Characterization of Straw tube detector

N. Nandi[1], S. Roy[2],* R. P. Adak[2], S. Biswas[2], S. Das[2], S. K. Ghosh[2], S. K. Prasad[2], and S. Raha[2]
[1]*Raja Peary Mohan College, 1 Acharya Dhruba Pal Road, Uttarpara, Hooghly, West Bengal- 712258, INDIA and*
[2]*Bose Institute, Department of Physics and CAPSS, EN-80, Sector V, Kolkata-700091, INDIA*

Introduction

Straw tubes are currently being used in large High Energy Physics (HEP) experiments as tracking detector with low material budget [1]. We are exploring the possibility to use straw tubes for the 3^{rd} and 4^{th} stations of CBM-MuCh [2, 3]. Basic R & D have been carried out with one small prototype straw tube detector with premixed gas of Ar+CO_2 in 70:30 ratio. The count rates and the ionisation current are measured using Fe^{55} radioactive source. The details of the measurement process and the experimental results are presented in this report.

The Straw tube detector

The straw tube detector is basically a single wire gas chamber operated in proportional region. The details of this detector and its principle of operation are described in Ref. [4, 5].

Experimental set up

A prototype straw tube detector with 6 straws each with diameter 6 mm and length 20 cm is tested with a premixed gas of Argon and CO_2 in 70/30 volume ratio in flow mode at a rate of 3 lt/h. The detector is tested using conventional NIM electronics. The positive high voltage (HV) is applied to one end of the central wire of the straws using a HV filter box and the signal is collected from the other end through a capacitor using LEMO connector. Single HV channel is used for each straw tube. From preliminary study, it is known that the straw tube detector reaches its highest efficiency at 1600 V and above [5]. The output signal from the straw is fed to a pre-amplifier and the output of the pre-amplifier is put to a timing SCA. The SCA is operated in integral mode and the lower level in the SCA is used as the threshold to the signal. The discriminated TTL signal is fed to a TTL-NIM adopter and the output is counted using a NIM scaler. The count rate (i.e. counts per second) of the detector is then calculated. The current due to ions collected at the cathode is measured from the HV power supply. In this report, the result of current measurements is presented.

Results

The variation of the ion current as a function of voltage is shown in FIG 1. It can be seen that the ion current exponentially increases with voltage.

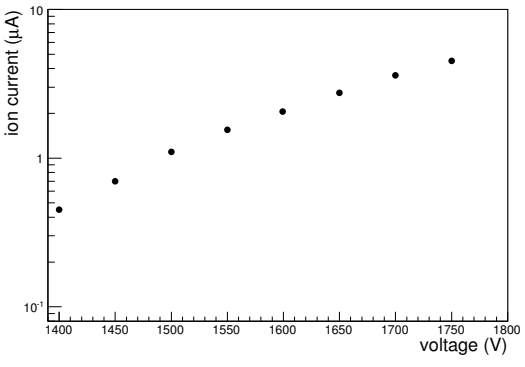

FIG. 1: Ion current as a function of voltage. The error bars are smaller than the symbols.

Ion current is also measured by placing the

*Electronic address: shreyaroy2509@gmail.com

Fe^{55} source at different positions along the length of the straw tube. The HV to the straw is set to 1750 V for this study. The results are shown in FIG 2. The ion current is observed to be uniform along the length except at the two ends.

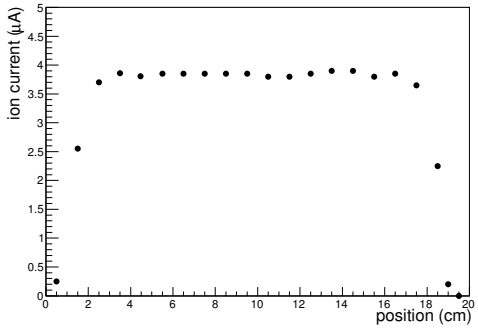

FIG. 2: Variation of the ion current along the length.

Variation of ion current at cathode resulting from incident X-ray from the source, as a function of height is measured by varying the distance of the source from the straws using a mechanical stand. The ion current is measured for each settings. The variation of the ion current as a function of the distance is shown in FIG 3. The ion current decreases with height as $\sim \frac{A}{r^2}$.

Summary and outlooks

Basic characteristic studies are performed for straw tube detector with $Ar+CO_2$ gas in 70:30 ratio using conventional NIM electronics. In this study ion current or the relative gain is studied systematically. The variation of the ion current at cathode with distance is also studied. It is observed that the relative gain increases exponentially with applied voltage, the gain remains uniform over the length of the straws and the ion current at cathode decreases with distance as $\frac{A}{r^2}$. Possibility to use of the straw tube detector in CBM MuCh as tracking stations with low material budget is under investigation.

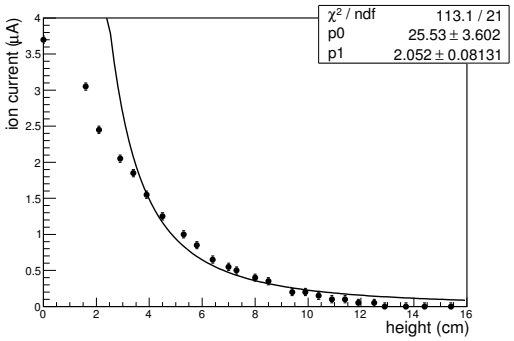

FIG. 3: Variation of X-ray intensity with height.

Acknowledgments

We would like to thank Late Prof. Vladimir Peshekhonov of JINR, Dubna for providing the straw tube prototype and Dr. Subhasis Chattopadhyay, Mr. J. Saini of VECC, Kolkata, Dr. Christian J. Schmidt of GSI Detector Laboratory for valuable discussions in the course of the study.

References

[1] T. Akesson et al., NIM A 449 (2000) 446.
[2] http://www.fair-center.eu/for-users/experiments/cbm.html .
[3] http://www.fair-center.eu/ .
[4] T. Akesson et al., NIM A 361 (1995) 440.
[5] R P Adak et al., Proc. of the DAE-BRNS Symp. on Nucl. Phys. 61 (2016) 996.