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The Recoil Directionality (ReD) Experiment

Directional sensitivity to nuclear recoils would provide a smoking gun for a possible discovery of dark matter in the form of WIMPs. A hint of directional dependence of the response of a dual-phase liquid argon Time Projection Chamber (TPC) was found in the SCENE experiment. Given the potential importance of such a capability in the framework of dark matter searches, a new dedicated experiment, ReD (Recoil Directionality), was designed in the framework of the DarkSide Collaboration, in order to scrutinize this hint.

A small dual-phase liquid argon TPC is irradiated with neutrons produced by the $p(\text{Li7},\text{Be7})n$ reaction from the TANDEM accelerator of the INFN Laboratori Nazionali del Sud (LNS), Catania, such to produce Ar nuclear recoils in the range of interest for Dark Matter searches. Energy and direction of nuclear recoils are inferred by the detection of the elastically-scattered neutron by a set of scintillation detectors. Golden scattering events can be further selected by gating of the associated Be7, which is detected by a telescope made of two Si detectors. As an additional valuable by-product, ReD can be operated to study the response of the TPC to very low-energy nuclear recoils (in the keV range).

In July 2018, the ReD set-up was deployed and integrated on a beam line of the LNS allowing for the first characterization and for the integration of the three detector systems (TPC, liquid scintillators, Si telescope). After this first test-beam, the entire system were re-assembled in the Cryogenic Laboratory for the research of Dark Matter of INFN Naples. This contribution will describe the performance of the detectors achieved during the test-beam in Catania, the current status of ReD and the perspectives for physics measurements during the forthcoming beam-time.

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