INSTALLATION AND OPERATION OF A NEW EXTRACTION AREA IN THE FNAL BOOSTER

J.R. Lackey, C.W. Owen, R.K. Rice
Fermi National Accelerator Laboratory,* P.O. Box 500, Batavia, IL. 60510

Abstract

We discuss the installation and operation of a new extraction area in the Booster. The primary purpose of this system was to provide protons for commissioning the Antiproton Debuncher and Accumulator. The area also serves during normal operations as a high intensity beam dump for 8 GEV protons not injected into the Main Ring. It permits parasitic Booster studies and the injection of a smaller number of beam bunches into the Main Accelerator for use in the Collider program.

Introduction

A new extraction area and a new transport line between the Booster and Debuncher have been constructed. The primary purpose of this facility was to provide a source of low intensity (<5E10 ppp) 8 Gev protons independent of the Main Accelerator for commissioning the antiproton source machines.

The new beam line (AP-4) was designed with a collimator and beam dump which could absorb 8 GEV protons at the maximum Booster intensity. It can be used as a high intensity dump during Collider operations when sending less than 84 bunches into the Main Accelerator and for Booster studies.

Beam Extraction

Beam is extracted from the Booster in one revolution. Normally all 84 beam bunches are extracted from the Long 13 straight section. At extraction time, the beam is kicked vertically at the Long 12 straight section by a set of four 50 ohm fast kicker magnets, MK01 through MK04, to provide the required full amplitude kick to move the beam across a pulsed septum 93 degrees downstream at Long 13. This septum, MP01, deflects the beam upward at a 40 mrad angle until it clears the main Booster magnets where it is deflected downward and enters the 8 GEV transport line. This extraction scheme is little changed in concept from that first installed in the Booster (1).

Beam for AP-4 is extracted at the Long 3 straight section. Extraction from Long 3 is similar to extraction from Long 13 and only two additional fast kicker magnets are used. These magnets, MK05 and MK06, are located in the Long 2 straight section. Long 2 is four full betatron periods from Long 12. Thus any pair of the Long 12 kickers can be used in combination with the Long 2 kickers to give the required full amplitude kick to put the beam into another pulsed septum magnet, MP02, at Long 3. MP02 bends the beam upward at a 45 mrad angle until it is clear of the Booster magnets. It is then put on line vertically with the collimator hole in the beam dump.

In order to transport the beam past the collimator and beam dump, it is necessary to energize a 6 mrad horizontal bending magnet. With that magnet off, the beam goes to the beam dump.

During normal Collider operation only three proton bunches are used in the Tevatron. These are very intense bunches and each is obtained by extracting 5 to 9 normal intensity bunches from the 84 bunches in the Booster and coalescing (2) them into one bunch in the Main Accelerator. The remaining bunches from that Booster cycle are extracted to the AP-4 dump. Thus, beam must be extracted from Long 13 and Long 3 on the same turn. This is done in the following manner. Two kickers at Long 12, typically MK01 and MK02, are triggered at the same time as MK05 and MK06 relative to the first bunch of extracted beam. The other two kickers at Long 12, MK03 and MK04, are delayed relative to the others by "84 - N" counts. Each delay count is equal to one bunch. Table 1 illustrates the possible extraction combinations.

TABLE 1

N = 0	84 BUNCHES TO MR
N = 1 TO 83	"N" BUNCHES TO MR "84 - N" BUNCHES TO AP-4
N = 84+	84 BUNCHES TO AP-4

Operational Experience

PBar Tune-Up

Final installation and commissioning of the AP-4 beam line was completed in January 1986. After commissioning, the line was operated nearly continuously through the remainder of 1986 for commissioning of the Debuncher and Accumulator.

Collider Operation

This method of injecting short batches into the Main Accelerator was first tried in May 1985 and has proven very satisfactory. Other schemes for achieving short batches for coalescing were discussed and tried. All, however, involved injecting a full Booster batch of 84 bunches into the Main Accelerator and risked the possibility of Tevatron aborts caused by the high losses associated with the removal of the undesired beam bunches.

Booster Studies

Except during actual Collider runs, the new extraction facility has made possible a series of parasitic Booster studies without interrupting normal operations.

Efficiency, Losses and Stability

It is not unusual to be able to account for all 84 beam bunches. Extraction efficiency is not 100% however because of the finite fill time and jitter of the kicker magnets. Full batch extraction efficiency to either area is typically 96 to 98 percent.

There is appreciable beam loss on the MP01 septum

*Operated by the Universities Research Association under contract with the U.S. Department of Energy.

CH2387-9/87/0000-1943 $1.00 © IEEE

on those cycles when beam is extracted to both beam lines during the same pulse. This loss is an unavoidable consequence of the present kicker configuration. The loss is 7 to 8 percent for high intensity beams. At least one more kicker would have to be added to the Long 2 set to avoid these losses. The total losses are not unacceptable, however, and are less than the losses on the septum during a normal fixed target run.

Acknowledgements

The extraction system for the AP_4 line was designed, built and installed primarily by the Booster group. New mechanical designs were done by Jim Fritz. Magnet installation was done by Danny Douglas and his crew of Mechanical Techs. Ken Bourkland designed and built the 25KA pulsed power supply for MP02. The necessary controls work was done by Bob Ducar and his group.

References

1. A.W. Maschke and L.W. Oleksiuk, IEEE Trans on Nuclear Sci. Vol. NS-18, No. 3, p.989 (1971)

2. Bunch Coalescing in the Fermilab Ring, D.Wildman, P. Martin, K. Meisner, H.W. Miller., these preceedings.