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Direct optical readout of ionisation tracks in gas-based TPCs

In the fields of particle physics and radiation detection, gas-based time projection chambers (TPCs) are used as a versatile tool for particle detection and 3D track reconstruction. Their operation principle requires a reference time obtained from a primary signal, which allows the absolute placement of an ionisation track in space.
Owing to their excellent spatial resolution and intuitive readout, optically read out signal intensifiers, such as MicroPattern Gaseous Detectors (MPGDs), are a promising candidate technology for providing the 2D projection on the end planes of TPCs, realisations of which are already actively pursued and studied. However, the anticipated technological progress in digital imaging sensor technology in the coming years makes the optical readout of not only a strongly intensified signal at the end caps of a TPC but also the optical detection of primary ionisation signals in TPCs feasible. Highly sensitive imaging sensors which can be operated at high frame rates might allow for direct imaging of the scintillation produced by primary ionisation events of particles traversing a gas volume. In fact, this could lead to a novel generation of particle detectors based solely on a volume of scintillating gas, which is ionised by crossing particles and read out directly with capable cameras, effectively making conventional TPCs obsolete. Not only would this detector concept be much simpler than current technologies, but it could also be scaled up effectively and be adapted to arbitrary geometrical requirements. Thus, the direct optical readout of primary scintillation by highly sensitive imaging sensors may prove to be of exceptional significance for future radiation and tracking detectors.

Summary

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