Hall C Cryogenic Target User Manual

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Online Documentation

This document is available on the JLab WWW server under the Hall-C documents link: www.jlab.org/Hall-C/document. It is available as html source as well as downloadable pdf and ps files. As of September 1999, the LaTex source is managed by Howard Fenker (hcf@jlab.org).

For historical reasons it is noted that an archive of the original version of this document plus others for the Hall C Cryogenic Target are available in the Hall C documents directory, /home/cdaq/documents/target, on the Jlab CUE machines.

The Latex Source of the archive version is in

```
ctarg_user_manual.tex
```

and a printable/viewable postscript file is in

```
ctarg_user_manual.ps
```

Recent Changes to the Control System

- New GUI Version 1.9 in directory,

  ```
  /cdaqh1/d1/epics/apple/ctarg/tk/tk_ctarg/gui/1-9
  ```

  on **cdaqh1** and in

  ```
  /home/cvxwrks/gui/1-9
  ```

  on **jeffylab**. On either computer type,

  ```
  cd $GUI
  ```

  to get to the directory.

- New GUI called `tgtgui` to start up the various target GUI's.
- New GUI called `tgtalh` to change and save alarm set points. This GUI can also be used to save the alarm setpoints to the boot files so that they are the defaults when the IOC reboots.

Every Target Operator Should

At The Begining of the Shift

- Know what cryogens are in each loop and what the set point temperatures are for those loops.
- Know what modes the high power heaters are in (OFF, MANUAL, CONSTANT, or PID).
- Know what the current heat loads are for each loop.

Once A Shift

- Print out a Shift Checklist and insert it into the Target Log Binder. The file Checklist.dat is produced in the directory `$GUI` when you activate the button `Options / Checklist` on the ctarg GUI screen. To format this file to fit on a single page and then print it in the counting room you can...
  - `mpage -2 $GUI/Checklist.dat > tmp_check`
  - `rlpr -Hprtsrv -Pchc1hp tmp_check`
  - `rm -f tmp_check`

  Alternatively, you can use the alias `print_check`, which does the same thing.

Once In A While

- Check the target strip charts — make sure that they have not "Flatlined".

If the IOC is Rebooted

- Note In the target log book that it happened.

Chapter 1

Starting The User Interfaces to the Control System

There are two computer systems that the target user interfaces are run from:

jeffylab is a LINUX PC located in the Hall C counting house. The **tgt** GUI used to control the target and the **tgtcharts** GUI used to display the target strip charts are run from this computer.

cdaqh1 is an HP/UX system located in the Hall C counting house. The target data logger is run on this computer and the alarm handlers (both **tgtalh** and the EPICS alarm handler) are run on this computer.

In fact all programs can be run from cdaqh1 but the **tgt** and **tgtcharts** GUI's were moved to `jeffylab` to to relieve the CPU load on `cdaqh1` (they are CPU intensive programs). Usually the user logs an Xterm onto `cdaqh1` and then telnets from there onto `jeffylab`. An **xhost** command is necessary on `cdaqh1` and a **DISPLAY=xterm_name:0.0** command is necessary on `jeffylab` to redirect the `jeffylab` graphics to the xterminal.

1.1 The Standard Configuration

The standard set of GUI's to have opened while operating the target are:

tgt running on **jeffylab**

tgtcharts running on **jeffylab**. With the **Loop Charts** displayed for the active loops (and the cryostat and ESR).

EPICS Alarm Handler running on **cdaqh1**. **Make sure that the *silence forever* option has not been selected.** The **Occupy All Work Spaces** option for the window should be selected (click on button in upper left hand corner of window).

tgtalh running on **cdaqh1**. The **Occupy All Work Spaces** option for the window should be selected (click on button in upper left hand corner of window).

1.2 Starting The `tgtgui` program bar

All the target GUI's can be started from the `tgtgui` program bar on either **jeffylab** or **cdaqh1**. The `tgtgui` GUI (see figure 1.1) has a series of buttons to start the different target GUI's. The different GUI's are:

tgt All target controls are done through this GUI

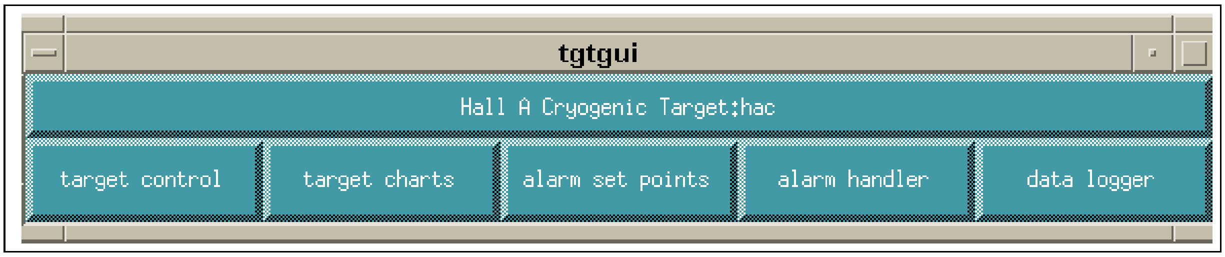

Figure 1.1: Window used to start target GUI's

tgtcharts Used to display the target strip charts

tgtalh The alarm handler used to display and change the target alarms

EPICS alh The EPICS alarm handler used to give audio alarms if the target parameters go out of their normal operating conditions.

tgtlogger Used to monitor target data logging

1.2.1 Starting tgtgui on jeffylab

1. Log onto **cdaqh1** using account **cvxwrks**
2. type the command

   ```
   xhost jeffylab
   ```

3. telnet to **jeffylab** and log on as **cvxwrks**
4. Go to the target directory by typing

   ```
   cd $GUI
   ```

5. Set the display to point to your Xterminal

   ```
   DISPLAY=myterm:0.0
   ```

   Note that this command is different from the **setenv** command used on cdaqh1 because you are in a different shell.
6. Start **tgtgui** by typing

   ```
   tgtgui
   ```

   Do **NOT** submit this as a background task as the tk interpreter prints several messages to the terminal.

The **tgtgui** should now appear in the top left corner of the xterminal.

1.2.2 Starting tgtgui on cdaqh1

1. Log onto **cdaqh1** using account **cvxwrks**
2. Go to the target directory by typing

   ```
   cd $GUI
   ```

3. Start **tgtgui** by typing

   ```
   tgtgui
   ```

   Do **NOT** submit this as a background task as the tk interpreter prints several messages to the terminal.

The **tgtgui** should now appear in the top left corner of the xterminal.

Figure 1.2: Target Control GUI

1.3 Starting the tgt User Interface

The TGT user interface is a Tcl/Tk based GUI used to communicate with the target IOC. It handles most of the target control with the exception of alarm handling . To start the GUI:

1. Start the `tgtgui` program window following the procedure in section 1.2.
2. Click on the **tgt** button in the **tgtgui** window.

Alternatively, to start the `tgt` GUI from the command line,

1. Log onto the appropriate computer, **jeffylab** or **cdaqh1** with the account **cvxwrks**
2. Change to the `tgt` directory,

   ```
   jeffylab> cd $GUI/tgt
   ```

3. Start `tgt`,

   ```
   jeffylab> tgt
   ```

   Do not submit this program as a background process. It prints important messages to the xterm window.

The `tgt` window (figure 1.2) will pop up along with the initialization window (figure 1.3). On the xterm window that `tgtgui` was started from, the following messages will be displayed:

```
--------------------------------------

tgt Hall C Cryogenic Target Control System
```

Figure 1.3: initialization window.

```
-- defining serialports ioc:vmec4 default:1
-- defining relay0 ioc:vmec4 default:1
-- defining relay1 ioc:vmec4 default:1
-- defining adcs ioc:vmec4 default:1
-- defining dacs ioc:vmec4 default:1
-- defining itc501 ioc:vmec4 default:1
-- defining itc502_1 ioc:vmec4 default:1
-- defining itc502_2 ioc:vmec4 default:1
-- defining itc502_3 ioc:vmec4 default:1
-- defining itc502_4 ioc:vmec4 default:1
-- defining sc200s ioc:vmec4 default:1
-- defining omegas ioc:vmec4 default:1
-- defining jtvs ioc:vmec4 default:1
-- defining fridge ioc:vmec15 default:1
-- defining quadrature ioc:vmec4 default:1
-- defining digitalio ioc:vmec4 default:0
-- defining highlevel ioc:vmec4 default:1
```

These messages describe the devices in the control system and which IOC the device records are located on. The `default` is whether the device will be connected to (1) or simulated (0). The initialization window offers several choices for starting the user interface. Usually, the defaults are fine so just click the left mouse button on the OK button. However, the options available are:

EPICS
: Connect the GUI to the EPICS database (default) or just create dummy records to test the control system.

Device Connection
: The Device Connection panel allows the user to select which devices the user interface will connect to in the EPICS database.

Message Logging
: If you want to start the user interface without message logging to a file, deselect **Message Logging**.

When the OK button is pressed in step 2 above, the GUI will try to connect to records for the devices. Each record that is trying to be connected to will be displayed in the `tgtgui` xterm window. The begining of the list looks like:

```
-- making Connections To Epics Data Base
   -- connecting to vmec4:serialports:501_Serial_Port.VAL
   -- connecting to vmec4:serialports:H2_502_Serial_Port.VAL
   -- connecting to vmec4:serialports:He_502_Serial_Port.VAL
   -- connecting to vmec4:serialports:D2_502_Serial_Port.VAL
   -- connecting to vmec4:serialports:N2_502_Serial_Port.VAL
   -- connecting to vmec4:serialports:H2_SC200_PG_Serial_Port.VAL
   -- connecting to vmec4:serialports:He_SC200_PG_Serial_Port.VAL
   -- connecting to vmec4:serialports:D2_SC200_PG_Serial_Port.VAL
   -- connecting to vmec4:serialports:H2D2_SC200_VPG_Serial_Port.VAL
   -- connecting to vmec4:serialports:He_SC200_VPG_Serial_Port.VAL
   -- connecting to vmec4:serialports:H2_Omega_DPG_Serial_Port.VAL
   -- connecting to vmec4:serialports:He_Omega_DPG_Serial_Port.VAL
   -- connecting to vmec4:serialports:D2_Omega_DPG_Serial_Port.VAL
   -- connecting to vmec4:relay0:Relay_0-0_R.VAL
```

```
-- connecting to vmec4:relay0:Relay_0-0_W.VAL
-- connecting to vmec4:relay0:Relay_0-1_R.VAL
-- connecting to vmec4:relay0:Relay_0-1_W.VAL
   ...
```

After connecting to all the database records and reading the parameter files for the various routines, the main GUI window (title tgt) will resize itself and display the status of the target loops and buttons to access the target subsystems. Across the top of the window are various menu items.

FOR PROBLEMS WITH STARTING THE `tgt` GUI SEE SECTION 2.1.

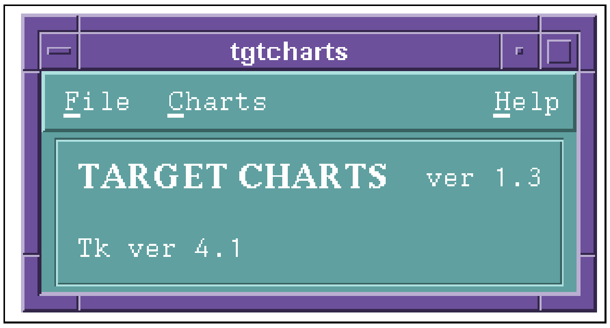

Figure 1.4: Chart Display GUI

1.4 Starting the tgtcharts Target Chart Display

Because the chart display is so cpu intensive, it is useful to start it as a process seperate from **tgt**. The GUI is called `tgtcharts` and is started as follows:

1. Start the `tgtgui` GUI following the instructions in section 1.4.
2. Start the Charts GUI by clicking on the **charts** button of the **tgtgui** window.

Alternatively, to start the `tgtcharts` GUI from the command line,

1. Log onto the appropriate computer, **jeffylab** or **cdaqh1** with the account **cvxwrks**
2. Change to the `tgtcharts` directory,

   ```
   jeffylab> cd $GUI/tgtcharts
   ```

3. Start `tgtcharts`,

   ```
   jeffylab> tgtcharts
   ```

   Do not submit this program as a background process. It prints important messages to the xterm window.

The `tgtcharts` window (see figure 1.4) window will appear along with an initializatio window. Usually taking the defaults in the initialization window is ok. To display the standard loop charts for the cryotarget:

- select the **Charts Menu**
- select the **Loop Charts** option
- select the **All** suboption

And seperate windows for each target loop will appear. Figure 1.5 shows the strip charts for loop 1.

FOR PROBLEMS WITH STARTING THE `tgtcharts` GUI SEE SECTION 2.1.

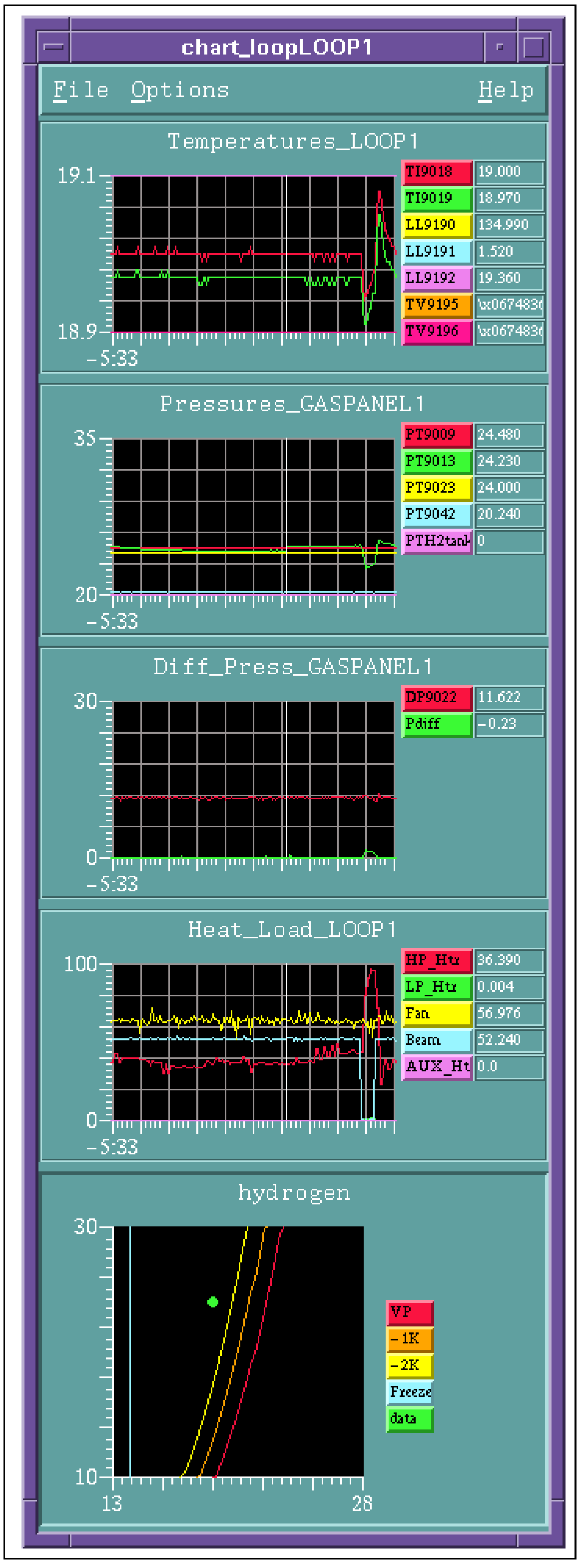

Figure 1.5: Loop 1 Chart Display

Figure 1.6: The tgtalh Window used to monitor and change alarm setpoints

1.5 Starting the tgtalh Alarms Control

The alarm setpoints are monitored and changed from the `tgtalh` GUI. It should only be started on **cdaqh1** because it needs to be able to write to the alarm set point boot file used to initialize the alarm settings when the IOC reboots. This file is on **cdaqh1** and thus `tgtalh` must be run from **cdaqh1**. To start `tgtgui`,

1. Start the **tgtgui** GUI on **cdaqh1**
2. Click on the **tgtalh** button

Alternatively, to start `tgtalh` from the command line,

1. log onto **cdaqh1** with the account **cvxwrks**
2. change to the alarm hander directory,

   ```
   cdaqh1> cd $GUI/tgtalh
   ```

3. start the `tgtalh` GUI,

   ```
   cdaqh1> tgtalh
   ```

An initialization window will pop up asking for the parameter file to use. Select the default file,

```
ctarg.alh
```

and the `tgtalh` window will reconfigure (see figure 1.6)

Figure 1.7: EPICS Alarm Handler

1.6 Starting the EPICS Alarm Handler

The EPICS Alarm Handler is run as a seperate program and can only be run on **cdaqh1**, not on **jeffylab**. To start the EPICS alarm Handler:

1. start the `tgtgui` program bar GUI on **cdaqh1**
2. click on the **alarm handler** button.

Alternatively, the alarm handler can be started from the command line by the sequence,

1. log onto **cdaqh1** with the account **cvxwrks**
2. change to the alarm handler directory,

   ```
   cdaqh1> cd $GUI/tgtalh
   ```

3. Start the alarm handler,

   ```
   cdaqh1> alh CTARG.alhConfig >& /dev/null &
   ```

This starts the alarm handler as a separate process. A small window appears showing a button with the name **CTARG** (see figure 1.7). The colour of this button reflects the alarm status, (yellow=MINOR, red=MAJOR, white=INVALID). By clicking on this button, a window showing the alarm tree for the Hall C target (figure 1.8) appears. By clicking on the arrows, the tree can be opened up or closed, until you get to the actual alarm records shown in the right hand panel. The alarm handler captures transient alarms in addition to continuing alarms, sounding a bell until the alarm is acknowledged.

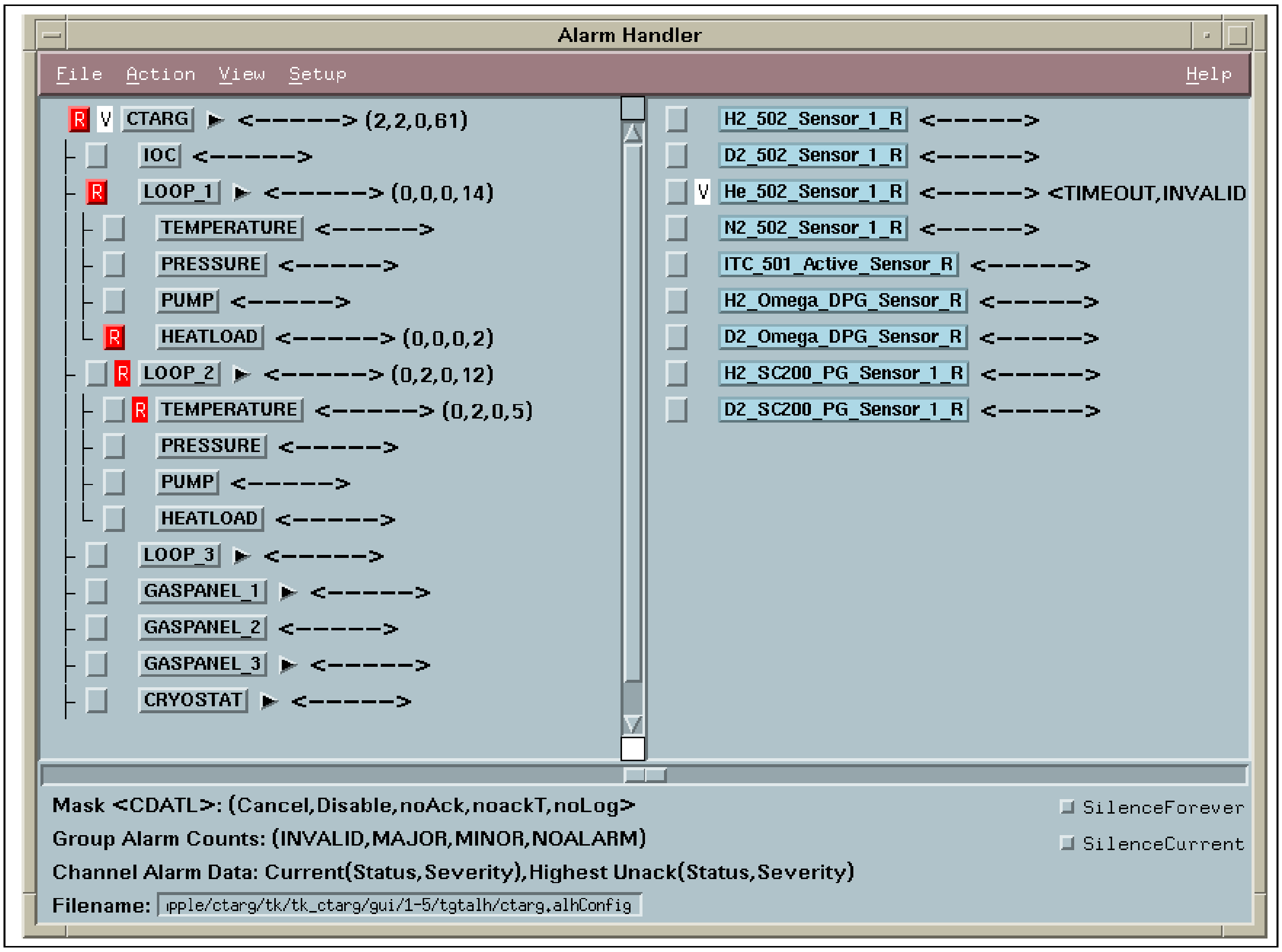

Figure 1.8: Alarm Tree For CTARG

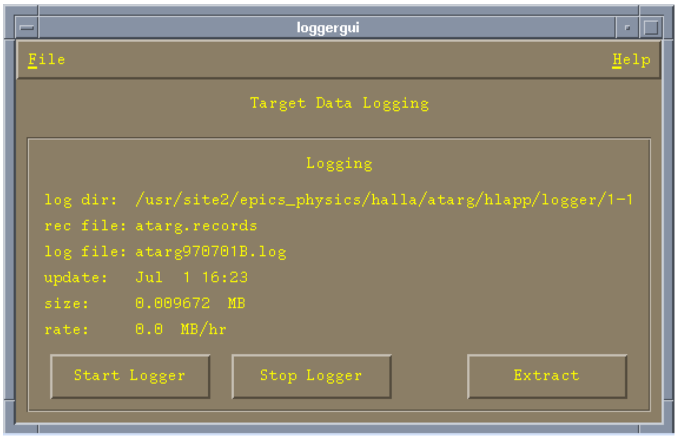

Figure 1.9: Target Data Logger and Extractor

1.7 Starting the tgtlogger GUI

There is a target data logger that runs as a seperate process on **cdaqh1**. This process runs all the time. If for some reason it is stopped, it is automatically restarted within 10 minutes. The `tgtlogger` GUI can be used to verify that the data logging is working. To start **tgtlogger** from the `tgtgui` program bar,

1. start `tgtgui`
2. click on the **data logger** button

and the data logger window will appear (figure 1.9). This window will display the data logging directory, the current data logging file, the size of this file and the rate at which data is accumulated.

A writeup on starting and using the target datalogging will be done by Kenneth Gustafsson. The data logging routines are based on the Hall C standard data logging developed by Steve Wood. The routines reside in the directory

`/home/cvxwrks/SLOWC/`

and write the data to files in

`/home/cvxwrks/SLOWC/TLOGGER/`

A new file is started each day at midnight and the naming convention is

`CtargYYMMDD_x.log`

where the "x" is a version letter (a new version is started with each reboot of the IOC). To access the data from the log files, see the document **CEBAF Hall C Cryogenic Target Control Data Logging** by Kenneth Gustafsson. **A copy of this document is in the User Manual binder — look under "Logged Data Retrieval".**

Chapter 2

What To Do If. . .

2.1 Can't Start tgt or tgtcharts

There are two IOC's being used for the Hall C cryotarget: **vmec4** which has most of the database and all of the control codes on it; and **vmec15** which ahs has the records for the refrigeration of the target (CHL and ESR). If the GUI crashes when you try to start it, the most likely problem is that it can't find a record in the database. If it can't find the very first record it looks for, then:

- The IOC has crashed or gotten "ill" *or*
- The database is not loaded

Most likely the IOC has gotten ill. If the GUI has successfully loaded some records before crashing, then only some of the records on the IOC are "ill". To recover from IOC illness see section 2.3. To determine which record the GUI has failed to find, look at the **tgtgui** xterm. There should be an error message like:

```
  -- making Connections To Epics Data Base
     -- connecting to vmec4:serialports:501_Serial_Port.VAL
The operation timed out:   on list of devices.
 501_Serial_Port.VAL          ***  device not found
The operation timed out:  501_Serial_Port.VAL
 Unconnected or corrupted chid:  501_Serial_Port.VAL

    while executing
"epics addlist $rec_VAL"
    invoked from within
"if { ($TGT_EPICSactive == 1) && ($TGT_DEVICES($sim) == 1) } {
        #
        set message ""
        append message "     -- connecting to " $TGT_DE ..."
    (procedure "tgt_epicsadd" line 19)
    invoked from within
"tgt_epicsadd serialports  501_Serial_Port"
    (file "/cdaqh1/d1/epics/apple/ctarg/tk/
            tk_ctarg/gui/1-9/tgt/tgt_ctarg_epics_add.tcl" line 78)
    invoked from within
"source $TGT_DIR/tgt_ctarg_epics_add.tcl"
    invoked from within
"if {$TGT(target) == "ctarg"} {
  source $TGT_DIR/tgt_ctarg_epics_add.tcl
```

```
} else {
  source $TGT_DIR/tgt_atarg_epics_add.tcl
}"
    (file "/cdaqh1/d1/epics/apple/ctarg/tk/tk_ctarg/gui/1-9/tgt/tgt"
     line 465)
```

on it. The line

```
     -- connecting to vmec4:serialports:foo501_Serial_Port.VAL
```

tells you what the IOC, device and record the GUI was attempting to connect to, in the format,

```
<ioc>:<device>:<record>
```

To fix the problem it is necessary to reboot the IOC that contains the bad record — see section 2.3. However, If you don't want to reboot or if the offending IOC is vmec15 and it is really dead, you can try working around the problem by disabling the **device** that contains the record that crashes in the initialization window of the GUI.

2.2 GUI Illness — The GUI's Slow Down

Symptoms of GUI illness are:

- When you change windows on the GUI, they update (i.e. redraw) very slowly.

This can be on either the **tgt** or the **tgtcharts** GUI What you should do is reboot the GUI. To do this follow the directions in sections 1.3 and 1.4. If when you restart the GUI it crashes and says that it can't find a database record, what you may be suffering from is **IOC ILLNESS**. See Section 2.3.

2.3 IOC Illness — Can't Connect To Database From GUI

There are 2 IOC's used in the target control system.

vmec4 contains all the important target controls and most of the database.

vmec15 contains the records that talk to the Central Helium Liquifier (CHL) and the End Station Refrigerator (ESR) — where we get our coolant from.

The more important of these IOC's is of course vmec4. If vmec4 gets ill, we have to carefully reboot the system. If vmec15 gets ill, then it can be easilly rebooted without affecting the stability of the cryotarget.

2.3.1 If vmec4 Gets Ill — Rebooting vmec4

Symptoms of IOC Illness on **vmec4**:

- The target strip charts "flatline", i.e. all the values are unchanging.
- The displays in **tgt** that normally have readbacks from various target systems that jump about are rock steady (i.e. again a constant value is read back from IOC database).
- A message pops up when trying to control something from the **tgt** GUI saying that the GUI can't connect to some variable in the database.
- Some or all of the records in the **Alarm Handler** show the white **V** (= inValid) alarm. This means that the Alarm Handler has lost contact with the IOC database.

These are symptoms of IOC illness for **vmec4**. If **vmec4** gets ill, it has to be rebooted. The problem with rebooting is that the control of the target high power heaters goes away during the reboot. This means that heat load on the target is not controlled and there is a danger of either boiling the target (not good) or freezing the target (very serious).

To prevent the loss of control of the target during a reboot, auxillary heaters, controlled from the counting house are turned on during the reboot. During the reboot the target operator watches the target loop temperature controllers on the TV monitor and adjusts the auxillary heaters as necessary. The reboot process takes about 5 minutes to complete. The procedure is:

1. Set the auxillary heaters to an appropriate heat load. "Appropriate" means that the heat load on the high power heaters should be such that the heat load left on the low power heaters is about 30 W (this is the middle of the low power heater dynamic range). To do this, calculate the current total heat load due to the Low Power Heater (P_{LPH}), the High Power Heater (P_{HPH}) and the Beam (P_{beam}),

   $$P_{tot} = P_{LPH} + P_{HPH} + P_{beam}$$

   The power setting for the Auxillary heater (P_{AUX}) should be,

   $$P_{AUX} = P_{tot} - 30W$$

   The auxillary heaters are set by adjusting the voltage on the supply using the knobs in the electronics room of the counting house.

   $$P_{htr} = \frac{V_{htr}^2}{R_{htr}}$$

   where R_{htr} is,

Loop	$R_{htr}(\Omega)$
1	2.4
2	0.95
3	2.1

The knobs are approximately 4 V per full turn. To Set the Loop Auxillary Heaters (only loops 1 and 3 have auxillary heaters) set the knob for thhe auxillary heater to the appropriate number of turns,

$$N_{turns} = \frac{\sqrt{P_{AUX}R_{htr}}}{4.0}$$

The appropriate knob settings for each heater are in table 2.1.

2. Select the **TGT IOC** (**vmec4**) setting (**POSITION 1**) on the **PIVOT** reboot switch located in the Hall C counting house electronics room.
3. **Call MCC ask for BEAM OFF** — Very Important.
4. Turn On the Auxillary Heaters for both Loops 1 and Loops 3 (The toggle switches on the Auxillary heater panel just below the reboot panel in the electronics room).
5. Press the Reboot button for the **TGT IOC** (**vmec4**)
6. The IOC will now start rebooting. Several things will happen:
   - The Alarm Handler will go off with INVALID alarms on most of the records (the records are no longer there).
   - Both the **tgt** and **tgtcharts** GUI's will have messages pop up indicating the loss of connection to database records. Acknowledge these messages.
7. **VERY IMPORTANT: While the reboot goes on, watch the displays of the target loop temperature controllers (they control the low power heaters that will regulate the target loop temperature during the reboot) on the TV monitor just above the cryotarget control xterminals. During the reboot the following will happen.**
   - **If the low power heaters were off (happens if the high power heaters were in PID control mode), they will come on.**
   - **Watch the temperatures for loops 1 and 3. (You should know what they are supposed to be. Usually Loop1 is at 19K and Loop3 is at 22K). If they change by more than 0.2 or 0.2 K, you may want to adjust the auxillary power heaters to compensate.**
   - **Watch the low power heater power indicator (the LED bar graph on the right of the displays). Try to adjust the auxillary heaters to keep the bar graph between the minimum and maximum values (this means that the ITC502 temperature controllers have the dynamic response to keep the temperature stable).**
8. While waiting for the IOC to reboot, reboot the **tgt** and the **tgtcharts** GUI's. If you don't do this, they may not connect properly to the IOC and you may think that they are working but in fact you have GUI illness.
9. While waiting for the IOC to reboot, pull up the Alarm Handler display and watch the alarm states. During the reboot, they will all be **INVALID**. As the IOC finishes rebooting and the database is reestablished, the alarms go out of the INVALID state. Some of them will go to yellow or red because the alarm limits are no longer correct. The IOC is probably finished rebooting when the **IOC opmode** alarm goes to the the red state. **The whole reboot process takes maybe 5 minutes.**
10. Now restart the **tgt** and **tgtcharts** GUI's. In the **tgtcharts** GUI, open up the **LOOP CHARTS** and look at the status of the target.
11. In the **tgt** GUI, go to the High Power Heaters for Loops 1 and 3. Reset the heater parameters to what they were before the reboot. In principle most of the parameters are automatically loaded and all you have to do is:

$P_{AUX}(Watts)$	Nturns(Loop1)	Nturns(Loop3)
10	1.2	1.1
20	1.7	1.6
30	2.1	2.0
40	2.4	2.3
50	2.7	2.6
60	3	2.8
70	3.2	3.0
80	3.5	3.2
90	3.7	3.4
100	3.9	3.6
110	4.1	3.8
120	4.2	4.0
130	4.4	4.1
140	4.6	4.3
150	4.7	4.4
160	4.9	4.6
170	5.0	4.7
180	5.2	4.9
190	5.3	5.0
200	5.5	5.1
210	5.6	5.3
220	5.7	5.4
230	5.9	5.5
240	6	5.6
250	6.1	5.7
260	6.2	5.8
270	6.4	6.0
280	6.5	6.1
290	6.6	6.2
300	6.7	6.3
310	6.8	6.4
320	6.9	6.5
330	7.0	6.6
340	7.1	6.7
350	7.2	6.8
360	7.3	6.9
370	7.4	7.0
380	7.5	7.1
390	7.6	7.2
400	7.7	7.2

Table 2.1: Auxillary Heater Settings. The number of full turns for the auxillary heater setting knobs.

(a) Verify all the heater settings.
(b) **ENABLE** the **Automatic PID Start**
(c) Change the **Heater Mode** to what it was before the reboot. Usually this will be either **CONSTANT HEAT MODE** or **PID CONTROL MODE**.

12. Turn **OFF** the auxillary heaters.
13. Watch the Loop charts, making sure that the target is stable.
14. Set the operations mode to **RUN**. Do this by,
    (a) Select the **Operation Mode** option from the **Security** menu on the main **tgt** display.
    (b) Click on the **RUN** option of the Operation Mode. In the alarm handler, the **IOC opmode** alarm should go off.
15. Set The Automatic Position Update
    (a) Select **position options** from the **Position** Menu of the main **tgt** window
    (b) Click on **Beam Energy Loss Update**. The green LED should come on.
    (c) Click on **Load Current Energy Loss Parameters**.
    (d) Check in the High Power Heater Windows that the correct energyloss parameters are loaded for each loop.
16. Set the ITC501 timing
    (a) Select **ITC501 Temperature Scanner** from the **Devices** menu of the main **tgt** window.
    (b) Change the **DISPLAY TIME** to 5.0 (the readback will change to 5.12 — this is normal).
    (c) Change the **INHIBIT TIME** to 4.0 (the readback will change to 4.10 — this is normal).
17. It is now safe to call MCC and ask for the beam to be restored.

2.3.2 If vmec15 Gets Ill — Rebooting vmec15

The symptom of **vmec15** getting ill is that the End Station Refrigerator (ESR) and Central Helium Liquifier (CHL) signals on the strip charts "flatline". If this happens, it is necessary to reboot **vmec15**. This is a much simpler procedure than rebooting **vmec4** since none of the important target operations are on this IOC. To reboot **vmec15**,

1. Select **CRYO EPICS** (**vmec15**) on the HMS Reboot switch (channel 7).
2. Press the Reboot button
3. While the IOC is rebooting the **CHL ecCFI11139** alarm in the Alarm Handler will go INVALID (because the record is not there anymore). When the IOC has finished rebooting, the alarm should go quiet.

The ESR and CHL signals should resume their normal behavour after the reboot. If they don't, then the problem may be the program used to get the signals from the Central Helium Liquifier and give them to EPICS. It will then be necessary to kill the program that is supposed to do this:

1. log onto **hallc2**
2. find the process by typing,

   ```
   hallc2> ps -ef
   ```

   and look for the process **STARmain** and get it's process ID (PID).
3. Kill the **STARmain** process,

   ```
   hallc2> kill -9 <PID>
   ```

   Within 10 minutes this process should automatically restart itself and the signals should come back.

Chapter 3

About The Control System

The Hall C Cryogenic Target Control System is the set of electronics, computers and programs used to monitor and control the Hall C Cryogenic Target. The control system consists of two major components: The *EPICS database and the* Tcl/Tk *based Graphical User Interface.*

1. *The EPICS database, device drivers and finite state machines which are run on a single board computer (referred to as an Input Output Controller or IOC in EPICS jargon) located in the VME crate next to the target electronics in Hall C. (These electronics racks are located next to the gas panels for the target — one of the first things you see when entering the hall.) The EPICS IOC is the core of the control system. Its job is to: monitor the devices on the target; look for and respond to deviations from proper operating conditions; and to service user requests to the control system.*

2. *The user interfaces to the EPICS database on the IOC. All communication between the user and the actual controls electronics is through the EPICS database running on the IOC. To communicate with this database, there are Graphical User Interfaces (GUI's) running on UNIX machines located in the counting house. There are two separate GUI's being used for the Hall C target.*

   tgt User Interface
   : *This is the main GUI used to monitor and control the target systems. It is used to change the states of heater, valves, temperature controllers etc. It is written in Tcl/Tk interfaced to EPICS through Channel Access.*

   EPICS Alarm Handler
   : *Warnings of alarm conditions are handled by the EPICS Alarm Handler. This is a GUI that looks at the analog signals in the database and warns the user if they deviate from the desired operating conditions.*

Since the user interface is implemented in an X windows environment, it is possible to have more than one GUI operating simultaneously. Thus in addition to the user interface that would normally be running in the Hall C counting house, a GUI can be running in the hall itself or from anywhere on the CEBAF site. While all the target systems are normally available for viewing by the user, any controls that affect the target are disabled. To implement changes in the target systems, it is necessary to enable the controls which in turn requires a password.

It should be noted that it is possible to attempt to control the target simultaneously from more than one location. Operators should be aware of this.

3.1 Overview of Control System

This section tries to give an overview of the function of the target control system.

3.1.1 Data Logging

Data logging for the Hall C cryogenic target is handled by the Hall C data logger developed by Steve Wood. The implementation for it used for the cryogenic target was developed by Kenneth Gustafsson. Data is logged to binary files, a new file being started each day at midnight.

3.1.2 Message Logging

All relevant messages to do with starting/stopping the GUI, and setting parameters in the EPICS database are logged in the subdirectory /messlog in the file

```
tgtYYMMDD.messlog
```

where tgtYYMMDD.messlog is a new file created each day at midnight. This file resides in the directory that the control system is started from. The format of the log file is one message per line with the time and the process ID of the GUI that issued the message, and the message itself. These messlog files are intended to give a complete list of all important commands issued from the GUI.

3.1.3 Alarm Handler

Alarm conditions on the target systems are defined within the EPICS database using the standard EPICS double level alarms. Each parameter has "mild" alarm conditions (referred to as HIGH and LOW) and "extreme" alarm conditions (referred to as HIHI and LOLO). If a target parameter enters an alarm condition it is detected by the EPICS Alarm Handler program which warns the user that an alarm condition has occurred. Control system responses to the alarms are handled within the EPICS database and its associated state machine. The four alarm conditions for each parameter can be displayed in the GUI and can be changed by the user. The GUI will be able to enable or disable the EPICS actions invoked by an alarm condition.

3.1.4 Response to Alarms

The IOC monitors various target parameters and if an alarm condition occurs (usually either HIHI or LOLO) on some parameters, the IOC performs an ALARM ACTION. *Currently, the only Alarm Actions implemented in the IOC are overpressure actions where the IOC opens relief valves if the target loop pressures go to high. In the near future, alarm actions will be implemented to trip the machine Fast Shut Down.*

3.1.5 Help Files

There are text based help files being developed for the Hall C target control system user interface. These files currently reside in the directory

```
/cdaqh1/d1/epics/apple/ctarg/tk/tk_ctarg/usrtgt/help/
```

and have the naming convention

```
tgthelp_xxxx.txt
```

where xxxx is the specific topic of the help file.

3.2 A Tour of the GUI

Following the start up procedure for the GUI described in chapter 1 the user will be have a window called **tgt** *(see figure 1.2).*

This is the main target operations window and most of the target control systems can be operated from either this window or windows created from it's menu bars and options. (Currently the only thing that can't be started from **tgt** GUI is the EPICS data logging.) *The* **tgt** *window displays at the top, the title of the* *target, and a row of green buttons that call up windows for the four main target sub systems (the three loops and the cryostat). Below the green buttons is a panel that displays the general status of the control system and below that are three panels that major data on each of the three loops. At the top of each loop status display is a Temperature VS Pressure Phase diagram showing the position of the cyrogen in each loop with respect to the vapour pressure and freezing curves for that cryogen. At the bottom of the window is a Message display that shows the last 100 messages noted by the control system (all messages get logged to files). And finally, along the very top of the window are menus to invoke the various target systems.*

3.2.1 Loop Windows

Each of three target loops has its own display window which can be invoked using the green buttons at the top of the **tgt** *window. LOOP1 is the top loop (nominally the Hydrogen Loop), LOOP2 is the middle loop (nominally the Helium Loop) and LOOP3 is the bottom loop (nominally the Deuterium Loop).*

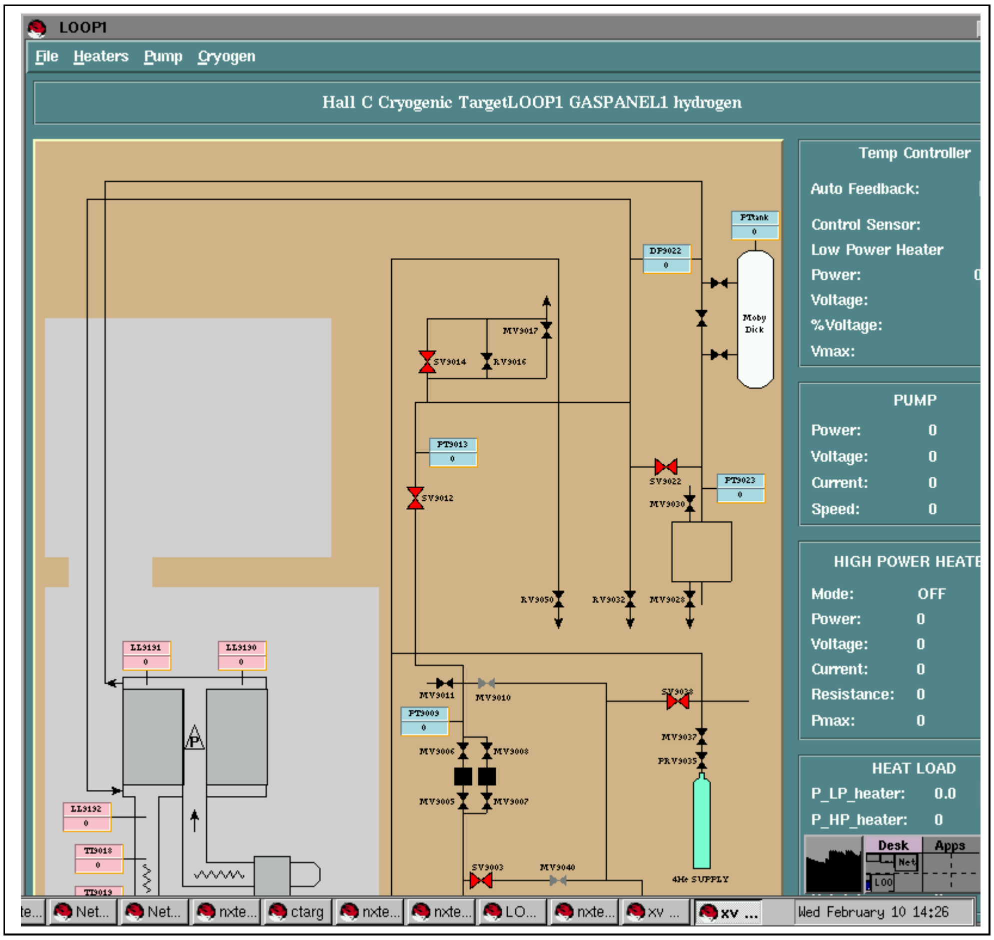

Figure 3.1: Target Loop Window

By clicking on a loop button, a window displaying a schematic diagram of the gas handling system for that loop will appear (see figure 3.1). Along the right side of the gas schematic are panels showing the status of the major systems for the loop. The border of the loop display is normally gray, indicating that the loop controls are disabled (i.e. the user can observe the state of the controls but not change them).

On the gas schematic itself are small rectangular windows showing the pressures (blue) and temperatures (pink) of the target loop. These indicators are shown at the physical locations where the measurements *are made. Mechanical valves in the gas handling system are shown in either black or gray. The solenoid valves are shown in either red or green with the colour indicating the state of the valve (red=closed, green=open). By clicking on a solenoid valve, a window will appear that enables the user to open or close the valve.*

At the top of the Loop Window are menu items that access the three subsystems of the loop: the temperature controller; the high power heater and the pump.

3.2.2 Cryostat Window

By clicking on the green **CRYOSTAT** *button on the* **tgt** *display, the user opens the Crystat Window. This window displays a schematic diagram of the cryostat (including the refrigeration plumbing and the target heat exchangers). On the left of the schematic diagram are panels that show the status of the cryostat subsystems.*

On the Cryostat Diagram, are displays for the temperatures and pressures read off the cyrostat. The indicators show the locations where the sensors are placed. The naming convention of the cryostat display is that used in the Hall C Cryotarget http://www.cebaf.gov/ fduncan/documents.

3.2.3 The tgt Menu Bar

The **tgt** *menu bar accesses windows and routines to manipulate the target control system. Describing the functions briefly:*

File *Option to exit the control system.*

Security *Accesses the security to permit controls to be changed and the operations modes that define the allowed operations on the target and sets alarm set points.*

EPICS *Invokes routines to examine and modify the control systems EPICS database at a low level.*

Cryogens *Information on the cryogens used in loops, and allows the user to select a cryogen and change it's properties.*

Charts *Pop up charts to graph the data. Include many predefined groups of charts (e.g. charts for each loop and the cryostat).*

Position *Routines related to moving the target.*

Alarms *Routines to change the alarm set points for the target and routine to start up the EPICS Alarm Handler.*

Interlocks *Routines to set and reset interlocks on various target systems.*

Devices *Windows to examine and modify the low level devices used in the control system. Mainly for system diagnostics.*

Help *Accesses help windows for* **tgt**.

Chapter 4

General Operation

4.1 Security

When first started the target GUI allows the user to look at the status of the target control system but does not allow any of the systems to be changed. Before any system can be changed, the controls for that target system have to be enabled. There are two levels of security in the GUI:

Operator *security is for the normal operations of the target.*

Expert *security is used to change target parameters that are not intended to be adjusted during normal target operation. Only someone knowledgable should attempt to adjust parameters protected by the "Expert" security.*

Different passwords are required for the different security levels.

For **Operator** *security, many (but not all) of the target systems can be enabled from the* **Operator** *window, invoked by selecting* **Operator** *from the* **Security Menu** *on the main target window. To enable Operator controls:*

1. *From* **Security Menu** *on the main tgt window, select* **Operator**. *The Control Enable window will appear. There are check buttons for each target system. If the check field of the button is red, the system is active.*
2. *Enter the Control Password in the password entry box. The buttons for the controls will become active.*
3. *Enable the controls to be used.*
4. *Close the Operator window (select* **Exit** *from the* **File Menu**.

Once enabled, controls (either Operator or Expert) will stay active for the **TIMEOUT** *period (default 45min, selectable by clicking on the* **TIMEOUT** *button at the bottom of the Control Enable window. If a control is active, then it is not necessary to enter a password to disable it (but it is necessary to enter a password to re-enable it later). Expert Controls are usually enabled from the* **Security Menu** *of the window which contains them. As an added precaution, some controls are disabled when the window is closed (for example target motion controls). Particularly sensitive controls will have a warning message appear when they are enabled. For example, when the user attempts to enable the target motion controls, a warning is displayed telling the user that the Accelerator Fast Shut Down.*

4.2 Selecting Operation Mode

The target operation modes are used to enable or disable various parts of the control system during certain stages of operation to prevent accidentally changing controls that should not be touched. Examples:

- *While cooling down the target, temperature alarms are meaningless and should be disabled.*
- *When the target is cold and stable with beam on target, there is no reason to open certain valves.*

Things to be enabled/disabled are:

1. *various alarms*
2. *solenoid valves*

The operations mode controls are enabled using the GENERAL enable.

The control modes for the target are:

PUMP/PURGE
cleaning the plumbing out with helium gas at room temperature.

```
alarms: disable temp alarms
        disable pump_freq alarm
        enable pressure alarms
solenoid valves: all valves enabled
```

FILL/COOLDOWN
Filling target loops with gas and cooling them down.

```
alarms: disable temp alarms
        enable pressure alarms
solenoid valves: disable valves
                 SV9003 SV9040 SV9010 SV9038
                 SV9046 SV9073 SV9044 SV9080
```

RUN
Can now put beam onto target.

```
alarms: all usual alarms enabled
solenoid valves: disable valves
                 SV9003 SV9040 SV9010 SV9038
                 SV9046 SV9073 SV9044 SV9080
```

The alarms are enabled and disabled by loading differing ranges for the alarm set points into the database. The set points are stored in the files:

```
tgt_pump.asp   -- PUMP/PURGE alarm set points

tgt_cool.asp   -- FILL/COLLDOWN alarm set points

tgt_run.asp    -- RUN alarm set points
```

Both the alarm set points and the alarm action enables are loaded from these files.

Loading alarm set points is optional and can be disabled using the OPMODE window (the **Update Alarm Set Points** *button — default is to load the set points).*

4.2.1 Changing The OPMODE

1. *Select the* **Operation Mode** *from the* **Modes Menu**. *A window will pop up. If the controls are enabled it will have a red border. If the border is gray, enable the* **DATABASE** *controls (see section 4.1). The window will show the currently selected OPMODE with a green "LED".*

2. *Click the left mouse button on the new OPMODE. If the* **Update Alarm Set Points** *option is enabled, the alarm set points will be loaded from appropriate set point file. The default is for the* **Update Alarm Set Points** *option to be enabled.*

4.3 Low Level Devices

All the low level devices used in the target control system can be viewed from the options under the **Devices Menu** *on the* **tgt** *window. Outputs on these devices can be modified but the sensitive devices (such as the relay boards that operate valves) require an EXPERT password.* **Low level manipulation of devices should only be done by an experienced user.**

4.4 Monitoring Data Logging

To be discussed by Kenneth Gustafsson.

4.5 Alarm Monitoring

Alarms are monitored on the target control system using the EPICS Alarm Handler. The alarm handler (*alh*) reads a configuration file for the Hall C target system called,

```
CTARG.alhConfig
```

located in the `alh/` subdirectory of the `usrtgt` directory. The EPICS alarm handler describes the alarms in a heirachy which is:

LOOP1

- **Temperature**
  All the temperatures associated with the loop.
- **Pressure**
  All the pressures associated with the loop
- **Pump**
  Pump speed, voltage, current, power

LOOP2
 ...

LOOP3
 ...

CRYOSTAT

- **Temperature**
- **Pressure**

DEVICES

Monitors records from each device connected to the IOC. If a device looses communications with the IOC, an alarm will sound.

OTHER

Other alarms for the target system.

The alarm handler detects both continuing alarm conditions, and transient conditions. If an alarm occurs, the display flashes and the terminal beeps at the user until the alarm is acknowledged (see section 4.5.1). The alarm handler shows which alarms have tripped but does not show the value of the parameters that triggered the alarms. To look at the parameter values and the alarm set points, see section 4.6, *Alarm Set Points*.

4.5.1 Acknowledging an Alarm

The Alarm handler has two windows associated with it. A compact window showing a button which indicates the overall alarm status. If the button turns **yellow** a *MINOR* alarm has occured (either HIGH or LOW). If the button turns **red** a *MAJOR* alarm has occured (either HIHI or LOLO). If the button turns white, an alarm such as a device timeout (i.e. loss of communications with a device) has occurred. If the button is flashing, the alarm condition is currently active. If the button is a solid colour, then the alarm condition was a transient. To determine which alarm has tripped, click on the button. The second ALH window will open up. This window shows the alarm heirachy for the target in the left panel and specific alarms in the right panel. At the bottom of the window are buttons to silence the alarms.

4.6 Alarm Set Points

Following the standard EPICS structure, there are two levels of alarms on each analog input. The LOW and HIGH alarms are a relatively tight band around the acceptable range for the signal. If the signal passes out of the range (LOW,HIGH), the VALUE field turns yellow and either the LOW or HIGH quantity has its lettering turn from white to yellow. The LOLO and HIHI set points are a more extreme alarm band. When the signal passes below LOLO or HIHI, the VALUE field turns red. If there is an "alarm action" enabled for the LOLO or HIHI condition, then that action is taken. Not all alarms have actions defined for them.

There is a hysteresis field defined in EPICS for each signal. When a signal triggers an alarm by passing into HIHI for example, the alarm condition remains true while,

```
VALUE > (HIHI - HYST)
```

Similarly if the signal triggers the LOLO alarm the alarm condition remains true while,

```
(LOLO + HYST) > VALUE
```

The hysteresis is used for actions such as opening overpressure valves where once the valve has been opened, it is desirable to keep it open for some time (to prevent "stuttering" when a pressure is just at the trip point).

The alarm set points can be changed and the alarm actions enable or disabled using the Alarm Set Point Windows or by loading the settings from a file.

4.6.1 Displaying Alarm Set Points

To examine the set points for the control system alarms,

1. Select the **Alarms Menu** on the main **tgt** window.
2. Select the Alarm Set Point Window containing the alarm record to be examined. The currently defined windows are: **Loop1**, **Loop2**, **Loop3**, **Cryostat** and **Other**. If the controls for the alarm set point window are active, the window will have a red border otherwise the border will be gray.

The layout of the window is a series of columns. The first column shows the name of the database record. The naming convention is that used in the gaspanel schematic for the target. The nest six columns show the LOLO, LOW, VAL, HIGH, HIHI and HYST fields of the database record. Then there is a description of the database record followed by enable buttons for the LOLO and HIHI actions. If the enable buttons are green if the actions are enabled and red if they are disabled. If an alarm condition is present, the VAL field for the record turns either YELLOW (MINOR alarm) or RED (MAJOR alarm). The alarm set point that triggers the alarm condition will be displayed in the same colour as the VAL field.

4.6.2 Changing Alarm Set Points from the Alarm Set Point Window

To change the alarm set points from the Alarm Set Window:

1. Ensure that the OPERATOR controls for the target subsystem containing the alarm set point are enabled. If the controls *are* enabled, the Set Point window will have a red border, otherwise the border will be gray. To enable the controls see section 4.1.

2. Click the left mouse button on the alarm set point to be changed. A window will pop up asking for the new value of the alarm set point.

3. Enter the new alarm set point value and click on **OK** (or **CANCEL** to abandon the change).

4. The value of the set point in the window should change to the new value.

4.6.3 Enabling and Disabling Alarm Actions

An "Alarm Action" may (or may not) be defined for HIHI and the LOLO alarm conditions. On the right side of the alarm set point window are the buttons to enable/disable the alarm actions. The state of the action is indicated by the colour of the button (red = disabled, green = enabled).

1. Ensure that the controls for the target subsystem containing the alarm set point are enabled. If the controls *are* enabled, the Set Point window will have a red border, otherwise the border will be gray. To enable the controls see section 4.1.

2. Click on the Action button (when the controls are enabled) to enable or disable the alarm action. Shown on the buttons are the actions taken by the EPICS database when the alarm condition is true.

4.6.4 Loading Alarm Set Points From Files

The alarm settings can be loaded from and saved to files. This feature is intended to allow the alarm bands to be changed depending on the operational state of the target. Only operator privilleges are required to load and save alarm set points. Obviously, extreme care should be taken when adjusting alarm set points.

To Load the alarm set points from a file:

1. Select the **Save Alarm Set Points** option of the **Files Menu** from *any* alarm set point window.

2. A file selection window will pop up displaying the named of the existing alarm set point files (these files have the extension ***.asp**). The default file name corresponds to the OPMODE the target is in (see section 4.2).

3. Click **OK** to accept the default set point file, or edit the window at the bottom of the file selector window to choose a different file.

   At present, clicking on an entry in the list box to select a file does not work.

   It can take up to two minutes to load all the alarm set points into the database. Be patient.

4.6.5 Saving Alarm Set Points To A File

To save target alarm set points to a file:

1. Select the **Save Alarm Set Points** option of the **Files Menu** from *any* alarm set point window.
2. A file selection window will pop up displaying the named of the existing alarm set point files (these files have the extension ***.asp**). The default file name corresponds to the OPMODE the target is in (see section 4.2).
3. Click **OK** to accept the default set point file, or edit the window at the bottom of the file selector window to choose a different file.

   At present, clicking on an entry in the list box to select a file does not work.

4.7 Alarm Actions

Associated with many (but not all) alarms are "Actions" which are invoked when an alarm occurs. Currently the alarm actions implemented in the Hall C target controls are:

- Software opening of relief valves if target pressure too high
- Software opening of supply valve if target pressure too low (not usually active)
- Software **Fast Shut Down** of beam if various alarms are triggerd.

The alarm actions are listed below:

```
LOOP 1 (Hydrogen)
-----------------
                         LOLO actions       HIHI actions
pressures     PT9013     open_SV9012        open_SV9014, take_beam
              PT9023     open_SV9012        open_SV9014, take_beam
              DP9022     take_beam          none
temperatures  TI9018     none               take_beam
              TI9019     none               take_beam
              VP9195     none               take_beam
              VP9196     none               take_beam

pump          P9090_freq take_beam          none


LOOP 3 (Deuterium)
------------------
                         LOLO actions       HIHI actions
pressures     PT9083     open_SV9082        open_SV9084, take_beam
              PT9093     open_SV9082        open_SV9084, take_beam
              DP9092     take_beam          none
temperatures  TI9088     none               take_beam
              TI9089     none               take_beam
              VP9125     none               take_beam
              VP9126     none               take_beam
pump          P9020_freq take_beam          none
```

Loop	FSD Relay	Sensors
H2	Temperature	TI9018 TI9019 VP9195 VP9196
H2	Pressure	PT9013 PT9023 PT9022
H2	Pump	P9090_frequency
H2	Spare	
D2	Temperature	TI9088 TI9089 VP9125 VP9126
D2	Pressure	PT9083 PT9093 PT9092
D2	Pump	P9020_frequency
D2	Spare	

Table 4.1: Fast Shut Down Sensors and Relays

4.8 Software Fast Shut Down

There are alarm actions implemented in the target IOC to take the beam away if the target deviates from safe operating conditions (the previous section explicitly lists the alarm actions). If take beam alarm action is enabled, and an alarm condition occurs, a relay is closed on Relay Board 0 which trips the beam. There are four relays allocated for the Hydrogen loop and four for the Deuterium loop (although only three on each loop are used right now). When a software condition occurs to trip the fast shutdown, The relay for the condition is set and the FSD indicator on the **tgt** main window will turn from green to red and indicate **TRIPPED**. Once a Fast Shutdown has been tripped, it can only be reset manually. Obviously, this should only be done after the cause of the trip has been found and the operator is sure that the target is in a stable state, ready for beam. Once these conditions are met, it is necessary to reset the software FSD before beam can be restored. To do so:

1. Click either on the FSD indicator on the **tgt** window *or* select **Fast Shut Down** from the **Interlocks Menu**. The **Fast Shut Down** window will appear indicating which of the eight fast shutdown relays is responsible for the trip.

2. Enable the controls for the **Fast Shut Down** window by selecting the **Enable Reset** option of the **Security Menu**. A window will appear asking for the **Operator** password. Enter the Password and click on **OK**. If the password is accepted, the background of the **Fast Shut Down** window will turn red and the reset controls will be enabled.

3. Click on the button for the FSD to be reset (the red **TRIPPED** button). If the Fast Shut Down condition is still present, the FSD can NOT be reset.

4. When all the FSD's have been reset, all the buttons should be green. The FSD indicator on the **tgt** window will also be green.

4.9 IOC Reboots

The IOC may either be deliberately rebooted to cure the "fatigue" that it suffers from after running for about one day, or it is possible that it may reboot by itself. The following will happen when the IOC does reboot:

1. The **opmode** EPICS variable is set to zero. The only valid opmodes are 1, 2 or 3 so this warns the GUI that the IOC has been rebooted.
2. The high power heaters will be turned OFF
3. The alarm set points will be set to defaults that may not be appropriate for the current target operating conditions.

The GUI detects an IOC reboot by monitoring the **opmode**. When the **opmode** is set to 0 during the reboot, the GUI will pop up an **IOC Crash Recovery Window** which warns the user that the IOC has rebooted and has buttons to open windows to set the necessary system parameters after a reboot. The systems to be reset are:

Set Operations Mode Opens the window to change the operations mode. When the IOC reboots, the opmode will be zero (which is called UNKNOWN in the tgt display).

Restore Heaters Opens a window displaying the last heater parameters that were sent to the IOC along with the current heater parameters in the database. If the current parameters are different from the values last sent to the IOC, they are indicated in red.

Load Alarm Set Points When the IOC reboots, it will load with default alarm set points. These are usually not appropriate for running so this button opens a dialog box to load the alarm set points.

Set ITC501 Timing at present when the IOC is rebooted, the ITC501 has it's **display** and **inhibit** timing set to too values that are too short. This button sets them to the proper values, (5.0 and 4.0 s) and displays the ITC501 window to confirm that they are changed.

4.10 Graphing Data

The two types of graphical data display within **tgt** are the *charts* and the *vapour pressure graphs*

4.10.1 Charts

TGT has a charting facility with predefined charts (see the various ones available under the **Charts Menu**). In addition new charts can be created using the Chart Maker (select the **Make Chart** option under the **Charts Menu**). The features available for the charts are:

Changing Y axis scale
Click the left mouse button on the number for either the upper y limit or the lower y limit. A window will pop up to input the new limit.

Pop Up Menu
Clicking the left mouse button on a chart pops up a menu of things that can be altered on the chart.

There are two chart types available. The **strip** chart causes the lines displayed to scroll off the chart to the left. This is extremely CPU intensive because the strip charts are implemented as Tcl scripts which are interpreted. The other type of chart is the **scope** chart which, after the trace gets to the right side of the chart, it wraps around and starts redrawing from the left side. To differentiate from the new and old lines, a vertical white line is shown. This type of chart is much less CPU intensive and is the default.

4.10.2 Vapour Pressure Graphs

Each target loop has associated with it, vapour pressure graphs that display the point in Temperature VS Pressure that the cryogen is located at. In fact the last ten points in Temp vs Press are displayed, with samples being taken every 5 seconds.

Drawn on the graphs are lines showing the liquid-vapour boundary of the cryogen, a 1K subcooling line, a 2K subcooling line and a freezing point line. To maintain a liquid target, the cryogen must be kept between the freezing line and the liquid-vapour line. Ideally, the hydrogen and deuterium loops will be operated at 2K subcooled. Features of the vapour pressure graphs are:

Changing axes scale
Click the left mouse button on the number for the axis limit to be changed. A window will pop up to input the new limit. The graph will then be redrawn with the new limits.

Pop Up Menu
Clicking the left mouse button on a chart pops up a menu of things that can be altered on the chart.

Chapter 5

Target Loop Operation

Much of the target loop operation is done through the **Loop Windows** invoked with the green buttons on the **tgt** window. A target loop window displays a schematic diagram of the gas panel, the heat exchanger and the target cells for the loop. On this display are indicators showing the readouts of the temperature sensors and pressure transducers for the loop. The schematic shows the positions and status of the solenoid valves on the gas panels. These valves are operated by clicking on their icons. The border of the window is shown in red if the controls for the loop are enabled and gray if the controls are disabled.

Along the right side of the loop window are panels showing the status of the major loop systems: the Temperature Controller, the Pump and the High Power Heater. The controls for these systems are accessed through the menu options at the top of the window. Also on the right side of the window is a panel showing the total heat load for the loop.

5.1 Opening and Closing Solenoid Valves

The valve controls are implemented from the loop panels through to the physical devices. The naming convention on the loop panels is that used on the gas panel schematic — drawing 67150-E-56825. The loop panels are invoked using the green buttons on the left side of the main window. To open or close a solenoid valve on a give loop, you must:

1. Ensure the OPERATOR controls for the loop are enabled (indicated by the read border around the window. If they are not, enable them using the procedure in section 4.1.

2. Ensure that the target is in the correct *operations mode* to permit operation of the desired valve. The operations mode is displayed on the main **tgt** window and the allowed valve operations are listed in section 4.2.

3. Click left mouse button on the COLOURED area of the valve to be opened or closed. A Valve Set Window will pop up. This window displays the name of the valve, the operations mode and the valve permit status (normal or disabled). At the bottom of this window are three buttons — "Open Valve", "Close Valve" and "Cancel". If the privileges are set properly, then the open and close buttons are active (white lettering — it is gray if they are disabled). Click the left mouse button on the desired action — to cancel click on the "Cancel" button. The Valve Set Window will disappear and after about 2 seconds, the valve colour on the loop window will change to reflect the new valve state — red = closed, green = open.

5.2 Interlocks on Solenoid Valves

There are interlocks on the solenoid valve between the gas bottle and the target cells for the hydrogen and deuterium loops. This interlock requires that the bottle side pressure be greater than the target cell pressure before operating the valve. (This is to prevent the target cell contents from back flowing into the gas bottle part of the gas panels.) The conditions for the interlocks must be met to open the valves:

```
Loop  valve         interlock condition
----  -----          ------------------
H2     SV9012        PT9009 > PT9013
D2     SV9082        PT9079 > PT9083
```

The status of the interlocks can be viewed by **valves** option of the **Locks Menu** on the **tgt** window. The "LED" indicator for each valve has three states:

gray interlock is disabled.

green interlock is enabled and condition is satisfied for valve operation. The valve may be opened or closed.

red interlock is enabled and the condition is **NOT** satisfied for valve operation. The valve may not be operated.

THE DEFAULT FOR THESE INTERLOCKS IS DISABLED

5.2.1 Enabling/Disabling Valve Interlocks

1. Ensure that the controls for the loop whose valve interlock is to be changed are enabled (see section 4.1
2. Select the **valves** option of the **Locks Menu** on the **tgt** window. The Valve Interlock Window will appear showing the current status of the interlock (see previous section). If the controls for the loop are enabled, the panel showing the valve interlock will be red, otherwise it is gray.
3. click on the button to enable/disable the interlock.

5.3 Adjusting the Temperature Controllers

Each loop has an Oxford ITC502 temperature controller that regulates the temperature of the loop using a 65W ("Low Power") heater. The ITC502 Controller windows are available from the **Heaters Menu** of the Loop windows or from the **Devices Menu** of the Main **tgt** window. These controllers can be operated in an automatic mode using a PID control loop or they can be operated manually.

5.3.1 Switching Temperature Controller Automatic Regulation On/Off

To change the set point temperature for a target loop Oxford Temperature controller: To switch the temperature controller between manual and automatic heater control:

1. Enable the controls for the target loop whose temperature controller is to be changed (see section 4.1).
2. Open the desired temperature controller window. The temperature controllers can be opened from the **Heaters Menu** of the Loop windows or from the **Devices Menu** of the Main **tgt** window.
3. Ensure that the controller in in **Remote Mode**. This is indicated by the LED next to the **Remote** button being green. If the controller is *not* in Remote, click on the **Remote** button.
4. Click on the **AUTO** button to enable or disable the Automatic heater control. The LED next to the **AUTO** button is green if the automatic heater control is on.

Note that when the temperature controller is switched from automatic to manual heater control, the heater is left at the power setting it had under automatic control. To then change the power setting manually, see section 5.3.2

5.3.2 Changing the Low Power Heaters Manually

When the ITC502 temperature controller is not in automatic temperature regulation mode, it can be operated manually by adjusting the voltage to the target loop low power heater. This voltage can be set from 0 to 40V which corresponds to a power setting of 0 to 65W. The voltage is set in units of percent where 100% is 40V. To change the low power heaters manually:

1. Enable the controls for the target loop whose temperature controller is to be changed (see section 4.1).
2. Open the desired temperature controller window. The temperature controllers can be opened from the **Heaters Menu** of the Loop windows or from the **Devices Menu** of the Main **tgt** window.
3. Ensure that the controller in in **Remote Mode**. This is indicated by the LED next to the **Remote** button being green. If the controller is *not* in Remote, click on the **Remote** button.
4. Click on the **% Voltage** button. A data entry window will appear.
5. Enter the new heater voltage (in percent full range) and click on OK.

5.3.3 Changing a Loop Set Point Temperature

To change the set point temperature for a target loop Oxford Temperature controller:

1. Enable the controls for the target loop whose temperature controller is to be changed (see section 4.1).
2. Open the desired temperature controller window. The temperature controllers can be opened from the **Heaters Menu** of the Loop windows or from the **Devices Menu** of the Main **tgt** window.
3. Ensure that the controller in in **Remote Mode**. This is indicated by the LED next to the **Remote** button being green. If the controller is *not* in Remote, click on the **Remote** button.
4. Click on the **Goal Temp** button in the controller window. A data entry window will appear.
5. Enter the new set point temperature and click on OK.

5.3.4 Changing the Temperature Controller Sensor

Each target loop has two Cernox resistors read by a ITC502 controller. They are located, one before and one after the low power heater. One of these sensors is used by the controller to regulate the target loop temperature (usually the resistor located before the heater). The sensor used by the controller can be changed:

1. Enable the controls for the target loop whose temperature controller is to be changed (see section 4.1).
2. Open the desired temperature controller window. The temperature controllers can be opened from the **Heaters Menu** of the Loop windows or from the **Devices Menu** of the Main **tgt** window.
3. Ensure that the controller in in **Remote Mode**. This is indicated by the LED next to the **Remote** button being green. If the controller is *not* in Remote, click on the **Remote** button.
4. click on the button for the desired sensor (**CH1** or **CH2**). The selected sensor will have a green LED beside it.

Note: The third channel of each ITC502 is used to measure temperature diodes on the refrigeration system and thus cannot be used to regulate the loop temperature. To prevent accidentally selecting these sensors, the buttons for them are disabled on the ITC502 control windows.

Cryogen	Proportional	Integral	Derivative
H_2	0.8	0.2	0.0
D_2	0.7	0.6	0.0
^4He	8.0	1.0	0.0

Table 5.1: Temperature Controller PID Parameters for the different Cryogens

5.3.5 Changing The PID Control Parameters

The Oxford temperature controllers are PID (Proportional, Integral Differential) type controllers. PID parameters for the cyrogens currently used for the Hall C Cryotarget are listed in table 5.1. To assist in the changing of the PID parameters for a temperature controller, there is a temperature chart (found under the **Charts Menu** in the temperature controller window) which displays all three temperature channels of the controller and the set point temperature. Set the PID parameters following the algorithm from the Oxford ITC502 controller manual[1].

1. Set INT for a time much longer than the expected response time of the system.
2. Set DERIV to zero.
3. Select AUTO and reduce PROP until the temperature starts to oscillate above and below some mean value (not necessarily the set point).
4. Time the period of oscillation (in minutes). This is a measure of the response time of the system.
5. Set INT to a value approximately equal to the response time. Then increase the PROP setting to a point where the oscillation just ceases. Note the value of PROP at this point, then set it to approximately double this value. This gives a good starting point for the PROP and INT control terms.
6. Test how the system responds to step changes in the SET point and modify the PROP and INT settings for a reasonably fast response without excessive overshoot.
7. If overshoot remains a problem following a large step change in SET, try the effect of adding some DERIVATIVE action. A good initial setting is halft to one third of the system response time measured above. This will probably require PROP to be re-optimized for best results.
8. When optimizing P, I and D the aim should be to achieve the lowest values of all three terms, consistant with no oscillation and in an acceptably small amount of overshoot. This will give the fastest response for the system.

When adjusting the control terms remember that **reducing** the PROPORTIONAL band **increases** the controller gain. This can cause some confusion when the concept of PID control is first encountered.

5.4 High Power Heaters

In addition to the low power (65W) heater in each loop controlled by ITC502 temperature controllers, there is a "high power" heater (in excess of 300 W). The purpose of the high power heater is to replace the heat load on a given target loop due to the beam. The heater is set by specifying the desired heat load in watts using one of the three algorithms specified below.

The control system calculates the appropriate voltage to set on the loop heater (which is powered by a voltage controlled voltage source which in turn is specified by a DAC from the IOC) by the formula,

$$V_{set} = \sqrt{R_h * P_{set}}$$

[1] taken verbatim from the ITC502 manual pg 21

where R_h is the resistance of the heater coil. R_h, is a measured quantity that should not change significantly once it is measured. V_{set} is the required voltage for the heater power supply to produce the desired heat load, P_{set}.

5.4.1 Heater Mode

There are four allowed heater modes (of which only the first three have been implemented so far). These are:

OFF
The heater is turned off.

Manual
The heater power setting is determined by the "Manual Power Setting" (see SETTINGS below) which is usually input by the user.

Constant Heat Load
The control system is required to keep the total heat load of the beam and the high power heater equal to a constant specified as the "Constant Power Setting" (see SETTINGS below). This is done by the control system calculating the heat deposited in the target by the beam and then adjusting the heater power to by the formula,

$$P_h = P_c - P_b$$

PID Control
In this mode, a software PID control loop on the IOC controls the high power heater setting, feeding back off the temperature of the CERNOX resistor on the target loop.

5.4.2 Setting High Power Heaters

5.4.2.1 Determining the High Power Heater Mode

The High Power Heater mode for each loop is displayed on the main tgt window as **htr Mode**. The allowed modes are: **OFF**, **MANUAL CONSTANT** and **PID Control**. The heater mode is also displayed on the Loop control panels (the **Mode:** entry on the side panel under **HIGH POWER HEATER**. And finally, the mode is displayed on the High Power Heater Control Panel.

5.4.2.2 Opening the High Power Heater Control Window

1. Open the Loop window for the desired loop (green button at top of main window).
2. Select **High Power Heater** from the **Heaters Menu** on the loop. A window will pop up for the High Power Heater Control. If the loop controls are enabled, the border of the window will be red. If the loop controls are not enabled, the border will be gray.

5.4.2.3 Setting Maximum Heater

To Set the maximum allowed heater power for the high power heater in a loop:

1. Open the High Power Heater Control Window (see section 5.4.2.2).
2. Ensure that the Controls for the loop whose heater is to be set are enabled. (See **Enabling Controls** section 4.1).
3. click on the sunken window displaying the **Maximum Heater Power:** in the **Settings** panel of the window. A popup window will appear asking for the new maximum heater value. Enter the new value and push *return* or click on the **OK** button. If you wish to cancel the operation, click on **CANCEL**.
4. The value shown in the sunken window will change to the new value for the maximum power.

5.4.2.4 Changing from Heater Off to Manual Heat Load

Assuming that the high power heater is off, to manually select the High Power Heater heat load for a target loop:

1. Open the High Power Heater Control Window (see section 5.4.2.2). To check that the heater is indeed off, check the **Pset** reading in the **Heater Readback** panel of the Heater control window. It should read zero.
2. Ensure that the Controls for the loop whose heater is to be set are enabled. (See **Enabling Controls** section 4.1). If the loop controls are enabled, the border of the window will be red. If the loop controls are not enabled, the border will be gray.
3. Select the desired Heater Power setting, by clicking on the sunken window showing the current **Manual Power Setting**. A pop up data entry window will allow you to enter the new value. After entering the new heater power setting, ensure that it was accepted by the EPICS data base (it will appear as the Manual Power Setting in the window).
4. Change the Heater Mode from **OFF** to **Manual** by clicking on the **Manual** button in the **Heater Mode** panel. The "LED" next to the **Manual** button should turn green and the "LED" next to the **OFF** button should turn gray. The high power heater should now be on. Verify this by looking at **Pset** in the **Heater Readback** window which should show a heater reading similar to the requested Manual Power setting.

5.4.2.5 Changing Constant Heat Load to Manual Heat Load

1. Open the High Power Heater Control Window (see section 5.4.2.2).
2. Ensure that the Controls for the loop whose heater is to be set are enabled. (See **Enabling Controls** section 4.1). If the loop controls are enabled, the border of the window will be red. If the loop controls are not enabled, the border will be gray.
3. Look at **Pset:** in the **Heater Readback** panel. Note the current heat load selected by the Constant Heat Load alogrithm. Set the Manual Heat Load to this value by clicking on the window displaying the **Manual Power Setting:**. A data entry window will pop up to input the new heat load.
4. click on the **Manual** button in the **Heater Mode** panel to change from **Constant Heat Load** to Manual.

5.4.3 PID control of High Power Heaters

The High power heaters have optional PID control from the IOC. IF the heaters are set in **PID control mode**, the IOC regulates the high power heater power to maintain a constant temperature on the CERNOX resistor used as the temperature sensor for the PID circuit. Currently the sensors used are:

```
loop    sensor
  1(H2)  cernox 1
  2(He)  cernox 2
  3(D2)  cernox 1
```

The choice of cernox 2 for loop 2 was because cernox 1 was unreliable. The PID control can be started in one of two ways:

1. By setting the heater mode to PID from the heater control window
2. By enabling the **PID enable** button. If the PID enable button is set, then if the temperature on the PID sensor goes outside the HIHI and LOLO range, the heater is switched to PID mode automatically and the PID control trys to restore the temperature. The HIHI and LOLO limits for the pid control are set from the heater PID window.

Ebeam (GeV)	H_2 dE/dx($MeVcm^2/gm$)	D_2 dE/dx($MeVcm^2/gm$)
0.845	4.64	2.32
1.645	4.74	2.37
2.445	4.80	2.40
3.245	4.85	2.43
4.045	4.88	2.44

Table 5.2: Electron energy loss in liquid hydrogen and liquid deuterium

The PID feedback parameters are:

```
PROP  600.0
INT    40.0
DERIV   0.0
```

5.4.4 CAMONSAVE High Power Heater Logging

The program camonsave running on cdaqh1 is automatically saving the latest values of the high power heater settings to the file

```
~/SCRIPTS/vmec4.heater.init
```

and these parameters will be reloaded into the IOC at boot time. Thus the last values of the high power heate used will be restored to the ioc. At present the acception to this are the **mode** and **PID enable** parameters. Instead, the high power heaters will boot up disabled so it is necessary for the user to manually restart them.

5.4.5 High Power Heater Restore from GUI

Every time a High Power Heater parameter is set, the file **tgt.par_heater** is updated with the current values. In the event of an IOC reboot, the GUI detects it and displays the **IOC crash** window. From this window the **Restore Heater Parameters** window is called which shows the current vs old heater parameters. This window is a guide for resetting the parameters to their original values. The **Restore Heater Parameters** window can also be called from the **Options** menu of any of the high power heaters.

5.5 Beam Heat Load Calculation

The beam heat load on a target cell is calcualated by the formula,

$$P = I_b \times \frac{dE}{dx} \times \rho \times t$$

where

I_b	= Beam current in μA
$\frac{dE}{dx}$	= electron energy loss in $MeVcm^2/gm$
ρ	= target density in gm/cm^3
t	= target length in cm

The energy loss for electrons in Hydrogen and Deuterium are given in table 5.2 (the values for Deuterium are Hydrogen values scaled by Z/A, i.e. 1/2).

5.5.1 Changing Beam Heat Load Parameters The Straight Forward Way

The most straight forward way to change then parameters used to calculate the beam power load on the target cells is to repeat this procedure for each target loop:

1. Open **Position Options** Window under the **Position Menu** on the **tgt** window
2. Verify that **Beam Energy Loss Update** is **NOT** selected
3. Move Target to new target cell position
4. Open High Power Heater Window for loop (**High Power Heater** option under the **Heaters Menu** on the loop window)
5. Inspect the beam parameters: **dedx**, **tgt dens**, and **tgt l**. If a parameter is incorrect, enable the **Heater Parameters** security under the **Security Menu** (this requires EXPERT privilleges), and change the necessary parameters by clicking in the recessed box.

5.5.2 Changing Beam Heat Load Parameters The Fancy Way

There is a more automated way to change the beam heat load parameters but it is more complicated to set up. Repeat for each target loop:

1. Verify that the correct cryogen has been selected for target loop. (This can be done by looking at the title of a loop window.)
2. Verify that the energy loss and density parameters for the cryogen being used are correct for the particular beam energy and target configurations. Do this by:
   (a) Select **Cryogen Properties** from the **Cryogens Menu** on the **tgt** window.
   (b) If the cryogenic properites are incorrrect, enable the **Cryogenic Properites** Security under the **Security Menu** of the Cryogen window (requires EXPERT privillages), and enter new values by clicking on the sunken window for the cryogen. These values can be saved using the **Save Cryogen Properties** option under the **File Menu** (requires EXPERT privillages).

Once this has been done for all three loops,

1. Open the **Position Options** window under the **Position Menu** on the **tgt** window.
2. Verify that the target cell lengths for the loops are correct. If not, they can be changed by enabling the **Target Cell Lengths** under the **Security Menu**.
3. Verify that the **Beam Energy Loss Update** in enabled. To enable it, first enable the **Beam Energy Controls** from the **Security Menu**.
4. Move the target to the new cell position using the target lifter window. When the target reaches the new cell position (indicated by the LED next to the selected position turning green) the target parameters will be automatically updated.
5. Verify that the correct energy loss parameters have been loaded by checking the high power heater window.

If cryogen parameters have been changed but the target has not been moved, the new parameters can be loaded using the **Load Current Energy Loss Parameters** button on the **Position Options** window (enable the **Beam Energy Controls** from the **Security Menu**).

5.6 Loop Pumps

The pumps (also called fans) in each loop circulate the cryogen through the target cells and then through the heat exchanger. The pumps are axial fans located inside the heat exchangers for the loops and are powered by 3 phase motors. The fans are powered by UD3 3 phase power supplies which allow frequency control over the pump. The frequency controller settings (the fan speeds) are set in the Fan Control window located in the "FANS" dialog box under the menu item "DEVICES" or under "FANS" in the Loop menu.

5.6.1 Changing Pump Speed

Caution should be used when setting the target loop pumps. If they are set too low, there is a danger of stalling which will prevent the circulation of the cryogen and possibly cause a boil off.

Type the desired frequency into the percent frequency box. The value can be 0 to 100% of the setpoint frequency. The nominal operating frequency is 60 Hz which is 25% of the nominal setpoint frequency of 240 Hz.

5.7 Loop Graph Displays

There are predefined charts for each target loop that can be displayed from the **Charts Menu** on the **tgt** window. Under the **Pump/Purge Charts** submenu, are charts for the H_2 and D_2 gas panel pressures, useful during the pump and purge cycles. Under the **Loop Charts** submenu are charts showing all the main parameters of each loop as charts. A vapour pressure graph is also shown. The **Loop Charts** can be displayed loop by loop or all three loops (and the cryostat charts as well) can be displayed at once using the **All** option.

Chapter 6

Cryostat Operation and Target Motion Control

6.1 Changing Cryostat Cooling

6.1.1 Manual Heat Load Change

To facilitate heat load changes on the target loops, there is a **Manual Heat Load Change** window that is accessed from the **Heat Menu** in the **Cryostat** window. This window groups together abridged versions of the controls for the temperature controllers, the high power heaters and the JT Valves for each loop and the cryostat. A companion window is the **Heat Load Charts** window that can be opened from either the cryrostat window or from the **Charts Menu** in the Manual Heat Load window. This chart window displays loop and cryostat temperatures, the loop and cryostat power loads and the JT valve settings.

6.1.2 Manually Setting JT Valves

First open the control window for the desired JT Valve:

1. Open The Cryostat Window (green button marked **CRYOSTAT** on the top right of the main **tgt** window.
2. Ensure that the **CRYOSTAT** controls are enabled (see section 4.1).
3. Click on the coloured part of the JT Valve to be changed. A popup control window for the JT Valve will appear. If the controls for the **CRYOSTAT** are enabled, the border of the window will be coloured red and the buttons will be raised.

The valve control window displays the name of the valve (make sure you have the one you want!), the current position in units of percent full open (i.e. 0= closed, 100=full open) and has buttons to enter a new valve position. There are two ways to change the JT Valve settings:

Absolute Position This sends the valve directly to a position.

1. click on the **Go To Position** button. A data entry window will appear and a new valve position can be entered.

Step Change The other way to change the valve setting is to do so in small steps. This is useful if fine tuning of the valve settings is desired.

1. First select the desired step size in percent. The smallest step that the valve can make is 0.4% so the step size should be larger than this. Click on **Relative Step** and a data entry window will ask you for a new step size.
2. Now use the **Step Close** and **Step Open** buttons to close or open the valve one step.

6.1.3 Manual Heat Load Changes

The **Manual Heat Load Change** is used to change the heat load settings on the target loops. It is opened from the **Heat Menu** on the **cryostat** window. The Manual Heat Load Change window has abreviated controls for the temperature controllers

6.2 Target Motion Control

6.2.1 Vertical Motion

The vertical target motion is controlled from the **Target Lifter** window. To open the target lifter window, click on **Target Lifting** under the **Position Menu** on the main **tgt** window. The Target Lifter window will appear.

The target lifter window has a panel on the left side displaying preset positions for the cyrogenic target ladder (the six target cells, two dummy cells, "home", "empty" and clear). By clicking on one of the buttons, the target can be moved to the desired preselected position.

Below the pos select panel is a kill button to immediately halt and target motion.

On the right side of the target lifter window is a display showing the current position of the target both graphically and numerically. Below the display is a button to input an absolute target position. Below the absolut position button is a panel that allows the user to "single step" the target up or down, with an adjustable stepsize. Below this panel is the button to select lifter speed (in RPM). Below the lifter speed input is a panel that displays the status of the target lifter.

To enable the lifter controls, select the **DATABASE** enable from the **Enable Controls** option of the **Modes Menu** (see section 4.1). Looking at the Lifter window,

POS SELECT

- **CLEAR** reset the target lifter controller after the position has been changed by either the single step or the absolute position controls (i.e. the target has been moved to a position other than the predefined positions).
- **GO HOME** Go to the "Home" position to recalibrate the position encoders. **Note: this button is not yet implemented and requires special EXPERT privillage to operate. Should not be used unless cleared by Jim Dunne.**
- **4 CM DUMMY** Go to the 4cm long dummy cell at the top of the cryostack.
- **4 CM H2 CELL** Go to the 4cm H2 target loop cell
- **15 CM H2 CELL** Go to the 15cm H2 target loop cell
- **4 CM He CELL** Go to the 4cm He target loop cell
- **15 CM He CELL** Go to the 15cm He target loop cell
- **4 CM D2 CELL** Go to the 4cm D2 target loop cell
- **15 CM D2 CELL** Go to the 15cm D2 target loop cell
- **15 CM DUMMY** Go to the 15cm long dummy cell at the bottom of the cryostack.
- **EMPTY** *there is no "empty target" position*

When a position is selected, the "LED" to the left of the display turns YELLOW. When a position is reached, the LED turns GREEN.

KILL The KILL button below the POS SELECT panel, immediately stops the target motion (the led to the right of the button will flash green for a brief moment).

POS DISPLAY Located on the right side of the lifter window, the position display has a cartoon of the target cryostack that indicates its current position. The current position is also indicated by the "Current Position:" indicator below the diagram of the stack.

Set Position The "Set Position" button is used to enter an absolute position for the cryotarget stack other than the preset positions from the "POS SELECT" panel. **ONCE THE TARGET HAS BEEN MOVED BY THE SET POSTION BUTTON, THE CONTROLLER IS NO LONGER ABLE TO RECONGNIZE THAT THE TARGET IS "AT" ONE OF THE PREDEFINED POSITIONS. BEFORE USING THE "POS SELECT" POSITIONS, THE "CLEAR" BUTTON MUST BE PRESSED.**

SINGLE STEP MOTION The "Single Step Motion" panel is used to move the target up or down in small increments. The step size is entered with the "Step Size" button and then by clicking on "UP" or "DOWN" the target is moved by that increment. **ONCE THE TARGET HAS BEEN MOVED BY THE "SINGLE STEP MOTION", THE CONTROLLER IS NO LONGER ABLE TO RECONGNIZE THAT THE TARGET IS "AT" ONE OF THE PREDEFINED POSITIONS. BEFORE USING THE "POS SELECT" POSITIONS, THE "CLEAR" BUTTON MUST BE PRESSED.**

Lifter Speed Sets the speed of the motors in RPM. The absolute speed limit is set currently at 300 RPM in the Lifter Control Box. A software limit only allows the user to input speeds between 0 and 299 RPM.

STATUS Shows the controller status

BUSY Indicates that the controller is moving the target

ERROR An error has occured (I have no idea what kind of error).

6.2.1.1 Selecting a Standard Target Position

IF YOU HAVE TO STOP THE TARGET QUICKLY WHILE IT IS MOVING, HIT THE **KILL** BUTTON

1. Check that the **DATABASE** controls are enabled (see section 4.1).
2. Ensure that it is safe to move the target.
3. If the last target motion was a move to a nonstandard target location, it is necessary to click on the **CLEAR** button to tell the lifter controller that it is supposed to go to a new location. One indication that the target has been moved to a nonstandard location is to look at the "LED"s next to the move buttons. If the selected target has a green LED, then the target is at that position and probably has not been moved. If the LED is yellow, then that position was selected, but the target is not at it, meaning that the target was moved to a nonstandard position.
4. Click on the button for the new target position. The selected position LED will turn yellow, the **BUSY** LED will come on and the target will start moving. The current position LED will turn from green to gray as soon as the target moves away from this position. When the target has reached the new position, the selected LED will turn green and the **BUSY** LED will turn off.

6.2.1.2 Moving to a Nonstandard Target Position

IF YOU HAVE TO STOP THE TARGET QUICKLY WHILE IT IS MOVING, HIT THE **KILL** BUTTON
Going to an Absolute Position

1. Check that the **DATABASE** controls are enabled (see section 4.1).
2. Ensure that it is safe to move the target.
3. Click on the **Set Position** button. A data entry window will pop up. Enter the new position. The **BUSY** light will come on and the target will move to the new position. When the target is at the new position, the **BUSY** light will go off.

Stepwise Motion

1. Check that the **DATABASE** controls are enabled (see section 4.1).
2. Ensure that it is safe to move the target.
3. Check that the desired step size is in place. If not, enter a new stepsize by clicking on the **Step Size** button.
4. Click on either the **UP** or the **DOWN** button to move the target. The **BUSY** light will come on and the target will move to the new position. When the target is at the new position, the **BUSY** light will go off.

6.2.2 ***Rotation

6.3 Solid Target Ladder Control

6.3.1 The GUI Interface

6.3.1.1 Novice window

As a Novice target operator, you are only able to observe the position of the target ladder. The GUI window for the Solid Target Ladder is displayed from the main target monitor application via the **Position** menu. The Solid Target Display has a number of buttons and one graphical display related to the position of the electron beam on the solid target ladder. A frame of buttons with target names and properties appears within the left most frame. A **KILL** motion button appears underneath the target selection list which simply stops target movement. The right most frames have a current position display, desired position selector, and a few motion parameters. The Bottom frame contains a few diagnostic LED's which may be of use. In order to select a target position other than the **HOME** position you must enter the target OPERATOR password using the security menu. To set motor parameters and select the HOME sequence button you must enter the target EXPERT password. When buttons are active, a red border will appear around the GUI display for that device and several buttons will become visably raised.

6.3.1.2 Target Operator state

As target operator, you are responsible for selecting solid targets and/or moving the solid target ladder to a desired absolute position. After entering the correct password, the GUI window for the Solid Target Ladder will have several active buttons for a time limit set by the target EXPERT. A target OPERATOR will not be able to set the target parameters of MIN and MAX software position limits, the lifter motor velocity, nor execute the **HOME** sequence.

6.3.1.3 Expert Target Operator State

As target EXPERT, you accept a heavy weight of responsibility. In addition to doing everything a standard OPERATOR can do you are also capable of selecting software position limits, motor speed, and executing the HOME sequence. After entering the correct password, the GUI window for the Solid Target Ladder will be completely active.

6.3.1.4 GUI interface quirks

Quirks: 1.) The **ERROR** LED is not very dependable. The light could be on (green) and yet you will still be able to move the target. It does appear to see every failure though.

2.) When a move is interupted (via a **KILL** command), motion to the selection made before the interuption will not be possible until an alternative position is selected. This is intrinsic to how EPICS works via data base updating etc....

Solution: When you find that the position selector button is not working select a nearby position and during the motion select the desired position. Sometimes the CLEAR button will rectify the situation, however the above method will always work in the absence of a hardware or software failure.

6.3.2 The Motor Controller

Currently the Solid target ladder is using the S6961 series motor.

6.3.2.1 The files

Programs used to control the target ladder motor are currently located in /cdaqh1/d1/epics/dvl/ctarg.3_12/ladder/.

6.3.2.2 How to make

goto the directory /cdaqh1/d1/epics/dvl/ctarg.3_12/ladder/O.mv162/ and type “make S5851L”

6.3.2.3 Putting it together

6.3.2.4 Resetting the Solid Target Lifter

As of July, 2000 there is a “reset” button which power-cycles the solid target lifter system. It is at position “3” on the PIVOT reset switch in the electronics room of the counting house.

6.4 Cryostat Graph Display

By selecting the **Cryostat** option of the **Loop Charts** submenu of the **Charts Menu** on the **tgt** window, charts of the cryostat temperatures and pressures will be displayed. These charts will also be displayed if the **All** option is used.

Appendix A

People to talk to and Places to Look for Stuff

A.1 People

Below is an incomplete list of people involved in the Hall C target controls and their areas of involvement. This list should give you an idea of who to talk to first about a given problem. For telephone and pager numbers you should use 'staff' on one of the jlab central computers or consult the *Essential Information for Target Operators document from the Hall-C Manuals*[1] *web page.*

```
Target Group People JLab loc    Responsibility
------------------- --------    --------------

Dave Meekins           7440     General Target Support for Hall C
                       5434

Chris Keith            5878     GUI programing; Epics

Mike Seely             5036     Target Group Leader; Hardware

Hall C People       CEBAF loc   Responsibility
-------------       ---------   --------------

Greg Smith             5405     Liaison between Target Group and Hall C;

Steve  Wood            7367     Hall C computers, network, interface to CHL data


Accelerator People (bother Hall C people first)
-------------------

David   Wetherholt    5066      Target motion device drivers and
                                user interface
```

[1] http://www.jlab.org/Hall-C/document/

A.2 Usefull places To Look For Stuff

A major source for documentation on the Hall C Cryogenic Target is the Hall C documents directory

`/home/cdaq/documents/target`

Some of the documents available in this directory are:

User Manual *This document*

Programmers Guide *for the Hall C cryogenic target control system. Contains a deeper discussion of the GUI and IOC programming.*

A.2.1 GUI Help Documents

The major souces of documentation for the GUI are the target home page (see previous section) and the GUI's help facility. Many help documents are available online from the GUI using the **Help Menu** *located at the top right of every window. Most of the* **tgt** *GUI windows have their own text based help files. These help files reside in the directory:*

`/cdaqh1/d1/epics/apple/ctarg/tk/tk_ctarg/usrtgt/help`

In addtion to the individual help files for the windows, there are more general help files. A brief description of some of these files follows:

tgthelp_bugs.txt
A report of known bugs in the target control system.

tgthelp_todo.txt
A list of the things to be done on the target control system.

tgthelp_wiring.txt
A description of what sensors are connected to what device hardware channels and the names of the EPICS database records.

tgthelp_ioc.txt

A detailed description of the necessary responses of the control system to alarm conditions and other actions. These are ultimately to be placed in the IOC but some actions are currently being controlled by the GUI.

tgthelp_program.txt
A description of the how the GUI program is implemented. Not terribly up to date or complete.

tgthelp_names.txt
A description of how variables are accessed from the GUI (the GUI and EPICS naming convention).

Most of the other files in this directory are descriptions of individual windows used in the GUI and can be accessed from the help menu in each window.

A.2.2 EPICS General Documentation

General documentation on the EPICS control system can be found at the Web sites: http://www.atdiv.lanl.gov/doc/epics/epics or http://epics.aps.anl.gov/asd/controls/software_tools.html

A.2.3 EPICS DATABASE STUFF

- *Mike Johnson is compiling documents describing the IOC and EPICS control system for the Hall C target in the directory,*

  ```
  /usr/user3/mjohnson/DocWork
  ```

- *Mike Johnson has a listing of the database elements in:*

  ```
  /usr/user3/mjohnson/Ctarg/database.2.1
  ```

  or whatever the highest number is. It is also broken up by the type of entry in the files,

  ```
  *parms.2
  ```

  etc.

- *In the directory*

  ```
  /cdaqh1/d1/epics/apple/ctarg/db/sr
  ```

  there is database stuff. In particular, if you type,

  ```
  grep PV ctgt.sf
  ```

  you get a list of all the database records from the CAPFAST database drawing.

- *If you are looking for names and parameters used by EPICS and can't find them in the documentation, you may want to grep through the source code. One place to look is:*

  ```
  /cdaqh1/d1/epics/dvl/ctarg.3_12/base/src/ascii
  ```

A.2.4 Target Motion

```
/cdaqh1/d1/epics/dvl/ctarg.3_12/motors
```

A.2.5 GUI STUFF

The TGT GUI stuff is developed in the directory:

```
/cdaqh1/d1/epics/apple/ctarg/tk/tk_ctarg/
```

and its subdirectories. The latest user version is kept in the subdirectory,

```
usrtgt/
```

and the development versions are in directories that reflect the version number,

```
tgtxxx/
```

where xxx is the version number.

Appendix B

IOC and EPICS Issues

B.1 Description of IOC Software

```
* What pieces of software sit in the IOC?
   - device drivers (list)
   - databases
   - finite state machines (sequencers?)
   - hardware mapping stuff


* What do they do?

* Where are their source codes on the UNIX machines?

               call Mike   Johnson  pager 680-0322
```

B.1.1 IOC Boot Scripts

The Boot scripts for the IOC software and the boot time values for EPICS parameters are located in the directory,

```
/home/cvxwrks/SCRIPTS
```

Important files in this directory:

vmec4.boot *The boot script loaded by the IOC*

vmec4.epics *The EPICS boot stuff called at the end of* **vmec4.boot**

vmec4.bdspos.txt *The positions of the target cells on the cryostack. Loaded at boot time. Used by the vertical motion control to move the target to the cells.*

B.2 VxWorks

Some useful commands are:

```
logout                        --  logs out of the IOC

dbpf''epicsfield'',''value''  --  puts a value in the epics database field
```

```
dbpr''epicsrecord'',num       --  displays the record.  0 = least info
                                                       5 = most
                                  can leave off the ,num and defaults to 0
```

B.3 Description of EPICS database

B.3.1 Low Level Database Records

B.3.2 High Level Database Records

B.3.3 Target Motion

```
#rotator
  tgt_epicsadd_ao 12  simbcm    ;#Choice button for choosing simulation.
                               ;# 0 -Not in simulation 1 -Use simulation value
  tgt_epicsadd_ao 12  simon     ;# Holds the simulation value for beam.
  tgt_epicsadd_ao 12  SMC00DEG  ;# setpoint for the 00 Degree pos
  tgt_epicsadd_ao 12  SMC90DEG  ;# setpoint for the 90 Degree pos
  tgt_epicsadd_ao 12  SMCABS    ;# set absolute position.
  tgt_epicsadd_ao 12  SMCBEAM   ;# beam current readback (a BCM).
  tgt_epicsadd_ao 12  SMCBUSY   ;# This has a value of 1 if the motor is busy.
                               ;#  0 - Not Busy           1 - Busy
  tgt_epicsadd_ao 12  SMCERR    ;# value of 1 if an error occured.
                               ;# 0 - No Error  1 - Error occured
  tgt_epicsadd_ao 12  SMCKILL   ;# Holds the value for the "Kill" pushbutton.
  tgt_epicsadd_ao 12  SMCPOS    ;# This is the current position of the motor.
  tgt_epicsadd_ao 12  SMCSELECT ;# value for the last motor position command
                               ;#  initiated throught the pulldown menu.
                               ;#  0 -Clear Command  2 -Go 00 Degree Position
                               ;#  1 -Go Home        3 -Go 90 Degree Position
  tgt_epicsadd_ao 12  SMCSET0   ;# value for the "Set 00 Deg Pos" pushbutton.
  tgt_epicsadd_ao 12  SMCSET1   ;# value for the "Set 90 Deg Pos" pushbutton.
  tgt_epicsadd_ao 12  SMCVEL    ;# value for setting velocity (speed)
  tgt_epicsadd_ao 12  SMCSTEPSIZE ;# size of step for single stepping

# lifter
  tgt_epicsadd_ao 12  BDSERR    ;# This has a value of 1 if an error occured.
                               ;#   0 - No Error           1 - Error occured
  tgt_epicsadd_ao 12  BDSBUSY   ;# This has a value of 1 if the motor is busy.
                               ;#   0 - Not Busy           1 - Busy
  tgt_epicsadd_ao 12  BDSSTAT   ;# value for "STATUS" command
  tgt_epicsadd_ao 12  BDSKILL   ;# value for the "Kill" pushbutton.
  tgt_epicsadd_ao 12  simon     ;# set simulation beam current.
  tgt_epicsadd_ao 12  BDSABS    ;# set absolute position.
  tgt_epicsadd_ao 12  BDSBEAM   ;# value for beam current readback (a BCM).
  tgt_epicsadd_ao 12  BDSVEL    ;# set velocity (speed)
  tgt_epicsadd_ao 12  BDSPOS    ;# current position of the motor.
  tgt_epicsadd_ao 12  BDSSELECT ;# value for the last motor position command

  tgt_epicsadd_ao 12  BDSSTEPSIZE ;# size of step for single stepping
```

B.4 Changing Boot Time Values of EPICS Database Parameters

The Sorts of things that should be loaded into the IOC database at boot time are:

- *Alarm set points and default settings for alarm enables*
- *Calibration parameters for devices (e.g. ADC to power supply voltages)*
- *Other calibrations such as the Vapour Pressure Thermometery calibrations.*

The currently existing initialization files are located in the directory,

```
/home/cvxwrks/SCRIPTS
```

and these are:

vmec4.par.init *This file used to be called* `vmec4.par.init` *and contained only the vapour pressure calibrations for the vapour pressure thermometers. It has had it's name changed and now contains in addition to the vapour pressure calibrations, general parameters as well.*

vmec4.p10cal.init *The calibrations (Voltage to ADC settings) for the Power 10 High Power Heater Power Supplies.*

vmec4.asp.init *The default alarm set points for boot up.*

The initialization files are loaded into the IOC by the boot script. In

```
vmec4.epics
```

are the lines

```
<vmec4.par.init
<vmec4.p10cal.init
<vmec4.asp.init
```

The command '<' instructs VxWorks to take commands from the following file. In the files are simple database put field commands, **dbpf***, which load the database fields. The lines of these files look like*

```
dbpf"myfield.HIHI","newval"
```

So to change the boot time value of a database field:

1. *Log onto the* **cvxwrks** *account*
2. *go to directory,*

   ```
   /home/cvxwrks/SCRIPTS
   ```

3. *Edit and then save the initialization file containing the desired parameter. If the file does not contain the desired parameters, new ones can be added.*
4. *The new values for parameters will be loaded with the next IOC reboot.*

B.5 Rebooting the IOC

As described by Mike Johnson:
These go from the least effective to the most effective and drastic.

1. *Login to the IOC. If you don't have the password, then you probably shouldn't. Control-X is the hotkey for reboot. Sometimes this works.*

2. *Login to the IOC. Our kernels are equipped with a "lifeline" task which will cause the IOC to reboot if it is ever removed. Delete it by entering "td tsysWdog" at the command prompt. This is somewhat more reliable.*

   For the above steps, login refers to a telnet or a serial line connected to the Console port of the IOC, as with a LAT server. If one is using a serial line directly to the IOC, you can watch the IOC reboot and scan all of the boot messages. This can be important for debugging. However, with telnet, you must logoff after reboot because the IOC forgets how to use this kind of ethernet connection and will not remember until it has finished executing its reboot script. Note that only one person may login to an IOC at a time. In the case where someone is at the console port and another person telnets in, the telnet will interrupt the console session. A telnet session cannot be interrupted, except by reboot.

3. *Hit the reset on the front of the crate controller (our IOC) or the crate itself. The reset on the front of the crate is wired in parallel to a breakout box in the Hall C Counting Room. Use the Cryotarget knob set on one to reset. Note that certain devices, such as Relay Boards or DACs, remember their last settings and keep them after a reset.*

4. *Turn the power on the crate off and back on. This is drastic since nothing in the crate (Industry Packs, Relay Cards) will remember what it was doing when they come back on. This is sometimes necessary to rid the system of serious runtime bugs. I have had to use it for a "spurious interrupt" error. I haven't discovered where this error is coming from.*

B.6 Channel Mapping: Changing the link between the EPICS Database and Hardware

```
From: IN%"mjohnson@CEBAF.GOV"  "Michael Johnson" 11-NOV-1995 11:26:05.56
To: IN%"terburg@CEBAF.GOV", IN%"fduncan@CEBAF.GOV", IN%"beattyd@CEBAF.GOV"
CC:
Subj: Channel Mapping

Guys,

All of my working documents are in ~mjohnson/DocWork.  Please jump
in anytime you need info, and mail me your comments.

-Mike-


### Enclosure : channels.txt ###

Changed : 11-11-95
Mike Johnson
Fraser Duncan

Channel Mapping
```

Channel mapping is being implemented in three stages, in a sequence of increasing difficulty.

1) Database Links : Solenoid Valves and ADC / DAC dependent devices (eg Power 10 Power Supplies for the High Power Heater) are represented by records in EPICS. These records are in turn linked to other records in the database, which I call "raw" records. These raw records represent things like Relay Channels on our Relay Boards, or ADC channels on our Industry Packs. By changing which raw channel an instrument links to, we can switch it off of a faulty channel and onto a good one. This method at its simplest level involves changing a file and recompiling the database. This process is described below.

2) Direct Addressing : The addressing problem could be automated by the use of "hwio" and "address" files. In this method, the instrument records are no longer linked to raw records, and the raw records may even be removed. Instead, the instrument records contain a direct message to a device driver (as did the raw records) instructing it which data to send or receive. The hardware and address files contain a convenient table matching messages, drivers, and records. This is an easier change, but still requires recompiling and rebooting. This process can be tricky if one accidentally requests the same information for multiple records. This can cause a bottleneck since our resources can only speak to one thing at a time.

3) RunTime Addressing : A record would be added to the database for each instrument which would indicate which channel that instrument is connected to. This would allow us to fix a problem without rebooting the IOC. It is very difficult to program and adds a great deal of complexity to the system.

##

Progress Report :

Serial Devices are in stage (3), but are still being debugged. -MJ
Power 10s, Pumps, and Solenoid Valves are in stage (1) for now.
JT Valves are in stage (0), that is the programmer would have to alter source code and recompile drivers.

##

Instructions for Emergency Implementation of (1) :

The EPICS database is defined in CapFast schematic files. However, changing this file is not needed for a quick fix. When the database is compiled, a Short Form file is created which contains a text description of everything in the database. (Note that more than one database may be loaded separately.)

1 - In the directory /cdaqh1/d1/epics/apple/ctarg/db/sr/ there is a file named ctgt.sf . Edit this file. (But copy it to a backup first :-)
2 - Search for the name of your record, eg SV9093_W, SV9093_R...

```
3 - Everything below the name and before the "^L" (pagebreak)
describes something in that record.  Scan for the name of a hardware
link, eg Relay_1-11_W, Relay_1-11_R, ADC_0_+_R, DAC_0_W, ...  This
link will most likely be in a field named OUT, INP, FLNK, VAL, or DOL.
It may be in two fields ; if so you need to change both.
4 - Change that name to a channel you think might work.
5 - If there is a matching read and write record for an instrument,
make sure you look for both.
5 - Go up and over to directory /cdaqh1/d1/epics/apple/ctarg/sch.
6 - Type "make".  This compiles all databases.  If you notice
errors in the one you just changed, go back and compare the file you
changed with its backup.  (You did make one, right?)
7 - Reboot the IOC.  The database is automatically loaded.
```

B.7 EPICS Alarms

What follows is a discussion of the EPICS alarms by Mike Johnson.

```
Changed : 11-26-95
Author :
Mike Johnson

EPICS Alarm States for Records

Each EPICS record contain the fields STAT and SEVR, which indicate
the alarm condition of the record whenever it was last processed.  If a
record is not processed, its status does not change.  The job of the SEVR
field is to indicate the level of the current alarm status, while STAT
indicates the cause of this status.  These levels and causes are listed
below.  EPICS is "smart", and will not let a lower level alarm override a
higher level one even if the lower one arrives later.
Records which are _directly_ connected to device drivers can receive
error status messages from the drivers themselves.  A serial driver, for
example, can tell "H2_502_Sensor_1_R" to go TIMEOUT/INVALID if the device
has not responded to a message in over 5 seconds.  Any record
which is linked to another record indirectly does not necessarily
absorb that lower level record's alarm status.  IE if the INP field of
"H2_TI_Fore_Heater_R" is pointing to "H2_502_Sensor_1_R", the VAL fields
of the records will match, but not necessarily the STAT/SEVR fields.

------- The following info is extracted from EPICS/base/include/
alarm.h and alarmString.h and is only as current as they are.

STAT :

- Values
NO_ALARM 0x0
MINOR_ALARM 0x1
MAJOR_ALARM 0x2
INVALID_ALARM 0x3
ALARM_NSEV INVALID_ALARM+1
```

```
- Matching Strings
"NO_ALARM"
"MINOR"
"MAJOR"
"INVALID"

SEVR :

- Values
READ_ALARM 1
WRITE_ALARM 2
/* ANALOG ALARMS */
HIHI_ALARM 3
HIGH_ALARM 4
LOLO_ALARM 5
LOW_ALARM 6
/* BINARY ALARMS */
STATE_ALARM 7
COS_ALARM 8
/* other alarms */
COMM_ALARM 9
TIMEOUT_ALARM 10
HW_LIMIT_ALARM 11
CALC_ALARM 12
SCAN_ALARM 13
LINK_ALARM 14
SOFT_ALARM 15
BAD_SUB_ALARM 16
UDF_ALARM 17
DISABLE_ALARM 18
SIMM_ALARM 19
READ_ACCESS_ALARM 20
WRITE_ACCESS_ALARM 21
ALARM_NSTATUS WRITE_ACCESS_ALARM + 1
** If SEVR==NO_ALARM then STAT appears to be empty

- Matching Strings
"NO_ALARM"
"READ"
"WRITE"
"HIHI"
"HIGH"
"LOLO"
"LOW"
"STATE"
"COS"
"COMM"
"TIMEOUT"
"HWLIMIT"
"CALC"
"SCAN"
"LINK"
```

```
"SOFT"
"BAD_SUB"
"UDF"
"DISABLE"
"SIMM"
"READ_ACCESS"
"WRITE_ACCESS"
```

B.8 EPICS Archiver

Following is a discussion of the archiver by Mike Johnson

```
From: IN%"mjohnson@CEBAF.GOV"  "Michael Johnson" 21-NOV-1995 17:35:28.51
To: IN%"fduncan@CEBAF.GOV"
CC: IN%"terburg@CEBAF.GOV", IN%"beattyd@CEBAF.GOV", IN%"mitchell@CEBAF.GOV"
Subj: Archiving


Changed : 11-21-95
Author :
Mike Johnson

EPICS Data Archiving

Procedure :

1) Start by logging into your favorite HP.

2) cd /cdaqh1/d1/epics/apple/ctarg/arc

- arReq contains request files for data
- arChan contains archived data in binary format
- arSet contains archived data in text format

3) cd arReq
   create a .req file of your own.
- Example :

vacuum.req

NAME: vacuum Should match file name
DESC:
ACT: always
INACT: never
SAMPLE: periodic 00:00:10 Periodic snapshots of all data
OUTPUT: set:txt Text format
%endHeader%
ADC_15_+_R.VAL Record names
ADC_15_-_R.VAL
```

- Bugs :

Periodic snapshots must be no less than 10 seconds apart.

If you mistype a record name / it can't be found anywhere, the archiver will NOT log ANY data and will NOT give you an error message. If you think this sucks, congratulations! You understand the archiver better than you think.

4) edit enabled.dat

Add a line for each "request file" you've created.

- Example

enabled.dat

vacuum

- Simple, ain't it?

5) cd .. (out of arReq)

6) AR_kbd

7) At the prompt type "enable all" to start archiving and "disable all" to quit archiving.

-Example

```
cebafe cvxwrks 87> AR_kbd
11/21/95 17:11:31 AR    : starting
  AR:  enable all
11/21/95 17:11:33 AR    : **** reading: arReq/enabled.dat ****
11/21/95 17:11:33 AR    :
11/21/95 17:11:33 AR    : bcm
11/21/95 17:11:33 AR    : **** EOF for arReq/enabled.dat ****
11/21/95 17:11:33 AR    : **** reading: arReq/bcm.req ****
11/21/95 17:11:33 AR    : NAME: bcm
11/21/95 17:11:33 AR    : DESC:
11/21/95 17:11:33 AR    : ACT: always
11/21/95 17:11:33 AR    : INACT: never
11/21/95 17:11:33 AR    : SAMPLE: periodic 00:00:10
11/21/95 17:11:33 AR    : OUTPUT: set:txt
11/21/95 17:11:33 AR    : %endHeader%
11/21/95 17:11:33 AR    : **** EOF for arReq/bcm.req ****
  AR:  disable all
```

- Stopping and restarting an archive session does not destroy any data. The program continues to write to the end of the file.

```
- IOC reboots do not crash the archiver.  It will "reconnect"
when the IOC comes back up.

8) Your file should be saved in arSet, named as described in
        your .req file.  The format is pretty straightforward, and some simple
        code is all that is needed to format the data for use in your
        favorite plotting program.

9) Further info on the archiver is found at :

http://www.atdiv.lanl.gov/doc/epics/epicshm.html

or

http://epics.aps.anl.gov/asd/controls/software_tools.html

Please do not come to me for a tutorial before reading these
documents.

10) CEBAF Accelerator is working on a better archive retriever
called xarr.  Other works may be in progress.
Right now, binary archives are only viewable from a program
called ARR, which only works on a Sun.
```

Appendix C

Vapour Pressure of Cryogens

Below are fits to vapour pressure curves for various cryogens used in the Hall C cryogenic target. The function fitted to the data is,

$$\log_{10}(P) = \frac{A}{T} + B + C \times T + D \times T^2$$

where P is in Atm and T is in K. The coefficients for cryogens used in the Hall C target are listed in table C.1.

```
references:

  Hydrogen: Wolley et al Journal of Research of National Bureau of Standards
            41, 379 (1948)

  Deuterium: scaled off a graph from Bates cyrotarget notes

  Helium4:   NIST Helium-4 data tables
```

coef	Hydrogen	Deuterium	Helium4	Neon
A	-55.256	-76.299	-4.0455	-105.7598
B	3.0683	4.2426	-4.73578e-2	4.643295
C	-3.1282e-2	-7.58832e-2	0.30335	-0.03751164
D	6.6989e-4	1.38539e-3	-1.52268e-2	0.0004279898
Tmin(K)	14	19	0.8	25
Tmax(K)	33.2	29	5.1	42

Table C.1: Vapour Pressure Coefficients for Cryogens

Appendix D

Hydrogen Vapour Pressure Thermometry

Each target loop has two vapour pressure thermometers in it, one near the target cell and one at the top of the heat exchanger. The vapour pressure curve used for the calibration is given in table D.1. The fit is:

$$\log_{10}(P) = 3.0683 - \frac{55.256}{T} - 3.1282 \times 10^{-2}T + 5.5989 \times 10^{-4}T^2$$

where T is the temperature in K and P is the vapour pressure in atm

$$P[PSIA] = 14.695 * P[atm]$$

```
ref:  Wolley et al
      "Compilations of Thermal Properties of Hydrogen in its Various
       Isotropic and Ortho-Para Modifications"
      Journal of Research of National Bureau of Standards 41, 379 (1948)
```

Inverting the fit, pressure is converted to temperature over the range 0.960 psia to 188.0 psia (corresponding to T ranging from 14K to 33.2 K).

$$logp = \log_{10}(P[psia]/14.695)$$

and

$$T = a_0 + a_1 * logp + a_2 * logp^2 + a_3 * logp^3 + a_4 * logp^4 + a_5 * logp^5 + a_6 * logp^6$$

with the coefficients given in table D.2.

T(K)	P(atm)	P(psia)
14	0.0653	0.960
15	0.1164	1.711
16	0.1931	2.838
17	0.3018	4.435
18	0.4492	6.601
19	0.5421	9.436
20	0.8870	13.04
21	1.190	17.49
22	1.559	22.91
23	1.999	29.38
24	2.518	37.00
25	3.123	45.90
26	3.824	56.20
27	4.629	68.03
28	5.549	81.55
29	6.593	96.89
30	7.777	114.3
31	9.120	134.0
32	10.62	156.1
33.2	12.8	188.0

Table D.1: Vapour Pressure For Hydrogen

coef	val
a_0	20.397
a_1	7.7560
a_2	2.7409
a_3	0.79024
a_4	6.65605×10^{-2}
a_5	-0.10861
a_6	-4.45630×10^{-2}

Table D.2: Hydrogen Vapour Pressure to Temperature Coefficients

Appendix E

Target Motion Calibrations

E.1 Target Lifter

E.1.1 GUI Lifter calibrations

The calibrations for the cryotarget lifter GUI are read from the file `lifter.dat` *in the* **tgt** *directory when the GUI is started. These calibrations are used by the GUI to indicate when the target has reached a position.* **They are NOT used by the lifter routines to select a new target position. See the next section.** *To change the calibrations, edit this file. The current values are:*

```
9.0283           # lifter resolver to position calibration a0
-1.40086e-6      # lifter resolver to position calibration a1
200              # lifter poswidth  if the resolver is within this amount
                 # it is 'at' a location.
-10000           # pos 0 -- ``Clear'' position --- dummy number
-10000           # pos 1 -- ``Home''  position --- dummy number
4982661          # pos 2 -- 4 cm dummy cell
4327227          # pos 3 -- 4 cm H2 cell
3611177          # pos 4 -- 15 cm H2 cell
2879589          # pos 5 -- 4 cm He cell
2165425          # pos 6 -- 15 cm He cell
1433410          # pos 7 -- 4 cm D2 cell
721082           # pos 8 -- 15 cm D2 cell
28729            # pos 9 -- 15 cm dummy cell
-10000           # pos 10 -- ``empty'' cell (not really reachable so set
                                       to a dummy value)
```

E.1.2 Lifter Set Point Calibrations

The cryotarget lifter calibration data which is loaded into the IOC and used by the lifter controller to set a target position when one of the target select buttons is used are contained in the file

`/home/cvxwrks/SCRIPTS/vmec4.bdspos.txt`

The contents of the file is shown below (the comments after the # signs are not actually in the file)

```
4982661          # pos 2 -- 4 cm dummy cell
4327227          # pos 3 -- 4 cm H2 cell
3611177          # pos 4 -- 15 cm H2 cell
2879589          # pos 5 -- 4 cm He cell
2165425          # pos 6 -- 15 cm He cell
```

```
1433410             # pos 7 -- 4 cm D2 cell
721082              # pos 8 -- 15 cm D2 cell
28729               # pos 9 -- 15 cm dummy cell
28729               # pos 9 -- 15 cm dummy cell
```

As of this writing, these numbers should be **wrong** *since these were taken before the latest target survey. To change the position calibrations, it is necessary to edit this file and then reboot the IOC.*

E.2 Target Rotator

E.3 Solid Target Ladder

The solid target ladder GUI reads the positions of the solid targets from the file `ladder.dat` *in the* **tgt** *directory.* **THESE VALUES ARE USED TO POSITION THE SOLID TARGET**

```
15 !_Ladder_Scale_factor_for_GUI
6 !_Ladder_Offset_from_Home
-0.094 -0.5625 -1.0 CH2[40mil,0.2%]       LavenderBlush1
-1.2 -1.6875 -2.2 BeO       LavenderBlush3
-2.3 -2.8125 -3.3 Carbon[40mil,0.5%]    Gray30
-3.5 -3.9375 -4.4 Iron[15mil,2.2%]      LemonChiffon4
-4.6 -5.0625 -5.5 Gold[4mil,3%]       DarkGoldenrod2
-5.7 -6.1875 -6.7 Aluminum              Gray81
-6.8 -7.3125 -7.8 Carbon[465mil,6%]     Gray22
-8.0 -8.4375 -8.9 Iron[40mil,6%]        LemonChiffon4
-9.1 -9.5625 -10 Gold[8mil,6%]         DarkGoldenrod
```

E.4 Radiator

Appendix F

Hardware Descriptions

The Hall C Cryogenic Target control system can be described in terms of the functions of the subsystems that make it up (i.e. the temperature regulation), or it can be described in terms of the hardware that is physically used to implement the systems. Many of the target systems, use several pieces of hardware and conversely, many pieces of the hardware are used to several systems. The main control systems *in the Hall C cryogenic target are:*

Temperature Readout

Temperature Control and Low Power Heaters

High Power Heaters

JT Valve Cryostat Coolent Control

Gas System Pressure Readout

Vapour Pressure Thermometers

Gas Panel Solenoid Valve Control

Target Loop Pumps

The physical hardware used make up these systems *are:*

MVE162 Single Board Computer (IOC)

ITC501 Temperature Scanner

ITC502 Temperature Controllers

ADIO Industry Pack

ADC Industry Pack

DAC Industry Pack

Quadrature Industry Pack

Octal Serial breakout board

SC200 Pressure readout boxes

Omega Differential pressure boxes

VME Relay Boards

Power Ten Power Supplies

CAMAC Stuff

F.1 JT Valve Controllers

There are four JT (Joule Thompson) Valves on the target. A main supply valve for the Helium coolent coming from either the CEBAF CHL (Central Helium Liquefier) or the ESR (End Station Refrigerator), two bypass valves (one for the hydrogen loop, one for the deuterium loop) and a supply valve for the LN2 precooler. Each valve has has two cables going to the JT controller box which contains all four JT valve controllers. One cable contains the analog voltage signal for the position. The other cable contains the signals for the stepper motor for the valve and the signals for limit switches and whatever.

F.1.1 Local Control

Each controller has a digital display of the valve setting in percent of full open. There is a local/remote switch and there is an open/closed switch

F.1.2 Computer Interface

The computer determines the current valve position by reading a 0-10V signal corresponding to 0-100analog signal is fed into single ended ADC's (one per valve). In addition to the analog input signal to the computer, there are thirteen digital output signals to the controller box.

- *8 bits give tell the controller box how big a step in position to make. The step size is*

  ```
  (8bit_signal/256) * 100percent
  ```

  I.e. a step size of 128 tells the controller to make a step of 50

- *1 bit to tell the controller to open or close (a "polarity" bit).*

  ```
  0 = open
  1 = close
  ```

- *4 bits to indicate which of the four controllers is being talked to. The computer generates a 100us pulse (normally 1, pulsing to 0) to latch the step size and polarity to the particular valve controller.*

F.2 Low Power Heaters

The Low Power Heaters are used by the Oxford ITC502 temperature controllers to regulate the temperature of the target loops. These heater have the following resistances:

```
Loop    LP heater resistance
H2         24.5 Ohms
He         24.4 Ohms
D2         24.5 Ohms
```

F.3 High Power Heaters

The High power heaters are used to replace the heat load from the beam when it goes off. The components of the heater system are:

- *Heater coils in target loops. These are approximately 2Ω resistive loads.*
- *Power Ten Power supplies. These are 0-40V, 0-25A power supplies, being operated as voltage controlled voltage sources but with current limits enabled (via voltage controlled current reference).*

- *DAC Industry Pack. The voltage references for the power supply voltage and current settings are supplied by six Digital to Analog Converters (DAC's) on the Greenspring DAC IP board.*
- *ADIO Industry Pack. Six single ended ADC's on the ADIO board are used to read back the voltage and current from the Power Ten power supplies. Because the voltage readback from the P10's is 0-40V and the ADIO board maximum voltage input is 10V, there is a 4:1 voltage divider that reduces the input voltage signal. This ADC channel is then multiplied by 4 in the EPICS database so that the final voltage displayed on the GUI is the correct power supply voltage.*

The resistances of the High power heater coils are:

```
Loop     Resistance
H2         2.4 Ohms
He         shorted out
D2         2.1 Ohms
```

Following is a note from Betsy Beise regarding the calibration of the Power Ten readback and setting the jumpers on the Power Ten's to operate them correctly.

```
From: UMDENP::BEISE        "Betsy Beise, UMD Physics, (301)-405-6109" 19-NOV-1995 15:39:58.00
To: DUNCAN, MX%"terburg@cebaf.gov"
CC: KGUSTAFS
Subj: high power heaters --- hall C target

Bart -- Please pass this on to Dave Beatty Betsy

**** High Power Heater notes ****

Betsy Beise, Kenneth Gustafsson, Bart Terburg 11/19/95

In order to get both an external current limit and external voltage
control, we used the following  bus configuration (back of supply):
(don't know why it works, but it does...)


JUMPERS

    1   2    3   4    5     6   7   8   9    10   11   12    13  14  15  16
   -----------------------------------------------------------------------
   V+  Vs+  Vp  Vc  Vset  Vs-  V-  Ip  Ic  Iset  Im-  Im+   ON/OFF   AC
    |   |    |   |         |    |   |   |                     |   |   |   |
    ---      ---           ----     ---                       ---     ---

WIRING

V DAC :   4 and 6  (6 = (-))
V ADC :   1 and 6  (6 = (-))

I DAC :   9  and 11 (11 = (-))
I ADC :   12 and 11 (11 = (-))

I DAC:  0 - 0.1 V   --->  0 - 100 %
V DAC:  0   5 V      --->  0 - 100 %
```

```
 ***  notes:


1) The DAC for I for PS #3 has a 20 mV offset. The DAC for I for PS #2
also has about a 20 mV offset. This means the only way to
get 0 power is to turn the voltage all the way down.

2) When the GUI  is taken down and brought back up, the DACs end up in an
undefined state. This is problematic if the power supply is not limited.

3) If GUI is brought down and back up, the DAC setting as read by GUI is
no reliable (usually 0, but true DAC value may not be 0). Need a way of
determining current DAC values.

4) ADC readout on GUI is also working. Check all 6 channels. Stability of
ADC output is about +- 0.02 volts on screen.

SUGGESTION:

A safer situation would be to have a MANUALLY controlled
0-100 mV voltage supply to control the current channel from the
counting house. One could then be sure to have no current (or
the appropriate value which may not be 0 because one may want
a nonzero heat load on the target) when the
computer gets rebooted, and could have human control over the
maximum allowable current to the heaters.

ALTERNATE SUGGESTION:

Bill Vulcan said he could modify the power supplies to have a 300
watt limit -- I think we don't want them to trip off at 300 watts but just
be limited to an output of no more than 300 W.

Calibration constants for ADCs: used the form
I = slope * (adc - offset)
V = slope * (adc - offset)

Supply I V
slope (amps)   offset(volts)      slope(amps)   offset(volts)
-------------------------------------------------------------------------------
 #1 4.88  0.006    4.18  0.083
 #2 4.99             0.036    3.94 -0.027
 #3 4.92             0.012    3.92 -0.055
```

F.4 Scattering Chamber Vacuum Gauge

The scattering chamber vacuum is measured by a cold cathode gauge. An analog voltage signal from this gauge is read by ADC_15_POS on the IOC (ADC card ch8+). The calibration for the analog signal is:

$$\log_{10}(P) = a_0 + a_1 * ADC$$

P(Torr)	ADC(V)
1.2e-5	5.05
8.1e-6	4.907
6.0e-6	4.769
5.1e-6	4.701
2.0e-6	4.256
2.5e-7	3.36

Table F.1: Scattering Chamber Vacuum Gauge Calibration Data

where P is in Torr and ADC is the ADC value in Volts.

$$a_0 = -9.8977$$

$$a_1 = 0.98210$$

The data for this calibration is rather poor and needs to be redone. In particular the calibration may underestimate the pressure at 1.0×10^{-4} *Torr by up to 20% and be worse above this pressure. See Fraser Duncan's CEBAF Log Book pg 18. The data is given in table F.1.*

F.5 SC200 Pressure Transducers

The SC200 Pressure readout units are 4 channel, serial interface units with 4-20mA current loop communication to the transducer. Three units are currently being used in the target control system. One each in the hydrogen and deuterium gas panels and one unit in the IOC rack.

These units use a 0.15A 250V 313 slow blow fuse.

```
From: CEBAF::TERBURG       7-DEC-1995 09:35:56.98
To: BEATTYD, FDUNCAN
CC:
Subj: for documentation purposes


Sensotec Pressure Transducers
-----------------------------------------------------------------------

*SC 200 Readout box 1

 type: 060-6834-07
 serial number: 434321

 Hook-up of heads (see CEBAF dwg  67150-E-56825)

 channel: name: type: serial number:
 --------------------------------


    1 PT9013 811-FMA 432325
    2 PT9009 811-FMA 432321
    3 PT9144 TJE/4178-03-01 471849
    4 PT9023 811-FMA 432324
```

```
*SC 200 Readout box 2

 type: 060-6834-07
 serial number: 434322

 Hook-up of heads (see CEBAF dwg  67150-E-56825)

 channel: name: type: serial number:
 --------------------------------

    1 PT9079 811-FMA 432323
    2 PT9083 811-FMA 432327
    3 PT9093 811-FMA 432319
    4 PT9042 811-FMA 432322

*SC 200 Readout box 3

 type: 060-6857-00
 serial number: 483815

 Hook-up of heads

 channel: name: type: serial number:
 --------------------------------

    1 VP9126 TJE/7156/07/01 488231
    2 VP9196 TJE/7156/07/01  488230
    3 VP9195 TJE/7156/07/01 488228
    4 VP9125 TJE/7156/07/01 488229
```

F.6 Target Lifter

(Fraser Duncan's limited understanding of a talk with Jim Dunne)

The target is lifted by threaded rods driven by motors with a 50:1 gear reduction. Directly on the rods are shaft encoders with 4096 counts per revolution. One revolution moves 22 mm (WHAT? thats huge!!!) making a single resolver count approximately 0.107 um. Moving the target up or down, the control system tends to get to the absolute position requested to within 1 resolver count. However, when the lifter is put in (standby mode?), the motor is turned off and the brakes applied. During this short time, the target assembly shifts down. If it starts at the top of the scattering chamber, it can slip down 50 to 100 counts. If it starts at the bottom of the scattering chamber, it can slip down maybe 3 counts. The calibration data for the lifter (given to FD by Jim Dunne on 7 Nov 95) is:

The BDS target lifting system has the following calibration given to Fraser Duncan By Jim Dunne. This calibration is seriously out of date because of the changes in the lifting mechanism.

```
4cm dummy cell   4982661
H2 4cm cell      4327227
H2 15cm cell     3611177
He 4cm cell      2879589
He 15cm cell     2165425
D2 4cm cell      1433410
```

```
D2 15cm cell      721082
15cm dummy cell    28729
empty target       28729  not possible to lift target this high
```

These parameters are read from the file

```
/home/cvxwrks/SCRIPTS/vmec4.bdspos.txt
```

by the IOC at boot time. Apparently, there is no empty target position because the target ladder does not have enough range. So for now, the same position as the 15cm dummy cell is used. The positions were fitted with Physica to convert them to a number from 1 to 9.

```
cell = 8.0283 - 1.40086e-6 * resolver
```

This is the calibration used for the display in the tgt GUI.

Also, there is no GO HOME command implemented yet. It has the same function as CLEAR for now.

Appendix G

HALL C Target Signal and Control Wiring

A listing of the wiring in the control system, the database records and the GUI names. The person overseeing the hardware installation is Dave Beatty.

```
ADIO Signals
------------
              BO      ADIO  ADIO   DB dev     DB  "high level"
signal        Box     rib B ch     rec        record                 checked
------        ------  ----- ----   ---        ------                 -------

JTV step D1(lsb)          3  B0                                          no
JTV step D2               4  B1                                          no
JTV step D3               5  B2                                          no
JTV step D4               6  B3                                          no
JTV step D5               7  B4                                          no
JTV step D6               8  B5                                          no
JTV step D7               9  B6                                          no
JTV step D8(msb)         10  B7                                          no
JTV sign                 11  C0                                          no
JTV W1                   12  C1                                          no
JTV W2                   13  C2                                          no
JTV W3                   14  C3                                          no
JTV W4                   15  C4                                          no


JTV#1 pos R              32  1+    ADC_0_POS_R                           no
P10 V 4:1 #1  adcP10V-1  33  1-    ADC_0_NEG_R                           yes

JTV#2 pos R              34  2+    ADC_1_POS_R                           no
P10 V 4:1 #2  adcP10V-2  35  2-    ADC_1_NEG_R                           yes

JTV#3 pos R              36  3+    ADC_2_POS_R                           no
P10 V 4:1 #3  adcP10V-3  37  3-    ADC_2_NEG_R                           yes

JTV#4 pos R              38  4+    ADC_3_POS_R                           no
P10 I #1      adcP10I-1  39  4-    ADC_3_NEG_R                           yes
```

P10 I #2	adcP10I-2	40	5+	ADC_4_POS_R		yes
P10 I #3	adcP10I-3	41	5-	ADC_4_NEG_R		yes
dif1	adcdif-1	42	6dif	ADC_5_DIF_R		yes
		43				
dif2	adcdif-2	44	7dif	ADC_6_DIF_R		yes
		45				
dif3	adcdif-3	46	8dif	ADC_7_DIF_R		yes
		47				
dacout1	dacout-1	49	dacA	DAC_0_out		yes
dacout2	dacout-2	50	dacB	DAC_1_out		yes

ADC Signals
----

signal	BO Box	ADC rib	ADC ch	DB dev rec	DB "high level" record	checked
fan V #1	adc fan-1	2	1dif	ADC_8_DIF_R		yes
		5				
fan V #2	adc fan-2	8	2dif	ADC_9_DIF_R		yes
		11				
fan V #3	adc fan-3	14	3dif	ADC_10_DIF_R		yes
		17				
fan I #1	adc fan-4	20	4dif	ADC_11_DIF_R		yes
		23				
fan I #2	adc fan-5	26	5dif	ADC_12_DIF_R		yes
		29				
fan I #3	adc fan-6	32	6dif	ADC_13_DIF_R		yes
		35				
spare dif	adc spare	38	7dif	ADC_14_DIF_R		yes
		41				
tgtvac	adc tgtvac	47 sig	8+	ADC_15_POS_R		
		48 gnd				
BCM3	adc BCM3	49 gnd	8-	ADC_15_NEG_R		
		50 sig				
power gnd		43				
+15V to card		45				
-15V to card		46				

DAC Signals
----

signal	BO Box	DAC rib	DAC ch	DB dev rec	DB "high level" record	checked
P10 ctrl V#1	dacP10V-1	1	1	DAC_2_out		yes
		2				
P10 ctrl V#2	dacP10V-2	7	2	DAC_3_out		yes
		8				

```
P10 ctrl V#3 dacP10V-3  13     3 DAC_4_out                            yes
                        14
P10 ctrl I#1 dacP10I-1  19     4 DAC_5_out                            yes
                        20
P10 ctrl I#2 dacP10I-2  25     5 DAC_6_out                            yes
                        26
P10 ctrl I#3 dacP10I-3  31     6 DAC_7_out                            yes
                        32


ITC502 -- H2
------------
transducer   box ch  DB dev rec
----------   ------  ----------
TI9018        1      H2_502_Sensor_1_R
TI9019        2      H2_502_Sensor_2_R
TD9131        3      H2_502_Sensor_3_R


ITC502 -- He
------------
transducer   box ch  DB dev rec
----------   ------  ----------
TI9182         1      He_502_Sensor_1_R
TI9183         2      He_502_Sensor_2_R
               3      He_502_Sensor_3_R

ITC502 -- D2
------------
transducer   box ch  DB dev rec
----------   ------  ----------
TI9088        1      D2_502_Sensor_1_R
TI9089        2      D2_502_Sensor_2_R
TI9125        3      D2_502_Sensor_3_R


ITC502 -- N2
------------
transducer   box ch  DB dev rec
----------   ------  ----------
              1      N2_502_Sensor_1_R
TD9143        2      N2_502_Sensor_2_R
TI9144        3      N2_502_Sensor_3_R


ITC501
------
transducer   box ch  DB dev rec
----------   ------  ----------
LL9190        1  501_Sensor_1_R
LL9191        2  501_Sensor_2_R
LL9180        3  501_Sensor_3_R
```

```
LL9181        4  501_Sensor_4_R
LL9120        5  501_Sensor_5_R
LL9121        6  501_Sensor_6_R
LL9192        7  501_Sensor_7_R
LL9182        8  501_Sensor_8_R
LL9122        9  501_Sensor_9_R
             10  501_Sensor_10_R
```

```
SC200 H2 panel
--------------
transducer  box ch    DB dev rec                          checked
----------  ------    ----------                          -------
PT9013        1       H2_SC200_PG_Sensor_1_R
PT9009        2       H2_SC200_PG_Sensor_2_R
PT9144        3       H2_SC200_PG_Sensor_3_R
PT9023        4       H2_SC200_PG_Sensor_4_R
```

```
SC200 D2 panel
--------------
transducer  box ch    DB dev rec                           checked
----------  ------    ----------                           -------
PT9079        1       D2_SC200_PG_Sensor_1_R
PT9083        2       D2_SC200_PG_Sensor_2_R
PT9093        3       D2_SC200_PG_Sensor_3_R
PT9042        4       D2_SC200_PG_Sensor_4_R
```

```
SC200 H2D2 panel
--------------
xducer  ch DB dev rec                         checked
------  -- ----------                         -------
VP9126   1 H2D2_SC200_PG_Sensor_1_R
VP9196   2 H2D2_SC200_PG_Sensor_2_R
VP9195   3 H2D2_SC200_PG_Sensor_3_R
VP9125   4 H2D2_SC200_PG_Sensor_4_R
```

```
JT Valve Controller
-------------------

Valve       name    controller ch   DB ch       checked
-----       ----    -------------   -----       -------
He4control  EV9130     1               0
H2bypass    EV9133     2               1
D2bypass    EV9134     3               2
LN2control  EV9125     4               3
```

```
Serial Breakout Box
-------------------

device           breakout ch      ioc ch         checked
------           -----------      ------         -------
ITC502 H2           1a             0               yes
ITC502 He           1b             1               yes
ITC502 D2           1c             2               yes
ITC502 N2           1d             3
ITC501              1e             4               yes
SC200(H2 gas panel) 1f             5               yes
SC200(He gas panel) 1g             6  * <---------- D2 gas panel for now
SC200(D2 gas panel) 1h             7 <--------- doesn't work
SC200(H2,D2 VP)     2a             8
solid target ladder 2b             9  *
Omega difpres(H2)   2c            10               yes
Omega difpres(H3)   2d            11  *
Omega difpres(D2)   2e            12
Target Lifter       2f            13
Target Rotator      2g            14
Sieve Slit control  2h            15

   *  not implemented in first go around of controls

Note: The CAEN HV controller in rack is serial device.  Currently
      assigned to  position 11 (2d).  Possibly other serial devices
      overbooked.
```

Appendix H

Software and Manual Revisions

An attempt is being made to implement version control on the Hall C cryotarget software. The software consists of:

```
IOC Codes:   Source   -- compiled on cdaqh1
             Binary   -- loaded from cdaqh1 onto IOC

IOC Scripts: text files read by IOC to set parameters at run time

GUI Scripts: Tcl/Tk and alh scripts executed on cdaqh1 or Jeffylab
```

The importance of maintaining version control of the codes is that the GUI and IOC codes are closely interwoven and changes in one affect the other. Steve Wood has implemented version control of the binaries that are loaded on the IOC. The GUI is maintained with version numbers. The environment variable, `GUI`*, always points to the latest version of the GUI. However, older versions are also kept. The proper versioning of the GUI started with version 1-5. Although there are previous versions in differing directory schemes, we should only work with version 1-5 or higher.*

GUI Versions

Ver	Date Implemented	Compatable IOC Binaries	Notes
1-5	Oct 1996	?	First of new versioning
1-9	Feb 1999	1-1	3 cell system

Table H.1: GUI Versions