Demonstrator: Electronic Readout for a Si(Li) – Compton – Polarimeter

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Within the portfolio process of the Helmholtz Association Detector Technology and System Platform (DTS) [1] KIT, GSI, and HI Jena collaborate closely bringing together the expertise of the partners in the development of advanced detector readout systems. As one of the first common projects we develop 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 compact and cost efficient readout electronics of thick planar strip detectors within 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 provided 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 fibre 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 TRIXOR-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. With this system we studied the electronic response of the strip detector system for offline testing of appropriate pulse shape analysis algorithms. Meanwhile we moved to the next FEBEX generation (version 3a) which is a 16 channel ADC-board with differential inputs. The FEBEX3a boards are mounted in a crate with PCIe backplane together with a fibre link interface to fit into the existing DAQ environment. The digitizer cards host enough on-board FPGA resources to perform online self-triggering, double hit detection and trapezoidal filters for energy and timing applications. To adapt the signal output of the preamplifier to the input of the FEBEX3a board the fast linear amplifier SiLiVer was developed. At a later stage the small form factor of the amplifier boards will allow us to mount them inside the preamplifier housing to avoid losses on the signal cables. 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.

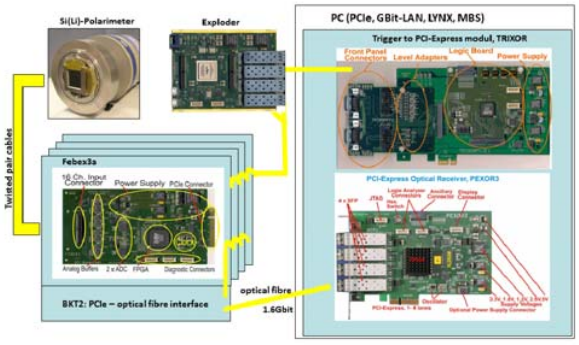

Figure 1: Sketch of the new readout chain of the Si(Li)-Polarimeter Demonstrator

References

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[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)

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