Seminar by IEEE Ottawa Educational Activities, Instrumentation & Measurement Chapter, PES, RS Chapters, and EPMG of INMS/NRC

The IEEE Ottawa Section is inviting all interested IEEE members and nonmembers to a seminar on

DC and AC Programmable Josephson Voltage Standards: applications, achievements and limitations

by

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DATE: Tuesday, October 21, 2008.
TIME: 11:00 a.m. – 12:00 p.m.
PLACE: National Research Council, 1200 Montreal Road, Ottawa, Building M-36, Kelvin Room.
PARKING: No fee at the visitor's parking. Please respect restricted areas.

Abstract This presentation reviews the status of voltage metrology based on Programmable Josephson Voltage Standards (PJVS). PJVS systems consist of sub-arrays of Josephson junctions connected in series. Each sub-array is current biased independently to produce the desired (programmable) voltage. Compared to the conventional Josephson systems, PJVS systems use superconductor – normal metal – superconductor junctions having no hysteretic behavior. With larger current operating margins, PJVS are ideal for applications other than the calibration of secondary voltage standards. Due to their providing voltage reference with quantum accuracy, PJVS systems are key components of the Watt–balance experiments, aiming at redefining kilogram in terms of electrical units.

The PJVS program started in the mid 90s at NIST. In 1998, the first 1 V PJVS systems were used in metrology labs. Since then, PJVS systems have followed many stages of technical improvements, in particular in the field of the fabrication with new barrier materials and the introduction of vertical junction stacks. Design improvements of junctions and on-chip microwave components enable an increase of the number of junctions for each array and therefore providing higher voltages. New results show PJVS systems reaching ultimately 10 V.

Using current bias electronics, PJVS systems produce stepwise-approximated AC waveforms such that the voltage on each step has the quantum accuracy of the Josephson effect. Unfortunately for this technique, the nonzero rise time of the bias electronics and other timing effects influence step transitions so that the AC PJVS-synthesized waveforms do not yield quantum-accurate rms voltages. Nevertheless, the quantum-accuracy of the waveform steps can be exploited by use of differential sampling techniques, since the samples containing transients can be discarded. This technique is particularly interesting for the low-frequency electrical power calibrations. Currently, new PJVS-based electrical power standards are under development in North-America (at NIST in Gaithersburg, MD, and at NRC in Ottawa, ON).

Alain Rüfenacht received his B.Sc. Degree in Physics from the Université de Neuchâtel, Switzerland, in 1998. In 1999, he worked as a scientific collaborator at the Swiss Federal Office of Metrology (METAS) in the Electrical Quantum Standards Laboratory. In 2005, he obtained his Ph.D. Degree from the Université de Neuchâtel for his work on high temperature superconducting ultra-thin films, done in collaboration with IBM Zurich Research Laboratory. Since 2007, he has been a guest researcher in the Quantum Voltage Laboratory at the National Institute of Standards and Technology in Boulder, Colorado, focusing mainly on the integration of Josephson junction arrays into primary voltage standards.

Admission: Free. Registration required.
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