A Micro-Strip Germanium Detector for Position Sensitive X-Ray Spectroscopy

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For the current x-ray spectroscopy program at the ESR storage ring, a position sensitive germanium detector for the hard x-ray regime (10 to 100 keV) has been developed by the group of D. Protic at FZ-Jülich in collaboration with the Atomic Physics Group at GSI. The general features of such detector systems are, beside their position sensitivity, a good energy resolution along with timing capability [1]. These properties make such a detector system also very well suited to fulfill the requirements of the crystal-spectrometer project. More general, by exploiting the capability of a micro-strip detector, a broad range of new challenging experiments can be anticipated, e.g. precise lifetime and Doppler tuned experiments.

In Fig. 1, the design scheme of the new detector is depicted. In total, the 3.6 mm thick Ge crystal is depleted into of 200 micro-strips. The width of the individual strips amounts to 200 μm with a length of 23 mm whereas the gap between the strips amounts to 30 μm. Each μ-strip is connected to a separate preamplifier, providing us with timing and energy information for each individual segment.

For illustration we depict in Fig. 2 a sample photon spectrum recorded with one individual strip. For this test a mixed γ-ray source consisting out of ^{241}Am and ^{133}Ba has been used. The energy resolution obtained during this first test correspond to 2.5 keV at 59 keV. Meanwhile, by optimizing the connections between the preamplifiers and the detector segments, a resolution of well below 2 keV has been achieved. Moreover, to investigate the position sensitivity a collimated ^{241}Am source was used. In Fig. 3 the corresponding event distribution obtained for three different positions is shown whereby a energy condition for the 59 keV γ-line was applied. The beam divergence leads to the observed position broadening of 0.8 mm. From the spectra displayed it is evident that the center of gravity of the lines can be determined with a precision of close to 100 μm. Moreover, we like to stress that due to the energy condition applied the position spectra are free of background events. This illustrates the advantage of this prototype detector compared to conventional position sensitive photon-detectors.

[1] G. Rossi et al., Nucl. Instr. Meth. A **391**, 264 (1997)

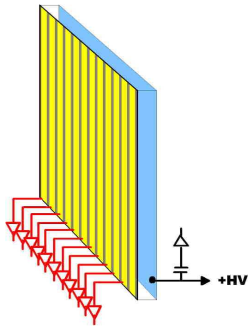

Fig. 1: Design scheme of the μ-strip Germanium detector. In total the detector consists of 200 μ-strips, each furnished with an individual read-out.

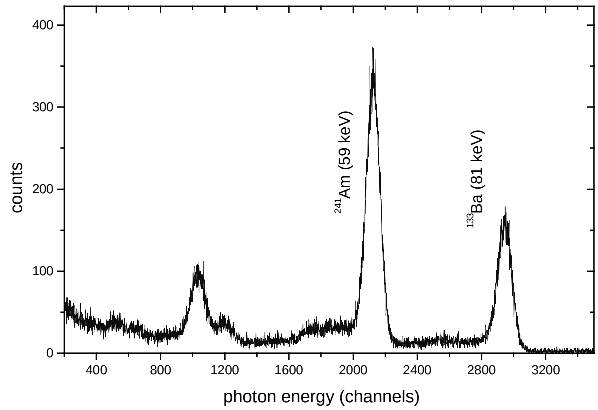

Fig. 2: Sample x-ray spectrum measured with one individual segment of the μ-strip detector .

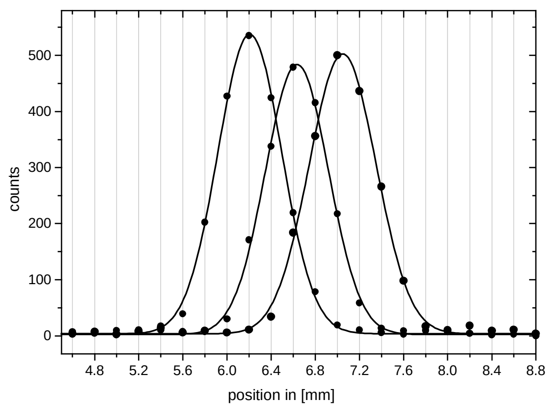

Fig. 3: Position spectra obtained with a collimated γ-ray source (59 keV, ^{241}Am) at three different positions. The beam divergence leads to the observed position broadening of 0.8 mm.