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Quantum Dot Based Scintillators: A New Type of Sensor for Particle Physics

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Development of semiconductor technology has enabled engineering of ultrafast, high-yield, and radiation-tolerant quantum dot (QD) based scintillation materials with sub-nanosecond emission time and light yield > 2x10ˆ5 photons/MeV. Such materials could be very attractive for various HEP applications, particularly for fast timing and low-mass tracking detectors. We present results on a scintillation detector based on self-assembled InAs QDs grown with molecular beam epitaxy and embedded into GaAs bulk. The detector consists of a 25 μm thick scintillator with an InGaAs photodiode grown directly on the scintillator. Signals measured using 5 MeV α-particles correspond to a light collection efficiency of ˜13% with a measured scintillation time of ˜500 ps, making this system the fastest high-yield scintillating material reported so far. Furthermore, strong carrier localization results in a radiation hardness that significantly exceeds that of bulk GaAs.

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