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A TES for ALPS II and other dark matter searches

Transition Edge Sensors (TES) are widely employed in the field of quantum sensing due to their exceptional energy resolution and sensitivity to single quanta of energy. When operated in its superconducting transition at mK temperatures, a single photon absorbed by the TES produces a significant change in its resistance, generating a measurable signal. In particular, TESs are an ideal tool for quantum optics, searches for rare events, and measurements of low energy deposits. Therefore, TESs are particularly suitable for experiments searching for light dark matter candidates, such as axions and axion-like particles. A precise understanding and control of the background sources affecting TESs is crucial, as false signals can limit the sensitivity for quantum sensing applications.

At DESY, Hamburg, we are investigating the uses of tungsten TESs, provided by NIST, for fundamental physics applications.

We have developed simulations of the expected background sources, including black body radiation, radioactivity, and cosmic rays, to better understand the observed background rates. The results of the simulations will be discussed, along with their validation with measured background data. Furthermore, we will give an overview of the current status of a direct dark matter search using our TESs, which aims to probe MeV-scale dark matter via dark matter-electron and dark matter-nucleon scattering.

In addition, these background simulation results motivated alternative design proposals to mitigate background contributions, which are currently being implemented. Preliminary results obtained with one of these newly developed modules especially dedicated for direct dark matter searches will be presented. The change in the module setup resulted in a reduction of the background rate by up to one order of magnitude.

Given our TESs sensitivity and low background rates, it is also a strong candidate for an alternative detection scheme for the Any Light Particle Search~II (ALPS~II) experiment at DESY, a light-shining-through-a-wall experiment that aims to explore the existence of axions and axion-like particles.

Secondary track

T11 - Detectors

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