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Characterizatio of light signal in the Liquid Argon TPC of the ReD experiment

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The existence of Dark Matter as a thermal remnant of the Big Bang could be proven observing the interaction of weakly interacting massive particles (WIMPs) with matter. To search for dark matter, we use argon as a target in a two-phase Time Projection Chamber (TPC). This is a demonstrated technology and has generated impressive results with the DarkSide-50 detector. The primary advantages of a TPC are the reduction in background by the detection of primary scintillation light and a delayed ionization signal and the excellent sensitivity of liquid argon to WIMP signals. As part of the Global Argon Dark Matter Collaboration, we are continuing to develop liquid argon TPCs.
The Recoil Directionality (ReD) project has been designed to characterize the response of a liquid Argon (LAr) TPC to neutron-induced nuclear recoils and to measure the charge yield for low-energy recoils. In particular the ReD project aims to cover the low-energy range of 2-5 keV, which is of interest for low-mass WIMP searches, and where the only available detection channel is the ionization one.
In ReD experiment the TPC was irradiated with neutrons from a 252Cf fission source and Nuclear Recoils (NR) were produced in the TPC via elastic scattering, finally using the two body kinematics approach the desired energy range is selected. The data taking campaign was conducted in Catania in 2023, the analysis is ongoing to finalize the measures of the ionization yield improve the models to be employed by the next generation of experiments dedicated to the light dark matter search.
The new project ReD+ aims to improve the results obtained in the predecessor project ReD, infact will extend the coverage of the measurements down to 0.4 keV, by using a new optimized TPC and a deuterium-deuterium neutron generator.

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