Bunch tomography for longitudinal diagnostics at FAIR

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The longitudinal diagnostics is an important tool to observe the beam behaviour under various RF gymnastic processes in FAIR rings. After installation of a dedicated FESA based data acquisition (DAQ) system for bunch measurements [1] the software and hardware parts were expanded providing the ability to perform the on-line bunch tomography. Presently, the system is under further developments which includes fine tuning of the GUI, debugging of the FESA class and final assembling of the electronics.

On-line bunch tomography

Tomographic reconstruction of longitudinal phase space is a reliable instrument in bunched beam diagnostic [2]. At GSI, the first simple on-line tool was realized [1] using Mathematica software and the tomography code. Measurements in the SIS18 were done using the sum signal of a single BPM. The Lecroy oscilloscope was used as DAQ. It was required to preview signal in a form of a waterfall plot and to choose different important parameters for tomography. For this purposes a test GUI in Mathematica was written. The tomographic reconstruction itself was done using a FORTRAN based code written at CERN [2].

After installation of the broadband FCT, the aim was to implement the tomography tool into the new FCT DAQ described below. First tests were performed in a "quasi on-line" regime which means the signal source was signal generator, the timing source was in-house developed timing simulator. A snapshot of the GUI is shown in Figure 1.

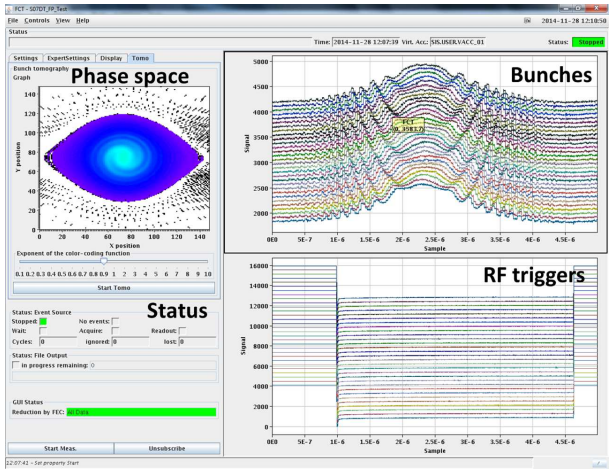

Figure 1: GUI with reconstructed phase space.

Temporarily, the tomography code resides on the PC where the GUI runs. It is planned to use a dedicated PC with a multi-core CPU in order to accelerate the reconstruction process. A more advanced option is to consider a GPU based tomography, while a speedup of 10-100 times can be achieved in comparison to a CPU. In addition, this option will require the development of a new tomography code.

DAQ system for bunch diagnostics

In parallel to the feasibility study of tomography the on-line system for the diagnostics using FCT was developed. This system consists of the FAIR specified VME based DAQ with FESA framework based software and Java GUI. The system was successfully tested in 2012 [3].

The length of the synchrotron cycle can ranges up to several seconds. At high sampling rates it will lead to a large amount of raw data. Data reduction can be achieved by triggering the DAQ system on a rate divider output to which the RF master oscillator is connected.

Previously the data reduction was realized using NIM modules. A new FPGA based single board electronics card covering multiple-event functionality including the timing receiver was designed, tested and will be assembled. The board is shown in Fig.2.

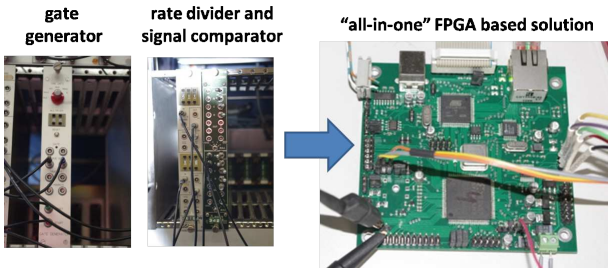

Figure 2: FPGA based single board electronics (right) for multiple-events triggering to replace NIM based solution (left).

References

[1] O. Chorniy, H. Bräuning, T. Hoffmann, H. Reeg, A. Reiter, "A FESA DAQ for Fast Current Transformer in SIS 18", IBIC2013, Oxford, September 2013

[2] S. Hancock, P. Knaus, M. Lindroos, Tomographic measurements of longitudinal phase space density, EPAC98.

[3] O. Chorniy, H. Bräuning, T. Hoffmann, H. Reeg, A. Reiter, M. Witthaus, "New Data Acquisition for Beam Transformers in SIS18 and Transfer Lines", GSI Scientific Report 2013

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