The Timing Properties of a Picosecond MCP-PMT Measured at the Fermilab MTEST Test Beam

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Abstract

We have measured timing properties of Photonis 5-cm-square micro-channel plate photomultipliers (MCP-PM) with 10-micron pores and a new novel charge-collection scheme at the anode of the tube. We have performed these measurements using the high energy particle test-beam at Fermilab and commercial Camac readout electronics. We compare the measured timing properties to results obtained with a picosecond laser on a bench test-stand.

Summary

Our interest in the timing properties of micro-channel plate photomultipliers (MCP-PM’s) project has focused on developing a detector module that can be used to construct a large-area system to measure the transit time of particles (“time-of-flight”, or “TOF”) approximately two orders-of-magnitude better than current large-scale systems. This would allow the identification of particle type, and hence the quark content, of particles produced in high-energy colliders for momenta an order-of-magnitude larger than with current TOF systems. We have proposed to use the Cherenkov light generated in a quartz plate radiator and the face window of a large array of custom micro-channel plate photomultipliers (MCP-PM’s), a new charge-collection scheme at the anode of the tube, and the development of custom readout electronics, integrated with the anode. In this paper we report on measurements of the timing properties, gain characterization and response uniformity of 10-cm by 10-cm MCP-PM modules from Photonis . The tubes are configured with several custom anode designs, including a new design that uses dual-readout transmission lines to measure position and time. Simulations indicate the transmission lines have an intrinsic time resolution on the order of 1 picosecond resolution. At present we use commercial front-end electronics to characterize the performance of the tubes and the new anode design.

The timing properties of the MCP-PM modules were measured in a test-beam configuration of 2 stations each containing 2 MCP-PM modules and a pair of trigger scintillation counters (2mm by 2mm). The main components of the data-acquisition system consist of a CAMAC parallel branch-highway and two Camac crates each containing a pair of Ortec AD411 peak-sensing analog-to-digital converters (ADC's, for time measurements) and a LeCroy 4300b 10-bit charge ADC (for pulse height measurements of the MCP-PM). A LeCroy FERA high speed readout and memory

buffered the data during beam spills. The anode of the MCP-PM was configured to provide both time and pulse height information via an Ortec 9327 constant-fraction discriminator that provided an analog output for the LeCroy ADC and a NIM pulse to a Ortec 566 time-to-amplitude converter for input to the Ortec AD411. The timing information was acquired in a common-stop mode which was supplied by separate 4 scintillation trigger counters defining the beam. We report measurements for particle beams of 120 GeV protons and 4-16 Gev secondary beams containing pions, kaons, muons and electrons as selected by a differential Cherenkov counter.