TÜBİTAK

UME

ANNUAL REPORT

TÜBİTAK NATIONAL METROLOGY INSTITUTE

2018
ANNUAL REPORT

CONTENTS

OUR VISION

To be a world-renowned
solution provider in measurement services

FOREWORD

Change Through Measurements

Dear Stakeholders,

We're pleased to present you our annual report in which you will find detailed information on the activities undertaken by the TÜBİTAK National Metrology Institute (UME) in 2018.

As in the past years, TÜBİTAK UME continued its activities aimed at the development and maintenance of national measurement standards and dissemnination of measurement traceability. In addition to these core activities, TÜBİTAK UME continued its involvement in international R&D projects and efforts to develop solutions to challenges in industrial measurements.

In 2018, TÜBİTAK UME performed work in 53 different projects, of which, 2 were funded by the Strategy and Budget Directorate of the Presidency (formerly Ministry of Development), 38 by the European Union, 3 by TÜBİTAK and 10 by customers (8 domestic and 2 international). In a change from years past, 23 new self-supported projects were initiated in 2018 using funds that had accummulated in an infrastructure renewal account, which was set-up as a requirement of a World Bank loan that had been used in earlier years. Of these 23 new projects, 9 were in emerging areas of metrology.

Work began on 11 joint research projects within the EU-funded European Metrology Programme for Innovation and Research (EMPIR) that were accepted for funding in the 2017 call cycle, while 5 EMPIR projects were completed within the year.

TÜBİTAK UME has 5 registered patents and 2 registered trademarks for its own design measurement systems. Currently, the application process is in progress for 1 patent and 1 utility model.

Through its efforts to increase both the quantity and quality of the services it provides to an increasing number of foreign national metrology institutes, TUBITAK UME is increasing its visibility on the international stage.

Two new Memorandums of Understanding were signed and one action plan was prepared as part of our effort to forge closer relations with other national metrology institutes in our geographical areas of interest; the Middle East, the Balkans, Central Asia and Africa.

Additionally, TUBITAK UME plans to work towards establishing the Metrology Center of Excellence for Islamic Countries within the framework of the Organization of Islamic Cooperation (OIC) for assuring the metrological traceability of halal products and intends to lead efforts to build and improve metrology insitutes in developing OIC countries and so ensure their integration to the international system.

TÜBİTAK UME aims to contribute to the enhancement of our country's export capacity and international competitiveness based on R&D and innovation, by improving its research infrastructure in areas such as defense, space and aviation, environment, energy, automotive industry, health and food, thus contributing to our country's progress in line with the requirements of its geopolitical position.

The Project for the Renewal and Development of TÜBİTAK UME Research Infrastructure, which was primarily initiated to establish quantum metrology laboratories in order to facilitate the realization of the new definitions of the kilogram, kelvin, ampere and mol units in the International System of Units (SI) is ongoing.

With all these innovative scientific and technological studies our goal is to succeed in taking a place among the most advanced metrology institutes in Europe and in the world in 2023.

TÜBİTAK UME

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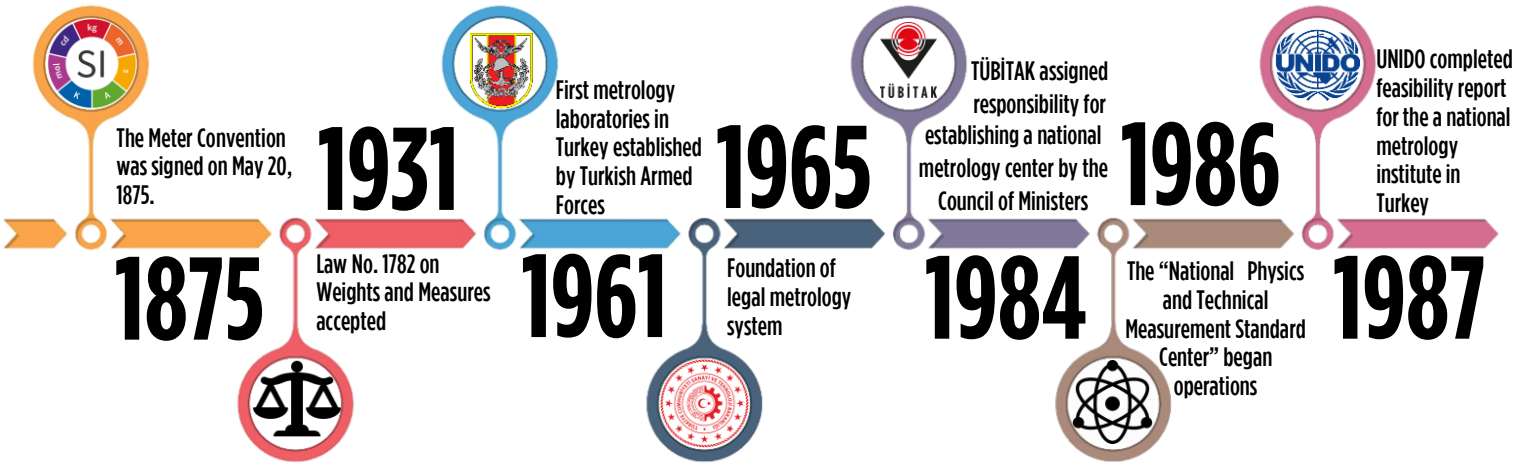
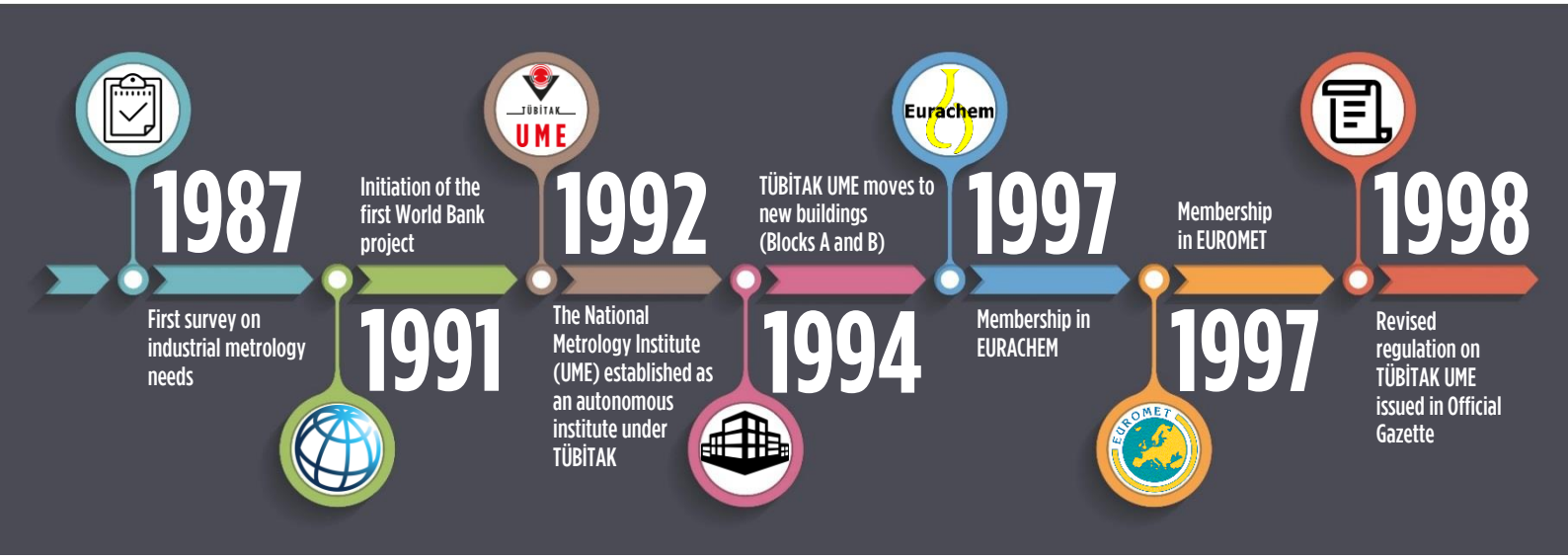
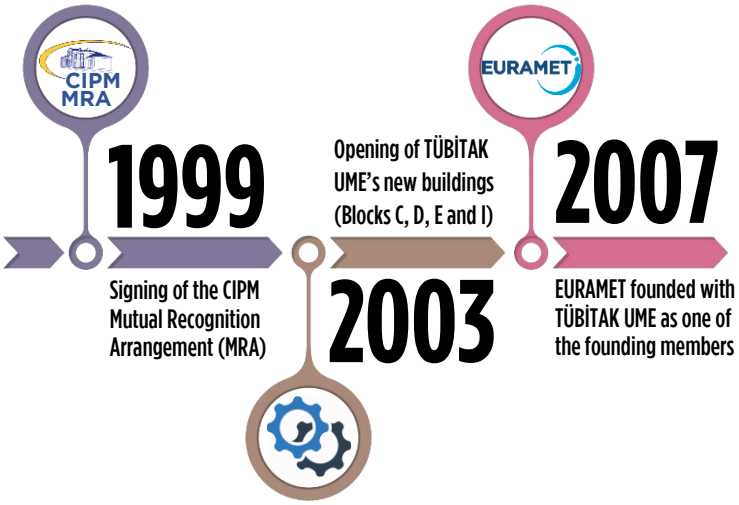




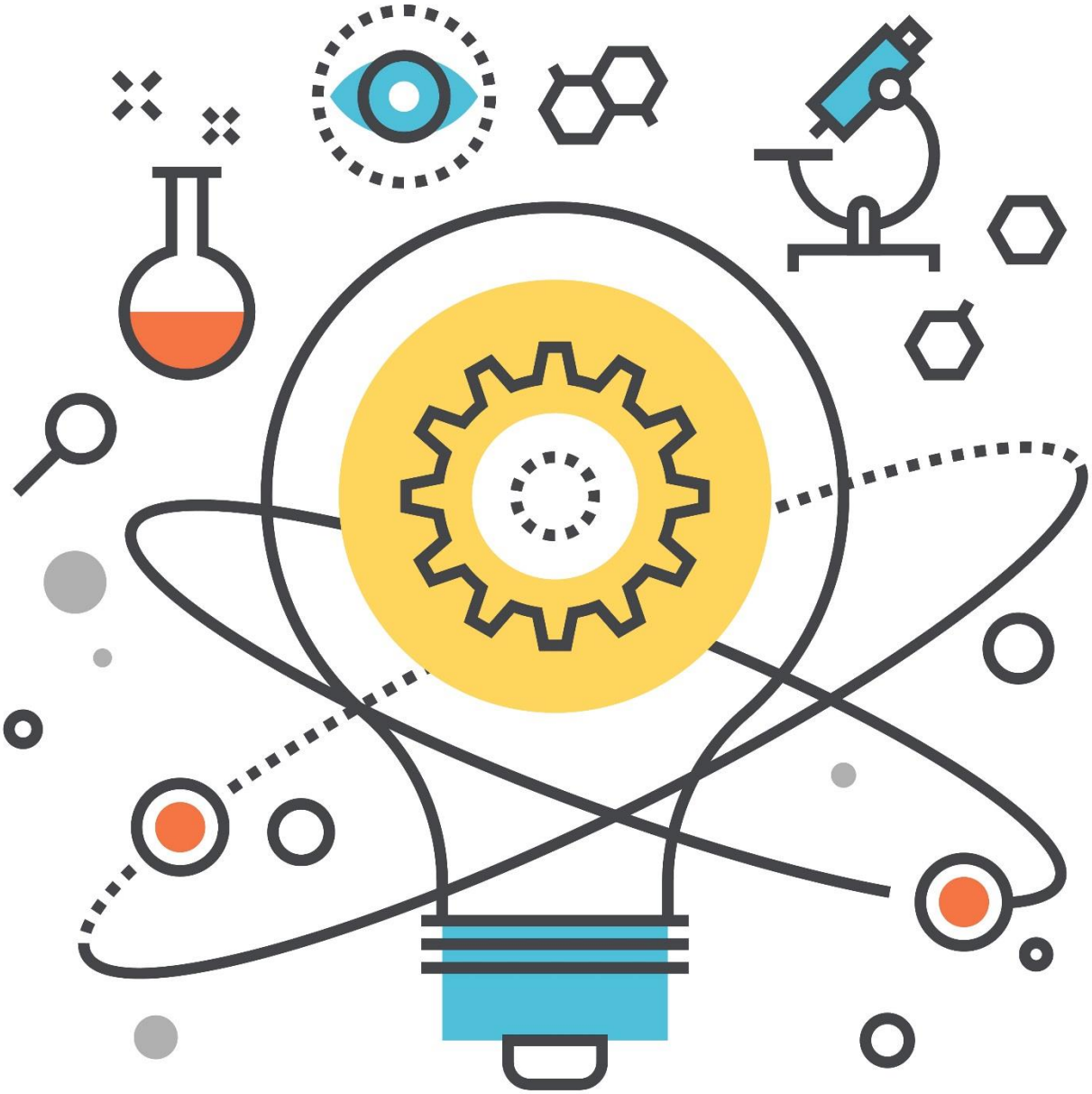


CHRONOLOGY OF METROLOGY IN TURKEY

TÜBİTAK NATIONAL METROLOGY INSTITUTE

TRUE MEASUREMENT EXCELLENCE

R&D ACTIVITIES



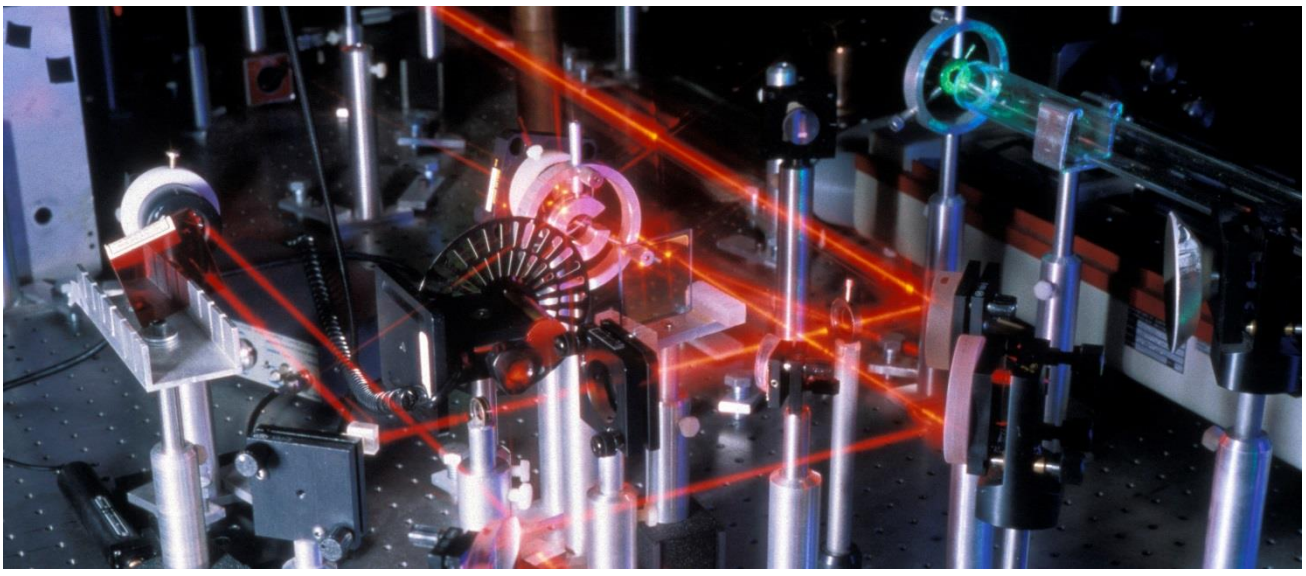
Activities related to the realization of primary level measurement standards remain the highest priority at TÜBİTAK UME in line with its institutional mission.

TÜBİTAK UME increased its participation in R&D projects with the aim of providing solutions to measurement challenges in critical areas such industry, health, environment, and energy. TÜBİTAK UME carried out work on a total of 53 projects in 2018. Of these, 38 were co-funded by the European Union, 2 were funded by the Ministry of Development, 3 were TÜBİTAK funded and 10 were directly financed by customers (8 from within Turkey and 2 international).

Within EMPIR, TÜBİTAK UME initiated work in 11 projects that were funded in the 2018 call cycle, while work on 5 EMRP projects was concluded.

ONGOING INTERNALLY FUNDED PROJECTS

LABORATORY	PROJECT
Bioanalysis	HbA1c Reference Material Production
Bioanalysis	Peptide / Protein Structured Reference Material Production for Clinical Analysis: C-Reactive Protein
Organic Chemistry	New Reference Material Production and Certification for Surface Area Measuring Device
Dimensional	Establishment of Ellipsometry and Skaterometry Methods and Measurement Systems Infrastructure
Gas Metrology	Certified Thermal Value Reference Material Production (Benzoic Acid)
Time/Frequency and Wavelength	Formation of Photonic Based Rb Atomic Clocks and Rb Atomic Frequency Standard
Atomic Sensors	Gas Cell Preparation and Characterization
Medical Metrology	Establishment of Ear Temperature Reference System for Infrared Thermometers (IR)
Medical Metrology	Development of Phantom for Ultrasonic Calibrations
Force	Design, Development and Installation of Rockwell-Brinell-Vickers Hardness Standards
Flow Mechanics	Design and Installation of Primary Level PVTt Systems for Low and Medium Gas Flow
Electromagnetics	Renewal and Improvement of Infrastructure of the Electromagnetic Laboratory
Pressure	Developing Primary Dynamic Pressure Standard at a Pressure Range of 10MPa-500 MPa
Power and Energy	Providing traceability of reference voltage transformer design and high voltage ratio and phase measurements to national standards
Dimensional	Advanced Level Angle Metrology
Temperature	Photonic Thermometers for Quantum (Nanoscale) Temperature Measurements
Temperature	Quantitative Thermal Monitoring Calibration System
Dimensional	Calibration Service Equipment Upgrade and Capacity Increase for Dimensional Laboratory
RF and Microwave	Extension of Microwave Power and S Parameter Measuring Infrastructure to 170 GHz
Optics	Spectrally Adjustable LED-Based Reference Collection Sphere Welding

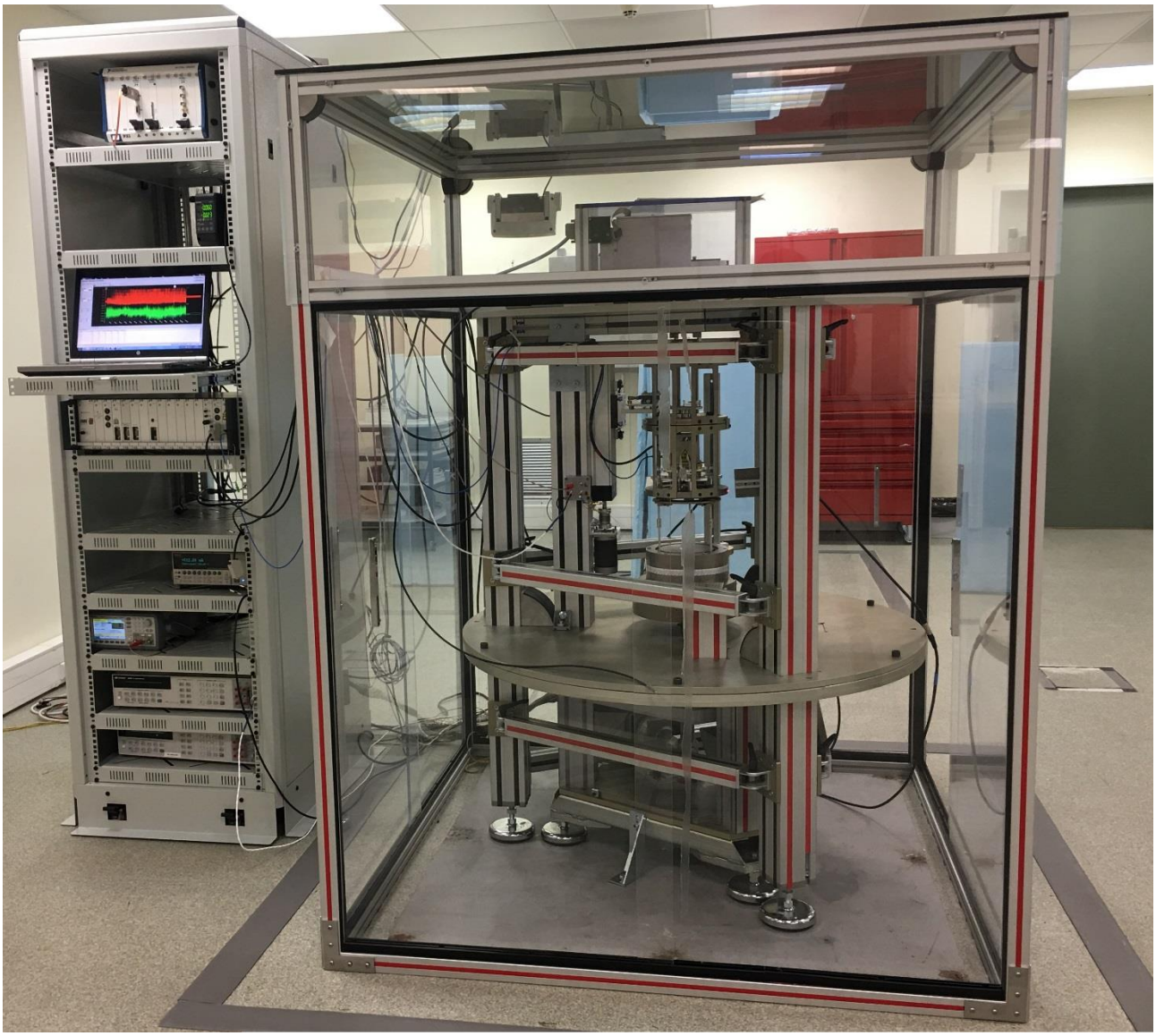


ONGOING INTERNALLY FUNDED PROJECTS

LABORATORY	PROJECT
Electrodynamics	Plasma Metrology and Applications
Optics	Investigation and Establishment of Robot based Absolute Diffuse Reflectance Measurement System
Optics	Establishment of Near Field Measurement System of Led-Based Light Sources
Optics	Construction of Reference UV-B Radiation Level Meter Radiometer and Formation of Calibration Infrastructure
Impedance	Characterization of Very High Resistance Standards
Temperature	Design, Development and Characterization of New Fixed Points for Construction of Primary Level Reference Temperature Cells and Temperature Scale
Force	Formation of Traceability in Brinell and Vickers Hardness Trace Measurements
High Voltage	Expansion of the Frequency Range of AC High Voltage Measurement System Calibrations
Electromagnetics	Development of Open Field Test Area (ASDA)
Pressure	Automation of Hydraulic and Pneumatic Primary Pressure Calibration System and Improvement of Cross-Float System
Voltage	Installation of Josephson Random Wave Synthesizer
Force	Establishment of Dynamic Force (Pulse-Impulse) Force Calibration System
Time/Frequency and Wavelength	Setting the Sub-Hz Line-Thickness Laser System for Strontium Optical Lattice Clock

COMPLETED INTERNALLY FUNDED PROJECTS

LABORATORY	PROJECT
Medical Metrology	Establishment of Medical Metrology Research Laboratory
Electrodynamics	First Generation UME Watt Balance
Time/Frequency and Wavelength	Improvement of National Time Scale System
Electromagnetics	Frequency Selective Electromagnetic Pollution Measurement
Impedance	Establishment of a Terminal Coaxial Digital Impedance Comparison System

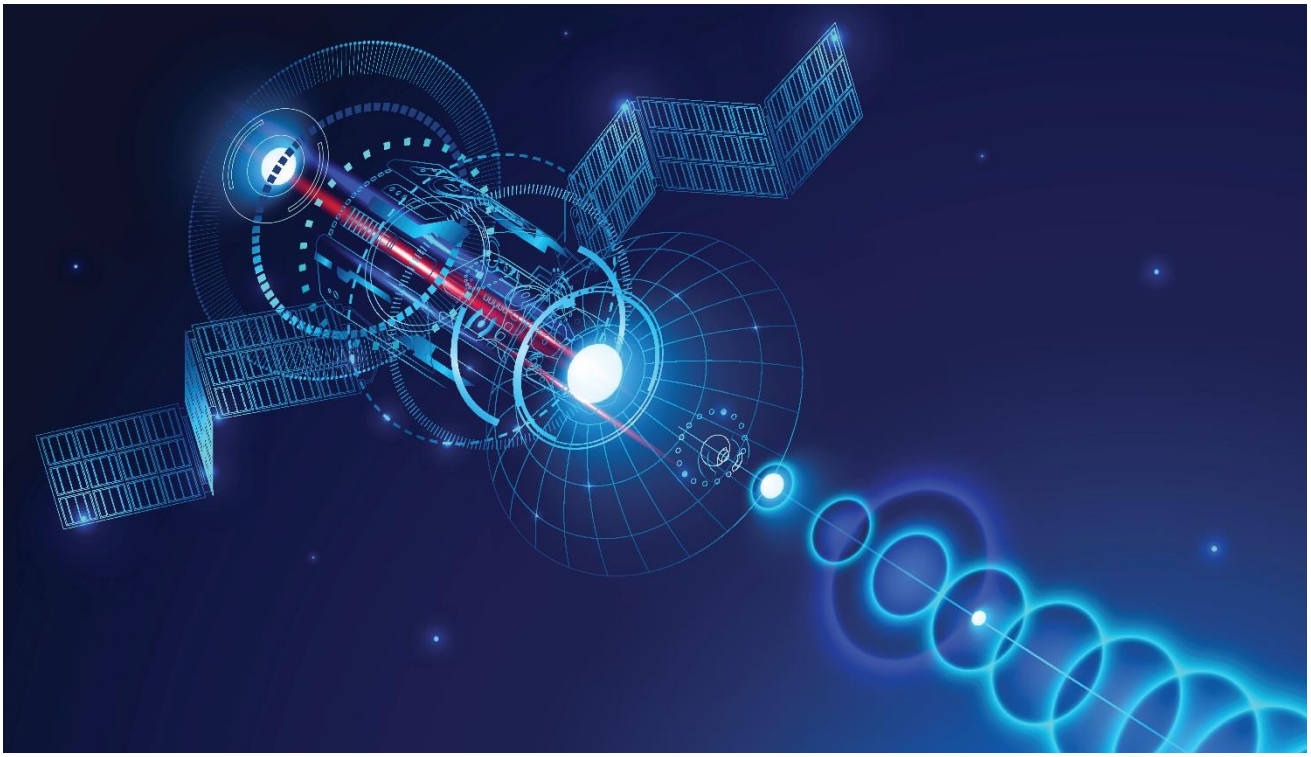


ONGOING EXTERNALLY FUNDED INTERNATIONAL PROJECTS

LABORATORY	PROJECT
Organic Chemistry	Development and Production of Fuel Marker System and On-Site Marker Control Devices for OPET Company
Time/Frequency and Wavelength	SASO J4 Training ve Consultancy Project
Time/Frequency and Wavelength	Establishment of Traceable Time/Frequency Information Distribution Infrastructure
Magnetics	Magnetometer and Magnetic Torque Bar Development
Temperature	Laser Damage Threshold Test System Development Project
Temperature	Optical Thin Film Absorption Measurement Test System
Flow Mechanics	Development, Production and Delivery of Speed and Height Measurement System
Flow Mechanics	Pitot Static Tube Development

COMPLETED EXTERNALLY FUNDED INTERNATIONAL PROJECTS

LABORATORY	PROJECT
Organic Chemistry	Production and Continous Update of National Marker System for Fuels (EMRA)
Organic Chemistry	Development and Production of Diesel Performance Additives for TP



ONGOING TÜBİTAK PROJECTS

LABORATORY	PROJECT
Time/Frequency and Wavelength	Development of High Power Laser System
Magnetics	Soft Magnetic Materials for Use in Space Qualified Magnetometers and Satellite Devices

COMPLETED TÜBİTAK PROJECTS

LABORATORY	PROJECT
Bioanalysis	Korea-Turkey Collaboration on Development of an International Standard System for Measurement of Gene Methylation

ONGOING EMPIR PROJECTS

LABORATORY	PROJECT
Acoustics	Metrology for Modern Hearing Assesment and Protecting Public Health from Emerging Noise
Impedance	Quantum Realisation of the SI Ampere
Time/Frequency	Optical Clocks with 1E-18 Uncertainty
High Voltage	Techniques for Ultra-High Voltage and Very Fast Transients
Bioanalysis	Novel Materials and Methods for the Detection, Traceable Monitoring and Evaluation of Antimicrobial Resistance
Dimensional	Freeform Lenses
Power and Energy	Traceability Routes for Electrical Power Quality Measurements
Temperature	Expansion of European Research Capabilities in Humidity Measurement
RF and Microwave	Development of RF and Microwave Metrology Capability
Temperature	Implementing the New Kelvin 2
Magnetics	Nano –Scale Traceable Magnetic Field Measurements
Time/Frequency and Wavelength	Optical Frequency Transfer – A European Network
Voltage	Waveform Metrology Based on Specctrally Pure Josephson Voltages
Inorganic Chemistry	Role of Metals and Metal Containing Biomolecules in Neurodegenerative Diseases such as Alzheimer's Disease
RF and Microwave	Measuring the SAR value using Vector Prob
Optic	Advanced PV Energy rating
Pressure	Developing Research Skills for Traceable Intraocular Pressure Measurements
Inorganic Chemistry	Development of Scientific and Technical Capabilities in Chemical Analysis
Inorganic Chemistry	Oxidized Mercury Metrology
Gas Metrology	Metrology for Nitrogen Dioxide
Gas Metrology	Metrology for Stable Isotope Reference Standards
Reference Material	Certified Alcohol Reference Material for Forensic Applications
Electrochemistry	Formation of Combined pH Scale
Power and Energy	Power Transformers and Loss Measurements in Reactors
Power and Energy	Metrology for New Generation Digital Systems in Electrical Power Stations
Pressure	Developing Measurement and Calibration Techniques for Dynamic Pressure and Temperatures
Power and Energy	Metrology in the Construction of the Future
Temperature	Improve Process Efficiency through Advanced Temperature Measurements
Volume Density and Viscocity	Establishment of Traceability in Liquid Density Measurements
Flow Mechanics	Metrology for Domestic Water Meters
Dimensional	Standards for Uncertainty Calculations in Coordinate Measurements in Industry
Impedance	Versatile Electrical Metrology Calibration Laboratory Based on Digital Impedance Bridges
Voltage	Digital Traceability Chain for AC Voltage and Current

COMPLETED EMPIR PROJECTS

LABORATORY	PROJECT
Pressure	Industrial Standards in the Intermediate Pressure-To-Vacuum Range
Mass	Traceable Calibration of Dynamic Weighing Instruments
Temperature	Developing Traceable Capabilities in Thermal Metrology
Reference Materials	Matrix Reference Materials for Environmental Analysis
Voltage	Towards the Propagation of AC Quantum Voltage Standards

NATIONAL MEASUREMENT STANDARDS

TÜBİTAK UME continued to fulfill the demands of its local and foreign customers for calibration, training and consultancy services in 2018.

TÜBİTAK UME provided 743 types of test and calibration services with its established infrastructure of 126 different primary level standards that encompass 119 different measurement quantities.

TÜBİTAK UME developed 16 new measurement techniques and added 7 measurement quantities to its range of measurement capabilities.

TÜBİTAK UME produced 18 new references / devices / standards in 2018 for use as national measurement reference standards and/or standard measurement systems.

NEW MEASUREMENT CAPABILITIES

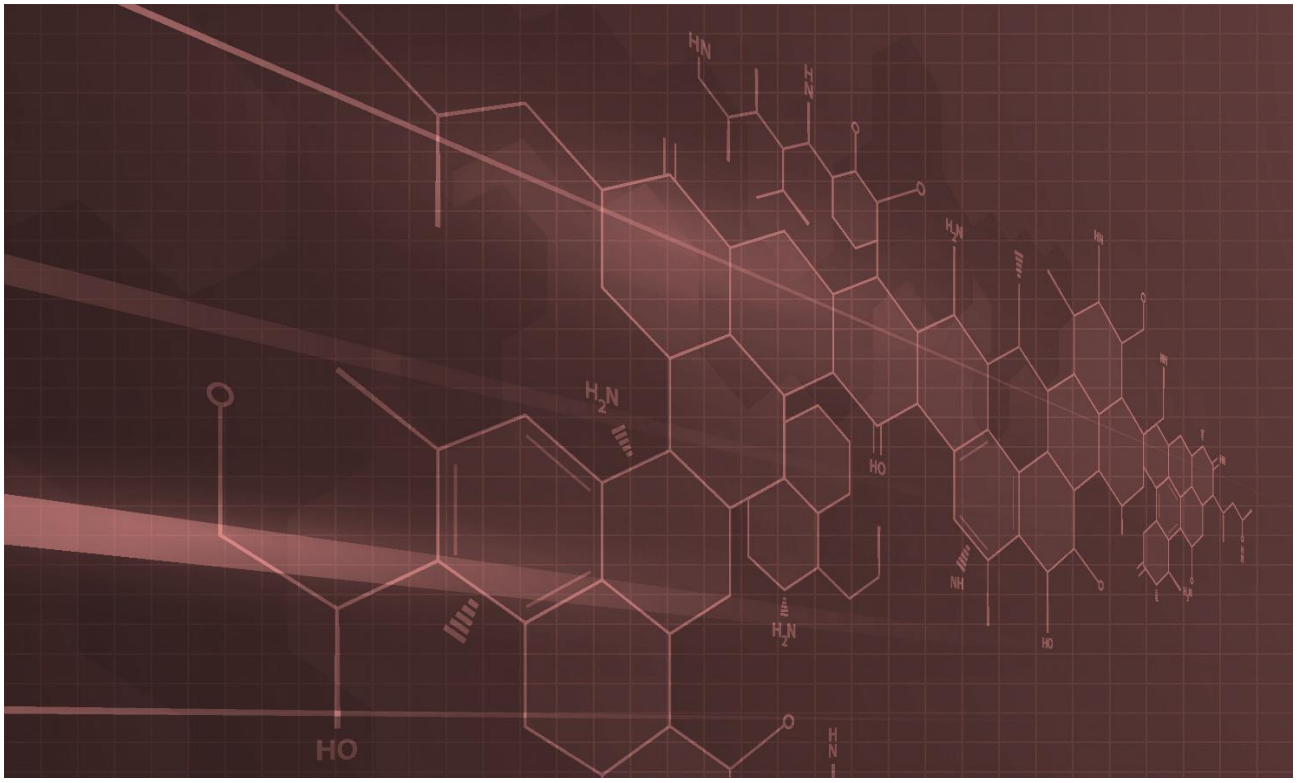
LABORATORY	MEASUREMENT QUANTITY
Electrodynamic	AC Josephson Voltage
Medical Metrology	Ultrasonic Power 0.01 W - 0.1 W and 8 MHz-16 MHz Range with 7% Uncertainty (revised CMC)
Medical Metrology	Ultrasonic Power 0.01 W - 15 W and 1 MHz-3 MHz Range with 5% Uncertainty (revised CMC)
Medical Metrology	Ultrasonic Power 0.01 W - 0.1 W and 3 MHz-8 MHz Range with 6% Uncertainty (revised CMC)
RF and Microwave	WR42 Band S-parameter Measurement
RF and Microwave	2.92 mm Airline Mechanical Dimension Measurements
RF and Microwave	2.92 mm S-parameter Measurements

NEW MEASUREMENT TECHNIQUES

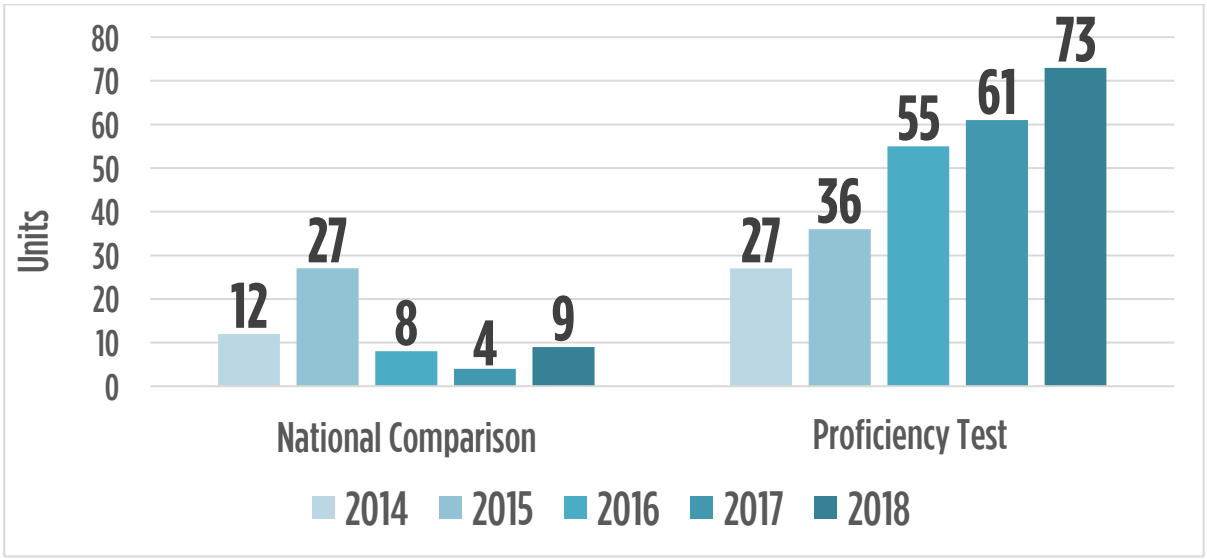
LABORATORY	MEASUREMENT TECHNIQUE
Acoustics	Determination of the Gas Response in the Transfer Functions of the Microcontroller's Preamplifiers
Electromagnetics	Newly Developed "Time-Domain Measurement Method" for CS101 Test Services
Electrochemistry	Primary Level Electrolytic Conductivity Measurement Technique
Gas Metrology	Determination of Nitrogen Monoxide in Nitrogen or Air
Gas Metrology	Determination of Nitrogen Dioxide in Nitrogen or Air
Electromagnetics	FFT based Realization of CS101 Test (Conducted Susceptibility)
Impedance	Dielectric Coefficient Measurement of Solid Materials
Impedance	Dielectric Coefficient Measurement of Liquid Materials
Inorganic Chemistry	Determination of Elements in Beef Liver
Inorganic Chemistry	Determination of Elements and Organotin Compounds in Skin
Medical Metrology	Sound Velocity Measurement in Tissue Phantom
Temperature	Effect of Ambient Conditions on Reading Value of Radiation Thermometers
Electrodynamics	Planck Constant Measurements for UME Oscillating Magnet Kibble Balance
Electrodynamics	Faraday Voltage Optimization Methods
Electrodynamics	Determination of the Effect of External Magnetic Field on Planck's Stabilization Using Magnetic Gradiometer
Electrodynamics	Software Development for Data Analysis of Watt Balancing Experimental System

REFERENCE DEVICES / MATERIALS PRODUCED

LABORATORY	REFERENCE DEVICE / MATERIAL
Electrodynamics	UME Oscillating Magnet Kibble Balancing Experiment System (1 unit)
Power and Energy	Standard Voltage Load (1 unit)
Mass	2 kg -50 kg robotic solid density system (1 unit)
Medical Metrology	Polymer Based Ultrasonic Imaging Phantom (3 units)
Medical Metrology	Portable Infrared Temperature Meter Calibration System, Portable IRET (1 unit)
Reference Materials	UVECO OQ/PQ Kit (50 units)
Reference Materials	Etibor-48-Special Production (450 units)
Reference Materials	Boric Acid- Special Production (450 units)
Reference Materials	Ulexite- Special Production (266 units)
Reference Materials	Kaisine Pyrite- Special Production (40 units)
Reference Materials	Etibor-68- Special Production (360 units)
Reference Materials	Etidot-67- Special Production (300 units)
Reference Materials	Boron Oxide - Special Production (240 units)
Reference Materials	Colemanite- Special Production (680 units)
Reference Materials	Borax Decahydrate - Special Production (280 units)
Reference Materials	Vitamin D Reference Materials in Serum (3000 units)
Temperature	Al Fixed Point Cell (1 unit)
Temperature	Silver Fixed Point Cell (1 unit)



In 2018, 9 national comparisons and 73 proficiency tests were organized. While the national comparisons consisted of measurements conducted in the areas of Acoustics, Optics, Electromagnetics, RF-Microwave and Time & Frequency; the proficiency tests were organized by the Gas Metrology, Medical Metrology, Force, and Reference Materials laboratories.



National Comparisons and Proficiency Tests Organized in the Last Five Years

NATIONAL COMPARISONS

LABORATORY	COMPARISON NAME
Acoustics	National Comparison of Accelerometer Calibration in the range of 0 Hz to 5000 Hz
Acoustics	National Comparison of Accelerometer Calibration in the range of 10 Hz to 5000 Hz
Acoustics	Binary Comparison with TSE according to ISO 354 Standard
Electromagnetics	Comparison of Harmonic Currents and Flicker Tests
Optics	Solar Energy Simulator STC Comparison
Optics	Solar Energy Simulator Temperature Comparison
Optics	Comparison of Reference Solar Cells
RF and Microwave	SAR Comparison with Information Technologies and Communications Authority
Time/Frequency	Frequency Measurements

PROFICIENCY TESTS

LABORATORY	PROFICIENCY TEST NAME
Gas Metrology	Determination of Propane in Air
Gas Metrology	Nitrogen Monoxide Determination in Nitrogen
Gas Metrology	Nitrogen Monoxide Determination in Nitrogen 2
Gas Metrology	Determination of Sulfur Dioxide in Nitrogen
Gas Metrology	Determination of Carbon Monoxide in Nitrogen
Force	Tensile and Peel Strength Resistance Tests in Adhesive Tape Materials
Force	Pressed Paper
Force	Pressed Carton
Force	Tensile Test for Plastic Materials
Force	Tensile Testing for Metallic Materials
Force	Determination of Decarburization Depth in Steel Materials
Medical Metrology	Ultrasonic Monitoring
Reference Materials	BOD5 Determination in Wastewater
Reference Materials	Benzoate Sorbate Determination in Ketchup
Reference Materials	Determination of Methanol in Alcoholic Beverages
Reference Materials	Determination of Fat Grease in Wastewater
Reference Materials	Determination of Anion in Drinking Water
Reference Materials	Cation Determination in Water
Reference Materials	Determination of PAH in Water
Reference Materials	Refractive Index in Sunflower Oil, Peroxide Number and Iodine
Reference Materials	Sunflower Oil Fatty Acid Composition
Reference Materials	Wheat Flour Moisture, Ash, Oil, Protein and Sedimentation Index
Reference Materials	Species Determination in Meat
Reference Materials	Determination of Element in Drinking Water

PROFICIENCY TESTS

LABORATORY	PROFICIENCY TEST NAME
Reference Materials	Water Turbidity Alkalinity TOC Reaction
Reference Materials	Animal Feed
Reference Materials	Determination of Acesulfame K, Aspartame, Benzoic Acid and Caffeine in Non-Alcoholic Beverages
Reference Materials	Determination of Element in Wastewater
Reference Materials	Determination of Aflatoxin, Moisture, Ash and Salt
Reference Materials	Determination of HMF, Glucose, Fructose, Saccharose, Diastase Number, Free Acidity, Moisture and Water Insoluble Solid Matter in Honey
Reference Materials	Determination of Sulfur Dioxide in Dry Apricot
Reference Materials	Determination of TOM and Lime in Soil
Reference Materials	Determination of Fruit Juice pH
Reference Materials	Determination of Electrical Conductivity in Water
Reference Materials	Determination of Elements in Tomato Paste
Reference Materials	Determination of Ph in Water
Reference Materials	Determination of Iodine in Salt
Reference Materials	Determination of Suspended Solids in Water
Reference Materials	Determination of KOI in Waste Water
Reference Materials	Tea
Reference Materials	Coal
Reference Materials	Determination of Aflatoxin in Dried Figs
Reference Materials	Determination of Colour in Water
Reference Materials	Determination of Milk pH
Reference Materials	Determination of d13C Isotope in Honey
Reference Materials	Determination of Salt in Bread
Reference Materials	Determination of Electrical Conductivity in Soil
Reference Materials	Determination of pH in Soil
Reference Materials	Determination of Mineral Oil in Edible Oil
Reference Materials	Determination of Anion in Drinking Water
Reference Materials	Determination of Electrical Conductivity in Waste Water
Reference Materials	Determination of elements in Wastewater 2
Reference Materials	Determination of pH in Wastewater 2
Reference Materials	Determination of Cation in Water 2
Reference Materials	Determination of EC in Wastewater 2
Reference Materials	Determination of Electrical Conductivity in Water 2
Reference Materials	Determination of Mineral Oil in Edible Oil 2

PROFICIENCY TESTS

LABORATORY	PROFICIENCY TEST NAME
Reference Materials	Determination of Conductivity in Wastewater 2
Reference Materials	Determination of Aflatoxin and Total Fat in Hazelnut
Reference Materials	Determination of pH in soil 2
Reference Materials	Wheat Flour
Reference Materials	Determination of Element in Wastewater 3
Reference Materials	Determination of Suspended Solids
Reference Materials	Determination of Benzoate Sorbate in Ketchup 2
Reference Materials	Determination of TOM and Lime in Soil 2
Reference Materials	Determination of KOI in Waste Water 2
Reference Materials	Determination of Total Nitrogen in Fertilizer
Reference Materials	Determination of Element in Drinking Water 2
Reference Materials	Determination of Color in Water 2
Reference Materials	Determination of Isotope Ratio in Honey
Reference Materials	Determination of Conductivity in Soil 2
Reference Materials	Determination of Anion in Drinking Water 2
Reference Materials	Determination of Element in Soil

INTERNATIONAL ACTIVITIES

TÜBİTAK UME raised its international profile with new initiatives to increase its engagement with the BIPM and regional metrology organizations in 2018.

While the Memorandum of Understanding was signed with the national metrology institutes of Portugal and Jordan, action plans and technical studies were initiated with the agreements signed with Bosnia and Herzegovina, Uzbekistan and Poland.

A training program, "BIPM – TÜBİTAK UME Project Placements", was organized for ten metrologists from Belarus, UAE, Bosnia Herzegovina, Ethiopia, Ghana, Iran, Kazakhstan, Kenya, Saudi Arabia and Zambia within the framework of the BIPM's Capacity Building and Knowledge Transfer Programme, as a cooperation initiative between TÜBİTAK UME and the BIPM. The second cycle of the program is planned for 2019.

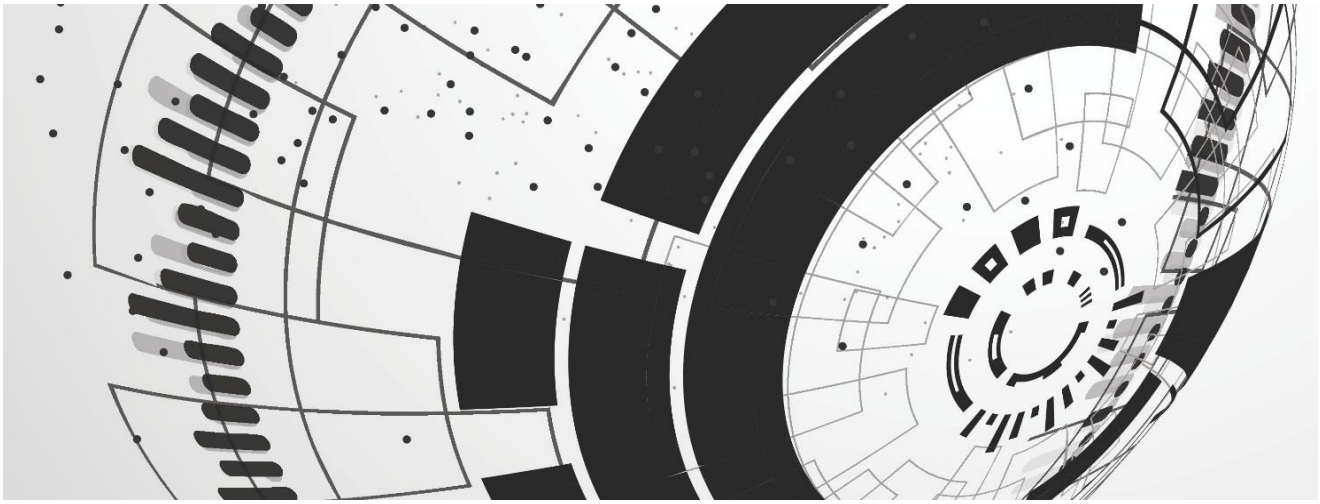
11 joint research projects funded within the scope of European Metrology Programme for Inovation and Research (EMPIR) were started in 2018. On the other hand, 5 EMPIR projects were completed within this time period.

With these steps, TÜBİTAK UME moved closer to its goal of becoming one of the leading national metrology institutes in Europe and the world by 2023, the centennial of the establishment of the Republic of Turkey.

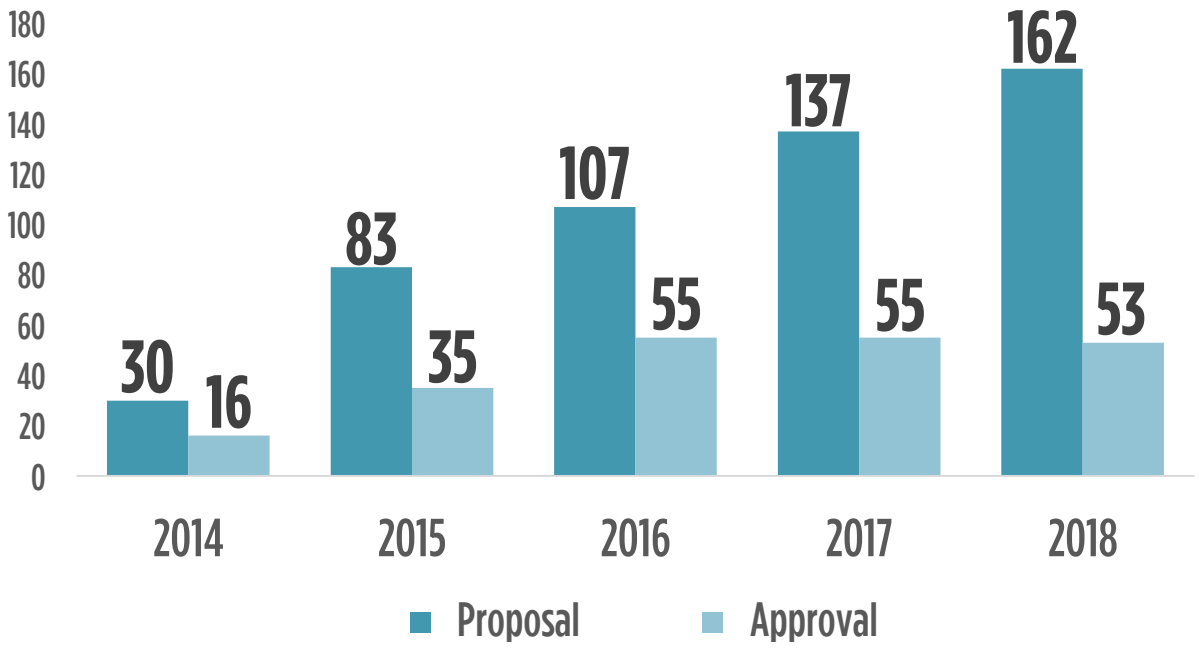
TÜBİTAK UME participated in 23 international measurement comparisons in 2018.

INTERNATIONAL COMPARISONS

LABORATORY	COMPARISON NAME
Gas Metrology	Comparison on Nitrogen Dioxide in Nitrogen (CCQM)
Inorganic Chemistry	Essential and Toxic Elements in Bovine Liver (CCQM)
Mass	Intercomparison on Automatic Catchweigher in Dynamic Mode (AWICAL)
Mass	Intercomparison on Automatic Gravimetric Weighing Instrument in Dynamic mode (AWICAL)
Optics	Comparison on Regular Spectral Permeability Between 380 nm and 1000 nm (EURAMET)
Bioanalysis	Copy number concentration and fractional abundance of a mutation (SNV or INDEL) mixed with WT DNA (CCQM)
Bioanalysis	Human growth hormone quantification in serum (CCQM)
Organic Chemistry	Measurement of BET specific surface area of nonporous sio2 (CCQM)
Acoustics	Key Comparison for Gravity Acceleration Measurement (EURAMET)
Impedance	Supplementary Comparison for Ultra-low DC Current Sources (EURAMET)
Organic Chemistry	Pilot Study on Peptide Purity Synthetic Oxytocin
Organic Chemistry	Benzo[a]pyrene in Olive Oil (CCQM)
Temperature	Bilateral Comparison on Relative Humidity (with INM, Moldova)
Mass	Bilateral Comparison betweeen UME and NMIE (Ethiopia) on Mass Standards
Organic Chemistry	Phthalates in Plastic (CCQM)
Gas Metrology	Natural gas Analysis (CCQM)
RF and Microwave	Comparion on S-Parameter On N-Type Connector Devices (EURAMET)
RF and Microwave	Comparison on Voltage Reflection Coefficient (Vrc) of an RF Source (EURAMET)
Acoustics	Ear Simulator Calibration within the scope of ears II Project
High Voltage	Comparison on PD Measurement System (EURAMET)
Organic Chemistry	Zearalenone in acetonitrile Track C Comparison and Mycotoxin CBKT Programme (CCQM)
Voltage	Comparison on AC-DC Voltage Transfer Standards (GULFMET)
Mass	Bileteral comparison of 50 kg Stainless Steel Mass Standard betweeen UME and CENAM (Mexico)

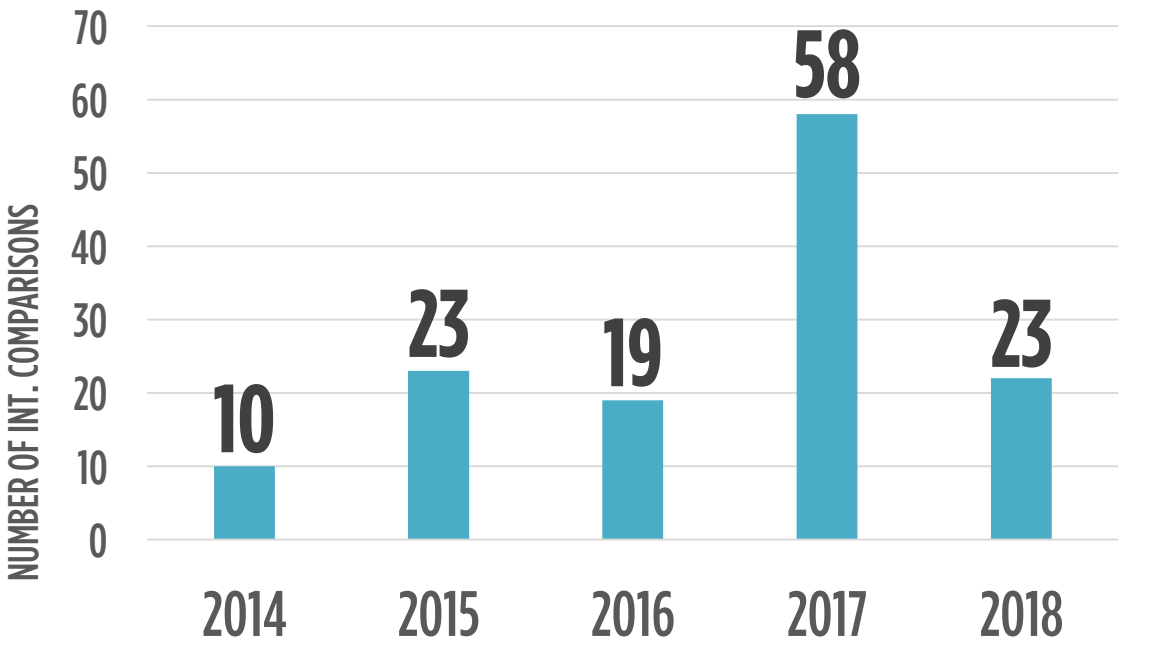


SERVICE PROPOSALS TO INTERNATIONAL CUSTOMERS

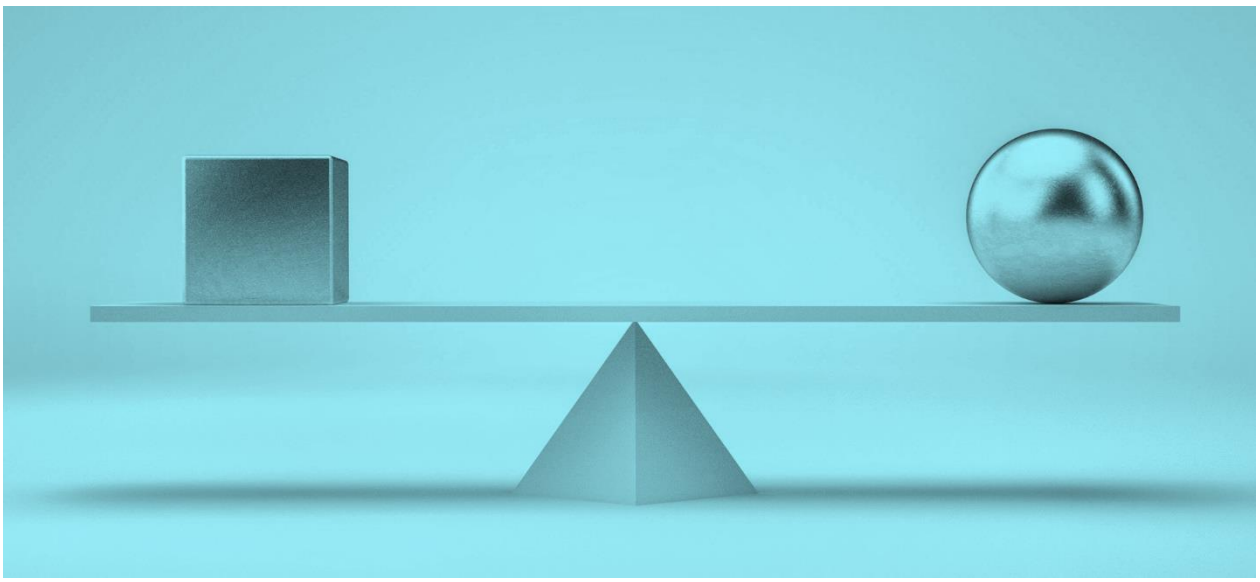


Service Proposals to International Customers in the Last Five Years

INTERNATIONAL COMPARISONS

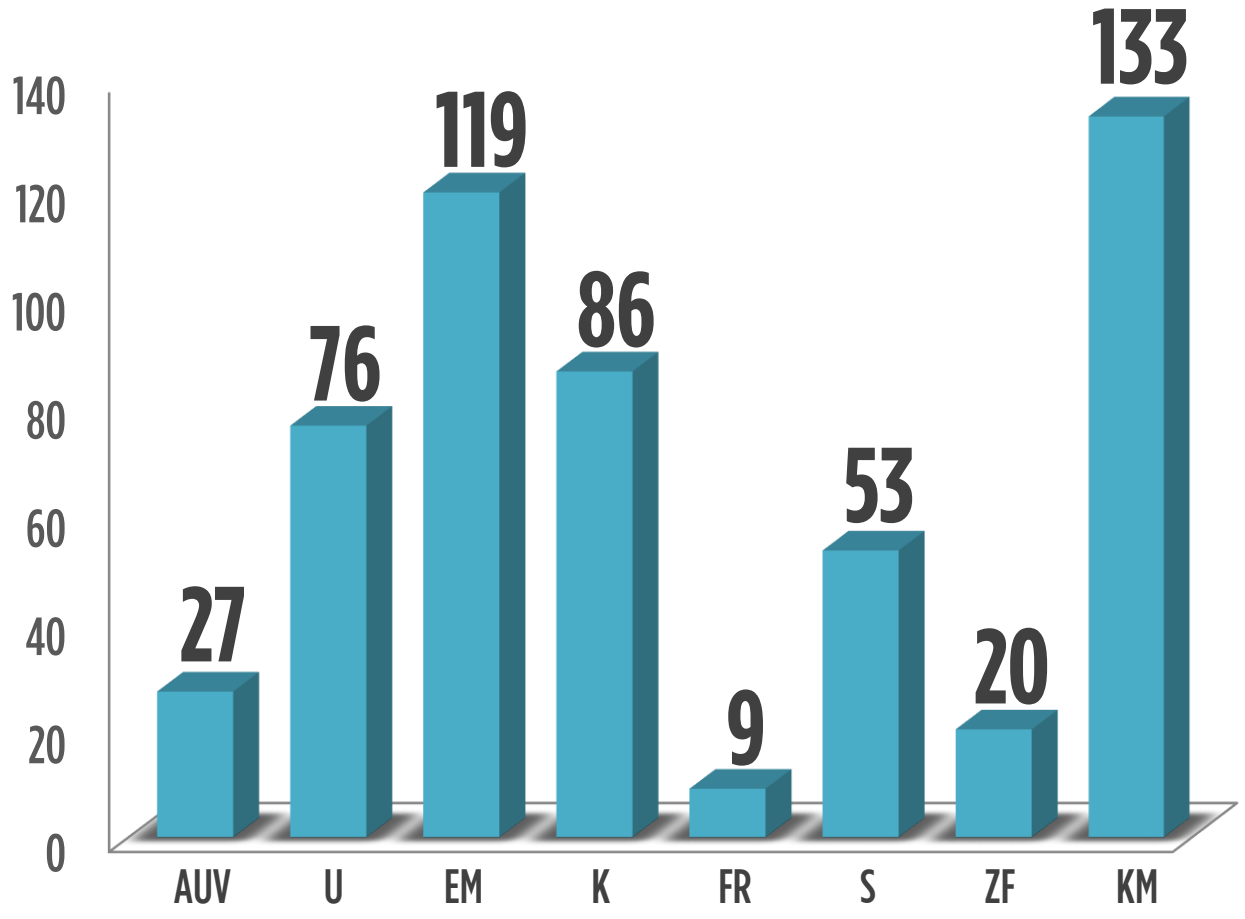


Number of International Comparisons in the Last 5 Years



TÜBİTAK UME has 523 Calibration and Measurement Capabilities (CMCs) published in the Key Comparison Database (KCDB) maintained by the BIPM. The certificates issued for calibrations encompassed by these CMCs are accepted by all other institutions that have signed the CIPM Mutual Recognition Arrangement (CIPM MRA). In 2018, TÜBİTAK UME's number of CMCs in the Chemistry area reached 133.

CMCs PUBLISHED IN THE BIPM KEY COMPARISON DATABASE (KCDB)

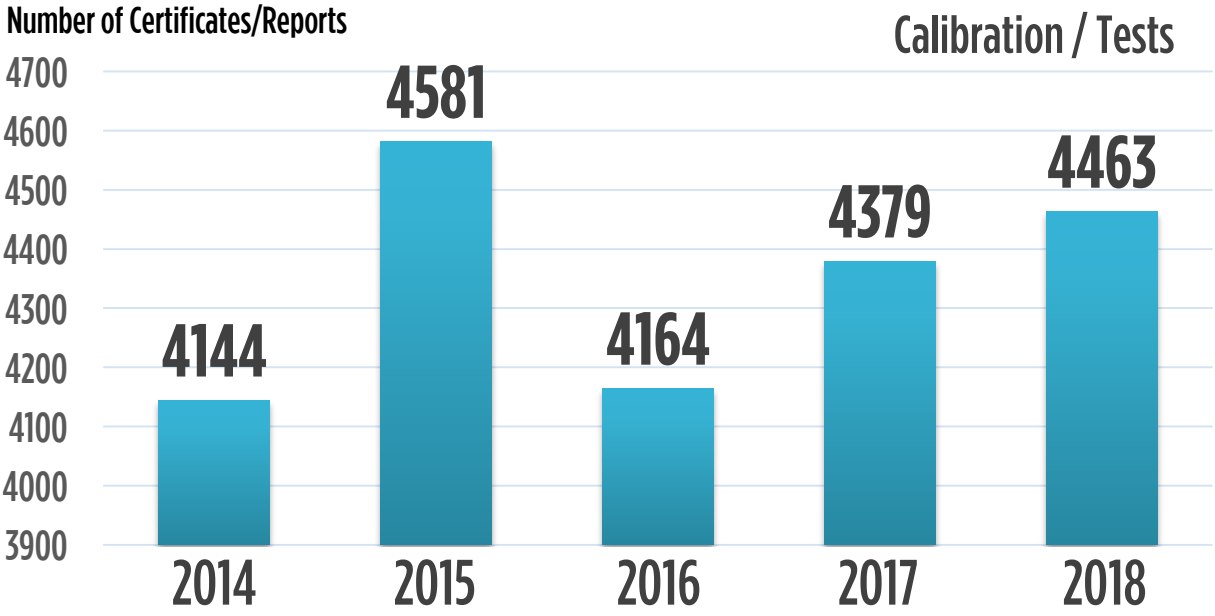


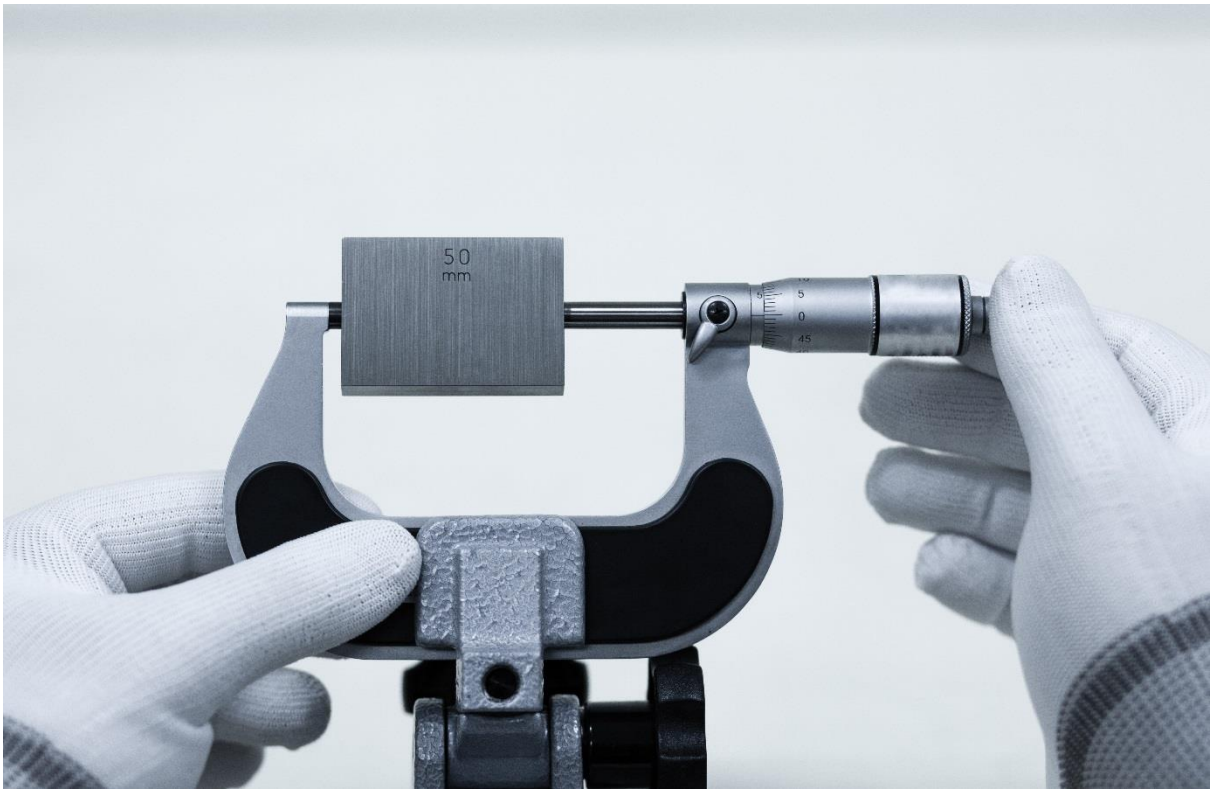
AUV	Acoustics, Ultrasound & Vibration
L	Length
EM	Electric and Magnetism
M	Mass
PR	Photometry & Radiometry
T	Temperature
TF	Time & Frequency
QM	Chemical Metrology

OUR SERVICES

CALIBRATION AND TEST SERVICES

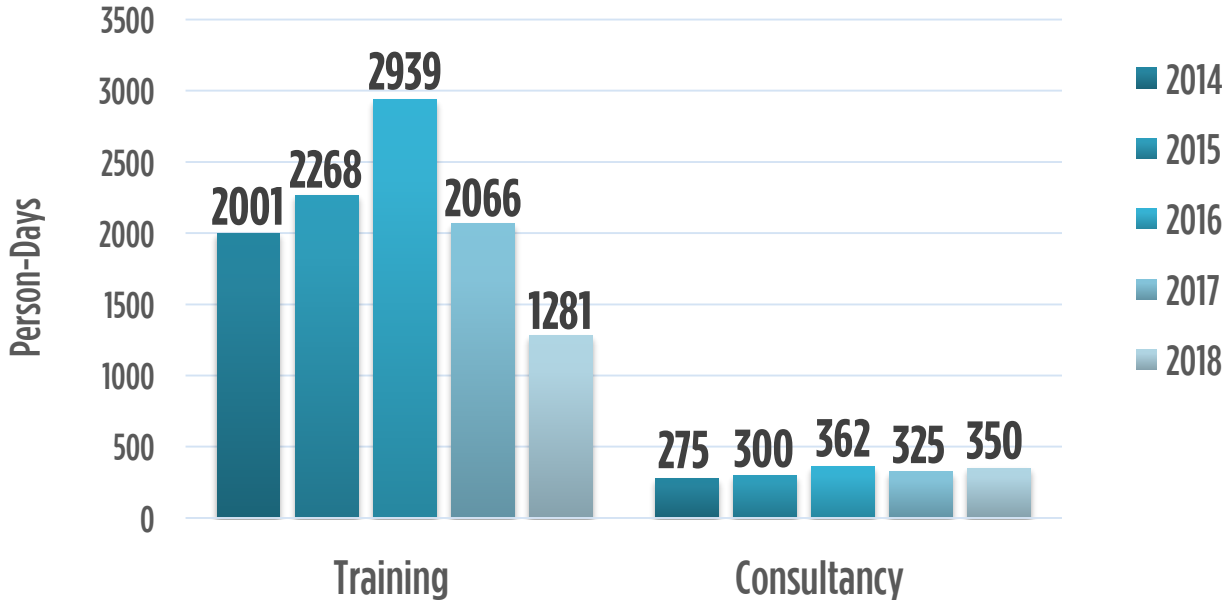
TÜBİTAK UME offered 743 types of calibrations / tests services to customers in year of 2018. Of these services, 302 were accredited.





TRAINING AND CONSULTANCY SERVICES

In 2018, 1281 person-days of training services of were provided to domestic and international customers, A total of 350 person-days of consultancy services were provided, of which 213 person-days were expended on support for accreditation assessments and 137 person-days on provision of on-site technical support and problem resolutions.



HIGHLIGHTSOF2018

The resolution for the redefinition of the kilogram, ampere, kelvin and mole was unanimously accepted at the 26th General Conference on Weights and Measures (CGPM) that took place in Versailles, France on 14-16 November 2018. The Director of TÜBİTAK National Metrology Institute, Mustafa ÇETİNTAŞ, and General Director of Metrology and Standardization, Prof. Dr. Necip CAMUŞCU, attended the event, representing the Republic of Turkey.

A training program, "BIPM-TUBITAK UME Project Placements", was organized for ten metrologists from Belarus, UAE, Bosnia Herzegovina, Ethiophia, Ghana, Iran, Kazakhstan, Kenya, Saudi Arabia and Zambia within the framework of the BIPM's Capacity Building and Knowledge Transfer Programme and as a cooperation initiative between TÜBİTAK UME and the BIPM.

TÜBİTAK National Metrology Institute (TÜBİTAK UME) signed a Memorandum of Understanding with the Portuguese Quality Institute (IPQ) in order to develop scientific metrological cooperation between the two countries. Mustafa ÇETİNTAŞ, Director of TÜBİTAK UME and António Mira dos SANTOS, the Chairman of the Board of Directors of IPQ signed the Memorandum of Understanding at the Turkey-Portugal Mutual Economic and Trade Commission (JETCO) 3rd session meeting held at the Portugal Foreign Ministry on March 8, 2018 in which Nihat Zeybekçi, the Minister of Economy also participated.

TÜBİTAK UME signed a Memorandum of Understanding with the Jordan Royal Scientific Society (RSS) and the Jordan National Metrology Institute (JNMI) to develop scientific metrological cooperation between the parties.

TÜBİTAK UME hosted the 5th Annual Meeting of the Standards and Metrology Institute for the Islamic Countries (SMIIC) Metrology Council on 18-19 April 2018 in Istanbul.

The Minister of Industry and Technology, Mustafa Varank, visited TÜBİTAK UME in order to examine preparations for the realization of the new definition of the kilogram.

A contract was signed on August 8, 2018 with TÜBİTAK UME and Turkish Aerospace Industries (TUSAŞ) in order to use "the Speed and Height Measurement System device" in the defense industry and other projects.

QUALITY MANAGEMENT & ACCREDITATION

All necessary work was completed to revise TÜBİTAK UME's Quality Management System to comply with the requirements of ISO/IEC 17025:2017 and ISO 17034:2016 standards.

On Janurary 22-23, 2018, the accreditation supervision assessment of TÜBİTAK UME according to ISO Guide 34 was performed by the Turkish Accreditation Agency (TÜRKAK).

TÜBİTAK UME participated in the 13th EURAMET Quality Technical Committee (TC-Q) meeting which was held on 18-19 April 2018 in Paris. TÜBİTAK UME's annual Quality Management System Report was approved by the technical committee without reservations.

On Feburary 27-28, 2018, a peer review of the Montenegro Bureau of Metrology (MBM) was carried out at their request The peer review was registered as a consultancy project with EURAMET.

On May 7, 2018, training on the revision of the ISO/IEC 17025 standard was given to 47 TÜBİTAK UME personnel who are members of the TÜRKAK assessors pool.

Work has been initiated to harmonize the TÜBİTAK UME Quality Management System with the requirements of AQAP-2110 "NATO Quality Assurance Requirements for Design, Development and Production".

Within the scope of AB-0034-K and AB-0092-T accreditation certificates, accreditation certificate renewal audits were carried out by TÜRKAK in the following laboratories and areas.

Laboratory	Scope
Optics	AB-0092-T Test
Impedance	AB-0034-K Calibration
Voltage	AB-0034-K Calibration
Temperature	AB-0034-K Calibration
Force	AB-0034-K Calibration
RF and Microwave	AB-0034-K Calibration
Acoustics	AB-0092-T Test
Flow Mechanics	AB-0034-K Calibration
Dimensional	AB-0034-K Calibration
High Voltage	AB-0034-K Calibration
High Voltage	AB-0092-T Test
Mass	AB-0034-K Calibration
Power	AB-0034-K Calibration
Electromagnetics	AB-0092-T Test
Pressure	AB-0034-K Calibration
Vacuum	AB-0034-K Calibration
Flow Mechanics	AB-0034-K Calibration (gas flow rate and air velocity)

On November 8 and December 6, 2018 all TÜBİTAK UME employees participated in training organized to bring the Quality Management System into compliance with the requirements of ISO/IEC 17025:2017 and to summarize the changes introduced by the revision of the standard.

TÜBİTAK UME participated in the meeting of the TÜRKAK Measurement Uncertainty Guidance Working Group and contributed to the guide preparation activities. TÜRKAK was informed about the revisions of Guidance Document R10.12 "Metrological Traceability Guidelines".

The document "Guideline on Policies and Rules on Interlaboratory Comparisons for Calibration Laboratories" (R12.34), under revision by TÜRKAK, was reviewed and opinions on the draft revisions were communicated to TÜRKAK.

Within the scope of the improvement of TÜBİTAK UME Quality Management System, a total of 17 documents, including 8 procedures, 2 instructions, 12 forms, 2 lists and 13 Quality Manual sections, were revised and put into effect by the UME Quality Board.

A document template in Excel format was prepared for form documents to be uploaded to the QDMS (Quality Documents Management System).

TÜBİTAK UME submitted replies to a survey conducted by the Turkish Accreditation Agency (TÜRKAK) for the purpose of ensuring harmonization between the assessors / technical experts, taking into account its experience in accreditation assessments.

The periodic review, carried out every 2 years, of documents within the scope of the Quality Management System Documentation was completed.

KNOWLEDGE&TECHNOLOGYTRANSFER

This year marks the 4th year of the metrology master program in Gebze Technical University. Currently, 14 courses are on offer in this programme. New courses will be introduced in the coming years in accordance with identified needs. Course contents are prepared and instruction is given by researchers employed at TÜBİTAK UME.

TÜBİTAK UME researchers also act as thesis co-advisors to students of the programme, who are given access to TÜBİTAK UME laboratories to perform research. The language of instruction is English, which allows the participation of international students in the programme.

TÜBİTAK UME organized numerous business development meetings with Turkey's leading industrial establishments and public institutions in order to develop new project ideas, disseminated information through national and international symposiums, workshops and conferences and participated in various organizations in order to promote its infrastructure and technical capabilities. In 2018, laboratory visits and metrology presentations were organized for 32 different student groups with total of 781 students, and 2 different Science Camp events were held.

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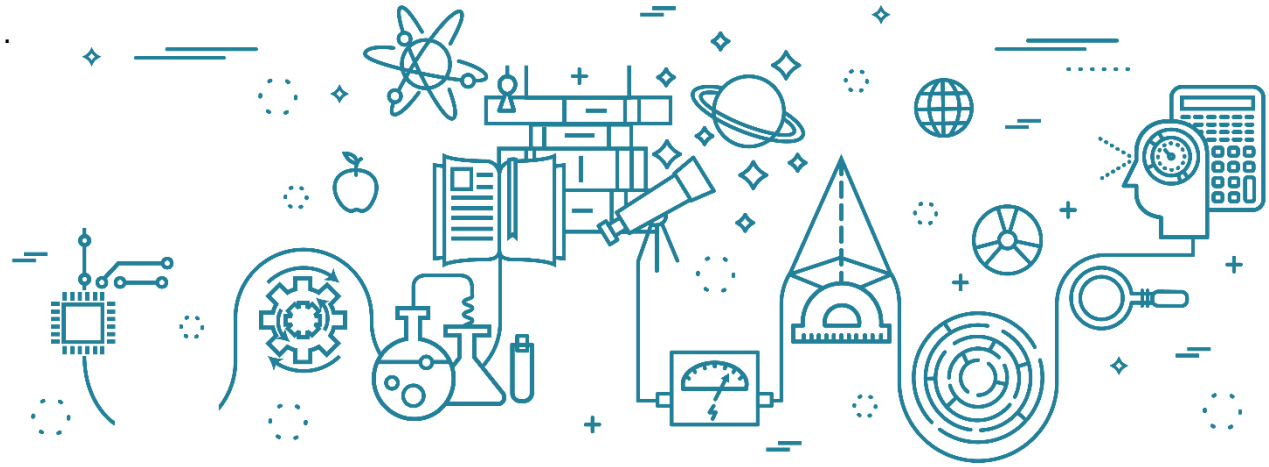


TÜBİTAK UME participated in the the 2nd Saudi Arabia International Quality Forum and Exhibition held at the Riyadh International Convention and Exhibition Center in Riyadh, Saudi Arabia. The organization which was held from April 29 to May 1, 2018 was supported by the Ministry of Energy, Industry and Mining Resources of Saudi Arabia. TÜBİTAK UME was also represented at the Aerospace and Technology Festival (TEKNOFEST).

TÜBİTAK UME participated in ICSG 6th International Istanbul Smart Grids and Cities Congress and Fair on April 25-26, 2018, the 4th National Laboratory Accreditation and Safety Symposium and Exhibition on April 25-27, 2018, the Istanbul Youth Festival on May 2-6, 2018, the Future Factories Summit and Exhibition Fair (FUTUREFACT) on September 25-26, 2018, the World Halal Summit 2018 and the 6th Organization of Islamic Cooperation (OIC) Halal Expo Fair (HALALEXPO) on November 29 - December 2, 2018; and contributed to spreading metrology awareness by organizing free General Metrology Seminars for 151 participants in 2018.

2018 IN NUMBERS

53 R&D Projects

32 National and International Comparisons

18 Reference Materials and Standards

119 Measureable Measurement Quantities

126 Primary Level Standards

743 Types of Calibration and Tests Offered

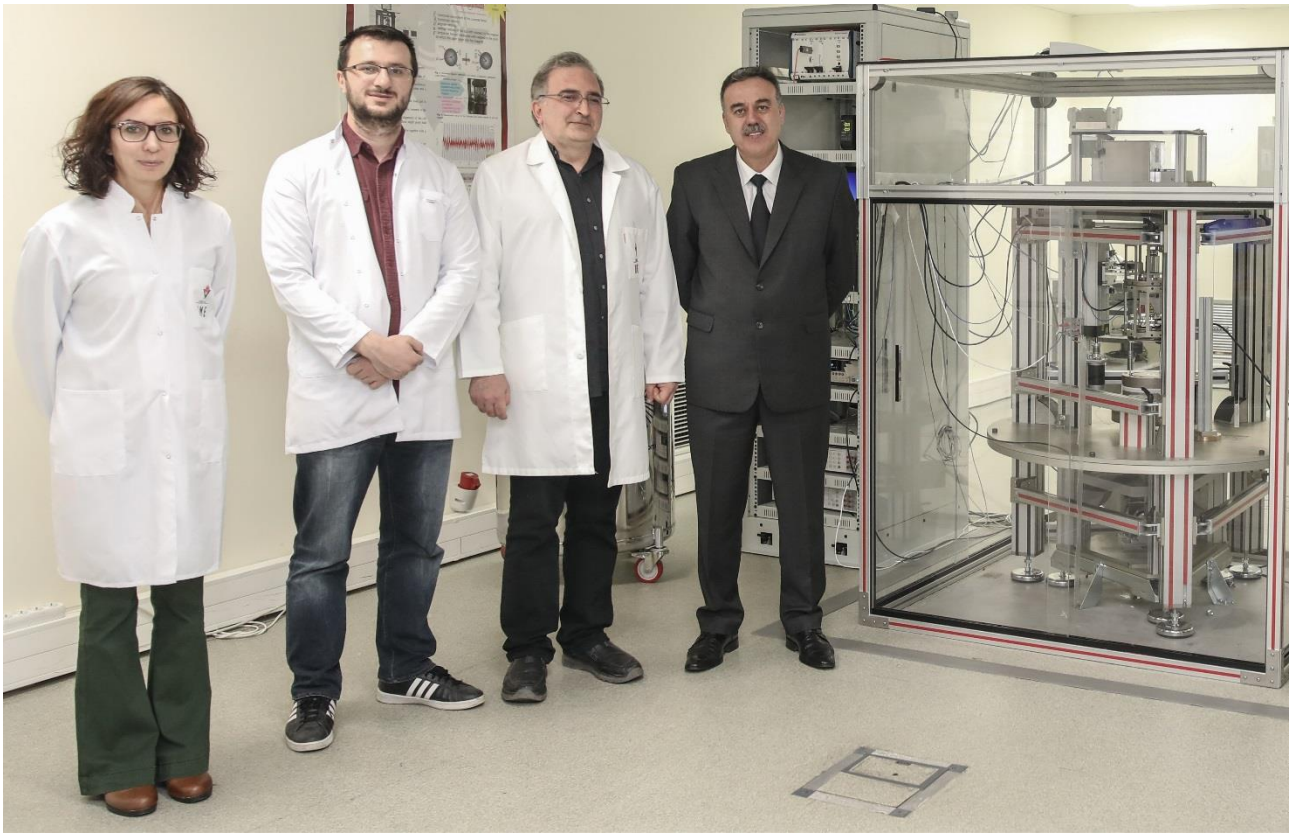
4463 Calibration Tests Performed

119 International & National Publications

126 Membership in Technical Committees

291 Employees

STEPSTOSUCCESS



The first phase of the tests performed on the TÜBİTAK UME Kibble Balance, designed to realize the new definition of the kilogram, was successfully completed.

Within the scope of the project, initiated in 2014 in order to realize the new definition of the mass unit kilogram of the International System of Units (SI), which is to go into effect on May 20, 2019, an entirely new measurement concept has been created by using a oscillating magnet design that significantly differs from the Kıbble Balances of the leading institutes in the field of scientific metrology.

Based on the principle of balancing mechanical and electrical power, experimental Kibble Balance setups may be designed with different geometries and experimental protocols. Turkey is one of the few countries in the world that owns such a system, allowing TUBITAK UME to contribute to the studies carried out worldwide towards acheiving primary realizations of the new kilogram.

In the first phase of the tests, a relative uncertainty of 3×10^{-7} was acheived. Thus, despite that fact that TÜBİTAK UME's project rather recently, the uncertainty level reached by institutes that have been working for much longer periods on the subject has been reached.

In the second phase of tests, the goal is acheive measurements with a relative uncertainty of 2 x 10-8. If reached, Turkey will have suceeded in establishing a primary realization of the new kilogram, thus avoiding dependence on foreign institutes for traceability in mass, and will be able to itself provide traceability and technology transfer to other NMIs that do not have primary realizations.

Before the redefinition of the kilogram, the primary realization consisted of cylindirical artefact made of a platinum – iridium alloy, which acted as the only reference for all mass measurements in the world.

Besides the practical difficulties of relying on a man made physical artefact, the increasing need for more accuracy and assured stability in mass measurements used in international trade, advanced technology industrial production, health and safety, the environment and climate measurement, drove the scientific effort to tie the kilogram to a natural constant. These efforts culminated in the decision to redefine it in terms of the Planck constant, accepted at the 26th General Conference on Weights and Measures in November 2018.

With the new definition, the long term stability of the unit realization is assured and the realization may now be acheived without the various constraints that applied under the previous definition.

The Kiblle (Watt) Balance experiment is one of two routes formally endorsed by the Consultative Committee for Mass and Related Quantities (CCM) to realize the new definition of the kilogram with the highest accuracy and lowest uncertainties.

TÜBİTAK UME is to develop Turkey's first Optical Atomic Clock

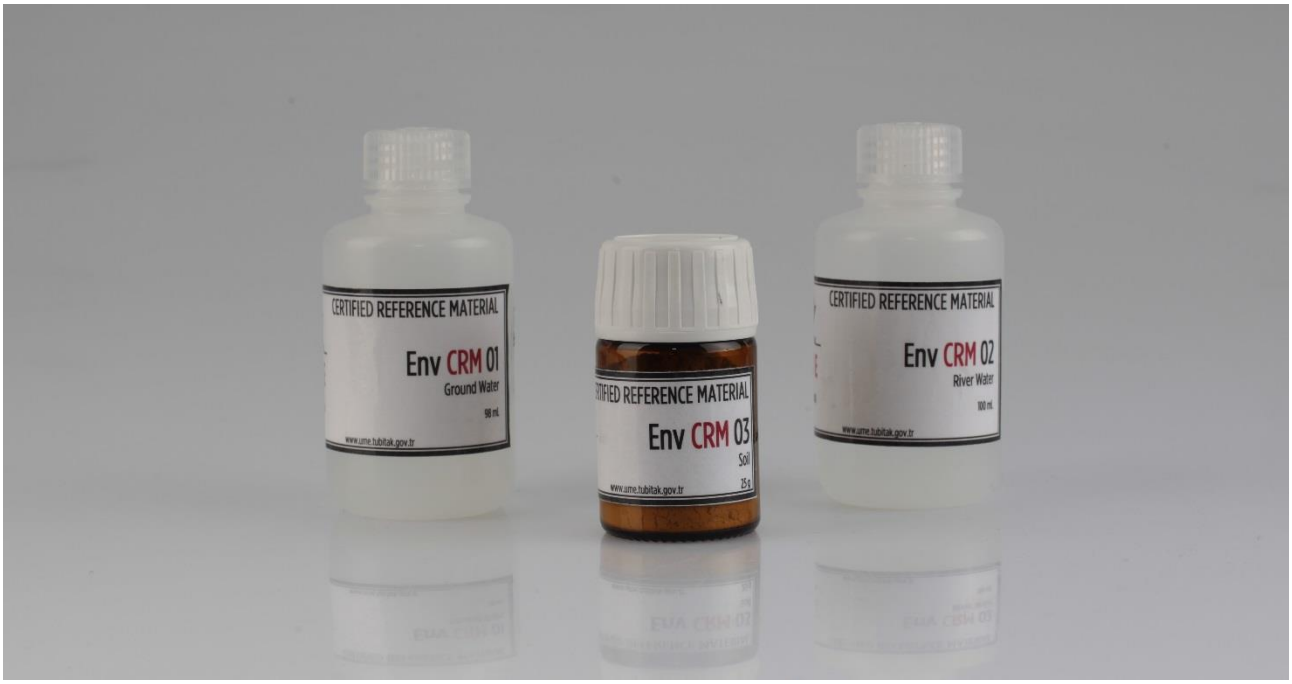
TÜBİTAK UME is planning to develop Turkey's first Optical Atomic Clock in cooperation with the All-Russian Scientific Research Institute of Physico-Technical Measurements (VNIIFTRI).

A delegation, headed by the Director General of VNIIFTRI, Prof. Dr. Sergey I. DONCHENKO, visited TÜBİTAK UME on September 17, 2018. At this visit, the parties agreed to conduct a joint project to develop Turkey's first Optical Atomic Clock.

Optical atomic clocks represent the latest technology for measuring time and have 10 to 100 times better consistency than the best microwave clocks. The Sr-lattice clock which will be developed by TÜBİTAK UME and VNIIFTRI, is projected to have the capability to measure time with less than a 1 second deviation in 1 billion years.

The project aims to increase the accuracy of Turkey's current time scale by a factor of 100 and to pave the way for new defence industry technologies, geodesics and fundamental scientific research. This project protocol, signed in 2018, forsees work to begin in 2019.

TÜBİTAK UME Completes "Matrix Reference Materials for Environmental Analysis" Project



The Matrix Reference Materials for Environmental Analysis Project (14-RPT-03 ENVCRM), funded within the European Metrology Programme for Research and Innovation (EMPIR) and coordinated by TÜBİTAK UME, was successfully completed.

A team of nine project partners from Europe, composed of four national metrology institutes, three designated institutes and two universities, worked together for the production of novel reference materials related to environmental measurements and for their certification in accordance with ISO 17034, under the coordination of TÜBİTAK UME.

The project, which started in 2015, aimed to produce matrix reference materials for the use in the quality control of measurements in the field of environmental measurements, taking into account the changing and increasing needs of analytical laboratories. Accordingly, the reference material needs and priorities of laboratories performing environmental measurements were identified through direct

communication. Of the needs identified, the project concentrated on those that were common among laboratories so as to produce the maximum impact.

Based on information obtained from analytical laboratories, studies were carried out for the production and certification of three candidate certified reference materials (CRMs). These were organic pollutants in groundwater (PFOS & PFOA), elements in river water (As, Cd, Hg, Ni, Pb, Se) and elements in Soil (As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, V, Zn).

The project is expected to have a number of impacts on partner institutions, analytical laboratories and the larger field of environmental measurements. Three new CRM's will be available for quality control and assurance of measurements performed by analytical laboratories. The new measurement capabilities gained by project partners may be used to develop new CRMs and offer new services to customers. The project partners will be able to provide new proficiency tests in their own countries. Furthermore, the groundwork has been laid for for further cooperation among project partners to jointly develop new CRMs and proficiency tests.

Among the benefits of the project outcomes to society at large, we can count greater reliability and comparability of environmental measurements, which eliminates excess repetition of measurements and the attendant cost inefficiencies; better monitoring of the health and quality of natural resources such as water and soil, leading to a healthier environment and higher quality agricultural products and thus, a better quality of life.

The ENVCRM Project was chosen as one of the two projects by the European Association of Metrology Institutes (EURAMET) to be presented as a sample project in the "Training and Workshop on Preparing High Impact Joint Project Proposals" (Berlin, Germany).

Cooperation between TÜBİTAK UME and BIPM in Training

The "BIPM - TÜBİTAK UME Project Placements", a long term training programme implemented in cooperation with the BIPM's Capacity Building and Knowledge Transfer (CBKT) programme started in 2018.

A total of 58 applications were received from 23 countries for 10 placements that were available. Among these, 10 applicants were selected from the United Arab Emirates, Belarus, Bosnia – Herzegovina, Ethiopia, Ghana, Iran, Kazakhstan, Kenya, Saudi Arabia, and Zambia to study at TUBITAK UME for periods ranging from one month to three months. Among the fields of study were impedence measurements, power and energy, flow measurements, thermometry, voltage measurements, pressure, RF and microwave, and dimensional measurements. At the end of their study, each participant produced a report detailing the work they performed, which have been published on the BIPM website.

Each participant in the programme designed their own project in a field of study of their choice. Additionally, they benefitted from training sessions on the CIPM MRA and uncertainty measurements with lecturers from the BIPM and TUBITAK UME.

The programme aims to support capacity building in emerging national metrology institutes through in depth knowledge transfer to technical personnel in areas of interest to the personnel and their insitutes and to enhance their engagement with the international metrology community and the BIPM.

The "BIPM – TÜBİTAK UME Project Placements" are being offered as TÜBİTAK UME's contribution to the Capacity Building and Knowledge Transfer (CBKT) Programme implemented by the BIPM, which aims to increase the visibility

and participation of emerging metrology systems in the world-wide metrology community. Other contributors to the CBKT Programme include NIST of the United States, PTB of Germany, METAS of Switzerland, NIM of China and NMISA of South Africa.

PUBLICATIONS&PATENTS

SCI Articles

91 articles by TÜBİTAK UME researchers were published in SCI journals in 2018.

1. Liv, L., Nakiboglu, N. "Voltammetric Determination of Boron using Poly Xylenol Orange-Modified Pencil Graphite Electrode", Analytical Letters, 51:1-2 (2018) : 170-185
2. Heinonen, M., Bell, S., Choi, B., Cortellessa, G., Fernicole, V., Georgin, E., Hudoklin, D., Ionescu, G., Ismail, N., Keawprasert, T., Aro, R., Nielsen, J., Oguz Aytekin, S., Osterberg, P., Skabar, J., Strnad, R. "New Primary Standards for Establishing SI Traceability for Moisture Measurements in Solid Material", International Journal of Thermophysics, 39:1 (2018) : 1-13
3. Asiri, S., Sertkol, M., Guner, S., Gungunes, H., Batoo, K., Salef, T., Sozeri, H., Almessiere, M., Manikandan, A., Baykal, A. "Hydrothermal Synthesis of CoyZnyMn1-2yFe2O4 Nanoferrites : Magneto-Optical Investigation", Ceramics International, 44:5 (2018) : 5751-5759
4. Amir, M., Sozeri, H., Korkmaz, A., Baykal, A. "Concentration and Temperature-Dependent Magnetic Properties of Ba1−xZnxFe12O19 Hexaferrites", Ceramics International, 44:1 (2018) : 988-992
5. Araz, I., Genc, F. "Development of Broadband Microwave Absorber and Measureent of Its Magnetic and Microwave Properties", Journal of Magnetism and Magnetic Materials, 31:1 (2018) : 279-283
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8. Han, H., Yilmaz, H., Gulcin, I. "Antioxidant Activity of Flaxseed (Linum usitatissimum L.) Shell and Analysis of Its Polyphenol Contents by LC-MS/MS ", Records of Natural Products, 12:4 (2018) : 397-402

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10. Chormey, D.S., Ozturk Er, E., Erarpat, S., Ozzeybek, G., Ari, B., Bakirdere, S. "A Novel Analytical Approach for the Determination of Parathion Methyl in Water: Quadrupole Isotope Dilution Mass Spectrometry-Dispersive Liquid–Liquid Microextraction Using Multivariate Optimization", Analyst, 143:5 (2018) : 1141-1146.

11. Fidan, E., Kucur, O. "Performance of Transceiver Antenna Selection in Two Way Full-Duplex Relay Networks over Rayleigh Fading Channels ", IEEE Transactions on Vehicular Technology, PP:99 (2018) : 1-13

12. Sayar, M., Karakus, E., Guner, T., Yildiz, B., Yildiz, H., Emrullahoglu, M. "A BODIPY-Based Fluorescent Probe to Visually Detect Phosgene: Toward the Development of a Handheld Phosgene Detector", Chemistry A European Journal, 24:13 (2018) : 3136-3140

13. Amir, M., Gumgunes, H., Baykal, A., Almessiere, M., Sozeri, H., Ercan, I., Sertkol, M., Asiri, S., Manikandan, A. "Effect of Annealing Temperature on Magnetic and Mössbauer Properties of ZnFe2O4 Nanoparticles by Sol-gel Approach", Journal of Superconductivity and Novel Magnetism , -:https://doi.org/10.1007/s (2018) : 1-10

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16. Atay Balkan, I., Dogan, H., Zengin, G., Colak, N., Ayaz, F., Goren, A.C., Kirmizibekmez, H., Yesilada, E. "Enzyme Inhibitory and Antioxidant Activities of Nerium Oleander L. Flower Extracts and Activity Guided Isolation of the Active Components", Industrial Crops and Products, 112:February (2018) : 24-31

17. Dobre, M., Peruzzi, A., Kalemci, M., Van Geel, J., Maeck, M., Uytun, A. "Effect of Impurities on the Triple Point of Water:Experiments with Doped Cells at Different Liquid Fractions", International Journal of Thermophysics, 39:5 (2018) : Article 60

18. Ahmedov, H., Babayigit, N., Korutlu, B., Orhan, R. "Preliminary Planck Constant Measurements Via UME Oscillating - Magnet Kibble Balance", Metrologia, 55:3 (2018) : 326-333

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23. Slimani, Y., Gungunes, H., Nawaz, M., Manikandan, A., El Sayed, H., Almessiere, M., Sozeri, H., Shirsath, S., Ercan, I., Baykal, A. "Magneto-Optical and Microstructural Properties of Spinel Cubic Copperferrites with Li-Al Co-Substitution", Ceramics International, -:- (2018) : 1-9

24. Cinar, M., Cankaya, S., Capan, A., Eroglu, M.S., Ozturk, T. "Thieno[2,3-b]Thiophene Based Polymers: Synthesis and Optoelectronic Properties", European Polymer Journal, 104:July (2018) : 72-80

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17. Kacmaz, S. " Technical Instruction Of Calibration Method Of Automatic Gravimetric Filling Instruments", Gebze : TÜBİTAK UME, 2018
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22. Kaçmaz, S., "Woldetensai, D. "BIPM Capacity Building & Knowledge Transfer Programme ", Cevres : BIPM, 2018

REGISTERED PATENTS

In 2018, 2 international patent applications in the field of Optical-Photonics and 3 international patent applications in the field of Chemistry have been registered.

Name of the Invention	Owners	Registered countries
Dynamically Monitoring and Deriving The Instantaneous Zero Rotation Rate Voltage of Interferometric Fiber Optic Gyroscope (IFOG) under Uniform Influence of Rotation	Oğuz ÇELİKEL	Japan USA
Fluorophore 3-hydroxyflavone	Turan ÖZTÜRK	Japan USA
Poly(thienothiophenylborane)s and poly(dithienothiophenylborane)s for white light emitting diodes	Turan ÖZTÜRK, Emine TEKİN, Onur ŞAHİN, Emine Billur SEVİNİŞ, Canan ŞAHİN, Mehmet Sayip EROĞLU, Ahmet Ceyhan GÖREN, Mehmet Emin ÇINAR, Gülşen TÜRKOĞLU	USA
Fiber coupled integrating sphere based-laser energy meter and calibration system traceable to primary level standards	Oğuz ÇELİKEL, Ferhat SAMETOĞLU	Japan USA
Thienothiophene and dithienothiophene - boron (donor-acceptor) based materials for organic light emitting diodes	Turan ÖZTURK, Ali BUYRUK, Gülşen TÜRKOĞLU, Emine TEKİN, Selin PİRAVADİLİ, Mehmet Emin ÇINAR, Ahmet Ceyhan GÖREN	USA

GLOSSARY

Metrology(*)

Science of measurement and its application

Measurement(*)

Process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity

Measurement Accuracy(*)

Closeness of agreement between a measured quantity value and a true quantity value of a measurand

Calibration(*)

Operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication.

Measurement Uncertainty(*)

Non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

Primary Measurement Standard(*)

Measurement standard established using a primary reference measurement pocedure, or created as an artifact

Metrological Traceability(*)

Property of a measurement whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty

Accreditation

Evaluation and confirmation of proficiency of Conformity Assesment Organizations by an accepted system through taken into account designated standards

Calibration Certificate

A document produced at the end of a calibration, containing information on the measurement standards and reference instruments used, the calibration method and procedure, enviromental conditions, measurement results and uncertainties and which establishes traceability to the national measurement standards that realize SI units

(*) International vocabulary of metrology – Basic and general concepts and associated terms (BIPM, 2008, 3rd edition)

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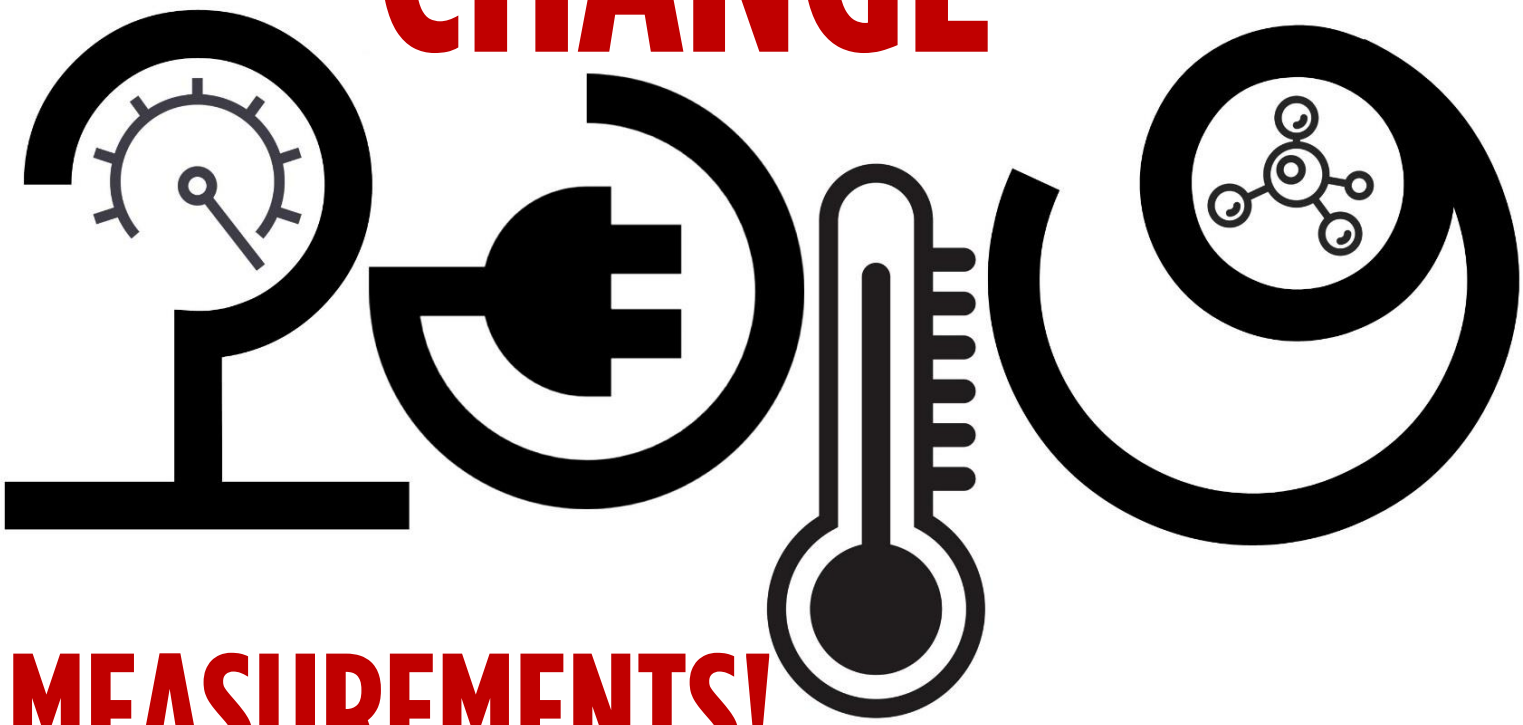

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