SEM-Grid Prototype Electronics with Charge-Frequency-Converter (QFW)

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Overview

GSI Beam Diagnostics department together with Experimental Electronics department has started investigations on a new economical solution for SEM-Grid (Secondary Electron eMission Grid) electronics. The front-end amplifiers and control devices of the existing version are outdated and very expensive. After extensive and promising tests with a 4-channel QFW (Charge-Frequency-Converter) test board [1, 2], it was decided to develop a prototype system with 8 QFW-ASICs (see Fig. 1). The goal of the project was to perform a functional test of ASICs connected to a SEM-Grid under real beam conditions at GSI.

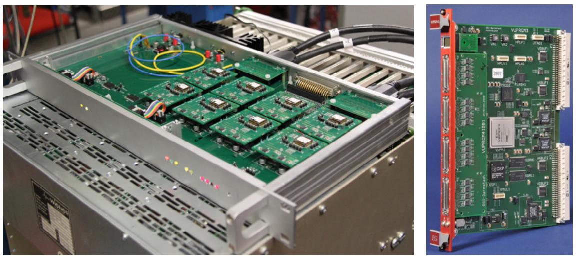

Figure 1: Prototype board with 8 QFW-ASICs (left), standard FPGA-I/O VME board (VUPROM) (right)

Hard- and Software

An important point of the new development was to use existing parts of hard- and software in order to save development time. The new SEM-Grid prototype system consists of:

- 32-ch.-motherboard equipped with 8 QFWs (II)
- VME-Crate
- RIO2-Board (MBS and Ethernet-Connection)
- VULOM-Board (for MBS Trigger operation)
- VUPROM-Board (for QFW Control)
- LEVCON Level-Converter
- Power-supply for QFW motherboard (+7V/3A)
- Go4 (GSI Objected Oriented On-line Off-line system)

The QFW motherboard is controlled by the VUPROM-Board, which sets up the QFW motherboard and operates internally its 32 scalers. The scaler data for different time slices are stored and transferred via the RIO2 board into a PC. The beam profiles are displayed and evaluated with online analysis software Go4. The QFW's parameters are set via a terminal program, and the VULOM board is necessary for the MBS trigger operation.

Measurement Results

The QFW board was tested with a 2x16-wire SEM-Grid assembly at the experimental beamline X2, which already is equipped with three SEM-Grids placed close to each other (< 1m). This experimental setup allowed to perform measurements with the prototype electronics at one SEM-Grid, and to compare the profiles with the two others. As shown in Fig. 2 the beam profiles showed a good signal resolution. Additionally, comparison between old and new electronics using the same SEM-Grid was performed with very good agreement.

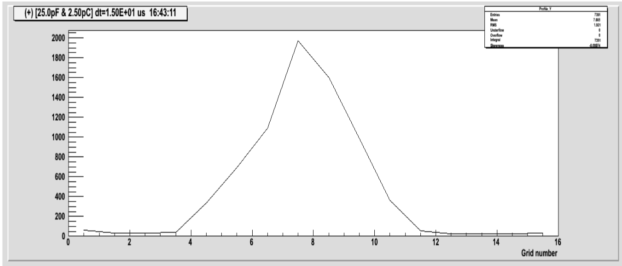

Figure 2: Vertical ion beam profiles obtained with QFW prototype board (grid with 16 wires)

With the support of Go4- and QFW-control software it was possible to display time slices of each beam pulse (see Fig. 3). Observation of the time-dependant changes of the beam profile during a single beam pulse is very helpful for accelerator operations and is not provided by the existing hardware.

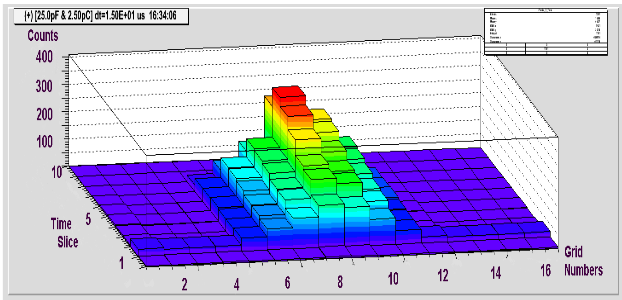

Figure 3: Time dependent and vertical beam profiles. The beam pulse length is around 100 µs, slice length is 15 µs.

Outlook

After the successful beam tests with the new QFW readout board it is planned to add a second 32-channel motherboard to the existing system. Further experiments with different diagnostic components like MWPC (Multi-Wire Proportional Chamber) as well as with different SEM-Grid types are foreseen.

References

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

[2] M. Witthaus et al., "Charge-Frequency-Converter (QFW) Test Board and Results", GSI Scientific Report, 2009