Neutron detector modules, electronics and software for a Time-of-Flight Spectrometer based on NI components

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A large scale neutron detector system has been developed by Datalist Systems, Ltd (previously: Ante Innovative Technologies) for the Time-of-Flight Spectrometer (V3, NEAT) spectrometer at Helmholtz Zentrum Berlin [1]. We present the implementation highlights as well as the first results of measurements such as position resolution. The basic concept was a modular architecture with 416 ^{3}He detector tubes organized into thirteen 32-tube modules that can be independently installed into the detector vacuum chamber with diameter of 12 m. The mechanical support modules contains 4 pcs of 8-tube units each having air-boxes for the front-end preamplifier electronics. The modules have been manufactured and partly assembled at Datalist Systems site in Hungary and then fully assembled and installed at HZB site by the Datalist Systems crew.

The signal processing and data acquisition electronics is based on proprietary preamplifier and parallel sampling ADC's running at 50 MS/s for all the 832 data channels. Although the preamplifiers are developed specifically for nuclear data acquisition, the ADCs and the FPGA electronics for the further data processing are standard products of National Instruments Inc. (NI). The data acquisition system comprises 26 FPGA modules each serving 16 tubes (providing for up to 50 kHz count rate per individual tube) and it is organized into two PXI chassis and two data acquisition computers that perform post-processing, event classification and provide appropriate preview of the collected data. The data acquisition software has been created in NI LabView environment taking the advance of the NI hardware drivers presence. It followed the Event Recording principles producing Event Record List with absolute timestamps of 100 ns resolution of the gathered data. Data in a single record list element (row) can be either neutron event including classification parameter or signals from the seven disc chopper system.

The classification data can be used for flexible data filtering in off-line analysis of the gathered event list. A unique 3-tier system of filtering criteria of events is in operation: a hard threshold in the FPGA's to reduce the effect of noise, a pulse-shape based classification to eliminate gamma sensitivity and an additional flexible feature to filter out pileup and other unwanted phenomena. This ensures high count rates (50 kHz per tube, 1 MHz overall) while maintaining good quality of measurements (e.g. position resolution).The measurement results showed that the delivered detector system meets the initial requirements of 20 mm position resolution along the 2000 mm long detector tubes. From the experience during the 18 months of operation we conclude that the system has a high stability also.

[1] *http : //www.helmholtz − berlin.de/pubbin/igama*$_o$*utput?modus = publi&gid =* 1717&*sprache = en* (retrieved 16/07/2018)