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CLAS TOF Online Manual

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Abstract

The purpose of this CLAS-NOTE is to provide new members of the TOF working group with enough information about the TOF system that they can diagnose and troubleshoot routine problems encountered by shift personnel. We emphasize aspects of the TOF system which are not documented elsewhere.

Contents

1 Quick Overview

The Time-of-Flight (TOF) system of CLAS consists of 56 counters per sector. The first 23 form panel 1 and are also called forward-angle counters. The forward-angle system resides on the forward carriage. The remaining counters (large-angle) are grouped into three panels, with panels 2 and 3 supported on the CLAM shells, and panel 4 supported directly off the space frame.

Counter number 1 is at the smallest scattering angle ($\sim$ 7.5 deg). The forward-angle counters are instrumented with EMI 9954A 2" PMTs (left and right sides) on each counter (46 PMTs per sector). The voltage divider chain is the UNH low-power active design, drawing approximately 350 mA @ 2000 V, independent of load.

The large-angle system is instrumented with Philips 3" 4312B PMTs, except for the last four scintillators which are of forward-angle design. The last 18 scintillators in each sector are paired to give a single output from the two PMTs at each end. These counters correspond to numbers 40 - 48, and are labeled as A and B. A separate HV channel is assigned to each PMT, so the HV can be set individually. However the readout (ADCs and TDCs) records 48 channels. In addition, due to geometrical constraints, scintillators 48B in sectors 3 and 5 are not mounted.

The PMT signals with typical voltage levels and corresponding discriminator thresholds are shown in Figure 1. The pretrigger board sums right and left photomultiplier tube signals, effectively doubling the input signal levels relative to the threshold.

1.1 Electronic Spares

Spare boards to replace failed electronics can be checked out of from the Jefferson Lab Electronics Equipment Pool. The Electronics Equipment Pool is located in the EEL building, room 108, at the rear of the JLab Stockroom. Normal operating hours are 8:30 a.m. to 5:00 p.m. Monday - Friday. Procedures to access the equipment pool during off hours can be found in Appendix C.

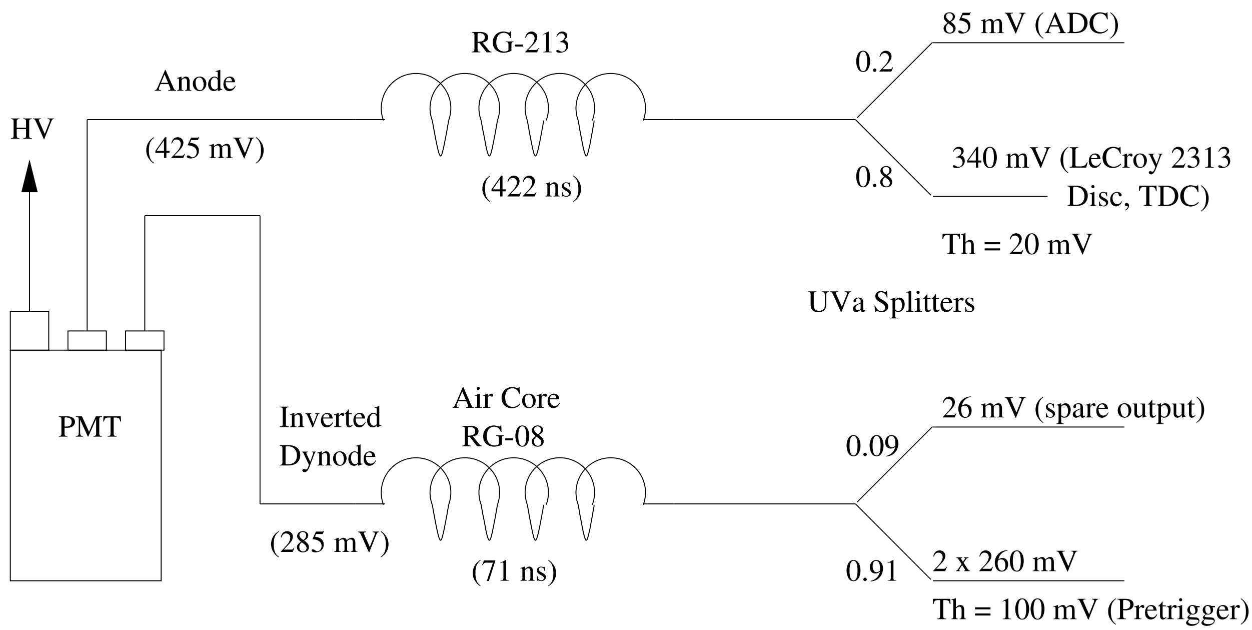

Figure 1: Schematic diagram of TOF signals with typical voltage levels.

2 PMT High Voltage

The HV are usually controlled and monitored with the EPICS slow-control software on clon01. The main GUI is brought up using the command > *clas_epics*. In case you get an error message type > *setup_epics* and retry.

To monitor the high voltage settings for the TOF PMT's, select the TOF HV button from the 'High Voltage' EPICS panel. To look at individual counters select the group for that PMT under the column Voltage/Current. The status on the HV display are given in Table 1.

Before the beginning of each run and during maintenance periods it is necessary to adjust the HV of some PMT's, (e.g. change of tube base). If you already know the new HV setting, run EPICS and locate the pointer on the blank space on the column *Input V* (for the PMT you want to adjust). Type the new value and hit the return button. The new value will be entered on the column *Demand V* and after a while the column *Measured V* will reflect the new setting. All HV values must be negative.

The physical location of the HV mainframes is specified in Appendix A. Further information on use of the HV interface can be found in the documentation for the CLAS slow control system. The LeCroy HV mainframes communicate with EPICS via two IOCs. The assignment of channels to the EPICS IOCs and their location is given in Table 2.

Table 1: Meaning of the status numbers on the HV display.

STATUS	Significance
0	off or disabled
1	ok
3	ramping up
4	ramping down
32,64	tripping
other	error

Table 2: HV System Assignment. We note that the IOCs also control other detectors systems, not just the TOF HV.

EPICS IOC	HV Mainframe	Location	Detectors
classc5	9	FC Deck 3	FC north: sectors 3, 4, 5
classc5	10	FC Deck 3	FC south: sectors 6, 1, 2
classc12	3	North Clam	LA north: sectors 3, 4, 5 panel 2&3
classc12	4	South Clam	LA south: sectors 6, 1, 2 panel 2&3
classc12	6	Space Frame	LA panel 4: all sectors

The following operations may be required during work on the TOF system:

2.1 Disabling Coupled Paddles (A/B)

To facilitate this operation there is a script is called **tof_AB_onoff.pl**. On a clon01 terminal, the following will shut all the B's off: $APP/hvca/scripts/tof_AB_onoff.pl B off. This will turn all the B's back on: $APP/hvca/scripts/tof_AB_onoff.pl B on. The A's can turned on and off in the same way by just substituting 'B' with 'A' in the command line. One final note: the user must be **clasrun** when running this script.

2.2 Restore

From the main EPICs HV control window, the "Restore" button will set all voltages in a given group to the HV settings in the backup file which should be loaded at the beginning of a run period with settings for proper operation (described later).

2.3 Reboot IOC

If the IOC looses communication with the HV mainframe (often indicated by a white alarm status and/or blank button on the HV EPICS GUI), one might have to reboot the IOC. Use the "reboot" button on "IOC Status" window for the appropriate IOC. The IOC light should be blinking on and off during proper operation.

2.4 Local operation

In cases that the EPICS control is not available, or for troubleshooting, the HV can also be controlled "locally" via a vt100 terminal (accessible via the terminal server). A key switch at the front of the mainframe should be set to "Standby" then back to "Remote" before restarting the mainframe. If that fails, then turn off the AC power with the white button on the back of the mainframe, and reenergize the system. See Appendix B.

2.5 HV Restore Files

The HV restore is accomplished from the EPICS HV GUI for each mainframe. The action reloads HV settings contained in the HV backup files. There is a one-to-one correspondence between these files and the grouping on the main TOF HV display except in the case of sc_space.dat (see below) which contains all counters from the 6 sectors while in the display there are two buttons for the same counters. All new HV entries should be saved in the backup files in order to insure that they are restored after a system reset.

The backup files for the TOF HV are located on clon01 in the directory $APP/hvca/db and have the .dat extension as shown in Table 3. To update the files with new HV settings, see Section **??**.

3 TOF Pretrigger

The pretrigger boards are located on Deck 2 in modified VXI crates (pretrig1 in C2-7 and pretrig2 in C2-9). Outputs from the front panel of each board go to both the trigger, scalers and TLV1 TDCs. Rear panel outputs (currently unused) gate the appropriate discriminators. The values of the *threshold* and *output width* of the discriminators are normally set by shift personnel using the DIMAN interface. DIMAN can be run on any clon machine by typing *diman*. Select the desired detector (TOF) with the left mouse (deselect using right mouse)
Select
> Action > Download > Pretrigger discriminator

Table 3: Description of the high voltage backup files.

Backup file	Description
sc1.dat	
sc2.dat	
sc3.dat	These files contain the HV settings for left-right
sc4.dat	PMT's for counters 1 to 23
sc5.dat	
sc6.dat	
sc_north.dat sc_south.dat	This files contain the HV setting for left-right PMT's for counters 24 to 39 and 40 to 42 A and B
sc_space.dat	This file contain the HV setting for left-right PMT's for counters 43 to 48 A and B.

to download values either from a file or the GUI interface.
Select
> Action > Read back > Pretrigger discriminator

to read the current values loaded in the hardware.
Select
> Action > Select_conf > Pretrigger discriminator

to select the file name (extension .cnf) which contains the settings for a given run period. By default the file names are specified by the run period, detector and year, e.g. eg1b_sc_pretrig_00.cnf (eg1b period, sc system, pretrigger, year 2000). At the beginning of each run period, we create a new file – even if the settings are unchanged– to keep a record of files previously used as well as to make it simple for shift personnel to identify the file which is valid for the current run. In order to edit a configuration file, select a configuration (see above) and then
> Edit > Pretrigger discriminator

The EMACS editor will come up with appropriate file. A new file can be produced by simply editing an old file and saving it under a new name.

The pretrigger boards for sectors 1, 2 and 3 are located in ROC pretrig1, and the boards for sectors 4, 5 and 6 are located in ROC pretrig2 (see Appendix app:pretrig). The current settings are

- Threshold = 100 mV
- Width = 100 ns

3.1 Threshold Calibration

The bench test calibration for the threshold gives: DAC = 5.2 x Threshold (mV) [DAC:0- 4095; Threshold: 0-788 mV] . The width calibration is approximately Width (ns) = 33 ns + 0.6*DAC [DAC:0-255; Width: 33-187 ns].

4 LeCroy 2313 CAMAC Discriminator

The discriminators are located in CAMAC crates on Deck 2, with controllers #0 in C2-7 and #1 in C2-9. They provide inputs to the FASTBUS high resolution TDCs. The values of the *threshold* and *output width* of the discriminators are normally set by shift personnel using the DIMAN interface. DIMAN can be run on any clon machine by typing *diman*. Select the desired detector (TOF) with the left mouse (deselect using right mouse)
Select
> Action > Download > Channel discriminator

to download values either from a file or the GUI interface.
Select
> Action > Read back > Channel discriminator

to read the current values loaded in the hardware.
Select
> Action > Select_conf > Channel discriminator

to select the file name (extension .cnf) which contains the settings for a given run period. By default the file names are specified by the run period, detector and year, e.g. eg1b_sc_discri_00.cnf (eg1b period, sc system, TDC discriminator, year 2000). At the beginning of each run period, we create a new file –even if the settings are unchanged– to keep a record of files previously used as well as to make it simple for shift personnel to identify the file which is valid for the current run. In order to edit a configuration file, select a configuration (see above) and then
> Edit > Channel discriminator

The EMACS editor will come up with appropriate file. A new file can be produced by simply editing an old file and saving it under a new name. The default (hardware) settings for most of these discriminators are:

- Threshold = 20 mV
- Width = 20 ns

However, there are three exceptions: the discriminator thresholds for the RF signals are set to 200 mV, the start counter signals are set to 10 mV, and the centerline counters are also set to 10 mV.

4.1 Calibration

The threshold calibration is given by Threshold (mV) = -DAC/4095 - 8 mV [Threshold: (negative) 8-1008 mV]. The width can be parametrized by

$$width(ns) \quad = \quad \frac{33406}{DAC + 209}$$

The DAC values range from 0 to 4095 [Width: 8-160 ns].

5 Readout Controllers (ROCs)

The TOF subsystems are integrated into the online via VME CPUs, referred to as Readout Controllers (ROCs). Table 4 shows the ROC names for the TOF subsystems. Communication loss with the electronics, reported either as errors or unsuccessful completion of commands, can frequently be resolved by rebooting the ROC.

Table 4: Readout Controllers for the TOF system. For EPICS IOCs, which control the HV, see Table 2.

Subsystem	Sectors	ROC
Pretrigger	1,2,3	pretrig1
Pretrigger	4,5,6	pretrig2
TDC Discriminators	1–6	camac1
FASTBUS (ADC and TDC)	1–6	sc1
Laser Forward Carriage	1–6	camac1
Laser South Carriage	6,1,2	sc-laser1
Laser Nort Carriage	6,1,2	sc-laser1
Laser Space Frame	3,4,5	sc-laser1

The status of this ROC can be obtained directly at the command line from any of the clon machines by typing > *get_roc_status ROC*, where *ROC* is given in Table 4. We note that some of the ROCs are not part of the run configuration, so they not listed with the standard > *roc_status* command. The status of the ROCs is also indicated on the DAQTLC GUI, [1] where green indicates proper operation and red indicates that the ROC has crashed. DAQTLC will automatically attempt reboot

[1]The DAQ information can be displayed using the *clasdsd* command away from the counting room.

when necessary. To reboot a ROC from the terminal type > *roc_reboot ROC*. An error condition is reported by the status *-1*. All other conditions are acceptable, including booted, active, downloaded or configured.

The ROC controlling the CAMAC crates with TDC discriminators is *camac1*. This ROC is in a mini-crate which is located inside rack C2-8, accessible from the back of the crate. If downloading discriminator settings is unsuccessful, even after remote rebooting of *camac1*, it is sometimes necessary to enter the hall and perform a hard reboot by pressing the *reset* button on the VME CPU module itself.

Pretrig1 and pretrig2 do not currently have a remote reset, therefore if remote rebooting is ineffective, the following can be tried:

telnet pretrig1 (or pretrig2)
<ctrnl>-X <return>

If this also does not work, a hall access must be made to push the reset button on the appropriate crate. Hardware has been ordered to install a remote reset line to these crates. Expected installation is January 2001. We note that until this hardware is installed DAQTLC also does not have the ability to reboot these ROCs.

The history of each ROC is recorded in $CLON_PARMS/daqtlc/log/roc.log. This information could be useful in determining the condition of system.

6 Gain Matching

The calibration of the PMT HV is a crucial part of the maintenance of the TOF subsystem. The procedure involves:

1. Taking the cosmic ray data (3 files in total).

2. Use the analysis software **tofHVcalib** to process and fit the data and calculate new voltage values.

3. Reading the new BURT HV into EPICS.

6.1 Taking Cosmic Ray Data: North, South and Space Frames

First, one needs to take two separate cosmic data-files for the calibration of the Space, North, and South carriages. For these two runs, one will be taken with only A PMTs turned on and the other with only the B's on.

1. Create a BURT backup file of the TOF HV's using the utility in the main TOF EPICS window.

2. Disable all the B's on the space, north, and south frames using **tof_AB_onoff.pl B off** (See Section 2.1).

3. Bring up the DAQ and select the configuration **nodc_all** and configure a run. When prompted for a trigger, go to the **comsic** directory and choose the **LA60deg.cfg** configuration file.

4. Begin the run and take between 500,000 and 750,000 events. This should take approximately 30-45 minutes Ensure that you record the run number and that this data file is for the A's on.

5. Go back to the EPICS GUI, disable the A's and enable the B's and repeat the steps above.

6. Turn the B coupled counters back on and then RESTORE the HV values using the BURT backup file created in step one.

7. On a clon machine, copy the BOS files to a work directory (or any directory with sufficient space) and note which one corresponds to the A counters on and which one corresponds to the B counters on.

6.2 Taking Cosmic Ray Data: Forward Carriage

The nature of incoming cosmic radiation requires a separate configuration for the forward carriage. Since incident cosmic rays are predominantly vertical, a trigger was developed, which utilizes the EC to construct approximate tracks back to the target. To use this configuration to take cosmic ray data for the forward carriage one must:

1. Make sure the EC (and of course the SC) HV is on

2. Set the EC thresholds for the EC by bringing up DIMAN on CLON10 and setting all the entries in the upper right to 20 mV.

3. Make sure you load the correct trigger. This is done via the TIGRIS GUI or at the run configuration step. A GUI should appear from the CODA DAQ GUI prompting you for a .trg file. The Trigger file is:

   TriggersFeb98/old_beam_triggers/Charged_Particle/
   Charged_EC_Sect123456.trg

4. Configure a run using the **EC_CALIB** configuration. The event rate should go up to about 2000 events/sec.

5. For this configuration, you must start a special ET (Event Transfer) Client. To so this log into a CLON10 machine and type:**/home/lcsmith/newl3/level3**. This should attach itself to the event transfer buffer. It will talk to you every 500,000 triggers.

6. Take about 10 million events, ctrl-C out of level3. This will write the file:

   /work/clas/calib/ec_cal/hist/cosmictest.rzh

7. Move this file to the same place as the previous two and note that this is for the forward carriage. Also note that a .rzh file is equivalent to an .hbook file.

6.3 Calculating New High Voltages

Once cosmic data has been obtained, the new TOF high voltages are calculated using the CVS-controlled GUI suite **tofHVcalib** located in packages/utilities/sc_calib/hvGUI. Checkout the software and make sure your working directory has at least 250MB of available hard disk space when calculating just large angles and 500MB when calculating HV's for both large-angle and forward-angle counters together. This is to accomodate the root DST files made during the process stage.

1. Open BOS file with A's on and with B's on and click **Process Data** button (see Fig 2). This will create a root DST file from the BOS files.

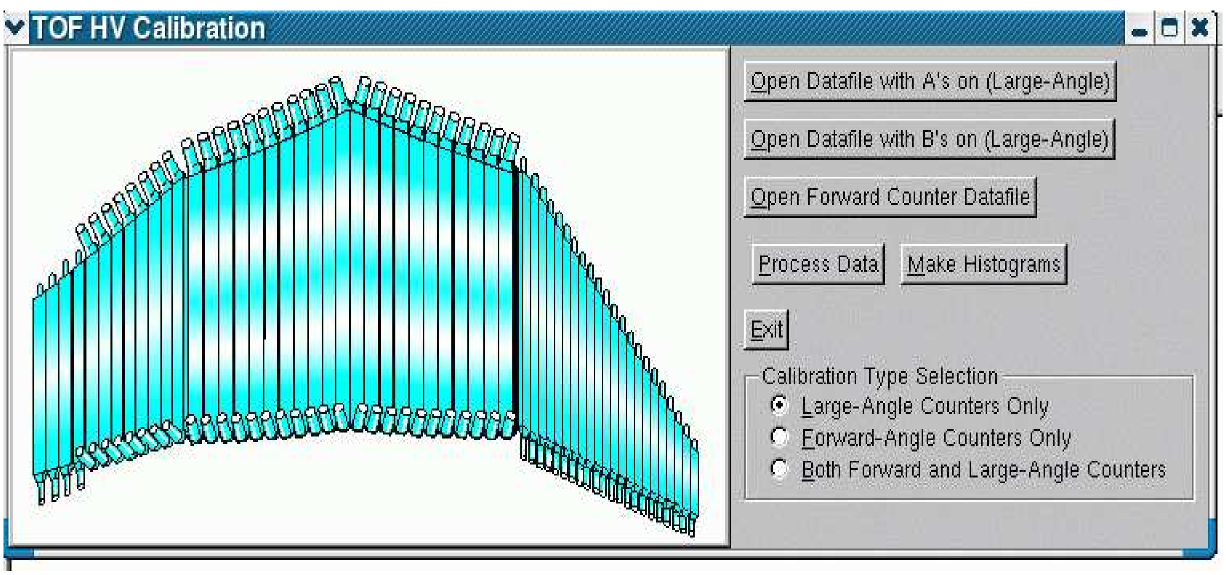

Figure 2: Main window of tofHVgui

2. Now click **Make Histograms**. This will create a new window, fit all the histograms, and give the option to inspect the fits from all six sectors as well as a tab to calculate new high voltages.

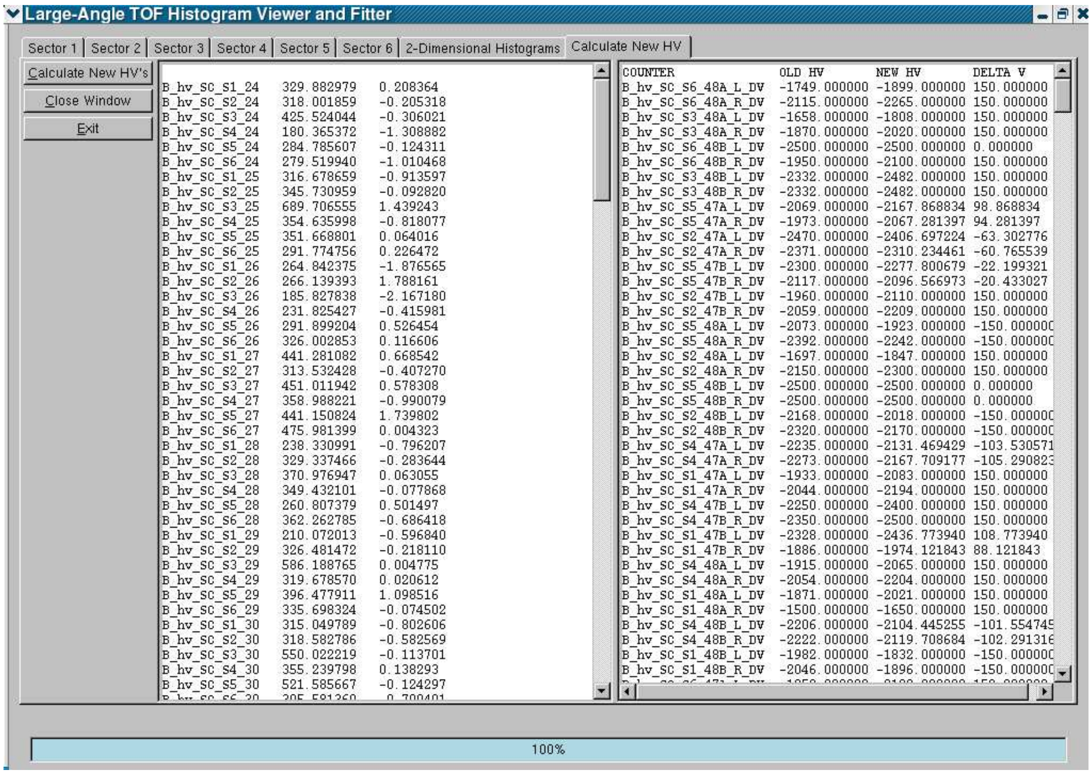

Figure 3: Histogram fitting, diagnostic and HV calculation window of tofHVgui

3. To calculate new voltages, click on the **Calculate New HV** tab in the histogram window and click **Calculate New HV** (see Fig. 3). When prompted for the input BURT file, make sure this file was the one used to take the cosmic data.

7 Monitoring Software

7.1 Viewing Individual Scintillators

During run time it is important to monitor the performance of the individual scintillators. This can be accomplished using the monitoring monb GUI. Log on as clasrun on any clon machine (e.g. clon05) and type *monb*. A window called mon_buttons.tcl will be displayed, select View Histograms and then on the mon_view.tcl window select: Disk File, View On Screen, Online Monitor and monPlot Histo Menu. Click go and select the run to monitor from the list shown on the window mon_disk.tcl (Click on the Select File button).

The main window (paw_monitor.csh) will show the options of monitoring histograms: 4 for the TOF monitoring histograms, after this a new set of options is available. To view individual histograms use monPlot and the instructions that come up on the screen.

7.2 Plotting all SC Histograms

A diagnostic postscript file can be created from the SC monplot histograms. The kumac to do this is located at *$CLON_KUMAC/sc/plot_sc_all.kumac*. To use this file one must first read in the histogram file of interest (with a name such as /hist/monitor/clasprod_mon_029292.hbook) using the PAW *hi/file 1 /hist/monitor/clasprod_mon_0* command. The command *exe $CLON_KUMAC/sc/plot_sc_all* will then create a postscript file called plot_sc_all.ps with 24 plots to a page, which can be printed in its entirety (quite long) or by selecting pages of interest using ghostview.

8 Program Requests

The following special runs must be taken during to obtain calibration constants for the TOF system. The frequency required is approximately weekly:

1. Pedestal Run - configuration is PEDS_ALL
2. TDC Calibration Run - configuration is TDC_CALIB
3. Laser Calibration Run - configuration is TOF_LASER

8.1 Laser Calibration

We add a few notes here that might help with debugging any problems that arise during the calibration procedure. The source file for the laser calibration is stored in $CLON_SOURCE/laser/sc/src/c_cntl/config/configuration.txt. However, during the calibration procedure itself, the file in $CLON_PARMS/TOF_config/configuration.txt is used to specify the sequence of steps during the calibration. This file may be edited for debugging purposes to specify a different sequence of steps.

When the laser calibration data is taken, one should verify that the laser diode TDC and ADC data for each laser is recorded in the data stream. The laser data is contained in the CALL bank as follows: forward carriage diode is id=2, north clam shell diode is id=3, south clam shell diode is id=4 and the space frame diode is id=5.

9 Calibration Procedures

The TOF calibration procedures are documented in "Calibration of the CLAS TOF System" [2].

References

[1] E.S. Smith *et.al.*, "The Time-of-flight system for CLAS", Nucl. Inst. and Meth. A432, 265 (1999).

[2] CLAS TOF Group, "Calibration of the CLAS TOF System", CLAS-NOTE 90-011, November 1999.

A HV map

The LeCroy 1458 HV mainframes are located on the

- Forward Carriage north, Deck 3: C3-1 top (Panel 1: Sectors 3, 4 and 5)
- Forward Carriage south, Deck 3: C3-8 top (Panel 1: Sectors 6, 1 and 2)
- North CLAM Shell, Deck 2: C2-1 bottom (Panels 2 and 3: Sectors 5, 4 and 3)
- South CLAM Shell, Deck 2: S2-5 mid (Panels 2 and 3: Sectors 6, 1 and 2)
- Tagger Racks, TA-5 top (Panel 4: Sectors 1, 2, 3, 4, 5 and 6)

The polarity of all high voltage required by the TOF system is *negative*. The negative voltage is generated by 1461N cards (12 channels per card). There are a total of 16 slots per mainframe, allowing up to 192 individually controllable voltages per mainframe.

B RS232 Control of High Voltage Mainframes

In general, the HV to each pmt will be controlled via Arcnet using the EPICS software and GUIs, which is described in the slow-control documentation.

However, if either of the LeCroy 1458 mainframes are not accessible via Arcnet, we must use the terminal server. This section explains how to control the high voltage with a RS232 connection. The RS232 connection can be made either with a "dumb" terminal directly plugged into the mainframe or through the terminal server with an NCD X-terminal. In this case, the mainframe must be connected to a server down on the forward carriage (e.g. lat1).

B.1 X-terminal

Pull down a new terminal from any NCD console (this only works on an actual X-terminal) and log into 'latsrv'. You will be asked for a username (clon) and a password (hallbc). To connect to mainframe 10 (TOF sectors 6, 1 and 2), type 'set host/lat lat1p5'. (Main- frame 9 (TOF sectors 3, 4 and 5) is not presently connected to the terminal server). The password is again 'hallbc'. Don't forget to choose exit from the NCD window when done.

B.2 VT100 Terminal

Once the cable has been connected to Port A in the back of the terminal, turn on the terminal and wait for a flashing prompt. Verify the following terminal setup by pressing F3 (SETUP):

- Use the arrow keys to highlight the Comm choice
- Press the ENTER key on the numeric keypad. The desired comm settings for Port A are: 9600 baud, 8 bit, no parity, XON/XOFF enabled.
- Exit from SETUP and press return.
- You should see a prompt asking you to enter the digits 1450.
- After typing 1450, you should see this prompt: 1/edit/1450>. Type *vt100*. You should see a spreadsheet appear on the screen. The right half of the screen will be occupied by a help window. The slot addresses, measured currents, measured voltages and demand voltages appear in columns on the left side of the screen.
- The arrow keys work as expected. PF1 and PF2 are the page-up/page-down keys.
- To change the demand voltage: Press the arrow keys until the desired slot address row/ demand voltage column is highlighted. Type in the new voltage setting and press return. As you type the numbers are echoed at the top of the screen. You do not need to type a minus sign; the polarity is fixed by the type of HV modules we are using.
- To enable (disable) a channel: Press the [(]) key.
- To turn on (off) the high voltage: Press the {(}) key.
- To select several adjacent slot addresses: Press the ">" key and use the arrow keys or *PF1/PF2* to select the channels. Press the appropriate command key (see above and the Help Screen).

C Electronic Pool After Hours

The Electronics Equipment Pool is located in the EEL building #90, room 108, at the rear of the JLab Stockroom. Normal operating hours are 8:30 a.m. to 5:00 p.m. Monday - Friday.

The following procedures should be used to access Jefferson Lab Electronics Equipment Pool on nights and weekends:

1. Contact Jefferson Lab Security Officer, ext.: 5822
2. Verify the recipient is a valid Jefferson Lab Staff member.
3. Enter the Stockroom through the CANS access door, Bldg. 90/108.
4. Security Officer open Equipment Pool entrance gate.
5. To access module cabinets: remove the appropriate key from the key box located directly behind cabinet #2, attached inside the gate. Fastbus power supply cabinet is located to the rear and is key #7.
   (a) The type of equipment in the cabinets is identified on the front of the cabinets.
   (b) No equipment should be taken from the Pool Test Stand area.
   (c) Do not remove equipment from the equipment shelves which has the red reject sticker attached.
6. Remove the desired equipment.
7. Fully complete the After - Hour Loan Form and place in the INBOX on the desk. Please include name, location and expected return dates.
8. Please lock all cabinets and return the key to Key Box.
9. Lock the Equipment Pool entrance gate.
10. Exit through CANS system entrance.

D Pretrigger Map

The pretrigger boards for sectors 1, 2 and 3 are located in ROC pretrig1, and the boards for sectors 4, 5 and 6 are located in ROC pretrig2. The active boards in each crate are 1,2,... 9. Each sector requires three boards, corresponding to scintillators 1-16, 17-32 and 33-48, respectively. The first pretrigger board provides the first cable input to Level 1 processor, the second and third boards provide the second cable input. The correspondence between scintillator numbers and trigger inputs is shown in Fig. 4.

Table 5: Inputs to Level 1 Trigger.

Router Board (Sector)	Cable	Pretrig Crate	Board	SC Cabling
1	1	1	1	16 inputs: Doubles, counters 1-16
1	2	1	2,3	8+8 inputs: Triples, counters 17-32+33-48
2	1	1	4	16 inputs: Doubles, counters 1-16
2	2	1	5,6	8+8 inputs: Triples, counters 17-32+33-48
3	1	1	7	16 inputs: Doubles, counters 1-16
3	2	1	8,9	8+8 inputs: Triples, counters 17-32+33-48
4	1	2	1	16 inputs: Doubles, counters 1-16
4	2	2	2,3	8+8 inputs: Triples, counters 17-32+33-48
5	1	2	4	16 inputs: Doubles, counters 1-16
5	2	2	5,6	8+8 inputs: Triples, counters 17-32+33-48
6	1	2	7	16 inputs: Doubles, counters 1-16
6	2	2	8,9	8+8 inputs: Triples, counters 17-32+33-48

E Scaler Map

The scalers for the SC and EC are located in a VME crate in the middle of C2-8. Their address is FF_ _0 0, where the _ _ is the slot number counting from the left facing the front of the crate. The slot number is set on the board using switches. For completeness we list the contents of all slots. The scaler id within the scaler bank is indicated in the square bracket. The correspondence between scintillator numbers and scaler inputs is shown in Fig. 4.

Table 6: Scaler Map.

Slot	Scaler Channel	System	Cabling
1		Controller	162 processor
2	[1-16]	EC Trig Sec 1	[Hi: inner, outer, total], [Lo: inner, outer, total]
3	[17-32]	EC Trig Sec 2	[Hi: inner, outer, total], [Lo: inner, outer, total]
4	[33-48]	EC Trig Sec 3	[Hi: inner, outer, total], [Lo: inner, outer, total]
5	[49-64]	EC Trig Sec 4	[Hi: inner, outer, total], [Lo: inner, outer, total]
6	[65-80]	EC Trig Sec 5	[Hi: inner, outer, total], [Lo: inner, outer, total]
7	[81-96]	EC Trig Sec 6	[Hi: inner, outer, total], [Lo: inner, outer, total]
8		Empty	
9		Interface Board	
10	[1-16]	SC Pretrig Sec 1	Doubles 1-16
11	[17-32]	SC Pretrig Sec 1	Triples 17-32 + 33-48
12	[33-48]	SC Pretrig Sec 2	Doubles 1-16
13	[49-64]	SC Pretrig Sec 2	Triples 17-32 + 33-48
14	[65-80]	SC Pretrig Sec 3	Doubles 1-16
15	[81-96]	SC Pretrig Sec 3	Triples 17-32 + 33-48
16	[97-112]	SC Pretrig Sec 4	Doubles 1-16
17	[113-128]	SC Pretrig Sec 4	Triples 17-32 + 33-48
18	[129-144]	SC Pretrig Sec 5	Doubles 1-16
19	[143-160]	SC Pretrig Sec 5	Triples 17-32 + 33-48
20	[159-176]	SC Pretrig Sec 6	Doubles 1-16
21	[175-192]	SC Pretrig Sec 6	Triples 17-32 + 33-48

F LeCroy 2313 CAMAC Discriminator Map

The CAMAC crates (Controllers #0 and #1) are downloaded from camac1 using DIMAN.

Table 7: CAMAC Discriminator Map.

	Crate 0	Crate 1
Slot 1	S1L1	S4L1
Slot 2	S1L3	S4L3
Slot 3	S2L2	S5L2
Slot 4	S3L1	S6L1
Slot 5	S3L3	S6L3
Slot 6		RF
Slot 7		
Slot 8	S1R1	S4R1
Slot 9	S1R3	S4R3
Slot 10	S2R2	S5R2
Slot 11	S3R1	S6R1
Slot 12	S3R3	S6R3
Slot 13		
Slot 14	S1L2	S4L2
Slot 15	S2L1	S5L1
Slot 16	S2L3	S5L3
Slot 17	S3L2	S6L2
Slot 18		
Slot 19	S1R2	S4R2
Slot 20	S2R1	S5R1
Slot 21	S2R3	S5R3
Slot 22	S3R2	S6R2
Slot 23	Centerline (1-6)	Start (1-6) laser diode (7-10)
Slot 24	Controller	Controller
Slot 25	Controller	Controller

G FASTBUS Readout Map

The ROC for the TOF FASTBUS crate is *sc1*, also known as *ROC13*. During download, the type of module in each slot is determined and recorded in $CLON_PARMS/feconf/rocmap/ROC13.hardmap. The mapping is specified in $CLON_PARMS/TT/ROC13.tab.

Table 8: FASTBUS ADC and TDC Map.

Slot	Module	Cabling
25	LeCroy 1881M ADC	S1L1, S1R1, S1L2, S1R2
24	LeCroy 1881M ADC	S1L3, S1R3, S2L1, S2R1
23	LeCroy 1881M ADC	S2L2, S2R2, S2L3, S2R3
22	LeCroy 1881M ADC	S3L1, S3R1, S3L2, S3R2
21	LeCroy 1881M ADC	S3L3, S3R3, CL(32-37),Hz(38)
20	LeCroy 1881M ADC	S4L1, S4R1, S4L2, S4R2
19	LeCroy 1881M ADC	S4L3, S4R3, S5L1, S5R1
18	LeCroy 1881M ADC	S5L2, S5R2, S5L3, S5R3
17	LeCroy 1881M ADC	S6L1, S6R1, S6L2, S6R2
16	LeCroy 1881M ADC	S6L3, S6R3, Start(32-37)laser(38-41)
15	LeCroy 1872A TDC	S1L1, S1R1, S1L2, S1R2
14	LeCroy 1872A TDC	S1L3, S1R3, S2L1, S2R1
13	LeCroy 1872A TDC	S2L2, S2R2, S2L3, S2R3
12	LeCroy 1872A TDC	S3L1, S3R1, S3L2, S3R2
11	LeCroy 1872A TDC	S3L3, S3R3, CL(32-37),Hz(38), RF(48,55)
10	LeCroy 1872A TDC	S4L1, S4R1, S4L2, S4R2
9	LeCroy 1872A TDC	S4L3, S4R3, S5L1, S5R1
8	LeCroy 1872A TDC	S5L2, S5R2, S5L3, S5R3
7	LeCroy 1872A TDC	S6L1, S6R1, S6L2, S6R2
6	LeCroy 1872A TDC	S6L3, S6R3, Start(32-37),laser (38-41)
5	Empty	
4	Empty	
3	Empty	
2	Struck STR/340 SFI	
1	Struck STR/340 SFI	
0	Struck STR/340 SFI	

Notes: Numbers in parenthesis above indicate FASTBUS channel (0-63)
ST : Start (1-6), CL : CL (1-6), CALL: Hz (1), laser (2-5), RF (6,7)

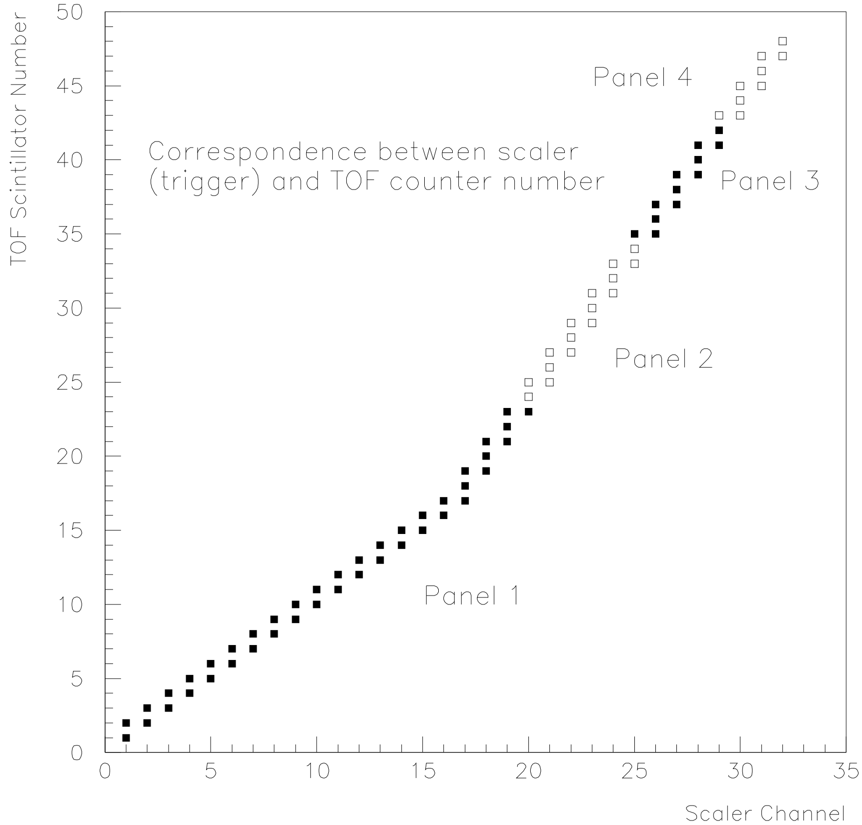

Figure 4: Correspondence between scintillators and trigger and scaler inputs.