High Data Rate Initiative: Electronic Readout for a Si(Li) – Compton – Polarimeter

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Within the High Data Rate Initiative (HDRI) [1] of the Helmholtz research program "Photons, Neutrons, and Ions" KIT and GSI collaborate closely within the working package "Real Time Data Processing" bringing together the expertise of the partners in the development of advanced detector readout systems. As one of the first common projects between KIT and GSI we started the development of a self-triggering 2-dimensional position-, time-, and energy sensitive Si(Li)-strip detector read out with modern custom designed FPGA-based signal digitizer hardware as a demonstrator system. This project is of great importance for future x-ray spectroscopy and polarimetry experiments of the SPARC collaboration [2] at GSI and FAIR.

As detector platform we have chosen an already existing Si(Li)-strip detector [3] that has worked reliable in several beam times at the ESR as well as external places, e.g. TU Darmstadt and DESY, Hamburg, and has produced excellent results [4]. Up to now it was equipped with standard NIM and VME electronic. The outcome of this project using custom designed FPGA-based signal digitizer hardware will serve as a blue print for the next generation of readout electronics of thick planar strip detectors with the collaboration.

The concept is based on the fast digitizing of the preamplifier signals coming from the detector to acquire the small signals directly. The consecutive employment of pulse shape analysis techniques will show the energy and timing information of an event.

For this first demonstrator we profit from recent developments of the Experiment Electronics department of GSI. They provide us with a set of 8 FEBEX2 – ADC boards [5] with 8 input channels each. Sampling the data is performed with a frequency of 65 Ms/s and a resolution of 12 bit at an input range of +/-1V. A 1.6 GBit fiber link connects the digitizer board with the PLEXOR3-PCIe Interface hosted by a commercial PC that manages the event building and data transport by ethernet. In addition a TRIXOR1-PCIe board takes over the trigger handling and the dead time locking. The PC runs a LYNX RT-operating system and as DAQ we employ MBS [6] to take advantage of the GSI data acquisition and storage environment. To adapt the signal output of the preamplifier to the input of the FEBEX2 board the fast linear amplifier SiLiVer was developed. It has a single ended input and gives a differential output. The two consecutive amplifier stages provide a voltage gain of forty. The small form factor of the amplifier boards allows us to mount them inside the preamplifier housing to avoid losses on the signal cables.

In a first step the pulse shape analysis of the event data will be managed by PC hardware. It allows us to optimize the algorithms within a short time. The main goal of this first step is to rebuild the functionality of the NIM and VME hardware and to be able to handle photo effect and Compton events. From this point on we can make use out of the system in atomic physics experiments. In collaboration with the KIT we will refine the algorithms for the digital pulse shape analysis with the aim to manage more complex event histories like two or three Compton events for one incident photon. We plan to meet the demand of increased computing power by dedicated hardware solutions designed by KIT.

Most parts of the hardware for the demonstrator have been produced and tested already. A few parts are still in the assembly phase. First tests of the complete system are planned for March 2011.

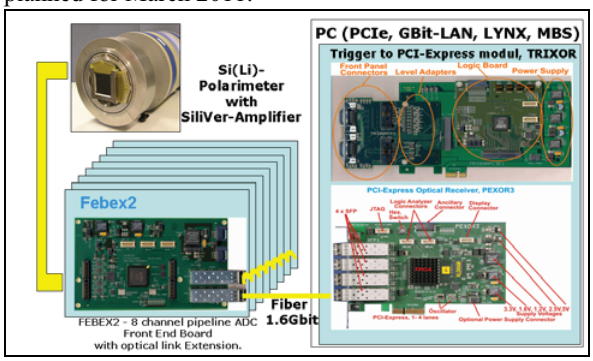

Figure 1: Sketch of the new readout chain of the Si(Li)-Polarimeter Demonstrator

References

[1] http://www.hdri-pni.de

[2] Technical Report of the SPARC collaboration http://www.gsi.de/fair/experiments/sparc/index_e.html

[3] G. Weber et al., "Performance of a position sensitive Si(Li) x-ray detector dedicated to Compton polarimetry of stored and trapped highly-charged ions", JINST 5,C07010 (2010)

[4] Th. Stöhlker et al., "Polarization and angular correlation studies of X-rays emitted in relativistic ion-atom collisions", EPJ-ST 169, 5-14 (2009)

[5] http://www.gsi.de/onTEAM/grafik/1130845854/febex2.pdf

[6] http://www-win.gsi.de/daq/