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The neutrinoless double beta decay CROSS experiment: demonstrator with surface sensitive bolometers

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Nowadays, double beta decay searches are an important point of interest in neutrino physics: the observation of neutrinoless double beta ($0\nu2\beta$) decay will give essential information on neutrino masses and nature as well as on lepton number violation. The technological challenge for highly sensitive $0\nu2\beta$ experiments includes the minimization of the background index in the region of interest. The key feature of CROSS (Cryogenic Rare-event Observatory with Surface Sensitivity) is the active surface background rejection using bolometric detectors coated with thin metallic films. Such a film on the detector surface affects the conversion of the energy deposited by the particle interaction. The phonon reabsorbtion in the film leads to a modification of the pulse shape for close-to-film events. With single-channel separation of surface α and β particles, the CROSS technology can be used for next-generation bolometric experiments, reaching a background index in the region of interest of $\sim10^{-5}$ counts/(keV$\times$kg$\times$y).

Several series of reduced-scale prototypes with coated Li_2MoO_4 and TeO_2 crystals (isotopes of interest for $0\nu2\beta$ are ^{100}Mo and ^{130}Te) were studied in an aboveground cryostat at IJCLab, Orsay.
Successful observation of surface alpha and beta separation with Pd-Al grids was performed, and first full-size (45x45x45 mm, $\sim$280 g) prototypes based on a $Li_2{}^{100}MoO_4$ crystal for the CROSS demonstrator were assembled.

The surface-event identification can be combined with alpha particle rejection achievable in scintillating bolometers, providing a powerful redundancy for background mitigation. In this framework, the underground cryogenic facility of CROSS (Canfranc Underground laboratory) hosted several arrays of $Li_2{}^{100}MoO_4$ scintillating bolometers (in collaboration with CUPID experiment) to perform studies of detectors performance and reproducibility. Several options for light collection optimization were investigated, with light yields ranging from $\sim$0.2 to $\sim$0.6 keV/MeV. These results are used for the optimization of the detector modules both for the CUPID experiment and the CROSS demonstrator, which will consist of an array of about 60 crystals of Li_2MoO_4 containing 6.6 kg of ^{100}Mo featuring both light-yield and pulse-shape discrimination capabilities. The 2 year sensitivity of the CROSS demonstrator is 2×10^{25} years, corresponding to effective neutrino mass bounds of 86 - 149 meV.

Reference to paper (DOI or arXiv)

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