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Bunch-by-Bunch Feedback Units at the DELTA Synchrotron Light Source *

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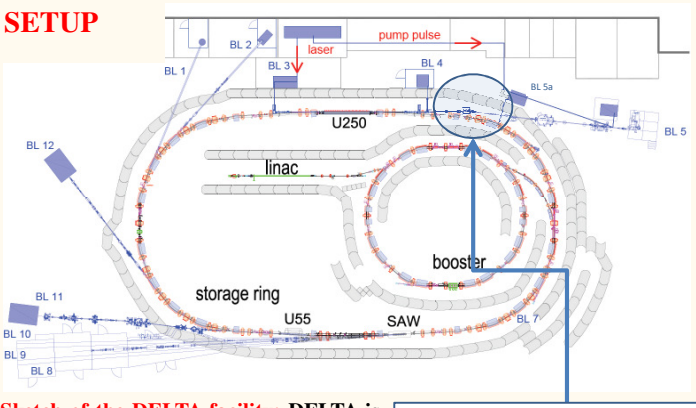
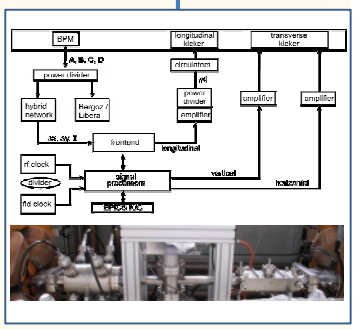
INTRODUCTION

At the DELTA synchrotron light source comprising a 1.5-GeV electron storage ring, longitudinal multi-bunch instabilities occur during user operation. Therefore, three bunch-by-bunch feedback units and the respective kicker structures are in use to detect and suppress these multi-bunch instabilities. Furthermore, the bunch-by-bunch feedback system can be used as a powerful diagnostics tool, since it is capable of storing digitized bunch positions in all three dimensions for each bunch at every turn over an extended time period (up to 800 ms). By exciting a certain number of bunches within the bunch train the inter-bunch coupling can be investigated. Other examples include studies of the injection process and monitoring bunch oscillations during sudden beam loss.

SETUP



Sketch of the DELTA facility: DELTA is a synchrotron light source with a beam energy of 1.5 GeV, a beam current up to 130 mA in multibunch mode, and a revolution frequency of 2.6 MHz.



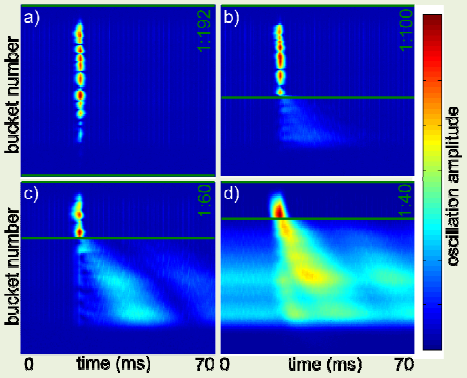
Overview of the feedback system: In the feedback frontend [2] the analog signals pass a two-cycle comb filter and are mixed with a multiple of the RF frequency. The analog signals are digitized and processed using a 32-tap FIR filter. The correction signal is converted to an analog signal and sent to a power amplifier driving the kicker.

INTER-BUNCH COUPLING

The electron bunches interact with each other due to wakefields driven by, e.g., the resistive-wall impedance and higher-order modes of the RF cavity (e.g. [5]).

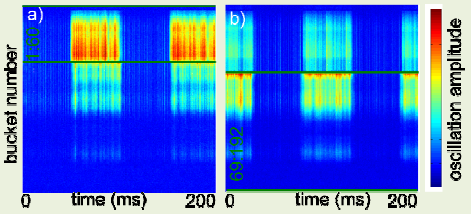
Above Instability Threshold

Grow-damp measurements above the instability threshold for different feedback patterns. The green lines indicate the fraction of the bunches which are temporarily excited by positive feedback while the other bunches are not influenced by the feedback system at all.



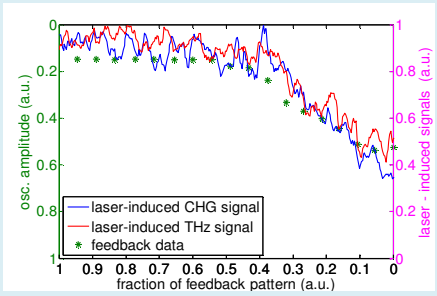
Below Instability Threshold

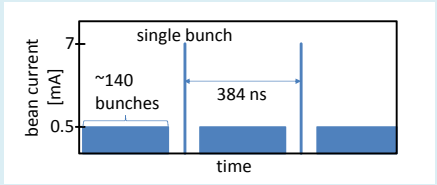
Periodic longitudinal excitation of parts of the bunch pattern below the instability threshold using a fast pin diode blocking the drive signal with a period of 100 ms.



Hybrid Mode

Oscillation amplitude of the single bunch in a hybrid filling pattern which was temporally and spatially overlapped with a Ti:Sapphire laser pulse to create ultrashort VUV pulses by coherent harmonic generation (CHG) [1] as well as laser-induced coherent THz pulses [6] while varying the fraction of the feedback-stabilized bunches.

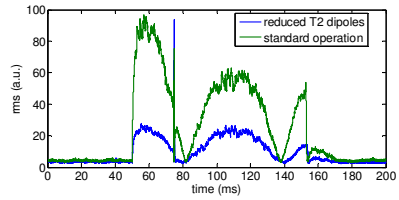


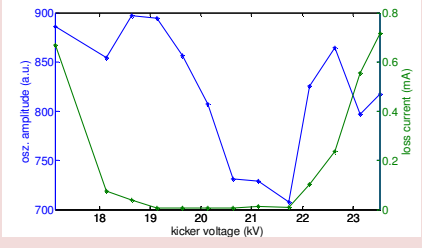


DIAGNOSTICS

Feedback systems can be synchronized to external events (e.g., injection process [4,7] and sudden beam loss).

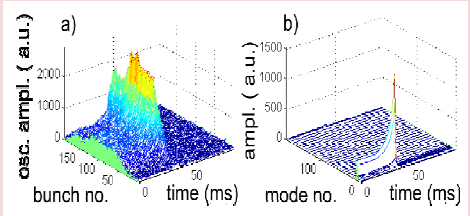
Beam oscillation versus time during the injection for two different configurations of the transfer-channel dipoles. The spike at about 75 ms results from the short term oscillations due to the kicker bump.





Bunch oscillation amplitudes and loss current due to a mismatch of the injection kickers under variation of the voltage of the first kicker.

Horizontal bunch position in the time domain (a) and corresponding mode-spectrum (b) for a sudden beam loss event.



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REFERENCES

[1] S. Khan et al., Sync. Rad. News 24, 18 (2011).
[2] Dimtel Inc. http://www.dimtel.com.
[3] T. Knuth, S. Khan, Proc. PAC 1999, New York, 1147.
[4] M. Höner et. al., Proc. IPAC 2012, New Orleans, 809.
[5] Chao, A.W., Physics of Collective Beam Instabilities in High Energy Accelerators, New York, 1993.
[6] P. Ungelenk et al., this conference (MOPEA014).
[7] D. Teytelman, F.-J. Decker, Proc. DIPAC 2007, Venice,322.

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