FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program
Aggregate Testing
ZK 2021/1

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

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

Date: 7/12/2021

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

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

Poskytovatel zkoušení
způsobilosti při SZK FAST

Proficiency testing
provider at the SZK FAST

Z 7008

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1   Introduction and Important Contacts

At the beginning of 2021, the Proficiency Testing Provider at SZK FAST (PoZZ) launched a Proficiency Testing Programme (PrZZ), designated ZK 2021/1, to verify and assess the consistency of aggregate test results. The assessment of the results of the proficiency testing programme was carried out by a committee consisting of the following PT Provider employees:

Head of the PT Provider, PTP coordinator

Assoc. Prof. Tomáš Vymazal, Ph.D.
Brno University of Technology
Faculty of Civil Engineering
Institute of Building Testing
Veveří 95, Brno 602 00
Czech Republic
Tel.: +420 603 313 337
Email: Tomas.Vymazal@vutbr.cz

Coordinator of PTP result assessment PTP

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

Test procedures 6, 9, 13, 16, 17 and 18 were not opened due to low interest of participants.
The supplier, BETOTECH s. r. o. (L 1195.3), was responsible for the preparation of testing samples for the PTP. The supplier is responsible for homogeneity and stability of testing samples.
The test results from individual PTP participants were compared via a method involving the statistical analysis of all their results in a manner complying with ISO 5725-2 [18] and with EN ISO/IEC 17043 [19]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

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71　laboratories took part in PTP. In order to maintain the anonymity of the PTP, each laboratory was given an identification number that will be used henceforth in this document. An integral part of the present final report is a Certificate of Participation in the Proficiency Testing Program. It is unique for each participant and includes the participant's ID used in this report. The following chart shows the participation of laboratories in individual parts of the PTP.

Table 1: Participation of individual laboratories in the PTP

ID/Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
a9484b	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
71fb49	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dcda09	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ec36d	-	-	X	X	X	-	-	X	-	-	X	X	-	-	-	-	-	-
247115	X	-	-	X	-	-	X	X	-	-	X	-	-	-	-	-	-	-
d96fe0	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
74e3c7	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
dcea97	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
6ca7c3	X	X	-	-	X	-	X	X	-	X	X	X	-	-	X	-	-	-
e18dad	X	-	X	-	-	-	-	X	-	-	X	-	-	X	-	-	-	-
4df05e	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
cbe732	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
9f9c67	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
4c0b2c	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8f35ba	X	-	X	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-
4abbcf	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-
de1e0d	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
508ab0	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
9abd02	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
a8aad4	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1198ac	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
218cd3	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
f47f78	X	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
ba0a1f	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
ca615b	X	X	X	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-
dbc3dc	X	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-
9b2ff8	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d706f9	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
c4690c	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
346a9a	X	X	-	-	X	-	-	X	-	-	-	X	-	-	-	-	-	-
9f937c	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
391ed0	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
4154b9	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
f4266e	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8d38c9	-	-	-	X	-	-	-	-	-	X	-	-	-	-	X	-	-	-
6d5a2f	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
57b998	-	-	-	-	-	-	X	X	-	-	-	-	-	-	X	-	-	-
2f9590	X	-	X	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-
72f43c	X	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-

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0a41a5	X	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-
4c84bf	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
f2feb9	X	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-
e39b2d	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
222b47	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-
8f40d2	X	X	X	-	-	-	X	X	-	X	-	X	-	-	X	-	-	-
d76b2a	-	-	-	-	-	-	X	-	-	-	-	-	-	X	X	-	-	-
6498ce	X	-	X	X	X	-	-	X	-	-	X	X	-	-	-	-	-	-
51d2e0	X	X	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
51ba4e	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
8616aa	-	-	-	-	-	-	-	-	-	X	X	-	-	-	X	-	-	-
777f0c	X	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-
6edfa7	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
d5e66f	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
eb640d	X	X	X	-	-	-	X	X	-	X	X	-	-	X	X	-	-	-
5aa151	X	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
697684	X	X	-	-	X	-	-	-	-	-	X	X	-	-	-	-	-	-
81a267	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
1c4a01	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
67e95f	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
f1932b	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
9e8f89	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
fd0c72	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21dd1e	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
bd4465	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
e24a24	-	X	-	-	X	-	X	X	-	-	-	X	-	-	X	-	-	-
549a2c	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4a9f9e	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
4febe7	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-
88377f	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
becddb	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
619869	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-

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

Laboratory	Address	Accreditation number
4G consite s.r.o.	Šlikova 406/29, Praha 6, 16900, Česká republika	1518
ARP GmbH	Johann-Sackl-Gasse 65-67, Leoben, 8700, Austria	A 0125
B-PROJEKTY Teplice s.r.o.	Kollárova 1879/11, Teplice, 415 01, Česká republika	AZL 1428
BETOTECH, s.r.o. - pracoviště Beroun	Beroun 660, Beroun, 26601, Česká republika	AZL 1195
BETOTECH, s.r.o. - pracoviště Brno	Beroun 660, Beroun, 26601, Česká republika	1195.3
BETOTECH, s.r.o. - pracoviště Jindřichův Hradec	Beroun 660, Beroun, 26601, Česká republika	AZL 1195
BETOTECH, s.r.o. - pracoviště Most	Beroun 660, Beroun, 26601, Česká republika	AZL 1195
BETOTECH, s.r.o. - pracoviště Ostrava	Beroun 660, 26601 Beroun, Ostrava, 70300, Česká republika	1195.2
BETOTECH, s.r.o. - pracoviště Trutnov	Beroun 660, Beroun, 26601, Česká republika	AZL 1195
BHP Laboratories Limited	New Road Thomondgate, Limerick, V94P9X4, Ireland	INAB Red No. 5T
Bechtel ENKA UK Limited Ogranak Beograd	Jasicki put 52 đ, Kruševac, 37000, Serbia	-
Betototech s.r.o.	Beroun 660, Beroun, 266 01, Česká republika	1195.3
BetónRacio s.r.o., Skúšobné laboratórium, Pracovisko Trnava	Skladová 2, Trnava, 917 01, Slovensko	S-320
BetónRacio, s.r.o., Skúšobné laboratórium, Pracovisko Veľký Šariš	Skladová 2, Trnava, 917 00, Slovenská republika	S-320
C.S.R. SRL CENTRO SVILUPPO E RICERCHE	Via Mestrina 46x, Noale, 30033, Italia	1000
CEMEX Czech Republic, s.r.o.	Semtín 102, Pardubice, 53354, Česká republika	1302
CRH (Slovensko) a. s., 906 38 Rohožník	CRH (Slovensko) a. s., Technicko - kompetenčné centrum, Pestovateľská 2, Bratislava, 821 04, Slovenská republika	426/S-313
CSS d.o.o.	Savska cesta 144a, Zagreb, 10000, CROATIA	HR1106
DSP a.s.	Kostěnice 111, Kostěnice, 530 02, Česká republika	-
DTQ d.o.o. Sarajevo	Stjepana Tomića 3, Sarajevo, 71000, BIH	LI-64-01
Ferriere Nord S.p.A.	Zona Industriale Rivoli di Osoppo, Osoppo (Udine), 33010, Italy	-

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Laboratory	Address	Accreditation number
GEO-TOPICS	Chemin des Maréchaux, 36, Wavre, 1300, Belgium	-
GEOTEST S.A.	6th km Ioanninon - Athinon, IOANNINA, 45500, EPIRUS	-
GEOtest, a.s.	Šmahova 1244/112, Brno, 62700, Česká republika	1271.2
Geotec-GS, a.s.	Chmelová 2920/6, Praha 10, 10600, Česká republika	1514
Gradjevinsko-arhitektonski fakultet Univerziteta u Nišu	Aleksandra Medvedeva 14, Niš, 18000, Serbia	01-202
Graz University of Technology	Rechbauerstraße 12/I, Graz, 8010, Austria	-
Holcim (Hrvatska) d.o.o.	Koromačno 7b, Koromačno, 52222, Hrvatska	1528
LABORATOIRE DES TRAVAUX PUBLICS DU SUD	Zone des activités Bouhraoua- PB 332 GHARDAIA, GHARDAIA, 47000, Algérie	-
Laboratoire Central des Travaux Publics - LCTP HUSSEIN DEY	1. rue Kaddour RAHIM- HUSSEIN DEY, ALGER, 16005, ALGERIE	-
Laboratoire Central des Travaux Publics - LCTP HUSSEIN DEY	1. rue Kaddour RAHIM- HUSSEIN DEY, ALGER, 16005, ALGERIE	-
Laboratoire Central des Travaux Publics- Unité de BOUIRA-LCTP	1. rue Kaddour RAHIM- HUSSEIN DEY, ALGER, 16005, ALGERIE	-
Laboratoire des Travaux Publics de l'Ouest LTP-Ouest	Rond point des Castors, Oran, 31000, ALGERIA	-
Laboratorija Koridori Srbije - Koridori Srbije d.o.o , Beograd, Kralja Petra 21	Kralja Petra 21, Beograd, 11000, Srbija	-
Lafage Cement, a.s.	Lafarge Cement a.s., Čížkovice čp. 27, 41112, Česká republika	1426
M.T.S. Limited	19 Kernanstown Industrial Estate, Carlow, R93 PY67, Ireland	-
Mediterranean float glass SPA	29, route de Meftah Larbaa, blida, 09300, Algeria	-
PUDIS a.s.	Podbabská 1014/20, Praha 6, 160 00, Česká republika	1762
Problematika	Granito street 3, Vilnius, LT-02241, Lithuania	-
QUALIFORM SLOVAKIA s.r.o.	Pasienková 9 D, Bratislava, 821 06, Slovensko	154/S-301
Romanian Railway Authority - AFER	393 Grivitei Way, Bucharest, sector 1, Romania (Calea Griviţei 393, Bucureşti, sector 1, România), Bucharest, sector 1, 010719, Romania	1183
S.C. GEOSTUD S.R.L.	Str. Sîngerului, nr. 11, sector 1, Bucharest, 014617, Romania	LI 974
SG Geotechnika a.s.	Geologická 988/4, Praha 5 - Hlubočepy, 152 00, Česká republika	1119

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Laboratory	Address	Accreditation number
SIBOTEC CVBA	Industriepark Oost 6 8730 Beernem, Beernem, 8730, West - Vlaanderen	BELAC 637-TEST
Structural Soils Ltd	Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR, England	1774
T.E.C. Translab Environmental Consult nv	OEVERSTRAAT 21, LOKEREN, 9160, BELGIUM	-
TEPVERAM s.r.o.	Třibřichy 13, Třibřichy, 53701, Česká republika	1759
THE HIGHWAY INSTITUTE, JOINT STOCK COMPANY, BELGRADE	45 Bulevar Peka Dapcevica, Belgrade, 11010, Serbia	nan
TPA EOOD CTC BURGAS	Rezbarska str. № 7, Sofia, 1510, Bulgaria	-
TPA EOOD CTC SOFIA	Rezbarska str. №7, Sofia, 1510, Bulgaria	-
TPA za obezbeđenje kvaliteta i inovacije d.o.o. Beograd	Milutina Milankovića 3B, Novi Beograd, 11070, Serbia	01-280
Technický a skúšobný stavebný, n.o. (SP BA)	Studená 3, Bratislava, 821 04, Slovenská republika	S-045
Technický a skúšobný stavebný, n.o. (SP KE)	Studená 3, Bratislava, 821 04, Česká republika	S-045
Technický a skúšobný stavebný, n.o. (SP NM)	Studená 3, Bratislava, 821 04, Česká republika	S-045
Technický a skúšobný stavebný, n.o. (SP NR)	Studená 3, Bratislava, 821 04, Česká republika	S-045
Technický a skúšobný stavebný, n.o. (SP PO)	Studená 3, Bratislava, 821 04, Česká republika	S-045
Technický a skúšobný stavebný, n.o. (SP ZV)	Studená 3, Bratislava, 821 04, Česká republika	S-045
Technický a zkušební ústav stavební Praha s.p., pobočka 0700-Ostrava	U Studia 14, Ostrava- Zábřeh, 700 30, Česká republika	1018.3
Technický a zkušební ústav stavební Praha, s.p.	Tolstého 447, Teplice, 41503, Česká republika	1018.3
Technický a zkušební ústav stavební Praha, s.p. se sídlem Prosecká 811/76a, Prosek, 190 00 Praha 9	Technický a zkušební ústav stavební Praha, s.p., Pobočka Plzeň, Zahradní 15, Plzeň, 326 00, Česká republika	1018.3
UAB LABORATORINIU BANDYMU CENTRAS	R. KALANTOS G. 85A, KAUNAS, LT-52310, LITHUANIA	LA.01.002
UAB Testlita	Sodų g. 14, Vilnius, LT-01313, Lithuania	LA.01.013
VIALAB CZ s.r.o., Laboratoř Čechy západ, pracoviště Plzeň Letkov	Národní 138/10, Praha 1, 110 00, Česká republika	1524
VIALAB CZ s.r.o., Laboratoř Čechy západ, pracoviště Sedlec	Národní 138/10, Praha 1, 110 00, Česká republika	1524
VIALAB CZ s.r.o., Laboratoř Čechy západ, pracoviště České Budějovice	Národní 138/10, Praha 1, 110 00, Česká republika	1524
Zkušebna kamene a kameniva, s.r.o.	Husova 2274, Hořice, 508 01, Česká republika	1046
i2 Analytical LTD Sp. z o.o. Oddział w Polsce	ul. Pionierów 39, Ruda Śląska, 41-711, Poland	-

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Laboratory	Address	Accreditation number
iTER solutions	Rue du Tronquoy, 24, Fernelmont, 5380, Belgique	BELAC 422-TEST
Ústav stavebního zkušebnictví s.r.o.	Jiřího Potůčka 115, Pardubice, 53009, Česká republika	1115
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, Praha, 140 00, ČR	1734

2　Procedures used in the Statistical Analysis of Laboratory Results

The statistical analysis is based on the following steps:

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

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

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

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

5. Evaluation of the assigned value.

6. The performance evaluation: The most significant outcome of the PT Program is the so-called z-score and ζ-score (zeta-score). These characteristics assess the performance of individual participants by comparing it with the assigned value and measurement uncertainties. z-score and ζ-score are compared with limit values. The resulting ζ-score values are not taken into account during the final evaluation of the performance of participants as they are to a considerable degree dependent on the values of the measurement uncertainties of the assessed institutions. The following scales are applied for the z-score values:

   - $|z\text{-score}| < 2 \Rightarrow$ shows that the laboratory performance is **satisfactory** and generates no signal – ✓.
   - $2 \leq |z\text{-score}| < 3 \Rightarrow$ shows that the laboratory performance is **questionable** and generates an action signal – **?** .
   - $|z\text{-score}| \geq 3 \Rightarrow$ shows that the laboratory performance is **unsatisfactory** and generates an action signal – **!** .

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

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3   Conclusions of the Statistical Analysis

The present report summarizes the results of the Proficiency Testing Program ZK 2021/1 (PT Program) organized by the PT Provider at the SZK FAST. 71 participants (laboratories) took part in the PT Program. The PT program focused on ordinary standardized testing of aggregates. The test results are evaluated separately for each testing procedure examined. An evaluation of statistical characteristics is included in the Appendix, as well as test results and graphic presentations.

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

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

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

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

ID	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
dcda09	✓	✓	✓	✓	✓	✓	✓
247115	✓	✓	✓	✓	✓	✓	✓
6ca7c3	✓	✓	✓	✓	✓	✓	✓
e18dad	✓	✓	✓	✓	✓	✓	✓
4df05e	✓	✓	✓	✓	✓	✓	✓
cbe732	✓	✓	✓	✓	✓	✓	✓
9f9c67	✓	✓	✓	✓	✓	✓	✓
4c0b2c	✓	**?**	**?**	✓	✓	✓	✓
8f35ba	✓	✓	✓	✓	✓	✓	✓
de1e0d	✓	✓	✓	✓	✓	✓	✓
a8aad4	✓	✓	✓	✓	✓	✓	✓
1198ac	✓	✓	✓	✓	✓	✓	✓
218cd3	✓	✓	✓	✓	✓	✓	✓
f47f78	✓	✓	✓	✓	✓	✓	✓
ba0a1f	✓	✓	✓	✓	✓	✓	✓
ca615b	✓	✓	✓	✓	✓	✓	✓
dbc3dc	✓	✓	✓	✓	✓	✓	✓
9b2ff8	✓	✓	✓	✓	✓	✓	✓
d706f9	✓	✓	**?**	**X**	**?**	✓	✓
c4690c	✓	✓	✓	✓	✓	✓	✓
346a9a	✓	✓	**?**	✓	✓	✓	✓
9f937c	✓	✓	✓	✓	✓	✓	✓

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ID	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
4154b9	✓	✓	✓	✓	✓	✓	✓
f4266e	✓	✓	✓	✓	✓	✓	✓
2f9590	✓	✓	✓	✓	✓	✓	✓
72f43c	✓	✓	✓	✓	✓	✓	✓
0a41a5	✓	✓	✓	✓	✓	✓	✓
4c84bf	✓	✓	?	?	?	✓	✓
f2feb9	✓	✓	✓	✓	✓	✓	✓
e39b2d	✓	?	✓	✓	✓	✓	✓
8f40d2	✓	✓	✓	✓	✓	✓	✓
6498ce	✓	✓	✓	✓	✓	✓	✓
51d2e0	✓	✓	✓	✓	✓	✓	✓
777f0c	✓	✓	✓	?	?	✓	✓
d5e66f	✓	✓	✓	✓	✓	✓	✓
eb640d	✓	✓	✓	✓	✓	✓	✓
5aa151	✓	✓	✓	✓	✓	✓	✓
697684	✓	✓	✓	✓	✓	✓	✓
549a2c	✓	✓	✓	✓	✓	✓	✓
88377f	✓	✓	✓	✓	?	✓	✓
619869	✓	✓	✓	✓	✓	✓	✓

3.2 Overall Performance Evaluation

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

Table 4: Evaluation of overall performance and outliers.

✓ – satisfactory performance; ? – questionable performance; ! – unsatisfactory performance, X – outlier

ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
a9484b	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
71fb49	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dcda09	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ec36d	-	-	✓	✓	✓	-	-	✓	-	-	?	✓	-	-	-	-	-	-
247115	✓	-	-	✓	-	-	✓	✓	-	-	✓	-	-	-	-	-	-	-
d96fe0	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
74e3c7	-	-	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
dcea97	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
6ca7c3	✓	✓	-	-	?	-	✓	✓	-	✓	✓	X	-	-	✓	-	-	-
e18dad	✓	-	✓	-	-	✓	-	✓	-	-	✓	-	-	✓	-	-	-	-
4df05e	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-

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ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
cbe732	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
9f9c67	✓	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
4c0b2c	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8f35ba	✓	-	✓	-	-	-	-	-	-	✓	✓	?	-	-	-	-	-	-
4abbcf	-	-	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-	-	-
de1e0d	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
508ab0	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
9abd02	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
a8aad4	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1198ac	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
218cd3	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
f47f78	✓	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
ba0a1f	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
ca615b	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
dbc3dc	✓	-	-	✓	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
9b2ff8	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d706f9	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
c4690c	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
346a9a	✓	✓	-	-	✓	-	-	✓	-	-	-	✓	-	-	-	-	-	-
9f937c	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
391ed0	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
4154b9	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
f4266e	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8d38c9	-	-	-	✓	-	-	-	-	-	✓	-	-	-	-	✓	-	-	-
6d5a2f	-	-	-	-	-	-	-	-	-	-	✓	X	-	-	-	-	-	-
57b998	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	✓	-	-	-
2f9590	✓	-	✓	-	-	-	-	✓	-	-	-	✓	-	-	-	-	-	-
72f43c	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
0a41a5	✓	-	-	✓	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
4c84bf	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
f2feb9	✓	-	-	✓	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
e39b2d	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
222b47	-	-	-	-	-	-	-	-	-	-	✓	-	-	✓	-	-	-	-
8f40d2	✓	✓	✓	-	-	-	✓	✓	-	✓	-	✓	-	-	✓	-	-	-
d76b2a	-	-	-	-	-	-	✓	-	-	-	-	-	-	✓	✓	-	-	-
6498ce	✓	-	✓	✓	✓	-	-	✓	-	-	✓	✓	-	-	-	-	-	-
51d2e0	✓	✓	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-

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ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
51ba4e	-	-	-	-	-	-	-	-	-	-	?	-	-	-	-	-	-	-
8616aa	-	-	-	-	-	-	-	-	-	!	✓	-	-	-	✓	-	-	-
777f0c	✓	-	-	-	-	-	-	-	-	-	✓	-	-	✓	-	-	-	-
6edfa7	-	-	-	-	-	-	✓	-	-	-	-	-	-	✓	-	-	-	-
d5e66f	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
eb640d	✓	✓	✓	-	-	-	✓	✓	-	✓	✓	-	-	✓	✓	-	-	-
5aa151	✓	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
697684	✓	✓	-	-	✓	-	-	-	-	-	✓	✓	-	-	-	-	-	-
81a267	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
1c4a01	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
67e95f	-	-	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
f1932b	-	-	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
9e8f89	-	-	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
fd0c72	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21dd1e	-	-	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
bd4465	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
e24a24	-	✓	-	-	✓	-	✓	✓	-	-	-	✓	-	-	✓	-	-	-
549a2c	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4a9f9e	-	✓	-	-	-	-	-	-	-	-	?	-	-	-	-	-	-	-
4febe7	-	-	-	-	-	-	-	-	-	✓	!	-	-	-	-	-	-	-
88377f	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
becddb	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
619869	✓	-	-	-	-	-	-	-	-	-	?	-	-	-	-	-	-	-

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

1.1 4 mm

1.1.1 Test results

Table 5: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d706f9	94.0	94.0	93.0	2.0	93.7	0.58	0.62
9b2ff8	93.4	94.2	93.9	1.4	93.8	0.45	0.48
247115	94.0	94.0	94.0	5.2	94.0	0.0	0.0
6ca7c3	94.0	94.0	94.0	-	94.0	0.0	0.0
777f0c	94.0	94.0	94.0	-	94.0	0.0	0.0
6498ce	94.0	93.0	95.0	0.6	94.0	1.0	1.06
4c0b2c	94.0	94.0	94.0	4.0	94.0	0.0	0.0
9f9c67	94.3	93.7	94.2	-	94.1	0.33	0.35
ca615b	95.4	93.3	93.8	-	94.2	1.1	1.16
a8aad4	94.0	95.0	94.0	1.0	94.3	0.58	0.61
eb640d	95.0	94.0	94.0	-	94.3	0.58	0.61
9f937c	94.0	95.0	94.0	0.1	94.3	0.58	0.61
51d2e0	94.4	94.4	94.5	0.1	94.4	0.06	0.06
f4266e	94.4	94.3	94.7	3.5	94.5	0.21	0.22
d5e66f	94.5	-	-	2.0	94.5	0.0	0.0
697684	94.5	94.0	95.1	1.3	94.5	0.55	0.58
5aa151	94.4	94.3	94.9	1.2	94.5	0.32	0.34
cbe732	94.0	95.6	94.1	2.5	94.6	0.88	0.93
4154b9	94.4	94.6	94.8	3.8	94.6	0.2	0.21
72f43c	94.0	94.0	96.0	1.0	94.7	1.15	1.22
e39b2d	94.7	94.7	94.8	-	94.8	0.05	0.05
218cd3	94.5	94.5	95.3	1.0	94.8	0.46	0.49
549a2c	95.6	94.7	94.1	-	94.8	0.75	0.8
de1e0d	94.9	94.9	95.0	1.0	94.9	0.06	0.06
f2feb9	95.0	95.0	95.0	1.7	95.0	0.0	0.0
0a41a5	95.0	95.0	95.0	0.6	95.0	0.0	0.0
619869	95.0	95.0	95.0	-	95.0	0.0	0.0
e18dad	96.0	95.0	94.0	1.0	95.0	1.0	1.05
c4690c	95.0	95.0	95.0	0.7	95.0	0.0	0.0
8f40d2	95.2	95.2	95.2	1.0	95.2	0.0	0.0
8f35ba	94.1	95.3	96.3	1.0	95.2	1.1	1.16
dcda09	95.0	96.0	95.0	0.9	95.3	0.58	0.61
ba0a1f	96.0	94.0	96.0	0.1	95.3	1.15	1.21
88377f	94.9	96.1	95.2	2.9	95.4	0.62	0.65
f47f78	95.4	95.8	95.2	2.3	95.5	0.31	0.32
4df05e	95.5	95.5	95.5	2.0	95.5	0.0	0.0
dbc3dc	96.1	95.3	95.6	1.1	95.7	0.4	0.42
4c84bf	96.0	96.0	95.0	0.6	95.7	0.58	0.6
2f9590	95.9	95.8	95.9	7.7	95.9	0.06	0.06
346a9a	96.0	96.0	96.0	2.0	96.0	0.0	0.0
1198ac	95.7	96.7	95.8	0.5	96.1	0.55	0.57

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1.1.2   The Numerical Procedure for Determining Outliers
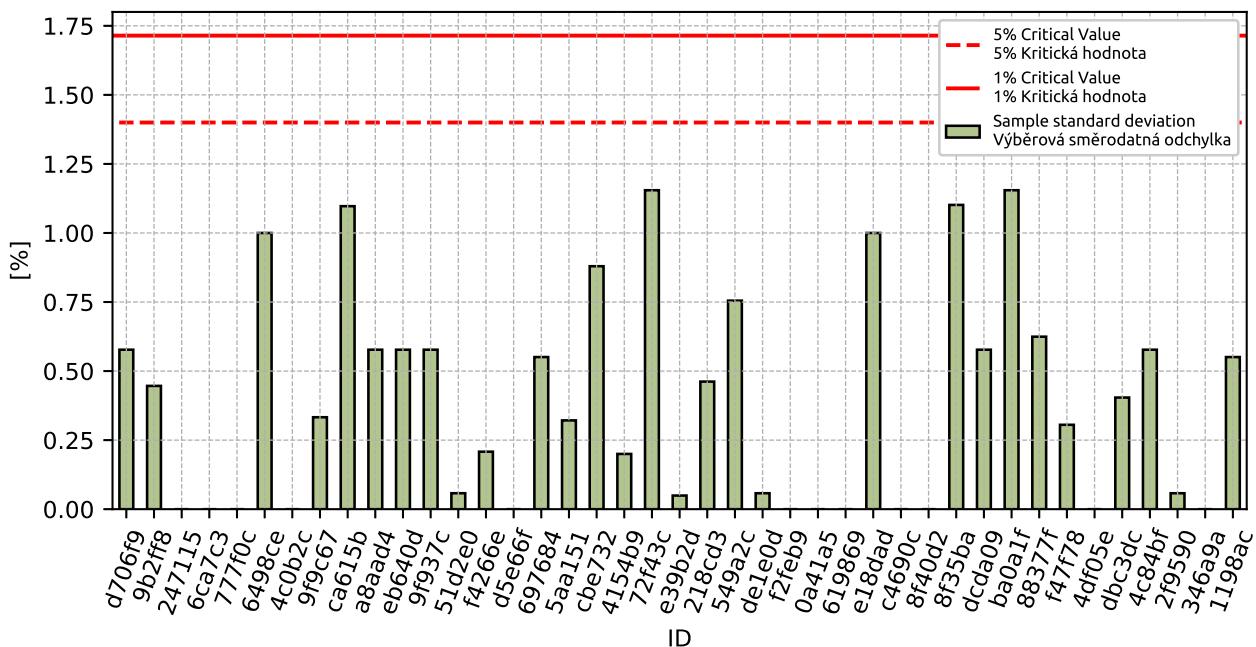


Figure 1: **Cochran's test** - sample standard deviations
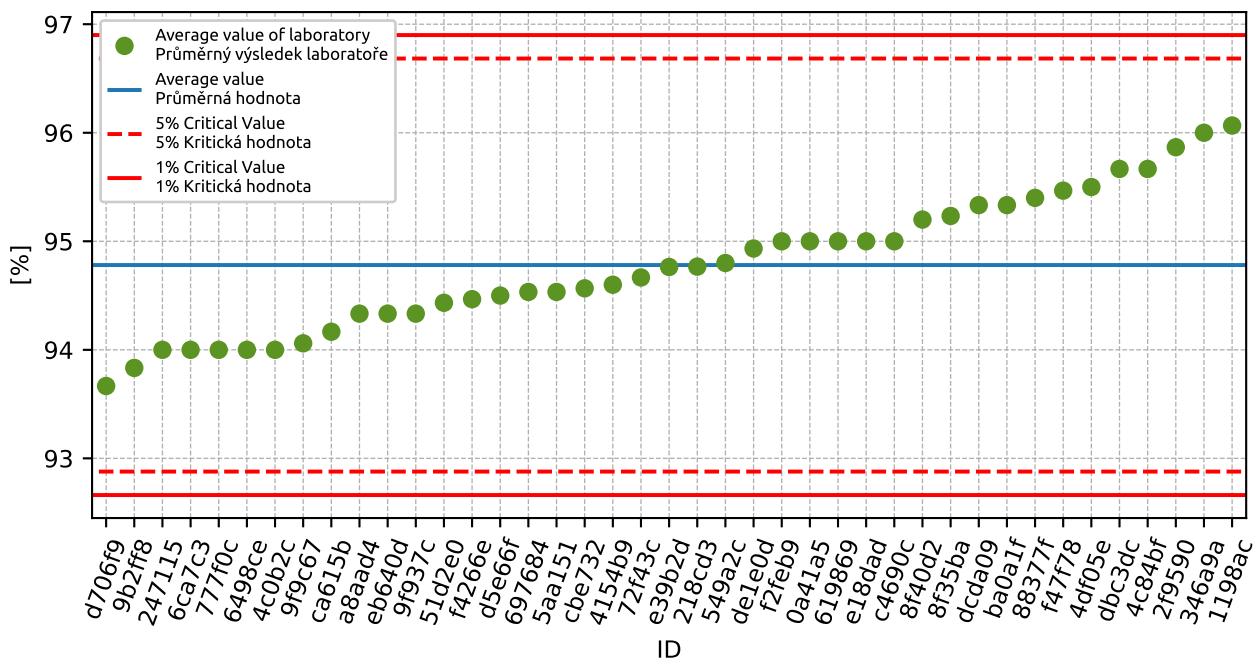

Figure 2: **Grubbs' test** - average values

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1.1.3   Mandel's Statistics
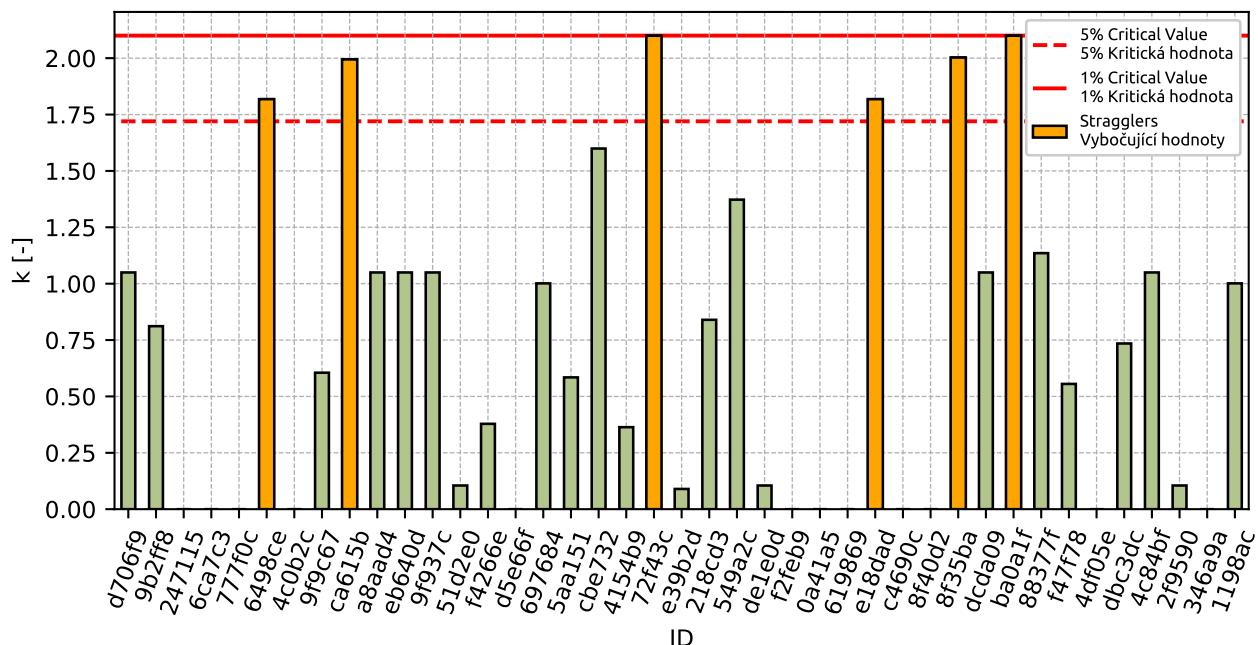
Figure 3: Intralaboratory Consistency Statistic
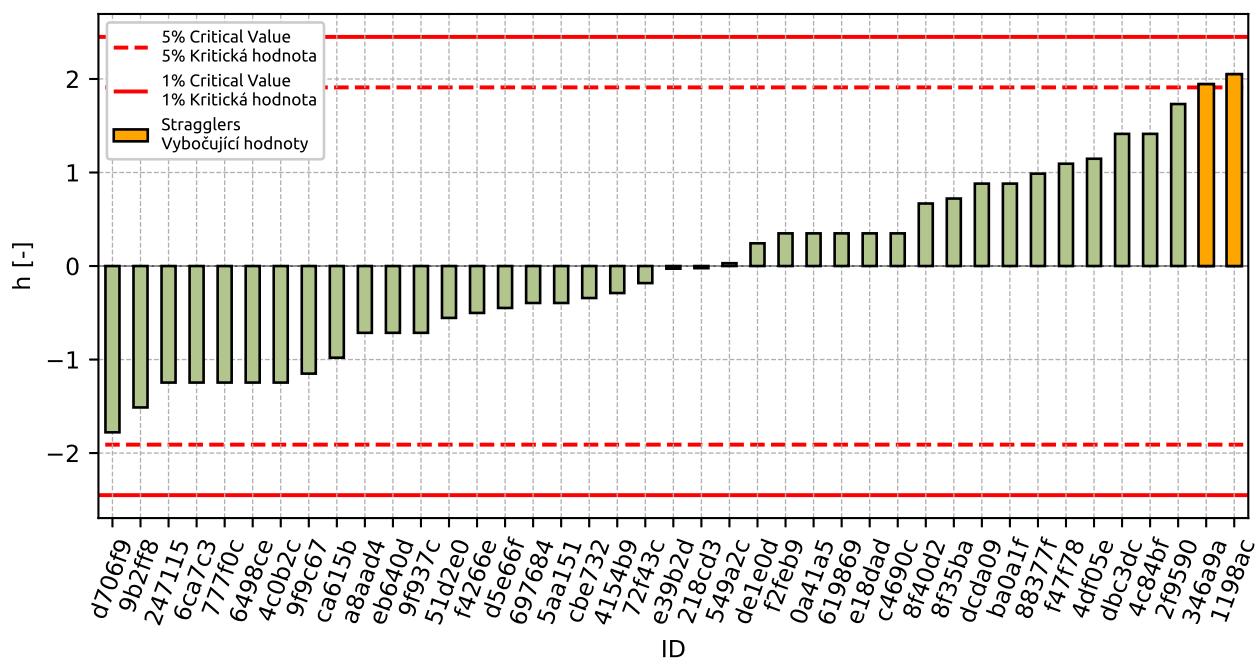
Figure 4: Interlaboratory Consistency Statistic

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1.1.4 Descriptive statistics
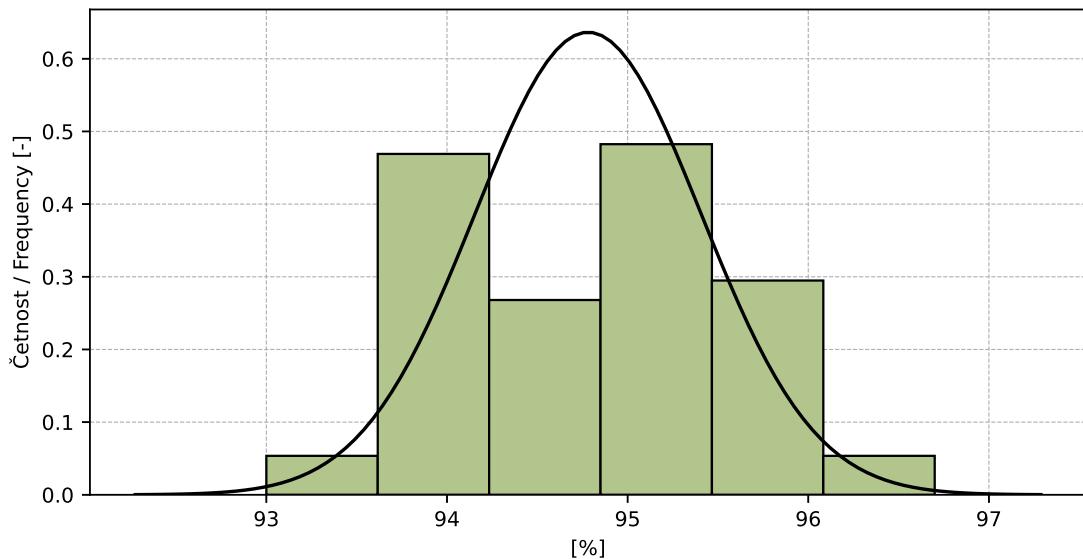
Figure 5: Histogram of all test results

Table 6: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	94.8
Výběrová směrodatná odchylka / Sample standard deviation – s	0.63
Vztažná hodnota / Asigned value – x^*	94.8
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.68
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.13
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.54
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.55
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.77
Opakovatelnost / Repeatability – r	1.5
Reprodukovatelnost / Reproducibility – R	2.2

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1.1.5   Evaluation of Performance Statistics
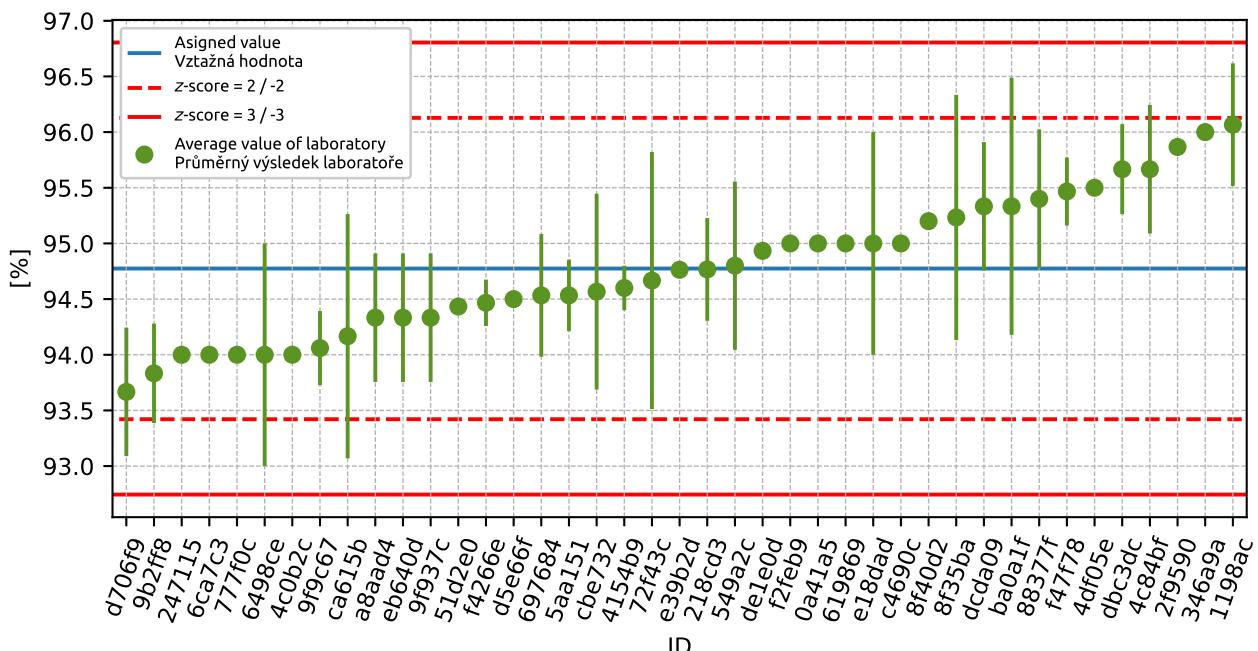

Figure 6: Average values and sample standard deviations
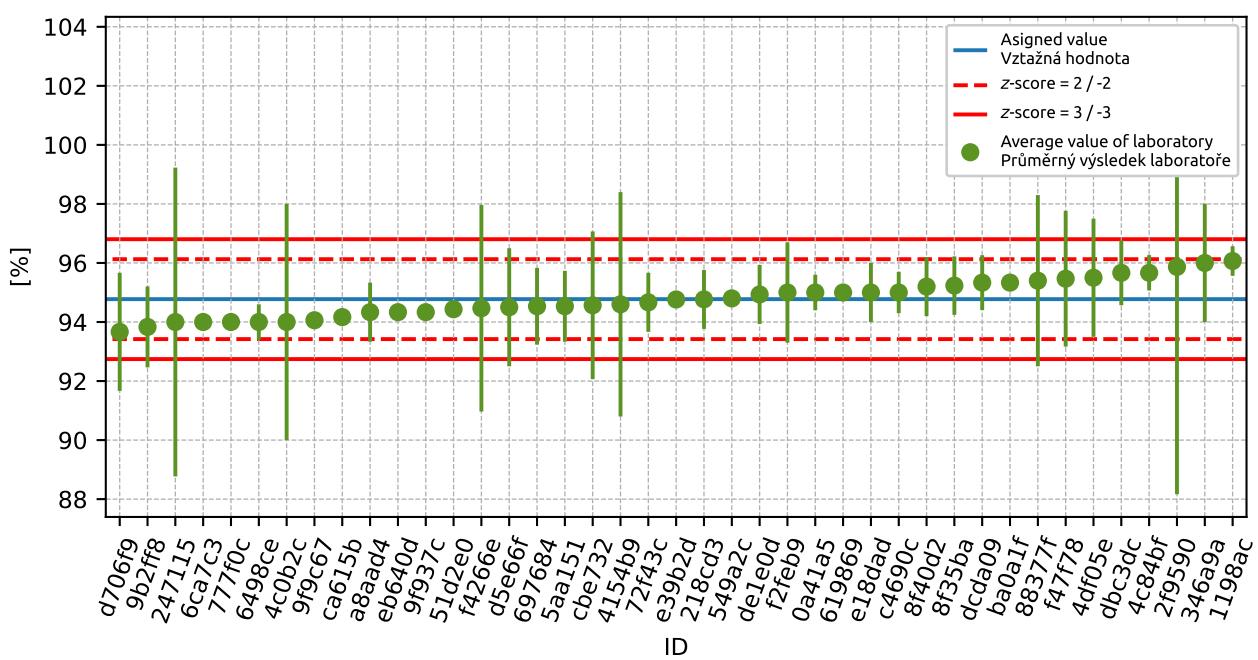
Figure 7: Average values and extended uncertainties of measurement

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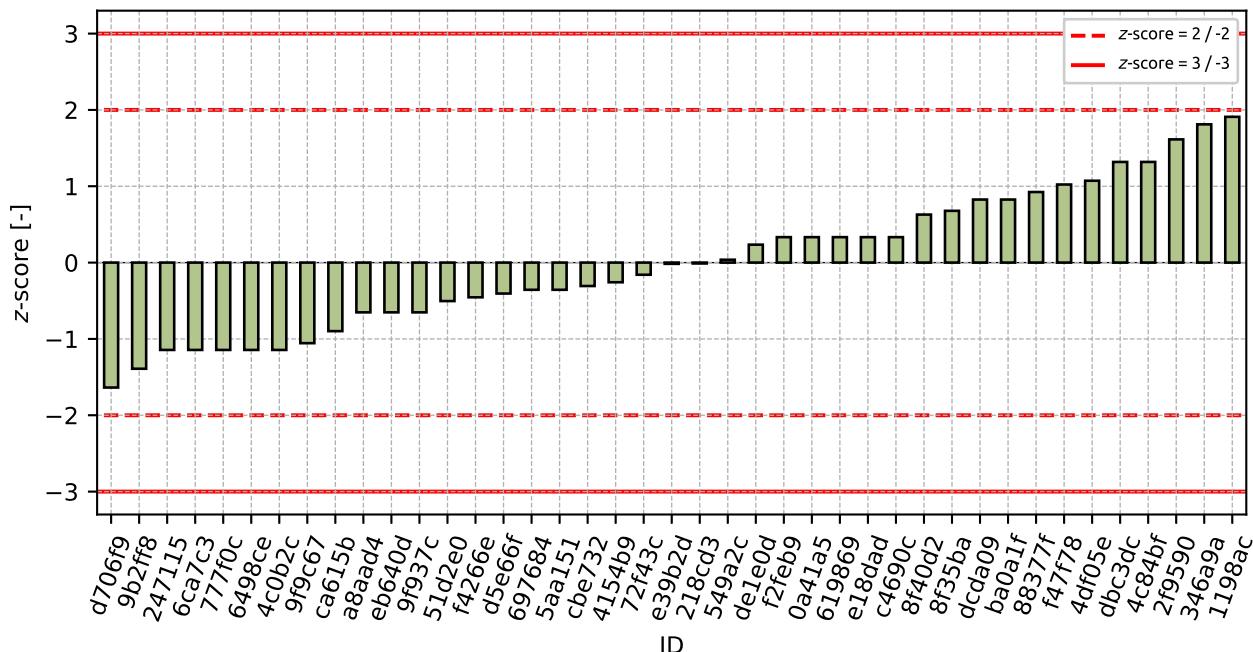
Figure 8: z-score

Figure 9: ζ-score

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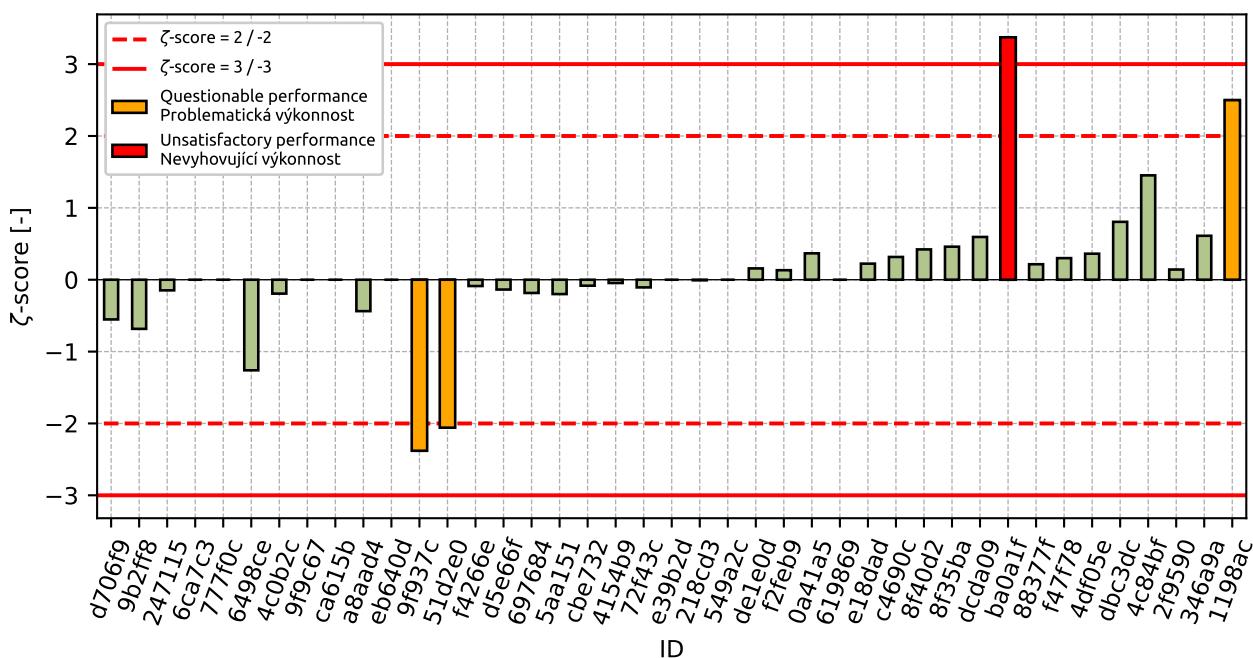
Table 7: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d706f9	-1.64	-0.55
9b2ff8	-1.39	-0.68
247115	-1.14	-0.15
6ca7c3	-1.14	-
777f0c	-1.14	-
6498ce	-1.14	-1.26
4c0b2c	-1.14	-0.19
9f9c67	-1.06	-
ca615b	-0.9	-
a8aad4	-0.65	-0.44
eb640d	-0.65	-
9f937c	-0.65	-2.38
51d2e0	-0.5	-2.06
f4266e	-0.45	-0.09
d5e66f	-0.41	-0.14
697684	-0.36	-0.18
5aa151	-0.36	-0.2
cbe732	-0.31	-0.08
4154b9	-0.26	-0.05
72f43c	-0.16	-0.11
e39b2d	-0.02	-
218cd3	-0.01	-0.01
549a2c	0.04	-
de1e0d	0.23	0.16
f2feb9	0.33	0.13
0a41a5	0.33	0.37
619869	0.33	-
e18dad	0.33	0.22
c4690c	0.33	0.32
8f40d2	0.63	0.42
8f35ba	0.68	0.46
dcda09	0.83	0.6
ba0a1f	0.83	3.37
88377f	0.92	0.22
f47f78	1.02	0.3
4df05e	1.07	0.36
dbc3dc	1.32	0.81
4c84bf	1.32	1.45
2f9590	1.61	0.14
346a9a	1.81	0.61
1198ac	1.91	2.5

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1.2   2 mm

1.2.1   Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
4c0b2c	82.0	82.0	82.0	4.0	82.0	0.0	0.0
d706f9	84.0	83.0	83.0	2.0	83.3	0.58	0.69
dbc3dc	84.0	82.8	83.7	0.7	83.5	0.62	0.75
9b2ff8	82.4	85.0	83.4	3.7	83.6	1.3	1.55
6498ce	84.0	83.0	84.0	0.6	83.7	0.58	0.69
777f0c	84.0	84.0	84.0	-	84.0	0.0	0.0
9f9c67	84.5	83.3	84.3	-	84.0	0.64	0.76
ca615b	85.4	83.2	83.6	-	84.1	1.17	1.39
f4266e	84.1	83.7	84.6	3.5	84.1	0.45	0.54
a8aad4	84.0	85.0	84.0	1.0	84.3	0.58	0.68
697684	84.4	83.7	84.9	1.6	84.3	0.6	0.71
d5e66f	84.4	-	-	2.0	84.4	0.0	0.0
5aa151	84.5	84.3	84.4	1.2	84.4	0.1	0.12
c4690c	85.0	85.0	84.0	0.7	84.7	0.58	0.68
51d2e0	84.2	84.6	85.4	0.2	84.7	0.61	0.72
4154b9	84.1	84.9	85.5	3.4	84.8	0.7	0.83
cbe732	85.0	85.4	84.2	2.5	84.8	0.61	0.72
de1e0d	84.8	84.8	85.0	2.0	84.9	0.12	0.14
dcda09	85.0	85.0	85.0	0.2	85.0	0.0	0.0
0a41a5	85.0	85.0	85.0	0.6	85.0	0.0	0.0
9f937c	85.0	86.0	84.0	0.1	85.0	1.0	1.18
619869	85.0	85.0	85.0	-	85.0	0.0	0.0
247115	85.0	84.0	86.0	1.7	85.0	1.0	1.18
6ca7c3	85.0	85.0	85.0	-	85.0	0.0	0.0
549a2c	86.1	84.8	84.3	-	85.1	0.93	1.09
72f43c	85.0	85.0	86.0	1.0	85.3	0.58	0.68
eb640d	86.0	85.0	85.0	-	85.3	0.58	0.68
e18dad	87.0	85.0	84.0	1.0	85.3	1.53	1.79
8f40d2	85.7	85.4	86.0	1.6	85.7	0.3	0.35
88377f	86.9	87.0	83.2	2.6	85.7	2.17	2.53
8f35ba	84.4	85.4	87.3	1.1	85.7	1.47	1.72
4df05e	85.8	86.4	85.2	2.0	85.8	0.6	0.7
f47f78	85.6	86.2	85.8	2.0	85.9	0.31	0.36
ba0a1f	86.0	85.0	87.0	0.3	86.0	1.0	1.16
1198ac	85.7	87.7	85.5	0.8	86.3	1.22	1.41
f2feb9	87.0	86.0	86.0	1.7	86.3	0.58	0.67
2f9590	86.9	86.2	86.7	5.7	86.6	0.36	0.42
218cd3	86.3	86.5	87.8	1.0	86.9	0.81	0.94
346a9a	87.0	87.0	87.0	2.0	87.0	0.0	0.0
4c84bf	88.0	88.0	86.0	0.6	87.3	1.15	1.32
e39b2d	88.7	88.7	88.8	-	88.7	0.06	0.07

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1.2.2   The Numerical Procedure for Determining Outliers
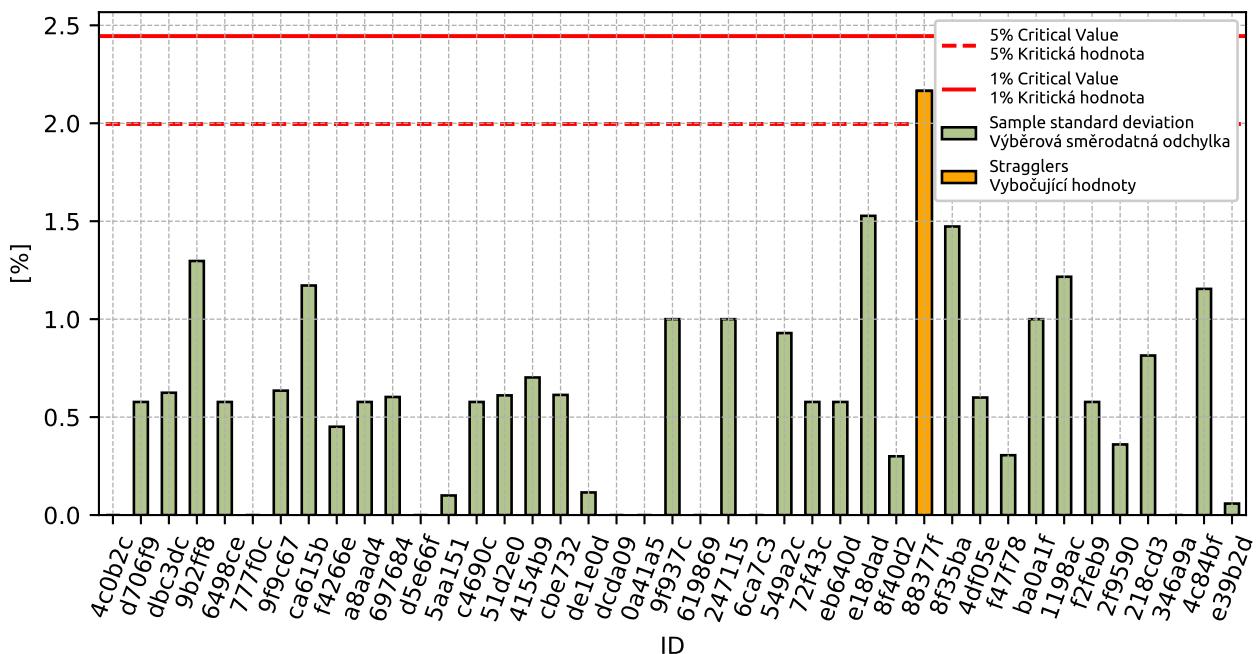
Figure 10: **Cochran's test** - sample standard deviations
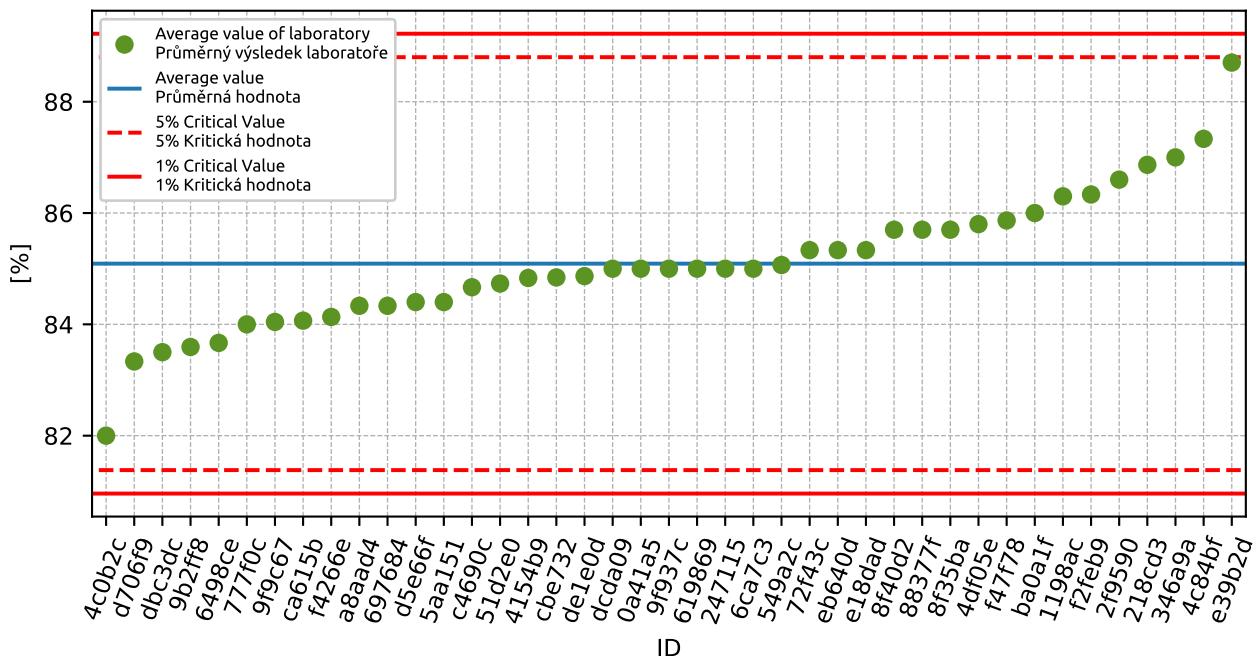
Figure 11: **Grubbs' test** - average values

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1.2.3　Mandel′s Statistics
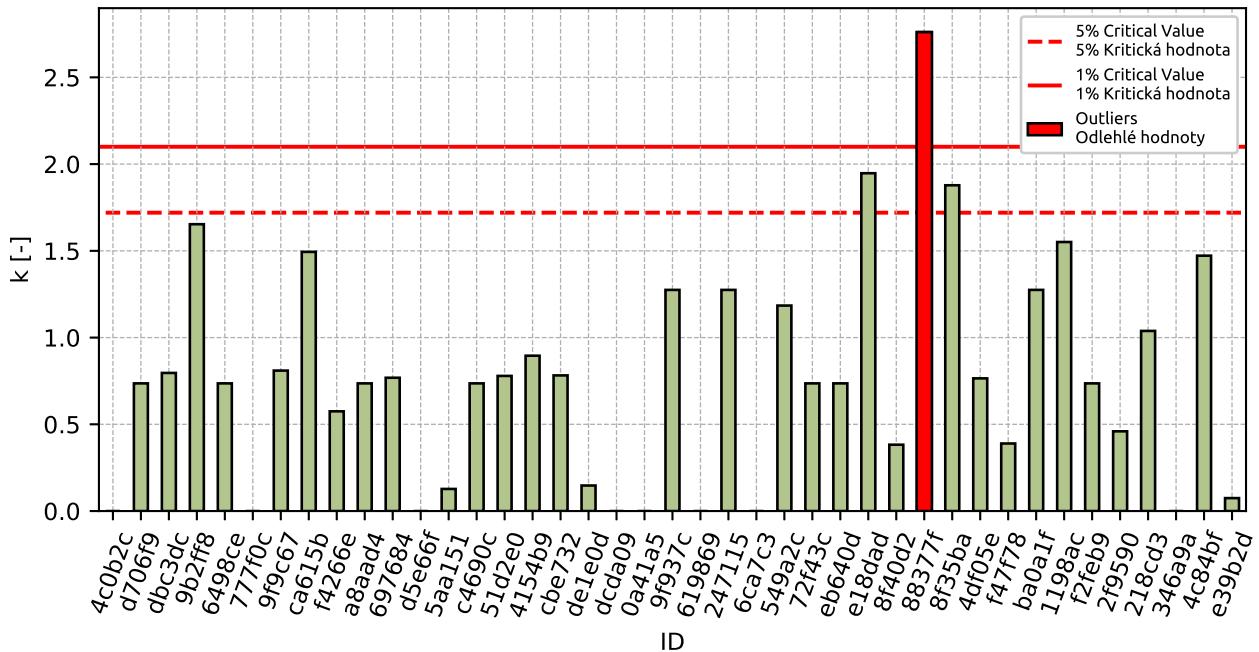
Figure 12: Intralaboratory Consistency Statistic
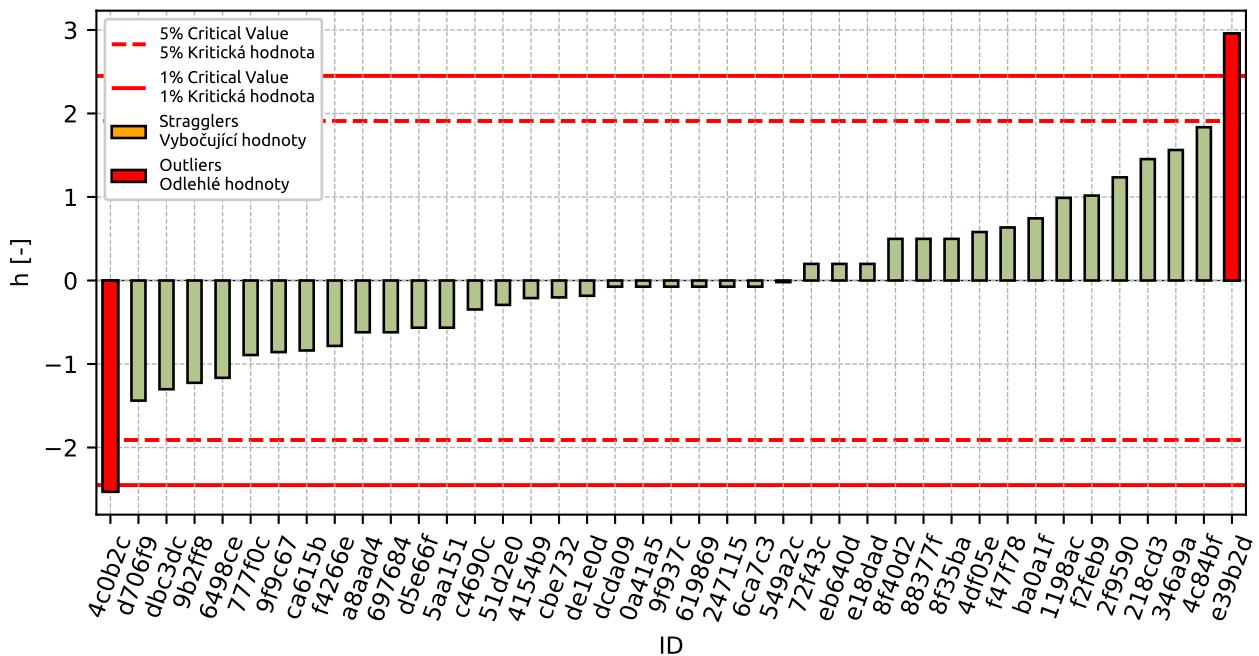
Figure 13: Interlaboratory Consistency Statistic

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1.2.4   Descriptive statistics
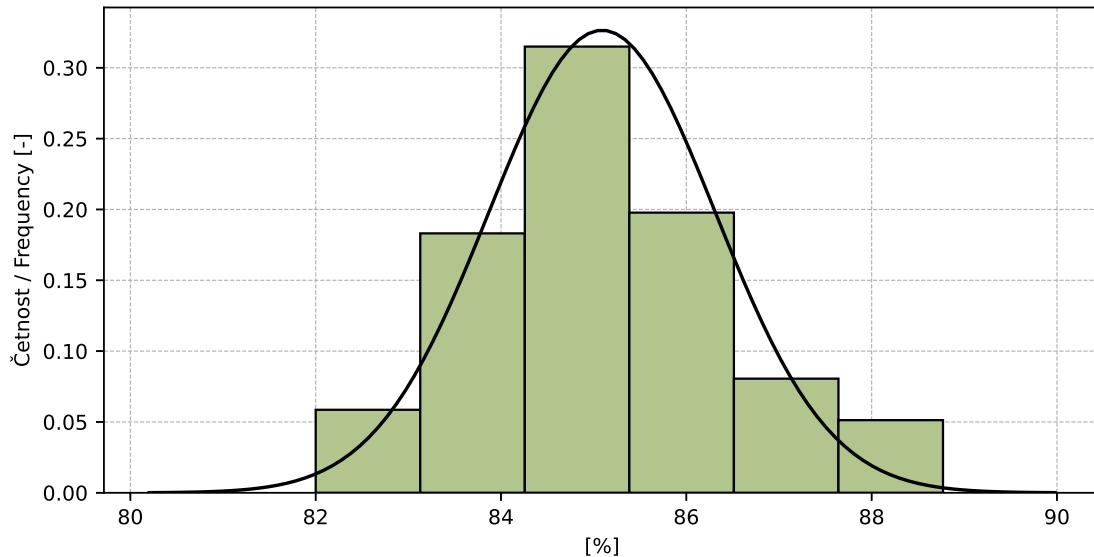
Figure 14: Histogram of all test results

Table 9: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	85.1
Výběrová směrodatná odchylka / Sample standard deviation – s	1.22
Vztažná hodnota / Asigned value – x^*	85.1
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.21
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.24
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.13
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.78
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.38
Opakovatelnost / Repeatability – r	2.2
Reprodukovatelnost / Reproducibility – R	3.9

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1.2.5   Evaluation of Performance Statistics
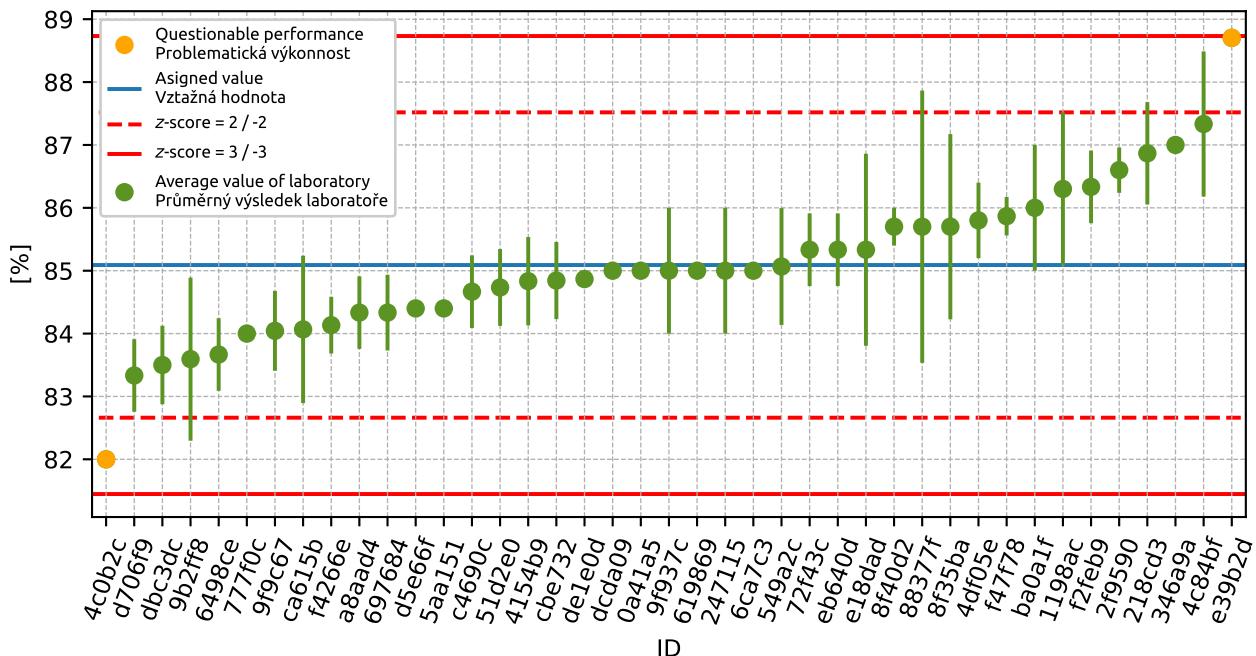

Figure 15: Average values and sample standard deviations
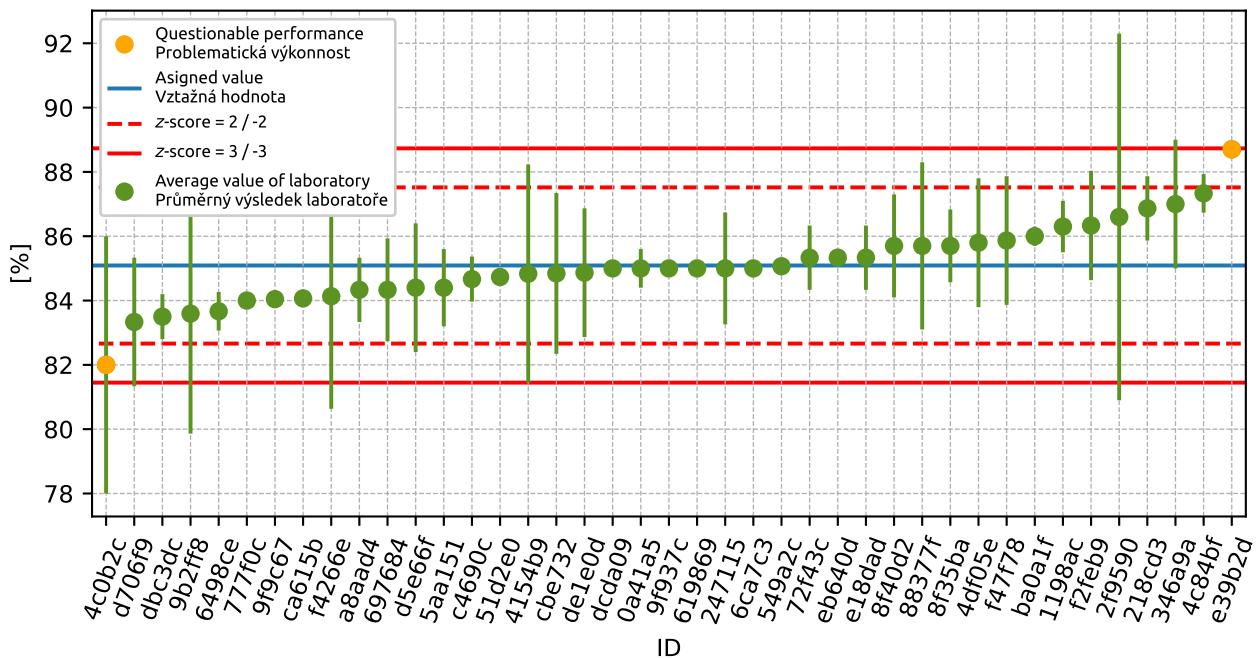
Figure 16: Average values and extended uncertainties of measurement

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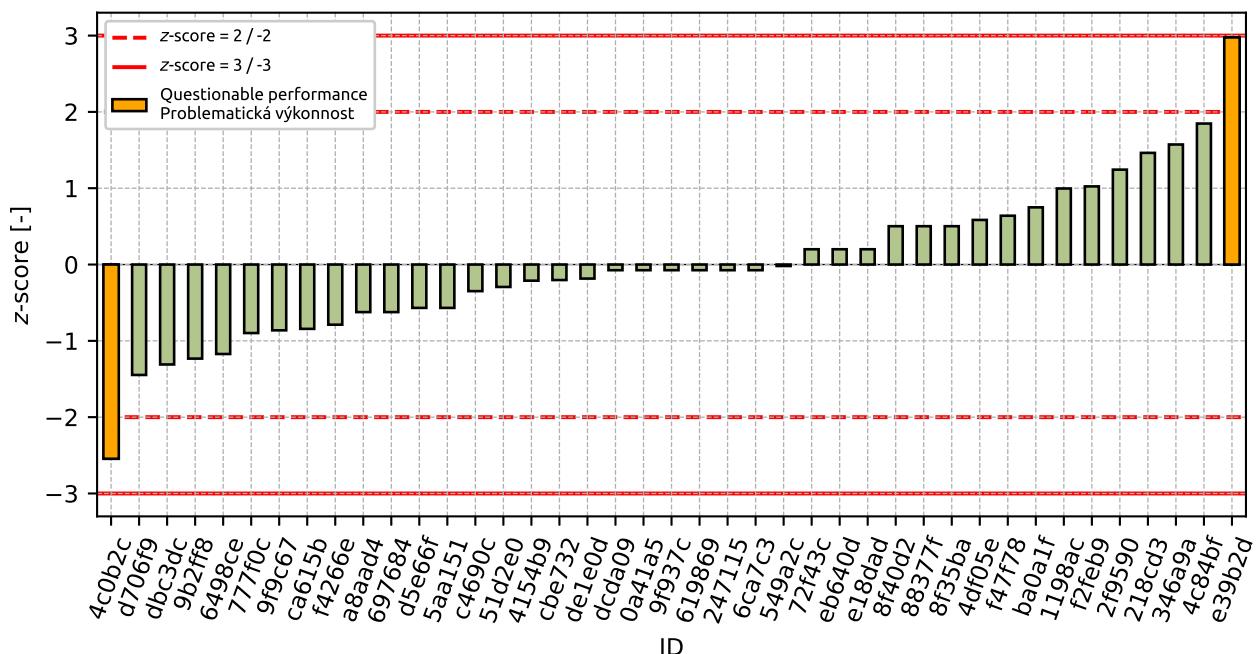
Figure 17: z-score

Figure 18: ζ-score

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Table 10: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
4c0b2c	-2.55	-0.77
d706f9	-1.45	-0.87
dbc3dc	-1.31	-2.15
9b2ff8	-1.23	-0.4
6498ce	-1.17	-2.21
777f0c	-0.9	-
9f9c67	-0.86	-
ca615b	-0.84	-
f4266e	-0.79	-0.27
a8aad4	-0.62	-0.74
697684	-0.62	-0.47
d5e66f	-0.57	-0.34
5aa151	-0.57	-0.56
c4690c	-0.35	-0.57
51d2e0	-0.29	-1.15
4154b9	-0.21	-0.08
cbe732	-0.2	-0.1
de1e0d	-0.18	-0.11
dcda09	-0.07	-0.3
0a41a5	-0.07	-0.14
9f937c	-0.07	-0.33
619869	-0.07	-
247115	-0.07	-0.05
6ca7c3	-0.07	-
549a2c	-0.02	-
72f43c	0.2	0.24
eb640d	0.2	-
e18dad	0.2	0.24
8f40d2	0.5	0.38
88377f	0.5	0.23
8f35ba	0.5	0.53
4df05e	0.58	0.35
f47f78	0.64	0.39
ba0a1f	0.75	2.38
1198ac	1.0	1.45
f2feb9	1.02	0.72
2f9590	1.24	0.26
218cd3	1.46	1.73
346a9a	1.57	0.95
4c84bf	1.85	3.48
e39b2d	2.98	-

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1.3 1 mm

1.3.1 Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d706f9	62.0	61.0	61.0	2.0	61.3	0.58	0.94
4c0b2c	61.0	62.0	61.0	3.0	61.3	0.58	0.94
9b2ff8	62.0	64.6	63.1	3.9	63.2	1.35	2.14
ca615b	64.0	62.7	63.3	-	63.3	0.65	1.03
a8aad4	63.0	64.0	63.0	1.0	63.3	0.58	0.91
6498ce	63.0	64.0	63.0	0.6	63.3	0.58	0.91
d5e66f	63.4	-	-	2.0	63.4	0.0	0.0
dbc3dc	63.9	63.4	64.1	1.0	63.8	0.36	0.57
697684	64.3	63.5	63.8	1.0	63.9	0.4	0.63
f4266e	63.6	63.8	64.2	3.5	63.9	0.31	0.48
cbe732	64.9	63.8	63.3	2.5	64.0	0.83	1.29
0a41a5	64.0	64.0	64.0	0.6	64.0	0.0	0.0
dcda09	64.0	64.0	64.0	0.4	64.0	0.0	0.0
e18dad	65.0	64.0	63.0	1.0	64.0	1.0	1.56
777f0c	64.0	64.0	64.0	-	64.0	0.0	0.0
de1e0d	64.2	64.1	64.0	3.0	64.1	0.1	0.16
5aa151	64.4	64.2	64.2	1.2	64.3	0.12	0.18
88377f	65.5	67.1	60.7	2.0	64.4	3.33	5.17
9f9c67	65.5	63.0	65.0	-	64.5	1.28	1.98
51d2e0	64.1	64.9	64.5	0.2	64.5	0.4	0.62
4154b9	64.2	64.7	65.0	2.6	64.6	0.4	0.63
1198ac	64.1	65.9	64.1	0.6	64.7	1.04	1.61
8f35ba	64.2	64.6	65.6	1.0	64.8	0.72	1.11
8f40d2	65.2	64.8	65.0	2.1	65.0	0.2	0.31
619869	65.0	65.0	65.0	-	65.0	0.0	0.0
549a2c	66.2	64.6	64.4	-	65.1	0.99	1.52
e39b2d	65.1	65.2	65.1	-	65.1	0.04	0.05
72f43c	65.0	65.0	66.0	1.0	65.3	0.58	0.88
9f937c	65.0	66.0	65.0	0.1	65.3	0.58	0.88
c4690c	65.0	65.0	66.0	0.6	65.3	0.58	0.88
4df05e	65.3	67.1	63.9	2.0	65.4	1.6	2.45
f47f78	65.0	65.7	65.9	1.6	65.5	0.47	0.72
218cd3	65.4	65.5	66.7	1.0	65.9	0.72	1.1
6ca7c3	66.0	66.0	66.0	-	66.0	0.0	0.0
ba0a1f	66.0	66.0	67.0	0.4	66.3	0.58	0.87
247115	66.0	66.0	67.0	0.7	66.3	0.58	0.87
2f9590	67.2	66.2	67.1	5.5	66.8	0.55	0.82
eb640d	68.0	67.0	66.0	-	67.0	1.0	1.49
f2feb9	69.0	67.0	66.0	1.7	67.3	1.53	2.27
346a9a	67.0	68.0	68.0	2.0	67.7	0.58	0.85
4c84bf	69.0	70.0	66.0	0.6	68.3	2.08	3.05

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1.3.2   The Numerical Procedure for Determining Outliers
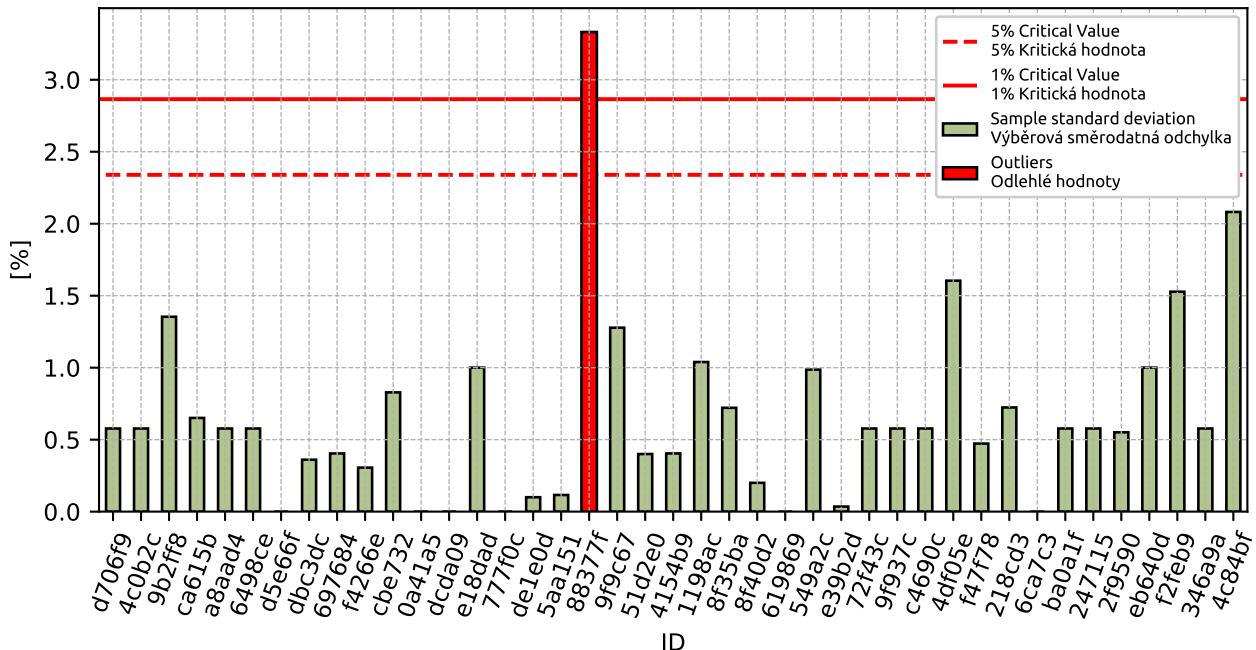

Figure 19: **Cochran's test** - sample standard deviations
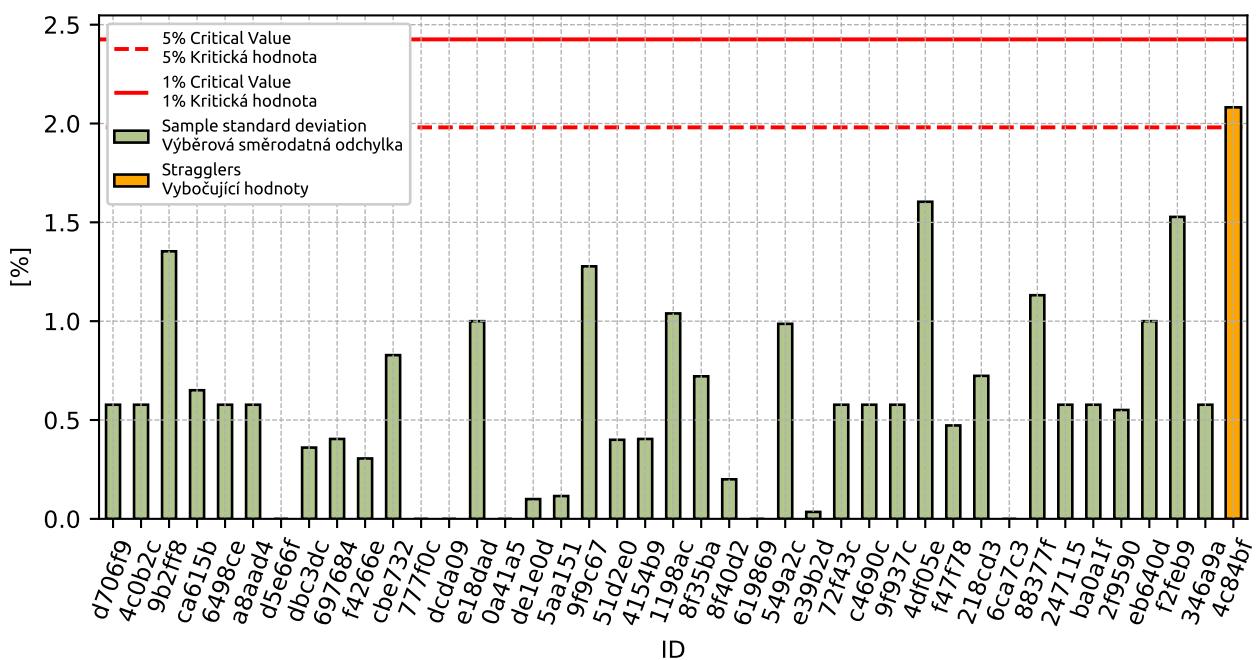
Figure 20: **Cochran's test** - sample standard deviations without outliers

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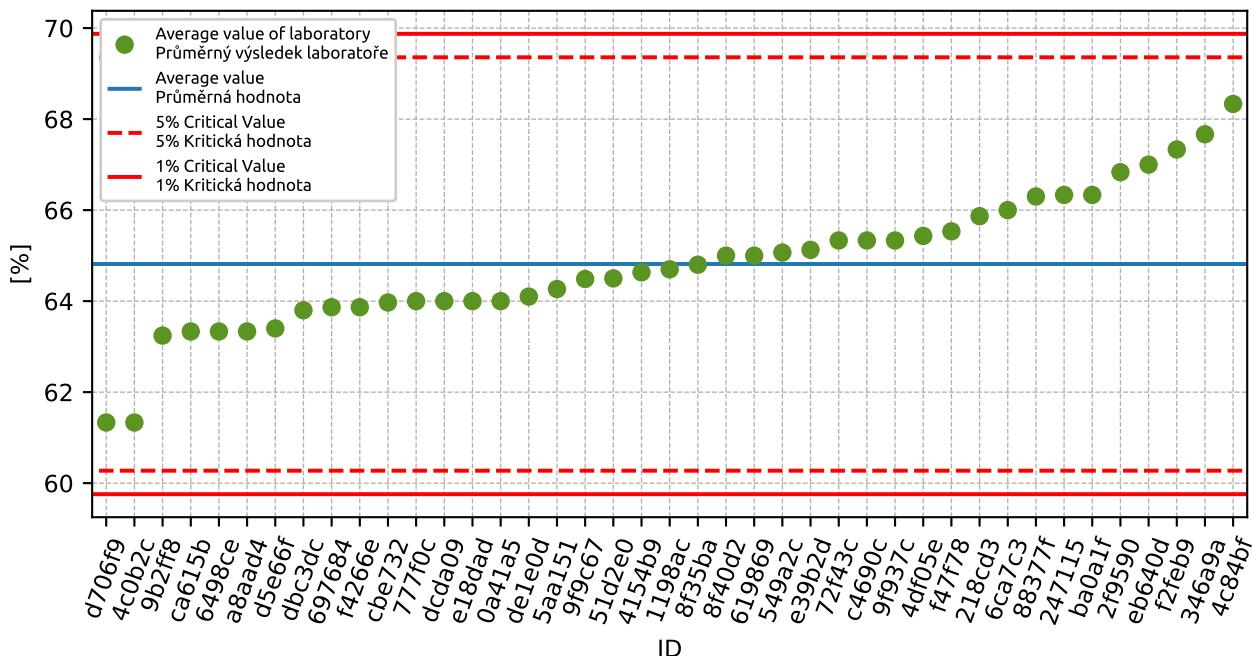
Figure 21: **Grubbs' test** - average values

1.3.3   Mandel's Statistics
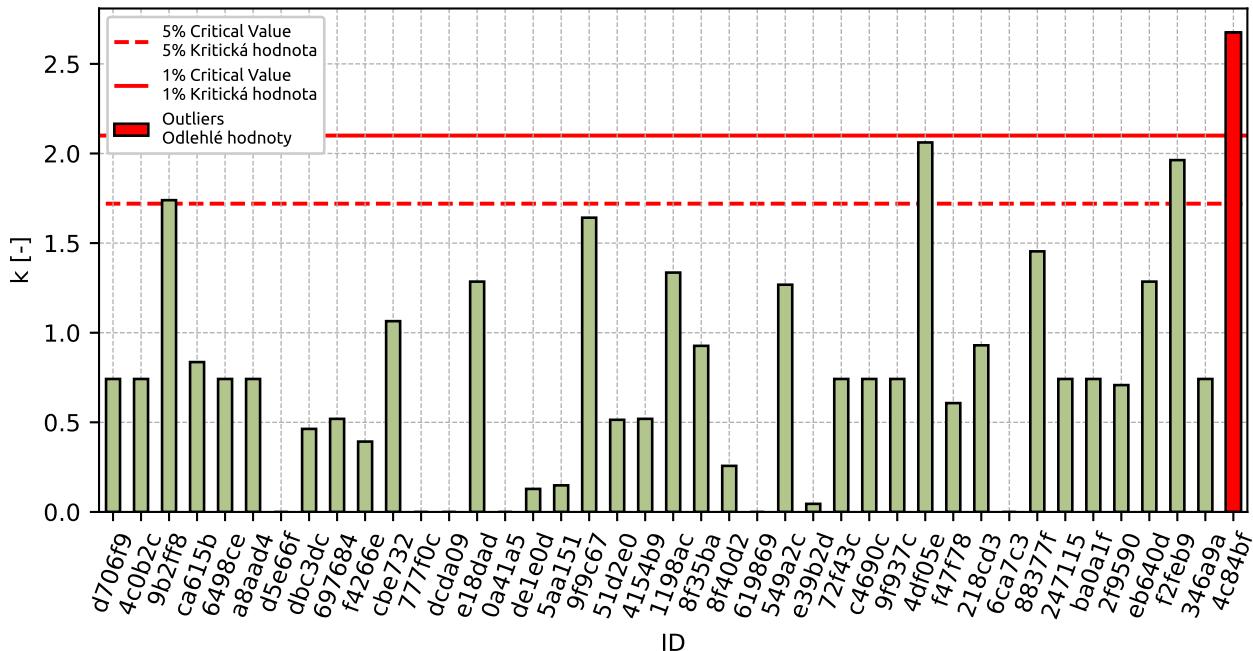

Figure 22: Intralaboratory Consistency Statistic

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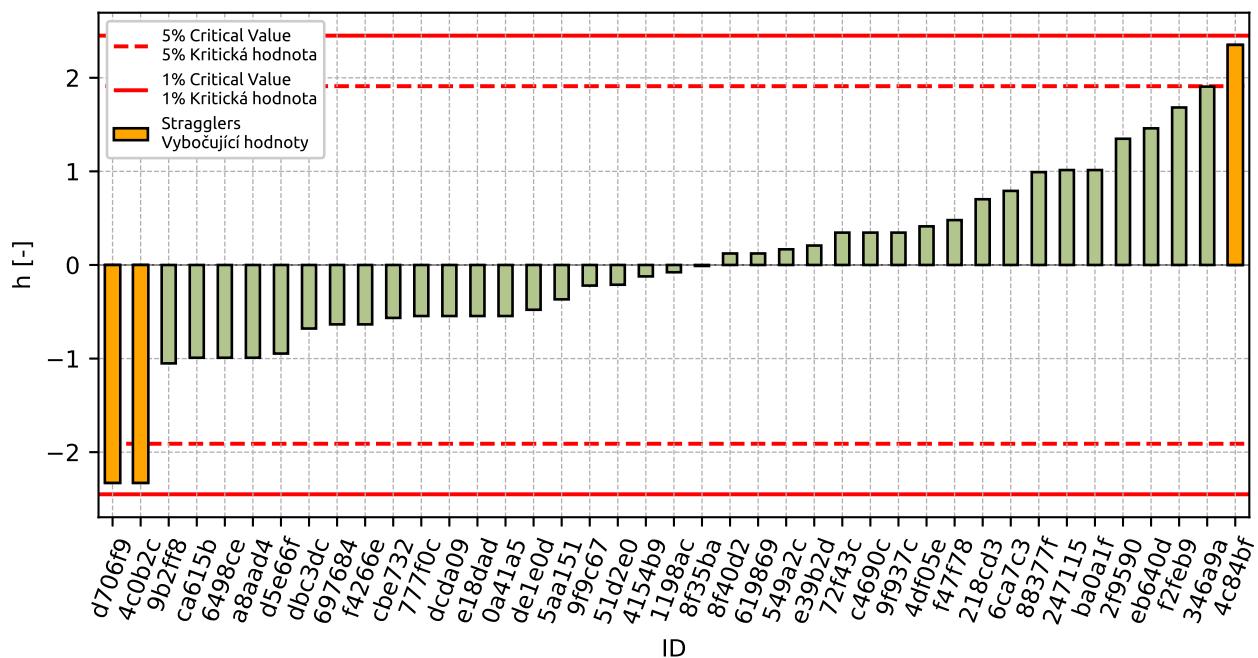
Figure 23: Interlaboratory Consistency Statistic

1.3.4   Descriptive statistics
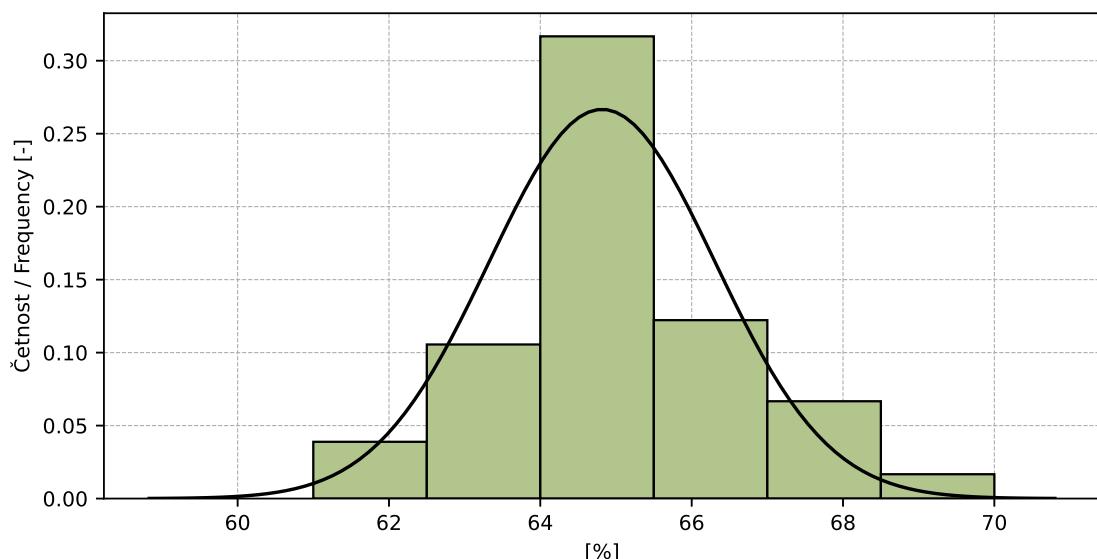
Figure 24: Histogram of all test results

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Table 12: Descriptive statistics

| Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	64.8
Výběrová směrodatná odchylka / Sample standard deviation – s	1.5
Vztažná hodnota / Asigned value – x^*	64.8
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.39
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.27
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.43
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.78
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.63
Opakovatelnost / Repeatability – r	2.2
Reprodukovatelnost / Reproducibility – R	4.6

1.3.5 Evaluation of Performance Statistics
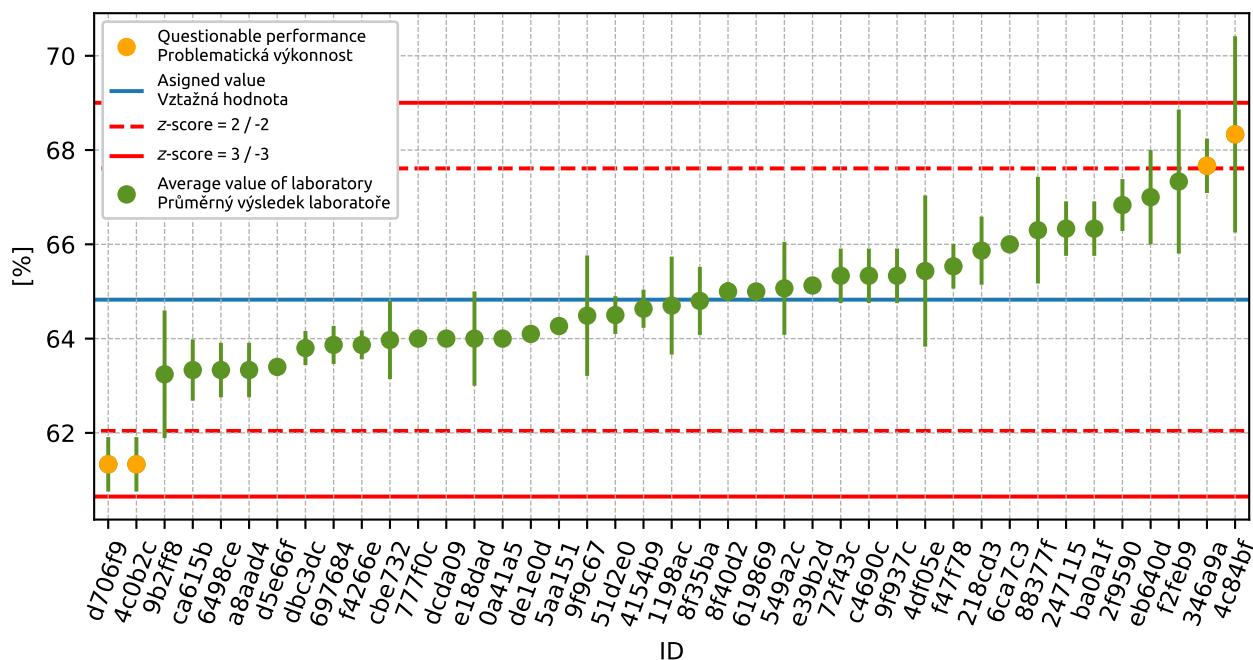
Figure 25: Average values and sample standard deviations

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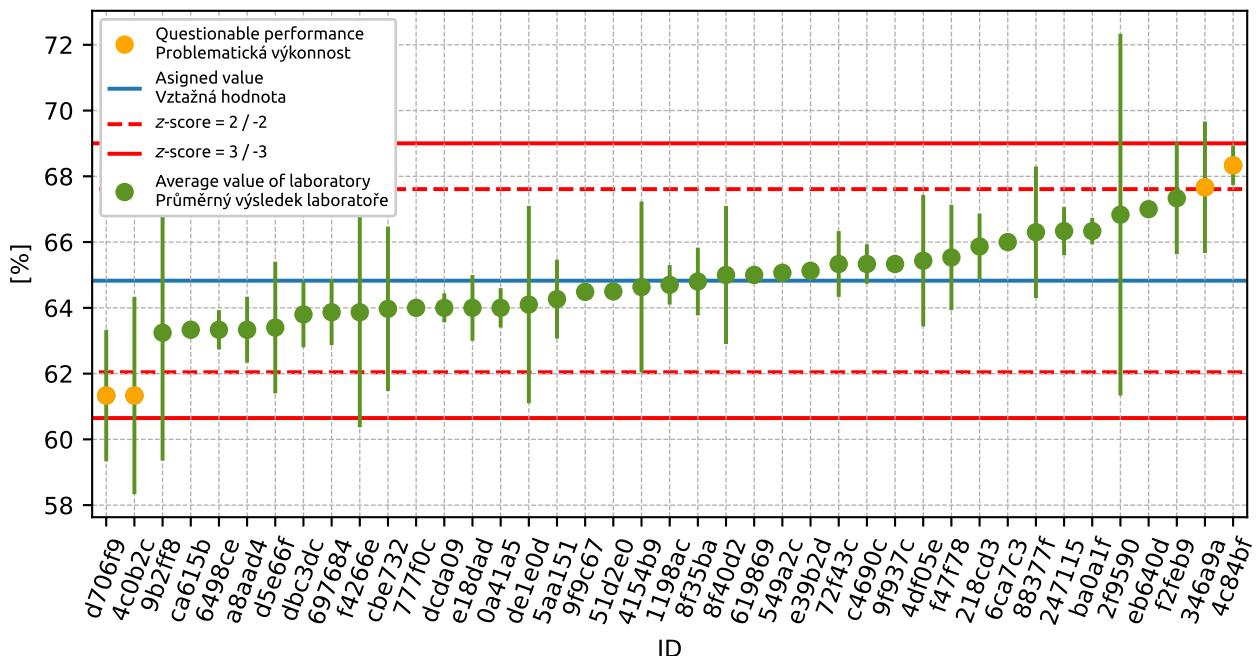
Figure 26: Average values and extended uncertainties of measurement

Figure 27: z-score

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Figure 28: ζ-score

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Table 13: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d706f9	-2.51	-1.73
4c0b2c	-2.51	-1.16
9b2ff8	-1.14	-0.41
ca615b	-1.07	-
6498ce	-1.07	-2.27
a8aad4	-1.07	-1.44
d5e66f	-1.02	-0.71
dbc3dc	-0.74	-0.99
697684	-0.69	-0.93
f4266e	-0.69	-0.27
cbe732	-0.61	-0.34
777f0c	-0.59	-
dcda09	-0.59	-1.6
e18dad	-0.59	-0.8
0a41a5	-0.59	-1.25
de1e0d	-0.52	-0.24
5aa151	-0.4	-0.45
9f9c67	-0.24	-
51d2e0	-0.23	-0.97
4154b9	-0.14	-0.07
1198ac	-0.09	-0.19
8f35ba	-0.02	-0.02
8f40d2	0.12	0.08
619869	0.12	-
549a2c	0.17	-
e39b2d	0.22	-
72f43c	0.36	0.49
c4690c	0.36	0.77
9f937c	0.36	1.68
4df05e	0.44	0.3
f47f78	0.51	0.44
218cd3	0.75	1.0
6ca7c3	0.84	-
88377f	1.06	0.73
247115	1.08	1.94
ba0a1f	1.08	3.12
2f9590	1.44	0.36
eb640d	1.56	-
f2feb9	1.8	1.46
346a9a	2.04	1.41
4c84bf	2.52	5.32

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1.4   0.5 mm

1.4.1   Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d706f9	26.0	28.0	29.0	4.0	27.7	1.53	5.52
777f0c	30.0	30.0	30.0	-	30.0	0.0	0.0
4c0b2c	31.0	32.0	31.0	3.0	31.3	0.58	1.84
88377f	34.1	32.7	28.4	1.0	31.7	2.97	9.36
8f35ba	31.9	32.0	32.4	1.0	32.1	0.26	0.82
ca615b	32.4	31.9	32.1	-	32.1	0.25	0.78
9f9c67	33.5	30.9	32.4	-	32.3	1.33	4.12
9b2ff8	31.4	33.5	32.3	3.0	32.4	1.02	3.15
d5e66f	32.6	-	-	1.5	32.6	0.0	0.0
c4690c	33.0	33.0	32.0	0.6	32.7	0.58	1.77
de1e0d	32.8	32.5	32.8	2.9	32.7	0.17	0.53
dbc3dc	33.2	32.4	32.6	1.0	32.7	0.42	1.27
a8aad4	33.0	33.0	33.0	1.0	33.0	0.0	0.0
0a41a5	33.0	33.0	33.0	0.6	33.0	0.0	0.0
6498ce	33.0	34.0	32.0	0.6	33.0	1.0	3.03
619869	33.0	33.0	33.0	-	33.0	0.0	0.0
1198ac	33.1	33.8	33.0	0.3	33.3	0.44	1.31
dcda09	33.0	34.0	33.0	0.3	33.3	0.58	1.73
e39b2d	33.8	33.8	32.7	-	33.4	0.61	1.83
5aa151	33.9	33.4	33.4	1.2	33.6	0.29	0.86
549a2c	34.2	33.7	33.5	-	33.8	0.36	1.07
cbe732	34.5	33.8	33.2	2.5	33.8	0.66	1.94
4154b9	33.5	34.1	34.0	1.4	33.9	0.32	0.95
f4266e	35.0	33.5	33.4	3.5	34.0	0.9	2.64
72f43c	34.0	34.0	34.0	1.0	34.0	0.0	0.0
eb640d	35.0	34.0	33.0	-	34.0	1.0	2.94
e18dad	35.0	34.0	33.0	1.0	34.0	1.0	2.94
218cd3	34.0	33.8	34.4	0.5	34.1	0.31	0.9
51d2e0	33.8	34.3	34.1	0.3	34.1	0.25	0.74
f47f78	34.0	34.1	34.3	0.9	34.1	0.15	0.45
8f40d2	34.1	34.8	34.0	2.1	34.3	0.44	1.27
4df05e	34.4	35.9	32.7	2.0	34.3	1.6	4.66
9f937c	34.0	35.0	34.0	0.1	34.3	0.58	1.68
697684	34.3	34.1	34.9	1.1	34.4	0.42	1.21
2f9590	35.3	34.0	34.7	3.4	34.7	0.65	1.88
6ca7c3	35.0	35.0	35.0	-	35.0	0.0	0.0
f2feb9	37.0	35.0	34.0	1.7	35.3	1.53	4.32
ba0a1f	35.0	35.0	36.0	0.4	35.3	0.58	1.63
247115	36.0	35.0	36.0	0.3	35.7	0.58	1.62
346a9a	34.0	37.0	36.0	2.0	35.7	1.53	4.28
4c84bf	39.0	39.0	35.0	0.6	37.7	2.31	6.13

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## 1.4.2　The Numerical Procedure for Determining Outliers
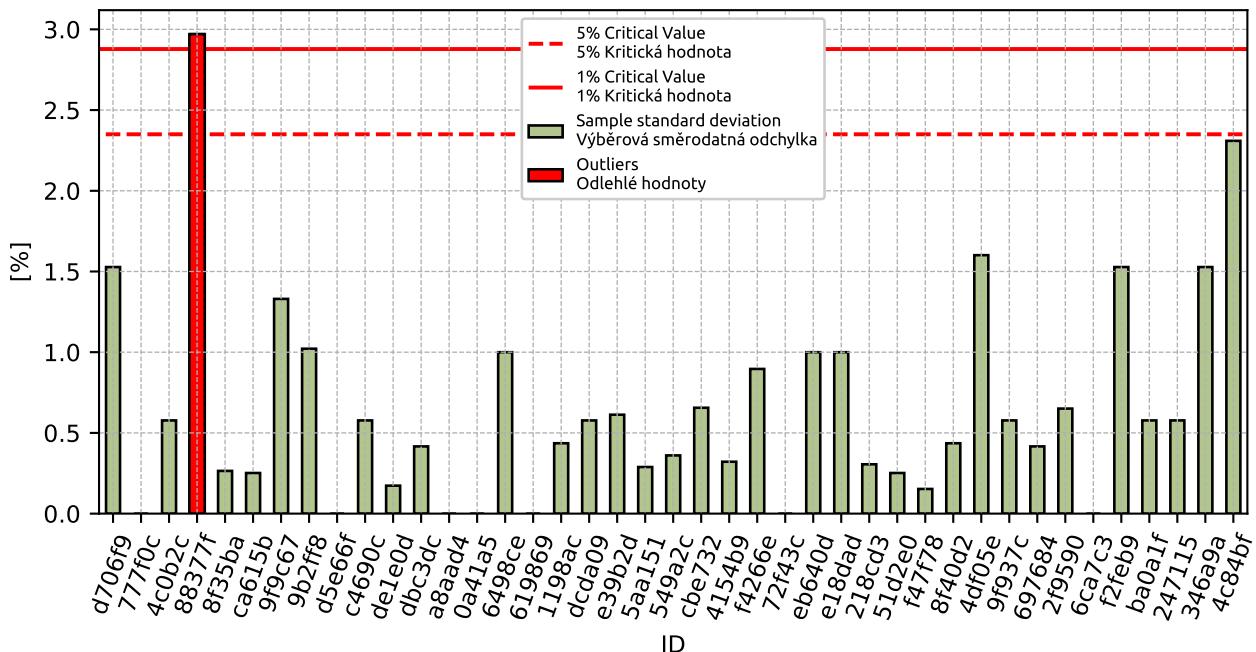
Figure 29: **Cochran's test** - sample standard deviations
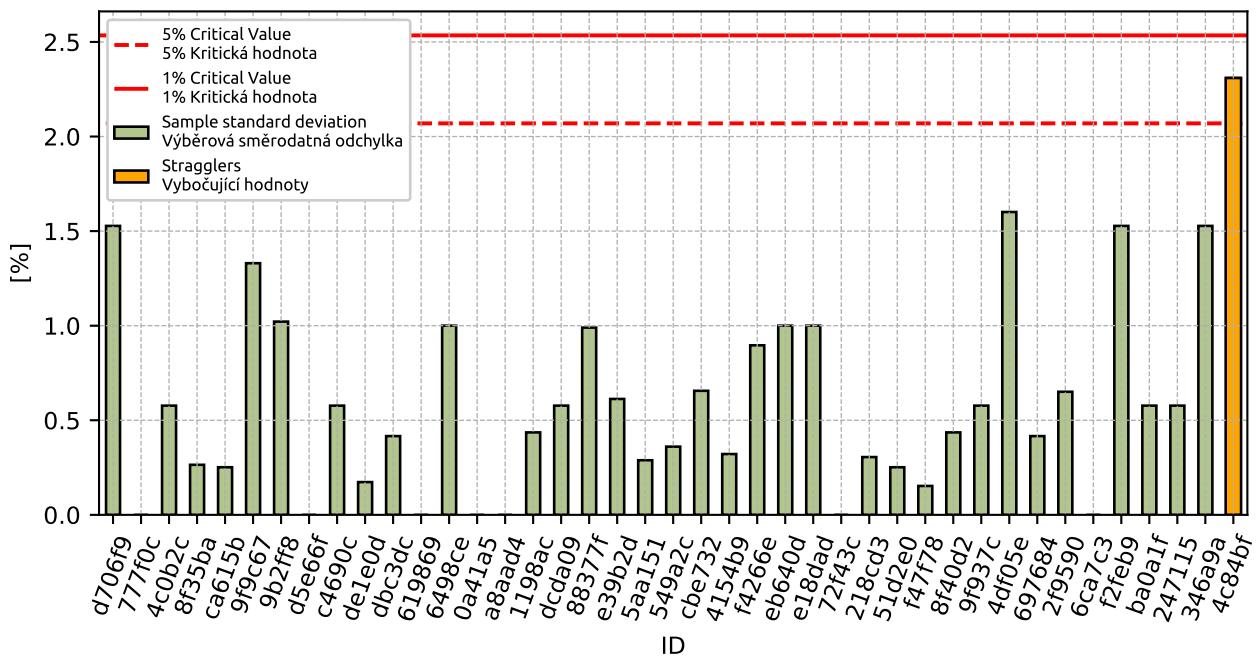
Figure 30: **Cochran's test** - sample standard deviations without outliers

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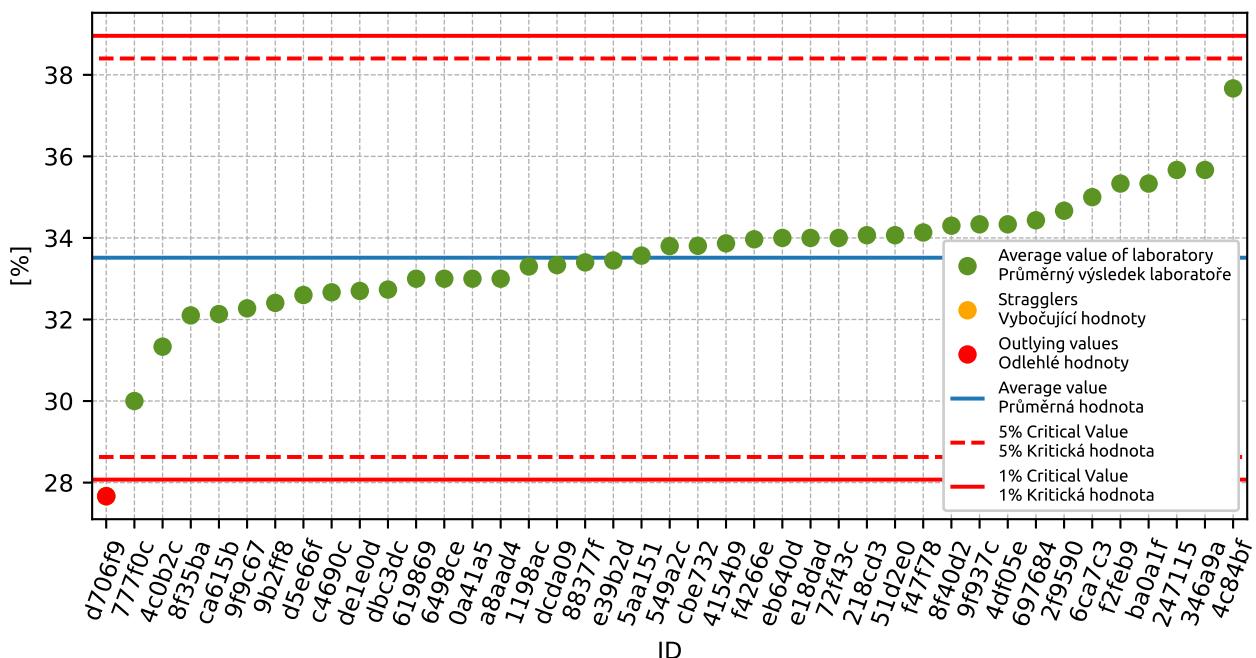
Figure 31: **Grubbs' test** - average values
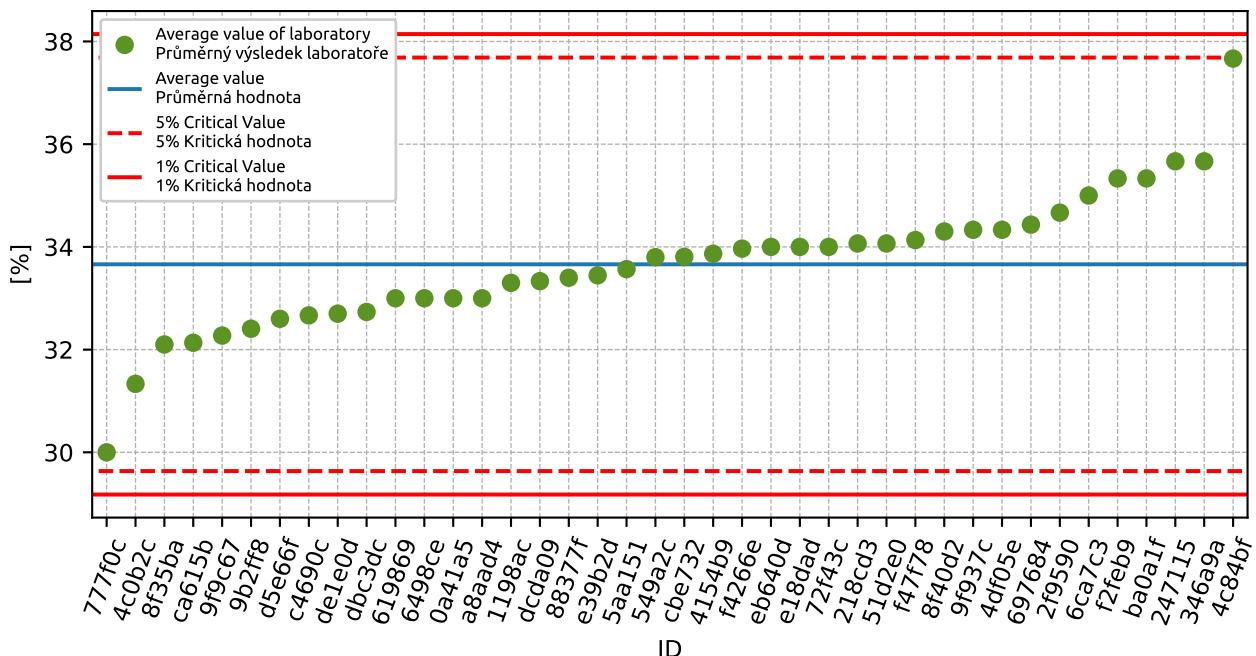
Figure 32: **Grubbs' test** - average values without outliers

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1.4.3   Mandel's Statistics
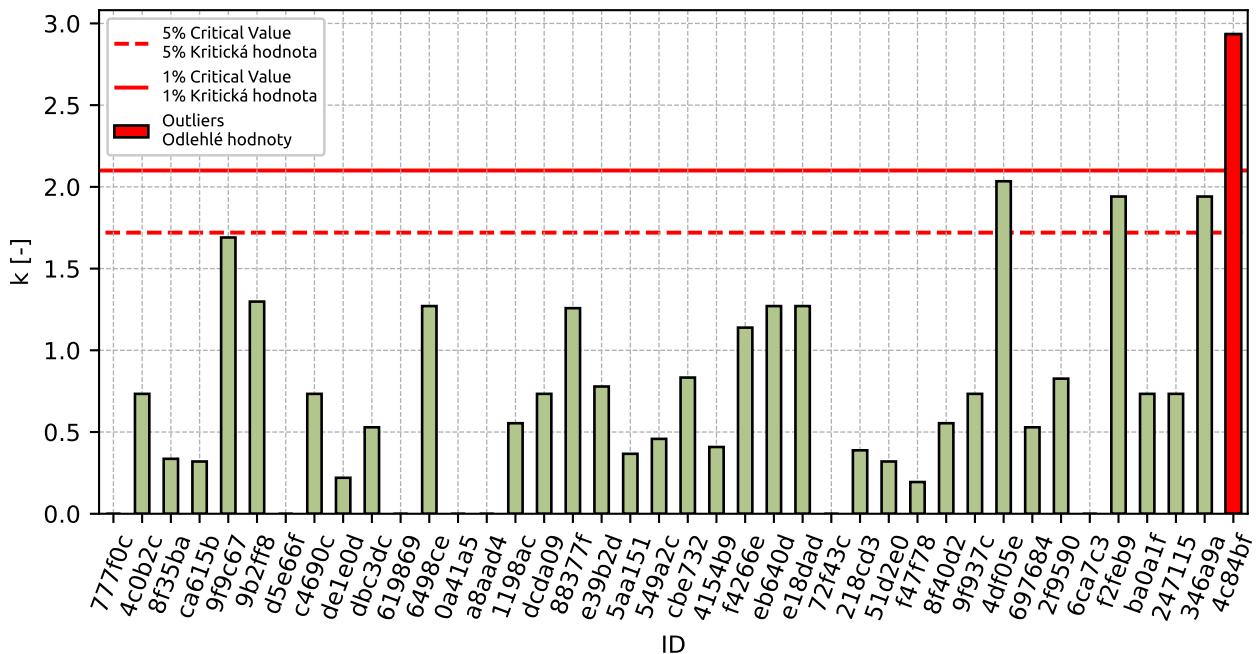
Figure 33: Intralaboratory Consistency Statistic
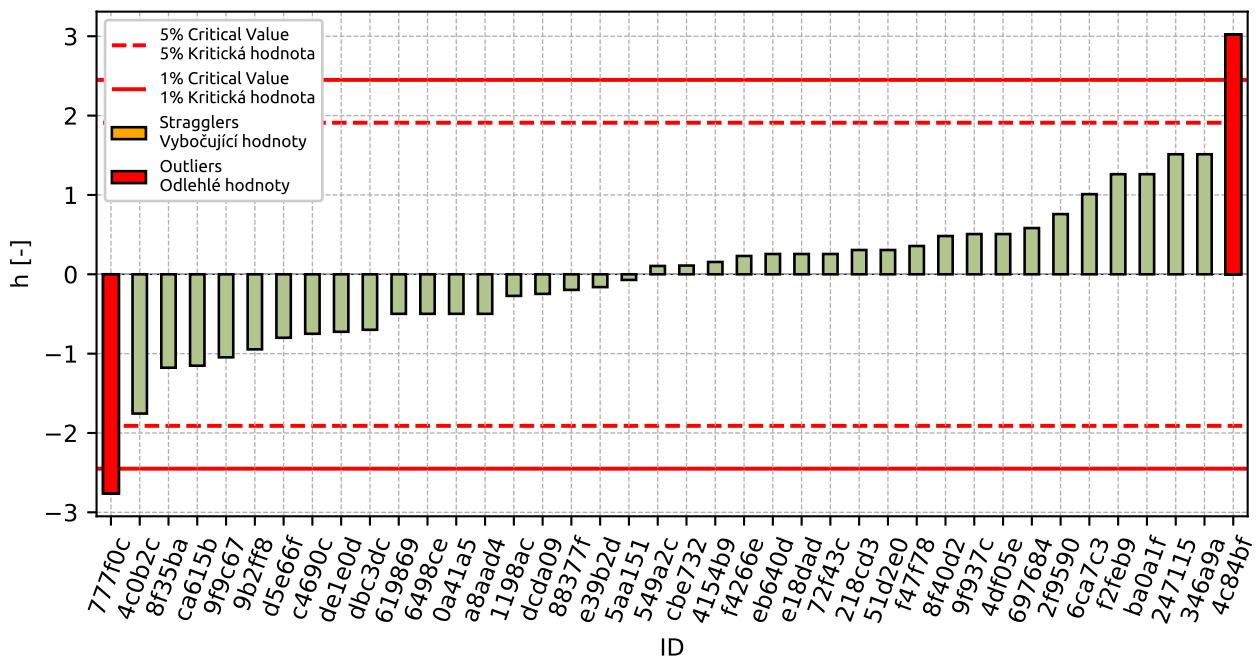

Figure 34: Interlaboratory Consistency Statistic

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1.4.4 Descriptive statistics
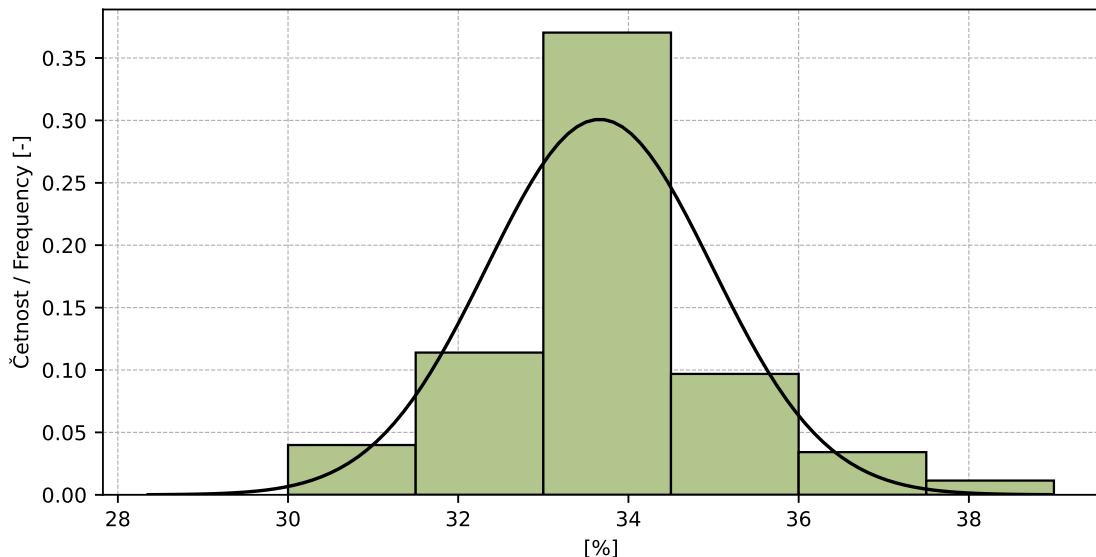
Figure 35: Histogram of all test results

Table 15: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	33.7
Výběrová směrodatná odchylka / Sample standard deviation – s	1.33
Vztažná hodnota / Asigned value – x^*	33.7
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.32
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.26
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.25
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.79
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.47
Opakovatelnost / Repeatability – r	2.2
Reprodukovatelnost / Reproducibility – R	4.1

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1.4.5   Evaluation of Performance Statistics
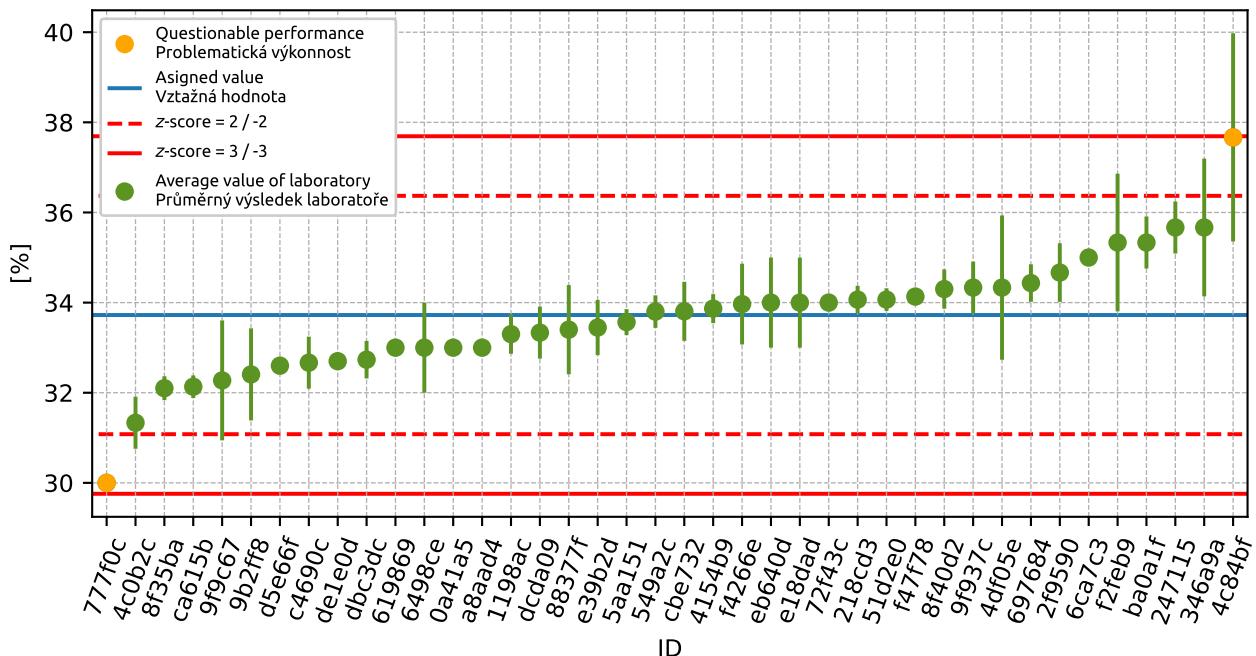
Figure 36: Average values and sample standard deviations
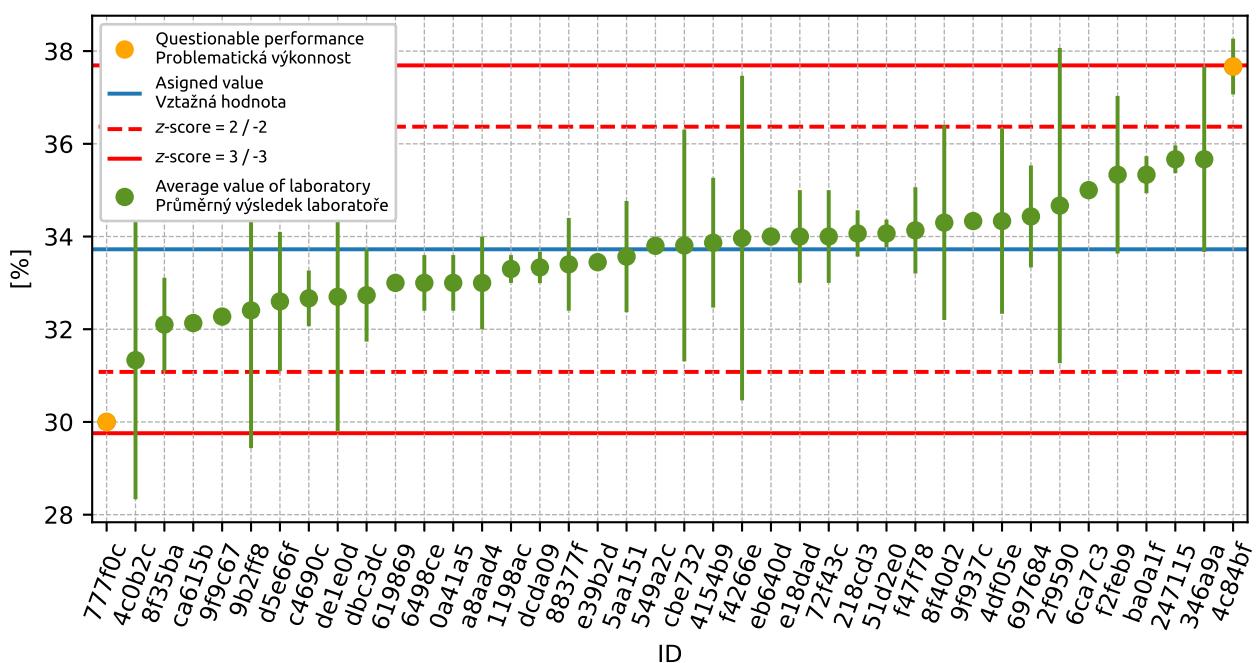
Figure 37: Average values and extended uncertainties of measurement

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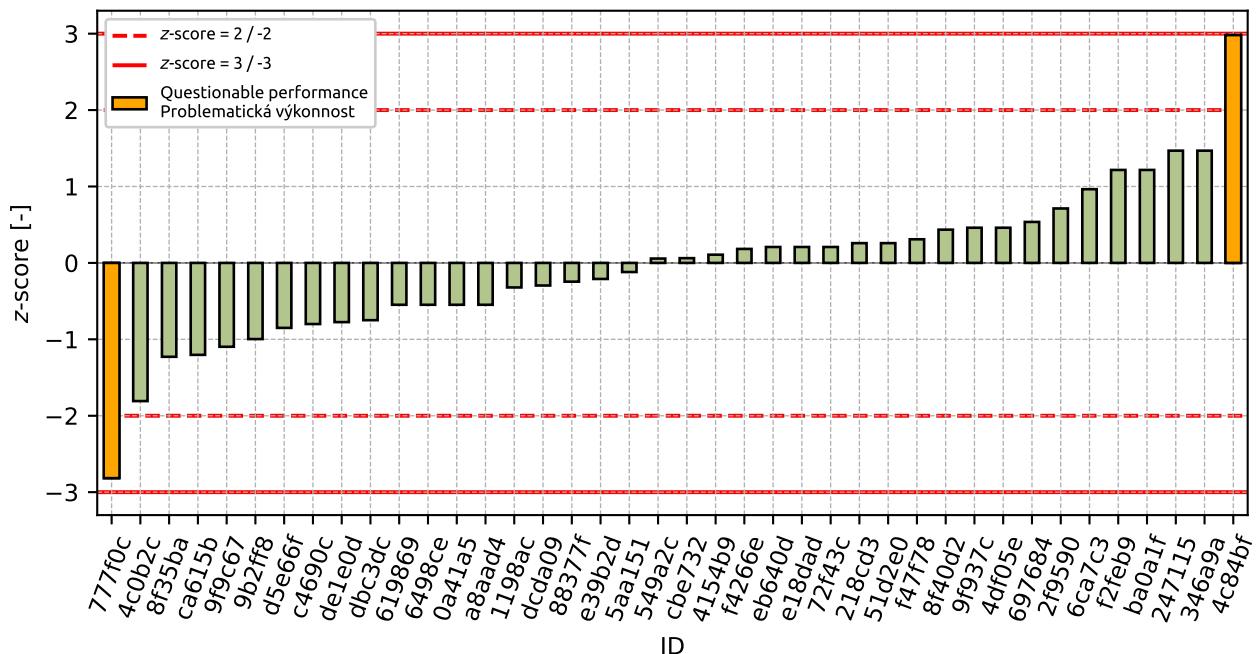
Figure 38: z-score

Figure 39: ζ-score

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Table 16: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
777f0c	-2.82	-
4c0b2c	-1.81	-0.79
8f35ba	-1.23	-1.56
ca615b	-1.2	-
9f9c67	-1.1	-
9b2ff8	-1.0	-0.44
d5e66f	-0.85	-0.74
c4690c	-0.8	-1.62
de1e0d	-0.77	-0.35
dbc3dc	-0.75	-0.96
619869	-0.55	-
6498ce	-0.55	-1.11
0a41a5	-0.55	-1.11
a8aad4	-0.55	-0.7
1198ac	-0.32	-1.07
dcda09	-0.3	-0.91
88377f	-0.25	-0.31
e39b2d	-0.21	-
5aa151	-0.12	-0.13
549a2c	0.06	-
cbe732	0.06	0.03
4154b9	0.11	0.1
f4266e	0.18	0.07
eb640d	0.21	-
e18dad	0.21	0.27
72f43c	0.21	0.27
218cd3	0.26	0.61
51d2e0	0.26	0.86
f47f78	0.31	0.42
8f40d2	0.44	0.27
9f937c	0.46	2.09
4df05e	0.46	0.3
697684	0.54	0.63
2f9590	0.71	0.28
6ca7c3	0.96	-
f2feb9	1.22	0.94
ba0a1f	1.22	3.37
247115	1.47	4.88
346a9a	1.47	0.96
4c84bf	2.98	6.02

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1.5 0.25 mm

1.5.1 Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d706f9	6.0	7.0	8.0	3.0	7.0	1.0	14.29
777f0c	7.0	7.0	7.0	-	7.0	0.0	0.0
8f35ba	7.7	7.4	7.2	1.0	7.4	0.25	3.39
eb640d	8.0	8.0	7.0	-	7.7	0.58	7.53
ca615b	8.0	7.5	7.5	-	7.7	0.29	3.77
9f9c67	8.2	7.2	7.8	-	7.7	0.51	6.59
9b2ff8	7.7	8.2	8.0	0.8	8.0	0.26	3.25
619869	8.0	8.0	8.0	-	8.0	0.0	0.0
4c0b2c	8.0	8.0	8.0	2.0	8.0	0.0	0.0
de1e0d	8.0	7.8	8.2	2.0	8.0	0.2	2.5
a8aad4	8.0	8.0	8.0	1.0	8.0	0.0	0.0
6498ce	8.0	9.0	8.0	0.6	8.3	0.58	6.93
e39b2d	8.5	8.5	8.2	-	8.4	0.15	1.8
697684	8.3	8.3	8.7	0.5	8.4	0.23	2.74
8f40d2	8.8	8.1	8.5	1.5	8.5	0.35	4.15
f47f78	8.5	8.3	8.6	0.2	8.5	0.15	1.8
5aa151	8.8	8.5	8.5	1.2	8.6	0.17	2.01
549a2c	8.7	8.6	8.7	-	8.7	0.06	0.67
247115	9.0	8.0	9.0	0.2	8.7	0.58	6.66
72f43c	8.0	9.0	9.0	1.0	8.7	0.58	6.66
0a41a5	9.0	9.0	8.0	0.6	8.7	0.58	6.66
d5e66f	8.7	-	-	1.0	8.7	0.0	0.0
51d2e0	8.5	8.9	8.7	0.3	8.7	0.2	2.3
dbc3dc	9.2	8.4	8.6	1.0	8.7	0.42	4.77
1198ac	8.9	8.8	8.6	0.1	8.8	0.15	1.74
4154b9	9.0	9.1	8.8	0.4	9.0	0.15	1.7
f2feb9	9.0	9.0	9.0	1.7	9.0	0.0	0.0
dcda09	9.0	9.0	9.0	0.3	9.0	0.0	0.0
c4690c	9.0	9.0	9.0	0.5	9.0	0.0	0.0
cbe732	9.1	9.2	8.7	2.5	9.0	0.28	3.15
e18dad	9.0	9.0	9.0	1.0	9.0	0.0	0.0
6ca7c3	9.0	9.0	9.0	-	9.0	0.0	0.0
218cd3	8.6	9.2	9.5	0.5	9.1	0.46	5.04
ba0a1f	9.0	9.0	10.0	0.2	9.3	0.58	6.19
346a9a	9.0	10.0	9.0	1.0	9.3	0.58	6.19
2f9590	9.7	9.0	9.4	0.9	9.4	0.35	3.75
f4266e	9.4	9.4	9.3	3.5	9.4	0.06	0.62
9f937c	10.0	10.0	9.0	0.1	9.7	0.58	5.97
4df05e	9.8	10.2	9.1	2.0	9.7	0.56	5.74
88377f	10.9	9.9	-	0.3	10.4	0.71	6.8
4c84bf	11.0	11.0	10.0	0.6	10.7	0.58	5.41

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1.5.2 The Numerical Procedure for Determining Outliers
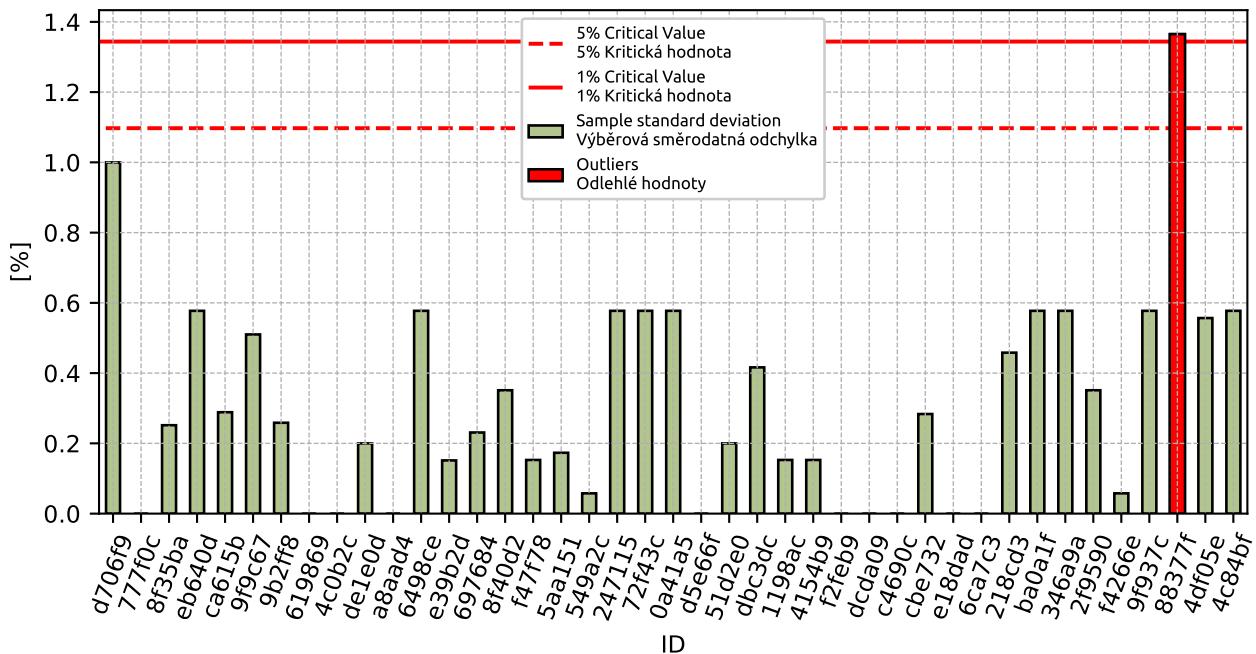

Figure 40: **Cochran's test** - sample standard deviations
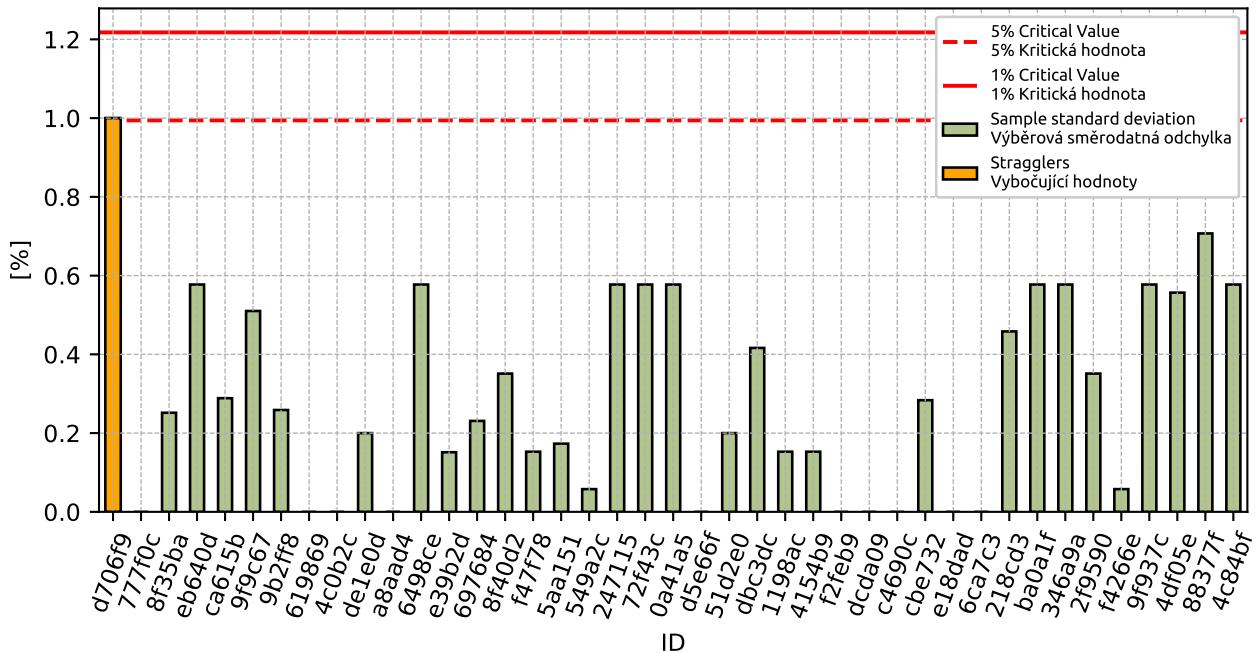
Figure 41: **Cochran's test** - sample standard deviations without outliers

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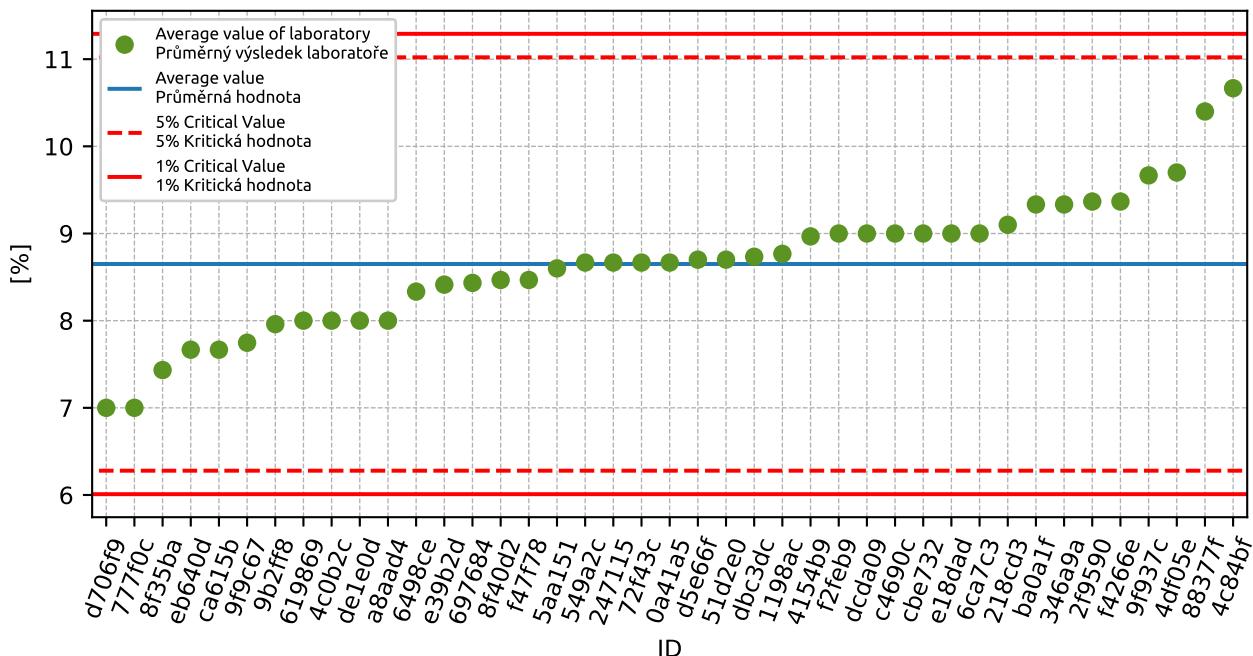
Figure 42: **Grubbs' test** - average values

1.5.3   Mandel's Statistics
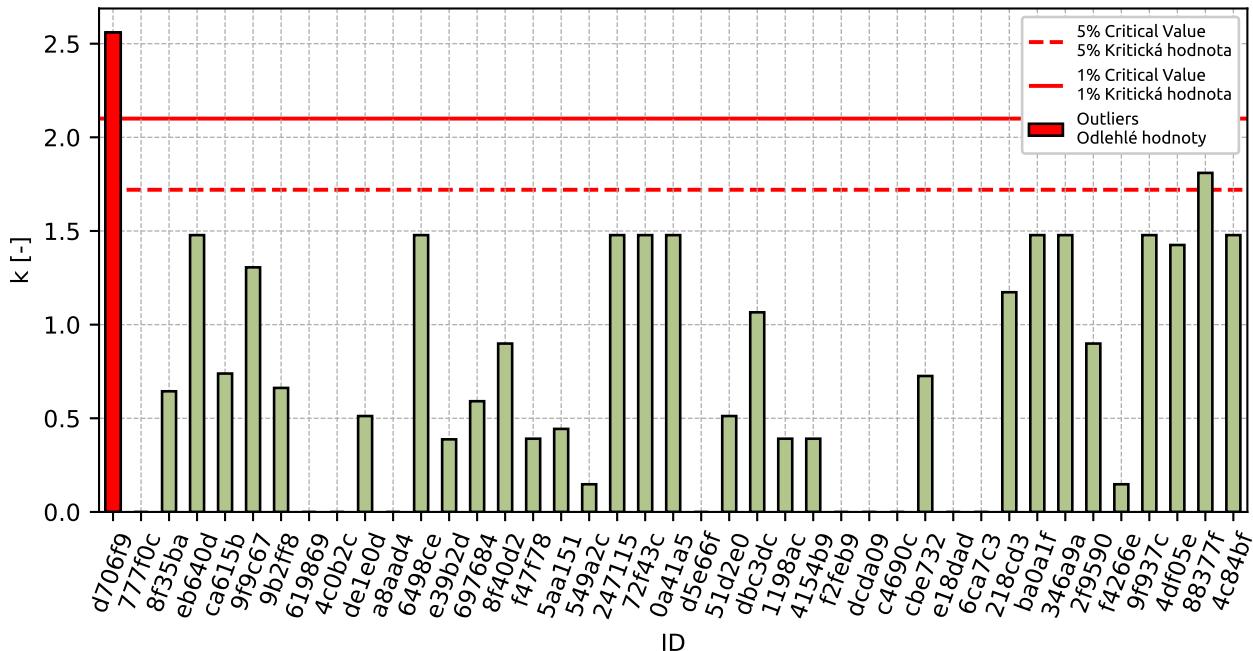
Figure 43: Intralaboratory Consistency Statistic

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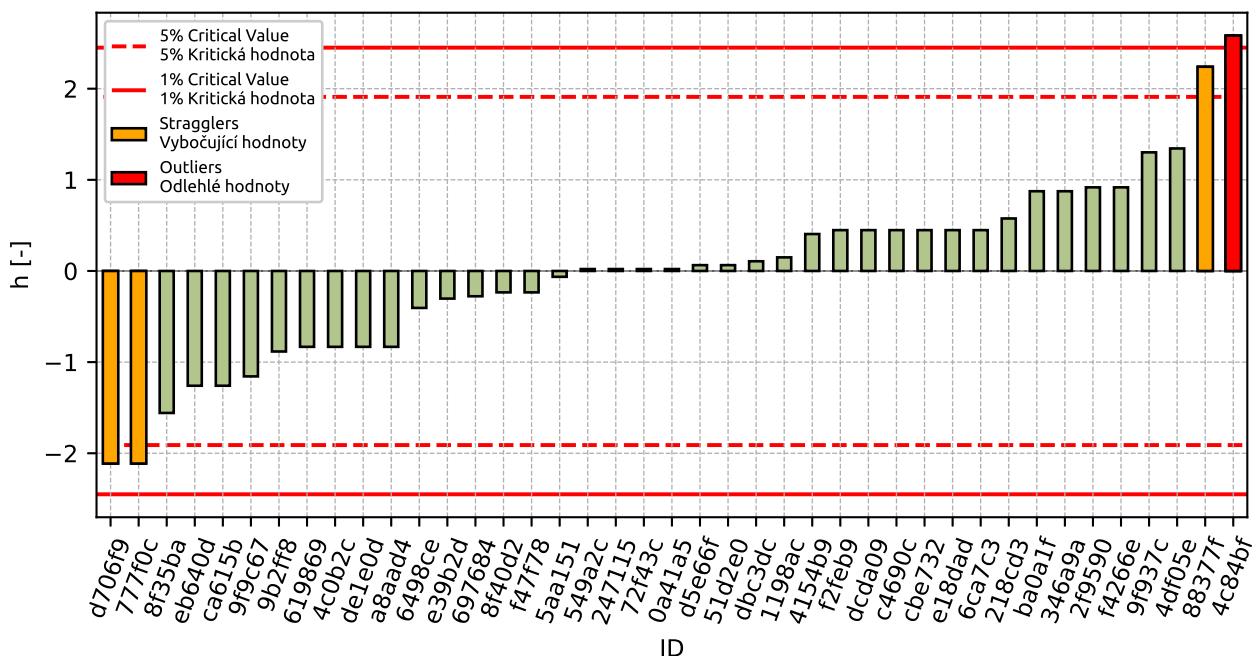
Figure 44: Interlaboratory Consistency Statistic

1.5.4   Descriptive statistics
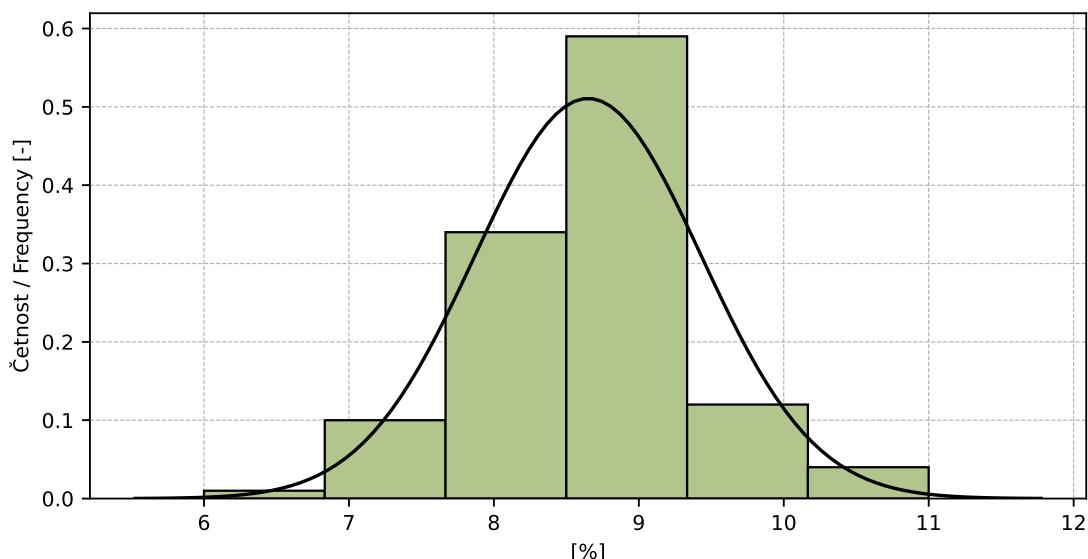
Figure 45: Histogram of all test results

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Table 18: Descriptive statistics

| Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	8.7
Výběrová směrodatná odchylka / Sample standard deviation – s	0.78
Vztažná hodnota / Asigned value – x^*	8.7
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.67
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.13
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.75
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.39
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.84
Opakovatelnost / Repeatability – r	1.1
Reprodukovatelnost / Reproducibility – R	2.4

1.5.5 Evaluation of Performance Statistics
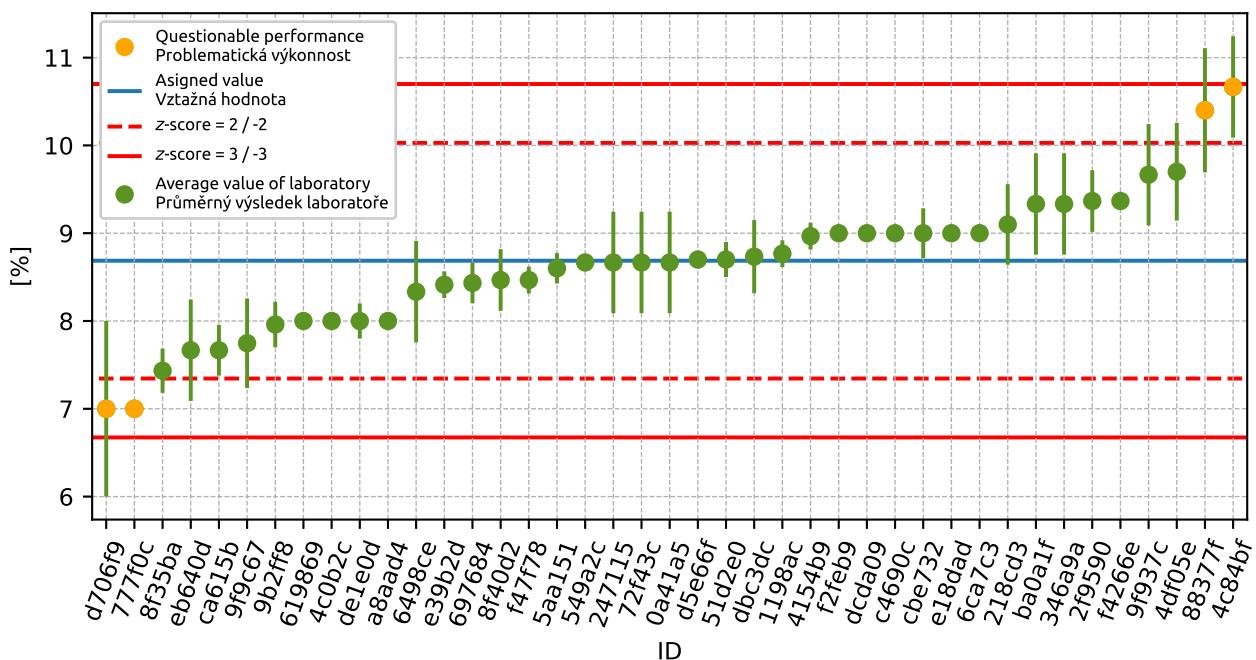
Figure 46: Average values and sample standard deviations

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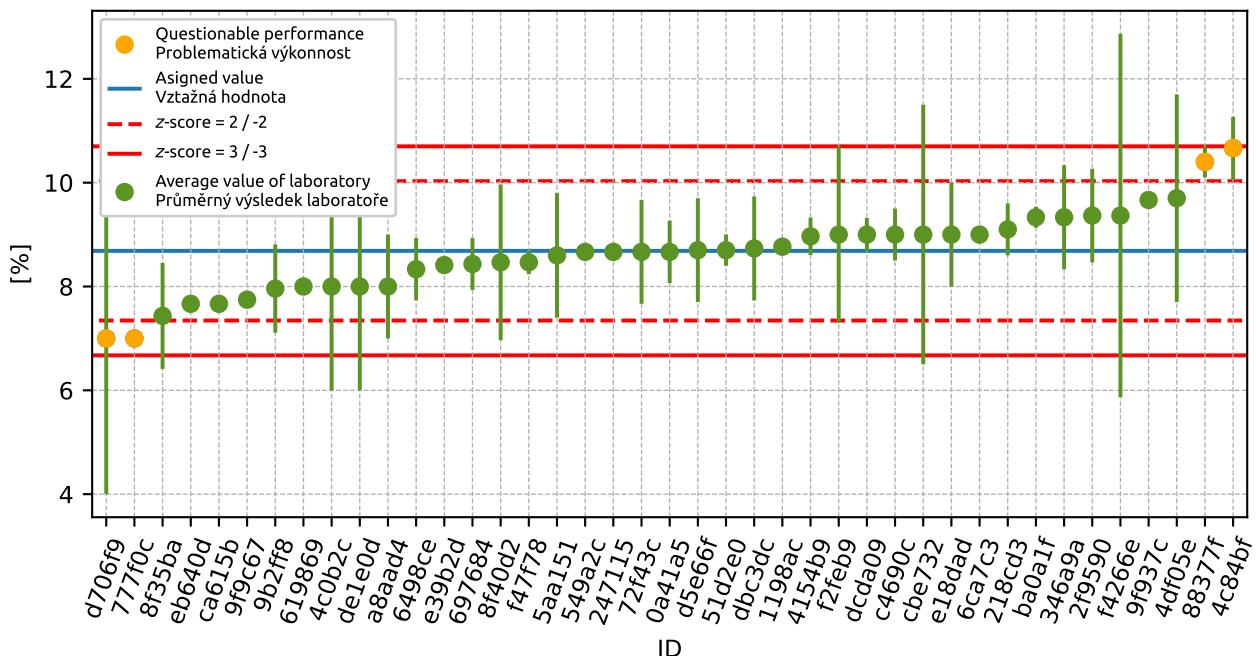
Figure 47: Average values and extended uncertainties of measurement

Figure 48: z-score

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Figure 49: ζ-score

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Table 19: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d706f9	-2.51	-0.56
777f0c	-2.51	-
8f35ba	-1.87	-1.22
eb640d	-1.52	-
ca615b	-1.52	-
9f9c67	-1.4	-
9b2ff8	-1.08	-0.84
619869	-1.02	-
4c0b2c	-1.02	-0.34
de1e0d	-1.02	-0.34
a8aad4	-1.02	-0.68
6498ce	-0.53	-0.58
e39b2d	-0.41	-
697684	-0.38	-0.49
8f40d2	-0.33	-0.15
f47f78	-0.33	-0.83
5aa151	-0.13	-0.07
549a2c	-0.03	-
247115	-0.03	-0.1
72f43c	-0.03	-0.02
0a41a5	-0.03	-0.03
d5e66f	0.02	0.01
51d2e0	0.02	0.04
dbc3dc	0.07	0.05
1198ac	0.12	0.52
4154b9	0.42	0.73
f2feb9	0.47	0.18
dcda09	0.47	0.91
c4690c	0.47	0.61
cbe732	0.47	0.13
e18dad	0.47	0.31
6ca7c3	0.47	-
218cd3	0.62	0.8
ba0a1f	0.96	2.71
346a9a	0.96	0.64
2f9590	1.01	0.75
f4266e	1.01	0.19
9f937c	1.46	5.31
4df05e	1.51	0.51
88377f	2.55	5.23
4c84bf	2.95	3.22

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1.6   0.125 mm

1.6.1   Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
dcda09	1.0	1.0	1.0	0.2	1.0	0.0	0.0
a8aad4	1.0	1.0	1.0	1.0	1.0	0.0	0.0
6ca7c3	1.0	1.0	1.0	-	1.0	0.0	0.0
e18dad	1.0	1.0	1.0	1.0	1.0	0.0	0.0
eb640d	1.0	1.0	1.0	-	1.0	0.0	0.0
777f0c	1.0	1.0	1.0	-	1.0	0.0	0.0
8f35ba	1.1	1.1	1.1	1.3	1.1	0.0	0.0
9b2ff8	1.1	1.1	1.1	0.2	1.1	0.01	1.05
de1e0d	1.3	1.2	1.3	-	1.3	0.06	4.56
697684	1.3	1.3	1.2	0.2	1.3	0.06	4.56
e39b2d	1.3	1.3	1.3	-	1.3	0.02	1.32
9f9c67	1.4	1.2	1.3	-	1.3	0.08	5.82
6498ce	1.0	2.0	1.0	0.6	1.3	0.58	43.3
8f40d2	1.6	1.4	1.2	0.4	1.4	0.2	14.29
ca615b	1.5	1.5	1.3	-	1.4	0.12	8.06
2f9590	1.6	1.5	1.5	0.2	1.5	0.06	3.77
f47f78	1.6	1.6	1.5	0.1	1.6	0.06	3.69
346a9a	1.0	3.0	1.0	1.0	1.7	1.15	69.28
dbc3dc	1.8	1.8	1.7	1.1	1.8	0.06	3.27
4154b9	1.8	1.9	1.6	0.1	1.8	0.15	8.65
549a2c	1.9	1.7	1.8	-	1.8	0.1	5.56
f4266e	1.9	1.9	1.9	3.5	1.9	0.0	0.0
d5e66f	1.9	-	-	0.2	1.9	0.0	0.0
1198ac	1.9	2.0	1.8	0.0	1.9	0.1	5.26
d706f9	2.0	2.0	2.0	-	2.0	0.0	0.0
247115	2.0	2.0	2.0	0.1	2.0	0.0	0.0
4c0b2c	2.0	2.0	2.0	2.0	2.0	0.0	0.0
f2feb9	2.0	2.0	2.0	1.7	2.0	0.0	0.0
619869	2.0	2.0	2.0	-	2.0	0.0	0.0
0a41a5	2.0	2.0	2.0	0.6	2.0	0.0	0.0
72f43c	2.0	2.0	2.0	1.0	2.0	0.0	0.0
ba0a1f	2.0	2.0	2.0	0.1	2.0	0.0	0.0
9f937c	2.0	2.0	2.0	0.1	2.0	0.0	0.0
88377f	2.0	2.0	2.0	0.1	2.0	0.0	0.0
c4690c	2.0	2.0	2.0	0.5	2.0	0.0	0.0
4c84bf	2.0	2.0	2.0	0.6	2.0	0.0	0.0
cbe732	1.9	2.2	1.9	2.5	2.0	0.18	9.06
218cd3	2.0	2.0	2.1	0.5	2.0	0.06	2.84
5aa151	2.2	2.0	2.0	0.4	2.1	0.12	5.59
51d2e0	2.1	2.1	2.2	0.1	2.1	0.06	2.71
4df05e	2.1	2.3	2.2	2.0	2.2	0.1	4.55

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1.6.2　The Numerical Procedure for Determining Outliers
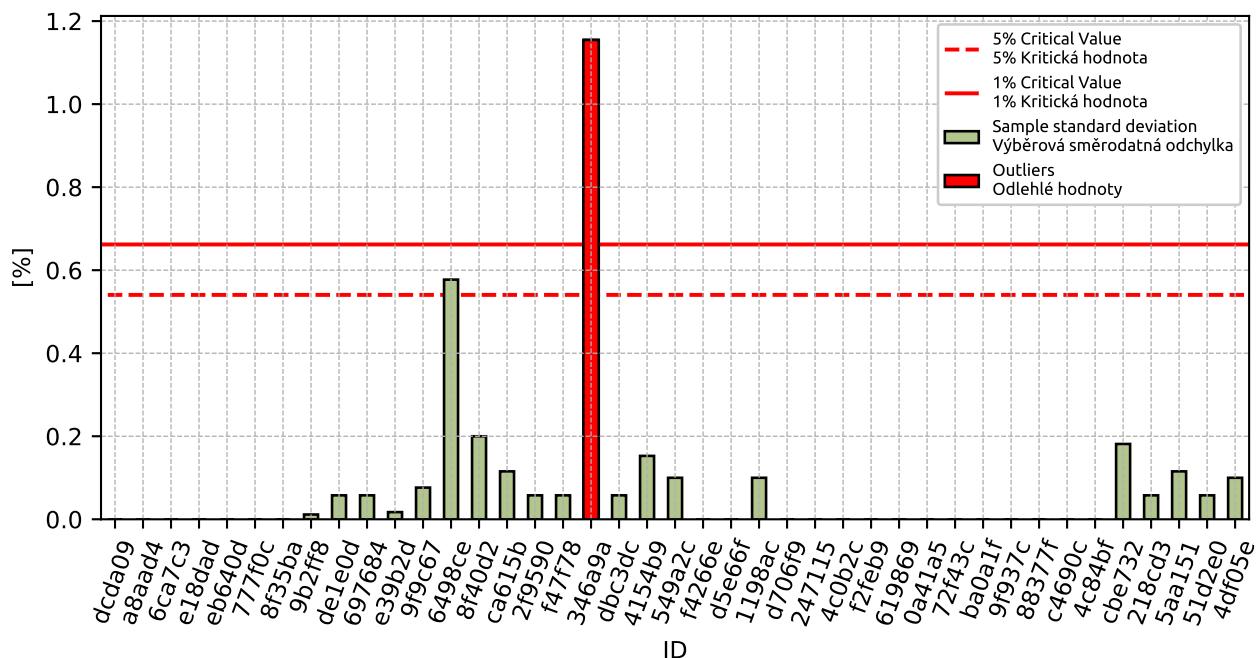
Figure 50: **Cochran's test** - sample standard deviations
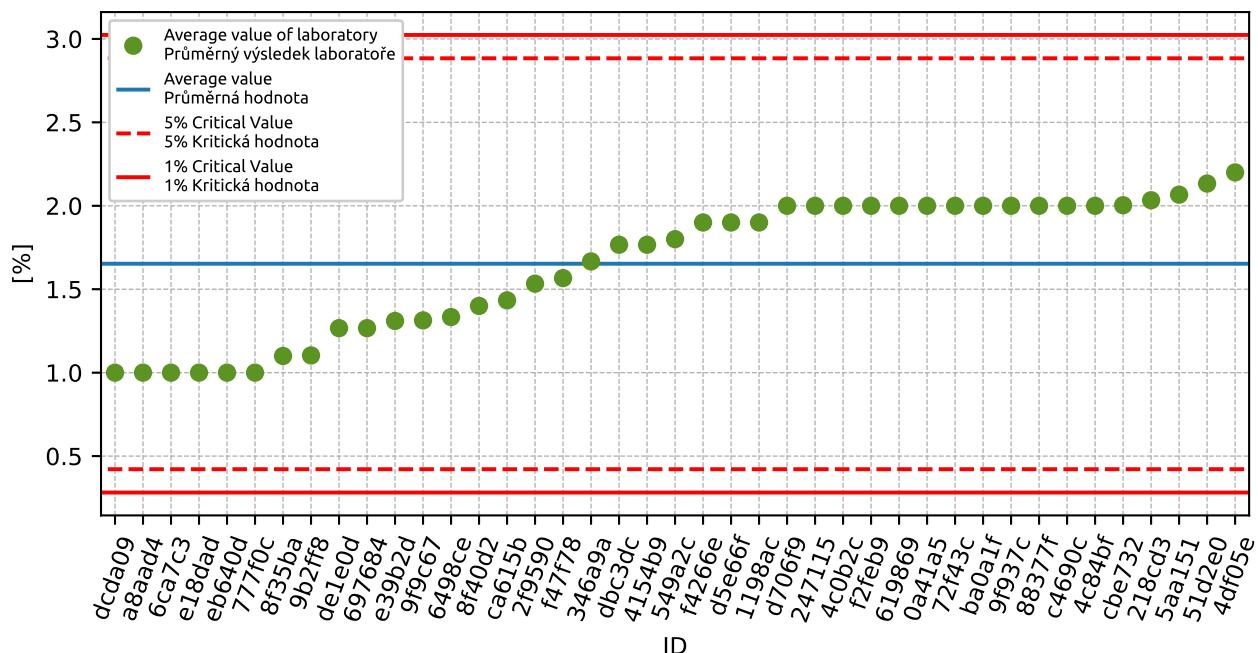
Figure 51: **Grubbs' test** - average values

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1.6.3　Mandel's Statistics
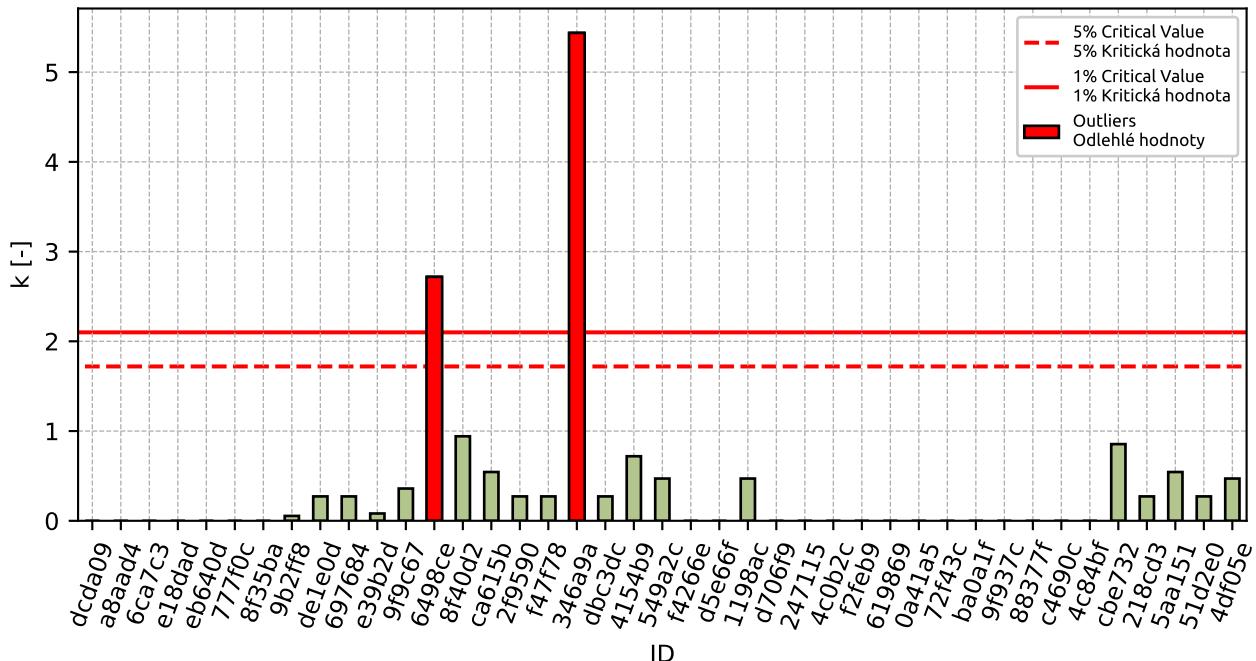
Figure 52: Intralaboratory Consistency Statistic
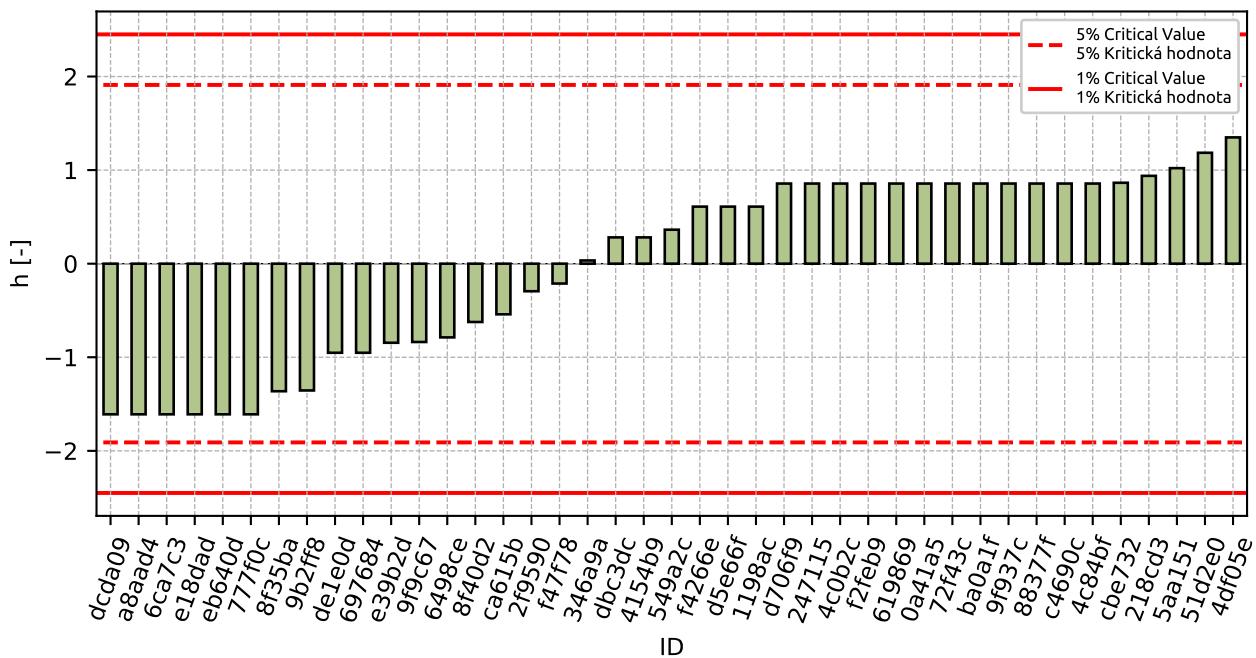
Figure 53: Interlaboratory Consistency Statistic

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1.6.4　Descriptive statistics
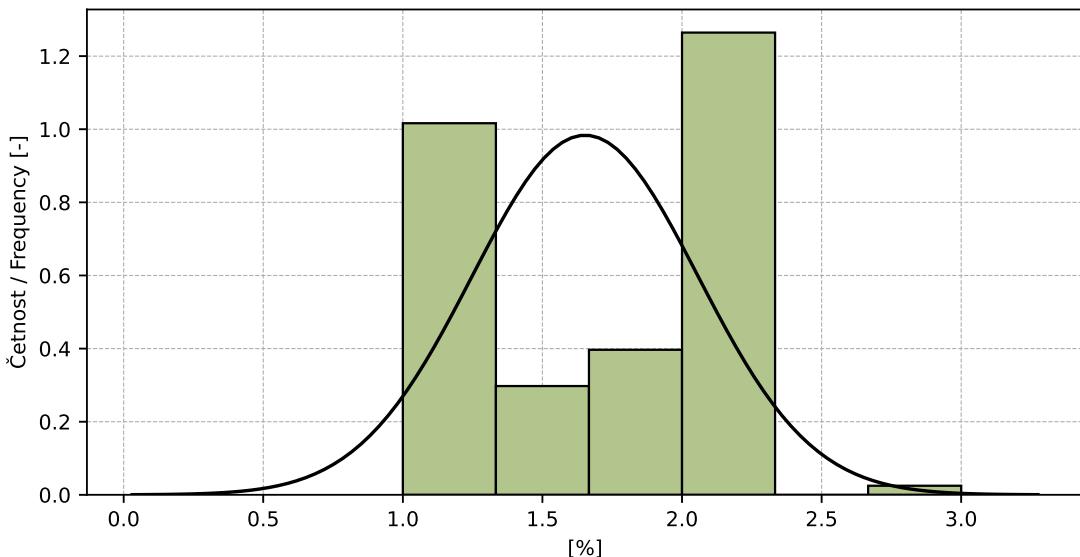
Figure 54: Histogram of all test results

Table 21: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	1.7
Výběrová směrodatná odchylka / Sample standard deviation – s	0.41
Vztažná hodnota / Asigned value – x^*	1.7
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.37
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.07
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.39
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.21
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.44
Opakovatelnost / Repeatability – r	0.6
Reprodukovatelnost / Reproducibility – R	1.2

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1.6.5   Evaluation of Performance Statistics
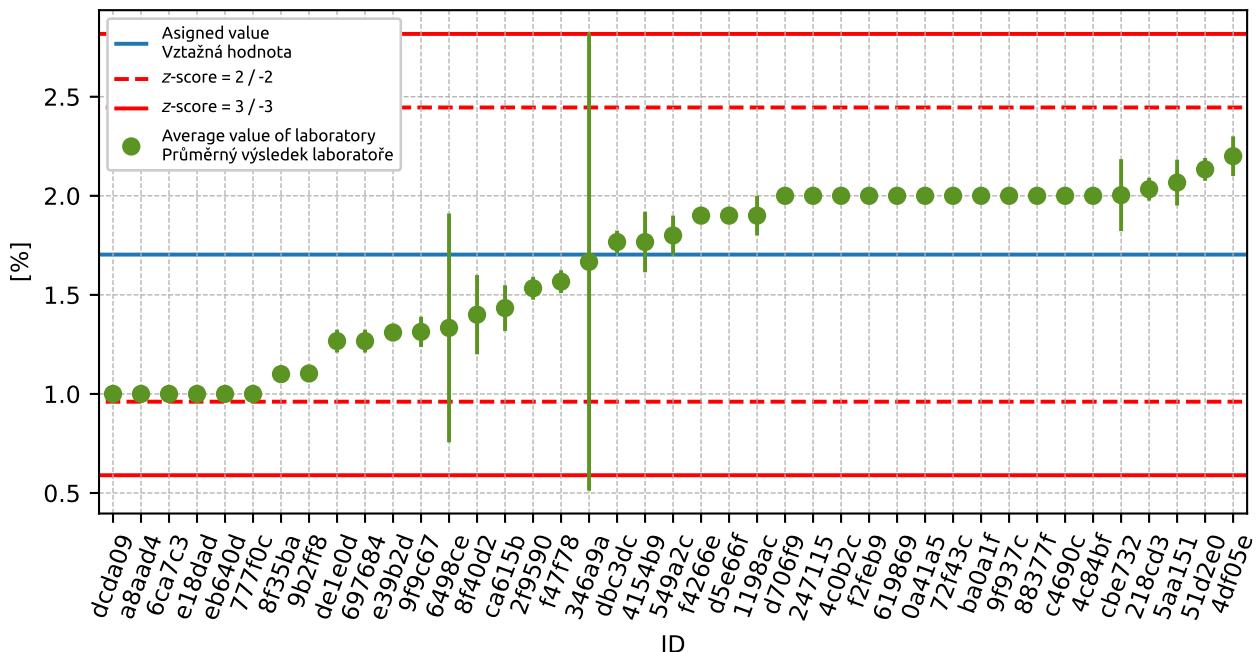
Figure 55: Average values and sample standard deviations
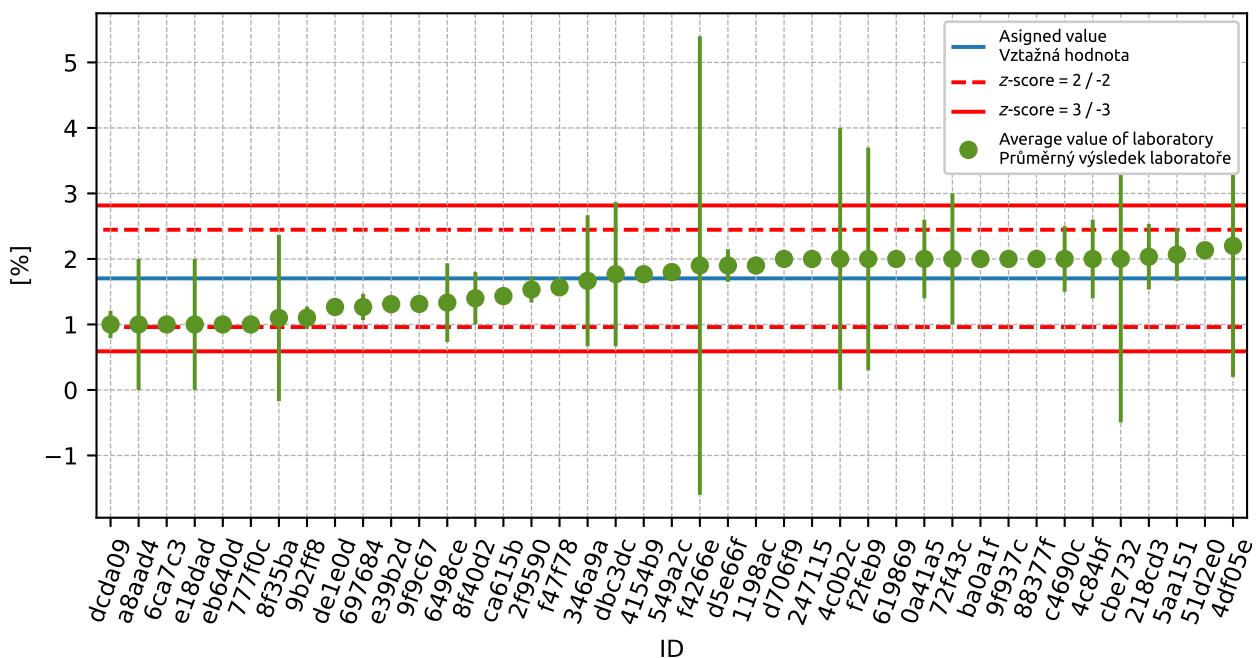
Figure 56: Average values and extended uncertainties of measurement

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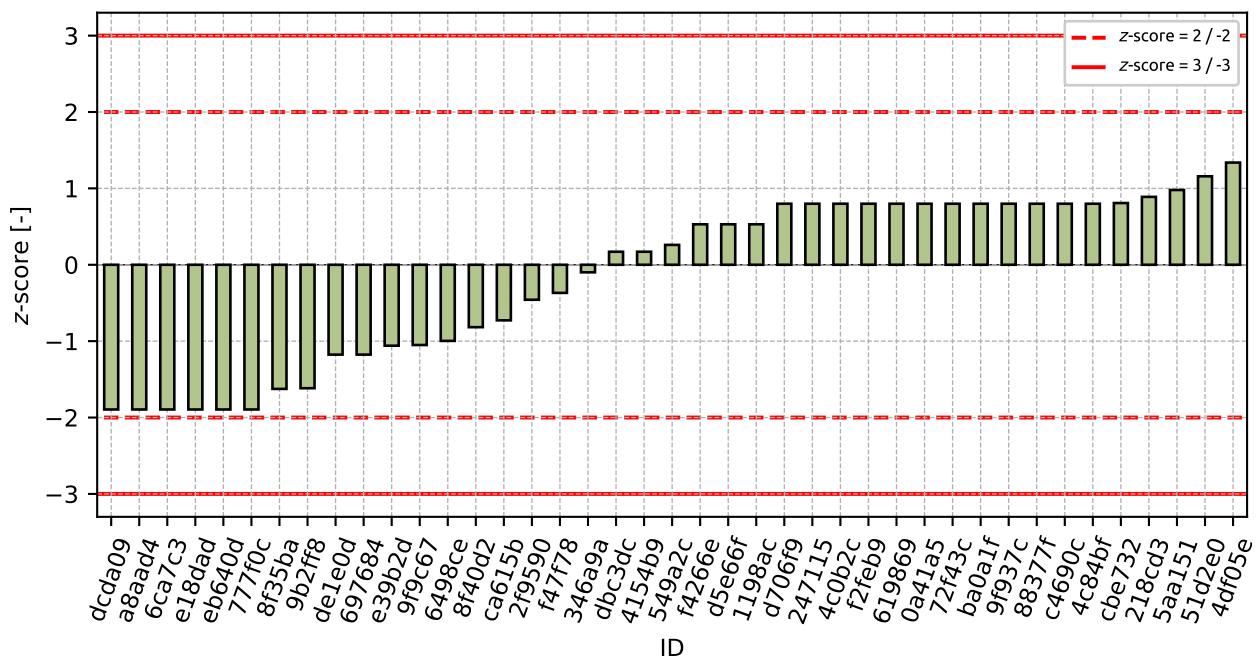
Figure 57: z-score

Figure 58: ζ-score

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Table 22: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dcda09	-1.89	-3.17
a8aad4	-1.89	-0.7
6ca7c3	-1.89	-
e18dad	-1.89	-0.7
eb640d	-1.89	-
777f0c	-1.89	-
8f35ba	-1.63	-0.47
9b2ff8	-1.62	-3.25
de1e0d	-1.18	-
697684	-1.18	-2.05
e39b2d	-1.06	-
9f9c67	-1.05	-
6498ce	-1.0	-0.61
8f40d2	-0.82	-0.75
ca615b	-0.73	-
2f9590	-0.46	-0.8
f47f78	-0.37	-1.5
346a9a	-0.1	-0.04
dbc3dc	0.17	0.06
4154b9	0.17	0.62
549a2c	0.26	-
f4266e	0.53	0.06
d5e66f	0.53	0.76
1198ac	0.53	2.62
d706f9	0.8	-
247115	0.8	2.25
4c0b2c	0.8	0.15
f2feb9	0.8	0.17
619869	0.8	-
0a41a5	0.8	0.49
72f43c	0.8	0.3
ba0a1f	0.8	2.4
9f937c	0.8	1.99
88377f	0.8	2.4
c4690c	0.8	0.59
4c84bf	0.8	0.49
cbe732	0.81	0.12
218cd3	0.89	0.65
5aa151	0.98	0.89
51d2e0	1.16	3.48
4df05e	1.34	0.25

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1.7   0.063 mm

1.7.1   Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
eb640d	0.0	0.0	0.0	-	0.0	0.0	-
8f35ba	0.0	0.1	0.0	5.0	0.0	0.06	173.21
e18dad	0.2	0.2	0.1	1.0	0.2	0.06	34.64
a8aad4	0.2	0.2	0.3	0.1	0.2	0.06	24.74
697684	0.3	0.2	0.2	0.1	0.2	0.03	12.91
9b2ff8	0.2	0.2	0.2	0.2	0.2	0.02	6.45
e39b2d	0.2	0.3	0.3	-	0.3	0.03	11.04
dcda09	0.3	0.3	0.3	0.2	0.3	0.0	0.0
777f0c	0.3	0.3	0.3	-	0.3	0.0	0.0
de1e0d	0.3	0.3	0.3	0.3	0.3	0.0	0.0
6498ce	0.3	0.4	0.3	0.1	0.3	0.06	17.32
9f9c67	0.3	0.3	0.3	-	0.3	0.01	1.73
8f40d2	0.3	0.3	0.4	0.1	0.3	0.06	17.32
346a9a	0.4	0.5	0.2	0.5	0.4	0.15	41.66
ca615b	0.5	0.4	0.3	-	0.4	0.1	25.0
619869	0.4	0.4	0.4	-	0.4	0.0	0.0
2f9590	0.4	0.4	0.4	0.1	0.4	0.0	0.0
6ca7c3	0.6	0.6	0.6	-	0.6	0.0	0.0
f47f78	0.8	0.6	0.7	0.1	0.7	0.1	14.29
ba0a1f	0.6	0.7	0.9	0.1	0.7	0.15	20.83
549a2c	0.9	0.7	0.7	-	0.8	0.12	15.06
4154b9	0.9	0.7	0.7	0.0	0.8	0.12	15.06
d5e66f	0.8	-	-	0.1	0.8	0.0	0.0
72f43c	0.7	0.9	0.8	0.1	0.8	0.1	12.5
f4266e	0.9	0.8	0.8	3.5	0.8	0.06	6.93
0a41a5	0.9	1.0	0.7	0.6	0.9	0.15	17.63
5aa151	0.9	0.8	0.9	0.4	0.9	0.06	6.66
1198ac	0.8	1.1	0.7	0.0	0.9	0.21	24.02
c4690c	0.8	0.9	0.9	0.4	0.9	0.06	6.66
d706f9	0.9	0.8	1.0	0.3	0.9	0.1	11.11
4c84bf	1.0	0.9	1.0	0.6	1.0	0.06	5.97
247115	1.0	1.0	1.0	0.1	1.0	0.0	0.0
dbc3dc	0.8	1.2	1.1	1.6	1.0	0.21	20.15
cbe732	1.0	1.2	0.9	2.5	1.1	0.15	14.52
88377f	1.0	1.1	1.1	0.0	1.1	0.06	5.41
f2feb9	0.9	1.1	1.2	1.7	1.1	0.15	14.32
218cd3	1.1	1.0	1.1	1.0	1.1	0.06	5.41
51d2e0	1.2	1.1	1.1	0.1	1.1	0.06	5.09
4df05e	1.1	1.1	1.2	2.0	1.1	0.06	5.09
9f937c	1.3	1.3	1.2	0.1	1.3	0.06	4.56
4c0b2c	1.2	1.3	1.3	1.0	1.3	0.06	4.56

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1.7.2 The Numerical Procedure for Determining Outliers
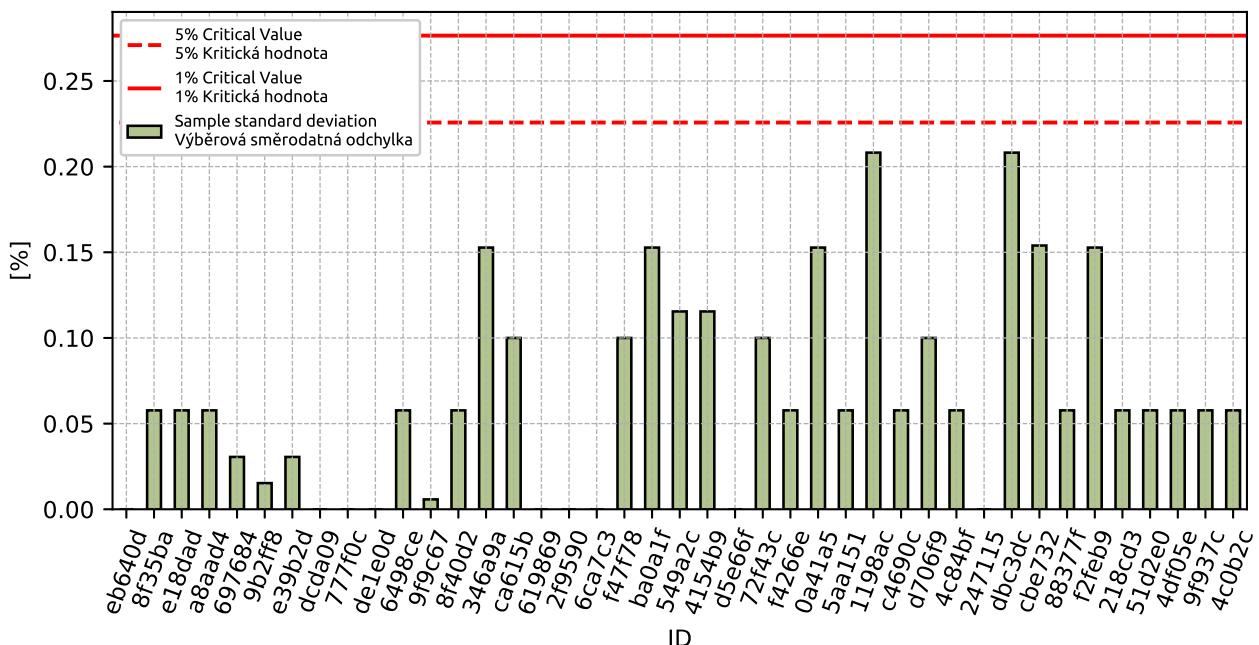
Figure 59: **Cochran's test** - sample standard deviations
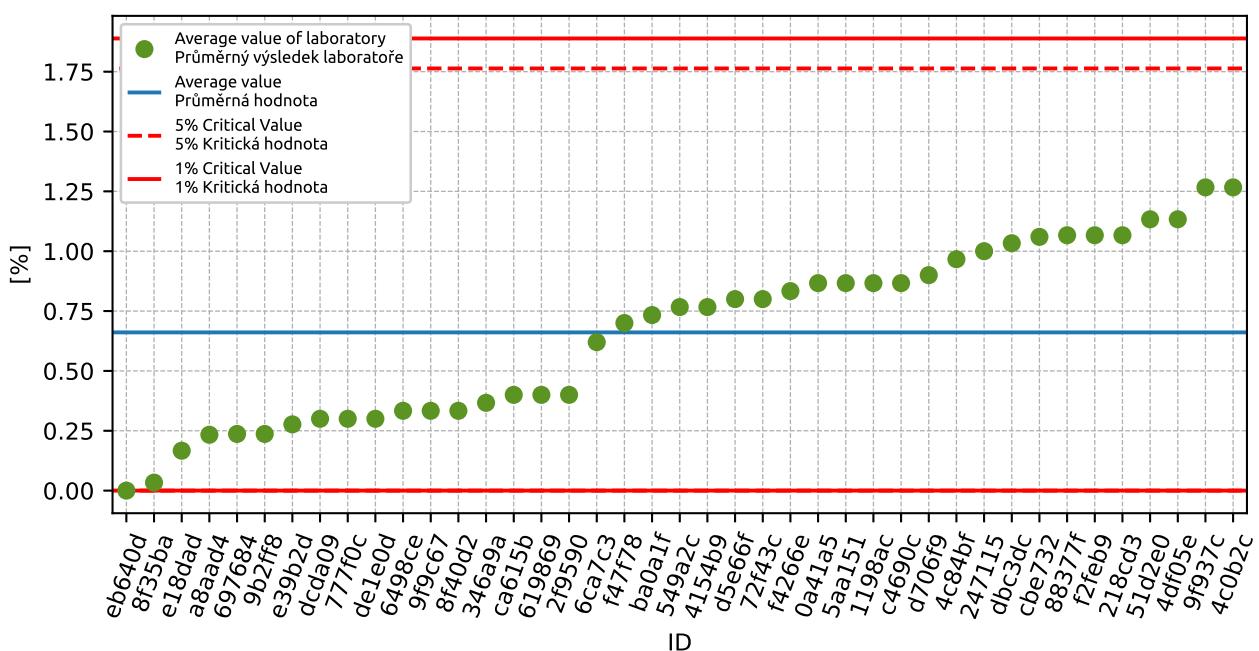
Figure 60: **Grubbs' test** - average values

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1.7.3   Mandel's Statistics
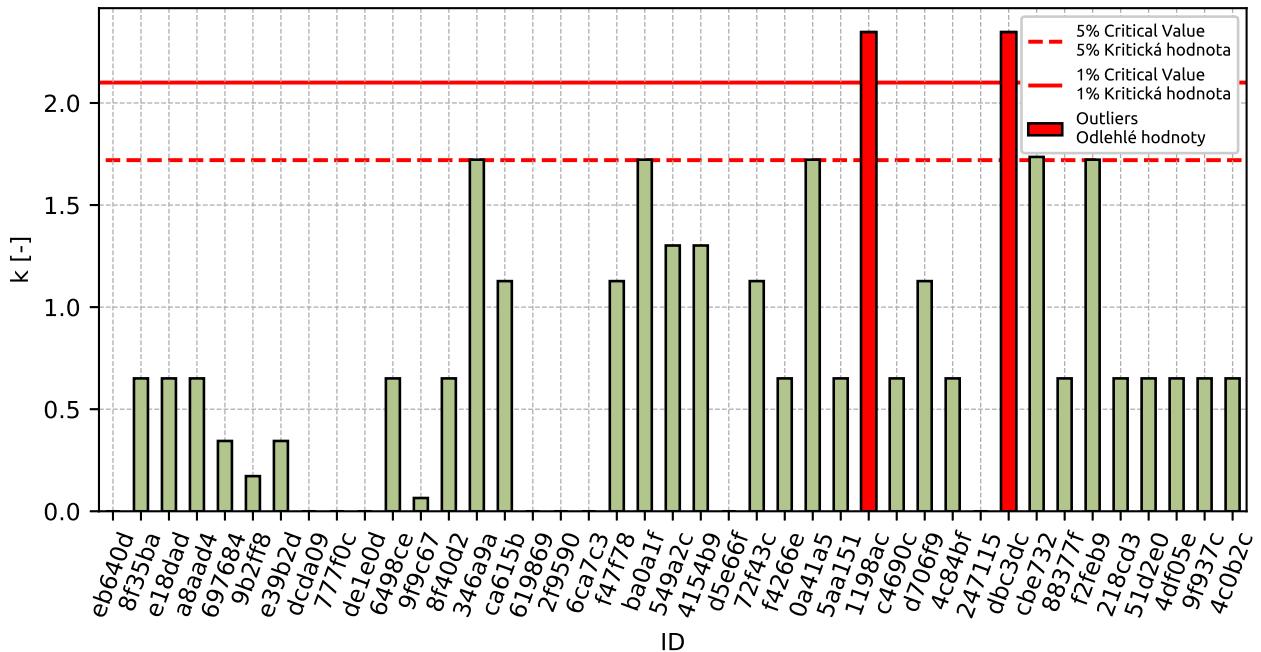
Figure 61: Intralaboratory Consistency Statistic
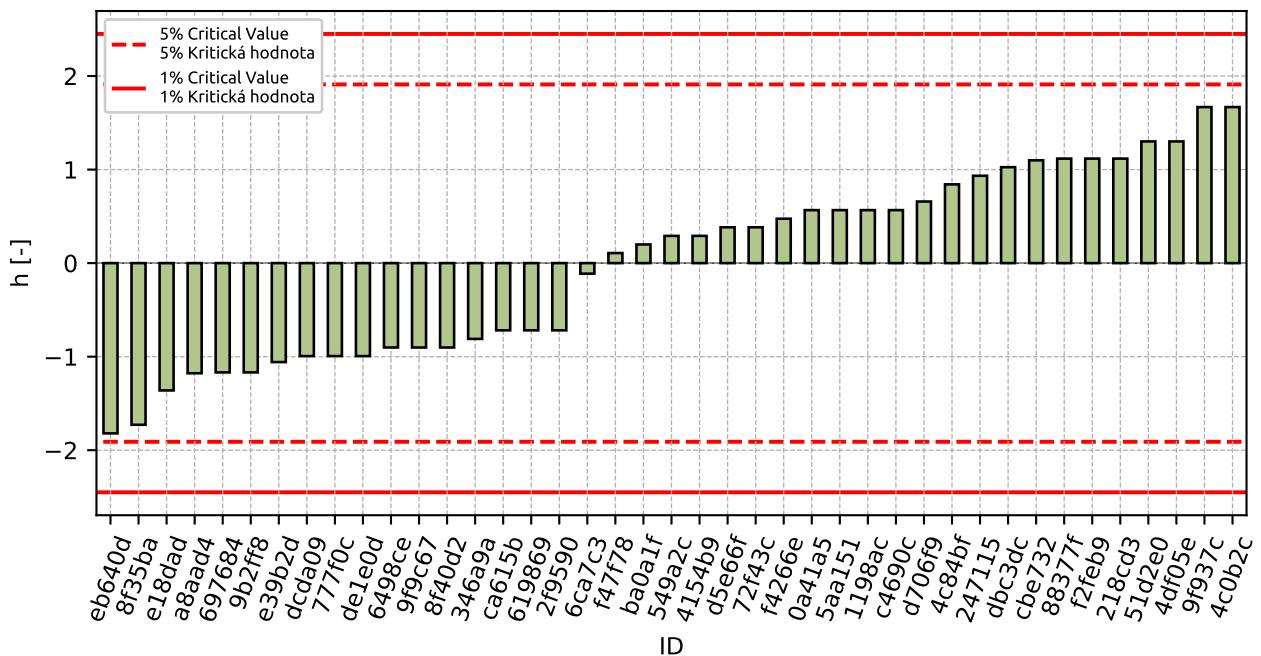
Figure 62: Interlaboratory Consistency Statistic

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1.7.4 Descriptive statistics
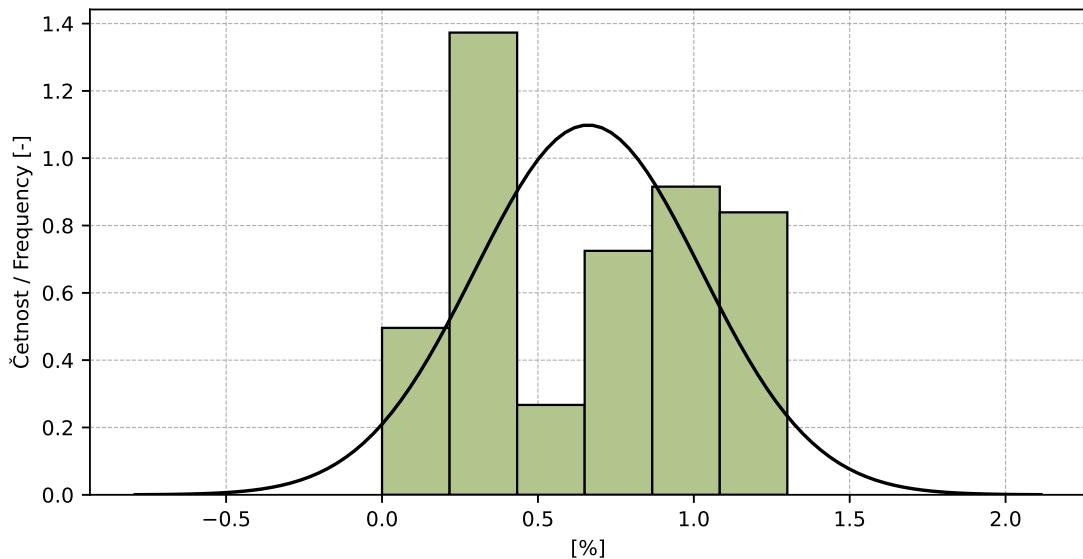
Figure 63: Histogram of all test results

Table 24: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	0.7
Výběrová směrodatná odchylka / Sample standard deviation – s	0.36
Vztažná hodnota / Asigned value – x^*	0.7
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.4
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.08
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.36
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.09
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.37
Opakovatelnost / Repeatability – r	0.2
Reprodukovatelnost / Reproducibility – R	1.0

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1.7.5   Evaluation of Performance Statistics
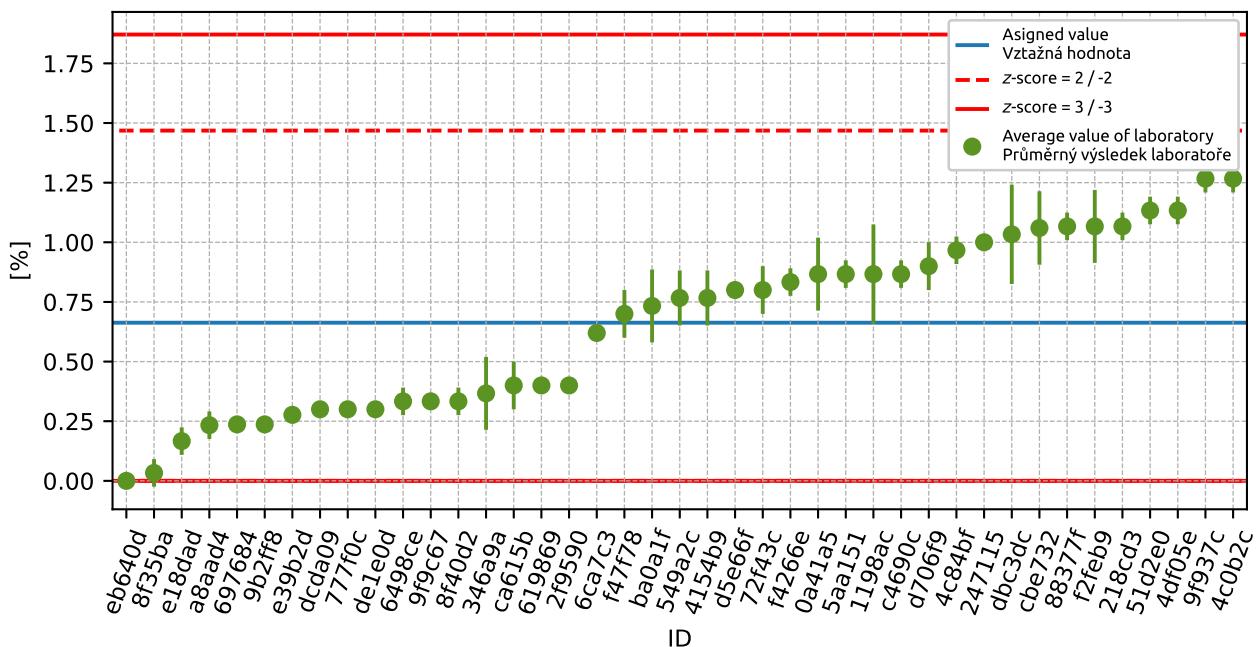
Figure 64: Average values and sample standard deviations
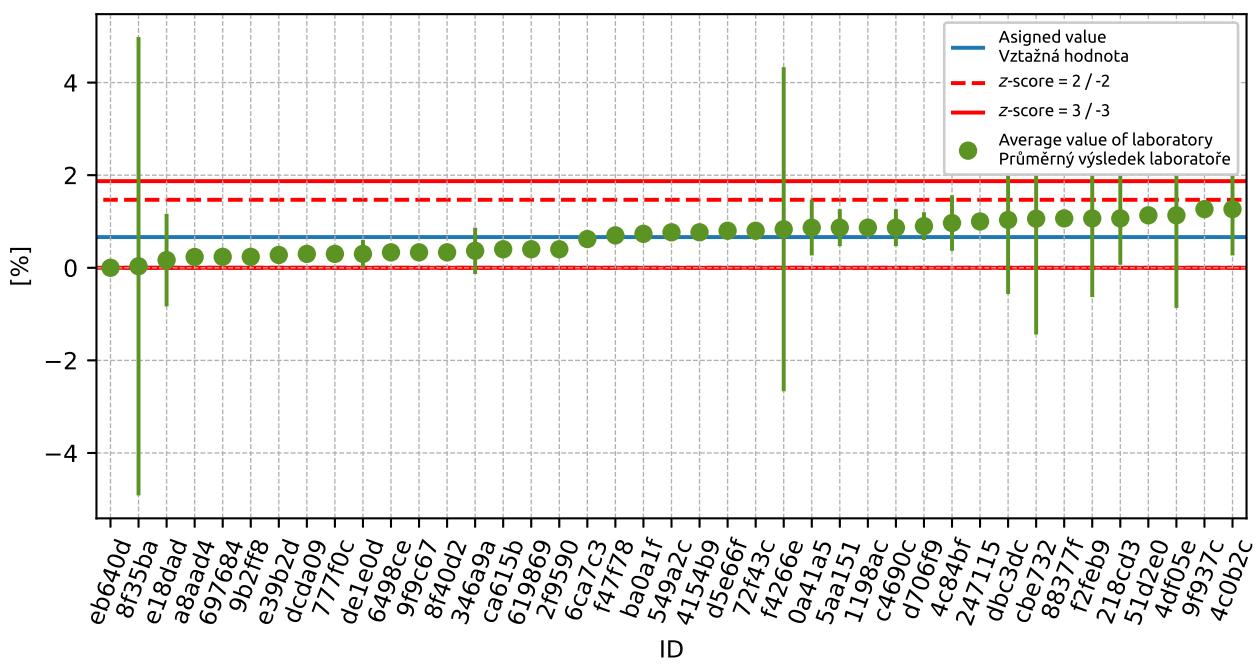
Figure 65: Average values and extended uncertainties of measurement

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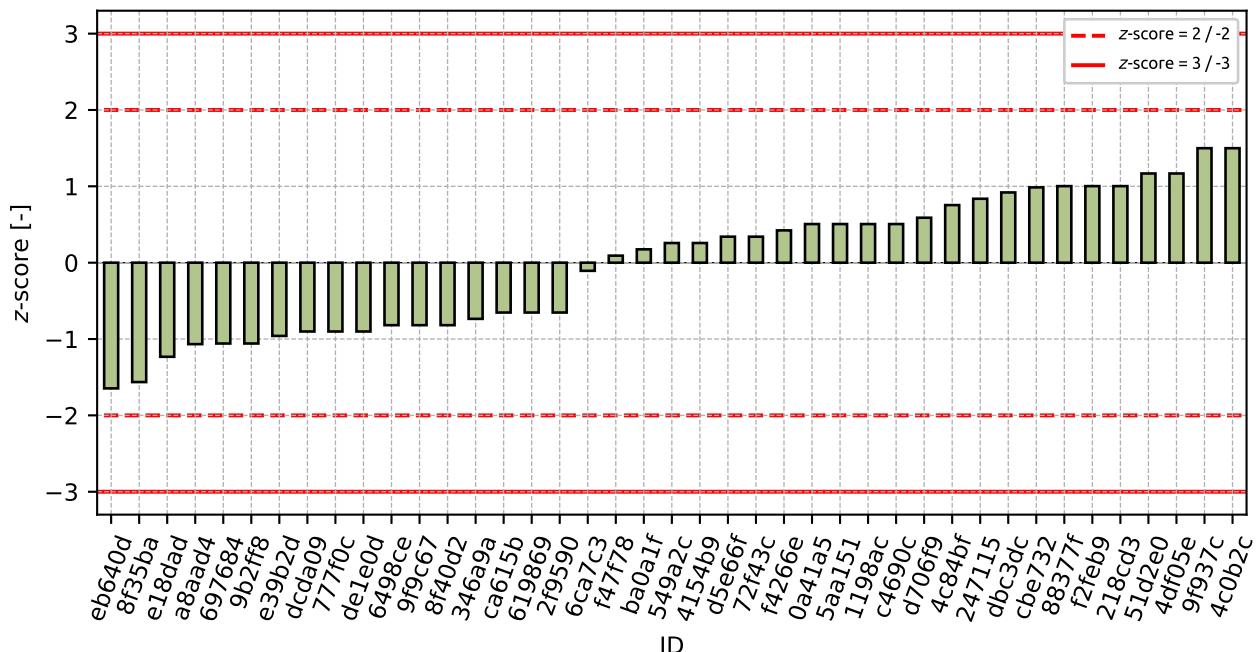
Figure 66: z-score

Figure 67: ζ-score

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Table 25: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
eb640d	-1.65	-
8f35ba	-1.56	-0.13
e18dad	-1.23	-0.49
a8aad4	-1.07	-3.38
697684	-1.06	-3.8
9b2ff8	-1.06	-2.17
e39b2d	-0.96	-
dcda09	-0.9	-1.94
777f0c	-0.9	-
de1e0d	-0.9	-1.17
6498ce	-0.82	-2.94
9f9c67	-0.82	-
8f40d2	-0.82	-2.59
346a9a	-0.74	-0.59
ca615b	-0.65	-
619869	-0.65	-
2f9590	-0.65	-2.07
6ca7c3	-0.11	-
f47f78	0.09	0.39
ba0a1f	0.17	0.55
549a2c	0.26	-
4154b9	0.26	1.23
d5e66f	0.34	1.08
72f43c	0.34	1.08
f4266e	0.42	0.05
0a41a5	0.51	0.34
5aa151	0.51	0.5
1198ac	0.51	2.51
c4690c	0.51	0.5
d706f9	0.59	0.76
4c84bf	0.75	0.5
247115	0.84	2.65
dbc3dc	0.92	0.23
cbe732	0.99	0.16
88377f	1.0	5.14
f2feb9	1.0	0.24
218cd3	1.0	0.4
51d2e0	1.17	3.7
4df05e	1.17	0.24
9f937c	1.5	3.97
4c0b2c	1.5	0.6

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

2.1   Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
6ca7c3	13.0	13.0	13.0	-	13.0	0.0	0.0
eb640d	15.7	15.6	15.6	0.1	15.6	0.06	0.37
8f40d2	15.8	16.0	15.6	0.3	15.8	0.2	1.27
51d2e0	15.7	16.2	16.4	0.9	16.1	0.36	2.24
697684	16.6	16.6	16.9	0.4	16.7	0.17	1.04
ca615b	18.0	18.0	18.0	-	18.0	0.0	0.0
346a9a	18.0	18.0	18.0	1.0	18.0	0.0	0.0
4a9f9e	18.0	18.0	18.0	1.0	18.0	0.0	0.0
e24a24	21.0	21.0	21.0	-	21.0	0.0	0.0

2.2   The Numerical Procedure for Determining Outliers
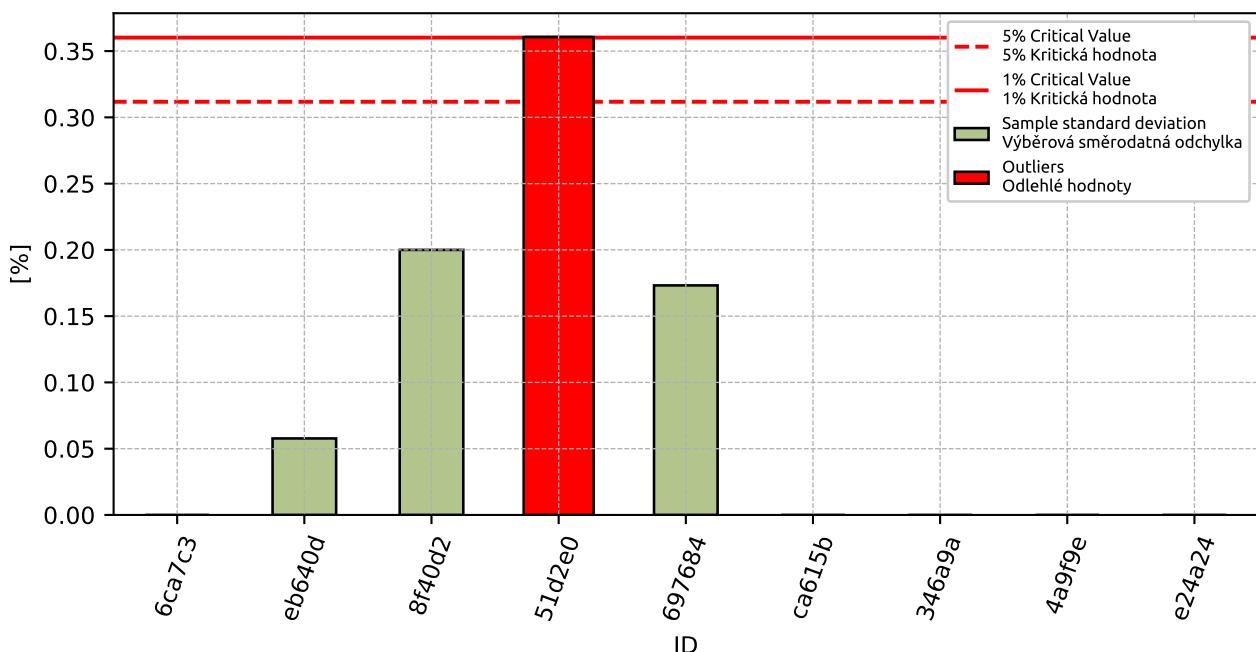
Figure 68: **Cochran's test** - sample standard deviations

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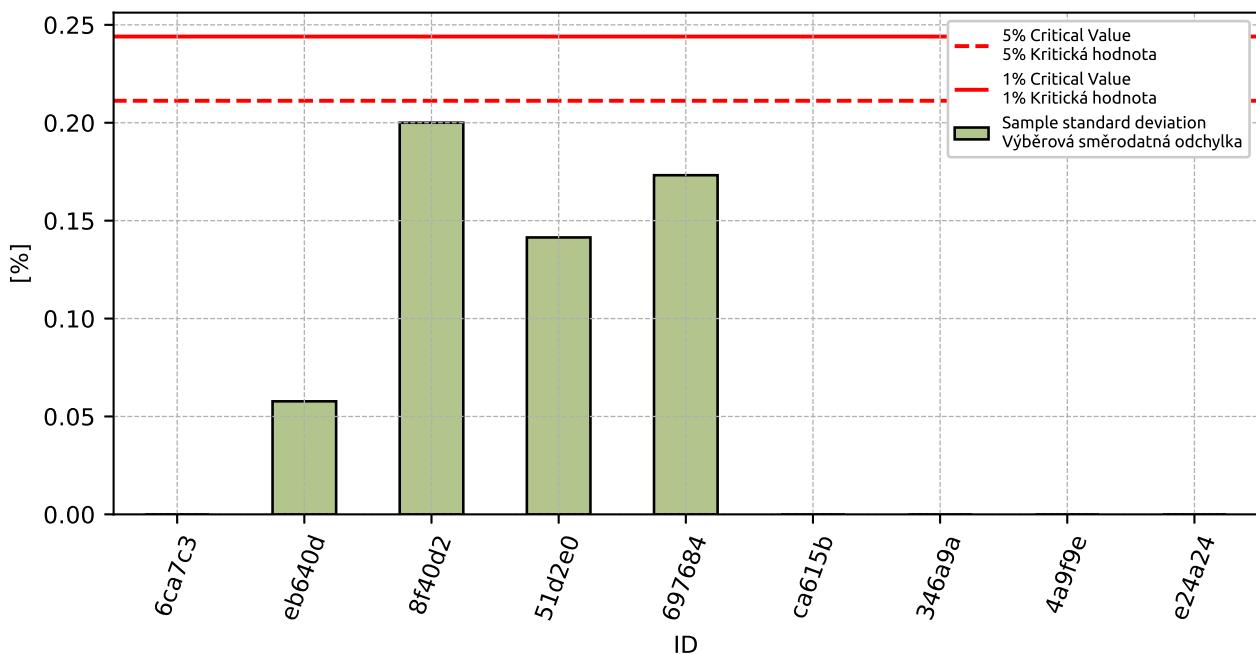
Figure 69: **Cochran's test** - sample standard deviations without outliers
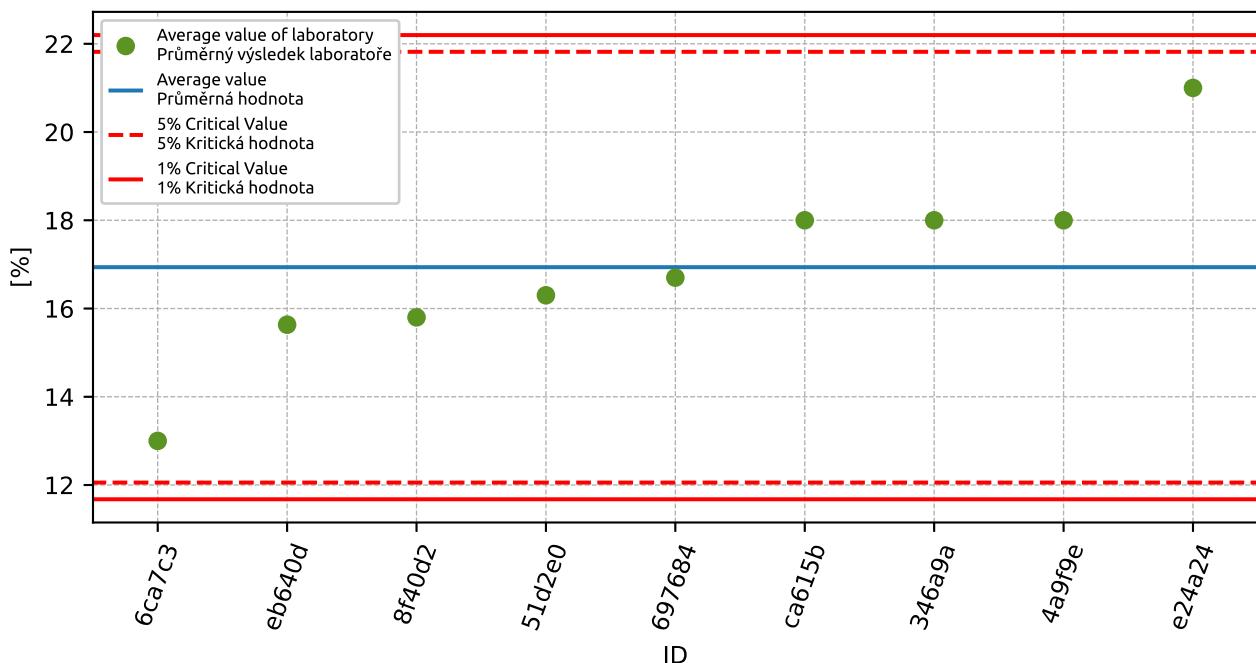

Figure 70: **Grubbs' test** - average values

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2.3   Mandel′s Statistics
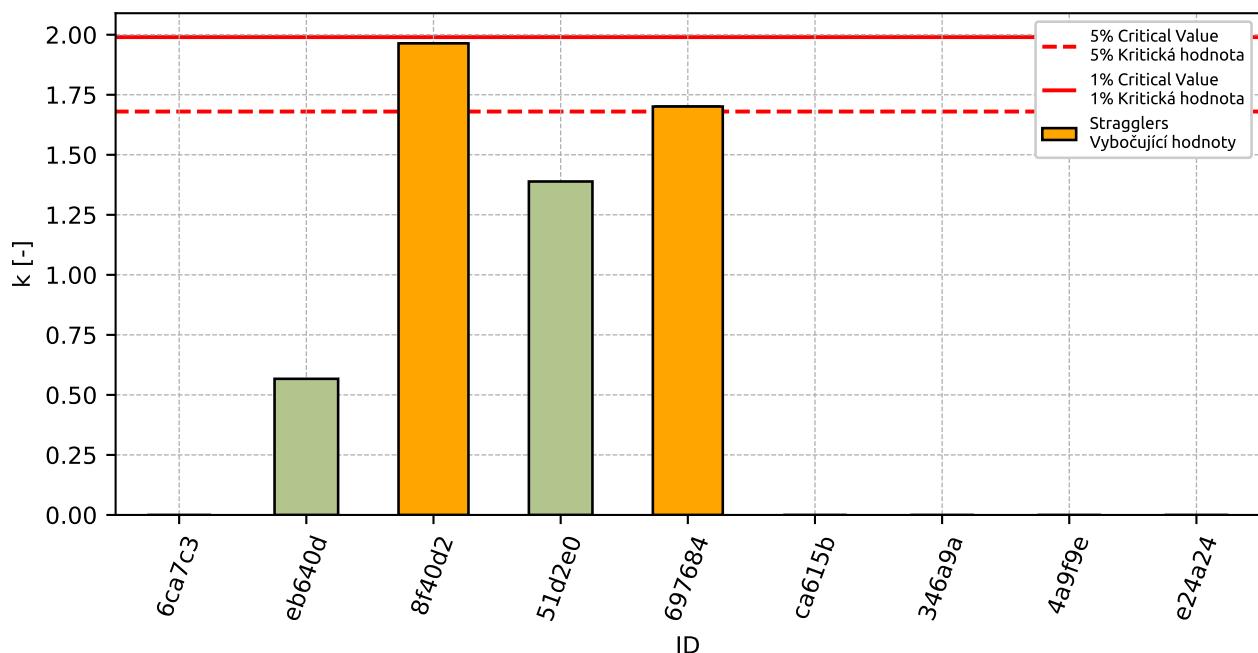
Figure 71: Intralaboratory Consistency Statistic
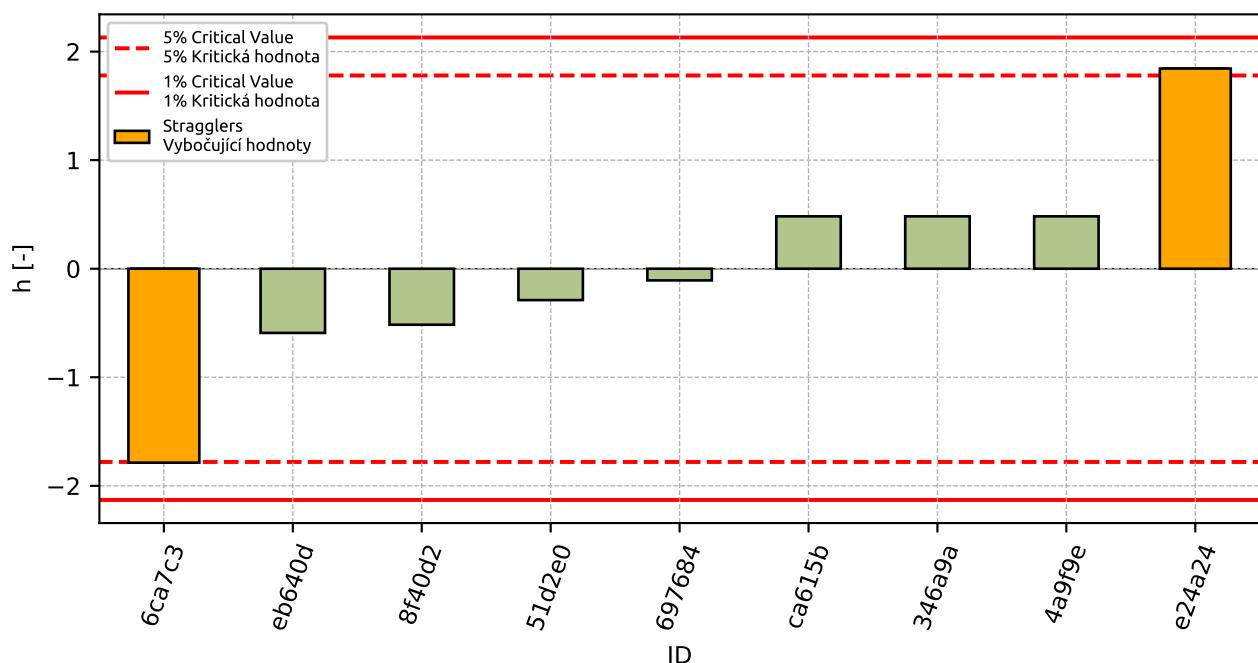
Figure 72: Interlaboratory Consistency Statistic

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2.4   Descriptive statistics
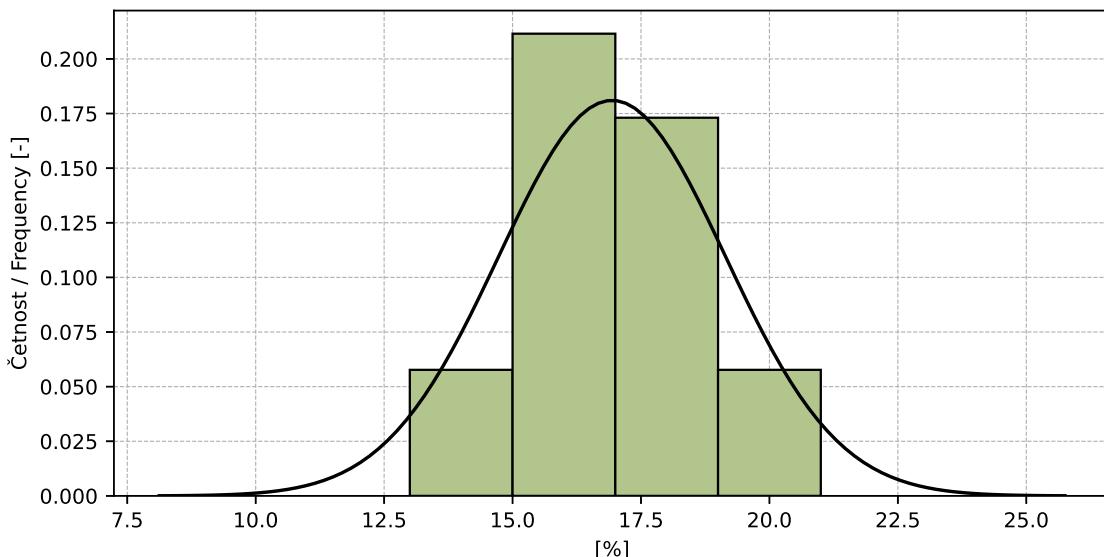
Figure 73: Histogram of all test results

Table 27: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	16.9
Výběrová směrodatná odchylka / Sample standard deviation – s	2.2
Vztažná hodnota / Asigned value – x^*	17.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	2.17
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.91
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	2.2
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.1
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	2.21
Opakovatelnost / Repeatability – r	0.3
Reprodukovatelnost / Reproducibility – R	6.2

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2.5 Evaluation of Performance Statistics
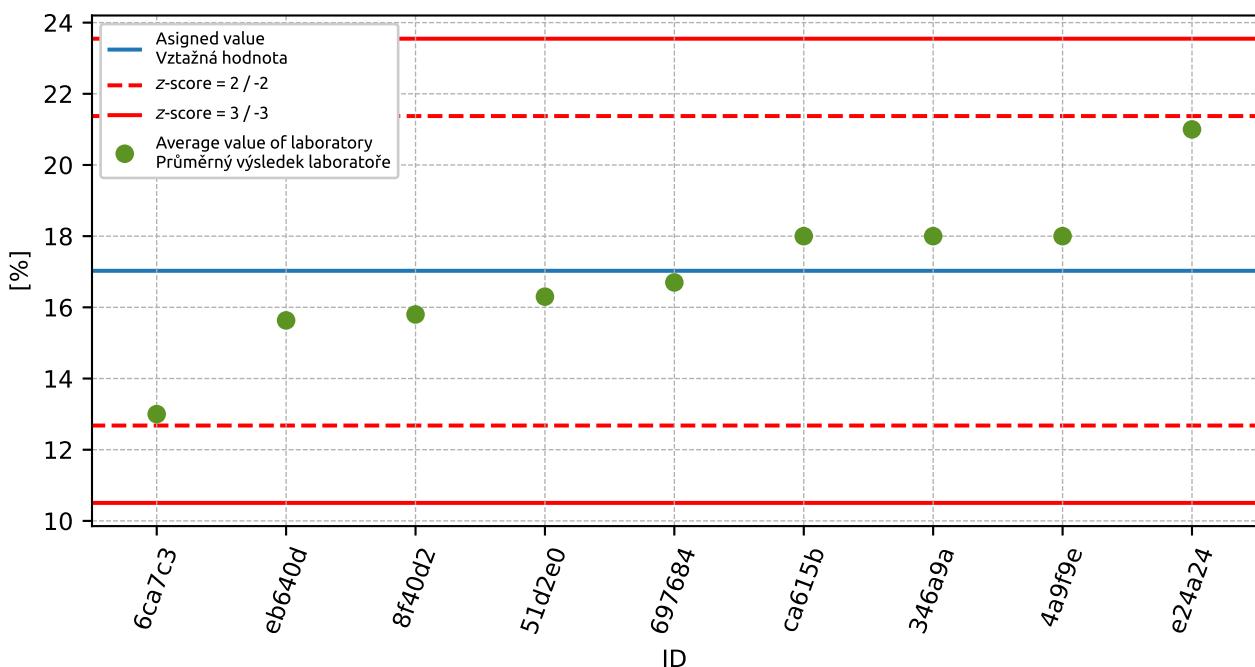
Figure 74: Average values and sample standard deviations
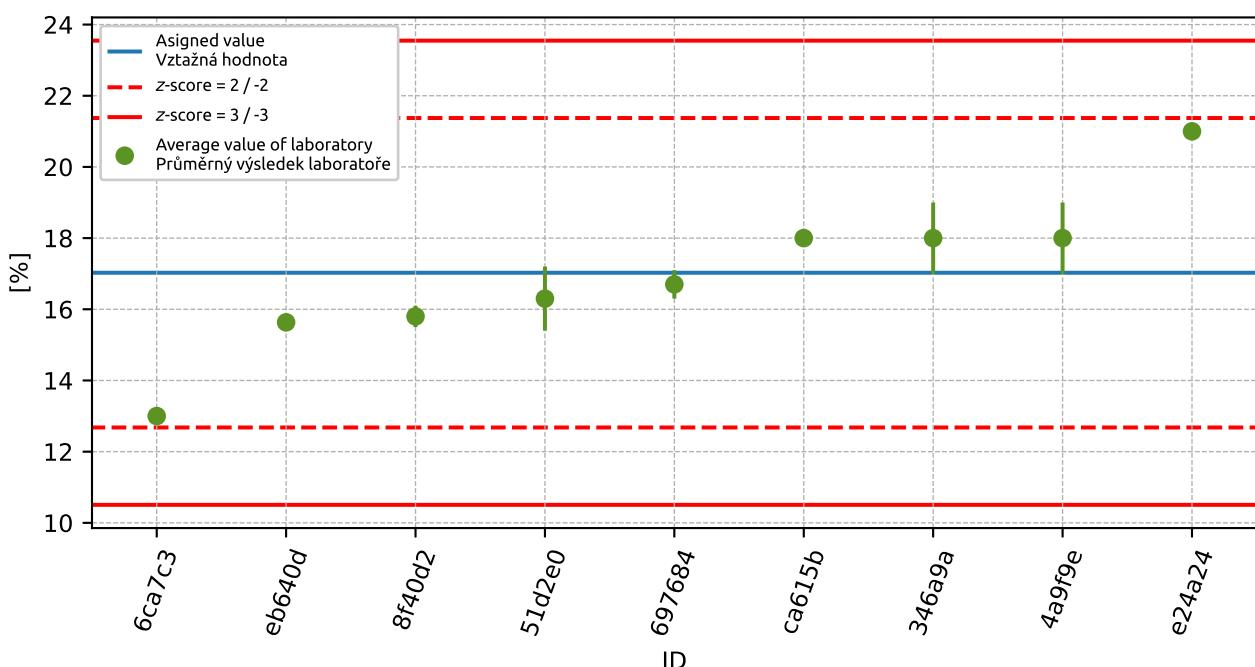
Figure 75: Average values and extended uncertainties of measurement

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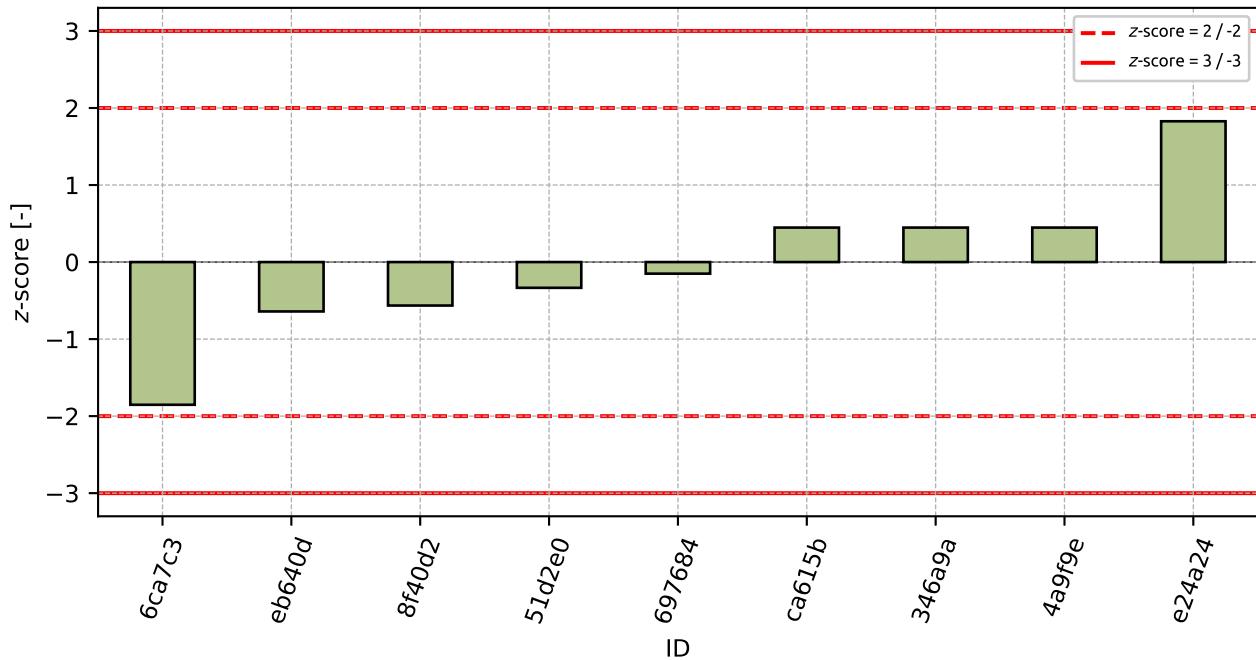
Figure 76: z-score

Figure 77: ζ-score

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Table 28: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
6ca7c3	-1.85	-
eb640d	-0.64	-1.53
8f40d2	-0.56	-1.29
51d2e0	-0.33	-0.57
697684	-0.15	-0.33
ca615b	0.45	-
346a9a	0.45	0.72
4a9f9e	0.45	0.72
e24a24	1.83	-

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

3.1　Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
51d2e0	18.9	18.8	21.2	0.3	19.6	1.36	6.92
ca615b	20.0	21.0	20.0	-	20.3	0.58	2.84
8f35ba	21.2	21.1	21.4	2.1	21.2	0.15	0.72
4154b9	22.0	21.0	21.0	0.5	21.3	0.58	2.71
5aa151	21.0	24.0	21.0	1.2	22.0	1.73	7.87
72f43c	22.0	22.0	23.0	1.0	22.3	0.58	2.59
8f40d2	23.5	24.1	23.5	1.2	23.7	0.35	1.46
eb640d	24.0	24.0	24.0	0.1	24.0	0.0	0.0
9e8f89	25.0	26.0	25.0	2.0	25.3	0.58	2.28
218cd3	24.8	25.9	25.3	2.0	25.3	0.55	2.17
bd4465	26.3	25.6	24.8	0.6	25.6	0.75	2.94
3ec36d	26.0	26.0	26.0	0.6	26.0	0.0	0.0
ba0a1f	26.5	25.8	26.3	3.2	26.2	0.36	1.38
6498ce	27.0	27.0	27.0	0.6	27.0	0.0	0.0
1c4a01	27.0	27.0	27.0	3.0	27.0	0.0	0.0
f1932b	27.0	28.0	27.0	2.0	27.3	0.58	2.11
1198ac	27.8	27.8	27.8	1.0	27.8	0.0	0.0
4c0b2c	29.0	27.0	28.0	2.0	28.0	1.0	3.57
2f9590	28.5	28.5	28.5	4.5	28.5	0.0	0.0
67e95f	29.0	29.0	29.0	2.0	29.0	0.0	0.0
fd0c72	29.0	29.0	29.0	2.0	29.0	0.0	0.0
549a2c	29.0	29.0	29.0	-	29.0	0.0	0.0
21dd1e	30.0	30.0	30.0	2.0	30.0	0.0	0.0
e18dad	31.0	31.2	31.2	11.6	31.1	0.12	0.37
74e3c7	33.0	33.0	34.0	0.1	33.3	0.58	1.73

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3.2   The Numerical Procedure for Determining Outliers
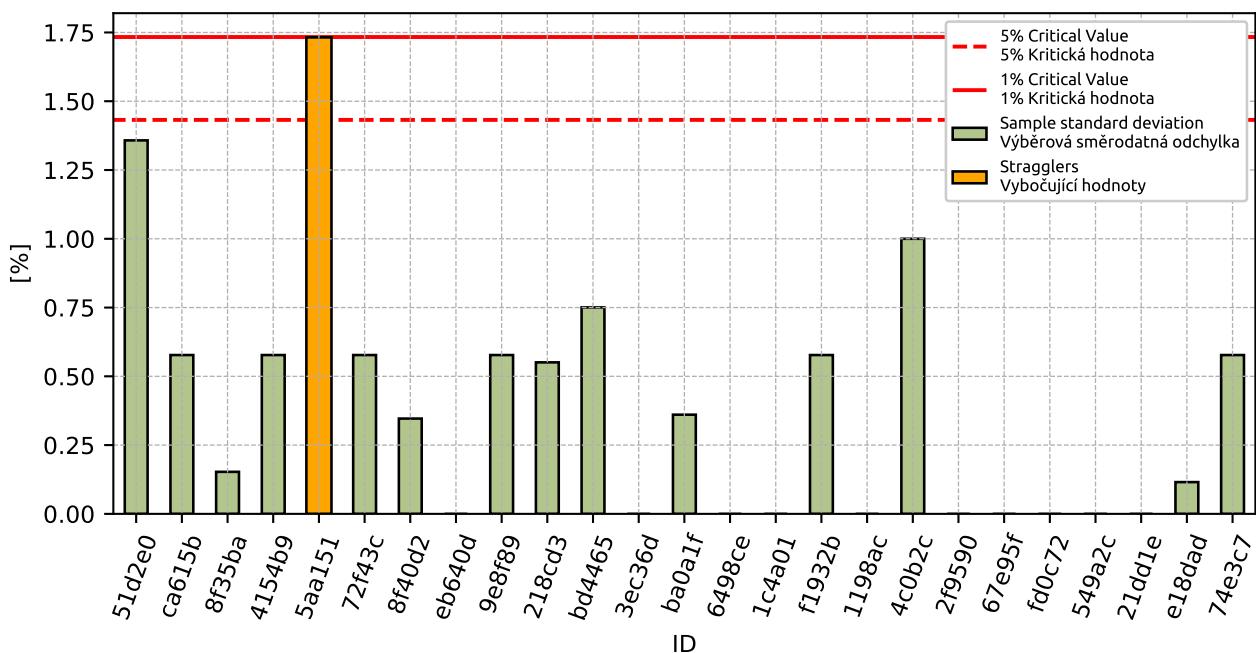

Figure 78: **Cochran's test** - sample standard deviations
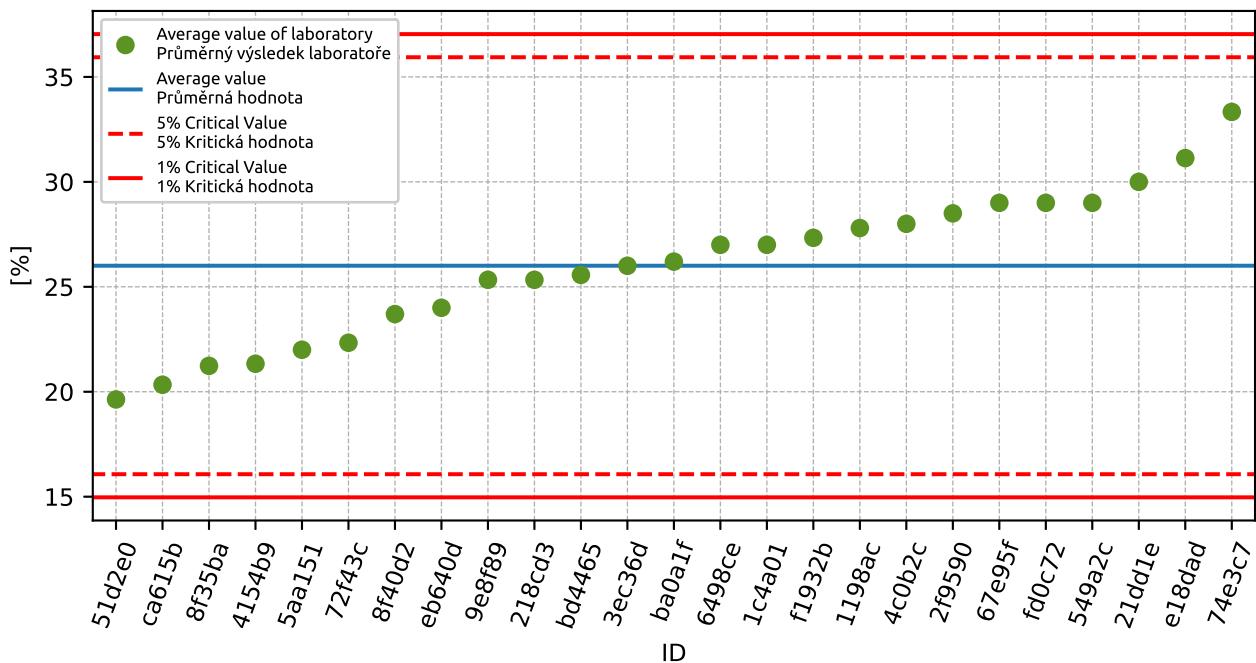
Figure 79: **Grubbs' test** - average values

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3.3 Mandel's Statistics
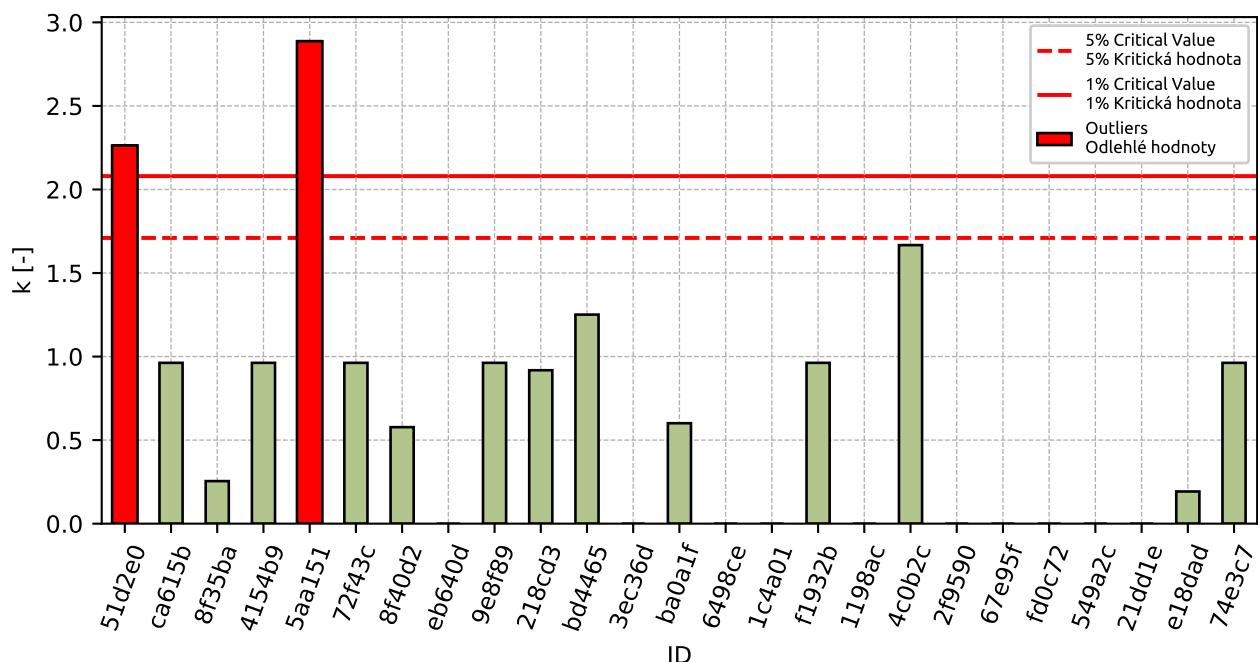
Figure 80: Intralaboratory Consistency Statistic
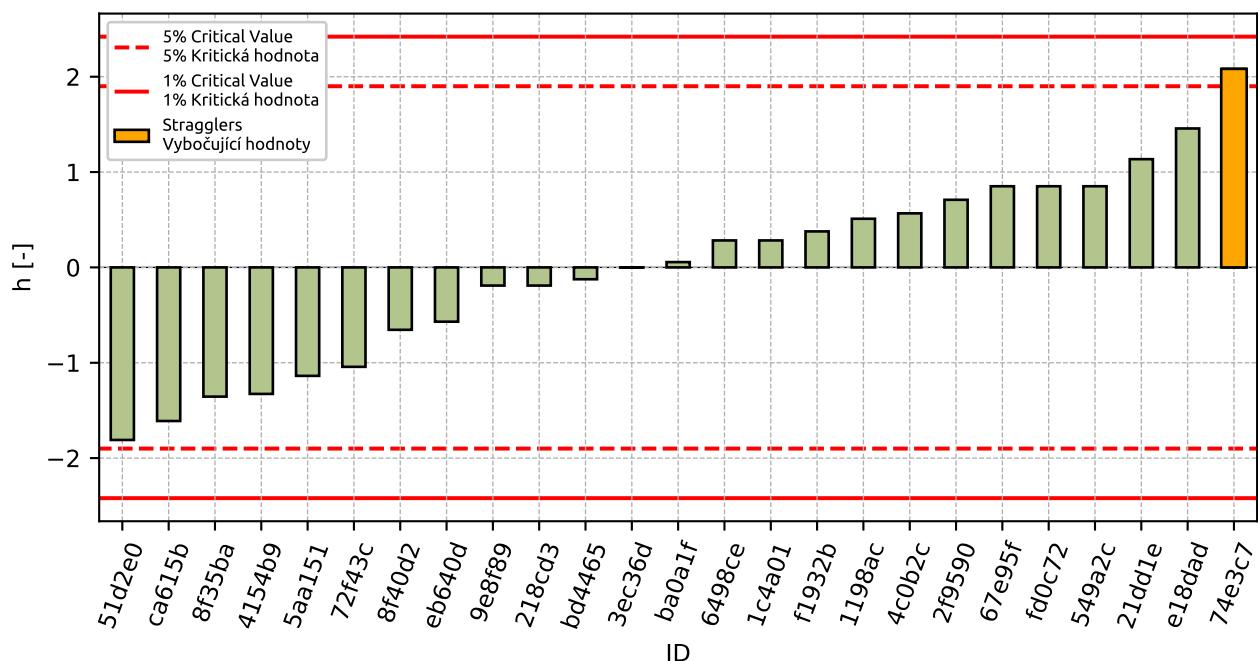
Figure 81: Interlaboratory Consistency Statistic

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3.4   Descriptive statistics
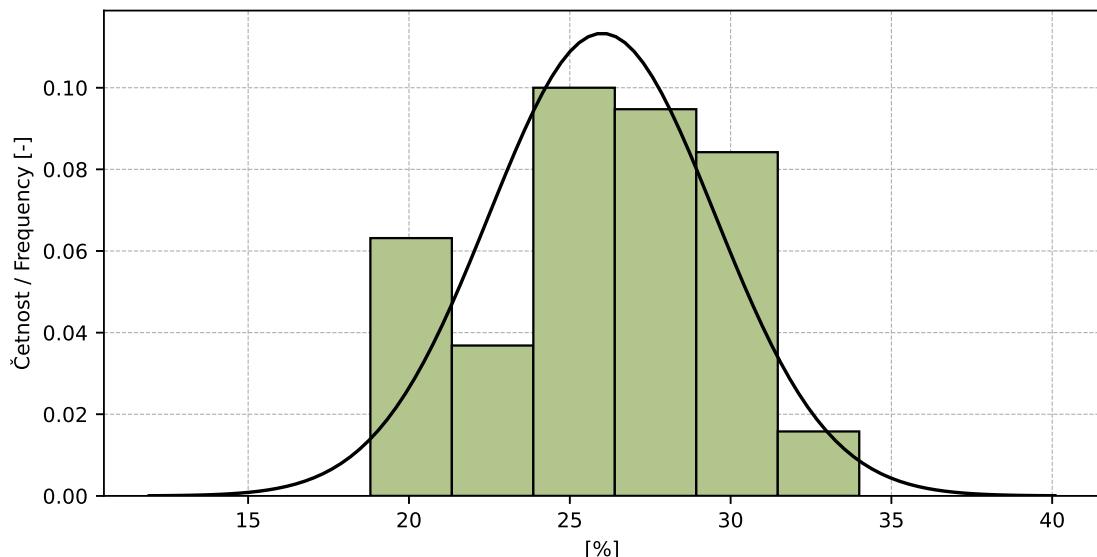
Figure 82: Histogram of all test results

Table 30: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	26.0
Výběrová směrodatná odchylka / Sample standard deviation – s	3.52
Vztažná hodnota / Asigned value – x^*	26.1
Robustní směrodatná odchylka / Robust standard deviation – s^*	3.81
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.95
p-hodnota testu normality / p-value of normality test	0.115 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	3.5
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.6
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	3.55
Opakovatelnost / Repeatability – r	1.7
Reprodukovatelnost / Reproducibility – R	10.0

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3.5　Evaluation of Performance Statistics
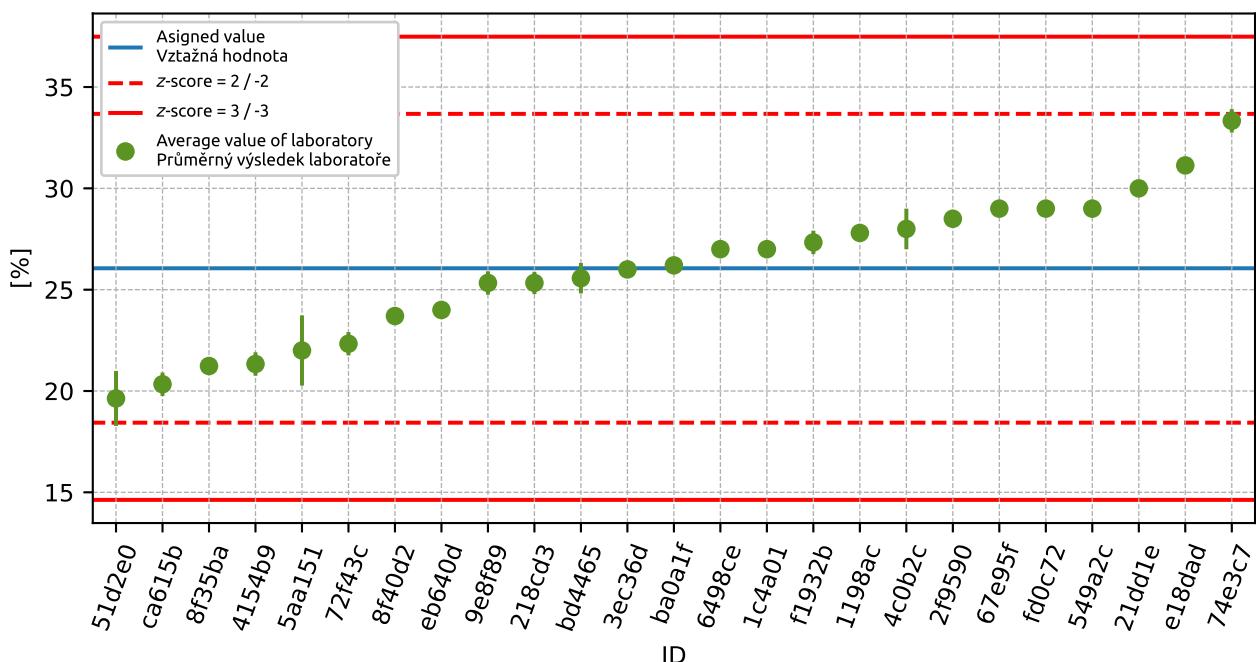
Figure 83: Average values and sample standard deviations
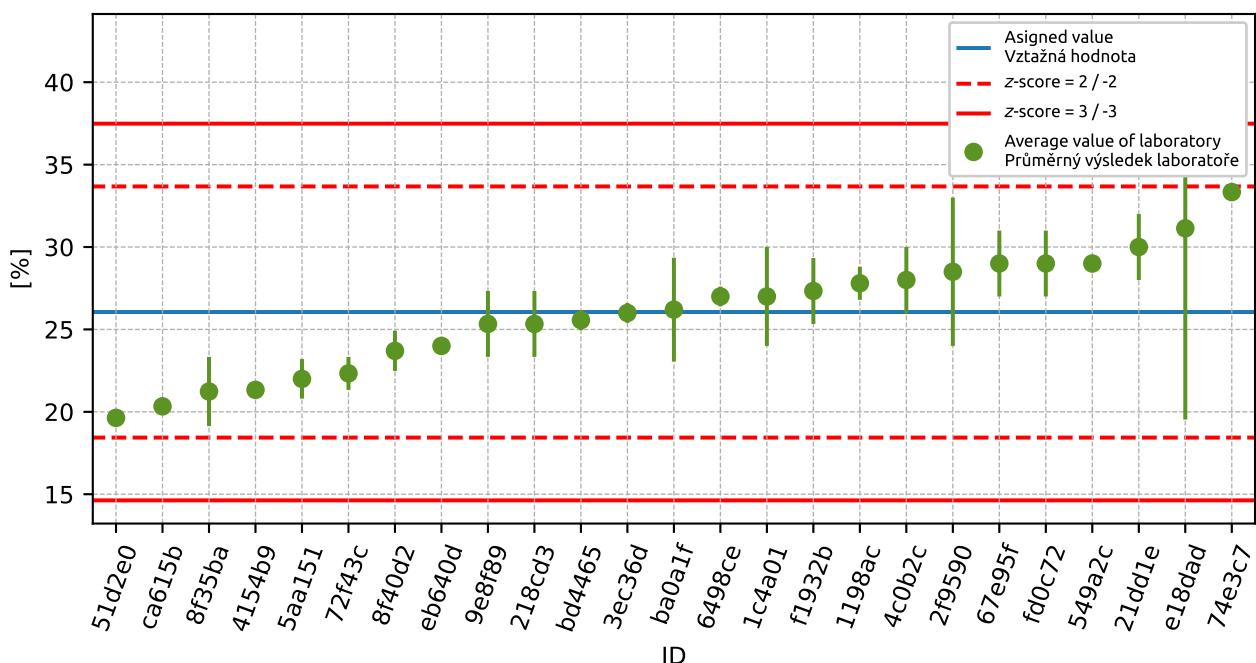
Figure 84: Average values and extended uncertainties of measurement

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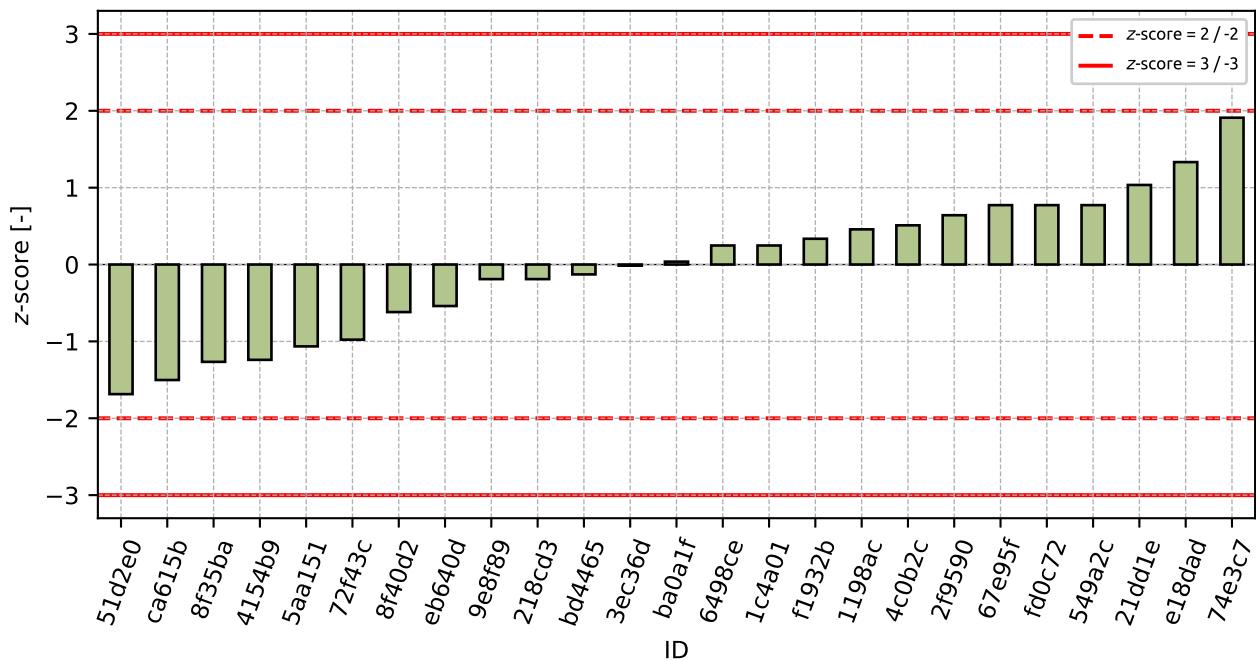
Figure 85: z-score

Figure 86: ζ-score

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Table 31: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
51d2e0	-1.69	-6.43
ca615b	-1.5	-
8f35ba	-1.27	-2.09
4154b9	-1.24	-4.41
5aa151	-1.06	-2.65
72f43c	-0.98	-2.7
8f40d2	-0.62	-1.52
eb640d	-0.54	-2.14
9e8f89	-0.19	-0.33
218cd3	-0.19	-0.33
bd4465	-0.13	-0.43
3ec36d	-0.01	-0.05
ba0a1f	0.04	0.04
6498ce	0.25	0.84
1c4a01	0.25	0.3
f1932b	0.34	0.58
1198ac	0.46	1.26
4c0b2c	0.51	0.88
2f9590	0.64	0.53
67e95f	0.77	1.33
fd0c72	0.77	1.33
549a2c	0.77	-
21dd1e	1.04	1.78
e18dad	1.33	0.44
74e3c7	1.91	7.6

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

4.1 Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
dbc3dc	56.0	55.0	56.0	-	55.7	0.58	1.04
ca615b	57.0	57.0	58.0	-	57.3	0.58	1.01
0a41a5	60.0	60.0	60.0	2.0	60.0	0.0	0.0
f2feb9	60.0	60.0	61.0	2.0	60.3	0.58	0.96
3ec36d	60.0	60.0	62.0	0.4	60.7	1.15	1.9
247115	61.0	61.0	61.0	0.4	61.0	0.0	0.0
bd4465	63.0	61.9	64.8	0.7	63.2	1.46	2.32
6498ce	66.0	64.0	64.0	0.9	64.7	1.15	1.79
8d38c9	66.0	69.0	68.0	-	67.7	1.53	2.26
71fb49	74.3	73.3	75.0	1.1	74.2	0.85	1.15

4.2 The Numerical Procedure for Determining Outliers
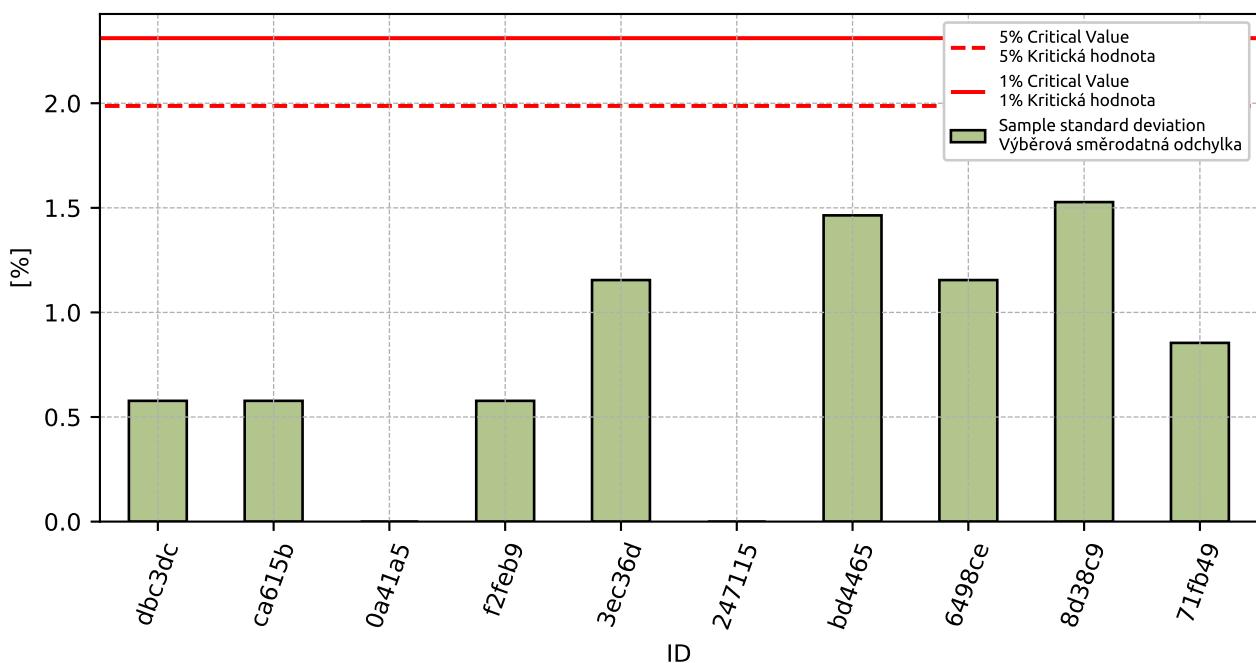
Figure 87: **Cochran's test** - sample standard deviations

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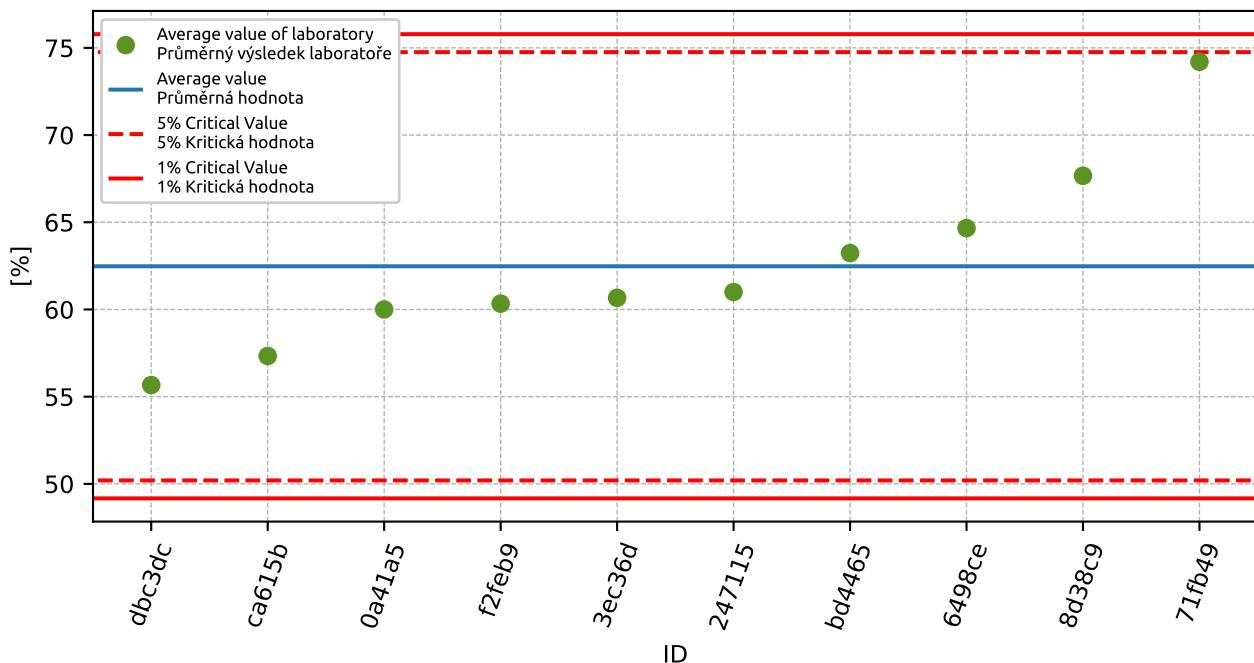
Figure 88: **Grubbs' test** - average values

4.3   Mandel's Statistics
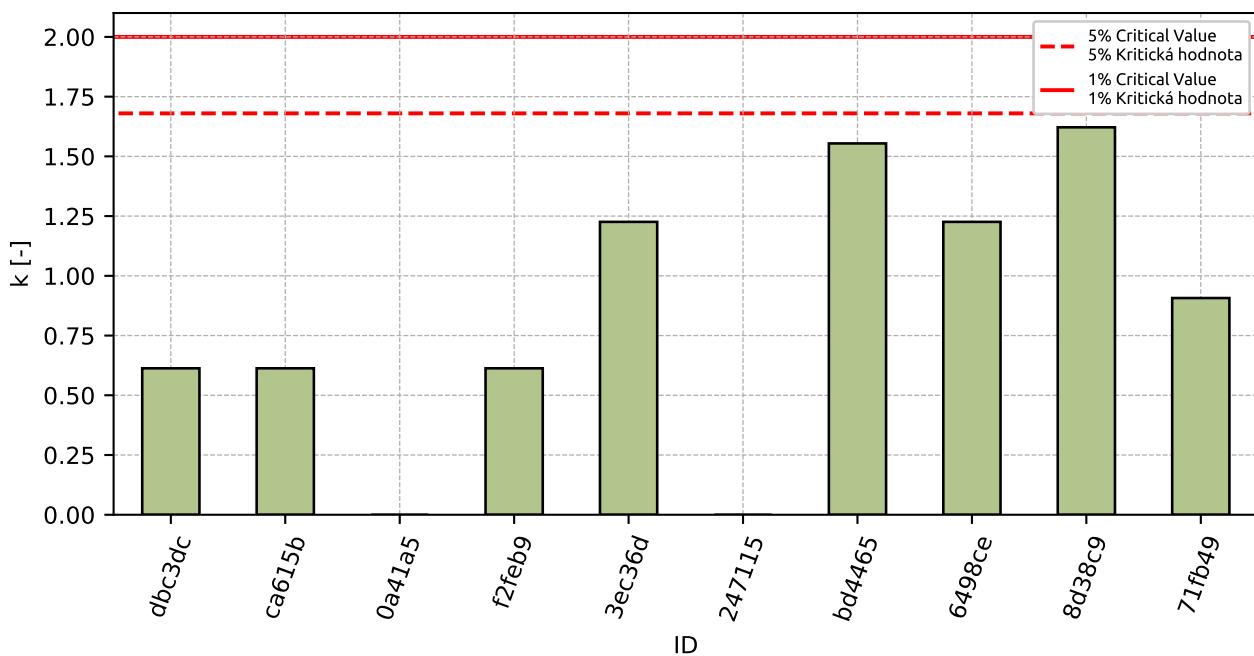
Figure 89: Intralaboratory Consistency Statistic

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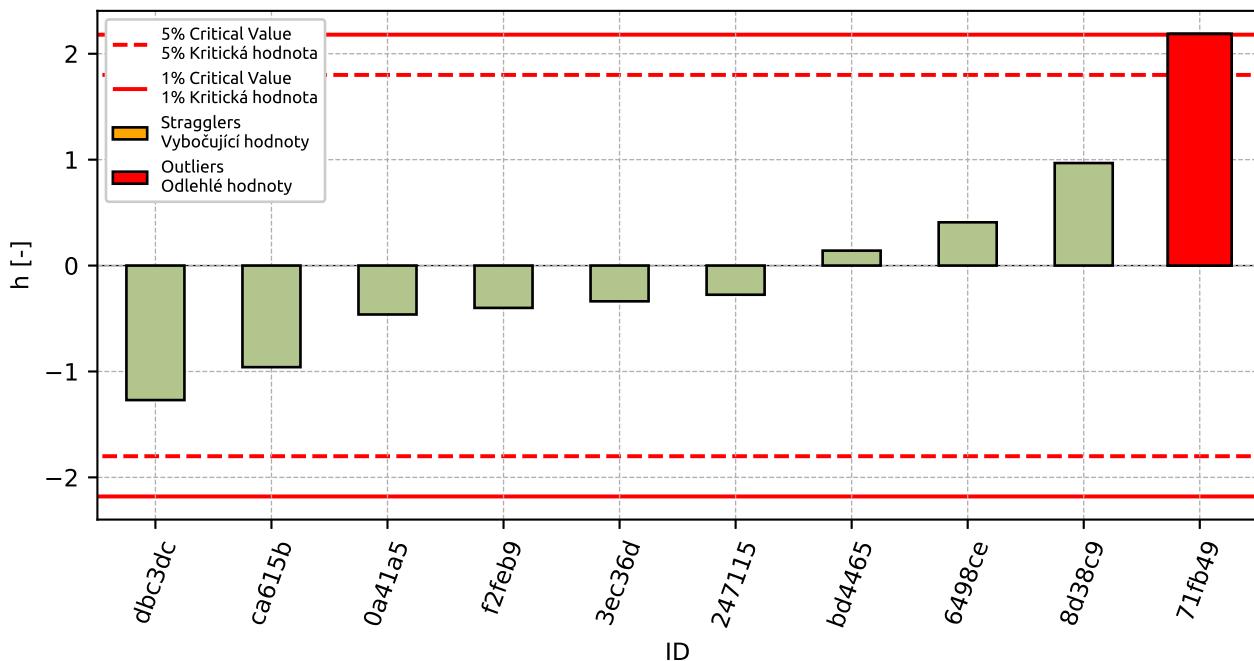
Figure 90: Interlaboratory Consistency Statistic

4.4 Descriptive statistics
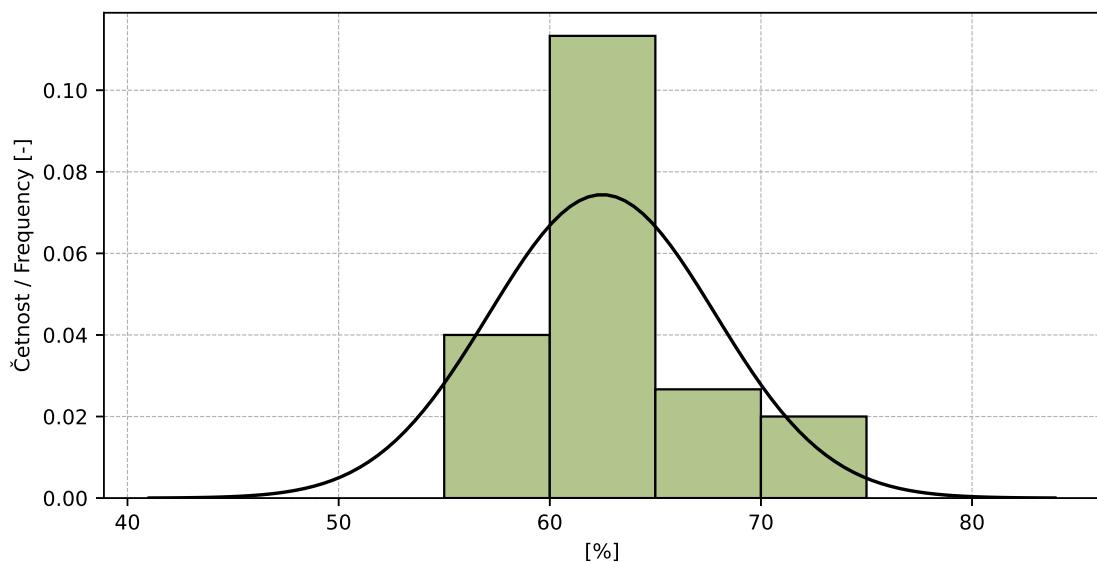
Figure 91: Histogram of all test results

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Table 33: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	62.5
Výběrová směrodatná odchylka / Sample standard deviation – s	5.36
Vztažná hodnota / Asigned value – x^*	62.4
Robustní směrodatná odchylka / Robust standard deviation – s^*	5.75
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	2.27
p-hodnota testu normality / p-value of normality test	0.009 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	5.33
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.94
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	5.42
Opakovatelnost / Repeatability – r	2.6
Reprodukovatelnost / Reproducibility – R	15.2

4.5　Evaluation of Performance Statistics
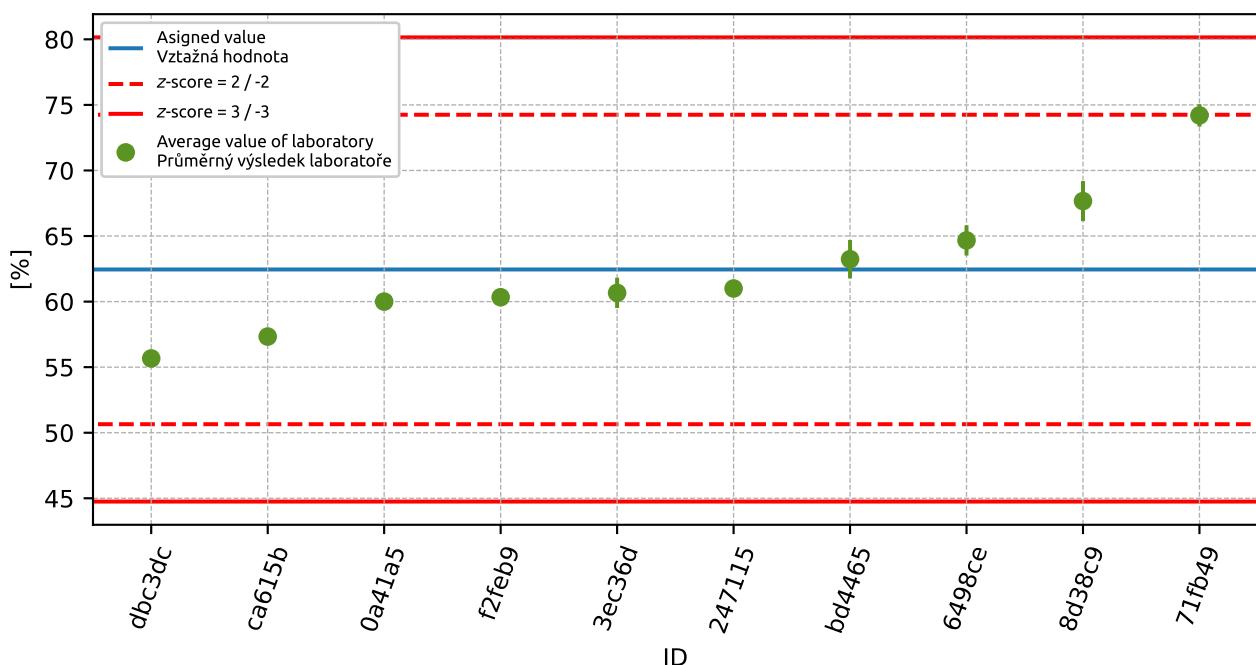
Figure 92: Average values and sample standard deviations

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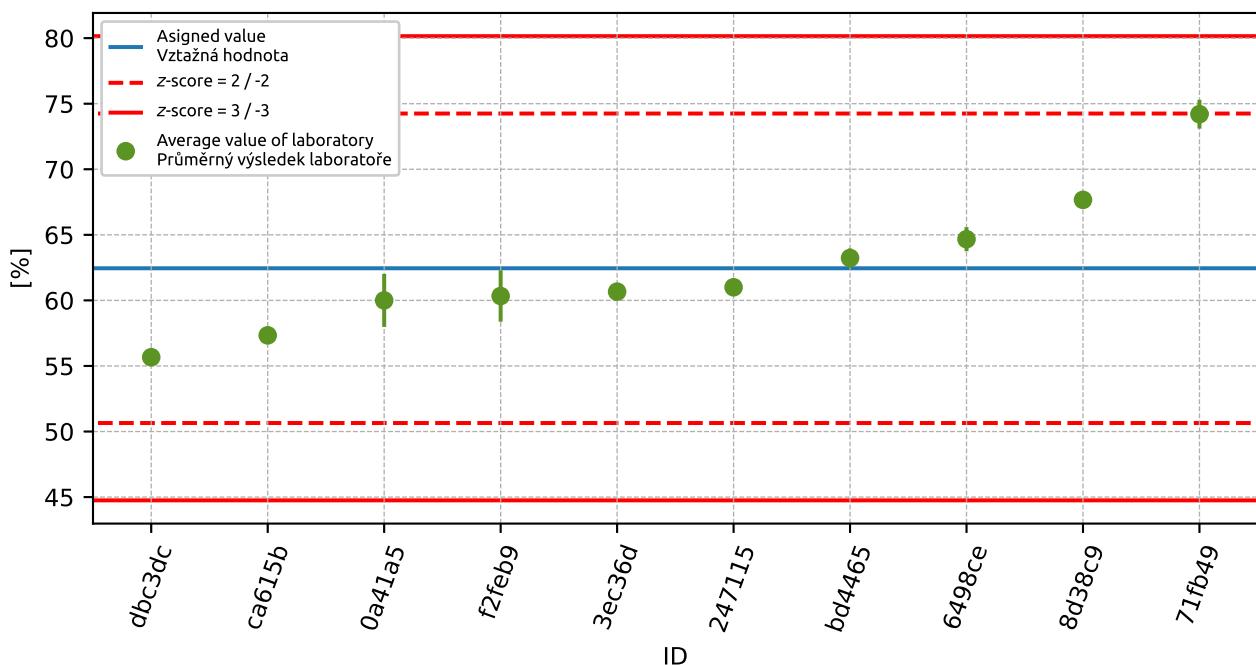
Figure 93: Average values and extended uncertainties of measurement

Figure 94: z-score

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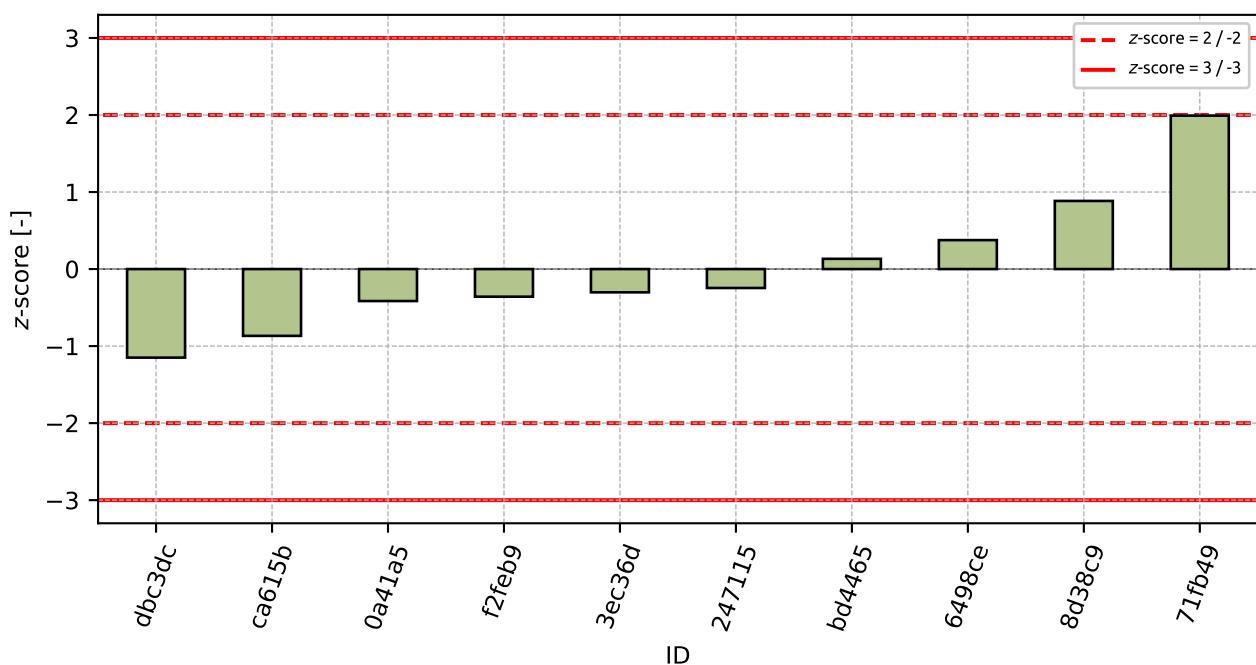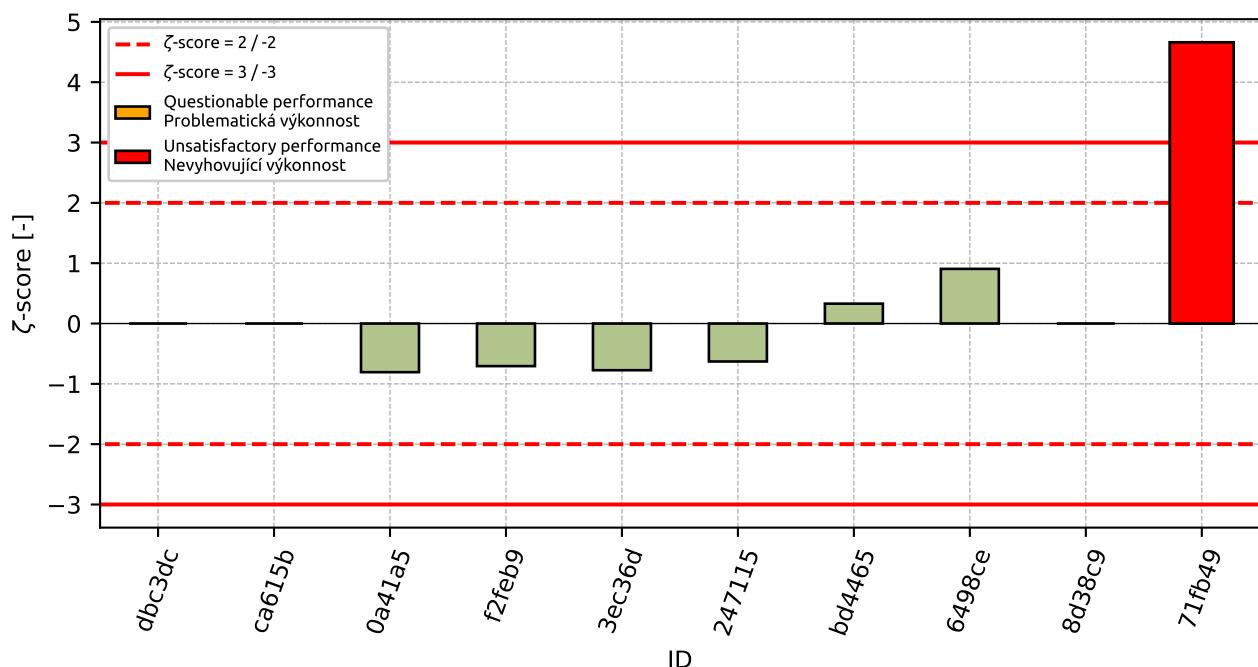
Figure 95: ζ-score

Table 34: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dbc3dc	-1.15	-
ca615b	-0.87	-
0a41a5	-0.42	-0.81
f2feb9	-0.36	-0.71
3ec36d	-0.3	-0.77
247115	-0.25	-0.63
bd4465	0.13	0.33
6498ce	0.38	0.91
8d38c9	0.88	-
71fb49	1.99	4.66

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

5.1 Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
6ca7c3	0.5	0.5	0.5	-	0.5	0.0	0.0
9abd02	0.9	1.0	0.9	0.2	0.9	0.06	6.19
e24a24	1.5	1.5	1.5	-	1.5	0.0	0.0
346a9a	1.9	2.0	1.9	0.1	1.9	0.06	2.99
becddb	2.1	2.1	2.1	-	2.1	0.0	0.0
3ec36d	2.0	2.2	2.2	0.2	2.1	0.12	5.41
697684	2.5	2.2	2.0	0.6	2.2	0.25	11.16
9f9c67	2.5	2.5	2.3	-	2.4	0.12	4.75
6498ce	2.8	2.8	2.8	0.0	2.8	0.0	0.0

5.2 The Numerical Procedure for Determining Outliers
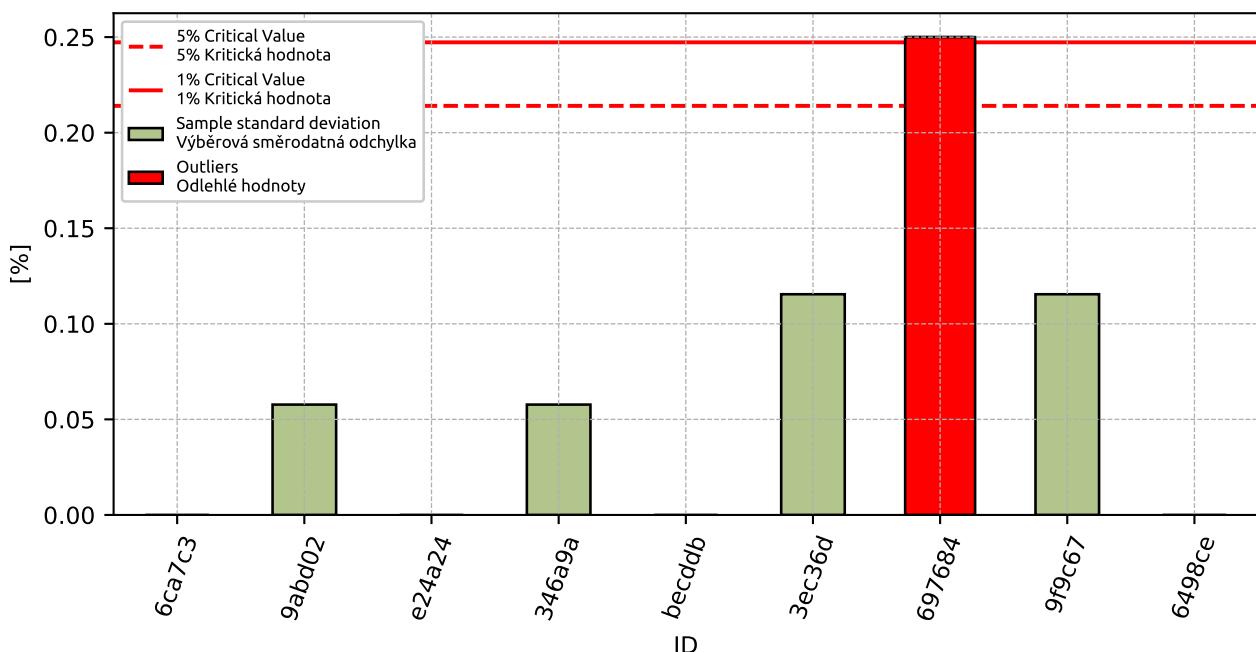
Figure 96: **Cochran's test** - sample standard deviations

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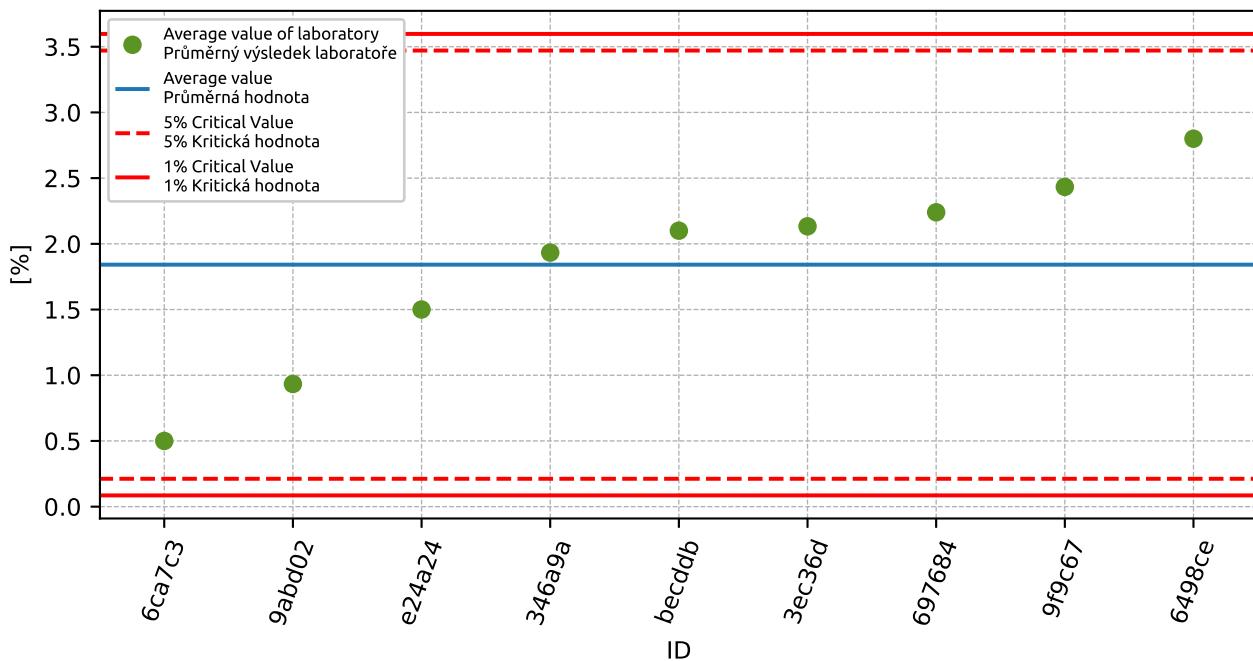
Figure 97: **Grubbs' test** - average values

5.3   Mandel′s Statistics
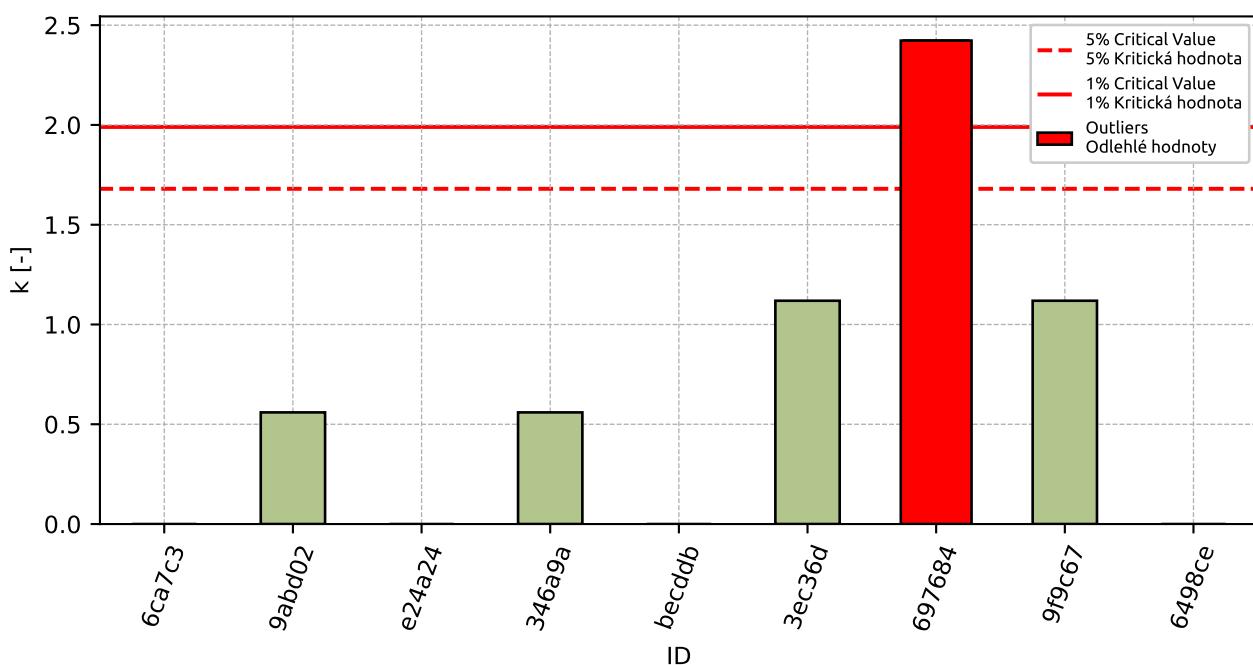

Figure 98: Intralaboratory Consistency Statistic

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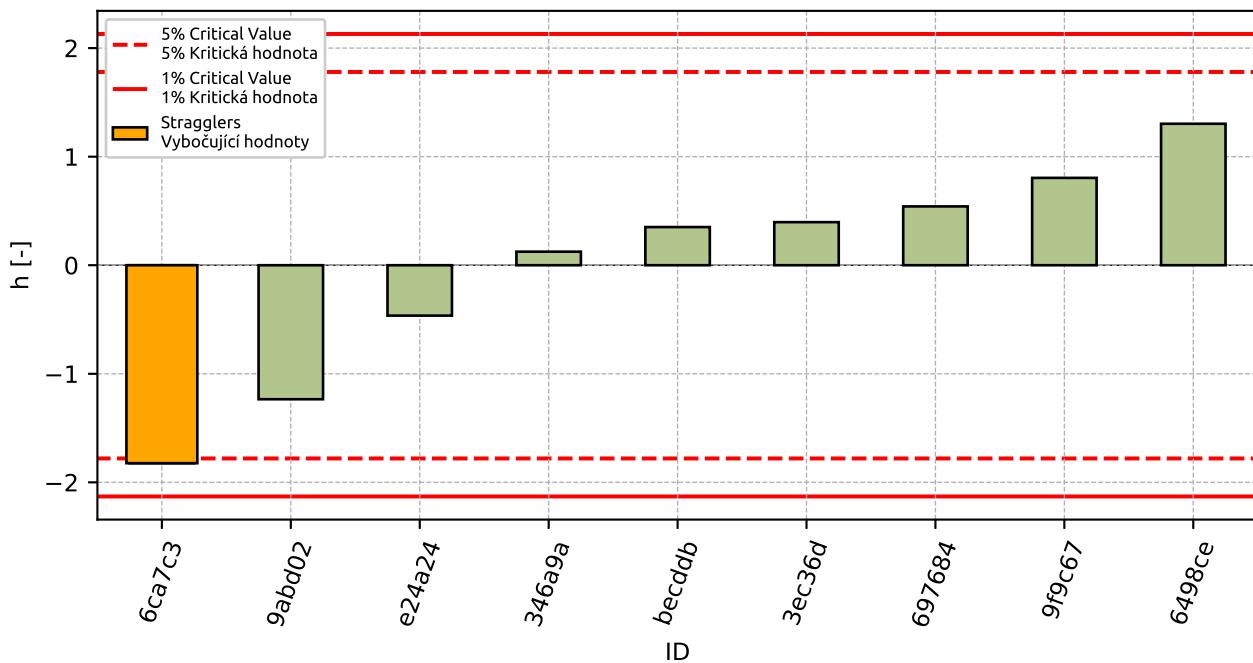
Figure 99: Interlaboratory Consistency Statistic

5.4   Descriptive statistics
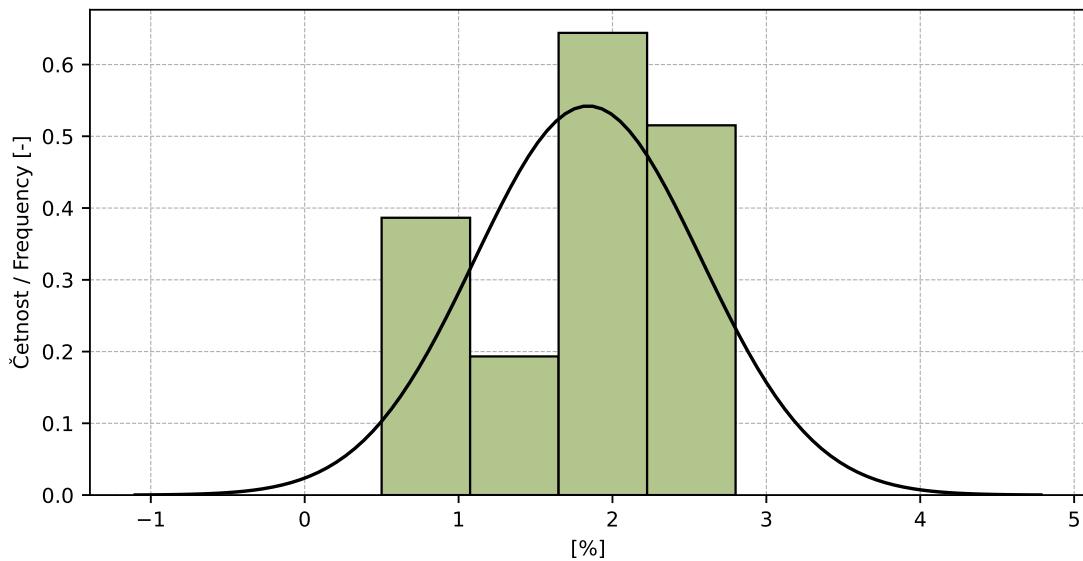
Figure 100: Histogram of all test results

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Table 36: Descriptive statistics

| Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	1.8
Výběrová směrodatná odchylka / Sample standard deviation – s	0.74
Vztažná hodnota / Asigned value – x^*	2.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.53
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.22
p-hodnota testu normality / p-value of normality test	0.018 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.73
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.1
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.74
Opakovatelnost / Repeatability – r	0.3
Reprodukovatelnost / Reproducibility – R	2.1

5.5   Evaluation of Performance Statistics
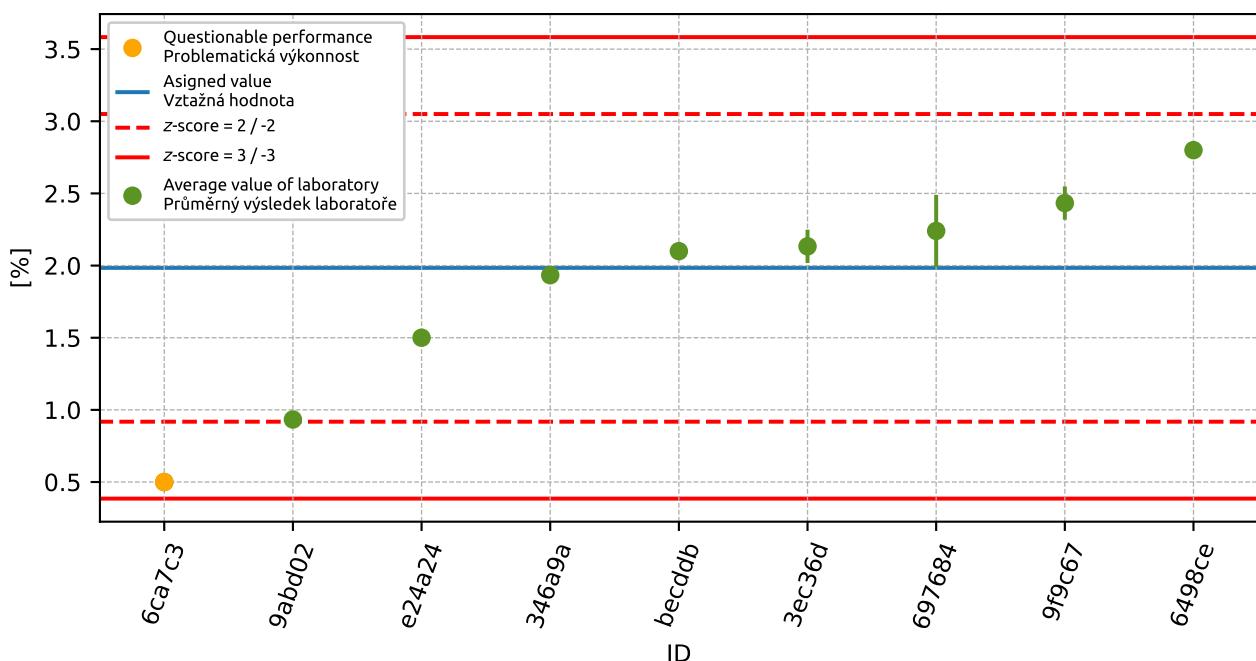
Figure 101: Average values and sample standard deviations

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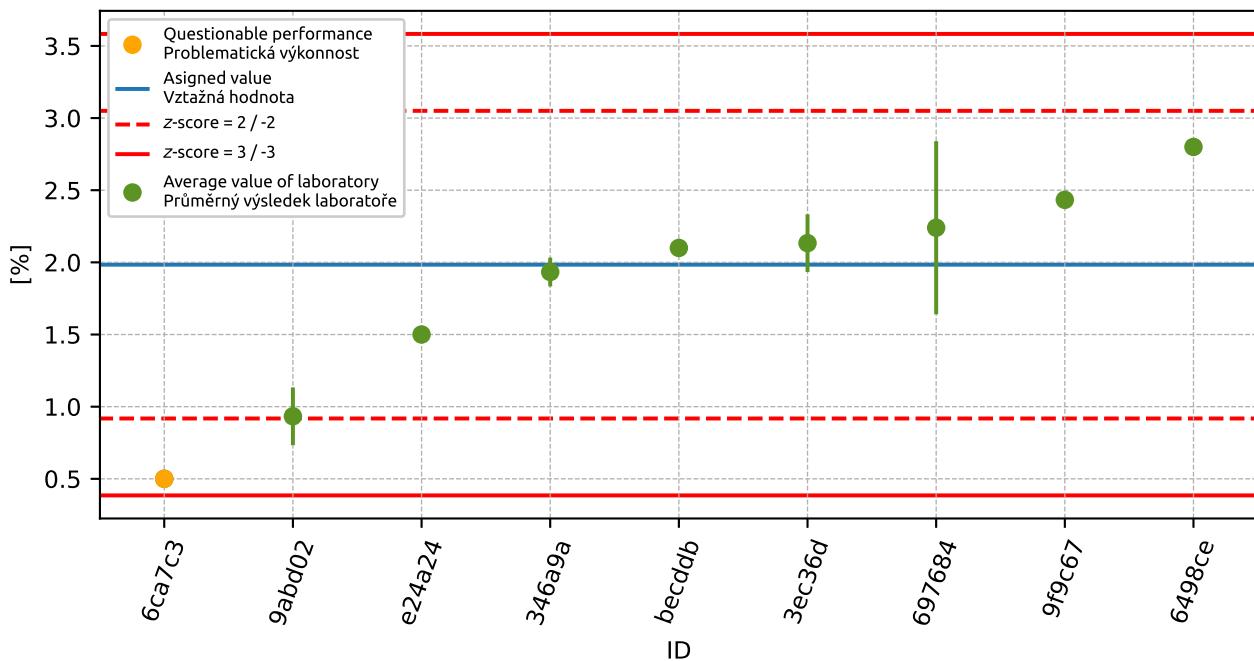
Figure 102: Average values and extended uncertainties of measurement

Figure 103: z-score

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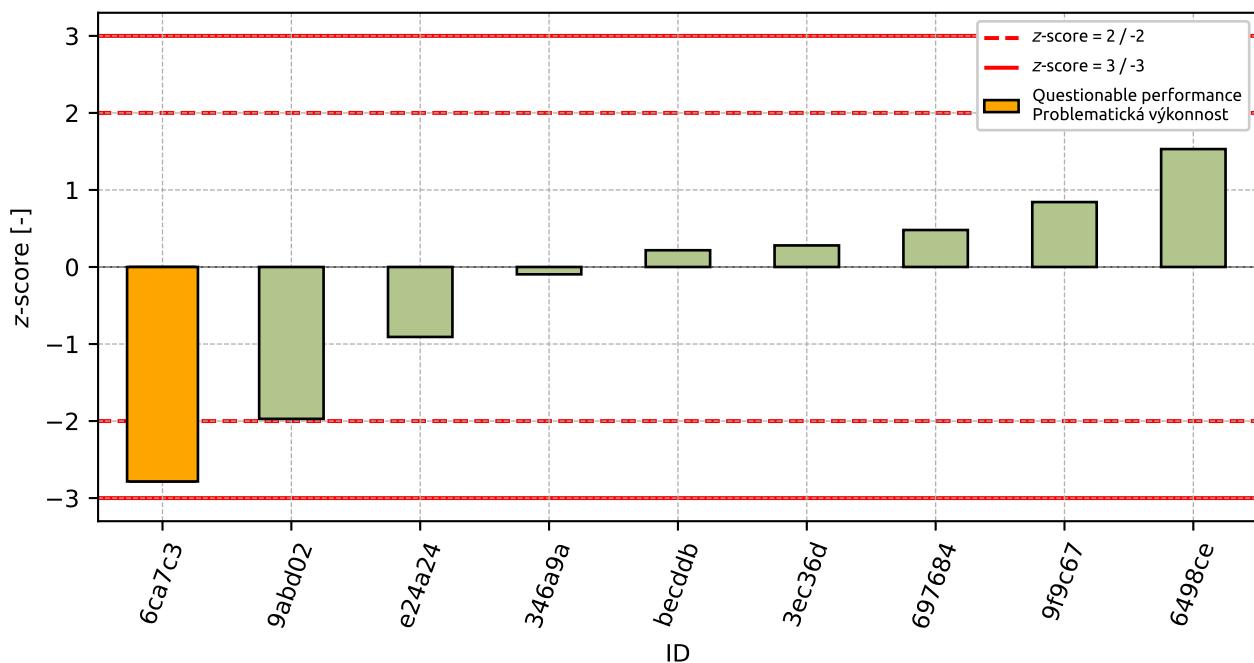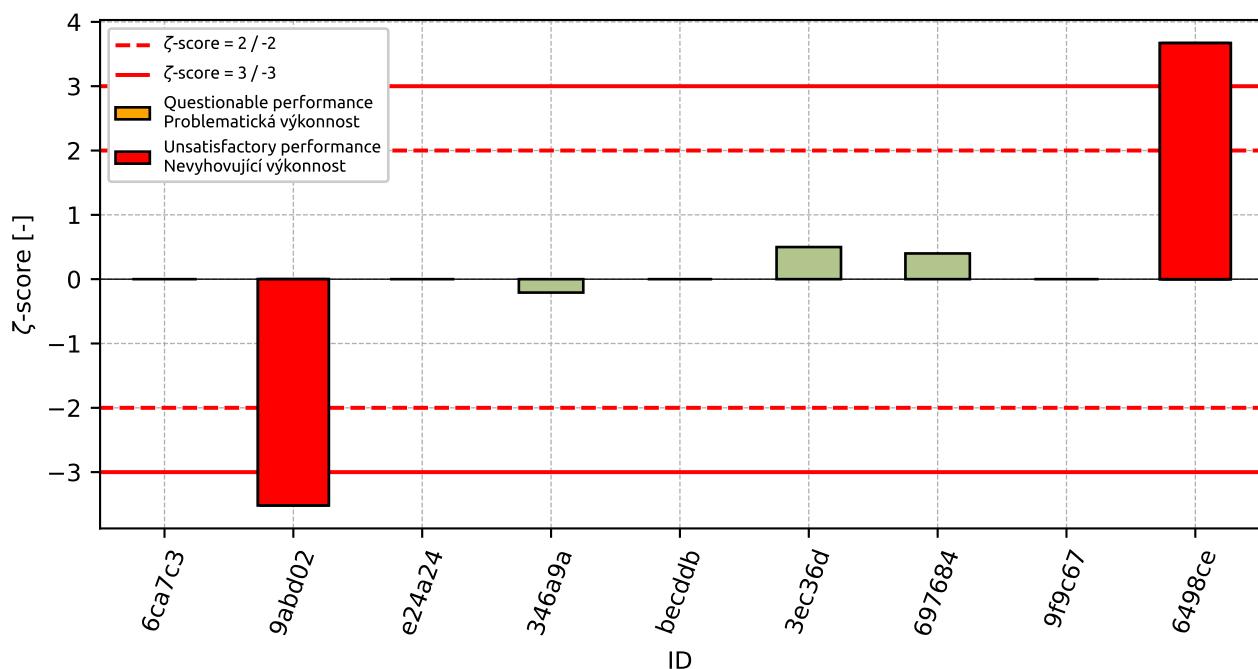
Figure 104: ζ-score

Table 37: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
6ca7c3	-2.78	-
9abd02	-1.97	-3.52
e24a24	-0.91	-
346a9a	-0.1	-0.21
becddb	0.22	-
3ec36d	0.28	0.5
697684	0.48	0.4
9f9c67	0.84	-
6498ce	1.53	3.67

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

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

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

7.1   Test results

Table 38: Test results - outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [-]	u_X [-]
74e3c7	13	0.0
6ca7c3	13	-
eb640d	14	0.0
57b998	14	1.0
dcea97	15	0.0
247115	15	0.0
8f40d2	15	3.0
d76b2a	16	1.0
e24a24	16	-

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7.2   The Numerical Procedure for Determining Outliers
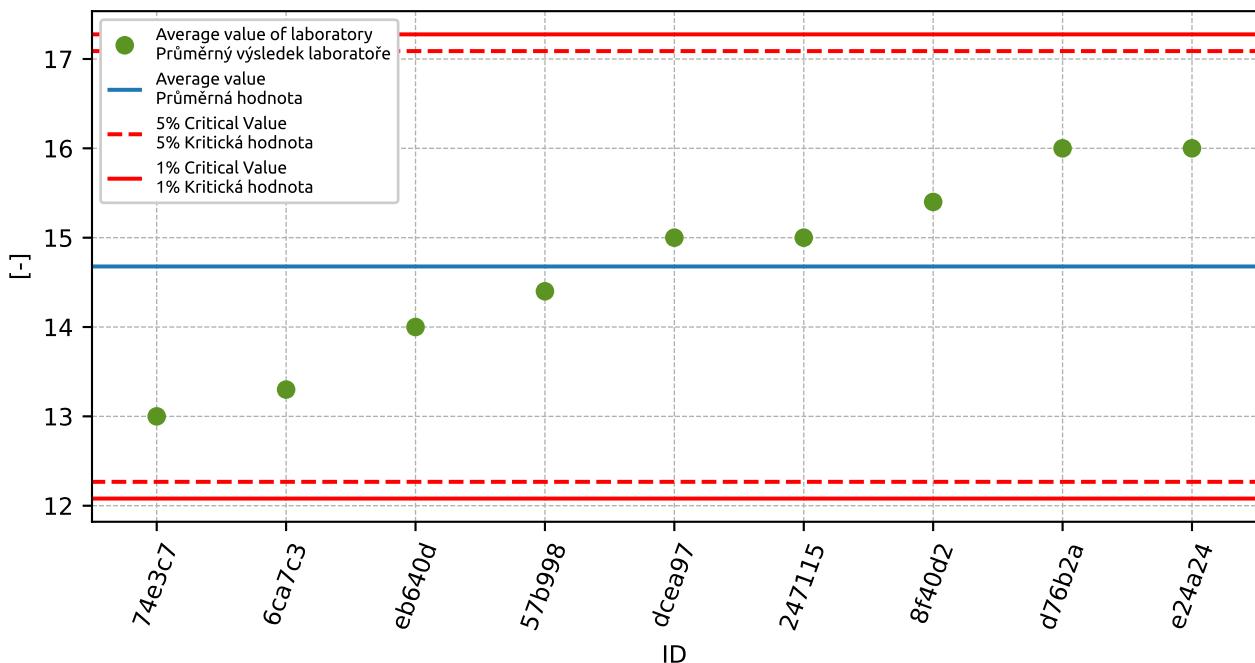
Figure 105: **Grubbs' test** - average values

7.3   Mandel's Statistics
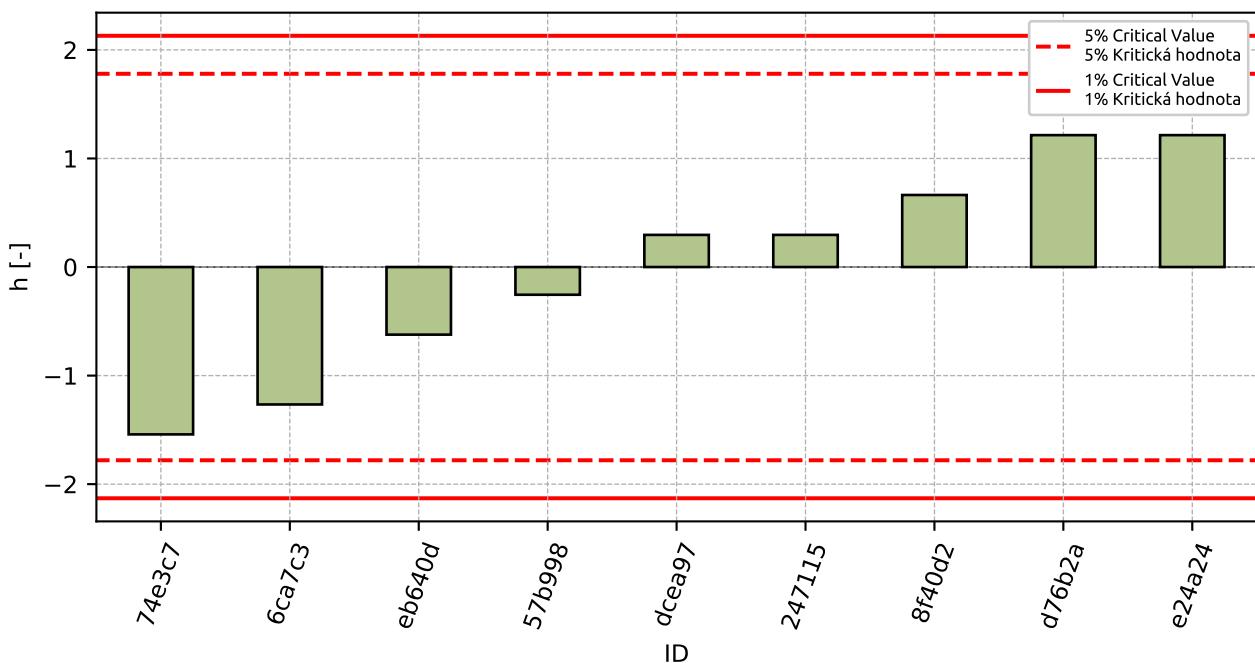
Figure 106: Interlaboratory Consistency Statistic

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7.4   Descriptive statistics
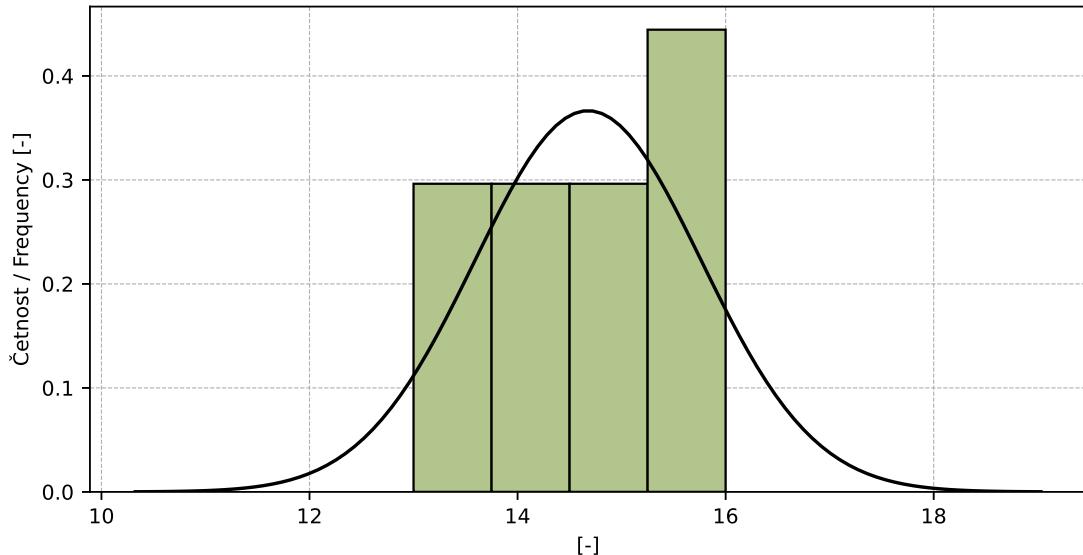
Figure 107: Histogram of all test results

Table 39: Descriptive statistics

Characteristics	[-]
Průměrná hodnota / Average value – $\bar{x}$	15.0
Výběrová směrodatná odchylka / Sample standard deviation – s	1.1
Vztažná hodnota / Asigned value – x^*	15.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.2
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.5
p-hodnota testu normality / p-value of normality test	0.527 [-]

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7.5 Evaluation of Performance Statistics
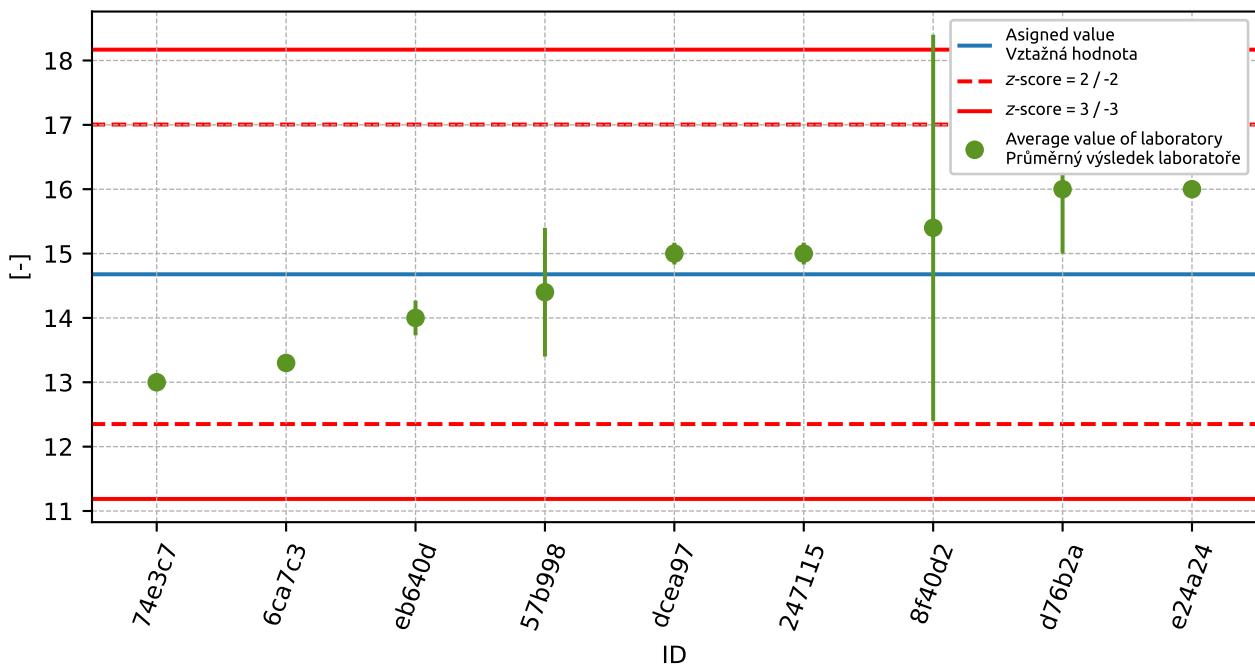
Figure 108: Average values and extended uncertainties of measurement

Figure 109: z-score

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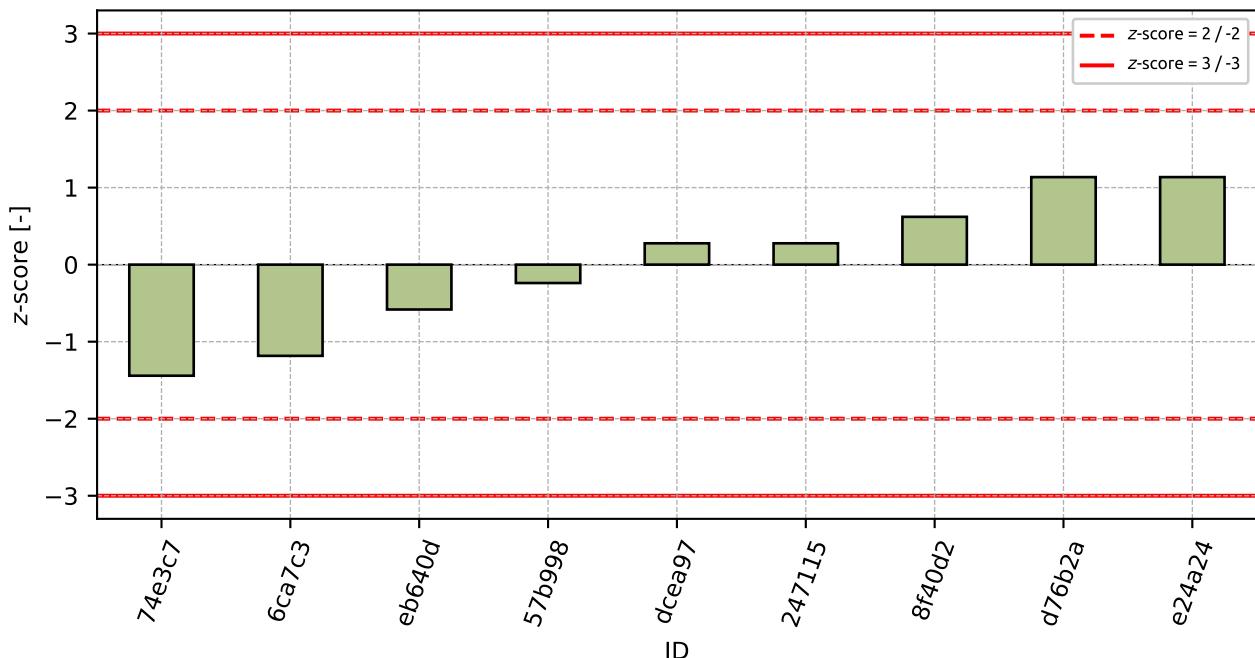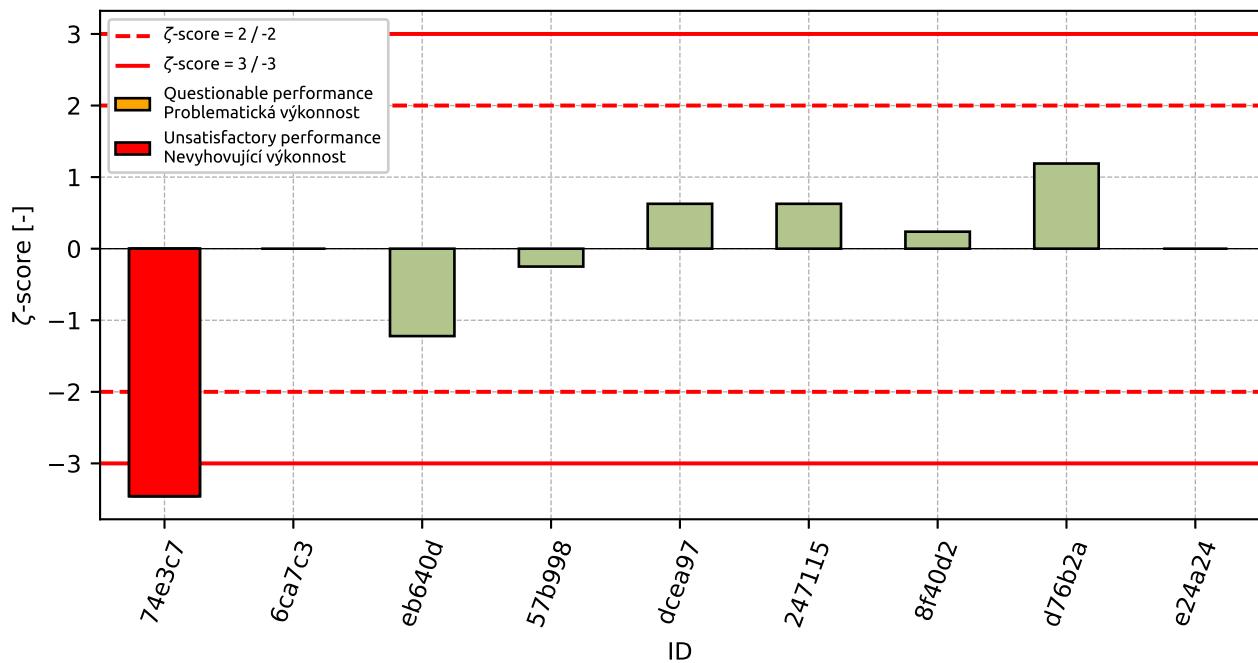
Figure 110: ζ-score

Table 40: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
74e3c7	-1.44	-3.46
6ca7c3	-1.18	-
eb640d	-0.58	-1.22
57b998	-0.24	-0.25
dcea97	0.28	0.63
247115	0.28	0.63
8f40d2	0.62	0.24
d76b2a	1.14	1.19
e24a24	1.14	-

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

8.1   Test results

Table 41: Test results - outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results	u_X
	[-]	[-]
346a9a	13.0	1.0
3ec36d	14.0	2.0
247115	14.0	0.0
eb640d	14.0	0.0
a9484b	15.0	1.0
4abbcf	15.0	0.0
6498ce	15.0	1.0
2f9590	16.0	3.0
51d2e0	16.0	1.0
6ca7c3	16.0	-
8f40d2	16.0	2.0
57b998	17.0	1.0
e18dad	18.0	1.0
6edfa7	18.0	1.0

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8.2   The Numerical Procedure for Determining Outliers
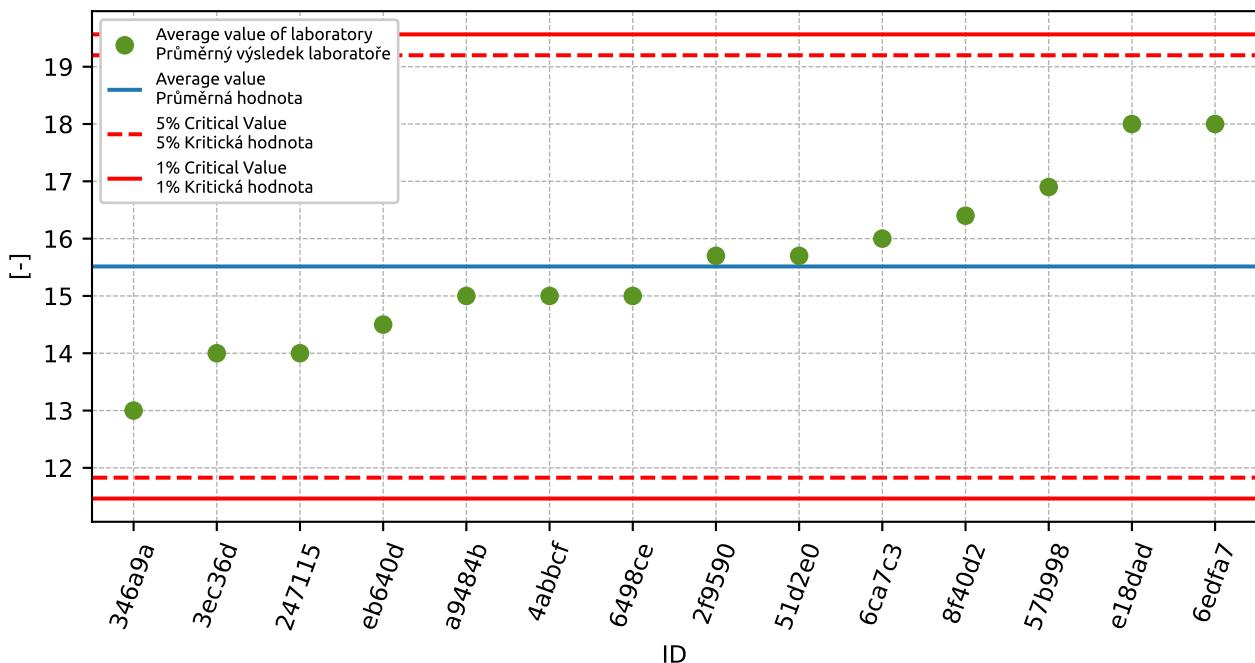
Figure 111: **Grubbs' test** - average values

8.3   Mandel's Statistics
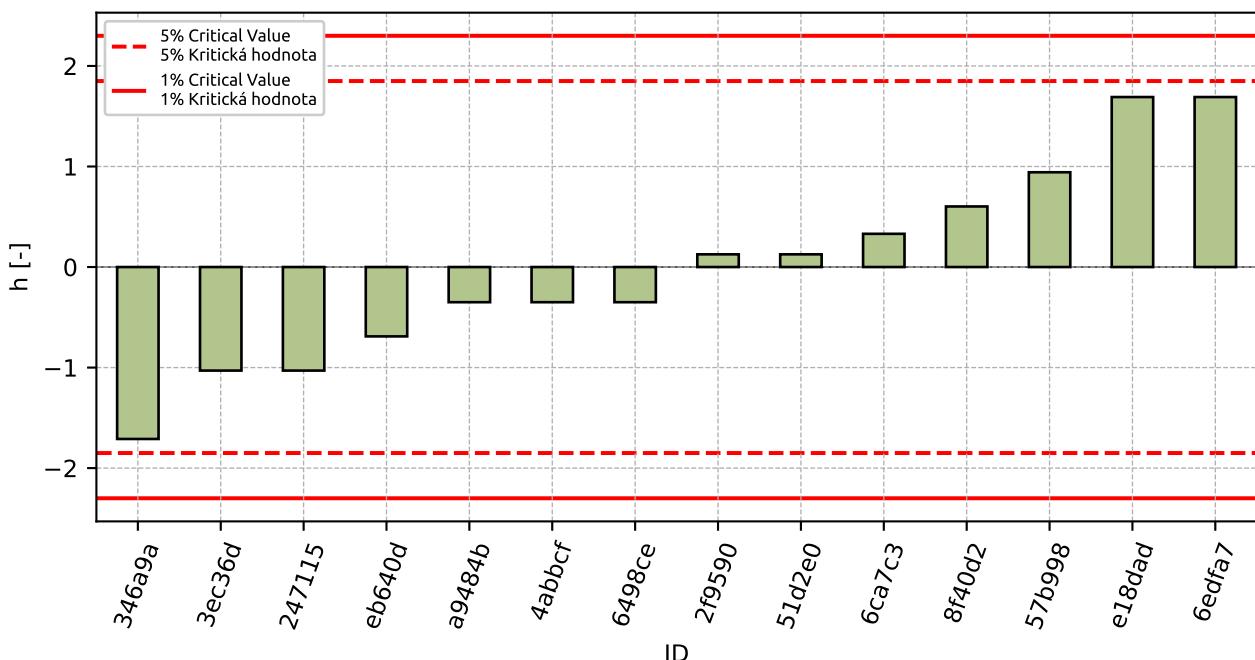
Figure 112: Interlaboratory Consistency Statistic

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8.4   Descriptive statistics
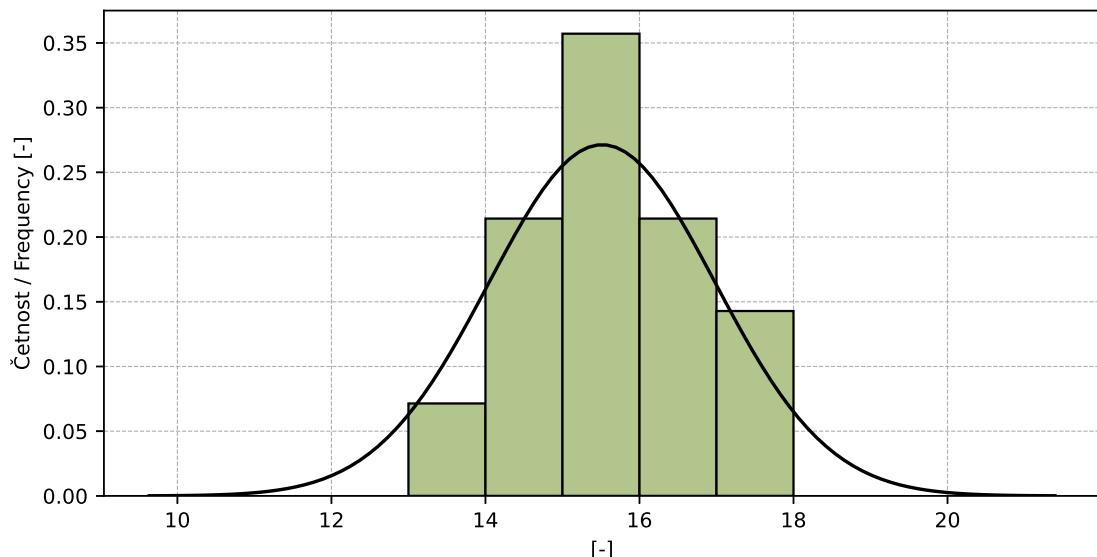
Figure 113: Histogram of all test results

Table 42: Descriptive statistics

Characteristics	[-]
Průměrná hodnota / Average value – $\bar{x}$	16.0
Výběrová směrodatná odchylka / Sample standard deviation – s	1.5
Vztažná hodnota / Asigned value – x^*	15.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.5
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.5
p-hodnota testu normality / p-value of normality test	0.761 [-]

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8.5 Evaluation of Performance Statistics
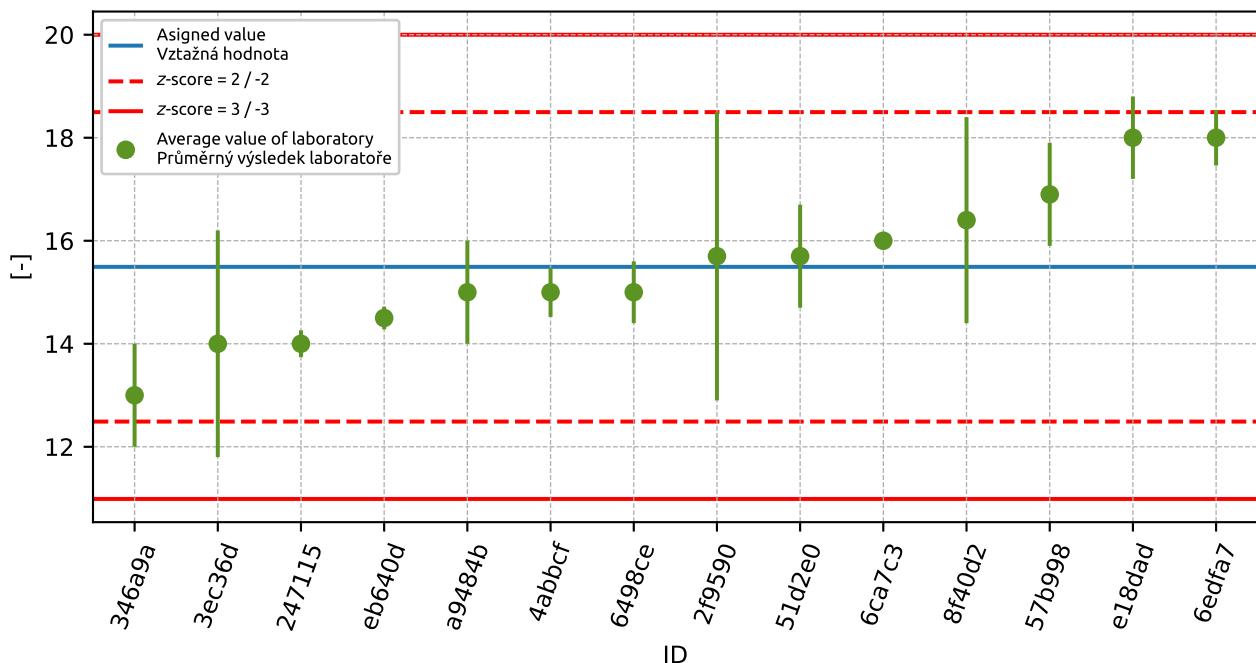
Figure 114: Average values and extended uncertainties of measurement

Figure 115: z-score

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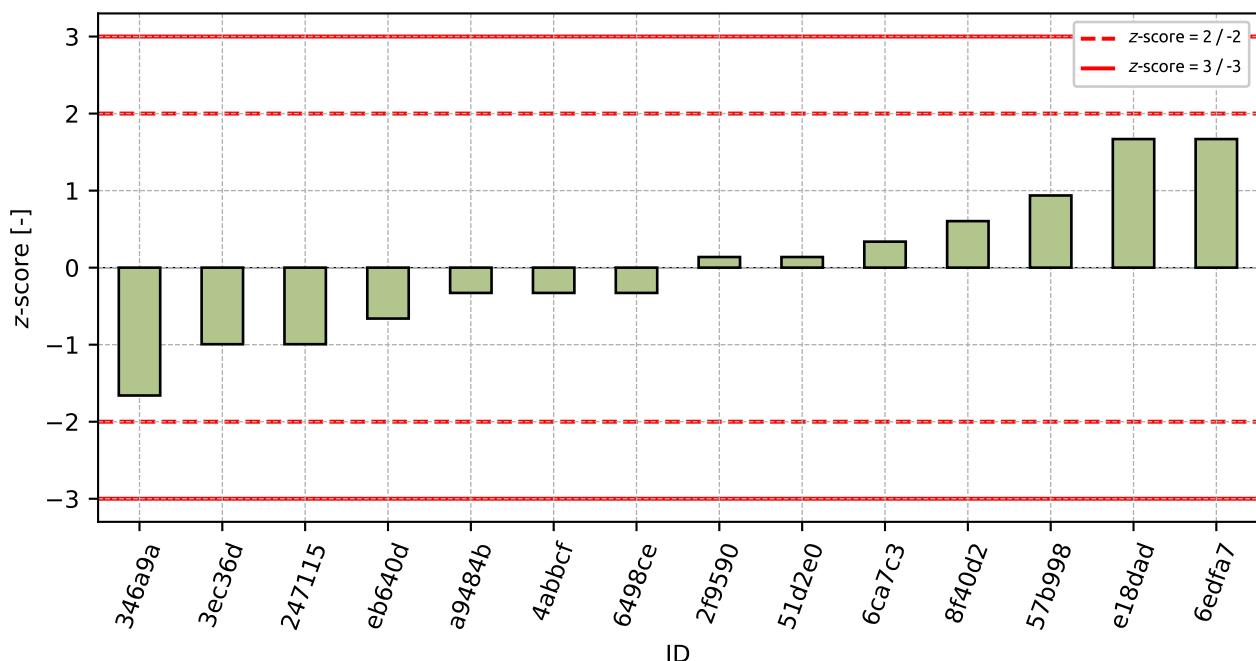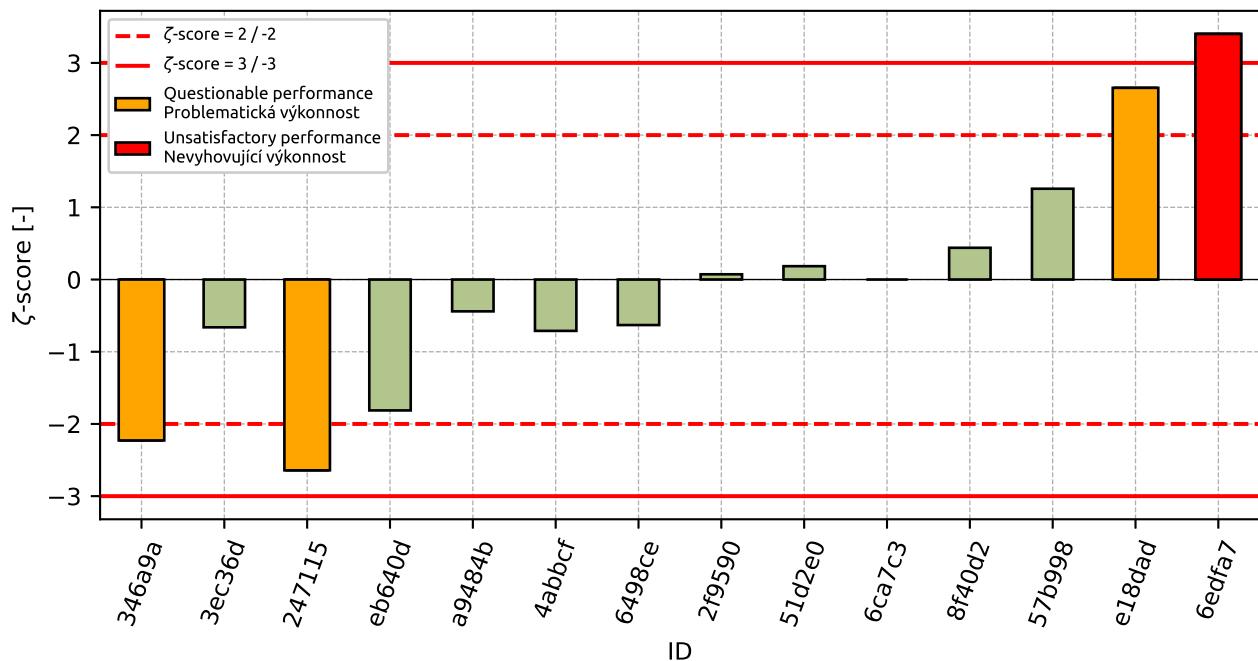
Figure 116: ζ-score

Table 43: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
346a9a	-1.66	-2.23
3ec36d	-0.99	-0.66
247115	-0.99	-2.64
eb640d	-0.66	-1.81
a9484b	-0.33	-0.44
4abbcf	-0.33	-0.71
6498ce	-0.33	-0.63
2f9590	0.14	0.07
51d2e0	0.14	0.18
6ca7c3	0.34	-
8f40d2	0.6	0.44
57b998	0.94	1.26
e18dad	1.67	2.65
6edfa7	1.67	3.4

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

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

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

10.1 Loose bulk density

10.1.1 Test results

Table 44: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID	Test results [Mg/m^3]			u_X [Mg/m^3]	$\bar{x}$ [Mg/m^3]	s_0 [Mg/m^3]	V_X [%]
eb640d	1.49	1.48	1.49	0.004	1.49	0.002	0.13
4febe7	1.50	1.50	1.49	0.01	1.50	0.006	0.39
6ca7c3	1.51	1.50	1.50	-	1.50	0.007	0.44
8d38c9	1.51	1.52	1.51	-	1.51	0.005	0.3
8f40d2	1.51	1.53	1.52	0.01	1.52	0.01	0.66
8616aa	1.55	1.56	1.56	0.01	1.56	0.006	0.37
8f35ba	1.57	1.57	1.58	0.02	1.57	0.002	0.15

10.1.2 The Numerical Procedure for Determining Outliers
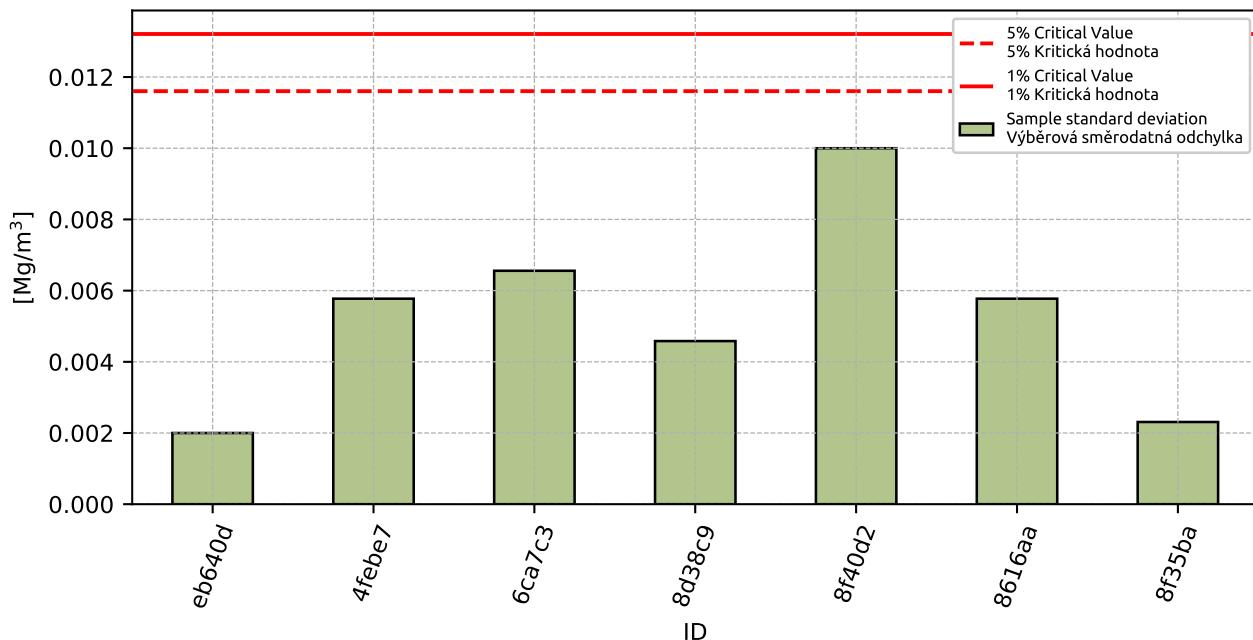
Figure 117: **Cochran's test** - sample standard deviations

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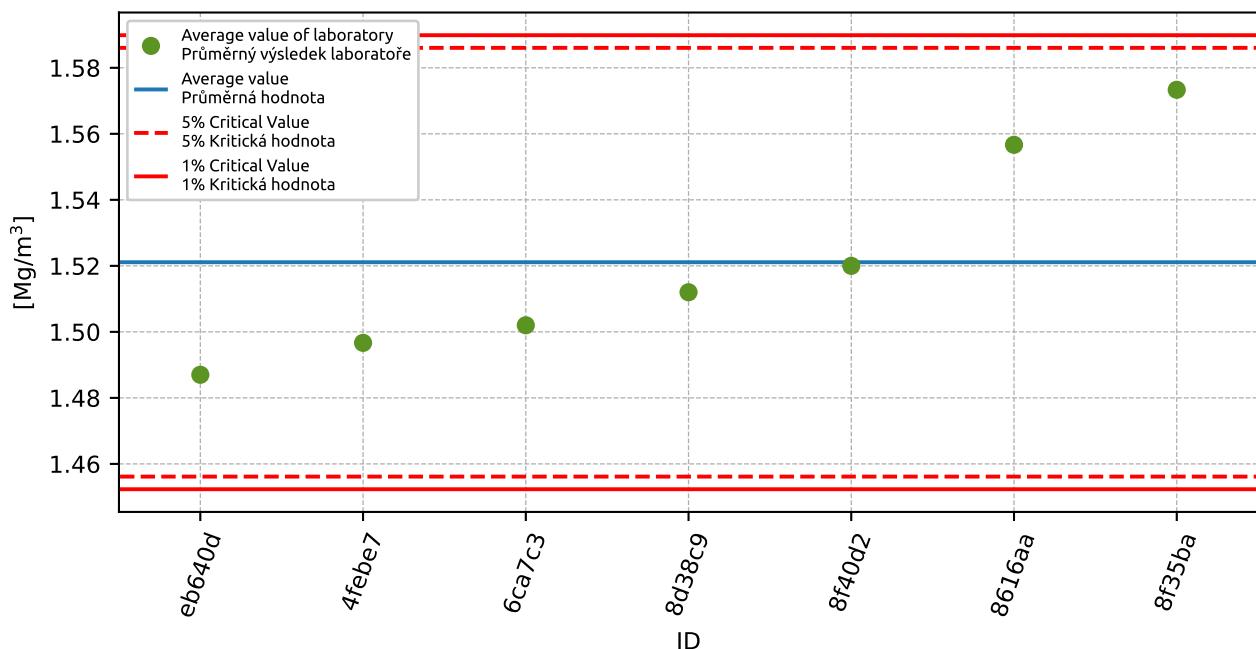
Figure 118: **Grubbs' test** - average values

10.1.3   Mandeľ's Statistics
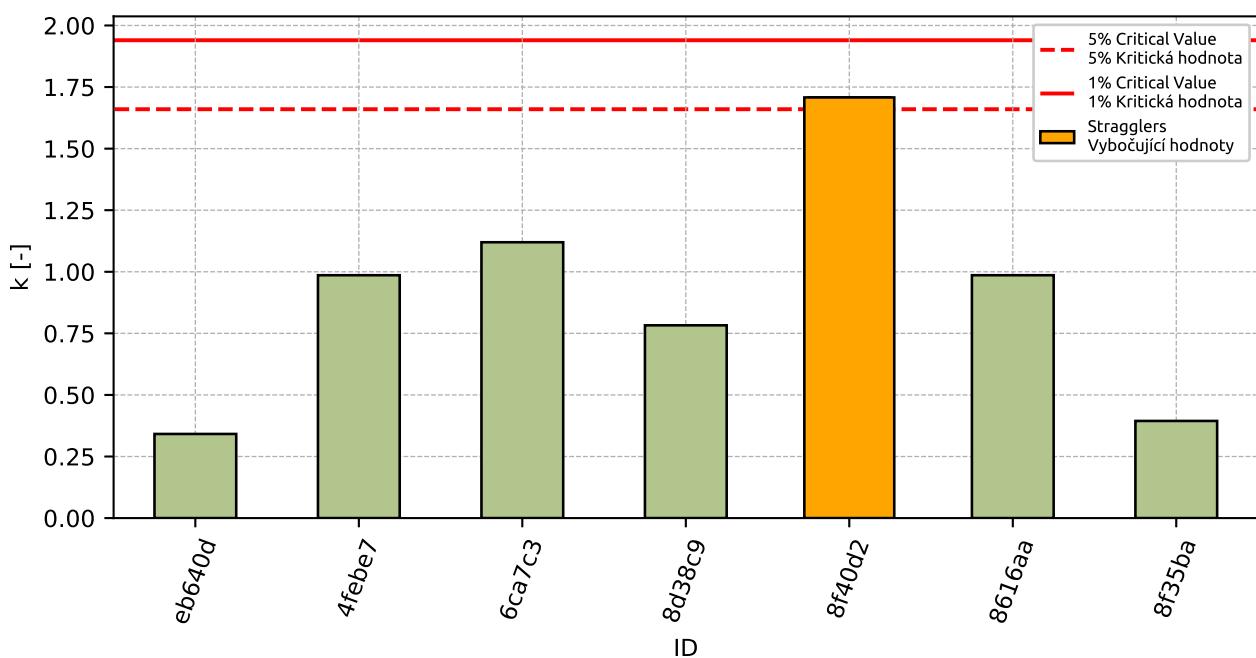

Figure 119: Intralaboratory Consistency Statistic

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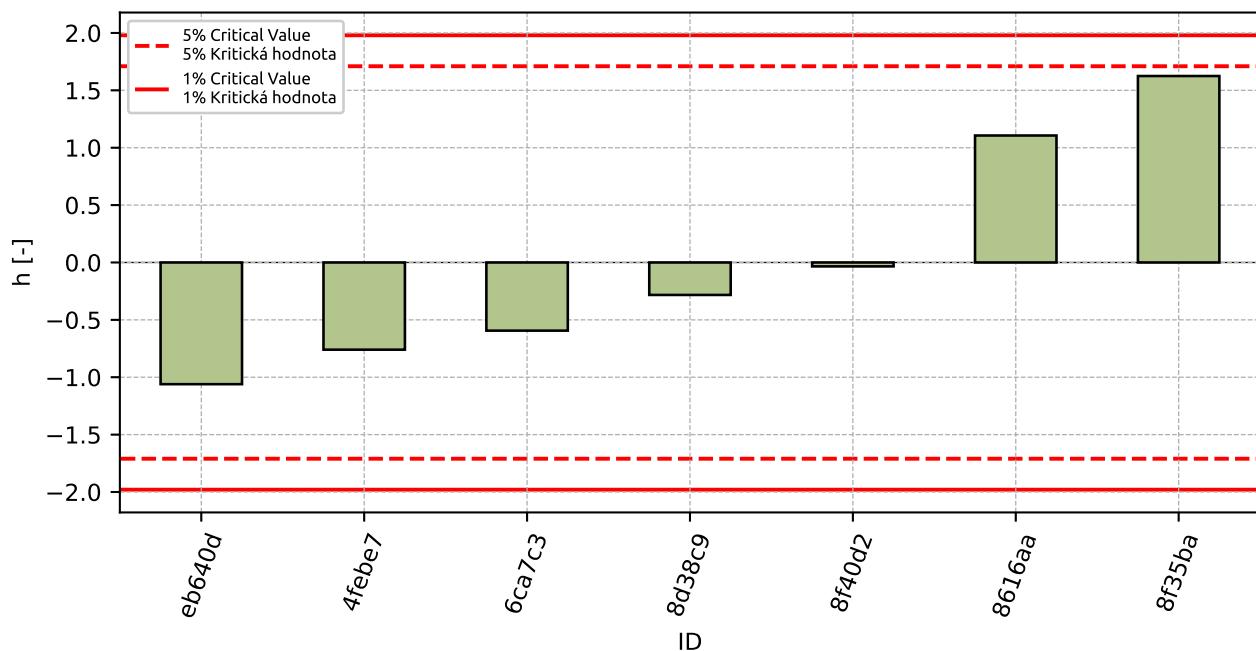
Figure 120: Interlaboratory Consistency Statistic

10.1.4 Descriptive statistics
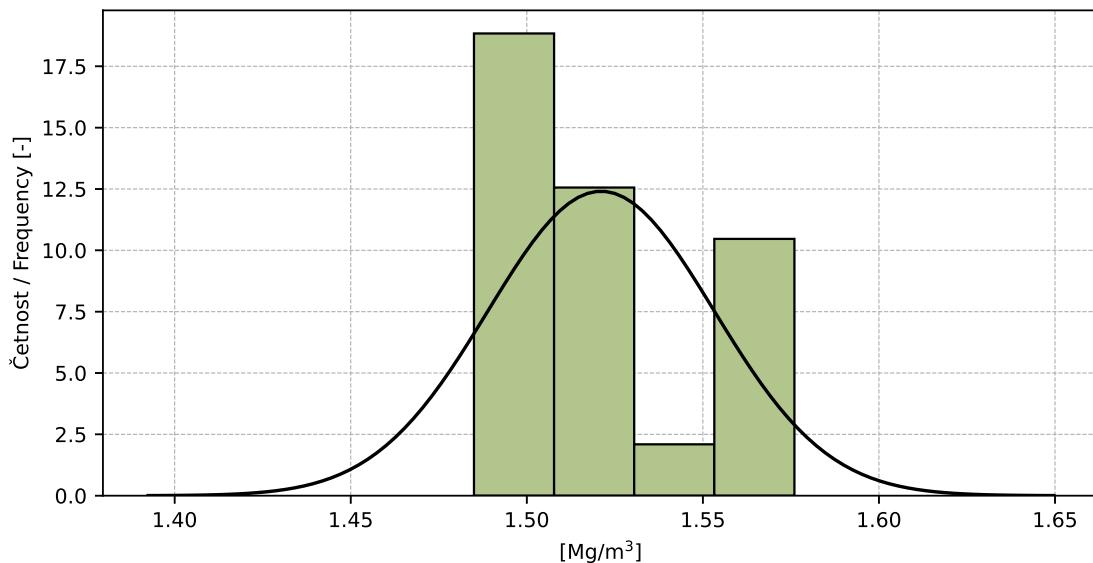
Figure 121: Histogram of all test results

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Table 45: Descriptive statistics

| Characteristics	[Mg/m^3]
Průměrná hodnota / Average value – $\bar{x}$	1.52
Výběrová směrodatná odchylka / Sample standard deviation – s	0.032
Vztažná hodnota / Asigned value – x^*	1.52
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.032
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.015
p-hodnota testu normality / p-value of normality test	0.01 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.032
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.006
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.033
Opakovatelnost / Repeatability – r	0.02
Reprodukovatelnost / Reproducibility – R	0.09

10.1.5   Evaluation of Performance Statistics
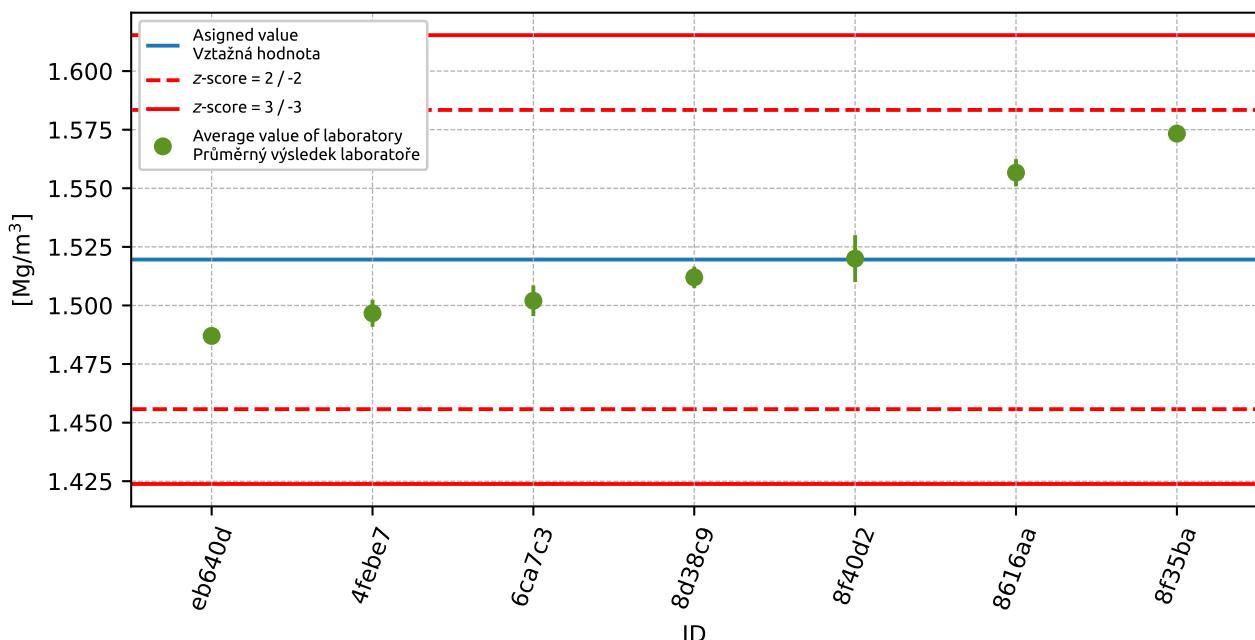
Figure 122: Average values and sample standard deviations

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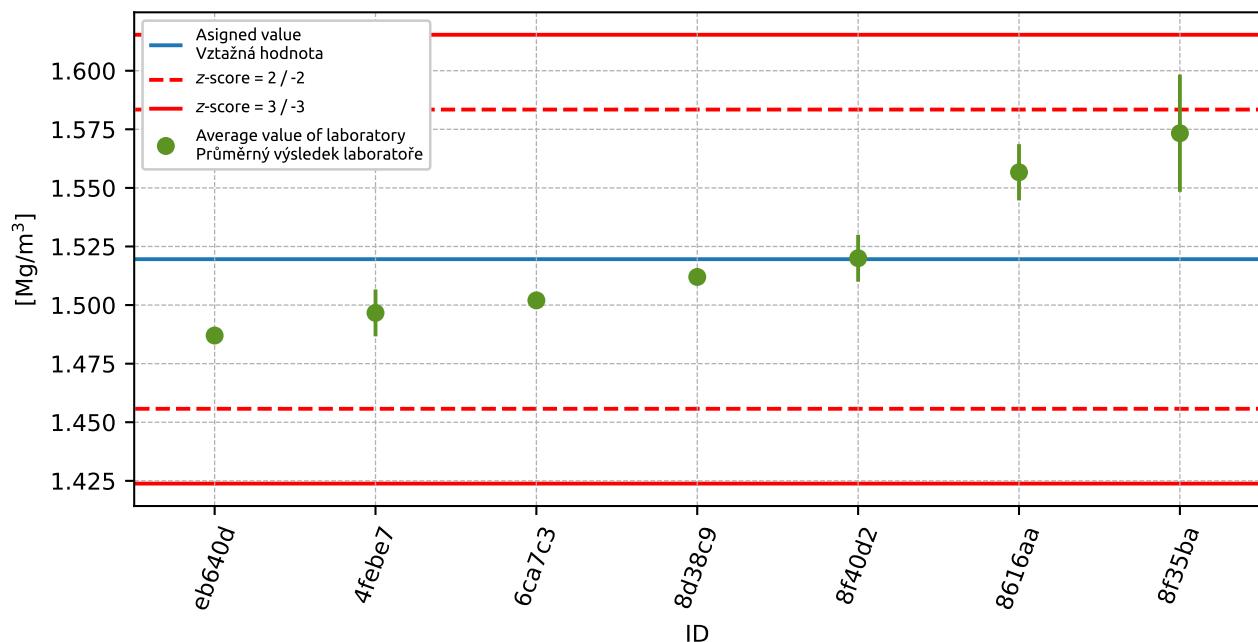
Figure 123: Average values and extended uncertainties of measurement

Figure 124: z-score

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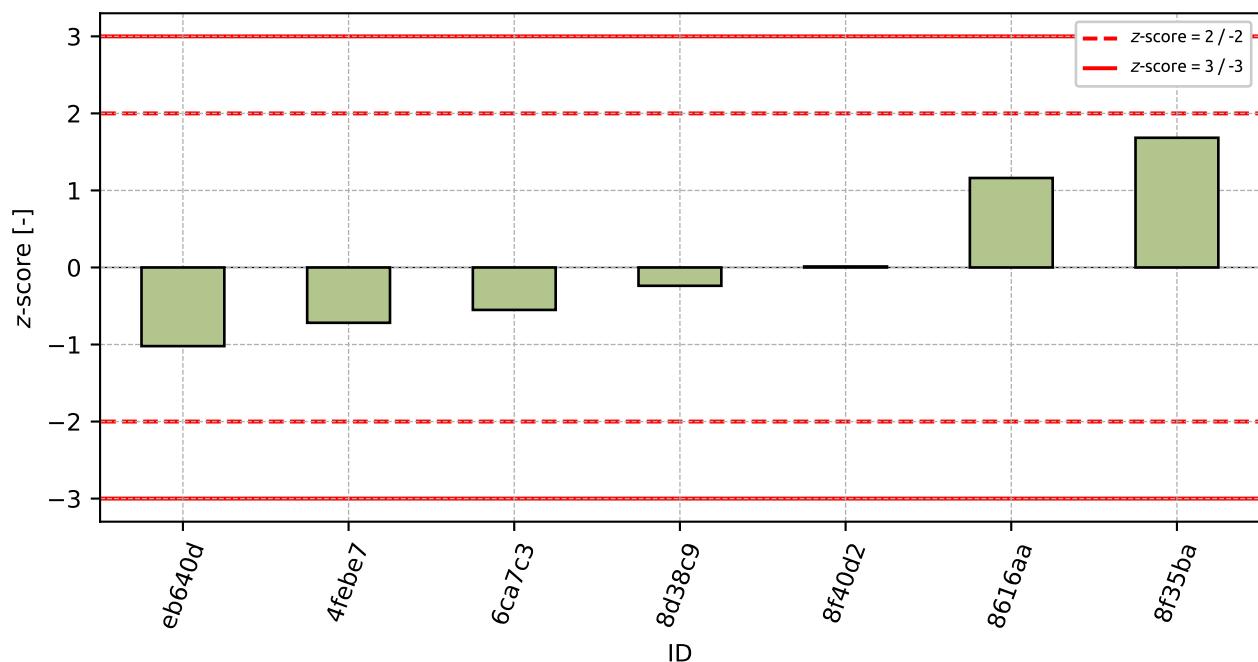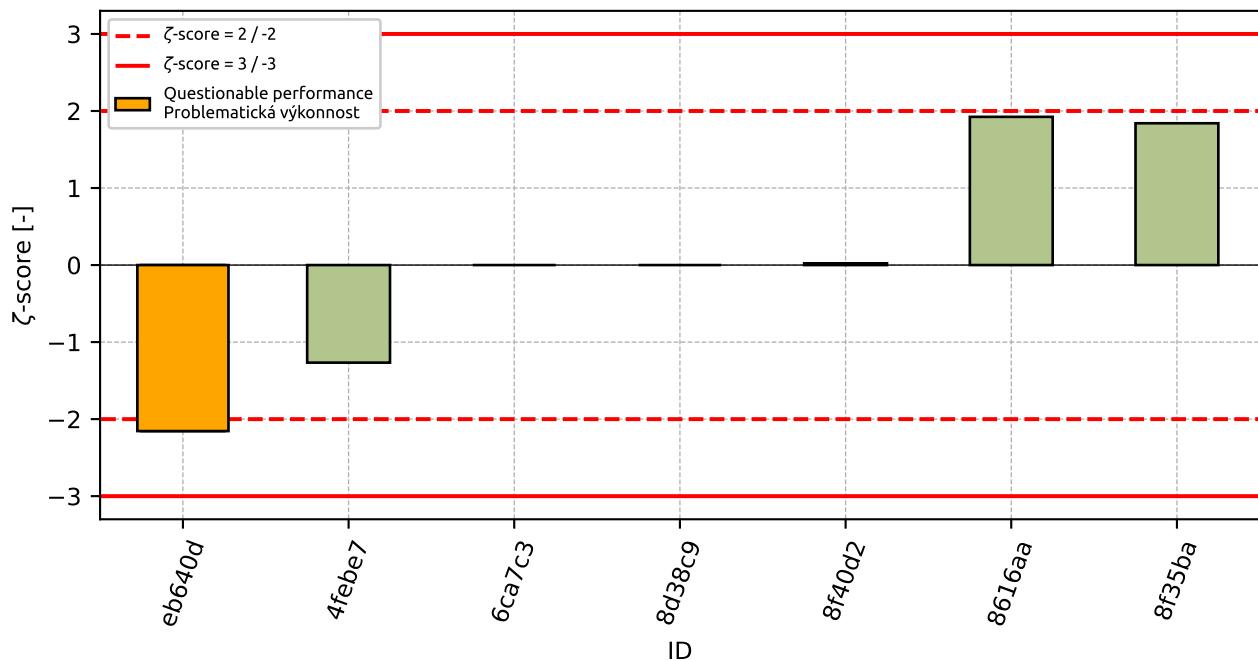
Figure 125: ζ-score

Table 46: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
eb640d	-1.02	-2.16
4febe7	-0.72	-1.27
6ca7c3	-0.55	-
8d38c9	-0.24	-
8f40d2	0.01	0.02
8616aa	1.16	1.92
8f35ba	1.68	1.84

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10.2   Voids

10.2.1   Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
8616aa	38.2	37.7	37.8	0.5	37.9	0.26	0.7
8f35ba	41.4	41.8	41.4	0.0	41.5	0.22	0.53
eb640d	42.1	42.2	42.6	0.2	42.3	0.26	0.63
8f40d2	42.4	42.4	42.3	0.1	42.4	0.06	0.14
8d38c9	43.0	42.7	42.8	-	42.8	0.15	0.36
6ca7c3	43.0	43.0	43.0	-	43.0	0.0	0.0

10.2.2   The Numerical Procedure for Determining Outliers
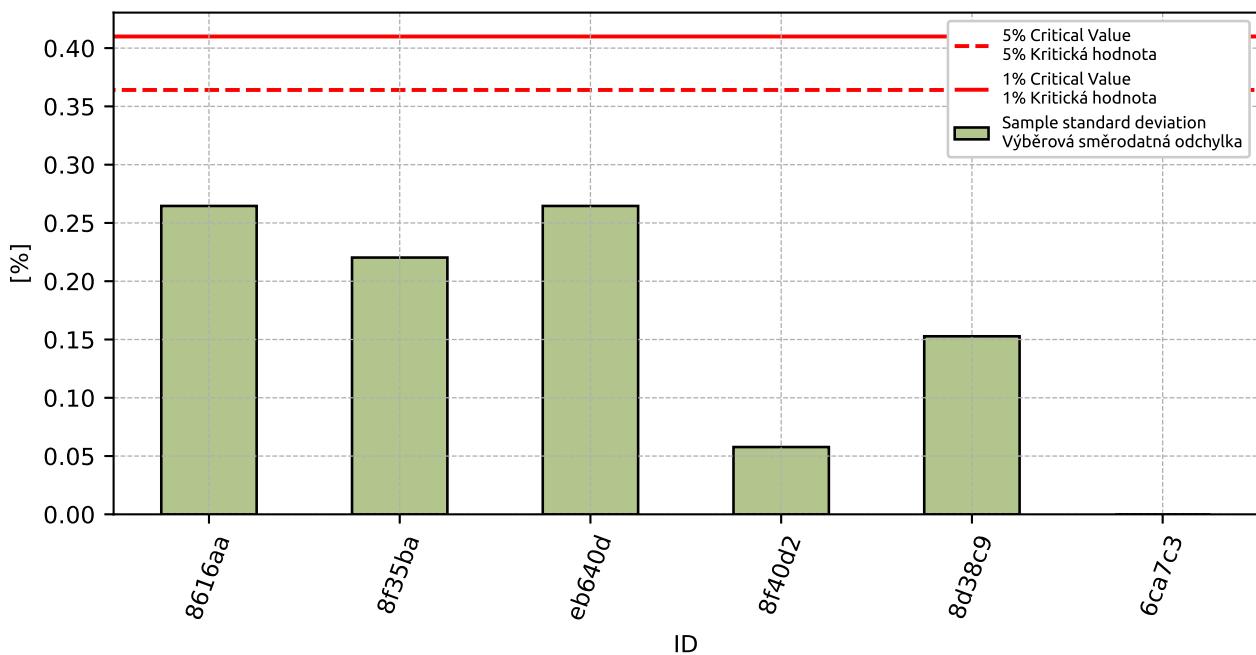
Figure 126: **Cochran's test** - sample standard deviations

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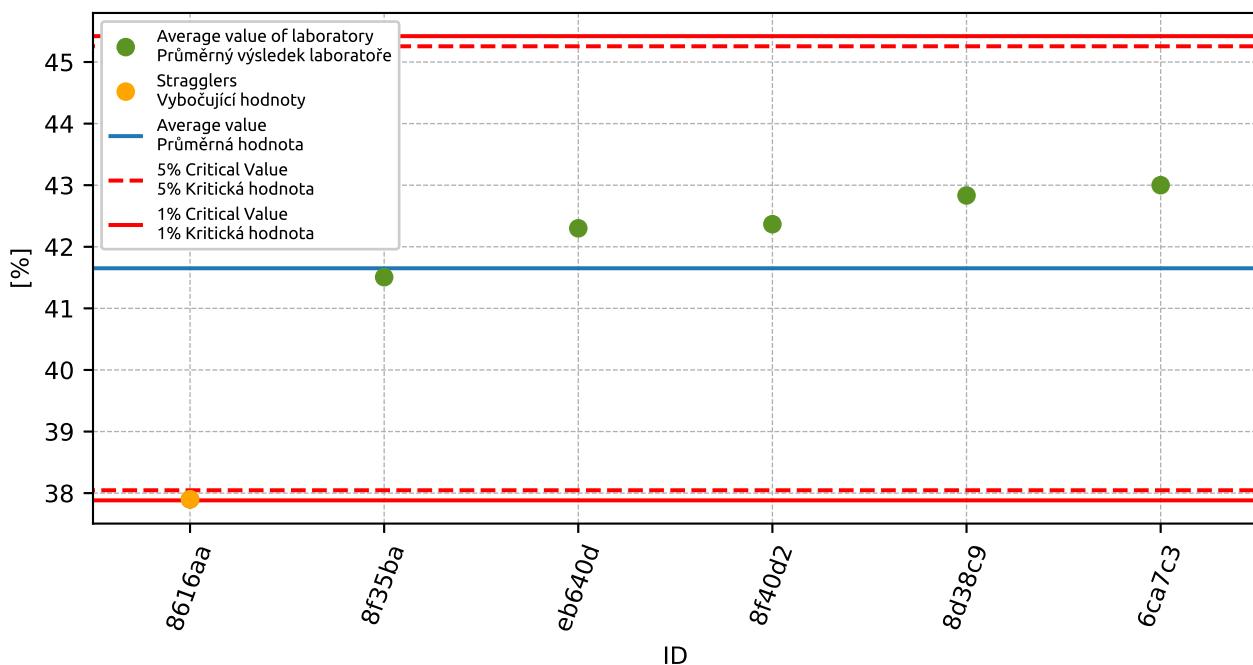
Figure 127: **Grubbs' test** - average values

10.2.3   Mandel's Statistics
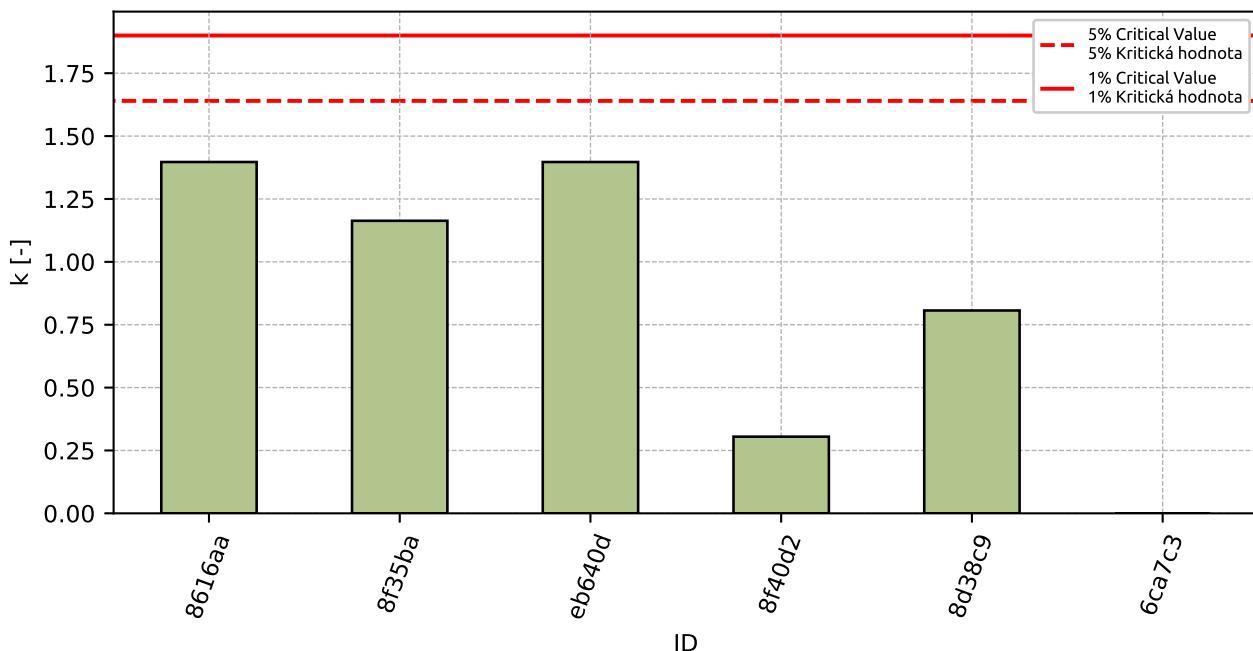
Figure 128: Intralaboratory Consistency Statistic

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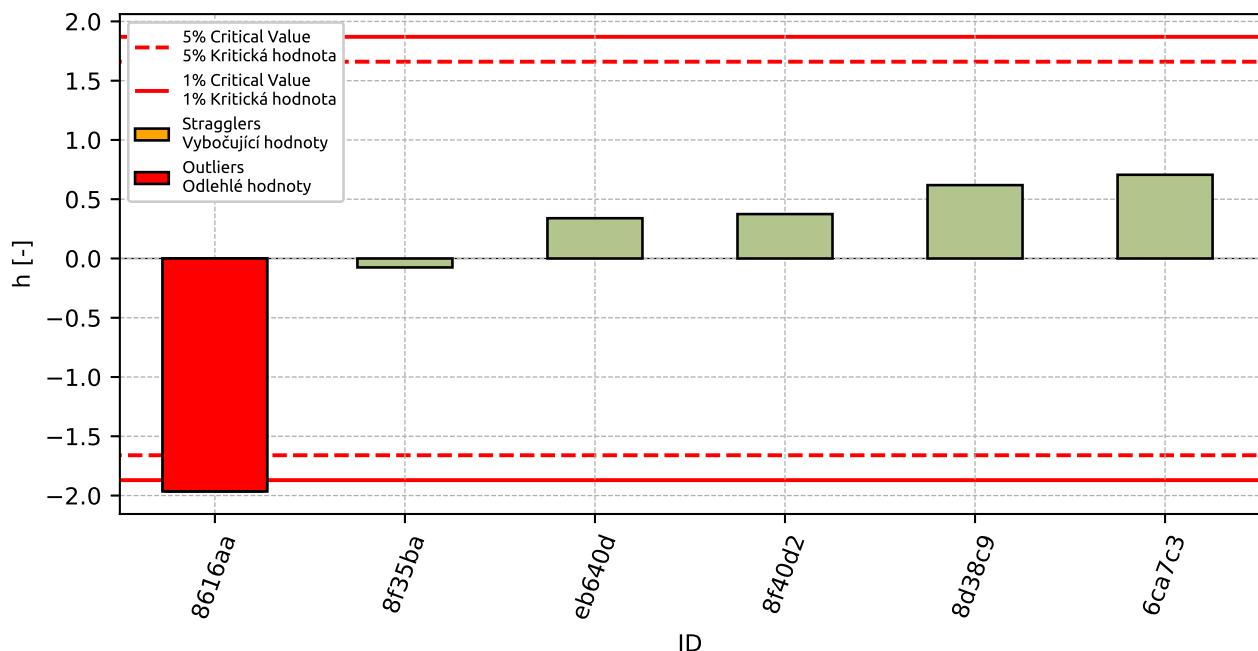
Figure 129: Interlaboratory Consistency Statistic

10.2.4   Descriptive statistics
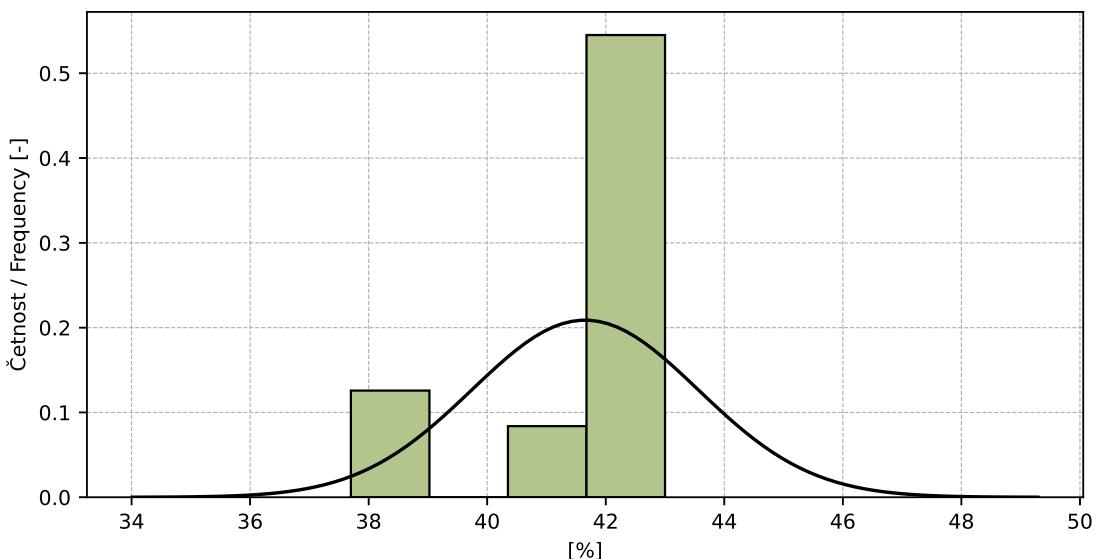
Figure 130: Histogram of all test results

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Table 48: Descriptive statistics

| Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	41.7
Výběrová směrodatná odchylka / Sample standard deviation – s	1.91
Vztažná hodnota / Asigned value – x^*	42.2
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.79
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.4
p-hodnota testu normality / p-value of normality test	0.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.91
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.19
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.92
Opakovatelnost / Repeatability – r	0.5
Reprodukovatelnost / Reproducibility – R	5.4

10.2.5　Evaluation of Performance Statistics
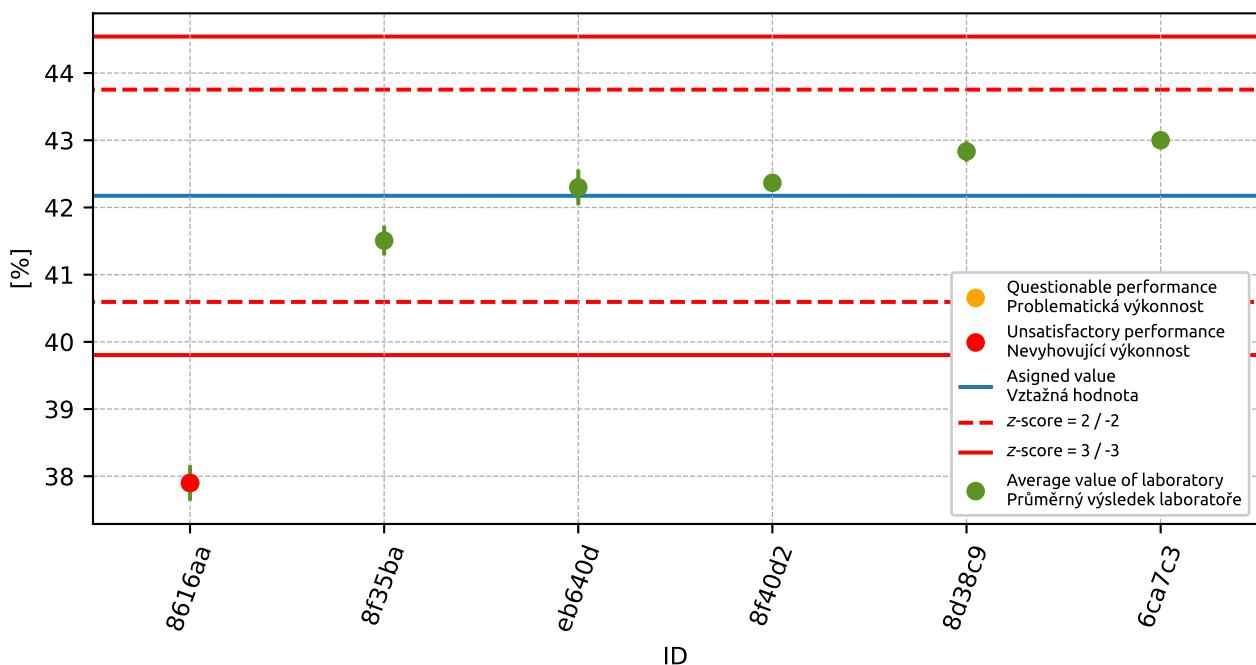
Figure 131: Average values and sample standard deviations

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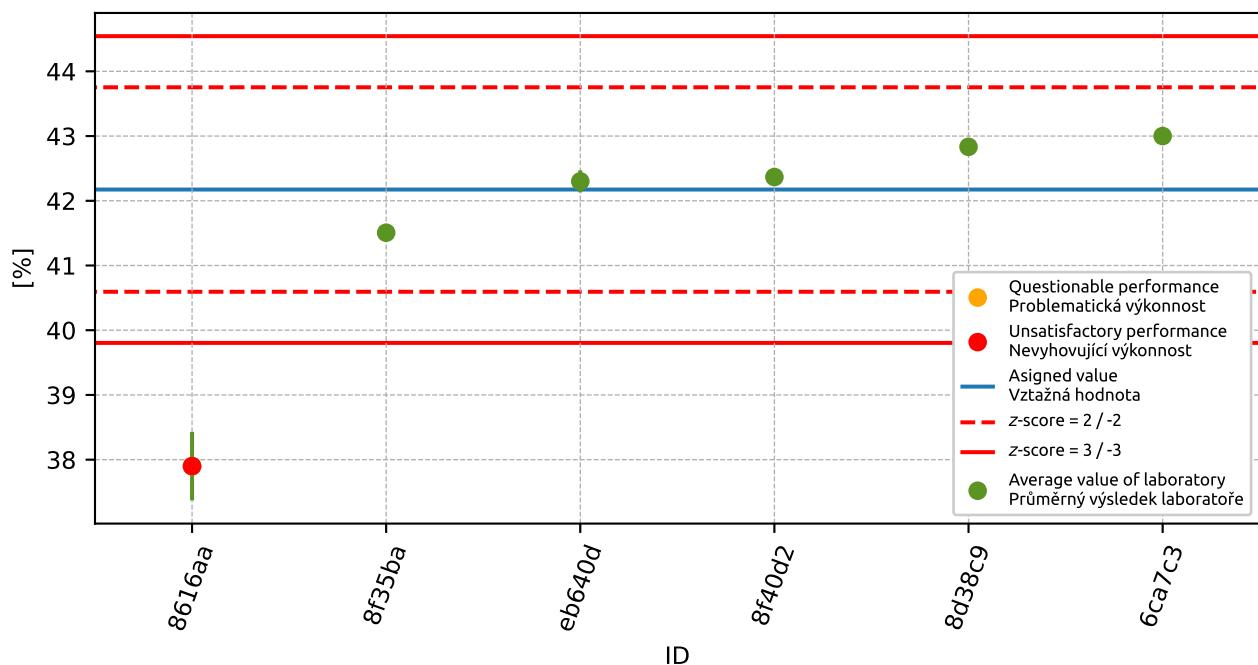
Figure 132: Average values and extended uncertainties of measurement

Figure 133: z-score

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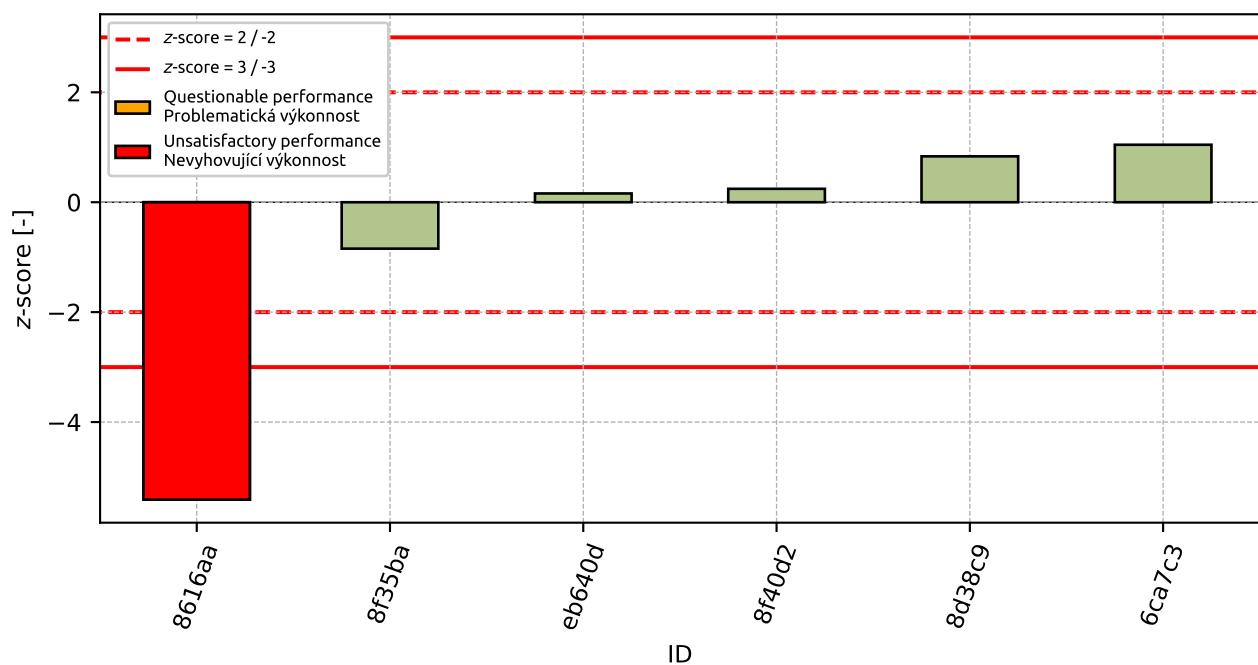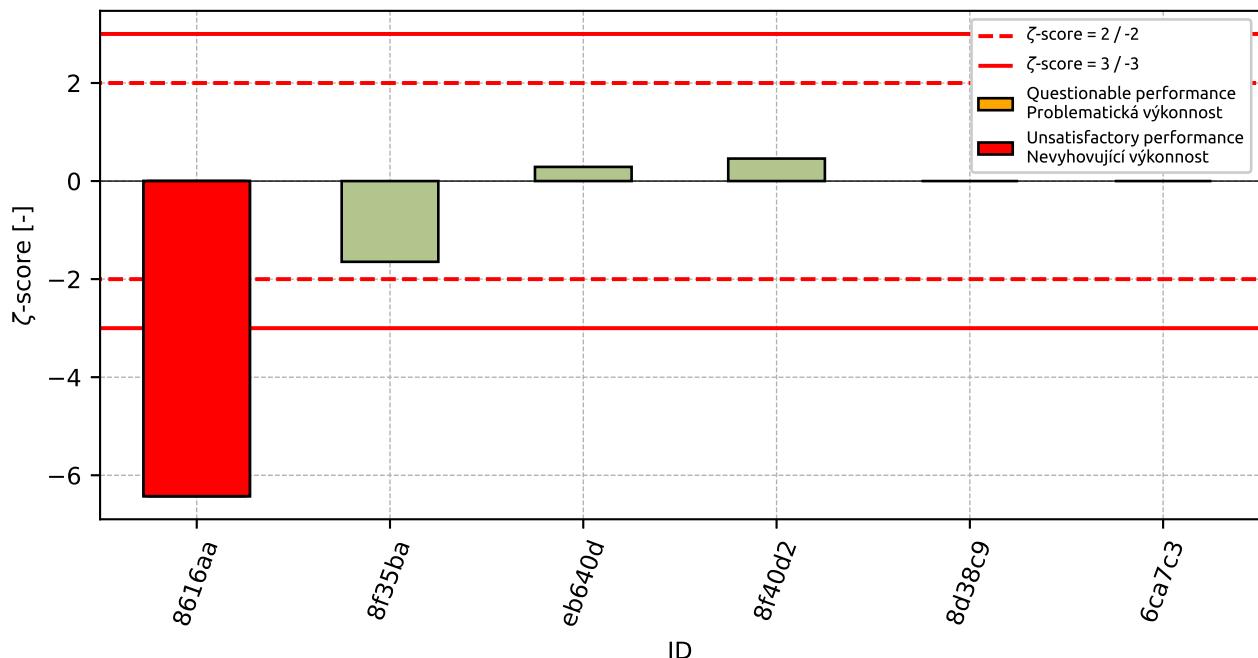
Figure 134: ζ-score

Table 49: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
8616aa	-5.41	-6.43
8f35ba	-0.84	-1.65
eb640d	0.16	0.29
8f40d2	0.24	0.46
8d38c9	0.84	-
6ca7c3	1.05	-

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
4febe7	5.7	5.7	5.9	0.2	5.8	0.12	2.0
3ec36d	5.9	6.0	5.8	0.2	5.9	0.1	1.69
51ba4e	5.9	6.0	6.0	0.4	6.0	0.06	0.97
218cd3	6.1	6.1	6.1	0.3	6.1	0.0	0.0
4a9f9e	6.1	6.2	6.2	0.2	6.2	0.06	0.94
ba0a1f	6.1	6.1	6.3	0.2	6.2	0.12	1.87
d5e66f	6.2	6.2	6.2	0.1	6.2	0.0	0.0
6498ce	6.2	6.3	6.1	0.1	6.2	0.1	1.61
6d5a2f	6.4	6.3	5.9	1.6	6.2	0.26	4.27
88377f	6.2	6.2	6.3	0.2	6.2	0.06	0.93
4154b9	6.3	6.1	6.3	0.3	6.2	0.12	1.85
72f43c	6.0	6.4	6.3	0.5	6.2	0.21	3.34
e18dad	6.2	6.2	6.3	0.1	6.2	0.06	0.93
eb640d	6.1	6.3	6.4	0.0	6.3	0.13	2.0
0a41a5	6.3	6.1	6.4	2.6	6.3	0.15	2.44
4c84bf	6.3	6.2	6.3	2.7	6.3	0.06	0.92
6ca7c3	6.3	6.3	6.3	-	6.3	0.0	0.0
777f0c	6.3	6.3	6.3	-	6.3	0.0	0.0
4df05e	6.5	6.3	6.2	-	6.3	0.15	2.41
247115	6.2	6.3	6.5	0.0	6.3	0.15	2.41
1198ac	6.2	6.3	6.5	0.3	6.3	0.15	2.41
8616aa	6.5	6.4	6.1	0.6	6.3	0.21	3.29
5aa151	6.4	6.4	6.3	0.2	6.4	0.06	0.91
dbc3dc	6.4	6.4	6.3	0.1	6.4	0.06	0.91
8f35ba	6.3	6.5	6.3	6.0	6.4	0.12	1.81
cbe732	6.4	6.5	6.3	0.3	6.4	0.1	1.56
697684	6.3	6.4	6.5	0.4	6.4	0.1	1.56
508ab0	6.4	6.4	6.5	0.5	6.4	0.06	0.9
222b47	6.5	6.3	6.6	0.8	6.5	0.15	2.36
f2feb9	6.4	6.4	6.6	2.7	6.5	0.12	1.79
f47f78	6.7	6.5	6.3	0.1	6.5	0.2	3.08
9f937c	6.6	6.6	6.9	0.4	6.7	0.17	2.59
619869	6.7	6.7	6.7	-	6.7	0.0	0.0

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11.2   The Numerical Procedure for Determining Outliers
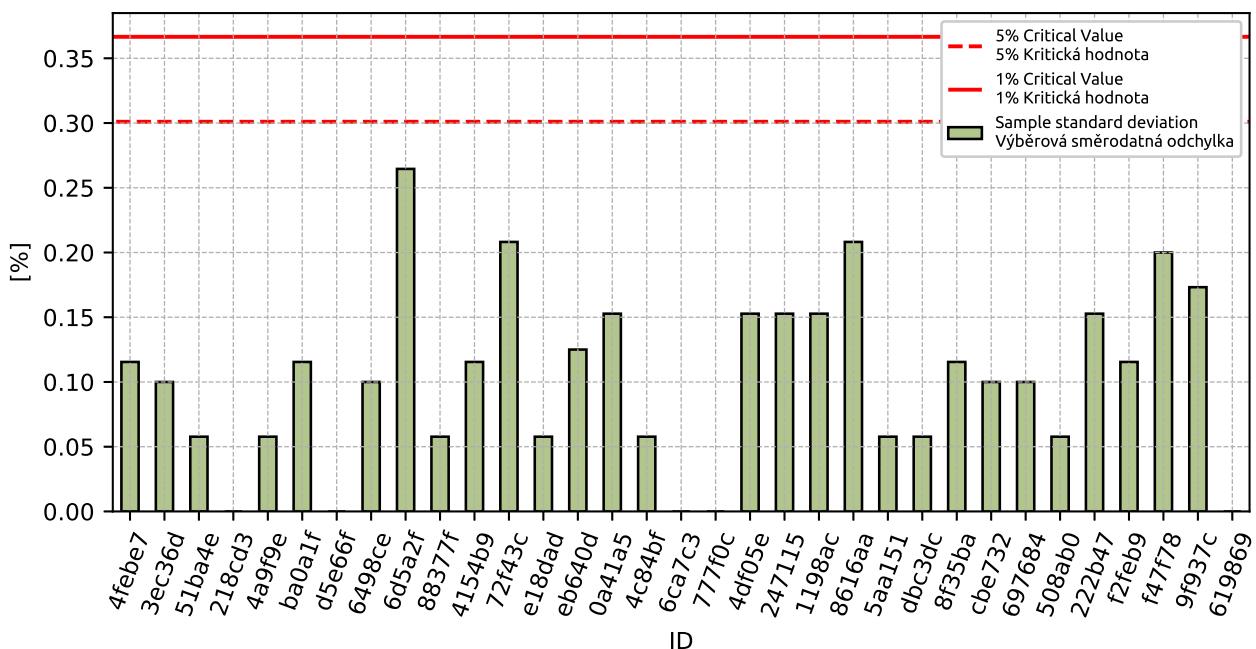
Figure 135: **Cochran's test** - sample standard deviations
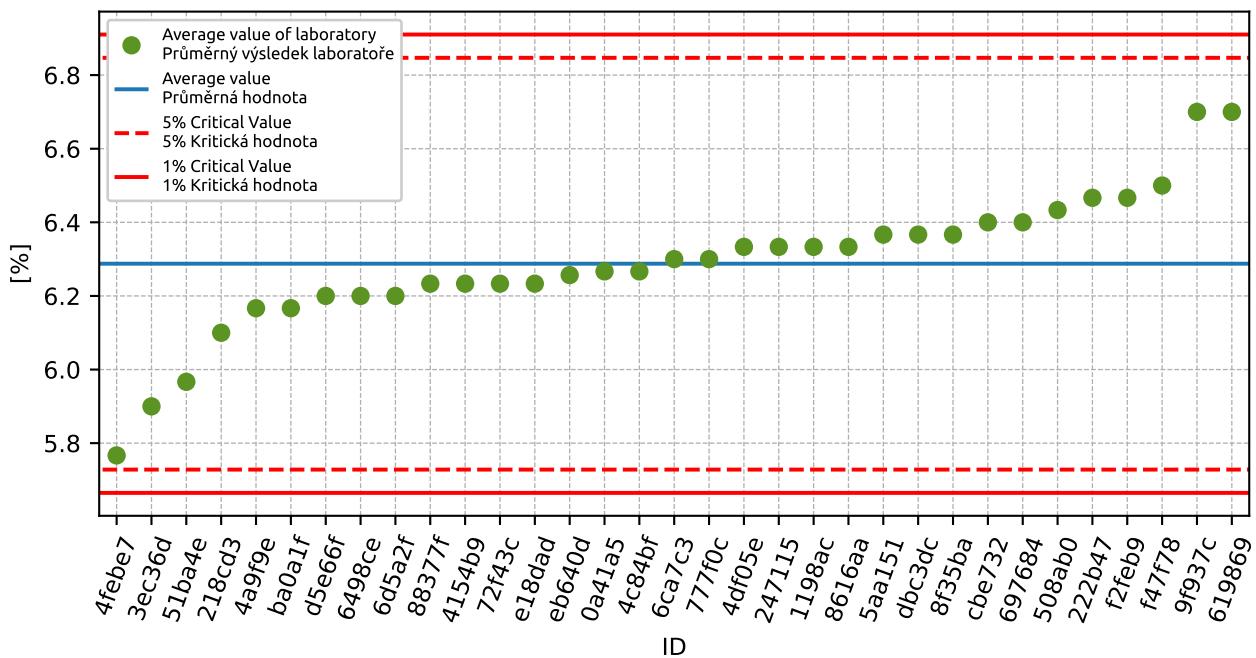
Figure 136: **Grubbs' test** - average values

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11.3   Mandel's Statistics
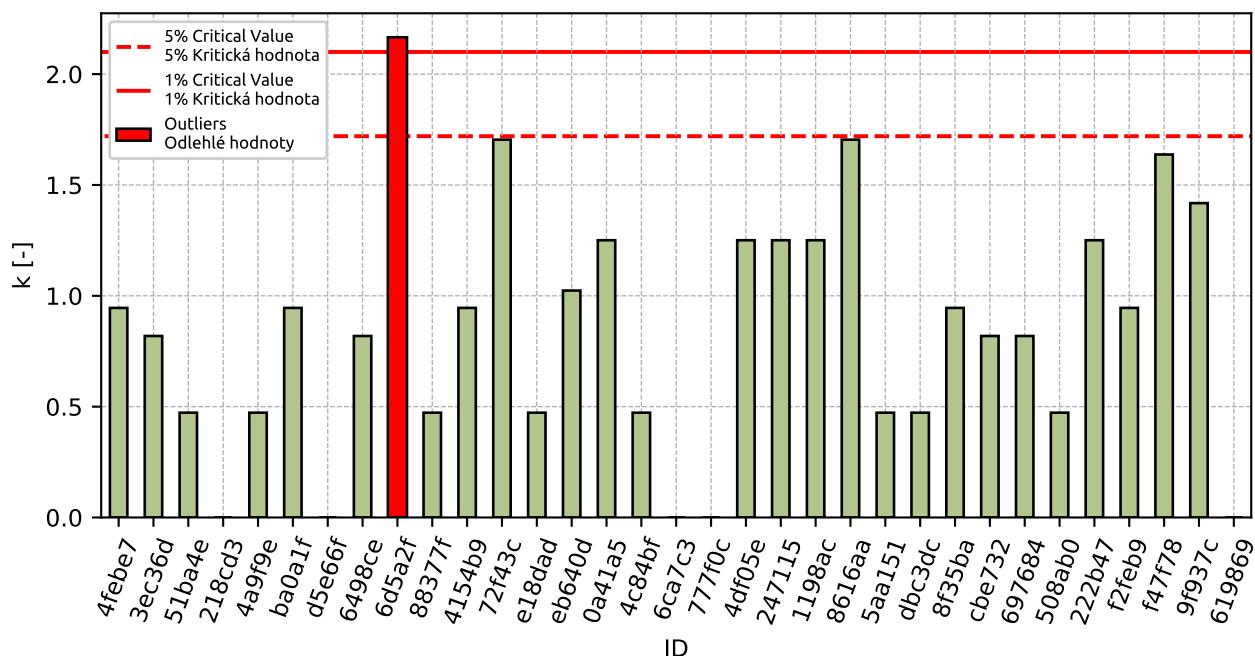
Figure 137: Intralaboratory Consistency Statistic
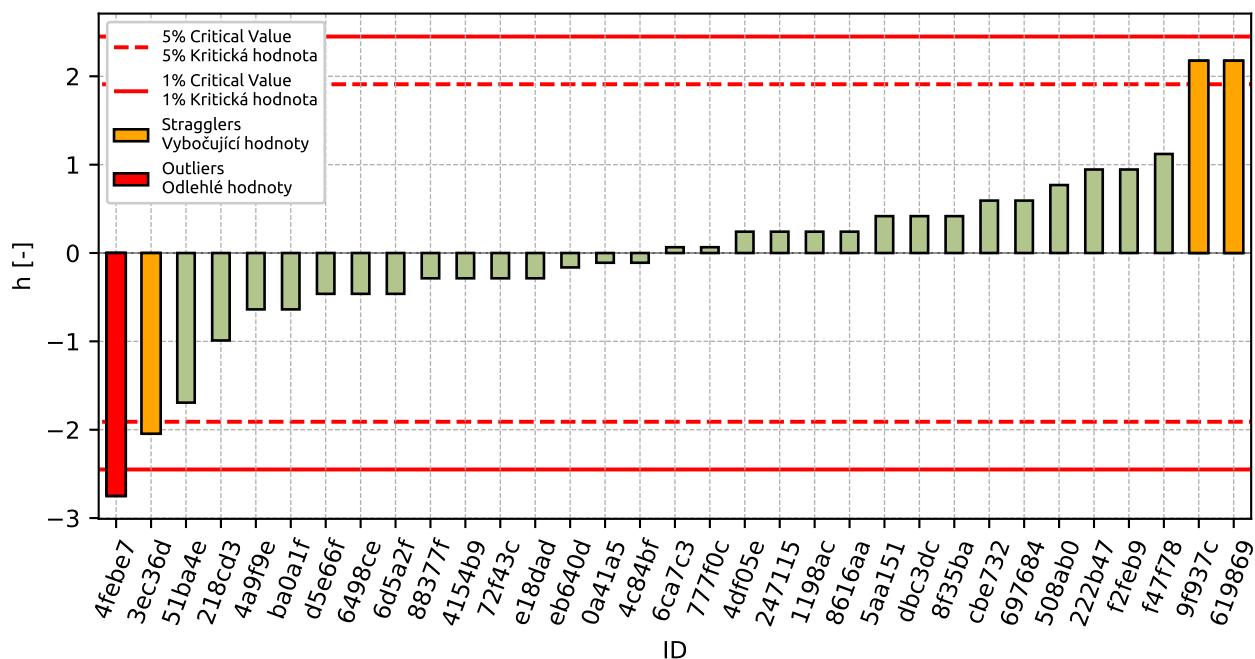
Figure 138: Interlaboratory Consistency Statistic

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11.4   Descriptive statistics
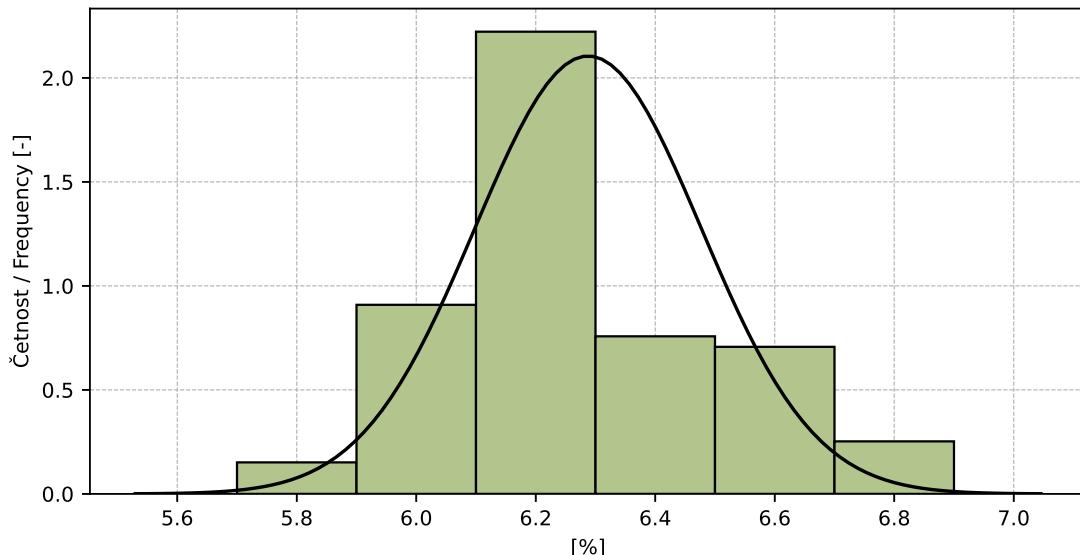
Figure 139: Histogram of all test results

Table 51: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	6.3
Výběrová směrodatná odchylka / Sample standard deviation – s	0.19
Vztažná hodnota / Asigned value – x^*	6.3
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.16
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.03
p-hodnota testu normality / p-value of normality test	0.01 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.18
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.12
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.21
Opakovatelnost / Repeatability – r	0.3
Reprodukovatelnost / Reproducibility – R	0.6

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11.5   Evaluation of Performance Statistics
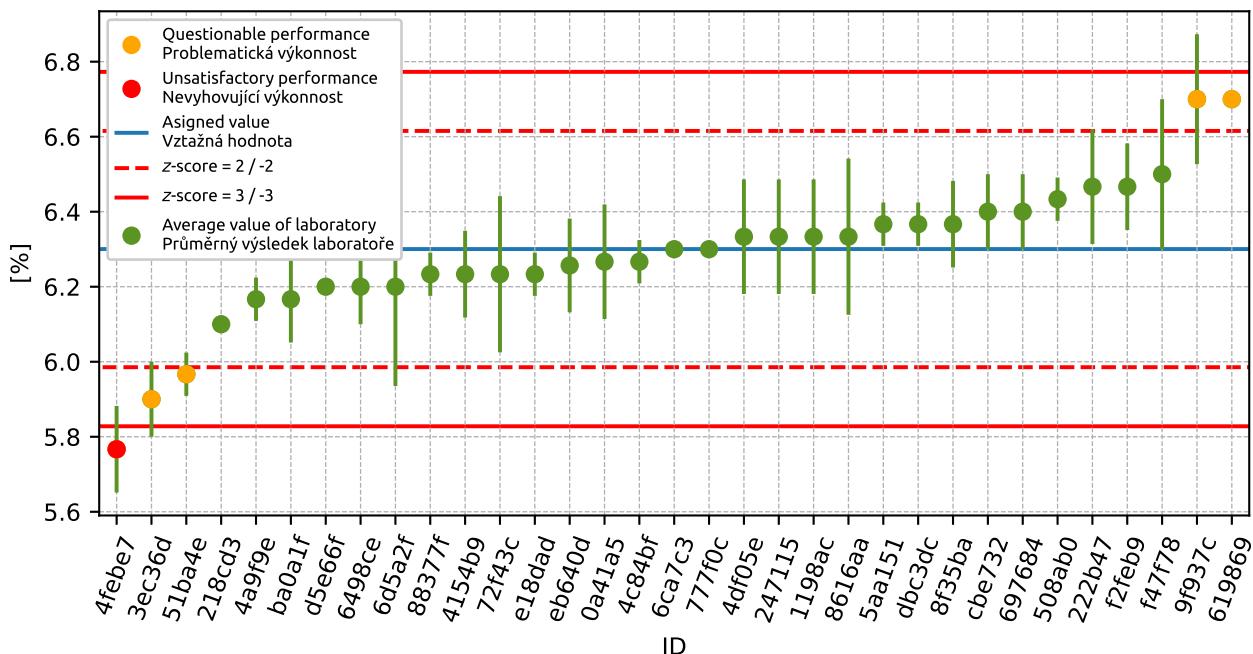

Figure 140: Average values and sample standard deviations
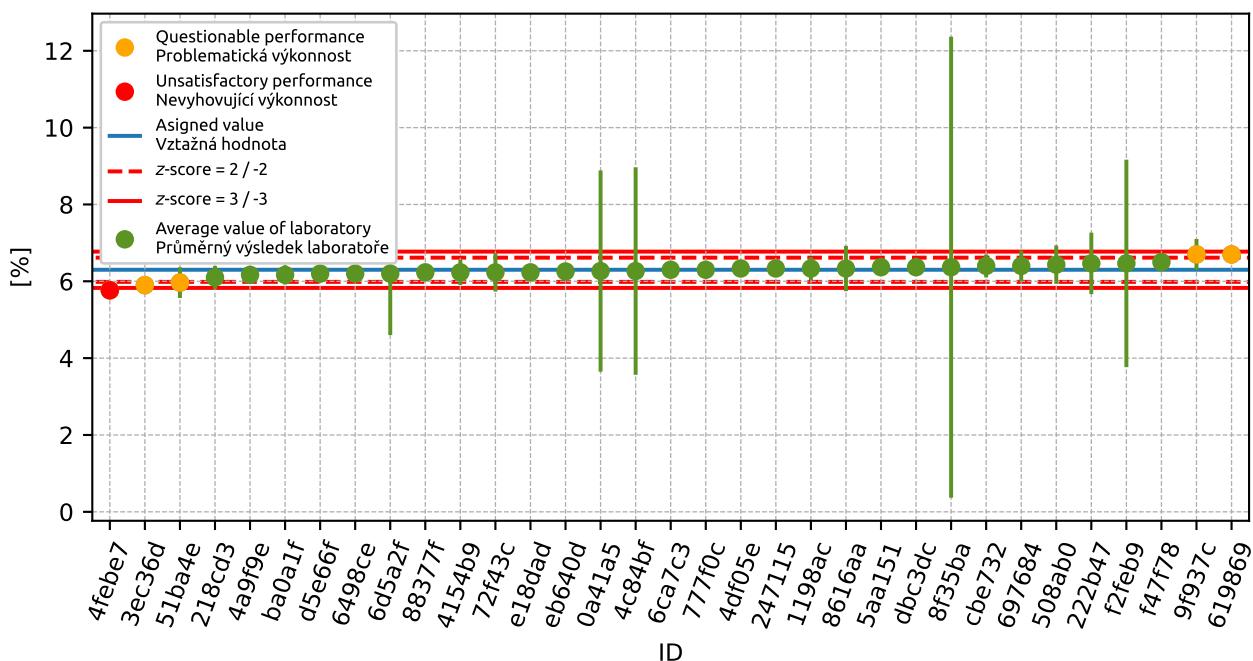
Figure 141: Average values and extended uncertainties of measurement

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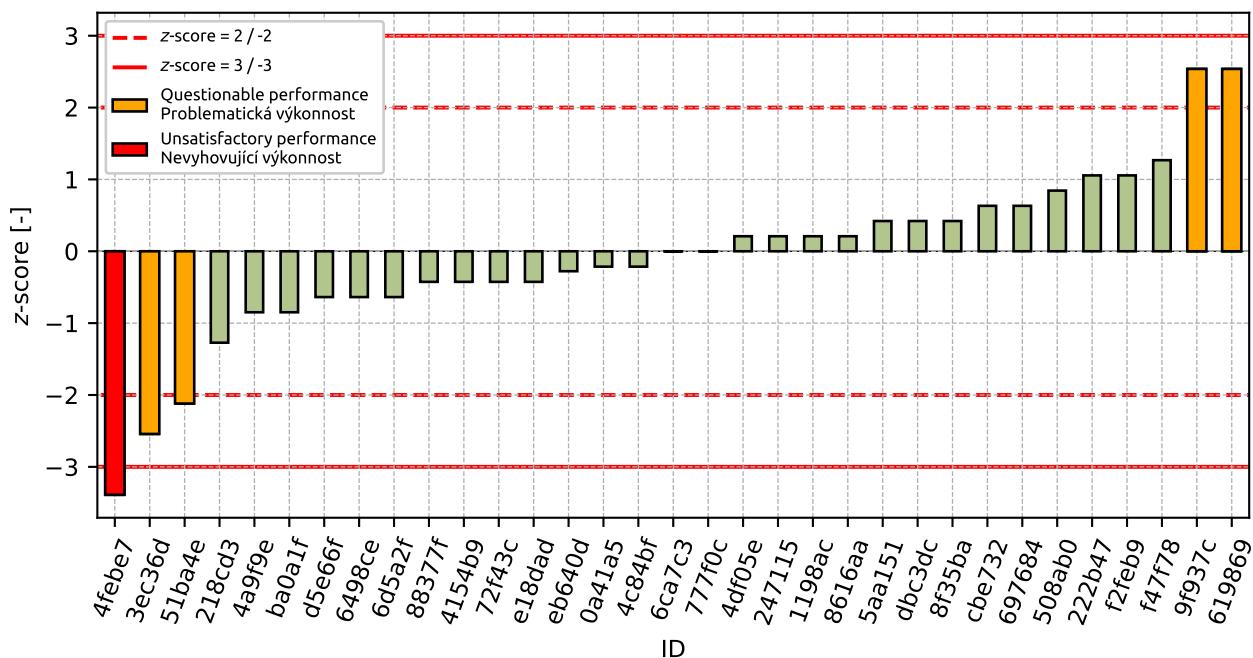
Figure 142: z-score

Figure 143: ζ-score

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Table 52: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
4febe7	-3.39	-2.76
3ec36d	-2.54	-2.18
51ba4e	-2.12	-0.83
218cd3	-1.27	-0.66
4a9f9e	-0.85	-0.66
ba0a1f	-0.85	-0.53
d5e66f	-0.64	-0.8
6498ce	-0.64	-1.45
6d5a2f	-0.64	-0.06
88377f	-0.43	-0.37
4154b9	-0.43	-0.2
72f43c	-0.43	-0.13
e18dad	-0.43	-0.63
eb640d	-0.28	-0.97
0a41a5	-0.21	-0.01
4c84bf	-0.21	-0.01
6ca7c3	-0.0	-
777f0c	-0.0	-
4df05e	0.21	-
247115	0.21	0.72
1198ac	0.21	0.11
8616aa	0.21	0.06
5aa151	0.42	0.33
dbc3dc	0.42	0.63
8f35ba	0.42	0.01
cbe732	0.63	0.33
697684	0.63	0.25
508ab0	0.84	0.27
222b47	1.06	0.21
f2feb9	1.06	0.06
f47f78	1.27	1.89
9f937c	2.54	1.0
619869	2.54	-

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

12.1   Particle density

12.1.1   Test results

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

ID	Test results [Mg/m^3]			u_X [Mg/m^3]	$\bar{x}$ [Mg/m^3]	s_0 [Mg/m^3]	V_X [%]
6d5a2f	2.55	2.53	2.57	0.1	2.55	0.02	0.78
d96fe0	2.74	2.71	2.72	0.02	2.72	0.015	0.56
4154b9	2.72	2.72	2.73	0.01	2.72	0.008	0.31
81a267	2.73	2.73	2.73	0.02	2.73	0.0	0.0
697684	2.73	2.75	2.74	0.03	2.74	0.01	0.36
6498ce	2.75	2.74	2.74	0.01	2.74	0.006	0.21
8f40d2	2.74	2.75	2.74	0.01	2.74	0.006	0.21
72f43c	2.74	2.74	2.75	0.05	2.74	0.006	0.21
3ec36d	2.75	2.75	2.75	0.01	2.75	0.0	0.0
e24a24	2.75	2.75	2.75	-	2.75	0.0	0.0
1198ac	2.76	2.76	2.76	0.03	2.76	0.004	0.14
2f9590	2.76	2.76	2.76	0.04	2.76	0.0	0.0
4abbcf	2.76	2.77	2.75	0.32	2.76	0.01	0.36
ca615b	2.76	2.77	2.77	-	2.77	0.006	0.21
f47f78	2.77	2.76	2.78	0.05	2.77	0.01	0.36
346a9a	2.76	2.8	2.79	0.05	2.78	0.021	0.75
ba0a1f	2.79	2.78	2.79	0.06	2.79	0.006	0.21
218cd3	2.78	2.79	2.8	0.02	2.79	0.01	0.36
6ca7c3	2.81	2.81	2.81	-	2.81	0.0	0.0
8f35ba	2.81	2.85	2.85	0.37	2.84	0.023	0.81

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12.1.2   The Numerical Procedure for Determining Outliers
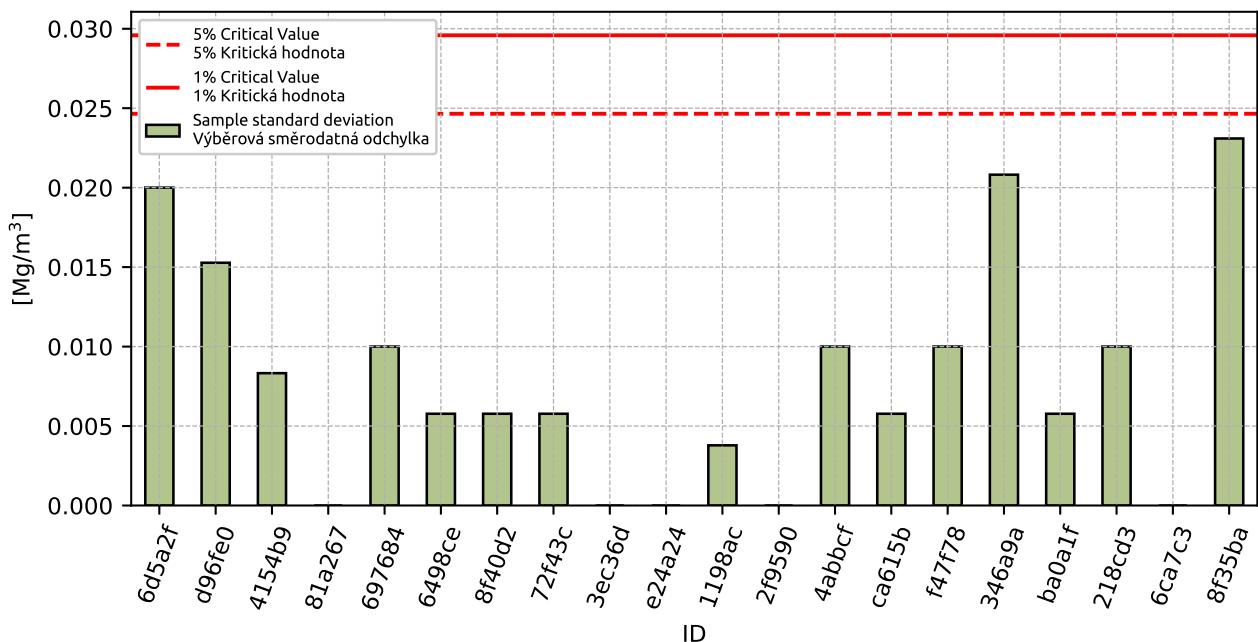
Figure 144: **Cochran's test** - sample standard deviations
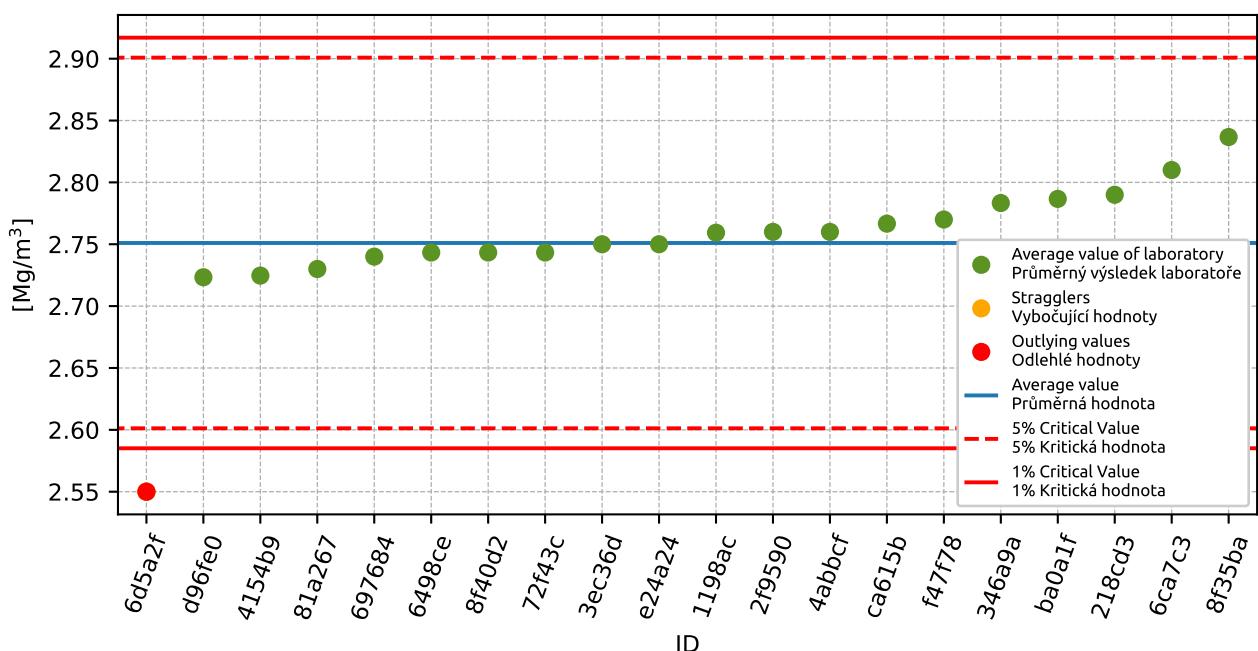
Figure 145: **Grubbs' test** - average values

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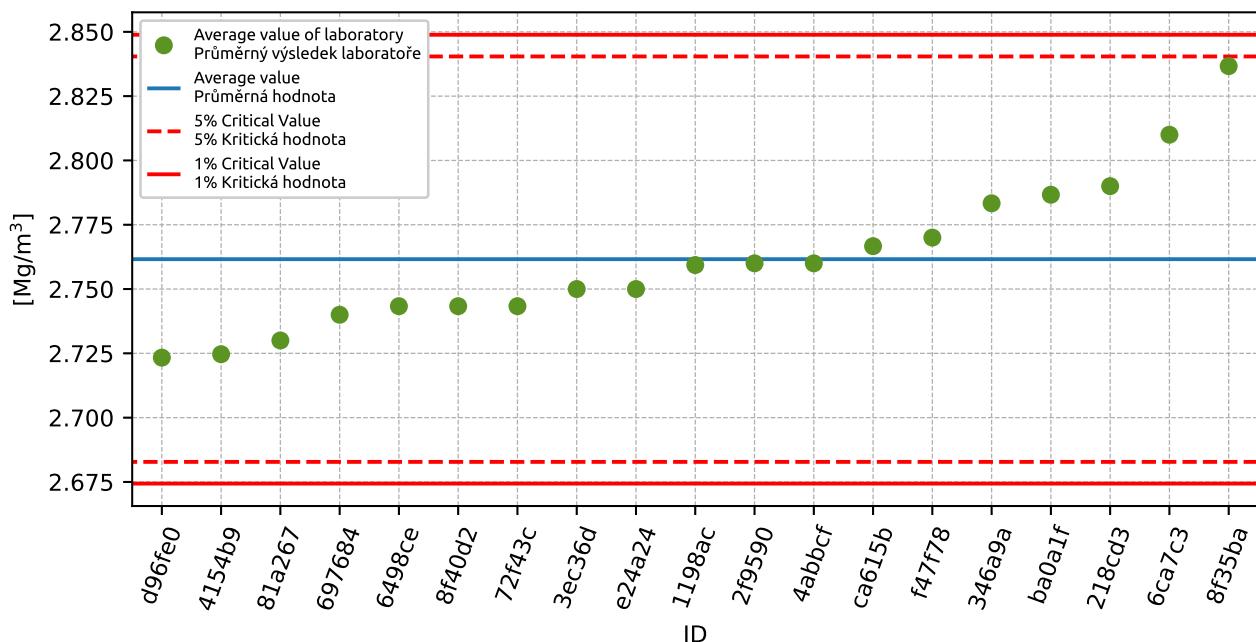
Figure 146: **Grubbs' test** - average values without outliers

12.1.3 Mandel's Statistics
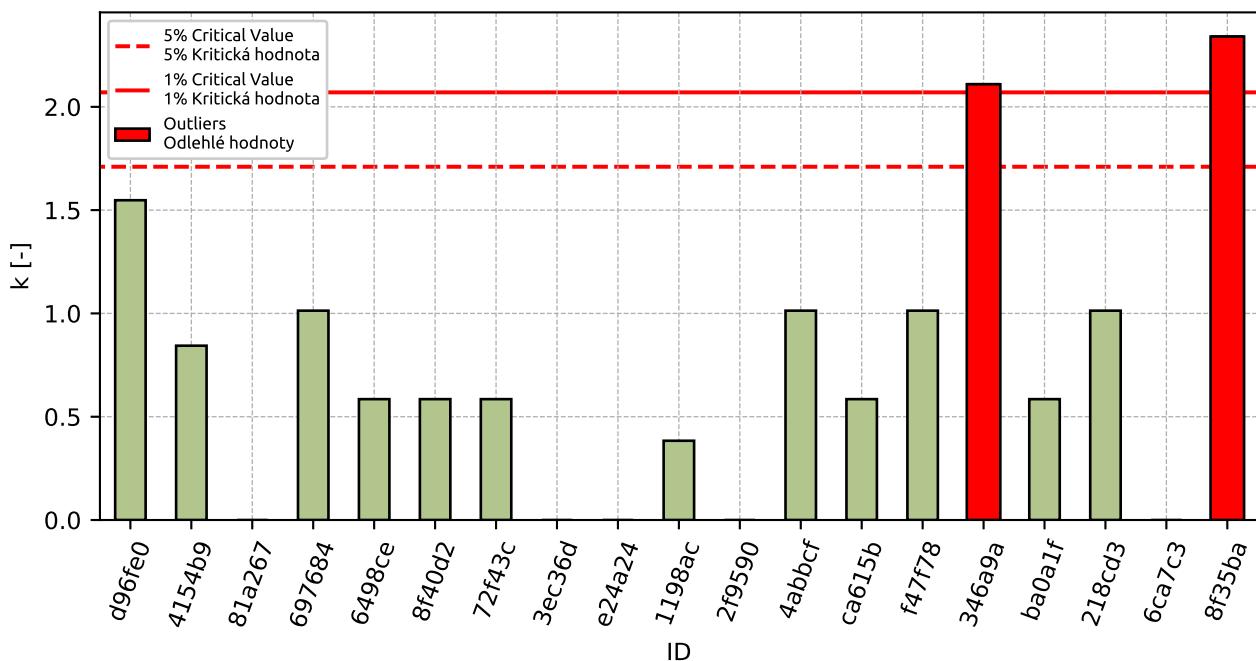
Figure 147: Intralaboratory Consistency Statistic

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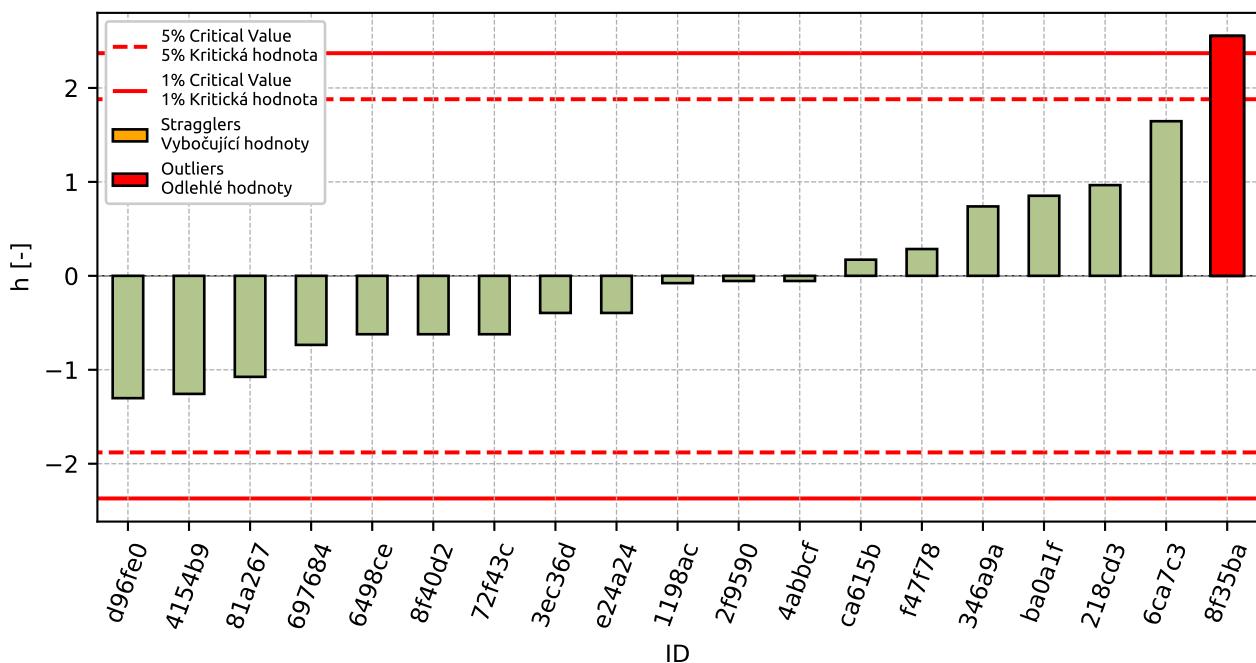
Figure 148: Interlaboratory Consistency Statistic

12.1.4 Descriptive statistics
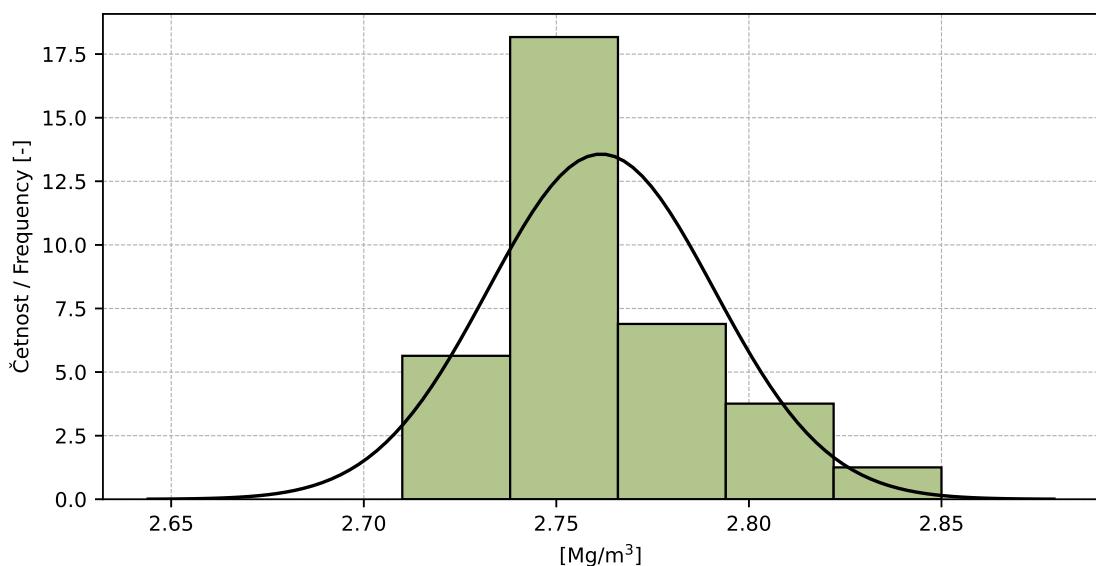
Figure 149: Histogram of all test results

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Table 54: Descriptive statistics

| Characteristics	[Mg/m³]
Průměrná hodnota / Average value – $\bar{x}$	2.76
Výběrová směrodatná odchylka / Sample standard deviation – s	0.029
Vztažná hodnota / Asigned value – x^*	2.76
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.031
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.009
p-hodnota testu normality / p-value of normality test	0.002 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.029
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.01
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.03
Opakovatelnost / Repeatability – r	0.03
Reprodukovatelnost / Reproducibility – R	0.09

12.1.5 Evaluation of Performance Statistics
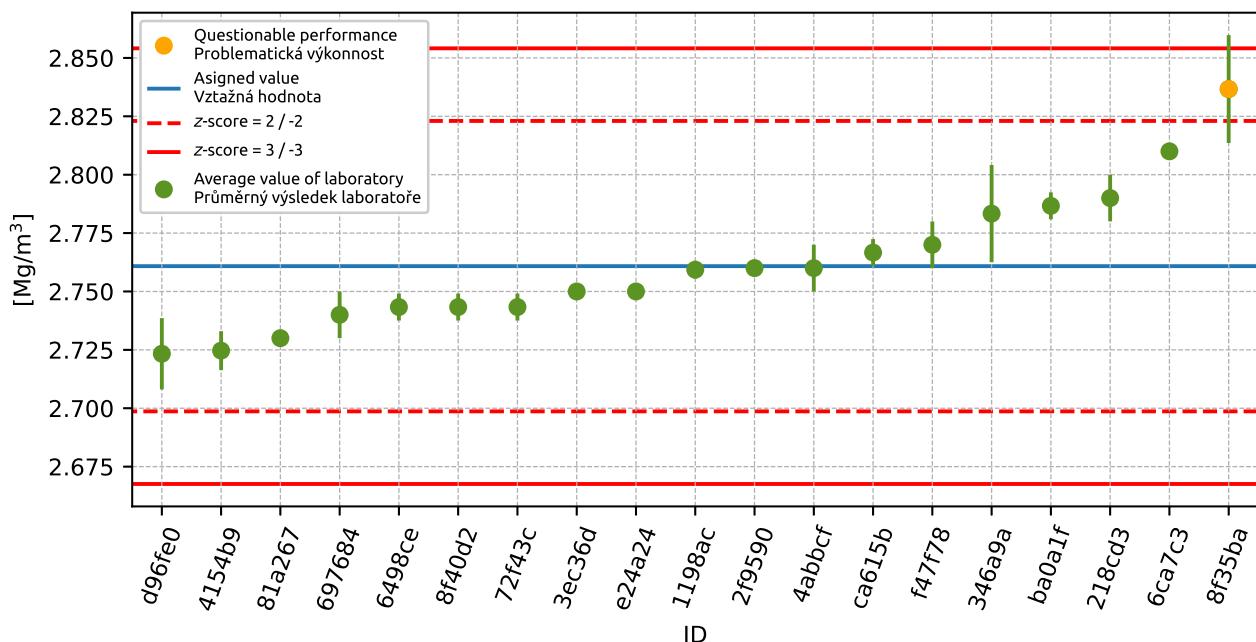

Figure 150: Average values and sample standard deviations

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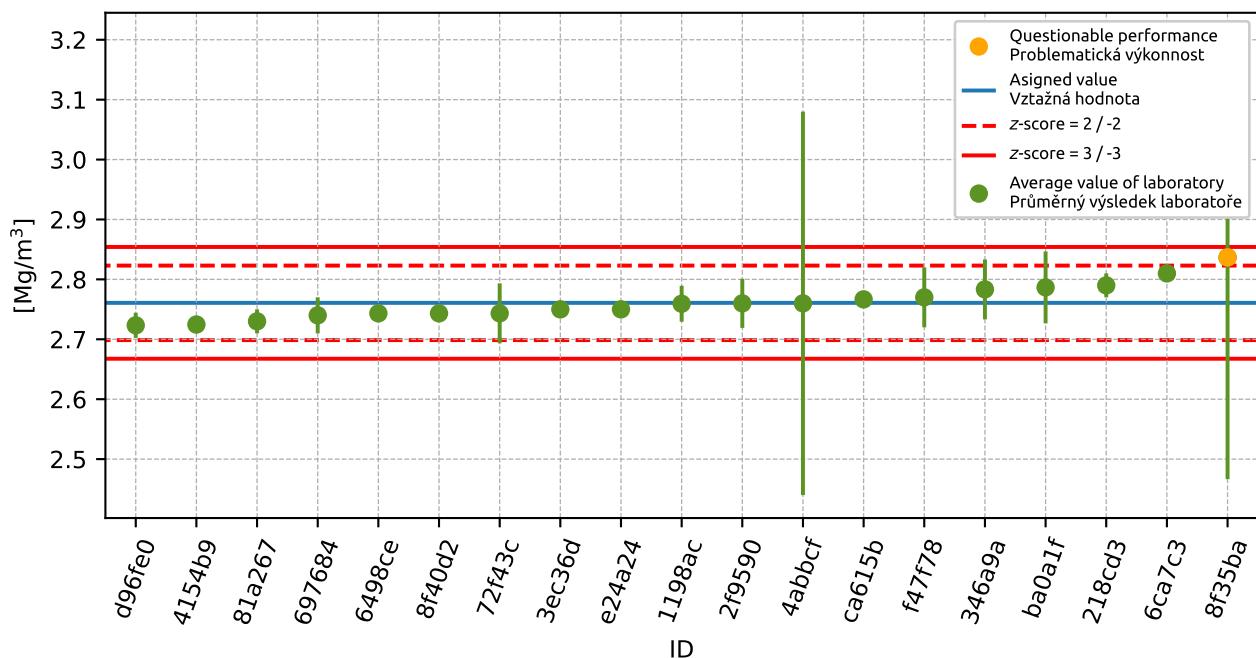
Figure 151: Average values and extended uncertainties of measurement

Figure 152: z-score

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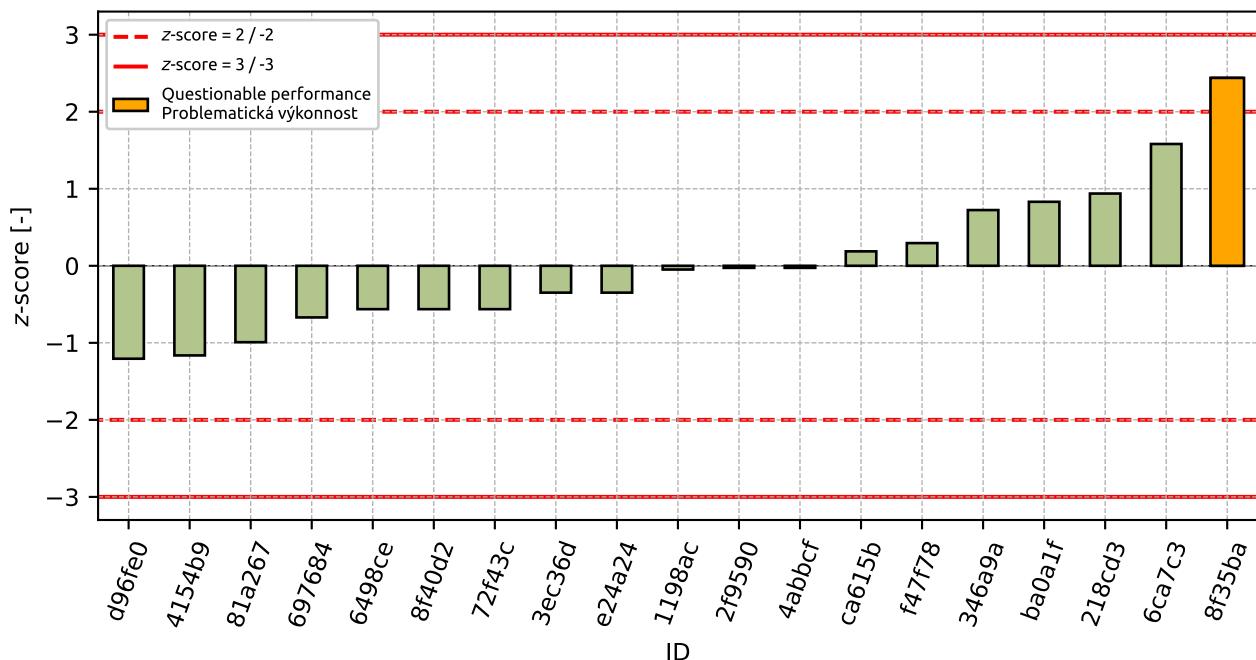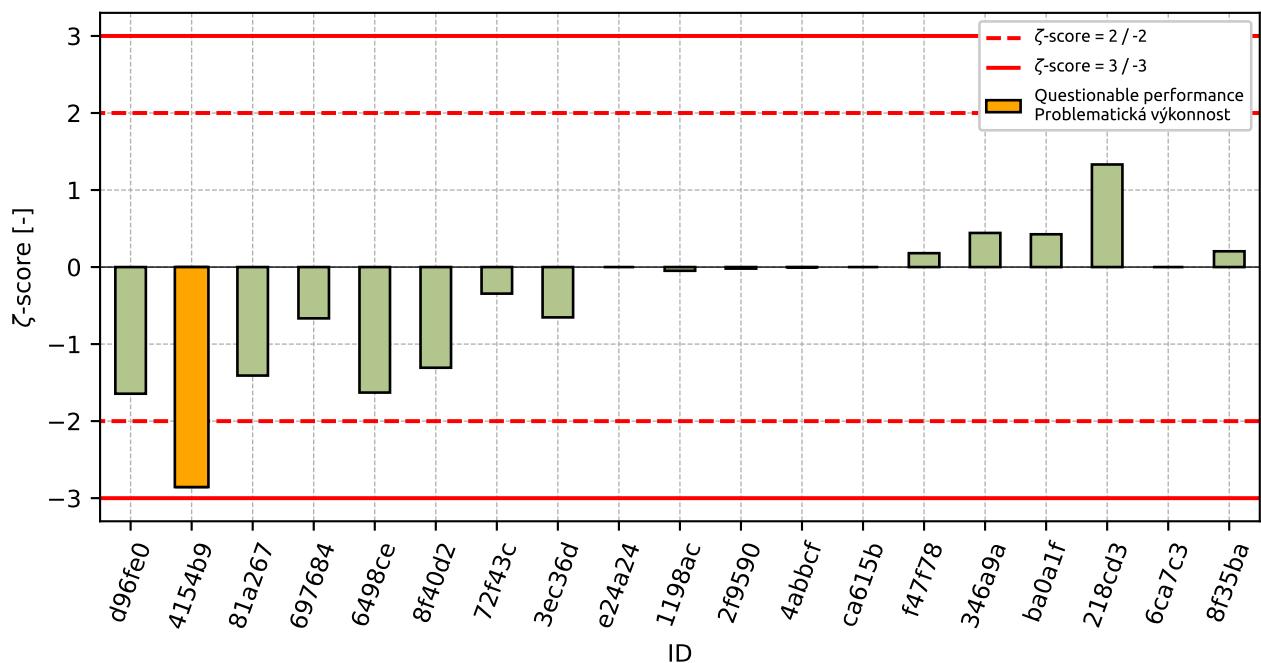
Figure 153: ζ-score

Table 55: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d96fe0	-1.21	-1.64
4154b9	-1.16	-2.86
81a267	-0.99	-1.41
697684	-0.67	-0.67
6498ce	-0.56	-1.63
8f40d2	-0.56	-1.31
72f43c	-0.56	-0.34
3ec36d	-0.35	-0.65
e24a24	-0.35	-
1198ac	-0.05	-0.05
2f9590	-0.03	-0.02
4abbcf	-0.03	-0.0
ca615b	0.19	-
f47f78	0.29	0.18
346a9a	0.72	0.44
ba0a1f	0.83	0.43
218cd3	0.94	1.33
6ca7c3	1.58	-
8f35ba	2.44	0.2

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12.2   Water absorption

12.2.1   Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
81a267	0.6	0.7	0.7	0.1	0.7	0.06	8.66
4abbcf	0.8	0.7	0.8	0.0	0.8	0.06	7.53
d96fe0	0.8	0.8	0.8	0.0	0.8	0.03	3.39
697684	0.8	0.8	0.9	0.2	0.8	0.08	10.31
ca615b	0.8	0.8	0.9	-	0.8	0.06	7.78
218cd3	0.8	0.9	0.8	0.1	0.8	0.06	6.93
6498ce	0.8	0.9	0.9	0.1	0.9	0.06	6.66
ba0a1f	0.9	0.8	0.9	0.0	0.9	0.06	6.66
3ec36d	0.9	0.9	0.9	0.2	0.9	0.0	0.0
1198ac	1.0	0.9	0.8	0.0	0.9	0.1	11.11
8f35ba	0.9	0.9	0.9	0.8	0.9	0.0	0.0
f47f78	1.0	0.8	0.9	0.1	0.9	0.1	11.11
e24a24	0.9	0.9	0.9	-	0.9	0.0	0.0
72f43c	1.0	0.9	1.0	0.3	1.0	0.06	5.97
346a9a	0.9	1.0	1.1	0.0	1.0	0.1	10.0
8f40d2	1.0	1.0	1.0	0.1	1.0	0.02	2.03
2f9590	1.0	1.0	1.1	0.2	1.0	0.06	5.59
4154b9	1.1	0.9	1.2	0.2	1.1	0.15	14.32
6d5a2f	1.2	1.2	0.9	0.2	1.1	0.17	15.75
6ca7c3	1.6	1.6	1.6	-	1.6	0.0	0.0

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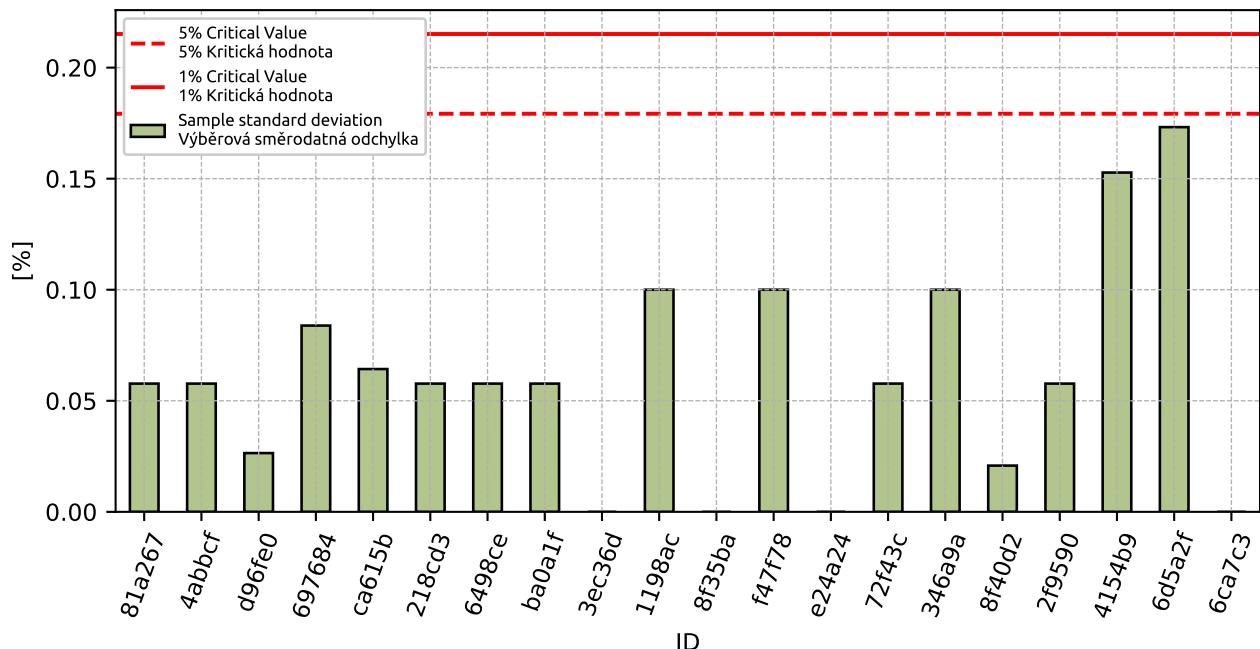
Figure 154: **Cochran's test** - sample standard deviations
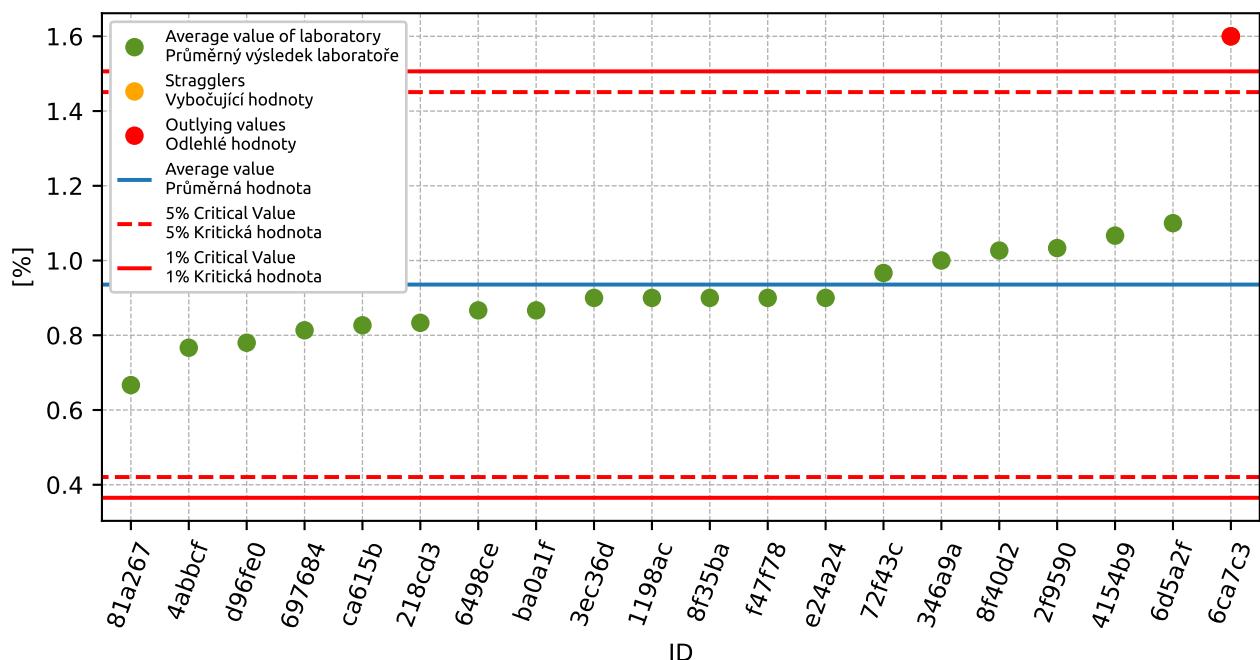
Figure 155: **Grubbs' test** - average values

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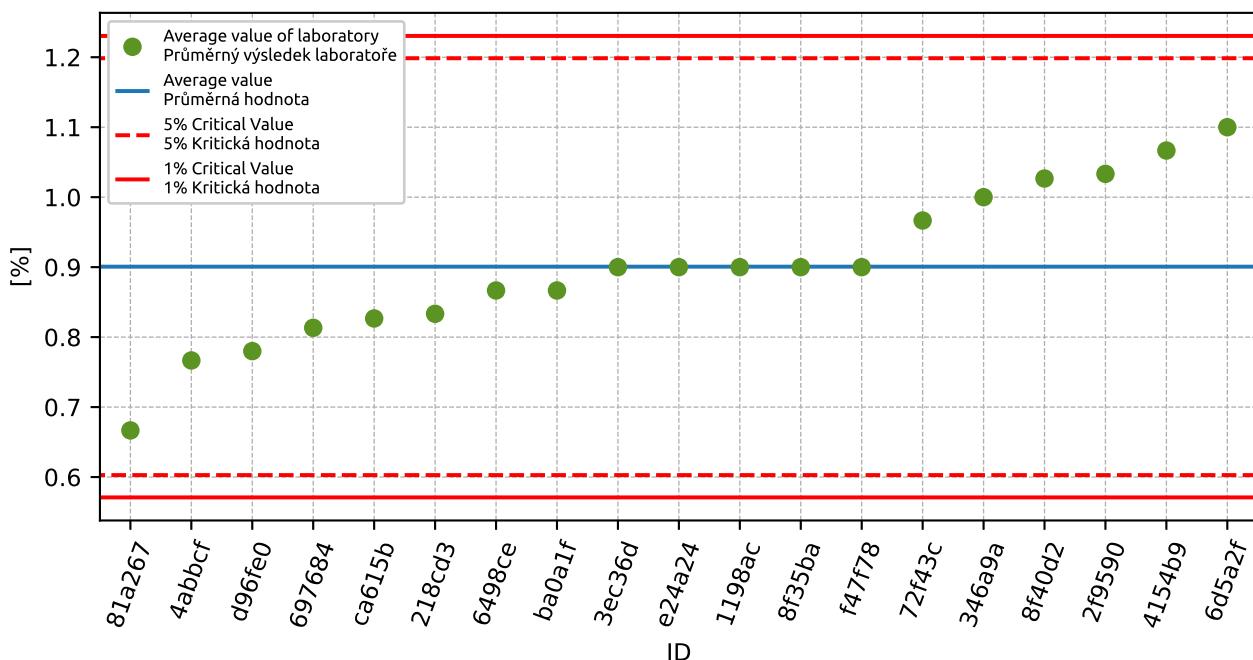
Figure 156: **Grubbs' test** - average values without outliers

12.2.3   Mandel's Statistics
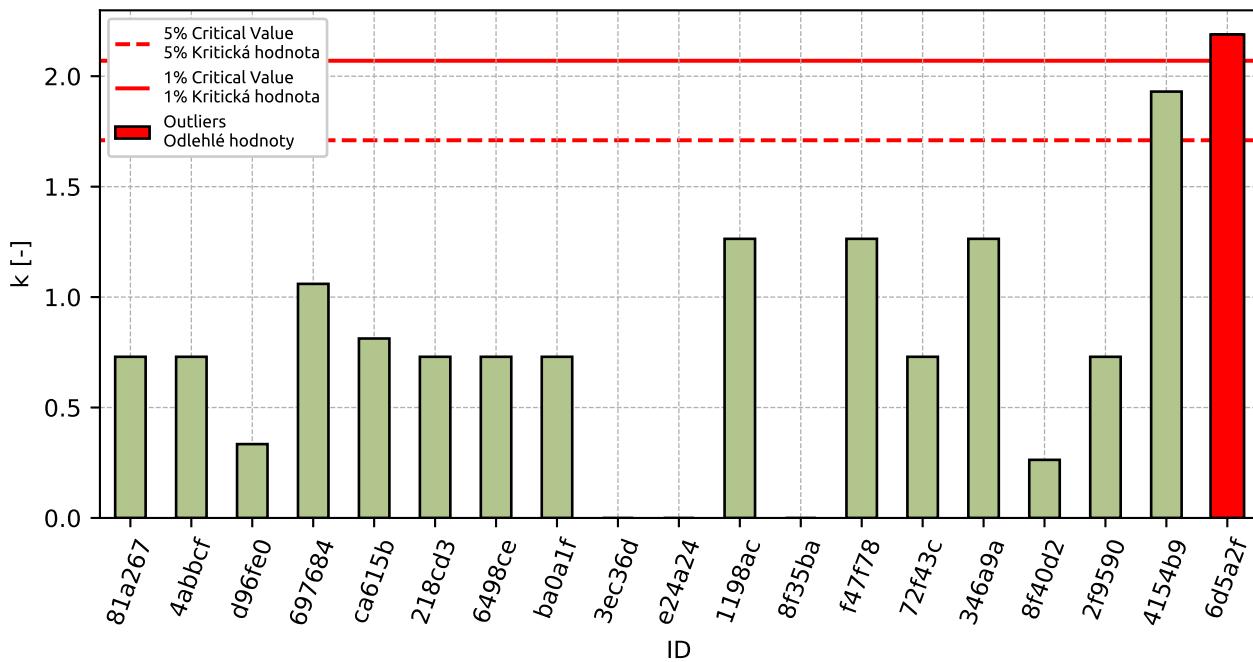
Figure 157: Intralaboratory Consistency Statistic

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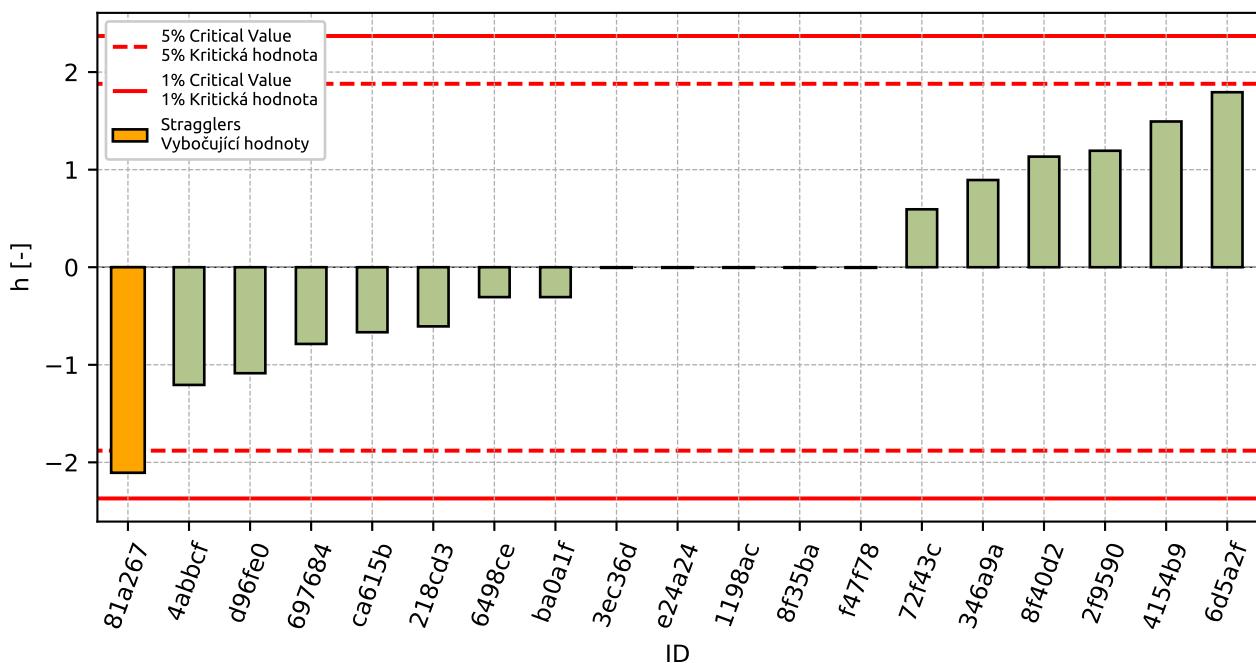
Figure 158: Interlaboratory Consistency Statistic

12.2.4 Descriptive statistics
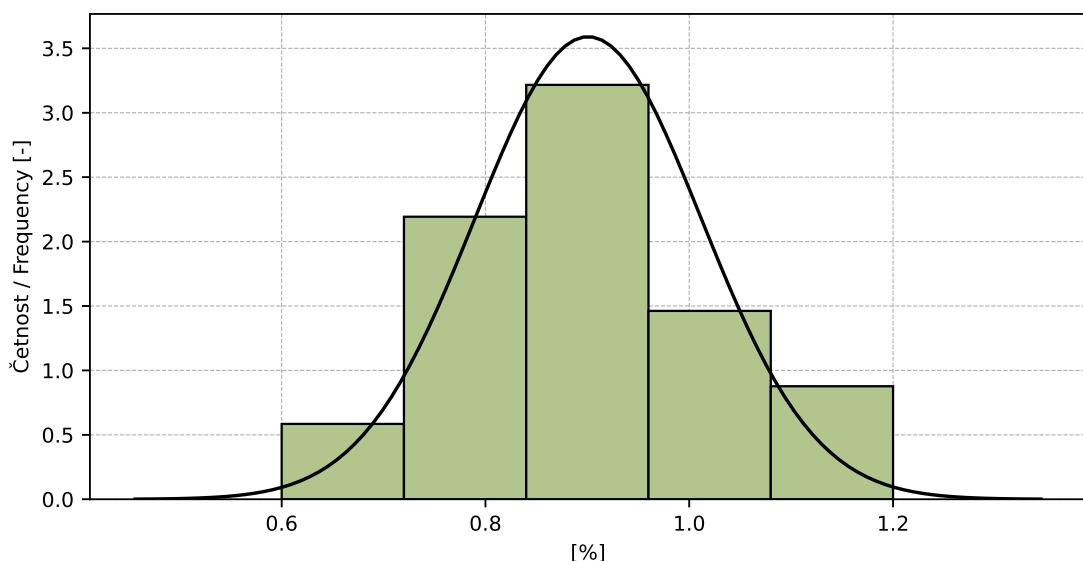
Figure 159: Histogram of all test results

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Table 57: Descriptive statistics

| Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	0.9
Výběrová směrodatná odchylka / Sample standard deviation – s	0.11
Vztažná hodnota / Asigned value – x^*	0.9
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.11
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.03
p-hodnota testu normality / p-value of normality test	0.007 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.1
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.08
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.13
Opakovatelnost / Repeatability – r	0.2
Reprodukovatelnost / Reproducibility – R	0.4

12.2.5 Evaluation of Performance Statistics
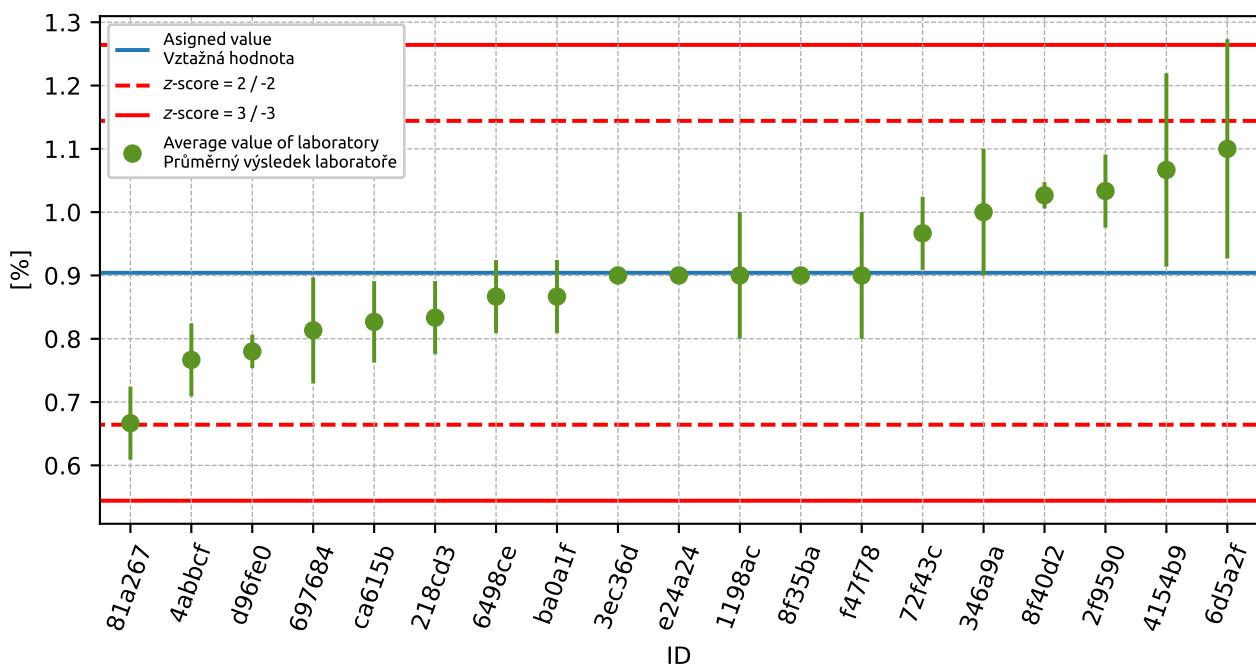
Figure 160: Average values and sample standard deviations

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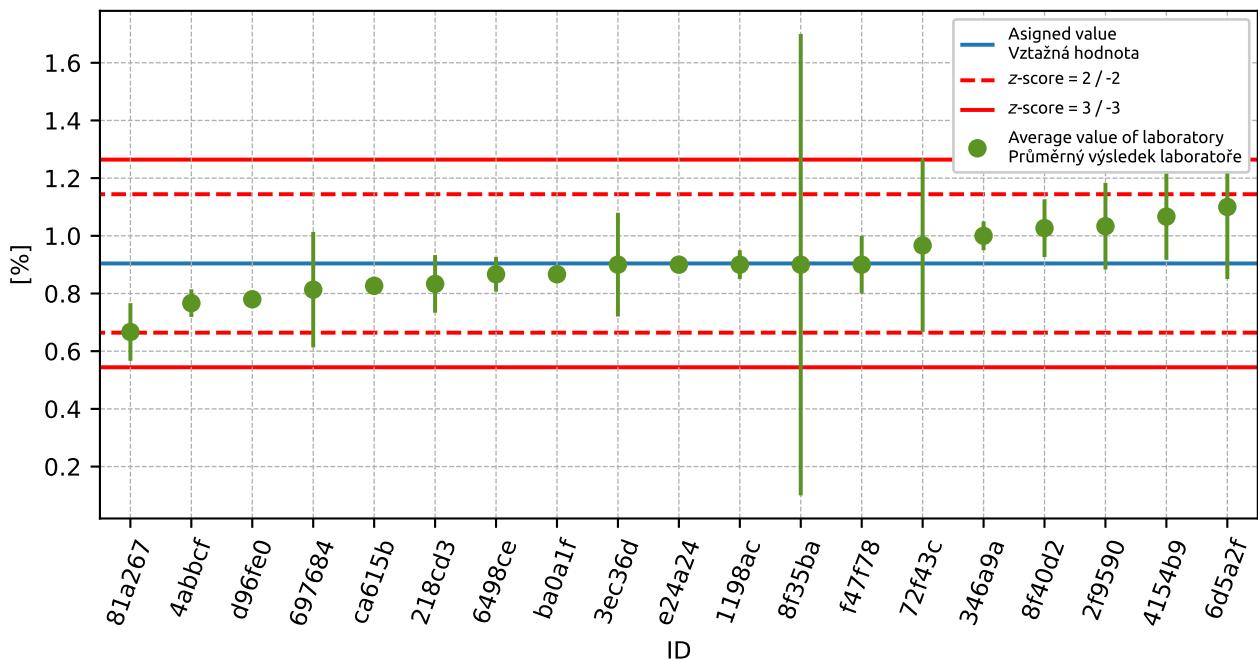
Figure 161: Average values and extended uncertainties of measurement

Figure 162: z-score

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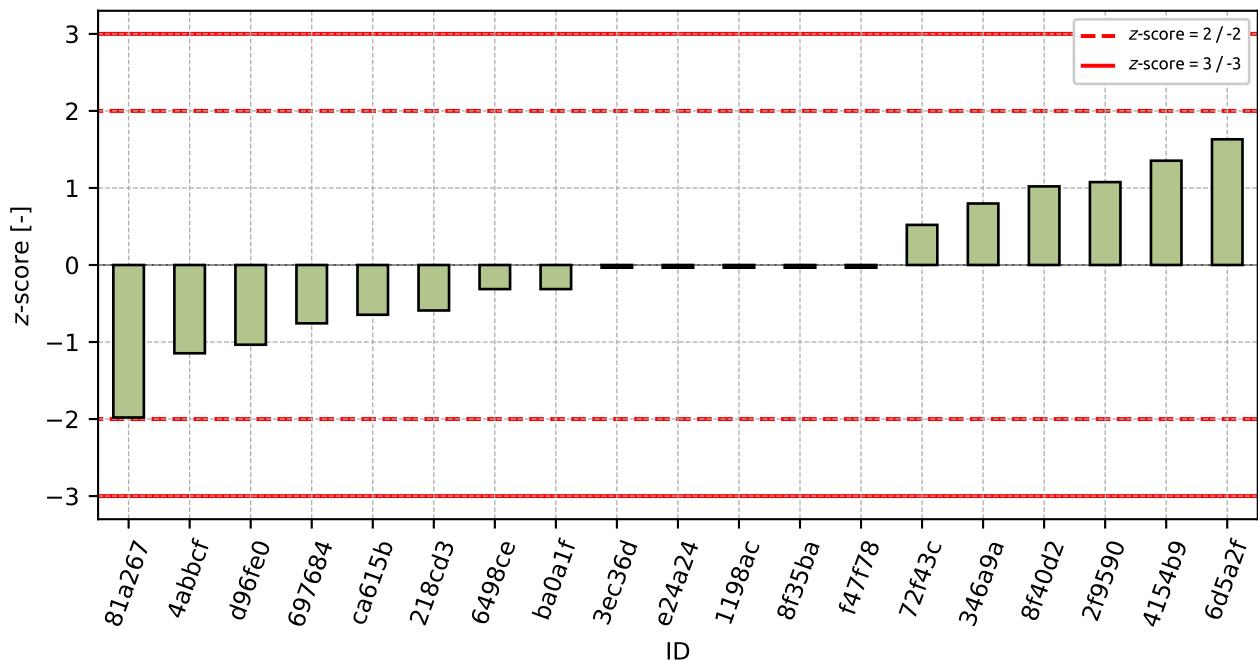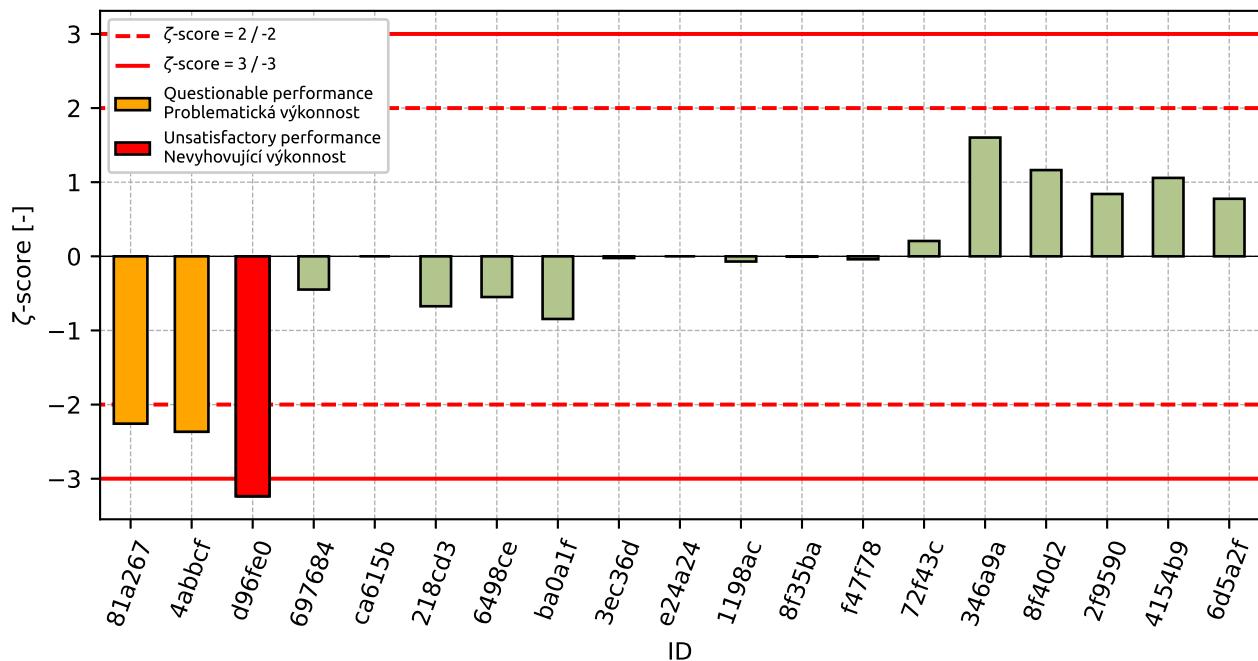
Figure 163: ζ-score

Table 58: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
81a267	-1.98	-2.26
4abbcf	-1.15	-2.37
d96fe0	-1.04	-3.24
697684	-0.76	-0.45
ca615b	-0.65	-
218cd3	-0.59	-0.67
6498ce	-0.31	-0.55
ba0a1f	-0.31	-0.85
3ec36d	-0.04	-0.02
e24a24	-0.04	-
1198ac	-0.04	-0.07
8f35ba	-0.04	-0.01
f47f78	-0.04	-0.04
72f43c	0.52	0.21
346a9a	0.8	1.6
8f40d2	1.02	1.16
2f9590	1.08	0.84
4154b9	1.35	1.06
6d5a2f	1.63	0.78

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

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

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

14.1   Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d76b2a	0.3	0.3	0.3	0.1	0.3	0.0	0.0
6edfa7	0.7	0.5	0.2	0.1	0.4	0.24	55.36
222b47	0.5	0.6	0.3	0.5	0.5	0.15	32.73
eb640d	0.5	0.6	0.6	0.0	0.6	0.05	8.77
e18dad	0.9	0.5	0.4	0.0	0.6	0.26	44.1
67e95f	0.6	-	-	0.1	0.6	0.0	0.0
9e8f89	0.6	-	-	0.1	0.6	0.0	0.0
f1932b	0.7	-	-	0.1	0.7	0.0	0.0
21dd1e	0.7	-	-	0.1	0.7	0.0	0.0
391ed0	0.6	1.1	0.9	-	0.9	0.25	29.04
777f0c	0.9	0.9	0.9	-	0.9	0.0	0.0

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14.2   The Numerical Procedure for Determining Outliers
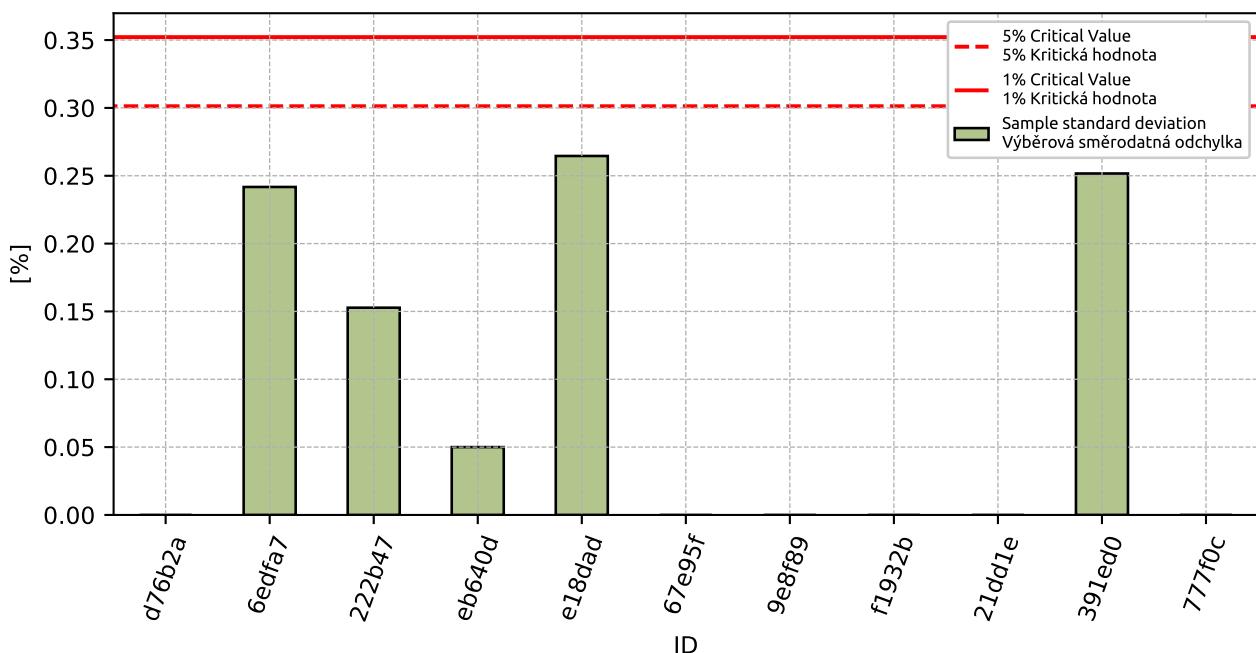
Figure 164: **Cochran's test** - sample standard deviations
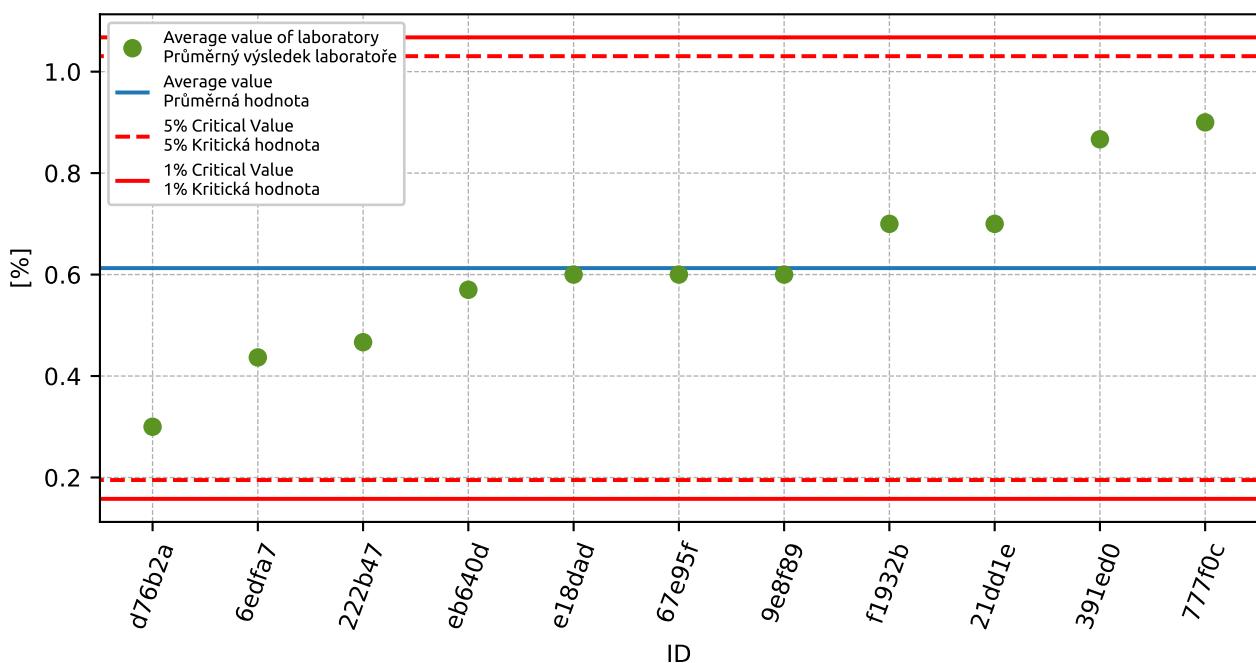
Figure 165: **Grubbs' test** - average values

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14.3   Mandel′s Statistics
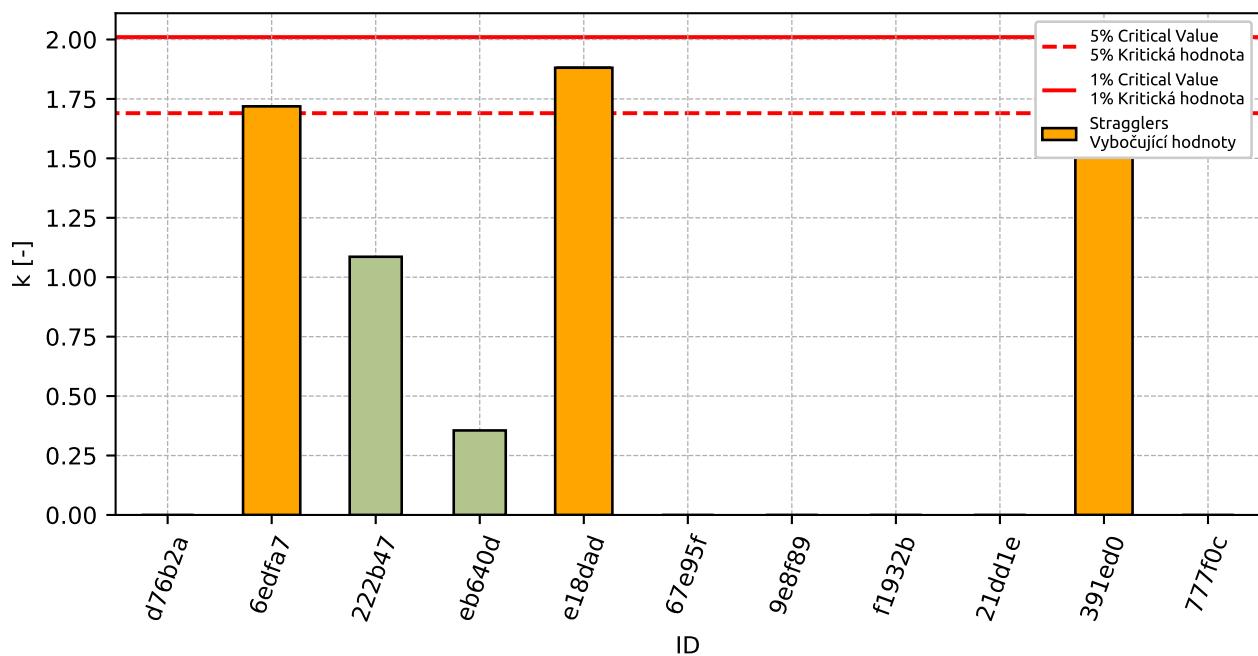
Figure 166: Intralaboratory Consistency Statistic
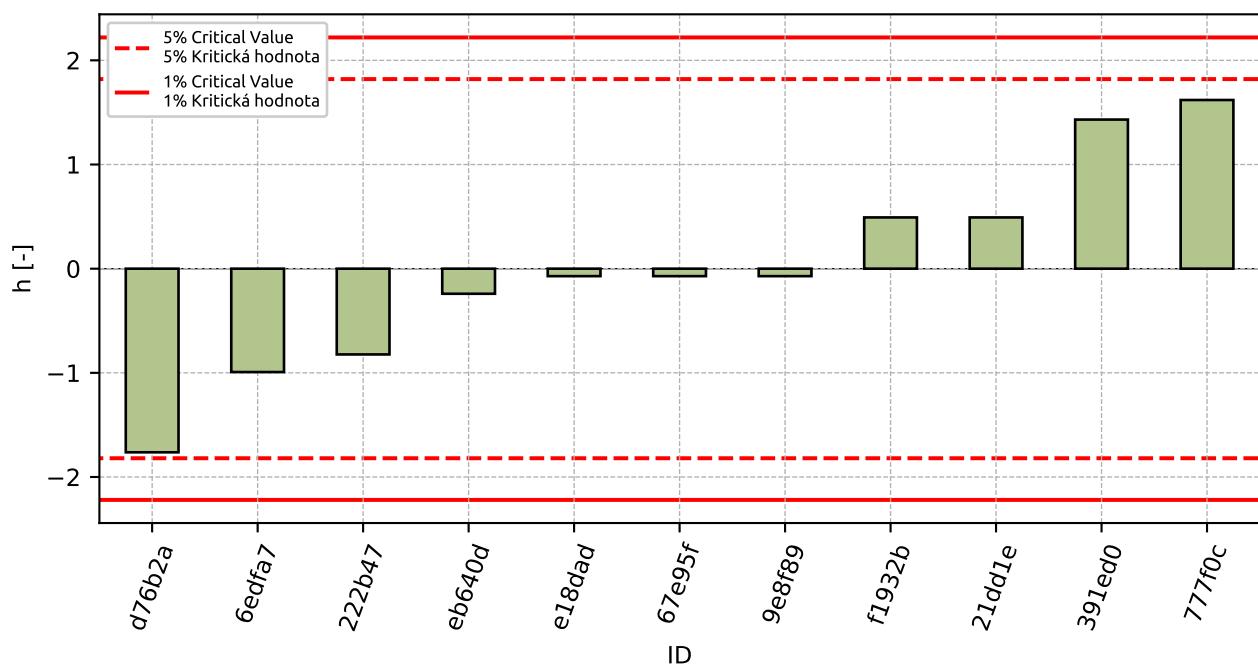
Figure 167: Interlaboratory Consistency Statistic

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14.4   Descriptive statistics
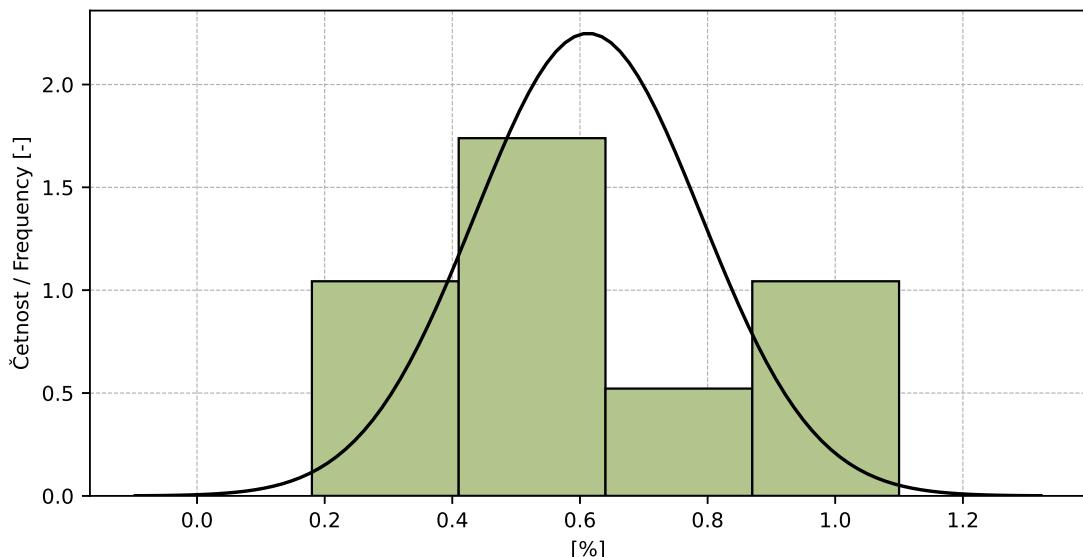
Figure 168: Histogram of all test results

Table 60: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	0.6
Výběrová směrodatná odchylka / Sample standard deviation – s	0.18
Vztažná hodnota / Asigned value – x^*	0.6
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.17
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.06
p-hodnota testu normality / p-value of normality test	1.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.16
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.14
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.21
Opakovatelnost / Repeatability – r	0.4
Reprodukovatelnost / Reproducibility – R	0.6

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14.5   Evaluation of Performance Statistics
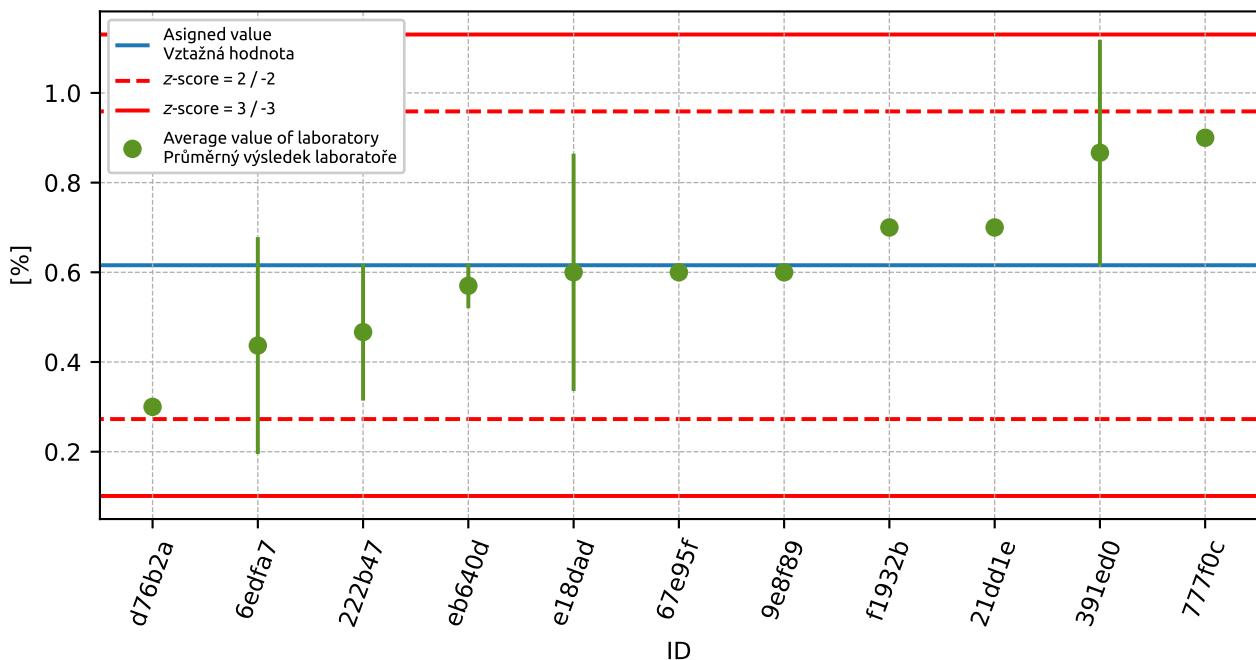
Figure 169: Average values and sample standard deviations
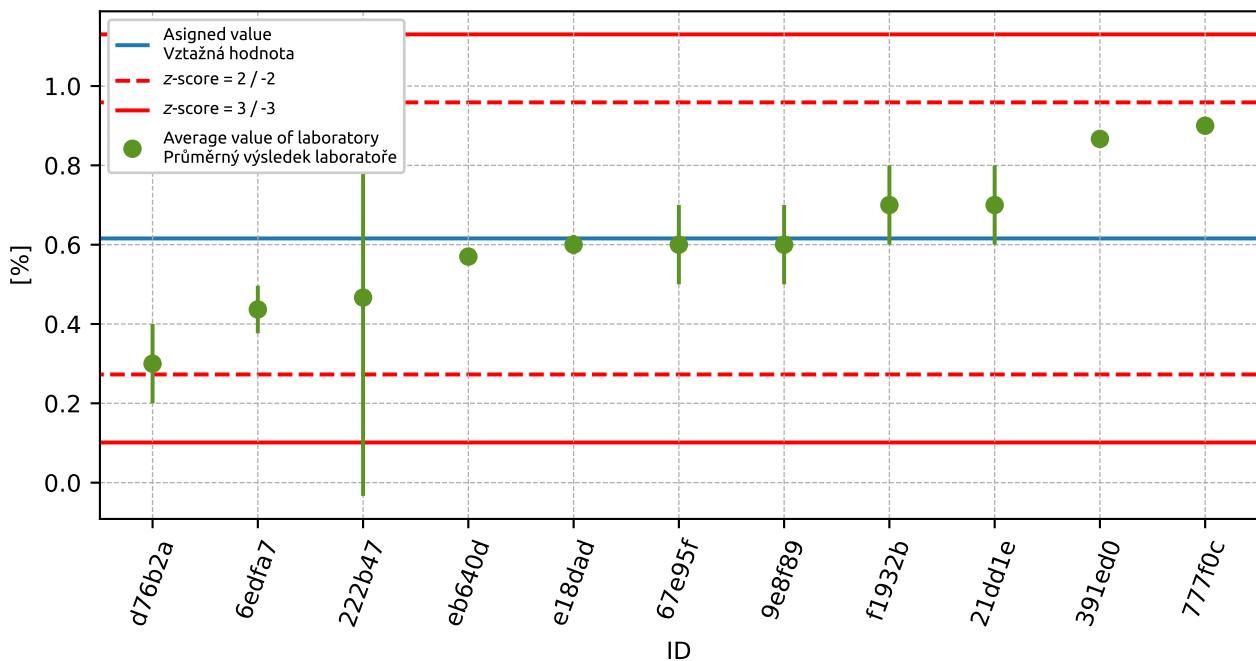
Figure 170: Average values and extended uncertainties of measurement

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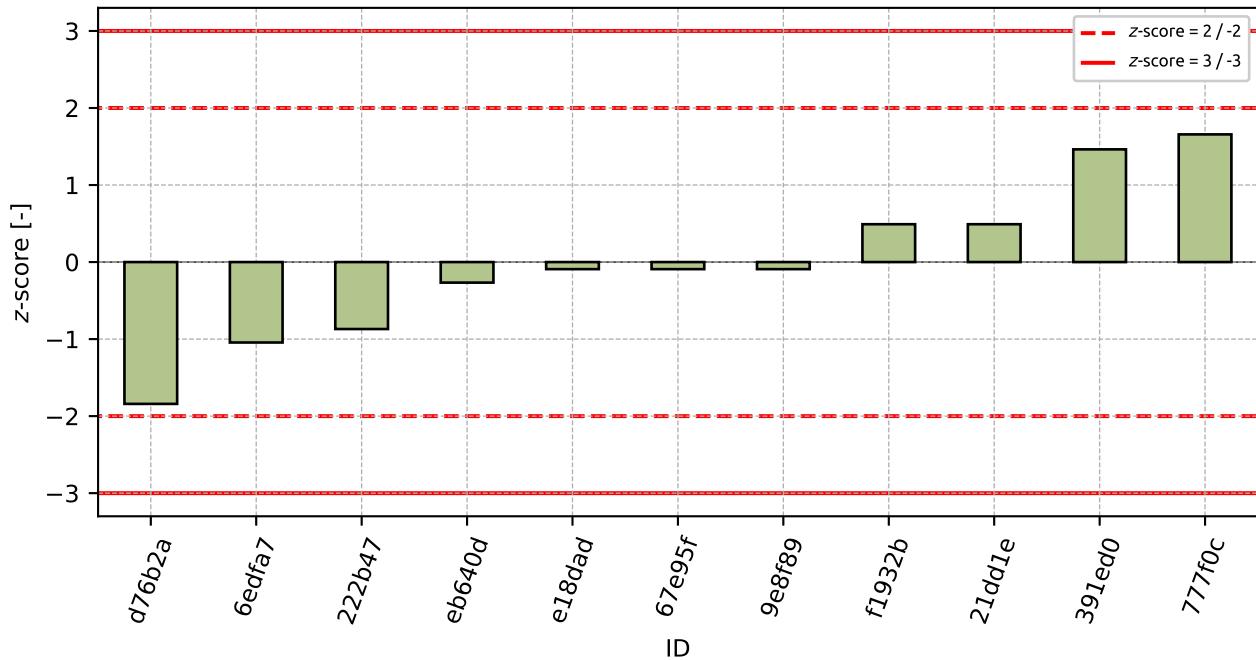
Figure 171: z-score

Figure 172: ζ-score

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Table 61: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d76b2a	-1.84	-2.65
6edfa7	-1.04	-2.03
222b47	-0.87	-0.3
eb640d	-0.27	-0.67
e18dad	-0.09	-0.23
67e95f	-0.09	-0.13
9e8f89	-0.09	-0.13
f1932b	0.49	0.71
21dd1e	0.49	0.71
391ed0	1.46	-
777f0c	1.66	-

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15   Appendix – EN 1367-2 Magnesium sulfate test

15.1   Test results

Table 62: Test results - outliers are marked by red color. u_X - extended uncertainty of measurement.

ID	Test results [%]	u_X [%]
eb640d	1.4	0.0
d76b2a	6.0	1.0
6ca7c3	7.0	-
e24a24	7.0	-
8d38c9	8.5	-
8f40d2	8.7	3.4
57b998	8.9	0.5
8616aa	9.0	0.6

15.2   The Numerical Procedure for Determining Outliers
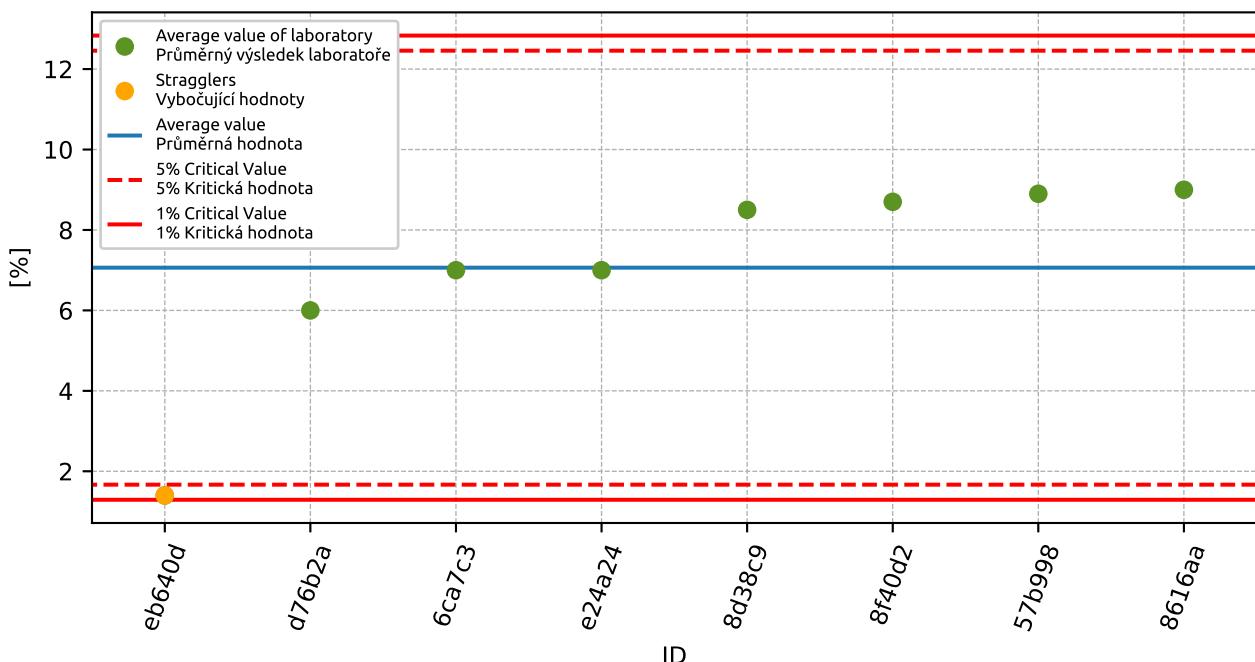
Figure 173: **Grubbs' test** - average values

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15.3   Mandel's Statistics
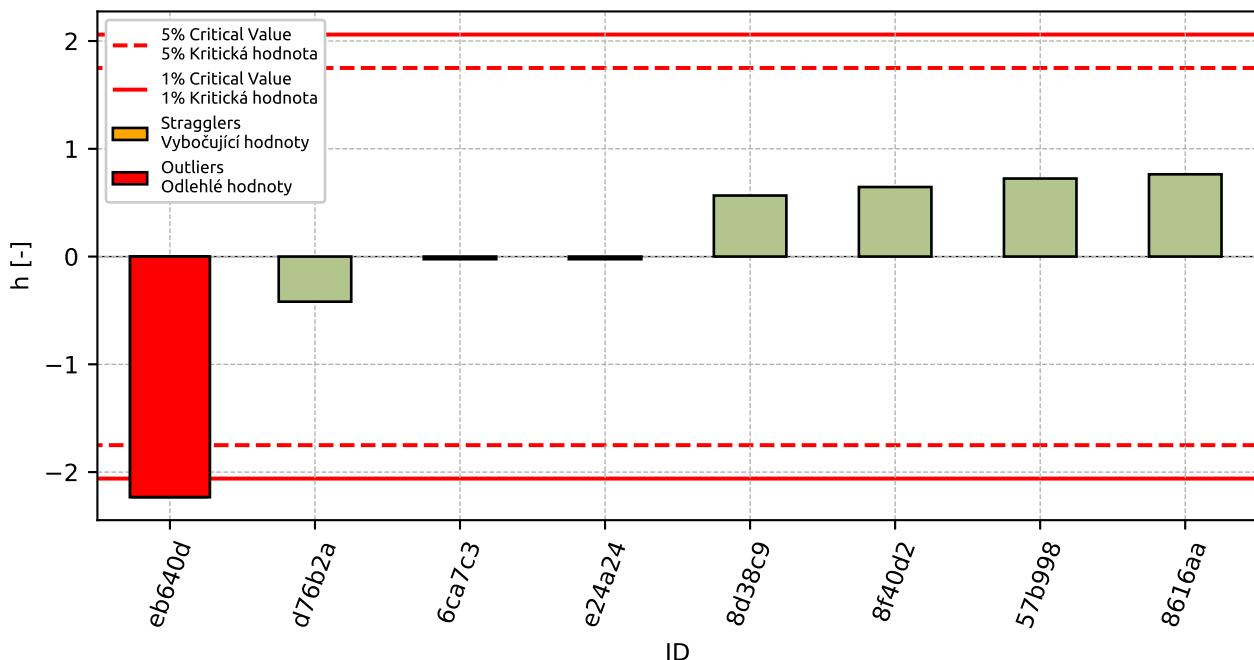
Figure 174: Interlaboratory Consistency Statistic

15.4   Descriptive statistics
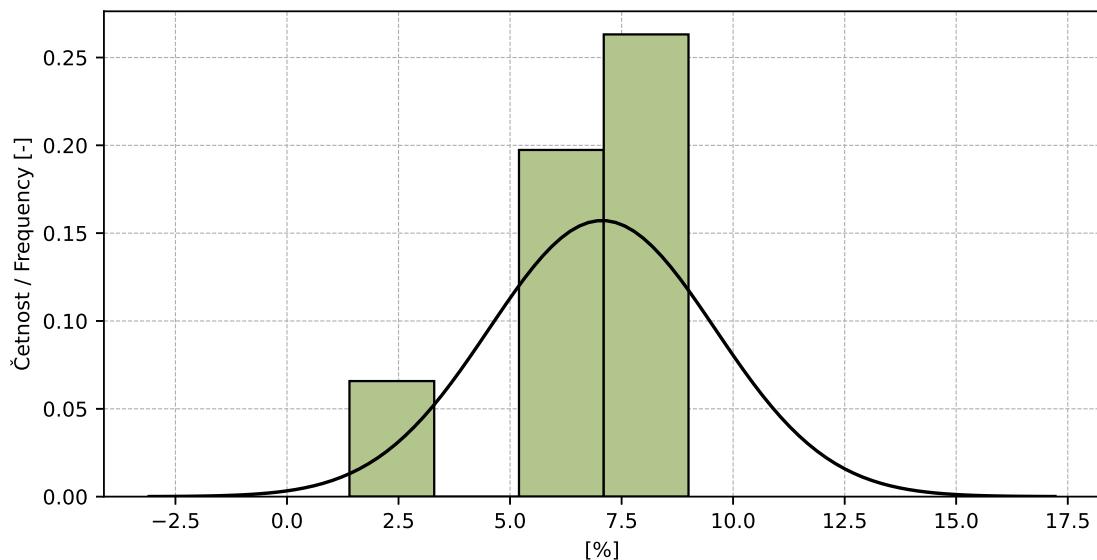
Figure 175: Histogram of all test results

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Table 63: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	7.1
Výběrová směrodatná odchylka / Sample standard deviation – s	2.54
Vztažná hodnota / Asigned value – x^*	7.6
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.48
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.66
p-hodnota testu normality / p-value of normality test	0.014 [-]

15.5   Evaluation of Performance Statistics
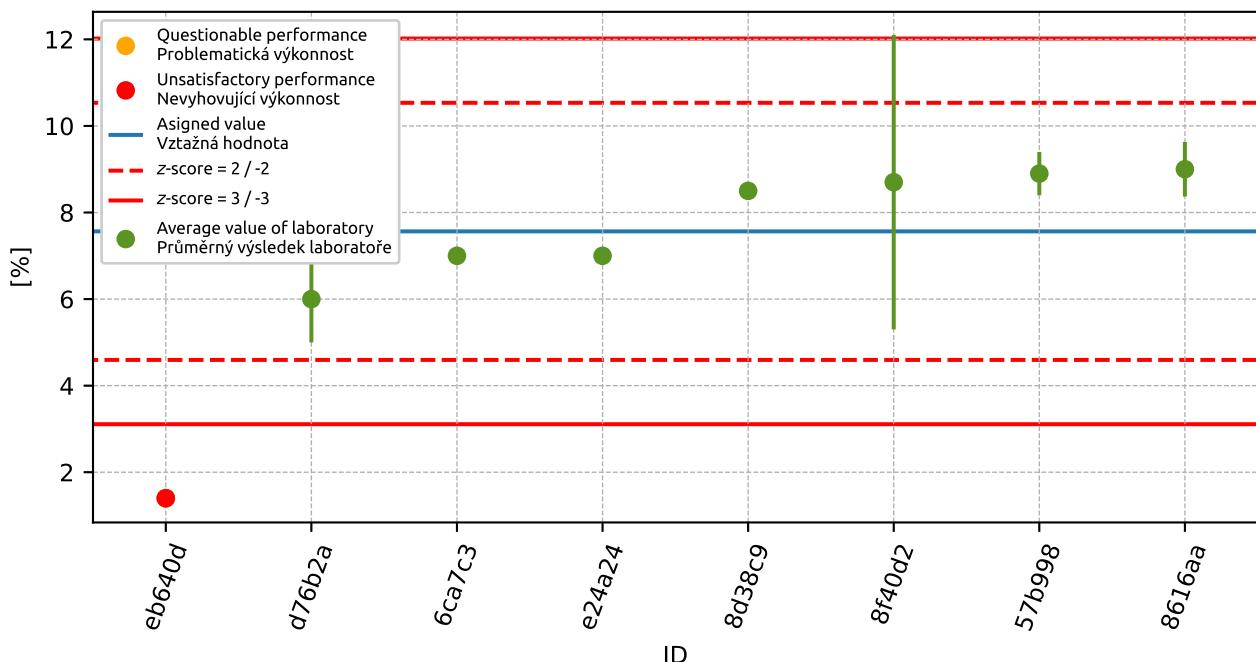
Figure 176: Average values and extended uncertainties of measurement

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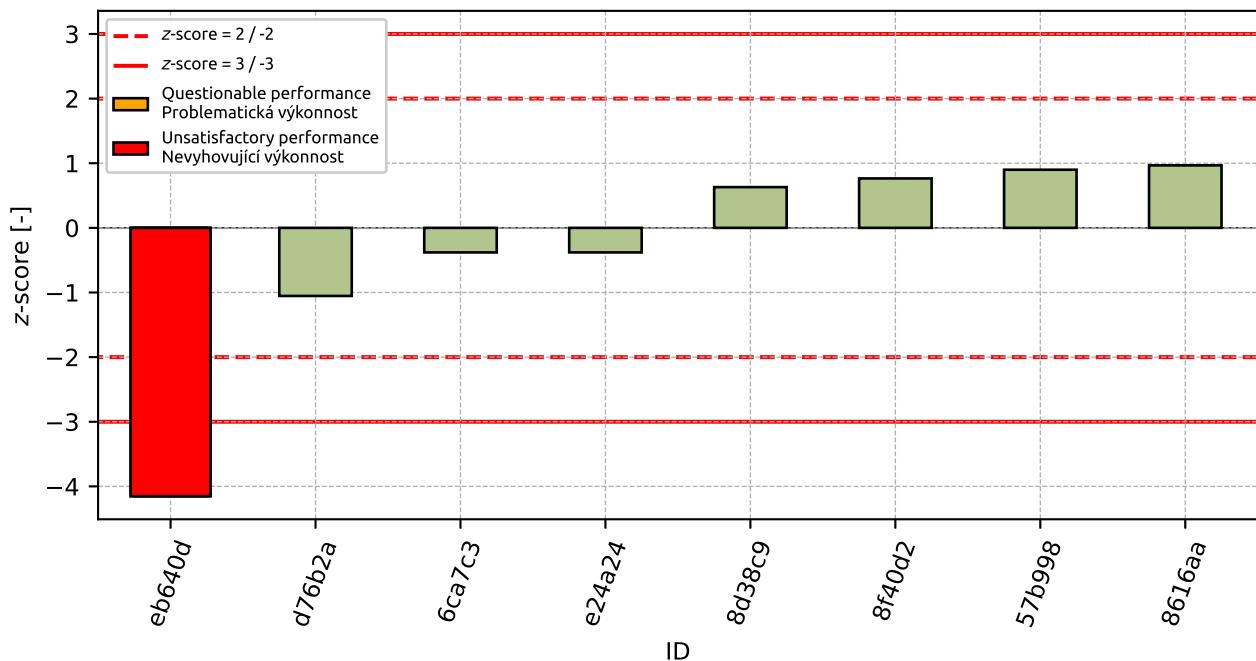
Figure 177: z-score

Figure 178: ζ-score

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Table 64: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
eb640d	-4.15	-9.39
d76b2a	-1.05	-1.31
6ca7c3	-0.38	-
e24a24	-0.38	-
8d38c9	0.63	-
8f40d2	0.76	0.33
57b998	0.9	1.62
8616aa	0.97	1.58

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

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

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

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

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

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

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