CHAPTER V

CONCLUSION DISCUSSION AND SUGGESTION

5.1 Conclusion

The signal processing method to enhance energy resolution in nuclear spectroscopy system is established. The method aims at the prediction of the optimum shaping time in spectroscopy amplifier that gives the minimum FWHM. The energy resolution degradation is affected by the preamplifier noise, signal pulse pile-up phenomenon and transfer function of spectroscopy amplifier. The three parameters: noise, photon signal and filter model are developed and used as the input parameters in the optimization process. Time domain simulation is selected as an optimization method because it can investigate the effect due to pulse pile-up phenomenon while it is unable to do so in frequency domain. The predicted optimum shaping time curves agree with those obtained from conventional experiment in the low and high count rates from nuclear radiation while that from pulser signal at 50 cps shows a rather great discrepancy around 80%. The significant parameters those are highly probable for the discrepancies may be summarized as follows:

5.1.1 Pseudo noise generation. The simulated noise has much more high frequency interference than the measured noise, which can be identified from their power spectral density and time domain simulation. However, the optimum shaping time simulation shows a rather small deviation from that-obtained directly from experiments. It can be concluded that, noise simulation is not a major source of error in simulation and can be considered as a background noise.

5.1.2 Time interval in preamplifier signal generation. The time interval distributions between the two consecutive pulses may become a major source of noise in case of long exponential decay time of pulses under study. In this case, pulse pile-up may have serious effect on simulation accuracy for optimum shaping time searching as can be seen in Fig. 5.1b. This is evident from the results of 60 cps and 1 kcps count rate from nuclear radiation which show the discrepancies of 11% and 28.75% in optimum shaping times respectively. Consequently, simulation of pulses with long exponential decay will face severe effect from pulse pile-up in case of high count rate investigation.

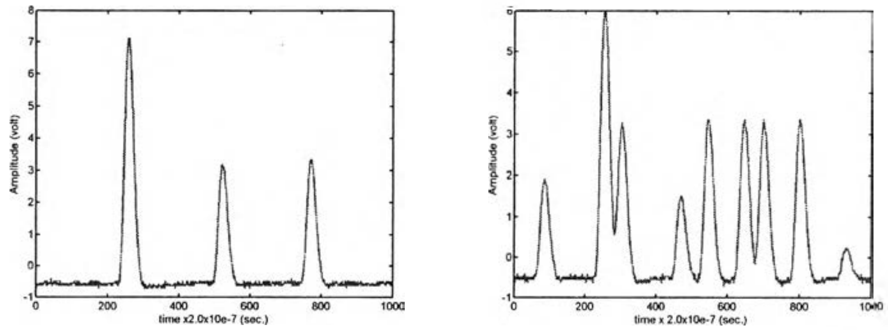

Fig. 5.1 The pile up phenomenon due to time interval between the two consecutive pulses.

5.1.3 Digital filters. The simulated amplifier outputs are different from the measuring ones as shown in Fig. 5.2a and 5.2b especially in the shape and amplitude of simulated signal at 4.0, 8.0 and 12.0 μs where the difference is extraordinary high. The digital filter derived algorithm cannot retrieve all information from frequency response of the amplifier especially in low frequency range. Also in high frequency range, many errors appear in all frequency responses of the amplifier, a major cause of pulse amplitude and shape deviation in spectroscopy amplifier simulated output. Pulse undershoot in simulated output signal and the irregular time interval distribution between incoming pulses account for the major source of errors in simulation process.

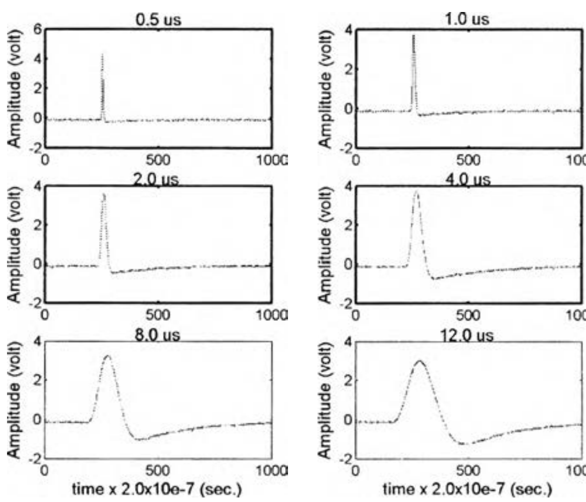

Fig. 5.2 a) The true amplifier of shaping time 0.5 to 12 μs

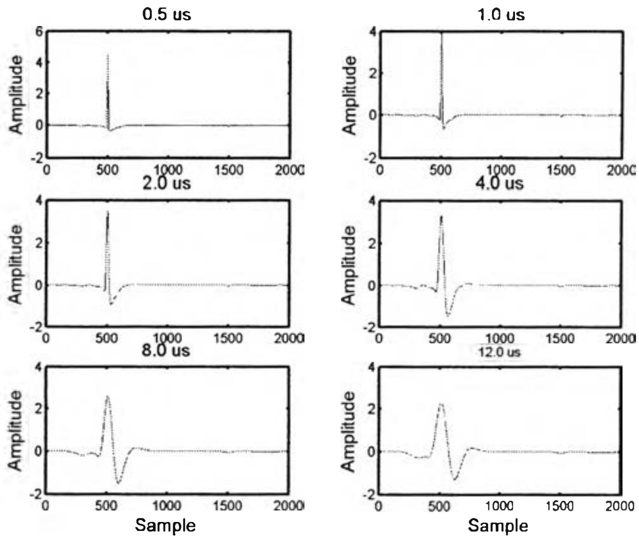

Fig. 5.2 b) The simulated amplifier output of shaping time 0.5 to 12.0 μs

5.2 Discussion

It is evident from experimental results in Chapter IV that there are discrepancies in optimum shaping times derived from the conventional searching experiment and simulation process and it needs to be investigated to identify the source of errors causing undesired optimum shaping time differences. Three cases based on counting rates are of interest:

5.2.1 50 cps signals from pulser. In the case of signals from pulser, the system under study is immune from pulse pile-up interference. The only source of errors is purely from digital filter which creates undesirable pulse shape as concluded in 5.1.2 while simulated noise which plays a role of background noise has minimal effect in simulation process. Error from digital filter alone causes difference in optimum shaping time by 80%.

5.2.2 60 cps nuclear radiation count rate. In this case pulse-pile up begins to have an effect in addition to error from digital filter described in 5.1.3. However, the combined effect from pulse pile-up and error from digital filter is outweighed by pulse pile-up error in the conventional optimum shaping time searching, resulting in the discrepancy of 11% in shaping time searching by both methods.

5.2.3 1 kcps nuclear radiation count rate. In this case the effect of pulse pile-up described in 5.1.2 increase considerably while the error from digital filter and background noise remain significantly the same, causing the rise of optimum shaping time discrepancy derived from both methods by 28.75%.

5.3 Suggestion

The developed simulation method can be used to predict the optimum shaping time in low count rate nuclear spectroscopy system. In the case of high count rate, the irregularity of time intervals between two consecutive pulses causes the so-called pulse pile-up, a natural statistical phenomenon, which should undergo mathematical treatment prior to the inclusion in simulation process in future work. Owing to the long decay time of nuclear pulses, pulse pile-up is one of the major problems in nuclear pulse spectroscopy. To solve the problem, ample amount of time intervals between two consecutive pulses should be sampled and the data go through mathematical process to form the probability distribution of time interval. The whole process would be an appropriate approach to determine the optimum shaping time described earlier.

It is worthwhile to say a few words on Digital Filter Design. The design of digital filter in 4.2.1.2.2 is based on non-parametric method which does not encompass the detail information of spectroscopy frequency response. A better solution is to use the parametric method in the digital filter design with the inclusion of retrievable information from the spectroscopy amplifier response under study.