May 25,1998

DESIGN AND ESTIMATIONS OF MUON COUNTER PARAMETERS

FOR E614 DETECTOR

(Technical Note)

Yu.I.Davydov, V.I.Selivanov, V.D.Torokhov

Muon counter design is suggested. It is based on time expansion chamber (TEC) [1] working at gas pressure P=20torr in order to restrict a multiple scattering of muon. TEC's parameters with very low gas pressures has been investigated by several authors. In paper [2], for example, gas gain more than 10^5 has been demonstrated. The suggested counter does not change muon beam parameters essentially.

DESIGN

A sketch of the TEC is presented on Fig.1. Muons are moving into area between HV3 and HV4 planes where an electric field E is low and uniform (drift region of the TEC). Amplification region is situated between HV1 and HV3 planes.

The TEC presented on Fig.1 measures a drift time of clusters along X-axis and, therefore, can measure track characteristics of muon in XZ-plane (X position and angle between muon track and Z-axis). Sketch of 3D TEC is presented on Fig.2. First TEC measures a muon track in XZ-plane, second TEC does it in YZ-plane.

LOCATION OF THE TEC

A location of the TEC inside E614 magnet can not be successful because a big Lorentz angle value will be in a low pressure gas at B=2T. Best place for the TEC location is close to a fringe field area where a B value is not so big. According to the file tos_10300.dat B(r) value has maximum at Z=160cm. B(z) value at r=1cm and Z=150, 160, 170cm is correspondingly 10.5, 7.3, 3.5kG. B(r) component is lesser than 6% of B(z). We have selected the TEC location inside area Z=170-180cm in order to restrict a multiple scattering of muon in Z=160cm.

DRIFT GAS CHOICE AND PRECISION OF TRACK RECONSTRUCTION

We need to select a drift gas with low Lorentz angle THETA because tan(THETA) ~ 1/pressure [3]. Unfortunately no Lorentz angle data at low pressure. We have interpolated to pressure 20torr existed at 1Bar data for DME gas [4]. Lorentz drift angle value is 34, 18, and 4.5degree correspondingly at 10.5, 7.3, and 3.5kG.

Number of electrons from a surface muon in DME gas at 20torr is about 2.6 per 1mm [5]. It will provide a reliable muon track registration by all wires at a threshold value equals to about 1.5e.

Precision of muon track reconstruction will be limited by multiple scattering, Lorentz drift angle, and longitudinal diffusion of clusters in a low pressure drift gas.

The suggested muon counter will be located inside area Z=170-180cm (Fig.2). 30 sense wires are in each TEC. Multiple scattering angle of 6um mylar window and 200mm of gas gap is correspondingly 4.5mrad and 3.8 mrad. It corresponds to an additional beam spread about 1mm at Z=160cm. Beam spot size will be 5.1mm (1/2*FWHM) at

Z=160cm because the scattering if initial beam spot size was equals to 5mm (1/2*FWHM). Beam divergence will be 16.1mrad (1/2*FWHM) if an original beam divergence equals to 15mrad (1/2*FWHM).

Biggest Lorentz angle value on the counter is 4.5degree (1/2*FWHM). It corresponds to an average lengthening 30um of an average drift distance 1cm in the TEC. The lengthening will cause a systematic shift 30um of X(or Y) coordinate of a measured track. A systematic shift of measured angle THETA will be negligible because a beam divergence is too small (15mrad). This lets us to try to move the TEC closer to Z=160cm, may be, in order to restrict more the above scattering contribution.

Longitudinal diffusion value in DME gas at 20torr has been interpolated from a high pressure data [6]. It is about 200um per 1cm. The diffusion will cause an error about 50um of a measured X (or Y) coordinate and an error about 2mrad of a measured track angle.

Drift time of clusters in the drift region will be defined by value E/p. For example, a drift velocity in DME gas will be 15um/ns at E/p=2V/cm-torr. It corresponds to a maximal drift time (L=2cm) to be 3.9us. E/p value for the amplification region can be selected experimentally because no data of using of DME as drift gas in a TEC.

CONCLUSION

The suggested muon counter has below characteristics:

- error of measured muon coordinate (X or Y) is +/-50um;
- error of measured track angle relative to Z-axis is +/-2mrad;
- multiple scattering of muon increases a beam divergence by 6mrad. It corresponds to divergence 16.1mrad for an original divergence 15mrad.
- multiple scattering of muon increases by 1mm of a beam spot size at focus. It corresponds to 5.1mm of a spot size for an original spot size 5mm.

REFERENCES

1. A.H.Walenta. IEEE Trans.Nucl.Sci. NS-26(1979)75
2. A.Breskin, R.Chechik, N.Zwang IEEE Trans. Nucl. Sci. NS-27(1980)133
3. W.Blum, L.Rolandi “Particle Detection with Drift Chambers”, Springer-Verlag(1993)p.335
4. B.Zhou, A.Marin, T.Coan, J.Beatty, S.Ahlen Nucl. Instr. and Meth. A287 (1990)439
5. A.Sharma, F.Sauli Preprint CERN-PPE/94-110 (1994)
6. B.A.Dolgoshein (1984), private communication to book A.Peisert and F. Sauli “Drift and Diffusion of Electrons in Gases: a Compilation”, CERN 84-08(1984)p.125