ORBIT CONTROL AND ABS TRIAL AT KEK 12GEV PROTON SYNCHROTRON MAIN RING

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Abstract
A new physics experiment of neutrino oscillation requires the high beam intensity at KEK 12 GeV Proton Synchrotron. The machine physics study and the improvements of machine equipment are now going on to increase the beam intensity for this experiment. The automated beam orbit control is one of the subjects for this intensity up-grade project. During the ABS implementation in the PS, we investigated how to reject the position monitor anomaly and an improvement of the orbit correction algorithm by including the correlation analysis of the orbit data with the beam loss around the machine. A brief description of the current ABS system in KEK PS is described in this article.

1. INTRODUCTION

The long-baseline neutrino oscillation experiment [1] requires a stable beam more than 6×10^{12} ppp, which are nearly equals to the current maximum achievement of the KEK PS. The ABS has to install for control the beam orbit continuously and precisely during the operation to keep this intensity. As an example, the beam orbit causes day by day drift from 3 mm to 10 mm in horizontal plane during the daily operation. This drift is speculated coming from (a) the exact orbit shift by a deformation of the accelerator floor etc. [2] [3] and (b) an anomalous signal level shift of a beam position monitor electronics or the pickup itself. In the case (a), we must correct the beam orbit. On the other hand, in case (b) we do not use data of such pickups. For separating these problems, it needs to identify the two types of cause in orbit measurement. To solve such problem, some trial was done to identify some failed position monitors. Nevertheless, in our case, results were not good. We need alternate method to do so. At operation of KEK PS, the beam loss signal has been used many works. When operators control the obit, also, they use the beam loss signal to control each local bump. Then, we are planning to use the beam loss signal for automated orbit control.

2. ORBIT MEASUREMENT

2.1 Typical orbit of our main ring

At KEK PS Main Ring, 56 beam position monitors are installed in four super periods [4]. Horizontal orbit data is shown in Fig. 1. In this figure, vertical scale is time from injection to near flat top. Each orbit trajectory stands side by side. Each group corresponds to a superperiod. The figure shows that there are some failed monitors and there are orbit deformation at both injection and extraction areas.

2.2 Drift of beam orbit

The orbits were corrected by operators day by day. Orbit distortion was checked and its result is shown in Fig. 2. The figure shows that our corrected orbits were drifted from 10 mm to 3 mm (selected monitors' rms).

Many causes are conjectured and many studies are doing now. Because relations between causes are complex, identification of main part of the cause of drift is not so easy. Therefore, we must improve the problem by automated correction engineering.

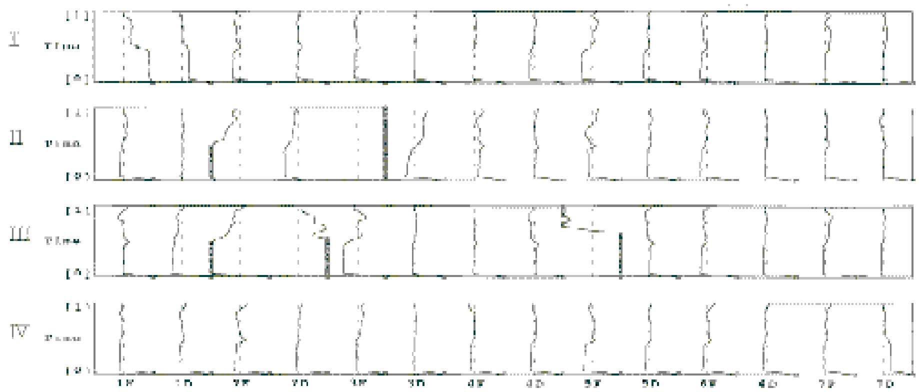

Fig. 1: Typical orbit trajectory from injection to near flat top.

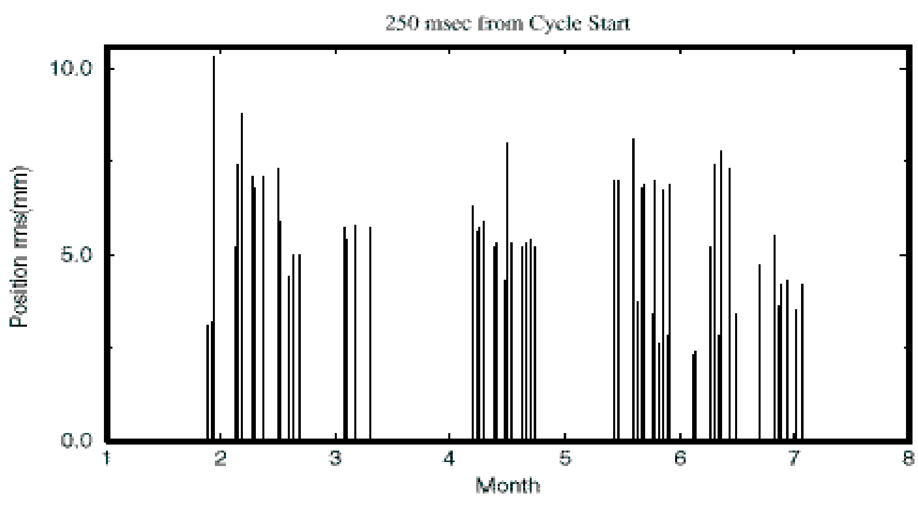

Fig. 2: Orbit RMS drifts day by day. (In 1998)

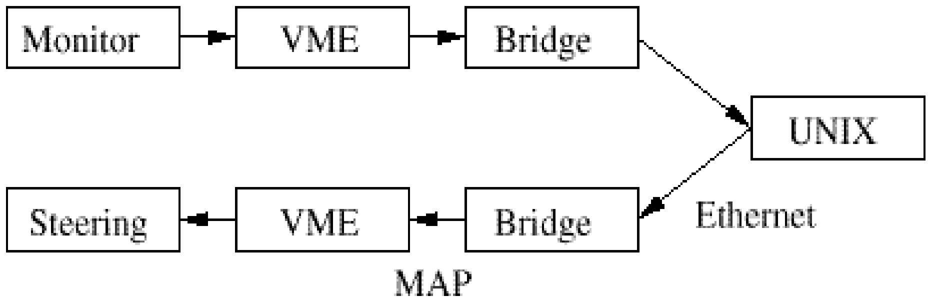

Fig. 3: Data flow of our study.

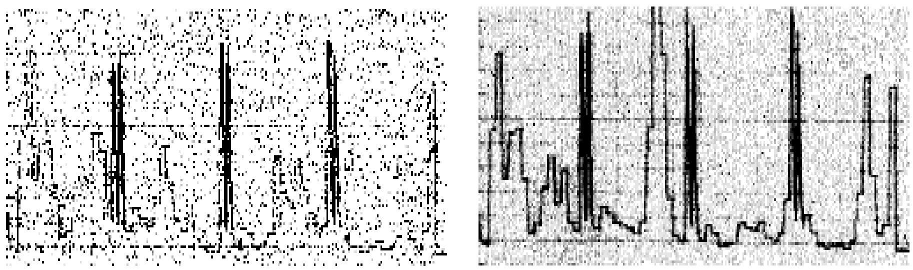

Fig. 4: Beam loss data when test of ABS.Left: Before correction. Right: After correction.

3. STUDY OF SEMI-AUTOMATED ORBIT CORRECTION

3.1 Correction method in this test

Simple automated orbit correction studies were done a few times to get an information which is used to build a full automated orbit correction system. Manual orbit correction system of KEK PS was built on the VME-MAP control system [5]. Position monitor signals were got and displayed by VME computer. The steering magnets were controlled also by the VME. In this study, a Unix computer was used to connect the two subsystems. Because the VME computers were operated under ”OBJP” environment [6], this part is so easy. The data/command flow is shown in Fig. 3.

3.2 Results of test

Simple programs of orbit correction were made of our own. Data flow shown in Fig. 3 was used for both orbit correction and making response matrix. Unix calculation server gets response matrixes and current orbit information and makes a set of current value of steering magnets. This process can do automatically. At the calculation of a set of current, monitor control table is used, which holds monitors live/dead information. At the study, these tables were manipulated by hand for correction state control. The result of orbit correction by position monitors were checked both intensity monitors and beam loss monitors [7]. One of the results of orbit correction is shown in Fig. 4, which is beam loss signals before and after orbit correction.

In this case, orbit was corrected, but locations of beam loss caused were moved but we can not decrease the beam losses. When we manipulated the monitor control table, we could get various results.

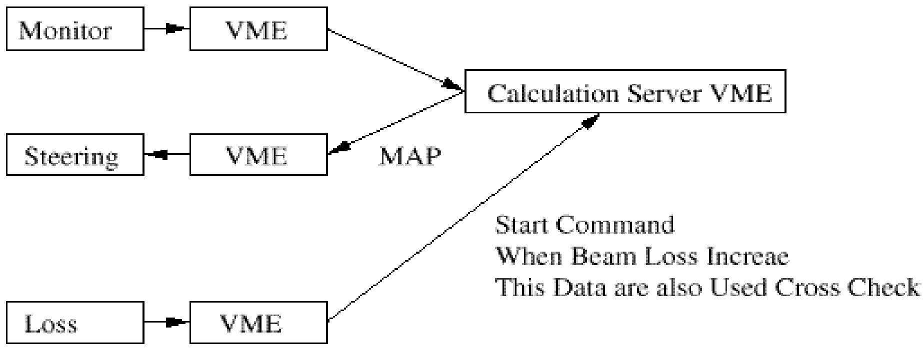

Fig. 5: Orbit correction system includes beam loss monitor.

4. IMPROVEMENT OF OUR SYSTEM

When that study were done, the beam loss monitoring system was separated from VME computers. From that time on, the loss monitoring system has been connected to a VME computer. It thus appears that the orbit correction can be done automatically when beam loss increase. In addition, finish condition of the automated orbit correction will be determined beam loss status. Decision of location where orbit must be corrected will be done from information of large beam loss areas. Operators corrected the orbit by local bump method using such information, and then we think that automated orbit correction system can do same method. Therefore, we are planning the automated orbit correction system shown in Fig. 5.

5. CONCLUSION

We think that beam steering is not performed only by BPM-steering system, but also it should be included both beam loss or intensity monitor to certify its performance. We are intending to make an event driven automated orbit correction architecture. Event←beam loss monitor In addition, the result of orbit correction is checked by the data from the beam loss monitor. A criterion to generate an event by beam loss is now investigating. They are now plan and study, but we would like to make complete automated orbit correction system.

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