Inductor Noise Study in Kinetic Inductance Detectors Made of TiN

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Collaborations on BLAST
Feedhorn-coupled TiN MKID for BLAST

- TiN/Ti/TiN trilayer films ($T_c \sim 1.4$ K, $L_k \sim 100$ pF/sq)
- IDC ~ 0.8 mm*0.8 mm finger/gap width ~ 5 μm
  Inductor width ~ 10 μm

Photon-noise limited sensitivity in TiN MKID
J. Hubmayr et al., APL 106, 073505 (2015)

In this work, we studied low-frequency dark noise of devices with different geometries.

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Photon absorber area

~ 800 μm

17 pW loading @ 1.2 THz

$S_{\delta f/f}$ [1/Hz]

$f$ [Hz]
Readout

- Synthesizer
- Splitter
- Resonator (50 mK)
- SiGe LNA (3 K)
- Amplifier (300 K)
- Mixer
- A/D
- homodyne readout

Resonance loop in IQ plane

- Dissipation
- Frequency
Noise features

Noise:
- No power dependence
- Little temperature dependence
- Independent of IDC area and finger/gap width (5 μm, 3.5 μm)

⇒ The noise is NOT from conventional TLS or IDC!
Noise decreases with inductor width

Inductor width ($w$):
1 $\mu$m $\sim$ 30 $\mu$m, length ($l$)
($l/w$ fixed so the total inductance unchanged)

$S_{\delta f/f} \sim \frac{a}{w^2} + b$

$f_0 \sim 1.0$ GHz, $Q_i \sim 200k$, $Q_c \sim 20k$
Noise is independent of inductor Length

In each group the inductor lengths vary by factors of 1, 2 and 4

\[ w = [5, 10, 20] \mu m, \quad l = [1, 2, 4]*l_0 \]

\[ f_0 \sim 0.6 \text{ GHz} - 1.4 \text{ GHz}, \quad T_{bath} = 100 \text{ mK} \]
Summary

We studied the dark noise of MKIDs (made from TiN trilayer) for BLAST and observed the following noise features:

- No power dependence, little temperature dependence
- Independent of IDC area and finger/gap size (5 μm, 3.5 μm)
- Noise decreases with inductor width (~ 1/w^2?)
- Independent of the inductor length
- Noise is from the inductor, not from IDC or TLS!

(See poster: G1.21)

Noise mechanisms?

- Conventional TLS
- Stray light