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POLAND - Low Current Profile Measurement Readout System

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Abstract

The development of a 32 channel readout system for low-current profile measurements called POLAND (Profile Acquisition Digitiser) was done in collaboration between the Beam Instrumentation (LOBI) and the Experiment Electronics (CSEE) departments. This electronic system is capable to read out beam diagnostic devices like Secondary Electron Monitor (SEM)-profile grids, Multi-Wire Proportional Chambers (MWPC), Ionisation Chambers or similar devices of the future FAIR accelerator system. Transverse beam profiles with a time resolution down to the microsecond range can be measured with POLAND.

After intensive tests with a prototype version in recent years[1], the complete readout system, close to the final version, has been built in 2013. It contains the current-to-frequency converter units based on the QFW ASIC[2], the logic unit based on an FPGA and an optical readout for data transfer to a host PC, mounted all together in a 1U 19" rack crate. The system is designed to be read out via FESA or MBS, two standard data acquisition systems for FAIR. Together with different diagnostic systems, POLAND was tested in 2013 at different beam-tests at COSY and HIT.

The POLAND readout system

The developed hard- and software is described in [1] and in detail in [3]. The main changes from the previous version are: a compact but maintenance-friendly design, higher time resolution during the beam pulse measurement, and a daisy chain readout for easy expansion of the number of readout channels. A photography of a POLAND readout unit is shown in Fig. 1.

The system has been intensively tested in laboratories of CSEE and LOBI. During this time the FPGA software has been improved and further developed.

A first test under beam conditions was done in summer 2013 at COSY in Jülich. Here the new electronics was used for monitoring the 2 GeV proton beam. A significant improvement in beam analysis compared to existing systems was achieved. Also the time-resolved beam profile was measured to analyse the extraction structure of the COSY beam. A typical 3D measurement of a time-resolved beam profile is shown in Fig. 2.

Within a second beam test at HIT medical accelerator facility in Heidelberg both the software improvements of the readout system and the new detector components connected to POLAND could be tested.

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Figure 1: Picture of a 32 channel readout system, including the four QFW units (left side) and the FPGA logic unit (middle). The complete system fits into a 1U 19" rack crate. All connectors are on the back side.

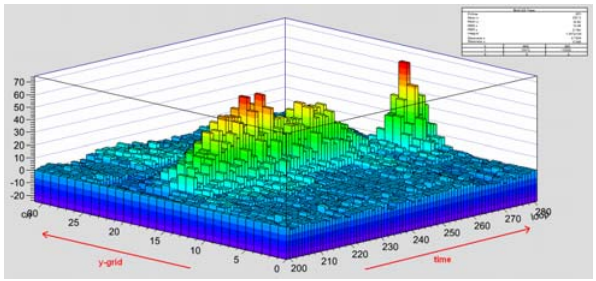

Figure 2: Time-resolved vertical beam profile measured at the 2013 COSY proton beam test. The beam extraction time was 7s with an "extra" short pulse at the end of the extraction.

Outlook

From February 2014, the system will be tested with various beam conditions at GSI experimental location UNILAC UX2 and HTP (after SIS 18) with different tasks. An important milestone will be the proton source acceptance test in summer at CEA/Saclay, France.

References

[1] M. Witthaus et al., Low Current Profile Measurements using a Current-to-Frequency-Converter (QFW), GSI Scientific Report, 2011

[2] H. Flemming and E. Badura, A high dynamic charge to frequency converter ASIC, GSI Scientific Report, 2004

[3] http://wiki.gsi.de/cgi-bin/view/EE/POLAND