NEWS FROM THE ENERGY SAVER

The major objective of the Energy Saver in the last several months has been to run at 400 GeV for the high-energy physics program with as high an intensity and reliability as possible. The Accelerator Division has worked hard to make this possible. There has also been a considerable amount of work directed toward solving problems in a longer time interval. This article will discuss a small part of this longer-range effort.

Reliability

One thing that was learned last time on the Main Ring was that detailed information on the frequencies and causes of failures is a necessary condition for improving reliability. We are now collecting such information in considerable detail. Frank Turkot and Duane Plant are working on this program. The accompanying tables are a summary of down times in the accelerator system.

The period October through January was the first four months of operation for the Tevatron. There were 2,200 hours of scheduled HEP and 1,039 actual hours delivered to at least one experimental area between October 3, 1983, and February 5, 1984. Major losses of operating hours were suffered during three weeks in October when a failure of the quench-protection system made it necessary to replace three damaged spool pieces. At about the same time, a broken water pipe kept the rf systems off for a considerable time. There were two power failures in December and one in January. The January failure was sitewide. The bad weather at the end of December interrupted nitrogen deliveries, all of which resulted in bad operating weeks. The bar graphs on the next page show reliability and down time in this period.

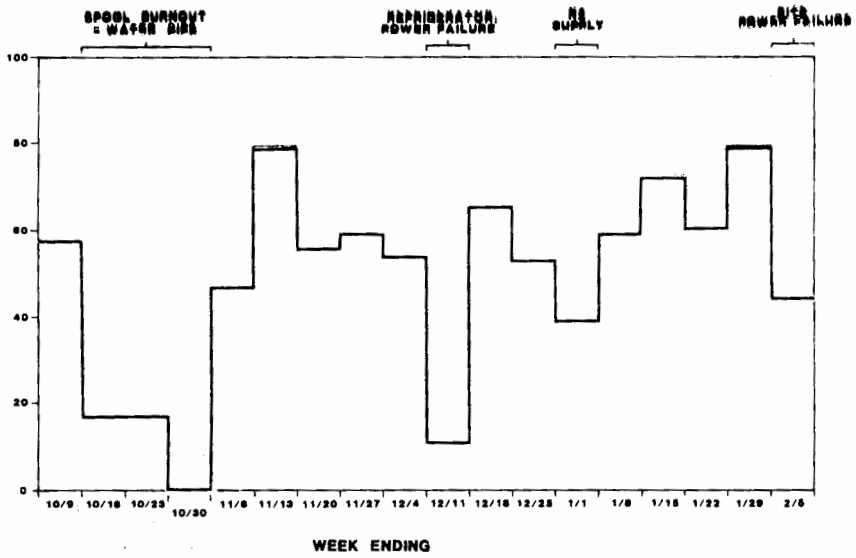
Typical operation is 60% of scheduled whereas it was about 80% before the turn off of the Main Ring for Energy Saver installation. Continual work will be required to get back to higher reliability.

Orbits

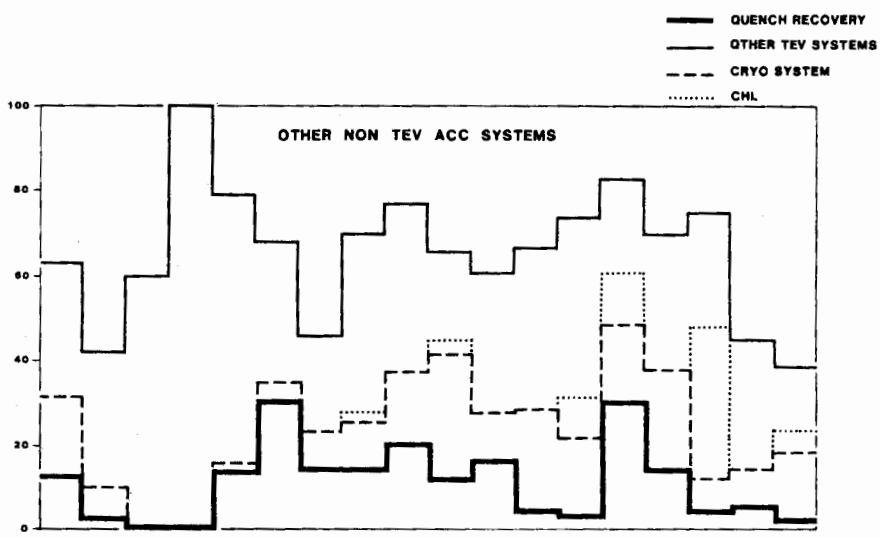
The ORBIT program described in these pages (October 1983) by Rajendran Raja has been used extensively to correct orbits to very small (<1 millimeter) deviations. It is worth noting that the orbit correction depends not only on ORBIT, but on the beam-position monitor (BPM) system designed and built by Bob Shafer and on the correction-magnet system.

Previous BPM systems have only been able to measure closed orbits--the sum over many turns. The Energy Saver BPM can measure positions of either closed orbits or single turns.

PERCENT OF SCHEDULED HEP



TEV PERCENT OF TOTAL DOWN TIME



Previous orbit correction at high fields has been done by realigning magnets; it has never been possible to provide a completely corrected orbit because of the time required to align magnets over the large distances of our accelerator. Realignment as a method for orbit correction is not feasible in the Energy Saver, because of the complicated cryogenics plumbing at the ends of the quadrupoles. Instead, the Energy Saver has a correction-magnet system that will move the beam across the chamber even at 1 TeV. In addition, the system has programmable waveform generators that give the capability of correction at all energies.

The accompanying plots show some recent results for the first turn and for the closed orbit at injection. In the first-turn plot (labelled FLASH FRAME) the horizontal positions at E11, E13, and E15 are set as prescribed for injection. The kicker at E17 kicks the first turn on to a centered path. There is a shorted horizontal correction coil at E26 and centering is not possible. In both horizontal and vertical, the positions at A0 and D0 are set to move the beam around extraction devices. The non-zero positions at D48 and D48 are part of the orbit-closing process.

In the closed-orbit plot (DISPLAY FRAME) the differences from the first turn are that horizontally E11 is now set to avoid the injection Lambertson and E15 is dictated by the closure process.

Studies

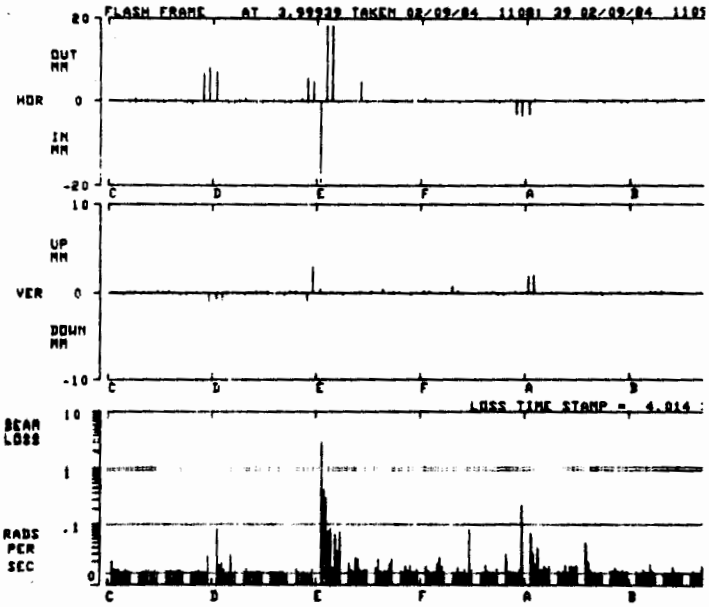
As part of the national effort on the design of the Superconducting Super Collider (SSC), many accelerator studies have been done. Rolland Johnson has summarized this effort.

The primary purpose of the Tevatron for the present and the next two years is to provide beams for fixed-target physics. As a consequence, virtually all studies have been directed toward the goals relevant to extraction and high-intensity fixed-target physics. The present situation is that low-intensity beams have been accelerated to 700 GeV and extraction to experimental areas has been accomplished up to 512 GeV. The present operating mode is at 400 GeV, about 10^{13} ppp, 15-sec flat-top, with a 39-sec cycle.

Some data from the commissioning of the fixed-target program are particularly relevant to the SSC, even if the SSC is not used for fixed-target physics. These data are mostly to answer the question "How predictable is/was the Tevatron?"

Collider

In 1983, there were three sessions of coasting-beam studies. These were directed towards the development of storage techniques and to get a first look at the Tevatron as a collider. Indeed, the techniques were quickly implemented and the initial coasting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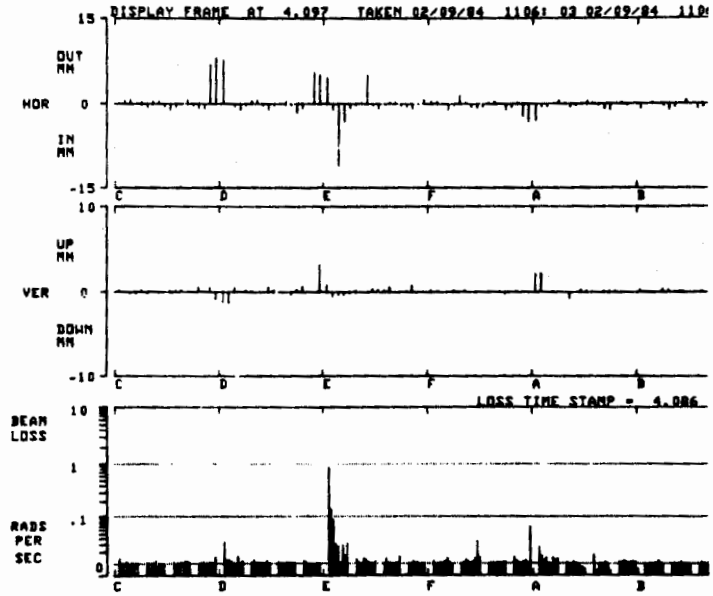
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beam studies at 400 GeV were very encouraging. The transverse stability of the coasting beam seems to be very good at low intensity, with long lifetimes (> 24 hours) even on potentially strong resonances. Longitudinal dilution seems to occur rapidly, and may need individual bunch damping.

Machine Studies

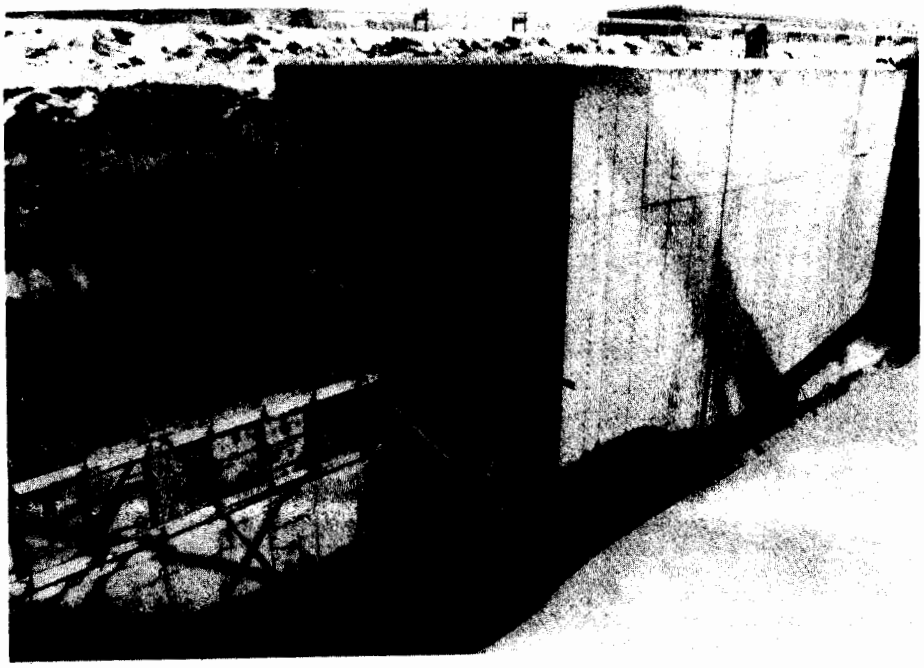
In 1983, there were two machine study sessions devoted to the dynamic range of superconducting magnets. These studies are particularly relevant for HERA, which will have an injection energy of 40 GeV and a top energy of 820 GeV, more than a factor of 20 higher. As well, the magnets and lattice are similar to the Tevatron design.

For the SSC to operate between 1 and 20 TeV implies that the Tevatron should certainly have a reasonably good field aperture from 50 GeV to 1 TeV. Details of SSC magnet construction such as bore diameter and filament size, as well as lattice design, make the measurements described here relevant, but not directly scaleable.

For these studies, the beam was injected into the Tevatron at the normal 150 GeV Main-Ring energy and then decelerated. This technique has several advantages over trying to inject directly at 50 GeV. First, it isn't necessary to change anything in the Main Ring itself or in the MR to Tevatron transfer system. Second, by starting from a known set of operating conditions the beam can be decelerated in a more controlled fashion in small steps, if necessary. The major disadvantage of the deceleration technique is that it is necessary to understand the hysteresis of the Tevatron magnets.

Detailed studies have also been done to compare the betatron tunes predicted from the measured field data with the measured tunes. The measured values of 19.6 and 19.2 horizontally and vertically differ from the predicted 19.4. This can be interpreted as a systematic error of approximately 1 mm in the sagitta of the dipole magnets when they were bent to have the same radius of curvature as the beam, although there is as yet no confirmation. The average sextupole behavior of the dipole magnets corresponds to the predicted chromaticity of the machine, although not perfectly.

The general conclusions of these studies are by no means discouraging for SSC. There are plenty of problems to be worked on in the Energy Saver, but they look solvable to the people working on them.



Construction of the Target Station for TeV I.
(Photograph by Fermilab Photo Unit)