3B2v7.51c GML4.3.1 NIMA : 19643 Prod.Type:COM pp.1–3(col.fig.:NIL) ED:Vandana PAGN: nvs SCAN: preethi

ARTICLE IN PRESS

Available online at www.sciencedirect.com

SCIENCE DIRECT®

ELSEVIER

Nuclear Instruments and Methods in Physics Research A ▮ (▮▮▮▮) ▮▮▮–▮▮▮

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

www.elsevier.com/locate/nima

The front-end electronics for the COMPASS MWPCs

A. Amoroso[a], M. Colantoni[b], O. Denisov[a,c], A. Ferrero[a,*], V. Frolov[a,c], A. Grasso[a], A. Korentchenko[c], M. Maggiora[a], D. Panzieri[b], A. Popov[c], A. Skachkova[c], V. Tchalyshev[c]

[a] *Dipartimento di Fisica Generale "A. Avogadro" and INFN, Torino, Italy*
[b] *Dipartimento di Scienze e Tecnologie Avanzate, UPO and INFN, Torino, Italy*
[c] *Joint Institute for Nuclear Research, LNP, Dubna, Russia*

Abstract

In the COMPASS experiment 34 planes of MWPCs for about 26,000 readout channels of MWPCs are used. The very high rate of the muon and hadron beams, and the consequently high trigger rate, requires the use of a front-end electronics with new conceptual design, to have a fast DAQ with a minimum dead-time.

Its scheme will be described, together with some results of the performances achieved.
© 2003 Published by Elsevier B.V.

PACS: ■; ■; ■

Keywords: ■; ■; ■

UNCORRECTED PROOF

1. Introduction

The detector of the COMPASS experiment is a multipurpose fixed target spectrometer [1] at the extracted beam of the CERN SPS accelerator complex. To provide a larger momentum and angular acceptance the whole set-up was subdivided into two spectrometer blocks. The Small Angle Spectrometer (SAS) has been designed to reconstruct particles with momentum $p > 10\ \mathrm{GeV}/c$, while the Large Angle Spectrometer (LAS) provides acceptance for particles with momentum $p < 50\ \mathrm{GeV}/c$. The tracking capability of the SAS is defined by the MWPCs system, described here.

*Corresponding author.
E-mail address: aferrero@to.infn.it (A. Ferrero).

0168-9002/$ - see front matter © 2003 Published by Elsevier B.V.
doi:10.1016/j.nima.2003.11.067

2. The MWPC front-end electronics

The functional block diagram of the read-out electronics, developed in Torino, is shown in Fig. 1. It consists of a printed circuit board, called "Mother Board", fixed to the chamber frame, and the front-end board where the signals of the chamber are discriminated and digitized. The data is transferred through a fast serial link to a VME board, called "Catch" [2], developed at the university of Freiburg, which performs the task of the local event builder.

The front-end electronic is organized in triplets of cards that can read 64 channels per board. Each card houses the MAD4 preamplifier/discriminator chips [3,4], developed by the INFN section of Padua for the read out of the muon detectors of

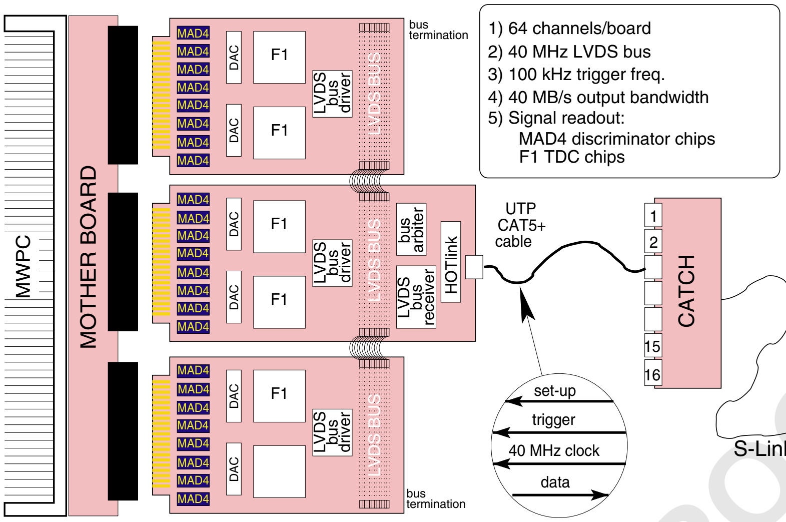

Fig. 1. Scheme of the front-end card housing the preamplifier/discriminators, digitizing electronics, and interfaces.

the CMS barrel, the digitalizing chips [5], and the threshold DACs. The three cards are connected together by a fast LVDS bus, which distributes the 38.8 MHz clock, trigger and synchronization signals. Production cost has been reduced by housing both analog and digital parts on the same PCB. Moreover central and side boards share a common design, except for the bus arbiter and the parallel-to-serial converter chips that allows for fast transmission of significant data to the "Catch" module, which are housed only on the central board. For noise prevention all the voltages required by the card components are regulated on-board and the ground separation technology between analog and digital grounds is used.

A test system has also been developed, capable of injecting into each wire a charge pulse similar to the signal of a minimum ionizing particle crossing the chamber. The system is composed of a VME control board and pulser boxes fixed to the frame of each MWPC detector. It allows for tests and calibration of the front-end cards and of the read-out system, including the input connectors.

3. Front-end calibration and performances

To obtain the linearity curve of Fig. 2 the threshold of a single channel has been changed together with the amplitude of the input signal (5–500 fC) to get a detection efficiency of the order of 50%. The results, obtained automatically for all the 26,000 channels, have been stored in a database used at the initialization time.

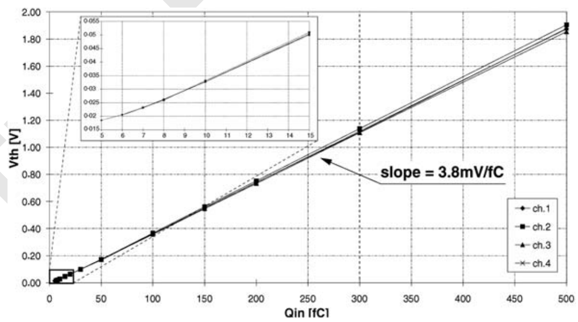

Fig. 2. Threshold/input charge calibration curve for one MAD4 chip.

With the electronics connected to the MWPC, the noise has been measured, with a threshold of 4 fC, by triggering with a pulse generator at 100 Hz. The counting rate/trigger in the whole detector was found to be of the order of 2%. Negligible crosstalk has been found at 5 fC of threshold when injecting in a single wire a signal of 30 fC.

The overall efficiency of one MWPC plane, determined with a $^{90}Sr\beta^{-}$ source and with three

UNCORRECTED PROOF

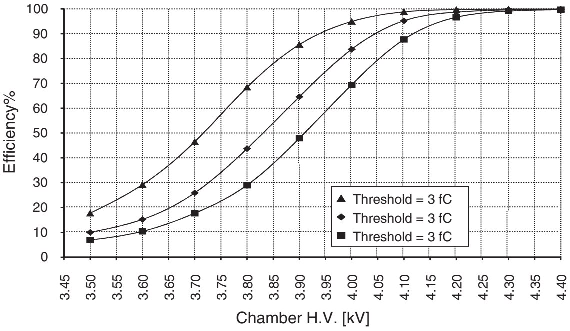

Fig. 3. Detection efficiency of one MWPC plane, measured with a $^{90}Sr\beta^-$ source for three threshold values.

different thresholds, is shown in Fig. 3. The detector is currently operated with a field voltage of 4.2 kV and a threshold of 4 fC.

4. Conclusions

The design of a conceptually new front-end electronics for the readout of the COMPASS MWPC detectors has been described. The electronics fulfills all the demanding requirements of the COMPASS experiment in terms of low noise, low dead-time and high rate capabilities.

The installation of the COMPASS MWPC detectors has been completed in spring 2001. Two years of production running using the muon beam with intensities up to 10^8 μm/s have been completed so far. During this period the detectors have shown very good stability, providing a tracking efficiency above 96% for all planes.

References

[1] CERN/SPSLC 96-14, SPSLC/P297, 1996.
[2] H. Fischer, et al., COMPASS internal note 2002-7.
[3] F. Gonnella, M. Pegoraro, CERN-LHCC-2001-034, pp. 204–208.
[4] A. Maggiora, et al., IEEE Trans. Nucl. Sci. NS-47 (2000) 791.
[5] H. Fischer, et al., IEEE Trans. Nucl. Sci. NS-49 (2002) 443.

UNCORRECTED PROOF