Novel Multiplexing Technique for Detector and Mixer Arrays

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Future space submillimeter telescopes would certainly benefit from large (1000's of elements) imaging detector arrays. A crucial issue related to a focal plane array is a readout scheme capable of handling many cryogenic sensing elements. When the number of elements becomes of the order of thousands the electrical layout for individual amplifiers becomes nearly impossible. Another important concern is about the large number of wires leading to a 0.1-0.3 K platform. In the case of transition-edge sensors (TES), a time-division multiplexing of read-out SQUID amplifiers has been proposed [1]. This allows for some reduction in the number of wires leading to the amplifiers but the number of amplifiers remains the same.

We are going to investigate a solution for the sensor read-out based on a combination of coded-mask technique and detector bias multiplexing. Coded mask technique was used, for example, in some X-ray telescopes to record an image using a single detector and a set of masks with transparent and opaque segments. If the sequence of segments fulfills certain mathematical ordering the original image can be recovered after recording a number of responses from a single detector to the radiation passed through different masks. An optimal set of mask is known to be represented by Walsh-Hadamard functions [2]. Many other applications of the Hadamard transform for imaging and spectroscopy are described in [3].

Our electrical read-out multiplexing technique is based on the Hadamard transform coding of bias voltages which allows to use just *one* amplifier to read out many detector elements. This technique should be especially efficient for bolometers (TES and hot-electron direct detectors, HEDD). In this case N different voltage bias polarity patterns are applied to N detectors and each time a summed current signal is read out by a SQUID amplifier. De-convolution of the image is done after that in a straightforward way using matrix technique. If the noises of individual detectors are non-correlated the signal-to-noise ratio for a reading event can be improved by factor of $N^{1/2}$. Since the detectors are connected in parallel, one damaged element would not affect the performance of the others.

The proposed coding/multiplexing techniques can be applied to various types of detector/mixer elements. In the case on elements with non-symmetrical current-voltage characteristic the multiplexing should be done by turning elements on and off rather than by changing the bias voltage polarity.

We will discus the details of practical implementation of the multiplexing technique and experimental data for a prototype detector array.

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