УДК 539.172.8

DEVELOPMENT OF DATA ACQUISITION SYSTEM FOR SPHERE SPECTROMETER

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The 4π-detector SPHERE for studying of multiple particle cumulative production is currently under construction at the Laboratory of High Energies, JINR, Dubna. This paper briefly describes the present status and future developments of the data acquisition system for this setup. A multiprocessor system based on VMEbus will be implemented for parallel read out, event-building, data preprocessing. A workstation will be used for data analysis and experimental control.

The investigation has been performed at the Laboratory of High Energies, JINR.

Развитие системы сбора данных спектрометра СФЕРА

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4π-детектор СФЕРА для изучения множественного кумулятивного рождения частиц разрабатывается в ЛВЭ ОИЯИ, Дубна. В этой статье дан краткий обзор современного состояния и будущего развития системы сбора данных для этого спектрометра. Многопроцессорная система на основе VME шины будет внедрена для параллельного считывания, накопления и предварительной обработки данных. Рабочая станция будет использована для анализа данных и управления экспериментом.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

1. Introduction

SPHERE (fig.1) is a 4π-detector designed to obtain as much detailed information as possible on multiple cumulative particle production at the JINR Synchrophasotron and Nuclotron [1]. The spectrometer contains three major components: a central detector for the detection of particles from the target-nucleus fragmentation region, a forward detector covering the projectile-nucleus fragmentation region, and a target for the generation

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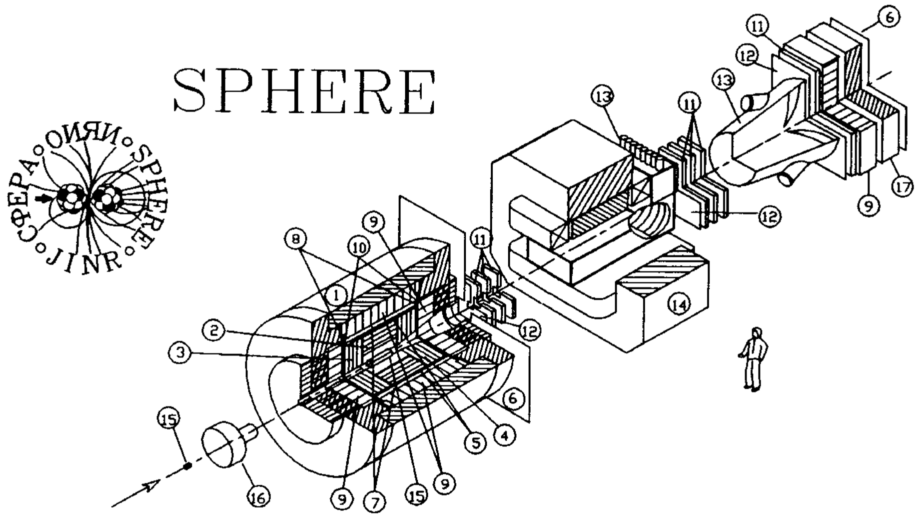

Fig.1. General layout of SPHERE 4π-detector. 1 — superconducting solenoid with iron yoke, 2 — central drift chamber, 3 — backward drift chambers, 4 — forward proportional chambers, 5 — cylindrical scintillation hodoscope, 6 — muon scintillation hodoscopes, 7 — cylindrical Cherenkov hodoscope, 8 — forward and backward Cherenkov hodoscopes, 9 — electromagnetic calorimeters, 10 — forward and backward scintillation hodoscopes, 11 — proportional chambers, 12 — scintillation hodoscopes, 13 — threshold gas Cherenkov counters, 14 — dipole magnet, 15 — targets, 16 — beam absorber, 17 — muon filter

of muon pairs with a beam absorber. The central detector is used for the momentum and angle analysis of secondary particles produced in the target positioned in the centre of the superconducting solenoid. A uniform 1.5 Tesla field along the beam is produced in a superconducting coil 2.2 m in diameter and 2.6 m long. Particles at small angles ($< 5°$) are detected by the forward magnetic spectrometer. The detector system consists of electromagnetic calorimeters, dE/dx and time of flight scintillation hodoscopes, and Cherenkov counters identifying γ, e, π, K, p, d, t, α, etc. The tracks are measured with MWDC's, and MWPC's. A data acquisition system is based on VME, FASTBUS and CAMAC. The first line of the forward detector is operated since 1990 and a number of experimental results [2—4] were obtained with it. The central detector is still at stage of R&D and the 4π-detector is hoped to be completed by the middle of 1995.

II. System Description

A data acquisition system for the first line of the forward detector was designed [5,6]. It provides: trigger selection, reading out, data recording, and on-line monitoring of experimental data from 600 hodoscopic,

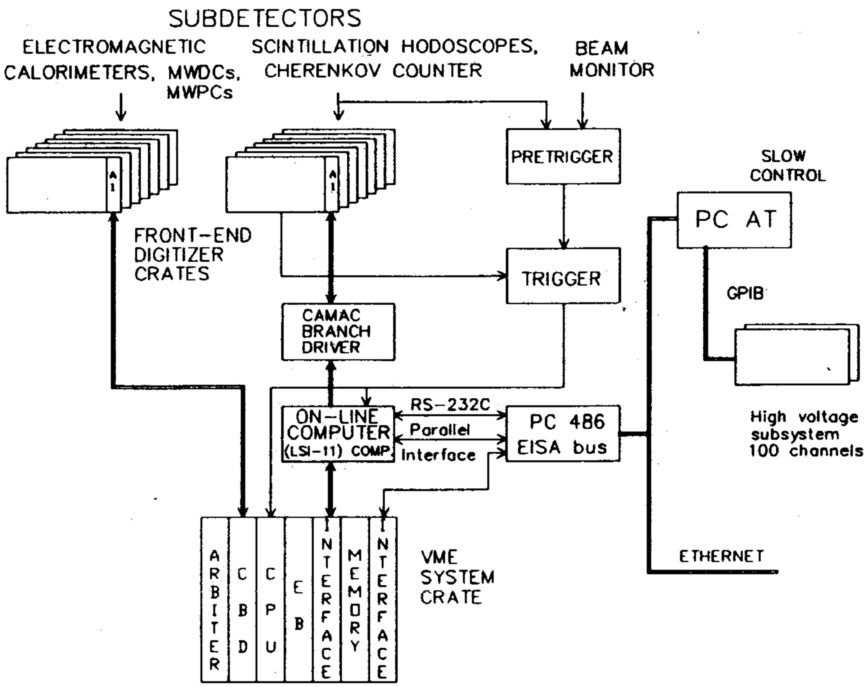

Fig.2. Schematic diagram of the data acquisition system

100 ADC, and 40 TDC channels from the scintillation detectors [5,6]. Now our setup has a number of subdetectors: scintillation hodoscopes, Cherenkov counters, electromagnetic calorimeters, MWDC's, and MWPC's with 2000 channels of information in total. To fit requirements of the expanding detector set of the spectrometer, we have implemented one more CAMAC branch with VMEbus interfaced CAMAC Branch Driver (Fig.2).

A. Trigger

The trigger logic provides two level event filtering with different algorithms. The first level trigger (pretrigger) is issued at coincidence of a beam monitoring signal and a combination of signals from scintillation hodoscopes which cut out possible corridor for passage of the particle under study. An essential feature of the experiment is the use of direct beam monitor, so every single incoming particle is noticed. Another opportunity for pretrigger is to use a gas filled threshold Cherenkov counter. The second level trigger uses fast outputs of the front-end latches of the hodoscopes' counters. Complex criteria can be applied for event pattern selection, such as narrower coridor for particle passage, some degree of symmetry for a pair of particles, limitation of a deflection angle in the dipole magnet, and so on. A newly implemented target enclosing detector [4] provides additional possibilities for event selection criteria. It is a two layer cylindrical scintillation hodoscope intended for a total and hard charged multiplicity tagging in an azimuthal angle from 20° to 90°.

B. Data Acquisition

The data acquisition system is based on two CAMAC branches with A-1 type controllers (Fig.2). The first branch carries on information from the scintillation detectors. Data readout is performed by a CAMAC Branch Driver via a DMA channel into on-line computer memory. The second CAMAC branch uses a VMEbus interfaced CAMAC Branch Driver. A MC68020 based VMEbus processor module (CPU) controls this branch, acquires and stores data from the new subdetectors. Another VMEbus processor module (EB) is assumed to build complete events from two data fragments and discard events not corresponding to the requested pattern. It is supposed that quite sophisticated algorithms, involving track recognition, momentum reconstruction, etc., may be used here. Two computers are occupied in new version of our system: LSI-11 compatible computer and EISAbus PC 486. The first one, directly connected to the CAMAC Branch Driver, acquires data event by event during an accelerator spill and responds to all external synchronization in real-time mode. The acquired data are transferred to PC 486 computer between accelerator cycles either via a VME memory module or via specially developed parallel interface. To interchange control words and messages, the computers are interconnected by means of a serial interface RS-232C. PC 486 computer writes data on a hard disk, books and displays histograms, displays single event topology and performs overall control of experiment. The data files are transferred from PC 486 hard disk to a JINR VAX-cluster via Ethernet.

Thus a single-crate VMEbus system makes it possible to integrate already existed various equipment into the whole system and to provide an easier and standard access to data flow. The most significant and attractive feature of this configuration is the expandability of the system in the future.

C. Slow Control

Recently we completed design and test of a 100 channel High Voltage Power Supply Subsystem. It was designed to power up a wide range of detectors. Flexibility and reliability have been achieved through the use of modular construction. The Subsystem consists of two Euro-crates and plug-in modules with 6 High Voltage channels in each. The High Voltage channels provide up to 3.0 kV at 3.0 mA per channel with overcurrent and overvoltage safety features. The voltage programmability of HV channels is 12 bit. A special software user interface for subsystem control and monitoring have been designed. Remote control is possible via either GPIB or RS-232C port. This High Voltage Subsystem is used to feed electromagnetic calorimeters and some of scintillation counters of the spectrometer SPHERE and associated experiments.

III. Future Enhancements

In the nearest future we are planning to enhance our data acquisition system by including several commercially available VMEbus processor modules, based on 680×0 family, running under OS-9 real-time operating system. Some of them (acquisition oriented processors) are supposed to work as subevent builders. They will readout front-end electronics via the respective type controllers. The use of one subevent builder for each CAMAC segment allows parallel readout of the several front-end crates. Another VMEbus processor module (event builder) will assemble the complete event from data fragments and organize the job of subevent builders. Complete events might be analyzed further by other VME processor to execute software trigger conditions, calculate particle tracks from the raw data. After this preprocessing the event buffers will be written to the SCSI interfaced 8 mm Exabyte or will be transferred via Ethernet into workstation. The UNIX workstation will be used for data analysis and experimental control in future. More distant plans are associated with implementation of FASTBUS front-end electronics for digitization. For development of slow control we work to increase quantity of High Voltage channels for our Time of Flight detectors and using a couple of PC computers for control and monitoring of secondary subsystems of spectrometer such as gas supply, colibration facilities, superconducting magnet.

IV. Conclusions

The described system has been in successful operation during first beam runs of the forward detector of SPHERE. Continual expansions take place according to the requirements of the SPHERE experiment. Limitation in the event rate, caused by the serial readout of front-end crates, will be avoided in future by using intermediate data buffering, implementation of new embedded processors, and parallel readout of the front-end segments.

V. Acknowledgements

The authors wish to thank their colleagues at LHE JINR and INR&NE, Sofia, Bulgaria for all the help and assistance they have given.

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Received on June 22, 1993.