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Beam tests of a large-scale TORCH time-of-flight demonstrator

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The TORCH time-of-flight detector is designed to provide particle identification over the momentum range 2–10 GeV/c over large areas. The detector exploits prompt Cherenkov light produced by charge particles traversing a 10 mm thick quartz plate. The photons propagate via total-internal reflection and are focussed onto a detector plane comprising position-sensitive micro-channel plate (MCP) detectors. The goal is to achieve a single-photon timing resolution of around 70 ps, giving a timing precision of 15 ps per charged particle by combining the information from around 30 detected photons. The MCP-PMT detectors have been developed with a commercial partner (Photek), leading to the delivery of a square tube of active area 53 x 53mmˆ2 with 8 x 128 pixels equivalent. A large-scale demonstrator of TORCH with a quartz plate of dimensions 660 x 1250 mmˆ2, read out by a pair of MCP-PMTs with custom readout electronics, has been verified in beam tests at the CERN PS. Preliminary results indicate that excellent single-photon timing resolution can be achieved by employing a data-driven calibration. The projected performance of a full-scale TORCH detector at the LHCb experiment will also be presented.

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