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Kinetic inductance neutron detector operated at near critical temperature

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Superconducting detectors have the advantages of high sensitivity, fast response, and high energy resolution such as a transition edge sensor [1], a superconducting nanowire single-photon detector [2], and a microwave kinetic inductance detector [3]. We first proposed a superconducting neutron detector using an MgB_2 superconductor [4]. Later on, we extended the idea to a current-biased kinetic inductance detector (CB-KID) [5] which consists of two orthogonal superconducting Nb meanderlines with a ^{10}B neutron conversion layer. The CB-KID neutron imager detects high spatial resolution neutrons transmission images by using a delay-line technique. We reported a spatial resolution of 22 μm [6]. The physical characteristics of a CB-KID detector have been studied systematically [7,8]. The theoretical basis of CB-KID was studied by means of the Maxwell-London theory [9]. Prior to this study, we found that the number of events was remarkably increased with increasing the detector temperature until close to the critical temperature T_c [10]. In the present study, we investigated the properties of CB-KID at near T_c.

We observed systematic changes of neutron signals as a function of the detector temperature from 4 K to T_c.

We evaluated the detection efficiency of the CB-KID detector and compared with PHITS Monte Carlo simulations. The simulations modeled the sequential physical processes for 10B(n,α)7Li reactions and energy deposition by particles within CB-KID, including neutrons, ^4He particles, ^7Li particles, photon and electron transport [11].

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