Digital readout of segmented solid state detectors based on Febex2

K.-H. Blumenhagen[1], *E. Badura*[2], *H. Bräuning*[2], *J. Hoffmann*[2], *K. Koch*[2], *N. Kurz*[2], *R. Märtin*[1,3], *S. Minami*[2], *W. Ott*[2], *Th. Stöhlker*[1,2,3], *U. Spillmann*[2], *G. Weber*[3], *and M. Weber*[4]

[1]PI, Universität Heidelberg, Germany; [2]GSI, Darmstadt, Germany; [3]HI Jena, Germany; [4]IPE, KIT, Karlsruhe, Germany

In atomic physics at GSI, solid state detectors are used to measure the energy of X-rays with a high resolution. Both segmented and non-segmented detectors were successfully employed in several works [1, 2] and will be an essential part of future spectroscopy experiments within the SPARC-collaboration [3] at FAIR. Up to now, the readout of these detectors has been performed with NIM and VME modules. Limitations of this system include insufficient rate acceptance and pile-up rejection as well as a hight cost per channel. To overcome these, a fully digital readout system is under development within the High Data Rate Initiative (HDRI) [4] of the Helmholtz Association. With this approach, not only cost and space of the readout system is reduced, one can also gain additional information by performing a digital pulse shape analysis. In this work, already available digitizer systems were used to read out different detectors. The preamplifier pulses – generated by an ^{241}Am source mounted in front of the detector – were digitized with a fixed sampling frequency and then stored entirely. These pulses were analyzed with software employing digital filters. A comparison of different filters was performed. The first setup was a HPGe-detector which was read out by a digitizer card (CompuScope card) that is built in a Windows-XP computer. First, the timing properties of several filter configurations have been investigated. The best time resolution obtained was $7.8\,\mathrm{ns} \pm 1\%$. Then the pulseheight spectrum was generated for different filters. A reference spectrum of ^{241}Am was used to perform the energy calibration. The quantity calculated for each filter in order to compare them was the FWHM at 59.54 keV (fit of a gaussian with linear background in the energy spectrum). The best value obtained was $0.38\,\mathrm{keV} \pm 1.6\%$ which corresponds to the result of a measurement with the same setup, but analog readout. The energy spectrum that gave this value with digital readout is shown in figure 1. The second setup was a segmented Si(Li)-detector [5] which was read out by the Febex2 card [6] and additional electronics which was all developed at GSI. The detector has 32 strips on the front side and orthogonal to them 32 strips on the backside of its crystal. In this work eight strips on the front side were read out and one of them was investigated (only energy resolution, no timing). The best value obtained was $1.98\,\mathrm{keV} \pm 1.6\%$. The corresponding spectrum is shown in figure 2. Similar results were obtained with analog electronics. One future activity is the development of a hardware-based pulse analysis. For this, the Febex2 card's built-in FPGA applies simple digital filters online to obtain time and energy information.

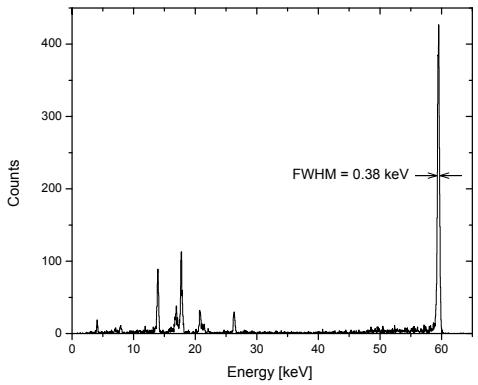

Figure 1: ^{241}Am spectrum of HPGe-detector.

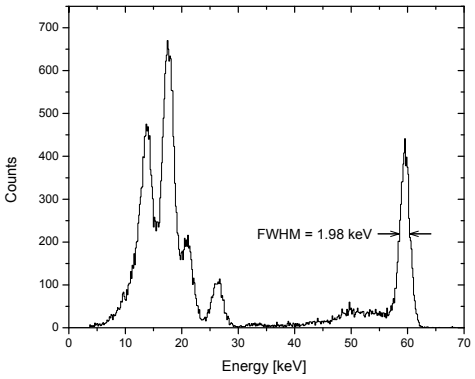

Figure 2: ^{241}Am spectrum of Si(Li)-detector.

References

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