BRNO UNIVERSITY OF TECHNOLOGY

Z 7008

FACULTY OF CIVIL ENGINEERING
institute of building testing

FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program
Soil Testing
ZZ 2019/1

Brno University of Technology
Proficiency testing provider at the SZK FAST
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Czech Republic

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Date: 01/24/2020

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1 Introduction and Important Contacts

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

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

Head of the PT Provider, PTP coordinator

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The subjects of proficiency testing were the following testing procedures:

1. EN ISO 17892-1 Geotechnical investigation and testing - Laboratory testing of soil - Part 1: Determination of water content [1],
2. EN ISO 17892-3 Geotechnical investigation and testing - Laboratory testing of soil - Part 3: Determination of particle density [2],
3. EN ISO 17892-4 Geotechnical investigation and testing - Laboratory testing of soil - Part 4: Determination of particle size distribution [3],
4. EN ISO 17892-5 Geotechnical investigation and testing - Laboratory testing of soil - Part 5: Incremental loading oedometer test [4],
5. EN ISO 17892-7 Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test [5],
6. CEN ISO/TS 17892-10 Geotechnical investigation and testing - Laboratory testing of soil - Part 10: Direct shear tests [6],
7. EN ISO 17892-12 Geotechnical investigation and testing - Laboratory testing of soil - Part 12: Determination of liquid and plastic limits [7],
8. EN 13286-2 Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory reference density and water content -Proctor compaction [8],
9. EN 13286-47 Unbound and hydraulically bound mixtures - Part 47: Test method for the determination of California Bearing ratio, immediate bearing index and linear swelling [9].

All parts of PT program were open.

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 [10] and with EN ISO/IEC 17043 [11]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

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

Table 1: Participation of individual laboratories in the PTP (tests designated according to part 1)

ID/Testing Method	1	2	3	4	5	6	7	8	9
4aba20	X	X	X	-	-	-	X	X	X
eb713f	-	-	-	-	-	-	X	-	-
c63e03	X	-	X	-	-	-	X	-	-
922362	-	-	-	-	-	-	-	-	X
0e19d1	-	-	-	X	X	-	-	-	-
f34852	X	-	-	-	-	-	-	X	-
50a49a	-	-	-	-	-	-	-	X	-
10f479	-	-	-	-	X	X	-	-	-
a6c0b5	X	X	-	X	-	X	-	-	-
fb2a44	X	-	-	-	-	-	-	X	-
19c3ea	X	X	X	-	-	-	X	-	-
4ffaa5	X	-	X	-	-	-	X	-	-
f996a0	X	-	X	-	-	-	X	X	X
d2b8b2	X	X	X	-	-	-	-	X	X
7897a4	-	-	-	-	-	-	X	-	-
dec8e3	-	-	-	-	-	-	-	X	-
c8f62e	X	-	-	X	-	-	-	-	-
349706	X	X	X	X	X	X	X	X	X
e452e6	X	X	X	-	-	-	X	X	X
8096b5	X	-	X	-	-	-	-	X	-
0af9cc	X	X	X	-	-	-	-	-	-
769d4f	X	X	X	X	-	-	X	X	X
6de47c	X	X	X	-	-	-	X	-	X
ef5463	-	-	-	-	-	-	-	X	-
8c246a	-	-	-	-	-	-	-	-	X
405cc9	-	-	-	-	-	-	-	X	X
2f577a	-	-	-	X	-	X	-	-	-
ab16b9	X	-	X	-	-	-	-	X	-
4f6c1c	-	-	-	-	-	-	-	X	-
d360e6	X	X	X	X	X	X	X	X	X
03e0cf	-	-	X	X	-	X	-	-	-
2fc7e3	-	X	X	-	-	X	X	-	-
4b7a6f	X	X	X	X	-	-	-	X	-
6361a4	X	-	X	-	-	X	X	X	X
3b178c	-	-	-	-	-	-	-	X	-
1dd437	-	-	-	-	-	-	-	X	-
fc37be	X	X	X	X	X	X	X	X	X
dbb7b3	-	-	-	-	-	-	-	X	X
d7df6e	X	-	X	-	-	-	X	-	-
d4c68e	X	X	X	X	X	X	X	X	X
7d1c14	-	-	-	-	X	-	-	-	-
62fddc	X	-	-	-	-	-	-	X	X
819834	X	X	X	-	-	-	X	X	-
5d54c5	-	-	-	-	-	-	X	X	X
d92fa5	-	-	-	-	-	-	X	X	-
ec262e	-	-	-	X	X	X	-	-	X
257e1b	X	-	X	-	-	-	X	X	-

ID/Testing Method	1	2	3	4	5	6	7	8	9
ebaae9	-	-	-	-	-	-	X	X	X
3ae2a7	-	-	-	-	-	-	-	X	-
ad498c	X	X	X	-	X	X	X	X	X

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

Laboratory	Address	Accreditation number
4G consite s.r.o.	Šlikova 406/29, Praha 6, 169 00, Česká republika	1518
AG Institut d.o.o. Novi Sad	dr Djordja Joanovica 4, Novi Sad, 21000, Republika Srbija	01-457
ANTONIS BOTSARIS	KENTAVROU 1 7103 INDUSTRIAL AREA ARADIPPOU, LARNACA, 7103, CYPRUS	-
AZ Consult, spol. s r.o., Klíšská 1334/12, 400 01 Ústí nad Labem, Laboratoř AZ Consult	Klíšská 1334/12, Ústí nad Labem, 400 01, Česká republika	1740
Baugrund institut knirim ood	Tsarevo selo Str. 3, atelie parter, Sofia, 1612, Bulgaria	255LI
CEMEX Czech Republic, s.r.o.	Semtín 102, Pardubice, 53354, Česká republika	1302
CONTROL-VHS-SK, s.r.o.	Kamenná 14, Žilina, 010 01, Slovenská republika	S-317
Centrum dopravního výzkumu v.v.i.	Líšeňská 33a, Brno, 63600, Česká republika	1506
DSP a.s.	Kostěnice 111, Pardubice, 530 02, Česká republika	-
Dobrovolný laboratoř s.r.o.	bratří Mrštíků 315/15, Brno, 61400, Česká republika	-
Faculty of Engineering - Mansoura University - Dakahlia - Egypt	Faculty of Engineering - Mansoura University, Mansoura, 35516, Dakahlia	CAB 215001
GEMATEST s.r.o.	Dr.Janského 954„ Černošice, 25228, Česká republika	1291
GUBT GmbH	Gewerbeparkstrasse 5, Markgrafneusiedl, 2282, Austria	0386
GeoTec-GS, a.s.	Chmelová 2920/6, Praha 10, 10600, Česká republika	1514
Geolab d.o.o. Sarajevo	Mustafe Bajića 19, Sarajevo, 71000, Bosna i Hercegovina	-
Geotest, a.s.	Šmahova 1244/112, Brno, 62700, Česká republika	1271.2
IGSL Ltd	Unit F M7 Business Park, NAAS, W91 DY93, Republic of Ireland	-
INGEO-ENVILAB, s.r.o., Divízia mechaniky zemín a hornín	Bytčická 16, Žilina, 010 01, Slovenská republika	S-008
Institut za građevinarstvo "IG" d.o.o. Banja Luka	Kralja Petra I Karađorđevića 92-94, Banja Luka, 78000, RS/BiH	-
M.I.S. a.s.	Resslova 956/13, Hradec Králové, 500 02, Česká republika	1197
Mining and Metallurgy Institute Bor	Zeleni bulevar 35, Bor, 19210, Serbia	01-308

Laboratory	Address	Accreditation number
Mining institute	Batajnički put br.2, Zemun-Beograd, 11080, Serbia	01-309
NIEVELT Labor CZ s.r.o.	Za Olomouckou 4184/17, Prostějov, 79601, Česká republika	1716
PUDIS a.s.	Nad Vodovodem 2/3258, Praha 10, 10000, Česká republika	-
QUALIFORM, a.s.	Mlaty 672/8, Brno - Bosonohy, 642 00, Česká republika	1008
QUALIFORM, a.s.	Mlaty 672/8, Brno - Bosonohy, 642 00, Česká republika	1008
REGIONAL GOVERMENT OF NORTH AEGEAN- DIVISION OF TECHNICAL WORKS -SECTION: LESVOS LABORATORIES	EL. BENIZELOU 1, MYTILENE, 81100, LESVOS - GREECE	-
S.C. GEOSTUD S.R.L.	Singerului, nr. 11, sector 1, Bucuresti, 014617, Romania	-
SG Geotechnika a.s.	Geologická 4, Praha 5, 15200, Česká republika	1119
SQZ s.r.o.	U místní dráhy 939/5, Olomouc - Nová ulice, 779 00, Česká republika	1135.2
Sibotec cvba	Industriepark Oost 6, Beernem, 8730, Belgium	-
Skanska a.s.	Křižíkova 682/34a, Praha 8 - Karlín, 186 00, Česká republika	1355
Slovenská správa ciest	M. Rázusa 104/A, Žilina, 010 01, Slovenská republika	181/S-322
Structural Soils Ltd - Bristol	Structural Soils Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR, England	1774
Structural Soils Ltd - Castleford	Structural Soils Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR, England	1774
Structural Soils Ltd - Hemel Hempstead	Structural Soils Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR, England	1774
Structural Soils Ltd - Tonbridge	Structural Soils Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR, England	1774
TPA EOOD CTC SOFIA	Rezbarska str. № 7, SOFIA, 1510, BULGARIA	-
TPA EOOD CTC SOFIA, Rezbarska 7 str., Sofia 1050, Bulgaria	Rezbarska 7 str., Sofia, 1510, Bulgaria	-
TPA za obezbeđenje kvaliteta i inovacije d.o.o. Beograd	Milutina Milankovića 3B, Novi Beograd, 11070, Serbia	-
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 370 06, Česká republika	1181
Terratest Laboratorio de Suelos Rocas Y Materiales s.a.s. (Terratest Rocks and Materials s.a.s Laboratory)	carrera 59C N°. 130-38, Bogotá, 111111, Bogotá, Colombia	-
UNIGEO a.s.	Místecká329/258, Ostrava, 720 00, Česká republika	1412

Laboratory	Address	Accreditation number
Výzkumný ústav pro hnědé uhlí a.s.	tř. Budovatelů 2830/3, Most, 43401, Česká republika	1078
Zavod za gradbeništvo Slovenije	Dimičeva ulica 12, Ljubljana, 1000, Slovenija	-
a.d. "Hidrozavod dtd" Novi Sad, Serbia	Bulevar Mihajla Pupina 25, Novi Sad, 21000, Serbia	ATS 01-405
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.	Dózsa György út 26., Szentendre, 2000, Hungary	NAH-1-1110/2018
ČVUT Kloknerův ústav	Šolínova 7, Praha 6, 166 08, Česká republika	1061
Ředitelství silnic a dálnic ČR	Rebešovická 40, Brno-Chrlice, 643 00, Česká republika	1072
Ředitelství silnic a dálnic, laboratoř Praha	Na Pankráci 546/56, Praha 4, Praha, 140 00, Česká republika	1734

2 Procedures used in the Statistical Analysis of Laboratory Results

The statistical analysis is based on the following steps:

1. Evaluation of intralaboratory variabilities by Cochran's C test: If 5% or 1% critical value is exceeded, the effect of the individual observations is first considered. If the results indicate that high participant variability is caused by a single observation, this value is excluded from the experiment, but the participant is not excluded as outlying. By overcoming 1% of the critical value, the participant's results can be marked as outlying and excluded from the experiment.
2. The numerical critical evaluation of the test results using Grubbs' test: By overcoming 1% critical value, the participant's results can be marked as outlying and excluded from the experiment.
3. Graphical determination of the consistency of laboratories (Mandel's statistics): The exceedance of the critical values of Mandel's statistics does not indicate that the results of the laboratories concerned are wrong; it only suggests minor inconsistencies.
4. Evaluation of descriptive statistics and, if possible, taking into account the number of observations, the repeatability and reproducibility.
5. Evaluation of the assigned value.
6. The performance evaluation: The most significant outcome of the PT Program is the so-called z-score and ζ-score (zeta-score).These characteristics assess the performance of individual participants by comparing it with the assigned value and measurement uncertainties. z-score and ζ-score are compared with limit values. The resulting ζ-score values are not taken into account during the final evaluation of the performance of participants as they are to a considerable degree dependent on the values of the measurement uncertainties of the assessed institutions.

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

3 Conclusions of the Statistical Analysis

The present report summarizes the results of the Proficiency Testing Program Soil Testing (PT Program) organized by the PT Provider at the SZK FAST. 50 participants (laboratories) took part in the PT Program. The program focused on ordinary standardized testing of soil. 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. Testing methods can be found in part **??** 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
03e0cf	-	-	X	✓	-	✓	-	-	-
0af9cc	✓	✓	?	-	-	-	-	-	-
0e19d1	-	-	-	✓	✓	-	-	-	-
10f479	-	-	-	-	?	✓	-	-	-
19c3ea	✓	✓	✓	-	-	-	✓	-	-
1dd437	-	-	-	-	-	-	-	✓	-
257e1b	✓	-	✓	-	-	-	✓	✓	-
2f577a	-	-	-	✓	-	!	-	-	-
2fc7e3	-	?	✓	-	-	✓	✓	-	-
349706	✓	✓	✓	✓	✓	?	✓	✓	✓
3ae2a7	-	-	-	-	-	-	-	✓	-
3b178c	-	-	-	-	-	-	-	✓	-
405cc9	-	-	-	-	-	-	-	✓	✓
4aba20	✓	X	?	-	-	-	✓	✓	✓
4b7a6f	✓	✓	✓	✓	-	-	-	✓	-
4f6c1c	-	-	-	-	-	-	-	✓	-
4ffaa5	✓	-	X	-	-	-	✓	-	-
50a49a	-	-	-	-	-	-	-	✓	-
5d54c5	-	-	-	-	-	-	?	✓	?
62fddc	?	-	-	-	-	-	-	?	✓
6361a4	✓	-	✓	-	-	✓	✓	?	?
6de47c	✓	✓	✓	-	-	-	✓	-	✓
769d4f	✓	✓	✓	✓	-	-	✓	?	✓
7897a4	-	-	-	-	-	-	✓	-	-
7d1c14	-	-	-	-	✓	-	-	-	-
8096b5	✓	-	✓	-	-	-	-	✓	-
819834	✓	✓	✓	-	-	-	✓	✓	-
8c246a	-	-	-	-	-	-	-	-	?
922362	-	-	-	-	-	-	-	-	✓
a6c0b5	✓	✓	-	✓	-	✓	-	-	-
ab16b9	✓	-	✓	-	-	-	-	✓	-
ad498c	✓	✓	✓	-	✓	✓	✓	✓	✓
c63e03	✓	-	✓	-	-	-	✓	-	-
c8f62e	✓	-	-	✓	-	-	-	-	-
d2b8b2	?	✓	✓	-	-	-	-	✓	✓
d360e6	✓	✓	✓	✓	!	✓	✓	✓	✓
d4c68e	✓	✓	✓	✓	✓	✓	✓	✓	✓
d7df6e	✓	-	✓	-	-	-	✓	-	-
d92fa5	-	-	-	-	-	-	?	X	-
dbb7b3	-	-	-	-	-	-	-	✓	✓
dec8e3	-	-	-	-	-	-	-	!	-
e452e6	✓	✓	✓	-	-	-	✓	✓	✓
eb713f	-	-	-	-	-	-	✓	-	-
ebaae9	-	-	-	-	-	-	✓	✓	✓
ec262e	-	-	-	✓	✓	✓	-	-	✓

ID / Method	1	2	3	4	5	6	7	8	9
ef5463	-	-	-	-	-	-	-	✓	-
f34852	✓	-	-	-	-	-	-	✓	-
f996a0	✓	-	✓	-	-	-	✓	✓	?
fb2a44	✓	-	-	-	-	-	-	!	-
fc37be	?	✓	✓	✓	✓	✓	✓	✓	✓

References

[1] EN ISO 17892-1. *Geotechnical investigation and testing - Laboratory testing of soil - Part 1: Determination of water content*. 2015.

[2] EN ISO 17892-3. *Geotechnical investigation and testing - Laboratory testing of soil - Part 3: Determination of particle density*. 2016.

[3] EN ISO 17892-4. *Geotechnical investigation and testing - Laboratory testing of soil - Part 4: Determination of particle size distribution*. 2017.

[4] EN ISO 17892-5. *Geotechnical investigation and testing - Laboratory testing of soil - Part 5: Incremental loading oedometer test*. 2017.

[5] EN ISO 17892-7. *Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test*. 2018.

[6] CEN ISO/TS 17892-10. *Geotechnical investigation and testing - Laboratory testing of soil - Part 10: Direct shear tests*. 2005.

[7] EN ISO 17892-12. *Geotechnical investigation and testing - Laboratory testing of soil - Part 12: Determination of liquid and plastic limits*. 2018.

[8] EN 13286-2. *Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory reference density and water content - Proctor compaction*. 2011.

[9] EN 13286-47. *Unbound and hydraulically bound mixtures - Part 47: Test method for the determination of California Bearing ratio, immediate bearing index and linear swelling*. 2012.

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

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

1 Appendix – EN ISO 17892-1 – Water content

1.1 Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
62fddc	3.4	-	-	-	3.4	0.0	0.0
fc37be	3.4	3.4	3.4	1.3	3.4	0.0	0.0
6de47c	3.3	3.5	3.5	0.7	3.4	0.12	3.36
d2b8b2	3.3	3.7	3.4	0.3	3.5	0.21	6.0
4b7a6f	3.5	3.5	3.5	-	3.5	0.01	0.17
fb2a44	3.6	3.6	3.6	0.1	3.6	0.0	0.0
0af9cc	3.6	3.7	3.6	0.7	3.6	0.06	1.59
f34852	3.6	3.7	3.7	0.5	3.7	0.06	1.57
769d4f	3.7	3.6	3.7	0.7	3.7	0.06	1.57
a6c0b5	3.7	3.7	3.7	0.3	3.7	0.02	0.41
d360e6	3.7	-	-	-	3.7	0.0	0.0
8096b5	3.7	-	-	-	3.7	0.0	0.0
d4c68e	3.7	3.8	3.7	-	3.7	0.04	1.12
4aba20	3.8	3.6	3.8	1.8	3.7	0.08	2.03
257e1b	3.7	3.8	3.7	0.1	3.7	0.06	1.55
c8f62e	3.8	3.8	3.8	0.1	3.8	0.02	0.53
819834	3.8	3.7	3.8	0.1	3.8	0.04	0.93
e452e6	3.9	3.8	3.7	0.7	3.8	0.1	2.63
f996a0	3.8	3.8	3.8	0.4	3.8	0.0	0.0
ad498c	3.8	3.8	3.8	0.6	3.8	0.0	0.0
6361a4	3.8	3.9	3.8	2.0	3.8	0.03	0.69
19c3ea	3.8	3.9	3.8	0.1	3.8	0.06	1.51
4ffaa5	3.9	3.8	3.8	2.0	3.9	0.03	0.69
349706	3.9	3.9	3.9	0.7	3.9	0.0	0.0
ab16b9	3.9	3.9	3.9	1.0	3.9	0.0	0.0
c63e03	3.9	3.9	3.9	0.1	3.9	0.0	0.0
d7df6e	4.0	3.9	4.0	0.1	3.9	0.02	0.39

1.2 The Numerical Procedure for Determining Outliers

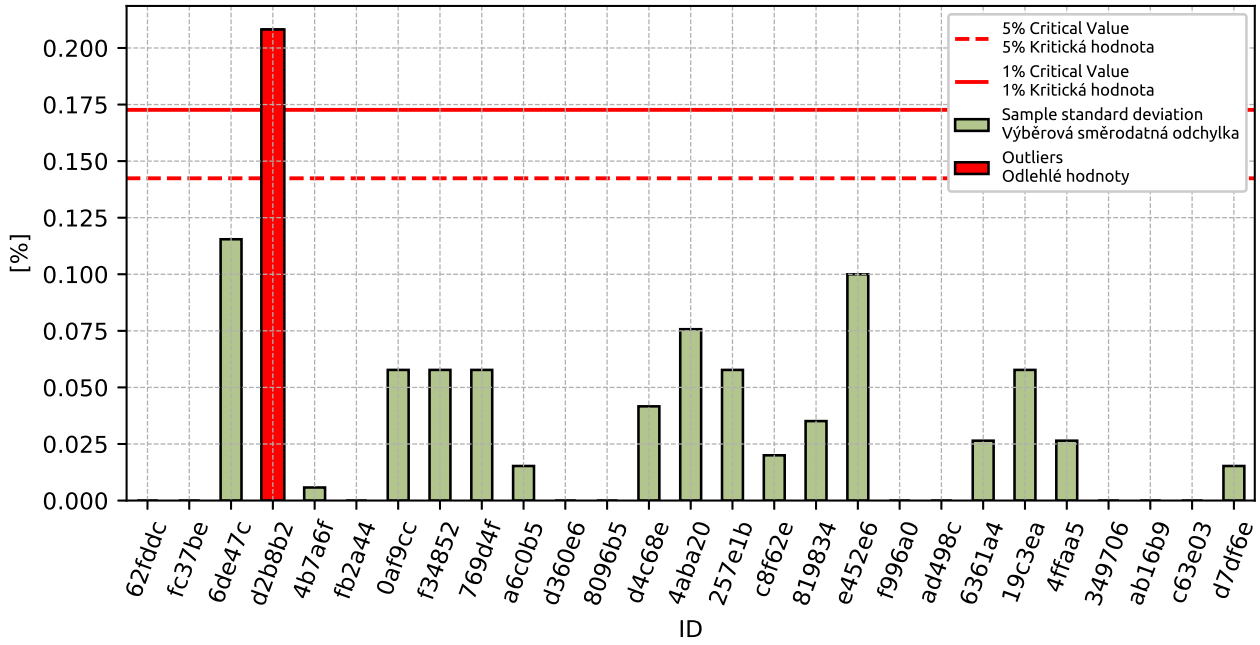

Figure 1: **Cochran's test** - sample standard deviations

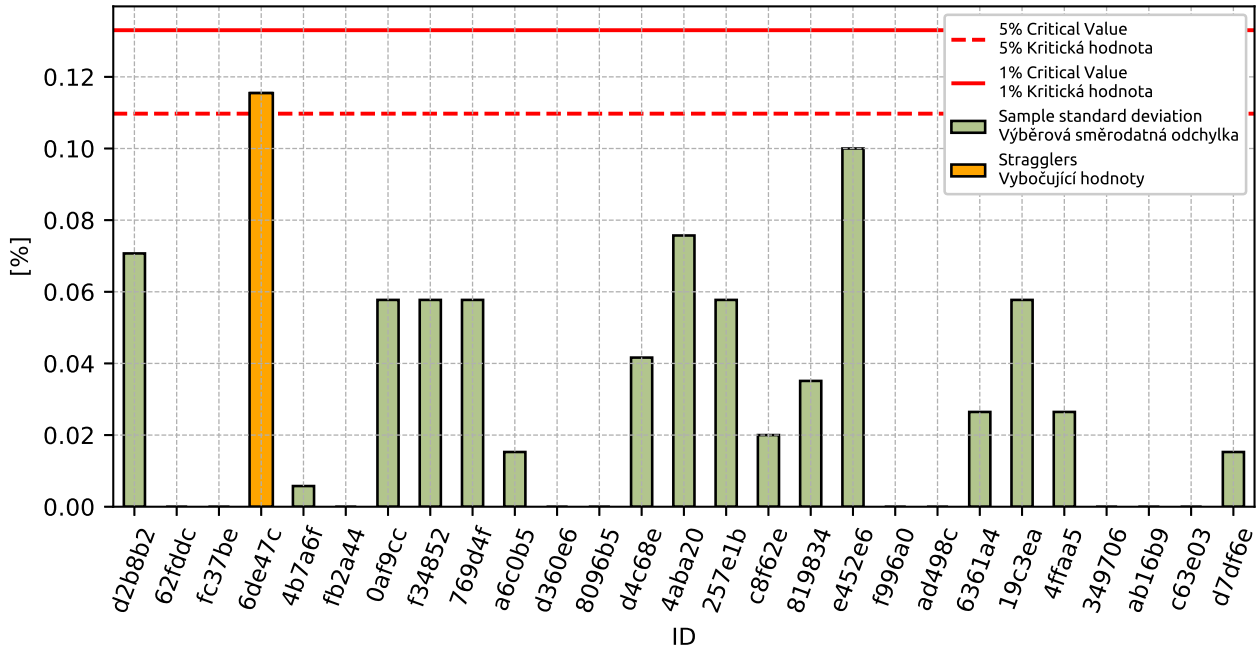

Figure 2: **Cochran's test** - sample standard deviations without outliers

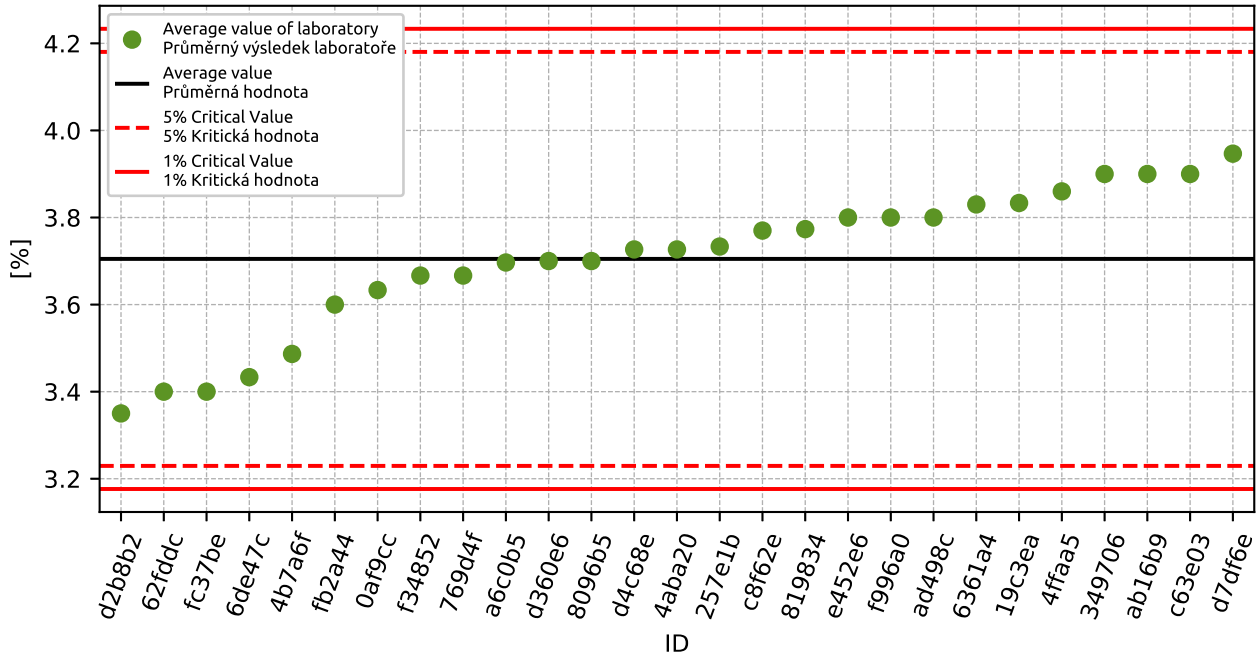

Figure 3: **Grubbs' test** - average values

1.3 Mandel's Statistics

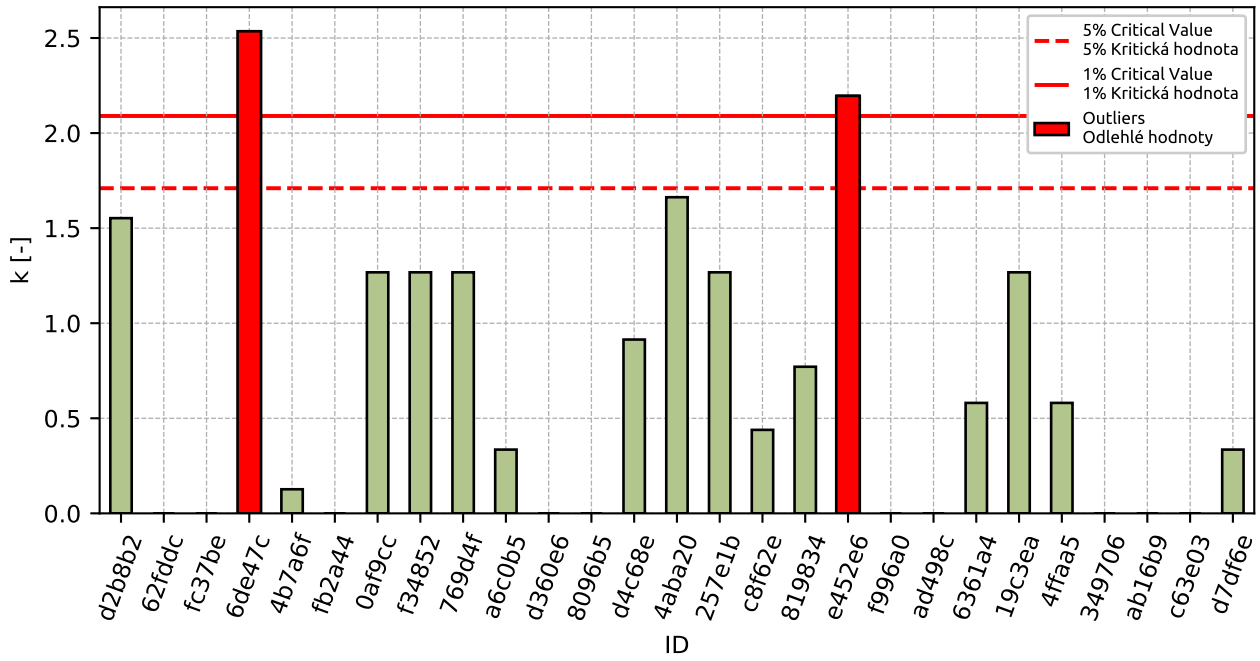

Figure 4: Intralaboratory Consistency Statistic

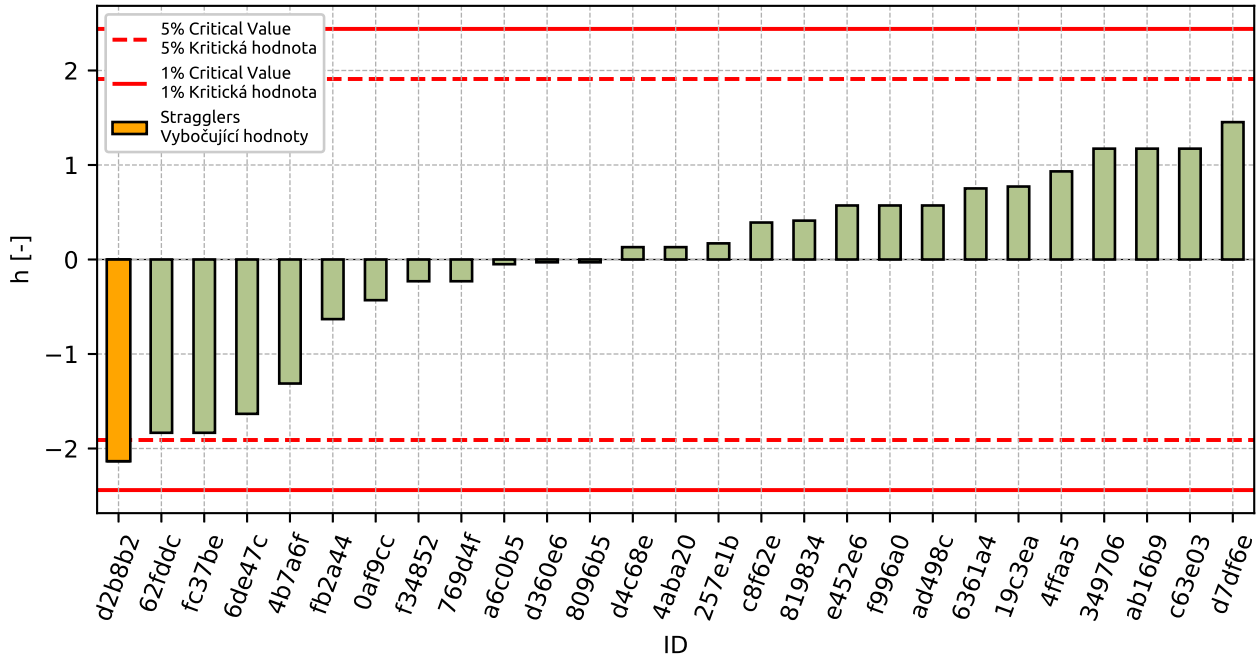

Figure 5: Interlaboratory Consistency Statistic

1.4 Descriptive statistics

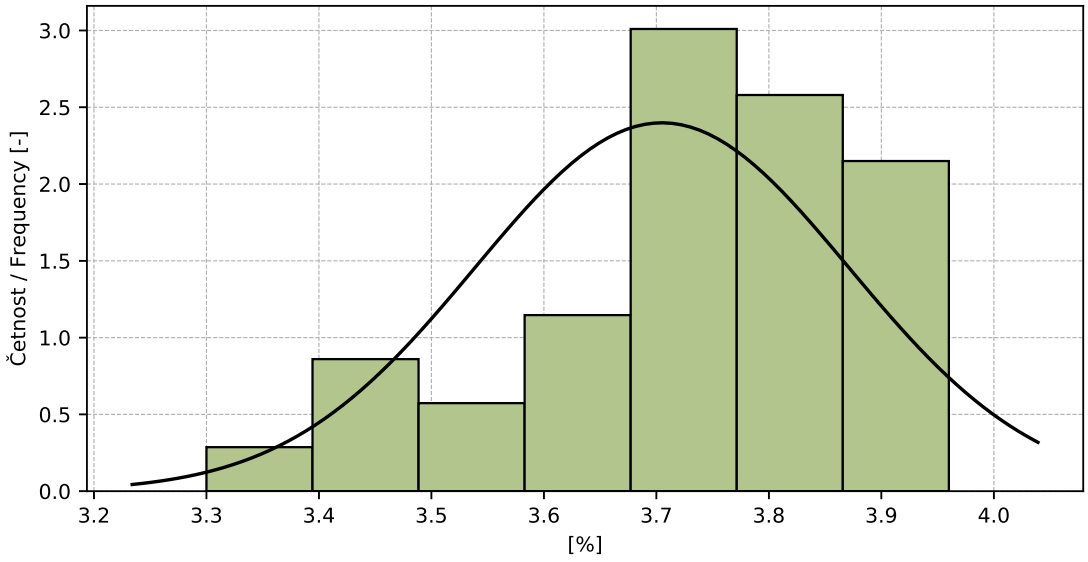

Figure 6: Histogram of all test results

Table 5: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	3.7
Výběrová směrodatná odchylka / Sample standard deviation – s	0.17
Vztažná hodnota / Asigned value – x^*	3.7
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.17
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.41
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.16
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.05
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.17
Opakovatelnost / Repeatability – r	0.1
Reprodukovatelnost / Reproducibility – R	0.5

1.5 Evaluation of Performance Statistics

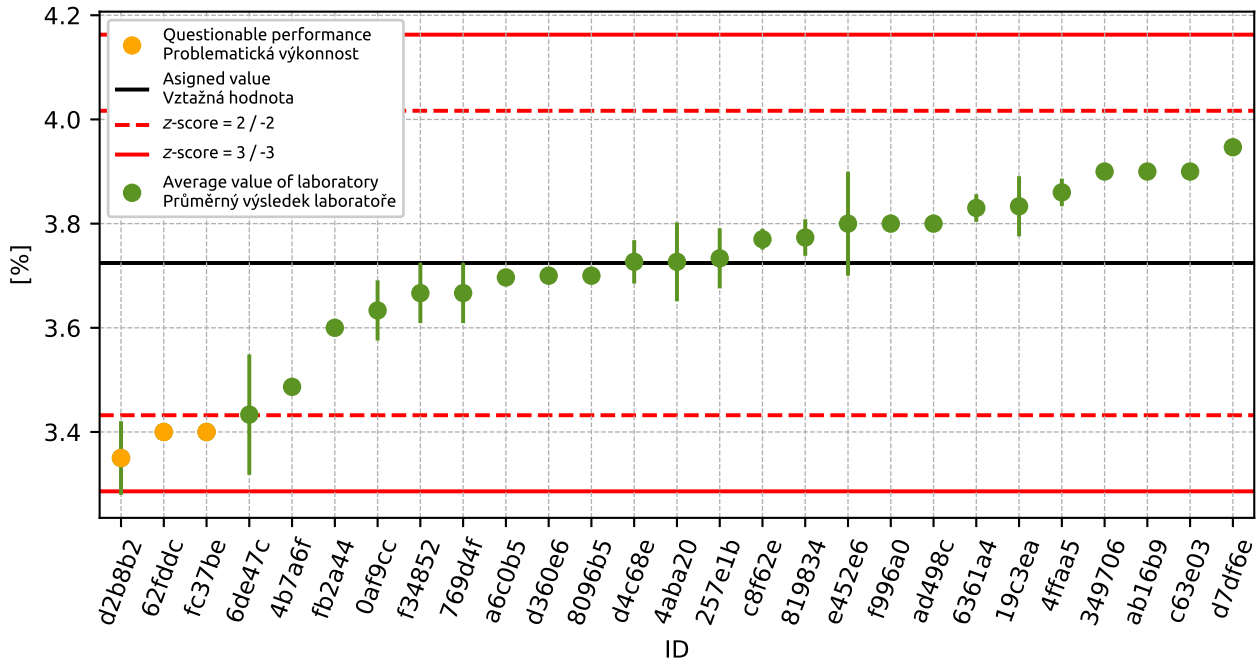

Figure 7: Average values and sample standard deviations

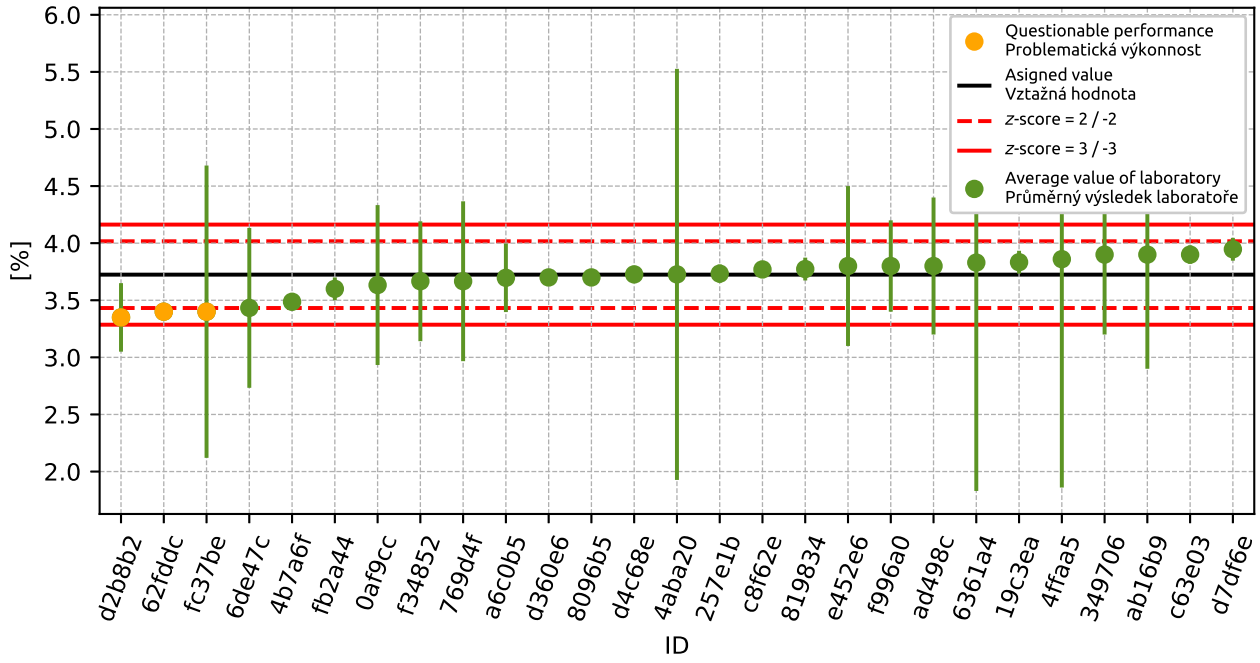

Figure 8: Average values and extended uncertainties of measurement

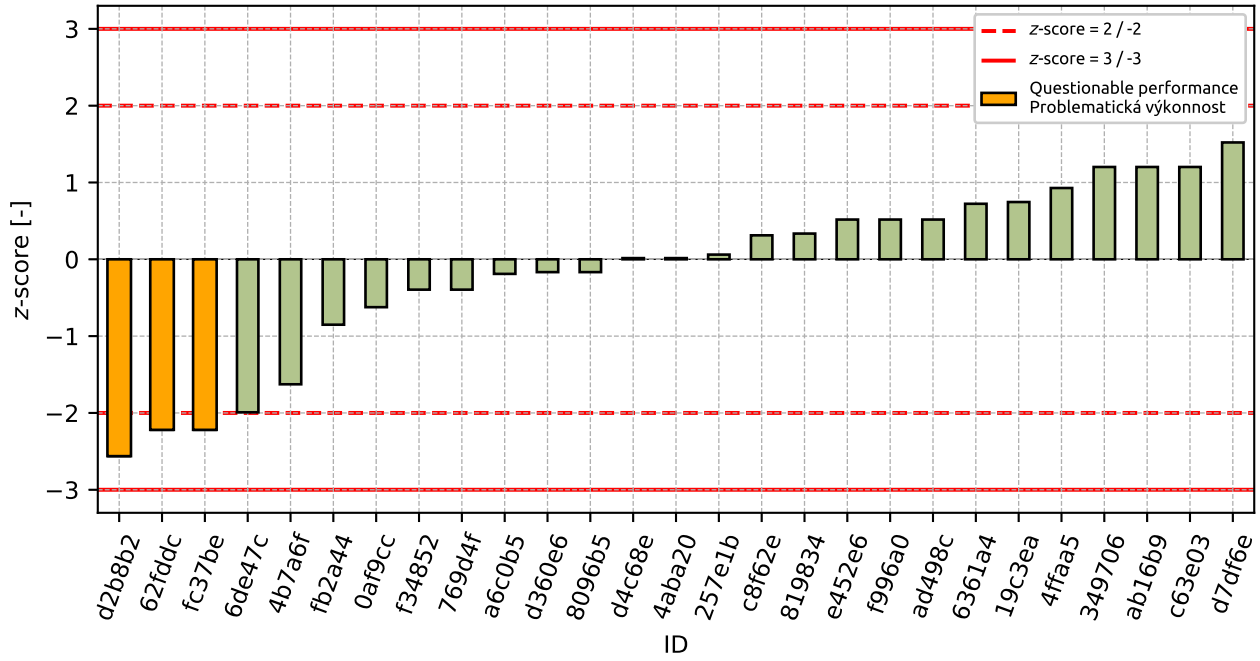

Figure 9: z-score

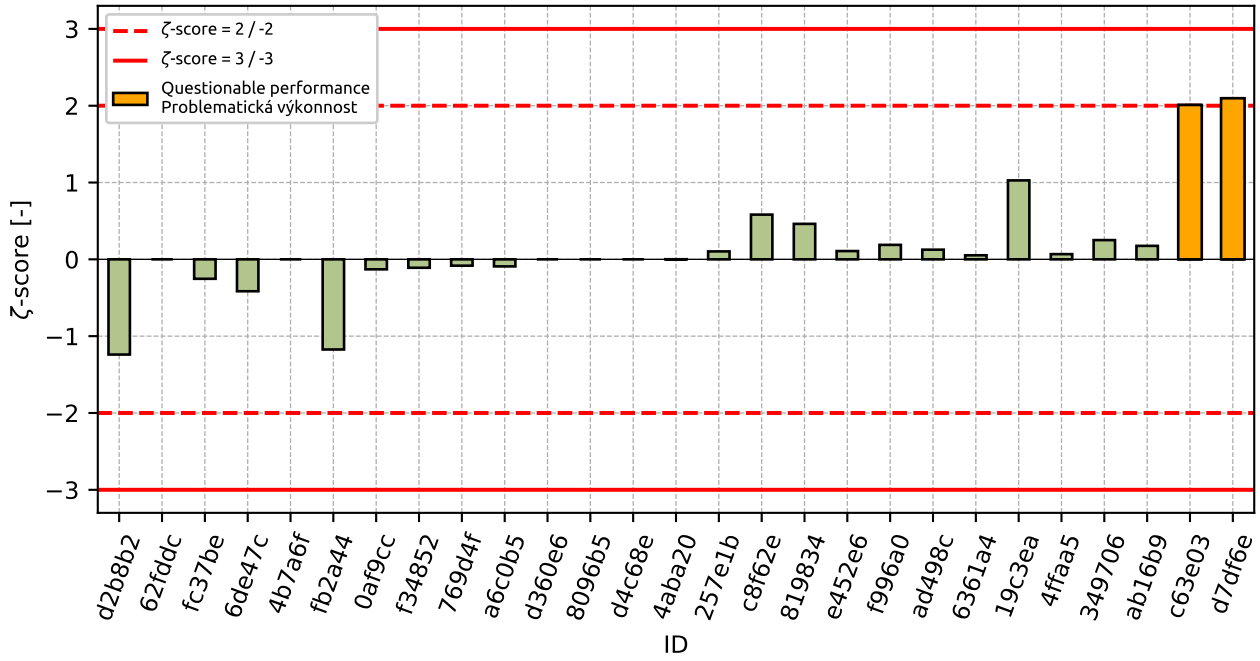

Figure 10: ζ-score

Table 6: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d2b8b2	-2.56	-1.24
62fddc	-2.22	-
fc37be	-2.22	-0.25
6de47c	-1.99	-0.42
4b7a6f	-1.63	-
fb2a44	-0.85	-1.17
0af9cc	-0.62	-0.13
f34852	-0.4	-0.11
769d4f	-0.4	-0.08
a6c0b5	-0.19	-0.09
d360e6	-0.17	-
8096b5	-0.17	-
d4c68e	0.02	-
4aba20	0.02	0.0
257e1b	0.06	0.1
c8f62e	0.31	0.58
819834	0.33	0.46
e452e6	0.52	0.11
f996a0	0.52	0.19
ad498c	0.52	0.13
6361a4	0.72	0.05
19c3ea	0.75	1.03
4ffaa5	0.93	0.07
349706	1.2	0.25
ab16b9	1.2	0.18
c63e03	1.2	2.01
d7df6e	1.52	2.1

2 Appendix – EN ISO 17892-3 – Particle density

2.1 Test results

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

ID	Test results [Mg/m^3]			u_X [Mg/m^3]	$\bar{x}$ [Mg/m^3]	s_0 [Mg/m^3]	V_X [%]
769d4f	2.6	2.6	2.6	0.7	2.6	0.0	0.0
0af9cc	2.62	2.62	2.61	0.0	2.62	0.006	0.22
ad498c	2.63	2.62	2.62	0.02	2.62	0.005	0.19
819834	2.63	2.62	2.63	-	2.63	0.003	0.12
349706	2.63	2.63	2.63	0.0	2.63	0.0	0.0
fc37be	2.63	2.63	2.63	1.24	2.63	0.0	0.0
d2b8b2	2.62	2.63	2.64	0.0	2.63	0.01	0.38
19c3ea	2.64	2.62	2.65	0.02	2.64	0.015	0.58
e452e6	2.64	2.64	2.64	0.01	2.64	0.005	0.17
6de47c	2.65	2.64	2.64	0.0	2.64	0.006	0.22
4b7a6f	2.64	2.64	2.65	-	2.64	0.006	0.22
d4c68e	2.65	2.65	2.65	-	2.65	0.002	0.06
d360e6	2.67	-	-	-	2.67	0.0	0.0
a6c0b5	2.67	2.69	2.67	0.01	2.68	0.012	0.43
2fc7e3	2.66	2.71	2.68	0.15	2.68	0.026	0.97
4aba20	2.75	2.75	2.75	-	2.75	0.002	0.07

2.2 The Numerical Procedure for Determining Outliers

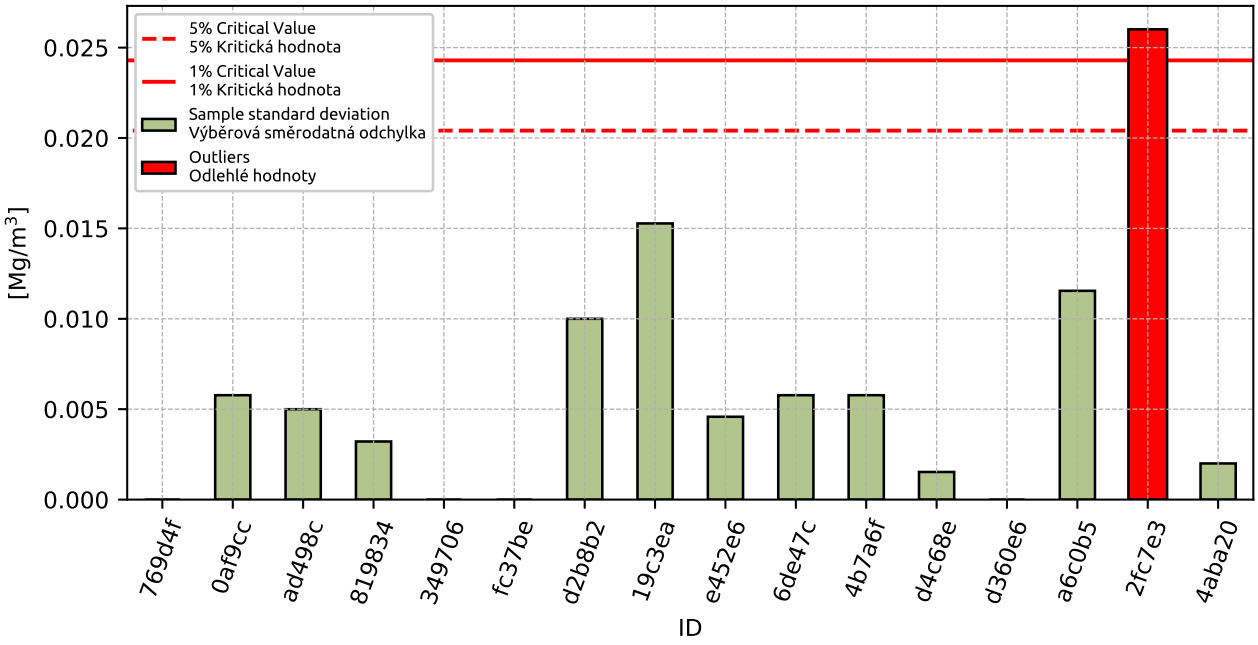

Figure 11: **Cochran's test** - sample standard deviations

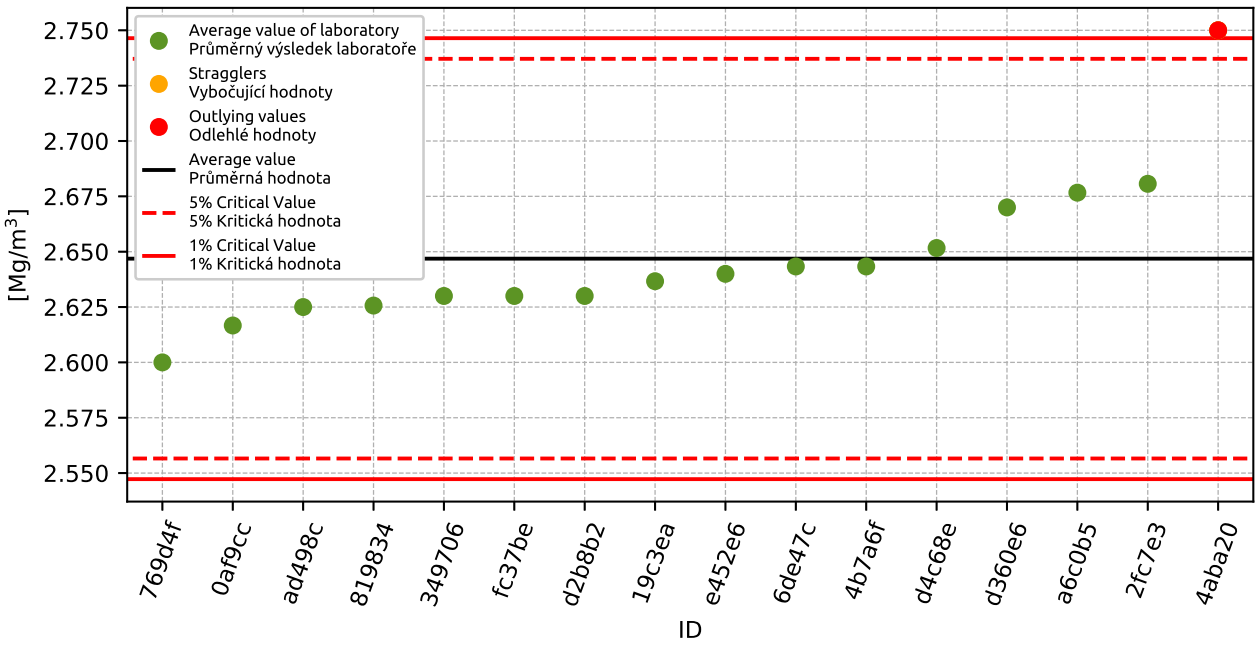

Figure 12: **Grubbs' test** - average values

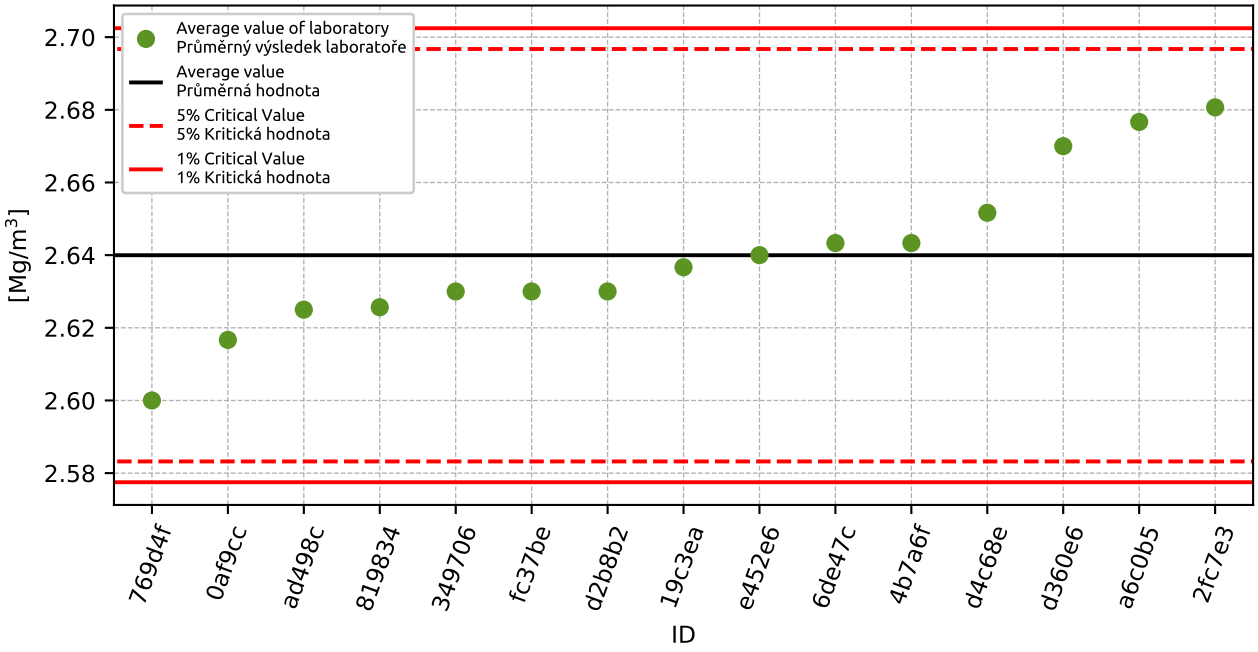

Figure 13: **Grubbs' test** - average values without outliers

2.3 Mandel's Statistics

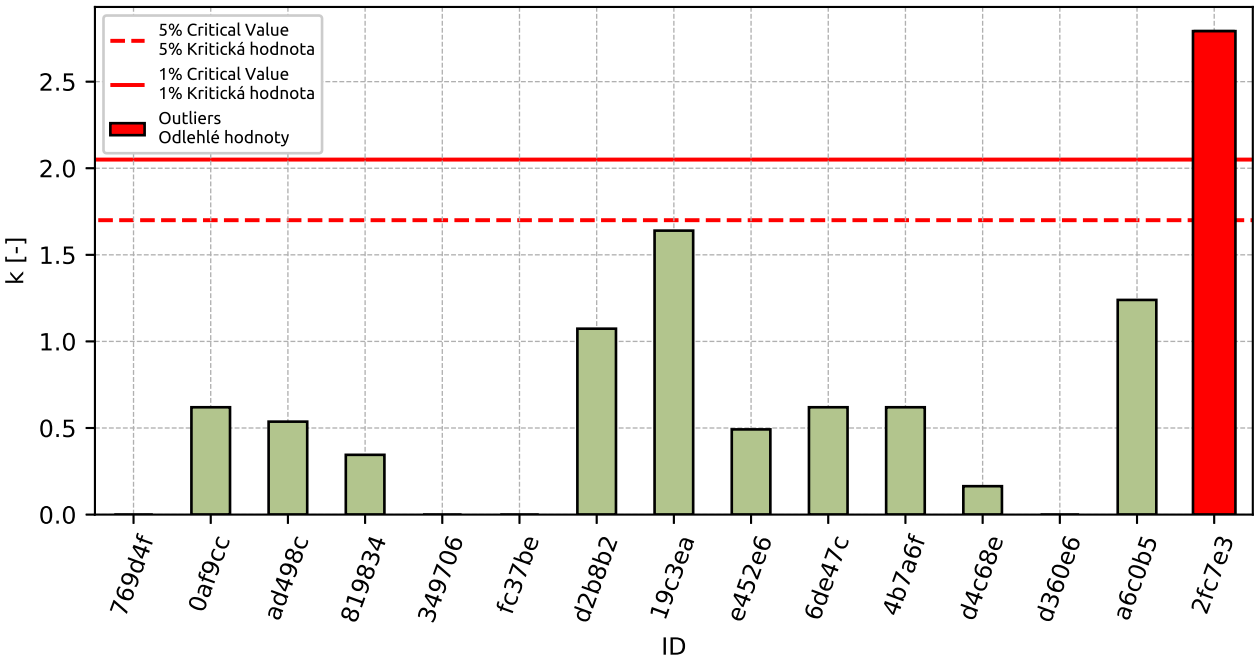

Figure 14: Intralaboratory Consistency Statistic

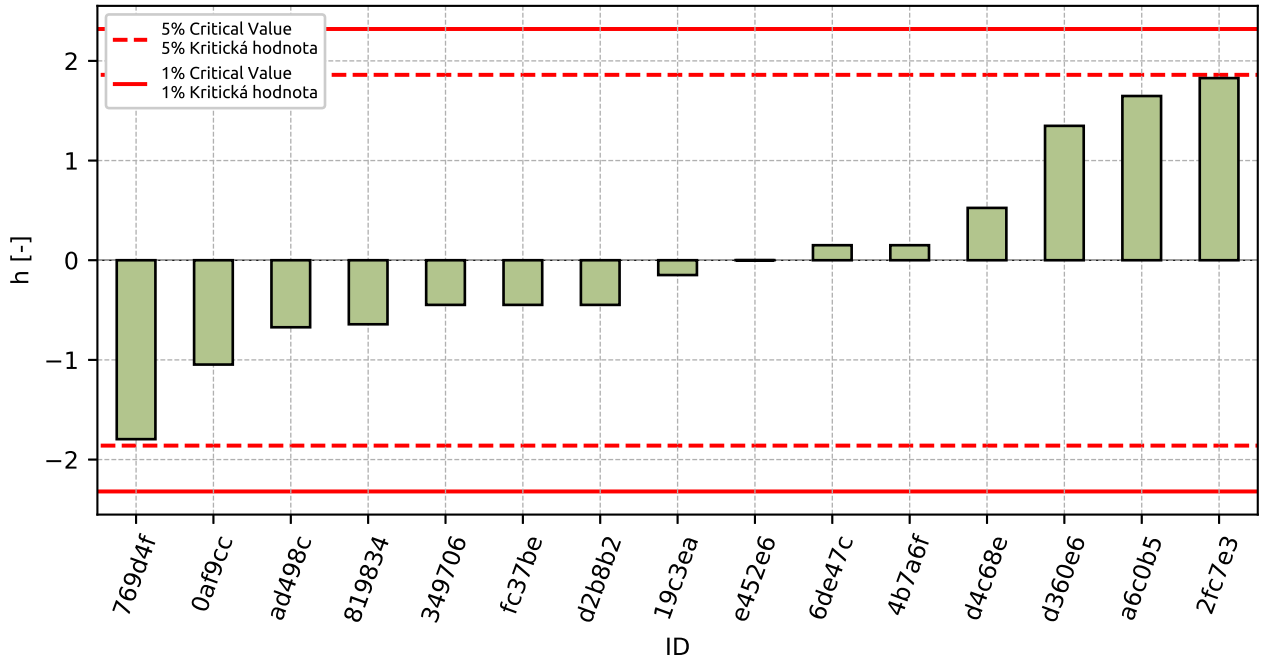

Figure 15: Interlaboratory Consistency Statistic

2.4 Descriptive statistics

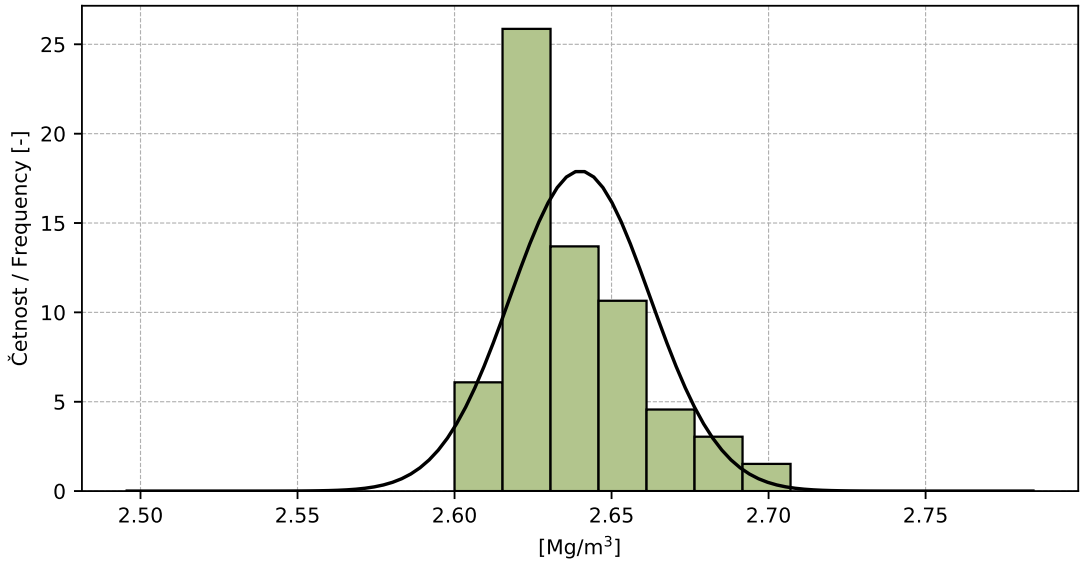

Figure 16: Histogram of all test results

Table 8: Descriptive statistics

Characteristics	[Mg/m³]
Průměrná hodnota / Average value – $\bar{x}$	2.64
Výběrová směrodatná odchylka / Sample standard deviation – s	0.022
Vztažná hodnota / Asigned value – x^*	2.64
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.02
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.007
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.022
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.009
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.024
Opakovatelnost / Repeatability – r	0.03
Reprodukovatelnost / Reproducibility – R	0.07

2.5 Evaluation of Performance Statistics

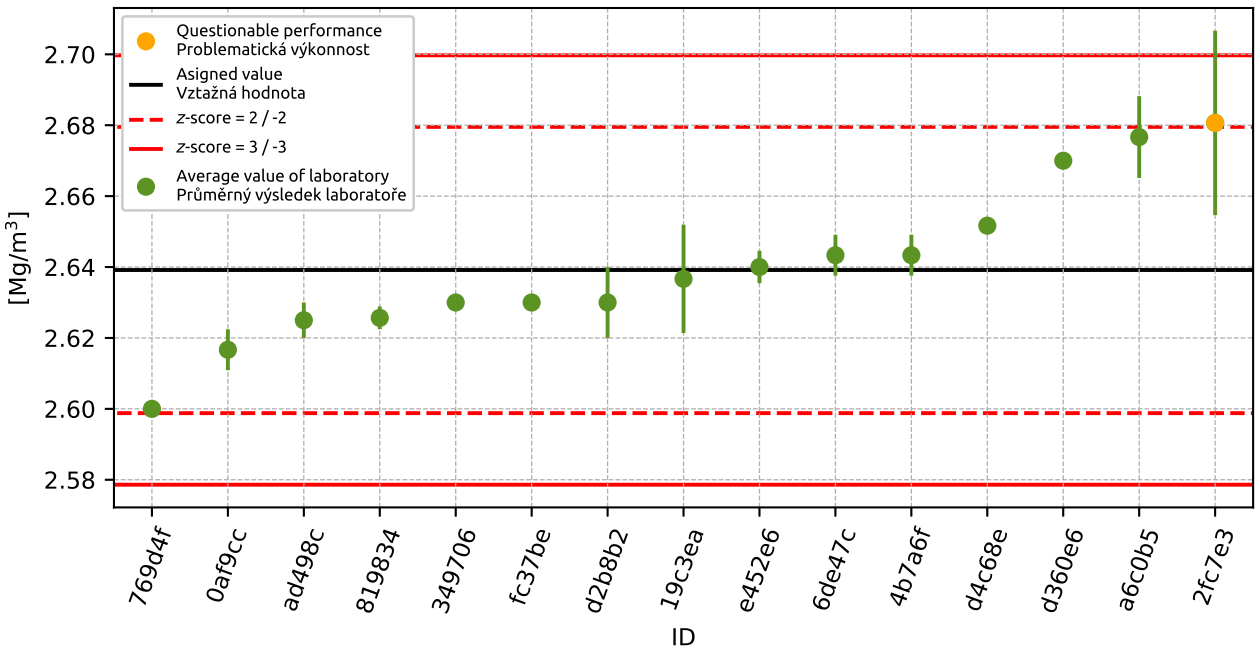

Figure 17: Average values and sample standard deviations

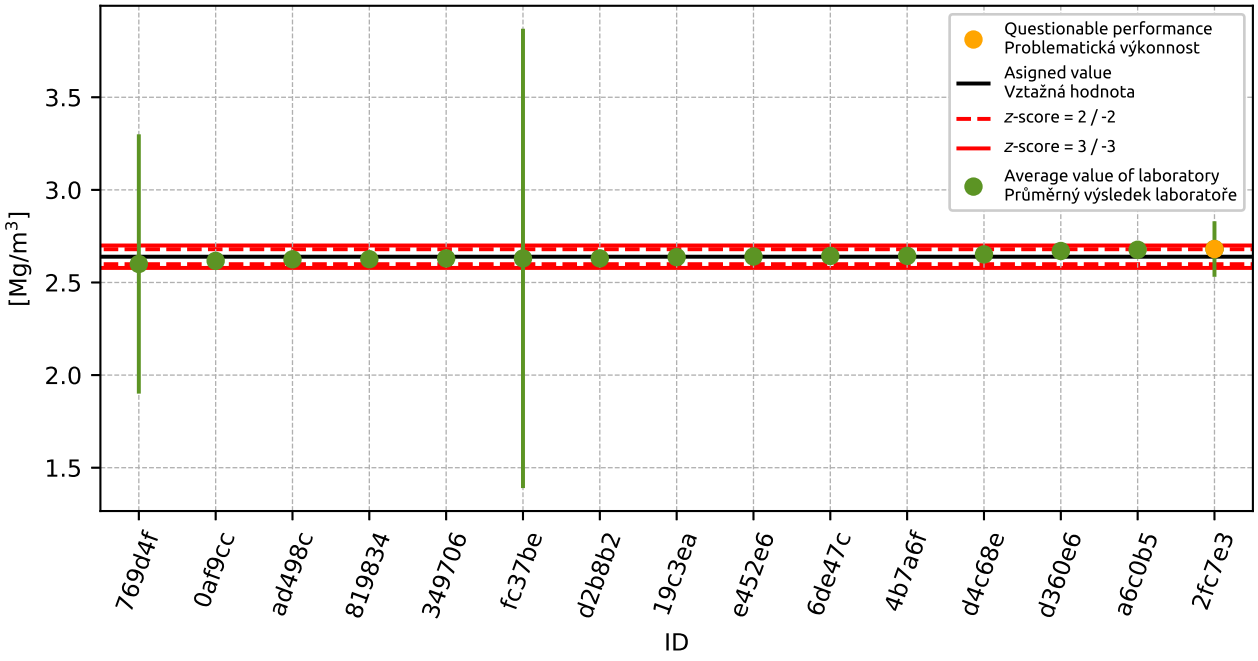

Figure 18: Average values and extended uncertainties of measurement

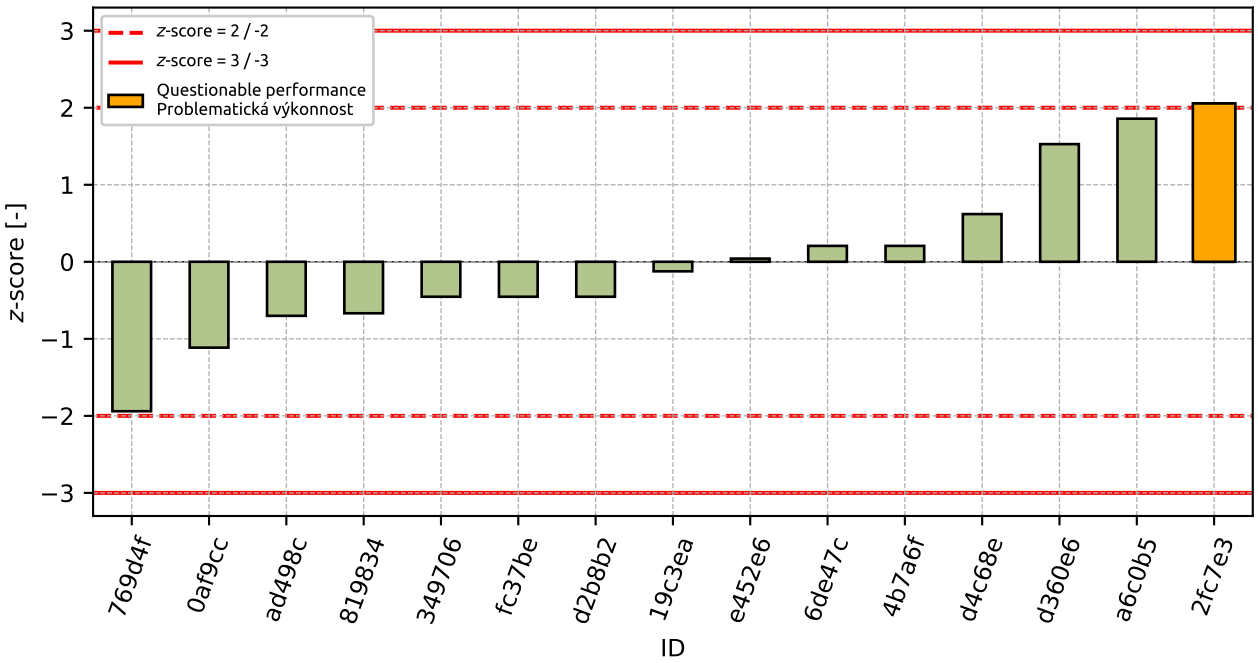

Figure 19: z-score

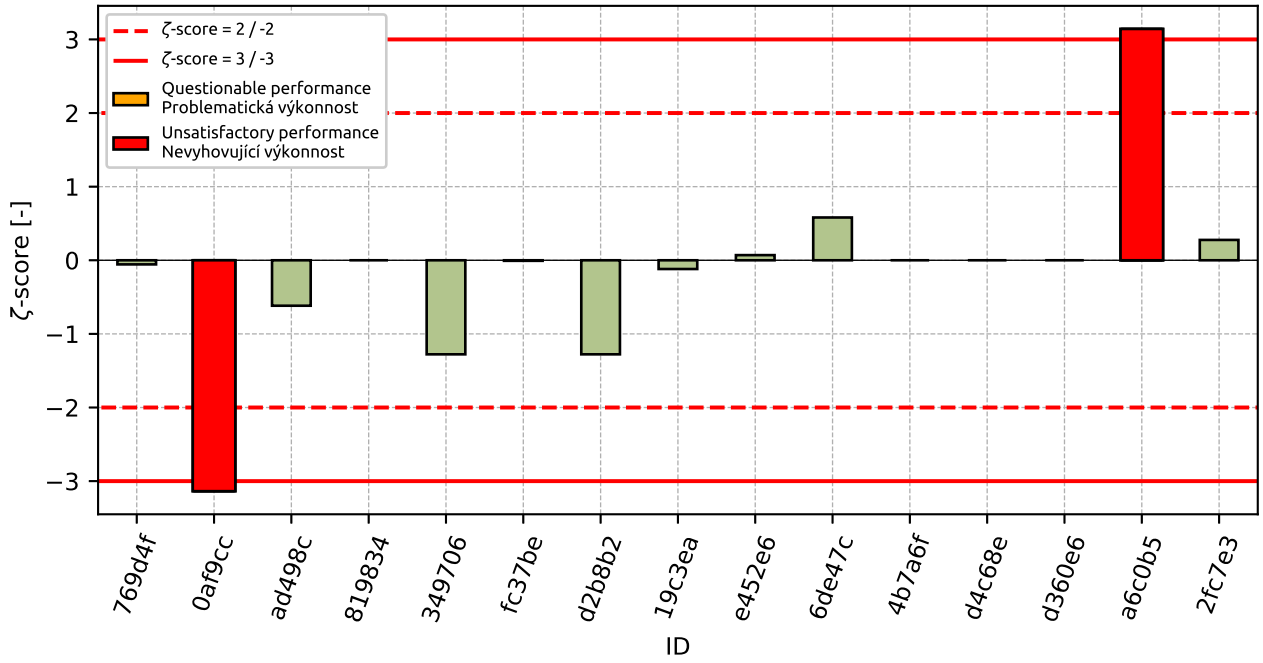

Figure 20: ζ-score

Table 9: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
769d4f	-1.94	-0.06
0af9cc	-1.11	-3.14
ad498c	-0.7	-0.62
819834	-0.67	-
349706	-0.45	-1.28
fc37be	-0.45	-0.01
d2b8b2	-0.45	-1.28
19c3ea	-0.12	-0.12
e452e6	0.04	0.07
6de47c	0.21	0.58
4b7a6f	0.21	-
d4c68e	0.62	-
d360e6	1.53	-
a6c0b5	1.86	3.14
2fc7e3	2.06	0.28

3 Appendix – EN ISO 17892-4 – Particle size distribution

Table 10: Test results - Sieve through [%]

ID of participant	Sieve through [%] 4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
4aba20	96.0	84.7	70.4	44.6	19.3	9.6	8.3
c63e03	96.5	86.0	64.4	36.2	13.3	4.8	3.0
19c3ea	94.7	79.5	59.9	34.8	13.4	4.4	2.4
4ffaa5	65.6	58.0	42.1	23.1	7.6	1.1	0.0
f996a0	96.0	85.0	64.0	37.0	15.0	5.0	3.1
d2b8b2	97.1	84.3	61.8	33.0	12.3	5.5	4.1
349706	95.0	84.0	67.0	28.0	10.0	7.0	4.0
e452e6	95.6	84.8	63.6	34.8	13.2	5.1	3.8
8096b5	94.0	85.0	70.0	32.0	9.0	5.0	5.0
0af9cc	88.0	75.0	56.0	19.0	6.0	5.0	4.0
769d4f	94.0	84.0	70.0	28.0	8.0	5.0	4.0
6de47c	95.0	86.0	70.0	31.0	11.0	7.0	4.0
ab16b9	97.0	86.6	65.6	38.5	15.7	6.0	3.8
d360e6	97.0	86.0	64.0	37.0	14.0	5.0	3.1
03e0cf	99.9	99.7	96.3	87.9	61.2	25.5	24.7
2fc7e3	96.0	85.0	66.0	40.0	18.0	7.0	4.0
4b7a6f	97.2	86.4	65.7	37.0	14.1	5.2	3.3
6361a4	95.7	84.2	64.2	43.4	15.2	6.1	4.0
fc37be	95.6	84.2	62.7	36.5	15.4	6.1	4.0
d7df6e	96.8	85.7	64.2	34.7	8.7	1.5	0.4
d4c68e	96.7	85.6	63.7	34.0	8.7	1.2	0.3
819834	95.8	84.8	65.0	36.9	13.8	5.1	3.5
257e1b	96.1	85.1	62.0	32.6	10.5	4.3	2.6
ad498c	96.9	86.8	65.1	35.3	8.8	1.2	0.4

Table 11: Grubbs' test [%]

Value	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
G_{min}	4.454	3.818	2.641	1.417	0.781	1.004	0.882
G_{max}	0.831	2.302	3.568	4.171	4.442	4.23	4.358
$G_{0.05}$	2.802	2.802	2.802	2.802	2.802	2.802	2.802
$G_{0.01}$	3.112	3.112	3.112	3.112	3.112	3.112	3.112

Table 12: Grubbs' test - without outliers [%]

Value	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
G_{min}	1.993	1.377	2.558	3.035	1.778	1.849	nan
G_{max}	1.298	1.809	1.634	1.802	2.025	2.263	nan
$G_{0.05}$	2.733	2.709	2.758	2.733	2.781	2.781	2.758
$G_{0.01}$	3.031	3.001	3.06	3.031	3.087	3.087	3.06

Table 13: *z*-score

ID of participant	*z*-score [-] / sieve 4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
4aba20	0.06	-0.58	1.63	1.8	2.02	2.26	-
c63e03	0.58	0.9	-0.11	0.22	0.31	-0.06	-0.03
19c3ea	-1.27	-	-1.42	-0.05	0.34	-0.25	-0.44
4ffaa5	-	-	-	-	-1.32	-1.85	-2.09
f996a0	0.06	-0.24	-0.23	0.37	0.8	0.04	0.04
d2b8b2	1.19	-1.04	-0.87	-0.39	0.02	0.28	0.73
349706	-0.96	-1.38	0.64	-	-0.63	1.01	0.66
e452e6	-0.35	-0.47	-0.35	-0.05	0.28	0.09	0.53
8096b5	-1.99	-0.24	1.52	-0.58	-0.92	0.04	1.35
0af9cc	-	-	-2.56	-3.03	-1.78	0.04	0.66
769d4f	-1.99	-1.38	1.52	-1.33	-1.21	0.04	0.66
6de47c	-0.96	0.9	1.52	-0.77	-0.35	1.01	0.66
ab16b9	1.09	1.58	0.24	0.65	1.0	0.52	0.53
d360e6	1.09	0.9	-0.23	0.37	0.51	0.04	0.04
03e0cf	-	-	-	-	-	-	-
2fc7e3	0.06	-0.24	0.35	0.93	1.65	1.01	0.66
4b7a6f	1.3	1.35	0.27	0.37	0.54	0.13	0.18
6361a4	-0.24	-1.15	-0.17	1.58	0.85	0.57	0.66
fc37be	-0.35	-1.15	-0.61	0.27	0.91	0.57	0.66
d7df6e	0.89	0.56	-0.17	-0.07	-1.01	-1.66	-1.82
d4c68e	0.78	0.44	-0.32	-0.2	-1.01	-1.8	-1.89
819834	-0.14	-0.47	0.06	0.35	0.45	0.09	0.32
257e1b	0.17	-0.13	-0.81	-0.47	-0.49	-0.3	-0.3
ad498c	0.99	1.81	0.09	0.04	-0.98	-1.8	-1.82

4 Appendix – EN ISO 17892-5 – Incremental loading oedometer test

4.1 100 kPa

4.1.1 Test results

Table 14: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [MPa]	u_X [MPa]
03e0cf	5.23	-
769d4f	5.3	-
a6c0b5	6.46	0.2
2f577a	8.52	-
c8f62e	10.63	-
fc37be	12.54	-
0e19d1	13.0	1.61
349706	14.12	-
ec262e	14.9	1.1
4b7a6f	17.7	-
d360e6	18.82	-
d4c68e	20.63	-

4.1.2 The Numerical Procedure for Determining Outliers

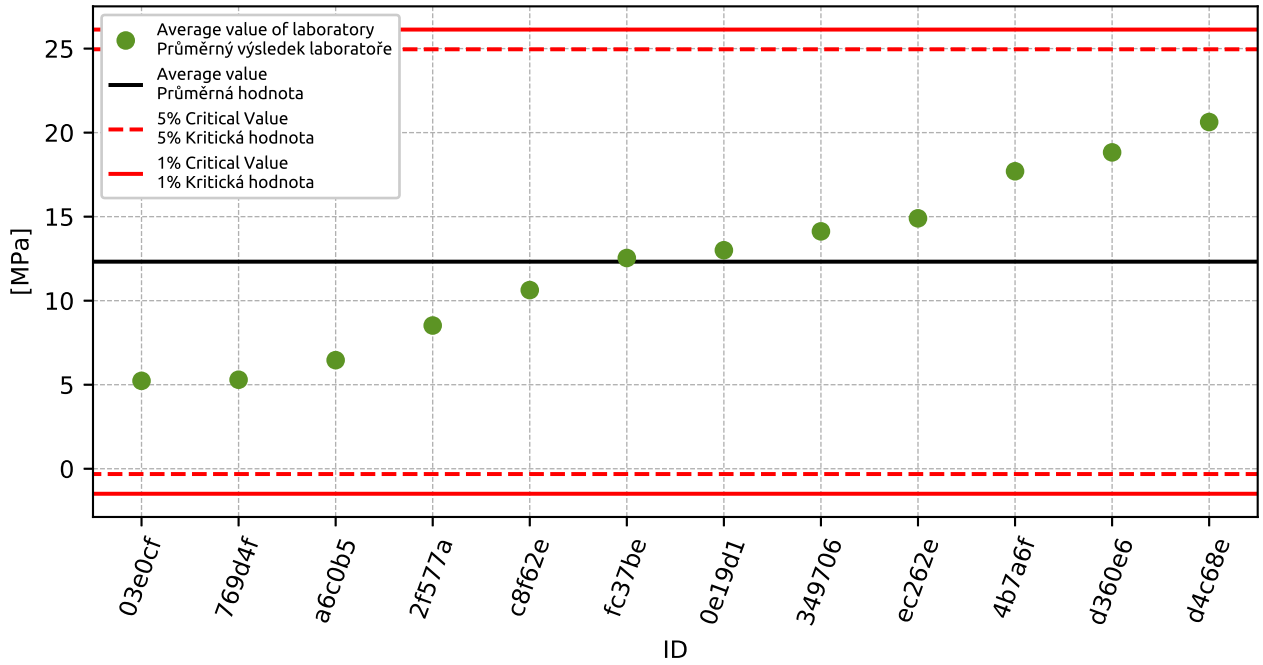

Figure 21: **Grubbs' test** - average values

4.1.3 Mandel's Statistics

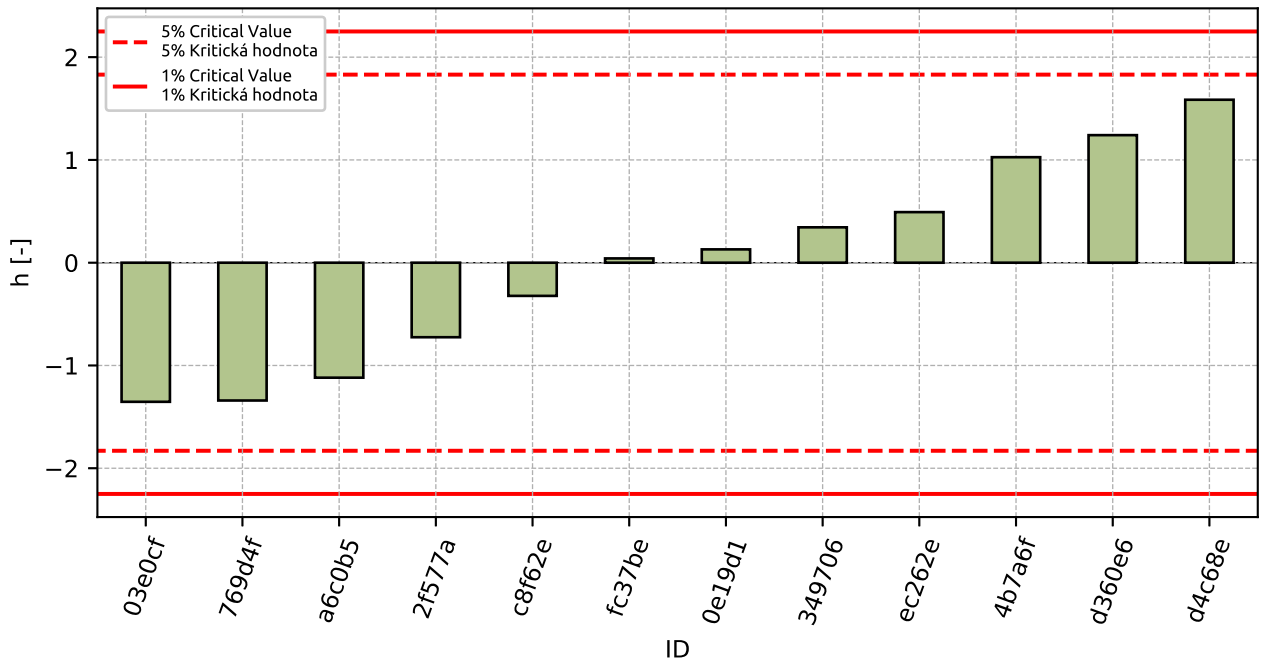

Figure 22: Interlaboratory Consistency Statistic *h*

4.1.4 Descriptive statistics

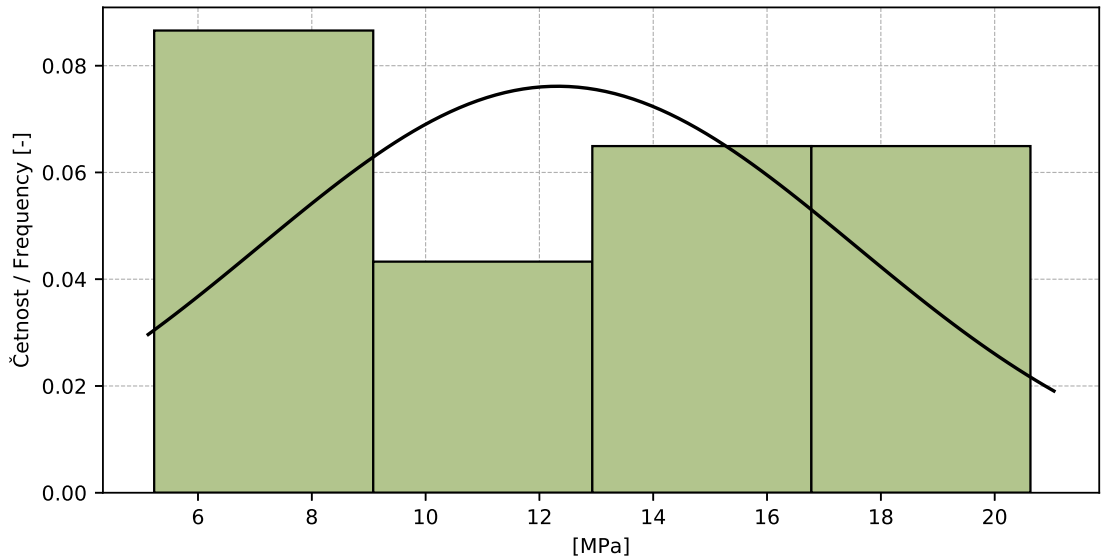

Figure 23: Histogram

Table 15: Descriptive statistics

Value	[MPa]
Průměrná hodnota / Average value – $\bar{x}$	12.32
Výběrová směrodatná odchylka / Sample standard deviation – s	5.239
Vztažná hodnota / Asigned value – x^*	12.32
Robustní směrodatná odchylka / Robust standard deviation – s^*	5.688
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	2.053
p-hodnota testu normality / p-value of normality test	0.565 [-]

4.1.5 Calculation of Performance Statistics

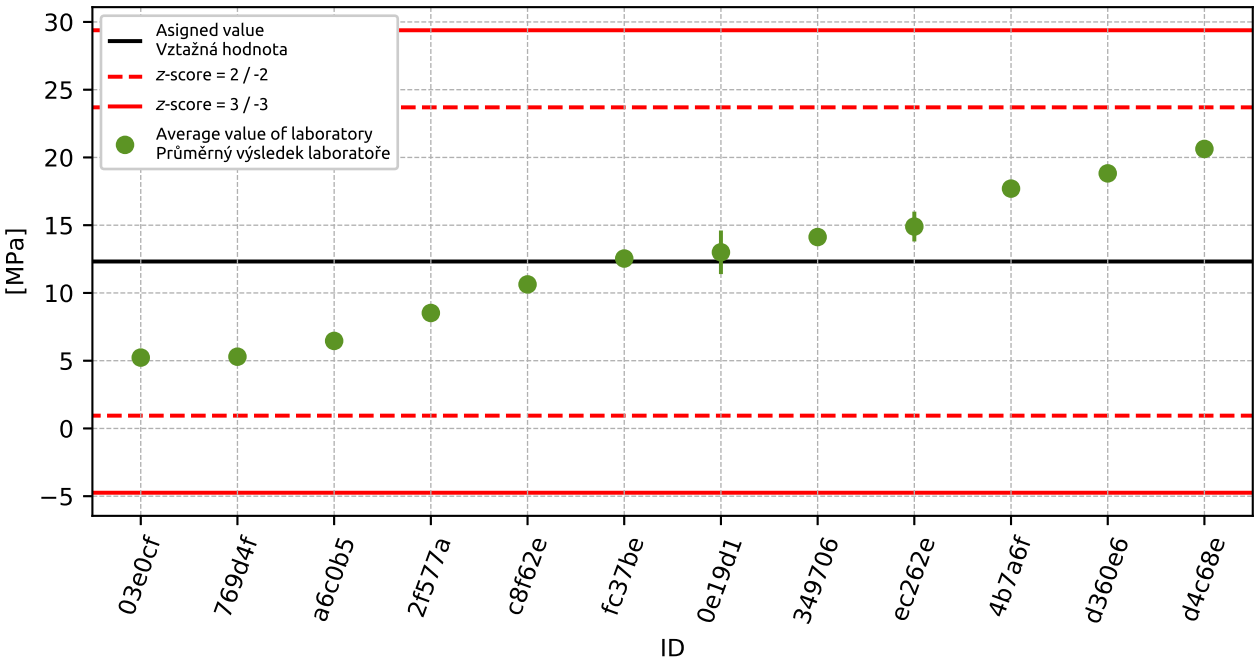

Figure 24: Average values and extended uncertainties of measurement

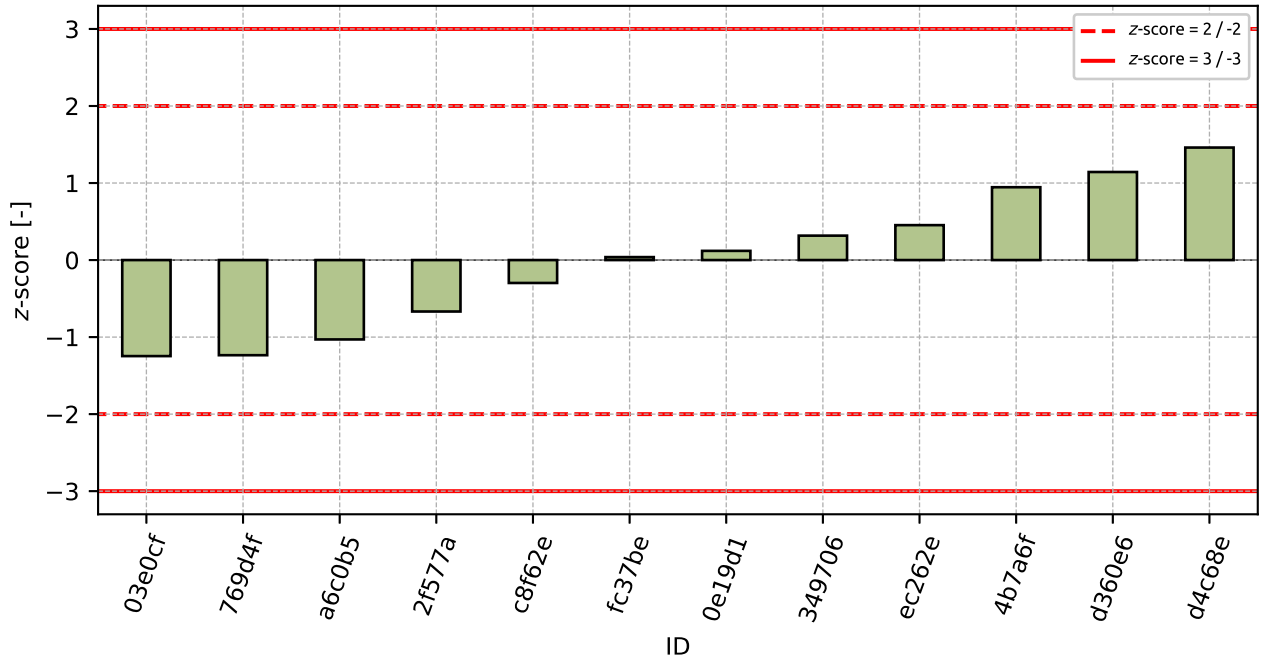

Figure 25: z-score

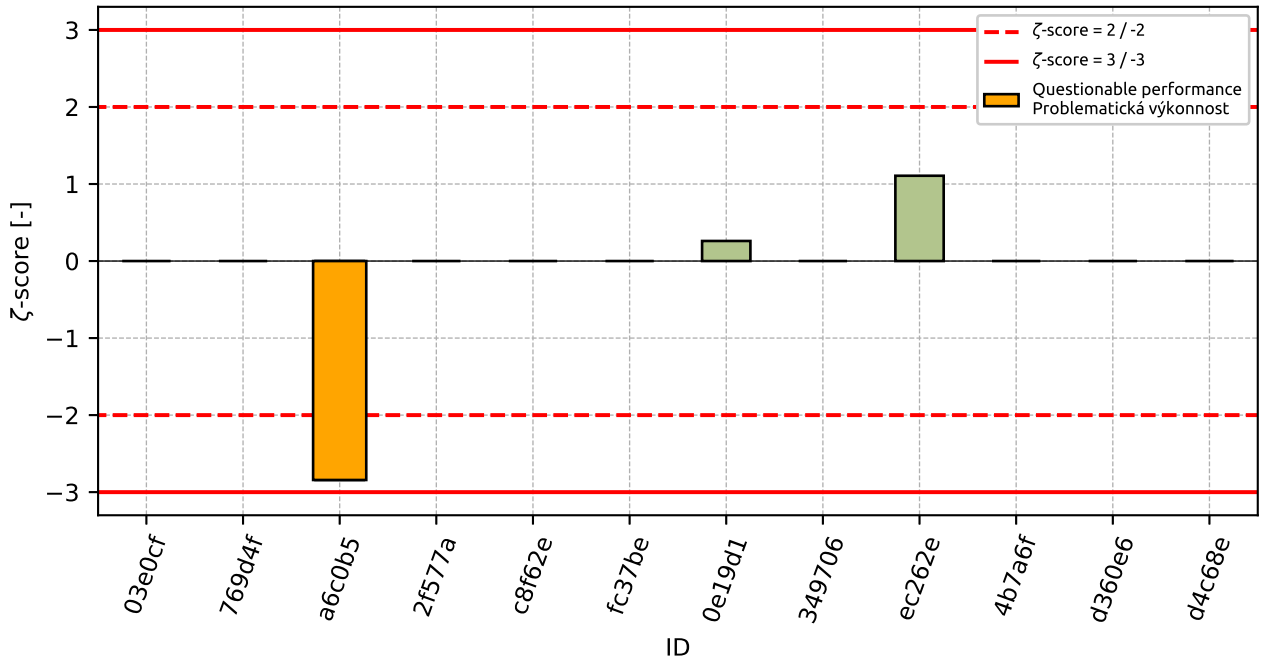

Figure 26: ζ-score

Table 16: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
03e0cf	-1.25	-
769d4f	-1.24	-
a6c0b5	-1.03	-2.84
2f577a	-0.67	-
c8f62e	-0.3	-
fc37be	0.04	-
0e19d1	0.12	0.26
349706	0.32	-
ec262e	0.45	1.11
4b7a6f	0.95	-
d360e6	1.14	-
d4c68e	1.46	-

4.2 200 kPa

4.2.1 Test results

Table 17: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [MPa]	u_X [MPa]
a6c0b5	5.88	0.2
769d4f	6.55	-
c8f62e	8.02	-
03e0cf	8.23	-
2f577a	9.09	-
fc37be	11.24	-
4b7a6f	13.7	-
0e19d1	14.69	0.33
d4c68e	15.03	-
ec262e	15.6	1.4
349706	17.93	-
d360e6	18.77	-

4.2.2 The Numerical Procedure for Determining Outliers

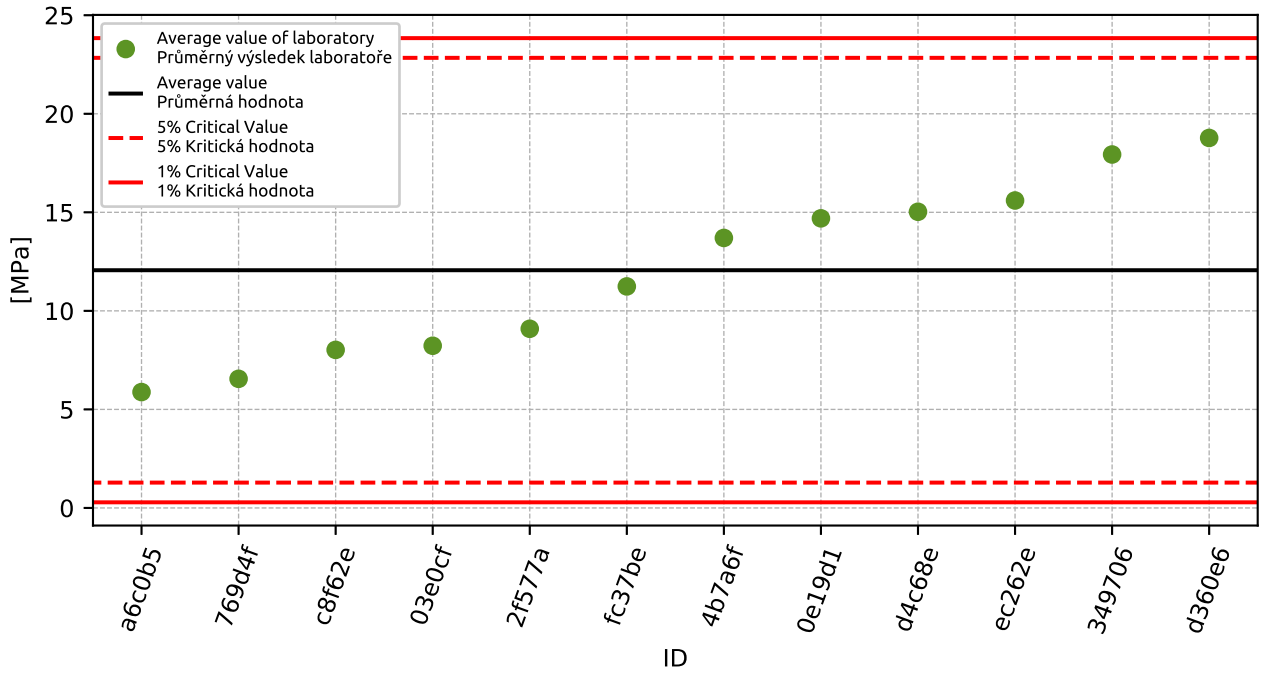

Figure 27: **Grubbs' test** - average values

4.2.3 Mandel's Statistics

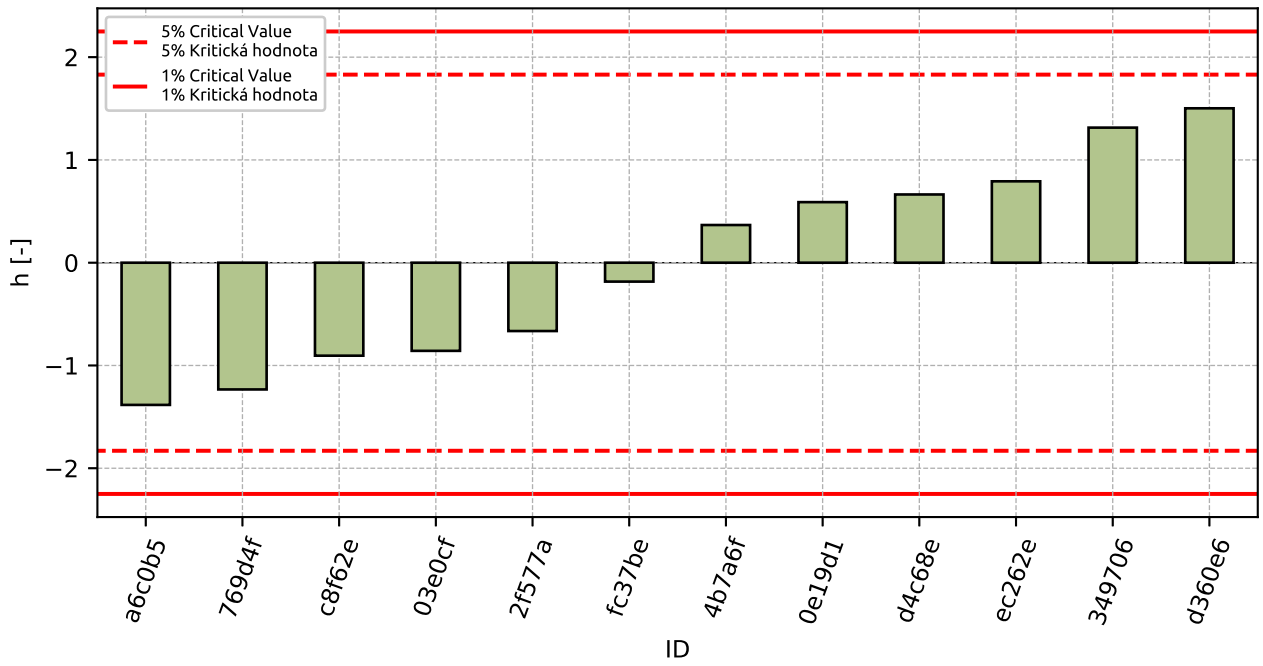

Figure 28: Interlaboratory Consistency Statistic *h*

4.2.4 Descriptive statistics

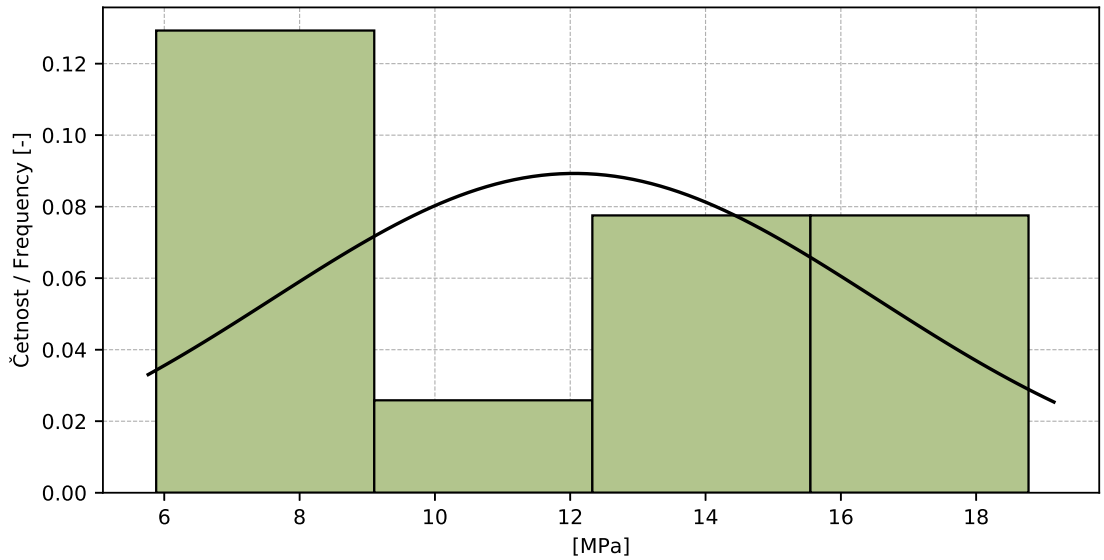

Figure 29: Histogram

Table 18: Descriptive statistics

Value	[MPa]
Průměrná hodnota / Average value – $\bar{x}$	12.06
Výběrová směrodatná odchylka / Sample standard deviation – s	4.468
Vztažná hodnota / Asigned value – x^*	12.06
Robustní směrodatná odchylka / Robust standard deviation – s^*	4.851
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	1.75
p-hodnota testu normality / p-value of normality test	0.276 [-]

4.2.5 Calculation of Performance Statistics

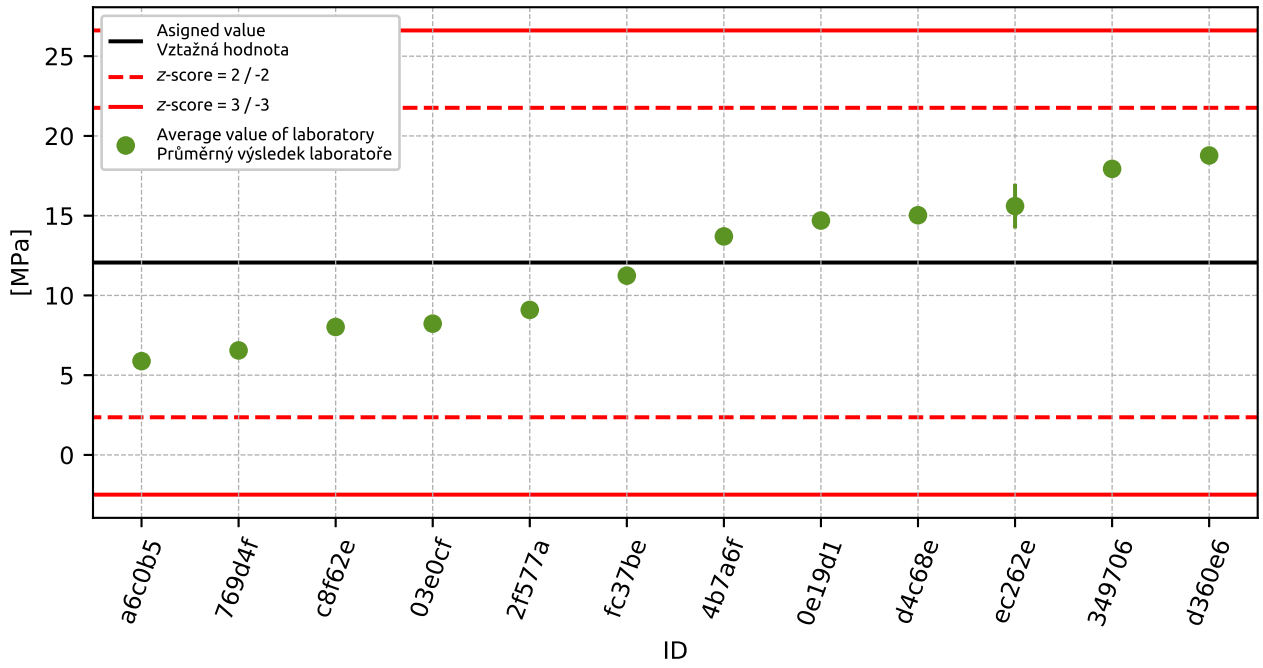

Figure 30: Average values and extended uncertainties of measurement

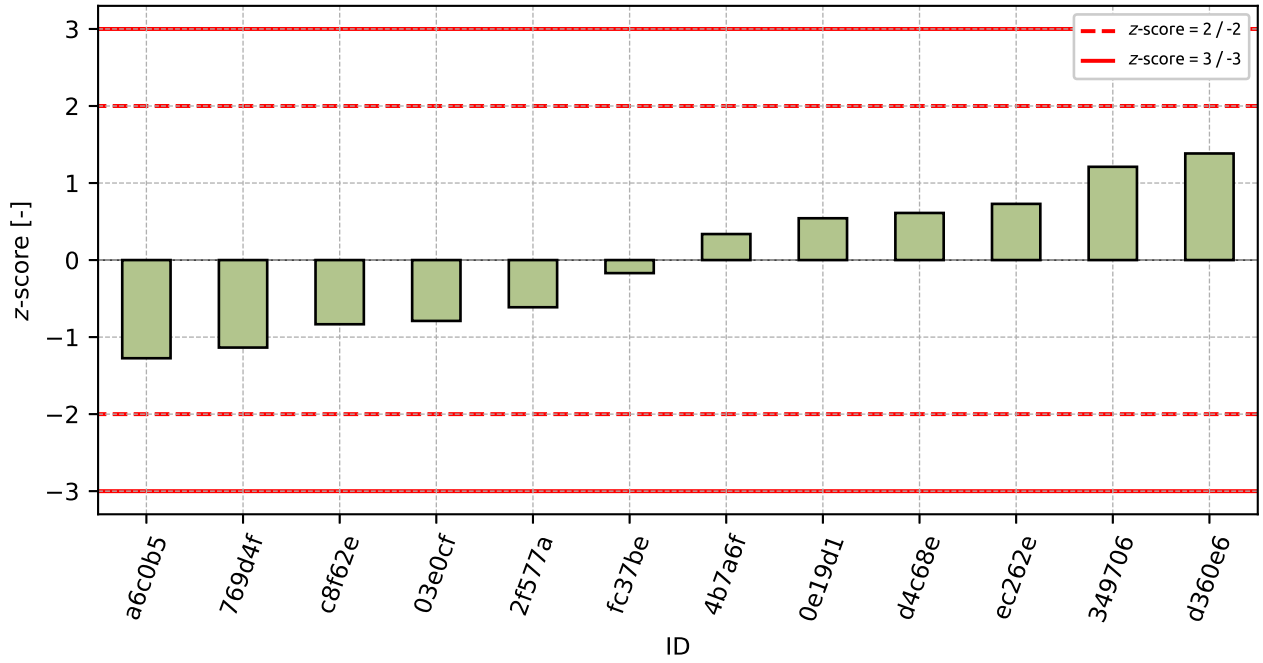

Figure 31: z-score

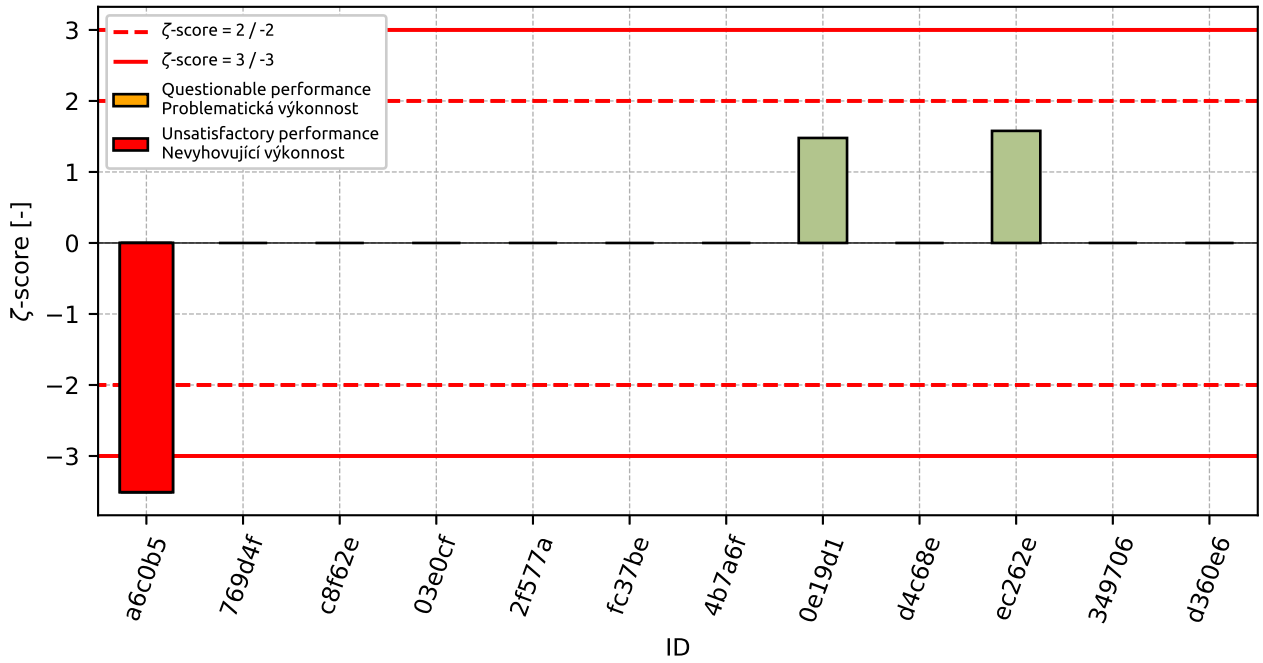

Figure 32: ζ-score

Table 19: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a6c0b5	-1.27	-3.51
769d4f	-1.14	-
c8f62e	-0.83	-
03e0cf	-0.79	-
2f577a	-0.61	-
fc37be	-0.17	-
4b7a6f	0.34	-
0e19d1	0.54	1.48
d4c68e	0.61	-
ec262e	0.73	1.58
349706	1.21	-
d360e6	1.38	-

4.3 400 kPa

4.3.1 Test results

Table 20: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [MPa]	u_X [MPa]
c8f62e	4.28	-
769d4f	8.64	-
a6c0b5	9.77	0.2
2f577a	10.34	-
0e19d1	10.86	0.85
03e0cf	12.23	-
4b7a6f	12.8	-
fc37be	13.06	-
d4c68e	17.89	-
349706	19.72	-
d360e6	21.6	-

4.3.2 The Numerical Procedure for Determining Outliers

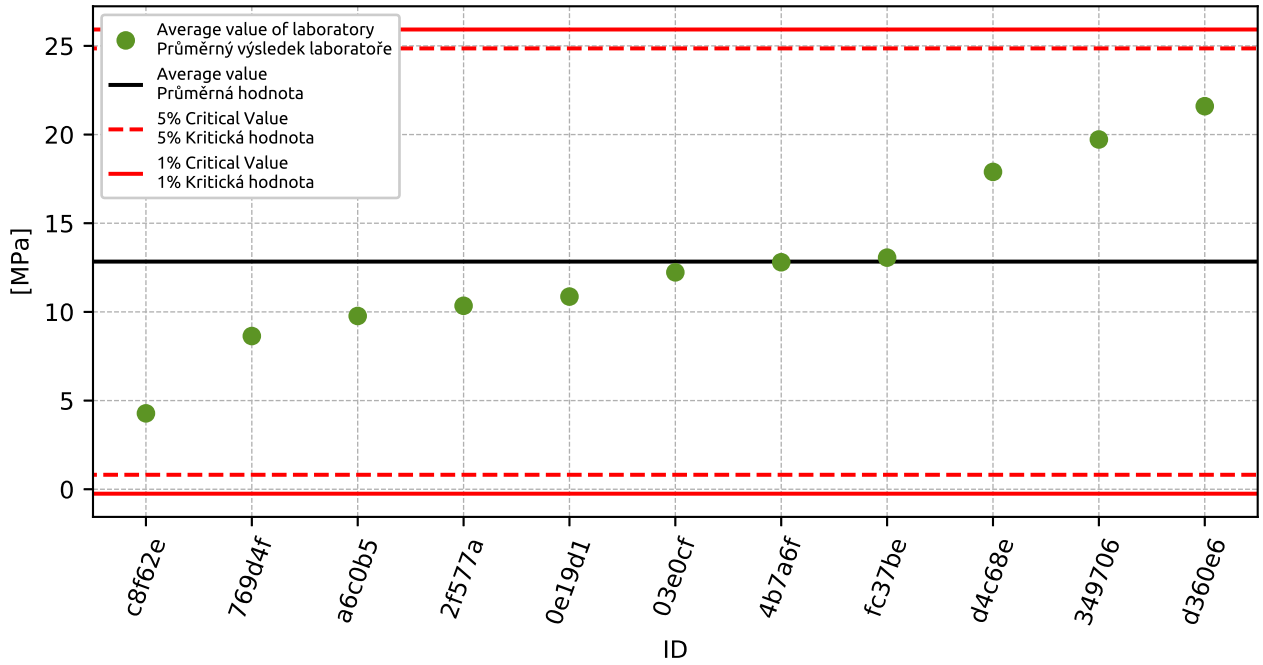

Figure 33: **Grubbs' test** - average values

4.3.3 Mandel's Statistics

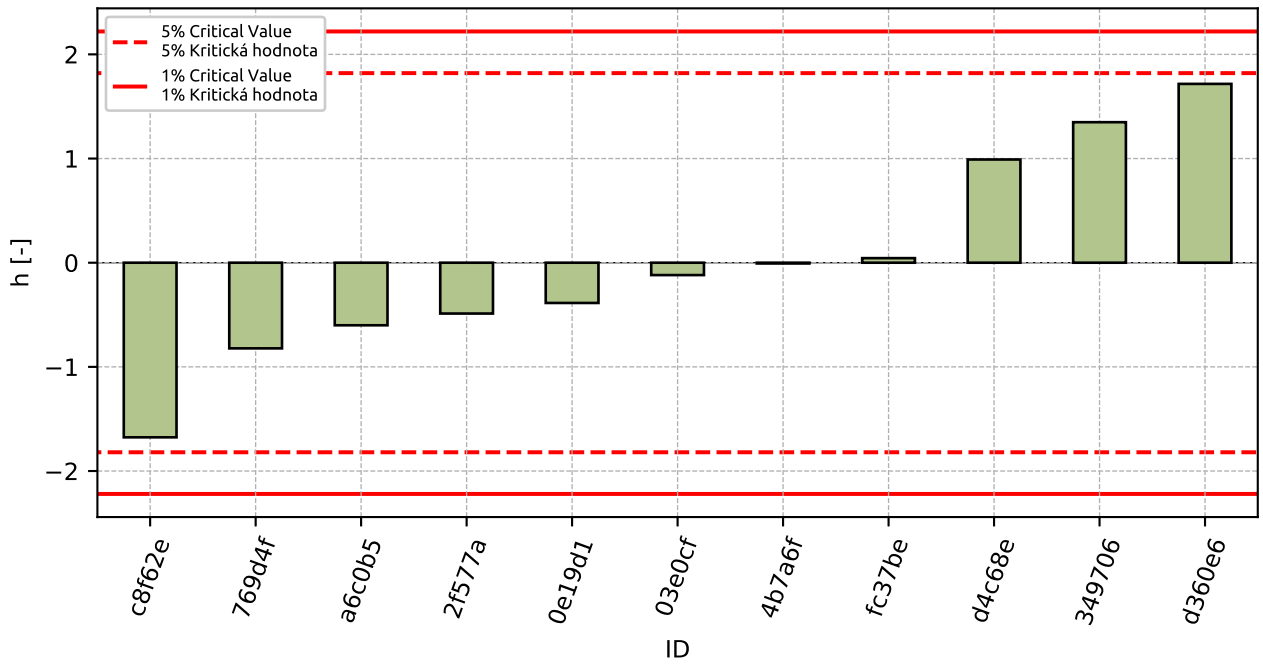

Figure 34: Interlaboratory Consistency Statistic *h*

4.3.4 Descriptive statistics

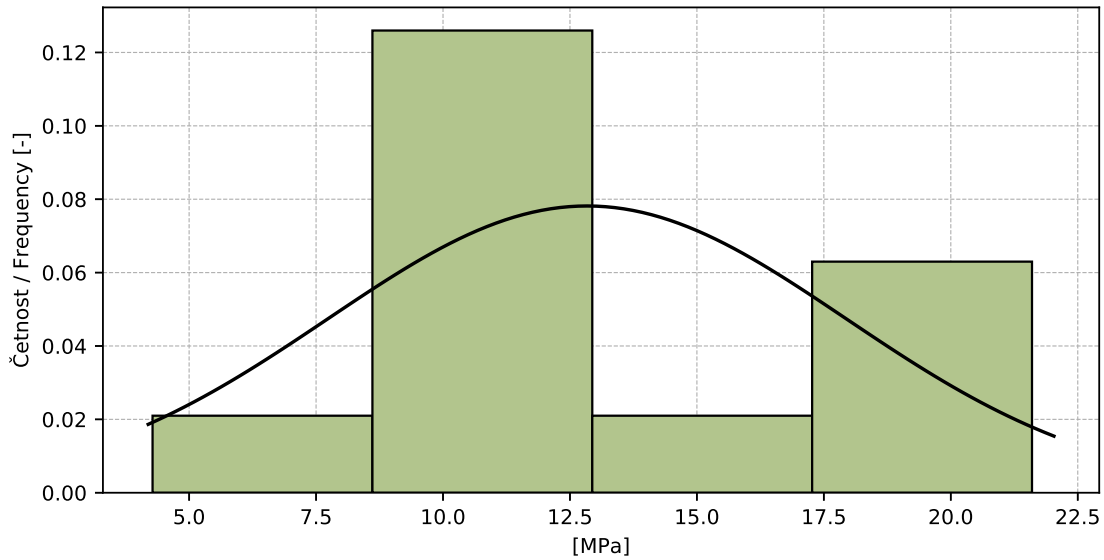

Figure 35: Histogram

Table 21: Descriptive statistics

Value	[MPa]
Průměrná hodnota / Average value – $\bar{x}$	12.84
Výběrová směrodatná odchylka / Sample standard deviation – s	5.104
Vztažná hodnota / Asigned value – x^*	12.86
Robustní směrodatná odchylka / Robust standard deviation – s^*	4.819
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	1.816
p-hodnota testu normality / p-value of normality test	0.863 [-]

4.3.5 Calculation of Performance Statistics

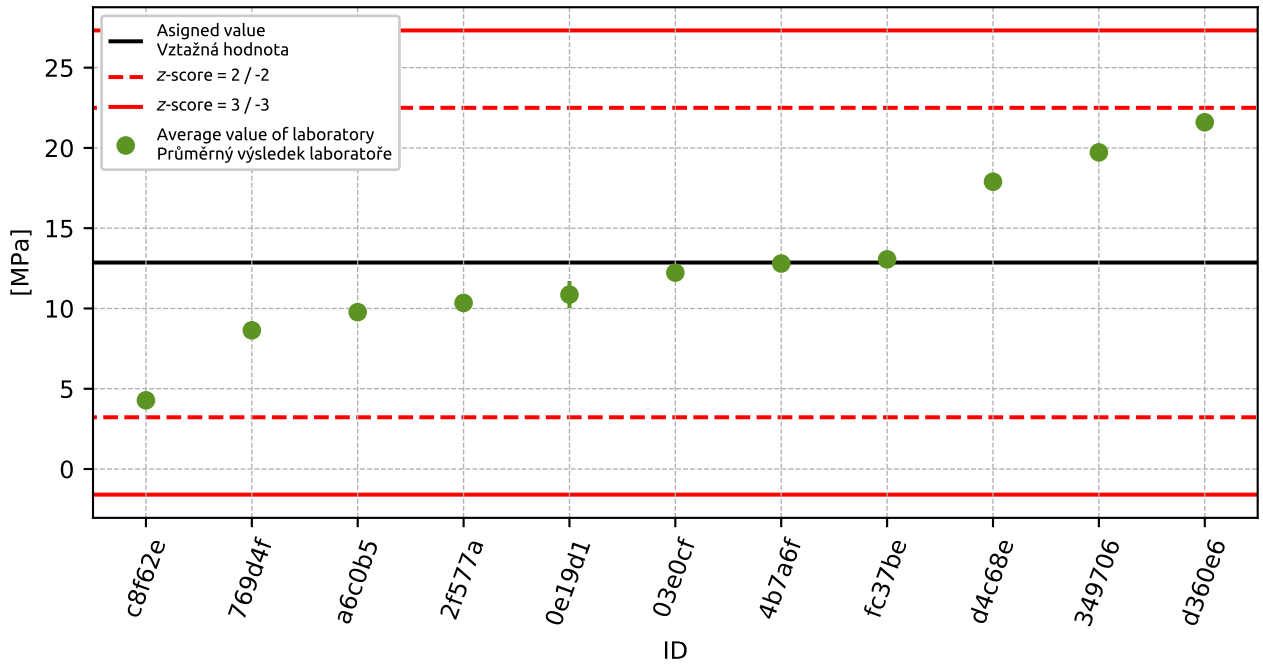

Figure 36: Average values and extended uncertainties of measurement

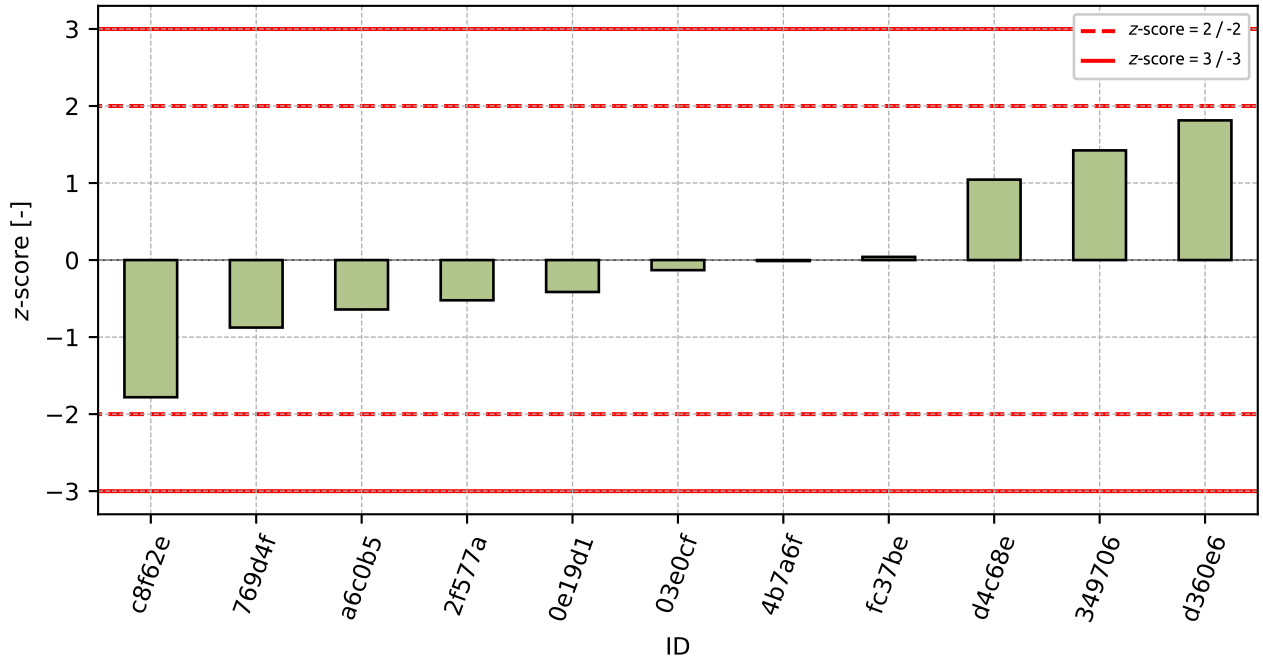

Figure 37: z-score

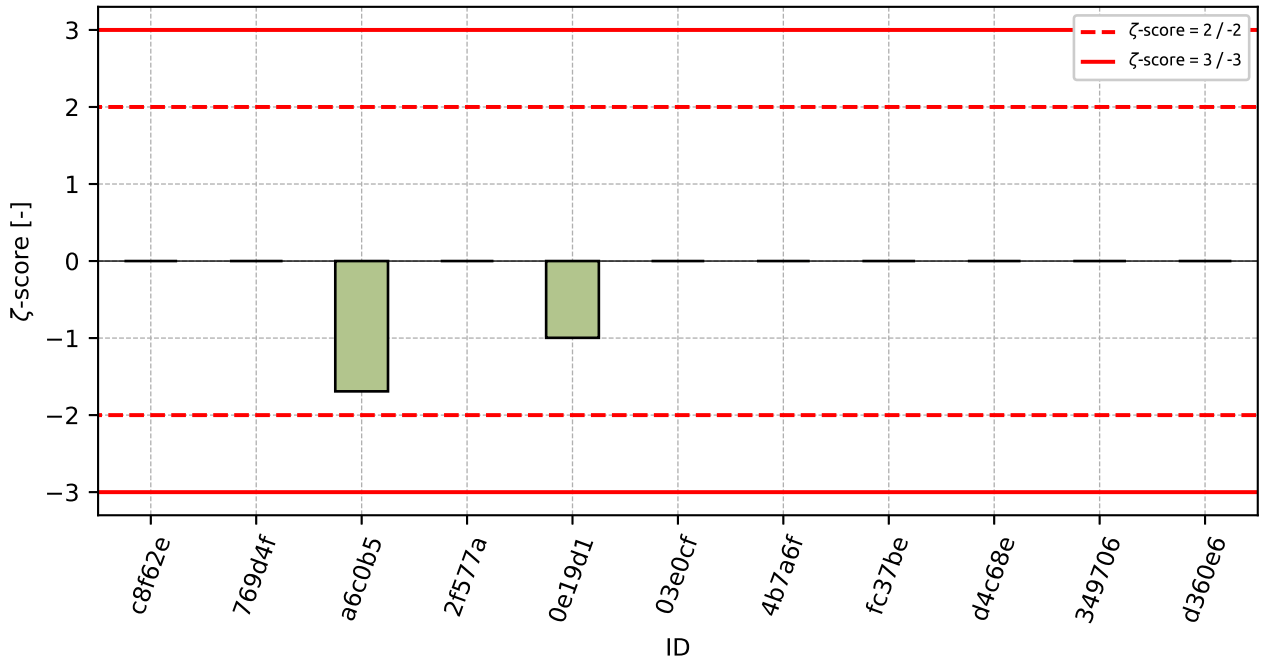

Figure 38: ζ-score

Table 22: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
c8f62e	-1.78	-
769d4f	-0.88	-
a6c0b5	-0.64	-1.69
2f577a	-0.52	-
0e19d1	-0.41	-1.0
03e0cf	-0.13	-
4b7a6f	-0.01	-
fc37be	0.04	-
d4c68e	1.04	-
349706	1.42	-
d360e6	1.81	-

5 Appendix – EN ISO 17892-7 – Unconfined compressive strength, Strain at failure

5.1 Unconfined compressive strength

5.1.1 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 [MPa]				u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
10f479	0.221	0.22	0.218	-	0.002	0.219	0.0015	0.68
d4c68e	0.259	0.264	0.255	-	-	0.259	0.0045	1.74
fc37be	0.305	0.311	0.315	0.31	0.001	0.31	0.0041	1.33
d360e6	0.355	0.33	-	-	-	0.342	0.0177	5.16
7d1c14	0.349	0.37	0.327	-	0.005	0.349	0.0215	6.17
ad498c	0.354	0.365	-	-	-	0.36	0.0078	2.16
0e19d1	0.391	0.383	0.354	0.374	0.018	0.376	0.016	4.27
ec262e	0.401	0.343	0.34	0.474	-	0.39	0.0629	16.16
349706	0.35	0.41	0.42	-	0.016	0.393	0.0379	9.63

5.1.2 The Numerical Procedure for Determining Outliers

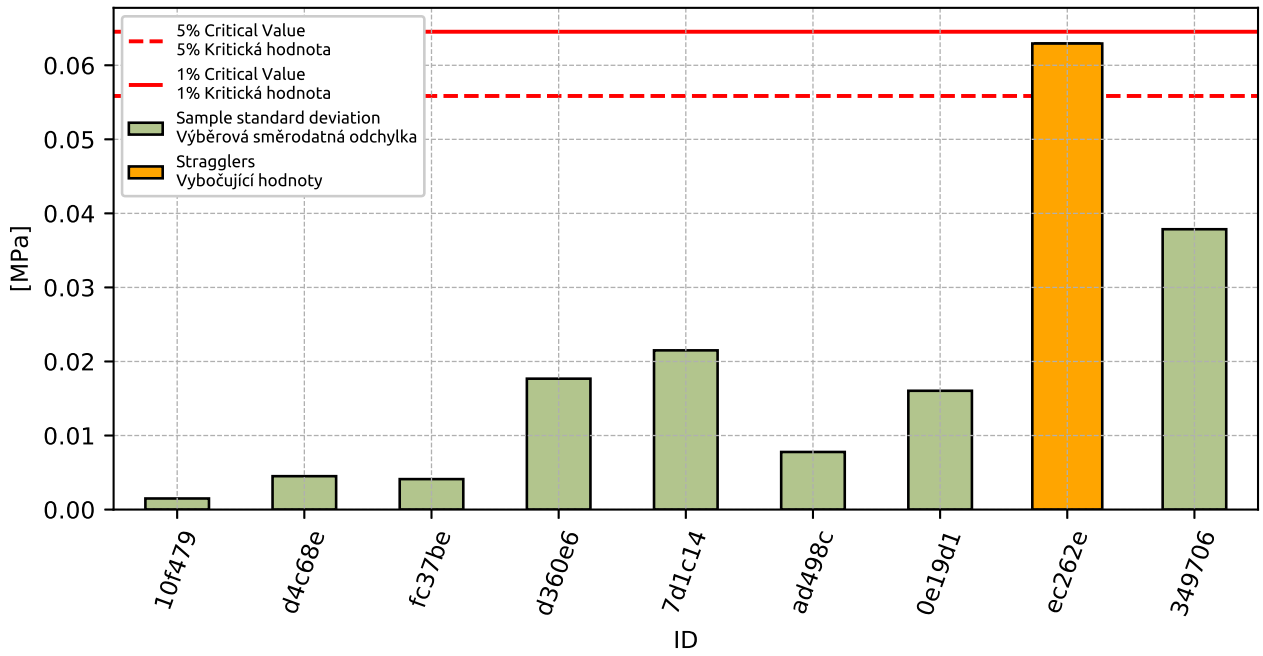

Figure 39: **Cochran's test** - sample standard deviations

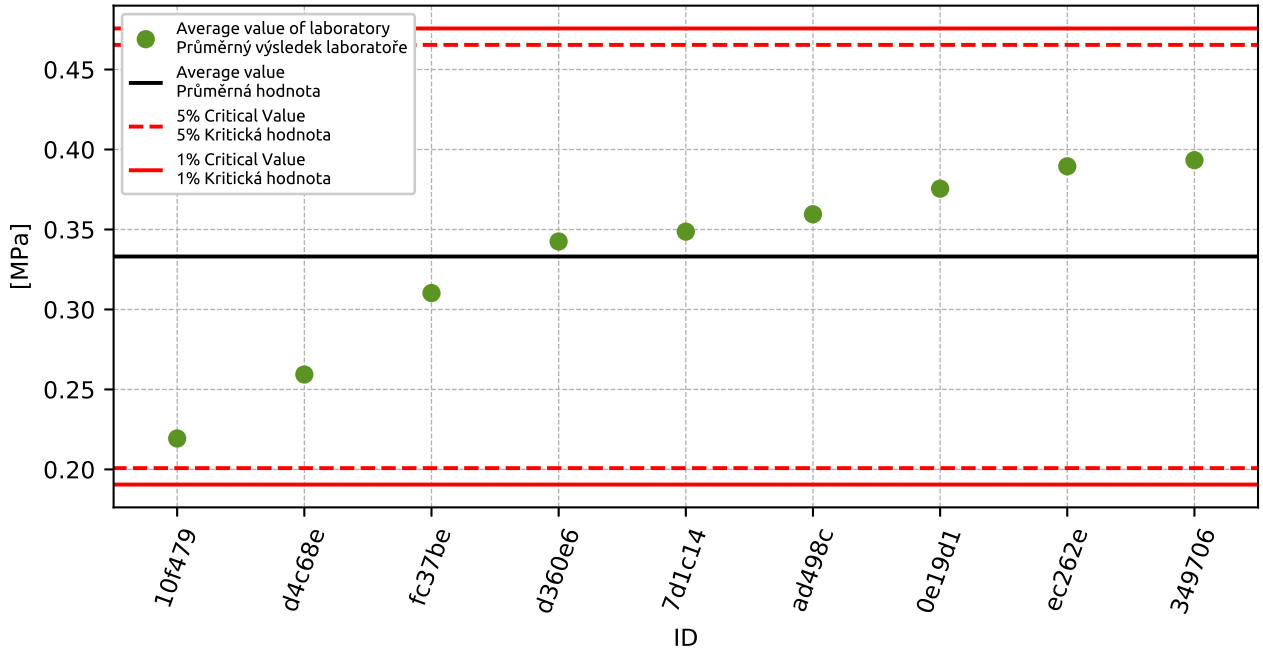

Figure 40: **Grubbs' test** - average values

5.1.3 Mandel's Statistics

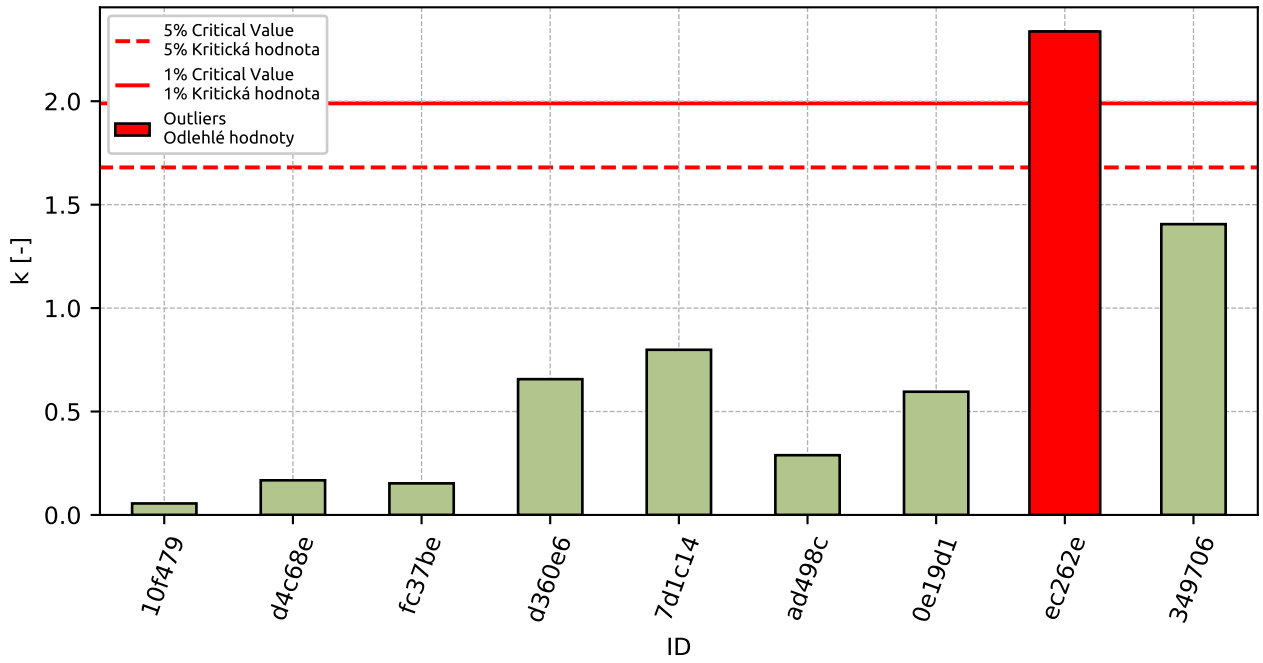

Figure 41: Intralaboratory Consistency Statistic

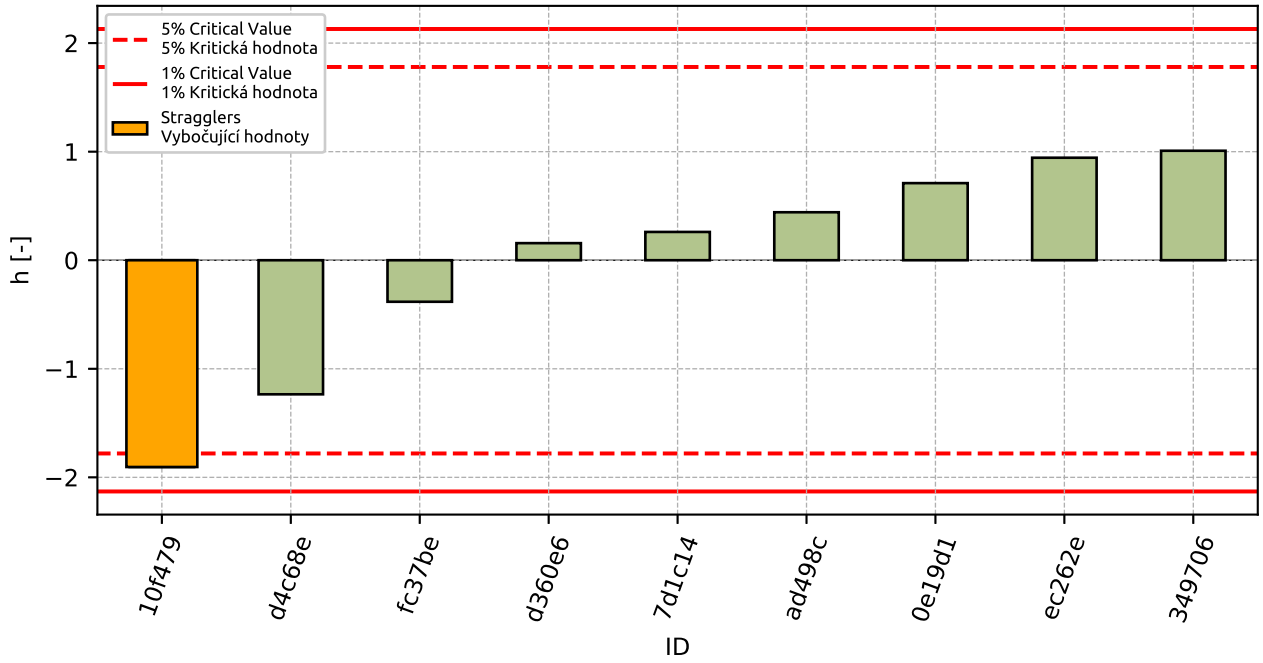

Figure 42: Interlaboratory Consistency Statistic

5.1.4 Descriptive statistics

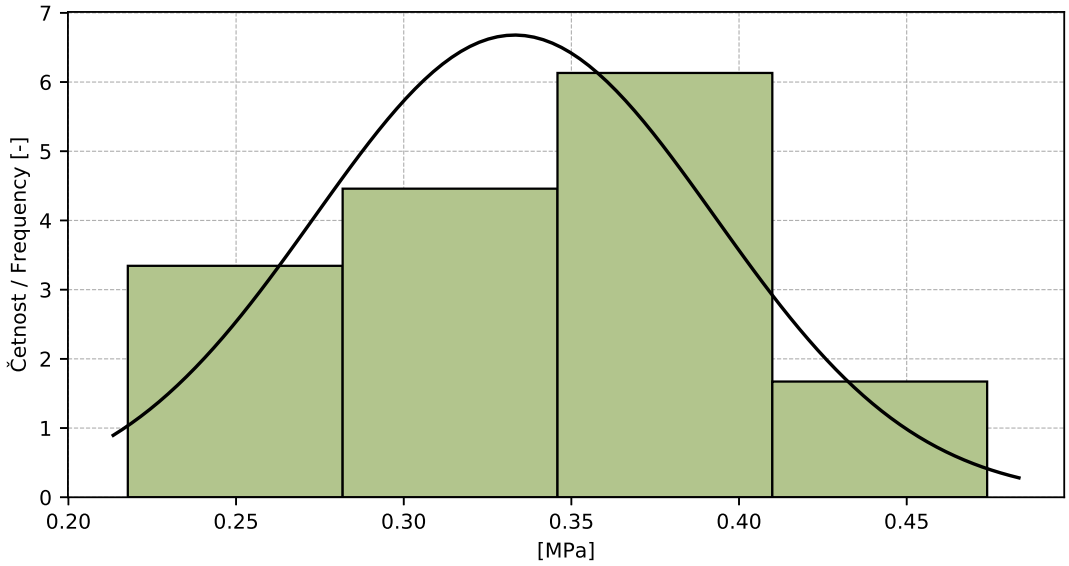

Figure 43: Histogram of all test results

Table 24: Descriptive statistics

Characteristics	[MPa]
Průměrná hodnota / Average value – $\bar{x}$	0.333
Výběrová směrodatná odchylka / Sample standard deviation – s	0.0597
Vztažná hodnota / Asigned value – x^*	0.338
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.053
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.0221
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.0582
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.0269
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.0641
Opakovatelnost / Repeatability – r	0.075
Reprodukovatelnost / Reproducibility – R	0.18

5.1.5 Evaluation of Performance Statistics

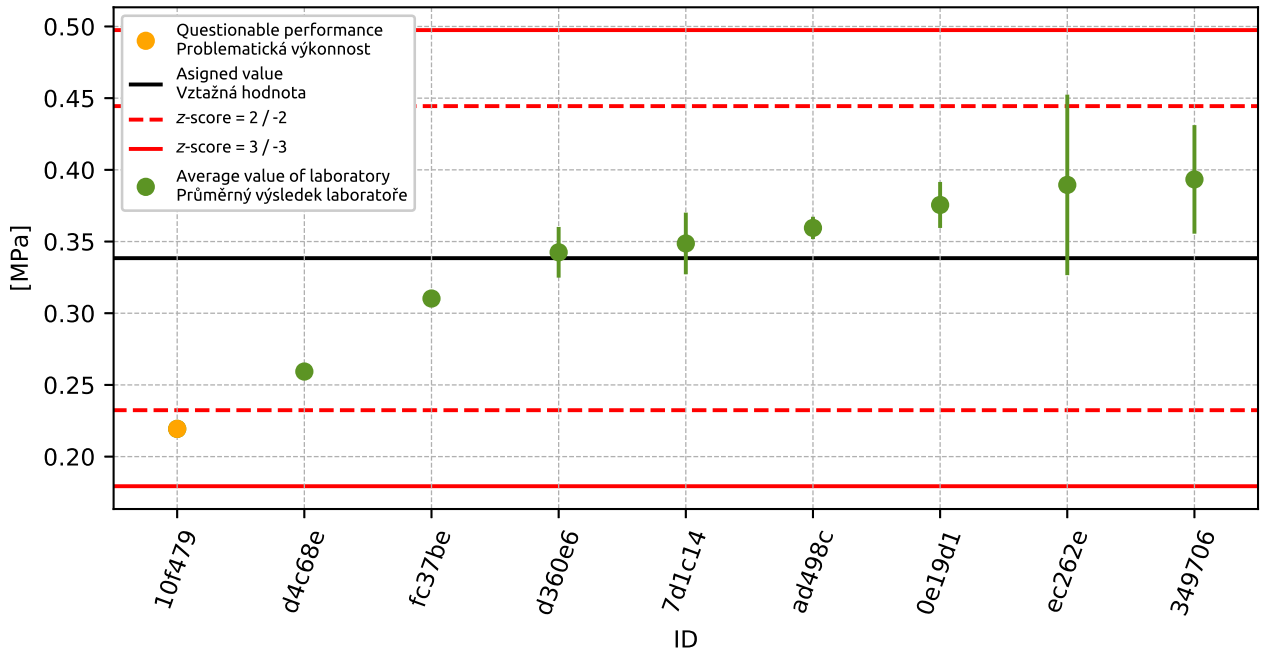

Figure 44: Average values and sample standard deviations

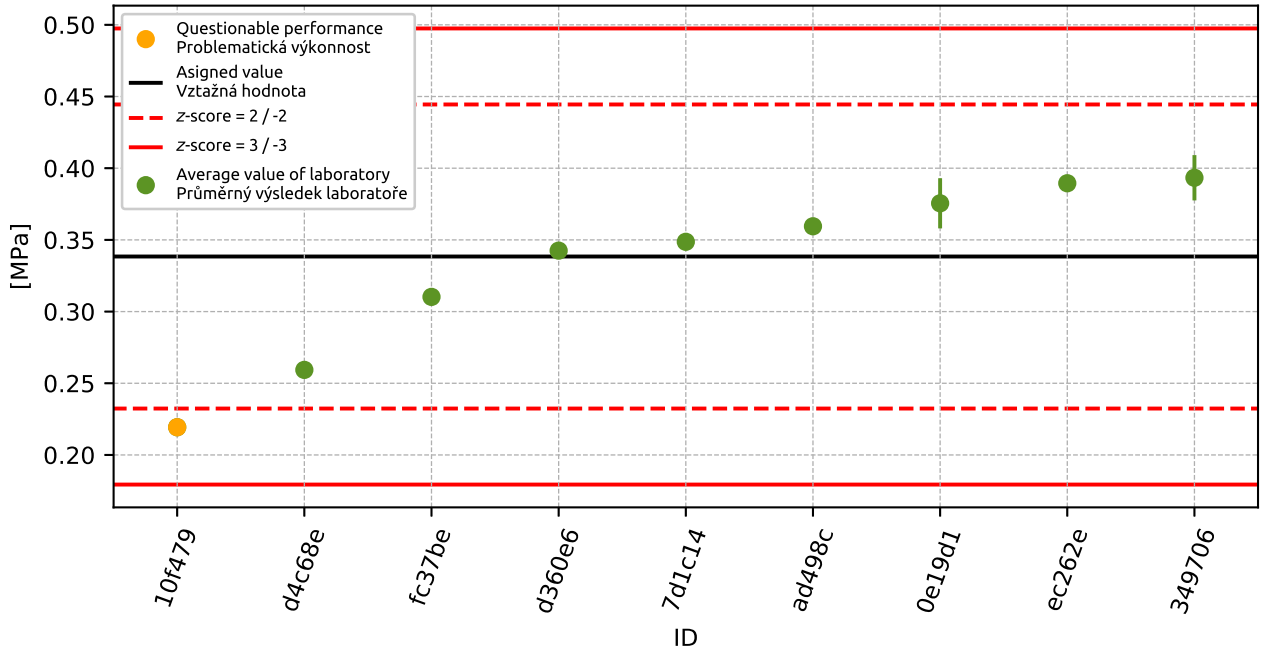

Figure 45: Average values and extended uncertainties of measurement

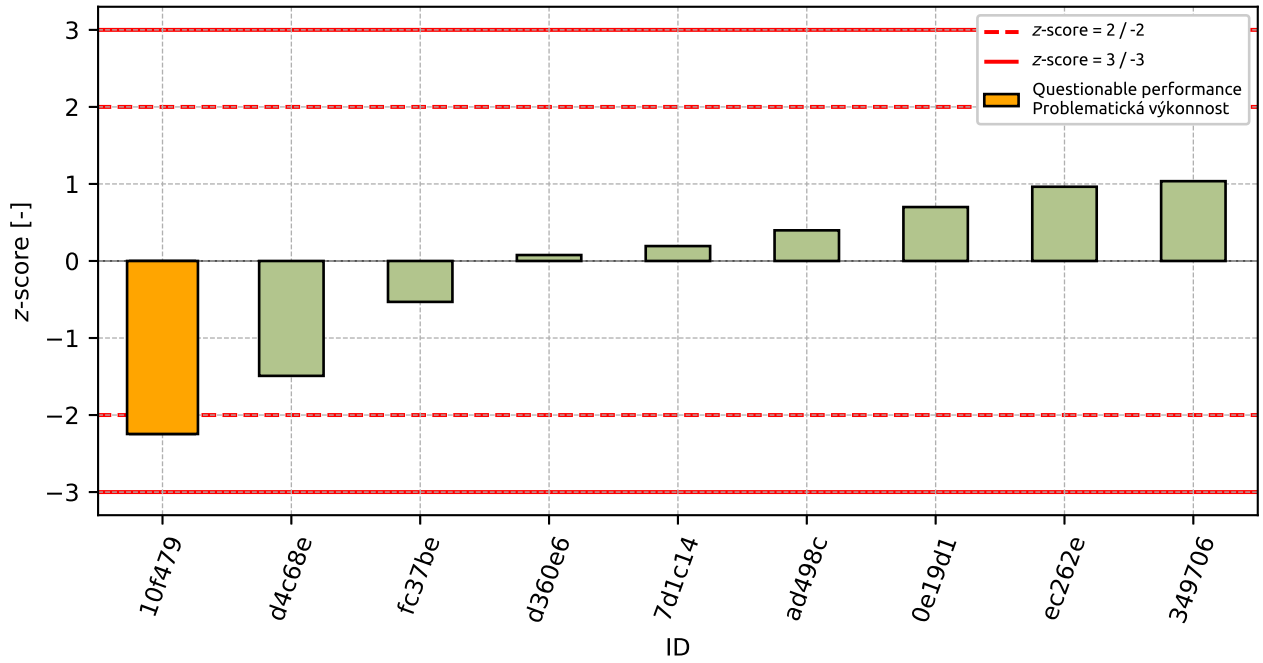

Figure 46: z-score

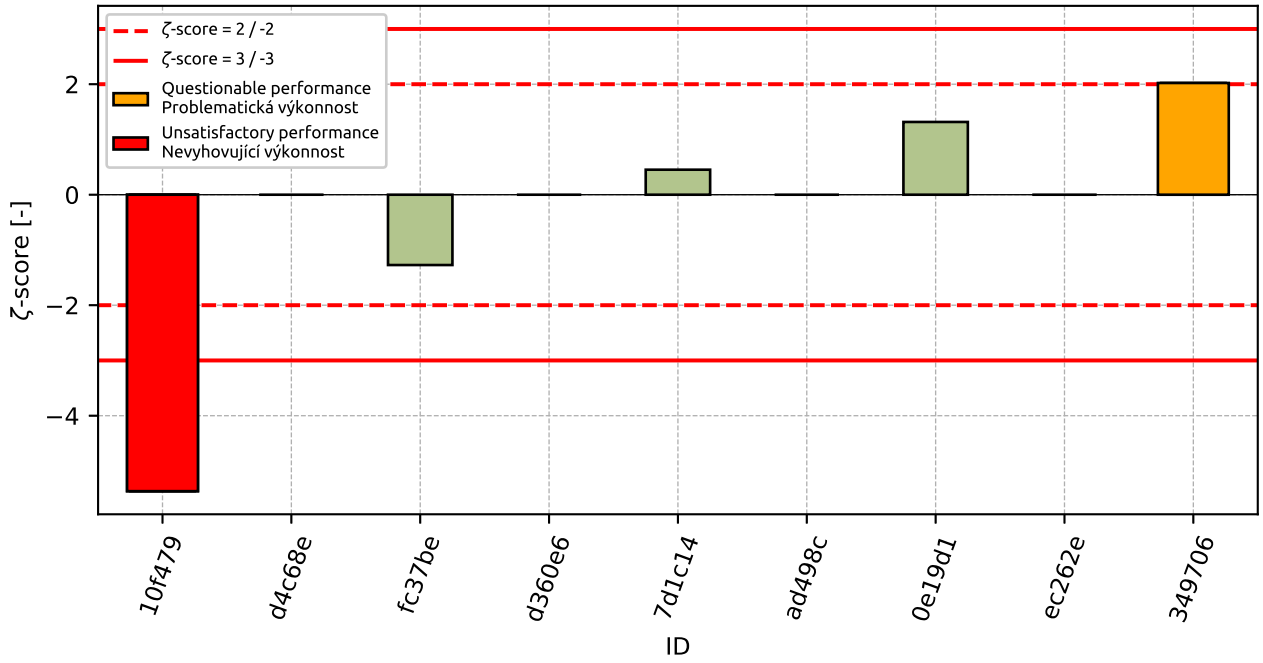

Figure 47: ζ-score

Table 25: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
10f479	-2.25	-5.37
d4c68e	-1.49	-
fc37be	-0.53	-1.27
d360e6	0.08	-
7d1c14	0.19	0.45
ad498c	0.4	-
0e19d1	0.7	1.32
ec262e	0.96	-
349706	1.04	2.02

5.2 Strain at failure

5.2.1 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 [%]
d360e6	1.6	1.4	-	-	-	1.5	0.1414	9.43
ad498c	2.3	2.2	-	-	-	2.25	0.0707	3.14
d4c68e	2.25	1.73	2.93	-	-	2.303	0.6018	26.13
10f479	2.4	2.7	2.0	-	-	2.367	0.3512	14.84
ec262e	2.4	1.6	2.2	3.3	-	2.375	0.7042	29.65
0e19d1	2.69	2.72	2.05	2.29	0.326	2.438	0.3243	13.3
fc37be	2.61	2.72	2.75	2.69	-	2.692	0.0602	2.24
7d1c14	2.53	2.91	2.94	-	0.5	2.793	0.2285	8.18
349706	2.91	2.45	3.53	-	-	2.963	0.542	18.29

5.2.2 The Numerical Procedure for Determining Outliers

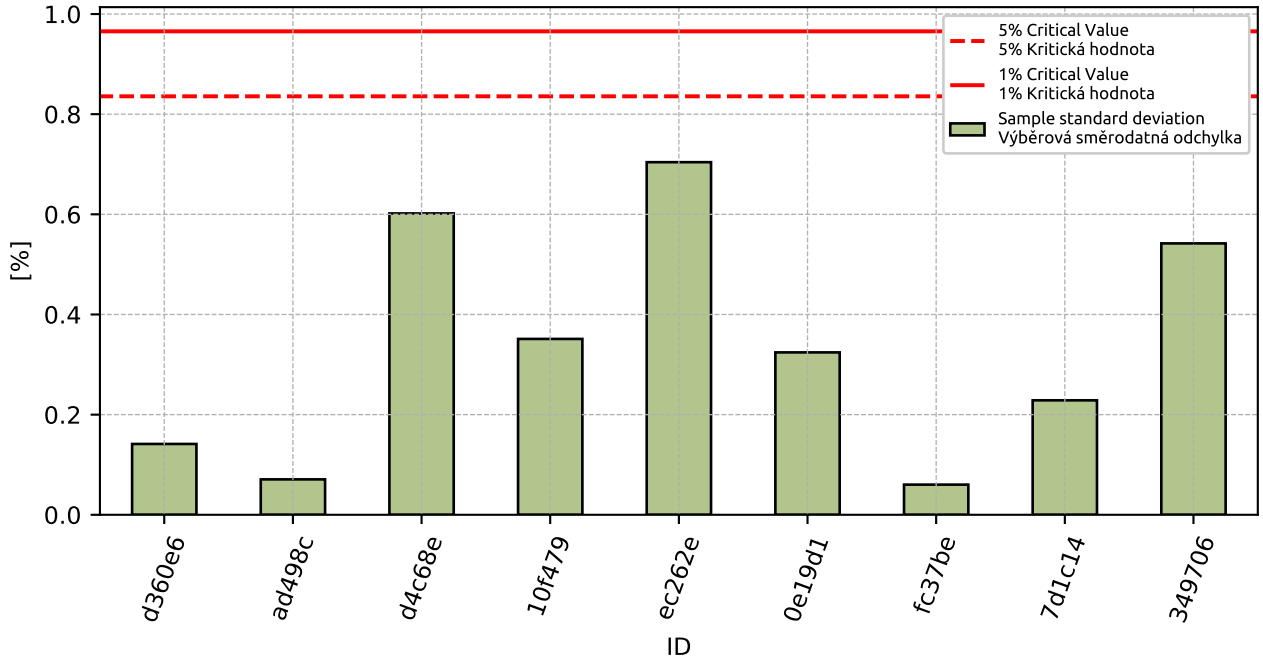

Figure 48: **Cochran's test** - sample standard deviations

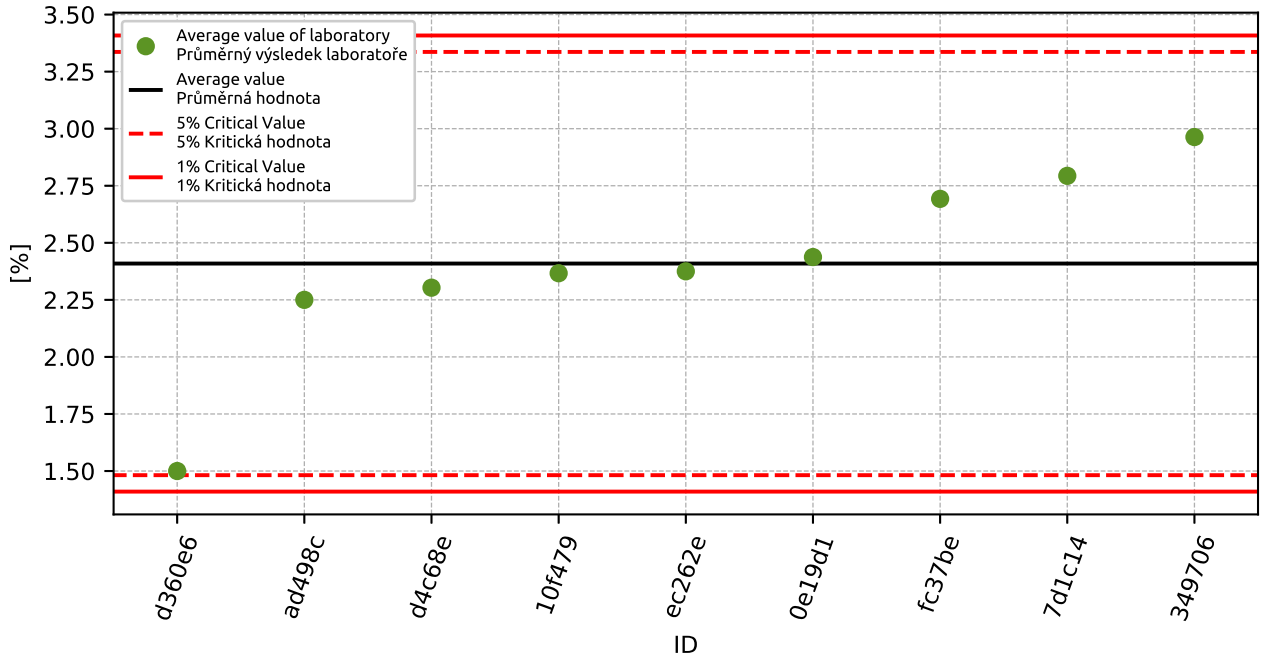

Figure 49: **Grubbs' test** - average values

5.2.3 Mandel's Statistics

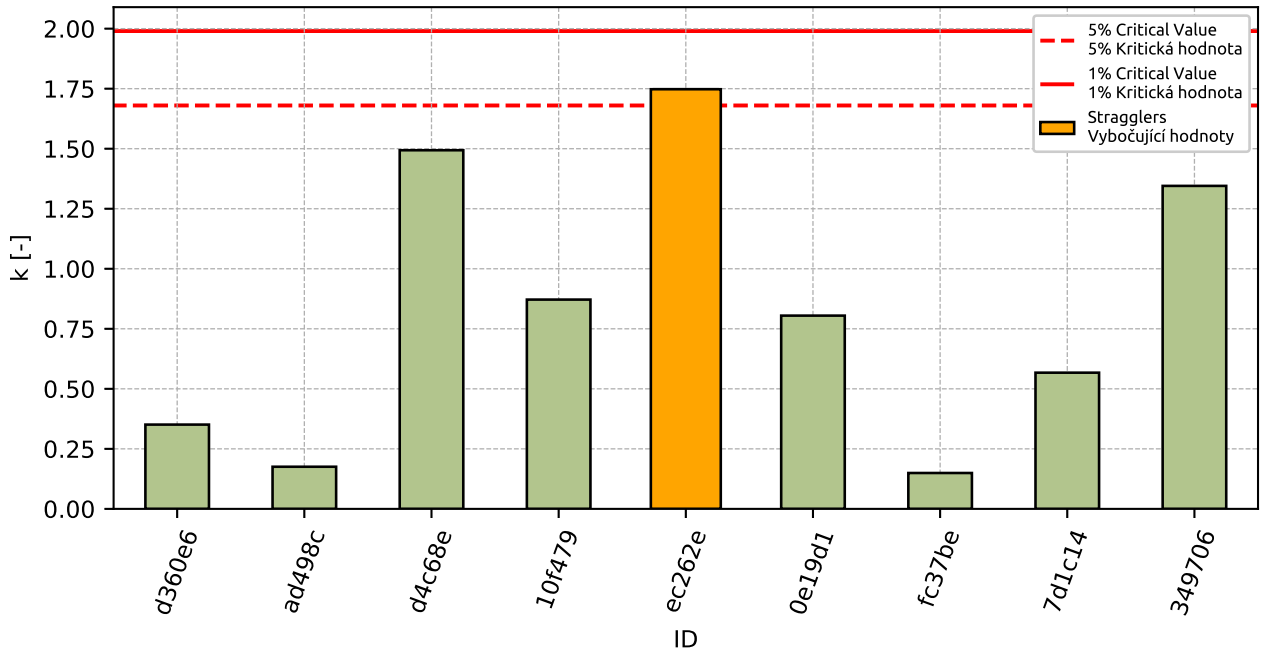

Figure 50: Intralaboratory Consistency Statistic

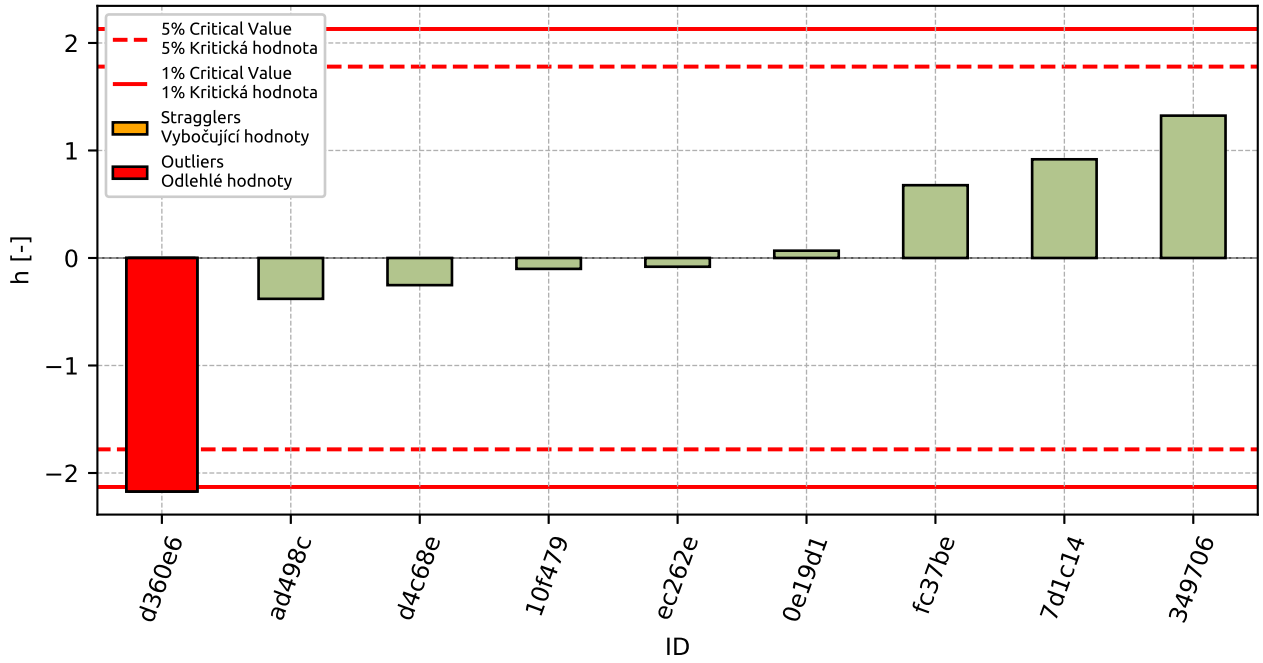

Figure 51: Interlaboratory Consistency Statistic

5.2.4 Descriptive statistics

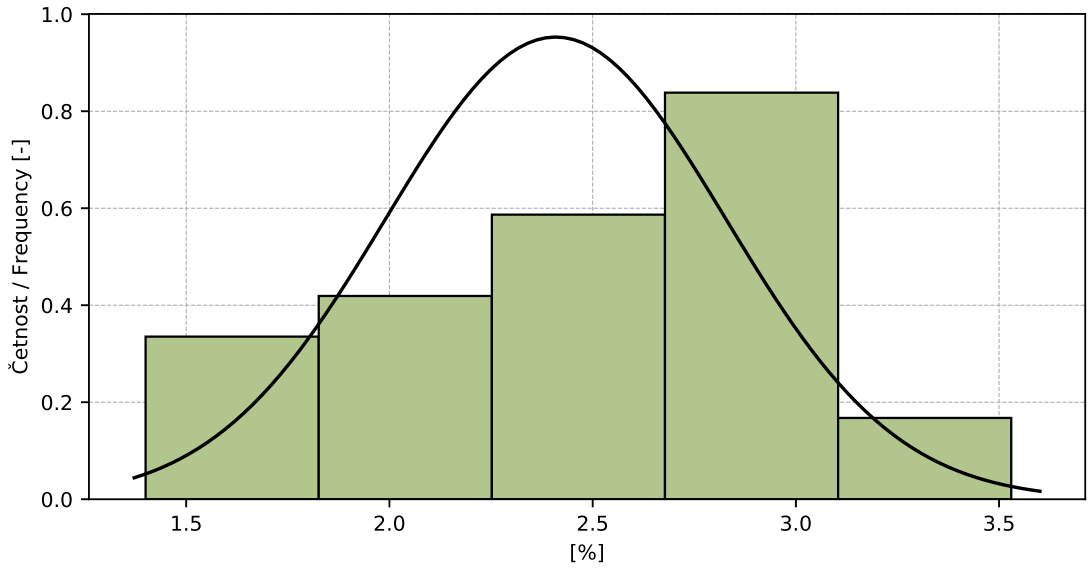

Figure 52: Histogram of all test results

Table 27: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	2.409
Výběrová směrodatná odchylka / Sample standard deviation – s	0.4186
Vztažná hodnota / Asigned value – x^*	2.455
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.279
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.1162
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.3669
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.4029
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.545
Opakovatelnost / Repeatability – r	1.128
Reprodukovatelnost / Reproducibility – R	1.526

5.2.5 Evaluation of Performance Statistics

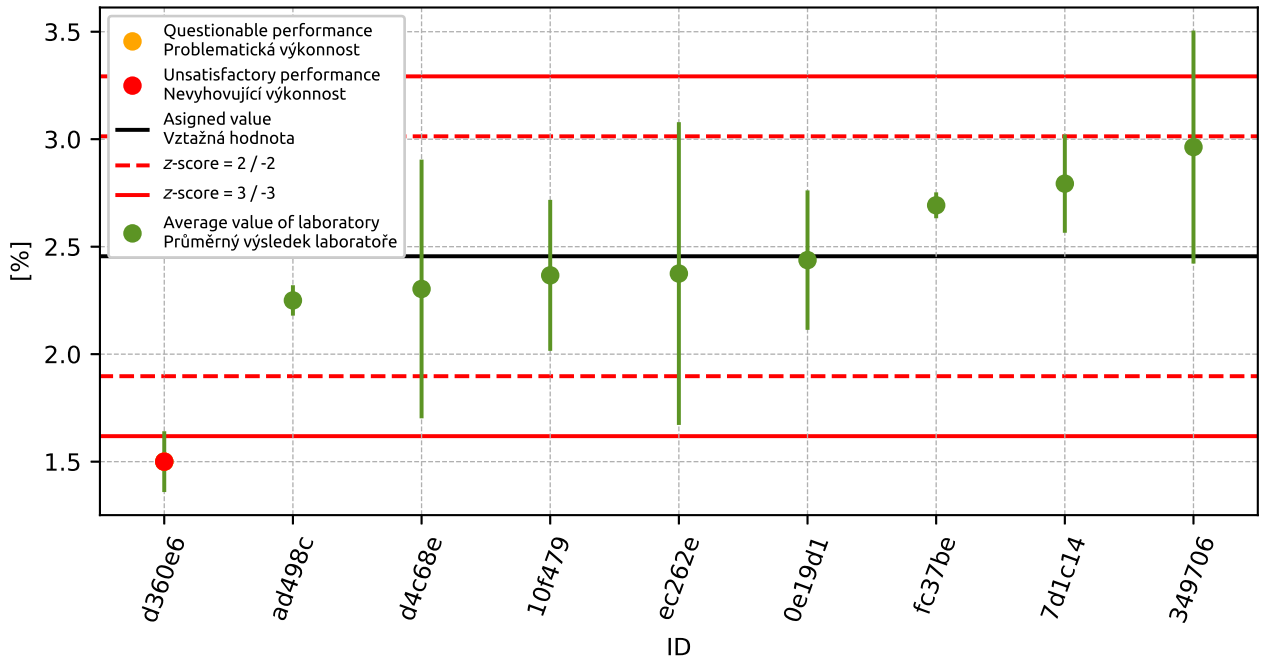

Figure 53: Average values and sample standard deviations

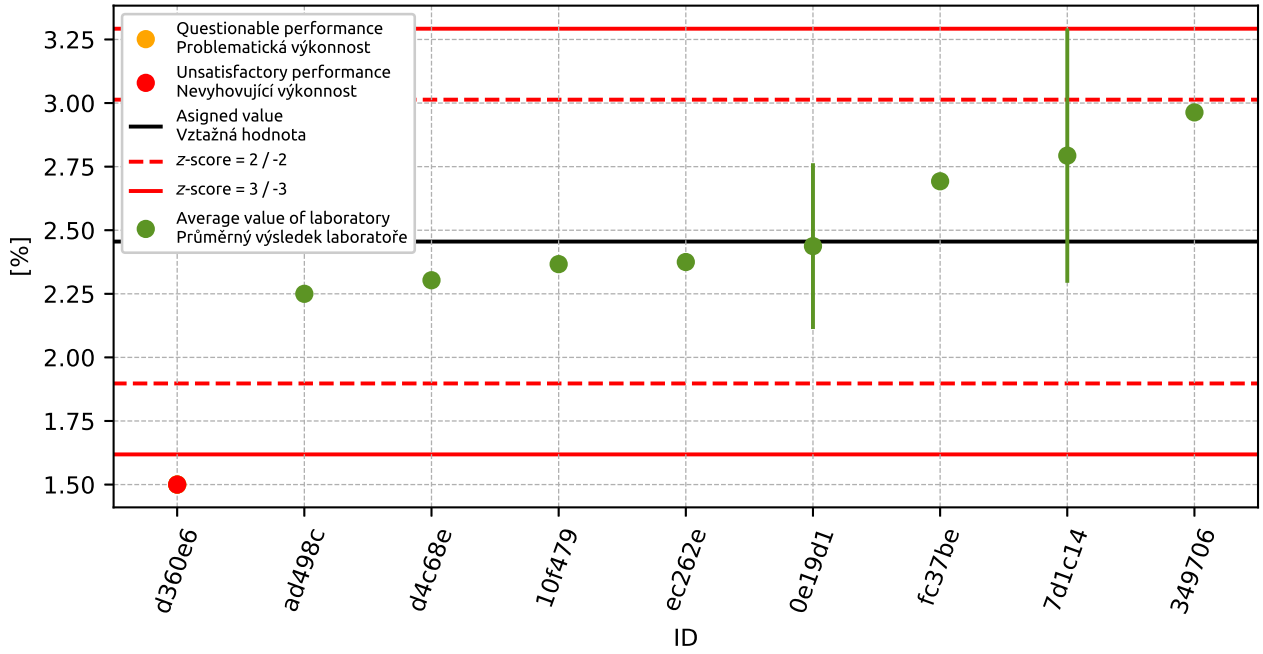

Figure 54: Average values and extended uncertainties of measurement

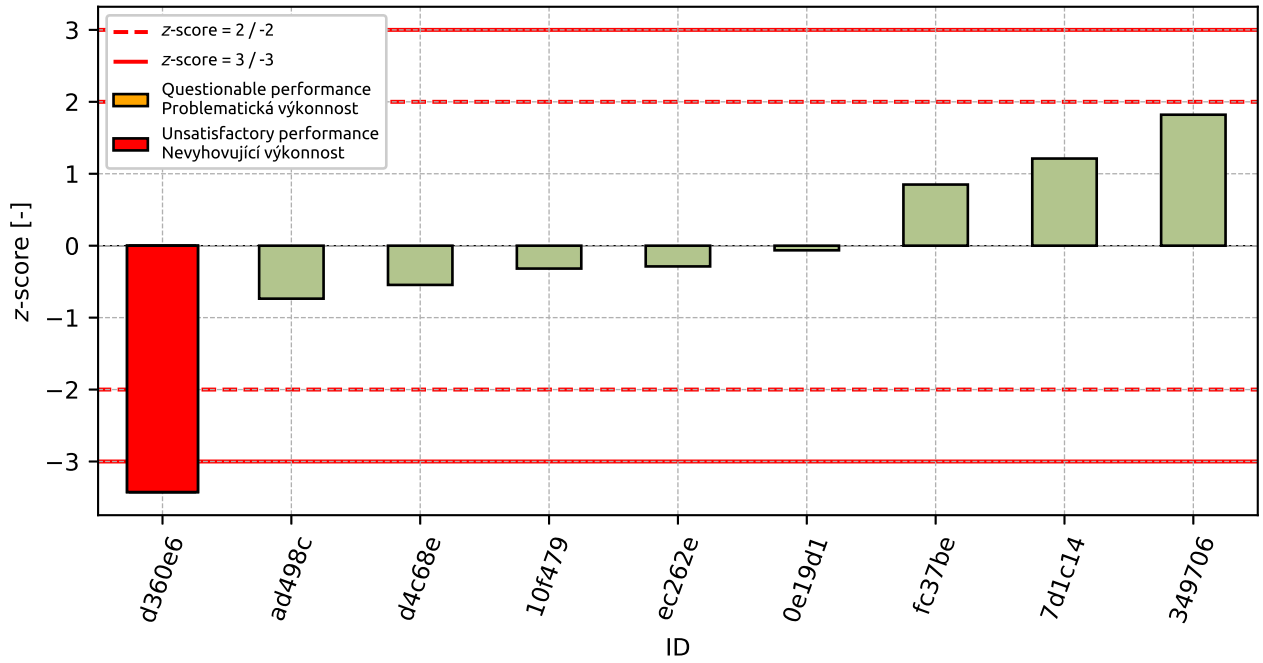

Figure 55: z-score

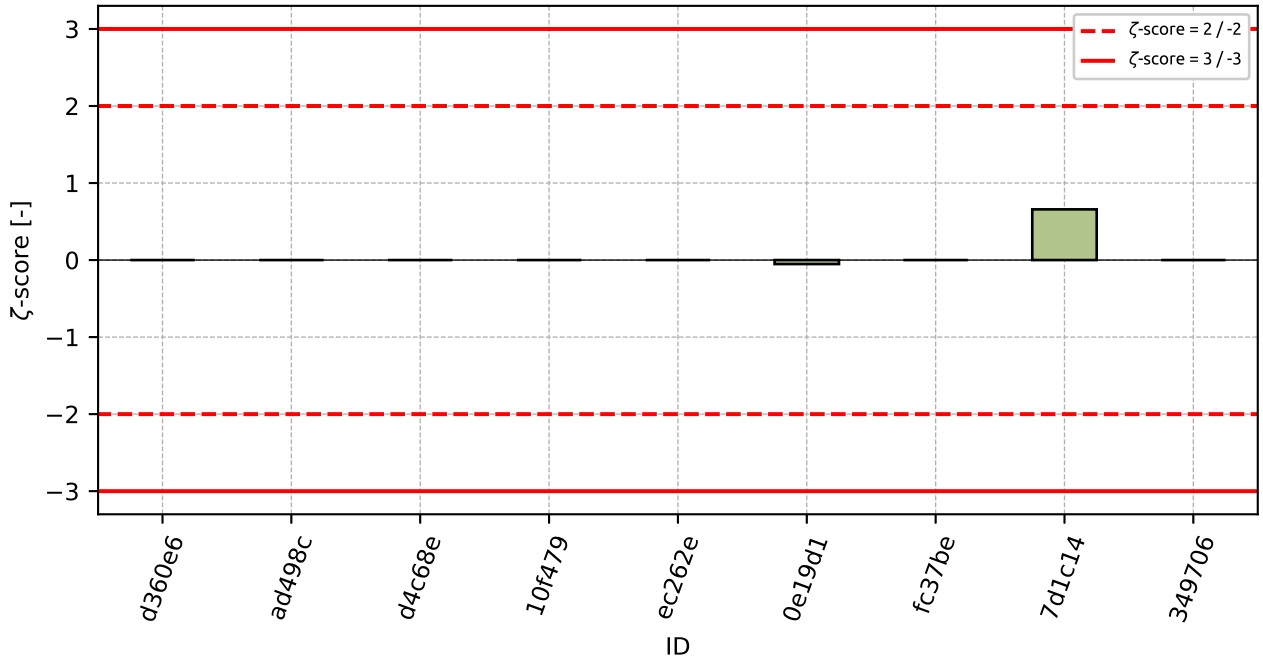

Figure 56: ζ-score

Table 28: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d360e6	-3.43	-
ad498c	-0.74	-
d4c68e	-0.55	-
10f479	-0.32	-
ec262e	-0.29	-
0e19d1	-0.06	-0.05
fc37be	0.85	-
7d1c14	1.21	0.66
349706	1.82	-

6 Appendix – CEN ISO/TS 17892-10 – Effective shear parameters

6.1 Friction angle

6.1.1 Test results

Table 29: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [°]	u_X [°]
2f577a	17	-
d4c68e	23	-
10f479	25	-
03e0cf	26	-
ec262e	26	2
fc37be	28	-
6361a4	28	-
2fc7e3	30	-
a6c0b5	30	-
ad498c	30	-
349706	30	-
d360e6	31	-

6.1.2 The Numerical Procedure for Determining Outliers

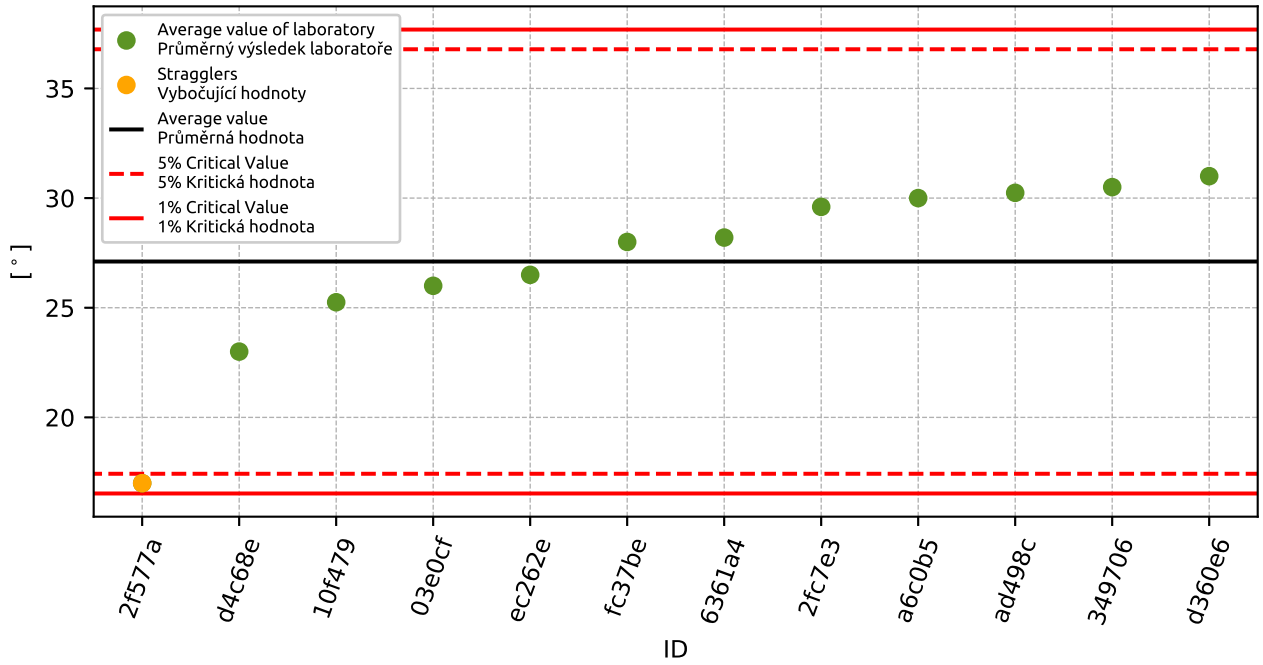

Figure 57: **Grubbs' test** - average values

6.1.3 Mandel's Statistics

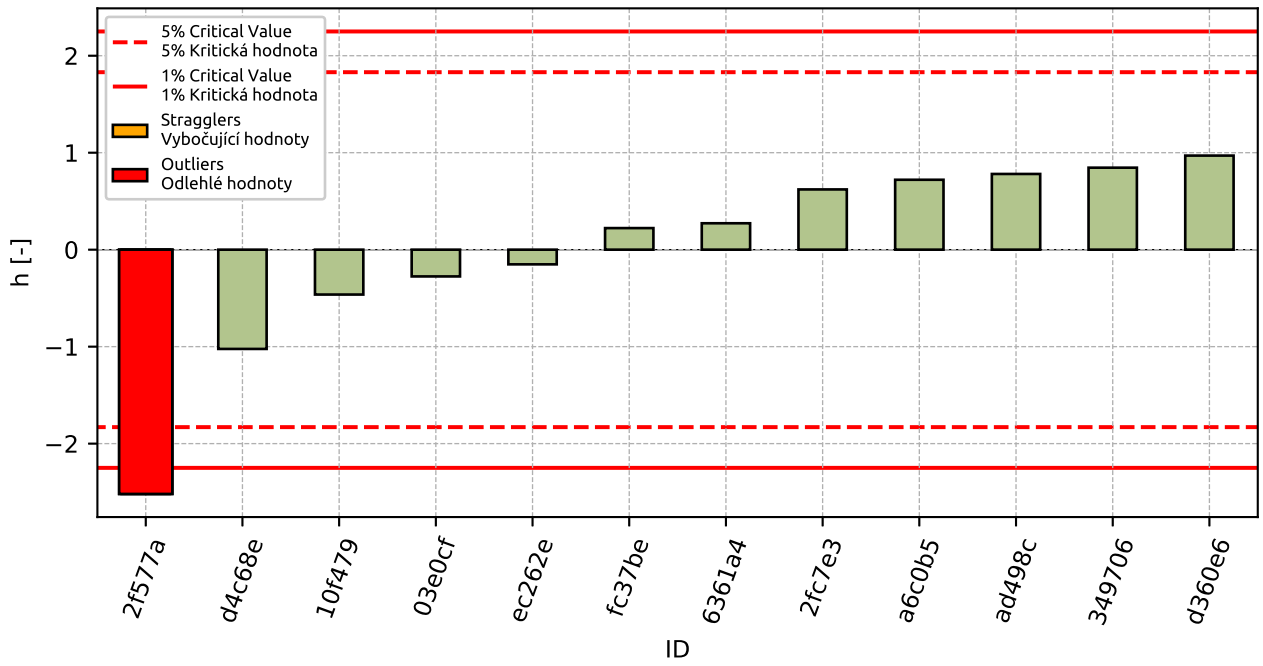

Figure 58: Interlaboratory Consistency Statistic *h*

6.1.4 Descriptive statistics

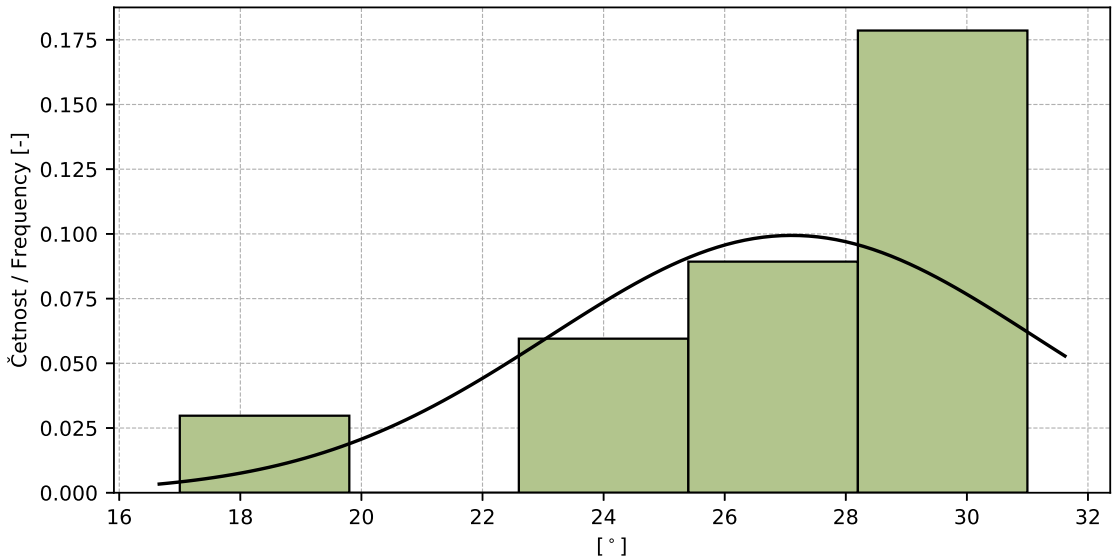

Figure 59: Histogram

Table 30: Descriptive statistics

Value	[°]
Průměrná hodnota / Average value – $\bar{x}$	27.0
Výběrová směrodatná odchylka / Sample standard deviation – s	4.0
Vztažná hodnota / Asigned value – x^*	27.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	4.0
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	2.0
p-hodnota testu normality / p-value of normality test	0.01 [-]

6.1.5 Calculation of Performance Statistics

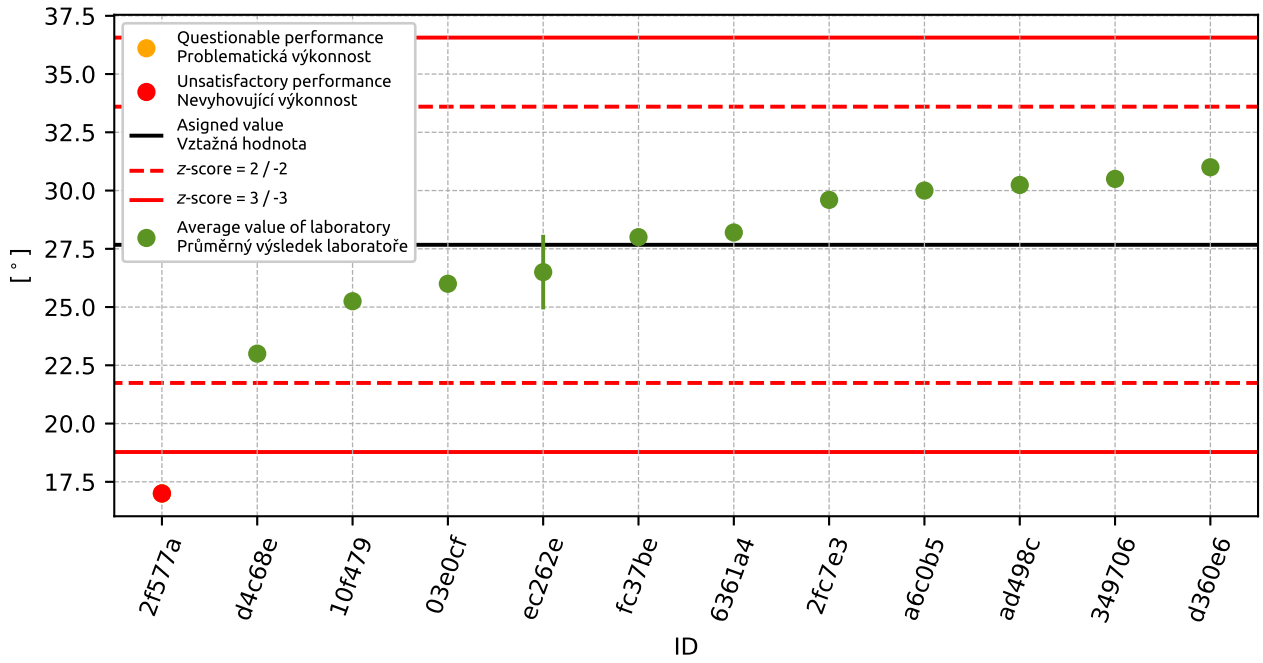

Figure 60: Average values and extended uncertainties of measurement

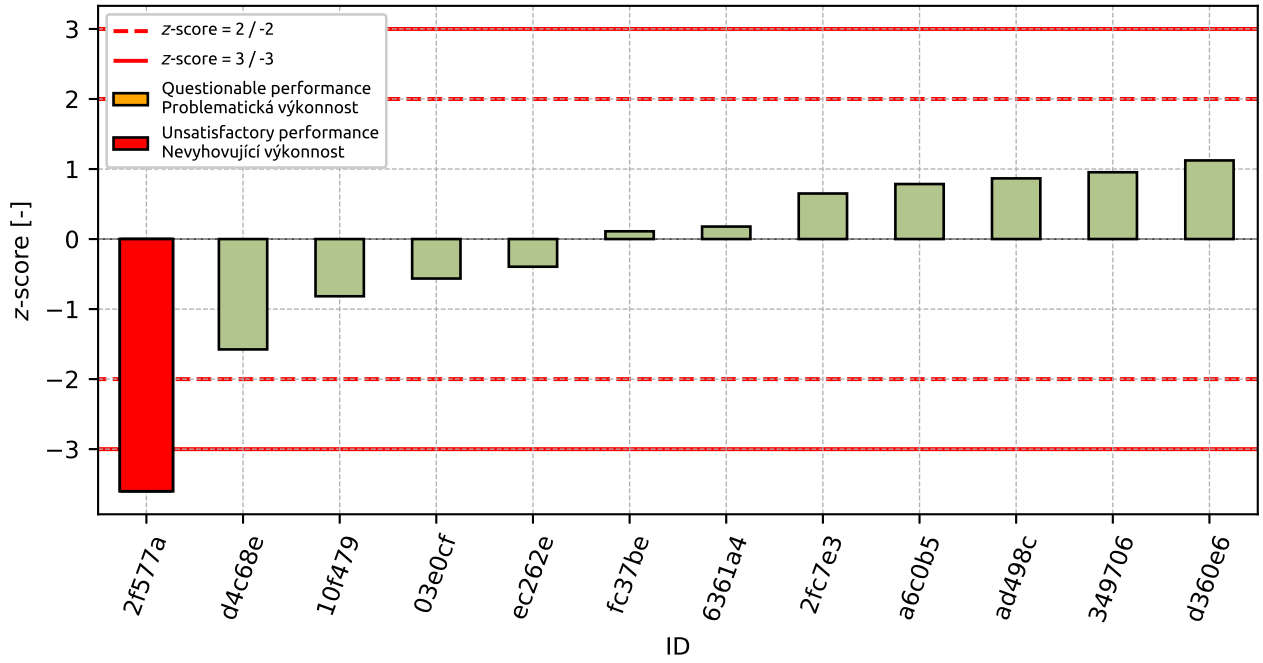

Figure 61: z-score

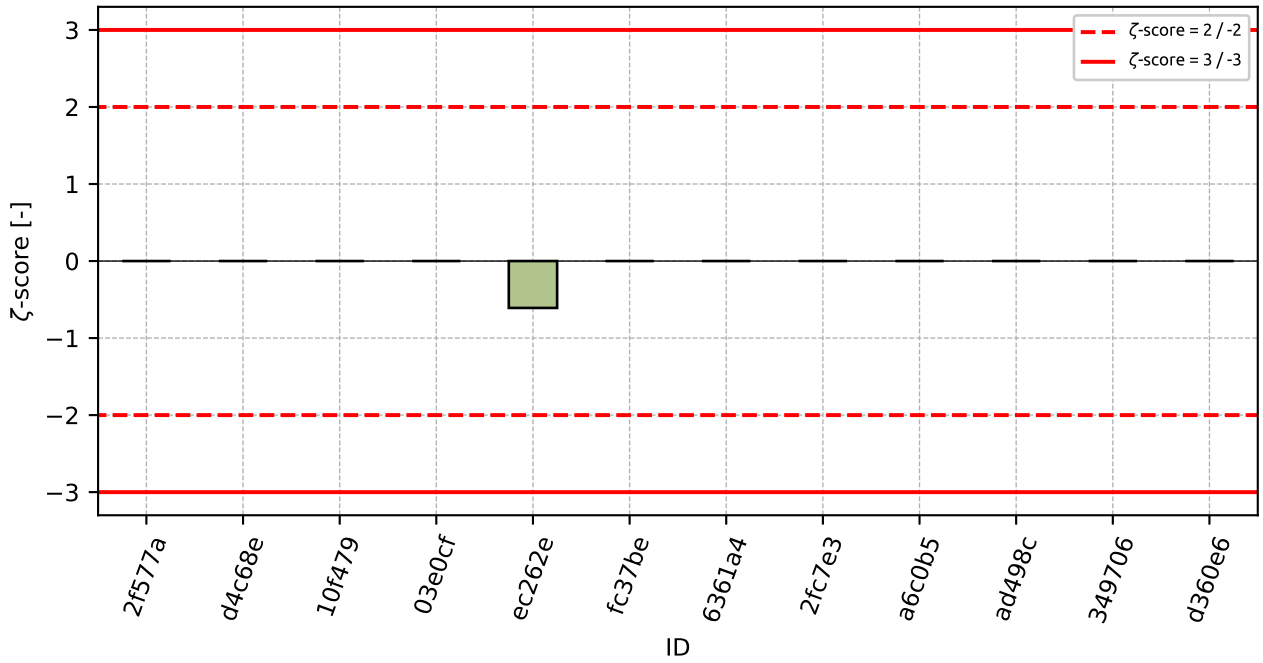

Figure 62: ζ-score

Table 31: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
2f577a	-3.6	-
d4c68e	-1.58	-
10f479	-0.82	-
03e0cf	-0.56	-
ec262e	-0.4	-0.61
fc37be	0.11	-
6361a4	0.18	-
2fc7e3	0.65	-
a6c0b5	0.79	-
ad498c	0.87	-
349706	0.95	-
d360e6	1.12	-

6.2 Shear stress

6.2.1 Test results

Table 32: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [kPa]	u_X [kPa]
349706	16.0	-
2f577a	17.0	-
10f479	18.0	-
d4c68e	23.0	-
03e0cf	26.0	-
ec262e	26.0	2.0
a6c0b5	27.0	-
fc37be	28.0	-
6361a4	28.0	-
2fc7e3	30.0	-
ad498c	30.0	-
d360e6	31.0	-

6.2.2 The Numerical Procedure for Determining Outliers

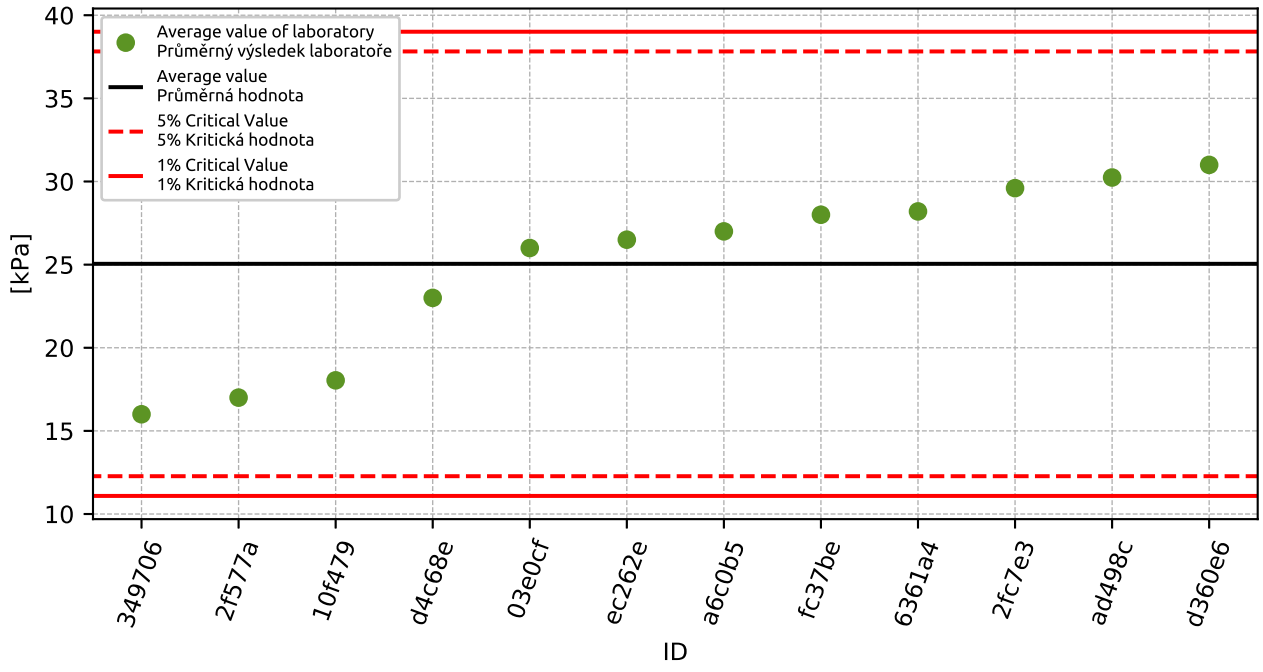

Figure 63: **Grubbs' test** - average values

6.2.3 Mandel's Statistics

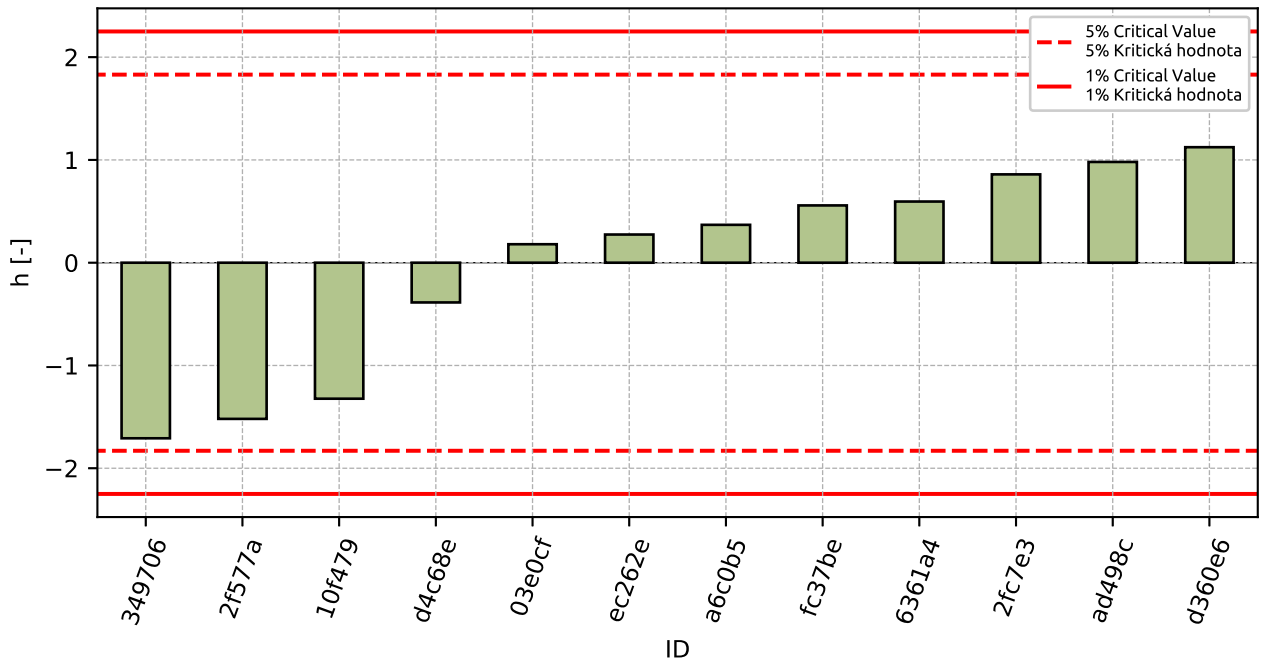

Figure 64: Interlaboratory Consistency Statistic *h*

6.2.4 Descriptive statistics

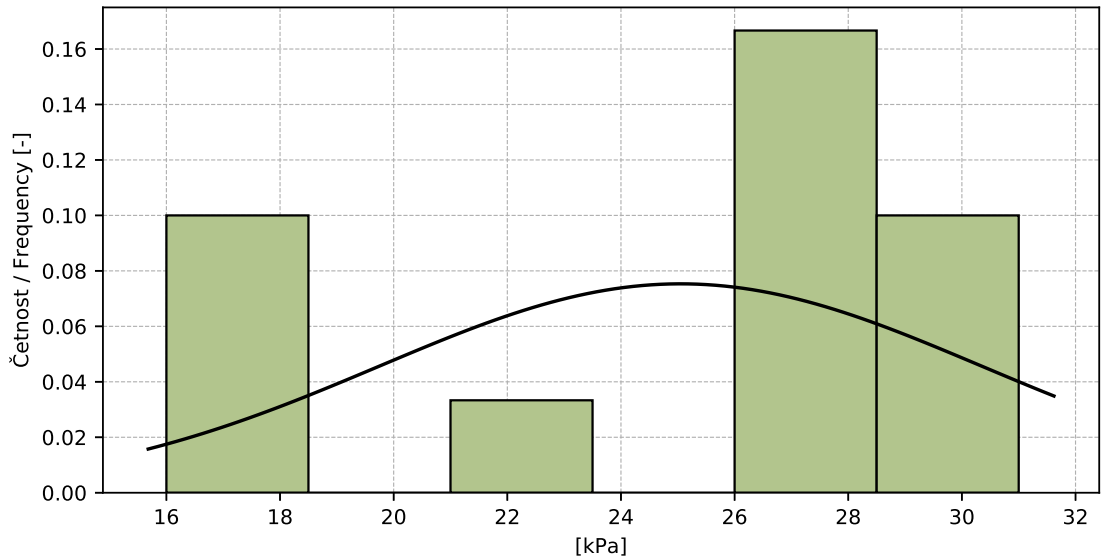

Figure 65: Histogram

Table 33: Descriptive statistics

Value	[kPa]
Průměrná hodnota / Average value – $\bar{x}$	25.0
Výběrová směrodatná odchylka / Sample standard deviation – s	5.3
Vztažná hodnota / Asigned value – x^*	26.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	4.6
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	1.6
p-hodnota testu normality / p-value of normality test	0.347 [-]

6.2.5 Calculation of Performance Statistics

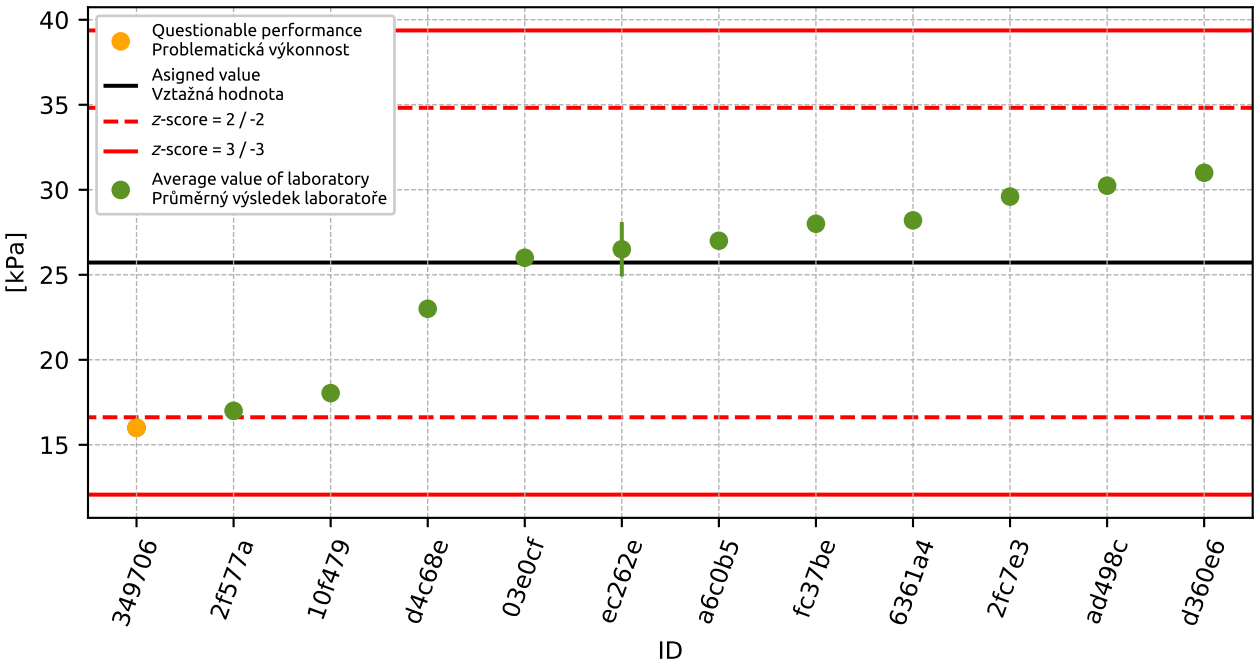

Figure 66: Average values and extended uncertainties of measurement

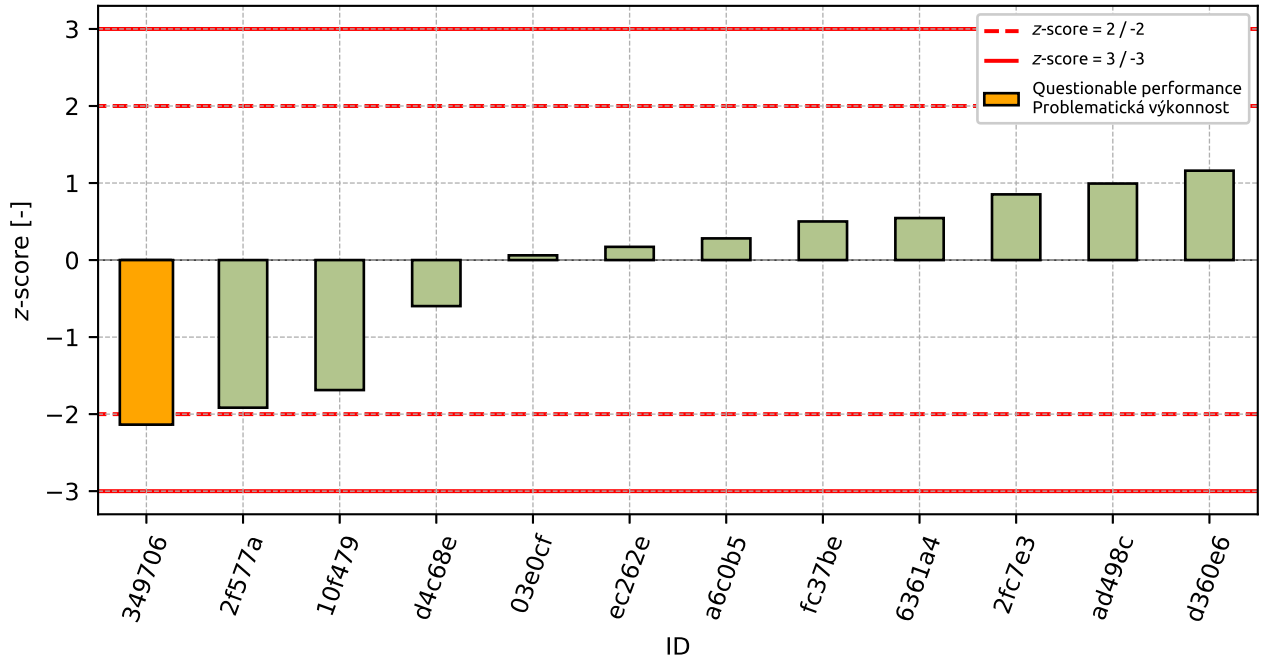

Figure 67: z-score

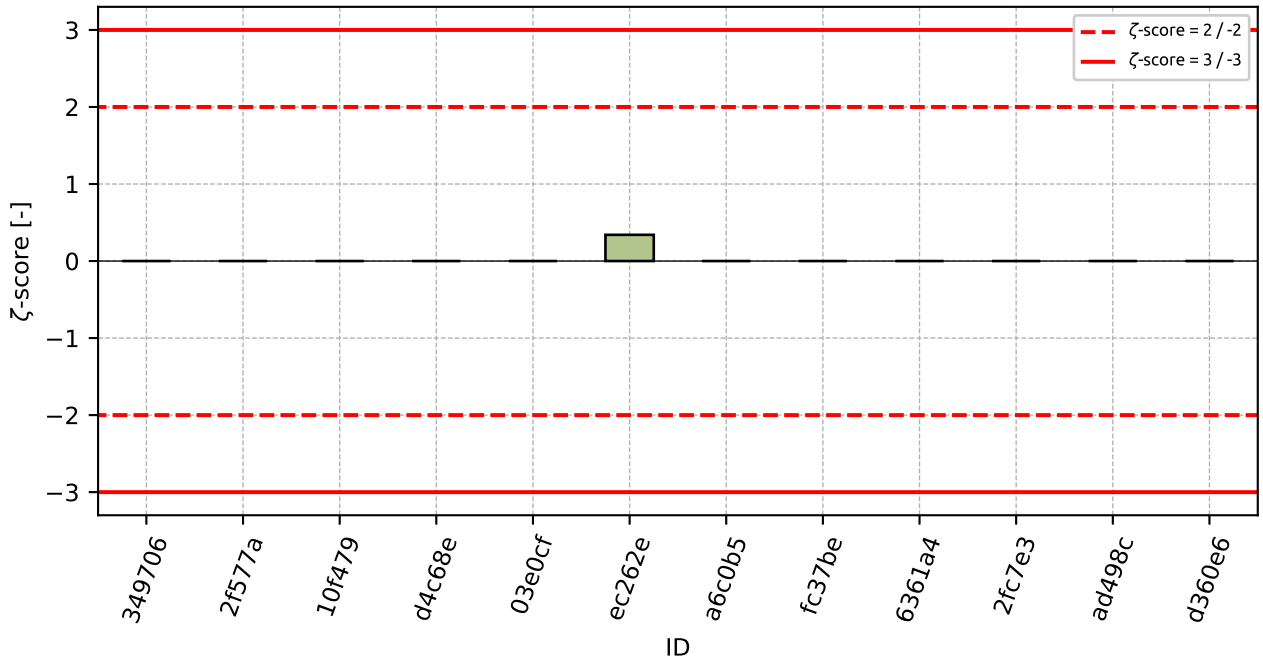

Figure 68: ζ-score

Table 34: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
349706	-2.14	-
2f577a	-1.92	-
10f479	-1.69	-
d4c68e	-0.6	-
03e0cf	0.06	-
ec262e	0.17	0.34
a6c0b5	0.28	-
fc37be	0.5	-
6361a4	0.55	-
2fc7e3	0.85	-
ad498c	0.99	-
d360e6	1.16	-

7 Appendix – EN ISO 17892-12 – Atterberg limits

7.1 Liquit limit

7.1.1 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 [%]
f996a0	34.1	34.2	34.0	1.5	34.1	0.1	0.29
d360e6	34.5	-	-	-	34.5	0.0	0.0
2fc7e3	33.8	36.5	34.2	3.0	34.8	1.46	4.18
4ffaa5	34.2	34.9	35.8	5.0	35.0	0.8	2.28
349706	35.0	35.0	35.0	1.2	35.0	0.0	0.0
eb713f	34.6	35.3	36.0	6.0	35.3	0.7	1.98
19c3ea	36.1	35.4	35.1	0.8	35.5	0.51	1.44
d4c68e	36.0	36.0	35.0	-	35.7	0.58	1.62
769d4f	36.0	36.0	35.0	1.2	35.7	0.58	1.62
6361a4	35.8	35.9	35.8	2.0	35.8	0.06	0.17
4aba20	36.2	36.4	36.2	0.2	36.3	0.12	0.32
ad498c	36.7	36.2	36.3	0.6	36.4	0.26	0.73
819834	37.0	36.9	35.8	0.4	36.6	0.67	1.82
257e1b	35.8	36.2	37.8	0.8	36.6	1.06	2.89
d7df6e	36.9	37.0	36.7	0.1	36.9	0.15	0.41
6de47c	37.0	37.0	37.0	1.2	37.0	0.0	0.0
7897a4	37.3	38.0	37.8	-	37.7	0.36	0.96
d92fa5	38.2	37.7	38.0	0.4	38.0	0.25	0.66
ebaae9	38.0	38.0	38.0	2.0	38.0	0.0	0.0
e452e6	38.4	38.3	38.6	1.6	38.4	0.15	0.4
c63e03	38.2	39.0	38.7	1.2	38.6	0.4	1.05
fc37be	38.0	39.0	39.0	4.3	38.7	0.58	1.49
5d54c5	40.0	40.0	41.0	1.0	40.3	0.58	1.43

7.1.2 The Numerical Procedure for Determining Outliers

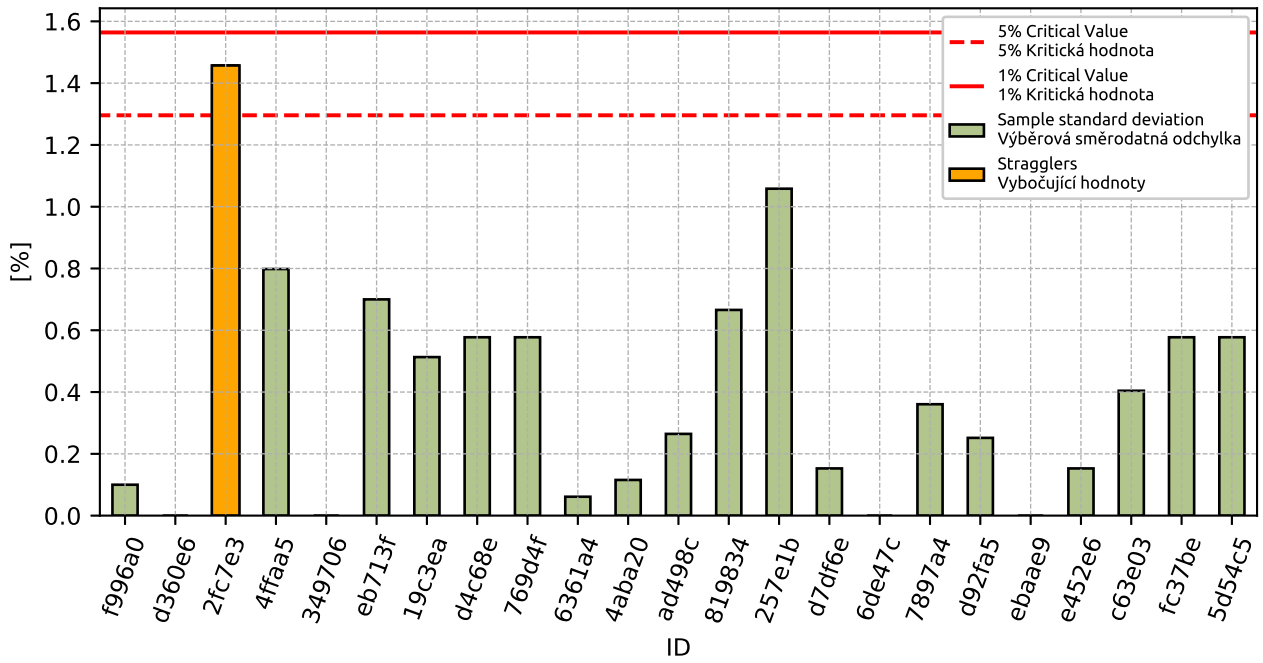

Figure 69: **Cochran's test** - sample standard deviations

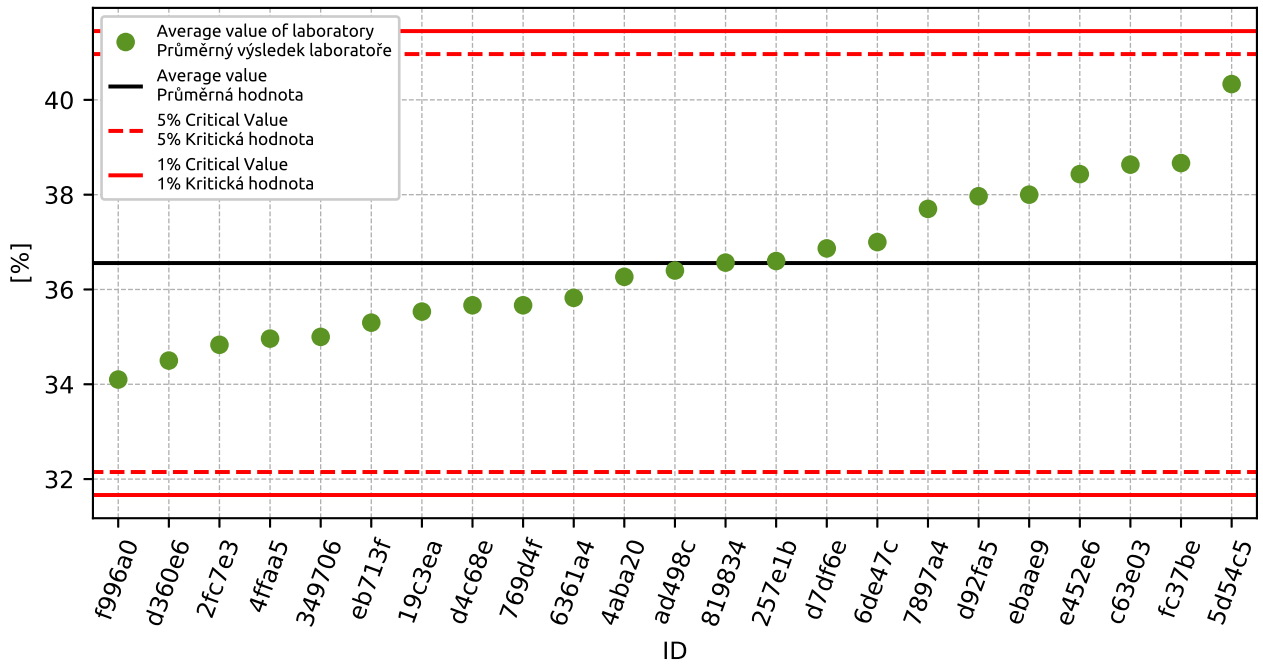

Figure 70: **Grubbs' test** - average values

7.1.3 Mandel's Statistics

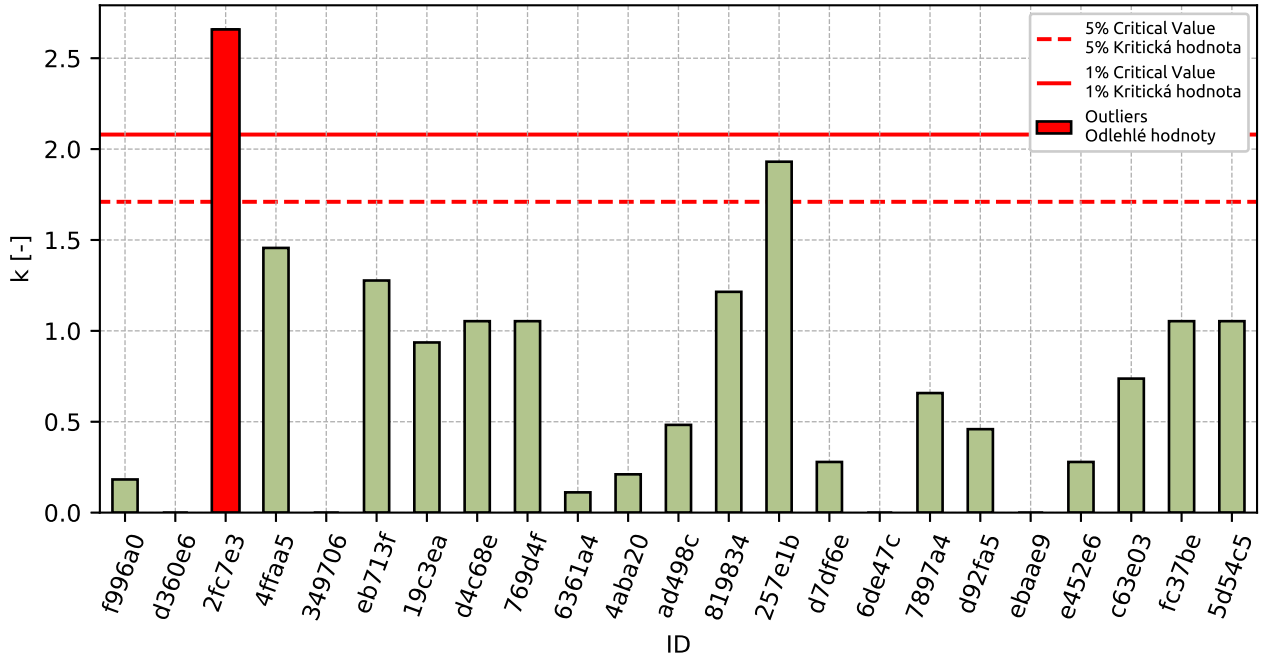

Figure 71: Intralaboratory Consistency Statistic

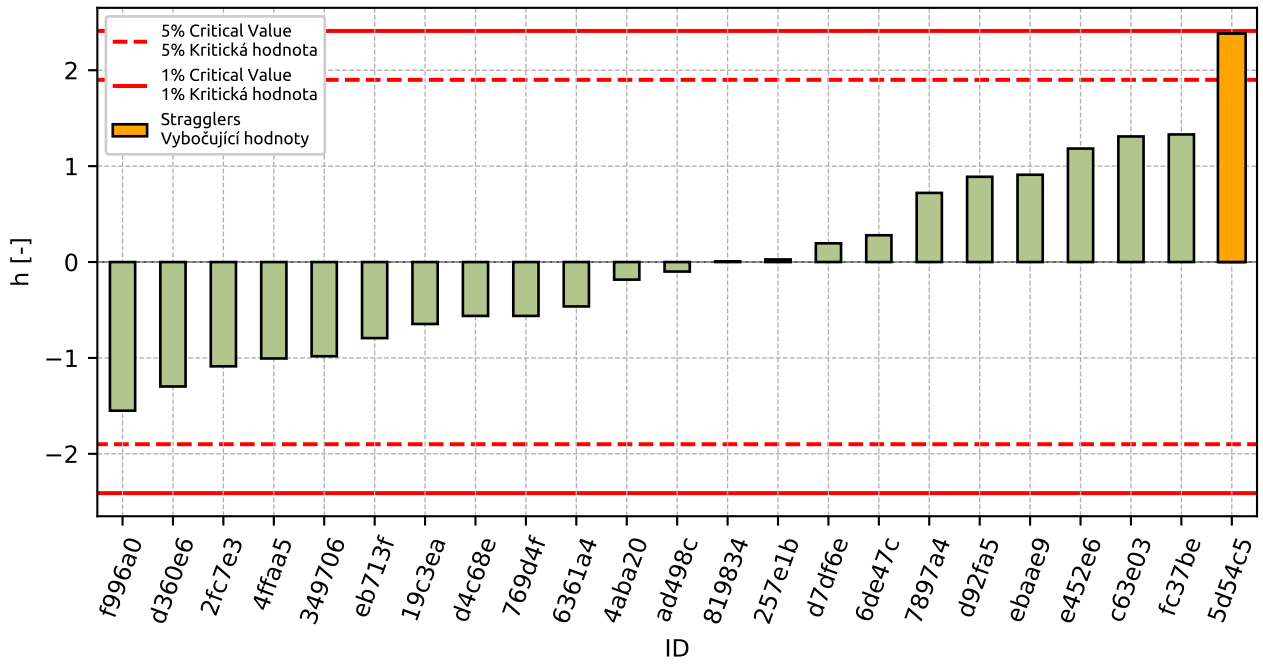

Figure 72: Interlaboratory Consistency Statistic

7.1.4 Descriptive statistics

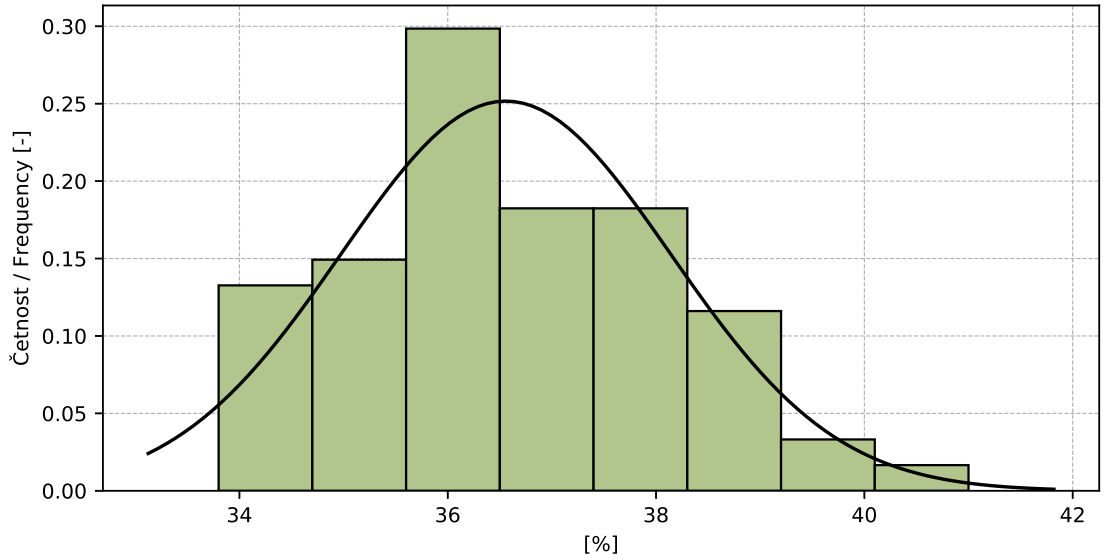

Figure 73: Histogram of all test results

Table 36: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	36.6
Výběrová směrodatná odchylka / Sample standard deviation – s	1.59
Vztažná hodnota / Asigned value – x^*	36.6
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.76
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.46
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.55
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.55
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.65
Opakovatelnost / Repeatability – r	1.5
Reprodukovatelnost / Reproducibility – R	4.6

7.1.5 Evaluation of Performance Statistics

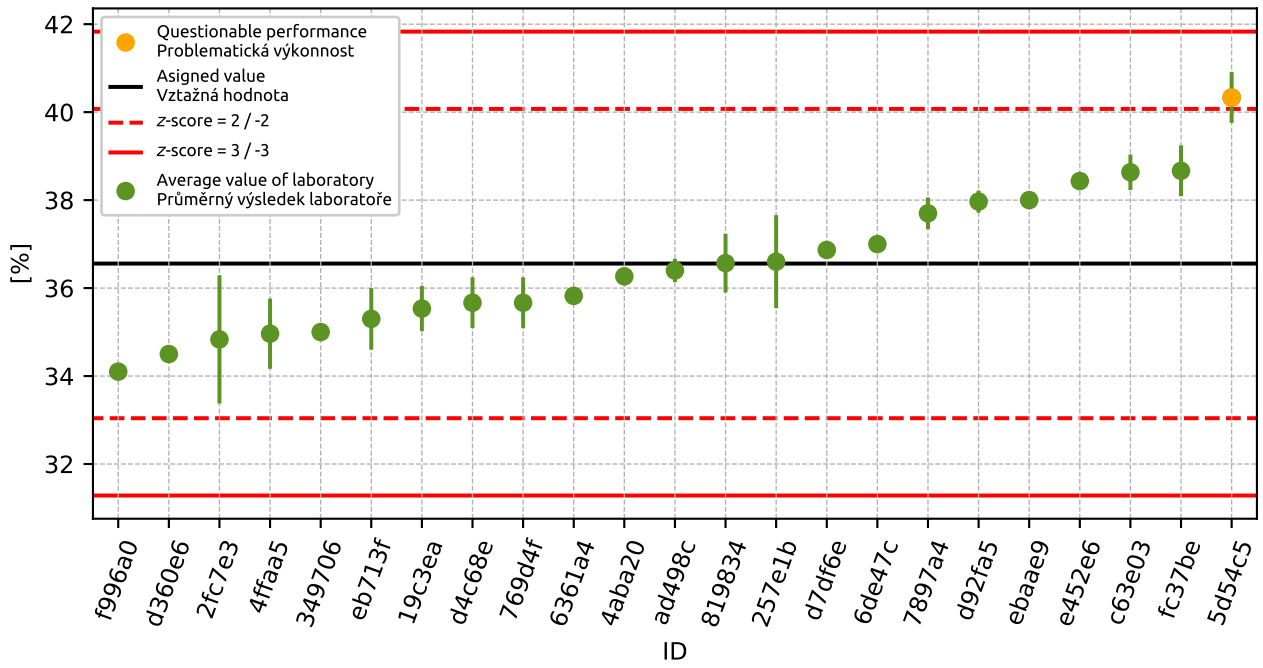

Figure 74: Average values and sample standard deviations

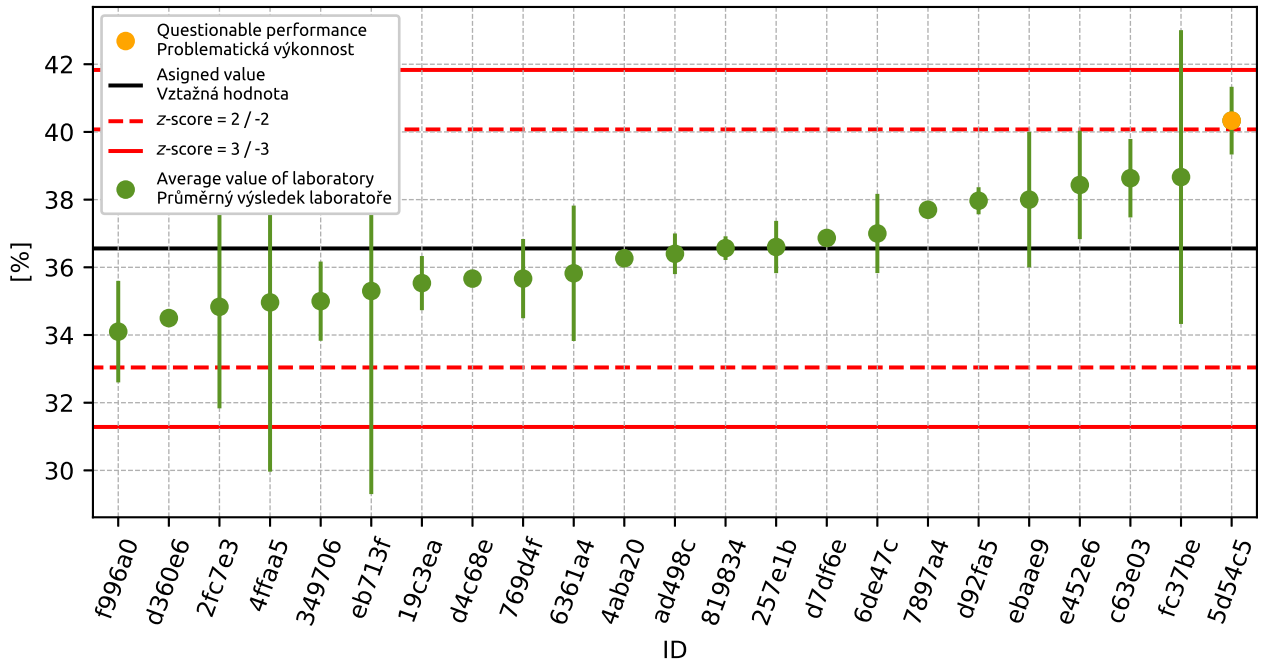

Figure 75: Average values and extended uncertainties of measurement

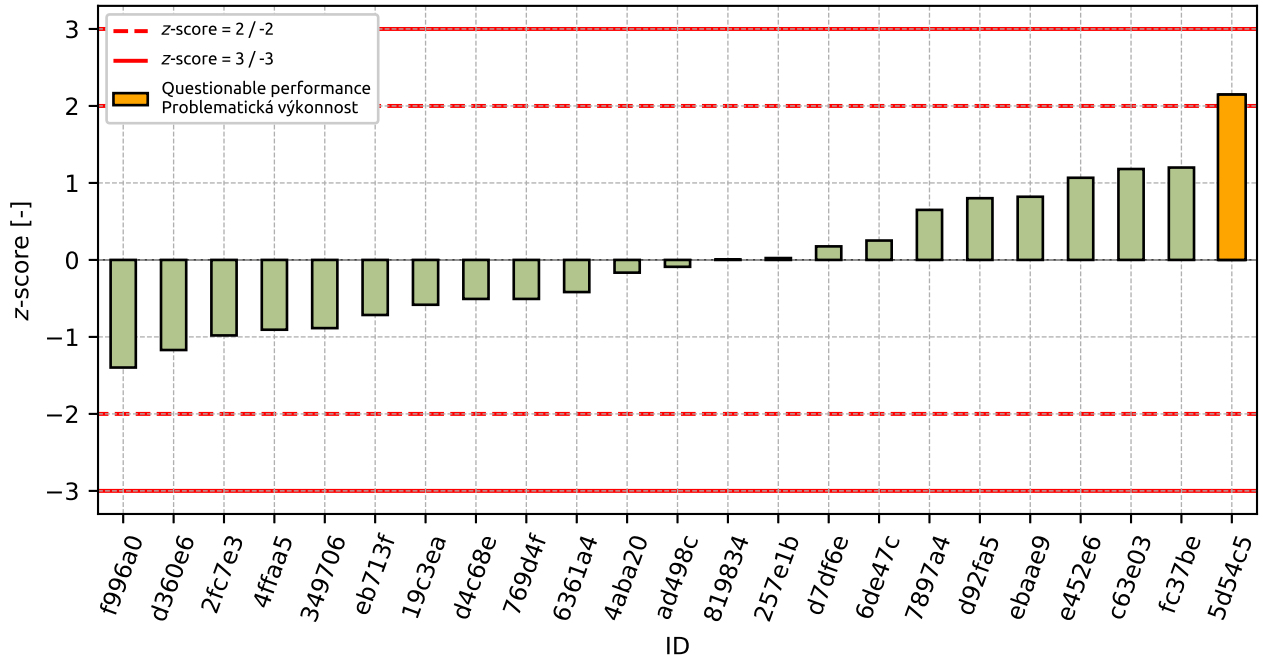

Figure 76: z-score

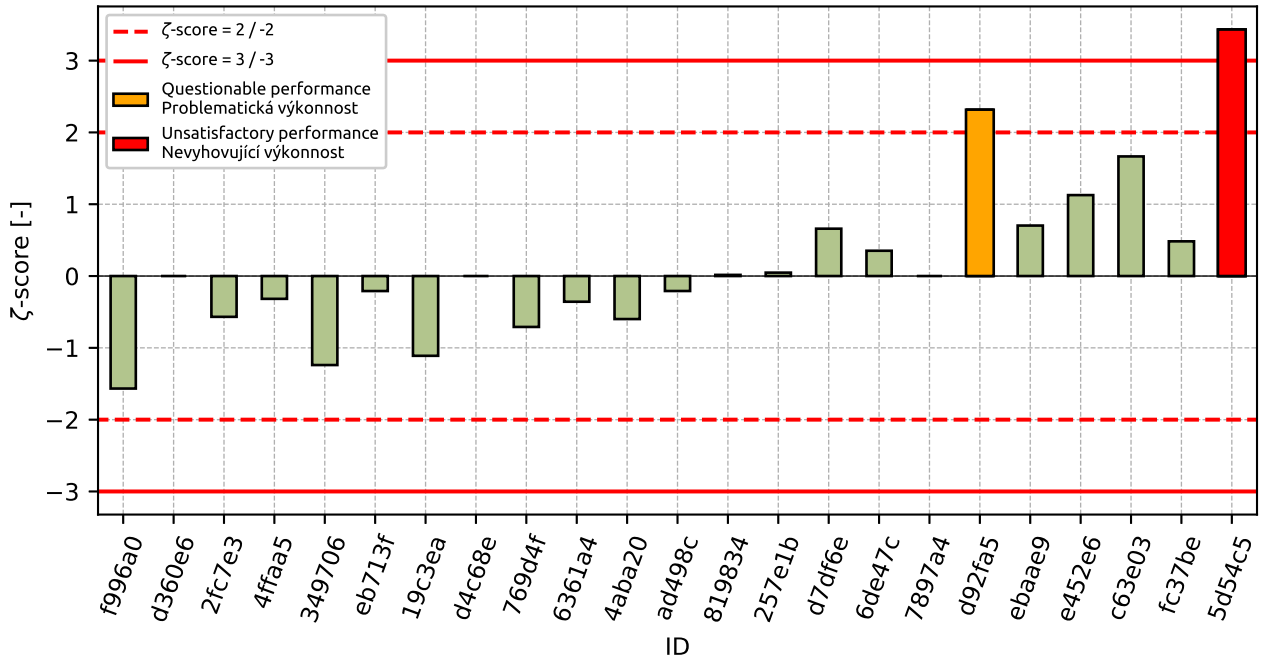

Figure 77: ζ-score

Table 37: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f996a0	-1.4	-1.57
d360e6	-1.17	-
2fc7e3	-0.98	-0.57
4ffaa5	-0.91	-0.32
349706	-0.89	-1.24
eb713f	-0.72	-0.21
19c3ea	-0.58	-1.11
d4c68e	-0.51	-
769d4f	-0.51	-0.71
6361a4	-0.42	-0.36
4aba20	-0.17	-0.6
ad498c	-0.09	-0.21
819834	0.01	0.02
257e1b	0.02	0.05
d7df6e	0.18	0.66
6de47c	0.25	0.35
7897a4	0.65	-
d92fa5	0.8	2.32
ebaae9	0.82	0.7
e452e6	1.07	1.13
c63e03	1.18	1.67
fc37be	1.2	0.48
5d54c5	2.15	3.43

7.2 Plastic limit

7.2.1 Test results

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

ID	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
819834	18.8	19.0	19.3	0.2	19.0	0.25	1.32
d4c68e	19.4	19.2	19.5	-	19.4	0.15	0.79
eb713f	20.0	20.5	19.5	3.0	20.0	0.5	2.5
e452e6	20.8	19.1	20.4	1.5	20.1	0.89	4.42
349706	20.0	22.0	19.0	0.6	20.3	1.53	7.51
769d4f	19.0	21.0	21.0	0.6	20.3	1.15	5.68
19c3ea	20.9	20.3	20.0	0.6	20.4	0.46	2.25
6361a4	20.8	20.3	20.6	4.0	20.5	0.24	1.15
257e1b	20.6	20.9	20.9	0.4	20.8	0.17	0.83
d7df6e	21.2	21.0	20.8	0.1	21.0	0.2	0.95
fc37be	21.0	21.0	21.0	4.0	21.0	0.0	0.0
d360e6	21.1	-	-	-	21.1	0.0	0.0
4ffaa5	21.4	21.3	21.2	5.0	21.3	0.1	0.47
4aba20	21.5	21.4	21.4	0.2	21.4	0.02	0.1
ad498c	21.8	21.4	21.6	0.7	21.6	0.2	0.93
f996a0	21.7	21.5	21.8	1.5	21.7	0.15	0.71
5d54c5	22.0	21.0	22.0	2.2	21.7	0.58	2.66
c63e03	21.9	21.9	21.4	0.7	21.7	0.29	1.33
7897a4	21.8	21.9	21.8	-	21.8	0.06	0.26
ebaae9	22.0	22.0	22.0	2.0	22.0	0.0	0.0
6de47c	22.0	22.0	22.0	0.6	22.0	0.0	0.0
2fc7e3	23.2	22.0	23.5	2.0	22.9	0.79	3.47
d92fa5	23.9	23.2	23.3	0.6	23.5	0.38	1.61

7.2.2 The Numerical Procedure for Determining Outliers

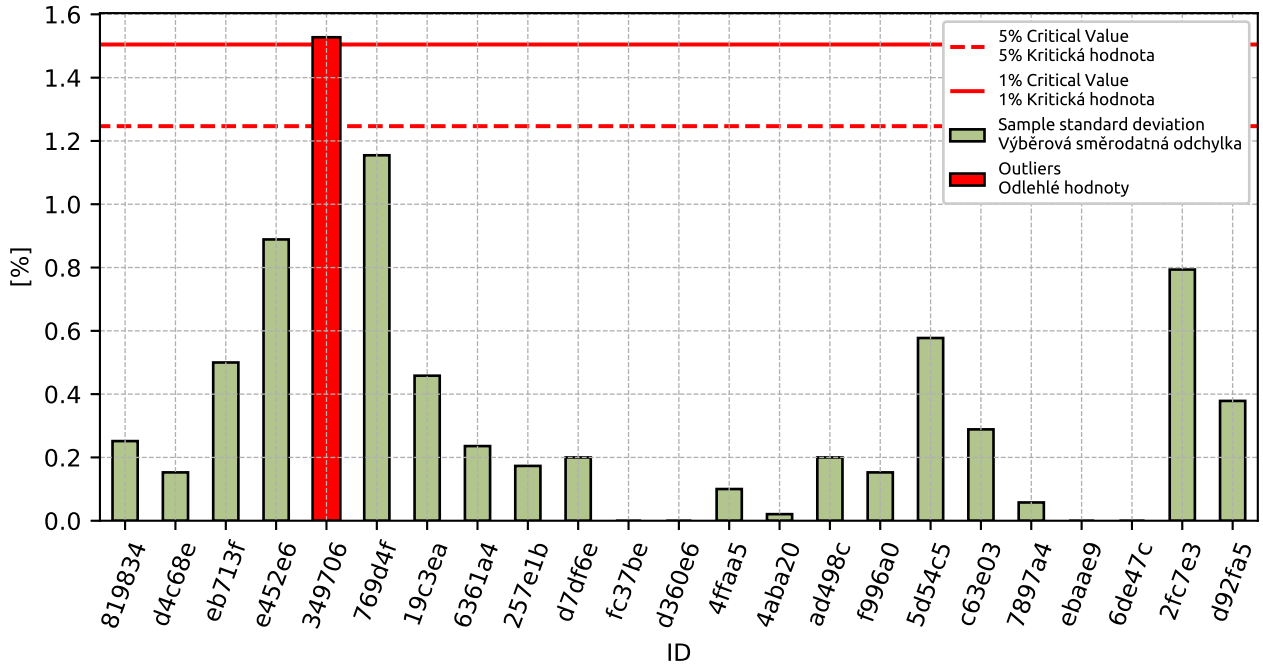

Figure 78: **Cochran's test** - sample standard deviations

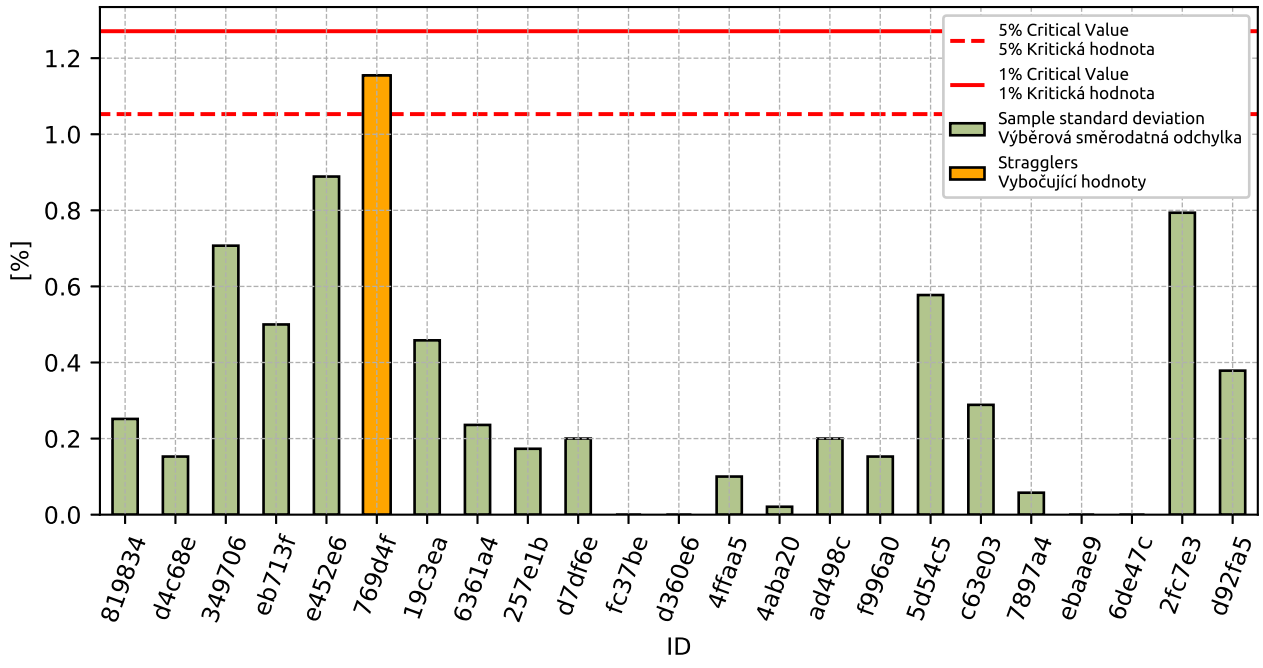

Figure 79: **Cochran's test** - sample standard deviations without outliers

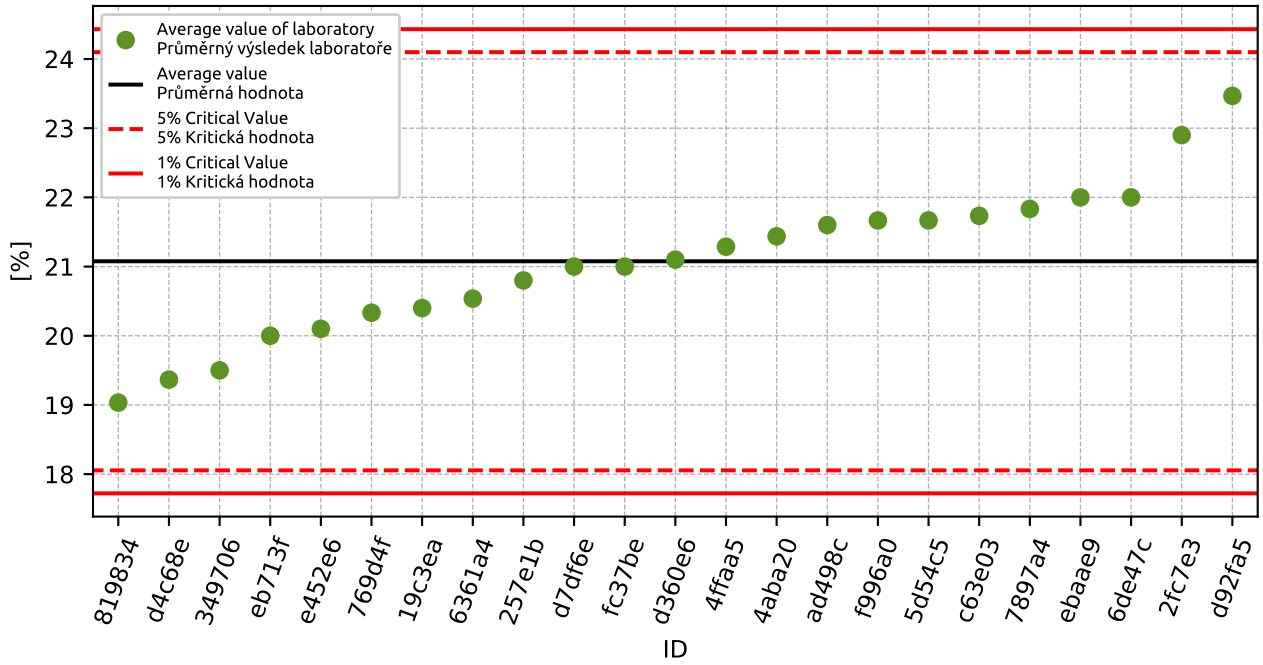

Figure 80: **Grubbs' test** - average values

7.2.3 Mandel's Statistics

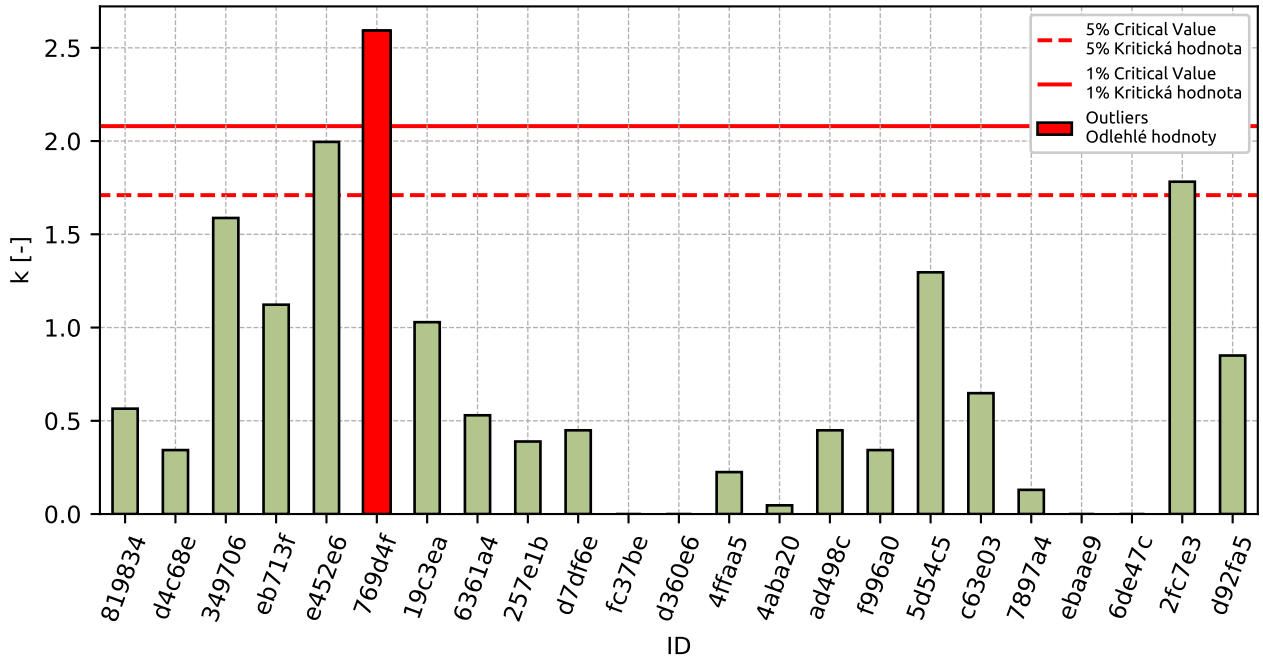

Figure 81: Intralaboratory Consistency Statistic

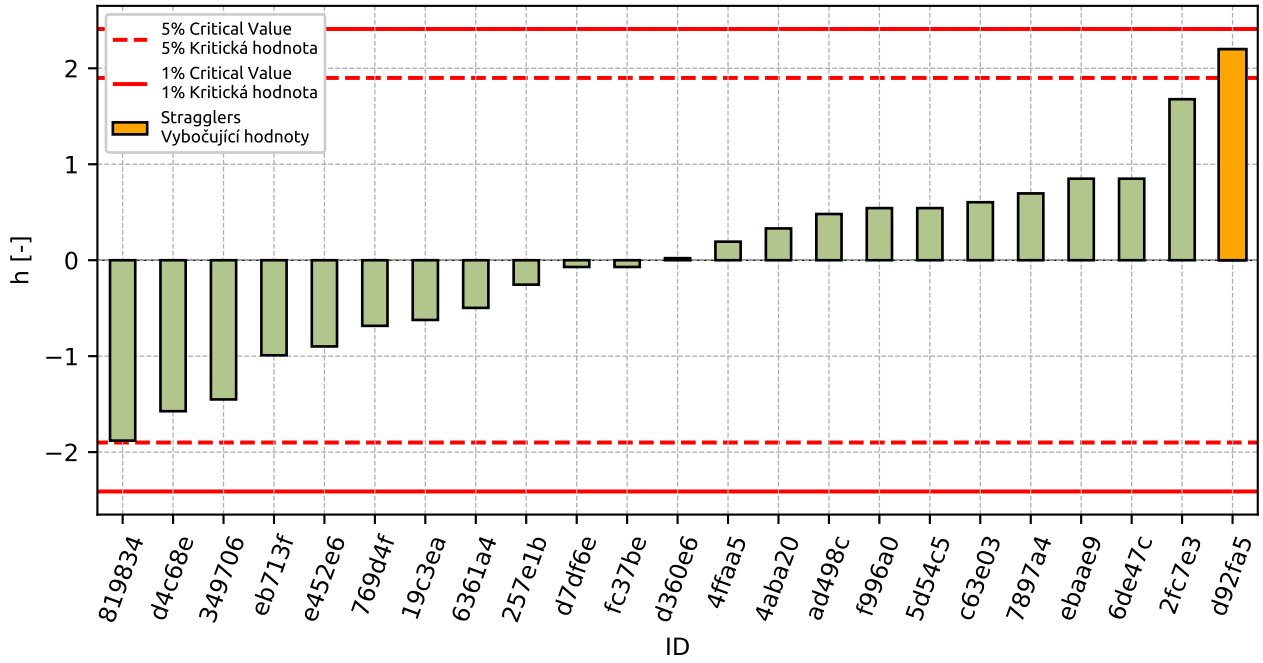

Figure 82: Interlaboratory Consistency Statistic

7.2.4 Descriptive statistics

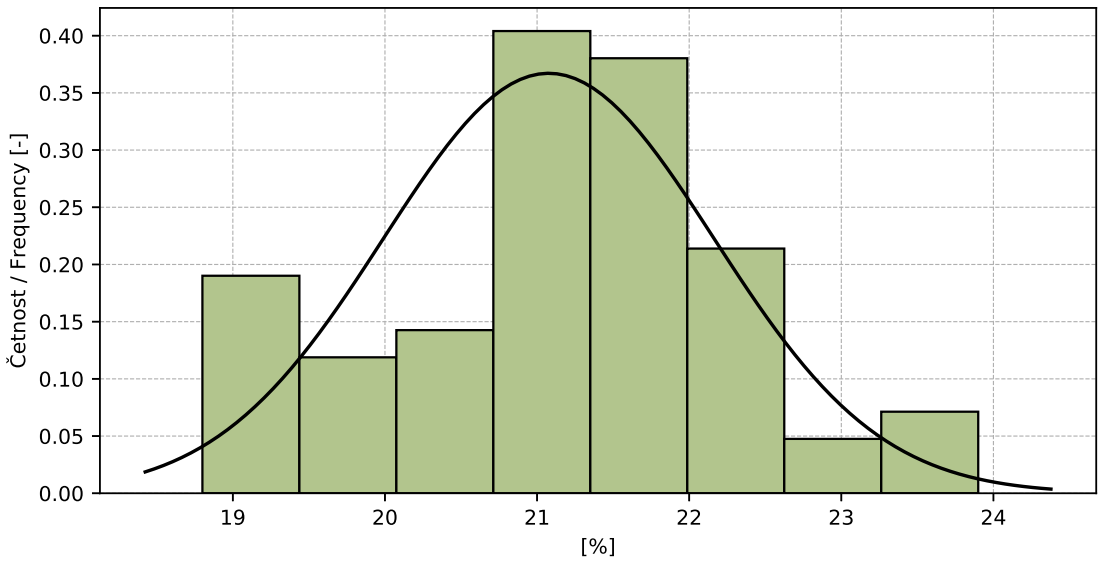

Figure 83: Histogram of all test results

Table 39: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	21.1
Výběrová směrodatná odchylka / Sample standard deviation – s	1.09
Vztažná hodnota / Asigned value – x^*	21.1
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.12
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.29
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.06
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.45
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.15
Opakovatelnost / Repeatability – r	1.2
Reprodukovatelnost / Reproducibility – R	3.2

7.2.5 Evaluation of Performance Statistics

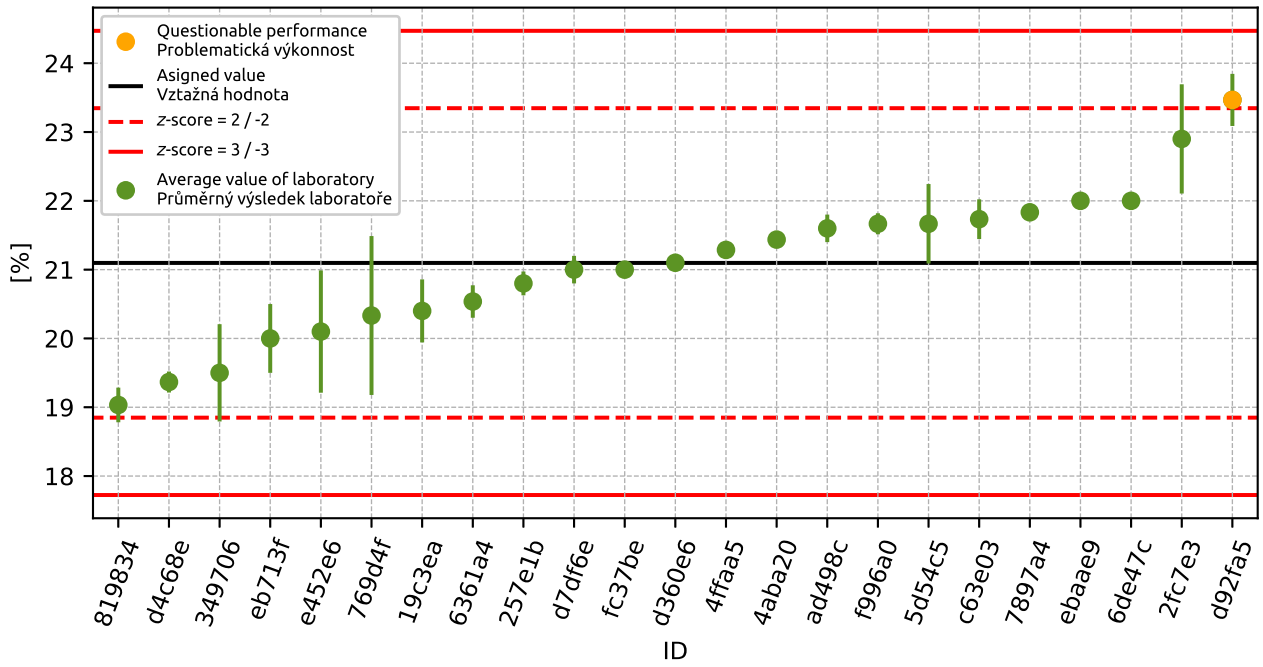

Figure 84: Average values and sample standard deviations

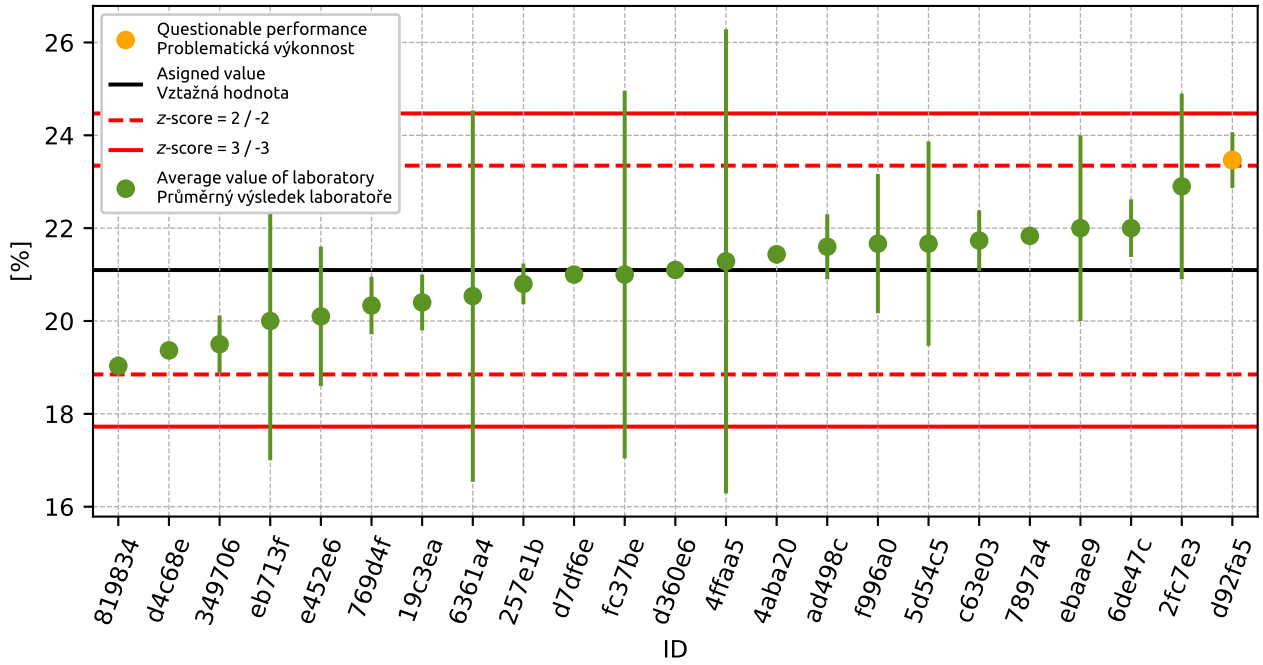

Figure 85: Average values and extended uncertainties of measurement

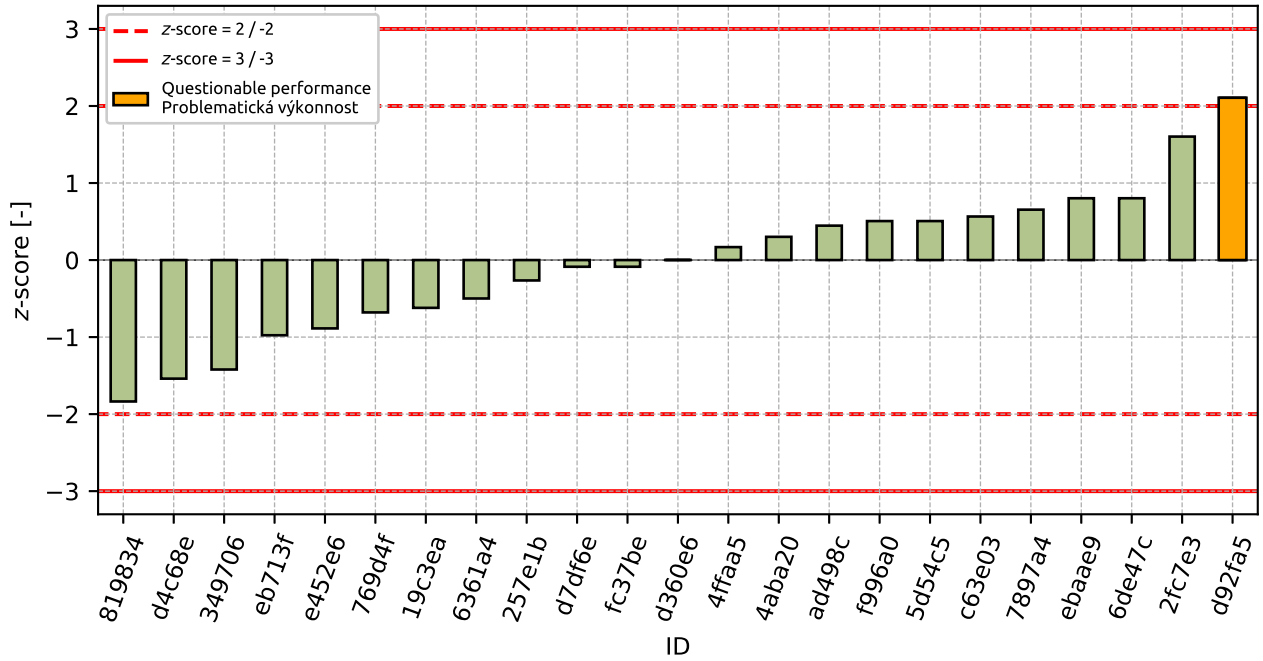

Figure 86: z-score

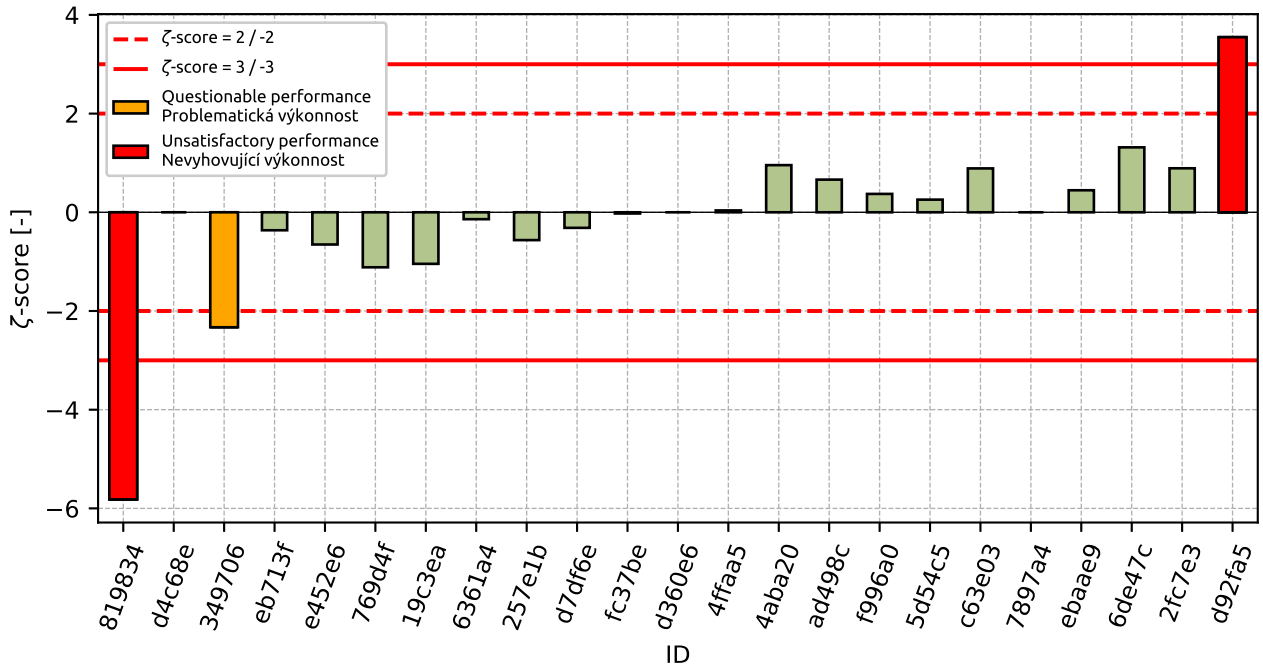

Figure 87: ζ-score

Table 40: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
819834	-1.84	-5.82
d4c68e	-1.54	-
349706	-1.42	-2.33
eb713f	-0.98	-0.36
e452e6	-0.89	-0.65
769d4f	-0.68	-1.11
19c3ea	-0.62	-1.04
6361a4	-0.5	-0.14
257e1b	-0.26	-0.56
d7df6e	-0.09	-0.32
fc37be	-0.09	-0.02
d360e6	0.0	-
4ffaa5	0.17	0.04
4aba20	0.3	0.96
ad498c	0.45	0.66
f996a0	0.51	0.37
5d54c5	0.51	0.26
c63e03	0.57	0.89
7897a4	0.65	-
ebaae9	0.8	0.45
6de47c	0.8	1.32
2fc7e3	1.6	0.89
d92fa5	2.11	3.55

8 Appendix – EN 13286-2 – Proctor

8.1 Proctor density

8.1.1 Test results

Table 41: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [kg/m^3]	u_X [kg/m^3]
dec8e3	1655	50
fb2a44	1660	35
62fddc	1667	-
3ae2a7	1698	67
8096b5	1700	-
349706	1710	10
4f6c1c	1724	25
dbb7b3	1727	-
4aba20	1728	2
257e1b	1730	37
f996a0	1730	-
d2b8b2	1730	0
819834	1737	90
ad498c	1738	9
e452e6	1739	25
4b7a6f	1740	-
50a49a	1740	80
fc37be	1740	-
405cc9	1745	20
f34852	1750	89
d4c68e	1750	-
ef5463	1750	3
3b178c	1756	20
ebaae9	1760	25
1dd437	1765	25
ab16b9	1770	50
5d54c5	1770	30
d360e6	1790	-
769d4f	1800	0
6361a4	1804	30
d92fa5	1920	164

8.1.2 The Numerical Procedure for Determining Outliers

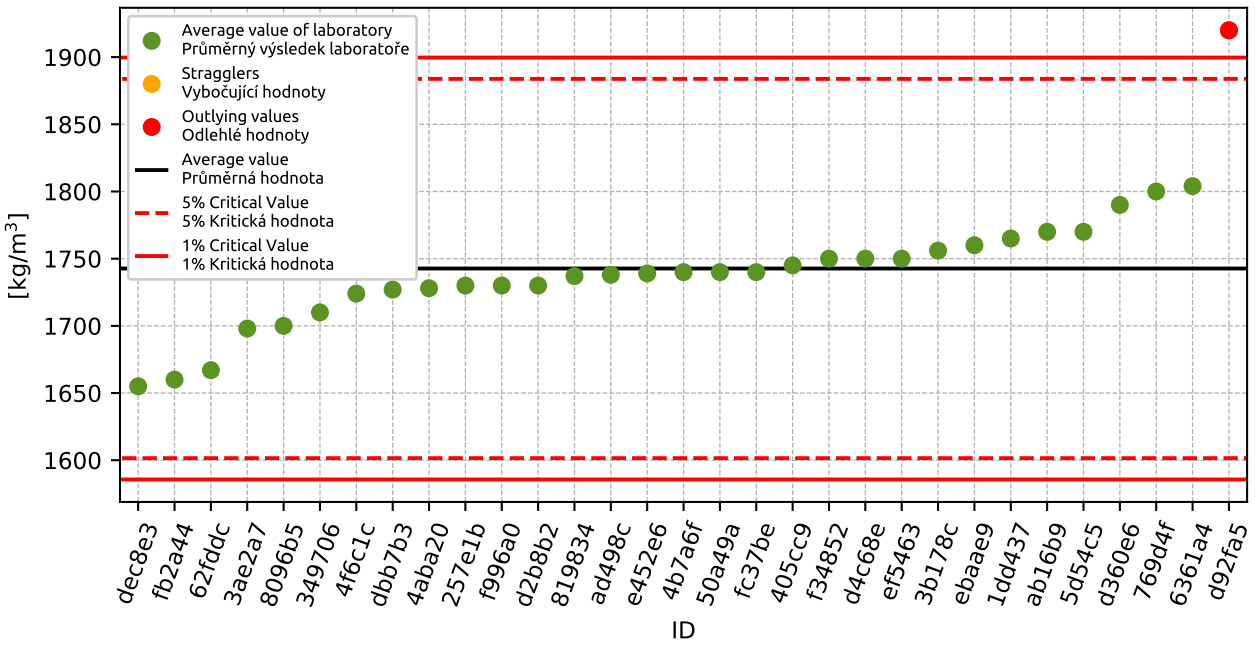

Figure 88: **Grubbs' test** - average values

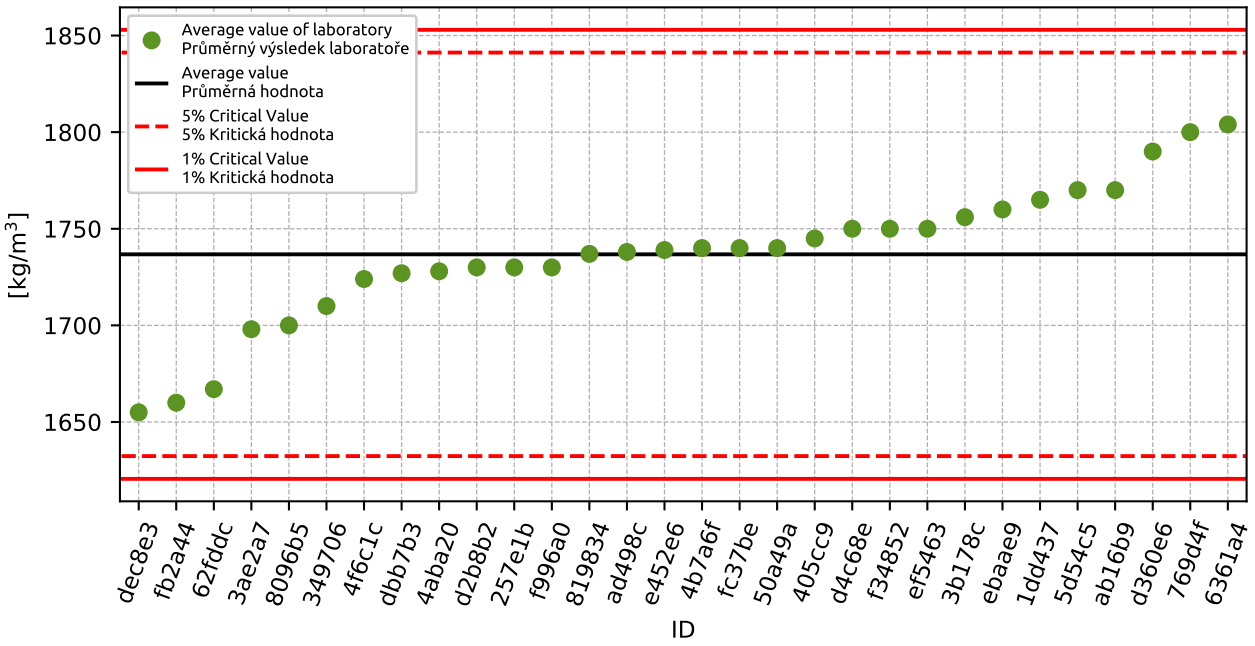

Figure 89: **Grubbs' test** - average values without outliers

8.1.3 Mandel's Statistics

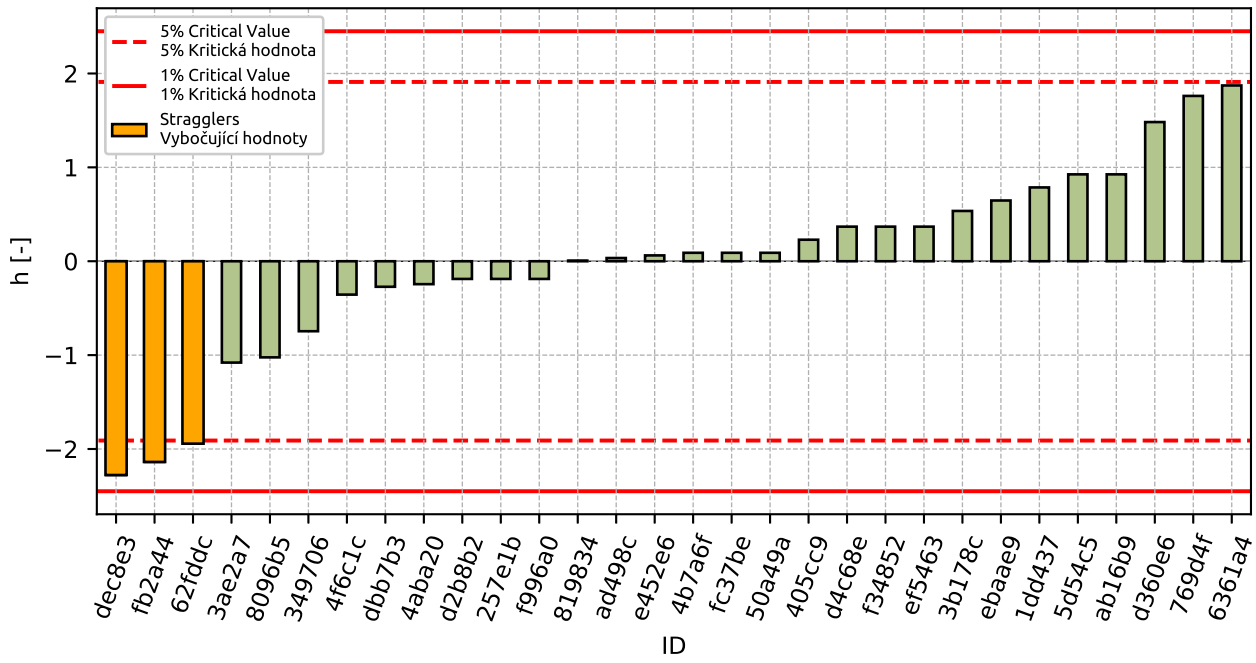

Figure 90: Interlaboratory Consistency Statistic *h*

8.1.4 Descriptive statistics

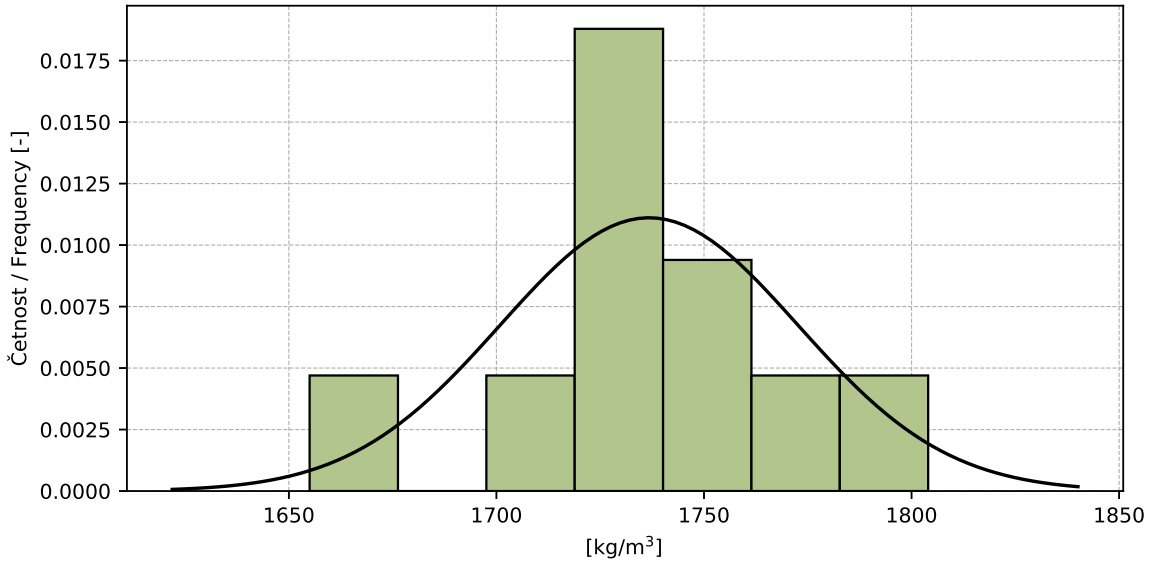

Figure 91: Histogram

Table 42: Descriptive statistics

Value	[kg/m^3]
Průměrná hodnota / Average value – $\bar{x}$	1737.0
Výběrová směrodatná odchylka / Sample standard deviation – s	35.9
Vztažná hodnota / Asigned value – x^*	1740.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	26.4
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	6.0
p-hodnota testu normality / p-value of normality test	0.302 [-]

8.1.5 Calculation of Performance Statistics

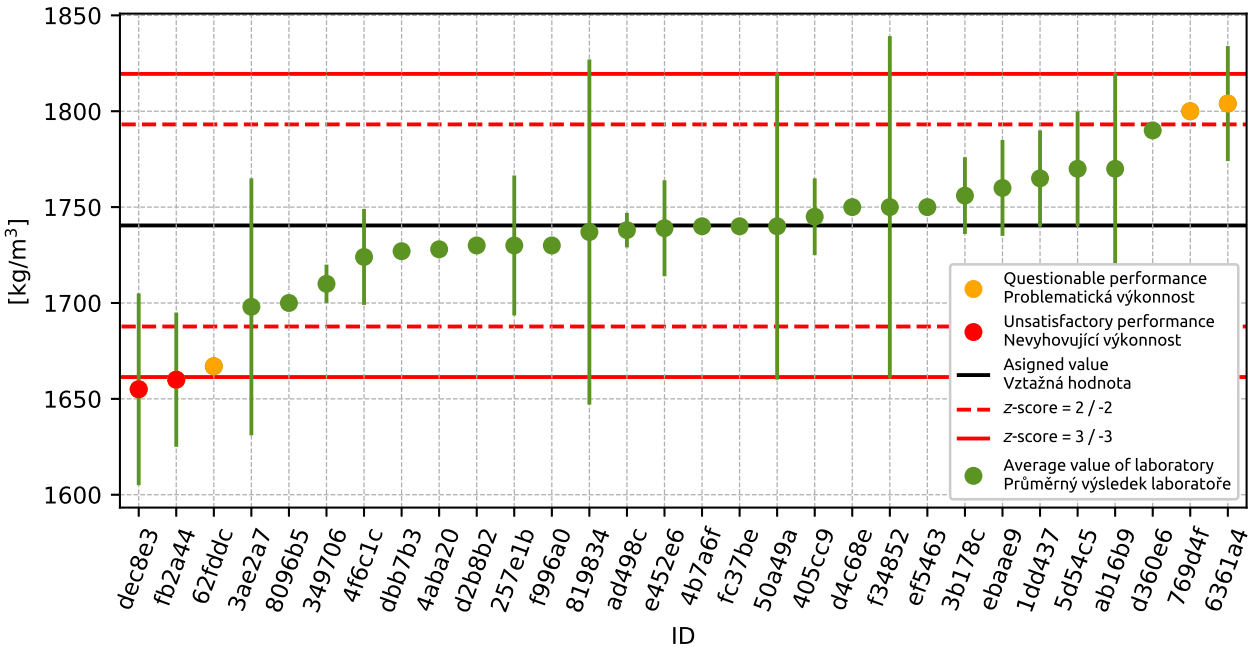

Figure 92: Average values and extended uncertainties of measurement

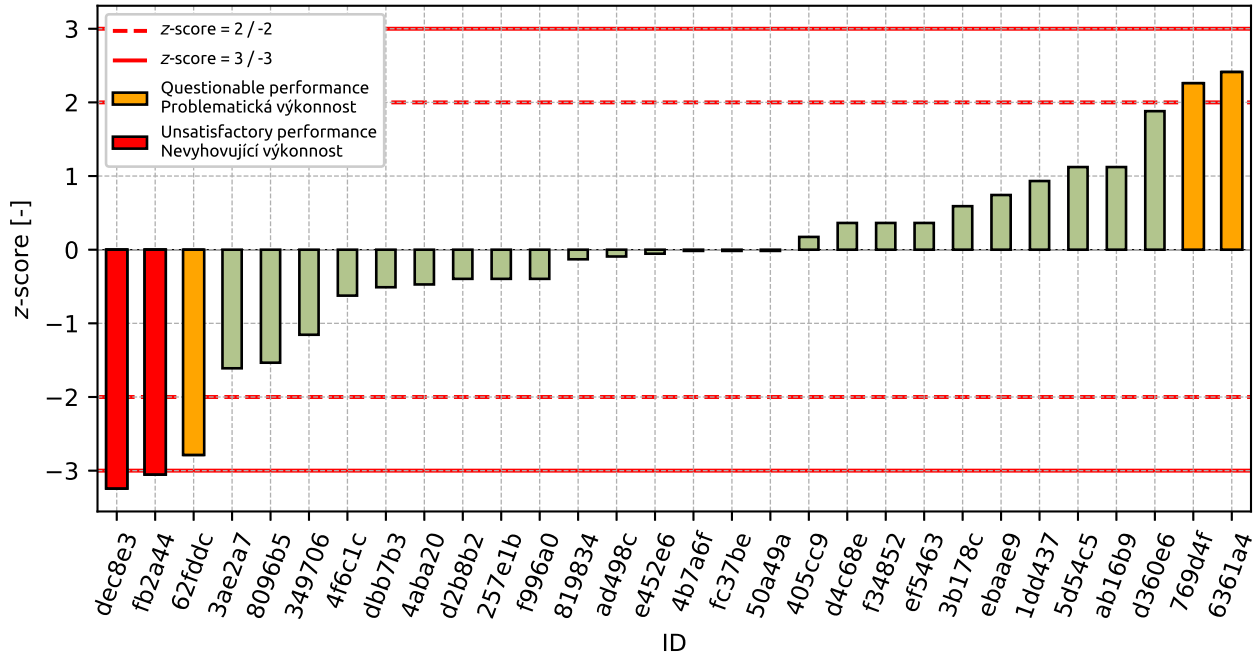

Figure 93: z-score

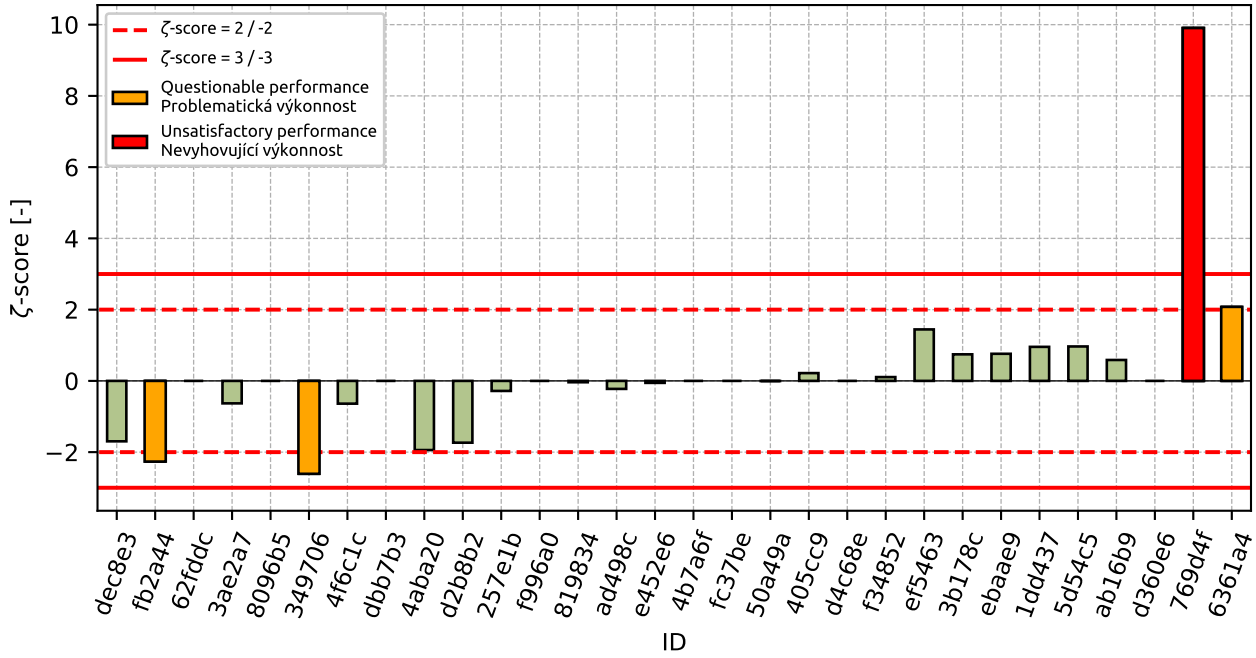

Figure 94: ζ-score

Table 43: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dec8e3	-3.24	-1.7
fb2a44	-3.05	-2.26
62fddc	-2.79	-
3ae2a7	-1.61	-0.63
8096b5	-1.53	-
349706	-1.15	-2.61
4f6c1c	-0.62	-0.64
dbb7b3	-0.51	-
4aba20	-0.47	-1.94
d2b8b2	-0.4	-1.73
257e1b	-0.4	-0.28
f996a0	-0.4	-
819834	-0.13	-0.04
ad498c	-0.09	-0.22
e452e6	-0.05	-0.06
4b7a6f	-0.02	-
fc37be	-0.02	-
50a49a	-0.02	-0.01
405cc9	0.17	0.22
d4c68e	0.36	-
f34852	0.36	0.11
ef5463	0.36	1.44
3b178c	0.59	0.75
ebaae9	0.74	0.76
1dd437	0.93	0.96
5d54c5	1.12	0.97
ab16b9	1.12	0.59
d360e6	1.88	-
769d4f	2.26	9.9
6361a4	2.41	2.08

8.2 Optimum water content

8.2.1 Test results

Table 44: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [%]	u_X [%]
d92fa5	12.3	0.1
fb2a44	13.0	0.4
fc37be	14.2	-
62fddc	14.5	-
f34852	15.0	0.3
6361a4	15.3	2.0
3b178c	15.3	1.0
1dd437	15.5	0.5
ef5463	15.5	0.1
257e1b	15.7	0.3
f996a0	15.8	-
d4c68e	15.9	-
ab16b9	16.0	1.0
50a49a	16.0	1.7
d360e6	16.0	-
dbb7b3	16.1	-
405cc9	16.3	1.0
4aba20	16.4	0.7
3ae2a7	16.5	0.8
819834	16.5	1.8
dec8e3	16.7	0.5
769d4f	17.0	0.4
8096b5	17.0	-
349706	17.0	0.4
d2b8b2	17.0	0.3
ebaae9	17.0	1.0
4b7a6f	17.0	-
5d54c5	17.1	1.0
e452e6	17.4	1.0
ad498c	17.5	0.6
4f6c1c	17.9	0.8

8.2.2 The Numerical Procedure for Determining Outliers

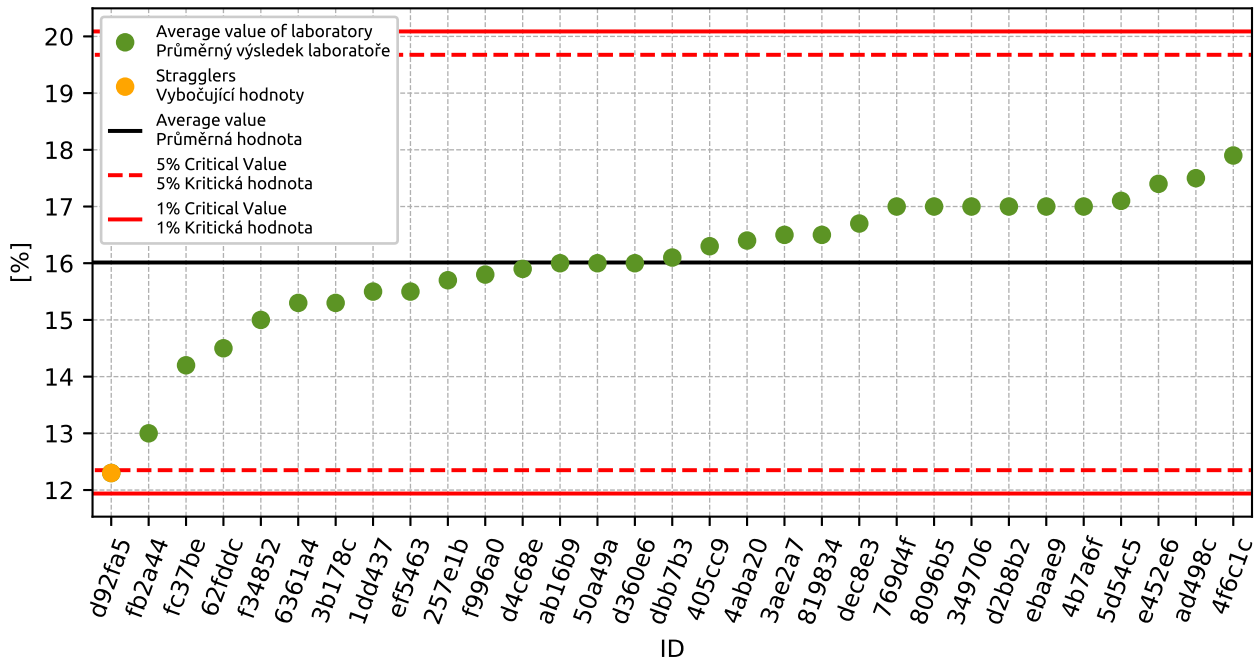

Figure 95: **Grubbs' test** - average values

8.2.3 Mandel's Statistics

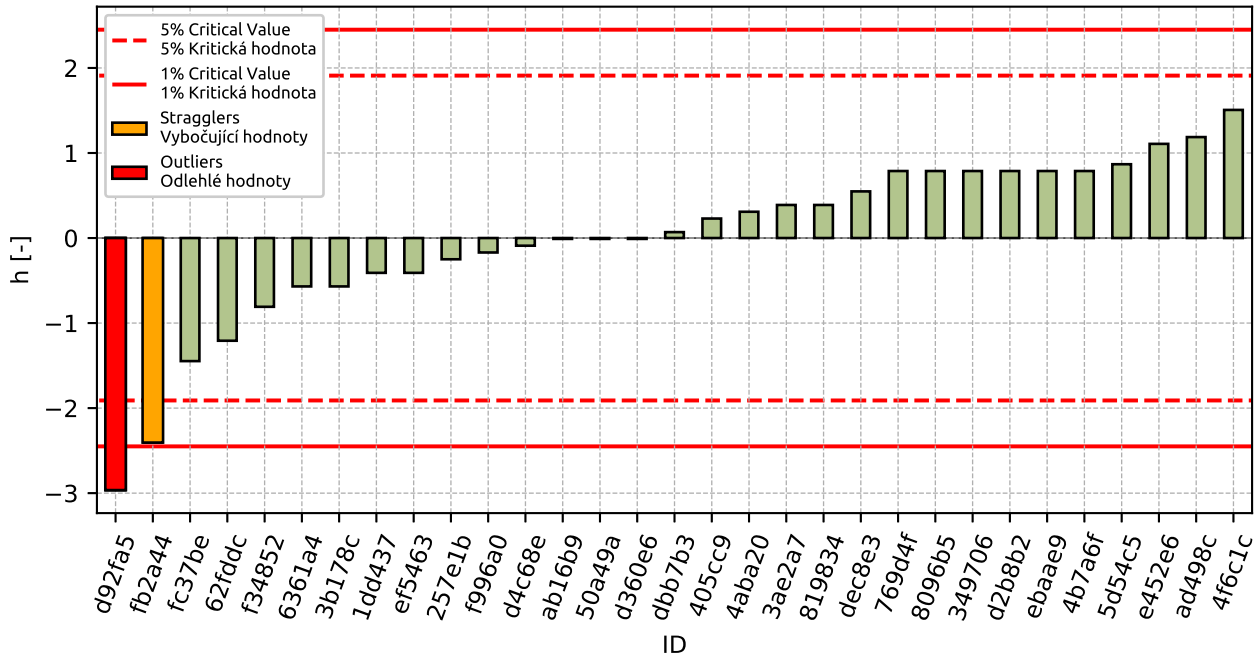

Figure 96: Interlaboratory Consistency Statistic *h*

8.2.4 Descriptive statistics

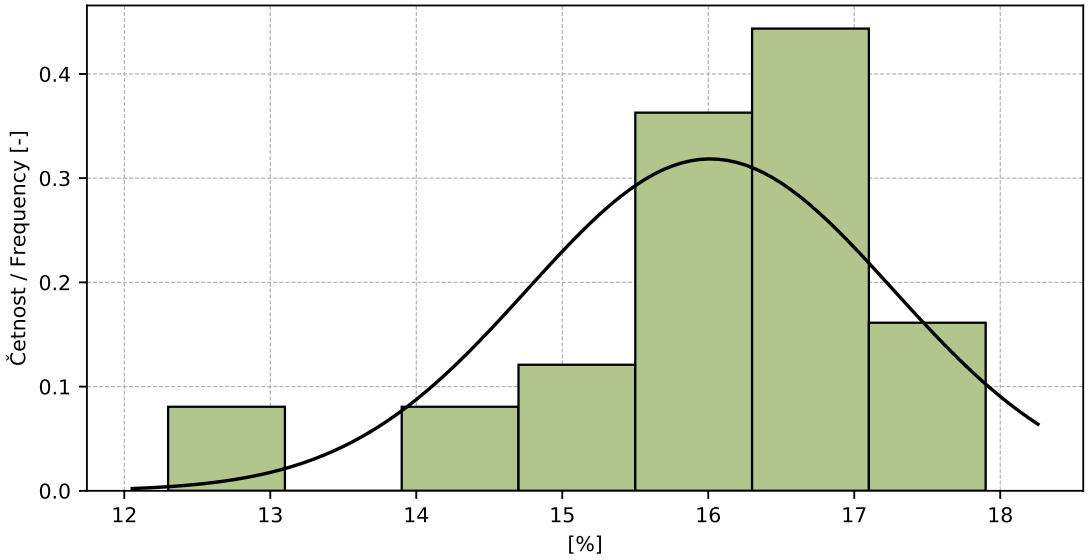

Figure 97: Histogram

Table 45: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	16.0
Výběrová směrodatná odchylka / Sample standard deviation – s	1.25
Vztažná hodnota / Asigned value – x^*	16.2
Robustní směrodatná odchylka / Robust standard deviation – s^*	1.04
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.23
p-hodnota testu normality / p-value of normality test	0.004 [-]

8.2.5 Calculation of Performance Statistics

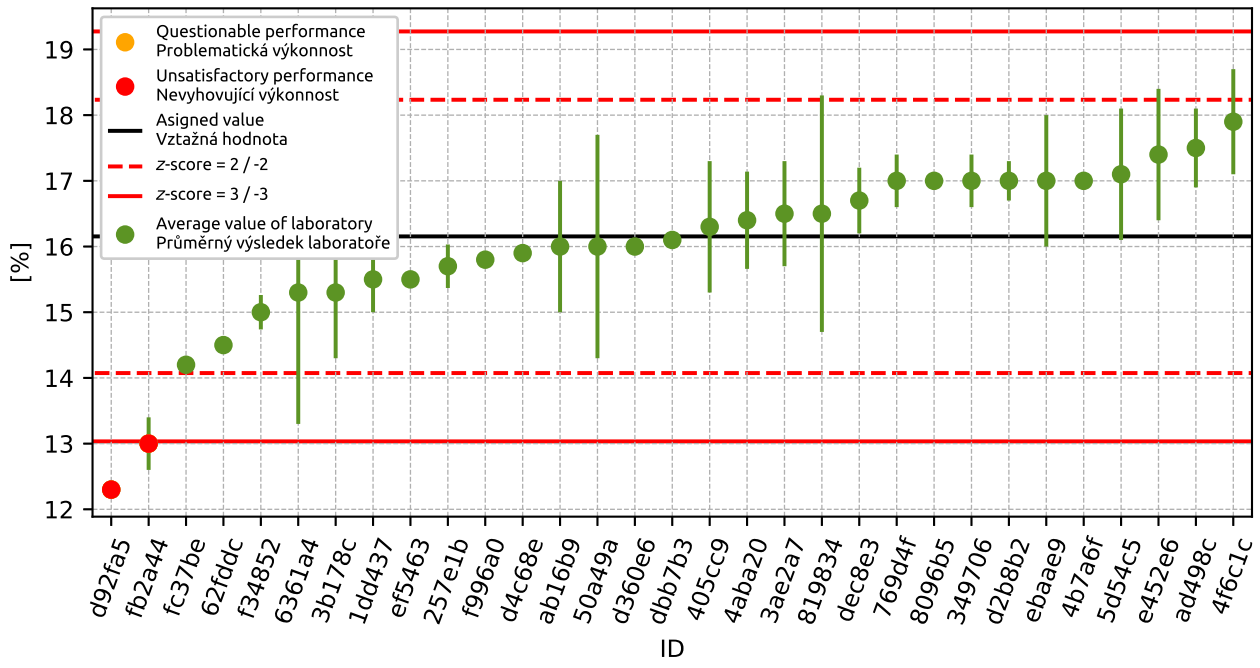

Figure 98: Average values and extended uncertainties of measurement

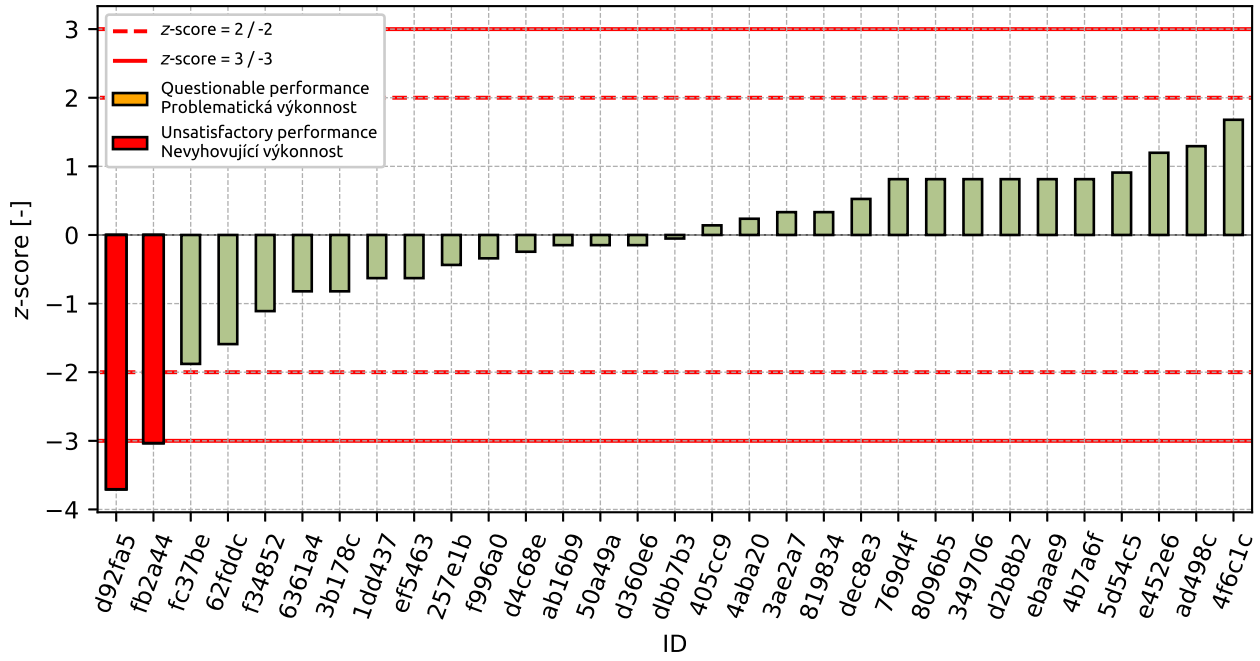

Figure 99: z-score

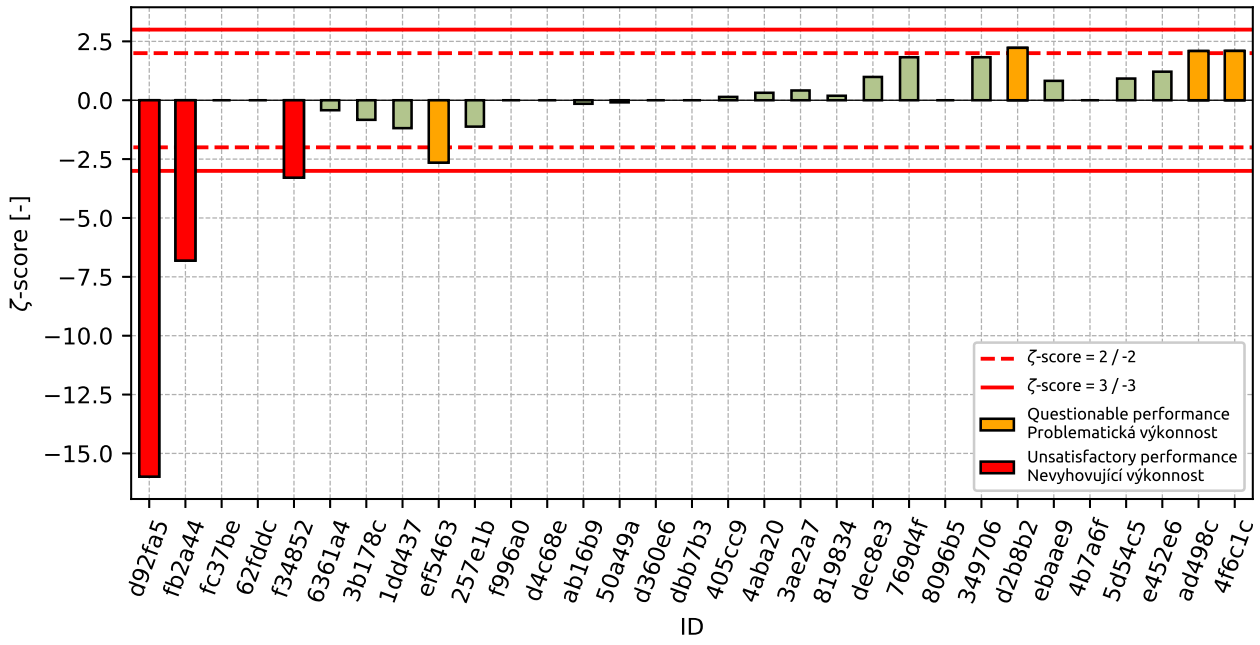

Figure 100: ζ-score

Table 46: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d92fa5	-3.71	-15.99
fb2a44	-3.03	-6.81
fc37be	-1.88	-
62fddc	-1.59	-
f34852	-1.11	-3.29
6361a4	-0.82	-0.42
3b178c	-0.82	-0.83
1dd437	-0.63	-1.19
ef5463	-0.63	-2.65
257e1b	-0.44	-1.12
f996a0	-0.34	-
d4c68e	-0.24	-
ab16b9	-0.15	-0.15
50a49a	-0.15	-0.09
d360e6	-0.15	-
dbb7b3	-0.05	-
405cc9	0.14	0.14
4aba20	0.24	0.32
3ae2a7	0.33	0.42
819834	0.33	0.19
dec8e3	0.52	0.99
769d4f	0.81	1.83
8096b5	0.81	-
349706	0.81	1.83
d2b8b2	0.81	2.23
ebaae9	0.81	0.82
4b7a6f	0.81	-
5d54c5	0.91	0.92
e452e6	1.2	1.21
ad498c	1.29	2.09
4f6c1c	1.68	2.1

9 Appendix – EN 13286-47 – IBI

9.1 Test results

Table 47: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [%]	u_X [%]
f996a0	3.5	-
6361a4	4.0	2.4
8c246a	6.0	-
349706	14.0	2.1
62fddc	16.9	-
fc37be	17.0	-
6de47c	19.0	2.1
4aba20	21.3	-
dbb7b3	21.5	-
e452e6	23.0	1.5
d2b8b2	23.9	3.6
922362	24.0	1.0
769d4f	24.0	2.1
ebaae9	25.0	2.0
d4c68e	26.0	-
405cc9	27.5	1.0
d360e6	28.0	-
ad498c	28.7	0.5
ec262e	30.0	2.0
5d54c5	36.5	2.6

9.2 The Numerical Procedure for Determining Outliers

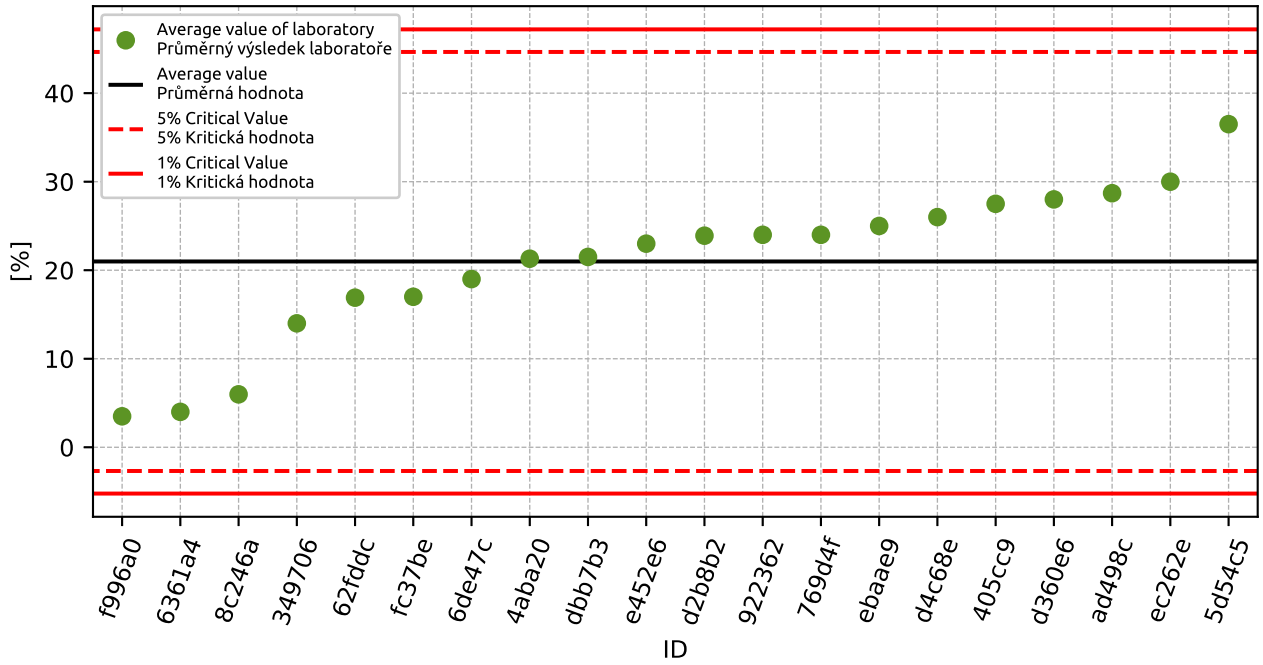

Figure 101: **Grubbs' test** - average values

9.3 Mandel's Statistics

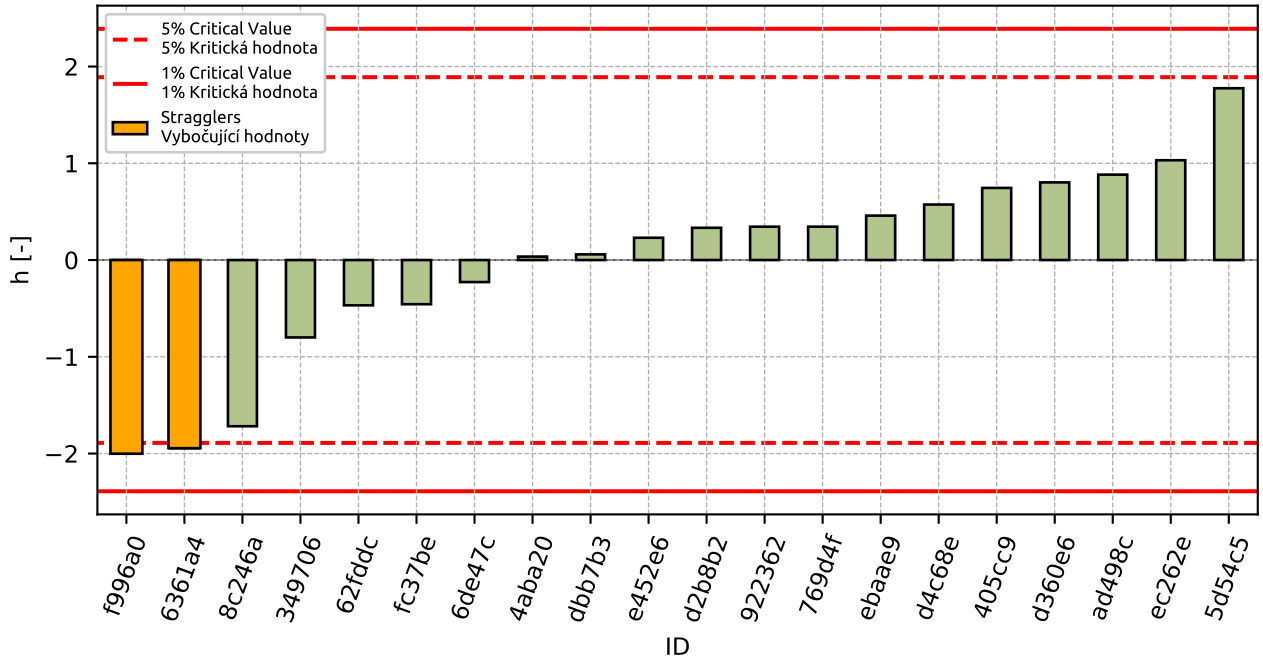

Figure 102: Interlaboratory Consistency Statistic *h*

9.4 Descriptive statistics

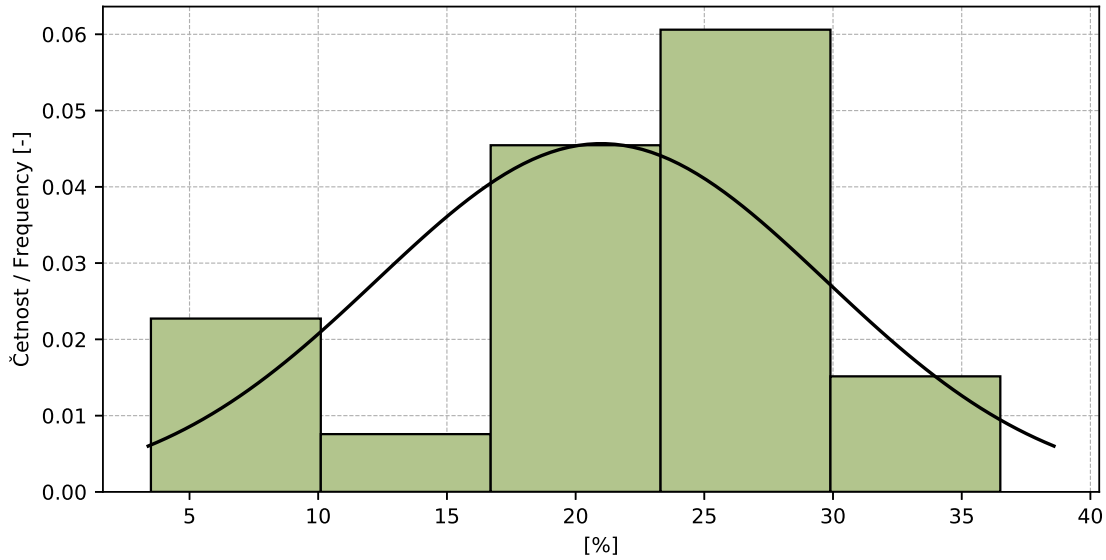

Figure 103: Histogram

Table 48: Descriptive statistics

Value	[%]
Průměrná hodnota / Average value – $\bar{x}$	21.0
Výběrová směrodatná odchylka / Sample standard deviation – s	8.74
Vztažná hodnota / Asigned value – x^*	22.3
Robustní směrodatná odchylka / Robust standard deviation – s^*	7.02
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	1.96
p-hodnota testu normality / p-value of normality test	0.314 [-]

9.5 Calculation of Performance Statistics

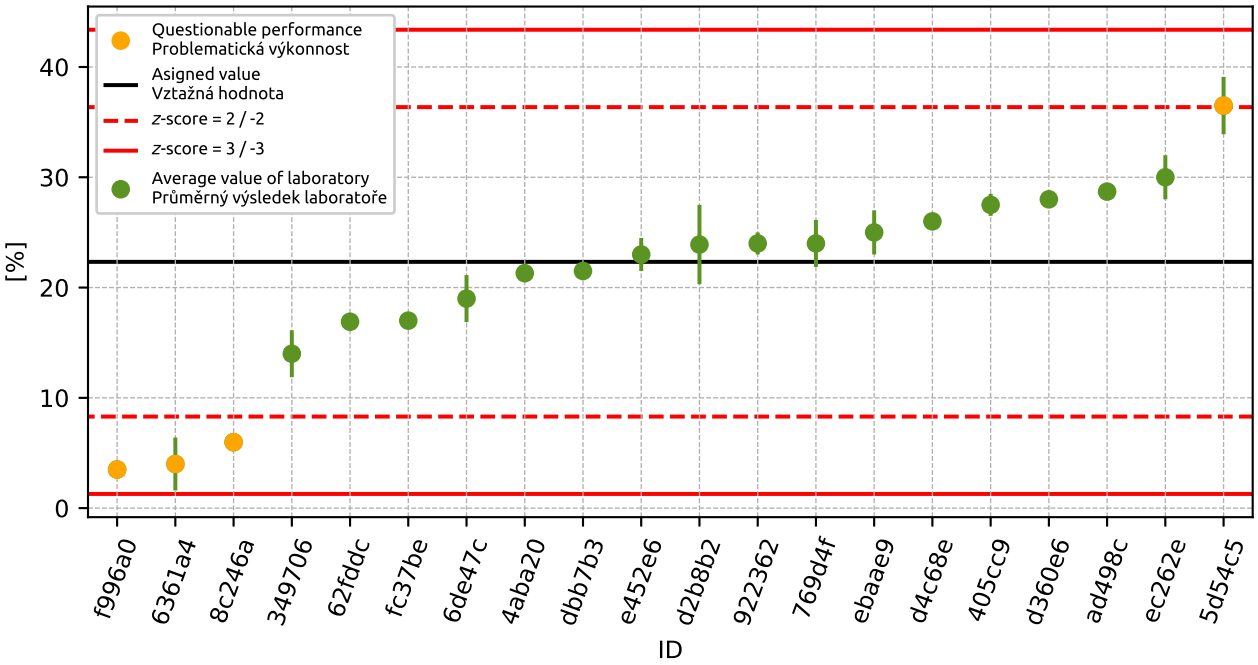

Figure 104: Average values and extended uncertainties of measurement

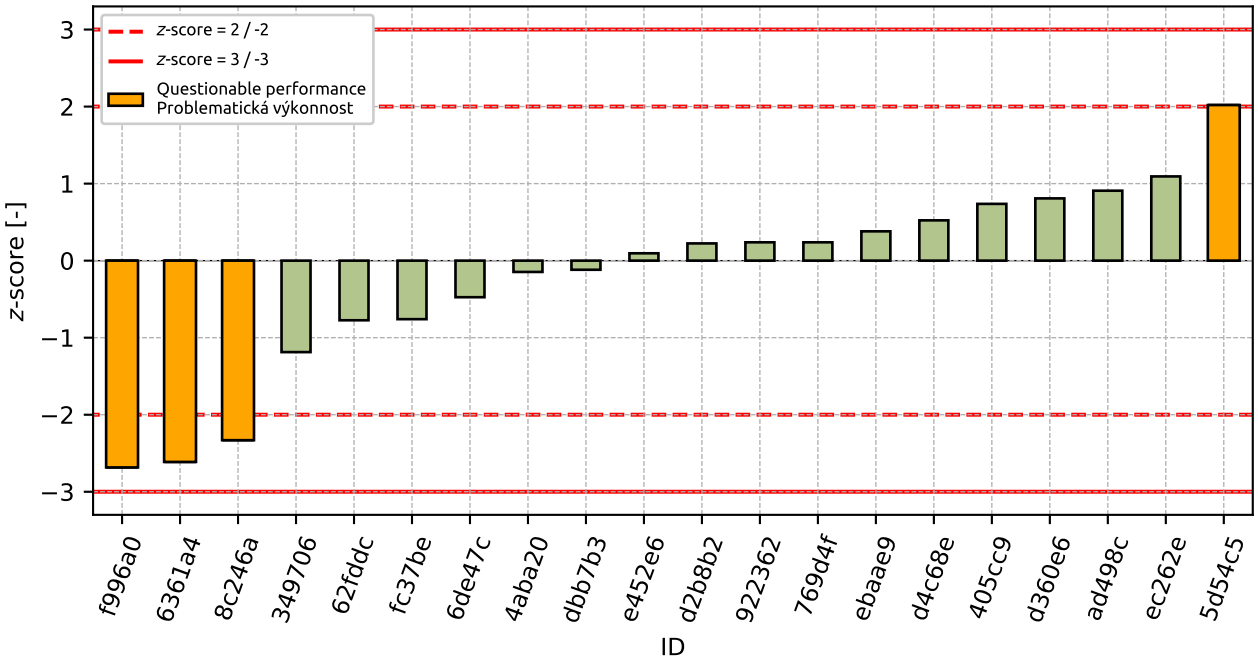

Figure 105: z-score

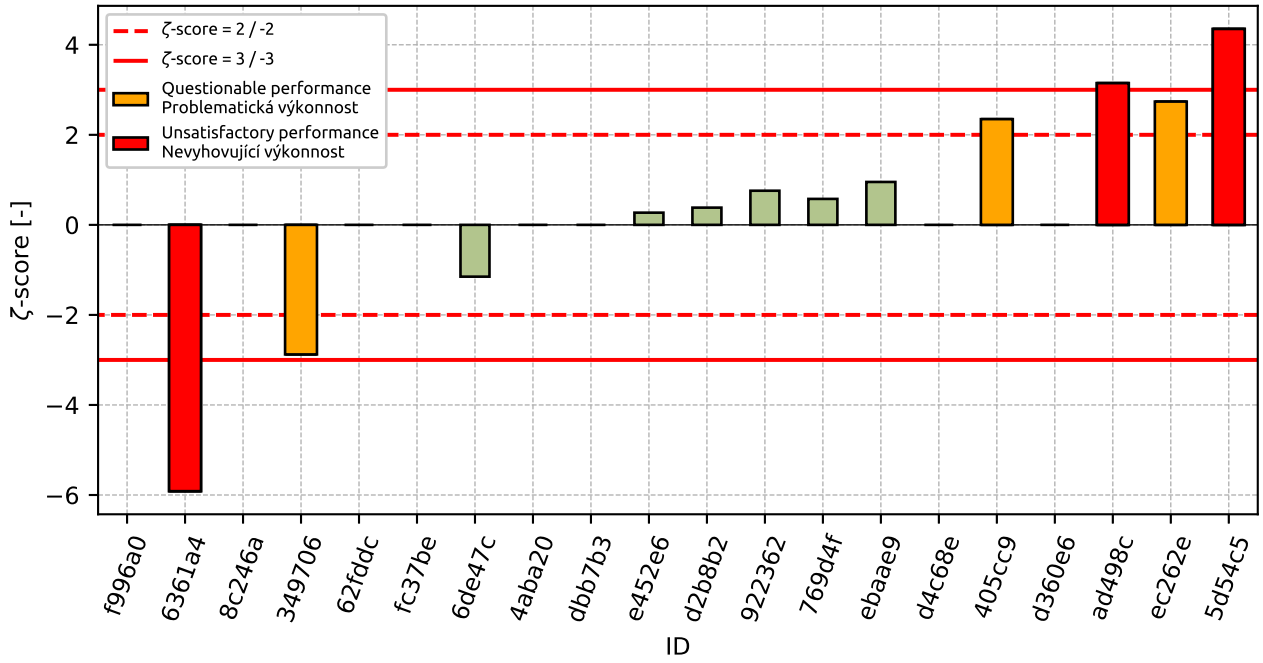

Figure 106: ζ-score

Table 49: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f996a0	-2.68	-
6361a4	-2.61	-5.91
8c246a	-2.33	-
349706	-1.19	-2.88
62fddc	-0.77	-
fc37be	-0.76	-
6de47c	-0.47	-1.15
4aba20	-0.15	-
dbb7b3	-0.12	-
e452e6	0.1	0.27
d2b8b2	0.22	0.38
922362	0.24	0.76
769d4f	0.24	0.58
ebaae9	0.38	0.95
d4c68e	0.52	-
405cc9	0.74	2.35
d360e6	0.81	-
ad498c	0.91	3.15
ec262e	1.09	2.74
5d54c5	2.02	4.35