# BEAM PROFILE MONITORING IN ATMOSPHERE

S. Fukumoto, Z. Igarashi and C. Kubota

National Laboratory for High Energy Physics

It is necessary to measure beam profiles of high energy protons not only in the vacuum but also in the atmosphere for cancer therapy or other applications. Photographic films have been used widely for monitoring the beams. However, both an X ray film and a Polaroid film are too sensitive to detect one burst of the KEK booster beam of $5 \times 10^{11}$ protons. And they are not suitable for tuning of the machine, because they should be developed after every exposure to the beam.

The multi-wire profile monitors were developed in the KEK[1] and they have been installed in the vacuum chambers of the accelerator complex. The proton energy is so high that almost all protons pass through the wires, but they release secondary electrons form them. The block diagram of the electric circuit is shown in Fig.1. There are few ions which impinge on the wires in the vacuum. If the wires are suitably biased, then secondary electrons, which are originated on the surface of the vacuum vessel or other equipments, could be suppressed. Conditions are different in the atmosphere, that is, many ions and electrons are produced by the proton beam. As the KEK 500 MeV booster beam is very short pulse of several times $10^{-8}$ sec., a fast gate circuit reduces the effect of the ions and the electrons above mentioned.

A beam profile at about 2 m upstream of the pulsed neutron target is shown in Fig.2. As a bin correspond to 2.5 mm, FWHM of the vertical profile is 22.5 mm and that of the horizontal one is 35 mm. To decelerate to 300 MeV, the protons pass through a carbon degrader of 44.5 cm thick. The beam sizes grow to 37.5 mm and 47.5 mm respectively as shown in Fig. 3. Duration of the gate pulse did not affect the beam profile but each output signals of 5 μS was about a half of corresponding one of 10 μS. The output signals are affected by a metal plate just upstream of the monitor and potentials applied to the plate as shown in Fig.4. Ions and electrons, which are produced by the beam, do not vanish by recombination in 10 μS. Some electrons arrive at the wire by a potential due to electrons which are released from the plate. If the plate is biased positively, then the electrons to the wire decreases and the output signals increase. If it is biased negatively, drift velocity of the electron becomes greater and finally the output signals are inverted. In both cases, however, the position of the peak and FWHM are not changed.

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## References

1) H. Ishimaru et al., IEEE Trans. Nucl. Sci., NS-24, 1821, 1977.
H. Ishimaru et al., Proc. 2 nd Symposium on Accelerator Science and Technology, 125, INS Tokyo, 1978.

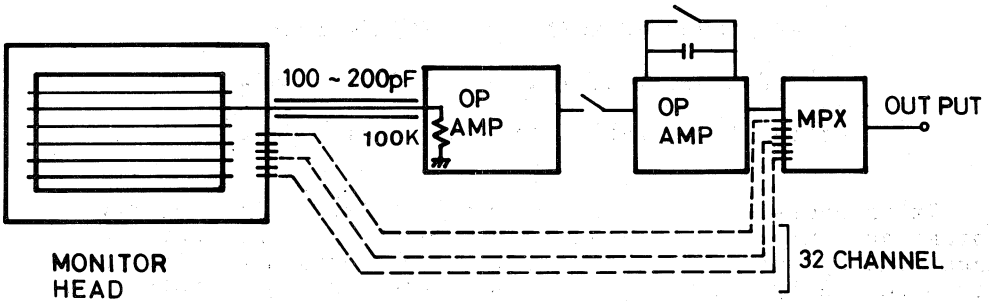


Fig.1 Block diagram of profile monitor.

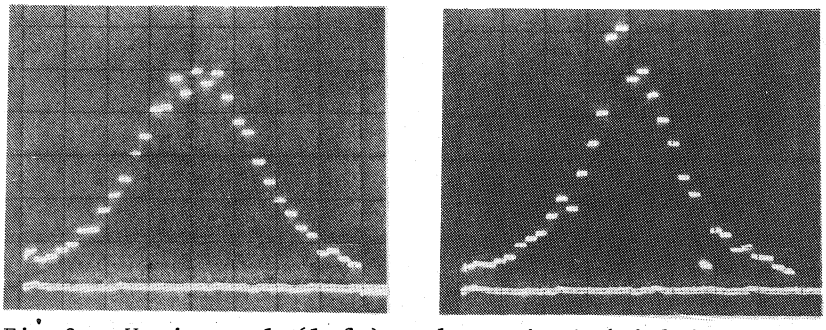

Fig.2 Horizontal (left) and vertical (right) 500 MeV beam profiles.

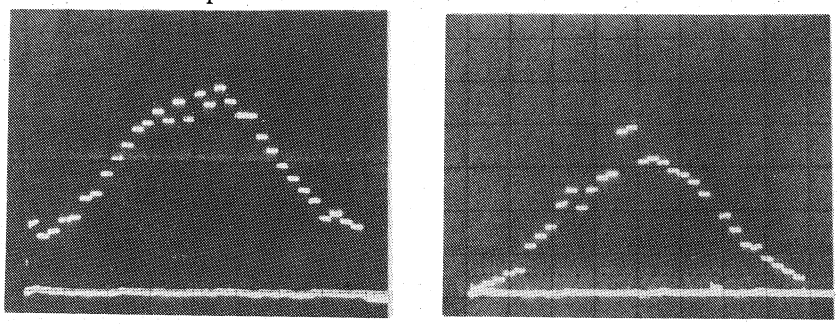

Fig.3 300 MeV beam profiles decelerated by carbon degrader.

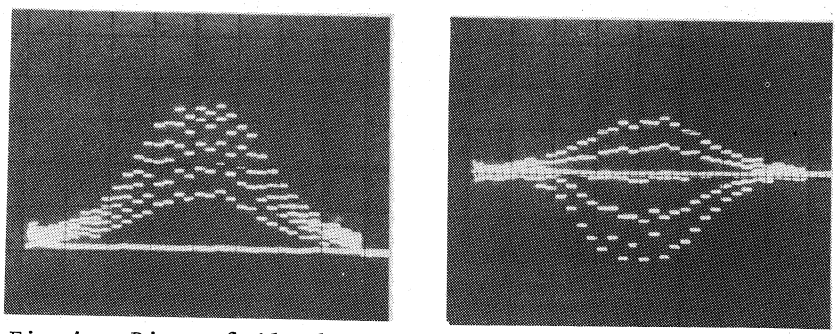

Fig.4 Bias of Al plate vs. monitor output. The plate is 5 cm upstream of the monitor. The bias voltages are, 200, 150, 100, 50 and 0 V (left) and 0, - 50, - 100, - 150 and - 200 V (right).