DEVELOPMENT OF HIGH INTENSITY BEAM HADLING SYSTEM
AT KEK-PS NEW EXPERIMENTAL HALL

PART I, GENERAL CONCEPT

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Introduction

A new counter experimental hall [1] is now being constructed at the KEK 12 GeV Proton Synchrotron (KEK-PS). The completion of the building of the new hall will be by the end of this year and immediately followed by the magnet installation. The new hall and the beam lines are schematically illustrated in Fig. 1. Three target stations will be prepared in the new hall to supply secondary particles for experiments.

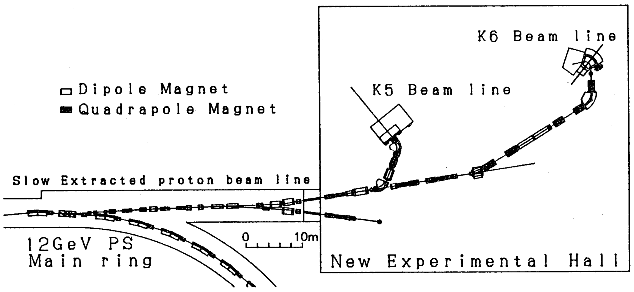

Fig. 1, Schematic illustration of the new counter experimental hall and beam lines of KEK-PS.

The new experimental hall has been designed to handle primary proton beam up to $1x10^{13}$ pps (protons per second). This beam intensity is almost one order of magnitude greater than the present level of the KEK-PS, $1x10^{12}$ pps, and will be realized in near future in connection with the Japanese Hadron Project (JHP)[2]. Therefore new technique to handle high intensity beams has been developed and employed in the construction of the new hall. In this paper we would like to describe about the new technical achievement employed at the new hall. The paper will be divided to three parts. In part 1, we will summarize the general design concept of the new hall especially for handling high intensity beams. The quick disconnect system to make the system easy-maintenance and the radiation hard components to make the system maintenance-free will be described in part 2 and part 3, respectively.

General design concepts

Beam line components such as electromagnets, vacuum ducts, beam monitors and, especially, production target stations will have to work under very high radioactive environments and will have very strong residual radioactivity even in the off beam period. The maintenance of these apparatus must be carried out against the very high radiations. Therefore the most important and essential performance of the apparatus is that those must never break. In other words, the beam handling system should be maintenance free. However, in case of need, the maintenance should be carried out quickly from a distant place to reduce the absorbed dose in the maintenance work. Therefore the most components of the system should be maintained or replaced easily by some remotely controlled tools such as robots or master slave manipulators.

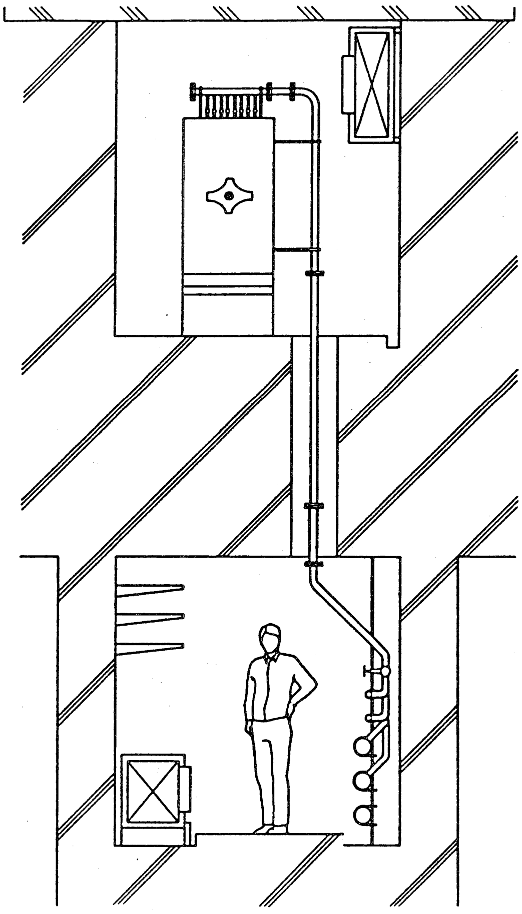

Fig. 2, The cross section of the beam line tunnel in the new experimental hall.

The cross section of the beam line tunnel in the new experimental hall is schematically shown in Fig. 2. The beam handling system such as electromagnets are placed in the beam tunnel. The cooling water, electric power of the magnets are supplied through the service tunnel constructed in parallel to the beam tunnel. The side concrete shielding is constructed as an immovable permanent wall instead that the shielding of the existing hall is made of temporal blocks. The top shielding is made of movable blocks. If some trouble happened in the magnets, the ceiling blocks will be removed and the magnet will be lifted by a over head crane. The maintenance of the magnet will be carried out in a hot cell prepared in the experimental hall. Therefore the most magnets must be removed easily from the beam tunnel. For this purpose, the quick disconnect system of the water, electric power and interlock signals are developed. The quick disconnect flange for the vacuum duct is also developed. The pumping down of the vacuum ducts is done from the service tunnel. Details of the quick system will be described in Part Ⅱ.

In order to make the beam handling system in the new hall maintenance free, the most components of the system are assembled from inorganic materials. Only organic material used is polyimide which is known as the most radiation-hard polymer. The radiation life of the polyimide is, however, tested by the existing proton beams from KEK-PS and no deterioration was found over 10^8Gy (10^{10}Rad). Vacuum seal employed is metallic C-ring known as "Helicoflex". The insulator between magnet coil and water manifold is made of ceramic. The lubrication oil is replaced by MoS_2 or the special metal which contains very fine carbon grains. It should be noted that the commercially available "radiation hard" material often means "radiation hard against gamma ray irradiation". The effect of hadrons on matter is somewhat different from that of photons and "radiation hard" materials are sometimes weaker than ordinal ones in the case of the hadron beam irradiation. The materials must be tested by ourselves under the similar condition we will use.

The general guidance for constructing easy maintenance system is that the remote handling system, which includes the robot or the master slave manipulator, can not handle things as clever as ones fingers. For example, the bolt nut combination never be used. In other words, the system should be designed to be maintained by only two fingers. This is also a definition of the "quick" disconnect system. For example, all the connection points of the magnets such as cooling water inlet/outlet to the coil should be arranged in the top or particular side surface of the magnet body. If the connection point would be left in the deep and complicated area of the coil, it would be impossible to replace it even the connector is "quick" disconnect.

References

1. K.H.Tanaka Present Status and Future Projects of KEK-PS, Nuclear Physics, 1986, A450, 533c-537c.
2. JHP Working Group, Japanese Hadron Project, Institute for Nuclear Study, University of Tokyo, March 1989.