Low-Threshold Cherenkov Counter Operations Manual

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Abstract

This document provides an overview of the CLAS12 Low-Threshold Cherenkov Counter (LTCC) and serves as an Operations Manual for the detector. Instructions are provided for shift workers related to basic steps of operating and monitoring the HV controls, monitoring the detector system and responding to alarms, and knowing when to contact the on-call personnel.

Contents

1 LTCC Overview

The CLAS12 spectrometer is built around a six-coil superconducting toroidal magnet that divides the active detection area into six 60°-wide azimuthal sectors. The spectrometer detects particles between $\sim$ 5 and $\sim$ 40 degrees in the Forward Detector system, and between $\sim$ 40 and $\sim$ 120 degrees in the Central Detector system.

The LTCC is part of the CLAS12 Forward Detector (see Fig. 1) and it is used for pion/kaon discrimination. The LTCC consists of 6 identical sectors of lightweight mirrors, light collecting cones, 5" PMTs and magnetic shields. The sectors are filled with C_4F_{10} gas, providing pion/kaon discrimination from 3.5 to 9 GeV/c. Each sector contains:

- 108 lightweight mirrors
- 36 Winston Cones
- 36 5" PMT
- 36 magnetic shields

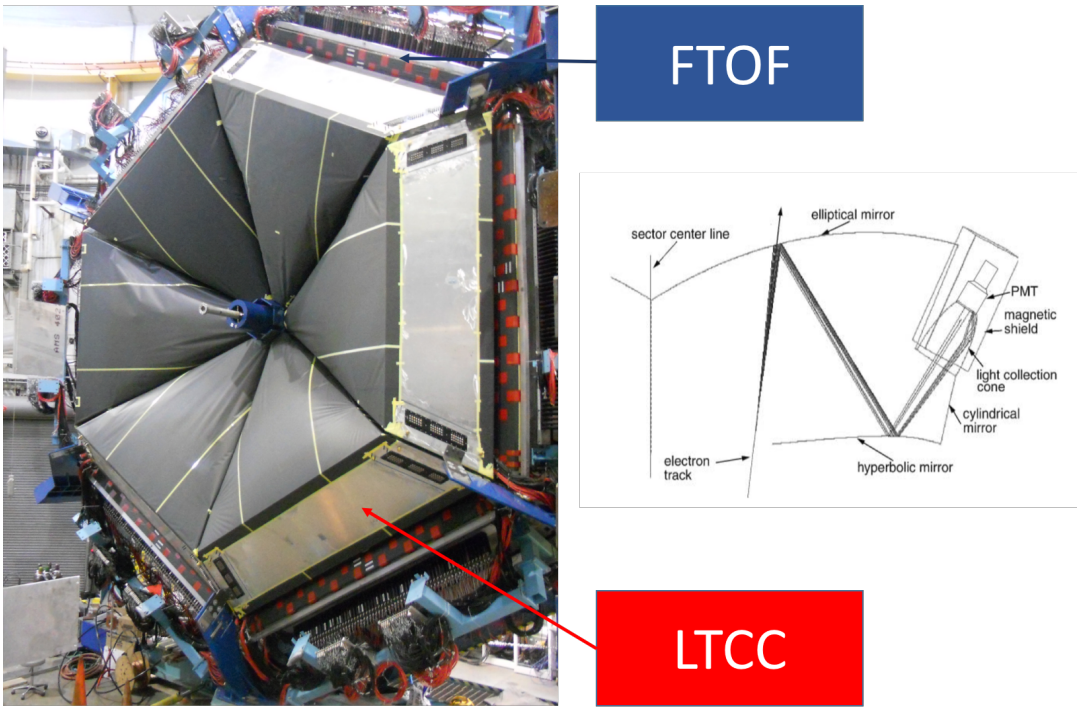


Figure 1: Left: The LTCC sectors installed on the Forward Carriage. The Forward Carriage is roughly 10 m in diameter. Right: The path of Cherenkov photons to the PMTs.

Fig. 2 shows the sector naming conventions for the LTCC system, as well as the definitions of the left and right sides of each sector, a block diagram of the readout electronics for each PMT and the rack locations for the LTCC VME electronics and HV mainframes. Note that "South" refers to beam left and "North" to beam right (closer to the Pie Tower).

The HV power supplies for each LTCC sector are CAEN 1527P mainframes outfitted with positive polarity 24-channel A1535P modules. Each PMT provides two identical outputs. One is connected to JLab 250 MHz VME flash ADCs (FADC) and the other to JLab VME leading edge discriminators and CAEN VME TDCs (100 ps LSB CAEN 1190A).

A summary of the LTCC technical parameters is given in Table 1.

Parameter	Design Value
Mirrors	
Support Structure	3 Kevlar layers sandwiched with vinyl foam
Elliptical	Length = 6" to 55", Width = 8" to 11"
Hyperbolic	Length = 12" to 30", Width = 8" to 9.25"
Mirror Coating	Al/MgF_2
Reflectivity	90% from 250 to 650 nm
C_4F_{10} **gas**	
Refraction Index	1.00134
Transparency	100% above 220 nm
Density	9.94 Kg/m^3
Window Material	Tedlar/Mylar/Tedlar composite
PMTs	
200	Photonis XP 4500B
16	Photonis XP 4500 (Quartz Window)
Magnetic Shields	
Material	Eagle AAA: 80% Ni, 4.20% Mo, and 15% Fe
Field Attenuation Factor	85 Axial, 390 Transverse
PID	
π/K separation	3.5 to 9 GeV/c

Table 1: Table of parameters for the LTCC mirrors, gas, PMTs, and their shielding.

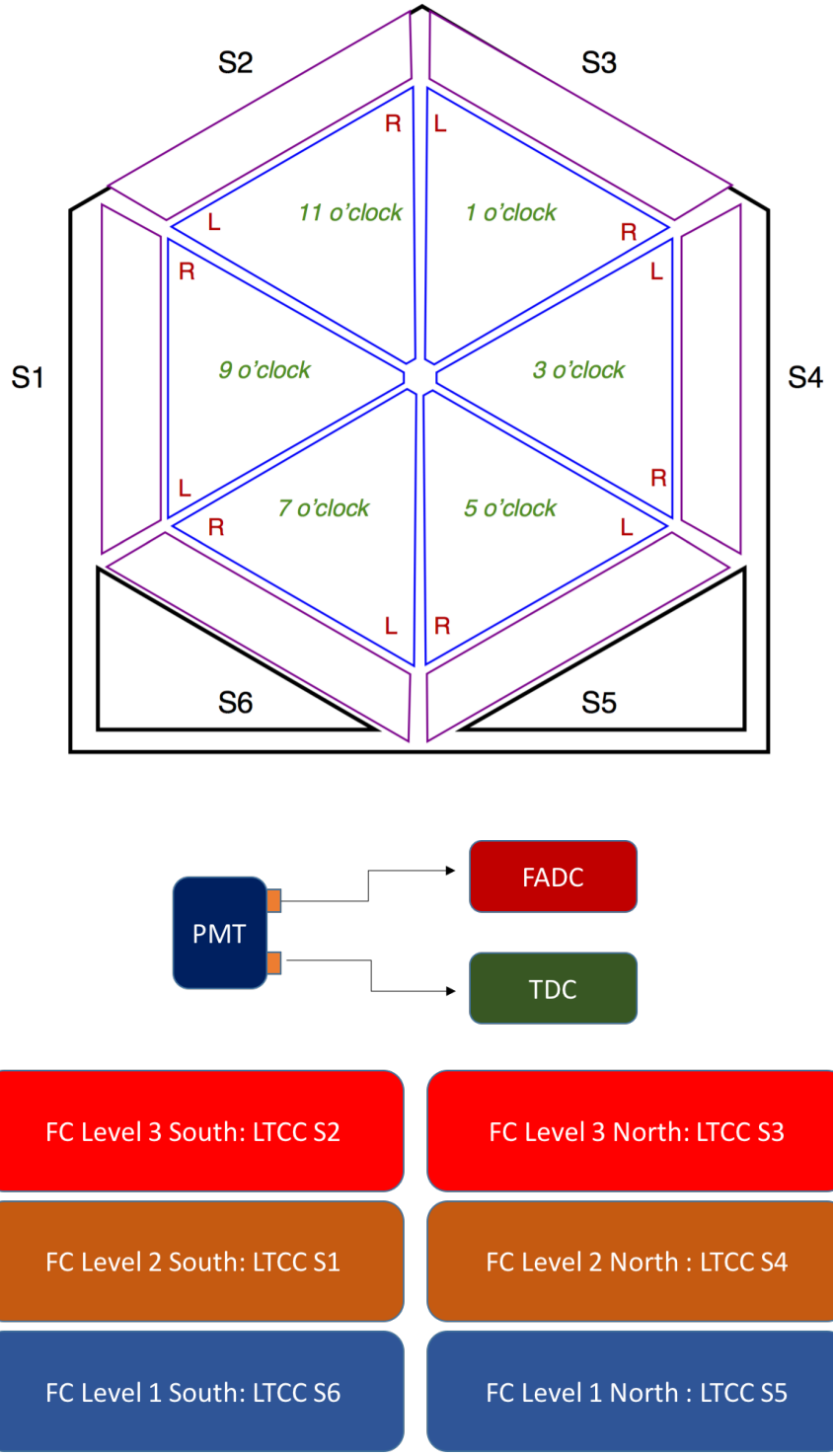


Figure 2: LTCC naming conventions and readout system. Top: each PMT connects two identical outputs to both FADC and TDC. Bottom: the location of the HV and readout electronics for each sector.

2 Information for Shift Workers

2.1 Shift Worker Responsibilities

The shift worker in the Hall B Counting House has five responsibilities with regard to the LTCC system:

1. Updating the Hall B electronic logbook with records of problems or system conditions (see Section 2.1.1).
2. Contacting LTCC system on-call personnel for any problems that are discovered (see Section 2.1.2).
3. Responding to LTCC system alarms from the Hall B alarm handler (see Section 2.1.3).
4. If necessary, turning on or off the high voltage for the LTCC system using the HV control interface (see Section 2.2).

2.1.1 Updating the Logbook

The electronic logbook (or e-log) [1] is set up to run on a specified terminal in the Hall B Counting House. Shift workers are responsible for keeping an up-to-date and accurate record of any problems or issues concerning the LTCC system. For any questions regarding the logbook, its usage, or on what is considered to be a "logbook worthy" entry, consult the assigned shift leader.

2.1.2 Contacting LTCC System Personnel

As a general rule, shift workers should spend no more than 10 to 15 minutes attempting to solve any problem that arises with the LTCC system. At that point they should contact the assigned LTCC on-call worker to either provide advice on how to proceed or to address the problem.

This document is divided into a section for shift workers and LTCC system experts. However, only LTCC system experts (as listed in Section 4) are authorized to make changes to the LTCC parameter settings, to work on the hardware or electronics, or to modify the DAQ system software. This division between shift worker responsibilities and expert responsibilities is essential to maintain in order to protect and safeguard the equipment, to ensure data collection is as efficient as possible, and to minimize down time. If the shift worker has any questions regarding how to proceed when an issue arises, the shift leader should be consulted.

2.1.3 Hall B Alarm Handler

The BEAST alarm handler system running in the Counting House monitors the entire Hall B Slow Controls system. This includes HV and LV systems, gas systems, torus and solenoid controls, subsystem environment controls (e.g. temperature, humidity), and pulser calibration systems (among several others). The system runs on a dedicated terminal in the Counting House. One of the main responsibilities of the shift worker is to respond to alarms from this system, either by taking corrective action or contacting the appropriate on-call personnel. Instructions and details on the alarm handler for Hall B are given in Ref. [2].

For the LTCC system, the two elements monitored by the alarm handler are the HV and gas systems. Any time a channel trips off an alarm will sound. The alarm handler will identify the specific channel (or channels) that have tripped. These channels can be reset either through the alarm handler or through the nominal LTCC HV control screens. These channels should be reset only after ensuring that whatever condition caused the trip (e.g. bad beam conditions) has been addressed.

2.2 High Voltage Controls

The LTCC HV is controlled through the Hall B CS-Studio suite, which is an Eclipse-based collection of tools used as an interface to the EPICS Slow Controls system. To start the user interface on any terminal in the Hall B Counting House, enter the command *clascss*. Fig. 3(left) shows the control panel that is launched.

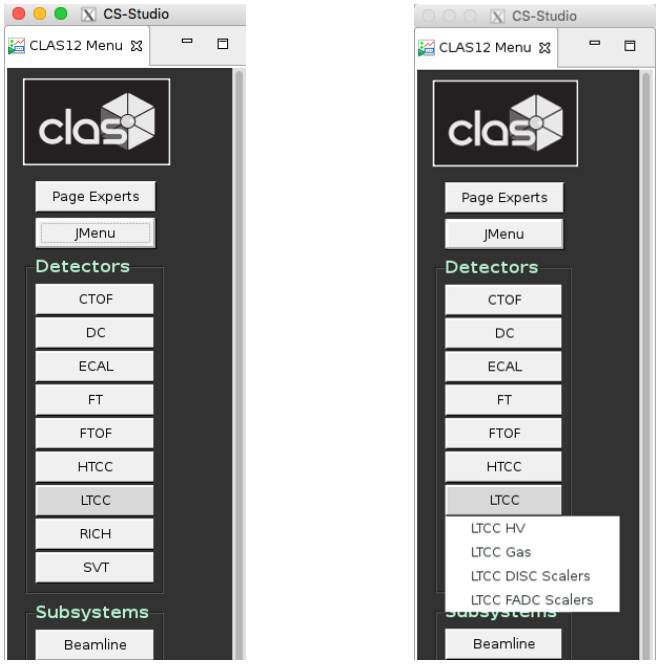


Figure 3: The CS-Studio interface used for the Slow Controls of the CLAS12 detectors and subsystems. (Left) General CLAS12 interface. (Right) Options for the LTCC system.

To bring up the LTCC HV controls, click on the "LTCC" button on the subsystem list. This pops up a sub-menu of all Slow Controls subprograms for the LTCC system (see Fig. 3(right)). Clicking the mouse on the "LTCC HV" option brings up the HV control interface for the LTCC system as shown in Fig. 4. This interface allows for HV operations at a number of functionality levels:

- All channels in the full LTCC system
- All channels in a single LTCC sector
- The left or the right PMTs in a given sector
- A single PMT in the LTCC system

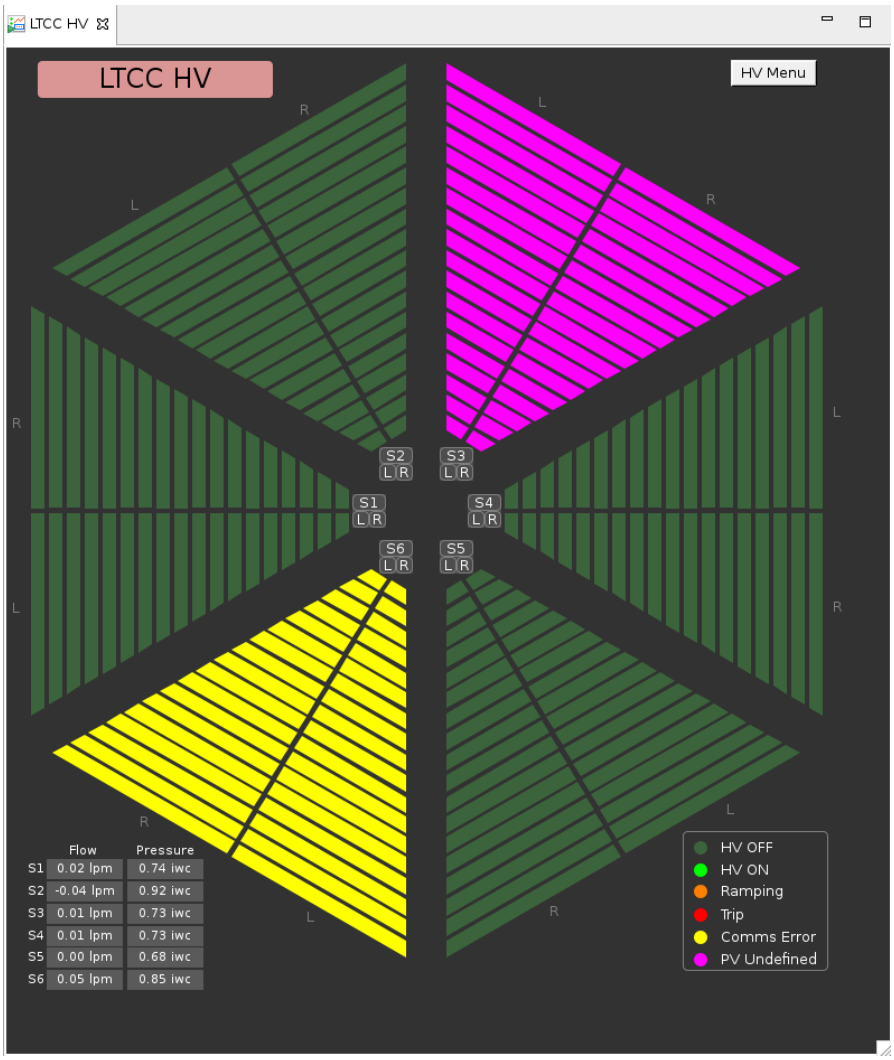


Figure 4: LTCC HV display and control interface.

For the shift worker the most common operations are:

1. To turn the HV for all system PMTs on or off. This is accomplished by clicking the button in the upper right corner "HV MENU". This pops up a sub-menu with the relevant options.

2. To turn the HV for all PMTs in a single sector on or off. This is accomplished by clicking on the corresponding sector button at its nose, denoted with the letter S followed by the sector number. This pops up a sub-menu with the relevant options.

3. To turn the left or right HV for the PMTs in a given sector on or off. This is accomplished by clicking on either the L or the R buttons near the sector nose. This pops up a sub-menu with the relevant options as shown in Fig. 5 (right).

4. To turn individual PMTs on or off. This is accomplished by clicking on the segment representing the channel of interest. Hovering on the detector picture pops up the segment nomenclature, see Fig. 5 (left). Clicking on the segment brings up a control screen for the channel of interest as shown in Fig. 6. Clicking on the "Pw" button toggles the channel HV on and off.

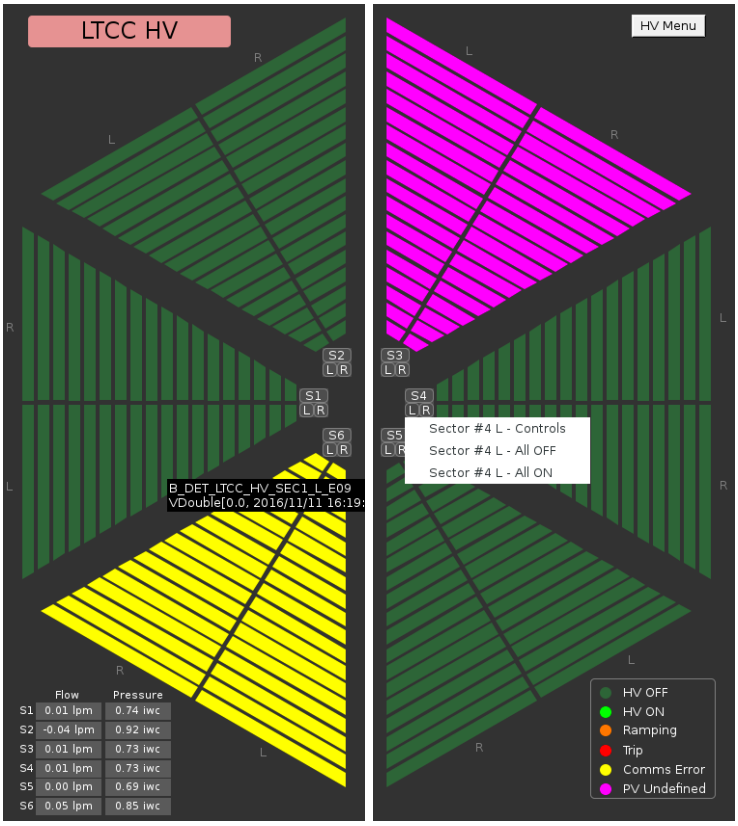


Figure 5: (Left) Hovering on a LTCC segment will display its index. (Right) Clicking on the L button brings up options for all PMTs on the left of that sector.

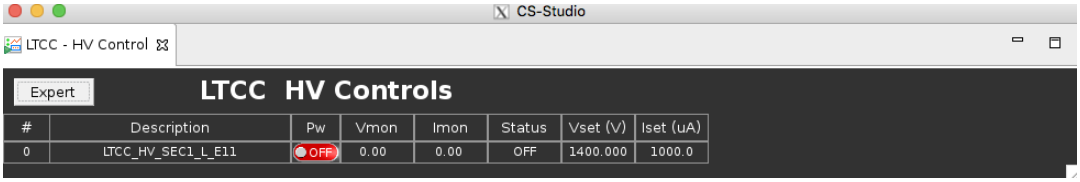
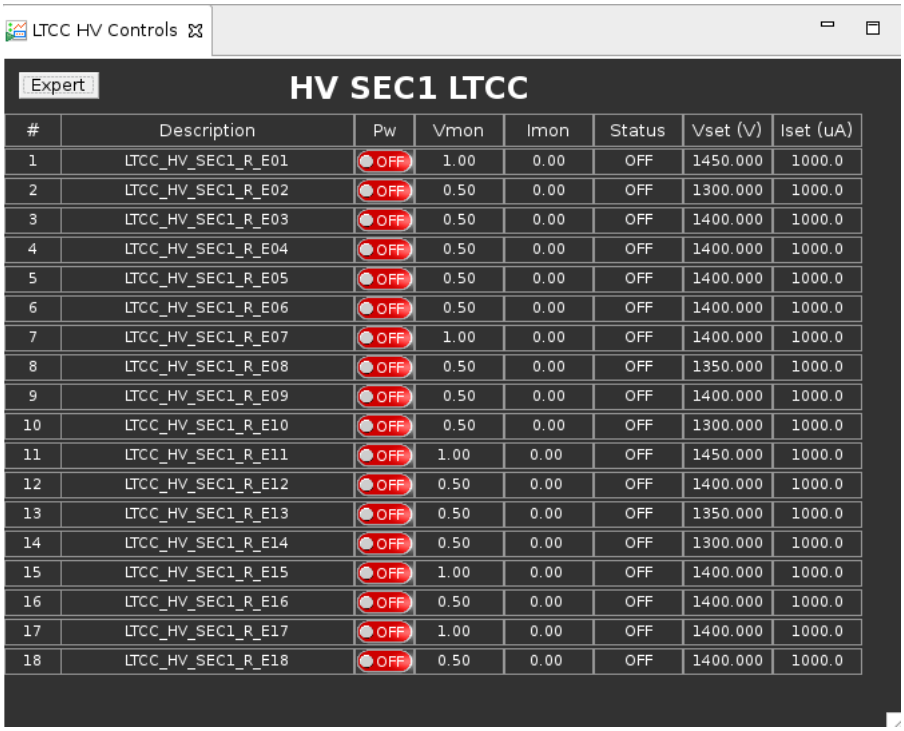


Figure 6: LTCC HV display and control interface for single channel parameters..

If the "Controls" option is selected for a sector or a left/right part of a sector, a "novice" window is opened as shown in Fig. 7. This window shows the monitored channel voltage and current (V_{mon} (V) and I_{mon} (μA)), the channel status (OFF, ON), and the set channel voltage and current (V_{set} (V) and I_{set} (μA)). If desired, shift workers can toggle the HV settings for single channels on or off through this interface.



#	Description	Pw	Vmon	Imon	Status	Vset (V)	Iset (uA)
1	LTCC_HV_SEC1_R_E01	OFF	1.00	0.00	OFF	1450.000	1000.0
2	LTCC_HV_SEC1_R_E02	OFF	0.50	0.00	OFF	1300.000	1000.0
3	LTCC_HV_SEC1_R_E03	OFF	0.50	0.00	OFF	1400.000	1000.0
4	LTCC_HV_SEC1_R_E04	OFF	0.50	0.00	OFF	1400.000	1000.0
5	LTCC_HV_SEC1_R_E05	OFF	0.50	0.00	OFF	1400.000	1000.0
6	LTCC_HV_SEC1_R_E06	OFF	0.50	0.00	OFF	1400.000	1000.0
7	LTCC_HV_SEC1_R_E07	OFF	1.00	0.00	OFF	1400.000	1000.0
8	LTCC_HV_SEC1_R_E08	OFF	0.50	0.00	OFF	1350.000	1000.0
9	LTCC_HV_SEC1_R_E09	OFF	0.50	0.00	OFF	1400.000	1000.0
10	LTCC_HV_SEC1_R_E10	OFF	0.50	0.00	OFF	1300.000	1000.0
11	LTCC_HV_SEC1_R_E11	OFF	1.00	0.00	OFF	1450.000	1000.0
12	LTCC_HV_SEC1_R_E12	OFF	0.50	0.00	OFF	1400.000	1000.0
13	LTCC_HV_SEC1_R_E13	OFF	0.50	0.00	OFF	1350.000	1000.0
14	LTCC_HV_SEC1_R_E14	OFF	0.50	0.00	OFF	1300.000	1000.0
15	LTCC_HV_SEC1_R_E15	OFF	1.00	0.00	OFF	1400.000	1000.0
16	LTCC_HV_SEC1_R_E16	OFF	0.50	0.00	OFF	1400.000	1000.0
17	LTCC_HV_SEC1_R_E17	OFF	1.00	0.00	OFF	1400.000	1000.0
18	LTCC_HV_SEC1_R_E18	OFF	0.50	0.00	OFF	1400.000	1000.0

Figure 7: LTCC HV novice channel controls screen.

In the upper left corner of this "Channel Controls" window is a button marked "expert" that brings up the window shown in Fig. 8. This allows changes to the system settings for the maximum channel current, maximum channel voltage setting, and the channel HV ramp up and ramp down rates. Clicking on the "novice" button in the upper left corner toggles between the expert and novice screens. The expert screen should only be used by the list of authorized LTCC personnel given in Section 4.

#	Description	Pw	Vmon	Imon	Status	Vset (V)		Iset (uA)		Vmax (V)		Up (V/s)		Down (V/s)	
1	LTCC_HV_SEC1_R_E01	OFF	1.000	0.00	OFF	1450.000	1450.000	1000	1000	1500	1500	50	50	100	100
2	LTCC_HV_SEC1_R_E02	OFF	0.500	0.00	OFF	1300.000	1300.000	1000	1000	1500	1500	50	50	100	100
3	LTCC_HV_SEC1_R_E03	OFF	0.500	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
4	LTCC_HV_SEC1_R_E04	OFF	0.500	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
5	LTCC_HV_SEC1_R_E05	OFF	0.500	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
6	LTCC_HV_SEC1_R_E06	OFF	0.500	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
7	LTCC_HV_SEC1_R_E07	OFF	1.000	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
8	LTCC_HV_SEC1_R_E08	OFF	0.500	0.00	OFF	1350.000	1350.000	1000	1000	1500	1500	50	50	100	100
9	LTCC_HV_SEC1_R_E09	OFF	0.500	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
10	LTCC_HV_SEC1_R_E10	OFF	0.500	0.00	OFF	1300.000	1300.000	1000	1000	1500	1500	50	50	100	100
11	LTCC_HV_SEC1_R_E11	OFF	1.000	0.00	OFF	1450.000	1450.000	1000	1000	1500	1500	50	50	100	100
12	LTCC_HV_SEC1_R_E12	OFF	0.500	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
13	LTCC_HV_SEC1_R_E13	OFF	0.500	0.00	OFF	1350.000	1350.000	1000	1000	1500	1500	50	50	100	100
14	LTCC_HV_SEC1_R_E14	OFF	0.500	0.00	OFF	1300.000	1300.000	1000	1000	1500	1500	50	50	100	100
15	LTCC_HV_SEC1_R_E15	OFF	1.000	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
16	LTCC_HV_SEC1_R_E16	OFF	0.500	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
17	LTCC_HV_SEC1_R_E17	OFF	1.000	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100
18	LTCC_HV_SEC1_R_E18	OFF	0.500	0.00	OFF	1400.000	1400.000	1000	1000	1500	1500	50	50	100	100

Figure 8: LTCC HV expert channel controls screen.

The HV Control Interface screen (see Fig. 4) also provides a color key to indicate the channel status:

- HV off - no highlight color (channel color dark green)
- HV on - bright green
- HV ramping up or ramping down - orange
- HV trip - red
- Communication problem - yellow
- Undefined channel status - magenta

3 Resetting the IOCs

If there is a communication problem present, which typically appears for all PMTs in a given sector, the usual cause is an issue of communication between the IOC computer and the HV mainframe. To reboot the IOC for a given sector, click on "IOCs" button on the Slow Controls panel within the "Subsystems" portion of the interface (see Fig. 3). Fig. 9 (left) shows the options that appear on the sub-menu that pops up. On this menu, select "HV IOC Health" to open the control window shown in Fig. 9 (right). Click on the "Reboot" button for the HV supply that has the IOC communication problem. The reboot will take less than two minutes to complete and the yellow communication problem channel indicators should all disappear. If rebooting the IOC does not solve the problems, contact the Slow Controls system expert.

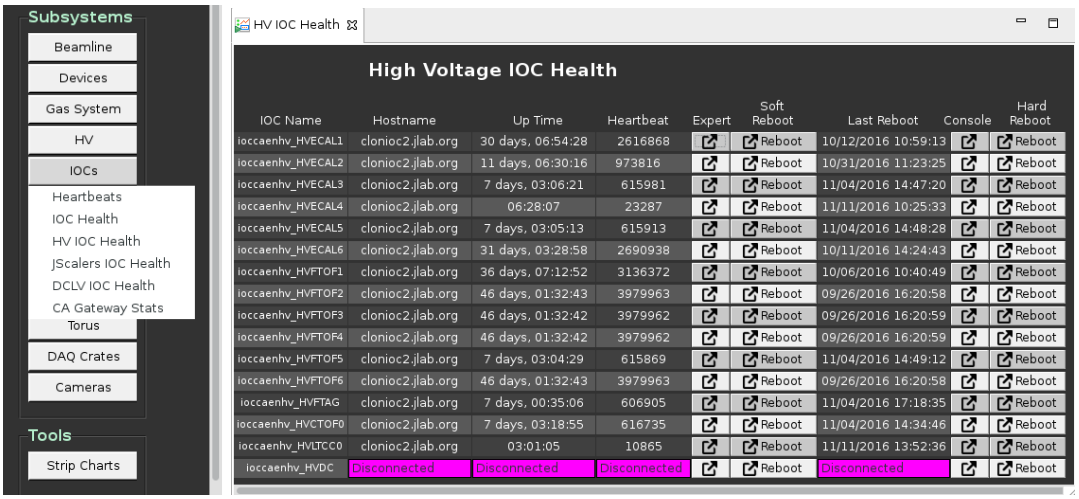


Figure 9: LTCC HV expert channel controls screen.

4 LTCC Authorized Personnel

Beyond turning on/off the LTCC system HV and monitoring the system scalers, all other operations and repairs are only to be carried out by the list of authorized personnel shown in Table 2. The list of authorized personnel for LTCC can only be modified by LTCC Group Leader.

Name	Telephone	email	Area
Maurizio Ungaro	757-269-7578	ungaro@jlab.org	LTCC Group Leader
Cole Smith		lcsmith@jlab.org	Hardware
Sergey Boyarinov	757-269-5795	boyarinov@jlab.org	DAQ
George Jacobs	757-269-5902	jacobsg@jlab.org	Gas System
Nathan Baltzell	757-269-5902	baltzell@jlab.org	Slow Controls

Table 2: LTCC detector authorized personnel.

References

[1] Hall B Electronic Logbook: https://logbooks.jlab.org/book/hblog

[2] Hall B BEAST alarm handler:
https://clasweb.jlab.org/wiki/index.php/Slow_Control_Alarms