Development of HEB mixers for GREAT and for security screening

A. Semenov, H. Richter, A. Smirnov, B. Günther, H.-W. Hübers
German Aerospace Center (DLR)
Rutherfordstrasse 2, 12489 Berlin, Germany

K. Il'in and M. Siegel
Institute of Micro- and Nanoelectronic Systems
University of Karlsruhe
Hertzstrasse 16, 76187 Karlsruhe, Germany

G. Gol'tsman
Physics department, Moscow State Pedagogical University,
M. Pirogovskaya 29, 119435 Moscow, Russia

V. Drakinskiy and H. Merkel
Department of Microtechnology and Nanoscience, Chalmers University of Technology
Fysikgrand 3, SE-41296, Gothenburg, Sweden

J. Karamarkovic
Faculty of Civil Engineering and Architecture, University of Nis
Aleksandra Medvedeva 14, 18000 Nis, Serbia

We report the study on the quasioptical coupling efficiency and the gain bandwidth of NbN hot-electron bolometer mixers developed for the 4.7 THz channel of the German receiver for Astronomy at THz-frequencies (GREAT) and for security screening at subterahertz frequencies. Radiation coupling efficiency and directive properties of integrated lens antennas with log-spiral, log-periodic and double-slot planar feeds coupled to a hot-electron bolometer were experimentally studied at frequencies from 1 THz to 6 THz and compared with simulations based on the method of moments and the physical-optics ray tracing. For all studied antennas the modeled spectral dependence of the coupling efficiency fits to the experimental data obtained with both Fourier transform spectroscopy and noise temperature measurements only if the complex impedance of the bolometer is explicitly taken into account. Our experimental data did not indicate any noticeable contribution of the quantum noise to the system noise temperature. The experimentally observed deviation of the beam pattern from the model prediction increases with frequency and is most likely due to a non-ideality of the presently used lenses. Study of the intermediate frequency mixer gain at local oscillator (LO) frequencies between 2.5 THz and 0.3 THz showed an increase of the gain bandwidth at low LO frequencies that was understood as the contribution of the direct interaction of magnetic vortices with the radiation field. We have found that the non-homogeneous hot-spot model more adequately describes variation of the intermediate frequency bandwidth with the applied local oscillator power than any of uniform mixer models. The state-of-the-day performance of the GREAT 4.7-THz channel and the 0.8-THz security scanner will be presented.