A user-friendly platform used for reading out from BGO calorimeter of DAMPE based on Labwindows

1 Introduction:

DAMPE (Dark Matter Particle Explore) is one of the five satellite missions in the framework of the Strategic Pioneer Research Program in Space Science of the Chinese Academy of Sciences (CAS), with a launch date planned to be in 2015-2016.

As an important part of the DAMPE satellite, the BGO calorimeter is made up of 14 layers of BGO bars. The calorimeter has 4 quadrants, each quadrant has 4 Front-end electronics (FEE) circuit board to get the data and monitor status. It has 2016 channels to read. The highest data acquisition rate is more than 10Mb/S. Besides, we need to pay attention to its remote status word in order to monitor status of all the system. If the channels are directly used without calibration when the environment changes, we may not get the correct results. As a result, an automatic calibration function is necessary. The hit signals which are transmitted to Data Acquisition (DAQ) system for the generation of triggers are produced by 32 ASIC chips. Therefore, every ASIC chip must be tested before used. The platform should have the function of testing ASIC chips.

Labwindows/CVI is an ANSI C integrated development environment (IDE) and engineering toolbox with built-in libraries for measurement, analysis, and engineering UI design[1].The availability of drivers for a lot of hardware make it easy to connect to a wide variety of instruments and FPGAs.The graphic user interface (GUI), which is easy to be built, allow us to develop a custom interface for applications. Labwindows/CVI has been already used by engineers in defferent project. It has been proved to be an efficient and convenient tool as a platform of detector system.

Next I will describe a user-friendly platform designed for reading out from BGO calorimeter based on Labwindows/CVI.

2 Specific needs

The hardware configuration is shown in the figure.



In order to get the data, the USB interface and RS-422 interface must be connected to DAQ board, which is designed by my team and used to receive all the signals from 16 FEE boards.The USB interface is used for transmitting of the science data which is generated by FEE boards and collected by the FPGA of DAQ board. The highest rate of science data is 2Mbps. The the FEE board control signal produced by data acquisition system on PC is transmitted by RS-422 interface.

The software diagram is shown.



The command control module sends instruction after packing it into the right format for FEE board and receives the return status words by which we can judge whether the instruction is received. In addition, reading status word helps catching the FEE’s 功能information such as current, temperature and FPGA status.

The monitor display module analyses status word receiving by command control module and shows status of temperature and current of all the FEE boards. The module will also save the information into the specified file.

The data acquisition module acquires science data from DAQ board in which the data is packed to the right format and saves it into file. The data can also be analysed by Data-Analysising module which is connected to MATLAB and takes it as a computational engine by transmitting data to it. Considering the convenience and complexity of the analysis code, offline analysis is also supported with .m files generated by MATLAB.

The features of TA selftest, signal-scanning and calibration is required by FEE testing process. The program provides specific modules to support the demands which have been proved to be effective and convenient.

3. Implementation of significant function

3.1 Hardware interface.

There are 2 kinds of interface, the USB and RS-422 in the data acquisition system. The chip of CY7C68013, which is an EZ-USB FX2 USB Microcontroller, is used on the DAQ board to connect the USB interface between DAQ board and PC. The USB interface transmits science data to PC and command word to DAQ board to control it. Considering the continued large amounts of data, the chip is set to be bulk transfer mode and slave FIFO interface mode.

The RS-422 interface, which is used for the transmission of command word to FEE, is connected to PC from DAQ board with the chip of FT230x. The device of FT230x is a USB to serial UART interface with optimized pin count for smaller PCB designs.

VISA (Virtual Instrumentation Software Architecture), a software standard on I/O interface specified by VPP union, provides standard I/O library for computer to control the instrument. The VISA library integrated in the Labwindows/CVI supplies function to connect USB and RS-422 interface. All the control of related peripheral and data transfers uses function to process provided by VISA library.

3.2 Command module

The platform controls the DAQ board and FEE board by sending different command words. The command word sent to DAQ board is composed by two bytes while the other kind of command word for FEE board is twelve bytes. The command words are stored in an array of type “unsigned char” and sent by function “viWrite()” provided by VISA library to the hardware. Some commands are written in the form of function for convenience.

3.3 Monitor status

There are 64 channels of temperature and 32 channels of current to be monitored on the BGO calorimeter. In addition, the status of every FEE’s FPGA also needs to be monitored. All the channels should be checked every 16 seconds. The program flow chart of monitor status is outlined in Fig. 3.



3.3 Data acquisition

Data acquisition which is the most important function of the platform, has a program flow chart in Fig. 4.



The science data of FEE boards are gathered and packed by the FPGA of DAQ board. Then it will be transferred to PC through USB interface. When the thread of data acquisition start, the software checks the USB buffer every 500mS with the function of “viRead()” supplied by VISA library. If the buffer is not empty, the function will read 512 bytes of data and save it into specified file. When the stop signal is checked, the software will read all the remaining data.

It is important to check the USB interface to make sure it is in the right state since the data acquisition process may last for dozens of hours. Another thread which will check the USB port with function “viFindRsrc()” to confirm whether the connection is broken will run when the thread of data acquisition starts.

3.4 Signal source scan

The signal source scan is an important feature through which we can fit the linear of each channel. The signal source provides square wave whose cycle is 50 Hz and amplitude is known. In addition, it gives a synchronous trigger signal of 500Ns at the rising edge of square wave to DAQ board. Because the trigger mode has been selected as the external trigger, the DAQ board will generate trigger to FEE board with the trigger that the signal source provides. The amplitude of square wave increases at s fixed interval.