EAPIC

ESSAIS D'APTITUDE PAR ESSAI DE COMPARAISON

RESULT PRESENTATION REPORT

N° 7.2.20

About the test

Determination of the polished stone value of aggregates

According to the standard
NF EN 1097-8 April 2020

September 11st 2023 by G. PIOT – EAPIC Executive Cell
Cerema IDF – Département Infrastructures Risques et Matériaux
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Preamble

After the EAPIC 19 series devoted to the determination of rutting of asphalt mixes (NF EN 12697-22), this serie focuses on the determination of the polished stone value of aggregates (NF EN 1097-8 April 2020).

EAPIC tests were already carried out on this method in 2010/2011 (EAPIC 11) on the December 2009 version. They had highlighted problems of repeatability and reproducibility. In the backdrop of the new version of the standard released in April 2020, this campaign was a natural choice.

As in the last series, a questionnaire was attached to the results to build up an anonymous database and list the potential elements of differentiation among the participants that will be proposed to the Commission de Normalisation des GRAnulats (CN GRA).
This additional analysis could lead to changes in a future project to improve the standard.
There were 18 laboratories registered for this campaign compared to 17 laboratories in 2011. Nearly 75% of the laboratories responded within the deadline. In the end, 17 participants submitted their results.

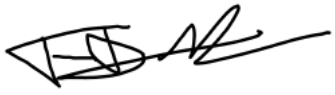
For this serie, 3 different aggregates were selected with respectively accelerated polishing values close to 44, between 50 and 52 and close to 60.

Please note:

- The preparation of materials (the aggregated particles pass the 10mm test sieve and are held on the grid sieve) was the responsibility of each participant ;
- The reference stone used is French stone.

Regards.

For EAPIC,



Frédéric DELFOSSE

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Summary

Session organization and data collection

Homogenized lots of constituents are supplied to participating laboratories. They must determine the polished stone value for 3 different aggregates, according to the standard NF EN 1097-8 on April 2020 « Tests for mechanical and physical properties of aggregates - Part 8 : determination of the polished stone value ».

A plan of the wheels with positioning of the aggregate plates has been provided.

The campaign unfolded as follows:

- Registration of laboratories between mid-June 2021 and mid-August 2021;
- Confirmation of registration of laboratories and start of the session in October 2021;
- Shipping of samples at the beginning December 2021;
- Results delivery from participating laboratories no later than April 1st, 2022.
  The number of participants to this session was 18 laboratories.
  72% results were transmitted on time.
  17 participating laboratories have transmitted their results.
- Publication of the results report in Summer 2022.

Preparation and shipping of samples

Support Laboratory: Cerema West - Department Laboratory of Angers

Materials

Each laboratory received one pallet with the quantities of materials needed to carry out their tests.

Each pallet is composed of the following fractions:

- 3 bags of 10 kg of material A ;
- 3 bags of 25 kg of material B ;
- 3 bags of 25 kg of material C ;
- 1 container of 10 kg of reference stone (*)
-

(*) According to the note of BNTRA CN Aggregates (« CN Granulats ») of 06/17/2020, the use of French reference stone from the Corbigny site (58) was validated, replacing the German reference stone (Herrnholzer), following an inter-laboratory comparison campaign (UNPG) involving 18 laboratories. The evaluation of the reference value for this new reference stone has been set at (54.5 ± 3) points.

The aggregates come from a single stock. The homogeneity of each granular fraction was verified by the Support Laboratory Cerema East Central - Department Laboratory Autun.

Preparation

To carry out this session, Cerema West – Department Laboratory of Angers received and allocated:

- 110 bags of 10 kg of material A ;
- 110 bags of 25 kg of material B ;
- 110 bags of 25 kg of material C ;
- 20 containers of 10 kg of reference stone.

Materials Shipping

The materials were sent by the Cerema West – Department Laboratory of Angers. The set of bags and buckets required for the campaign were set on pallets before shipment.

Verification of aggregates samples homogeneity

Support Laboratory: Cerema East Central - Department laboratory of Autun

To ensure that all the samples are homogeneous, the instructions given in Annex B of the ISO 13528 standard of October 2015 (French corrected version of December 2016) – which gives a statistical method used in inter-laboratory comparison aptitude tests – are applied. This appendix is based on the comparison between-sample standard deviation S_s and the standard deviation for proficiency assessment σ_{PT}. A sample is considered to be homogeneous if $S_s \leq 0.3 \times \sigma_{PT}$.

The homogeneity criteria considered by the EAPIC Executive Cell is the pre-dried aggregates density of 6/10 fraction determined according to the standard NF EN 1097-6 annex A, of January 2014.

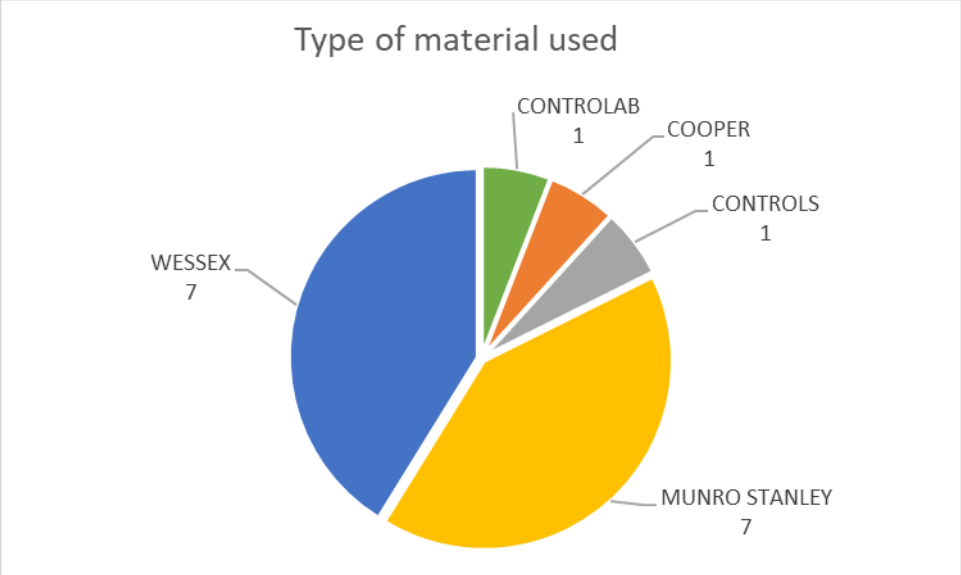
For each bag or container, the value of the inter-sample standard deviation is compared to the estimate of the homogeneity criterion $0.3 \times \boldsymbol{\sigma_{PT}}$.

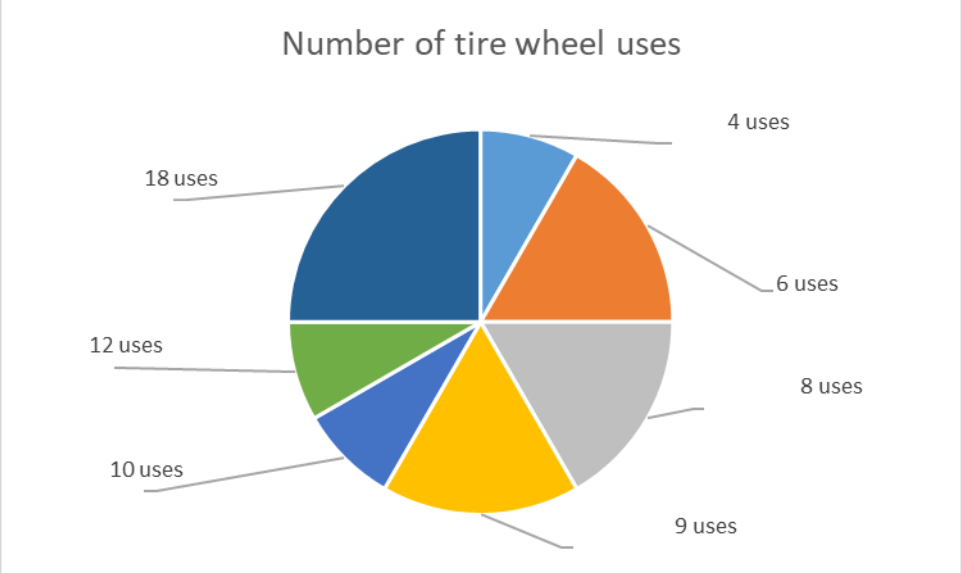
	Maximum density (kg/L) Material A	**MD (kg/L) Material B**	**MD(kg/L) Material C**
Average	2.717	2.904	2.699
r	$4.5.10^{-6}$	$9.53.10^{-5}$	$1.6.10^{-6}$
R	$3.76.10^{-6}$	$8.54.10^{-5}$	$6.68.10^{-6}$
$\boldsymbol{\sigma_r}$	$2.12.10^{-3}$	$9.76.10^{-3}$	$1.26.10^{-3}$
$\boldsymbol{\sigma_R}$	$1.94.10^{-3}$	$9.24.10^{-3}$	$2.58.10^{-3}$
$\boldsymbol{0.3 \times \sigma_{PT}}$	$3.7.10^{-4}$	$1.84.10^{-3}$	$7.3.10^{-4}$
Between-sample standard deviation S_s	$7.39.10^{-7}$	$9.99.10^{-6}$	$5.08.10^{-6}$
Validation $\boldsymbol{S_s \leq 0.3 \times \sigma_{PT}}$	condition fulfilled	condition fulfilled	condition fulfilled

Criteria is fulfilled for each test.

Therefore, it can be concluded that samples are sufficiently homogeneous.

Elements of differentiation between the participants





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Data processing

Data processing is based on series of standards ISO 5725 « Application of statistics – Accuracy (trueness and precision) of measurement methods and results ».
The treatment is performed using an Excel sheet. Results are then checked using the XLSTAT software.

Graphic representation

Raw data are represented in histogram diagrams that express each participating laboratories' results. The raw average and corrected average (after removal of outliers) are placed in the graph.

Statistical tests

The following statistical tests are run successively on the raw results:

- Mandel h and k tests: identification of differences at sample levels :
  - The between-laboratory consistency statistic, h (at the mean level)
  - The within-laboratory consistency statistic, k (at the variance level)
- Cochran and Grubbs' tests :
  - Cochran test (within-laboratory variability) : detection of variance outliers in the statistical sense of the results in a laboratory ;
  - Simple Grubbs' test or possibly double (between-laboratory variability) : detection of averages outliers among the population of laboratories.

Results exceeding the critical value of 1% are reported as outliers and removed from the statistical treatment that only deals with corrected data.

Z-Score

Calculated according to NF ISO 13528 standard of October 2015, the Z-Score is the number of standard deviations that are above or below the population mean.

Z-Score is calculated from the following formula :
$z = (|X - \mu| / \sigma)$
where :
z is z-score ;
X is the laboratory average ;
μ is the average of population ;
σ is the standard deviation of the population.

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Determination of polished stone value of aggregates (PSV)

Determination of PSV on stone A

Graphical representations

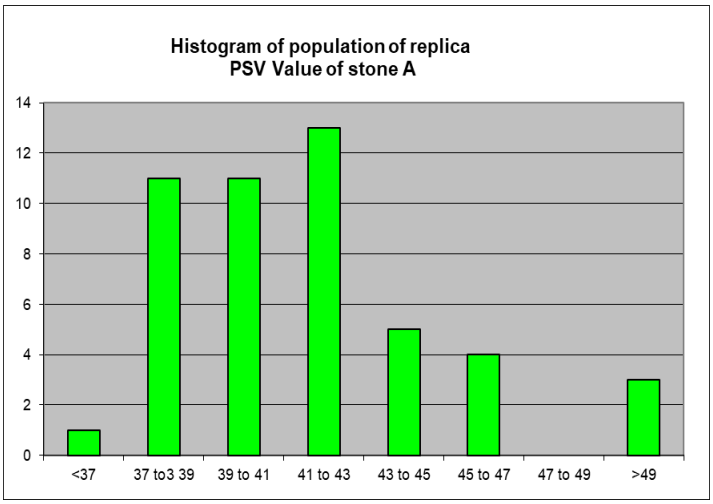
	Raw data	Results rejected by statistical tests	Corrected data	Earlier series Series 11 (*) (For material with PSV closest to Stone A)	Standard 1097-8 of December 2009 (**) (For material with PSV closed to Stone A)
Number of results considered	16	h Mandel : PSV16	15		
Average m	41.7		41.1		
Standard deviation repeatability	1.2		1.2		
repeatability r	3.4		3.4	r = 2.6	r = 2.0
Standard deviation Reproducibility	3.4		2.6		
Reproducibility R	9.7		7.2	R = 11.0	R = 5.0

(*) Serie realized according to NF EN 1097-8 standard of December 2009.

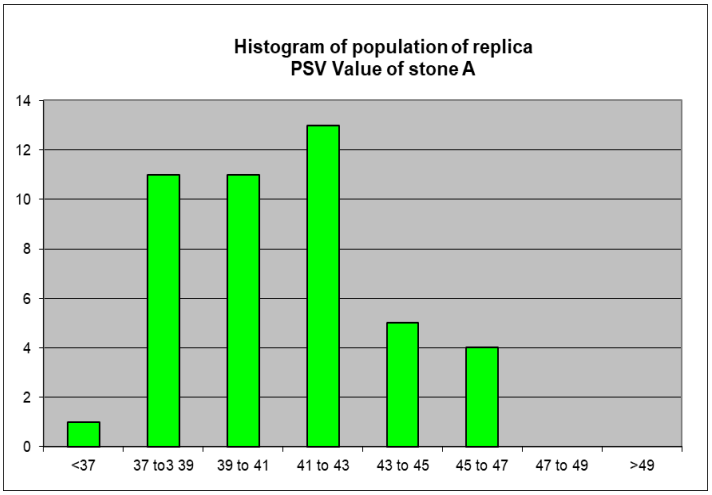
(**)NF EN 1097-8 standard of April 2020 doesn't specify values of r and R. Values included in the report are taken from NF EN 1097-8 standard of December 2009, Annex E.3 Table E.1.

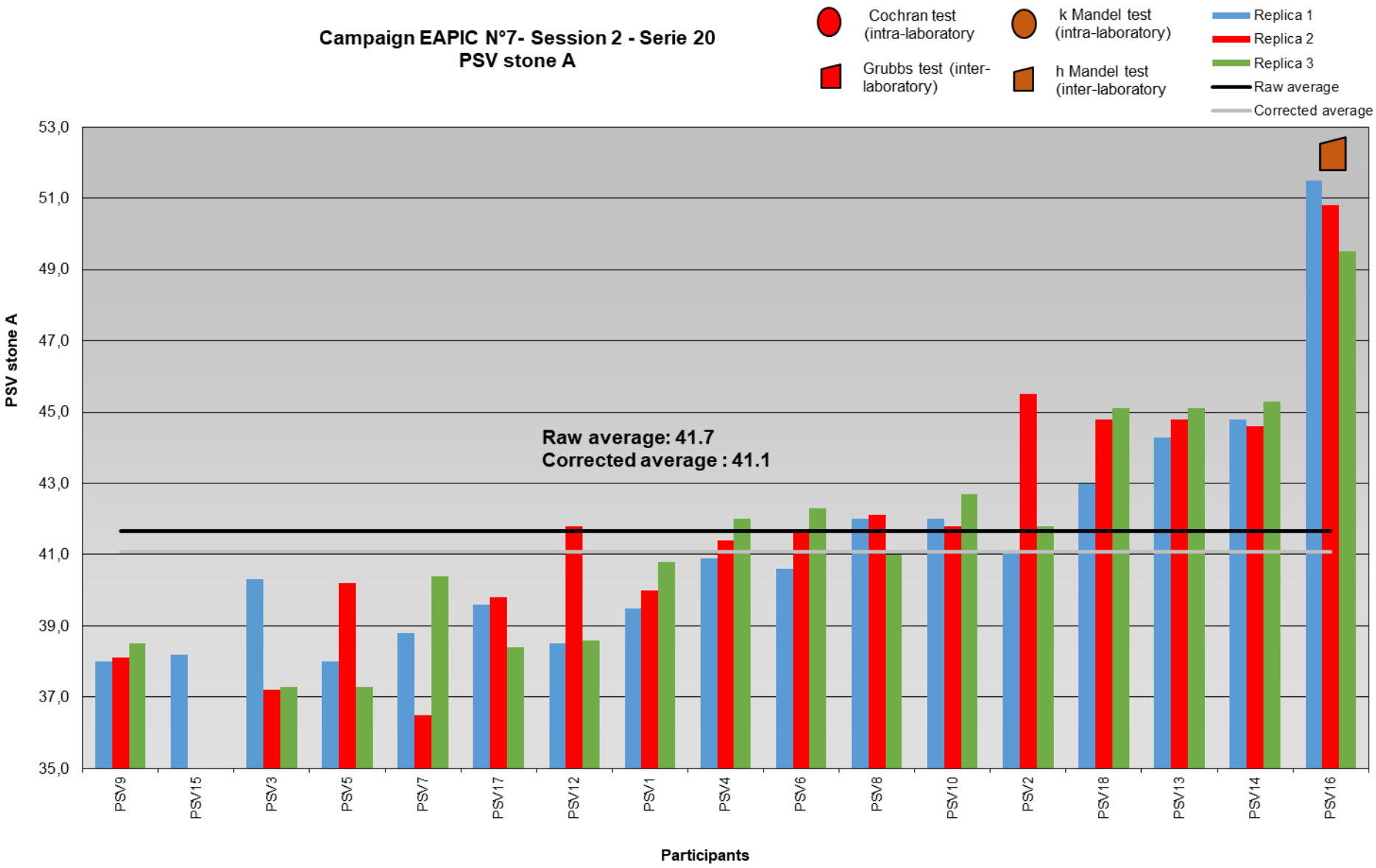
Results of laboratory PSV15 are not considered in the statistical processing (only one replica produced). Its results are shown in the summary graph

Raw data



Corrected data




Campaign EAPIC N°7- Session 2 - Serie 20
PSV stone A
Cochran test (intra-laboratory
k Mandel test (intra-laboratory)
Grubbs test (inter-laboratory)
h Mandel test (inter-laboratory
Replica 1
Replica 2
Replica 3
Raw average
Corrected average
Raw average: 41.7
Corrected average : 41.1
PSV stone A
53,0
51,0
49,0
47,0
45,0
43,0
41,0
39,0
37,0
35,0
PSV9
PSV15
PSV3
PSV5
PSV7
PSV17
PSV12
PSV1
PSV4
PSV6
PSV8
PSV10
PSV2
PSV18
PSV13
PSV14
PSV16
Participants

Average difference and Z-score value on raw data

Difference less than 1 standard deviation

Code results	Average deviation	Z-Score
PSV8	0.03	0.01
PSV6	0.14	0.04
PSV4	0.24	0.07
PSV10	0.50	0.14
PSV2	1.13	0.33
PSV1	1.57	0.45
PSV12	2.04	0.59
PSV17	2.40	0.70
PSV18	2.63	0.76
PSV13	3.06	0.89
PSV7	3.10	0.90
PSV5	3.17	0.92
PSV14	3.23	0.94
PSV3	3.40	0.99

Difference more than 1 standard deviation

Code results	Average deviation	Z-Score
PSV9	3.47	1.01

Difference more than 2 standard deviation

Code results	Average deviation	Z-Score
PSV16	8.93	2.59

Determination of PSV value on stone B

Graphical representations

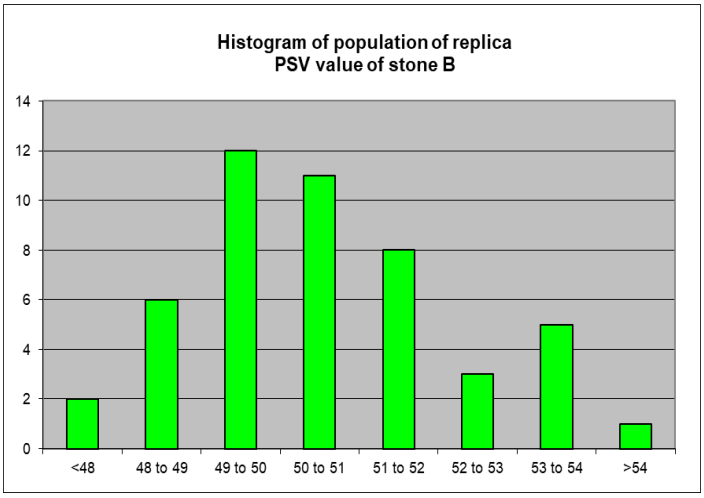
	Raw data	Results rejected by statistical tests	Corrected data	Earlier series Series 11 (*) (For material with PSV closest to Stone B)	Standard 1097-8 of December 2009 (**) (For material with PSV closed to Stone B)
Number of results considered	16	k Mandel PSV2 PSV17	14		
Average m	50.6		50.6		
Standard deviation repeatability	1.1		0.7		
repeatability r	3.0		2.1	r = 2.4	r = 2.1
Standard deviation Reproducibility	1.7		1.7		
Reproducibility R	4.8		4.7	R = 8.2	R = 4.8

(*) Serie realized according to NF EN 1097-8 standard of December 2009.

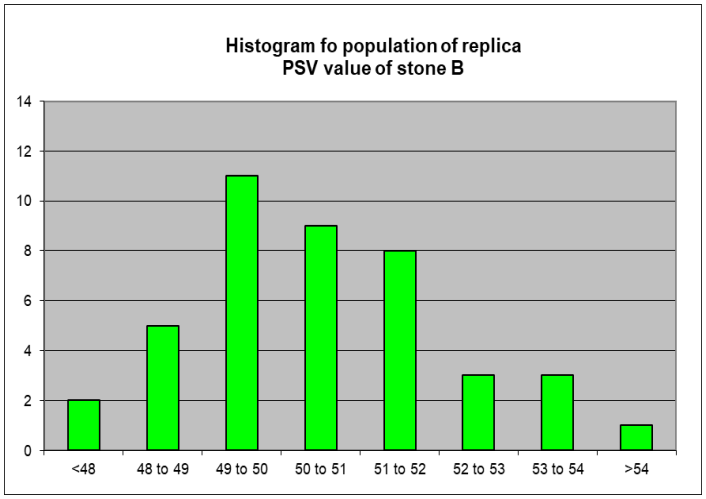
(**) NF EN 1097-8 standard of April 2020 doesn't specify values of r and R. Values including in the report are taken from NF EN 1097-8 standard of December 2009, Annex E.3 Table E.1.

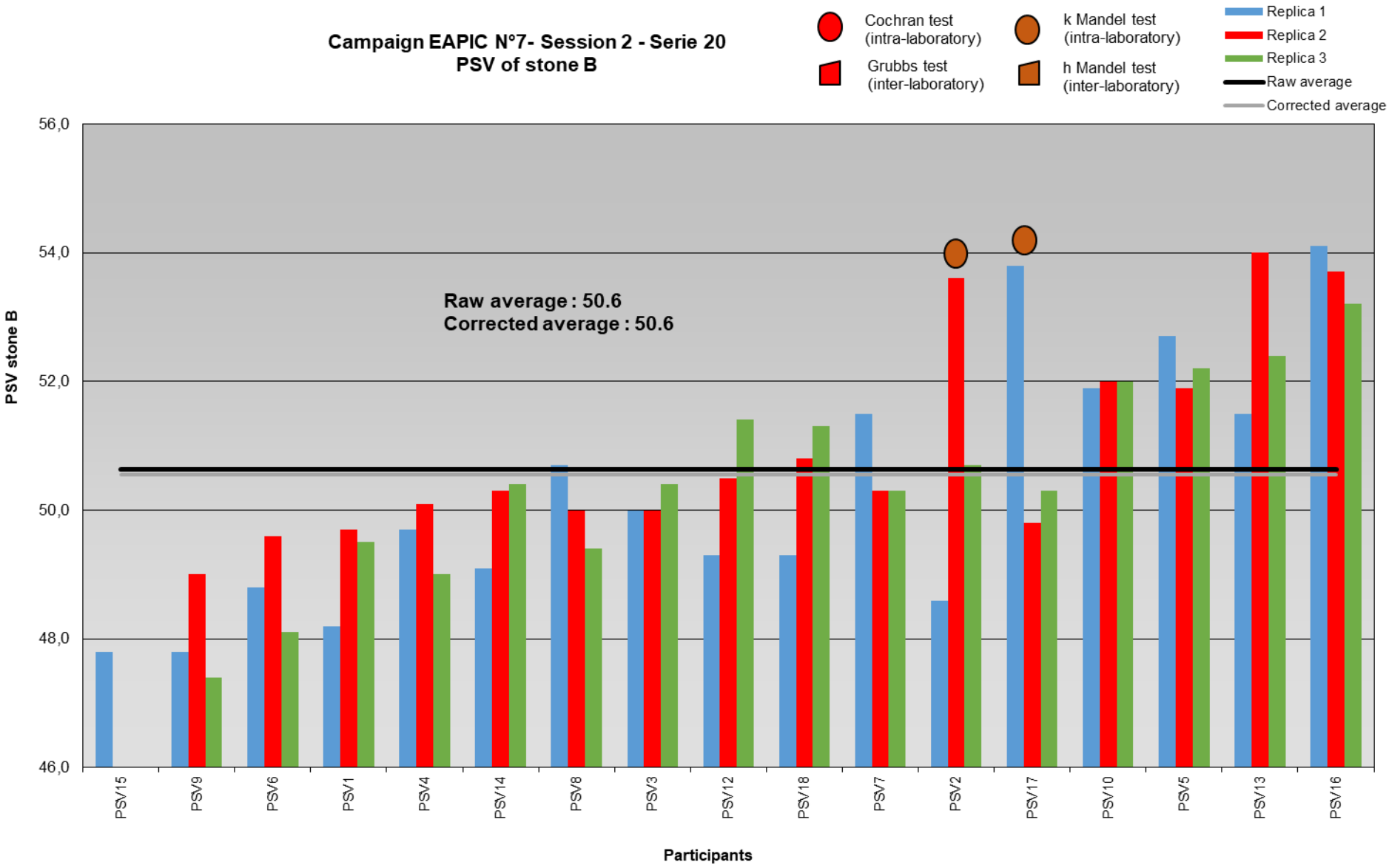
Results of laboratory PSV15 are not considered in the statistical processing (only one replica produced). Its results are shown in the summary graph

Raw data



Corrected data




Campaign EAPIC N°7- Session 2 - Serie 20
PSV of stone B
Cochran test (intra-laboratory)
k Mandel test (intra-laboratory)
Grubbs test (inter-laboratory)
h Mandel test (inter-laboratory)
Replica 1
Replica 2
Replica 3
Raw average
Corrected average
Raw average : 50.6
Corrected average : 50.6
PSV stone B
56,0
54,0
52,0
50,0
48,0
46,0
PSV15
PSV9
PSV6
PSV1
PSV4
PSV14
PSV8
PSV3
PSV12
PSV18
PSV7
PSV2
PSV17
PSV10
PSV5
PSV13
PSV16
Participants

Average difference and Z-score value on raw data

Difference less than 1 standard deviation

Code results	Average deviation	Z-Score
PSV7	0.07	0.04
PSV18	0.16	0.10
PSV12	0.23	0.13
PSV2	0.34	0.20
PSV3	0.50	0.29
PSV8	0.60	0.35
PSV17	0.67	0.39
PSV14	0.70	0.41
PSV4	1.03	0.60
PSV10	1.34	0.78
PSV1	1.50	0.87
PSV5	1.64	0.95

Difference more than 1 standard deviation

Code results	Average deviation	Z-Score
PSV6	1.80	1.05
PSV13	2.00	1.16
PSV9	2.56	1.49
PSV16	3.04	1.76

Determination of SV on stone C

Graphical representations

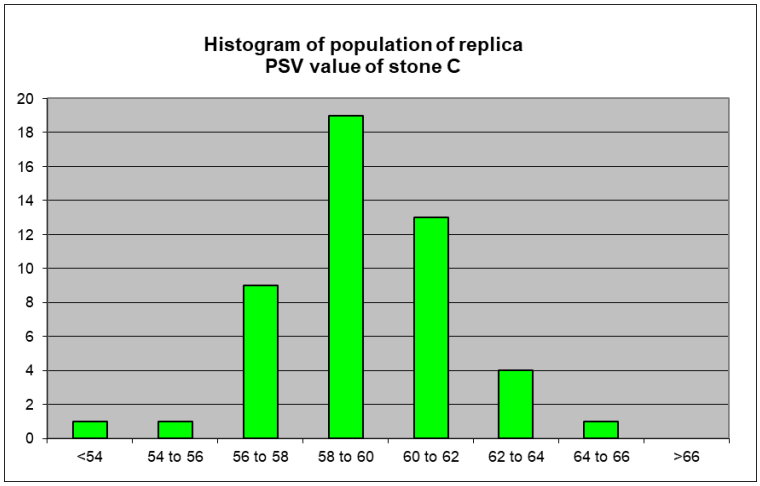
	Raw data	Results rejected by statistical tests	Earlier series Series 11 (*) (For material with PSV closest to Stone C)	Standard 1097-8 of December 2009 (**) (For material with PSV closed to Stone C)
Number of results considered	16	/		
Average m	59.4			
Standard deviation repeatability	1.4			
repeatability r	3.8		r = 2.3	r = 3.0
Standard deviation Reproducibility	2.3			
Reproducibility R	6.4		R = 7.4	R = 5.7

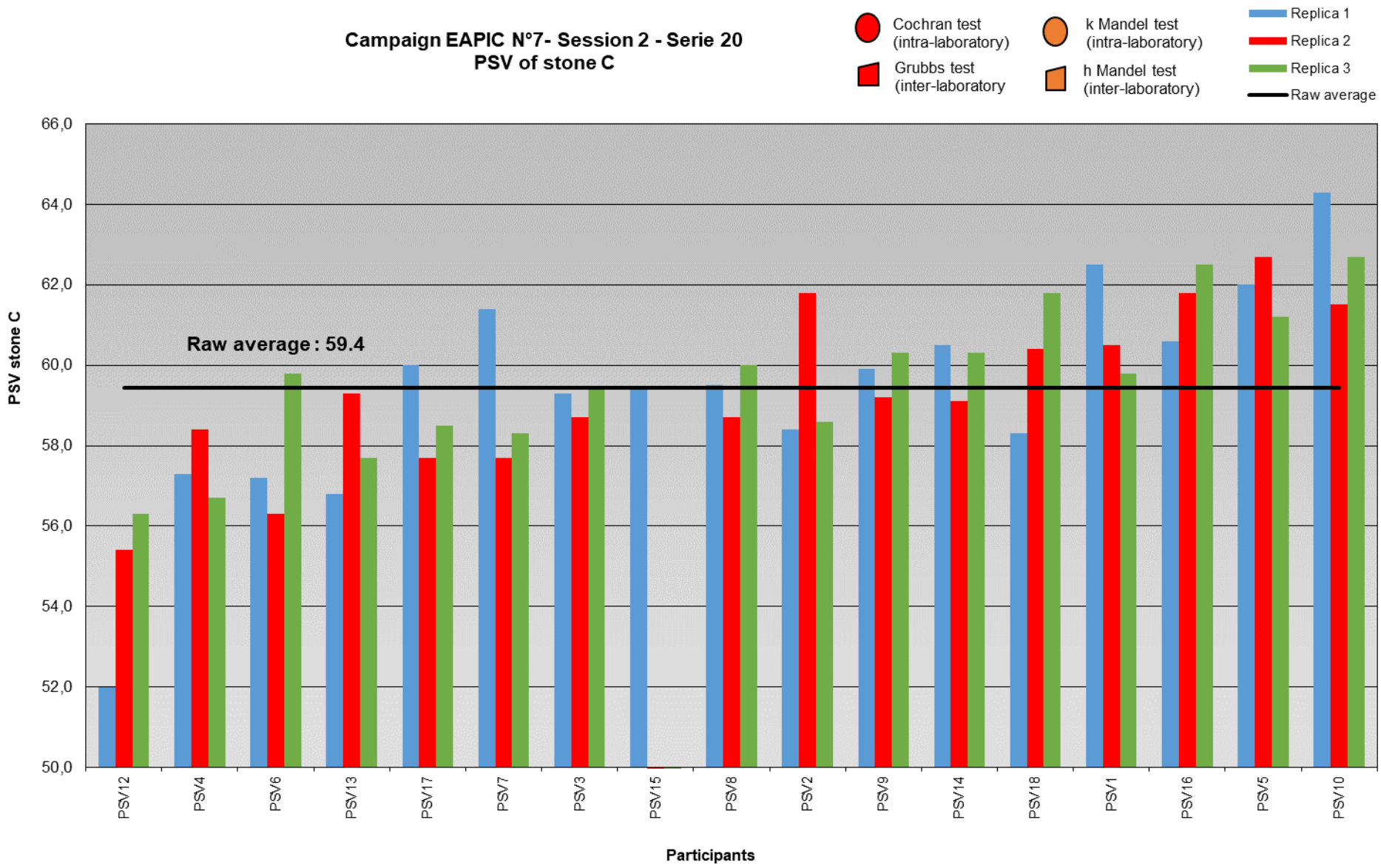
(*) Serie realized according to NF EN 1097-8 standard of December 2009.

(**)NF EN 1097-8 standard of April 2020 doesn't specify values of r and R. Values including in the report are taken from NF EN 1097-8 standard of December 2009, Annex E.3 Table E.1.

Results of laboratory PSV15 are not considered in the statistical processing (only one replica produced). Its results are shown in the summary graph

Raw data




Campaign EAPIC N°7- Session 2 - Serie 20
PSV of stone C
Cochran test (intra-laboratory)
k Mandel test (intra-laboratory)
Grubbs test (inter-laboratory
h Mandel test (inter-laboratory)
Replica 1
Replica 2
Replica 3
Raw average
Raw average : 59.4
PSV stone C
66,0
64,0
62,0
60,0
58,0
56,0
54,0
52,0
50,0
PSV12
PSV4
PSV6
PSV13
PSV17
PSV7
PSV3
PSV15
PSV8
PSV2
PSV9
PSV14
PSV18
PSV1
PSV16
PSV5
PSV10
Participants

Average difference and Z-score value on raw data

Difference less than 1 standard deviation

Code results	Average deviation	Z-Score
PSV8	0.04	0.02
PSV2	0.16	0.07
PSV3	0.31	0.13
PSV7	0.31	0.13
PSV9	0.36	0.16
PSV14	0.53	0.23
PSV17	0.71	0.31
PSV18	0.73	0.32
PSV1	1.49	0.66
PSV13	1.51	0.66
PSV6	1.67	0.73
PSV4	1.97	0.87
PSV16	2.19	0.96

Difference more than 1 standard deviation

Code results	Average deviation	Z-Score
PSV5	2.53	1.11
PSV10	3.39	1.49

Difference more than 2 standard deviation

Code results	Average deviation	Z-Score
PSV12	4.87	2.14

EAPIC Organisation

The Specialized Group « Inter Comparison Aptitude Tests (EAPIC) » is placed under the aegis of the Operational Committee for Qualification and inter-laboratory Comparison (COQC) of the Institute of Roads, Streets and Infrastructures for Mobility (IDRRIM) chaired by Eric OLLINGER (assistant: Anaïs FERMINE).

The ***Specialized Group*** relies on ***Executive Cell*** to organize the test campaign. Logistic for samples preparation is provided by ***Support Laboratories.***

EAPIC Specialised Group

General Secretary: Frédéric DELFOSSE

Members :
ARGHYRIS Adso
DANIEL Vincent
DELFOSSE Frédéric
DUPRIET Stéphane
ESPIEUX Baudouin
LE CUNFF Franck
PIOT Géraldine
PRIEZ Christophe
SOME Ciryle

EAPIC Executive Cell

Cerema IDF- Sourdun site: PIOT Géraldine

EAPIC Support Laboratories

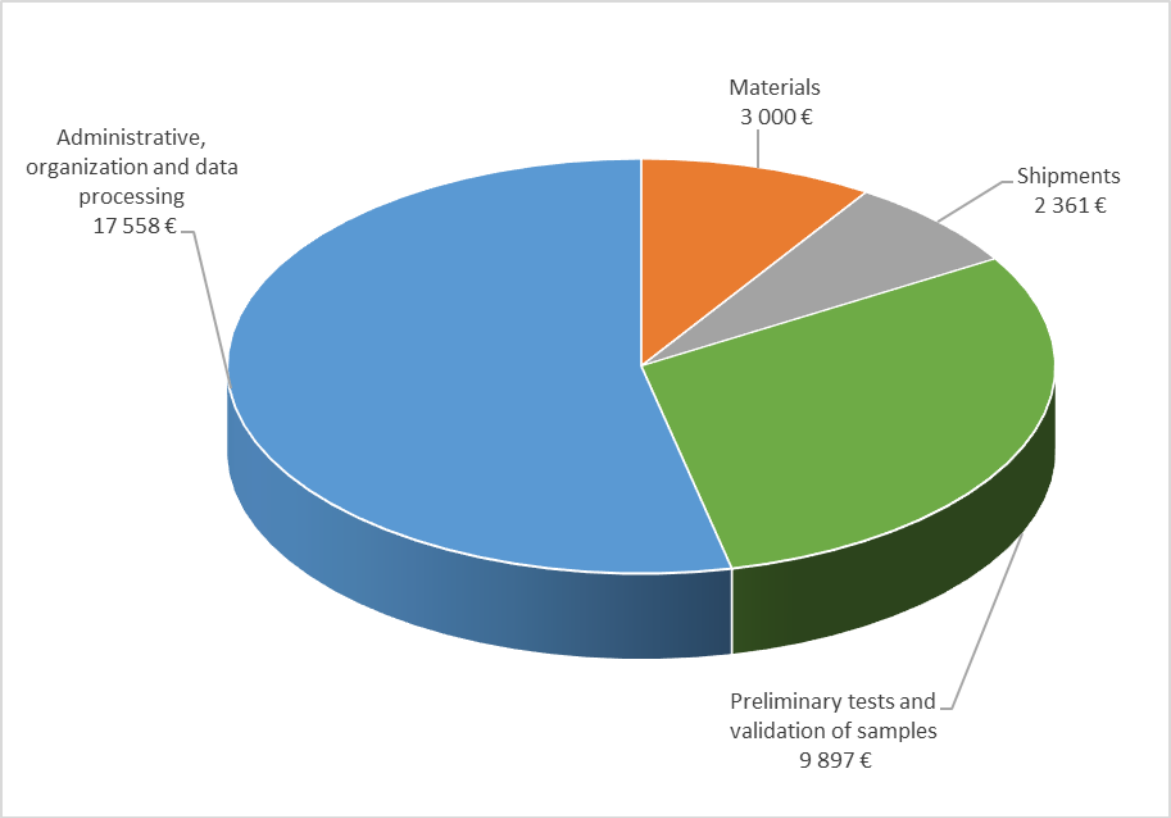
Cerema West Department Laboratory of Angers: DANIEL Vincent

Cerema East Central Department Laboratory of Autun: ESPIEUX Baudouin & ARGHYRIS Adso

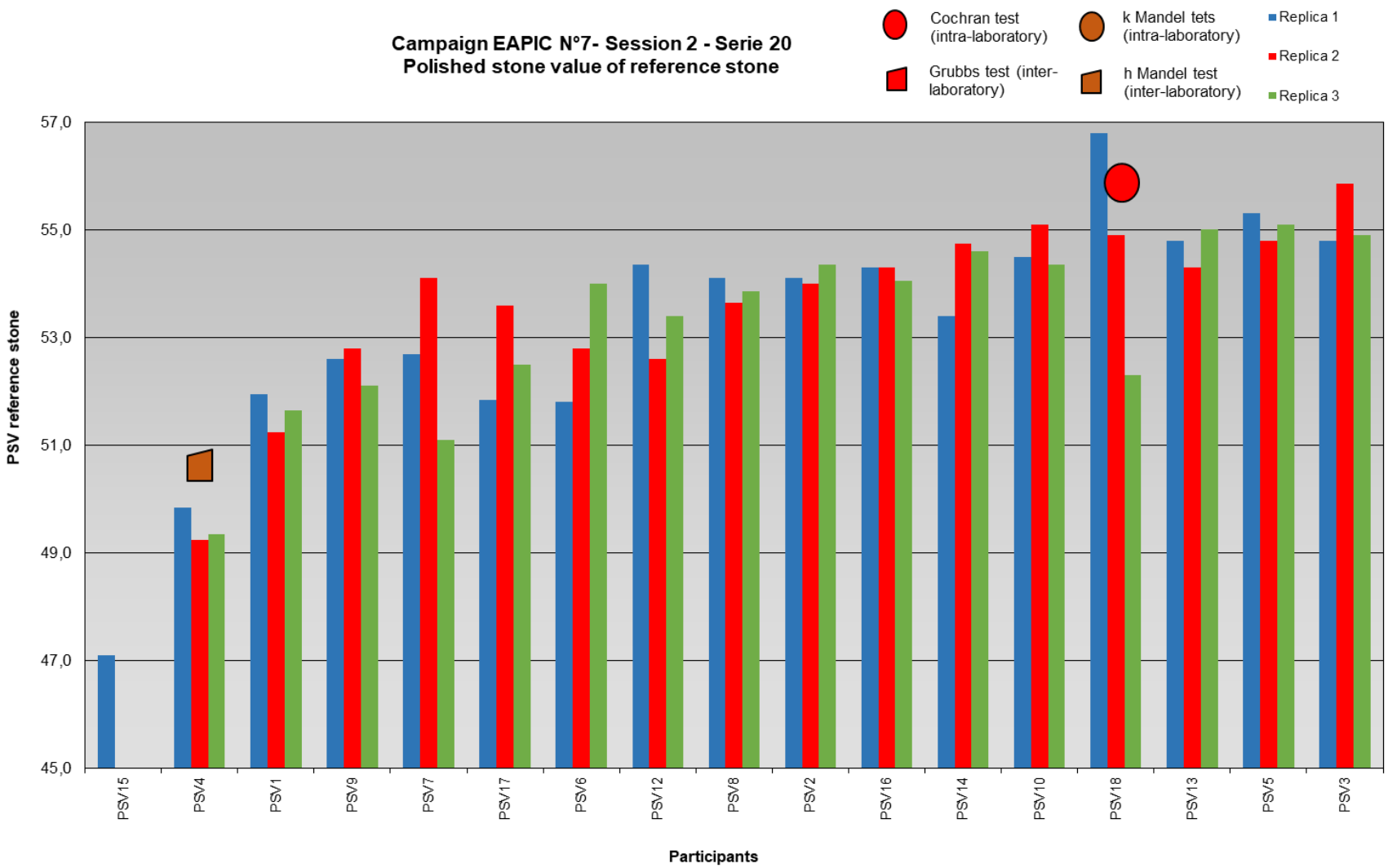
Appendix

- Financial balance sheet
- Determination of polished stone value of reference stone

Financial balance sheet



Determination of PSV on reference stone



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