Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Nuclear Instruments and Methods in Physics Research A 538 (2005) 358–371
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A
www.elsevier.com/locate/nima

Design and construction of new central and forward muon counters for CDF II

A. Artikov[a,1], J. Budagov[a], I. Chirikov-Zorin[a], D. Chokheli[a,2], V. Kolomoets[a], M. Lyablin[a], O. Pukhov[a,*], A. Sissakian[a], G. Bellettini[b], F. Cervelli[b], M. Incagli[b], A. Menzione[b], F. Palmonari[b], A. Scribano[b], A. Stefanini[b], D. Cauz[c], H. Grassmann[c], G. Pauletta[c], L. Santi[c], G. Introzzi[d], A. Penzo[e], M. Iori[f], B. Grinyov[g], V. Lagutin[g], V. Lebedev[g], V. Lyubynskiy[g], V. Senchyshyn[g], V. Kovtun[h], I. Zaljubovsky[h], I. Fedorko[i], S. Tokar[i], V. Giakoumopoulou[j], N. Giokaris[j], A. Manousakis-Katsikakis[j]

[a]*JINR, Dubna, Russia*
[b]*INFN, University of Pisa, Italy*
[c]*INFN, University of Udine, Italy*
[d]*INFN, University of Pavia, Italy*
[e]*INFN, University of Trieste, Italy*
[f]*INFN, University of Rome, Italy*
[g]*Institute of Scintillating Materials, Kharkiv, Ukraine*
[h]*Kharkiv Karazin National University, Ukraine*
[i]*Department of Nuclear Physics, Comenius University, Bratislava, Slovakia*
[j]*University of Athens, Greece*

Received 12 April 2004; received in revised form 10 August 2004; accepted 6 September 2004
Available online 12 October 2004

*Corresponding author. Fermi National Laboratory, P.O. Box 500, Batavia IL 60510-0550, USA. Tel.: +7 09621 64681.
E-mail addresses: akram@nu.jinr.ru (A. Artikov), julian.boudagov@cern.ch (J. Budagov), chirikov@nu.jinr.ru (I. Chirikov-Zorin), chokheli@nu.jinr.ru (D. Chokheli), lyablin@nu.jinr.ru (M. Lyablin), oleg@fnal.gov (O. Pukhov), sisakian@jinr.ru (A. Sissakian), bellettini@fnal.gov (G. Bellettini), cervelli@pi.infn.it (F. Cervelli), incagli@pi.infn.it (M. Incagli), menzione@pi.infn.it (A. Menzione), palmonari@bo.infn.it (F. Palmonari), scribano@pi.infn.it (A. Scribano), stefanini@pi.infn.it (A. Stefanini), giovanni.pauletta@fisica.uniud.it (G. Pauletta), gianluca.introzzi@pv.infn.it (G. Introzzi), maurizio.iori@romal.infn.it (M. Iori), lebedev@kharkov.com (V. Lebedev), lubinsky@isc.kharkov.com (V. Lyubynskiy), sench@isc.kharkov.com (V. Senchyshyn), kovtun@pht.univer.kharkov.ua (V. Kovtun), ivan.fedorko@pi.infn.it (I. Fedorko), stanislav.tokar@fmph.uniba.sk (S. Tokar), ngiokar@cc.uoa.gr (N. Giokaris), amanous@cc.uoa.gr (A. Manousakis-Katsikakis).
[1]On leave from NPL, Samarkand State University, Uzbekistan.
[2]On leave from HEPI, Tbilisi State University, Georgia.

doi:10.1016/j.nima.2004.09.009

Abstract

New scintillation counters have been designed and constructed for the upgradation of the CDF detector at the Fermilab Tevatron in order to complete the muon coverage of the central detector and to extend it to a larger pseudorapidity interval. A novel light collection technique using wavelength shifting fibers, together with high-quality polystyrene-based scintillator resulted in compact counters with good and stable light collection efficiency over lengths extending up to 320 cm. Their design and construction is described and results of their initial performance are reported.

Keywords: Muon; Scintillation counter; Photoelectron; Amplifier; Optical; Magnetic field; CDF; Photomultiplier

1. Introduction

The importance of detecting muons at CDF and of measuring their momentum accurately can hardly be overstressed. Drell-Yan muon pair production are a mean for testing the basics of the EW theory and for searching additional vector bosons, for leptons and quark substructure as well as for possible extra-dimensions [1]. Muons originate with large branching fractions from the decay of the top quark and of beauty-flavored hadrons. Detailed studies of production and decay properties of the top quark are eagerly awaited and can be best performed in the muon decay channels [1]. An extended beauty physics program, ranging from relatively simple lifetime studies to the study of subtle CP-violation effects can be performed on a muon event sample. A search for the light Higgs boson, that is expected to decay predominantly into b-quark pairs, can be made in the muon b-decay channel [1]. Finally, muons are expected to appear as products of the decay chain in most SUSY processes.

A considerable effort was therefore made in the CDF upgrade [1] to increase the muon acceptance. As a result, the refurbished CDF detector that has started a new run of data taking (Run 2) in March 2001, features nearly complete muon coverage up to a pseudorapidity η of ± 1.5.

Over most of the solid angles the muon detector is a sandwich of drift chambers and plastic scintillation counters, which can be used to trigger on penetrating muon tracks to identify their bunch crossing and to signal their trajectory. In particular, the fast response of the scintillation counters is important in associating a muon track with its corresponding bunch crossing.

The complex and compact CDF geometry (see Fig. 1 and Ref. [1]) has required the construction and installation of a large set of counter hodoscopes employing a total of about 1200 plastic scintillators with different dimensions and light collection assemblies. Part of those (more than 600 counters) constructed for the CDF upgrade was designed to overcome the space restrictions and to improve on light collection from long counters.

This paper describes the design and performance of these new counters, which distinguish themselves by their unconventional and compact light collection system.

The overall performance of the muon detector in terms of muon triggering efficiency and of background rejection will be the subject of a future publication.

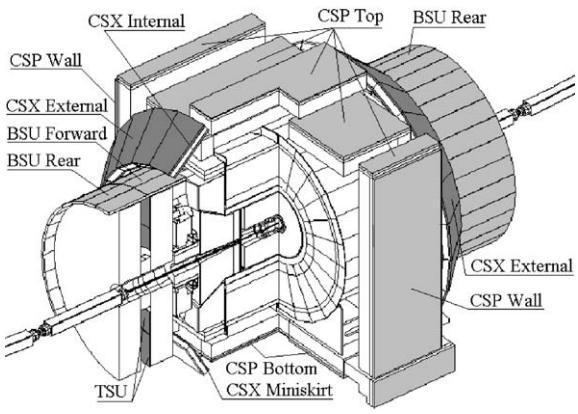

Fig. 1. The CDF II detector.