

16 May 2012

1. General Aspects

For the TC-EM community, 2011 was marked by the end of the iMERA-Plus program (TC-EM was involved in seven research projects), a good progress of JRPs linked to “Energy” 2009 EMRP call and “Industry – I” 2010 EMRP call, lukewarm results for call 2011 despite the great efforts collectively spent to prepare the topics then the JRPs and by the start of preparation for the next phase EMPIR.

In parallel to this full and entire involvement for research activities, the TC-EM was well occupied with routine affairs for MRA (comparisons and CMC review). TC-EM continues its initiative towards simplified and more efficient MRA procedures and prepares new propositions to definitively convince the other RMOs at the time of the CPEM’12.

2. Projects

Detailed information about the EURAMET projects in the EM field are available from the EURAMET web-site and currently updated. An overview of the number of projects is given in the table below.

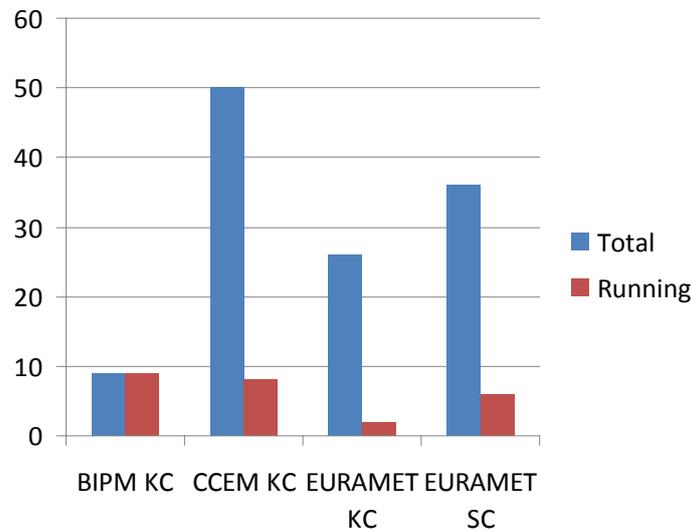
	Comparison	Consultation	Co-operation & research	Traceability	Total
On-going	15 (20)	0 (1)	3 (3)	11 (10)	29 (34)
Completed	81 (72)	59 (58)	45 (45)	2 (2)	187 (177)
Total	96 (92)	59 (59)	48 (48)	13 (12)	216 (211)

(Figures in brackets denote the numbers of the previous period)

Like the preceding years, the total number of projects continues to slightly increase (rate of 2%). A significant number of projects have been completed in 2011. As expected, there is no more consultation project and the number of the co-operation and research projects remains very low due to the shift towards joint research projects in the framework of the EMRP. Already pointed out in the previous report, the small number of traceability projects does not reflect the real situation in the EM field. The present form for this kind of project needs to be rethought, allowing a NMI to document especially the cases where it establishes traceability through the calibration of its equipment in another NMI.

3. Comparisons

During 2011, almost half of the key or supplementary comparisons have been completed in the EM field, leading now to 8 active comparisons (2 KCs, 6 SCs) compared to 14 for the previous period. The total number of EURAMET comparisons listed in the key comparison data base sums up to 26 (23) KCs and 36 (32) SCs (number in brackets: previous period). Besides this, EURAMET is or has been active in a large number of CCEM comparisons: 9 BIPM KCs, 48 CCEM KCs and 2 CCEM SCs. This situation is also illustrated in the following figure. The comparisons support a total of 3667 (3635) entries of EURAMET members, published in the KCDB in the EM field (to be compared with 6874 entries for all the RMOs in this field).



In order to improve the process for running comparison with the aim at shortening the duration (typically around 4 to 5 years but in some cases up to 11 years!) and increasing the number of labs capable to be pilots, the TC-EM has decided to implement some ideas right now:

- 1) Extend the role of the support group (sharing the tasks with the pilot, taking part in the data analysis, participating in the writing both of the protocol and the draft A);
- 2) Constitute a comparison toolbox (templates for management and calculation purposes, reference papers, summary description of most important analysis methods, ...) which will be available on the website. A task force within the TC is already working on it;
- 3) Create a group of experts will be asked for supporting the comparison pilots and the support group in the data analysis in the hard cases or for giving a neutral opinion if disagreement occurs from partner in the data analysis. This Expert group will be composed of the above-mentioned task force and statisticians from different NMIs. Some of them have already accepted to be member;
- 4) Ask pilot laboratories to provide the TC chair with a very short (few lines) perioding report each four months

In addition, the TC-EM contributes to the organization of the training workshop at CPEM'2012 (Sunday 1st July 2-4 pm) on the International Comparisons as agreed during the last WGLF&CCEM meeting in 2011. This workshop will deal with design, data analysis and reporting. 22 attendees (incl. speakers) are currently registered.

Besides, for some specific quantities such as Low Frequency power, the CCEM comparisons take too long to be repeated while much progress is being made in the corresponding area. The solution undertaken by EURAMET TC-EM is to push actively the organization of the CCEM comparison and to start the EURAMET comparison loop immediately after the start of the CCEM comparison.

4. CMCs

4.1 EURAMET EM CMCs

The set EURAMET.EM.7.2010 was published on 1 October 2011.

This set was started on 31 May 2010. 15 NMIs submitted in total 215 new entries (incl. 41 matrices) and 293 modified entries (incl. 54 matrices). In addition, for 395 entries (23 matrices) the

scope was reduced, the uncertainty was increased or editorial modifications were applied. 171 entries are announced for removal from the KCDB.

In November 2010, the entries were reviewed by the members of the working group on the analysis of CMCs and the entries which successfully passed the EURAMET review process were submitted on 6 December 2010 to the inter-RMO review for approval. 4 RMOs reviewed the set and this Inter-RMO review process was ended in August 2011 (nearly 9 months).

In September 2011: a last check was done from the KCDB manager prior to publication

As previously reported, the TC-EM has proposed a number of measures to improve the handling of the CMC entries, the form of the entries and the inter-RMO review process to the RMO working group (RMO-WG) of the CCEM. While most of the propositions were approved by the CCEM, an international agreement was not found on significantly reducing the amount of entries altogether. TC-EM will attempt to get this international agreement at the next meeting of the RMO-WG in July (during CPEM'12). If the proposal remains unsuccessful, the EURAMET TC-EM will proceed with cleaning up the tables (and put more entries in matrices) for the next round.

A new set EURAMET.EM.8.2011 has been prepared (during the period 17 October 2011 - 31 January 2012). 15 NMIs have submitted in total 195 new entries (incl. 83 matrices) and 125 improved entries (incl. 7 matrices). In addition, for 60 entries (10 matrices) the scope was reduced, the uncertainty was increased or editorial modifications were applied. 158 entries (incl. 5 matrices) are announced for removal from the KCDB. The Intra RMO review process is on-going and should be completed by the end of May 2012.

4.2 Inter-regional review of CMCs

The TCEM carried out the following inter-RMO reviews in 2011/12:

- *APMP.EM.7.2011*: This set is composed of 403 entries (not incl. editorial changes) and 30 matrices from 9 NMIs. For the first time a sharing of the review between RMOs has been decided: SIM and AFRIMET: cat 1,2, 3, 4 and 7, COOMET and EURAMET: the remaining. The TC-EM review of entries has started in September 2011 and has been completed on 9 December 2011.

- *SIM.EM.5.2011*: This set was posted for review 11 October 2011. Because this is limited to a very few number of new entries (7 new entries for cat 7 and 1 for cat 9), in agreement with the other RMOs, it has been decided that only APMP and EURAMET will proceed to its review. The TC-EM review has been completed on 21 December 2011.

5. Main highlights in the SC fields since June 2011

5.1 SC “DC and Quantum Metrology”

Convenor: J.T. Janssen, NPL

- The quantum metrological triangle has been closed at the uncertainty level of 1.7 parts in 10^6 at PTB by implementing an electron counting capacitance standard.
- The JRP “quantum ampere” from EMRP call 2011 has just started on 1st May 2012.
- The next SC meeting will be held during CPEM 2012 in Washington DC as a short satellite meeting.

5.2 SC “Low Frequency”

Convenor: J. Melcher;

Deputy Convenor: L. Callegaro, INRIM (special mandate until 31st December 2012)

- Significant progress have been made in digital sampling and synthesis techniques for the impedance metrology (digital current comparator ratio bridge at INRIM, LCR sampling bridge and Imped-

ance simulator for LCR bridge calibrations at METAS.

- MEMS electrostatic devices as ac voltage standards have been developed at LNE.
- Measurement of phase angle of current shunts with sampling methods has been carried out at INRIM.
- A task group has been formed to revise the whole document of cg 15 (calibration guideline of digital multimeters).
- A CCEM WG-LF meeting will be held at CPEM'12.

5.3 SC “Power and Energy”

Convenor: G. Rietveld, VSL

- Three cooperation projects have been launched with the aim at solving issues and exchange experiences. They concern the topics of sampling power (a cookbook proposed by SIQ), Wideband power and power quality.
- The question on splitting the subcommittee (*i.e* separate committee for high-voltage) was asked during the annual TC-EM meeting but this proposal was rejected.
- High voltage expert meeting with worldwide attendance has been held on 29-31 August 2011 in Hannover.
- 4th SC meeting has been held on 7 March 2012 at METAS, Bern

5.4 SC “Radio Frequencies and Microwave”

Convenor: M. Zeier, METAS

- Two JRPs from EMRP call 2010 - Industry have started on 1st June and 1st July 2011: EMINDA (Electromagnetic Characterization of Materials for Industrial Applications up to Microwave Frequencies) and ULTRAFast (Metrology for ultrafast electronics and high-speed communications).
- Within the SC, a revised version of the cg 12 (Calibration for Oscilloscopes) was completed and approved by the TC-EM.
- The next meeting of the SC will be planned for 2013.

6. Participation in the EMRP

The TC-EM community was involved in the elaboration of proposal for the following selected research topics in the three fields of 2011 EMRP call: New Technologies, Health, and SI Broader scope (out of 50):

SI Broader scope:

- SRT s01: A quantum standard for sampled electrical measurements
- SRT s02: Quantum ampere: Realization of the new SI ampere
- SRT s03: Automated impedance metrology extending the quantum toolbox for electricity
- SRT s06: Realization of the awaited definition of the kilogram - resolving the discrepancies

New technologies:

- SRT n04: Graphene metrology
- SRT n07: Metrology with/for NEMS
- SRT n08: Metrology for spintronic circuits and devices
- SRT n015: Microwave and terahertz metrology for homeland security

Health:

- SRT h016: Diagnostic and therapy using magnetic nanoparticles

Most of these selected topics came from the proposed topics discussed during the dedicated workshop, which was held on 10 January 2011 at LNE in Paris. Four of the nine proposals were selected for funding (s02, s06, n07, n015).

With the same goal to coordinate the preparation of PRTs for the 2012 EMRP call within the TC-EM community as much as possible, a PRT preparation workshop was held on 17-18 January 2011 at METAS in Paris. 35 delegates from 13 NMIs attended the workshop and 12 potential PRTs were defined and drafted (4 in “metrology for Industry – II”, 5 in “SI broader scope – II” and 3 in “Open excellence call”).

7. Preparation for the next phase “EMPIR”

The TC-EM is being to elaborate five scientific-technical roadmaps to the future "EMPIR". Based on some discussions within the Working Group Strategic Planning (WGSP) of the TC-EM and within the subcommittees who have the responsibility to prepare these roadmaps, it has been decided to deal with the following topics (listed in table below) in link to the three pillars (great challenges, innovation and science). A link to the module “Capacity Building” is also suggested for one of the topics:

Pillar	Topic	Responsible SC
Great Challenges	Power and Energy in an era of emerging smart grids	P&E
Innovation + Capacity Building	Innovative calibration means in electricity/magnetism	DCQM and LF
Innovation	Metrology for future applications of complex RF to THz systems	RF&MW
Science	Foundations of the SI, fundamental tests and quantum measurements	DCQM
	Nanoelectronics and nanomagnetism	DCQM

The roadmaps have been prepared in the frame of three meetings:

- DCQM&LF roadmap meeting held on 18-19 January in Bern (following the PRT preparation workshop, with almost the same participants);
- P&E roadmap meeting held on 8 March in Bern (following the Smart Grid JRP meeting);
- RF&MW roadmap meeting held on 19-20 March in Berlin.

Some "interdisciplinary" areas, which could be the subject of roadmap, have also been identified within TC-EM. They concern the nanometrology, the THz metrology and the material properties. Following the last TC-IM meeting, TCEM chair was asked for collecting the possible subjects linked to THz from the other TCs. Following the received answers, it seems that this topic will be only pointed out by TC-EM.

Below are given the key features (triggers and targets) of the five proposed roadmaps. They all have been drawn up for the period 2012-2024 and are now completed. Explanatory notes have been drafted for three of them.

7.1 Power and Energy in an era of emerging smart grids

Three triggers:

- Make our energy supply and use sustainable – economically, environmentally and socially;
- Ensure continuity and quality of electricity supply in an era where electrical grids, the backbone of our society, are evolving into Smart Grids;
- Scarcity of resources demand energy saving and efficient supply, transport, and utilisation.

Four targets (given in a chronological order):

- Network Power Quality tools;
- In-situ and complex power measurement;
- Energy saving and efficiency;
- Improved tools for grid monitoring and control.

7.2 Innovative calibration means in electricity/magnetism

A single trigger:

- Need for improved production and support to emerging technologies through intrinsically referenced, “best practice” electrical measurements.

Three targets (given in a chronological order):

- Improved and extended scales of electrical units;
- Simplified “fit-for-purpose” calibration tools and procedures;
- Quantum calibration systems for industrial use.

7.3 Metrology for future applications of complex RF to THz systems

Four triggers:

- New and improved technologies for health care, security, traffic management, environmental monitoring, advanced industrial production and quality testing;
- Demand for unlimited information at any time and at any place;
- Improving the quality of life;
- Enhancing the competitiveness of the European industry.

Three targets (given in a chronological order):

- Improved and extended scales of units for RF quantities;
- Multi-parameter characterisation of RF systems;
- Metrology for large-scale fully-automated complex RF systems.

7.4 Foundations of the SI, fundamental tests and quantum measurements

Two triggers:

- Development of future quantum technologies and exploitation of fundamental science requires new (quantum based) metrology;
- New science will create new opportunities for metrology.

Four targets (given in a chronological order):

- Practical realization of the new definition of the SI units according to the CIPM recommendations;
- Fundamental consistency tests in electrical quantum metrology and determination of fundamental constants;
- Metrology for solid-state quantum engineering;
- Quantum enhanced electrical SI standards.

7.5 Nanoelectronics and nanomagnetics

A single trigger:

- Metrology at the nanoscale is required by industry and society to enable down scaling of electronics for advanced ICT and nano bio applications for health and environment.

Three targets (given in a chronological order):

- Characterization tools for today's electronics and sensors;
- Characterization tools for beyond CMOS technology;
- Characterization tools on single molecule / single atom level.

8. Meetings

The annual meeting of the TC-EM was held in Istanbul on 13 and 14 October 2011. The meeting was hosted by TÜBİTAK - UME. 25 delegates representing 24 EURAMET members attended it. The main topics of the agenda were:

- Reports on new developments within EURAMET, the BIPM electricity section, the activities of the four TC-EM subfields and news from the CCEM and JCRB
- Review of ongoing and new projects related to research, consultation and comparison
- Discussion on possible improvements in the MRA processes (comparisons and CMC review)
- Three technical talks from UME scientists:
 - "A method for characterization of 4TP capacitors up to 30 MHz" by Turgay Özkan,
 - "Microwave field measurements based on double radio optical resonance", by Mustafa Çetintaş.
 - "Magneto-optic technique for traceable local magnetic field measurements", by Lev Dorosinskii.
- News from NMIs in form of a poster session.
- EMRP (update projects call 2009 on Energy, new developments, next EMRP call 2012, EMRP feedback) and Preparation for the next phase "EMPIR Outlook for 2012"

8.1 Special activities

- Preparation of PRTs for the TPs “SI broader scope - II”, “Metrology for Industry – II”, and “Open excellence call” in the framework of the Art.169-EMRP.
- Preparation of 5 to 6 roadmaps to the future EMPIR

8.2 Meetings

- TC-EM: 11 to 12 October 2012, Bratislava, hosted by SMU, Slovak Republic, Working group on strategic planning: 10 October 2012, Bratislava.
- CPEM'2012, 1 to 6 July 2012, Washington DC and satellite meetings

Trappes, 16 May 2012

François Piquemal
Technical Committee Chairman
for Electricity and Magnetism