FIXED TARGET TO COLLIDER CHANGEOVER AT A0

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Abstract

The A0 sector of the Main Accelerator at Fermilab serves a dual function. During a collider run this sector is used as an abort. The same area is used to divert beam to the switchyard during a fixed target run. The area is subject to high residual radiation, therefore making it important that personnel working to change the equipment do so with a minimal amount of radiation exposure. A system has been designed to reduce the time a technician must spend in this area.

I. INTRODUCTION

The method of changing from fixed target physics to collider physics at Fermilab requires that equipment be moved in or out of the beam line. At the A0 sector of the ring, the residual radiation is high, necessitating either a larger number of technicians required to do this work, or allowing the technicians to accumulate larger amounts of radiation exposure.

The addition of ten kickers and two abort dumps in this area for collider physics meant that there would need to be some major changes made, even if equipment was simply swapped out. Because of these major changes this project became a good candidate for a new approach

A method for changing this equipment was devised to not only decrease the amount of radiation exposure, but to also reduce the number of technicians required to change the equipment. This was the first attempt to design a system with minimal radiation exposure as the primary concern.

The project was divided into two phases. The first phase included the collider devices and their associated hardware. The second phase includes all the fixed target devices and their associated hardware. Phase two also includes some construction work.

Phase one was completed in January 1992. Phase two design and fabrication work has been completed. The construction work and final installation will take place during the summer of 1994.

II. PHASE ONE

A. Kicker Magnets

There are two groups of five kickers magnets. The purpose of these magnets is to steer the beam into one of two abort dumps. The proton kickers are at approximately F49, the anti-proton kicker magnets are at approximately A11.

B. Abort Dumps

There are two abort dumps, one for protons and one for anti-protons. The abort dumps were fabricated from the steel of a Tevatron dipole. The abort dumps are shielded by two inches of steel on all four sides. This minimizes the amount of radiation to the ground water, as well as the surrounding equipment in the main ring tunnel.

C. Support System

The stands for the kicker magnets were left with same degree of adjustment that they would normally have at any other location in the tunnel. The abort dumps use the Tevatron stands. Minor changes, such as the addition of a bracket to attach the stand to the transfer system were made. This left both the device and the stand interchangeable with other like types both around the ring and in spare storage. (Figure 1)

D. Transfer Mechanism

The method used to transfer magnets in or out of the beam line is a system of plates. Plates are tied together to form banks of like components. Each set of five kickers comprises one bank, the abort dumps comprise another bank. Stands mount directly to the plates. Once the magnets are mounted, each bank becomes an integral unit. This is a permanent arrangement, with a magnet change being the only exception. The plates have ball transfers on the floor side. This makes maneuvering in all directions possible for rough alignment. Final alignment is done in the usual way, using the adjusters on the stands. Steel plates are grouted and fastened to the concrete floor for the ball transfers to ride on.

During a collider run, the proton kickers occupy the same space the Lambertsons occupy during a fixed target run. Up to one inch of concrete had been chiseled out of the floor under the Lambertsons to allow for downward adjustment of the magnet. This area was too rough to allow placement of kicker stands on the floor. Since the amount of concrete removed was not consisent over the entire length, this left the area too uneven to allow placement of steel plates. The depressions were filled with epoxy grout and leveled before the steel floor plates were installed.

The steel floor plates were installed in two segments, which allows the removal of one segment for phase two and does not disturb the other segment.

E. Vacuum System

Each bank of components has a beam valve at each end. These valves are closed before moving equipment out of the beam line. The kickers especially need to be protected from atmosphere as much as possible, since they have ceramic beam tubes. Beam valves are installed at the extreme upstream and downstream ends to protect equipment not affected by this project.

All cabling was done in such a manner that they do not need to be disconnected when the equipment is moved from one mode to the other.

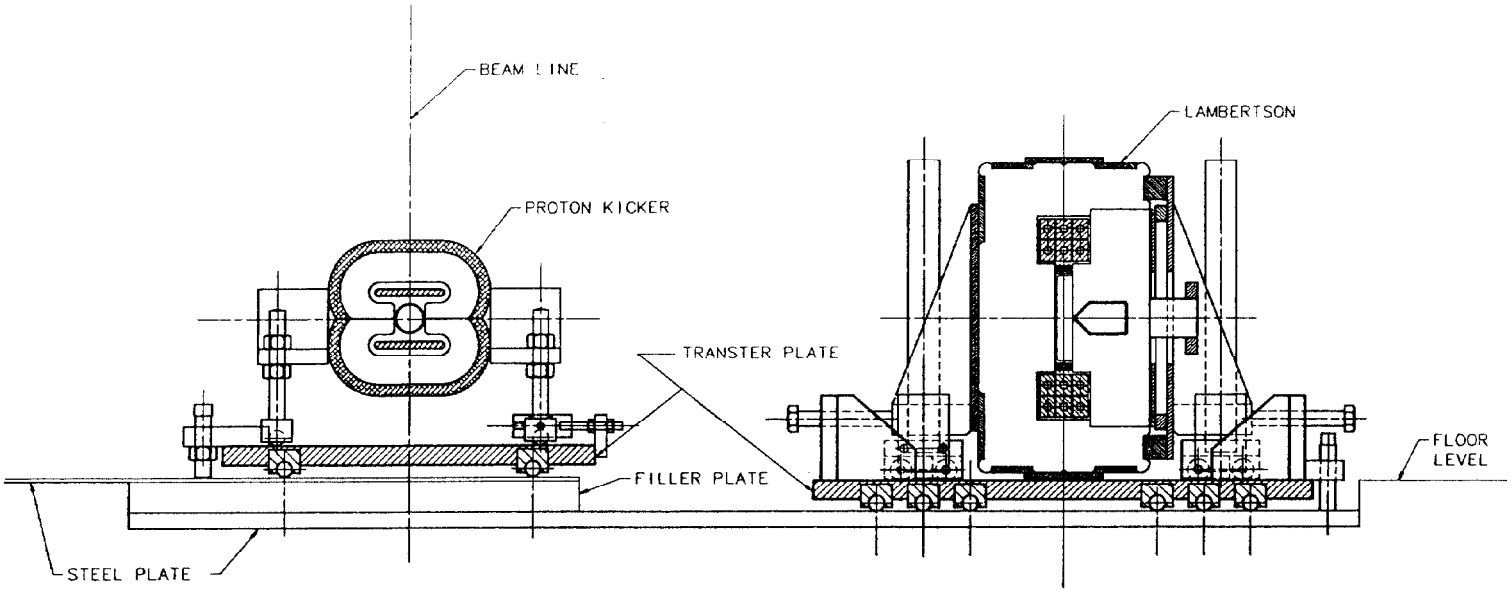

Figure 1

III. PHASE TWO

A. Skew Dipoles

Three skew dipoles are installed for fixed target physics. The skew dipoles take the proton beam out of the circular orbit and direct it to the switchyard. Skew dipoles are located at A11.

B. Lambertsons

Starting at F49, there are three six inch symmetric Lambertsons followed by two A0 downstream Lambertsons. The purpose of the Lambertsons is to prepare the beam for extraction to switchyard. This function causes them to become highly radioactive. It is not uncommon for these magnet to be class 4 (>100Mr @ 1ft.)

C. Support System

New skew dipole stands were made to allow them to be attached to transfer plates. The new stands are shorter than the previous stands to allow for the thickness of the transfer plates, but otherwise are identical to the old stands. (Figure 2)

The Lambertson stands were not changed in any way, except to allow them to be mounted to transfer plates. They retain the same degree of adjustment and any Lambertson of a like type can replace those at A0. (Figure 1)

D. Transfer Mechanism

The same system of plates was used for the fixed target devices as for the collider devices. Plate thickness' were increased to carry the additional loads. In the same manner, transfer balls are mounted on the underside of the plates. The number of transfer balls per plate was increased for the increased loading.

The three six inch symmetric Lambertson comprise one bank, the two A0 downstream Lambertsons comprise another bank. The three skew dipoles comprise the third fixed target bank.

E. Installation

Placing the Lambertsons on the transfer plates raises the center of these magnets. Complicating the matter was the fact that some of these magnets were already sitting below the floor level in the chiseled out area. A trench will be carved out of the concrete floor in order to be able to install these magnets at the proper height for the beam line as well as allow for some downward adjust. There was no downward adjustment previously. The trench will be approximately 6' wide by 100' long. The depth of the trench will vary from 1.25" to 3.5" depending on the distance from the present floor level to the beam line. Varying the depth of the concrete removal allows the minimum amount of concrete to be removed. Steel plates will be grouted and fastened in the trench for the transfer plates to ride on. The areas where there are no plates will be removed just deep enough to clear the equipment. A magnetic survey of the floor has been made to determine the depth and location of the concrete rebar. This survey indicates that, at most, one or two pieces of rebar will need to be cut or bent out of the way.

Since the concrete floor may be radioactive, in preparation for the removal of the concrete, the area will be sealed off. Ventilating equipment will be used to keep this enclosure dust free and provide a negative pressure. All dust will be vented through hepa filters. In addition, all personnel will wear the appropriate respirator while working in this enclosure.

One of the methods being considered to remove the concrete is a dry method. This method uses steel shot to break up the concrete. The shot is recycled and the waste is passed through two filters, making this operation virtually dust free. One filter box collects gravel and other large particles, the other collects the fine particles and dust. The air that is exhausted passed through a hepa filter.

The dry removal method also provides the option to re-use the concrete removed. The coarse and fines can be

combined with an additive during the removal process. Later, water can be added and the mixture poured into forms to make concrete blocks. These blocks can later be used for shielding.

F. Vacuum System

Like the collider devices, each bank of equipment has a beam valve at each end. This valve is closed before moving the equipment. All cabling for ion pumps and electrical as well as water connections need not be disconnect before moving equipment.

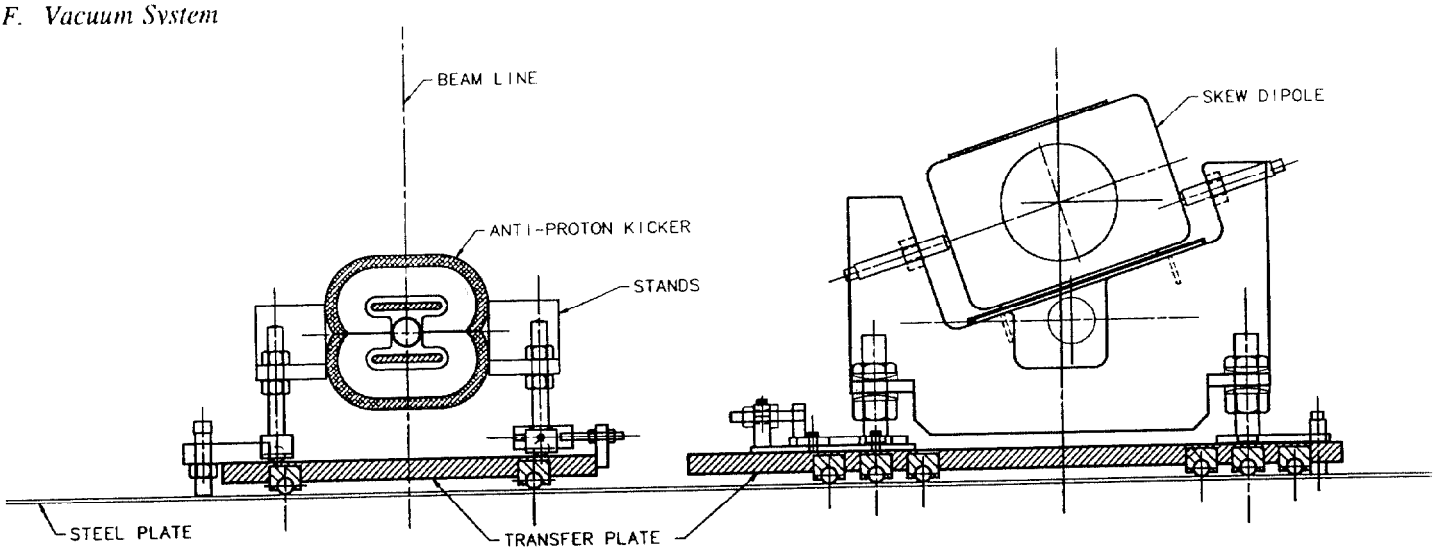

Figure 2

IV. CHANGEOVER

A. Off Line Collider Devices

When the accelerator is in the fixed target mode, the kicker magnets and abort dumps must be removed from the beam line. The kicker magnets are stored along the outside wall, in order to minimize any damage to the epoxy from radiation. The abort dumps are moved just enough to the radial outside to allow the fixed target equipment to be installed.

B. Off Line Fixed Target Devices

The Lambertsons and skew dipoles are stored just to the radial inside of the beam line during a collider run.

C. Switching From Fixed Target to Collider Physics

In order to change from fixed target physics to collider physics, large screw mechanisms are used. One end of the mechanism is attached to a bracket on the transfer plate, while the other end is attached to a bracket mounted on the floor near the inside wall.

The beam valves are closed, the water is shut off and any necessary electrical shut off before moving any devices. No connections need to be broken except beam tube. Spool pieces are also removed.

Once the screw mechanism is attached, two technicians are able to slowly turn the screws, moving the bank of devices towards the inside of the beam line. When the bank of devices is out of the beam line, pins are used to lock the plates to the floor. The screw mechanism is removed and the next bank is moved. Once all three fixed target banks are moved out of the way, the collider banks can be moved into place.

Filler plates are placed in the trench where the kicker magnets will be located. The purpose of these plates is to elevate the rolling surface for the transfer plates from the Lambertson height to the kicker height.

The screw mechanisms are again used to move the three collider banks into the beam line. Because the kicker magnets are stored against the outside wall, they must be moved in two steps. First the bank is pulled towards the beam line, then the mechansim is mounted on the other side of the transfer plate and the bank is pushed the rest of the way into the beam line. Abort dumps, which are stored next to the beam line are simply pushed several feet into the beam line. Because of the length and placement of the screw devices, while this transfer is taking place, the technicians are not working in close proximity with the radioactive devices.

The kicker magnets and abort dumps are the connected to the beam line, the beam valves are opened and the electrical devices turned on.

The switch from collider to fixed target physics is achieved by reversing the steps described above.

V. CONCLUSION

Using the methods described above, the changeover from fixed target to collider physics at Fermilab can be accomplished safely and easily. The steps involved in this switch keep the technicians as far from radioactive devices as possible. The entire process can be accomplished by two technicians in a fraction of the time it would take using the traditional method. It has been estimated that the use of the screw mechanism and having only beam pipe connections to break, the time these technicians will take to accomplish this changeover can be reduced by a factor of ten.