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A New Digital-Analog Multiplex Method Using Simple Adder Circuit

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Recently, In order to decrease dead space to increase efficiency, several research using monolithic crystal have been conducting in the field of PET scanner[1]. Since pixelation of photo detector is necessary to get exact gamma ray interaction location, read out channel will greatly increase. Signal multiplex plays a important role to decrease read out channels, but almost every pixel emits signal at the same time in the case of monolithic crystal, therefore separation of each channel has to be strongly required.
Unlike conventional resistive division multiplex method[2], we propose a new digital-analog multiplex method using a simple adder circuit to get not only channel information, but also energy information. Each output signal from a detector is digitized by comparators, this process is well known as Time-Over-Threshold method[3], and this digitized signals flow into an adder circuit. The relation between input resisters (Rin) and a feedback resister (Rf) contributes output voltage, which is the proportional to Rf/Rin. Therefore, by setting input resisters as the binary scale, added signal output can be separated by its pulse height, also pulse width has energy information.
In order to validate the method, a 12mm x 12mm x 12mm GAGG[4] monolithic crystal was mounted on a 16ch HAMAMATSU MPPC. Each pixel of the MPPC is 3mm x 3mm. Comparator thresholds and bias supply were set at 100mV above baseline and 3.3V, respectively. The Input resisters of adder circuit were set at 1kohm, 2kohm, 4kohm, 8kohm, and so on, and the feedback resister was set at 500ohm. Output pulse from adder circuit was sampled by an Agilent Technologies L4534A digitizer, whose sampling rate and energy resolution are 20MSa/a and 16bit, respectively, and analyzed.
So far, we had been tested 4ch multiplex. In this case, there are 15 patterns in multiplexed pulse height. By decoding it and counting pulse width, energy spectrums of Cs137 were clearly obtained in each channel. Since resolution of output pulse height of Each channel was about 7mV FWHM, we expected that at least 8ch multiplex can be possible. Now we have been extending to 8ch multiplex, additional results will be presented in the conference.

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