SERVO-SPILL SYSTEM FOR KEK INTERNAL TARGET

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Servo-spill system for an internal target at KEK has been used since the beginning of 1977.

The arrangements of the bump magnets (B4 and B5) for a local orbit bump, the beam channel of the secondary particles and the internal target in the main ring is illustrated in Fig.1. The location of the target is 15 mm outside of the central orbit and its angle made by the beam is 10 degrees in the horizontal plane.[1] The orbit displacement at the target versus the exciting current of the B4 bump magnet is approximately given by $\Delta r[\mathrm{mm}] \simeq 0.293\ I_4[\mathrm{A}]$.

The target process is multi-traversal, and the step increment of orbit displacement onto the target produces a secondary beam spill with finite interval. This process may be considered equivalently as a R-C differentiation network, whose transfer function is $\frac{s}{s + \omega_T}$, where ω_T is $\sim 2\pi \times 200$ rad/sec, depending on the target and machine parameter.

The transfer characteristics of the bump power supply was analyzed. It gave nearly 130° phase lag at 300 Hz (Fig.2). The secondary beam spill is monitored with a scintillation counter, working in the linear mode. Its location is the downstream of the target. This monitor has a higher cut-off frequency of 1.4 KHz.

The block diagram of the servo system is shown in Fig.3. The difference between the spill and the reference signal is fed into two phase lead networks, which compensate the phase lag of bump power supply, and then into an integrator with a phase lead resistor, which compensates the target process. And finally the signal drives the bump power supplies to sweep out the beam onto the target. The Bode diagrams of the system are shown in Fig.4, where dotted lines show the case when there is a difference between the network and the real target process.

The oscilloscope traces of the spill monitor output with and without operation of the servo-spill system are given in Figs.5 and 6. At the end of the spill there are small spike which is due to the hallow of debunched beam. It was impossible to remove the spike because of the limitation of the loop gain and of the dynamic range of the bump power supply.

Improvement of the spill structure in operating the servo-spill system is apparent. The low frequency structure in the spill due to the momentum distribution of the debunched beam could be removed by the installation of this system.

Reference

1) 第一回加速器科学研究発表会報告集 p 47 1976
2) H.G. Hereward et al., Efficiency of Multi-traversal Targets, CERN 65-1.
3) G. Shering, Servo-Spill System for Targets and Slow Ejection, CERN/MPS/CO 71-8.

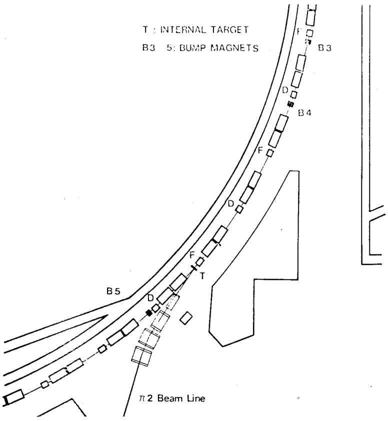

Fig.1 Layout of bumps and internal target in the main ring.

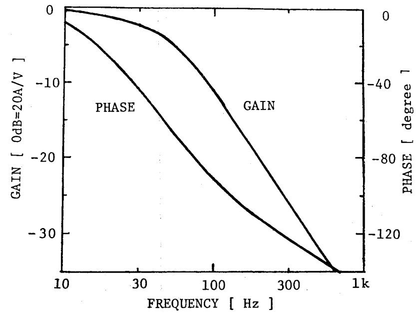

Fig.2 Frequency responce of bump power supply.

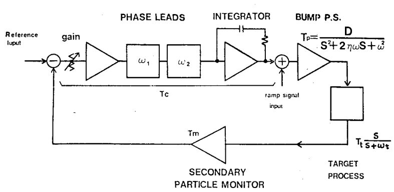

Fig.3 Block diagram of servo-spill system.

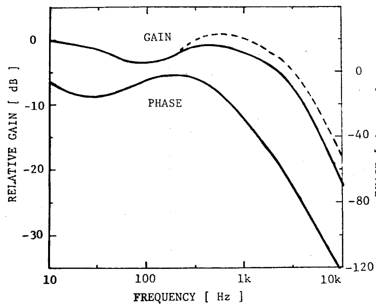

Fig.4 Estimated loop gain of servo-spill system.

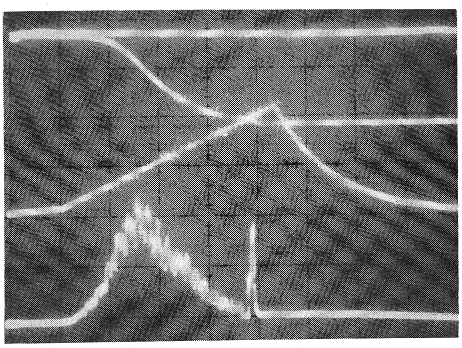

Fig.5 A photo of the beam spill without servo. The traces are circulating beam current, current of bump magnet, and output of spill monitor.(Horizontal= 100msec)

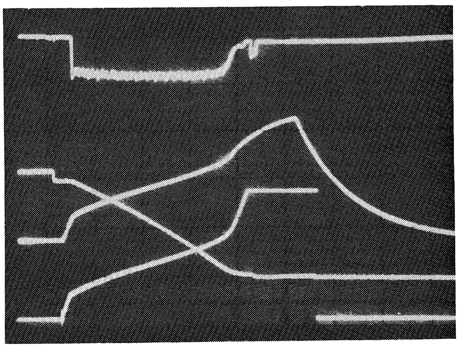

Fig.6 A photo of the beam spill with servo. The traces are output of spill monitor, circulating beam current, current of bump magnet, and output of connecting circuit.(Horizontal= 100 msec)