

News from TÜBİTAK UME

CCEM 2023

NEW FACILITIES/DEVELOPMENTS:

Voltage Laboratory (Contact: mehedin.arifovic@tubitak.gov.tr)

Josephson Arbitrary Waveform Synthesizer (JAWS), with superconducting integrated circuits mounted in a top loading cryocooler, is operated using optoelectronic pulse drive; optimization of the system is continuing. Design of the wideband voltage dividers of 5 V/V and 101 V/V is optimized; dividers, combined with the digitizers are calibrated by using PJVS and then compared to the thermal transfer technique. Methodology of the using digitizers combined with the PJVS in AC Voltage measurement is established. Software for automatic calibration of the multifunction calibrators and meters is upgraded.

EMPIR 17RPT03 DIG-AC project has been completed while 20FUN07 SuperQuant project has been continued.

Impedance Laboratory (Contact: enis.turhan@tubitak.gov.tr)

Two pieces of temperature controlled calculable resistors have been bought from CMI. Using these calculable resistors, the characterizations of the digital impedance bridge and transformer-based impedance bridge are going to be performed. Two new EMPIR projects began in June 2021, which are SRT f14 MEMQuD (Memristive devices as Quantum Standard for Nanometrology) and SRT i06 Elena (Electrical nanoscale metrology in industry). A new CCC measurement system was purchased and established in TÜBİTAK UME. The Quantum Hall Resistance System is going to be replaced with a cryogen-free system. In addition, two new Quantum Hall samples is going to be supplied. The work on designing appropriate sample holders for the cryogen-free system continues with the support of PTB experts.

The planned bilateral comparisons with BIPM will be performed just after starting the Quantum Hall measurements with cryogen-free systems. One of the comparisons will be performed with reference resistors the other comparison will be performed with QH resistor.

A study to produce electrochemical sensors and electrical measurement devices for detecting SARS-CoV-2 virus has been performed together with Electrochemistry Laboratory of TÜBİTAK UME. In this scope, it was aimed the minimization, production and characterisation of the relatively macro-sized sensors in order to lessen the consumption of chemical matters, optimisation and formation of the measurement procedure, real sample application, design, production and verification of the mini-sized device performing the measurement. As a result, eight different electrochemical sensors and a mini-sized, cheap and verified potentiostat/galvanostat were produced that could detect the specific antigen or antibody proteins of the SARS-CoV-2 in real and/or synthetic samples.

RF & Microwave Laboratory (Contact: erkan.danaci@tubitak.gov.tr)

Primary level measurement system on calculable impedance standard was proven with experimental comparison in EMPIR 18SIB09 project up to 90 GHz (1.35 mm connector). Power measurement capability was proven with experimental comparison in EMPIR 18SIB09 project up to 170 GHz and at 500 GHz - 750 GHz frequency range. RF noise measurement capability is also expanded up to 50 GHz.

A software was developed on power sensor calibration for direct comparison transfer method at millimeter-wave frequency. Development a commercial software with uncertainty calculation tools such as Bayesian and Monte Carlo Simulation Methods was supported for absolute RF power measurement. A new method was applied for RF power sensor calibration with Vector Network Analyser (VNA). A new software was developed for VNA based power sensor calibration method.

Technology transfer has been carried out to make the uncertainty calculations of the measurement systems in the test stations of the factory production lines producing RF circuits.

EMPIR 18SIB09 and TEYDEB-1505 5200040 OTORFGUC (funded by TÜBİTAK) projects were completed. EMPIR 20IND03 FutureCom and EMPIR 20FUN07 SuperQuant projects have been launched. EMP 22RPT04 RFMicrowave-II Project was offered and accepted in 2022 and negotiations process is continued by EMP MSU office.

Electromagnetic Laboratory (Contact: soydan.cakir@tubitak.gov.tr)

The establishment of a primary level Antenna Calibration Test Site (CALTS), which measures 30 m by 60 m, has been completed and validated with a maximum Site Insertion Loss (SIL) value of 0.6 dB as per CISPR 16-1-5. With the development of this high-quality CALTS, TÜBİTAK UME has started to provide antenna calibration services in accordance with CISPR 16-1-6.

The EMP project titled “21NRM06 EMC-STD Metrology for emerging electromagnetic compatibility standards” has been started with the participation of 6 internal and 3 external funded partners from 8 European countries. TÜBİTAK UME is the coordinator of the project. The overall aim of the project is to support standardisation in electromagnetic compatibility (EMC) through the introduction of new, validated, and traceable emissions measurement methods for the revision of and forthcoming development of CISPR EMC standards.

An international magnetic field probe calibration comparison titled “EURAMET.EM.RF-S46 (EURAMET Project No: 1538) Comparison of Magnetic Field Strength Measurements for Frequencies up to 30 MHz” has been started in the range of 50 Hz – 30 MHz with the participation of 9 metrology institutes. TÜBİTAK UME is the pilot institute for this comparison. In addition, the international current probe calibration comparison titled “EURAMET.EM.RF-S45 (EURAMET Project No: 1478) EURAMET Supplementary Comparison on Calibration of RF Current Monitoring Probe” has been completed and the final report has been published. TÜBİTAK UME was the pilot institute for this current probe calibration comparison. Ultimately, a national rod antenna calibration comparison has been finalized with the participation of three national calibration laboratories and the report has been issued.

Two new CMC entries have been published in BIPM KCBDB. One of them is the current clamp calibration (RF Transfer Impedance) and the other is the loop antenna calibration (Three Antenna Method). Additionally, the measurement uncertainty of one CMC entry with two rows about the electric field probe calibration above and below 50 kHz has been improved.

High Voltage Laboratory (Contact: ahmet.merev@tubitak.gov.tr)

International project 19ENG02-Future Energy that is related to build up a reference calibration system up to 2000 kV for HVDC of the EMPIR programme of the European Union's Horizon 2020 research and innovation programme started in June 2020. HVDC divider up to 200 kV has been constructed within the scope of this project and the comparison measurements have been performed about it by the NMIs: TÜBİTAK UME, RISE, VTT, PTB, and VSL. The comparison results have been shared at CPEM 2023 in New Zealand. The high voltage lightning impulse divider capacity of the laboratory has been increased from 1000 kV to 2200 kV. But unfortunately, due to the transportation and customs problems of this divider, it was not attended to the measurement campaign at Delft University, The Netherlands. This project will be completed at the end of May 2023.

Another international project "19NRM07-HV-com²: Support for standardisation of high voltage testing with composite and combined wave shapes", is concerning the standardisation proposal about combined and composite measuring and testing systems. In the scope of this international project, several reference measuring dividers have been constructed and characterized by TÜBİTAK UME, PTB, VTT, LNE, LCOE and INRIM. The results of this characterization have been presented at CPEM 2023 in New Zealand. Another output of this project is to investigate and implement the composite and combined measurement software. The software with a special recorder has been performed and implemented for the combined and composite measurements. This project will be completed at the end of April 2023.

In 2022 the national laboratory comparison organization on the measurement of capacitance and dissipation factor ($\tan\delta$) under high voltage up to 10 kV have been organized and completed by TÜBİTAK UME successfully.

Power & Energy Laboratory (Contact: ozlem.yilmaz@tubitak.gov.tr)

The project named "The Installation of Calibration Laboratory of EÜAŞ (Electricity Generation Company of Türkiye)", in the fields of Electricity, Temperature, Pressure, Time-Frequency, Fluid Mechanics and Acoustics Metrology, was completed in 2022. In addition, EÜAŞ quality management system infrastructure was established and accreditation applications were made for the relevant fields.

A three-phase measurement setup has been established for simultaneous testing of combined instrument transformers and sensors up to 36 kV and currents up to 2 kA within in the scope of EMPIR 19NRM05. Waveforms to be generated can be selected as sine-wave with steady-state harmonics and with other PQ parameters. And, each channel can be configured individually for both amplitude and phase. The measurement setup allows analysis of multiple external magnetic and electrical fields on each VT and CT of the tested three-phase combined IT, simultaneously with and three dimensions, as well.

The frequency response of MV resistive voltage divider has been measured by comparing it with a calibrated 1000 V Resistive Voltage Divider of Digital Sampling Wattmeter at a fundamental signal at 50 Hz and a fixed amplitude of 560 V with a harmonic frequency sweep from 100 Hz up to 6400 Hz with a first estimated uncertainty of 200 ppm.

Wideband characterization of electronically compensated current comparator was carried out by using the calibrated current shunts of DSWM up to 10 kHz.

EMPIR 17NRM01 and EMPIR 17IND07 are completed. EMPIR 19NRM05 has been continued.

Magnetism Laboratory (Contact: huseyin.sozeri@tubitak.gov.tr)

International project 18HLT06 RaCHy “Radiotherapy coupled with hyperthermia - adapting the biological equivalent dose concept” of the EMPIR programme of the European Union’s Horizon 2020 research and innovation programme, coordinated by INRIM (Italy), was completed in October 2022. In this project TÜBİTAK UME contributed to WP1 “Heat delivery systems for hyperthermia treatments” by preparing several Fe₃O₄ nanoparticles to be used in magnetic hyperthermia.

International project JRP g03 HEFMAG ”Metrology of magnetic losses in electrical steel sheets for high-efficiency energy conversion” of the EMPIR programme of the European Union’s Horizon 2020 research and innovation programme, coordinated by INRIM (Italy) started in September 2020. In this Project TÜBİTAK UME participates in WP2 “Power losses under operating temperature conditions”, WP3 “Alternating power losses in thin sheets up to the MHz range” and WP4 “Two-dimensional magnetization and power losses”.

International project SIP-15SIB06 qMOIF ”Standardization of a quantitative Magneto-Optical Indicator Film based magnetic field measurement technique” of the EMPIR programme of the European Union’s Horizon 2020 research and innovation programme, coordinated by PTB (Germany) started in July 2021. In this Project TÜBİTAK UME participates in all four WPs (WP1” Impact on unification of qMOIF Terminology and Best Practice”, WP2 “Impact on Standardization”, WP3 “Impact on awareness and uptake of the standardization”, WP4 “Management and coordination”).

National project about preparation of soft magnetic alloys used in high sensitive fluxgate magnetometers continued. Several ribbon type soft magnetic materials have been prepared by planar flow casting method. Characterization of several sensors produced using these ribbons was performed.

Joint project, between TÜBİTAK UME and Slovakia Academy of Science (SAS) on the preparation and design of space qualified magnetic sensors was completed. A set of magnetometer and torque rod was produced as an outcome of the project.

Quantum Metrology Laboratory (Contact: mustafa.arikan@tubitak.gov.tr)

The first phase of the establishment of the laboratory infrastructure of the Quantum Metrology Laboratory has been successfully completed. The second phase which will add the nanoelectronic and quantum device fabrication capabilities to the lab will start in 2023 with a new cleanroom (730 m² class 100-1000).

The devices / systems / measurement capabilities of the Quantum Metrology Laboratory now includes:

Helium-Ion Microscope /Scanning Thermal Probe Lithography, Wafer Dicing, Interferometric and Stylus Profilometry (Thin Film Thickness, Stress, Surface Roughness, Step Height, 3D Mapping), Spectroscopic Ellipsometry, Electrical Characterization of Semiconductor Materials, Impedance Measurements On Semiconductor Materials And Devices (up to 120 MHz), Precision Impedance And Phase Measurements Via Lock-In Amplifiers (up to 600 MHz), Low (up to 40 MHz) and High (up to 50 GHz) Frequency Noise Measurements On Semiconductor Devices (On-Wafer/Fixture I-V, C-V measurements), On-Wafer S-Parameter Measurements (up to 110 GHz), Sampling and Real Time Oscilloscopes, X-Ray Diffraction Measurements, Wire And Ribbon Bonding, PCB & SMT processing, low temperature and high magnetic field cryostats, cryogenic and cryomagnetic Probe Stations, Raman and TERS microscope

The laboratory participates in several international projects: 19NET02 European Metrology Network for Quantum Technologies, COMET, MEMQuD, SuperQuant, FutureCom, Elena, QADeT within EURAMET research programme.

PARTICIPATION of TÜBİTAK UME in ILCs/PTs

No	Type of ILC/PT	Field/subfield	Pilot lab	Identification of ILC/PT	Parameters/ range of measurements	Status	Evaluation criterion	Result
1.	CIPM key comparison	EM/Radio frequencies	NMIJ	CCEM.RF-K5.c.CL	Scattering coefficients 100 MHz – 33 GHz 3.5 mm connector	Draft A report circulated	degrees of equivalence	-
2.	CIPM key comparison	EM/Radio frequencies	NMIJ	CCEM.RF-K26	Attenuation at 18 GHz, 26.5 GHz and 40 GHz using a step attenuator	Draft A report circulated	degrees of equivalence	-
3.	CIPM key comparison	EM/Radio frequencies	NIM	CCEM.RF-K28.W	Effective efficiency of calibration factor of RF thermistor mounts Frequency: 18 GHz to 26.5GHz	Protocol complete	degrees of equivalence	-
4.	EURAMET supplementary comparison	EM/Radio frequencies	TÜBİTAK UME	EURAMET.EM.RF-S45 (EURAMET Project 1478)	Transfer Impedance (dB Ω): 10 kHz, 100 kHz, 1 MHz, 10 MHz, 100 MHz, 200 MHz, 300 MHz, 400 MHz, 500 MHz	Final report	degrees of equivalence	New CMCs were submitted.
5.	EURAMET supplementary comparison	EM/Radio frequencies	TÜBİTAK UME	EURAMET.EM.RF-S46	Correction Factor (dB): 53 Hz, 400 Hz, 10 kHz, 100 kHz, 300 kHz, 500 kHz, 5 MHz, 10 MHz, 20 MHz, 30 MHz	In progress	degrees of equivalence	-
6.	Multilateral ILC	EM/Radio frequencies	TÜBİTAK UME	EURAMET Project 1512	Effective Efficiency Frequency: 10 MHz to 18 GHz	Draft A report circulated	degree of equivalence	-
7.	Multilateral ILC	EM/DC voltage, DC current, AC voltage, AC current, Resistance	TÜBİTAK UME	EURAMET Project 1341	DC voltage:100 mV, 10 V, 100 V, 1000 V DC current: 100 μ A, 10 mA, 1 A AC Voltage: 100 mV, 10 V, 100 V (55 Hz, 1 kHz, 100 kHz) AC Current: 10 mA, 1 A (300 Hz, 1 kHz) Resistance: 10 Ω , 10 k Ω , 1 M Ω	Final report	degrees of equivalence	Passed.
8.	EURAMET supplementary comparison	EM/DC Current	TÜBİTAK UME	EURAMET.EM-S44 (EURAMET Project 1381)	DC Current: \pm 9.5 fA, \pm 95 fA, \pm 0.95 pA, \pm 9.5 pA, \pm 95 pA	Final report	degrees of equivalence	CMCs supported.

No	Type of ILC/PT	Field/subfield	Pilot lab	Identification of ILC/PT	Parameters/ range of measurements	Status	Evaluation criterion	Result
9.	EURAMET key comparison	EM/Resistance	TÜBİTAK UME, NPL, PTB	EURAMET.EM-K2.2023	DC Resistance: 10 MΩ, 1 GΩ	Protocol under preparation	degrees of equivalence	-
10.	GULFMET key comparison	EM/Resistance	EMI	GULFMET.EM-K2	DC Resistance: 10 MΩ and 1 GΩ	Planned	degrees of equivalence	-
11.	EURAMET supplementary comparison	EM/Resistance	RISE	EURAMET.EM-S47	DC Resistance:2 GΩ Voltage: up to 200 kV	Measurements completed	degrees of equivalence	-
12.	EURAMET supplementary comparison	EM/High voltage and current	TÜBİTAK UME	EURAMET.EM-S43	Primary voltage: 3 kV, 6 kV, 10 kV, 20 kV and 30 kV Secondary voltage: 100 V Frequency: 50 Hz	Final Report	degrees of equivalence	CMCs supported.
13.	GULFMET supplementary comparison	EM/High voltage and current	SE	GULFMET.EM-S6	Primary voltage: 6 kV, 10 kV, 22 kV, 35 kV, Secondary voltage: 100 V Frequency: 50 Hz and 60 Hz	Final Report	degrees of equivalence	CMCs supported.
14.	GULFMET supplementary comparison	EM/High voltage and current	SE	GULFMET.EM-S7	Primary current: 5 A, 50 A, 200 A, 400 A, 800 A, 1500 A, 2000 A, 4000 A Secondary current: 5 A Frequency: 50 Hz and 60 Hz	Final Report	degrees of equivalence	CMCs supported.
15.	EURAMET supplementary comparison	EM/High voltage and current	RISE	EURAMET.EM-S36	Apparent charge and rise time of internal step voltage pulse	In progress	degrees of equivalence	-
16.	EURAMET supplementary comparison	EM/High voltage and current	RISE	EURAMET.EM-S46	High Voltage DC Ratio: 20000	Measurements completed	degrees of equivalence	-
17.	EURAMET key comparison	EM/AC power	VSL	EURAMET.EM-K5.2018	AC power: (120 V & 240 V, 5 A, 53 Hz, PF: 0 - 1)	Draft A report under preparation	degrees of equivalence	-
18.	Multilateral ILC	EM/High voltage and current	TÜBİTAK UME	COOMET Project 859/TR/22	Primary current: 10 A, 50 A, 100 A, 500 A, 1500 A Secondary current: 5 A Frequency: 50 Hz	In progress	degrees of equivalence	-

SCI PAPERS AND PROCEEDINGS:

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