New Data Acquisition for Beam Transformers in SIS18 and Transfer Lines

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This contribution presents the development of new data acquisition system for fast beam current transformers (FCT) for SIS18 and HTP beam line. These systems serve as prototypes for the diagnostics in SIS100 and high-energy beam transfer lines of the FAIR facility.

Longitudinal Bunch Diagnostics in SIS18

Recently, the longitudinal diagnostics capabilities in SIS18 were upgraded by installation of a wide-band FCT [1] and a dedicated VME data acquisition (DAQ) system. A FESA [2] class on the front-end CPU controls the FCT amplifier stage and records the signal by a 500 MSa/s and 12 bit resolution ADC module [3].

Since the time scale for longitudinal motion is 100-1000 times longer than the revolution period T_r, sampling of the entire SIS18 machine cycle would result in an unnecessarily large amount of data. The DAQ system merely needs to acquire a sequence of single-turn data blocks at intervals larger than T_r, provided that these data blocks are synchronized to the radio-frequency (RF) signal. This data reduction is achieved by triggering the DAQ system on a rate divider output to which the RF master oscillator is connected. A complete sequence of data blocks is presented in Fig. 1 (top) together with the derived bunch length (bottom) of the central bunch. The measurements were done along the acceleration ramp at harmonic number $h = 4$.

A graphical user interface is under development. It will provide enhanced online features such as trending plots of bunch length or bunch center within the machine cycle.

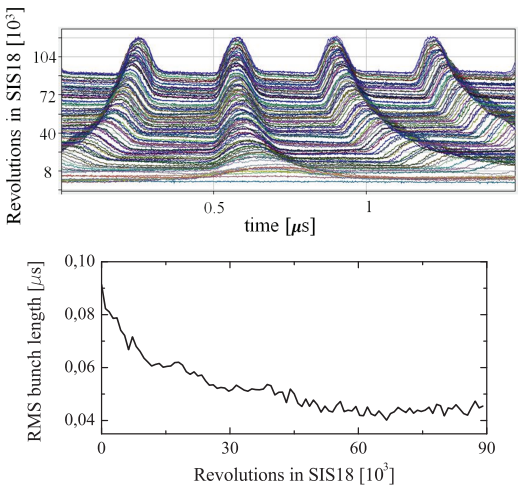

Figure 1: Online waterfall plot of bunch evolution (top) and RMS length evolution (bottom) of the central bunch.

Transformers in high-energy Beam Lines

Monitoring of beam transmission is an important task for an acceleration facility with several accelerators and experimental areas. Presently, two detectors for intensity measurements are installed at HTP: a GSI-made FCT and a charge-sensitive Resonant Transformer (RT). A new VME DAQ system has been tested with two FESA classes, one for FCT readout with a 5 GSa/s ADC (CAEN V1742) and one for RT readout with a 100 MSa/s ADC [3]. The FCT output is fed to a remote-controlled precision attenuator followed by a fixed-gain, inverting amplifier. The raw data of Fig. 2, taken at a rate of 1 GSa/s, presents the FCT response to a single bunch ($h = 1$) of 350 MeV/u U^{73+} ions. The observed ringing effects come from the FCT winding itself due to incomplete matching to 50 Ω geometry.

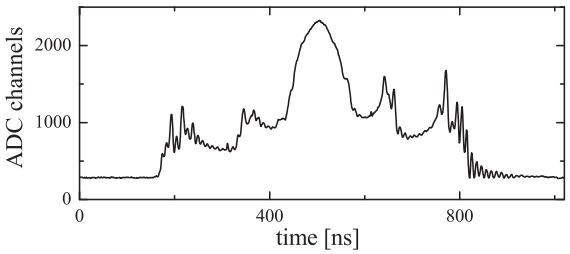

Figure 2: Bunch profile from FCT recorded at 1GSa/s.

Currently, only the RT is foreseen as charge monitor for FAIR. Considering the large bandwidth and dynamic range, the FCT may in principle also be used to measure bunch charges in transfer lines. Thereby, the offset-corrected and normalized FCT integral is multiplied by its calibration factor to derive the bunch charge. The comparison with the RT is under evaluation. Due to the uncertainty introduced by the unwanted ringing of the GSI-type FCT, this investigation will be continued with data of a new prototype FCT/RT transformer combination which is planned to be ready for tests in autumn 2013. This device will be equipped with a commercial FCT [1], similar to the one installed in the SIS18. A key component for the future transmission monitoring system will be a precision calibration circuit which must be developed in order to achieve a resolution in the percent region.

References

[1] http://www.bergoz.com/

[2] T. Hoffmann, M. Schwickert, G. Jansa, FESA at FAIR - the front-end software architecture, PCaPAC 2008 proceedings

[3] http://www.struck.de/