Detection of Weak Radioactivity in the Example of Potassium Fizzy Tablets

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The detection of natural radioactivity is not trivial and may really challenge a PIN diode counter to its limits. To show a working example despite this challenge I analyzed a sample in terms of a potassium fizzy tablet (effervescent tablet). Such fizzy tablets are administered as medication in case of a potassium deficiency symptom that may appear as nervous or muscular dysfunction e.g. cardiac arrhythmia or to reduce the probability for repeated generation of kidney stones. They contain potassium salts in relatively high concentration. With respect to possible injuries caused by radioactivity such a drug is of course most harmless. It is available in a pharmacy at less than 10 Euros without prescription.

Natural potassium without special treatment always contains about 0.012% of its radioactive isotope K-40 (half-life $1.277*10^9$ years) which decays into calcium and argon emitting beta and gamma radiation. Since we ingest potassium with food (it is vitally important for stimulus propagation), it contributes to about 50% to the natural radioactivity (about 4000Bq) of a human body. To measure the activity of potassium in a fizzy tablet I used the amplifier of the "Stuttgarter Geigerle" (with AD8666 as OP) and equipped it with 3 BPW photo diodes. The measurement I performed in a tightly shielded box where I also positioned the sample tablet.

The counts of a commercial Geiger-Mueller counter tube show the potassium activity with coarsely twice the value of the background radiation (mostly caused by the local radon concentration in air). In my experimental setup the background radiation of the radon was not visible within the observation time. With the potassium tablet however, all 2min in average a pulse popped up. On the scope, with an appropriately adjusted trigger level, the pulses can be accumulated over time and all pulses can be plotted on top of each other to also get an impression of the statistics.

If you don't like the tedious waiting for a pulse with earphone and stopwatch you can also connect the earphone output to the microphone input of your PC-soundcard and do a recording over a longer time. Since the „Stuttgarter Geigerle" already has a capacitively coupled earphone output this is easily possible without any other modifications. Afterwards the analysis is possible with PC software. Programs (e.g. Matlab) offer a reader fort he .wav audio-format to further automate the analysis (see fig. 4).

To get a comparison to a sample of moderate activity I additionally analyzed an old thorium containing mantle of a petroleum lantern with the same amplifier. For this sample a pulse occurs roughly all 4 seconds with 3 BPW34 diodes. The scope also shows higher amplitudes of the pulses as for the potassium.

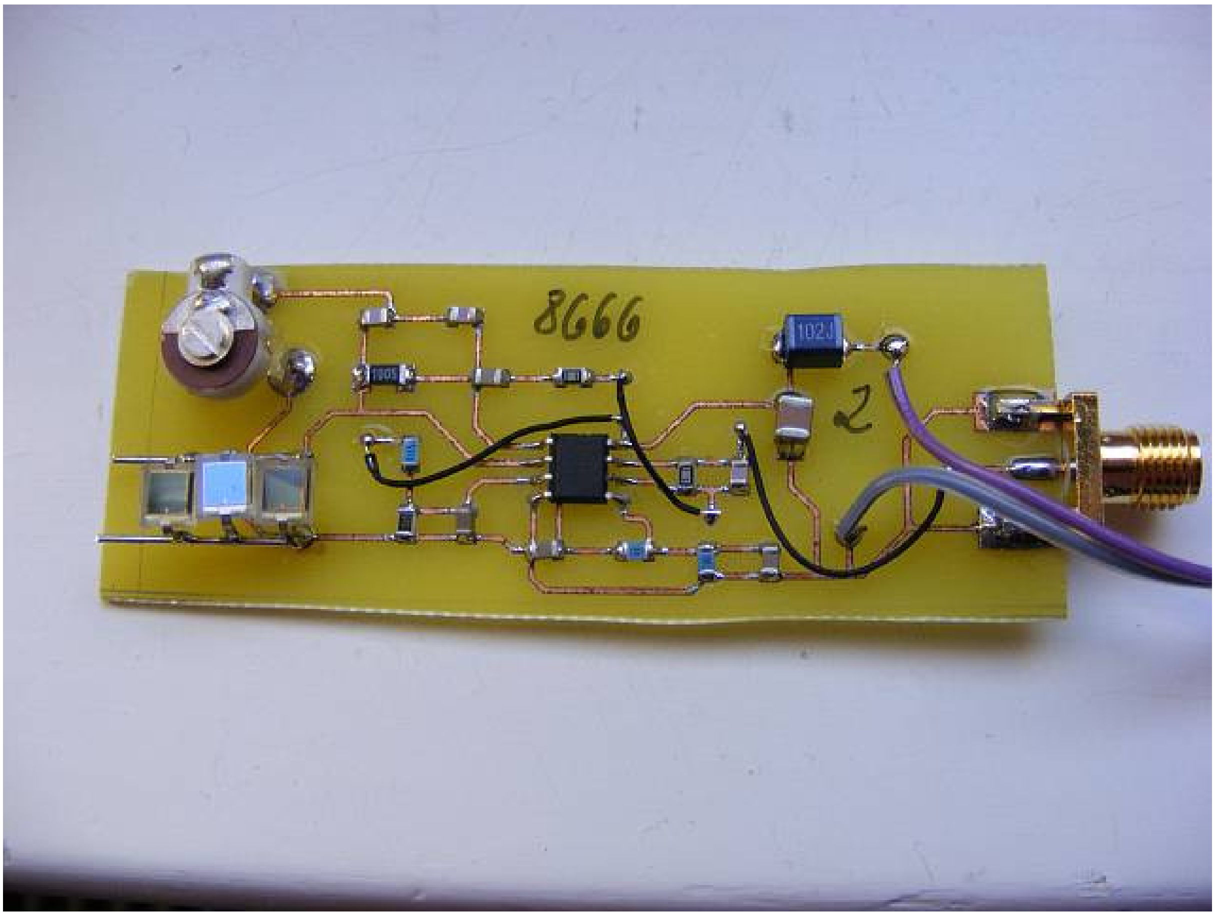

Fig. 1: Geigerle amplifier prototype PCB with AD8666 OP

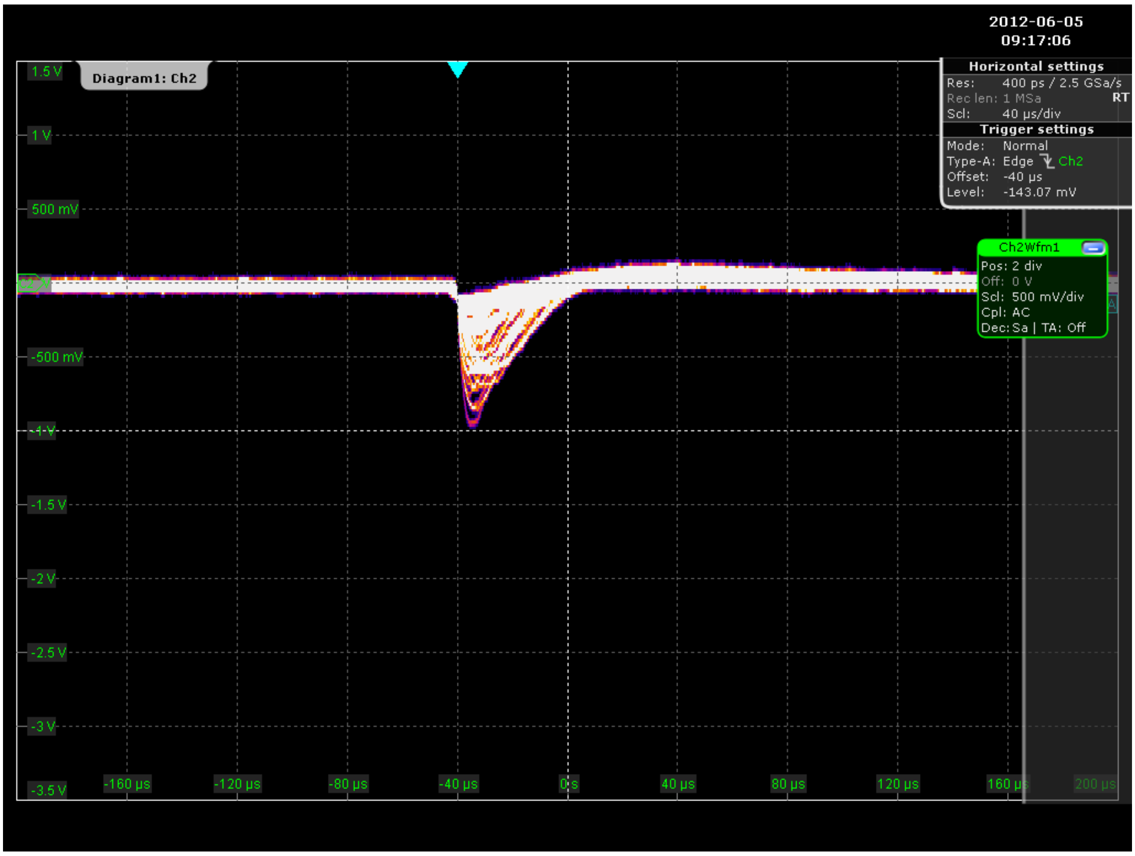

Fig. 2: Accumulated pulses of the potassium fizzy tablet

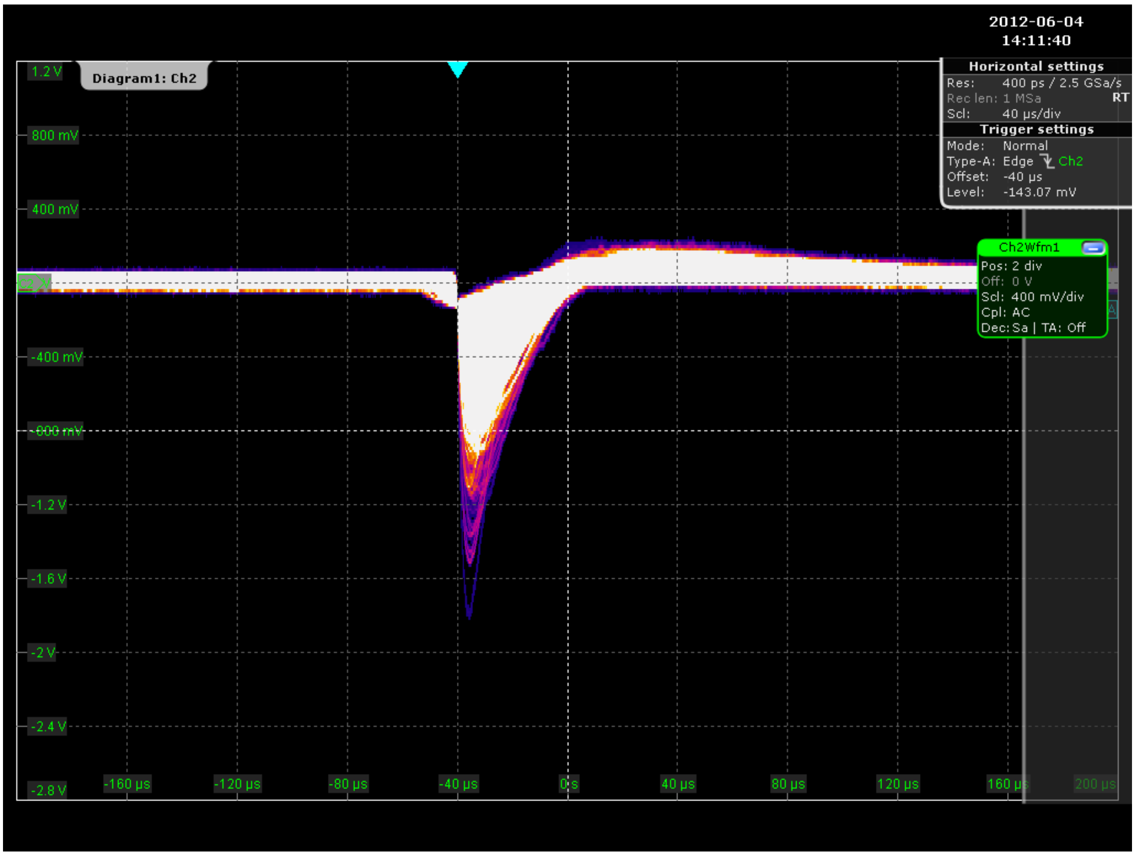

Abb.3: Comparing measurement with a thorium containing mantle

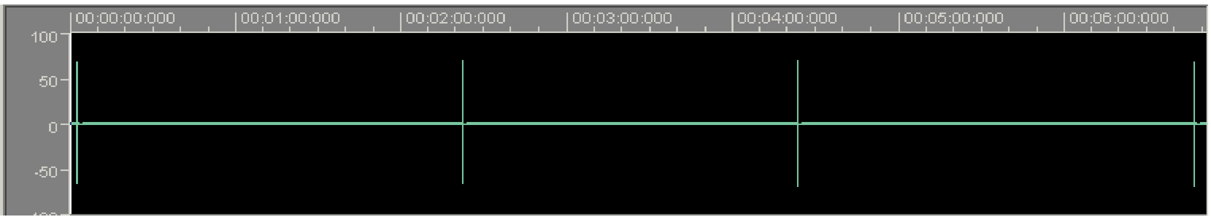

Abb. 3a: Recording of the comparator output pulses with the soundcard

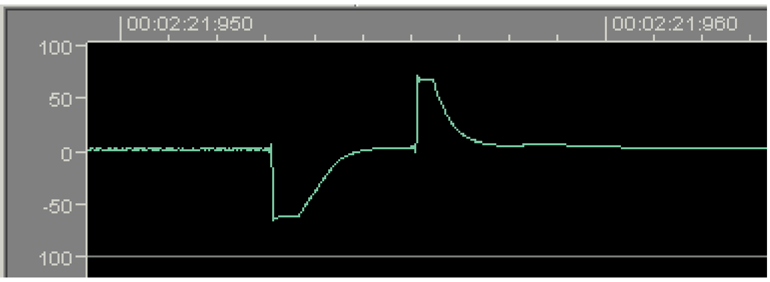

Abb. 3b: Zoom-in to a comparator impulse recorded with the soundcard

```
clear;
fname='GeigerleSound\Kalinor.wav';
[y,Fs,bits] = wavread(fname) ;
z=diff(y(:,1));
gt=find(z>0.2);
x=1:length(gt);
dgt=diff(gt);
[hdgt,xh]=hist(dgt);
thres=(xh(end)-xh(1))/2;
dgtClean=find(dgt>thres);
dgt2=[];
for n=1:length(dgtClean)
    dgt2=[dgt2 dgt(dgtClean(n))];
end
Tmean=mean(dgt2)/Fs;
fprintf(1,'%s %.3f\n', fname, 1/Tmean);
```

Fig. 4: Matlab-script for analysis of the count rate