# Single electron interferometric sensing of quantum electromagnetic noise

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The on-chip sensing of electromagnetic fields on very short time scales is a notoriously difficult challenge. On chip systems such as rf-SETs, QPC, rf-SQUIDS or quantum dots have a bandwidth in the tens of MHz. On the other hand, the development of solid state quantum technologies in the microwave to THz range calls for the development of sub-nanosecond time resolved sensors of the electromagnetic field.

In this presentation, we discuss how recent progress in the generation and characterization of single electron wave packets in quantum conductors [1,2,3] can help us reach such short time scales. We will show how single electron interferometers be used as a time resolved sensors of the quantum noise of an electromagnetic field with a few tens of pico-second time resolution [3]. As an example, we will explain how a single electron wave packet can be used to detect sub vacuum fluctuations (squeezing) of microwave radiation as well as to map the energy profile of a single microwave photon in the time domain [4].

References

1. R. Bisognin *et al*, Nature Communications **10**, 3379 (2019).
2. C. Bauerle *et al*, Reports on Progress in Physics, **81**, 056603 (2018).
3. V. Kashchaeyvevs, P. Degiovanni, B. Roussel, M. Kataoka, J.D. Fletcher, L. Freise, N. Ubbelohde, G. Fève, H. Bartolomei, F. Couëdo, A. Kakykov, W. Poirier, P. Roulleau, F.D. Parmentier, and F. Hohls, *Single electron wave packets for quantum metrology, concepts, implementations and applications*, Technical Report of the EMPIR project SEQUOIA (17FUN04).
4. H. Souquet-Basiège *et al*, *Quantum sensing of time dependent electromagnetic fields with single electron excitations* (in preparation).

Figures

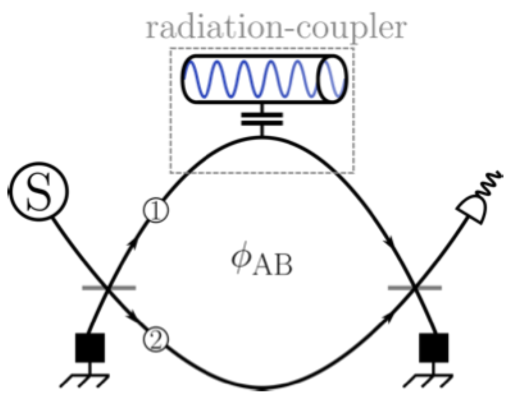


**Figure 1:** Scheme of principle for sensing electromagnetic fields with single electrons: an electronic Mach-Zehnder interferometer is fed by a single electron source S. The interference pattern is then sensitive to the external radiation interacting with one branch of the interferometer via capacitive coupling within the radiation coupler. The quantum noise of the radiation then alters@ the interference pattern