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
Mechanical Properties of Plastics
ZVP 2020/1

Brno University of Technology
Proficiency testing provider at the SZK FAST
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Date: 8/17/2020

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1 Introduction and Important Contacts

In the year 2020, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZVP 2020/1 whose aim was to verify and assess the conformity of test results across laboratories when testing plastics.

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 527-1, 2 (Tensile modulus) [1, 2]
2. EN ISO 527-1, 2 (Stress at yield, Strain at yield) [1, 2]
3. EN ISO 527-1, 2 (Stress at yield) [1, 2]
4. EN ISO 178 (Flexural modulus) [3]
5. EN ISO 178 (Flexural strength, Flexural strain at flexural strength) [3]
6. EN ISO 179-1 (Charpy unnotched impact strength) [4]
7. EN ISO 179-1 (Charpy notched impact strength (note: notch made by distributor)) [4]
8. EN ISO 179-1 (Charpy notched impact strength (note: notch made by laboratory)) [4]
9. EN ISO 868 (Shore hardness D) [5]
10. EN ISO 306 (Vicat softening temperature VST/A/50) [6]
11. EN ISO 306 (Vicat softening temperature VST/B/50) [6]
12. EN ISO 75-1, -2 (Temperature of deflection under load, method A) [7, 8]
13. EN ISO 75-1, -2 (Temperature of deflection under load, method B) [7, 8]
14. EN ISO 1183-1 (Density) [9]
15. EN ISO 11357-1, -3 (Melting temperature T_{m1} ,Enthalpy of fusion ΔH_{m1}) [10, 11]
16. EN ISO 1133-1 (Melt mass-flow rate) [12]
17. EN ISO 1628-1, -5 (Viscosity) [13, 14]
18. EN ISO 11358-1 (Filler content) [15]

Due to lack of interested participants were open following methods only: **No 4, 5, 10 and 14**.

The supplier, UNIPETROL RPA, s.r.o. – POLYMER INSTITUTE BRNO, odštěpný závod, 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 [16], ISO 13528 [17] and EN ISO/IEC

17043 [18]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

8 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 table shows the participation of laboratories in individual parts of the PTP.

Table 1: List of participants (laboratories)

Laboratory	Address	Accreditation number
Assit Engeneering Ltd.	j.k. Lagera, 2 Baba Iliica Str., bl. 80B, Sofia, 1612, Bulgaria	186-LI
Institut pro testování a certifikaci, a.s.	třída Tomáše Bati 299, Louky, Zlín, 76302, CZ	1004
SILON s.r.o.	Průmyslová 451, Sezimovo Ústí 2, 39102, Česká republika	-
Synpo, akciová společnost	S. K. Neumanna 1316, Pardubice, 532 07, Česká republika	1105.2
UNIPETROL RPA, s.r.o. - POLYMER INSTITUTE BRNO, odštěpný závod	Tkalcovská 36/2, Brno, 60200, Česká republika	1380
UNIPETROL RPA, s.r.o. - POLYMER INSTITUTE BRNO, odštěpný závod	Tkalcovská 36/2, Brno, 60200, Česká republika	-
Unipetrol RPA s.r.o.	Záluží 1, DS 954, Litvínov 7, 43670, Česká republika	-
ŠKODA AUTO a.s.	Třída Václava Klementa 869, Mladá Boleslav, 29301, Česká republika	-

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 ZVP 2020/1 (PT Program) organized by the PT Provider at the SZK FAST. 8 participants (laboratories) took part in the PT Program. PT program focused on ordinary standardized testing of plastics. The test results are evaluated separately for each testing procedure examined. An evaluation of statistical characteristics is included in the Appendix, as well as test results and graphic presentations. The designation of the test procedures is given in the section 1 of this report.

Table 2: 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
b8086d	-	-	-	-	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-
92bbe6	-	-	-	✓	✓	-	-	-	-	✓	-	-	-	✓	-	-	-	-
a0bbcd	-	-	-	-	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-
d568e2	-	-	-	✓	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-
4c09b3	-	-	-	-	-	-	-	-	-	X	-	-	-	✓	-	-	-	-
d748b8	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
76a96b	-	-	-	X	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
8c5320	-	-	-	✓	✓	-	-	-	-	✓	-	-	-	✓	-	-	-	-

References

[1] EN ISO 527-1. *Plastics - Determination of tensile properties - Part 1: General principles*. 2012.

[2] EN ISO 527-2. *Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics*. 2012.

[3] EN ISO 178. *Plastics - Determination of flexural properties*. 2011.

[4] EN ISO 179-1. *Plastics - Determination of Charpy impact properties - Part 1: Non-instrumented impact test*. 2010.

[5] EN ISO 868. *Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)*. 2003.

[6] EN ISO 306. *Plastics - Thermoplastic materials - Determination of Vicat softening temperature (VST)*. 2014.

[7] EN ISO 75-1. *Plastics - Determination of temperature of deflection under load - Part 1: General test method*. 2013.

[8] EN ISO 75-2. *Plastics - Determination of temperature of deflection under load - Part 2: Plastics and ebonite*. 2013.

[9] EN ISO 1183-1. *Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pyknometer method and titration method*. 2013.

[10] EN ISO 11357-1. *Plastics - Differential scanning calorimetry (DSC) - Part 1: General principles*. 2017.

[11] EN ISO 11357-3. *Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization*. 2018.

[12] EN ISO 1133-1. *Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics - Part 1: Standard method*. 2012.

[13] EN ISO 1628-1. *Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscometers - Part 1: General principles*. 2009.

[14] EN ISO 1628-5. *Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscometers - Part 5: Thermoplastic polyester (TP) homopolymers and copolymers*. 2015.

[15] EN ISO 11358-1. *Plastics - Thermogravimetry (TG) of polymers - Part 1: General principles*. 2014.

[16] 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.

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

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

1 Appendix – EN ISO 527-1, 2 (Tensile modulus)

The test method was not opened due to the low number of participants.

2 Appendix – EN ISO 527-1, 2 (Stress at yield, Strain at yield)

The test method was not opened due to the low number of participants.

3 Appendix – EN ISO 527-1, 2 (Stress at yield)

The test method was not opened due to the low number of participants.

4 Appendix – EN ISO 178 (Flexural modulus)

4.1 Test results

Table 3: 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 [%]
d748b8	1710	1720	1650	1800	1580	100	1692	82.3	4.86
92bbe6	1720	1720	1730	1720	1710	12	1720	7.1	0.41
8c5320	1740	1750	1750	1740	1750	13	1746	5.5	0.31
d568e2	1870	1908	1894	1881	1880	26	1887	15.0	0.79
76a96b	2800	2924	2851	2866	2954	61	2879	60.9	2.12

4.2 The Numerical Procedure for Determining Outliers

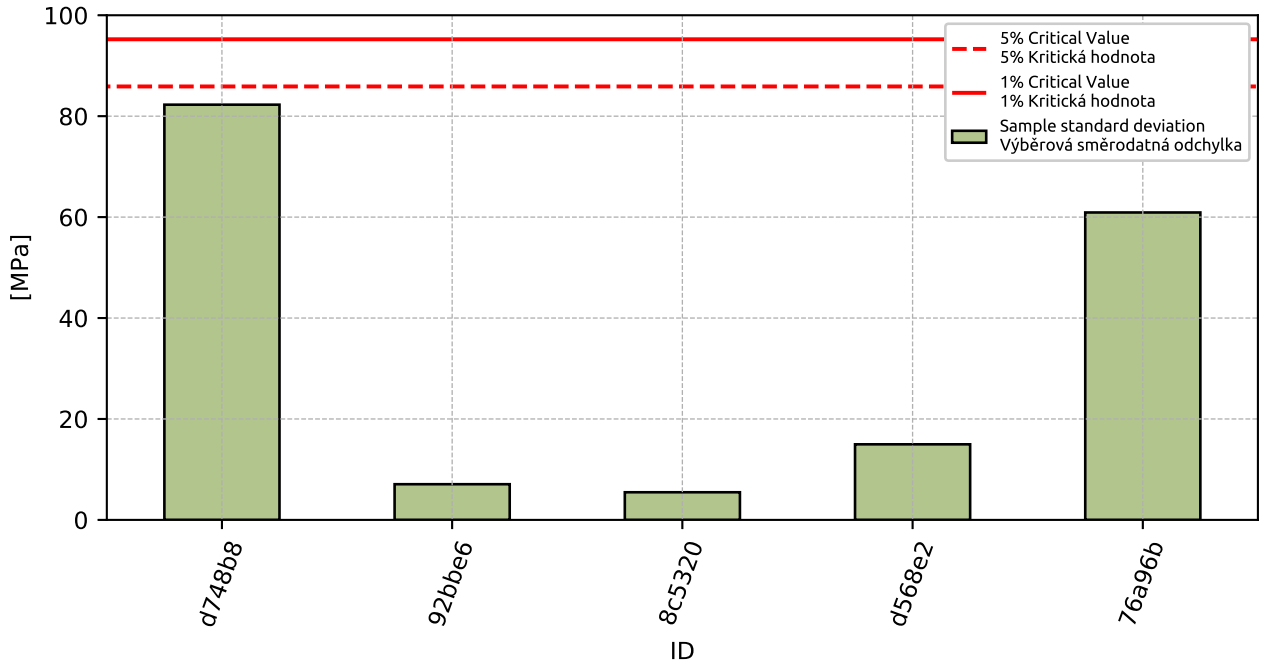

Figure 1: **Cochran's test** - sample standard deviations

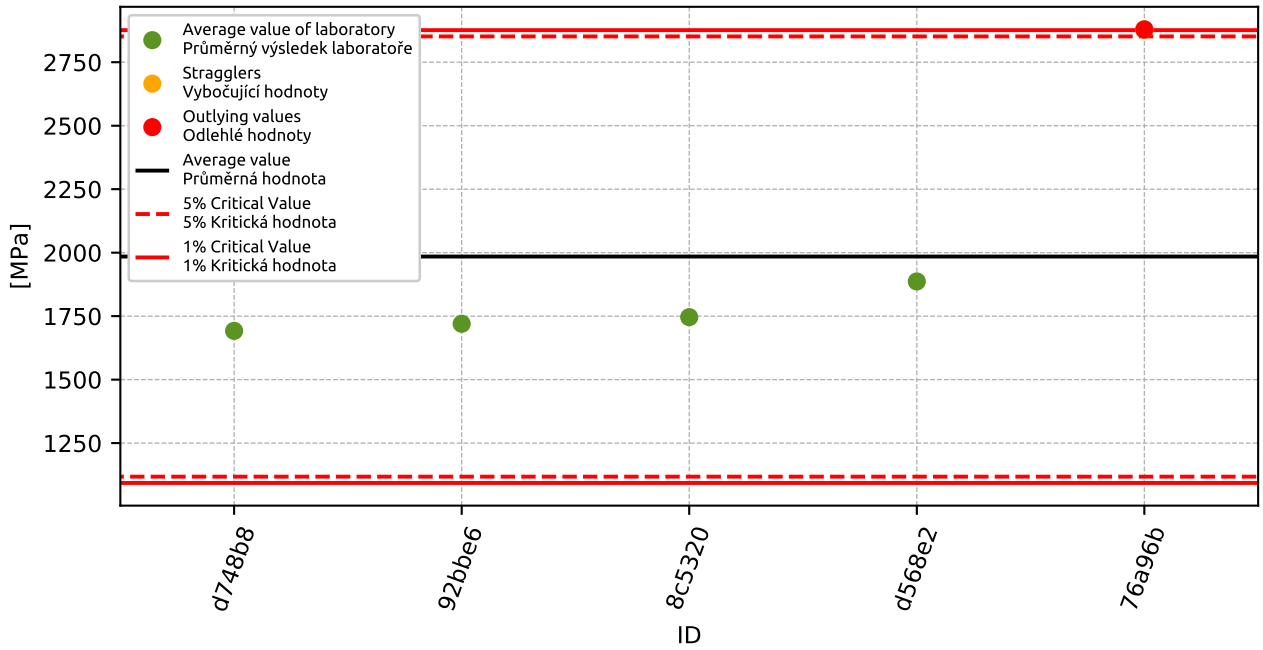

Figure 2: **Grubbs' test** - average values

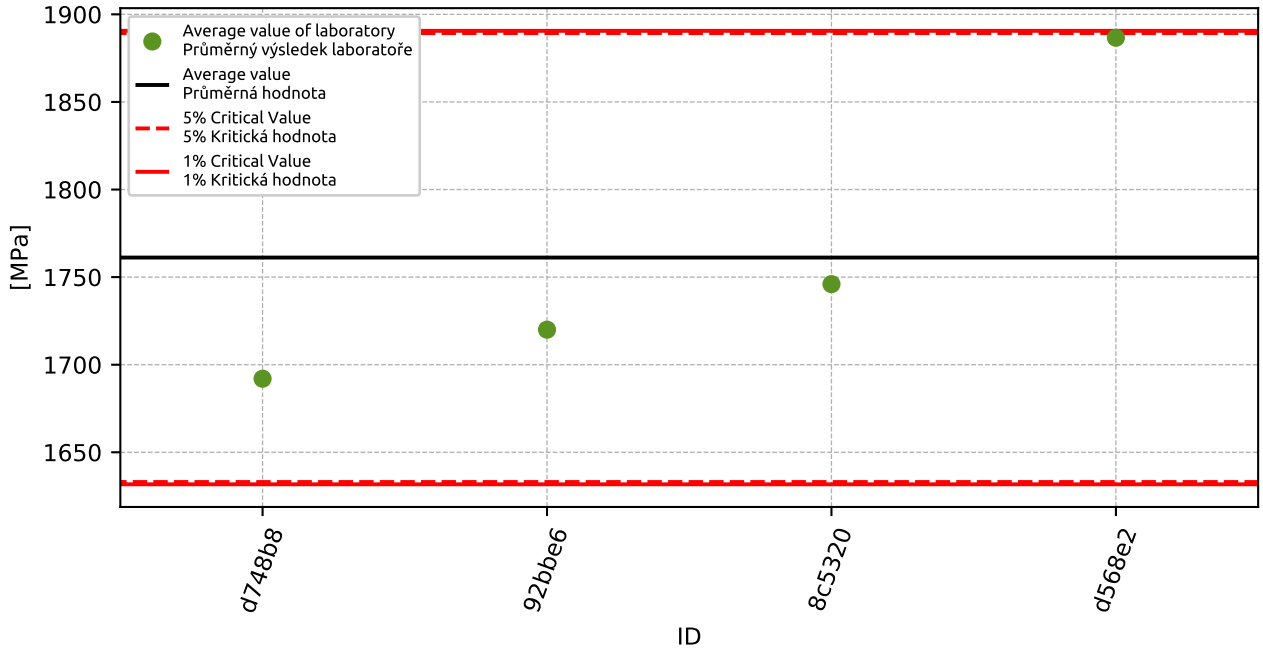

Figure 3: **Grubbs' test** - average values without outliers

4.3 Mandel's Statistics

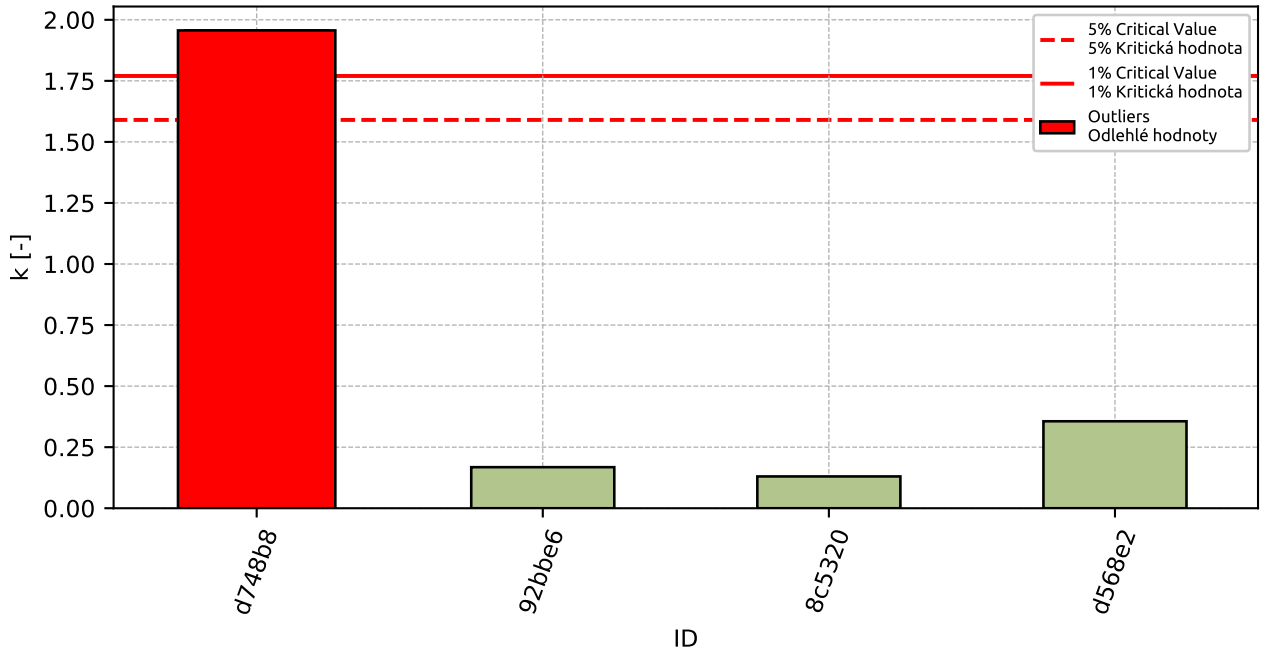

Figure 4: Intralaboratory Consistency Statistic

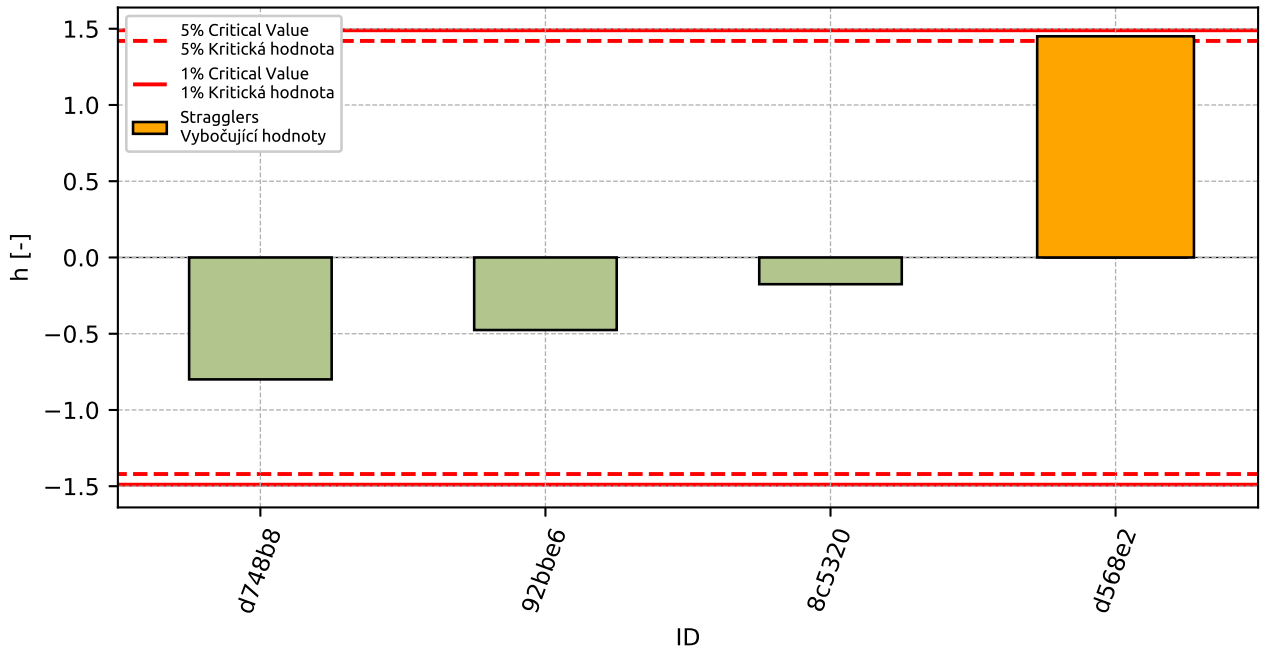

Figure 5: Interlaboratory Consistency Statistic

4.4 Descriptive statistics

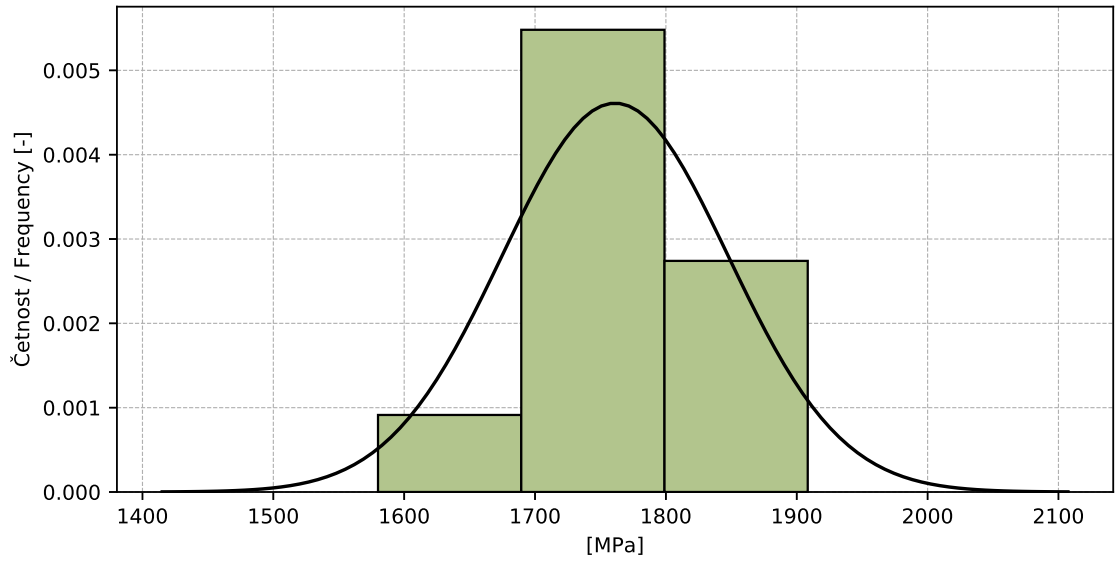

Figure 6: Histogram of all test results

Table 4: Descriptive statistics

Characteristics	[MPa]
Průměrná hodnota / Average value – $\bar{x}$	1761.0
Výběrová směrodatná odchylka / Sample standard deviation – s	86.5
Vztažná hodnota / Asigned value – x^*	1761.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	85.0
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	53.1
p-hodnota testu normality / p-value of normality test	0.036 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	84.5
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	42.1
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	94.3
Opakovatelnost / Repeatability – r	118.0
Reprodukovatelnost / Reproducibility – R	264.0

4.5 Evaluation of Performance Statistics

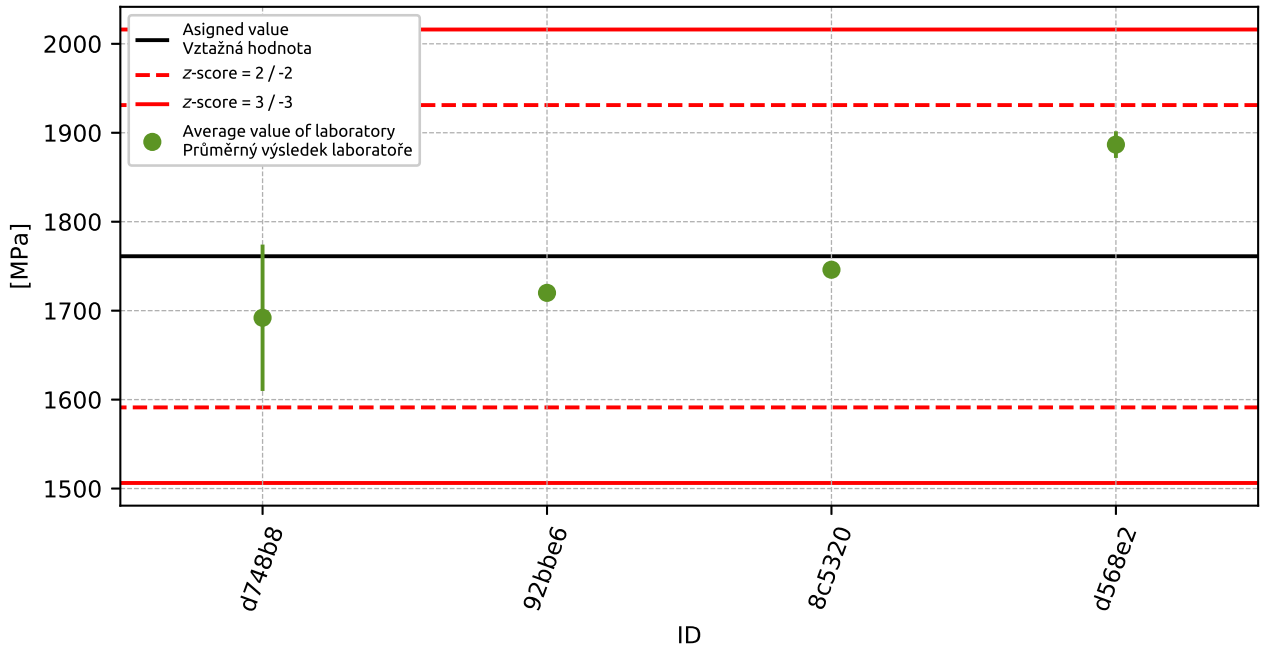

Figure 7: Average values and sample standard deviations

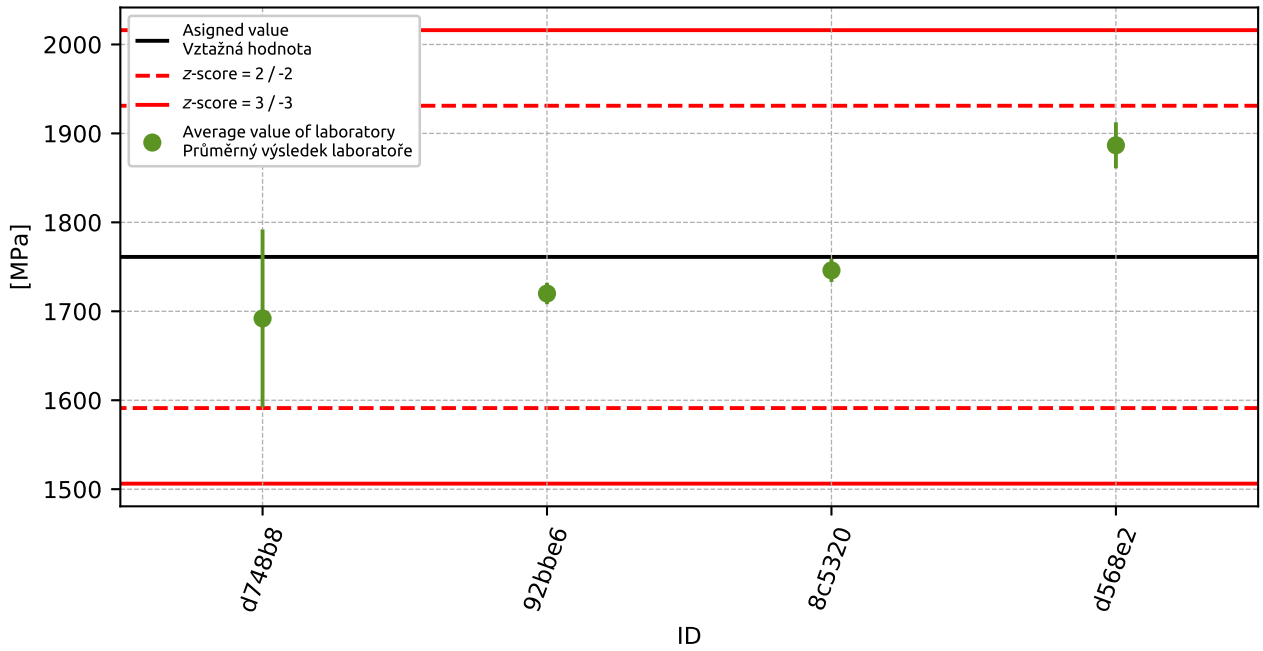

Figure 8: Average values and extended uncertainties of measurement

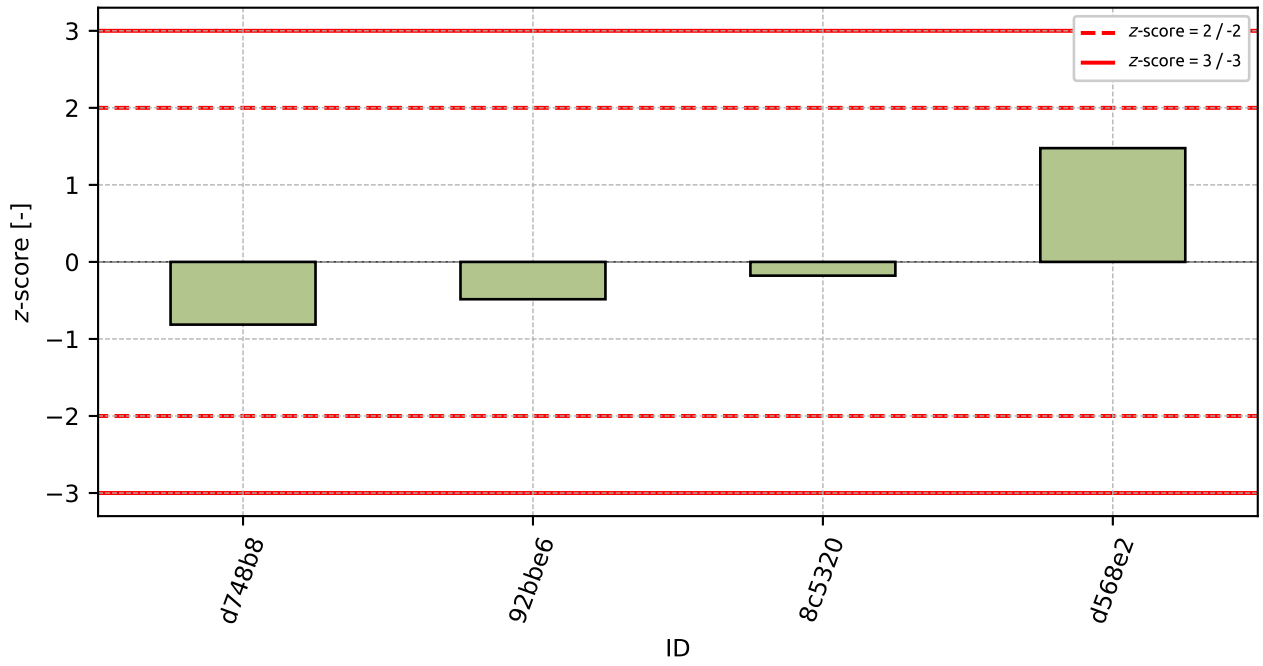

Figure 9: z-score

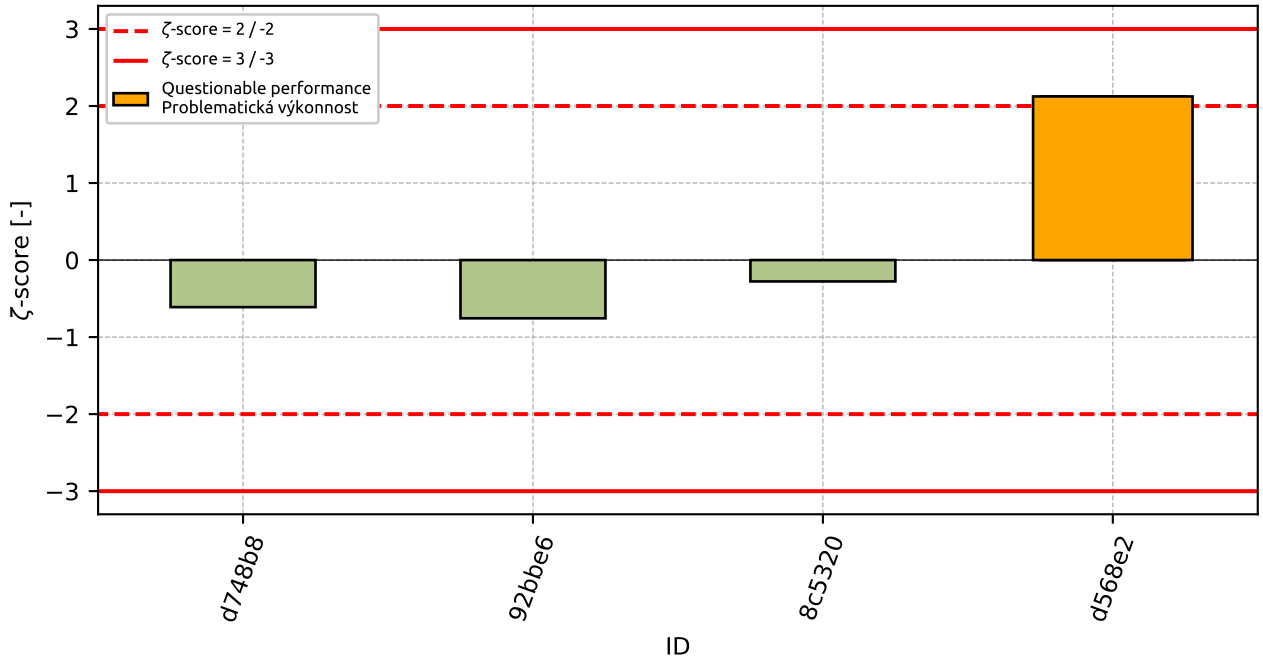

Figure 10: ζ-score

Table 5: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d748b8	-0.81	-0.61
92bbe6	-0.48	-0.76
8c5320	-0.18	-0.28
d568e2	1.48	2.12

5 Appendix – EN ISO 178 (Flexural strength, Flexural strain at flexural strength)

5.1 Flexural strain at flexural strength

5.1.1 Test results

Table 6: 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 [%]
76a96b	3.2	3.1	3.1	3.1	3.1	0.1	3.1	0.05	1.62
b8086d	4.8	4.8	4.7	4.8	4.8	0.1	4.8	0.05	1.05
8c5320	6.2	6.2	6.1	6.0	6.2	0.2	6.1	0.09	1.46
d748b8	6.4	6.1	6.2	6.1	6.4	2.3	6.2	0.15	2.43
92bbe6	6.2	6.3	6.3	6.3	6.3	0.0	6.3	0.04	0.71

5.1.2 The Numerical Procedure for Determining Outliers

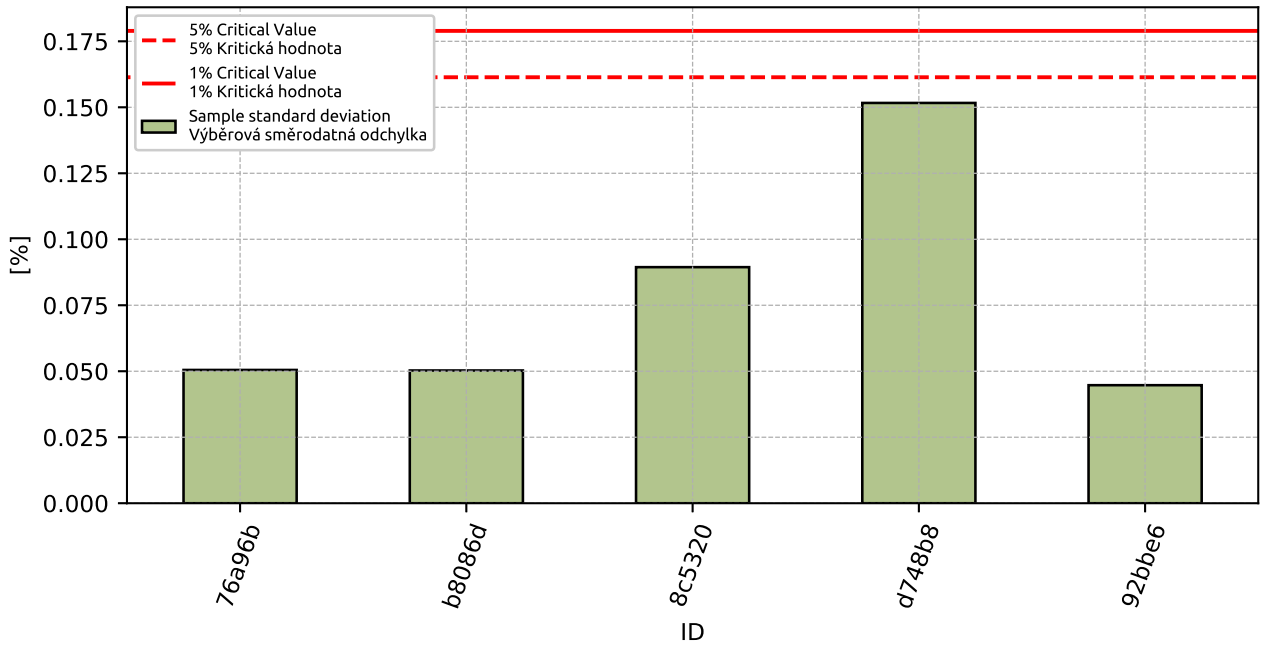

Figure 11: **Cochran's test** - sample standard deviations

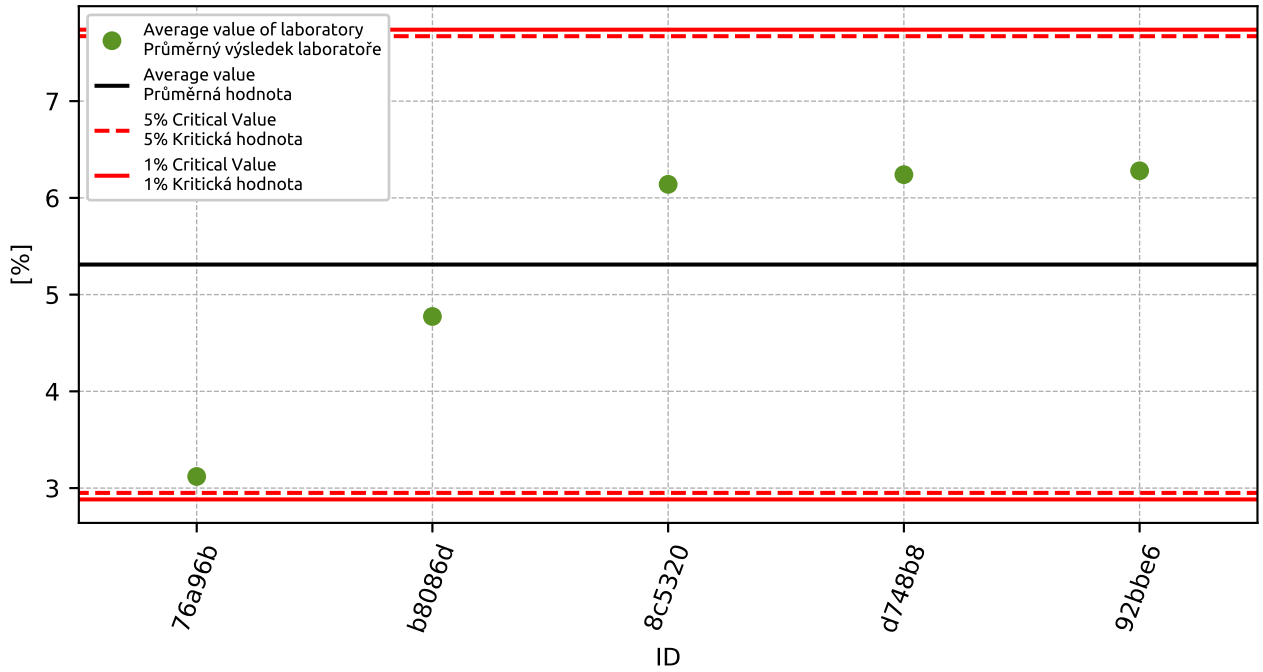

Figure 12: **Grubbs' test** - average values

5.1.3 Mandel's Statistics

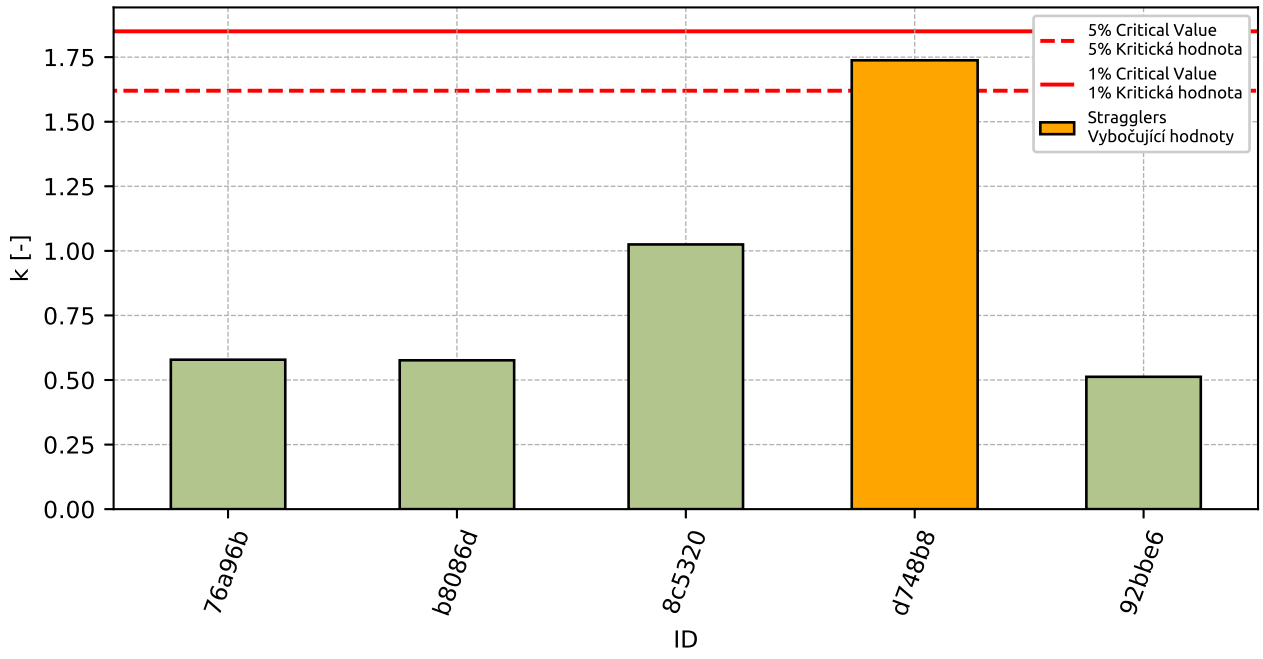

Figure 13: Intralaboratory Consistency Statistic

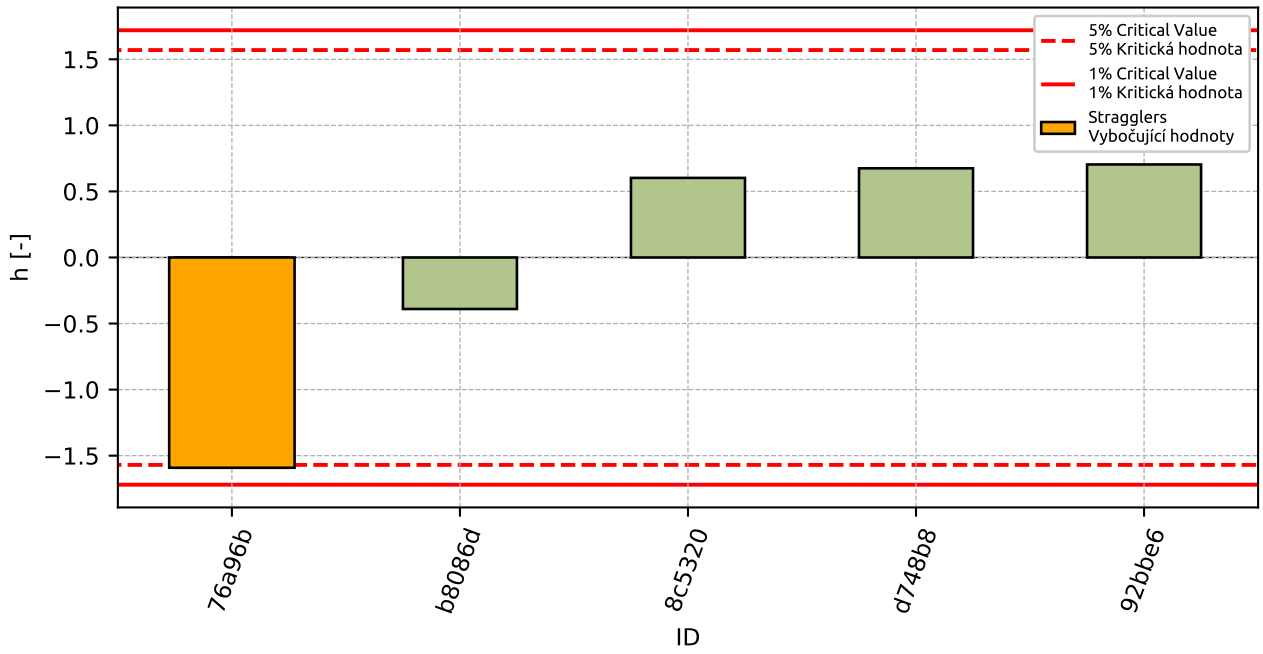

Figure 14: Interlaboratory Consistency Statistic

5.1.4 Descriptive statistics

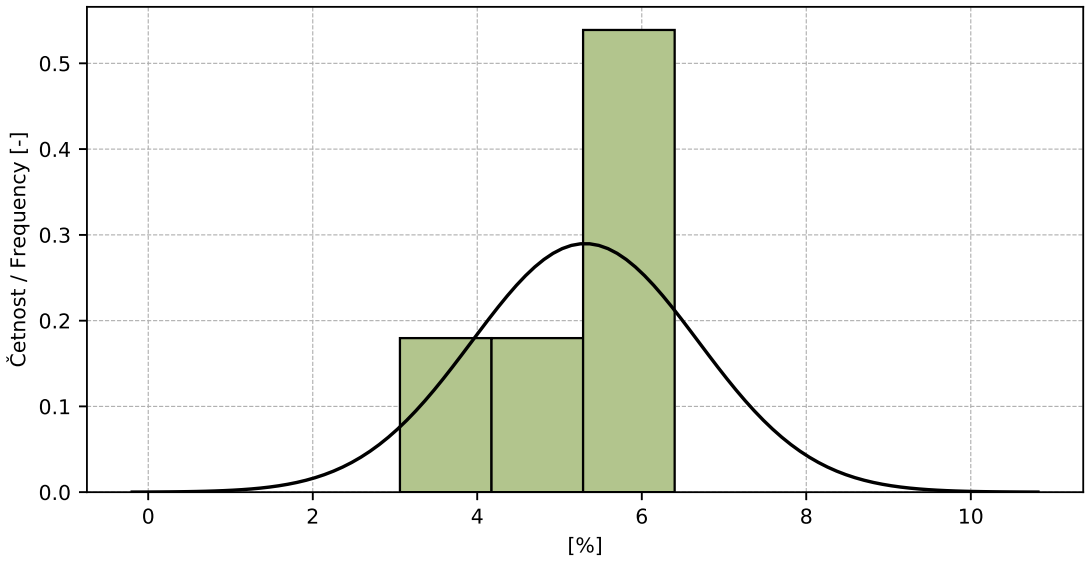

Figure 15: Histogram of all test results

Table 7: Descriptive statistics

Characteristics	[%]
Průměrná hodnota / Average value – $\bar{x}$	5.3
Výběrová směrodatná odchylka / Sample standard deviation – s	1.38
Vztažná hodnota / Asigned value – x^*	6.1
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.22
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.12
p-hodnota testu normality / p-value of normality test	0.0 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	1.38
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.09
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	1.38
Opakovatelnost / Repeatability – r	0.2
Reprodukovatelnost / Reproducibility – R	3.9

5.1.5 Evaluation of Performance Statistics

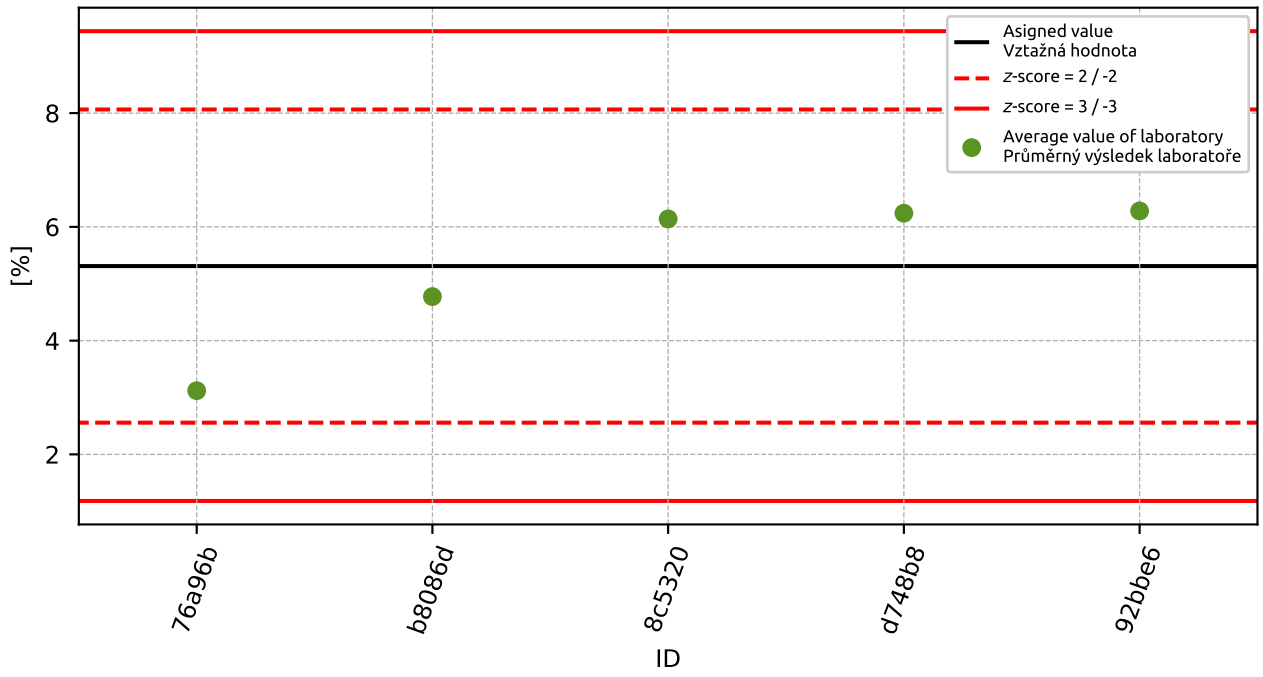

Figure 16: Average values and sample standard deviations

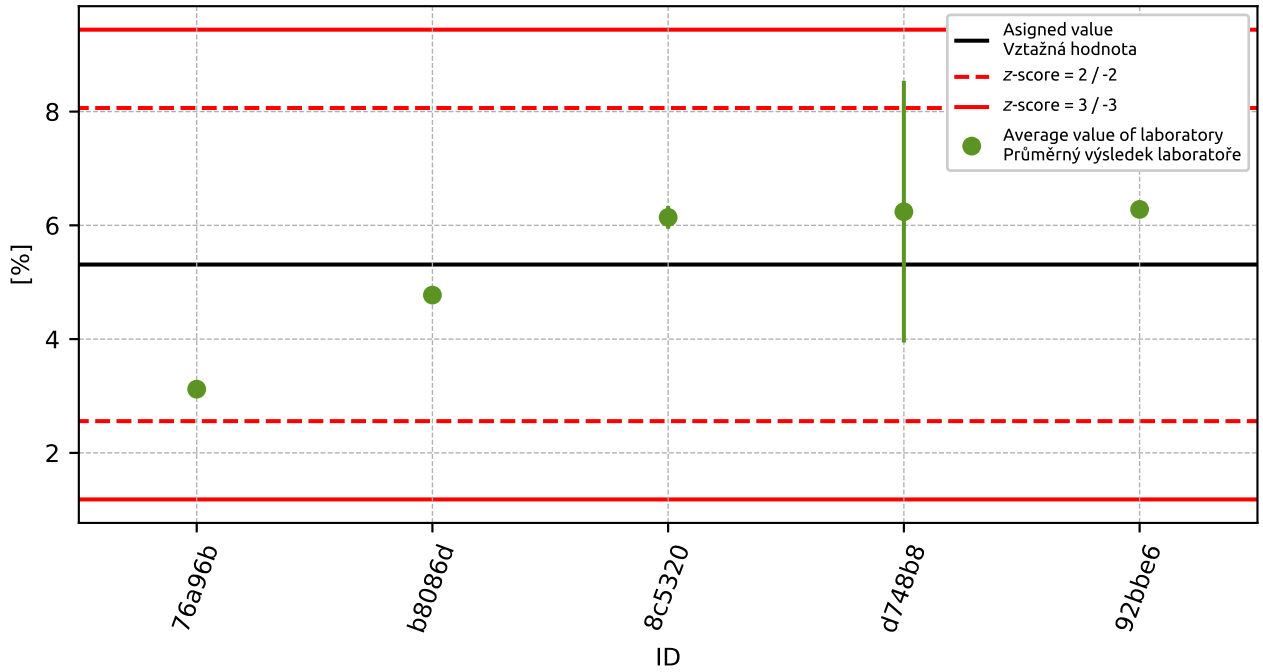

Figure 17: Average values and extended uncertainties of measurement

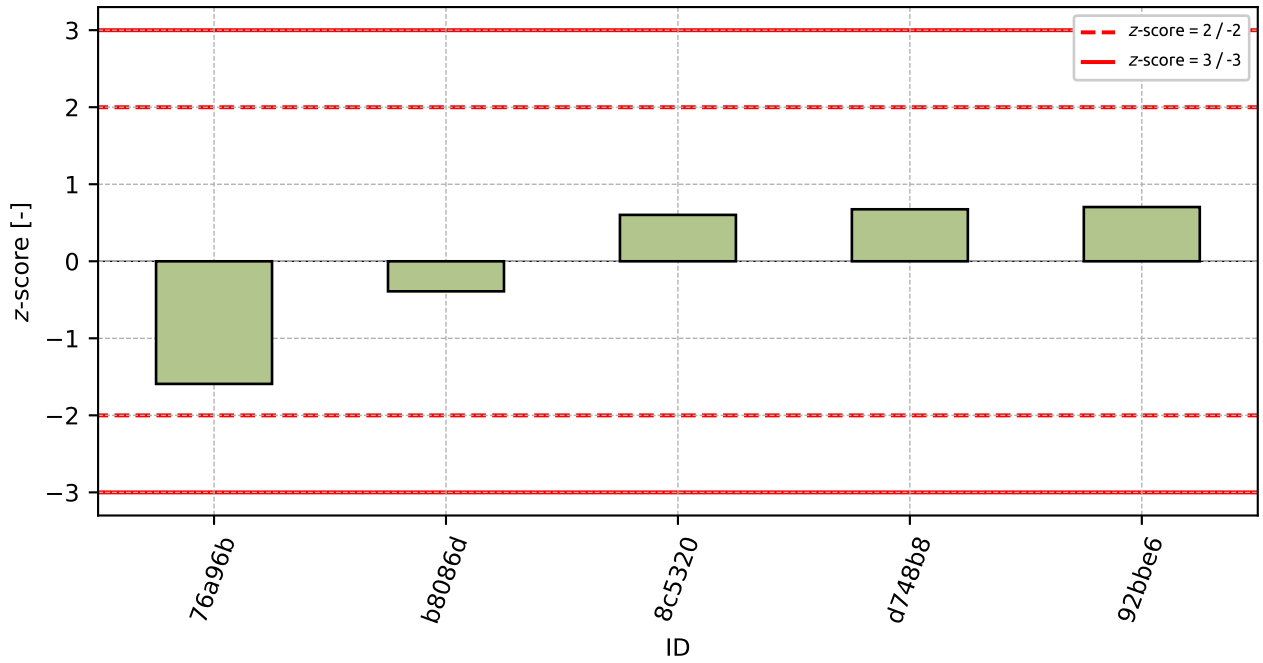

Figure 18: z-score

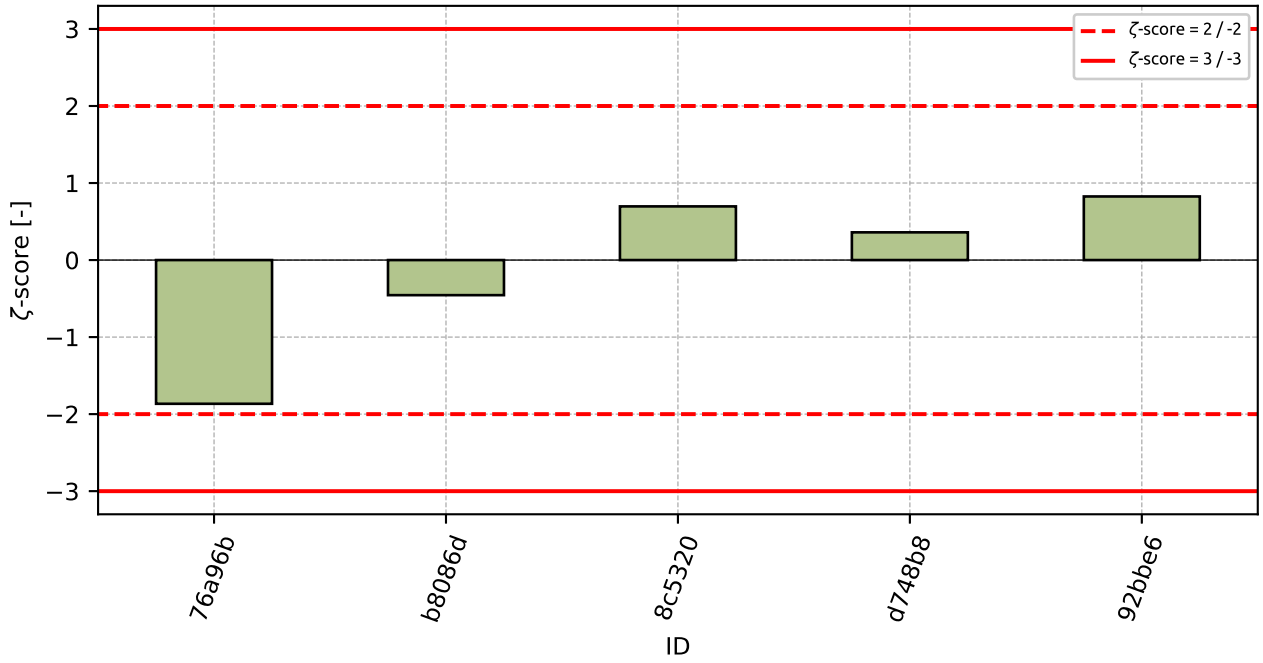

Figure 19: ζ-score

Table 8: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
76a96b	-1.59	-1.87
b8086d	-0.39	-0.46
8c5320	0.6	0.7
d748b8	0.68	0.36
92bbe6	0.7	0.83

5.2 Flexural strength

5.2.1 Test results

Table 9: 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 [%]
92bbe6	45.8	45.7	45.7	45.2	45.3	0.6	45.5	0.27	0.59
76a96b	45.3	45.7	45.5	46.0	45.9	0.3	45.7	0.29	0.63
8c5320	46.3	46.0	46.0	45.7	45.9	0.4	46.0	0.22	0.47
b8086d	46.1	46.1	46.2	46.7	46.3	1.0	46.3	0.24	0.53
d748b8	48.1	47.9	47.4	47.6	47.2	1.5	47.6	0.36	0.77

5.2.2 The Numerical Procedure for Determining Outliers

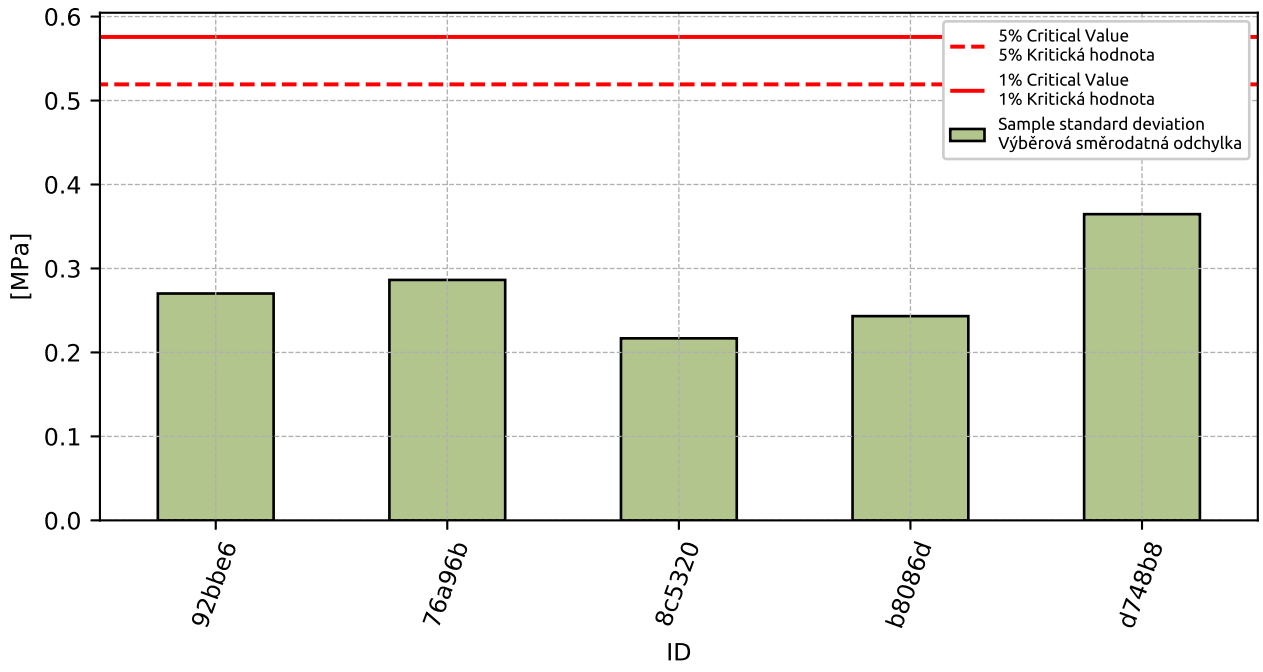

Figure 20: **Cochran's test** - sample standard deviations

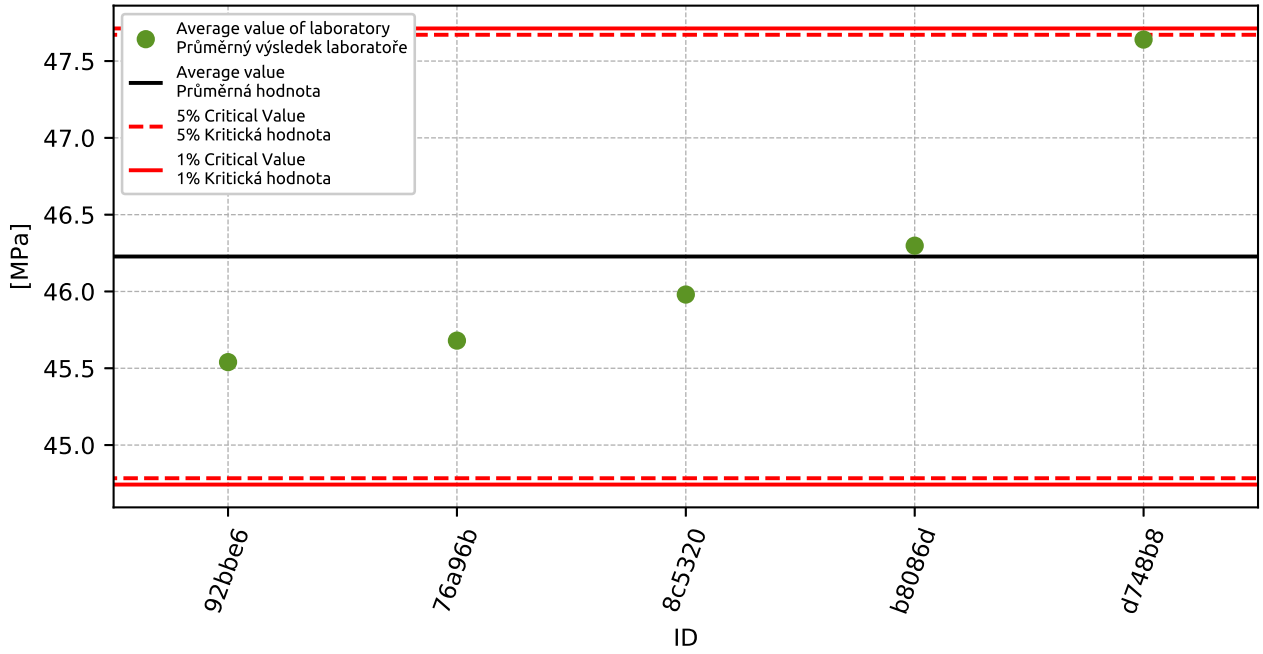

Figure 21: **Grubbs' test** - average values

5.2.3 Mandel's Statistics

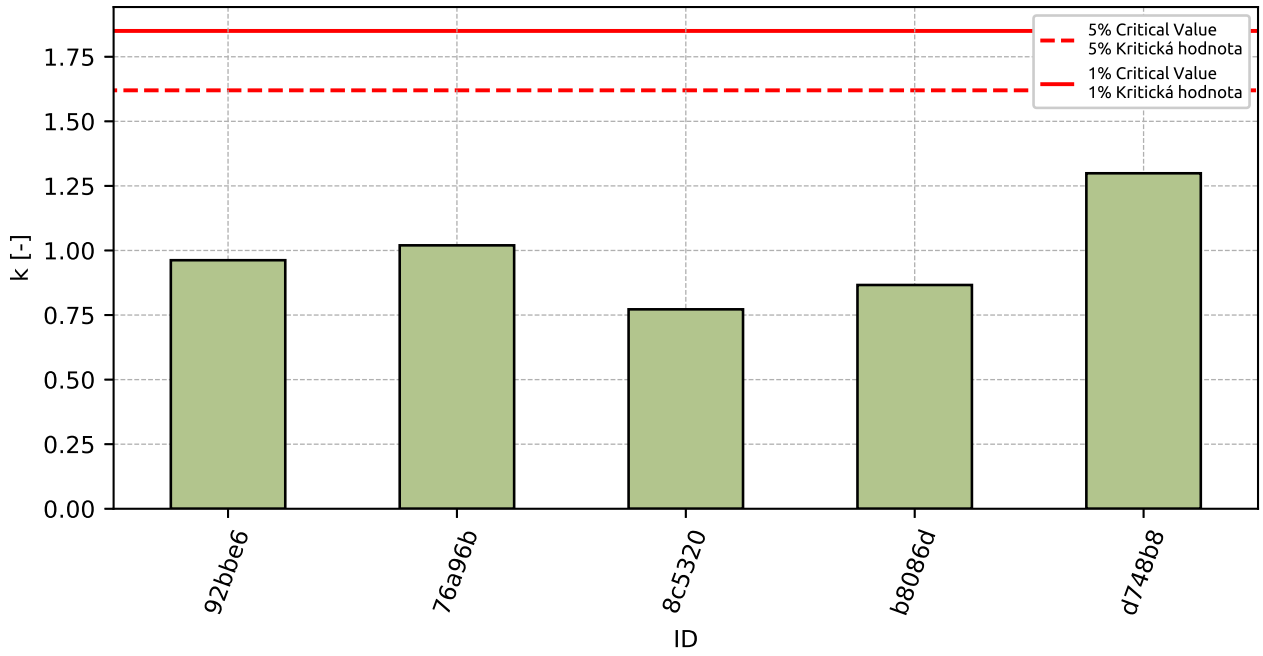

Figure 22: Intralaboratory Consistency Statistic

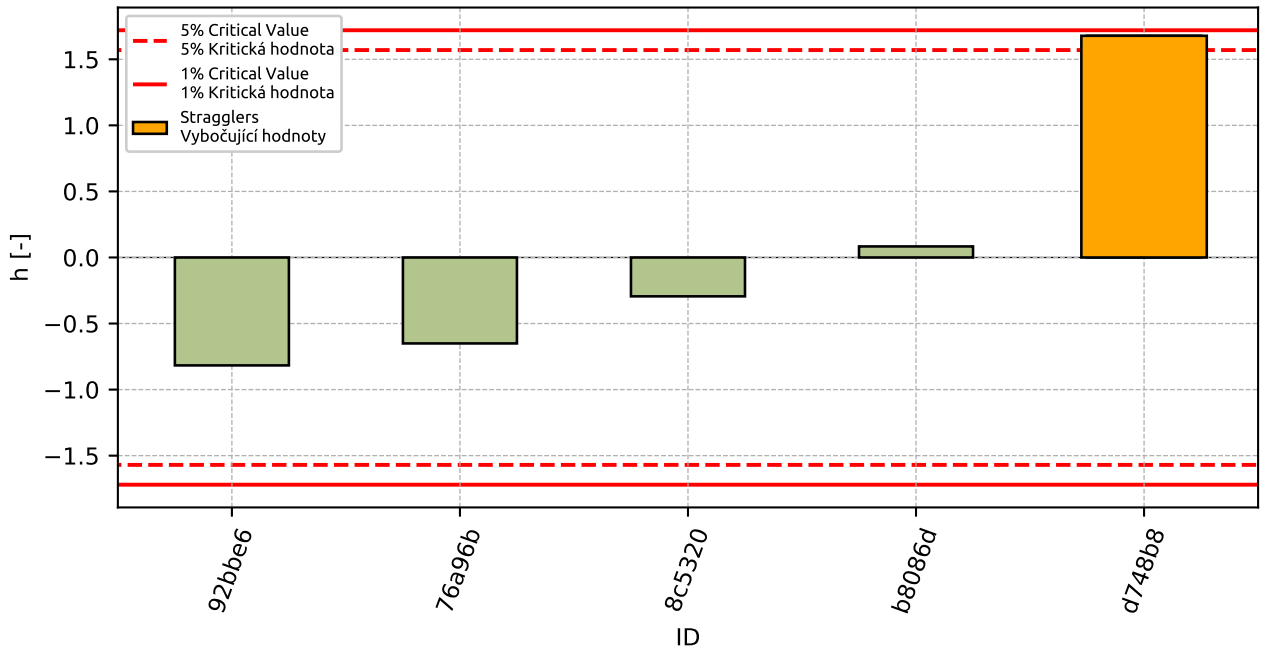

Figure 23: Interlaboratory Consistency Statistic

5.2.4 Descriptive statistics

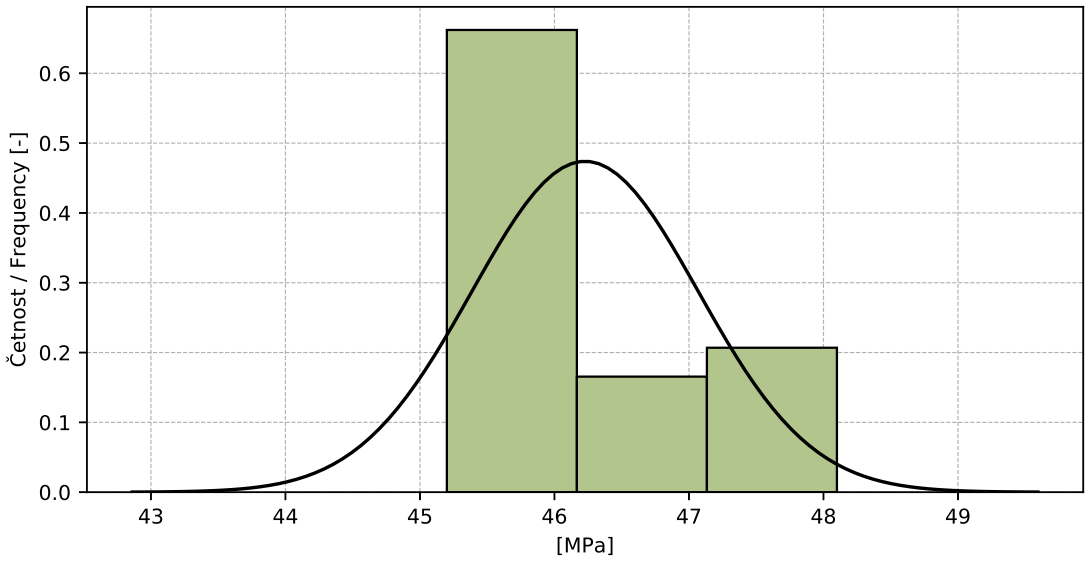

Figure 24: Histogram of all test results

Table 10: Descriptive statistics

Characteristics	[MPa]
Průměrná hodnota / Average value – $\bar{x}$	46.2
Výběrová směrodatná odchylka / Sample standard deviation – s	0.84
Vztažná hodnota / Asigned value – x^*	46.2
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.84
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.92
p-hodnota testu normality / p-value of normality test	0.005 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.83
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.28
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.88
Opakovatelnost / Repeatability – r	0.8
Reprodukovatelnost / Reproducibility – R	2.5

5.2.5 Evaluation of Performance Statistics

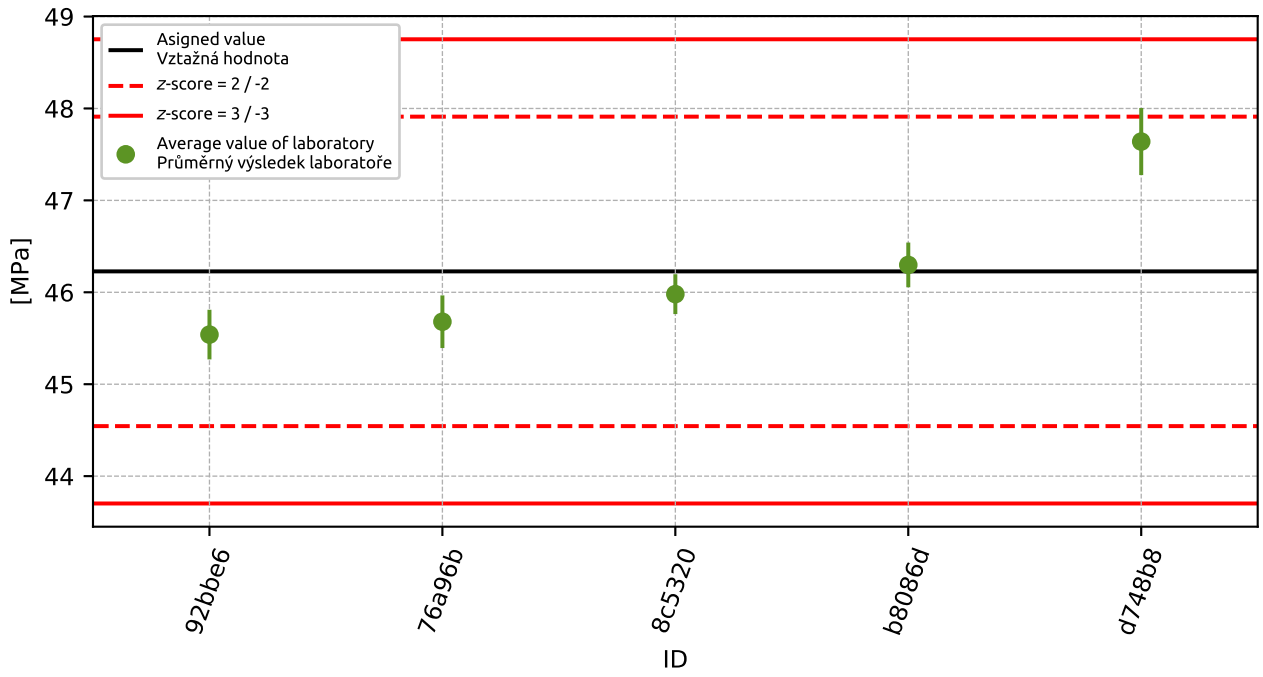

Figure 25: Average values and sample standard deviations

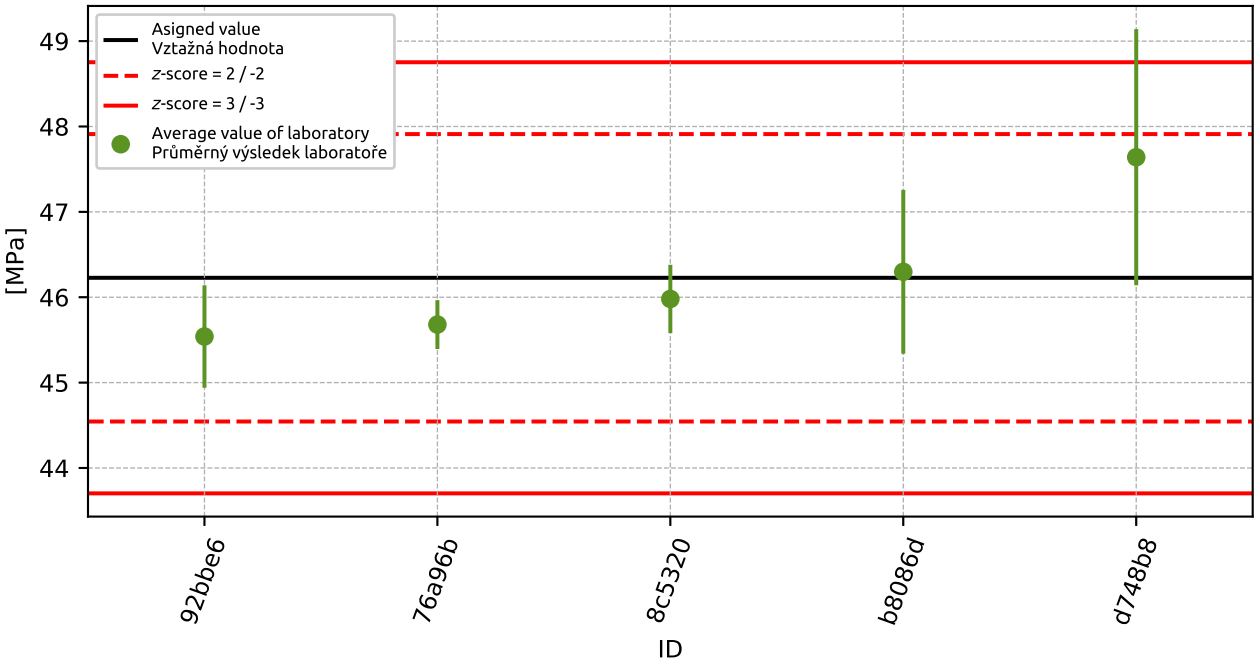

Figure 26: Average values and extended uncertainties of measurement

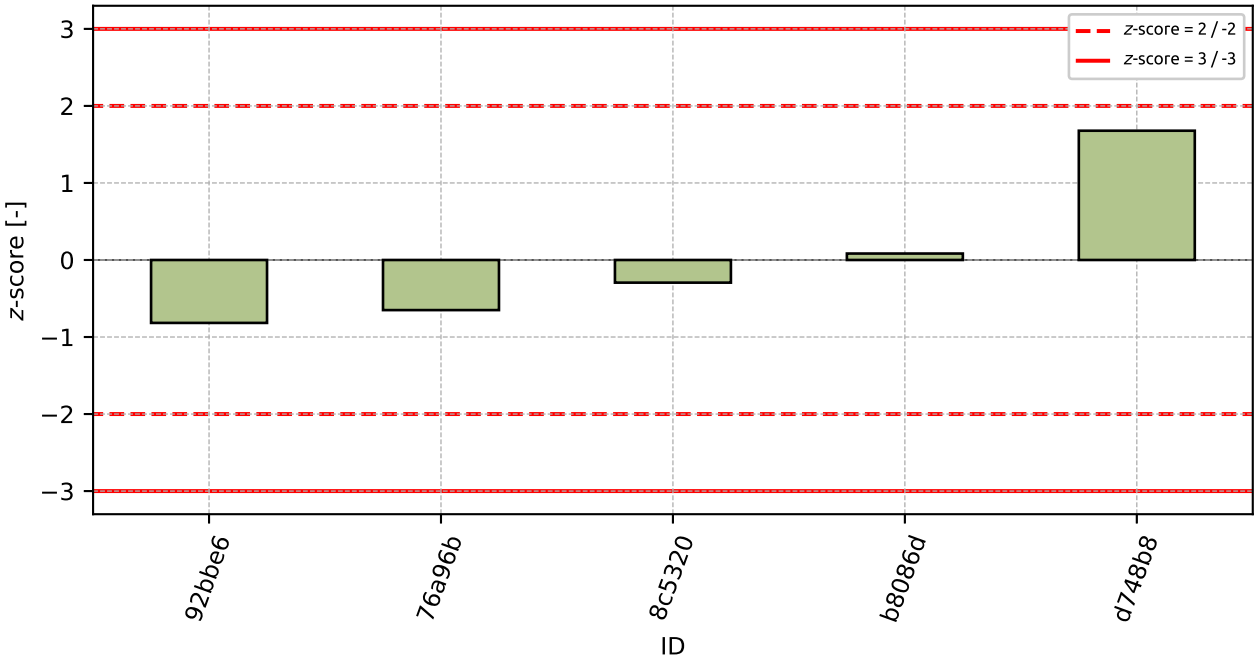

Figure 27: z-score

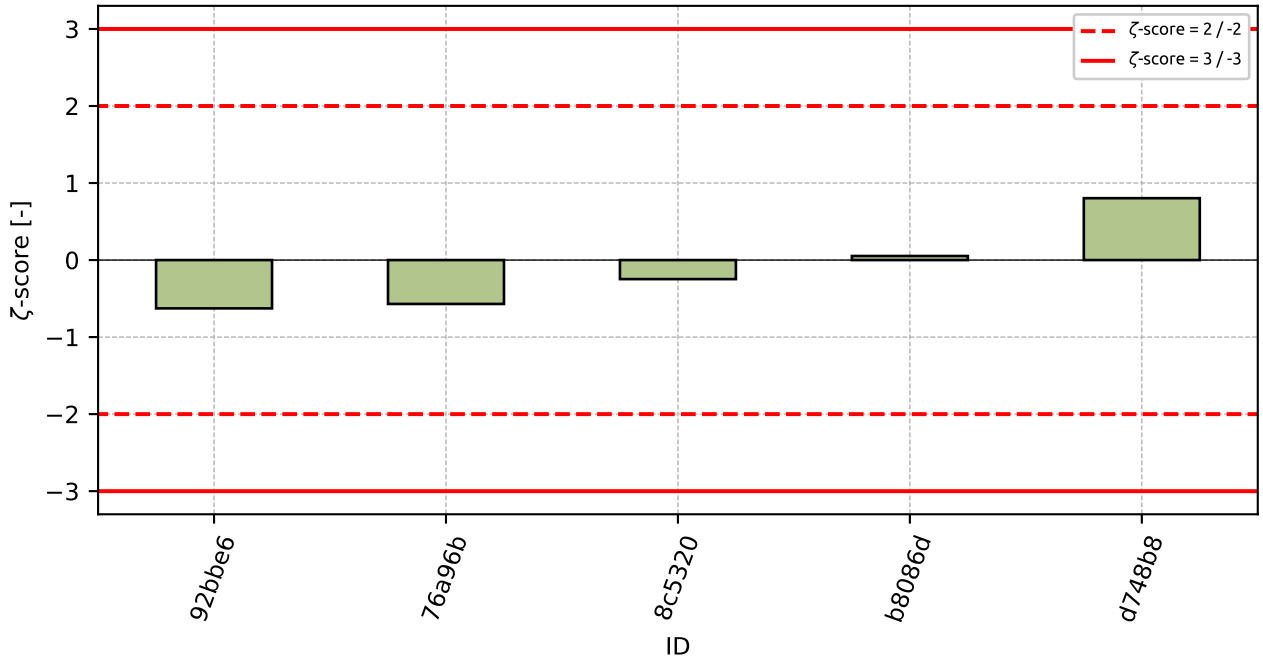

Figure 28: ζ-score

Table 11: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
92bbe6	-0.82	-0.63
76a96b	-0.65	-0.57
8c5320	-0.29	-0.25
b8086d	0.08	0.05
d748b8	1.68	0.8

6 Appendix – EN ISO 179-1 (Charpy unnotched impact strength)

The test method was not opened due to the low number of participants.

7 Appendix – EN ISO 179-1 (Charpy notched impact strength (note: notch made by distributor))

The test method was not opened due to the low number of participants.

8 Appendix – EN ISO 179-1 (Charpy notched impact strength (note: notch made by laboratory))

The test method was not opened due to the low number of participants.

9 Appendix – EN ISO 868 (Shore hardness D)

The test method was not opened due to the low number of participants.

10 Appendix – EN ISO 306 (Vicat softening temperature VST/A/50)

10.1 Test results

Table 12: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID	Test results [°C]			u_X [°C]	$\bar{x}$ [°C]	s_0 [°C]	V_X [%]
b8086d	153.4	153.5	153.1	2.0	153.3	0.21	0.14
a0bbcd	153.4	153.4	153.5	0.1	153.4	0.06	0.04
d568e2	153.8	153.7	154.0	0.2	153.8	0.15	0.1
92bbe6	154.7	154.2	154.6	0.6	154.5	0.26	0.17
8c5320	155.3	155.1	154.8	0.6	155.1	0.25	0.16
4c09b3	163.5	162.9	164.1	1.6	163.5	0.6	0.37

10.2 The Numerical Procedure for Determining Outliers

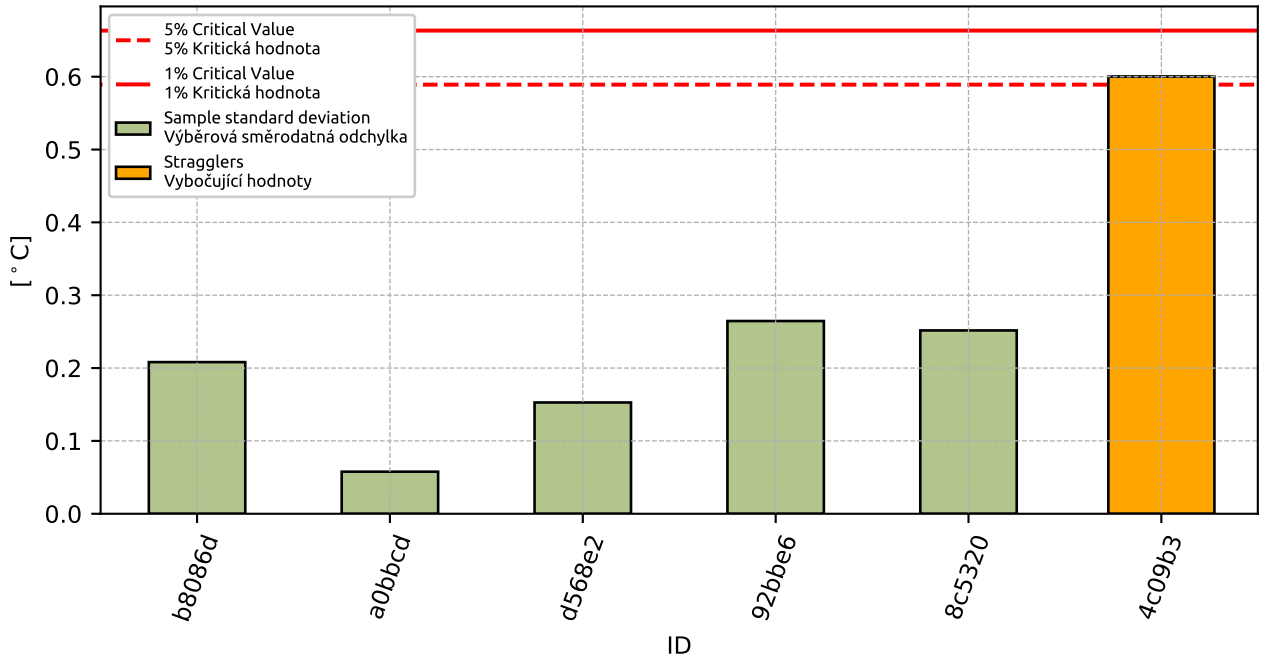

Figure 29: **Cochran's test** - sample standard deviations

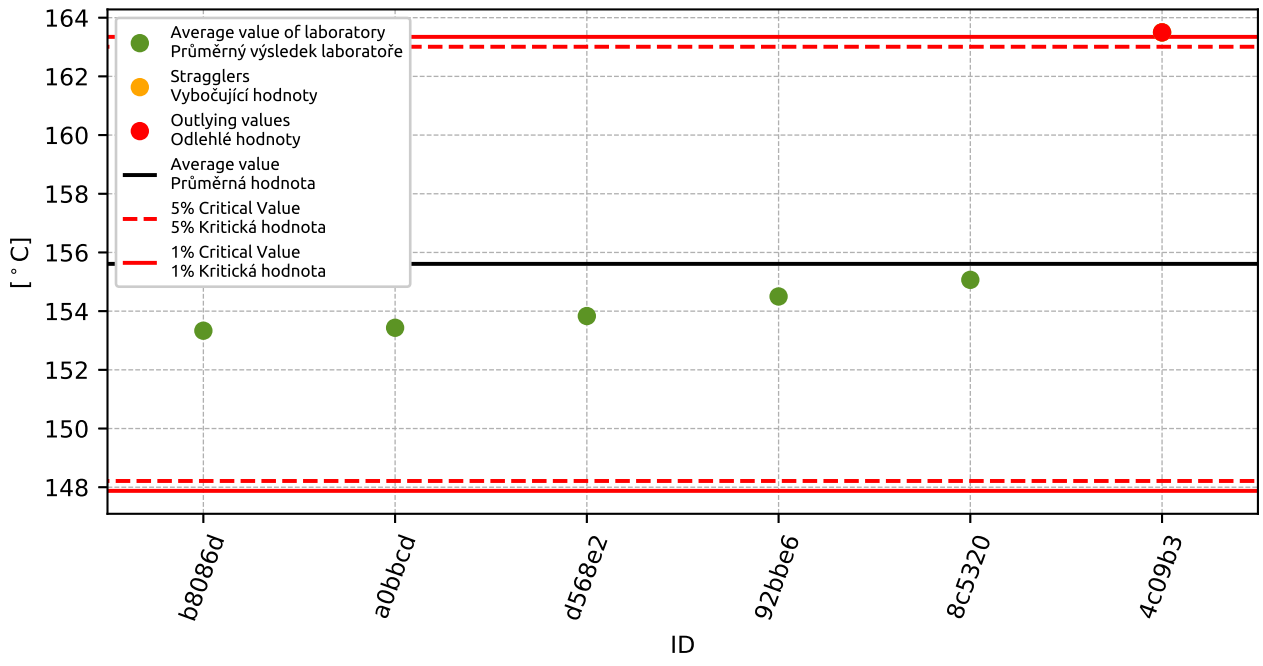

Figure 30: **Grubbs' test** - average values

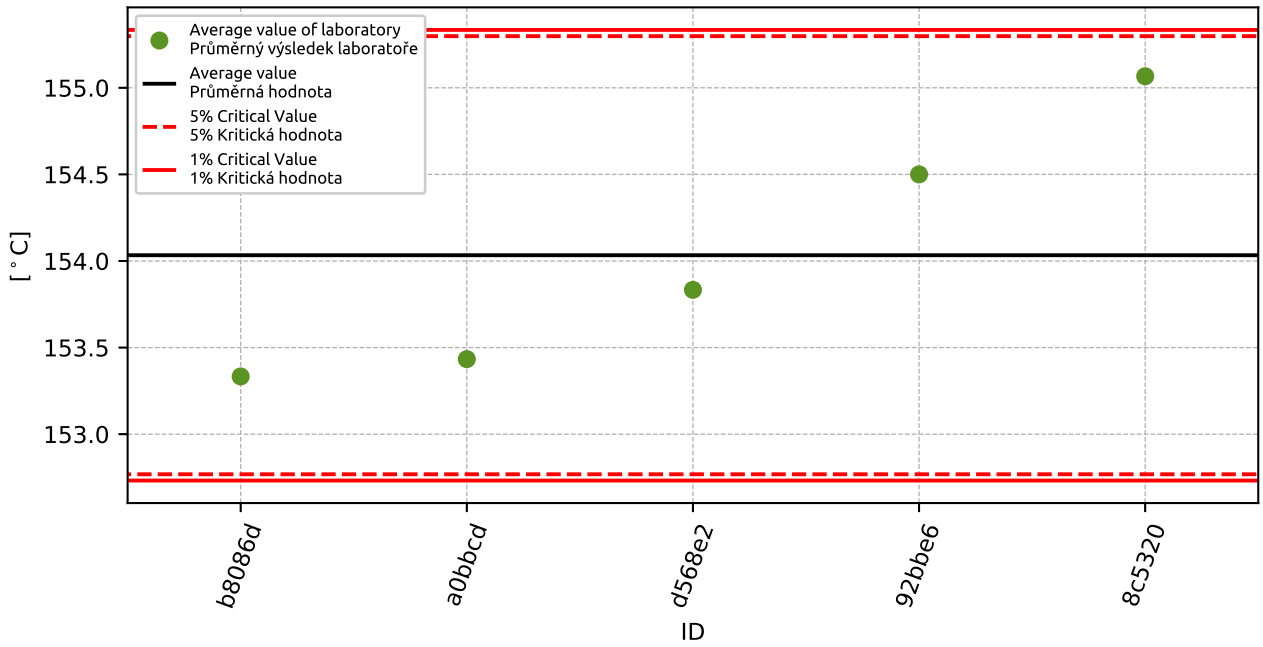

Figure 31: **Grubbs' test** - average values without outliers

10.3 Mandel's Statistics

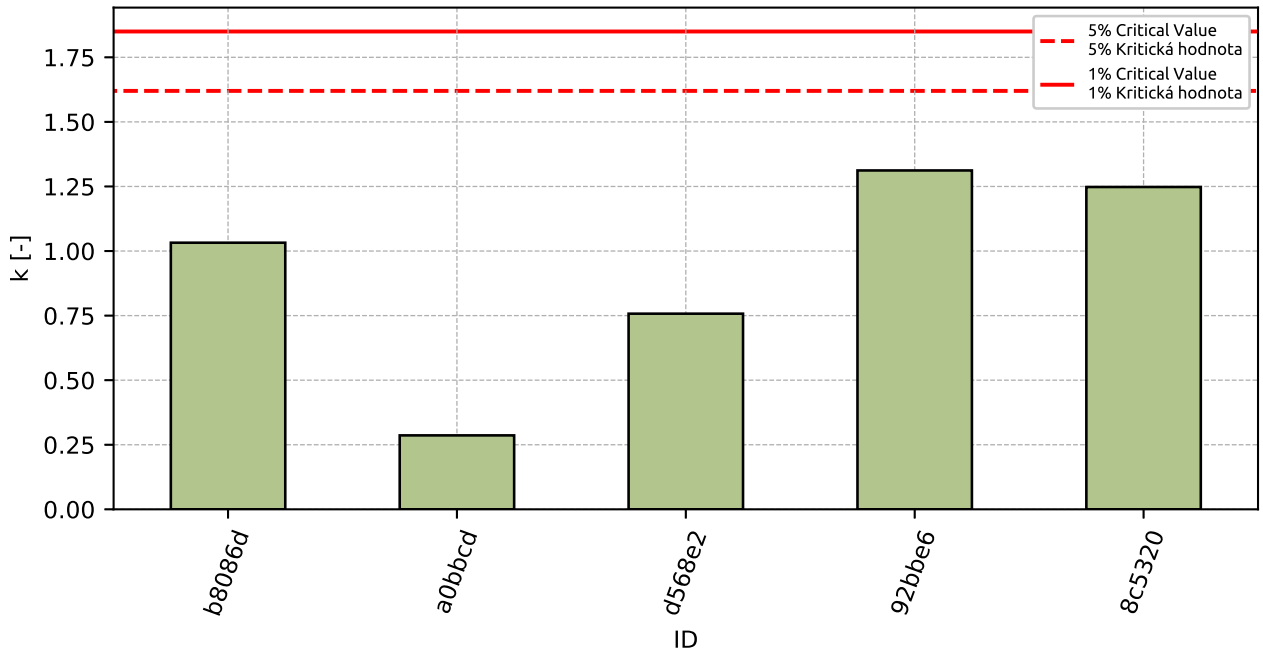

Figure 32: Intralaboratory Consistency Statistic

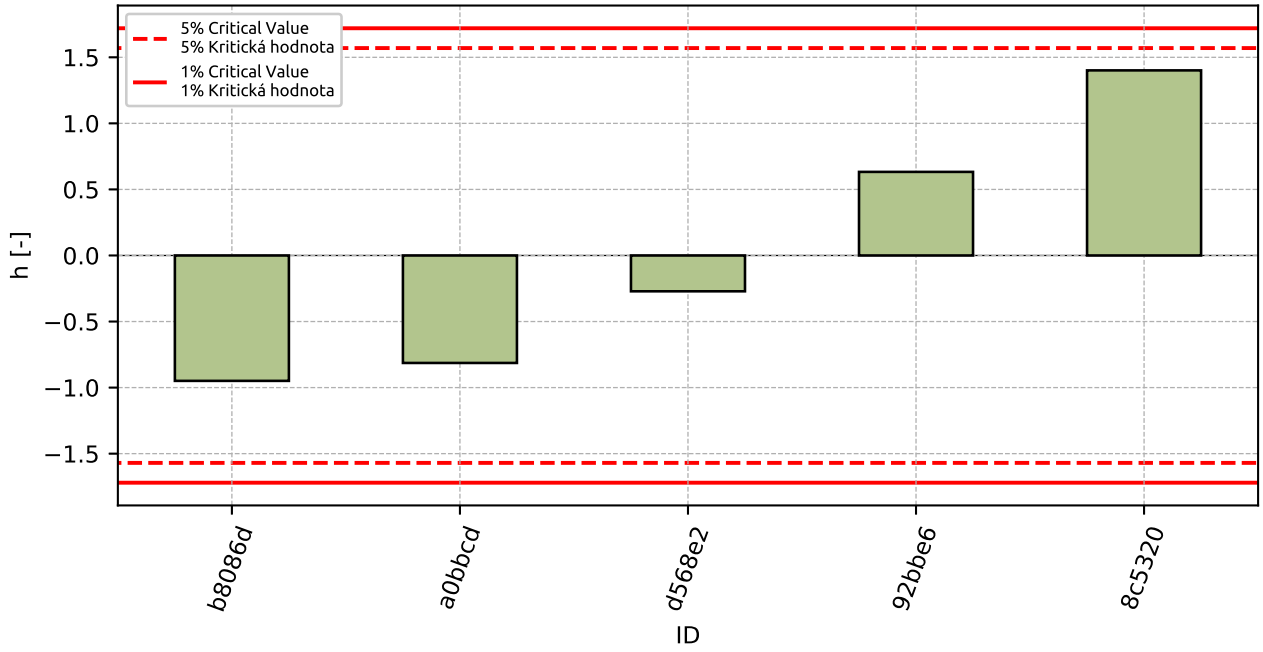

Figure 33: Interlaboratory Consistency Statistic

10.4 Descriptive statistics

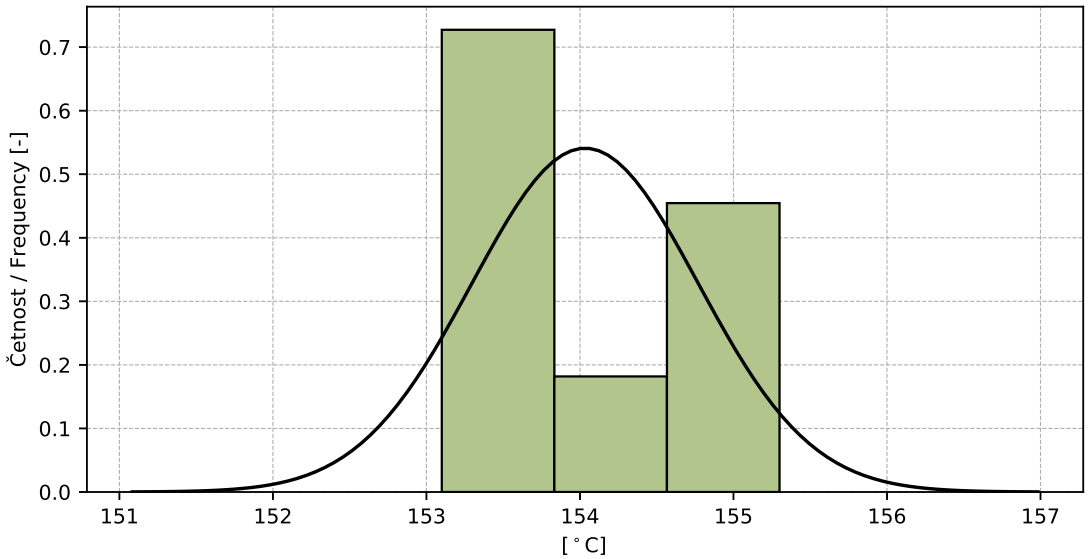

Figure 34: Histogram of all test results

Table 13: Descriptive statistics

Characteristics	[°C]
Průměrná hodnota / Average value – $\bar{x}$	154.0
Výběrová směrodatná odchylka / Sample standard deviation – s	0.74
Vztažná hodnota / Asigned value – x^*	154.0
Robustní směrodatná odchylka / Robust standard deviation – s^*	0.74
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	0.86
p-hodnota testu normality / p-value of normality test	0.136 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	0.73
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.2
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	0.76
Opakovatelnost / Repeatability – r	0.6
Reprodukovatelnost / Reproducibility – R	2.1

10.5 Evaluation of Performance Statistics

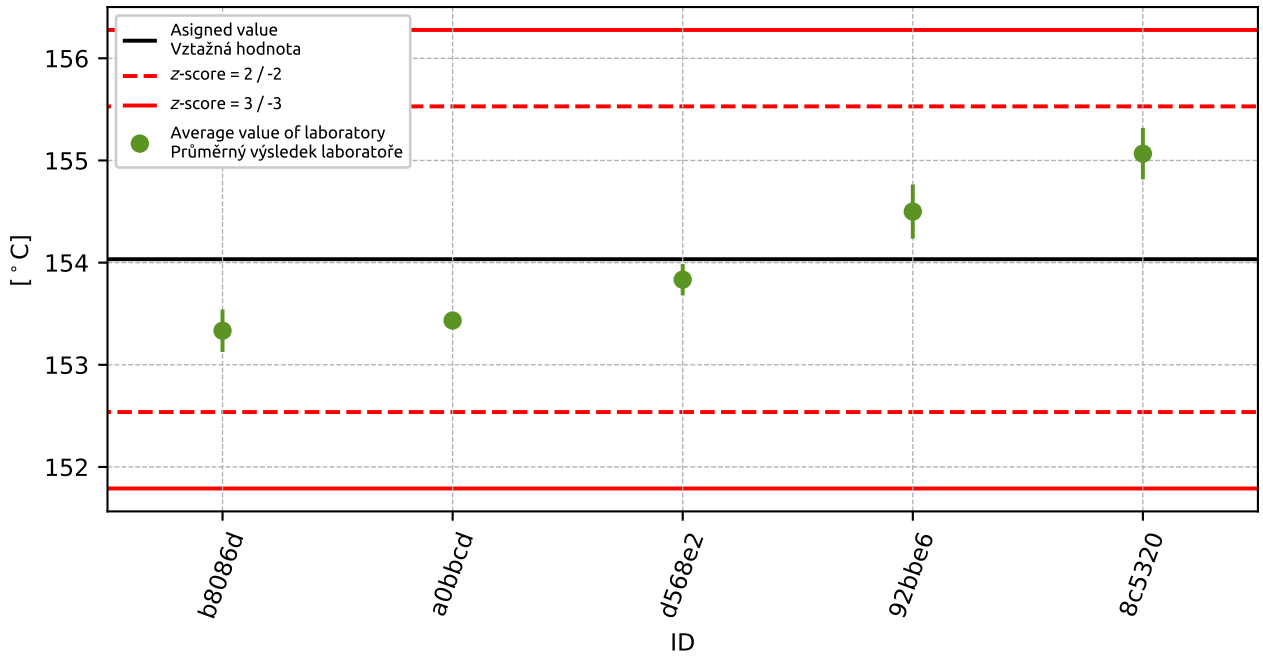

Figure 35: Average values and sample standard deviations

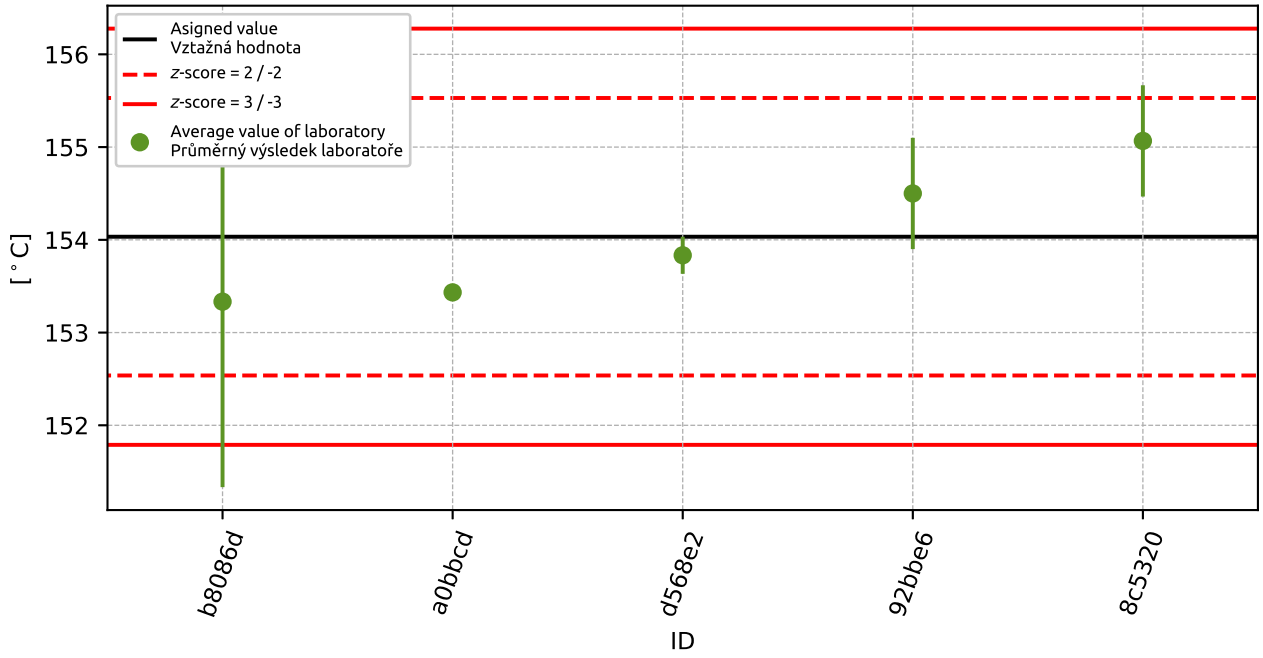

Figure 36: Average values and extended uncertainties of measurement

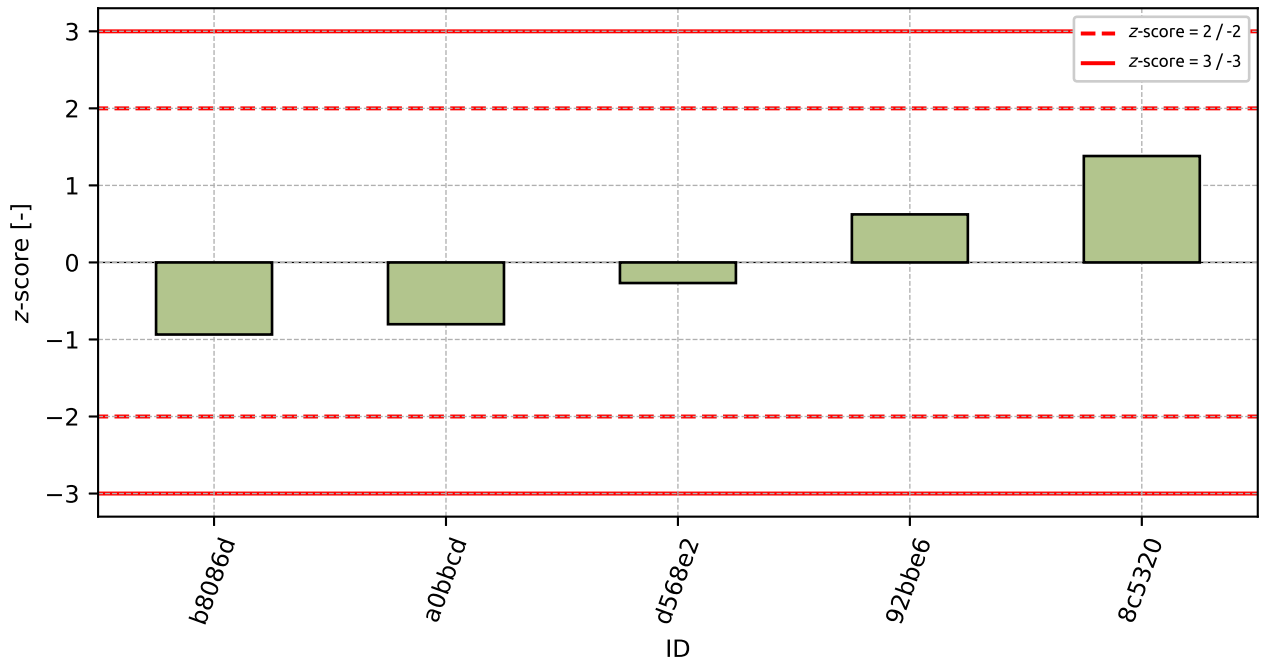

Figure 37: z-score

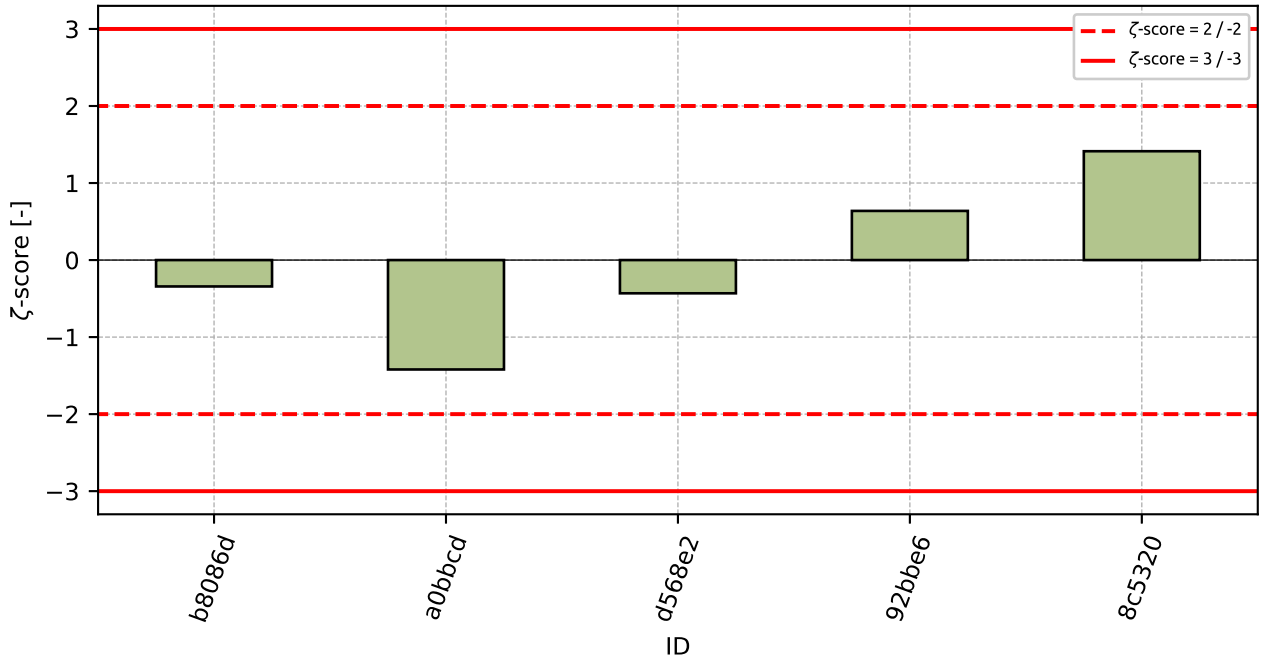

Figure 38: ζ-score

Table 14: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
b8086d	-0.94	-0.34
a0bbcd	-0.8	-1.42
d568e2	-0.27	-0.43
92bbe6	0.62	0.64
8c5320	1.38	1.41

11 Appendix – EN ISO 306 (Vicat softening temperature VST/B/50)

The test method was not opened due to the low number of participants.

12 Appendix – EN ISO 75-1, -2 (Temperature of deflection under load, method A)

The test method was not opened due to the low number of participants.

13 Appendix – EN ISO 75-1, -2 (Temperature of deflection under load, method B)

The test method was not opened due to the low number of participants.

14 Appendix – EN ISO 1183-1 (Density)

14.1 Test results

Table 15: 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 [kg/m³]			u_X [kg/m³]	$\bar{x}$ [kg/m³]	s_0 [kg/m³]	V_X [%]
d568e2	903.1	903.2	903.3	0.1	903.2	0.1	0.01
92bbe6	905.2	904.9	905.1	0.2	905.1	0.15	0.02
8c5320	905.5	905.4	905.4	0.2	905.4	0.06	0.01
a0bbcd	907.0	907.1	907.0	0.1	907.0	0.06	0.01
4c09b3	910.8	907.1	908.1	5.4	908.7	1.91	0.21

14.2 The Numerical Procedure for Determining Outliers

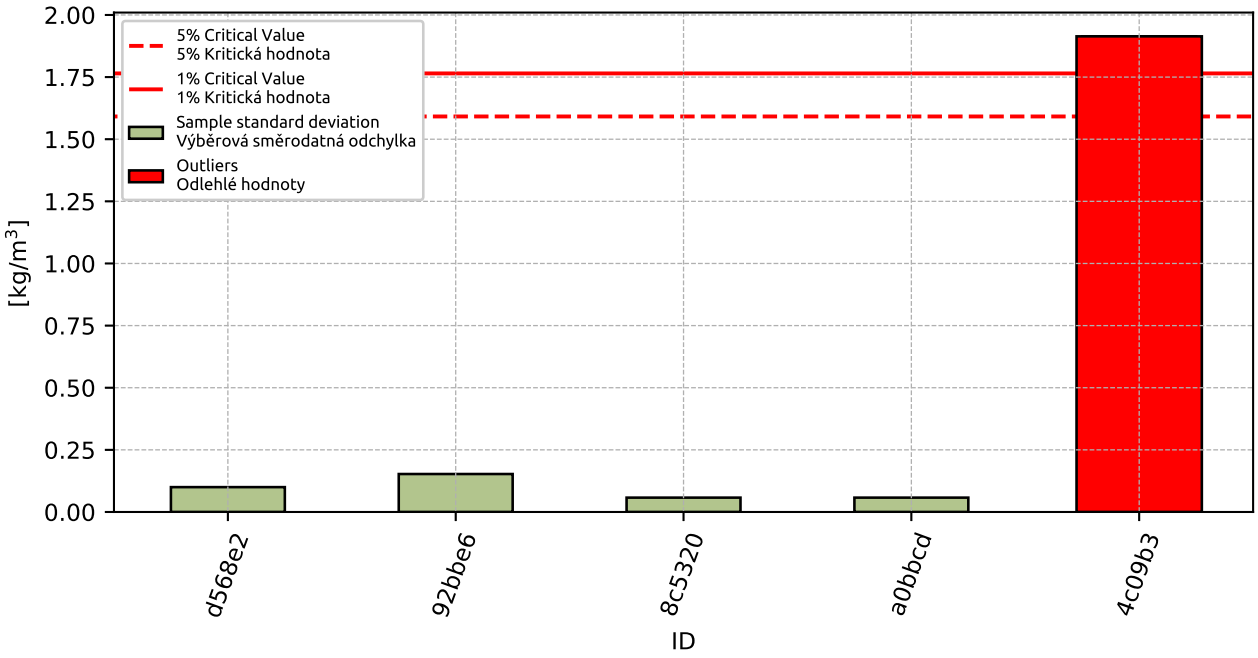

Figure 39: **Cochran's test** - sample standard deviations

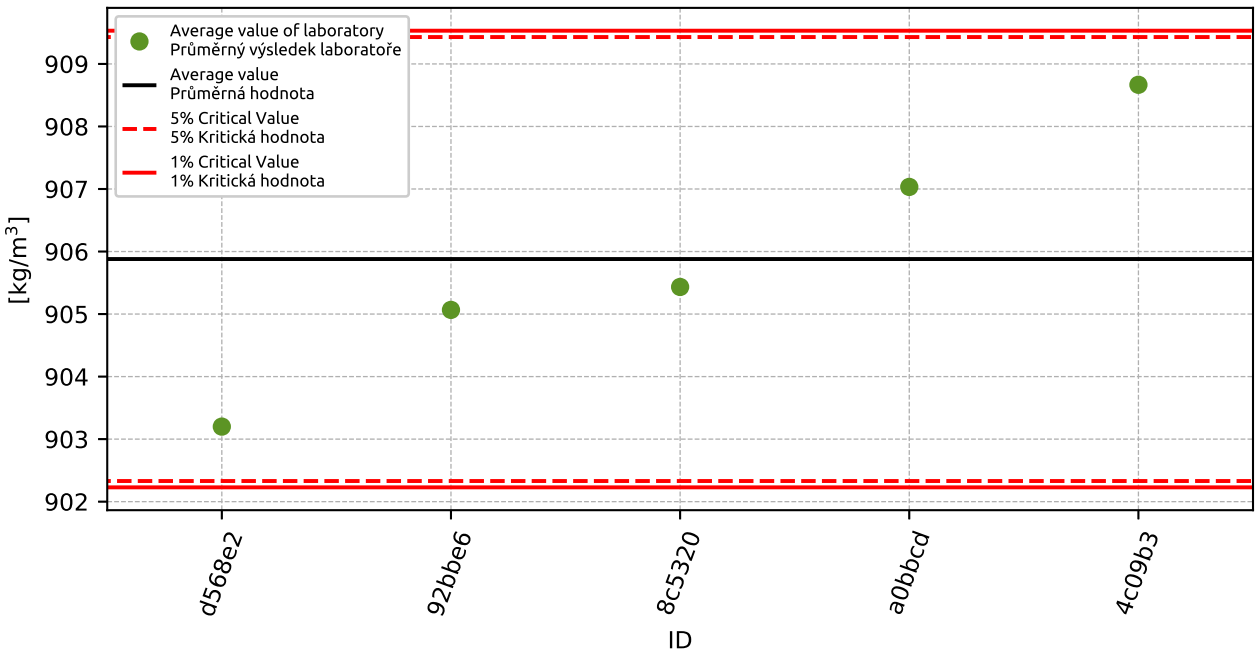

Figure 40: **Grubbs' test** - average values

14.3 Mandel's Statistics

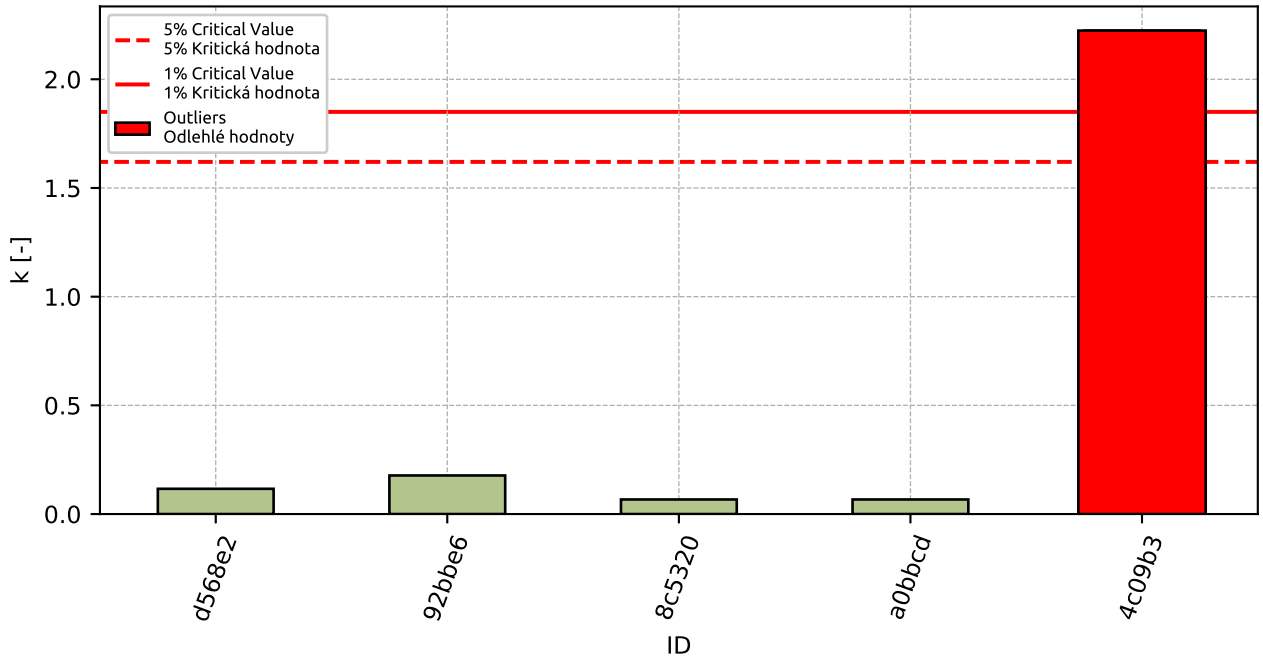

Figure 41: Intralaboratory Consistency Statistic

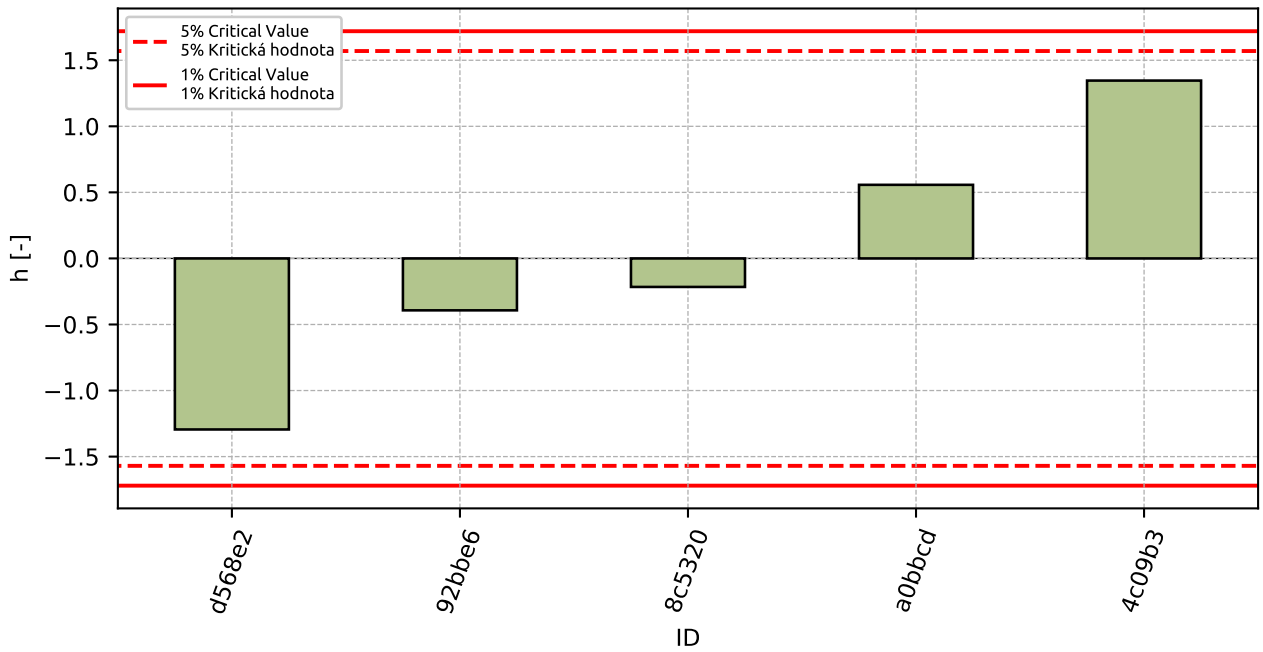

Figure 42: Interlaboratory Consistency Statistic

14.4 Descriptive statistics

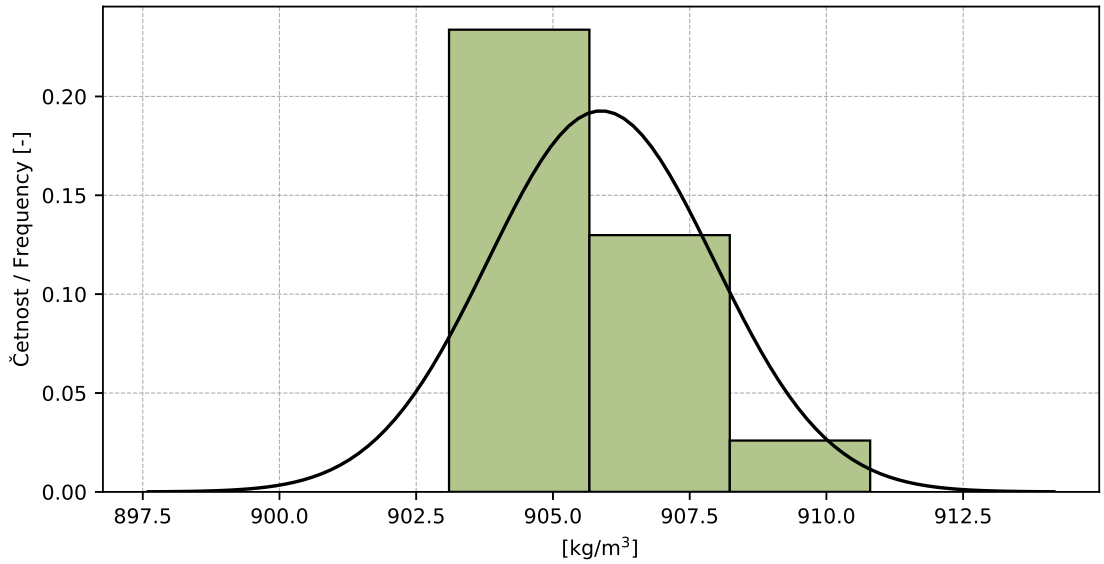

Figure 43: Histogram of all test results

Table 16: Descriptive statistics

Characteristics	[kg/m^3]
Průměrná hodnota / Average value – $\bar{x}$	905.9
Výběrová směrodatná odchylka / Sample standard deviation – s	2.07
Vztažná hodnota / Asigned value – x^*	905.9
Robustní směrodatná odchylka / Robust standard deviation – s^*	2.1
Nejistota měření vztažné hodnoty / Measurement uncertainty of asigned value – u_X	1.17
p-hodnota testu normality / p-value of normality test	0.211 [-]
Mezilaboratorní sm. odch. / Interlaboratory standard deviation – s_L	2.01
Směrodatná odchylka opakovatelnosti / Repeatability standard deviation – s_r	0.86
Směrodatná odchylka reprodukovatelnosti / Reproducibility standard deviation – s_R	2.19
Opakovatelnost / Repeatability – r	2.4
Reprodukovatelnost / Reproducibility – R	6.1

14.5 Evaluation of Performance Statistics

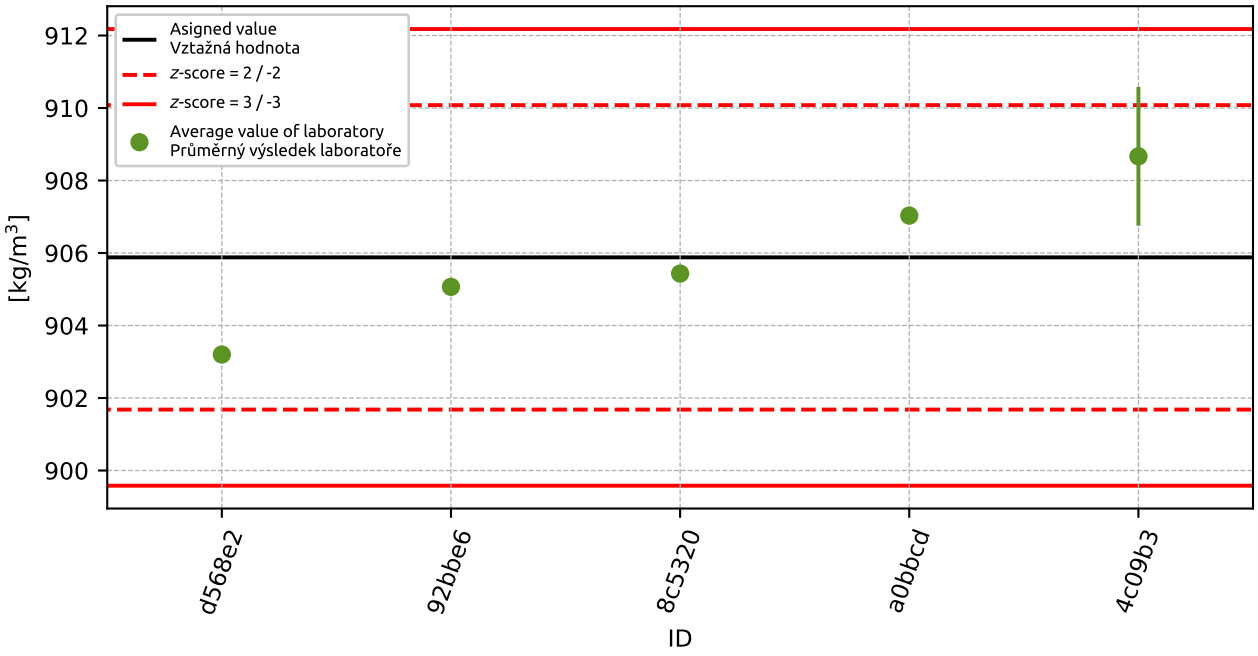

Figure 44: Average values and sample standard deviations

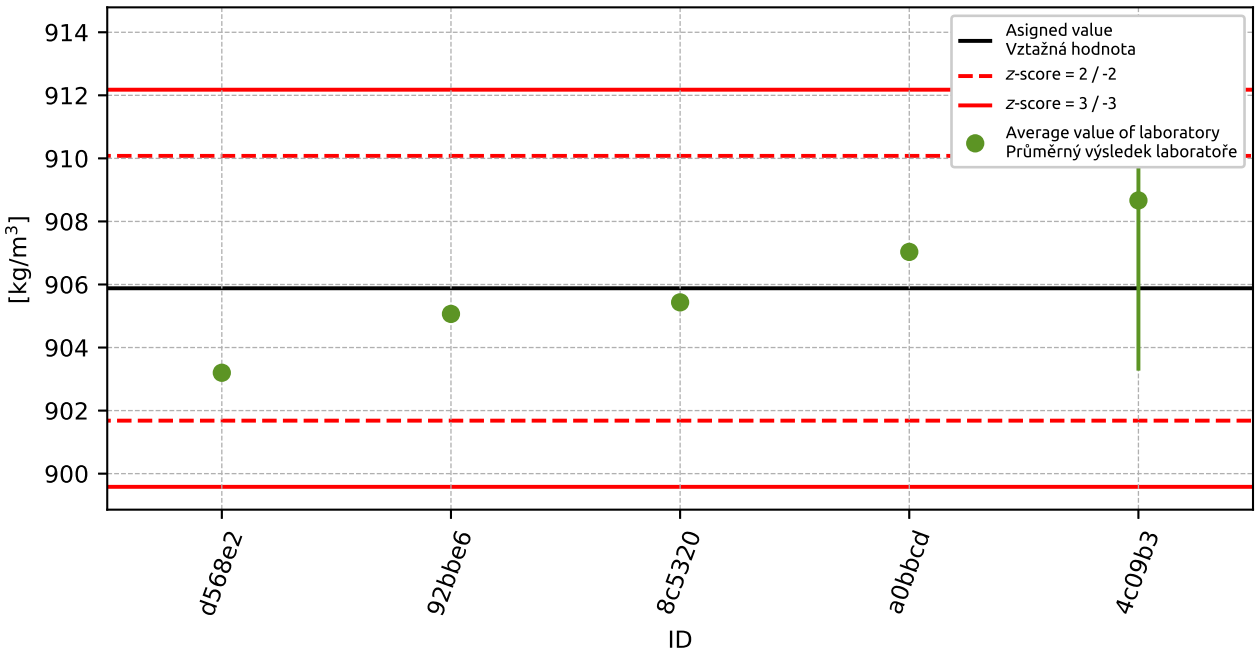

Figure 45: Average values and extended uncertainties of measurement

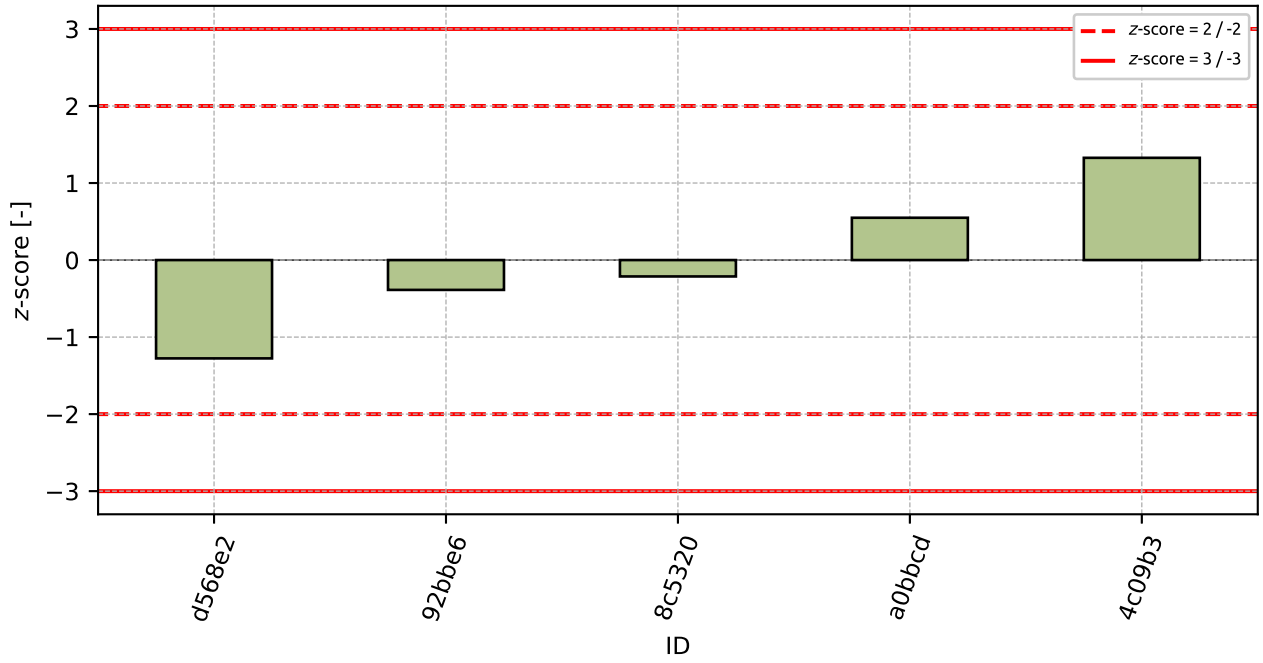

Figure 46: z-score

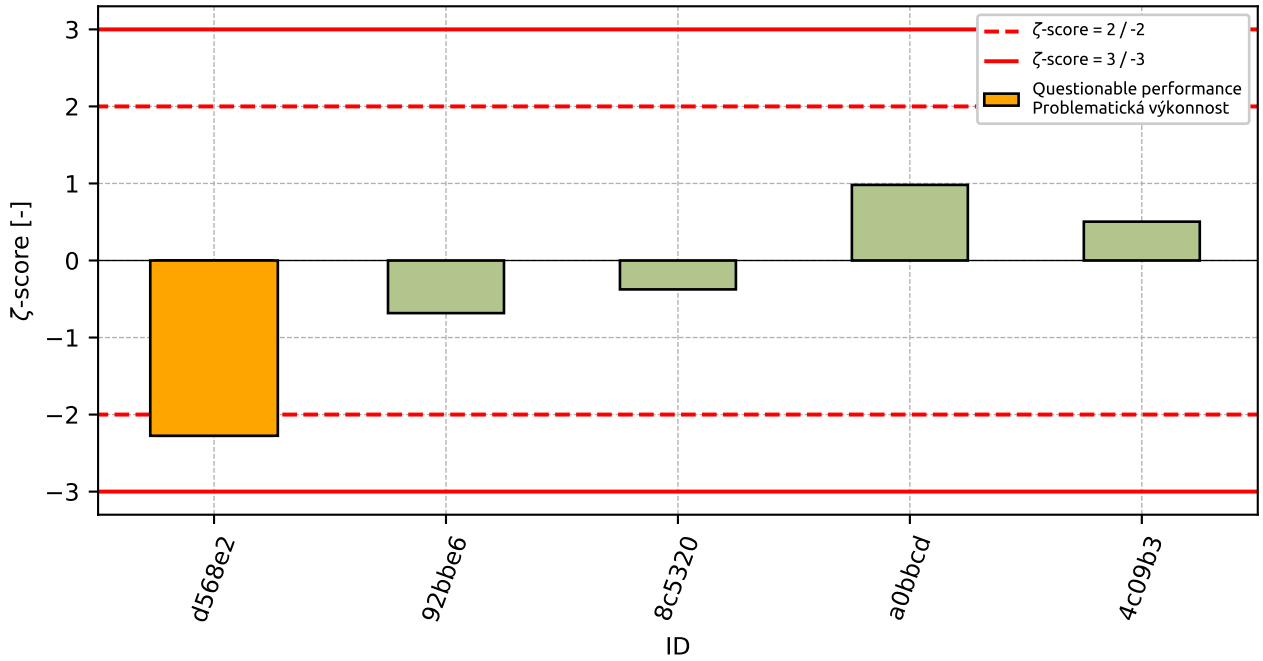

Figure 47: ζ-score

Table 17: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d568e2	-1.28	-2.28
92bbe6	-0.39	-0.68
8c5320	-0.21	-0.38
a0bbcd	0.55	0.98
4c09b3	1.33	0.5

15 Appendix – EN ISO 11357-1, -3 (Melting temperature T_{m1}, Enthalpy of fusion ΔH_{m1})

The test method was not opened due to the low number of participants.

16 Appendix – EN ISO 1133-1 (Melt mass-flow rate)

The test method was not opened due to the low number of participants.

17 Appendix – EN ISO 1628-1, -5 (Viscosity)

The test method was not opened due to the low number of participants.

18 Appendix – EN ISO 11358-1 (Filler content)

The test method was not opened due to the low number of participants.