Beam-halo Measurement

T.Tahara, Y.Irie, T.Adachi and S.Mutou
National Laboratory for High Energy Physics
1-1 Oho,Tukuba-shi, Ibaraki, 305 Japan

Abstract

Precise measurement of a transverse beam profile was carried out by scanning a thin wire across the pulsed beam. Scintillation counter that was located outside the beam-line vault counted the radiations caused by the interaction of the beam with the wire. The peak-to-background counting ratio amounted to $10^{2.8}$, and a clear shape of the tail part, which we call 'beam-halo', was obtained. It took 30 minutes for the measurement.

I. Introduction

It is important for the design of beam-line aperture to know real extent of the beam distribution. Such a measurement was performed so far in relation to high radiation level in the experimental areas, by means of activation method using $^{12}C(p, p'n)^{11}C$ reaction [1]. The result showed a two dimensional distribution of particles with very low background counting. However, it took more than half a day and much effort was needed. The procedure reported here only concerns one dimensional distribution, but it is simple and timesaving with sufficient resolution.

II. Measurement

The pulsed beam, which is extracted at 20 Hz from the PS Booster synchrotron and has a 100 nsec duration, was scanned horizontally by a 1mmϕ copper wire, which was driven by a reversible motor. The plastic scintillator with the photomultiplier was located in the shielding bank and with perpendicular direction to the beam-line from the scanning point. The detector output was fed through an energy discriminator into the coincidence circuit, where the output pulse was gated by the timing requirements. Figure 1 shows a block diagram of the counting system. The kicker pulse was sent from the PS control room to the counting system a few µsec before the beam extraction was actuated. Different kinds of timing gates were tested; a delay time with respect to the kicker pulse and a gate width. Consequently, the pulse of 200 µsec width with 40 µsec delay was chosen as the timing gate in order to obtain the highest peak-to-background counting ratio. The output signal from the detector is shown in Figure 2, where 2.2 KV was imposed on the photomultiplier. All the signals below the threshold of -0.3 V were counted.

The distance from the scanning point to the beam dumps at the end of the beam-line was also varied in order to see the effect upon the measurement. In the first scanning point (position 1), the distances to the neutron production target (depleted uranium) and the primary proton dump (iron) which is located downstream of a muon production target were 22 m and 33 m, respectively. In the second point (position 2), the scanning point was moved upstream and the distances became 35 m and 45 m, respectively. The beam intensities during the course of these measurements were 1.4~1.7 protons per pulse.

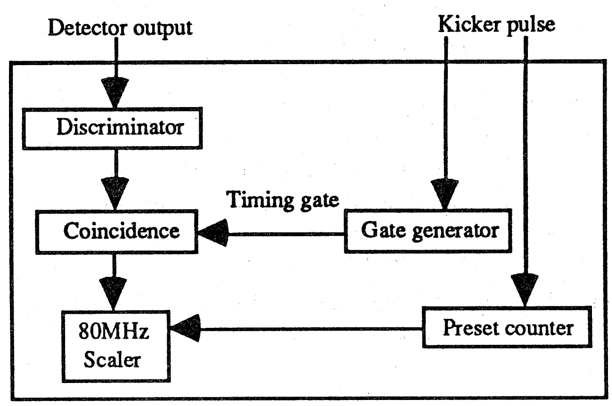


Figure 1 Block diagram of the counting system which is made of NIM modules.

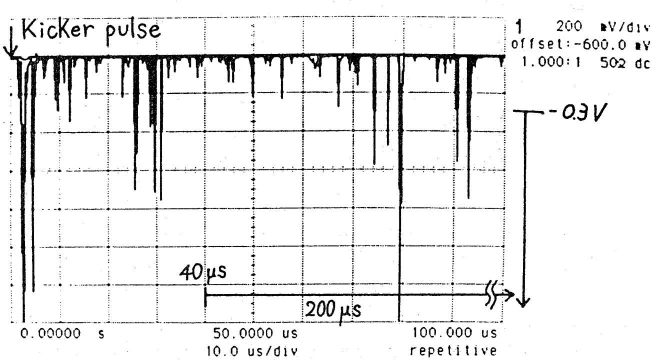
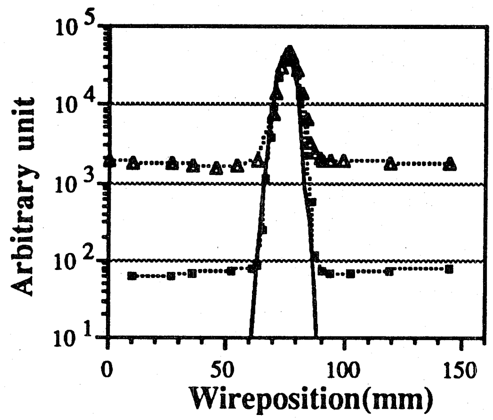


Figure 2 Raw signal from the plastic scintillator output.

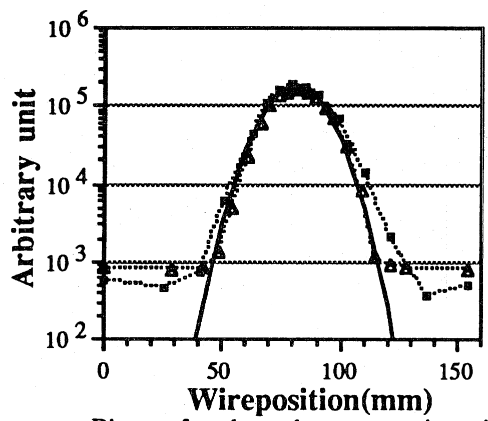
III. Results

Figures 3 and 4 show the results of beam profile measurement with wire scanning at different positions. It took about 30 minutes for each scanning. In position 1, the effect of the beam dump upon the background counting is clear, while not so much difference can be seen in the position 2. The fitting of the data to the Gaussian distribution was examined to compare the 2σ width with the analytical value obtained by another method [2]. The comparison is shown in the Table, where the present measurement indicates narrower beam width than the analytical one by 30~50 %.



Distance from beam dump to scanning point is 22m
Distance from beam dump to scanning point is 33m
Gaussian-curve fitting

Figure 3 Horizontal beam profile measurement with wire scanning at position 1



Distance from beam dump to scanning point is 35m
Distance from beam dump to scanning point is 45m
Gaussian-curve fitting

Figure 4 Horizontal beam profile measurement with wire scanning at position 2

Table Comparison of 2σ beam width by the present measurement with those given in reference [2] which utilizes a multiwire secondary emission monitor for beam profile measurement.

	Analytical value given in reference [2]	Present measurement
Position 1	12.1 mm	6.6 mm
Position 2	36.0 mm	23.6 mm

IV. Conclusion

Precise measurement of a transverse beam profile could be done by scanning a 1mmϕ wire across the pulsed beam. The plastic scintillation counter, located far from the beam-line, counted the scattered radiations. The peak-to-background counting ratio amounted to $10^{2.8}$, and it took 30 minutes for the measurement. Preparation is in progress to observe the radiations by using a boron loaded scintillator.

V. References

[1] M. Arai et al, "Proton beam profile and radiation level in KENS facility", KEK Progress Report 86-2, pages 29-36, 1987.

[2] Y.Irie et al, "Progress during the decade of the BSF Beam-Line", KEK Report 91-6, July 1991.