Manual for HPS ECal

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1   General description of the ECal

The electromagnetic calorimeter (ECal), installed downstream of the pair spectrometer dipole magnet (figure 1), performs two essential functions for the experiment: it provides a trigger signal and it is used to identify electrons and positrons. The ECal modules are based on tapered 160 mm long PbWO crystal with a 13.3x13.3 mm^2 (16x16 mm^2) front (rear) face wrapped in VM2000 multilayer polymer mirror film. The scintillation light, approximately 110 photons / MeV, is read out by a 10x10 mm^2 Hamamatsu S8664-1010 Avalanche Photodiode (APD) with 75% quantum efficiency glued to the rear face surface. The low gain of APDs (150 pC/pC) is compensated with custom-made preamplifier boards, which provide a factor of 225 amplification of the APD signal. In front of the crystals, LEDs are installed to send light into the crystals. These are used in order to check the proper functionning of the ECal and provides complementary information to evaluate gain variations in the various channels of the calorimeter (see figure 2).

The ECal is built in two separate halves that are mirror reflections of one another about the plane of the nominal electron beam. The 221 modules in each half are supported by aluminum frames and arranged in rectangular formation with five layers and 46 crystals / layer, except for the layer closest to the beam where nine modules were removed to allow a larger opening for the outgoing electron and photon beams (figure 3). Each half is enclosed in a temperature controlled box ($<$ 1 F stability and $<$ 4 F uniformity) to stabilize the crystal light yield and the operation of the APDs. Four printed circuit boards (refered as mother boards) mounted on the backplane penetrate the enclosure and are used to supply the 5 V operating voltage for the preamplifiers, the 400 V bias voltage to the APDs, and to read out signals from the APDs. Each half of the ECal is divided into 26 bias voltage groups to improve the gain uniformity of the APDs.

After a 2:1 signal splitter, 1/3 of an amplified APD signal is fed to a single channel of a JLab flash ADC (FADC) board. 2/3 of the signal is sent to a discriminator module and then to a TDC for a timing measurement. The FADC boards are high speed VXS modules digitizing up to 16 crystal signals at 250 MHz and storing 4 ns samples with 12-bit resolution. When a trigger is received, the part of the pipeline from 5 samples before and 30 after the signal (those values will be adapted during commissioning) which crossed a programmable threshold (to be adapted during commissioning).
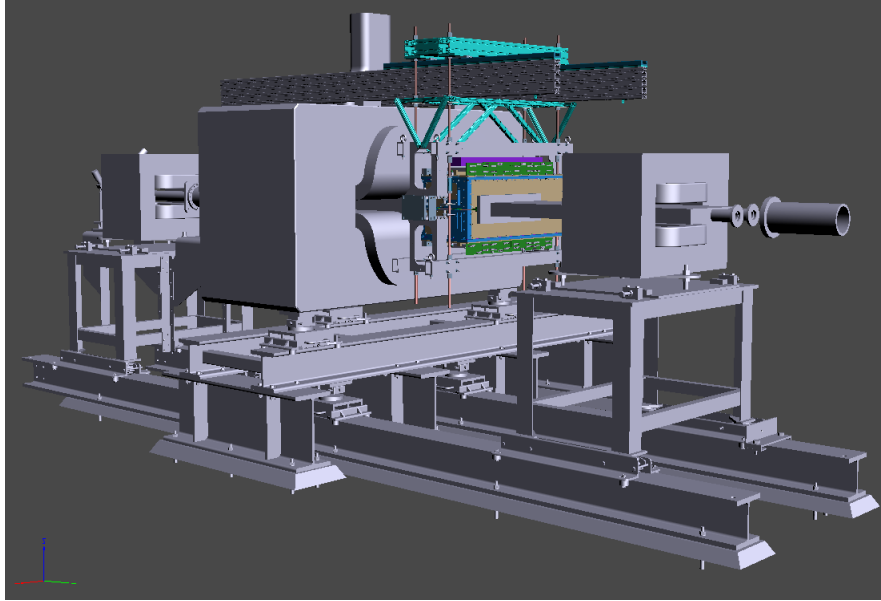
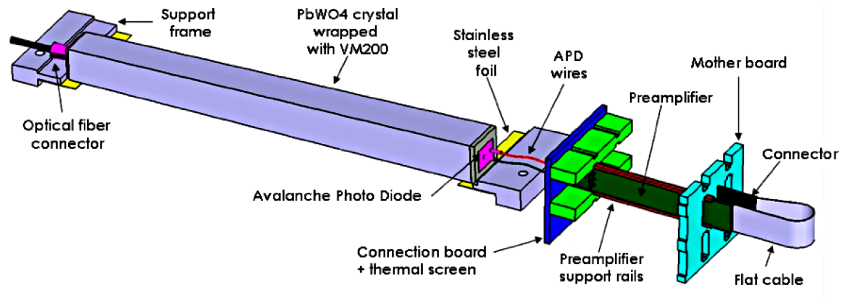Figure 1:   General view of the ECal setup with the magnets.

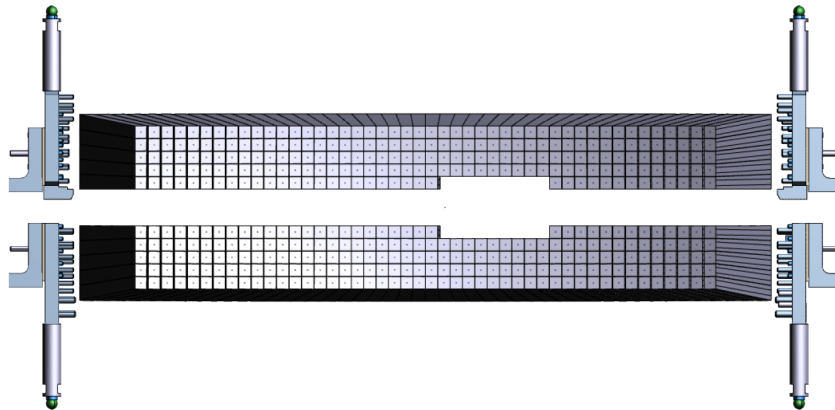Figure 2:   View of an ECal crystal and the amplification chain.

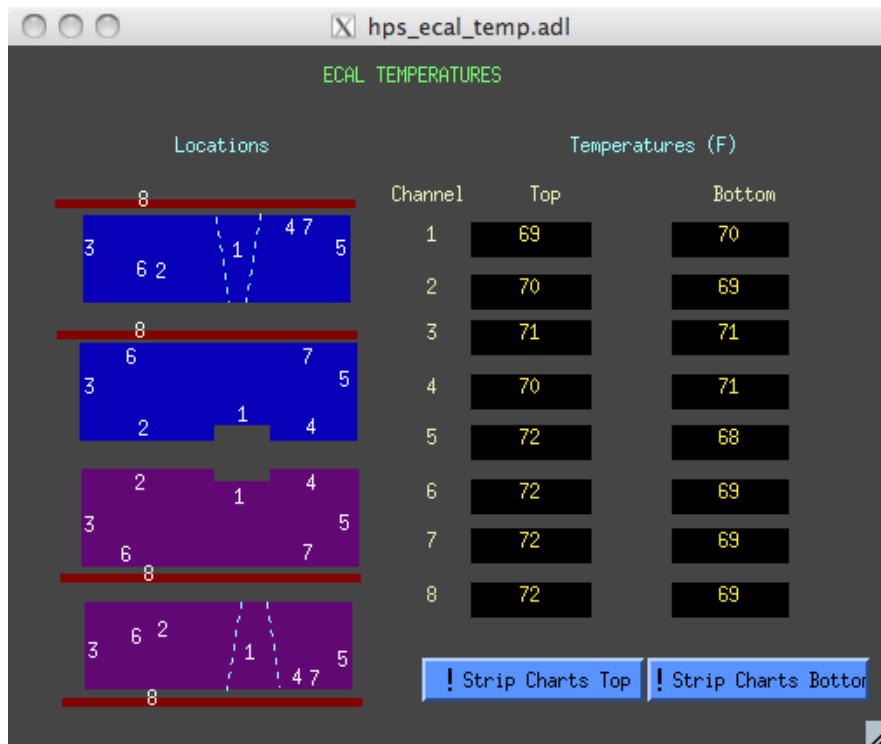Figure 3:   View of the ECal crystals layout.

Figure 4: View of the EPICS temperature monitoring window.

Location of other elements (electronics, chiller...) in the Hall to be added when ECal installed.

Part I
For Shift Takers

2 The Monitoring System

2.1 Temperature

The ECal temperature should remain as stable as possible in order to avoid gain variation in the system. Ten temperature sensors are placed in the ECal enclosure and should be monitored through EPICS (see figure 4). Variations of two degrees F or more during a shift should be reported to ECal expert on call.

2.2 Scalers

Rates are indicated in the EPICS (Add Fig here) and should remain constant within 10%.
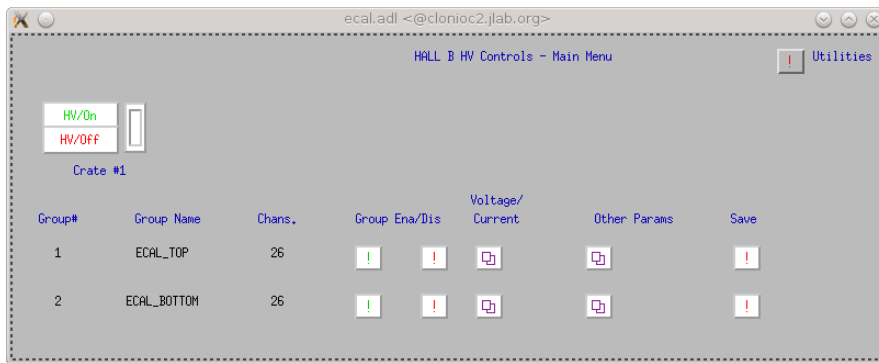
Figure 5: View of the EPICS HV monitoring and control window.

3 Turning on/off the ECal

3.1 Turning on

Turn on (remote or in the hall TBD) low voltage supply (**The low voltage should always be on before HV.**) or check that it is already on (monitoring TBD). Ramp up the HV using the EPICS application (see figure 5).

3.2 Turning off

Turn off high voltage supply using the EPICS application (see figure 5) then turn off low voltage.

4 Responding to HV trips

HV trips are indicated by an alarm in the EPICS Please indicate all HV trips in the log book with indication of the group and run number concerned. HV can be turned back on in the same EPICS window. The HV takes around xx (to be updated) to turn back on. If that does not work try again, if still not working ask MCC to turn off the beam and retry. If that is still not working contact the ECal expert on call.

If you encounter more than two HV trips during your run, you should notify the ECal Expert.

5 LED Monitoring

5.1 System setup

NOTE 1: At the time of writing of this manual, the EPICS interface is currently under development. Therefore, the instructions reported refer to the operation mode with a direct connection to the controller, using a program such as `nc` to connect with it and send commands. When the EPICS interface will be available, these operations will be performed directly trough it.

NOTE 2: Only commands to perform "basic" operations are here reported. The full list of available commands is reported here:

```
http://wiki.ge.infn.it/g3wiki/index.php/Monitoring_system
```
(username: clas, password: e1tocome)

1. Connect to the TOP controller using the `nc` command. For example, if the IP address of the TOP controller is 192.168.0.2, use:
   ```
   nc 192.168.0.2 9764
   ```

2. Turn it ON, using the `TURN ON` command.

3. Set the clock to internal, using 1 KHz frequency:
   ```
   SET CLOCK INT
   SET FREQ 3
   ```

4. On a different shell, connect to the BOTTOM controller using the `nc` command.

5. Turn it ON, using the `TURN ON` command.

6. Set the clock to external:
   ```
   SET CLOCK EXT
   ```

5.2 System usage

5.2.1 Get system info

Here we assume that the system setup is already performed, and that the user is connected via `nc` to the proper controller (TOP controller if the LED is connected to Ecal TOP, BOTTOM controller if the LED is connected to Ecal BOTTOM).

Get system status `GET STATUS`: returns ON/OFF

Get clock source `GET CLOCK`: returns INTERNAL / EXTERNAL

Get clock frequency `GET FREQ`: returns the internal clock frequency, in Hz. If the clock source is External, the reported value is meaningless.

Get LED status `GET LED_STATUS n`: returns the status of LED n ($0 \leq n < 224$). "1" if the LED is ON, "0" if the LED is OFF.

Get LED amplitude `GET AMPLITUDE n`: returns the amplitude setting for LED n.

Get LED width `GET WIDTH n`: returns the width setting for LED n.

5.2.2 Switch ON/OFF a LED

These are the instruction to switch ON/OFF a single LED. Remember that, for each driver board, only one LED at time can be switched ON. Here we assume that the system setup is already performed, and that the user is connected via `nc` to the proper controller (TOP controller if the LED is connected to Ecal TOP, BOTTOM controller if the LED is connected to Ecal BOTTOM).

We refer to the LED to turn on as `n`, with $0 \leq n < 224$.

To switch ON:

1. Optional: set the LED amplitude, using:
   `SET AMPL n x`
   with $0 \leq x < 4096$. If this step is skipped, the LED will be turned ON with the amplitude that was last set with this command. If the command was never issued, the default value (1000) will be used.

2. Optional: set the LED color, using:
   `SET COL R/SET COL B`
   If this step is skipped, the last color selected for **any LED on the same driver** will be used. If the command was never issued before, the default color is Blue.

3. Switch ON the LED:
   `SWITCH ON n .`
   If there is already a LED ON on the same driver, the command has no effect.

To switch OFF: `SWITCH OFF n`. If the LED was already OFF, this command has no effect.

5.2.3 Set the amplitude setting of ALL LEDs

To set the amplitude setting of ALL LEDs connected to a controller to the same value with one command only, use:
`SET AMPL_ALL x`, with $0 \leq x < 4095$.

5.2.4 Set the width setting of ALL LEDs

To set the width setting of ALL LEDs connected to a controller to the same value with one command only, use:
`SET WIDTH_ALL x`, with $0 \leq x < 4095$.

5.2.5 Reboot a controller

To reboot a controller, use:
`REBOOT`
Note that after a reboot, the user has to exit from `nc` and re-connect again to the controller.

6   Making a cosmics calibration run

To be added later.

Part II
For ECal Experts

To be added later.