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ACTIVITY OF INTERLABORATORY COMPARISON ON WEIGHT MEASUREMENT IN THAILAND

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Abstract – This paper shows the results of an interlaboratory comparison in Thailand for weight conducted three times. At the first starting from October 2001 to December 2001, eleven participating laboratories joined in OIML weight 500g F1 and brass weight 500 g programs. Next, from October 2003 to February 2004, F1 OIML weights of 100 mg, 10 g, 1 kg and 5 kg were calibrated among sixteen participating laboratories. At last, started from May 2006 to July 2006 with two sets of F1 OIML weights : 100 mg, 2 g, 20 g, 50g and 1 kg, seventeen laboratories participated. The National Institute of Metrology (Thailand), NIMT, Mass Laboratory under the Department of Mechanical Metrology was a pilot laboratory, which as the coordinating interlaboratory on these three programmes, carried out to check the results on these artifacts at the beginning, the middle and the end of circulating loop. The report of these comparison is being in this document.

Keywords : Weight, Interlaboratory comparison, Thailand

1. INTRODUCTION

From the National Metrological System Development Act of Thailand in 1997, clause 13(3) "To encourage metrological professions and calibration laboratory capability" and clause 14(5) "Support private calibration laboratories in metrological participation; traceability, information service, measurement technology consultation, and other related metrological activities" [1] , the Mass laboratory of National Institute of Metrology Thailand initiated the capability enhancement project for calibration laboratories in Thailand by providing support in terms of consultation and training, in order to develop and enhance the calibration laboratory's capability in transferring values from the national standard to reference instruments and working-level instruments used in production, industry and other economic sectors which are related.

Therefore, this interlaboratory comparison programme is an activity to provide both theoretical and technical support to calibration laboratories in field of weight calibration. The main objectives were to provide participating laboratories with the means of measurement result comparison and opportunities for improvement. The artifacts were circulated among the participating laboratories. NIMT acted as the reference laboratory. The reference values were derived from the average of NIMT's results. Furthermore, it prepares the laboratory for accreditation from Thai Industrial Standards Institute (TISI).

2. DESCRIPTION OF THE PROGRAMME

2.1. Artifact and participating Laboratories

The first interlaboratory weight comparison of Thailand was code number MM01. The two of 500g weights, OIML F1 weight and brass weight, were circulated among eleven participating laboratories from October 2001 and finish in December 2001. The purpose of using the 500 g brass artifact was to evaluate the air buoyancy measurement of the participating laboratories. Unfortunately, it was discovered that the mass of the brass weight constantly decreased during the 3 months of the calibration program. From October to December 2001, the mass decreased approximately 1.5 mg, the air buoyancy evaluations and the E_n numbers of the participating laboratories were omitted. Therefore, the artefact of MM01 programme was only OIML weight 500g class F1.

Next, the programme was code number MM02 from October 2003 to February 2004, OIML F1 OIML weights of 100 mg, 10 g, 1 kg and 5 kg were calibrated among sixteen participating laboratories. At last, started from May 2006 to July 2006 and nomination the code number was MM03, with two sets of F1 OIML weights : 100 mg, 2 g, 20 g, 50g and 1 kg, seventeen laboratories participated.

The participating laboratory are as given in the following Table 1.

Table 1. A list of participants

No.	participating laboratory
A list of MM01 participants	
1	Siam Cement Industry Co., Ltd. (SCI), Bangkok
2	Calibratech Co., Ltd., Nonthaburi

No.	participating laboratory
3	Center on Industrial Instrument Calibration (CIC), Bangkok
4	Paisarn Karnchang Co., Ltd., Bangkok
5	Technology Promotion Association (Thailand-Japan), Bangkok
6	Thai Airways International Public Company Limited, Bangkok
7	Thailand Institute of Scientific and Technological Research (TISTR), Bangkok
8	NEC Communication Systems (Thailand) Co., Ltd., Pathumthani
9	Central Bureau of Weights and Measures (CBWM), Nonthaburi
10	International Laboratories Corp. Co., Ltd., Samutprakarn
11	Department of Science Services (DSS), Bangkok
A list of MM02 participants	
1	Calibratech Co., Ltd., Nonthaburi
2	Calibration Laboratory Co., Ltd., Bangkok
3	Center on Industrial Instrument Calibration (CIC), Bangkok
4	Central Bureau of Weights and Measures (CBWM), Nonthaburi
5	Department of Science Services (DSS), Bangkok
6	Electricity Generating Authority of Thailand (EGAT), Nonthaburi
7	Instrument Calibration Center Prince of Songkla University (PSU), Songkla
8	International Laboratories Corp. Co., Ltd., Samutprakarn
9	Mettler Toledo (Thailand) Ltd., Bangkok
10	NEC Corporation (Thailand) Limited, Pathumthani
11	Scientific Promotion Co .,Ltd., Bangkok
12	Siam Cement Industry Co., Ltd. (SCI), Bangkok
13	Technology Promotion Association (Thailand-Japan), Bangkok
14	Thai Airways International Public Company Limited, Bangkok
15	Thailand Institute of Scientific and Technological Research (TISTR), Bangkok
16	Thai Scale Co., Ltd., Nakornpratom
A list of MM03 participants	
1	Center on Industrial Instrument Calibration (CIC), Bangkok
2	Instrument Calibration Center Prince of Songkla University (PSU), Songkla
3	Department of Science Services (DSS), Bangkok
4	Central Bureau of Weights and Measures (CBWM), Nonthaburi
5	National Food Institute, Bangkok
6	Thailand Institute of Scientific and Technological Research (TISTR), Bangkok
7	Technology Promotion Association (Thailand-Japan), Bangkok
8	Electricity Generating Authority of Thailand (EGAT), Nonthaburi
9	Mettler Toledo (Thailand) Ltd., Bangkok
10	SPC Calibration Center Co .,Ltd., Bangkok
11	Calibration Laboratory Co., Ltd., Bangkok
12	Thai Airways International Public Company Limited, Bangkok
13	NEC Corporation (Thailand) Limited, Pathumthani 12120
14	Siam Cement Industry Co., Ltd. (SCI), Bangkok
15	Thai Scale Co., Ltd., Nakornpratom
16	International Laboratories Corp., Ltd., Samuthprakhan
17	Calibratech Co., Ltd., Nonthaburi

2.2. Transportation

The artifacts were circulated among the participating laboratories in two loops (designated Loop 1 and 2). The Mass Laboratory, Mechanical Metrology Department, NIMT acted as the reference laboratory. The reference values were derived from the average of NIMT's results at the beginning (N1), the middle (N2) and the end (N3) of the programmes.

Each participant laboratory had to responsible for its own cost of measurement and transportation of artifacts. When each participant finished the measurement, laboratory had to send back to NIMT. Then the next participant had to get the artifact for the process. NIMT was the centre of delivery and participant must check the artifacts upon unpacking when received and before packing for the next delivery.

2.3. Reporting by participants

The technical protocol provide appropriate for reporting the main following information to pilot laboratory, NIMT.

(i) Detail of participating laboratory's instrument
(ii) Calibration results
(iii) Uncertainty

Uncertainty calculations should be performed in accordance to OIML R 111-1 "International Recommendation Weights of classes E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} and M_3", 2004 [2] or/and ISO "Guide to the Expression of Uncertainty in Measurement", 1993 (GUM) [3].

Participating laboratories were in addition asked to report their measurement results on their normal calibration certificates and also asked to supply worksheets and a copy of their calibration reports of their reference weight(s) used.

The programme coordinator, NIMT sent out the draft summary result of NIMT-Weight Interlaboratory Comparison to all participants for comment before prepare the final report with the Laboratory code number for each laboratories as confidential. Each laboratory would see all results but would not know the owners of results other than its own.

3. SUMMARY OF RESULTS

The assessment of the participant measurement capabilities were based on the E_n numbers ISO/IEC GUIDE 43-2 : 1997 "Proficiency Testing by the Interlaboratory Comparison" [4]. The E_n numbers are calculated using a standard statistical technique for comparing values and are derived from the following equation (1).

$$E_n = \frac{Lab_{result} - Ref_{value}}{\sqrt{(U_{95}Lab)^2 + (U_{95}\,Ref)^2}} \qquad (1)$$

where :

Lab_{result} is the participant result.
Ref_{value} is the reference laboratory's assigned value.
$U_{95}Lab$ is the uncertainty of the participant result.
$U_{95}Ref$ is the uncertainty of the reference laboratory's assigned value.

These three times of an interlaboratory comparison in Thailand for weight. NIMT acted as the reference laboratory, all result of comparison shown in appendix. The reference values were derived from the average of NIMT's results. An E_n number between –1 and +1 indicates an acceptable degree of compatibility between the laboratory's result and the reference value when the quoted uncertainties are taken into account.

The E_n number of all participants were within ±1.0. Therefore the measurement capability 500g OIML weight class F1 of all participants were accepted in the first programme MM01. Consider based on OIML-R111 the uncertainty of 500 g, class F1, must be within 1/3 of Maximum Permissible Error (MPE) that is ±0.8 mg. The difference of measurement results among most participating laboratories is agreeable within ±0.8 mg. In the programme MM02, all of measuring results were agreed within an E_n number between –1 and +1. Although, one comparison result appeared to be anomalous, the measuring result of 10 g was out of E_n number (+1.6). However, the participating laboratory re-measured and re-sent the corrected result to the programme coordinator, NIMT.

Especially, in the programme MM03. The participating laboratories (group A) determined the conventional mass of a set A artifacts (100 mg, 2 g, 20 g, 500 g and 1 kg) while the remaining eight laboratories (group B) determined the conventional mass of a set B artifacts (same nominal weights of the set A). The comparisons were carried out over a period of about two months. After finished the comparisons all participants results were sent to the pilot laboratory (NIMT) for analyzed and drafted the report., it was found that the comparison result of 100 mg of laboratory (LA4) seem to be wrong after checking they found that, who took the data from the other 100 mg weight (not from the 100 mg artifact). After finished the closed meeting, the participation laboratory (LB2) would like to repeat measurement of 20 g artifact again. Because they have the suitable weighing instrument resolution for this artefact. To fullfill the objective of this comparison program, the pilot laboratory allow the laboratory (LB2) to repeat the measurement. Therefore the corrected results were changed, the pilot laboratory reanalyzed the comparison result before presented this report.

4. CONCLUSIONS

The results of interlaboratory comparison show that nowadays the calibration laboratories in Thailand are capable of calibration to OIML weight class F1. Moreover, to ensure that the calibration laboratory's capability in transferring values from the national standard to reference instruments and working-level instruments used in production, industry and other economic sectors which are related.

ACKNOWLEDGMENTS

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REFERENCES

[1] Royal Thai Government Gazette, "*National Metrological System Development Act of Thailand",* B.E 2540, vol. 114, chapter 47, Date 12 September, pp. 4-5.

[2] OIML R 111-1 : *International Recommendation Weights of classes E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} and M_3 Part 1* ; Metrological and Technical requirements requirements , 2004.

[3] GUM : Guide to the Expression of "*Uncertainty in Measurement*, 1993.

[4] ISO/IEC Guide 43-1 , *Proficiency Testing by Interlaboratory Comparisons,* 1997.

APPENDIX

The results of the reported conventional mass values and their combined standard uncertainties as given by the participants and the pilot laboratory show as figures below.

Where ■ is the conventional mass which deviation from nominal mass (mg) with the expanded uncertainty (k=2).

● is E_n ratio

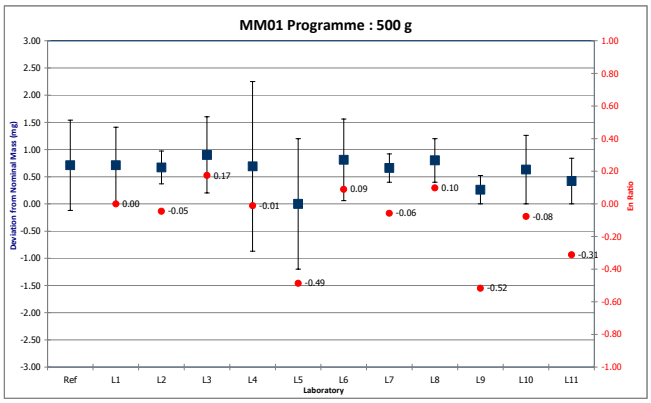

Fig. 1. MM01 programme : 500 g

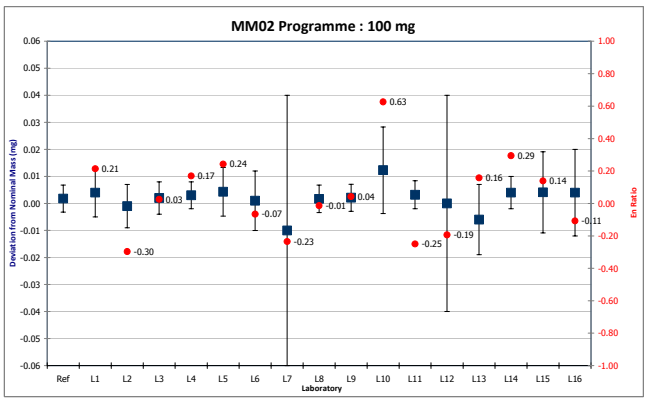

Fig. 2. MM02 programme : 100 mg

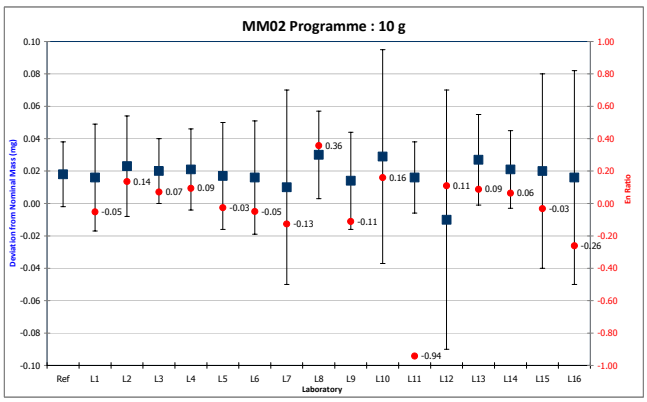

Fig. 3. MM02 programme : 10 g

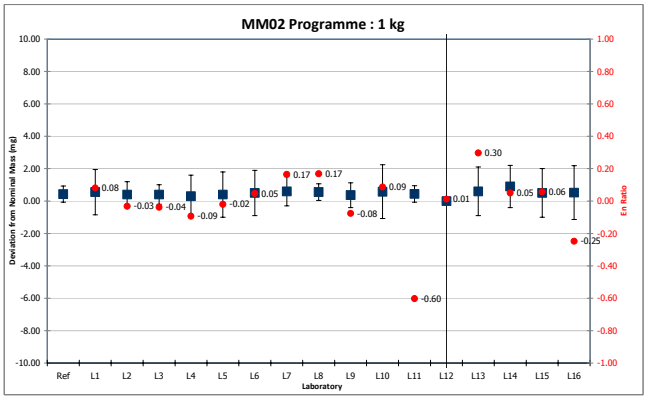

Fig. 4. MM02 programme : 1 kg

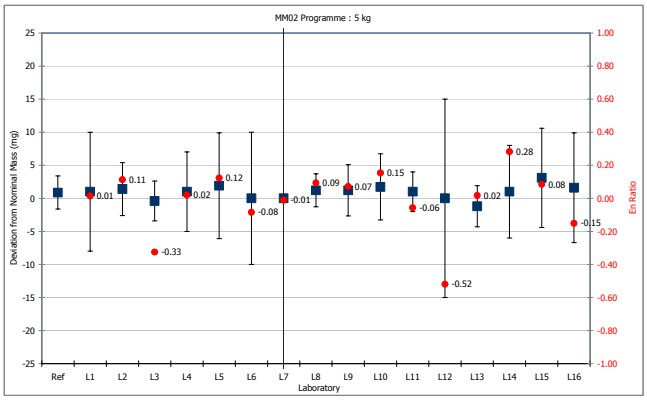

Fig. 5. MM02 programme : 5 kg

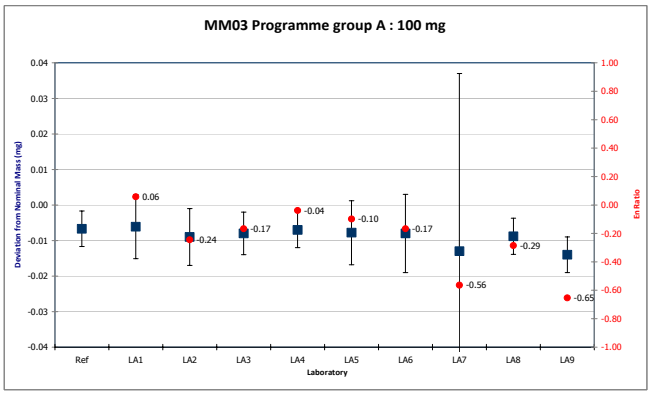

Fig. 6. MM03 programme group A : 100 mg

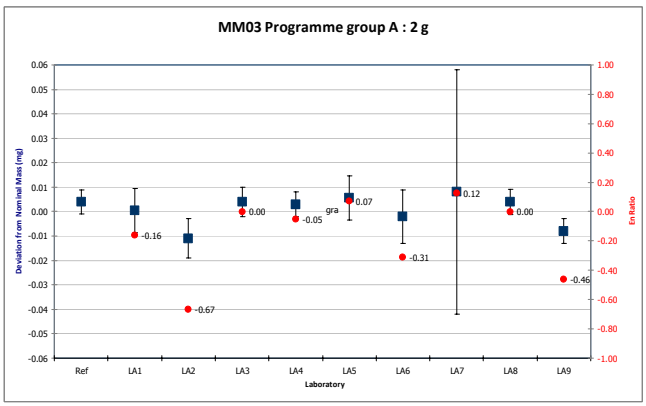

Fig. 7. MM03 programme group A : 2 g

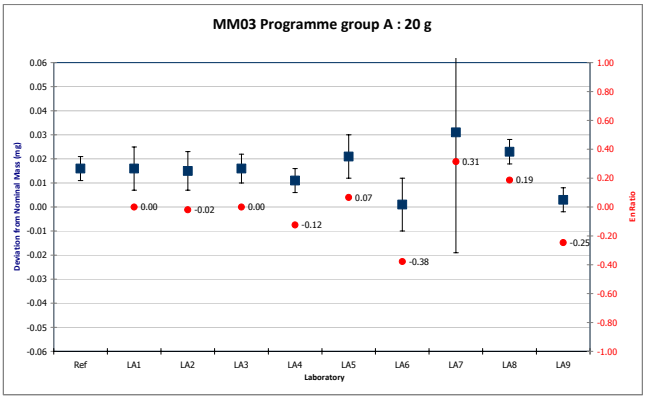

Fig. 8. MM03 programme group A : 20 g

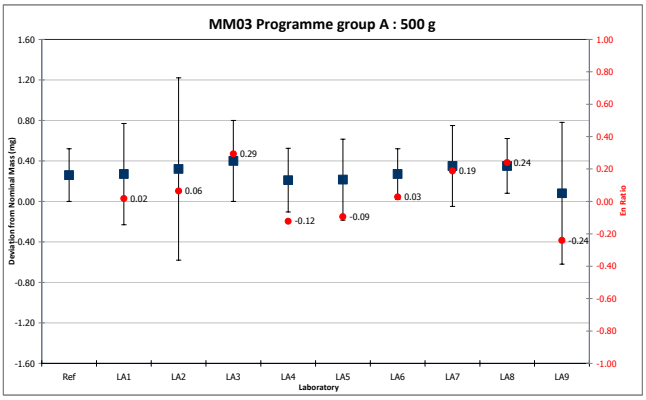

Fig. 9. MM03 programme group A : 500 g

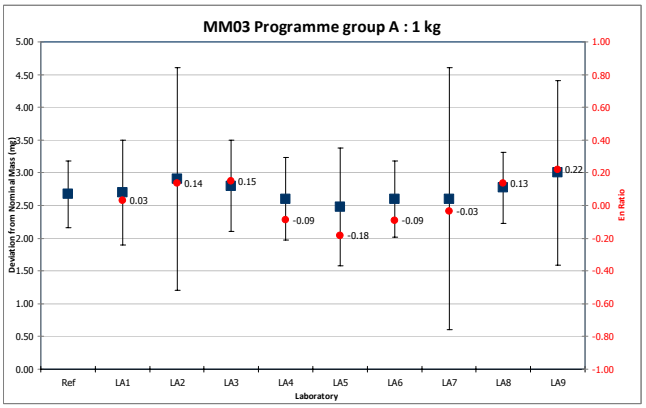

Fig. 10. MM03 programme group A : 1 kg

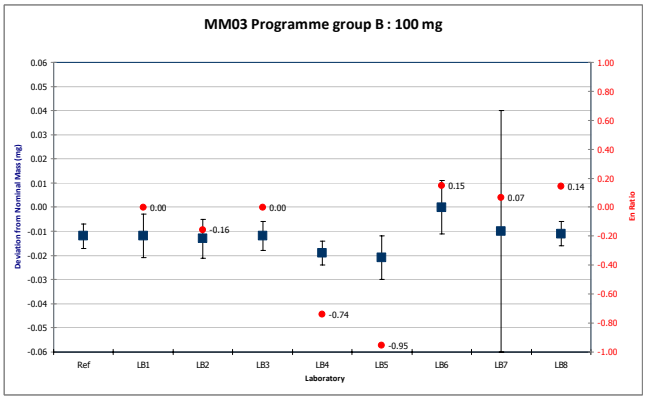

Fig. 11. MM03 programme group B : 100 mg

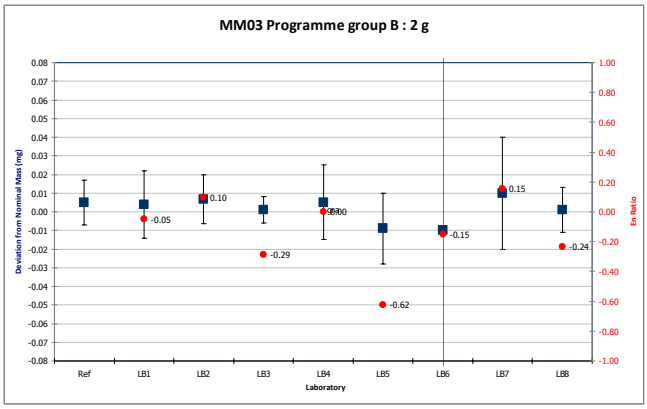

Fig. 12. MM03 programme group B : 2 g

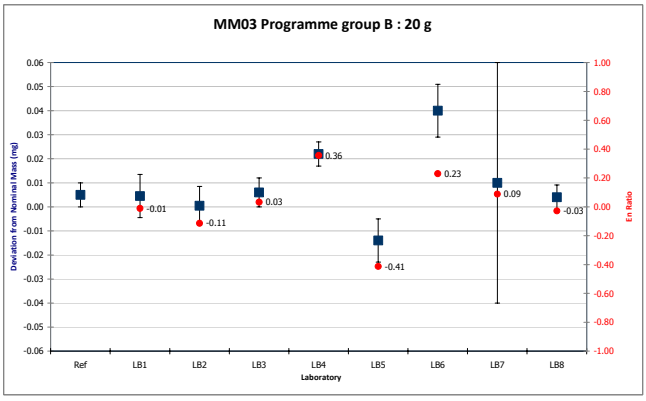

Fig. 13. MM03 programme group B : 20 g

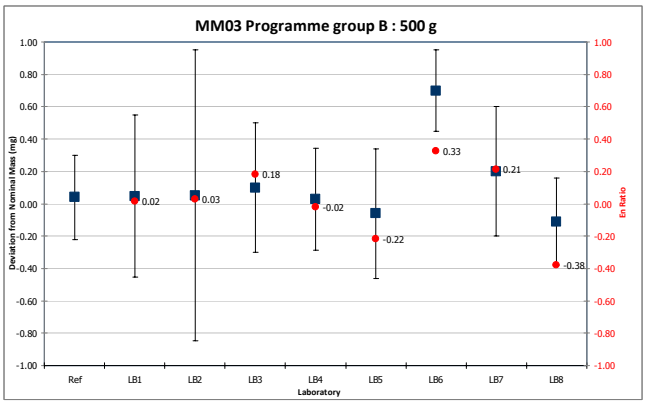

Fig. 14. MM03 programme group B : 500 g

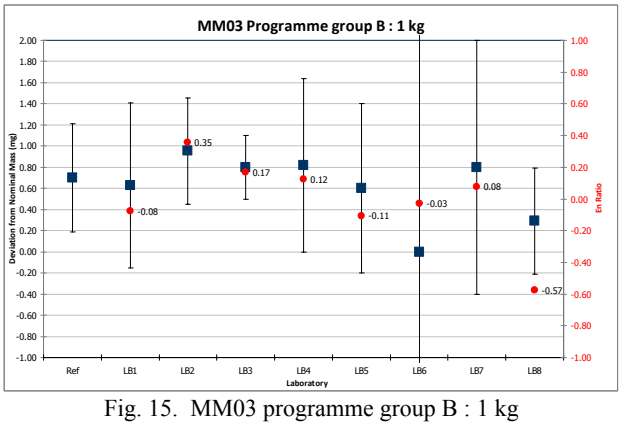

Fig. 15. MM03 programme group B : 1 kg