Performance test of a Cylindrical Drift Chamber

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In order to measure intermediate energy pion, kaon, and proton with high efficiency, we have designed and constructed a jet-type Cylindrical Drift Chamber (CDC) [1]. The CDC consists of 12 sectors with 16 sense wires each. The total sensitive volume is 50 cm long and spans 9 cm to 25 cm in radius. The particle position in the rϕ plane is determined by the drift time measurement. The longitudinal coordinate along z axis is measured by the charge division method.

The sense wires are kept at ground potential. All potential wires are held at the same potential of -1.36 kV by using a single power supply. The gas gain can be adjusted through this voltage. The cathode wires and field-shaping wires are connected to the resistor-divider chains and kept at an electrical potential so as to generate a uniform electric field perpendicular to the anode plane. Two high-voltage power supplies are used to power the 12 resistor divider chains. One supplies -1.36 kV and another -9.43 kV. At this condition, the electric field in the drift region is about 1.1 kV/cm.

The performance test of the CDC has been done by using cosmic muons. A trigger for cosmic ray muons is provided by two scintillation counters placed above and below the CDC. A 5 cm layer of lead placed just above the second scintillator provides an energy cut of about 96 MeV. The counter gas used was Ar(70%) - isobutane(30%) mixture at atmospheric pressure. The gas gain was estimated to be 2.9 $\times 10^4$, and the wire efficiency was about 99.1%. The readout electronics consists of Preamp, Post-Amp, Discri, ADC and TDC. The Preamps are attached to the end plates of the CDC. The experimental arrangement together with the DAQ system is shown in fig. 1. Two examples of cosmic muon trajectories observed with CDC are shown in fig. 2.

At the beginning of the performance test, the drift velocity was measured experimentally as $v_D = 52.1 \pm 0.7$ μm/ns. The value reproduces previous data with the above gas. The absolute value of drift distance could be described as $d=v_D T$, when the drift distance from the sense was larger than 0.5 mm. Here T denotes the drift time. In the case of drift distance within 0.5 mm, some correction is needed for the x-t relation.

The position resolution was determined by using three adjacent hit wire's data. The time resolution was improved by a timing correction due to signal's pulse height for the leading-edge type discriminator. The position resolution in the rϕ plane obtained is shown in fig. 3. The value was $\sigma_{r\phi}$=100 $\sim$ 190 μm dependent on the drift distance. Near the sense wire, the spacial fluctuation of the primary electron causes a deterioration of the position resolution. On the other hand, at large distance from the sense wire, the resolution is deteriorated by the effect of spacial diffusion of the drifting electrons.

In order to determine the position resolution in the z direction by the charge division method, first the gains of Preamp and Post-Amp system were calibrated for every channel by using a small size scintillation counter placed at the middle of the sense wire length and the cosmic ray muons. As shown in fig. 4., the resolution obtained was σ_z = 2.4 $\sim$ 3.5 mm. This value is about 0.5% for the total 60 cm Ni-Cr sense wire. The noise level of the Preamp on the end plates mainly affects the z-direction resolution. It seems to be necessary to place

an effective electrical shield on the end plates to improve the resolution.

The left-right ambiguity of the trajectory with respect to the anode plane could be resolved with an accuracy of 98% owing to the ± 200 μm staggering of the sense wire [2].

References

[1] N. Matsuoka et al., RCNP Annual Report (1996) 124 and (1997) 237.

[2] J. Heintze, Nucl. Instru. Meth. **156** (1978) 227.

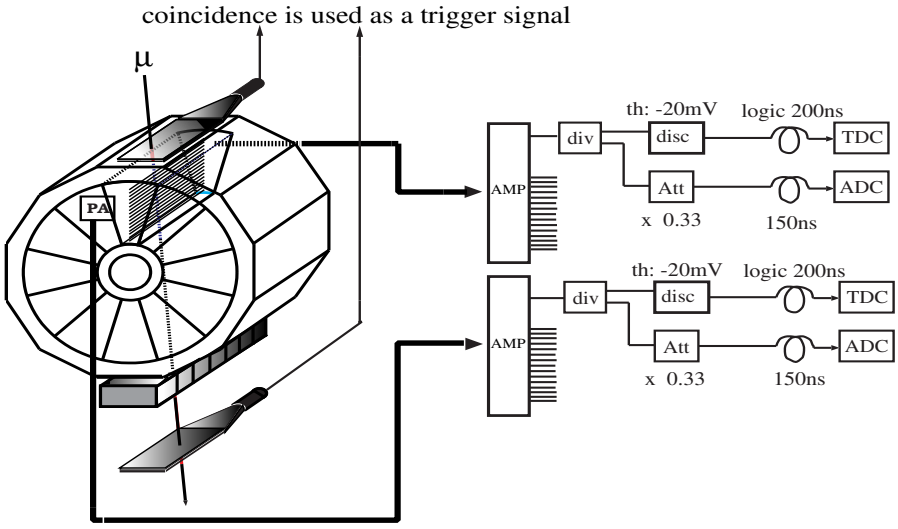

Fig. 1. Experimental arrangement and the DAQ system for the performance test of the CDC.

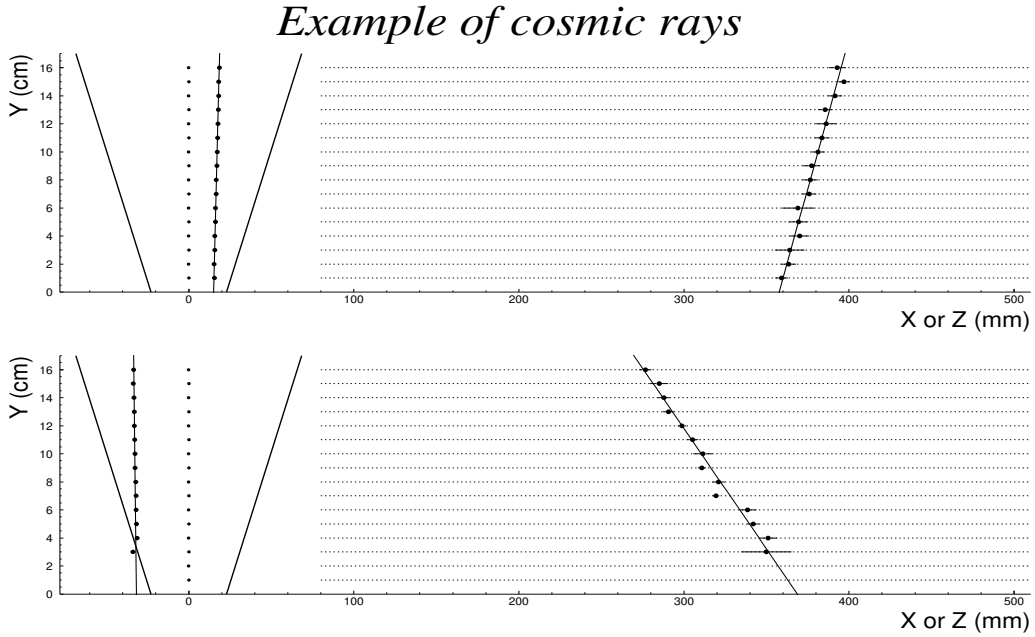

Fig. 2. Two examples of the cosmic muon trajectories observed with the CDC. Left part shows the drift length to the anode plane, and right part the position along the z-axis. Small dots at x=0 along y-axis show the sense wires. The straight lines are the result of the fitting to the data points.

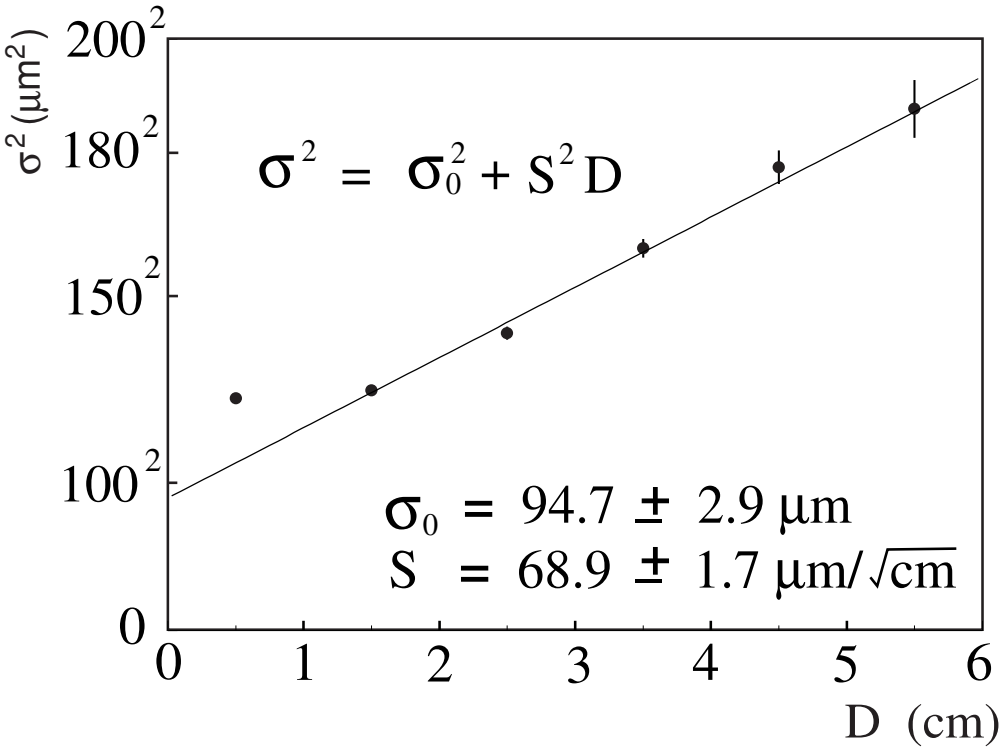

Fig. 3. Position resolution in the rϕ plane as a function of the drift distance. The straight line is the result of the fitting to the data at D $\geq$ 1cm.

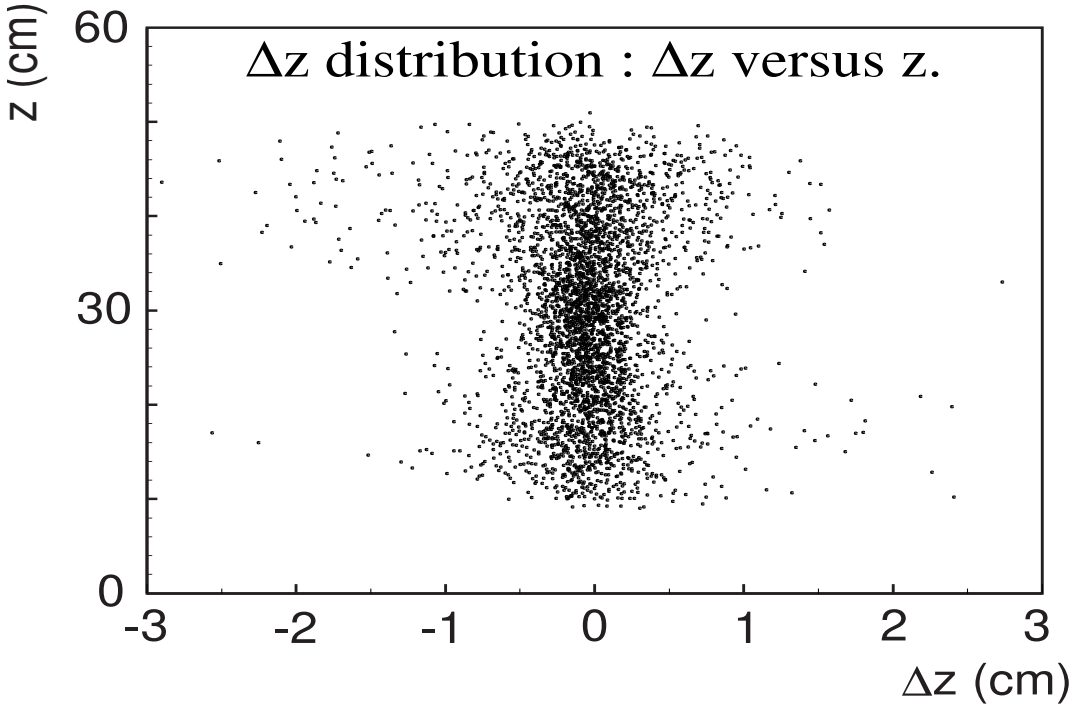

Fig. 4. Dependence of Δz on the z-coordinate