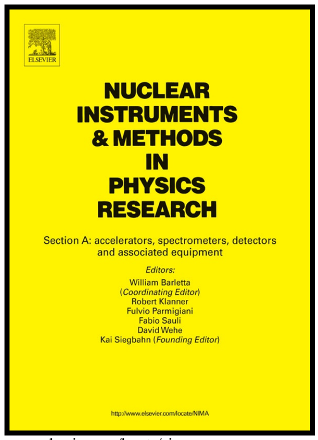

www.elsevier.com/locate/nima

Precision Timing Detectors with Cadmium-Telluride Sensor

A. Bornheim, C. Pena, M. Spiropulu, S. Xie, Z. Zhang

PII: S0168-9002(17)30474-6
DOI: http://dx.doi.org/10.1016/j.nima.2017.04.024
Reference: NIMA59812

To appear in: *Nuclear Inst. and Methods in Physics Research, A*

Received date: 13 December 2016
Revised date: 4 April 2017
Accepted date: 15 April 2017

Cite this article as: A. Bornheim, C. Pena, M. Spiropulu, S. Xie and Z. Zhang Precision Timing Detectors with Cadmium-Telluride Sensor, *Nuclear Inst. an Methods in Physics Research, A,* http://dx.doi.org/10.1016/j.nima.2017.04.024

Precision Timing Detectors with Cadmium-Telluride Sensor

A. Bornheim[a], C. Pena[a], M. Spiropulu[a], S. Xie[*,a], Z. Zhang[a]

[a] *California Institute of Technology, Pasadena, CA, USA*

Abstract

Precision timing detectors for high energy physics experiments with temporal resolutions of a few 10 ps are of pivotal importance to master the challenges posed by the highest energy particle accelerators such as the LHC. Calorimetric timing measurements have been a focus of recent research, enabled by exploiting the temporal coherence of electromagnetic showers. Scintillating crystals with high light yield as well as silicon sensors are viable sensitive materials for sampling calorimeters. Silicon sensors have very high efficiency for charged particles. However, their sensitivity to photons, which comprise a large fraction of the electromagnetic shower, is limited. To enhance the efficiency of detecting photons, materials with higher atomic numbers than silicon are preferable. In this paper we present test beam measurements with a Cadmium-Telluride (CdTe) sensor as the active element of a secondary emission calorimeter with focus on the timing performance of the detector. A Schottky type CdTe sensor with an active area of 1 cm^2 and a thickness of 1 mm is used in an arrangement with tungsten and lead absorbers. Measurements are performed with electron beams in the energy range from 2 GeV to 200 GeV. A timing resolution of 20 ps is achieved under the best conditions.

Key words: Cadmium Telluride, Timing, Calorimeter

1. Introduction

There has been much recent interest in enhancing the timing capability of large particle physics collider experiments to the level of $20 - 30$ ps for each final state particle reconstructed in the detector. In order to probe increasingly rare high energy particle interactions, future hadron colliders must provide large instantaneous luminosity well above 10^{35} cm^{-2}s^{-1}. With current accelerator and particle detector capabilities, such a high instantaneous luminosity will result in very large amounts of simultaneous particle collisions, referred to as pileup. For the high luminosity upgrade of the Large Hadron Collider (HL-LHC), pileup is expected to exceed 200 inelastic proton-proton collisions per bunch crossing, when two ensembles of up to 10^{12} particles collide at the center of the detectors. In the LHC, the collisions from each bunch crossing are spread out over a length of about 10 cm along the beam axis direction and have an additional time dispersion of about 150 ps. Under such conditions, the task to associate particles measured

*Corresponding author
Email address: sixie@hep.caltech.edu (S. Xie)

Preprint submitted to Nucl. Instrum. Meth. A *April 17, 2017*