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The Front-End Electronics and the Data Acquisition System for a Kinetic Inductance Detector

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The Data Acquisition System (DAQ) and the Front-End electronics for an array of Kinetic Inductance Detectors (KIDs) are described. KIDs are superconductive detectors, in which electrons are organized in Cooper pairs. Any incident radiation could break such pairs generating quasi-particles, whose effect is increasing the inductance of the detector. Electrically, any KID is equivalent to a parallel RLC resonant circuit. An array of N KIDs is composed of N pixels, each one resonating on its own frequency. A feed line passes close to each KID and delivers a unique Stimulus signal containing all the resonant frequencies. If one of the KIDs was hit by some radiation, its inductance would change and the corresponding sine component in the readout signal would have its intensity reduced and its phase shifted. The DAQ system we developed is a hardware/software co-design, based on state machines and a Microprocessor embedded into an FPGA. A commercial DAC/ADC board is used to interface the FPGA to the analog environment of the array of KIDs. The DAQ system generates a Stimulus signal for an array of up to 128 KIDs, by creating and adding up 128 sinusoids parted by one MHz. The Stimulus is in the form of a Look-Up Table and it is provided to the DAC device. The analog signal generated is up-mixed with a 3 GHz carrier wave and it then travels through the KIDs array. The read-out signal from the detector is down-mixed with respect to the 3 GHz sine wave and it is read back by the ADC device. The microprocessor stores the read out data via a PCI bus into an external disk. It also elaborates the Fast Fourier Transform of the acquired read out signal: this allows to extrapolate which KID interacted and the energy of the impinging radiation. Simulations and tests have been performed successfully and experimental results are presented.

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