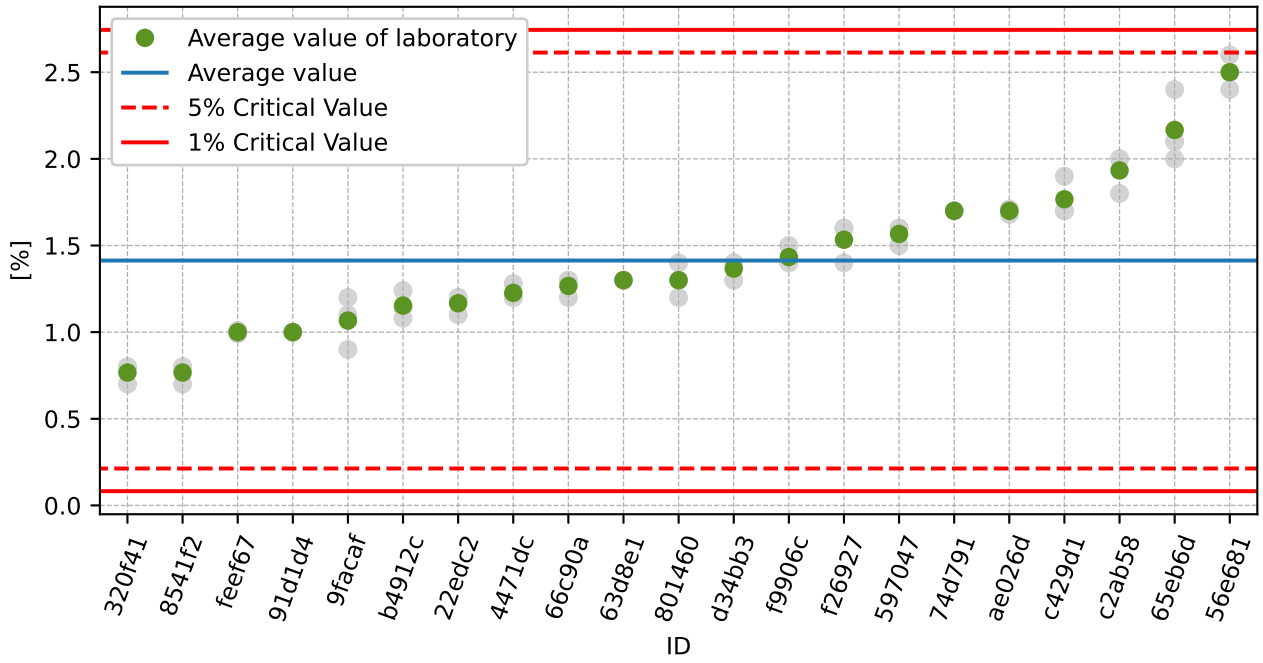

Figure 187: **Grubbs' test** - average values

12.2.3 Mandel's Statistics

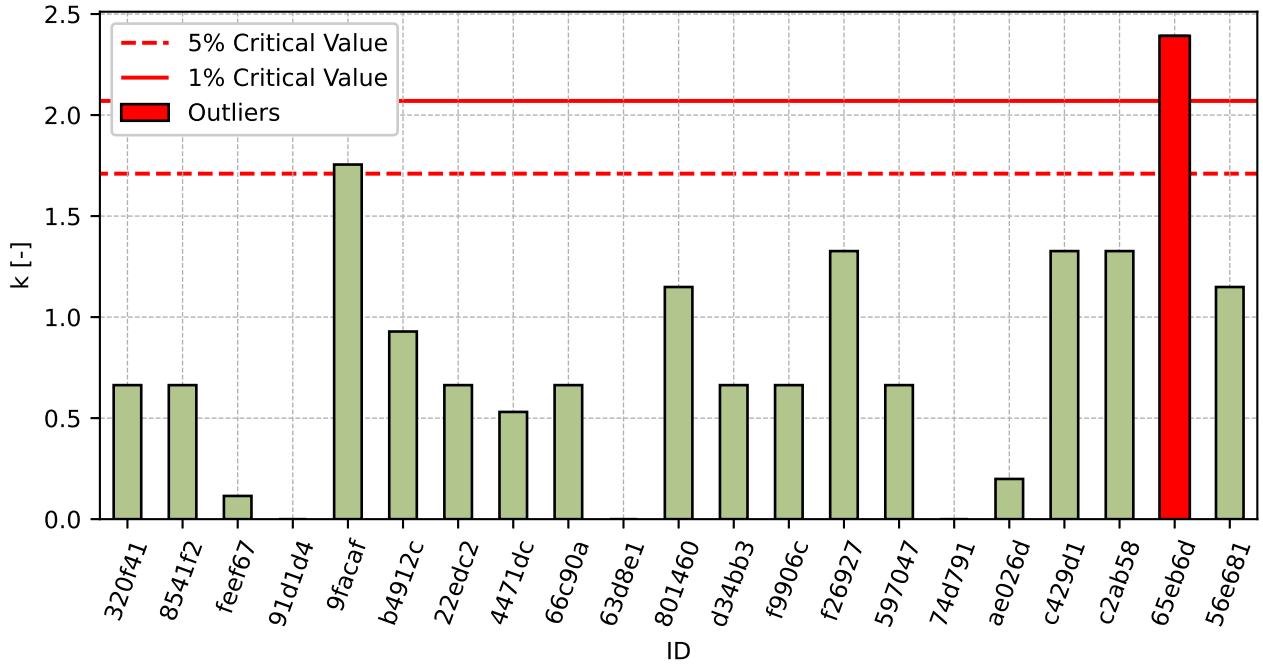

Figure 188: Intralaboratory Consistency Statistic

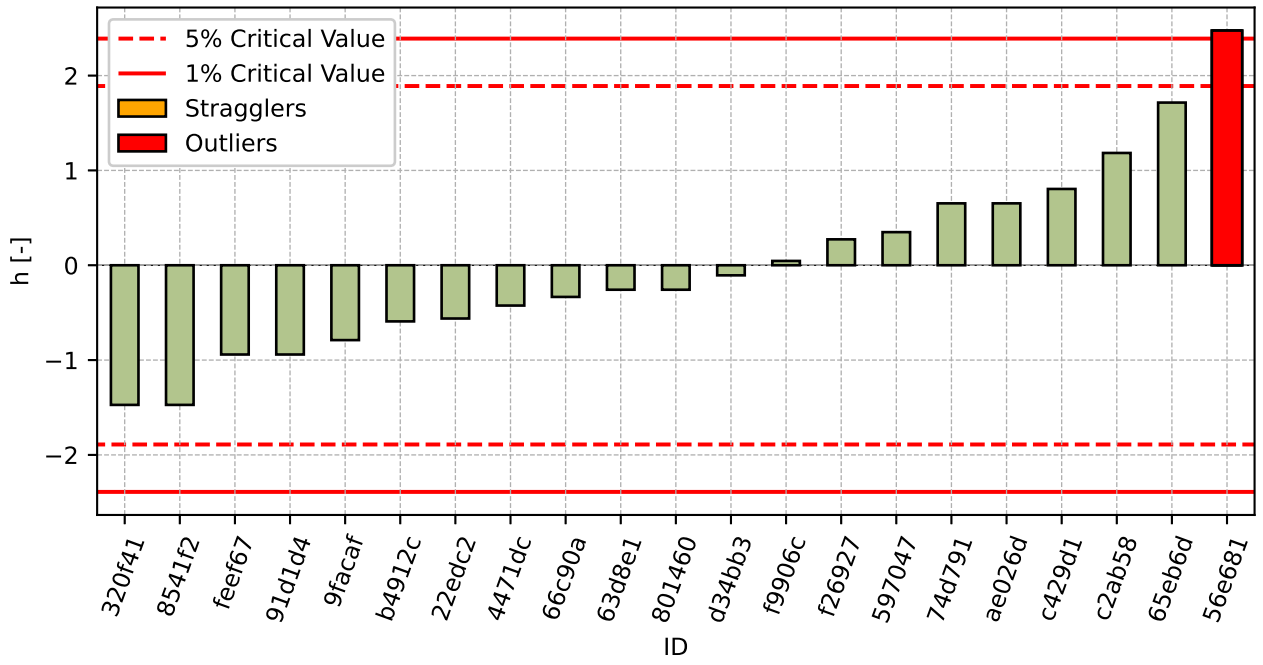

Figure 189: Interlaboratory Consistency Statistic

12.2.4 Descriptive statistics

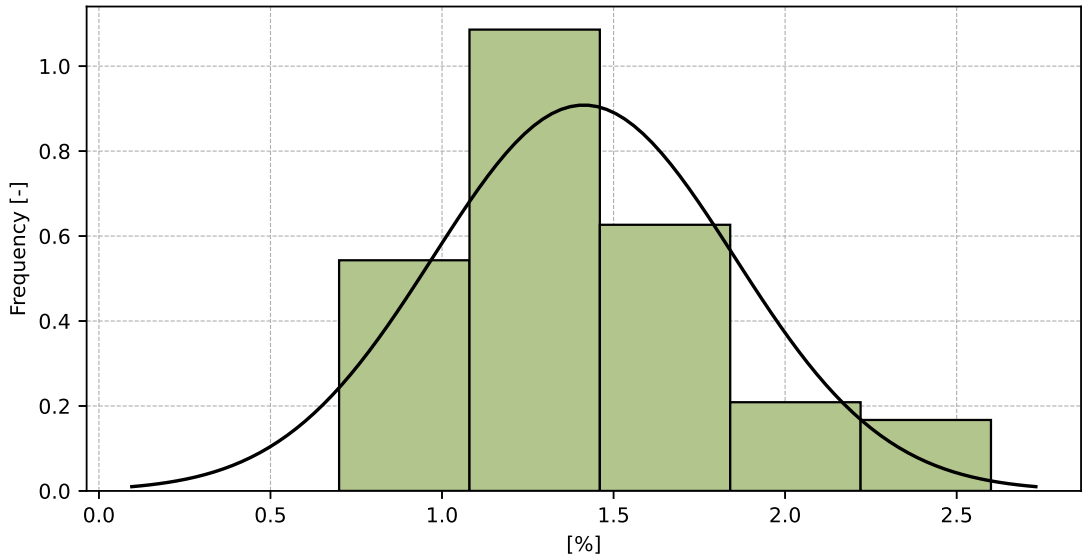

Figure 190: Histogram of all test results

Table 66: Descriptive statistics

Characteristics	**[%]**
Average value – $\bar{x}$	1.4
Sample standard deviation – s	0.44
Asigned value – x^*	1.4
Robust standard deviation – s^*	0.44
Measurement uncertainty of asigned value – u_X	0.1
p-value of normality test	0.012 [-]
Interlaboratory standard deviation – s_L	0.44
Repeatability standard deviation – s_r	0.09
Reproducibility standard deviation – s_R	0.44
Repeatability – r	0.2
Reproducibility – R	1.2

12.2.5 Evaluation of Performance Statistics

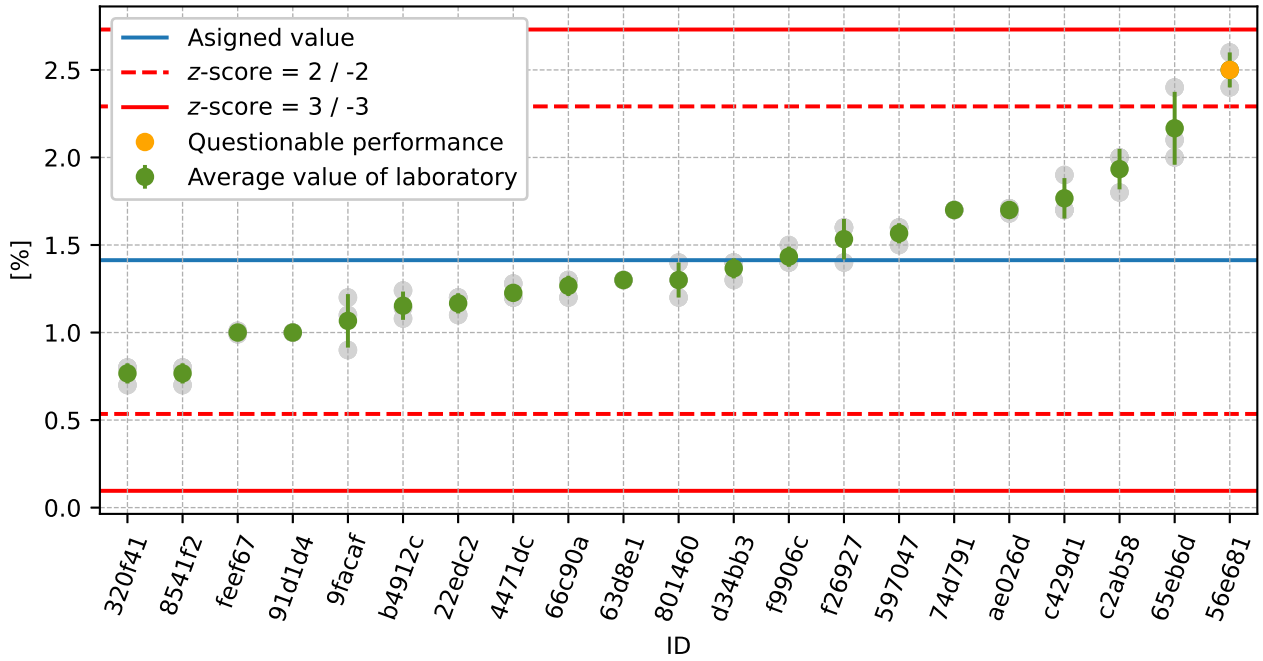

Figure 191: Average values and sample standard deviations

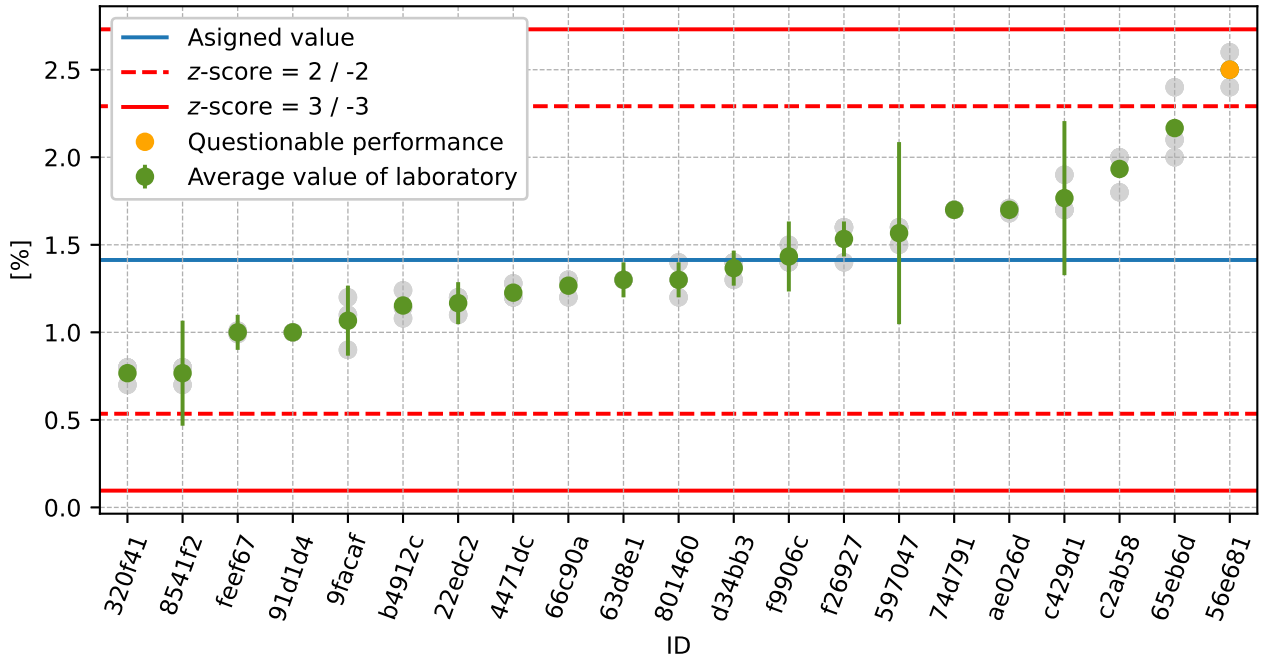

Figure 192: Average values and extended uncertainties of measurement

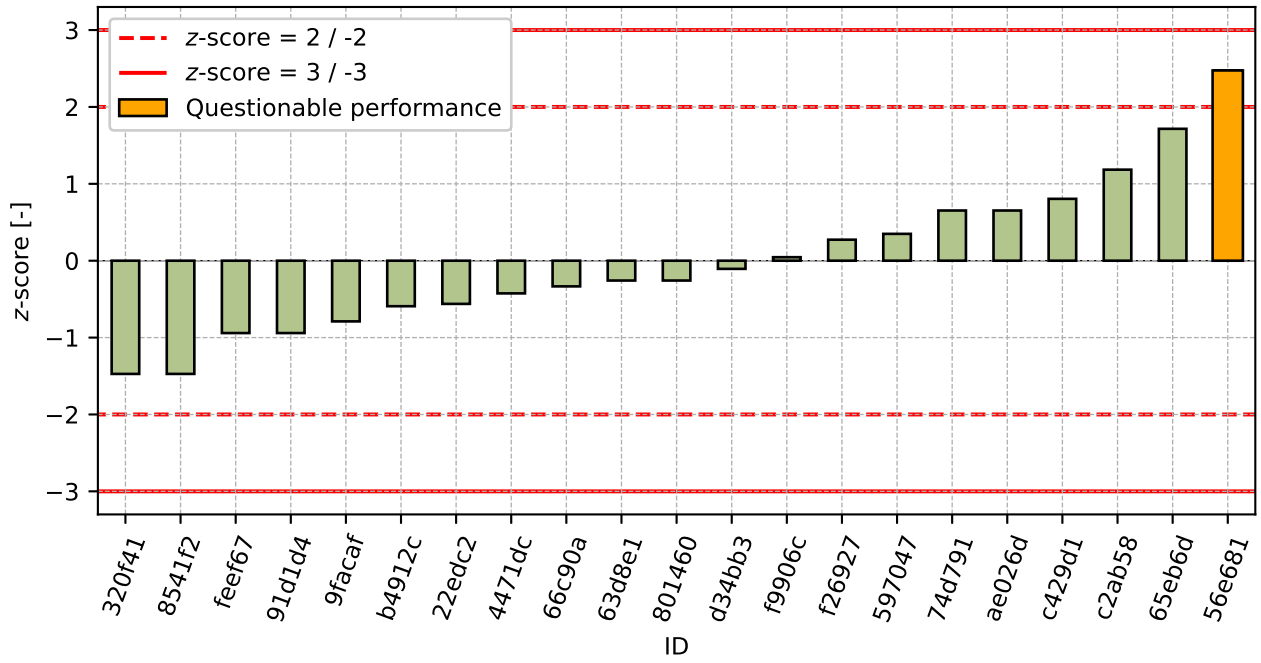

Figure 193: z-score

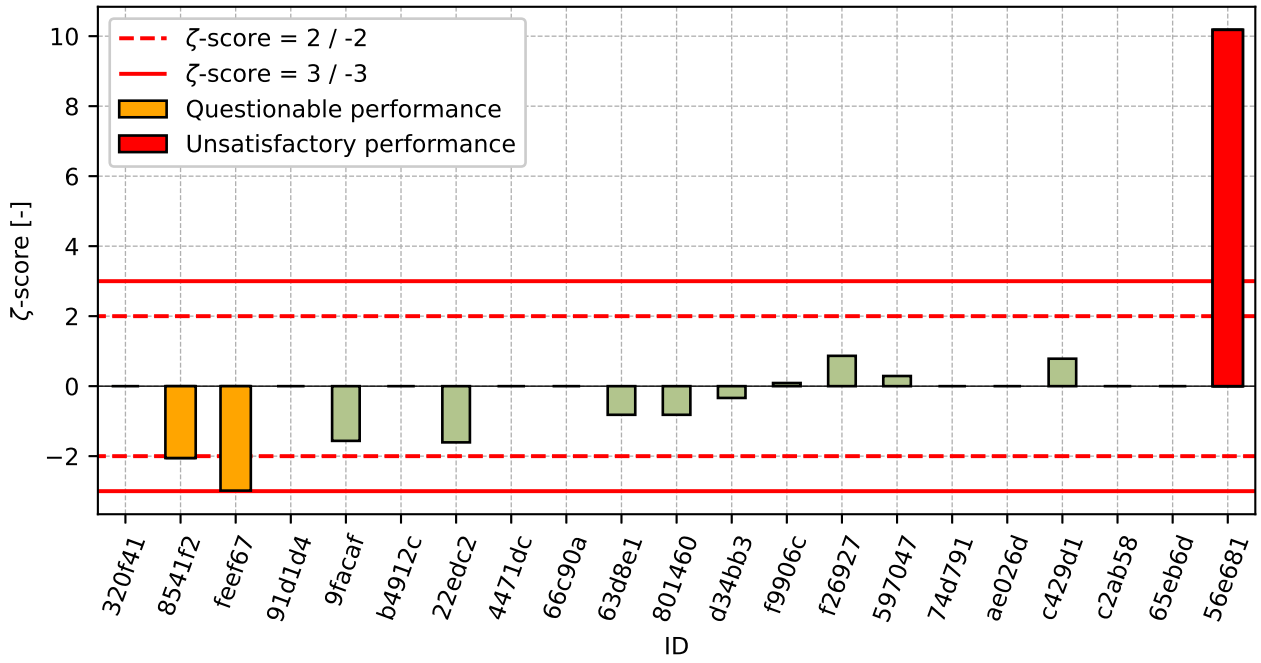

Figure 194: ζ-score

Table 67: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
320f41	-1.47	-
8541f2	-1.47	-2.05
feef67	-0.94	-2.98
91d1d4	-0.94	-
9facaf	-0.79	-1.56
b4912c	-0.59	-
22edc2	-0.56	-1.61
4471dc	-0.43	-
66c90a	-0.33	-
63d8e1	-0.26	-0.82
801460	-0.26	-0.82
d34bb3	-0.11	-0.34
f9906c	0.05	0.09
f26927	0.27	0.87
597047	0.35	0.29
74d791	0.65	-
ae026d	0.65	-
c429d1	0.8	0.78
c2ab58	1.18	-
65eb6d	1.72	-
56e681	2.47	10.18

13 Appendix – EN 1097-7 Determination of the particle density of filer - Pyknometer method

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

14 Appendix – EN 1367-1 Determination of resistance to freezing and thawing

14.1 Test results

Table 68: 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 [%]
b4912c	0.18	0.16	0.15	0.13	0.16	0.015	9.35
feef67	0.17	0.16	0.23	0.1	0.19	0.038	20.28
65eb6d	0.23	0.18	0.19	-	0.2	0.026	13.23
9db03c	0.2	0.2	0.2	0.5	0.2	0.0	0.0
597047	0.2	0.3	0.2	0.4	0.23	0.058	24.74
1ae021	0.3	0.2	0.3	0.01	0.27	0.058	21.65
99772d	0.39	0.22	0.37	1.5	0.33	0.093	28.44
25dbc8	0.34	0.35	0.32	0.61	0.34	0.015	4.54
d6b7ab	0.5	0.3	0.3	0.2	0.37	0.115	31.49
ba0755	0.4	0.4	0.4	0.1	0.4	0.0	0.0

14.2 The Numerical Procedure for Determining Outliers

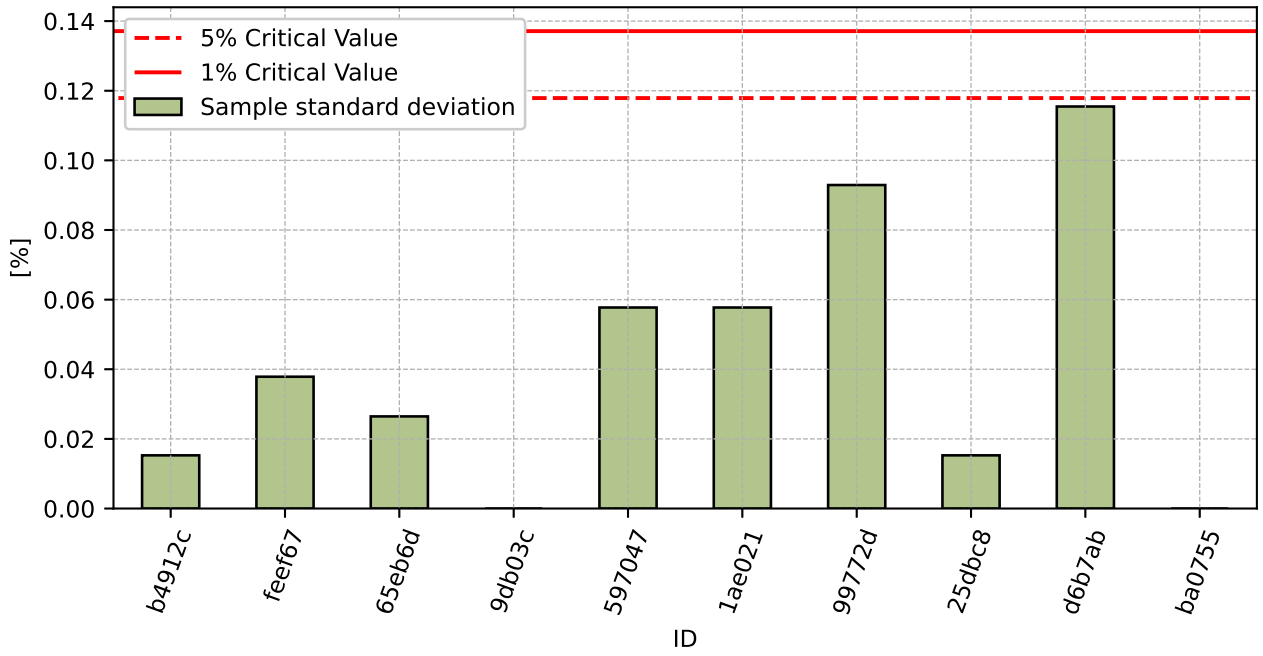

Figure 195: **Cochran's test** - sample standard deviations

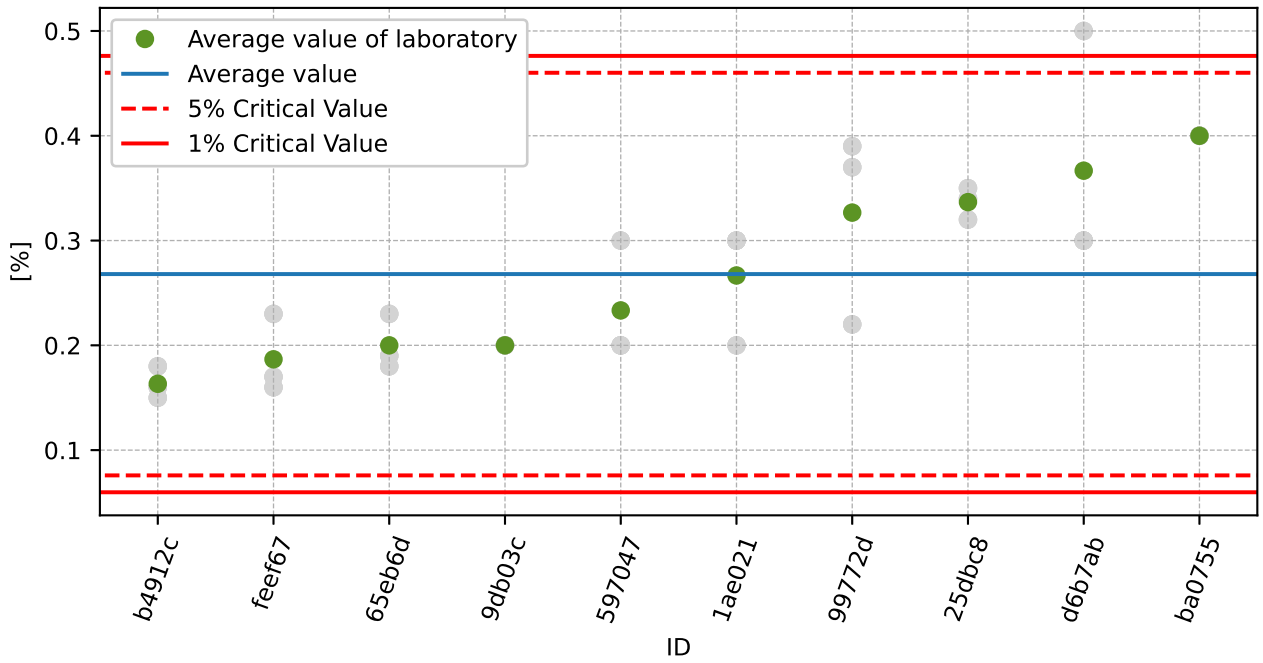

Figure 196: **Grubbs' test** - average values

14.3 Mandel's Statistics

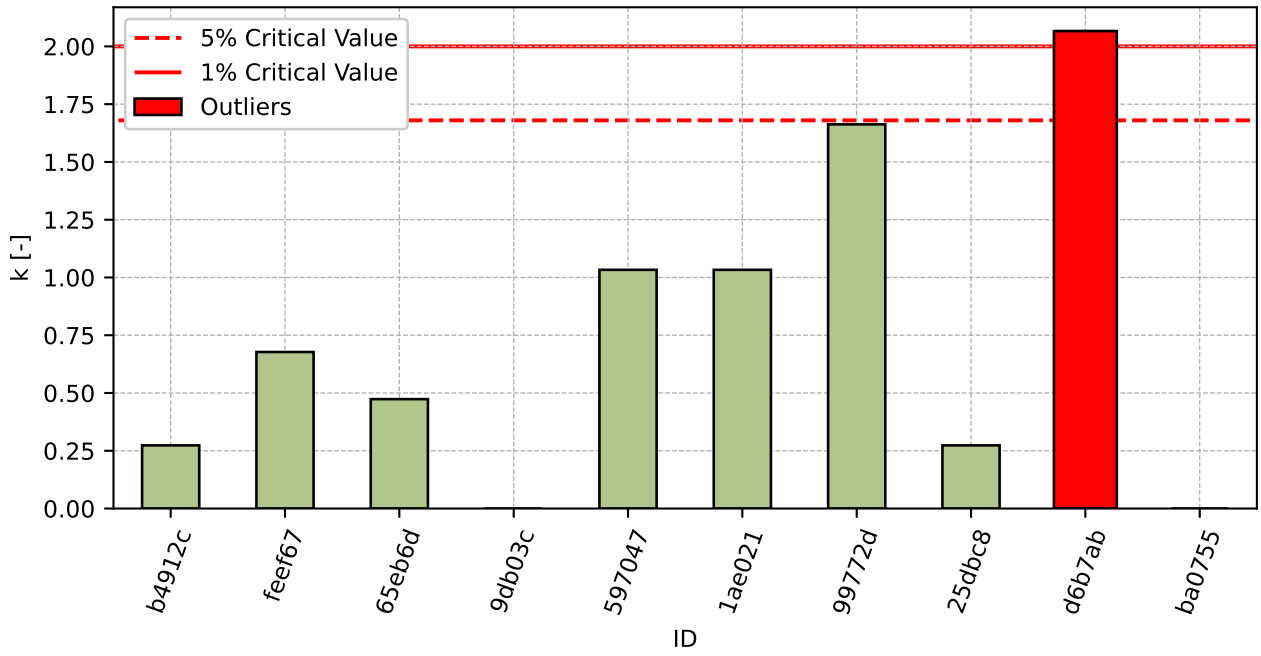

Figure 197: Intralaboratory Consistency Statistic

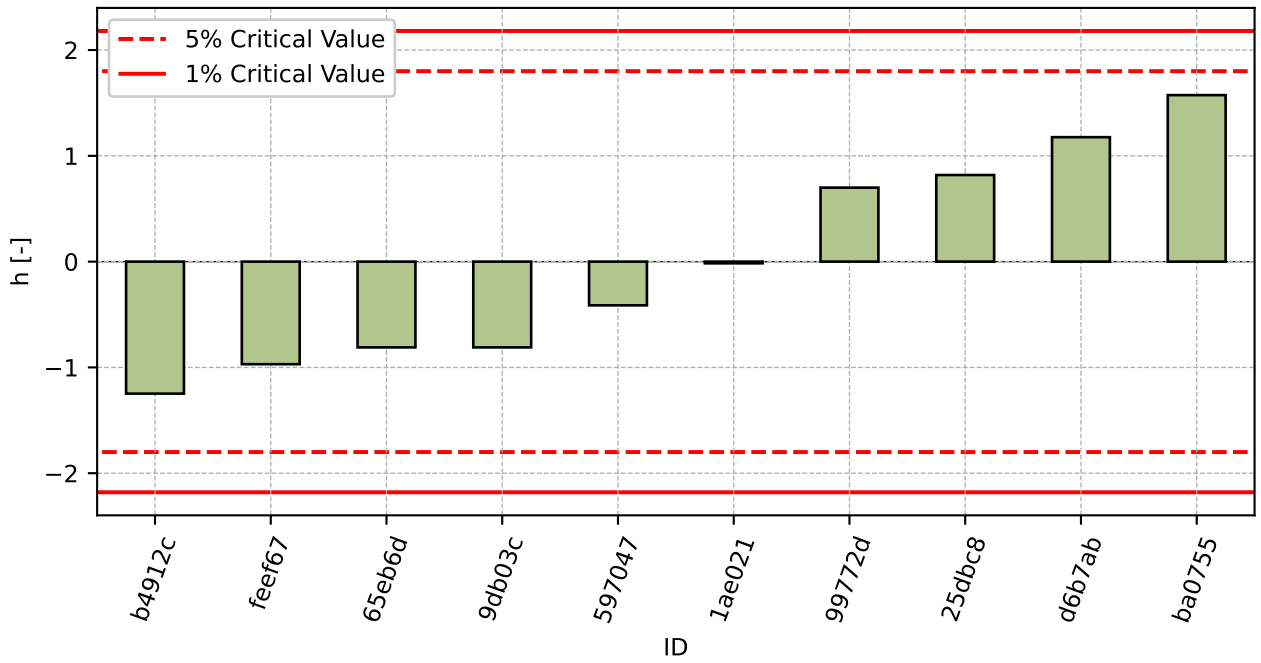

Figure 198: Interlaboratory Consistency Statistic

14.4 Descriptive statistics

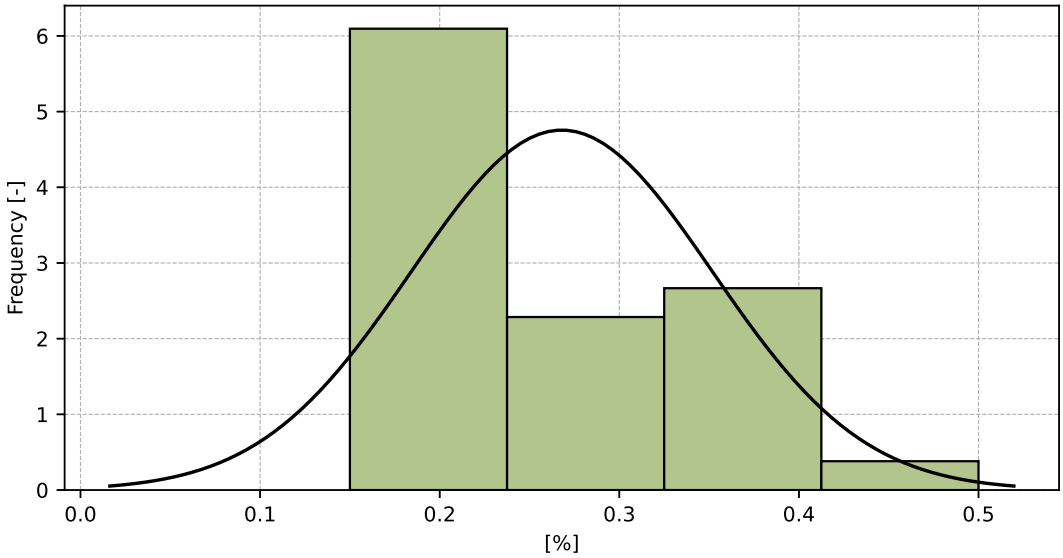

Figure 199: Histogram of all test results

Table 69: Descriptive statistics

Characteristics	**[%]**
Average value – $\bar{x}$	0.27
Sample standard deviation – s	0.084
Asigned value – x^*	0.27
Robust standard deviation – s^*	0.084
Measurement uncertainty of asigned value – u_X	0.027
p-value of normality test	0.011 [-]
Interlaboratory standard deviation – s_L	0.077
Repeatability standard deviation – s_r	0.056
Reproducibility standard deviation – s_R	0.095
Repeatability – r	0.16
Reproducibility – R	0.27

14.5 Evaluation of Performance Statistics

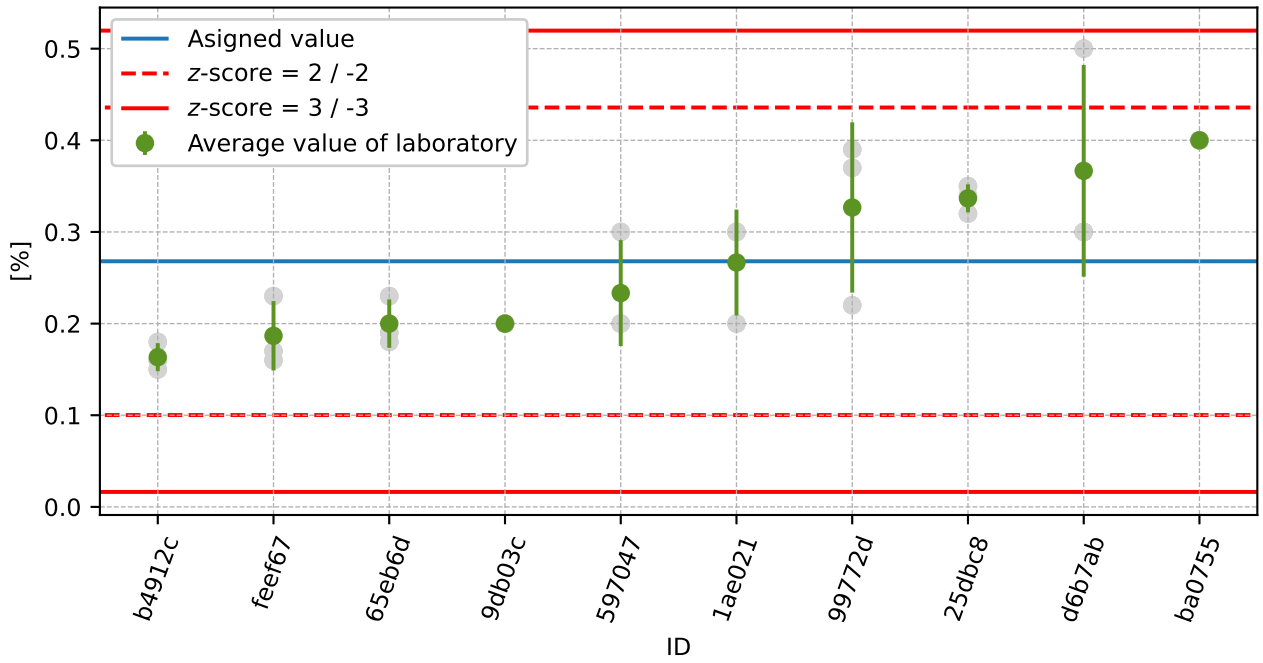

Figure 200: Average values and sample standard deviations

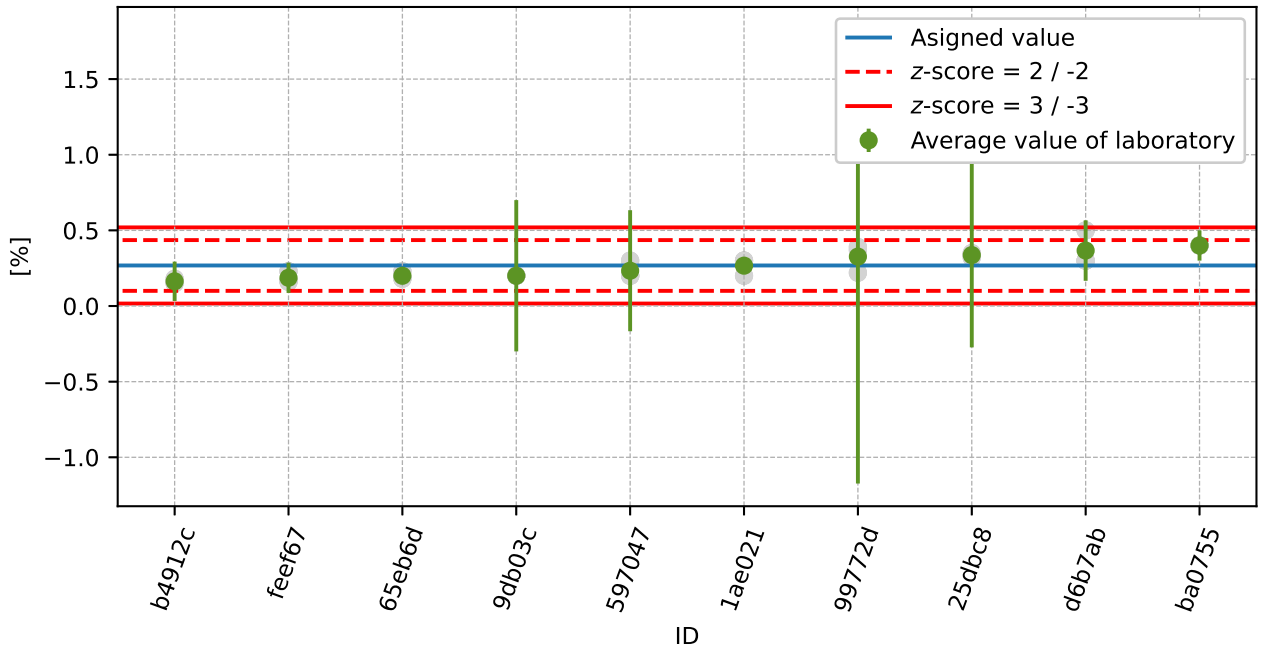

Figure 201: Average values and extended uncertainties of measurement

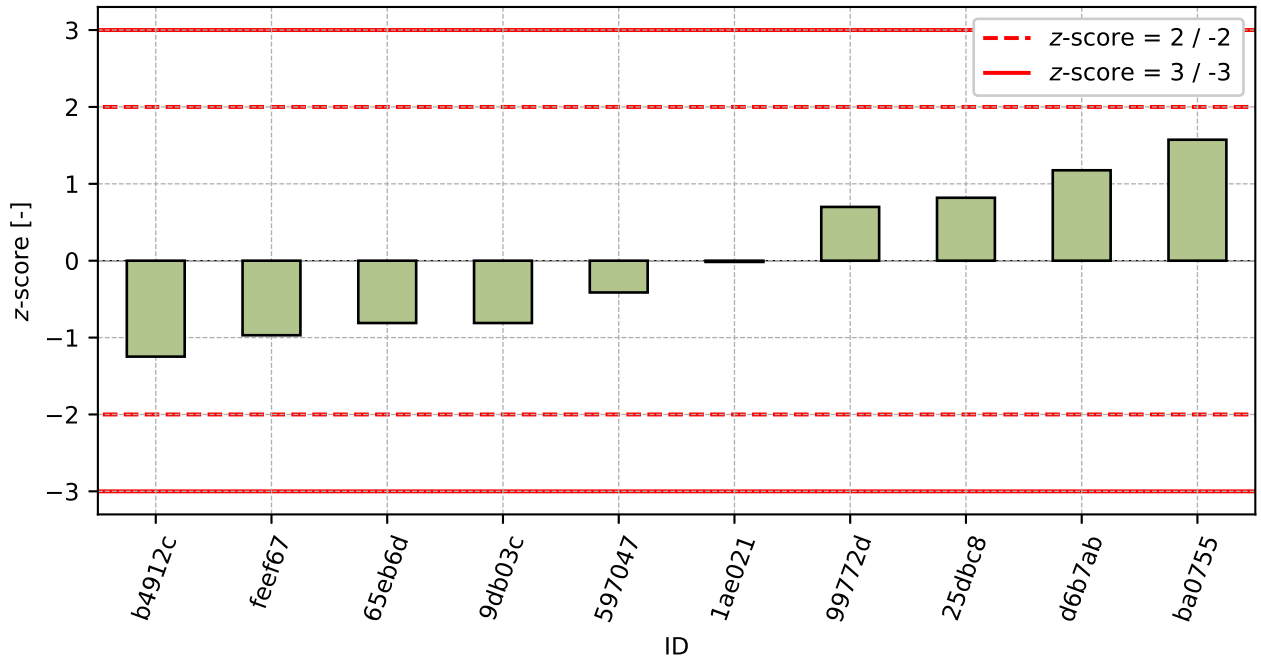

Figure 202: z-score

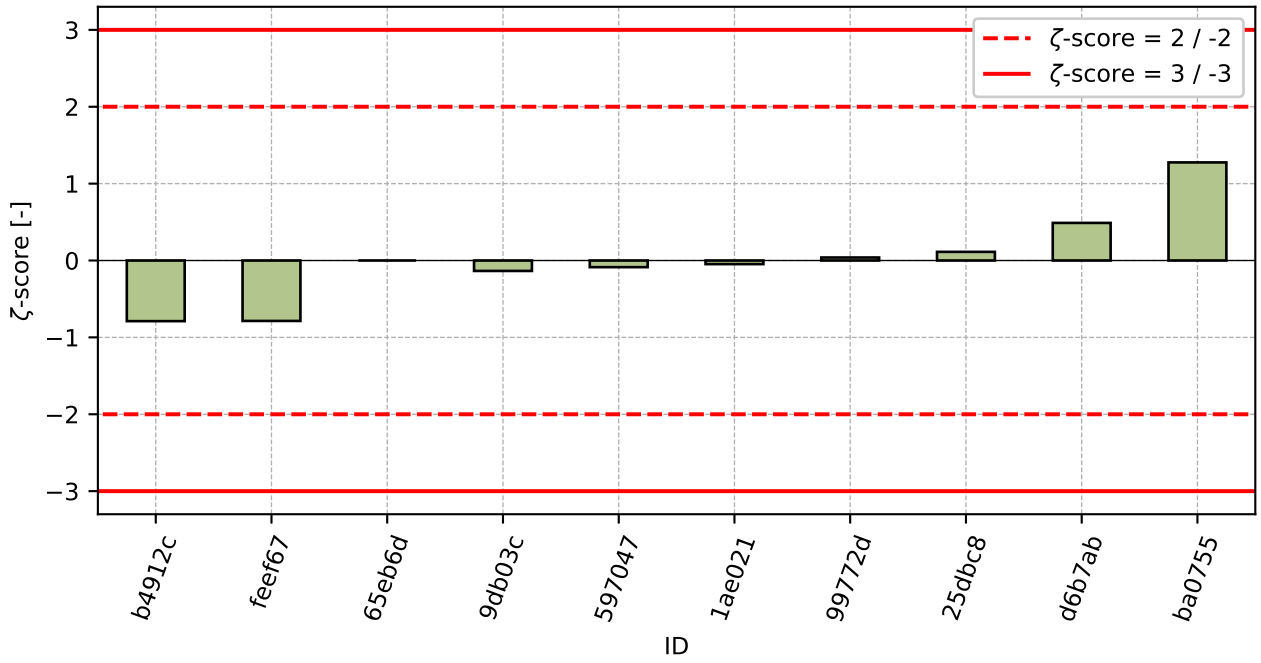

Figure 203: ζ-score

Table 70: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
b4912c	-1.25	-0.79
feef67	-0.97	-0.79
65eb6d	-0.81	-
9db03c	-0.81	-0.14
597047	-0.41	-0.09
1ae021	-0.02	-0.05
99772d	0.7	0.04
25dbc8	0.82	0.11
d6b7ab	1.18	0.49
ba0755	1.57	1.28

15 Appendix – EN 1367-2 Magnesium sulfate test

15.1 Test results

Table 71: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [%]	u_X [%]
f9906c	1.0	0.5
cce71a	1.0	1.0
bf844c	1.0	1.7
63d8e1	1.0	0.1
25dbc8	2.24	0.22
feef67	2.24	0.2
d2edc0	2.6	1.0
74d791	4.58	-
b0263e	6.5	0.65
d6b7ab	7.9	0.5

15.2 The Numerical Procedure for Determining Outliers

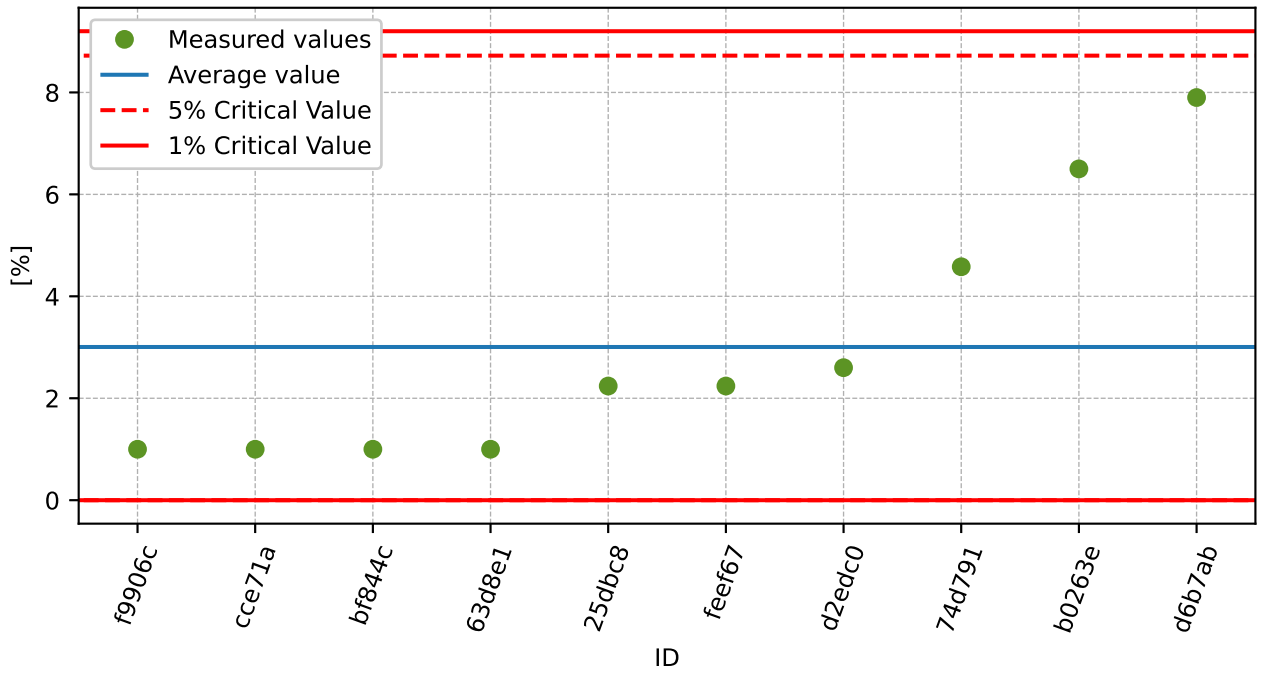

Figure 204: **Grubbs' test** - average values

15.3 Mandel's Statistics

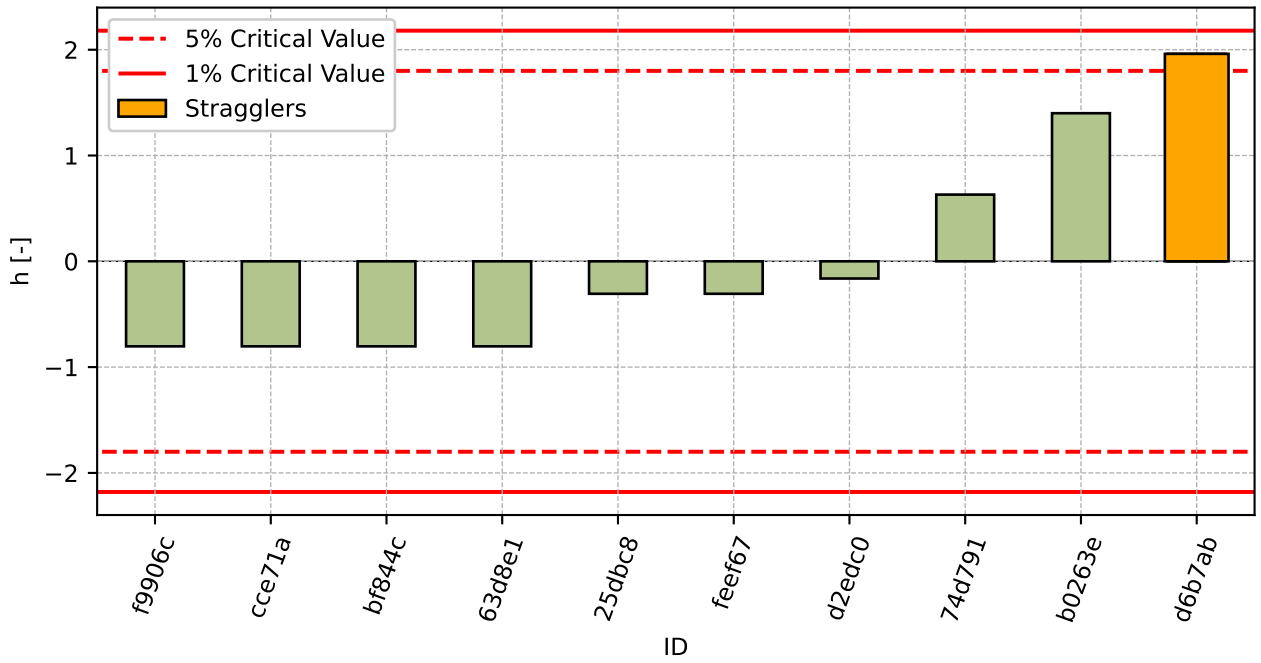

Figure 205: Interlaboratory Consistency Statistic

15.4 Descriptive statistics

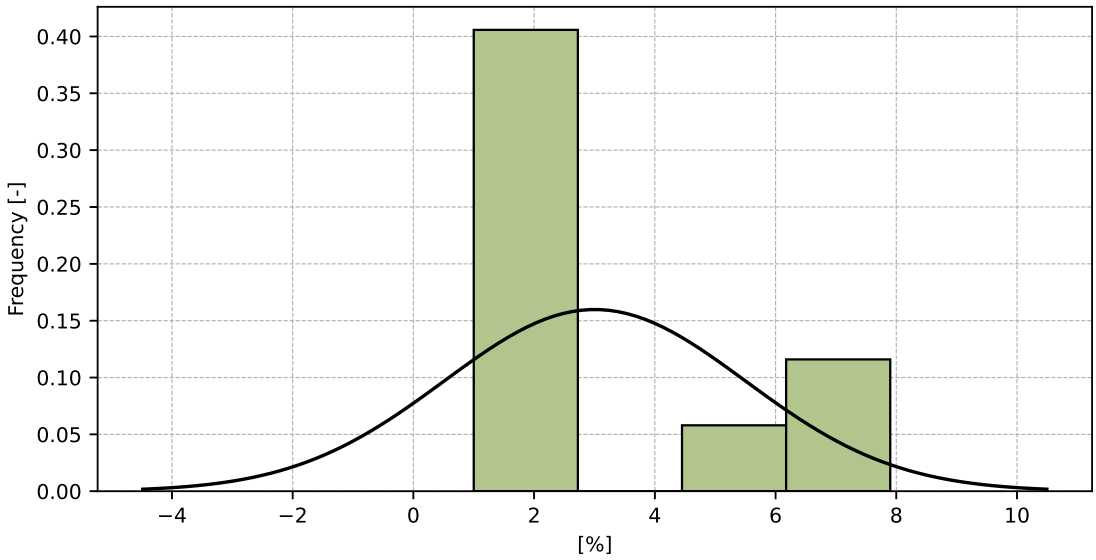

Figure 206: Histogram of all test results

Table 72: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	3.01
Sample standard deviation – s	2.496
Asigned value – x^*	3.01
Robust standard deviation – s^*	2.496
Measurement uncertainty of asigned value – u_X	0.789
p-value of normality test	0.018 [-]

15.5 Evaluation of Performance Statistics

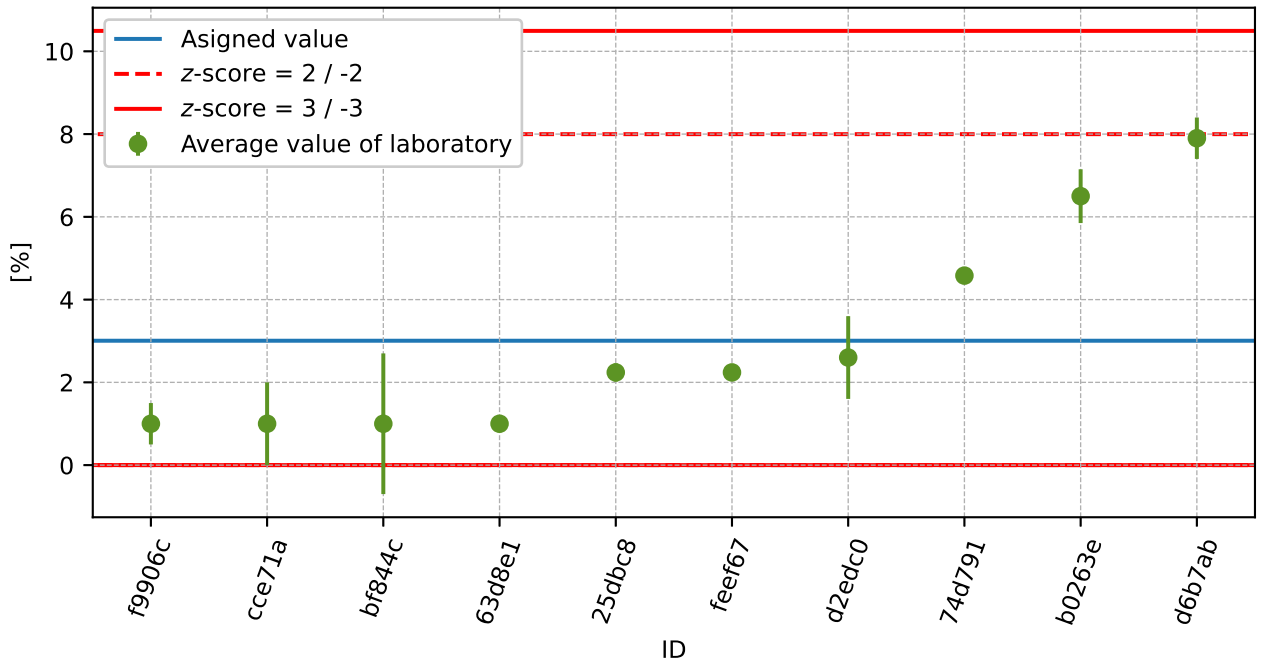

Figure 207: Average values and extended uncertainties of measurement

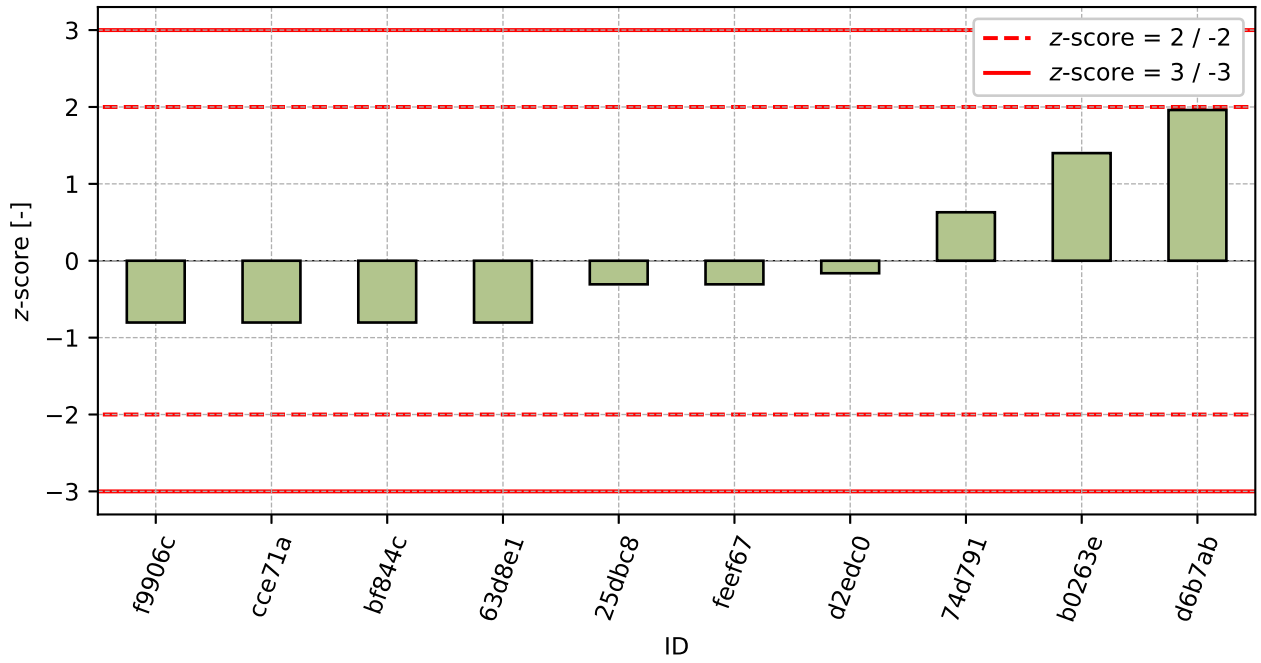

Figure 208: z-score

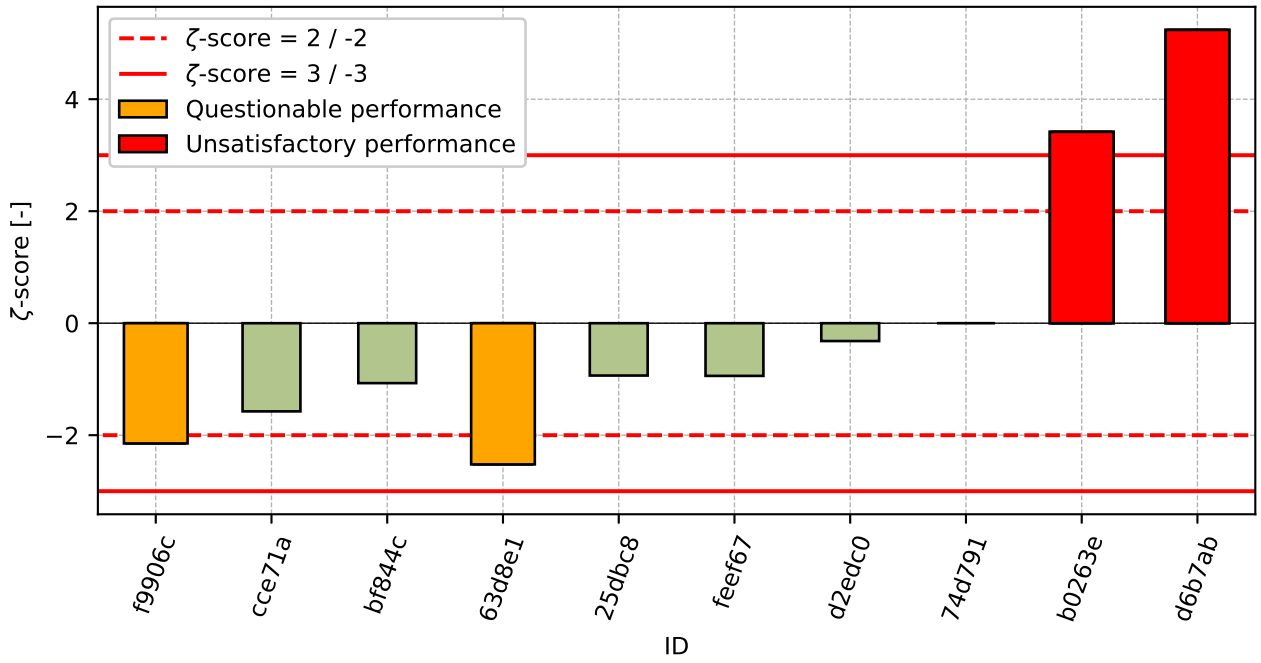

Figure 209: ζ-score

Table 73: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f9906c	-0.8	-2.15
cce71a	-0.8	-1.57
bf844c	-0.8	-1.07
63d8e1	-0.8	-2.52
25dbc8	-0.31	-0.93
feef67	-0.31	-0.94
d2edc0	-0.16	-0.32
74d791	0.63	-
b0263e	1.4	3.42
d6b7ab	1.96	5.24

16 Appendix – EN 1367-3 Boiling test for "Sonnenbrand basalt"

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

17 Appendix – TP 137 - Příloha 1 a 2 – Reaktivnost kameniva s alkáliemi

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

18 Appendix – ČSN 72 1179 Determination of reactivity of aggregates in connection with alkalies – chapter B

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