



Report on Electromagnetic Metrology Activities at JV, Norway Prepared for the 29th Meeting of the CCEM, 12-13 March 2015

Staff

Dr. Helge Malmbekk – ACI/ACV

Mr. Kåre Lind, working a few days a week after formal retirement - ACI/ACV

Mr. Frank Sengebusch – DCV, Josephson

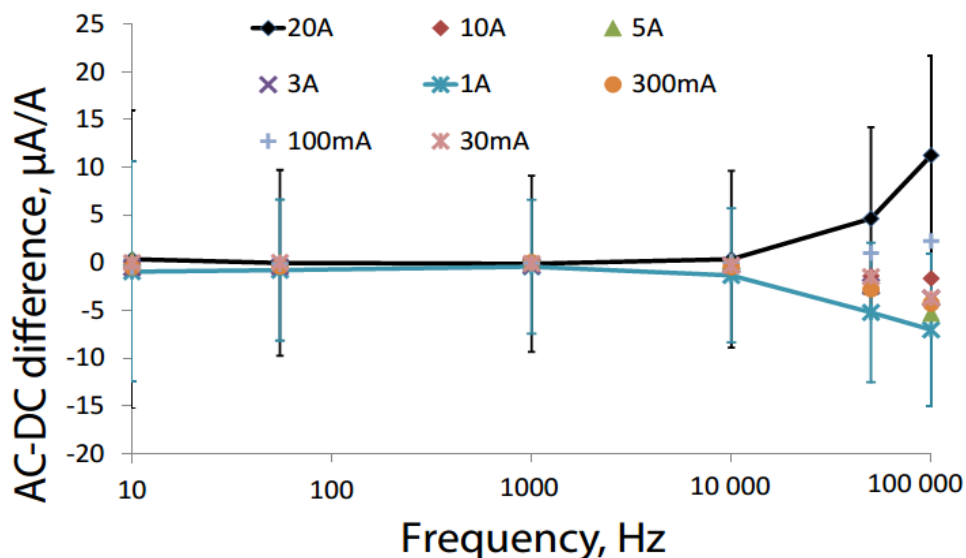
Mr. Tore Sørdsdal – Resistance, QHR

Mr. Kristian Ellingsberg – Power and Energy

Mr. Bjørnar Karlsen – Started Phd-program in December 2014.

ACI/ACV

- The last years, we have extensively tested our self-designed high precision AC/DC current shunts, with excellent results. A production line has been established with a Norwegian company, which assemble the shunts for us. The reproducibility has been shown to be very good, and the figure below shows results from a typical set of shunts. The AC-DC difference has been shown to be within ± 10 ppm up to 100 kHz.
- Participation in the ongoing EURAMET.EM-K12 was reported in May 2014. A bilateral comparison with PTB ([EURAMET.EM-S39](#)), on a complete set of our current shunts, was also conducted in 2013/2014, and piloted by JV.



Measurements of a complete set. The uncertainty bars are based on calculated uncertainties.

- We are currently part of the EMRP Q-Wave project for development of an AC Josephson setup with voltages up to MHz frequencies. Our part of the project is to choose and characterize photodiodes for delivering current to the Josephson arrays.
 - As part of this project, we are developing a robust mounting system for fibre optic coupling between the photo diode and the laser source.
- In the 2014 call for the EMPIR program, we were part of the approved project ACQ-PRO, which is a research potential project on AC Josephson standards, where Dr. Helge Malmbekk will spend some time at NPL in the start of 2016 together with other participants in the project. The projects aim, is to spread the knowledge of, and research on, AC Josephson systems across the EURAMET-region.
- In December 2014, Mr. Bjørnar Karlsen started his PhD at JV, where he will be working on modelling and designing of resistive voltage dividers, and the building of an AC Josephson system.
- A collaboration with Buskerud and Vestfold University College (HBV) was established during the Q-Wave project, and a joint supervision of two PhD candidates are now under way.

DC

- A Zener comparison with BIPM, was conducted in the first months of 2015 (BIPM.EM-K11), from which we are awaiting the results. A possible on-site DC-Josephson comparison with BIPM (BIPM.EM-K10) has been planned for the second part of 2015.
- Our QHR setup was run in 2012/2013, after some years of problems with the setup, and new measurements are being planned for the spring of 2015. Problems with an aging CCC has led to some difficulties, so plans for a future replacement of the CCC is under way.

Power & Energy

- We have developed a continuous Sampling Watt Meter, which has been tested and verified for operation in some calibration services. Development of the system is still on-going and various operation modes are explored.
- We are planning to participate in the coming EURAMET.EM-K5 comparison.

Personnel change

- Dr. Helge Malmbekk was hired in December 2012, as Mr. André Evenstad left Justervesenet in January 2013. Dr. Helge Malmbekk was appointed as contact person for TC-EM.
- Mr. Kåre Lind retired in the fall of 2013, but will continue as a senior consultant a few days a week.
- Mr. Bjørnar Karlsen was hired in January 2014.

Publications

- Kristian Ellingsberg: "System for in-circuit current measurement, the JV-actie Shunt", p254-255, Conference Digest CPEM2014, IEEE: CFP14PEM-PRT, ISBN:978-1-4799-5205-2.
- Jarle Gran, Helge Malmbekk, and Kåre Lind: "Photodiodes as current source in high-frequency low temperature applicatins", CPEM 2014, Rio de Janeiro, 25. – 29.08.2014, poster.

- Jane Ireland, Dale Henderson, Jonathan Williams, Oliver Kieler, Johannes Kohlmann, Ralf Behr, Jarle Gran, Helge Malmbekk, Kåre Lind and Chi Kwong Tang: "An opto-electronic coupling for pulse driven Josephson junction arrays", CPEM 2014, Rio de Janeiro, 25. – 29.08.2014, poster.
- J. Kohlmann, R. Behr, O. Kieler, J. Diaz De Aguilar Rois, M. Šíra, A. Sosso, B. Trinchera, J. Gran, H. Malmbekk, B. Jeanneret, F. Overney, J. Nissila, T. Lehtonen, J. Ireland, J. Williams, R. Lapuh, B. Voljc, T. Bergsten, G. Eklund, T. Coskun Öztürk, E. Houtzager, H.E. van den Brom, P. Øhlckers: "A quantum standard for sampled electrical measurements – main goals and first results of the EMRP project Q-WAVE", CPEM 2014, Rio de Janeiro, 25. – 29.08.2014. poster.
- Kristian Ellingsberg: "Predictable maximum RMS-error for windowed RMS (RMWS)." Precision Electromagnetic Measurements (CPEM), 2012 Conference on. IEEE, 2012.
- Jarle Gran and Kåre Lind. "An optically-powered current source operating under cryogenic conditions." Precision Electromagnetic Measurements (CPEM), 2012 Conference on. IEEE, 2012.