

BIPM Capacity Building & Knowledge Transfer Programme

2020 BIPM - TÜBİTAK UME Project Placement

REPORT

Project name	Research of new developments and measurement methods in angle metrology and laser heterodyne measurements.
Description	Revision and amendment of the existing calibration procedures of plane angle measuring devices, taking into account the increase in the accuracy of the applied measuring devices and the use of alternative measurement methods. Improvement of skills in the calibration of iodine-stabilized lasers.
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Motivation & Introduction

Measurements of length and dimensional quantities are in demand in many industries, which causes a huge range of measuring instruments used by enterprises and organizations. In particular, angular measurements are one of the most popular types of measurements in the construction industry. They are performed during operational control of the parameters of most construction processes, as well as during acceptance control and ensure the manufacture of products and the construction of structures with specified dimensions. Compliance with the specified tolerances for geometric parameters depends on the accuracy of the measurements made.

Taking into account the long-term experience of «TUBITAK UME» in the field of length and dimensional measurements, one of the main goals is considering the possibility of modernization of standards of RSE «Kazakhstan Standartization and Metrology Institute» to improve the accuracy of the measurements, as well as organizing the comparisons with TUBITAK UME.

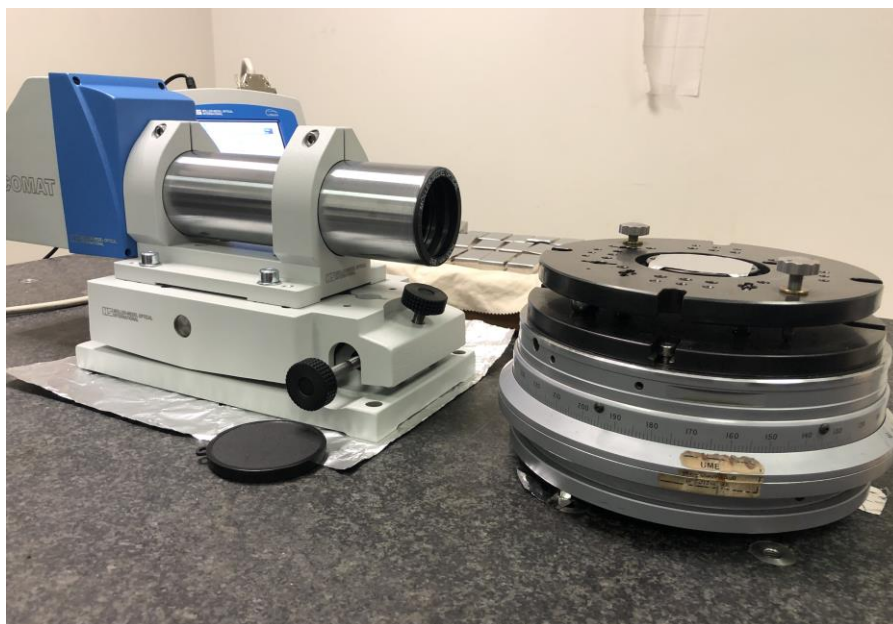
Research

The last actual modernization of The KazStandard RSE plane angle standard was carried out in 2013: the Elcomat 3000 digital autocollimator manufactured by «Moller Wedel Optical GMBH», Germany, was purchased, which made it possible to increase the accuracy of plane angle measurements (measurement error $\pm 0,1$ arc. sec.). Unlike the previous model, this autocollimator is equipped with a remote display, which significantly simplified its operation.

The metrological characteristics of the Elcomat 3000 are currently sufficiently accurate to ensure that the unit size is transferred to the measuring instruments of the subjects of accreditation of the Republic of Kazakhstan through their calibration (with low uncertainty), as well as for solving other measurement tasks. But in order to ensure increased measurement accuracy during the calibration of polygons in the Republic of Kazakhstan we need the inclined table the effect of which was demonstrated by experts of angle measurements laboratory.

Calibration of polygons consists in measuring deviations from the nominal values of polygon angles by the autocollimator. These deviations are measured in arc seconds. The accuracy of these measurements directly depends on the correct pre-setting of the polygon position on the indexing table. And the slightest accidental shift of the polygon during the measurement process or the initial incorrect adjustment of its position significantly affects the accuracy of measurements. All this is due to the high degree of precision of both the polygon and the autocollimator. Therefore, the measurement results directly depend on the correct, reliable fixation of the position of the calibrated polygon. Usually, all national institutes use their tilt tables when calibrating polygons.

During the training period at TUBITAK UME, two measurement options were performed to compare the results of measurements of the same polygon with and without an inclined table. The results showed that with the use of an inclined table, the extended measurement uncertainty is approximately 2-3 times less than without the use of an inclined table. This fact confirms the need to use an inclined table when calibrating polygons, especially when conducting international comparisons.



Conclusions and Future Work

As a result of the training, suggestions and ideas for upgrading the plane angle standard were formulated in order to improve the accuracy of measurements, reduce measurement uncertainty, in particular when calibrating polygons. The current calibration procedures of the polygons and plane angle gauges have been revised, and necessary adjustments have been made. All these activities will contribute in the future to participate in international comparisons and show the best results, and confirm the equivalence of our standards.

Acknowledgements

I would like to express my deep gratitude to BIPM and TUBITAK UME for such a unique opportunity to gain valuable knowledge in the field of angle measurements. I would also like to thank Mr. Tanfer Yandayan and Mrs. Asli Akgoz for their excellent, competent, easy-to-understand theoretical and practical training, after which my knowledge has now improved a lot. And also for their good-natured, selfless attitude and assistance during the pandemic. I also want to thank Mrs. Muge Atam for the competent and prompt solution of all issues, for the comfort created during training and accommodation. I hope to attend similar courses at TUBITAK UME more than once in the future.