LONGITUDINAL DAMPER FOR THE SRRC/TLS STORAGE RING

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Abstract

A longitudinal damper is being developed for the TLS storage ring in the few bunch mode. Preliminary test of the damper in single bunch mode demonstrated that Robinson instability excited by the slightly detuned cavities can be suppressed by such damper.

1. INTRODUCTION

Operation of the TLS storage ring in the few bunch mode has been requested by pump-probe experiment users. For such experiments, accurate timing between the 25 picoseconds synhrotron radiation pulses and the sub-picosecond laser pulses is essential. However, longitudinal coupled-bunch instabilities (LCBI) that cause bunch arrival time jittering prohibited synchronization of the two light pulses. LCBI with threshold of a few milliamperes can still be observed even with four bunches equally spaced. Therefore, a longitudinal damper is considered to stabilize these instabilities in the few bunch mode.

2. SYSTEM DESCRIPTION

The design of this longitudinal damper basically follows the concept of the PEPII/ALS digital longitudinal damping system [1] except that it has a different digital electronics that are slower but still fast enough to control eight bunches (Figure 1). Since commercial A/D, DSP and D/A cards with well developed control and application softwares are now available, the time required to develop such system is reduced.

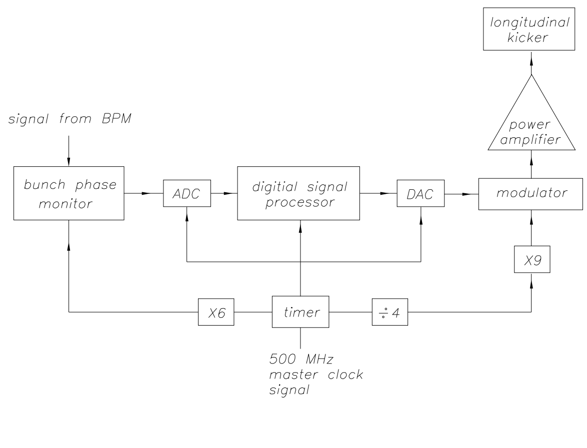

Figure 1. Schematics of the Longitudinal Damper.

2.1 Bunch Phase Detection

By feeding an electrode signal from BPM into a 3-1/8" coaxial line with four coupling loops (10 cm aparts) distributed along the side wall of the outter conductor, 3 GHz pulse trains are generated by combining the four pick-up signals. The phase error signal of each bunch is detected by a double balanced mixer which compares the phases of the pulse trains with a 3 GHz reference that is phase locked to the 500 MHz master clock. The output of the mixer is digitized by an fast analog-to-digital converter at desired sampling frequency for digital filtering [2]. Figure 2 is an example of the detected bunch phase oscillation of a single bunch in the storage ring. The oscillation is driven by phase modulating the cavity voltage via the cavity phase control loop.

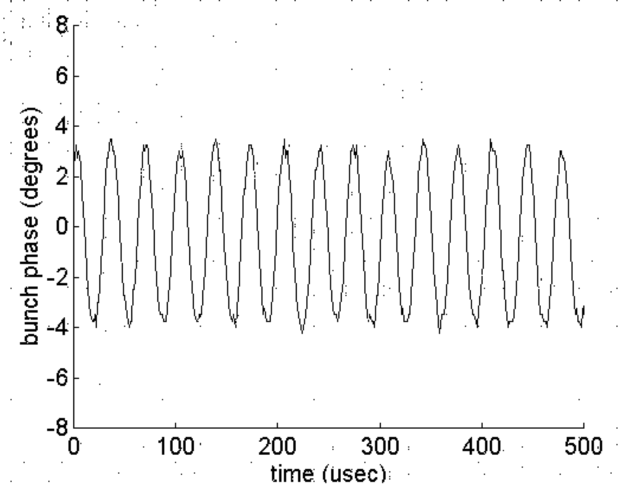

Figure 2. Phase Oscillation as Detected by the Bunch Phase Detector

2.2 Analog-Digital Conversion and Digital Filtering

Digitization of the mixer output signal is done by the hp e1429b 20MSa/s 12 bits A/D converter. Its outputs are sent to the hp e1485a DSP module through local bus for digital filtering. D/A conversion is done by the hp e1445a arbitrary function generator in which a 13 bits DAC can be driven directly from local bus. All these are VXI modules are controlled by the slot 0 controller. In our system, the V743/64 VXI embedded controller is used so that we can gain benifits from the very well developed control software such as C-SCPI.

2.3 Kicker Structure

The design of a broadband kicker to operate at 1.125 GHz was just started. The first prototype for cold test has been constructed. It resembles an common excitation electrode structure but with discontinuities along the beam axis such that the quality factor is ajusted to desired values to provide enough kick voltage. More rigorous studies of this concept are in progress. This kicker will be driven by a 200 Watts TWT power amplifier with instantaneous bandwidth of 70%.

3. RESULTS OF SINGLE BUNCH FEEDBACK

Despites the facts that kicker, modulator and DSP algorithm are not available, a partial test of the damper in single bunch mode was performed by using rf cavities as the longitudinal kicker. Without the DSP board, digitized mixer output signal were fed directly into the DAC in e1445a through local buc. The analog output of DAC were then used to phase modulate the rf cavity voltage. By proper adjustments of the modulation signal amplitude and phase, Robinson instability excited by the slightly detuned cavities can be suppressed. Figure 3 shows the synchrotron sidebands excited by Robinson instability. Figure 4 shows that the sidebands disappeared when feedback was turned on.

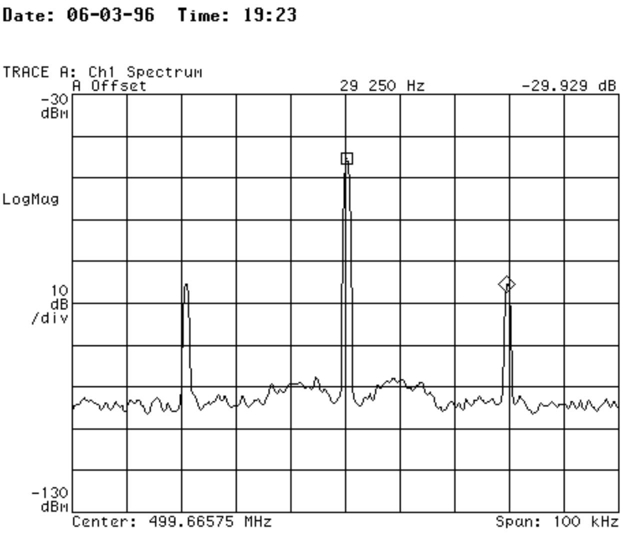

Figure 3. Spectrum of the stripline signal (with damper turned off). Synchrotron sidebands near the rf carrier shows Robinson instabilities was excited by detuning cavities slightly.

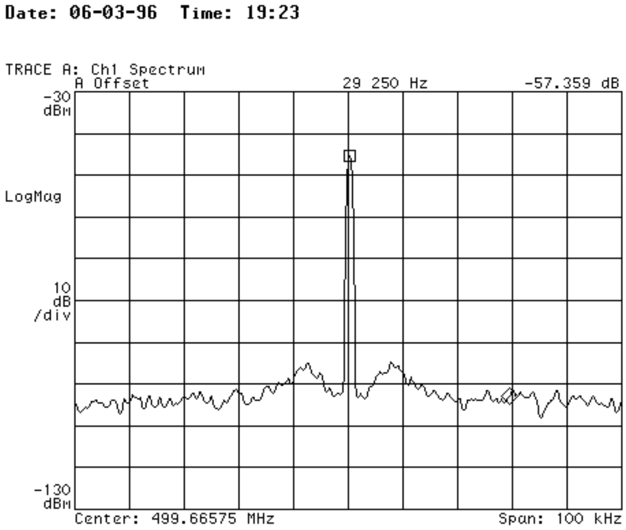

Figure 4. Disappearence of synchrotron sidebands after damper was turned on showing Robinson instability was suppressed.

4.ACKNOWLEDGMENTS

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5. REFERENCES

[1] J. D. Fox et al,"Operation an Performance of a Longitudinal Damping System using Parallel Digital Signal Processing ." Proceedings of the 1994 EPAC Conference.

[2] D. Briggs et al,"Prompt Bunch by Bunch Synchrotron Oscillation Detection via a Fast Phase Measurement", Proceedings of the Workshop on Advanced Beam Instrumentation, KEK, Vol. 2, p.494, 1991.