FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program
Aggregate Testing
ZK 2022/1

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: June 29, 2022

Poskytovatel zkoušení
způsobilosti při SZK FAST

Proficiency testing
provider at the SZK FAST
Z 7008
Veveří 95
602 00 Brno   szk.fce.vutbr.cz
Czech Republic

Assoc. Prof. Ing. Tomáš Vymazal, Ph.D.
Head of the PT Provider, PTP coordinator

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

Contents

Proficiency Testing Provider at the SZK FAST | Z 7008 1/163
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
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1   Introduction and Important Contacts

At the beginning of 2022, the Proficiency Testing Provider at SZK FAST (PoZZ) launched a Proficiency Testing Programme (PrZZ), designated ZK 2022/1, 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@vutbr.cz

Coordinator of PTP result assessment PTP

Ing. Petr Misák, Ph.D.
Brno University of Technology
Faculty of Civil Engineering
Institute of Building Testing
Veveří 95, Brno 602 00
Czech Republic
Tel.: +420 774 980 255
Email: Petr.Misak@vutbr.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 9, 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].

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

64 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
6d687c	X	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
82c914	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-
4faf4d	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
ce221c	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
c9969b	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
c64ad2	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
8b4386	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ec14be	-	X	X	-	X	-	-	X	-	-	-	-	-	X	-	-	-	-
42b389	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
228042	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d03349	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0bde87	X	X	-	-	X	-	X	X	-	-	-	X	-	-	-	-	-	-
a7a3e5	X	X	X	-	-	-	X	X	-	X	X	X	-	-	X	-	-	-
9b4b63	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1ce009	-	-	X	X	-	-	-	-	-	X	-	X	-	-	-	-	-	-
b96536	-	-	-	X	X	X	X	-	-	-	-	-	-	X	X	-	-	-
8267dd	-	-	X	X	-	X	-	X	-	X	-	X	-	-	X	-	-	-
fe1b70	-	X	X	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-
a27013	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
e5d49b	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
53919c	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
a9c83a	-	-	-	X	-	-	X	X	-	-	-	X	-	-	X	-	-	-
3ceee7	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5cab48	X	-	-	-	X	-	-	-	-	-	X	-	-	X	-	-	-	-
8f3a62	X	-	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-
6f05cd	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-
a5e1f6	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-
79bd98	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
86714d	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
eeb447	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
3f9c15	X	X	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-
4d51a8	-	-	-	-	-	X	-	-	-	-	-	X	-	-	X	-	-	-
ae859e	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
a259ca	X	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
2c58f4	-	X	-	-	X	-	X	X	-	-	X	-	-	-	X	-	-	-
048532	-	-	-	-	-	X	X	-	-	-	-	-	-	X	-	-	-	-
bc1df4	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-

Continued on next page

Proficiency Testing Provider at the SZK FAST | Z 7008   6/163
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
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Continued from previous page

ID/Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
d4530f	X	-	X	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-
8dbf83	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
fbc95e	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
ba9637	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
80076b	-	-	-	-	X	-	-	X	-	-	-	X	-	-	X	-	-	-
8c48c2	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
79536f	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8acb0f	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
c53a30	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1e7fc1	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
18e860	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
9020c7	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
0be6c3	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
7cfd58	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
e64c92	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
7346a5	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
278e12	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
e7e3b2	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
d96997	X	-	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-
58ed4e	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4f2532	X	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
38a7ee	X	-	X	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-
4c70c6	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
7b3306	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
500354	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3bc27f	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
667101	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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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	Kostenetz str 12, Sofia, 1612, Bulgaria	182 LI
AG Institut doo Novi Sad, Laboratorija za ispitivanje AGI - Beograd	Đorđa Zličića 53A, Novi Sad, 21000, Republika Srbija	01-457
AG Institut doo Novi Sad, Laboratorija za ispitivanje AGI - Novi Sad	Đorđa Zličića 53A, Novi Sad, 21000, Republika Srbija	01-457
A&A MACEDONIA LAB TEST LTD	10, Moisi Street, Chlroraka, Paphos, 8220, Cyprus	-
BEST, a.s.	Lučice 87, Chlumec nad Cidlinou, 50351, Česká republika	1739
BETOTECH, s.r.o. - pracoviště Beroun	Beroun 660, Beroun, 26601, 25066153	AZL 1195
BETOTECH, s.r.o. - pracoviště Jindřichův Hradec	Beroun 660, Beroun, 26601, Česká republika	AZL 1195
BETOTECH, s.r.o. - pracoviště Most	Beroun 660, Beroun, 26601, Česká republika	AZL 1195
BETOTECH, s.r.o. - pracoviště Ostrava	Beroun 660,, Beroun, 266 01, Česká republika	1195.2
BETOTECH, s.r.o. - pracoviště Trutnov	Beroun 660, Beroun, 26601, Česká republika	AZL 1195
Bechtel ENKA UK Limited Ogranak Beograd	Jasicki put 52 dj, Krusevac, 37000, Serbia	-
Betotech s.r.o., laboratoř Gajdošova	Beroun 660, Beroun, 266 01, Česká republika	1195.3
CEMEX Czech Republic, s.r.o.	Semtín 102, Pardubice, 53354, Česká republika	1302
CSS d.o.o.	Savska cesta 144a, Zagreb, 10000, CROATIA	HR1106
Cement Hranice, akciová společnost	Bělotínská 288, Hranice I - Město, 75301, Česká republika	1284
Centrum dopravního výzkumu, v. v. i.	Líšeňská 33a, Brno, 636 00, Česká republika	1506
Danucem Slovensko a.s. , Rohožník	Danucem Slovensko a. s., Technicko - kompetenčné centrum, Pestovateľská 2, Bratislava, 821 04, Slovenská republika	426/S-313
Debbie van den Hemel	Industriepark Oost 6, Beernem, 8730, West - Vlaanderen	BELAC 637-TEST
Disoma NV	Krommewege 31g, Maldegem, 9990, Belgium	-
EDAFOMICHANIKI S.A.	19 EMMANUEL PAPADAKI, NEO IRAKLEIO, 14121, GREECE	-
Ferriere Nord S.p.A.	Zona Industriale Rivoli di Osoppo, Osoppo (Udine), 33010, Italy	-

Continued on next page

Proficiency Testing Provider at the SZK FAST | Z 7008   8/163
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
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Continued from previous page

Laboratory	Address	Accreditation number
GEODRILL s.r.o.	K Bukovinám 169/45, Brno, 63500, Česká Republika	1596
GEOtest, a.s.	Šmahova, 1244/112, BRNO, 62700, Česká republika	1271.2
GIM-TEST D.O.O. BANJA LUKA	Palih boraca 55, local No. 2, Banja Luka, 78000, RS, BiH	LI-152-01
Geoput d.o.o. Beograd	Tome Rosandića 2, Beograd, 11010, Srbija	126366206
Graz University of Technology	Rechbauerstraße 12, Graz, 8010, Austria	-
INISMa (Institut Interuniversitaire des Silicates, Sols et Matériaux) - MONS, Belgique	Avenue du Gouverneur Emile Cornez 4, MONS, 7000, BELGIUM	032-TEST
INSTITUT IGH, d.d. - Osijek	Drinska 18, Osijek, 31000, Hrvatska	-
INSTITUT IGH, d.d. - Zagreb	Janka Rakuše 1, Zagreb, 10000, Croatia	1043
INSTITUT IGH, d.d. za istraživanje i razvoj u graditeljstvu	Janka Rakuše 1, Zagreb, 10000, Croatia	1043
Institut IGH, d.d. - Split	Matice hrvatske 15, Split, 21000, Croatia	HAA 1043
Institut za Beton d.o.o	Ugrinovački put 31, deo 50, Beograd-Zemun, 11080, Serbia	-
JSC Laboratoriniai tyrimai	R. Kalantos str. 85, Kaunas, 52310, Lithuania	LA.01.173
KOLEJCONSULT & servis, spol. s r.o.	Křenová 131/35, Brno, 60200, Česká republika	1305
LABORATOIRE DES TRAVAUX PUBLICS DU SUD	Zone des activités Bouhraoua- PB 332 GHARDAIA, GHARDAIA, 47000, 98-B-0862065	-
Labo Devlieger - Van Vooren	industriepark Rosteyne 1, zelzate, 9060, België	296-TEST
Labomosan, Laboratoire de Génie Civil & Expertise Des Sols à Namur	Chemin du Fond des Coupes, 6, Floreffe, 5150, Belgique	208-TEST
Laboratoire Central des Travaux Publics- Unité de BOUIRA-LCTP	1. rue Kaddour RAHIM- HUSSEIN DEY, ALGER, 16005, ALGERIE	-
Lafage Cement, a.s.	Čížkovice 27, Čížkovice, 41112, Česká republika	1426
Laura Viviana Niño	calle 72a, BOGOTA, D.C., 111211, 66-11	-
Mediterranean float glass SPA	29 route de meftah Larbaa, Blida, 09300, Algeria	-
Mining and Metallurgy Institute Bor	Zeleni bulevar 35, Bor, 19210, Serbia	01-308, ATS Serbia
Northern Regional Laboratory	Canna Road, Tabuan Jaya, Kuching, 93350, Sarawak	-
Národná diaľničná spoločnosť a. s.	Dúbravská cesta 14, Bratislava, 84104, Slovenská republika	456/S-328
BETOTECH, s.r.o. - pracoviště Brno	Beroun 660, Beroun, 26601, Česká republika	1195.3

Continued on next page

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Continued from previous page

Laboratory	Address	Accreditation number
STATS ASIA PACIFIC PTE LTD	71 Toh Guan Road East #02-02, TCH Techcentre, Singapore 608598, Singapore, 608598, Singapore	-
Skanska Transbeton, s.r.o. - Zkušební laboratoř Letňany	Skanska a.s., Křižíkova 682/34a, Praha 8 - Karlín, 18600, Česká republika	1122
Skanska Transbeton, s.r.o. - Zkušební laboratoř Olomouc	Skanska a.s., Křižíkova 682/34a, Praha 8 - Karlín, 18600, Česká republika	1122
Slovenská správa ciest, IVSC Žilina, Oblastné laboratórium	Martina Rázusa, 104/A, Žilina, 01001, Slovenská republika	181/S-322
Sveučilište u Zagrebu Građevinski fakultet	Fra Andrije Kačića Miošića 26, Zagreb, 10000, Croatia	-
TEPVERAM s.r.o.	Třibřichy 13, Třibřichy, 53701, ČR	1759
TESScontrol, s.r.o. - Laboratórium Bratislava	efaktury@tesscontrol.sk - preferovaná adresa; Hronská 3211/1, Zvolen, 960 93, Slovenská republika	-
TESScontrol, s.r.o. - Laboratórium Zvolen	efaktury@tesscontrol.sk - preferovaná adresa; Hronská 3211/1, Zvolen, 960 93, Slovenská republika	S-375
TESScontrol, s.r.o. - Laboratórium Žilina	efaktury@tesscontrol.sk - preferovaná adresa; Hronská 3211/1, Zvolen, 960 93, Slovenská republika	S-375
TPA EOOD CTC BURGAS, Bulgaria, Burgas, territory "Meden Rudnik", area "Nad Dzhambazlare"	Rezbarska str. № 7, Sofia, 1510, Bulgaria	-
TPA EOOD CTC KREPOST, territory "Dolna cheshma", municipality Dimitrovgrad	Rezbarska № 7, Sofia, 1510, Bulgaria	-
TZÚS Praha, s.p. - pobočka 0200 České Budějovice	Nemanická 441/8, České Budějovice, 37010, Česká republika	1018.3
UNIGEO a.s.	Místecká 329/258, Ostrava - Hrabová, 720 00, Česká republika	1412
VUIS - CESTY, spol. s r. o.	Lamačská cesta 8, Bratislava, 811 04, Slovenská republika	20
Vysoké učení technické v Brně, Fakulta stavební, Zkušební laboratoř při ÚTHD FAST VUT v Brně - č. 1396	Veveří 331/95, Brno, 60200, Česká republika	L1396
i2 Analytical Limited Sp. z o o Oddział w Polsce	Pionierów 39, Ruda Śląska, 41-711, Polska	UKAS 4041
Ředitelství silnic a dálnic ČR - laboratoř Brno	Rebešovická 40, Brno-Chrlice, 643 00, Česká republika	1072
Ředitelství silnic a dálnic ČR, Laboratoř Praha	Čerčanská 12, Praha 4, 140 00, Česká republika	1734

Continued on next page

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

10/163

Continued from previous page

Laboratory	Address	Accreditation number
"ЦЕНТЪР ЗА ИЗПИТВАНЕ И ЕВРОПЕЙСКА СЕРТИФИКАЦИЯ" ЕООД/Center for Testing and European Certification Ltd.	2, Industrialna street, Stara Zagora, 6006, Bulgaria	252 LI

2   Procedures used in the Statistical Analysis of Laboratory Results

The statistical analysis is based on the following steps:

1. Evaluation of intralaboratory variabilities by Cochran's C test: If 5% or 1% critical value is exceeded, the effect of the individual observations is first considered. If the results indicate that high participant variability is caused by a single observation, this value is excluded from the experiment, but the participant is not excluded as outlying. By overcoming 1% of the critical value, the participant's results can be marked as outlying and excluded from the experiment (symbol **X**).

2. The numerical critical evaluation of the test results using Grubbs' test: By overcoming 1% critical value, the participant's results can be marked as outlying and excluded from the experiment (symbol **X**).

3. Graphical determination of the consistency of laboratories (Mandel's statistics): The exceedance of the critical values of Mandel's statistics does not indicate that the results of the laboratories concerned are wrong; it only suggests minor inconsistencies.

4. Evaluation of descriptive statistics and, if possible, taking into account the number of observations, the repeatability and reproducibility.

5. Evaluation of the assigned value.

6. The performance evaluation: The most significant outcome of the PT Program is the so-called z-score and 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 – $\checkmark$.

   • $2 \leq |z\text{-score}| < 3 \Rightarrow$ 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.

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3   Conclusions of the Statistical Analysis

The present report summarizes the results of the Proficiency Testing Program ZK 2022/1 (PT Program) organized by the PT Provider at the SZK FAST. 64 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.

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
6d687c	✓	✓	✓	✓	✓	✓	✓
4faf4d	**?**	✓	✓	✓	✓	✓	✓
ce221c	✓	✓	✓	✓	✓	✓	✓
d03349	✓	✓	✓	✓	✓	✓	✓
0bde87	✓	✓	✓	✓	✓	✓	✓
a7a3e5	✓	✓	✓	✓	✓	**?**	✓
a27013	✓	✓	✓	✓	✓	✓	✓
e5d49b	✓	✓	✓	✓	✓	✓	✓
53919c	✓	✓	✓	✓	✓	✓	✓
3ceee7	✓	**?**	**?**	✓	✓	✓	✓
5cab48	✓	✓	✓	✓	✓	✓	✓
8f3a62	✓	✓	✓	✓	✓	✓	✓
79bd98	✓	✓	✓	✓	✓	✓	✓
3f9c15	✓	✓	✓	✓	✓	✓	✓
ae859e	**?**	✓	✓	✓	✓	✓	✓
a259ca	✓	✓	✓	✓	✓	✓	✓
d4530f	✓	✓	✓	✓	✓	✓	✓
8c48c2	**?**	✓	✓	**?**	**?**	✓	✓
79536f	✓	✓	✓	✓	✓	✓	✓
c53a30	✓	✓	✓	✓	✓	✓	✓
18e860	✓	✓	✓	✓	✓	✓	✓
0be6c3	✓	✓	✓	✓	✓	✓	✓

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ID	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
7cfd58	✓	✓	✓	✓	✓	✓	✓
e64c92	✓	✓	✓	✓	✓	✓	✓
7346a5	✓	X	✓	✓	✓	✓	✓
278e12	✓	✓	✓	✓	✓	✓	✓
e7e3b2	✓	✓	✓	✓	✓	✓	✓
d96997	✓	✓	✓	✓	✓	✓	✓
58ed4e	✓	✓	✓	✓	✓	✓	✓
4f2532	✓	✓	✓	✓	✓	✓	✓
38a7ee	✓	✓	✓	✓	✓	✓	✓
4c70c6	✓	✓	?	✓	✓	✓	✓
500354	✓	✓	?	✓	X	?	?
3bc27f	✓	✓	✓	✓	✓	✓	✓
667101	✓	✓	✓	✓	✓	✓	✓

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
048532	-	-	-	-	-	✓	✓	-	-	-	-	-	-	✓	-	-	-	-
0bde87	✓	✓	-	-	✓	-	✓	✓	-	-	-	✓	-	-	-	-	-	-
0be6c3	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
18e860	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
1ce009	-	-	✓	✓	-	-	-	-	✓	-	✓	-	-	-	-	-	-	-
1e7fc1	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
228042	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
278e12	✓	-	✓	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-
2c58f4	-	✓	-	-	✓	-	✓	✓	-	-	✓	-	-	✓	-	-	-	-
38a7ee	✓	-	✓	-	-	-	-	-	✓	✓	✓	-	-	-	-	-	-	-
3bc27f	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ceee7	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
3f9c15	✓	✓	-	-	-	-	-	-	-	-	✓	-	-	✓	-	-	-	-
42b389	-	-	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
4c70c6	✓	-	-	-	-	-	-	-	-	?	-	-	-	-	-	-	-	-
4d51a8	-	-	-	-	✓	-	-	-	✓	-	-	✓	-	✓	-	-	-

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ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
4f2532	✓	-	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
4faf4d	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
500354	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53919c	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58ed4e	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5cab48	✓	-	-	-	✓	-	-	-	-	-	✓	-	-	✓	-	-	-	-
667101	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6d687c	✓	-	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
6f05cd	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-
7346a5	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
79536f	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
79bd98	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7b3306	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
7cfd58	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80076b	-	-	-	-	✓	-	-	✓	-	-	-	✓	-	-	✓	-	-	-
8267dd	-	-	✓	✓	-	✓	-	✓	-	✓	-	✓	-	-	X	-	-	-
82c914	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-
86714d	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8acb0f	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
8b4386	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8c48c2	✓	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8dbf83	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8f3a62	✓	-	✓	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-
9020c7	-	-	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
9b4b63	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
a259ca	✓	-	✓	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
a27013	✓	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
a5e1f6	-	-	-	-	-	✓	-	-	-	-	-	✓	-	-	-	-	-	-
a7a3e5	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	✓	-	-	✓	-	-	-
a9c83a	-	-	-	✓	-	-	✓	✓	-	-	-	✓	-	-	✓	-	-	-
ae859e	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b96536	-	-	-	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	-	-	-
ba9637	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
bc1df4	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
c53a30	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
c64ad2	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
c9969b	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

Continued on next page

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ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
ce221c	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d03349	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d4530f	✓	-	✓	-	-	-	-	✓	-	-	-	✓	-	-	-	-	-	-
d96997	✓	-	✓	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-
e5d49b	✓	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
e64c92	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
e7e3b2	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
ec14be	-	✓	✓	-	✓	-	-	✓	-	-	-	-	-	✓	-	-	-	-
eeb447	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
fbc95e	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
fe1b70	-	✓	✓	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-

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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 [%]
4faf4d	98.9	98.3	98.6	3.9	98.6	0.3	0.3
8c48c2	99.0	98.0	99.0	1.0	98.7	0.58	0.59
ae859e	99.0	99.0	98.0	0.3	98.7	0.58	0.59
58ed4e	98.5	98.9	98.8	0.6	98.7	0.21	0.21
53919c	98.6	99.1	98.5	2.0	98.7	0.32	0.33
4c70c6	99.2	99.1	98.2	1.0	98.8	0.55	0.56
e5d49b	98.7	99.2	98.6	0.8	98.8	0.32	0.33
667101	98.7	98.9	98.9	0.7	98.8	0.12	0.12
3bc27f	99.0	98.8	98.9	0.8	98.9	0.1	0.1
7346a5	98.9	98.9	99.0	7.5	98.9	0.06	0.06
79bd98	99.0	98.9	99.0	-	98.9	0.08	0.08
a7a3e5	99.1	98.9	99.0	3.3	99.0	0.1	0.1
38a7ee	99.0	99.0	99.0	0.1	99.0	0.0	0.0
4f2532	99.0	99.0	99.0	-	99.0	0.0	0.0
d03349	99.0	99.0	99.0	1.0	99.0	0.0	0.0
d96997	99.0	99.0	99.0	0.1	99.0	0.0	0.0
e7e3b2	99.0	99.0	99.0	0.2	99.0	0.0	0.0
278e12	99.0	99.0	99.0	2.3	99.0	0.0	0.0
e64c92	99.0	99.0	99.0	5.0	99.0	0.0	0.0
18e860	99.0	99.0	99.0	0.1	99.0	0.0	0.0
6d687c	99.0	99.0	99.0	2.0	99.0	0.0	0.0
d4530f	99.0	99.0	99.0	8.7	99.0	0.0	0.0
a259ca	99.0	99.0	99.0	0.1	99.0	0.0	0.0
8f3a62	99.0	98.9	99.1	5.9	99.0	0.1	0.1
5cab48	99.0	99.0	99.0	-	99.0	0.0	0.0
3ceee7	99.0	99.0	99.0	1.4	99.0	0.0	0.0
c53a30	99.0	99.0	99.0	0.1	99.0	0.0	0.0
0bde87	99.0	99.1	99.0	1.0	99.0	0.06	0.06
a27013	99.2	99.0	99.1	6.9	99.1	0.1	0.1
ce221c	99.1	99.1	99.1	0.6	99.1	0.0	0.0
7cfd58	99.0	99.1	99.2	2.0	99.1	0.1	0.1
3f9c15	99.1	99.0	99.2	-	99.1	0.1	0.1
0be6c3	99.1	99.2	99.0	2.5	99.1	0.08	0.08
79536f	99.1	99.1	99.2	0.2	99.1	0.06	0.06
500354	99.1	99.0	99.3	0.9	99.1	0.15	0.15

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1.1.2   The Numerical Procedure for Determining Outliers
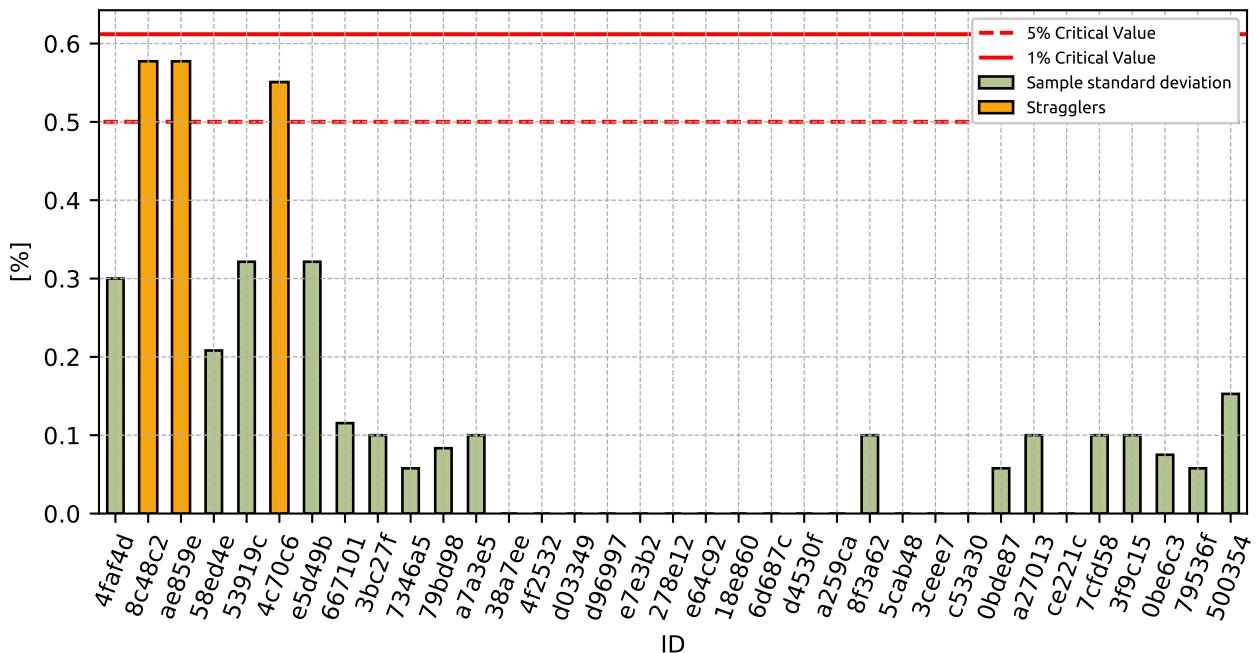
Figure 1: **Cochran's test** - sample standard deviations
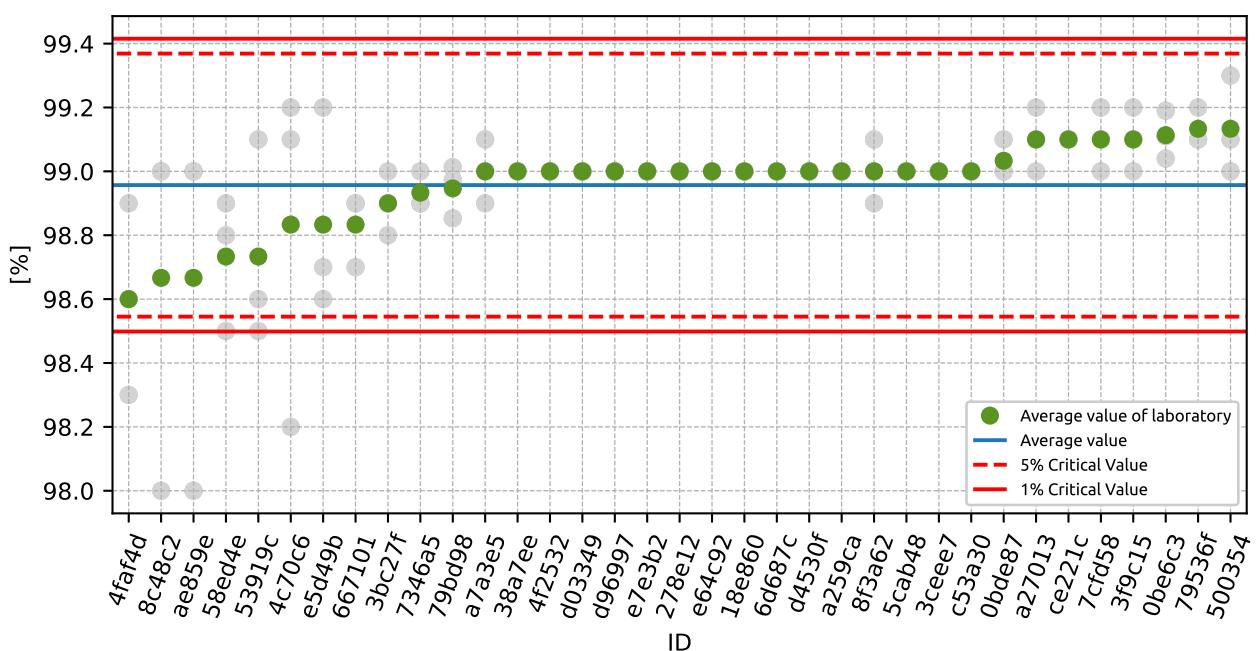
Figure 2: **Grubbs' test** - average values

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1.1.3   Mandelʼs Statistics
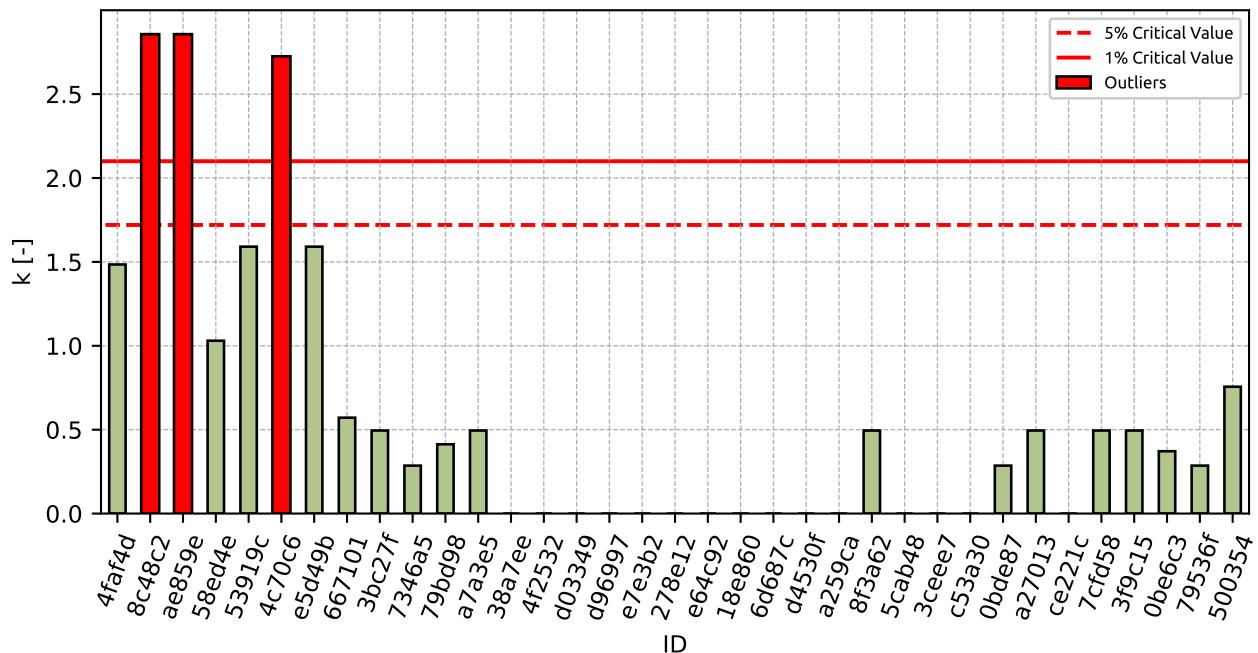
Figure 3: Intralaboratory Consistency Statistic
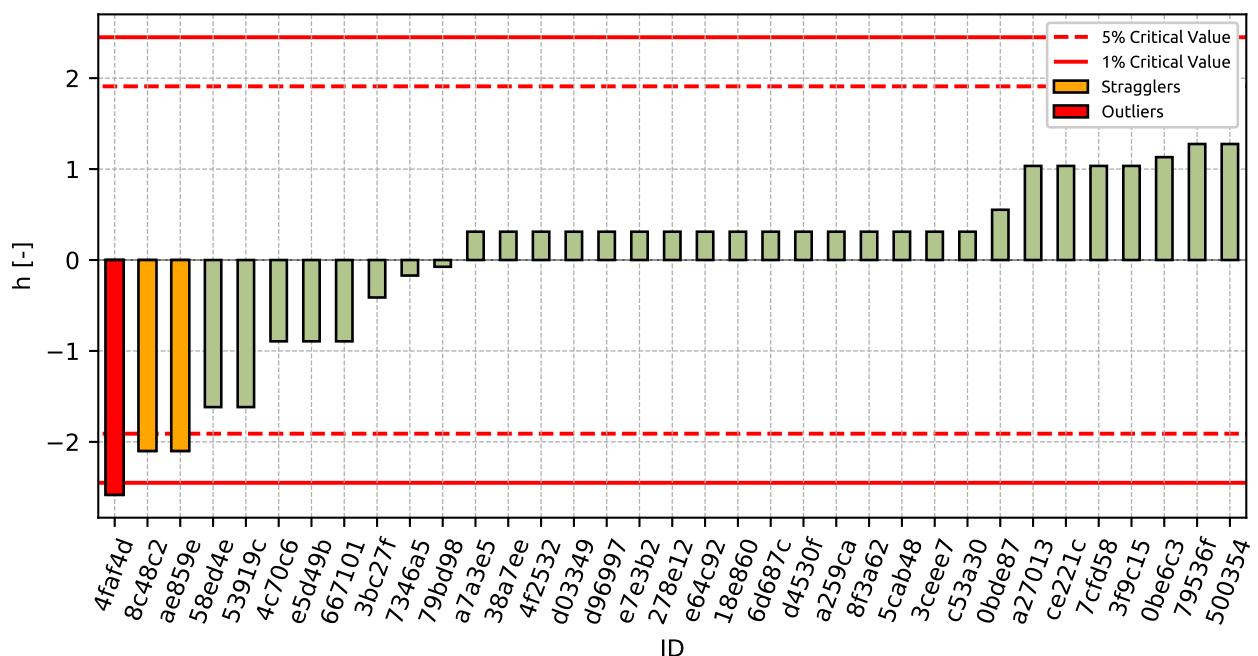
Figure 4: Interlaboratory Consistency Statistic

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1.1.4   Descriptive statistics
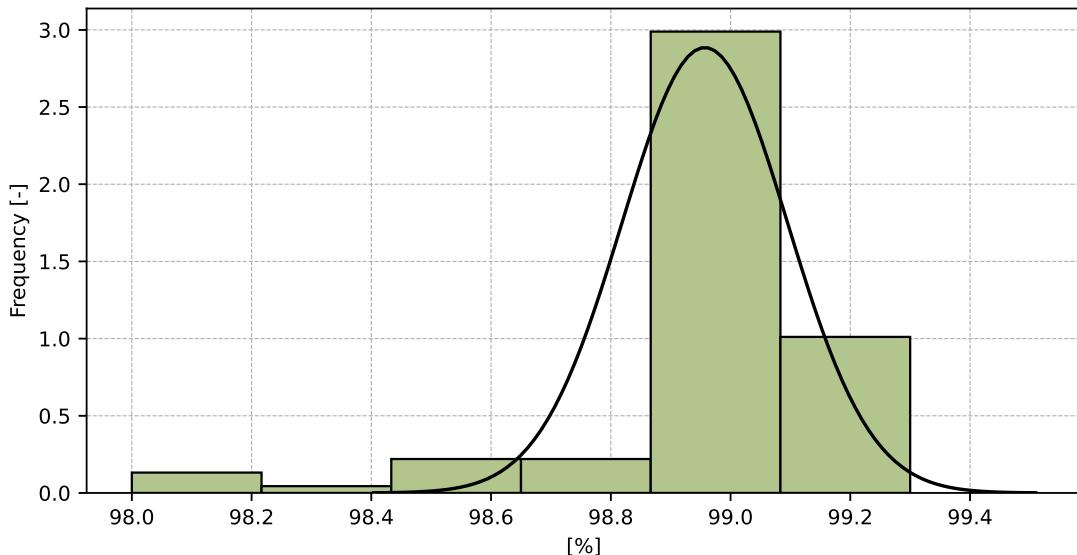
Figure 5: Histogram of all test results

Table 6: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	99.0
Sample standard deviation – s	0.14
Asigned value – x^*	99.0
Robust standard deviation – s^*	0.14
Measurement uncertainty of asigned value – u_X	0.02
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.07
Repeatability standard deviation – s_r	0.2
Reproducibility standard deviation – s_R	0.22
Repeatability – r	0.6
Reproducibility – R	0.6

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1.1.5   Evaluation of Performance Statistics
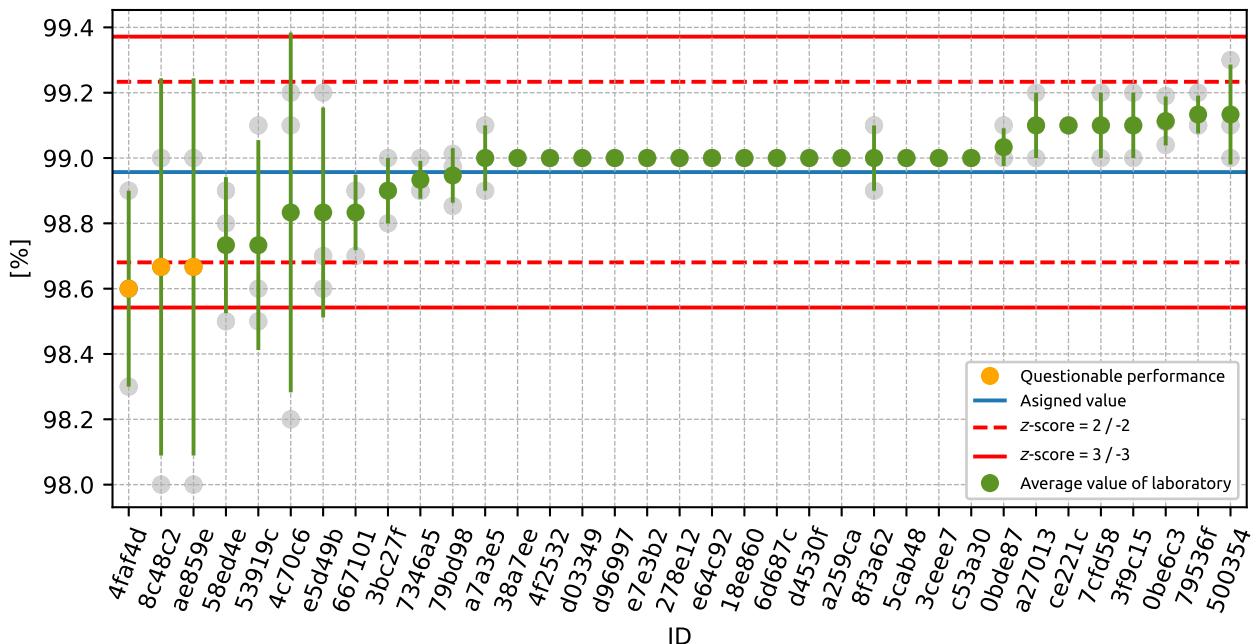
Figure 6: Average values and sample standard deviations
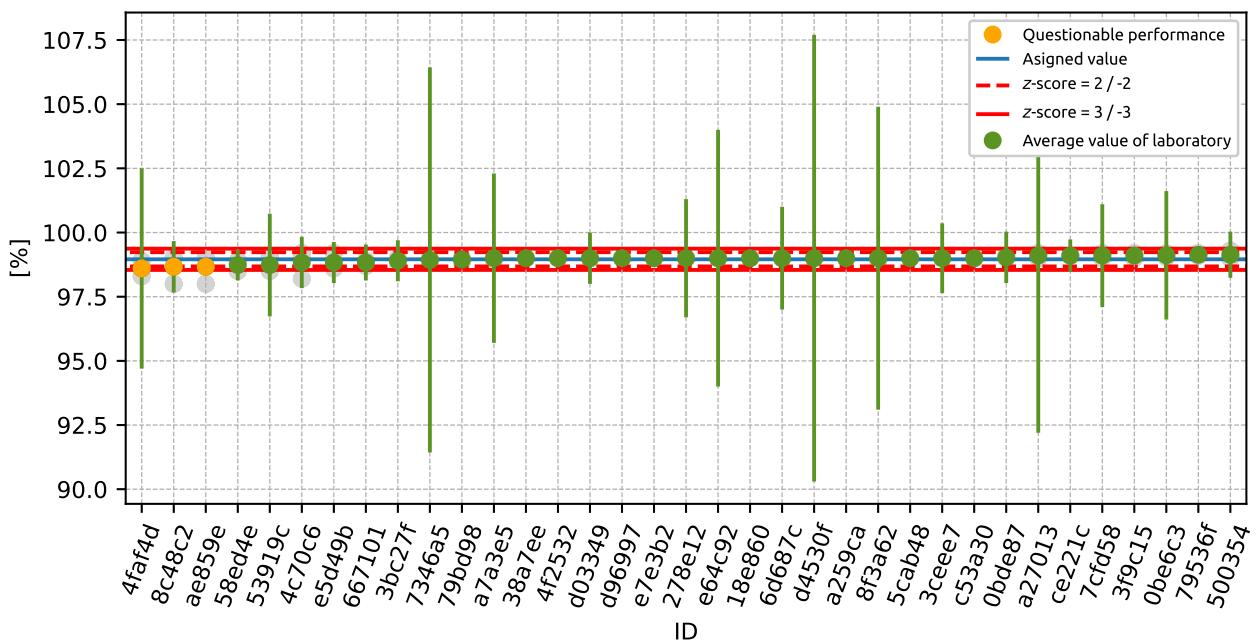
Figure 7: Average values and extended uncertainties of measurement

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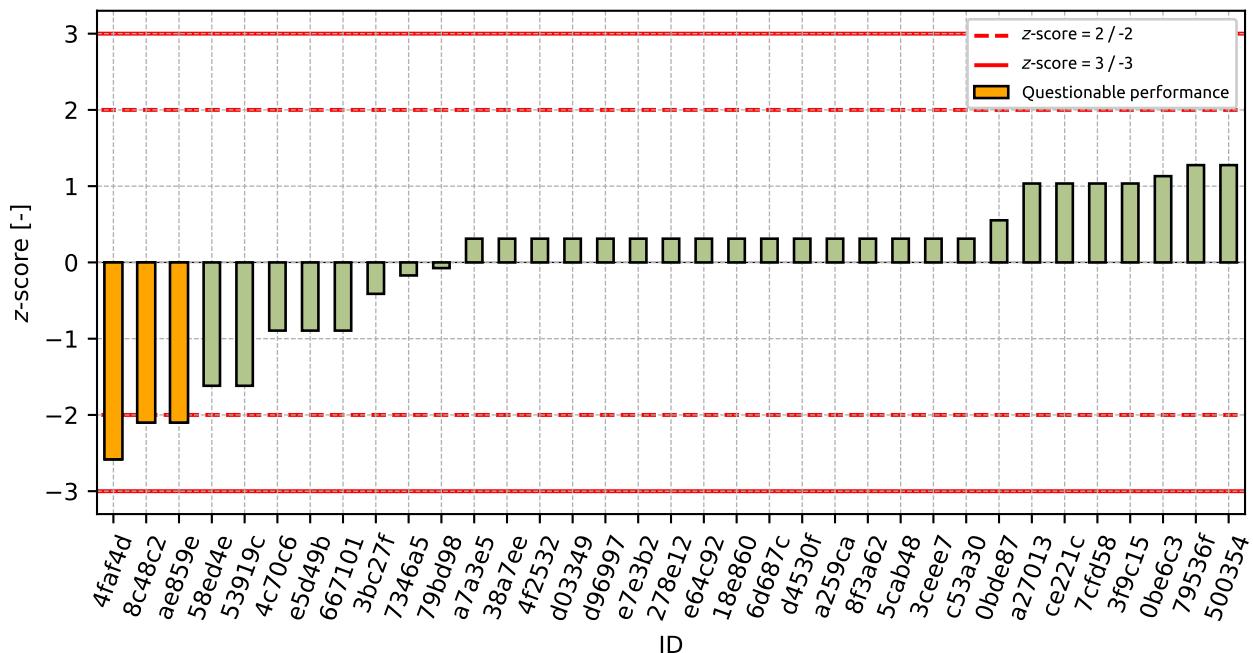
Figure 8: z-score

Figure 9: ζ-score

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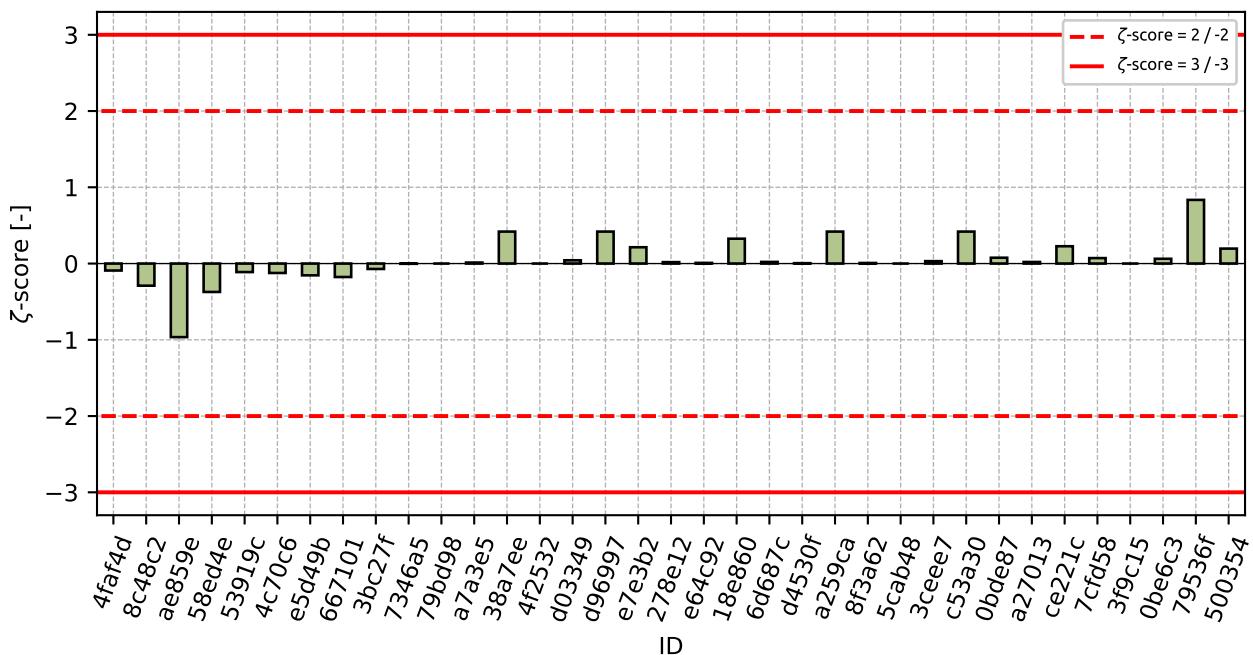
Table 7: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
4faf4d	-2.58	-0.09
8c48c2	-2.1	-0.29
ae859e	-2.1	-0.96
58ed4e	-1.62	-0.37
53919c	-1.62	-0.11
4c70c6	-0.89	-0.12
e5d49b	-0.89	-0.15
667101	-0.89	-0.18
3bc27f	-0.41	-0.07
7346a5	-0.17	-0.0
79bd98	-0.07	-
a7a3e5	0.31	0.01
38a7ee	0.31	0.42
4f2532	0.31	-
d03349	0.31	0.04
d96997	0.31	0.42
e7e3b2	0.31	0.21
278e12	0.31	0.02
e64c92	0.31	0.01
18e860	0.31	0.33
6d687c	0.31	0.02
d4530f	0.31	0.0
a259ca	0.31	0.42
8f3a62	0.31	0.01
5cab48	0.31	-
3ceee7	0.31	0.03
c53a30	0.31	0.42
0bde87	0.55	0.08
a27013	1.03	0.02
ce221c	1.03	0.23
7cfd58	1.03	0.07
3f9c15	1.03	-
0be6c3	1.13	0.06
79536f	1.28	0.83
500354	1.28	0.2

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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 [%]
e5d49b	84.3	84.4	84.6	0.8	84.4	0.15	0.18
4faf4d	84.4	84.1	84.8	3.3	84.4	0.35	0.42
ae859e	86.0	84.0	84.0	0.3	84.7	1.15	1.36
58ed4e	84.8	85.6	83.7	2.5	84.7	0.95	1.13
4c70c6	86.9	87.9	79.7	1.0	84.8	4.44	5.24
d03349	85.0	85.0	85.0	1.0	85.0	0.0	0.0
c53a30	85.0	85.0	85.0	0.1	85.0	0.0	0.0
e64c92	85.0	85.0	85.0	4.0	85.0	0.0	0.0
0bde87	85.6	84.9	84.6	1.0	85.0	0.51	0.6
79bd98	85.0	84.3	85.9	-	85.1	0.83	0.97
0be6c3	85.3	84.9	85.2	2.5	85.2	0.2	0.24
53919c	85.4	84.8	85.3	2.0	85.2	0.32	0.38
3bc27f	85.5	84.7	85.4	1.5	85.2	0.44	0.51
3f9c15	85.3	83.8	86.7	-	85.3	1.45	1.7
a259ca	86.0	85.0	85.0	0.1	85.3	0.58	0.68
278e12	86.0	85.0	85.0	1.7	85.3	0.58	0.68
6d687c	85.0	86.0	85.0	2.0	85.3	0.58	0.68
ce221c	85.4	85.5	85.4	0.8	85.4	0.06	0.07
667101	85.1	85.2	86.1	1.4	85.5	0.55	0.64
d4530f	86.0	85.0	86.0	8.7	85.7	0.58	0.67
d96997	86.0	86.0	85.0	0.2	85.7	0.58	0.67
4f2532	86.0	85.0	86.0	-	85.7	0.58	0.67
a27013	85.8	86.0	85.6	5.8	85.8	0.2	0.23
79536f	85.8	86.0	85.7	0.1	85.8	0.15	0.18
8f3a62	86.2	85.6	85.8	5.2	85.9	0.31	0.36
500354	86.2	85.1	86.6	0.8	86.0	0.78	0.9
18e860	86.0	86.0	86.0	0.1	86.0	0.0	0.0
e7e3b2	86.0	86.0	86.0	0.3	86.0	0.0	0.0
8c48c2	85.0	86.0	87.0	1.0	86.0	1.0	1.16
38a7ee	86.0	87.0	86.0	0.3	86.3	0.58	0.67
5cab48	86.0	88.0	86.0	-	86.7	1.15	1.33
7cfd58	86.8	87.1	87.8	2.0	87.2	0.51	0.59
a7a3e5	86.8	88.0	87.3	3.3	87.4	0.6	0.69
3ceee7	89.0	88.0	87.0	1.4	88.0	1.0	1.14
7346a5	89.9	89.0	88.9	6.7	89.3	0.55	0.62

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1.2.2   The Numerical Procedure for Determining Outliers
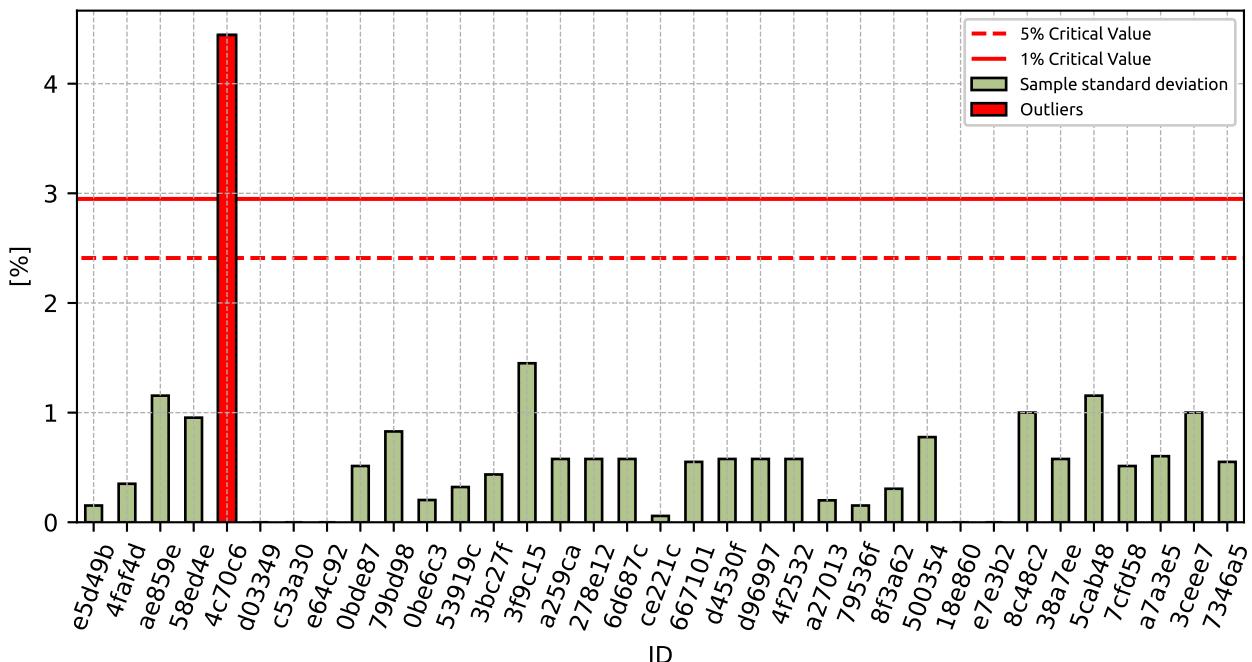
Figure 10: **Cochran's test** - sample standard deviations
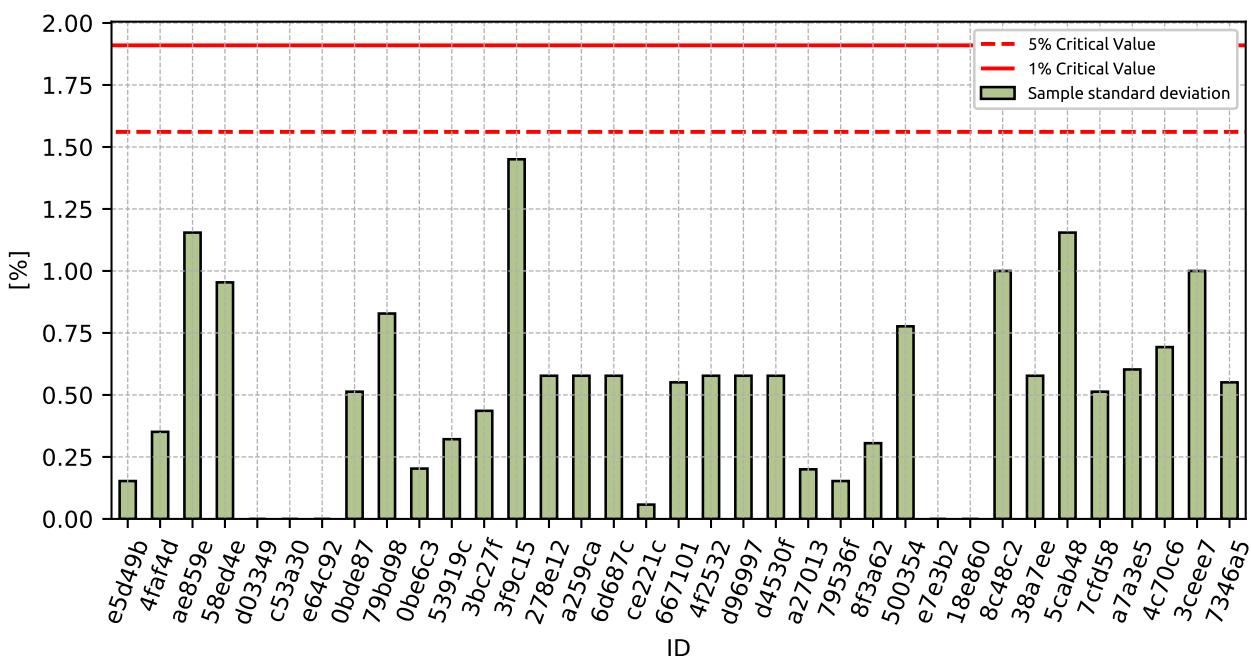
Figure 11: **Cochran's test** - sample standard deviations without outliers

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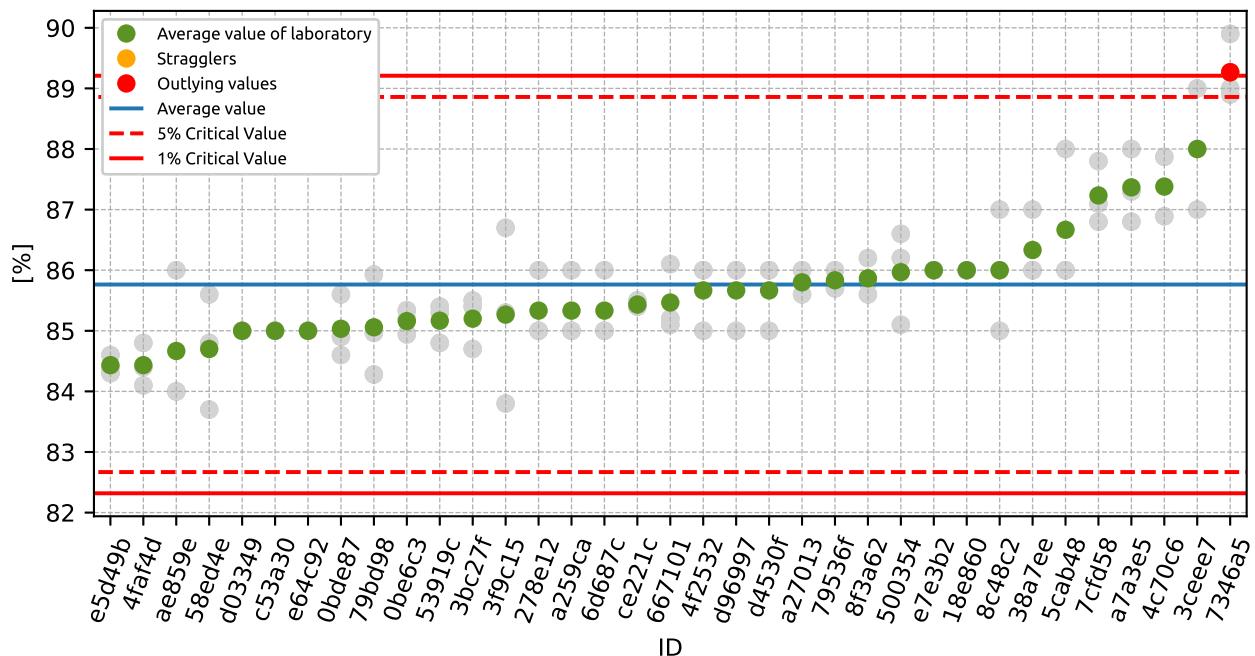
Figure 12: **Grubbs' test** - average values
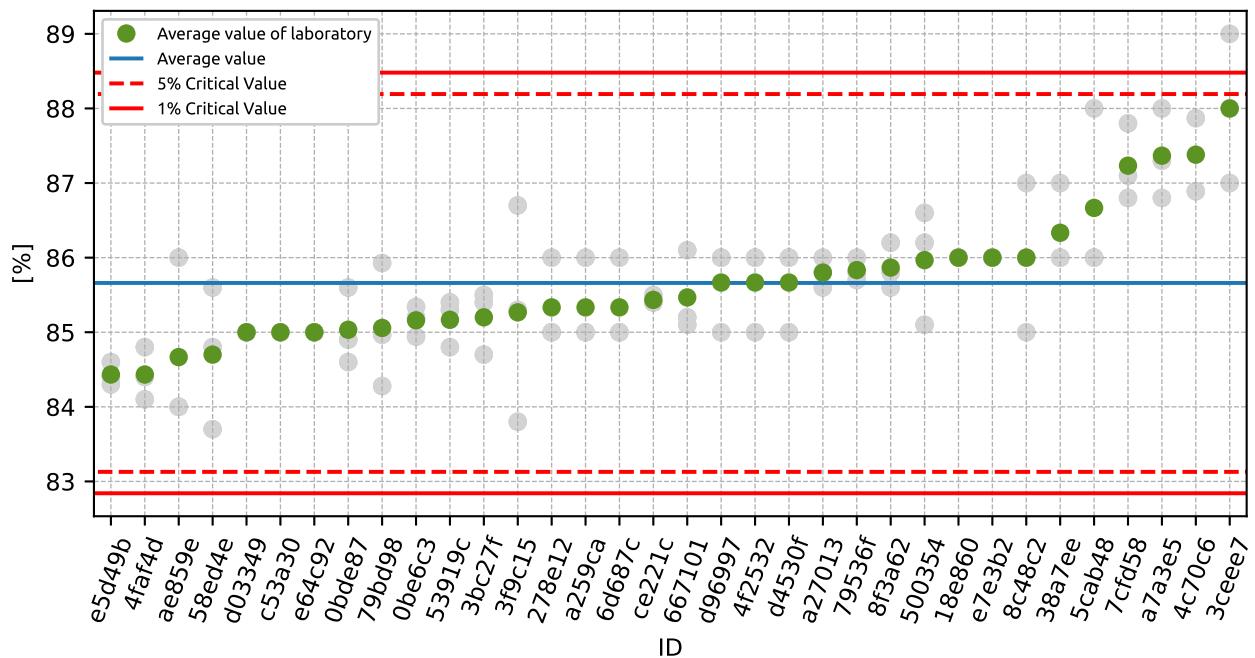
Figure 13: **Grubbs' test** - average values without outliers

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1.2.3   Mandel′s Statistics
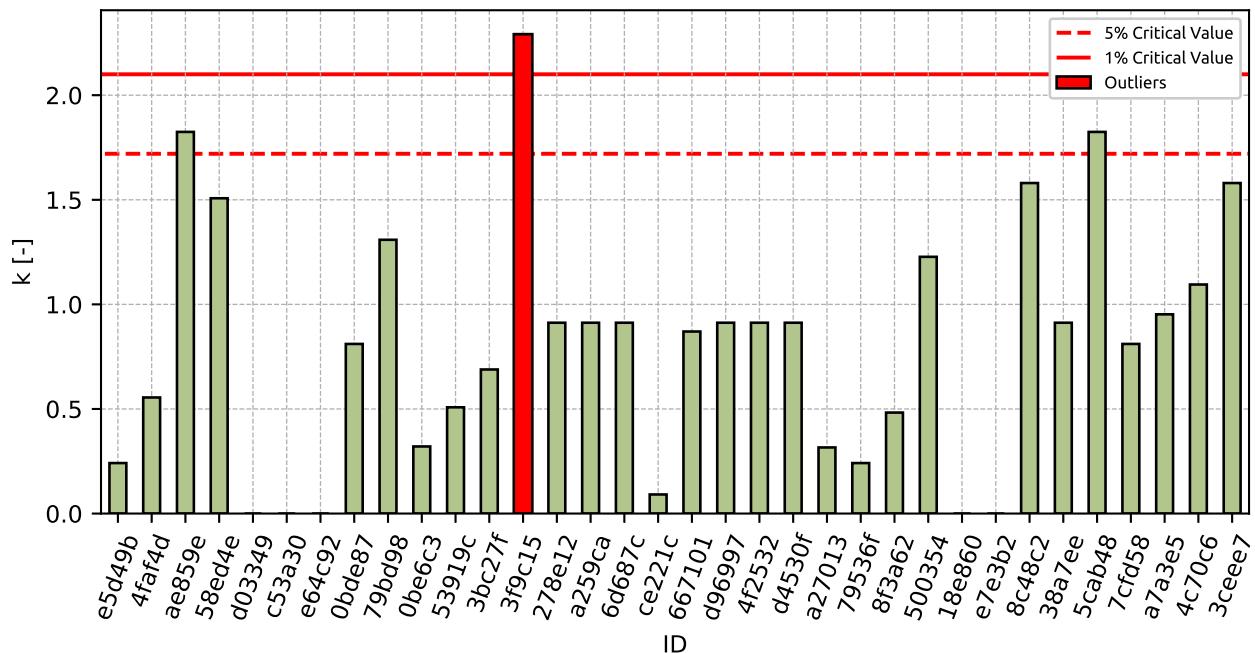
Figure 14: Intralaboratory Consistency Statistic
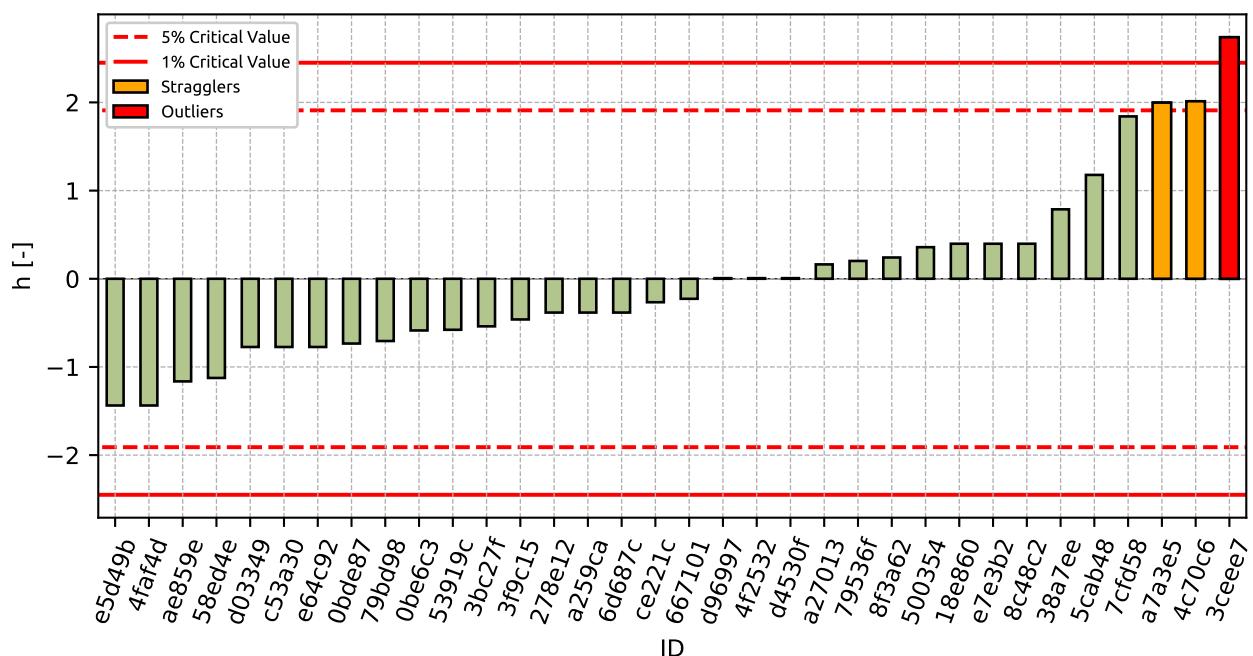
Figure 15: Interlaboratory Consistency Statistic

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1.2.4 Descriptive statistics
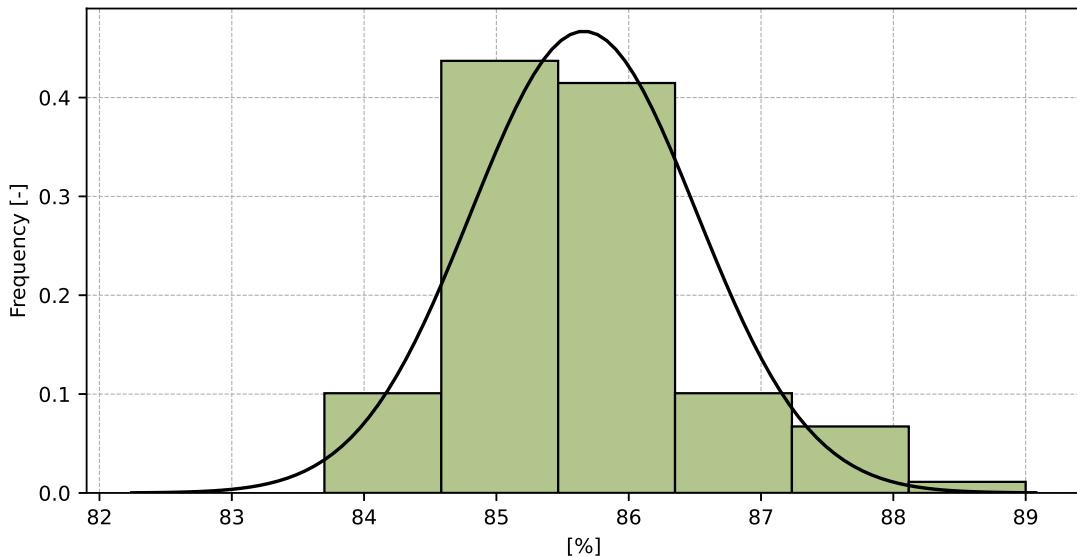
Figure 16: Histogram of all test results

Table 9: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	85.7
Sample standard deviation – s	0.85
Asigned value – x^*	85.7
Robust standard deviation – s^*	0.85
Measurement uncertainty of asigned value – u_X	0.15
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	0.77
Repeatability standard deviation – s_r	0.63
Reproducibility standard deviation – s_R	1.0
Repeatability – r	1.8
Reproducibility – R	2.8

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1.2.5   Evaluation of Performance Statistics
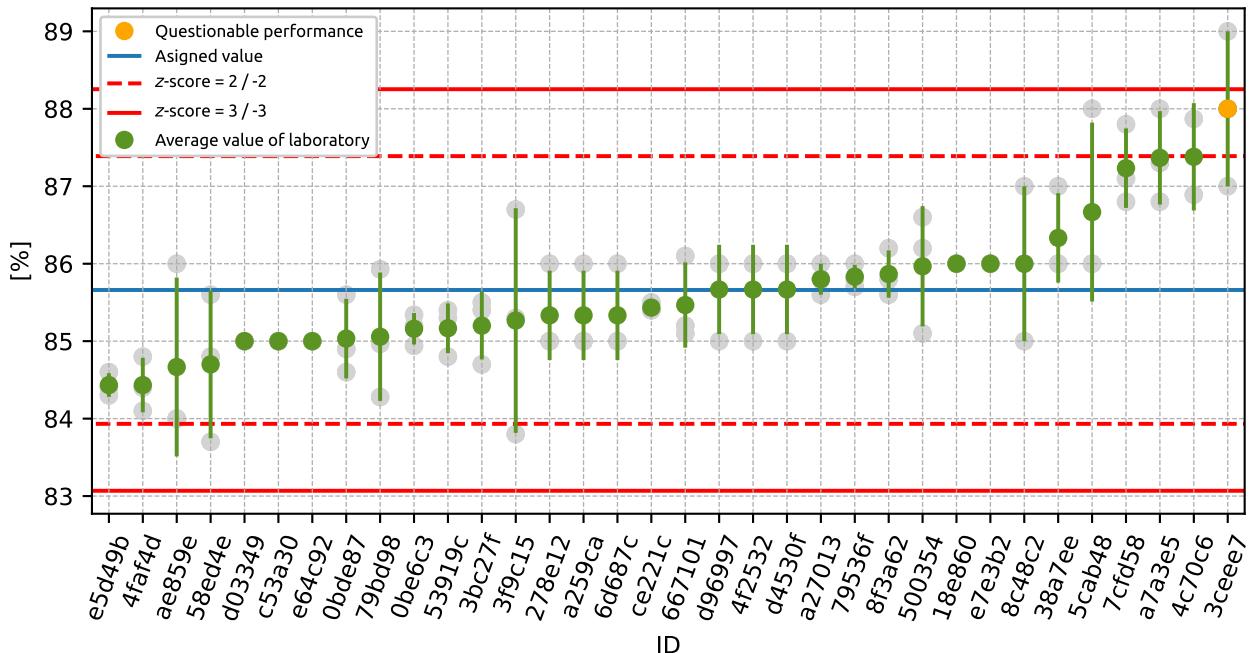
Figure 17: Average values and sample standard deviations
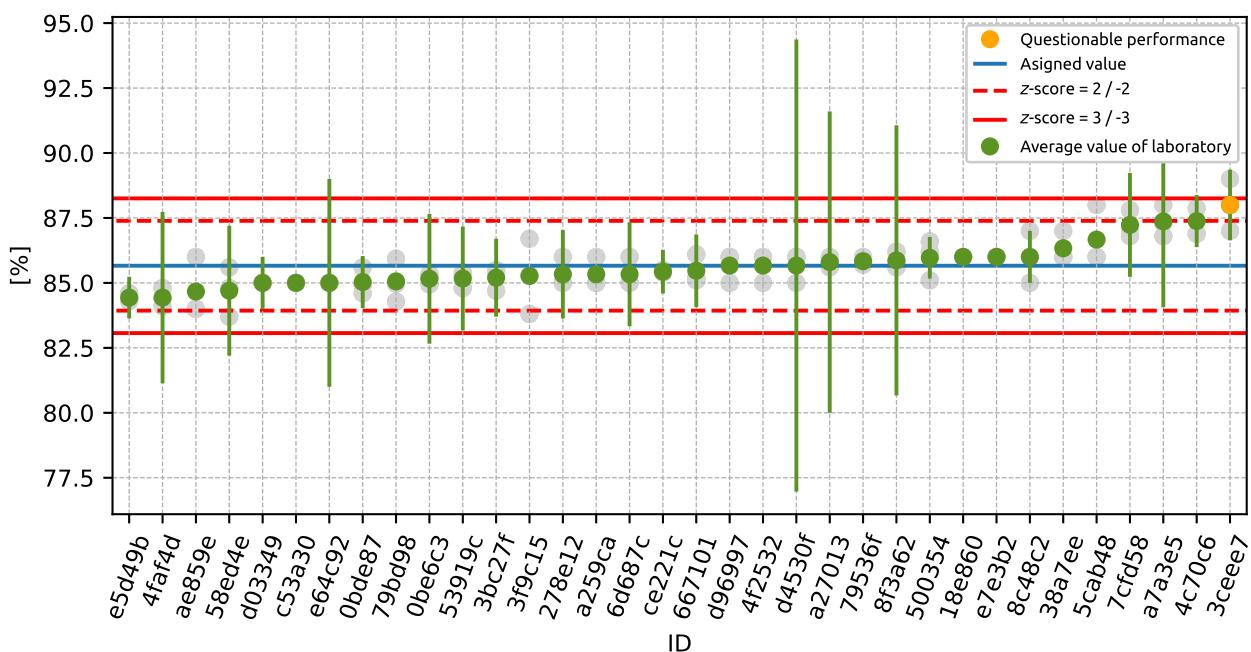
Figure 18: Average values and extended uncertainties of measurement

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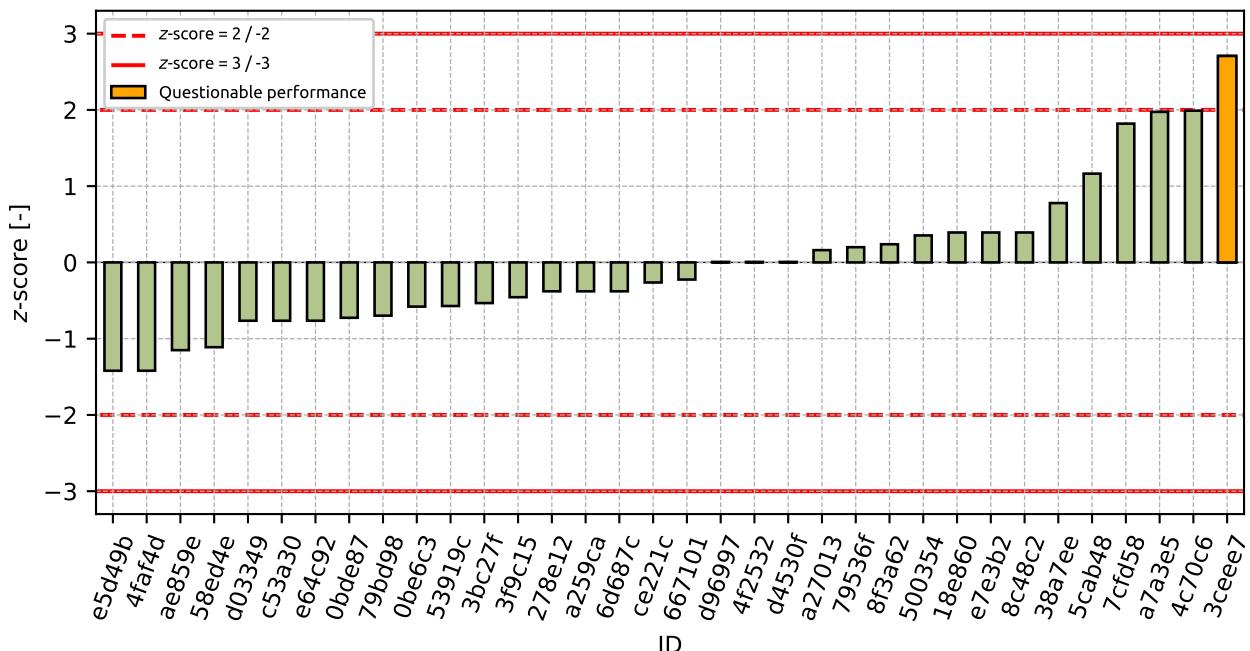
Figure 19: z-score

Figure 20: ζ-score

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Table 10: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
e5d49b	-1.42	-1.51
4faf4d	-1.42	-0.37
ae859e	-1.15	-2.97
58ed4e	-1.11	-0.38
d03349	-0.76	-0.65
c53a30	-0.76	-3.7
e64c92	-0.76	-0.17
0bde87	-0.73	-0.62
79bd98	-0.7	-
0be6c3	-0.58	-0.2
53919c	-0.57	-0.25
3bc27f	-0.53	-0.31
3f9c15	-0.46	-
278e12	-0.38	-0.19
a259ca	-0.38	-1.83
6d687c	-0.38	-0.16
ce221c	-0.26	-0.27
667101	-0.22	-0.14
d96997	0.01	0.02
4f2532	0.01	-
d4530f	0.01	0.0
a27013	0.16	0.02
79536f	0.2	0.94
8f3a62	0.24	0.04
500354	0.35	0.38
18e860	0.39	1.72
e7e3b2	0.39	1.01
8c48c2	0.39	0.34
38a7ee	0.78	2.01
5cab48	1.16	-
7cfd58	1.82	0.78
a7a3e5	1.97	0.52
4c70c6	1.99	1.7
3ceee7	2.71	1.71

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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 [%]
58ed4e	55.9	57.9	55.4	1.5	56.4	1.32	2.35
53919c	56.4	56.7	56.4	2.0	56.5	0.17	0.31
3bc27f	58.5	53.9	58.5	1.5	57.0	2.66	4.66
e64c92	57.0	57.0	57.0	3.0	57.0	0.0	0.0
0bde87	57.1	56.8	57.4	1.0	57.1	0.3	0.53
0be6c3	57.6	57.4	57.5	2.5	57.5	0.1	0.18
4faf4d	57.7	57.3	57.6	2.3	57.5	0.21	0.36
4c70c6	60.5	62.6	50.8	1.0	58.0	6.29	10.86
8c48c2	58.0	60.0	56.0	1.0	58.0	2.0	3.45
d03349	58.0	58.0	58.0	1.0	58.0	0.0	0.0
278e12	58.0	58.0	58.0	1.4	58.0	0.0	0.0
d4530f	58.0	58.0	58.0	8.7	58.0	0.0	0.0
a7a3e5	57.6	58.4	58.1	3.3	58.0	0.4	0.7
e5d49b	57.7	57.9	58.5	0.8	58.0	0.42	0.72
667101	56.1	58.6	59.8	1.5	58.2	1.89	3.25
7346a5	58.5	58.1	58.0	4.4	58.2	0.26	0.45
ce221c	58.2	58.2	58.2	1.0	58.2	0.0	0.0
8f3a62	58.6	58.1	58.0	3.5	58.2	0.32	0.55
ae859e	60.0	57.0	58.0	0.3	58.3	1.53	2.62
79536f	58.4	58.7	58.3	0.2	58.5	0.21	0.36
79bd98	58.4	57.4	60.0	-	58.6	1.33	2.27
4f2532	59.0	58.0	59.0	-	58.7	0.58	0.98
a259ca	59.0	58.0	59.0	0.1	58.7	0.58	0.98
c53a30	59.0	59.0	58.0	0.1	58.7	0.58	0.98
6d687c	59.0	59.0	58.0	2.0	58.7	0.58	0.98
5cab48	59.0	62.0	56.0	-	59.0	3.0	5.08
e7e3b2	59.0	59.0	59.0	0.4	59.0	0.0	0.0
38a7ee	59.0	59.0	59.0	0.1	59.0	0.0	0.0
3f9c15	58.5	57.5	61.1	-	59.0	1.86	3.15
a27013	58.4	58.9	59.9	3.7	59.1	0.76	1.29
18e860	59.0	59.0	60.0	0.1	59.3	0.58	0.97
d96997	59.0	60.0	59.0	0.3	59.3	0.58	0.97
7cfd58	60.1	60.8	60.3	2.0	60.4	0.36	0.6
3ceee7	63.0	62.0	60.0	1.4	61.7	1.53	2.48
500354	62.8	62.0	62.8	0.4	62.5	0.46	0.74

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1.3.2   The Numerical Procedure for Determining Outliers
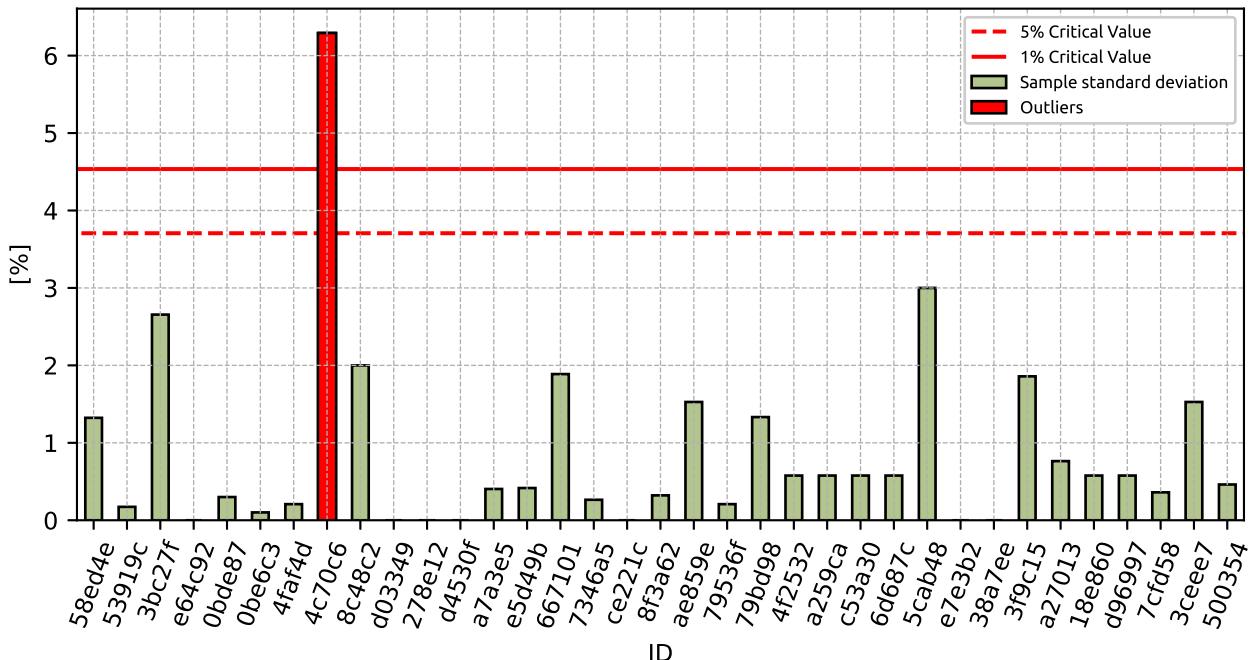
Figure 21: **Cochran's test** - sample standard deviations
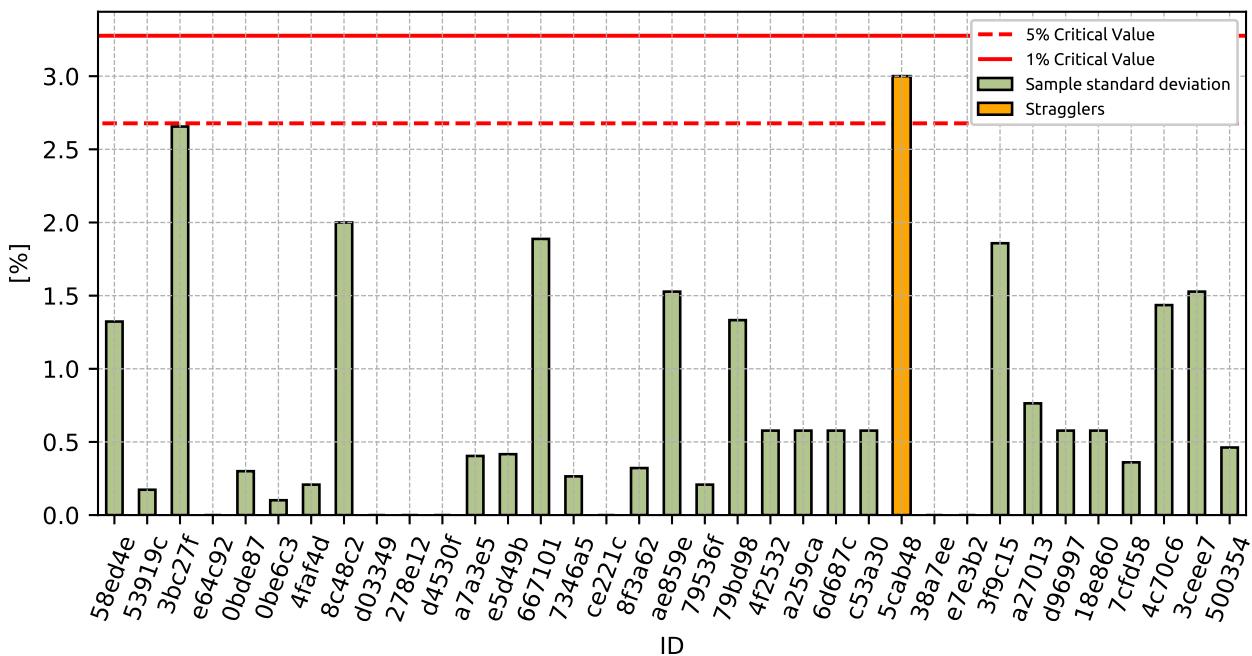
Figure 22: **Cochran's test** - sample standard deviations without outliers

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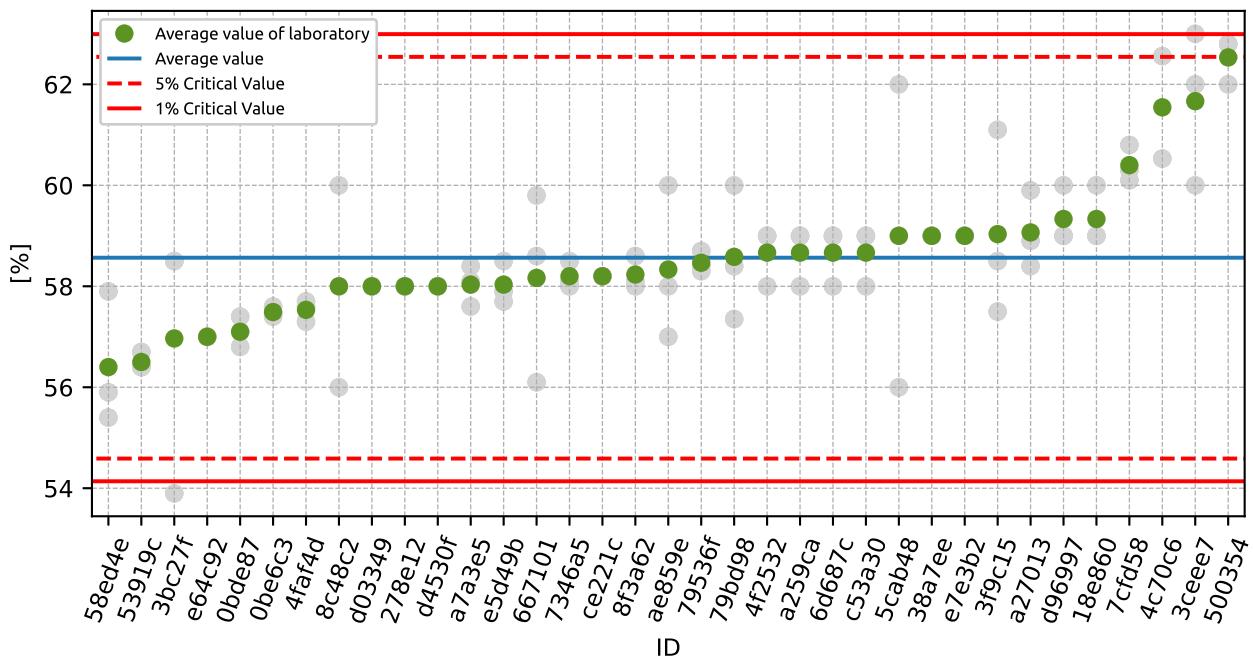
Figure 23: **Grubbs' test** - average values

1.3.3 Mandel's Statistics
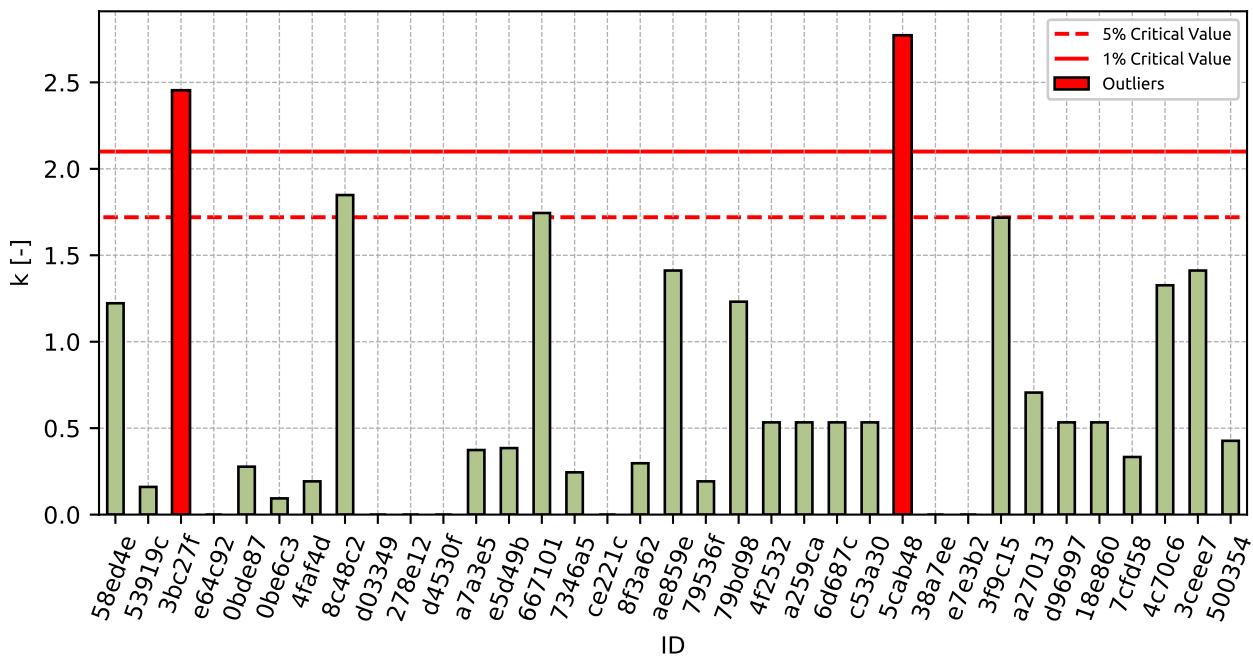
Figure 24: Intralaboratory Consistency Statistic

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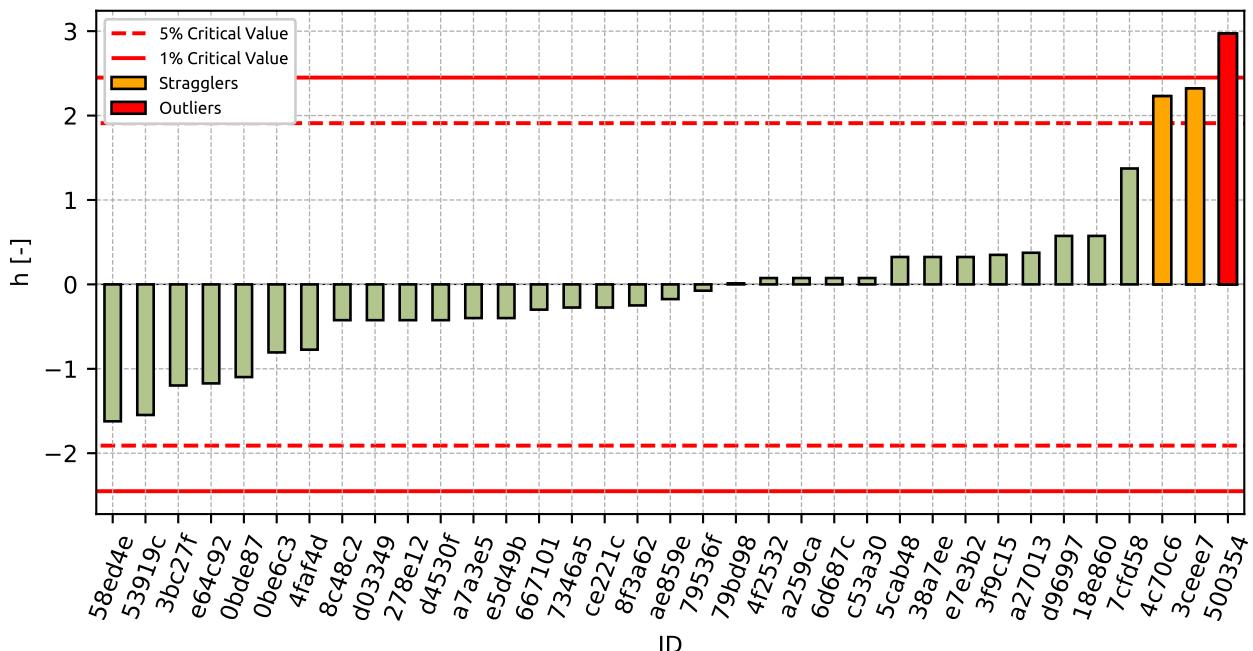
Figure 25: Interlaboratory Consistency Statistic

1.3.4 Descriptive statistics
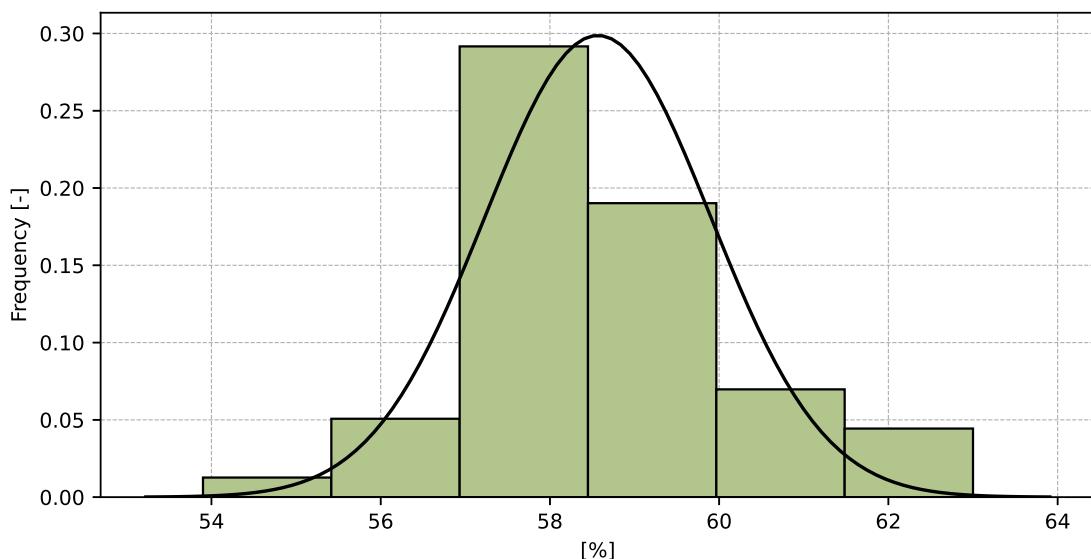
Figure 26: Histogram of all test results

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Table 12: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	58.6
Sample standard deviation – s	1.34
Asigned value – x^*	58.6
Robust standard deviation – s^*	1.34
Measurement uncertainty of asigned value – u_X	0.23
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	1.18
Repeatability standard deviation – s_r	1.08
Reproducibility standard deviation – s_R	1.6
Repeatability – r	3.0
Reproducibility – R	4.5

1.3.5 Evaluation of Performance Statistics
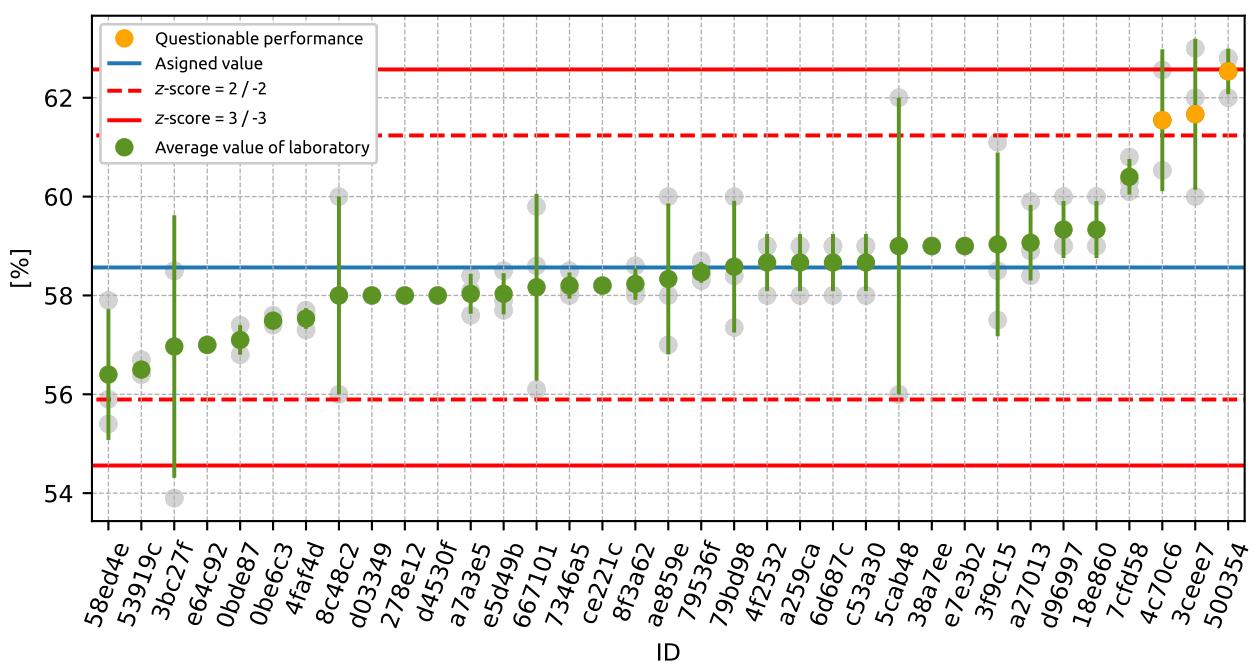
Figure 27: Average values and sample standard deviations

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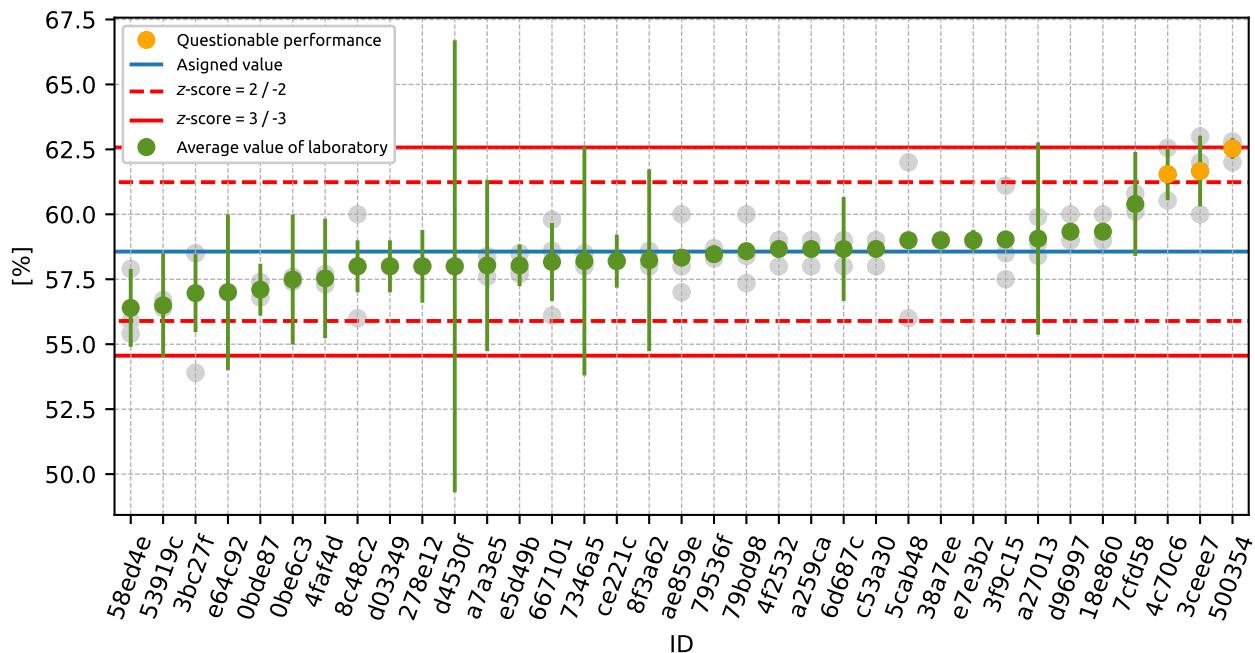
Figure 28: Average values and extended uncertainties of measurement

Figure 29: z-score

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Figure 30: ζ-score

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Table 13: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
58ed4e	-1.62	-1.43
53919c	-1.55	-1.03
3bc27f	-1.2	-1.05
e64c92	-1.17	-0.52
0bde87	-1.1	-1.43
0be6c3	-0.81	-0.43
4faf4d	-0.77	-0.45
8c48c2	-0.42	-0.55
d03349	-0.42	-0.55
278e12	-0.42	-0.4
d4530f	-0.42	-0.07
a7a3e5	-0.4	-0.16
e5d49b	-0.4	-0.64
667101	-0.3	-0.26
7346a5	-0.27	-0.08
ce221c	-0.27	-0.35
8f3a62	-0.25	-0.09
ae859e	-0.17	-0.62
79536f	-0.07	-0.31
79bd98	0.01	-
4f2532	0.08	-
a259ca	0.08	0.41
6d687c	0.08	0.05
c53a30	0.08	0.41
5cab48	0.32	-
38a7ee	0.32	1.76
e7e3b2	0.32	0.94
3f9c15	0.35	-
a27013	0.37	0.14
d96997	0.57	2.04
18e860	0.57	2.94
7cfd58	1.37	0.91
4c70c6	2.23	2.91
3ceee7	2.32	2.25
500354	2.97	8.64

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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 [%]
8c48c2	27.0	28.0	26.0	1.0	27.0	1.0	3.7
79bd98	28.6	26.9	29.0	-	28.1	1.09	3.88
3bc27f	28.9	28.3	28.2	1.1	28.5	0.38	1.33
278e12	29.0	29.0	28.0	0.7	28.7	0.58	2.01
e64c92	29.0	29.0	29.0	1.5	29.0	0.0	0.0
58ed4e	29.3	30.0	29.0	2.3	29.4	0.51	1.74
ae859e	31.0	29.0	29.0	0.3	29.7	1.15	3.89
0bde87	30.0	29.3	30.0	1.0	29.8	0.4	1.36
53919c	29.6	30.1	29.7	2.0	29.8	0.26	0.89
79536f	30.0	30.0	29.8	0.1	29.9	0.12	0.39
4c70c6	31.8	33.2	24.9	1.0	30.0	4.42	14.74
d03349	30.0	30.0	30.0	1.0	30.0	0.0	0.0
c53a30	30.0	30.0	30.0	0.1	30.0	0.0	0.0
d4530f	30.0	30.0	30.0	8.7	30.0	0.0	0.0
ce221c	30.1	30.1	30.1	0.9	30.1	0.0	0.0
7346a5	30.3	30.2	30.0	2.2	30.2	0.15	0.51
4faf4d	30.4	30.0	30.1	1.2	30.2	0.21	0.69
667101	29.2	30.4	31.0	1.2	30.2	0.92	3.03
3f9c15	29.4	29.6	31.8	-	30.3	1.33	4.4
a259ca	31.0	30.0	30.0	0.1	30.3	0.58	1.9
5cab48	31.0	33.0	27.0	-	30.3	3.06	10.07
0be6c3	30.7	30.5	30.4	2.5	30.5	0.14	0.47
4f2532	31.0	30.0	31.0	-	30.7	0.58	1.88
d96997	31.0	31.0	30.0	0.3	30.7	0.58	1.88
e7e3b2	31.0	31.0	30.0	0.4	30.7	0.58	1.88
6d687c	30.0	31.0	31.0	2.0	30.7	0.58	1.88
8f3a62	31.0	30.7	30.9	1.9	30.9	0.15	0.49
a27013	30.6	30.8	31.3	1.9	30.9	0.36	1.17
7cfd58	31.1	30.7	31.1	2.0	31.0	0.23	0.75
38a7ee	31.0	31.0	31.0	0.1	31.0	0.0	0.0
e5d49b	31.2	30.7	31.2	0.8	31.0	0.29	0.93
a7a3e5	30.8	31.1	31.3	3.3	31.1	0.25	0.81
500354	31.0	31.0	31.5	0.6	31.2	0.29	0.93
18e860	32.0	31.0	31.0	0.1	31.3	0.58	1.84
3ceee7	33.0	33.0	30.0	1.4	32.0	1.73	5.41

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1.4.2   The Numerical Procedure for Determining Outliers
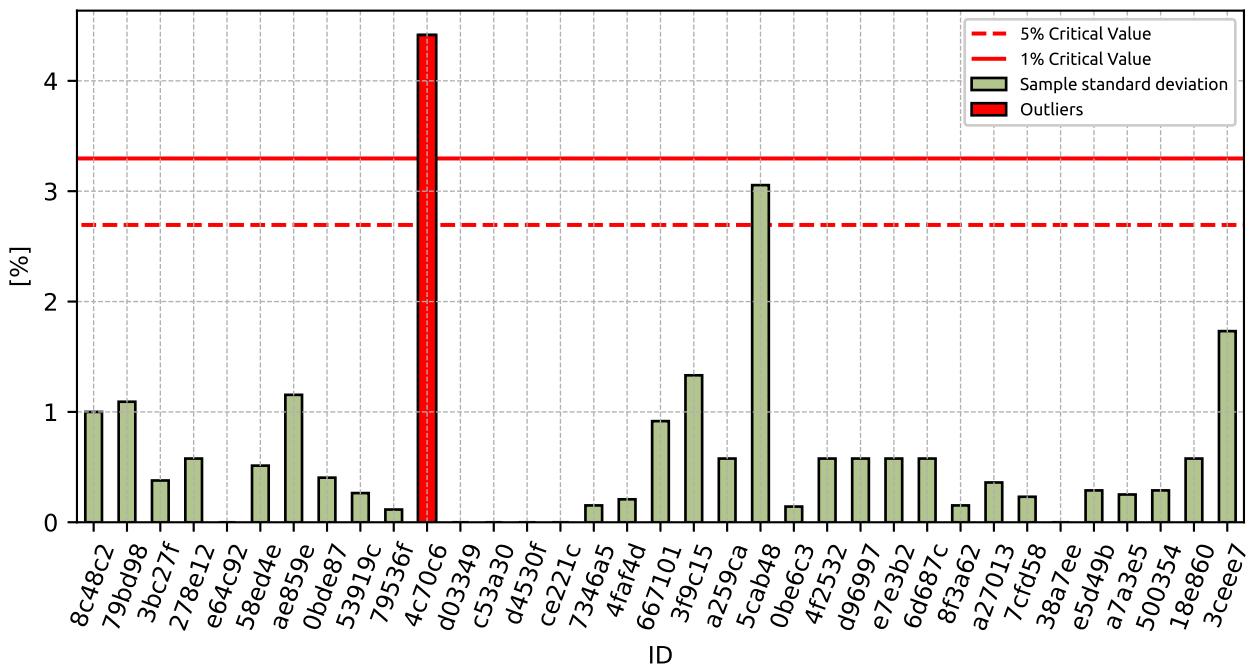
Figure 31: **Cochran's test** - sample standard deviations
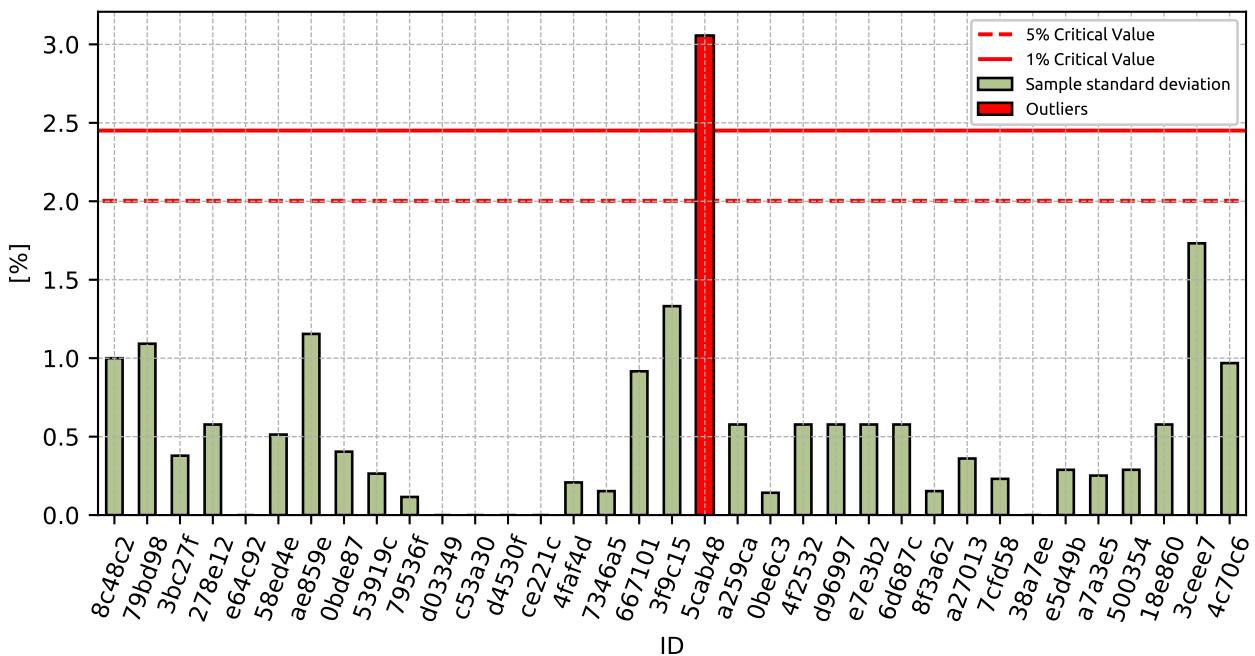
Figure 32: **Cochran's test** - sample standard deviations without outliers

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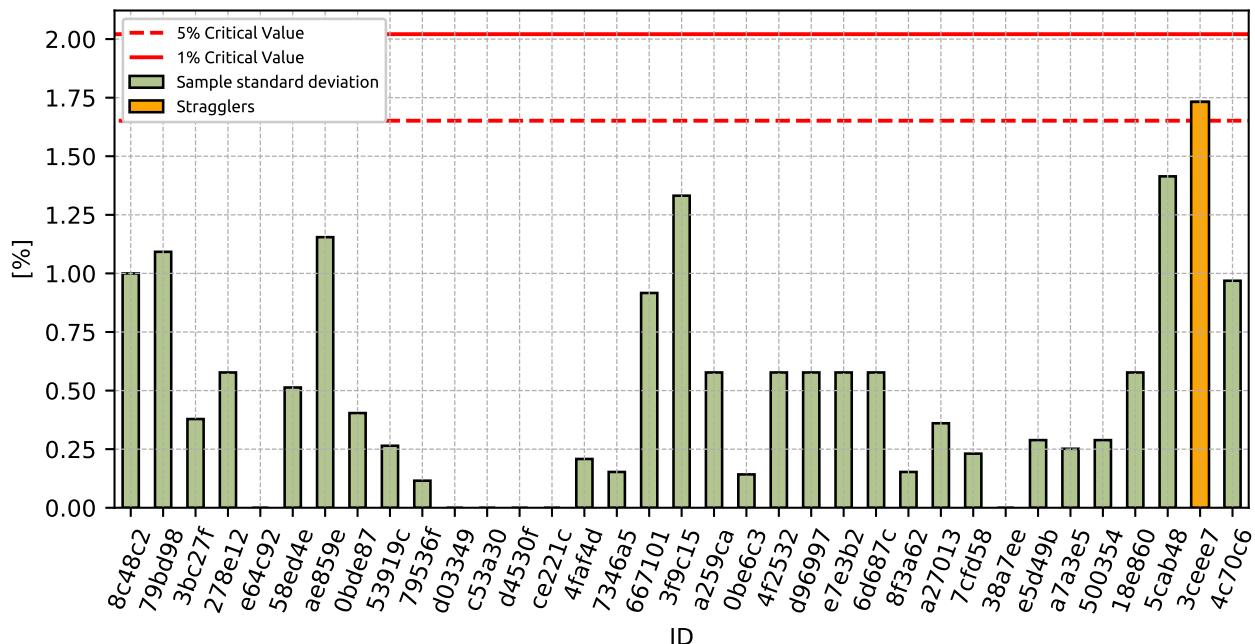
Figure 33: **Cochran's test** - sample standard deviations without outliers
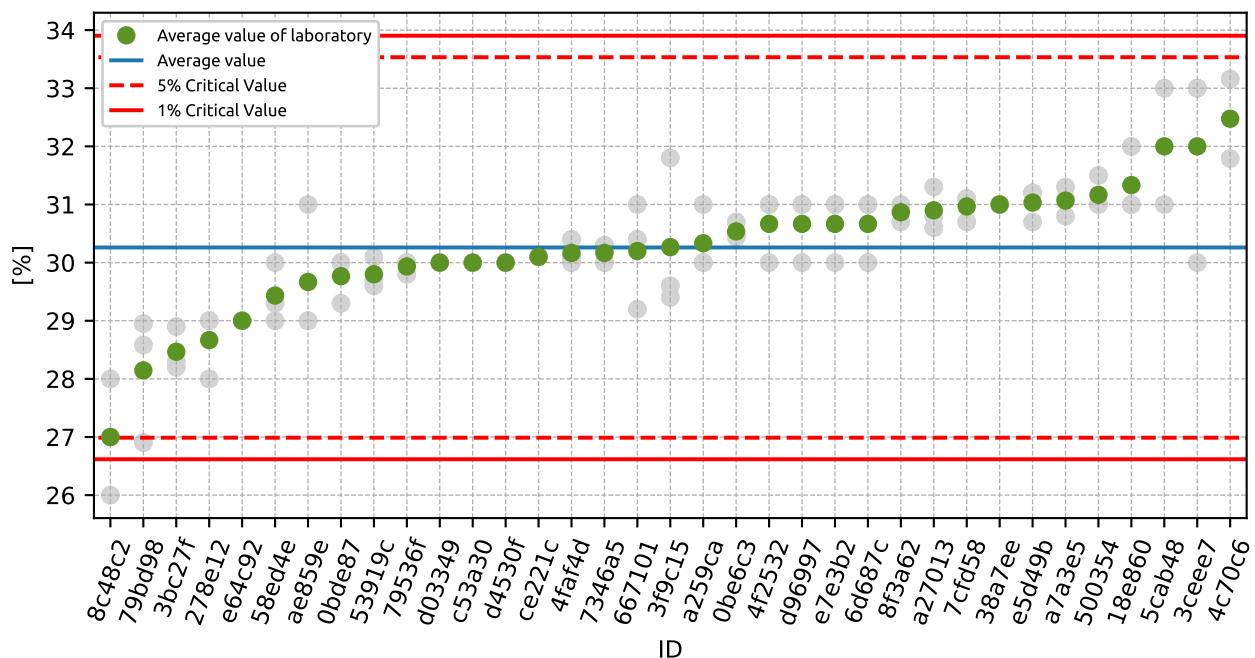
Figure 34: **Grubbs' test** - average values

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1.4.3 Mandel's Statistics
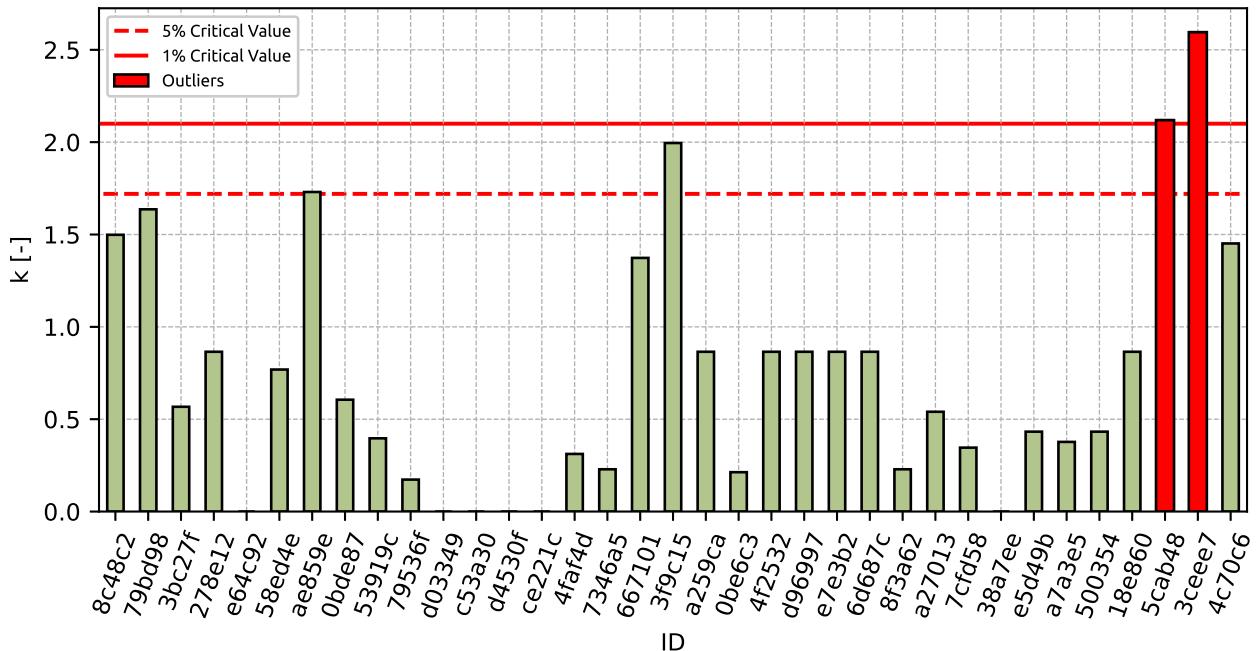
Figure 35: Intralaboratory Consistency Statistic
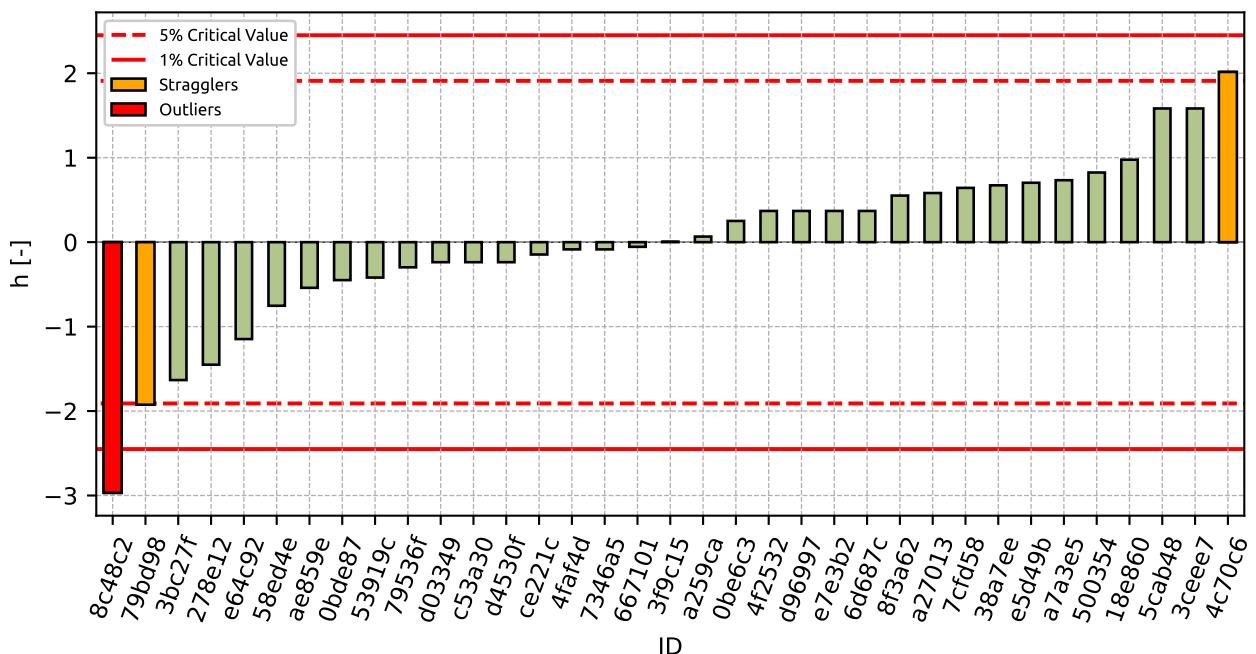
Figure 36: Interlaboratory Consistency Statistic

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1.4.4   Descriptive statistics
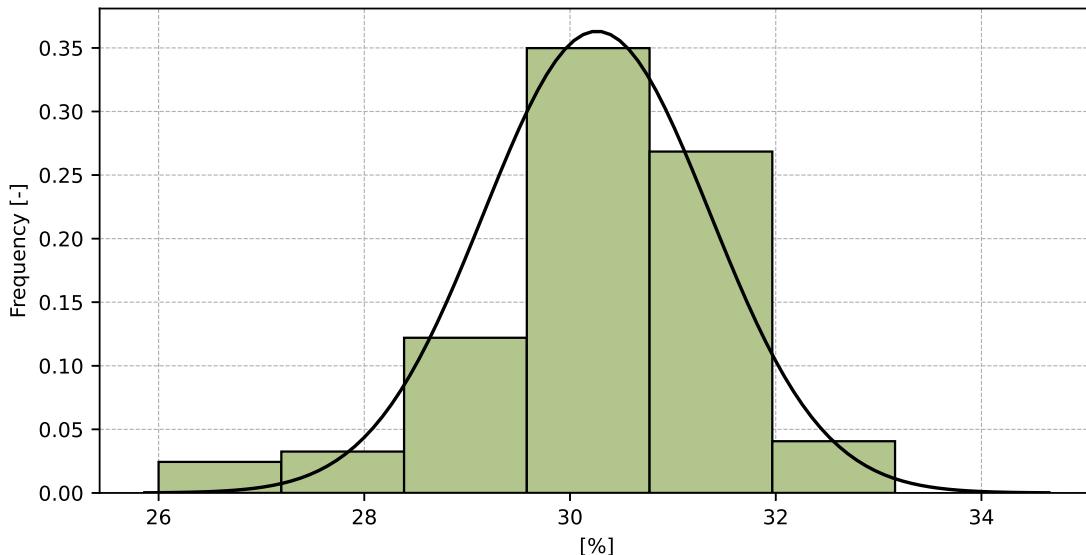
Figure 37: Histogram of all test results

Table 15: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	30.3
Sample standard deviation – s	1.1
Asigned value – x^*	30.3
Robust standard deviation – s^*	1.1
Measurement uncertainty of asigned value – u_X	0.19
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	1.03
Repeatability standard deviation – s_r	0.67
Reproducibility standard deviation – s_R	1.23
Repeatability – r	1.9
Reproducibility – R	3.4

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1.4.5   Evaluation of Performance Statistics
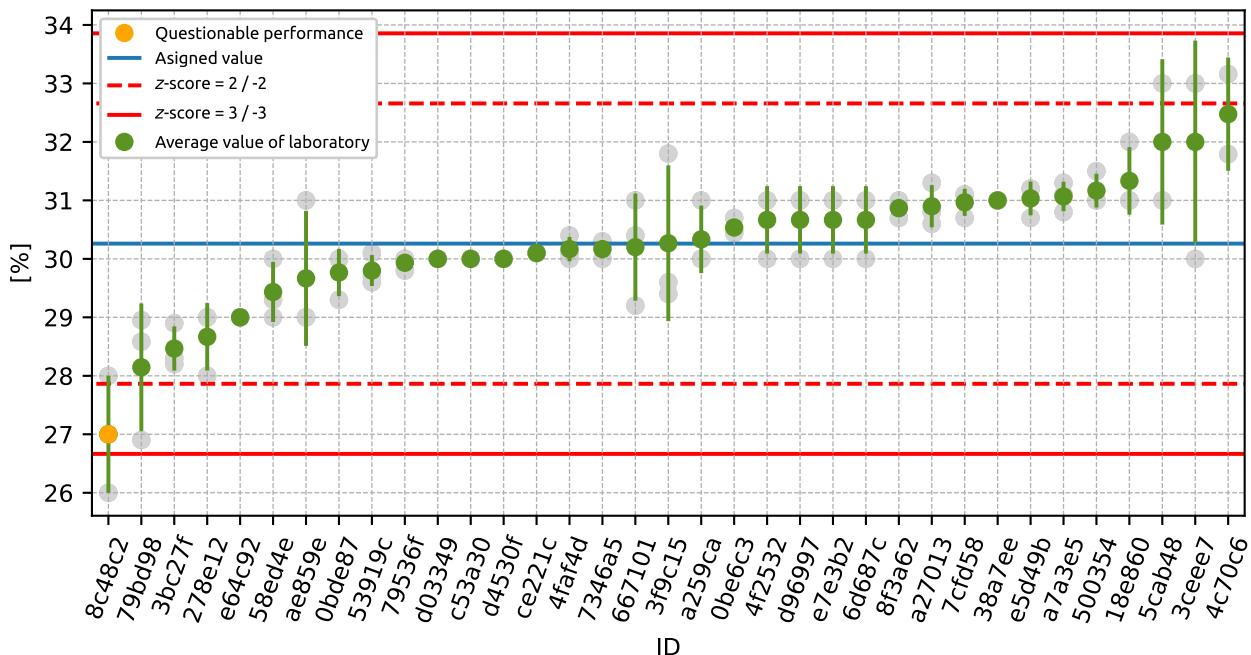

Figure 38: Average values and sample standard deviations
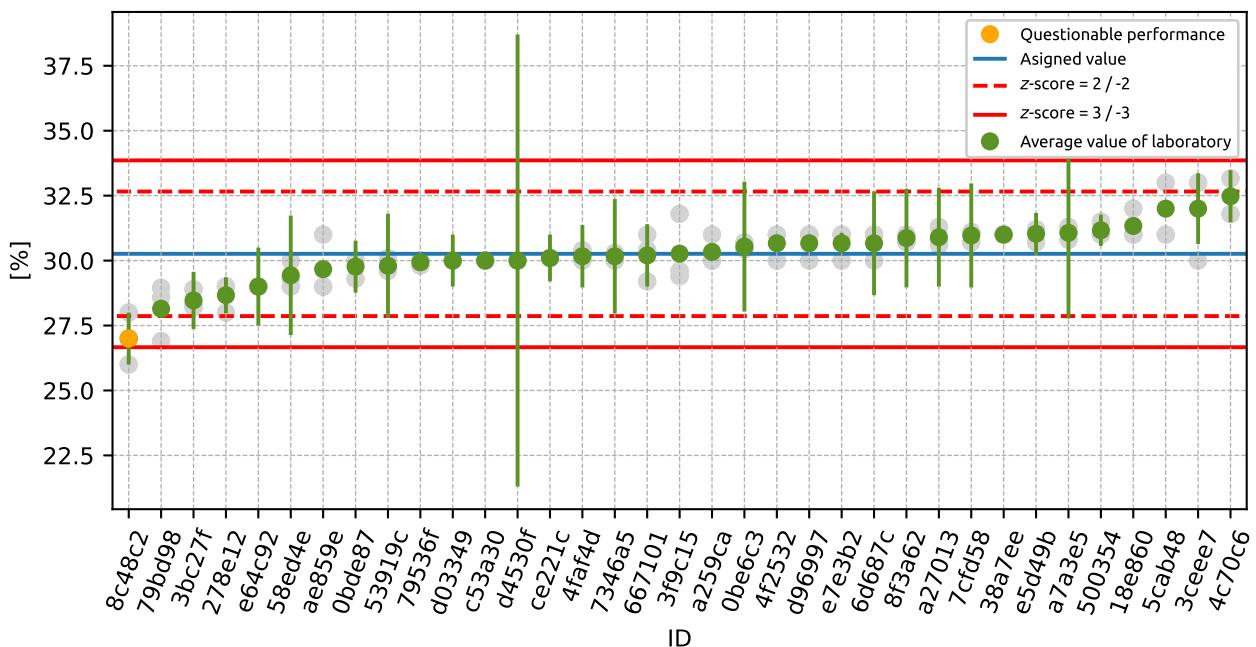
Figure 39: Average values and extended uncertainties of measurement

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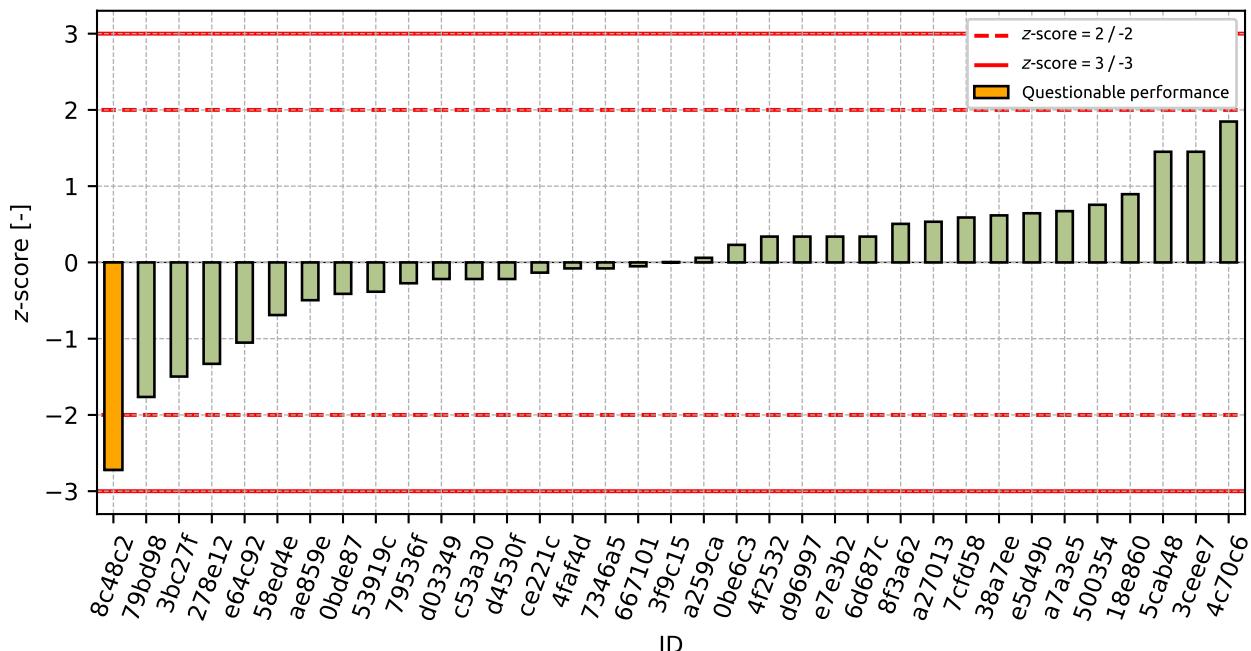
Figure 40: z-score

Figure 41: ζ-score

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Table 16: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8c48c2	-2.72	-3.2
79bd98	-1.76	-
3bc27f	-1.5	-1.6
278e12	-1.33	-2.22
e64c92	-1.05	-0.83
58ed4e	-0.69	-0.36
ae859e	-0.5	-1.6
0bde87	-0.41	-0.48
53919c	-0.38	-0.23
79536f	-0.27	-1.39
d03349	-0.22	-0.26
c53a30	-0.22	-1.15
d4530f	-0.22	-0.03
ce221c	-0.13	-0.17
4faf4d	-0.08	-0.08
7346a5	-0.08	-0.04
667101	-0.05	-0.05
3f9c15	0.0	-
a259ca	0.06	0.32
0be6c3	0.23	0.11
4f2532	0.34	-
d96997	0.34	1.12
e7e3b2	0.34	0.91
6d687c	0.34	0.2
8f3a62	0.51	0.32
a27013	0.53	0.33
7cfd58	0.59	0.35
38a7ee	0.62	3.27
e5d49b	0.64	0.94
a7a3e5	0.67	0.24
500354	0.76	1.43
18e860	0.89	4.46
5cab48	1.45	-
3ceee7	1.45	1.26
4c70c6	1.85	2.17

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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 [%]
8c48c2	7.0	7.0	7.0	1.0	7.0	0.0	0.0
3bc27f	7.2	7.9	6.6	0.4	7.2	0.65	9.0
79bd98	7.5	7.0	7.5	-	7.3	0.29	3.95
ce221c	7.8	7.8	7.8	0.6	7.8	0.0	0.0
d03349	8.0	8.0	8.0	1.0	8.0	0.0	0.0
278e12	8.0	8.0	8.0	0.2	8.0	0.0	0.0
e64c92	8.0	8.0	8.0	0.4	8.0	0.0	0.0
4faf4d	8.2	8.0	8.0	0.3	8.1	0.12	1.43
667101	7.8	8.7	8.8	0.4	8.4	0.55	6.53
53919c	8.6	9.5	7.3	2.0	8.5	1.11	13.06
4c70c6	8.8	9.0	7.7	1.0	8.5	0.7	8.25
58ed4e	8.4	8.6	8.6	1.4	8.5	0.12	1.35
0bde87	8.7	8.1	8.8	1.0	8.5	0.38	4.44
3f9c15	8.4	8.5	9.1	-	8.7	0.38	4.37
c53a30	9.0	8.0	9.0	0.1	8.7	0.58	6.66
7346a5	9.1	8.9	8.5	0.6	8.8	0.31	3.46
0be6c3	9.0	8.7	8.9	2.5	8.9	0.13	1.5
d96997	9.0	9.0	9.0	0.3	9.0	0.0	0.0
e7e3b2	9.0	9.0	9.0	0.2	9.0	0.0	0.0
3ceee7	9.0	10.0	8.0	1.4	9.0	1.0	11.11
a259ca	9.0	9.0	9.0	0.1	9.0	0.0	0.0
ae859e	9.0	9.0	9.0	0.3	9.0	0.0	0.0
5cab48	9.0	9.0	9.0	-	9.0	0.0	0.0
6d687c	9.0	9.0	9.0	1.0	9.0	0.0	0.0
a27013	8.9	8.9	9.5	0.6	9.1	0.35	3.81
7cfd58	9.2	9.1	9.0	1.0	9.1	0.1	1.1
79536f	9.3	9.3	9.2	0.2	9.3	0.06	0.62
4f2532	10.0	9.0	9.0	-	9.3	0.58	6.19
8f3a62	9.6	9.4	9.4	0.6	9.5	0.12	1.22
e5d49b	9.5	9.4	9.8	0.8	9.6	0.21	2.18
a7a3e5	9.7	9.7	9.9	3.3	9.8	0.12	1.18
18e860	10.0	10.0	10.0	0.1	10.0	0.0	0.0
d4530f	10.0	10.0	10.0	8.7	10.0	0.0	0.0
38a7ee	10.0	10.0	10.0	0.1	10.0	0.0	0.0
500354	12.6	12.2	12.1	0.3	12.3	0.26	2.15

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1.5.2   The Numerical Procedure for Determining Outliers
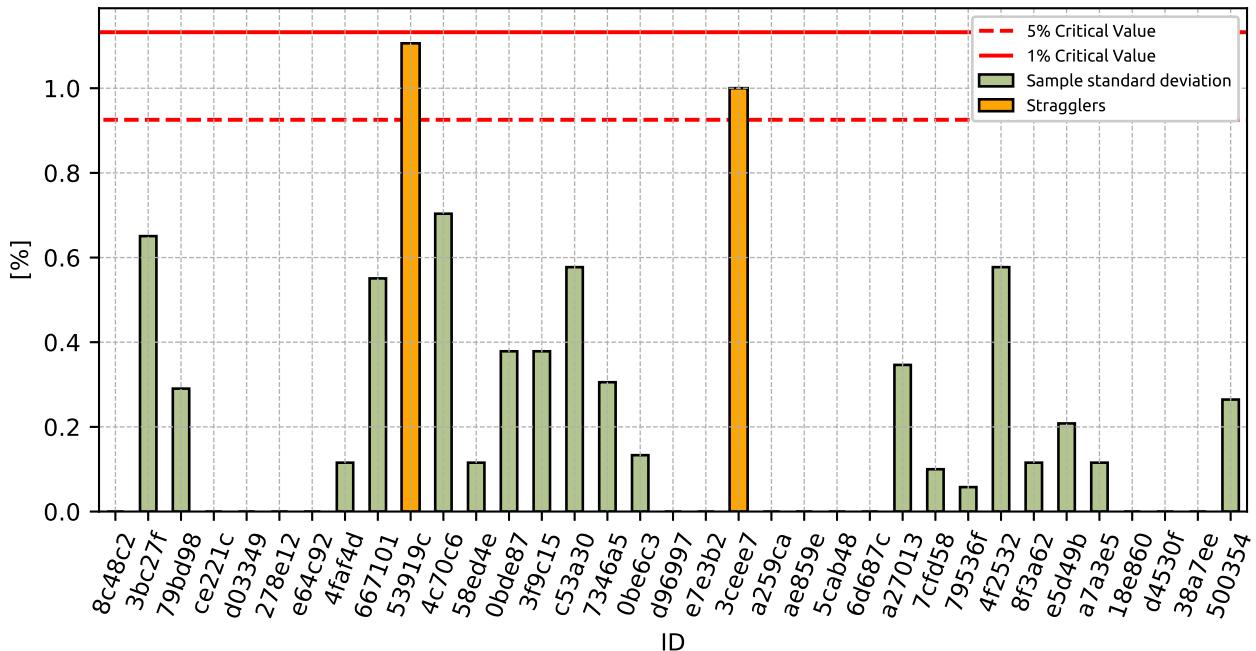

Figure 42: **Cochran's test** - sample standard deviations
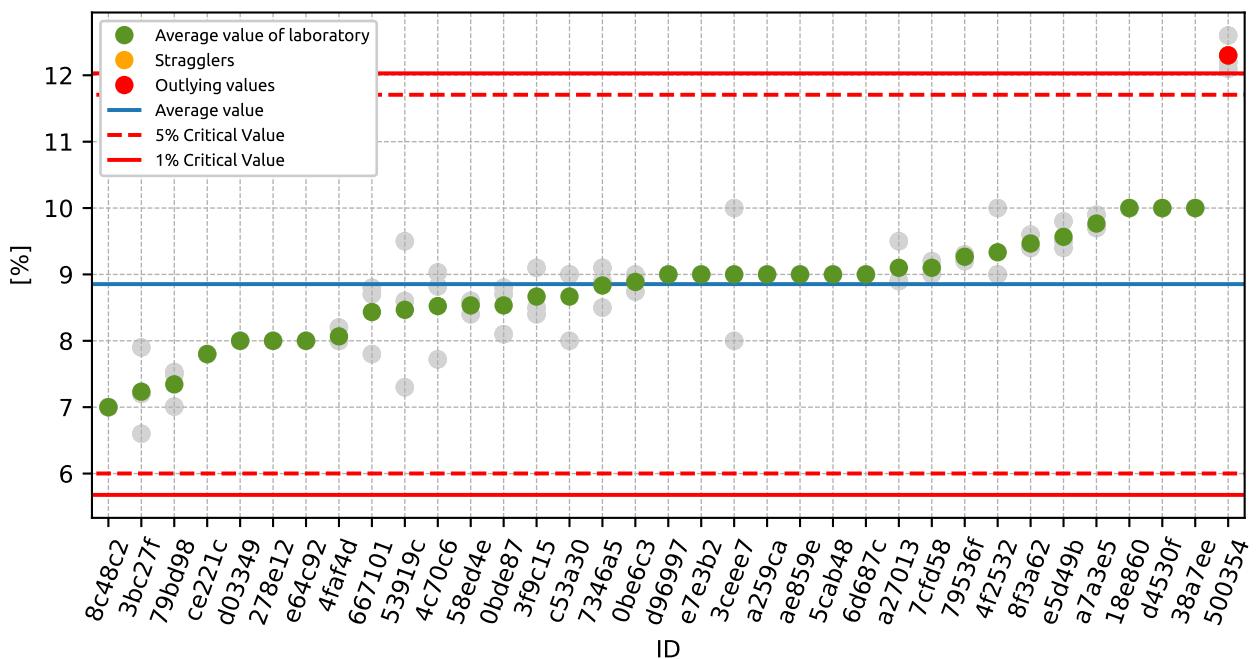

Figure 43: **Grubbs' test** - average values

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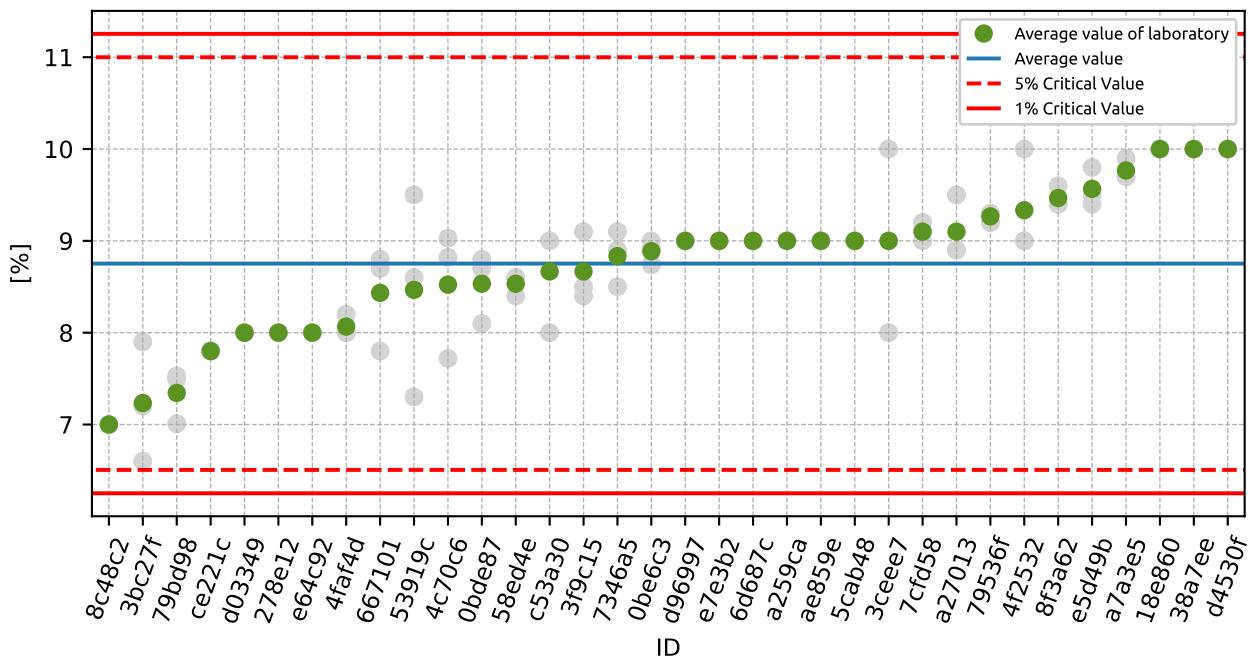
Figure 44: **Grubbs' test** - average values without outliers

1.5.3 Mandel′s Statistics
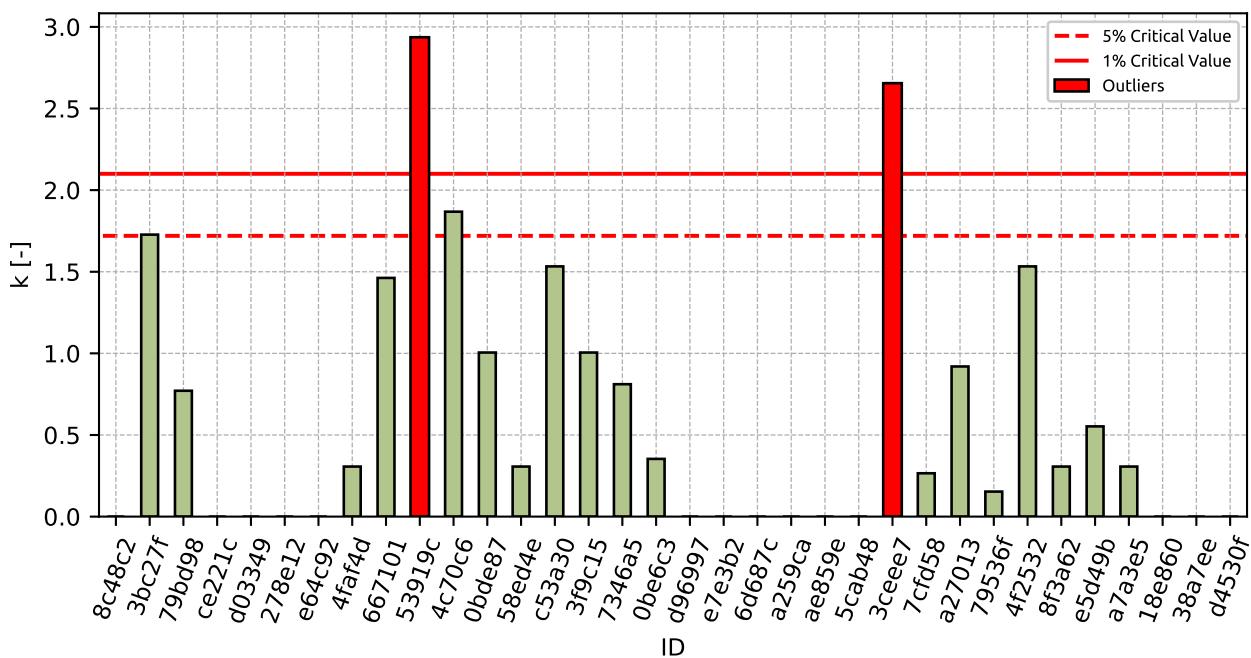
Figure 45: Intralaboratory Consistency Statistic

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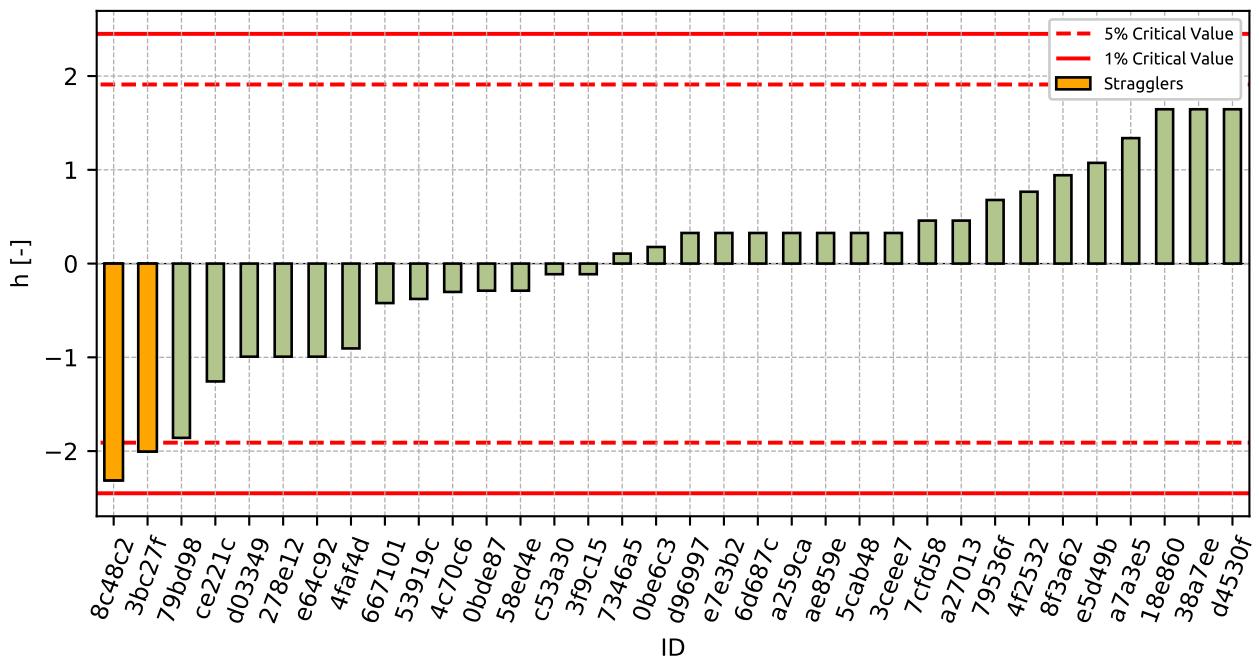
Figure 46: Interlaboratory Consistency Statistic

1.5.4 Descriptive statistics
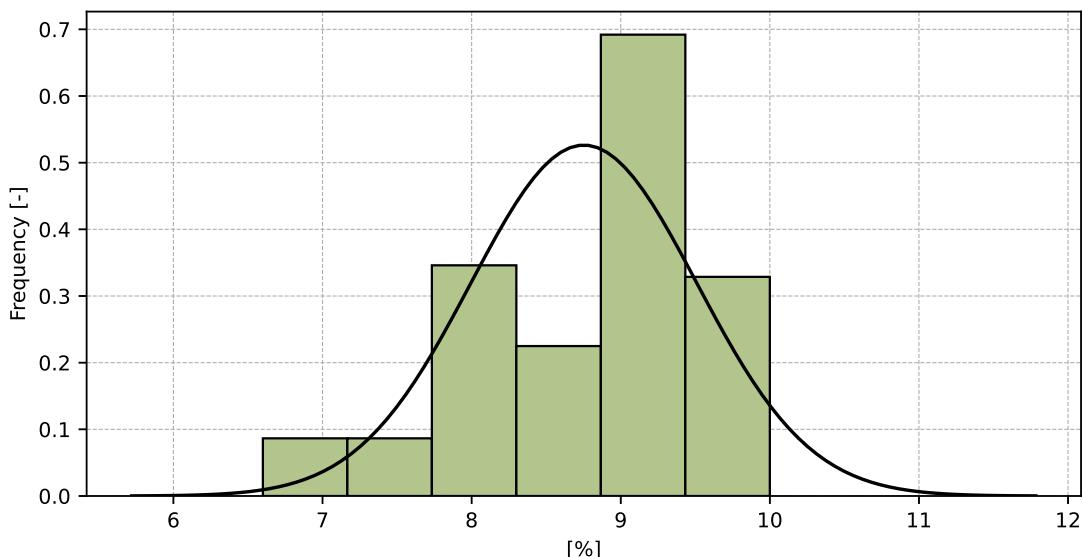
Figure 47: Histogram of all test results

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Table 18: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	8.8
Sample standard deviation – s	0.76
Asigned value – x^*	8.8
Robust standard deviation – s^*	0.76
Measurement uncertainty of asigned value – u_X	0.13
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.73
Repeatability standard deviation – s_r	0.38
Reproducibility standard deviation – s_R	0.82
Repeatability – r	1.1
Reproducibility – R	2.3

1.5.5   Evaluation of Performance Statistics
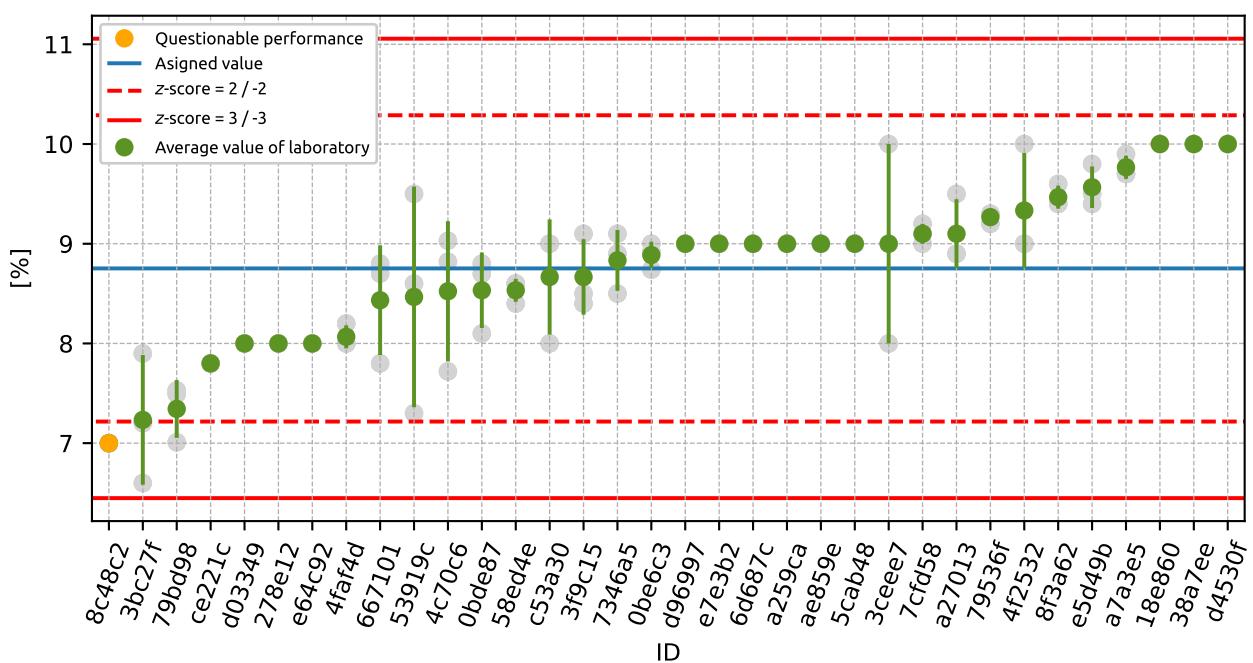

Figure 48: Average values and sample standard deviations

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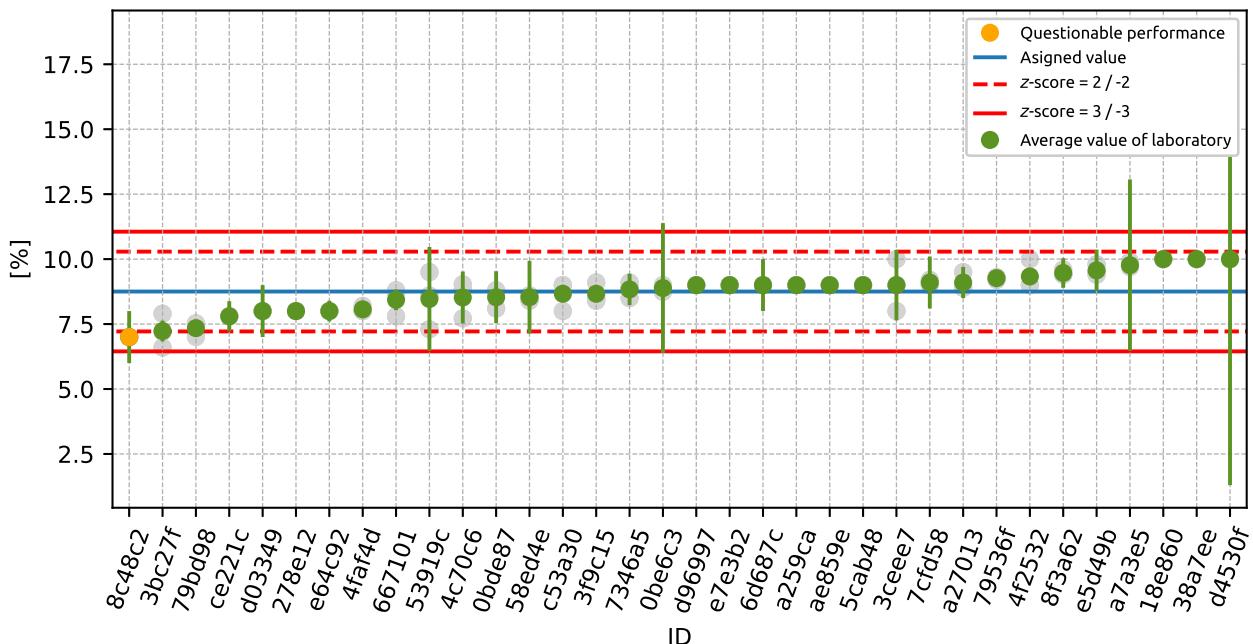
Figure 49: Average values and extended uncertainties of measurement

Figure 50: z-score

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Figure 51: ζ-score

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Table 19: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8c48c2	-2.28	-1.74
3bc27f	-1.98	-3.61
79bd98	-1.83	-
ce221c	-1.24	-1.6
d03349	-0.98	-0.75
278e12	-0.98	-3.63
e64c92	-0.98	-1.79
4faf4d	-0.89	-2.09
667101	-0.42	-0.76
53919c	-0.37	-0.14
4c70c6	-0.3	-0.23
0bde87	-0.29	-0.22
58ed4e	-0.29	-0.16
c53a30	-0.11	-0.52
3f9c15	-0.11	-
7346a5	0.11	0.13
0be6c3	0.17	0.05
d96997	0.32	0.76
e7e3b2	0.32	1.03
6d687c	0.32	0.25
a259ca	0.32	1.5
ae859e	0.32	0.72
5cab48	0.32	-
3ceee7	0.32	0.18
7cfd58	0.45	0.34
a27013	0.45	0.57
79536f	0.67	2.22
4f2532	0.76	-
8f3a62	0.93	1.22
e5d49b	1.06	1.0
a7a3e5	1.32	0.31
18e860	1.62	6.74
38a7ee	1.62	7.54
d4530f	1.62	0.14

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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 [%]
3ceee7	1.0	1.0	0.0	1.4	0.7	0.58	86.6
79bd98	0.8	0.7	0.8	-	0.8	0.05	5.88
4faf4d	1.0	1.0	0.9	0.0	1.0	0.06	5.97
6d687c	1.0	1.0	1.0	1.0	1.0	0.0	0.0
e64c92	1.0	1.0	1.0	0.2	1.0	0.0	0.0
c53a30	1.0	1.0	1.0	0.1	1.0	0.0	0.0
a259ca	1.0	1.0	1.0	0.1	1.0	0.0	0.0
ae859e	1.0	1.0	1.0	0.3	1.0	0.0	0.0
5cab48	1.0	1.0	1.0	-	1.0	0.0	0.0
8c48c2	1.1	1.0	0.9	0.1	1.0	0.1	10.0
d03349	1.0	1.0	1.0	1.0	1.0	0.0	0.0
3f9c15	1.1	1.1	1.1	-	1.1	0.0	0.0
79536f	1.2	1.1	1.1	0.2	1.1	0.06	5.09
7cfd58	1.2	1.1	1.2	1.0	1.2	0.06	4.95
3bc27f	1.0	1.4	1.2	0.1	1.2	0.2	16.67
53919c	1.3	1.3	1.0	2.0	1.2	0.17	14.43
8f3a62	1.4	1.2	1.2	0.1	1.3	0.12	9.12
0bde87	1.3	1.2	1.4	1.0	1.3	0.1	7.69
ce221c	1.3	1.3	1.3	0.4	1.3	0.0	0.0
58ed4e	1.2	1.4	1.4	0.2	1.3	0.12	8.66
e7e3b2	2.0	1.0	1.0	0.1	1.3	0.58	43.3
278e12	1.0	2.0	1.0	0.1	1.3	0.58	43.3
667101	1.2	1.5	1.4	0.1	1.4	0.15	11.18
a27013	1.4	1.4	1.5	0.2	1.4	0.06	4.03
4c70c6	1.3	1.4	1.6	1.0	1.4	0.15	10.38
0be6c3	1.5	1.4	1.4	2.5	1.5	0.05	3.17
7346a5	1.5	1.5	1.4	0.1	1.5	0.06	3.94
e5d49b	1.5	1.3	1.6	0.8	1.5	0.15	10.41
d96997	2.0	2.0	1.0	0.1	1.7	0.58	34.64
18e860	2.0	2.0	2.0	0.1	2.0	0.0	0.0
d4530f	2.0	2.0	2.0	8.7	2.0	0.0	0.0
4f2532	2.0	2.0	2.0	-	2.0	0.0	0.0
38a7ee	2.0	2.0	2.0	0.1	2.0	0.0	0.0
a7a3e5	2.2	2.2	2.3	0.3	2.2	0.06	2.59
500354	2.1	2.5	2.8	0.3	2.5	0.35	14.24

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1.6.2   The Numerical Procedure for Determining Outliers
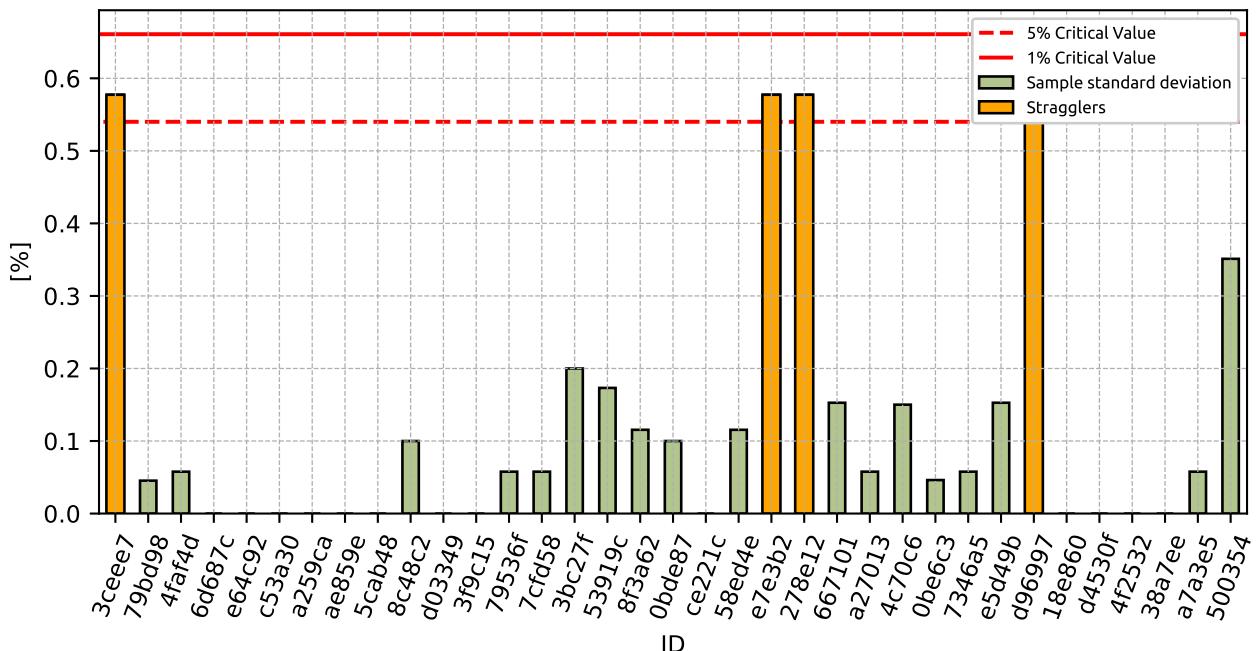
Figure 52: **Cochran's test** - sample standard deviations
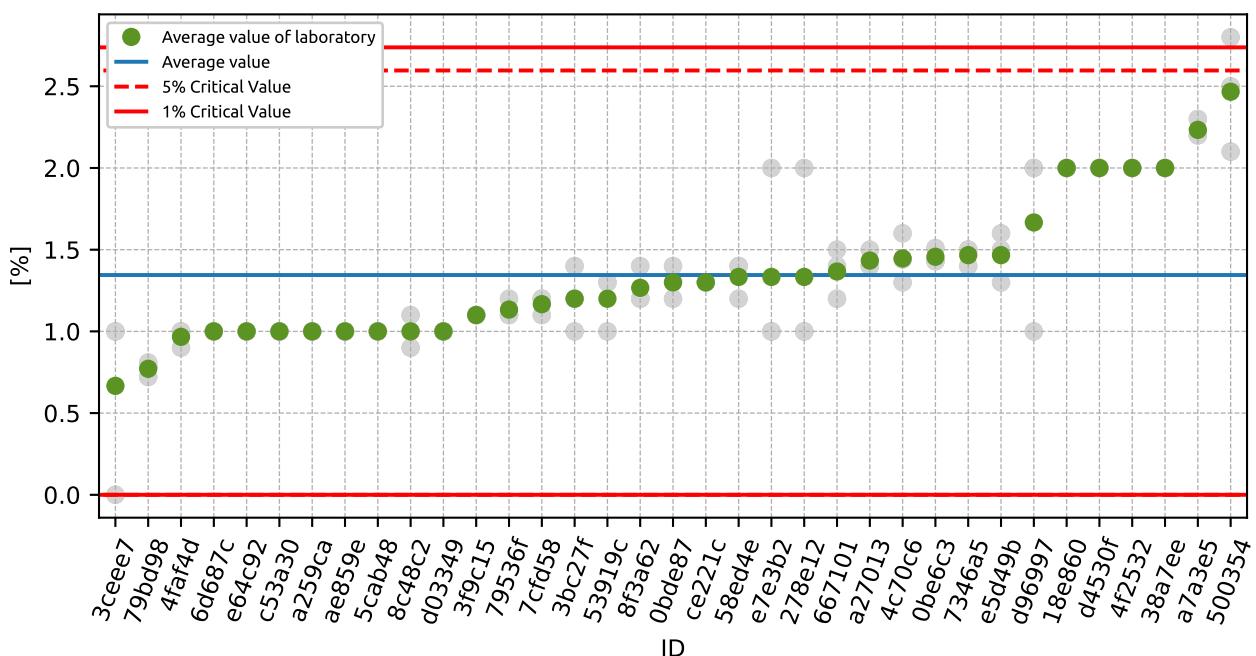
Figure 53: **Grubbs' test** - average values

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1.6.3   Mandel's Statistics
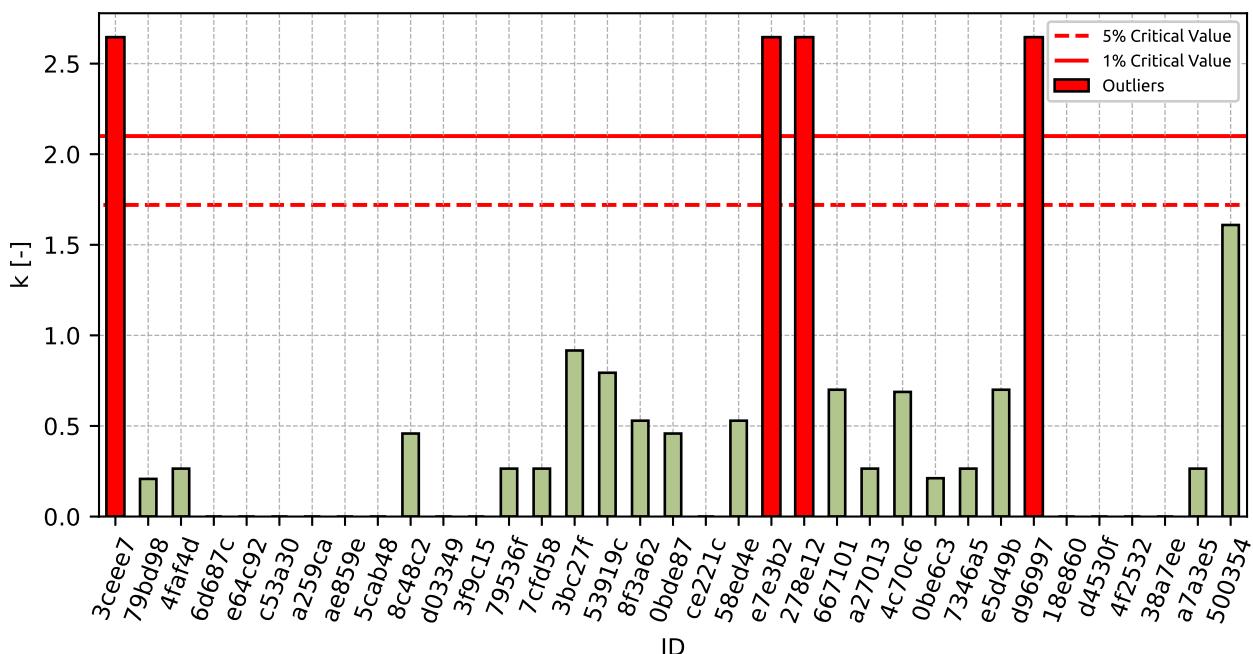
Figure 54: Intralaboratory Consistency Statistic
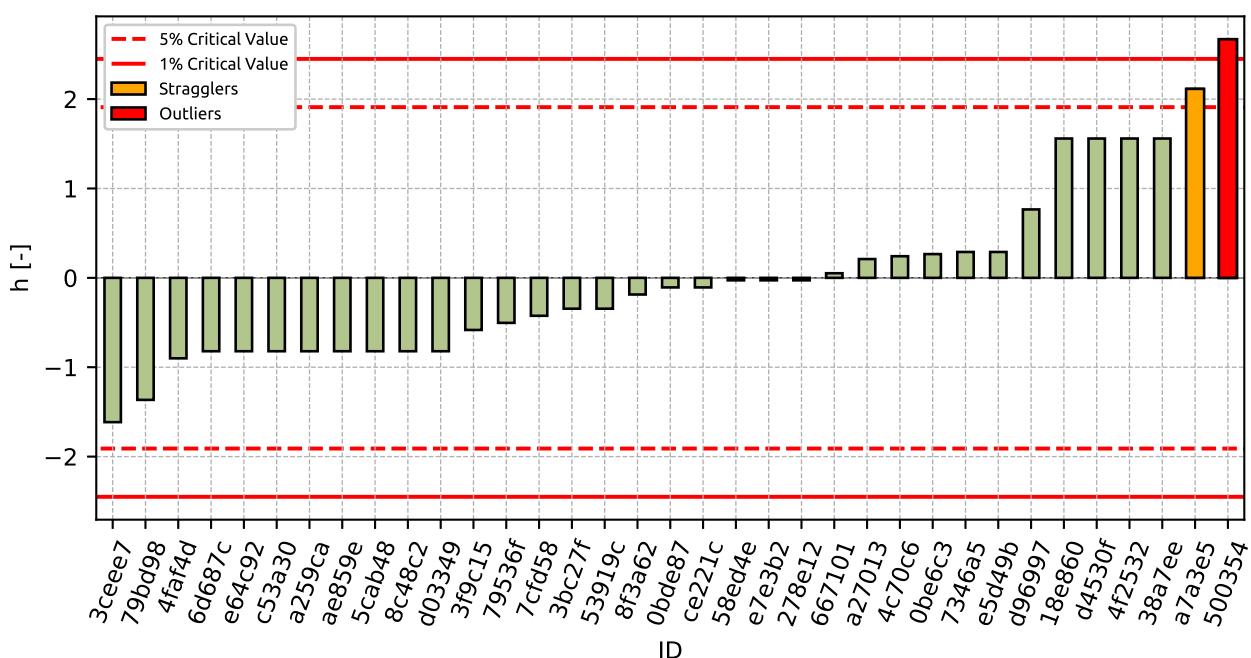
Figure 55: Interlaboratory Consistency Statistic

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1.6.4   Descriptive statistics
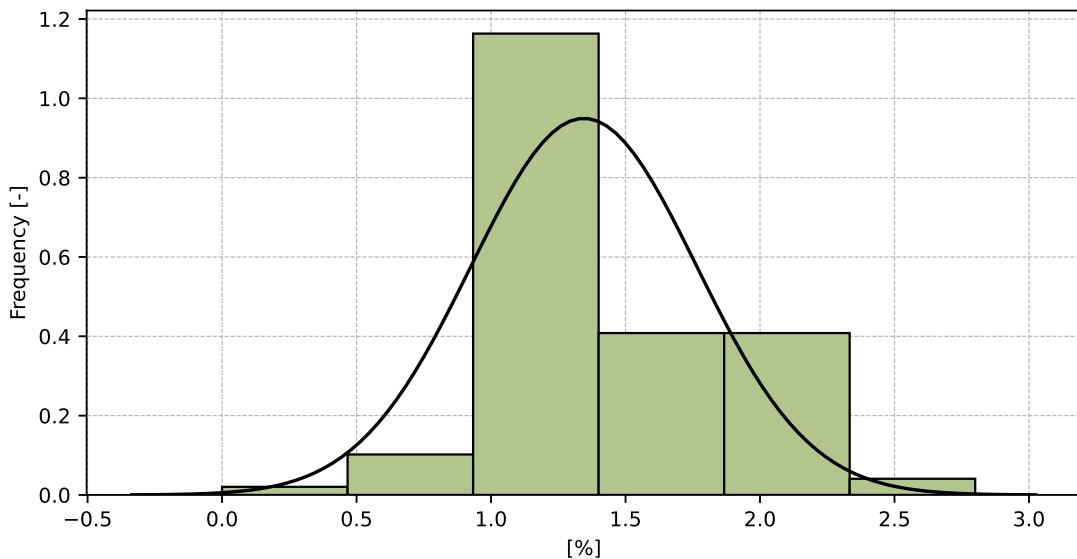
Figure 56: Histogram of all test results

Table 21: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	1.3
Sample standard deviation – s	0.42
Asigned value – x^*	1.3
Robust standard deviation – s^*	0.42
Measurement uncertainty of asigned value – u_X	0.07
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.4
Repeatability standard deviation – s_r	0.22
Reproducibility standard deviation – s_R	0.46
Repeatability – r	0.6
Reproducibility – R	1.3

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1.6.5 Evaluation of Performance Statistics
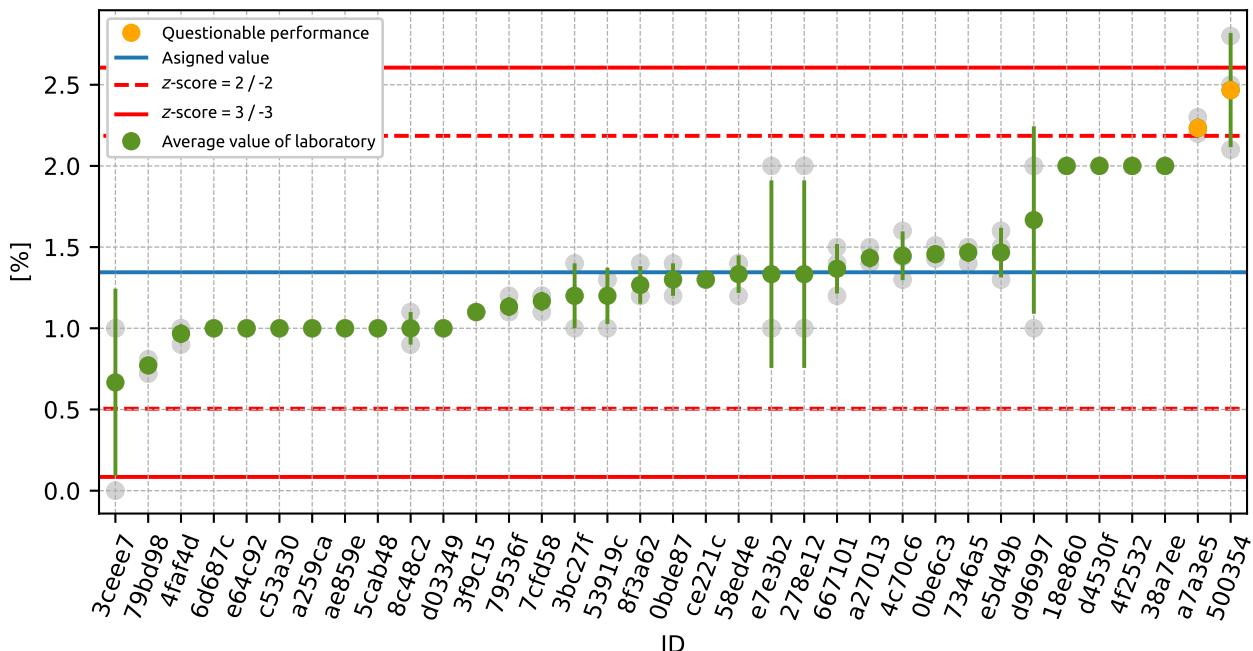

Figure 57: Average values and sample standard deviations
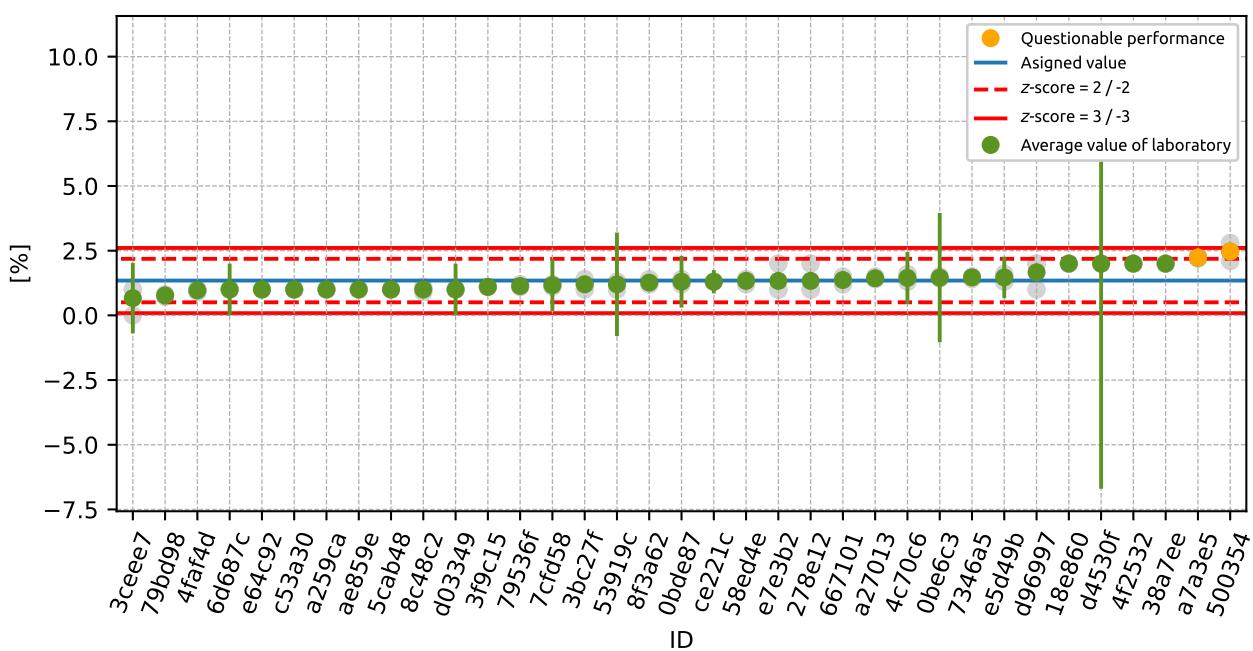
Figure 58: Average values and extended uncertainties of measurement

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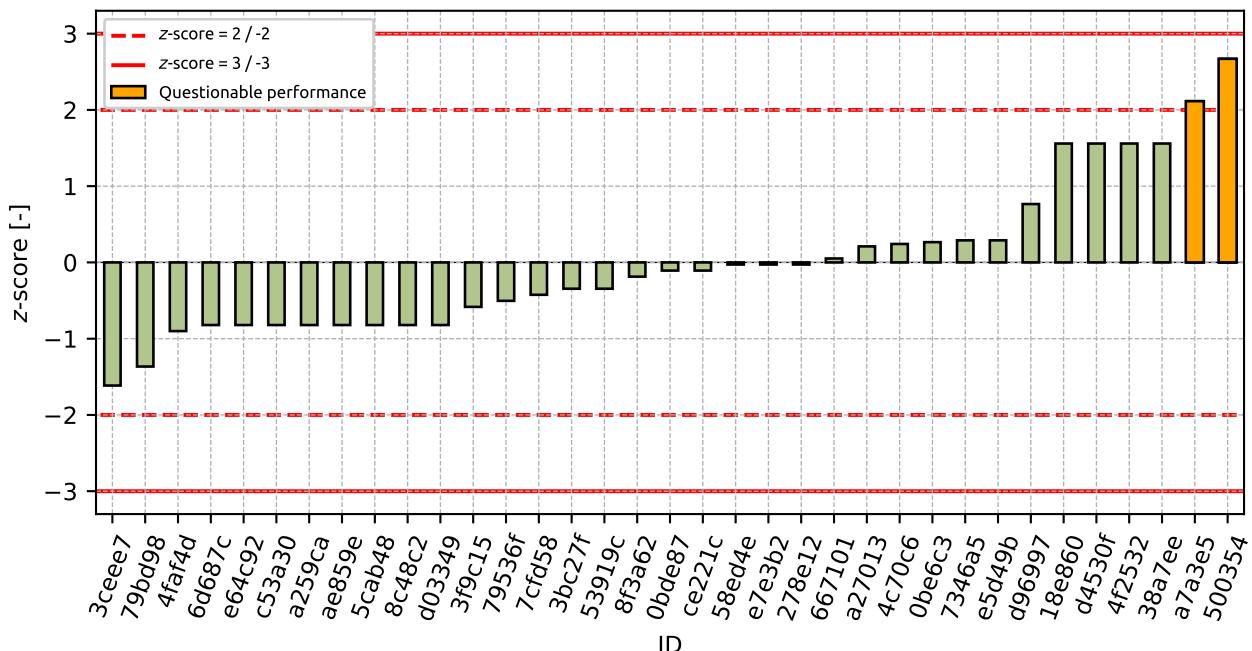
Figure 59: z-score

Figure 60: ζ-score

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Table 22: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
3ceee7	-1.61	-0.5
79bd98	-1.37	-
4faf4d	-0.9	-4.64
6d687c	-0.82	-0.34
e64c92	-0.82	-1.63
c53a30	-0.82	-2.81
a259ca	-0.82	-2.81
ae859e	-0.82	-1.05
5cab48	-0.82	-
8c48c2	-0.82	-2.81
d03349	-0.82	-0.34
3f9c15	-0.58	-
79536f	-0.5	-1.28
7cfd58	-0.42	-0.18
3bc27f	-0.35	-1.18
53919c	-0.35	-0.07
8f3a62	-0.19	-0.73
0bde87	-0.11	-0.04
ce221c	-0.11	-0.1
58ed4e	-0.03	-0.05
e7e3b2	-0.03	-0.1
278e12	-0.03	-0.13
667101	0.05	0.18
a27013	0.21	0.42
4c70c6	0.24	0.1
0be6c3	0.27	0.04
7346a5	0.29	0.99
e5d49b	0.29	0.15
d96997	0.77	2.62
18e860	1.56	4.42
d4530f	1.56	0.08
4f2532	1.56	-
38a7ee	1.56	5.34
a7a3e5	2.11	2.88
500354	2.67	3.64

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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 [%]
8c48c2	0.0	0.0	0.0	0.1	0.0	0.0	-
3ceee7	0.0	0.0	0.0	1.4	0.0	0.0	-
c53a30	0.0	0.1	0.1	0.1	0.1	0.06	92.8
79bd98	0.2	0.1	0.2	-	0.1	0.03	20.17
ce221c	0.2	0.2	0.2	0.4	0.2	0.0	0.0
3f9c15	0.2	0.1	0.3	-	0.2	0.1	50.0
4faf4d	0.3	0.2	0.2	0.0	0.2	0.06	24.74
5cab48	0.2	0.2	0.3	-	0.2	0.06	24.74
ae859e	0.2	0.2	0.3	0.2	0.2	0.06	24.74
79536f	0.4	0.4	0.3	0.1	0.4	0.06	15.75
a259ca	0.6	0.4	0.3	0.1	0.4	0.15	35.25
38a7ee	0.3	0.6	0.5	0.1	0.5	0.15	32.73
e64c92	0.5	0.4	0.5	0.1	0.5	0.06	12.37
53919c	0.5	0.6	0.5	2.0	0.5	0.06	10.83
7cfd58	0.6	0.6	0.5	1.0	0.6	0.06	10.19
6d687c	0.5	0.6	0.6	0.4	0.6	0.06	10.19
0bde87	0.5	0.6	0.6	1.0	0.6	0.06	10.19
3bc27f	0.3	0.9	0.6	0.1	0.6	0.3	50.0
a27013	0.6	0.6	0.6	0.1	0.6	0.0	0.0
8f3a62	0.7	0.5	0.6	0.0	0.6	0.1	16.67
e7e3b2	0.7	0.6	0.6	0.1	0.6	0.06	9.12
d03349	0.7	0.7	0.6	0.1	0.7	0.06	8.66
58ed4e	0.6	0.7	0.7	0.2	0.7	0.06	8.66
d4530f	0.7	0.7	0.7	-	0.7	0.0	0.0
d96997	0.7	0.7	0.7	0.1	0.7	0.0	0.0
667101	0.6	0.8	0.7	0.1	0.7	0.1	14.29
7346a5	0.8	0.7	0.7	0.0	0.7	0.06	7.87
0be6c3	0.8	0.7	0.7	2.5	0.8	0.04	5.74
e5d49b	0.8	0.6	0.9	0.8	0.8	0.15	19.92
278e12	0.7	0.8	0.8	0.0	0.8	0.06	7.53
4f2532	0.8	0.8	0.8	-	0.8	0.0	0.0
4c70c6	0.7	0.8	0.9	1.0	0.8	0.11	13.07
a7a3e5	0.9	0.9	1.0	0.3	0.9	0.06	6.19
18e860	1.1	1.1	0.8	0.1	1.0	0.17	17.32
500354	1.2	1.2	1.4	0.4	1.3	0.12	9.12

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1.7.2   The Numerical Procedure for Determining Outliers
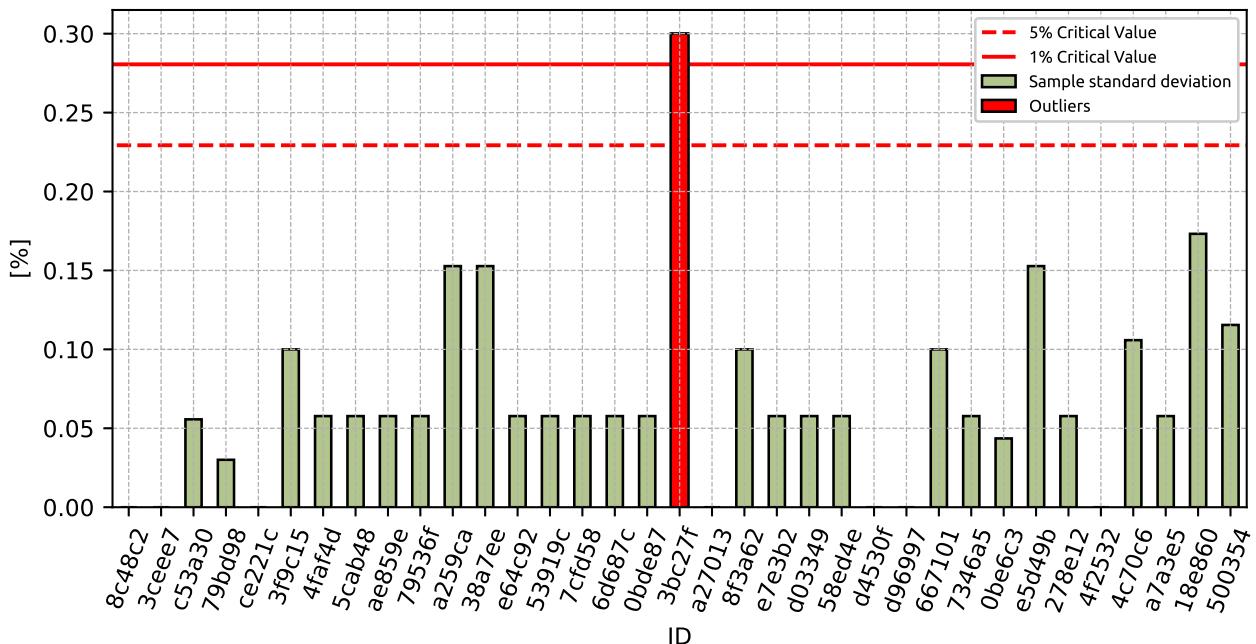
Figure 61: **Cochran's test** - sample standard deviations
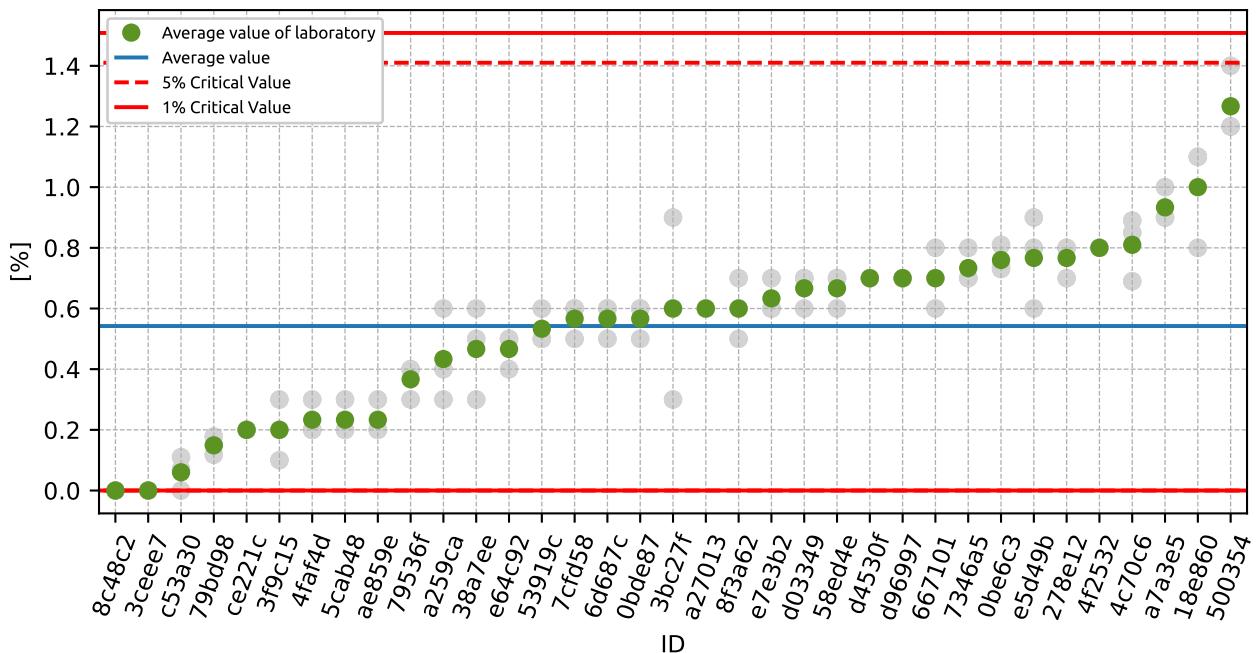

Figure 62: **Grubbs' test** - average values

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1.7.3 Mandel's Statistics
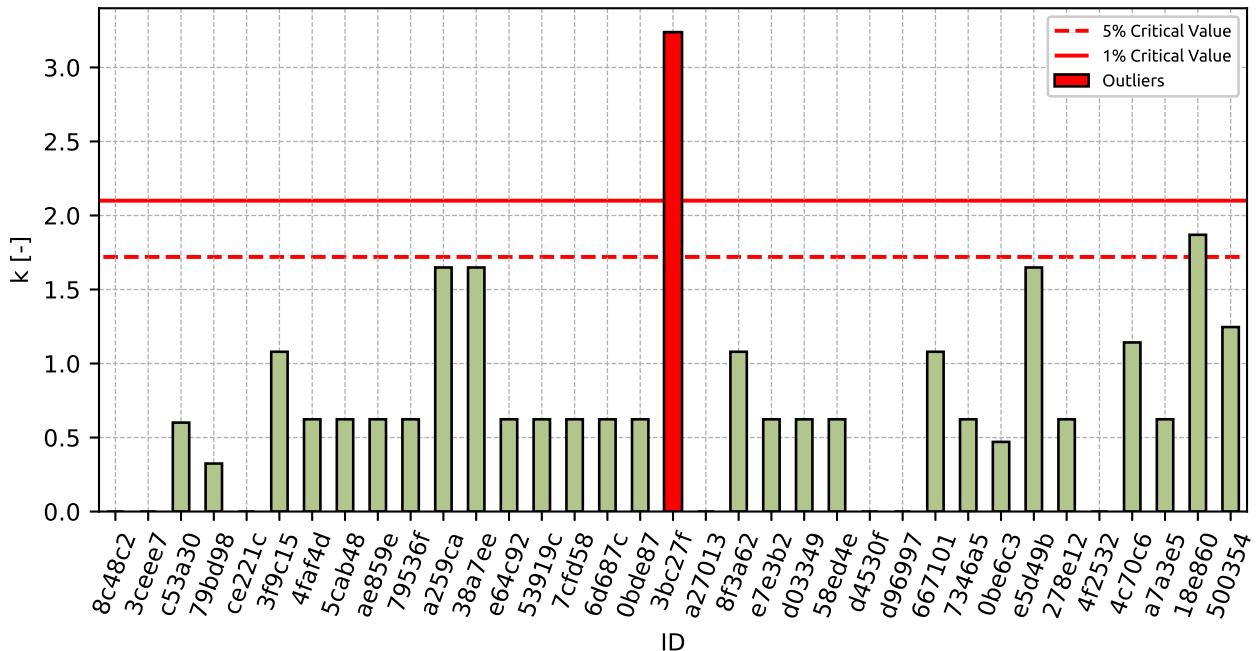
Figure 63: Intralaboratory Consistency Statistic
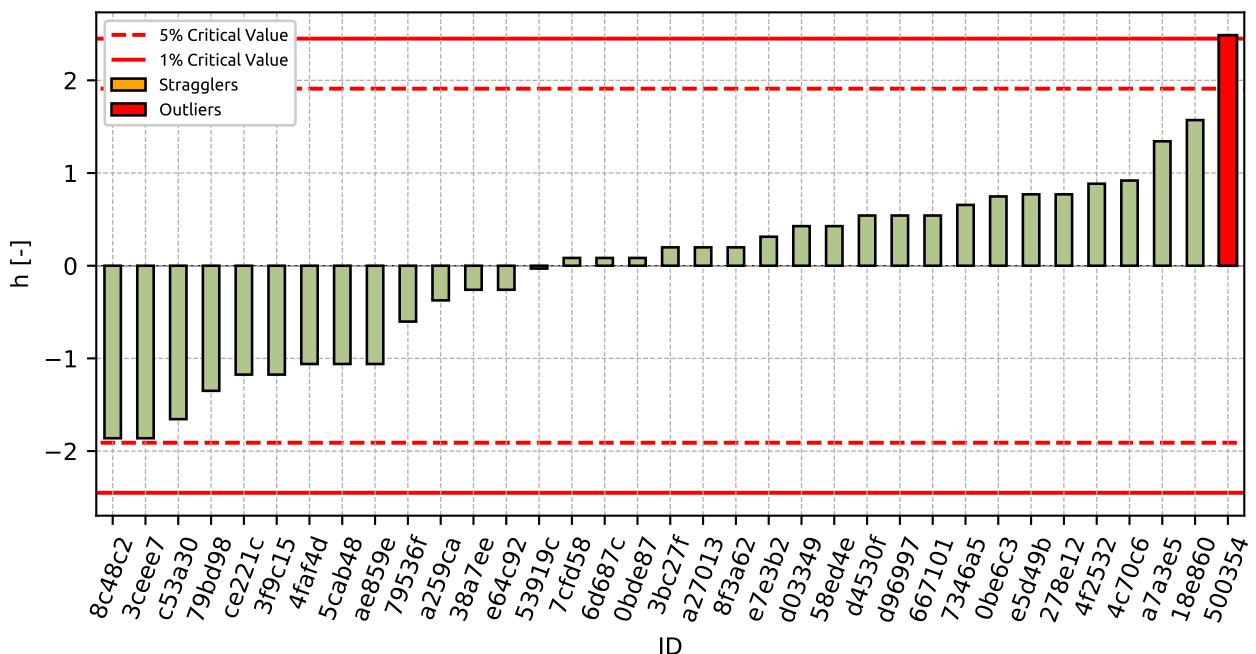
Figure 64: Interlaboratory Consistency Statistic

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1.7.4 Descriptive statistics
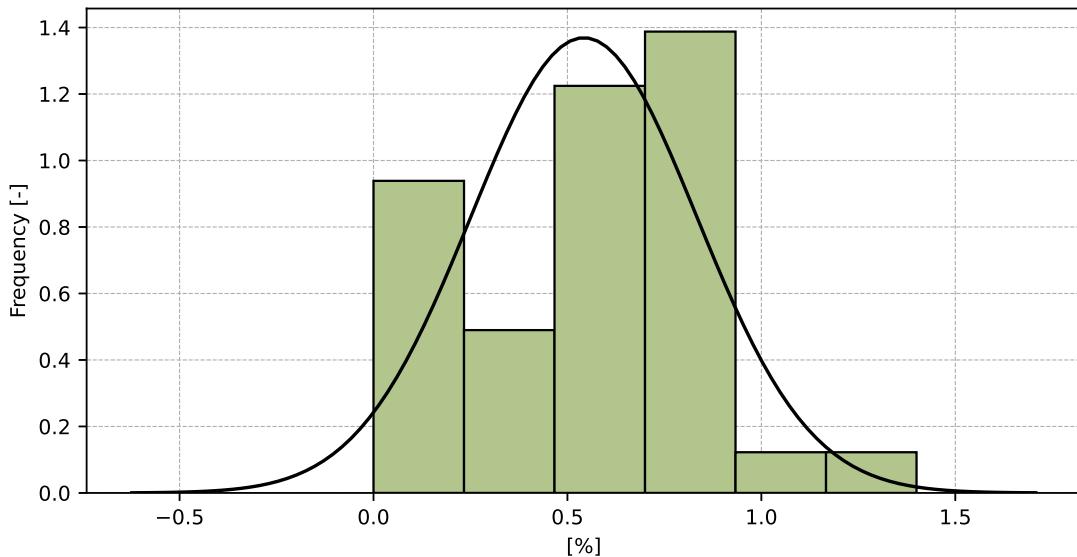
Figure 65: Histogram of all test results

Table 24: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	0.5
Sample standard deviation – s	0.29
Asigned value – x^*	0.5
Robust standard deviation – s^*	0.29
Measurement uncertainty of asigned value – u_X	0.05
p-value of normality test	0.003 [-]
Interlaboratory standard deviation – s_L	0.29
Repeatability standard deviation – s_r	0.09
Reproducibility standard deviation – s_R	0.3
Repeatability – r	0.3
Reproducibility – R	0.8

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1.7.5   Evaluation of Performance Statistics
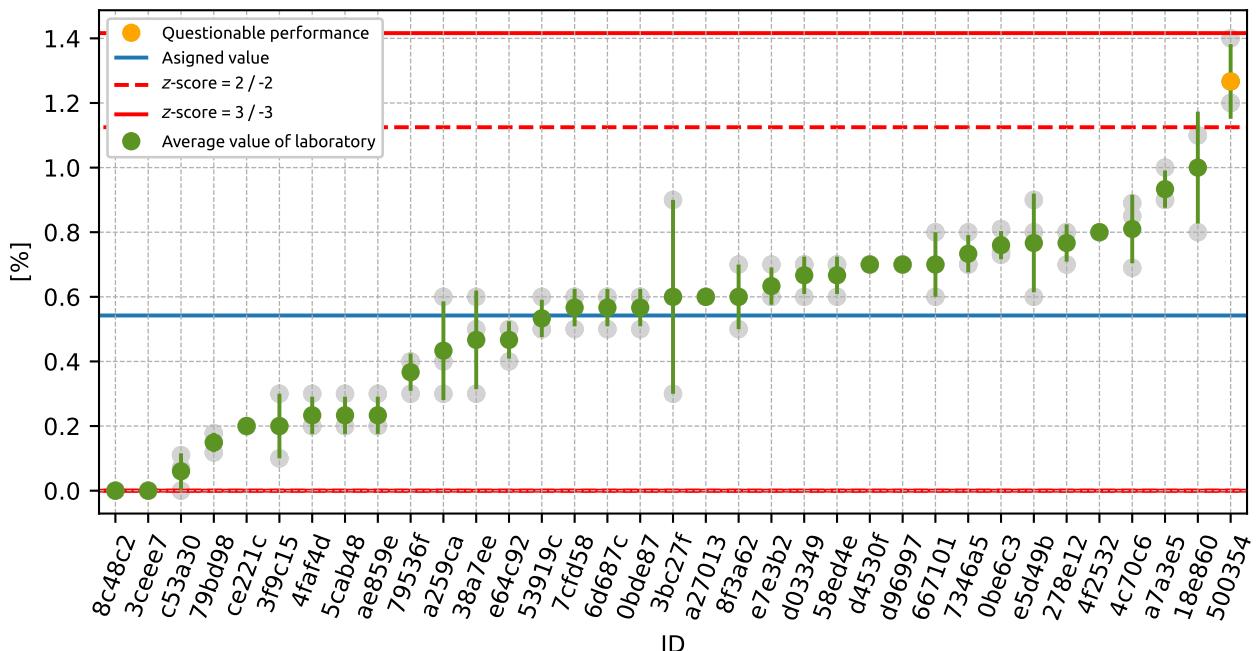
Figure 66: Average values and sample standard deviations
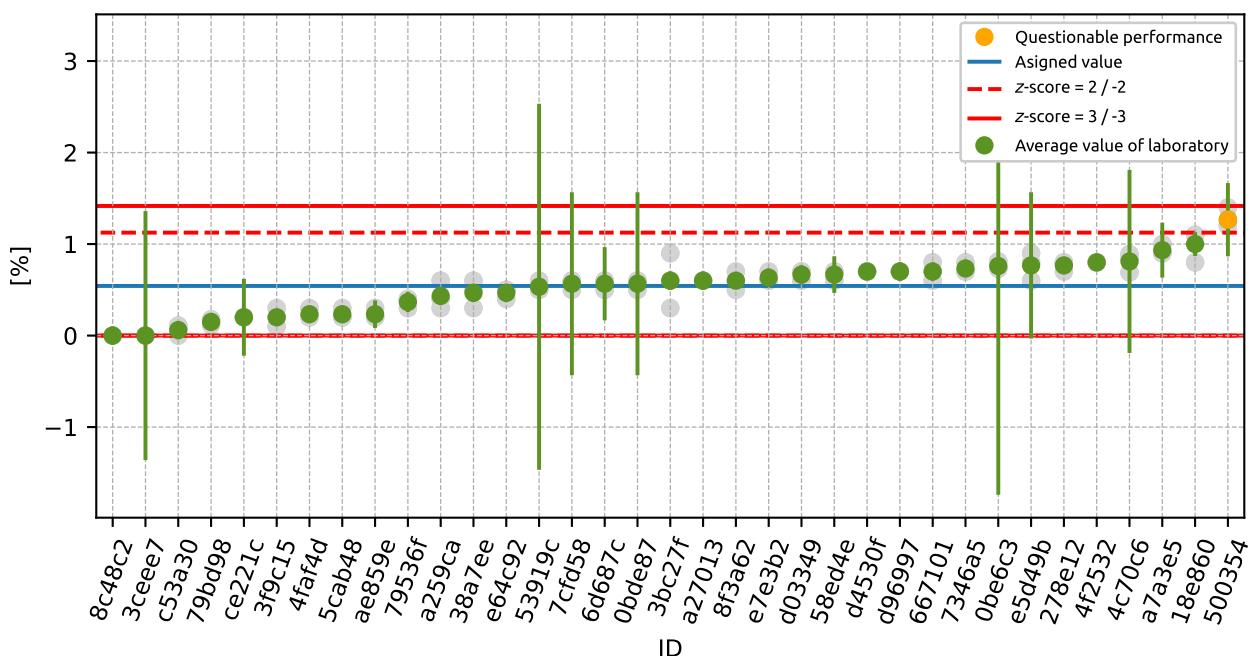
Figure 67: Average values and extended uncertainties of measurement

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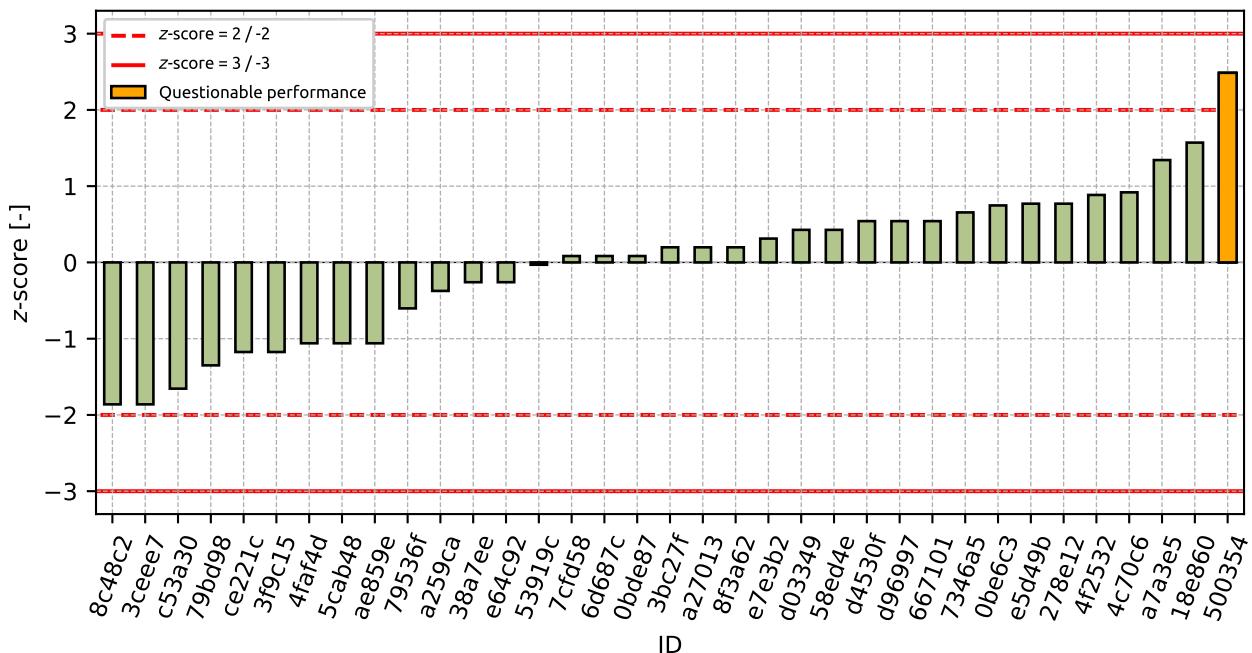
Figure 68: z-score

Figure 69: ζ-score

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Table 25: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8c48c2	-1.86	-4.86
3ceee7	-1.86	-0.4
c53a30	-1.66	-4.33
79bd98	-1.35	-
ce221c	-1.17	-0.81
3f9c15	-1.17	-
4faf4d	-1.06	-6.15
5cab48	-1.06	-
ae859e	-1.06	-1.96
79536f	-0.6	-1.46
a259ca	-0.37	-0.98
38a7ee	-0.26	-0.68
e64c92	-0.26	-0.68
53919c	-0.03	-0.0
7cfd58	0.08	0.02
6d687c	0.08	0.06
0bde87	0.08	0.02
3bc27f	0.2	0.52
a27013	0.2	0.52
8f3a62	0.2	0.91
e7e3b2	0.31	0.82
d03349	0.43	1.12
58ed4e	0.43	0.6
d4530f	0.54	-
d96997	0.54	1.42
667101	0.54	1.42
7346a5	0.66	2.72
0be6c3	0.75	0.09
e5d49b	0.77	0.28
278e12	0.77	3.3
4f2532	0.88	-
4c70c6	0.92	0.27
a7a3e5	1.34	1.29
18e860	1.57	3.29
500354	2.49	1.8

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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 [%]
0bde87	20.8	20.4	20.6	1.0	20.6	0.2	0.97
ec14be	21.0	21.0	21.0	-	21.0	0.0	0.0
3f9c15	22.0	22.0	22.0	1.0	22.0	0.0	0.0
8dbf83	22.0	23.0	23.0	0.3	22.7	0.58	2.55
2c58f4	23.0	24.0	23.0	2.4	23.3	0.58	2.47
a7a3e5	24.4	24.4	24.7	0.5	24.5	0.17	0.71
fe1b70	25.0	24.0	25.0	-	24.7	0.58	2.34
86714d	25.0	25.0	25.0	-	25.0	0.0	0.0
8c48c2	58.0	58.0	58.0	0.5	58.0	0.0	0.0

2.2　The Numerical Procedure for Determining Outliers
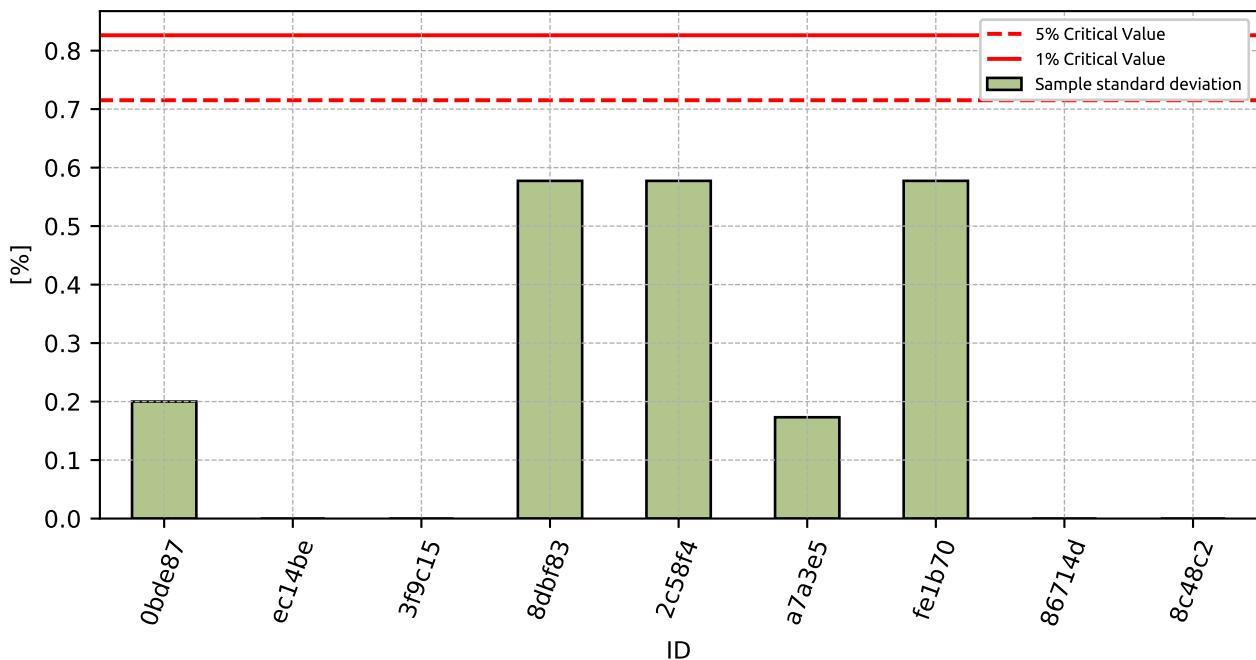

Figure 70: **Cochran's test** - sample standard deviations

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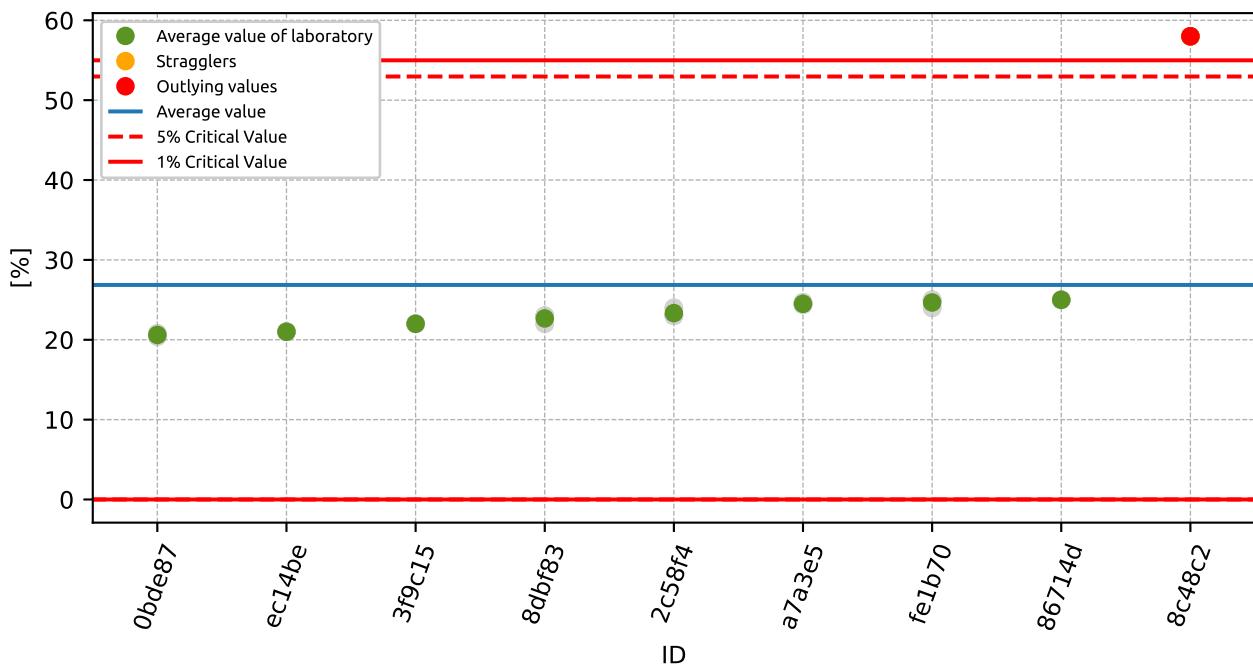
Figure 71: **Grubbs' test** - average values
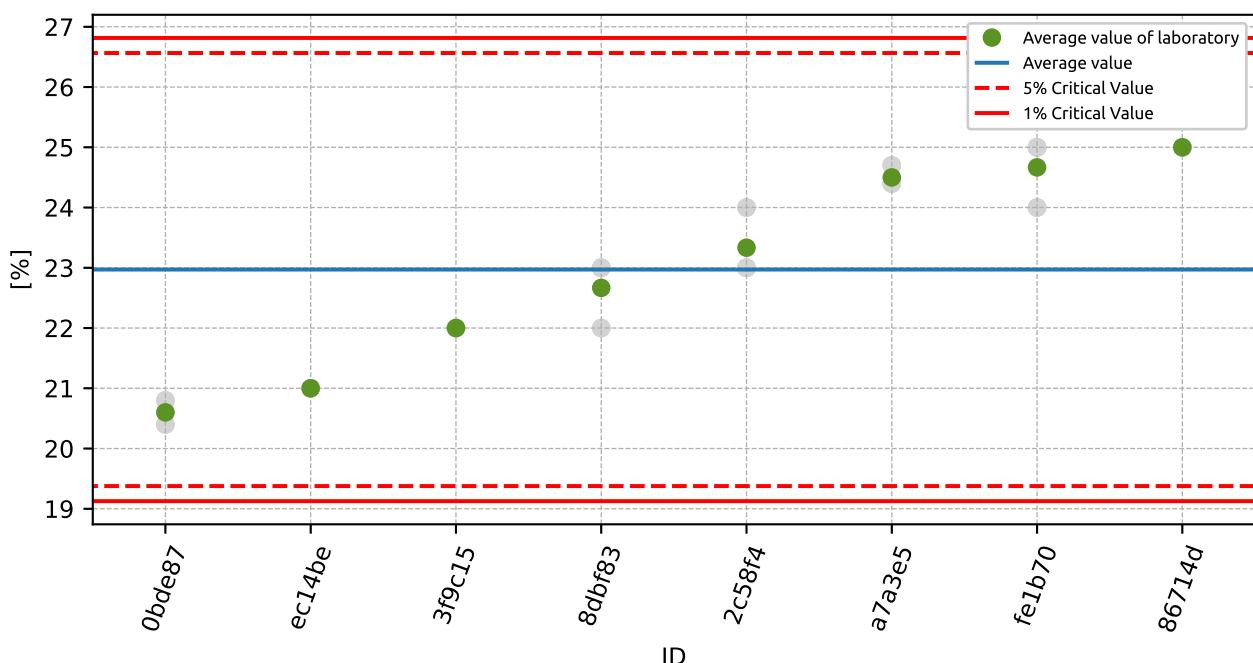
Figure 72: **Grubbs' test** - average values without outliers

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2.3 Mandel's Statistics
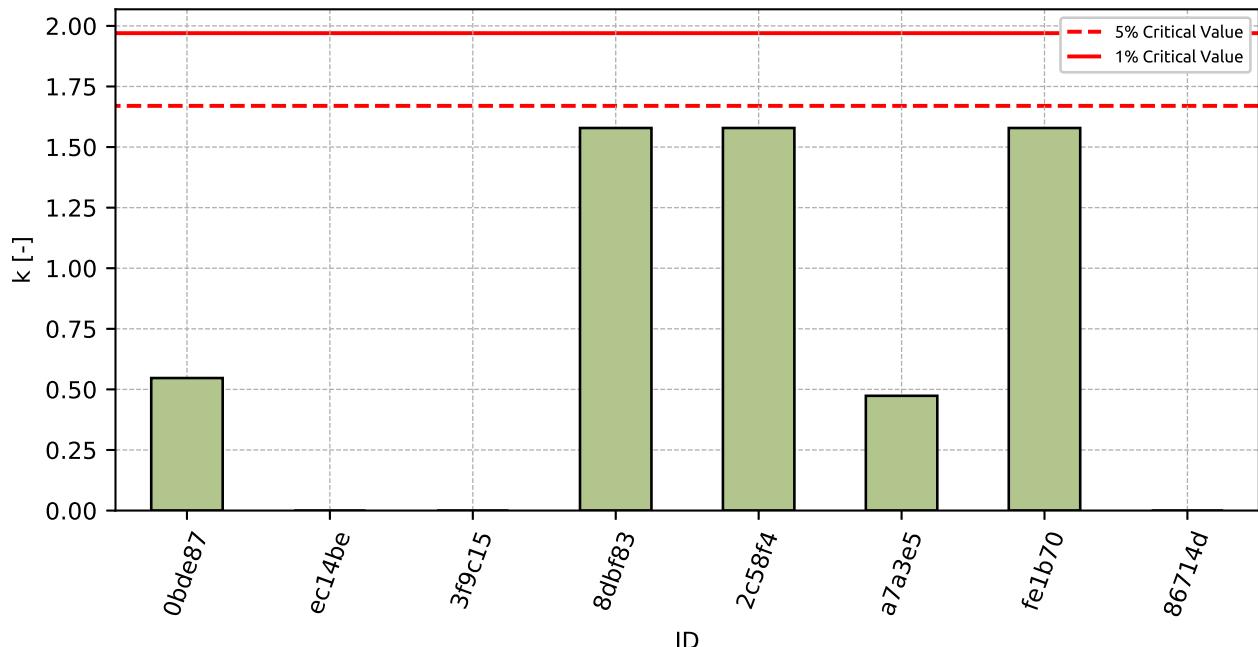
Figure 73: Intralaboratory Consistency Statistic
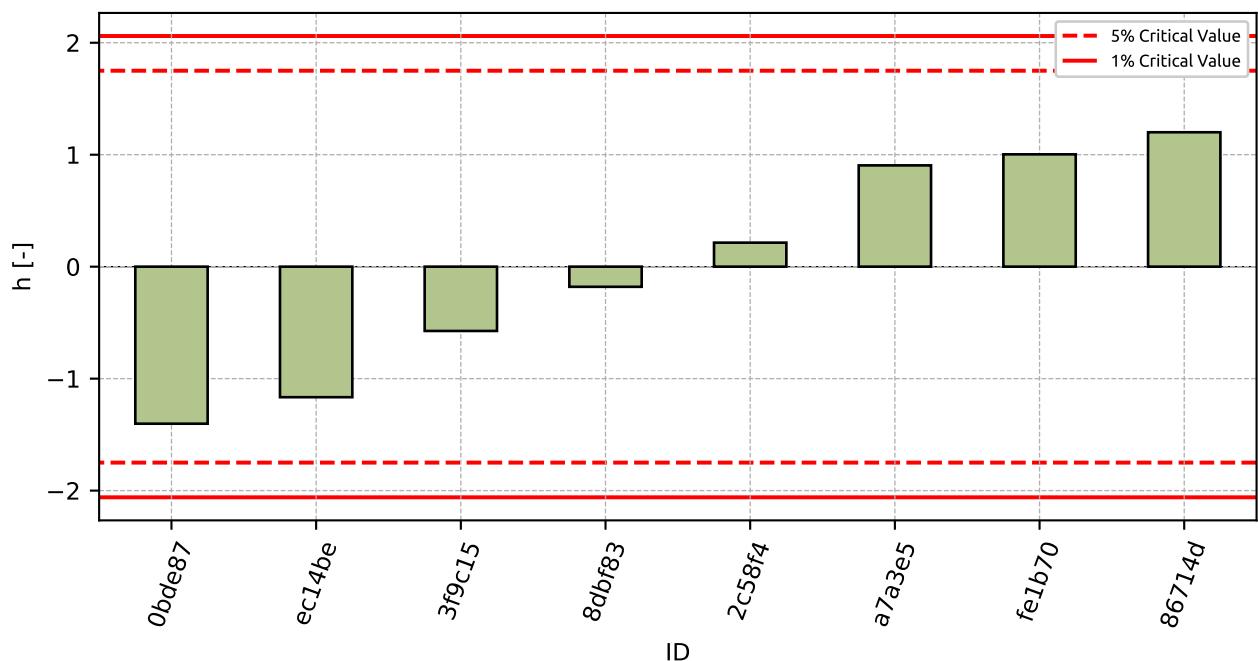
Figure 74: Interlaboratory Consistency Statistic

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2.4 Descriptive statistics
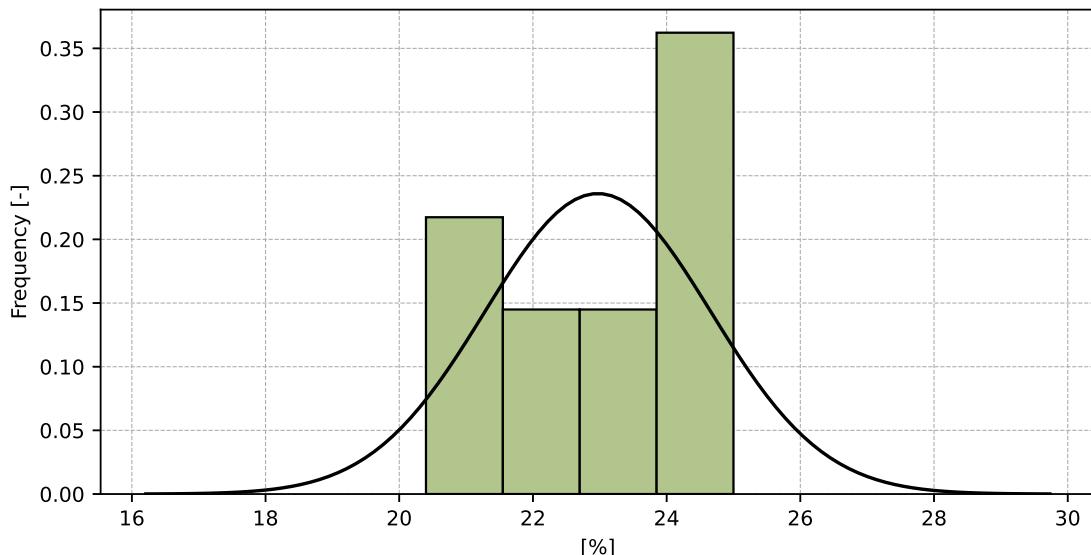
Figure 75: Histogram of all test results

Table 27: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	23.0
Sample standard deviation – s	1.69
Asigned value – x^*	23.0
Robust standard deviation – s^*	1.79
Measurement uncertainty of asigned value – u_X	0.79
p-value of normality test	0.014 [-]
Interlaboratory standard deviation – s_L	1.68
Repeatability standard deviation – s_r	0.37
Reproducibility standard deviation – s_R	1.72
Repeatability – r	1.0
Reproducibility – R	4.8

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2.5   Evaluation of Performance Statistics
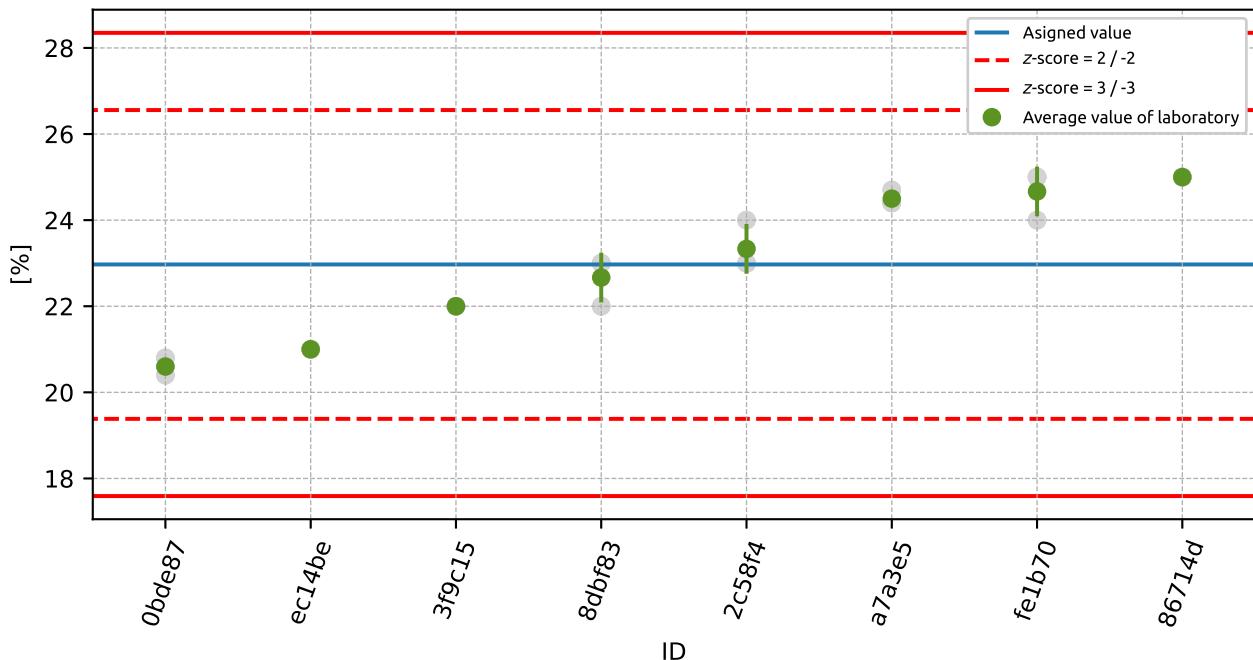

Figure 76: Average values and sample standard deviations
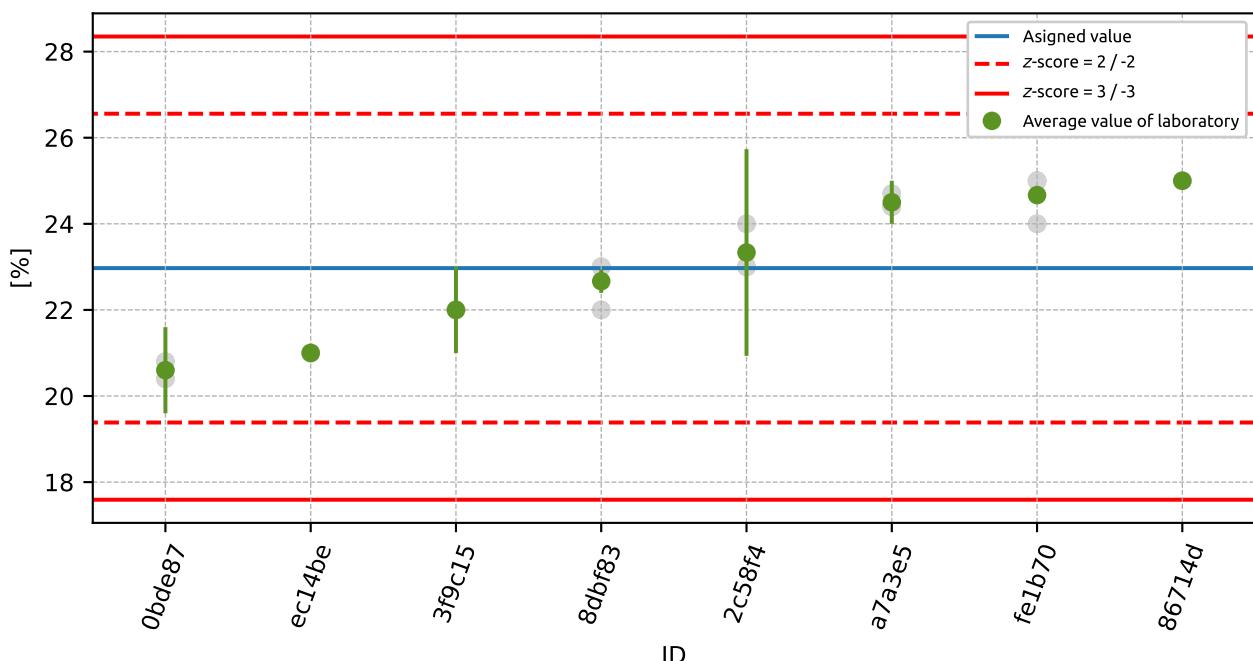
Figure 77: Average values and extended uncertainties of measurement

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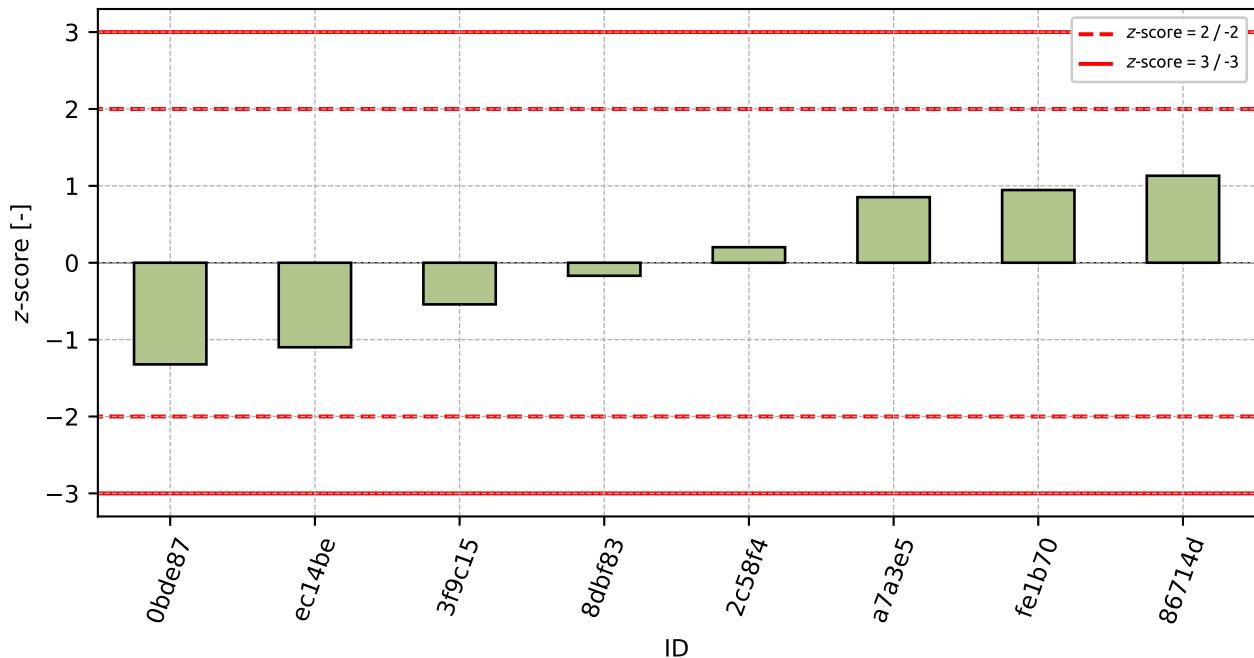
Figure 78: z-score

Figure 79: ζ-score

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75/163

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Table 28: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
0bde87	-1.32	-1.86
ec14be	-1.1	-
3f9c15	-0.54	-0.76
8dbf83	-0.17	-0.36
2c58f4	0.2	0.14
a7a3e5	0.85	1.63
fe1b70	0.95	-
86714d	1.13	-

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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 [%]
a27013	33.0	34.0	32.0	2.0	33.0	1.0	3.03
9020c7	34.5	34.7	34.5	2.5	34.6	0.12	0.33
228042	36.0	35.0	36.0	-	35.7	0.58	1.62
8f3a62	37.0	36.0	36.0	1.0	36.3	0.58	1.59
4f2532	36.1	35.6	37.3	-	36.3	0.87	2.4
1ce009	36.2	36.5	36.7	1.2	36.5	0.25	0.69
c53a30	37.0	37.0	37.0	1.7	37.0	0.0	0.0
8267dd	37.0	37.0	37.0	-	37.0	0.0	0.0
d4530f	37.6	37.4	37.6	2.4	37.5	0.12	0.31
d96997	37.0	38.0	39.0	0.3	38.0	1.0	2.63
6d687c	38.0	37.0	39.0	2.5	38.0	1.0	2.63
ec14be	38.0	38.0	38.0	-	38.0	0.0	0.0
a259ca	39.0	38.0	38.0	0.5	38.3	0.58	1.51
fe1b70	40.0	40.0	39.0	-	39.7	0.58	1.46
42b389	40.0	39.0	40.0	-	39.7	0.58	1.46
a7a3e5	40.2	39.4	40.3	0.4	40.0	0.49	1.23
38a7ee	39.0	39.0	42.0	1.0	40.0	1.73	4.33
278e12	41.0	40.0	41.0	2.2	40.7	0.58	1.42
e64c92	41.0	41.0	41.0	5.0	41.0	0.0	0.0
e7e3b2	41.0	42.0	40.0	5.0	41.0	1.0	2.44
e5d49b	41.2	41.7	43.2	2.9	42.0	1.04	2.48
7346a5	41.0	45.0	43.0	4.4	43.0	2.0	4.65
4faf4d	43.0	45.0	44.0	2.4	44.0	1.0	2.27

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3.2   The Numerical Procedure for Determining Outliers
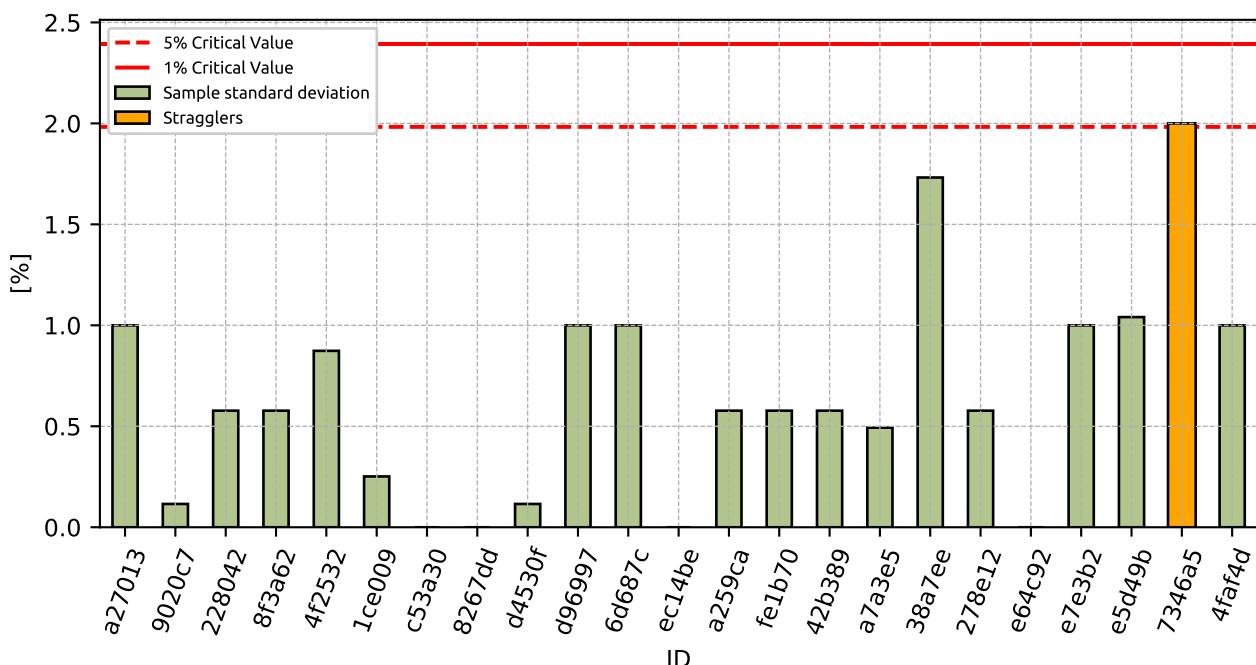
Figure 80: **Cochran's test** - sample standard deviations
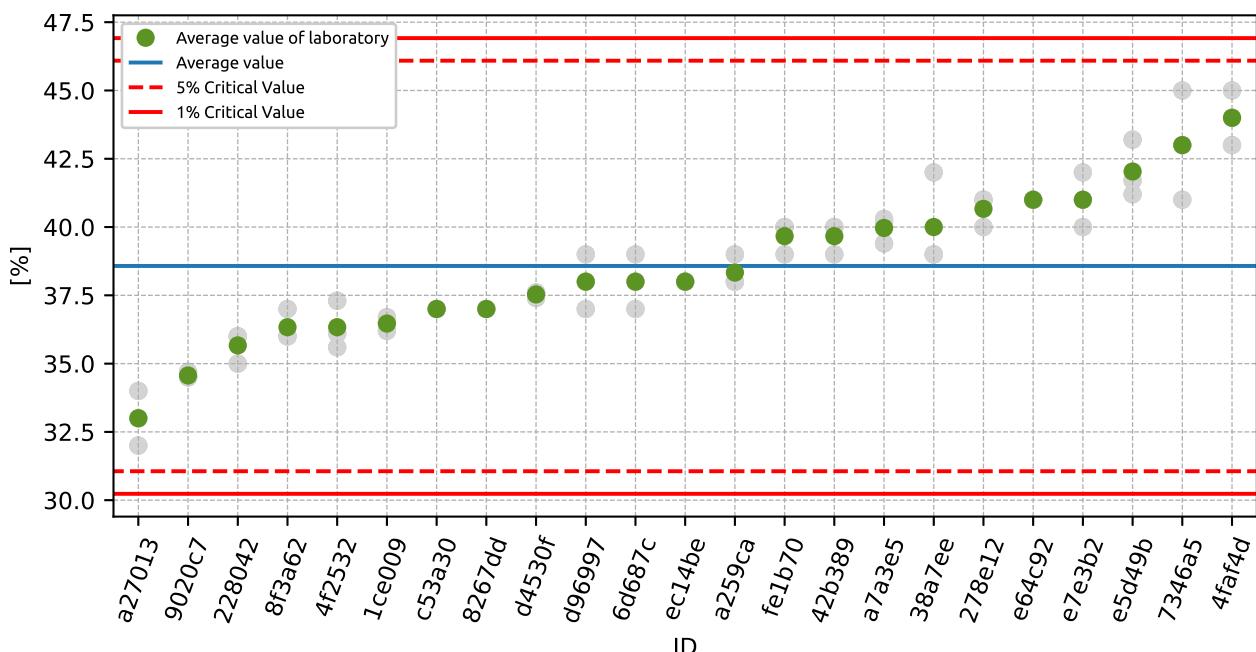
Figure 81: **Grubbs' test** - average values

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3.3   Mandel′s Statistics
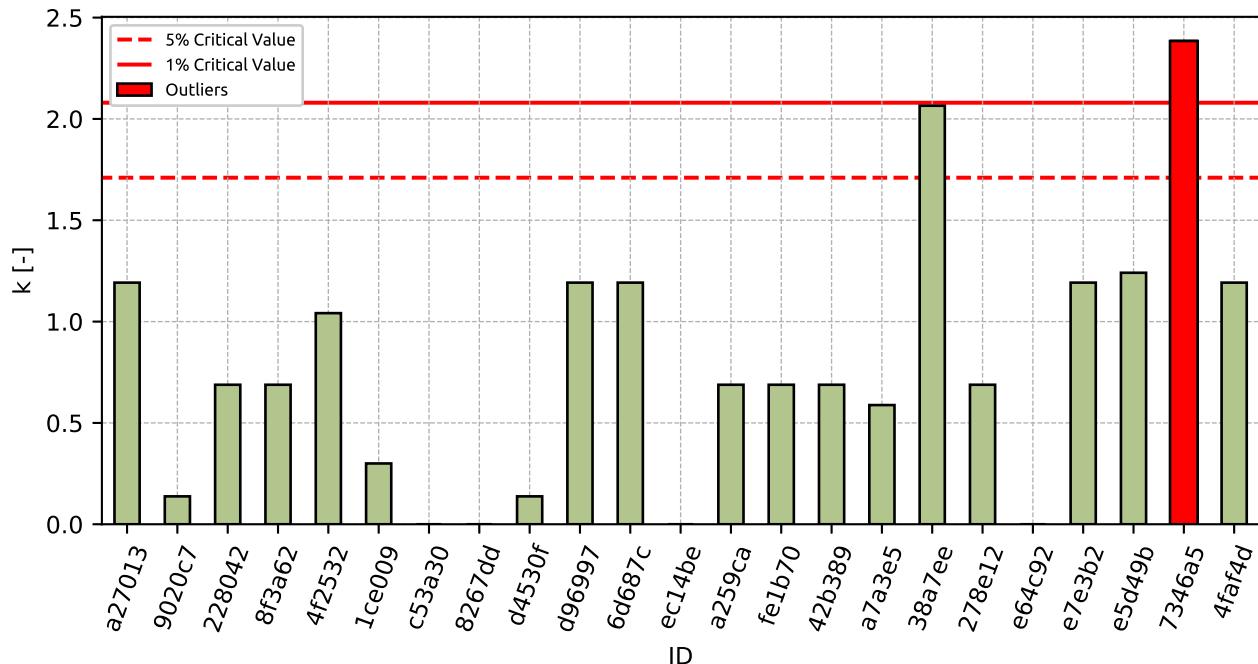
Figure 82: Intralaboratory Consistency Statistic
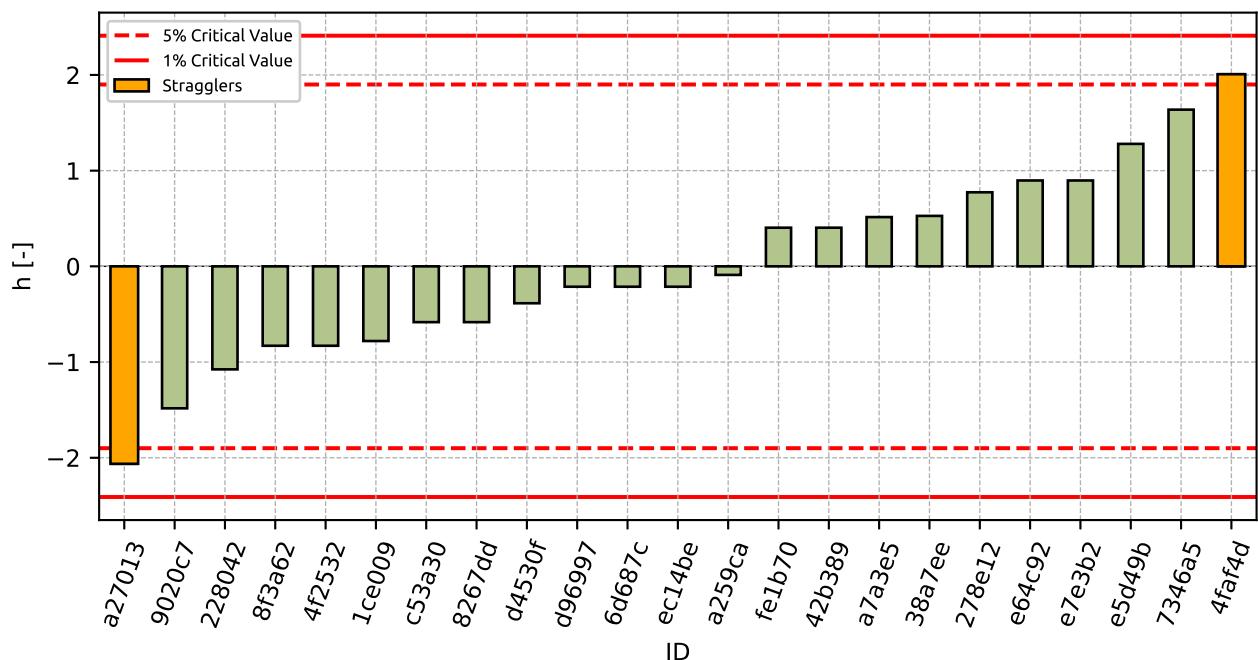
Figure 83: Interlaboratory Consistency Statistic

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3.4 Descriptive statistics
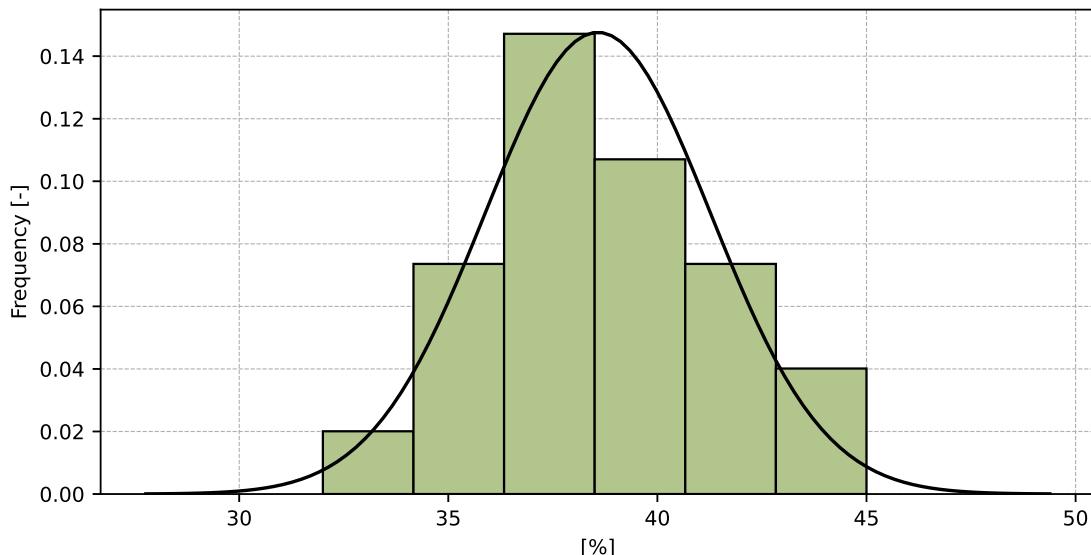
Figure 84: Histogram of all test results

Table 30: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	38.6
Sample standard deviation – s	2.7
Asigned value – x^*	38.6
Robust standard deviation – s^*	2.79
Measurement uncertainty of asigned value – u_X	0.72
p-value of normality test	0.616 [-]
Interlaboratory standard deviation – s_L	2.66
Repeatability standard deviation – s_r	0.84
Reproducibility standard deviation – s_R	2.79
Repeatability – r	2.3
Reproducibility – R	7.8

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3.5   Evaluation of Performance Statistics
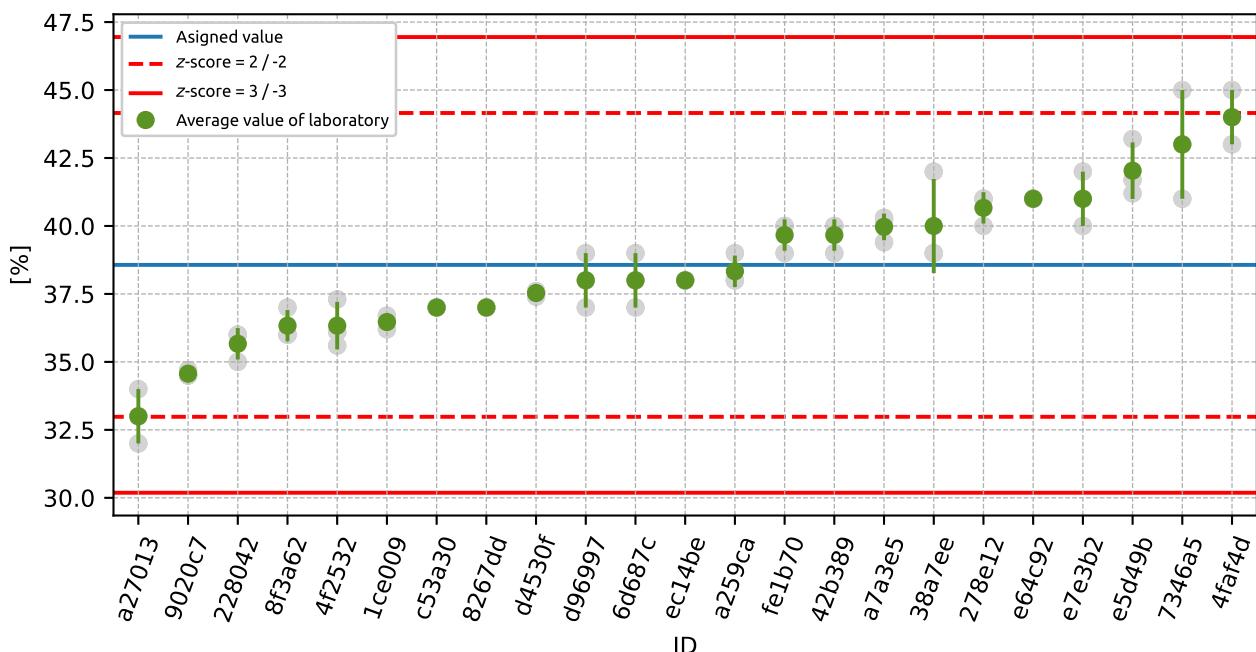
Figure 85: Average values and sample standard deviations
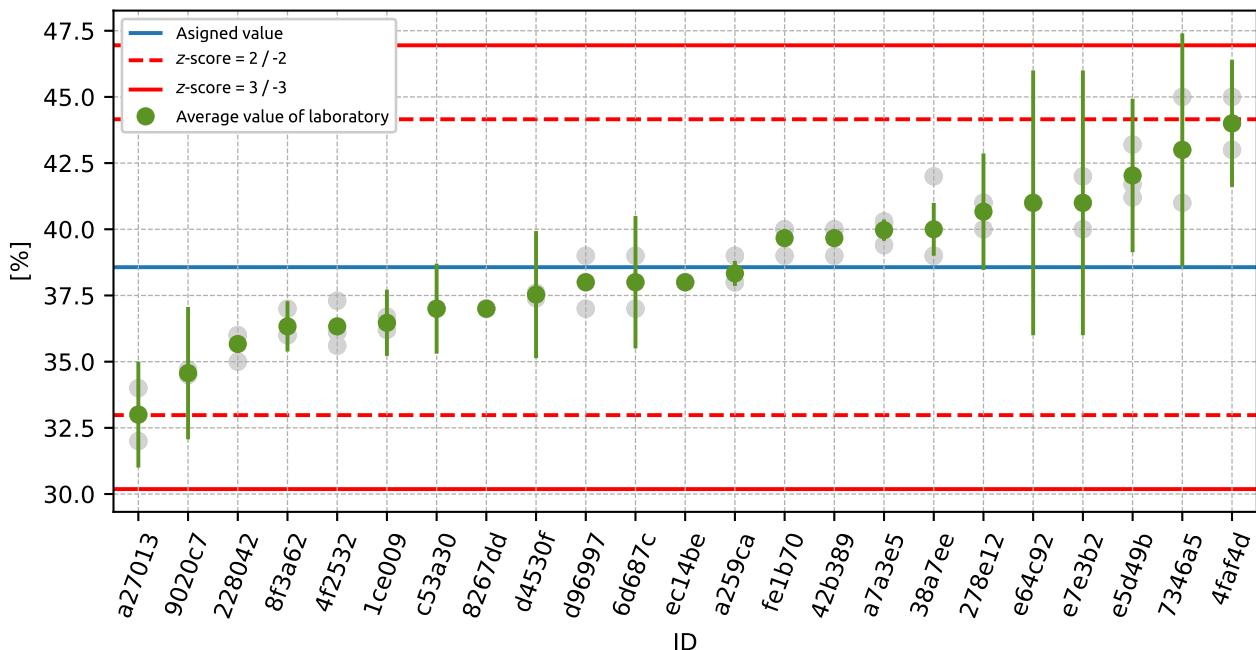
Figure 86: Average values and extended uncertainties of measurement

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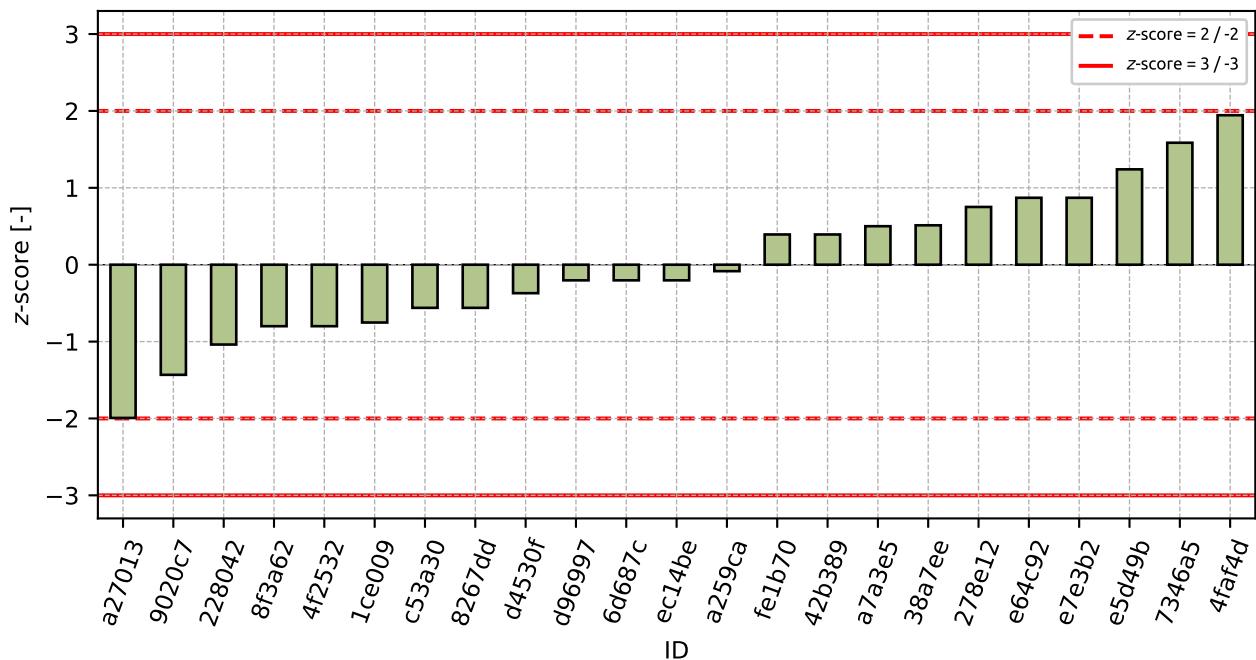
Figure 87: z-score

Figure 88: ζ-score

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Table 31: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a27013	-1.99	-2.62
9020c7	-1.43	-1.54
228042	-1.04	-
8f3a62	-0.8	-1.88
4f2532	-0.8	-
1ce009	-0.75	-1.46
c53a30	-0.56	-0.85
8267dd	-0.56	-
d4530f	-0.37	-0.41
d96997	-0.2	-0.73
6d687c	-0.2	-0.22
ec14be	-0.2	-
a259ca	-0.08	-0.27
fe1b70	0.39	-
42b389	0.39	-
a7a3e5	0.5	1.71
38a7ee	0.51	1.16
278e12	0.75	0.91
e64c92	0.87	0.48
e7e3b2	0.87	0.48
e5d49b	1.24	1.16
7346a5	1.59	0.99
4faf4d	1.94	2.17

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83/163

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 [%]
8267dd	55.0	56.0	55.0	-	55.3	0.58	1.04
1ce009	55.0	57.0	57.0	2.7	56.3	1.15	2.05
9b4b63	57.1	57.5	58.1	1.3	57.6	0.5	0.87
8b4386	59.0	60.0	60.0	1.0	59.7	0.58	0.97
b96536	64.0	63.0	63.0	0.9	63.3	0.58	0.91
a9c83a	64.6	67.1	65.3	-	65.7	1.29	1.96
6d687c	70.0	71.0	70.0	3.0	70.3	0.58	0.82

4.2 The Numerical Procedure for Determining Outliers
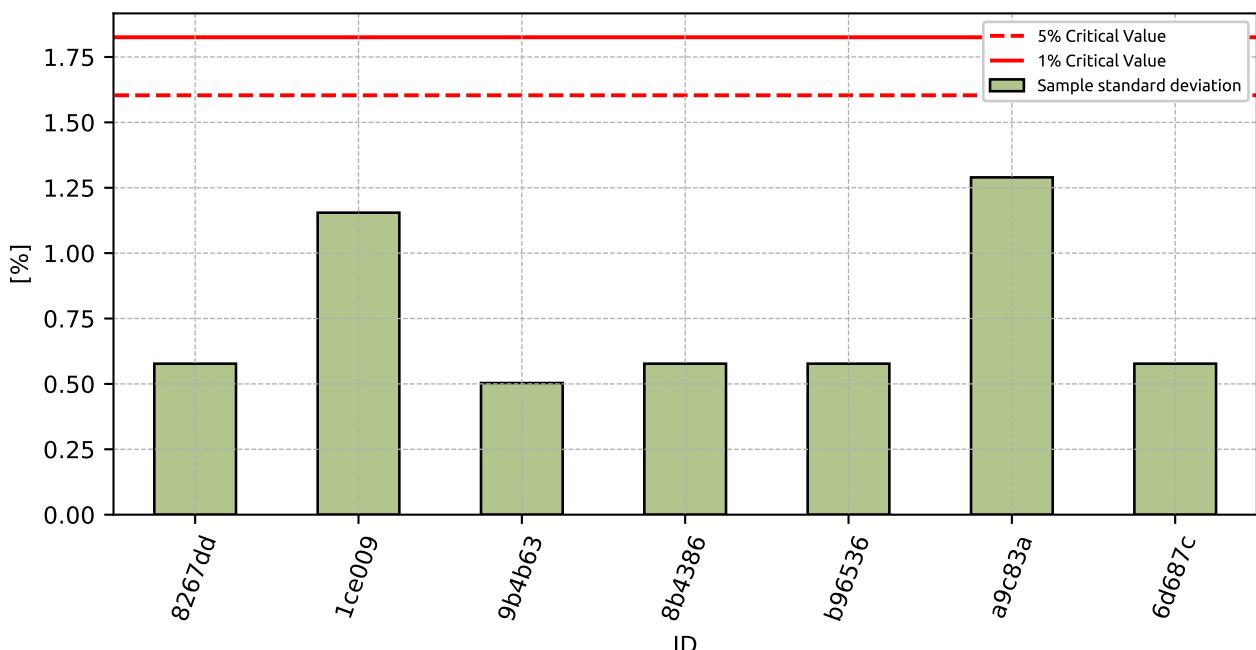

Figure 89: **Cochran's test** - sample standard deviations

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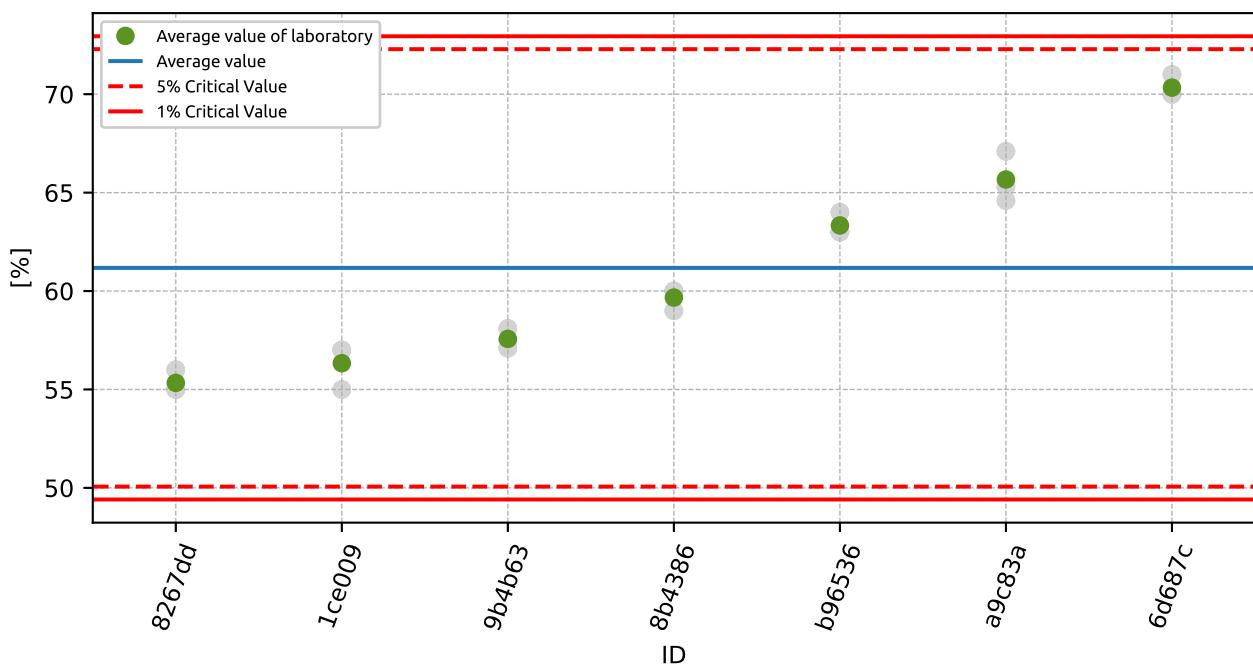
Figure 90: **Grubbs' test** - average values

4.3 Mandel's Statistics
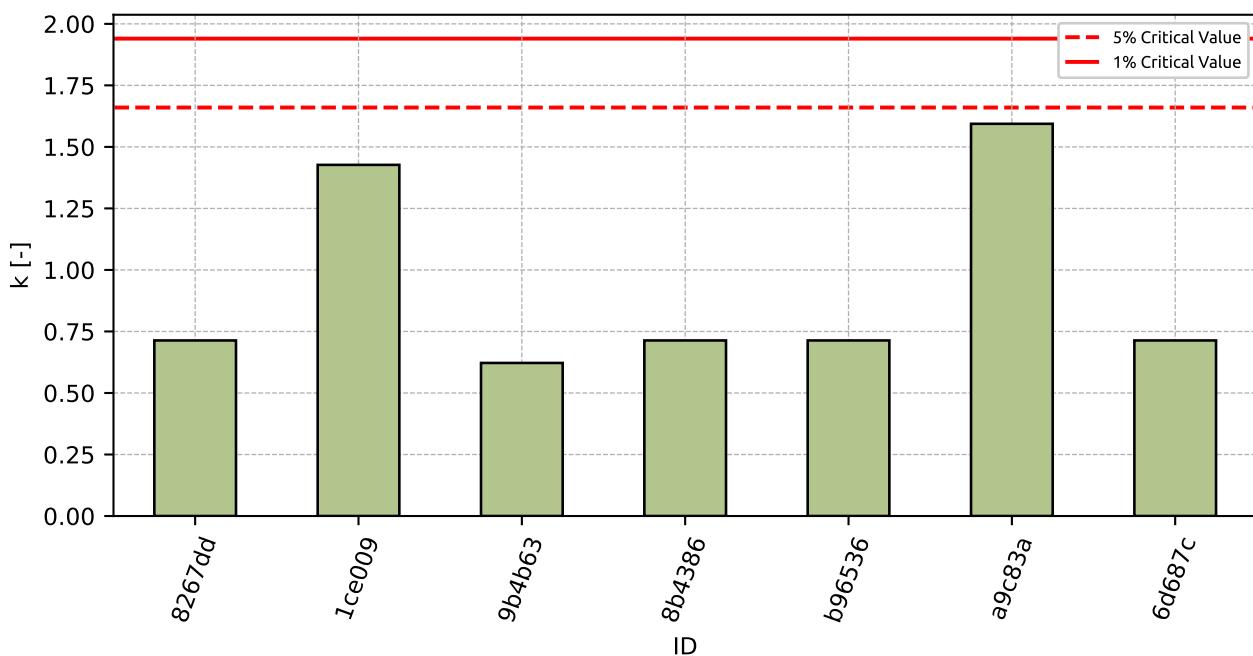
Figure 91: Intralaboratory Consistency Statistic

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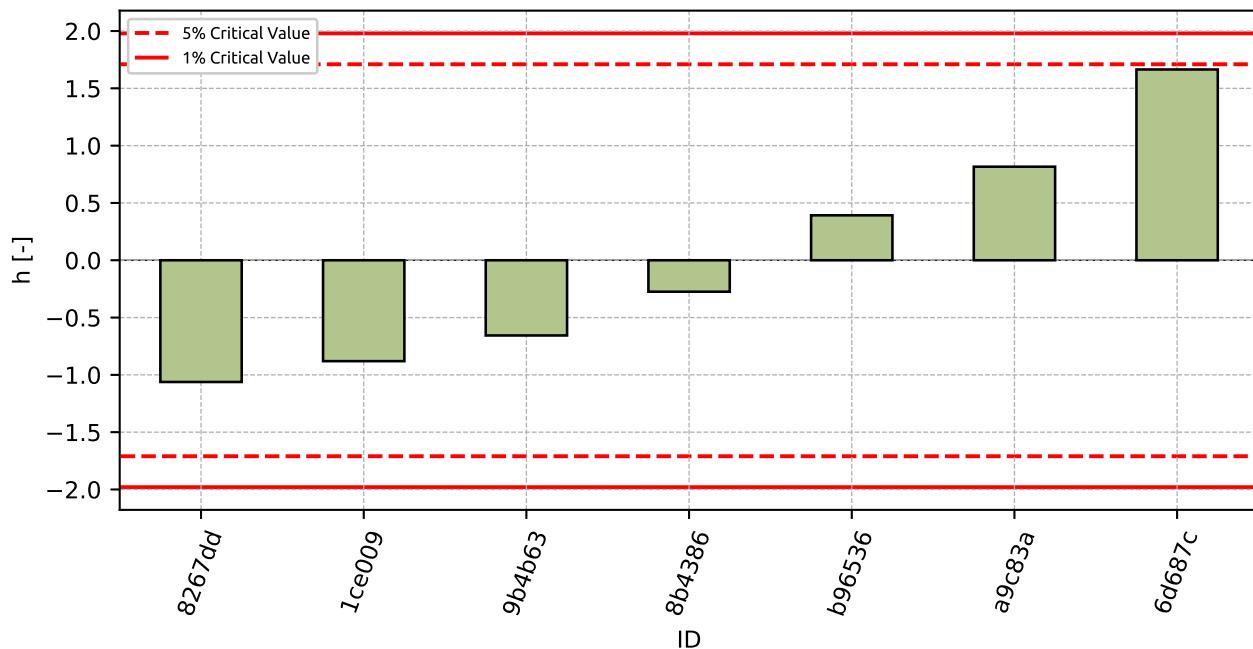
Figure 92: Interlaboratory Consistency Statistic

4.4 Descriptive statistics
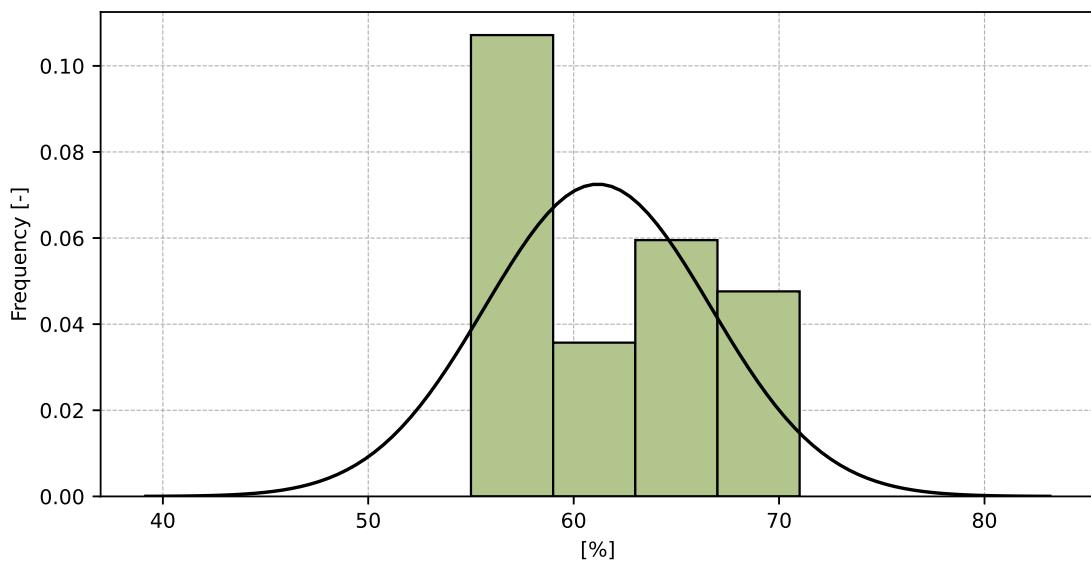
Figure 93: Histogram of all test results

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Table 33: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	61.2
Sample standard deviation – s	5.5
Asigned value – x^*	61.2
Robust standard deviation – s^*	5.78
Measurement uncertainty of asigned value – u_X	2.73
p-value of normality test	0.044 [-]
Interlaboratory standard deviation – s_L	5.48
Repeatability standard deviation – s_r	0.81
Reproducibility standard deviation – s_R	5.54
Repeatability – r	2.3
Reproducibility – R	15.5

4.5 Evaluation of Performance Statistics
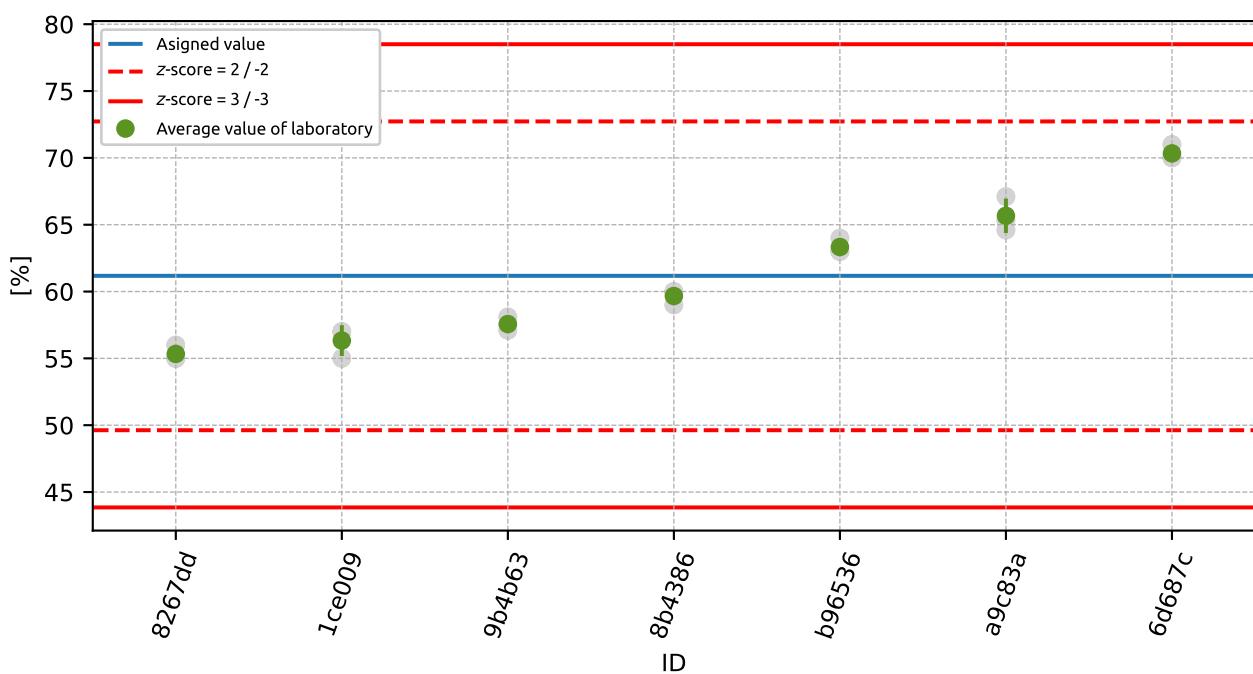

Figure 94: Average values and sample standard deviations

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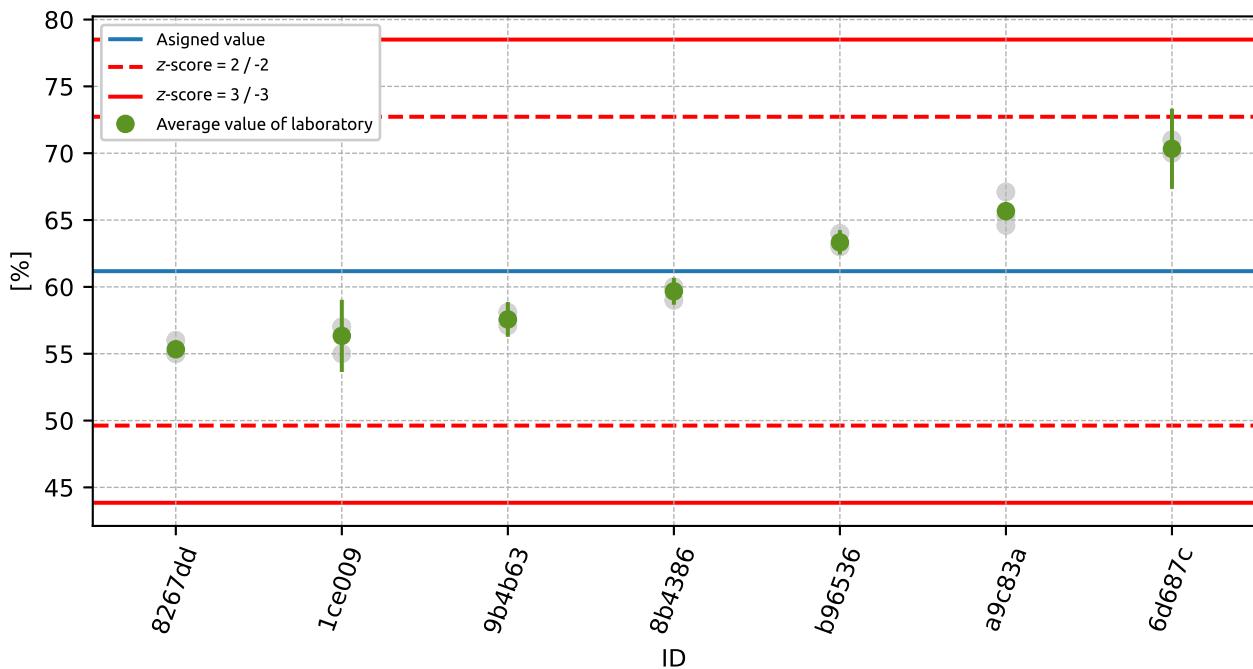
Figure 95: Average values and extended uncertainties of measurement

Figure 96: z-score

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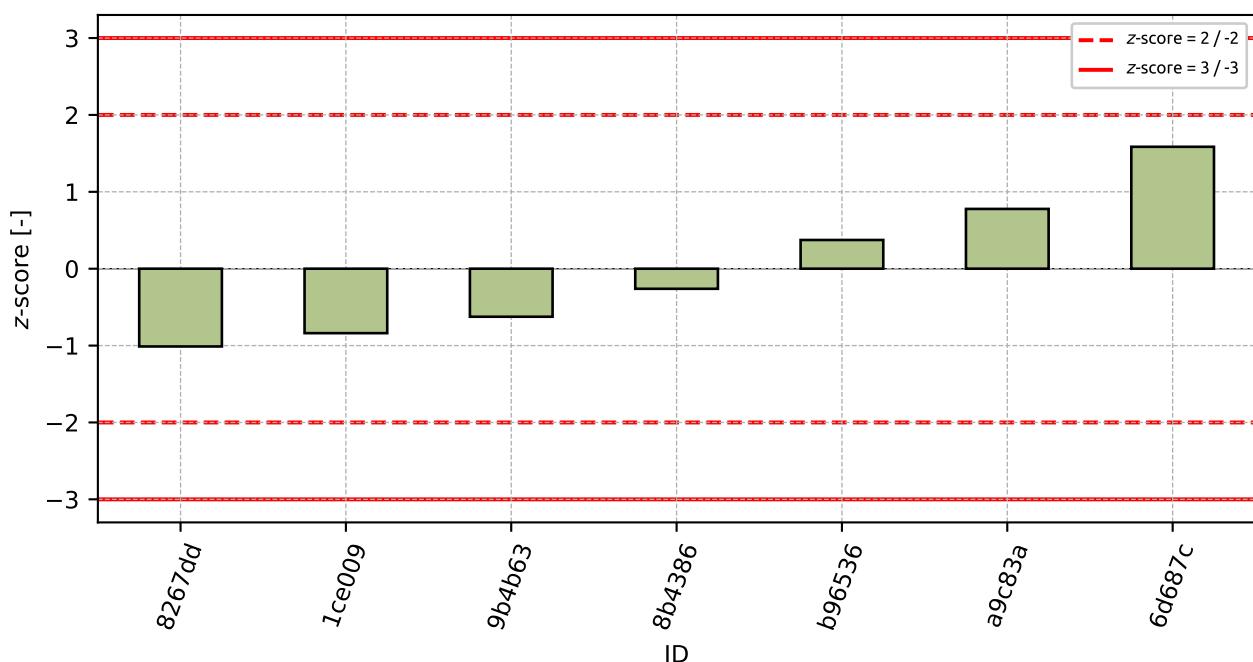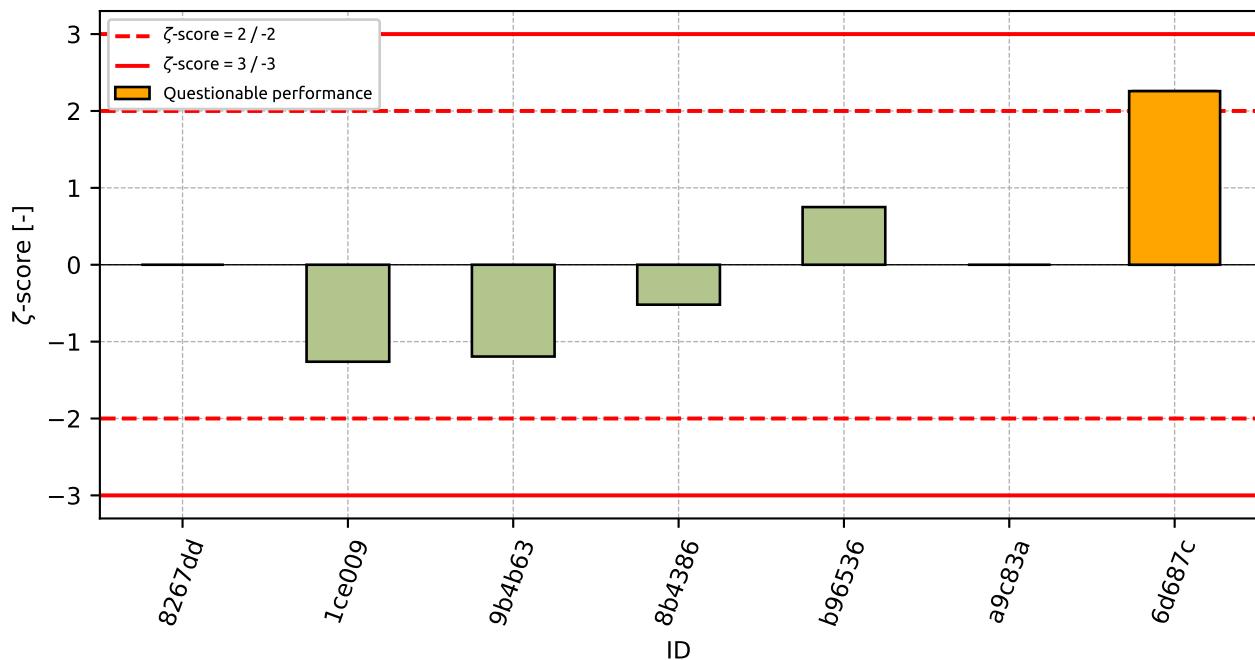
Figure 97: ζ-score

Table 34: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8267dd	-1.01	-
1ce009	-0.84	-1.26
9b4b63	-0.62	-1.19
8b4386	-0.26	-0.52
b96536	0.37	0.75
a9c83a	0.78	-
6d687c	1.59	2.26

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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 [%]
1e7fc1	0.2	0.2	0.2	0.0	0.2	0.0	0.0
42b389	1.7	1.5	1.6	-	1.6	0.1	6.25
6d687c	1.8	1.8	1.8	0.2	1.8	0.03	1.63
0bde87	2.0	2.1	2.0	0.2	2.0	0.06	2.84
6f05cd	2.1	2.1	2.0	-	2.1	0.06	2.79
80076b	2.2	2.0	2.1	0.1	2.1	0.1	4.76
2c58f4	2.2	2.2	2.1	0.1	2.2	0.06	2.66
b96536	2.2	2.2	2.2	0.1	2.2	0.0	0.0
5cab48	2.3	2.3	2.3	0.2	2.3	0.0	0.0
c9969b	2.5	2.5	2.5	0.2	2.5	0.0	0.0
ec14be	2.8	2.7	2.9	-	2.8	0.1	3.57

5.2   The Numerical Procedure for Determining Outliers
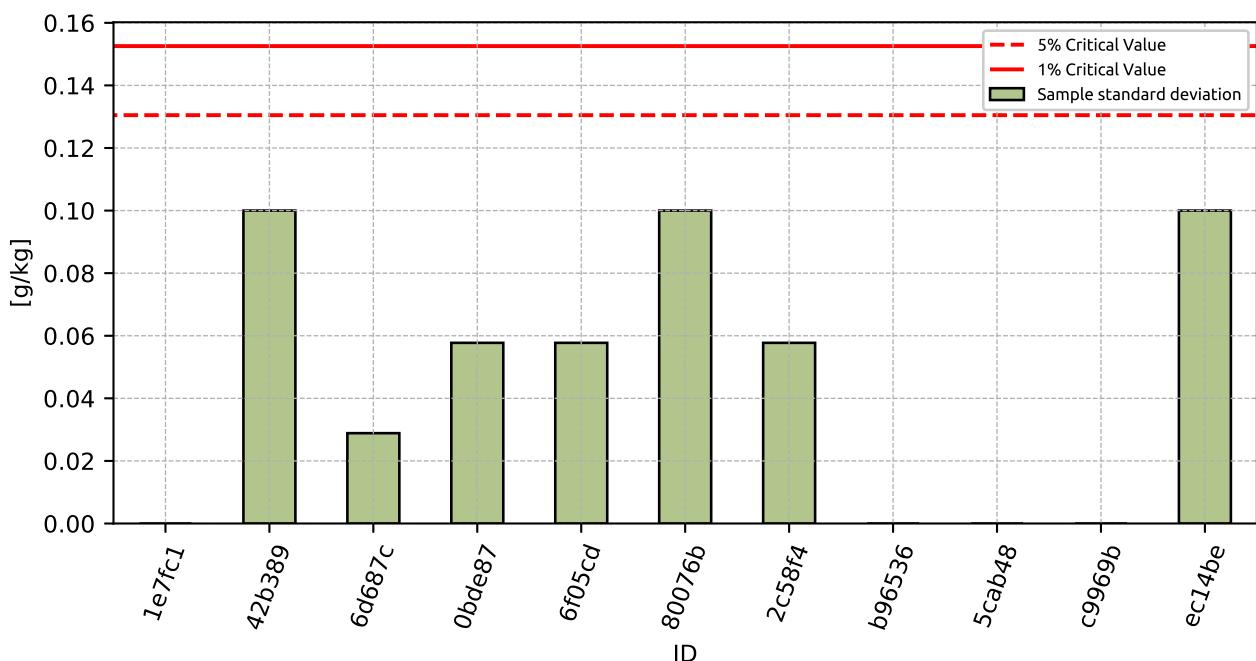
Figure 98: **Cochran's test** - sample standard deviations

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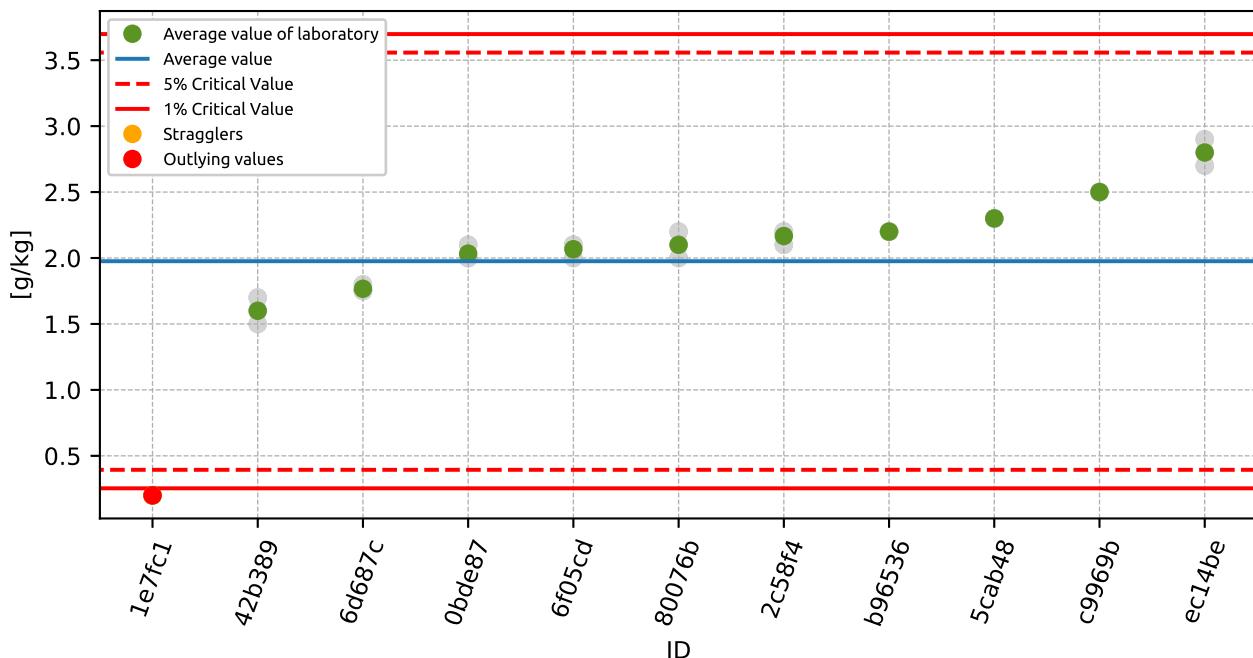
Figure 99: **Grubbs' test** - average values
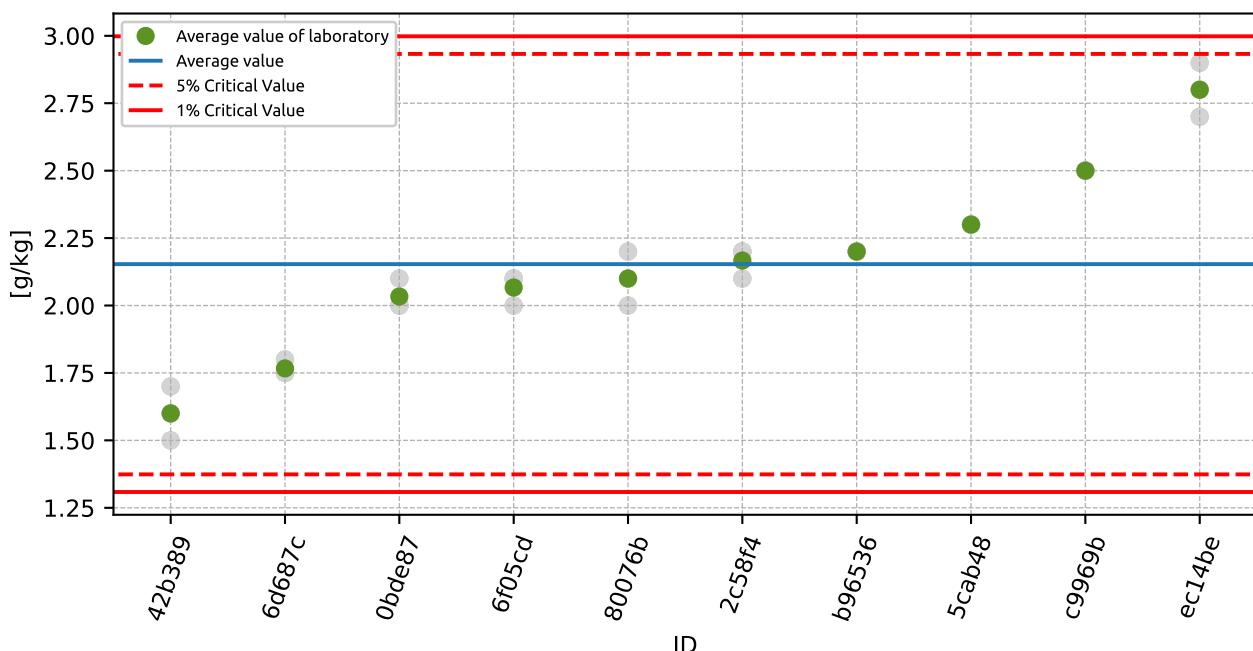
Figure 100: **Grubbs' test** - average values without outliers

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5.3   Mandel′s Statistics
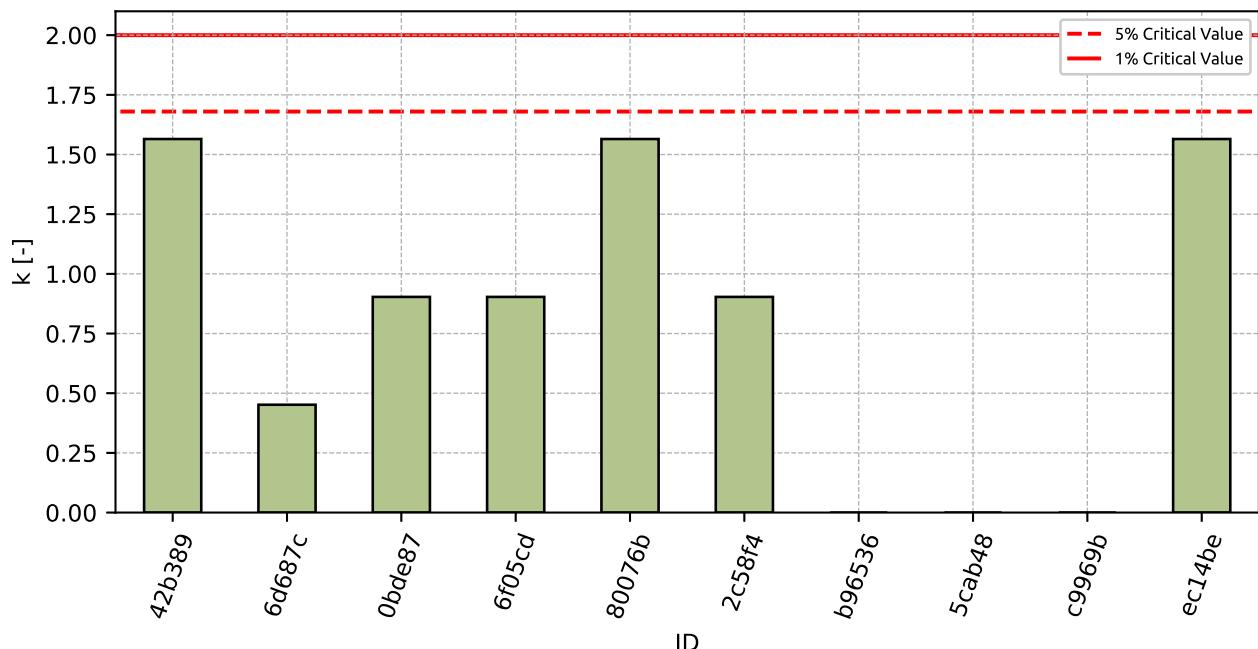
Figure 101: Intralaboratory Consistency Statistic
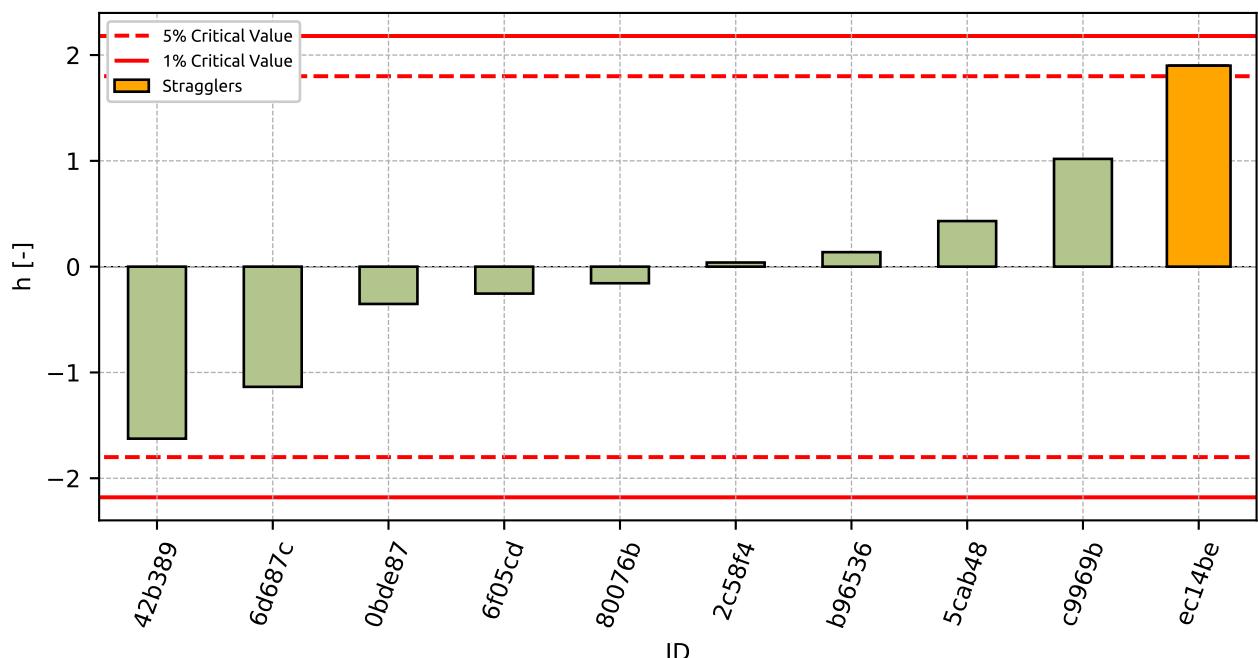
Figure 102: Interlaboratory Consistency Statistic

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5.4   Descriptive statistics
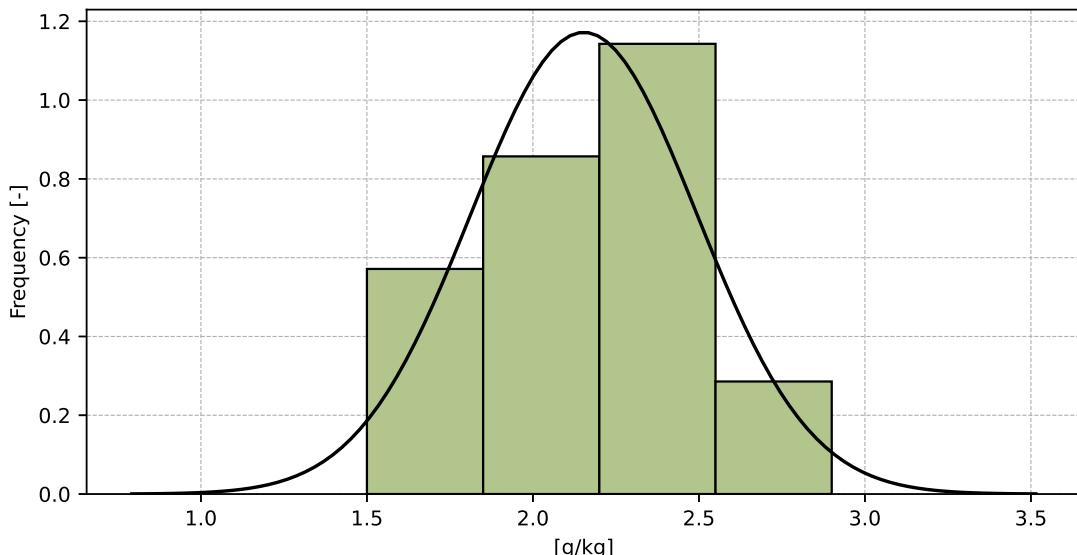
Figure 103: Histogram of all test results

Table 36: Descriptive statistics

Characteristics	[g/kg]
Average value – $\bar{x}$	2.2
Sample standard deviation – s	0.34
Asigned value – x^*	2.2
Robust standard deviation – s^*	0.32
Measurement uncertainty of asigned value – u_X	0.12
p-value of normality test	0.441 [-]
Interlaboratory standard deviation – s_L	0.34
Repeatability standard deviation – s_r	0.06
Reproducibility standard deviation – s_R	0.34
Repeatability – r	0.2
Reproducibility – R	1.0

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5.5   Evaluation of Performance Statistics
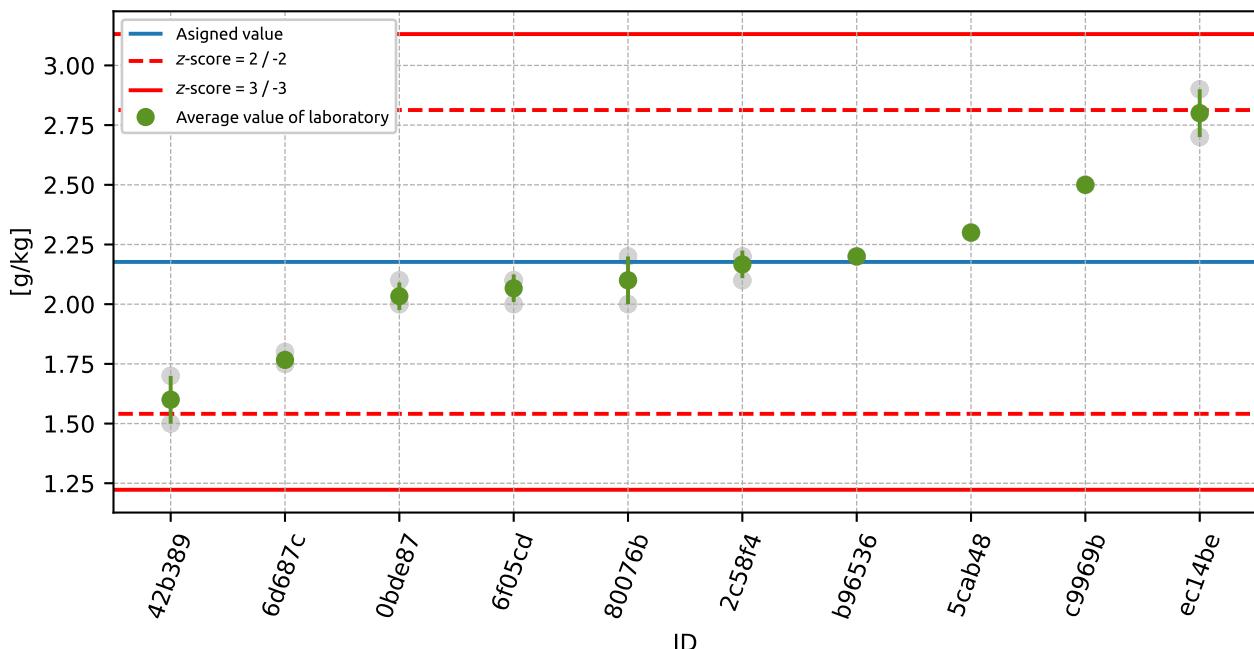

Figure 104: Average values and sample standard deviations
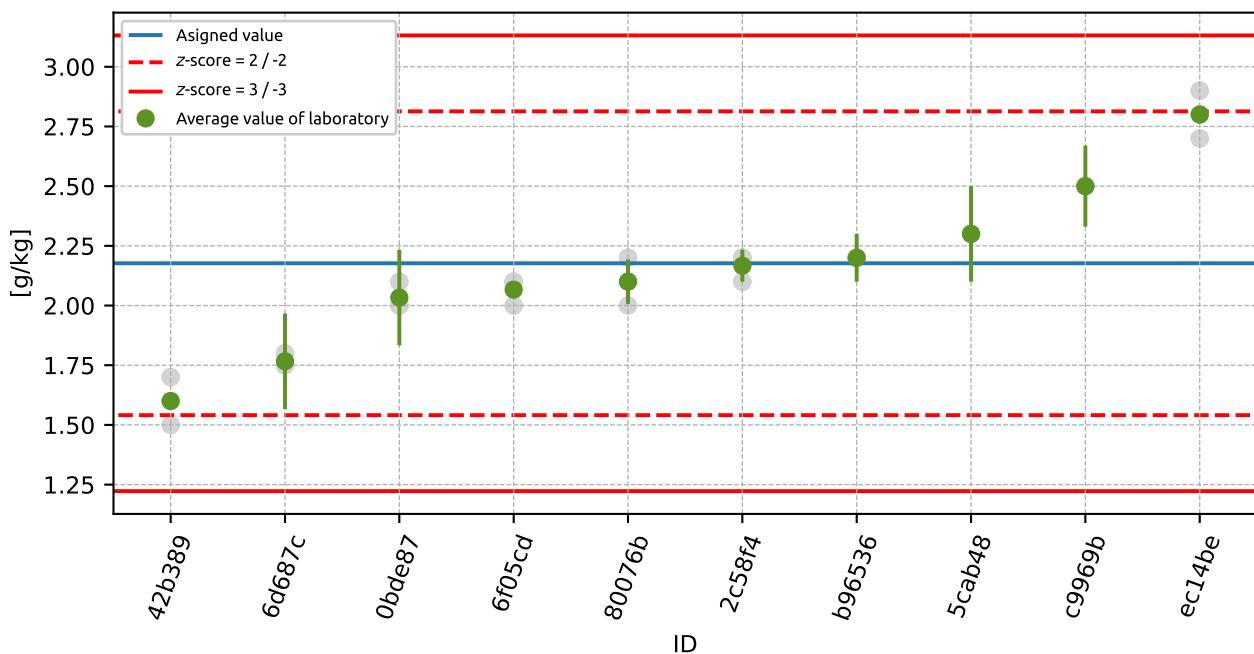
Figure 105: Average values and extended uncertainties of measurement

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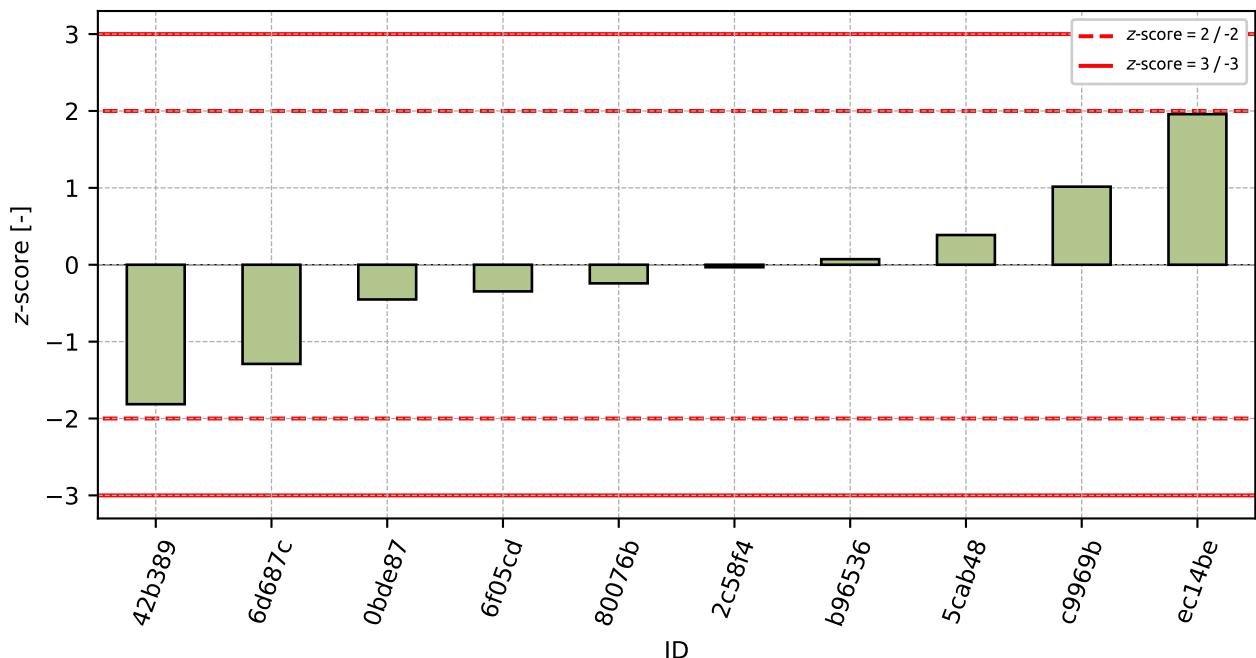
Figure 106: z-score

Figure 107: ζ-score

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Table 37: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
42b389	-1.81	-
6d687c	-1.29	-1.75
0bde87	-0.45	-0.61
6f05cd	-0.35	-
80076b	-0.24	-0.5
2c58f4	-0.03	-0.07
b96536	0.07	0.15
5cab48	0.39	0.53
c9969b	1.02	1.54
ec14be	1.96	-

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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 [%]
b96536	100	100	100	0.0	100.0	0.0	0.0
8267dd	100	100	100	-	100.0	0.0	0.0
a5e1f6	100	100	100	-	100.0	0.0	0.0
4d51a8	100	100	100	0.3	100.0	0.0	0.0
048532	100	100	100	0.0	100.0	0.0	0.0

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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 [%]
4d51a8	97	97	97	0.3	97.0	0.0	0.0
048532	97	97	97	0.0	97.0	0.0	0.0
b96536	98	98	98	0.5	98.0	0.0	0.0
8267dd	98	98	98	-	98.0	0.0	0.0
a5e1f6	98	98	98	-	98.0	0.0	0.0

6.2.2　The Numerical Procedure for Determining Outliers
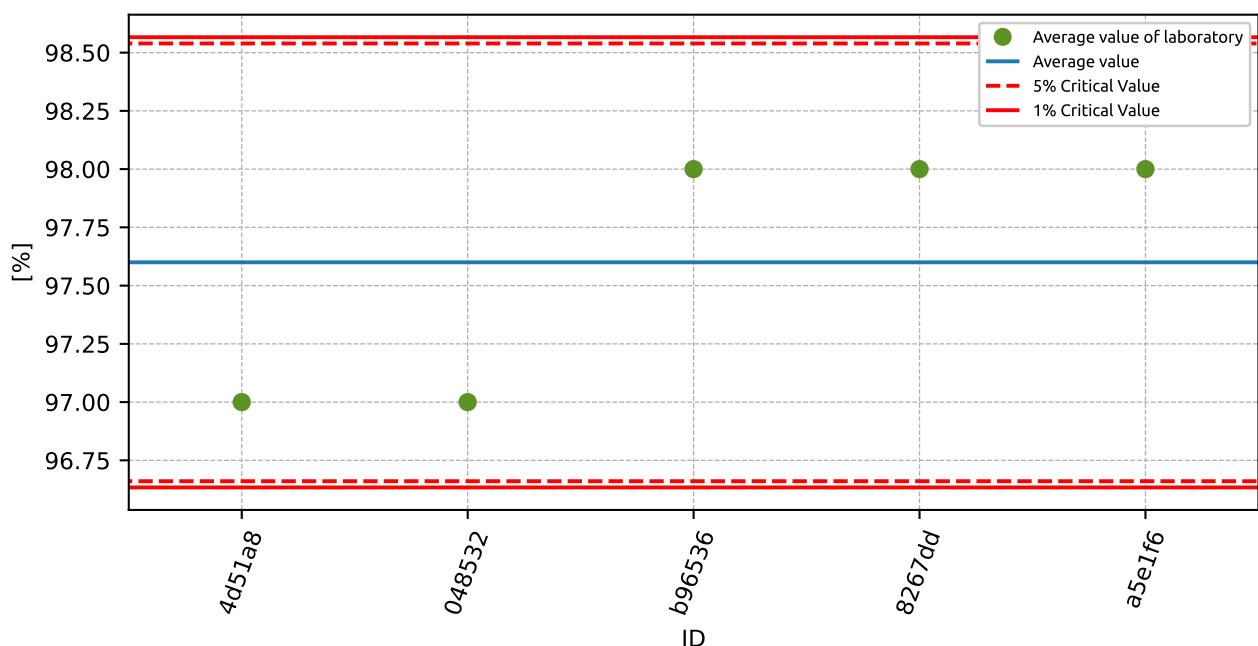
Figure 108: **Grubbs' test** - average values

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6.2.3 Mandel′s Statistics
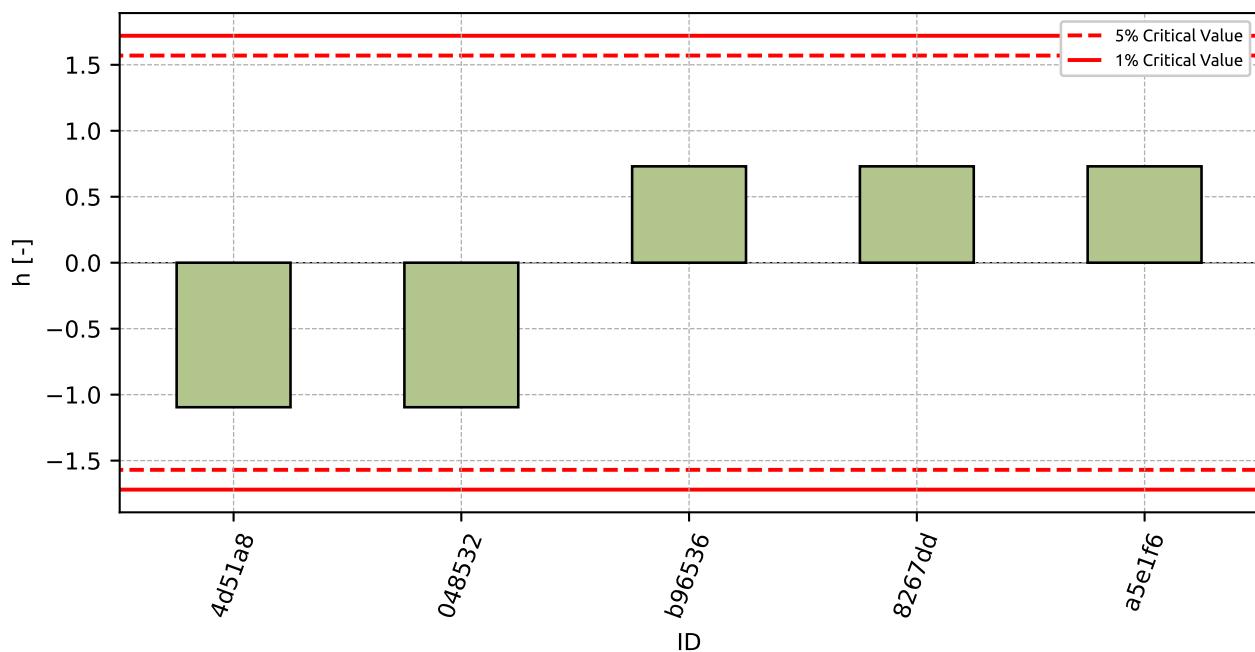
Figure 109: Interlaboratory Consistency Statistic

6.2.4 Descriptive statistics
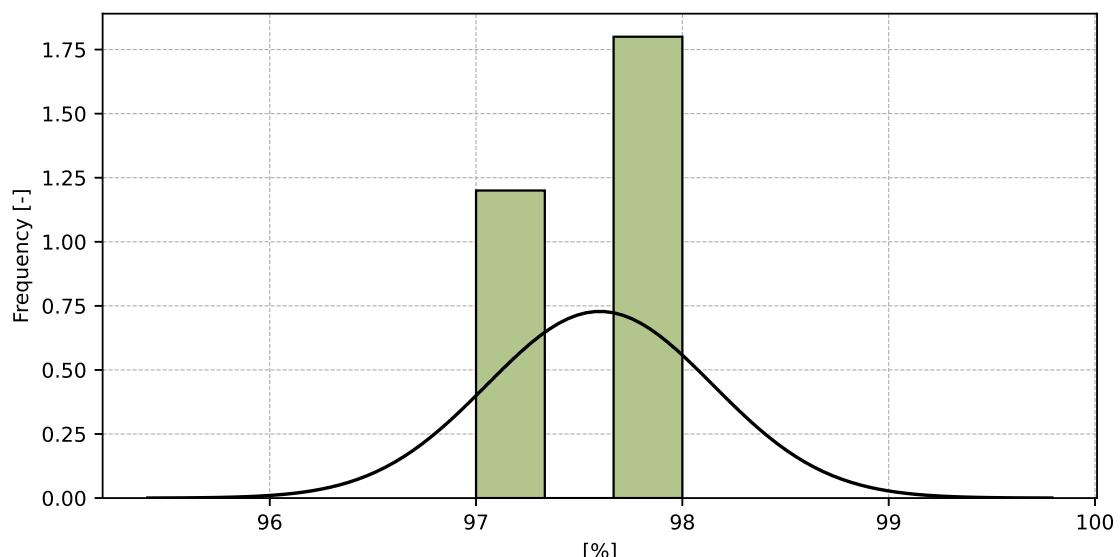
Figure 110: Histogram of all test results

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Table 40: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	97.6
Sample standard deviation – s	0.55
Asigned value – x^*	98.0
Robust standard deviation – s^*	0.0
Measurement uncertainty of asigned value – u_X	0.0
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.55
Repeatability standard deviation – s_r	0.0
Reproducibility standard deviation – s_R	0.55
Repeatability – r	0.0
Reproducibility – R	1.5

6.2.5 Evaluation of Performance Statistics
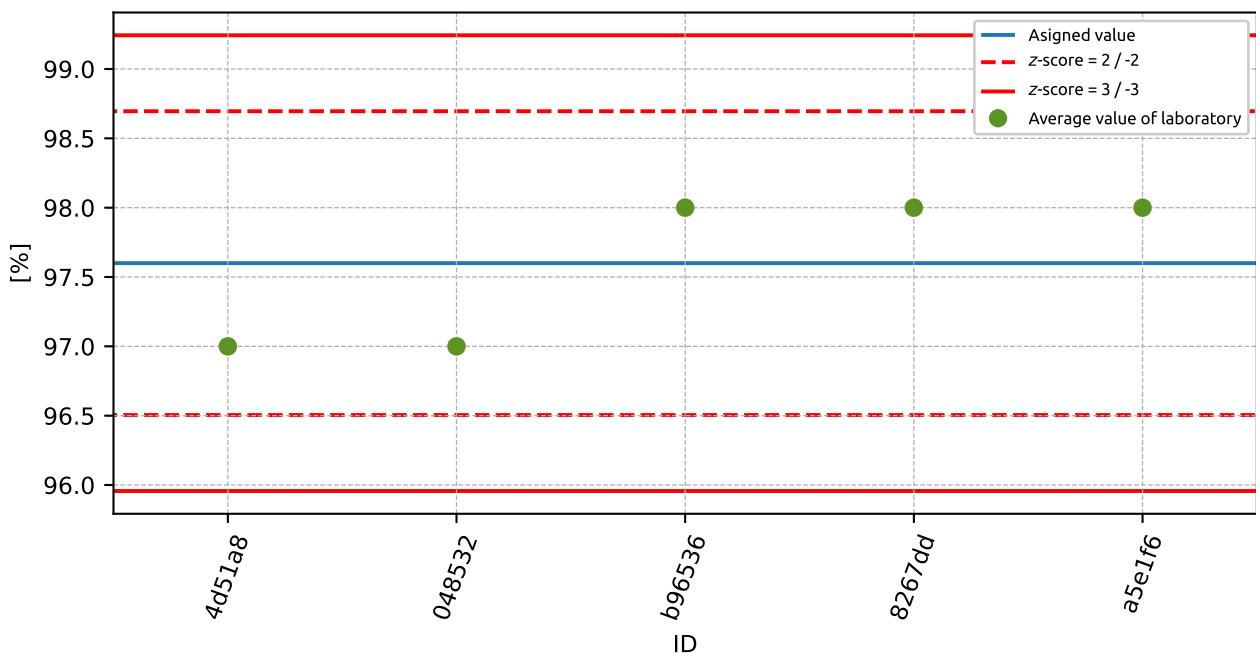

Figure 111: Average values and sample standard deviations

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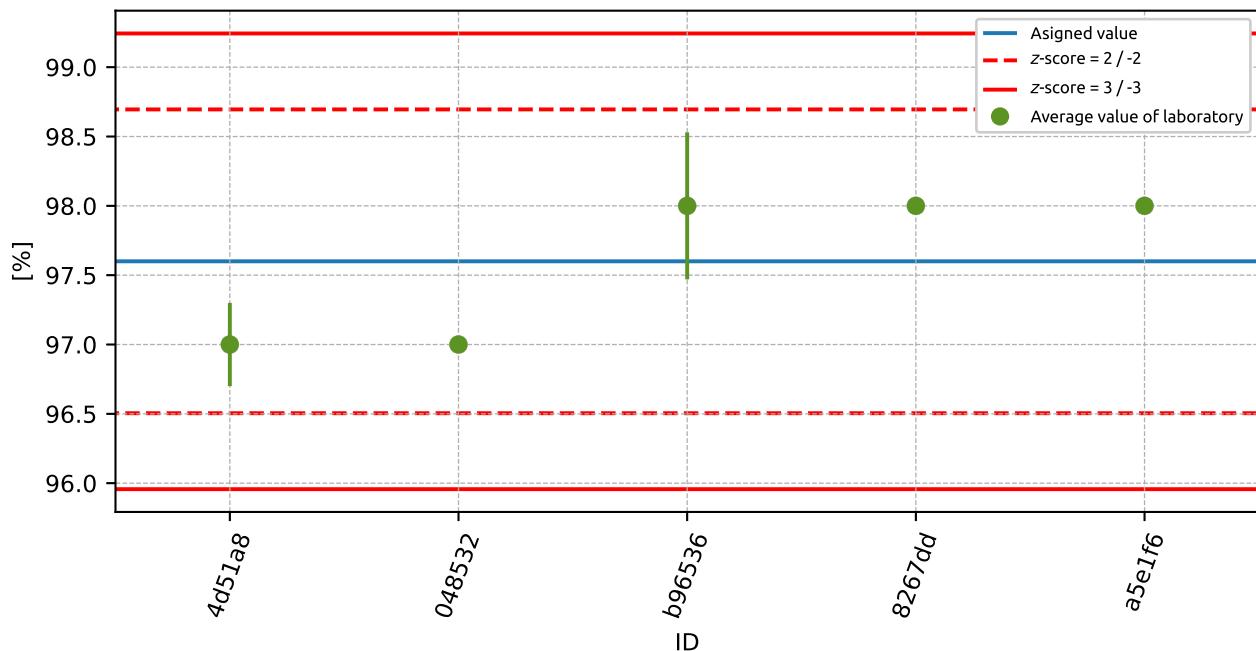
Figure 112: Average values and extended uncertainties of measurement

Figure 113: z-score

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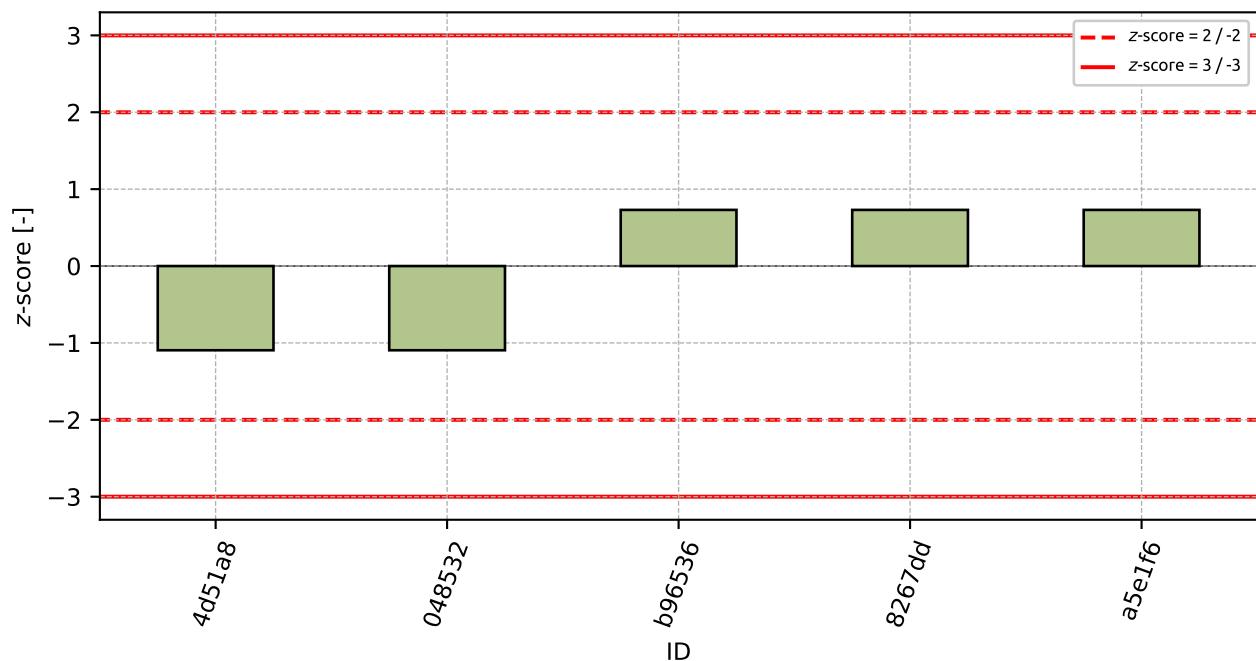
Figure 114: ζ-score
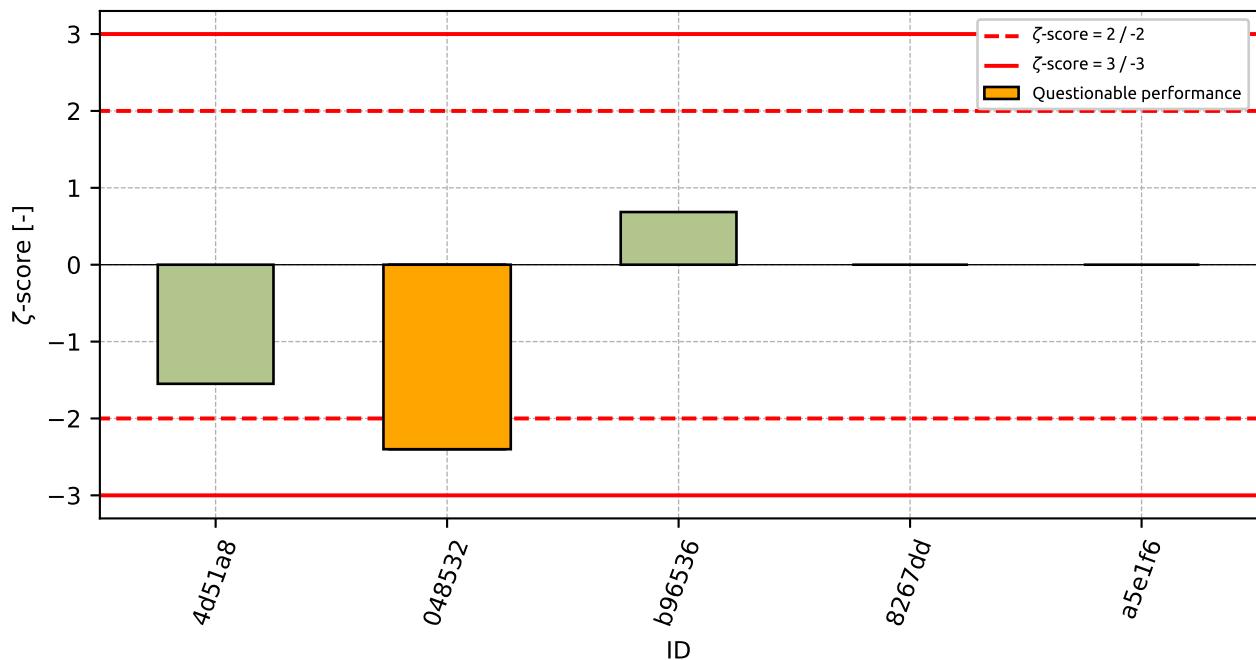
Table 41: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
4d51a8	-1.1	-1.55
048532	-1.1	-2.4
b96536	0.73	0.69
8267dd	0.73	-
a5e1f6	0.73	-

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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 [%]
048532	77	77	78	0.0	77.3	0.58	0.75
4d51a8	81	80	80	0.3	80.3	0.58	0.72
b96536	81	81	81	0.7	81.0	0.0	0.0
8267dd	81	81	81	-	81.0	0.0	0.0
a5e1f6	82	81	81	-	81.3	0.58	0.71

6.3.2   The Numerical Procedure for Determining Outliers
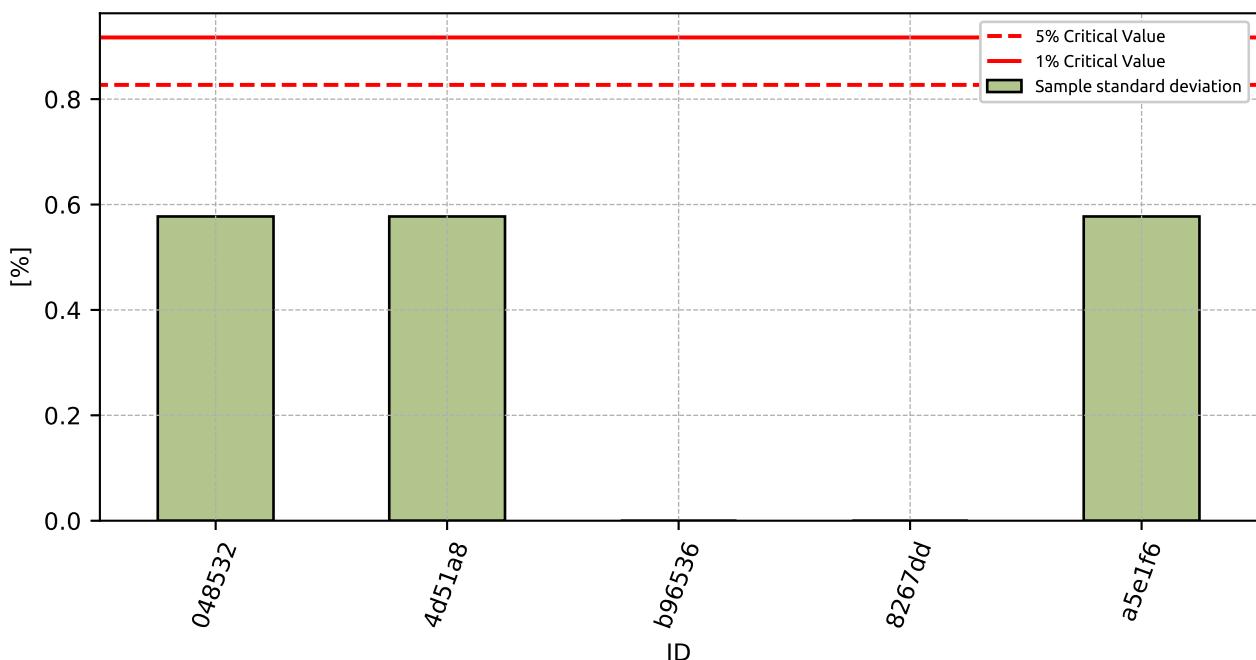
Figure 115: **Cochran's test** - sample standard deviations

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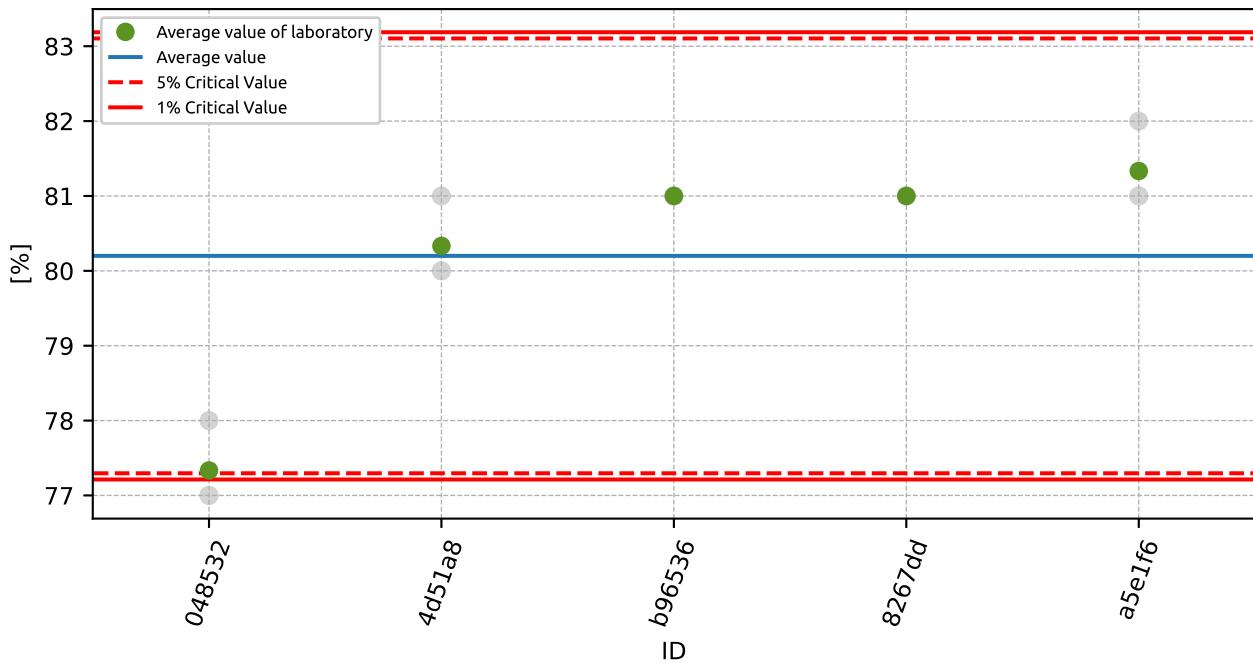
Figure 116: **Grubbs' test** - average values

6.3.3   Mandel's Statistics
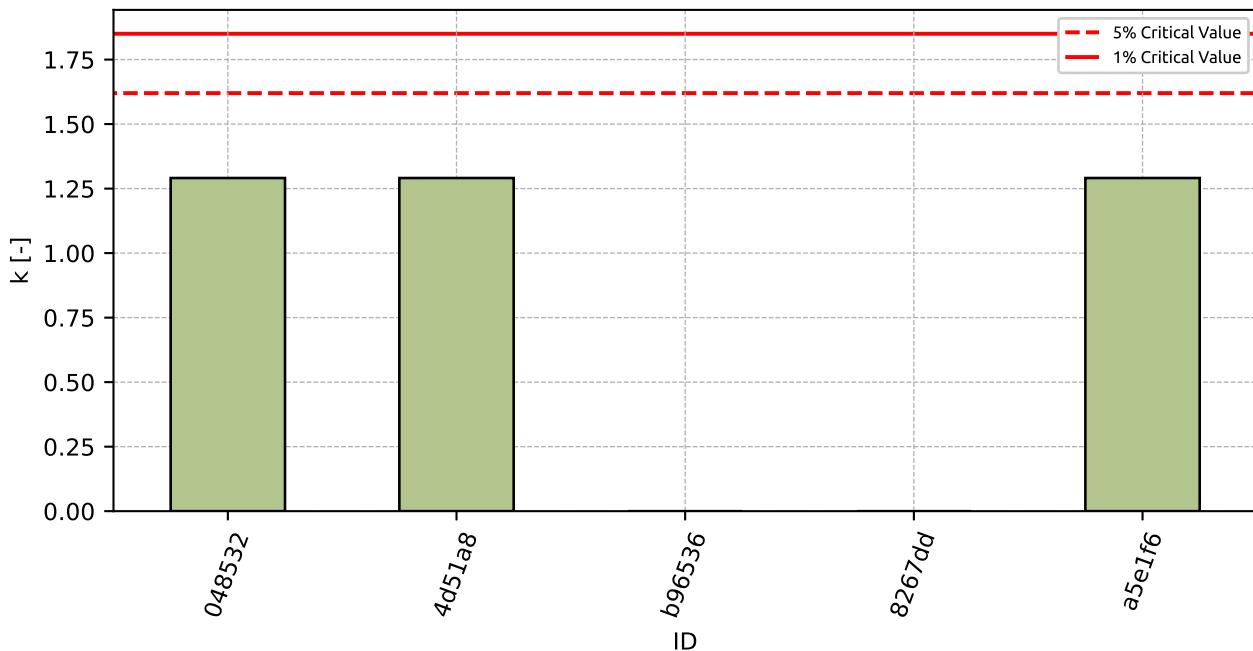
Figure 117: Intralaboratory Consistency Statistic

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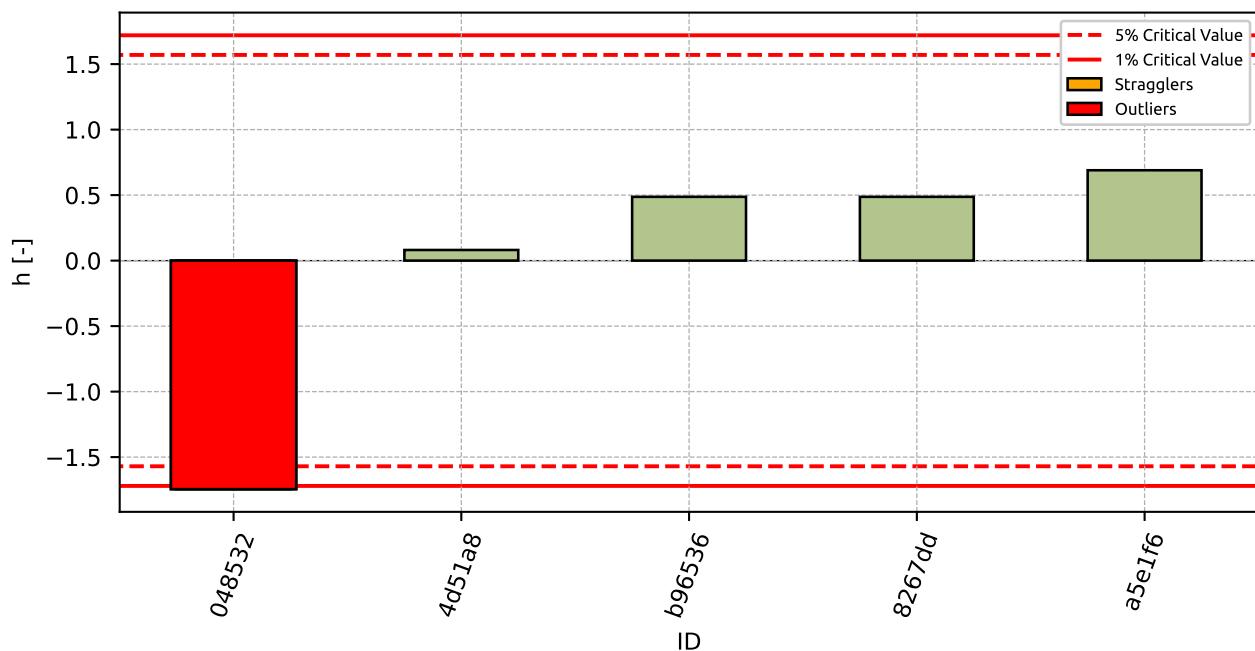
Figure 118: Interlaboratory Consistency Statistic

6.3.4　Descriptive statistics
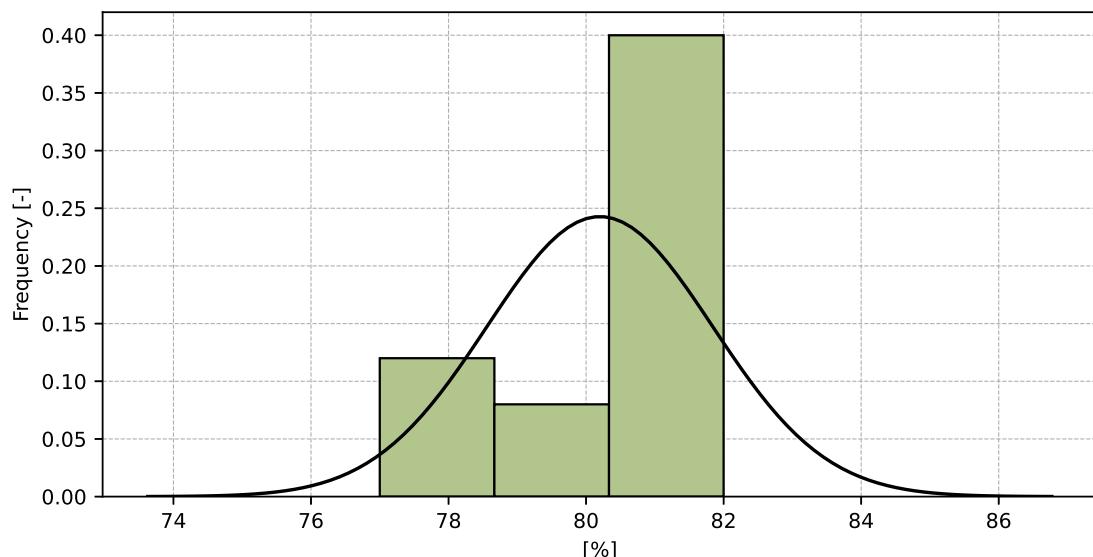
Figure 119: Histogram of all test results

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Table 43: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	80.2
Sample standard deviation – s	1.64
Asigned value – x^*	80.2
Robust standard deviation – s^*	1.64
Measurement uncertainty of asigned value – u_X	0.73
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	1.62
Repeatability standard deviation – s_r	0.45
Reproducibility standard deviation – s_R	1.68
Repeatability – r	1.3
Reproducibility – R	4.7

6.3.5 Evaluation of Performance Statistics
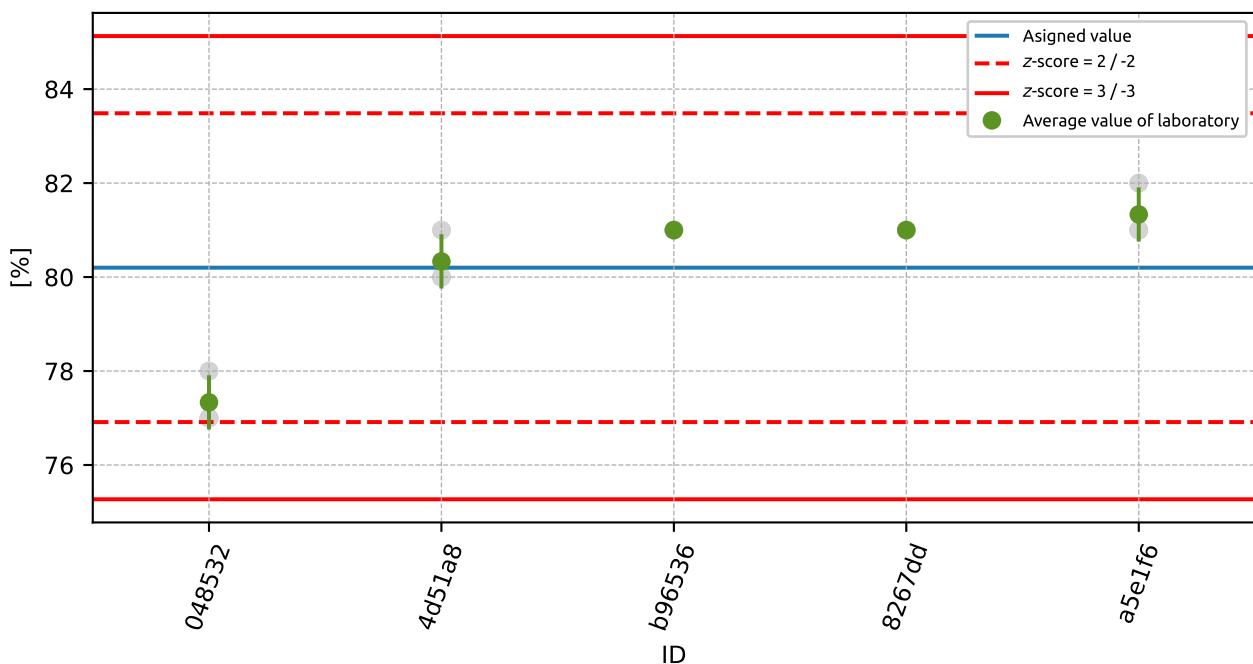

Figure 120: Average values and sample standard deviations

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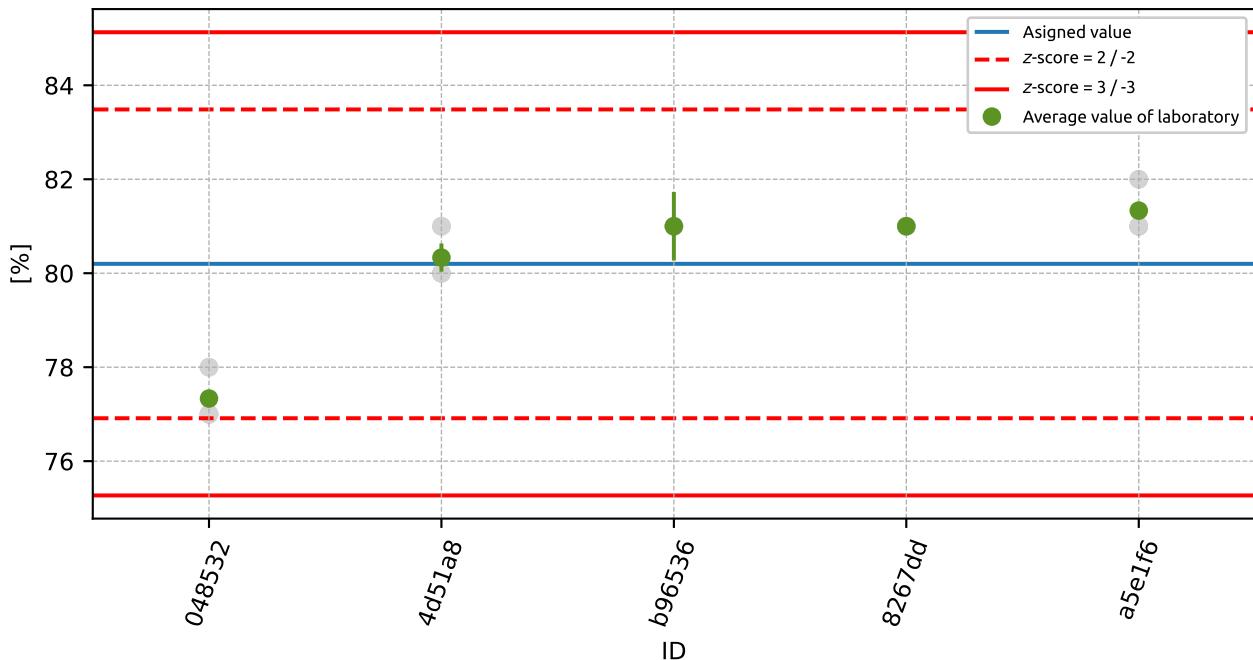
Figure 121: Average values and extended uncertainties of measurement

Figure 122: z-score

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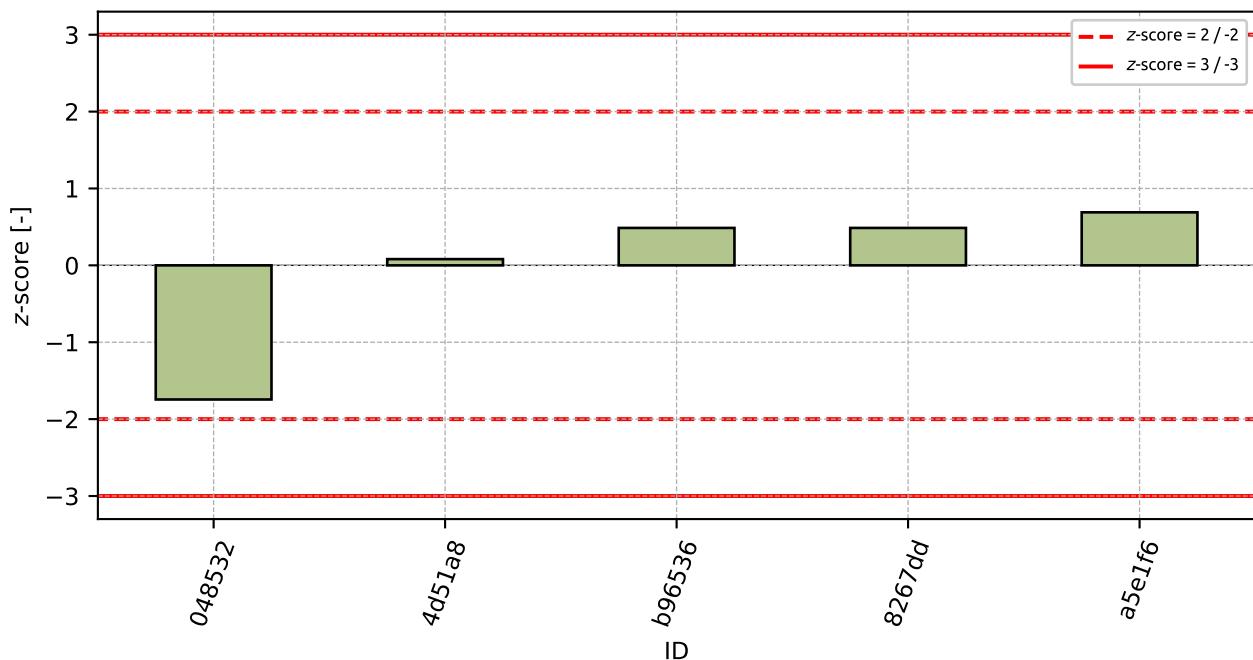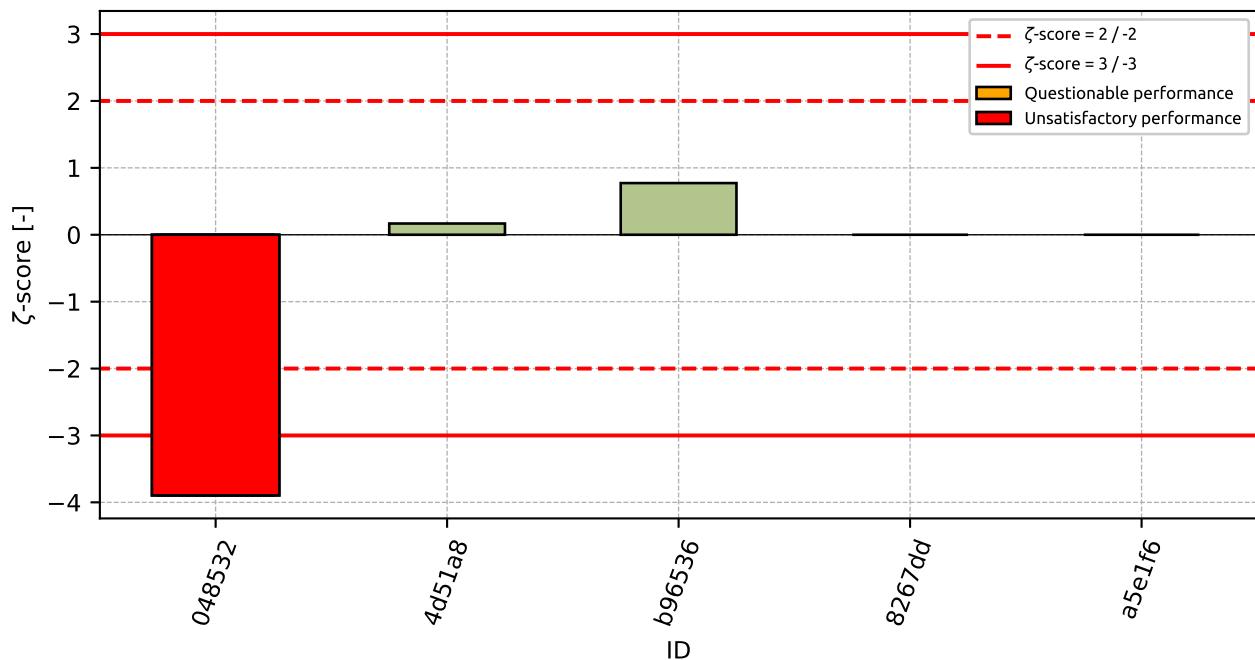
Figure 123: ζ-score

Table 44: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
048532	-1.74	-3.9
4d51a8	0.08	0.17
b96536	0.49	0.77
8267dd	0.49	-
a5e1f6	0.69	-

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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 [-]
a9c83a	8.1	-
a7a3e5	8.6	0.5
8acb0f	8.8	0.4
82c914	8.9	-
0bde87	9.0	1.0
b96536	9.0	3.6
fe1b70	9.0	-
2c58f4	9.0	0.4
048532	9.4	0.0

7.2　The Numerical Procedure for Determining Outliers
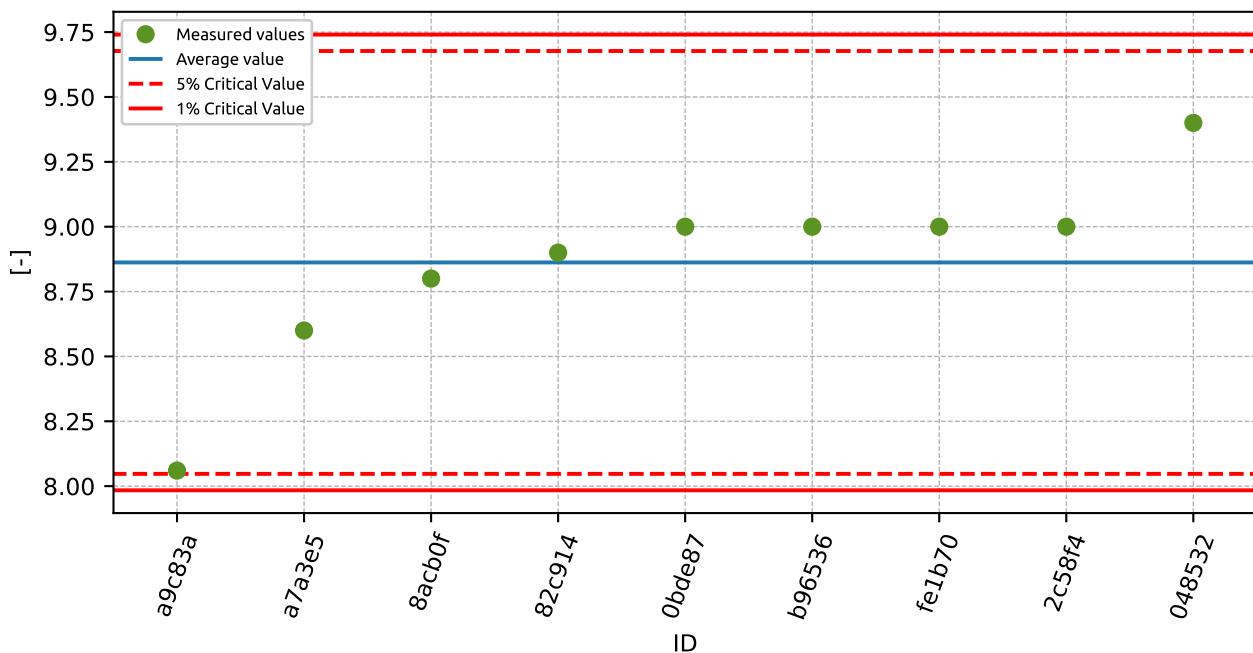
Figure 124: **Grubbs' test** - average values

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7.3 Mandel's Statistics
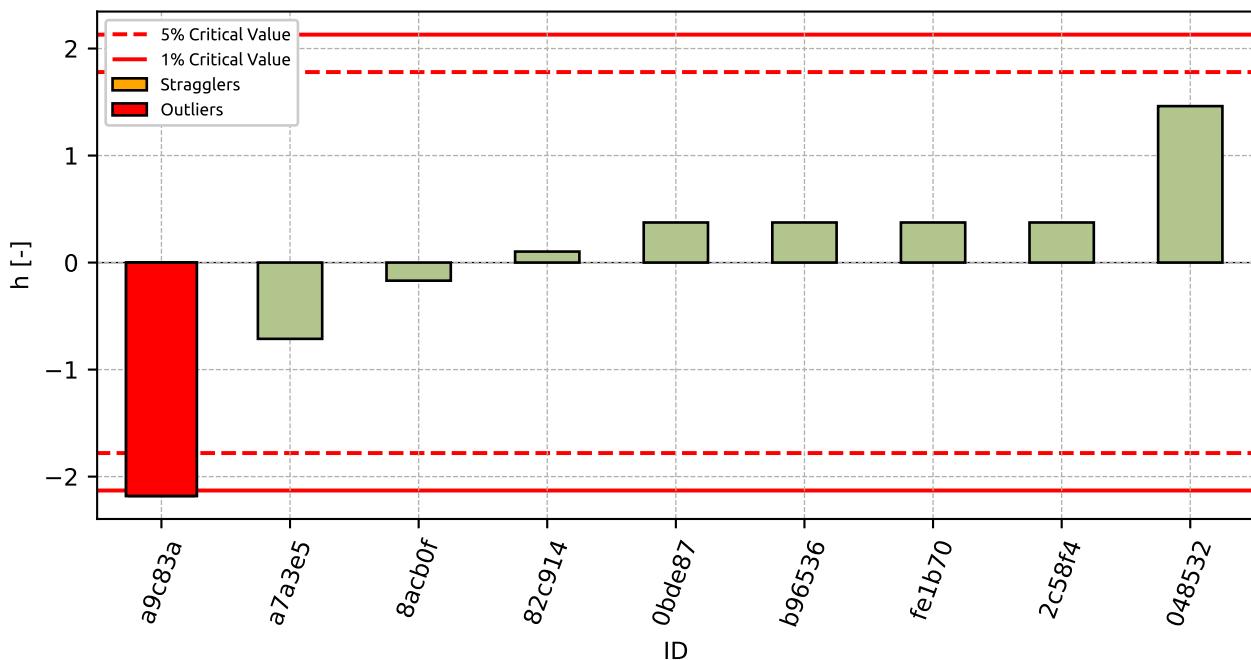
Figure 125: Interlaboratory Consistency Statistic

7.4 Descriptive statistics
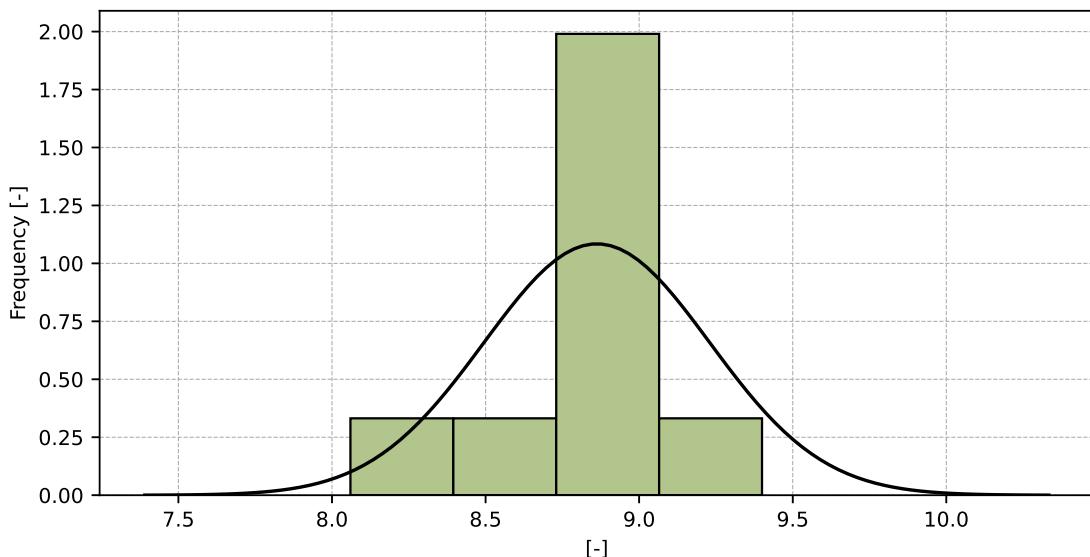
Figure 126: Histogram of all test results

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110/163

Table 46: Descriptive statistics

| Characteristics	[-]
Average value – $\bar{x}$	8.9
Sample standard deviation – s	0.37
Asigned value – x^*	8.9
Robust standard deviation – s^*	0.41
Measurement uncertainty of asigned value – u_X	0.14
p-value of normality test	0.108 [-]

7.5　Evaluation of Performance Statistics
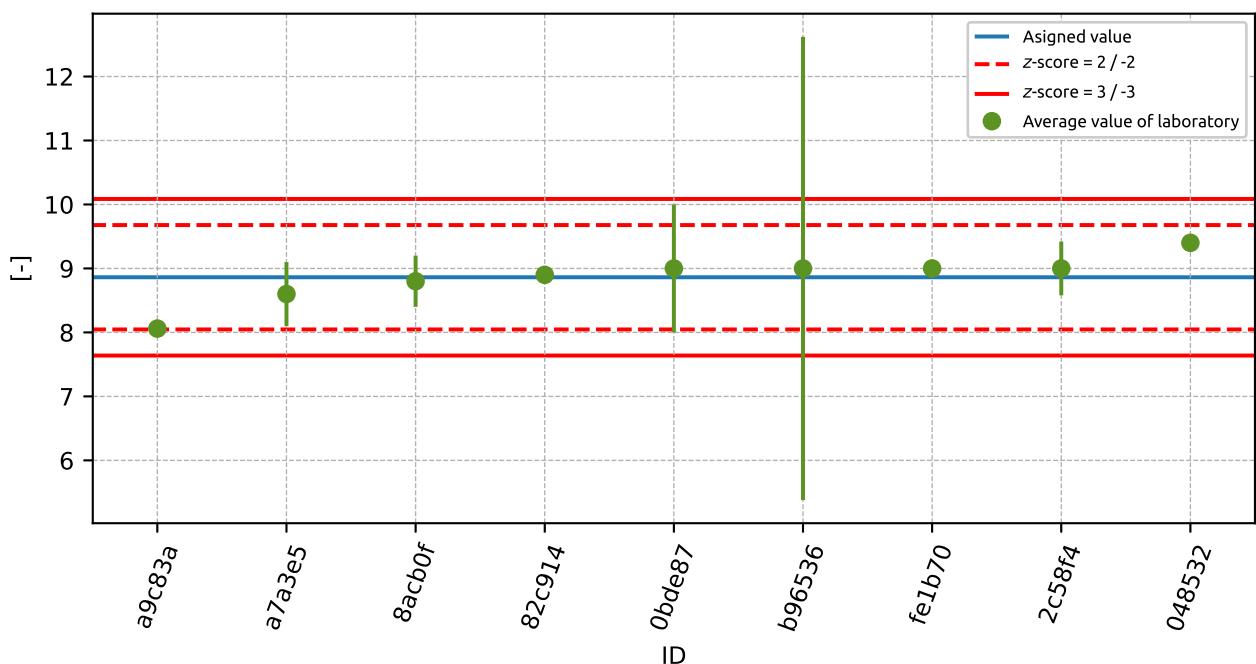
Figure 127: Average values and extended uncertainties of measurement

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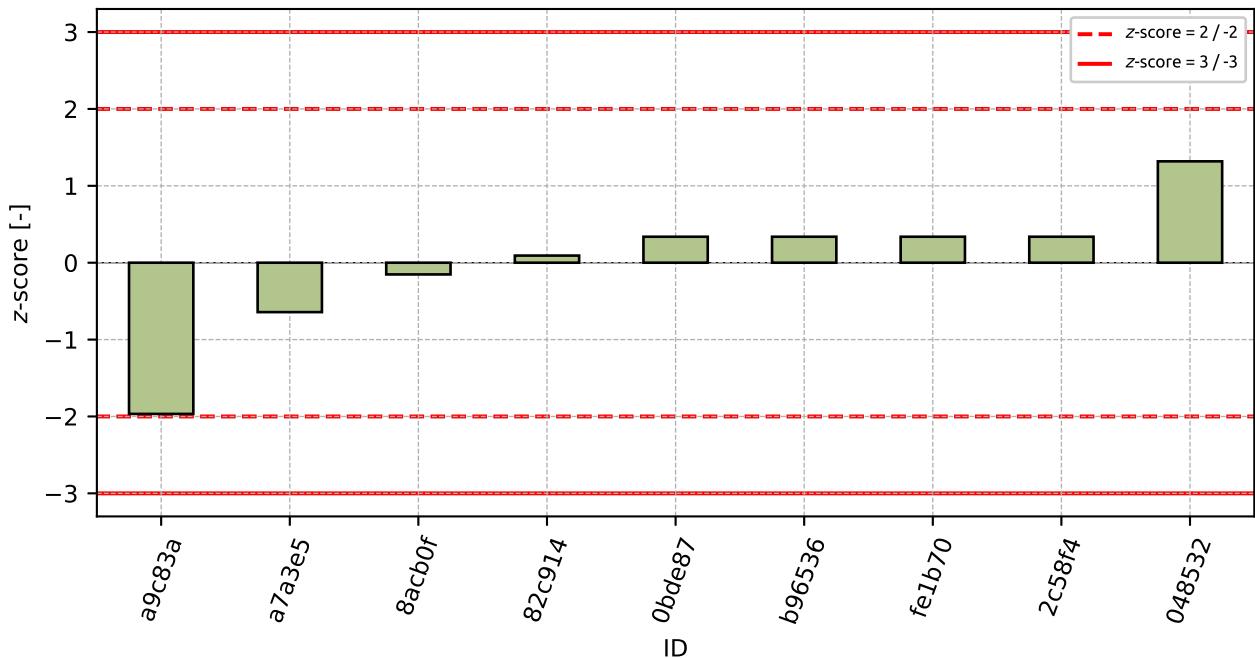
Figure 128: z-score

Figure 129: ζ-score

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Table 47: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a9c83a	-1.97	-
a7a3e5	-0.64	-0.51
8acb0f	-0.15	-0.15
82c914	0.09	-
0bde87	0.34	0.14
b96536	0.34	0.04
fe1b70	0.34	-
2c58f4	0.34	0.31
048532	1.32	3.91

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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 [-]
8267dd	16.0	-
fbc95e	16.0	13.4
a7a3e5	16.1	1.3
0bde87	17.0	1.0
fe1b70	17.0	-
a259ca	17.0	0.1
ba9637	18.0	15.5
a9c83a	18.6	-
ec14be	19.0	-
80076b	19.0	0.6
2c58f4	19.0	0.1
eeb447	19.5	-
d4530f	20.0	3.6

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## 8.2   The Numerical Procedure for Determining Outliers
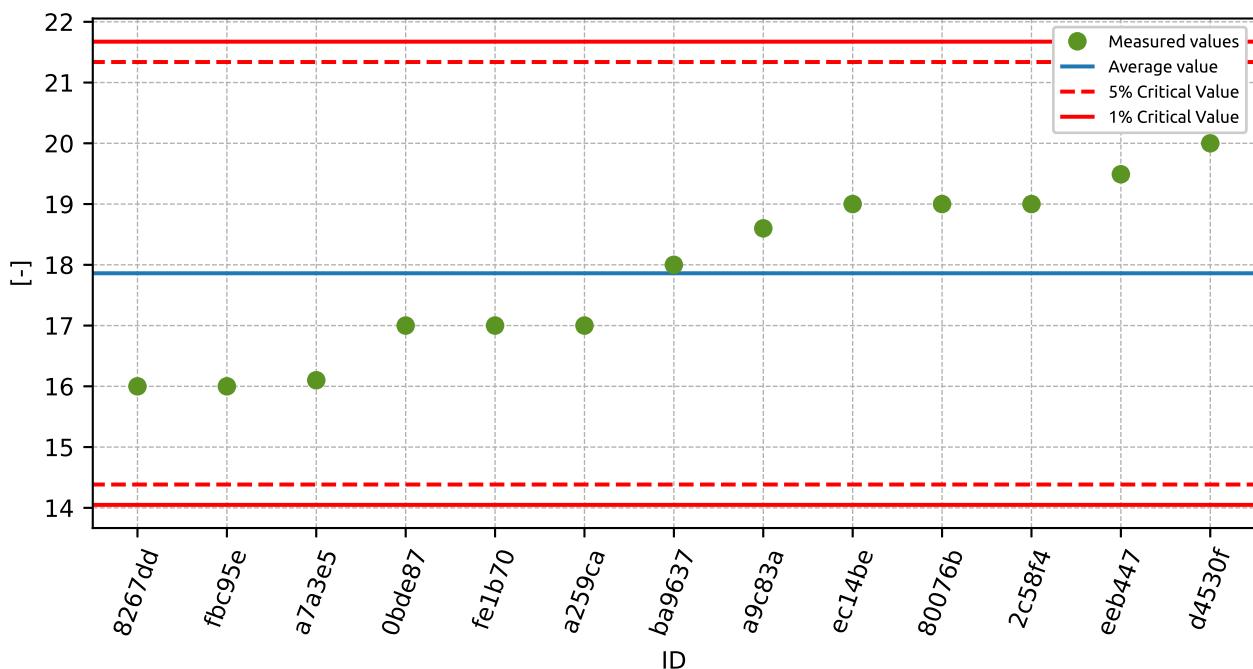
Figure 130: **Grubbs' test** - average values

8.3   Mandel's Statistics
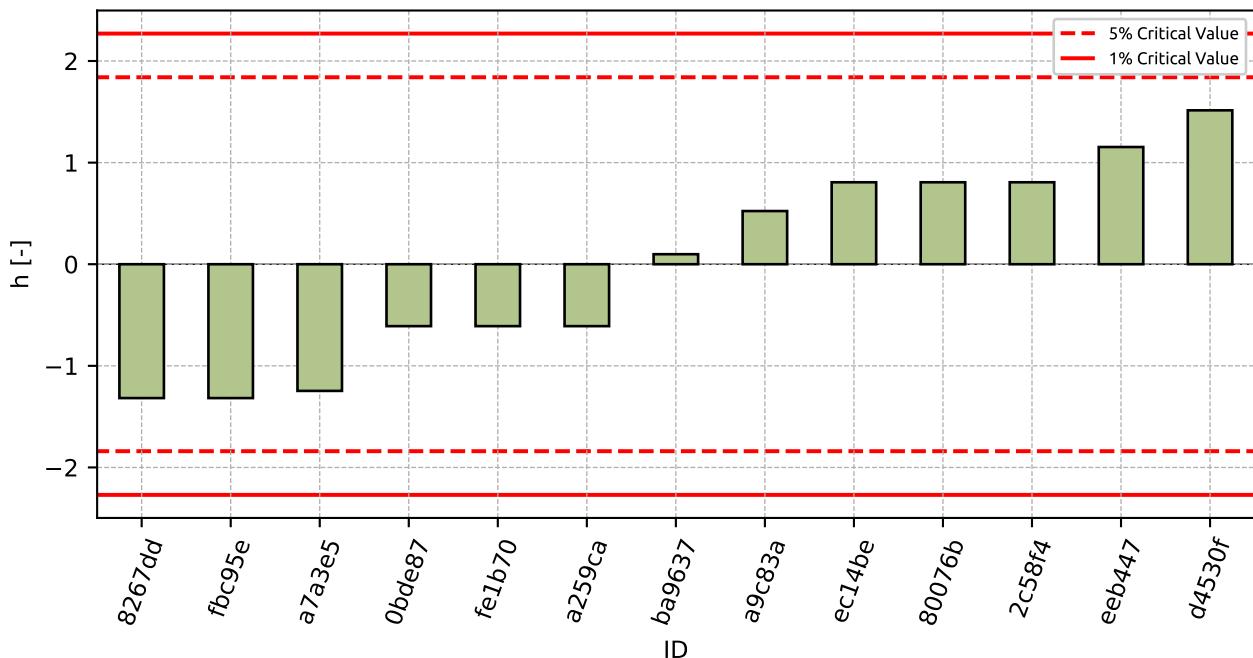
Figure 131: Interlaboratory Consistency Statistic

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8.4   Descriptive statistics
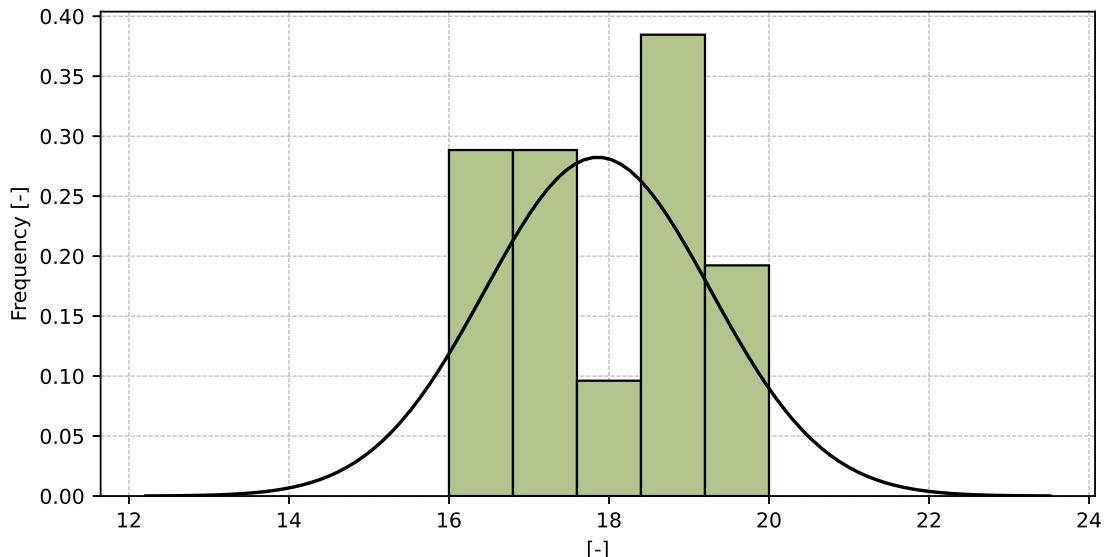
Figure 132: Histogram of all test results

Table 49: Descriptive statistics

Characteristics	[-]
Average value – $\bar{x}$	17.9
Sample standard deviation – s	1.41
Asigned value – x^*	17.9
Robust standard deviation – s^*	1.54
Measurement uncertainty of asigned value – u_X	0.53
p-value of normality test	0.15 [-]

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8.5   Evaluation of Performance Statistics
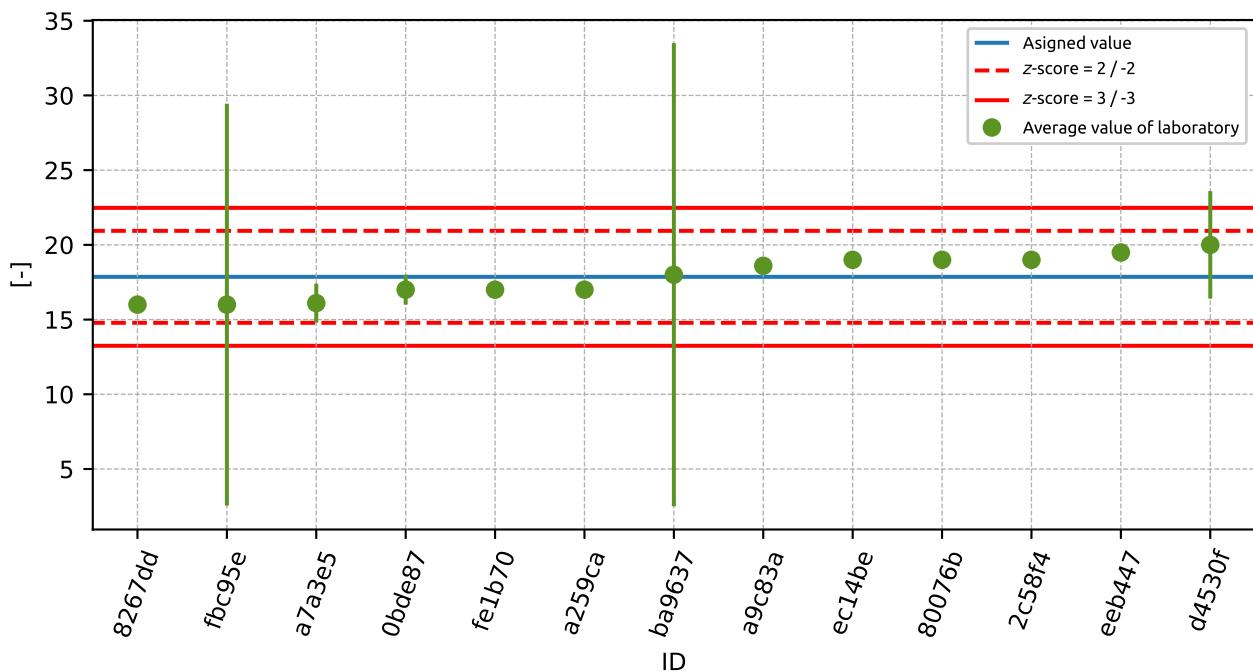
Figure 133: Average values and extended uncertainties of measurement

Figure 134: z-score

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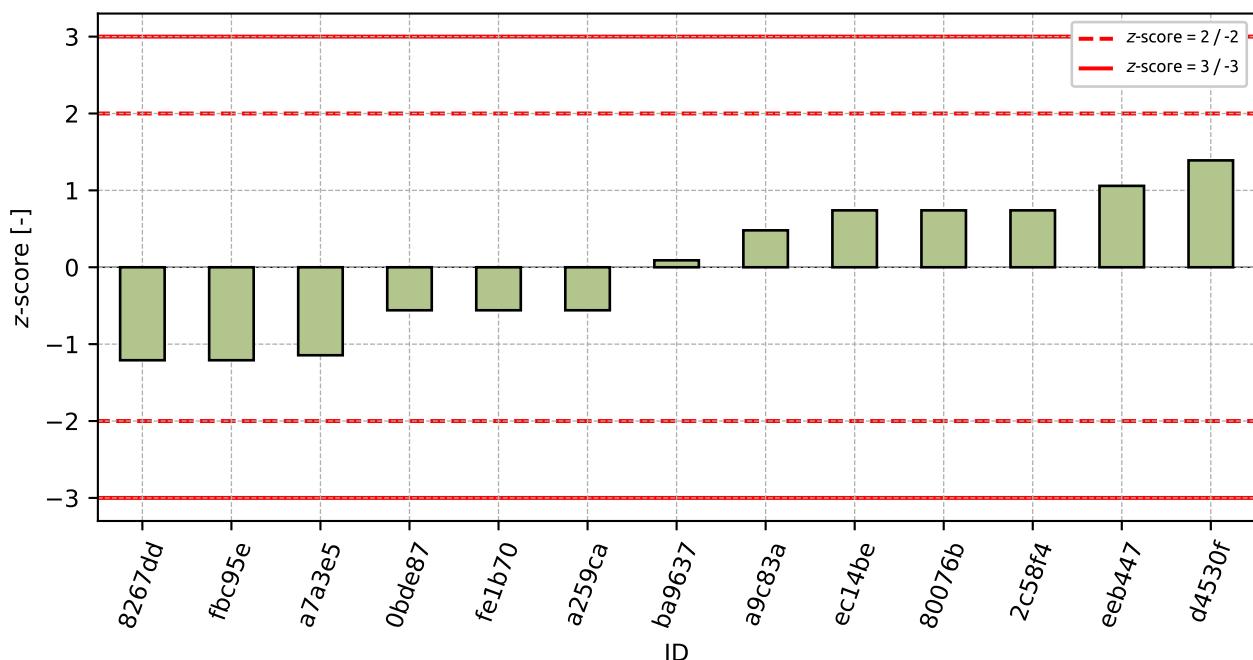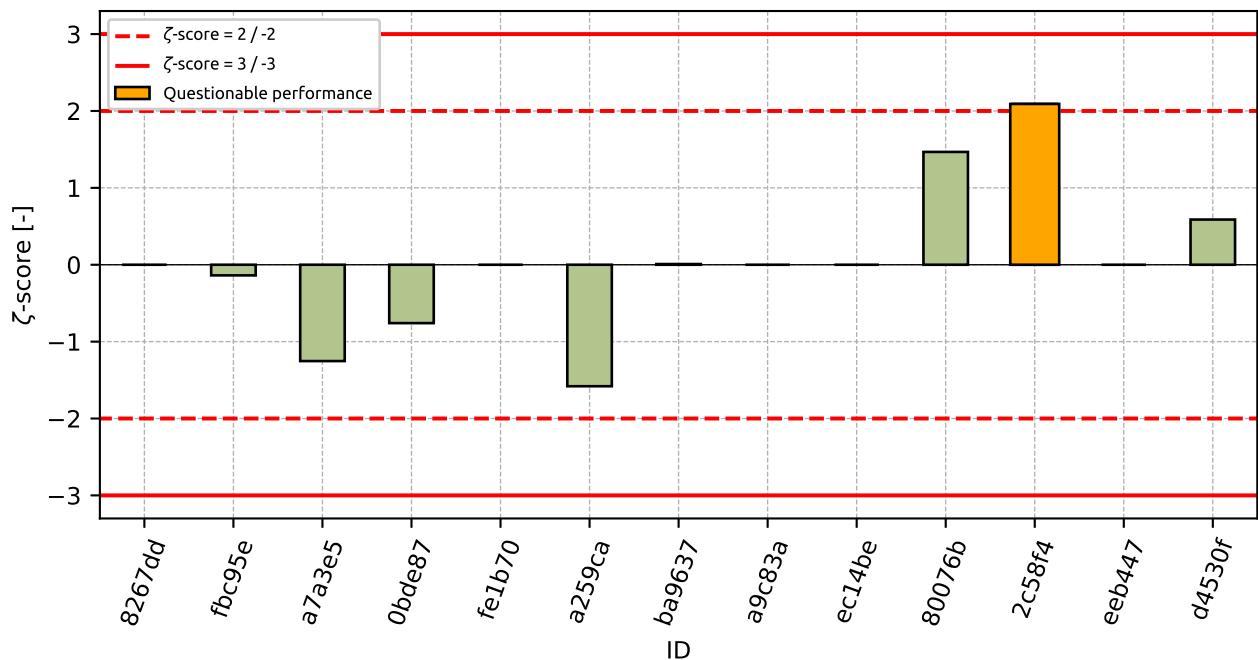
Figure 135: ζ-score

Table 50: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8267dd	-1.21	-
fbc95e	-1.21	-0.14
a7a3e5	-1.14	-1.25
0bde87	-0.56	-0.76
fe1b70	-0.56	-
a259ca	-0.56	-1.58
ba9637	0.09	0.01
a9c83a	0.48	-
ec14be	0.74	-
80076b	0.74	1.47
2c58f4	0.74	2.09
eeb447	1.06	-
d4530f	1.39	0.59

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

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

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

10.1   Loose bulk density

10.1.1   Test results

Table 51: 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 [%]
8f3a62	1.308	1.298	1.302	0.03	1.303	0.005	0.39
38a7ee	1.29	1.31	1.32	0.043	1.307	0.0153	1.17
d96997	1.308	1.311	1.318	0.02	1.312	0.0051	0.39
1ce009	1.32	1.31	1.32	0.01	1.317	0.0058	0.44
8267dd	1.32	1.32	1.31	-	1.317	0.0058	0.44
a7a3e5	1.37	1.37	1.37	0.1	1.37	0.0	0.0

10.1.2   The Numerical Procedure for Determining Outliers
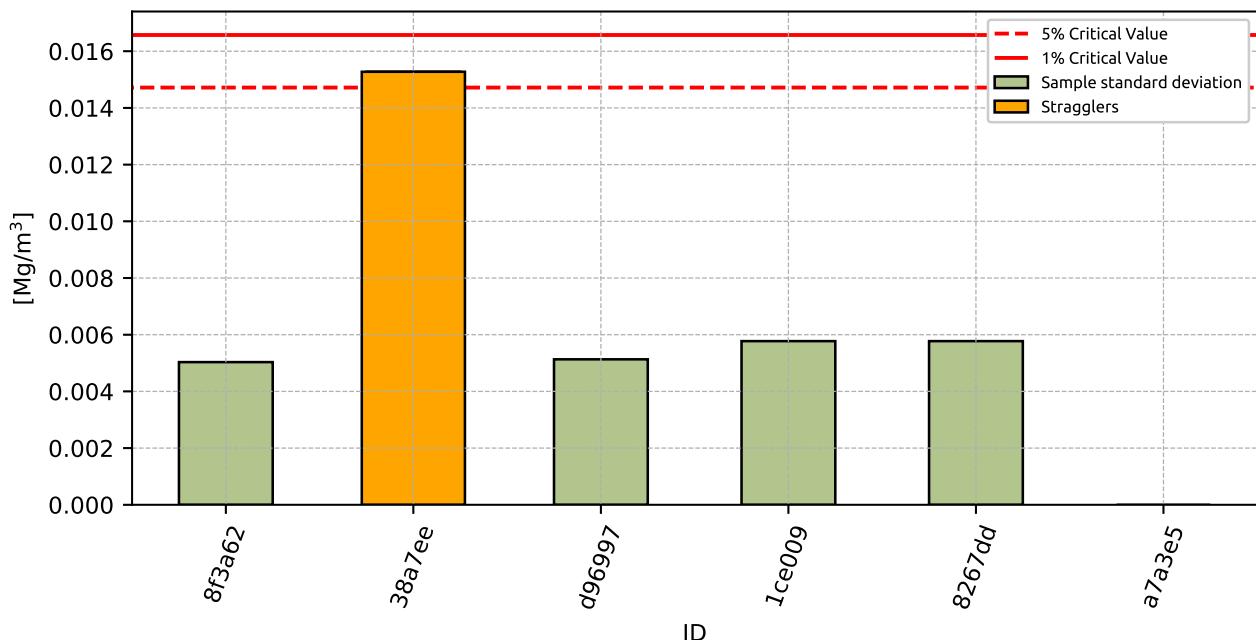
Figure 136: **Cochran's test** - sample standard deviations

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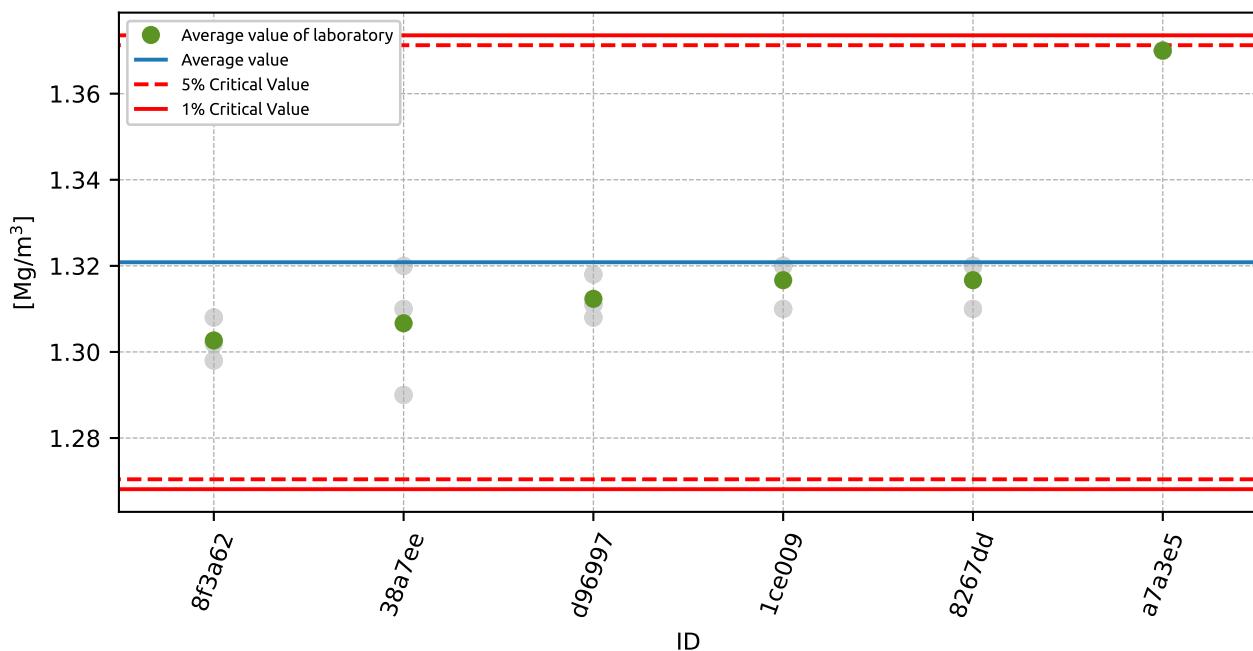
Figure 137: **Grubbs' test** - average values

10.1.3   Mandel′s Statistics
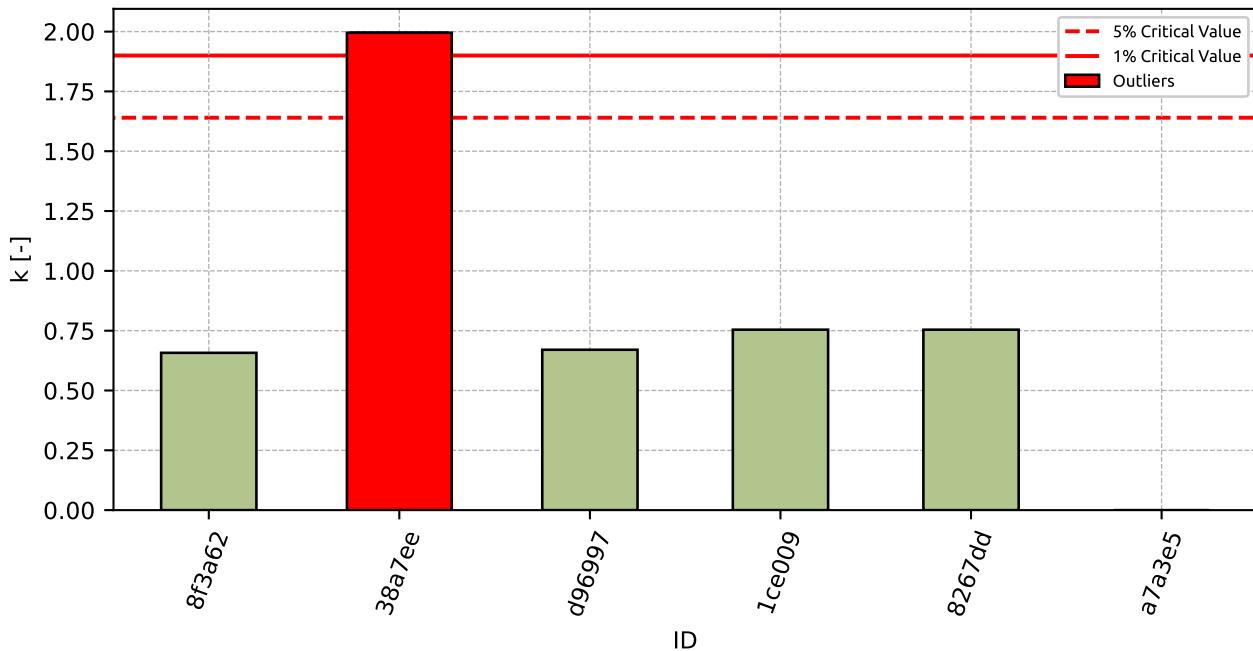
Figure 138: Intralaboratory Consistency Statistic

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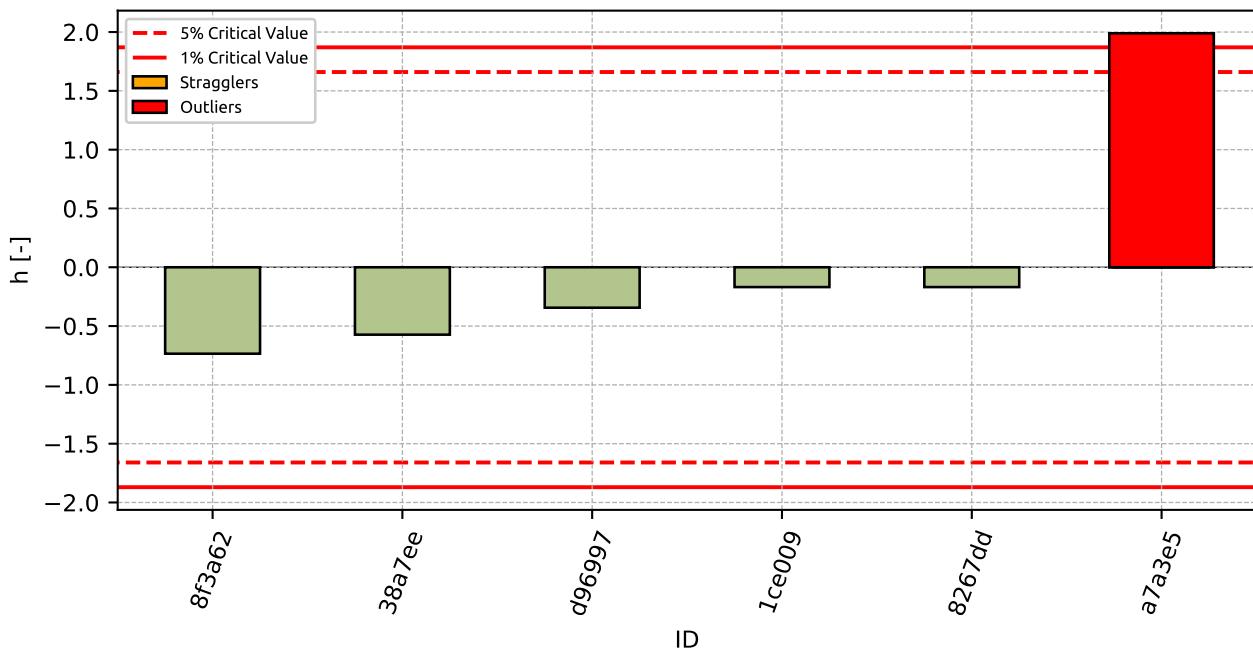
Figure 139: Interlaboratory Consistency Statistic

10.1.4 Descriptive statistics
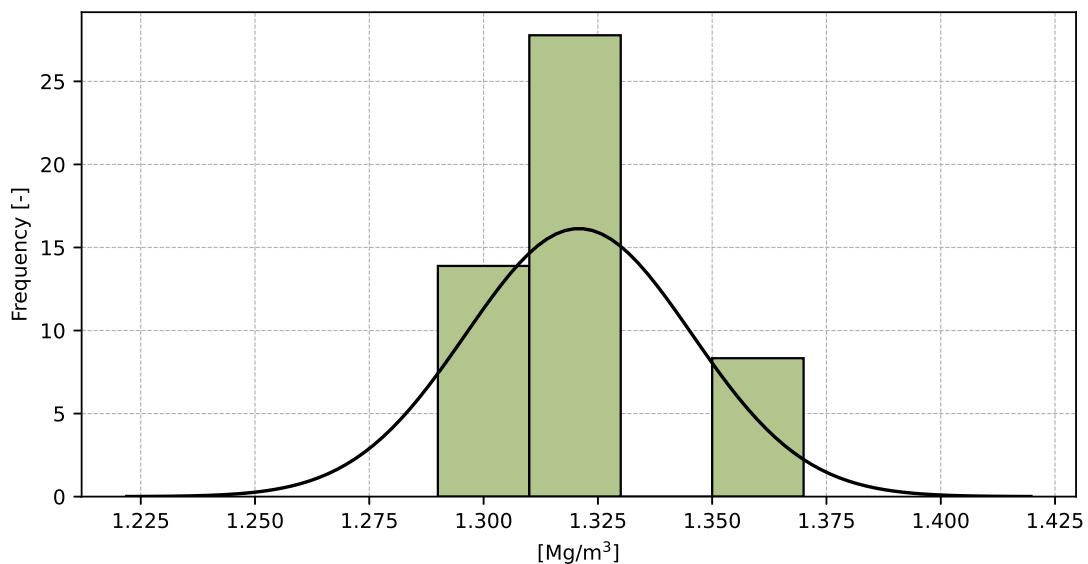
Figure 140: Histogram of all test results

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Table 52: Descriptive statistics

Characteristics	[Mg/m^3]
Average value – $\bar{x}$	1.321
Sample standard deviation – s	0.0247
Asigned value – x^*	1.321
Robust standard deviation – s^*	0.0255
Measurement uncertainty of asigned value – u_X	0.013
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.0243
Repeatability standard deviation – s_r	0.0077
Reproducibility standard deviation – s_R	0.0255
Repeatability – r	0.021
Reproducibility – R	0.071

10.1.5   Evaluation of Performance Statistics
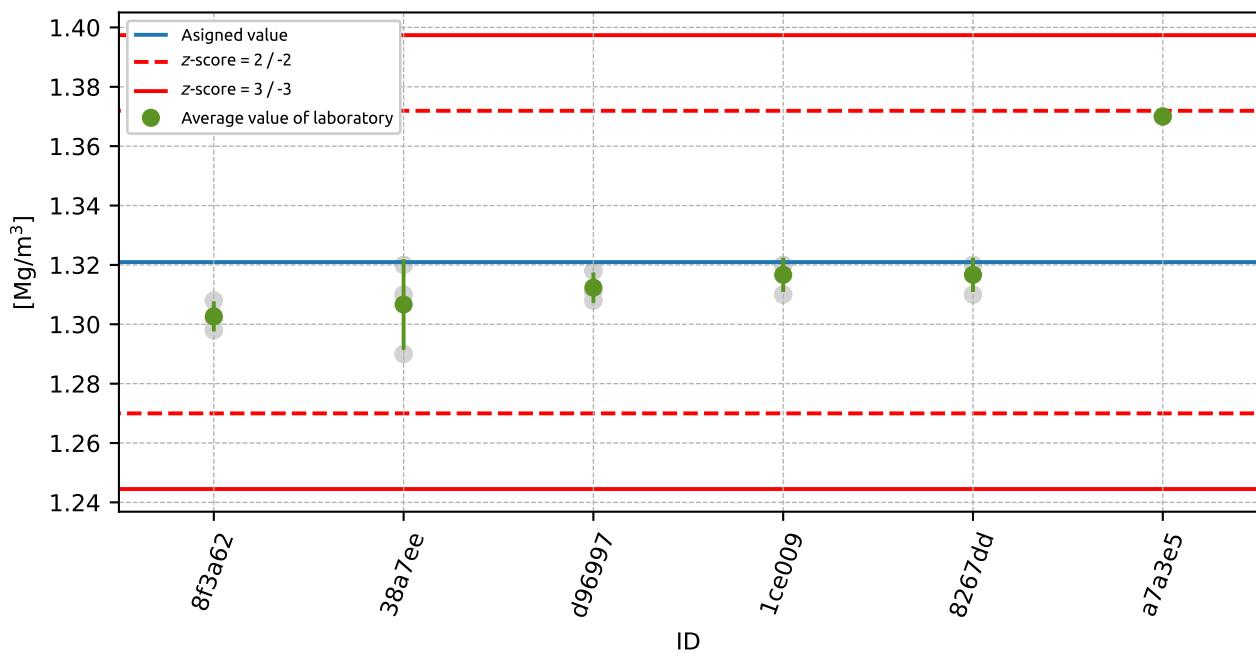
Figure 141: Average values and sample standard deviations

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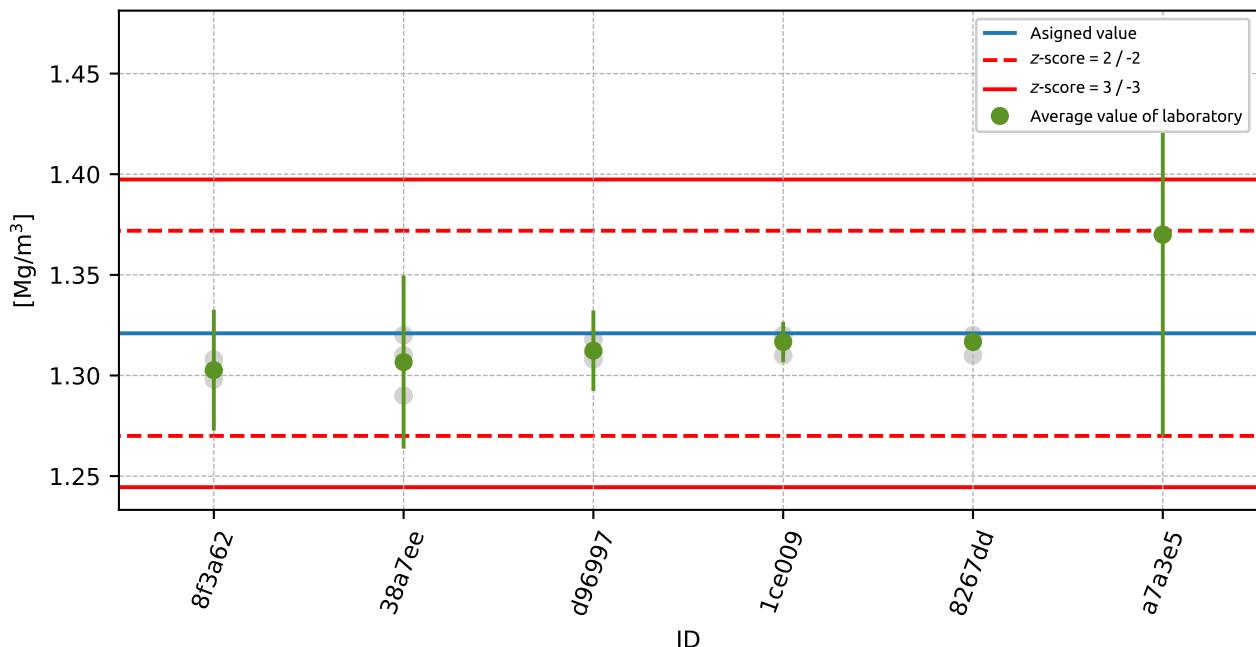
Figure 142: Average values and extended uncertainties of measurement

Figure 143: z-score

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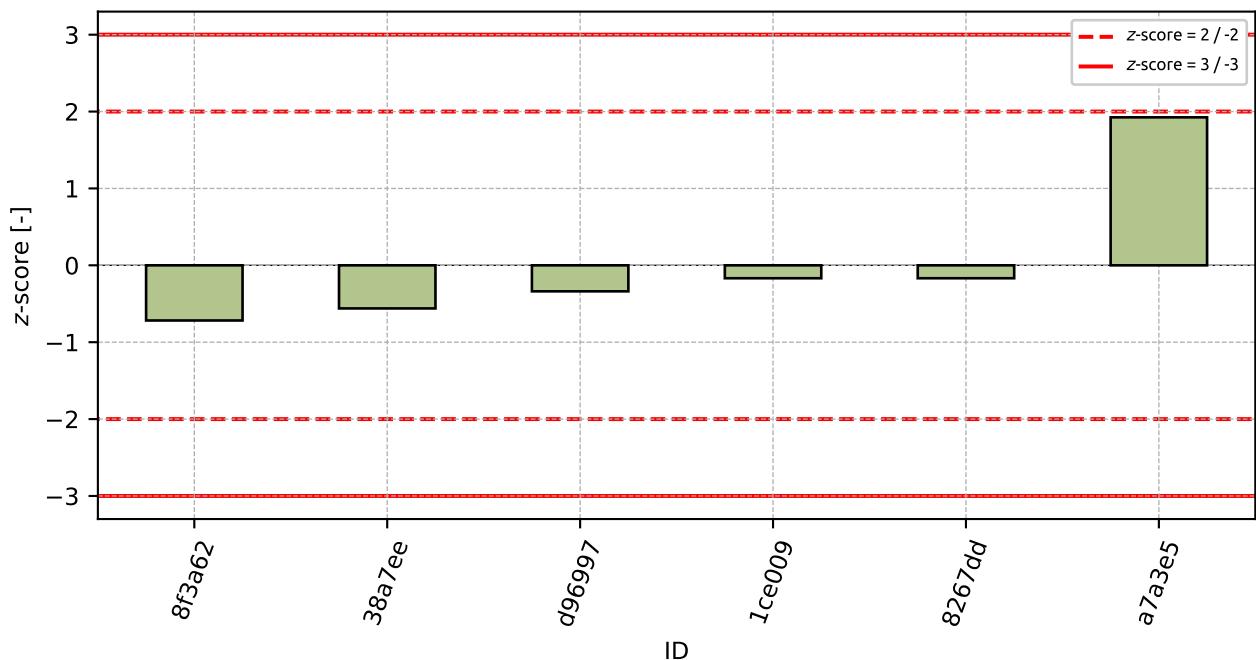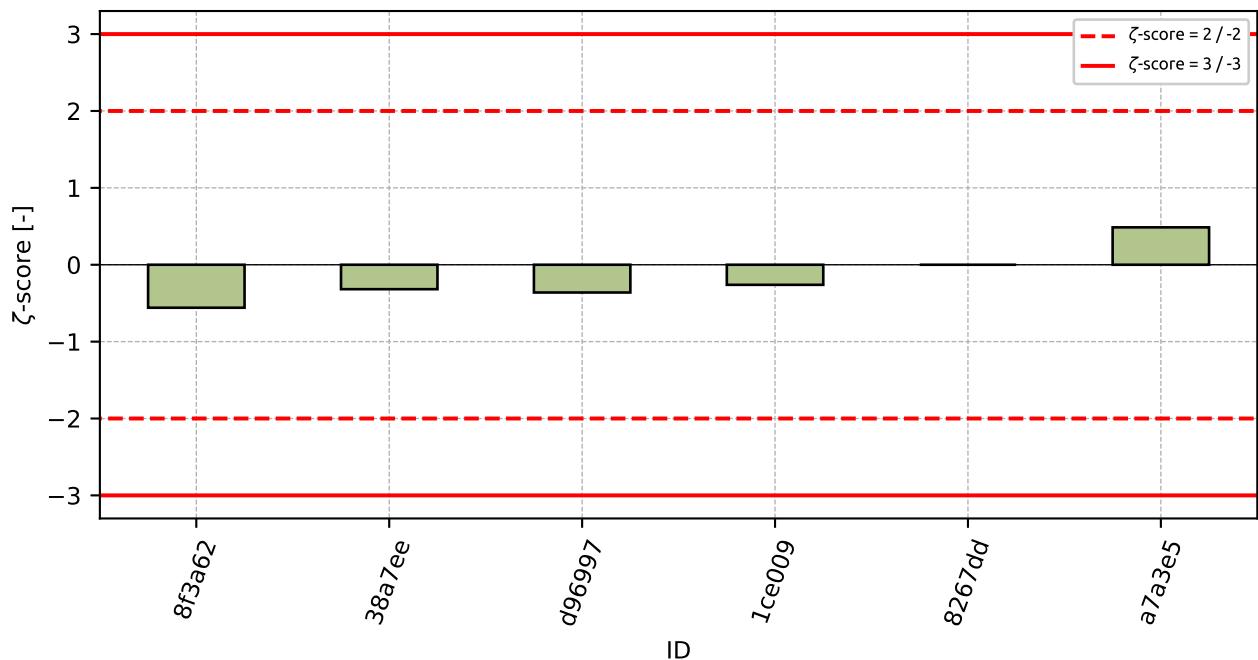
Figure 144: ζ-score

Table 53: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8f3a62	-0.72	-0.56
38a7ee	-0.56	-0.32
d96997	-0.34	-0.36
1ce009	-0.17	-0.26
8267dd	-0.17	-
a7a3e5	1.92	0.49

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10.2   Voids

10.2.1   Test results

Table 54: 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 [%]
a7a3e5	48.2	48.1	48.2	0.5	48.2	0.06	0.12
8267dd	50.0	50.0	51.0	-	50.3	0.58	1.15
38a7ee	51.0	50.0	50.0	0.3	50.3	0.58	1.15
1ce009	51.0	51.0	51.0	0.0	51.0	0.0	0.0

10.2.2   The Numerical Procedure for Determining Outliers
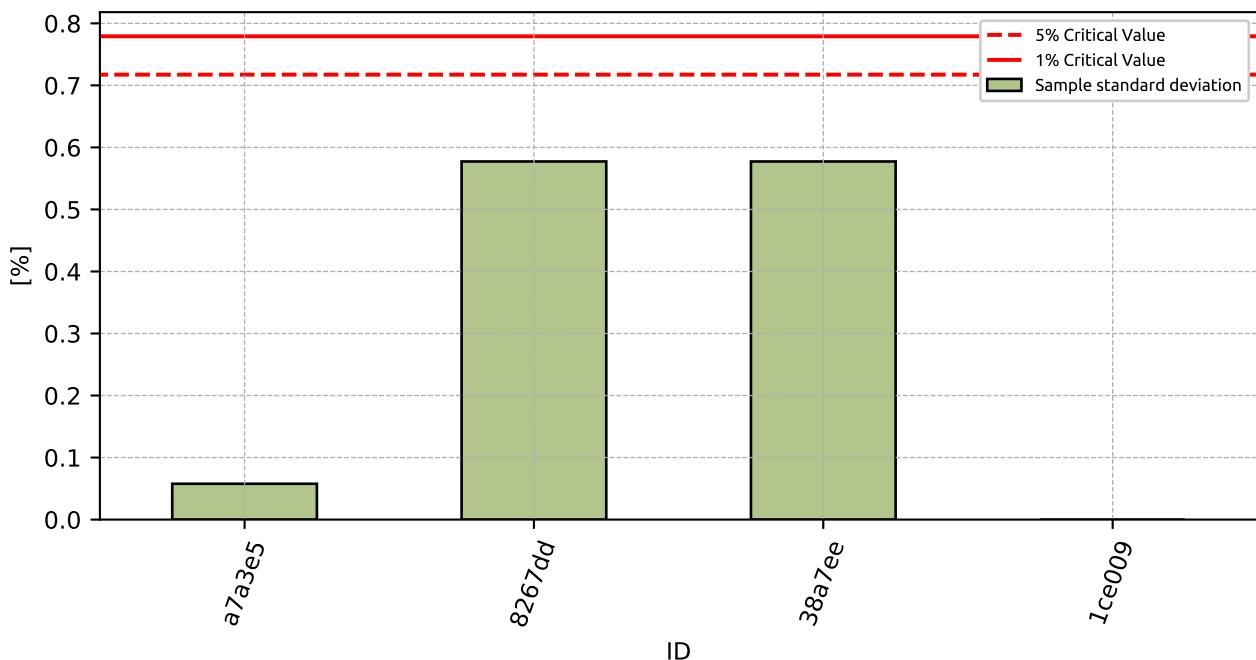
Figure 145: **Cochran's test** - sample standard deviations

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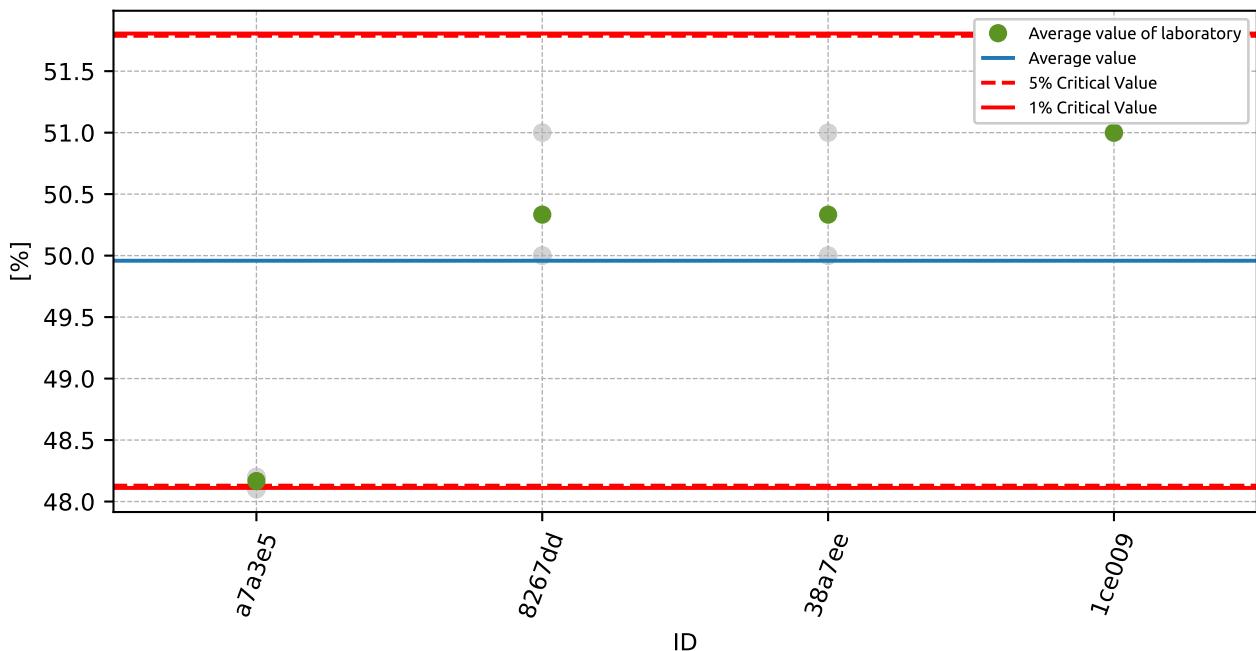
Figure 146: **Grubbs' test** - average values

10.2.3   Mandel's Statistics
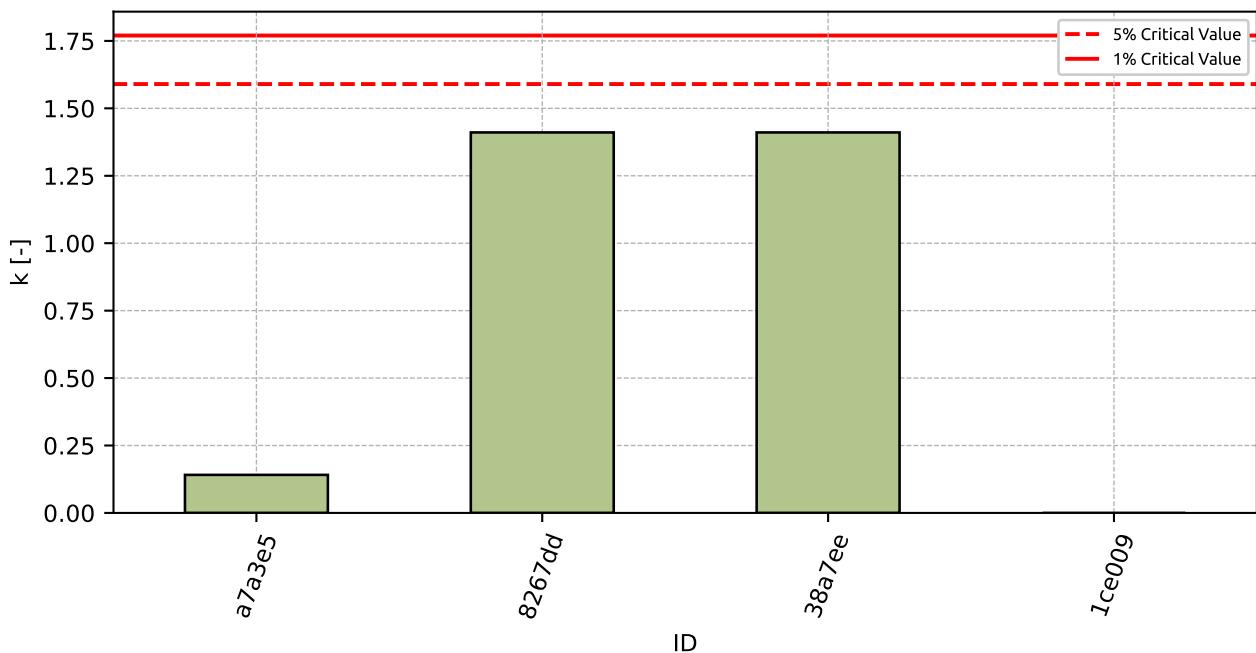
Figure 147: Intralaboratory Consistency Statistic

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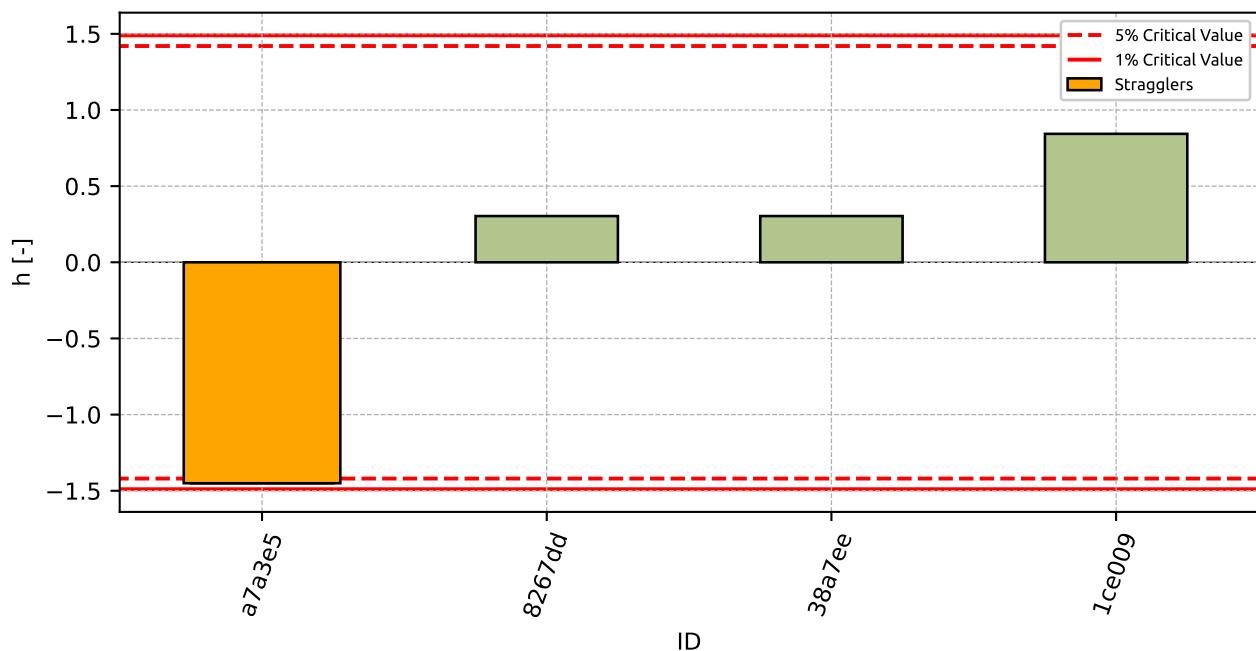
Figure 148: Interlaboratory Consistency Statistic

10.2.4   Descriptive statistics
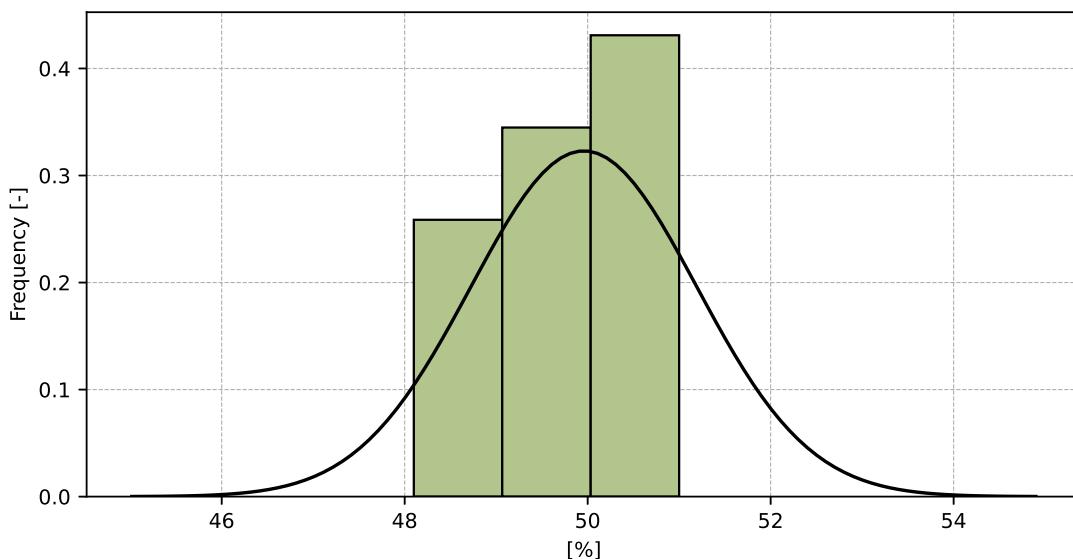
Figure 149: Histogram of all test results

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Table 55: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	50.0
Sample standard deviation – s	1.24
Asigned value – x^*	50.0
Robust standard deviation – s^*	1.24
Measurement uncertainty of asigned value – u_X	0.62
p-value of normality test	0.005 [-]
Interlaboratory standard deviation – s_L	1.21
Repeatability standard deviation – s_r	0.41
Reproducibility standard deviation – s_R	1.28
Repeatability – r	1.1
Reproducibility – R	3.6

10.2.5   Evaluation of Performance Statistics
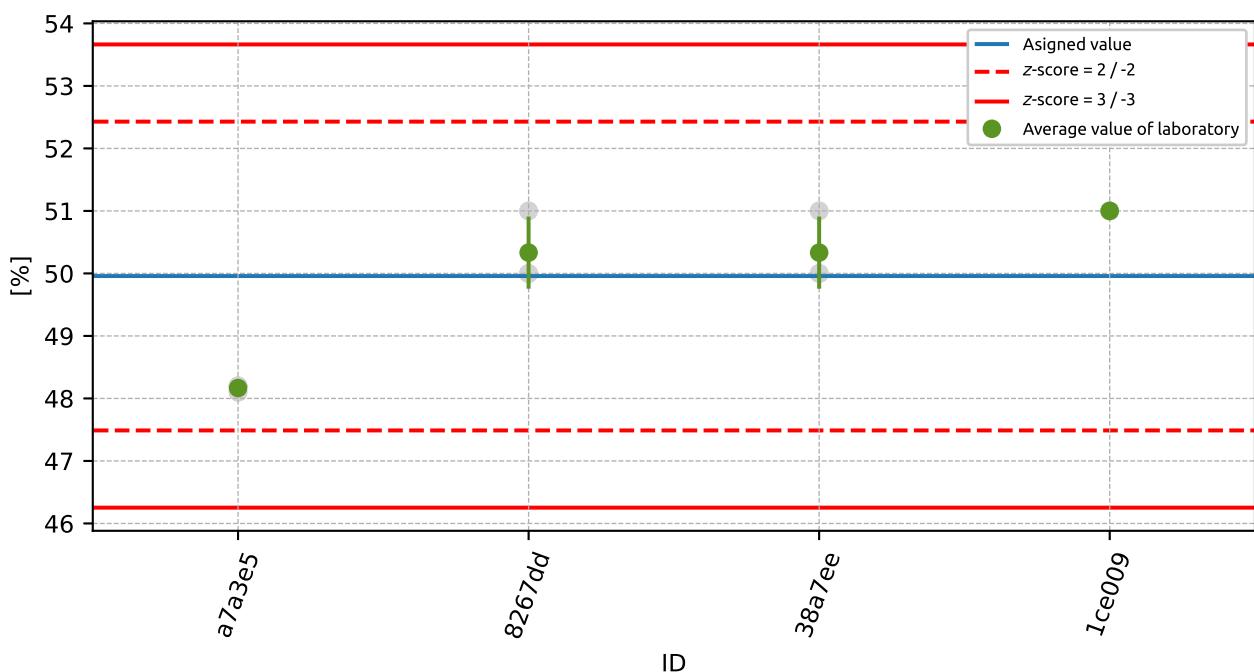
Figure 150: Average values and sample standard deviations

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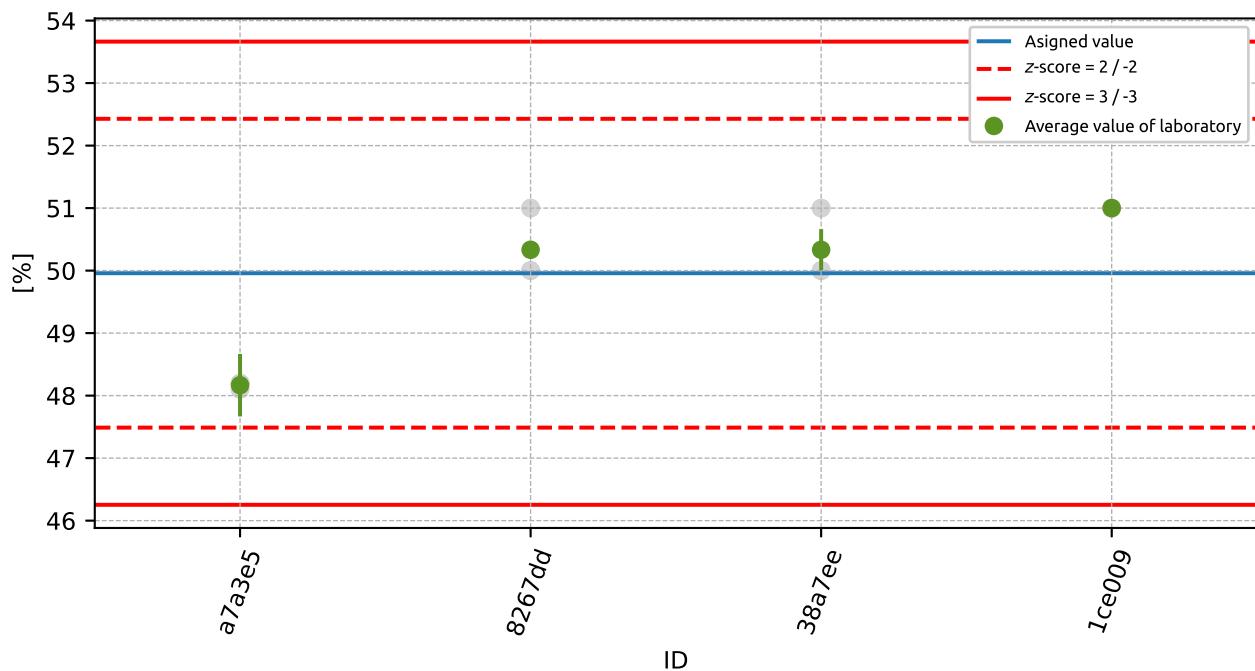
Figure 151: Average values and extended uncertainties of measurement

Figure 152: z-score

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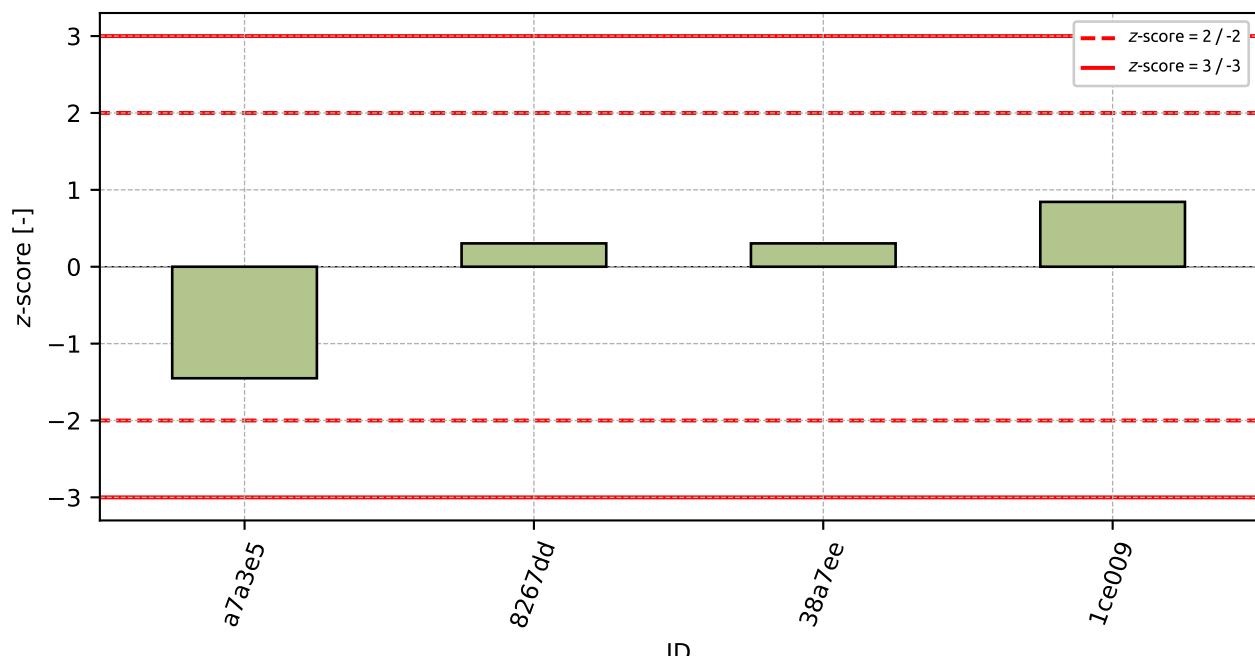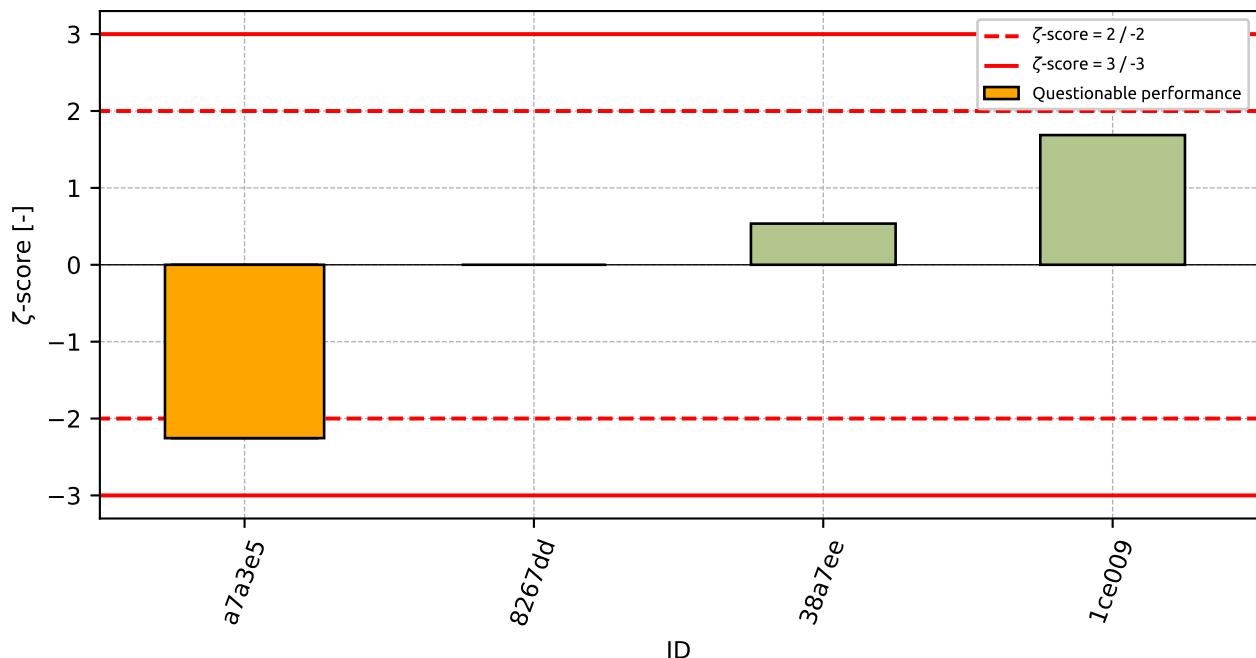
Figure 153: ζ-score

Table 56: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a7a3e5	-1.45	-2.25
8267dd	0.3	-
38a7ee	0.3	0.54
1ce009	0.84	1.69

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130/163

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

11.1 Test results

Table 57: 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 [%]
4c70c6	5.8	5.7	5.7	0.3	5.7	0.07	1.26
e64c92	6.1	6.4	6.3	0.6	6.3	0.15	2.44
8f3a62	6.8	6.1	6.3	0.3	6.4	0.36	5.63
3f9c15	6.4	6.5	6.7	0.4	6.5	0.15	2.34
e7e3b2	6.6	6.6	6.7	0.3	6.6	0.06	0.87
38a7ee	6.6	6.7	6.7	0.0	6.7	0.06	0.87
5cab48	6.4	6.8	6.8	0.5	6.7	0.23	3.46
e5d49b	6.9	6.5	6.8	1.0	6.7	0.21	3.09
bc1df4	6.7	6.8	6.9	1.0	6.8	0.1	1.47
0be6c3	6.8	6.8	6.9	0.3	6.8	0.06	0.84
d96997	6.9	6.8	6.8	0.1	6.8	0.06	0.84
a27013	6.9	6.9	6.8	0.2	6.9	0.06	0.84
278e12	7.0	6.8	6.9	0.1	6.9	0.1	1.45
7346a5	7.6	6.5	7.1	0.1	7.1	0.55	7.79
c64ad2	7.1	7.0	7.1	0.2	7.1	0.06	0.82
2c58f4	7.0	7.1	7.1	0.1	7.1	0.06	0.82
a7a3e5	7.5	7.1	6.7	0.6	7.1	0.4	5.63
4faf4d	6.5	7.3	7.5	0.4	7.1	0.53	7.45
18e860	6.8	7.7	7.8	6.0	7.4	0.55	7.41

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11.2   The Numerical Procedure for Determining Outliers
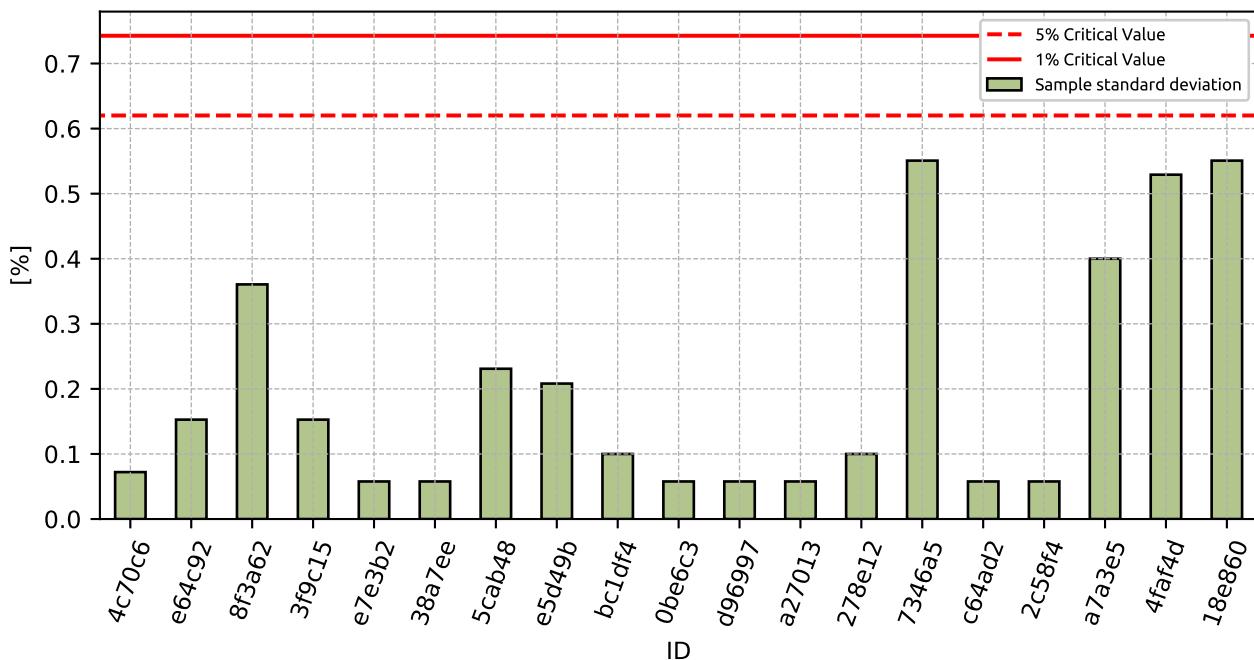
Figure 154: **Cochran's test** - sample standard deviations
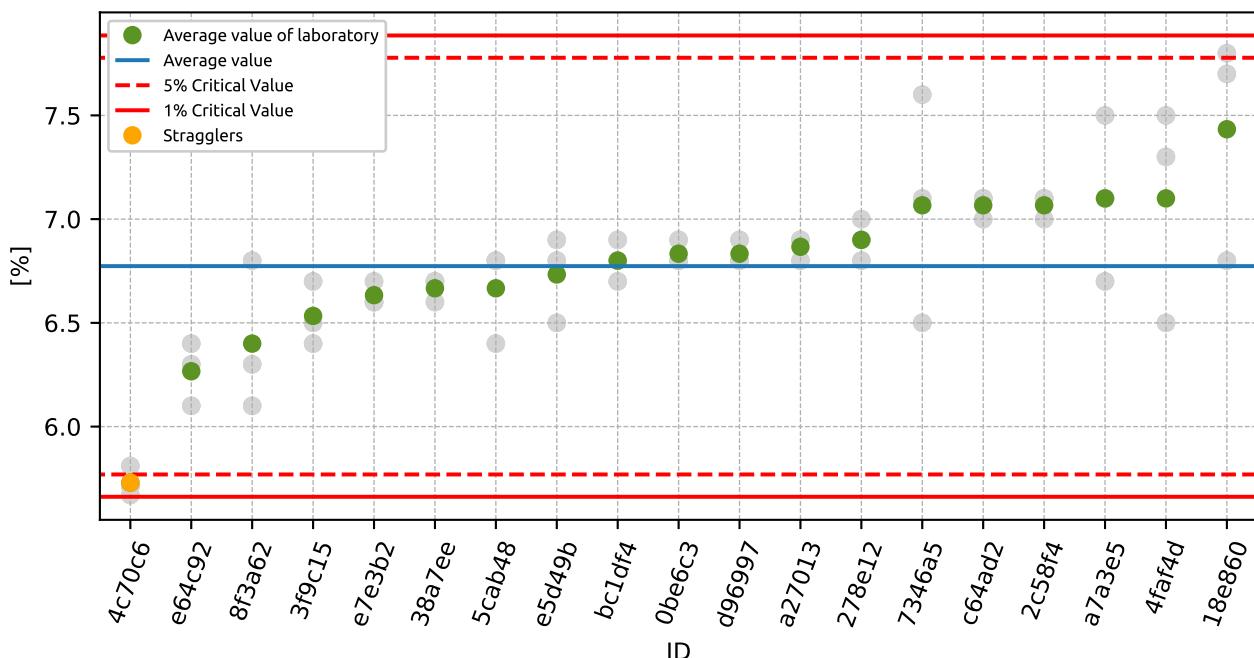
Figure 155: **Grubbs' test** - average values

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11.3 Mandel's Statistics
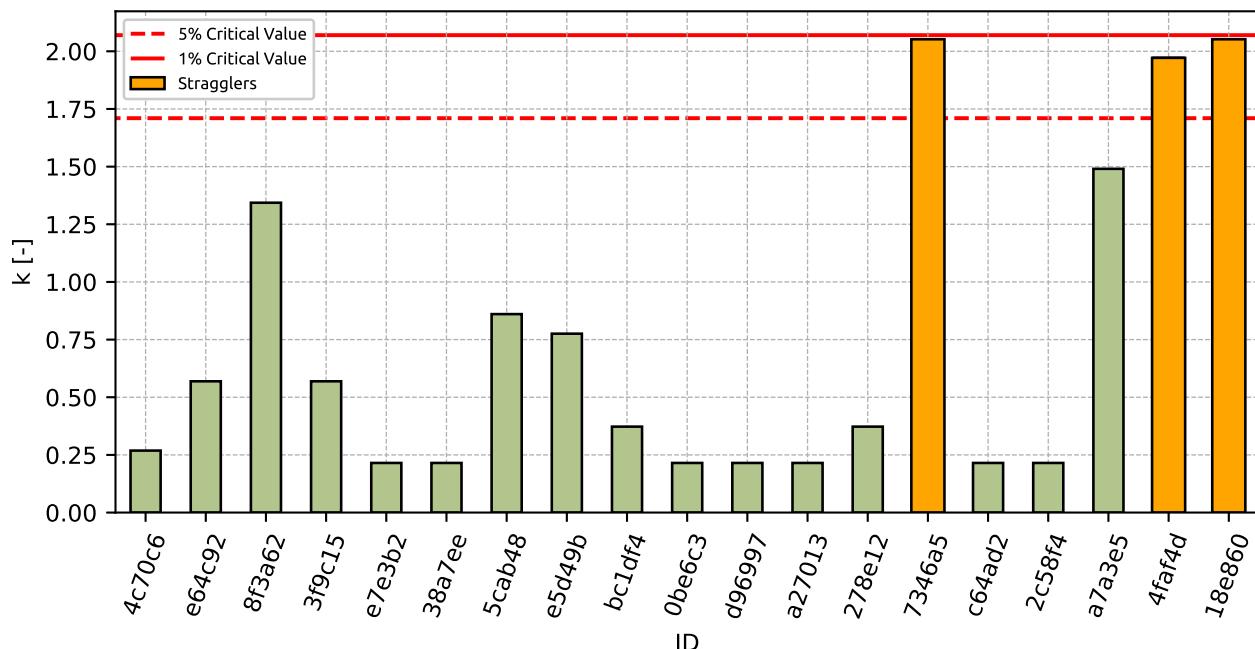
Figure 156: Intralaboratory Consistency Statistic
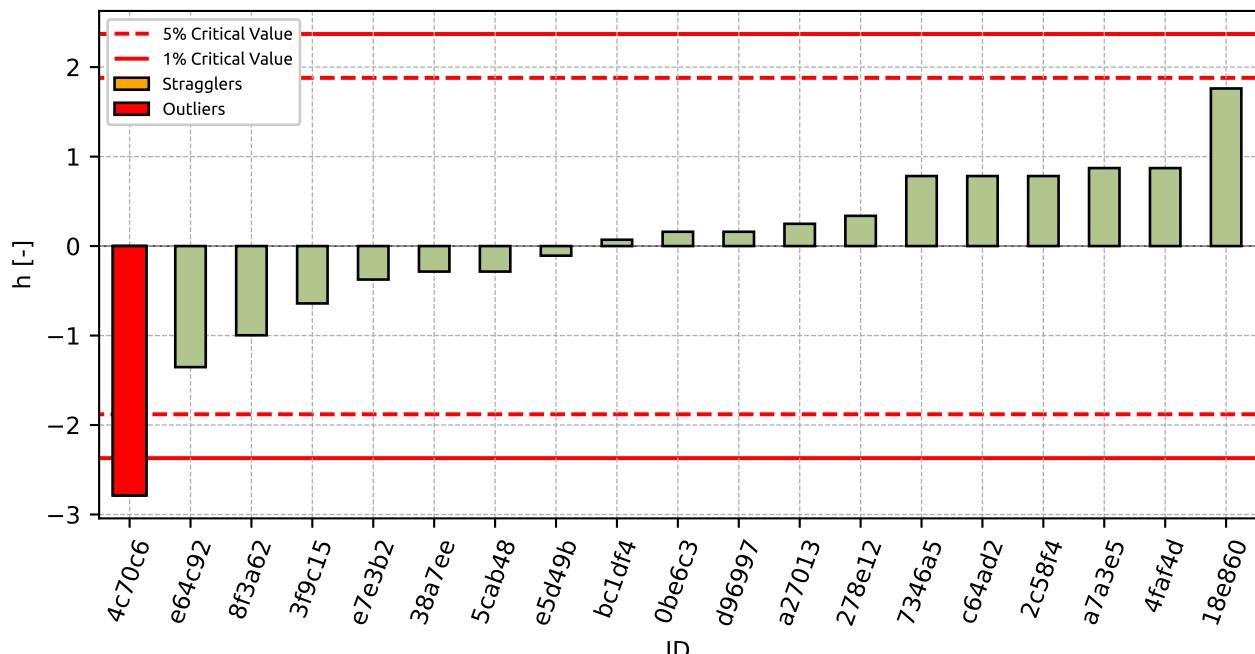
Figure 157: Interlaboratory Consistency Statistic

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11.4   Descriptive statistics
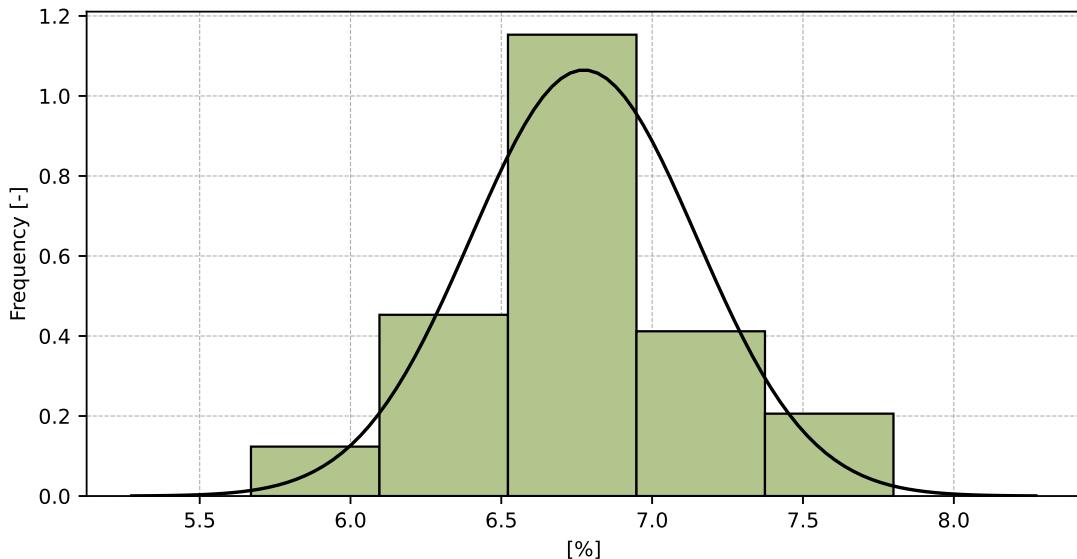
Figure 158: Histogram of all test results

Table 58: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	6.8
Sample standard deviation – s	0.37
Asigned value – x^*	6.8
Robust standard deviation – s^*	0.37
Measurement uncertainty of asigned value – u_X	0.09
p-value of normality test	0.026 [-]
Interlaboratory standard deviation – s_L	0.34
Repeatability standard deviation – s_r	0.27
Reproducibility standard deviation – s_R	0.43
Repeatability – r	0.8
Reproducibility – R	1.2

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11.5   Evaluation of Performance Statistics
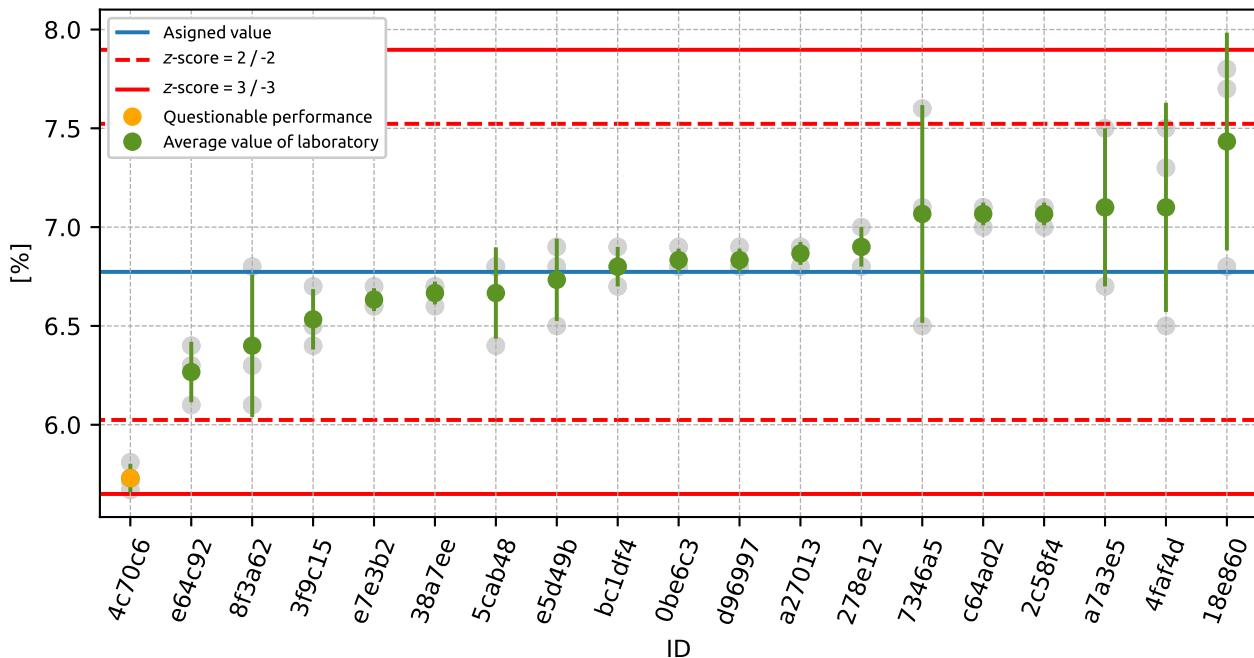
Figure 159: Average values and sample standard deviations
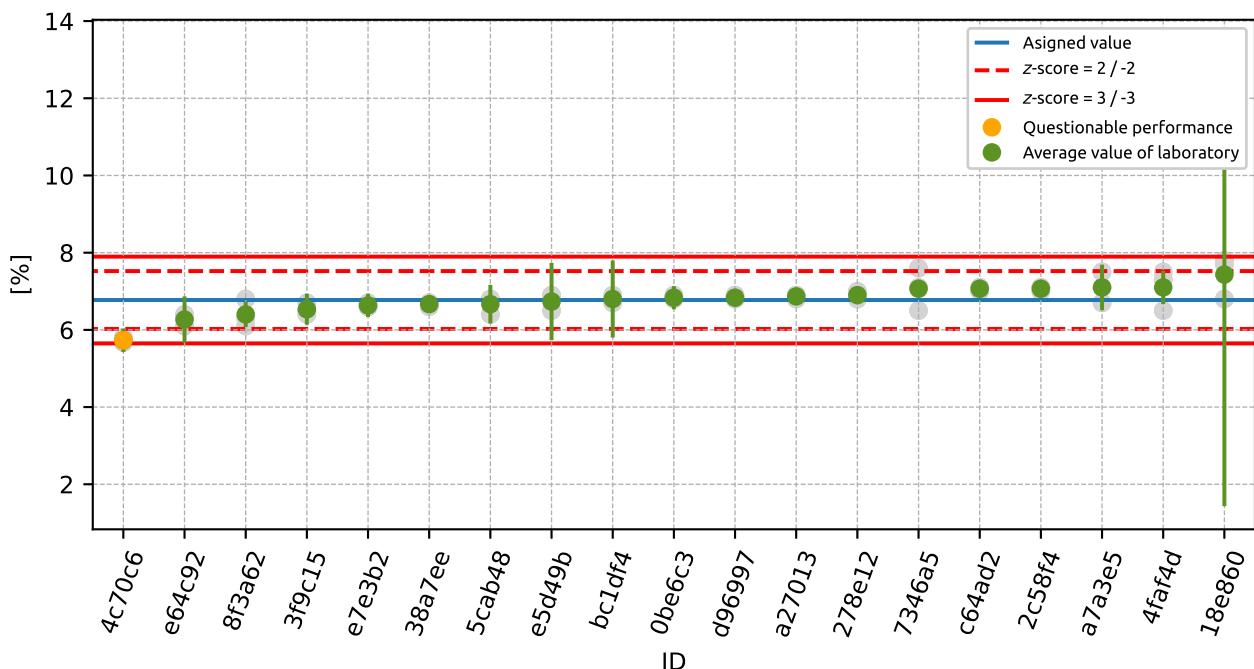
Figure 160: Average values and extended uncertainties of measurement

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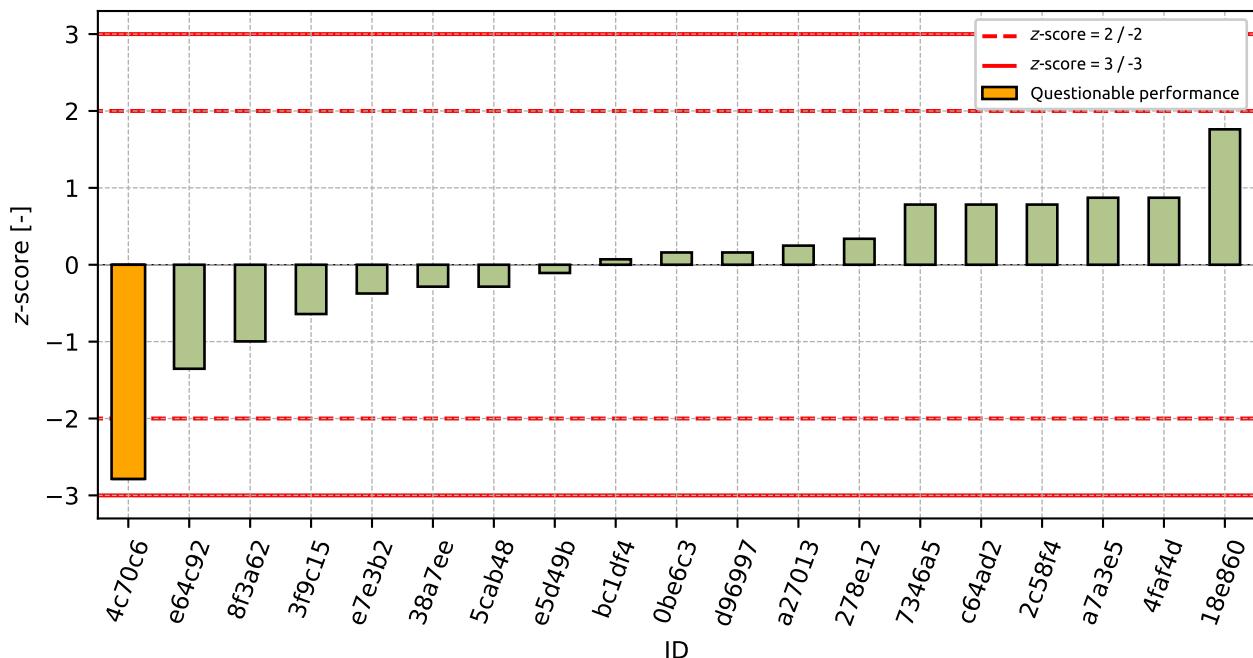
Figure 161: z-score

Figure 162: ζ-score

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Table 59: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
4c70c6	-2.79	-3.34
e64c92	-1.35	-0.84
8f3a62	-1.0	-1.1
3f9c15	-0.64	-0.59
e7e3b2	-0.37	-0.45
38a7ee	-0.29	-1.17
5cab48	-0.29	-0.21
e5d49b	-0.11	-0.04
bc1df4	0.07	0.03
0be6c3	0.16	0.19
d96997	0.16	0.45
a27013	0.25	0.43
278e12	0.34	0.96
7346a5	0.78	2.22
c64ad2	0.78	1.35
2c58f4	0.78	1.99
a7a3e5	0.87	0.55
4faf4d	0.87	0.74
18e860	1.76	0.11

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

12.1   Particle density

12.1.1   Test results

Table 60: 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 [%]
d4530f	2.63	2.64	2.63	0.06	2.63	0.006	0.22
a9c83a	2.64	2.64	2.64	-	2.64	0.004	0.13
e64c92	2.65	2.65	2.65	0.04	2.65	0.0	0.0
80076b	2.67	2.66	2.65	0.01	2.66	0.01	0.38
4d51a8	2.66	2.66	2.66	0.0	2.66	0.0	0.0
4f2532	2.68	2.65	2.66	-	2.66	0.015	0.57
38a7ee	2.67	2.66	2.66	0.01	2.66	0.006	0.22
4faf4d	2.67	2.67	2.67	0.02	2.67	0.0	0.0
8267dd	2.67	2.67	2.67	-	2.67	0.0	0.0
1ce009	2.67	2.67	2.68	0.02	2.67	0.006	0.22
a7a3e5	2.68	2.68	2.67	0.22	2.68	0.006	0.22
a5e1f6	2.68	2.68	2.68	-	2.68	0.002	0.08
0bde87	2.67	2.68	2.69	0.01	2.68	0.01	0.37
e7e3b2	2.69	2.69	2.73	0.05	2.7	0.023	0.85
278e12	2.69	2.72	2.71	0.05	2.71	0.015	0.56
7346a5	2.74	2.71	2.7	0.05	2.72	0.021	0.77
7b3306	2.75	2.72	2.75	0.36	2.74	0.017	0.63

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12.1.2 The Numerical Procedure for Determining Outliers
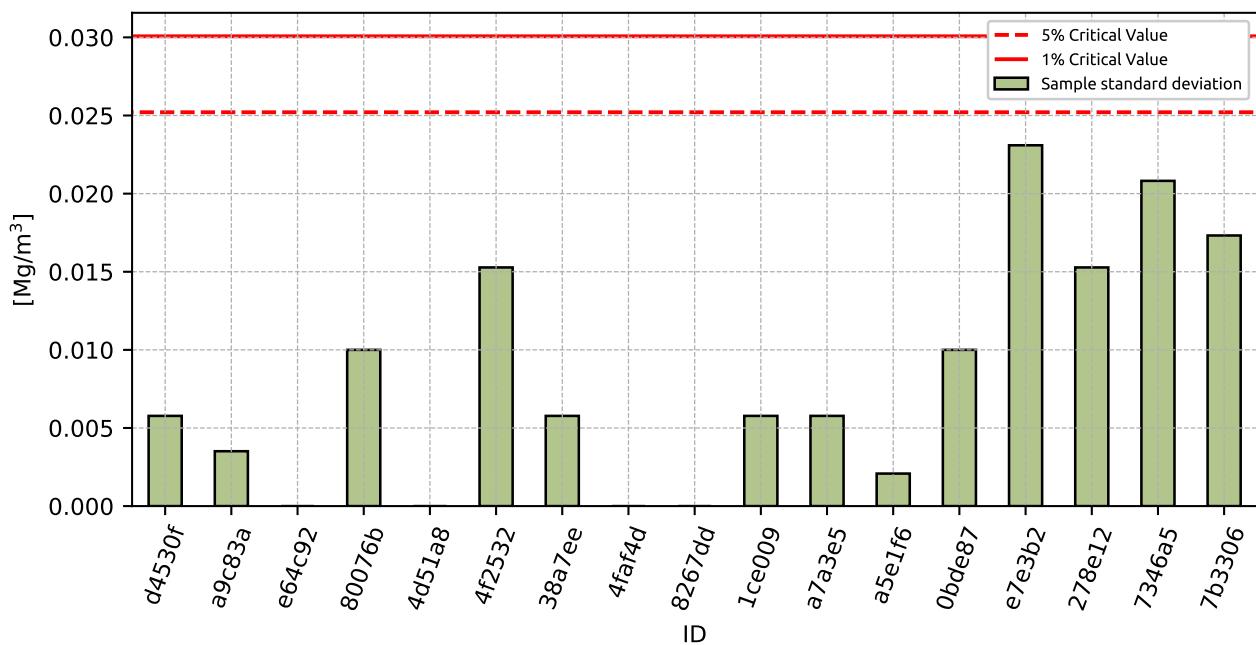
Figure 163: **Cochran's test** - sample standard deviations
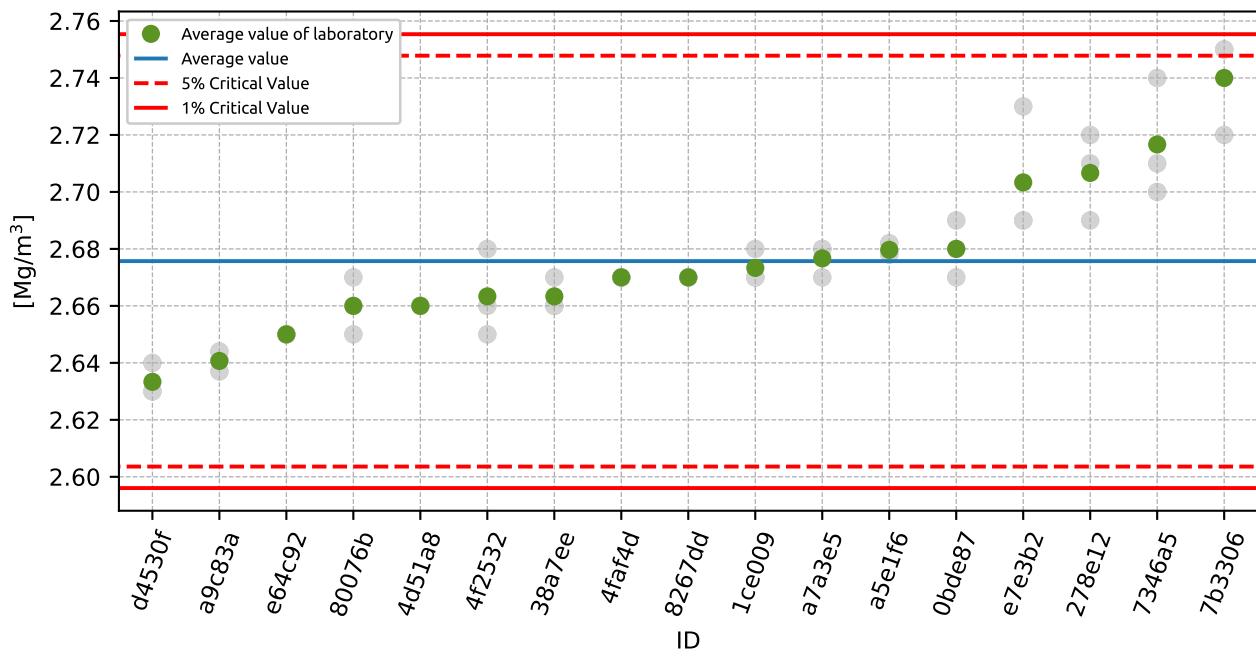

Figure 164: **Grubbs' test** - average values

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12.1.3   Mandel's Statistics
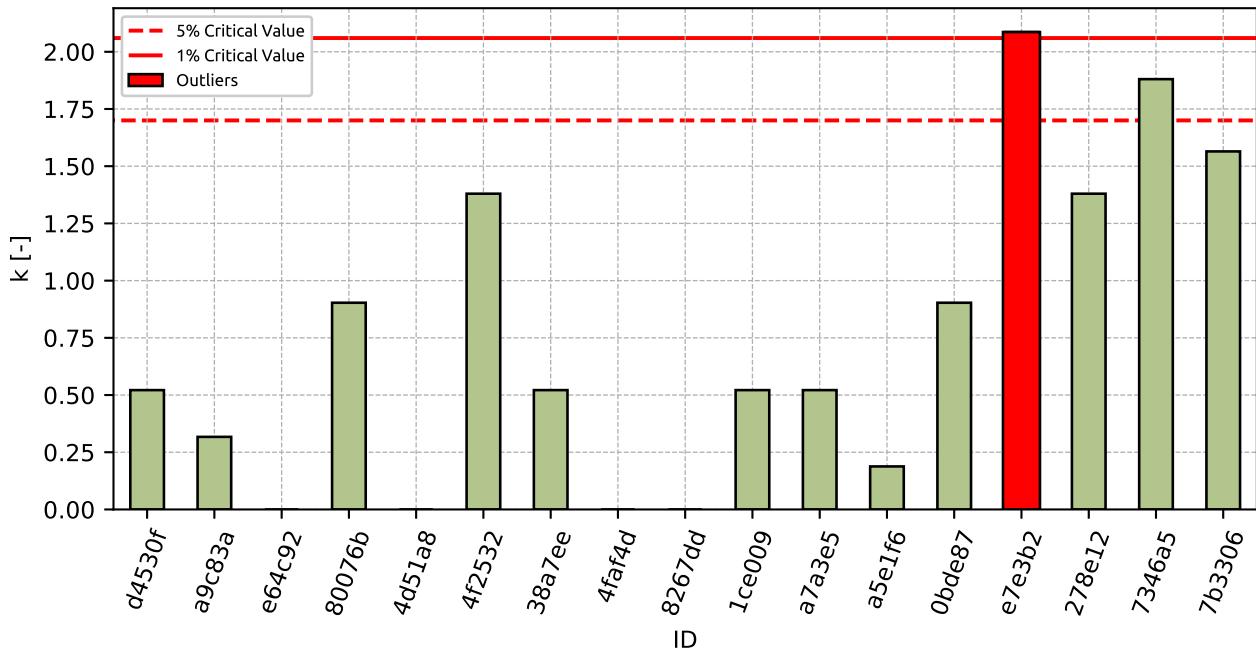
Figure 165: Intralaboratory Consistency Statistic
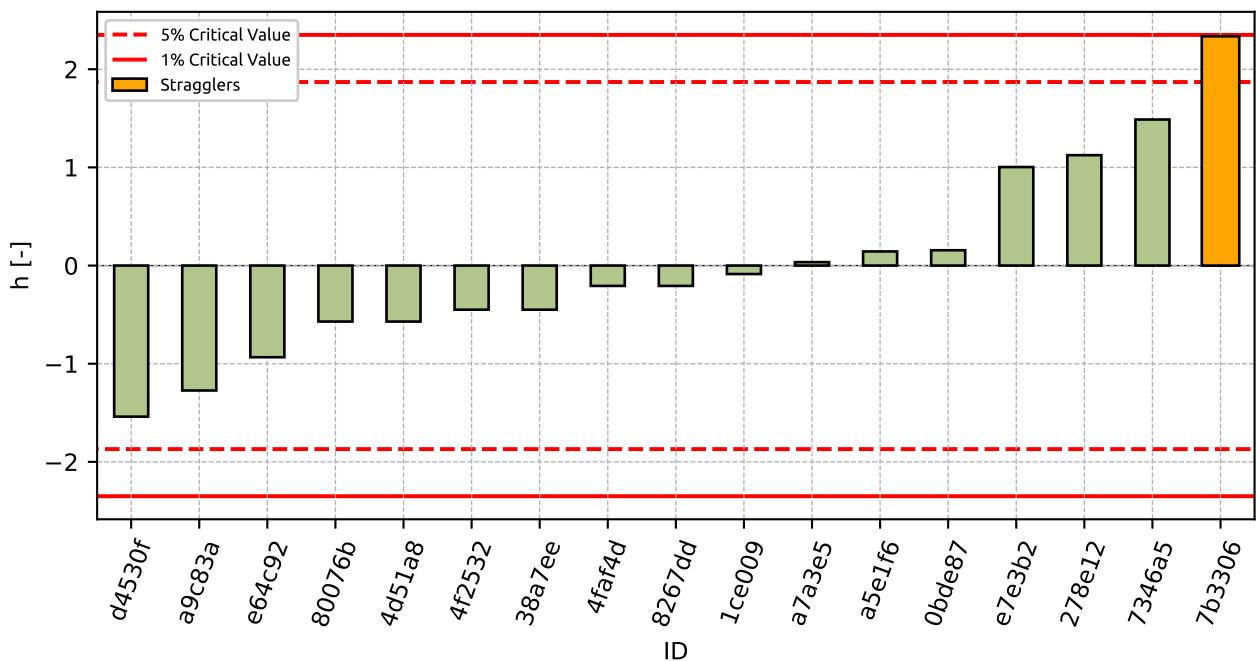
Figure 166: Interlaboratory Consistency Statistic

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12.1.4　Descriptive statistics
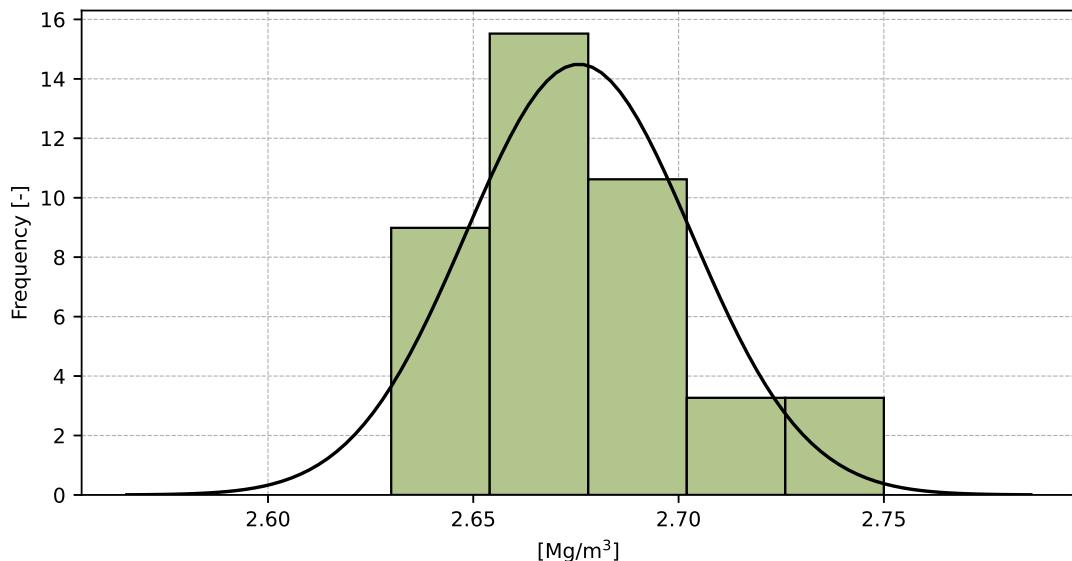
Figure 167: Histogram of all test results

Table 61: Descriptive statistics

Characteristics	[Mg/m^3]
Average value – $\bar{x}$	2.68
Sample standard deviation – s	0.028
Asigned value – x^*	2.67
Robust standard deviation – s^*	0.035
Measurement uncertainty of asigned value – u_X	0.007
p-value of normality test	0.002 [-]
Interlaboratory standard deviation – s_L	0.027
Repeatability standard deviation – s_r	0.011
Reproducibility standard deviation – s_R	0.029
Repeatability – r	0.03
Reproducibility – R	0.08

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12.1.5   Evaluation of Performance Statistics
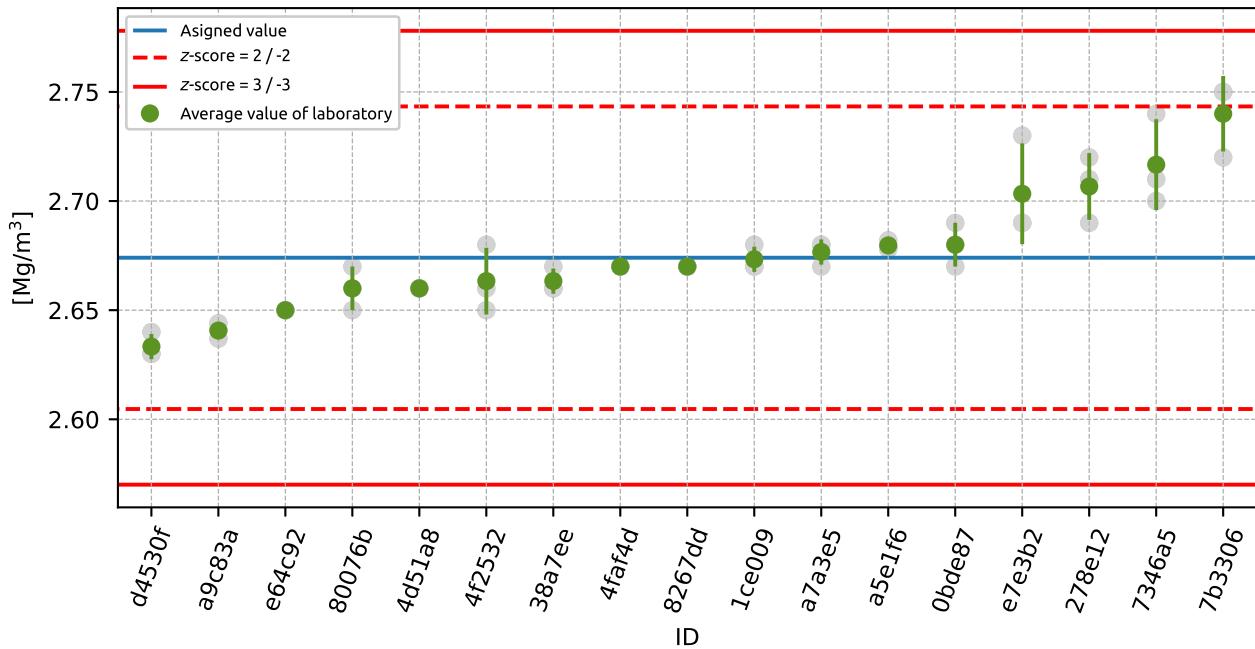

Figure 168: Average values and sample standard deviations
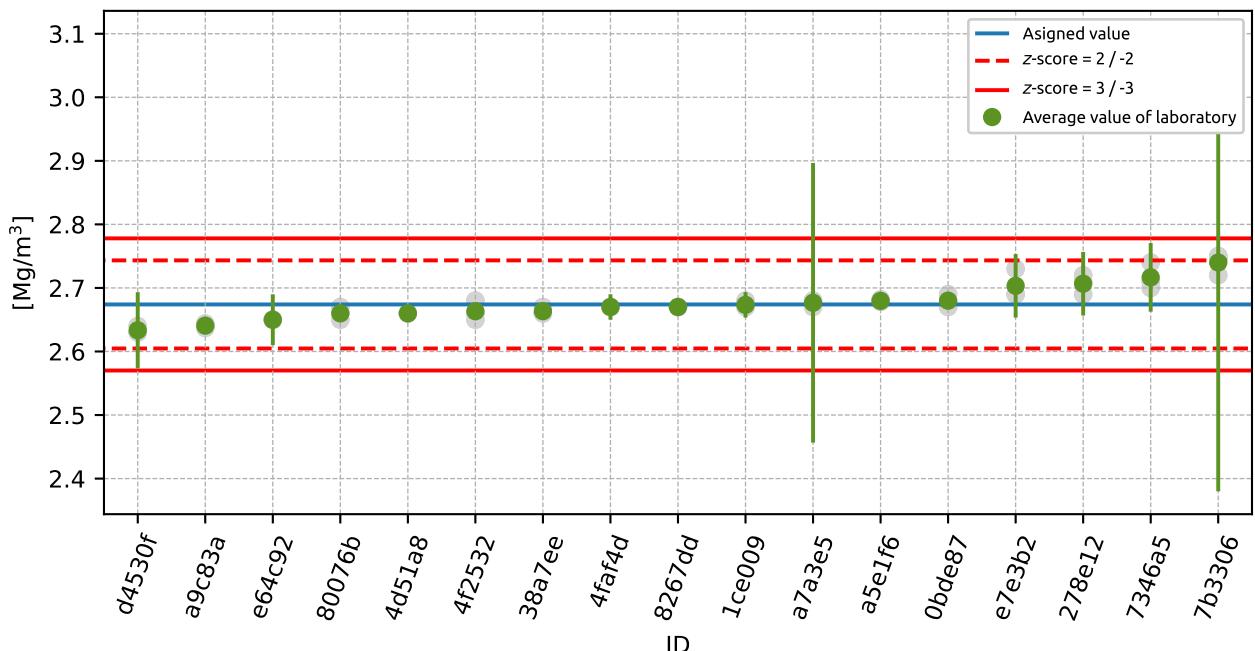
Figure 169: Average values and extended uncertainties of measurement

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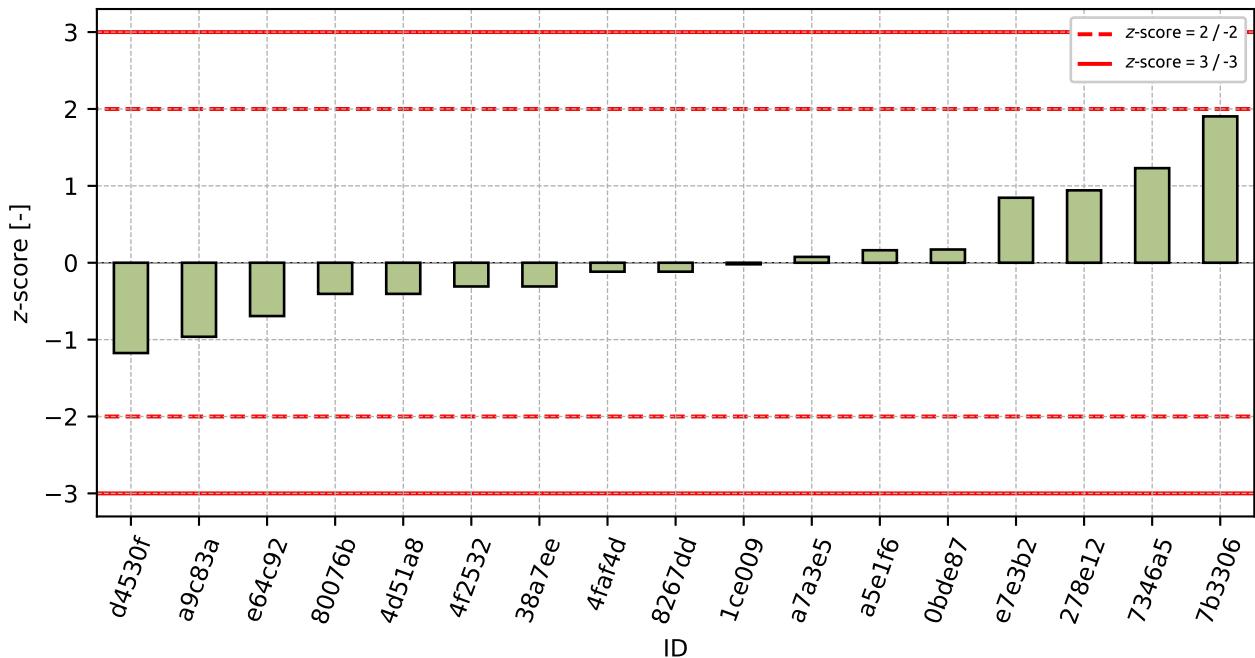
Figure 170: z-score

Figure 171: ζ-score

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Table 62: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d4530f	-1.17	-0.67
a9c83a	-0.96	-
e64c92	-0.69	-0.59
80076b	-0.4	-1.2
4d51a8	-0.4	-1.81
4f2532	-0.31	-
38a7ee	-0.31	-0.86
4faf4d	-0.12	-0.19
8267dd	-0.12	-
1ce009	-0.02	-0.03
a7a3e5	0.08	0.01
a5e1f6	0.16	-
0bde87	0.17	0.48
e7e3b2	0.85	0.58
278e12	0.94	0.65
7346a5	1.23	0.78
7b3306	1.9	0.18

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12.2 Water absorption

12.2.1 Test results

Table 63: 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 [%]
80076b	0.3	0.2	0.4	0.1	0.3	0.1	33.33
e64c92	0.3	0.4	0.3	0.1	0.3	0.06	17.32
0bde87	0.4	0.4	0.3	0.1	0.4	0.06	15.75
4faf4d	0.5	0.4	0.3	0.0	0.4	0.1	25.0
8267dd	0.5	0.4	0.5	-	0.5	0.06	12.37
a7a3e5	0.5	0.5	0.5	0.0	0.5	0.0	0.0
4d51a8	0.6	0.4	0.5	0.0	0.5	0.1	20.0
38a7ee	0.6	0.5	0.5	0.0	0.5	0.06	10.83
4f2532	0.6	0.6	0.5	-	0.6	0.06	10.19
e7e3b2	0.5	0.6	0.6	0.1	0.6	0.06	10.19
7b3306	0.6	0.5	0.6	1.4	0.6	0.06	10.19
d4530f	0.6	0.7	0.6	2.3	0.6	0.06	9.12
a5e1f6	0.7	0.7	0.7	-	0.7	0.0	0.0
278e12	0.7	0.8	0.7	0.1	0.7	0.06	7.87
1ce009	0.8	0.8	0.7	0.2	0.8	0.06	7.53
a9c83a	0.8	0.9	0.9	-	0.9	0.07	7.85
7346a5	0.9	1.0	1.2	0.1	1.0	0.15	14.78

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12.2.2   The Numerical Procedure for Determining Outliers
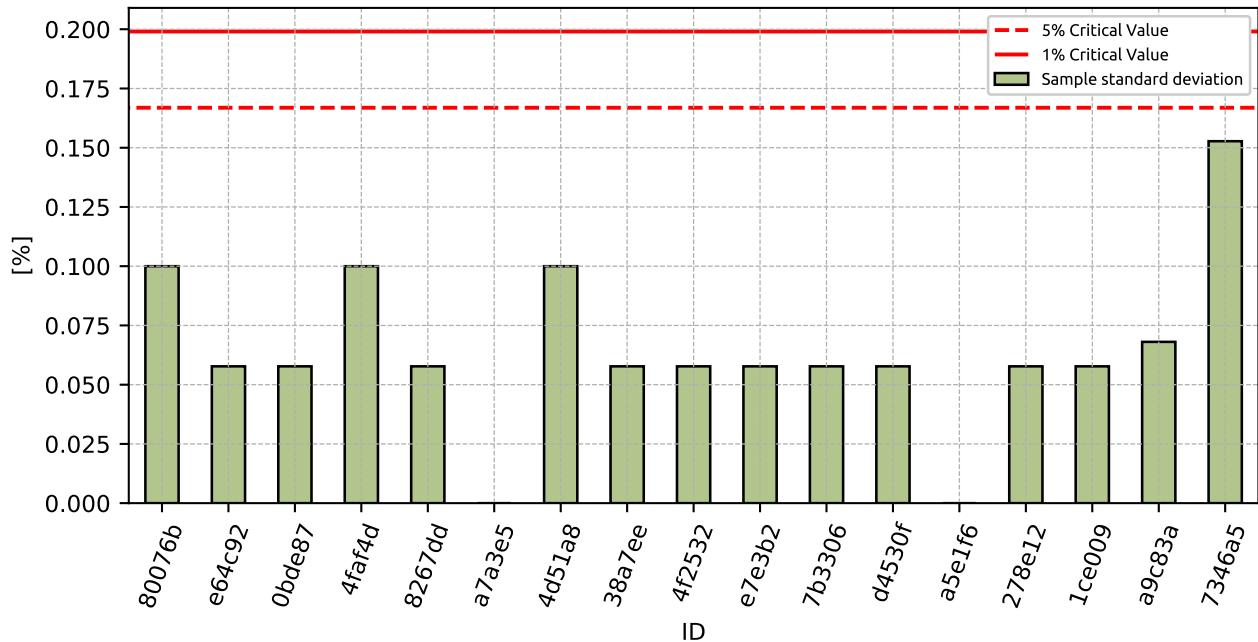
Figure 172: **Cochran's test** - sample standard deviations
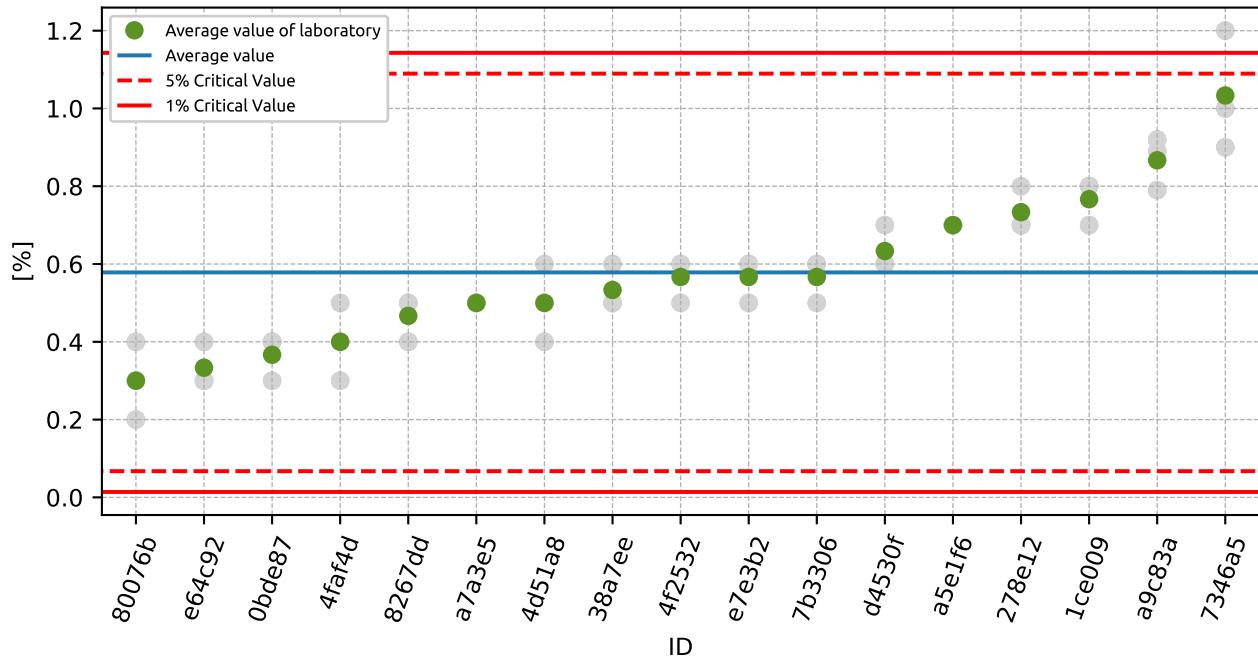
Figure 173: **Grubbs' test** - average values

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12.2.3   Mandel's Statistics
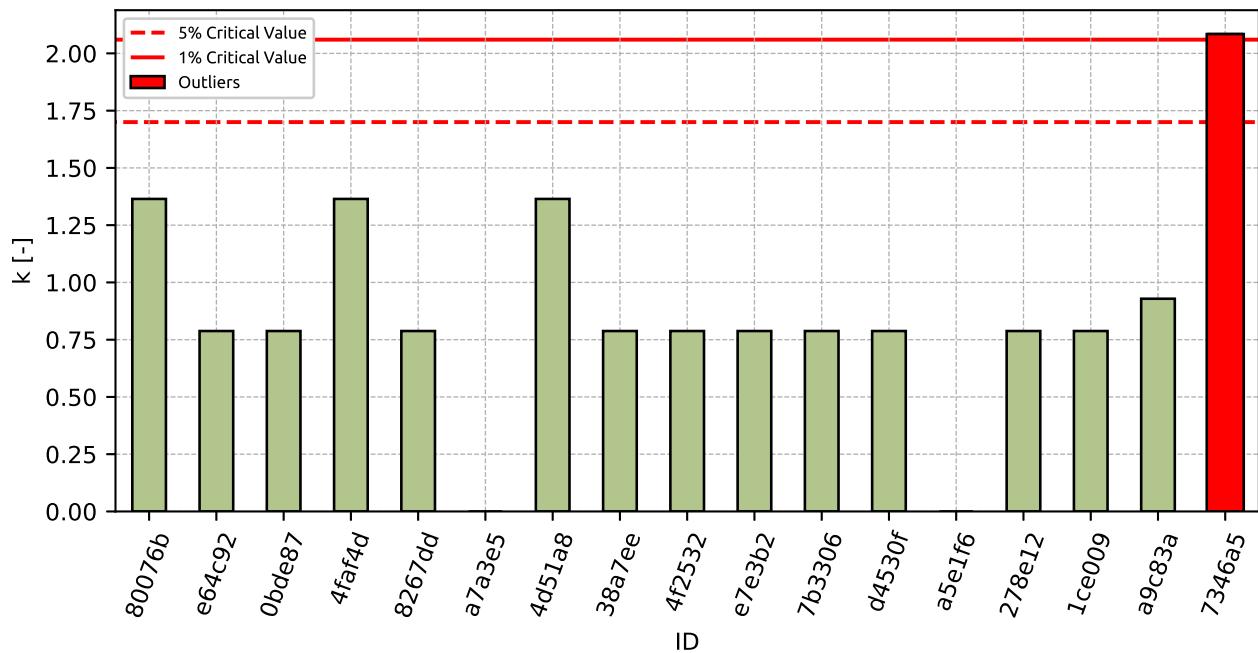
Figure 174: Intralaboratory Consistency Statistic
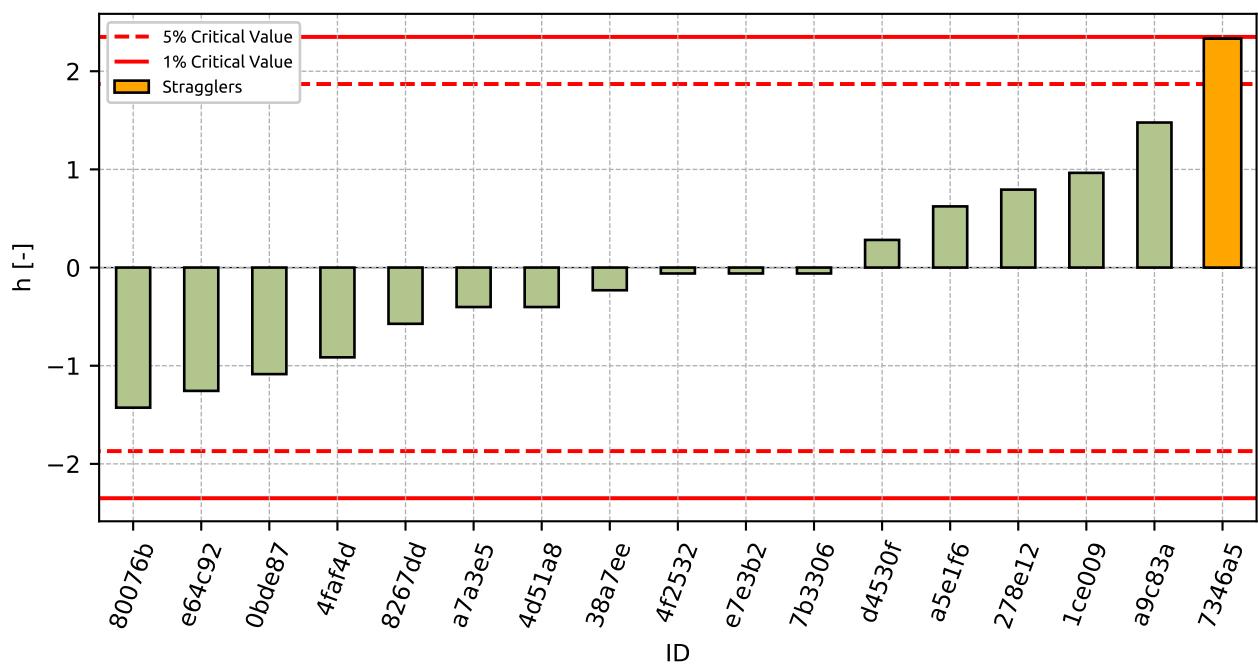
Figure 175: Interlaboratory Consistency Statistic

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12.2.4   Descriptive statistics
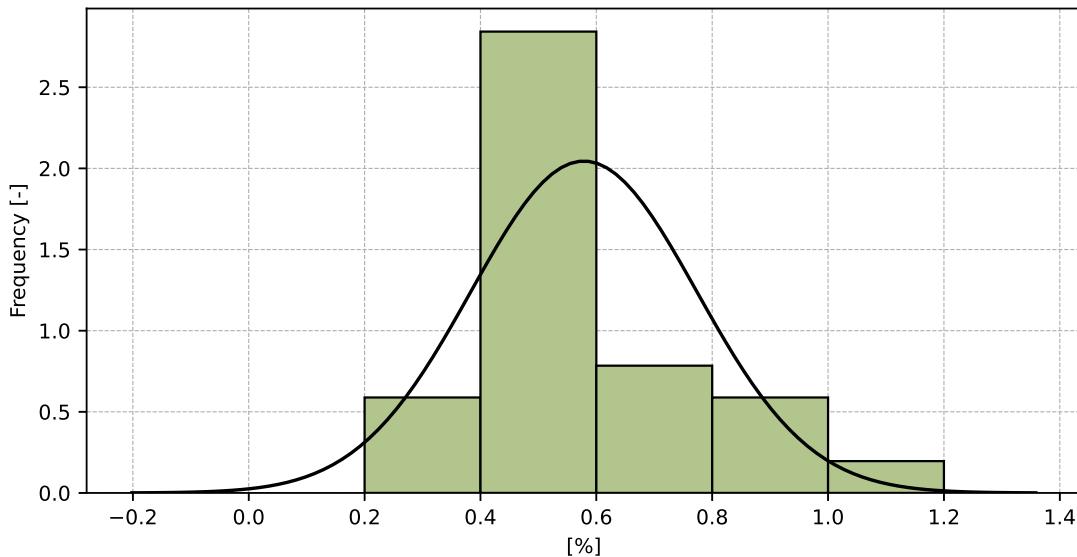
Figure 176: Histogram of all test results

Table 64: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	0.6
Sample standard deviation – s	0.2
Asigned value – x^*	0.6
Robust standard deviation – s^*	0.23
Measurement uncertainty of asigned value – u_X	0.06
p-value of normality test	0.049 [-]
Interlaboratory standard deviation – s_L	0.19
Repeatability standard deviation – s_r	0.07
Reproducibility standard deviation – s_R	0.2
Repeatability – r	0.2
Reproducibility – R	0.6

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12.2.5   Evaluation of Performance Statistics
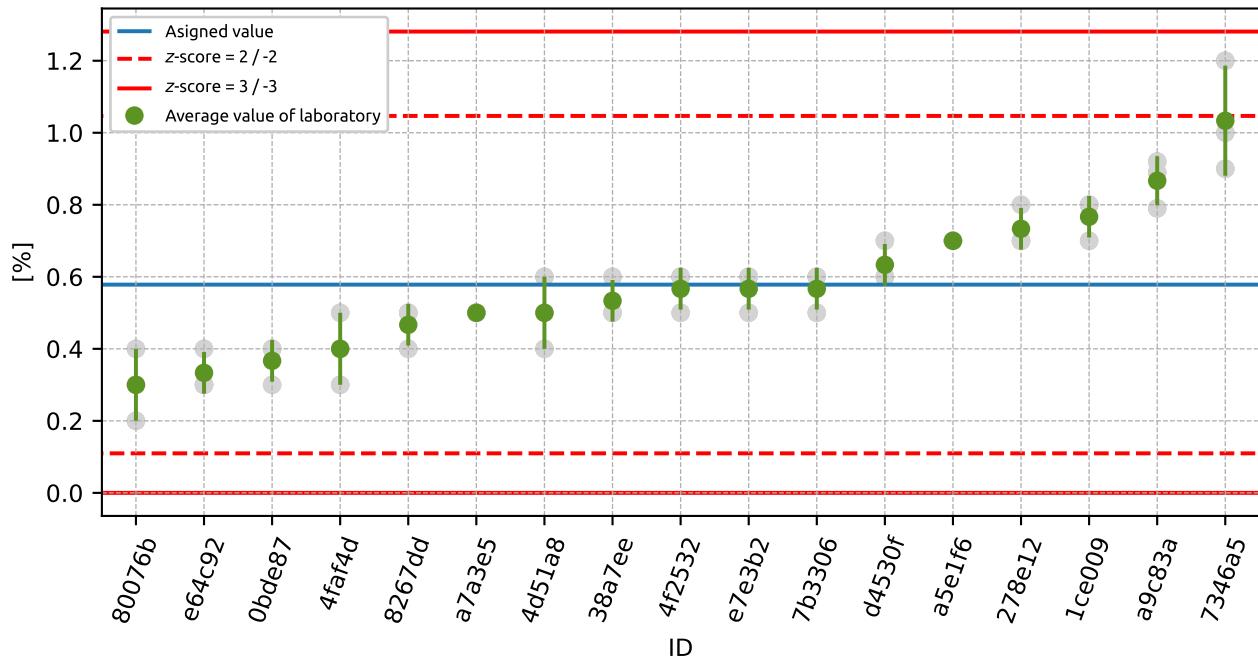

Figure 177: Average values and sample standard deviations
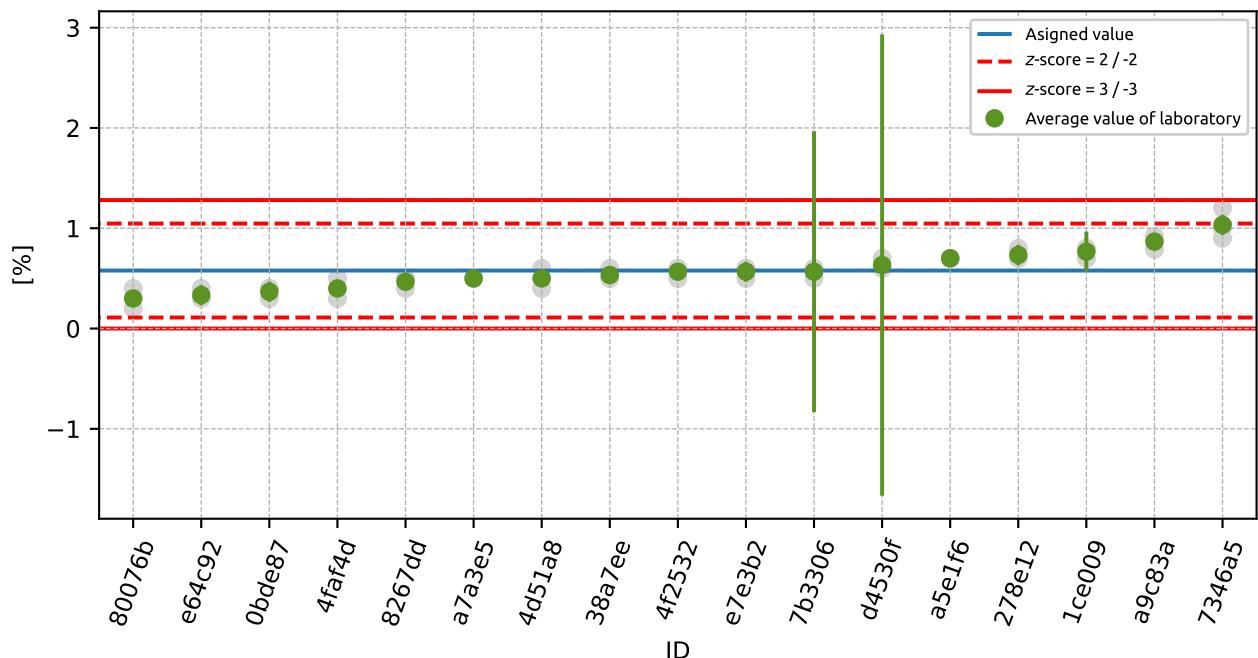
Figure 178: Average values and extended uncertainties of measurement

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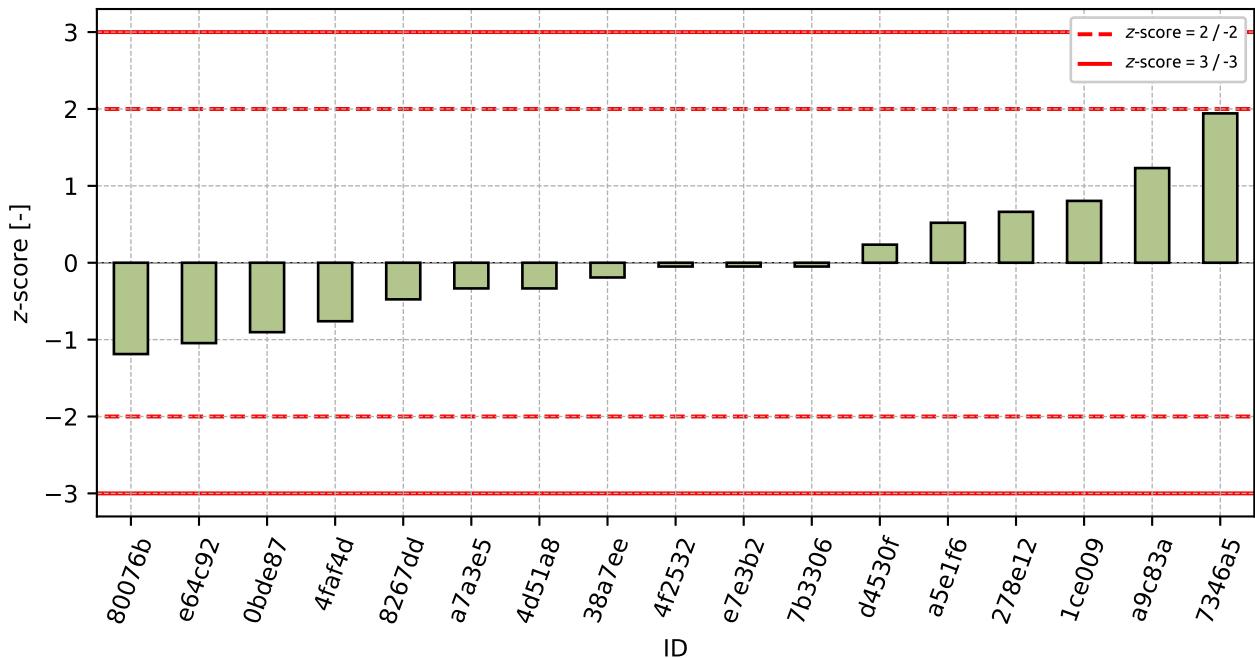
Figure 179: z-score

Figure 180: ζ-score

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Table 65: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
80076b	-1.19	-3.15
e64c92	-1.05	-2.05
0bde87	-0.9	-1.77
4faf4d	-0.76	-2.62
8267dd	-0.48	-
a7a3e5	-0.33	-1.09
4d51a8	-0.33	-1.09
38a7ee	-0.19	-0.63
4f2532	-0.05	-
e7e3b2	-0.05	-0.1
7b3306	-0.05	-0.01
d4530f	0.24	0.02
a5e1f6	0.52	-
278e12	0.66	1.3
1ce009	0.8	0.9
a9c83a	1.23	-
7346a5	1.94	3.82

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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 66: 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 [%]
9020c7	0.1	0.09	0.1	0.0	0.1	0.006	5.97
b96536	0.1	0.1	0.1	0.07	0.1	0.0	0.0
5cab48	0.1	0.1	0.1	0.04	0.1	0.0	0.0
048532	0.1	0.1	0.1	-	0.1	0.0	0.0
2c58f4	0.14	0.13	0.16	0.02	0.14	0.015	10.66
3f9c15	0.29	0.22	0.22	0.1	0.24	0.04	16.61
ec14be	0.2	0.3	0.3	-	0.27	0.058	21.65

14.2   The Numerical Procedure for Determining Outliers
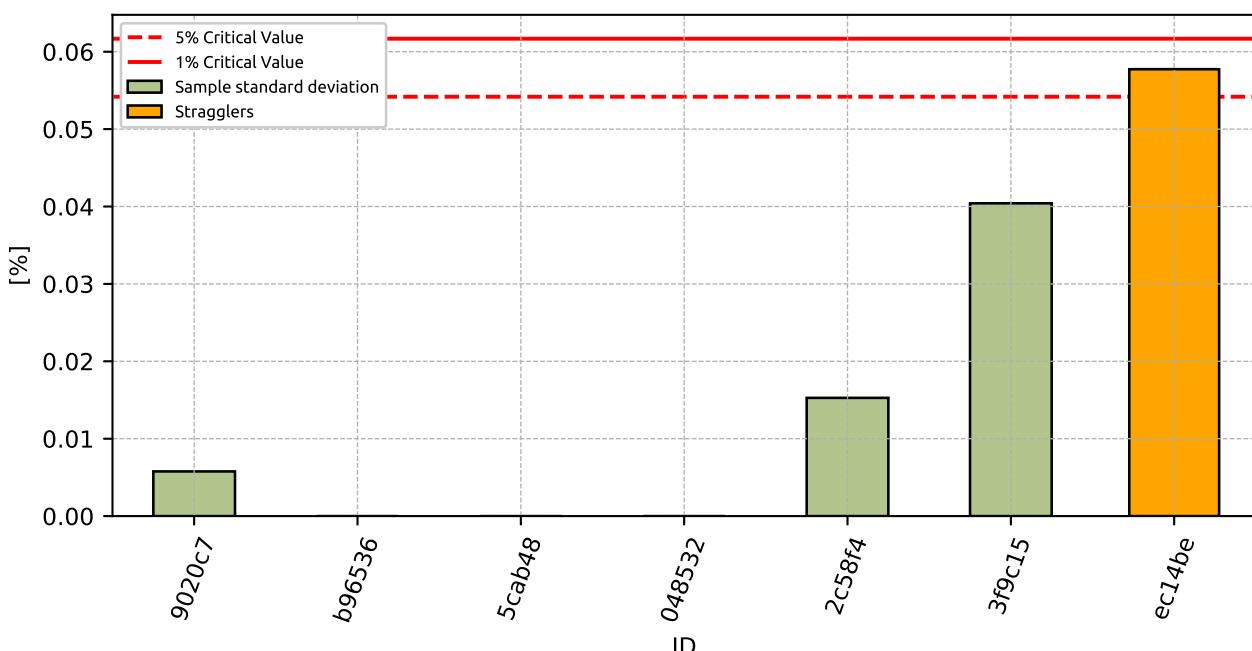
Figure 181: **Cochran's test** - sample standard deviations

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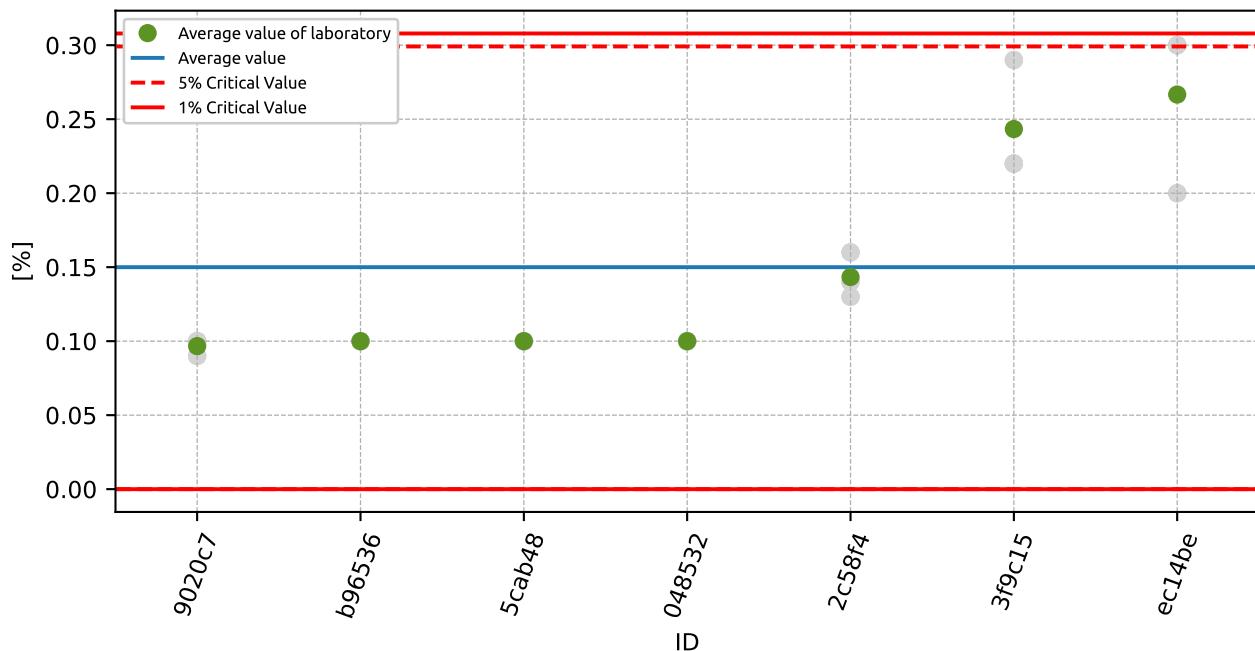
Figure 182: **Grubbs' test** - average values

14.3 Mandel's Statistics
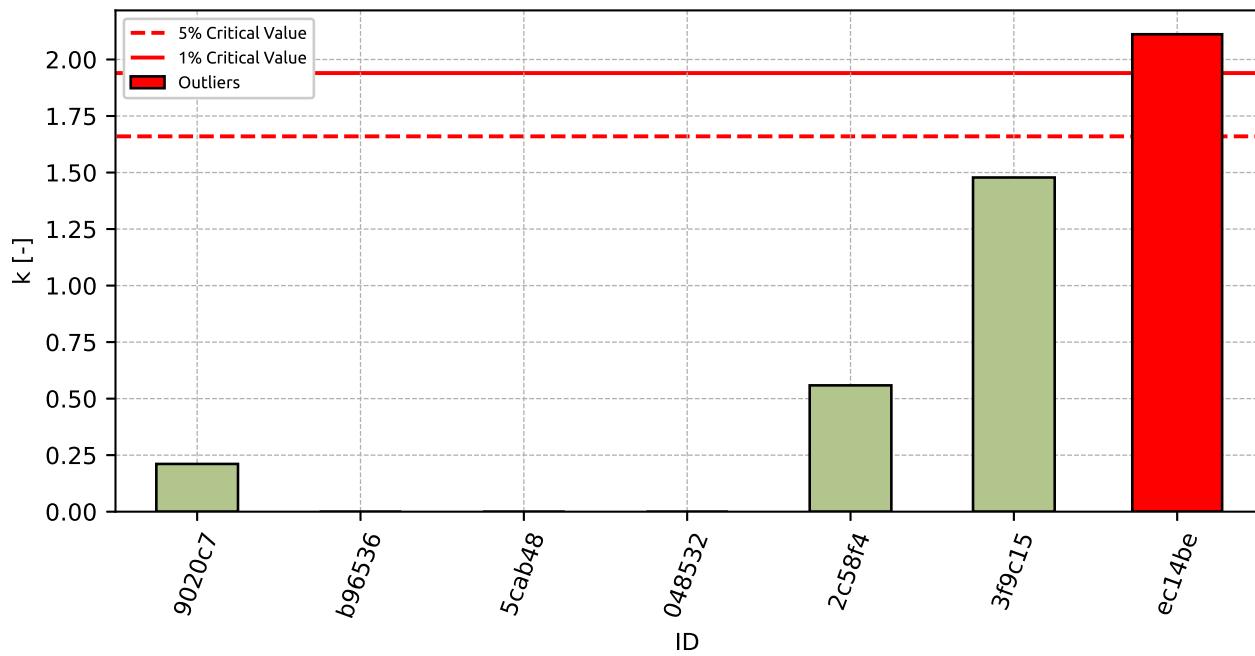
Figure 183: Intralaboratory Consistency Statistic

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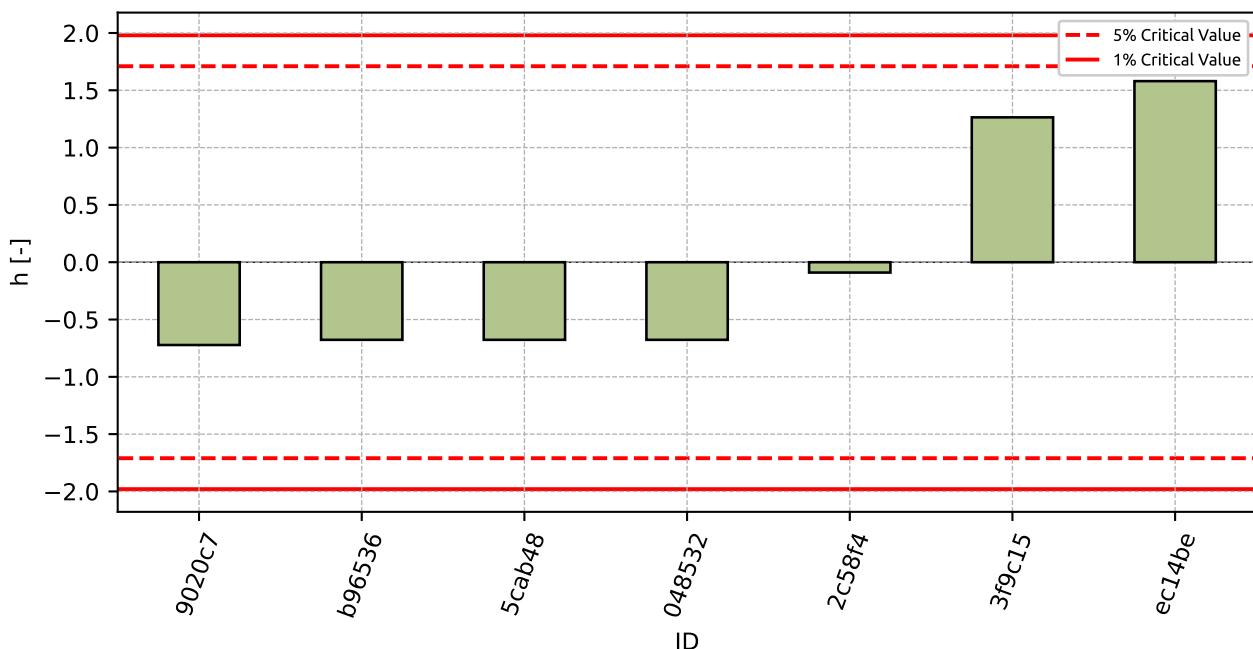
Figure 184: Interlaboratory Consistency Statistic

14.4 Descriptive statistics
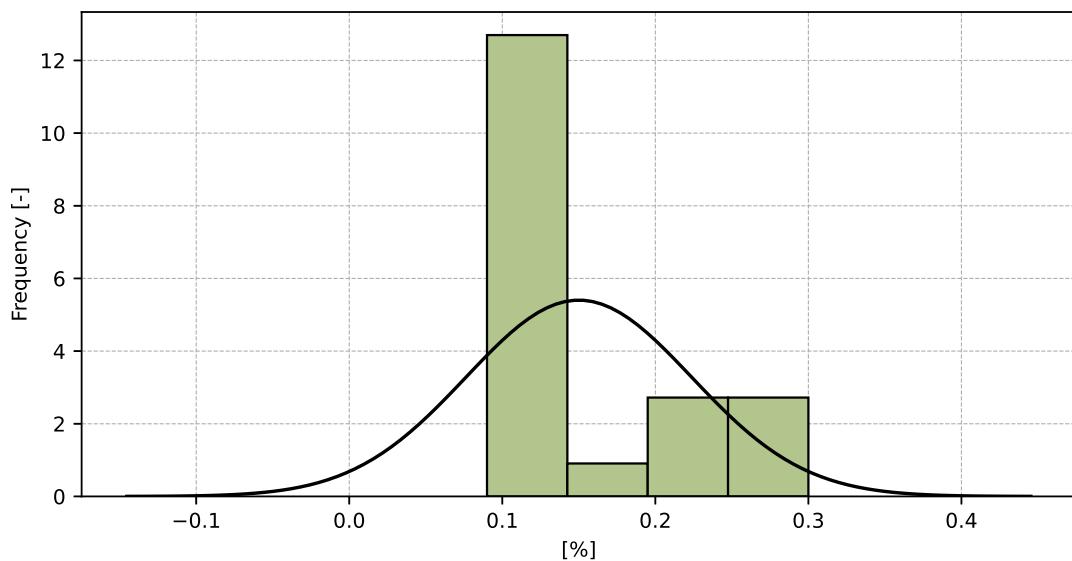
Figure 185: Histogram of all test results

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Table 67: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	0.15
Sample standard deviation – s	0.074
Asigned value – x^*	0.15
Robust standard deviation – s^*	0.074
Measurement uncertainty of asigned value – u_X	0.028
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	0.072
Repeatability standard deviation – s_r	0.027
Reproducibility standard deviation – s_R	0.077
Repeatability – r	0.08
Reproducibility – R	0.22

14.5   Evaluation of Performance Statistics
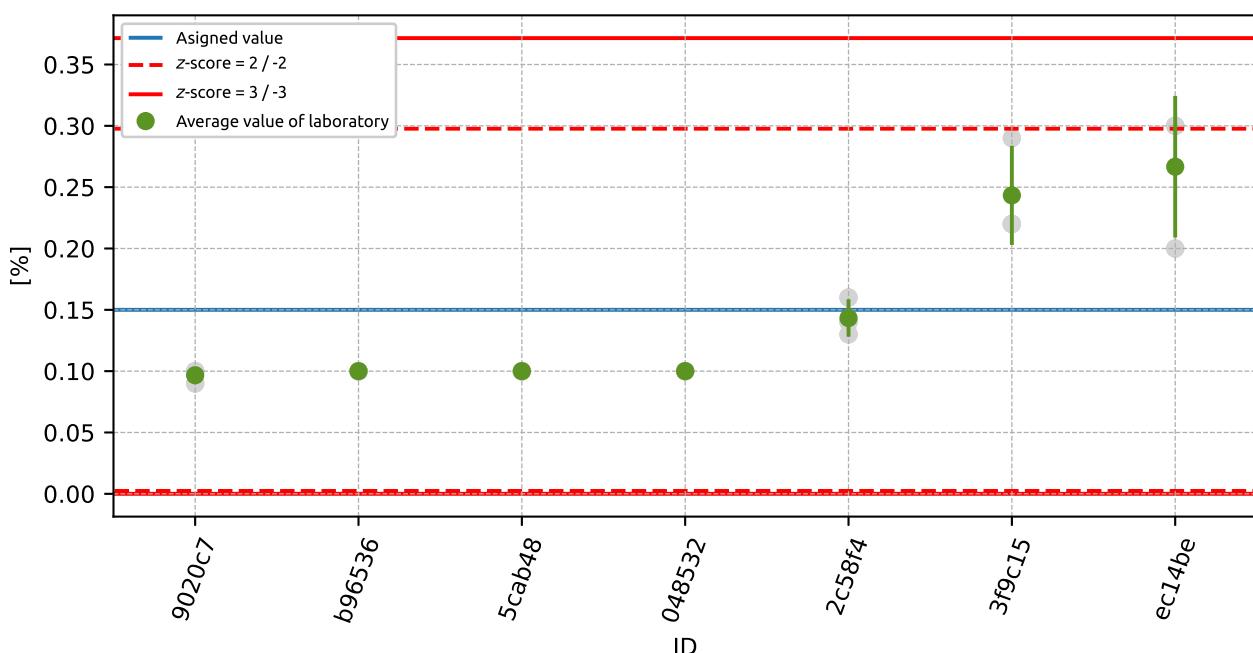
Figure 186: Average values and sample standard deviations

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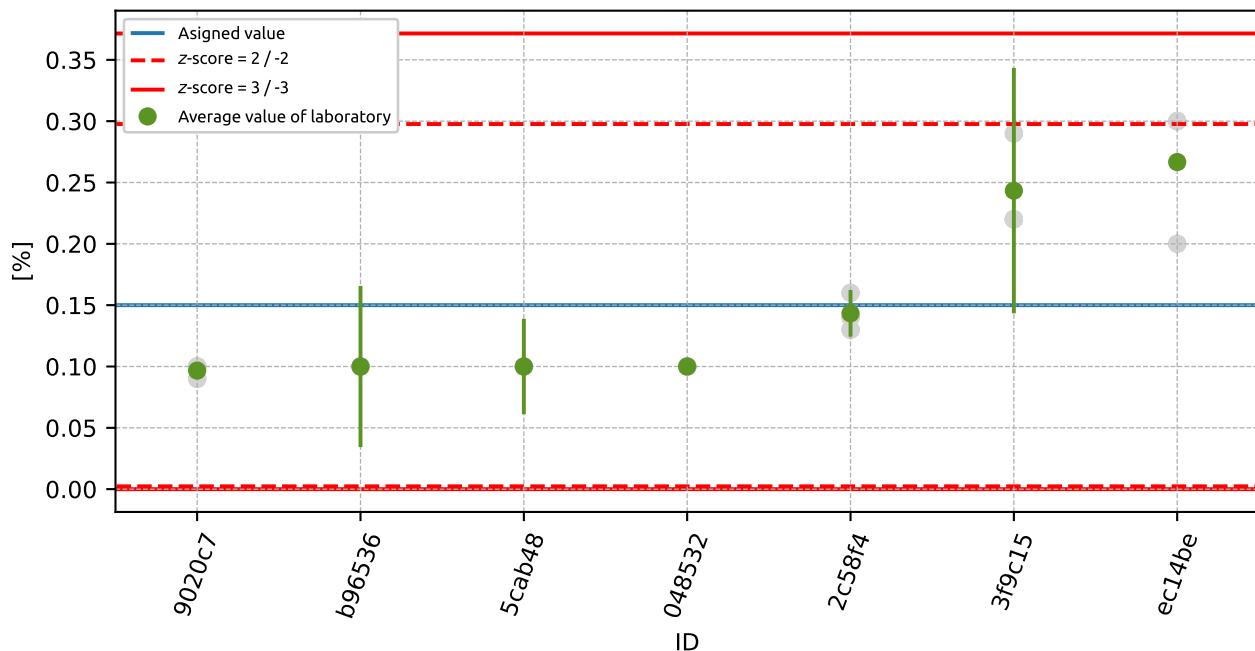
Figure 187: Average values and extended uncertainties of measurement

Figure 188: z-score

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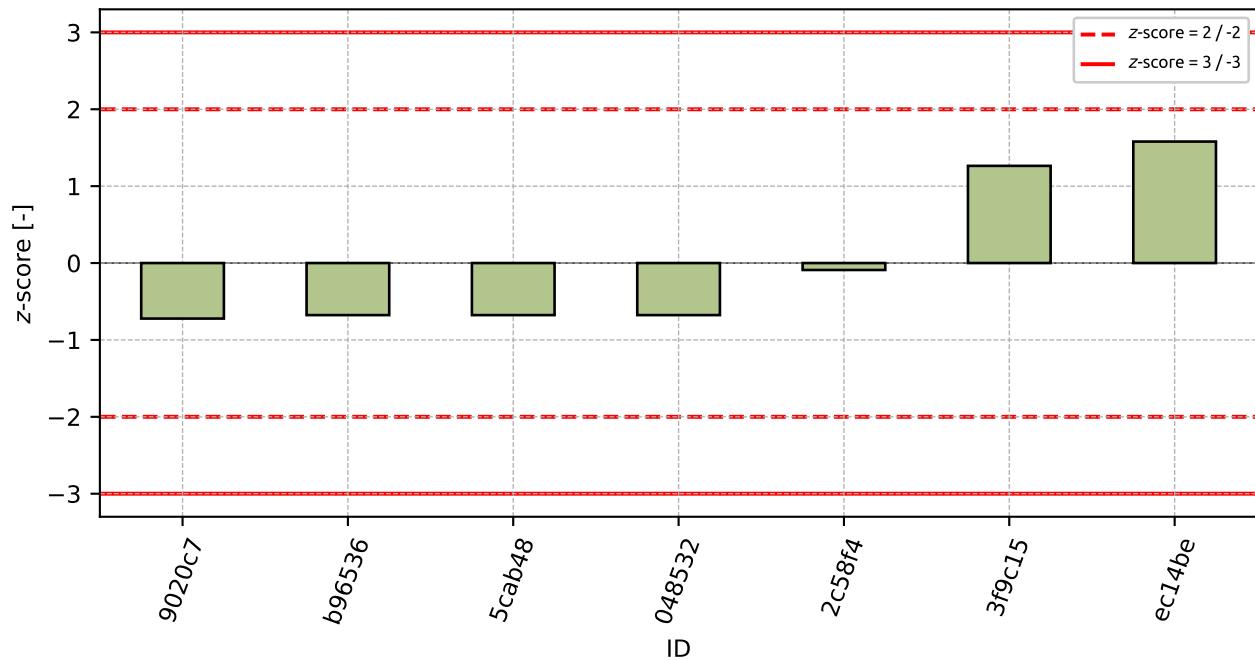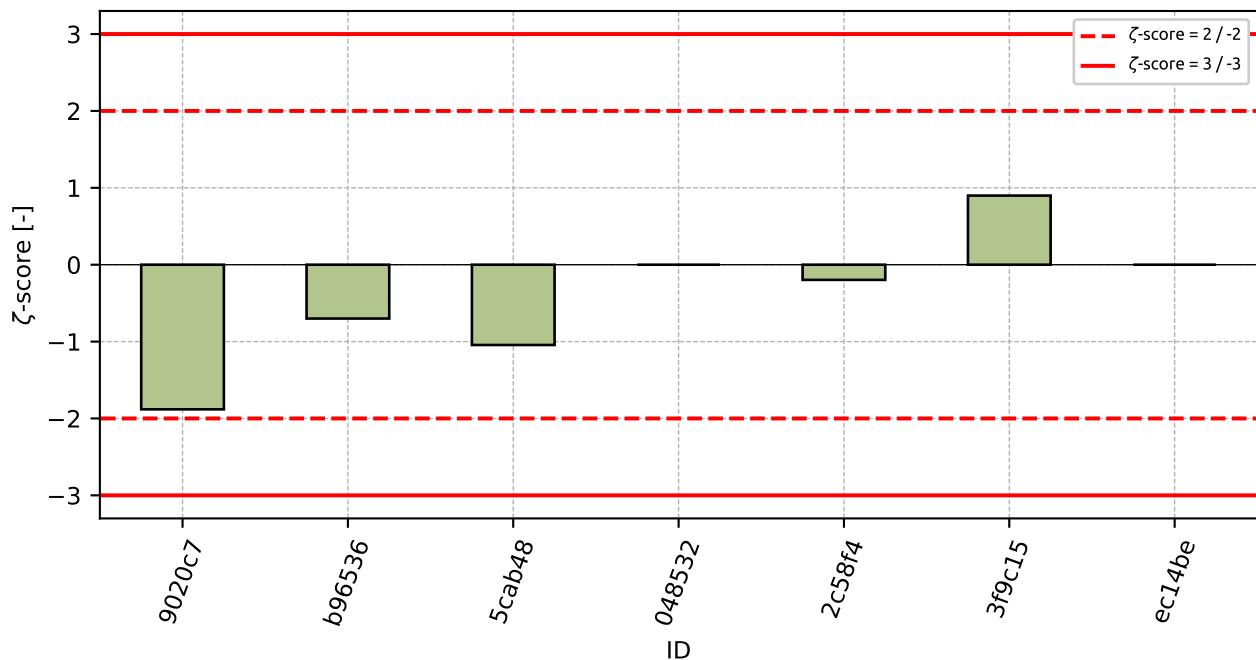
Figure 189: ζ-score

Table 68: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
9020c7	-0.72	-1.88
b96536	-0.68	-0.7
5cab48	-0.68	-1.04
048532	-0.68	-
2c58f4	-0.09	-0.2
3f9c15	1.26	0.9
ec14be	1.58	-

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15   Appendix – EN 1367-2 Magnesium sulfate test

15.1   Test results

Table 69: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [%]	u_X [%]
b96536	0.0	10.4
6f05cd	0.0	-
4d51a8	0.7	0.0
a9c83a	0.9	-
80076b	1.0	0.8
a7a3e5	1.3	0.6
82c914	1.9	-
8267dd	5.0	-

15.2   The Numerical Procedure for Determining Outliers
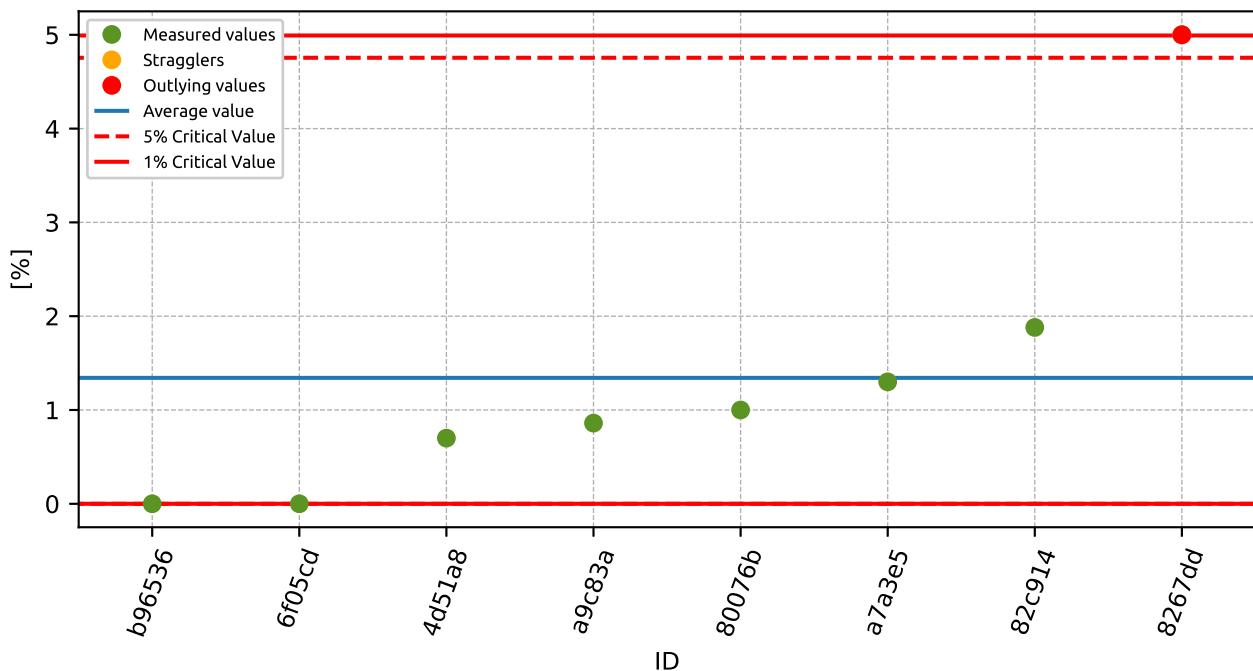
Figure 190: **Grubbs' test** - average values

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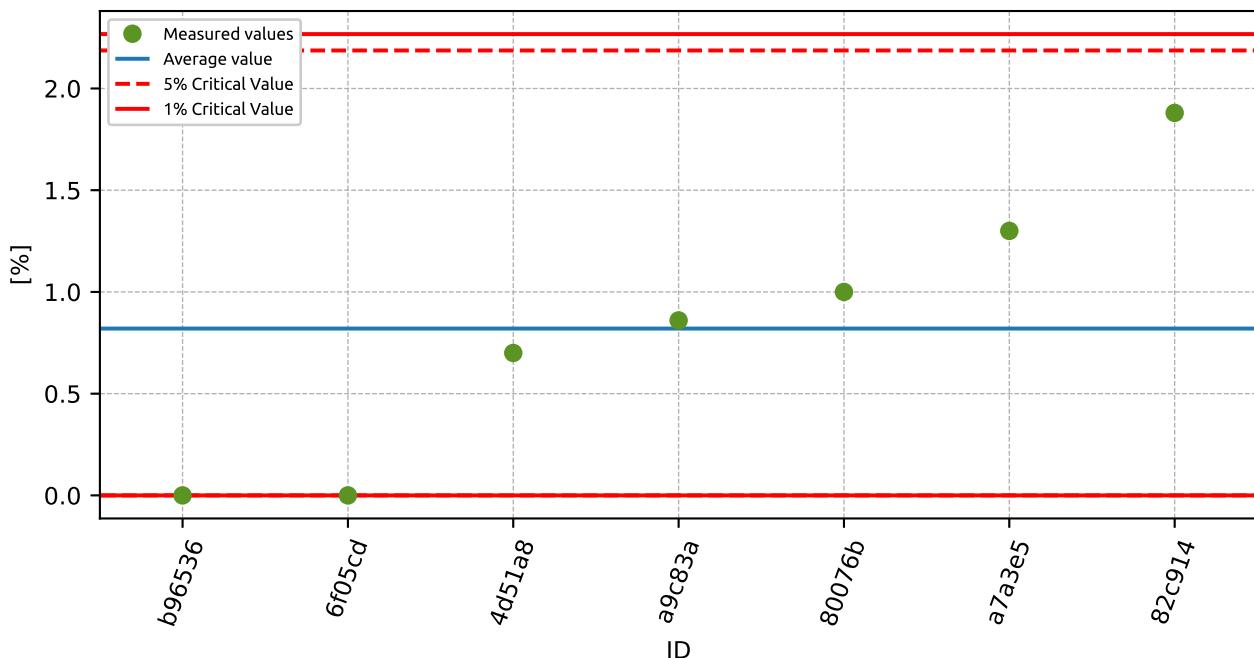
Figure 191: **Grubbs' test** - average values without outliers

15.3   Mandel's Statistics
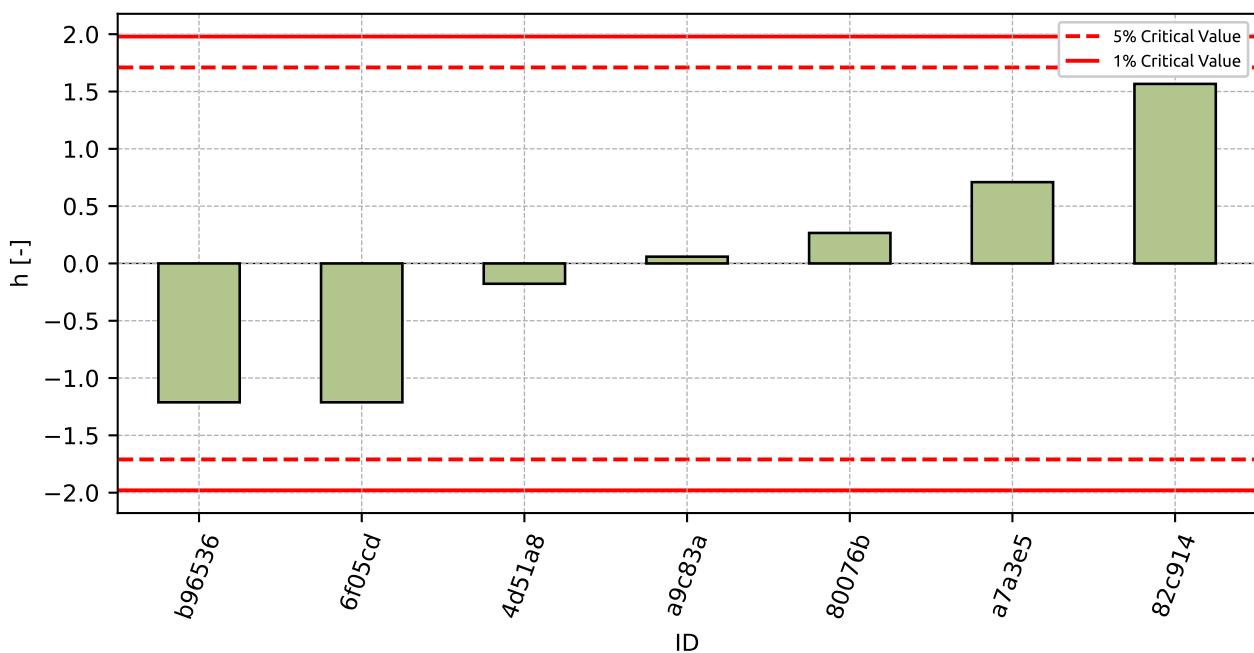
Figure 192: Interlaboratory Consistency Statistic

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15.4 Descriptive statistics
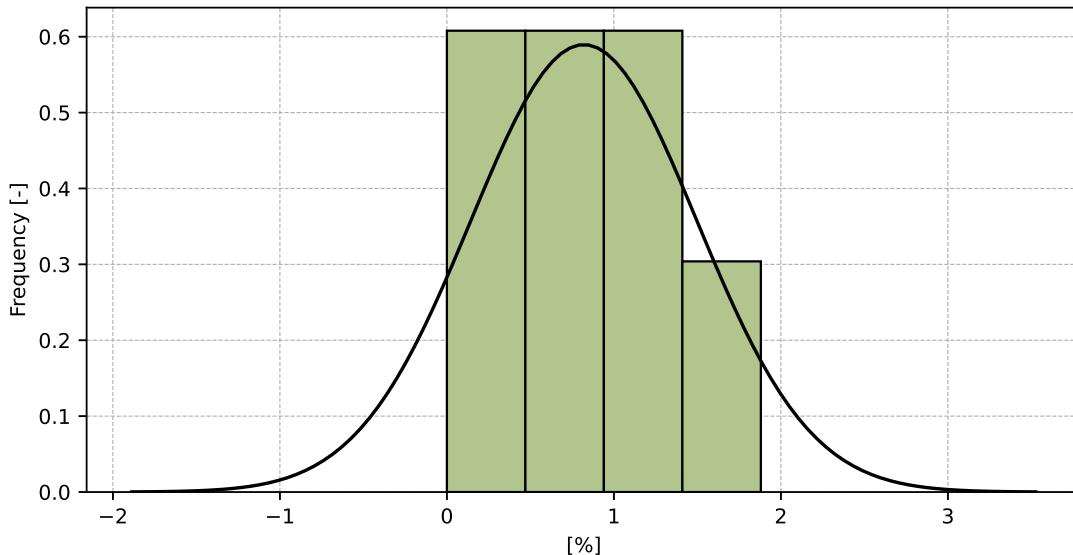
Figure 193: Histogram of all test results

Table 70: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	0.8
Sample standard deviation – s	0.68
Asigned value – x^*	0.8
Robust standard deviation – s^*	0.71
Measurement uncertainty of asigned value – u_X	0.34
p-value of normality test	0.646 [-]

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15.5   Evaluation of Performance Statistics
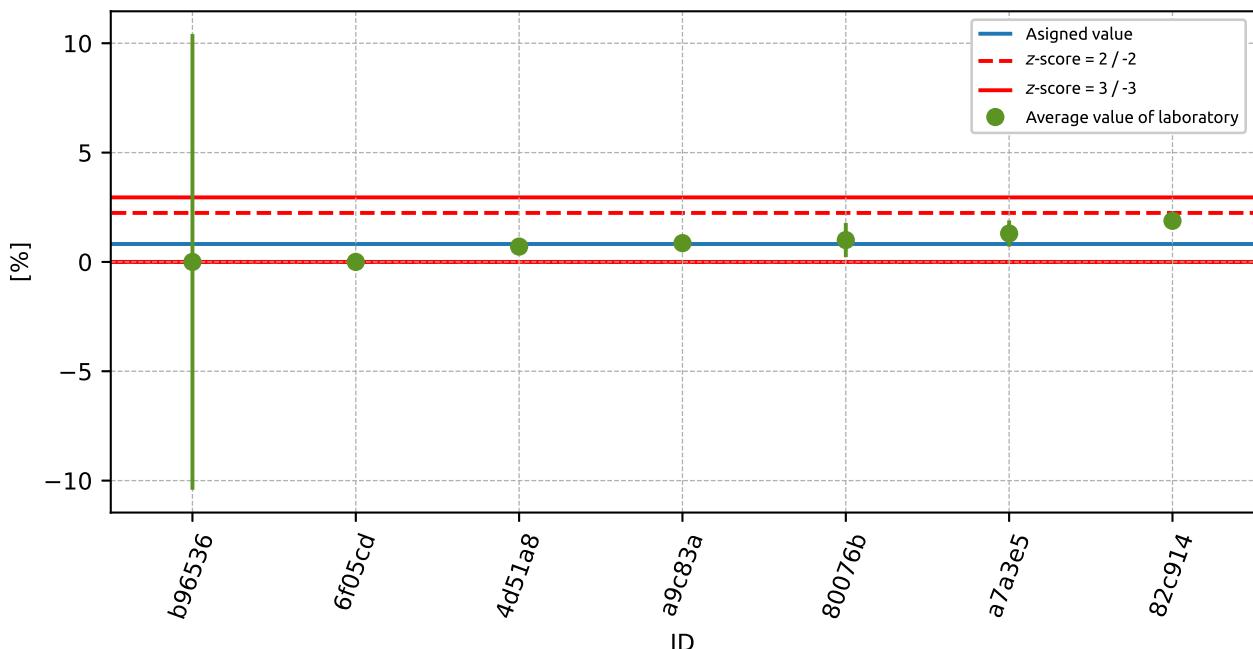
Figure 194: Average values and extended uncertainties of measurement

Figure 195: z-score

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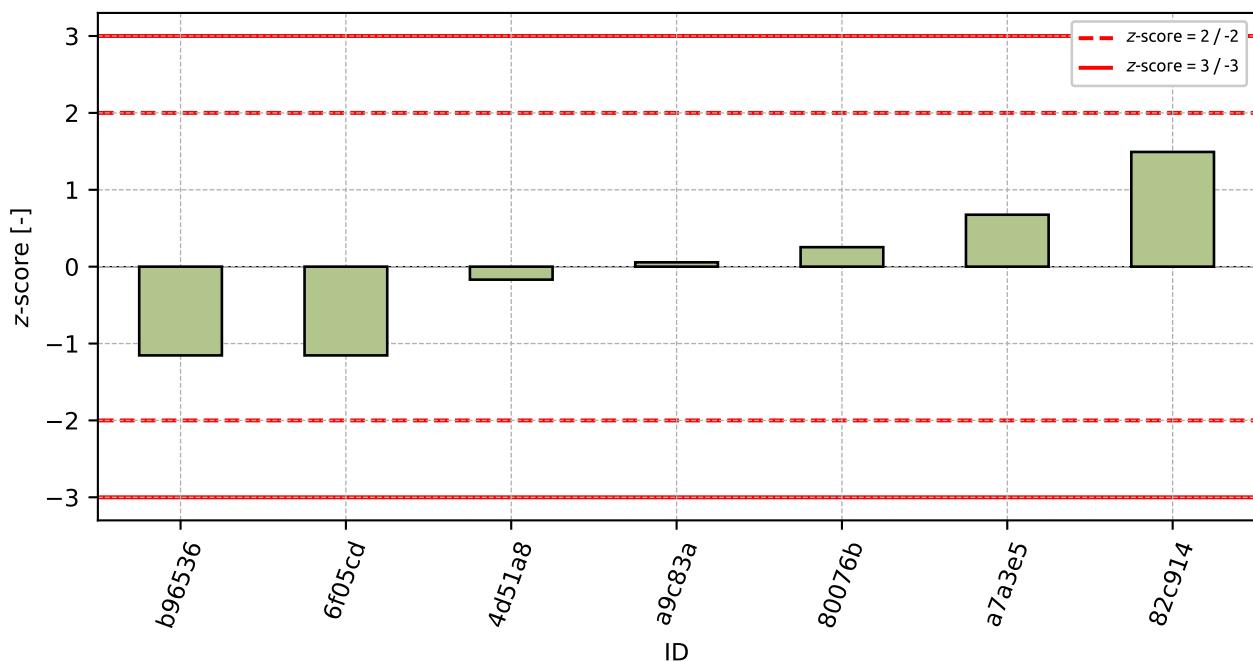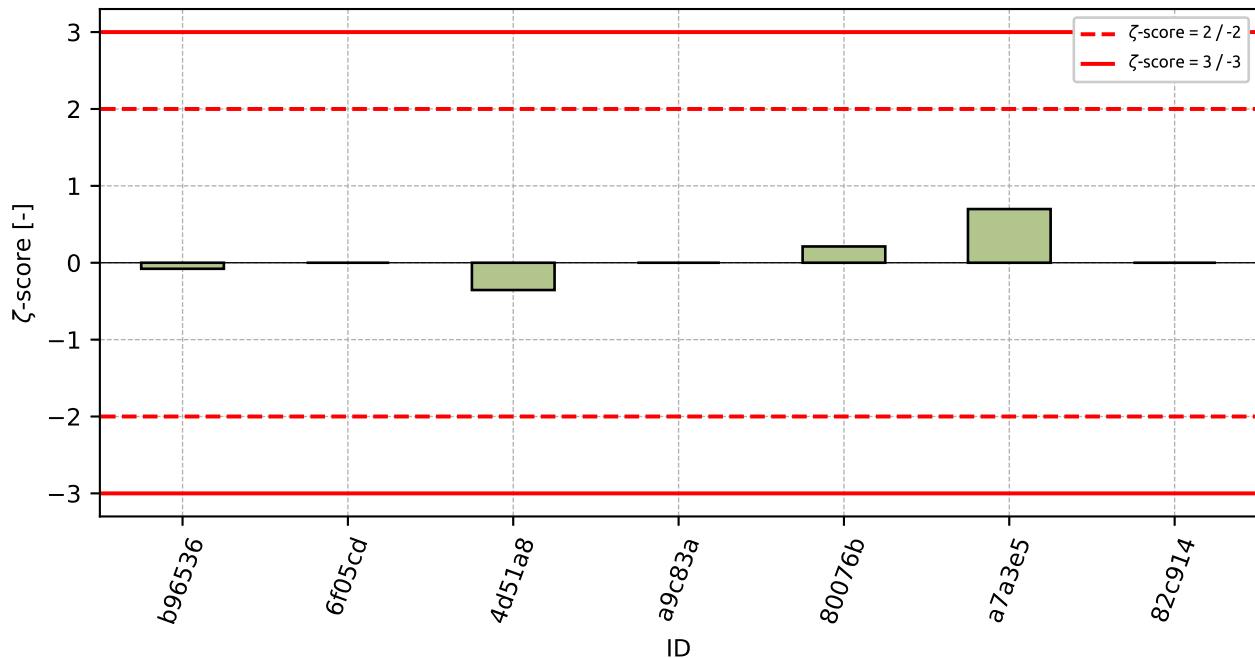
Figure 196: ζ-score

Table 71: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
b96536	-1.15	-0.08
6f05cd	-1.15	-
4d51a8	-0.17	-0.36
a9c83a	0.06	-
80076b	0.25	0.21
a7a3e5	0.68	0.7
82c914	1.49	-

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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.

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