Fermilab

Beam "Notching" Tests with the Main Ring Super Damper

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PURPOSE:

Our original operations scenario to provide 12 proton bunches for the accelerator studies in the fall had us injecting 12 partial Booster batches into the main ring, accelerating them to flattop, then coalescing them. One of the main limitations of these coalescing studies for the last few months has been the inability of the Booster to provide enough beam without radiation trips. These radiation trips are considered difficult to eliminate due to the fact that the unwanted Booster beam cannot be aborted cleanly. During last week's study period we successfully used a new method that shows much promise.

METHOD:

The new method requires only three full Booster batches to be loaded into the main ring. After injection the desired beam structure (twelve groups of 11 full buckets followed by 10 empty buckets) is produced using the super damper to knock out the unwanted beam. A special gate for the "invert" input to the super damper was constructed using NIM & Controls electronics to control the super damper.

BEAM RESULTS:

The super damper proved highly effective at producing the desired beam distributions. The unwanted beam was knocked out in about 1/10 second. and the resulting beam distribution could be very clean when everything was tuned up. The effectiveness of the super damper at knocking out the undesired beam, however, appeared to be very sensitive to the delay time, which can only be set in increments of RF buckets. Also, due to what may be unbalanced signal levels in the super damper circuitry, there is a large glitch in the super damper output when the invert signal

changes state. This voltage swing may have been detrimental to the beam in some cases. A planned upgrade to the super damper should improve our ability to knock out unwanted beam without damaging beam in adjacent buckets.

OPERATIONAL ASPECTS:

This mode of operation has one unsettling feature, we are deliberately dumping large amounts of radiation into the main ring. If all this radiation were to end up in one place we would generate a large problem. On the other hand, if we heat the beam slowly the radiation pattern will be similar to a /29/ cycle. Since we normally lose about 25% of a Booster batch for each /29/ cycle, the total radiation that we are deliberately dumping into the main ring is less than what normally would be deposited if the /2B/ cycle were replaced with four /29/'s. Radiation surveys of the tunnel shortly after the studies period showed no abnormally hot spots, supporting a view that the radiation is widely dispersed around the main ring. The following table shows the total lost beam per supercycle for three operating scenarios:

TABLE I
Total Beam loss per Super Cycle
(Units are "Booster Batches")

	83 /29/'s	5 /2B/ + 60 /29/ (12 Batch mode)	5 /2B/ + 60 /29/ (Damper Notching)
Lost in Booster	0	1.42	0
Total for /29/	20.75	15	15
Notched MR beam	0	0	7.14
/2B/ on ramp	0	3.92	3.92
Total	20.75	20.34	26.06

This estimate yields a radiation exposure to non-dump areas of the machines about 25% larger than normal during the study periods. These studies will occur much less frequently than 8 hours a day, 5 days a week. Therefore, the total excess radiation exposure to non-dump areas of the machines is expected to be less than 6% above normal. There is also one positive aspect of this method. Because the extraction of full batches from the Booster is a lot cleaner than partial batches, much less radiation is lost around the Booster ring using the "Notching" method (based on an estimate of 2 bunches/batch lost around the ring).

Another concern about this method was that the extra radiation from the main ring would quench the Tevatron. During at least one test period the Tevatron was ramping with no ill effects.

CONCLUSION:

We have demonstrated a promising method for providing high intensity beams with the proper bunch structure for the fall studies period. Some of the difficulties experienced using the Super Damper in the manner may be eliminated by the new bunch by bunch damper system, expected to be operational in the Fall.