Optimizing features of SCA towards improvement of Mössbauer spectra productivity

Univesity Palacky Olomouc – Department of Experimental Physics

Roman Prochazka, Miroslav Mashlan

Introduction

- The statistical quality (productivity) of Mössbauer spectra is one of the most important features characterizing detection and discrimination system of Mössbauer spectrometer.
- Optimizing the discrimination part of the spectrometer, including the novel way of selection represents a route how to increase the spectrum productivity.

Introduction

- Statistical quality of Mössbauer spectra is determined by expression:

$$Q = \frac{\varepsilon^2}{\varepsilon + 2} N_\infty$$

- where ε is the value of the resonant effect :

$$\varepsilon = \frac{\left| N_\infty - N_0 \right|}{N_\infty}$$

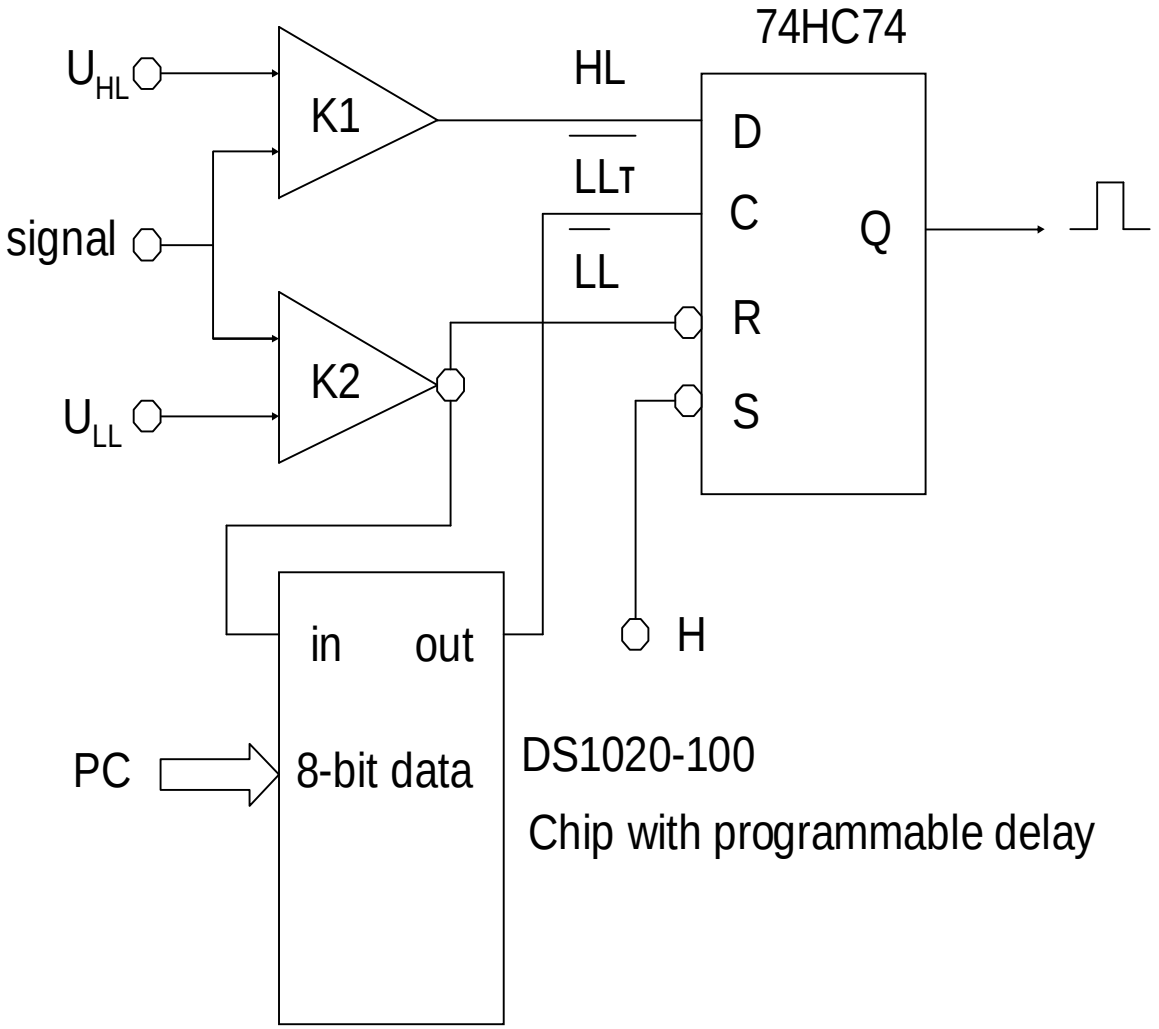
- N_∞ stands for the counts of background and N_0 then denotes the counts of the minimal resonance peak
- For transmission measurments, ε is always much smaller then unity, and we can use an approximate relation:

$$Q = \frac{1}{2} \varepsilon^2 N_\infty$$

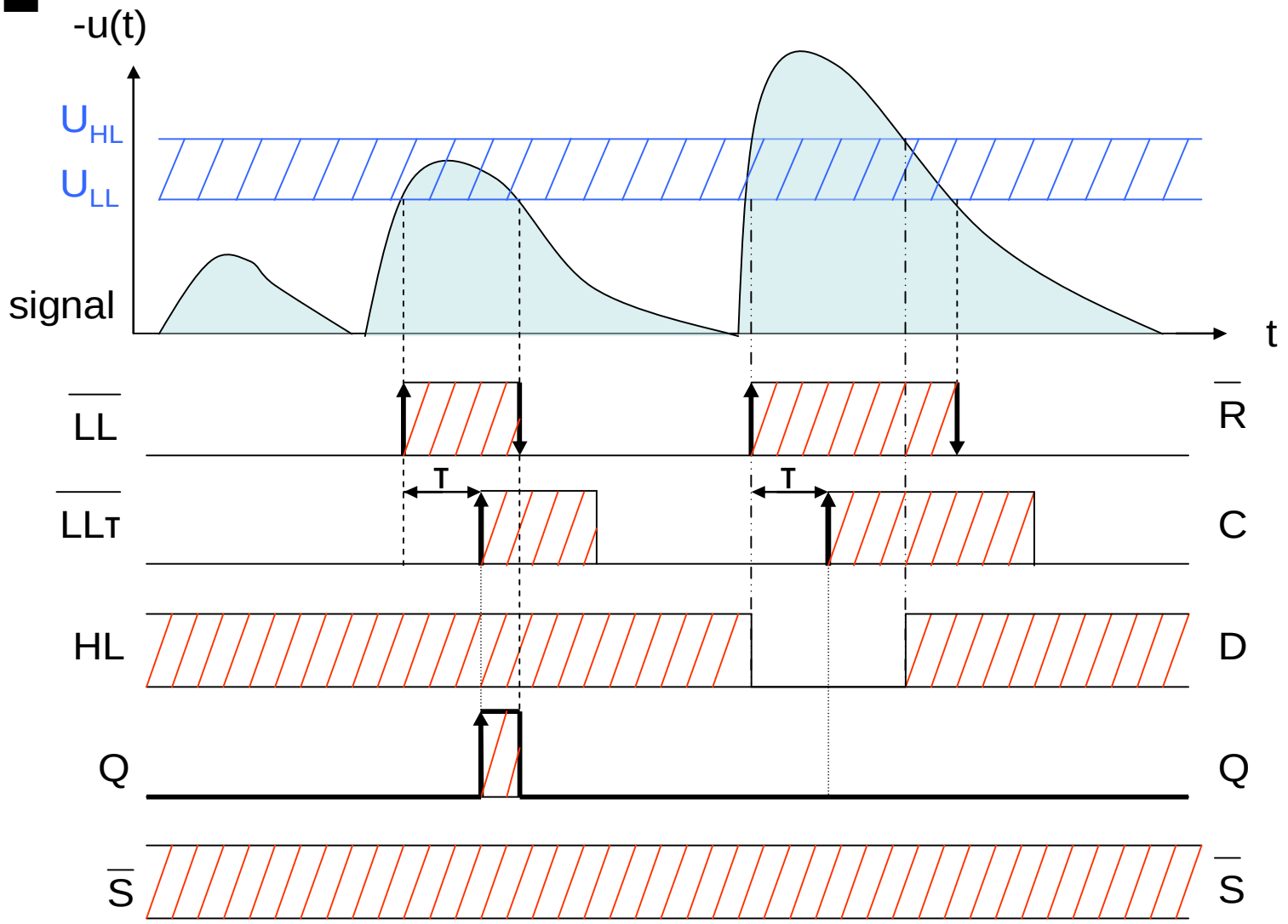
Motivation and goals

- Higher statistical quality of the spectra
- Shorter time of measurement with lower operating costs (low – temperature measuring)
- System applicable with a high active source of radiation and fast detection system for a faster accumulation of the spectra
- Simple and high-stability solution with selectable parameters for optimizing features of the analyzer

Electronic solution of SCA with programmable delay



Principle of operation

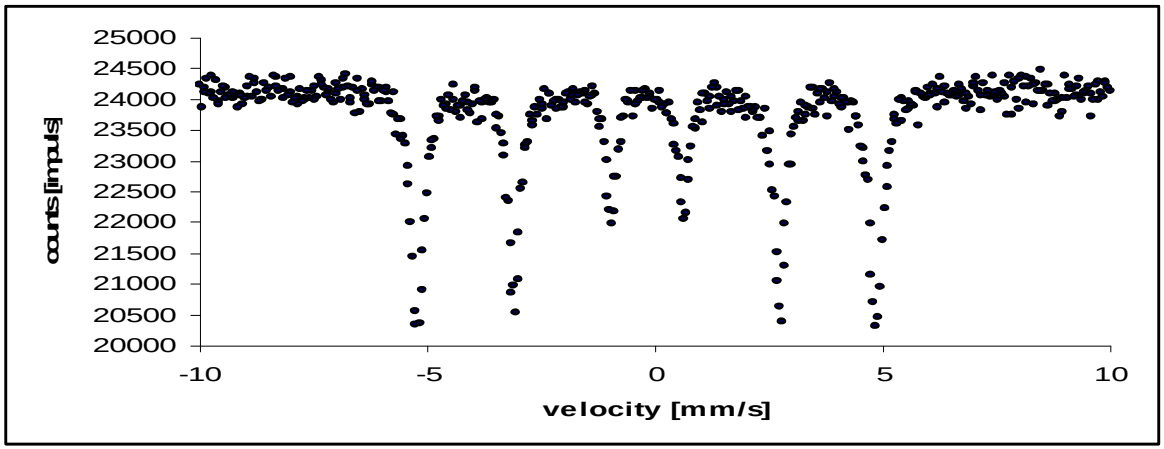


Conditions of experiments

- We used fast YAP scintilation detector

  (high voltage – 950 V for multiplier, decay time of YAP scintilator - 30 ns)
- Setting of discrimination levels at half-width of the peak corresponding to energy of 14.4 keV
- Measuring time of Mössbauer spectra was one hour with a calibration sample of α-Fe
- Measuring system based on MS 96
- Measuring in laboratory conditions

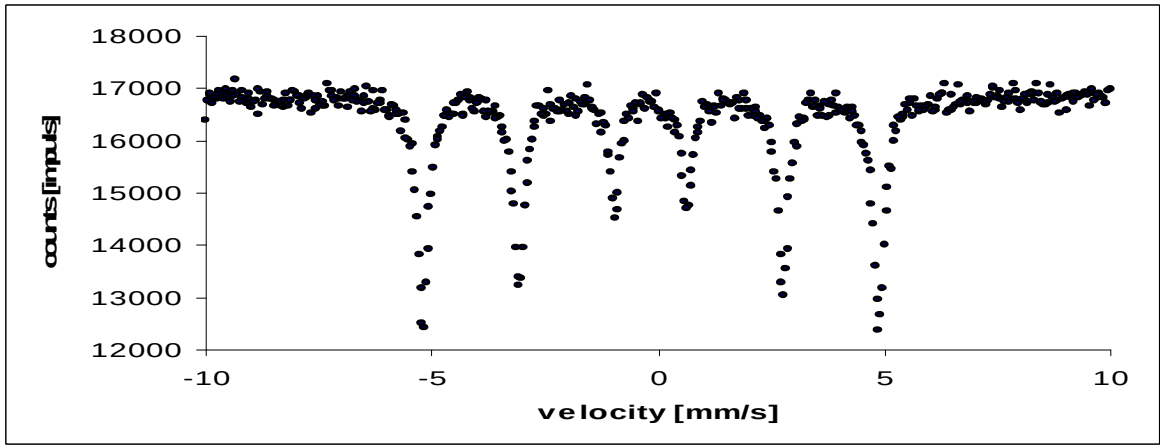
Resulting spectra from new SCA



ε = 18,2 %

N_∞ = 24250

YAP detector and SCA with programmable delay – 35 ns

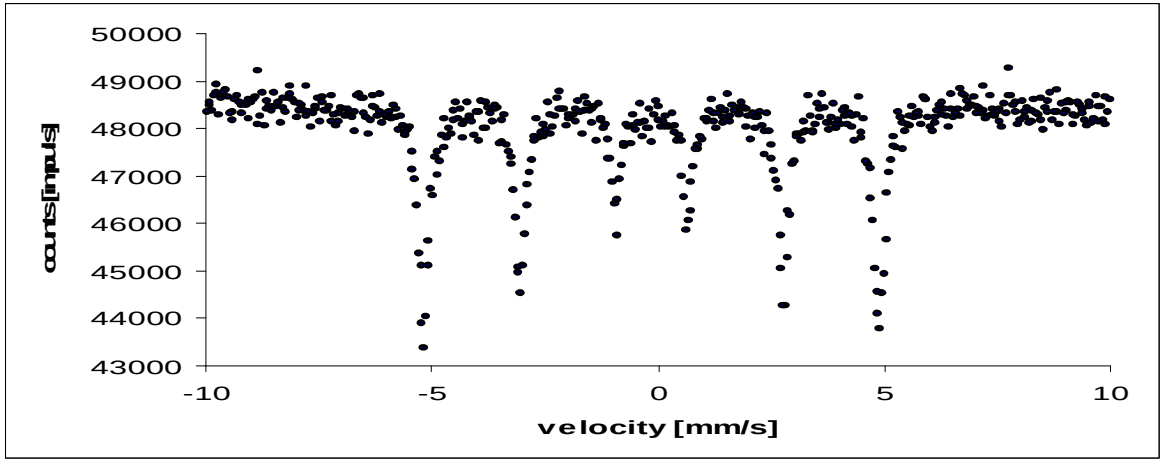


ε = 26,5 %

N_∞ = 16900

NaI(Tl) detector and SCA with programmable delay – 264 ns

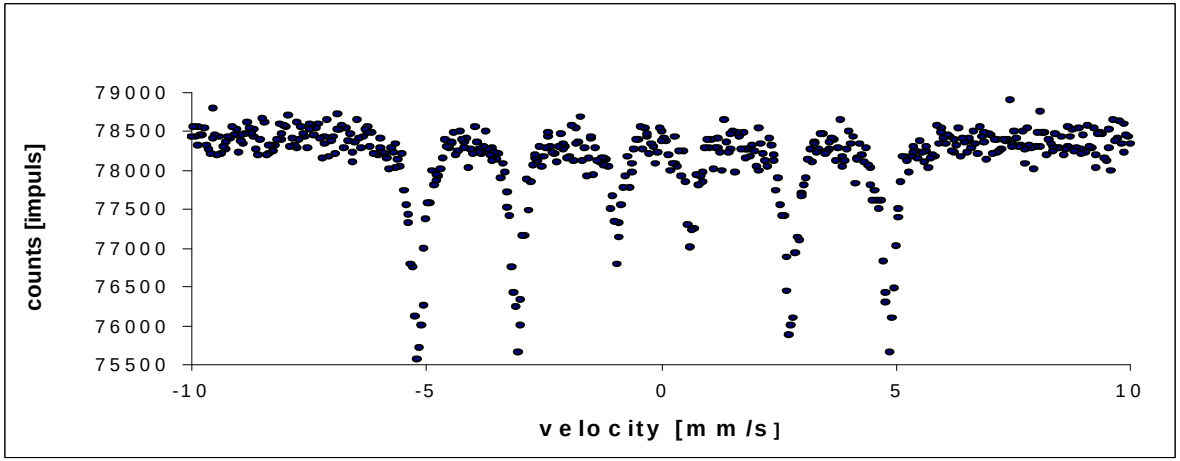
Resulting spectra from old version and commercial SCA



ε = 10,3 %

N_∞ = 48500

YAP detector and SCA from MS 96

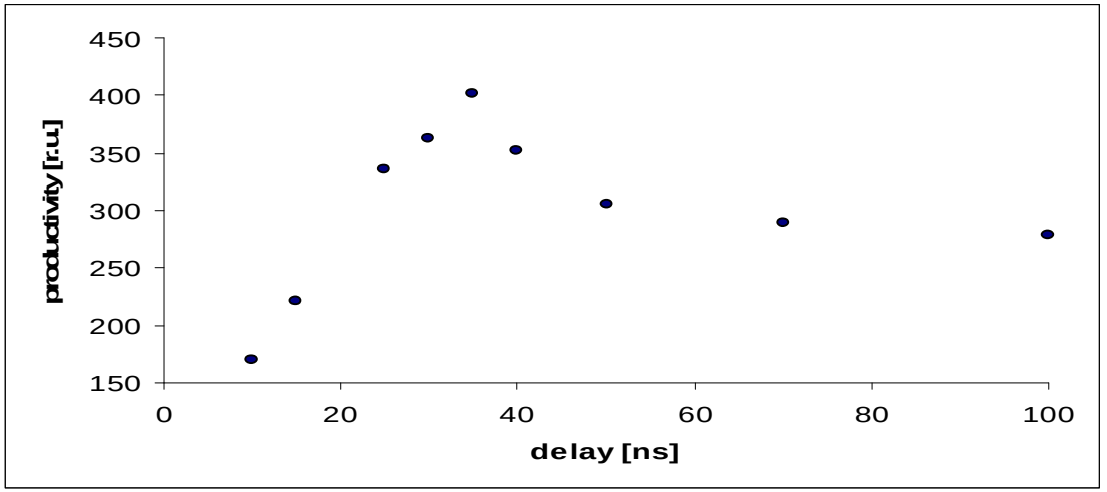


ε = 3,8 %

N_∞ = 78500

YAP detector and commercial SCA Ortec 950 A

Dependance productivity on delay of trigger signal



Dependence of productivity on delay

- For this discrimination system, the dependance of productivity on delay of trigger signal is important to understand. We show the characteristics of YAP detector, however, for other detection systems, this dependance is different.
- Pattern of the output signal from the detector plays a very important role on this dependancy.

Comparing features of SCA

SCA with programmable delay

delay	counts	effect	productivity
[*ns*]	[*impuls*]	[*%*]	[*r.u.*]
10	148000	4,8	170,50
15	49000	9,5	221,11
25	34250	14	335,65
30	26000	16,7	362,56
35	**24250**	**18,2**	**401,63**
40	21750	18	352,35
50	19500	17,7	305,46
70	17500	18,2	289,84
100	17000	18,1	278,47

Previous version of SCA for MS 96

Counts	effect	productivity
[*impuls*]	[*%*]	[*r.u.*]
48500	**10,3**	**257,27**

Ortec 950A

Counts	effect	productivity
[*impuls*]	[*%*]	[*r.u.*]
78500	**3,8**	**56,68**

Conclusions

- From results, we can say that our new SCA has better characteristics than those of commercial solution from Ortec and our old version of the selector.
- What is interesting is the possibility to use this system with some other types of spectrometric detectors where we can find optimal settings.
- Our solution is very simple and cheap with a high functional reliability.