SUPERCONDUCTING ELECTRONICS : FROM QUANTUM-ACCURATE SENSORS TO SUPERCOMPUTING

Pascal Febvre

Université Savoie Mont Blanc, IMEP-LAHC, CNRS UMR5130, 73376 Le Bourget du Lac, France
e-mail: pascal.febvre@univ-smb.fr

Superconducting electronics, either based on low- or high-T_c materials, has provided many advances in several fields since its infancy in the early 1970s, with the main non-linear element being the Josephson junction. The explanation of the associated Josephson dc and ac effects, followed by the invention of the Superconducting Quantum Interference Device (SQUID), has placed superconducting electronics as a compulsory technology when ultimate quantum accuracy is required, either to measure faint magnetic fields in medicine, geophysics, non-destructive evaluation, or to acquire faint electromagnetic signals, especially helpful in the astronomy field, in a wide spectrum ranging from radiofrequencies to X-rays. As a result, superconducting electronics is today a technology that satisfies the most stringent quality standards, being installed in hospitals or aboard satellites.

Today, superconducting electronics is a mature technology whose fabrication processes reach industry standards and allow to fabricate circuits with tens to hundreds of Josephson junctions. Such developments are made possible by ambitious programmes, including in particular the development of superconducting supercomputing machines. On the other hand, Josephson devices are also a key element to fabricate superconducting qubits used for future quantum computing systems.

In this talk, I will present an overview of the state-of-the-art concerning Josephson-based circuits, either for magnetometry, the detection of THz signals and when operated in digital mode to process signals at high frequency with very high energy-efficiency. The last achievements and the challenges for the next decade will also be described, in particular in the frame of European activities.