Pulse Shape Analysis for the TASISpec Implantation Detector[*]

U. Forsberg[1], P. Golubev[1], D. Rudolph[1], D. Ackermann[2], L.-L. Andersson[3], Ch.E. Düllmann[2,4,5], J. Even[4], J.M. Gates[6], J. Gellanki[1], F.P. Heßberger[2,5], R. Hoischen[1,2], E. Jäger[2], I. Kojouharov[2], J. Krier[2], N. Kurz[2], H. Schaffner[2], B. Schausten[2], M. Schädel[2], and A. Yakushev[2]

[1]Lund University, Sweden; [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany; [3]University of Liverpool, UK; [4]Universität Mainz, Germany; [5]Helmholtz Institute Mainz, Germany; [6]Lawrence Berkely National Laboratory, USA

In TASISpec – TASCA in Small Image Mode Spectroscopy setup, which aims at decay spectroscopy of superheavy elements [1] – heavy ions are implanted into a double-sided silicon strip detector (DSSSD). Their subsequent decays are recorded in this, as well as in the surrounding silicon and germanium detectors. The use of sampling ADCs in the experimental setup open up for new possibilities, such as particle identification, as they allow for investigations of the actual pulse shapes from the detectors. Pulses from the DSSSD were integrated in charge-sensitive preamplifiers [2] and studied by splitting the signals between the standard electronics read-out chain and sampling ADCs (CAEN V1724) as shown in Fig. 1. The sampling ADCs digitise the pulses at a rate of 100 MHz. For each event, a time span of 2.56 μs around the arrival of the pulse was recorded and analysed offline. Triggers from the standard electronics were used. The accumulated data originates from a 3-line α source and an in-beam experiment in which the DSSSD was irradiated with heavy ions using the reaction ^{207}Pb(^{48}Ca,$2n$)^{253}No.
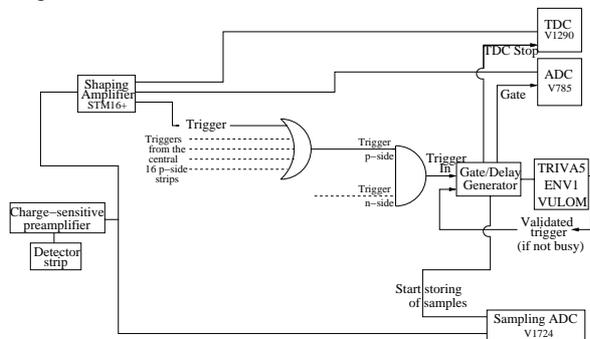
Figure 1: Electronics scheme for the DSSSD of TASISpec.

Any particle information present in the pulse shape resides within the rise of the pulse. The pulses were differentiated in order to emphasize this region of interest. Figure 2 shows the summed derivatives of pulses originating from the p-side (implantation side) of one pixel of the DSSSD; from α particles (red) and from implanted heavy ions (black). A difference between the pulse shapes appears in the "tail" of the derivative, which corresponds to the top of the original signal. This discrepancy was characterised by calculating the ratio of the integral over the particle-dependent area, and the integral of the main peak in the derivative. The regions used are marked in the figure.
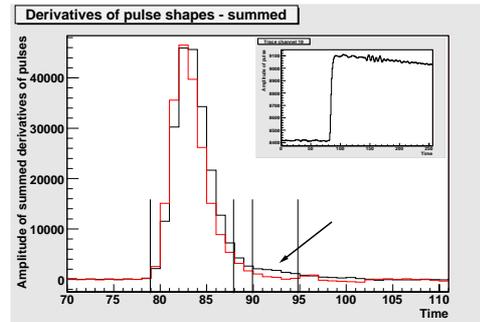
Figure 2: Summed derivatives of pulses from α particles (red) and implanted heavy ions (black). Insert: Typical pulse shape before software treatment.

The ratio between the two integrals was calculated for all pulses from the pixel, and the resulting distributions are shown in Fig. 3. The distribution from heavy ions is clearly shifted to the right compared to the one from α particles. Other pixels that were investigated show the same tendencies. This testifies that particle information is indeed present in the pulse shapes.
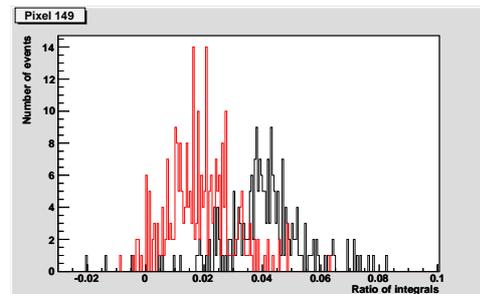
Figure 3: The ratio between the integrals for α particles (red) and implanted heavy ions (black).

In order to use the existing differences for a separation into α particles and implanted heavy ions, each strip, and possibly also every pixel, must be analysed individually in order to optimise the parameters used for the characterisation of the differences. This issue will be addressed in future analyses of pulse shapes from the TASISpec implantation detector.

References

[1] L.-L. Andersson *et al.*, Nucl. Instr. Meth. A **622**, 164 (2010)

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