News from TUBITAK UME

CCEM 2017

NEW FACILITIES/DEVELOPMENTS:

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

- The new 10 V Programmable Josephson Voltage Standard is established. In the scope of the work, cryoprobe, microwave generator and software are designed. System is capable to produce DC and staircase approximated AC voltages up to 10 V up to several kHz's. Work on the construction of the system operated in Crycooler is continuing.
- AC-DC transfer software and switch has been developed for IMBIH (Bosnia and Herzegovina).
- Development and Realization of Voltage Measurement and Calibration Systems for SASO/NMCC, Saudi Arabia is continuing.
- Establishing of the UME oscillating magnet Watt balance system. The objective of this project is redefinition of the mass unit-kg using electrical quantum standards, at the uncertainty level of 10^{-8}.

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

- 2TP Digital Impedance Bridge: A 2TP digital impedance comparison bridge is being developed for like impedances. After this project finished, 4 TP digital impedance bridge project will start.

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

- A reference calculable lightning and switching impulse calibrator and step generator have been designed and constructed in 2016. With this project, traceability of the impulse high voltage measurements was provided internally. Also, a reference partial discharge calibrator and a detector have been designed and constructed for the PD measurements traceability.

Power & Energy Laboratory (Contact: huseyin.cayci@tubitak.gov.tr)

- A national project was finalized in the end of 2016. Project concept was "Electromagnetic Field Measurements, Feasibility Report for Instrument Transformer Calibrations, Calibration Automation for Power Quality Analyzers, Design of an Energy Analyzer Calibrator and Establishment of a Test and Calibration Laboratory for Turkish Transmission Company (TEIAS)". Last work package on the study on the accreditation of measurement capabilities established in the laboratories of TEIAS is in progress.
- A sampling based AC Power Measurement Standard was designed and established for SASO/NMCC (Saudi Arabia Metrology Institute) within the project work package of "Design of Power & Energy Measurement Standards for SASO". A multi-stage reference current transformer and a

semi-automatic calibration system for instrument current and voltage transformers were designed and established at Power & Energy Laboratory of SASO/NMCC.

- Final reports and the metrological outputs of a national project were accepted and the project was finalized. Project no: 5130048, "Robust Design of High Precision Instrument Current and Voltage Transformers and Kombi Sensors", National Support Programme for Cooperation Between Universities and Industry (1505).
- A synchronous phase-locked system for the calibration of power loss measurement systems was designed and verified through several on-site calibrations. New and more precise reference instruments are going to be developed and integrated to the system to improve the accuracies.

RF & Microwave Laboratory (Contact: murat.celep@tubitak.gov.tr)

- Establishment of Microcalorimeter System for Egypt Metrology Institute (NIS): In the scope of the project, twin type microcalorimeter with N type (working frequency range is 10 MHz -18 GHz) connector is produced, delivered, and project finished.
- Establishment of RF & Microwave Laboratory for Saudi Arabia Metrology Institute (SASO): SASO have secondary level calibration capabilities for S-parameters and RF power measurement in the frequency range 100 kHz - 50 GHz with the project. The project is nearly finished.

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

- A reverberation chamber that operates from 200 MHz up to 40 GHz has been installed and a software solution which covers calibration, testing and loading measurements as per prominent reverberation chamber immunity standards such as IEC61000-4-21, DO160F, and DO160G has been designed and put into operation.
- A computer-controlled harmonic cancellation system was successfully developed, tested and verified for more precise E&H field sensor calibrations. The system automatically adjusts the low pass filters in accordance with the current frequency and eliminates the harmonics of amplifiers without any interruption in calibrations, which improves accuracy.
- The establishment of an E&H Field Sensor Calibration System for the Saudi Arabia Metrology Institute (SASO): With this project, SASO has acquired calibration capabilities for E and H field sensor calibrations in the frequency range from 30 Hz to 18 GHz. The project has been almost completed.

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

- Project on the measurement of ultra low DC magnetic fields (nT) is in progress, 2 SCI-Index papers were published.
- Research on functional magnetic nanoparticles is continued, 27 SCI-index papers were published.
- Research on high frequecy (GHz) magnetic and dielectric properties of magnetic materials is continued, 4 SCI-index papers were published.
- Research on atomic magnetometers has started.

EMRP/EMPIR PROJECTS:

Voltage Laboratory

- A Quantum Standard for Sampled Electrical Measurements (Q-WAVE), completed in 2016
- EMPIR Waveform Metrology based on spectrally pure Josephson voltages (QuADC), continuing
- EMPIR Towards the propagation of ac quantum voltage standards (ACQ-PRO), continuing

Impedance Laboratory

- EMRP Project- 15SIB08 e-SI-Amp: Quantum realisation of the SI ampere (started in 2016). TUBİTAK UME is responsible for producing ultra-low DC current source, temperature controlled Standard capacitors, ramp generators. In addition, characterization of Standard capacitors, ramp generator and ultra-low DC current source will be performed.

High Voltage Laboratory

- EMPIR JRP-n11: UHV Techniques for ultra-high voltage and very fast transients (started in 2016). Aim: to detect and measure PD signals on the DC high voltage transmission systems with low uncertainties.

Power & Energy Laboratory

- EMPiR 15RPT04, “Traceability routes for electrical power quality measurements”, started in 2016. TUBITAK has several responsibilities in all workpackages of the project. And, project team has already start to work on the design of reference transducers and for the development of algorithms use in the reference sampling power and power quality measurement systems.
- EMRP ENG61 (SRT-g20), “Non-Conventional Voltage and Current Sensors for Future Power Grids (FutureGrids)”, started in 2014. TUBITAK almost finalized the responsibilities in the project by the design of enhanced Rogowski coil, and by the design of amplifiers for the testing of electronic current and voltage sensors.
- EMRP ENG63 (SRT-g16), “Sensor Network Metrology for the Determination of Electrical Grid Characteristics (GridSens)”, started in 2014. TUBITAK finalized the responsibilities in the project with the analysis of a certain network in cooperation with a distribution company in Turkey.
- EMRP IND60, “Improved EMC test methods in industrial environments (EMC)”, finished in 2016. A new and practical harmonic and flicker test method was developed for EMC laboratories by the project team from the power & energy laboratory. And, a patent pending round robin device was successfully designed, constructed and verified with the intercomparison in 2016.

RF & Microwave Laboratory

- 15RPT01 RF Microwave - Development of RF and Microwave Metrology Capability Project (started in 2016): This project aims to increase and develop research and measurement capacities and expertise of emerging EURAMET countries on microwave metrology by transferring the theoretical and practical know-how between the partners and combining their skills to focus on microwave and electromagnetic compatibility (EMC) measurements. TÜBİTAK UME is a coordinator of the project and there are 10 partners from 9 countries. The partners are TÜBİTAK UME, CMI, GUM, INTA, SIQ, SP, NIS, NQIS, UPC and METAS.

- JRP-N14 Vector SAR - Metrology for SAR measurement using vector probe: Project aims to provide the required metrology for successful completion of IEC62209-3 so that the benefits of these new systems can be realised. Whilst developing this standard, urgent metrological needs have been identified which cannot be met by the measurement system manufacturers alone, but require a larger collaborative effort. The challenges are to establish traceable calibration and uncertainty analysis for sealed “black box” type systems, to develop uncertainty propagation methods when complex (and sometimes undisclosed) transformation algorithms are being used to determine the measurand based, and to assess the performance of a large array of sensors for all field distributions generated by the wide range of devices being SAR tested, including MIMO devices. LNE is a coordinator of the project and there are 6 participants from 3 countries. The partners are LNE, NPL, TÜBİTAK UME, ART-FI, IMT and KAPTEOS.

Electromagnetic Laboratory

- Improved EMC test methods in industrial environments (IND60): is to guarantee the quality of non-standard alternative EMC test methods which are widely used in industry for physically large equipment, installed systems and distributed/complex systems as well as smaller items such as consumer electronics. This Project firstly focused on the performance, characterization and improvement of the already existing alternative test methods, and then extensive correlation was established between the alternative methods used in industry and the standard test methods. This project also focused on the development of new alternative test methods in accordance with the needs of industry for all types of EMC tests. The JRP-Consortium includes 10 partners from 8 European countries; Turkey (Coordinator), France, Netherlands, Spain, Slovenia, Sweden, and Switzerland. The project has been completed in July 2016.
- Development RF & Microwave Metrology Capability (EMPIR 15RPT01): Scattering parameter (S-parameter) measurements, RF power measurements and EMC tests and calibrations are important areas in RF&MW metrology to ensure and increase product quality and end user confidence. Most of the national metrology institutes (NMIs) participating in this project have had to decline requests to perform measurements in RF&MW from stakeholders due to a lack of knowledge and/or experience in these areas. Therefore there is a strong need to improve the abilities of these European NMIs. The gap between developed and currently developing countries is growing constantly and this situation is even more pronounced for RF&MW metrology where not only knowledge and expertise are required, but also experience is required. In order to prevent further widening of this gap in RF&MW metrology, the knowledge and expertise of the more developed NMIs needs to be transferred to NMIs with less experience. This sharing of knowledge and skills would help to strengthen the European RF&MW metrology network and would support a better and more effective cooperation between European NMIs. It would also ensure a joint effort from European NMIs on the big challenges in RF&MW metrology and be instrumental for establishing future collaborations. The overall objective of “Development RF & Microwave Metrology Capability (EMPIR 15RPT01)” project is to improve the European measurement and research capability for RF&MW metrology and to establish a basis for future cooperation between European NMIs. This will enable less developed European NMIs to build necessary research capacity for challenging future joint projects, as well as improving their calibration and measurement capabilities (CMCs) and reducing the increasing technological gap between NMIs.

Magnetism Laboratory

- EMRP JRP IND 11 Metrology for Advanced Industrial Magnetics (MetMags): Goal of the proposed metrology research is to foster development, production and calibration of advanced magnetic sensors by the European sensor industry and to advance their application in present and emerging technologies. This goal is achieved by providing the metrological framework for the development, production, and testing and calibration of advanced magnetic sensors in accordance with the following objectives: Develop metrological tools and methods for industrial magnetic sensor development (traceable characterization of advanced materials, optimization of sensor devices, emerging new concepts). Develop metrological in-line tools and methods for sensor production (traceable measurement of magnetic parameters of devices such as thin films, multilayer stacks, patterned magnetic microstructures, individual magnetic microdevices etc). Develop metrology for sensor testing and calibration (metrological chain including specific coil setups, reference and test magnetic materials, metrological tools for testing magnetic properties in HF range (GHz), stress and reliability properties)
- EMPIR JRP S01 Nano-scale traceable magnetic field measurements (NanoMag): The overall goal of this JRP is to provide joint, sustainable, and coordinated European metrology capabilities that extend reliable and traceable measurements of spatially resolved magnetic fields down to the micrometer and nanometer length scale. The specific objectives are: To provide metrology tools and methods suitable for traceable measurements of the local stray field distribution of permanent magnets and magnetic encoder scales with spatial resolution from 50 µm down to 500 nm to underpin ultra-precise magnetic position sensing; to evaluate different local stray field measurement techniques with respect to traceability and uncertainties; and to establish traceability of local stray field measurements to macroscopic SI standards and to evaluate their uncertainties. To provide validated calibration techniques to ensure SI traceability of magnetic force microscopy (MFM) with spatial resolution below 50 nm; to develop, test and validate different calibration approaches; to establish traceability to macroscopic SI standards and to evaluate their uncertainties. To provide calibration artifacts suitable for traceable on-site calibrations to underpin reliability of micro- and nano-scale traceable magnetic field measurements of end-users. To facilitate the uptake of new advanced high resolution magnetic field metrology techniques by the measurement supply chain, ensuring traceability of measurement results to the users of metrology services and contribute to the development of standards by the international (IEC) standardization committees concerning nano-scale magnetic measurements or nano-electronics.

COMPARISONS:

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 by broad band methods 100 MHz – 33 GHz – 3.5 mm connector	In progress	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	In progress	degrees of equivalence	-
3.	CIPM key comparison	EM/Radio frequencies	NIST	CCEM.RF-K23.F	Antenna gain at 12.4 GHz, 15 GHz and 18 GHz with nominal values 23.48 dB, 24.46 dB and 25 dB respectively	Results available	degrees of equivalence	Satisfactory
4.	EURAMET key comparison	EM/AC current	BEV	EURAMET.EM-K12	Current: 10 mA and 5 A Frequency: 10 Hz, 55 Hz, 1 kHz, 10 kHz, 20 kHz, 50 kHz and 100 kHz	Results available	degrees of equivalence	CMCs supported
5.	EURAMET supplementary comparison	EM/AC High voltage	LCOE	EURAMET.EM-S33	Linearity and stability of AC high voltage reference system up to 100 kV	Results available	degrees of equivalence	CMCs supported
6.	EURAMET supplementary comparison	EM/High voltage impedance	LCOE	EURAMET.EM-S34	Capacitance and loss factor (100 pF / 200 kV, 500 nF / 10 V, 5000 nF / 10 V)	Results available	degrees of equivalence	CMCs supported
7.	EURAMET supplementary comparison	EM/High voltage impedance	LCOE	EURAMET.EM-S36	Apparent charge and rise time of internal step voltage pulse	Postponed	degrees of equivalence	-
8.	EURAMET supplementary comparison	EM/High AC current	CMI	EURAMET.EM-S37	Primary current: 4 kA, 5 kA, 6 kA, 8 kA, 10 kA; secondary current: 5 A; class: 0.05; nominal burden: 15 VA resistive	Draft A	degrees of equivalence	-
9.	EURAMET supplementary comparison	EM/High voltage lightning impulse	SP, MIKES, LCOE	EURAMET.EM-S42	Peak voltage (U_t), Front time (T_1), Time to half value (T_2), Time to chopping (T_C) Relative overshoot magnitude (β')	In progress	degrees of equivalence	-
10.	Interlaboratory Comparison	EM/DC Current	UME	EURAMET Project 1381	DC Current : 9.5 fA, 95 fA, 0.95 pA, 9.5 pA, 95 pA	Registered for	degrees of equivalence	-

No	Type of ILC/PT	Field/subfield	Pilot lab	Identification of ILC/PT	Parameters/ range of measurements	Status	Evaluation criterion	Result
11.	EURAMET supplementary comparison	EM/ DC voltage, DC current, AC voltage, AC current, Resistance	UME	EURAMET Project 1341	DC Voltage: 100 mV, 10 V, 100 V, 1000 V DC Current: 100 µA, 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 kΩ, 1 MΩ	In progress	degrees of equivalence	-
12.	COOMET key comparison	EM/AC Power	SE	COOMET.EM-K5 695/UA/16	AC power at 50/60 Hz Power factor: 1.0, 0.5 Lag, 0.5 Lead, 0.0 Lag, 0.0 Lead	In progress	degrees of equivalence	-
13.	COOMET supplementary comparison	EM/High Current Ratio	UNIIM	681/RU-a/16	I_P : 1 A ... 5000 A I_S : 1 A / 5 A Frequency: 50 Hz	In progress	degrees of equivalence	-
14.	GULFMET key comparison	EM/Resistance	UME	GULFMET.EM- S1	Resistance at 100 Ω	Planned	degrees of equivalence	-
15.	Bilateral Comparison	EM/DC Voltage	UME	UME-EM-D3-2.20.6.a	DC Voltage: 1.018 V & 10 V	In progress	E_n	-
16.	Bilateral Comparison	EM/AC Voltage	UME	UME-EM-D3-2.20.6.b	Voltage : 10 mV, 100 mV, 1 V, 10 V, 100 V, 1000 V Frequency: 10 Hz, 55 Hz, 1 kHz, 20 kHz, 100 kHz, 1 MHz	In progress	E_n	-
17.	Bilateral Comparison	EM/DC Current	UME	UME-EM-D3-2.20.6.c	DC Current: 100 µA, 10 mA and 1 A	In progress	E_n	-
18.	Bilateral Comparison	EM/AC Current	UME	UME-EM-D3-2.20.6.d	AC Current: 10 mA, 100 mA, 1 A, 10 A Frequency: 10 Hz, 55 Hz, 1 kHz, 10 kHz, 20 kHz, 50 kHz, 100 kHz	In progress	E_n	-
19.	Bilateral Comparison	EM/DC resistance	UME	UME-EM-D3-2.21.6.a	DC resistance: 100 Ω	In progress	E_n	-
20.	Bilateral Comparison	EM/Capacitance	UME	UME-EM-D3-2.21.6.b	Capacitance: 10 pF, 100 pF Frequency: 1 kHz	In progress	E_n	-
21.	Bilateral Comparison	EM/Inductance	UME	UME-EM-D3-2.21.6.c	Inductance: 100 mH Current: 1 mA, Frequency: 1 kHz	In progress	E_n	-

No	Type of ILC/PT	Field/subfield	Pilot lab	Identification of ILC/PT	Parameters/ range of measurements	Status	Evaluation criterion	Result
22.	Bilateral Comparison	EM/Calibration Factor	UME	UME-EM-D3-2.1.6.a	Calibration Factor at 10 MHz, 50 MHz, (1, 4, 8, 12, 15, 18) GHz	In progress	E_n	-
23.	Bilateral Comparison	EM/Transmission Coefficient	UME	UME-EM-D3-2.1.6.b	Attenuation: (3, 6, 10, 20, 30, 40, 50, 60) dB Frequency: 50 MHz to 18 GHz	Completed	E_n	-
24.	Bilateral Comparison	EM/Electric Field EM/Magnetic Field	UME	UME-EM-D3-2.23.6.a.b	E: 30 V/m (100 Hz, 1 kHz, 10 MHz, 100 MHz, 1 GHz, 9 GHz, 18 GHz) H: 3 A/m, 0.3 A/m (1 kHz, 400 kHz, 1 MHz, 10 MHz, 100 MHz, 1 GHz)	In progress	E_n	-
25.	Bilateral Comparison	EM/AC Power	UME	UME-EM-D3-2.22.6.a	Voltage: 60 V, 120 V Current: 1 A, 5 A PF: 0.25k, 0.25İ, 0.5k, 0.5i, 0.8k, 0.8i:, 1 Frequency: 53 Hz	In progress	E_n	-
26.	Bilateral Comparison	EM/High Current Ratio	UME	UME-EM-D3-2.22.6.b	I_P : 5 A, 10 A, 50 A, 100 A, 500 A, 1000 A I_S : 5 A Frequency: 60 Hz	In progress	E_n	-
27.	Bilateral Comparison	EM/High Voltage Ratio	UME	UME-EM-D3-2.22.6.c	V_P : 10/√3 kV, 34,5/√3 kV V_S : 100/√3 V Frequency: 60 Hz	In progress	E_n	-
28.	Bilateral Comparison	EM/High Voltage Ratio	UME	UME-EM-16-01	V_P : 10,5/√3 kV, 33/√3 kV V_S : 100/√3 V f: 50 Hz	Completed	E_n	Final Report
29.	Interlaboratory Comparison	EM/ DC voltage, DC current, AC voltage, AC current, Resistance	UME	UME-G1LV-15-01	DC Voltage: 50 mV, 200 mV, 20 V, 200 V, 1000 V DC Current: 200 µA, 200 mA, 1 A AC Voltage: 200 mV, 20 V, 750 V (45 Hz, 1 kHz, 100 kHz) AC Current: 100 µA, 200 mA, 1 A (45 Hz, 1 kHz, 10 kHz) Resistance: 1.9 Ω, 10 Ω, 10 kΩ, 10 MΩ	Completed	E_n	-

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Impedance Laboratory

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PATENT and OTHERS:

Power & Energy Laboratory

- Frequency adaptive harmonic current generator: National patent application in 2016. International patent application is in progress.
