THE DATA ACQUISITION OF THE SPHERE 4π-DETECTOR

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The experiments on the 4π-SPHERE detector for multiple particle cumulative production is currently being prepared at the Laboratory of High Energies, JINR, Dubna. We report on present status of the data acquisition for this setup. A multiprocessor system based on VMEbus will be used for read out, event-building, fast data analysis and buffered data transfer to the host computer. Future developments will be also presented.

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 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

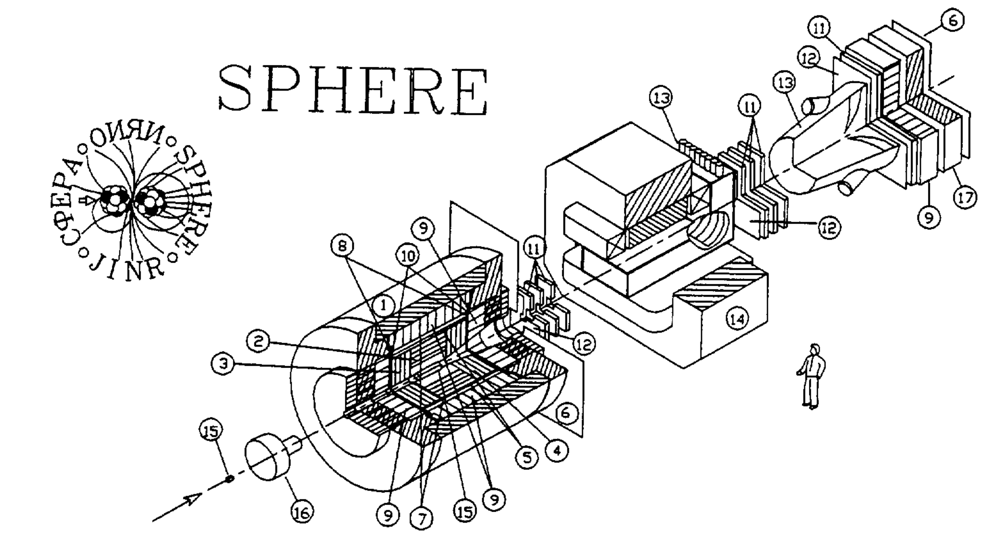

Figure 1: General layout of SPHERE 4π-detector

($< 5^o$) 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 has been operated since 1990 and some experimental results[2, 3, 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.

Present Status

A data acquisition system (Fig. 2) for the first line of the forward detector has been designed. It provides: trigger selection, reading out, data recording, and on-line monitoring of experimental data from scintillation hodoscopes[5]. 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 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 hodoscopes counters. Complex criteria can be applied for event pattern selection, such as narrower corridor for particle passage, some degree of symmetry for a pair of particle, limitation of a deflection angle in a dipole magnet, and so on. A positive trigger decision initiates data readout, while the negative one resets

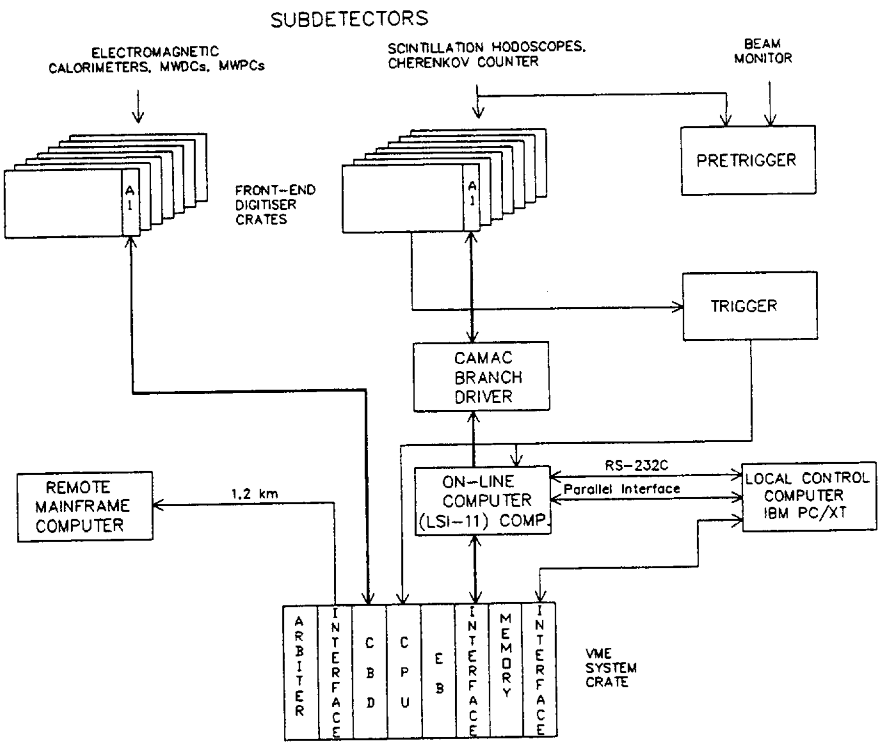

Figure 2: Schematic diagram of the data acquisition and trigger system

front-end electronics.

The data acquisition system is based on CAMAC parallel branch with A-1 type controllers. It supports up to 600 hodoscopic, 100 ADC, and 40 TDC channels for registration of information from the scintillation detectors. Data readout is performed by a CAMAC Branch Driver via a DMA channel into on-line computer memory. The time needed for acquisition of a single event of a few hundreds byte length is about 1 ms.

Two computers are occupied in the system: LSI-11 compatible computer and IBM PC. 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 IBM PC 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. IBM PC 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 IBM PC hard disk to a remote mainframe computer via VMEbus interface. This data transfer is not synchronized with the experiment at all, but initiated regularly by the user. The period, at which this procedure is required, depends on trigger rate and extends from a few hours to a couple of days.

Now our setup has few subdetectors: scintillation hodoscopes, cherenkov counters, electromagnetic calorimeters, MWDC's, MWPC's with 2000 channels of information in total. To fit requirements of the expanding detector set of the spectrometer, we are finishing work on the implementation of one more CAMAC branch with VME interfaced CAMAC Branch Driver. A VME processor (CPU) based on MC68020 microprocessor controls this branch, acquires and stores data from the new subdetectors. Another VME processor (EB) builds complete events from two data fragments and discards events which don't correspond to the requested pattern. It is supposed that quite sophisticated algorithms, involving track reconstruction, momentum recognition etc., may be used here. The preprocessed data are transferred to IBM PC between accelerator cycles.

Thus a single VME system crate 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.

Future Developments

In the nearest future we are planning to enhance our data acquisition system including several commercially available VME processors, based on 680X0 family, running under OS-9 real-time operating system. Some of them are acquisition oriented processors, working as subevent builders 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 VME processor (event builder) will format the complete event from data fragments and organizes the job of subevent builders. Complete events might be analyzed further by other VME processor to constrain software trigger conditions, determine particle tracks from the raw data. After this preprocessing the event buffers will be written via SCSI interface on 8 mm Exabyte or will be transferred via Ethernet into workstation. In the future the UNIX workstation will be used for data analysis and experimental control. More distant plans are associated with implementation of FASTBUS front-end electronics for digitization and using a couple of PC computers for slow control and monitoring of secondary subsystems of spectrometer such as high voltage, gas supply, calibration facilities.

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