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DATA ACQUISITION SYSTEM FOR THE FOCAL-PLANE DETECTOR OF THE MASS SEPARATOR MASHA

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The results of the development and the general information about the data acquisition system which was recently created at the MASHA setup (Flerov Laboratory of Nuclear Reactions at the Joint Institute for Nuclear Research) are presented. The main difference from the previous system is that we use a new modern platform, National Instruments PXI with XIA multichannel high-speed digitizers (250 MHz 12 bit 16 channels). At this moment the system has 448 spectrometric channels. The software and its features for the data acquisition and analysis are also described. The new DAQ system expands precision measuring capabilities of alpha decays and spontaneous fission at the focal-plane position-sensitive silicon strip detector which, in turn, increases the capabilities of the setup in such a field as low-yield registration of elements.

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INTRODUCTION

One of the significant changes over the past years at the MASHA mass spectrometer was an upgrade of the data acquisition system. MASHA stands for the Mass Analyzer of SuperHeavy Atoms and represents an online mass spectrometer where masses of new elements are measured directly in the course of their synthesis with accelerated heavy-ion beams. The mass spectrometer was designed and manufactured at the Flerov Laboratory of Nuclear Reactions of the Joint Institute for Nuclear Research.

The bulk of the work on replacement of the data acquisition system began toward the end of the last year. The previous version of the system was outdated and had some hardware and software inflexibilities. This paper describes the hardware we use and software which was developed for our needs.

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HARDWARE

The main difference from the previous CAMAC DAQ software is that we use a new modern platform, National Instruments PXI with XIA multichannel high-speed digitizers (250 MHz 12 bit 16 channels). PXI (PCI eXtention for Instrumentation) is a modular platform based on the PCI bus for measurement and automation systems which, was developed in 1997 by the National Instruments Corporation.

The first device in our data acquisition system is the well-type Si strip detector (Fig. 1). It is designed for registration of alpha decays or/and spontaneous fission. The strip number includes the information on the mass of new synthesized atoms separated by the magneto-optical system of the spectrometer.

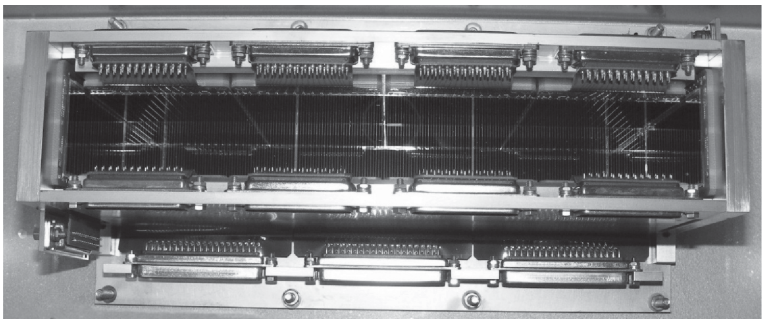

Fig. 1. Si strip detector of the well type

All the detector sections are 300 μm thick, with the thickness of the dead layer not exceeding 50 nm. The energy resolution for alpha particles from the ^{226}Rn source is $\sim$ 30 keV [1]. There are 448 spectrometric channels. Each channel has its charge-sensitive preamplifier, the latter grouped by 16. The grouped channels are connected to multiplexers-amplifiers (Fig. 2) and subsequently to digitizers. Odd and even strips from the front Si panel

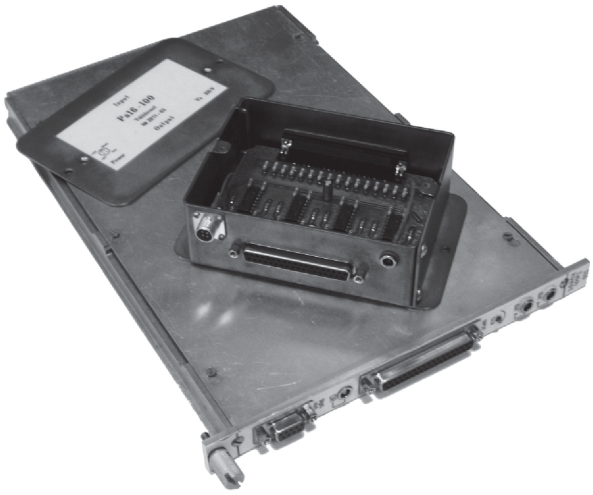

Fig. 2. Multichannel preamplifier and multiplexer-amplifier

are connected to different multiplexers for load balancing. In this instance, in case there are some events between the strips, they will not present a problem as two signals will get transmitted to different multiplexers at the same time. The preamplifiers and multiplexers-amplifiers are designed at FLNR, JINR [2].

After amplification and multiplexing, three outputs from the multiplexer are used: alpha, fragment, and digital channels. Alpha and fragment signal outputs are the same signals as the source but with different level of amplification. This is quite standard for such devices. The digital channel includes the information on the source of the input signal. These outputs are connected to the XIA multichannel high-speed digitizers (Fig. 3).

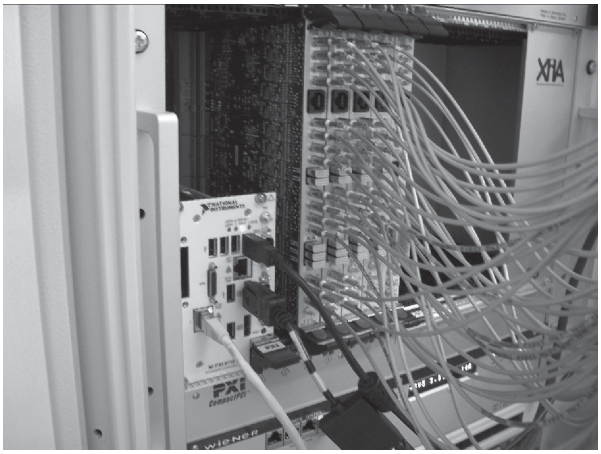

Fig. 3. PXI chassis with XIA digitizers and a NI controller

The information from the digitizers is read and stored by the NI PXI controller — PXI-8119:

- Intel Core i7-3610QE quad-core processor (2.3 GHz (base), 3.3 GHz (single-core, Turbo Boost mode)),
- 4 GB (1×4 GB DIMM) single-channel 1600 MHz DDR3,
- High-performance 7200-rpm integrated hard drive,
- Two 10/100/1000BASE-TX Ethernet ports,
- Other peripherals (the GPIB (IEEE 488) controller, RS232 serial port, and IEEE 1284 ECP/EPP parallel port),
- In-ROM memory and hard drive diagnostics,
- Operation system (embedded version of Windows 7).

The stored information is read by a program running on the multimonitor PC in a control room through the internal Ethernet network.

SOFTWARE

The software for data acquisition is written in C++ and consists of two main parts: the back and front ends. The first one is run at the PXI controller for collecting and storing the data from the digitizers located in the experimental hall. The second one is a viewer (Fig. 4) at PC for on-line and off-line data analysis located in the MASHA control room.

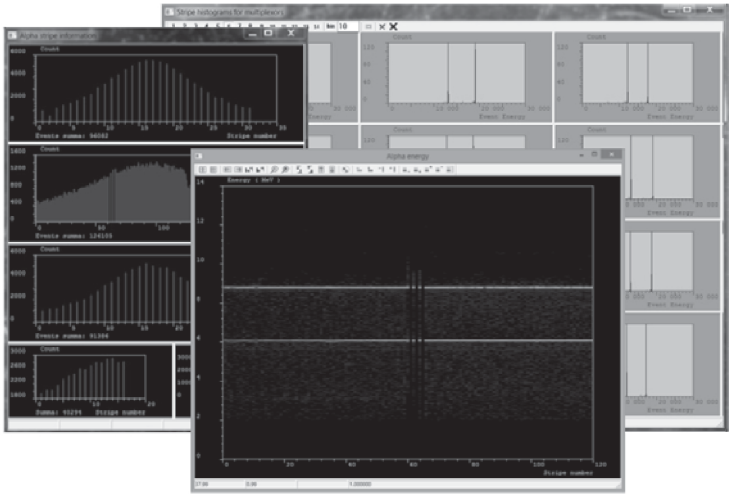

Fig. 4. GUI samples of viewer

The operator of the setup generally uses the information presented as a heat map (Fig. 5), where the strip number and energy are shown on the X and Y axes. The number of events in the area is shown in color. This version allows observation of a number of isotopes and their daughter product decays on the same graph.

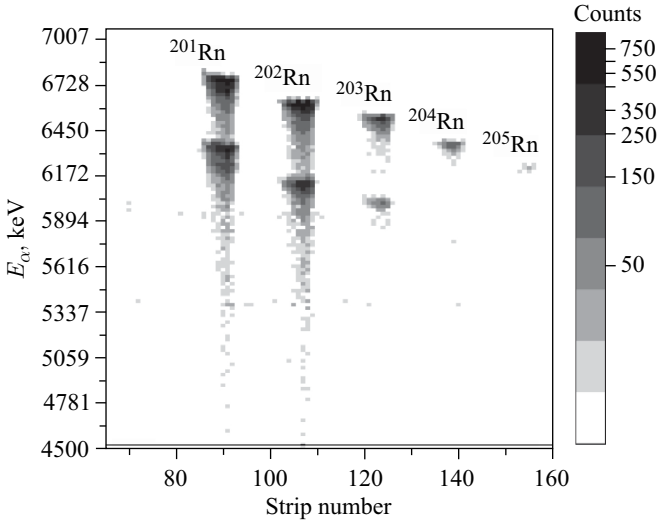

Fig. 5. $^{40}\mathrm{Ar} + {}^{166}\mathrm{Er} \rightarrow {}^{206-xn}\mathrm{Rn} + xn$ heat map

For debugging purposes, an online watchdog is enabled, which sounds an alarm when problems with the data occur (e.g., when nothing changes within 10 min). Moreover, there is strip statistics and a filter to work with each event. The filter can select the events by their energy, time, amplitude, multiplexer, and a strip number. It is generally used to observe waveforms to be sure that a rare event is a real one rather than some kind of noise which is necessary in case of synthesis of new elements with the low cross-section level.

SUMMARY

The new DAQ system expands precision measuring capabilities of alpha decays and spontaneous fission at the focal-plane position-sensitive silicon strip detector which, in turn, increases the capabilities of the setup in such a field as low-yield registration of elements.

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