

## **33<sup>rd</sup> meeting of the CCEM**

**8 – 9 March 2023**

### **Progress report**

### **CEM Electricity and Energy**

The activities of the Electricity and Energy are mainly directed to give fulfilment to the following fundamental points:

a) Establishment, maintenance, conservation, development and dissemination of the national standards of/for the measurement units corresponding to the electrical quantities in DC, LF and EMC. Therefore, the requirements established in the Mutual Recognition Arrangement are fulfilled in their entirety:

- Participation in international key comparisons.
- Declaration of the optimal Calibration and Measurement Capabilities, CMC.
- Implantation of a quality system in the laboratories of the Electricity Division.

b) Execution of research, development and technological innovation projects: National and EMPIR projects.

c) Search and optimisation of methods for the improvement of uncertainty values, the extension of the existing measurement ranges and the beginning of activities in new quantities.

The technical activities can be summarised as follows:

#### **DC Voltage**

Development of helium free cryostat for the PJVS operation

Development of fully automatic system for the calibration of high precision calibrators and multimeters.

Development of a system for electrical charge measurements.

Routine calibrations of Zener references and high accuracy voltmeters with the Josephson System.

Routine calibration of DC quantities

## **DC Resistance**

New services of calibration of resistance ratio bridges have been presented in the EURAMET.EM.16.2019 review process. They have been approved in 2022.

The laboratory is going to acquire a new liquid helium free Quantum Hall cryostat System to replace the more than 20 years old cryostat. This will improve research capabilities.

Calibration of standard resistors and reference groups is ongoing.

## **AC laboratory**

Routine calibration of customers thermal converters, calibrators, digital multimeters and ac/dc difference of resistors and ac dividers have been carried out.

As part of the DIG-AC project, CEM studied the effect of digitiser's instabilities with time, temperature, frequency, considering in particular the input impedance for the loading effect on dividers and shunts at higher frequencies as well as a digital counterpart of thermal-converter-based step up of shunts using a calibrated combination of shunt and quantum-traceable digitiser to obtain a complete set of shunts-digitisers calibrations up to the highest current.

## **Power and Energy**

The lab has acquired systems that reach a current up to 200 A. The automated calibration system RS703 has been modified to reach that current. A new three phase standard has been acquired with current range between 1 mA and 200 A.

The new automated high accuracy current transformer developed by NMIA has been integrated in the CEM sampling systems.

Besides, the CEM Measurement Assurance Program (MAP) continues in order to ensure the traceability of the electrical energy measurement in Spain. This program is based on a set from RADIANT travelling standards.

## **Impedance**

The laboratory continues with the activities leading to the impedance standards maintenance and dissemination and the reference capacitors have been calibrated at BIPM in 2022.

A new method to calibrate LCR meters over simulated impedances from 100 Hz to 20 kHz over the whole complex plane has been implemented.

## **Magnetism**

In 2022 a Magnetic Measurements Laboratory has been setting up for the realization of the unit of magnetic flux density by means of Helmholtz coils in the field range from 1 mT to 50 mT, and using a NMR magnetometer. To avoid influences of the earth's magnetic field, a triaxial coil was also implemented.

## **Electromagnetic compatibility**

The GTEM cell has been updated with a new RF generators and amplifier from 9 kHz to 3,2 GHz and from 60 W to 30 W.

A new isotropic E-field proof has been acquired.

A new system for electrostatic discharge immunity test has been implemented

Immunity test according to the IEC 61000-4, has been performed to several equipment for conformity evaluation.

## **New laboratories**

### **Electrical Vehicle Charging Stations**

Has been working in the development of a new laboratory for the metrology characterization of AC and DC Electrical Vehicle Charging stations

## **Frequency**

CEM has been working in the development of an optical clock based on Ca<sup>+</sup> ion trap

## **Comparisons**

CEM has participated in the Bilateral comparison of 1  $\Omega$  and 10 k  $\Omega$  standards (ongoing BIPM key comparisons BIPM.EM-K13) with good results.

CEM has participated in the EURAMET.EM-K5.2018. Waiting for draft A

## Participation in European projects (2021-2022)

17RPT03 DIG-AC: *A digital traceability chain for AC voltage and current*. This project focused on the development of metrological capacity for the transition from analogue to digital measurements for AC voltage and current to enable operation under dynamic conditions has successfully finished in May 2022.

19RPT01 Quantum Power: *Quantum traceability for AC power standards*.

The lab is participating in the QPOWER project. The overall objective of the project is to develop a quantum sampling standard for electrical power which provides direct traceability to the new quantum SI. New software has been developed within this project, it's being implemented into our systems. Also, a multiplexer has been constructed and proved.

20FUN03 COMET, *Two dimensional lattices of covalent- and metal-organic frameworks for the quantum Hall resistance standard*. The project, which will assess the potential of 2D organic- and metal-organic frameworks for realising the QHRS. CEM is dealing with the project coordination

21SCP02 TRaMM: *Traceability Routes for Magnetic*. This new project has started in September 2022 and the overall objective is to make traceable magnetic measurements more widely available in the EU, by disseminating the knowledge and expertise of an expert NMI to those NMIs with less developed capabilities that have market and stakeholder needs in this field.

## Publications

[1] “*A method for using Josephson voltage standards for direct characterization of high performance digitizers to establish AC voltage and current traceability to SP*”, J. Ireland, P. G. Reuvekamp, J. M. Williams, D. Peral, J. Díaz de Aguilar, Y. A. Sanmamed, M. Šira, S. Mašlán, W. Rządkiwicz, P. Bruszewski, G. Sadkowski, A. Sosso, V. Cabral, H. Malmbekk, A. Pokatilov, J. Herick, R. Behr, T. Coşkun Öztürk, M. Arifoviç, D. Ilić: *Measurement Science and Technology*, vol. 34, no. 1, 2022, 015003 (17 pp). <https://doi.org/10.1088/1361-6501/ac9542>

[2] “*Traceability routes for magnetic measurements*”, IMEKO-TC4 2022 International Congress.

[3] “*Feasibility of a digital counterpart of thermal-converter-based current step up*”, IMEKO-TC4 2022 International Congress.

[4] “*Validation of a digital current step-up traceable to quantum standards*”, Conference on Precision Electromagnetic Measurements CPEM 2022.

[5] “Aportación de la metrología a la movilidad eléctrica”, J. Díaz de Aguilar, AutoRevista N° 2.358 de Marzo 2021