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# An α/γ Discrimination Method for BaF2 Detector by FPGA-based Linear Neural Network

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A pulse shape discrimination (PSD) method based on linear neural network is proposed for separation of α- and γ-induced events in BaF2 crystal.<br>
An artificial linear neural network was designed to identify α- and γ- induced events in BaF2 crystal with the inputs of several pulse information, including pulse pedestal, amplitude, gradient, long/short amplitude integral, and the amount of the samples over threshold. The neural network output, which is a two-element vector, (Y1, Y2), indicates which type the input pulse is of three: the α-induced, the γ-induced and the noises. The linear neural network is trained in Matlab using 40000 BaF2 detector pulses, and the desired optimality is achieved. Then we implement the linear neural network in a Spartan-6 FPGA using the weight matrix of the neurons.<br>
We build a signal digitalization and real-time discrimination system basing on this method. A 1Gsps ADC is used for BaF2 detector signal sampling. Once trigged, a 2K sampling-point pulse sequence will be sent into a data processing module, and several pulse information will be extracted in FPGA, as the inputs of the linear neural network. Then the output vector transfers to PC, and after a graphic analysis, it's shown that the α-induced events, γ-induced events and noises are well separated.<br>
To evaluate the performance of this system, a coincidence evaluation test is processed. We utilize a LaBr3 detector as another input of the digitalization system. And a collimated 22Na γ-source is placed between the BaF2 and LaBr3 crystals. Owing to the two-photon radiation of 22Na, the self-trigged events in BaF2 detector in coincidence with γ-rays in LaBr3 crystal should also be a γ-induced event except for occasional coincidence. Among 5000 two-detector-coincidence events, 28 BaF2 events are identified as α-induced by the system, the false coverage rate is below 0.5% considering the chance of occasional coincidence. The test verifies good effect and feasibility of this system.<br>

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