„Spectroscopy“ with the Mini-Geigerle and the Alpha Sensor

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In previous experiments it became quite evident that the alpha sensitive detector with the S1223 PIN diode from Hamamatsu yields an energy dependent signal strength at the amplifier output of the (Mini-) Geigerle. Therefore it appeared promising and interesting to me to also try something like a spectroscopy.

Since I currently had a piece of pitchblende available I prepared a respective experiment (accompanied with deep respect of the high natural radioactivity of 200uS/h) and did an analysis of the results. I fed the output of the amplifier directly into the PC soundcard and tried to ensure not to overload the input. This means I adjusted the maximum amplitudes to be somewhat below 100% of the input range. The duration of the recording was always about 1 minute. I also did comparing measurements to the Am241 source from the smoke detector and from the radium containing luminous dial of the wrist watch.

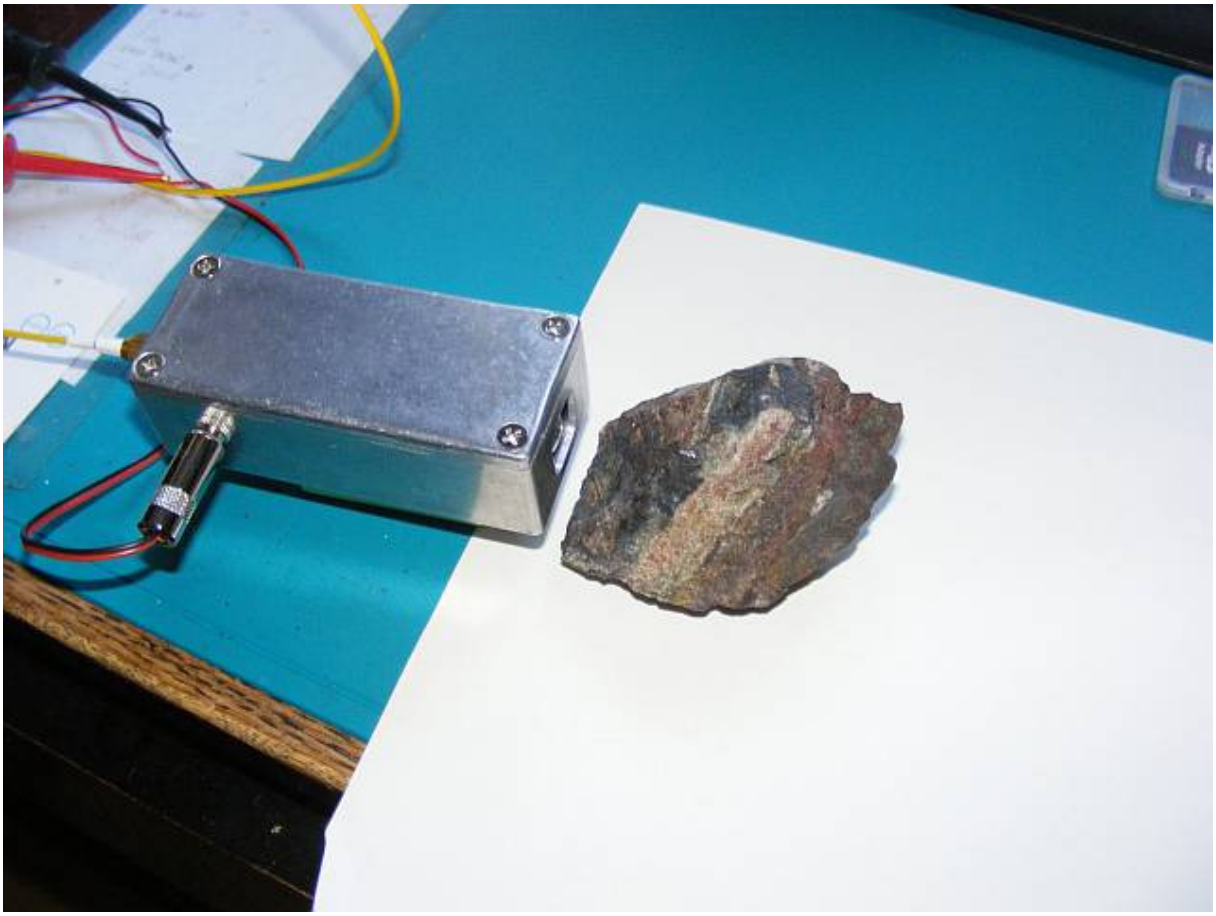

Fig. 1: Mini-Geigerle in front of a piece of pitchblende mineral

The soundcard samples the amplified signal of the detector with 48000Hz, just sufficient to represent the short pulses correctly. It is required however to read in the samples from the .wav audio file with a program followed by processing and an analysis of the samples. It is not possible to hear much from the audio file except a high frequent noise, the pulses right after the amplifier are too short.

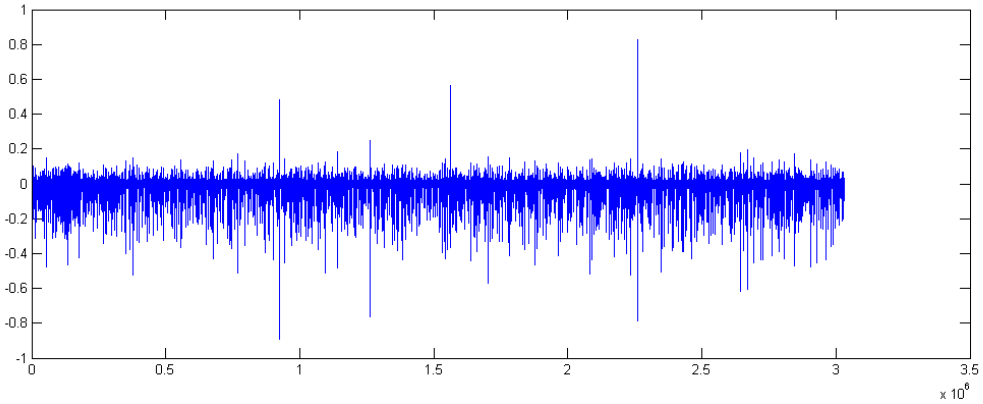

Fig. 2: Recorded audio signal of the pitchblende

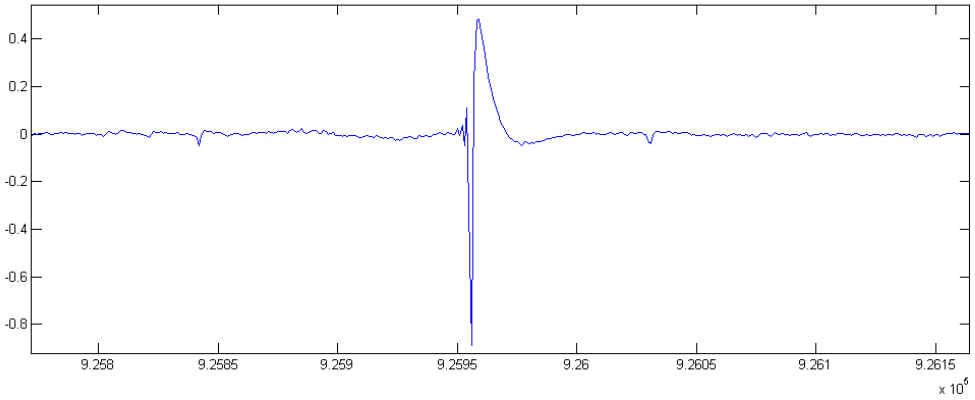

Fig. 3: A relatively strong alpha-pulse (the positive ringing is an artifact of the soundcard)

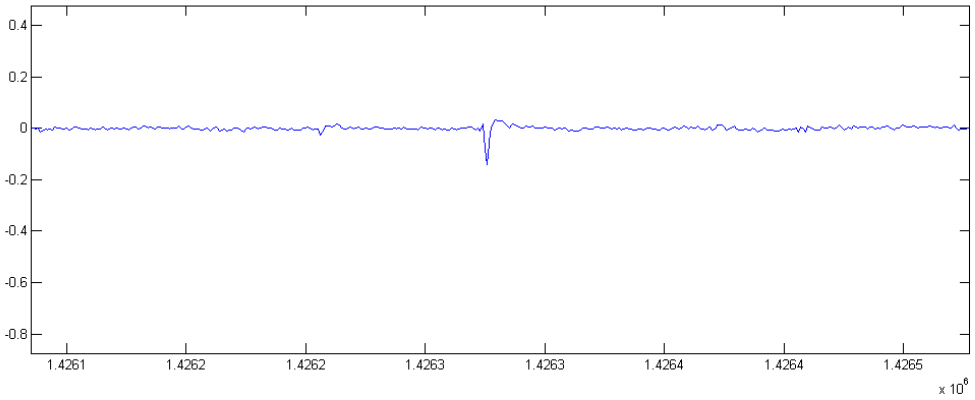

Fig. 4: A weak pulse (supposedly beta- or gamma radiation)

The information is mainly contained in the negative amplitudes since the amplifier inverts the signal from the detector. However, the soundcard generates a wider subsequent positive ringing caused by its non-ideal frequency response. The ringing is also dependent on the energy of the radiation quanta. Several strong pulses are visible caused by alpha radiation and a high density stream of weaker pulses most likely beta or gamma radiation because these pulses persist when shielding the detector with a piece of paper.

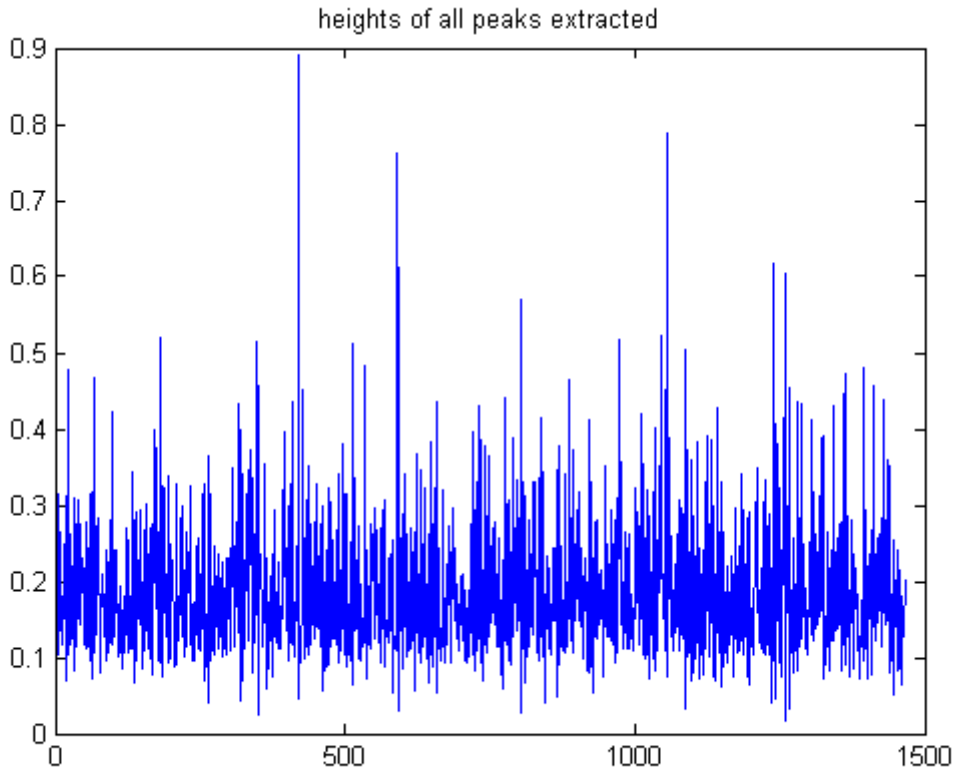

Fig. 5: Absolute values of extracted peak heights from the pitchblende radiation

Now it is possible to define a threshold (best for the derivative of the signal) which subsequently is used to extract the maximal amplitude in each peak. All these extracted peak heights are then plotted in a graph (fig. 5). Now a distribution of amplitudes can already be recognized.

When now a histogram is calculated from the extracted peak heights, the distribution can be visualized nicely. A maximum of 0.1 is clearly visible (1 is the maximum range of the sound card). For this amplitude about 430 cpm are detected. It also becomes evident that the distribution crosses the value 0.4 and reaches 0.8 with some counts per minute.

Since pitchblende (U_3O_8) contains uranium and should predominantly emit a 4MeV alpha radiation this result is a bit strange. For this reason I did a similar measurement and analysis for the Am241 source from the smoke detector that should be an almost pure alpha radiation source. Indeed, much more high energy pulses are visible and the histogram yields a significantly higher ratio of amplitudes above 0.4 . However, the maximum of the distribution is also located below 0.4 what leads to the conclusion that there are also alpha pulses with weaker energy supposed to be slowed down by the distance in air and the aluminum foil shielding of the detector.

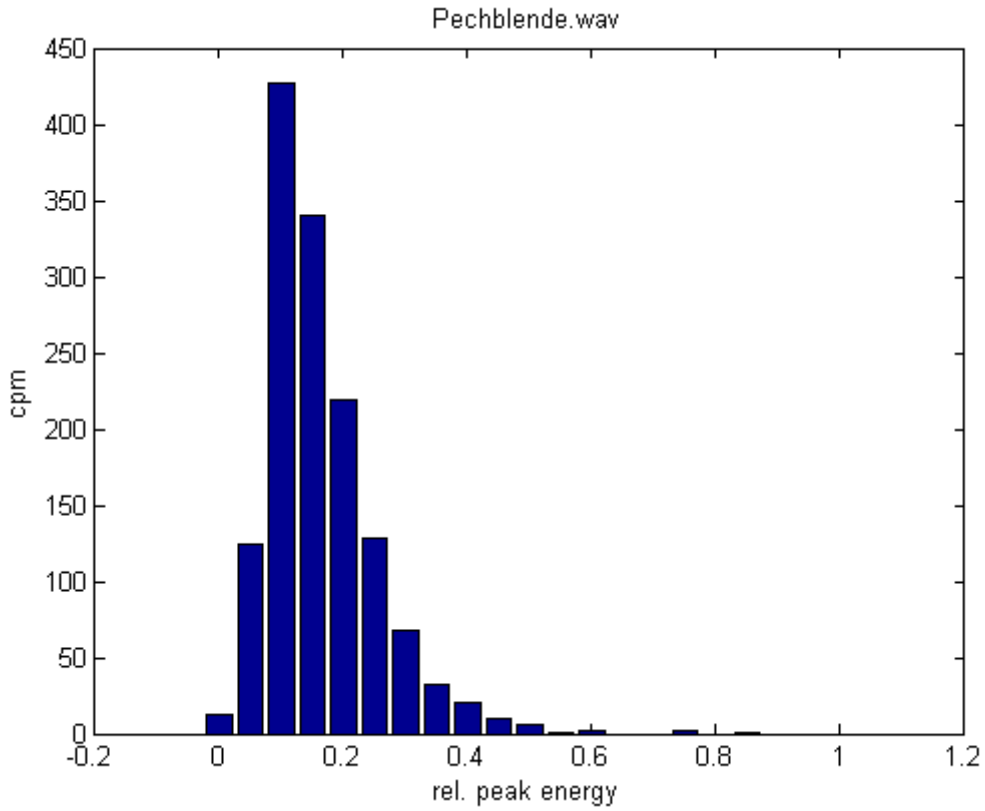

Fig. 6: Histogram of pitchblende peak amplitudes (peak rate 1392 cpm)

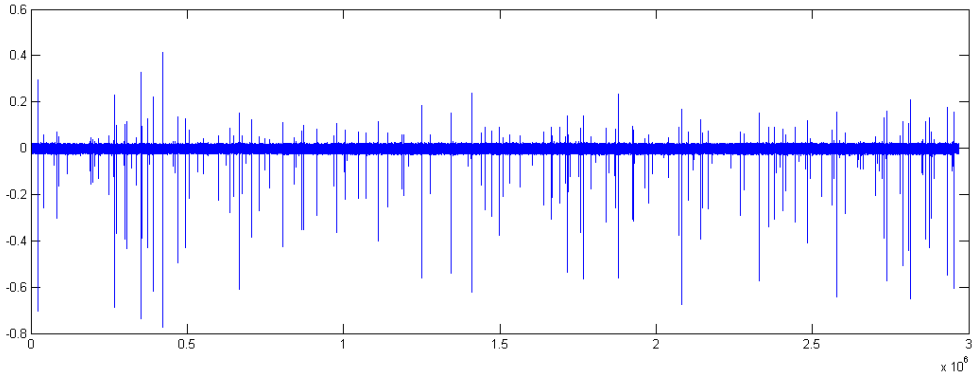

Fig. 7: Recorded audio signal of the Am241 smoke detector source

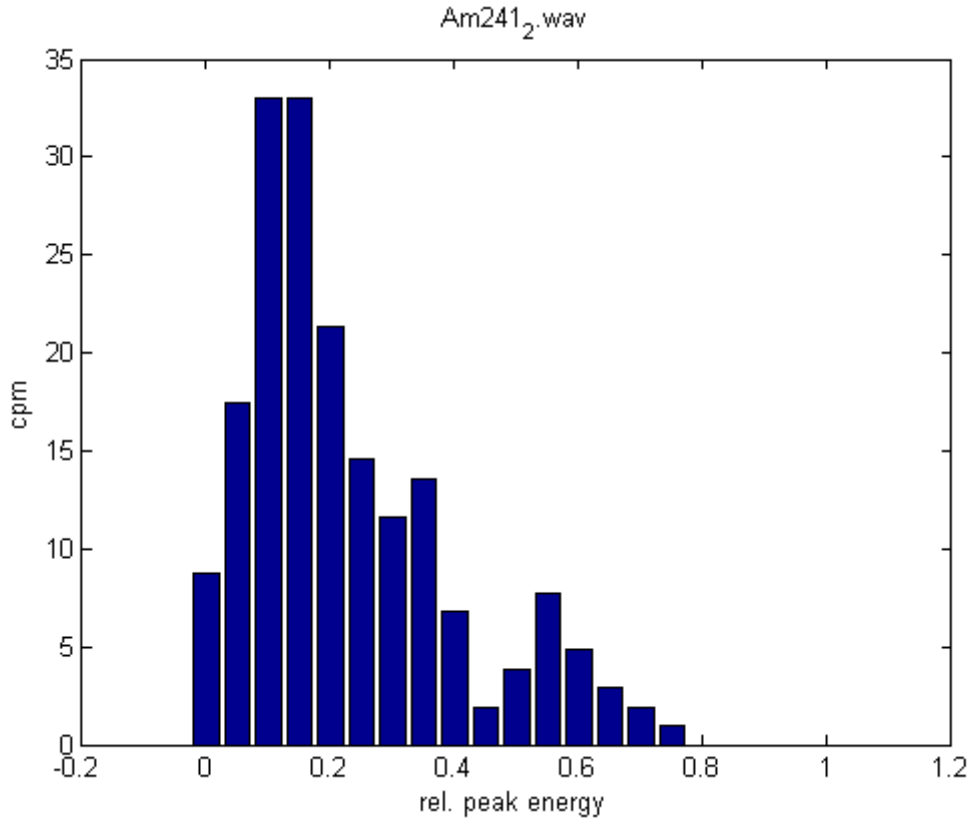

Fig. 8: Histogram of peak amplitudes of the Am241 source (peak rate 184cpm)

Finally I repeated the measurement also with the radium containing luminous dial of the old wrist watch. It has a plastic cover in front of the dial that should suppress the alpha radiation from reaching the detector. Indeed this becomes obvious in the audio recording. However, there are still a few strong alpha peaks passing through. The histogram looks similar to that of the pitchblende but with much less peak rate per amplitude.

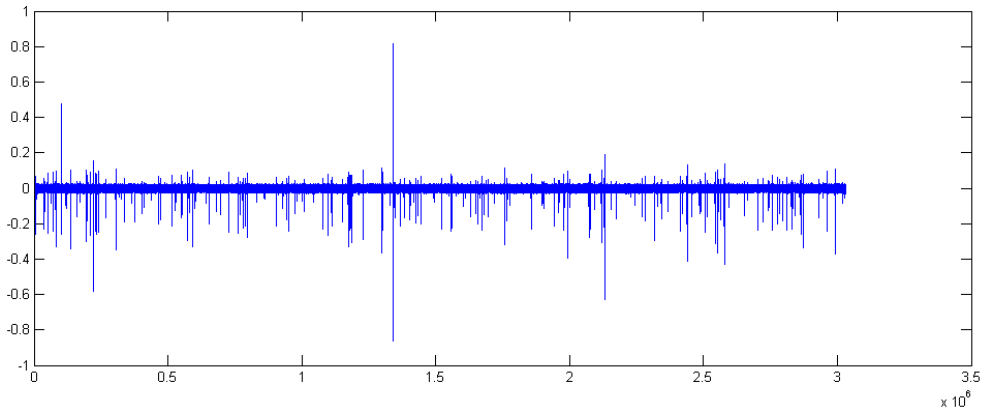

Fig. 9: Recorded audio signal of the wrist watch luminous dial

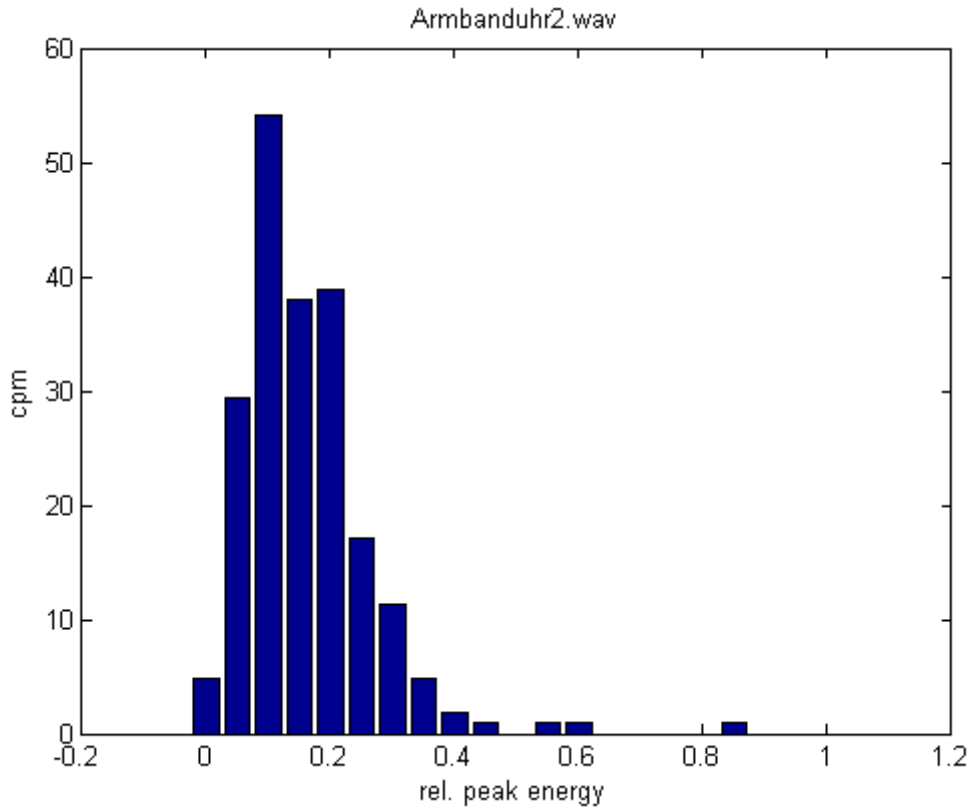

Fig. 10: Histogram of peak amplitudes of the wrist watch dial (peak rate 204cpm)

As a conclusion it can be stated that the detector and TIA amplifier of the (Mini-) Geigerle clearly maps energy differences in the radiation detected. To my opinion however, under these „hobby conditions“ a real spectroscopy with sharp energy peaks providing an exact conclusion on the radiation source is not possible so far.