BRNO UNIVERSITY OF TECHNOLOGY

Z 7008

FACULTY OF CIVIL ENGINEERING
institute of building testing

FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

PROFICIENCY TESTING PROGRAM
Aggregate Testing

ZK 2019/1

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

www.szk.fce.vutbr.cz

Date: 6/21/2019

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

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

1 Introduction and Important Contacts

In the year 2019, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZK 2019/1 whose aim was to verify and assess the conformity of test results across laboratories when testing aggregate.

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

Head of the PT Provider, PTP coordinator

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 - Příloha 1 a 2 – Reaktivnost kameniva s alkáliemi [16],
18. ČSN 72 1179 Determination of reactivity of aggregates in connection with alkalies – chapter B [17].

Testing procedures No 7, 9, 13, 15, 16, 17 a 18 were not open according to the low number of participants.

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

The test results from individual PTP participants were compared via a method involving the statistical analysis of all their results in a manner complying with ISO 5725-2 [18] and with EN ISO/IEC 17043 [19]. The

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

56 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 (tests designated according to part 1)

ID/Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
3650eb	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
a7d721	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
7a0d97	X	-	X	-	-	-	-	-	-	-	X	X	-	X	-	-	-	-
3bc72f	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
952fc1	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
9652ef	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
6a816e	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
bceff1	X	-	X	-	-	X	-	X	-	X	-	X	-	-	-	-	-	-
65b250	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5069ff	X	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-
f45ea9	X	X	-	-	X	-	-	X	-	-	-	X	-	-	-	-	-	-
362356	X	-	X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-
e4a52e	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
ca9c4c	X	-	-	-	X	-	-	-	-	X	X	X	-	-	-	-	-	-
289dec	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
446aaf	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
f5d861	X	-	X	-	-	-	-	-	-	-	X	X	-	X	-	-	-	-
369f99	-	X	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-	-
8845bf	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
154720	-	-	-	-	X	-	-	X	-	-	-	X	-	-	-	-	-	-
f10b2d	X	-	X	X	-	-	-	X	-	-	X	-	-	-	-	-	-	-
e5e0c9	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
08acdc	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30dfbb	-	-	X	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-
610646	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
e5c7e6	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6f4ad8	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
fdec09	X	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
45cc00	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
296593	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7e5d0a	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
b87672	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
c46861	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
425f4e	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
940f5e	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3fb977	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47cee1	X	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
d08d8d	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-
33435c	-	X	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
6585c7	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
a2c2e4	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-

ID/Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
fa5fc9	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-
717772	X	-	X	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-
f51f2b	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
5def6c	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
119cda	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
f2c559	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
30b65f	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
cecb5e	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
ec35db	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3a8f9d	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-
fb44b2	X	-	X	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-
8c3204	X	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
c1b9d8	X	-	X	X	-	-	-	-	-	X	X	X	-	-	-	-	-	-
b9f9c1	X	-	X	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-
34dbaf	X	X	-	X	X	-	-	X	-	X	X	X	-	X	-	-	-	-

Table 2: List of participants (laboratories) – the order in the table does not correspond to the identification number in Table 1

Laboratory	Address	Accreditation number
ARP GesmbH	Johann-Sackl-Gasse 65-67, Leoben, 8700, Austria	A0125
BEST, a.s.	Lučice 87, Chlumec nad Cidlinou, 50351, Česká republika	-
BETOTECH, s.r.o.	Beroun 660, Beroun, 266 01, Česká republika	1195.3
BETOTECH, s.r.o. - pracoviště Beroun	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Cheb	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Jindřichův Hradec	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Klatovy	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Most	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Ostrava	Beroun 660, BEROUN, 266 01, Česká republika	1195.2
BETOTECH, s.r.o. - pracoviště Trutnov	-	1195
Betotech s.r.o., Brno - kamenivo	Beroun 2, Beroun, 266 01, Česká republika	1195.3
CEMEX Czech Republic, s.r.o.	Semtín 102, Pardubice, 53354, Česká republika	1302
CS-BETON s.r.o. Zkušební laboratoř CS-BETON	Velké Žernoseky 184, Litoměřice, 412 01, Česká republika	1500
CSS d.o.o.	Savska cesta 144a, Zagreb, 10000, CROATIA	HR 1106
Centrum dopravního výzkumu, v.v.i.	Líšeňská 33a, Brno, 63600, Česká republika	1506
Concrefy	Olivier van Noortweg 10, Venlo, 5929 LX, Limburg	-

Laboratory	Address	Accreditation number
DOO ”Gradjevinski Institut Montenegro” Podgorica	Mitra Bakića 124, Podgorica, 81000, Montenegro	-
DOO Geomehanika, Ivica Ivandić	Dobropoljska 21, Belgrade, 11 000, Serbia	-
DSP a.s.	Kostěnice 111, Pardubice, 530 02, Česká republika	-
Dobrovolný laboratoř s.r.o.	bratří Mrštíků 315/15, Brno - Husovice, 614 00, Česká republika	-
ESLAB, spol. s r.o.	Běluňská 2913/11, Praha, 193 00, Česká republika	1699
Holcim (Hrvatska) d.o.o.	Koromačno 7b, Koromačno, HR – 52222 Koromačno, Croatia	1528
Institute IMS a.d.,	Bulevar vojvode Misica 43„ Belgrade, 11000, Serbia	-
LABIS EOOD - Independent construction laboratory LABIS	DOIRAN 9A, SOFIA, 1680, BULGARIA	6 LI
LB MINERALS, s.r.o.	Tovární 431, Horní Bříza, 33012, Česká republika	-
Laboratoire Central des Travaux Publics - LCTP	1, Rue Kaddour RAHIM- HUSSEIN DEY, ALGER, 16040, ALGERIE	-
Lafarge Cement, a.s.	Čížkovice čp. 27, Čížkovice, 411 12, Česká republika	1426
MC-Bauchemie s.r.o.	Skandinávská 990, Žebrák, 26753, Česká republika	208
MIRTEC S.A.(EBETAM A.E.), Thiva Branch	72nd Km of Athens-Lamia National Road, Ritsona, Chalkida, 34100, Greece	0453
QUALIFORM SLOVAKIA s.r.o. , Pracovisko 01 Bratislava	Pasienková 9 D, Bratislava, 82106, Slovenská republika	154/S-301
QUALIFORM SLOVAKIA s.r.o. - organizační složka	Lesní 693, Bílovice nad Svitavou, 66401, Česká republika	S-301
QUALIFORM, a.s. - Brno	Mlaty 672/8, Brno - Bosonohy, 642 00, Česká republika	1008
QUALIFORM, a.s. - Olomouc	Mlaty 672/8, Brno - Bosonohy, 642 00, Česká republika	1008
SMP CZ,a.s Centrální laboratoř	Vyskočilova 1566, Michle, PRAHA 4, 140 00, Česká republika	1168
SQZ s.r.o.	U místní dráhy 939/5, Olomouc - Nová ulice, 779 00, Česká republika	1135.2
SQZ, s.r.o. - organizačná zložka Bratislava	Mlynské Nivy 68, Bratislava, 82105, Slovensko	566/S-376
STACHEMA Bratislava a.s.	Železničná 714/180, Rovinka, 900 41, Slovenská republika	S-275
Sibotec cvba	Industriepark Oost 6, Beernem, 8730, Belgium	-
Skanska Transbeton, s.r.o. - zkušební laboratoř Letňany	Skanska a.s., Křižíkova 682/34a, Praha 8 - Karlín, 186 00, Česká republika	1122
Skanska Transbeton, s.r.o. - zkušební laboratoř Olomouc	Skanska a.s., Křižíkova 682/34a, Praha 8 - Karlín, 186 00, Česká republika	1122
Sofia,Bulgaria, Kostenec STR.12 Accredited laboratory 182 LI	Kostenec STR.12, Sofia, 1612, Bulgaria	-

Laboratory	Address	Accreditation number
TPA EOOD CTC BURGAS, land Meden rudnik, area Nad Djambazlare, Bulgaria	Rezbarska 7 str., SOFIA, 1510, BULGARIA	-
TPA EOOD CTC KREPOST, Asphalt plant Strabag, municipality Dimitrovgrad, area Haskovo, Bulgaria	Rezbarska 7 str., SOFIA, 1510, BULGARIA	-
TPA EOOD CTC SOFIA, Rezbarska 7 str., SOFIA, 1510, BULGARIA	Rezbarska 7 str., SOFIA, 1510, BULGARIA	-
TPA spoločnosť pre zabezpečenie kvality a inovácie s.r.o - pracovisko Zvolen	Neresnická cesta 3, Zvolen, 960 01, Slovenská republika	211/S-176
TPA ČR s.r.o.	Vrbenská 1821/31, České Budějovice, 37006, Česká republika	1181
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 37006, Česká republika	1181
TPA ČR, s.r.o.	Ústřední 62, Praha 10, 102 00, Česká republika	1181
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 370 06, Česká republika	1181
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 370 06, Česká republika	1181
TPA ČR, s.r.o.	Vrbenksá 1821/31, České Budějovice, 370 06, Česká republika	1181
Výzkumný ústav pozemních staveb - Certifikační společnost s.r.o.	Pražská 810/16, Praha 10, 102 21, Česká republika	1234
iTER solutions S.A.	Rue du Tronquoy, 24, Fernelmont, 5380, Brlgium	BELAC 422-TEST
Ústav stavebního zkušebnictví s.r.o.	Jiřího Potůčka 115, Pardubice, 53009, Česká republika	-
Ředitelství silnic a dálnic ČR	Rebešovická 40, Brno-Chrlice, 643 00, Česká republika	1072
Ředitelství silnic a dálnic ČR, laboratoř Praha	Na Pankráci 546/56, Praha 4, 145 05, 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.
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.
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.

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

3 Conclusions of the Statistical Analysis

The present report summarizes the results of the Proficiency Testing Program ZK 2019/1 (PT Program) organized by the PT Provider at the SZK FAST. 56 participants (laboratories) took part in the PT Program. 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.

The testing method No. 1 (EN 933-1) is evaluated separately in part 3.1. Testing method No. 6: The evaluation of intralaboratory variability was not used due to the different number of observations.

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 three levels at least.

Considering the different rounding of test results, the numerical critical evaluation by Cochran's test was not used. The outliers were evaluated by Grubbs' test only (see section 2).

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 / Sieve	4	2	1	0.5	0.25	0.125	0.063	Performance
289dec	✓	✓	✓	✓	✓	✓	✓	✓
296593	✓	✓	✓	?	?	✓	✓	✓
30b65f	✓	✓	✓	✓	✓	✓	✓	✓
34dbaf	✓	✓	✓	✓	✓	✓	✓	✓
362356	✓	✓	✓	✓	✓	?	✓	✓
3bc72f	✓	✓	✓	✓	✓	✓	✓	✓
3fb977	✓	✓	✓	✓	✓	✓	✓	✓
425f4e	✓	✓	✓	✓	✓	✓	✓	✓
446aaf	✓	✓	✓	✓	✓	✓	✓	✓
45cc00	✓	✓	✓	?	?	✓	✓	✓
47cee1	✓	✓	✓	✓	✓	✓	✓	✓
5069ff	!	✓	X	✓	✓	X	X	X
6585c7	✓	?	?	✓	✓	✓	✓	✓
65b250	✓	X	?	✓	✓	✓	✓	✓
6a816e	✓	✓	✓	✓	✓	✓	✓	✓
717772	✓	✓	✓	?	✓	✓	✓	✓

ID / Sieve	4	2	1	0.5	0.25	0.125	0.063	Performance
7a0d97	✓	✓	✓	✓	✓	!	✓	✓
8c3204	✓	✓	✓	✓	✓	✓	?	✓
940f5e	✓	✓	✓	✓	✓	?	✓	✓
952fc1	✓	✓	✓	✓	✓	✓	✓	✓
9652ef	✓	✓	✓	✓	✓	!	✓	✓
a2c2e4	✓	✓	✓	✓	✓	✓	✓	✓
a7d721	✓	✓	?	✓	✓	✓	✓	✓
b87672	✓	✓	✓	✓	✓	✓	✓	✓
b9f9c1	✓	✓	✓	✓	✓	✓	✓	✓
bceff1	✓	✓	✓	✓	✓	✓	✓	✓
c1b9d8	✓	✓	✓	✓	✓	✓	✓	✓
c46861	✓	✓	✓	✓	✓	✓	✓	✓
ca9c4c	✓	✓	✓	?	?	!	?	?
e4a52e	✓	✓	✓	✓	✓	✓	✓	✓
e5c7e6	✓	✓	✓	✓	✓	✓	✓	✓
ec35db	✓	✓	✓	✓	✓	✓	✓	✓
f10b2d	?	✓	X	✓	✓	✓	✓	✓
f45ea9	✓	✓	✓	✓	✓	✓	✓	✓
f5d861	!	✓	✓	?	X	X	X	X
fb44b2	✓	✓	✓	✓	✓	✓	✓	✓
fdec09	✓	✓	✓	✓	✓	✓	✓	✓

3.2 Overall Performance Evaluation

Testing methods can be found in part 1 of this report. Non-open testing methods in this PT program are not shown in the following table.

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

ID / Method	1	2	3	4	5	6	8	10	11	12	14
154720	-	-	-	-	X	-	✓	-	-	✓	-
296593	✓	-	-	-	-	-	-	-	-	-	-
362356	✓	-	✓	-	-	-	-	✓	?	-	-
610646	-	-	-	✓	-	-	-	-	-	-	-
717772	✓	-	✓	-	-	✓	-	-	✓	-	-
08acdc	-	-	-	✓	-	-	-	-	-	-	-
119cda	-	-	-	-	-	✓	-	-	-	-	-
289dec	✓	-	✓	✓	-	-	-	-	-	-	-
30b65f	✓	-	-	-	-	-	-	-	✓	-	-
30dfbb	-	-	✓	-	-	-	✓	-	-	✓	-
33435c	-	✓	-	-	-	-	-	-	✓	✓	-
34dbaf	✓	✓	-	✓	✓	-	✓	✓	✓	✓	✓
3650eb	-	-	-	-	-	✓	-	-	-	-	-
369f99	-	✓	-	-	-	-	✓	✓	-	-	-
3a8f9d	-	-	-	✓	-	-	-	-	✓	-	-
3bc72f	✓	-	-	-	-	-	-	-	✓	-	-
3fb977	✓	-	-	-	-	-	-	-	-	-	-
425f4e	✓	-	✓	-	-	-	-	-	-	-	-
446aaf	✓	-	-	-	-	-	-	-	✓	-	-

ID / Method	1	2	3	4	5	6	8	10	11	12	14
45cc00	✓	-	-	-	-	-	-	-	-	-	-
47cee1	✓	-	✓	-	-	-	-	-	-	✓	-
5069ff	X	-	-	✓	-	-	-	-	X	-	-
5def6c	-	-	-	-	-	✓	-	-	-	-	-
6585c7	✓	-	✓	-	-	-	-	-	✓	-	-
65b250	✓	-	-	-	-	-	-	-	-	-	-
6a816e	✓	-	✓	-	-	-	-	-	✓	✓	-
6f4ad8	-	-	-	-	-	-	✓	-	-	-	-
7a0d97	✓	-	✓	-	-	-	-	-	✓	✓	✓
7e5d0a	-	✓	-	-	-	-	-	-	-	-	✓
8845bf	-	-	-	-	✓	-	-	-	-	-	-
8c3204	✓	-	✓	-	-	-	-	-	-	X	-
940f5e	✓	-	-	-	-	-	-	-	-	-	-
952fc1	✓	-	✓	-	-	-	-	-	✓	✓	-
9652ef	✓	-	-	-	-	-	-	-	✓	-	-
a2c2e4	✓	-	✓	-	-	-	-	-	✓	-	-
a7d721	✓	-	✓	-	-	-	-	-	✓	✓	-
b87672	✓	-	-	-	-	-	-	-	✓	-	-
b9f9c1	✓	-	✓	-	-	-	-	✓	✓	✓	-
bceff1	✓	-	✓	-	-	✓	✓	✓	-	✓	-
c1b9d8	✓	-	✓	✓	-	-	-	✓	✓	✓	-
c46861	✓	-	✓	-	-	-	-	-	✓	-	-
ca9c4c	?	-	-	-	✓	-	-	✓	✓	✓	-
cecb5e	-	-	-	-	-	✓	-	-	-	-	-
d08d8d	-	-	-	-	-	-	-	✓	-	-	✓
e4a52e	✓	-	✓	-	-	-	-	-	✓	✓	-
e5c7e6	✓	-	-	-	-	-	-	-	-	-	-
e5e0c9	-	-	-	-	✓	-	-	-	-	-	-
ec35db	✓	-	-	-	-	-	-	-	-	-	-
f10b2d	✓	-	✓	✓	-	-	✓	-	✓	-	-
f2c559	-	-	-	-	-	?	-	-	-	-	-
f45ea9	✓	✓	-	-	✓	-	✓	-	-	✓	-
f51f2b	-	-	-	-	-	✓	-	-	-	-	-
f5d861	X	-	✓	-	-	-	-	-	✓	✓	✓
fa5fc9	-	-	-	✓	-	✓	-	-	-	-	-
fb44b2	✓	-	✓	-	-	-	-	✓	✓	✓	-
fdec09	✓	-	✓	-	-	-	-	✓	-	-	-

References

[1] EN 933-1. *Tests for geometrical properties of aggregates - Part 1: Determination of particle size distribution - Sieving method*. 2012.

[2] EN 933-3. *Tests for geometrical properties of aggregates - Part 3: Determination of particle shape - Flakiness index*. 2012.

[3] EN 933-4. *Tests for geometrical properties of aggregates - Part 4: Determination of particle shape - Shape index*. 2008.

[4] EN 933-8. *Tests for geometrical properties of aggregates - Part 8: Assessment of fines - Sand equivalent test*. 2015.

[5] EN 933-9. *Tests for geometrical properties of aggregates - Part 9: Assessment of fines - Methylene blue test*. 2013.

[6] EN 933-10. *Tests for geometrical properties of aggregates - Part 10: Assessment of fines - Grading of filler aggregates (air jet sieving)*. 2010.

[7] EN 1097-1. *Tests for mechanical and physical properties of aggregates - Part 1: Determination of the resistance to wear (micro-Deval)*. 2011.

[8] EN 1097-2. *Tests for mechanical and physical properties of aggregates - Part 2: Methods for the determination of resistance to fragmentation*. 2010.

[9] EN 1097-3. *Tests for mechanical and physical properties of aggregates - Part 3: Determination of loose bulk density and voids*. 1999.

[10] EN 1097-5. *Tests for mechanical and physical properties of aggregates - Part 5: Determination of the water content by drying in a ventilated oven*. 2008.

[11] EN 1097-6. *Tests for mechanical and physical properties of aggregates - Part 6: Determination of particle density and water absorption*. 2014.

[12] EN 1097-7. *Tests for mechanical and physical properties of aggregates - Part 7: Determination of the particle density of filer - Pyknometer method*. 2008.

[13] EN 1367-1. *Tests for thermal and weathering properties of aggregates - Part 1: Determination of resistance to freezing and thawing*. 2007.

[14] EN 1367-2. *Tests for thermal and weathering properties of aggregates - Part 2: Magnesium sulfate test*. 2010.

[15] EN 1367-3. *Tests for thermal and weathering properties of aggregates - Part 3: Boiling test for "Sonnenbrand basalt"*. 2001.

[16] TP 137. *Příloha 1 a 2 – Reaktivnost kameniva s alkáliemi*.

[17] ČSN 721179. *Determination of reactivity of aggregates in connection with alkalies*. 2004.

[18] ISO 5725-2. *Accuracy (trueness and precision) of measurement methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*. 1997.

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

[20] ISO 13 528. *Statistical methods for use in proficiency testing by interlaboratory comparisons*. 2005.

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 star. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
c1b9d8	97.0	97.0	97.0	-	97.0	0.0	0.0
8c3204	97.0	98.0	96.0	2.1	97.0	1.0	1.03
65b250	97.0	97.0	97.0	3.4	97.0	0.0	0.0
47cee1	96.9	96.8	97.7	3.9	97.1	0.49	0.51
952fc1	98.0	97.0	97.0	0.3	97.3	0.58	0.59
446aaf	97.6	97.8	96.9	2.9	97.4	0.47	0.49
c46861	97.5	97.3	97.6	1.1	97.5	0.15	0.16
296593	97.6	97.5	97.5	0.1	97.5	0.06	0.06
e5c7e6	97.3	97.8	97.6	1.4	97.6	0.25	0.26
6585c7	98.2	97.5	97.0	0.2	97.6	0.6	0.62
940f5e	98.0	97.3	97.4	-	97.6	0.38	0.39
717772	97.6	97.6	97.7	3.0	97.6	0.06	0.06
a7d721	97.6	98.0	97.4	3.0	97.7	0.31	0.31
f45ea9	98.0	97.0	98.0	1.9	97.7	0.58	0.59
ec35db	98.0	97.0	98.0	2.0	97.7	0.58	0.59
3bc72f	98.0	97.0	98.0	2.0	97.7	0.58	0.59
425f4e	98.0	98.0	97.0	0.1	97.7	0.58	0.59
ca9c4c	97.0	98.0	98.0	-	97.7	0.58	0.59
362356	97.4	97.9	97.8	0.9	97.7	0.26	0.27
b87672	97.9	97.8	97.9	0.2	97.9	0.06	0.06
45cc00	98.1	98.0	97.7	0.1	97.9	0.21	0.21
3fb977	97.9	97.6	98.4	0.5	98.0	0.4	0.41
a2c2e4	98.0	98.0	98.0	0.6	98.0	0.0	0.0
30b65f	98.0	98.0	98.0	0.1	98.0	0.0	0.0
fb44b2	98.0	98.0	98.0	0.8	98.0	0.0	0.0
34dbaf	99.0	97.0	98.0	1.0	98.0	1.0	1.02
289dec	98.0	98.0	98.0	-	98.0	0.0	0.0
e4a52e	98.0	98.0	98.0	1.0	98.0	0.0	0.0
6a816e	98.0	98.0	98.0	2.3	98.0	0.0	0.0
9652ef	98.0	98.0	98.0	0.3	98.0	0.0	0.0
7a0d97	98.0	98.0	98.0	2.0	98.0	0.0	0.0
b9f9c1	98.0	98.0	98.0	-	98.0	0.0	0.0
bceff1	98.0	98.0	99.0	0.1	98.3	0.58	0.59
fdec09	99.0	97.8	98.4	1.2	98.4	0.6	0.61
f10b2d	97.6	99.8	99.8	-	99.1	1.31	1.32
f5d861	100.0	100.0	100.0	1.0	100.0	0.0	0.0
5069ff	100.0	100.0	100.0	0.0	100.0	0.0	0.0

1.1.2 The Numerical Procedure for Determining Outliers

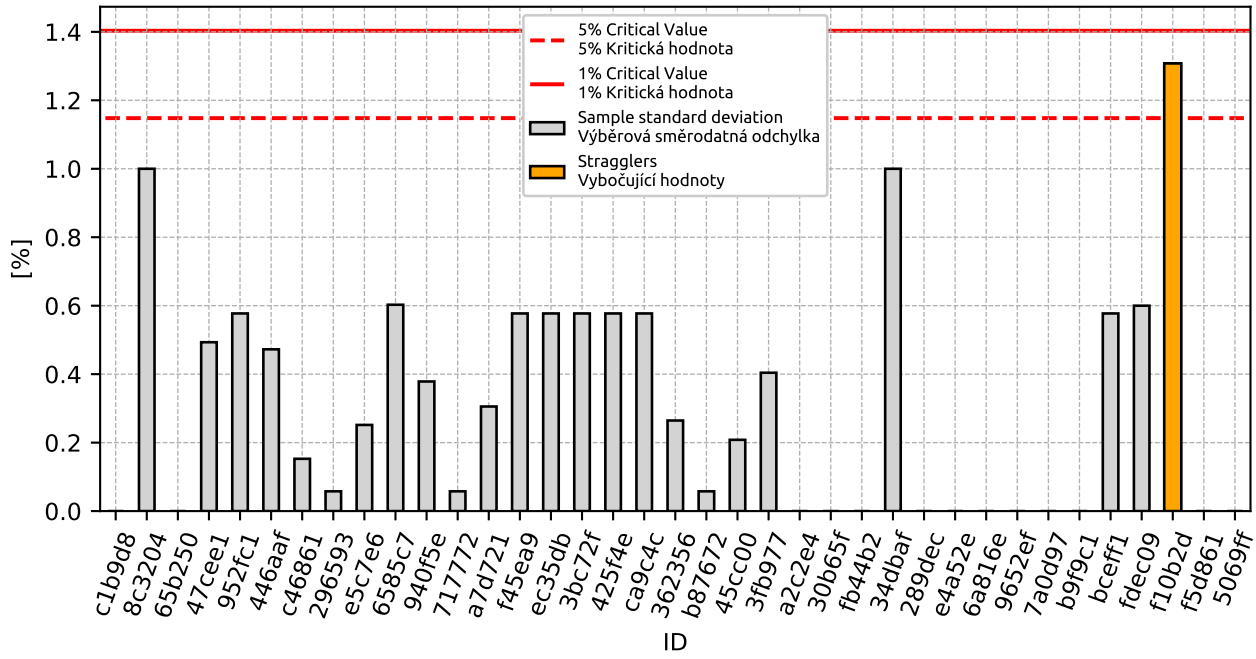

Figure 1: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

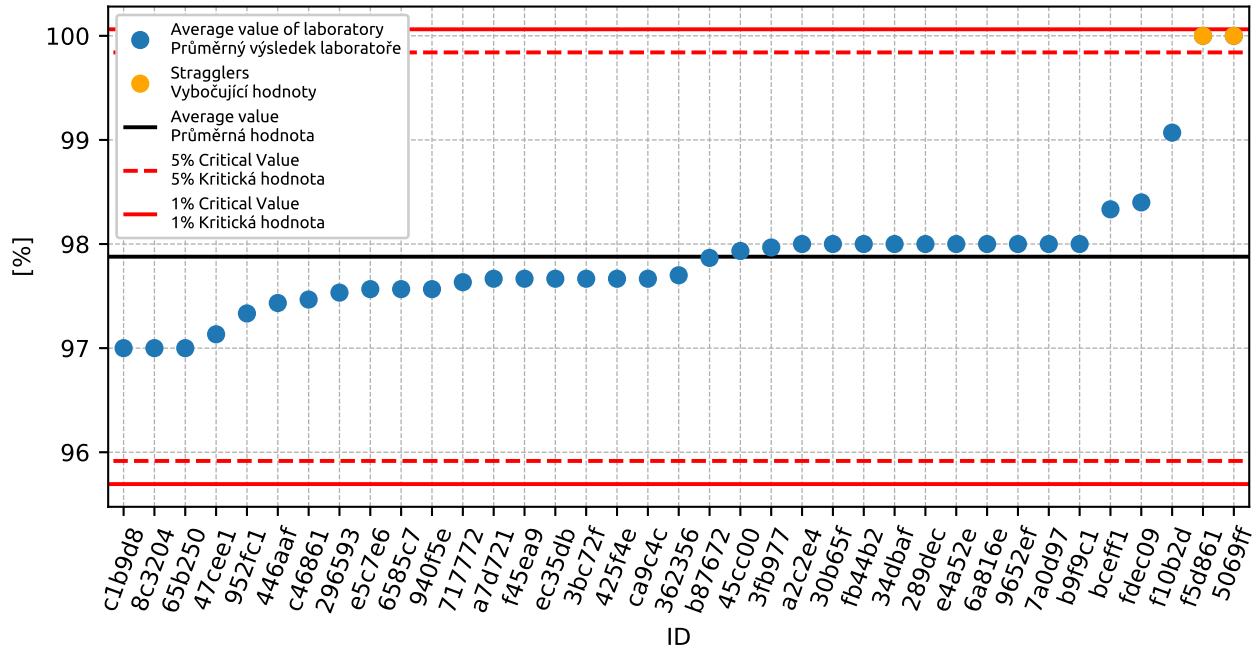

Figure 2: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

1.1.3 Mandel's Statistics

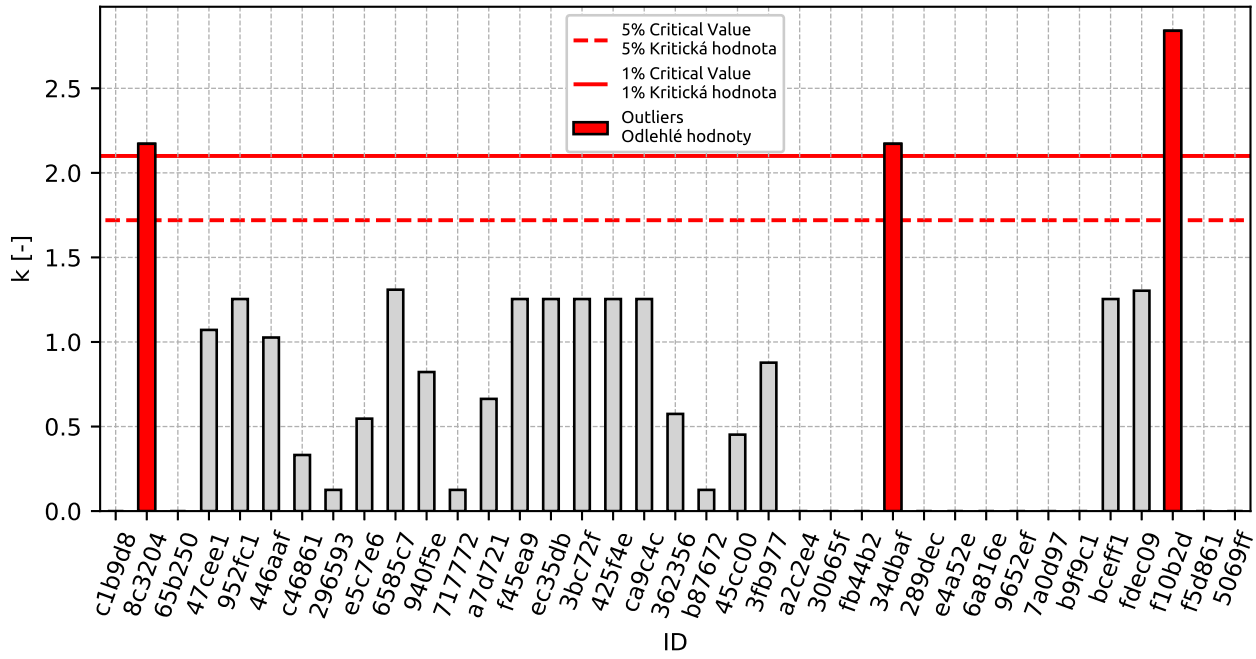

Figure 3: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

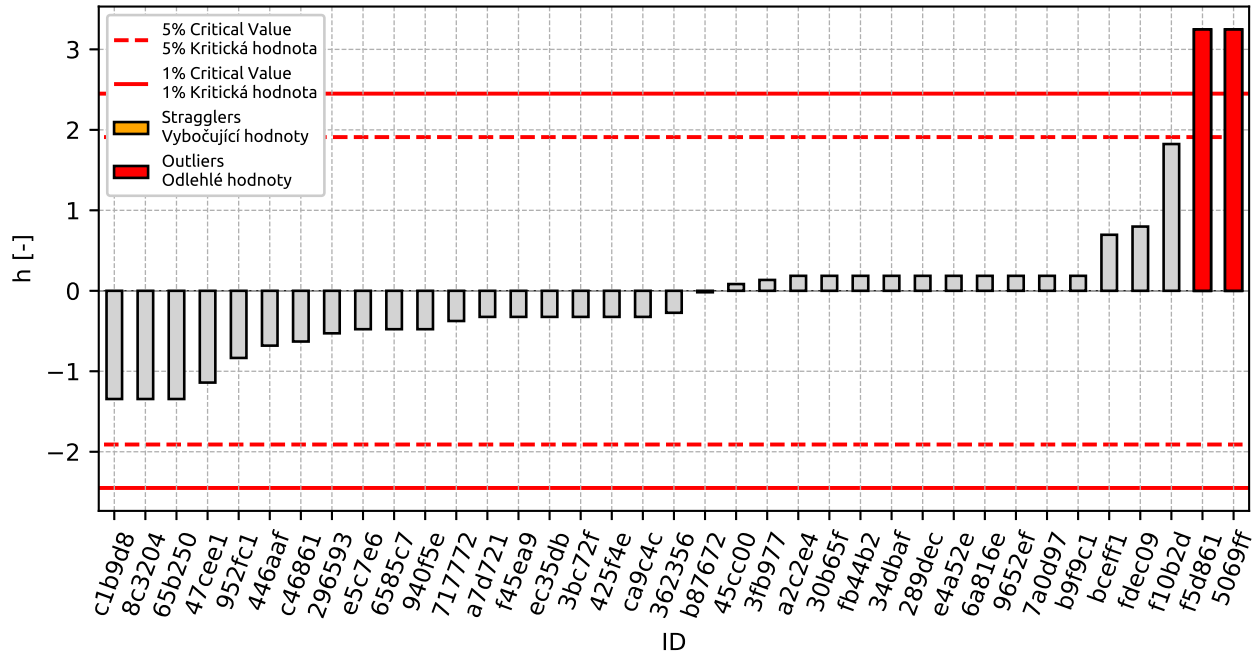

Figure 4: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

1.1.4 Descriptive statistics

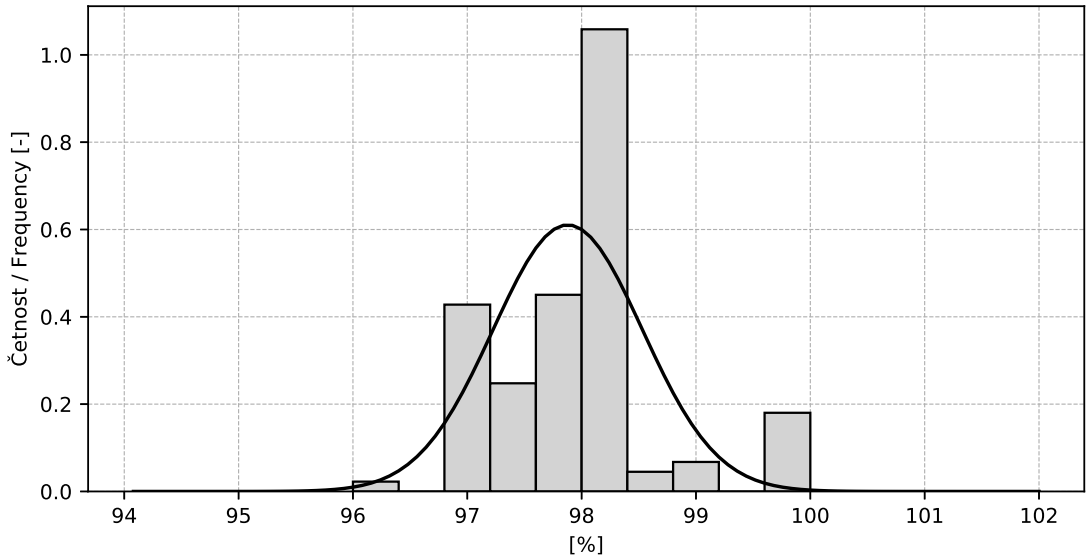

Figure 5: Histogram

Table 6: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	97.9
Výběrová směrodatná odchylka / Sample standard deviation – s	0.65
Vztažná hodnota / Asigned value – x^*	97.8
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.58
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.12
p-hodnota testu normality / p-value of normality test	0.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.6
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.46
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.75
Opakovatelnost / Repeatability – r	1.3
Reprodukovatelnost / Reproducibility – R	2.1

1.1.5 Calculation of Performance Statistics

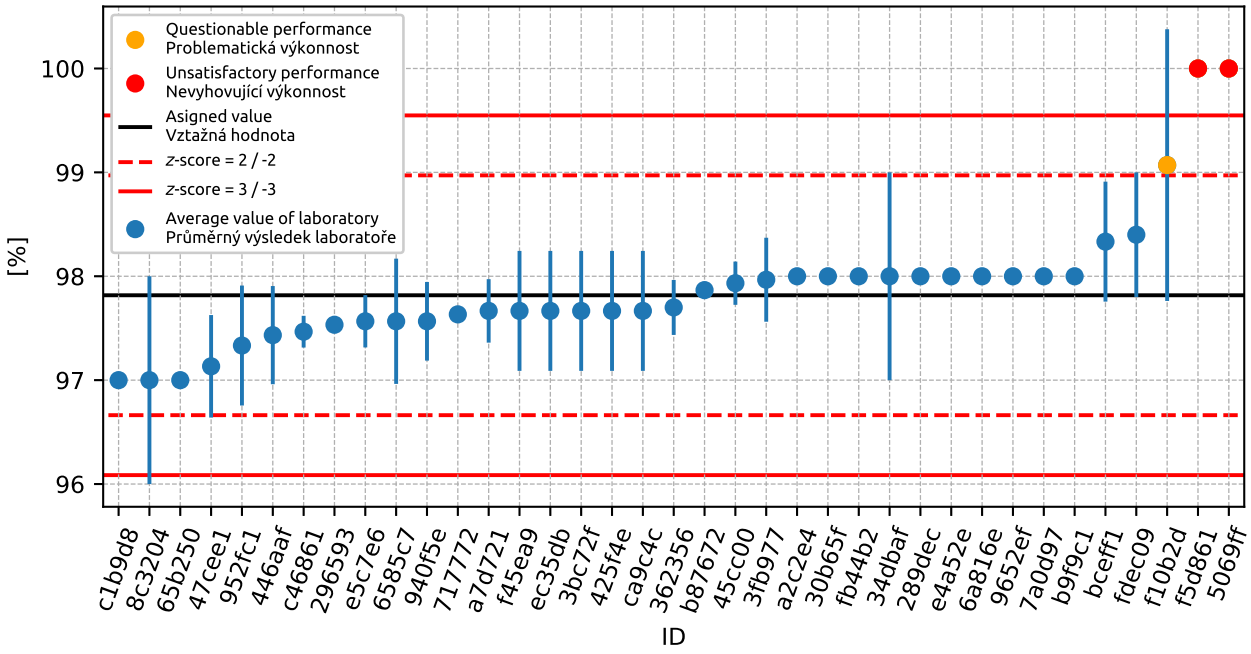

Figure 6: Average values and sample standard deviations

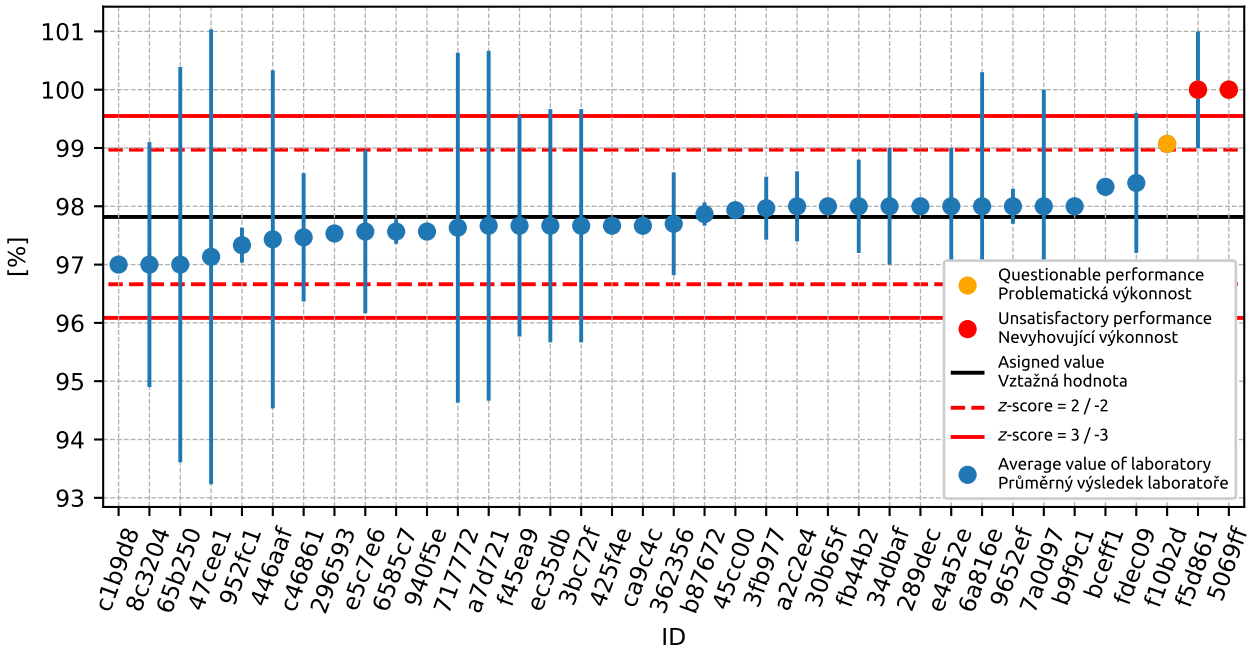

Figure 7: Average values and extended uncertainties of measurement

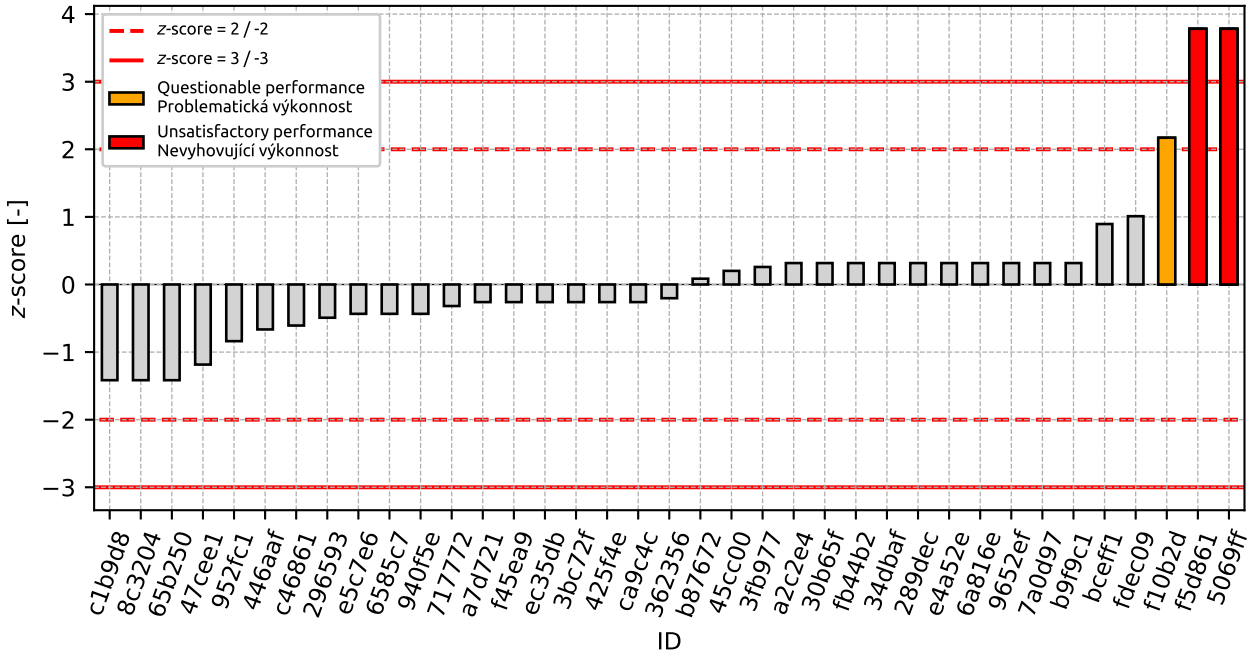

Figure 8: z-score

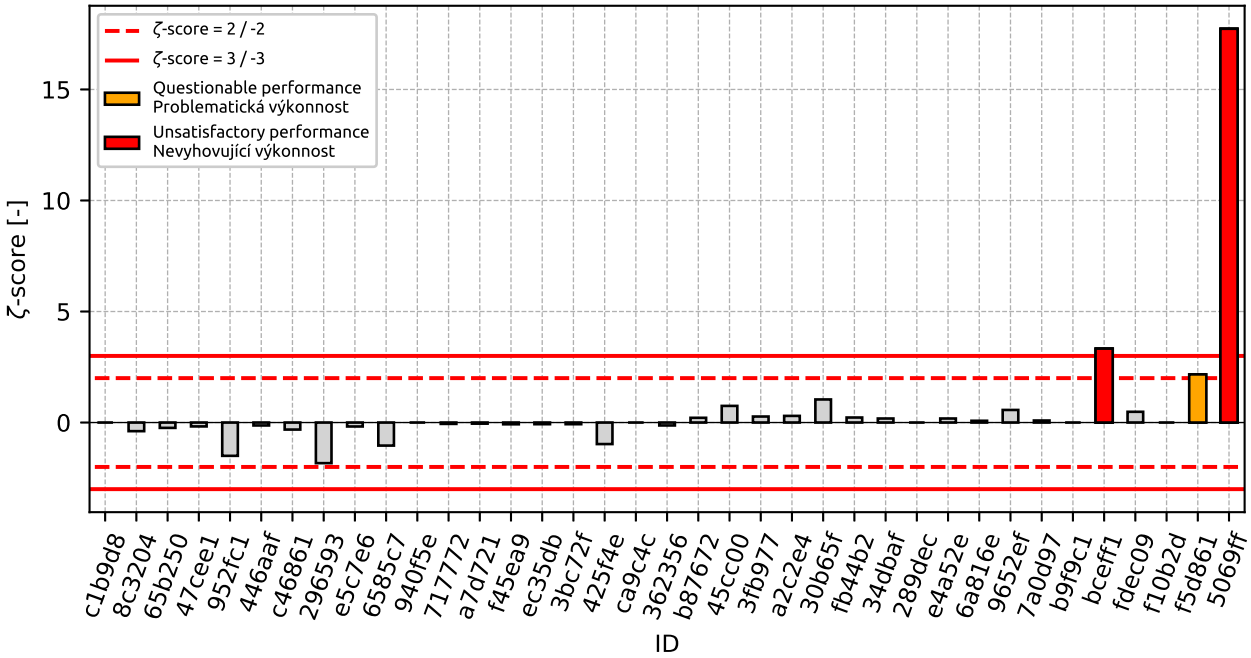

Figure 9: ζ-score

Table 7: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
c1b9d8	-1.42	-
8c3204	-1.42	-0.39
65b250	-1.42	-0.24
47cee1	-1.18	-0.18
952fc1	-0.84	-1.5
446aaf	-0.67	-0.13
c46861	-0.61	-0.32
296593	-0.49	-1.83
e5c7e6	-0.43	-0.18
6585c7	-0.43	-1.04
940f5e	-0.43	-
717772	-0.32	-0.06
a7d721	-0.26	-0.05
f45ea9	-0.26	-0.08
ec35db	-0.26	-0.08
3bc72f	-0.26	-0.08
425f4e	-0.26	-0.97
ca9c4c	-0.26	-
362356	-0.2	-0.13
b87672	0.09	0.21
45cc00	0.2	0.75
3fb977	0.26	0.27
a2c2e4	0.32	0.3
30b65f	0.32	1.04
fb44b2	0.32	0.23
34dbaf	0.32	0.18
289dec	0.32	-
e4a52e	0.32	0.18
6a816e	0.32	0.08
9652ef	0.32	0.57
7a0d97	0.32	0.09
b9f9c1	0.32	-
bceff1	0.89	3.33
fdec09	1.01	0.48
f10b2d	2.17	-
f5d861	3.78	2.17
5069ff	3.78	17.73

1.2 2 mm

1.2.1 Test results

Table 8: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
65b250	80.0	81.0	81.0	2.8	80.7	0.58	0.72
b9f9c1	84.0	83.0	83.0	-	83.3	0.58	0.69
fb44b2	84.0	83.0	84.0	0.8	83.7	0.58	0.69
c1b9d8	84.0	84.0	84.0	-	84.0	0.0	0.0
ec35db	83.0	83.0	86.0	2.0	84.0	1.73	2.06
8c3204	83.0	84.0	85.0	2.4	84.0	1.0	1.19
296593	84.1	83.9	84.6	0.5	84.2	0.36	0.43
c46861	84.4	84.2	84.1	1.1	84.2	0.15	0.18
717772	84.3	84.3	84.4	3.0	84.3	0.06	0.07
425f4e	84.0	85.0	84.0	0.1	84.3	0.58	0.68
e5c7e6	84.2	84.7	84.2	1.4	84.4	0.29	0.34
5069ff	85.0	84.0	84.2	0.5	84.4	0.53	0.63
362356	83.8	84.9	84.7	1.0	84.5	0.59	0.69
47cee1	84.6	84.3	84.6	3.4	84.5	0.17	0.2
940f5e	84.7	84.5	84.3	-	84.5	0.2	0.24
6a816e	84.0	85.0	85.0	2.0	84.7	0.58	0.68
30b65f	84.0	85.0	85.0	0.1	84.7	0.58	0.68
f10b2d	84.3	84.8	85.8	-	85.0	0.72	0.85
fdec09	85.3	84.1	85.6	1.1	85.0	0.79	0.93
3fb977	84.7	85.6	84.7	0.5	85.0	0.52	0.61
a2c2e4	86.0	85.0	84.0	1.7	85.0	1.0	1.18
f45ea9	85.0	85.0	85.0	1.9	85.0	0.0	0.0
7a0d97	85.0	85.0	85.0	2.0	85.0	0.0	0.0
45cc00	85.7	84.8	84.9	0.5	85.1	0.49	0.58
446aaf	86.0	85.8	83.7	2.6	85.2	1.27	1.5
bceff1	86.0	85.0	85.0	0.1	85.3	0.58	0.68
952fc1	86.0	85.0	85.0	0.4	85.3	0.58	0.68
b87672	85.7	85.0	86.3	1.7	85.7	0.65	0.76
e4a52e	87.0	86.0	84.0	1.0	85.7	1.53	1.78
a7d721	86.1	86.8	84.7	3.0	85.9	1.07	1.25
ca9c4c	85.0	87.0	86.0	-	86.0	1.0	1.16
9652ef	86.0	86.0	86.0	0.4	86.0	0.0	0.0
289dec	87.0	86.0	86.0	-	86.3	0.58	0.67
6585c7	88.2	86.6	84.2	0.2	86.3	2.01	2.33
34dbaf	87.0	86.0	86.0	1.0	86.3	0.58	0.67
3bc72f	86.0	87.0	87.0	2.0	86.7	0.58	0.67
f5d861	87.0	87.0	87.0	1.2	87.0	0.0	0.0

1.2.2 The Numerical Procedure for Determining Outliers

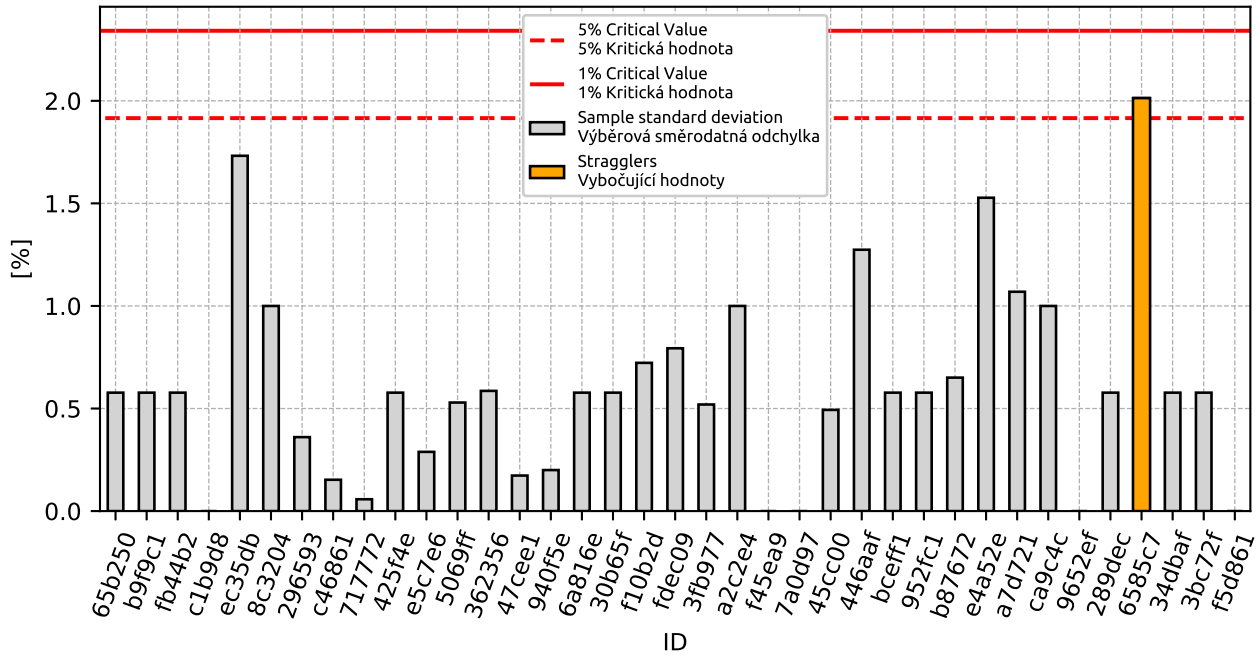

Figure 10: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

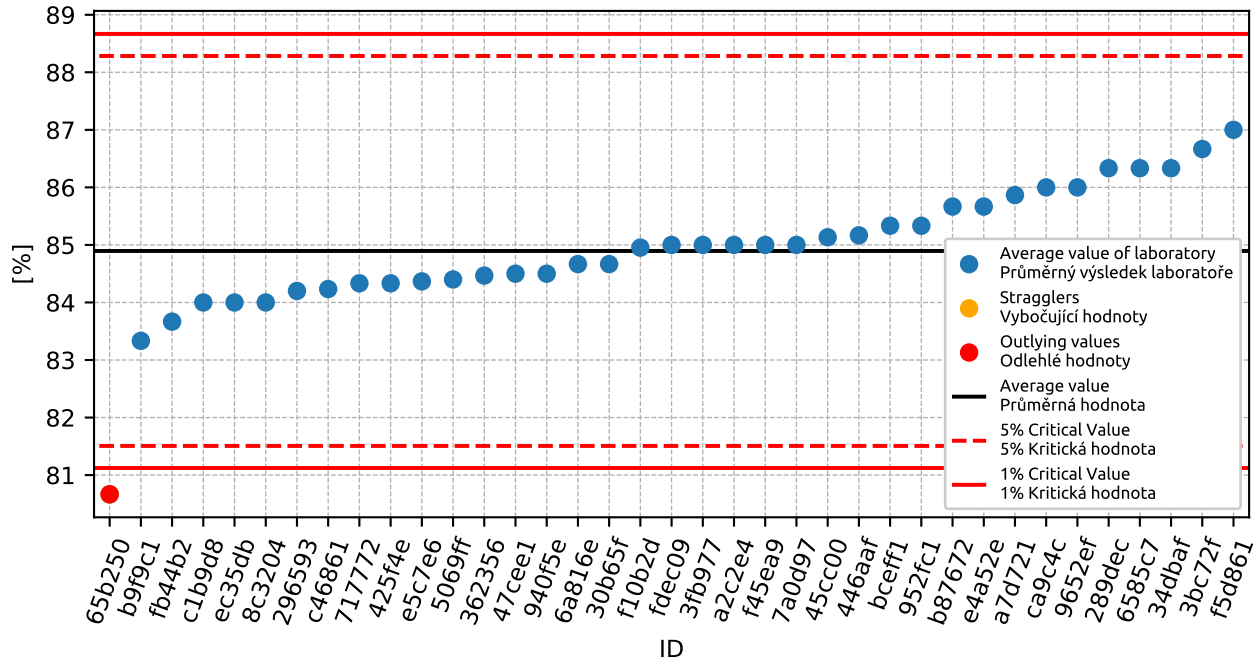

Figure 11: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

1.2.3 Mandel's Statistics

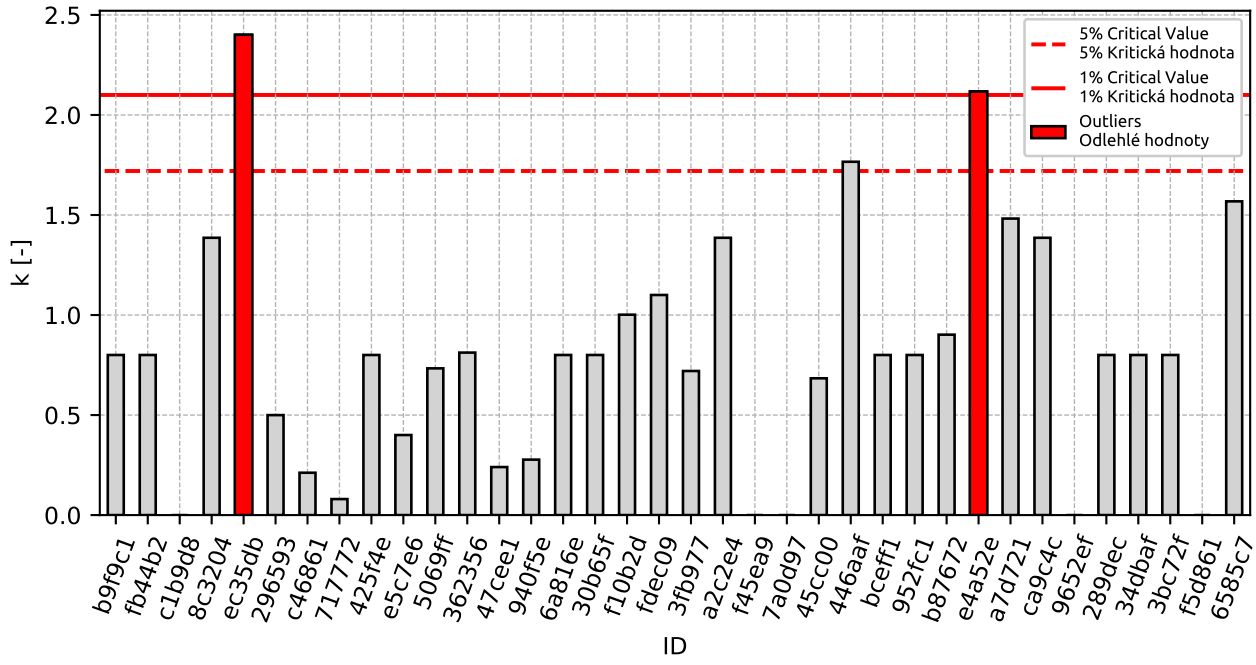

Figure 12: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

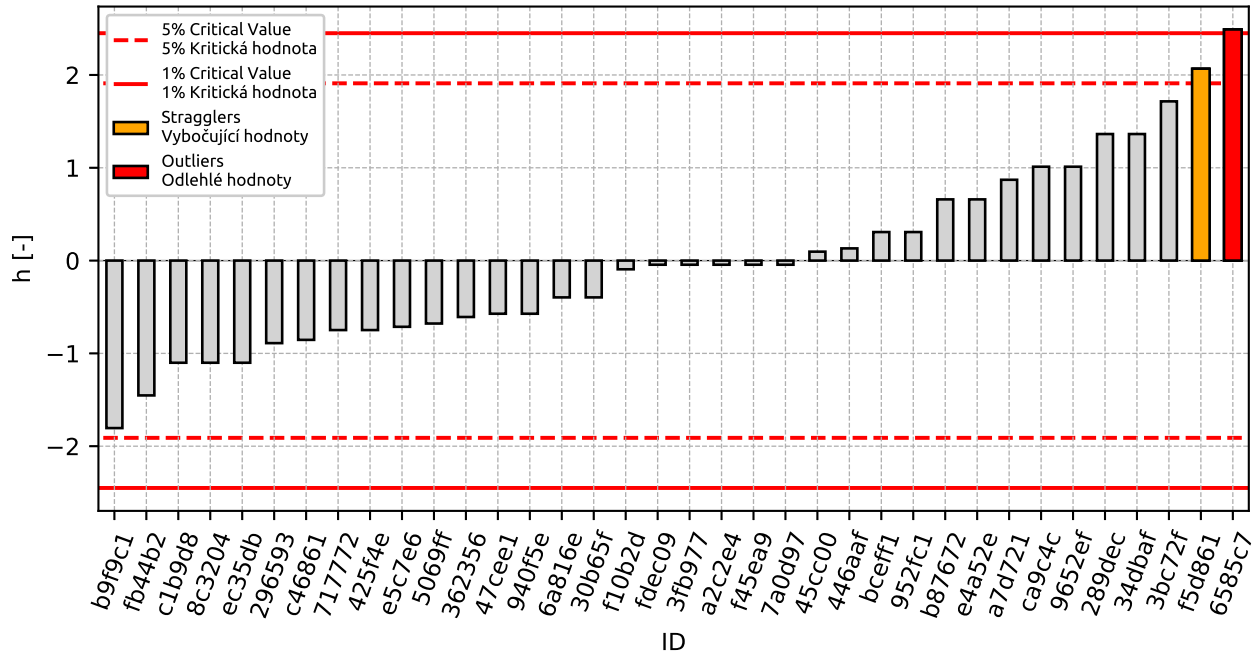

Figure 13: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

1.2.4 Descriptive statistics

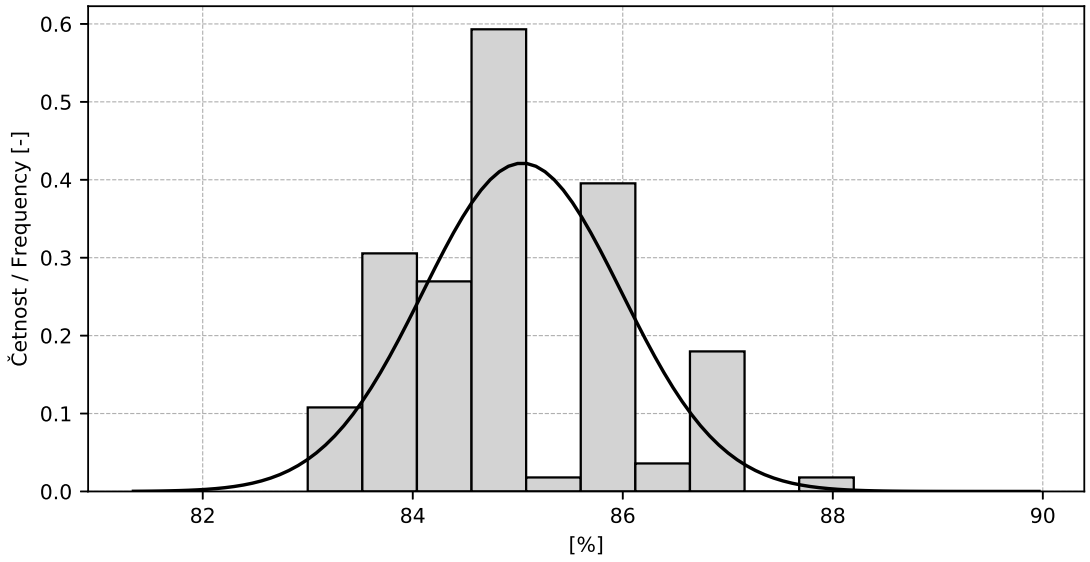

Figure 14: Histogram

Table 9: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	85.0
Výběrová směrodatná odchylka / Sample standard deviation – s	0.95
Vztažná hodnota / Asigned value – x^*	85.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.01
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.21
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.85
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.72
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.12
Opakovatelnost / Repeatability – r	2.0
Reprodukovatelnost / Reproducibility – R	3.1

1.2.5 Calculation of Performance Statistics

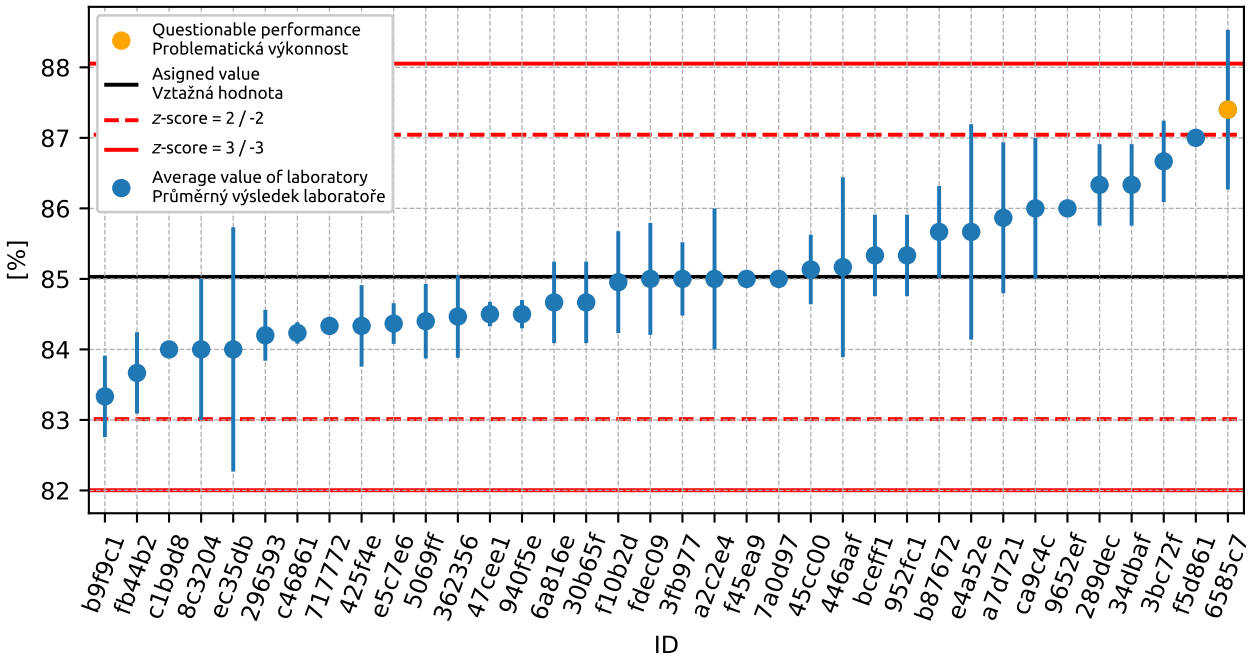

Figure 15: Average values and sample standard deviations

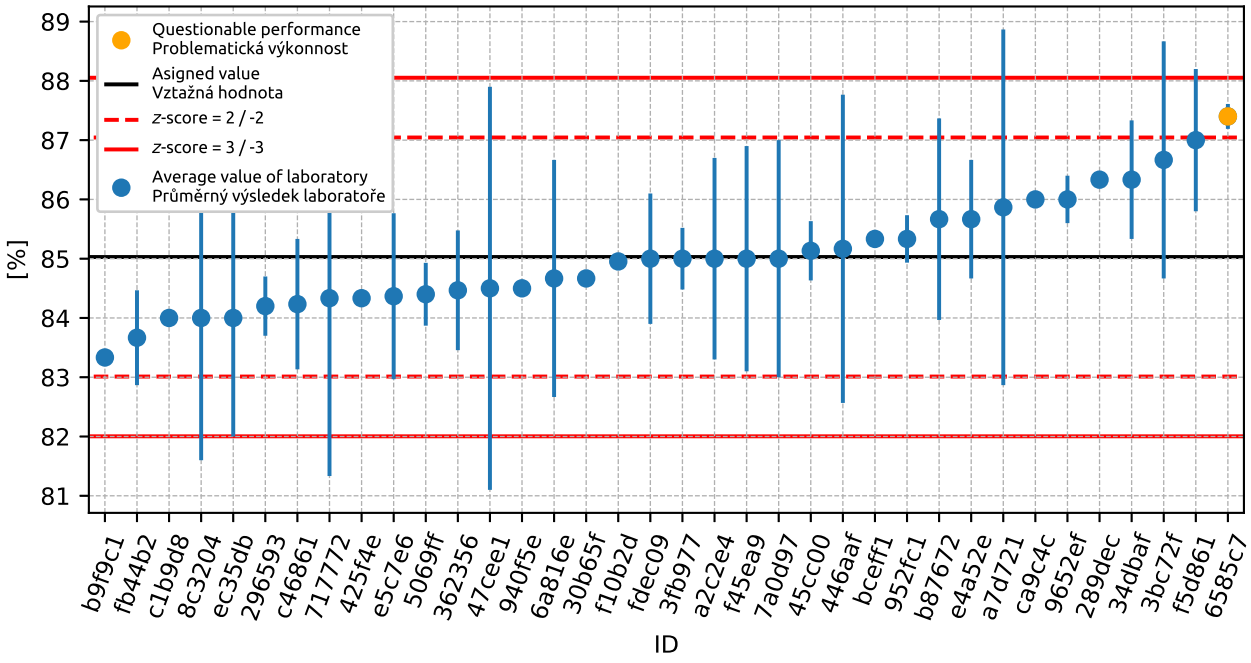

Figure 16: Average values and extended uncertainties of measurement

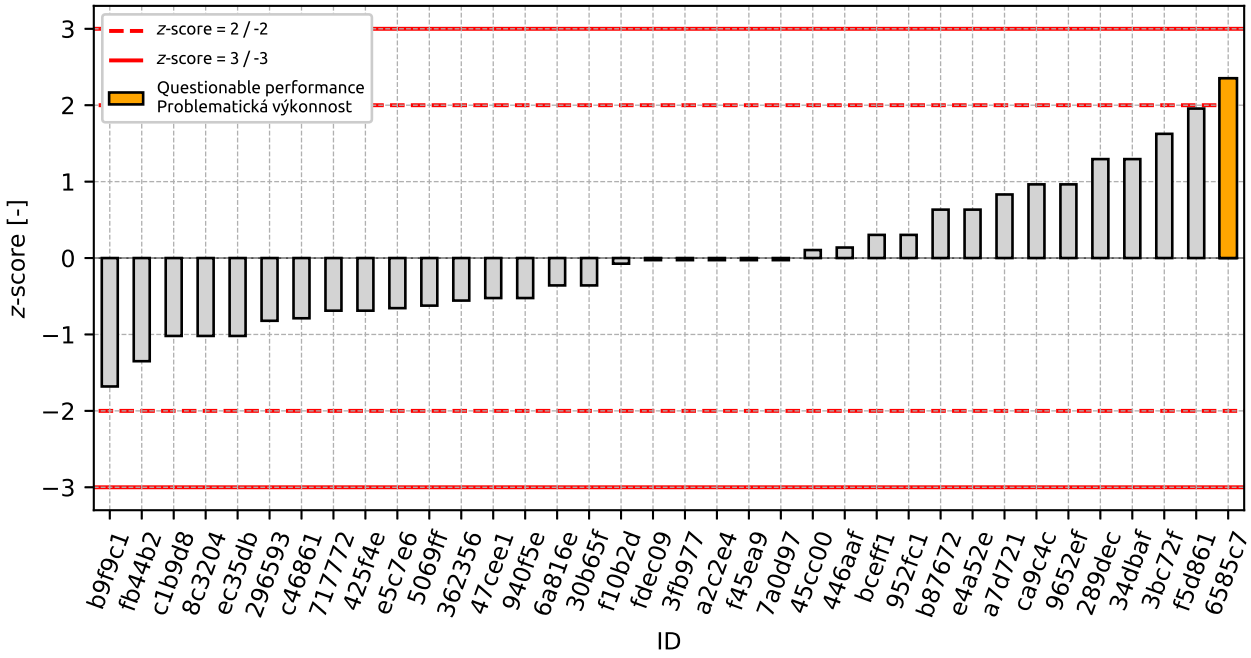

Figure 17: z-score

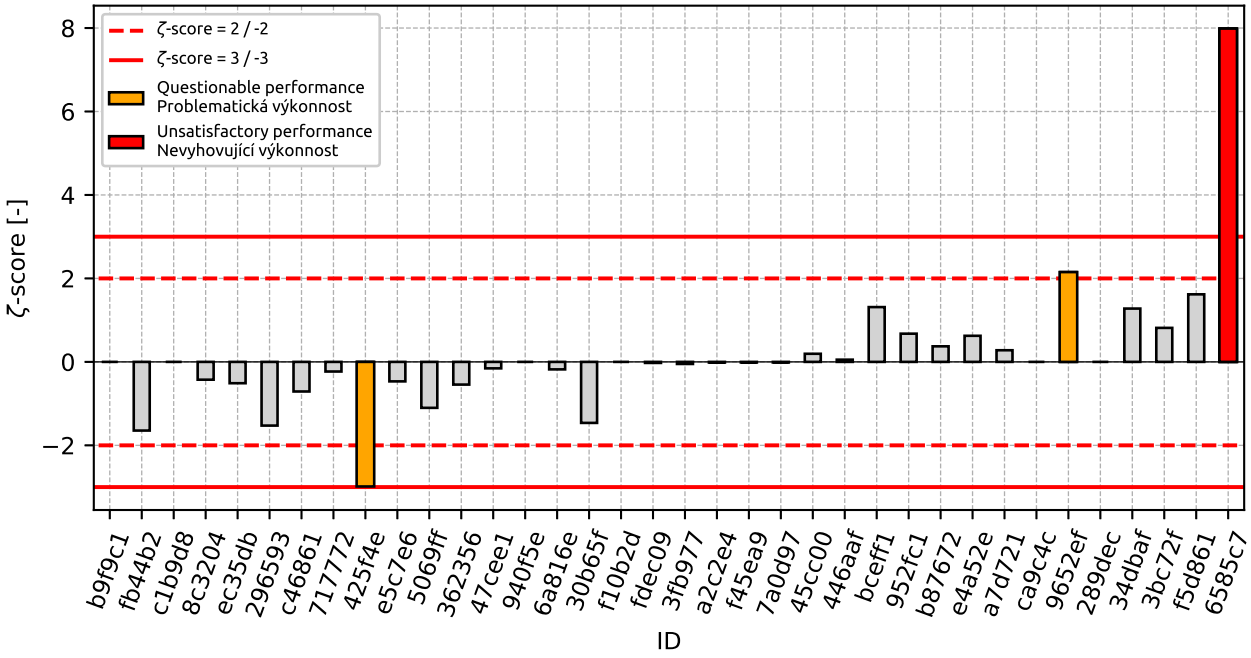

Figure 18: ζ-score

Table 10: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
b9f9c1	-1.68	-
fb44b2	-1.35	-1.65
c1b9d8	-1.02	-
8c3204	-1.02	-0.43
ec35db	-1.02	-0.51
296593	-0.82	-1.53
c46861	-0.79	-0.71
717772	-0.69	-0.23
425f4e	-0.69	-2.99
e5c7e6	-0.66	-0.47
5069ff	-0.62	-1.1
362356	-0.56	-0.54
47cee1	-0.52	-0.15
940f5e	-0.52	-
6a816e	-0.36	-0.18
30b65f	-0.36	-1.46
f10b2d	-0.07	-
fdec09	-0.03	-0.02
3fb977	-0.03	-0.05
a2c2e4	-0.03	-0.02
f45ea9	-0.03	-0.01
7a0d97	-0.03	-0.01
45cc00	0.1	0.19
446aaf	0.14	0.05
bceff1	0.3	1.31
952fc1	0.3	0.68
b87672	0.63	0.37
e4a52e	0.63	0.63
a7d721	0.83	0.28
ca9c4c	0.96	-
9652ef	0.96	2.15
289dec	1.29	-
34dbaf	1.29	1.28
3bc72f	1.63	0.81
f5d861	1.96	1.62
6585c7	2.35	7.99

1.3 1 mm

1.3.1 Test results

Table 11: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
65b250	57.0	58.0	58.0	2.0	57.7	0.58	1.0
362356	58.6	59.3	58.9	1.0	58.9	0.35	0.6
8c3204	59.0	57.0	61.0	6.8	59.0	2.0	3.39
717772	59.2	59.3	59.1	3.0	59.2	0.1	0.17
b9f9c1	60.0	59.0	59.0	-	59.3	0.58	0.97
30b65f	60.0	60.0	59.0	0.1	59.7	0.58	0.97
c1b9d8	59.0	60.0	60.0	-	59.7	0.58	0.97
ec35db	57.0	60.0	62.0	2.0	59.7	2.52	4.22
296593	60.3	59.1	60.1	0.9	59.8	0.64	1.07
940f5e	60.2	59.5	60.2	-	60.0	0.4	0.67
a2c2e4	63.0	60.0	57.0	2.8	60.0	3.0	5.0
47cee1	60.1	60.0	60.7	2.5	60.3	0.38	0.63
e5c7e6	60.5	60.4	60.0	1.2	60.3	0.26	0.44
6a816e	60.0	60.0	61.0	1.5	60.3	0.58	0.96
425f4e	60.0	60.0	61.0	0.1	60.3	0.58	0.96
45cc00	60.8	60.5	60.2	0.9	60.5	0.3	0.5
e4a52e	61.0	61.0	60.0	1.0	60.7	0.58	0.95
3fb977	60.7	61.4	60.4	0.7	60.8	0.51	0.84
446aaf	62.0	61.8	59.0	1.8	60.9	1.68	2.75
b87672	61.1	60.7	61.1	1.2	61.0	0.23	0.38
289dec	61.0	61.0	61.0	-	61.0	0.0	0.0
952fc1	61.0	61.0	61.0	0.6	61.0	0.0	0.0
7a0d97	61.0	61.0	61.0	2.0	61.0	0.0	0.0
f45ea9	61.0	61.0	61.0	1.9	61.0	0.0	0.0
c46861	61.5	61.1	60.9	1.1	61.2	0.31	0.5
3bc72f	61.0	61.0	62.0	2.0	61.3	0.58	0.94
34dbaf	62.0	61.0	61.0	1.0	61.3	0.58	0.94
fb44b2	62.0	62.0	62.0	0.8	62.0	0.0	0.0
fdec09	63.0	62.2	60.8	1.5	62.0	1.11	1.8
bceff1	63.0	61.0	62.0	0.3	62.0	1.0	1.61
9652ef	62.0	62.0	62.0	0.6	62.0	0.0	0.0
f5d861	63.0	62.0	62.0	1.1	62.3	0.58	0.93
ca9c4c	62.0	63.0	63.0	-	62.7	0.58	0.92
6585c7	66.7	64.0	59.9	0.2	63.5	3.42	5.39
a7d721	62.6	61.8	68.7	2.0	64.4	3.77	5.86
f10b2d	66.4	67.7	69.0	-	67.7	1.27	1.87
5069ff	69.2	68.4	68.6	0.4	68.7	0.42	0.61

1.3.2 The Numerical Procedure for Determining Outliers

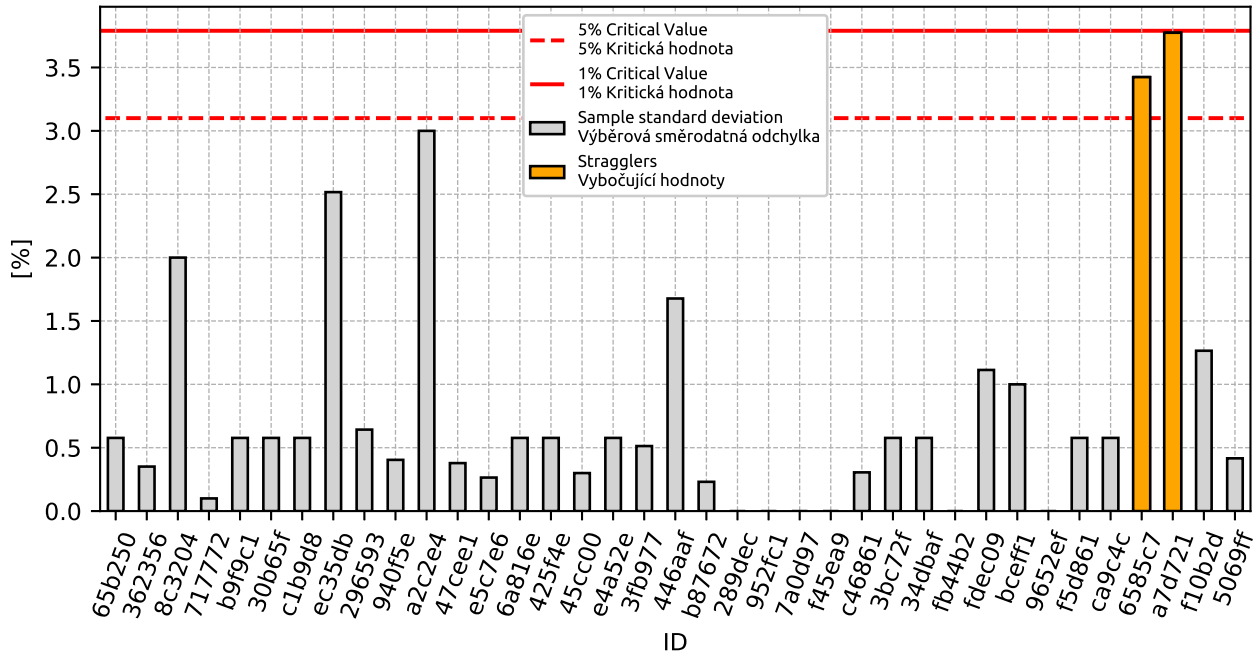

Figure 19: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

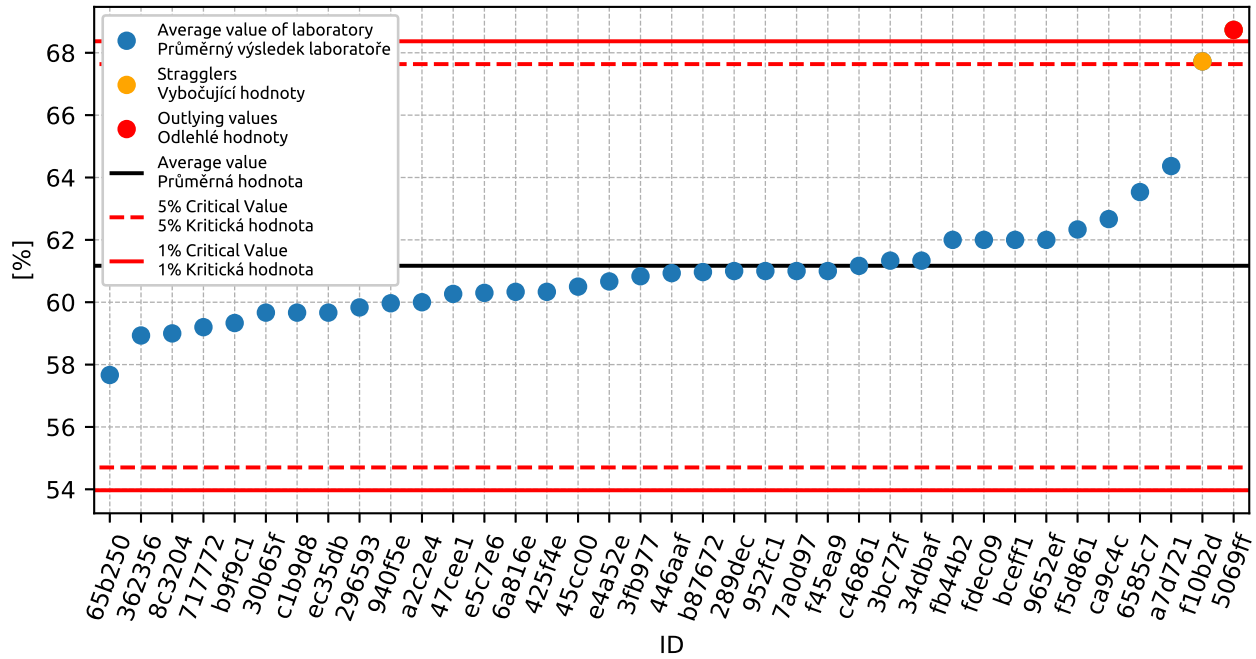

Figure 20: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

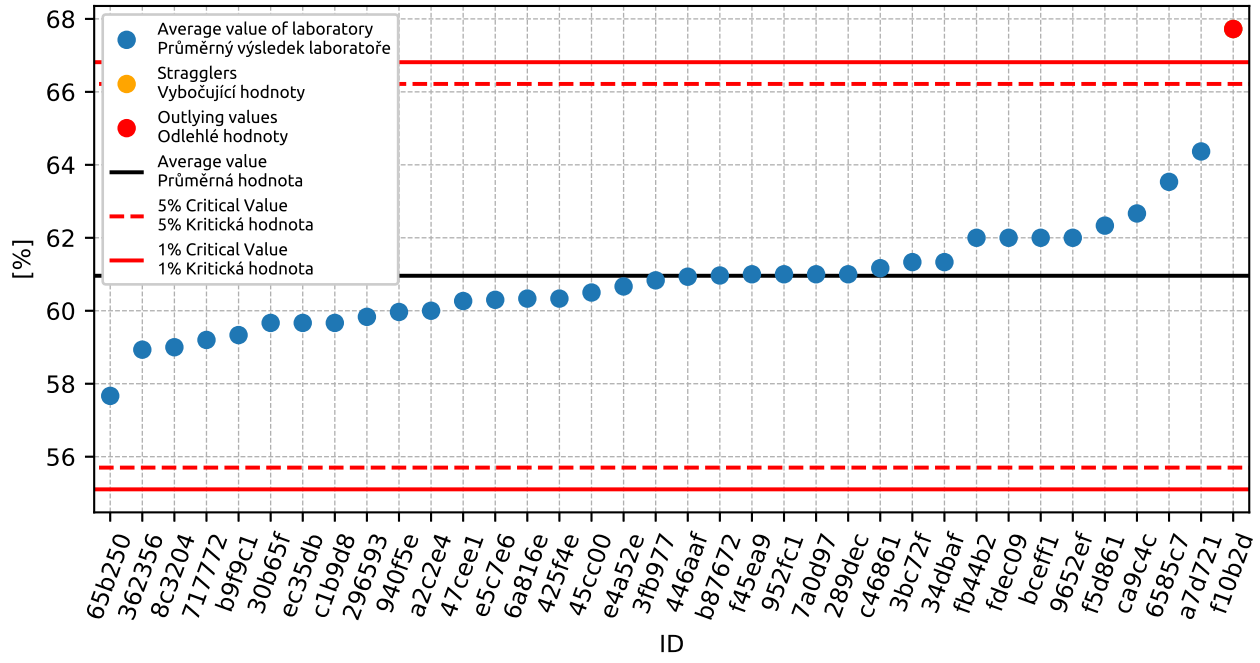

Figure 21: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color

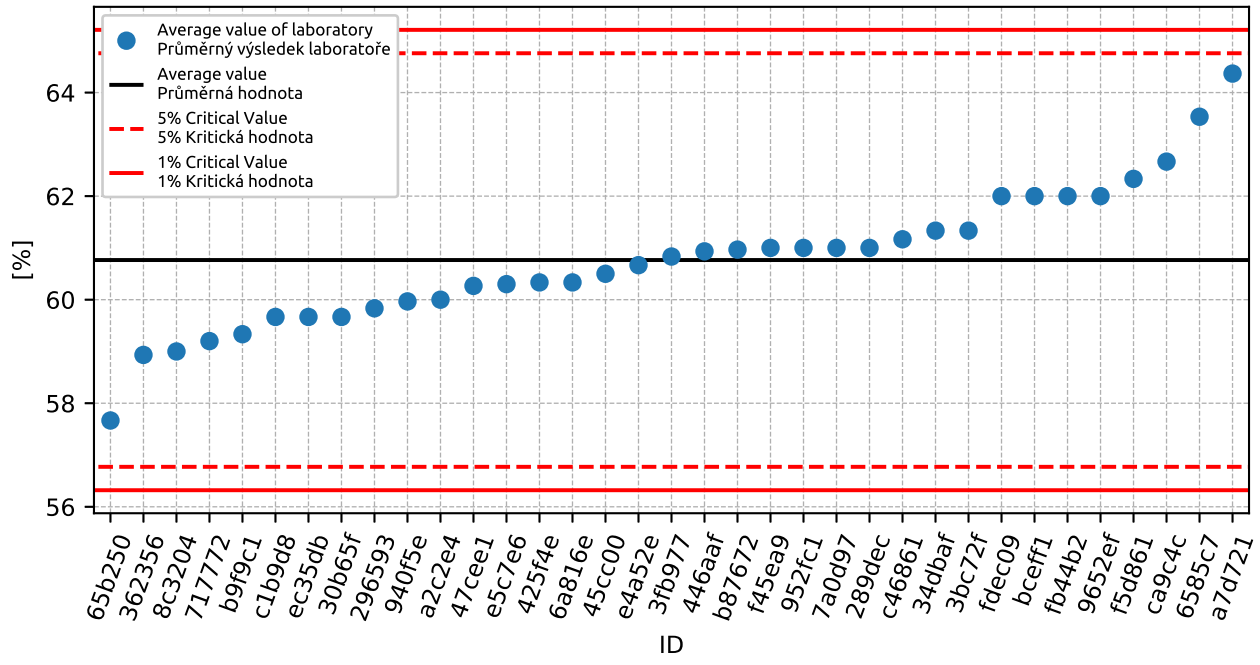

Figure 22: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color

1.3.3 Mandel's Statistics

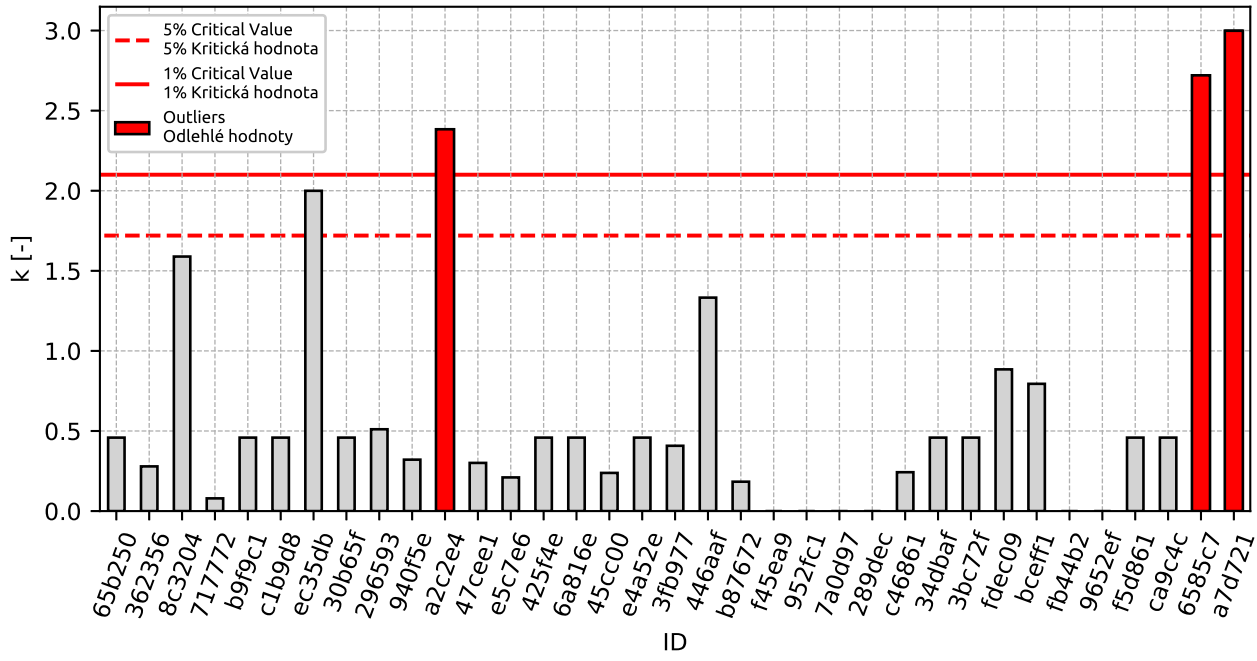

Figure 23: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

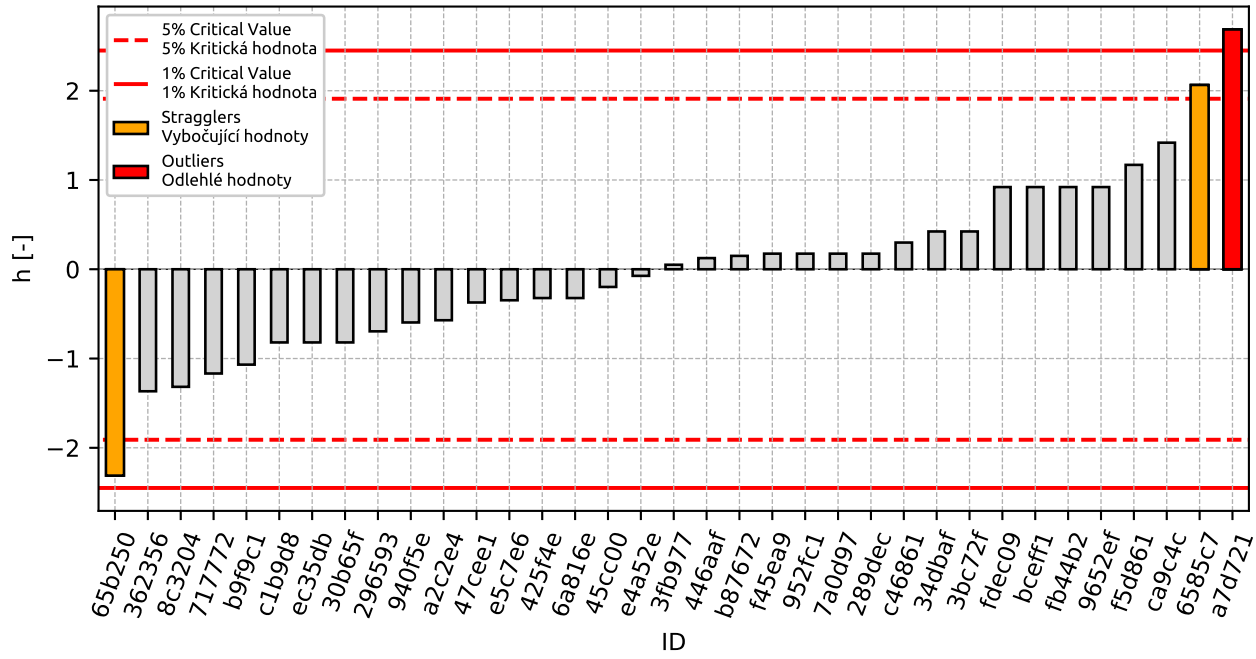

Figure 24: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

1.3.4 Descriptive statistics

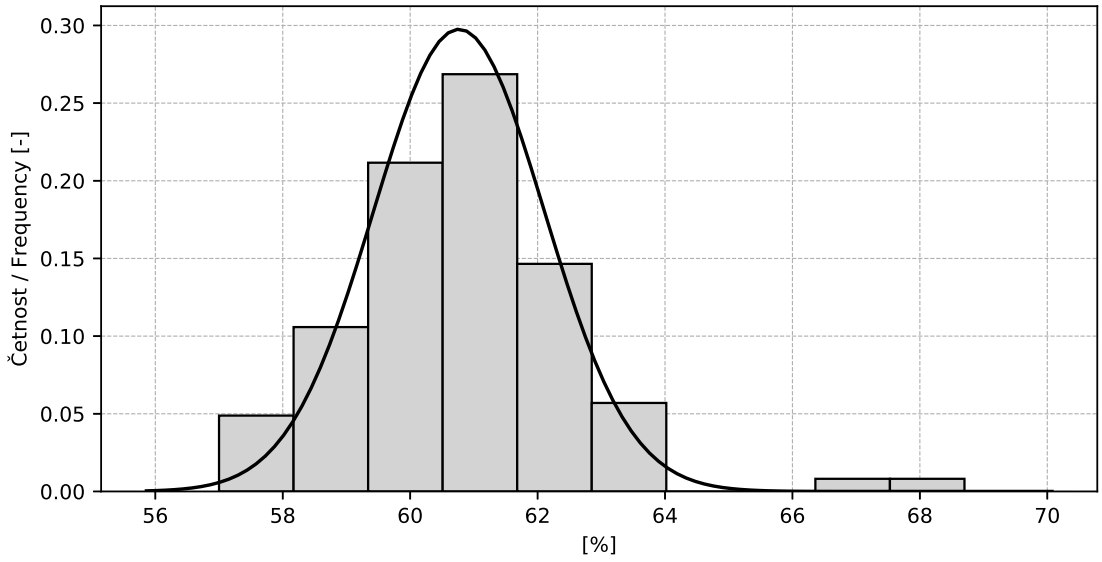

Figure 25: Histogram

Table 12: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	60.8
Výběrová směrodatná odchylka / Sample standard deviation – s	1.34
Vztažná hodnota / Asigned value – x^*	60.8
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.37
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.29
p-hodnota testu normality / p-value of normality test	0.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.13
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	1.26
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.69
Opakovatelnost / Repeatability – r	3.5
Reprodukovatelnost / Reproducibility – R	4.7

1.3.5 Calculation of Performance Statistics

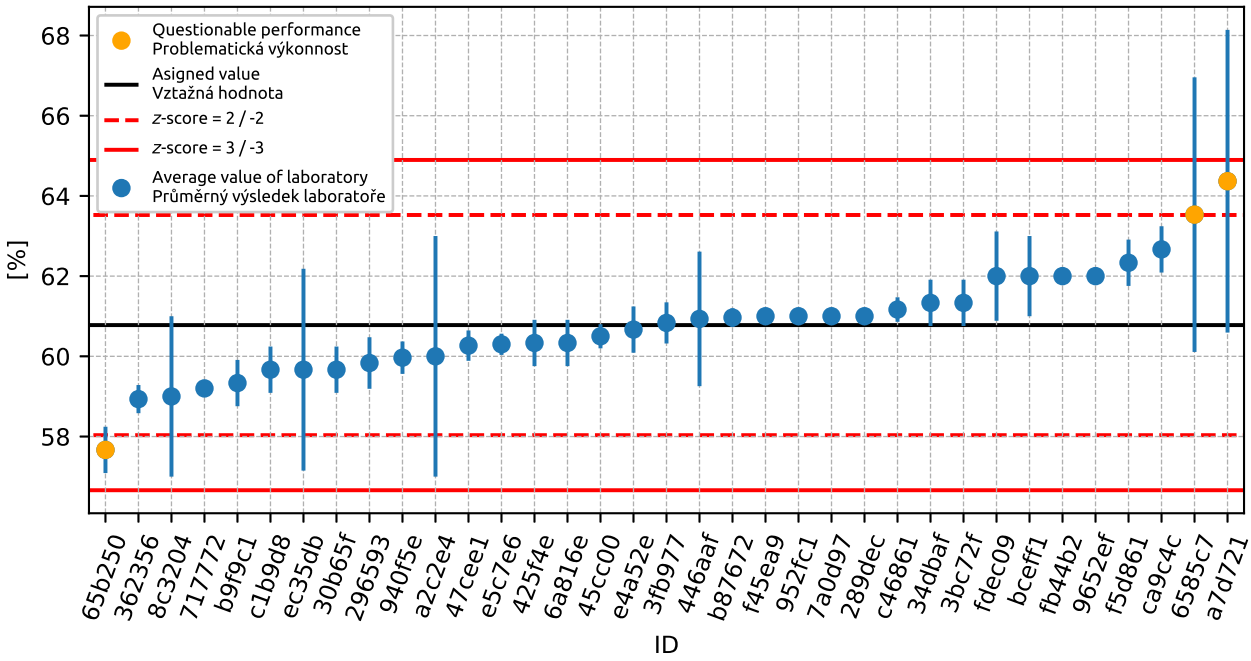

Figure 26: Average values and sample standard deviations

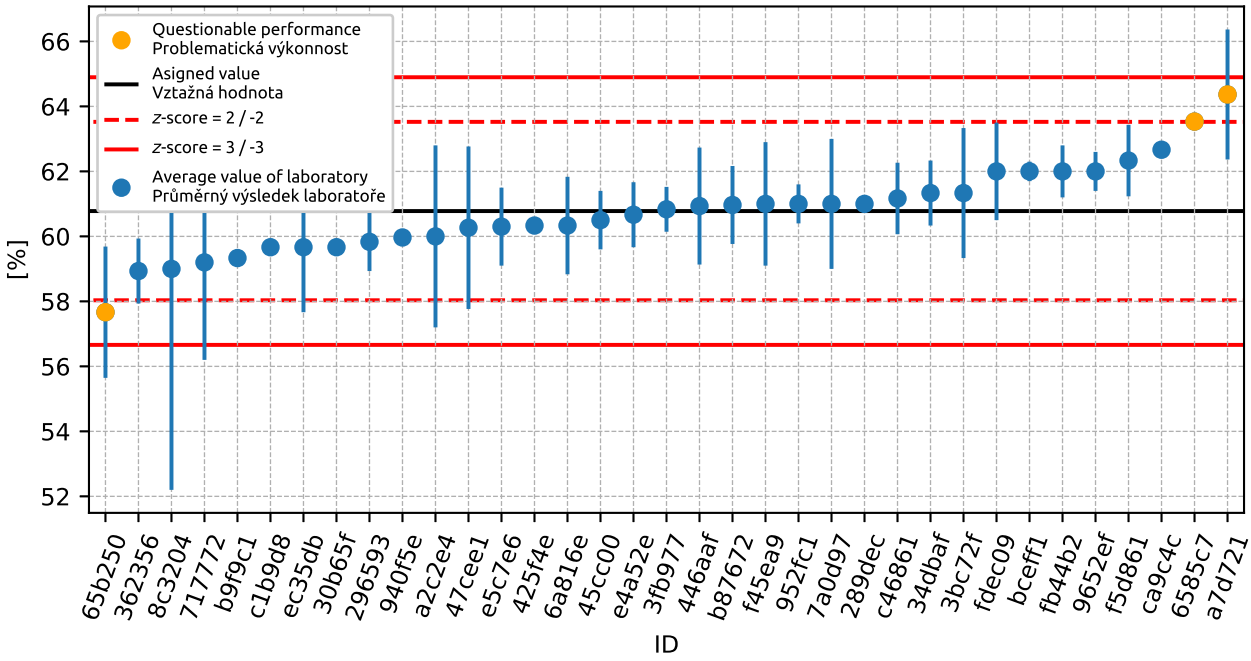

Figure 27: Average values and extended uncertainties of measurement

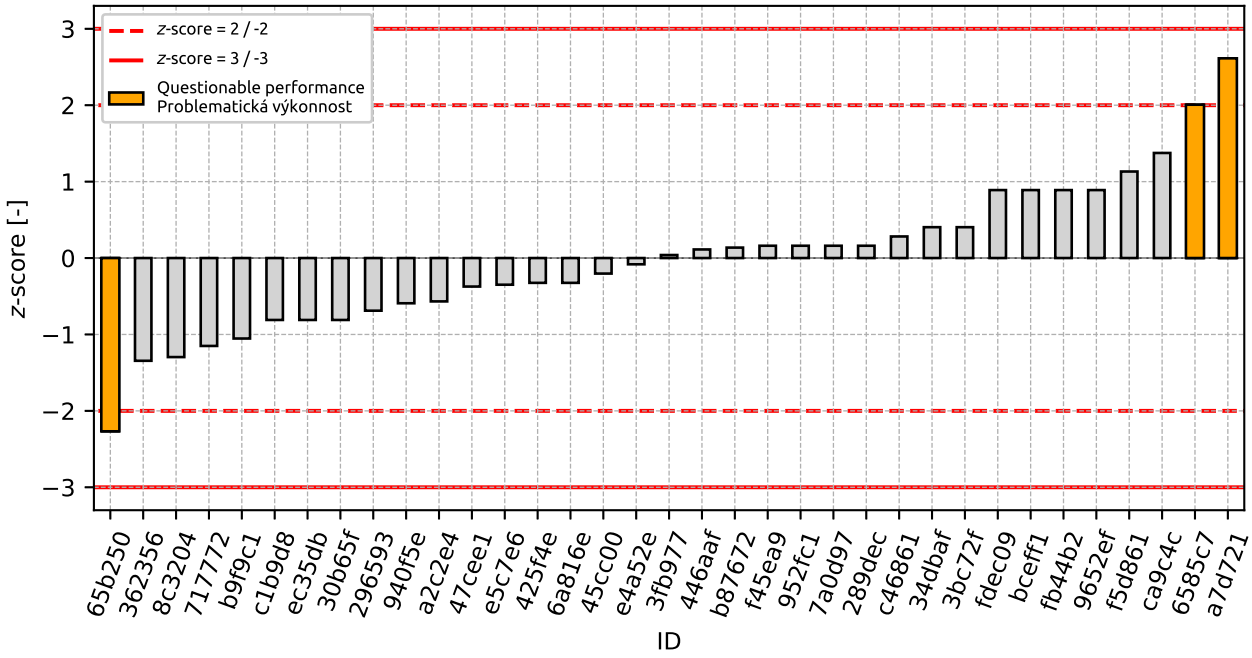

Figure 28: z-score

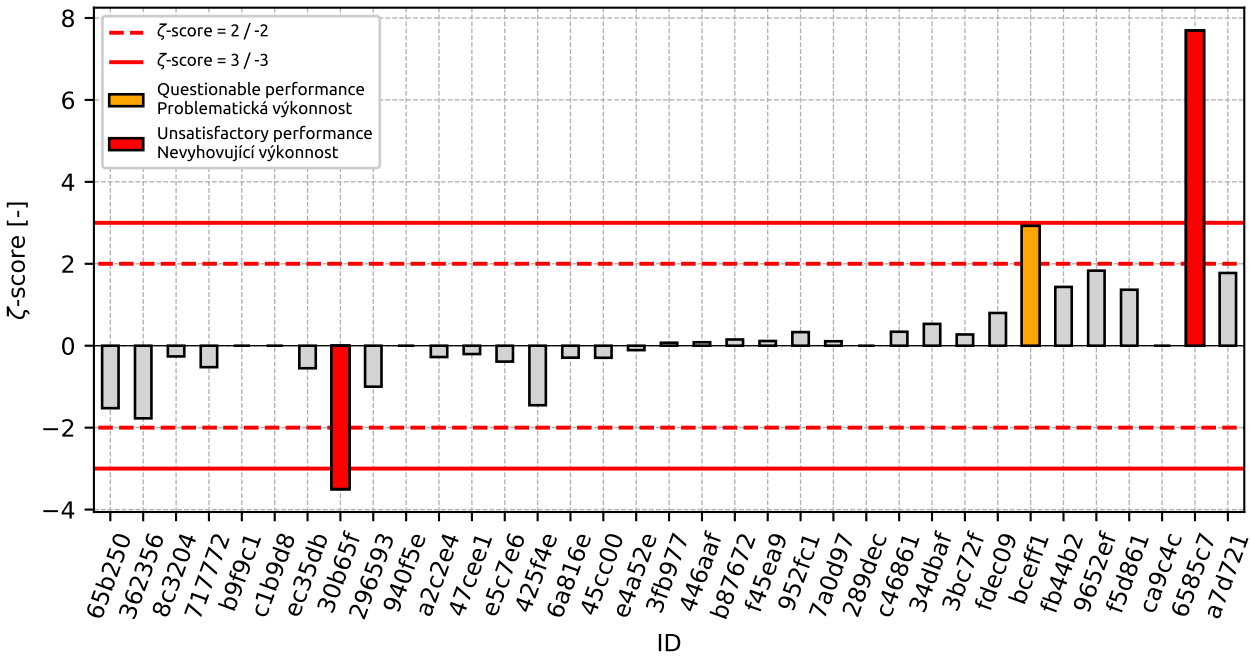

Figure 29: ζ-score

Table 13: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
65b250	-2.27	-1.53
362356	-1.34	-1.77
8c3204	-1.3	-0.26
717772	-1.15	-0.52
b9f9c1	-1.05	-
c1b9d8	-0.81	-
ec35db	-0.81	-0.55
30b65f	-0.81	-3.5
296593	-0.69	-1.0
940f5e	-0.59	-
a2c2e4	-0.57	-0.28
47cee1	-0.37	-0.2
e5c7e6	-0.35	-0.39
425f4e	-0.32	-1.45
6a816e	-0.32	-0.29
45cc00	-0.2	-0.3
e4a52e	-0.08	-0.11
3fb977	0.04	0.07
446aaf	0.11	0.08
b87672	0.14	0.15
f45ea9	0.16	0.11
952fc1	0.16	0.33
7a0d97	0.16	0.11
289dec	0.16	-
c46861	0.28	0.34
34dbaf	0.4	0.53
3bc72f	0.4	0.27
fdec09	0.89	0.8
bceff1	0.89	2.93
fb44b2	0.89	1.43
9652ef	0.89	1.83
f5d861	1.13	1.37
ca9c4c	1.38	-
6585c7	2.01	7.69
a7d721	2.61	1.78

1.4 0.5 mm

1.4.1 Test results

Table 14: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
45cc00	29.3	29.1	27.0	1.2	28.5	1.27	4.48
717772	28.8	28.9	28.7	3.0	28.8	0.1	0.35
296593	30.9	27.8	27.9	1.2	28.9	1.76	6.1
65b250	29.0	29.0	29.0	1.0	29.0	0.0	0.0
c1b9d8	29.0	30.0	30.0	-	29.7	0.58	1.95
a2c2e4	33.0	29.0	27.0	2.8	29.7	3.06	10.3
362356	29.9	29.9	29.4	1.0	29.7	0.29	0.97
fb44b2	30.0	30.0	30.0	0.8	30.0	0.0	0.0
446aaf	30.9	30.7	28.4	0.9	30.0	1.39	4.63
8c3204	31.0	31.0	30.0	3.8	30.7	0.58	1.88
ec35db	28.0	32.0	32.0	2.0	30.7	2.31	7.53
3fb977	30.6	30.8	30.7	0.1	30.7	0.1	0.33
e5c7e6	31.7	30.8	31.0	1.2	31.2	0.47	1.52
425f4e	31.0	31.0	32.0	0.1	31.3	0.58	1.84
6a816e	32.0	31.0	31.0	0.9	31.3	0.58	1.84
289dec	32.0	31.0	31.0	-	31.3	0.58	1.84
b9f9c1	32.0	31.0	31.0	-	31.3	0.58	1.84
5069ff	32.2	31.4	31.2	0.5	31.6	0.53	1.67
b87672	31.9	31.3	31.7	0.5	31.6	0.31	0.97
e4a52e	30.0	32.0	33.0	1.0	31.7	1.53	4.82
30b65f	32.0	32.0	31.0	0.1	31.7	0.58	1.82
3bc72f	32.0	31.0	32.0	2.4	31.7	0.58	1.82
a7d721	33.2	31.4	30.7	1.0	31.8	1.29	4.06
940f5e	32.4	31.2	31.9	-	31.8	0.6	1.89
34dbaf	32.0	32.0	32.0	1.0	32.0	0.0	0.0
952fc1	32.0	32.0	32.0	0.5	32.0	0.0	0.0
7a0d97	32.0	32.0	32.0	2.4	32.0	0.0	0.0
47cee1	31.8	31.7	32.7	1.3	32.1	0.55	1.72
f10b2d	30.8	32.2	33.2	-	32.1	1.22	3.81
c46861	32.5	32.3	32.0	1.1	32.3	0.25	0.78
bceff1	32.0	33.0	32.0	0.3	32.3	0.58	1.79
f45ea9	33.0	32.0	34.0	1.9	33.0	1.0	3.03
9652ef	33.0	33.0	33.0	0.5	33.0	0.0	0.0
fdec09	34.2	33.4	32.7	0.8	33.4	0.75	2.24
6585c7	36.2	34.7	30.9	0.2	33.9	2.73	8.05
ca9c4c	34.0	35.0	34.0	-	34.3	0.58	1.68
f5d861	35.0	34.0	35.0	1.0	34.7	0.58	1.67

1.4.2 The Numerical Procedure for Determining Outliers

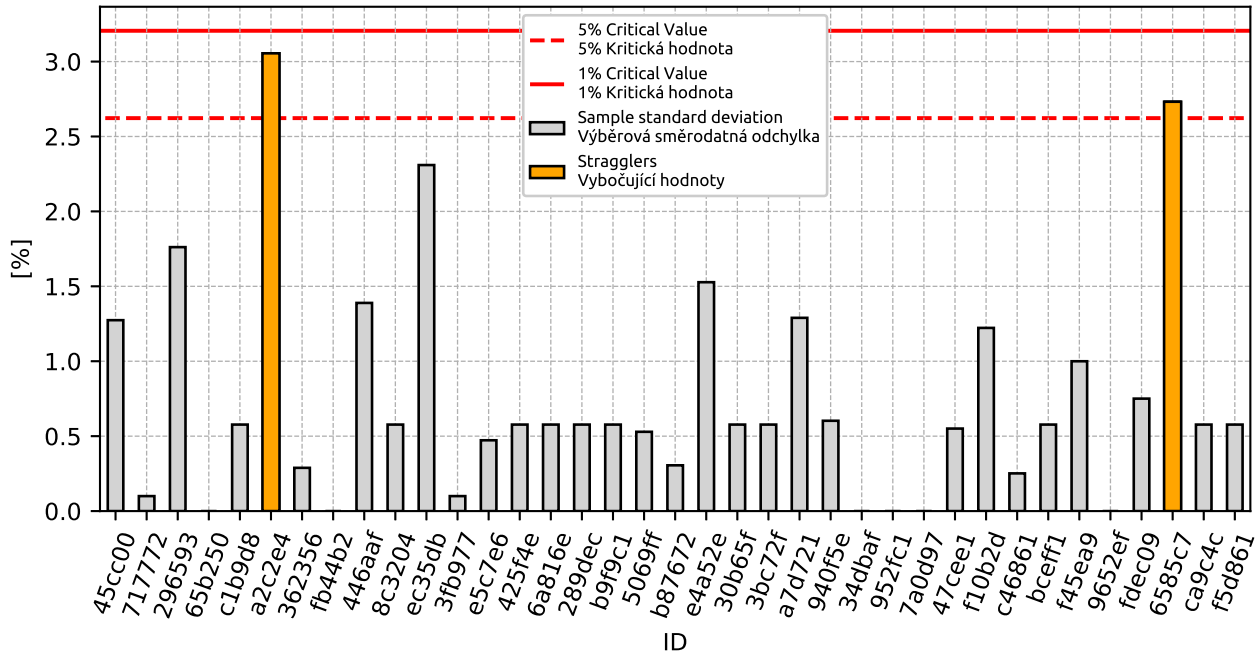

Figure 30: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

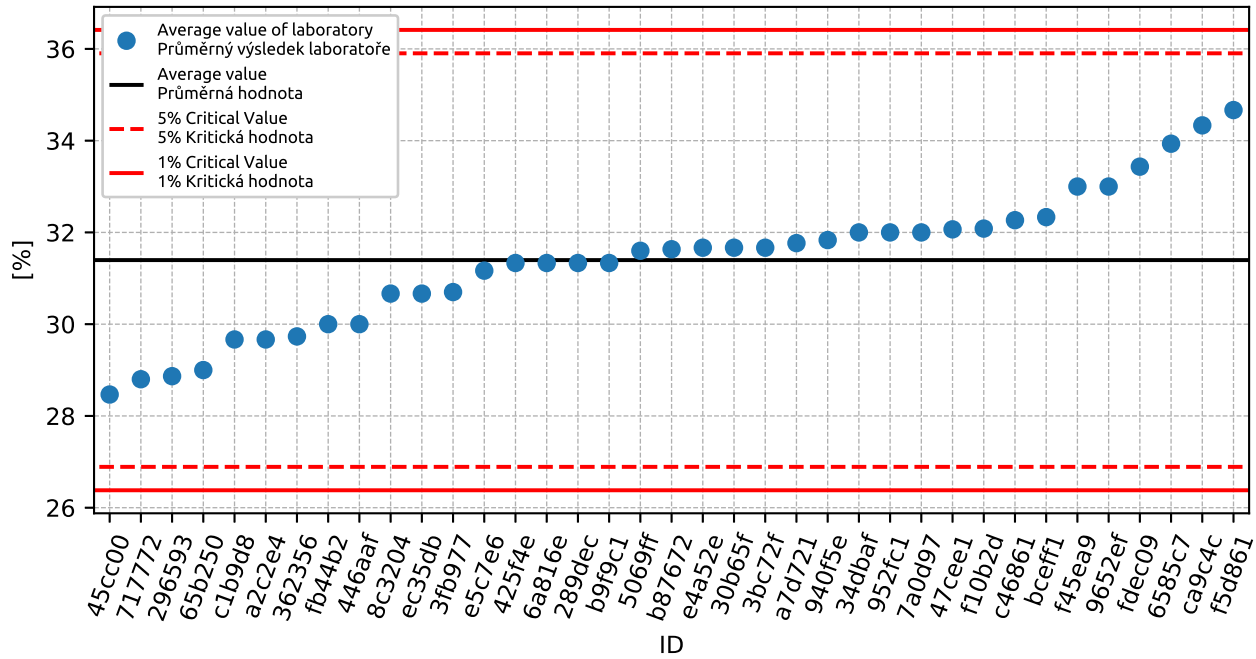

Figure 31: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

1.4.3 Mandel's Statistics

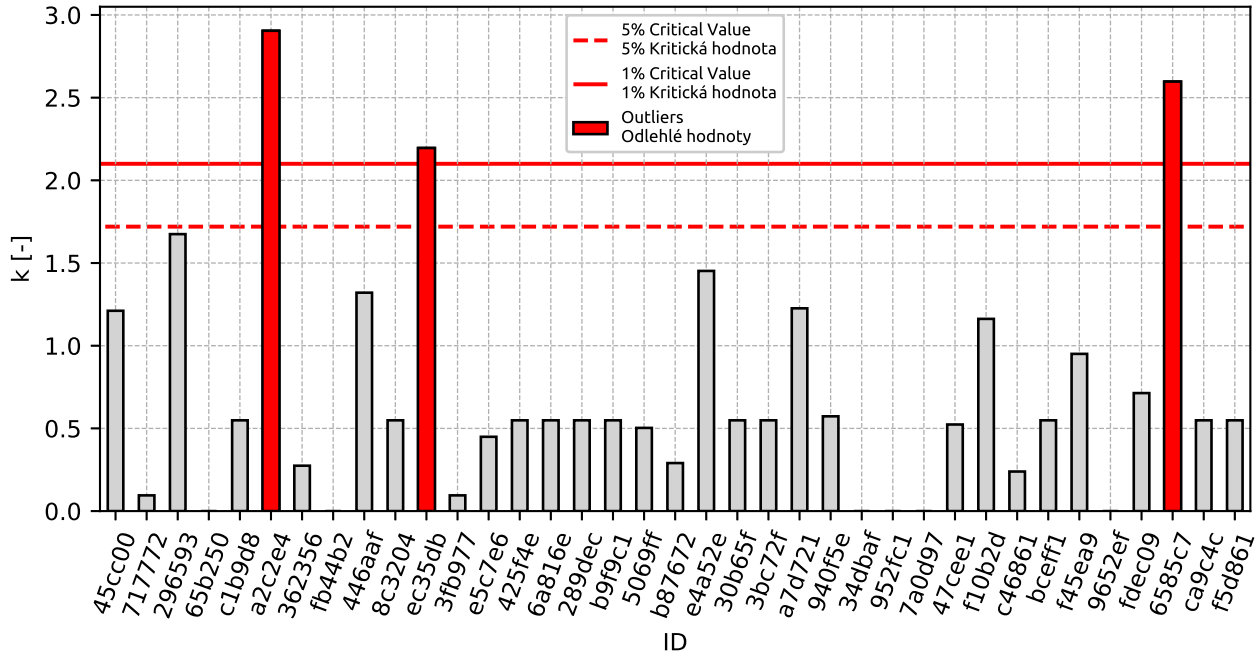

Figure 32: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

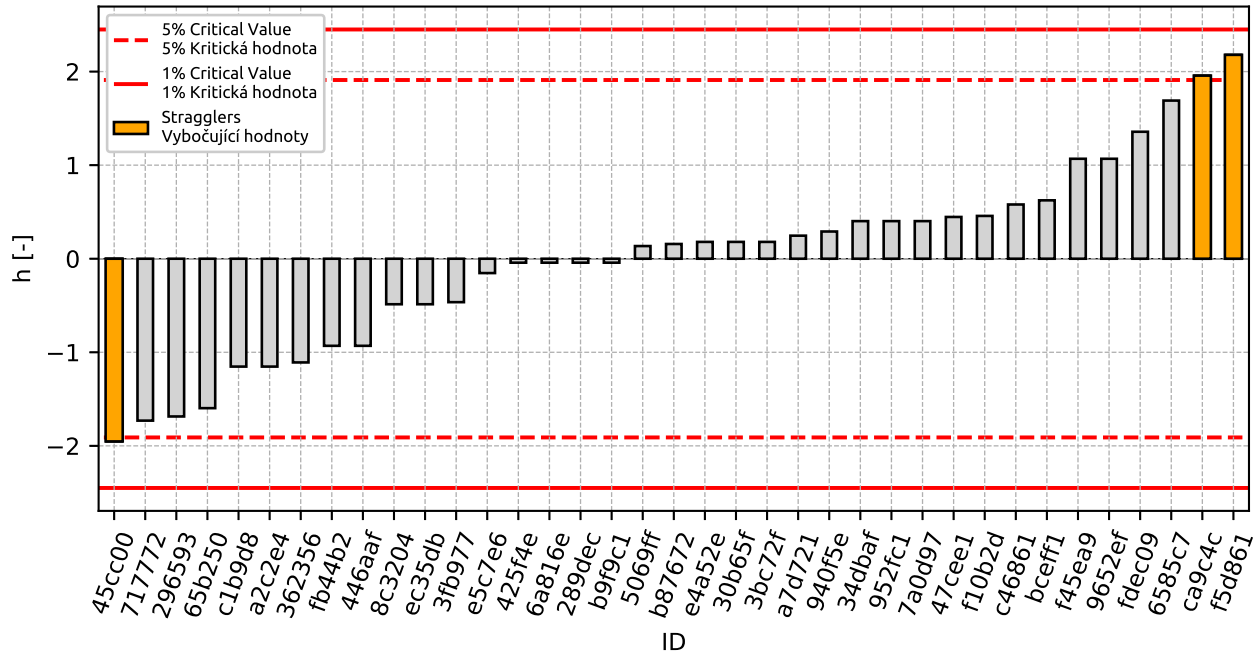

Figure 33: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

1.4.4 Descriptive statistics

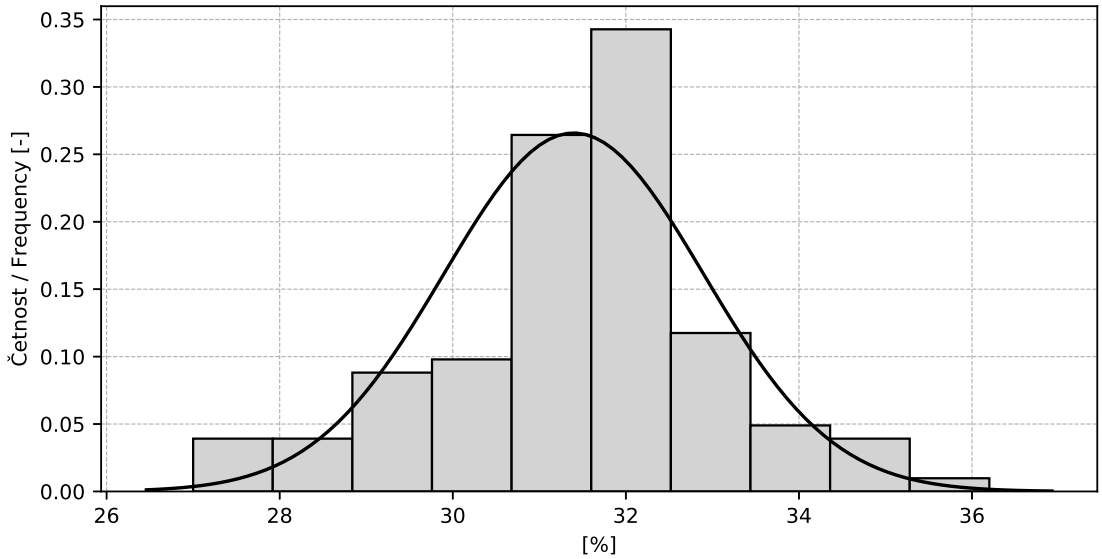

Figure 34: Histogram

Table 15: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	31.4
Výběrová směrodatná odchylka / Sample standard deviation – s	1.5
Vztažná hodnota / Asigned value – x^*	31.5
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.27
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.26
p-hodnota testu normality / p-value of normality test	0.533 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.37
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	1.05
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.73
Opakovatelnost / Repeatability – r	2.9
Reprodukovatelnost / Reproducibility – R	4.8

1.4.5 Calculation of Performance Statistics

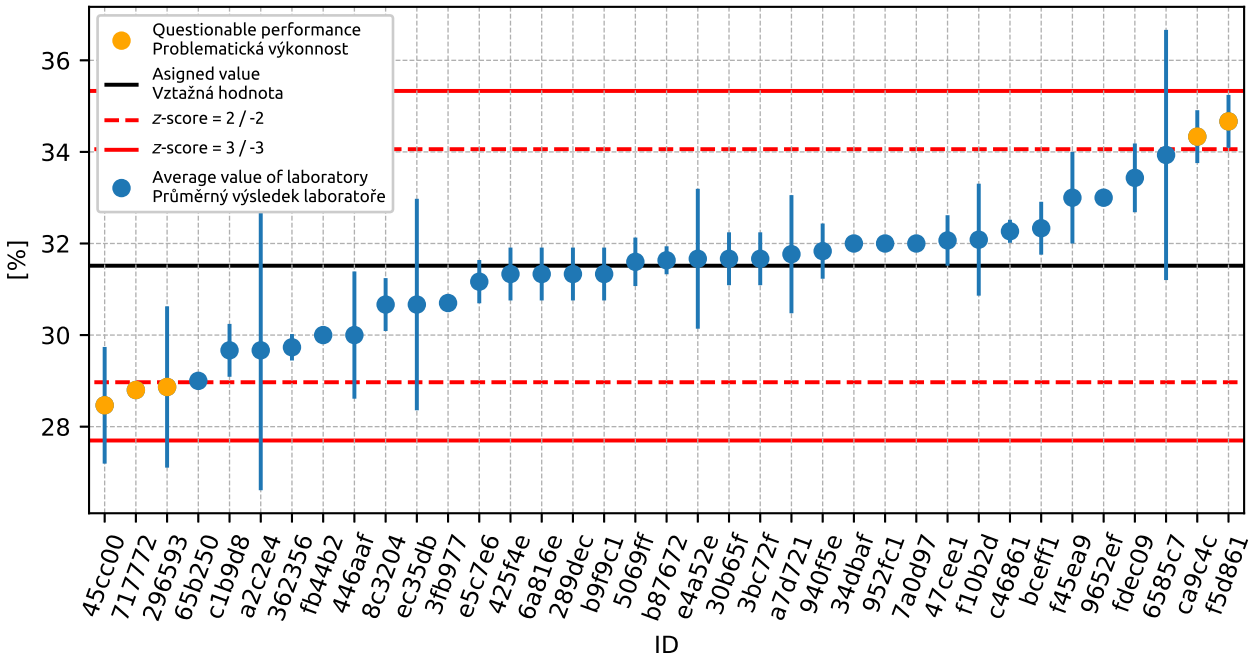

Figure 35: Average values and sample standard deviations

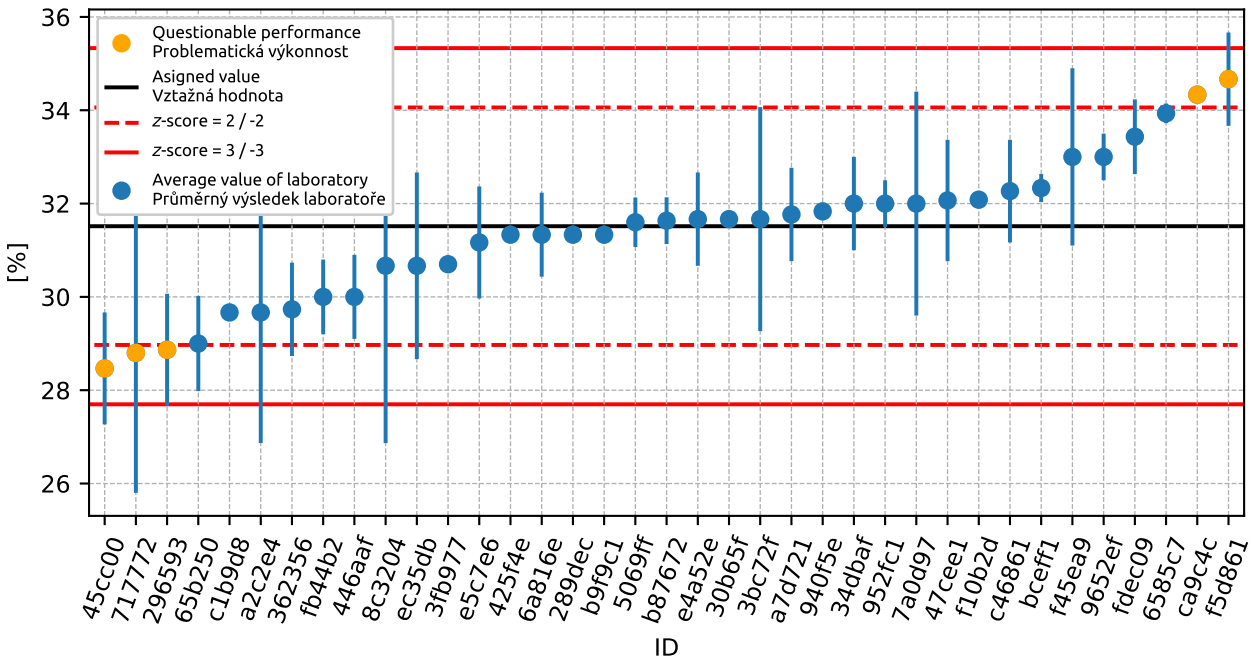

Figure 36: Average values and extended uncertainties of measurement

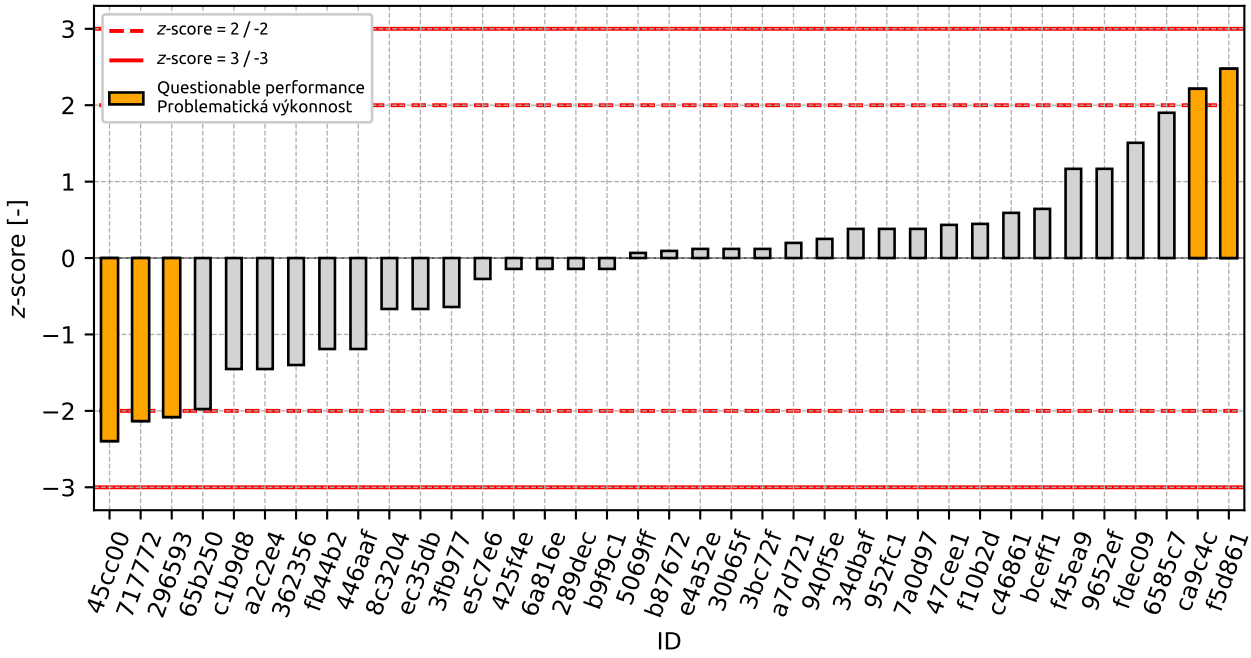

Figure 37: z-score

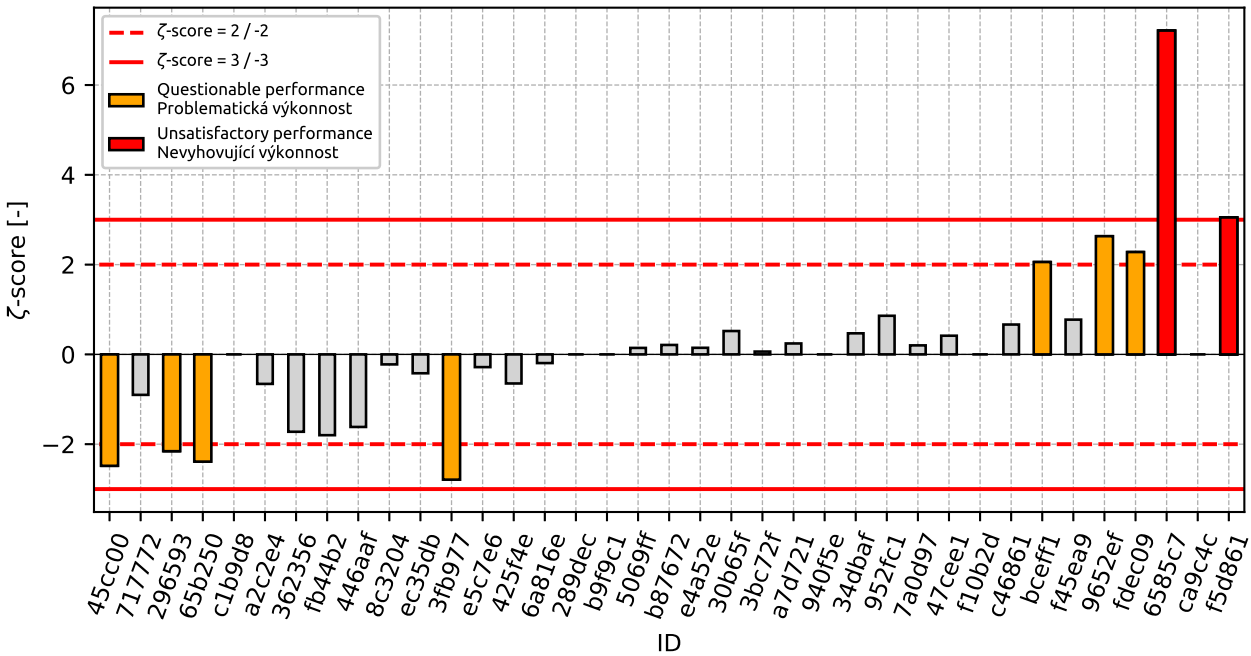

Figure 38: ζ-score

Table 16: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
45cc00	-2.4	-2.48
717772	-2.13	-0.9
296593	-2.08	-2.16
65b250	-1.98	-2.39
c1b9d8	-1.45	-
a2c2e4	-1.45	-0.66
362356	-1.4	-1.72
fb44b2	-1.19	-1.8
446aaf	-1.19	-1.62
8c3204	-0.67	-0.22
ec35db	-0.67	-0.42
3fb977	-0.64	-2.79
e5c7e6	-0.27	-0.28
425f4e	-0.14	-0.65
6a816e	-0.14	-0.19
289dec	-0.14	-
b9f9c1	-0.14	-
5069ff	0.07	0.14
b87672	0.09	0.21
e4a52e	0.12	0.15
30b65f	0.12	0.52
3bc72f	0.12	0.06
a7d721	0.2	0.24
940f5e	0.25	-
34dbaf	0.38	0.47
952fc1	0.38	0.86
7a0d97	0.38	0.2
47cee1	0.43	0.42
f10b2d	0.45	-
c46861	0.59	0.67
bceff1	0.64	2.06
f45ea9	1.17	0.77
9652ef	1.17	2.63
fdec09	1.51	2.28
6585c7	1.9	7.21
ca9c4c	2.22	-
f5d861	2.48	3.05

1.5 0.25 mm

1.5.1 Test results

Table 17: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
296593	7.5	6.0	6.4	0.9	6.6	0.78	11.71
45cc00	7.2	7.0	6.8	0.8	7.0	0.2	2.86
c1b9d8	7.0	7.0	8.0	-	7.3	0.58	7.87
717772	7.7	7.8	7.7	3.0	7.7	0.06	0.75
a2c2e4	9.0	8.0	7.0	2.2	8.0	1.0	12.5
8c3204	8.0	8.0	8.0	0.0	8.0	0.0	0.0
3fb977	8.1	8.1	8.0	0.1	8.1	0.06	0.72
362356	8.1	8.4	8.2	1.0	8.2	0.15	1.86
a7d721	8.5	7.8	8.4	0.5	8.2	0.38	4.6
6a816e	8.0	8.0	9.0	0.3	8.3	0.58	6.93
bceff1	9.0	8.0	8.0	0.3	8.3	0.58	6.93
65b250	9.0	8.0	8.0	0.3	8.3	0.58	6.93
e5c7e6	8.7	8.1	8.4	0.8	8.4	0.3	3.57
ec35db	8.0	9.0	9.0	2.0	8.7	0.58	6.66
940f5e	9.1	8.4	8.8	-	8.8	0.35	4.01
f10b2d	8.5	8.7	9.1	-	8.8	0.28	3.17
446aaf	9.1	9.4	8.3	0.3	8.9	0.57	6.37
6585c7	9.7	9.3	7.9	0.2	9.0	0.95	10.54
7a0d97	9.0	9.0	9.0	2.4	9.0	0.0	0.0
3bc72f	9.0	9.0	9.0	2.4	9.0	0.0	0.0
425f4e	9.0	9.0	9.0	0.1	9.0	0.0	0.0
289dec	9.0	9.0	9.0	-	9.0	0.0	0.0
30b65f	9.0	9.0	9.0	0.1	9.0	0.0	0.0
f45ea9	9.0	9.0	9.0	1.9	9.0	0.0	0.0
e4a52e	9.0	9.0	9.0	1.0	9.0	0.0	0.0
b87672	9.2	9.0	9.0	0.7	9.1	0.12	1.27
5069ff	10.2	8.7	8.8	0.8	9.2	0.84	9.08
952fc1	9.0	9.0	10.0	0.4	9.3	0.58	6.19
b9f9c1	9.0	9.0	10.0	-	9.3	0.58	6.19
47cee1	9.5	9.2	9.5	0.4	9.4	0.17	1.84
c46861	9.7	9.5	9.3	1.1	9.5	0.2	2.11
fdec09	9.8	9.9	9.4	0.7	9.7	0.26	2.73
fb44b2	10.0	10.0	10.0	0.8	10.0	0.0	0.0
9652ef	10.0	10.0	10.0	0.4	10.0	0.0	0.0
34dbaf	10.0	10.0	10.0	0.8	10.0	0.0	0.0
ca9c4c	10.0	11.0	11.0	-	10.7	0.58	5.41
f5d861	12.0	12.0	13.0	1.1	12.3	0.58	4.68

1.5.2 The Numerical Procedure for Determining Outliers

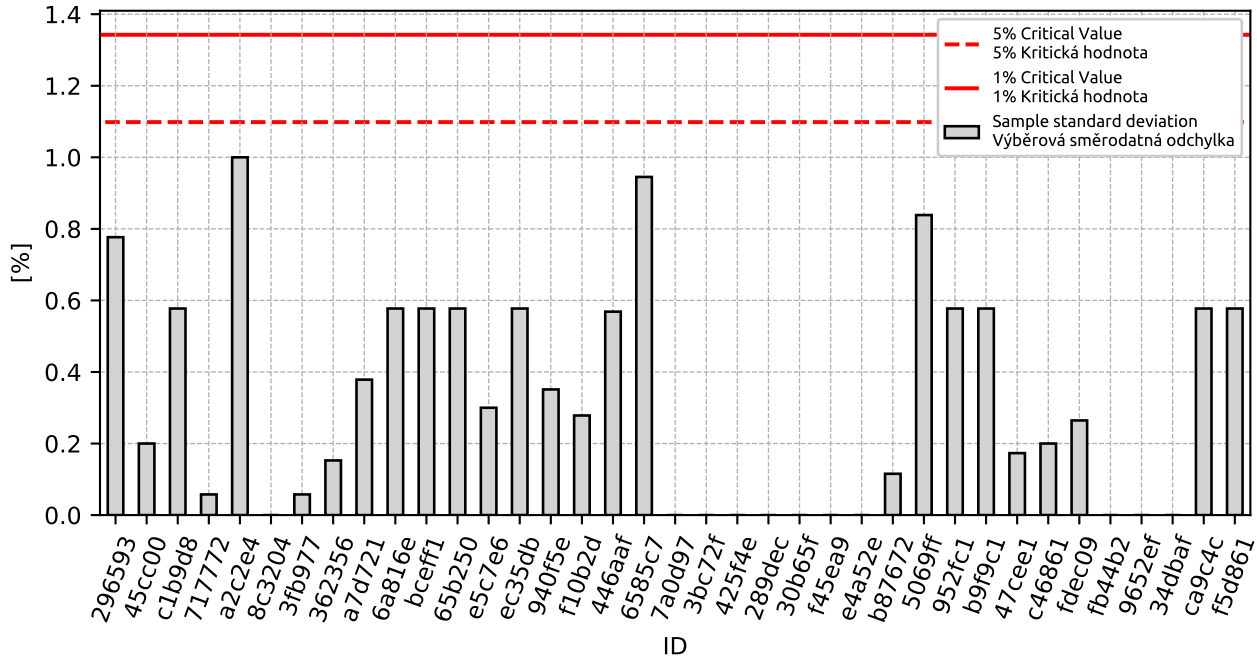

Figure 39: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

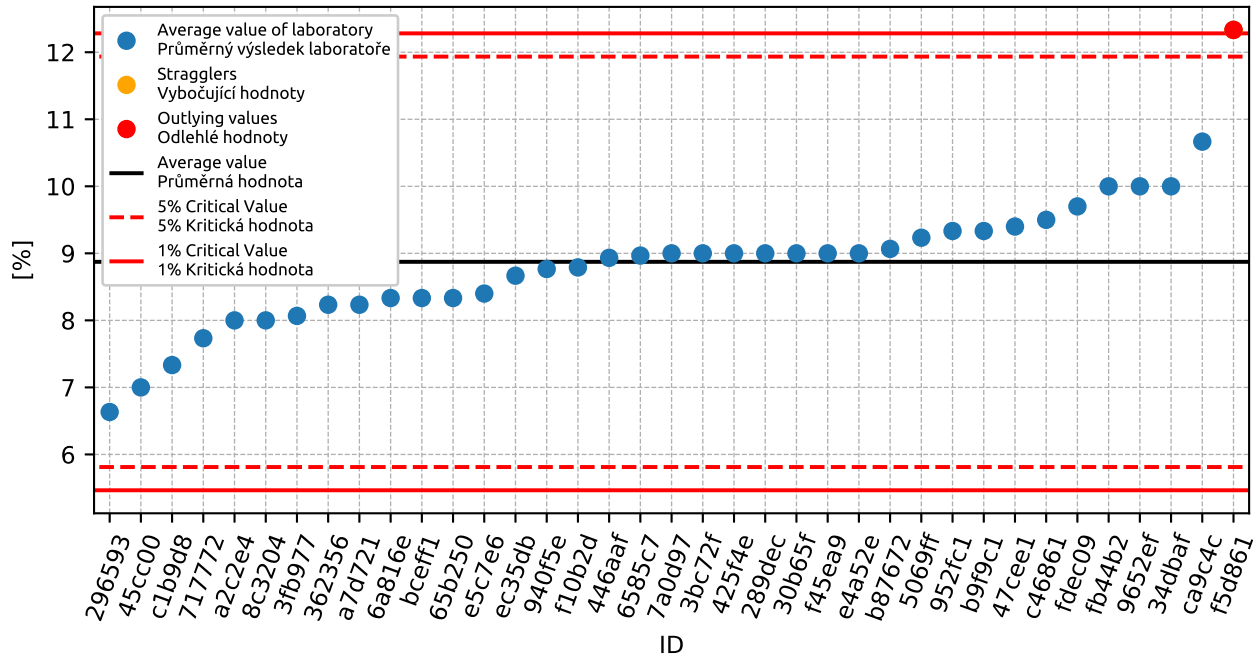

Figure 40: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

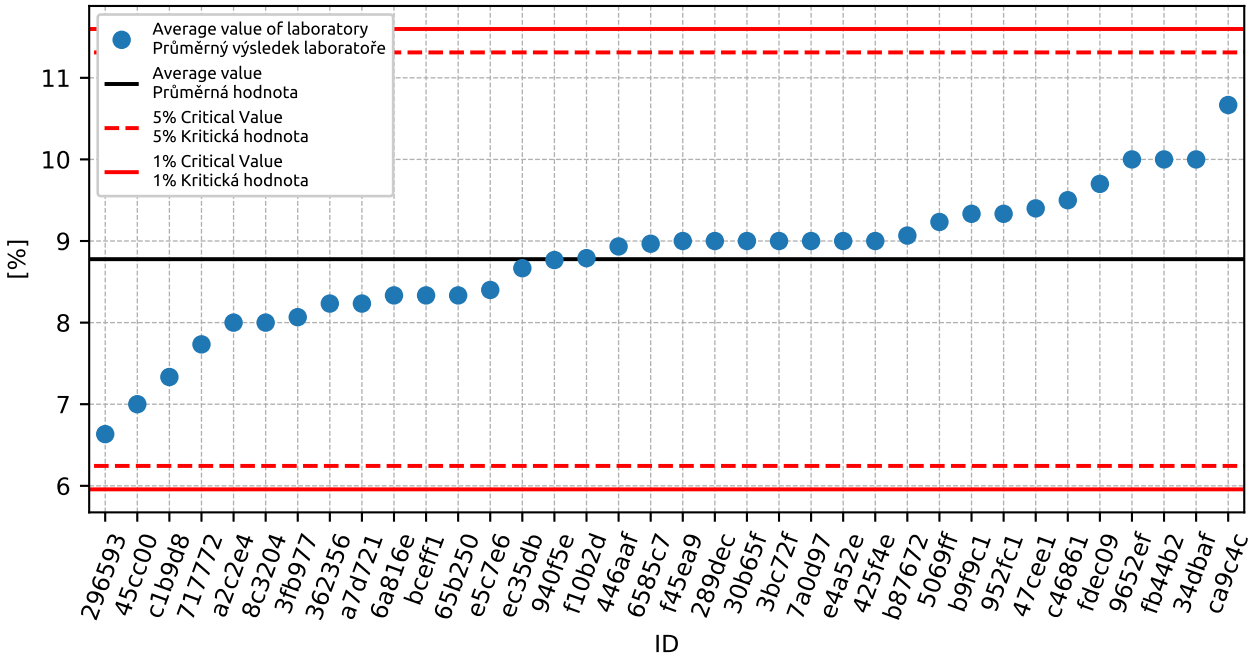

Figure 41: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color

1.5.3 Mandel's Statistics

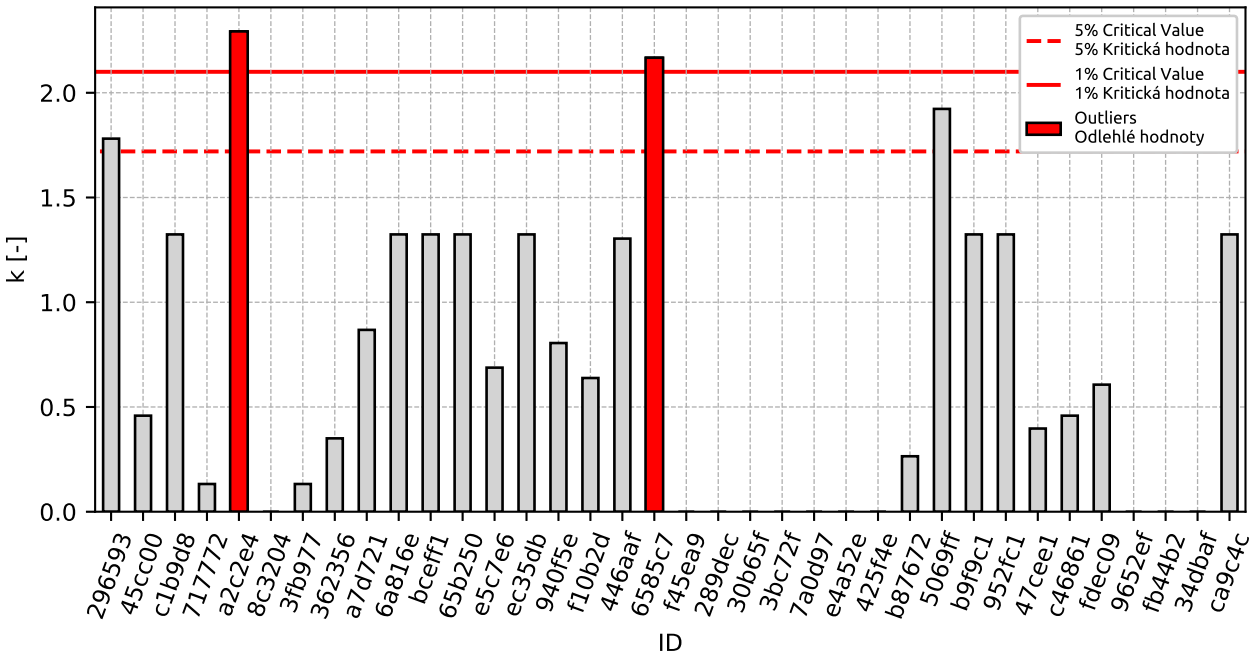

Figure 42: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

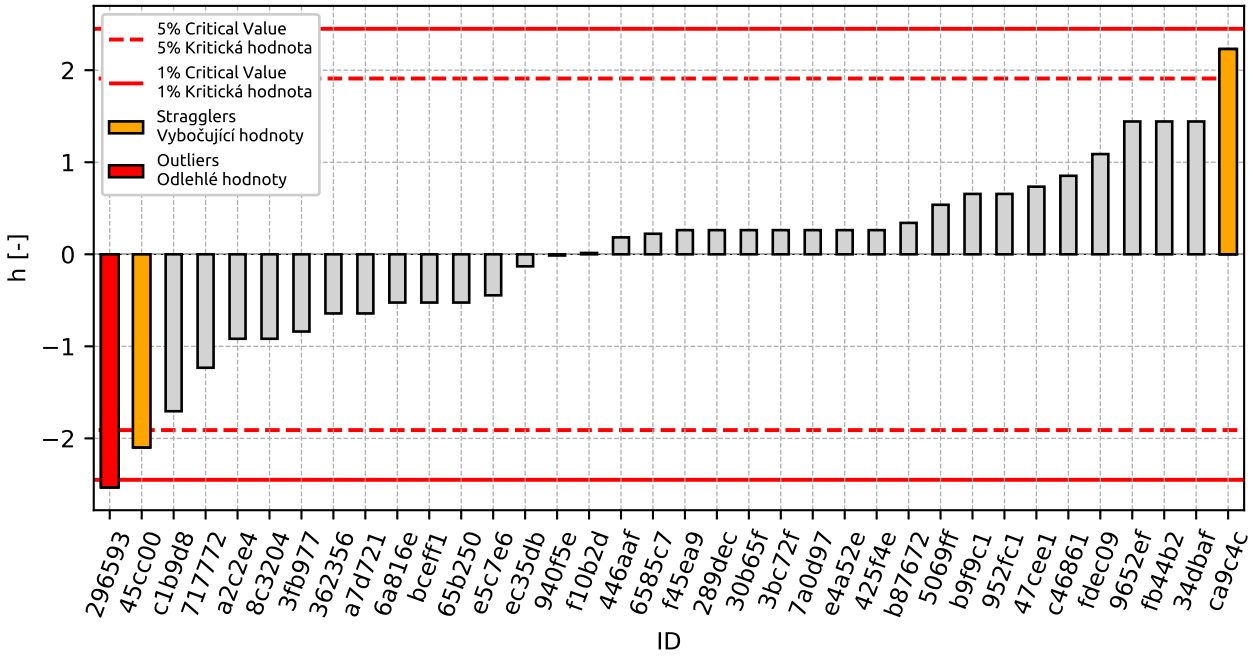

Figure 43: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

1.5.4 Descriptive statistics

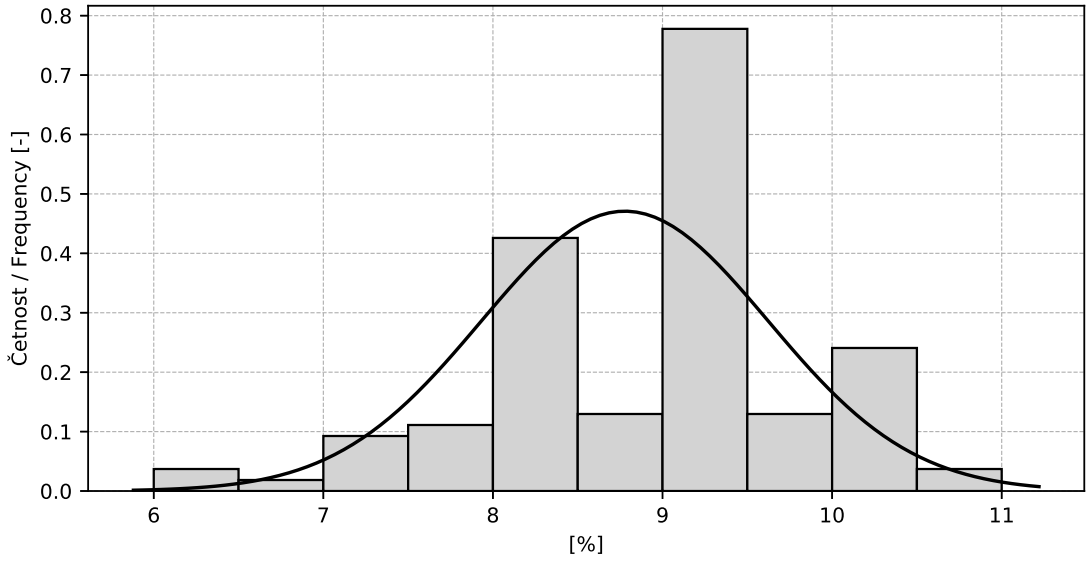

Figure 44: Histogram

Table 18: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	8.8
Výběrová směrodatná odchylka / Sample standard deviation – s	0.85
Vztažná hodnota / Asigned value – x^*	8.8
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.81
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.17
p-hodnota testu normality / p-value of normality test	0.13 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.81
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.44
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.92
Opakovatelnost / Repeatability – r	1.2
Reprodukovatelnost / Reproducibility – R	2.6

1.5.5 Calculation of Performance Statistics

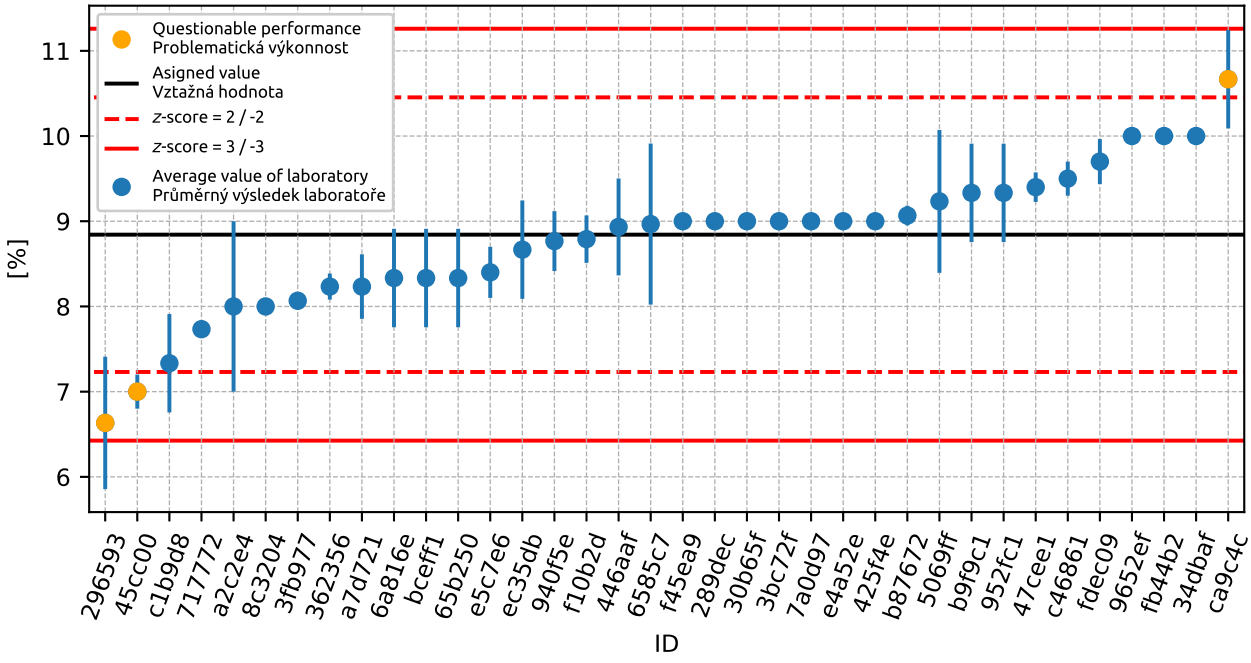

Figure 45: Average values and sample standard deviations

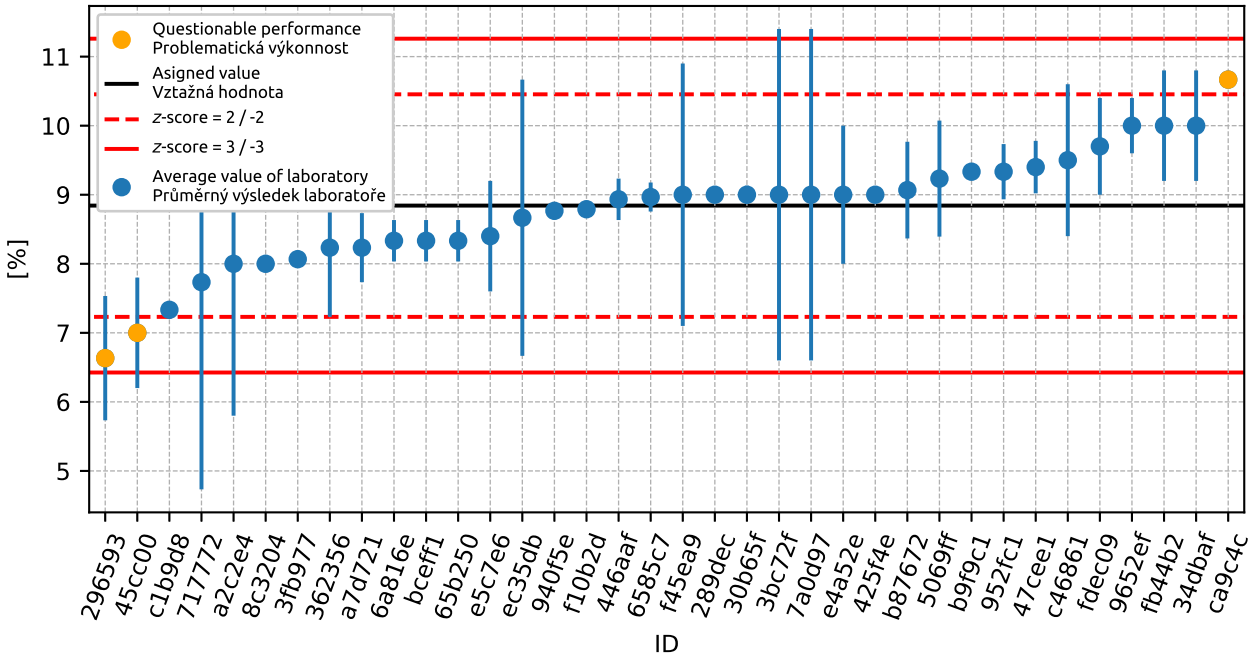

Figure 46: Average values and extended uncertainties of measurement

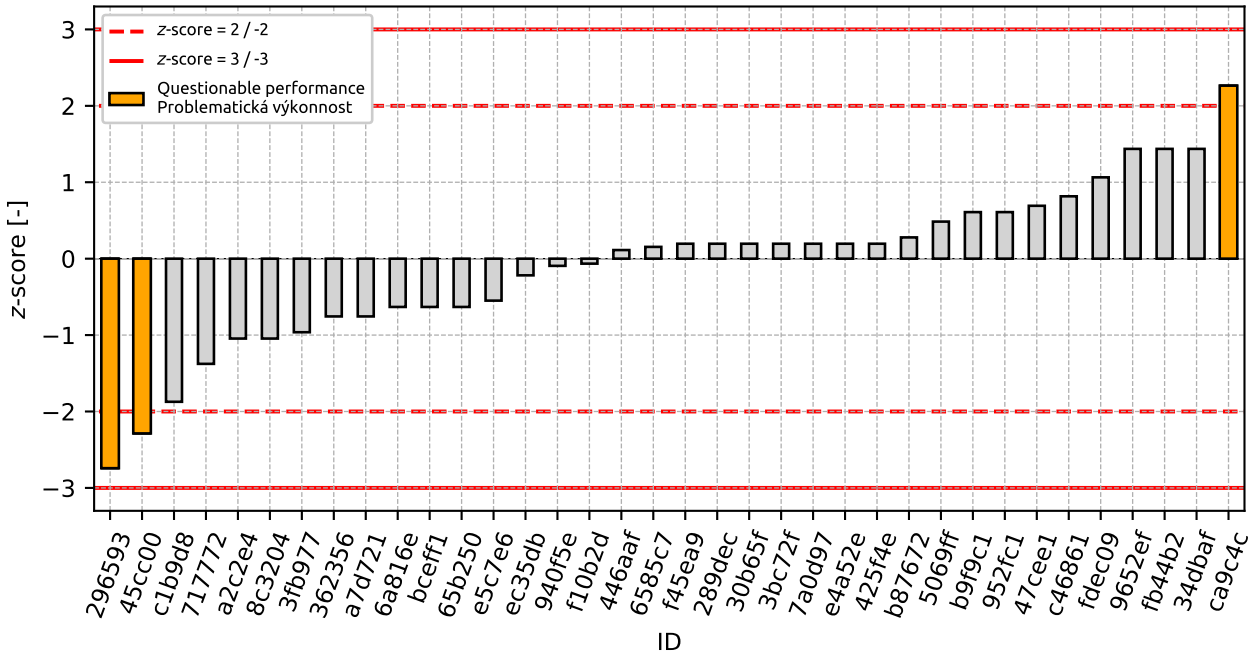

Figure 47: z-score

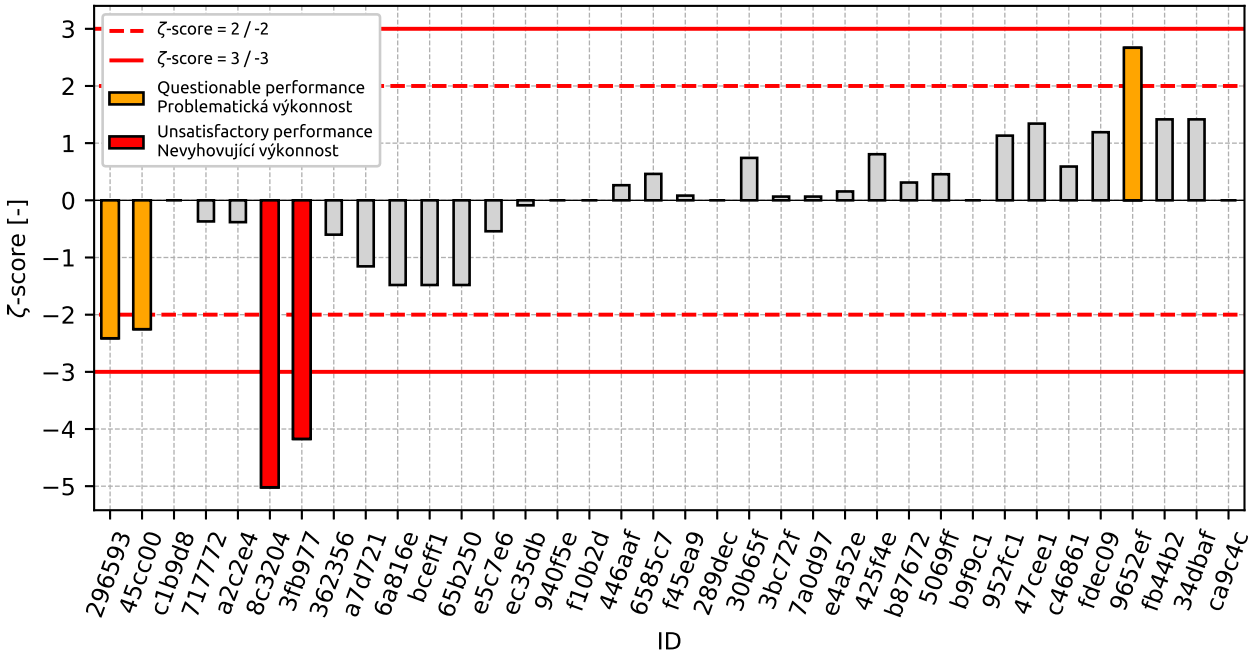

Figure 48: ζ-score

Table 19: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
296593	-2.74	-2.41
45cc00	-2.29	-2.25
c1b9d8	-1.87	-
717772	-1.38	-0.37
a2c2e4	-1.05	-0.38
8c3204	-1.05	-5.02
3fb977	-0.96	-4.17
362356	-0.76	-0.6
a7d721	-0.76	-1.15
6a816e	-0.63	-1.48
bceff1	-0.63	-1.48
65b250	-0.63	-1.48
e5c7e6	-0.55	-0.54
ec35db	-0.22	-0.09
940f5e	-0.09	-
f10b2d	-0.07	-
446aaf	0.11	0.26
6585c7	0.15	0.46
f45ea9	0.2	0.08
289dec	0.2	-
30b65f	0.2	0.74
3bc72f	0.2	0.07
7a0d97	0.2	0.07
e4a52e	0.2	0.16
425f4e	0.2	0.81
b87672	0.28	0.31
5069ff	0.49	0.46
b9f9c1	0.61	-
952fc1	0.61	1.13
47cee1	0.69	1.34
c46861	0.82	0.59
fdec09	1.06	1.19
9652ef	1.44	2.67
fb44b2	1.44	1.42
34dbaf	1.44	1.42
ca9c4c	2.26	-

1.6 0.125 mm

1.6.1 Test results

Table 20: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
296593	0.9	0.8	0.9	0.3	0.9	0.06	6.66
e5c7e6	0.9	0.9	0.8	0.4	0.9	0.06	6.66
f10b2d	1.0	1.0	0.9	-	1.0	0.08	7.6
425f4e	1.0	1.0	1.0	0.1	1.0	0.0	0.0
289dec	1.0	1.0	1.0	-	1.0	0.0	0.0
6585c7	1.1	1.1	0.8	0.2	1.0	0.17	17.32
e4a52e	1.0	1.0	1.0	1.0	1.0	0.0	0.0
a2c2e4	1.0	1.0	1.0	1.5	1.0	0.0	0.0
b9f9c1	1.0	1.0	1.0	-	1.0	0.0	0.0
34dbaf	1.0	1.0	1.0	0.5	1.0	0.0	0.0
65b250	1.0	1.0	1.0	0.0	1.0	0.0	0.0
bceff1	1.0	1.0	1.0	0.1	1.0	0.0	0.0
ec35db	1.0	1.0	1.0	2.0	1.0	0.0	0.0
fb44b2	1.0	1.0	1.0	0.8	1.0	0.0	0.0
8c3204	1.0	1.0	1.0	0.0	1.0	0.0	0.0
3bc72f	1.0	1.0	1.0	3.2	1.0	0.0	0.0
c1b9d8	1.0	1.0	1.0	-	1.0	0.0	0.0
30b65f	1.0	1.0	1.0	0.1	1.0	0.0	0.0
f45ea9	1.0	1.0	1.0	1.9	1.0	0.0	0.0
3fb977	1.1	1.0	1.0	0.1	1.0	0.06	5.59
a7d721	0.8	1.1	1.2	0.3	1.0	0.21	20.15
45cc00	1.2	1.0	1.0	0.3	1.1	0.12	10.83
47cee1	1.2	1.0	1.2	0.0	1.1	0.12	10.19
446aaf	1.2	1.3	1.2	0.0	1.2	0.06	4.68
b87672	1.4	1.3	1.1	0.4	1.3	0.15	12.06
fdec09	1.2	1.3	1.4	0.3	1.3	0.1	7.69
c46861	1.5	1.3	1.2	0.1	1.3	0.15	11.46
717772	1.3	1.4	1.3	3.0	1.3	0.06	4.33
6a816e	1.0	2.0	1.0	0.1	1.3	0.58	43.3
952fc1	1.0	1.0	2.0	0.3	1.3	0.58	43.3
362356	1.5	1.5	1.4	1.0	1.5	0.06	3.94
940f5e	1.6	1.4	1.5	-	1.5	0.1	6.67
ca9c4c	1.0	2.0	2.0	-	1.7	0.58	34.64
9652ef	2.0	2.0	2.0	0.3	2.0	0.0	0.0
7a0d97	2.0	2.0	2.0	3.2	2.0	0.0	0.0
5069ff	3.0	2.5	2.3	0.4	2.6	0.36	13.87
f5d861	4.0	4.0	5.0	1.0	4.3	0.58	13.32

1.6.2 The Numerical Procedure for Determining Outliers

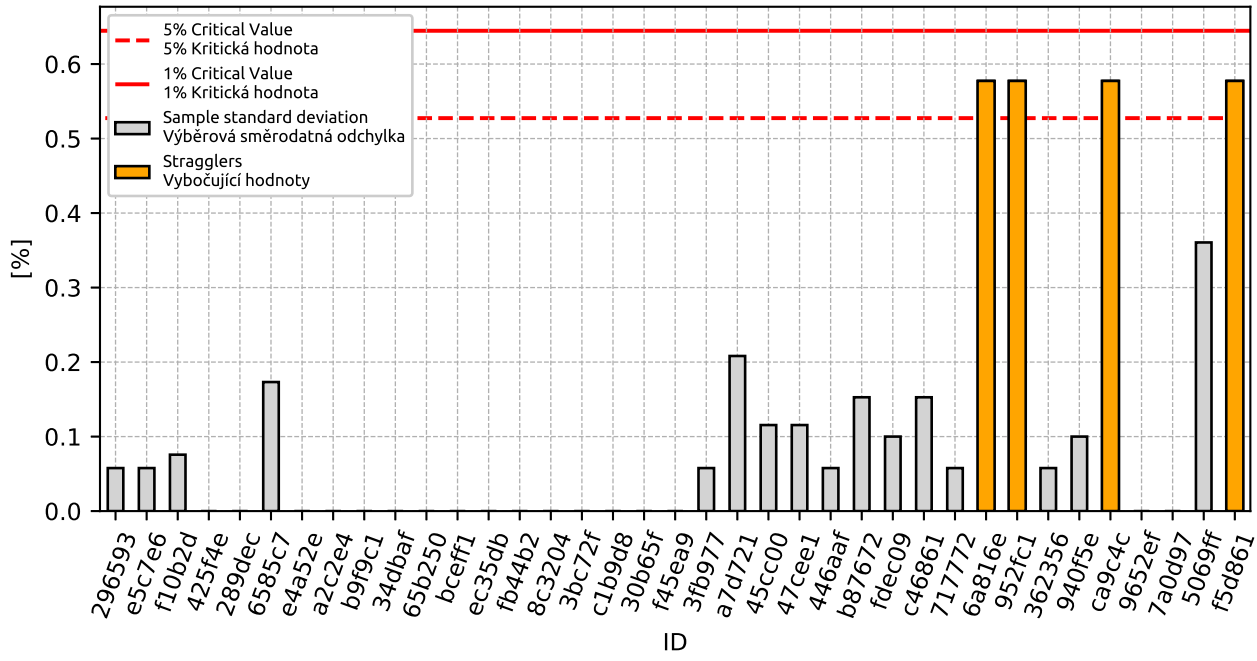

Figure 49: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

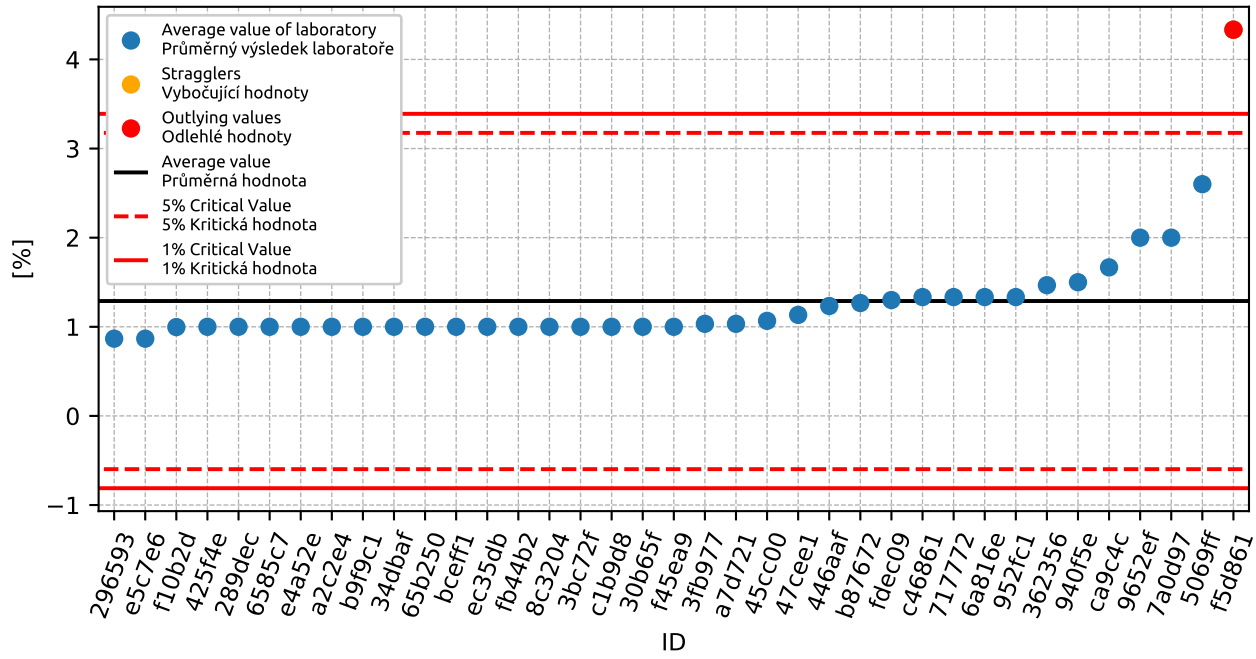

Figure 50: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

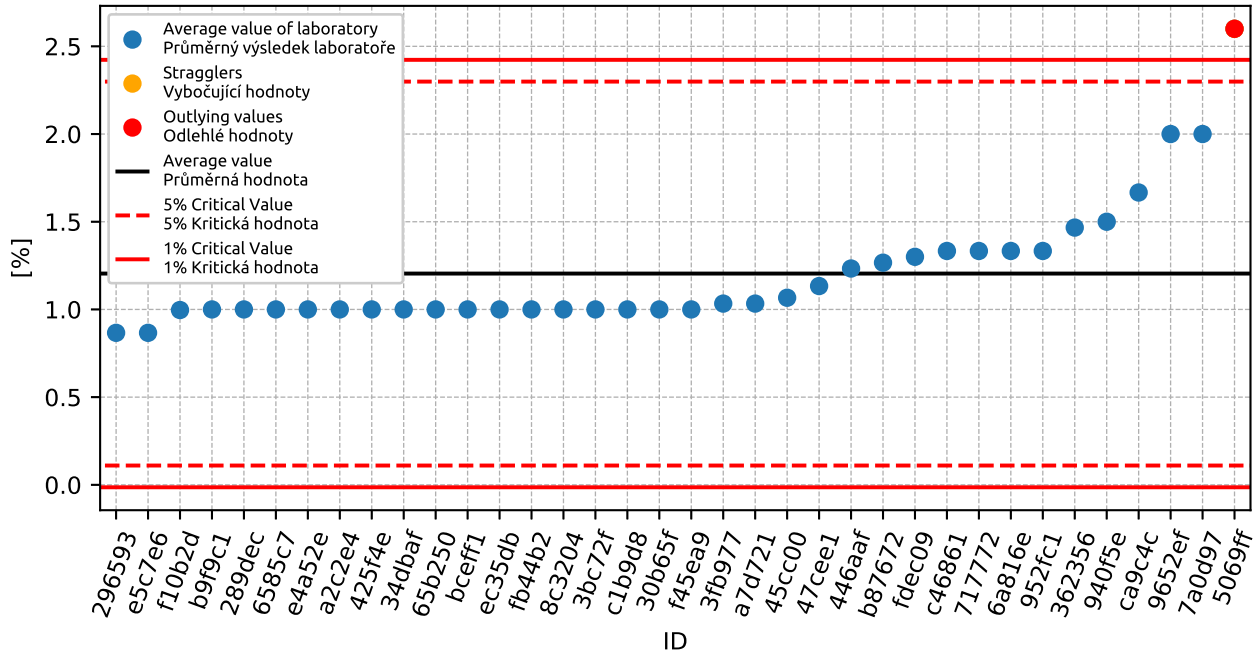

Figure 51: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color

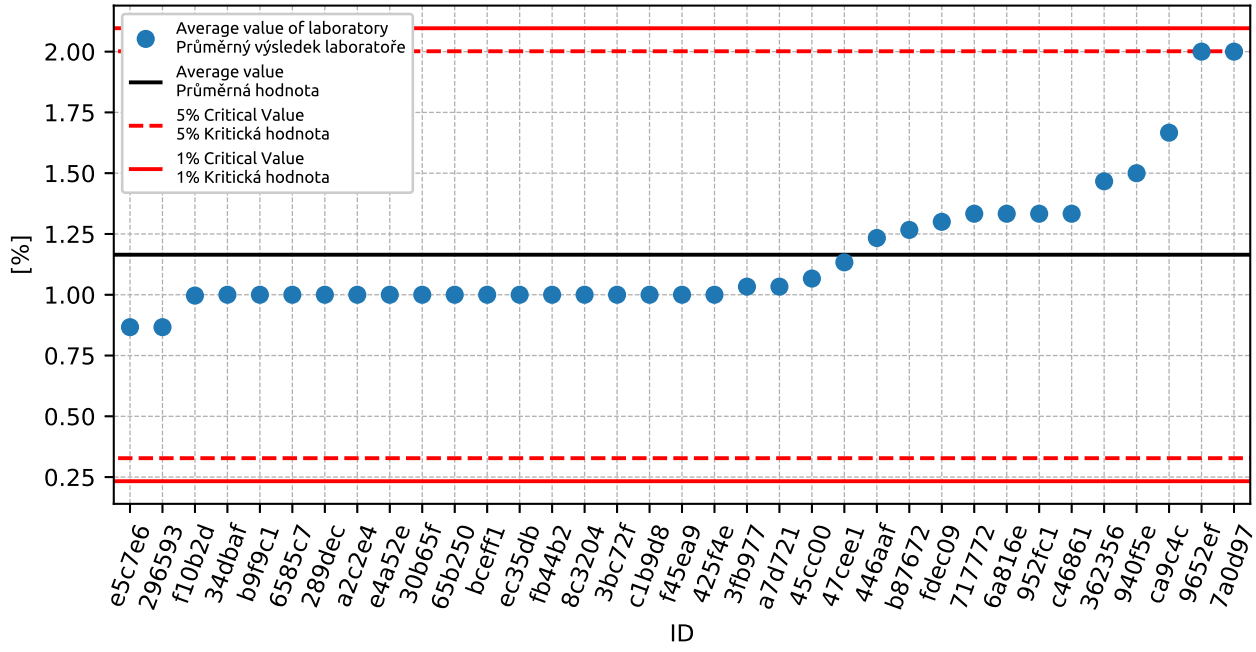

Figure 52: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color

1.6.3 Mandel's Statistics

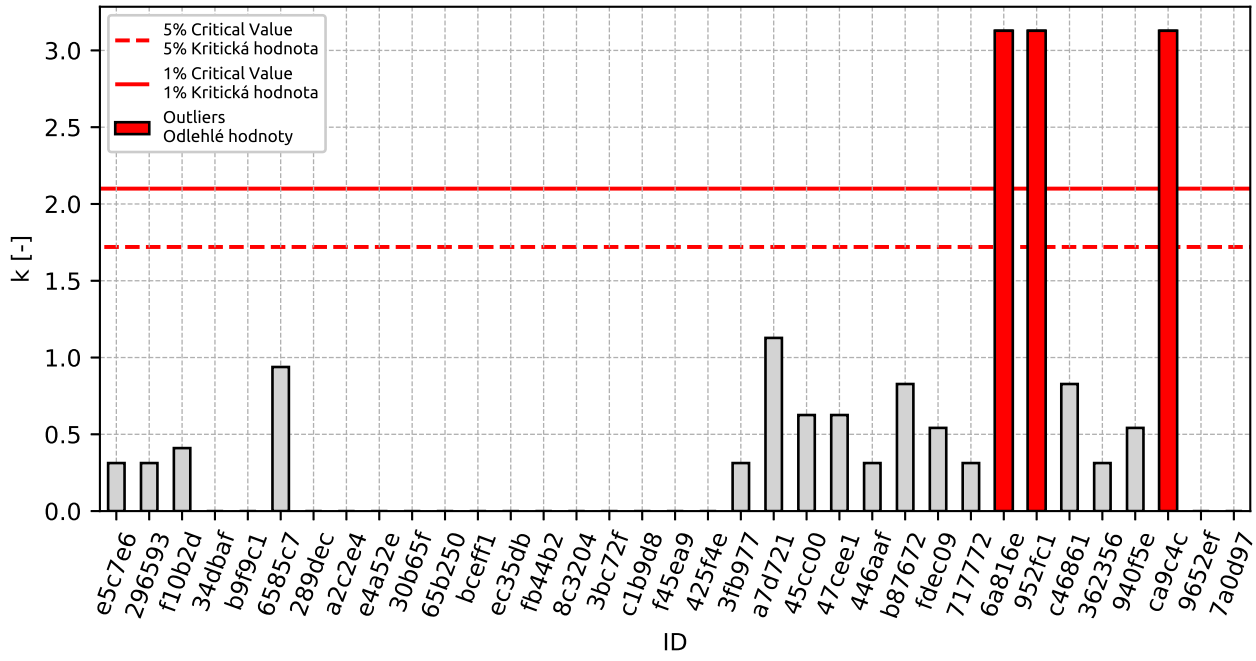

Figure 53: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

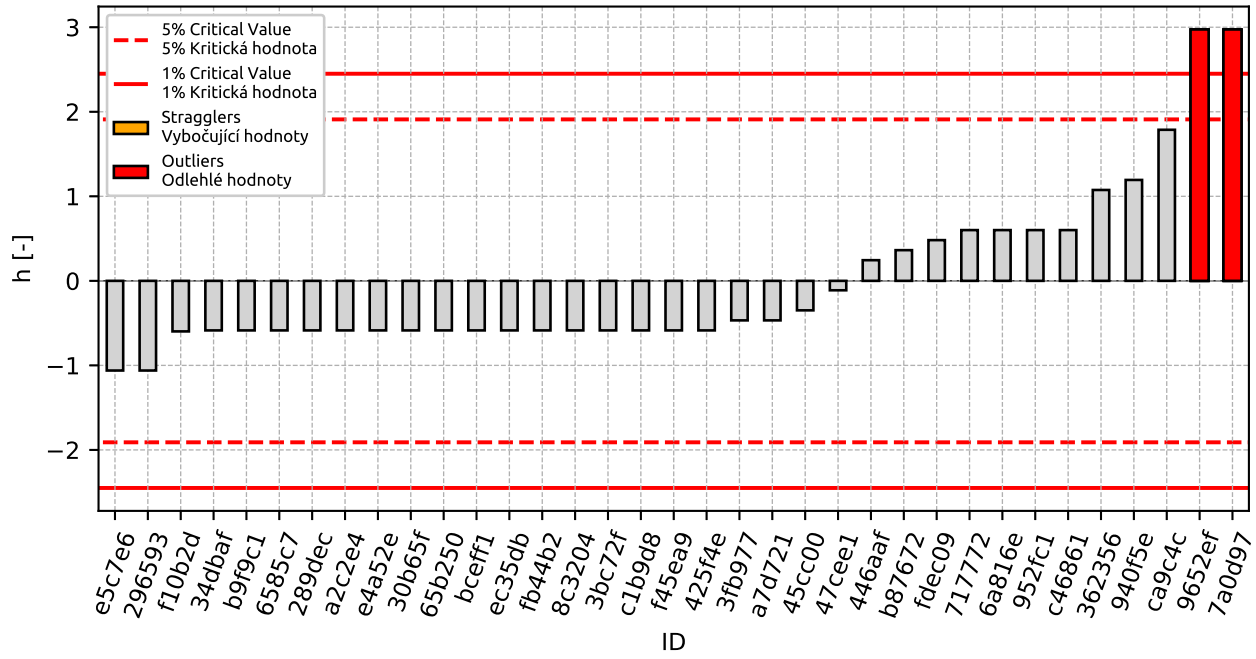

Figure 54: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

1.6.4 Descriptive statistics

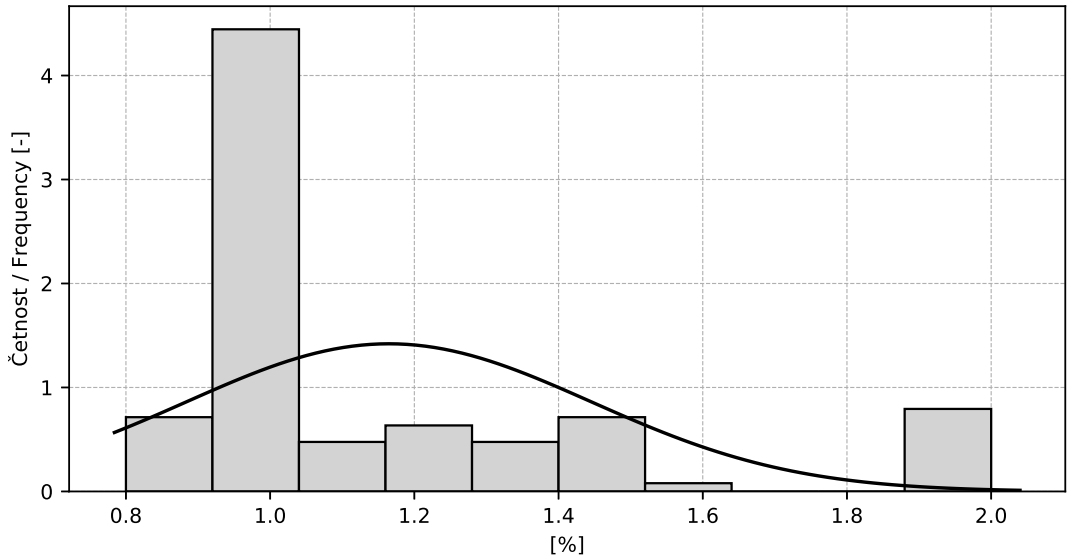

Figure 55: Histogram

Table 21: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	1.2
Výběrová směrodatná odchylka / Sample standard deviation – s	0.28
Vztažná hodnota / Asigned value – x^*	1.1
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.19
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.04
p-hodnota testu normality / p-value of normality test	0.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.26
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.18
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.32
Opakovatelnost / Repeatability – r	0.5
Reprodukovatelnost / Reproducibility – R	0.9

1.6.5 Calculation of Performance Statistics

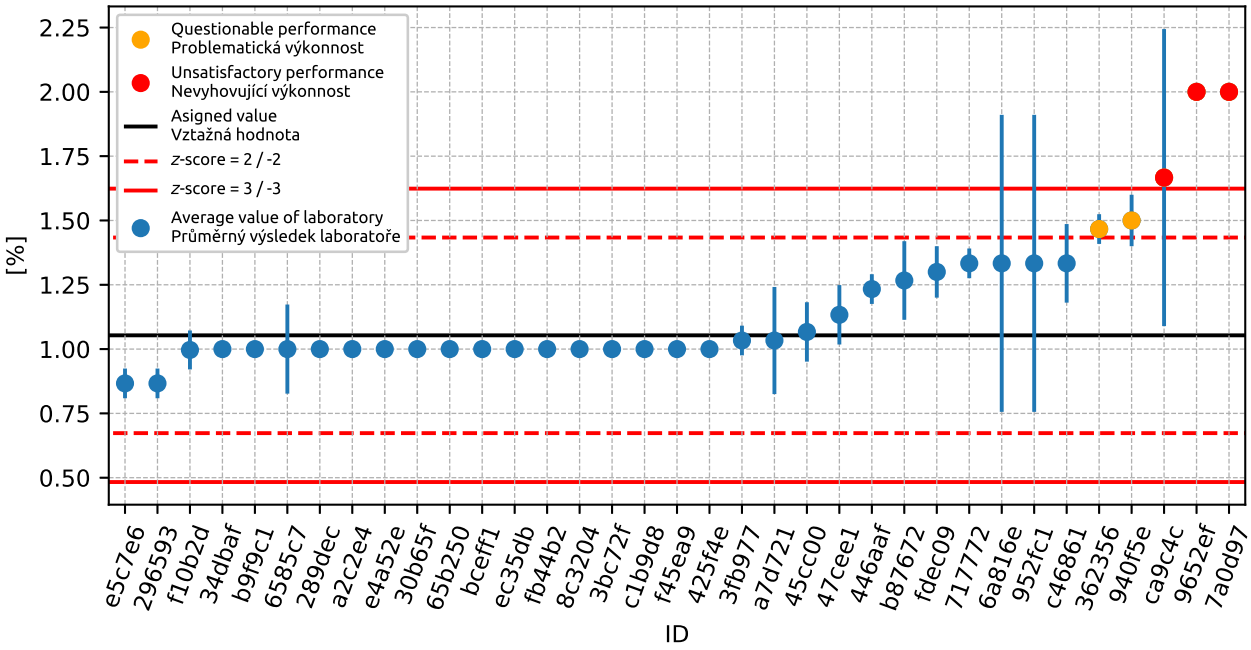

Figure 56: Average values and sample standard deviations

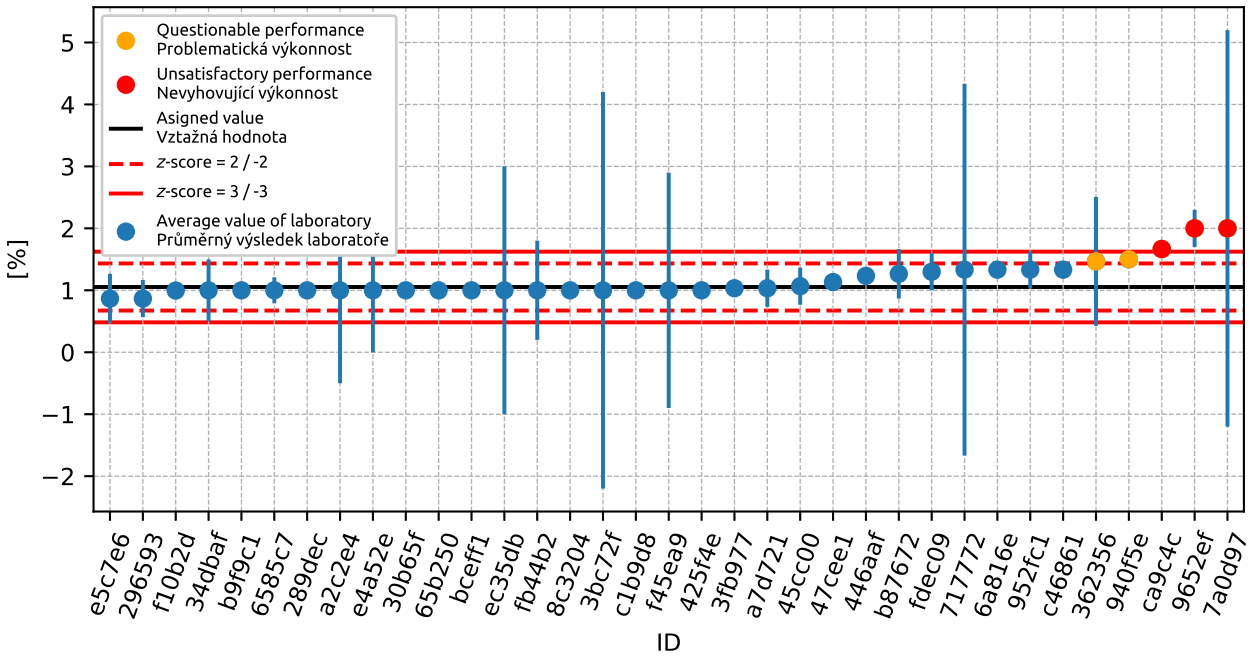

Figure 57: Average values and extended uncertainties of measurement

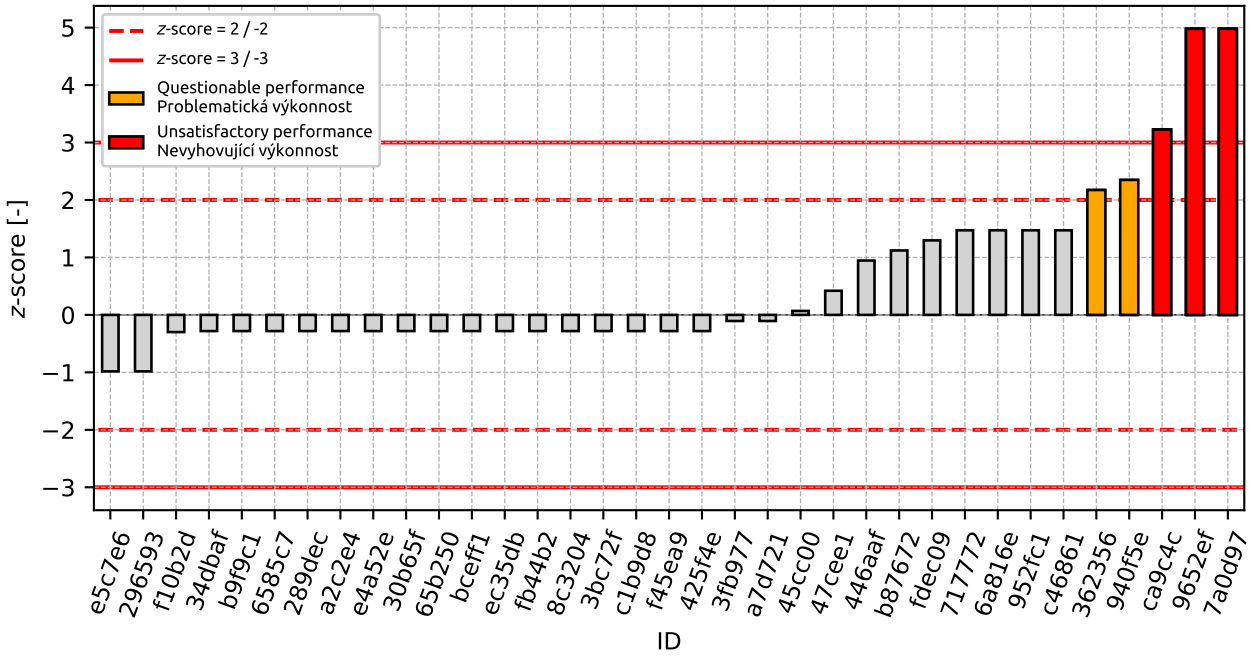

Figure 58: z-score

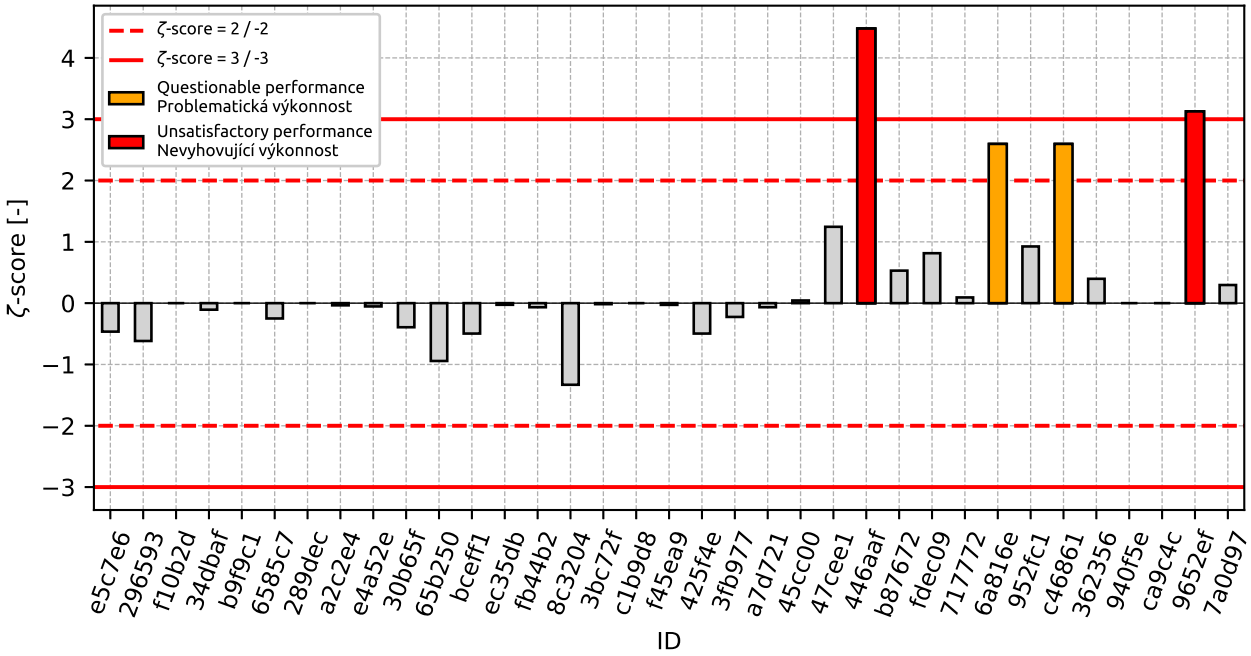

Figure 59: ζ-score

Table 22: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
e5c7e6	-0.98	-0.46
296593	-0.98	-0.62
f10b2d	-0.3	-
34dbaf	-0.28	-0.11
b9f9c1	-0.28	-
6585c7	-0.28	-0.25
289dec	-0.28	-
a2c2e4	-0.28	-0.04
e4a52e	-0.28	-0.05
30b65f	-0.28	-0.39
65b250	-0.28	-0.94
bceff1	-0.28	-0.5
ec35db	-0.28	-0.03
fb44b2	-0.28	-0.07
8c3204	-0.28	-1.33
3bc72f	-0.28	-0.02
c1b9d8	-0.28	-
f45ea9	-0.28	-0.03
425f4e	-0.28	-0.5
3fb977	-0.11	-0.22
a7d721	-0.11	-0.07
45cc00	0.07	0.04
47cee1	0.42	1.25
446aaf	0.95	4.48
b87672	1.12	0.53
fdec09	1.3	0.81
717772	1.47	0.09
6a816e	1.47	2.6
952fc1	1.47	0.92
c46861	1.47	2.6
362356	2.17	0.4
940f5e	2.35	-
ca9c4c	3.23	-
9652ef	4.98	3.13
7a0d97	4.98	0.3

1.7 0.063 mm

1.7.1 Test results

Table 23: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
8c3204	0.0	0.0	0.0	0.0	0.0	0.0	-
e5c7e6	0.2	0.1	0.1	0.1	0.1	0.06	43.3
3fb977	0.1	0.2	0.2	0.1	0.2	0.06	34.64
425f4e	0.1	0.2	0.2	0.1	0.2	0.06	34.64
f10b2d	0.3	0.2	0.1	-	0.2	0.09	51.36
fdec09	0.1	0.2	0.3	0.1	0.2	0.1	50.0
296593	0.3	0.1	0.3	0.1	0.2	0.12	49.49
34dbaf	0.3	0.2	0.2	0.1	0.2	0.06	24.74
6585c7	0.3	0.4	0.1	0.2	0.3	0.15	57.28
45cc00	0.4	0.3	0.3	0.1	0.3	0.06	17.32
e4a52e	0.4	0.3	0.4	0.1	0.4	0.06	15.75
a2c2e4	0.5	0.4	0.3	0.9	0.4	0.1	25.0
b9f9c1	0.4	0.4	0.4	-	0.4	0.0	0.0
952fc1	0.5	0.3	0.5	0.1	0.4	0.12	26.65
47cee1	0.5	0.4	0.4	0.0	0.4	0.06	13.32
c46861	0.6	0.4	0.3	0.1	0.4	0.15	35.25
446aaf	0.4	0.5	0.5	0.0	0.5	0.06	12.37
b87672	0.6	0.5	0.3	0.1	0.5	0.15	32.73
ec35db	0.5	0.5	0.5	1.0	0.5	0.0	0.0
c1b9d8	0.5	0.5	0.5	-	0.5	0.0	0.0
65b250	0.5	0.5	0.5	0.0	0.5	0.0	0.0
717772	0.5	0.5	0.5	3.0	0.5	0.0	0.0
3bc72f	0.5	0.5	0.5	4.8	0.5	0.0	0.0
bceff1	0.5	0.5	0.6	0.1	0.5	0.06	10.83
6a816e	0.6	0.5	0.5	0.1	0.5	0.06	10.83
9652ef	0.5	0.5	0.6	0.1	0.5	0.06	10.83
289dec	0.6	0.6	0.6	-	0.6	0.0	0.0
f45ea9	0.6	0.6	0.6	1.9	0.6	0.0	0.0
fb44b2	0.6	0.7	0.5	0.2	0.6	0.1	16.67
a7d721	0.6	0.7	0.6	0.2	0.6	0.06	9.12
940f5e	0.7	0.6	0.6	-	0.6	0.06	9.12
30b65f	0.8	0.6	0.6	0.1	0.7	0.12	17.32
362356	0.7	0.7	0.6	2.7	0.7	0.06	8.66
7a0d97	0.7	0.8	0.6	4.8	0.7	0.1	14.29
ca9c4c	0.6	0.9	1.1	-	0.9	0.25	29.04
5069ff	2.0	1.1	1.6	0.5	1.6	0.47	29.97
f5d861	3.0	3.0	4.0	1.5	3.3	0.58	17.32

1.7.2 The Numerical Procedure for Determining Outliers

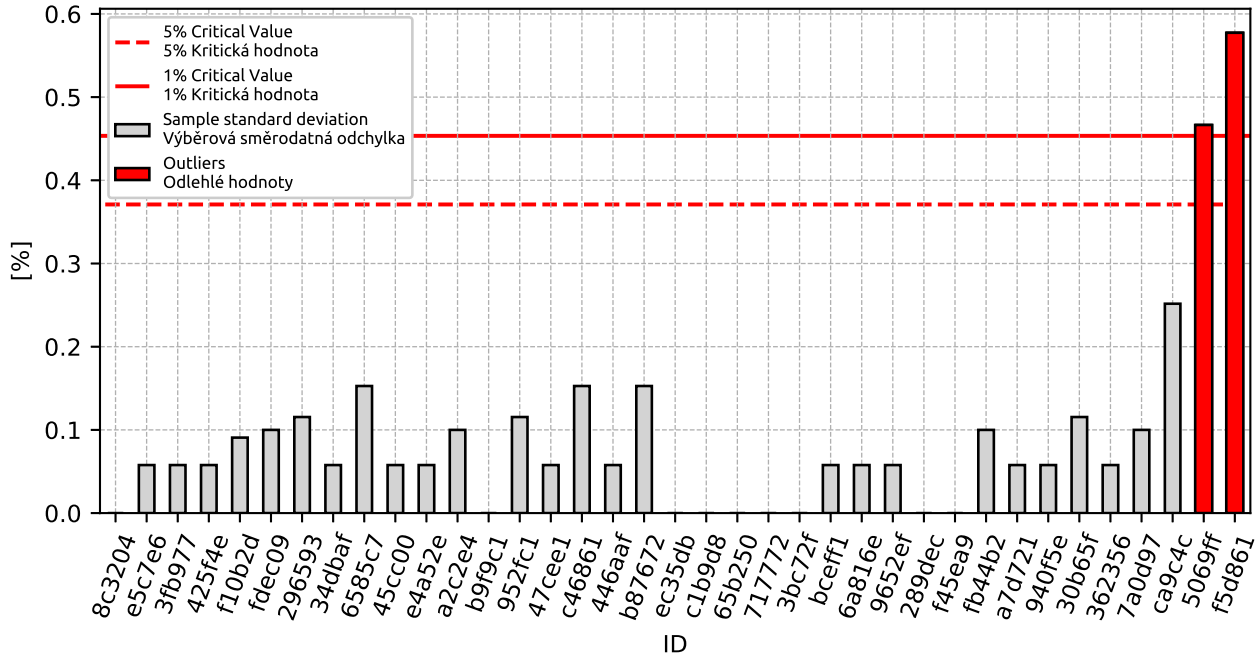

Figure 60: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

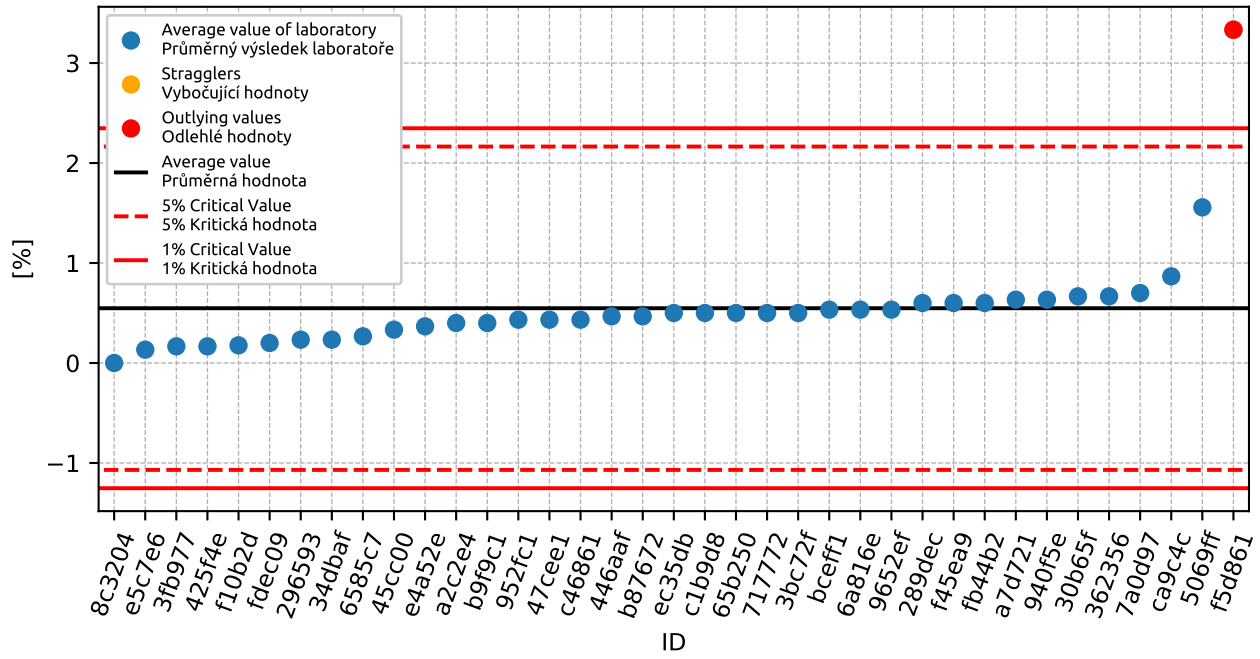

Figure 61: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

1.7.3 Mandel's Statistics

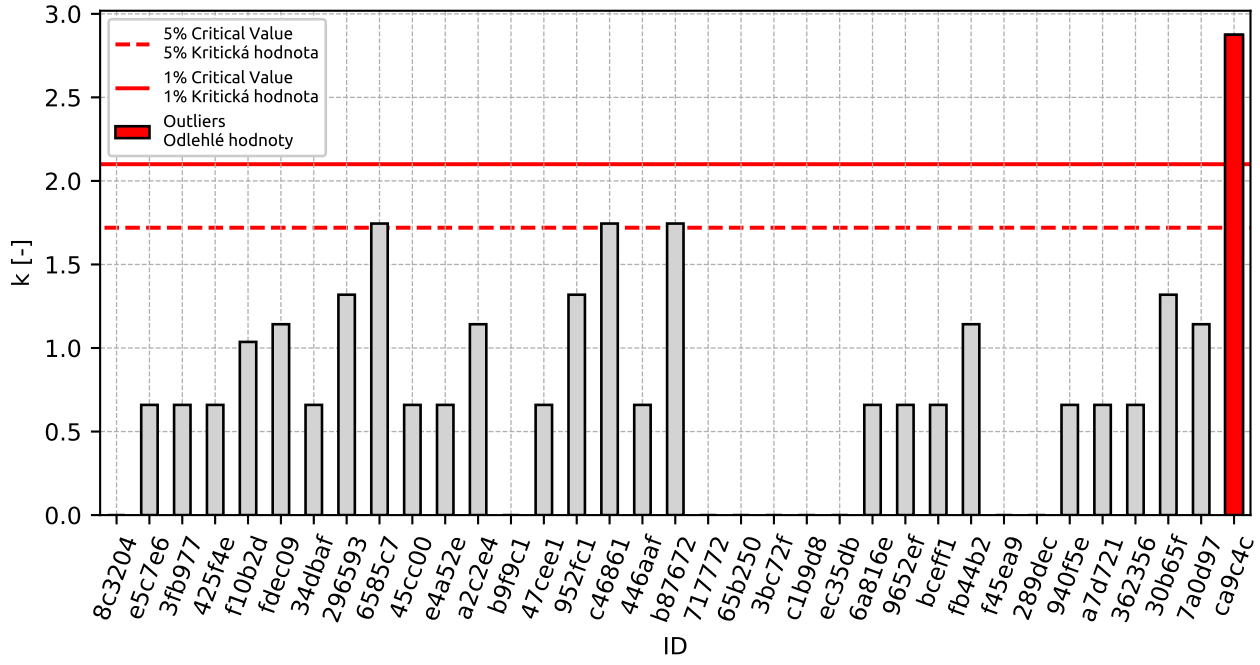

Figure 62: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

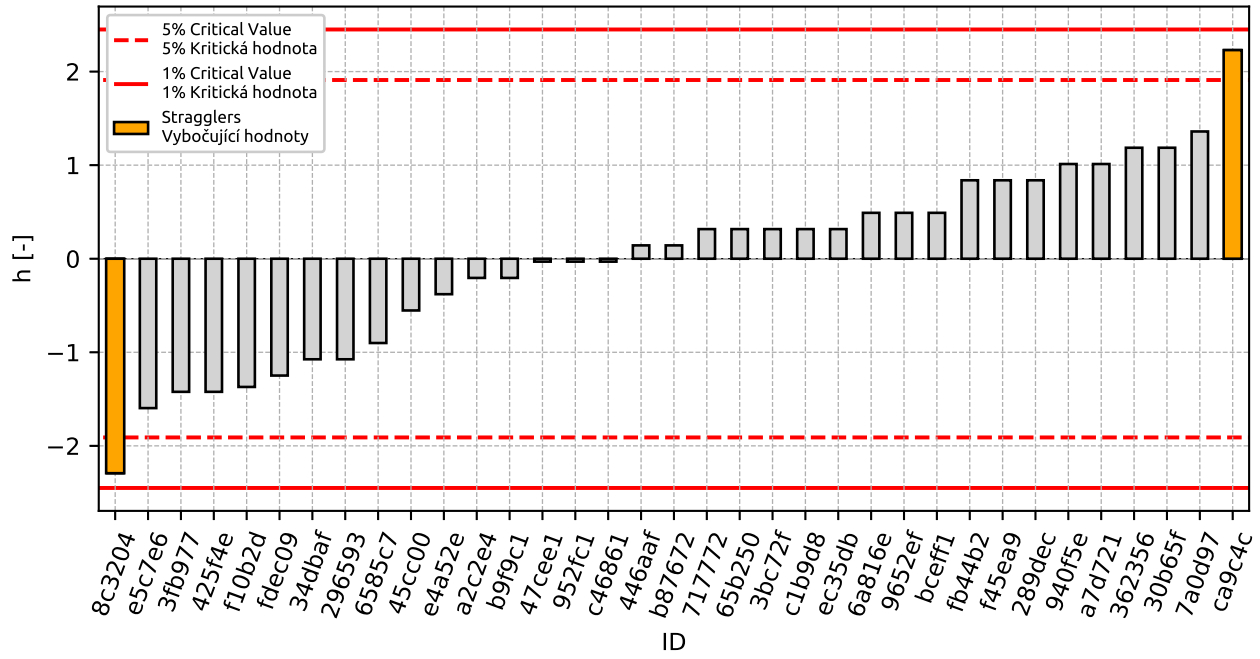

Figure 63: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

1.7.4 Descriptive statistics

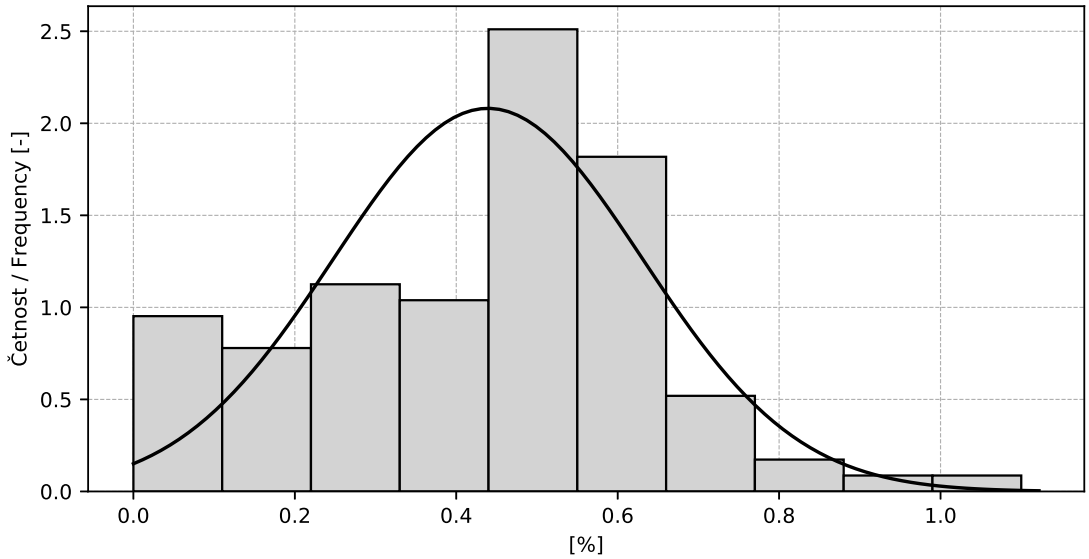

Figure 64: Histogram

Table 24: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	0.4
Výběrová směrodatná odchylka / Sample standard deviation – s	0.19
Vztažná hodnota / Asigned value – x^*	0.4
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.2
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.04
p-hodnota testu normality / p-value of normality test	0.677 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.18
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.09
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.2
Opakovatelnost / Repeatability – r	0.2
Reprodukovatelnost / Reproducibility – R	0.6

1.7.5 Calculation of Performance Statistics

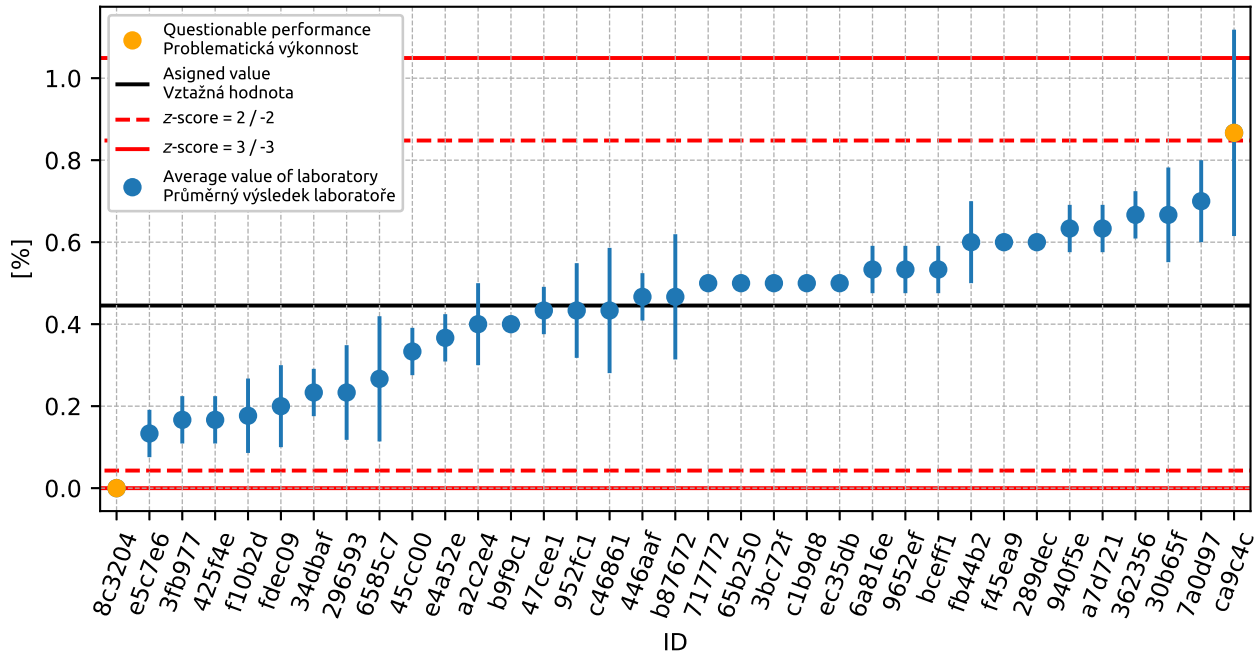

Figure 65: Average values and sample standard deviations

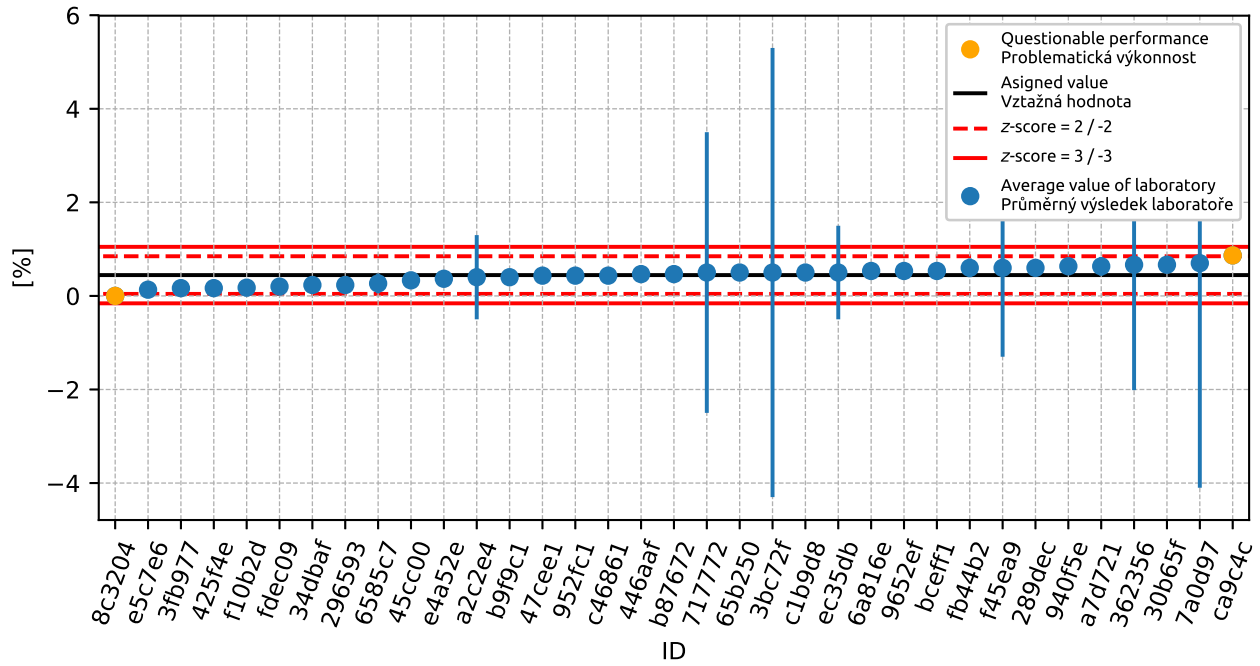

Figure 66: Average values and extended uncertainties of measurement

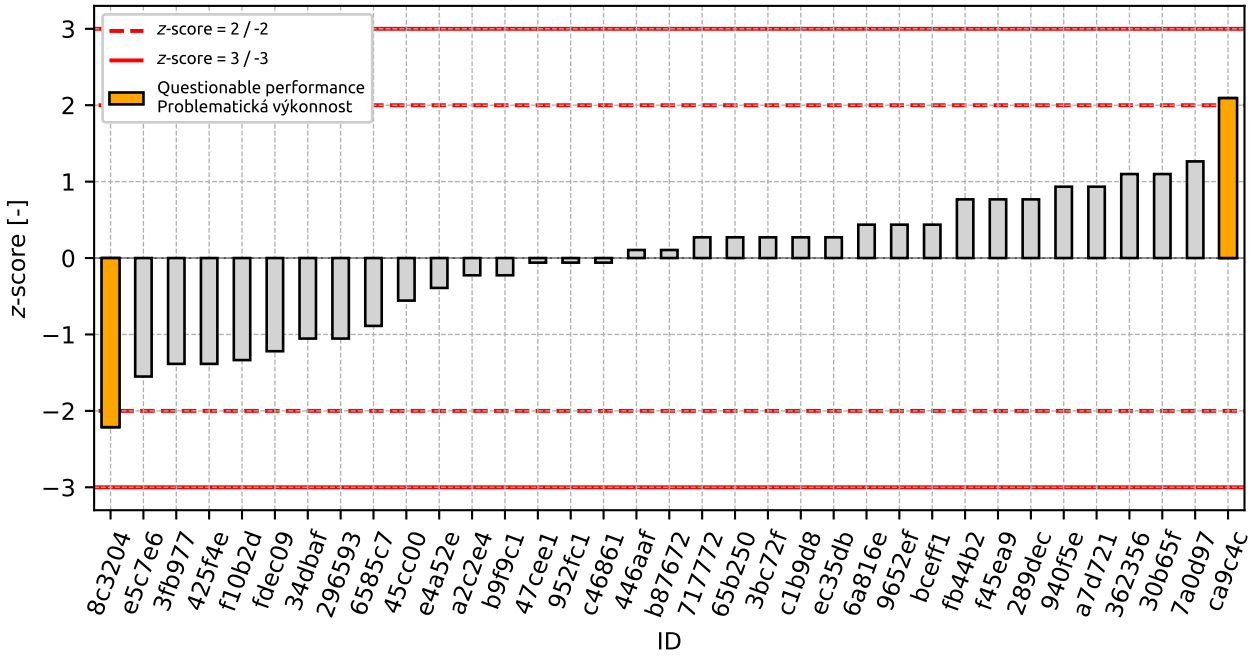

Figure 67: z-score

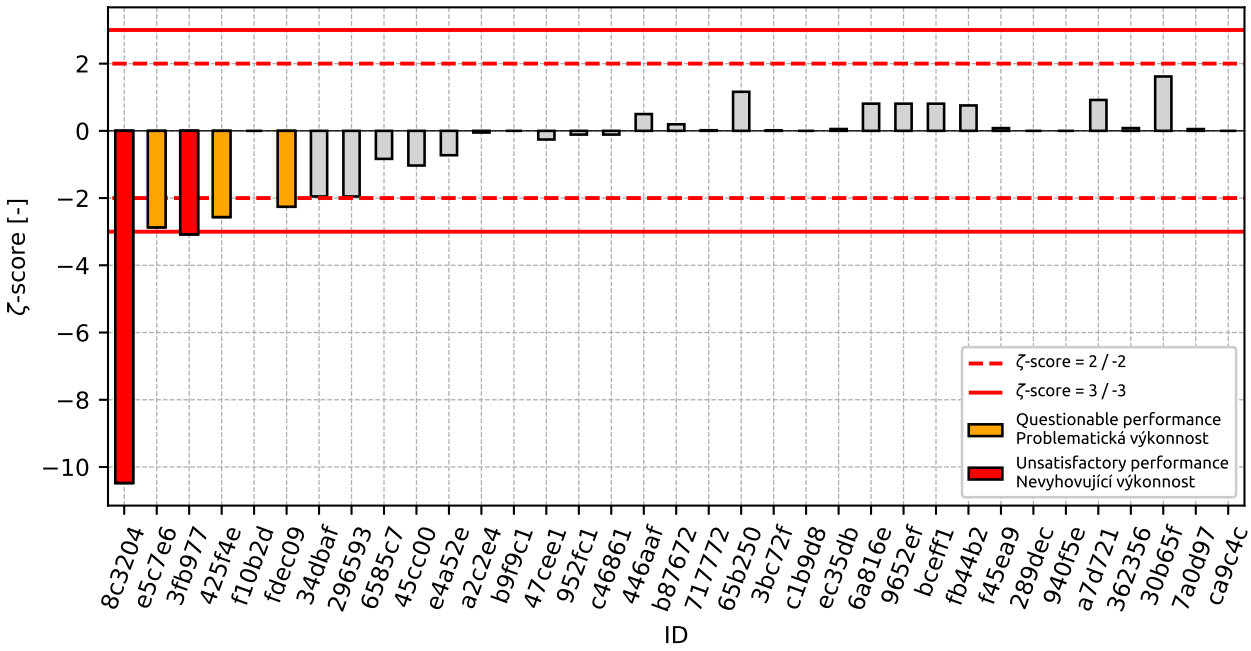

Figure 68: ζ-score

Table 25: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8c3204	-2.21	-10.48
e5c7e6	-1.55	-2.87
3fb977	-1.39	-3.08
425f4e	-1.39	-2.57
f10b2d	-1.34	-
fdec09	-1.22	-2.26
34dbaf	-1.05	-1.95
296593	-1.05	-1.95
6585c7	-0.89	-0.83
45cc00	-0.56	-1.03
e4a52e	-0.39	-0.72
a2c2e4	-0.23	-0.05
b9f9c1	-0.23	-
47cee1	-0.06	-0.26
952fc1	-0.06	-0.11
c46861	-0.06	-0.11
446aaf	0.11	0.5
b87672	0.11	0.2
717772	0.27	0.02
65b250	0.27	1.16
3bc72f	0.27	0.01
c1b9d8	0.27	-
ec35db	0.27	0.05
6a816e	0.44	0.81
9652ef	0.44	0.81
bceff1	0.44	0.81
fb44b2	0.77	0.76
f45ea9	0.77	0.08
289dec	0.77	-
940f5e	0.93	-
a7d721	0.93	0.92
362356	1.1	0.08
30b65f	1.1	1.62
7a0d97	1.26	0.05
ca9c4c	2.09	-

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

2.1 Test results

Table 26: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
f45ea9	18.0	18.0	18.0	3.5	18.0	0.0	0.0
34dbaf	18.0	18.0	18.0	1.0	18.0	0.0	0.0
7e5d0a	18.7	18.5	18.9	0.1	18.7	0.2	1.07
33435c	20.0	20.0	20.0	0.2	20.0	0.0	0.0
369f99	22.2	22.4	22.0	0.6	22.2	0.2	0.9

2.2 The Numerical Procedure for Determining Outliers

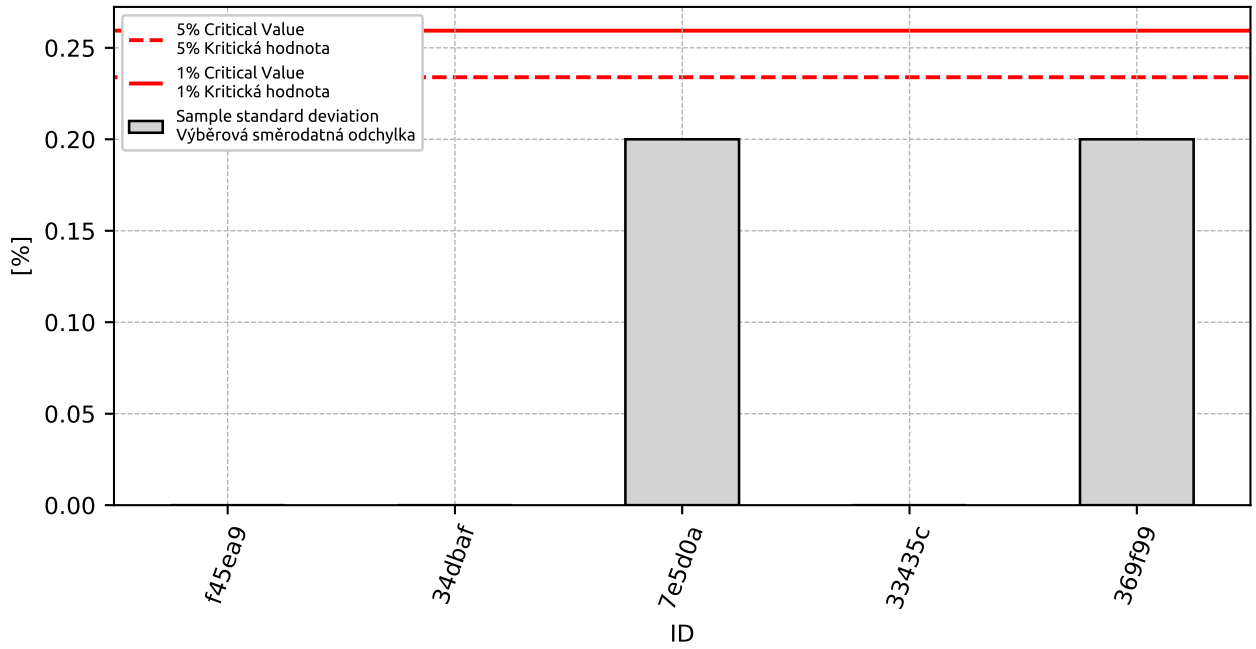

Figure 69: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

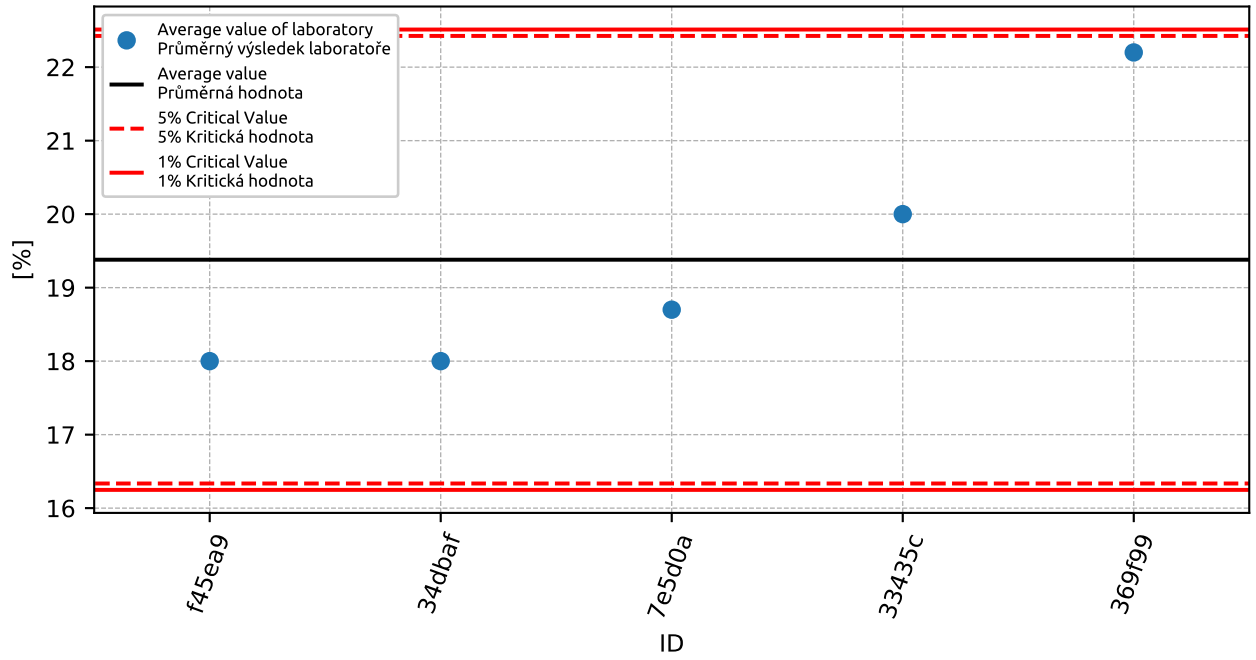

Figure 70: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

2.3 Mandel's Statistics

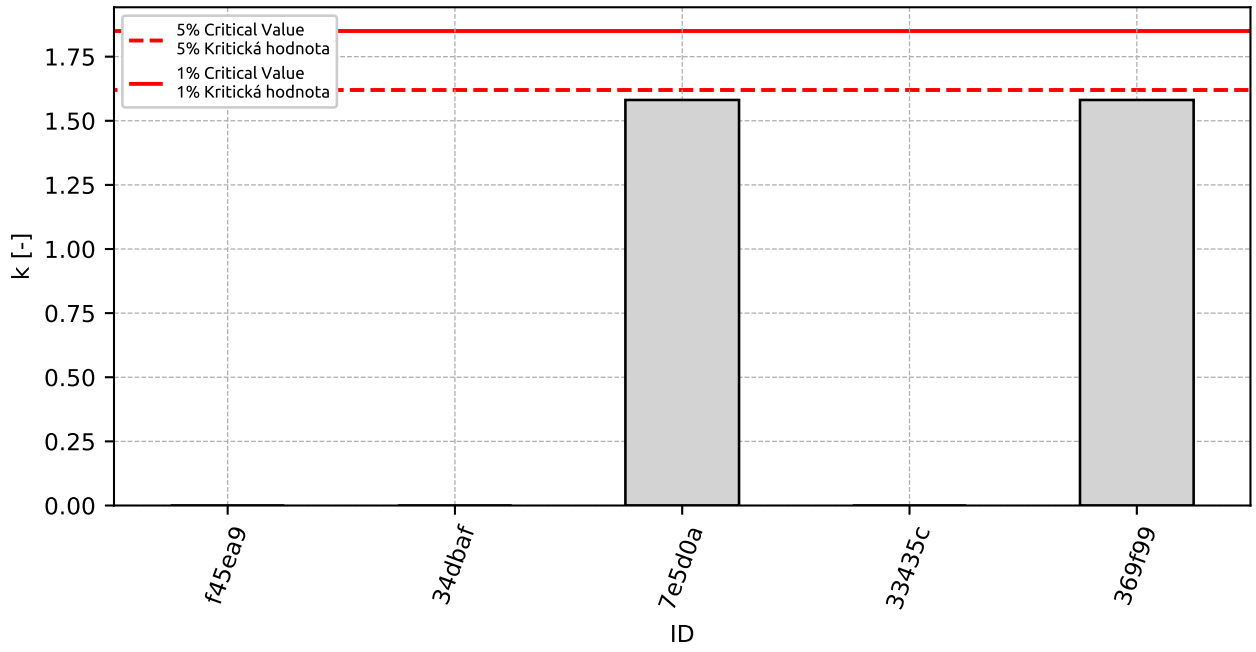

Figure 71: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

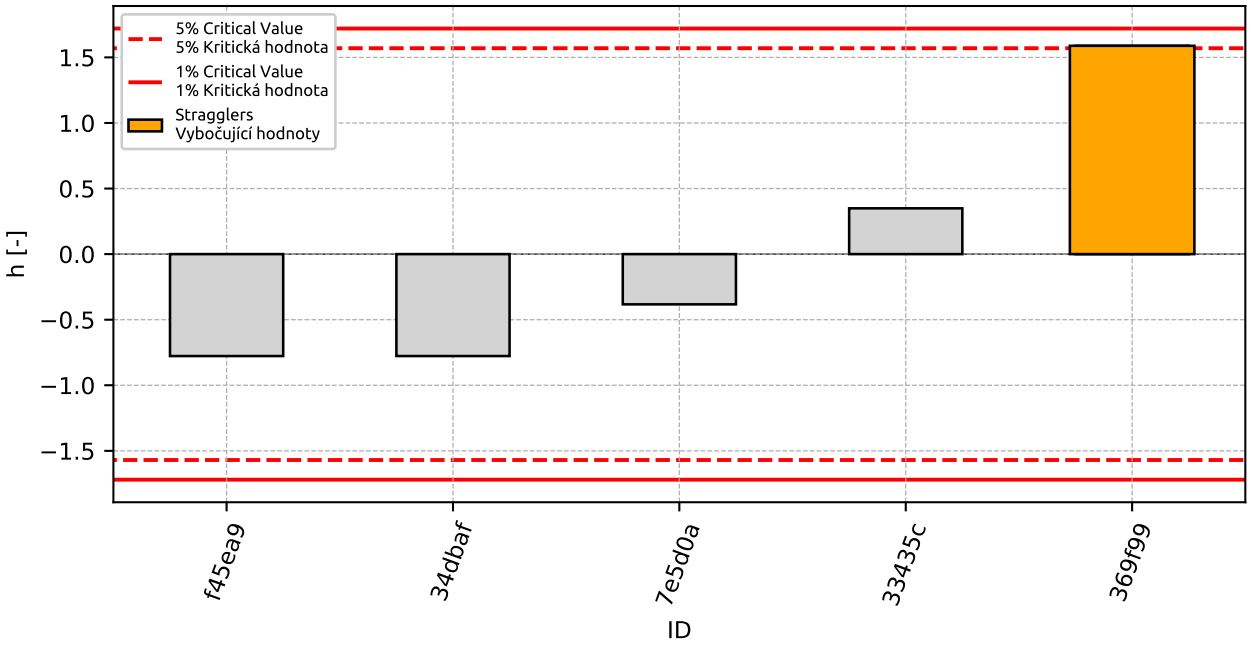

Figure 72: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

2.4 Descriptive statistics

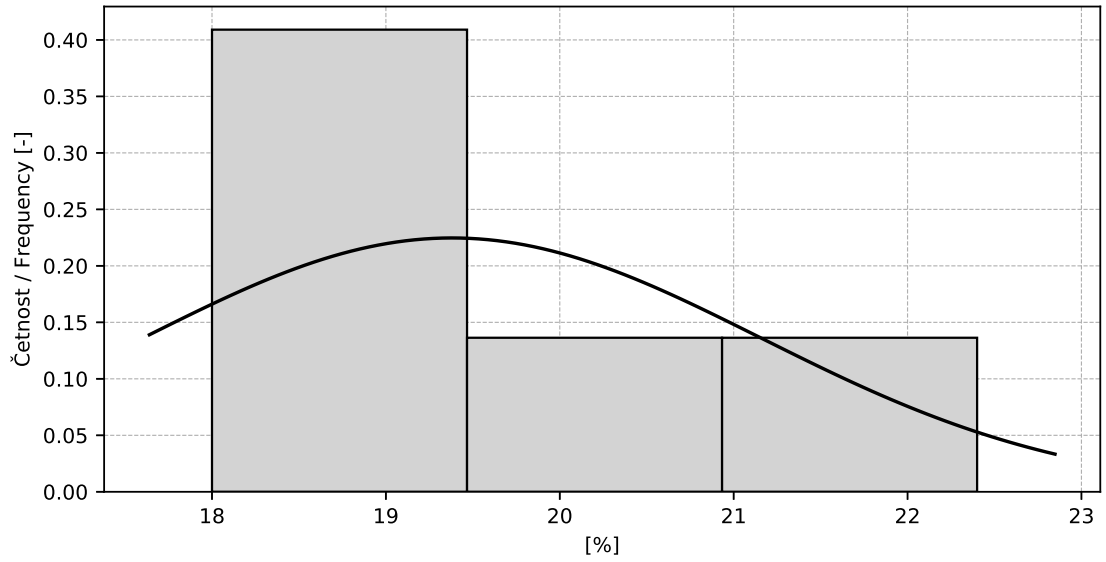

Figure 73: Histogram

Table 27: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	19.4
Výběrová směrodatná odchylka / Sample standard deviation – s	1.78
Vztažná hodnota / Asigned value – x^*	19.4
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.8
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	1.01
p-hodnota testu normality / p-value of normality test	0.238 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.77
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.13
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.78
Opakovatelnost / Repeatability – r	0.4
Reprodukovatelnost / Reproducibility – R	5.0

2.5 Calculation of Performance Statistics

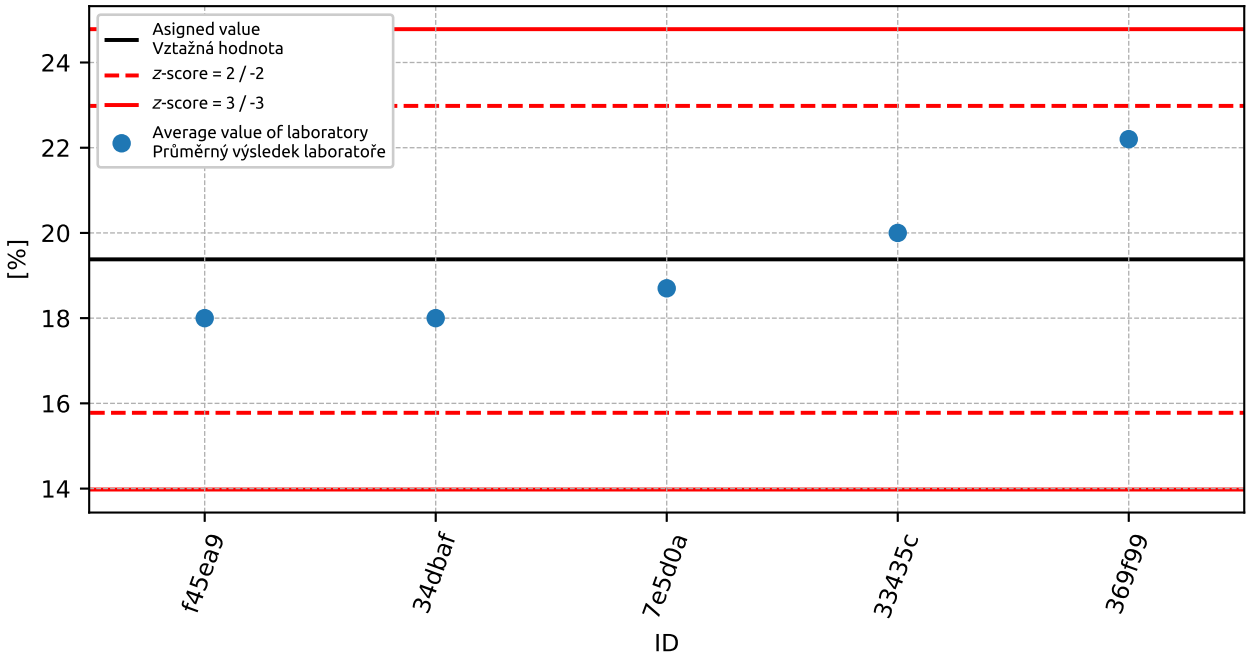

Figure 74: Average values and sample standard deviations

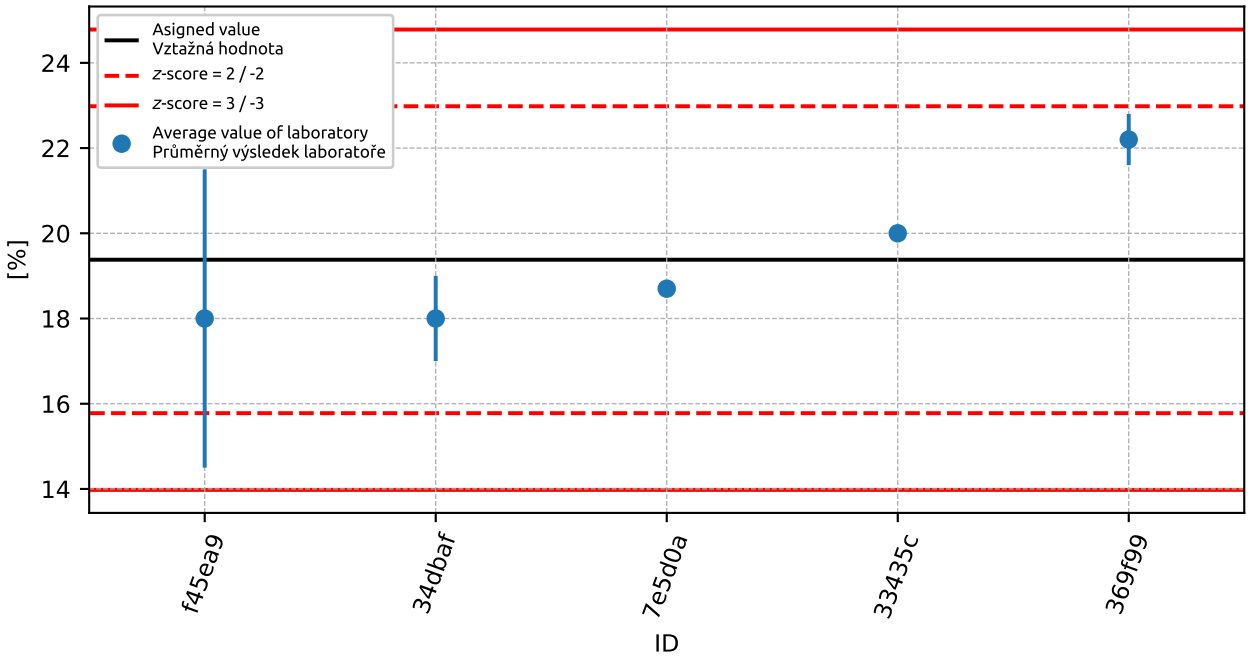

Figure 75: Average values and extended uncertainties of measurement

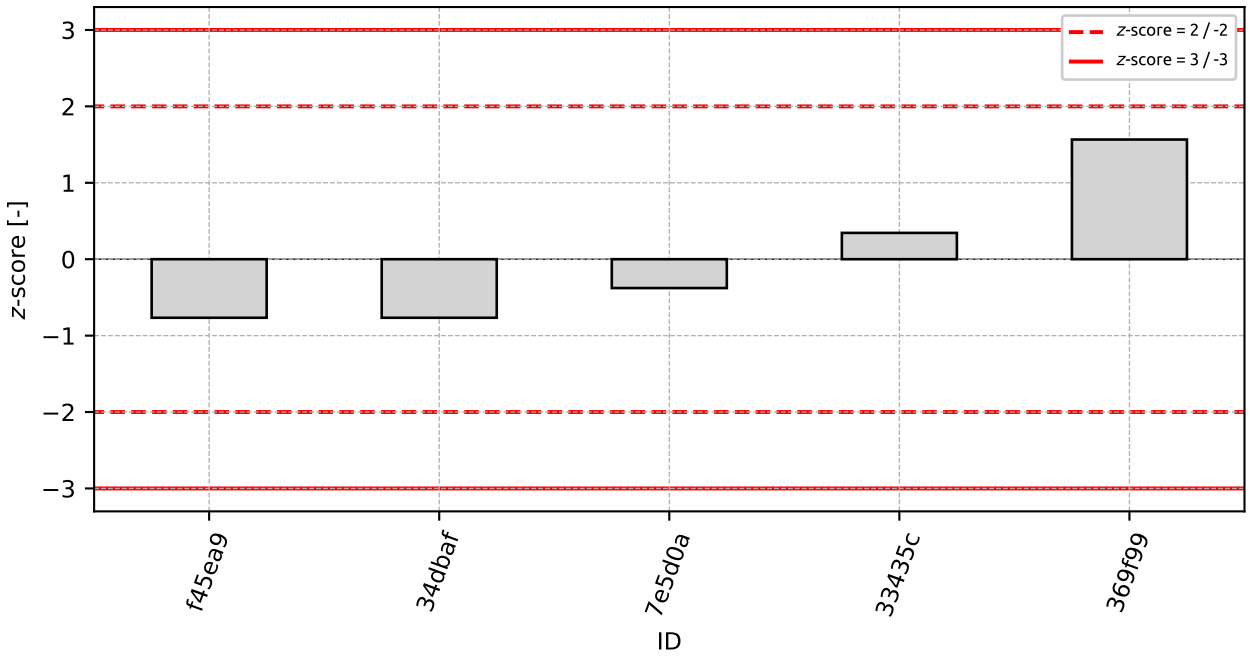

Figure 76: z-score

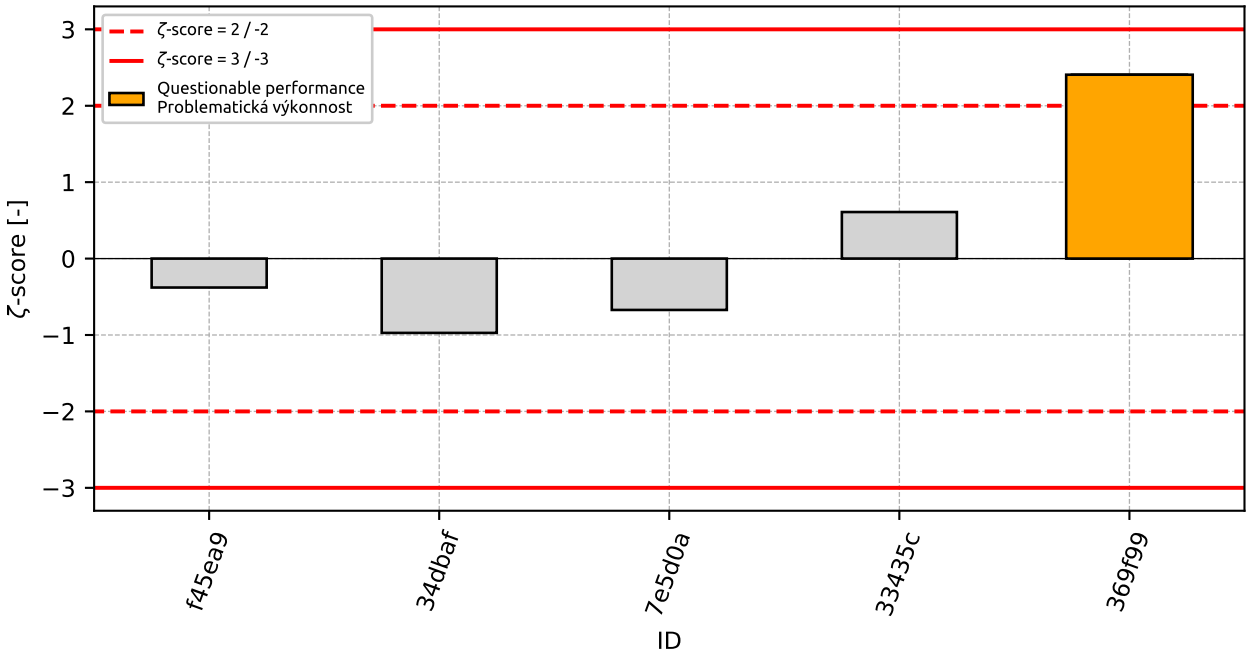

Figure 77: ζ-score

Table 28: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f45ea9	-0.77	-0.38
34dbaf	-0.77	-0.97
7e5d0a	-0.38	-0.67
33435c	0.34	0.61
369f99	1.57	2.41

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

3.1 Test results

Table 29: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
8c3204	25.0	26.0	25.0	4.6	25.3	0.58	2.28
362356	26.2	26.8	26.5	2.6	26.5	0.3	1.13
952fc1	26.0	27.0	27.0	3.2	26.7	0.58	2.17
e4a52e	29.0	28.0	27.0	1.0	28.0	1.0	3.57
6585c7	30.6	30.5	30.3	0.5	30.5	0.15	0.5
289dec	30.5	31.7	30.9	-	31.0	0.61	1.97
f5d861	31.3	31.3	31.2	0.5	31.3	0.06	0.18
f10b2d	30.5	32.3	31.5	-	31.4	0.89	2.84
bceff1	30.0	32.0	35.0	0.3	32.3	2.52	7.78
6a816e	32.6	32.7	32.6	1.7	32.6	0.06	0.18
b9f9c1	33.0	32.0	33.0	-	32.7	0.58	1.77
c46861	32.4	33.0	33.4	2.0	32.9	0.5	1.53
47cee1	33.0	34.0	32.0	0.7	33.0	1.0	3.03
a7d721	33.5	33.6	33.5	3.0	33.5	0.06	0.17
425f4e	33.6	34.0	33.8	1.7	33.8	0.2	0.59
fdec09	34.1	33.4	35.2	1.4	34.2	0.91	2.65
30dfbb	35.0	36.0	36.0	0.5	35.7	0.58	1.62
a2c2e4	36.0	36.0	37.0	2.0	36.3	0.58	1.59
717772	37.0	37.0	37.0	5.0	37.0	0.0	0.0
7a0d97	37.0	37.0	37.0	4.4	37.0	0.0	0.0
c1b9d8	38.0	37.0	37.0	-	37.3	0.58	1.55
fb44b2	38.0	39.0	37.0	1.5	38.0	1.0	2.63

3.2 The Numerical Procedure for Determining Outliers

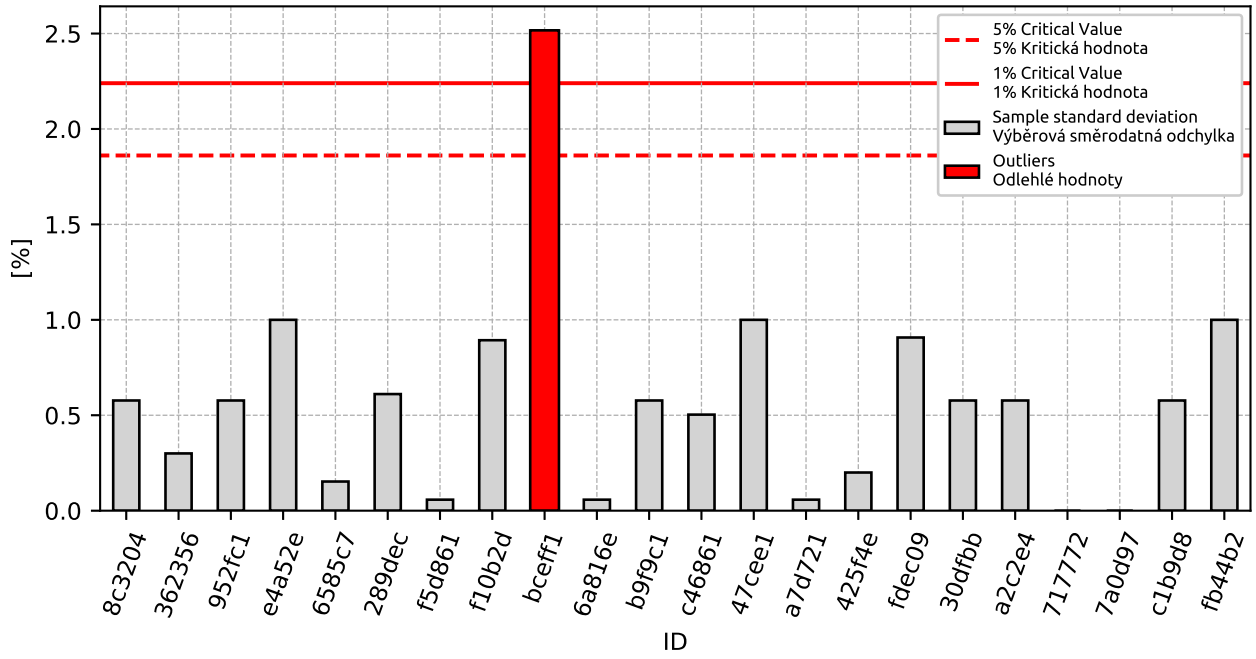

Figure 78: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

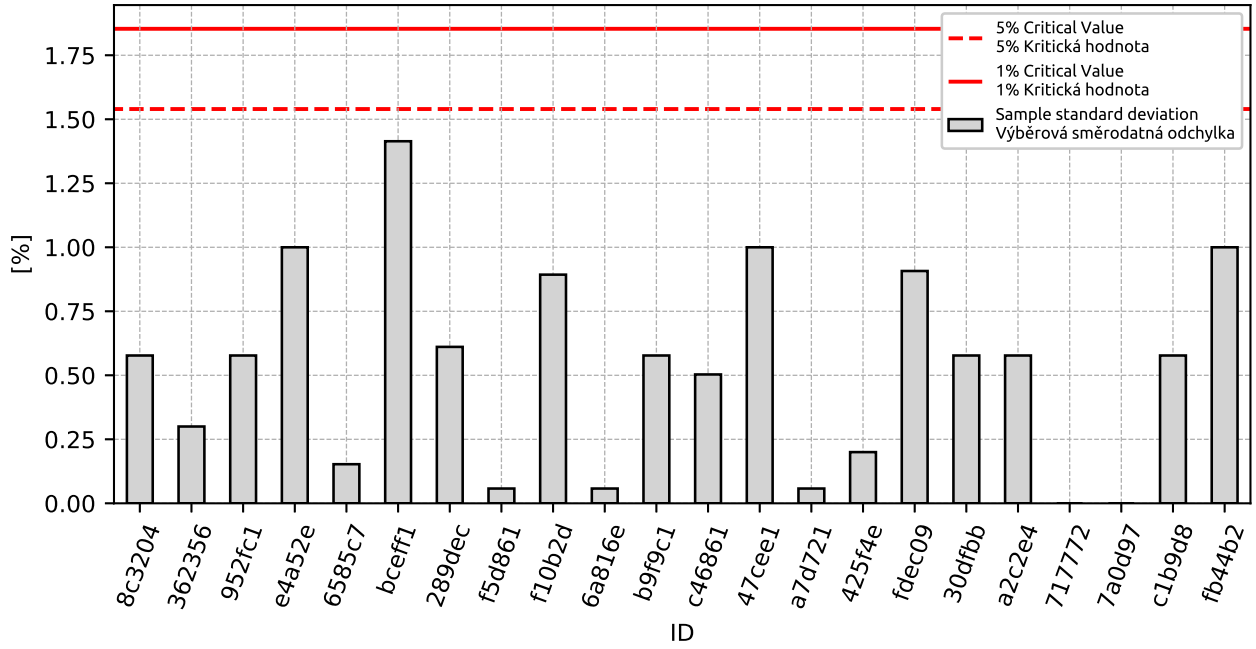

Figure 79: **Cochran's test** - sample standard deviations without outliers: 1% critical value - red color; 5% critical value - blue color

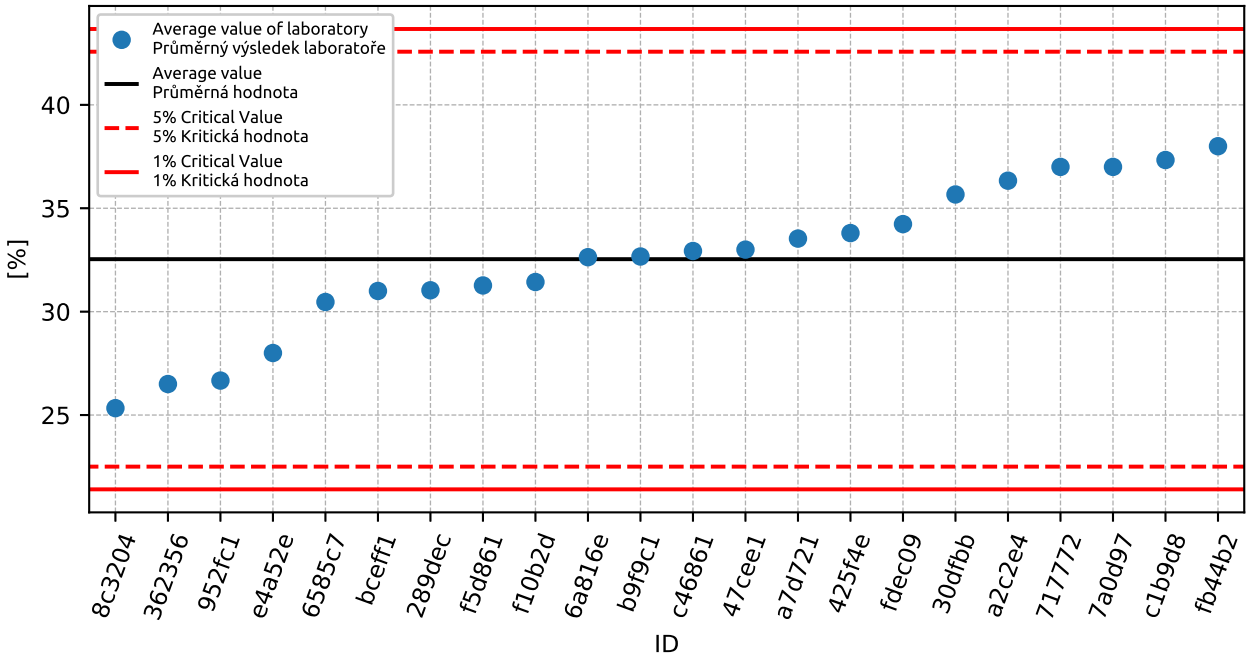

Figure 80: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

3.3 Mandel's Statistics

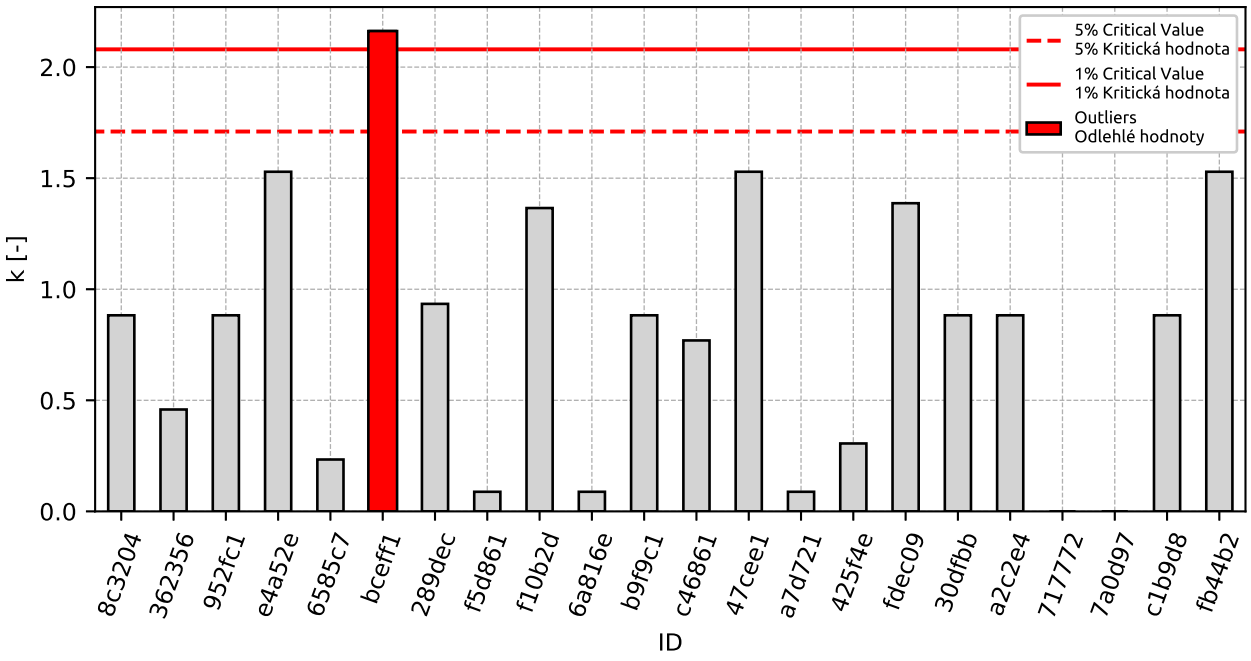

Figure 81: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

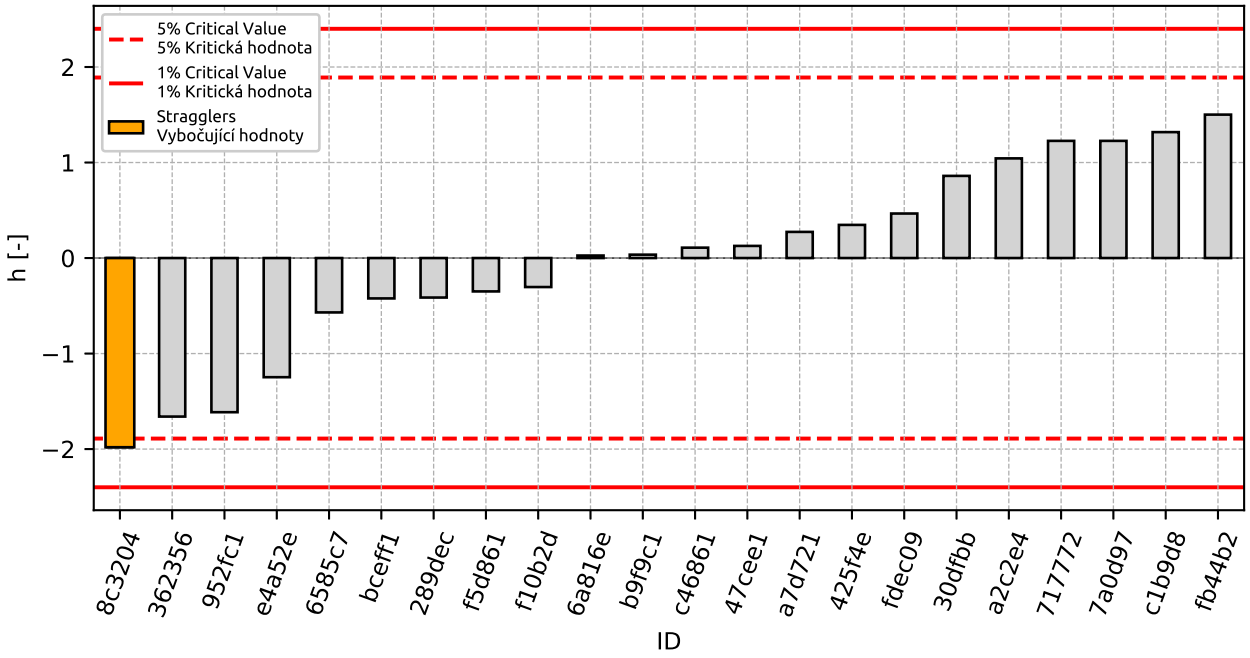

Figure 82: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

3.4 Descriptive statistics

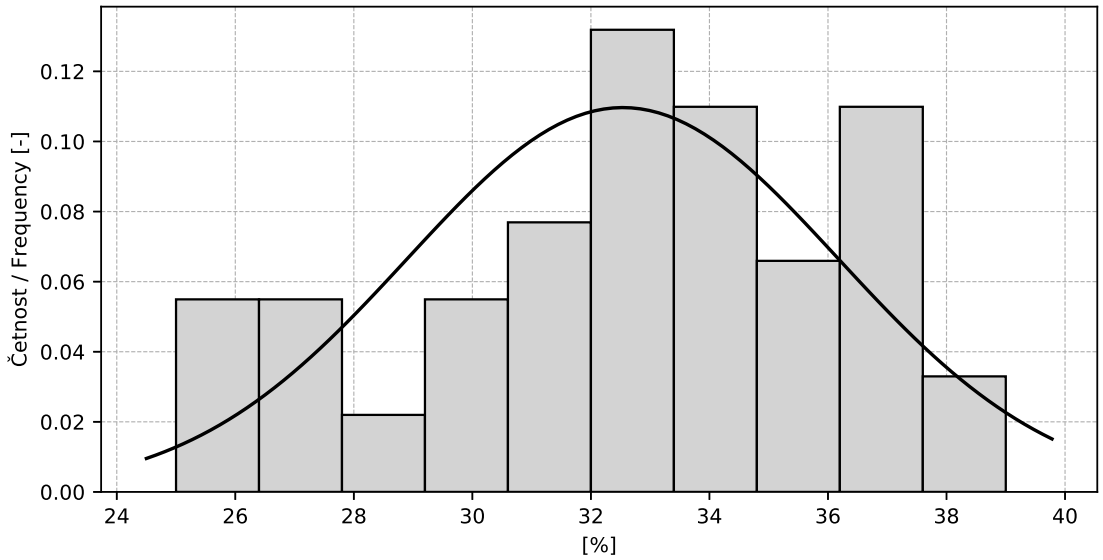

Figure 83: Histogram

Table 30: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	32.5
Výběrová směrodatná odchylka / Sample standard deviation – s	3.64
Vztažná hodnota / Asigned value – x^*	32.5
Robustní směrodatná odchylka / Robust standard deviation – s^*	3.64
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	1.91
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	3.62
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.65
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	3.68
Opakovatelnost / Repeatability – r	1.8
Reprodukovatelnost / Reproducibility – R	10.3

3.5 Calculation of Performance Statistics

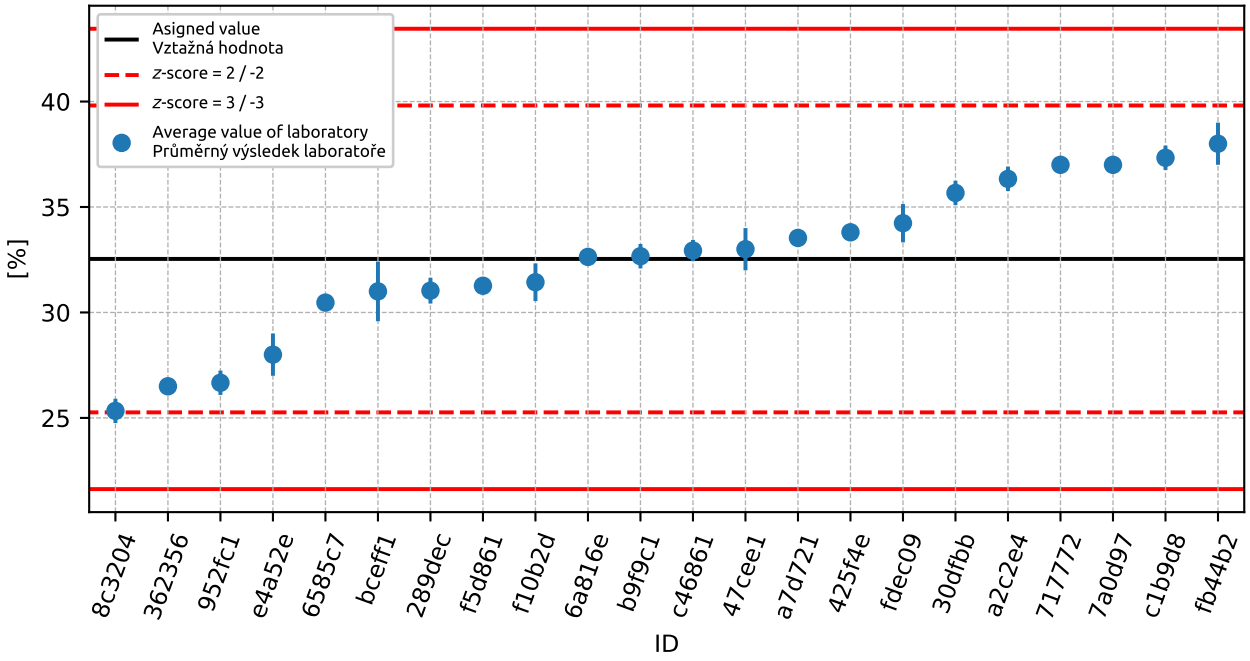

Figure 84: Average values and sample standard deviations

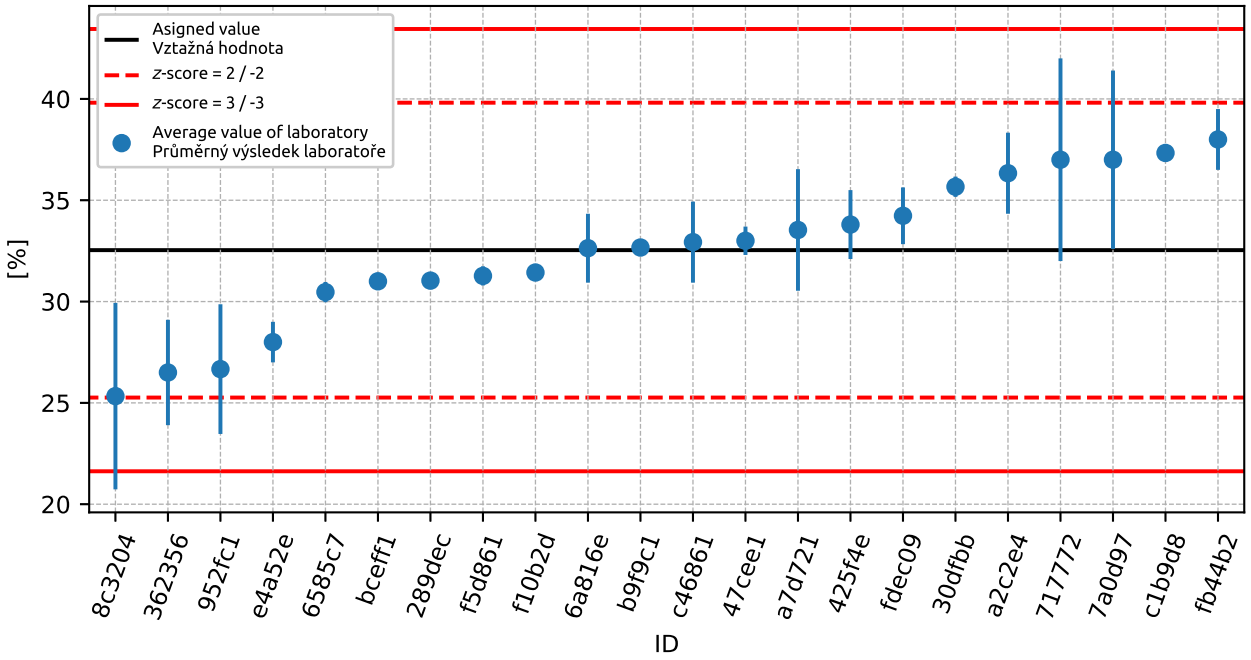

Figure 85: Average values and extended uncertainties of measurement

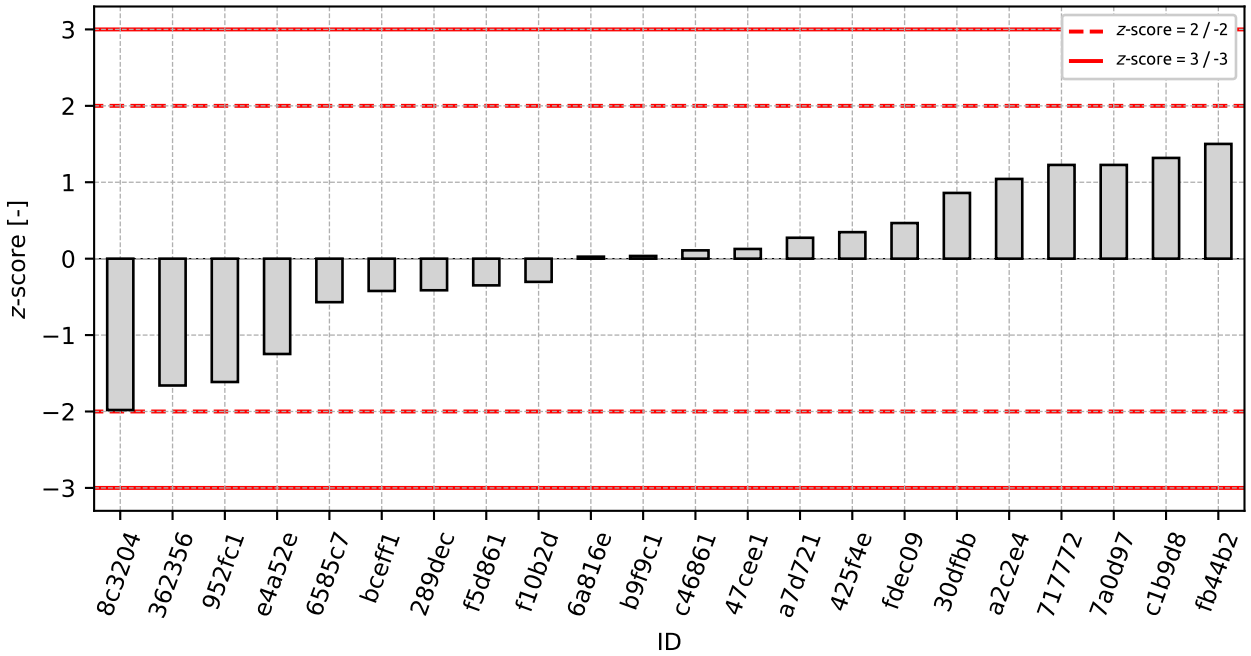

Figure 86: z-score

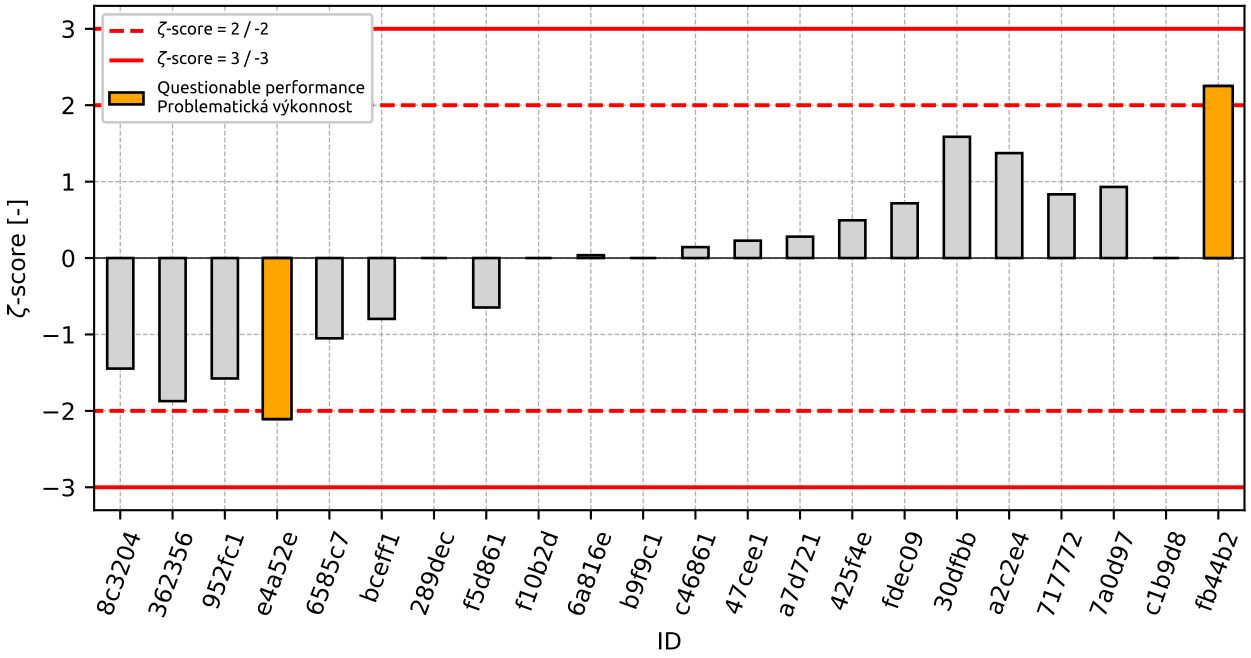

Figure 87: ζ-score

Table 31: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8c3204	-1.98	-1.45
362356	-1.66	-1.87
952fc1	-1.61	-1.58
e4a52e	-1.25	-2.11
6585c7	-0.57	-1.05
bceff1	-0.42	-0.8
289dec	-0.41	-
f5d861	-0.35	-0.65
f10b2d	-0.3	-
6a816e	0.03	0.04
b9f9c1	0.04	-
c46861	0.11	0.14
47cee1	0.13	0.23
a7d721	0.27	0.28
425f4e	0.35	0.49
fdec09	0.47	0.72
30dfbb	0.86	1.59
a2c2e4	1.04	1.37
717772	1.23	0.83
7a0d97	1.23	0.93
c1b9d8	1.32	-
fb44b2	1.5	2.25

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

4.1 Test results

Table 32: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [-]			u_X [-]	$\bar{x}$ [-]	s_0 [-]	V_X [%]
34dbaf	40.0	39.0	39.0	2.0	39.3	0.58	1.47
289dec	47.0	47.0	-	-	47.0	0.0	0.0
fa5fc9	54.0	-	-	4.0	54.0	0.0	0.0
08acdc	55.0	54.0	54.0	4.0	54.3	0.58	1.06
610646	56.0	56.4	54.7	2.0	55.7	0.89	1.6
c1b9d8	57.0	55.0	56.0	-	56.0	1.0	1.79
5069ff	61.0	61.0	62.0	0.6	61.3	0.58	0.94
f10b2d	62.7	62.2	62.2	-	62.4	0.28	0.45
3a8f9d	76.2	75.6	75.2	-	75.7	0.5	0.67

4.2 The Numerical Procedure for Determining Outliers

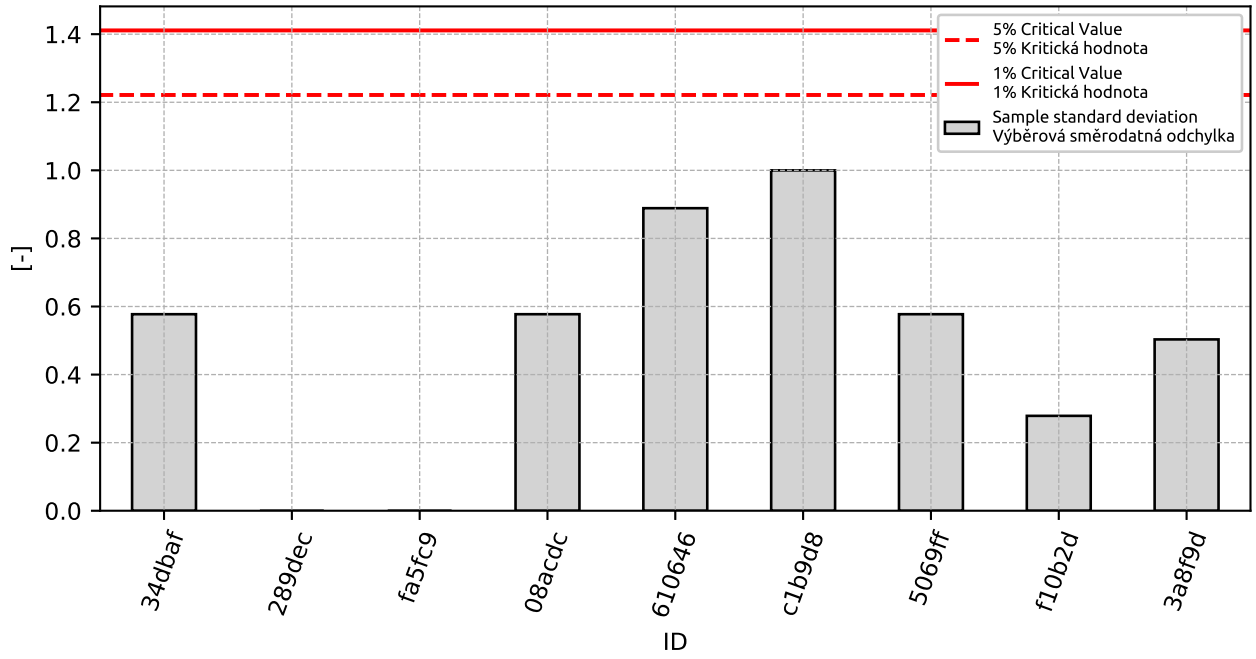

Figure 88: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

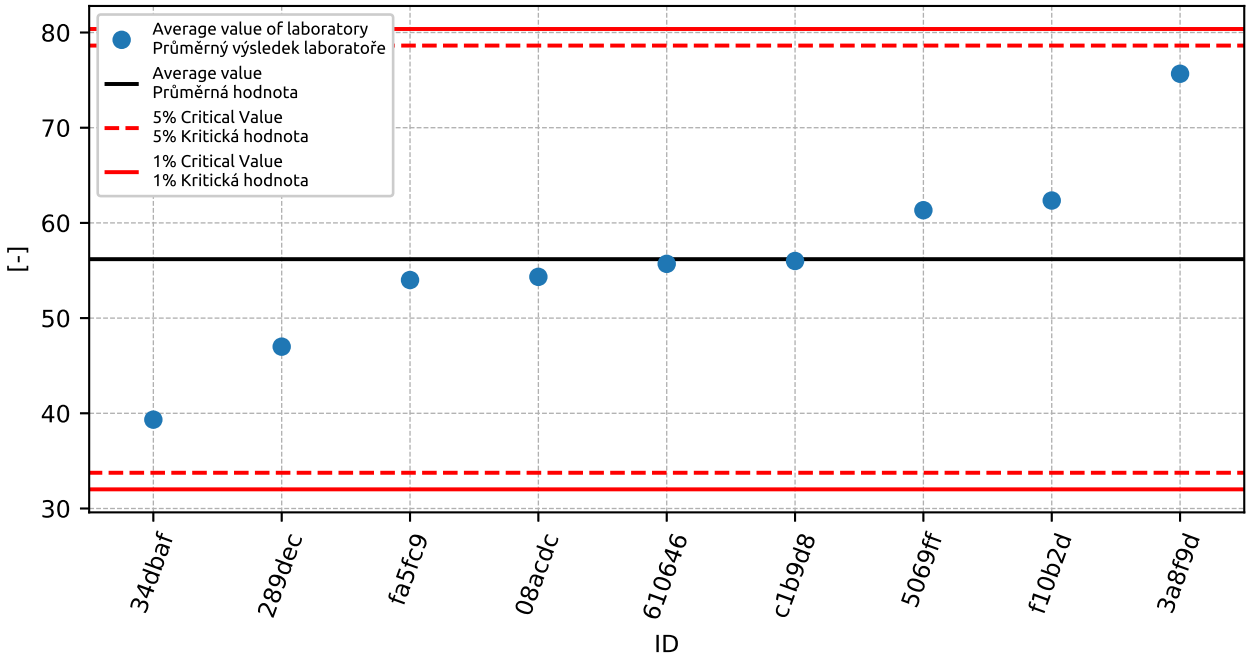

Figure 89: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

4.3 Mandel's Statistics

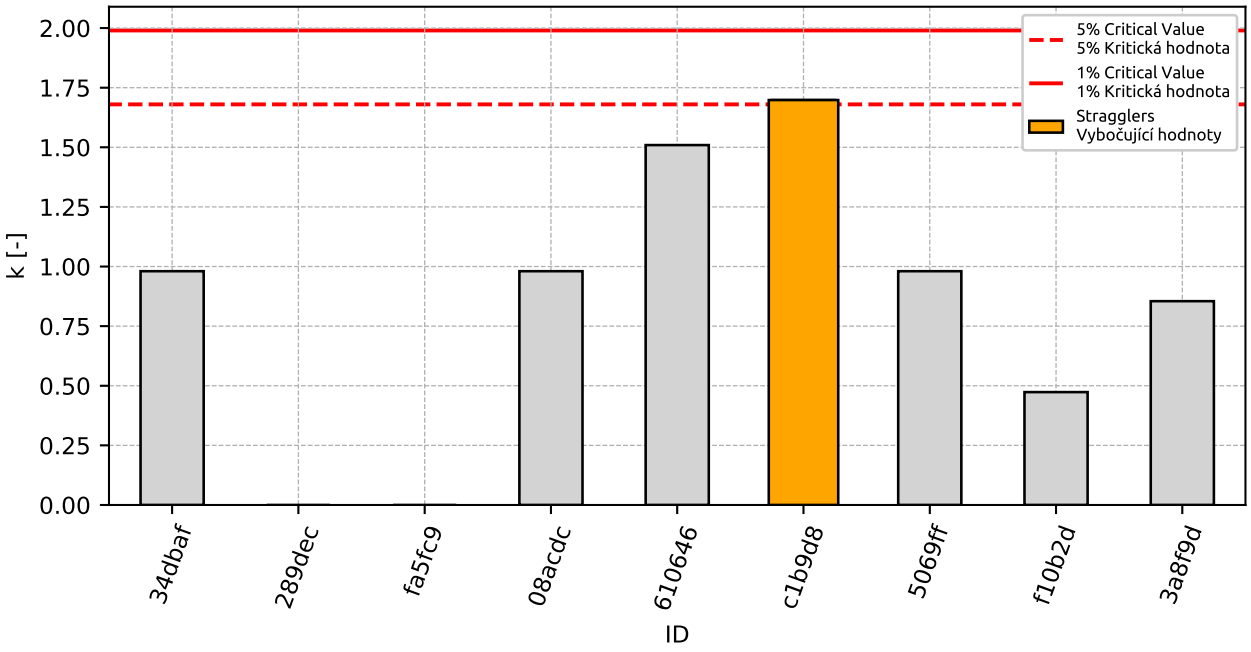

Figure 90: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

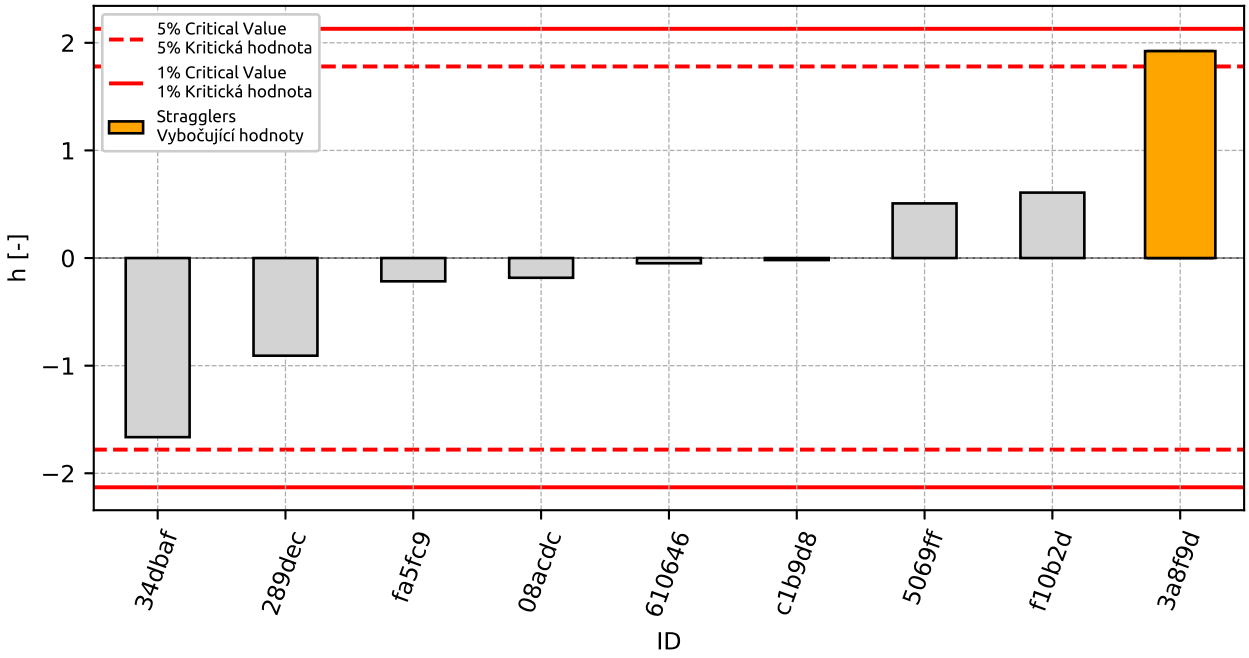

Figure 91: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

4.4 Descriptive statistics

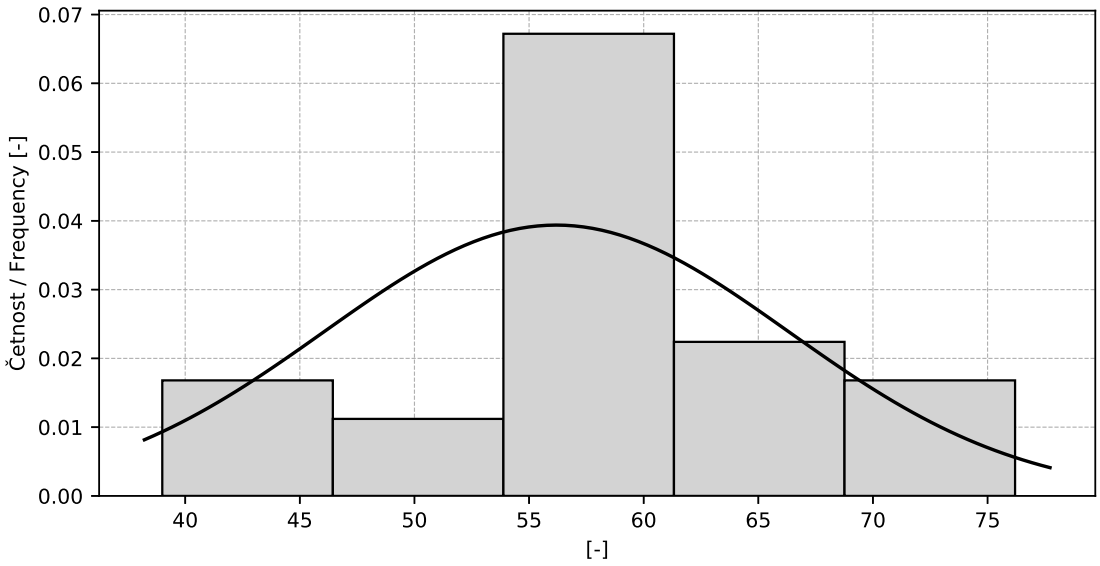

Figure 92: Histogram

Table 33: Descriptive statistics

Value	[-]
Průměrná hodnota / Average value – $\bar{x}$	56.2
Výběrová směrodatná odchylka / Sample standard deviation – s	10.13
Vztažná hodnota / Asigned value – x^*	56.6
Robustní směrodatná odchylka / Robust standard deviation – s^*	10.03
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	4.18
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	10.12
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.59
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	10.14
Opakovatelnost / Repeatability – r	1.6
Reprodukovatelnost / Reproducibility – R	28.4

4.5 Calculation of Performance Statistics

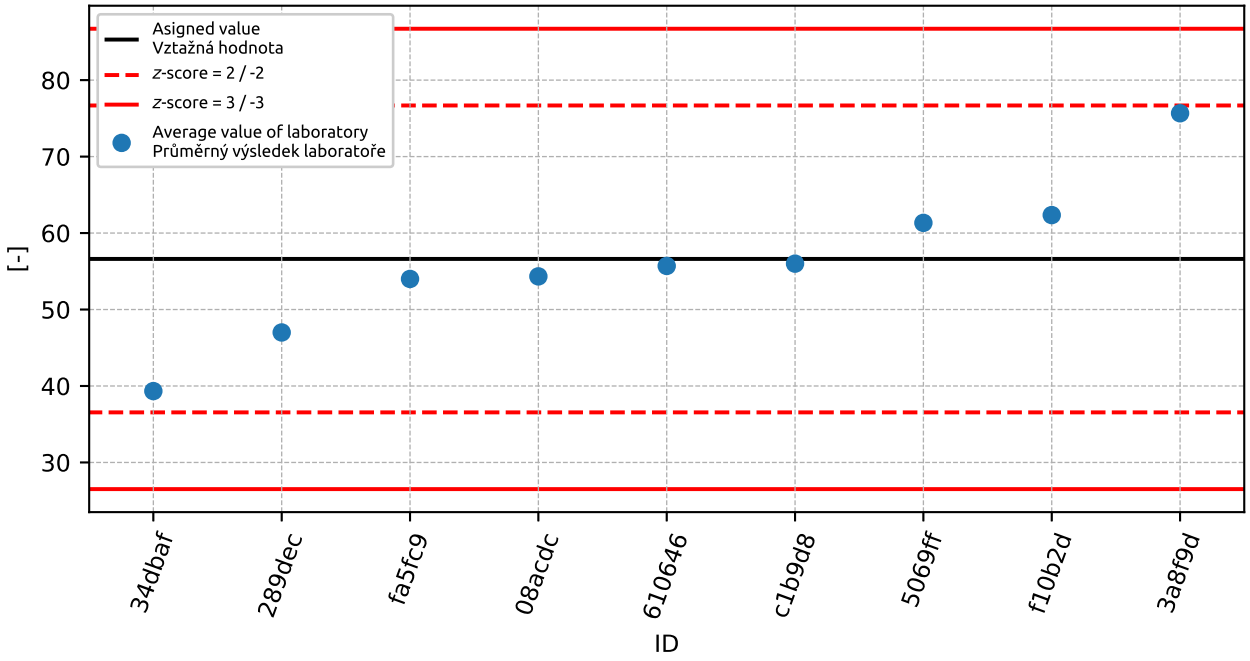

Figure 93: Average values and sample standard deviations

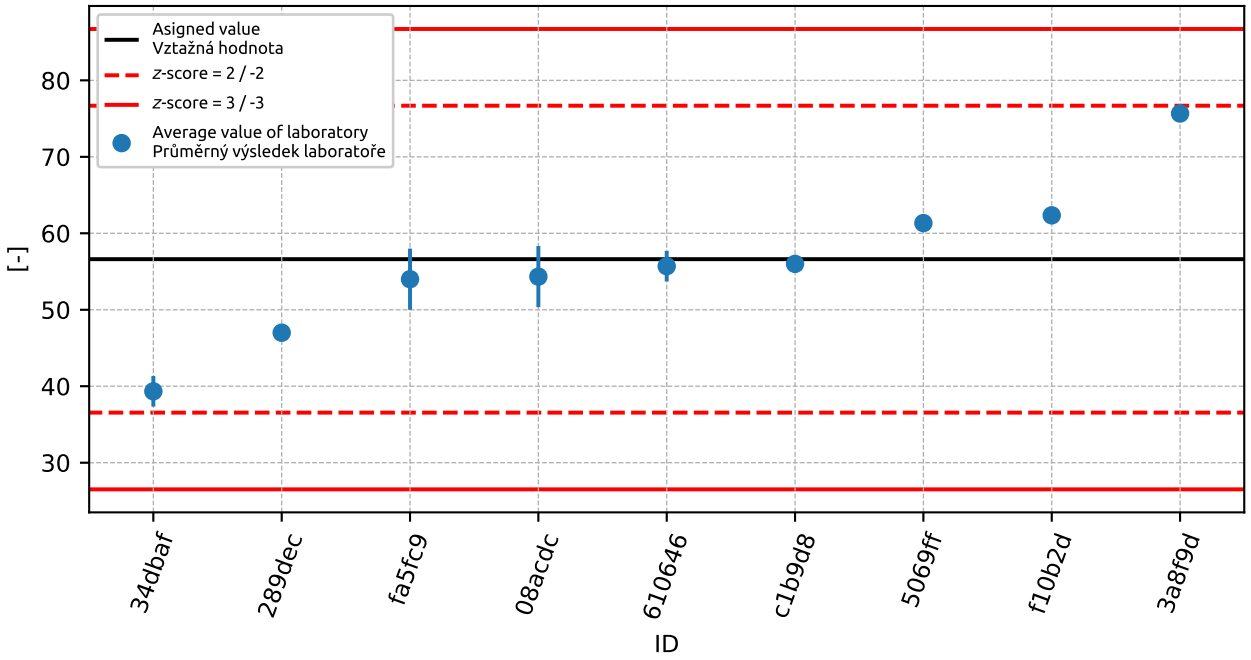

Figure 94: Average values and extended uncertainties of measurement

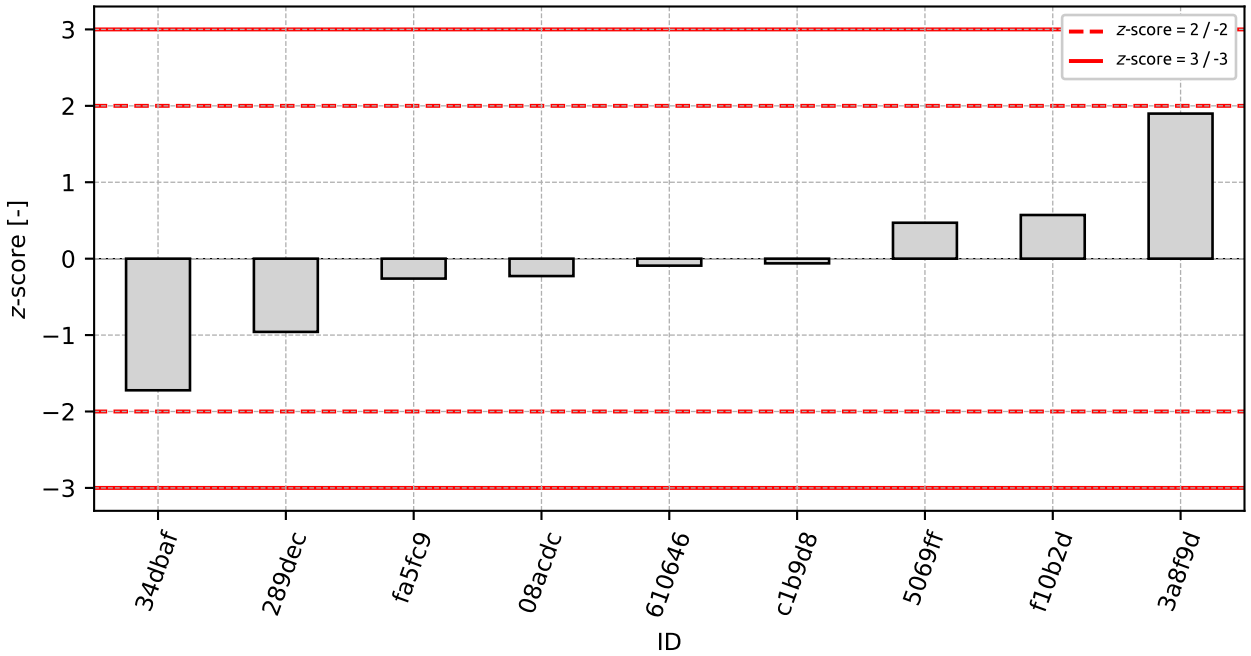

Figure 95: z-score

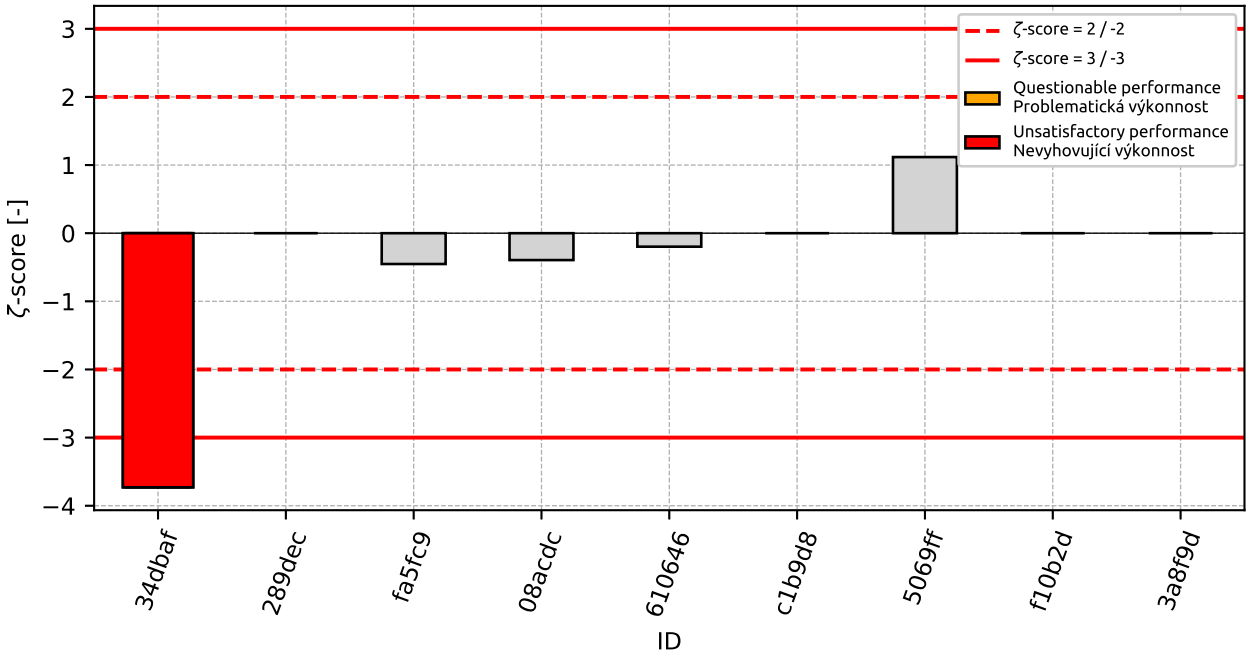

Figure 96: ζ-score

Table 34: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
34dbaf	-1.72	-3.73
289dec	-0.96	-
fa5fc9	-0.26	-0.45
08acdc	-0.23	-0.39
610646	-0.09	-0.2
c1b9d8	-0.06	-
5069ff	0.47	1.12
f10b2d	0.57	-
3a8f9d	1.9	-

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

5.1 Test results

Table 35: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [g/kg]			u_X [g/kg]	$\bar{x}$ [g/kg]	s_0 [g/kg]	V_X [%]
34dbaf	0.3	0.3	0.2	0.1	0.3	0.06	21.65
ca9c4c	1.0	0.9	0.9	-	0.9	0.06	6.19
e5e0c9	1.0	1.0	1.0	0.1	1.0	0.0	0.0
f45ea9	1.1	1.1	1.1	0.1	1.1	0.0	0.0
8845bf	1.5	1.4	1.5	-	1.5	0.06	3.94
154720	15.0	15.1	15.0	0.2	15.0	0.06	0.38

5.2 The Numerical Procedure for Determining Outliers

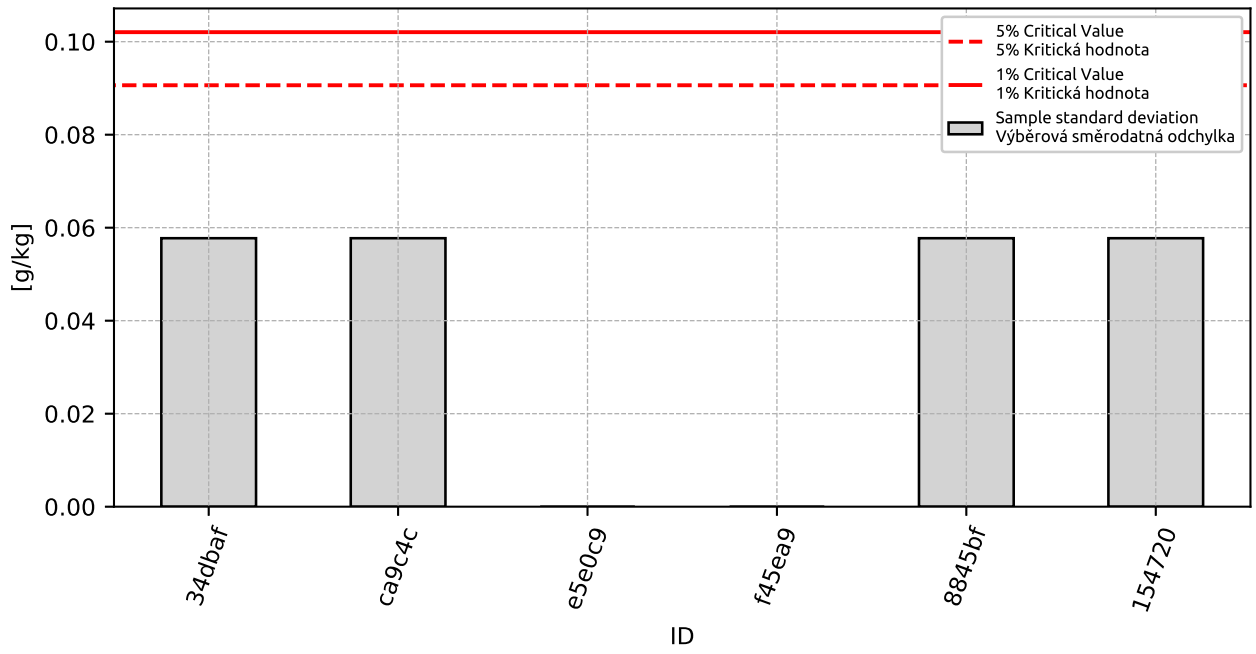

Figure 97: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

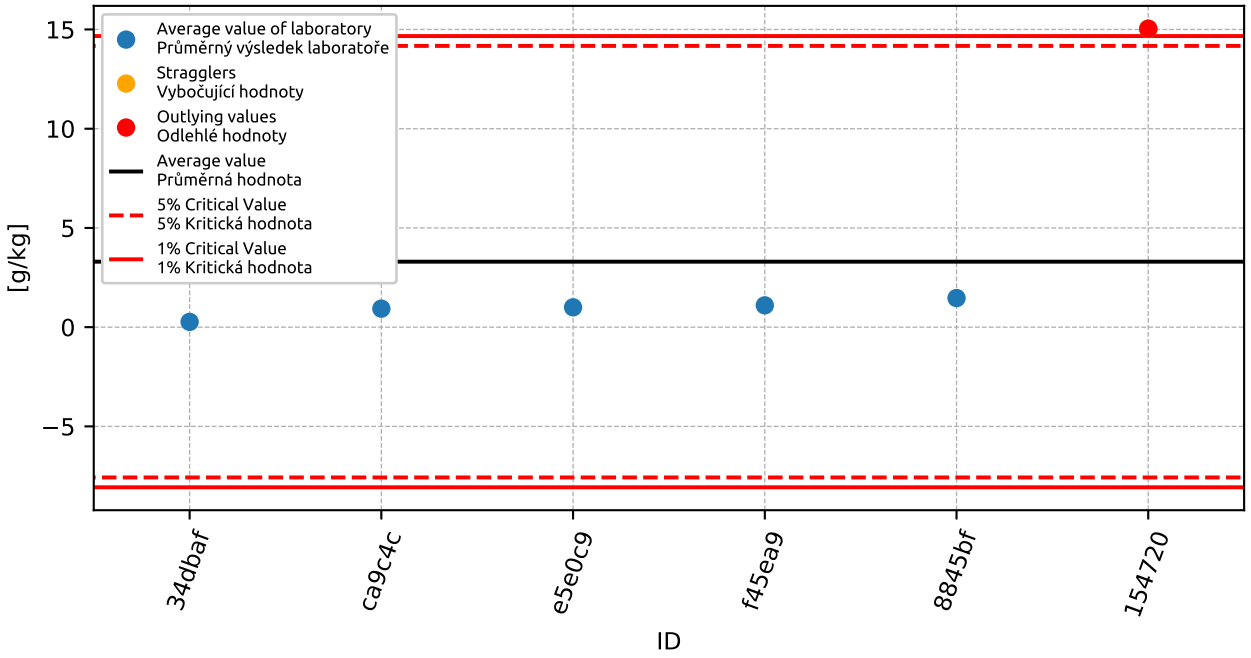

Figure 98: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

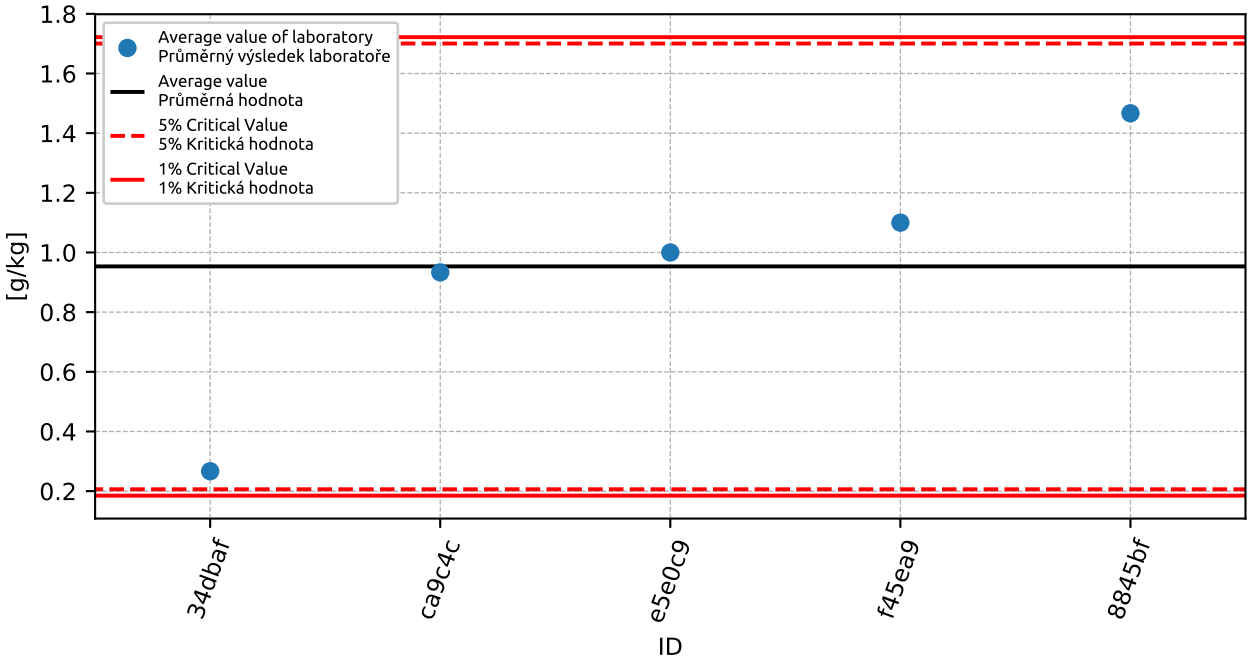

Figure 99: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color

5.3 Mandel's Statistics

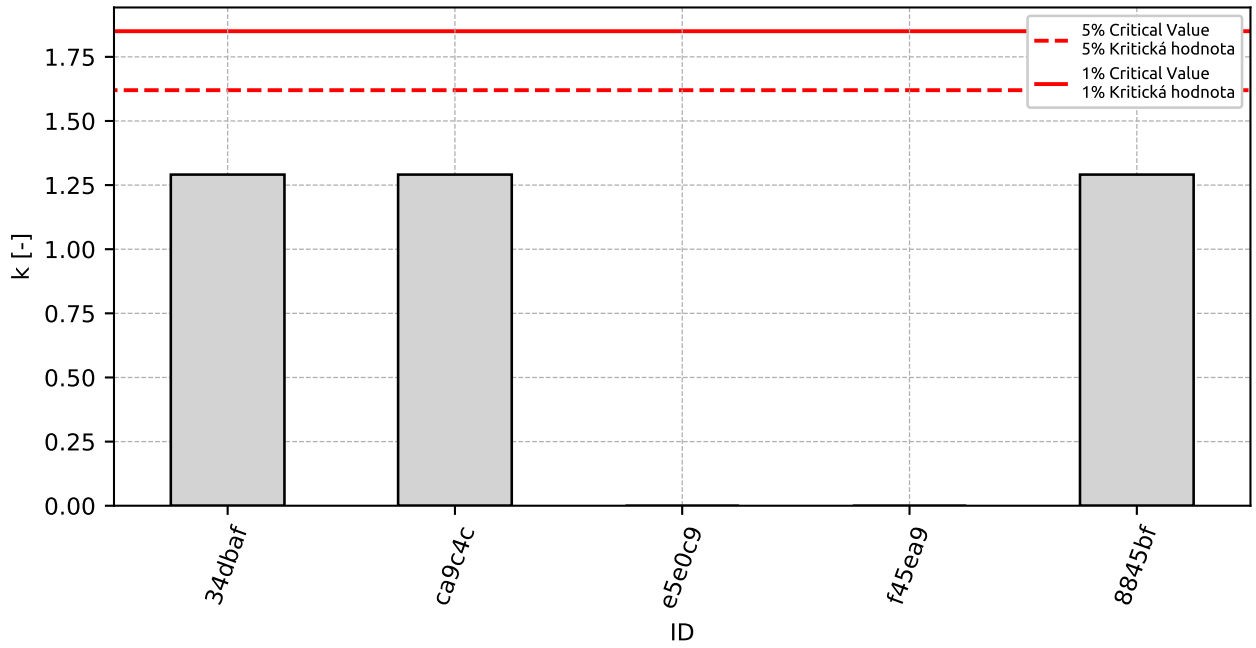

Figure 100: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

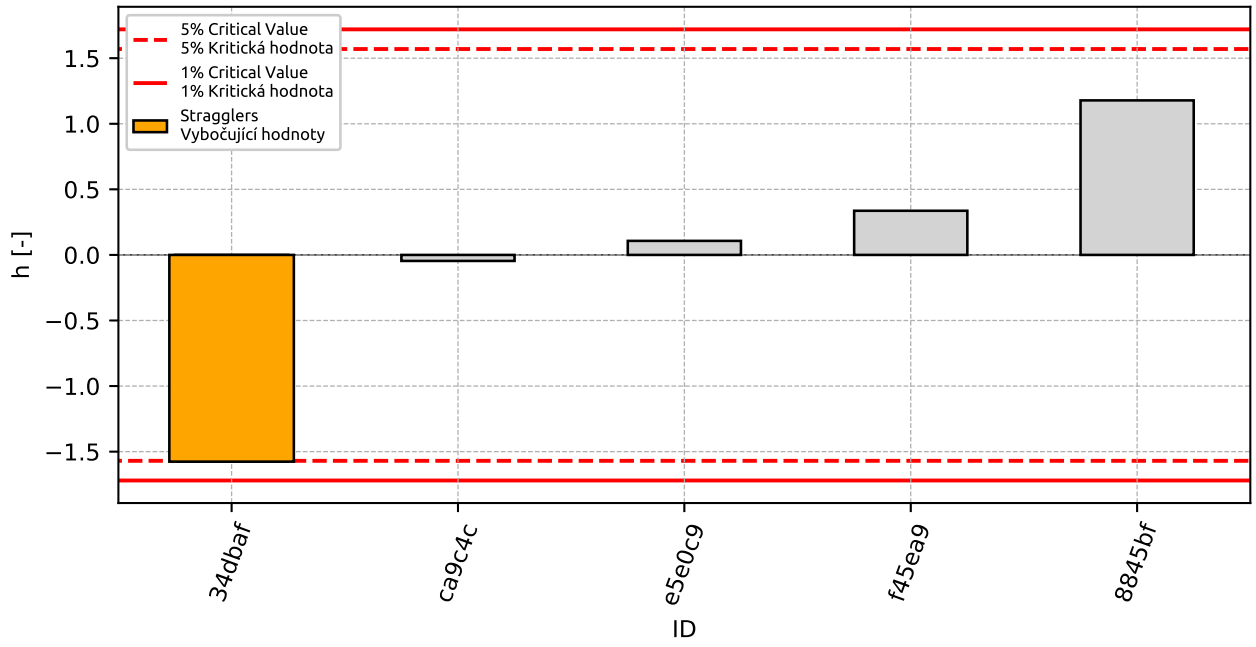

Figure 101: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

5.4 Descriptive statistics

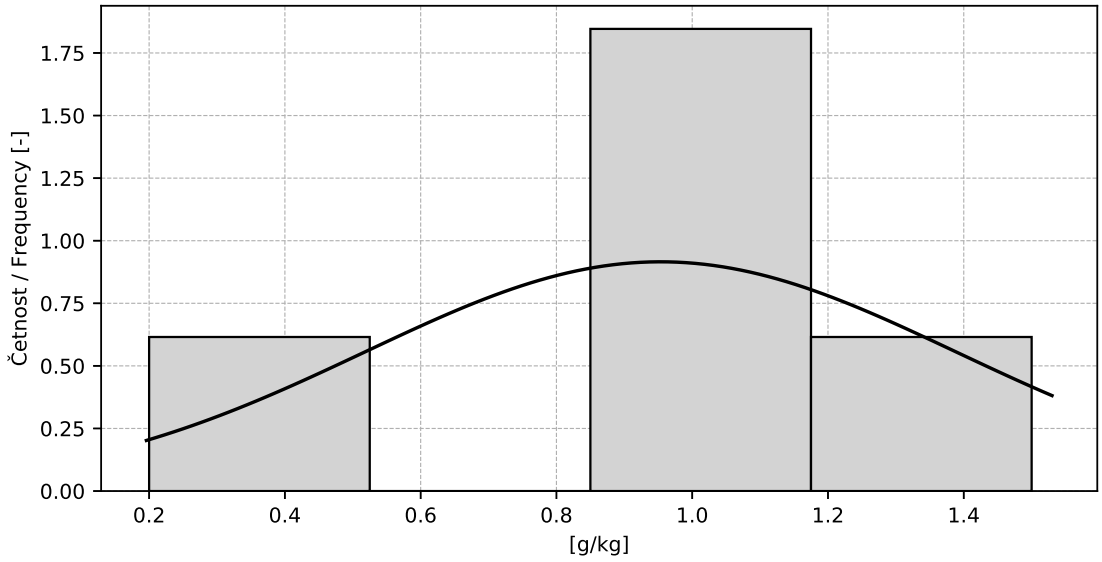

Figure 102: Histogram

Table 36: Descriptive statistics

Value	[g/kg]
Průměrná hodnota / Average value – $\bar{x}$	1.0
Výběrová směrodatná odchylka / Sample standard deviation – s	0.44
Vztažná hodnota / Asigned value – x^*	1.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.44
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.66
p-hodnota testu normality / p-value of normality test	0.463 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.43
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.04
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.44
Opakovatelnost / Repeatability – r	0.1
Reprodukovatelnost / Reproducibility – R	1.2

5.5 Calculation of Performance Statistics

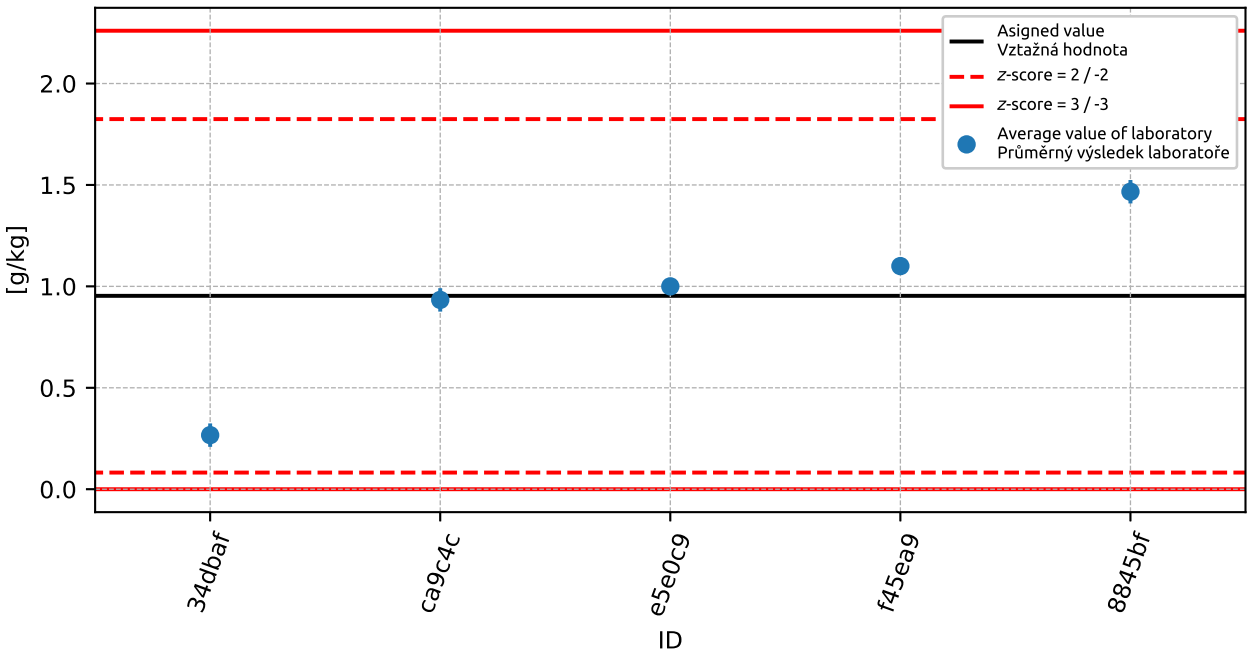

Figure 103: Average values and sample standard deviations

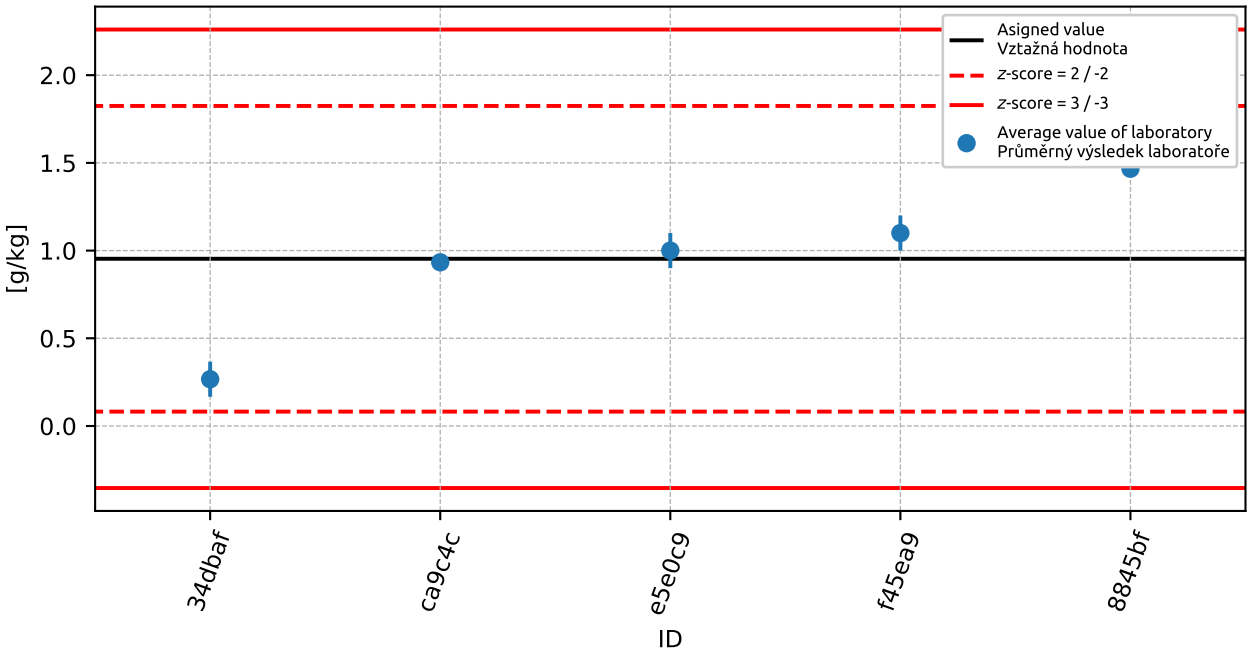

Figure 104: Average values and extended uncertainties of measurement

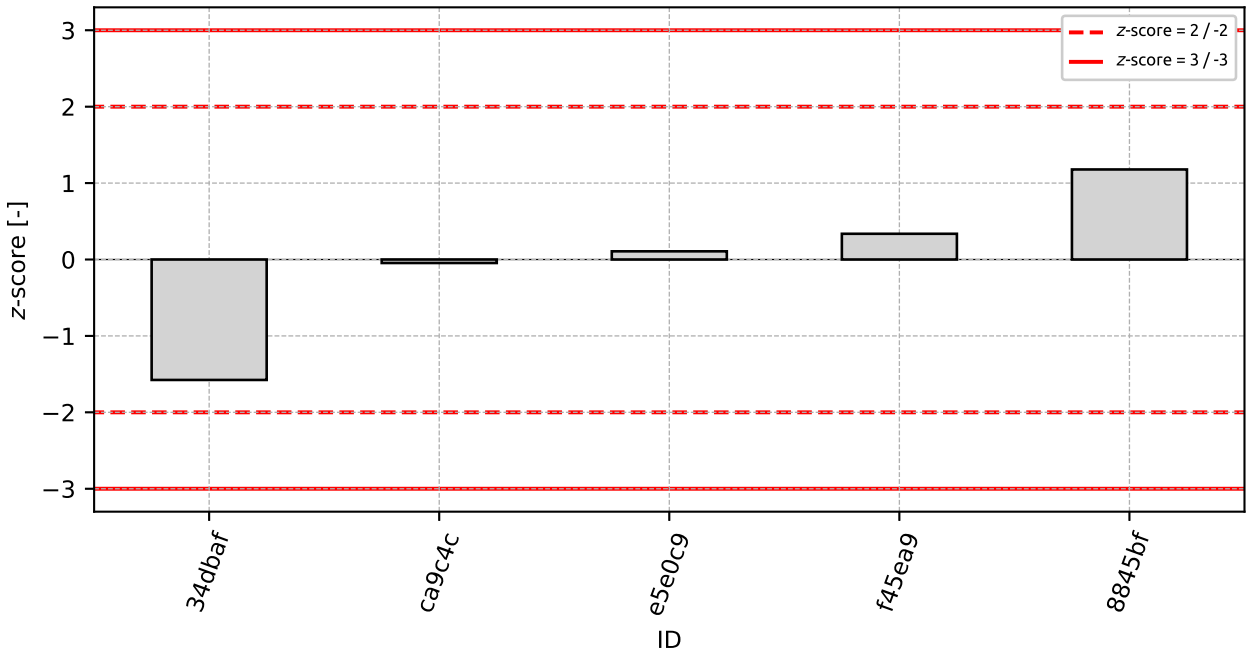

Figure 105: z-score

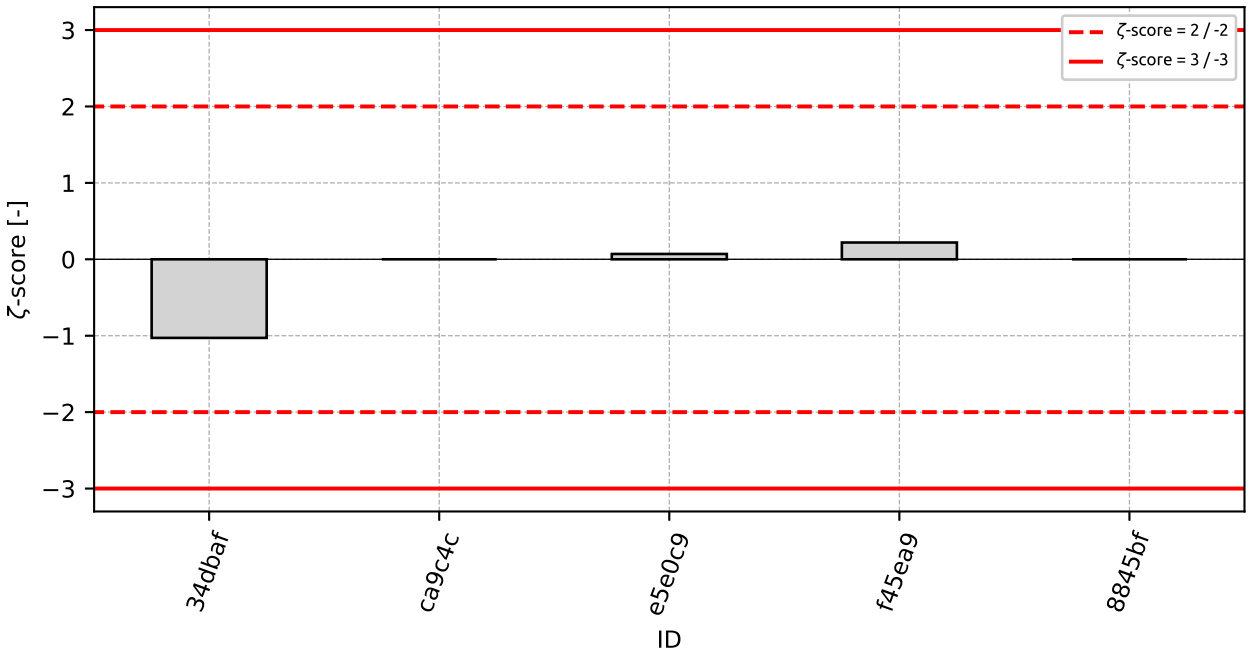

Figure 106: ζ-score

Table 37: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
34dbaf	-1.58	-1.03
ca9c4c	-0.05	-
e5e0c9	0.11	0.07
f45ea9	0.34	0.22
8845bf	1.18	-

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

6.1 Test results

Table 38: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
119cda	75.8	75.7	75.9	2.3	75.8	0.1	0.13
fa5fc9	76.1	75.8	75.9	2.4	75.9	0.15	0.2
5def6c	76.0	-	-	2.7	76.0	0.0	0.0
717772	76.2	76.1	76.1	3.5	76.1	0.06	0.08
cecb5e	76.2	75.8	76.6	0.8	76.2	0.4	0.52
f51f2b	77.8	77.8	77.8	2.3	77.8	0.0	0.0
3650eb	79.0	79.0	79.0	3.0	79.0	0.0	0.0
bceff1	79.4	80.2	78.8	0.7	79.5	0.7	0.88
f2c559	83.0	-	-	3.2	83.0	0.0	0.0

6.2 The Numerical Procedure for Determining Outliers

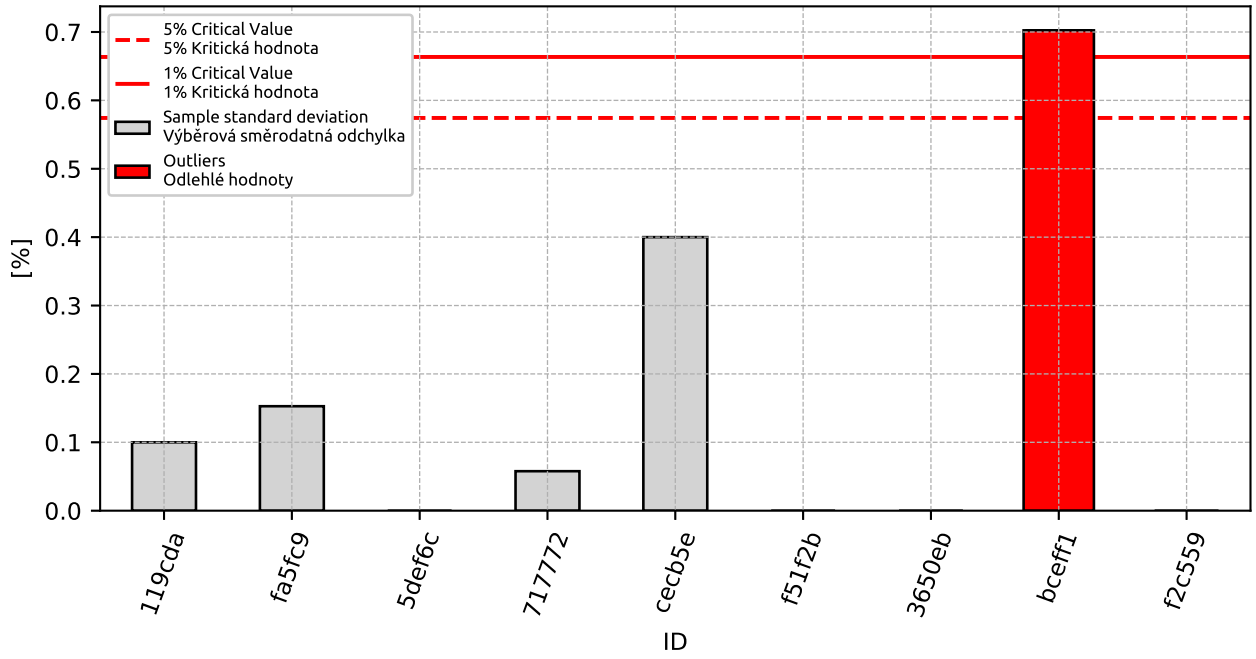

Figure 107: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

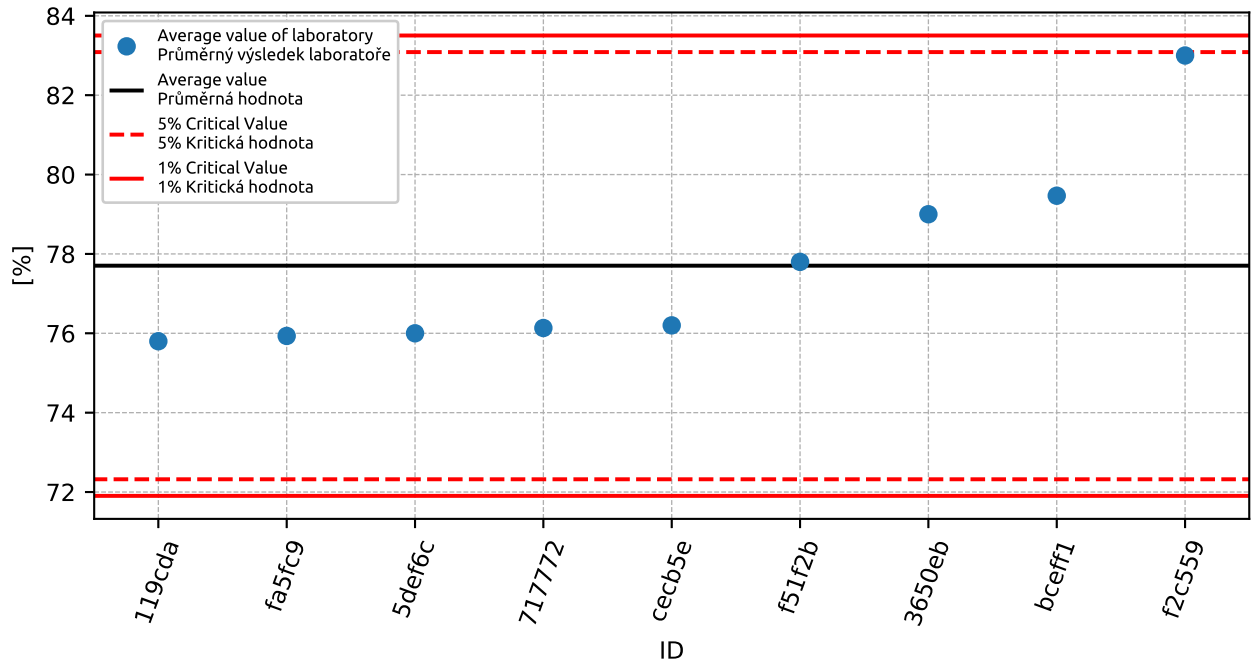

Figure 108: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

6.3 Mandel's Statistics

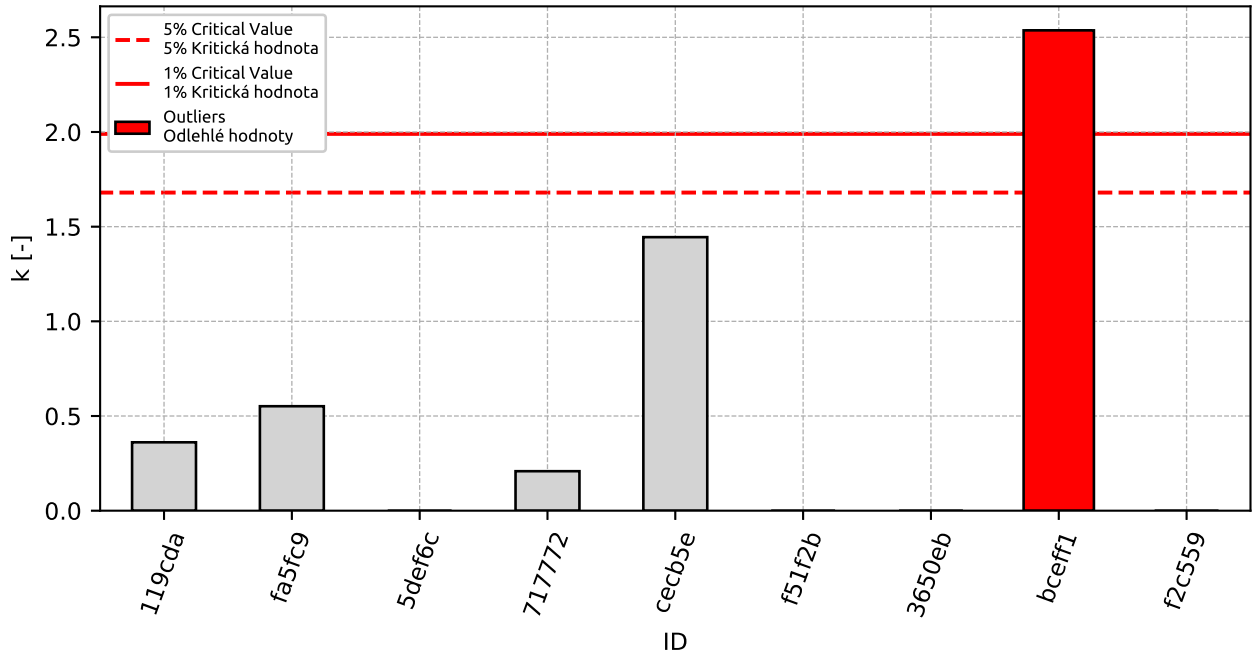

Figure 109: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

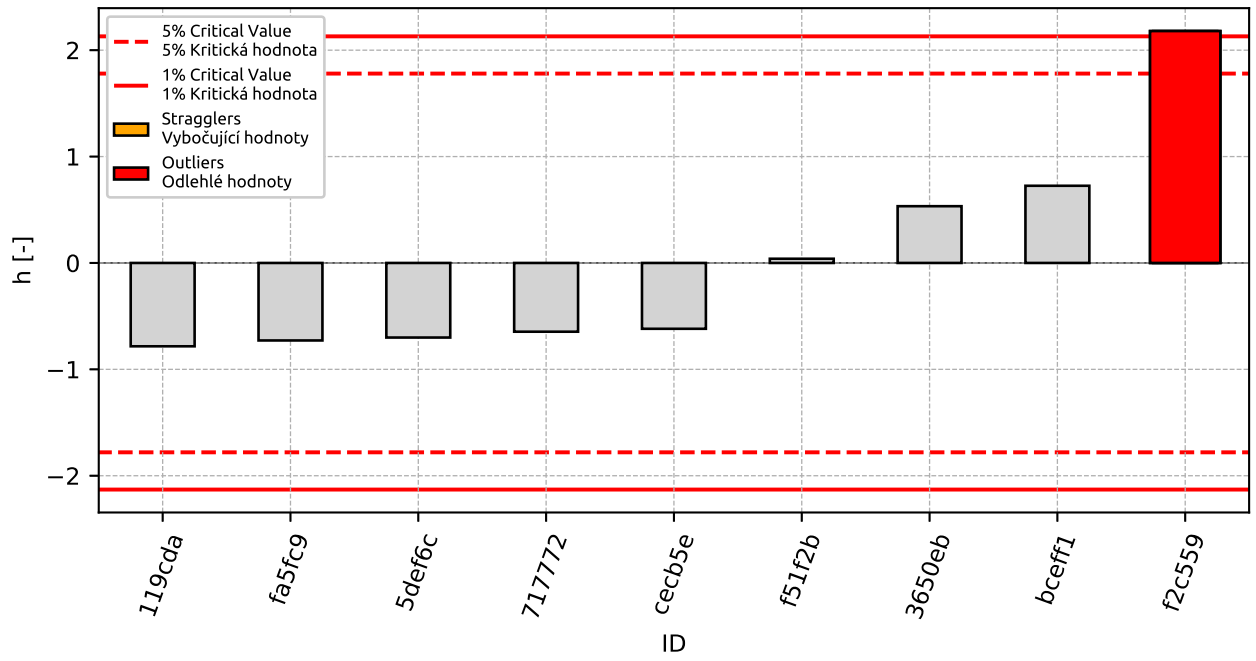

Figure 110: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

6.4 Descriptive statistics

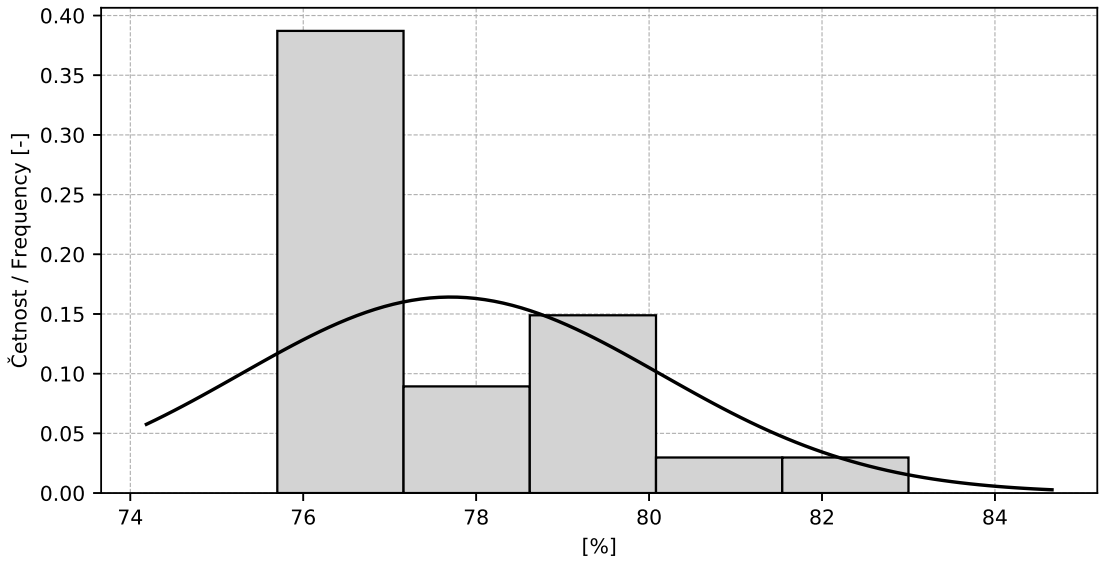

Figure 111: Histogram

Table 39: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	77.7
Výběrová směrodatná odchylka / Sample standard deviation – s	2.43
Vztažná hodnota / Asigned value – x^*	77.5
Robustní směrodatná odchylka / Robust standard deviation – s^*	3.0
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	2.06
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	2.42
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.28
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	2.44
Opakovatelnost / Repeatability – r	0.8
Reprodukovatelnost / Reproducibility – R	6.8

6.5 Calculation of Performance Statistics

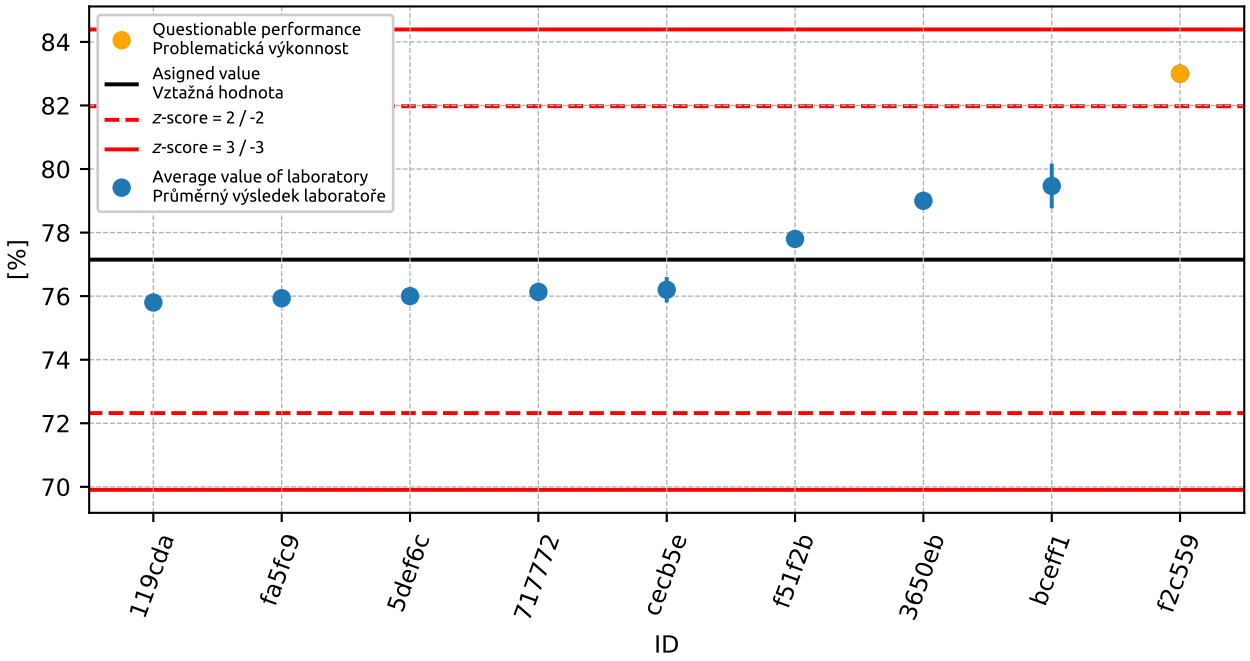

Figure 112: Average values and sample standard deviations

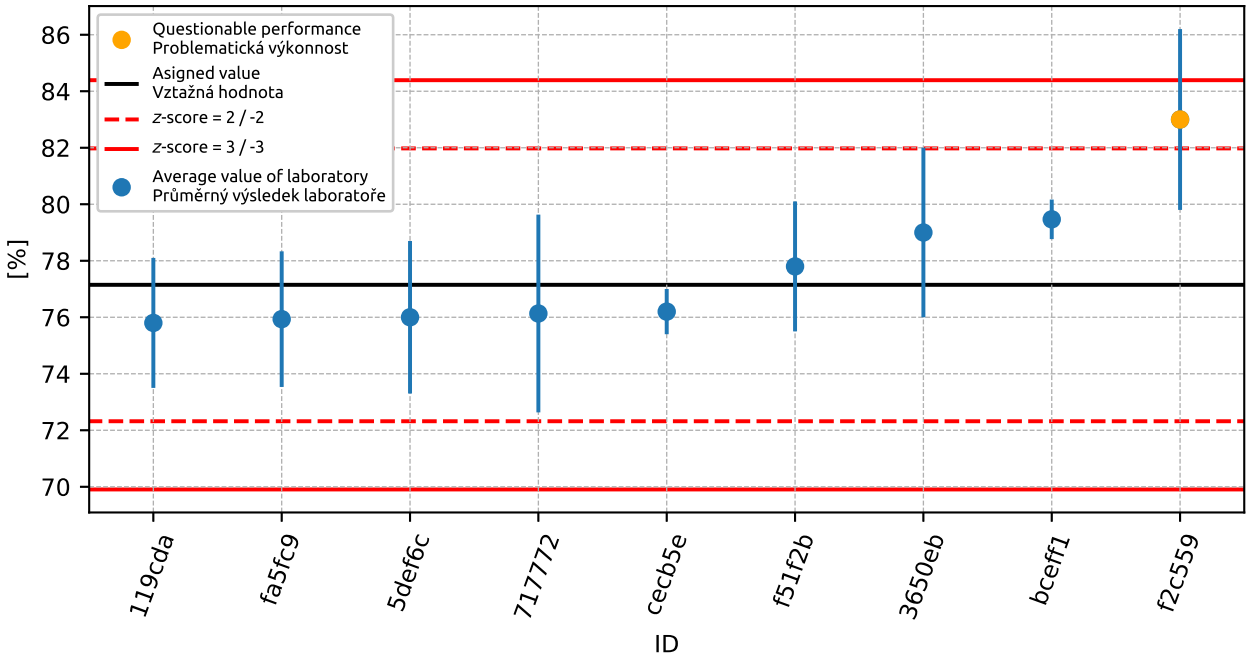

Figure 113: Average values and extended uncertainties of measurement

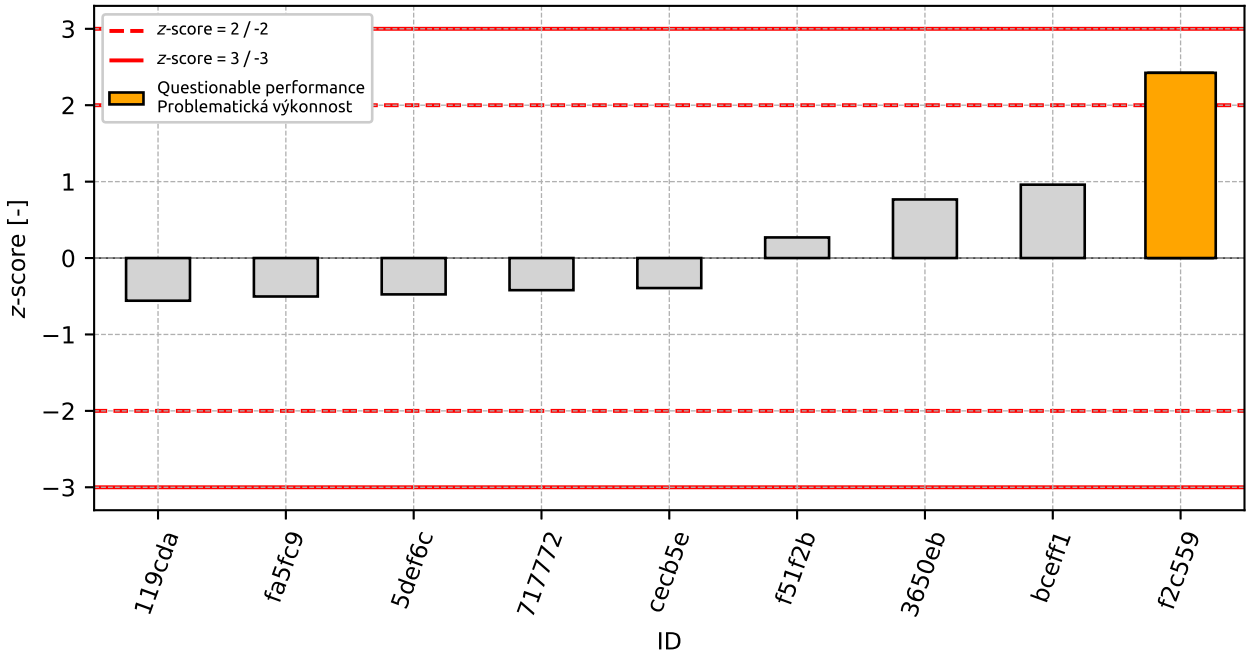

Figure 114: z-score

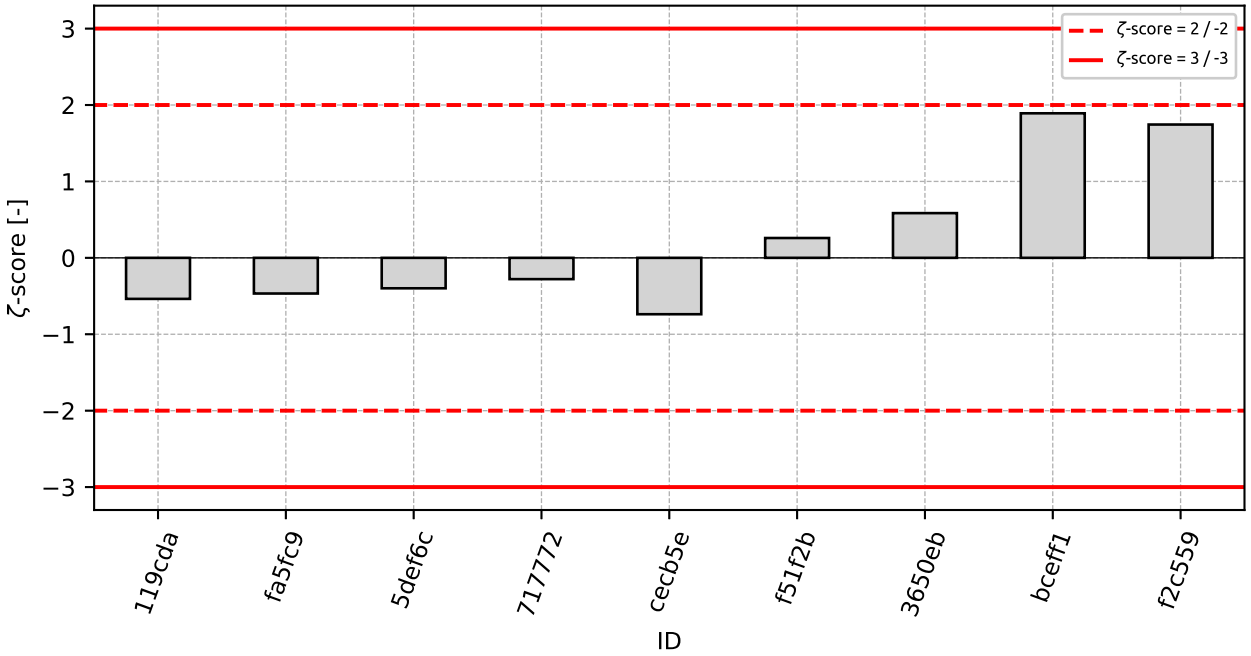

Figure 115: ζ-score

Table 40: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
119cda	-0.56	-0.54
fa5fc9	-0.5	-0.47
5def6c	-0.48	-0.4
717772	-0.42	-0.28
cecb5e	-0.39	-0.74
f51f2b	0.27	0.26
3650eb	0.77	0.59
bceff1	0.96	1.89
f2c559	2.42	1.74

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

This part of PT program was not open due to the lack of participants.

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

8.1 Test results

Table 41: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [-]	u_X [-]
f45ea9	17.0	1.9
369f99	18.0	1.0
34dbaf	18.0	1.0
154720	18.5	1.2
30dfbb	19.0	0.5
6f4ad8	19.0	2.0
f10b2d	19.4	-
bceff1	20.0	0.6

8.2 The Numerical Procedure for Determining Outliers

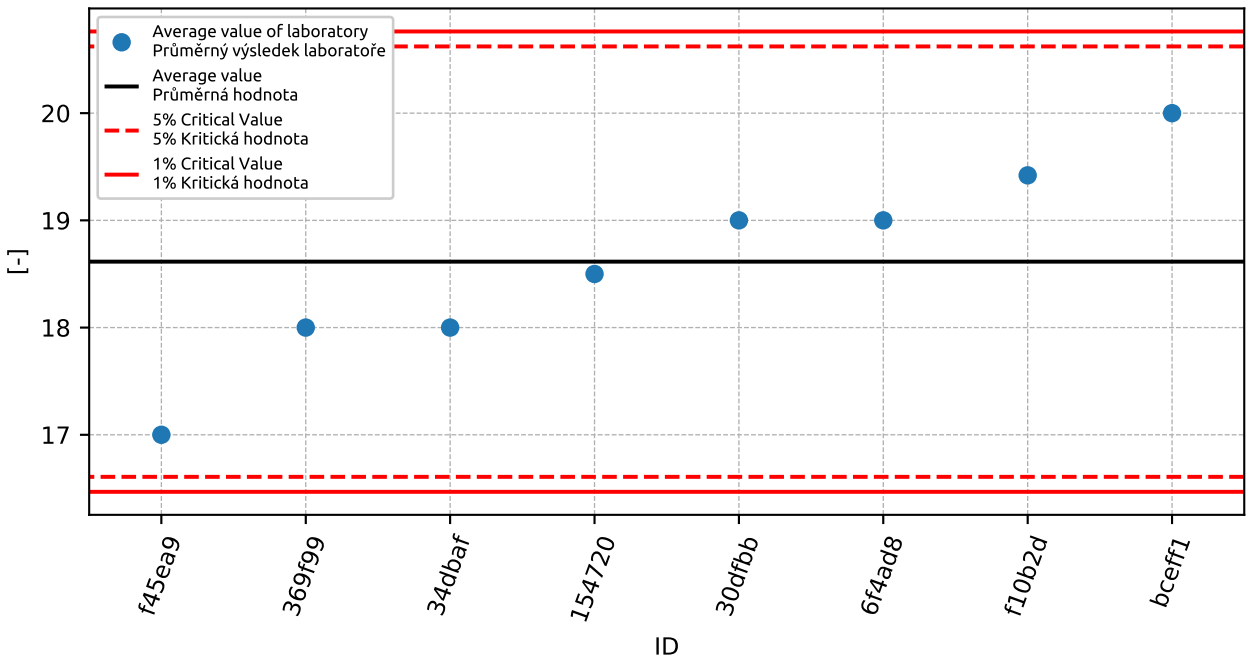

Figure 116: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

8.3 Mandel's Statistics

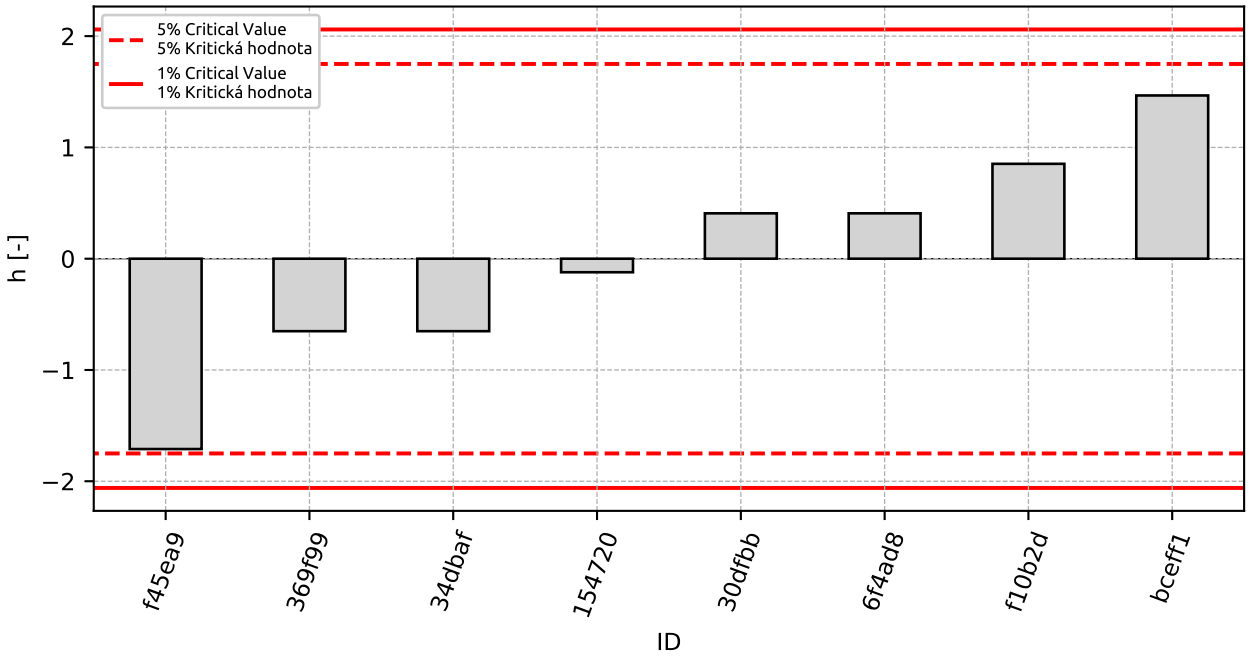

Figure 117: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

8.4 Descriptive statistics

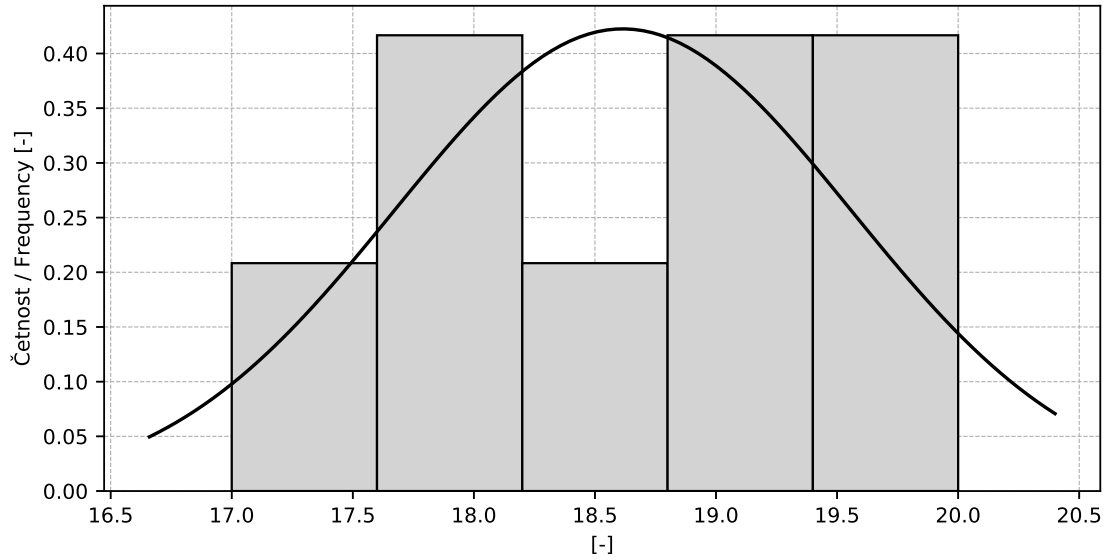

Figure 118: Histogram

Table 42: Descriptive statistics

Value	[-]
Průměrná hodnota / Average value – $\bar{x}$	18.6
Výběrová směrodatná odchylka / Sample standard deviation – s	0.94
Vztažná hodnota / Asigned value – x^*	18.6
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.95
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.42
p-hodnota testu normality / p-value of normality test	0.906 [-]

8.5 Calculation of Performance Statistics

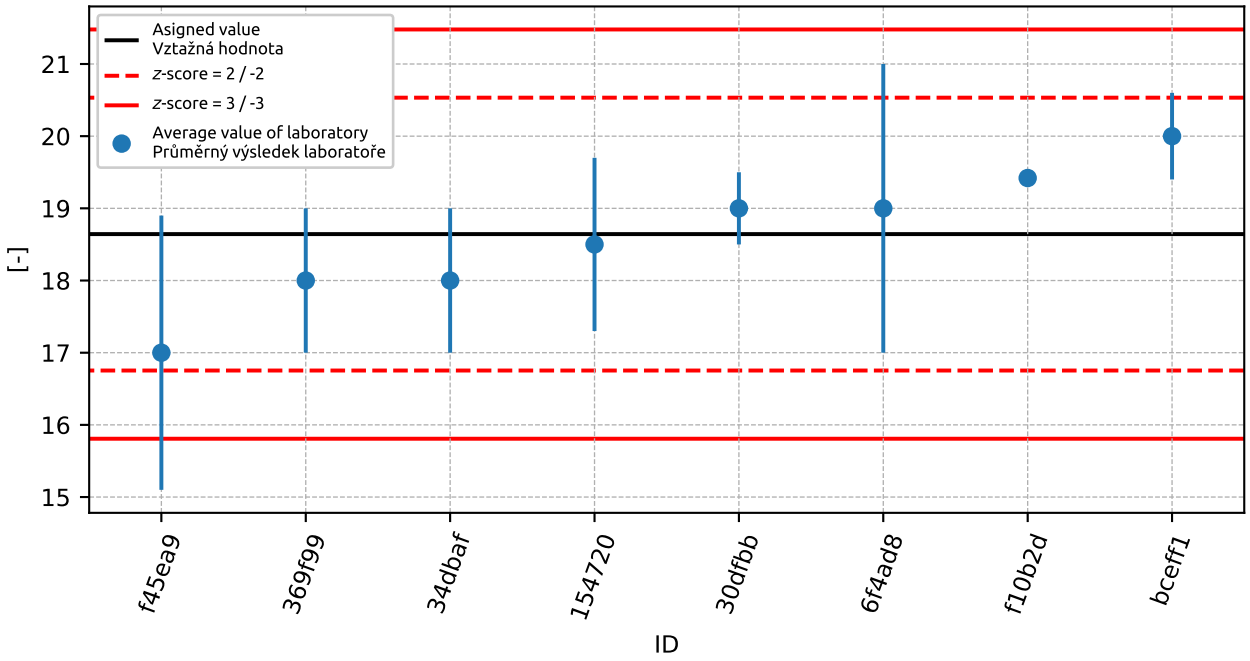

Figure 119: Average values and extended uncertainties of measurement

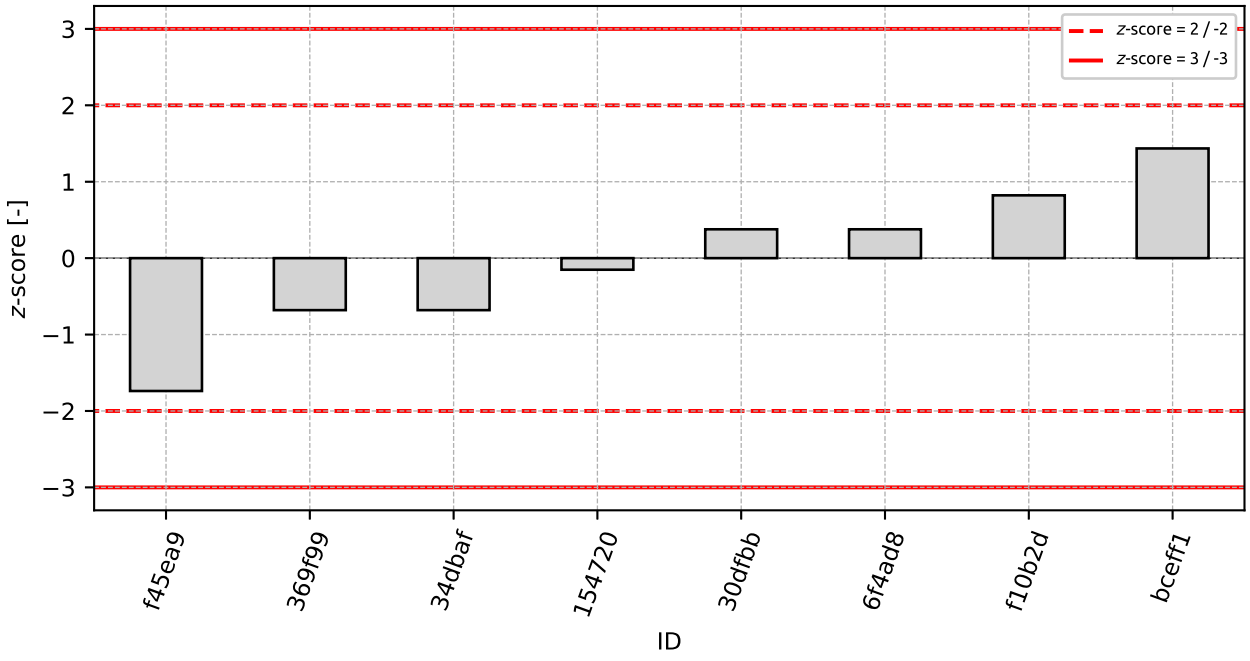

Figure 120: z-score

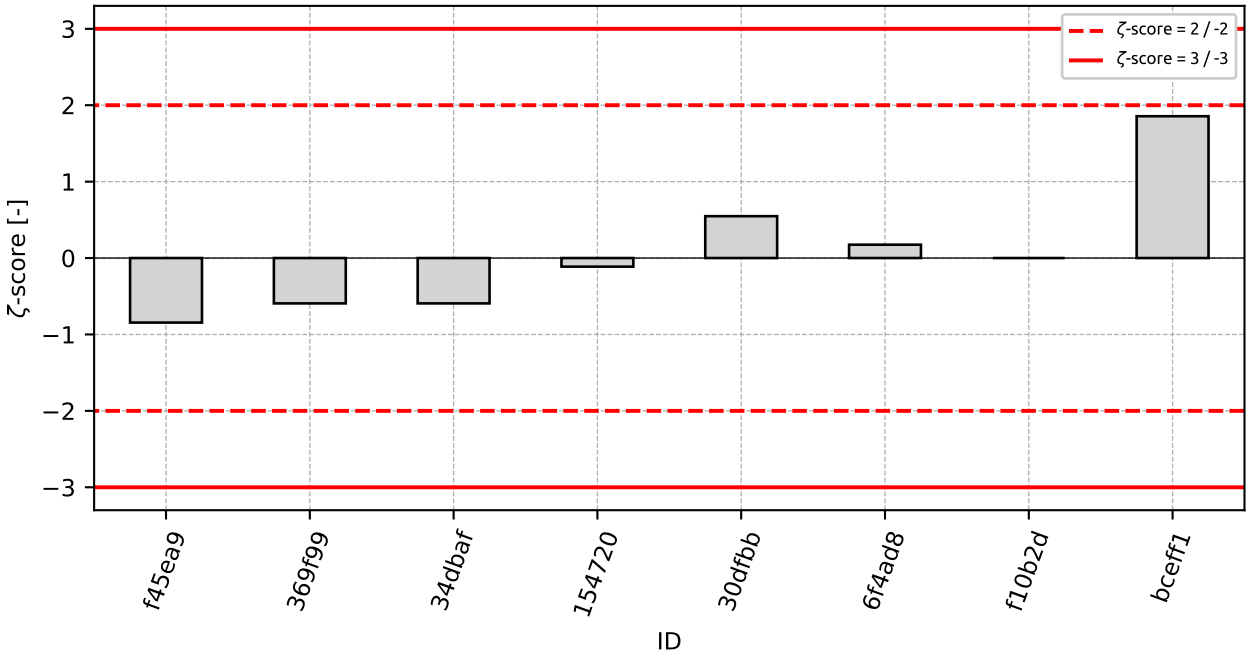

Figure 121: ζ-score

Table 43: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f45ea9	-1.74	-0.84
369f99	-0.68	-0.59
34dbaf	-0.68	-0.59
154720	-0.15	-0.11
30dfbb	0.38	0.55
6f4ad8	0.38	0.17
f10b2d	0.82	-
bceff1	1.44	1.86

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

This part of PT program was not open due to the lack 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 44: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [Mg/m³]			u_X [Mg/m³]	$\bar{x}$ [Mg/m³]	s_0 [Mg/m³]	V_X [%]
b9f9c1	1.22	1.21	1.22	-	1.22	0.006	0.47
c1b9d8	1.22	1.22	1.22	-	1.22	0.0	0.0
bceff1	1.23	1.24	1.24	0.02	1.24	0.006	0.47
34dbaf	1.23	1.24	1.24	0.02	1.24	0.006	0.47
fb44b2	1.27	1.25	1.27	0.02	1.26	0.012	0.91
d08d8d	1.28	1.26	1.27	0.0	1.27	0.01	0.79
ca9c4c	1.3	1.29	1.3	-	1.3	0.006	0.45
369f99	1.29	1.3	1.3	0.02	1.3	0.006	0.45
fdec09	1.32	1.3	1.31	0.03	1.31	0.006	0.46
362356	1.33	1.33	1.33	0.02	1.33	0.0	0.0

10.1.2 The Numerical Procedure for Determining Outliers

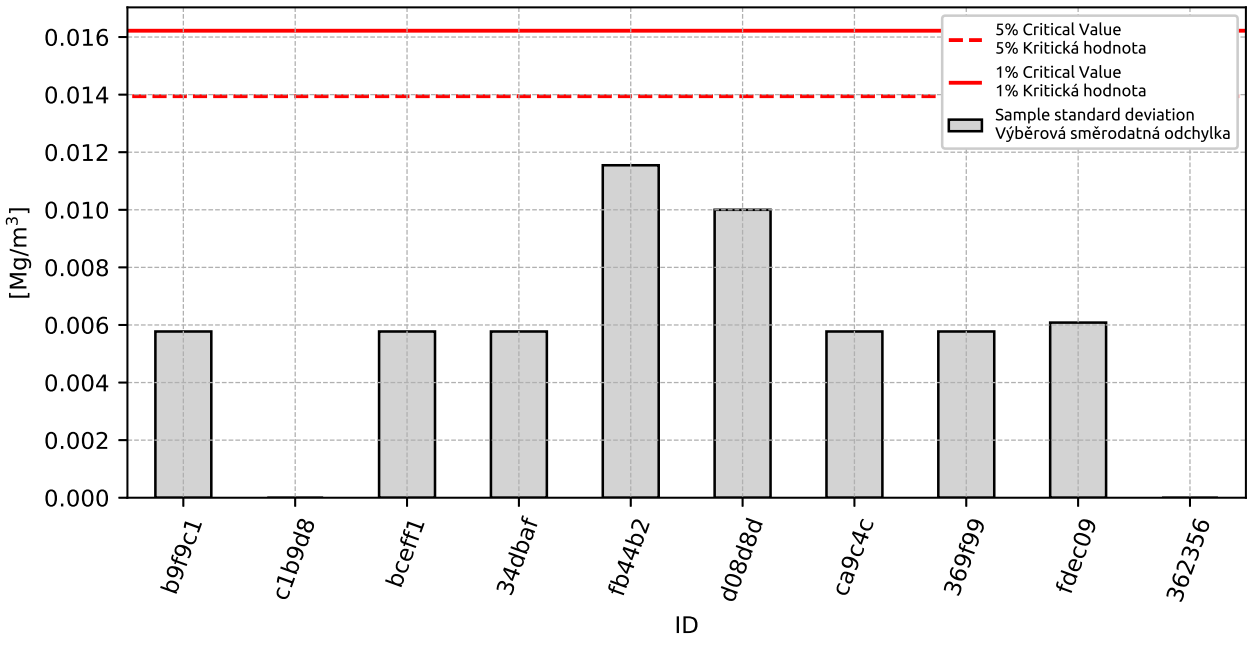

Figure 122: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

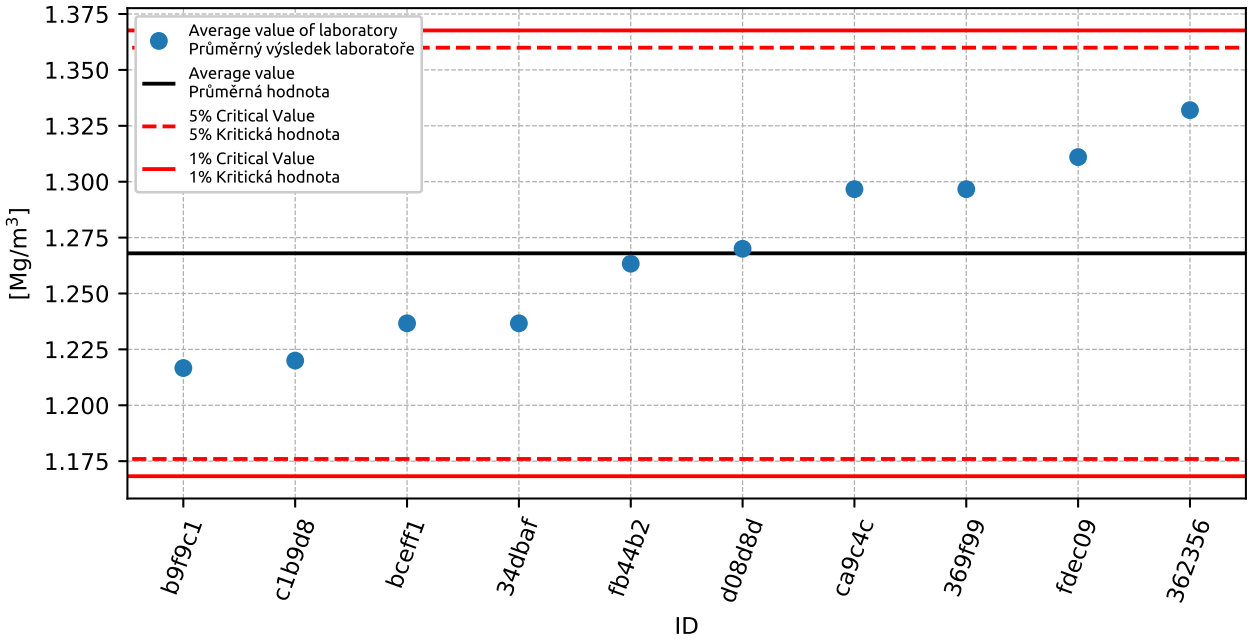

Figure 123: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

10.1.3 Mandel's Statistics

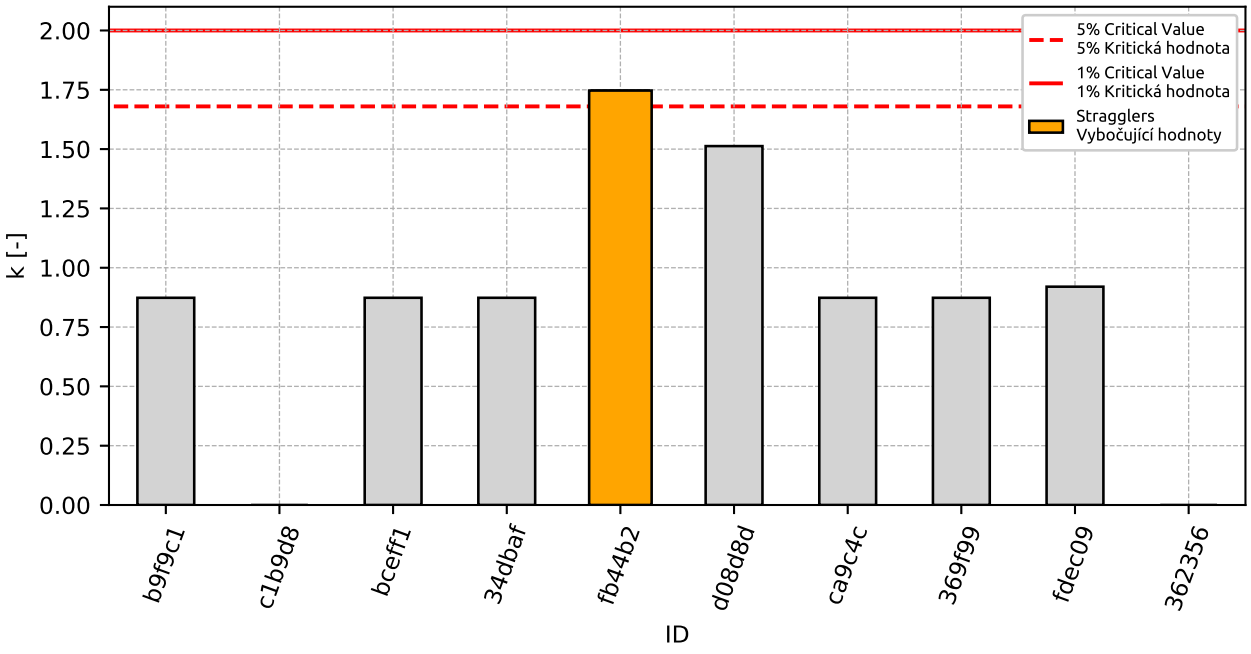

Figure 124: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

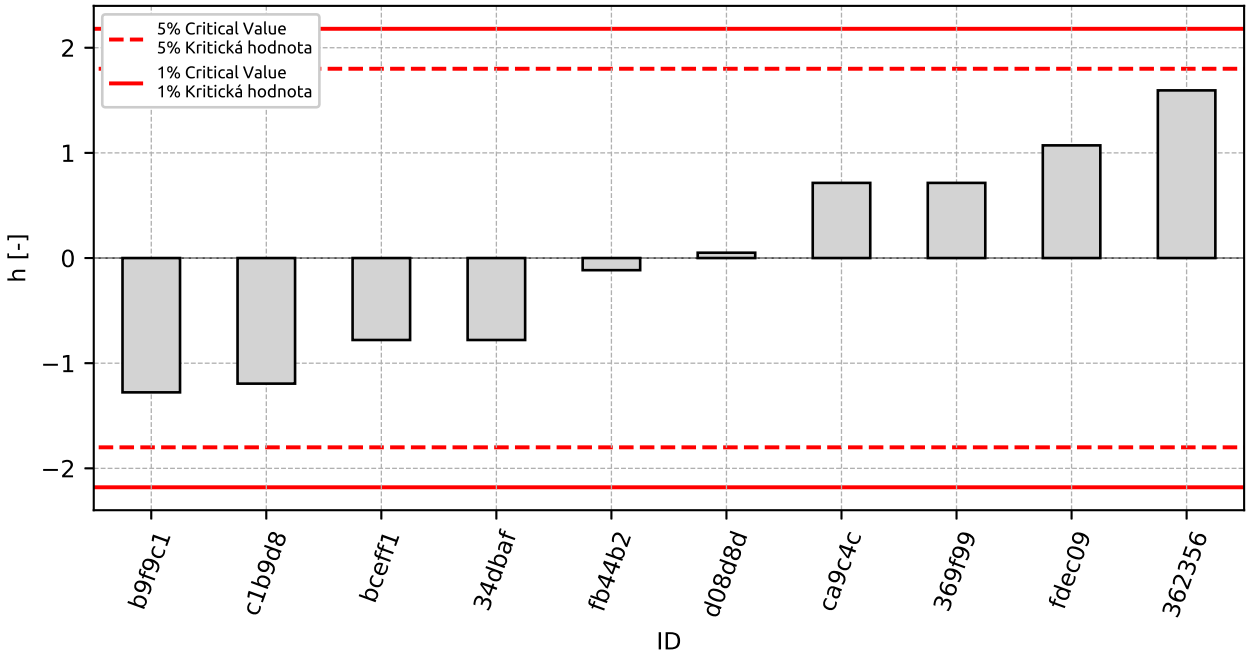

Figure 125: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

10.1.4 Descriptive statistics

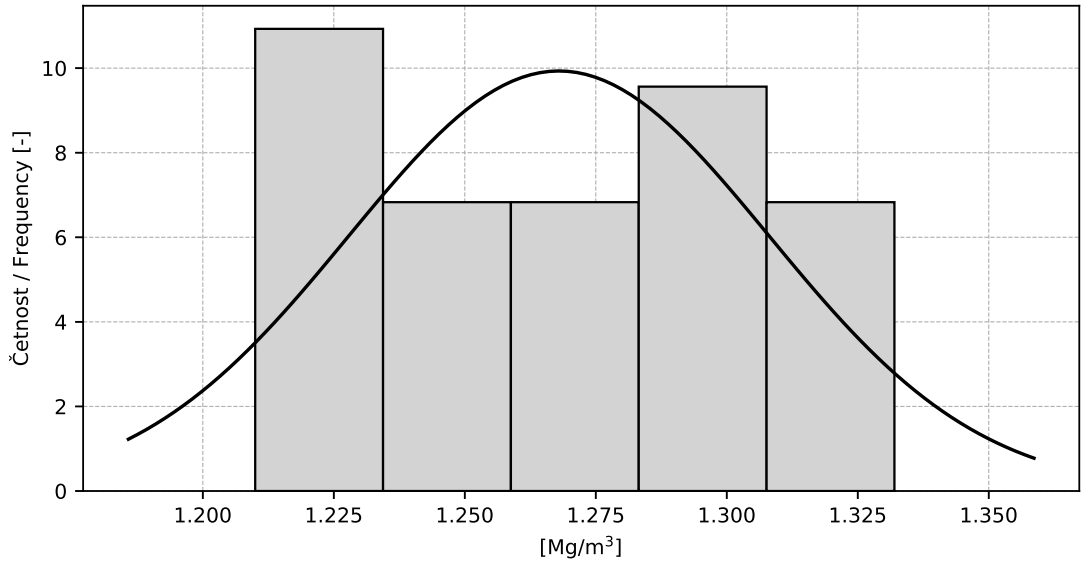

Figure 126: Histogram

Table 45: Descriptive statistics

Value	[Mg/m³]
Průměrná hodnota / Average value – $\bar{x}$	1.27
Výběrová směrodatná odchylka / Sample standard deviation – s	0.04
Vztažná hodnota / Asigned value – x^*	1.27
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.043
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.017
p-hodnota testu normality / p-value of normality test	0.015 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.04
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.007
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.041
Opakovatelnost / Repeatability – r	0.02
Reprodukovatelnost / Reproducibility – R	0.11

10.1.5 Calculation of Performance Statistics

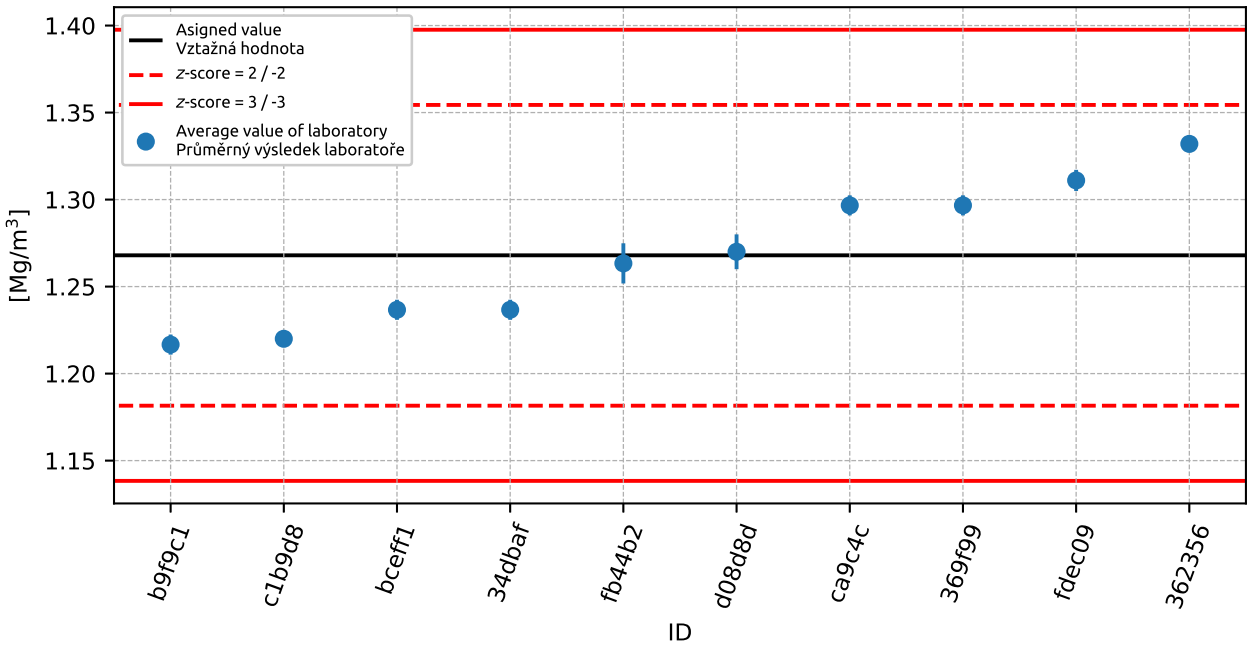

Figure 127: Average values and sample standard deviations

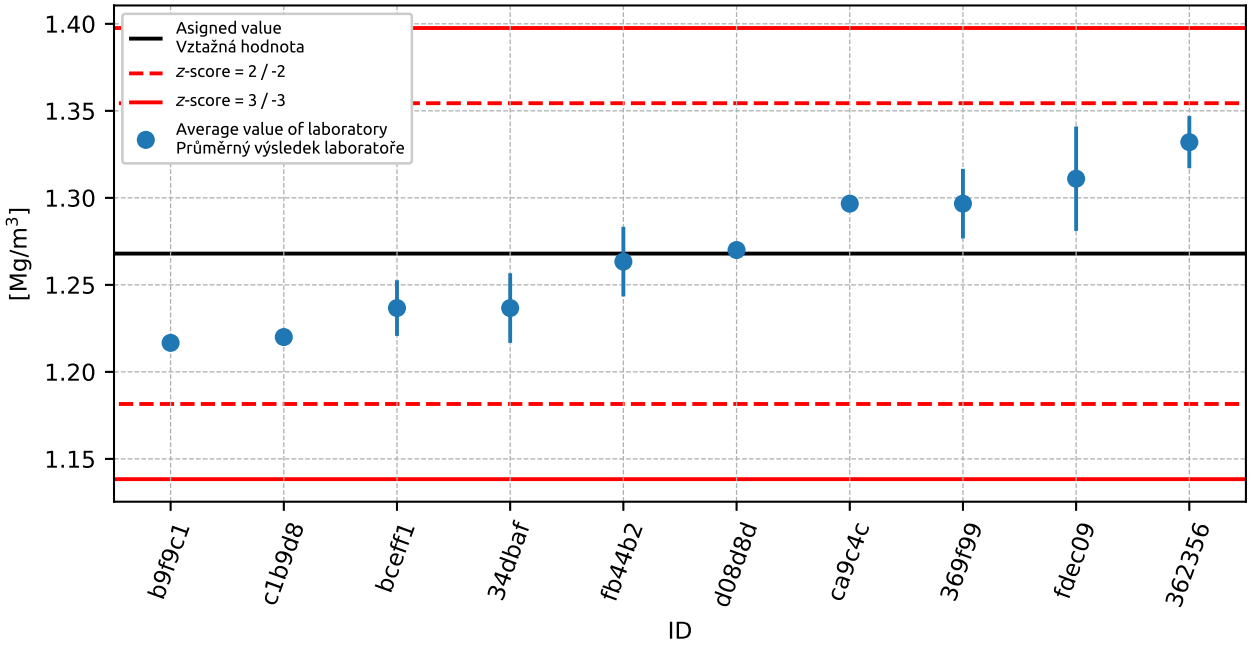

Figure 128: Average values and extended uncertainties of measurement

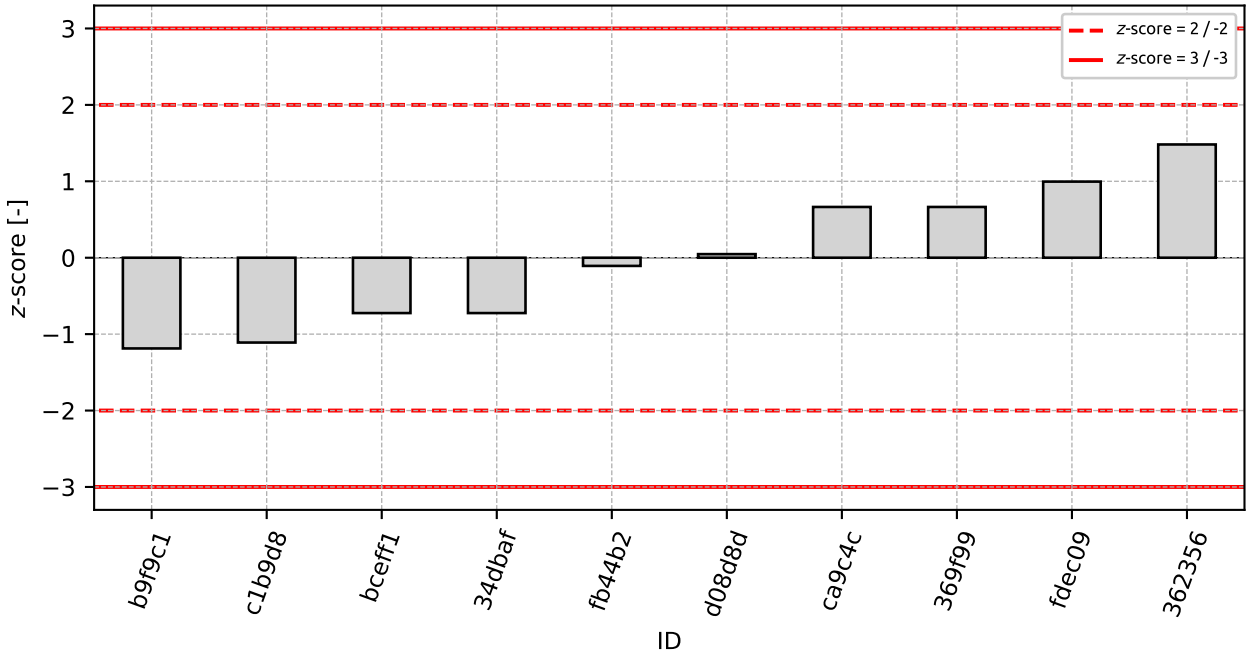

Figure 129: z-score

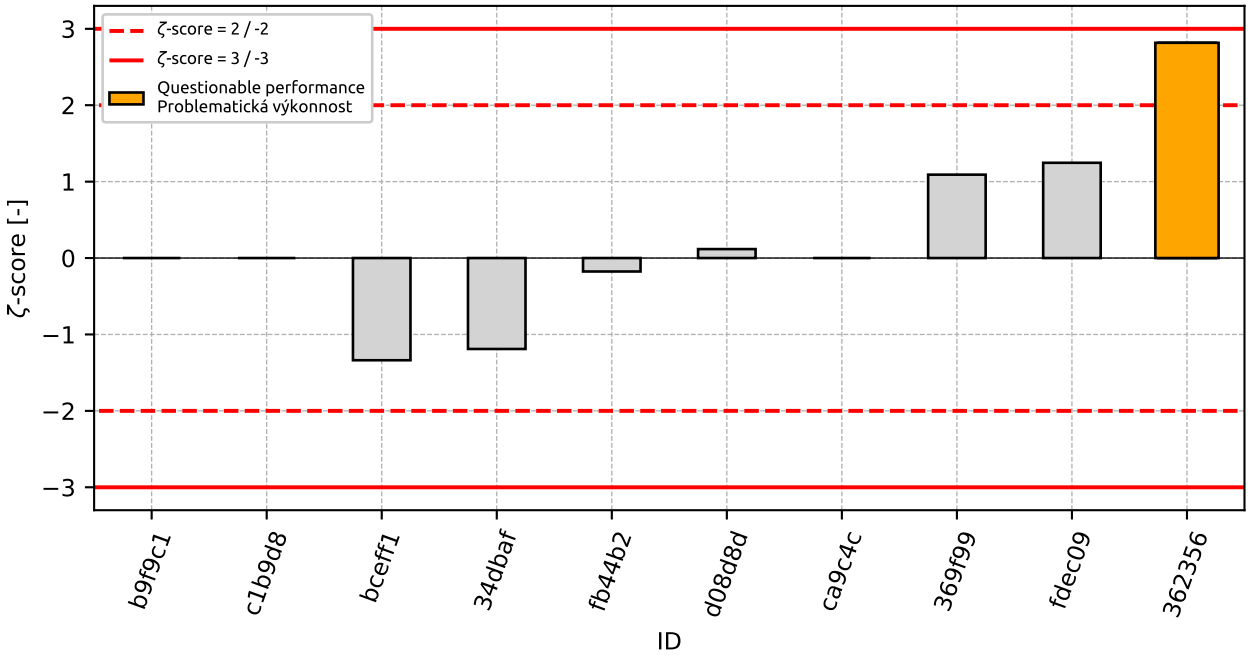

Figure 130: ζ-score

Table 46: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
b9f9c1	-1.19	-
c1b9d8	-1.11	-
bceff1	-0.72	-1.34
34dbaf	-0.72	-1.19
fb44b2	-0.11	-0.18
d08d8d	0.05	0.12
ca9c4c	0.66	-
369f99	0.66	1.09
fdec09	1.0	1.25
362356	1.48	2.82

10.2 Voids

10.2.1 Test results

Table 47: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
362356	50.1	50.8	50.3	0.0	50.4	0.38	0.76
fb44b2	50.7	50.9	50.8	1.5	50.8	0.1	0.2
fdec09	50.9	51.1	50.8	1.1	50.9	0.15	0.3
d08d8d	52.6	53.2	53.5	3.8	53.1	0.46	0.86
b9f9c1	54.1	54.4	54.2	-	54.2	0.15	0.28
c1b9d8	57.5	57.5	57.3	-	57.4	0.12	0.2

10.2.2 The Numerical Procedure for Determining Outliers

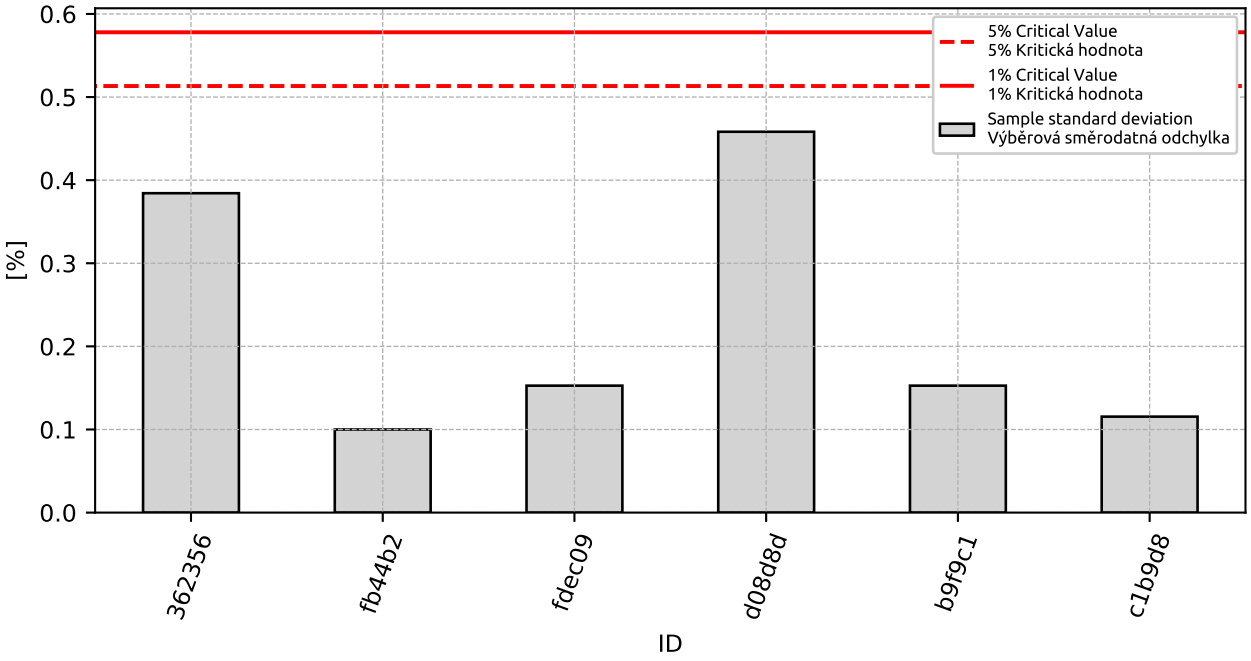

Figure 131: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

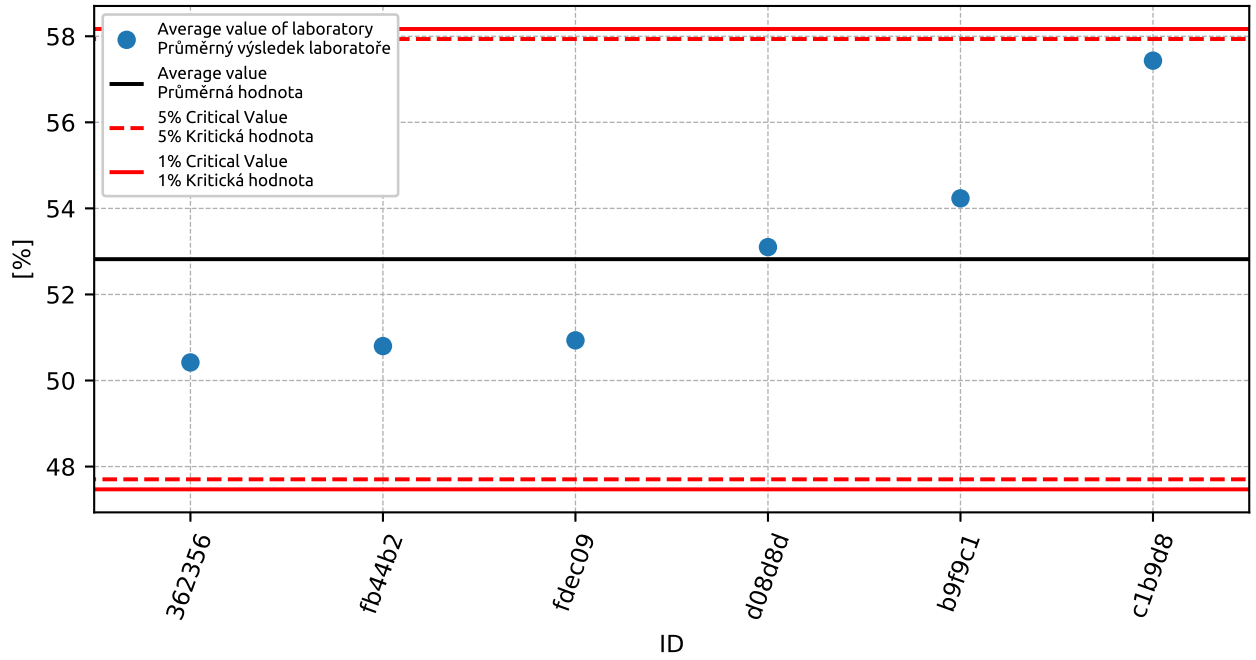

Figure 132: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

10.2.3 Mandel's Statistics

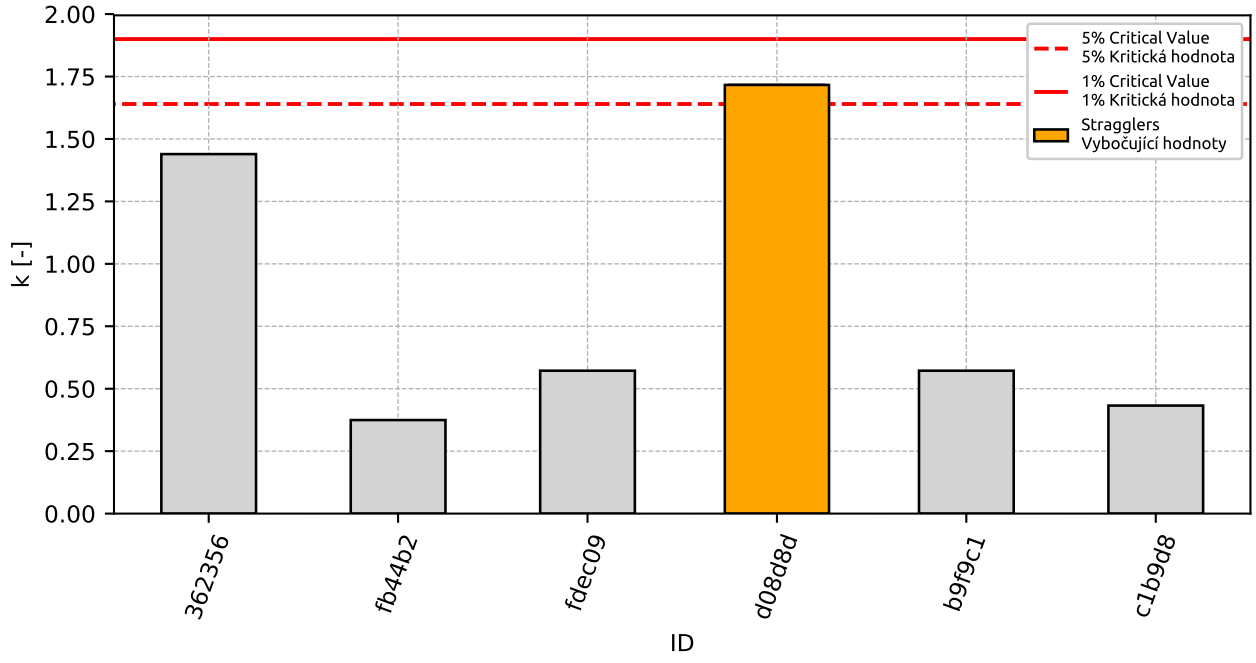

Figure 133: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

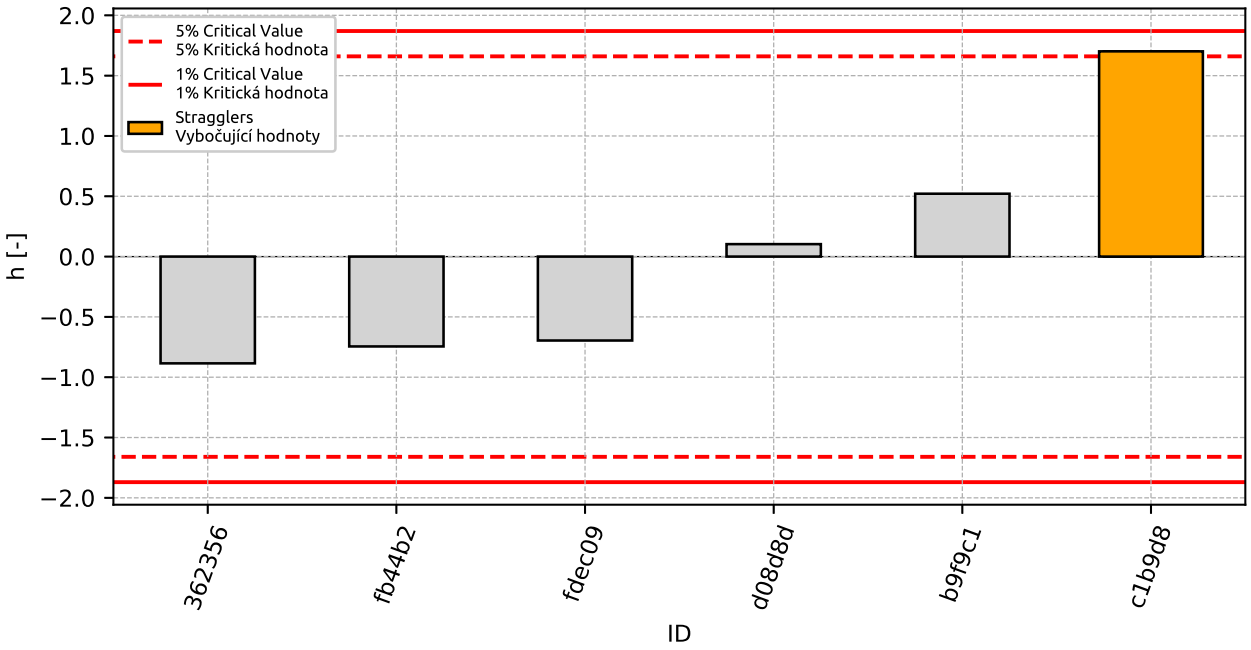

Figure 134: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

10.2.4 Descriptive statistics

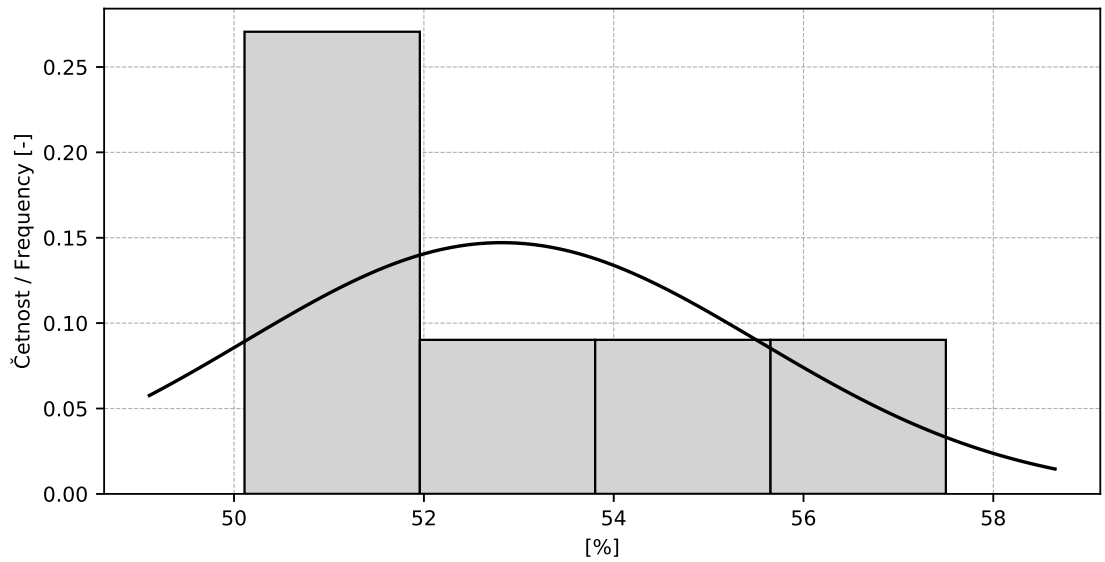

Figure 135: Histogram

Table 48: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	52.8
Výběrová směrodatná odchylka / Sample standard deviation – s	2.71
Vztažná hodnota / Asigned value – x^*	52.8
Robustní směrodatná odchylka / Robust standard deviation – s^*	2.81
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	1.43
p-hodnota testu normality / p-value of normality test	0.255 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	2.71
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.27
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	2.72
Opakovatelnost / Repeatability – r	0.7
Reprodukovatelnost / Reproducibility – R	7.6

10.2.5 Calculation of Performance Statistics

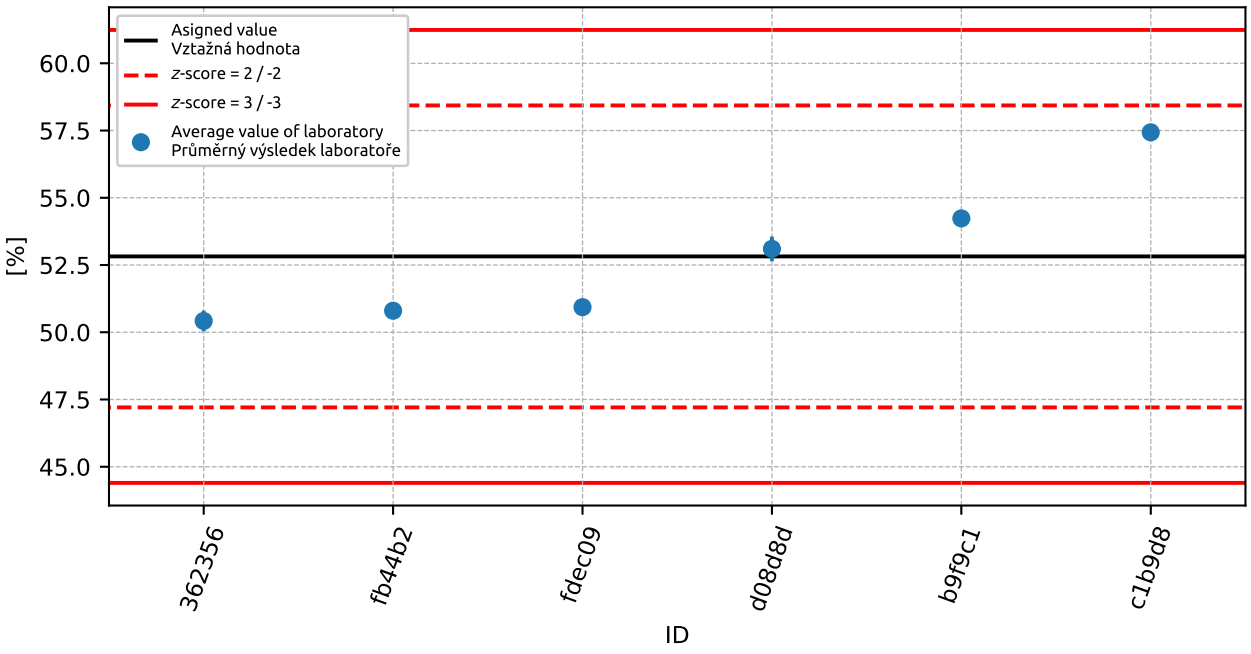

Figure 136: Average values and sample standard deviations

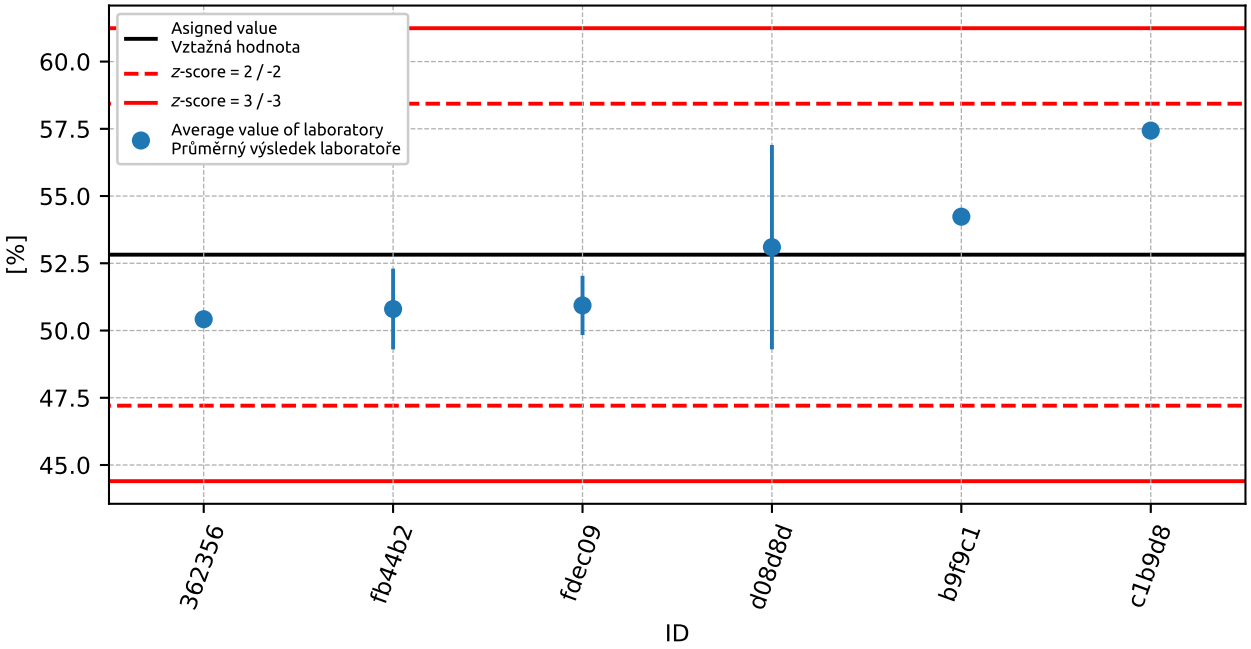

Figure 137: Average values and extended uncertainties of measurement

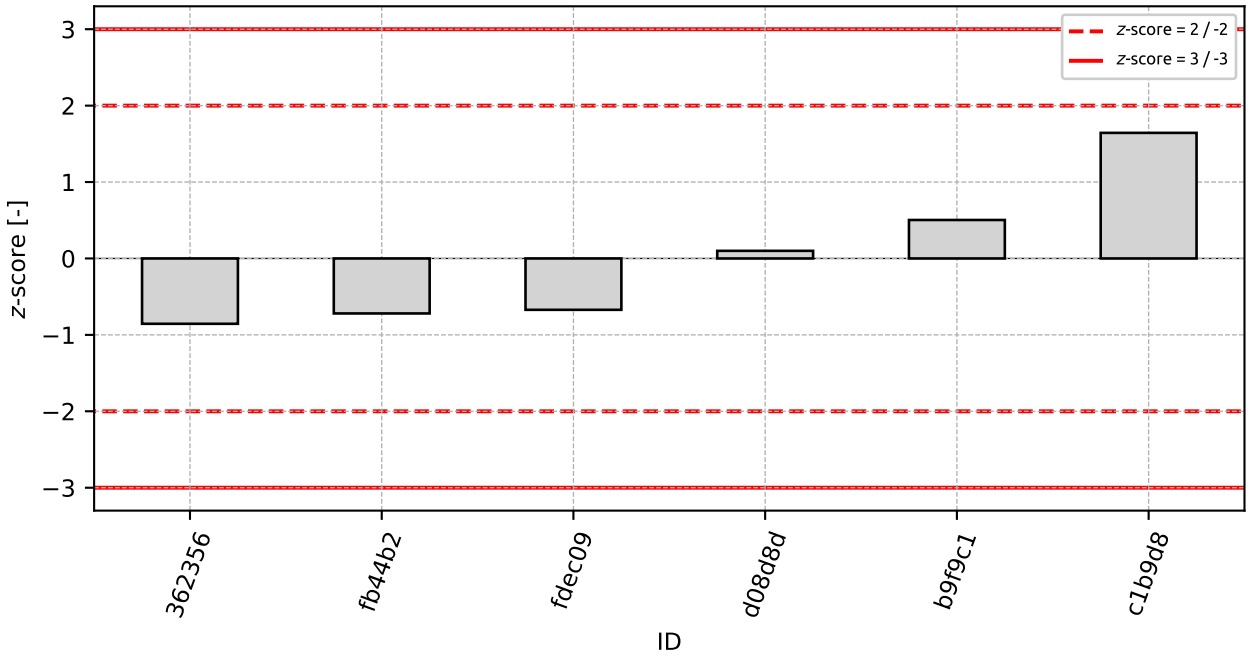

Figure 138: z-score

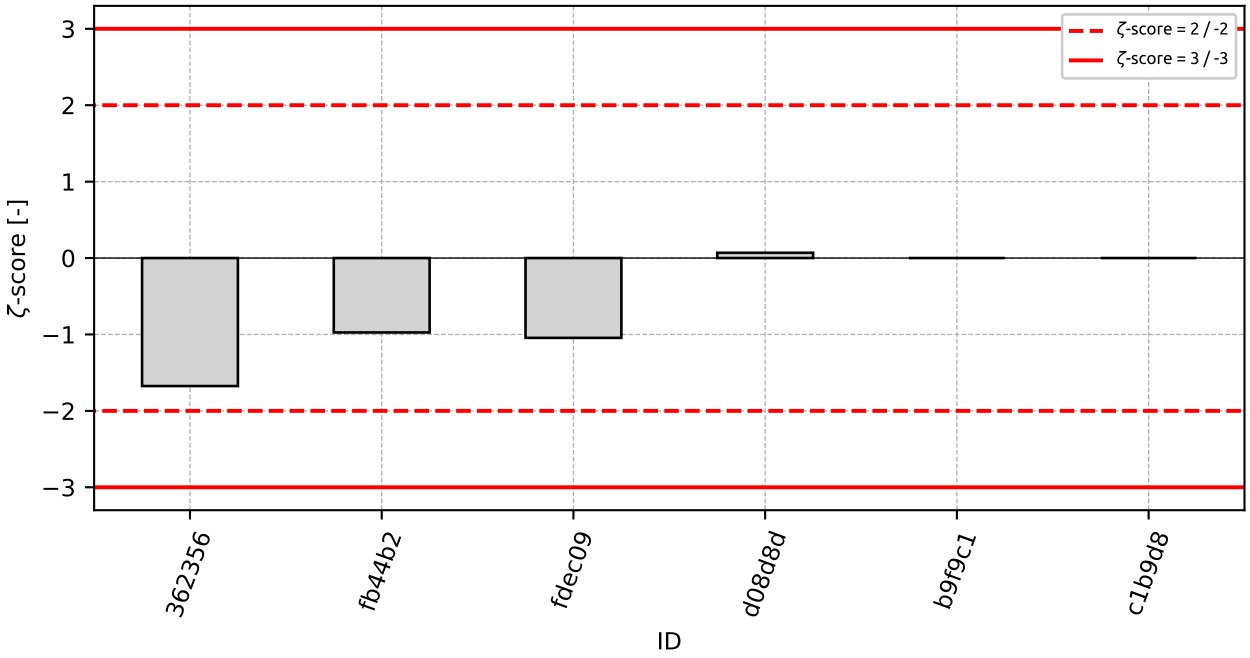

Figure 139: ζ-score

Table 49: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
362356	-0.86	-1.68
fb44b2	-0.72	-0.97
fdec09	-0.67	-1.04
d08d8d	0.1	0.07
b9f9c1	0.5	-
c1b9d8	1.64	-

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

11.1 Test results

Table 50: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
5069ff	6.9	6.8	6.7	0.2	6.8	0.1	1.53
f5d861	7.7	8.0	7.8	0.2	7.8	0.15	1.95
e4a52e	8.0	7.9	7.7	0.5	7.9	0.15	1.94
a7d721	8.2	7.6	7.9	1.0	7.9	0.3	3.8
c1b9d8	8.2	7.9	8.0	-	8.0	0.15	1.9
b9f9c1	8.2	8.1	8.1	-	8.1	0.06	0.71
717772	8.2	8.2	8.2	6.0	8.2	0.0	0.0
446aaf	8.2	8.2	8.2	0.2	8.2	0.0	0.0
7a0d97	8.3	8.2	8.2	0.7	8.2	0.06	0.7
33435c	8.3	8.2	8.2	0.3	8.2	0.06	0.7
952fc1	8.2	8.2	8.4	0.3	8.3	0.12	1.4
c46861	8.1	8.3	8.4	1.0	8.3	0.15	1.85
3bc72f	7.7	8.3	8.9	0.7	8.3	0.6	7.23
30b65f	8.5	8.3	8.2	6.0	8.3	0.15	1.83
6585c7	8.4	8.5	8.1	0.2	8.3	0.21	2.5
34dbaf	8.3	8.4	8.3	0.1	8.3	0.06	0.69
f10b2d	8.4	8.3	8.4	-	8.4	0.06	0.72
fb44b2	8.3	8.4	8.6	0.2	8.4	0.15	1.81
ca9c4c	8.6	8.3	8.5	-	8.5	0.15	1.8
a2c2e4	8.5	8.4	8.6	0.2	8.5	0.1	1.18
6a816e	8.5	8.4	8.6	0.2	8.5	0.1	1.18
3a8f9d	8.5	8.5	8.5	0.8	8.5	0.0	0.0
9652ef	8.6	8.6	8.8	0.4	8.7	0.12	1.33
b87672	8.8	8.9	8.9	0.3	8.9	0.06	0.65
362356	9.0	8.9	8.9	1.7	8.9	0.06	0.65

11.2 The Numerical Procedure for Determining Outliers

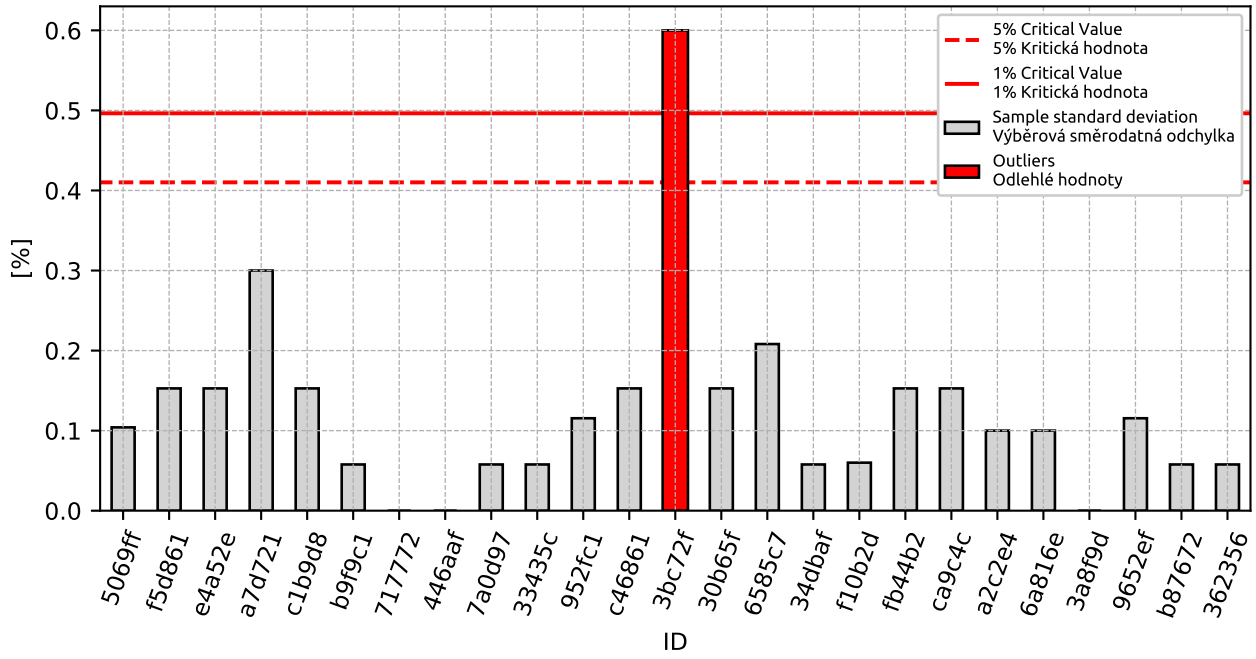

Figure 140: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

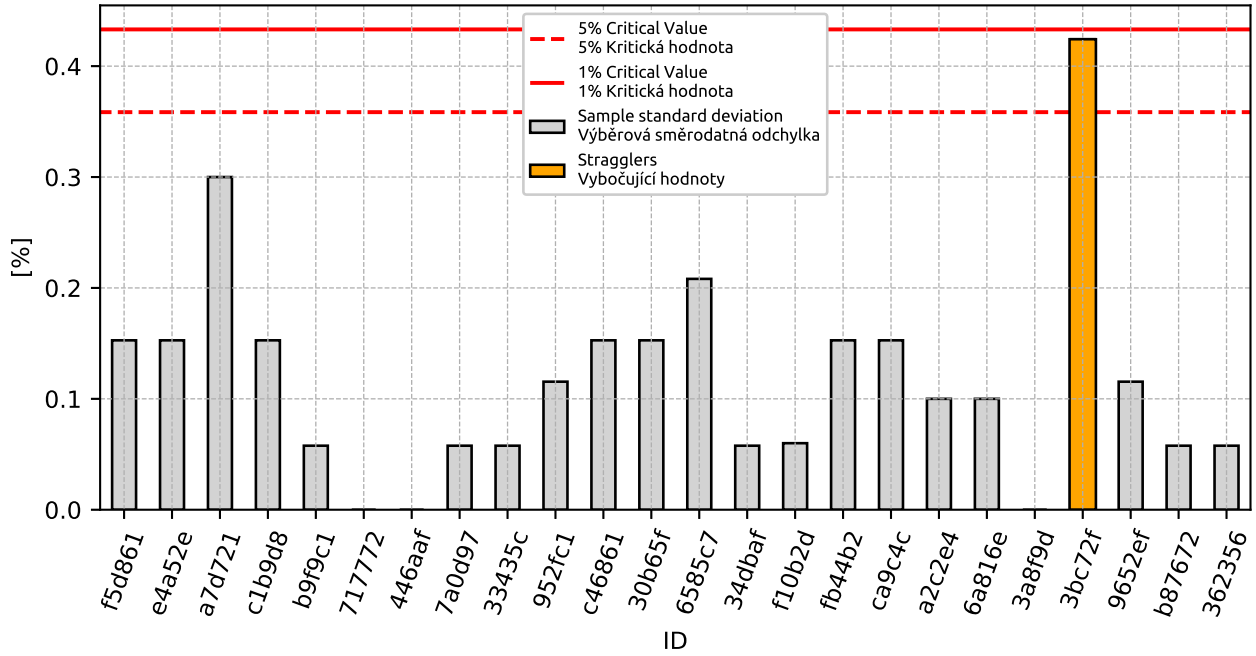

Figure 141: **Cochran's test** - sample standard deviations without outliers: 1% critical value - red color; 5% critical value - blue color

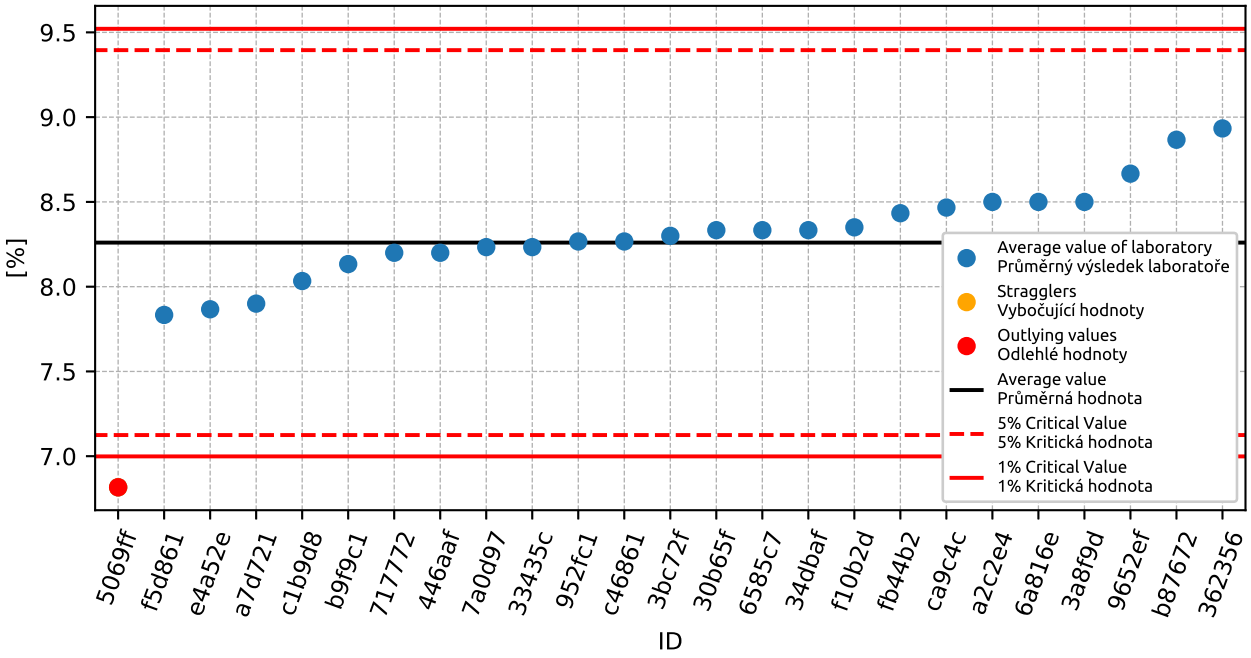

Figure 142: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

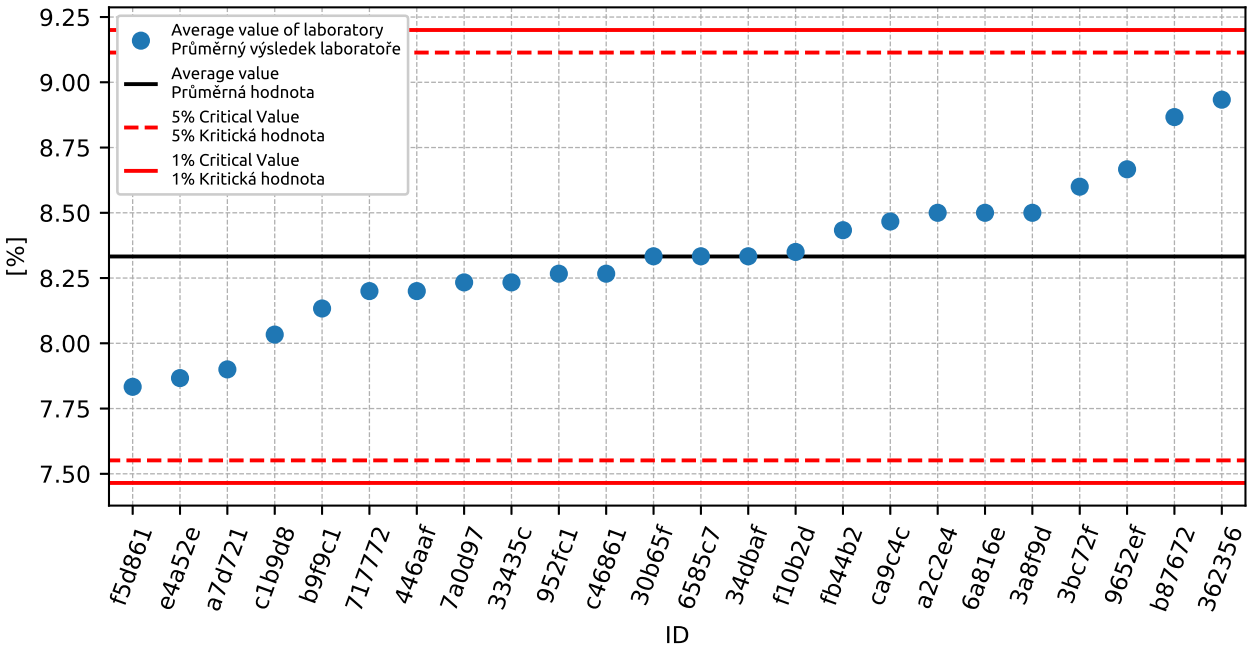

Figure 143: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color

11.3 Mandel's Statistics

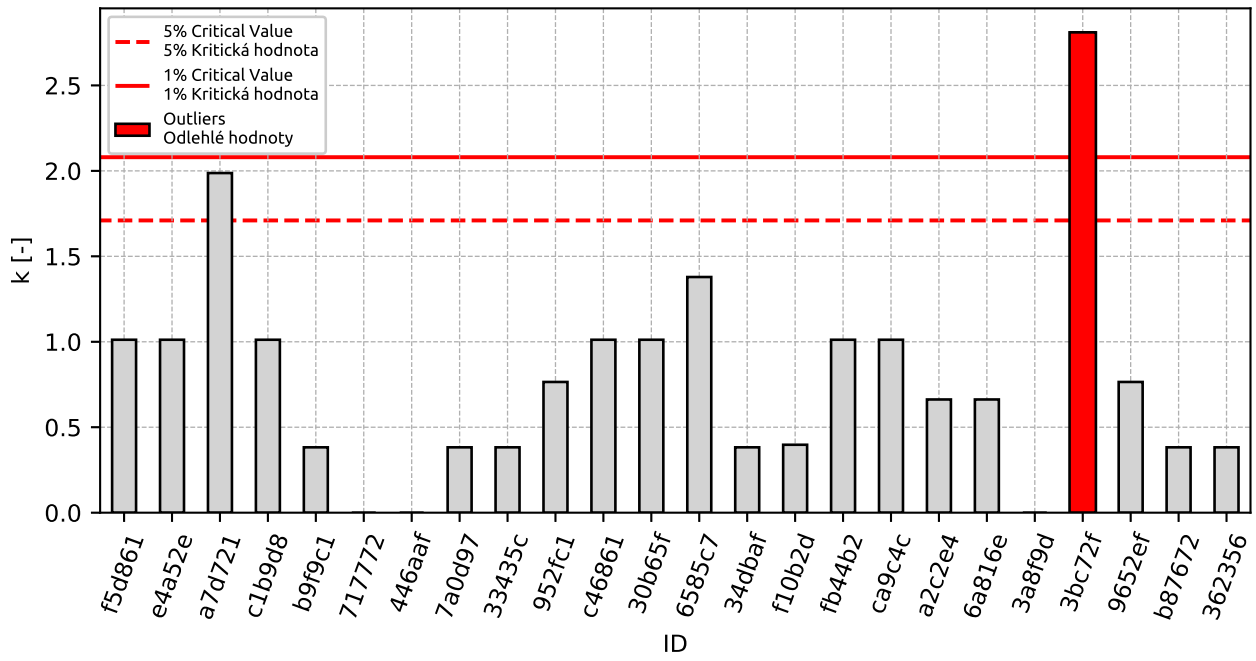

Figure 144: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

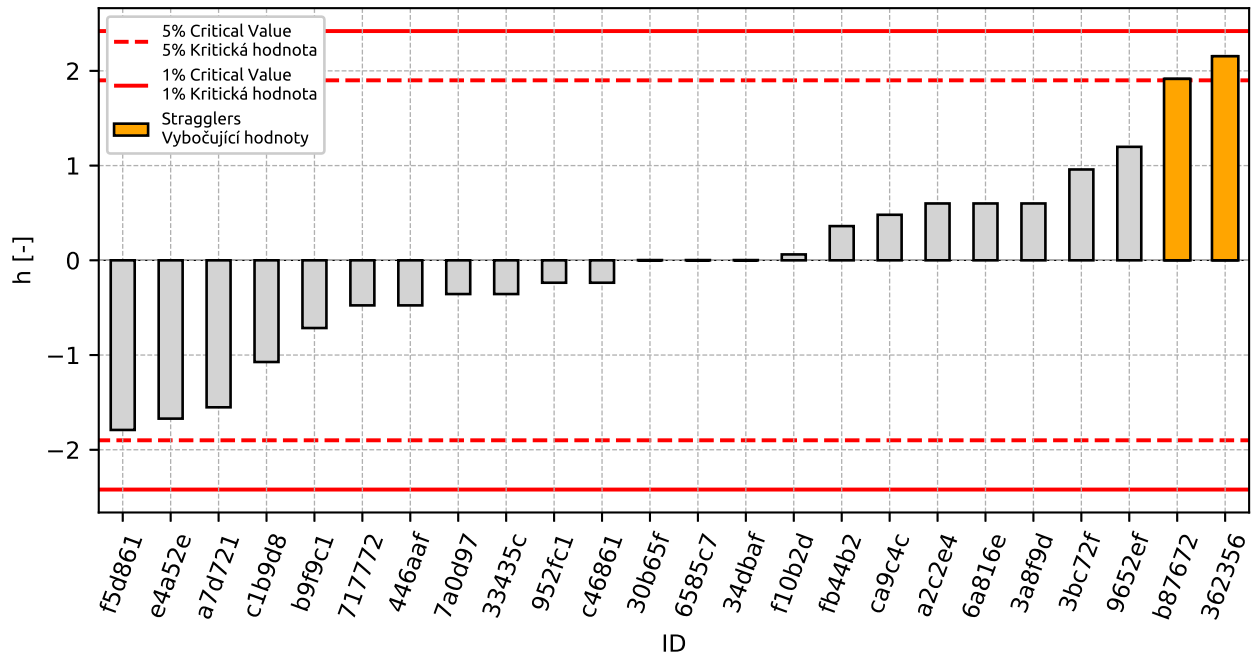

Figure 145: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

11.4 Descriptive statistics

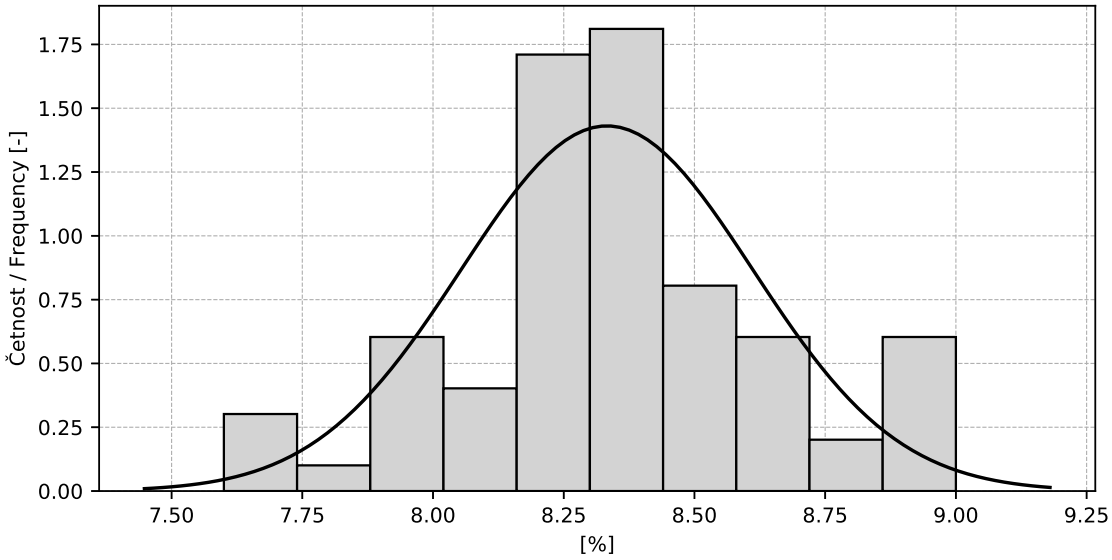

Figure 146: Histogram

Table 51: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	8.3
Výběrová směrodatná odchylka / Sample standard deviation – s	0.28
Vztažná hodnota / Asigned value – x^*	8.3
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.26
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.07
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.26
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.15
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.3
Opakovatelnost / Repeatability – r	0.4
Reprodukovatelnost / Reproducibility – R	0.9

11.5 Calculation of Performance Statistics

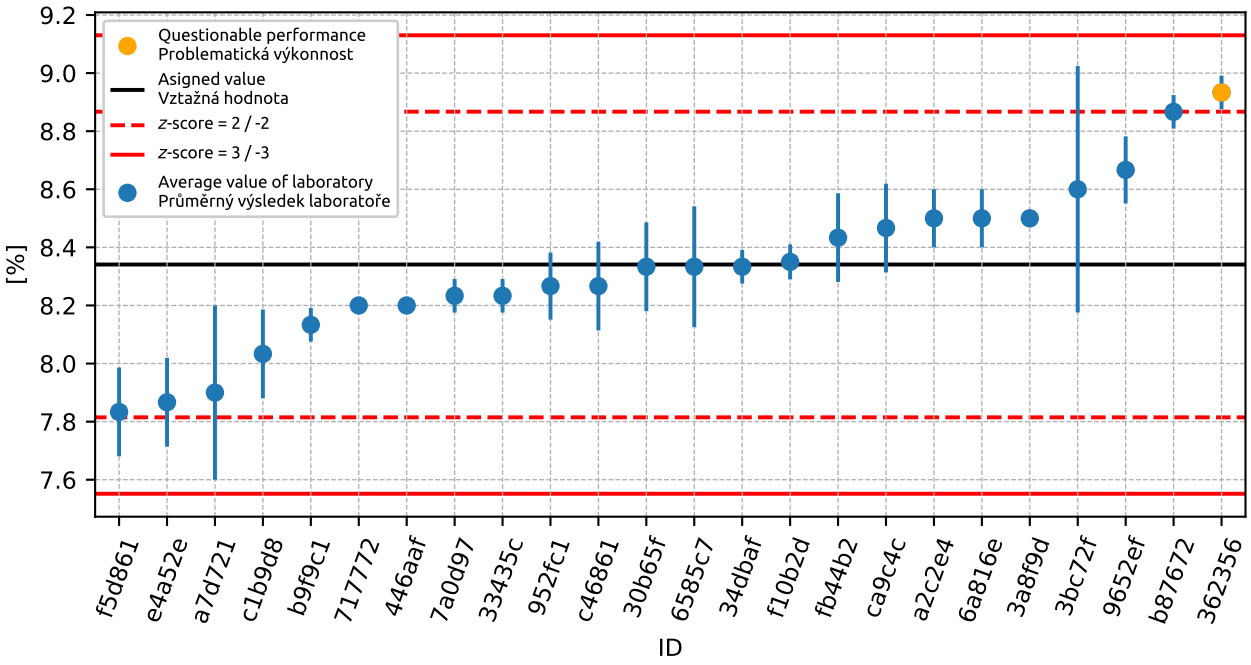

Figure 147: Average values and sample standard deviations

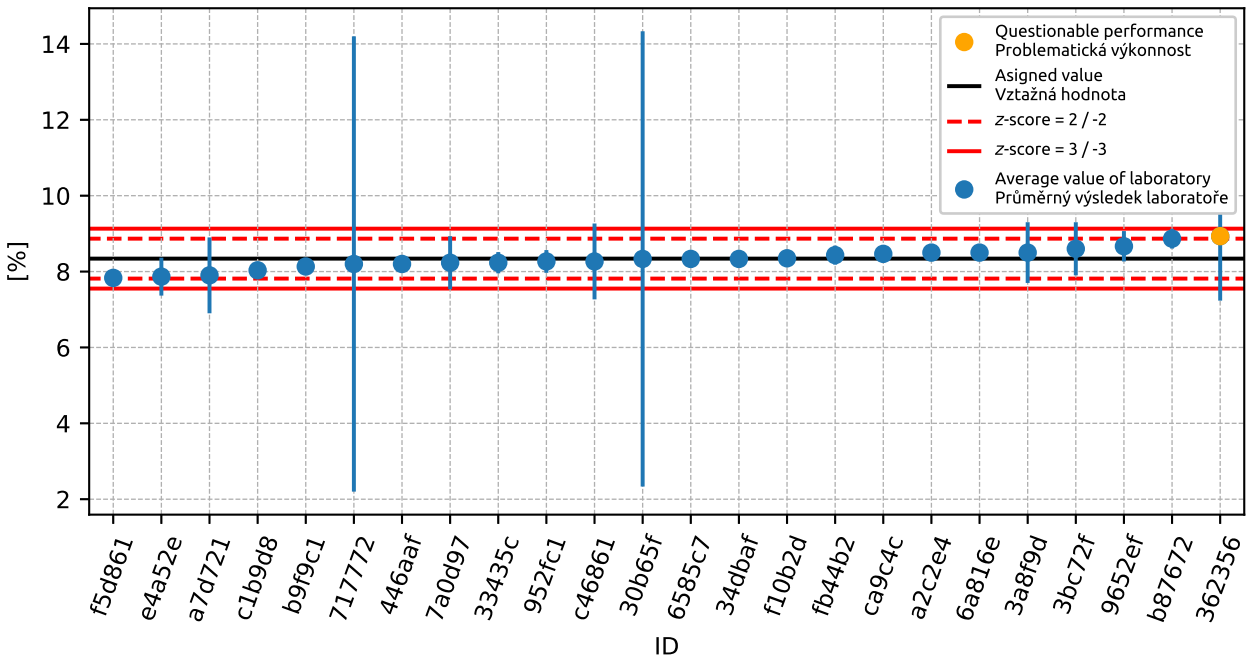

Figure 148: Average values and extended uncertainties of measurement

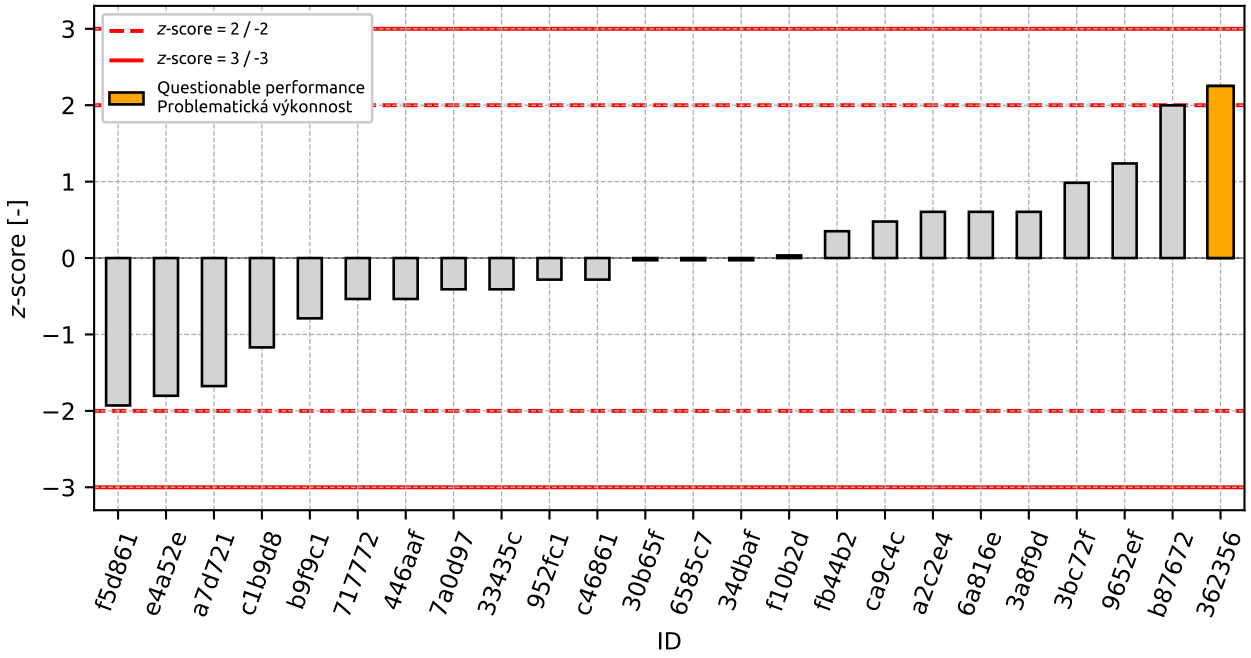

Figure 149: z-score

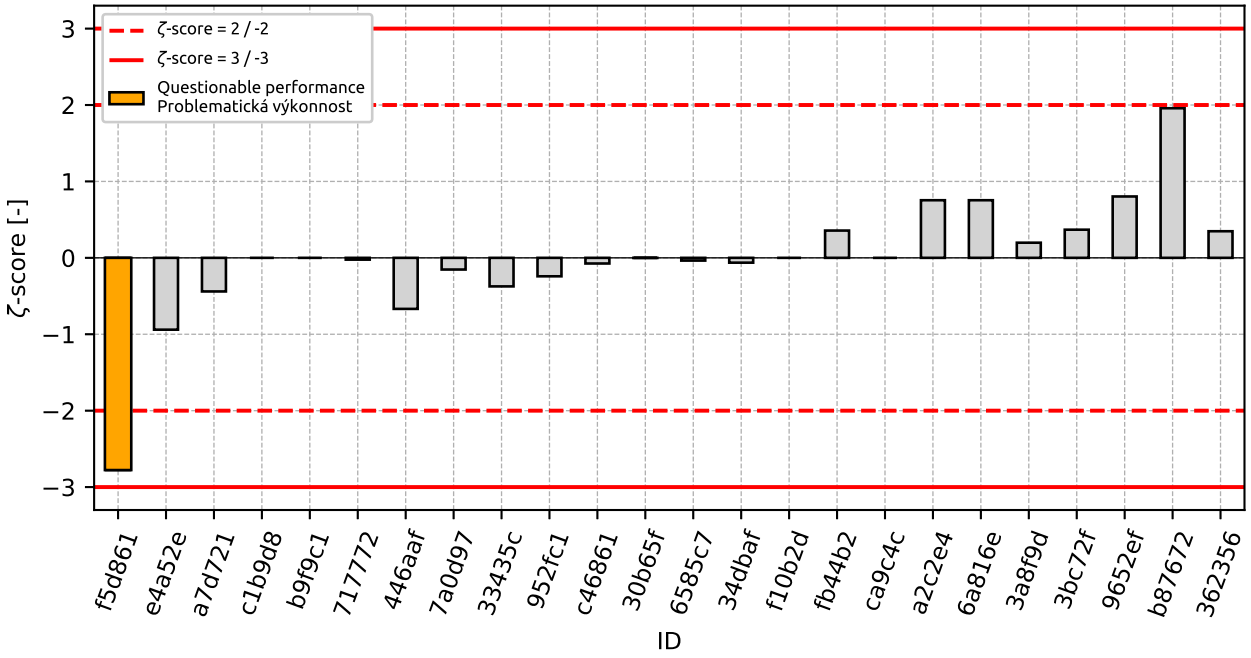

Figure 150: ζ-score

Table 52: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f5d861	-1.93	-2.78
e4a52e	-1.8	-0.94
a7d721	-1.68	-0.44
c1b9d8	-1.17	-
b9f9c1	-0.79	-
717772	-0.54	-0.02
446aaf	-0.54	-0.67
7a0d97	-0.41	-0.15
33435c	-0.41	-0.37
952fc1	-0.28	-0.24
c46861	-0.28	-0.07
30b65f	-0.03	-0.0
6585c7	-0.03	-0.04
34dbaf	-0.03	-0.06
f10b2d	0.03	-
fb44b2	0.35	0.36
ca9c4c	0.48	-
a2c2e4	0.6	0.75
6a816e	0.6	0.75
3a8f9d	0.6	0.2
3bc72f	0.98	0.37
9652ef	1.24	0.8
b87672	2.0	1.96
362356	2.25	0.35

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

12.1 Particle density

12.1.1 Test results

Table 53: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [Mg/m³]			u_X [Mg/m³]	$\bar{x}$ [Mg/m³]	s_0 [Mg/m³]	V_X [%]
8c3204	2.61	2.61	2.6	0.44	2.61	0.006	0.22
7a0d97	2.74	2.74	2.74	0.06	2.74	0.0	0.0
952fc1	2.75	2.76	2.75	0.06	2.75	0.006	0.21
6a816e	2.75	2.76	2.75	0.1	2.75	0.006	0.21
c1b9d8	2.76	2.78	2.79	-	2.78	0.015	0.55
bceff1	2.81	2.76	2.78	0.05	2.78	0.025	0.9
f45ea9	2.78	2.79	2.78	0.02	2.78	0.006	0.21
e4a52e	2.79	2.78	2.79	0.04	2.79	0.006	0.21
a7d721	2.8	2.81	2.8	0.2	2.8	0.006	0.21
ca9c4c	2.82	2.79	2.81	-	2.81	0.015	0.54
f5d861	2.81	2.81	2.81	0.02	2.81	0.0	0.0
47cee1	2.81	2.82	2.81	0.01	2.81	0.004	0.15
34dbaf	2.82	2.81	2.81	0.01	2.81	0.006	0.21
33435c	2.81	2.82	2.82	0.05	2.82	0.006	0.2
b9f9c1	2.81	2.82	2.82	-	2.82	0.006	0.2
154720	2.82	2.82	2.82	0.03	2.82	0.004	0.14
30dfbb	2.83	2.82	2.82	0.04	2.82	0.006	0.2
fb44b2	2.83	2.83	2.83	0.02	2.83	0.0	0.0

12.1.2 The Numerical Procedure for Determining Outliers

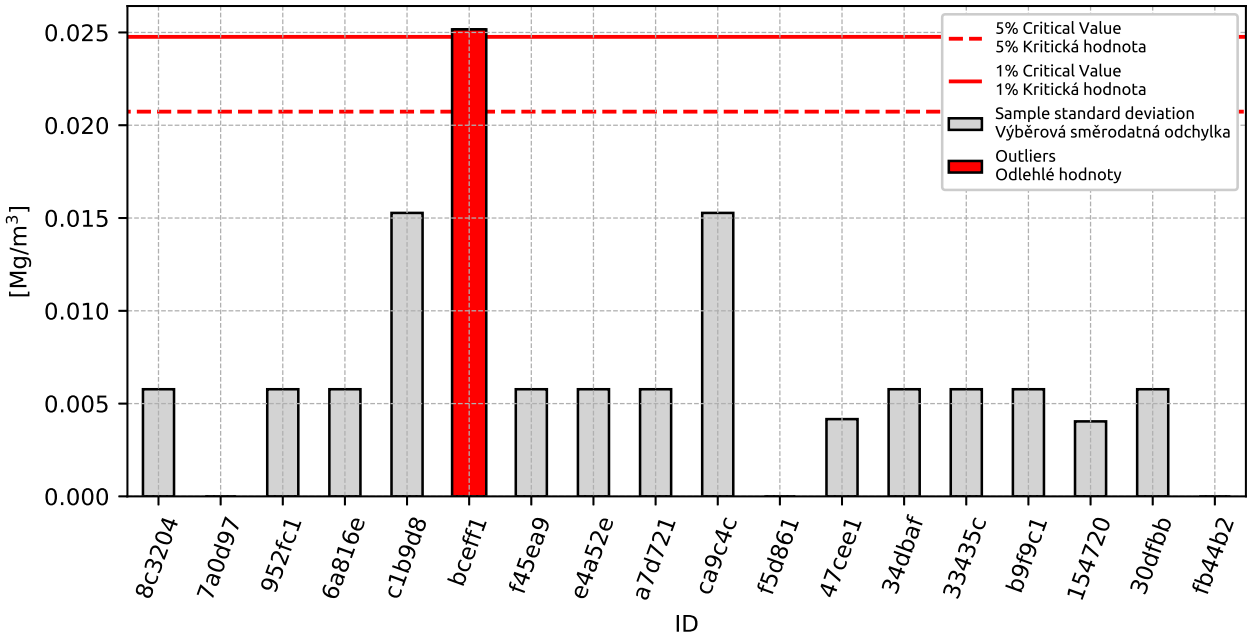

Figure 151: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

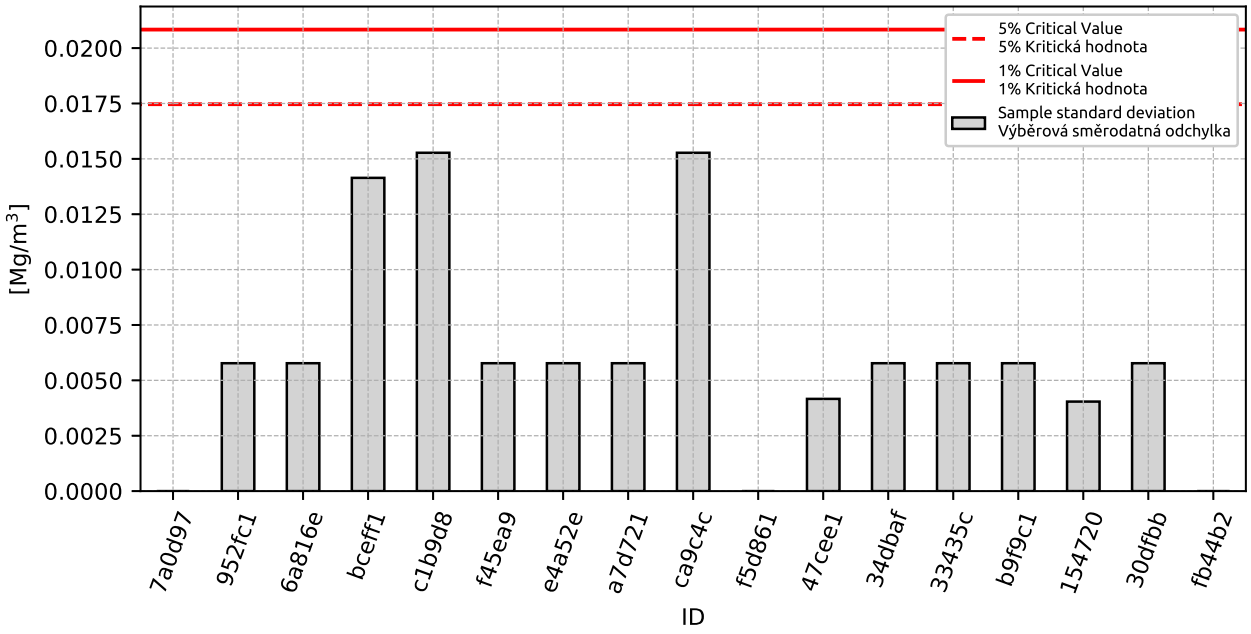

Figure 152: **Cochran's test** - sample standard deviations without outliers: 1% critical value - red color; 5% critical value - blue color

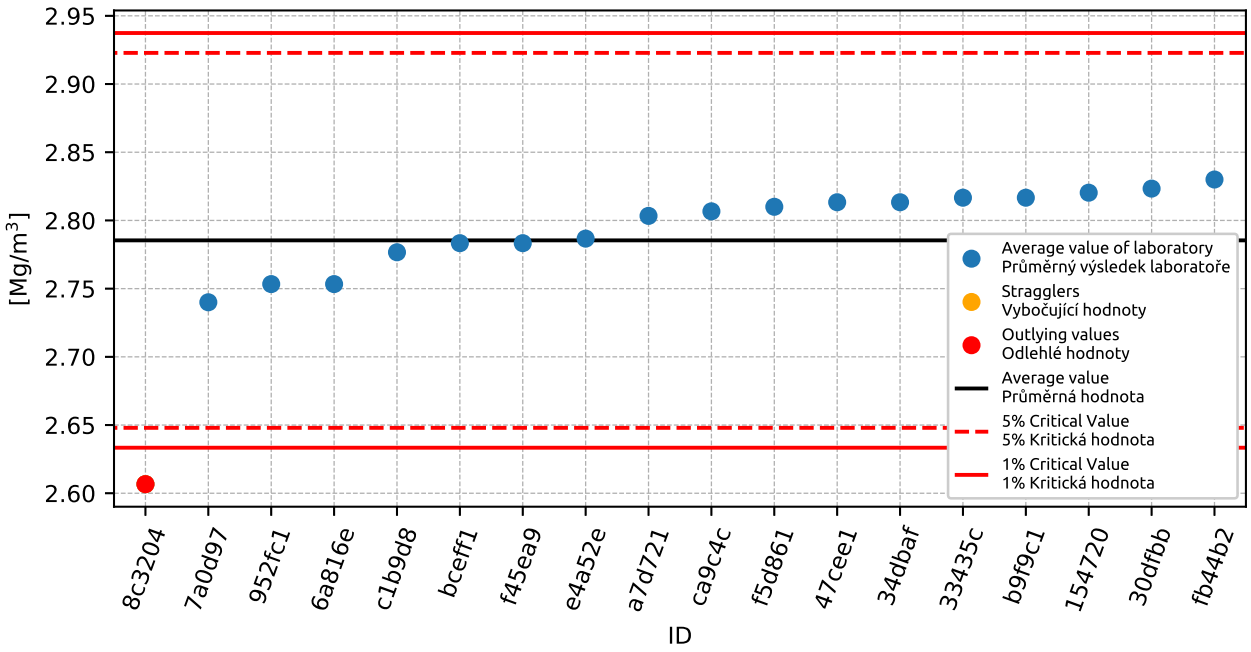

Figure 153: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

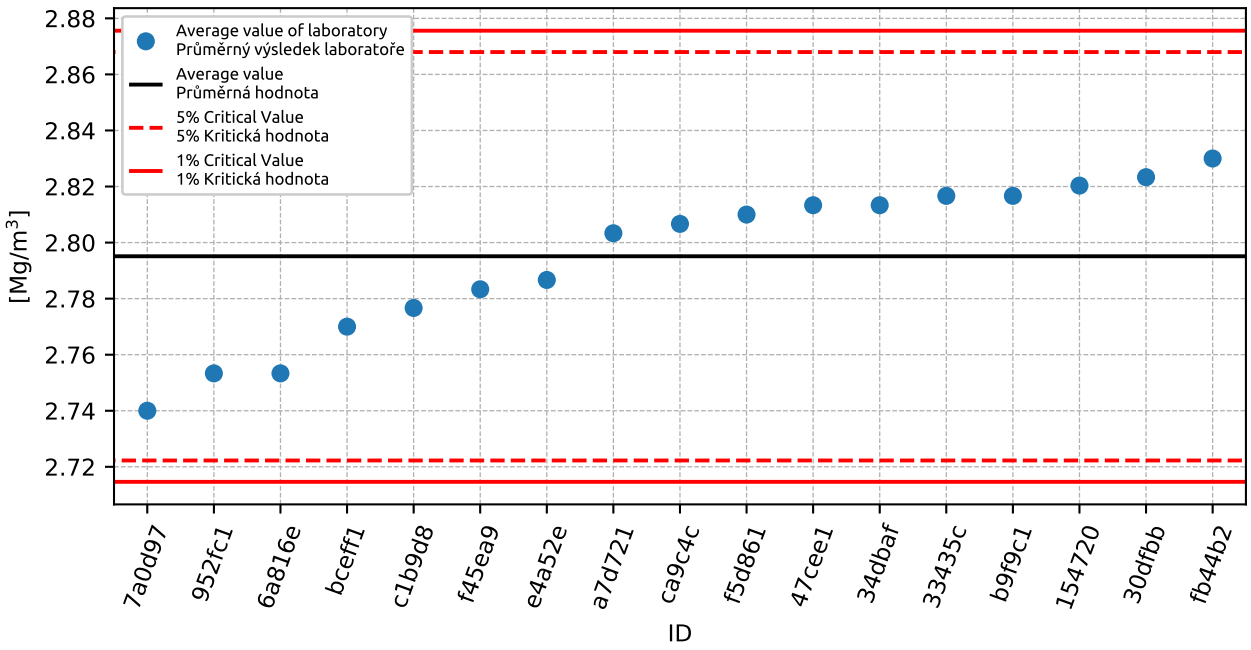

Figure 154: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color

12.1.3 Mandel's Statistics

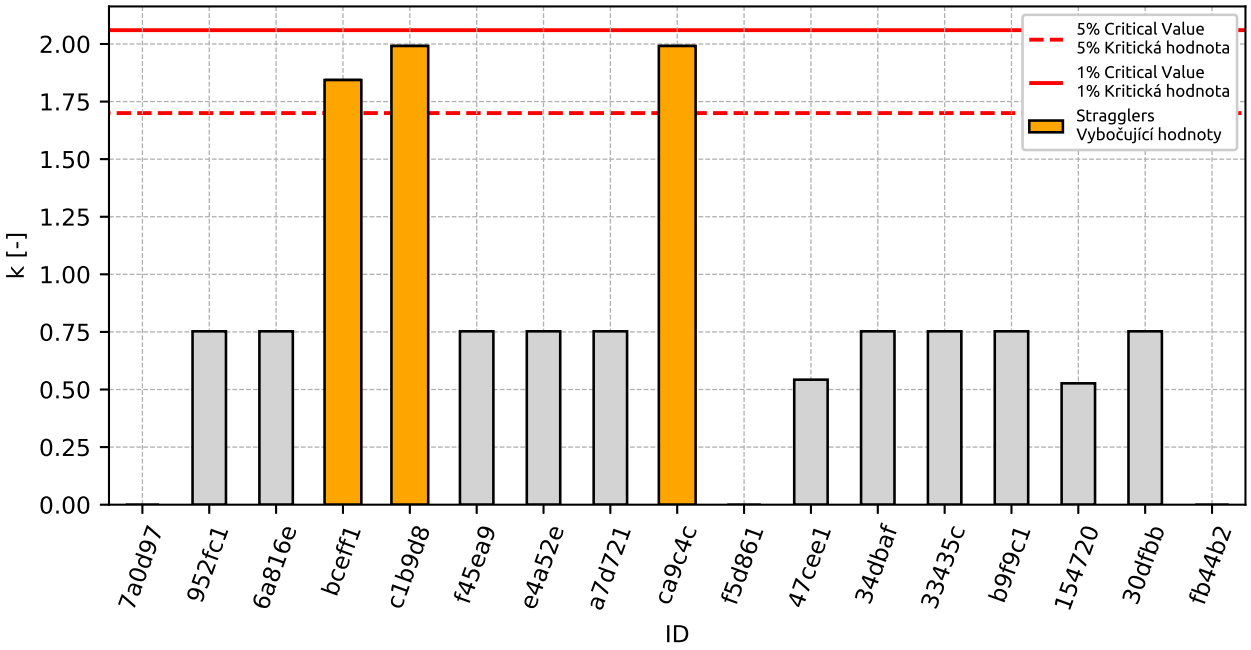

Figure 155: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

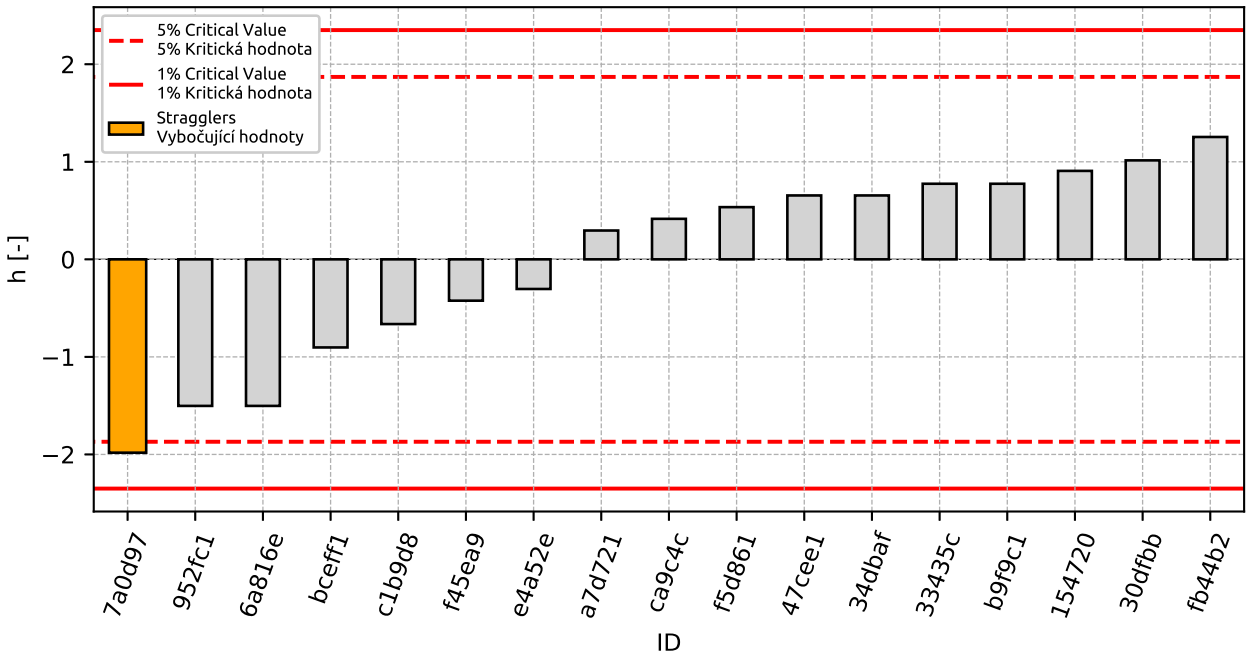

Figure 156: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

12.1.4 Descriptive statistics

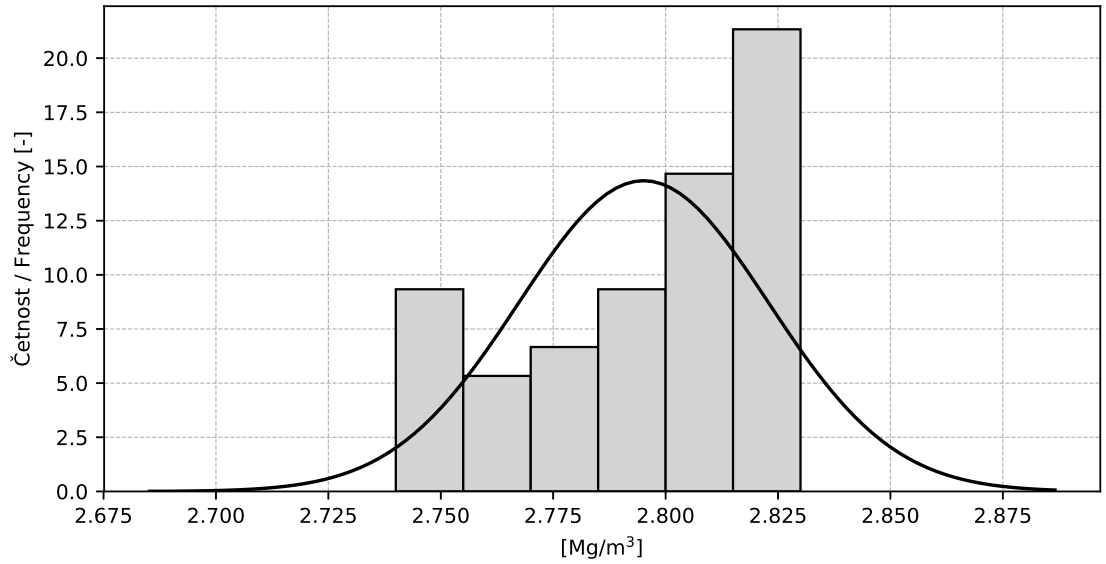

Figure 157: Histogram

Table 54: Descriptive statistics

Value	[Mg/m^3]
Průměrná hodnota / Average value – $\bar{x}$	2.8
Výběrová směrodatná odchylka / Sample standard deviation – s	0.028
Vztažná hodnota / Asigned value – x^*	2.8
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.028
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.167
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.027
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.008
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.029
Opakovatelnost / Repeatability – r	0.02
Reprodukovatelnost / Reproducibility – R	0.08

12.1.5 Calculation of Performance Statistics

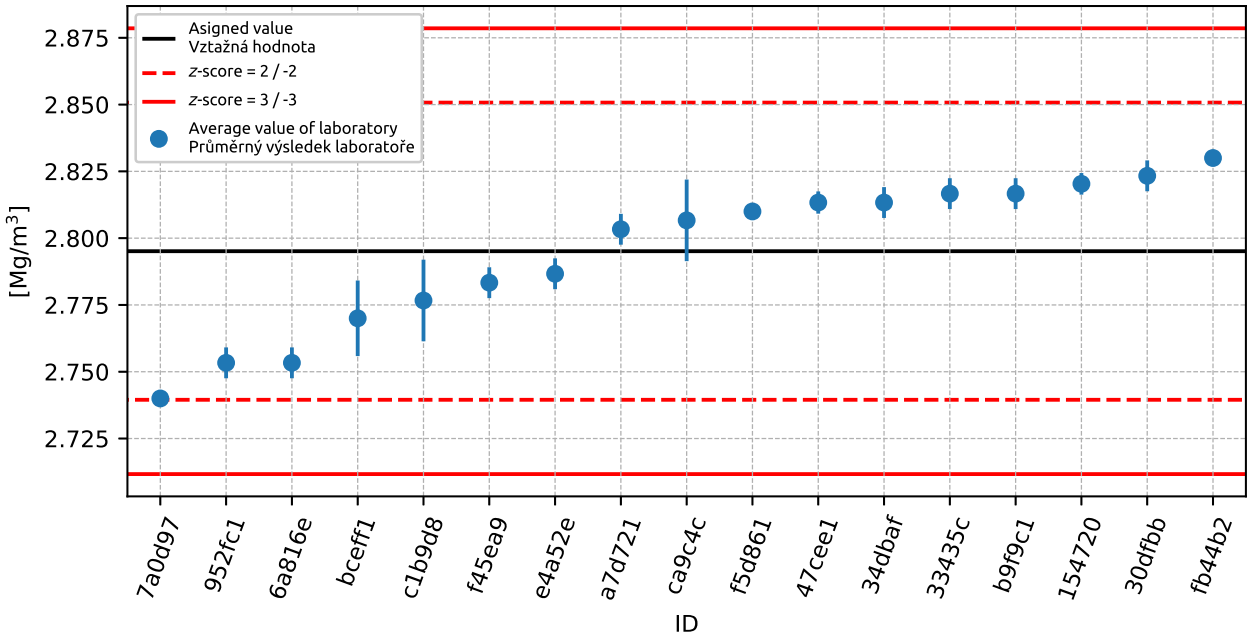

Figure 158: Average values and sample standard deviations

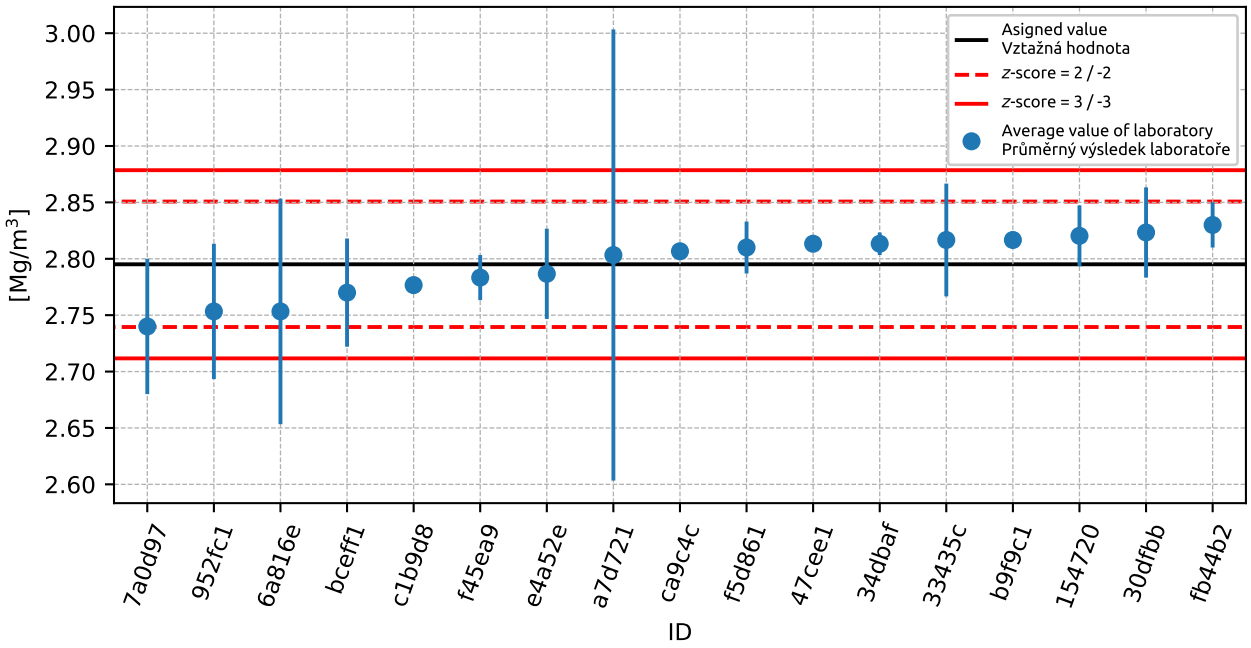

Figure 159: Average values and extended uncertainties of measurement

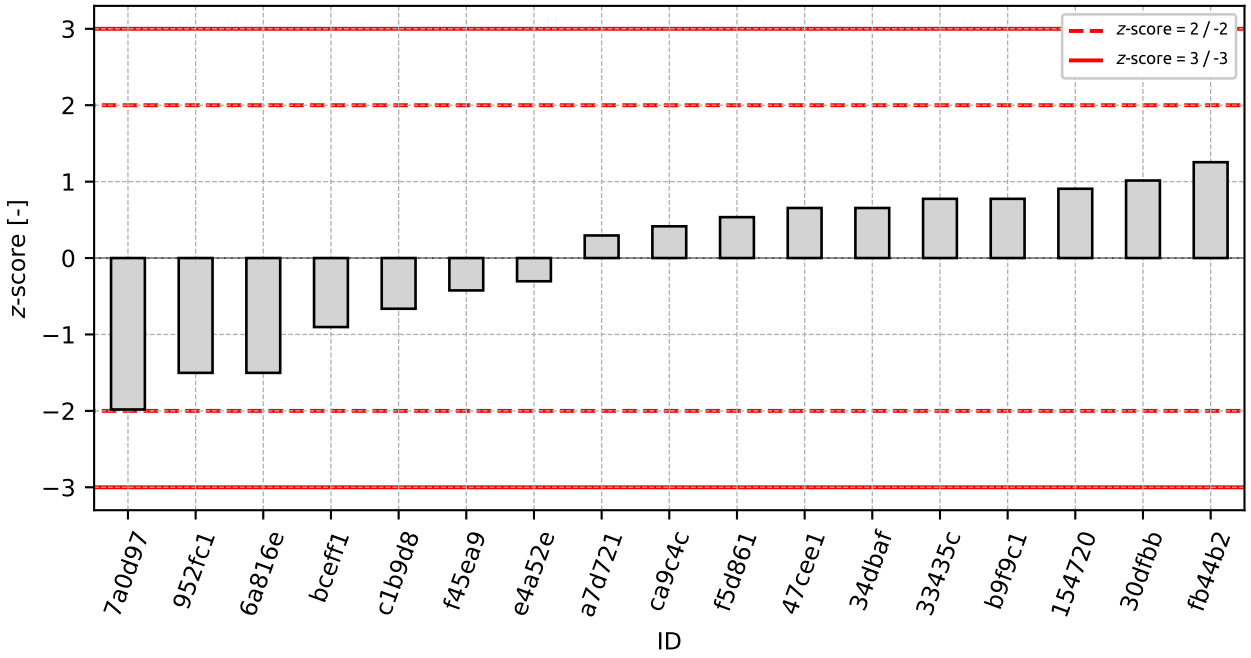

Figure 160: z-score

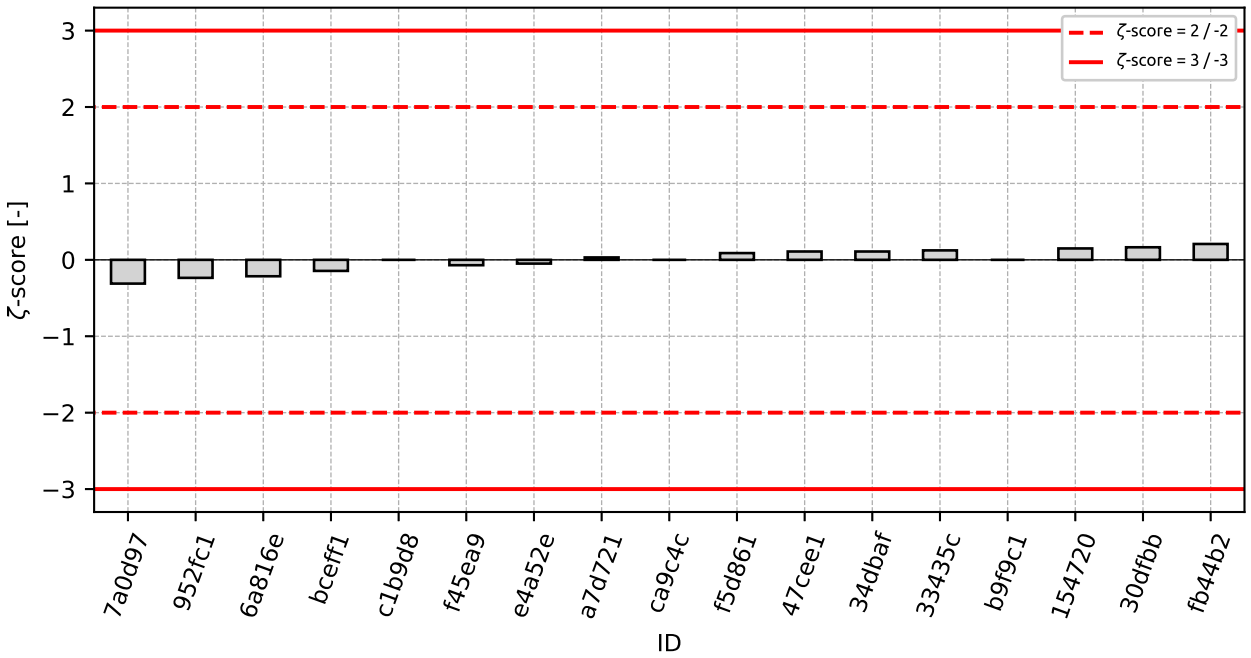

Figure 161: ζ-score

Table 55: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
7a0d97	-1.98	-0.31
952fc1	-1.5	-0.24
6a816e	-1.5	-0.21
bceff1	-0.9	-0.14
c1b9d8	-0.66	-
f45ea9	-0.42	-0.07
e4a52e	-0.3	-0.05
a7d721	0.3	0.03
ca9c4c	0.42	-
f5d861	0.54	0.09
47cee1	0.65	0.11
34dbaf	0.65	0.11
33435c	0.77	0.12
b9f9c1	0.77	-
154720	0.91	0.15
30dfbb	1.01	0.16
fb44b2	1.25	0.21

12.2 Water absorption

12.2.1 Test results

Table 56: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
ca9c4c	0.6	0.5	0.7	-	0.6	0.1	16.67
f5d861	0.7	0.7	0.7	0.1	0.7	0.0	0.0
952fc1	0.8	0.8	0.8	0.1	0.8	0.0	0.0
47cee1	0.7	0.9	0.9	0.1	0.8	0.12	13.86
a7d721	0.8	0.8	0.9	0.1	0.8	0.06	6.93
7a0d97	0.9	0.8	0.8	0.2	0.8	0.06	6.93
6a816e	1.0	0.9	0.9	0.1	0.9	0.06	6.19
33435c	0.9	1.0	0.9	0.3	0.9	0.06	6.19
f45ea9	1.0	0.9	1.0	0.3	1.0	0.06	5.97
fb44b2	1.0	1.0	1.0	0.1	1.0	0.0	0.0
30dfbb	1.0	1.0	1.1	0.1	1.0	0.06	5.59
b9f9c1	1.0	1.1	1.1	-	1.1	0.06	5.41
bceff1	1.1	1.1	1.0	0.1	1.1	0.06	5.41
34dbaf	1.0	1.1	1.3	0.1	1.1	0.15	13.48
e4a52e	1.1	1.2	1.2	0.3	1.2	0.06	4.95
c1b9d8	1.3	1.2	1.2	-	1.2	0.06	4.68
154720	1.3	1.3	1.3	0.0	1.3	0.01	0.7
8c3204	1.4	1.3	1.4	0.1	1.4	0.06	4.22

12.2.2 The Numerical Procedure for Determining Outliers

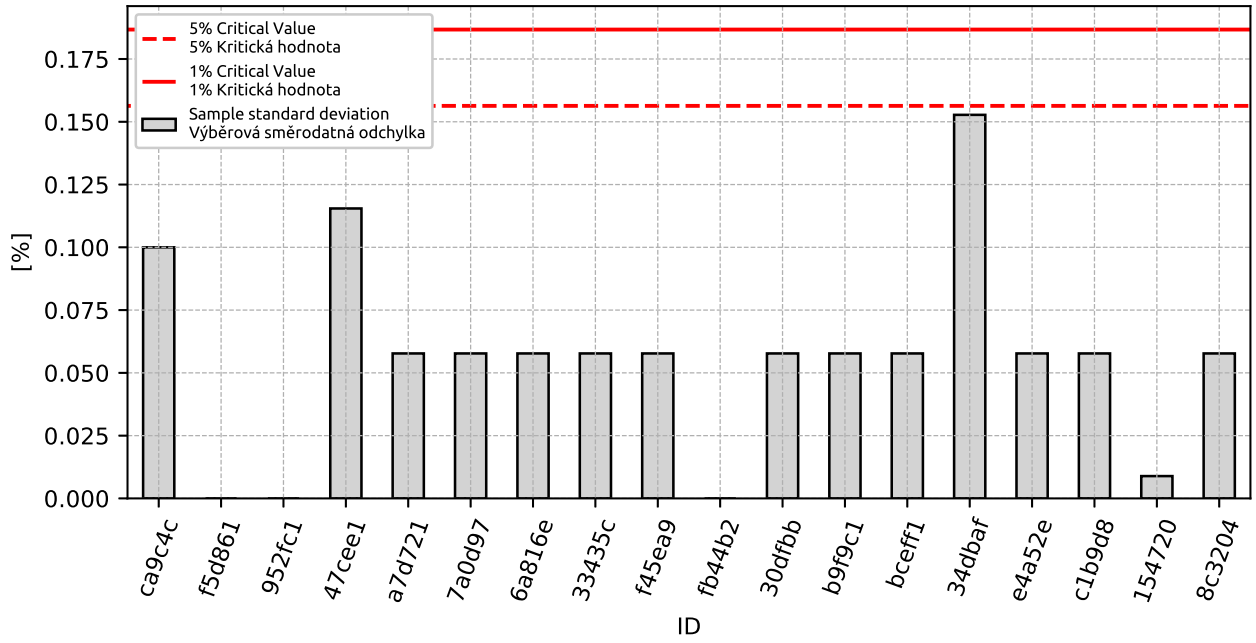

Figure 162: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

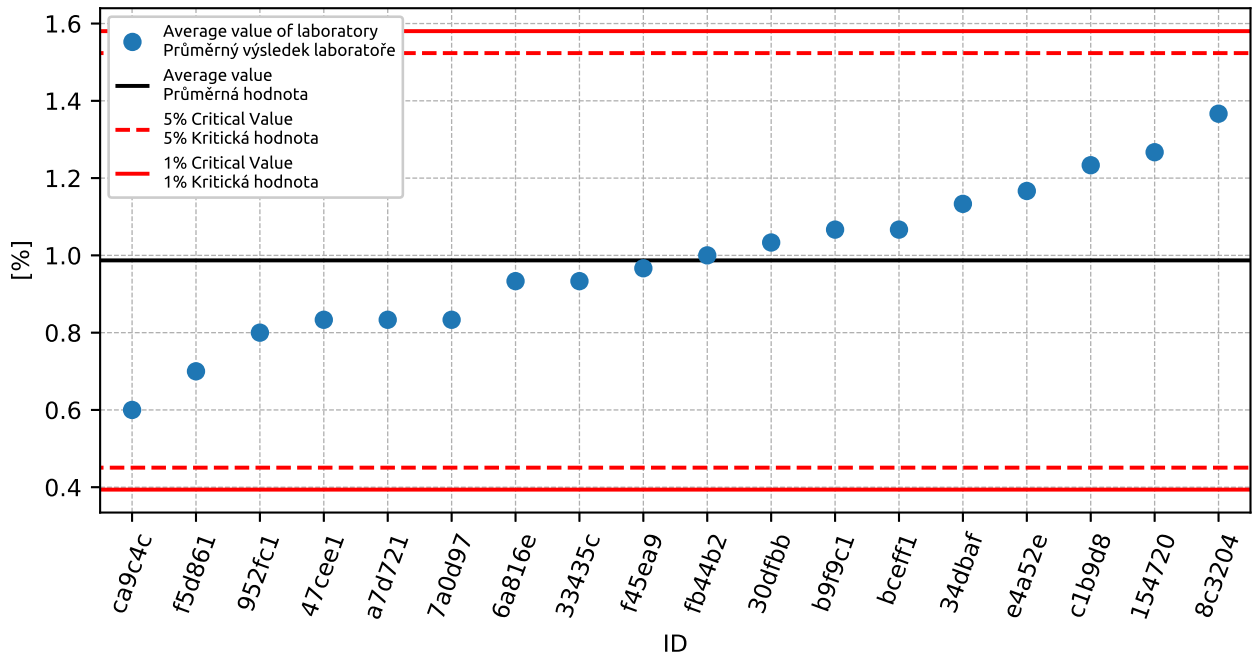

Figure 163: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

12.2.3 Mandel's Statistics

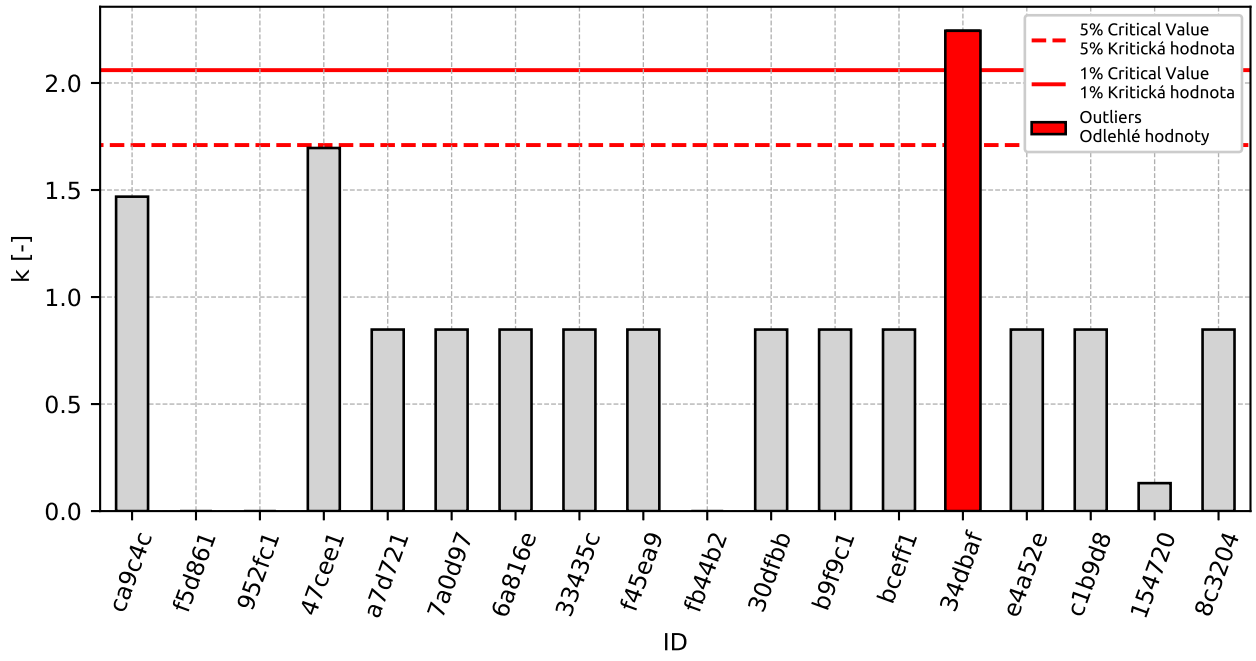

Figure 164: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

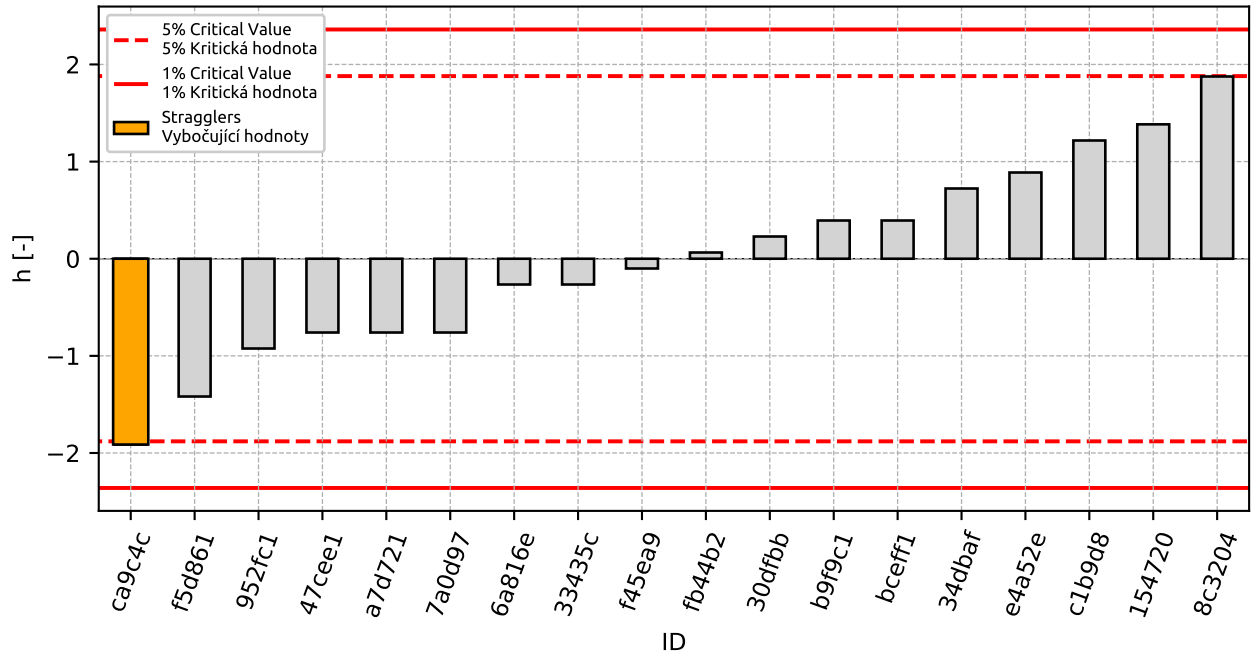

Figure 165: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

12.2.4 Descriptive statistics

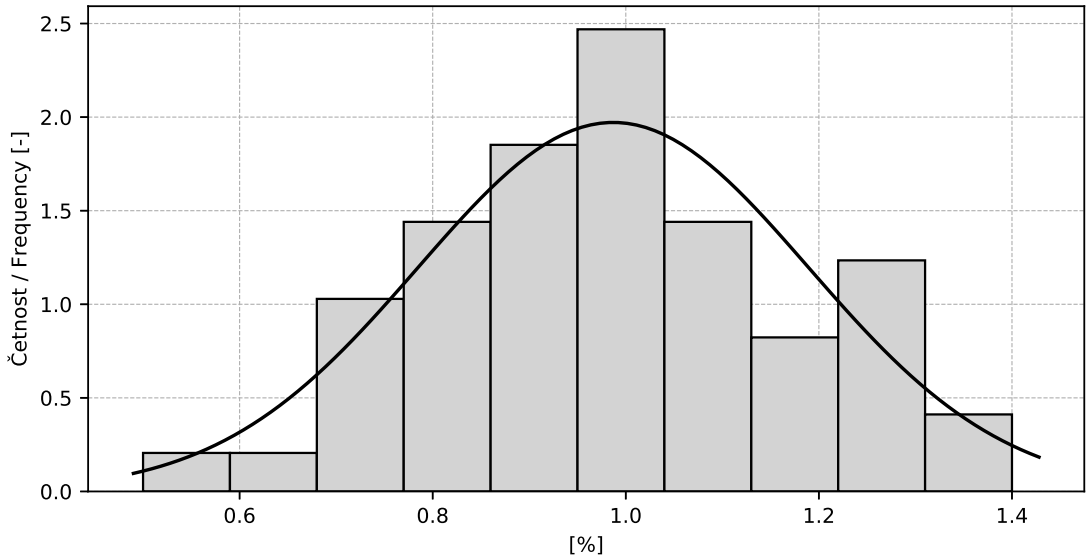

Figure 166: Histogram

Table 57: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	1.0
Výběrová směrodatná odchylka / Sample standard deviation – s	0.2
Vztažná hodnota / Asigned value – x^*	1.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.22
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.06
p-hodnota testu normality / p-value of normality test	0.829 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.2
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.07
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.21
Opakovatelnost / Repeatability – r	0.2
Reprodukovatelnost / Reproducibility – R	0.6

12.2.5 Calculation of Performance Statistics

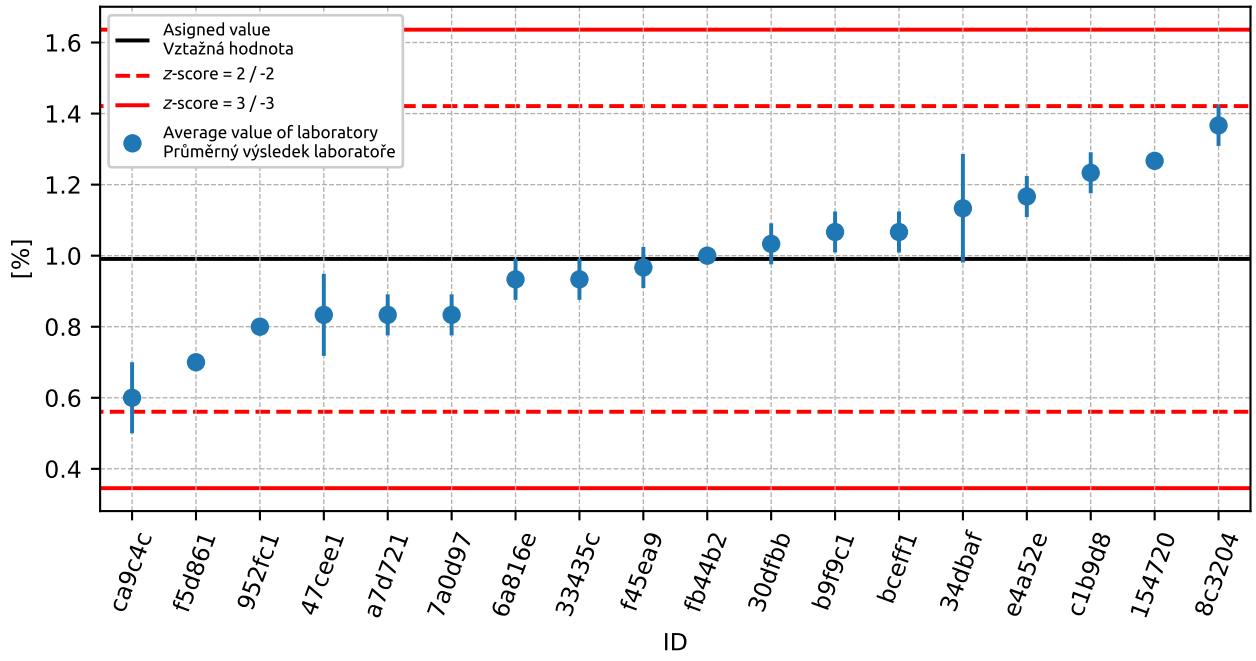

Figure 167: Average values and sample standard deviations

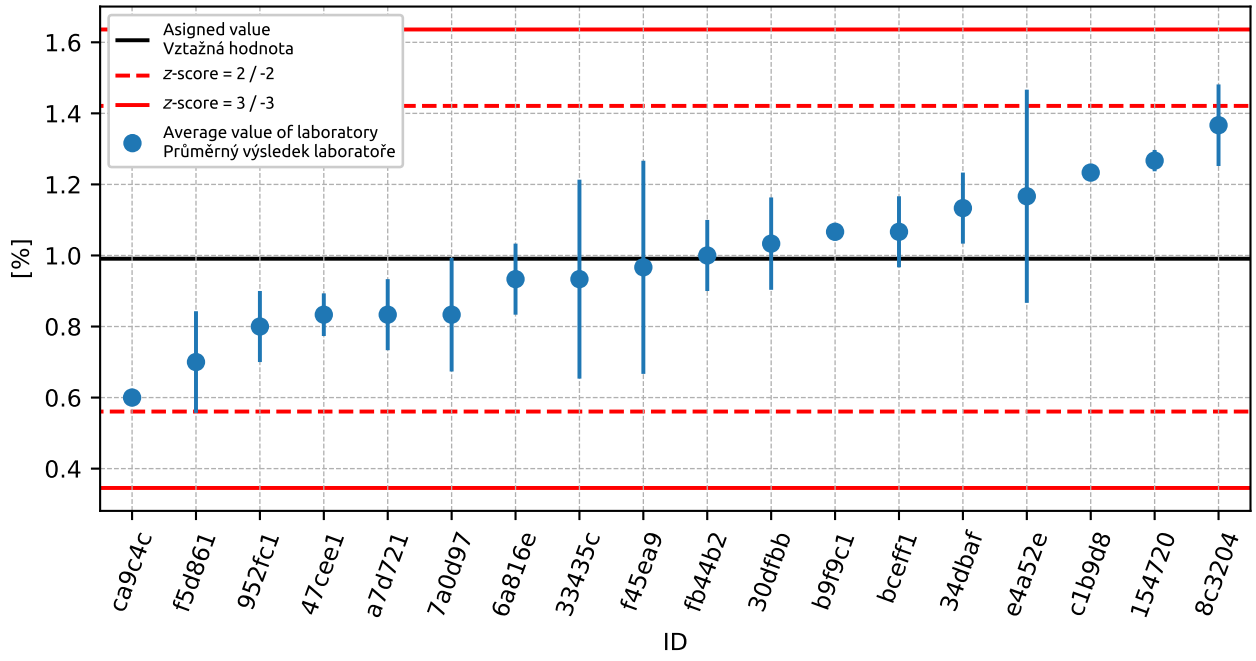

Figure 168: Average values and extended uncertainties of measurement

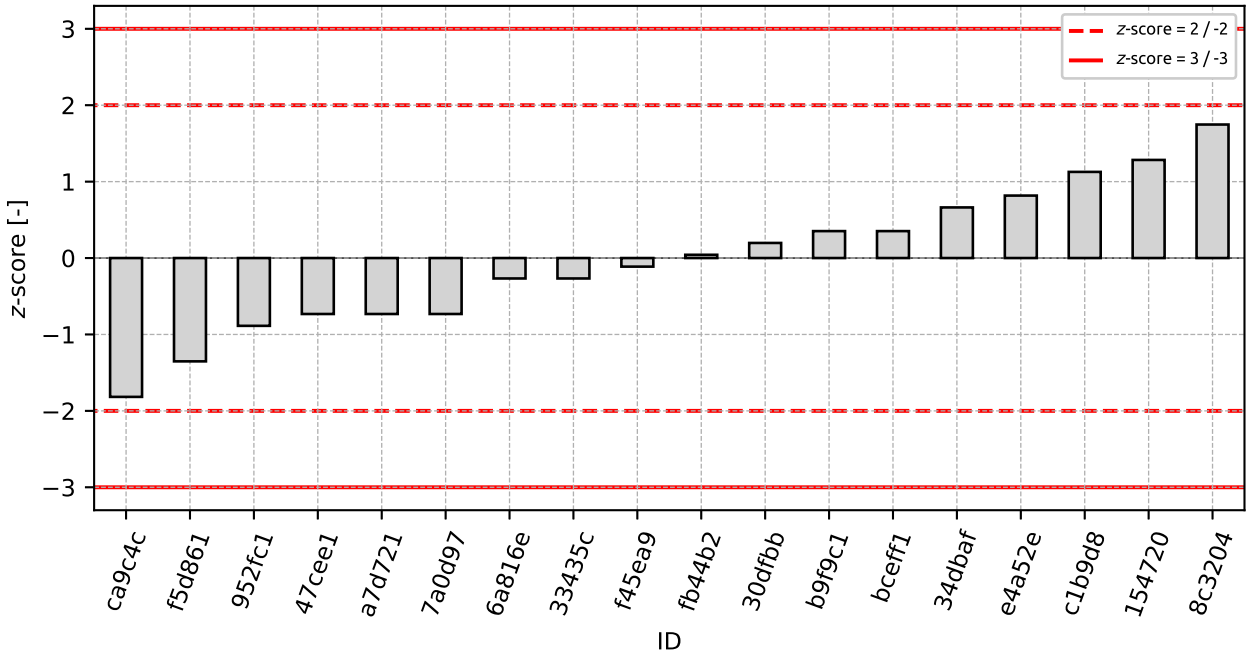

Figure 169: z-score

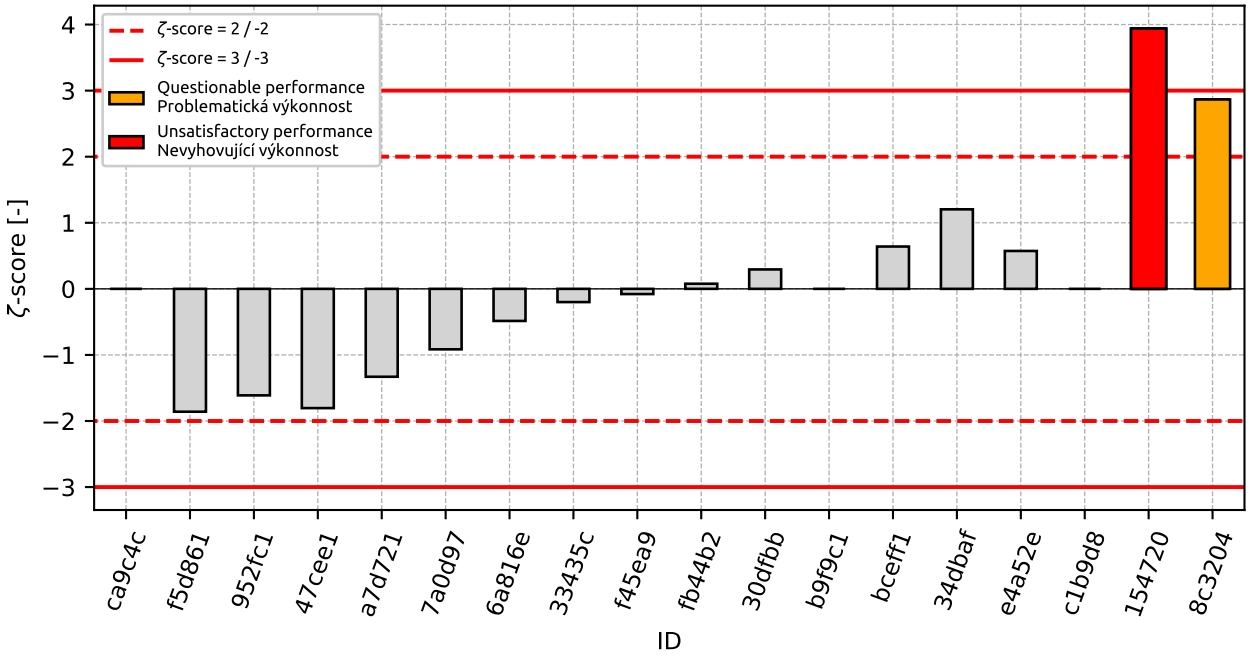

Figure 170: ζ-score

Table 58: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
ca9c4c	-1.82	-
f5d861	-1.35	-1.86
952fc1	-0.89	-1.61
47cee1	-0.73	-1.8
a7d721	-0.73	-1.33
7a0d97	-0.73	-0.92
6a816e	-0.27	-0.49
33435c	-0.27	-0.2
f45ea9	-0.11	-0.08
fb44b2	0.04	0.08
30dfbb	0.2	0.29
b9f9c1	0.35	-
bceff1	0.35	0.64
34dbaf	0.66	1.2
e4a52e	0.82	0.57
c1b9d8	1.13	-
154720	1.28	3.94
8c3204	1.75	2.87

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

This part of PT program was not open due to the lack of participants.

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

14.1 Test results

Table 59: Test results - ordered by average value. Outliers colored in red. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
f5d861	0.4	0.5	0.4	0.0	0.4	0.06	13.32
7a0d97	0.5	0.7	0.5	0.0	0.6	0.12	20.38
7e5d0a	1.2	0.9	1.0	0.0	1.0	0.15	14.78
34dbaf	1.1	1.2	-	0.1	1.2	0.07	6.15
d08d8d	1.3	1.4	1.3	0.0	1.3	0.06	4.33

14.2 The Numerical Procedure for Determining Outliers

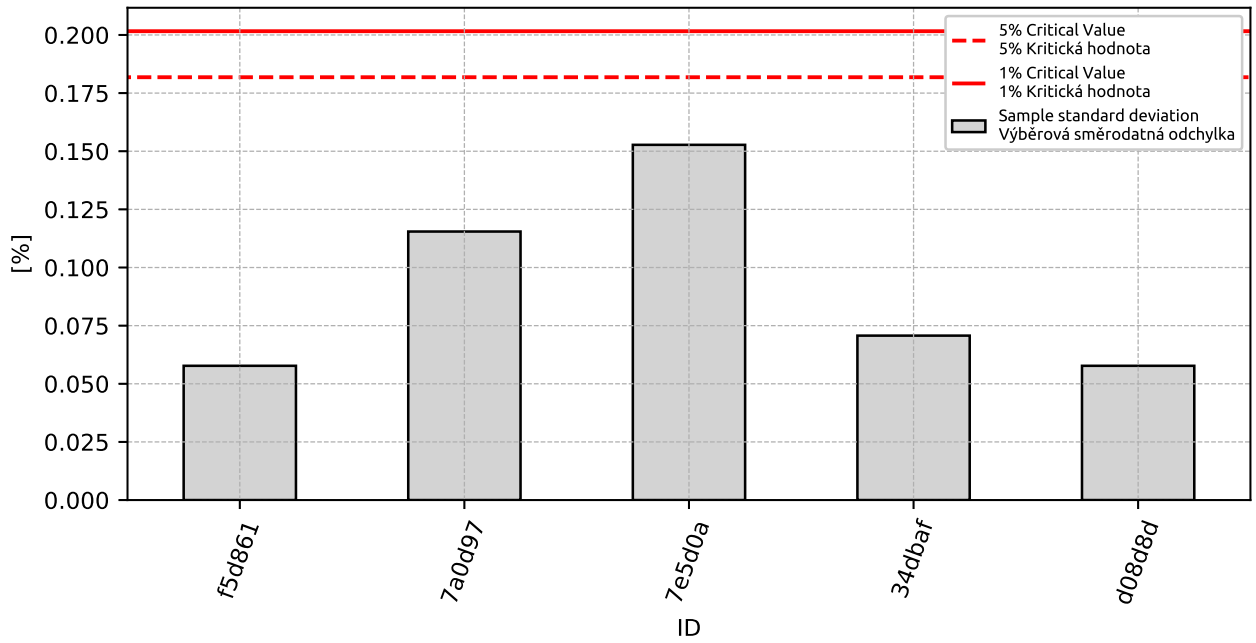

Figure 171: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

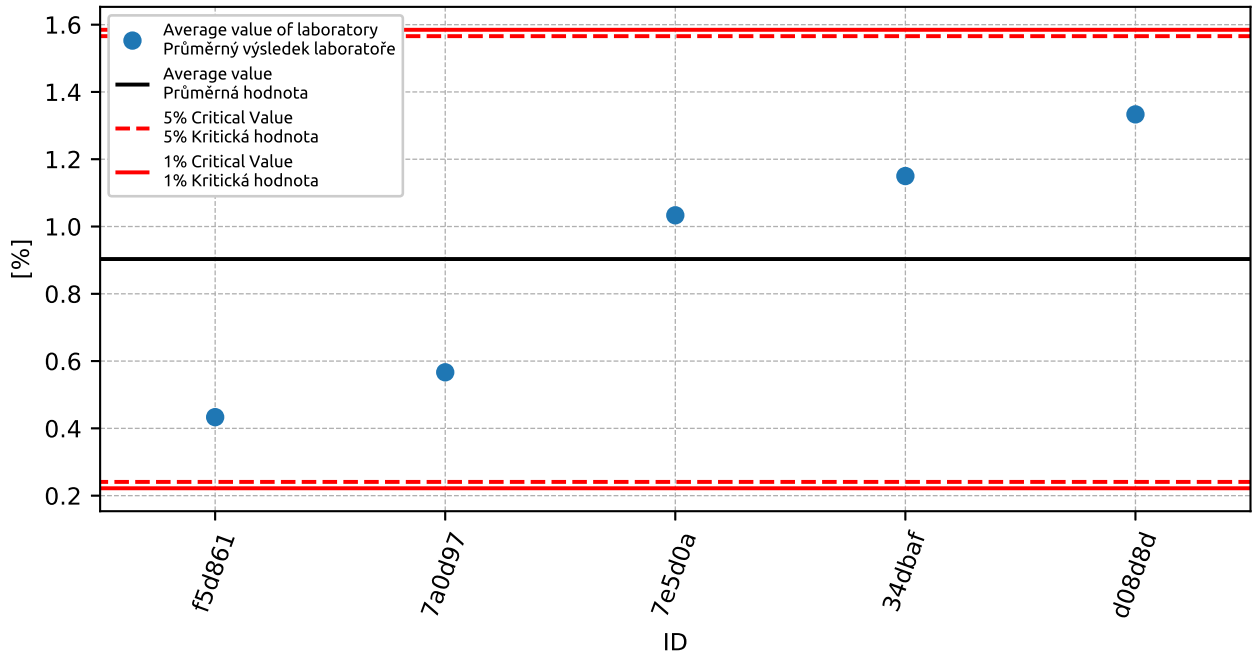

Figure 172: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

14.3 Mandel's Statistics

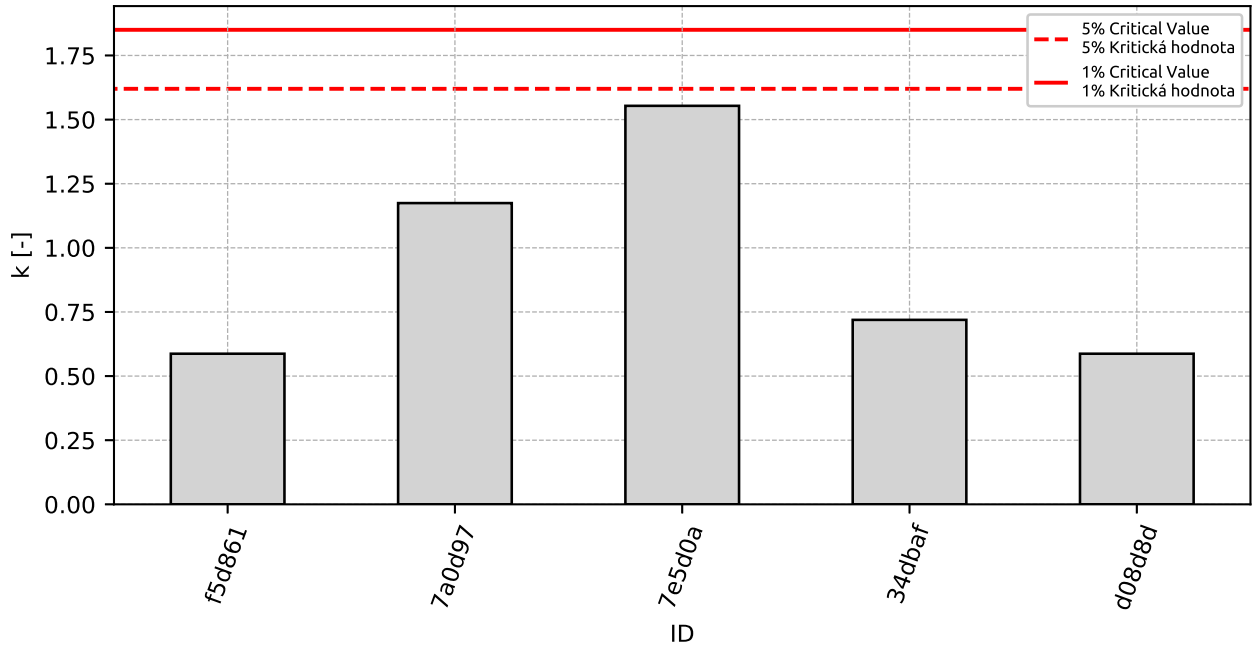

Figure 173: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color

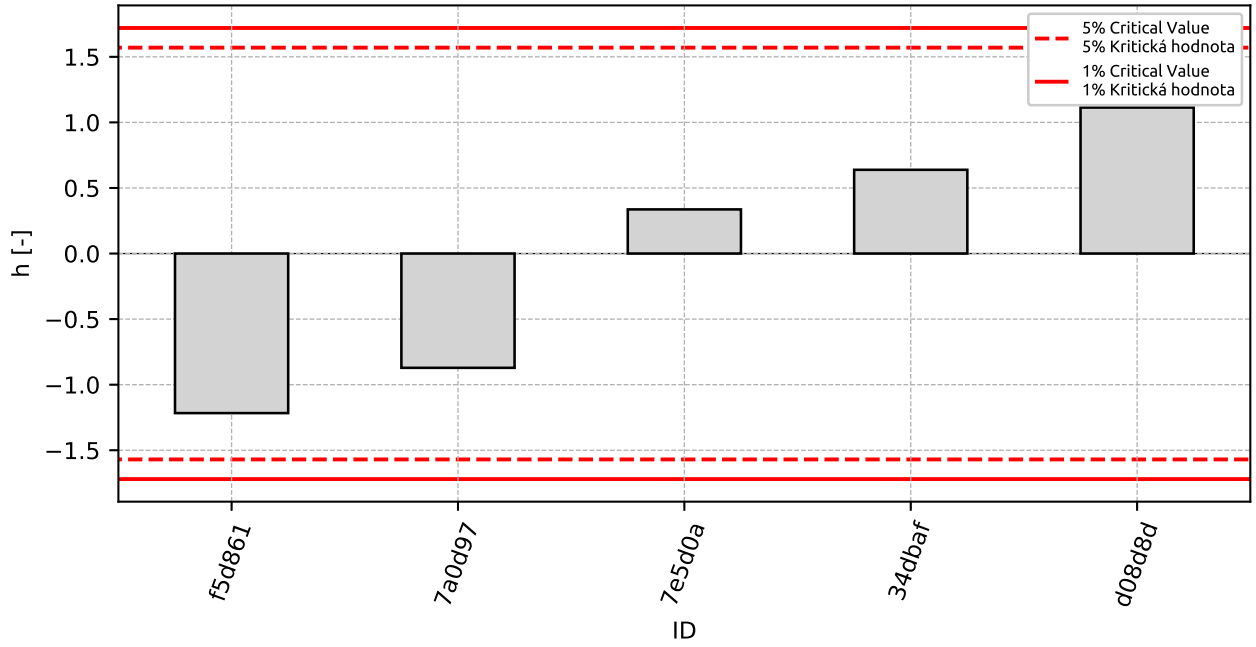

Figure 174: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

14.4 Descriptive statistics

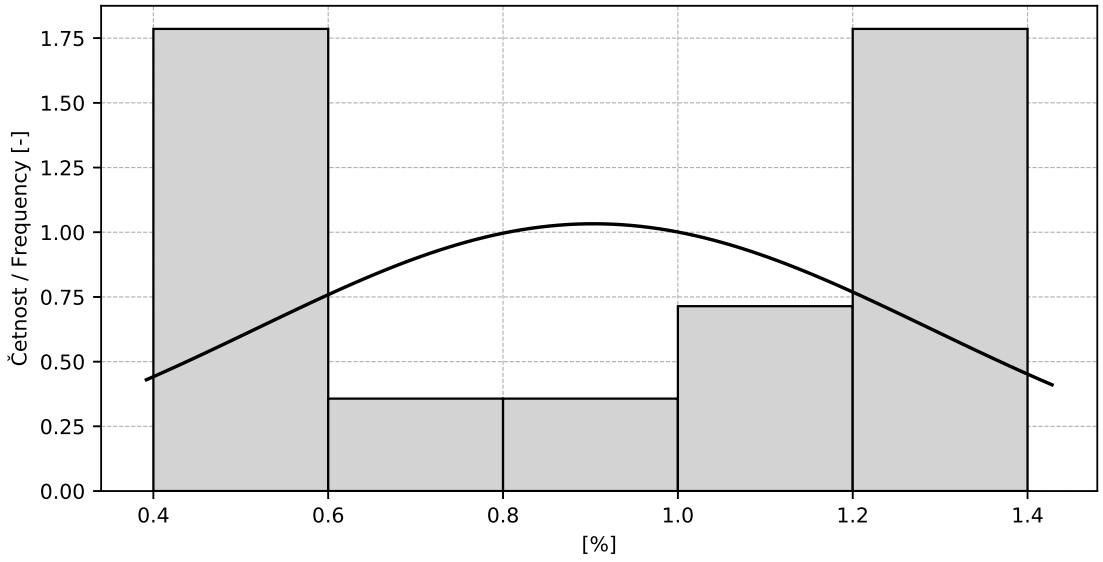

Figure 175: Histogram

Table 60: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	0.9
Výběrová směrodatná odchylka / Sample standard deviation – s	0.39
Vztažná hodnota / Asigned value – x^*	0.9
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.39
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.22
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.38
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.1
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.39
Opakovatelnost / Repeatability – r	0.3
Reprodukovatelnost / Reproducibility – R	1.1

14.5 Calculation of Performance Statistics

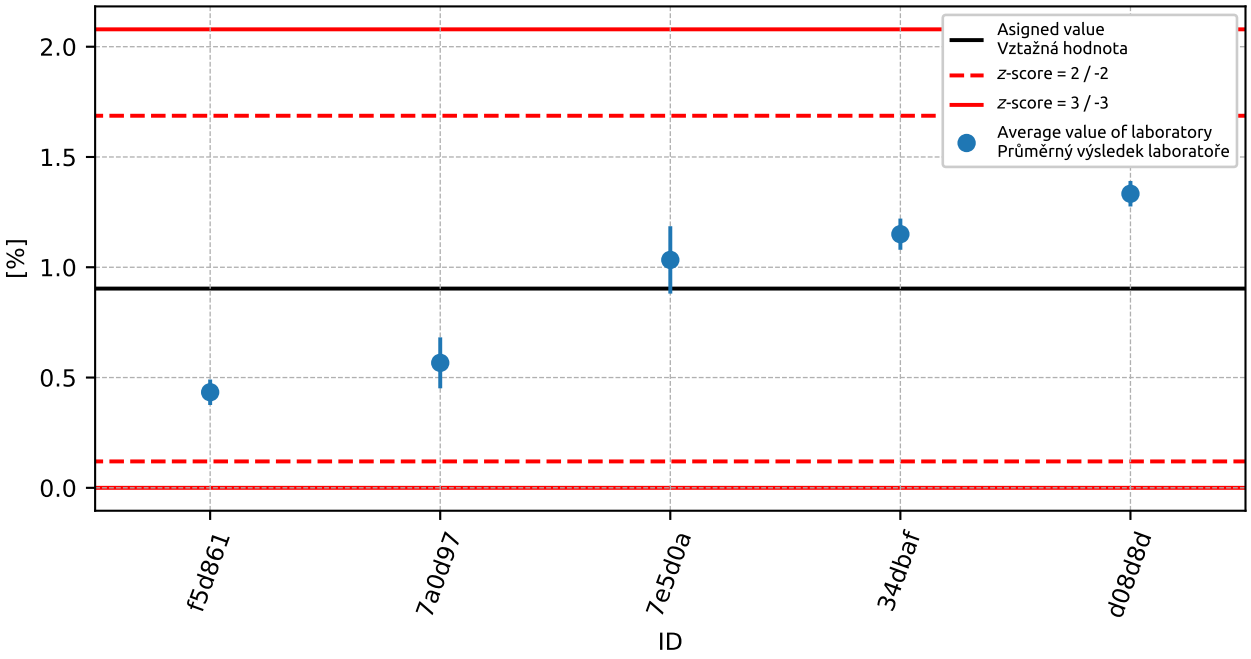

Figure 176: Average values and sample standard deviations

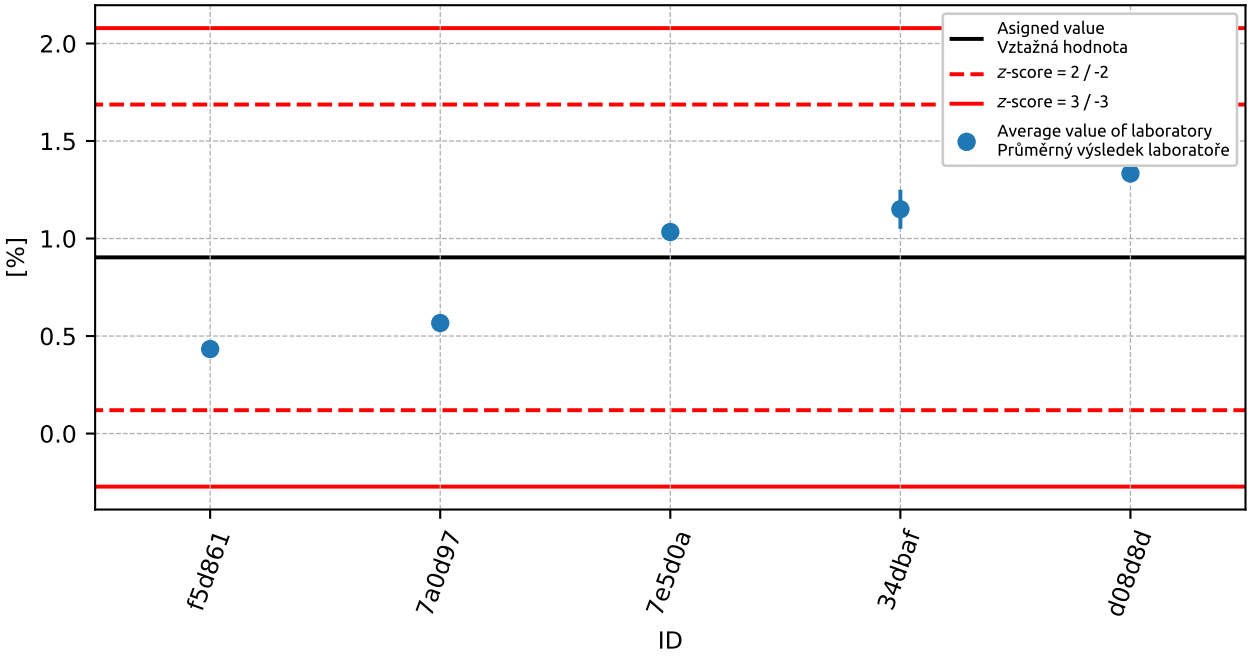

Figure 177: Average values and extended uncertainties of measurement

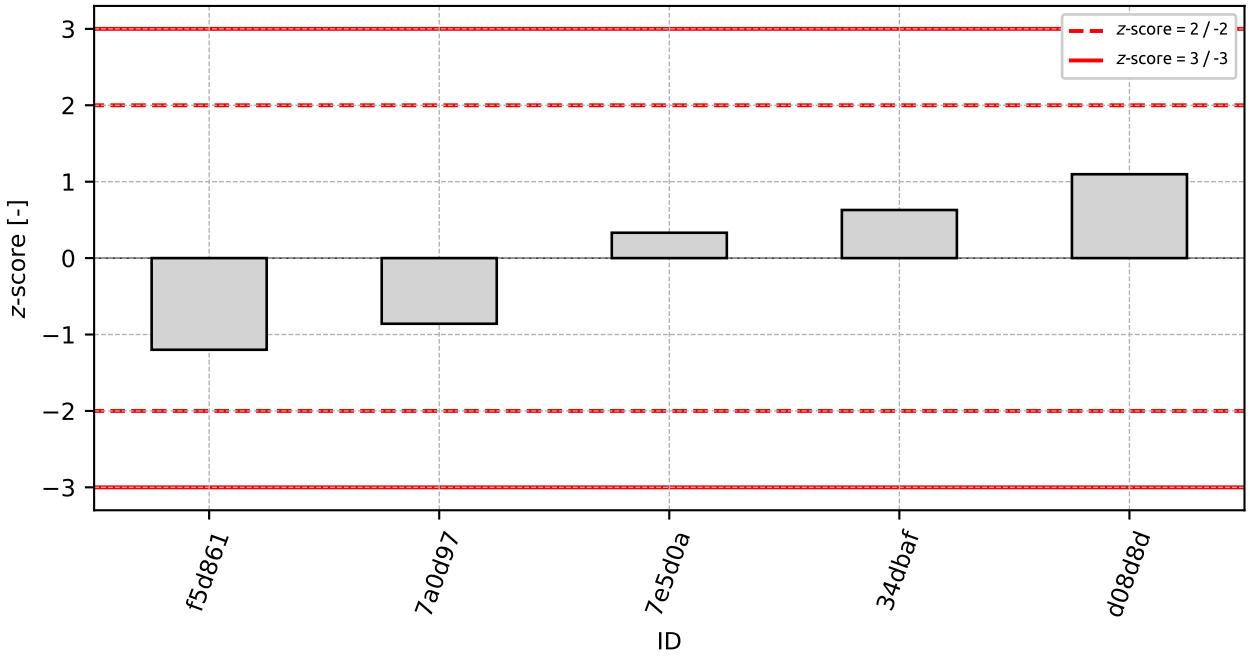

Figure 178: z-score

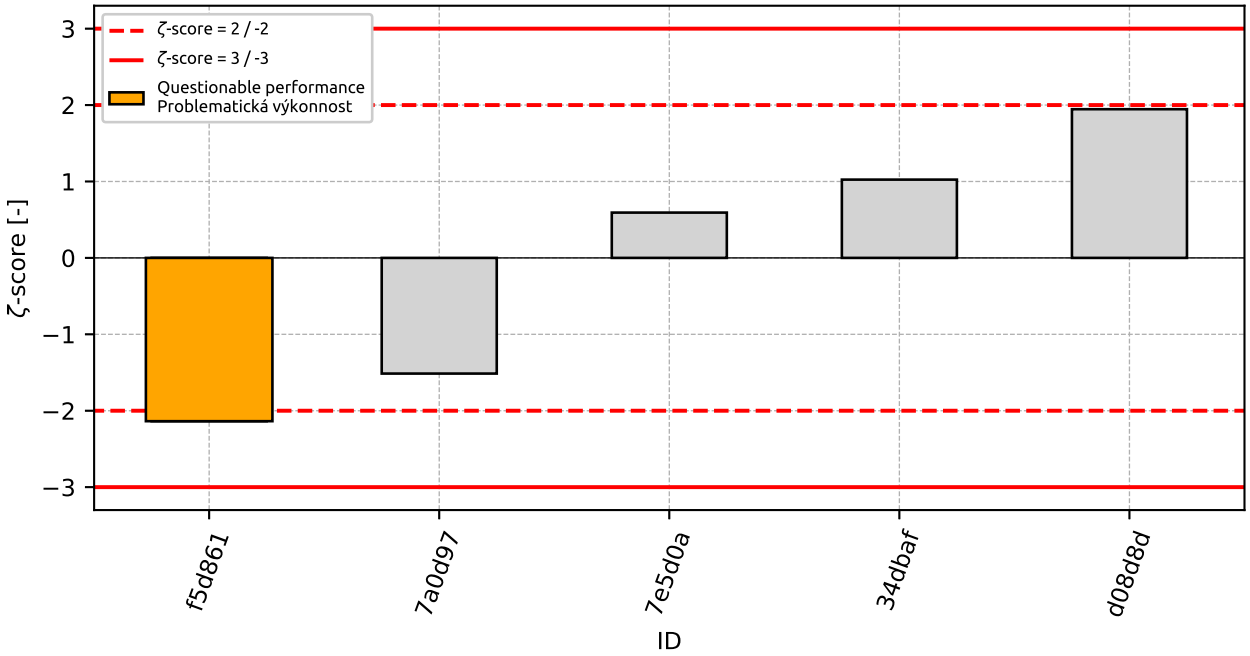

Figure 179: ζ-score

Table 61: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f5d861	-1.2	-2.14
7a0d97	-0.86	-1.51
7e5d0a	0.33	0.59
34dbaf	0.63	1.02
d08d8d	1.1	1.95

15 Appendix – EN 1367-2 Magnesium sulfate test

This part of PT program was not open due to the lack of participants.

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

This part of PT program was not open due to the lack of participants.

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

This part of PT program was not open due to the lack of participants.

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

This part of PT program was not open due to the lack of participants.