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DRIFT CHAMBERS FOR PRECISION TRACK MEASUREMENT OF THE TRAJECTORIES OF HIGH ENERGY MUONS

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The possibilities of increasing the registration precision of drift chambers are discussed, the conditions of space charge effects suppression with the help of a summation scheme are considered, a scheme of the muon spectrometer with a ϕ-magnetic field for neutrino detector is proposed.

The investigation has been performed at the Laboratory of Nuclear Problems, JINR.

Дрейфовые камеры для точного измерения траекторий мюонов высоких энергий

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Обсуждены возможности повышения точности регистрации треков в дрейфовых камерах, рассмотрены условия подавления эффектов объемного заряда с помощью схемы суммирования, предложена схема мюонного спектрометра с ϕ-товым магнитным полем для установки НЕЙТРИННЫЙ ДЕТЕКТОР.

Работа выполнена в Лаборатории ядерных проблем ОИЯИ.

The momentum of muons produced in neutrino interactions is shifted to a (100-300) GeV/c range for an expected energy of neutrinos in UNK beams. The wish for precision measurement of muon momenta imposes rigid requirements on the precision of measuring the particle tracks in detectors used to measure track coordinates in muon spectrometers and excludes the possibility of applying the magnetized iron disks.

The possibility of increasing the registration precision of drift chambers used to register events in muon spectrometers is discussed in this paper.

The detectors can be sufficiently extended along the beam, and this is one of the conditions which enables one to use some wires for the registration of a track section. This feature can be used even when drift chambers are placed in the magnetic field.

At the same time the following condition should be fulfilled:

$\Delta L \cong \sigma_d$,

where ΔL is the track deflection in the chamber along the beam and σ_d is the registration precision of the chamber which is equal to:

$$\sigma_d = \sigma_i \sqrt{n}, \tag{1}$$

with σ_i the track precision of an individual wire and n the number of wires.

The Table shows the values of ΔL for different muon momenta at σ_d equal to 10 μm, 50 μm and 100 μm in a magnetic field of 1.0 Tl.

Table

	P(Gev/c)					
σ_d, μm	1	10	100	300	500	1000
10	1.95	6.2	19.5	33.8	43.6	67.1
50	3.65	11.5	36.5	63.2	81.6	115.5
100	5.17	16.3	51.7	89.4	115.5	163.3

ΔL is shown in cm.

Thus, a drift chamber for the registration of muon tracks looks like that in fig.1a. The chamber cell has two drift gaps with D ≅ (15-30) mm. The signal element placed in the cell centre may have a configuration of the central electrode of a minidrift chamber or contain separate sensitive and cathode wire planes/1/. It is possible to have the registration precision of an individual wire equal to (50-100) μm using a "slow" gas mixture.

The main limitation on registration precision is by the statistics of clusters registered by the sensitive wires. A possible way of suppression of the space charge effects is to increase the sensitive wire diameter, to apply a "slow" gas mixture and to reduce the gas gain coefficient. However, in this case the pulse height from the sensitive wires decreases and the requirement for the information readout channels rises.

It seems possible to solve this discrepancy by grouping the sensitive wires and reducing the number of electronic channels simultaneously. In this case the errors of measuring the track coordinates can be estimated by formula (1). The scheme of connection of the sensitive wires is shown in fig.1b.

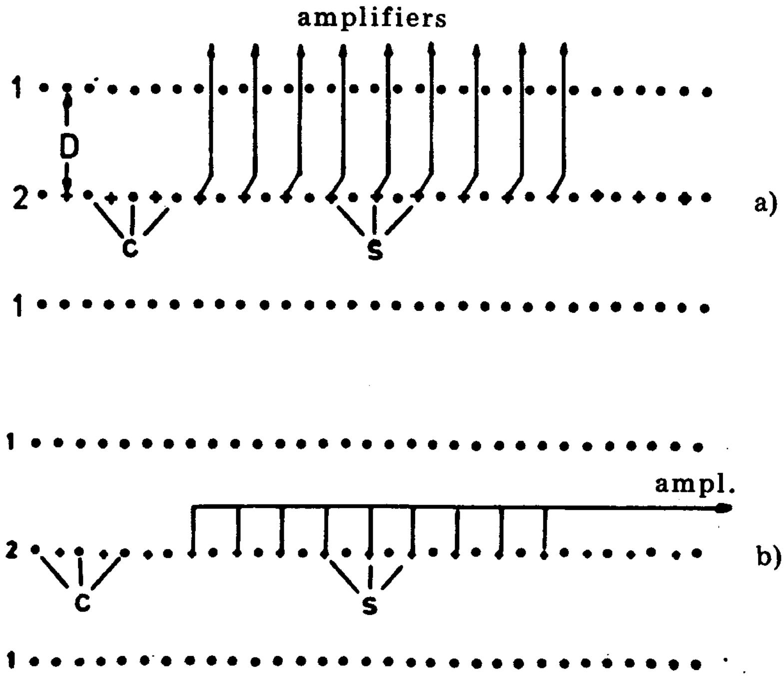

Fig.1. Cell scheme of the drift chamber; 1 — high voltage wire planes, 2 — plane of the sensitive (S) and cathode (C) wires, a — scheme with individual information registration channels from the sensitive wires, b — scheme with the connected sensewires.

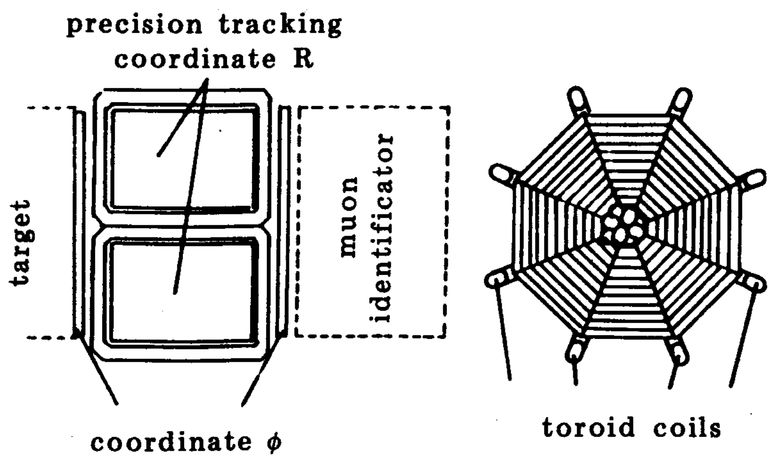

Fig.2. Scheme of the spectrometer for the measurement of muon momenta in the neutrino detector.

Thus, based on the proposed drift chambers, it is possible to construct a muon spectrometer which provides a precision of about some per cent for the measurement of muon momenta and has a moderate number of electronic channels.

The main element of such a spectrometer is a toroidal magnet forming a ϕ-magnetic field[2]. The second coordinate of the tracks is measured by the detectors placed in front of and behind the toroid. As a result, the view of the muon spectrometer is transformed to that shown in fig.2.

References

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2. EMPACT LOI, CLN, 5668-3180-90, 30 April 1990.

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