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Characterizing New Multi-Channel Peak Sensing ADC-Mesytec MADC-32

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Abstract. The following paper presents the results from two different types of modules resolution and linearity comparison, as well as shows the methods from RadWare software fitting. The first module is ORTEC ASPec-927 which is one of the best in the γ-ray spectroscopy, but expensive and the second one is the new fast Mesytec MADC-32 which is much cheaper. We showed that it is possible to pick up parameters in the RadWare, so the Mesytec MADC-32 module will have same uncertainty as ORTEC ASPec-927 module.

Keywords: Mesytec MADC-32, ORTEC ASPec-927, RadWare

1. Introduction

We compare two different types of ADC modules with respect to resolution. In Gamma-Ray spectroscopy, some of the best ADCs used are the NIM ORTEC ACPec-927[1] ADCs. In the nuclear physics, it is important to do good electronic calibration for getting better results. This ADC has a maximum resolution of 16K bit and yields an energy resolution 1.6 keV at 1 MeV, but this ADC is expensive. We have tested and characterized a much cheaper ADC in comparison with NIM standard ORTEC module. The second one was Mesytec MADC-32 [2] with 32 input channels. High purity Germanium detector with 109% relative efficiency [3] was used to detect gammas from ^{152}Eu calibration source. Signals from Ge detector were divided into two parts one for MADC module and other for ORTEC module. RadWare [4] software was used to analyze both spectra and look at the resolutions of the ADCs as a function of energy, as well as the linearity.

2. Software description

Radware is least-squares peak-fitting program designed to do gamma-ray spectroscopy, but it can be used for electron spectroscopy as well. In the current program peak will be divided into three components. First one is Gaussian function, second is skewed Gaussian and third one is step function.

Fig. 1 shows how each component makes up main peak. There are two parameters "R" and "step". "R" describes part of the peak coming from skewed Gaussian and "step" describes low-energy side background increase. There is also another important parameter that describes skewness of skewed Gaussian function. It is called β decay constant. Third component arise due to photon Compton scattering in the detector. It is possible to put zero in the software both second and third function if they are not required. It is important to define background of whole spectrum after peak shape definition. Background can be defined with the Eq. 1:

$$Background = A + B * x + C * x^2 \tag{1}$$

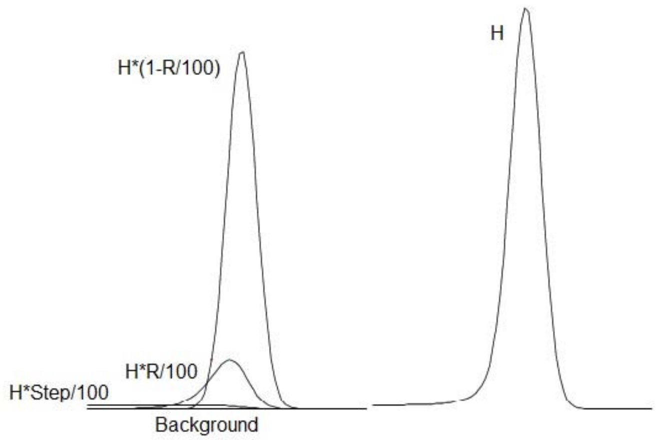

Fig. 1. There components and how they make up total peak shape. Total height of the peak is "H". First component is Gaussian function with "H*(1-R/100) part, second component is skewed Gaussian function with "H*R/100". Third component is "Step" function with part "H*Step/100".

In the background function A, B and C are parameters. Totally, there are six parameters to describe background and peak shape to get best fitting results.

3. Results and Discussion

We used 152Eu calibration source to test both modules at the University of Notre Dame. In our test, the High Purity Germanium (HPGe) detector has 109% relative efficiency. Relative efficiency is in comparison to NaI detector with 3-inch diameter and 3 inch width. Fig. 2 shows 152Eu spectra from both MADC-32 and ORTEC ASPec-927. All labeled peaks have more than 1% intensity. Wecan see that 152Eu peaks cover range from 100-1400 keV. This is working range for the most low-energy nuclear physics experiments that need γ-ray spectroscopy.

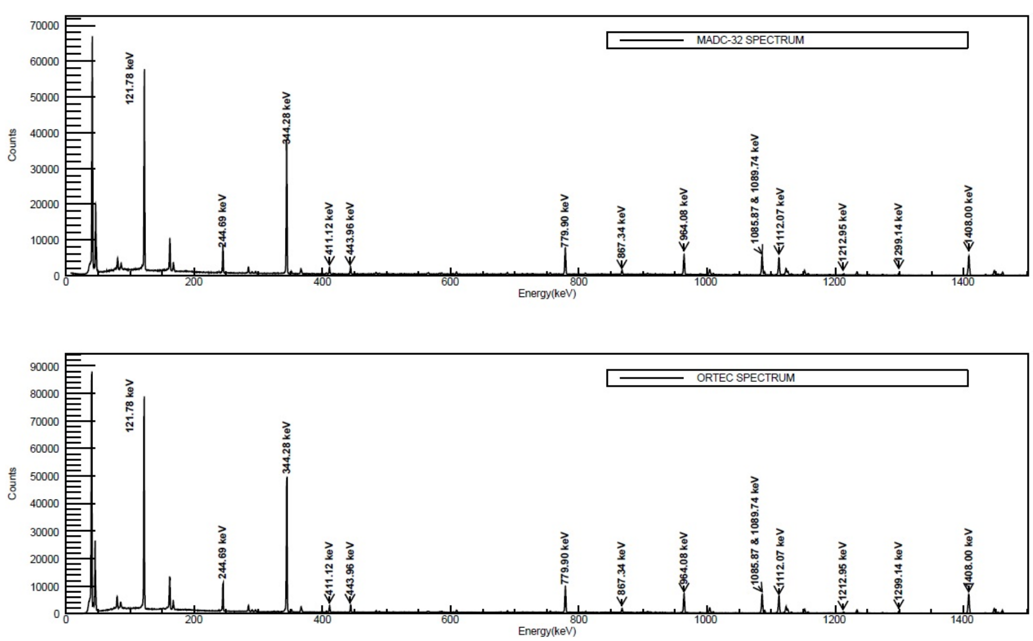

Fig. 2. Spectra from both modules. All labeled peaks are from 152Eu, which have more than 1% intensity.

We did RadWare analyses for four different cases to get nonlinearity and resolution measurements. The cases are: 1. C=R=β=Step=0, 2. B=C=R=β=0, 3. R=10, β=3, B=C=0, 4. R=10, β=3, B=Step=0. Fig. 3 shows the comparison of the FWHM for both MADC-32 and ORTEC ASPec-927 for all RadWare cases. We can see that the shape for all cases is very similar for both modules. There is only small difference between two modules resolutions near the 1300 keV. It is due to the fact that the peak that was used has low intensity.

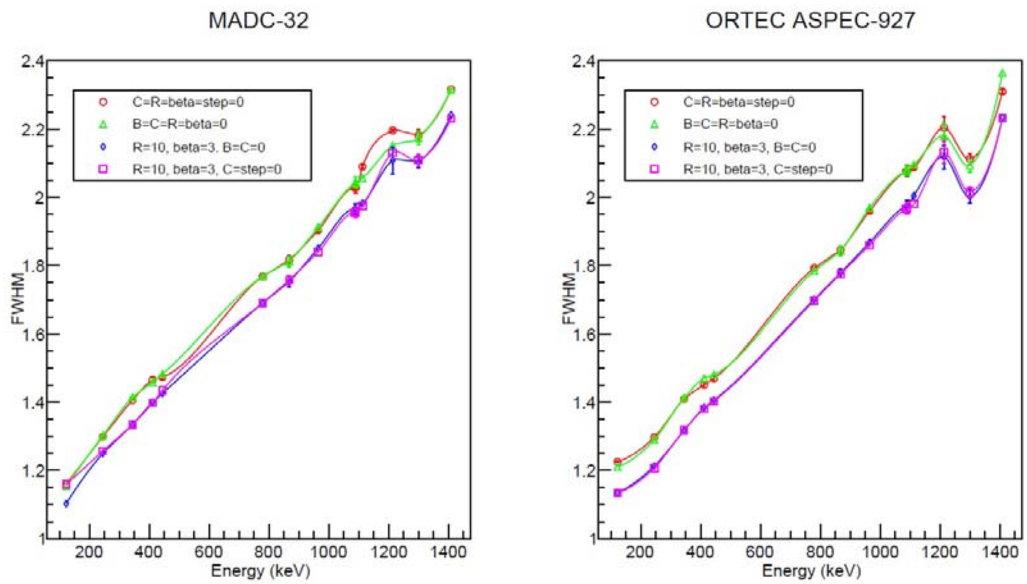

Fig. 3. FWHM comparison for all RadWare cases for both modules.

Fig. 4 shows the linearity comparison of all RadWare cases for both modules. The ORTEC APEC-927 nonlinearity is very good. It is less than 0.1 keV in the whole range. On the other hand, we can see that except B=C=R=β=0 case all others have similar structure for MADC-32.

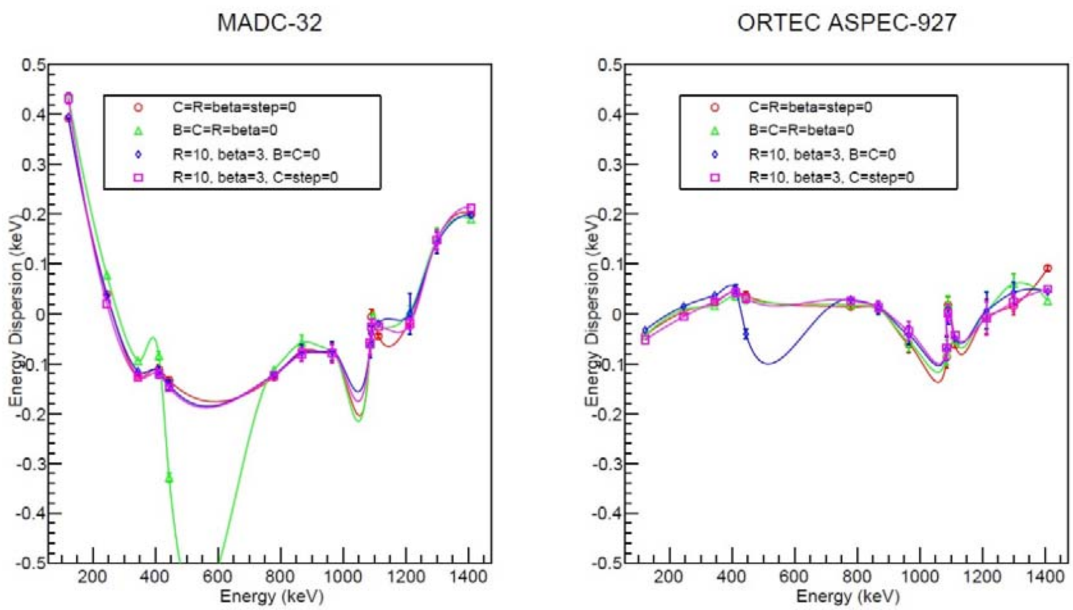

Fig. 4. Linearity comparison for all RadWare cases for both modules.

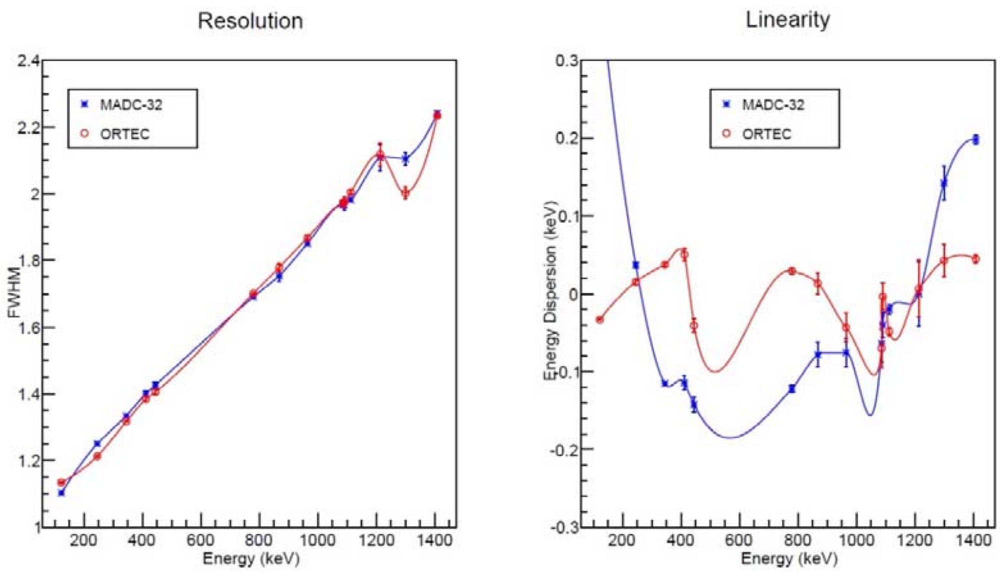

Fig. 5. Resolution and linearity comparison between two modules.

In the low-energy tail the nonlinearity for MADC-32 increases until 0.45 keV. In the range 200-1400 keV both modules nonlinearity is less than 0.1 keV. The best case for MADC-32 is case 3 (R=10, β=3, B=C=0). Both modules FWHM and linearity comparison for that case is shown in the Fig. 5.

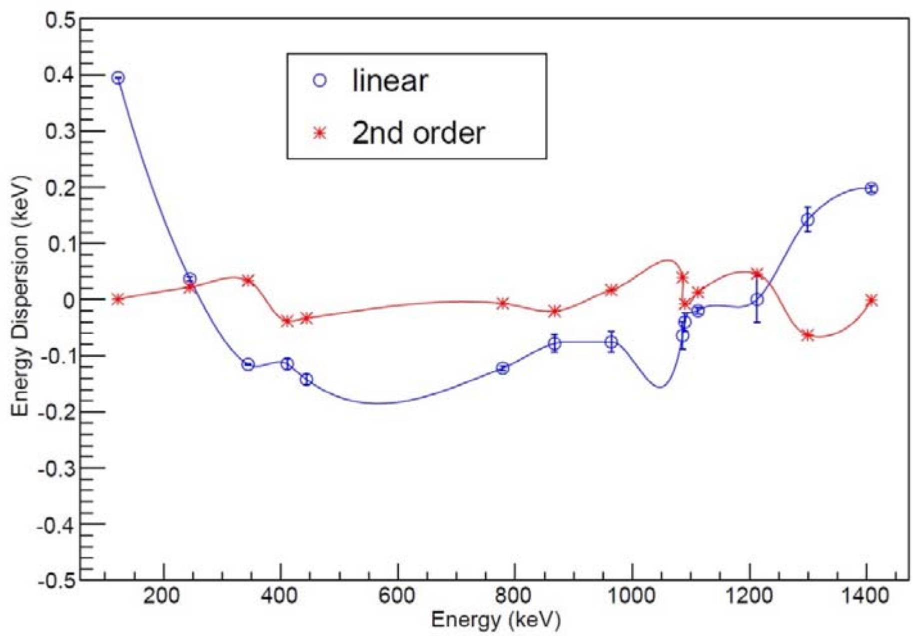

Fig. 6. Energy dependence from channel number comparison in the linear and second order polynomial cases.

FWHM matched together perfectly except the point near 1300 keV, which was discussed before. In the low-energy range (100 – 200 keV) MADC-32 nonlinearity is increasing too much, but in the rest part it can be used. In the following linearity calculation, we assumed that the energy depends on channel number linearly.

If we do in place of linear, second order polynomial dependence, we will achieve better results. The comparison between the linear and second order dependences is shown in the Fig. 6. We can see that with the second order polynomial dependence, energy dispersion is less than 0.1 keV. So, the same linearity was reached for MADC-32 that has ORTEC ASPec-927 module.

4. Conclusion

NIM Standard ORTEC ADC has very high quality, but expensive. However, it does not work with the new VME-based daq [5] systems. MADC-32 provides almost the same performance on energy resolution in practice. With higher order corrections using high precision pulsar, MADC-32 also achieve the similar quality on differential nonlinearity. MADC-32 works very well with the fast NSCL daq system unlike other choices. If we take into account also financial side, MADC-32 is cheaper than ORTEC ADC. That makes new peak sensing Mesytec MADC-32 ideal for large HPGe or SiLi array or complicated set ups involving multiple detectors in γ-ray spectroscopy.

Acknowledgment

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References

[1] CAEN, "ASPec-927.pdf", www.caen.it

[2] MESYTEC, "MADC-32" http://www.mesytec.com/datasheets/MADC-32.pdf

[3] Radiation Detection and Measurement, 3rd edition, G. F. Knoll (1999)

[4] RadWare, "Notes on the use of the program gf3", http://radware.phy.ornl.gov/gf3/gf3.html

[5] Flexible High Performance VME based Data Acquisition System for the ESA Physics Program, P. R. Anthony and Z. M. Szlata, SLAC-PUB-7201 (1996)

[6] Data Acquisition and Online Analysis at the NSCL, R. Fox, NSCL (2006)