BUNCH SIGNAL SENSITIZATION BY USE OF SECONDARY ELECTRON EMISSION

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When beam bunches are measured at the early acceleration stage of heavy ion linacs where the beam is relatively slow ($\beta \sim 0.01$) the bunch signals are distorted by slow ions. Therefore it is difficult to know accurately the longitudinal distribution of beam bunch from the bunch signal shape. In order to eliminate this signal distortion, a shield plate is set just in front of a detection plate in case of a coaxial Faraday cup (Ref. 1). But the beam is stopped partly by this shield and the bunch signals are weakened. As the result, a SN ratio becomes worse. This problem can be solved easily using the secondary electron effect which usually is suppressed in the coaxial Faraday cup.

A secondary electron effect bunch probe was developed and is being used to monitor the bunch structure at the RILAC (RIKEN linac). A schematic diagram of the probe head is shown in Fig.1. The probe is plunged into the beam line remotely with a pneumatic cylinder during the measurement. The structure is similar to that of the coaxial Faraday cup except that an electon collector is set to absorb efficiently the electrons emitted from the stopping plate by the beam bombardment.

Two kinds of currents appear in the signal coaxial cable. One is the induction current I_i by the ions which are approaching to the stopping plate and stopped there. The other is due to the secondary electron emission I_e. The signal shapes of these currents are calculated on the assumption that the beam bunch has a triangle shape distribution with the spread of 2 nsec (fwhm), and that no electric charge is induced on the stopping plate until the ion goes through the entrance aperture of the electron collector. The results of calculation are shown in Fig. 2 a) and b). When the electron collector is biased at a negative voltage as in normal use of a coaxial Faraday cup, the signal I_i can be observed. On the other hand, when the electron collector is biased at a positive voltage, the signal of $I_i + I_e$ is obtained. But I_e is in general much larger than I_i and, therefore, the signal shape is almost due to I_e. The output signals on a 350 MHz oscilloscope are shown in Fig. 3 a) and b): a) is with a negative bias on the electron collector, while b) is with a positive bias. The signals have the same tendency as those of the calculations in Fig. 2 a) and b). A factor of signal enhancement, which depens on the beam energy, the ion species and the material of stopping plate, is around 15 for a 2.3 MeV Ar^{4+} beam with a copper plate for the stopping plate.

Using the secondary electron effect bunch probe, the beam bunch measurement for a low intensity beam can be made with a better SN ratio as well as a fast response to the beam bunch.

Ref.1) J. Klabunde et al. Proc. of 1979 Linear Acc. Conf. p297

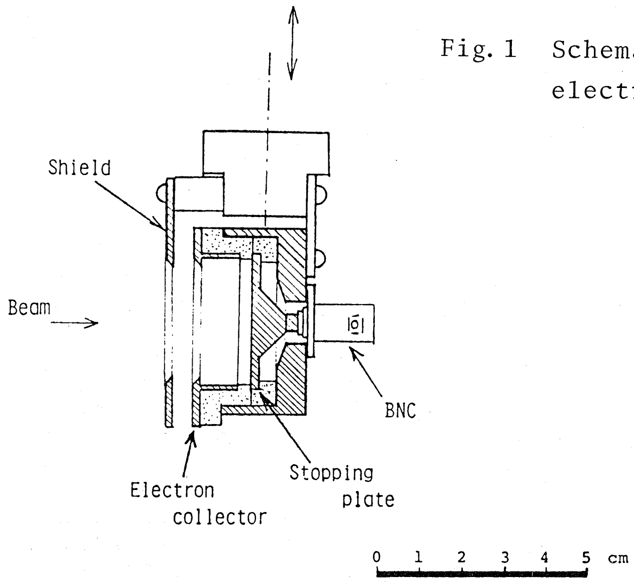

Fig. 1 Schematic view of the secondary electron effect bunch probe.

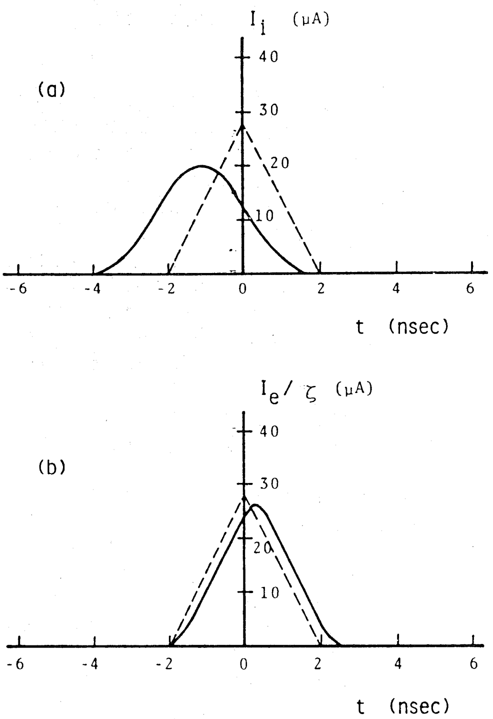

Fig.2 Calaulation of bunch signals I_i and I_e. $\beta = 0.015$, the beam intensity is 1 μA. The bunch shape is shown by a dashed line. ζ is a factor of signal enhancement by secondary electrons.

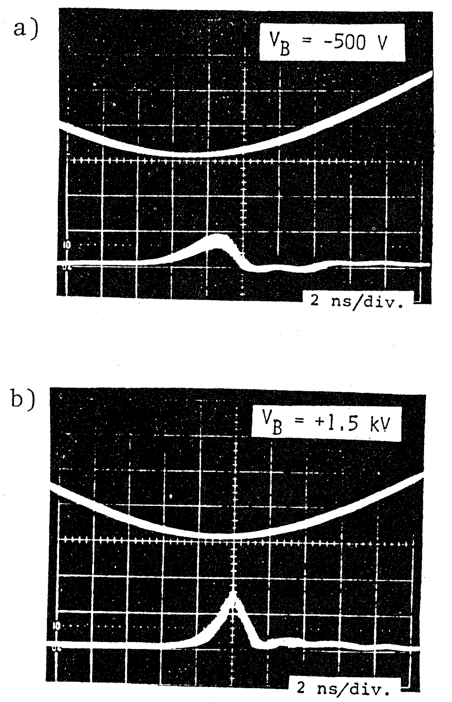

Fig.3 Bunch signals for I_i a), for I_e b). The beam is of 2.3 MeV N^+ (β = 0.019)