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Performance of a prototype TORCH detector

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TORCH (Time Of internally Reflected CHerenkov light) is a novel time-of-flight detector, designed to provide $\pi/K/p$ particle identification up to ~ 10 GeV/c momentum and beyond. To achieve this, a time resolution of ~ 15 ps combining information from ~ 30 detected photons is required over a 10 m flight path. Large areas can be covered with TORCH, nominally up to 30 m². One such application is for the LHCb experiment, to complement the particle identification capabilities of its RICH detectors.

TORCH has a DIRC-like construction with 10 mm-thick synthetic amorphous fused-silica plates as a radiator. Cherenkov photons propagate by total internal reflection to the plate edges and there are focussed onto an array of position-sensitive photodetectors. Custom-built micro-channel plate photo-multipliers (MCP-PMTs) are being developed in collaboration with industry to provide the lifetime, granularity and time resolution to meet the TORCH specifications. Laboratory tests have been performed on the MCP-PMTs developed for TORCH and its readout electronics. Test beam measurements of a prototype TORCH detector in a low-momentum mixed beam of pions and protons are highlighted. Time resolutions for individual photons approaching 100 ps are achieved, after correction for dispersion effects in the quartz medium.

Author: CASTILLO GARCIA, Lucia (University of Oxford)

Presenter: CASTILLO GARCIA, Lucia (University of Oxford)

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