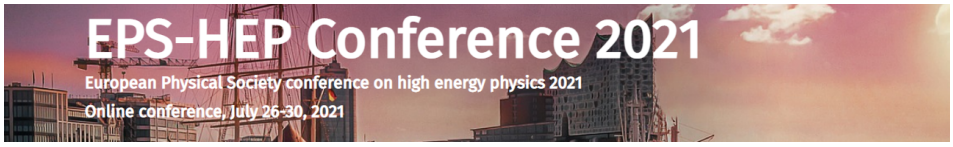


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# ReD: characterisation of a SiPM based Liquid Argon TPC for directional dark matter detection studies

*Monday 26 July 2021 17:30 (15 minutes)*

A double-phase argon Time Projection Chamber (TPC), with an active volume of $5 \times 5 \times 5$ cm$^3$, has been designed and constructed for the Recoil Directionality (ReD) experiment, within the DarkSide collaboration. The aim of the ReD project is to investigate the directional sensitivity of argon-based TPCs via columnar recombination to nuclear recoils in the energy range of interest (20-200\,keV$_{nr}$) for direct dark matter searches. The key novel feature of the ReD TPC is a readout system based on cryogenic Silicon Photomultipliers (SiPMs), which are employed and operated continuously for the first time in an argon TPC. Over the course of six months, the ReD TPC had been characterised under various operating conditions using $\gamma$-ray and neutron sources, demonstrating stability of the optical sensors and reproducibility of the results.
The scintillation gain and ionisation amplification of the TPC were measured to be $g_1 = (0.194 \pm 0.013)$ photoelectrons/photon and $g_2 = (20.0 \pm 0.9)$ photoelectrons/electron, respectively. The ratio of the ionisation to scintillation signals (S2/S1), instrumental for the positive identification of a candidate directional signal induced by WIMPs, has been investigated for both nuclear and electron recoils. At a drift field of 183 V/cm, an S2/S1 dispersion of 12% was measured for nuclear recoils of approximately 60-90 keV$_{nr}$, as compared to 18% for electron recoils depositing 60\,keV of energy. The detector performance discussed in this talk will allow the investigation of a directional effect due to columnar recombination. In addition a phenomenological parameterisation of the recombination probability in liquid argon is presented and employed for modeling the dependence of scintillation quenching and charge yield on the drift field for electron recoils between 50-500 keV and fields up to 1000 V/cm.

## Collaboration / Activity

DarkSide (GADMC)

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