Characterizing horn-coupled, aluminum lumped-element kinetic inductance detectors using coherent and incoherent illumination from a millimeter-wave source

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We report on the characterization of horn-coupled, aluminum lumped-element kinetic inductance detectors using a millimeter-wave source, which uses an active multiplier chain to produce radiation in a band between 140 and 160 GHz. The multiplier chain can be fed with either amplified thermal Johnson noise or with a continuous-wave tone from

a microwave signal generator. We characterize the detector response across a 60 dB range of incident power, and compare it to theoretical predictions. We describe the fluctuations in the detector output using noise equivalent power (NEP). At the lowest source power levels the NEP is limited by some combination of background photon noise and detector noise, and at higher source power levels the NEP is dominated by photon noise alone. We observe the expected relationships between source power and photon noise under both thermal and continuous-wave illumination. We use the photon shot noise level in continuous-wave mode, along with a simultaneous measurement of the power emitted by the source, to perform an absolute calibration of the absorbed power. We extract the quasiparticle lifetime from the time-domain response to pulsed millimeter-wave illumination.