



## The VME test stand

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### Abstract

We report on a simple setup which records signals from up to 16 photodetectors, digitizes them in QDCs and stores the amplitudes on a computer disc using VME modules from CAEN and LabView as communication software.

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# 1 Introduction

In our recent activities in CALICE collaboration we contributed to the selection of the effective combination of WLS fibre – scintillator tile size and groove geometry for the HCAL prototype. As a source of particles we used radioactive source  $^{90}\text{Sr}$  or cosmics. The light from WLS fibre was read by photomultipliers or avalanche photodiodes (APDs)[1]. The response from photodetectors was measured continuously by an electrometer or digitized by ADCs. In the latter case we used for triggering and digitization old CAMAC and NIM modules. We were limited by range of 10-bit ADCs, instabilities in some electronic modules and by the old data acquisition program with unknown source program. We decided to renew the setup using only VME modules and LabView for its control. We call it the VME test stand. The first task of the stand will be long term testing of the calibration electronics for the HCAL prototype which is our activity in JRA3. The setup is located in the Institute of Physics AS CR in Prague it is very general and can be used by any member of the EUDET or CALICE collaborations.

## 2 The description of the stand

### 2.1 The electronics

The VME electronics was produced by CAEN. The crate Wiener 6023 6+3U hosts the following modules:

- **Controller V2718 with optical link** – main VME unit for a control and read-out system. It can be interfaced to the chainable optical network (CONET) and controlled by a standard PC equipped with the 32-bit 33 MHz PCI card CAEN Mod. A2818 (see below).
- **16 channel low threshold discriminator V814B**. It accepts 16 inputs and produces 16 differential ECL outputs. The thresholds are individually settable in a range from -1 mV to -255 mV via VME.
- **16 channel multievent charge QDC V792NC**. The input integrated charge (0-400 pC) for each channel is converted to a voltage level by a QAC whose outputs are multiplexed and subsequently converted by 12-bit ADCs. The module offering 32 event buffer memory can be addressed and data transferred through the VME to a PC.
- **16 channel 32 bit scaler NIM V560AN**. The module provides 16 independent 32-bit counting channels operating at the input frequency of 100 MHz and is fully controlled through VME.
- **Quad 4 fold AND/OR/MAJ V976B**. The module has 16 inputs and 16 outputs on lemo connectors divided to 4 sections. Each section can operate as a 4 channel NIM-to-TTL or TTL-to-NIM translator or perform the AND/OR logic function. It works also as Fan out and supports the Majority logic function.
- **Dual timer V993B**. It houses two identical triggered pulse generators which produce NIM, TTL and ECL pulses whose width ranges from 50 ns to 10 s when triggered. Timers can be re-triggered with the end marker signal. The adjustment of the output width can be performed via either a rotary handle or by providing an external voltage.
- **Dual gate generator V462**. The unit consists of two independent gate generators. Each generator has independently programmable gate width between 100 ns to 10s in 100ns steps. Besides three standard NIM Gate signals these generate a Begin marker and an End Marker of fixed 100ns width at the beginning and the end of the gate, respectively.

- **Delay unit V972.** This module is completely passive delay via a set of calibrated coaxial cable stubs. Delay ranges from 0 to 31.5 ns with 2.6 ns offset and 0.5 ns resolution.
- **Dual attenuator V859 (2x).** Attenuation ranges from 0 to 44.5 dB for each of two sections which can be cascaded.

Except of these modules placed in the VME create of the VME test stand our test-room is provided with other equipment needed for proper measurement tests:

- **Oscilloscope Tektronix DPO4104.** 4-channel scope allows displaying response from the photodetectors and setup a gate width and delays to measure properly signals by the QDC within tests.
- **4 channel high voltage power supply CAEN N472.** This module consists of 4 channels which are able to supply an output voltage from 0 to 3 kV, 3mA. HV power supply is needed to the photodetectors measure with sufficient gain.
- **Low voltage power supply.** It provides LV for electronics.
- **Multimeter Agilent 34401A.** It works as a voltmeter to check and adjust precisely HV and LV power supplies.
- **Multimeter METEX M-4660A.** It serves as a meter of temperature.

This setup (see Figure 1) enables to trigger on signals from photodetectors used for detection of signals coming from the calibration electronic modules – CMBs – as a part of the HCAL calorimeter prototype. This and a read-out system are described as follows.

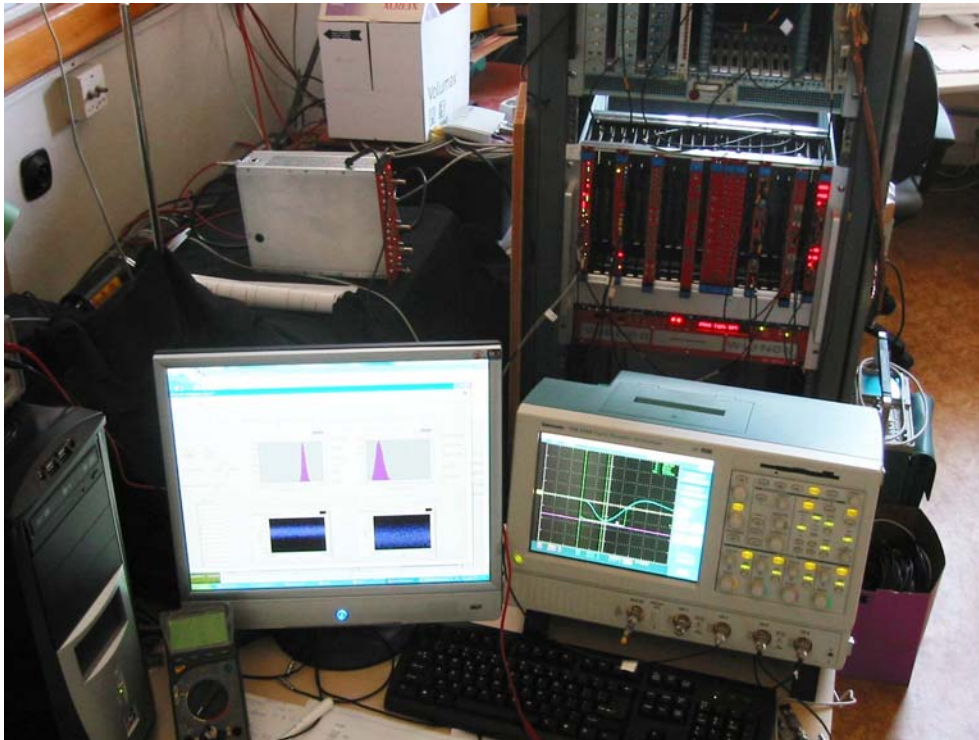


Figure 1. View of the VME test stand.

## 2.2 Control and readout system

The read-out of data and the control of the VME stand is carried out using a standard PC which is equipped with the PCI CONET Controller for communication via V2718 controller and with GPIB Interface Card.

The PCI CONET Controller allows communicating with the VME controller through an optical fiber enabling data transfer rate up to 70 MBytes/s. The Linux and MS Windows drivers are available. Moreover the C/C++ and LabView libraries are supplied by CAEN. The system allows controlling some of the VME boards: QDC, Low Threshold Discriminator, Dual Gate Generator or Scalers and read-out data stored in QDC and Scalers.

In the present setup we use for the control and read-out of the VME stand programs written in the graphical package LabView 6.0 under MS Windows XP. The LabView allows to use all functionality of the VME stand (an example of the flowchart in LabView see in Figure 2). The data from QDC are written into a text file for later analysis. Simultaneously with the VME stand we can control and read other devices via GPIB bus and a serial bus respectively. In present setup the Agilent 34401A multimeter with GPIB bus and METEX 4660A were tested under LabView. The data from all instruments can be read simultaneously and stored in one place.

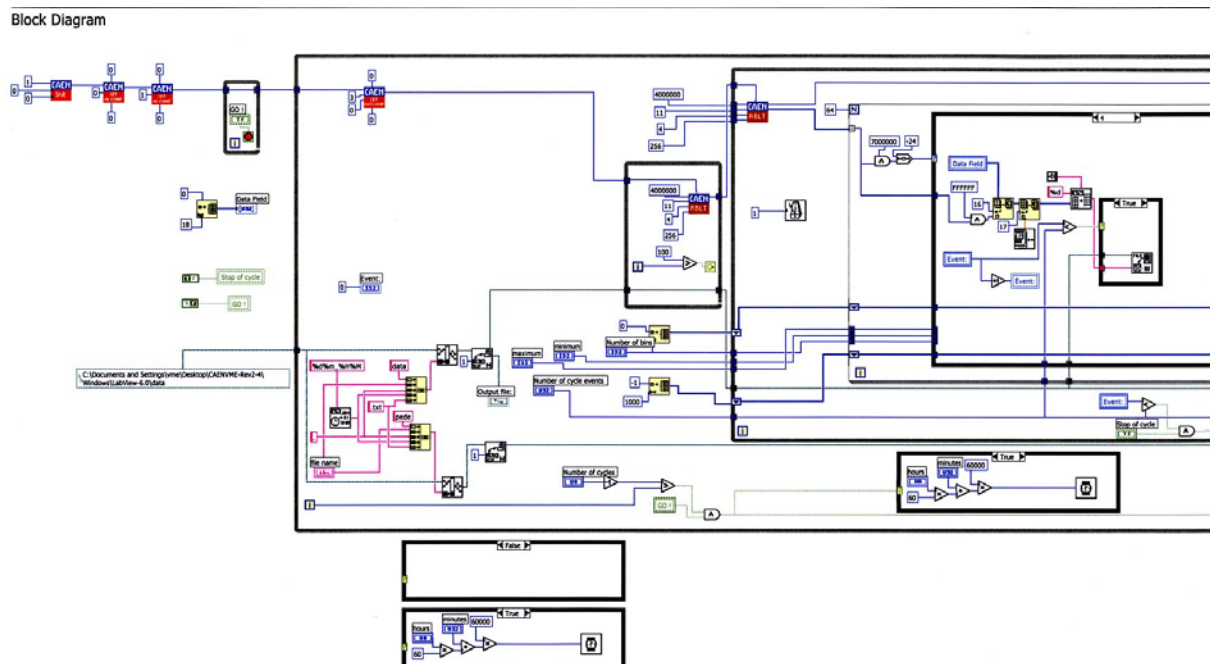


Figure 2. Flowchart of the signal processing in LabView with the Initialization, QDC reading and Input buffer decoding phases.

In future we plan to investigate a possibility to use Linux. It can bring not only higher stability but the possibility to use the standard HEP programs like ROOT and remote control of measurement.

## 3 Tests

The first real task of the VME stand will be long term tests of the so-called CMBs[2]. The CMBs are electronic modules which are made for calibration purposes. They are part of the prototype of a hadronic calorimeter (HCAL) being built by the CALICE collaboration.

A basic function of the CMBs is to provide short light pulses which are led through clear fibers to scintillator tiles as an active part of the HCAL detector. These light pulses are made by light emission diodes (UV LED) with the wave length close to the ultraviolet light. For pulsing of the UV LEDs the CMB provides electrical pulses which are adjustable in intensity and width via the V-calib control signal and can be triggered by the DAQ via T-calib signal.

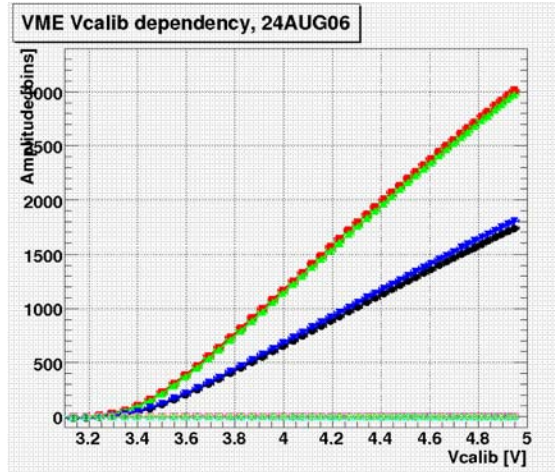
### 3.1 Control setup

Recently we have tested in the VME stand a small, 1-channel prototype of the CMB. The T-calib signal was supplied by the dual gate generator. It sets up the frequency of light pulses. We usually used pulses of 1 kHz. The generator simultaneously provided also a trigger signal of the beginning of the gate in which the QDC integrates charge of signals coming from the photodetectors (PD). To adjust correctly the trigger gate and responses of the PDs this signal was firstly used as an input to the dual timer. By the timer control and displaying the signal waveforms on the scope we can correctly tune (at a level of ns) delays between the gate triggers and the final PD signals. In the second generator of the dual timer we could regulate the width of the gate for the QDC. We have used the gate width to about 135 ns.

Intensity of the LED light pulses was adjusted in this case manually by a potentiometer in the range of 0 to 5 V and the LED current was measured by the multimeter Agilent 34401A. The UV LED light pulses go through a light adaptor to a bundle of 4 light fibers. Through the fibers the LED light is led to 4 PDs. We use avalanche photodiodes (APD) from Hamamatsu as photodetectors. The fibers and APDs are tightly connected by a mask and rubber. The APDs are supplied by high voltage of CAEN power supply. We use HV in the range of 200 – 400 V to have a possibility to change amount of charge of the APD output signal going to the 12-bit QDC. The response from the APDs has to be amplified by preamplifiers and also

electronically shaped. In addition, to check and keep same conditions during measurements we read the temperature by the multimeter METEX.

The output signals from the APDs, after amplifying and shaping are brought through coaxial cables on the input of the 16 channel VME QDC, converted from charge to voltage and integrated in the trigger gate. From the memory buffer of the QDC unit the data are read out via the VME bus by the controller and sent to a PC for a subsequent analysis.



**Figure 3. Dependence of LED amplitude on the voltage V-calib.**

For each measured point we took 10000 events (automatically pedestal and signal data are taken in the LabView data acquisition). All measured data were stored via the optical link on the PC and afterwards were treated with the analytical package RooT to get results displayed in the Figure 3. In this figure we can see very good linearity (above a threshold of ~ 3.5 V) for each fiber. Four different curves are taken from different fiber positions on the LED surface. Different slopes reflect more the differences in optical coupling than the inhomogeneity of the light emission over the LED surface. Such dependence of the LED pulses on different light intensities is expected and it is in an agreement with previous measurements[3] done with the old CAMAC/NIM system.

## 4 Conclusion

We build a VME based system for measurements of properties of photodetectors controlled by LabView. We call it the VME test stand. Its functionality was tested by measurements of linearity response of an LED to the bias voltage using short pulses of a typical width of ~10 ns. The system proved to be operational. The stand is given to the disposal of any participant of the EUDET project. For further contacts, please, contact J. Zálešák, e-mail address: [zalesak@fzu.cz](mailto:zalesak@fzu.cz).

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