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Multi-Purpose Fast Neutron Spectrum Analyzer with Real-Time Signal Processing

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Neutron counting is one of most important diagnostic tool of high-temperature plasma experiment. Informativeness and relevance of this diagnostic can be increased with analysis of shapes and amplitude distribution of count pulses, which allows to separate gamma-quanta background and pulse overlapping, or to find timing of the counts in relation to some events in plasma. At the same time modern fusion plasma facilities with quasi-continuous regime of operation issue the challenge for such analysis because of the huge amount of memory needed to store the primary data from detector. A solution is to combine DAQ electronics with real-time signal processing that should implement algorithms of pulse shape analysis. This approach can significantly reduce the flow of data and possibly even include this diagnostic to a facility feedback system.
In the Budker Institute of Nuclear Physics (Novosibirsk, Russia) multi-purpose neutron spectrum analyzer with real-time signal processing has developed. Detector part of the analyzer consisting on stilbene crystal and spectrometric PMT responds to incoming particle by 20-ns-wide pulse with a tail sensitive to a sort of the particle (neutron or gamma). DAQ electronics includes 12-bit 500 MHz ADC and the FPGA-based unit of stream data processing. Processing algorithms in controller firmware can be modified according to the required task, that allows to use analyzer in the wide range of different applications. The analyzer was tested and calibrated with 252Cf source, and then have been used in fusion experiments on GDT facility as well in development of pulsed neutron generators for industrial applications.

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