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Search for light WIMPs with BULLKID-DM experiment using monolithic arrays of detectors

BULLKID-DM is a cryogenic experiment designed for direct detection of WIMP-like dark matter particles with a mass below 1 GeV/c^2. The detector will consist of a stack of 16 intrinsic silicon wafers, for a total mass of 800 g, that are carved in 2320 active dice with a volume of $5.4\times5.4\times5$ mm^3. Each die will be instrumented with multiplexed Kinetic Inductance Detectors (KIDs), acting as a particle absorber with an individual energy threshold of 200 eV or better. The array design enables the volume fiducialization to improve background discrimination.
To minimize the background signals from ambient radioactivities, besides using radiopure materials, a comprehensive shielding system, including a mixture of lead, copper and neutron moderator material (⊠4⊠) that placed both inside and outside the cryostat will be implemented. A cryogenic anti-coincidence veto system is also designed to further suppress the external gamma backgrounds. The veto system will use scintillating crystals and their light output is read out by phonon-mediated KIDs. The overall background with the veto system is expected to be close to the zero-background limit of 10^{-2} counts / (keV kg day).

This work presents the first operation of a 60 g demonstrator with 180 dice, in a surface laboratory equipped with a lead and copper radiation shield. The recorded backgrounds are in line with Geant4 simulations performed by the collaboration, paving the path to the deployment of final 800 g array. Current efforts focus on the low-radioactivity detector mounting, a cryogenic scintillating veto readout with KIDs, in situ calibration techniques, and detector upgrades such as KIDs with dedicated phonon-collecting structures and germanium substrates for multi-target capabilities.
The demonstrator is intended to be installed at the Gran Sasso underground laboratory (LNGS) by late 2026, following successful validation, the full experiment is expected to be commissioned in 2027.

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