UPGRADE OF THE MULTICHANNEL SPECTROMETER DELTA.

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Abstract

This publication presents the latest hardware and software development for the spectrometer "DELTA". The spectrometer is essentially upgraded by installation of new modules using VME and FASTBUS standards. The modules will take large dataflow from the incoming three hundred data registration channels. The spectrometer includes processor module VME FIC-8234D, FASTBUS ADC and TDC modules, CAMAC modules, personal computers of IBM PC type, and a local area network. A software package for the data acqisition system, based on the VME FIC-8234D controller, was designed. The software is a flexible program package easily adjustable for the necessary number of analog and time channels. In addition, VME processor modules performs on-line data analysis and transfer the results via local area network for further visualization on personal computers.

1 INTRODUCTION

Recent advances in accelerator and beam-target technology at JINR have opened up new possibilities for nuclear physics. Using slowly extracted polarized deuterons, available at the Synchrophasotron-Nuclotron accelerator complex of the Laboratory of High Energies JINR, polarized quasi-monochromatic neutrons of momenta from 1.1 to 4.5 GeV/c were generated [1]. In addition, for the JINR physics program, the Argonne-Saclay frozen spin proton polarized target (used initially in the E704 experiment at FERMILAB) was updated and installed on the LHE polarized neutron beam line [2].

2 SETUP OF THE MULTICHANNEL SPECTROMETER DELTA

2.1 The experimental setup

The experimental setup, "DELTA", has been constructed and used to study the particle production process (basically mesons), in nucleon–nucleon interactions at intermediate energies from hundreds MeV to 6–7 GeV. Fig.1 shows a layout of the "DELTA" detectors. There are two main units: a 300-channel γ,e-Cherenkov spectrometer consisting of two blocks (CH1 and CH2) each based on 150 lead-glass prisms; and a 14 - layer scintillation telescope (ST) of detectors based on opto-fiber plates used to identify charged particles and to measure their energy by the method of repeated ionization loss measurements.
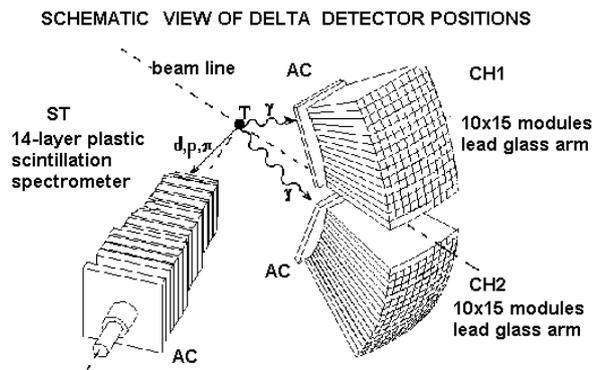

Figure 1: Layout of DELTA detectors.

2.2 The glass Cherenkov spectrometer

The spectrometer is designed to determine energies and exit angles of π^0 and η mesons coming from the studied target. The experimental method used consists of detecting two energetic photons, emitted in the decay of a neutral meson, in an array of Cherenkov lead-glass detectors. The shoulders of the spectrometer (CH1 and CH2) are two blocks. The blocks are built up from glass prisms made of F8-type Pb-glass with PbO 45% additions. The number of cells in each block is 150 (10 along the horizontal line and 15 along the vertical line). Each prism is shaped as a cut pyramid, 400 mm high, 12 rad.in length. Each cell is viewed by a 34-mm FEU84-3 photomultiplier tube. The Cherenkov light output from the Pb-glass cells is proportional to the incident gamma-ray energy, and the signals of all the PM tubes are summed to give a measure of the total phonon energy. Two anticoincidence detectors (AC) of plastic scintillators are located in front of the Cherenkov spectrometer units. The AC's serve to separate γ-quanta from the background charged particles. The thickness of each AC is 20 mm, and are looked through by two photo-electron multipliers FEU-84.

2.3 The plastic scintillation spectrometer.

The scintillation telescope, used to measure charged particles, consist of a 14-layer scintillation spectrometer assembled from plastic scintillator slices with optical reradiating wires for gathering light from the slices.Its transmission is on to an entrance window of the photomultiplier. The obtained light-output homogeneity on the surface of the slices is no worse than 95-97%. To define the type and energy of charged particles taking off

from the target, the technique of repeated power loss measurements in the scintillator slices (the Bregg-curve, reconstruction previously calculated with Monte-Carlo) is used with a measurement of the time of flight at a distance of 1 m. An error of about 12% in measuring the power loss in each slice allows one to determine the energy of a charged parti•le with an error of about 3-4 % (over a range from 30 to 150 MeV for the pion) and its type with error probability at a level of 10^{-4}. The functionality of the plastic spectrometer was proved in the measurements of K-meson production on the Nuclotron internal target and 1.2 and 2 GeV proton beam [3].

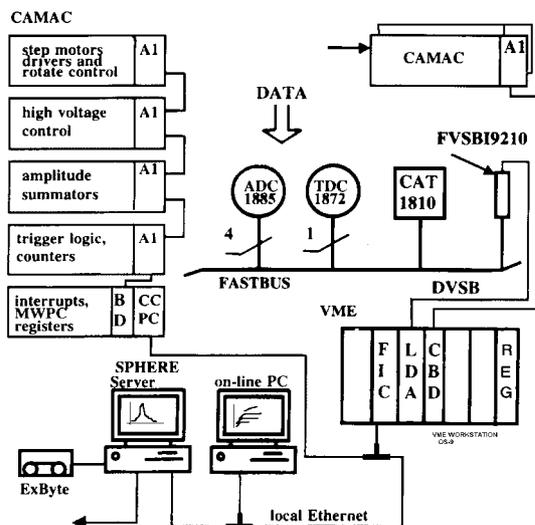# 3 UPGRADE OF THE DATA ACQUISITION SYSTEM

3.1 Hardware.

Figure 2: Architecture of the data acquisition system.

The new architecture of the data acquisition system is schematically shown in Fig. 2. The 300 detector channels of "DELTA" (earlier digitizing electronics were housed in CAMAC crates) were connected to a FASBUS segment. The FASTBUS crate contains four 96-channel QDCs (LeCroy 1885F[4]), 64-channel TDC (LeCroy 1872A[5]), calibration and trigger module (LeCroy 1810[6]) and FASTBUS to VSB interface FVSBI9210[7]. The differential VSB provides an efficient interface between the FASTBUS segment and the disk based professional OS9 VME workstation with FIC-8234[8] Dual 68040 Fast Intelligent Controller.

Specialized input/output registers in the VME crate are used to control an interrupt request signal according to the accelerator's cycles and to generate "Start" for TDC and "Gate" for QDC FASTBUS modules.

The FASTBUS part of the data acquisition system was created without regards to any special demands of a particular spectrometer, so, it may be used not only for the "Delta" project, but for any other spectrometers in the Laboratory of High Energy JINR.

3.2 Software

The VME modules are controlled by the Microwire real-time operating system, OS-9.

There are two Ethernet cards in the "SPHERE" server, so it works as a bridge between the Delta local area network and the external JINR LAN. The socket Sock_Stream (TCP IP protocol) was used to organize exchange over the LAN. A special base set of commands control the date acquisition system. These commands set the placement of FASTBUS modules in the crate, the order of data reading, the direction of the data stream (to disk or to LAN) and so on.

DAQ software is open for future modification and for adding more channels. It is designed as an extra user process in the OS-9 operatin system.This process gets a pointer to a data buffer according to a signal passed throgh OS-9. All network commands which differ from the base set must be processed by the user software. The main task of the user process for the "Delta" spectrometer is perform data analysis at the VME level. Collected histograms are sent by LAN to the screen of personal computers for visualization. In the future, some data filters will be added to the VME user process.

4 CONCLUSIONS

A spectrometer for the detection of charged parti•les and neutral mesons has been constructed for the LHE JINR accelerators complex. The calibration experiment has demonstrated that a high-performance instrument now exists. Its capabilities open up numerous areas of research at the LHE polarized beam and target for which detection of π^0- and eta-mesons detection is required.

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