TOF HV/LV and Slow Control documentation

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This document

Contents

List of Figures

List of Tables

Chapter 1

Introduction

UCLA signed up for providing not only the low voltage (LV) and high voltage (HV) for the Time-of-Flight (TOF) detector but also the slow control interface[1] for controlling these supplies from the STAR control room.

I joined the nuclear physics group at UCLA as a graduate student in summer of 2006 and worked on this hardware project under the supervision of Vahe Ghazikhanian, the senior researcher of the group. In January 2008 I took over the role of sub-system manager when Vahe left the group. I continued working on this project until I graduate in summer 2010, at which point I was asked to write this summary document. The hope is to pass on some of the knowledge I have gained over the years in order to main the system.

1.1 TOF HV and LV overview

There are 120 trays comprising the stop-side of TOF, the start-side are the two upVPD[2] detectors along the beam pipe on either side of STAR. When talking about TOF I implicitly refer to the trays, a bias on my part since most of the HV and LV goes to these. A tray is composed of 32 multi-gap resistive plate chambers (MRPC) modules and on board readout electronics, see figures 1.1 and 1.2. The HV requirement for a tray is $+7$ and $-7\,\mathrm{kV}$ for the MRPC's and the LV requirement is $20\,\mathrm{A}$ at $4.5\,\mathrm{V}$ for the electronics.

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[1]It is called this as the interface is used by humans, which is slower than automated systems.

[2]**u**pgraded **p**seudo **V**ertex **P**osition **D**etector
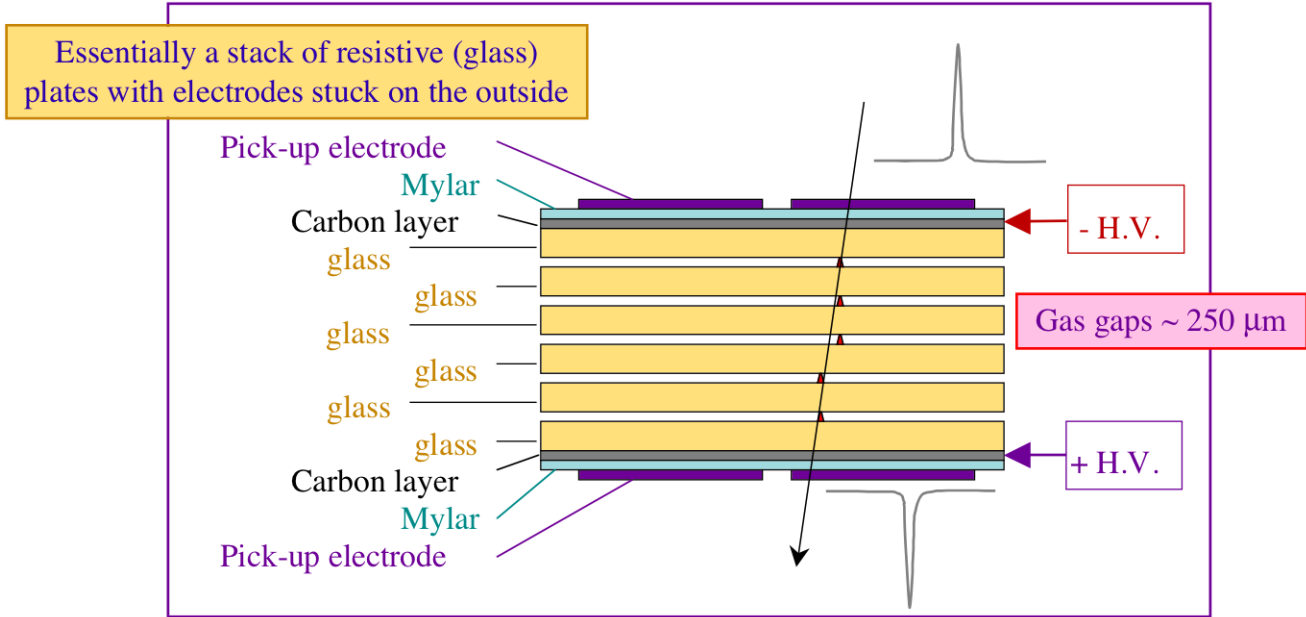
Figure 1.1: Schematic side view of a MRPC module.

Figure 1.2: TOF tray without top cover, notice the 32 MPRC modules.

TOF is divided into an east and west side, each side having 60 trays, see figure 1.3 for a layout diagram. The tray positions[3] start at 1 on the west side at roughly 12 o'clock and then proceed to the east side starting with tray position 61, see figures 1.4 and 1.5. It is common to refer to a tray as being at "East 65" even though 65 implies being located on the east.
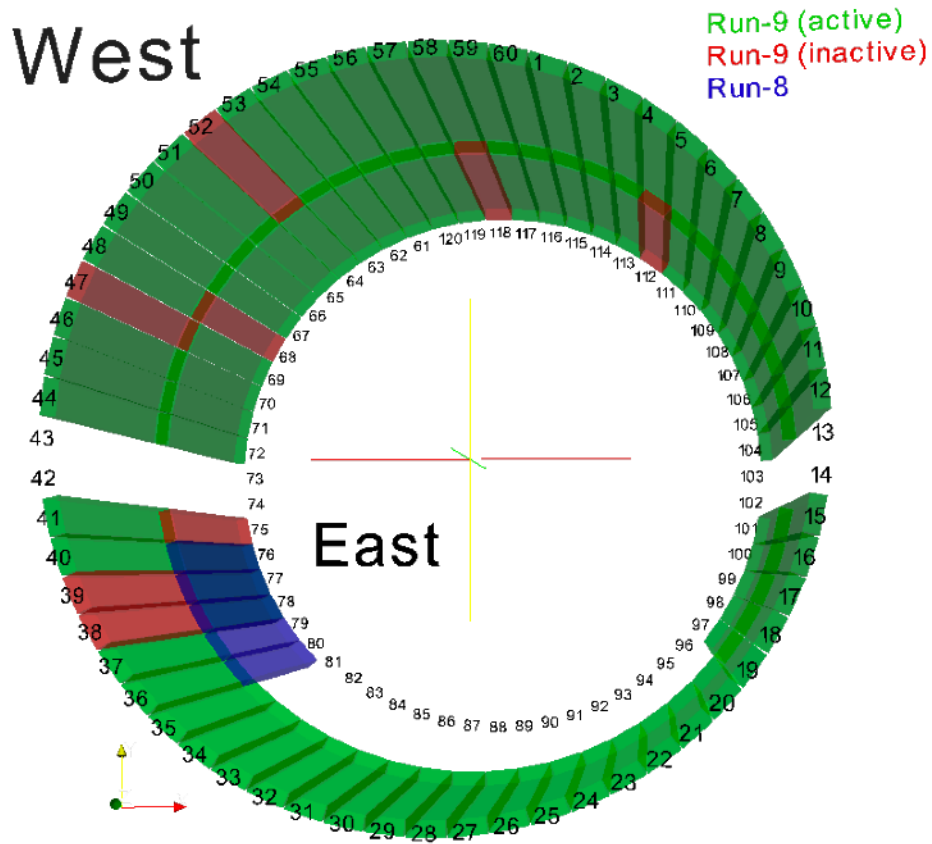
Figure 1.3: TOF tray layout for Run 7 through Run 9. The two purple trays (79 and 80) were there for Run 7.

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[3]Not the same as the tray serial number.
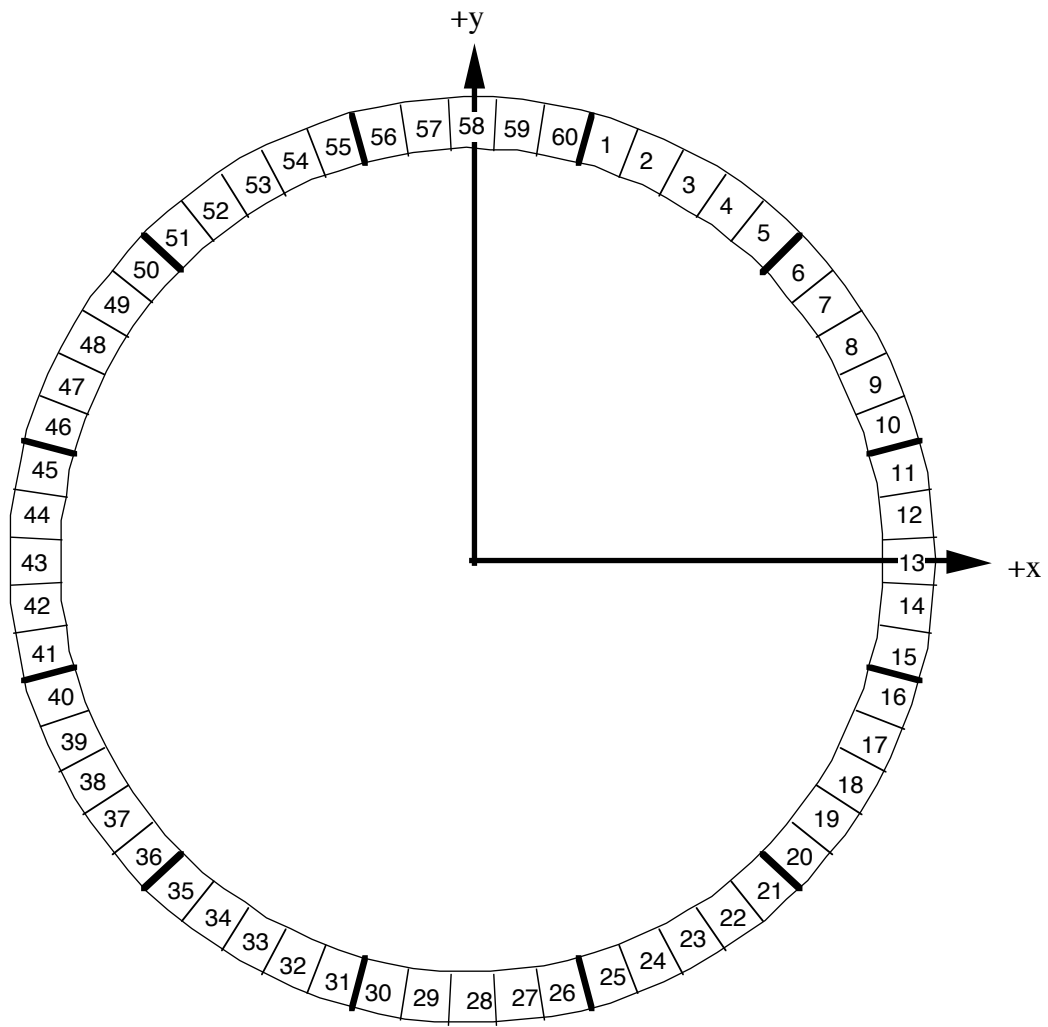
Figure 1.4: TOF tray position numbers for the West side.
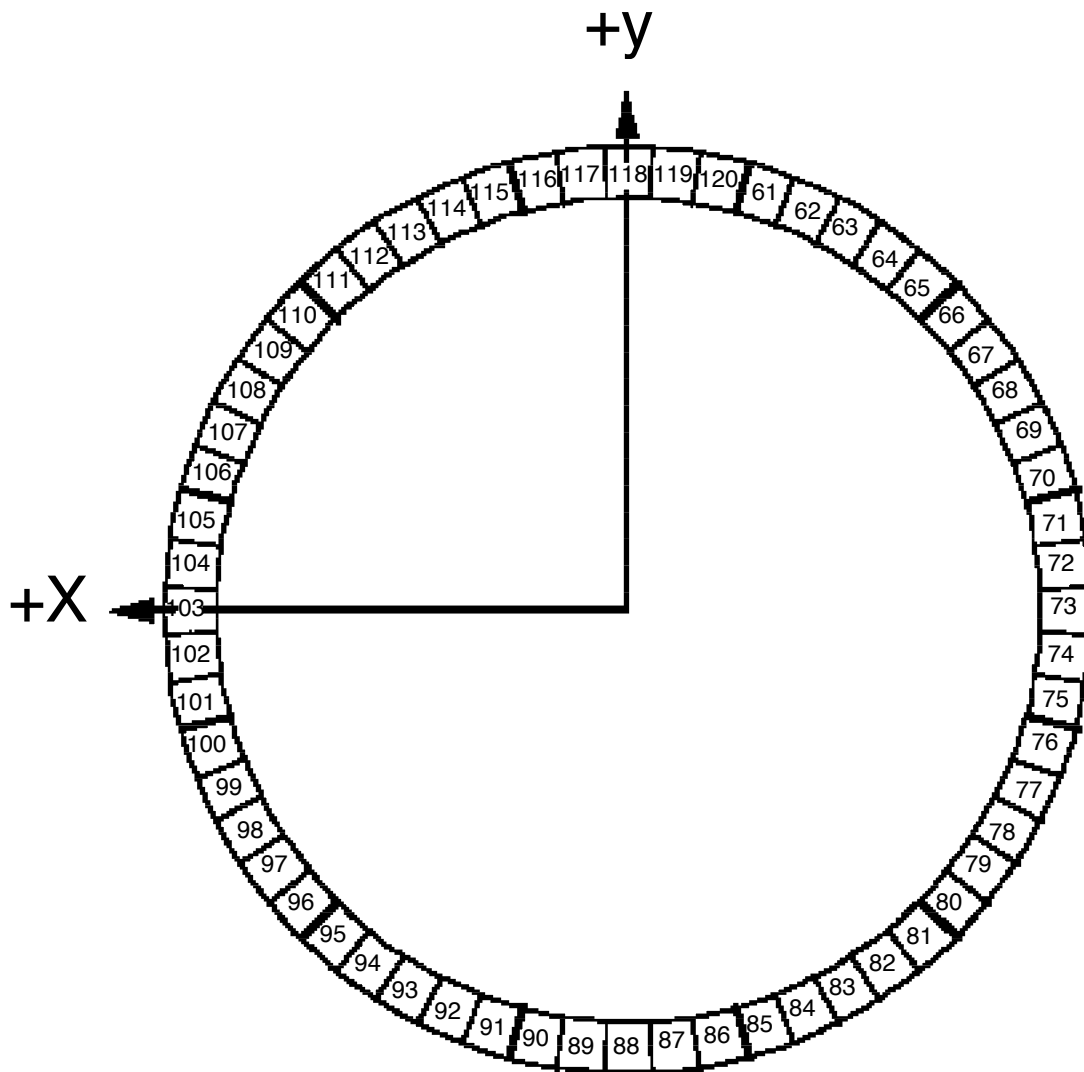
Figure 1.5: TOF tray position numbers for the East side.

There is a dedicated LV channel for each tray so that we can turn on/off individual tray electronics, meaning there are 120 channels. For the HV, the trays are powered in groups of 12 via a HV distribution box. This means there are five sectors for each side of TOF, i.e. West sector 1 through 5 and East sector 1 through 5. In total there are 20 HV channels being used to power the distribution boxes, ten per side with five positive and five negative polarity ones.

The trays electronics are read out by four THUB's: THUBNW, THUBSW, THUBNE and THUBSE. A group of 30 trays is assigned to a particular THUB. The LV requirement for a THUB is naturally different from a tray: 14.5 A at 4.2 V.

The start side of TOF (i.e. upVPD) also has LV power requirements: 3 A at −9 V and 6.8 A at 4.5 V. To my knowledge this is used to power the discriminators and electronics of the PMT's. There is a separate HV power supply for the PMT's which is not part of the system I worked on.

Table 1.1 lists the various devices powered by the supplies covered in this document, along with their HV and LV requirements.

Device	HV	# of Ch	LV	# of Ch
Tray	+7 / −7 kV	10 +ve / 10 -ve	20 A at 4.5 V	120
THUB	None		14.5 A at 4.2 V	4
Start Electronics	None		6.8 A at 4.5 V	2
			3 A at −9.1 V	1

Table 1.1: Summary table of LV and HV provided by the supplies covered in this document.

1.2   High voltage

The HV is provided by equipment from the italian company *CAEN*: www.caen.it. We bought two SY1527LC mainframes (one is a spare) and six A1534 HV boards (two are spares), see the next section for more detail. There are 12 HV distribution boxes (two are spares) which were designed by Vahe Ghazikhanian, built by Zak Sandler and test by me, see section 1.2.2. There are 260 "short" HV cables running from a distribution box channel to a tray input (20 are spares) and then 14 "long" cables (four are spares) which run from a HV channel to a distribution box input. These cables have a complicated story which will be covered in section 1.2.3. In short, most of them are working, but there continue to be problems with them.

1.2.1   HV mainframe and boards

The CAEN mainframe is a SY1527LC which has 16 slots (0 through 15) to house various types of boards. Figure 1.6 shows a general layout of a SY1527 unit, while figure 1.7 shows the front panel for a SY1527LC.
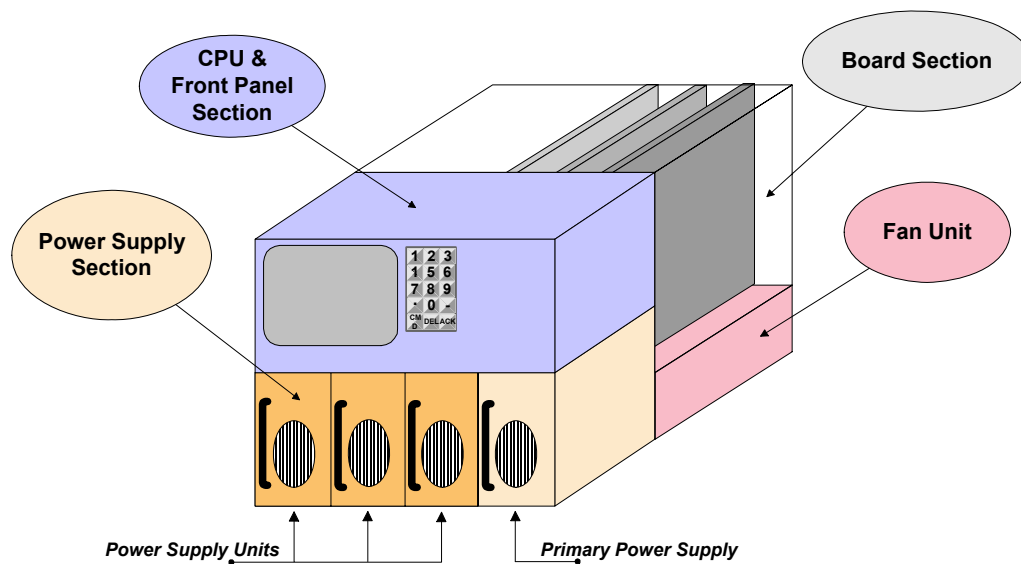
Figure 1.6: Important components of SY1527 mainframe, the LC version has no built-in display or front panel buttons.
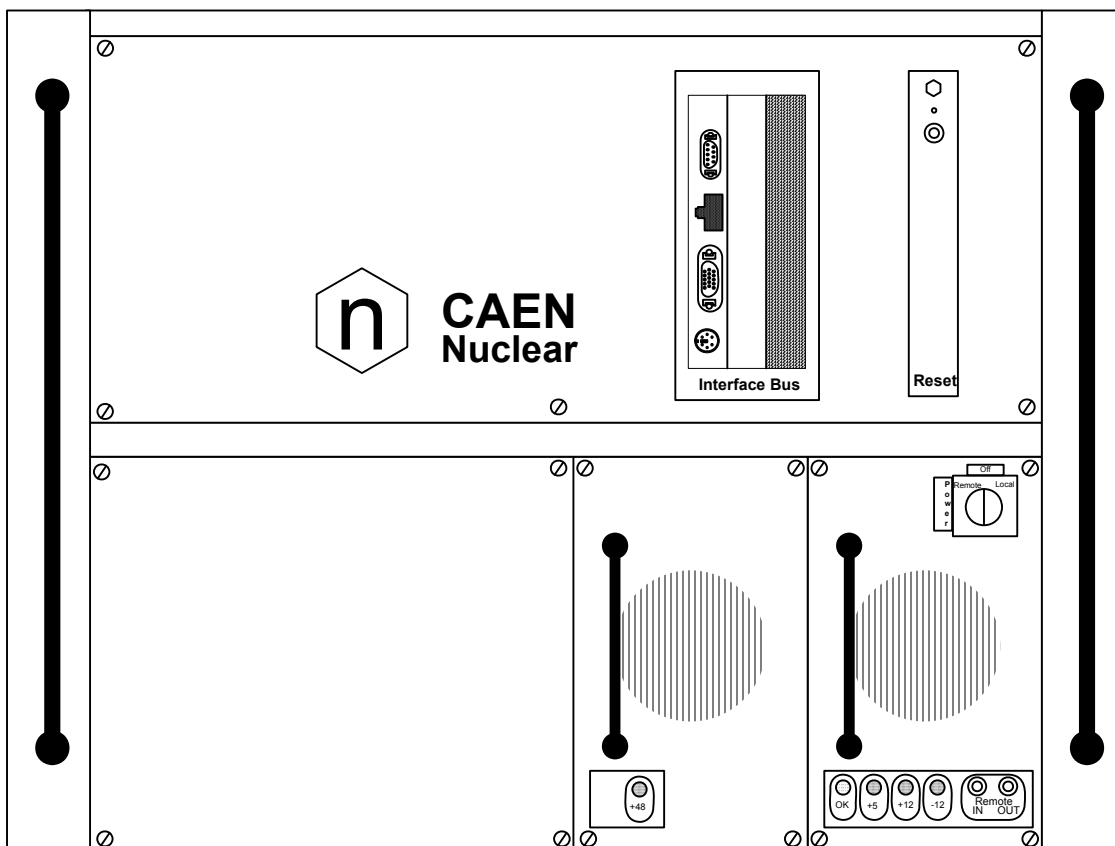
Figure 1.7: Important components of SY1527 mainframe, the LC version has no built-in display or front panel buttons.

For TOF we are using four A1534 HV boards each of which can operate up to 8 kV. We have two negative and two positive boards to power TOF and then a spare of each polarity.
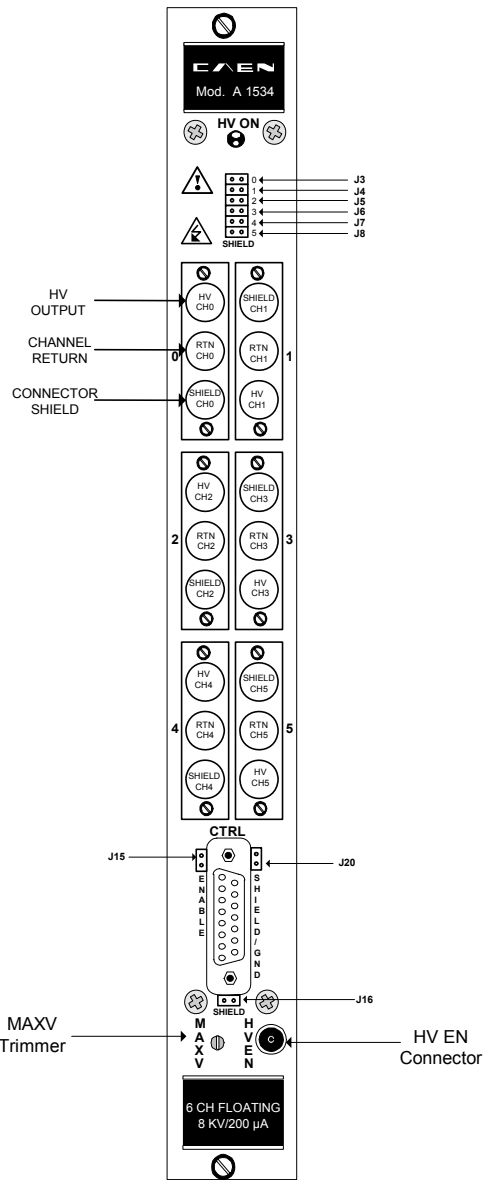
Figure 1.8: Front panel of an A1534 HV board.

1.2.2 HV distribution boxes

1.2.3 HV cables

1.3 LV

1.3.1 LV supplies

1.3.2 LV cables

1.4 NPS switches

1.5 Networking

1.5.1 Accessing tofp

Chapter 2

Control Interface

2.1 Supply provided interfaces

2.2 LabVIEW

2.3 EPICS

2.3.1 HV IOC

2.3.2 LV IOC

2.4 EPICS add-ons

2.4.1 Sequencer

2.4.2 autosave

2.4.3 MEDM

2.4.4 Alarm Handler

2.4.5 Channel Archiver

2.5 Shell scripts

Chapter 3

How to

The following sections will explain in detail the steps needed for some common tasks I have encountered while working with the HV and LV for TOF. Hopefully the vast majority of issues will be covered here. All of these task assume you are already logged into the *tofp* computer and are familiar with the command line (i.e. I don't need to say "press enter to execute the command").

   If all else fails I will be available for consultation, although there is a fee of one dark chocolate cake per incident.

3.1   Powering up TOF from a cold start

This situation usually occurs during the summer shutdown but can also occur during an access day. Whatever the cause, here is the procedure I follow[1]

1. Check that no IOC's are running by typing

   ```
   runningIOCs.sh
   ```

   If there are any then

   (a) Type

      ```
      screen -ls
      ```

      to get a list of the screen names for the running IOC's

---

[1]You can naturally omit steps if you truly know what you are doing, but in that case I didn't need to tell you that :)

(b) Type

```
screen -r name
```

where `name` is gotten from the prior step.

(c) Once in the screen session either type `exit` or press CTRL-D to end the session.

You could have skipped step (a) if you are more familiar with the system, I naturally gave the screen's for the various IOC's meaningful names (e.g. "East2" or "THUB")

2. Ping the various supplies to see if the NPS switch for them are off or if there is a communication issue. Here is a quick reminder of the host names: *tof-hv* and *tof-lvps[0-12]*. Keep in mind that there are spare PL512's which most likely aren't installed so there should be hostnames which return no ping. You will need to be aware of which supplies should reply. An up-to-date list can be found here:

www.star.bnl.gov/public/tof/electronics/index.html,

look at the "Tray Mapping. . ." spreadsheet for the appropriate run.

If there is a problem, in order to determine if it is a communication or lack-of-power issue you will need to telnet into the appropriate NPS unit and see if the corresponding plug is on. Here is a table for what plugs of *tofpnps* power what

Plug	Device
1	CAEN_HV
2	TOFcontrolPC
3	LV_B4_1234
4	LV_B4_5
5	Start-Box_Fans
6	Barrel-THUB_Fans
7	LV_C1_1234
8	LV_C1_5

Table 3.1: Devices controlled by *tofpnps* NPS

As a quick reminder, the PL512's powering the West and East of TOF have their own dedicated NPS units, however these units were plugged into *tofpnps* as a global interlock system. This means the LV for West and East sectors 1 through 4 are controlled by plug 3 and 7 respectively. West and East sector 5 is controlled by plug 4 and 8 respectively. You will need to know which PL512 is powering a particular sector in order to know the appropriate plug to turn on (use the afore mentioned spreadsheet for that).

Here is the plug/device table for the *tofrnps* unit

Plug	Device
1	MTD
2	THUB
3	TOCK
4	Not used
5	MTD2
6	Broken
7	Not used
8	Not used

Table 3.2: Devices controlled by *tofrnps* NPS

If after telnet'ing into the NPS unit it is determined the necessary plug is on, then there is a communication issue. If possible, check to make sure it is not just a loose connection at either the supply or network switch. If that is not the case and/or you cannot trace the cables then Wayne Betts need to be contacted.

Alternatively, if the necessary plug is off you will naturally need to first turn it on. At the NPS prompt type

```
/on #,y
```

where # is the particular plug number and the `,y` is used to skip the confirmation question. Wait one minute before trying to ping the supply again, since there is a boot-up time for both the HV and LV supplies.

Retry pinging the supplies to make sure one is able to communicate with them. If still not, then there is a network problem.

3. There is a small possibility the last time the system was used the IOC's were exited before the channels were all turned off. If the IOC's are brought up now, those channels would be restored to their original on state—something which probably isn't desired.

In order to avoid this check the following files[2] to make sure all the saved values are 0, if not edit the file to make it so.

~/TOF/HV/HVCAENx527_3.7.2/iocBoot/save_restore_module/ashv.sav
~/TOF/LV/LVWienerPL5xx_2.0.6/iocBoot/save_restore_module/asTHUB.sav

4. Now that we made sure we can communicate with both the HV and LV supplies and also verified the channels won't be turned on due to a prior run state, it is time to launch the various IOC's.

   (a) At the *tofp* prompt type

   ```
   TOFHV_IOC
   ```

   to launch the HV IOC. I immediately follow this with a `runningIOCs.sh` check to make sure the IOC is running and then using the alias `screenHVIOC` in order to access the screen session and make sure everything launched fine. Stay in the screen session for a minute or two to make sure there is not a "lost/regained communication" issues. If there is, then see section 3.3 on what needs to be done.

   (b) In order to launch all of the LV IOC's just type

   ```
   TOFLV_IOC
   ```

   followed by a `runningIOCs.sh` to make sure all 11 LV IOC's are up. I then either use the `screen -r` to connect to the various IOC's or just use the `getoutputStatus.sh` shell script to check on the output status of the various supplies.

5. The next steps needs to be done physically at the *tofp* machine.

   (a) At a prompt type

   ```
   TOF_Alarm
   ```

   This will launch the alarm handler runtime window

---

[2]These file paths assume the original folder structure is still valid, if not please adjust appropriately

(b) Click on the window in order to open the main window
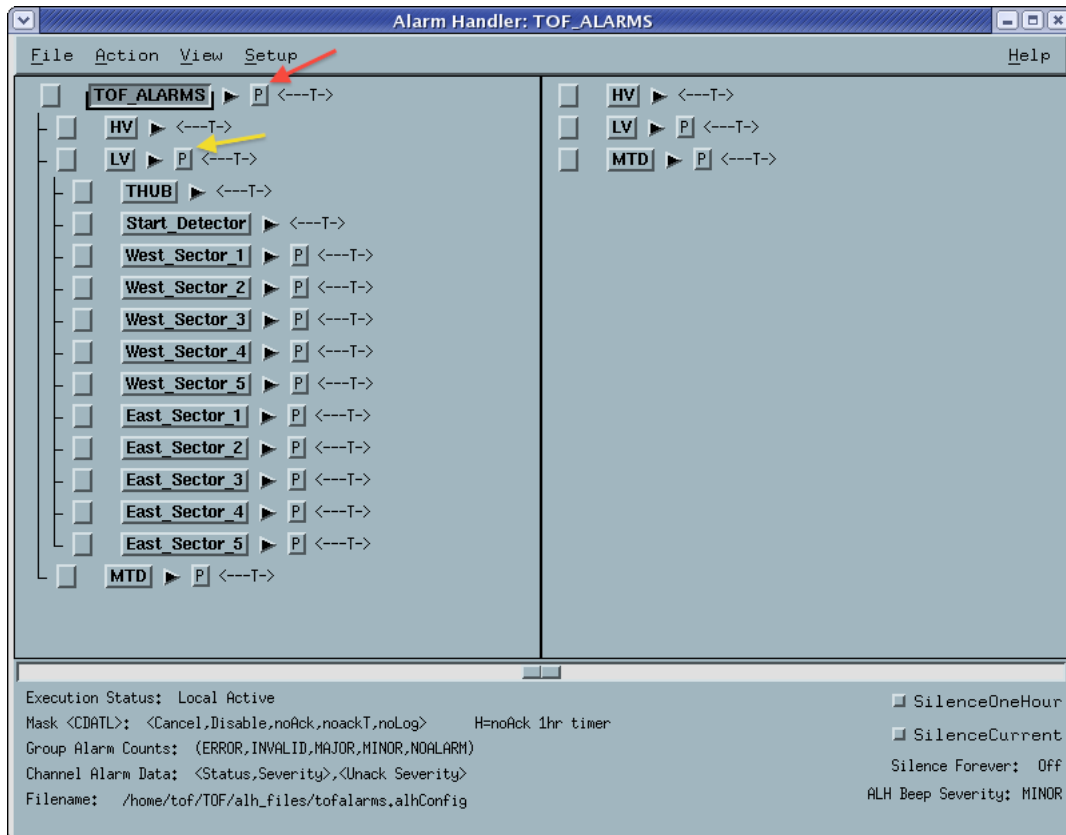
(c) Then click on the *P* marked by the red and yellow arrows in order to open the "TOF Main GUI" and "TOF light weight LV GUI" respectively, see figures 3.1 and 3.2.

6. The last step is to start the custom HV logger.

(a) At the tofp prompt type `hvlogger_running.sh` to see if the logger is already running.

Figure 3.1: TOF Main GUI interface with both the HV and LV off.

(b) If not, look in the file ∼/.HV_logger.rc and delete the line stop if present.

(c) Launch the HV logger by typing hvlogger_start.sh and verify the logger is running by using the prior command. There should also be a log file with the present date in ∼/logs.
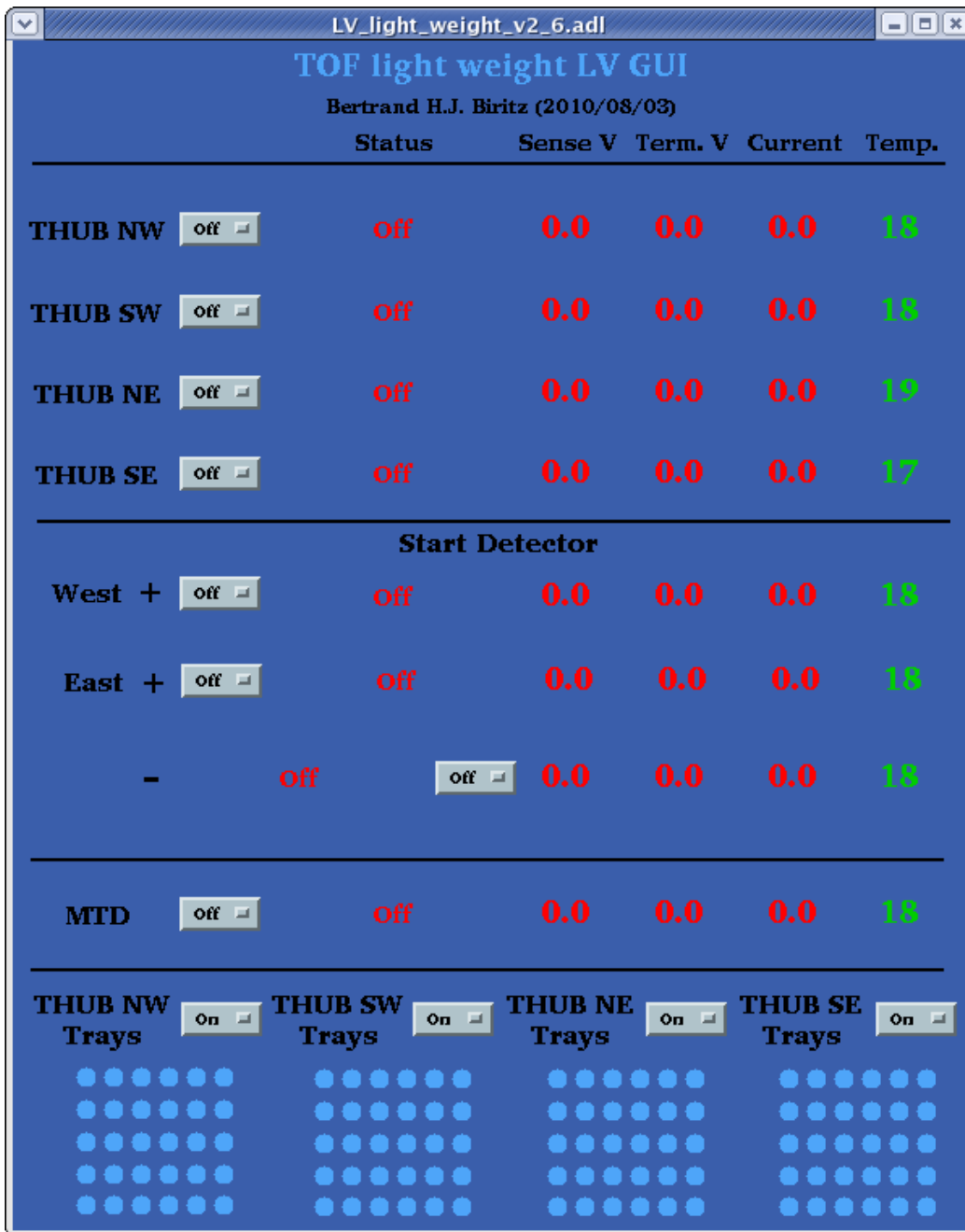
Figure 3.2: TOF light weight LV GUI interface with all LV off.

3.2 Recovering from a power dip

Bla

3.3 HV IOC lost and regained communication with main frame

3.4 Swapping a "tray" LV supply

3.5 Swapping a "tray" LV channel

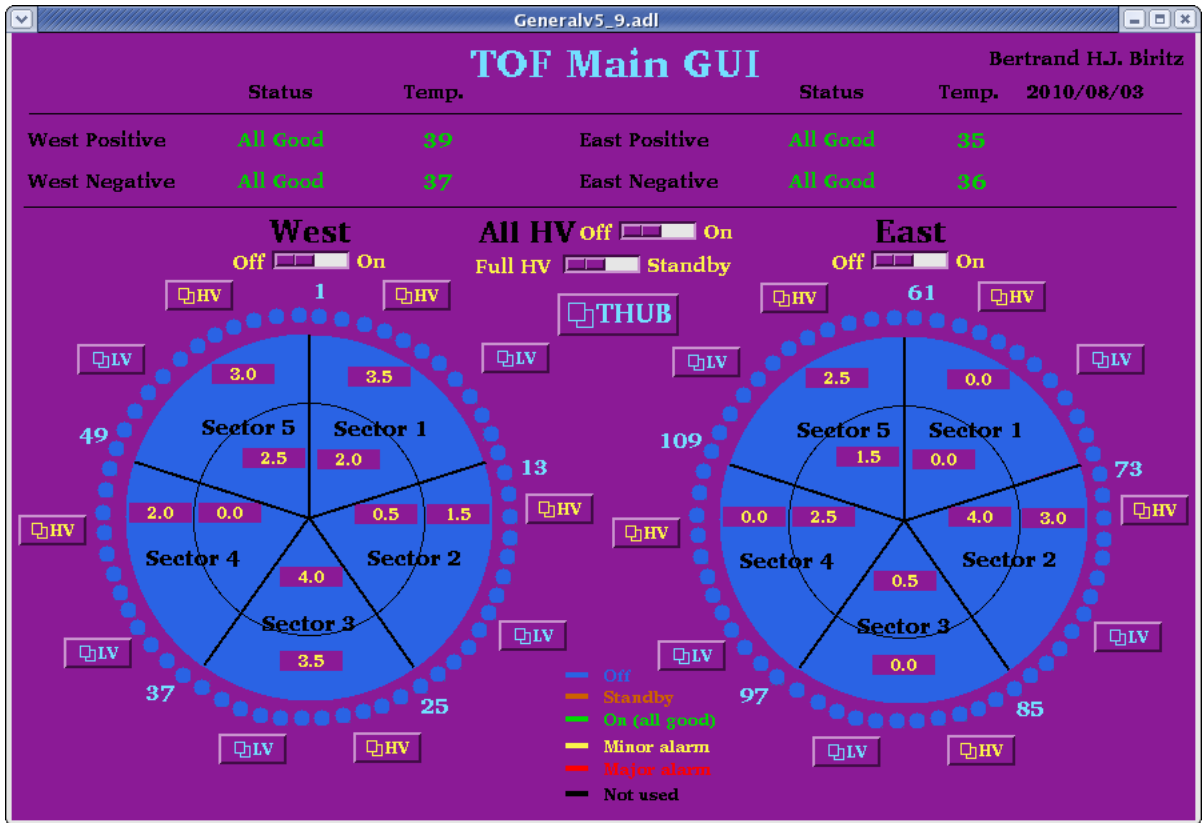Now that TOF is fully installed I don't really see the need for this to arise. There are no spare channels on a "tray" PL512 and replacing the entire unit with a spare seems excessive. If one tray out of 120 is no longer operable due to bad LV it can be masked out at the relevant THUB and then dealt with during the summer shutdown.

However, just for completeness here are the steps for swapping a LV channel.

1. Bring down the entire LV system, including the THUB's. Keep in mind the supplies need to be adjacent to one another since the LV cables have custom lengths.

2. Turn off the LV IOC's of the two supplies the cable swap will be done with. Use the tray map spreadsheet located here:

   www.star.bnl.gov/public/tof/electronics/index.html,

   The relevant *screen* names are *West1-5* and *East1-5*. At the *tofp* prompt type `screen -r` and the appropriate name (e.g. `screen -r West1`). Once at the IOC prompt either type `exit` or just press CTRL+D to quit the IOC and terminate the screen session.

   There will be alarms coming from the alarm handler and also the GUI interface will have white indicators. Either close both interfaces or just ignore those particular warnings.

3. Next we want to turn off the NPS switches for the two supplies. This requires logging into the interlocked NPS units[3]. At the *tofp* prompt ssh into *daqman* using the *operator* account. Once there telnet either into *tofnps1* (rack 1B4) or *tofnps2* (rack 1C1) depending upon which PL512's you are wanting to turn off, see the following tables[4]

Plug	Device
1	tof-lvps3
2	tof-lvps8
3	tof-lvps9
4	tof-lvps0
5	tof-lvps2
6	Not used
7	Not used
8	Not used

Table 3.3: Devices controlled by *tofnps1* NPS in 1B4

Plug	Device
1	tof-lvps7
2	tof-lvps4
3	tof-lvps6
4	tof-lvps5
5	tof-lvps11
6	Not used
7	Not used
8	Not used

Table 3.4: Devices controlled by *tofnps2* NPS in 1C1

At the telnet prompt for the appropriate NPS type

```
/off plug_#,y
```

---

[3]One could use the *tofrnps* or *tofpnps* to turn off the entire system, but why go so far and it is also good practice

[4]The names of the supplies listed were valid at the end of August 2010, it might not be anymore so check with someone who knows

in order to turn off the supply.

4. Now that the power is off have STSG swap the relevant cables.

5. Using the same procedure as before, restore power to the two supplies where you turned off the NPS switch.

6. One needs to update the GUI interface with the new channel mapping. Specifically the PV name associated with the on-screen LV tray dot needs updating. The relevant files are

   ∼/TOF/HV/HV_MEDM/Generalv5_9.adl
   ∼/TOF/LV/LV_MEDM/LV_light_weight_v2_6.adl

   Say one has swapped the LV cables of tray 1 with tray 16, the relevant PV's would be *TOF:LV:West:1:U0* and *TOF:LV:West:2:U3*—which you can ascertain from the tray map spreadsheet. In the above two files one needs to swap the occurrences of these PV's. There are five place per PV which need updating. The first four can be easily edited by using a search/replace command, they have an additional field at the end: *ChannelStatus*, *Current.STAT*, *ChannelStatus* and *DisableChannel* (yes, there are two *ChannelStatus*). The fifth is inside of the "related display" button which launches the file *LVChannelStatus_v2_1.adl*. One needs to manually update the values of *Sector* and *Channel*.

7. Relaunch the LV IOC's by typing `startWest#IOC` or `startEast#IOC` at the tofp prompt and also bring back the GUI interfaces if they were closed. Verify that there are no white indicators on the displays, else there is a typo in the prior step.

8. Initialize the THUB's and then bring up the relevant THUB group. Power cycle the tray to make sure the mapping has been updated correctly.

3.6   Swapping the "THUB" LV supply

3.7   Swapping a "THUB" LV channel

3.8   "Swapping" a HV channel

Each A1534 HV board has six channels of which only five are being used to power TOF. This means there is one spare channel per board—ideally it should be channel 0. Here are the steps necessary in using a different channel to power a sector.

1. Bring down the HV for all sectors and wait a couple of minutes until the voltage reading on the channels is less than 100 V.

2. At the *tofp* prompt type `screenHVIOC` in order to access the screen session of the HV IOC. Once there either type `exit` or press *CTRL+D* to shut down the IOC and terminate the *screen* session.

   This will cause the HV information in the main GUI interface to be replaced by white boxes and also the alarm handler to give connection warnings. Either close both interfaces or just disregard it.

3. At the HV main frame turn the front panel turn-key to the *OFF* position.

4. To disconnect the supply from the main power do one of the following:

   (a) Standing at rear of the main frame, flip the switch at the bottom left.

   (b) At the *tofp* prompt telnet into *tofpnps* and then turn off plug 1 (`/off 1,y`).

5. Have STSG disconnect the long HV cable (Ciro calls it a "feeder cable") from the defective channel to the good one.

6. The HV IOC configuration file needs to be updated.

   With your favorite text editor open the file *save_restore_hv.cmd* located in

   ∼/TOF/HV/HVCAENx527_3.7.2/iocBoot/save_restore_module/

   and update the appropriate *Slot* and *Ch* to correspond to the new layout.

7. Restore power to the main frame, remembering to have the front panel turn-key in the *Local* position.

8. Relaunch the HV IOC by typing `TOFHV_IOC` at the *tofp* prompt. I immediately follow this with a `runningIOCs.sh` check to make sure the IOC is running and then using the alias `screenHVIOC` in order to access the screen session and make sure everything launched fine. Stay in the screen session for a minute or two to make sure there is not a "lost/regained communication" issues. If there is, then see section 3.3 on what needs to be done. Also, if there were any typographical errors made when modifying the configuration file one would notice it here.

9. Relaunch the GUI and alarm handler interface if they were closed and then exercise the system to make sure everything is functioning properly.

3.9   Tracking down bad channels

3.10   Swapping a HV board

As explained in section 1.2.1, TOF uses four A1534 HV boards for normal operations and has two spares. Before I left, both of these spares were to be used for powering the MTD for Run 11. Once the MTD progresses past the design test stage my guess is they will acquire their own power supply and TOF will have two spare boards once more. Here are the steps required to replace a defective board with another one.

1. Bring down the HV for all sectors and wait a couple of minutes until the voltage reading on the channels is less than 100 V.

2. At the *tofp* prompt type `screenHVIOC` in order to access the screen session of the HV IOC. Once there either type `exit` or press *CTRL+D* to shut down the IOC and terminate the *screen* session.

   This will cause the HV information in the main GUI interface to be replaced by white boxes and also the alarm handler to give connection warnings. Either close both interfaces or just disregard it.

3. At the HV main frame turn the front panel turn-key to the *OFF* position.

4. To disconnect the supply from the main power do one of the following:

(a) Standing at rear of the main frame, flip the switch at the bottom left.

(b) At the *tofp* prompt telnet into *tofpnps* and then turn off plug 1 (`/off 1,y`).

5. Have STSG replace the defective board, remembering the 50 Ω LEMO terminator needed at the bottom of the board.

6. In case the board couldn't be put into the same slot or one of the channels is already defective, then the HV IOC configuration file needs to be updated.

   With your favorite text editor open the file *save_restore_hv.cmd* located in

   ∼/TOF/HV/HVCAENx527_3.7.2/iocBoot/save_restore_module/

   and update the appropriate *Slot* and *Ch* to correspond to the new layout.

7. Restore power to the main frame, remembering to have the front panel turnkey in the *Local* position.

8. Check to make sure the hardware limit for the maximum voltage has been set beyond 8 kV. Type `telnet_caen` at the *tofp* prompt in order to access the telnet interface. Once logged in press the down arrow in order access the menu item *CHANNELS* under *MAIN*. Press return and then use the right arrow key to scroll the display until you see the *HVMax* column. If it isn't beyond 8 kV then have STSG turn the front panel screw.

9. Relaunch the HV IOC by typing `TOFHV_IOC` at the *tofp* prompt. I immediately follow this with a `runningIOCs.sh` check to make sure the IOC is running and then using the alias `screenHVIOC` in order to access the screen session and make sure everything launched fine. Stay in the screen session for a minute or two to make sure there is not a "lost/regained communication" issues. If there is, then see section 3.3 on what needs to be done. Also, if there were any typographical errors made when modifying the configuration file one would notice it here.

10. Relaunch the GUI and alarm handler interface if they were closed and then exercise the system to make sure everything is functioning properly.

3.11 Sending a HV board to CAEN

When we purchased the boards in 2007 and 2009 they came with a one year warranty. STSG tried to repair defective boards during the summer shutdown of 2010 to no avail sadly. There apparently is a general STAR budget for repairing equipment. Ciro and/or Tim will know how to take care of it. To help out STSG I filled out CAEN's "product return form" and just emailed them the copy which needed to be included with the shipment.

1. Have STSG remove the board from the HV main frame. Follow the procedure in prior section for accomplishing this safely.

   We kept the original packaging material, in particular the custom foam padding, so this should be used once more to ensure safe transport.

2. Go to the main page www.caen.it and click on the *Electronic Instrumentation* link.

3. On that page click on the *Support* link and then look for the *Product Return Form* link—at the time of writing this document it was located at the right hand side of the page.

4. A new window will appear with various fields which need to be filled out. The board serial number is located on the front panel at the bottom.

Appendix A

HV equipment

hostname	I.P. address
tof-hv	130.199.60.8
tof-lvps0	130.199.60.87
tof-lvps1	130.199.60.65
tof-lvps2	130.199.60.72
tof-lvps3	130.199.60.99
tof-lvps4	130.199.60.107
tof-lvps5	130.199.60.108
tof-lpvs6	130.199.60.109
tof-lvps7	130.199.60.110
tof-lvps8	130.199.60.111
tof-lvps9	130.199.60.112
tof-lvps10	130.199.60.113
tof-lvps11	130.199.60.129
tof-lvps12	130.199.60.135

Appendix B

LV equipment

hostname	I.P. address
tof-hv	130.199.60.8
tof-lvps0	130.199.60.87
tof-lvps1	130.199.60.65
tof-lvps2	130.199.60.72
tof-lvps3	130.199.60.99
tof-lvps4	130.199.60.107
tof-lvps5	130.199.60.108
tof-lpvs6	130.199.60.109
tof-lvps7	130.199.60.110
tof-lvps8	130.199.60.111
tof-lvps9	130.199.60.112
tof-lvps10	130.199.60.113
tof-lvps11	130.199.60.129
tof-lvps12	130.199.60.135

Appendix C

Who's who

1. Geary Eppley

2. Bill Llope

3. Bill Christie

4. Lijuan Ruan

5. Yury Gorbunov

6. Wayne Betts

7. Jo Schambach

8. Frank Geurts

9. Bob Soja

10. Ciro D'Agostino Head of the STSG electronics group,

11. Tim Camarda