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Current-biased transition-edge sensors based on re-entrant superconductors

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Transition-edge sensors are widely recognized as one of the most sensitive tools for the photon and particles detection in many areas –from astrophysics to quantum computing. Their application became practical after understanding that rather than being biased in a constant current mode, they should be biased in a constant voltage mode. Despite the methods of voltage biasing of these sensors are well developed since then, the current biasing generally is more convenient for superconducting circuits. Thus transition-edge sensors designed inherently to operate in the current-biased mode are desirable. We developed a design for such detectors based on the re-entrant superconductivity. In this case constant current biasing takes place in the normal state, below the superconducting transition, so that it does not yield a latching following the absorption of a photon. Rather, the sensor gains energy and shifts towards the lower resistant (e.g., superconducting) state, and then cools down fast (since Joule heating is now reduced), and resets in a natural way to be able to detect the next photon. We prototyped this kind of transition edge sensors and tested them operational in accordance with the outlined physics. The samples used in experiments were modified compositions of YBCO-superconductors in a ceramic form, which reproducibly demonstrated pronounced re-entrant superconductivity. In this presentation we report their composition, methods of preparation, and the detection results. This approach, in some areas, may have practical advantage over the traditional voltage-biased devices.

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