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Equivalence of Optical and Electrical Noise Equivalent Power of Hybrid NbTiN-Al Microwave Kinetic Inductance Detectors

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Lens-antenna coupled hybrid NbTiN-Al Microwave Kinetic Inductance Detectors (MKIDs) have shown photon noise limited performance in both phase and amplitude read-out down to 100 fW of optical loading as well as a high optical efficiency [1]. This makes them a very promising candidate as detector for sub-mm camera's and spectrometers developed in the next decade. For large array development electrical and thermal tests are preferred as initial tests over a full optical evaluation, which requires a time-consuming measurement and a dedicated setup with a controlled illumination source. We have measured and compared the response of hybrid NbTiN-Al Microwave Kinetic Inductance Detectors (MKIDs) to changes in bath temperature and illumination by sub-mm radiation. We show that [2]:

thermal and optical excitations have an equivalent effect on the resonance feature of hybrid MKIDs.

the electrical NEP, which is determined from the temperature responsivity, quasiparticle recombination time, superconducting transition temperature and noise spectrum, is within a factor of two of the optical NEP, which is measured directly using sub-millimeter radiation.We attribute this to the unique geometry of the hybrid NbTiN-Al MKIDs, which integrate a 1 mm long

Al absorber in a NbTiN resonator. The 1 mm Al section is long enough to absorb the incoming radiation, but is shorter than the quasiparticle diffusion length. In addition, the

electric field is roughly constant over this section of the MKID. As a result the weighted spatial average of the complex conductivity measured by hybrid MKIDs is the same for thermal and optical excitation. In different MKID embodiments the equivalence between optical and electrical response is not a priori justified.

[1] Janssen et al., Applied Physics Letters 103, 203503 (2013)
[2] Janssen et al., Applied Physics Letters 105, 193504 (2014)