

BIPM Capacity Building & Knowledge Transfer Programme

2023 BIPM - TÜBİTAK UME Project Placement

REPORT

Project Name	Traceable Calibration of Radiation Thermometers and Thermal Imagers
Description	Theoretical and practical studies of the primary level radiation thermometry principles below 1600 °C
Author, NMI	Doniyorbek Abdumajidov Department of Measurements of Physical-Chemical, Optical-Physical and Temperature Quantities UzNIM, Republic of Uzbekistan
Mentor at TÜBİTAK UME	Dr. Hümbet Nasibli Thermodynamic Metrology Laboratory, TÜBİTAK Ulusal Metroloji Enstitüsü (UME), Türkiye
Date	2 October 2023 to 24 November 2023

Motivation & Introduction

The main objective of this project is to establish a traceable approach for the calibration of radiation thermometers by using existing national means. Significant attention will be paid to calibration of relatively broadband pyrometers and thermal imagers, which are the most demanded instruments in the field in the Republic of Uzbekistan. The intention was to put a special emphasis on the calibration of ear- and forehead thermometers and low-temperature thermal cameras for human body temperature measurements and fever detection, which were much-demanded issues during the COVID-19 pandemic.

Problems in radiation thermometry:

1. Creation of a standard
2. To provide metrological service of the standard from -50 °C to 3000 °C
3. To study calibration methods
4. To investigate new calibration methods for Radiation Thermometers
5. The lack of calibration of thermal imagers in the country
6. Increasing the scale of measurements in the field of radiation thermometry
7. Using modern standard requirements

Currently, there is a need for radiation thermometers in many fields in the Republic of Uzbekistan. The main goal of the implementation of this project is to expand the availability of standard measuring instruments available in our country (currently -10°C to 1200°C) and to establish a thermal camera calibration service.

Research

The following methods were used for the research:

- The international Temperature Scale of 1990 (ITS-90) was used for the study $>960\text{ }^{\circ}\text{C}$ temperature, $S(t) = \int L(\varepsilon, T) R(\lambda) \{\varepsilon(\lambda, T) d\lambda\}$
- Planck's law
- Spectral responsivity measurement
- MEP-K ABSOLUTE PRIMARY RADIOMETRIC THERMOMETRY
- Fixed point measurement (Ag, Au, Cu) and ITS-90 creation radiation temperature scale

The TSP-1 model pyrometer and Type R Thermocouple was used in the research.

The main findings and conclusions of the study:

The main results obtained during the study are presented in the figures presented in the following pages.

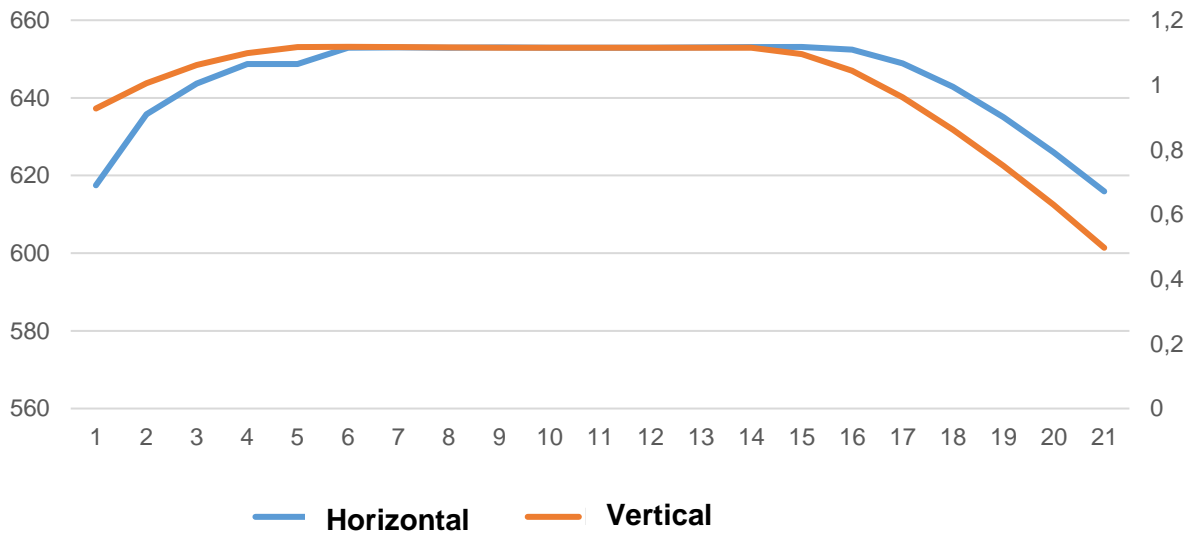
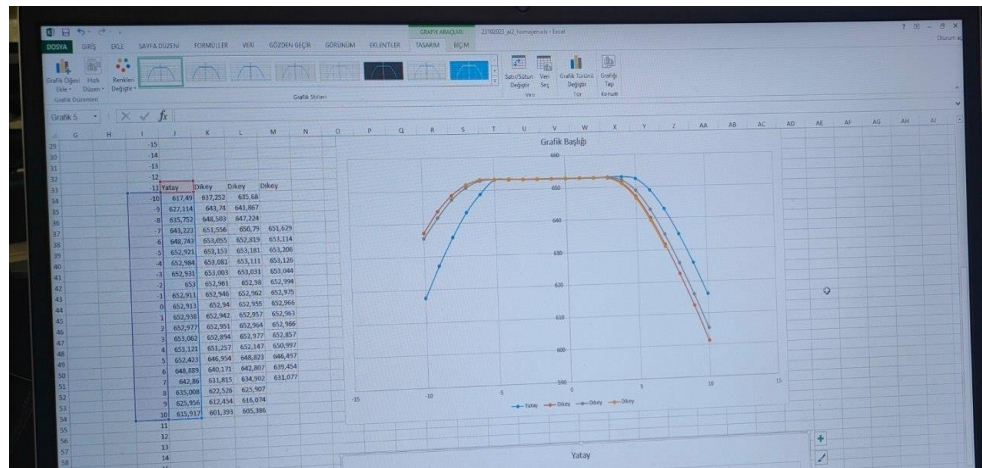


Figure 1. Graph for of Al fixed point



Figure 2. Reference used during the measurements

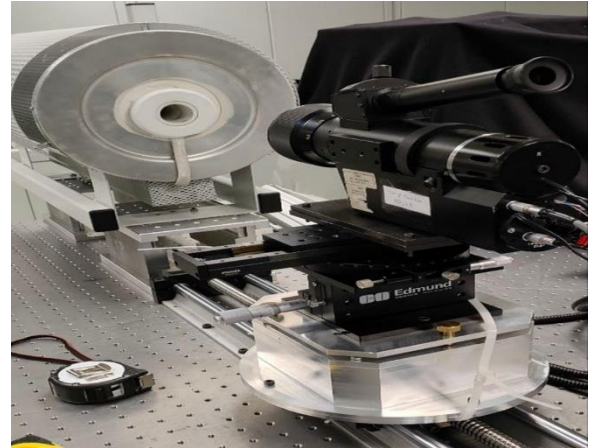


Figure 3. View of experimental set-up

Implementation and dissemination of project results can be summarized as follows:

- a) theoretical and practical study of the principles of primary level radiation thermometry below 1600 °C;
- b) Creation of necessary standards for the project in the Republic of Uzbekistan;
- c) Putting standards into practice;
- d) International comparison of standards and service in radiation thermometry.

Conclusions and Future Work

The conclusion from the research and studies at TÜBİTAK UME is that it is necessary to set standards, introduce new methods, expand the scope of measurement, and increase the personnel capacity of the laboratory of radiation thermometry at UzNIM.

In the future, we plan to implement measures to achieve international recognition and to obtain CMC, to participate in international comparisons.

Acknowledgements

I would like to express my sincere gratitude to the people behind this joint training initiative for giving me the opportunity to experience the state-of-the-art laboratories of advanced NMI like TÜBİTAK UME by participating in this 6th cycle of BIPM UME Placement Programme.

I am deeply grateful to Dr. Hümbet Nasibli, the head of the Thermodynamic Metrology Laboratory. He always answered my questions accurately and completely. It taught me very much necessary knowledge and skills related to the field of Radiation Thermometry.

I also thank Mr. Mücahit Korkmaz, the technician in the laboratory, for helping me during the period of my project.

Last but not the least, thank you to the International Relations Department of TÜBİTAK UME, Ms. Müge Atam, Dr. Enver Sadıkoğlu and the support groups from the drivers, security personnel, housekeepers, and food attendants, for taking good care of our needs and requests in making participant's training duration a memorable and comfortable one. Aside from the new experience and learnings, I would like to thank all of my colleagues coming from different NMIs through this capacity building initiative. I am hoping for the continuation of the alike partnership and to be a gateway to more collaboration for developing a better world through the science of measurement. Hoping that this will not be our last occasion in participating in the BIPM - TÜBİTAK UME Project Placement as we still have a lot of things to learn and implement in our NMIs.