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Background Discrimination for the TES-Based Detection System of ALPS II: Machine Learning and A Cryogenic Optical Filter Bench

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The Any Light Particle Search (ALPS II) expects an axion-photon reconversion rate of 1 photon per day, setting an upper limit for the required background in the foreseen Transition Edge Sensor (TES) based experiments. We present two distinct software and hardware based approaches contributing to achieving this goal: i) discriminating background events using state-of-the-art machine learning (ML) models and ii) physically limiting the background originating from black-body photons using a cryogenic optical filter bench. Regarding the ML-based approach, the use of data-informed simulation of TES pulses has enabled extensive optimization of the utilized models. Despite effectively distinguishing between most background events, the black-body photons coupled to the optical fiber still need to be physically reduced to meet the desired sensitivity. We are currently building a custom optical filter bench that can be operated inside the dilution refrigerator at 40 K. The transmission of 1064 nm photons has been optimized by using an ultra-narrow pass filter that can be remotely rotated with respect to the laser beam in order to compensate for the effects of thermal contraction. We have further applied the possibility to fine tune the positions of the used fiber collimators while the system is cold by attaching them to remotely controllable piston stages. The presentation discusses the practical implementation and the limits of the two above introduced methods in background discrimination and reduction for ALPS II.

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