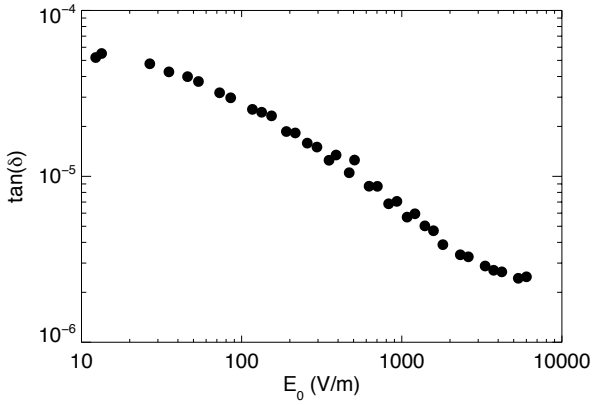

FIG. 3: The loss tangent of the a-Si:H dielectric, $\tan(\delta)$, dramatically decreases as the electric field in the resonator increases. The electric field E_0 shown is the value at the open ends of the half wave resonator tested. This resonator is 3985 μm long, with $Q_m = 35500$ and a resonant frequency of 9.054 GHz when operated under an optimal magnetic field of 30 mG. It shows a fractional frequency noise [17] of 4.1×10^{-18} Hz^{-1} at a readout power of -91 dBm (equivalent to a current density of 17.5 A/m).

parallel plate capacitor approximation for the capacitance per unit length, $C = \epsilon_0\epsilon_r w/d$.

Since resonators used as detectors will nearly always be operated at the highest readout power possible before non-linear effects set in, the right side of the plot with loss tangents below 2×10^{-6} are the most relevant for MKIDs. The flattening of the loss tangent towards the right side of the plot is due to the high readout power generating quasiparticles in the resonator.

The sensitivity of the MKID can be calculated by first taking noise spectra on resonance in both the phase (S_θ) and dissipation (S_D) direction at a readout power just below the level where the MKID becomes nonlinear. The dimensionless phase or dissipation shift per quasiparticle referenced to the center of the resonance loop, $\partial\theta/\partial N_{qp}$ and $\partial D/\partial N_{qp}$, can be computed by taking a temperature sweep of the resonance loop and converting the temperature to an effective number of quasiparticles in the resonator center strip, $N_{qp} = 2N_0V\sqrt{2\pi k_BT\Delta_0}e^{-\Delta_0/k_BT}$. Performing this operation on the resonator measured in Figure 3 leads to $\partial\theta/\partial N_{qp} = 8.2\times10^{-7}$ and $\partial D/\partial N_{qp} = 3.8\times10^{-7}$ radians per quasiparticle. Equation 4 predicts $\partial\theta/\partial N_{qp} = 4.9\times10^{-7}$ and $\partial D/\partial N_{qp} = 1.3\times10^{-7}$. The match between the predicted and measured responsivities is reasonably good, showing that the derived