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Beam test studies of a prototype TORCH detector

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TORCH is a time-of-flight detector designed to provide particle identification over the 2-10 GeV/c momentum range. Consisting of 18 large quartz plates, TORCH measures the time of arrival of charged particles through prompt Cherenkov light which is trapped by total-internal reflection. At the top of the plate the light is focused onto a row of micro-channel plate (MCP) detectors which measure the photon arrival time and position. Designed for the LHCb detector, TORCH aims for a 15 ps track time resolution over a 10 m flight path. This translates into a 3 standard deviation separation between pions and kaons with momenta of 10 GeV/c. To achieve such a track resolution requires a time resolution of 70 ps per photon for 30 detected photons per track.

In the latter half of 2018 both a small-scale (120 x 350 x 10 mm³) and a half-scale (660 x 1250 x 10 mm³) prototype were tested in a 5 GeV/c mixed proton-pion beam at the CERN PS. Employing data-driven calibrations, the single photon timing performance has been measured, providing proof of principle for the TORCH concept. The projected performance of a full-scale TORCH detector instrumented in the LHCb experiment, determined through simulation studies, will also be presented.

Presenter: HANCOCK, Thomas Henry (University of Oxford (GB))

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