National Aeronautics and Space Administration

FY24 Strategic Initiatives Research and Technology Development (SRTD)

# Thermal Kinetic Inductance Detectors for far-IR Astrophysics

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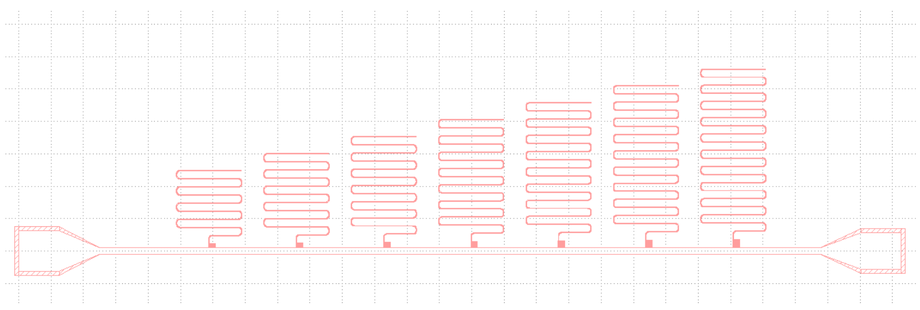
**Strategic Focus Area:** Long-Wavelength Detectors **| Strategic Initiative Leader:** Charles Lawrence

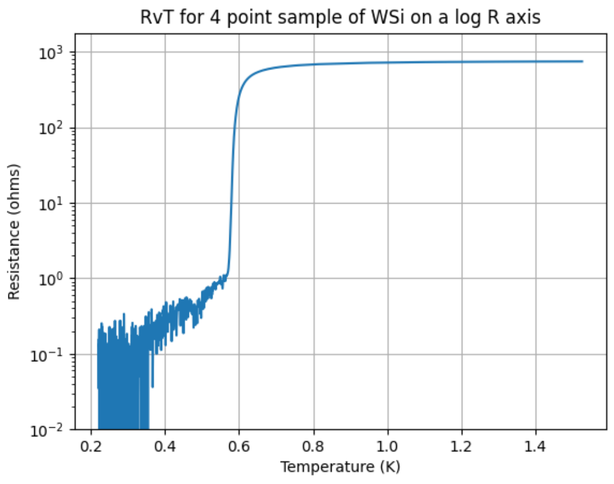
**Objectives**: Our objective has shifted from far-IR applications to developing TKIDs with the sensitivity required for spaced based CMB observatories. We sought to develop high resistivity films with low transition temperatures for our inductors, bolometer designs with low thermal conductance, and control of internal non-fundamental noise levels.

**Background**: CMB measurements require background limited performance with millimeter wave powers of roughly 0.1pW. The state-of-the-art detectors are TES bolometers, which provide the required sensitivity, but with readout complexity that generates significant risk to these missions. TKIDs are bolometers with the inductor of a high Q resonator used as the thermal sensor: they retain the noise properties of bolometers but with simplified KID readout. We previously developed TKIDs for a ground-based technology demonstration, while this project seeks to adjust them for use in space.

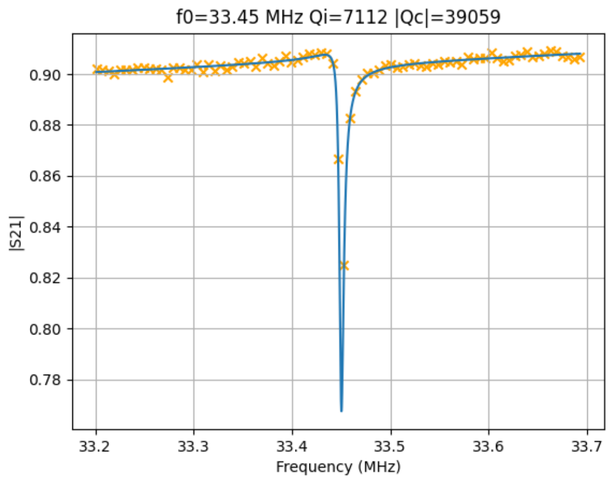
**Approach and Results**: We need to reduce the Tc of our inductors and increase the resistivity to operate background limited. We have focused our attention on Tungsten Silicide (WSi) because it can meet these requirements because of the extensive in-house experience with this material for us in SNSPDs. We co-sputter WSi allows with pure Si films to customize the resulting film stoichiometry. We designed a single film resonator chip to study the Wsi film properties. Finally, we cooled the chip to sub-kelvin temperatures and conducted measurements of transition temperature, normal state resistivity, and resonator Q. Figures below show our first attempt with $T_c$~0.6K, $R_\square$~50Ω, and $Q_i$~7000. Adjusting the transition higher will very likely boost the $Q_i$. Our funds were suspended in January of 2024, but we look forward to resuming work on this project in FY25.



Test chip Layout




Resistance vs Temperature




Sample Resonance

**Significance/Benefits to JPL and NASA:**

Spaced based CMB remains a priority for NASA, with detectors ranked Tier 2 in the technology gap list., and this project speaks to those needs. JPL seeks to maintain their leading position in this area., and progress here also helps maintain that role. These efforts have resulting in our team winning an APRA to pursue some of the tasks that were previously funded by this RTD.

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