

Report Suramet Supplementary Comparison(SIM 7.17).

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1. Introduction

It has been agreed between National Laboratories of countries of Suramet to perform a Supplementary comparison in 2000 with standards of four nominal values:

1 g
 10 g
 100 g
 1000 g

Laboratories that accepted to participate are the ones listed below:

Laboratory	Country
Centro de Estudios, Medición y Certificación de Calidad CESMEC	Chile
Instituto Nacional de Tecnología Industrial INTI	Argentina
Instituto Nacional de Metrologia, Normalização e Qualidade Industrial INMETRO	Brasil
Laboratorio Tecnológico del Uruguay LATU	Uruguay
National Institute of Standards and Technology NIST	USA

LATU has accepted the role as pilot laboratory.

The calibrations were carried out from 02/2001 to 09/2002. All laboratories have reported their values to pilot lab by 12/2002.

2. Description of the devices.

The standards were chosen among those available for comparison in LATU and INTI, that could cover the range of weights mostly used in labs involved.

Data of volume of weights and their uncertainty were available to all participants in the "Measurement Protocol", and were not measured by the participants (except

CESMEC that measured magnetic susceptibility and permanent magnetization for 1000 g, 100 g and 10 g weights).

The magnetic susceptibilities of weights were in accordance to E2 class.

The stability of the standards has been checked over a period of one year .

3. Summary of the results reported by participants.

Five laboratories determined the mass of the standards, LATU as pilot laboratory determined the mass of each standard at the beginning and at the end of the comparison. The results are summarized in Table 1.

3.1. Values of mass and expanded uncertainty.

Table 1.-

Date	Laboratory	1000 g		100 g		10 g		1 g	
		(m-m0) / mg	U / mg	(m-m0) / mg	U / mg	(m-m0) / mg	U / mg	(m-m0) / mg	U / mg
01-2001	LATU	2,470	0,05	0,068	0,015	0,0409	0,0060	-0,0154	0,0030
02-2001	INTI	2,51	0,10	0,071	0,020	0,0368	0,0037	-0,0078	0,0037
09-2001	INMETRO	2,50	0,15	0,070	0,020	0,0320	0,0060	-0,0110	0,0030
01-2002	CESMEC	2,502	0,032	0,086	0,016	0,028	0,006	-0,020	0,003
05-2002	LATU	2,554	0,050	0,083	0,015	0,0417	0,0060	-0,0132	0,0030
08-2002	NIST	2,572	0,047	0,089	0,019	0,0428	0,0059	-0,0167	0,0015
Δm /mg	LATU	0,084		0,015		0,0008		0,0022	

m- reported mass of the standard

m0- nominal mass of the standard

U - expanded uncertainty of the mass reported.

m- mass drift measured at LATU.

3.2.- Stability of travelling standards.

100 g weights. This issue is taken into account to analyze the results.

We can appreciate a variation higher than the magnitude of LATU's uncertainty values in the case of the mass of 1000 g and

In the case of 10 g and 1 g weights we can assume that there was no significant drift.

4. Reference Value.

The reference value was taken as the weighed mean of all labs. Consistency check was performed, assumed normal distribution. In the cases that a significant variation was detected, the reference value was corrected taking into account the estimated drift according to the following equation:

$$R_{Vc} = R_V + \Delta m_{LATU} \frac{(t_{LAB} - t_{Rv})}{\Delta t_{LATU}}$$

R_{Vc} - Corrected reference value.

R_V - Reference value calculated as the weighed mean.

m_{LATU} - mass drift measured at LATU.

t_{LAB} - time of the measure at a given lab.

t_{Rv} - mean time of all the comparison (that is 12/2002)

t_{LATU} -time difference between LATU's measurements.

The magnetic susceptibilities of the weights were in accordance with E2 class. Then, the corresponding uncertainty contributions due to magnetic susceptibilities were considered negligible in comparison with E2 uncertainties. To illustrate the fact that some laboratories reported much lower uncertainties than E2 class, in Fig 1., 2., 3. and 4., the reference value was represented with limits corresponding to the maximum permissible uncertainties of E2 class in red full line, and of E1 class in red dotted line,. These uncertainties are taken as uncertainties in the reference values in the calculation of the normalized error in Table 3, and of the bilateral coefficient in Table 4.

5. Figure Captions

Fig. 1.- Results for 1 000 g weight

Fig. 2.- Results for 100 g weight.

Fig. 3.- Results for 10 g weight.

Fig. 4.- Results for 1 g weight.

Fig. 1
1 000 g

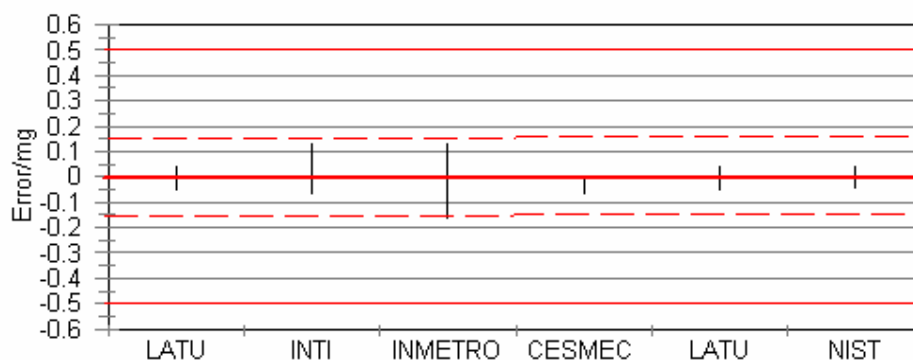


Fig. 2
100 g

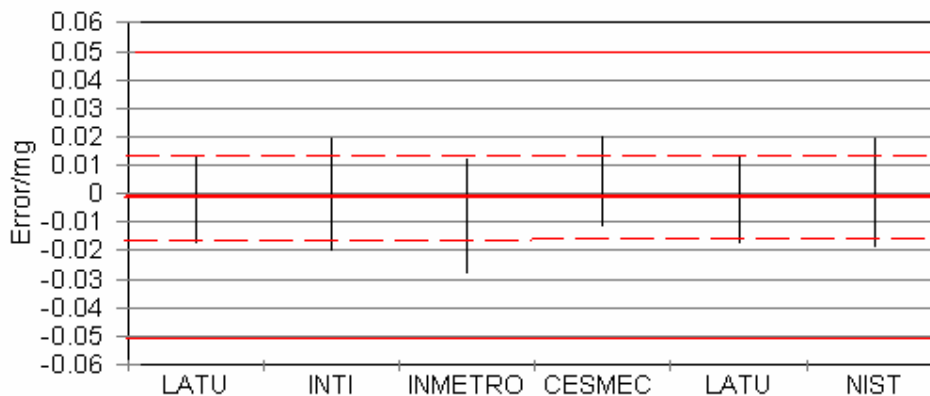


Fig. 3.
10 g

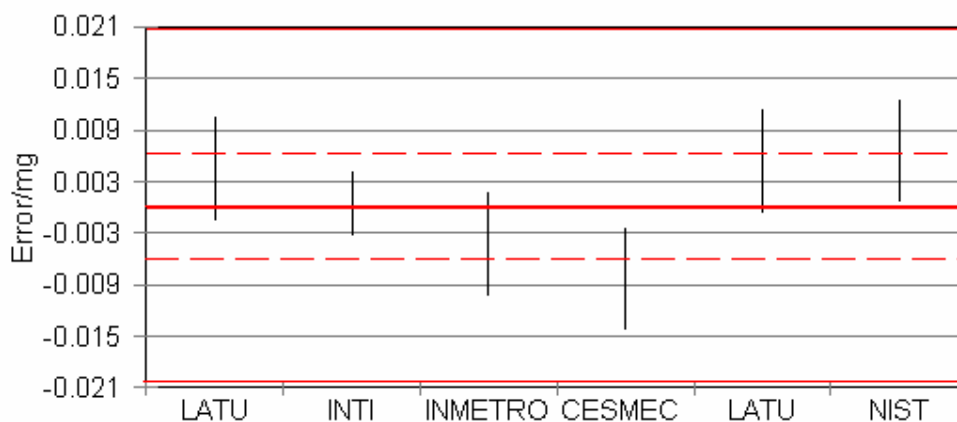
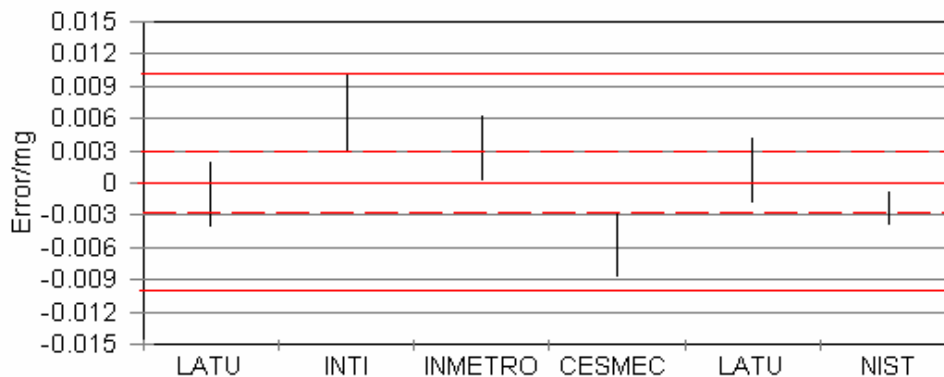


Fig. 4.
1 g.



6.- Equivalence between laboratories.

Table. 2.- List of reference values and errors of each participant laboratory.

R = Reference value (taking into account comments of point 4).

E = Error = Value reported by the laboratory - Reference value

		LATU	INTI	INMETRO	CESMEC	LATU	NIST
1000 g	R	2.470	2.475	2.511	2.532	2.553	2.569
	E	0.000	0.035	-0.011	-0.030	0.000	0.003
100 g	R	0.070	0.071	0.078	0.081	0.085	0.088
	E	-0.002	0.000	-0.008	0.005	-0.002	0.001
10 g	R	0.0362	0.0362	0.0362	0.0362	0.0362	0.0362
	E	0.0047	0.0006	-0.0042	-0.0082	0.0054	0.0066
1 g	R	-0.0144	-0.0144	-0.0144	-0.0144	-0.0144	-0.0144
	E	-0.0009	0.0066	0.0034	-0.0056	0.0012	-0.0023

Table 3.- List of the normalized errors of each value reported by laboratories respect to the reference value.

$$E_n = \frac{E}{\sqrt{U_{RV} + U_{Lab}}}$$

- U_{RV} – Expanded uncertainty in the reference value

- U_{Lab} – Expanded uncertainty reported by the lab

-En (E1) - Normalized error considering for the reference value the expanded uncertainty corresponding to E1 class.

-En (E2) - Normalized error considering for the reference value the expanded uncertainty corresponding to E2 class.

	En\Lab	LATU	INTI	INMETRO	CESMEC	LATU	NIST
1000 g	En(E1)	0.00	0.20	-0.05	-0.20	0.00	0.02
	En(E2)	0.00	0.07	-0.02	-0.06	0.00	0.01
100 g	En(E1)	-0.09	0.01	-0.30	0.21	-0.09	0.04
	En(E2)	-0.03	0.00	-0.12	0.07	-0.03	0.01
10 g	En(E1)	0.55	0.09	-0.49	-0.97	0.64	0.79
	En(E2)	0.23	0.03	-0.20	-0.39	0.26	0.32
1 g	En(E1)	-0.22	1.39	0.80	-1.32	0.29	-0.67
	En(E2)	-0.09	0.62	0.33	-0.54	0.12	-0.22

Table 4.- Bilateral coefficients (bilateral normalized errors) are estimated taking into account the maximum between declared uncertainty and E1 uncertainties for 1000 g and 100 g weights and E2 uncertainties for 10 g and 1 g weights

1000 g

	LATU	INTI	INMETRO	CESMEC	LATU	NIST
LATU	0.0	-0.2	-0.1	-0.2	-0.4	-0.5
INTI	0.2	0.0	0.0	0.0	-0.2	-0.3
INMETRO	0.1	0.0	0.0	0.0	-0.3	-0.3
CESMEC	0.2	0.0	0.0	0.0	-0.2	-0.3
LATU	0.4	0.2	0.3	0.2	0.0	-0.1
NIST	0.5	0.3	0.3	0.3	0.1	0.0

100 g

	LATU	INTI	INMETRO	CESMEC	LATU	NIST
LATU	0.0	-0.1	-0.1	-0.8	-0.7	-0.9
INTI	0.1	0.0	0.0	-0.6	-0.5	-0.7
INMETRO	0.1	0.0	0.0	-0.6	-0.5	-0.7
CESMEC	0.8	0.6	0.6	0.0	0.1	-0.1
LATU	0.7	0.5	0.5	-0.1	0.0	-0.2
NIST	0.9	0.7	0.7	0.1	0.2	0.0

10 g

	LATU	INTI	INMETRO	CESMEC	LATU	NIST
LATU	0.0	0.1	0.3	0.5	0.0	-0.1
INTI	-0.1	0.0	0.2	0.3	-0.2	-0.2
INMETRO	-0.3	-0.2	0.0	0.1	-0.3	-0.4
CESMEC	-0.5	-0.3	-0.1	0.0	-0.5	-0.5
LATU	0.0	0.2	0.3	0.5	0.0	0.0
NIST	0.1	0.2	0.4	0.5	0.0	0.0

1 g

	LATU	INTI	INMETRO	CESMEC	LATU	NIST
LATU	0.0	-0.5	-0.3	0.3	-0.2	0.1
INTI	0.5	0.0	0.2	0.9	0.4	0.6
INMETRO	0.3	-0.2	0.0	0.6	0.2	0.4
CESMEC	-0.3	-0.9	-0.6	0.0	-0.5	-0.2
LATU	0.2	-0.4	-0.2	0.5	0.0	0.2
NIST	-0.1	-0.6	-0.4	0.2	-0.2	0.0

As it can be seen there is a good equivalence between participants of comparison.

.- References.

- (1) The evaluation of key comparison data . M. G. Cox- Metrologia, 2002, 39, 589-595-
- (2) Mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes, BIPM, Paris, 14 October 1999.
- (3) Weights of classes E1, E2, F1, F2, M1, M2, M3, International recommendation OIML R 111, OIML Paris 1994.
- (4) ISO Guide to the Expression of Uncertainty in Measurement