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Energy-Resolved Neutron Imaging using a Delay Line Current-Biased Kinetic-Inductance Detector

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Superconducting detectors are one of the most successful superconducting applications [1]. It has an advantage in high sensitivity and fast response, and has been applied to the detection of cosmic rays and single photons [2]. We have been developing a unique superconducting neutron detector, called current-biased kinetic-inductance-detector (CBKID) [3,4]. Our detector comprises X and Y superconducting Nb meander lines with Nb ground plane and a ^{10}B neutron conversion layer, which converts a neutron into two charged particles. High-energy charged particles (α particle or ^{7}Li particle) are able to create hot spots simultaneously in the X and Y meander lines, and thus, the local Cooper pair density in meander lines are reduced temporary. When a DC-bias currents are fed into the meander lines, pairs of voltage pulses are generated at hot spots and propagate toward both ends of the meander lines as electromagnetic waves. The position of the original hot spot is determined by a difference in arrival times of the two pulses at the two ends with a spatial resolution of the order of the meander repetition length for X and Y meander lines, independently. This is so-called the delay-line method, and allows us to reconstruct the two-dimensional neutron transmission image of test patterns with four signal readout lines.

CBKIDs can handle multi-hit events, and the typical signal width was a fen tens ns. Hence, we estimate the detection-rate tolerance to be as high as a few tens MHz. Therefore, energy resolved-neutron imaging is available with the combination of the time-of-flight technique in pulsed neutron sources.

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