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Drift chamber with a c-shaped frame

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Abstract

We present the construction of a planar drift chamber with wires stretched between two arms of a c-shaped aluminum frame. The special shape of the frame allows to extend the momentum acceptance of the COSY-11 detection system towards lower momenta without suppressing the high-momentum particles. The proposed design allows for construction of tracking detectors covering small angles with respect to the beam, which can be installed and removed without dismounting the beam-pipe. For a three-dimensional track reconstruction a computer code was developed using a simple algorithm of hit pre-selection.

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1. Introduction

The drift chamber which is described in this report was built for the COSY-11 experimental

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facility operating at the Cooler Synchrotron COSY-Jülich [1]. The COSY-11, described in details in Ref. [2] and shown schematically in Fig. 1, is a magnetic spectrometer for measurements at small angles and is dedicated to studies of near-threshold meson production in proton–proton and proton–deuteron collisions (see e.g. Refs. [3–5]). It uses one of the regular COSY dipole magnets for momentum analysis of charged reaction products originating from interaction of the internal COSY beam particles with the nuclei of a cluster beam target [6]. Trajectories of positively charged particles which are deflected in the dipole magnet towards the center of the COSY-ring are registered with a set of two planar drift chambers indicated as D1 and D2 in Fig. 1. These chambers cover only the upper range of momenta of the outgoing particles what suffices to measure e.g. two outgoing protons in the $pp \to pp\eta'$ process [5] or $p-p-K^+$ tracks in the $pp \to ppK^+K^-$ reaction close to threshold [4]. For tracking positively charged pions appearing in near-threshold reactions such as $pp \to pp\pi^+\pi^-$ with momenta by a factor of m_π/m_p smaller then the proton momenta it was necessary to extend the COSY-11 momentum acceptance towards smaller values.

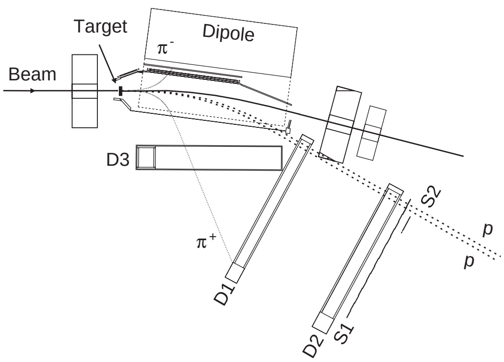

Fig. 1. COSY-11 detection system. Indicated particle tracks correspond to a $pp \to pp\pi^+\pi^-$ event simulated for the beam momentum exceeding by 1 MeV/c the threshold momentum equal to 1219 MeV/c. The two outgoing protons are registered with a set of two chambers—D1 and D2 and the π^+ trajectory is measured with the presently introduced chamber—D3. The scintillation hodoscopes S1 and S2 are used as start detectors and S3 hodoscope placed in a distance of 9.4 m from S1 and not indicated in the figure is used as stop detector for time of flight measurements.

Another important purpose was the detection of positively charged kaons prior to their decay what is especially important for the measurement of the $pp \to ppK^+K^-$ close to threshold due to its small cross-section on the level of a few nanobarns. For this, an additional drift chamber was built and installed in the free space along the COSY-11 dipole magnet (see chamber D3 in Fig. 1). The main requirement for the chamber was a shape of the supporting frame which would not interfere with high momentum particles that are registered in the detectors D1 and D2. This demand was fulfilled by choosing the frame of a rectangular form but with one vertical side missing, called c-shaped frame since it resembles the character c. The main design characteristics of the chamber are given in Section 2. It was also essential, that the chamber allows for a three-dimensional track reconstruction in order to determine the momentum vectors of registered particles at the target by tracing back their trajectories in the magnetic field of the COSY-11 dipole magnet to the nominal target position. Therefore, three different wire orientations were chosen and a track reconstruction program was developed. This program is described in Section 3. The chamber calibration and results of the track reconstruction are presented in Section 4.

2. The chamber construction

The sensitive chamber volume is built up by hexagonal drift cells (see Fig. 2) identical with the structure used in the central drift chamber of the SAPHIR detector [7]. In this type of cells the drift field has approximately cylindrical symmetry, and thus the distance–drift time relation depends only weekly on the particles' angle of incidence. In order to minimize the multiple scattering on wires, gold-plated aluminum [8] is used for the 110-μm-thick field wires, whereas the sense wires are made of 20-μm-thick gold-plated tungsten.

The cells are arranged in seven detection planes as indicated in Fig. 3 showing one of two parallel aluminum endplates between which the wires are stretched. Three detection planes (1, 4 and 7) contain vertical wires, two planes (2, 3) have wires