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Characterization of low energy argon recoils with ReD and ReD+

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The Recoil Directionality project (ReD) within the Global Argon Dark
Matter Collaboration characterized the response of a liquid argon (LAr) dual-phase Time Projection Chamber (TPC) to neutron-induced nuclear recoils, to measure the charge yield at low-energy. The charge yield is a critical parameter for the experiments searching for dark matter in the form of low-mass WIMPs and measurements in Ar below 10 keV are scarce in the literature. ReD was designed to cover the gap down to 2 keV.

The ReD data taking took place in 2023 at the INFN Sezione di Catania. The TPC was irradiated by neutrons produced by an intense ^{252}Cf fission source in order to produce Ar recoils in the energy range of interest. The energy of the nuclear recoils produced within the TPC by (n,n') scattering was determined by detecting the outgoing neutrons by a dedicated neutron spectrometer made of 18 plastic scintillators. The kinetic energy of neutrons interacting in the TPC was evaluated event by-event by measuring the time of flight. Data analysis is currently being finalized, but it has been confirmed that ReD collected and characterized a sample of nuclear recoils down to 2 keV, thus meeting its design goal.

The ReD effort will be further extended by a new project, ReD+, funded by a PRIN grant from the Italian Ministry of Research. ReD+ is designed to push the sensitivity down to 0.5 keV, by using the same conceptual design of ReD and improved components. A new TPC is being re designed and optimized in order to increase the signal rate and the signal-to background ratio, which limited the sensitivity of ReD.

In this contribution, we describe the experimental setup and the preliminary results from the data analysis of ReD, as well as the perspectives to further lower the coverage down to the sub-keV range with ReD+.

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