Automated Beam Position and Split Control for the Fermilab Switchyard

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Abstract

A new instrumentation and software system has been designed to automate tuning of the Fermilab Switchyard. The tuning system will adjust electrostatic septa for splitting beam and dipole trims for correcting positions -- for both types of resonant extracted beam. The slow spill lasts ~20 s and is interrupted by several fast or pulsed spills lasting ~1.5 ms each.

Introduction

The Switchyard makes use of three cryogenic magnet strings, eight electrostatic septa strings and twelve pulsed dipole magnets to deliver beam to nine primary slow spill users and one fast spill user. The automated tuning system is designed to control the three functions of Switchyard. The septa are positioned to split the requested share of beam to each experimental area. Slow spill is steered onto the desired trajectory. Fast spill is diverted around the appropriate septa wires by pulsed dipole trims.

Positioning Electrostatic Septa

Accelerator operators specify the experimental area requests. The control program calculates needed split ratios and moves septa via stepping motors. The calculation of septa positions is based on the transverse beam distributions at each septa string. These profiles are calculated from simulations and will be modified with empirical data. The program monitors the septa strings making sure they reach the calculated positions. Expected accuracy is 3 to 10 percent, depending on the split ratio.

This feature will be implemented in the upcoming fixed target run.

Fast Spill Tracking

Several fast spill pulses (~1.5 ms each) of beam are extracted from the Tevatron during the long slow spill. Fast spill follows the slow spill beam path except at the septa. There, pulsed dipole bumps divert the fast pulse to the proper side of the septa wires[2]. The control program calculates and sets the pulse levels any time the septa are moved; maintaining local bumps around each septa string.

This feature was operational during the second half of the last fixed target run at Fermilab.

Steering Slow Beam

The control program will use an iterative process to set the slow beam onto the desired trajectory through the Switchyard. Beam position will be measured throughout Switchyard on sixty-four tuned stripline detectors[3]. Needed dipole corrections are calculated from a beamline transfer matrix and their currents are set. An over damped response is maintained by making less than the full correction on each iteration.

A version of this program is used on the Fermilab 8 GeV Line, the transfer line between the Booster and Main Ring.

Environment

Two programs, initiated by accelerator operators, run on the Main Control Room processors. One program adjusts septa and pulsed dipoles. The other corrects slow spill positions. Calculations and communication with hardware use ACNET[4], the existing accelerator control system.

Expectations

Septa will be moved while the Tevatron is ramping. Steering corrections will be made at about a 4 Hz rate -- based on the existing 8 GeV Line program's performance. With these two requisites we expect to be able to adjust split ratios and correct beam positions in one Tevatron machine cycle.

References

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