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TORCH - a Cherenkov based Time-of-Flight Detetor

Tuesday, April 8, 2014 5:00 PM (15 minutes)

TORCH (Time Of internally Reflected CHerenkov radiation) is an innovative time-of-flight system designed to provide particle identification over large areas up to a momentum of 10 GeV/c. Cherenkov photons emitted within a 1 cm thick quartz radiator are propagated by internal reflection and imaged on to an array of Micro-Channel Plate photomultiplier tubes (MCPs).

Performing 3-σ pion/kaon separation at the limits of this momentum regime requires a time-of-flight resolution per track of 10-15 ps, over a ˜10m flight path. With ˜30 detected photons per track the required single-photon time resolution is ˜70 ps.
This presentation will discuss the development of the TORCH R&D program and present an outline for future work.

Summary

TORCH (Time Of internally Reflected CHerenkov radiation) is a highly compact Time-of-Flight (ToF) system utilizing Cherenkov radiation to achieve particle identification up to 10 GeV/c. At the upper limit of this momentum, a 10-15 ps resolution per track is required to achieve a 3-σ ToF difference between pions and kaons.

TORCH will consist of a 1cm thick radiator plate equipped with light guides along the top and bottom of the plate which focus the produced Cherenkov radiation onto a series of micro-channel plate photomultipliers (MCPs). Precise timing of the arrival of the photons and their association with a particle track is then used to determine the particle time-of-flight. Around 30 photons are expected to be detected per track which results in a required time resolution per photon of around 70 ps. The time of propagation of each photon through the plate is governed by its wavelength which affects both its speed of propagation and its Cherenkov emission angle, and by measuring this angle to 1mrad precision TORCH will correct for chromatic dispersion.

The performance of the system relies on the MCP combining fast timing and longevity in high radiation environments, with a high granularity to allow precise measurement of the Cherenkov angle. Development of a 53 mm x 53 mm active area device with 8x128 effective pixel granularity, sub 50ps time resolution and long lifetime is under way with an industrial partner as part of the TORCH development.

A GEANT-4 simulation of the TORCH detector and its performance is currently being developed, taking account of the contributions to the overall TORCH resolution. This talk will focus on the requirements of the TORCH design and R&D developments including progress toward a prototype and the development and laboratory tests of the MCP.

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