

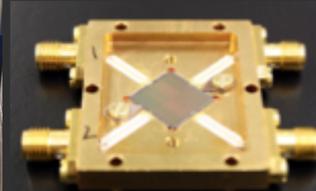
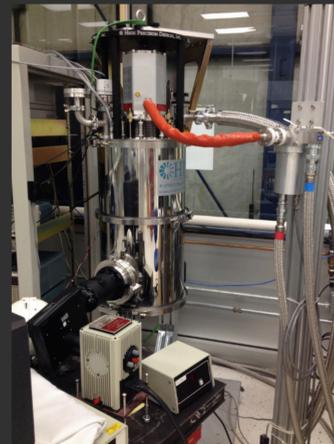
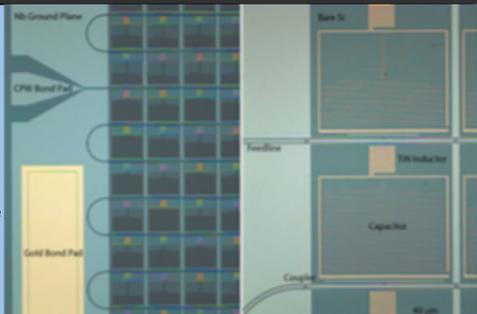
Microwave Kinetic Inductance Detectors

Nina Mazzarelli, CCI Program

Microwave kinetic inductance detectors (MKIDs) are cryogenic photon detectors used for astronomical observation. Introduced by Drs. Rick LeDuc and Jonas Zmuidzinas at the California Institute of Technology and the NASA Jet Propulsion Laboratory, MKID technology provides a break from semiconductor-based detector field, where advancements are quickly plateauing. MKIDs use microwave frequencies to measure the change in surface impedance of a superconductor. They operate at temperatures near 100 mK, thereby decreasing sources of thermal noise. In order to more completely understand the functionality of the device, it was necessary to test the response and resolution of individual pixel detectors, as well as investigate causes of pixel failure. Tests were run using monochromatic 400 nm light, and the output frequency data were analyzed and interpreted. MKID detector technology allows for multiplexing and has the capacity to be scaled economically. The ultimate goal of the project is to improve the consistency and precision of this device so that it may be widely employed as a means of astronomical observation.

Advantages of MKIDs:

- Reduced thermal noise
- No dark current
- Precise time resolution:
Measures photon arrival times to μs
- Multiplexing
Allows MKIDs to be economically scaled to a large array of pixels
- Electron gap = meV
One photon breaks thousands of Cooper pairs.

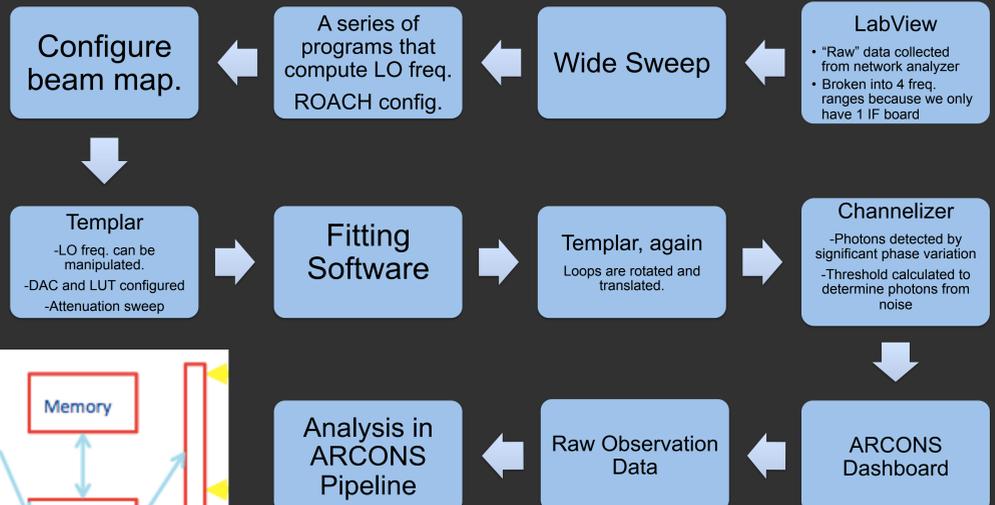
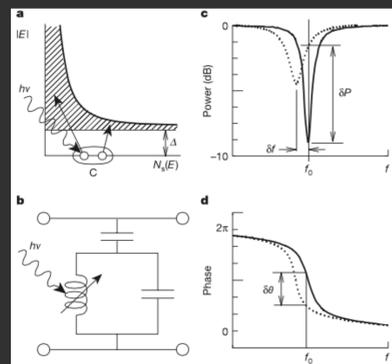


Disadvantages of Current Detection Methods

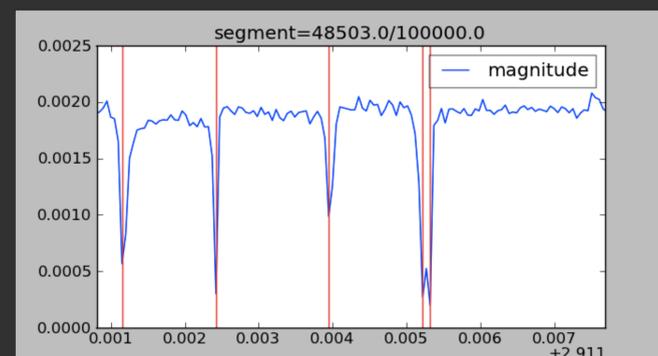
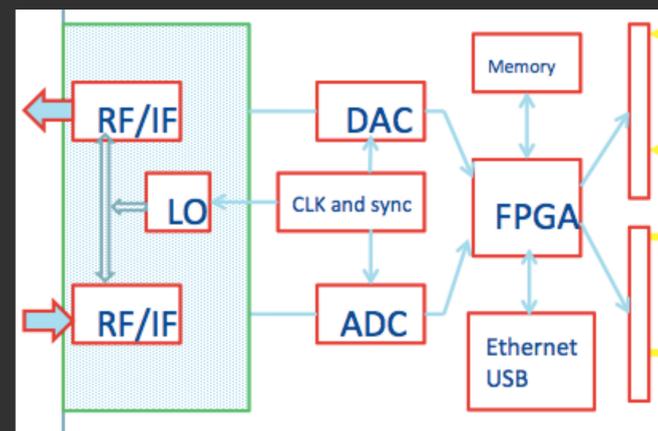
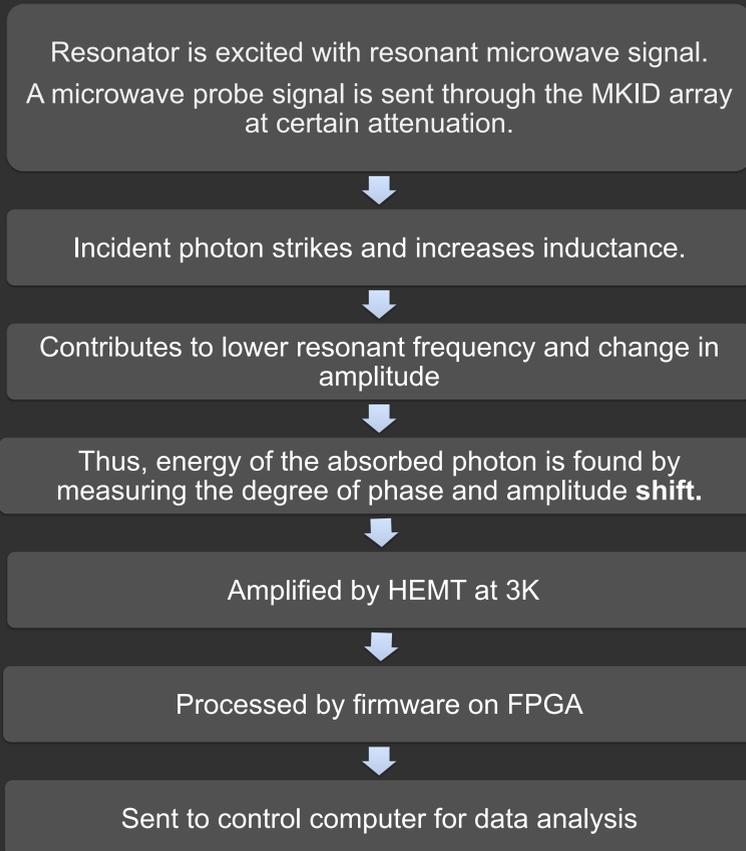
Spectroscopy and CCDs:

- CCDs are not capable of determining time and energy of incident photons.
- Filters are required to create full images, which is inefficient.
- They only produce 2D images.
- Spectrographs break up light detected by CCDs.

MKIDs work on the principle of the kinetic inductance effect, or the principle that super current is stored in a superconductor; when an incident photon strikes, it elicits a change in the current, and therefore a change in the kinetic energy. This results in a change in inductance. Inductors are placed in a resonator with a tuned microwave probe, and any changes in the inductance are recognized as changes in phase and amplitude of the probe signal. Below is a detailed description of the steps:



Readout Operations

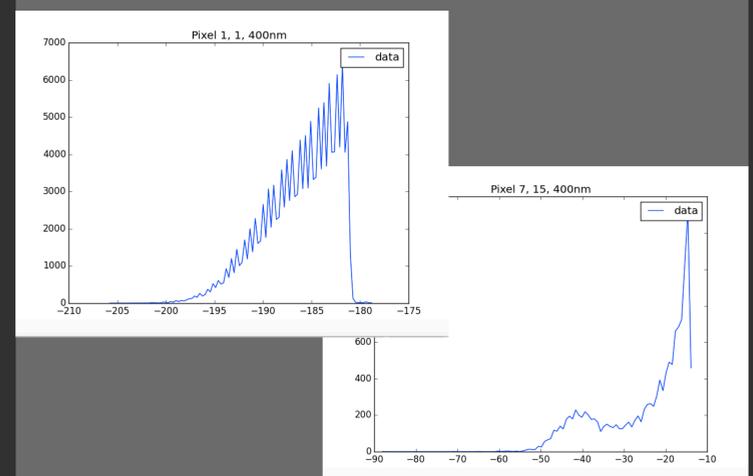


Pictured above are pixels that appeared abnormally close together in wide sweep. This is reputed to be caused by variations in TiN gap.

Qualitatively, it was found that at ~250 kHz distance, the pixels exhibited very poor quality.

Tests were done to determine whether the load oscillation frequency value contributed to the performance quality of the resonant frequency set. The LO value was varied from the specified value in .1 GHz intervals.

The first as well and fourth set of frequencies were tested using these parameters. Altering the LO freq. did not affect the quality of poor performance set, as was hoped.



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