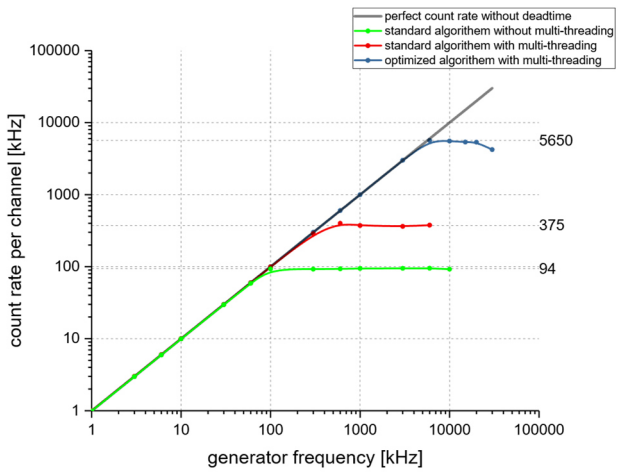
Digital positron annihilation lifetime spectroscopy for applications with high count rates

E. Hirschmann,[1,2*] U. Hernandez Acosta[1,3], M. Butterling[1], A. Wagner[1] and R. Krause-Rehberg[2]

[1] *Helmholtz-Zentrum Dresden-Rossendorf, Inst. of Radiation Physics, 01314 Dresden, Germany,*
[2] *Martin-Luther-University Halle-Wittenberg, Department of Physics, 06099 Halle, Germany*
[3] *TU Dresden, Institut für Theoretische Physik, 01062 Dresden, Germany*

For over 10 years[1] of research the positron group from the MLU Halle and the HZDR are developing a solution to employ a digital positron lifetime setup at the MePS[2] system at the ELBE[3] accelerator, using an appropriate digitizer to replace the analog setup. The idea is to analyze data online using a software written in C++ and a graphical user interface designed in QT. Over the years, a conventional setup could be built up and tested using an *Agilent* digitizer with an inhouse made coincidence trigger unit, which significantly reduces the data traffic. Unfortunally, the bandwidth limitation of this digitizer was too high to use the same technique at the MePS system, because this setup reaches up to 100 kcps at optimal setting and highest bunch repetition rates. To overcome this problem a new generation of digitizer (Teledyne SPDevices ADQ14DC-2X) was tested using an innovative FPGA supported pulse detection firmware. This firmware reduces the transferred data stream to the pulse shape only, coupled with an appropriate timestamp. Based on the data reduction an inhouse made software was written to calculate the time stamps for the positron generated PMT pulses and the 3.2 MHz ELBE time reference signals online.



In this talk the hard- and software solution will be presented. The used FPGA based pulse detection logic, the drastically simplified time calculating algorithm and the multithreading approach, which leads to a maximized throughput for high performance positron annihilation lifetime spectrometers will be shown in detail.

Figure 1 *A generator pulse is used for start and stop to check the limitation of the used software changes: (grey) perfect performance without dead time, (green) standard algorithm, (red) standard algorithm with multi-threading and (blue) simplified algorithm with multi-threading*

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*Eric Hirschmann, Email: e.hirschmann@hzdr.de