BRNO UNIVERSITY OF TECHNOLOGY

FACULTY OF CIVIL ENGINEERING
institute of building testing

ilac-MRA

Z 7008

# FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

**Proficiency Testing Program**
**Testing of Asphalt Products**
**ZAP 2025/1**

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

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

Date: July 10, 2025

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

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# 1 Introduction and Important Contacts

At the beginning of 2025, the Proficiency Testing Provider at SZK FAST (PoZZ) launched a Proficiency Testing Programme (PrZZ), designated ZAP 2025/1, to verify and assess the consistency of asphalt products 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
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Coordinator of PTP result assessment PTP

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The subjects of proficiency testing were the following testing procedures:

1. EN 1426 Determination of needle penetration of bitumen and bituminous binders [1],
2. EN 1427 Determination of the softening point of bitumen and bituminous binders – Ring and Ball method [2],
3. EN 13398 Determination of elastic recovery (RE) of modified bitumen [3],
4. EN 12593 Determination of the Fraass breaking point (T) [4],
5. EN 1429 Determination of residue on sieving of bituminous emulsions and storage stability [5],
6. EN 12697□1 Determination of soluble binder content [6],
7. EN 12697□2+A1 Determination of particle size distribution [7],
8. EN 12697□5 Determination of maximum density [8],
9. EN 12697□6 Determination of bulk density of bituminous specimens [9],
10. EN 12697□8 Determination of void characteristics of bituminous mixtures [10],
11. EN 12697□12, EN 12697□23 ITSR – Resistance to water sensitivity expressed as Indirect Tensile Strength Ratio – Method A [11, 12],
12. EN 12697□18 Determination of binder drainage – Clause 5 – Beaker method [13],
13. EN 12697□20 Determination of hardness number on cube or Marshall specimens – Penetration by pin after 60 min [14],
14. EN 12697□22+A1 Wheel tracking test – Small□size device, Procedure B in air [15],
15. ČSN 73 6161 Determination of adhesion of bituminous binders to aggregates – Dry aggregate test [16].

**Test procedures 4 and 5 were not opened due to low interest of participants.**

The supplier, SQZ, s. r. o., 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 [17] and with EN ISO/IEC 17043 [18]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

38 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5097f9 | - | - | - | - | - | - | - | - | - | - | - | - | X | - | - |
| f68f15 | - | - | - | - | - | - | - | X | - | - | - | - | - | - | - |
| 9253fc | - | - | - | - | - | X | X | X | X | X | - | - | - | - | - |
| e2f9b5 | X | X | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 10cca9 | - | - | X | - | - | - | - | - | - | - | X | X | - | X | - |
| c087fe | - | - | - | - | - | X | X | X | X | X | - | - | - | - | - |
| 10b504 | - | - | X | - | - | - | - | - | - | - | - | - | - | - | - |
| 4db578 | X | X | - | - | - | X | X | X | X | X | - | - | - | - | - |
| 4cdbad | X | X | X | - | - | - | - | - | - | - | - | - | - | - | - |
| 3c68f6 | - | - | X | - | - | - | - | - | - | X | - | X | - | X | - |
| 40f911 | - | - | X | - | - | X | - | - | - | - | - | - | X | - | - |
| 7ec83d | X | X | - | - | - | X | X | X | X | X | - | - | - | - | - |
| f08bcd | - | - | - | - | - | X | X | X | X | X | - | - | - | - | - |
| 64ea0e | - | - | X | - | - | - | - | - | - | - | - | - | X | - | - |
| 671d46 | - | X | - | - | - | - | - | - | - | - | - | X | - | - | - |
| 87e572 | - | - | - | - | - | - | - | - | X | - | - | - | - | - | - |
| 84a75d | - | - | - | - | - | - | - | - | - | - | X | - | X | - | - |
| b0b09d | X | X | X | - | - | X | X | X | X | X | - | X | X | X | - |
| acb415 | - | - | - | - | - | - | - | X | - | X | - | - | - | - | - |
| b74330 | X | X | - | - | - | - | - | - | - | - | - | - | - | - | - |
| a7b1c1 | - | - | - | - | - | - | - | - | - | - | X | X | - | X | X |
| c9849a | X | X | X | - | - | - | - | - | - | - | X | - | - | - | - |
| 76d982 | - | - | - | - | - | X | X | X | X | X | - | - | - | - | - |
| de0c90 | - | X | X | - | - | X | X | - | - | - | - | - | - | - | X |
| aa6fd2 | - | - | - | - | - | - | - | - | - | - | X | X | - | - | X |
| 49e1c8 | - | - | X | - | - | X | X | X | X | X | X | X | - | X | - |
| 29c947 | X | X | - | - | - | - | - | X | - | - | - | - | - | - | - |
| 81b0e4 | - | - | - | - | - | - | - | - | - | X | - | - | - | - | - |
| 62ea7a | - | - | - | - | - | X | X | X | X | X | - | - | - | - | - |
| c451a4 | - | - | - | - | - | X | X | - | - | - | - | - | - | - | - |
| de68ea | - | - | - | - | - | - | - | - | - | - | X | X | - | - | - |
| cd3235 | X | X | - | - | - | X | X | X | - | X | X | - | - | - | - |
| 0789d1 | X | - | - | - | - | - | X | - | - | - | - | - | - | - | - |
| d91cf1 | - | - | - | - | - | - | - | - | - | - | - | X | - | - | - |
| ed6d00 | - | - | - | - | - | - | - | - | - | - | - | - | X | - | - |
| c22812 | - | - | - | - | - | X | X | X | X | X | - | - | - | - | - |
| be8406 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | X |
| 3224cf | - | - | - | - | - | - | - | - | - | X | - | - | - | - | - |

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

| Laboratory | Address | Accreditation number |
|---|---|---|
| AWV | Olympiadenlaan 10, Evere, 1140, Belgium | - |
| A&A MACEDONIA LAB TEST LTD | 10, Moisi Street, Chlroraka, Paphos, 8220, Cyprus | - |
| Banat Inzenjering LBI DOO | Makedonska 15, Zrenjanin, 23000, Republic of Seriba | 01-540 |
| Bechtel ENKA UK Limited Ogranak Beograd - Kraljevo | Jasički put 52 đ, Kruševac, 37000, Serbia | - |
| Bechtel ENKA UK Limited Ogranak Beograd - Krusevac | Jasički put 52 đ, Kruševac, 37000, Serbia | - |
| C.N.A.I.R prin CESTRIN | BD. IULIU MANIU, NR.401A, SECTOR 6, BUCURESTI, 061101, ROMANIA | LI220/28.10.2024 |
| CSS d.o.o. | Savska cesta 144a, Zagreb, 10000, Croatia | HR1106 |
| DIGITAL SOIL FACILITY MANAGEMENT | Krommewege 31G, Maldegem, 9990, België | 409-TEST |
| DSP a.s. | Kostěnice 111, Kostěnice, 530 02, Česká republika | 1782 |
| Gradezen Institut ”Makedonija” AD Skopje | Drezdenska No.52, SKOPJE KARPOS, 1000, North Macedonia | LT-014 |
| Group Vavooren | Industriepark Rosteyne 1, Zelzate, 9060, België | - |
| INISMa - Institut Interuniversitaire des Silicates, Sols et Matériaux | Avenue du Gouverneur Emile Cornez n°4, Mons, 7000, Belgique | BE0401144686 |
| KORIDORI SRBIJE LTD. | Kralja Petra 21, Belgrade, 11000, Srbija | - |
| LPM Laboratorio Prove Materiali di Impresa bacchi srl | Via Don Giuseppe Dossetti 19, Carpiano (MI), 20074, Italy | - |
| Laboratorium Drogowe Szczecin Sp. z o.o. | Tama Pomorzańska 13L, Szczecin, 70-030, Poland | AB1806 |
| Laboratorium Drogowe Wojciech Bogacki | Słowicza 1, Rzgów, 95-030, Rzgów | - |
| Labos d.o.o. | Pavlinska ulica 5, Varazdin, 42000, Croatia | - |
| MTS Ltd | 19 Kernanstown Ind Est, Carlow, R93 PY67, Ireland | - |
| Mega Infrastructure d.o.o., Beograd-Savski Venac, 11000, Belgrade, Serbia | Paje Adamova 2, Belgrade, 11000, Serbia | - |
| Michael Kirchweger | Alpenstraße 157, Salzburg, 5300, Österreich | 0003 |
| NIEVELT Labor CZ s.r.o. | Za Olomouckou 4184/17, Prostějov, 79601, Česká republika | 1716 |
| Národná diaľničná spoločnosť a. s. | Dúbravská cesta 14, Bratislava, 84104, Slovensko | 456/S-328 |

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| Laboratory | Address | Accreditation number |
|---|---|---|
| QUALIFORM, a.s. | Mlaty 672/8, Bosonohy, Brno, 642 00, Česká republika | 1008 |
| Rita Raposo | Rua Pedro Hispano, s/n, Coimbra, 3030-289, Portugal | L0446-1 |
| SQZ, s.r.o. - pracoviště Chvaletice | 939/5 U místní dráhy, Olomouc, 779 00, Česká republika | 1135.1 |
| SQZ, s.r.o. - pracoviště Dobřany | 939/5 U místní dráhy, Olomouc, 779 00, Česká republika | 1135.1 |
| Sibotec | Industriepark Oost 6, Beernem, 8730, Belgium | - |
| Slovenská správa ciest | Dúbravská cesta 1152/3, Bratislava - Karlova Ves, 841 04, Slovenská republika | 181/S-322 |
| TESSCONTROL - Oblastné laboratórium Žilina | Štrková 17, Žilina, Žilina, 01001, Slovenská republika | S-375 |
| TESSCONTROL - Zkušební laboratoř Znojmo | Brněnská 3797/29, Znojmo, 669 02, Česká republika | L-1793 |
| TESScontrol, s. r. o. Oblastné Laboratórium Bratislava, Laboratórium Bratislava | Ľubochnianska 1/A„ Bratislava, 831 04, Slovenská republika | S-375 |
| TESTAROSA, s.r.o. | Pribylinská 12, Bratislava - mestská časť Rača, 831 04, Slovenská republika | - |
| TPA ČR, s.r.o. | Vrbenská 1821/31, České Budějovice, 37006, Česká republika | 1181 |
| TPA ČR, s.r.o. - pracoviště Ostrava | Vrbenská 1821/31, České Budějovice, 370 06, Česká republika | 1181 |
| TPA ČR, s.r.o. pracoviště č.4 Olomouc, Tovární 731, 783 53 Velká Bystřice | Tovární 731, Velká Bystřice, 783 53, Česká republika | 1181 |
| UAB Laboratoriniu bandymu centras | R. Kalantos street 85a, Kaunas, 45293, Lithuania | LA.01.002 |
| Ředitelství silnic a dálnic s. p. | Čerčanská 2023/12, Praha 4 - Krč, 140 00, Česká republika | 1072 |
| Ředitelství silnic a dálnic s. p., Samostatné oddělení zkušebnictví Praha, Laboratoř Praha | Na Pankráci 546/56, Praha, 140 00, Česká republika | 1734 |

## 2 Procedures used in the Statistical Analysis of Laboratory Results

The statistical analysis is based on the following steps:

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

value, the participant's results can be marked as outlying and excluded from the experiment (symbol **X**).

3. Graphical determination of the consistency of laboratories (Mandel's statistics): The exceedance of the critical values of Mandel's statistics does not indicate that the results of the laboratories concerned are wrong; it only suggests minor inconsistencies.
4. Evaluation of descriptive statistics and, if possible, taking into account the number of observations, the repeatability and reproducibility.
5. Evaluation of the assigned value.
6. The performance evaluation: The most significant outcome of the PT Program is the so-called $z$-score and $\zeta$-score (zeta-score). These characteristics assess the performance of individual participants by comparing it with the assigned value and measurement uncertainties. $z$-score and $\zeta$-score are compared with limit values. The resulting $\zeta$-score values are not taken into account during the final evaluation of the performance of participants as they are to a considerable degree dependent on the values of the measurement uncertainties of the assessed institutions. The following scales are applied for the $z$-score values:
   - $|z\text{-score}| < 2 \Rightarrow$ shows that the laboratory performance is **satisfactory** and generates no signal – ✓.
   - $2 \leq |z\text{-score}| < 3 \Rightarrow$ shows that the laboratory performance is **questionable** and generates an action signal – **?**.
   - $|z\text{-score}| \geq 3 \Rightarrow$ shows that the laboratory performance is **unsatisfactory** and generates an action signal – **!**.

Procedures used in the statistical analysis of proficiency testing programs can be found here: http://ptprovider.cz/?lang=en.

# 3 Conclusions of the Statistical Analysis

The present report summarizes the results of the Proficiency Testing Program ZAP 2025/1 (PT Program) organized by the PT Provider at the SZK FAST. 38 participants (laboratories) took part in the PT Program. The PT program focused on ordinary standardized testing of asphalt products. The test results are evaluated separately for each testing procedure examined. An evaluation of statistical characteristics is included in the Appendix, as well as test results and graphic presentations. In some cases, overcoming the critical values of the Cochran test due to incorrect rounding of test results by laboratories was not taken into account. 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5097f9 | - | - | - | - | - | - | - | - | - | - | - | - | ✓ | - | - |
| f68f15 | - | - | - | - | - | - | - | ✓ | - | - | - | - | - | - | - |
| 9253fc | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - |
| e2f9b5 | ✓ | ✓ | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 10cca9 | - | - | ✓ | - | - | - | - | - | - | - | ✓ | ✓ | - | ✓ | - |
| c087fe | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - |
| 10b504 | - | - | ✓ | - | - | - | - | - | - | - | - | - | - | - | - |
| 4db578 | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - |
| 4cdbad | ✓ | X | ✓ | - | - | - | - | - | - | - | - | - | - | - | - |
| 3c68f6 | - | - | ✓ | - | - | - | - | - | - | ✓ | - | ✓ | - | ✓ | - |
| 40f911 | - | - | ✓ | - | - | ✓ | - | - | - | - | - | - | ✓ | - | - |
| 7ec83d | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - |
| f08bcd | - | - | - | - | - | ✓ | ✓ | ? | ? | ✓ | - | - | - | - | - |
| 64ea0e | - | - | ✓ | - | - | - | - | - | - | - | - | - | ✓ | - | - |
| 671d46 | - | ✓ | - | - | - | - | - | - | - | - | - | ✓ | - | - | - |
| 87e572 | - | - | - | - | - | - | - | - | ✓ | - | - | - | - | - | - |
| 84a75d | - | - | - | - | - | - | - | - | - | - | ✓ | - | ✓ | - | - |
| b0b09d | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - |
| acb415 | - | - | - | - | - | - | - | ✓ | - | ✓ | - | - | - | - | - |
| b74330 | ✓ | ✓ | - | - | - | - | - | - | - | - | - | - | - | - | - |
| a7b1c1 | - | - | - | - | - | - | - | - | - | - | ✓ | ✓ | - | ✓ | ? |
| c9849a | ✓ | ✓ | ✓ | - | - | - | - | - | - | - | ✓ | - | - | - | - |
| 76d982 | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - |
| de0c90 | - | ✓ | ✓ | - | - | ✓ | ✓ | - | - | - | - | - | - | - | ✓ |
| aa6fd2 | - | - | - | - | - | - | - | - | - | - | ✓ | ✓ | - | - | ✓ |
| 49e1c8 | - | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - |
| 29c947 | ? | ✓ | - | - | - | - | - | ✓ | - | - | - | - | - | - | - |
| 81b0e4 | - | - | - | - | - | - | - | - | - | ✓ | - | - | - | - | - |

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| ID / Method | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62ea7a | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - |
| c451a4 | - | - | - | - | - | ✓ | ✓ | - | - | - | - | - | - | - | - |
| de68ea | - | - | - | - | - | - | - | - | - | - | ✓ | ✓ | - | - | - |
| cd3235 | ✓ | ✓ | - | - | - | ✓ | ✓ | ! | - | ✓ | ? | - | - | - | - |
| 0789d1 | ✓ | - | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| d91cf1 | - | - | - | - | - | - | - | - | - | - | - | ✓ | - | - | - |
| ed6d00 | - | - | - | - | - | - | - | - | - | - | - | - | ✓ | - | - |
| c22812 | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - |
| be8406 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | ✓ |
| 3224cf | - | - | - | - | - | - | - | - | - | X | - | - | - | - | - |

## References


[1] EN 1426. *Bitumen and Bituminous Binders - Determination of Needle Penetration*. 2024.

[2] EN 1427. *Bitumen and Bituminous Binders - Determination of the Softening Point - Ring and Ball Method*. 2015.

[3] EN 13398. *Bitumen and Bituminous Binders - Determination of the Elastic Recovery of Modified Bitumen*. 2018.

[4] EN 12593. *Bitumen and Bituminous Binders - Determination of the Fraass Breaking Point*. 2015.

[5] EN 1429. *Bitumen and bituminous binders - Determination of residue on sieving of bituminous emulsions, and determination of storage stability by sieving*. 2013.

[6] EN 12697-1. *Bituminous mixtures - Test methods - Part 1: Soluble binder content*. 2020.

[7] EN 12697-2+A1. *Bituminous mixtures - Test methods - Part 2: Determination of particle size distribution*. 2020.

[8] EN 12697-5. *Bituminous mixtures - Test methods - Part 5: Determination of the maximum density*. 2020.

[9] EN 12697-6. *Bituminous mixtures - Test methods - Part 6: Determination of bulk density of bituminous specimens*. 2021.

[10] EN 12697-8. *Bituminous mixtures - Test methods - Part 8: Determination of void characteristics of bituminous specimens*. 2020.

[11] EN 12697-12. *Bituminous mixtures - Test methods - Part 12: Determination of the water sensitivity of bituminous specimens*. 2020.

[12] EN 12697-23. *Bituminous mixtures - Test methods - Part 23: Determination of the indirect tensile strength of bituminous specimens*. 2018.

[13] EN 12697-18. *Bituminous mixtures - Test methods - Part 18: Binder drainage*. 2018.

[14] EN 12697-20. *Bituminous Mixtures - Test Methods for Hot Mix Asphalt - Part 20: Indentation Using Cube or Cylindrical Specimens*. 2012.

[15] EN 12697-22+A1. *Bituminous mixtures - Test methods - Part 22: Wheel tracking*. 2024.

[16] ČSN 73 6161. *Determination for adhesion of asphaltic binders to aggregate*. 2000.

[17] ISO 5725-2. *Accuracy (trueness and precision) of measurement methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*. 2019.

[18] EN ISO/IEC 17043. *Conformity assessment - General requirements for proficiency testing*. 2010.

# 1 Appendix – EN 1426 Determination of needle penetration

## 1.1 Test results

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

| ID | Test results [0.1 mm] | | | | | | $u_X$ [0.1 mm] | $\bar{x}$ [0.1 mm] | $s_0$ [0.1 mm] | $V_X$ [%] |
|---|---|---|---|---|---|---|---|---|---|---|
| b0b09d | 50.0 | 48.0 | 48.0 | 49.0 | 49.0 | 49.0 | 2.0 | 48.8 | 0.75 | 1.54 |
| 4db578 | 50.3 | 50.5 | 51.0 | 50.2 | 50.7 | 50.9 | - | 50.6 | 0.32 | 0.64 |
| 0789d1 | 50.0 | 51.0 | 52.0 | 51.0 | 51.0 | 51.0 | 1.1 | 51.0 | 0.63 | 1.24 |
| e2f9b5 | 53.2 | 52.8 | 53.1 | 53.5 | 52.5 | 52.6 | 3.7 | 53.0 | 0.38 | 0.72 |
| 4cdbad | 53.0 | 55.0 | 54.7 | 52.9 | 53.4 | 52.7 | 2.1 | 53.6 | 0.99 | 1.84 |
| 7ec83d | 53.2 | 54.1 | 53.1 | 53.0 | 54.9 | 53.5 | 0.7 | 53.6 | 0.74 | 1.37 |
| b74330 | 55.0 | 54.9 | 53.1 | 54.8 | 53.9 | 55.2 | - | 54.5 | 0.81 | 1.49 |
| c9849a | 56.0 | 55.0 | 55.0 | 55.0 | 54.0 | 55.0 | 1.8 | 55.0 | 0.63 | 1.15 |
| cd3235 | 56.0 | 57.0 | 55.0 | 55.0 | 55.0 | 56.0 | 2.0 | 55.7 | 0.82 | 1.47 |
| 29c947 | 64.0 | 64.0 | 64.0 | 63.0 | 64.0 | 63.0 | 0.4 | 63.7 | 0.52 | 0.81 |

## 1.2 The Numerical Procedure for Determining Outliers

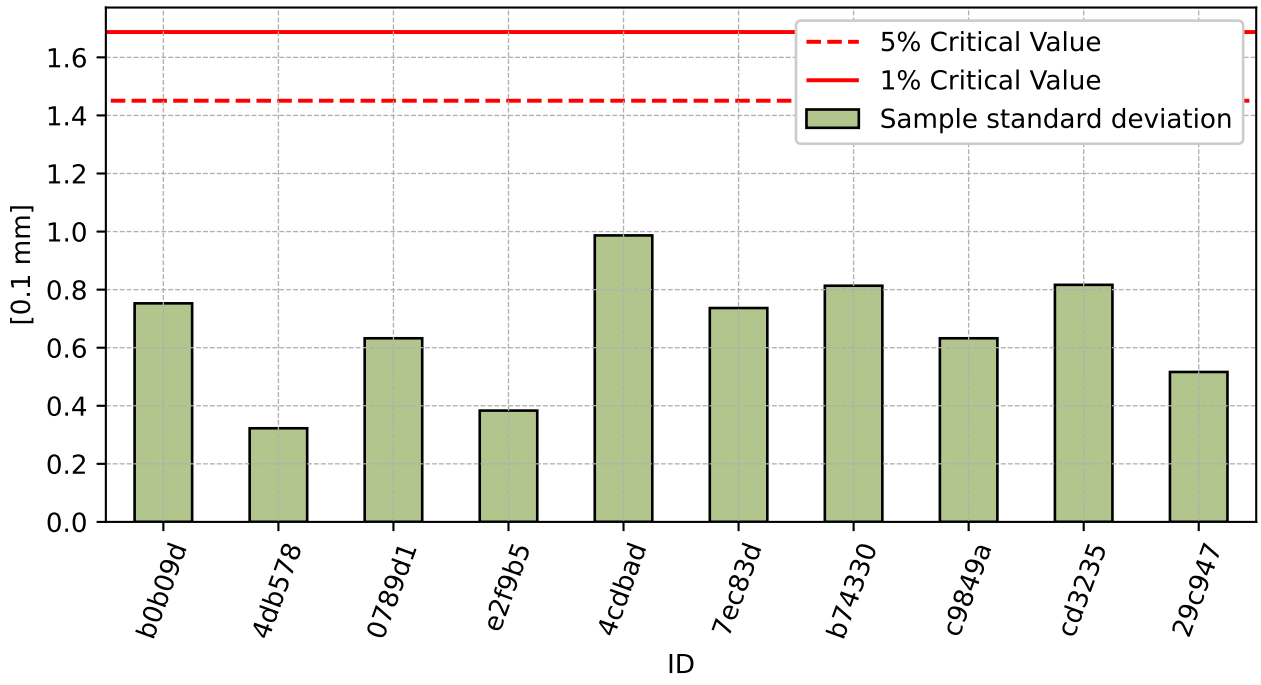


Figure 1: **Cochran's test** - sample standard deviations

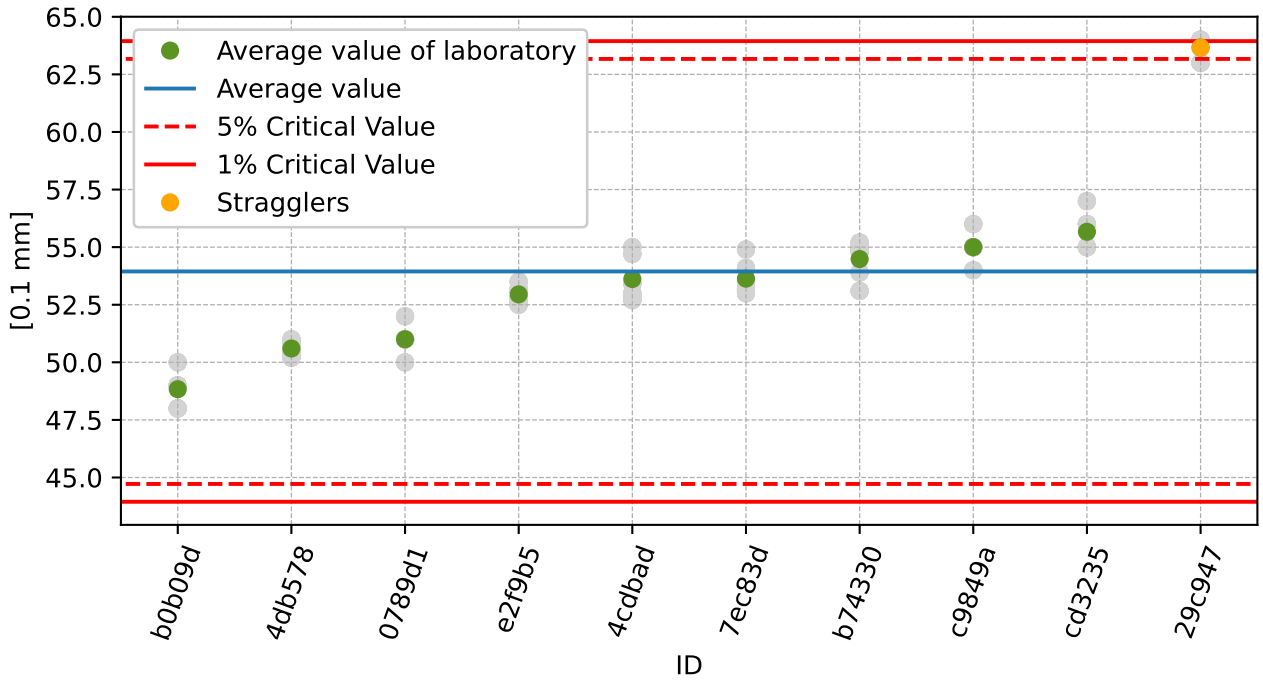


Figure 2: **Grubbs' test** - average values

## 1.3 Mandel's Statistics

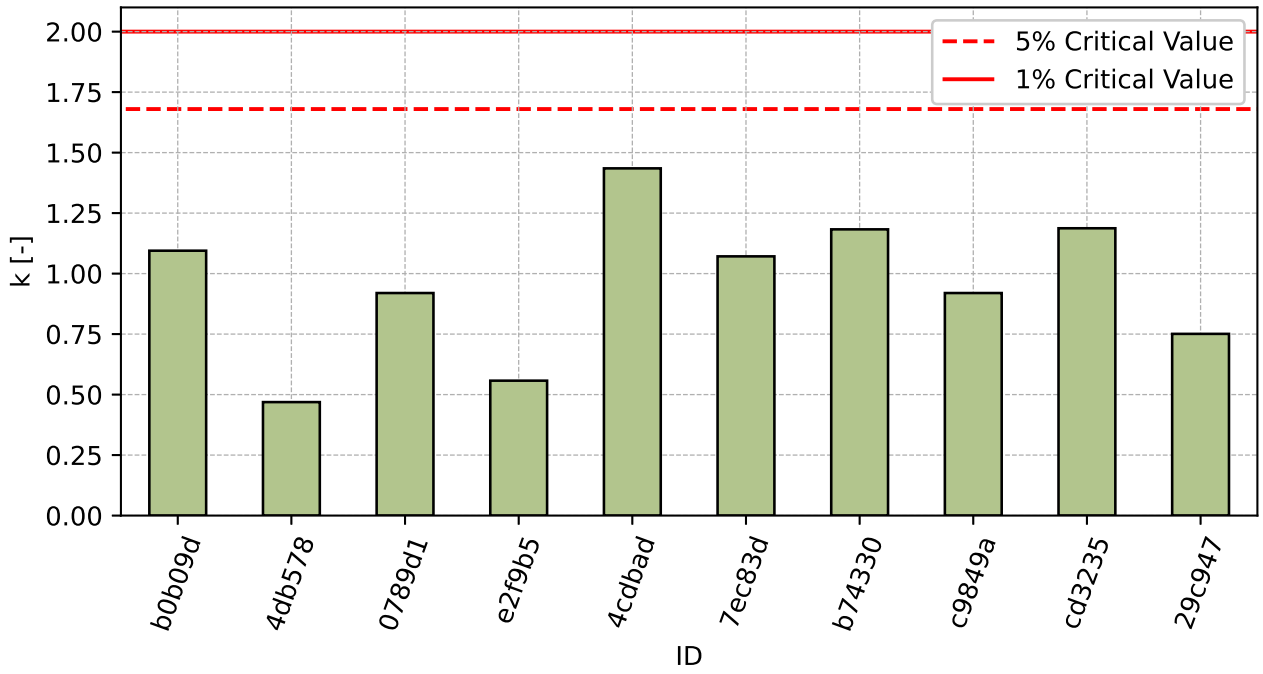


Figure 3: Intralaboratory Consistency Statistic

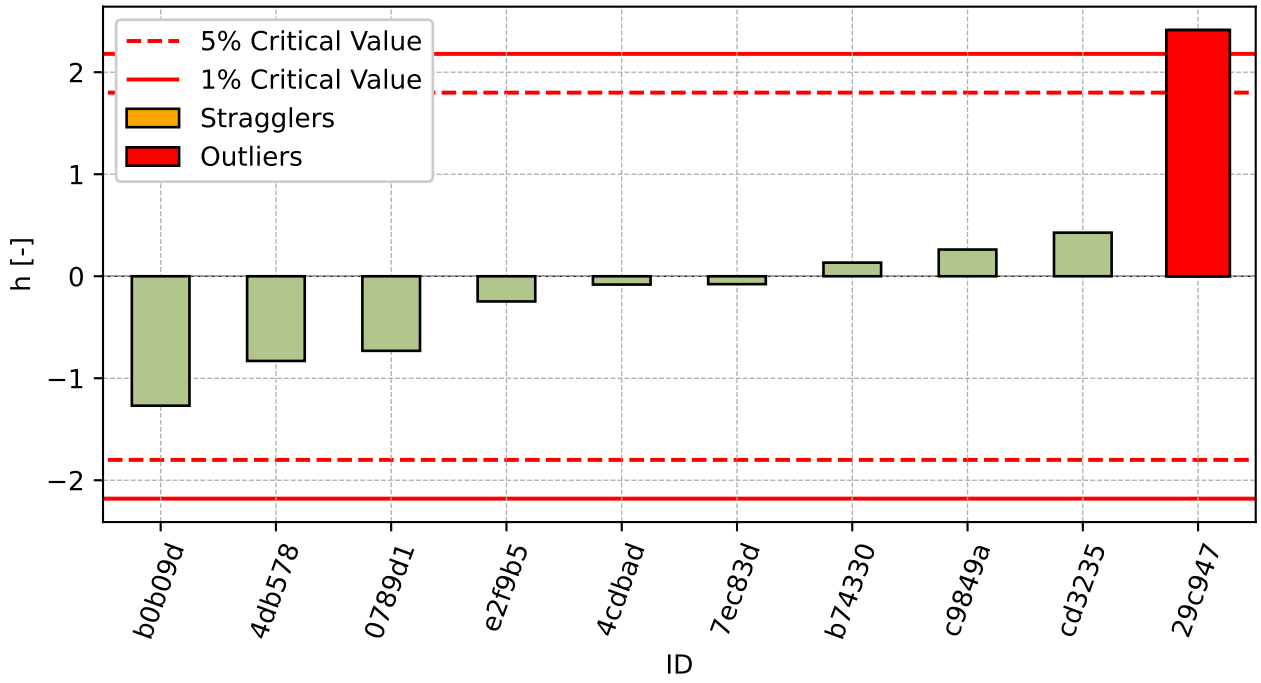


Figure 4: Interlaboratory Consistency Statistic

## 1.4 Descriptive statistics

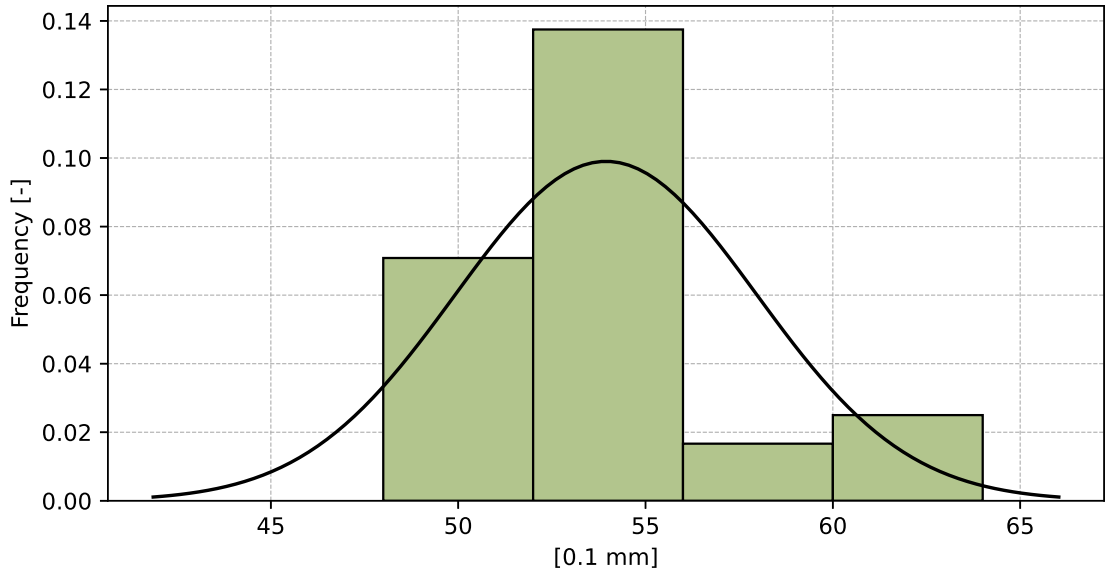


Figure 5: Histogram of all test results

Table 5: Descriptive statistics

| Characteristics | [0.1 mm] |
|---|---|
| Average value – $\bar{x}$ | 53.9 |
| Sample standard deviation – $s$ | 4.03 |
| Asigned value – $x^*$ | 54.0 |
| Robust standard deviation – $s^*$ | 4.19 |
| Measurement uncertainty of asigned value – $u_X$ | 1.66 |
| $p$-value of normality test | 0.0 [-] |
| Interlaboratory standard deviation – $s_L$ | 4.02 |
| Repeatability standard deviation – $s_r$ | 0.69 |
| Reproducibility standard deviation – $s_R$ | 4.08 |
| Repeatability – $r$ | 1.9 |
| Reproducibility – $R$ | 11.4 |

## 1.5 Evaluation of Performance Statistics

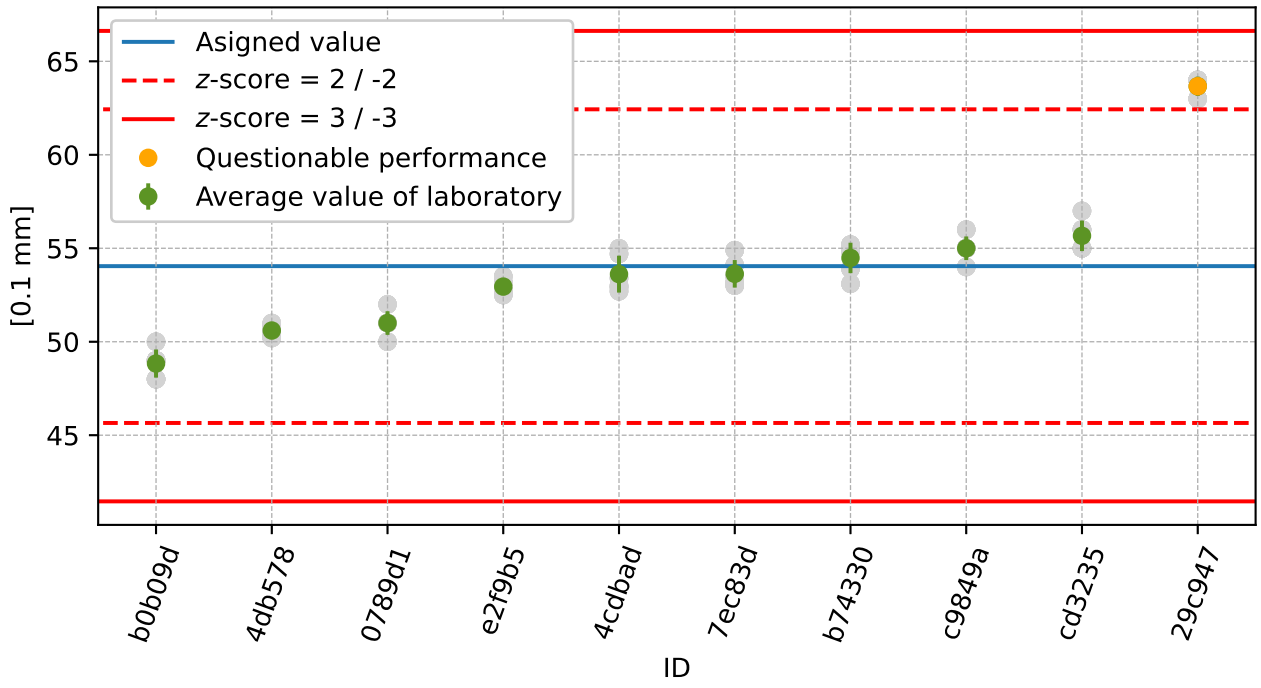


Figure 6: Average values and sample standard deviations

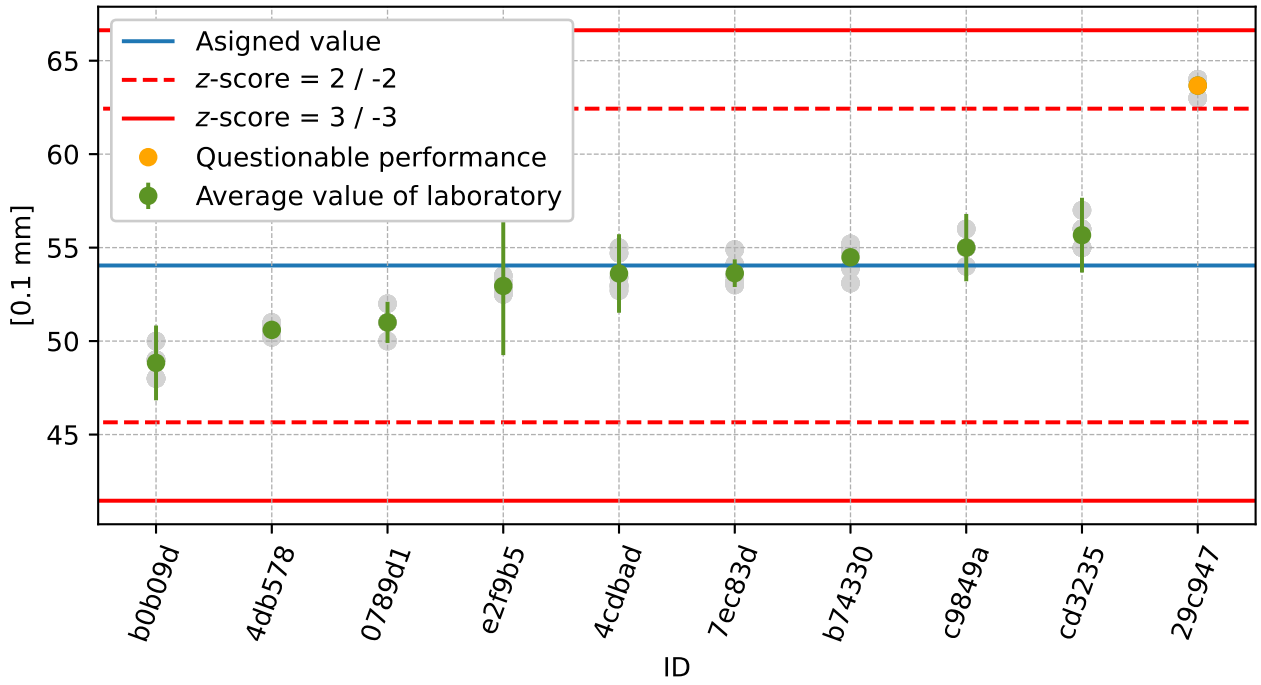


Figure 7: Average values and extended uncertainties of measurement

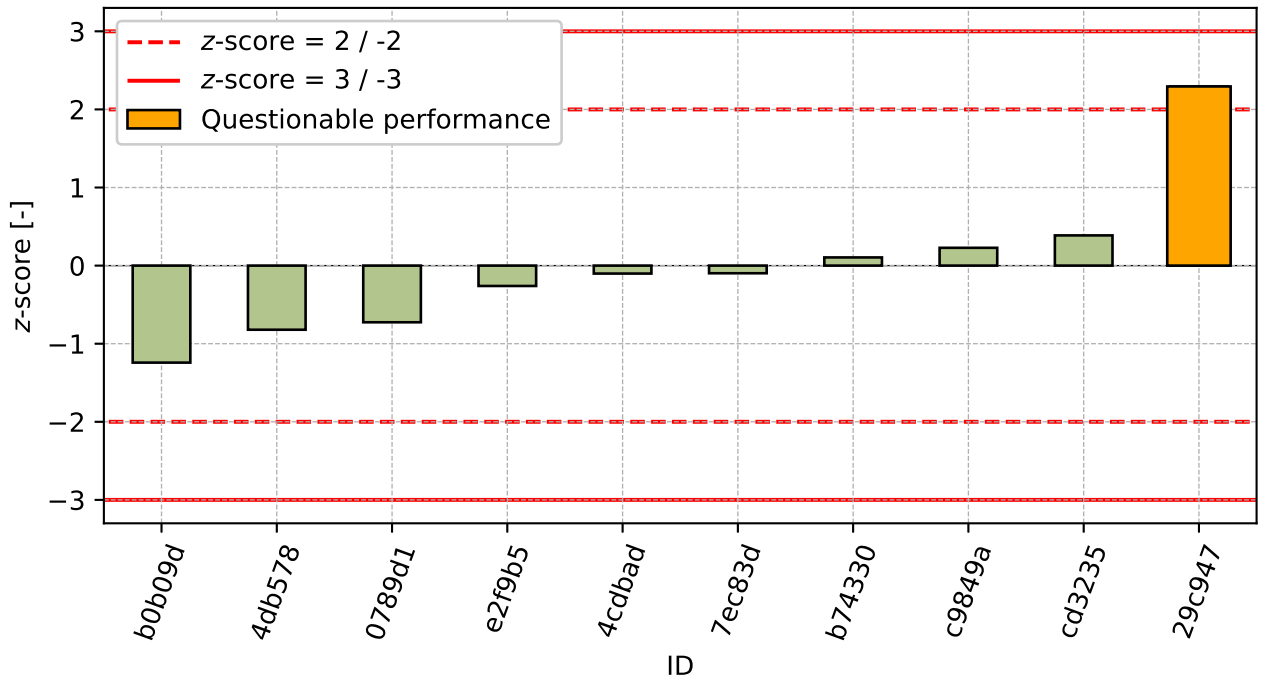


Figure 8: z-score

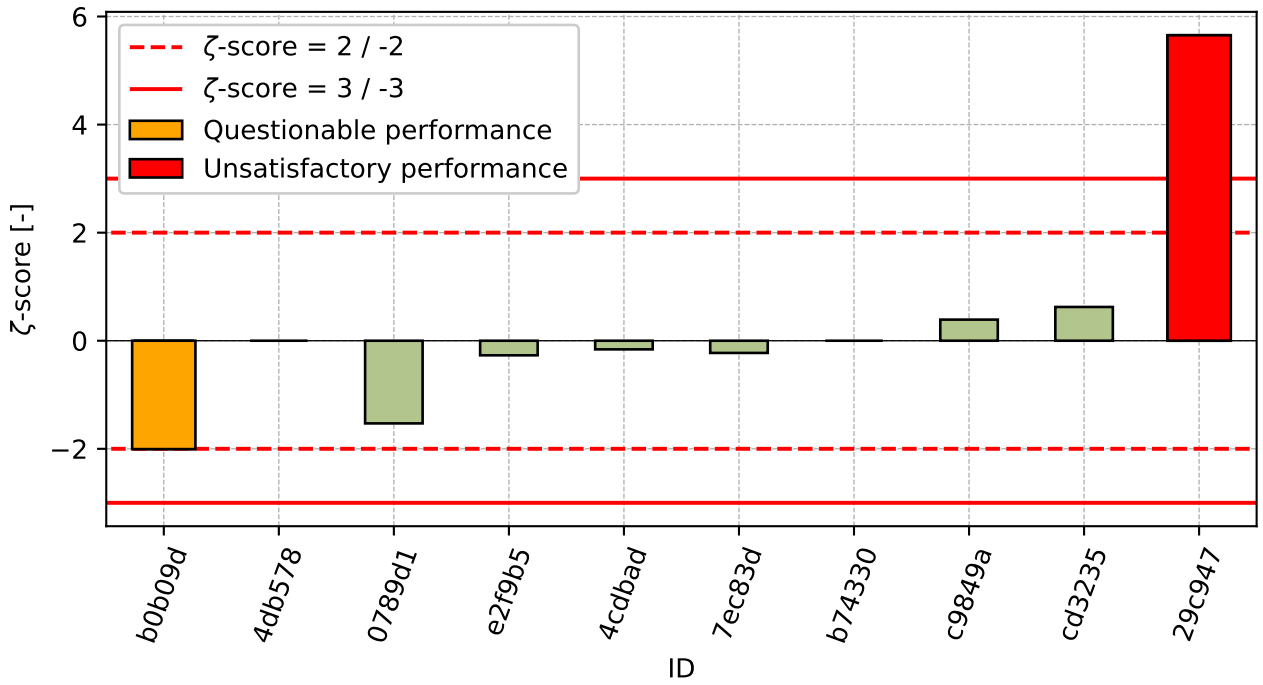


Figure 9: $\zeta$-score

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

| ID | $z$-score [-] | $\zeta$-score [-] |
|---|---|---|
| b0b09d | -1.24 | -2.01 |
| 4db578 | -0.82 | - |
| 0789d1 | -0.73 | -1.53 |
| e2f9b5 | -0.26 | -0.27 |
| 4cdbad | -0.10 | -0.16 |
| 7ec83d | -0.10 | -0.23 |
| b74330 | 0.10 | - |
| c9849a | 0.23 | 0.39 |
| cd3235 | 0.39 | 0.62 |
| 29c947 | 2.29 | 5.65 |

# 2 Appendix – EN 1427 Determination of the softening point – Ring and Ball method

## 2.1 Test results

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

| ID | Test results [°C] | | $u_X$ [°C] | $\bar{x}$ [°C] | $s_0$ [°C] | $V_X$ [%] |
|---|---|---|---|---|---|---|
| 671d46 | 49.2 | 48.4 | 0.5 | 48.8 | 0.57 | 1.16 |
| b74330 | 49.0 | 49.2 | - | 49.1 | 0.14 | 0.29 |
| 29c947 | 49.0 | 49.4 | 0.3 | 49.2 | 0.28 | 0.57 |
| c9849a | 49.5 | 49.9 | 1.4 | 49.7 | 0.28 | 0.57 |
| 7ec83d | 50.1 | 49.7 | 0.6 | 49.9 | 0.28 | 0.57 |
| b0b09d | 49.8 | 50.1 | 0.3 | 50.0 | 0.21 | 0.42 |
| cd3235 | 50.2 | 50.0 | 1.0 | 50.1 | 0.14 | 0.28 |
| e2f9b5 | 50.2 | 50.6 | 2.0 | 50.4 | 0.28 | 0.56 |
| 4db578 | 50.7 | 50.2 | - | 50.5 | 0.35 | 0.7 |
| de0c90 | 51.2 | 51.2 | 2.0 | 51.2 | 0.0 | 0.0 |
| 4cdbad | 53.4 | 53.8 | 1.0 | 53.6 | 0.28 | 0.53 |

## 2.2 The Numerical Procedure for Determining Outliers

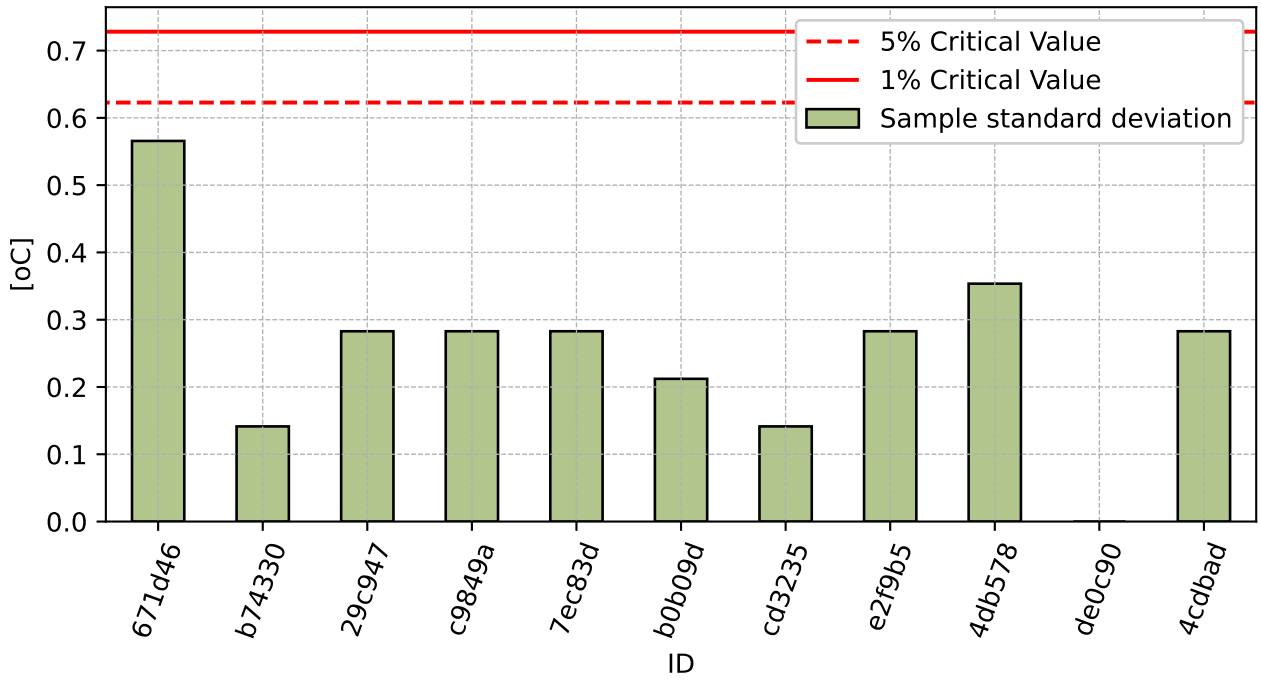


Figure 10: **Cochran's test** - sample standard deviations

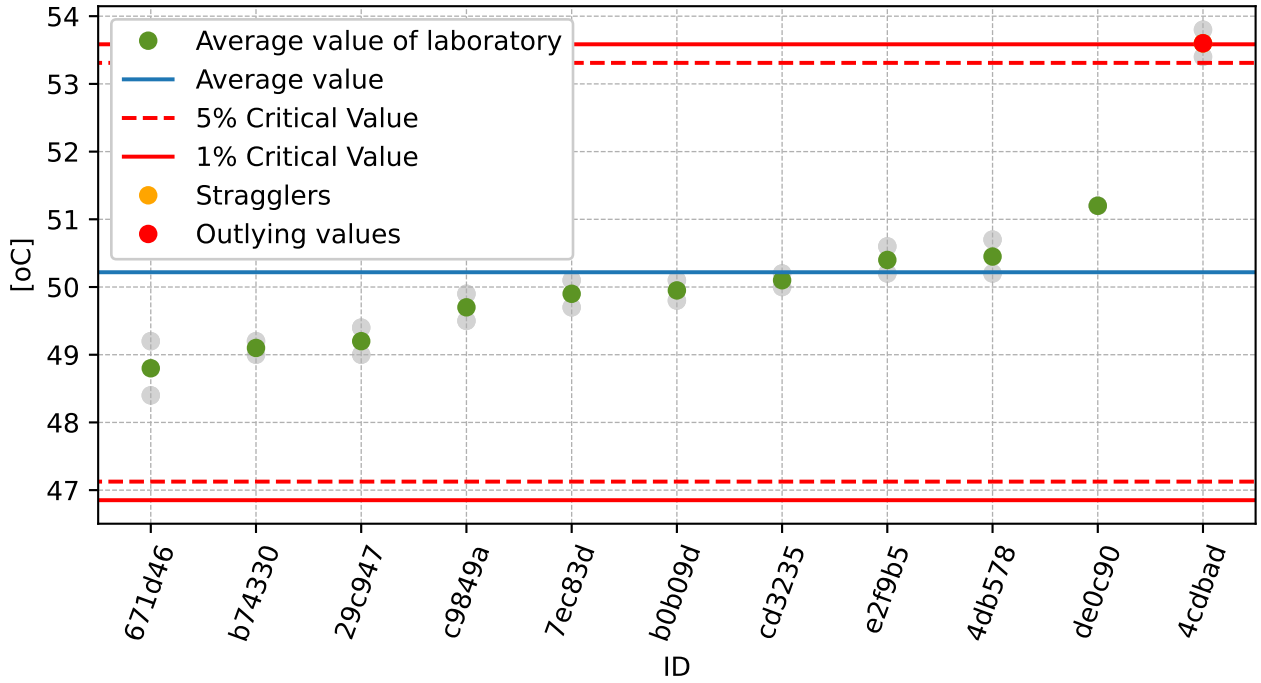


Figure 11: **Grubbs' test** - average values

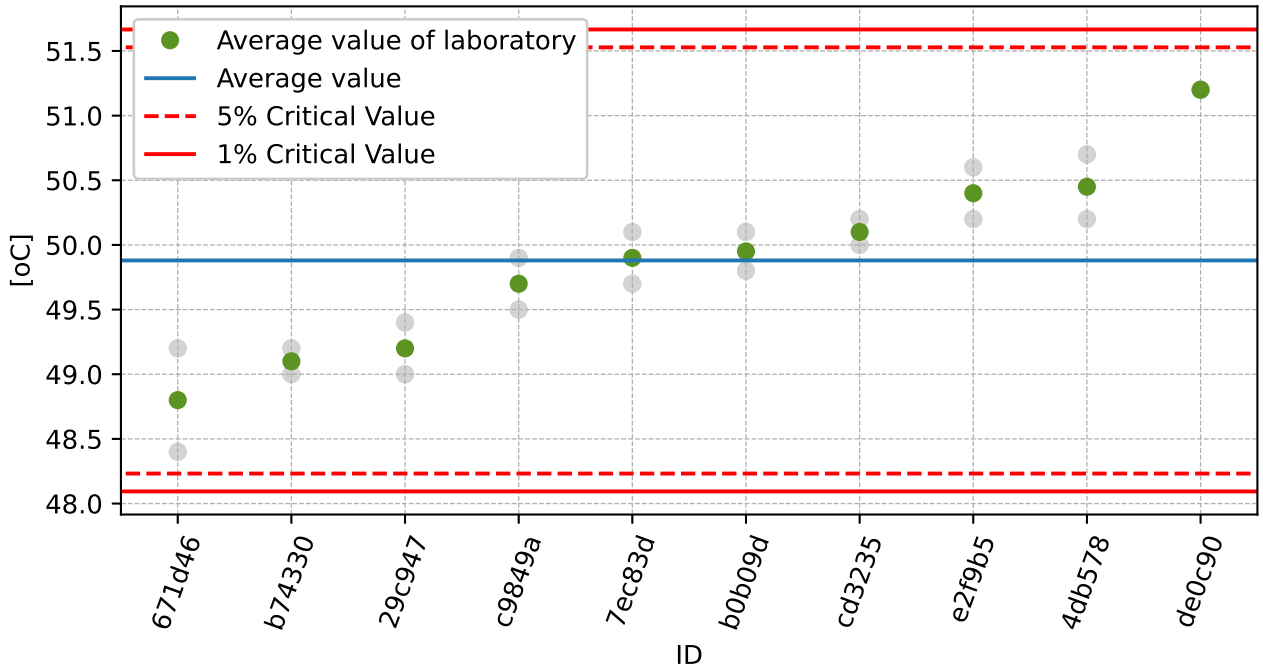


Figure 12: **Grubbs' test** - average values without outliers

## 2.3 Mandel's Statistics

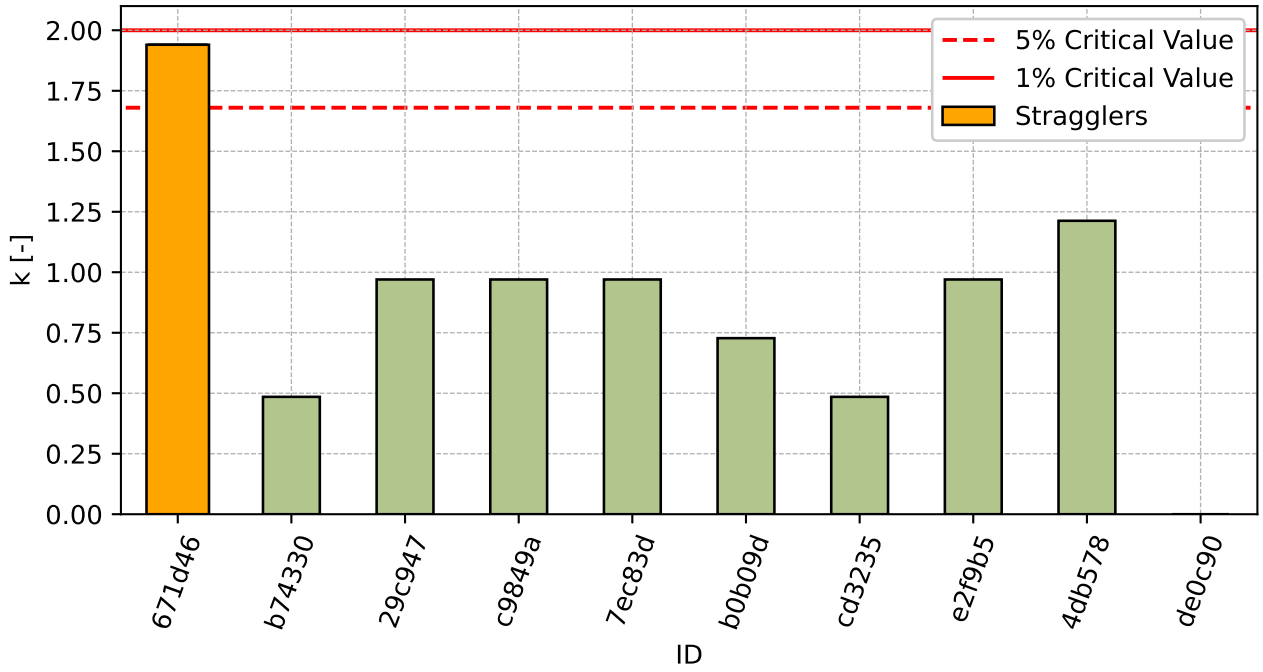


Figure 13: Intralaboratory Consistency Statistic

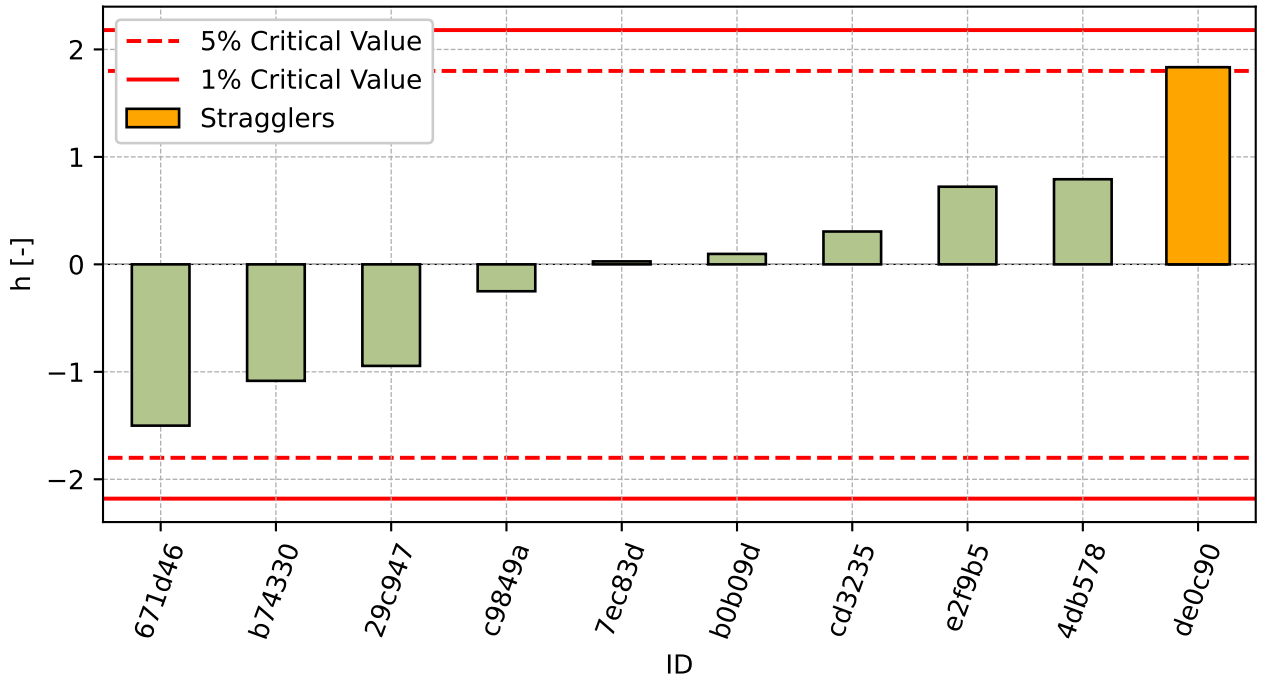


Figure 14: Interlaboratory Consistency Statistic

## 2.4 Descriptive statistics

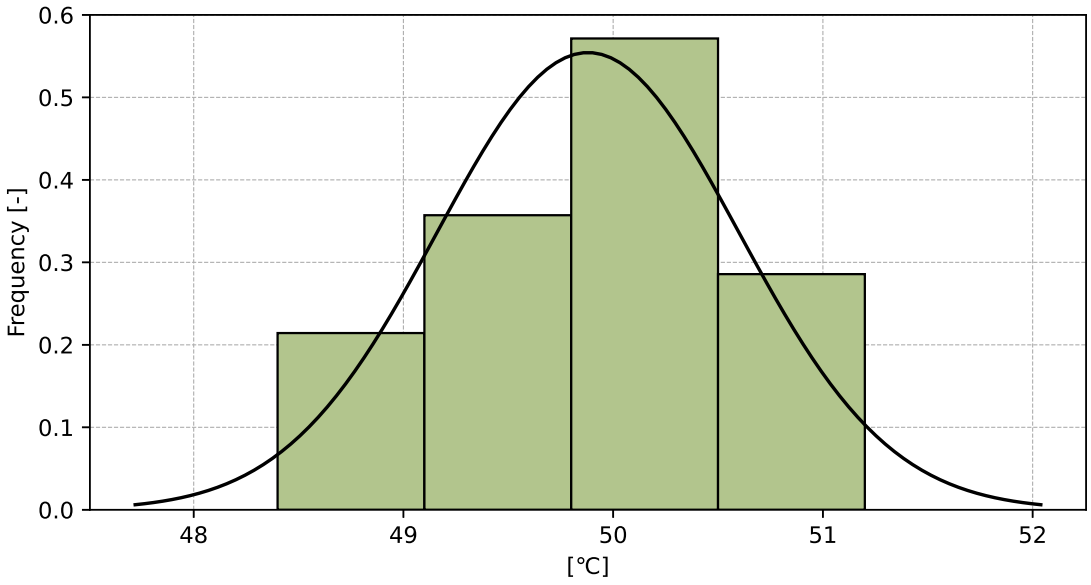


Figure 15: Histogram of all test results

Table 8: Descriptive statistics

| Characteristics | [°C] |
|---|---|
| Average value – $\bar{x}$ | 49.9 |
| Sample standard deviation – $s$ | 0.72 |
| Asigned value – $x^*$ | 49.9 |
| Robust standard deviation – $s^*$ | 0.77 |
| Measurement uncertainty of asigned value – $u_X$ | 0.31 |
| $p$-value of normality test | 0.848 [-] |
| Interlaboratory standard deviation – $s_L$ | 0.69 |
| Repeatability standard deviation – $s_r$ | 0.29 |
| Reproducibility standard deviation – $s_R$ | 0.75 |
| Repeatability – $r$ | 0.8 |
| Reproducibility – $R$ | 2.1 |

## 2.5 Evaluation of Performance Statistics

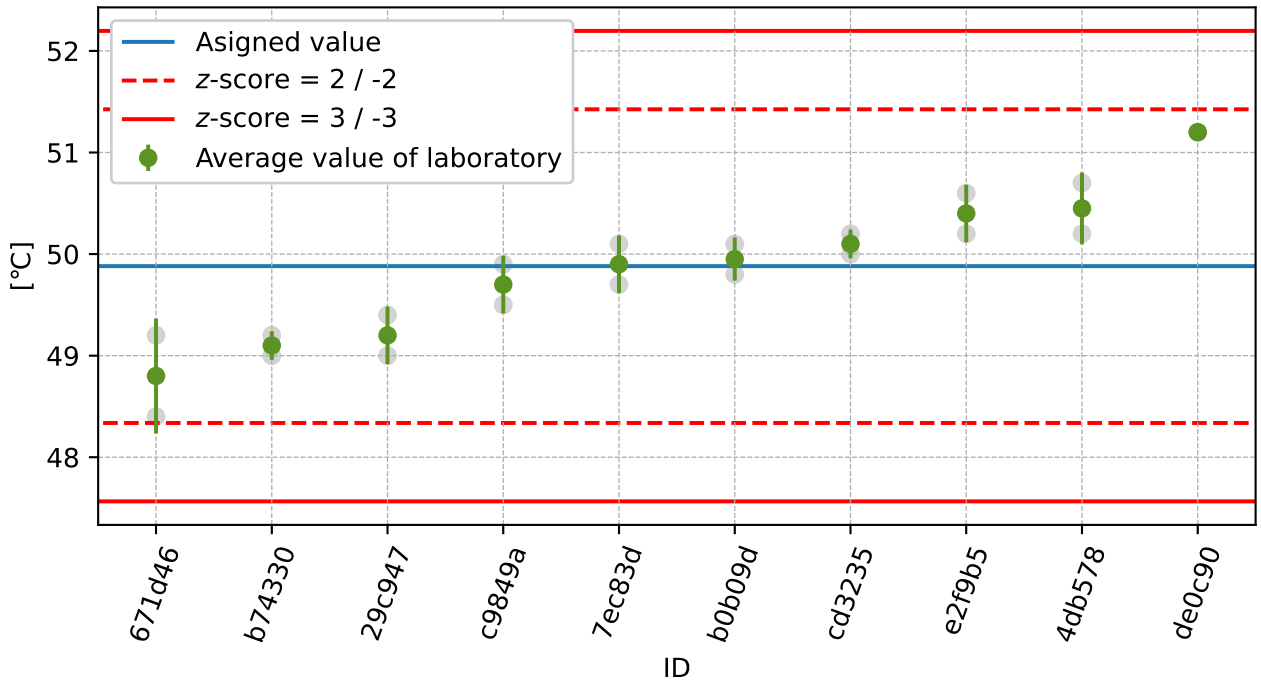


Figure 16: Average values and sample standard deviations

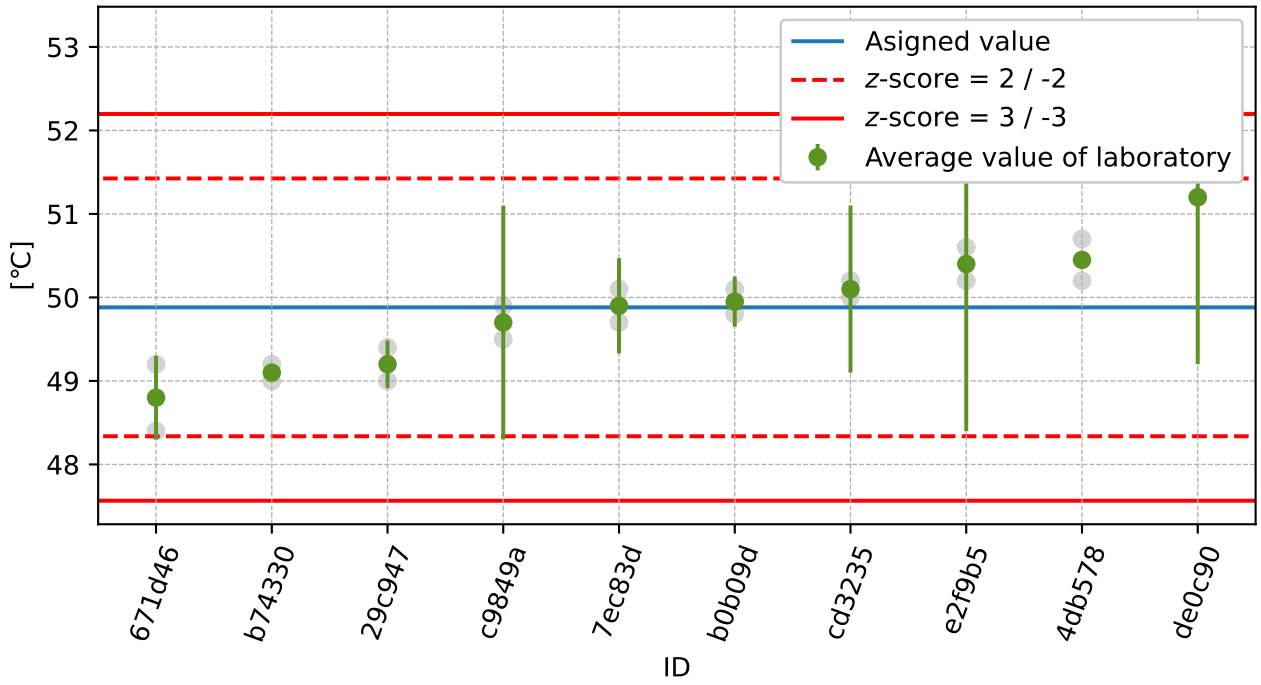


Figure 17: Average values and extended uncertainties of measurement

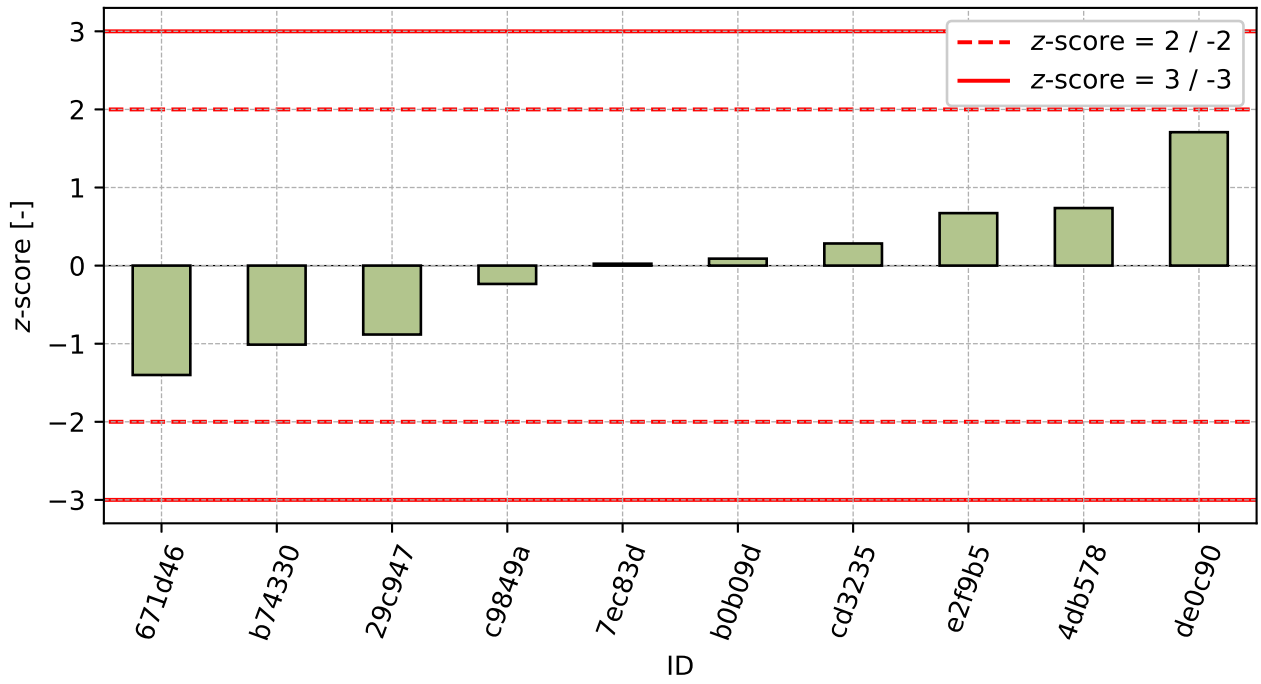


Figure 18: z-score

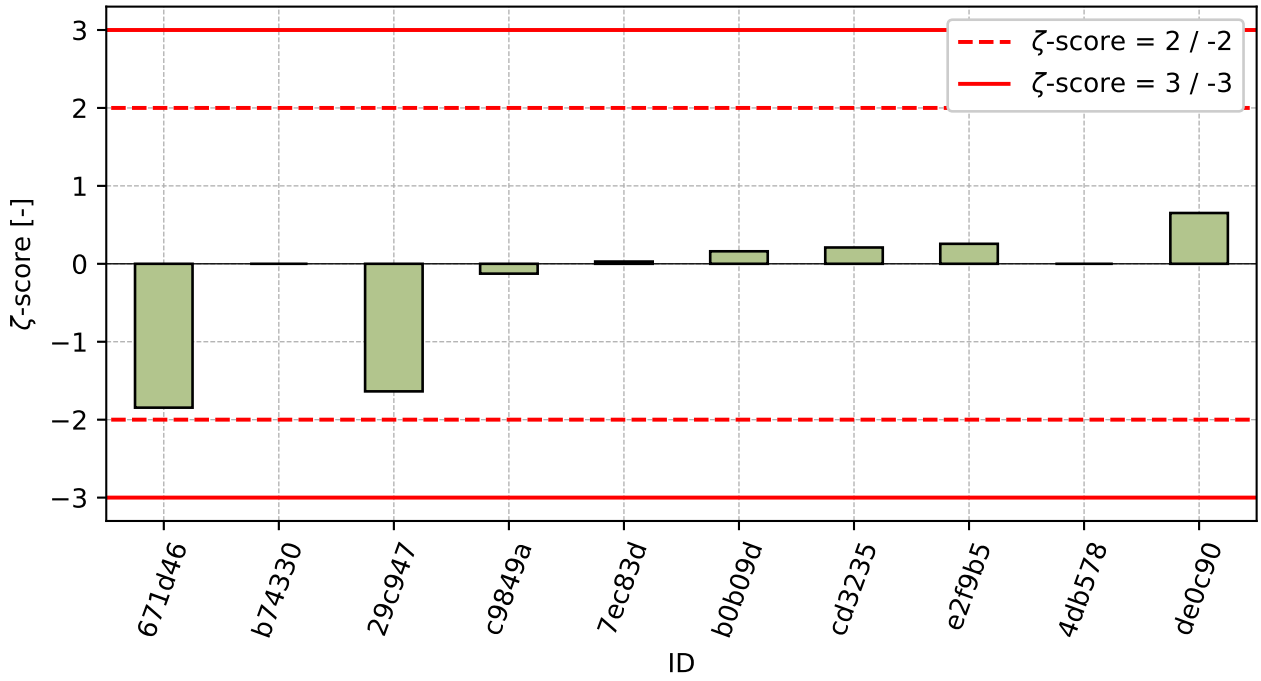


Figure 19: ζ-score

Table 9: *z*-score and ζ-score

| ID | *z*-score [-] | ζ-score [-] |
|---|---|---|
| 671d46 | -1.40 | -1.85 |
| b74330 | -1.01 | - |
| 29c947 | -0.88 | -1.64 |
| c9849a | -0.23 | -0.13 |
| 7ec83d | 0.02 | 0.03 |
| b0b09d | 0.09 | 0.16 |
| cd3235 | 0.28 | 0.21 |
| e2f9b5 | 0.67 | 0.26 |
| 4db578 | 0.74 | - |
| de0c90 | 1.71 | 0.65 |

# 3 Appendix – EN 13398 Determination of elastic recovery of modified bitumen (RE)

## 3.1 Test results

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

| ID | Test results [%] | | $u_X$ [%] | $\bar{x}$ [%] | $s_0$ [%] | $V_X$ [%] |
|---|---|---|---|---|---|---|
| b0b09d | 94.0 | 94.0 | 1.0 | 94.0 | 0.0 | 0.0 |
| c9849a | 94.0 | 95.0 | 2.0 | 94.5 | 0.71 | 0.75 |
| 40f911 | 95.0 | 95.0 | 4.0 | 95.0 | 0.0 | 0.0 |
| 10cca9 | 96.0 | 96.0 | - | 96.0 | 0.0 | 0.0 |
| 10b504 | 96.0 | 96.0 | - | 96.0 | 0.0 | 0.0 |
| 3c68f6 | 96.0 | 96.0 | 3.0 | 96.0 | 0.0 | 0.0 |
| 64ea0e | 97.0 | 96.0 | 2.0 | 96.5 | 0.71 | 0.73 |
| 4cdbad | 96.4 | 96.8 | 4.0 | 96.6 | 0.28 | 0.29 |
| de0c90 | 97.0 | 97.0 | 0.2 | 97.0 | 0.0 | 0.0 |
| 49e1c8 | 97.5 | 98.0 | 1.1 | 97.8 | 0.35 | 0.36 |

## 3.2 The Numerical Procedure for Determining Outliers

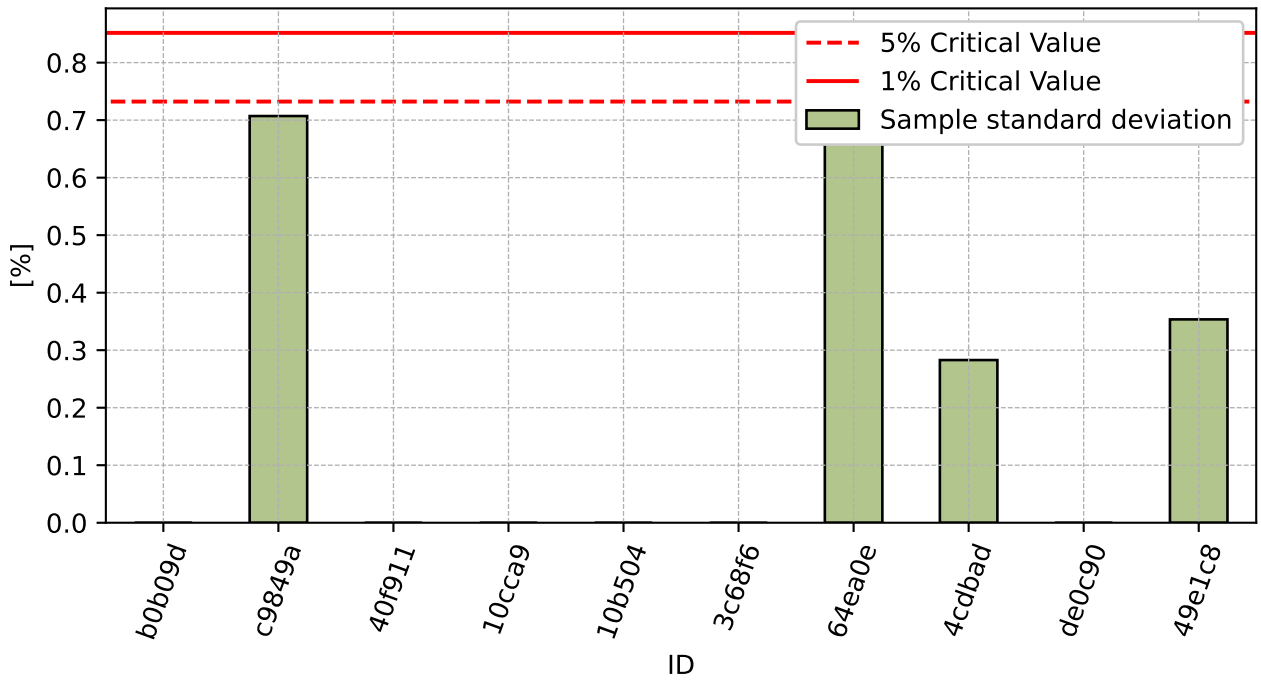


Figure 20: **Cochran's test** - sample standard deviations

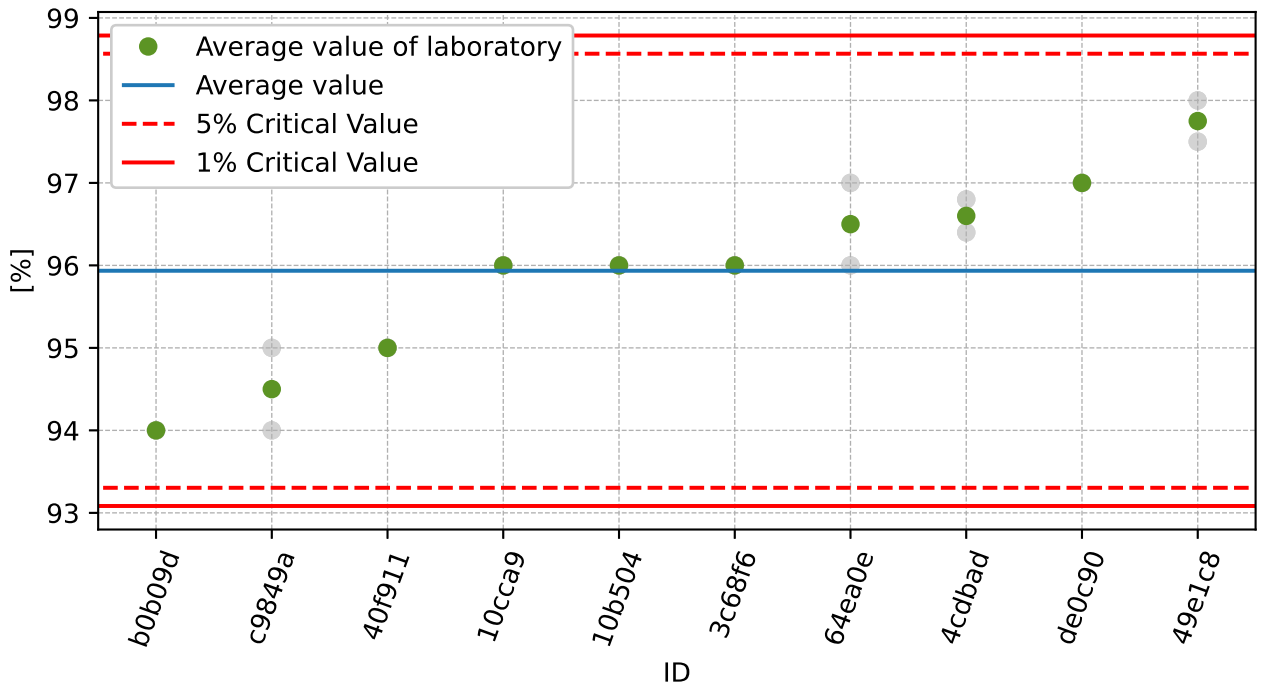


Figure 21: **Grubbs' test** - average values

## 3.3 Mandel's Statistics

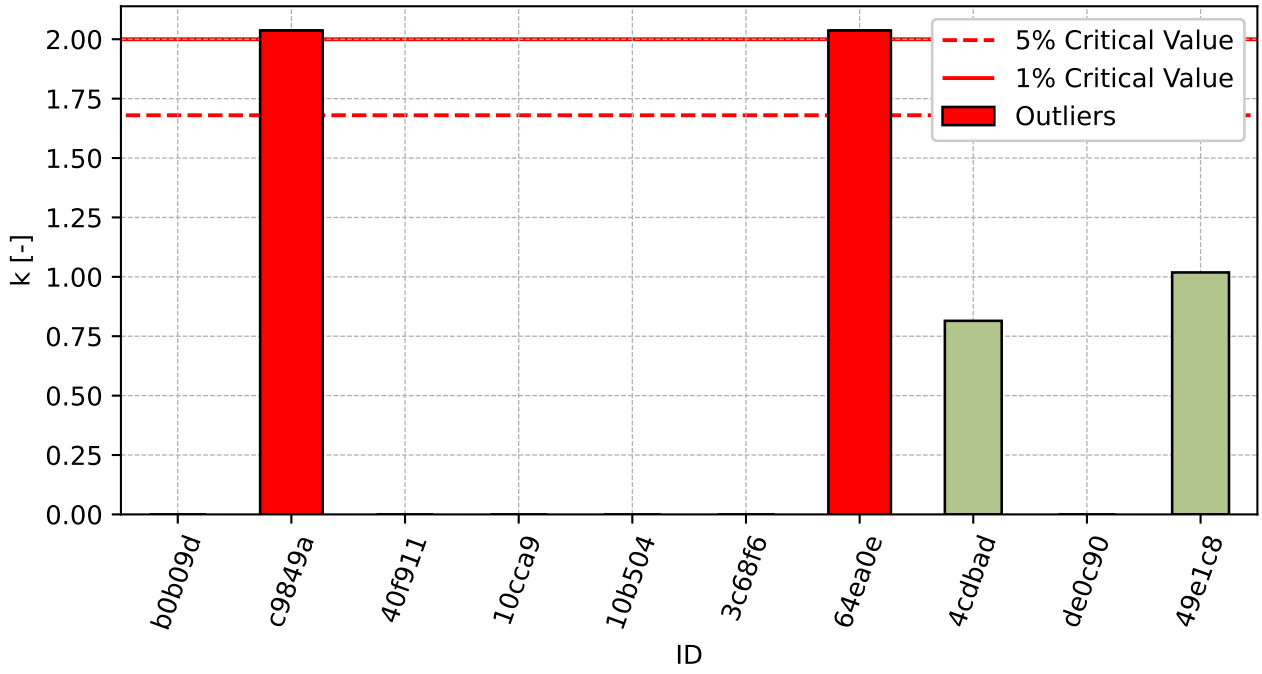


Figure 22: Intralaboratory Consistency Statistic

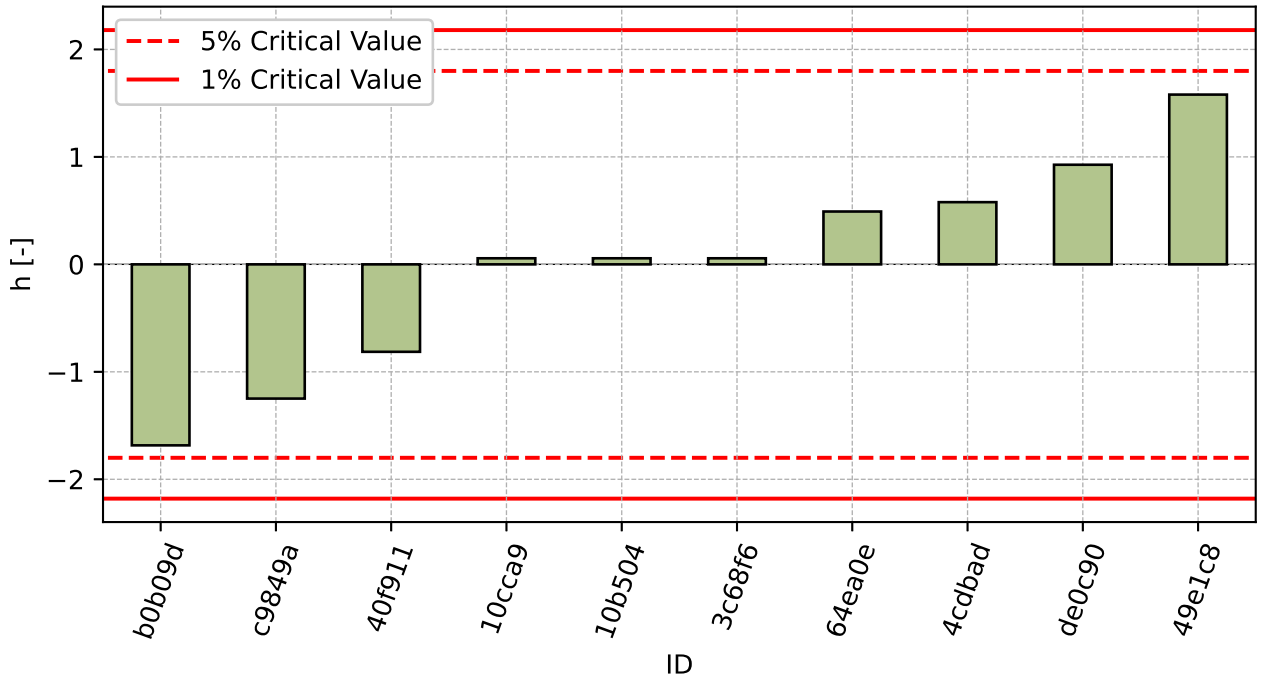


Figure 23: Interlaboratory Consistency Statistic

## 3.4 Descriptive statistics

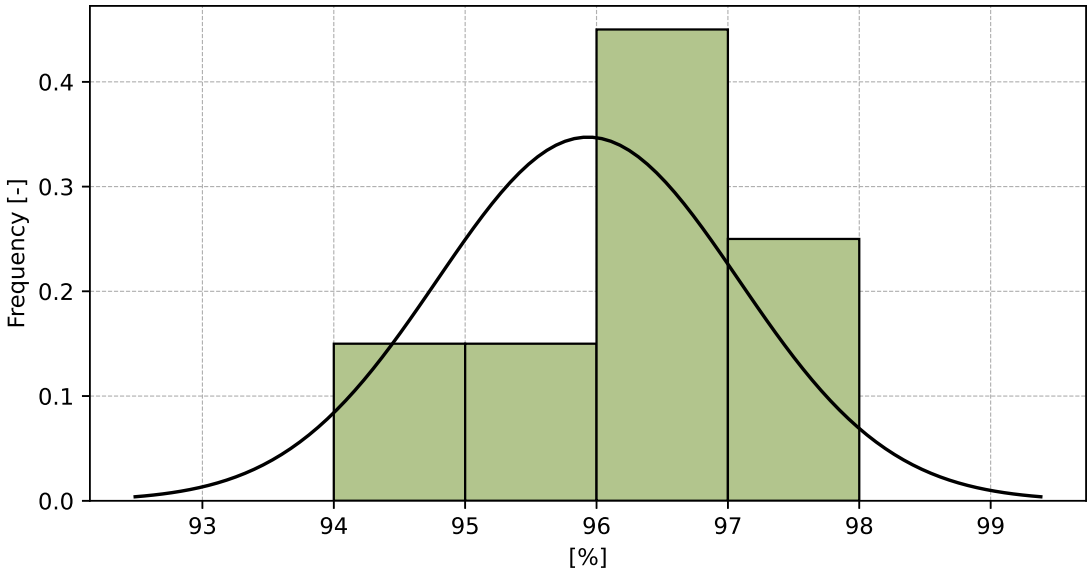


Figure 24: Histogram of all test results

Table 11: Descriptive statistics

| Characteristics | [%] |
|---|---|
| Average value – $\bar{x}$ | 95.9 |
| Sample standard deviation – $s$ | 1.15 |
| Asigned value – $x^*$ | 96.0 |
| Robust standard deviation – $s^*$ | 1.19 |
| Measurement uncertainty of asigned value – $u_X$ | 0.47 |
| $p$-value of normality test | 0.163 [-] |
| Interlaboratory standard deviation – $s_L$ | 1.12 |
| Repeatability standard deviation – $s_r$ | 0.35 |
| Reproducibility standard deviation – $s_R$ | 1.17 |
| Repeatability – $r$ | 1.0 |
| Reproducibility – $R$ | 3.3 |

## 3.5 Evaluation of Performance Statistics

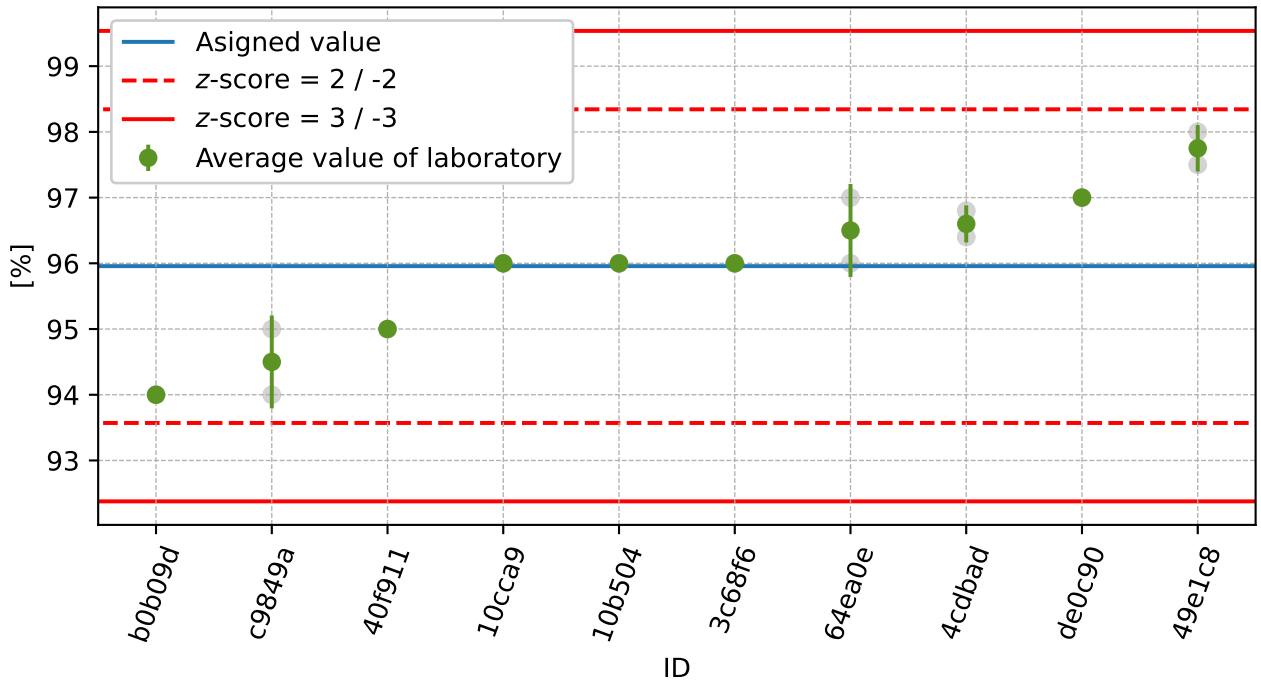


Figure 25: Average values and sample standard deviations

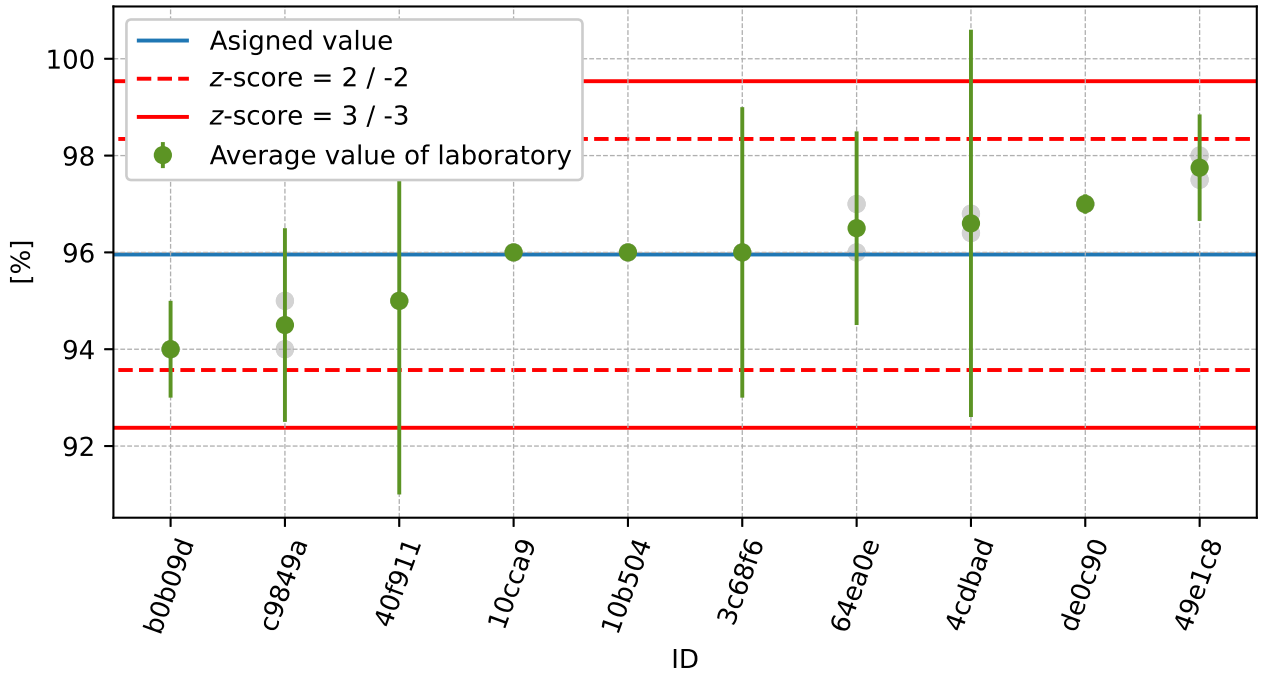


Figure 26: Average values and extended uncertainties of measurement

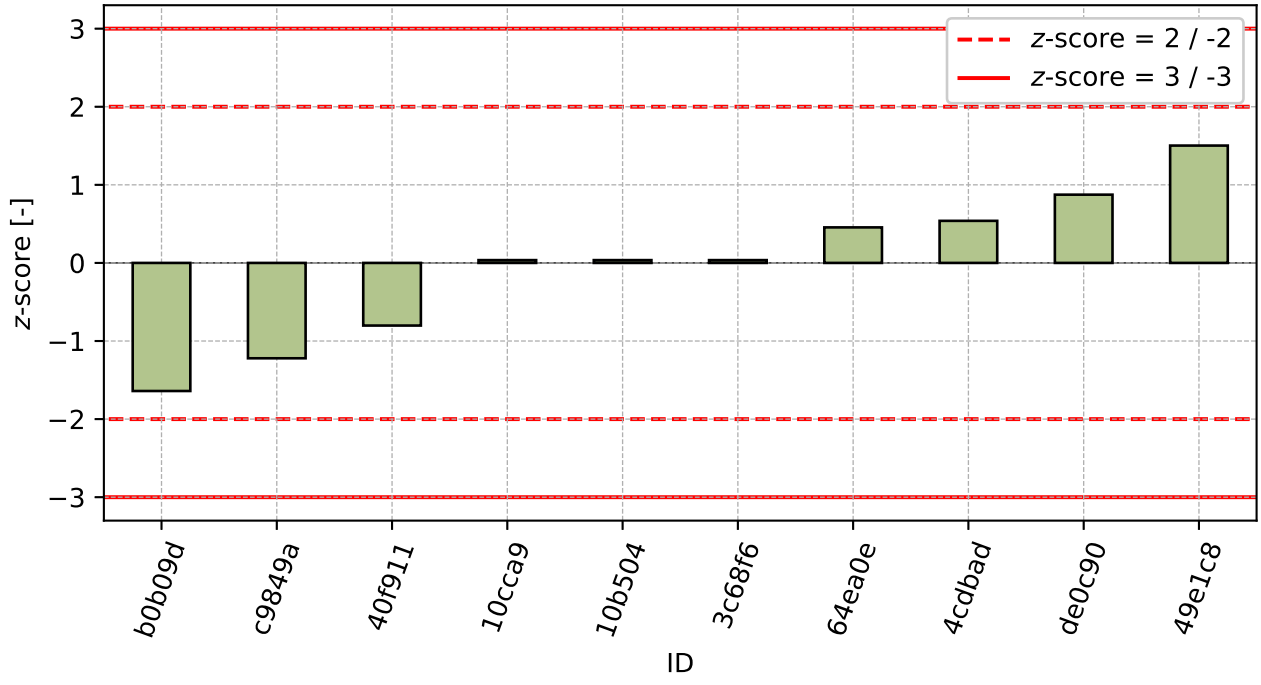


Figure 27: z-score

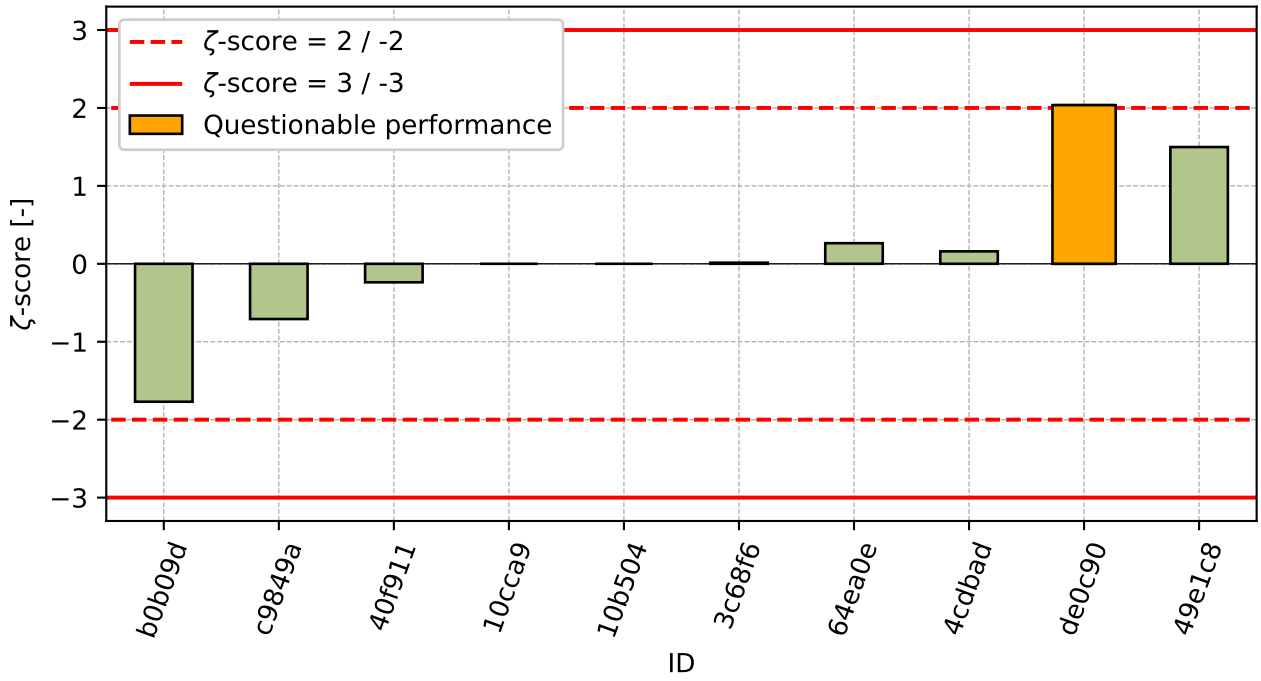


Figure 28: ζ-score

Table 12: *z*-score and ζ-score

| ID | *z*-score [-] | ζ-score [-] |
|---|---|---|
| b0b09d | -1.64 | -1.77 |
| c9849a | -1.22 | -0.71 |
| 40f911 | -0.80 | -0.24 |
| 10cca9 | 0.04 | - |
| 10b504 | 0.04 | - |
| 3c68f6 | 0.04 | 0.01 |
| 64ea0e | 0.46 | 0.26 |
| 4cdbad | 0.54 | 0.16 |
| de0c90 | 0.87 | 2.04 |
| 49e1c8 | 1.50 | 1.50 |

# 4 Appendix – EN 12593 Determination of the Fraass breaking point (T)

This part of the PT programme was not opened due to low interest from laboratories.

# 5 Appendix – EN 1429 Determination of residue on sieving of bituminous emulsions and storage stability

This part of the PT programme was not opened due to low interest from laboratories.

# 6 Appendix – EN 12697-1 Determination of soluble binder content

## 6.1 Test results

Table 13: Test results - ordered by average value. Outliers are marked by red color. $u_X$ - extended uncertainty of measurement.

| ID | Test results [%] | $u_X$ [%] |
|---|---|---|
| 9253fc | 5.2 | 0.4 |
| c22812 | 5.2 | - |
| 7ec83d | 5.3 | 0.1 |
| 62ea7a | 5.3 | 0.1 |
| b0b09d | 5.5 | 0.1 |
| de0c90 | 5.5 | 0.2 |
| c451a4 | 5.5 | - |
| 40f911 | 5.6 | 0.0 |
| cd3235 | 5.7 | 0.1 |
| f08bcd | 5.7 | 1.0 |
| 49e1c8 | 5.7 | 0.1 |
| 76d982 | 5.8 | - |
| c087fe | 5.9 | - |
| 4db578 | 6.0 | - |

## 6.2 The Numerical Procedure for Determining Outliers

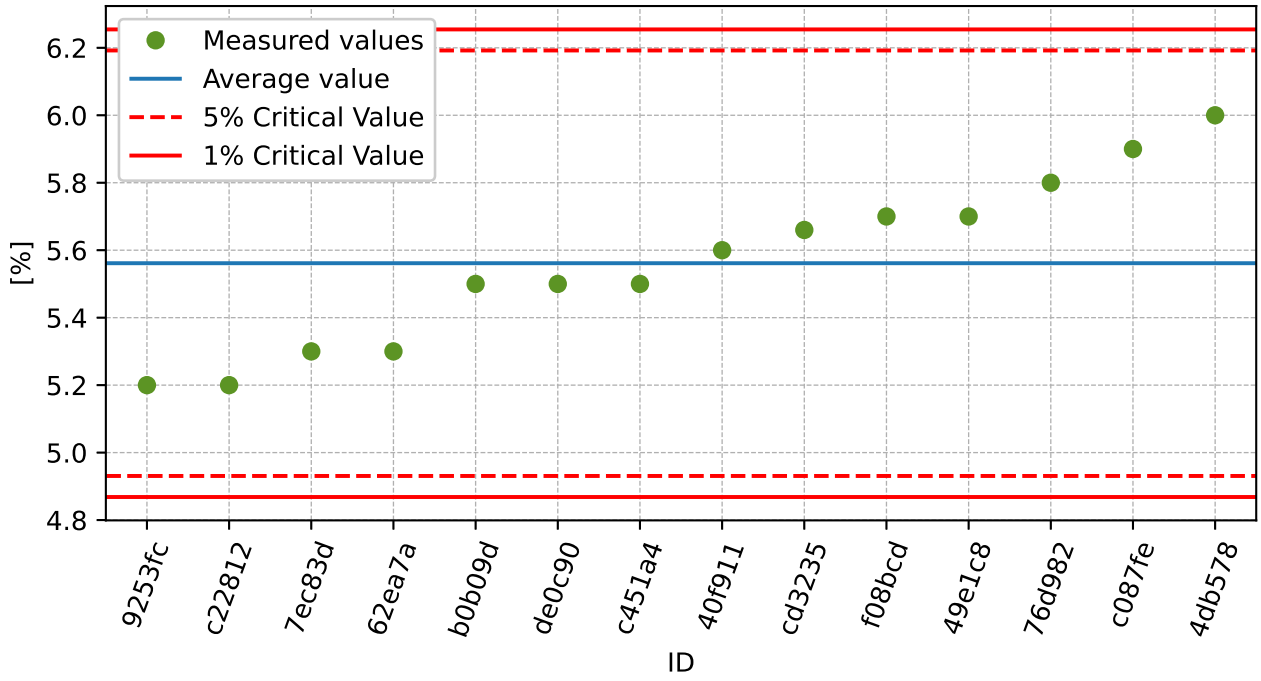


Figure 29: **Grubbs' test** - average values

## 6.3 Mandel's Statistics

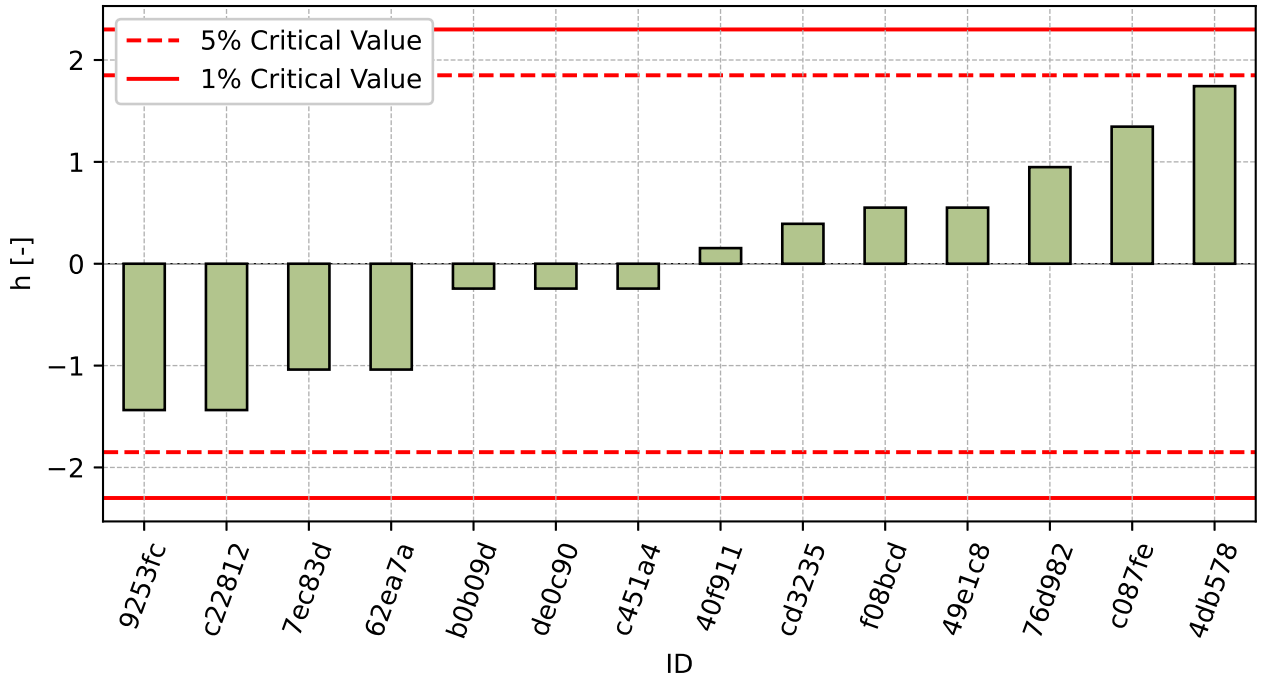


Figure 30: Interlaboratory Consistency Statistic

## 6.4 Descriptive statistics

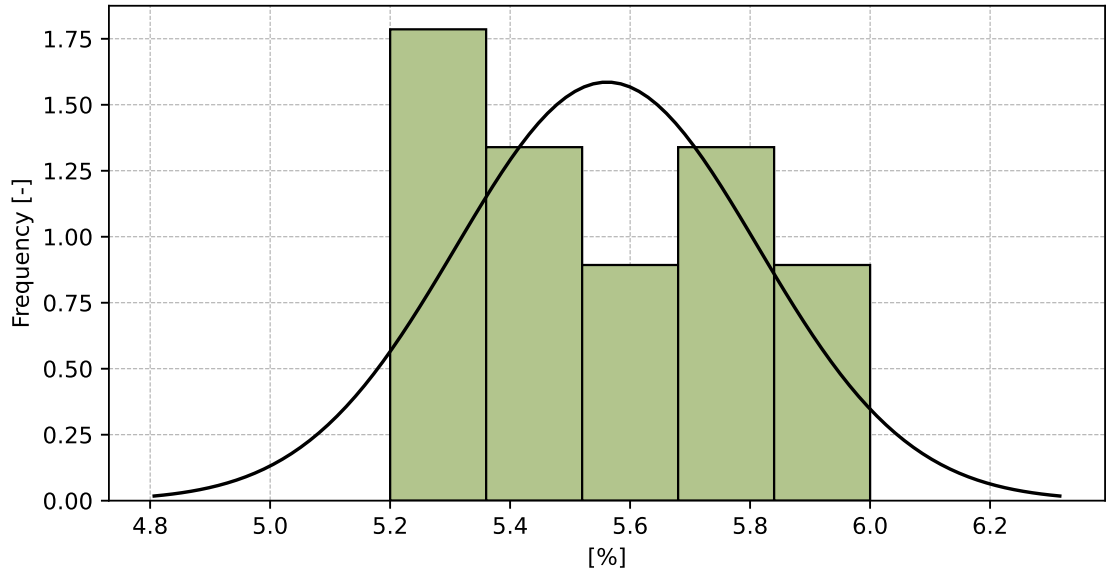


Figure 31: Histogram of all test results

Table 14: Descriptive statistics

| **Characteristics** | **[%]** |
|---|---|
| Average value – $\bar{x}$ | 5.6 |
| Sample standard deviation – $s$ | 0.25 |
| Asigned value – $x^*$ | 5.6 |
| Robust standard deviation – $s^*$ | 0.27 |
| Measurement uncertainty of asigned value – $u_X$ | 0.09 |
| $p$-value of normality test | 0.634 [-] |

## 6.5 Evaluation of Performance Statistics

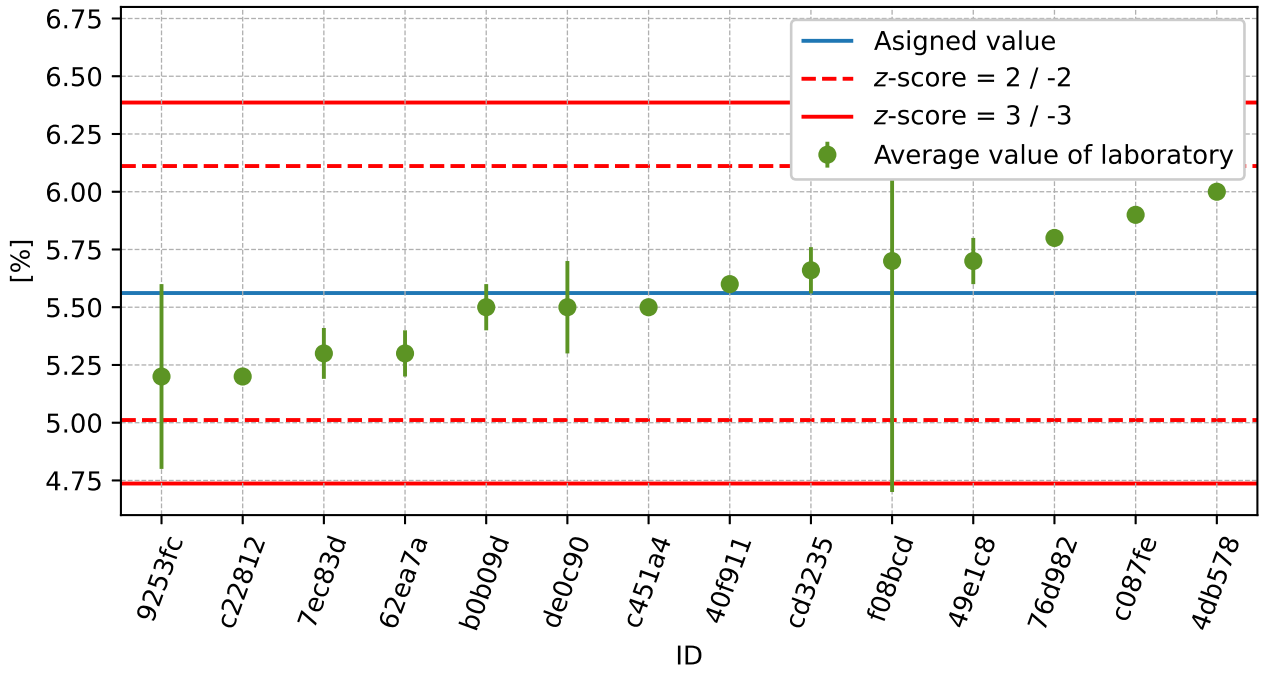


Figure 32: Average values and extended uncertainties of measurement

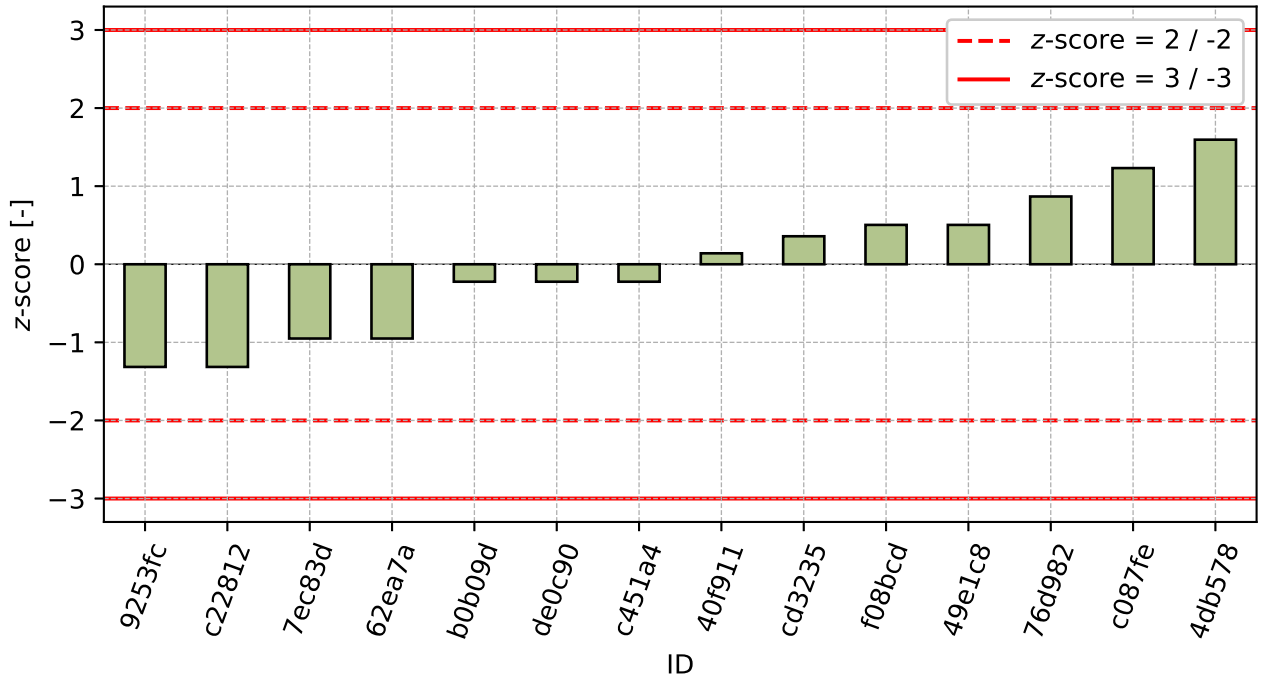


Figure 33: z-score

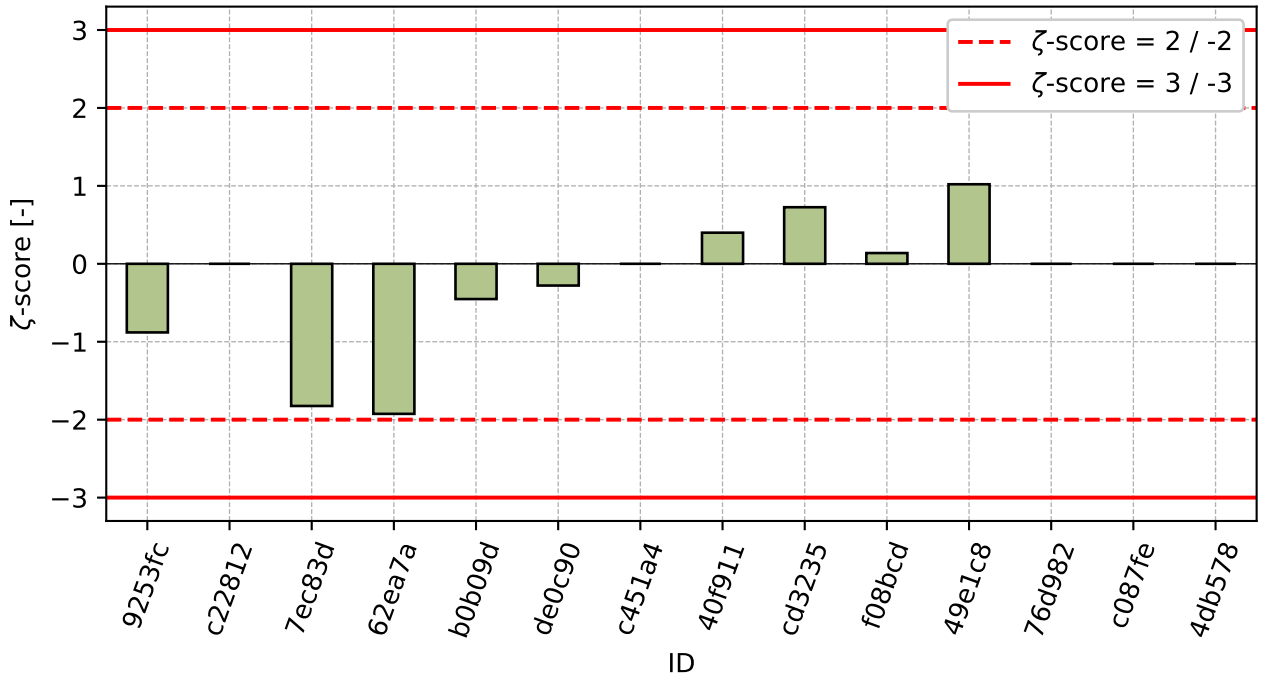


Figure 34: ζ-score

Table 15: *z*-score and ζ-score

| ID | *z*-score [-] | ζ-score [-] |
|---|---|---|
| 9253fc | -1.31 | -0.88 |
| c22812 | -1.31 | - |
| 7ec83d | -0.95 | -1.82 |
| 62ea7a | -0.95 | -1.93 |
| b0b09d | -0.22 | -0.45 |
| de0c90 | -0.22 | -0.28 |
| c451a4 | -0.22 | - |
| 40f911 | 0.14 | 0.40 |
| cd3235 | 0.36 | 0.73 |
| f08bcd | 0.50 | 0.14 |
| 49e1c8 | 0.50 | 1.02 |
| 76d982 | 0.87 | - |
| c087fe | 1.23 | - |
| 4db578 | 1.60 | - |

# 7 Appendix – EN 12697-2+A1 Determination of particle size distribution

Table 16: Výsledky zkoušek – propad sítem [%]; odlehlé hodnoty jsou označeny červeně

| ID účastníka | Propad sítem [%] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 11.2 mm | 8 mm | 5.6 mm | 4 mm | 2 mm | 1 mm | 0.5 mm | 0.25 mm | 0.125 mm | 0.063 mm |
| 9253fc | 99.0 | 82.0 | 52.0 | 39.0 | 25.0 | 17.0 | 12.0 | 9.0 | 7.0 | 6.2 |
| c087fe | 99.0 | 86.0 | 60.0 | 46.0 | 29.0 | 18.0 | 13.0 | 10.0 | 8.0 | 7.0 |
| 4db578 | 98.0 | 83.0 | 57.0 | 46.0 | 29.0 | 17.0 | 12.0 | 10.0 | 8.0 | 7.0 |
| 7ec83d | 99.2 | 84.5 | - | 39.4 | 25.6 | 17.4 | 12.7 | 9.6 | 7.9 | 7.3 |
| f08bcd | 100.0 | 86.0 | 57.0 | 42.0 | 29.0 | 20.0 | 14.0 | 10.0 | 8.0 | 7.0 |
| b0b09d | 100.0 | 86.0 | 55.0 | 40.0 | 27.0 | 17.0 | 12.0 | 9.0 | 7.0 | 6.0 |
| 76d982 | 98.0 | 80.0 | 51.0 | 46.0 | 31.0 | 21.0 | 13.0 | 10.0 | 8.0 | 6.9 |
| de0c90 | 100.0 | 86.0 | 57.0 | 43.0 | 28.0 | 18.0 | 12.0 | 9.0 | 8.0 | 6.6 |
| 49e1c8 | 100.0 | 81.0 | 57.0 | 40.0 | 27.0 | 18.0 | 12.0 | 9.0 | 7.0 | 5.7 |
| 62ea7a | 99.5 | 81.8 | - | 39.6 | 25.9 | 16.8 | 11.8 | 8.7 | 6.9 | 5.4 |
| c451a4 | 100.0 | 82.0 | 51.0 | 40.0 | 26.0 | 17.0 | 12.0 | 9.0 | 7.0 | 5.8 |
| cd3235 | - | 84.0 | - | 43.0 | 29.0 | 20.0 | 14.0 | 10.0 | 8.0 | 6.9 |
| 0789d1 | 100.0 | 83.0 | 53.0 | 40.0 | 27.0 | 18.0 | 13.0 | 10.0 | 8.0 | 6.5 |
| c22812 | 100.0 | 85.0 | - | 39.0 | 25.0 | 16.0 | - | - | 7.0 | 6.0 |

Table 17: Výsledky Grubbsova testu

| Charakteristika | 11.2 mm | 8 mm | 5.6 mm | 4 mm | 2 mm | 1 mm | 0.5 mm | 0.25 mm | 0.125 mm | 0.063 mm |
|---|---|---|---|---|---|---|---|---|---|---|
| $G_{min}$ | 1.912 | 1.75 | 1.294 | 0.979 | 1.316 | 1.354 | 1.003 | 1.475 | 1.271 | 1.762 |
| $G_{max}$ | 0.746 | 1.173 | 1.617 | 1.614 | 1.983 | 2.131 | 1.837 | 0.969 | 0.857 | 1.427 |
| $G_{0.05}$ | 2.462 | 2.507 | 2.29 | 2.507 | 2.507 | 2.507 | 2.462 | 2.462 | 2.507 | 2.507 |
| $G_{0.01}$ | 2.699 | 2.755 | 2.482 | 2.755 | 2.755 | 2.755 | 2.699 | 2.699 | 2.755 | 2.755 |

Table 18: Výsledné hodnoty *z*-score

| ID účastníka | 11.2 mm | 8 mm | 5.6 mm | 4 mm | 2 mm | 1 mm | 0.5 mm | 0.25 mm | 0.125 mm | 0.063 mm |
|---|---|---|---|---|---|---|---|---|---|---|
| 9253fc | -0.58 | -0.78 | -0.97 | -0.98 | -1.32 | -0.66 | -0.74 | -0.91 | -1.08 | -0.42 |
| c087fe | -0.58 | 1.17 | 1.62 | 1.61 | 0.88 | 0.04 | 0.55 | 0.97 | 0.86 | 0.92 |
| 4db578 | -1.91 | -0.29 | 0.65 | 1.61 | 0.88 | -0.66 | -0.74 | 0.97 | 0.86 | 0.92 |
| 7ec83d | -0.32 | 0.44 | - | -0.83 | -0.99 | -0.38 | 0.16 | 0.22 | 0.66 | 1.43 |
| f08bcd | 0.75 | 1.17 | 0.65 | 0.13 | 0.88 | 1.43 | 1.84 | 0.97 | 0.86 | 0.92 |
| b0b09d | 0.75 | 1.17 | 0.0 | -0.61 | -0.22 | -0.66 | -0.74 | -0.91 | -1.08 | -0.76 |
| 76d982 | -1.91 | -1.75 | -1.29 | 1.61 | 1.98 | 2.13 | 0.55 | 0.97 | 0.86 | 0.76 |
| de0c90 | 0.75 | 1.17 | 0.65 | 0.5 | 0.33 | 0.04 | -0.74 | -0.91 | 0.86 | 0.25 |
| 49e1c8 | 0.75 | -1.26 | 0.65 | -0.61 | -0.22 | 0.04 | -0.74 | -0.91 | -1.08 | -1.26 |
| 62ea7a | 0.08 | -0.87 | - | -0.76 | -0.82 | -0.8 | -1.0 | -1.47 | -1.27 | -1.76 |
| c451a4 | 0.75 | -0.78 | -1.29 | -0.61 | -0.77 | -0.66 | -0.74 | -0.91 | -1.08 | -1.09 |
| cd3235 | - | 0.2 | - | 0.5 | 0.88 | 1.43 | 1.84 | 0.97 | 0.86 | 0.76 |
| 0789d1 | 0.75 | -0.29 | -0.65 | -0.61 | -0.22 | 0.04 | 0.55 | 0.97 | 0.86 | 0.08 |
| c22812 | 0.75 | 0.69 | - | -0.98 | -1.32 | -1.35 | - | - | -1.08 | -0.76 |

# 8 Appendix – EN 12697-5 Determination of maximum density

## 8.1 Test results

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

| ID | Test results [Mg/m³] | | $u_X$ [Mg/m³] | $\bar{x}$ [Mg/m³] | $s_0$ [Mg/m³] | $V_X$ [%] |
|---|---|---|---|---|---|---|
| cd3235 | 2.365 | 2.366 | - | 2.365 | 0.0007 | 0.03 |
| c087fe | 2.422 | 2.422 | - | 2.422 | 0.0 | 0.0 |
| 4db578 | 2.425 | 2.428 | - | 2.426 | 0.0021 | 0.09 |
| 76d982 | 2.439 | 2.435 | - | 2.437 | 0.0028 | 0.12 |
| f68f15 | 2.441 | 2.439 | 0.231 | 2.44 | 0.0014 | 0.06 |
| b0b09d | 2.439 | 2.444 | 0.013 | 2.442 | 0.0035 | 0.14 |
| 29c947 | 2.445 | 2.455 | 0.007 | 2.45 | 0.0071 | 0.29 |
| 9253fc | 2.456 | 2.447 | 0.008 | 2.452 | 0.0064 | 0.26 |
| c22812 | 2.458 | 2.458 | - | 2.458 | 0.0 | 0.0 |
| acb415 | 2.458 | 2.462 | 0.001 | 2.46 | 0.0028 | 0.11 |
| 7ec83d | 2.46 | 2.463 | 0.003 | 2.462 | 0.0021 | 0.09 |
| 49e1c8 | 2.466 | 2.464 | 0.006 | 2.465 | 0.0014 | 0.06 |
| 62ea7a | 2.475 | 2.484 | 0.008 | 2.479 | 0.0064 | 0.26 |
| f08bcd | 2.534 | 2.495 | 0.041 | 2.514 | 0.0278 | 1.11 |

## 8.2 The Numerical Procedure for Determining Outliers

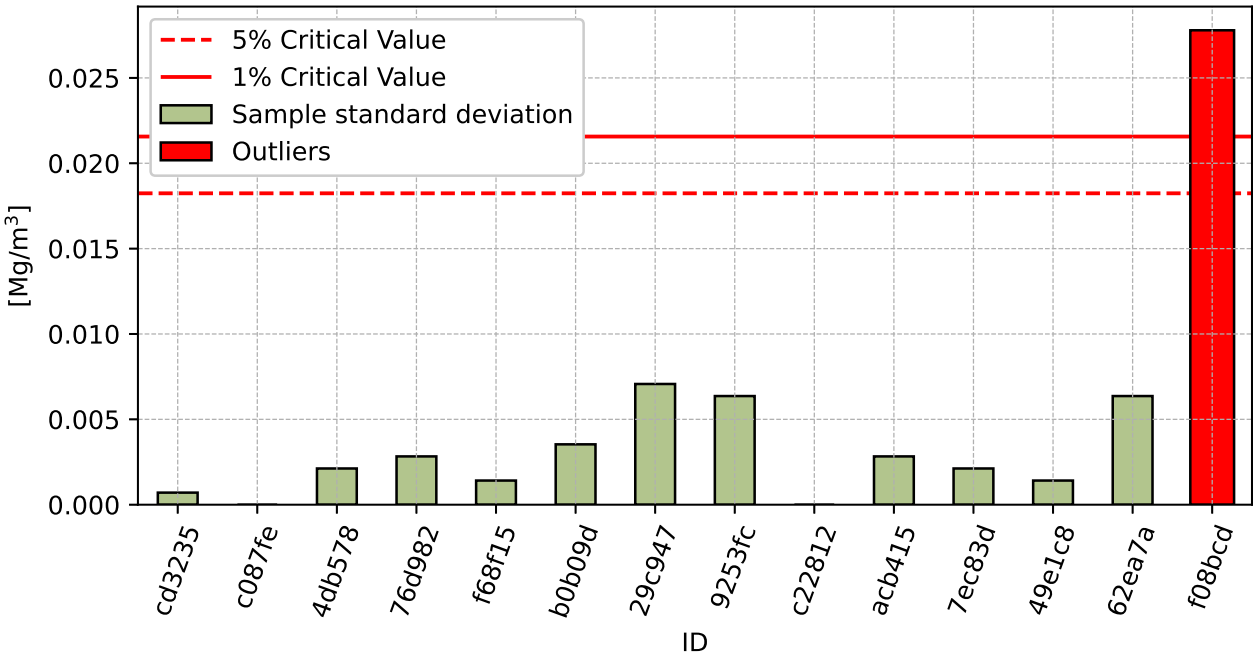


Figure 35: **Cochran's test** - sample standard deviations

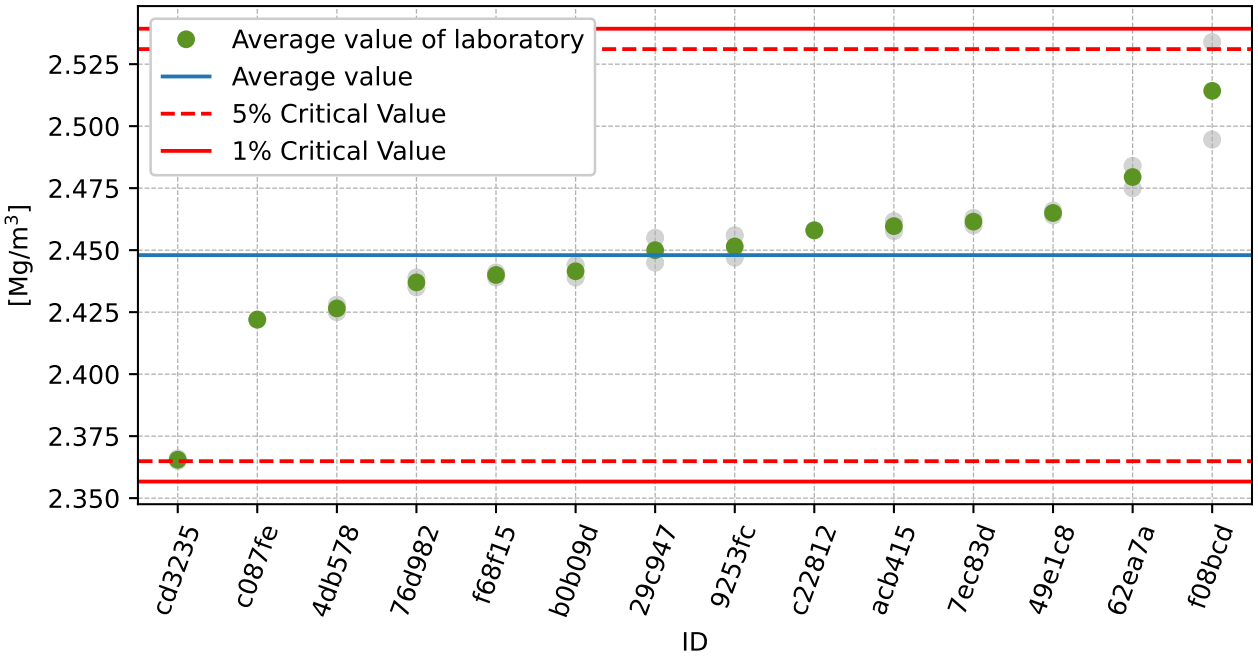


Figure 36: **Grubbs' test** - average values

## 8.3 Mandel's Statistics

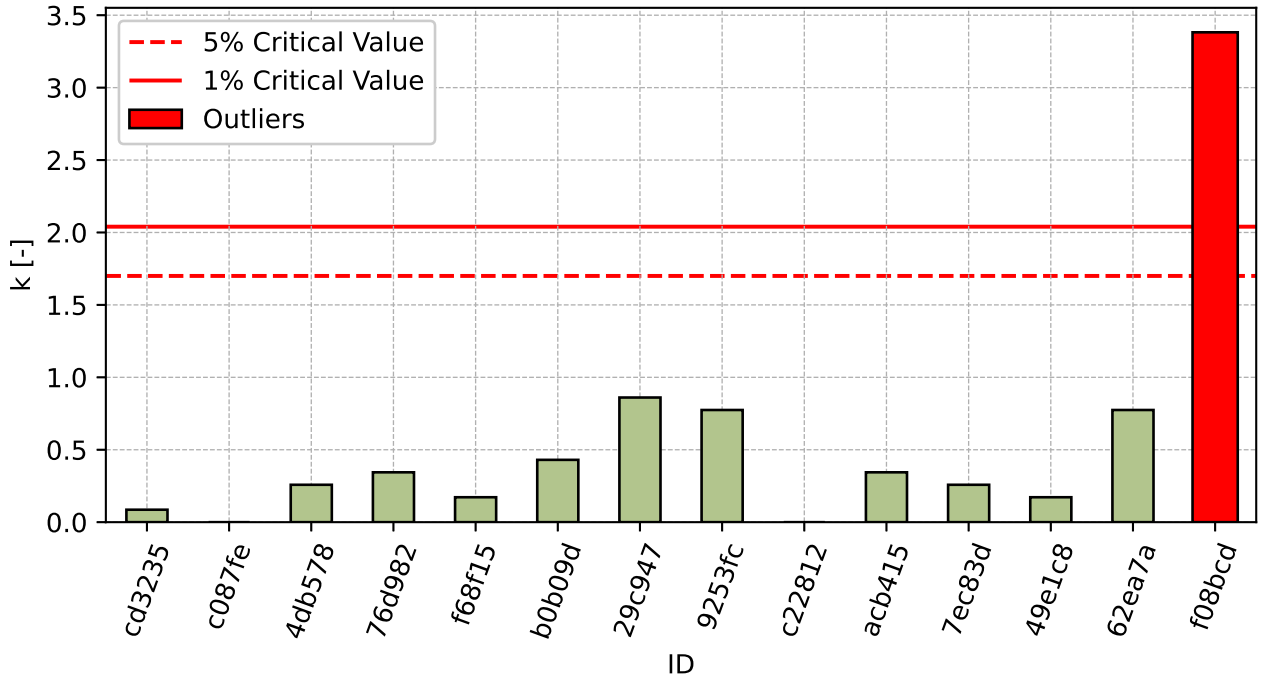


Figure 37: Intralaboratory Consistency Statistic

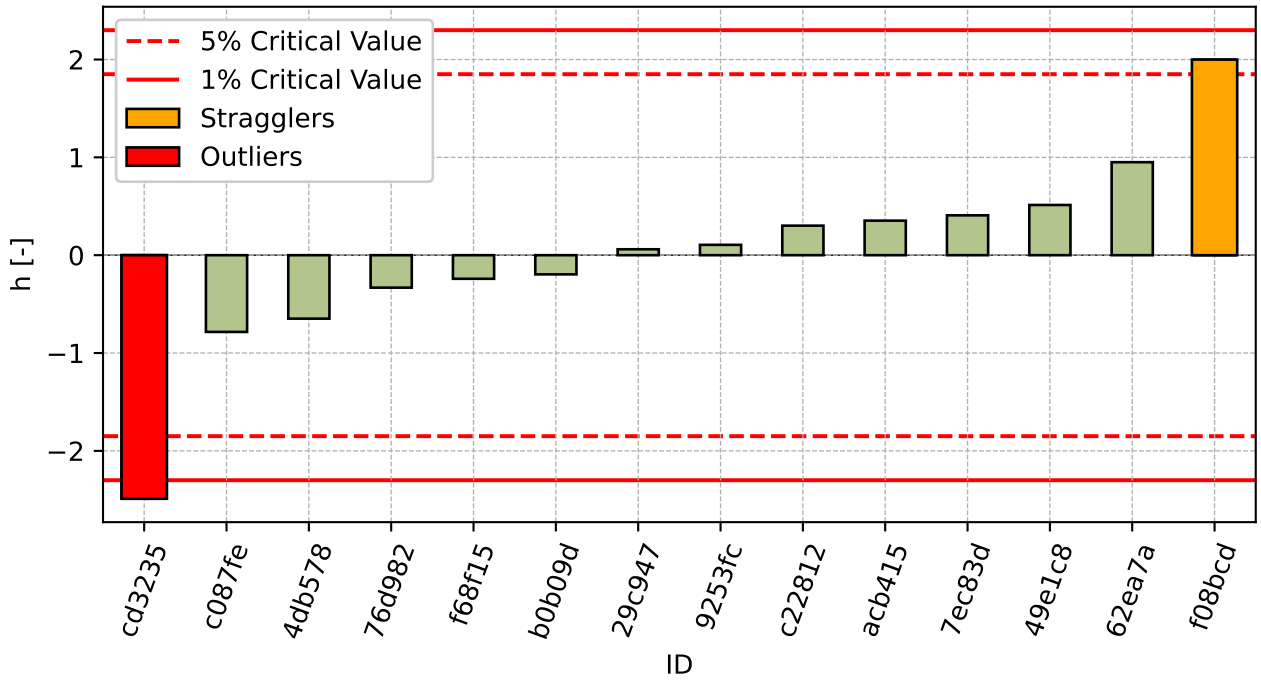


Figure 38: Interlaboratory Consistency Statistic

## 8.4 Descriptive statistics

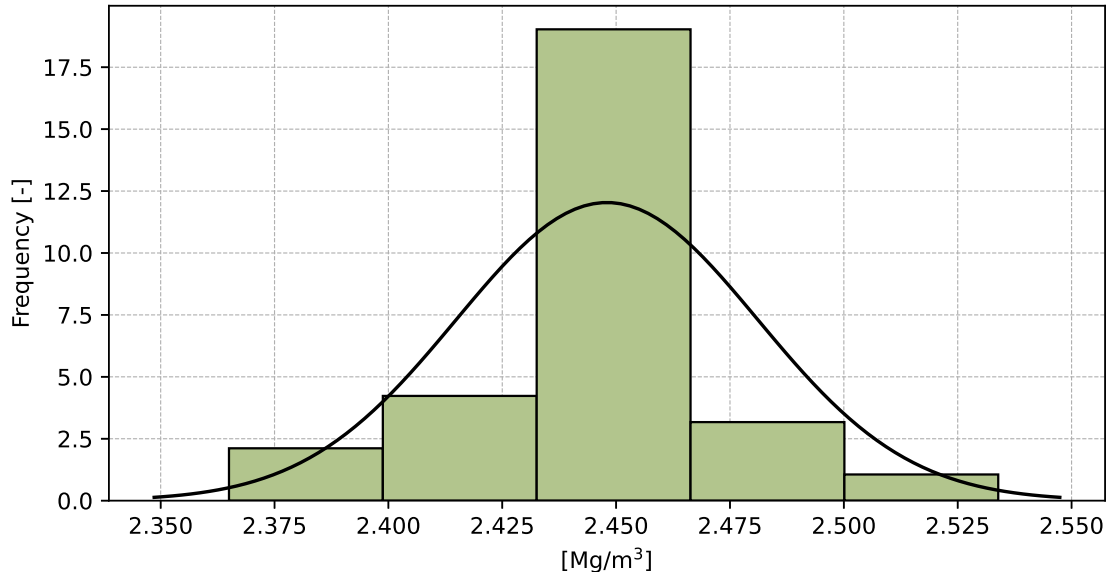


Figure 39: Histogram of all test results

Table 20: Descriptive statistics

| **Characteristics** | **[Mg/m$^3$]** |
|---|---|
| Average value – $\bar{x}$ | 2.448 |
| Sample standard deviation – $s$ | 0.0331 |
| Asigned value – $x^*$ | 2.452 |
| Robust standard deviation – $s^*$ | 0.0265 |
| Measurement uncertainty of asigned value – $u_X$ | 0.0089 |
| $p$-value of normality test | 0.018 [-] |
| Interlaboratory standard deviation – $s_L$ | 0.0326 |
| Repeatability standard deviation – $s_r$ | 0.0082 |
| Reproducibility standard deviation – $s_R$ | 0.0336 |
| Repeatability – $r$ | 0.023 |
| Reproducibility – $R$ | 0.094 |

## 8.5 Evaluation of Performance Statistics

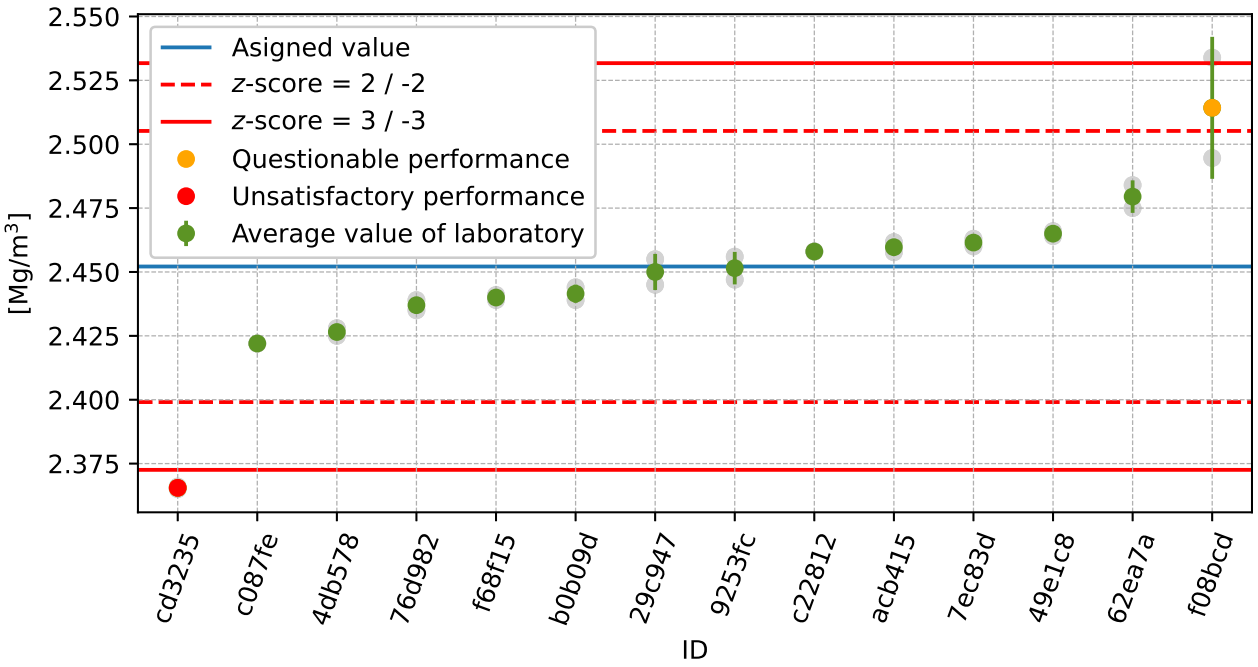


Figure 40: Average values and sample standard deviations

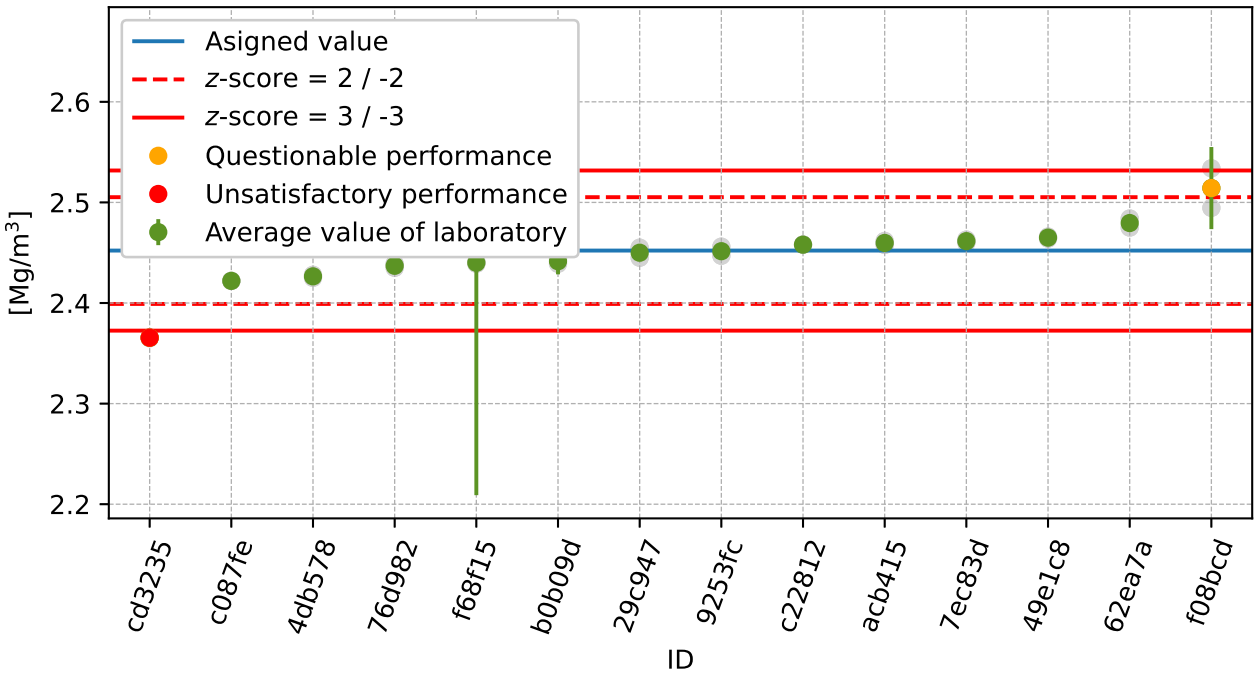


Figure 41: Average values and extended uncertainties of measurement

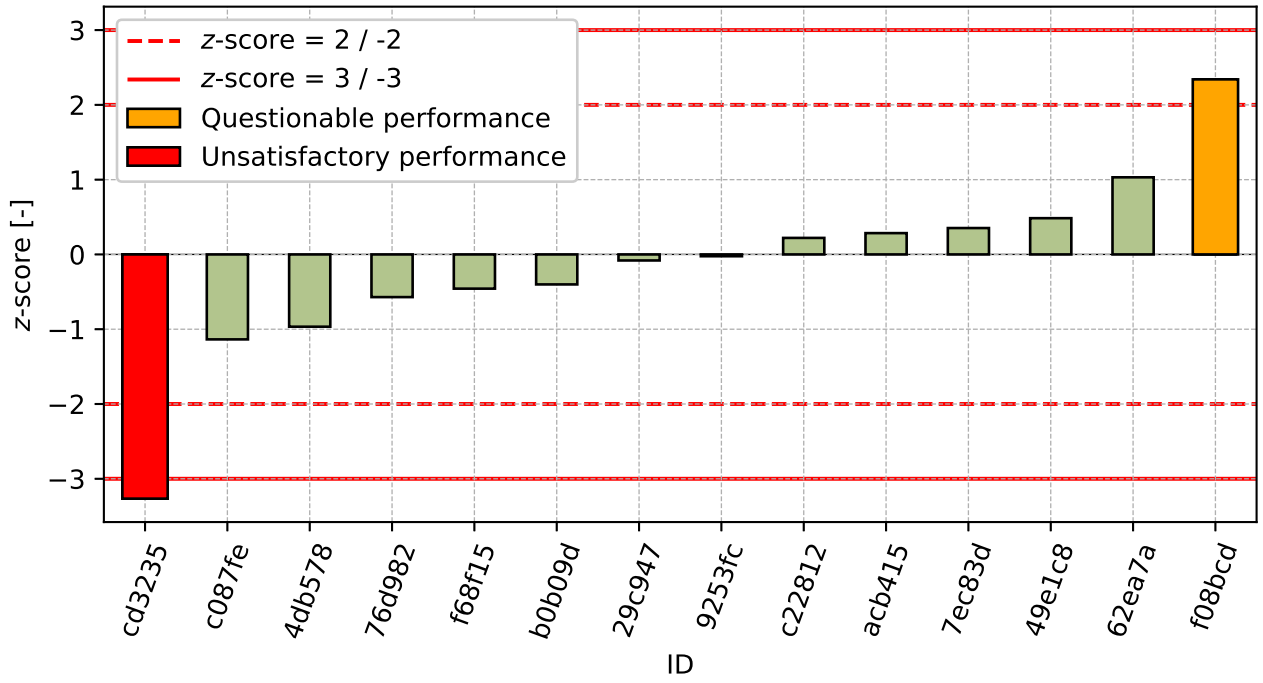


Figure 42: z-score

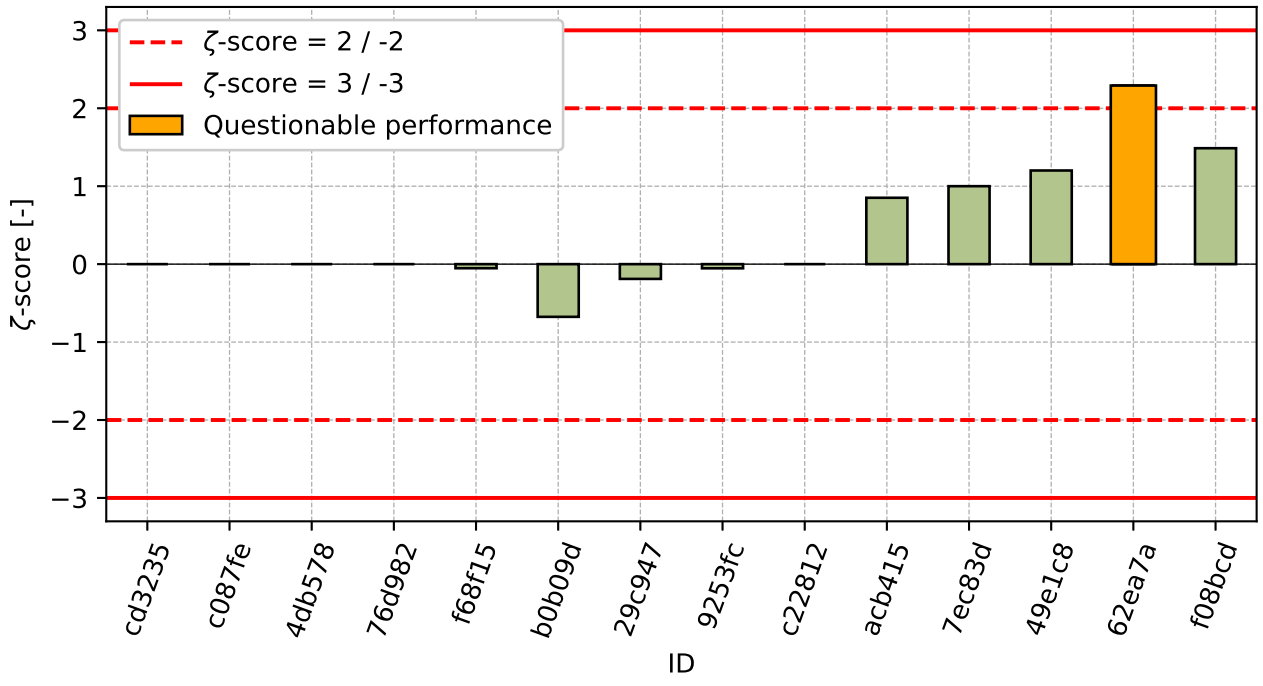


Figure 43: ζ-score

Table 21: $z$-score and $\zeta$-score

| ID | $z$-score [-] | $\zeta$-score [-] |
|---|---|---|
| cd3235 | -3.27 | - |
| c087fe | -1.14 | - |
| 4db578 | -0.97 | - |
| 76d982 | -0.57 | - |
| f68f15 | -0.46 | -0.05 |
| b0b09d | -0.40 | -0.68 |
| 29c947 | -0.08 | -0.19 |
| 9253fc | -0.02 | -0.05 |
| c22812 | 0.22 | - |
| acb415 | 0.28 | 0.85 |
| 7ec83d | 0.35 | 1.00 |
| 49e1c8 | 0.48 | 1.20 |
| 62ea7a | 1.03 | 2.29 |
| f08bcd | 2.34 | 1.49 |

# 9 Appendix – EN 12697-6 Determination of bulk density of bituminous specimens

## 9.1 Test results

Table 22: Test results - ordered by average value. Outliers are marked by red color. $u_X$ - extended uncertainty of measurement.

| ID | Test results [Mg/m³] | $u_X$ [Mg/m³] |
|---|---|---|
| 87e572 | 2.223 | 0.03 |
| c087fe | 2.232 | - |
| 4db578 | 2.234 | - |
| c22812 | 2.245 | - |
| 62ea7a | 2.249 | 0.006 |
| b0b09d | 2.254 | 0.008 |
| 9253fc | 2.259 | 0.007 |
| 7ec83d | 2.274 | 0.028 |
| 76d982 | 2.325 | - |
| 49e1c8 | 2.325 | 0.009 |
| f08bcd | 2.418 | 0.015 |

## 9.2 The Numerical Procedure for Determining Outliers

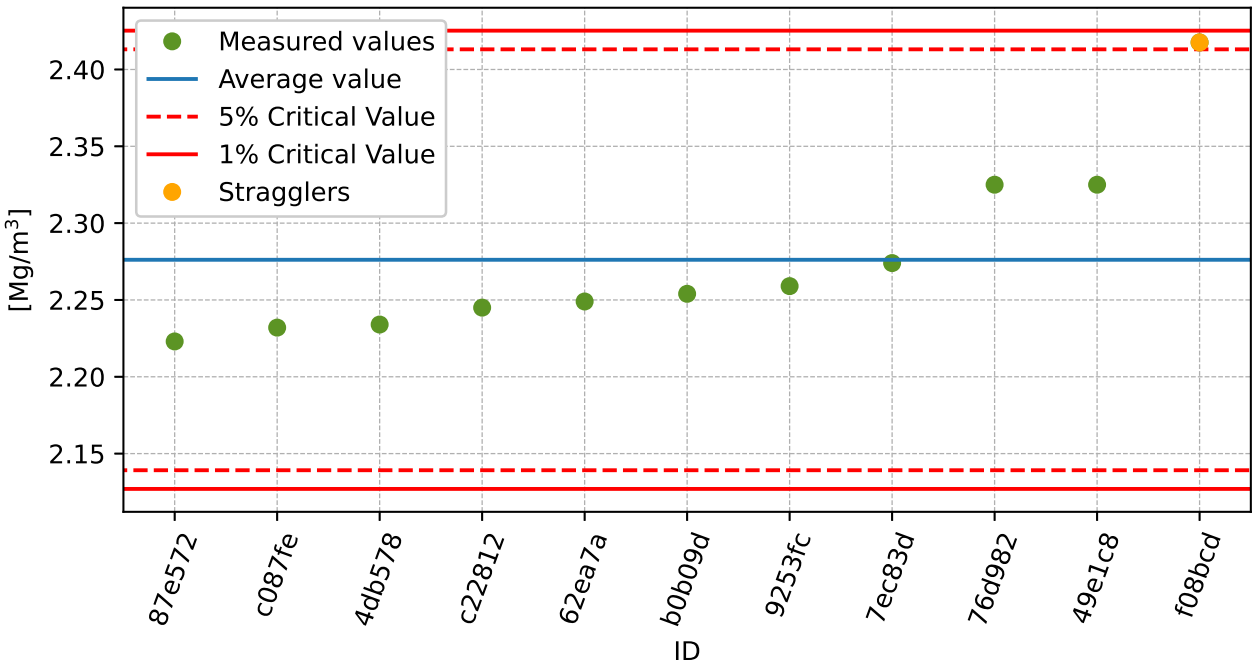


Figure 44: **Grubbs' test** - average values

## 9.3 Mandel's Statistics

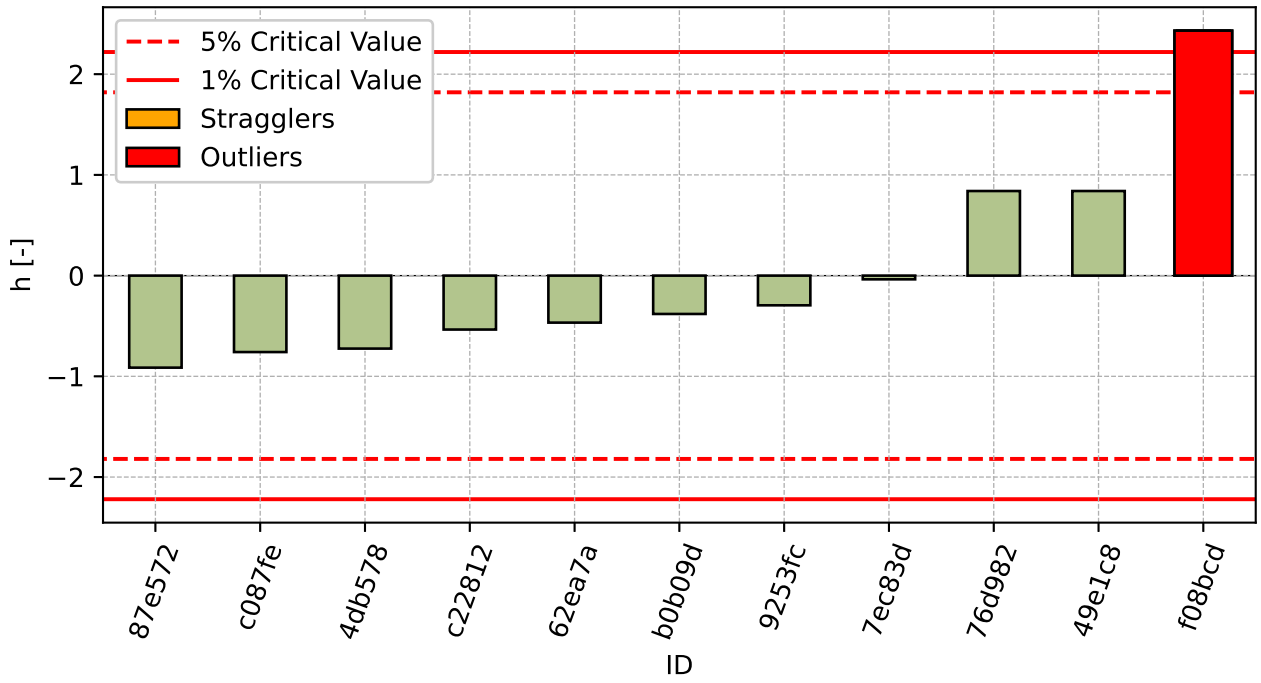


Figure 45: Interlaboratory Consistency Statistic

## 9.4 Descriptive statistics

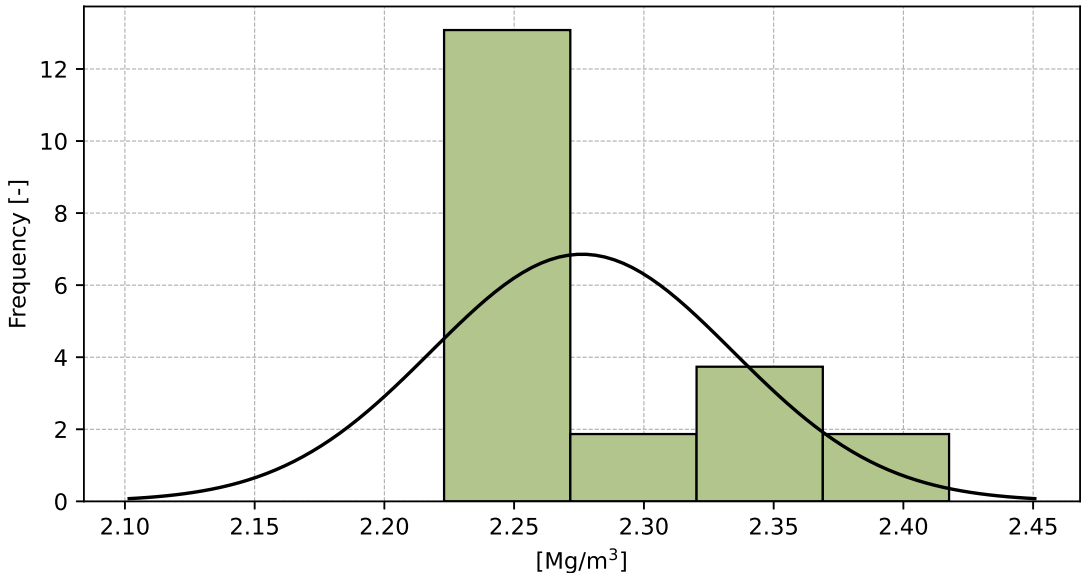


Figure 46: Histogram of all test results

Table 23: Descriptive statistics

| Characteristics | [Mg/m$^3$] |
|---|---|
| Average value – $\bar{x}$ | 2.276 |
| Sample standard deviation – $s$ | 0.0582 |
| Asigned value – $x^*$ | 2.271 |
| Robust standard deviation – $s^*$ | 0.059 |
| Measurement uncertainty of asigned value – $u_X$ | 0.0222 |
| $p$-value of normality test | 0.012 [-] |

## 9.5 Evaluation of Performance Statistics

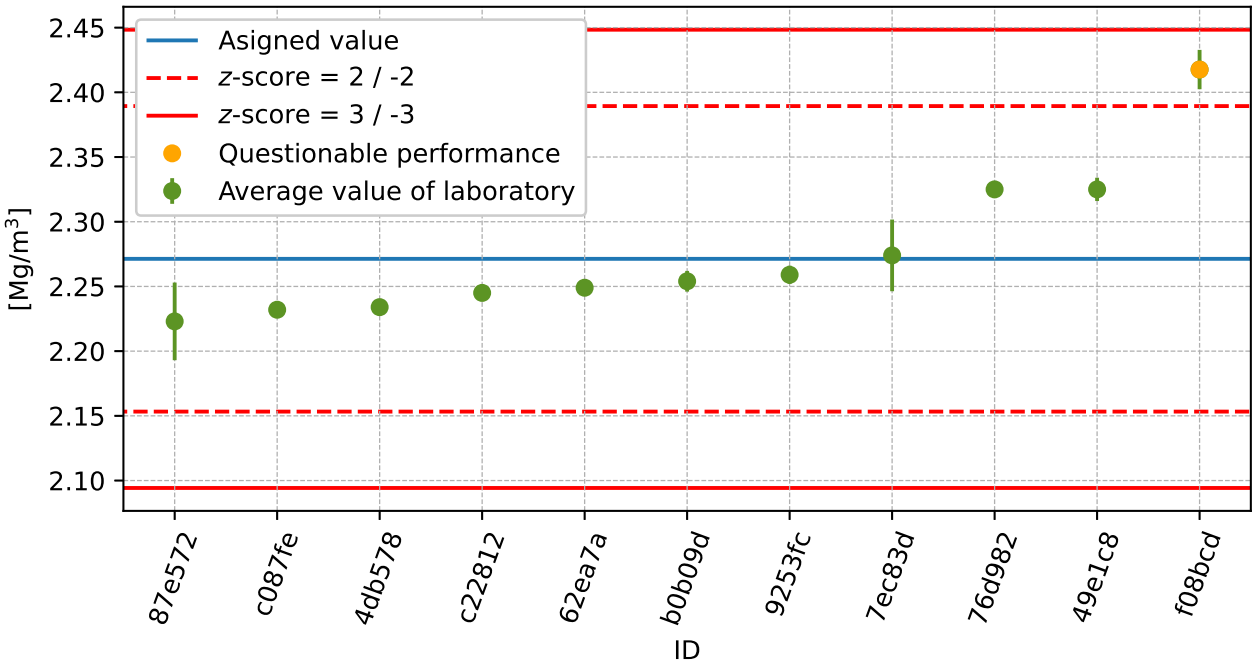


Figure 47: Average values and extended uncertainties of measurement

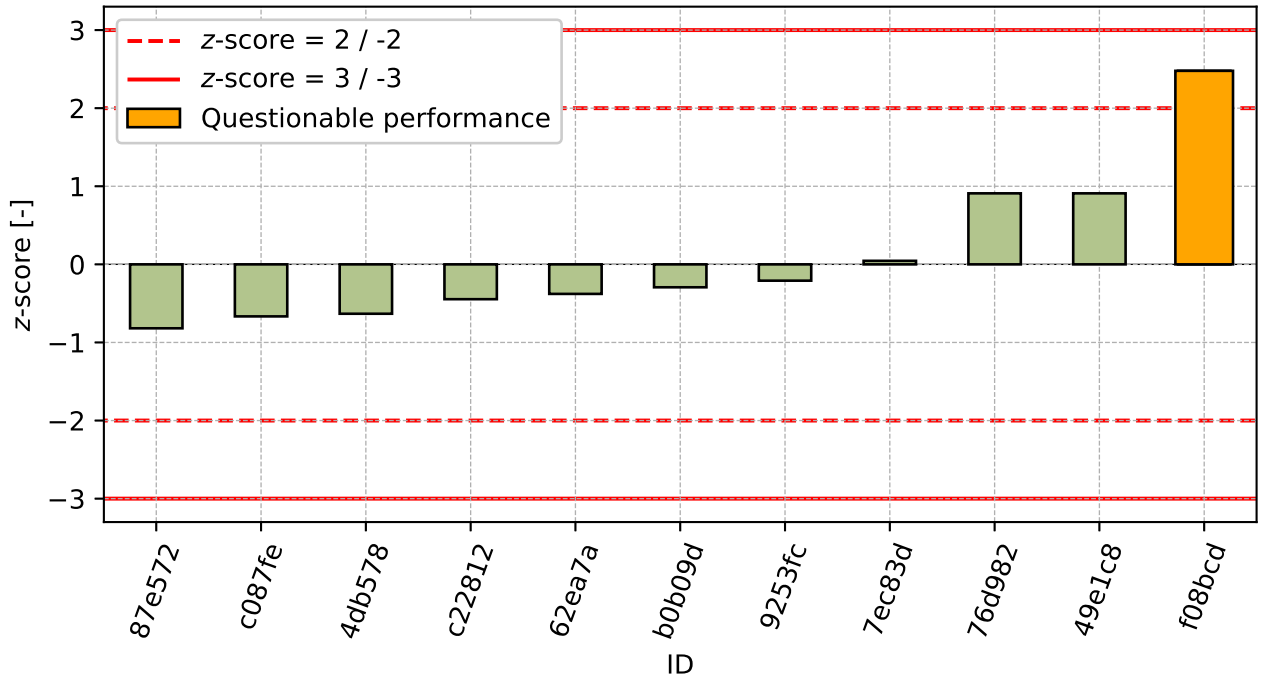


Figure 48: z-score

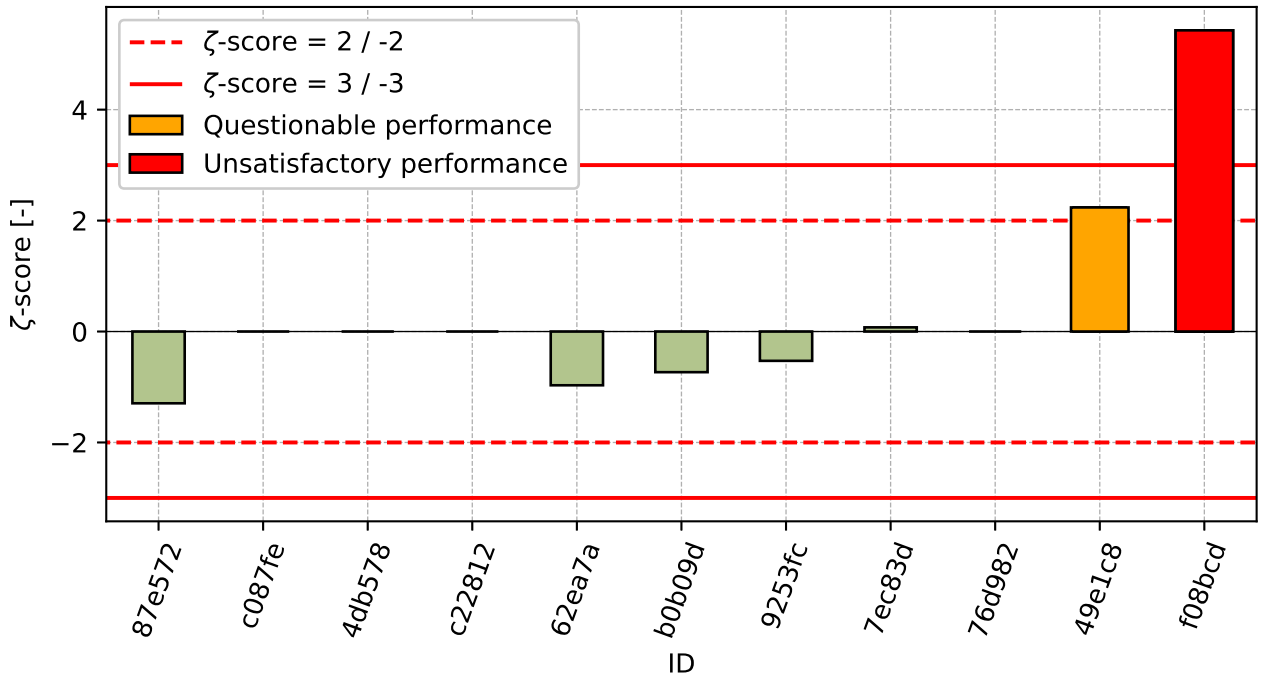


Figure 49: ζ-score

Table 24: $z$-score and $\zeta$-score

| ID | $z$-score [-] | $\zeta$-score [-] |
|---|---|---|
| 87e572 | -0.82 | -1.29 |
| c087fe | -0.67 | - |
| 4db578 | -0.63 | - |
| c22812 | -0.45 | - |
| 62ea7a | -0.38 | -0.97 |
| b0b09d | -0.29 | -0.73 |
| 9253fc | -0.21 | -0.53 |
| 7ec83d | 0.05 | 0.08 |
| 76d982 | 0.91 | - |
| 49e1c8 | 0.91 | 2.24 |
| f08bcd | 2.48 | 5.43 |

# 10 Appendix – EN 12697-8 Determination of void characteristics of bituminous mixtures

## 10.1 Test results

Table 25: Test results - ordered by average value. Outliers are marked by red color. $u_X$ - extended uncertainty of measurement.

| ID | Test results [%] | $u_X$ [%] |
|---|---|---|
| cd3235 | 3.3 | 0.3 |
| f08bcd | 3.9 | - |
| 76d982 | 4.6 | - |
| 81b0e4 | 5.6 | - |
| 49e1c8 | 5.7 | 0.1 |
| 3c68f6 | 7.5 | 1.9 |
| 7ec83d | 7.5 | - |
| b0b09d | 7.7 | 0.4 |
| c087fe | 7.8 | - |
| 4db578 | 7.8 | - |
| 9253fc | 7.9 | 0.6 |
| c22812 | 8.7 | - |
| acb415 | 9.0 | 0.2 |
| 62ea7a | 9.3 | - |
| 3224cf | 17.3 | 1.6 |

## 10.2 The Numerical Procedure for Determining Outliers

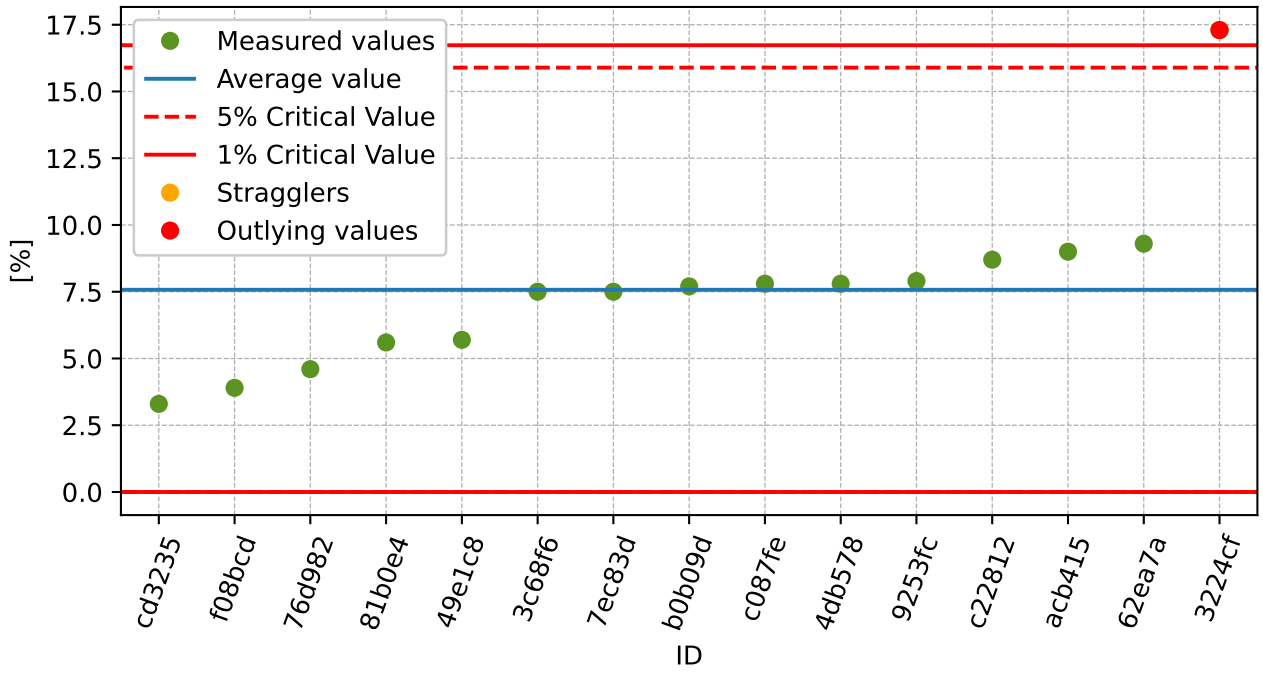


Figure 50: **Grubbs' test** - average values

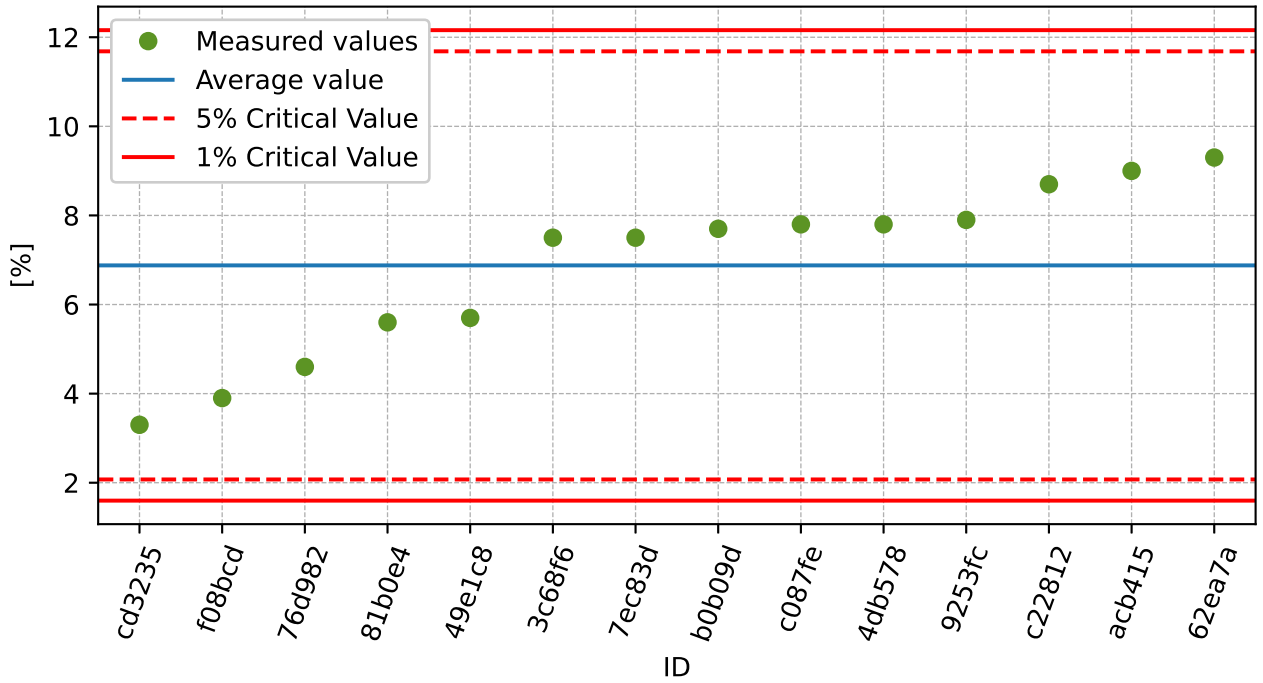


Figure 51: **Grubbs' test** - average values without outliers

## 10.3 Mandel's Statistics

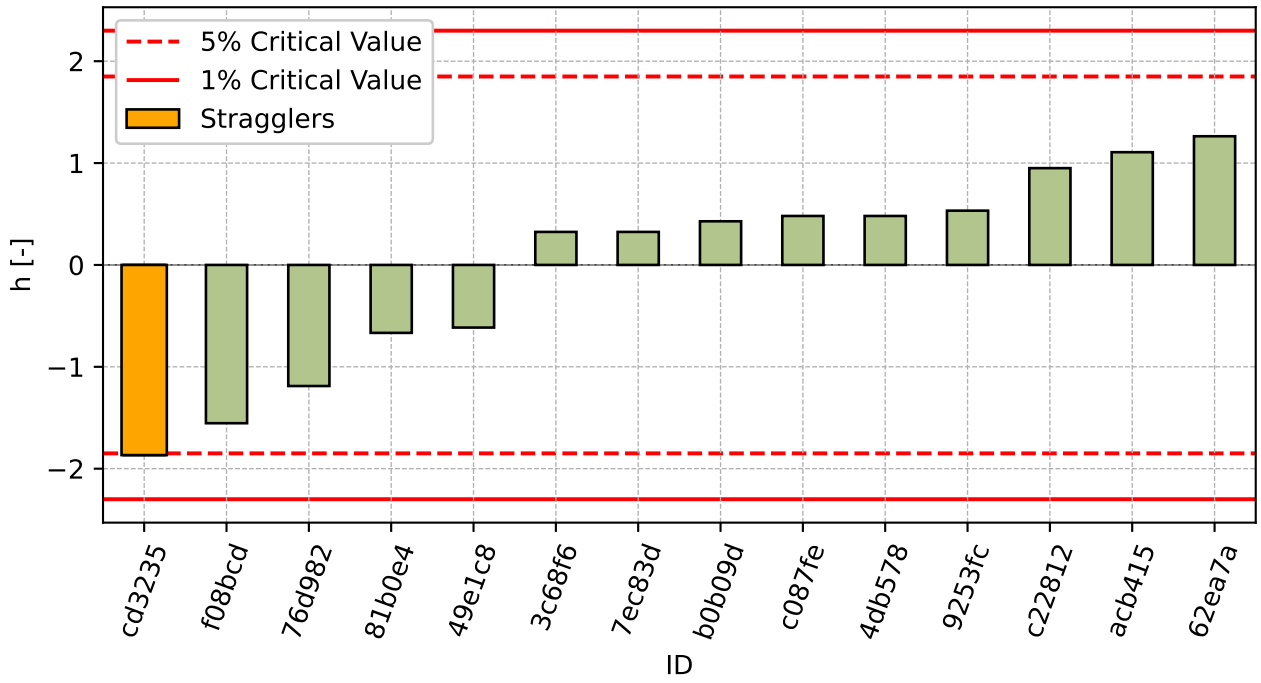


Figure 52: Interlaboratory Consistency Statistic

## 10.4 Descriptive statistics

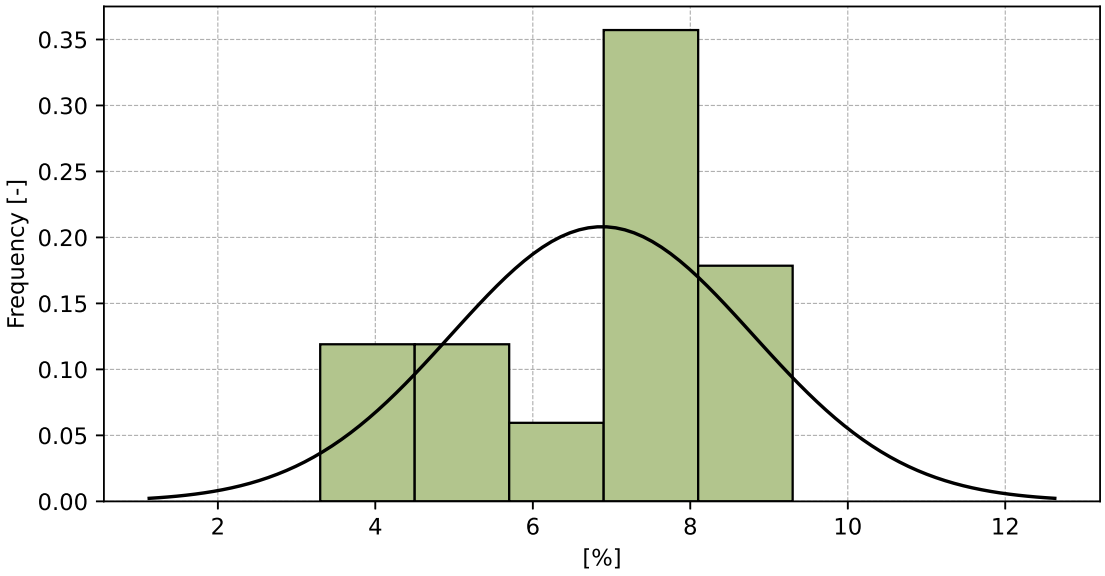


Figure 53: Histogram of all test results

Table 26: Descriptive statistics

| Characteristics | [%] |
|---|---|
| Average value – $\bar{x}$ | 6.9 |
| Sample standard deviation – $s$ | 1.92 |
| Asigned value – $x^*$ | 7.1 |
| Robust standard deviation – $s^*$ | 1.89 |
| Measurement uncertainty of asigned value – $u_X$ | 0.58 |
| $p$-value of normality test | 0.109 [-] |

## 10.5 Evaluation of Performance Statistics

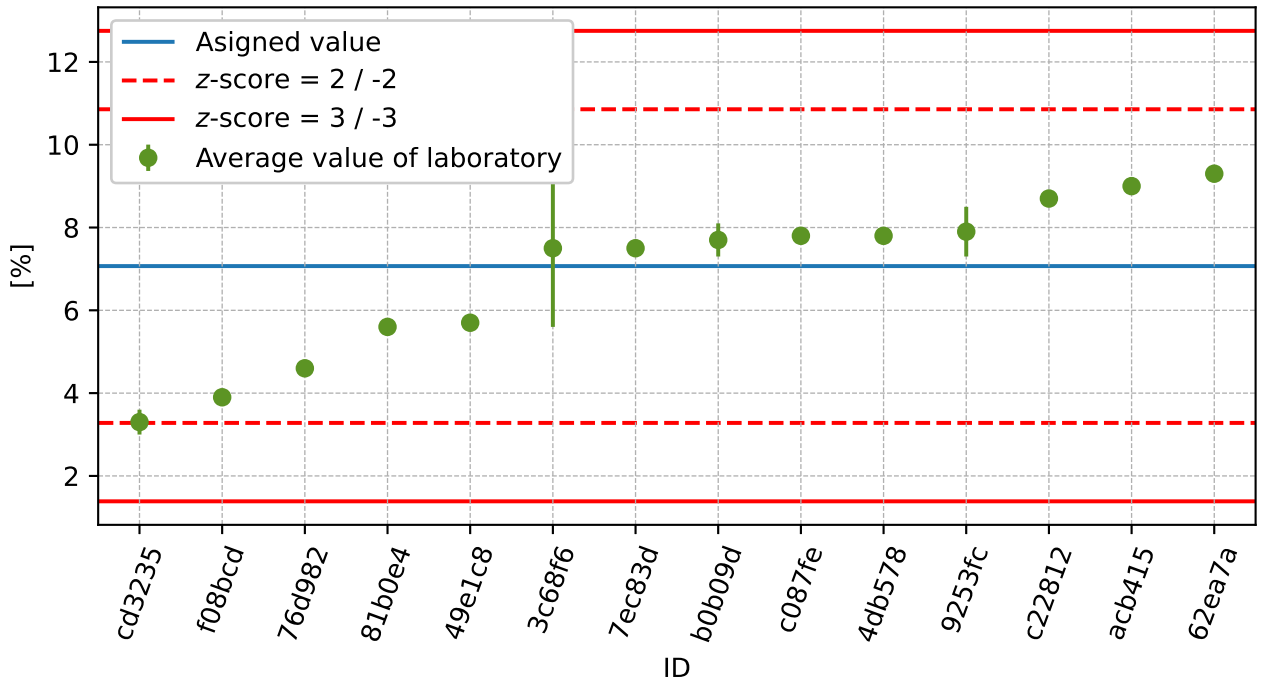


Figure 54: Average values and extended uncertainties of measurement

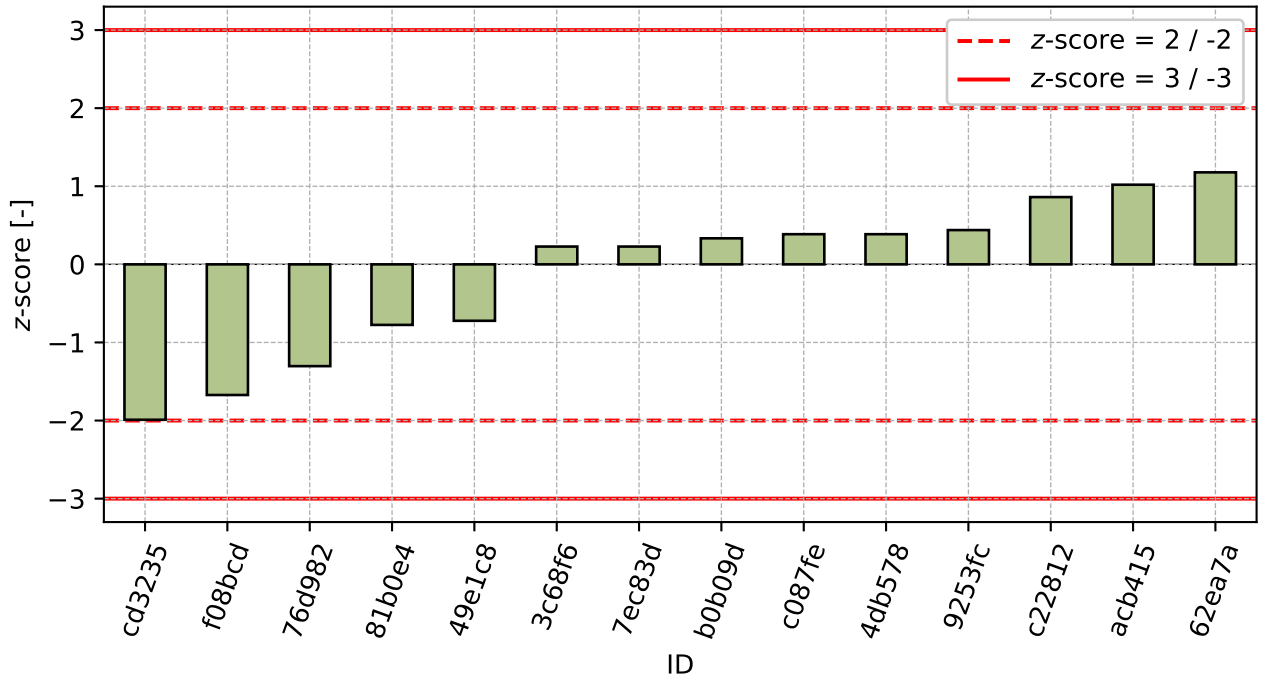


Figure 55: z-score

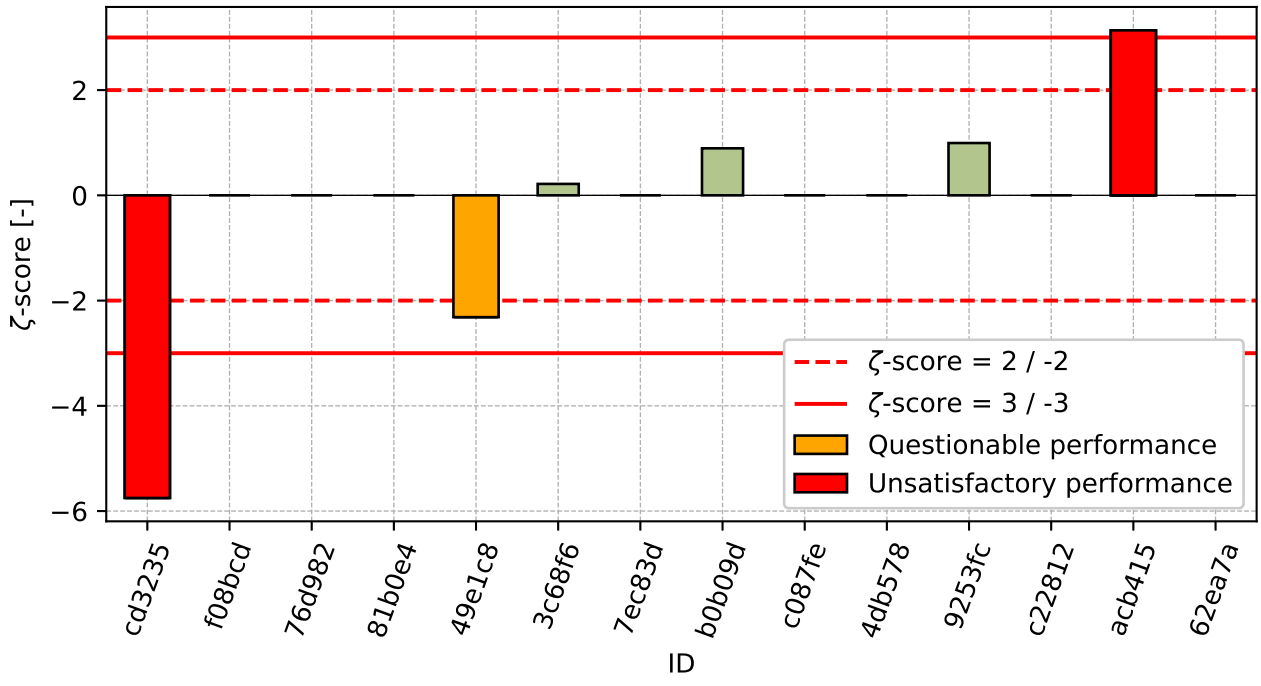


Figure 56: ζ-score

Table 27: $z$-score and $\zeta$-score

| ID | $z$-score [-] | $\zeta$-score [-] |
|---|---|---|
| cd3235 | -1.99 | -5.75 |
| f08bcd | -1.67 | - |
| 76d982 | -1.30 | - |
| 81b0e4 | -0.78 | - |
| 49e1c8 | -0.72 | -2.31 |
| 3c68f6 | 0.23 | 0.22 |
| 7ec83d | 0.23 | - |
| b0b09d | 0.33 | 0.89 |
| c087fe | 0.39 | - |
| 4db578 | 0.39 | - |
| 9253fc | 0.44 | 0.99 |
| c22812 | 0.86 | - |
| acb415 | 1.02 | 3.14 |
| 62ea7a | 1.18 | - |

# 11 Appendix – EN 12697-12, -23 ITSR – Resistance to water sensitivity (Method A)

## 11.1 Mean indirect tensile strength of dry specimens (ITSd)

### 11.1.1 Test results

Table 28: Test results - ordered by average value. Outliers are marked by red color. $u_X$ - extended uncertainty of measurement.

| ID | Test results [%] | $u_X$ [%] |
|---|---|---|
| cd3235 | 677.0 | 80.0 |
| 49e1c8 | 1030.0 | 127.0 |
| aa6fd2 | 1190.3 | 36.0 |
| c9849a | 1196.4 | 9.2 |
| de68ea | 1374.9 | 41.5 |
| a7b1c1 | 1448.0 | 65.0 |
| 10cca9 | 1619.7 | - |
| 84a75d | 1645.0 | 260.0 |

### 11.1.2 The Numerical Procedure for Determining Outliers

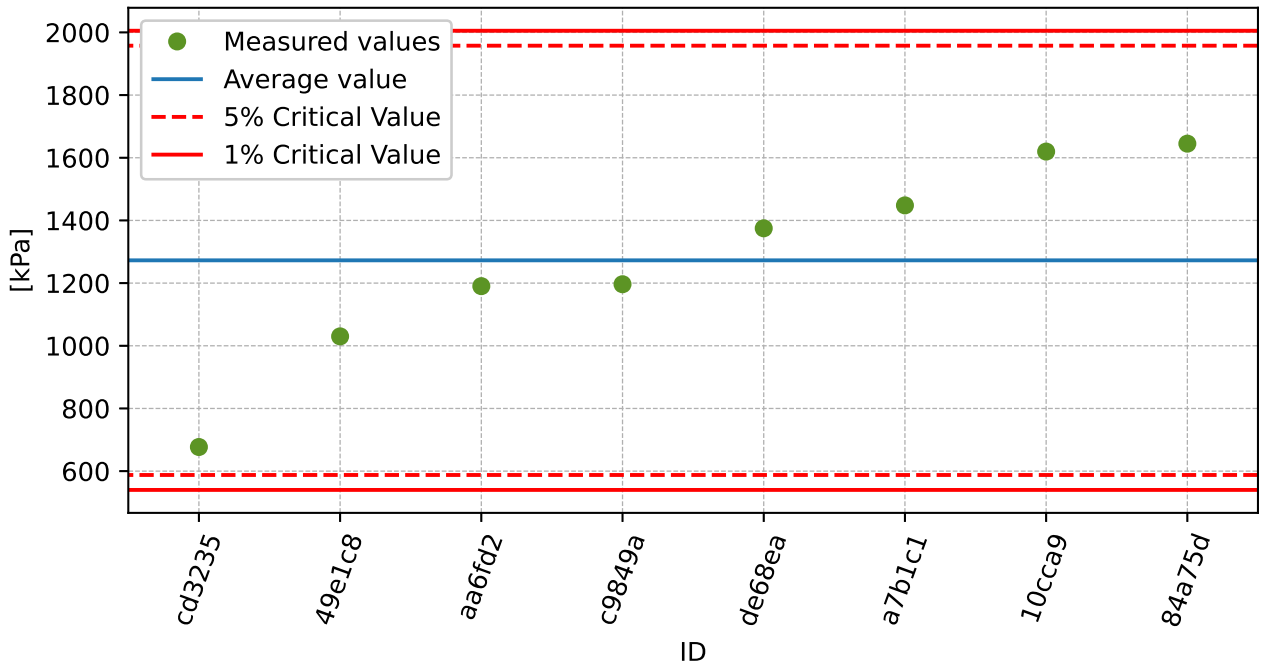


Figure 57: **Grubbs' test** - average values

### 11.1.3 Mandel's Statistics

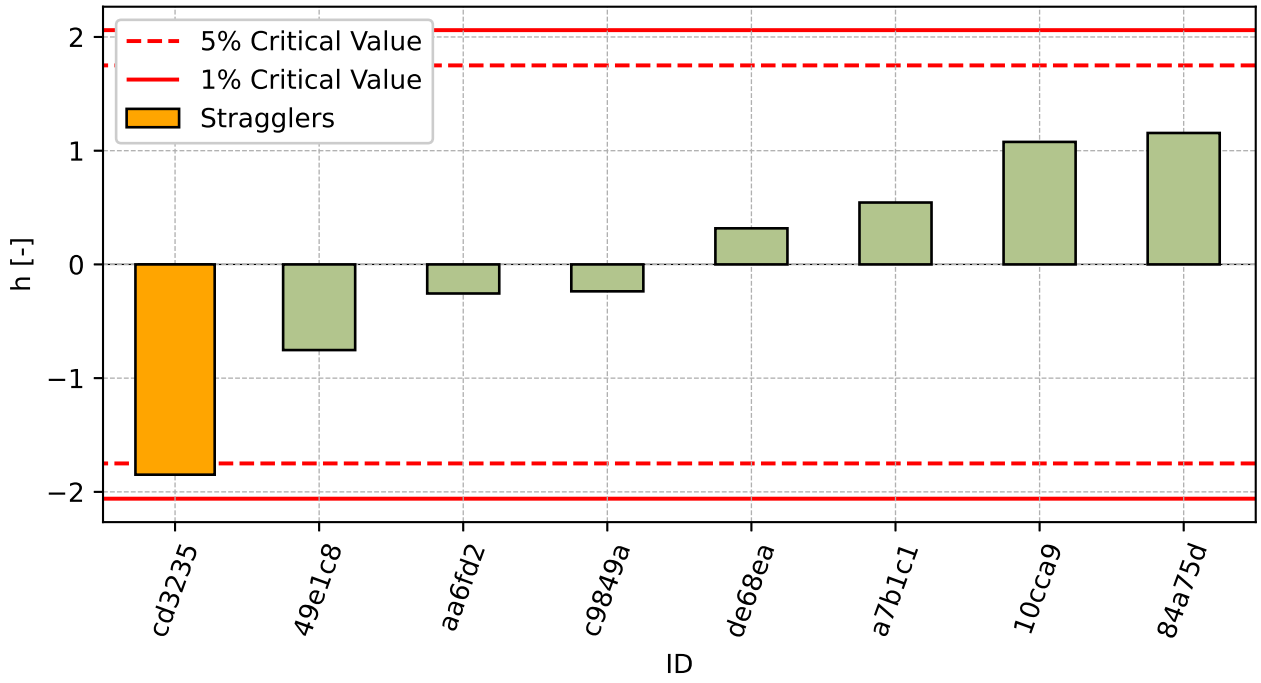


Figure 58: Interlaboratory Consistency Statistic

### 11.1.4 Descriptive statistics

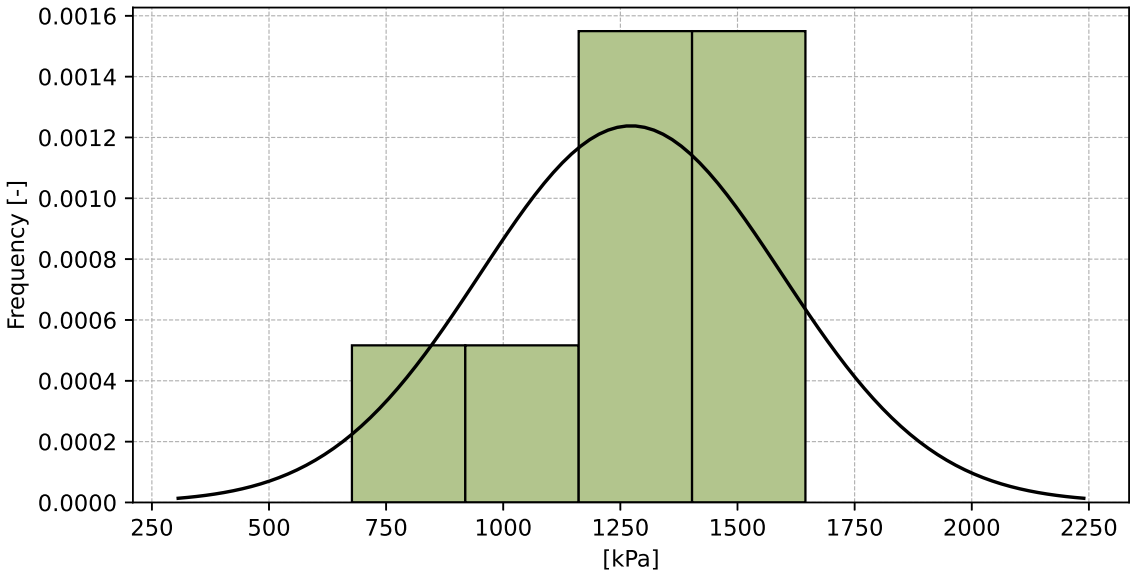


Figure 59: Histogram of all test results

Table 29: Descriptive statistics

| Characteristics | [%] |
|---|---|
| Average value – $\bar{x}$ | 1272.7 |
| Sample standard deviation – $s$ | 322.17 |
| Asigned value – $x^*$ | 1294.2 |
| Robust standard deviation – $s^*$ | 296.61 |
| Measurement uncertainty of asigned value – $u_X$ | 131.08 |
| $p$-value of normality test | 0.634 [-] |

### 11.1.5 Evaluation of Performance Statistics

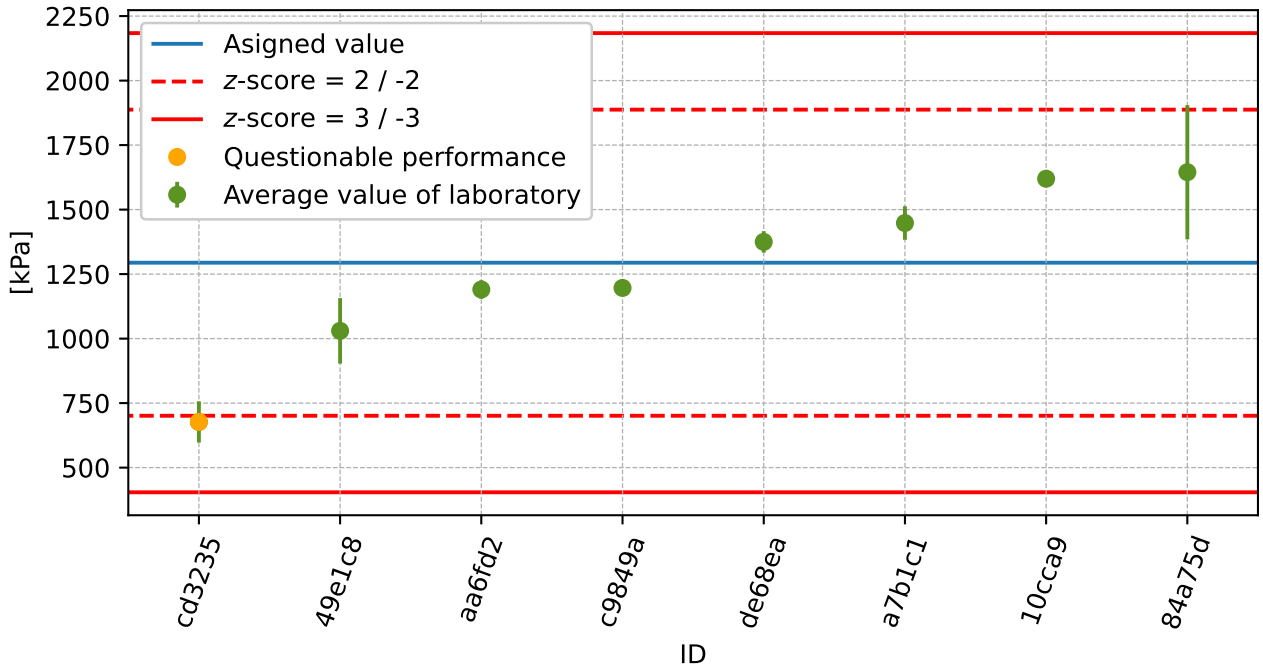


Figure 60: Average values and extended uncertainties of measurement

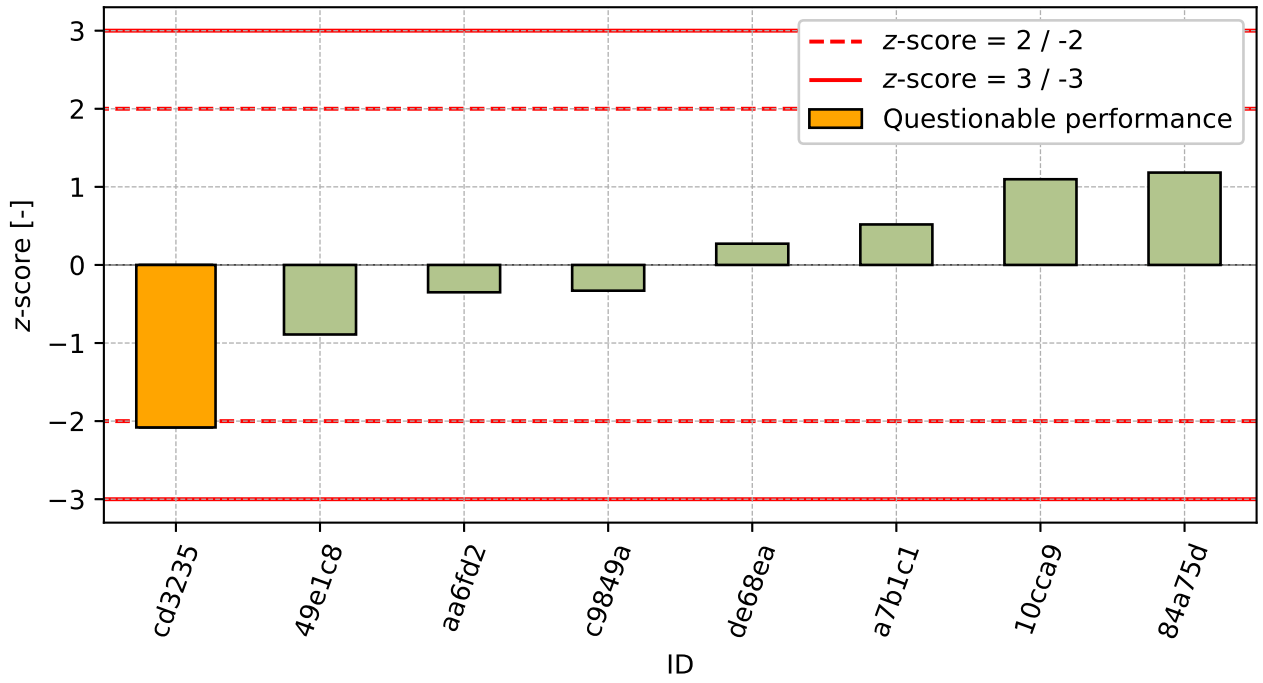


Figure 61: z-score

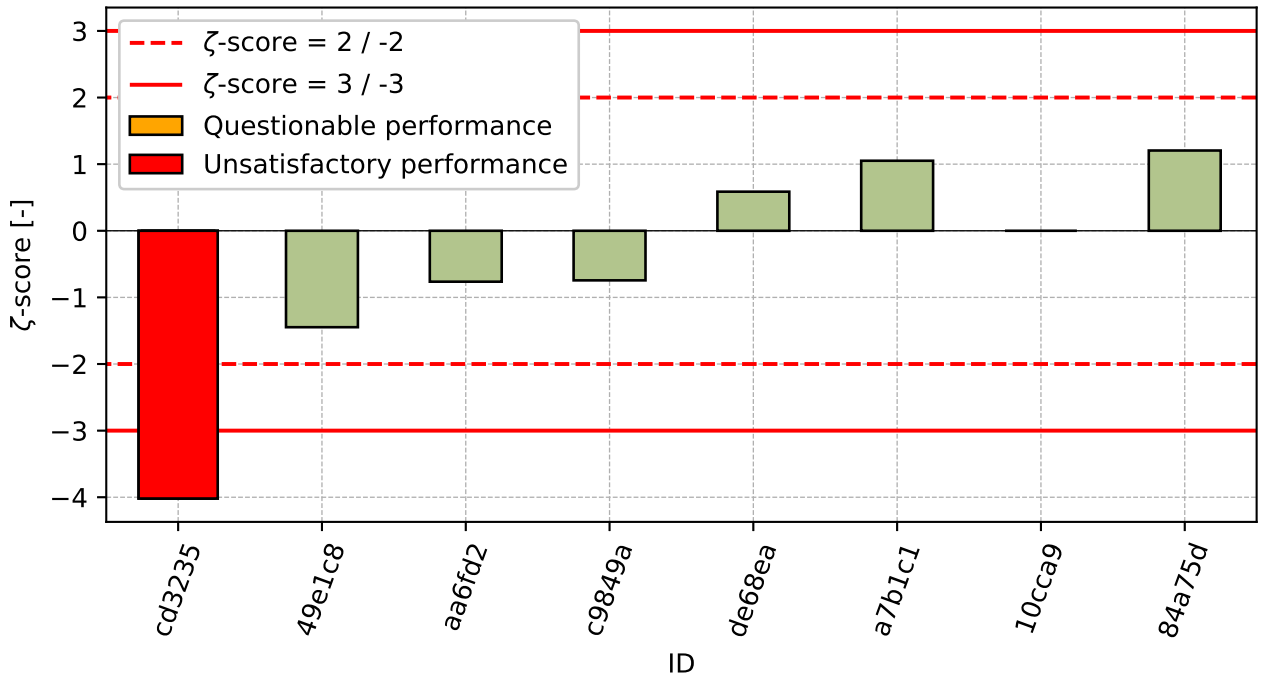


Figure 62: ζ-score

Table 30: $z$-score and $\zeta$-score

| ID | $z$-score [-] | $\zeta$-score [-] |
|---|---|---|
| cd3235 | -2.08 | -4.02 |
| 49e1c8 | -0.89 | -1.45 |
| aa6fd2 | -0.35 | -0.76 |
| c9849a | -0.33 | -0.74 |
| de68ea | 0.27 | 0.59 |
| a7b1c1 | 0.52 | 1.05 |
| 10cca9 | 1.10 | - |
| 84a75d | 1.18 | 1.20 |

## 11.2 Mean indirect tensile strength of wet specimens (ITSw)

### 11.2.1 Test results

Table 31: Test results - ordered by average value. Outliers are marked by red color. $u_X$ - extended uncertainty of measurement.

| ID | Test results [kPa] | $u_X$ [kPa] |
|---|---|---|
| cd3235 | 633.0 | 80.0 |
| 49e1c8 | 922.0 | 105.0 |
| c9849a | 963.8 | 7.8 |
| aa6fd2 | 1034.9 | 31.0 |
| 10cca9 | 1318.8 | - |
| a7b1c1 | 1351.0 | 65.0 |
| 84a75d | 1419.0 | 360.0 |
| de68ea | 1534.7 | 41.5 |

### 11.2.2 The Numerical Procedure for Determining Outliers

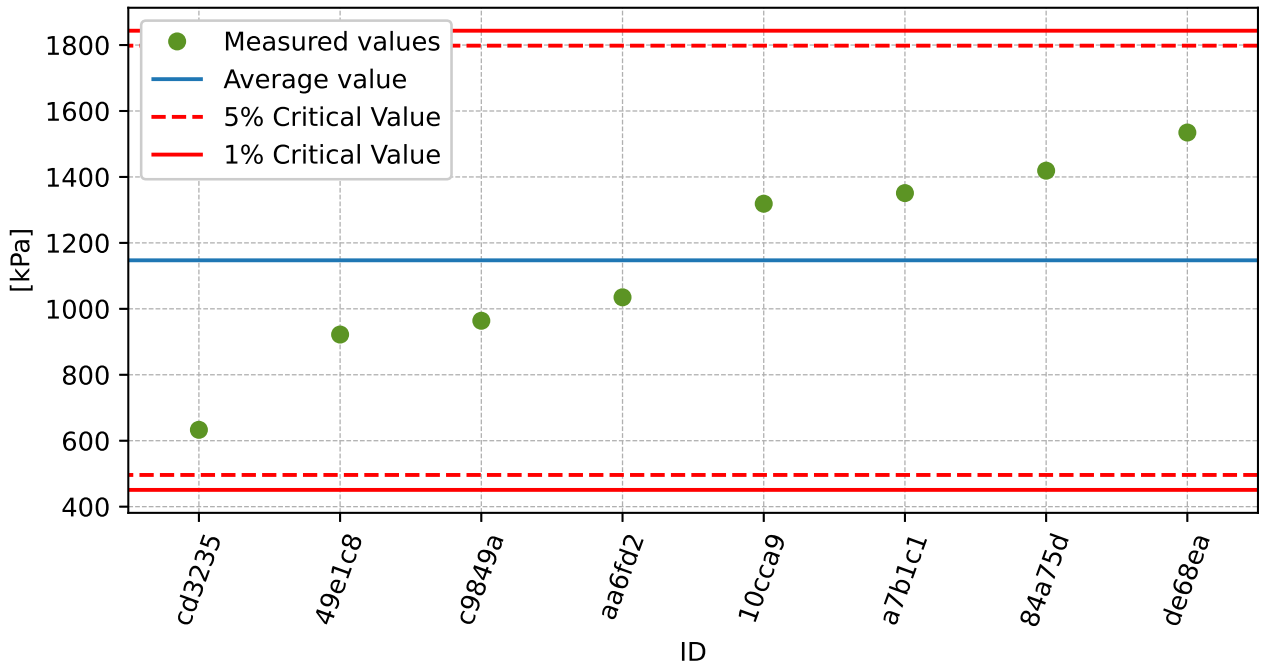


Figure 63: **Grubbs' test** - average values

### 11.2.3 Mandel's Statistics

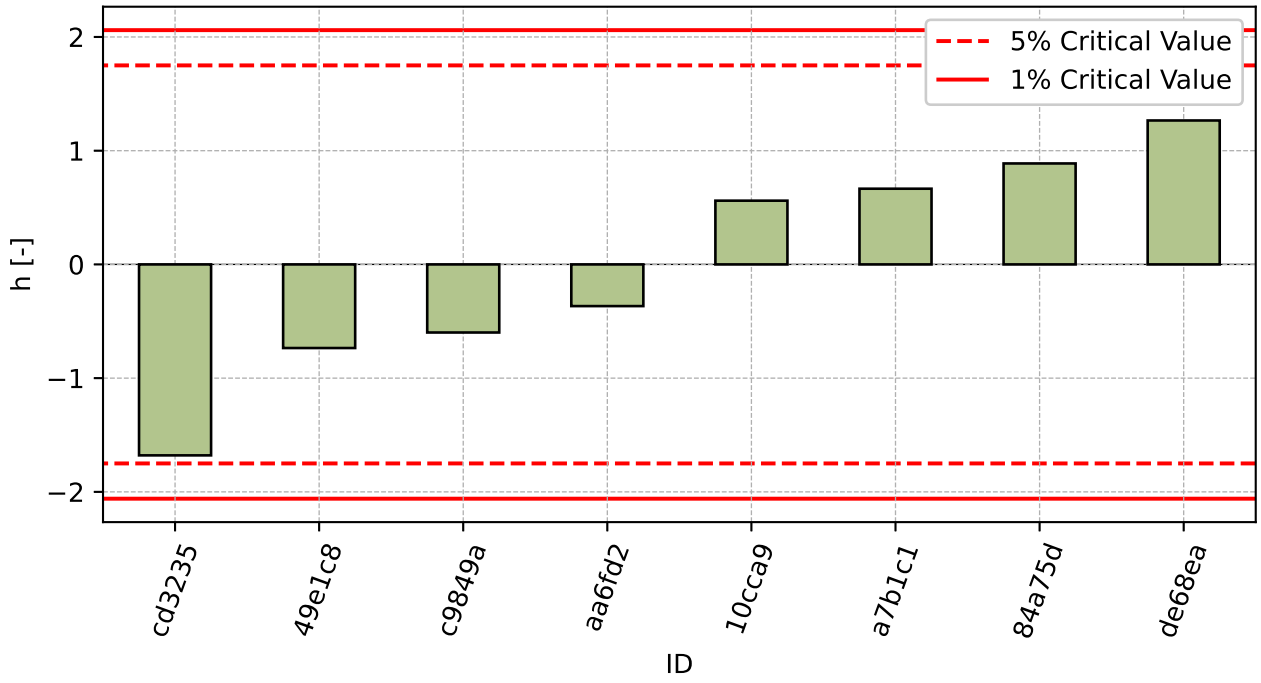


Figure 64: Interlaboratory Consistency Statistic

### 11.2.4 Descriptive statistics

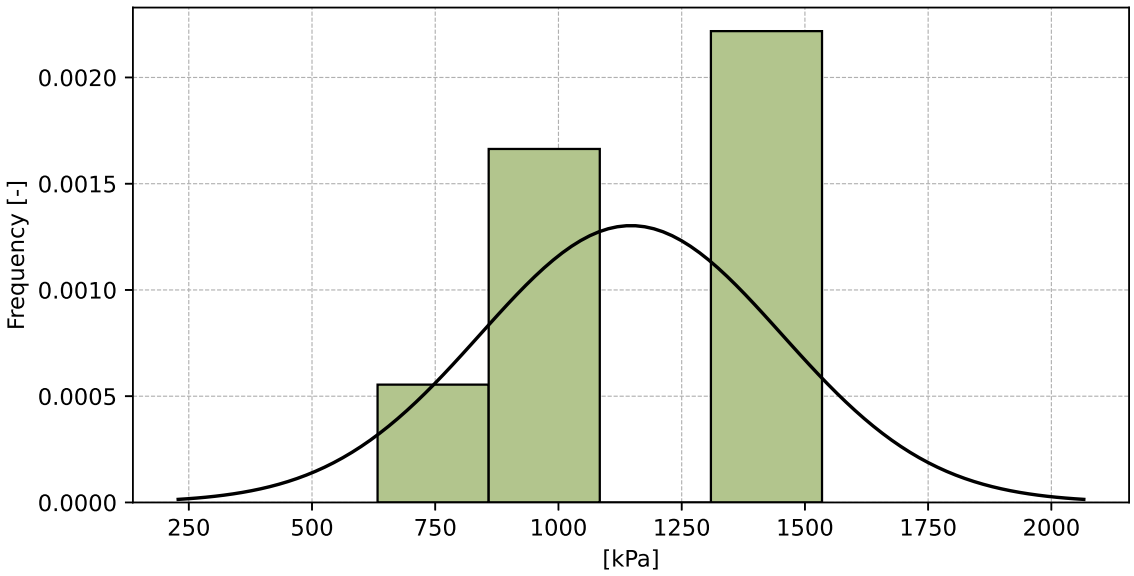


Figure 65: Histogram of all test results

Table 32: Descriptive statistics

| Characteristics | [kPa] |
|---|---|
| Average value – $\bar{x}$ | 1147.1 |
| Sample standard deviation – $s$ | 306.21 |
| Asigned value – $x^*$ | 1153.8 |
| Robust standard deviation – $s^*$ | 311.56 |
| Measurement uncertainty of asigned value – $u_X$ | 137.69 |
| $p$-value of normality test | 0.638 [-] |

### 11.2.5 Evaluation of Performance Statistics

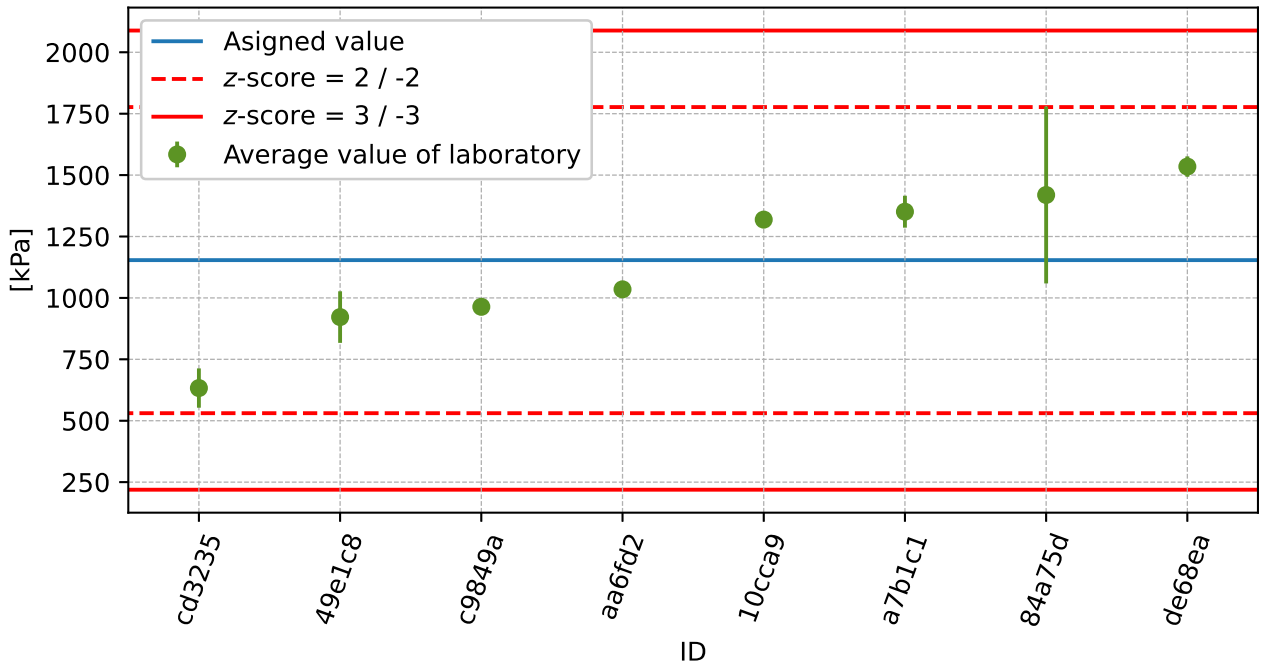


Figure 66: Average values and extended uncertainties of measurement

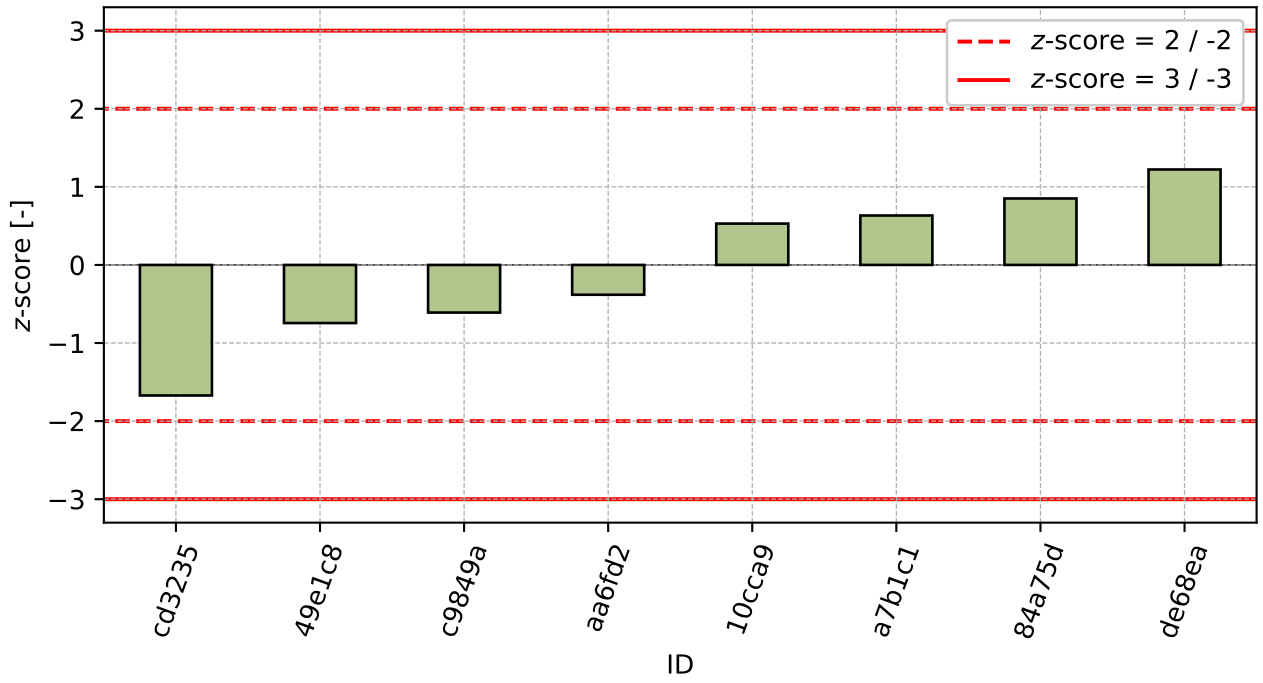


Figure 67: z-score

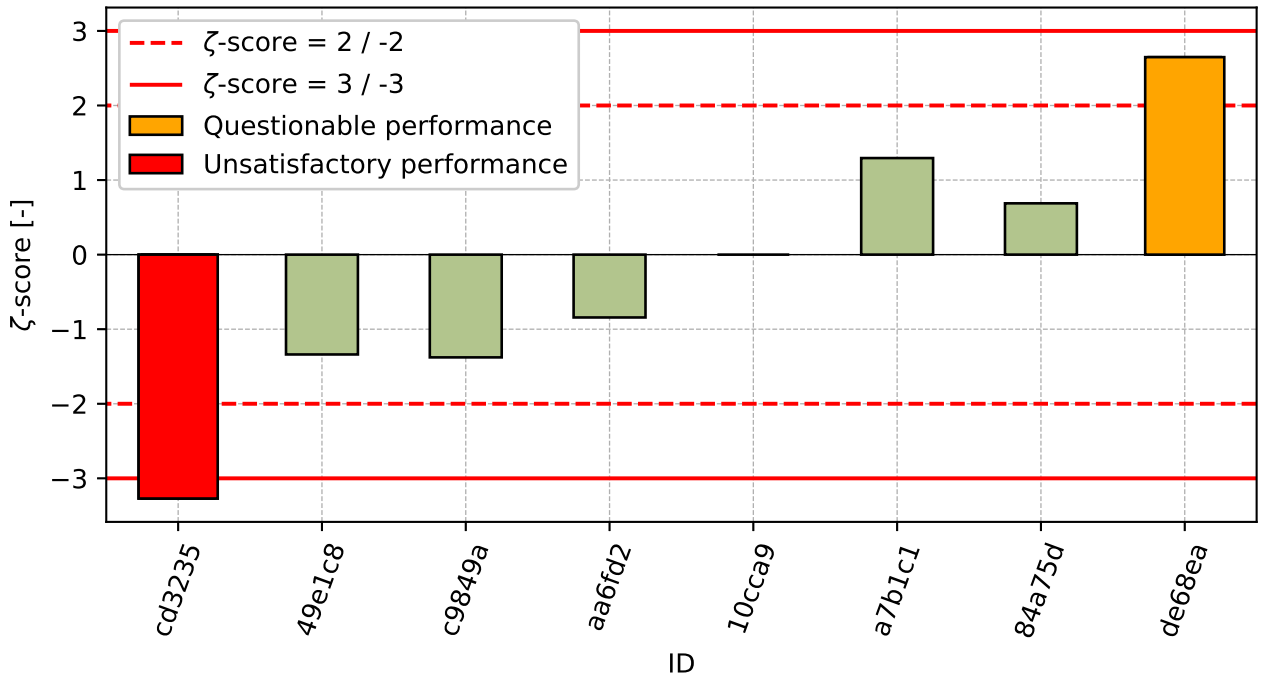


Figure 68: ζ-score

Table 33: $z$-score and $\zeta$-score

| ID | $z$-score [-] | $\zeta$-score [-] |
|---|---|---|
| cd3235 | -1.67 | -3.27 |
| 49e1c8 | -0.74 | -1.34 |
| c9849a | -0.61 | -1.38 |
| aa6fd2 | -0.38 | -0.84 |
| 10cca9 | 0.53 | - |
| a7b1c1 | 0.63 | 1.29 |
| 84a75d | 0.85 | 0.69 |
| de68ea | 1.22 | 2.65 |

## 11.3 ITSR

### 11.3.1 Test results

Table 34: Test results - ordered by average value. Outliers are marked by red color. $u_X$ - extended uncertainty of measurement.

| ID | Test results [%] | $u_X$ [%] |
|---|---|---|
| c9849a | 80.6 | 1.5 |
| 10cca9 | 81.0 | - |
| 84a75d | 86.0 | 6.8 |
| aa6fd2 | 86.9 | 3.0 |
| 49e1c8 | 90.0 | 108.0 |
| a7b1c1 | 93.3 | 4.5 |
| cd3235 | 93.5 | - |
| de68ea | 111.6 | 34.3 |

### 11.3.2 The Numerical Procedure for Determining Outliers

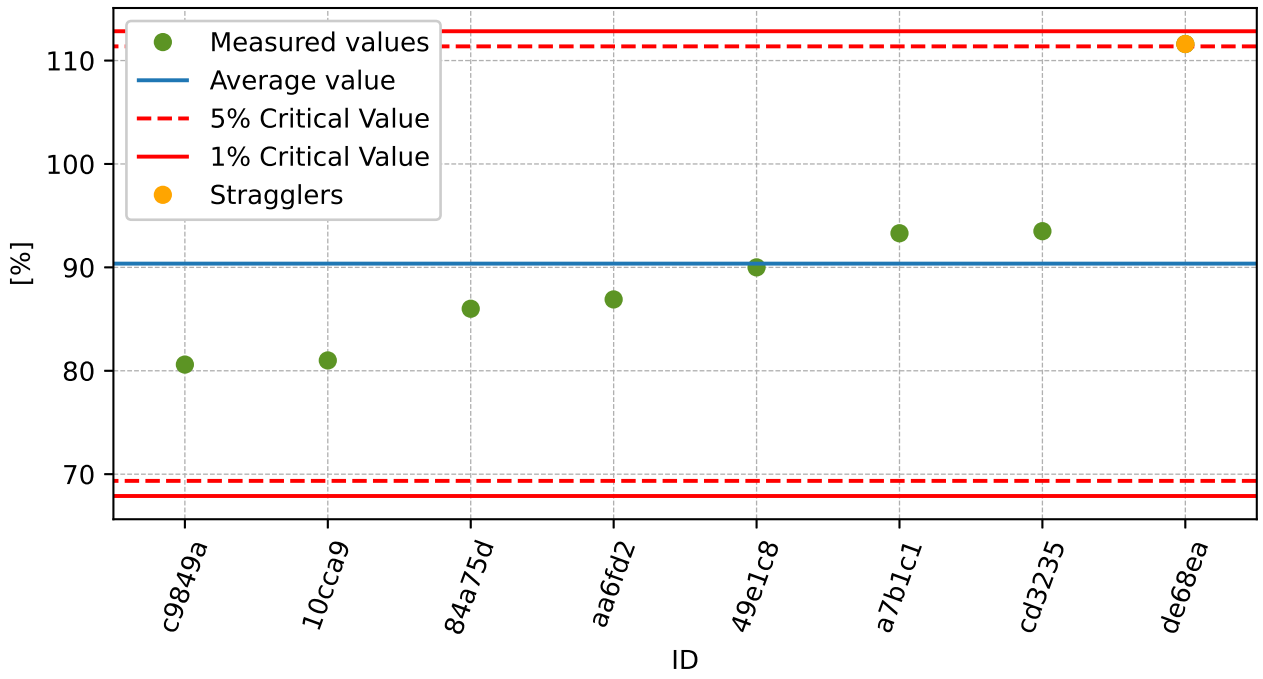


Figure 69: **Grubbs' test** - average values

### 11.3.3 Mandel's Statistics

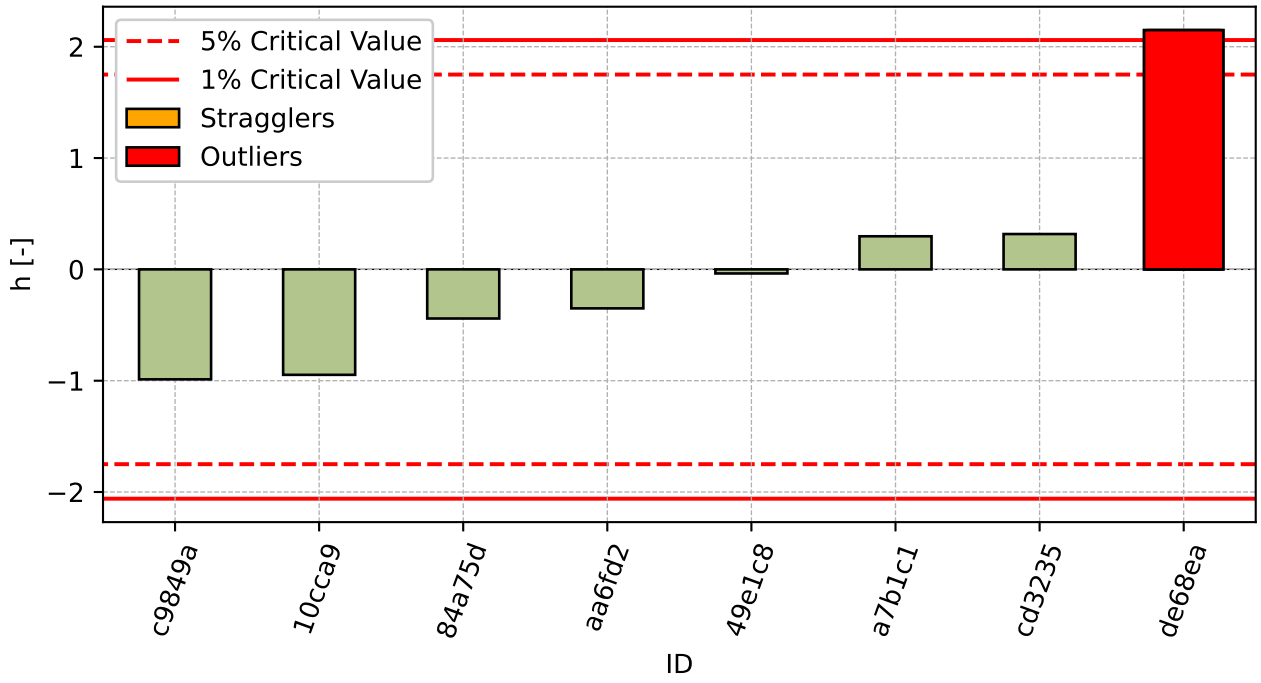


Figure 70: Interlaboratory Consistency Statistic

### 11.3.4 Descriptive statistics

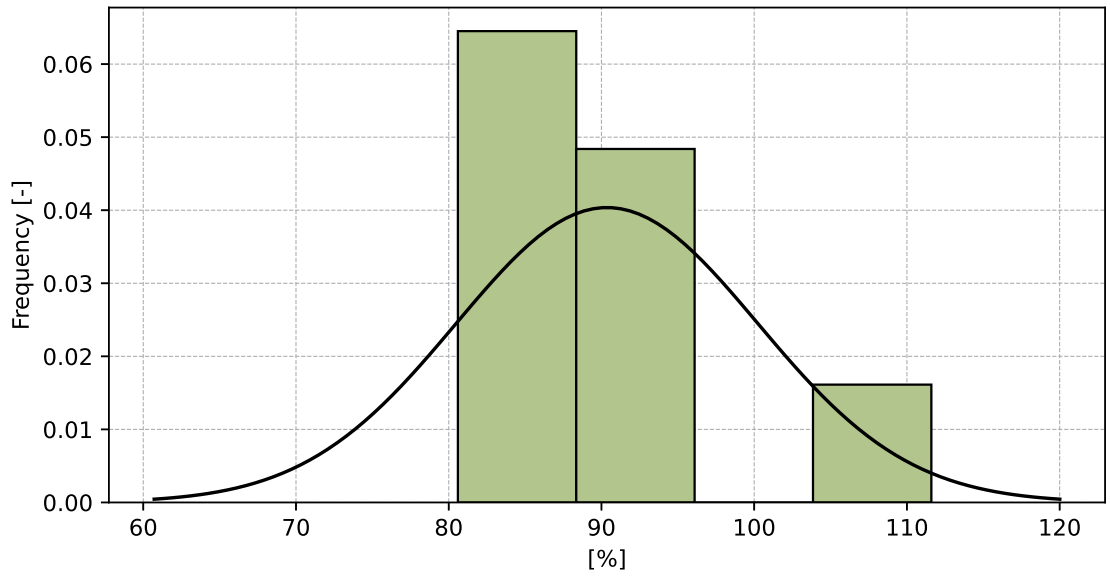


Figure 71: Histogram of all test results

Table 35: Descriptive statistics

| Characteristics | [%] |
|---|---|
| Average value – $\bar{x}$ | 90.4 |
| Sample standard deviation – $s$ | 9.88 |
| Asigned value – $x^*$ | 90.4 |
| Robust standard deviation – $s^*$ | 10.68 |
| Measurement uncertainty of asigned value – $u_X$ | 4.63 |
| $p$-value of normality test | 0.105 [-] |

### 11.3.5 Evaluation of Performance Statistics

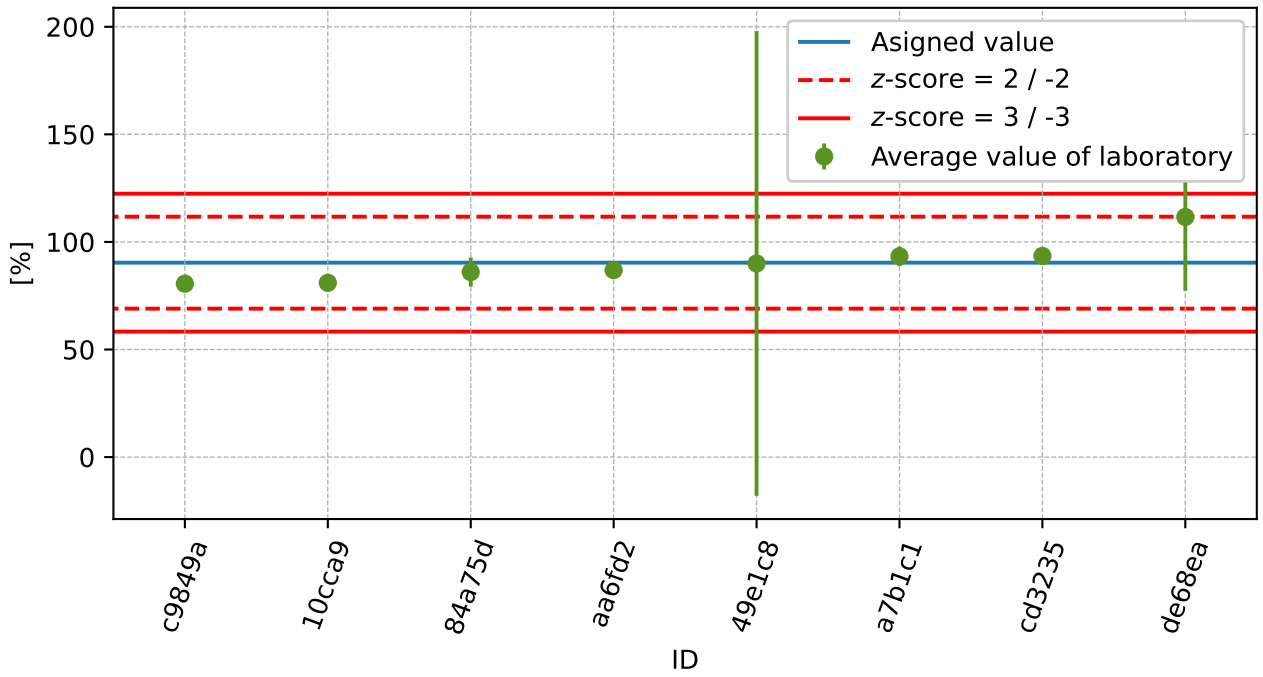


Figure 72: Average values and extended uncertainties of measurement

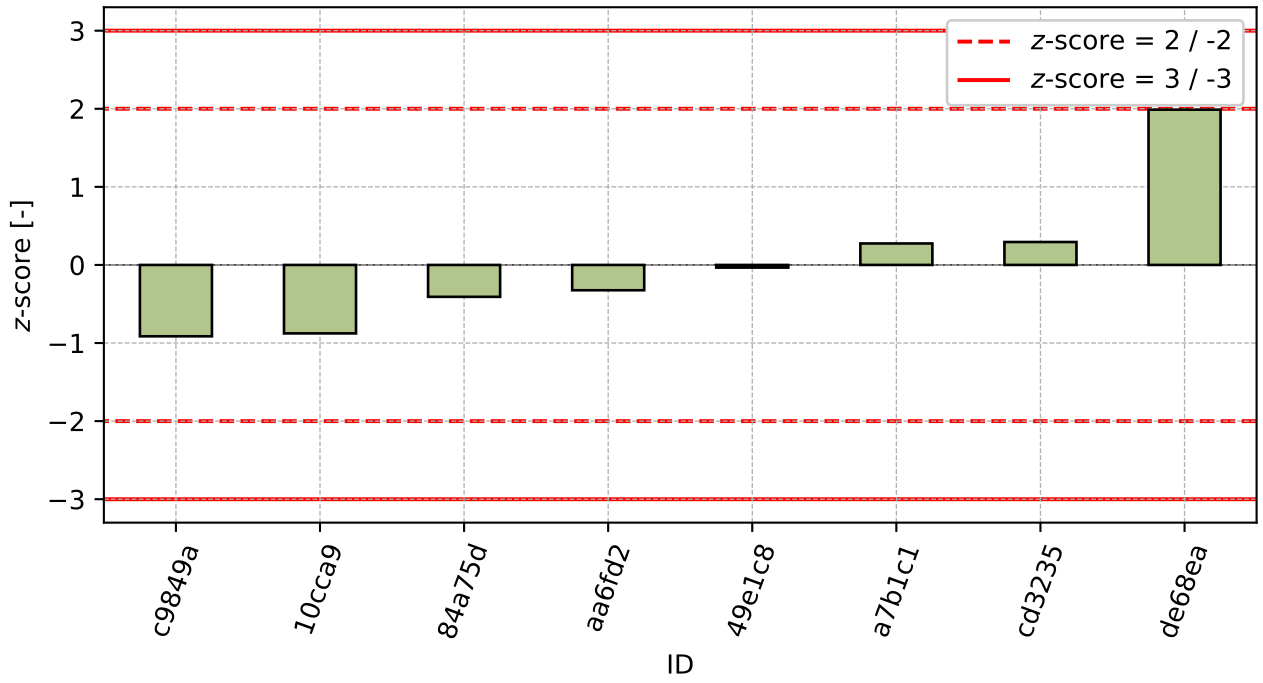


Figure 73: z-score

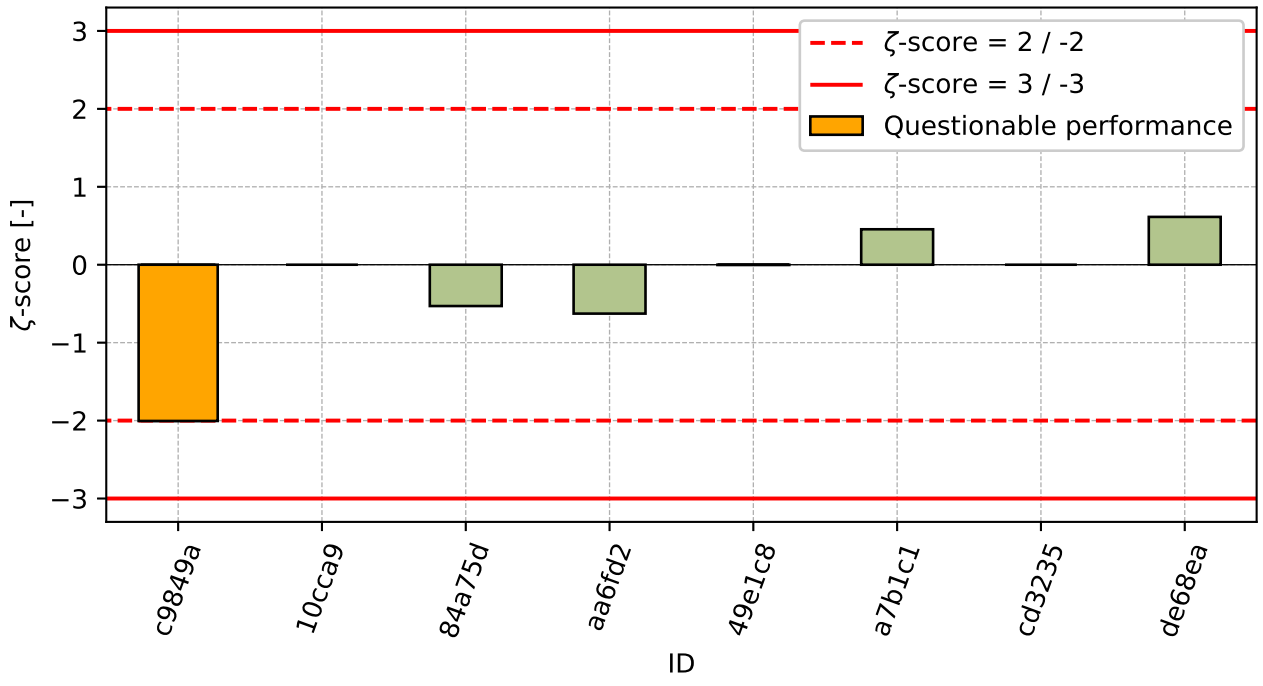


Figure 74: ζ-score

Table 36: $z$-score and $\zeta$-score

| ID | $z$-score [-] | $\zeta$-score [-] |
|---|---|---|
| c9849a | -0.91 | -2.00 |
| 10cca9 | -0.88 | - |
| 84a75d | -0.41 | -0.53 |
| aa6fd2 | -0.32 | -0.63 |
| 49e1c8 | -0.03 | -0.00 |
| a7b1c1 | 0.27 | 0.45 |
| cd3235 | 0.29 | - |
| de68ea | 1.99 | 0.61 |

# 12 Appendix – EN 12697-18 Determination of binder drainage – Beaker method

## 12.1 Test results

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

| ID | Test results [%] | | $u_X$ [%] | $\bar{x}$ [%] | $s_0$ [%] | $V_X$ [%] |
|---|---|---|---|---|---|---|
| 671d46 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3c68f6 | 0.01 | 0.03 | 0.01 | 0.02 | 0.014 | 70.71 |
| aa6fd2 | 0.06 | 0.02 | 0.01 | 0.04 | 0.028 | 70.71 |
| 49e1c8 | 0.05 | 0.04 | 0.01 | 0.04 | 0.007 | 15.71 |
| 10cca9 | 0.04 | 0.06 | - | 0.05 | 0.014 | 28.28 |
| de68ea | 0.06 | 0.04 | 0.02 | 0.05 | 0.014 | 28.28 |
| d91cf1 | 0.1 | 0.03 | - | 0.07 | 0.049 | 76.15 |
| b0b09d | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| a7b1c1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |

## 12.2 The Numerical Procedure for Determining Outliers

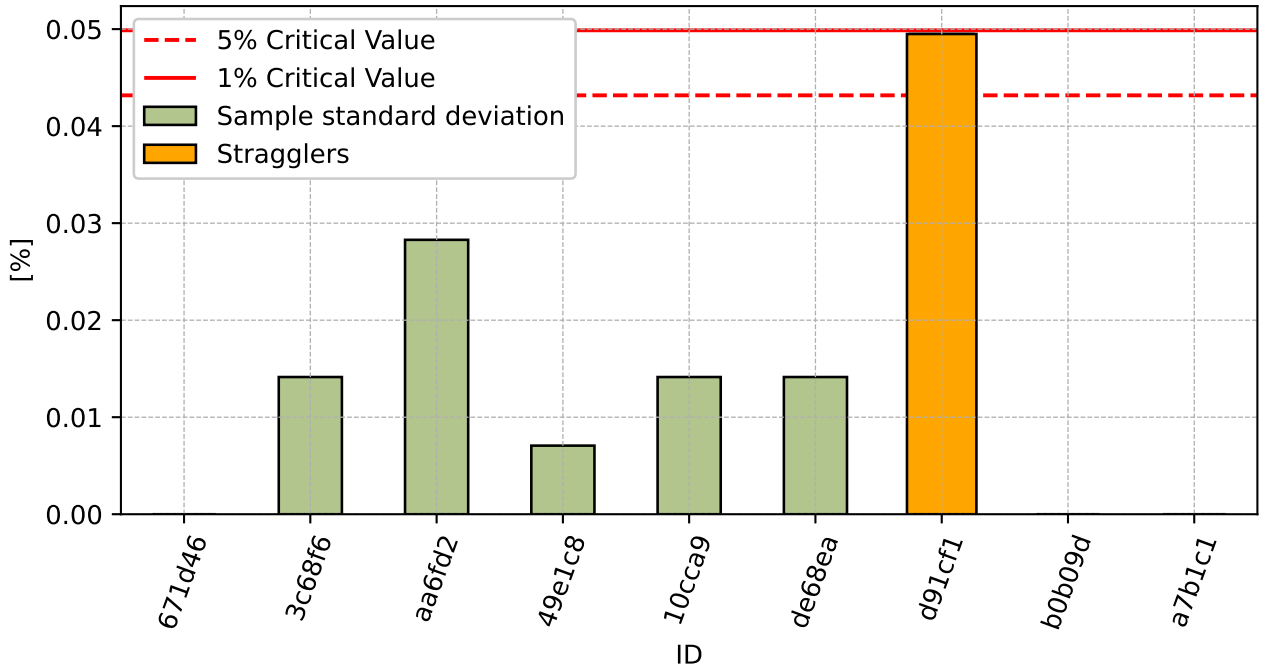


Figure 75: **Cochran's test** - sample standard deviations

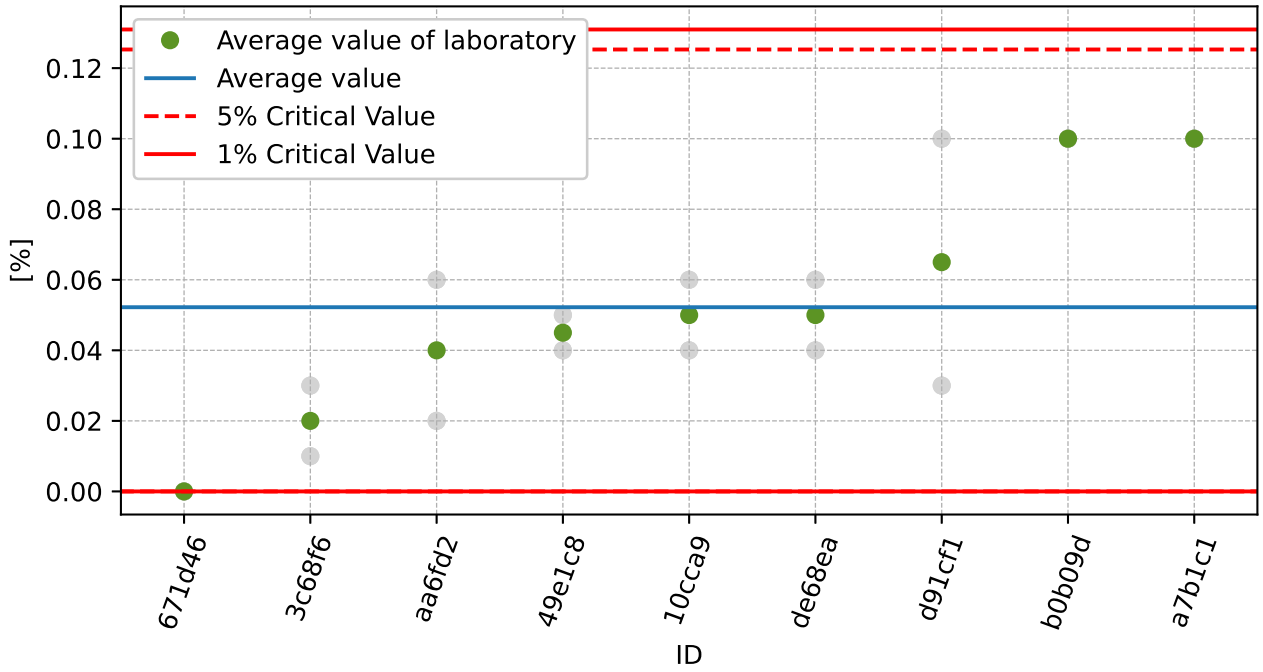


Figure 76: **Grubbs' test** - average values

## 12.3 Mandel's Statistics

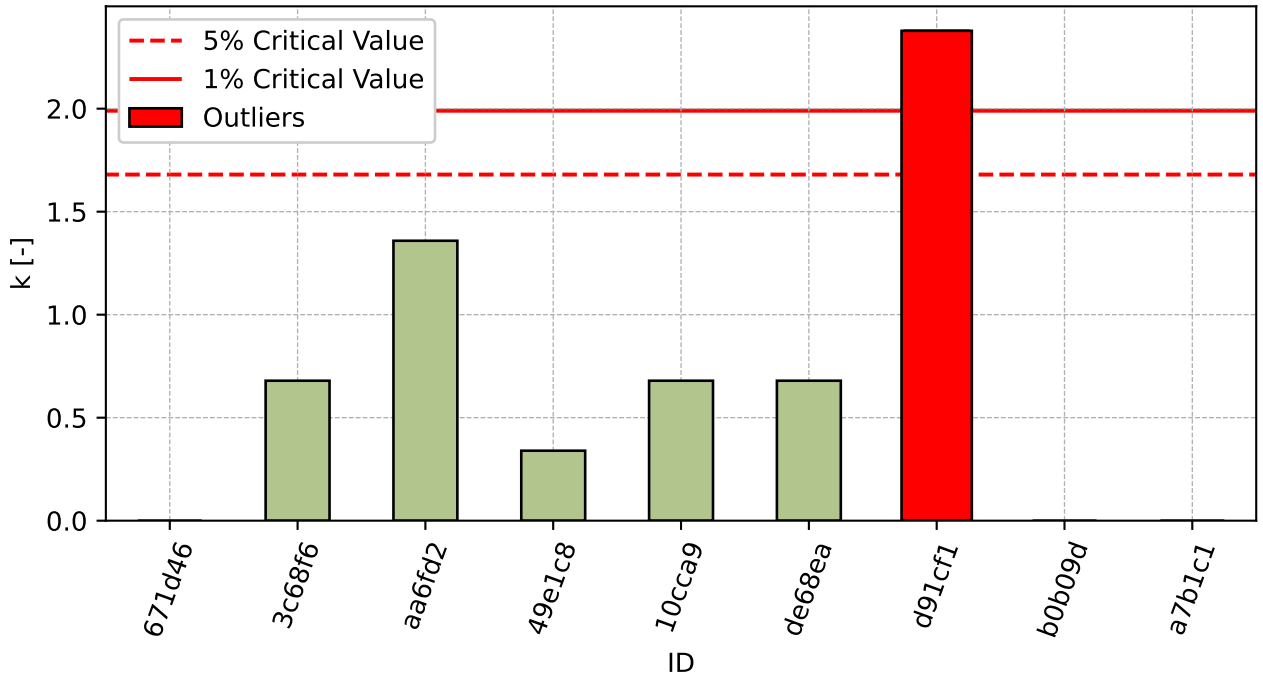


Figure 77: Intralaboratory Consistency Statistic

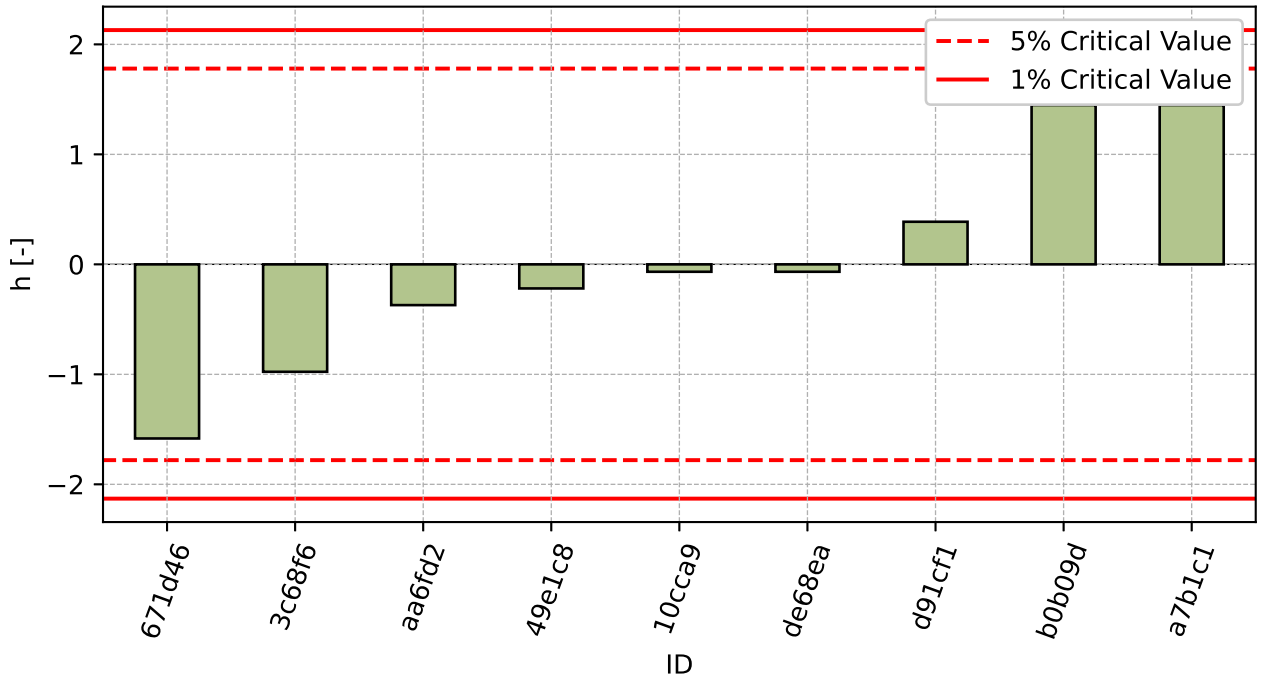


Figure 78: Interlaboratory Consistency Statistic

## 12.4 Descriptive statistics

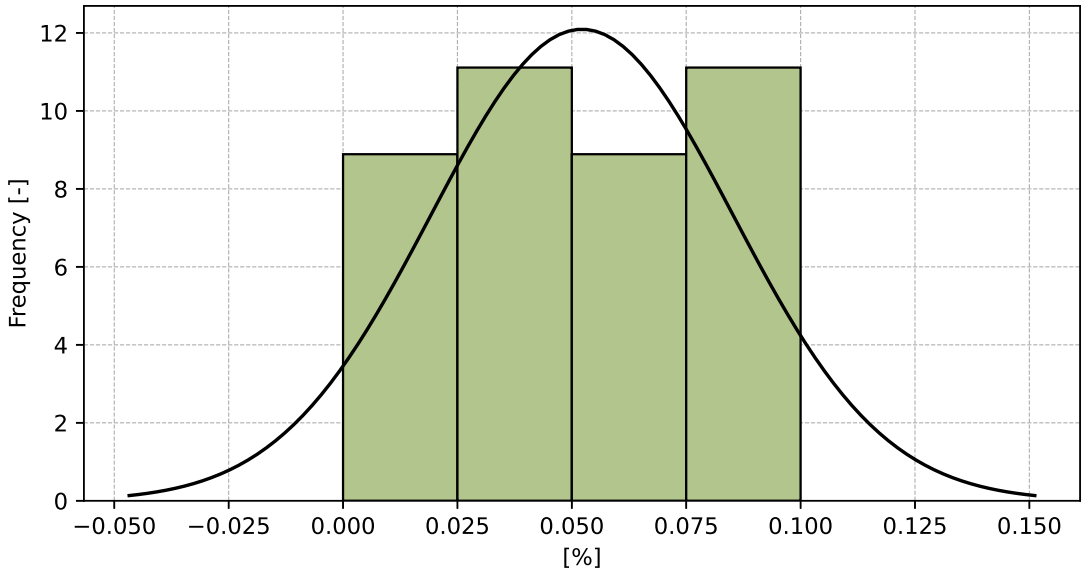


Figure 79: Histogram of all test results

Table 38: Descriptive statistics

| Characteristics | [%] |
|---|---|
| Average value – $\bar{x}$ | 0.05 |
| Sample standard deviation – $s$ | 0.033 |
| Asigned value – $x^*$ | 0.05 |
| Robust standard deviation – $s^*$ | 0.029 |
| Measurement uncertainty of asigned value – $u_X$ | 0.012 |
| $p$-value of normality test | 0.047 [-] |
| Interlaboratory standard deviation – $s_L$ | 0.03 |
| Repeatability standard deviation – $s_r$ | 0.021 |
| Reproducibility standard deviation – $s_R$ | 0.036 |
| Repeatability – $r$ | 0.06 |
| Reproducibility – $R$ | 0.1 |

## 12.5 Evaluation of Performance Statistics

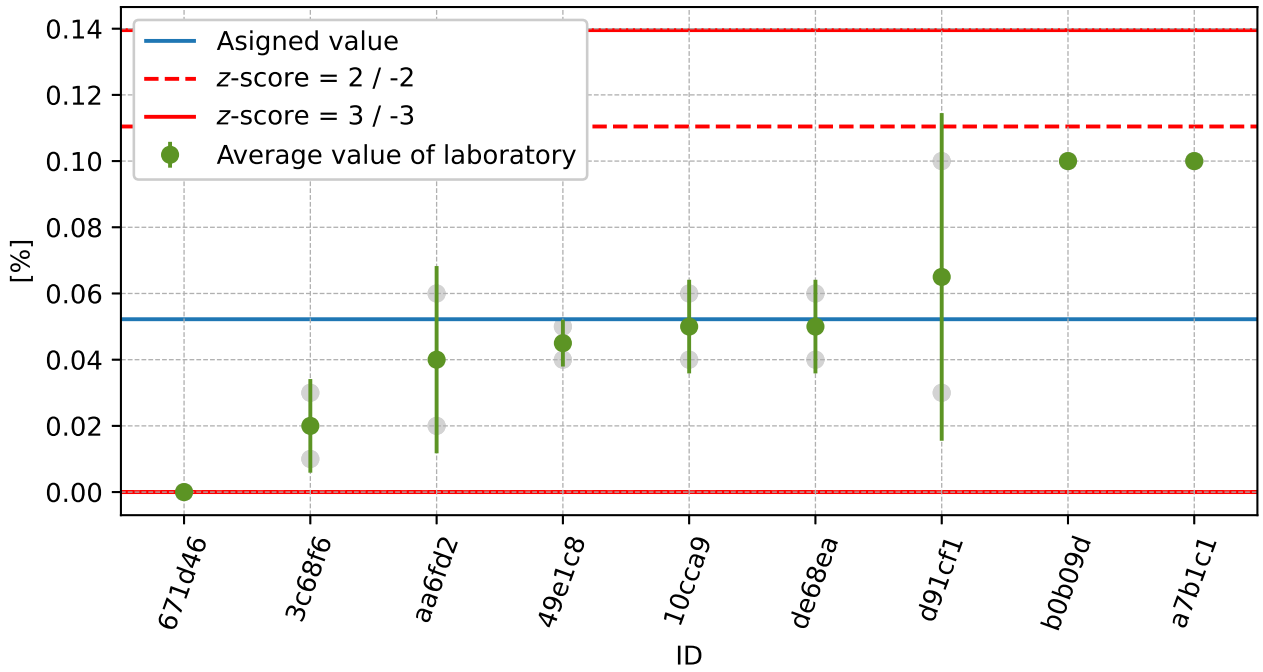


Figure 80: Average values and sample standard deviations

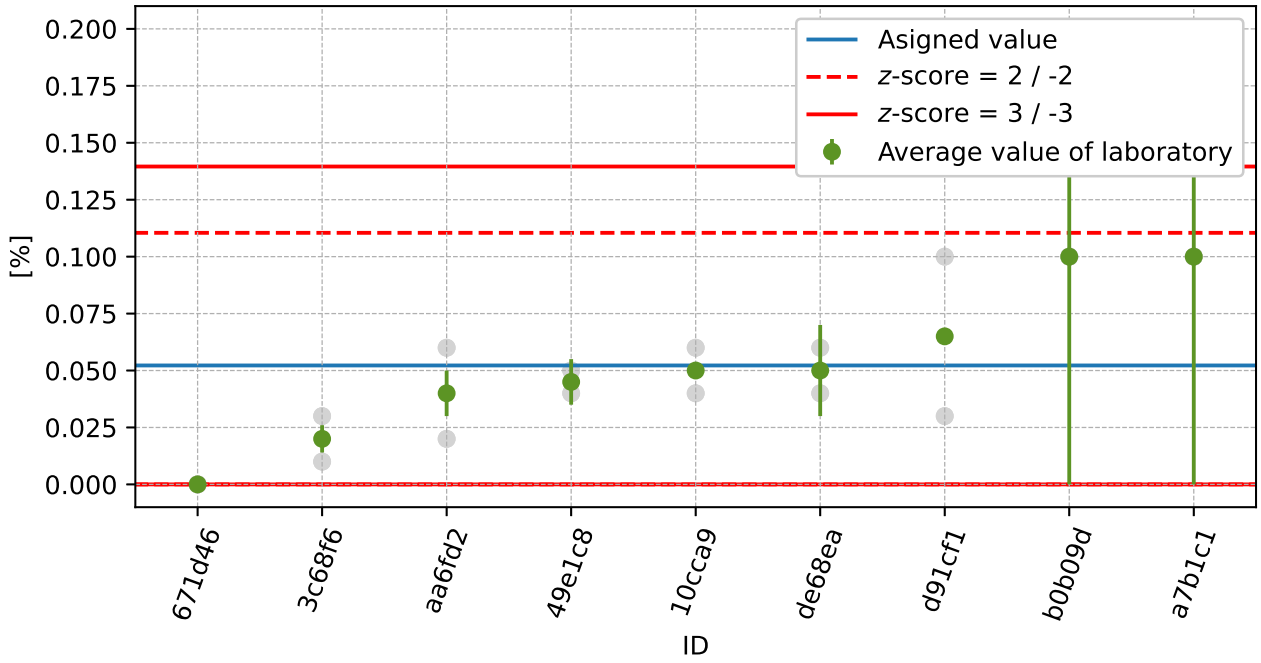


Figure 81: Average values and extended uncertainties of measurement

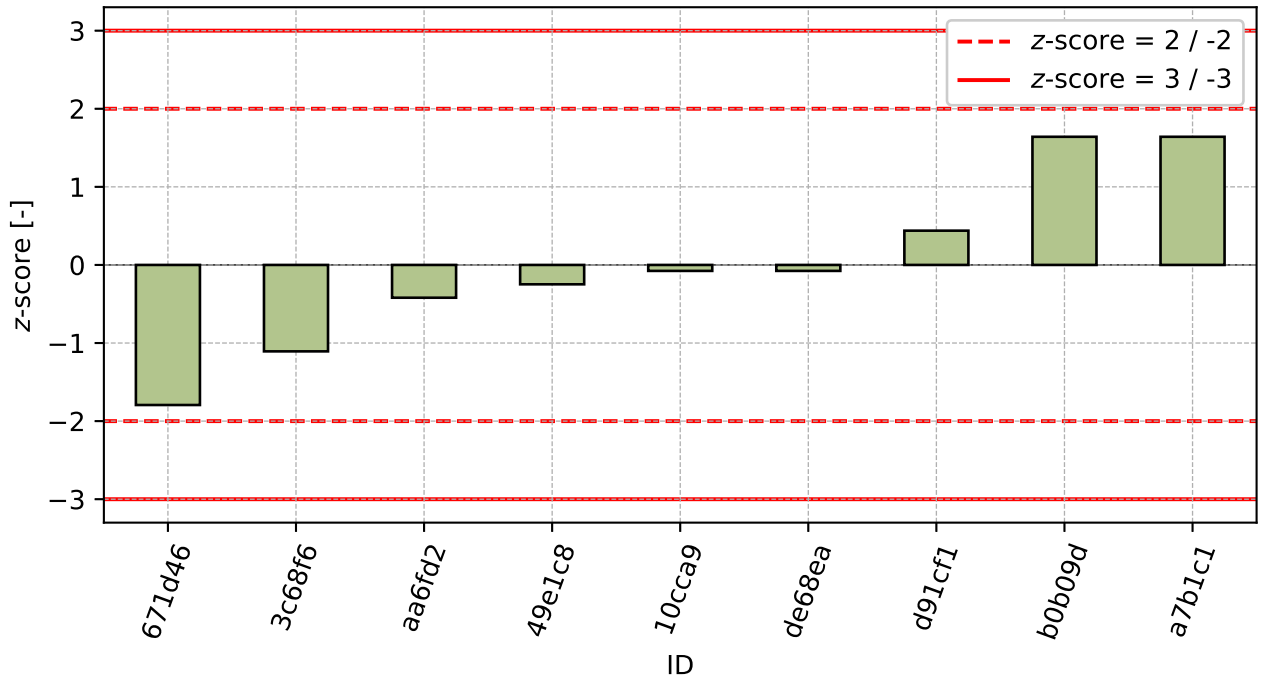


Figure 82: z-score

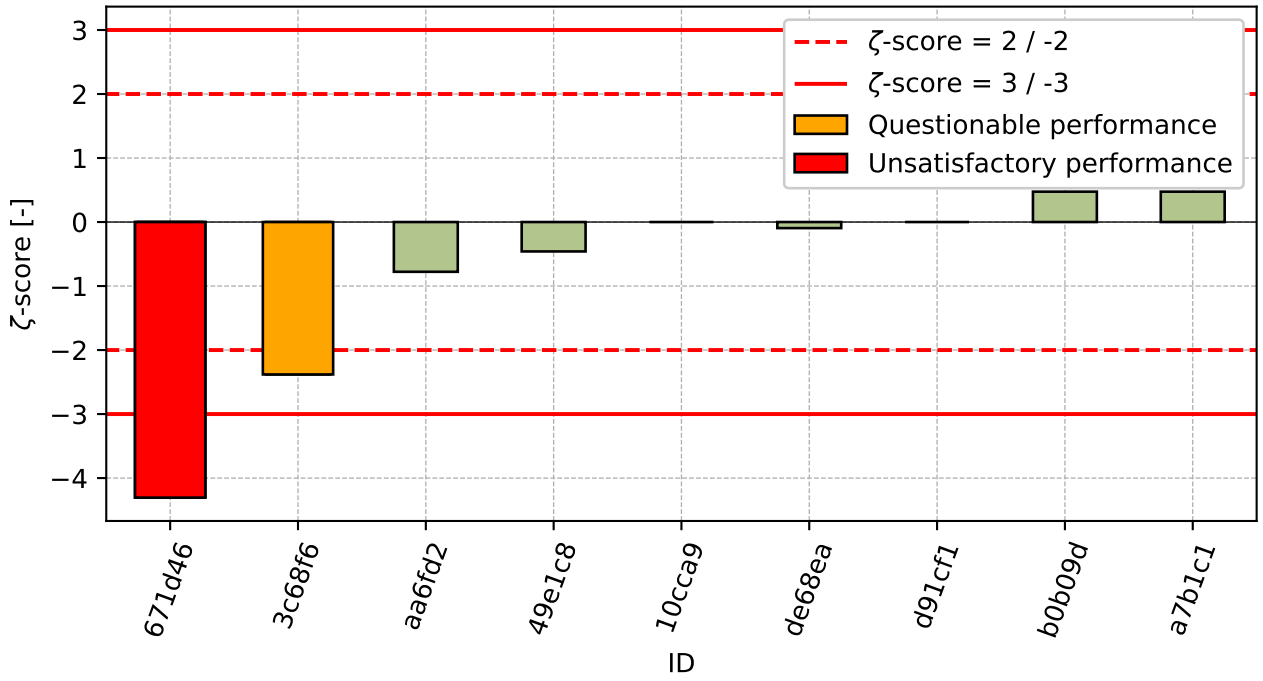


Figure 83: ζ-score

Table 39: *z*-score and ζ-score

| ID | *z*-score [-] | ζ-score [-] |
|---|---|---|
| 671d46 | -1.79 | -4.30 |
| 3c68f6 | -1.11 | -2.38 |
| aa6fd2 | -0.42 | -0.78 |
| 49e1c8 | -0.25 | -0.46 |
| 10cca9 | -0.08 | - |
| de68ea | -0.08 | -0.10 |
| d91cf1 | 0.44 | - |
| b0b09d | 1.64 | 0.47 |
| a7b1c1 | 1.64 | 0.47 |

# 13 Appendix – EN 12697-20 Penetration by pin after 60 min

## 13.1 Test results

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

| ID | Test results [mm] | | $u_X$ [mm] | $\bar{x}$ [mm] | $s_0$ [mm] | $V_X$ [%] |
|---|---|---|---|---|---|---|
| 84a75d | 0.5 | 0.6 | 0.7 | 0.6 | 0.04 | 7.71 |
| b0b09d | 0.5 | 0.6 | 0.2 | 0.6 | 0.07 | 12.86 |
| 40f911 | 0.6 | 0.7 | 0.1 | 0.6 | 0.07 | 10.88 |
| 64ea0e | 0.7 | 0.8 | 0.1 | 0.8 | 0.07 | 9.43 |
| 5097f9 | 0.8 | 0.8 | - | 0.8 | 0.0 | 0.0 |
| ed6d00 | 1.0 | 1.0 | - | 1.0 | 0.03 | 2.77 |

## 13.2 The Numerical Procedure for Determining Outliers

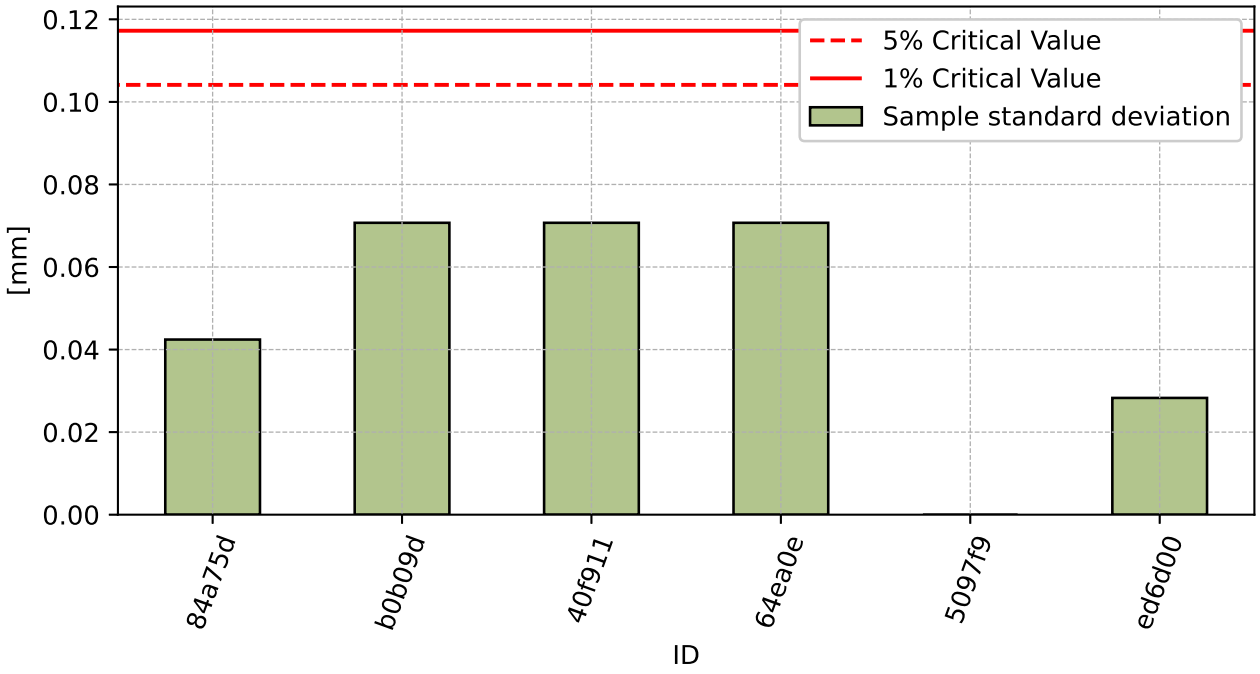


Figure 84: **Cochran's test** - sample standard deviations

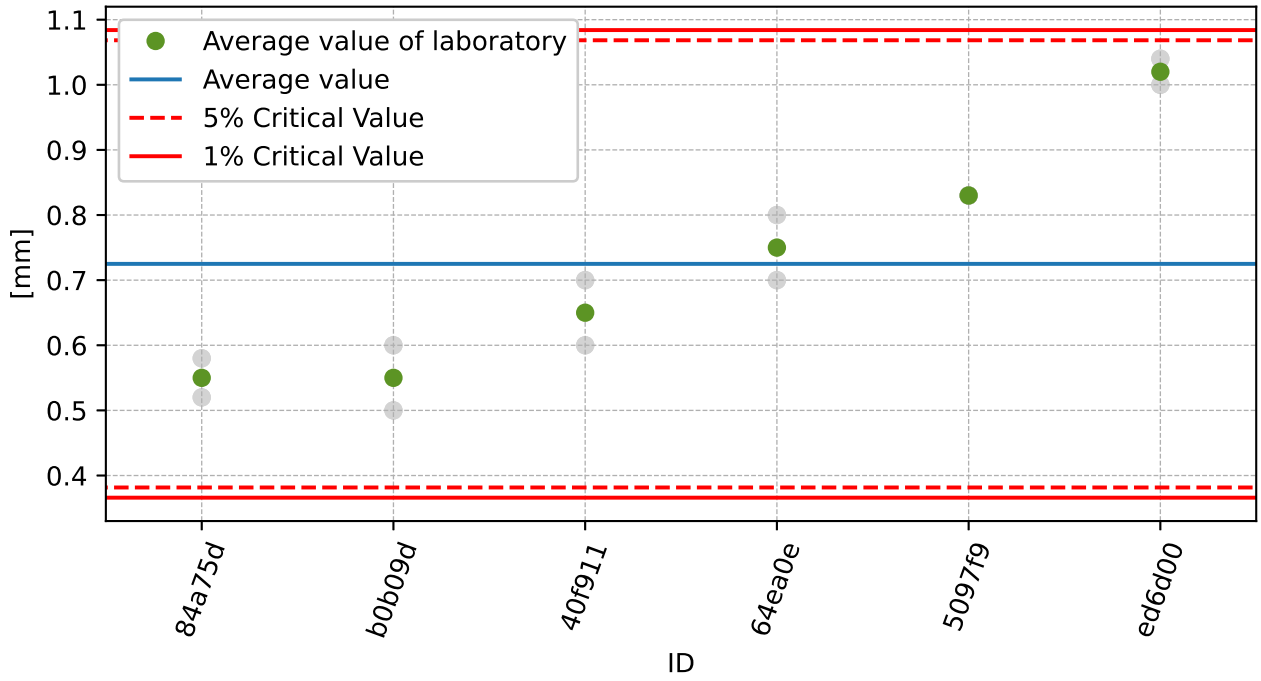


Figure 85: **Grubbs' test** - average values

## 13.3 Mandel's Statistics

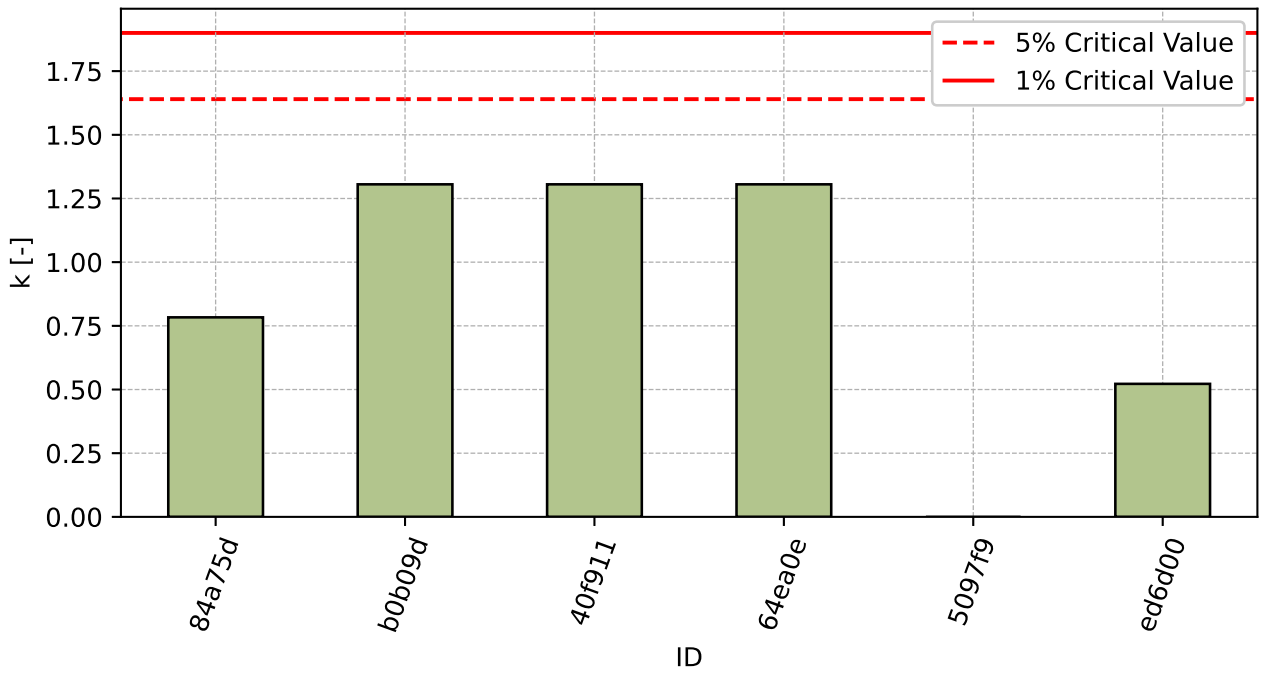


Figure 86: Intralaboratory Consistency Statistic

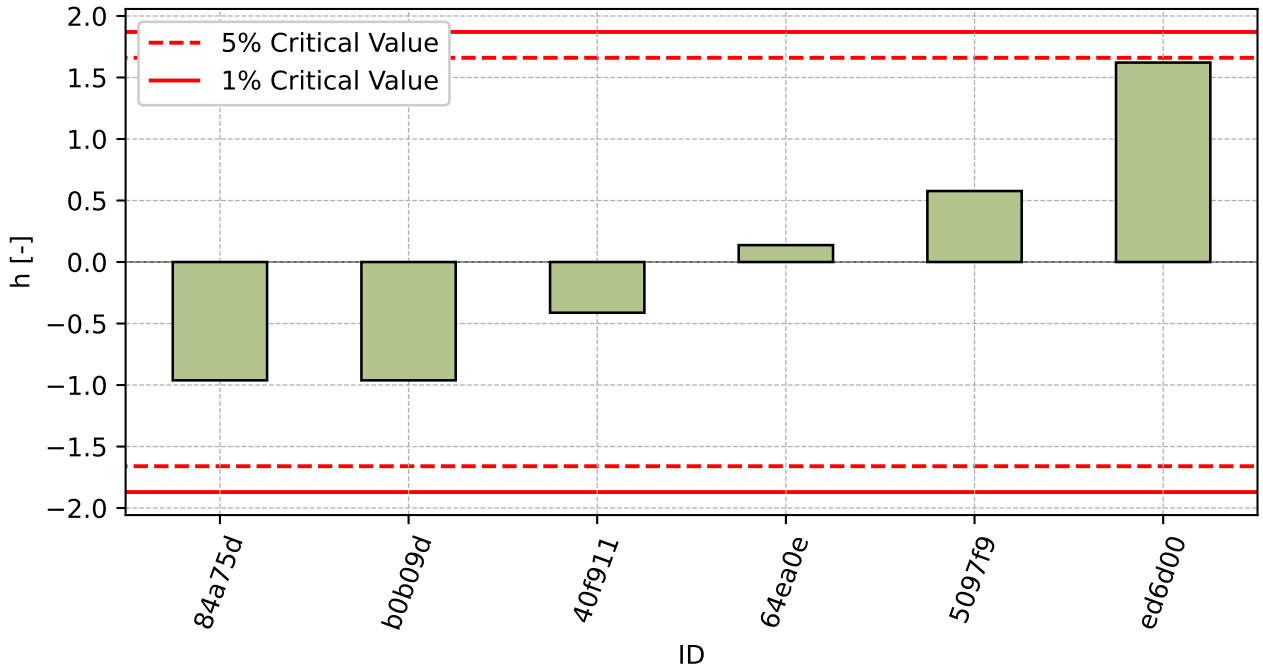


Figure 87: Interlaboratory Consistency Statistic

## 13.4 Descriptive statistics

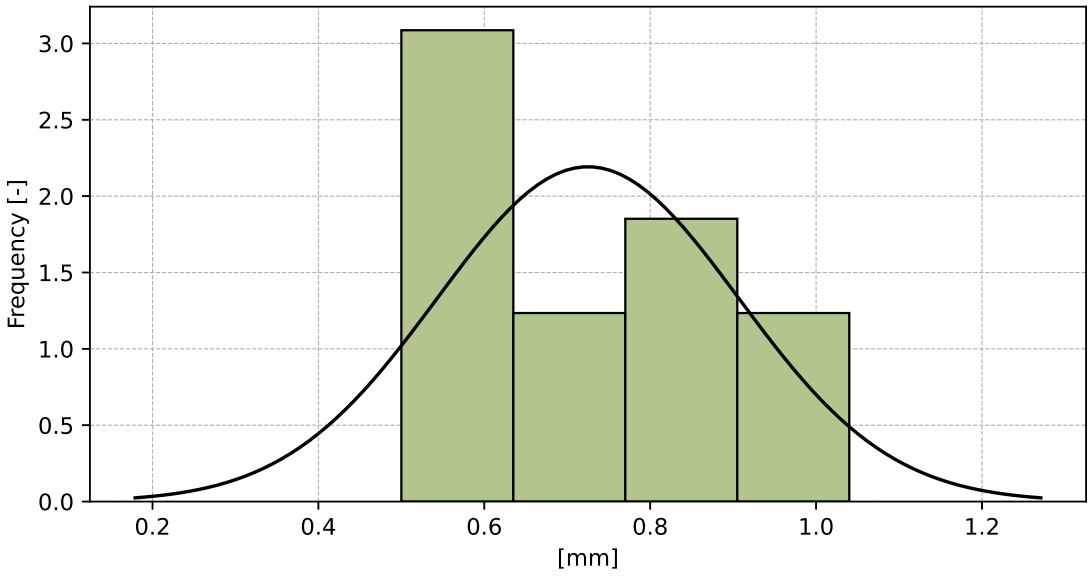


Figure 88: Histogram of all test results

Table 41: Descriptive statistics

| Characteristics | [mm] |
|---|---|
| Average value – $\bar{x}$ | 0.72 |
| Sample standard deviation – $s$ | 0.182 |
| Asigned value – $x^*$ | 0.72 |
| Robust standard deviation – $s^*$ | 0.188 |
| Measurement uncertainty of asigned value – $u_X$ | 0.096 |
| $p$-value of normality test | 0.361 [-] |
| Interlaboratory standard deviation – $s_L$ | 0.178 |
| Repeatability standard deviation – $s_r$ | 0.054 |
| Reproducibility standard deviation – $s_R$ | 0.186 |
| Repeatability – $r$ | 0.15 |
| Reproducibility – $R$ | 0.52 |

## 13.5 Evaluation of Performance Statistics

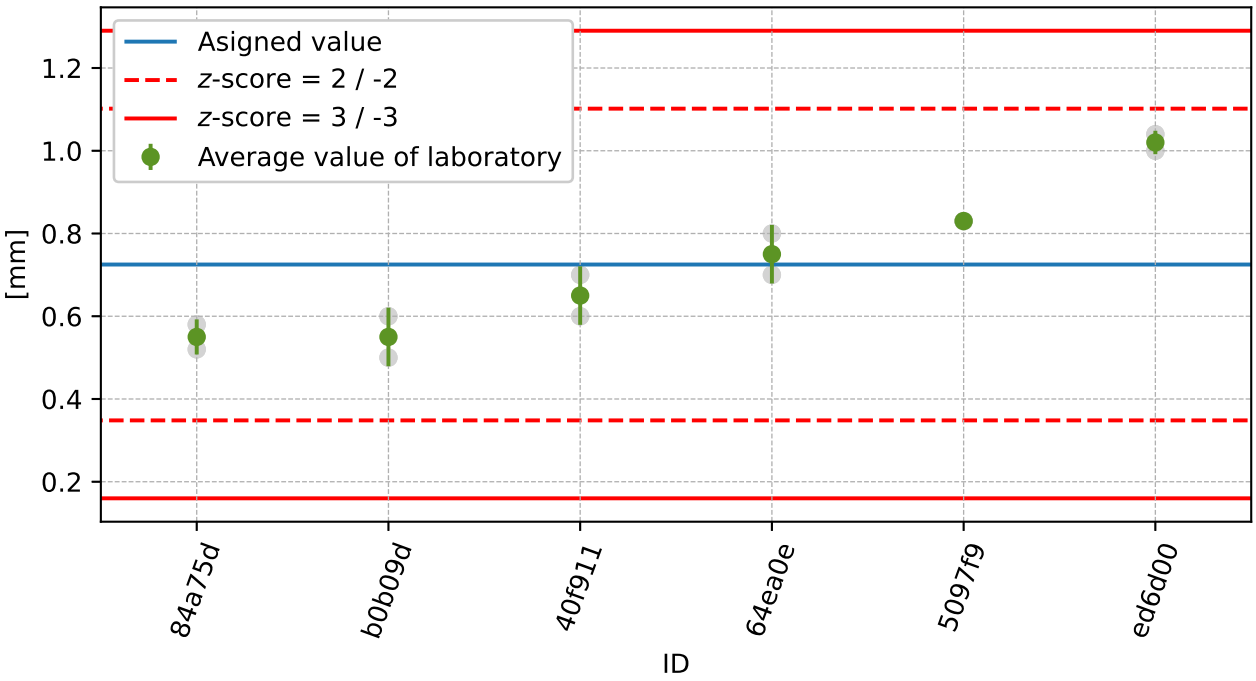


Figure 89: Average values and sample standard deviations

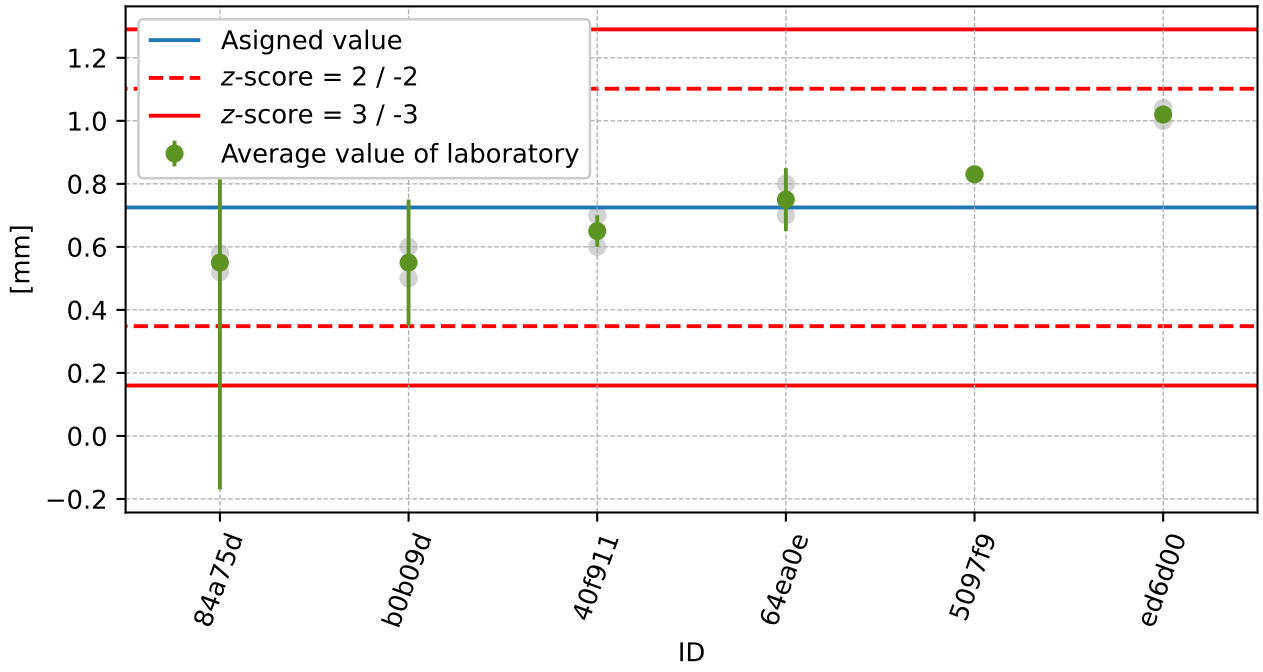


Figure 90: Average values and extended uncertainties of measurement

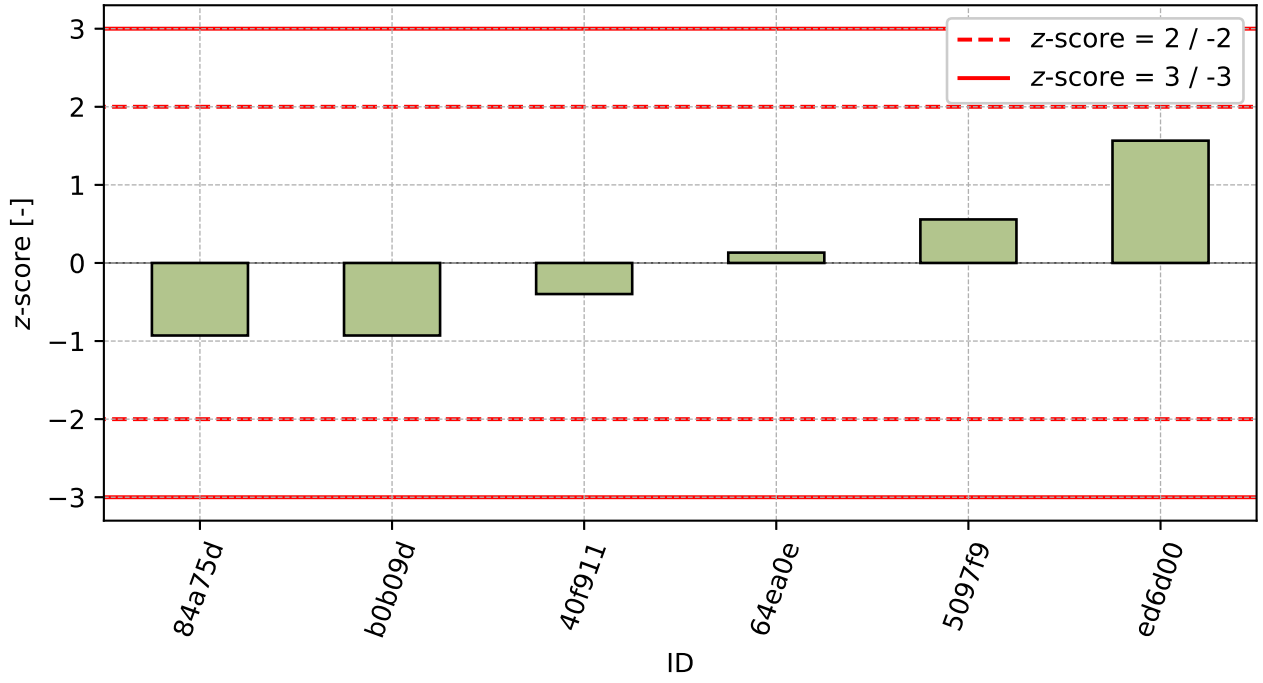


Figure 91: z-score

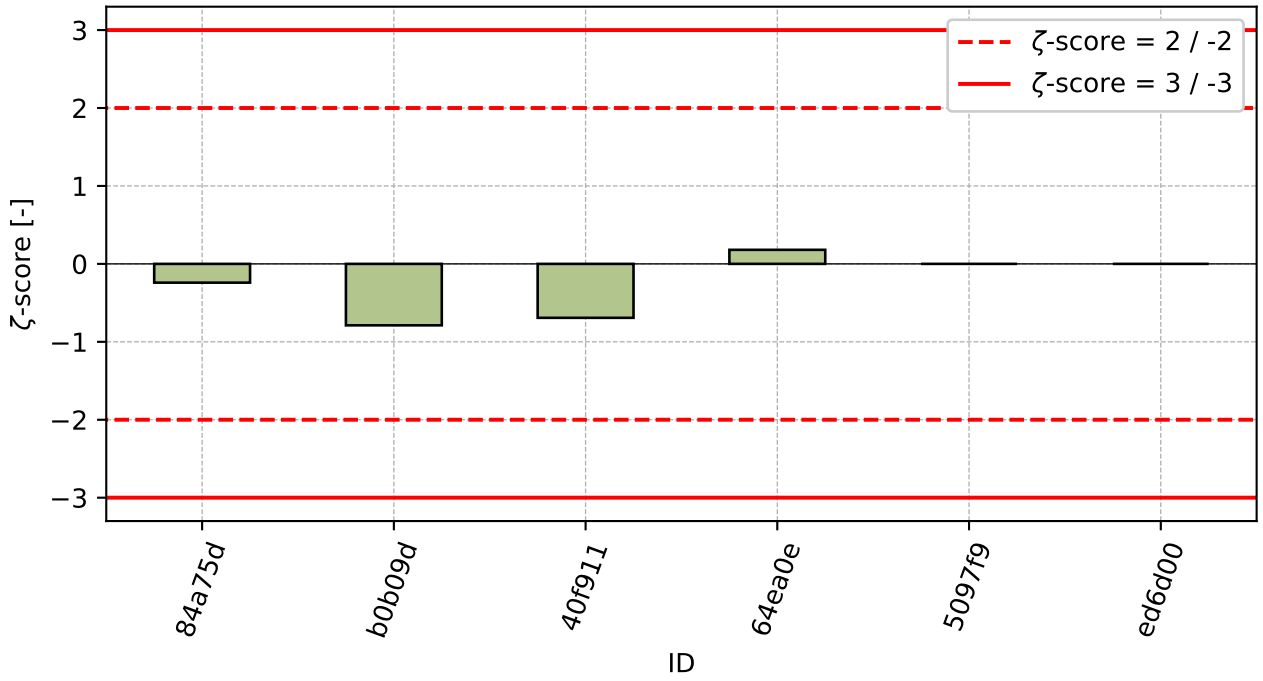


Figure 92: ζ-score

Table 42: $z$-score and ζ-score

| ID | $z$-score [-] | ζ-score [-] |
|---|---|---|
| 84a75d | -0.93 | -0.24 |
| b0b09d | -0.93 | -0.79 |
| 40f911 | -0.40 | -0.69 |
| 64ea0e | 0.13 | 0.18 |
| 5097f9 | 0.56 | - |
| ed6d00 | 1.57 | - |

# 14 Appendix – EN 12697-22+A1 Wheel tracking test – Procedure B in air

## 14.1 Wheel tracking

### 14.1.1 Test results

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

| ID | Test results [mm/1000 cycles] | | $u_X$ [mm/1000 cycles] | $\bar{x}$ [mm/1000 cycles] | $s_0$ [mm/1000 cycles] | $V_X$ [%] |
|---|---|---|---|---|---|---|
| 49e1c8 | 0.01 | 0.02 | 0.01 | 0.01 | 0.007 | 47.14 |
| 10cca9 | 0.02 | 0.02 | - | 0.02 | 0.0 | 0.0 |
| 3c68f6 | 0.02 | 0.02 | 0.01 | 0.02 | 0.0 | 0.0 |
| b0b09d | 0.03 | 0.03 | 0.02 | 0.03 | 0.0 | 0.0 |
| a7b1c1 | 0.04 | 0.05 | 0.01 | 0.04 | 0.007 | 15.71 |

### 14.1.2 The Numerical Procedure for Determining Outliers

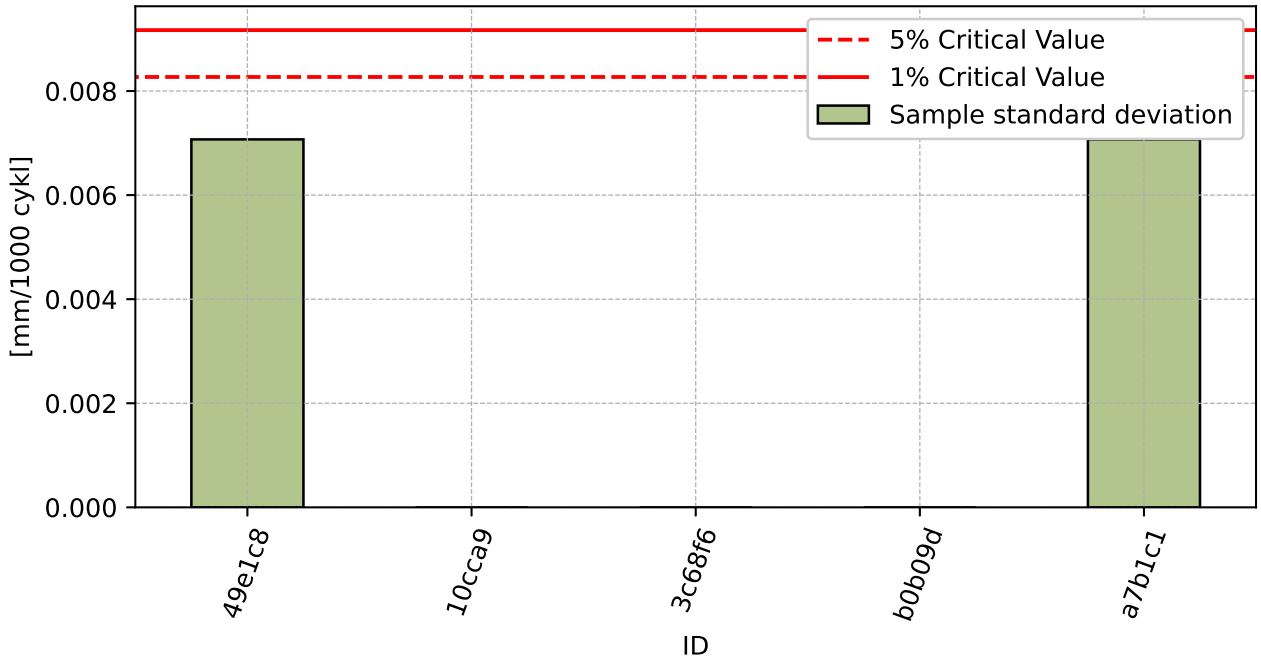


Figure 93: **Cochran's test** - sample standard deviations

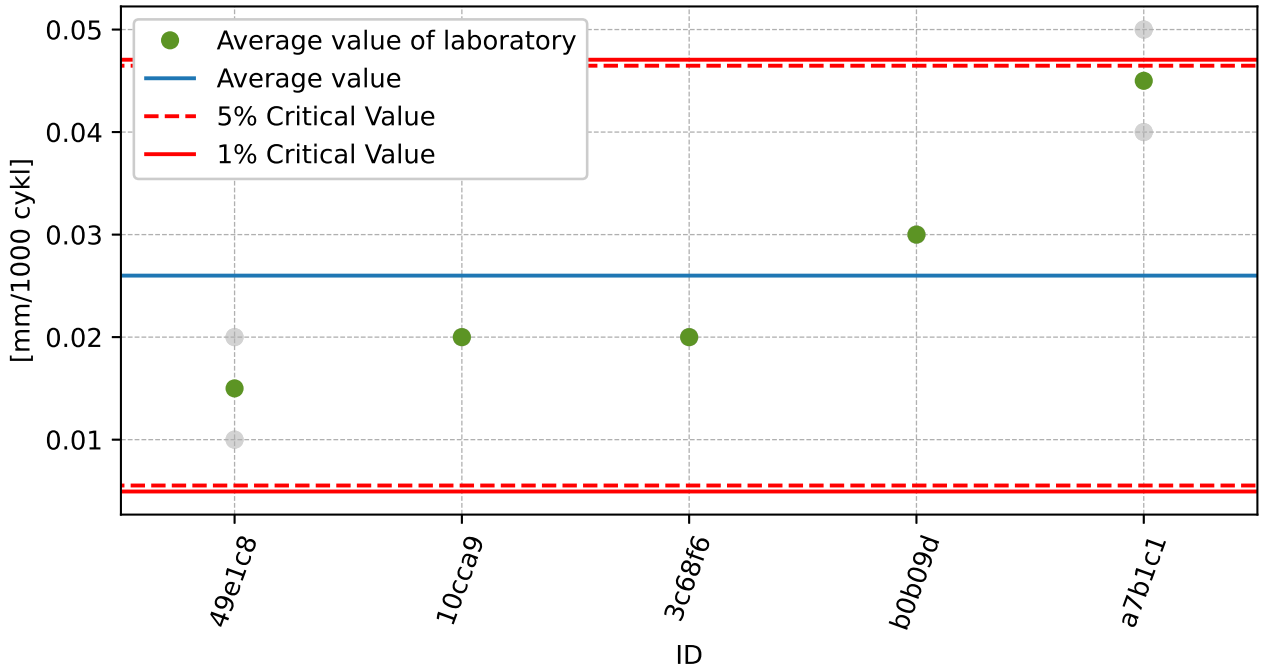


Figure 94: **Grubbs' test** - average values

### 14.1.3 Mandel's Statistics

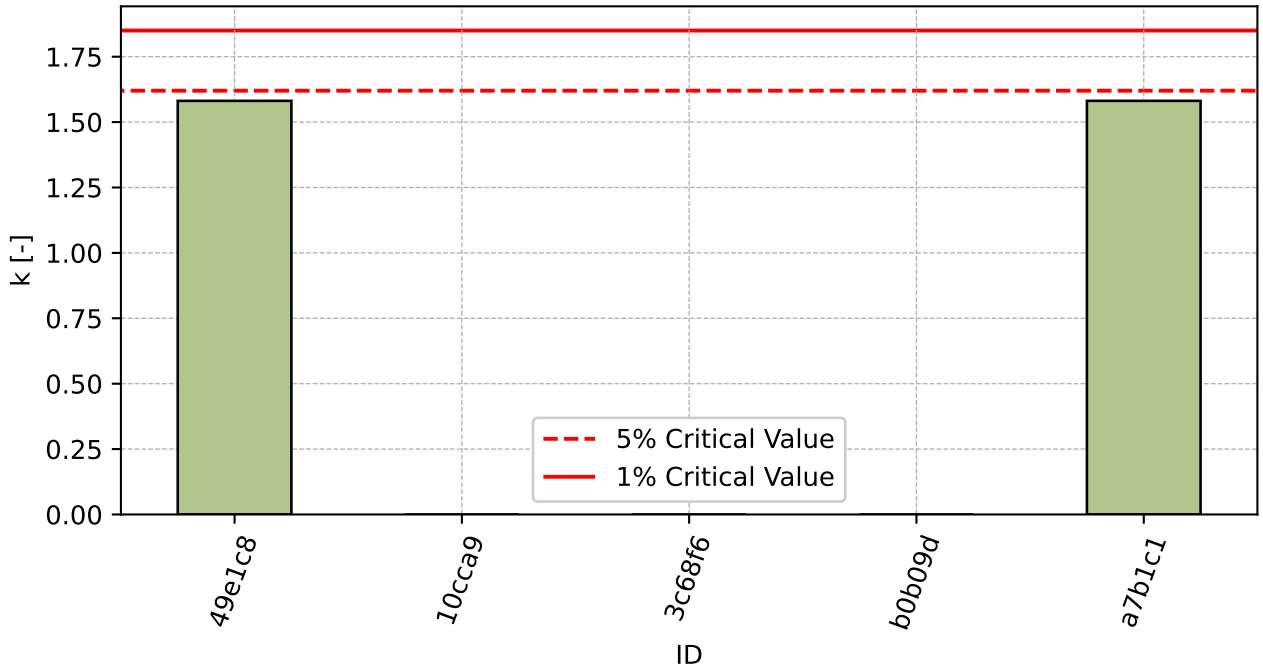


Figure 95: Intralaboratory Consistency Statistic

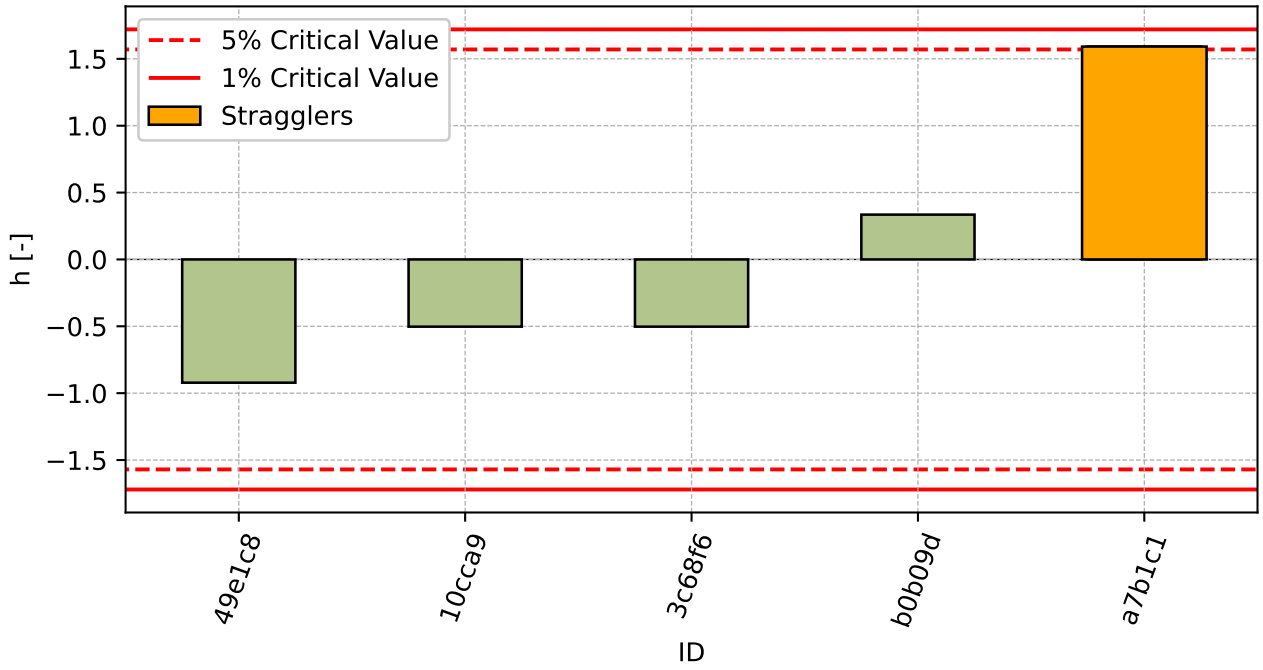


Figure 96: Interlaboratory Consistency Statistic

### 14.1.4 Descriptive statistics

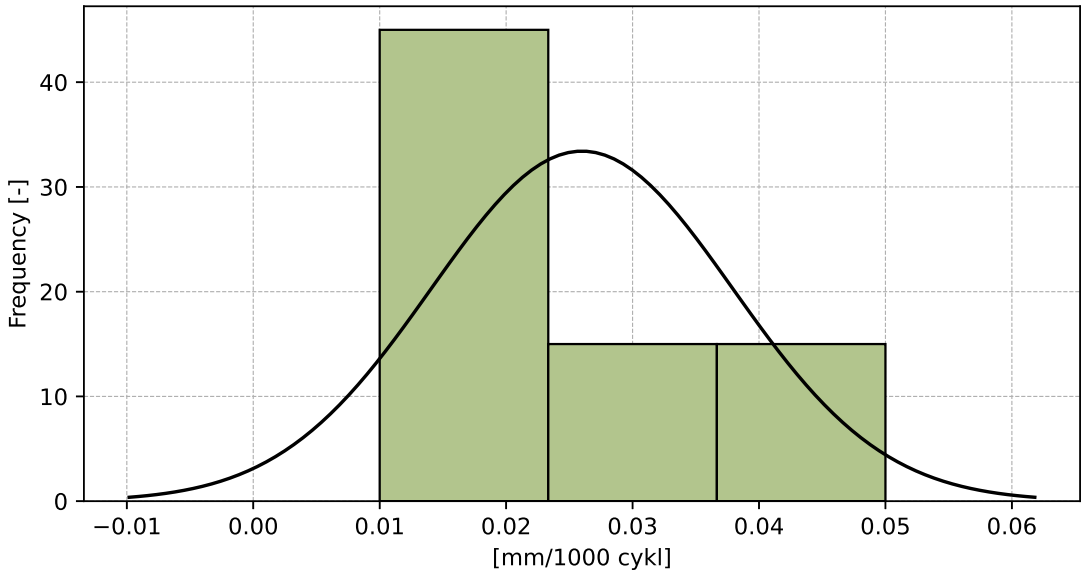


Figure 97: Histogram of all test results

Table 44: Descriptive statistics

| Characteristics | [mm/1000 cycles] |
|---|---|
| Average value – $\bar{x}$ | 0.03 |
| Sample standard deviation – $s$ | 0.012 |
| Asigned value – $x^*$ | 0.03 |
| Robust standard deviation – $s^*$ | 0.012 |
| Measurement uncertainty of asigned value – $u_X$ | 0.007 |
| $p$-value of normality test | 0.108 [-] |
| Interlaboratory standard deviation – $s_L$ | 0.012 |
| Repeatability standard deviation – $s_r$ | 0.004 |
| Reproducibility standard deviation – $s_R$ | 0.012 |
| Repeatability – $r$ | 0.01 |
| Reproducibility – $R$ | 0.03 |

### 14.1.5 Evaluation of Performance Statistics

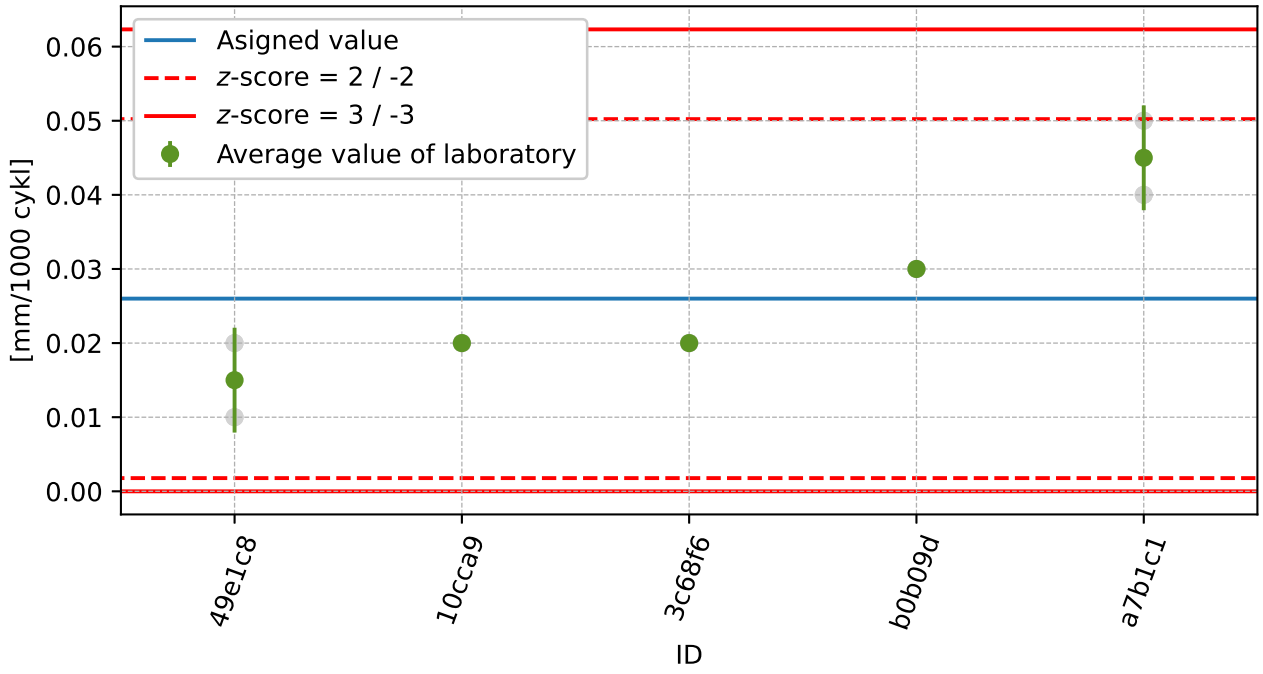


Figure 98: Average values and sample standard deviations

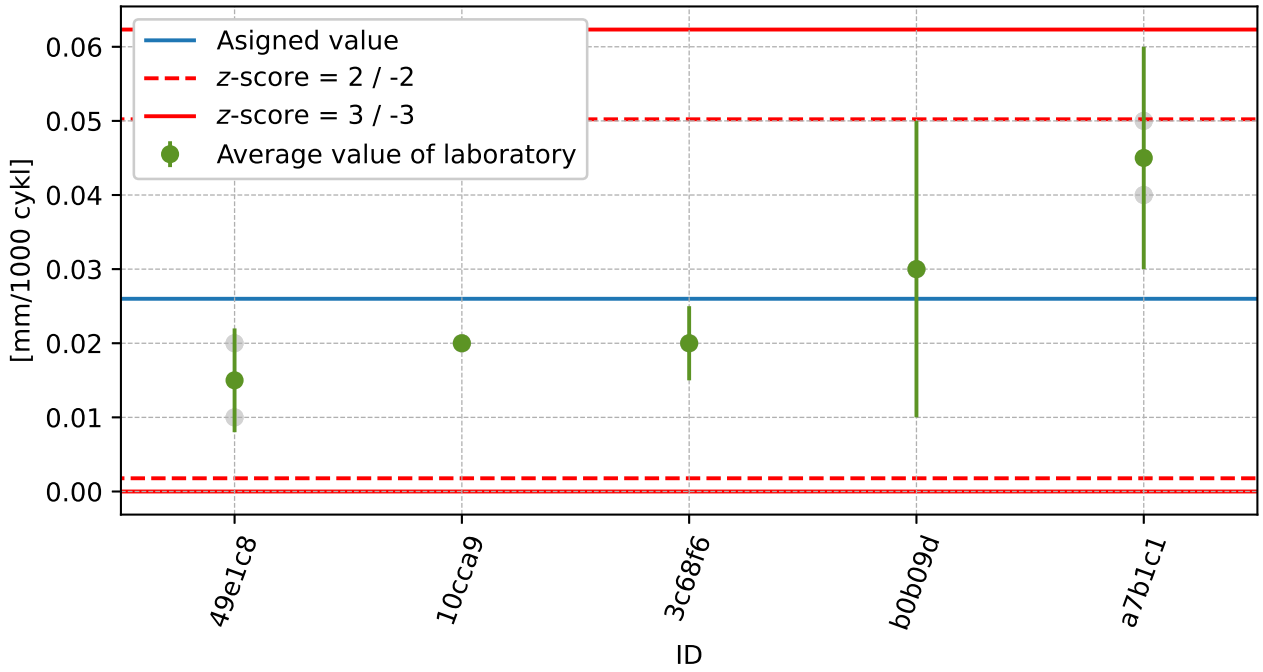


Figure 99: Average values and extended uncertainties of measurement

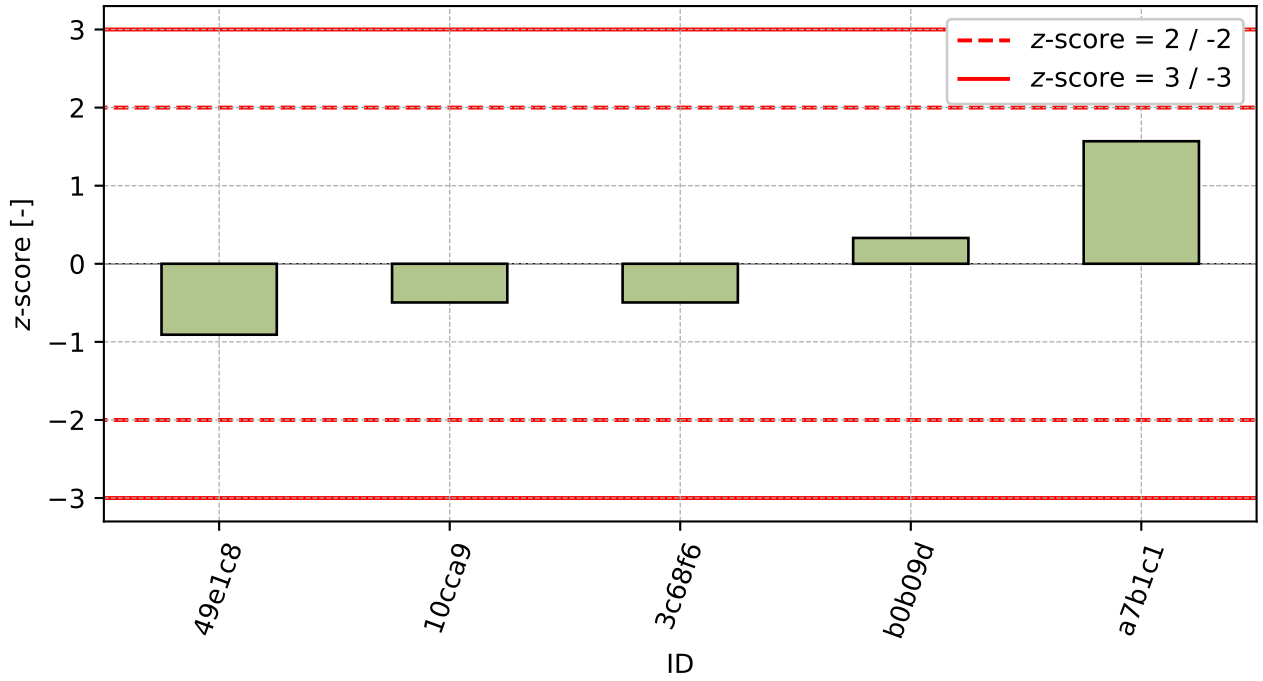


Figure 100: z-score

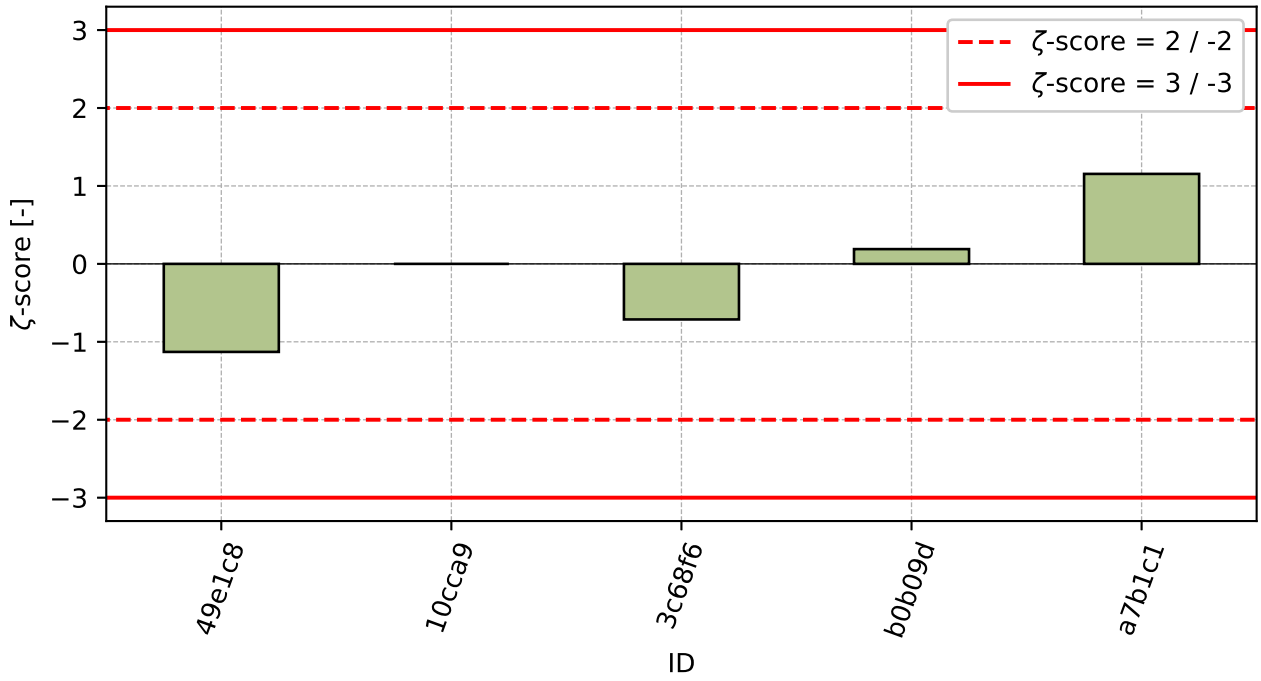


Figure 101: ζ-score

Table 45: *z*-score and ζ-score

| ID | *z*-score [-] | ζ-score [-] |
|---|---|---|
| 49e1c8 | -0.91 | -1.13 |
| 10cca9 | -0.50 | - |
| 3c68f6 | -0.50 | -0.71 |
| b0b09d | 0.33 | 0.19 |
| a7b1c1 | 1.57 | 1.15 |

## 14.2 Wheel tracking test – small-size device, Procedure B in air

### 14.2.1 Test results

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

| ID | Test results [%] | | $u_X$ [%] | $\bar{x}$ [%] | $s_0$ [%] | $V_X$ [%] |
|---|---|---|---|---|---|---|
| 49e1c8 | 2.5 | 2.3 | 0.3 | 2.4 | 0.14 | 5.89 |
| 3c68f6 | 2.8 | - | 0.7 | 2.8 | 0.0 | 0.0 |
| 10cca9 | 3.6 | 2.8 | - | 3.2 | 0.57 | 17.68 |
| a7b1c1 | 4.0 | 4.4 | 0.3 | 4.2 | 0.28 | 6.73 |
| b0b09d | 4.3 | - | 0.5 | 4.3 | 0.0 | 0.0 |

### 14.2.2 The Numerical Procedure for Determining Outliers

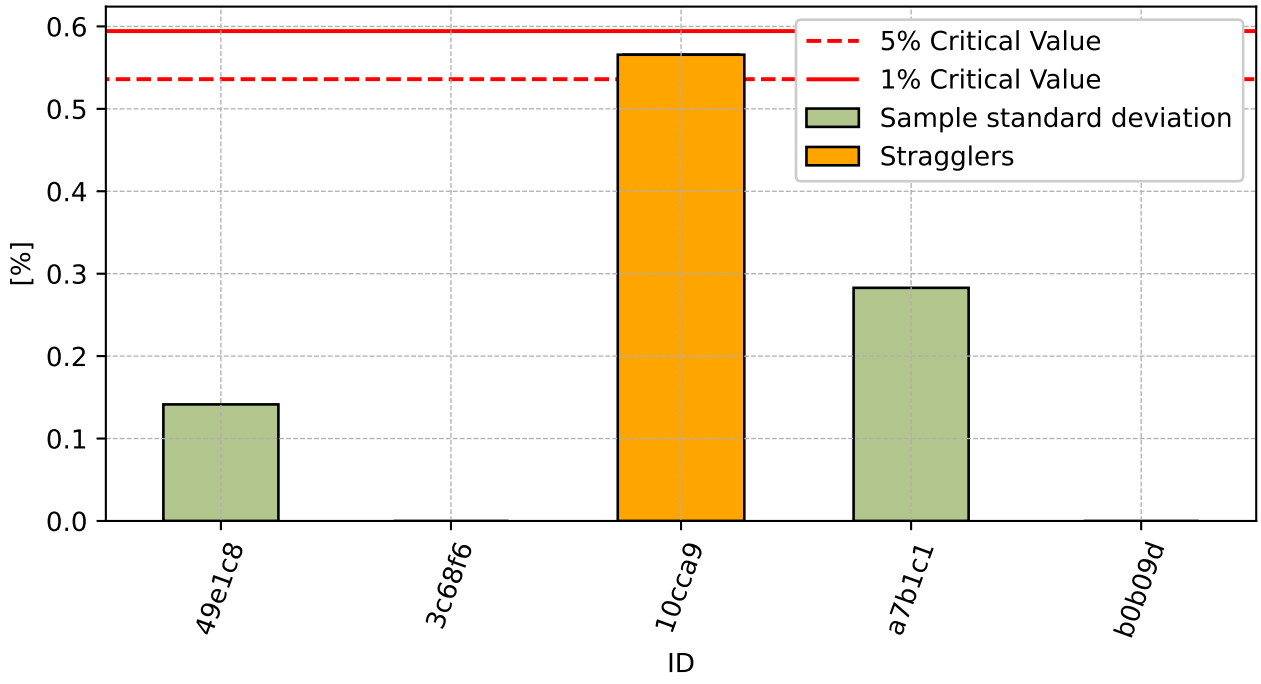


Figure 102: **Cochran's test** - sample standard deviations

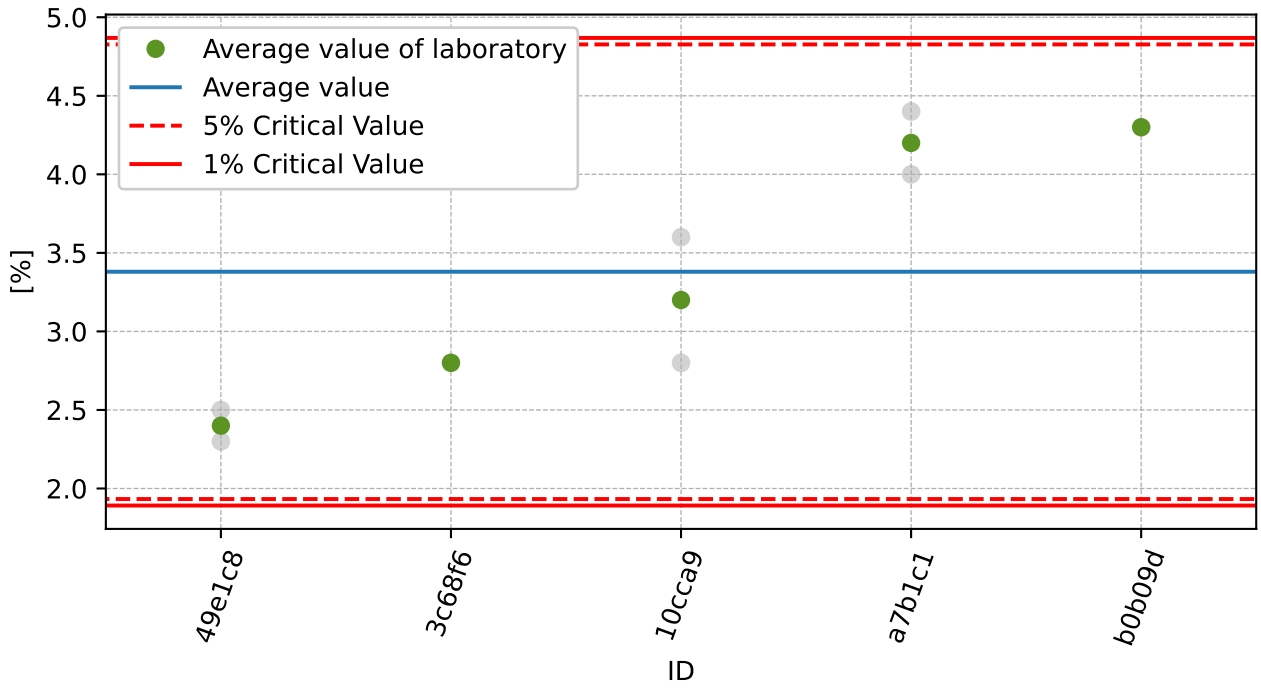


Figure 103: **Grubbs' test** - average values

### 14.2.3 Mandel's Statistics

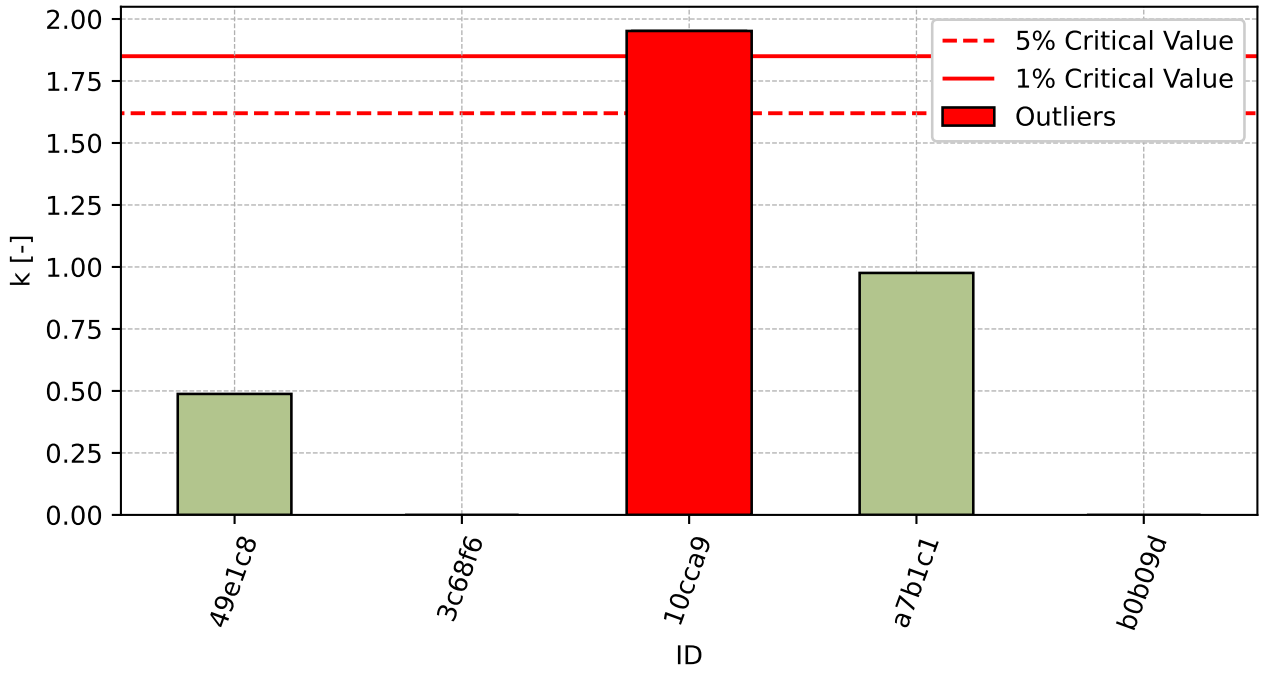


Figure 104: Intralaboratory Consistency Statistic

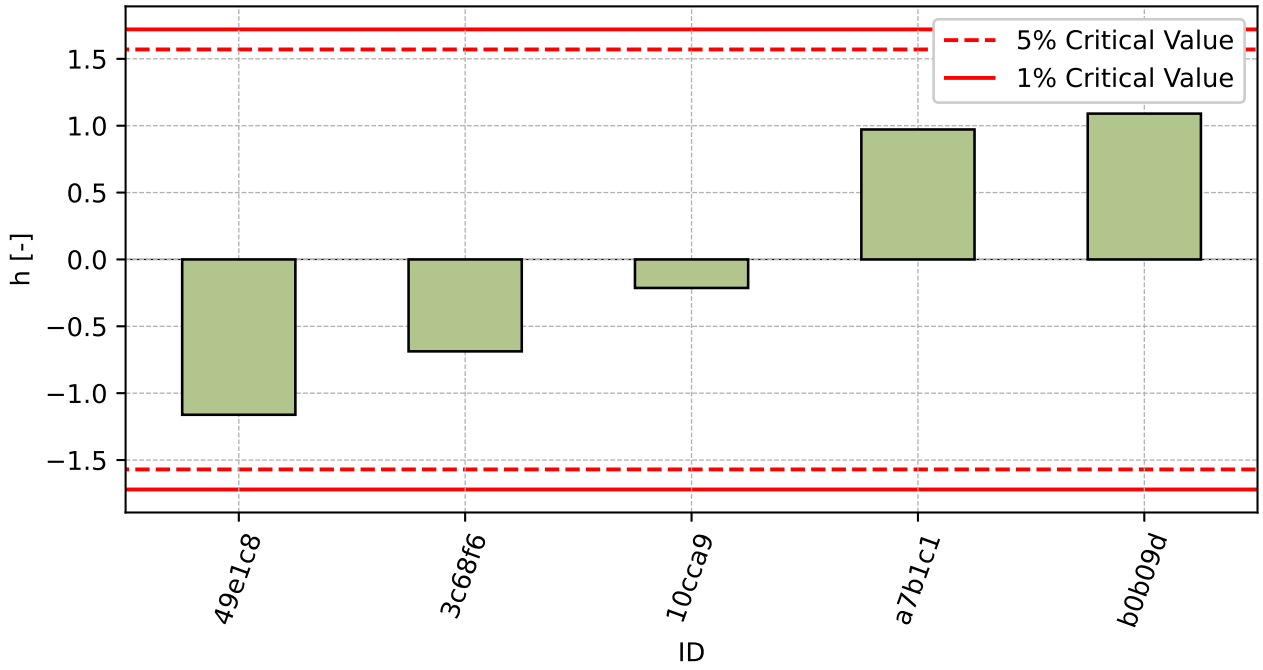


Figure 105: Interlaboratory Consistency Statistic

### 14.2.4 Descriptive statistics

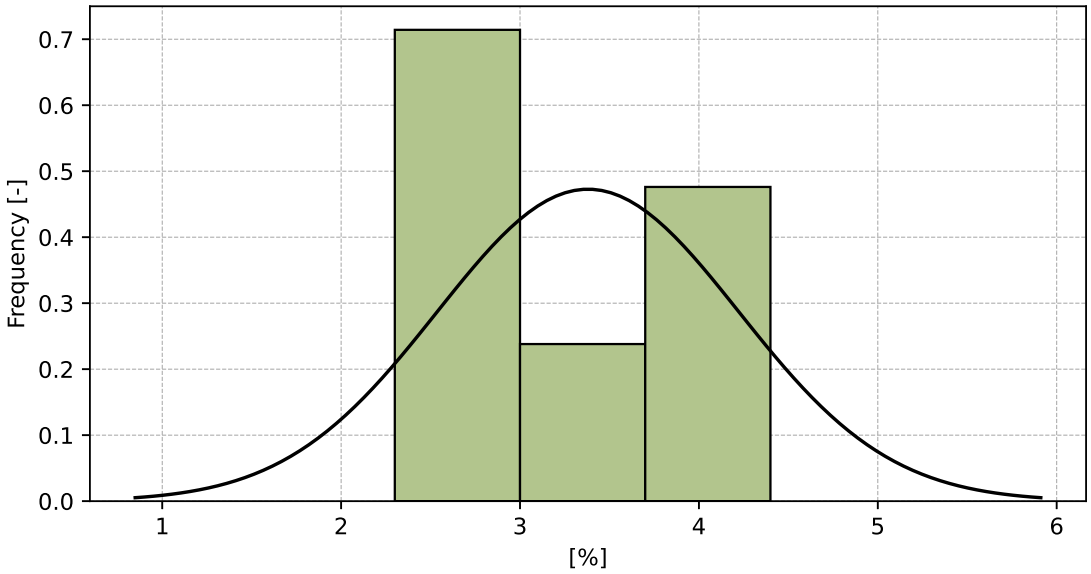


Figure 106: Histogram of all test results

Table 47: Descriptive statistics

| Characteristics | [%] |
|---|---|
| Average value – $\bar{x}$ | 3.4 |
| Sample standard deviation – $s$ | 0.84 |
| Asigned value – $x^*$ | 3.4 |
| Robust standard deviation – $s^*$ | 0.86 |
| Measurement uncertainty of asigned value – $u_X$ | 0.48 |
| $p$-value of normality test | 0.532 [-] |
| Interlaboratory standard deviation – $s_L$ | 0.82 |
| Repeatability standard deviation – $s_r$ | 0.29 |
| Reproducibility standard deviation – $s_R$ | 0.87 |
| Repeatability – $r$ | 0.8 |
| Reproducibility – $R$ | 2.4 |

### 14.2.5 Evaluation of Performance Statistics

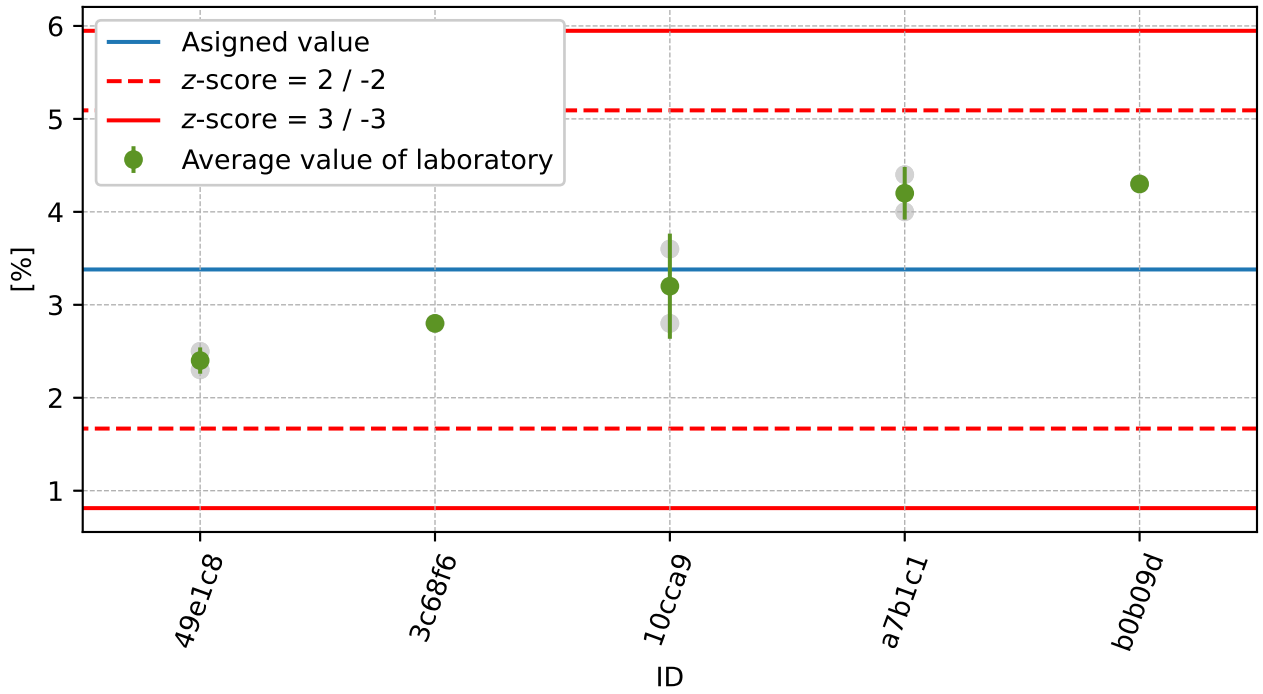


Figure 107: Average values and sample standard deviations

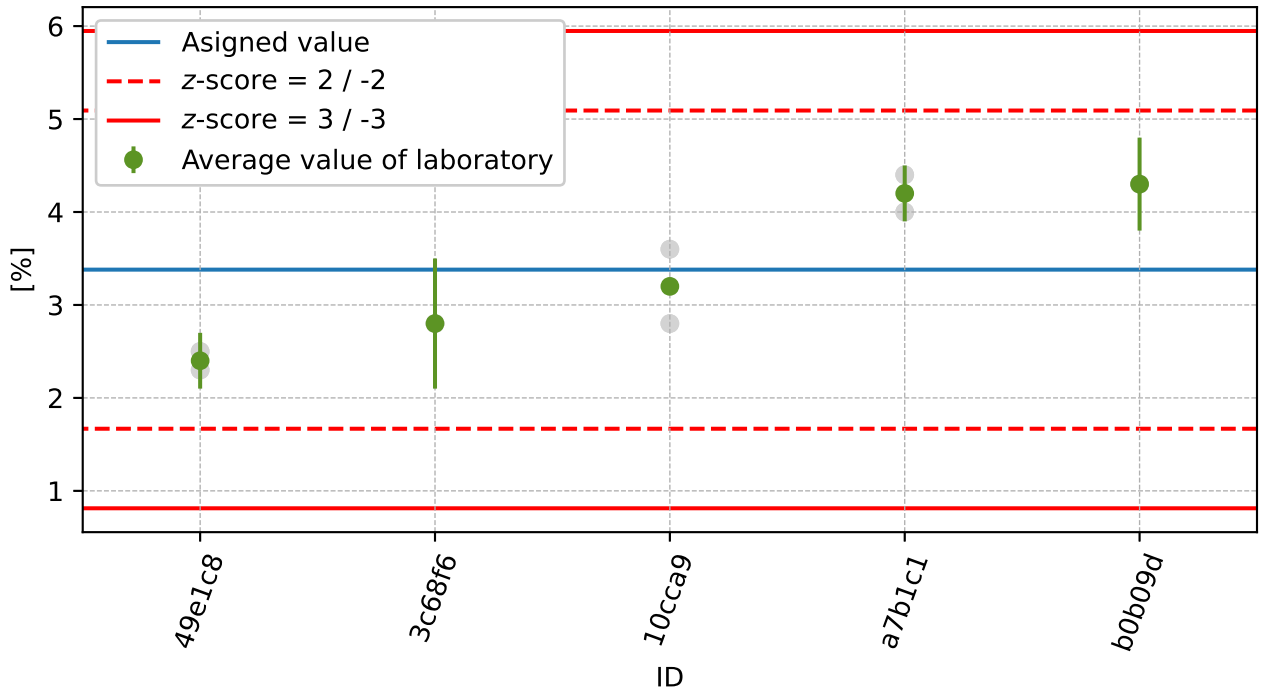


Figure 108: Average values and extended uncertainties of measurement

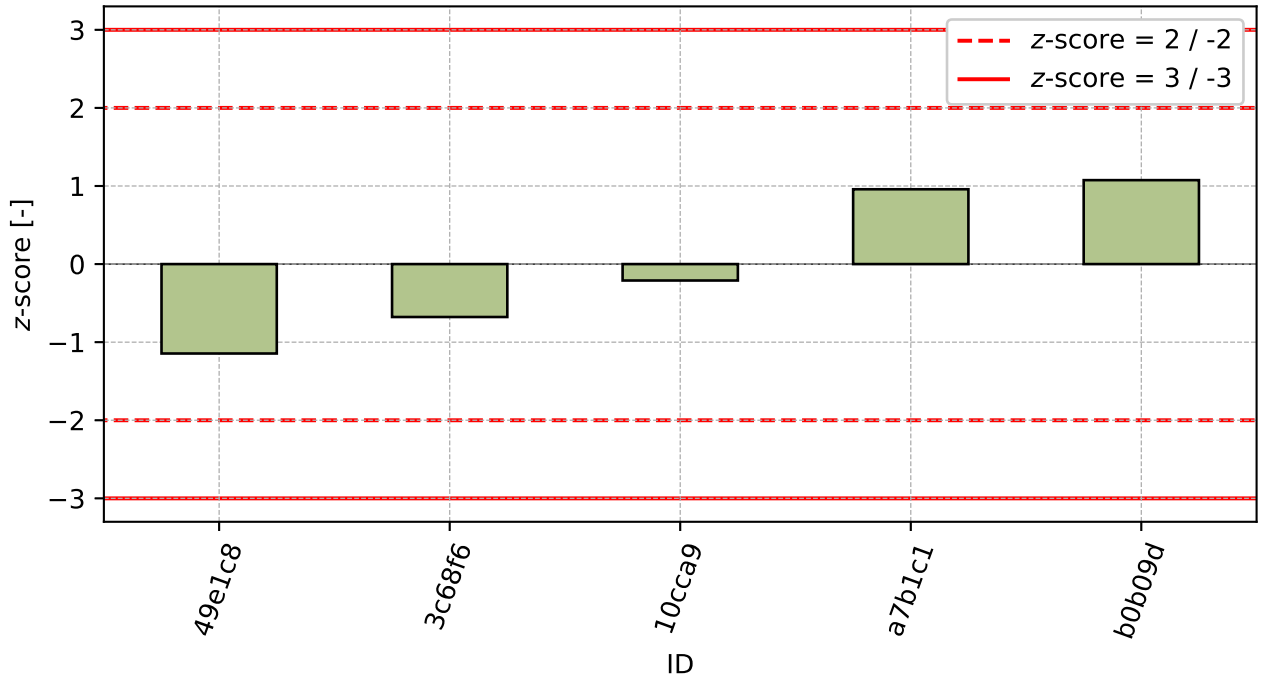


Figure 109: z-score

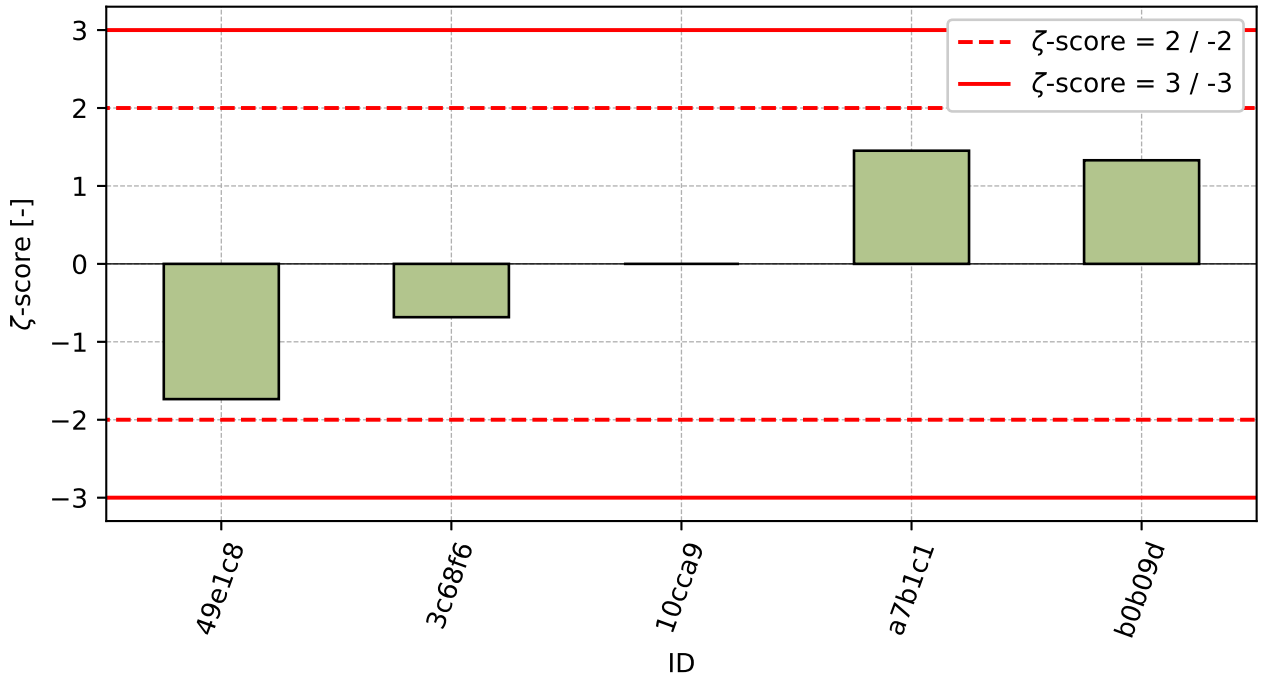


Figure 110: ζ-score

Table 48: *z*-score and ζ-score

| ID | *z*-score [-] | ζ-score [-] |
|---|---|---|
| 49e1c8 | -1.15 | -1.74 |
| 3c68f6 | -0.68 | -0.68 |
| 10cca9 | -0.21 | - |
| a7b1c1 | 0.96 | 1.45 |
| b0b09d | 1.07 | 1.33 |

# 15 Appendix – ČSN 73 6161 Adhesion of bituminous binders to aggregates

## 15.1 Test results

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

| ID | Test results [%] | | $u_X$ [%] | $\bar{x}$ [%] | $s_0$ [%] | $V_X$ [%] |
|---|---|---|---|---|---|---|
| a7b1c1 | 85.0 | 80.0 | 10.0 | 82.0 | 3.5 | 4.29 |
| de0c90 | 87.0 | 89.0 | - | 88.0 | 1.4 | 1.61 |
| be8406 | 90.0 | 90.0 | - | 90.0 | 0.1 | 0.08 |
| aa6fd2 | 91.0 | 92.0 | - | 92.0 | 0.7 | 0.77 |

## 15.2 The Numerical Procedure for Determining Outliers

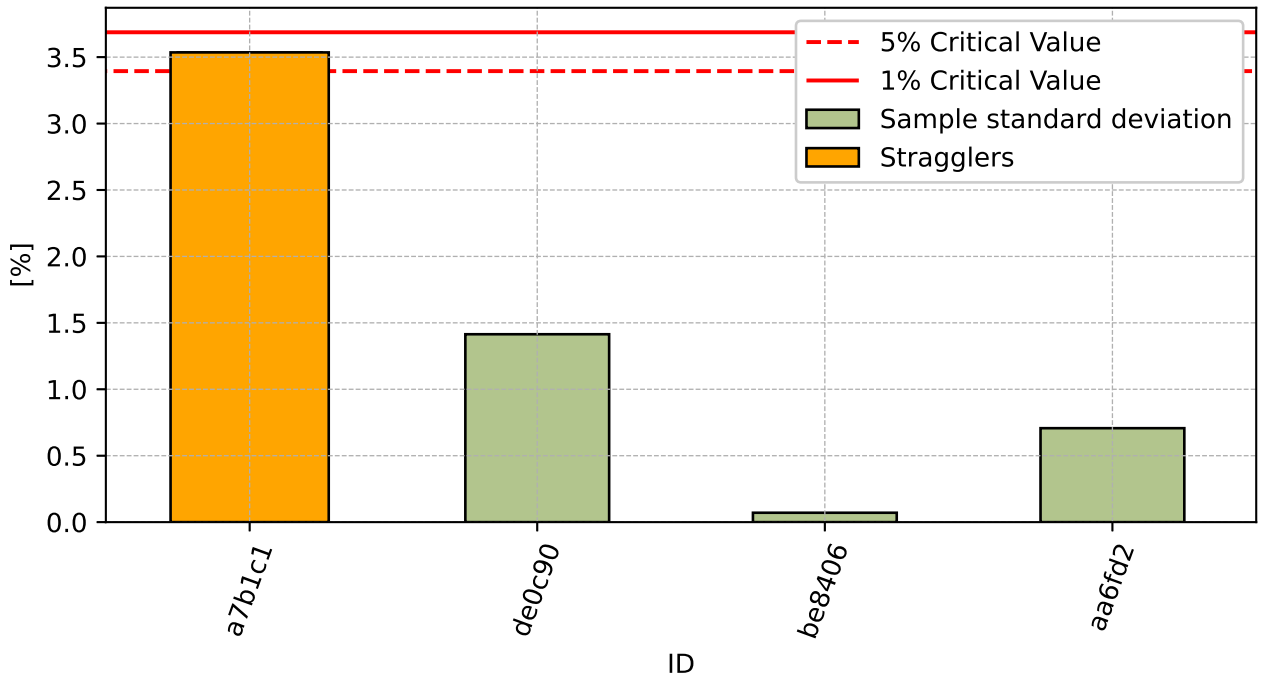


Figure 111: **Cochran's test** - sample standard deviations

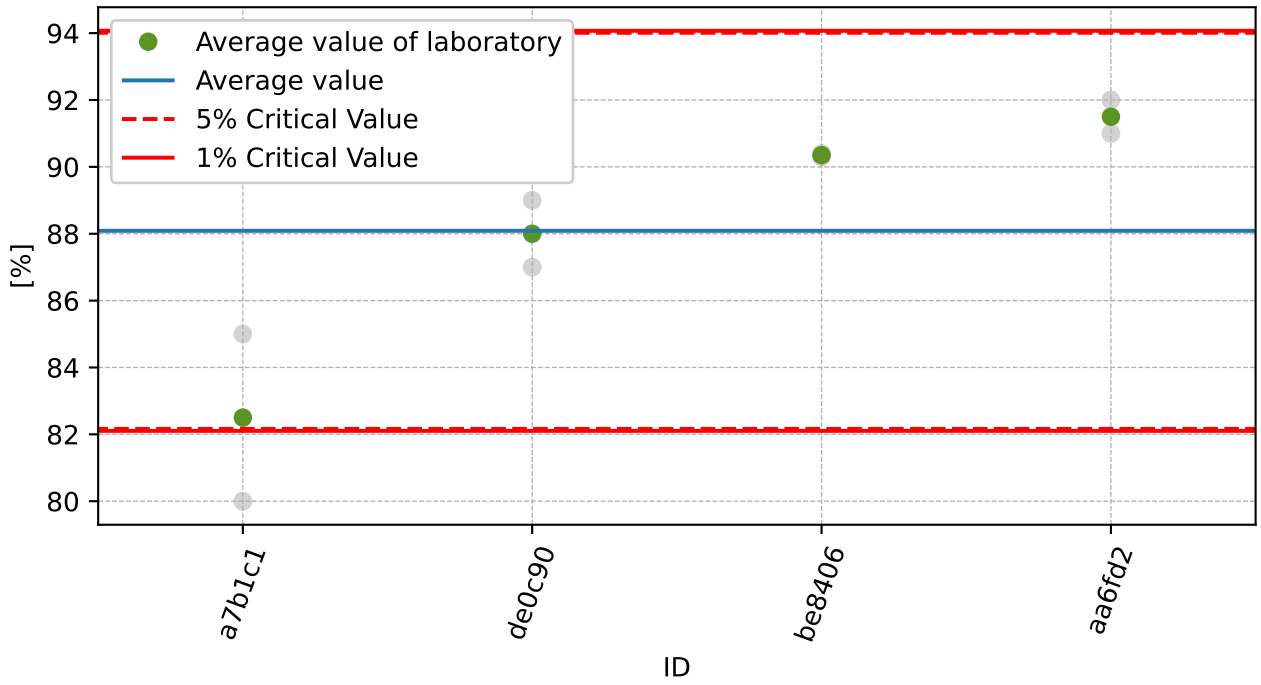


Figure 112: **Grubbs' test** - average values

## 15.3 Mandel's Statistics

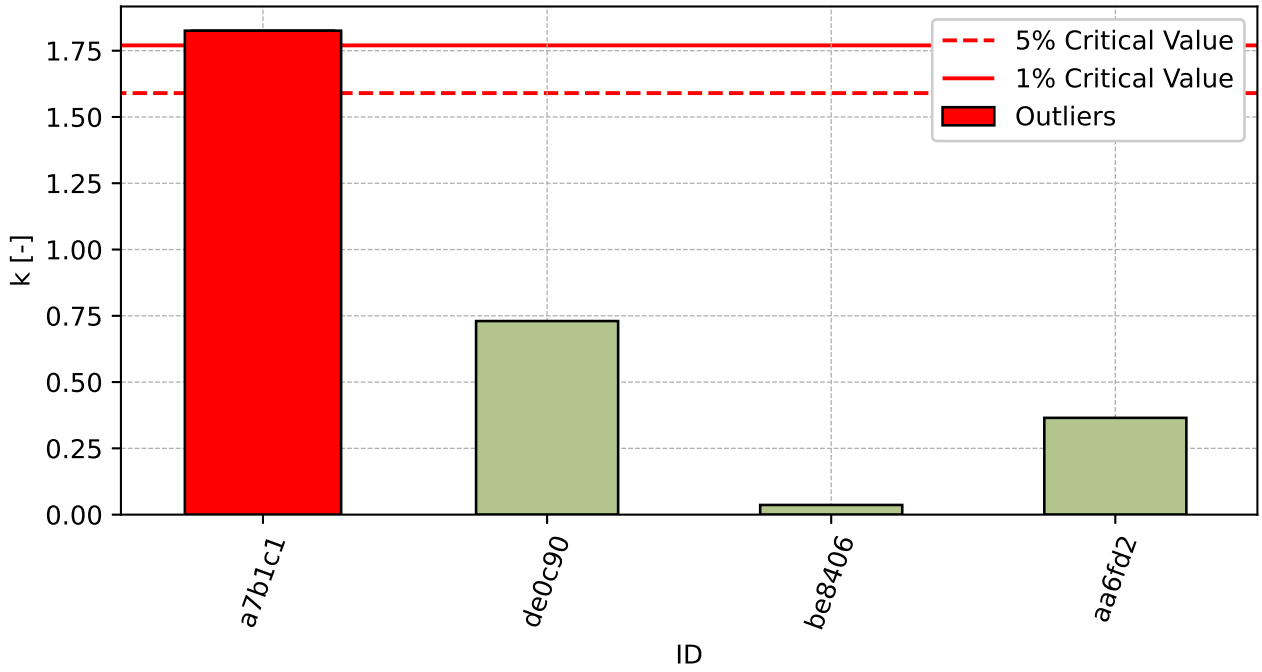


Figure 113: Intralaboratory Consistency Statistic

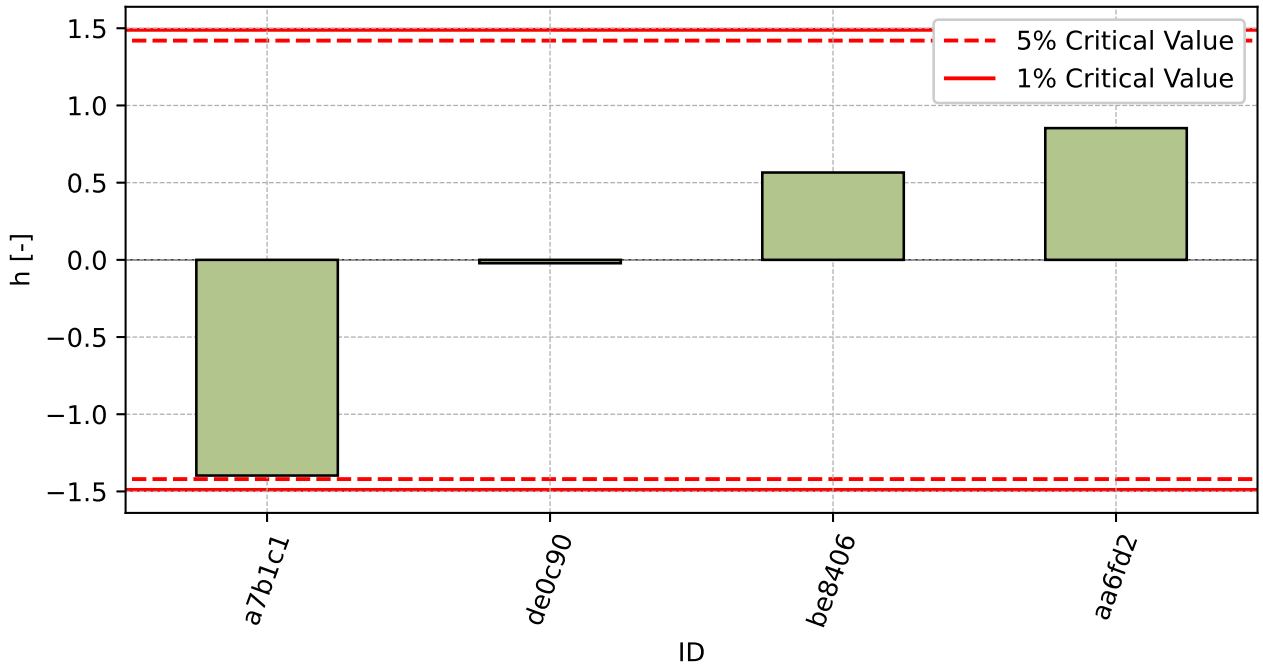


Figure 114: Interlaboratory Consistency Statistic

## 15.4 Descriptive statistics

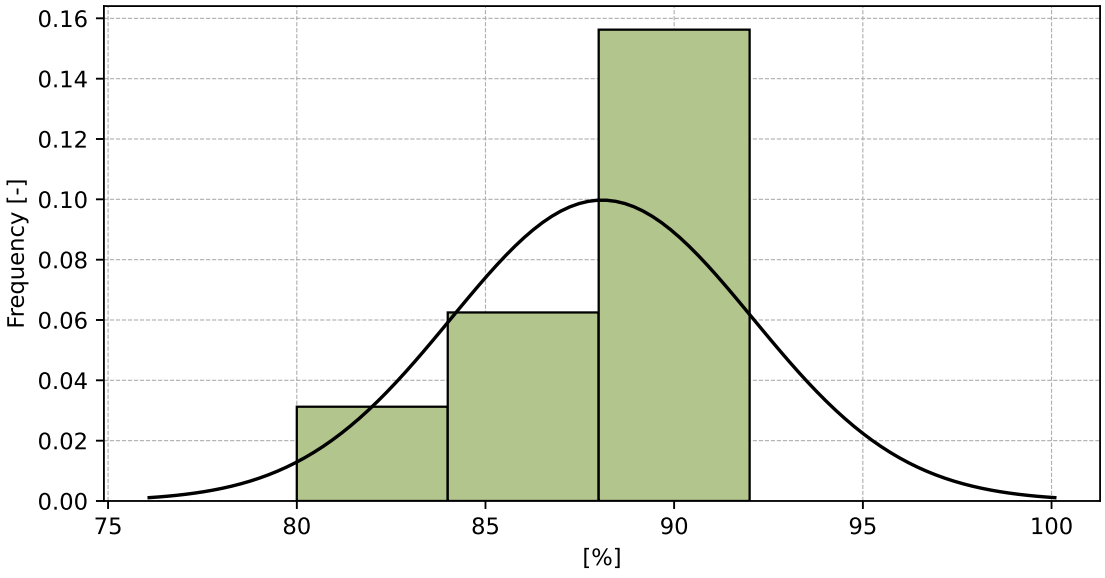


Figure 115: Histogram of all test results

Table 50: Descriptive statistics

| Characteristics | [%] |
|---|---|
| Average value – $\bar{x}$ | 88 |
| Sample standard deviation – $s$ | 4.0 |
| Asigned value – $x^*$ | 89 |
| Robust standard deviation – $s^*$ | 2.7 |
| Measurement uncertainty of asigned value – $u_X$ | 1.7 |
| $p$-value of normality test | 0.151 [-] |
| Interlaboratory standard deviation – $s_L$ | 3.8 |
| Repeatability standard deviation – $s_r$ | 1.9 |
| Reproducibility standard deviation – $s_R$ | 4.2 |
| Repeatability – $r$ | 5 |
| Reproducibility – $R$ | 12 |

## 15.5 Evaluation of Performance Statistics

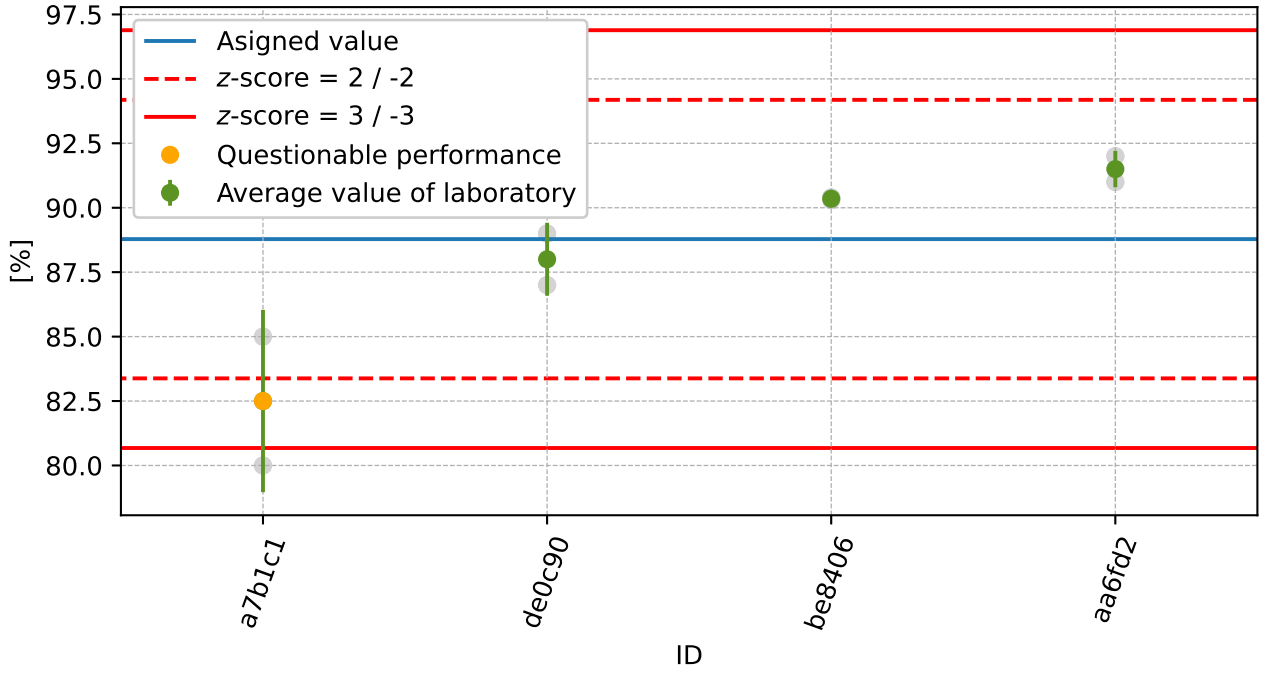


Figure 116: Average values and sample standard deviations

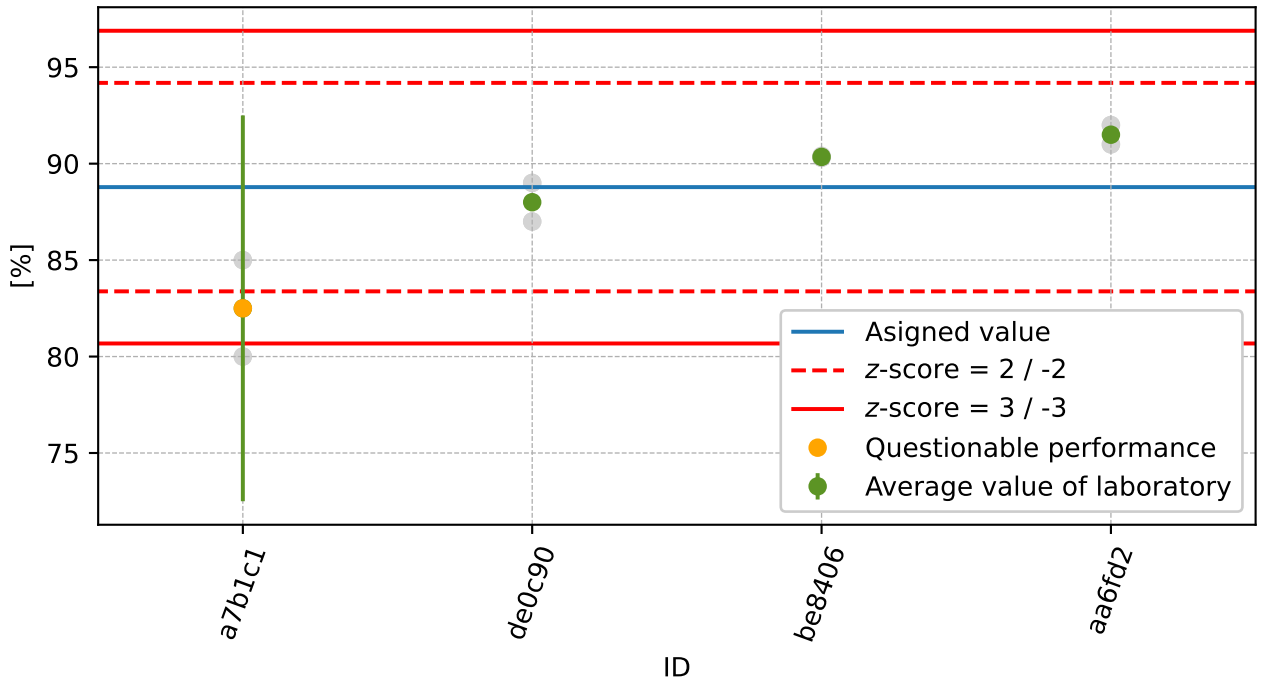


Figure 117: Average values and extended uncertainties of measurement

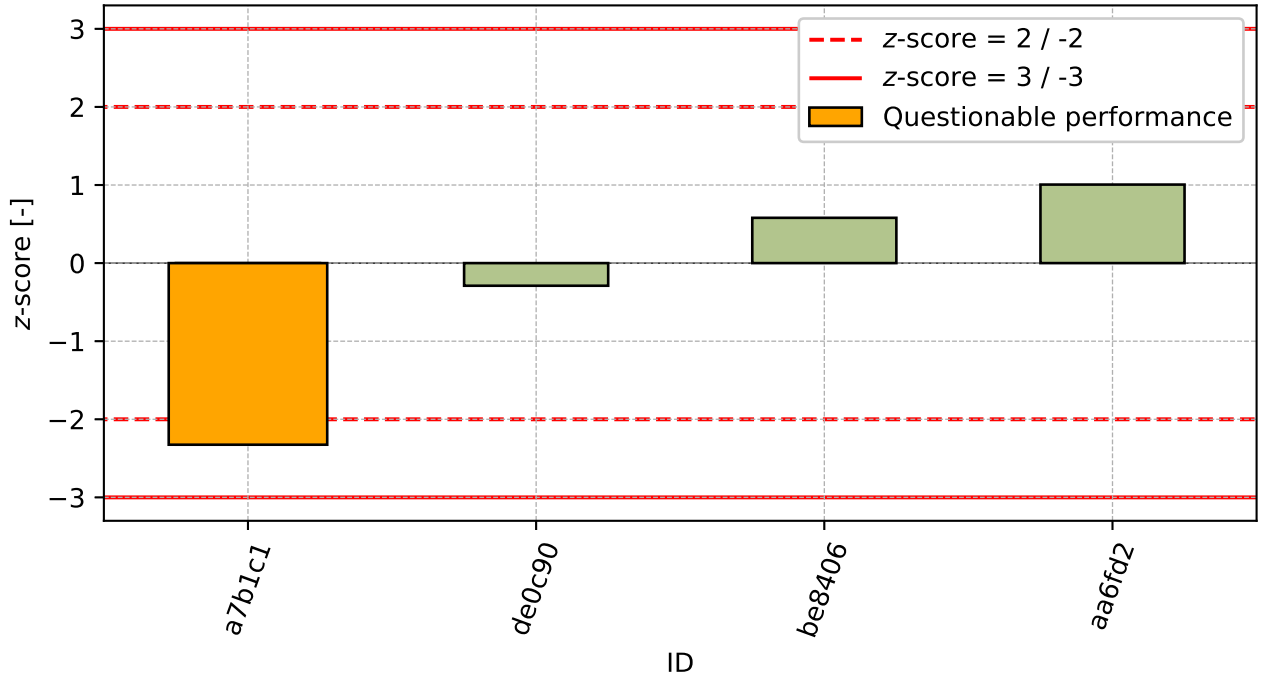


Figure 118: z-score

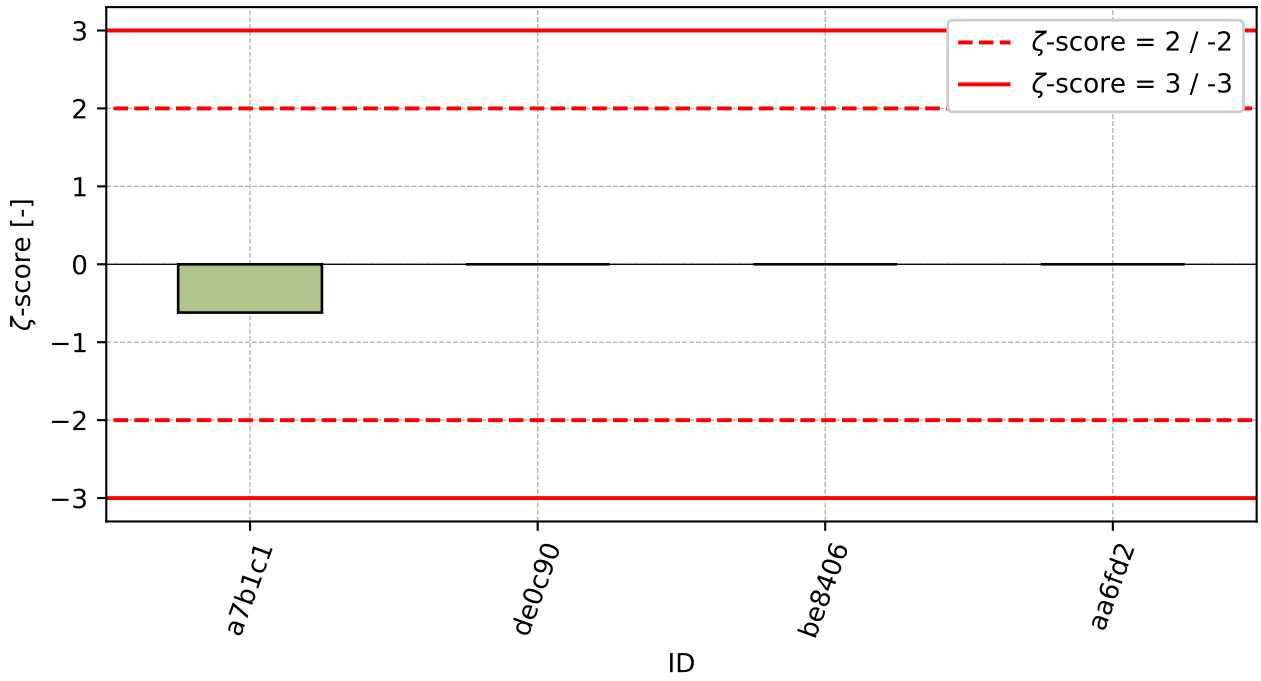


Figure 119: ζ-score

Table 51: *z*-score and ζ-score

| ID | *z*-score [-] | ζ-score [-] |
|---|---|---|
| a7b1c1 | -2.33 | -0.62 |
| de0c90 | -0.29 | - |
| be8406 | 0.58 | - |
| aa6fd2 | 1.01 | - |