Fermi National Accelerator Laboratory

FERMILAB RECYCLER STOCHASTIC COOLING FOR LUMINOSITY PRODUCTION

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INTRODUCTION

IBS Model

The IBS model suggests that there is no point at which the 6-dimensional diffusion rate is zero. The spread that minimizes the 6-dimensional IBS diffusion rate is because there is a small non-zero dispersion.

STOCHASTIC COOLING

Sympathetic IBS cooling has been demonstrated at the Recycler. The measurement was conducted with a bunched antiproton beam of 20–25 MeV/particle, which was initially compressed to minimize the 6-dimensional IBS diffusion rate. The measurement was repeated to allow 3-MeV/τ by increasing the amplitude of the rf voltage and then compressing the beam. The figures below show the anticipated transverse emittance and longitudinal moment decomposition. Also shown is the IBS model. The only adjustable parameters in this model are the vacuum-related emittance growth rates.

SUMMARY

Stochastic cooling in the Recycler has been shown to be limited by diffusion processes. A precise IBS model has been developed for the Recycler. This model has been verified with beam measurements and design changes to enhance the performance. The Recycler has successfully increased the number of antiprotons available for Tevatron collider operations for the past year.

ABSTRACT

The Fermilab Recycler began regularly delivering antiprotons for Tevatron luminosity operations in 2005. Methods for tuning the Recycler stochastic cooling systems are presented. The unique conditions and resulting procedures for minimizing the longitudinal phase space density of the Recycler antiproton beam are outlined.

SYNCHROTRON RADIATION COOLING

Longitudinal Emittance Summary

Antiprotons are transferred to the Recycler and are cooled stochastically. The rms momentum spread is kept constant by decreasing the bunch length. Since the beams is confined inside a barrier-bucket, bunch length is determined by decreasing the separation of the barrier buckets.

CONCLUSION

The overall transverse emittance evolution for a bunched antiproton beam is shown.

OVERVIEW DIAGRAM OF ALL THE STOCHASTIC COOLING SYSTEMS

VARIATION OF BUNCH LENGTH DURING IBS EXPERIMENT

OPTICAL LINKS PROVIDE FLAT AMPLITUDE AND PHASE RESPONSE. FOR TIMING STABILITY, THE LASER LIGHT IS TRANSMITTED THROUGH A VACUUM.

ANTIPRONS ARE TRANSFERRED TO THE RECYCLER AND ARE COOLED STOCHastically.

A zero span signal suppression measurement normalized to the resolution bandwidth of 0.01% is compared to the peak signal suppression measured in a single sideband.

The IBS model uses the measured Recycler lattice functions to predict a momentum spread approximately the same.