VME BASED DAQ IN THE EXPERIMENTS AT ACCULINNA

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The VME based data acquisition system for the first time was fully tested in the recent experiment [1] with the $^{3}H(^{8}He,p)^{10}He$ reaction on the ACCULINNA fragment separator [2]. This DAQ allowed us to combine in the same experiment several types of detectors: multiwire proportional chambers, silicon detectors, CsI detectors and stilbene detectors. The DAQ system includes a RIO-3 processor connected with CAMAC crate via GTB resources, TRIVA-5 master trigger, standard VME units ADC, TDC, QDC (about 250 parameters in total) and various software (Multi Branch System – MBS version 5.0, based on CERN ROOT Go4 version 4.4.3 and real time OS LynxOS version 3.3.1). The new DAQ is faster and more flexible than the old system based on CAMAC and provides possibility to use in the future new VME modules (for instance digitizers).

Keywords: VME, data acquisition system, ROOT, Go4, software.

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1. INTRODUCTION

Studying the properties of nuclear matter at the nucleon border is in the front line in nuclear physics experiments worldwide. New experimental facilities and techniques have rapid development in the studies of nuclear matter conducted at the leading research centers: GSI (Germany), RIKEN (Japan), GANIL (France), and MSU (Unites States). Since 1996, these studies have been performed by the Flerov Laboratory of Nuclear Reactions (FLNR) of the Joint Institute for Nuclear Research (JINR) at the ACCULINNA fragment separator (http://aculina.jinr.ru/). Since this setup was produced from available magnetic optics elements designed for transporting primary beams of the MC-400 cyclotron, its characteristics are modest relative to the foreign analogs. New fragment separator named ACCULINNA-2 [3] will be built by 2015 in the context of the 7 year JINR roadmap aimed at developing new basic facilities. A relevant data acquisition system (DAQ) for the ACCULINNA and ACCULINNA-2 separators is necessary.

2. VME based DAQ

There are methodological conditions that must be satisfied due to specific character of the radioactive beams production. First and foremost, the energy measurements of the radioactive ion beam must be taken event by event and the place of beam hit on the physical target

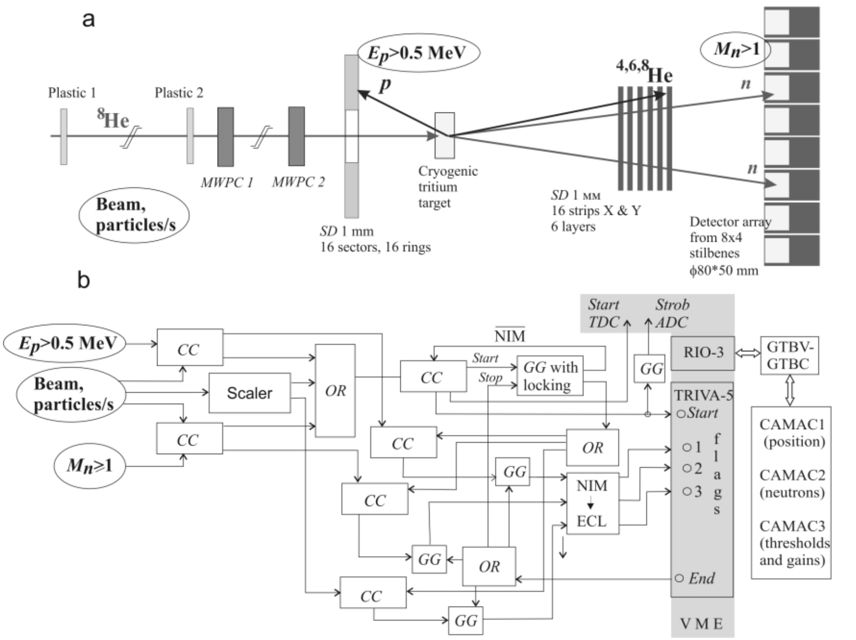

Figure 1. Schematic representation of detector array (a) and data acquisition system (b) in the $^{3}H(^{8}He, p)^{10}He$ experiment. *MWPC* – multiwire propotional chamber, *SD* – semiconductor detector, *TDC* – time-to-digital converter, *ADC* – analog-to-digital converter , *CC* – coincidence circuit, *GG* – gate generator, TRIVA-5 – master trigger, RIO-3 – processor module.

must be determined in wide energy region and intensities (in our case, $E \sim 15$–35 MeV/nucleon and $I \sim 10^2$–10^7 particles/s). Second, one must provide precise correlation measurements for obtaining new information about exotic nuclei properties (as a rule, for the energy and angle of the decay products of studying nuclei), which implies registration of the many physical parameters with a high accuracy. Finally, to attain reliable statistics, measurements must frequently be made at small angles with respect to a beam particle, which gives rise to the problem of high counting rates (several thousand triggers per second). It is these basic criteria that must be satisfied by a modern DAQ aimed at solving this type of problem.

The typical block diagram of the experiments on the fragment separator ACCULINNA is shown on fig. 1. As a rule, the DAQ includes a few (four or less) independent triggers combined by the OR scheme and, therefore, marked by a special flag. First, this is the beam flag derived from two thin (in our case, 0.2–0.5 mm thick, depending on the sort and energy of particles) plastic detectors that are located at a distance of 8 m and provide information on the energy of a particle by its time of flight (TOF). Second, this is the main trigger produced by coincidence of the signals from the silicon detector array with the signals from the plastic detectors. Finally, this is an auxiliary trigger, e.g., due to coincidence of the signals from the neutron and thin plastic detectors.

There are a few widespread standards that are often used in nuclear physics experiments as a basis for a DAQ: (i) old CAMAC and (ii) modern FASTBUS, FERABUS, VXI, VME standards, which are advantageous in the operating speed and the capability of working with large data flows. In order to upgrade the CAMAC DAQ of the ACCULINNA separator, we decided to use a VME based system as an architectural prototype [4]. This system was developed at GSI (Darmstadt, Germany) and used to good effect by more than 20 research centers worldwide. This DAQ is based on a RIO family processor from CES Co. with the LynxOS realtime operating system, the Multi Branch System (MBS) public domain software capable of combining several standards together, and the Go4 software package needed for online visualization and rapid analysis of data and for their conversion into a format suitable for subsequent processing in the ROOT environment. First experiments with the VME DAQ [5, 6] have demonstrated the high potential capabilities of this system, namely: (i) operation at high data flows (at a rate of 5000 triggers/s, the dead time was ~ 40%,whereas the CAMAC DAQ had the same dead time at 400 triggers/s); (ii) rapid online analysis of complex two-dimensional spectra; (iii) efficient processing of large data arrays with a size of a few gigabytes; and (iv) simple and convenient communication with CAMAC electronics, which allows as many as nine crates to be linked to the VME bus.

3. Conclusion

The new VME based DAQ comprising the RIO-3 processor was produced and tested at the ACCULINNA fragment separator (FLNR, JINR). This DAQ was upgraded: new user functions for VME electronic modules (Mesytec MADC-32 and CAEN V775NC) were developed and the MBS and Go4 software packages were installed (in particular, on the 64 bit Scientific Linux platform). Today, we are working on the integration of new electronic modules – SIS3320-250 digitizers into the developed DAQ for use in measurements with neutron detectors. Since the format of collected data files can easily be converted into the ROOT (CERN) format, the ROOT system is used for subsequent data processing and analysis. The described upgrade of the DAQ has made it possible to perform and design nuclear physics experiments on a level with the world standards.

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