EUROBALL HV Control Specification

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1 Introduction

The High Voltage supplied to the Ge and BGO detectors in the Euroball array is computer controlled due to the large number of detector channels involved. This enables the setup and control of the HV supplies to be integrated into the general data acquisition system via a user-friendly computer interface.

2 Hardware

3 Euroball Array composition

The number of High Voltage connections are as follows:

	TAPERED	CLOVER	CLUSTER	INNER BALL	TOTAL
BG	300	416	360	22	1098
GE	30	26	105		161

Total number of channels is 1259.

3.1 High Voltage supply systems

A combination of LeCroy 1440 and CAEN SY527 systems supply High Voltage to the Euroball array. Both systems are modular, the HV crates are linked together, and each crate holds various types of High Voltage cards. Both systems are accessible remotely, allowing the system to be computer controlled via a VME based system and allowing automatic monitoring. The mapping of high voltage channel to detector is configured into the system. LeCroy and CAEN both provide VME boards to interface with their respective High Voltage systems.

3.1.1 LeCroy 1440 system

There is space for 16 boards in each HV crate and up to 16 HV crates may be connected to one VME interface. Euroball uses 4 LeCroy HV crates to supply High Voltage to the Tapered and Clover detectors in the array.

The Tapered and Clover BGO shields are fed from boards of type 1443P. These boards have 16 output channels of up to 2.5 kV each. A total of 716 channels plus spares (46 boards) are needed.

For Euroball III the Tapered and Clover Ge detectors were fed from boards of type 1444. These boards have 8 output channels of upto 5.6 kV each. The Tapered Ge detectors require 30 negative channels (4 x 1444N boards), the Clover detectors need 24 positive channels (3 x 1444P boards).

The VME interface uses the **LeCroy VME1131** board. This module communicates with the 1440 via the LeCroy parallel SIB bus. This bus is very fast and the VME1131 uses DMA to read out voltages and transfer commands to the 1440 system. The commands themselves are in ASCII format.

3.2 CAEN SY527

There is space for 10 boards in each crate and upto 99 HV crates may be linked to a VME interface. Euroball III used 3 CAEN crates to provide HV to the Cluster detectors. For Euroball IV a fourth CAEN crate was added for the Tapered and Clover Ge and for the inner BGO ball.

The Cluster BGO detectors are fed from boards of type A734P. These boards have 16 output channels of up to 3 kV each. A total of 360 BGO channels requires 23 of these boards.

The Cluster Ge detectors are fed from boards of type A832P. These boards have 12 output channels of up to 6 kV each. A total of 105 channels require 9 boards. The Clover Ge requires 26 channels (3 A832P boards) and the Tapered Ge 30 channels (3 A832N boards).

The computer interface uses the **CAEN VME288** interface board. The communication is via a LAN which can have up to 100 stations chained to it. It is not as fast as the LeCroy SIB bus, but more robust. It uses a binary data transfer protocol.

3.3 VME system

The High Voltage control system has exclusive use of a VME crate. This because the LeCroy part of the system has proved very vulnerable to the VME crate being switched on/off. Power cycling of the crate would be more likely with if modules shared the VME crate.

4 Software

The software for control and monitoring of the HV system runs on one or more CPUs in the VME crate. The user interface is run on UNIX workstations in a Windows environment. Several user interfaces may be active at the same time.

The design is similar to that used for the earlier Eurogam project as much of the hardware is identical. The GUI software will be written in TCL/TK.

A single task in the VME system monitors the voltages, and manages a database of setup/status in its memory. This database is available for read/write from a network task, thus making the system accessible from UNIX workstations. The run time environement for the HV controller is **VxWorks**, and the application itself is written in **C**.

The VME control task starts by reading a basic configuration file, which contains details of how the individual HV crates are connected to the VME systems.

4.1 System configuration

The configuration file for the Euroball HV is as follows:

```
# ============================================================================
# HV crate id ! HV system     ! VME crate! VME interface ! HV crate address
# =========   !===============!==========!===============! ================
   1            CAEN_SY527      ebhv       0xf0f00000         1
   2            CAEN_SY527      ebhv       0xf0f00000         2
   3            CAEN_SY527      ebhv       0xf0f00000         3
   4            CAEN_SY527      ebhv       0xf0f00000         4
   5            CAEN_SY527      ebhv       0xf0f00000         5
   6            LeCroy_1445A    ebhv       0xf0e00000         6
   7            LeCroy_1445A    ebhv       0xf0e00000         7
   8            LeCroy_1445A    ebhv       0xf0e00000         8
```

Each HV crate has a logical id, which is then associated with a VME crate, a VME interface card, and High Voltage crate. The VME control task first checks that the configuration file corresponds to the real world, then initialises the VME interface cards, initialises the database by reading the current setup of the HV crates, and before entering a control/monitoring loop, reads a second confuration file which maps logical detector names on to physical HV channels. This file is known as the **wire list**.

```
Format of a wire list entry:

Mainframe id, slot number, channel number, array position name*

* As specified in the "Euroball Naming Scheme" (Dino Bazzacco)

Example of wire list entries:

1 07 15  Q04eB /* Clover BGO,  shield  4, segment L */
2 15 00  T26aB  /* Tapered BGO, shield 26, segment C */
4 11 03  Q13aG  /* Clover GE,   position 13  */
4 03 03  T24aG  /* Tapered BGO, position 24  */
5 00 00  C15cG  /* Cluster GE,  position 15, segment  C */
7 08 03  C15rB  /* Cluster BGO, position 10, segment  R */
```

So the first entry states that, HV crate 1, slot 17, channel 15 is wired to element *l* of Clover BGO shield *4*.

The VME control task can interrogate each HV crate to find out which board type is present in each slot. This allows any mix of board types within a HV crate. This freedom of placement may not in practice be used, but has been incorporated in the design. There is also be total freedom of wiring of detectors (so say, Tapered/Clover detectors *may* use CAEN supplies even though this was not the intention initially. The information in the wirelist is checked against the actual configuration of the crates so connection mistakes can be avoided.

4.2 HV control database

The VME task keeps a local database of the current setup state for interrogation by users over the network. This database lists all available supply channels and indicates the state of each. The state contains the following details:

- Demand voltage (the voltage the users wants a channel to have)
- Present on/off/ramping/error status
- Actual measured voltage
- Voltage limit
- Ramp values
- Trip status ... whether turned off automatically
- Name associated with channel

The control task monitors the state of each channel to check for any irregularities. In particular, the Ge HV cards have a trip feature which allows the voltage to be ramped down to zero on application of an external signal. This condition will be noticed and a warning message sent to the user.

The control task also interprets user commands issued via the ethernet, translate them to a format recognised by the LeCroy or CAEN systems, and passes them on to the HV crates as appropriate.

5 User Requirements

The user interface runs in a Windows environment, where control is done by clicking on graphical objects (buttons, sliders etc.). It communicates with the VME control task via ethernet, using an RPC protocol.

The user interface is similar between CAEN and LeCroy systems so that the user does not have to be concerned about specific manufacturer dependent details, nor which HV supply channel a detector derives its power from.

The general user interface provides logical objects which will directly reflect physical detectors and NOT a HV channel. Each object (detector) has certain parameters associated with it, some of them fixed (ramp etc.) and some changeable (demand etc.). Other parameters are by their nature read-only, but not fixed (actual voltage, actual current).

There is a *main window* which will display an overview of the whole system. Windows for direct access to HV crates will be provided, these show status and statistics crate by crate, and also contain the HV master switch. Other controls are provided, such as zeroing all demands in the crate (or just for one board).

Separate windows are provided for control of the various parts of the array. Because of the high number of channels it is impractical to control all from the same window and the interface is grouped as follows:

- Tapered Ge
- Clover Ge
- Cluster Ge
- Tapered BGO
- Clover BGO
- Cluster BGO
- Inner BGO Ball

These windows allow the user control individual detectors or groups of detectors together. The latter is particularly relevant as regards to segments of BGO shields or Cluster detectors. However, some flexibility exists so the user can choose to control all detectors of a particular type, say Clover Ge, together.

A **Setup/Wire list** window is provided so the user has the means to alter the wire list or the fixed parameters.

6 Alarm situations

After a voltage drop on any channel due to the application of the trip signal, that channel will be turned off and will only be re-activated by user command. The trip detection is only available for Germanium detectors and Cluster BGO detectors.

The CAEN crates have additional detection of undervoltage, overvoltage and overcurrent. These must be passed on to the user and trigger an alarm when they occur. In the LeCroy system no such checks are built in, so they must be done in the VME control software in a similar manner.

7 Detector database

Although this is strictly speaking not a part of the High Voltage system, it will depend on the HV for some of its information. The High Voltage is therefore designed in such a way that the database management program can have easy access to necessary data. Vice versa, the High Voltage might get information about wiring and demands from this database.

8 Action on trip conditions

The HV must be switched off when a detector has heated up or for some other reason is drawing too much current. Both the LeCroy and CAEN systems provide for this by internal current measurements and programmable trip values. So if a channel draws too much current it will switch the HV off. There is also a facility for connecting an external trip signal to each channel. This is connected to the GE preamp via a breakout box (signal conditioning). When a detector warms up, this signal is asserted and the HV channel switched off (without fast ramping!). A third level of security is also provided: the autofill LN2 system sends an RPC message to the HV when the temperature gets too high, thus anticipating the trip. This enables the HV software to ramp the channel down in advance of a trip.