A BRIEF OUTLINE OF THE CTD HV SYSTEM

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1 Operating the CTD HV for data taking

All commands (in **bold***) should be completed by 'return'* $\hookleftarrow$*.*

1.1 During injection and HERA tuning

(between fills and during shutdowns) keep the CTDHV system in the OFF state.

1.2 Turning the volts on at start of fill

Once luminosity optimisation is complete, type:

standby$\hookleftarrow$

This can be done just before Cal is closed; it does some time-consuming checking/switching-on of the CTD HV system, and sets some very low volts.

Once conditions are OK to raise to operational voltage, make sure calorimeter is completely closed and then type:

hvon$\hookleftarrow$

which raises the CTD to operational voltage.

If all is well, the double-height message at top of screen should read:

CTD HV RAMPING UP TO HVON

then after about a minute:

CTD HV ALL ON OK

If there are trips see section 4 below.

If the volts do not ramp up after hvon, then the program may consider there is anALARM status which prevents volts being raised. See section on ALARMS in the CTDHV reference manual on page **??**.

It is also possible that the calorimeter is not closed or the calorimeter os9 has crashed. Try re-closing the calorimeter (after rebooting the calorimeter os9 if necessary).

1.3 Turning volts off at end of a fill

Before opening the calorimeter type:

hvoff↩

Check the volts are coming down on the HV-terminal before opening the calorimeter.

(of course you do not need to turn off the volts at the end of a run if the next run is going to continue immediately with the same fill)

1.4 In the case of trips during a run or ramping up

In this case the GFLT is paused via the the BBL3.

Any trip now causes an automatic rampdown of all superlayer quadrants to STANDBY with the following message at the bottom of the screen:

"Too many simultaneous trips. WAIT! Rampdown to STANDBY and CLEAR forced"

This occurs even for a single trip.

When the system reaches STANDBY trips are cleared automatically. After this is completed and all sections of the CTD show voltages of about 19 or 20 volts, it is possible to raise the voltages by typing **hvon**↩

If conditions are bad, wait until it is clear that beam conditions are stable before trying to raise the volts. If conditions remain poor HERA should be informed and **the volts should not be raised.**

In the event of persistent trips due to bad background do not repeatedly attempt to raise the volts...

keep the CTD in STANDBY or OFF instead.

The CTD doesn't normally trip without a reason (but see 5 below if you think the trips are due to some program error state.)

The command for raising the volts again is:

hvon↩

When full volts are returned the BBL3 data taking veto is removed and the GFLT will resume data-taking.

1.5 If the program gets in to an error state

where it cannot supply volts for data taking, and no expert help is available, then END the current lumi run.

Make sure the HV is down (press the red emergency-off button in the rack A2,06 if necessary).

The command to exit the program is

exit↩

Then reload the program *ab initio* by the command:

ctdhvxxx↩

Where xxx is the current version number on the notice by the CTD HV terminal.

1.6 HERA injection veto and ZEUS data taking veto

The ctd hv sends a "HERA injection veto" signal to input 5 of the bbl3 if any part of the ctd has voltages higher than a threshold set a little above standby voltages.

The ctd hv sends a "ZEUS data taking veto" signal to input 11 of the bbl3 if ((the last run SETUP was a physics run OR the ctd hv is in a STANDBY OR HVON state) AND (the ctd has any voltage lower than the proper working voltage)).

Thus this data taking veto (and its audible warning messages in the control room) are suppressed if the ctdhv is in an OFF state and a non-physics run is SETUP.

In the event of serious problems contact:

Rod Walker, Alex Tapper or the Run Coordinator at DESY
or
Ash Jamdagni in London (I.C.)

1.7 CONTACTING EXPERT ADVICE

at DESY

Rod Walker	email: rwalker@zow.desy.de tel x.3032 home phone 8099-5793
Alex Tapper	email: tapperad@mail.desy.de tel x.3032 home phone 8907-0132

or others on the list in the ZEUS control room

non-resident

Ash Jamdagni	email: a.jamdagni@ic.ac.uk office phone 0044-171-594-7819 Mobile 0044-403-179-211
Don Miller	email: d.b.miller@ic.ac.uk office phone 0044-171-594-7806 home phone 0044-181-940-8573
Norman Mccubbin	email: mccubbin@rl.ac.uk phone 0044-123-544-6268 or ext.3646 at DESY

2 INTRODUCTION. FEATURES OF THE CTD HV SYSTEM

The following section describes briefly the features of the CTD HV system.

2.1 HV system states

The program has three basic states. The current state is indicated by the message in double height letters at the top of the display screen (see the section "interpreting the screen displays" for more information).

Transitions between these states take about one minute each.

The three basic states are:

state	screen message	description
"OFF"	CTD HV OFF (ALL CHANNELS OFF)	all 110 hv channels are switched off and the volts in the CTD are zero.
"STANDBY"	CTD HV SYSTEM IN STANDBY STATE	all hv channels have been switched on, but are at low (safe) volts.
"HVON"	HV ALL ON OK	all the voltages have been successfully ramped up to the data taking voltages.

There is hardware which detects hv trips within a microsecond and sends signals to stop data taking to the ctd final decision module and master timing controller on the same time scale.

2.2 Program structure

The basic cycle time of the hv program is about one second.

Every cycle it

- monitors the next superlayer-quad combination of the ctd. Since the ctd has 9 superlayers, each with 4 quadrants, it takes around 40 seconds to update this slowly monitored information (voltages, currents) for the whole ctd.
- However every 1 second cycle it also scans the whole of the ctd hv hardware for any trips, and also looks for any other alarms, new run control message, new characters typed on the keyboard, updates signals output to the bbl3 and updates messages displayed on the screen, all for the whole ctd and every second.

2.3 Trips

CTD HV trips cause problems because they stop data taking until they can be reset. Dealing with trips is the major unplanned activity of the shift crew with the CTD HV.

WHAT IS A TRIP?

The CTD has wires arranged in 9 concentric superlayers (superlayer 1 nearest the beams to superlayer 9 just inside the solenoid), each of which is divided into 4 quadrants. Each of the 36 superlayer-quadrants is supplied by 3 HV supplies. The 3 HV supplies for one superlayer-quadrant are interconnected so that if one senses a current higher than an adjustable threshold (usually the one supplying the sense wires) then all of the three HV supplies for that superlayer-quadrant are switched off to 0 volts output within a microsecond, to avoid damage to the CTD.

Thus there are 36 (actually 38 when counting 2 further signals for the additional HV supplies for the inner and outer concentric electro-static screens in the CTD) independent hardware signals which are ORed to provide a hardware signal which first stops data taking on a time scale of 1 microsecond, which is sent to the bbl3 and also the CTD master timing controller and the final decision module.

On a time scale of 1 second the program reads and analyses which superlayer-quadrants have been switched off by the over-current hardware, i.e. which superlayer-quadrants are "tripped".

The program then provides an additional output signal which is ORed with the fast hardware signal above to input 11 of the bbl3 (the bbl3 calls this signal "trip", but it really means at least one part of the CTD is at voltages below working volts).

This program generated bbl3 signal remains when the trip(s) are "cleared", and is not removed until all the parts of the CTD have again reached working volts.

The CTD usually operates for long periods (hours) without any part tripping. However when trips do happen the common experience is that many (often >50%) of the independent superlayer-quadrants trip simultaneously.

This may be because a speck of dust has fallen through the beam, or one of the beams has had a momentary disturbance causing it to hit an obstacle. Some of the resulting extensive shower of ionising particles may be trapped in the magnetic channels of HERA and arrive in all parts of the CTD simultaneously, running closely parallel to the sense wires and causing a surge of ionisation current.

Note that this spike of ionisation could last just a very short time, comparable with the revolution time (~20microsecs) of HERA. The CTD trips on the instantaneous current level. A spike lasting 1 msec only, and a size 2 times bigger than the normal level will appear as of only 0.1% spike on background monitors which integrate over one second.

TRIP INFORMATION ON THE SCREEN

When the program realises there are trips, information is displayed on the screen in several ways.

- in the double height top line.
- in the "alarm line" immediately below the double height top line.

  Trips are classified as "alarms" and will appear here as

  ALARMS= ... TRIPS 1 2 3 4; ...

  in white letters on a black background to make it more easily noticed from a distance. The numbers following the "TRIPS" are the CTD quadrants which contain tripped superlayers.
- Also in the display lower down the screen, "trip" is attached to the information displayed about each tripped superlayer-quad.
- Finally, and more slowly, informative messages (which are also logged for later analysis) are scrolled on the lower part of the screen.

CLEARING TRIPS

All trips in the CTD can be cleared by the single keyboard command **clear**↩, but normally an automatic "clear" procedure without manual intervention is in use. (see section 2.4 "keyboard commands for operations").

When trips are cleared the "trip" messages on the screen are generally replaced (in the STANDBY and HVON state) by "low voltage" or "lowv" messages against each formerly tripped superlayer-quadrant on the display giving information on each superlayer-quadrant separately.

At this stage the hardware signal rapidly generated by the trip hardware disappears, but the signal generated by the program indicating some part of the CTD has low volts now exists and continues. This is ORed and continues to send a "low voltage" signal to bbl3 input 11 until every superlayer-quadrant is back at working voltages again (this signal ceases if the os9 is rebooted.)

This signal is also sent to the CTD master timing controller and the CTD final decision module.

If the system is in an HVON state at this time, or ramping up to HVON, the program suspends monitoring of the superlayer-quadrants that it knows are not tripped or at low voltage, to concentrate its attention on those not at working volts.

2.4 Keyboard commands for operations

Each command is terminated by the "return" key, indicated by "↩" in the instructions below; commands are printed in **bold** type.

Currently the editing keys (backspace, delete, ...) do not work with keyboard commands, but commands are reversible immediately e.g. if you type **hvon**↩ when you meant **hvoff**↩, just follow the mistaken **hvon**↩ immediately by **hvoff**↩.

SEQUENCE OF COMMANDS FOR RUNNING

1. When HERA is injecting make sure that the HV system is in the "OFF" state. (i.e. an **off**↩ or **hvoff**↩ has been typed earlier, or the program has just been loaded and finished initialisation.)

   This is also the state for the system during any long period of no data taking such as an access or HERA fault condition. Do not **"exit"** ↩ the program except at very long shutdowns, or in case of HV system faults.

2. When injection is finished and luminosity with acceptable backgrounds for the CTD is expected soon, put the system in the "STANDBY" state by typing:

   standby↩

   This will switch the hv channels on and save time later.

   standby↩ does not NEED the calorimeters to be closed.

3. To get to working volts on the CTD from a STANDBY state, make sure there are no alarms (such as trips, ups alarms (= AC mains power failures)). See the sections on trips and alarms below.

   The special alarm

   ALARMS=CALS OPEN/DATA TAKING SWITCH OFF

   will ONLY disappear when the calorimeters are closed and the data taking switch is on.

4. To get to HVON, the system must start in STANDBY state, with no alarms. Then type:

   hvon↩

   and the volts should smoothly ramp up, all parts of the CTD simultaneously, in about one minute, and the system is ready for data taking.

   See 6. below if there are trips.

5. At the end of a run if it is necessary to prepare for HERA injection type:

   hvoff↩

   The volts will first of all ramp smoothly down to STANDBY volts, followed automatically by a transition back to the OFF state.

6. Trips cause problems because they waste luminosity.

   The CTD finds it difficult to recover from many simultaneous trips (which is the normal occurence).

   Currently one or more trips will cause the hv program to automatically begin a ramp down from HVON to STANDBY, where recovery is easier.

   It will generally be obvious when this happens. The last message at the bottom of the screen will confirm.

   Thus there are two sections here

   - a first section for "normal" trips which recover successfully with no problems, and
   - a "last hope" section if all else fails.

6a. “Normal” Recovery from trips in the HVON or ramping up state.

The HV program will have started an automatic ramp down to STANDBY.

A message “Too many simultaneous trips. WAIT! Rampdown to STANDBY and CLEAR forced” should appear at the bottom of the screen. Do nothing, but wait.

The program reports after about one minute (in the double height line at the top of the screen) that the STANDBY state has been reached.

Then the program should automatically (without human intervention) clear the trips by itself; this takes a few seconds and all the “trip” state labels on the display currently on the lower part of the screen should be replaced by “lowv” labels.

Within about 1 minute all the voltages seen on the “dav” screen should read approximately 40/20/30 and the system will be stable in the STANDBY state.

If all trips are properly cleared in this STANDBY state, (and if the background is now thought to be OK) then type:

hvon↩

to ramp up the hv to working volts. The alarm messages disappear soon after the clear has been successful, BUT the data taking veto will be released only after, and as soon as, the last superlayer-quadrant reaches its running volts.

If there are problems with this semi_automatic method, try the actions below.

6b. Last hope trip recovery possibility.

If the trip recovery procedure(s) above fail for any reason and the system is in the STANDBY state, then type

off↩

WAIT till the OFF state has been reached then type

clear↩

and all trips should surely be properly cleared.

The system is now as though hv was being raised for the very start of a fill. Type **standby**↩ and **hvon**↩ in turn just as in sections 2 and 4 above, waiting between these commands until the system gets to STANDBY before typing **hvon**↩.

The following are not normally required during luminosity periods. They may be required after power outages, etc. See the also the section on rebooting and logging in.

7. The program can be exited at any time by typing

exit↩

If necessary this will bring down the system to the “OFF” state first, from “HVON” or “STANDBY”.

8. The program can now be restarted, if properly logged in, by typing

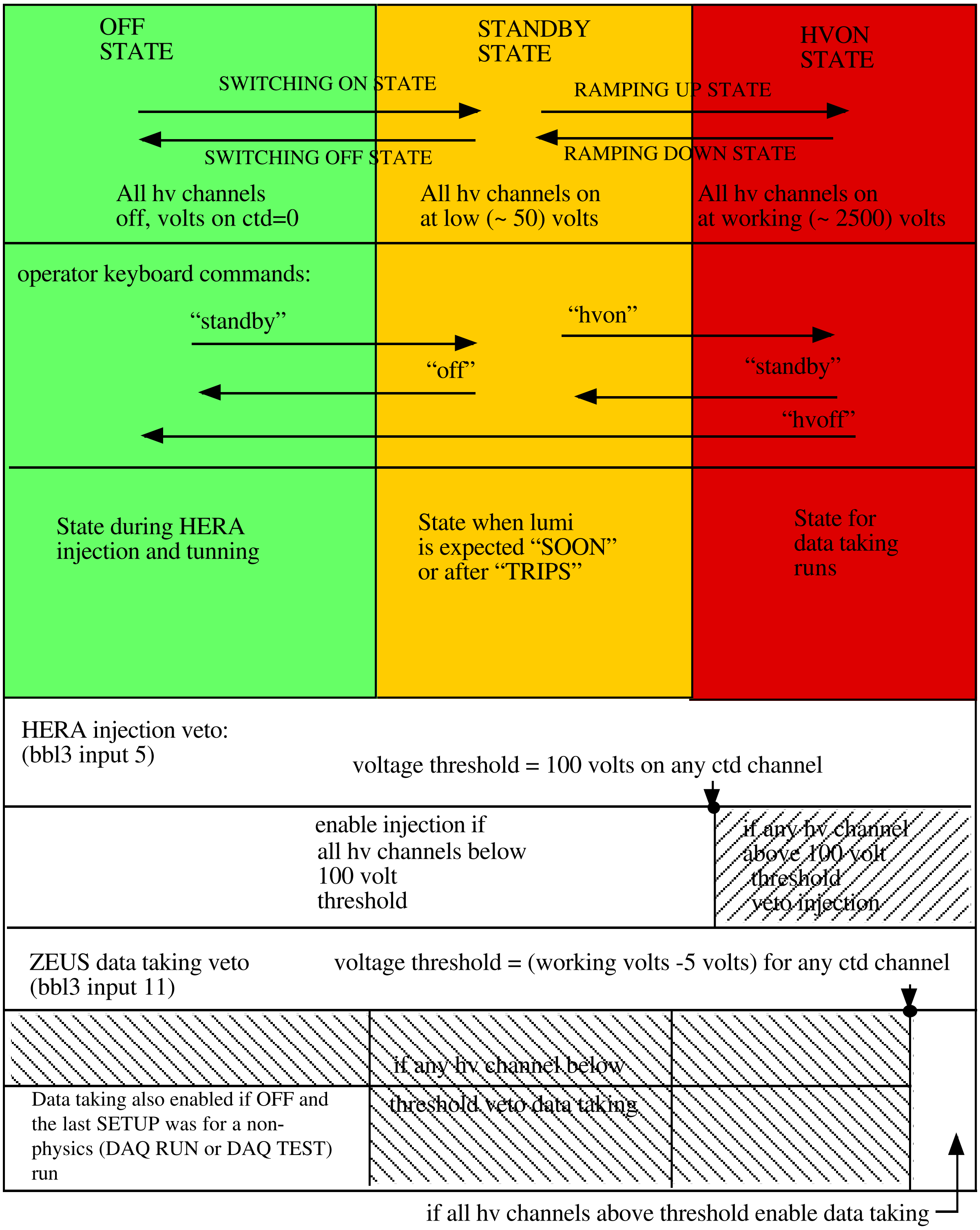
ctdhvxxx↩

where **xxx** is the version number of the current program from the notice by the controlling terminal.

There is a long initialisation phase taking about 3 minutes.

STATES OF THE CTD HV SYSTEM

(In 1998 and later the system is always "active" never "inactive")



3 INTERPRETING THE CTD HV SCREEN.

The CTD HV monitor screen is divided into sections as below -

- The DOUBLE HEIGHT top line gives a short summary of the system state.
- The 3rd line - ALARM LINE - is reserved for alarms. This section of these explanatory notes gives an explanation of each alarm.
- The next two lines give less urgent information on important internal program flags.
- This is followed by a DISPLAY of some useful parameters of each of the 36 superlayer-quadrants of the CTD.
- The lowest 8 lines are a scrolling region where keyboard commands are echoed, and longer informative messages from the program are printed.

3.1 The TOP DOUBLE HEIGHT line.

The possibilities are:

1. During hardware initialisation for ∼3 minutes after program startup.

   CTD HV SYSTEM INITIALISING

   No keyboard commands are possible at this time.

2. The system is in the OFF state

	OFF (! BUT NO DATA TAKING VETO!)	the last RCC SETUP was for a non-physics run
	CTD HV OFF (ALL CHANNELS OFF) : OK	no trips exist
or	ALL CHANNELS OFF (SOME TRIPS) :	trips exist and can be cleared by **clear**↩

3. The system is in transition (which takes about 1 minute) from OFF ⟶ STANDBY

CTD HV SWITCHING ON TO STANDBY :	even if trips exist, DONT clear

4. The system is in transition (which takes about 1 minute) from STANDBY ⟶ OFF

HV SWITCHING TO OFF STATE :	even if trips exist DONT clear

5. The system is in the STANDBY state

CTD HV SYSTEM IN STANDBY STATE : OK	no trips exist
STANDBY HV STATE (SOME TRIPS) :	trips exist which can be cleared by **clear**↩

6. The system is ramping up from STANDBY to HVON

CTD HV RAMPING UP TO HVON :	even if trips exist DONT clear

7. The system is in an HVON state

CTD HV ALL ON : OK	no trips exist, data taking enabled.
HV TRIPPED (NO AUTO TRIP RESET) :	A few trips exist. Data taking disabled.
CTD HV ON, BUT SOME HV LOW :	There were a few trips which were successfully cleared, but the HV for the channels cleared has not yet ramped up to working volts. Wait until the message prompting "HVON" has appeared at the bottom of the screen, then type **hvon**↩ and wait until this is completed.

8. The system is ramping down from HVON ⟶ STANDBY

HV RAMPING DOWN TO STANDBY :	even if trips exist DONT clear.

3.2 Alarm line and Alarms

CTD HV system alarms are displayed on line 3 on the screen, just below the double height top line.

If there are no alarms active this line reads “there are no alarms” and the rest of the line is blank.

If alarms exist they are reported on this line as white letters on a black background to make them more obvious from a distance.

If any alarm exists the system will not change from OFF $\longrightarrow$ STANDBY (with the exception of the “CALS OPEN/DATA TAKING SWITCH OFF” alarm) or from STANDBY $\longrightarrow$ HVON.

If the system is in HVON, then the appearance of any alarm will force an automatic rampdown to STANDBY, and data taking will be vetoed.

Any alarm except “CALS OPEN/DATA TAKING SWITCH OFF” will force the system in STANDBY to OFF.

When alarms exist then the line begins ALARMS = followed by a list of alarms.

The possible alarms in order of appearance on the line are

CALS OPEN/DATA TAKING SWITCH OFF

For safe CTD running the HV cannot be raised till the CALS are closed (lower background) and it is the intention to start a lumi run.

This CALS OPEN ... message exists until just before data taking starts for a fill.

An **hvon**$\hookleftarrow$ command will be rejected if a CALS OPEN/DATA TAKING SWITCH OFF alarm exists, but a **standby** $\hookleftarrow$ (from the OFF state) will not be rejected.

Note that sometimes the signal that the calorimeters are closed becomes unreliable and disappears due to bad contacts, or bad calorimeter os9. This then causes the CALS OPEN/DATA TAKING SWITCH OFF alarm to appear unexpectedly, which causes the HV to ramp down and data taking to be vetoed.

This signal (CALS OPEN/DATA TAKING SWITCH OFF) comes to the CTD HV system from output number 23 on the bbl3 system.

RED_BUTTON

The HV emergency off button in the rucksack (high up between racks A2,06 and A2,07) has been pushed in. This forces the HV off by hardware. The remedy is to release the button (after checking that this is safe to do) by twisting the button slightly.

TRIPS

means that some trips exist. The numbers that follow TRIPS are the CTD quadrant numbers which contain tripped superlayers. The remedy is to clear the trips, using the procedures already described.

UPS_POWER

means that the AC power into (one or more) of the 5 uninterruptable power supplies (ups) has failed. These ups keep the HV system going for a few minutes after a power failure until the HV can be ramped down.

The numbers following the UPS_POWER show which CTD quadrants are affected; CMPTR means it is the ups for the CTD HV computer in its VME crate in rack A2,06.

If an UPS_POWER alarm lasts longer than 20 seconds then the HV is ramped down. When the system reaches the OFF state, all the CTD HV electronics is switched off. There will not be enough time to fix anything before this happens.

The remedy is to switch everything back on and reboot, reload and restart the HV program. See the section on rebooting, reloading, etc.

HV_STALL

should not appear for manual command operation of the system. (It means that the automatic hvon system has run into a problem in automatically raising the HV.)

If it appears then check if line 5 on the screen says that auto hvon is ENABLED. If it does, type **dahvon**↩ and HV_STALL should disappear.

ALARM OVERFLOW

If there is not enough space on the alarm line to contain all the current alarms a “>” printed near the end of the line indicates that further alarms exist (a very rare occurence)

The next two lines (lines 4 and 5) show some useful program flags.

Line 4 shows

- The state of the veto signal output from the program to control HERA injection. Injection is either ENABLED or DISABLED according to the highest actual voltages in the CTD.
- The state of the ZEUS data taking veto output from the program. As far as the CTD HV is concerned data-taking is either ENABLED or DISABLED according to whether every part of the CTD is at working voltages or not.
- “novice” or “expert”. Certain internal parameters can only be altered by “experts”. “novice” is the standard indication.
- The last indication on line 4 is the status of the ZEUS run that is currently happening, so that the program can correlate its internal records with ZEUS data.

  The run is either

physics/non_physics

with the shown run number, and is either

SETUP/ON (if activated)/ENDED/ABRTD/PAUSED/RESUMED

Line 5 shows

- auto trip reset DISABLED (currently only a reduced version of this is in operation. The standard indication is DISABLED)
- auto HV on DISABLED (currently this is not allowed to be enabled)
- HV selection by pressure. The standard indication is ENABLED. The system makes small adjustments to the HV according to the atmospheric pressure (before a run begins) to try to minimise consequent pulse height variations.

3.3 DISPLAYs of useful superlayer-quad monitored quantities

These usually show the values of parameters for the 36 superlayer quadrants of the CTD.

STANDARD DISPLAY

The standard display which appears after the initialisation process finishes shows the following parameters for the sense wires (if this default display is replaced by another, the default can be recalled by typing **dss**↩).

On this standard dss display the parameters shown are, for each superlayerquad

vvvv/dd/cc/status

where

- vvvv is the actual voltages of the sense wires.
- dd is the difference between the actual voltages and the working voltages of this superlayer-quad.

  In running conditions these differences are normally less than 5.

  If the difference is greater than 99 (i.e. in off or standby state) this field is printed as blanks.
- cc is the difference between the sense trip current for this superlayer-quad and the actual sense current. Trips become more likely as the actual currents rise due to bad backgrounds. Again if the trip current is more than 60 units above the actual current this field is printed as blanks.

  If this field reads less than 50, perhaps it is time to press HERA to decrease the background (or increase the trip current, but this for experts only.)

- status has 7 possible values; only the highest priority value, nearest the top of the following priority list is printed. If printed in white on black, there is a serious fault.

  "trip" means this superlayer-quad is currently tripped

  "lowv" means this superlayer-quad has voltages less than the working volts.

  "fld" means that the "field current" is low. Usually this is due to no AC power in a HV relay crate in the rucksack.

  "noAB" means that the HV switching relays for both octant A and octant B of this superlayer-quadrant are switched off, and no HV is being supplied to this part of the CTD.

  This is normally done by experts if the hv cables are damaged between the rucksack and the CTD.

  "noA" similarly means that only octant A is switched off

  "noB" means only octant B is switched off

  " " a blank field means that none of the above apply. This is the normal state and is OK.

OTHER DISPLAYS

Other displays of useful information can be called up onto the screen by typing the following commands. Once called up they remain until a different display is called. It is **strongly recommended** that the STANDARD DISPLAY (dss) or dav is run normally during data taking.

Each separate display includes a description of the information it displays.

3.4 Keyboard commands to produce displays

displays↩ a list of the useful displays

commands↩ a list of the useful commands

dst↩ display sense trips a static list of sense ramping and running trips

dmpt↩ display magnetic field (atmospheric) pressure and (ctd end plate) temperatures

dss↩ display standard sense wire data - the standard display mentioned above

dav↩ display all volts in the CTD

dac↩ display all currents in the CTD

dsv↩ display sense volts in the CTD

dsc↩ display sense currents in the CTD

dar↩ display all relays in the CTD

daes↩ display all electrostatic screens in the CTD

daav↩ display all 'aim' volts in the CTD

dapcv$\hookleftarrow$ display all per centage volts in the CTD

dafv$\hookleftarrow$ display all full volts in the CTD

darr$\hookleftarrow$ display all (voltage) ramp rates in the CTD

datc$\hookleftarrow$ display all trip current in the CTD

daqsn $\hookleftarrow$ display all quadrants of superlayer 'n' (n=1, ..., 9) in the CTD

dcasqn $\hookleftarrow$ display currents of all superlayers of quadrant 'n'('n'=1, ..., 4) in the CTD

dvasqn $\hookleftarrow$ display volts of all superlayers of quadrant 'n' ('n'=1, ..., 4) in the CTD

3.5 What to do if the Program seems to "HANG"

This formerly happened about once a week with an old CTD HV program when the caen HV channels got stuck when being switched off or on by the program. The new system moves this operation to a step (the transition "OFF" $\leftrightarrow$ "STANDBY") which is not so time critical. It has not happened now for over one year. But if it does, (see the first item on the list below) please send an e-mail giving the circumstances to a.jamdagni@ic.ac.uk. Thank you.

What we have observed on a very few occasions during testing is that it is the display terminal in the ZEUS control room, NOT the program itself, which has "hung".

HOW TO TELL WHAT IS HUNG.

The 6 digit time of day appears at the right hand end of line 6 on the display screen. This is normally updated by the program approximately every second, but there are occasions such as printing many trip messages on the screen that this happens only after an interval of 5 or 10 seconds.. However in these cases it should be obvious that neither the terminal nor the program has hung.

If the screen is not visibly updated for more than 30 seconds then something has hung.

Go to the CTD HV computer in the VME crate at around shoulder height in rack A2,06 in the rucksack. The computer board is the second module from the left.

- If the RUN light on this board is flashing then the computer and program has NOT hung.
- look at the red coloured module ("model A200 SY127 controller") in the middle of this VME crate.

  If the "ack" and "data" leds on this module are pulsing with a slightly irregular period of less than 1 second, not operating in a continuous unmodulated fashion, then the A200 has NOT hung.
- If neither of the above two appears hung, then it is likely that the display terminal has hung.

If in doubt, try the following remedies in the sequence 1, 2.

REMEDIES

1. If the CTD display terminal in the control room appears to be hung, then switch off its AC mains power for a few seconds, then switch it back on again. The AC power switch is the black rocker switch on the base, at the front right-hand side. Switching off the terminal power has no effect on the program, and is safe to do.

   If the display begins to be updated, you have solved the problem. If it happens often, replace the terminal.

2. If the os9 computer or the A200 module has hung, a reboot is neccessary. Before trying this, read the section below about rebooting.

   Without care, serious HERA problems (e.g. beam loss) can be caused.

4 REBOOTING, LOGGING IN AND STARTING THE HV PROGRAM

1. If it is necessary to reboot the CTD HV program while a data taking run is in progress then it is essential to END this run first.

2. If a reboot is necessary and any part of the CTD has HV at working volts, it is essential to try to get the volts first to a low level.

   If, and only if, any part of the CTD has volts up, go to the module 5th (or the spare 4th) from the left in the VME crate at shoulder height in rack A2,06. The 4th coax cable counting from the top is labelled "vsel". Pull this out, and leave it out till the HV program has been successfully started again.

   Pulling this cable out should make the volts ramp down smoothly to about 50 volts on all 4 caen HV crates in a time of about 30 seconds. Check that this happens in the front panel displays of the 4 CAEN HV supply crates.

   Then press in the large red "emergency off" button high up between rack A2,06 and A2,07.

   This section 2. action is UNNECESSARY if the CTD has no voltages up.

3. Before pressing the computer reset button to reboot, lock bbl3 switch 5 and bbl3 switch 11 by moving them to the left. Keep them there until the reboot and restart of the hv program is complete (see section 8 below). This is because rebooting the HV computer inevitably generates an "injection veto" for HERA which is intercepted by locking bbl3 switch 5 and rebooting may also release the data taking veto.

4. If the power is ok in the VME crate, simply press the "reset" switch on the 147S computer module (second from left in the VME crate, press the lower "reset" button, not the upper "abort" button) to initiate a reboot, and go to section 7 below.

5. But if the mains has been off (e.g. power outage, or power off by fire alarm or gas alarm) the VME crate will not be powered up.

5a. Check that power is coming in to the "Wiener module" of the CTD HV VME crate. This is the module at the right hand end (seen from the front) in the CTD HV VME crate.

   If the large orange light is lit on the crate above head height in rack A2,06, above the VME crate, then power should be available to the VME crate - go to section 5b.

   If this orange light is not lit there are 4 possible faults to be checked in sequence:

- ◦ check that the rucksack power control panel in the corner of the rucksack has rack A2,06 “on”.
- ◦ check that the “Hager trip” for the HV system - inside the top back panel of rack A2,06 at the very top, labelled “battery backup for HV disc” is on (= up).
- ◦ The power comes through a “slow-blow” 3.15 amp fuse in a fuseholder at the bottom right hand corner (as seen from the back of the rack) of the crate next above the CTD HV VME crate in rack A2,06. There should be spare fuses taped on to the back of this crate.
- ◦ If this is also ok, and there are no obvious mains cables unplugged, this points to a fault in the “uninterruptable power supply” (ups) which drives the VME crate. This is situated in the crate mentioned above, at above head height in rack A2,06, whose fuse you have just checked. It has a large orange light on its front panel.

  This ups can be temporarily bypassed by unplugging the mains input to the ups (thick grey mains cable with rf filters) at the back of the crate, in the lower right hand corner as seen from the back) and unplugging the mains output cable #2 (orange cable) from the ups and just plugging them together. (Also at this stage unplug and leave unplugged meanwhile the ups mains output #1, a thin grey cable).

  The orange light at the front of this crate should now be lit, and the CTD HV VME crate Wiener module should have power.

  Bypassing the ups can be only a very temporary solution. Contact a CTD HV expert as soon as possible. Now go to 5b below.

5b. Once power is available to the Wiener module again, the VME crate can be switched on.

This is done by pressing down and releasing the bottom switch (“local”) on the “Wiener module” which is at the furthest right in the CTD HV VME crate.

The green “local” led at the bottom of the Wiener module should now be lit.

Once the green “local” led is lit, lift up and then release the top “power” switch on the Wiener module at the right hand side of the VME crate. This brings the power on and the top green “power” led should now be lit. If this fails at this stage, it may be necessary to “reset” the Wiener module by gently pressing its reset button behind the small hole near the top of the Wiener module front panel and repeating section 5b.

6. Switching on the VME crate power initiates a reboot of the computer. Go to section 7.

7. The reboot takes about 1 minute. The end of the reboot is when the small green led (labelled “mains request”) below the large orange light in the crate above the VME crate comes on, and messages about the boot procedure appear on the display screen in the ZEUS control room.

8. It is then necessary to login.

   Press return on the HV terminal keyboard in the control room, and the system should respond by asking for the user name **super**↩ and password **hera**↩.

   Following the initial typing simply type **ctdhvxxx**↩ (the **xxx** of the **ctdhvxxx** command should be given in a notice by the display terminal in the ZEUS control room) and the system will run the HV program, which takes about 3 minutes to initialise the hardware.

   When the initialisation is complete a display screen giving information about each superlayer-quadrant of the CTD is shown.

At this stage:

(a) If it had been necessary to unplug the "vsel" cable mentioned in part 1 of this section, plug "vsel" cable back into its original place (the 4th socket from the top of the 5th (or 4th) module from the left hand side in the CTD HV VME crate).

(b) release the red emergency button (high up between racks A1,06 and A1,07) by twisting it slightly. (if it had been pressed in section 1)

(c) unlock bbl3 switches 5 and 11 by moving them to the right.

(d) restart the CTD read out - send a local SETUP to the CTD, then a local ABORT before the SETUP is completed.

If appropriate, send an e-mail message as requested above about the origin of any fault circumstance which forced this reboot.

4.1 Reloading and restarting the HV program

1. If it is necessary to reload the HV program while a data taking run is in progress then it is essential to END this run first. Also lock bbl3 switch 5 so that HERA does not get any injection veto from the HV program.

2. Exit the existing HV program by typing

   exit↩

   on the HV terminal keyboard. This should bring down any existing HV on the CTD and exit the program in an orderly way. If this does NOT happen go to section 3 below, if the **exit**↩ does work properly skip section 3 and go to section 4.

3. If the HV program has crashed so that **exit**↩ does not work, try typing

   control E

   on the keyboard. (**control C** will not work). If **control E** works, continue with section 4 below. If **control E** does not work a reboot of the os9 is needed. Follow the instructions in the section REBOOTING, LOGGING IN AND STARTING THE HV PROGRAM on page **??**.

4. Reload the HV program by typing

   ctdhvxxx↩

   on the keyboard, where **xxx** is the version number of the HV program on a notice by the CTD HV terminal in the ZEUS control room. It takes about 3 minutes to initialise the HV hardware.

   After initialisation is complete a display screen giving information about each superlayer-quadrant of the CTD is shown.

   At this stage the system is in an OFF state, just like between fills.

5. It is wise to restart the CTD read out (unless this has just been done immediately previously following a ctdhv os9 reboot.)

   To do this send a local SETUP to the CTD, then a local ABORT before the SETUP is completed.

   Then continue with proper SETUP commands for the next run, and standby ↩ and hvon ↩ commands as normal.

5 USEFUL DATA RECORDED BY THE CTDHV SYSTEM

1. Web site http://www-zeus.desy.de/∼jamdagni/CTDHV.html

   at present contains only a little (self-explanatory) data. Updated ∼ every minute, this will be expanded.

2. Files useful for Physics analyses on the os9 computer 'CTDHV'

2.1 In the directory /h0/RUN_DATA/ the ascii files with the general names hv_N.set, hv_N.act and hv_N.end where N is the physics run number give a snapshot of the state of the ctd hv system at the SETUP time, ACTIVATE time and END (or ABORT) time of physics run N.

The format is the same for each file: 17 (integer) words for each of 44 superlayer - quadrants in the order:

superlayer 1 quadrant 1

superlayer 2 quadrant 1

superlayer 3 quadrant 1

superlayer 4 quadrant 1

superlayer 5 quadrant 1

superlayer 6 quadrant 1

superlayer 7 quadrant 1

superlayer 8 quadrant 1

superlayer 9 quadrant 1

superlayer 10 quadrant 1 (= inner electrostatic screen)

superlayer 11 quadrant 1 (= outer electrostatic screen)

superlayer 1 quadrant 2

superlayer 2 quadrant 2

superlayer 3 quadrant 2

superlayer 4 quadrant 2

superlayer 5 quadrant 2

superlayer 6 quadrant 2

superlayer 7 quadrant 2

superlayer 8 quadrant 2

superlayer 9 quadrant 2

superlayer 10 quadrant 2 (all zeros)

superlayer 11 quadrant 2 (all zeros)

superlayer 1 quadrant 3

superlayer 2 quadrant 3

superlayer 3 quadrant 3

superlayer 4 quadrant 3

superlayer 5 quadrant 3

superlayer 6 quadrant 3

superlayer 7 quadrant 3

superlayer 8 quadrant 3

superlayer 9 quadrant 3

superlayer 10 quadrant 3 (all zeros)

superlayer 11 quadrant 3 (all zeros)

superlayer 1 quadrant 4

superlayer 2 quadrant 4

superlayer 3 quadrant 4

superlayer 4 quadrant 4

superlayer 5 quadrant 4

superlayer 6 quadrant 4

superlayer 7 quadrant 4

superlayer 8 quadrant 4

superlayer 9 quadrant 4

superlayer 10 quadrant 4 (all zeros)

superlayer 11 quadrant 4 (all zeros)

Note that the series of 17 words for quadrants 2, 3 and 4 of superlayers 10 and 11 are empty. These quadrants do not exist

The 17 integer words for each real quadrant (and ies and oes) are:

1. quadrant number ($1 \rightarrow 4$)
2. superlayer number ($1 \rightarrow 9$, $10 =$ ies, $11 =$ oes)
3. field high (fhi) in volts
4. flo volts in volts
5. sense wire potential (**in $\frac{1}{2}$ volt units**)
6. fhi current in microamps
7. flo current in microamps
8. sense wire current (**in $\frac{1}{10}$ microamp units**)
9. hv relays switched on
    1. = octant A only
    2. = octant B only
    3. = both octant A and octant B

10. "event"
    for a SETUP record, event = 1 if not at working volts
    = 6 if all hv system is at working volts
    for an ACTIVE record, event = 1 if not at working volts
    = 7 if all hv system is at working volts
    for an END (or ABORT) record, event = 2
11. = 1 if THIS superlayer is at working volts = 0 otherwise
12. The date (eg. 19980801)
13. time (eg.153001 = 3.30.01pm) that this superlayer-quadrant information was last updated (normally updated at intervals of about 30 seconds)
14. current run number
15. last measured (about $\frac{1}{2}$ second previously) gflt accept number
16. normally 0 but +1 if this is the first update after this superlayer-quadrant reached working volts ($\sim \frac{1}{2}$ second ago) and -1 if this is the first updated after this superlayer-quadrant left (i.e. trip or "hvoff") working volts
17. spare = 0

2.2 in the directory /h0/RUN_DATA/ the file system_on_year_ month.dat where "year_ month" is the year and month of running (eg. "system_on_199808.dat" will be the file name for August '98; a new file each month)

This ASCII file is in 6 integer word records

(a.) date (eg. 19980801)
(b.) time (eg. 153001)
(c.) RUN number
(d.) last seen gflt number (about $\frac{1}{2}$ second previously)
(e.) a FLAG (see below)
(f.) The current nominal sense wire surface field (currently either 182 or 183 KV/cm, whether the hv is actually on or off).
"FLAG" has one of the values below:

= +1 means that the (hv part of) the ZEUS data taking veto has just been removed for a run which is already in progress (i.e. recovery from a trip, or an ACTIVATE has been issued while the hv is ramping up at the beginning of a run).

= -1 means that (any part of) the hv system has newly fallen below working volts (and just previously all was at working volts. The (hv part of the) zeus data taking veto is just newly asserted (eg. a new trip, ups power fail, calorimeter opened or any other alarm while a run is on).

= + 2 means that a new physics run has just been ACTIVATED with all parts of the hv system already at working voltages (eg. a new run with the same fill as last run)

= - 2 means that a physics run has just been ENDed or ABORTed with the volts still all up

= + 3 means that the run type of the current run has changed from being a daq test (which is not recorded) to a physics run, and the whole ctd is at working volts.

= - 3 means that the present physics run has changed into a daq test run, with all ctd hv up

= - 4 means that the current physics run is newly PAUSED
= + 4 means that the current physics run is newly RESUMED
(± 4 does not depend on all the hv being up)

3. The following may be of interest in case of technical problems with the ctd hv

3.1 /h0/hourly_log.dat records (in 9 integer-word ASCII records) the following information every hour (whether hv is up or not, whether a run is on or not)

(a.) date
(b.) time
(c.) atmospheric pressure (in m bar * 10)
(d.) magnetic field (in gauss. NB when the field is off this gives random numbers between 0 and about 23000. It is only reliable if the field is known to be on, or the result is stable at about 14300. The value -1 means that communication problems prevent a measurement being obtained)
(e.) the temperature (degrees centigrade x 10) of the rear (RTD end) of the CTD (-1 means communication problems)
(f.) the temperature (degrees centigrade x10) of the front (FTD end) end plate of the CTD (-1 means communicaation problems)
(g.) = 1 if all parts of the ctd hv system are at working volts at that time = 0 otherwise
(h.) = current number of superlayer-quadrants of the ctd which are tripped
(i.) = the instantaneous sum of the sense wire currents of all 4 quadrants of superlayer 1 (in microamp x 10)

3.2 /h0/RUN_LOGS/ contains one file for each day the hv program is running.

File names are like "run_log_19980801.dat". A new file is started soon after midnight each day.

These ASCII files record most changes in the ctd hv system: alarms, keyboard commands typed, trips, run control commands, etc.

Each record consists of 6 integer numbers followed by text messages of up to 50 ascii characters

The ascii characters give the general meaning of each message; the detailed interpretation needs a dictionary for the meaning of the numbers (which is different for different messages). This will be provided later.

The first number is always the time of day and the last number is always the number (1 to about 200) of the type of message.

3.3 /h0/boot.log is an ASCII file which records the time and date of each reboot of the os9 computer

3.4 /h0/currents_"date".log (where "date" is as usual eg. 19980801 for the first day of August 1998) is a new ASCII file each day, recorded every 2 minutes only when all parts of the ctd are at working volts

Every 2 minutes 4 lines are written containing the instantaneous sense currents (in $\frac{1}{10}$ microamp units) of each superlayer quadrant. The format of each line is:

date (eg.19980528) time (eg.100140) quadrant number ($1 \rightarrow 4$) followed by 9 entries for the sense wire currents of superlayers $1 \rightarrow 9$ for this quadrant (quadrant 1 has two additional -1 at the end; these correspond to the non-existent sense wires of the inner and outer electrostatic screens.

6 BASIC REQUIREMENTS FOR THE CTD HV SYSTEM

The full design of the ctd is described in "The design and construction of the ZEUS central tracking detector", B.Foster et al NIM A338 (1994) 254-283. A copy may be found at the end of this document.

An outline of the hv requirements is summarised here.

The aim of the ctd is to make many, precise measurements of points on charged tracks leaving the interaction point, to gain information on the track angles, curvature and ionisation density.

The position measurements are made by measuring the drift times of the ionisation electrons produced in 8mm thick (radially) segments of track. The drift time is measured from the position of the track segment to the precisely known position of a "sense" wire.

The gas in the ctd is at (a variable) atmospheric pressure for mechanical reasons so as to achieve low ctd wall thickness. The number of electron - positive ion pairs produced by a minimum ionising particle in 8mm is about 60.

The heavy gas ions and the electrons separate in a uniform electric drift field ($\sim$ 1.22 kv/cm) and drift at constant speed. The drift rate for electrons is about 50 microns per nsec; the heavy positive ions are much slower.

The maximum drift time for the electrons is set at about 500 microsec, not too many multiples of the 96 nsec ep bunch crossing interval. This corresponds to a maximum drift distance of about 25mm.

The direction of the electron drift in the ctd is deviated from the electric drift field direction by the solenoidal magnetic field.

In the ctd gas this angle between the electron drift direction and the electric drift field, the "Lorentz angle" is about 45°. In the ctd the electric drift field is set at 45° to the local radius so electrons drift (approximately) in the azimuthal direction at a constant radius from the ctd axis (= ep beam axis) see figure **??**. Thus knowing the sense wire position and the drift time gives the (azimuthal) postion of that segment of the track.

The inner radius of the useful ctd volume is about 160mm and the outer radius is about 800mm. For azimuthal drift at a radius of R mm, the 25mm maximum drift distance requires that at radius R there should be $\frac{2\pi R}{25}$ drift spaces, varying from 40 drift spaces at the inner radius to 200 at the outer radius.

To fill the $2\pi R$ azimuthal drift space at radius R the drift directions and hence drift field directions are alternately clockwise and anticlockwise. Thus drift distances are measured in both clockwise and anticlockwise directions from a plane of sense wires. The drift field terminates on each side of this "sense wire plane" on two planes of negative potential field wires.

This "cell" structure of a plane of sense wires between 2 planes of field wires is repeated (an integral number of times) round each azimuth, see figure **??**.

This indicates there should be about 40 drift spaces/2 = 20 cells round the inner radius up to 200/2 = 100 cells round the outer radius.

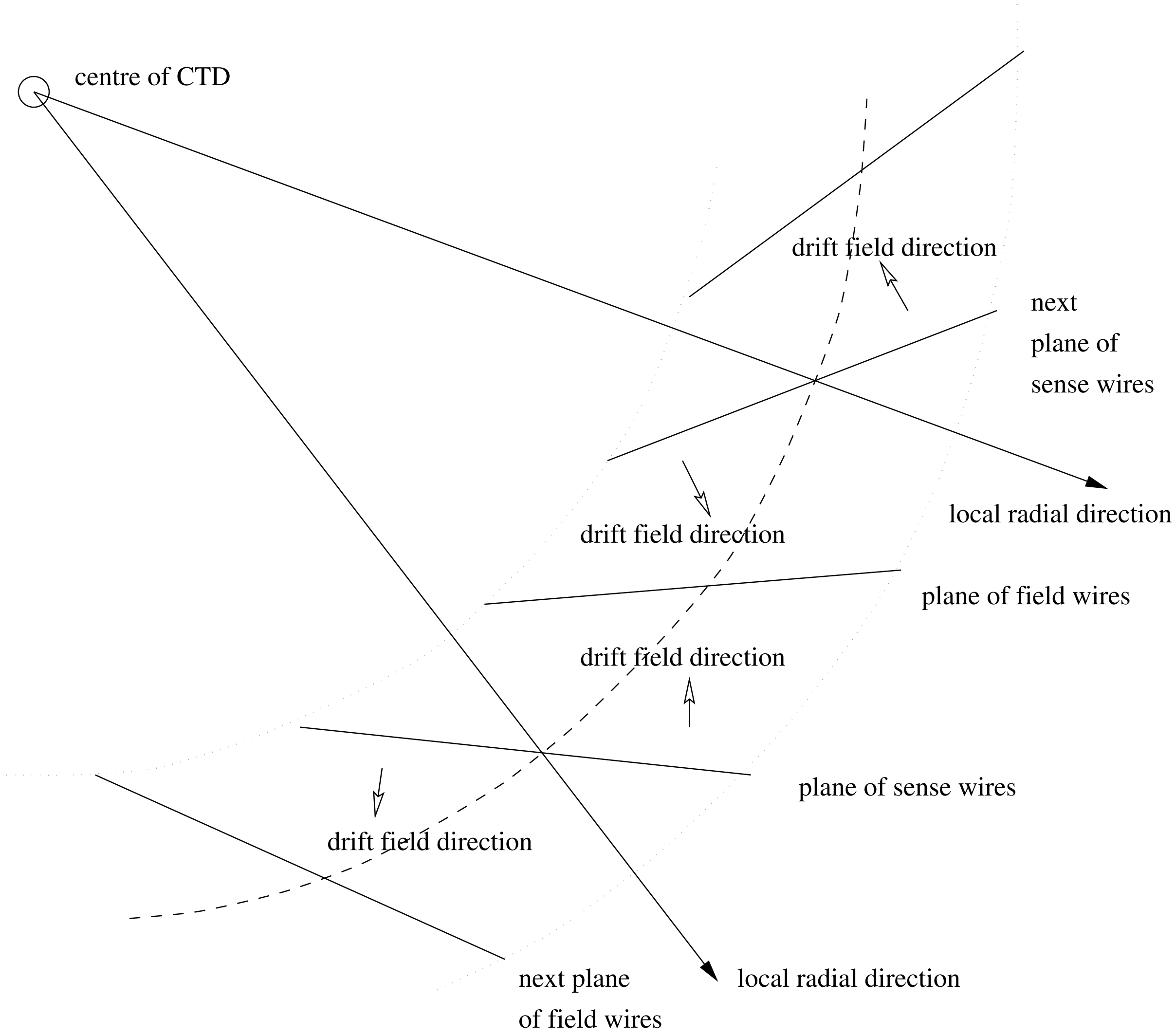


Figure 1: Electric fields in a 'typical' ctd cell

To take care of the variation of the number of cells with radius, the cells are arranged in 9 "superlayers" which have 32 cells in the innermost superlayer 1, then 36 in superlayer 2, ... up to 96 cells in the outermost superlayer 9.

The design requires:

- azimuthal electron drift
- Lorentz angle of 45 degrees
- for simplicity all SENSE wires at the same potential
- So the drift field is perpendicular to the sense wire plane,
- and every sense wire plane is at 45 degrees to the local radius
- the negative end of the drift field lines is at 'FIELD WIRE' planes placed between the sense wire planes

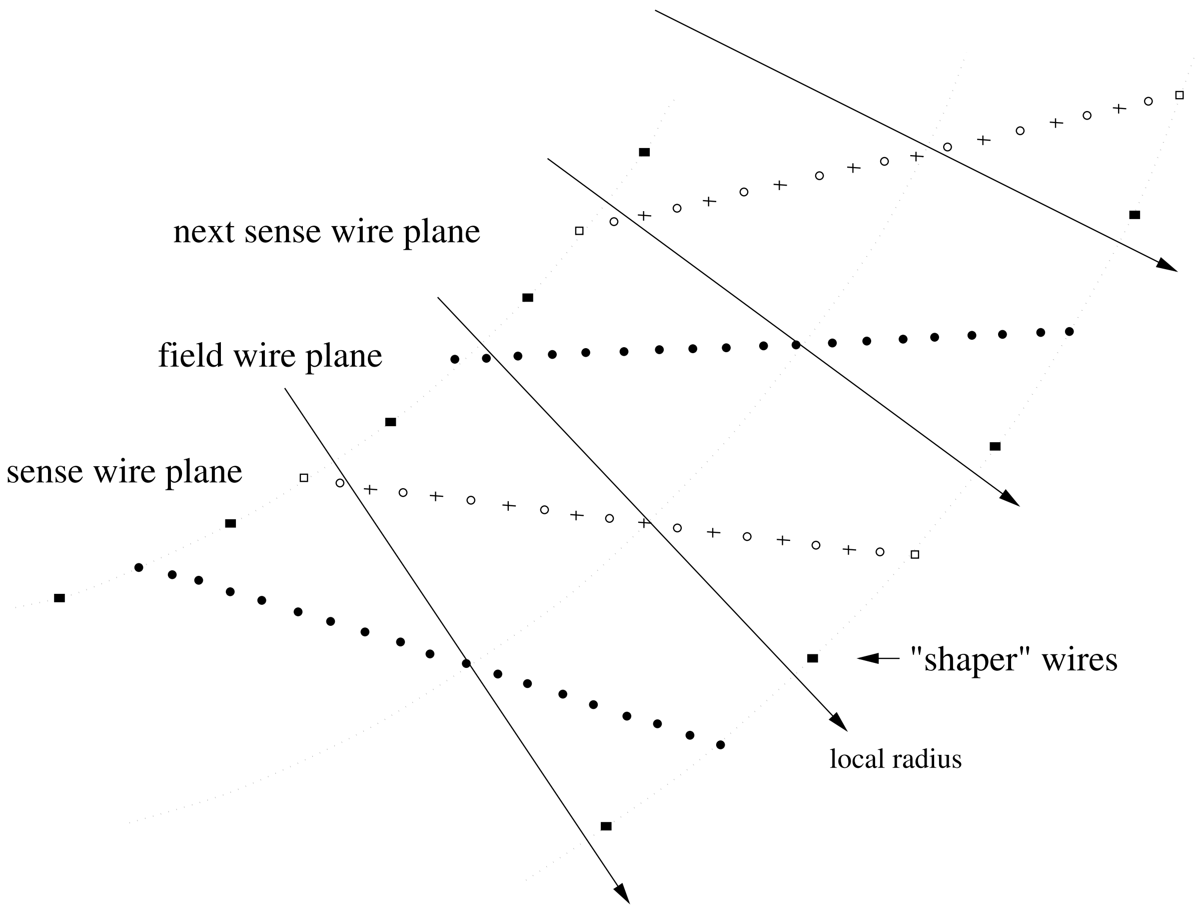


Figure 2: Details of a ctd cell

- The drift field is NOT perpendicular to the field wire planes, so there is a potential gradient along the field wire plane, i.e. the field wires are at different potentials.

6.1 Sense wire planes

Each sense wire plane has 8 active sense wires 8mm connected to preamplifiers apart plus two “guard wires” (= dummy sense wires) at each end of the plane not connected to preamplifiers. With this design a high momentum ($\sim$ straight) track will cross at least one sense wire plane in every superlayer it passes. Thus in each superlayer there will be one signal from each track which will have had a very short ($\sim$ 0) drift distance. Hence it is easy to attribute this track to one particular ep bunch crossing. Later signals from that track in that superlayer (with longer drift times) are associated to the same track because their azimuthal positions are a simple function of the radial position of the sense wire.

Because the number of electron - ion pairs produced in an 8mm segment of track is low ($\sim$ 60) this signal must be amplified before detection and recording. This is done by a proportional “avalanche multiplication” in a volume of high electric field (up to $\sim$ 182 kv/cm) in the immediate neighbourhood of each (30 micron diameter) sense wire.

Thus close to the sense wire the uniform drift field ($\sim$1.22 kv/cm) is replaced by a very non-uniform field which amplifies the number of electrons ($\sim \times 10^5$) and guides them towards the sense wires.

A wire which is positive with respect to the field wire planes (potential $\sim$ -2500 volts) and negative with respect to the sense wires (potential $\sim$ +1250 volt) is placed between each neighbouring pair sense wires (and guard wires), to make sure there are no saddle points of weak field between the sense wires. For simplicity these wires are at 0 volts. As well as eliminating points of 0 total electric field, these intermediate wires help to reduce capacitative coupling between neighbouring sense wires.

6.2 The field wire planes

Each field wire plane has 19 wires like each sense wire plane (for simplicity in construction see figure **??**)

- The maximum -ve voltage ($\sim$ - 2750 volts) on each field wire plane is at the outer end where the cell is widest.
- In principle the 19 + 4 voltages needed for the field and shaper wires for shaper wires (see section **??** below) can be derived from a resistor chain.
- The voltage step between field wires is $\sim$ 50 volts, but the voltage steps for shapers is $\sim$ 1000 volts.
- Currents through the resistor chain vary with HERA backgrounds because +ve ions from the avalanche region near the sense wires end up on field and shaper wires.
- To better fix the field wire potentials in spite of this varying current we fix <u>two</u> places on the chain from low impedance supplies - the outer end and (near) the inner end, and also make sure the standing current in the field wire resistor chain is high enough.

6.3 "Shaper" wires

4 more wires are required to adequately define the magnitude and direction of the drift field and reduce the effects of electric charges on neighbouring superlayers. These 4 "shaper" wires effectively close each end of the two drift spaces of each cell see figure **??**.

6.4 Electric potential supplies to the ctd wires

- Each superlayer has a different geometry and hence voltage, but within one superlayer all field wire planes are the same and all sense wire planes are the same.
- Each superlayer is fed HV by 4 sets of three HV supplies, one set for each "quadrant" of the superlayer
- Each superlayer - quadrant has 3 separate supplies in its set see figure **??**.
  - $\sim$ -2500 volts for the outer end of field planes
  - $\sim$ -2000 volts for the (near) inner end of field planes

  - ∼ +1250 volts for the sense planes

- The 3 HV supplies for one superlayer quadrant are divided to supply 2 superlayer - octants . These can be switched on/off independently by HV switches in the rucksack. Thus if something goes wrong, need to lose only 1 superlayer - octant see figure **??**.
- There are 9 (sl) x 4 (quad) x 2 (oct) x 3 HV Cables = 216 HV Cables to CTD.
- Also 2 more for the inner and outer electrostatic screens which make the field inside sl1 and outside sl9 more uniform.

The potentials of all wires in each cell are optimised numerically. Every cell in one superlayer has identical potentials for corresponding wires; the optimum potential pattern for each superlayer is different.

The ctd also has a concentric "inner electrostatic screen" inside superlayer 1 and an "outer electrostatic screen" outside superlayer 9 both held at an optimum potential.

The superlayers are divided into the "axial" class (superlayers 1, 3, 5, 7, 9 with all wires parallel to the beam axis) and the "stereo" class (superlayers 2, 4, 6, 8 with all wires displaced azimuthally by about 5° to the beam axis, alternately in the positive and negative sense).

Cross corelation of track signals between axial and stereo layers gives information on the Z coordinate of track segments and hence on the polar angle of tracks.

Axial superlayers 1, 3 and 5 have preamplifier cards at both ends of the sense wires planes. (All 8 sense wires in superlayer 1, only some sense wires in superlayer 3 and 5). Information on the track Z coordinate comes from the time difference between the signals from the two ends of a sense wire.

All the hv is generated in the rucksack (see figures **??** and **??**) 44m long hv cables carry the hv to the "services ring" at the RTD end of the ctd. Cables mounted on the outer surface of the ctd deliver all the hv to the FTD end, where it is distributed via a "mini services ring" to the preamplifier cards (for the sense wires and guard wires) and the field wire cards (for the field wires and shaper wires). Each set of 3 supplies is daisy chained around one octant at the FTD end.

Superlayers 1, 3 and 5 are used for Z-by-timing, so have preamplifiers at both ends (see figure **??**).

All field wire planes (and shaper wires) are supplied with hv power at the FTD end; all field wire planes have a second field wire card at the RTD end. Every sense wire plane at the RTD end has a preamplifier card; The sense wire planes used for Z by timing measuremants also have a second preamplifier card at the FTD end. The other sense wire planes at the FTD end have a dummy (inpedance matching preamplifier card to make the electrical environment the same for these sense wire planes. For both the sense wire planes and the field wire planes the hv connexion between the FTD end where the hv power is supplied and the sense and field wire cards at the RTD end is through the chamber wires themselves.

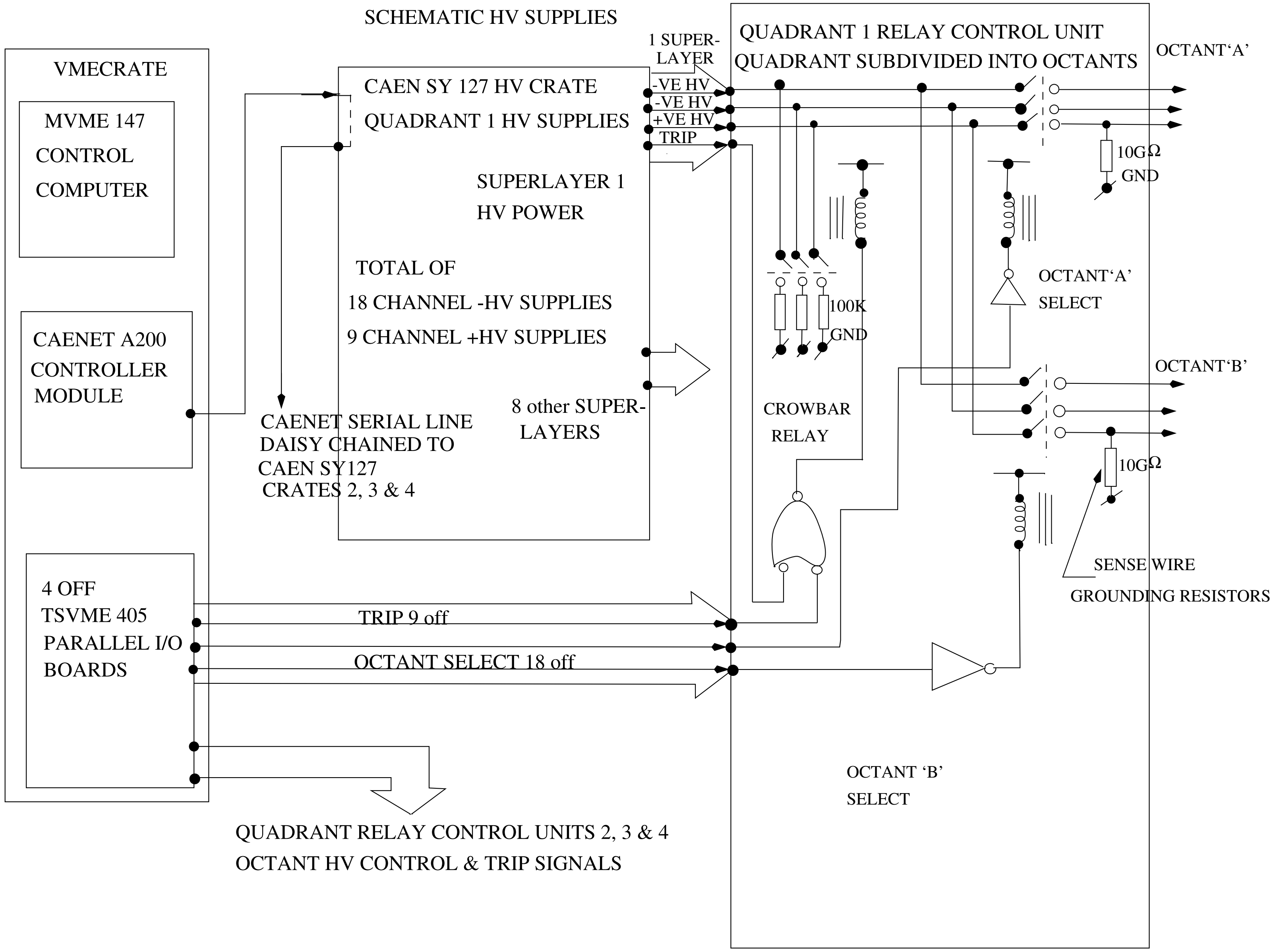


Figure 3: Schematic arrangement of hv supplies

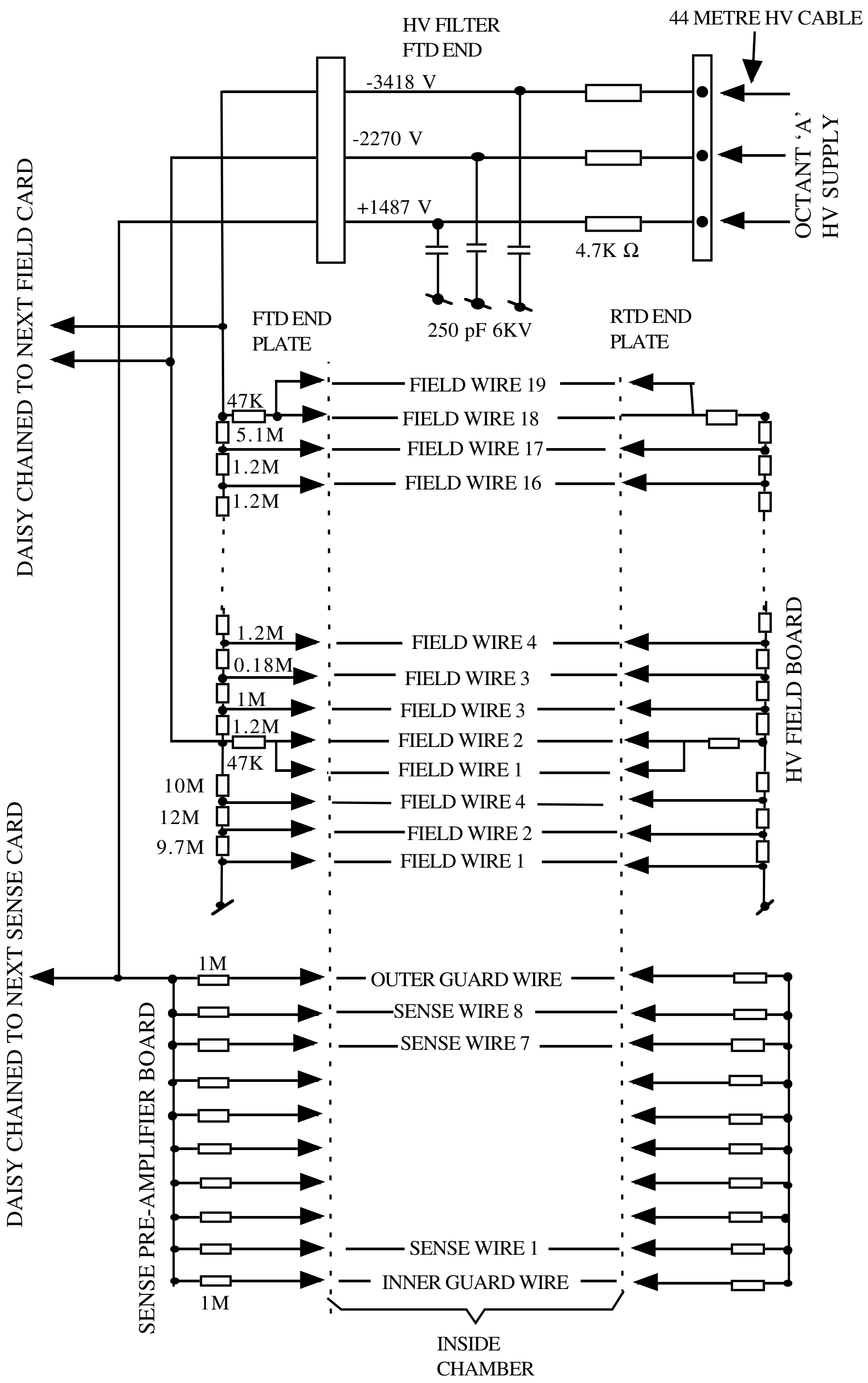
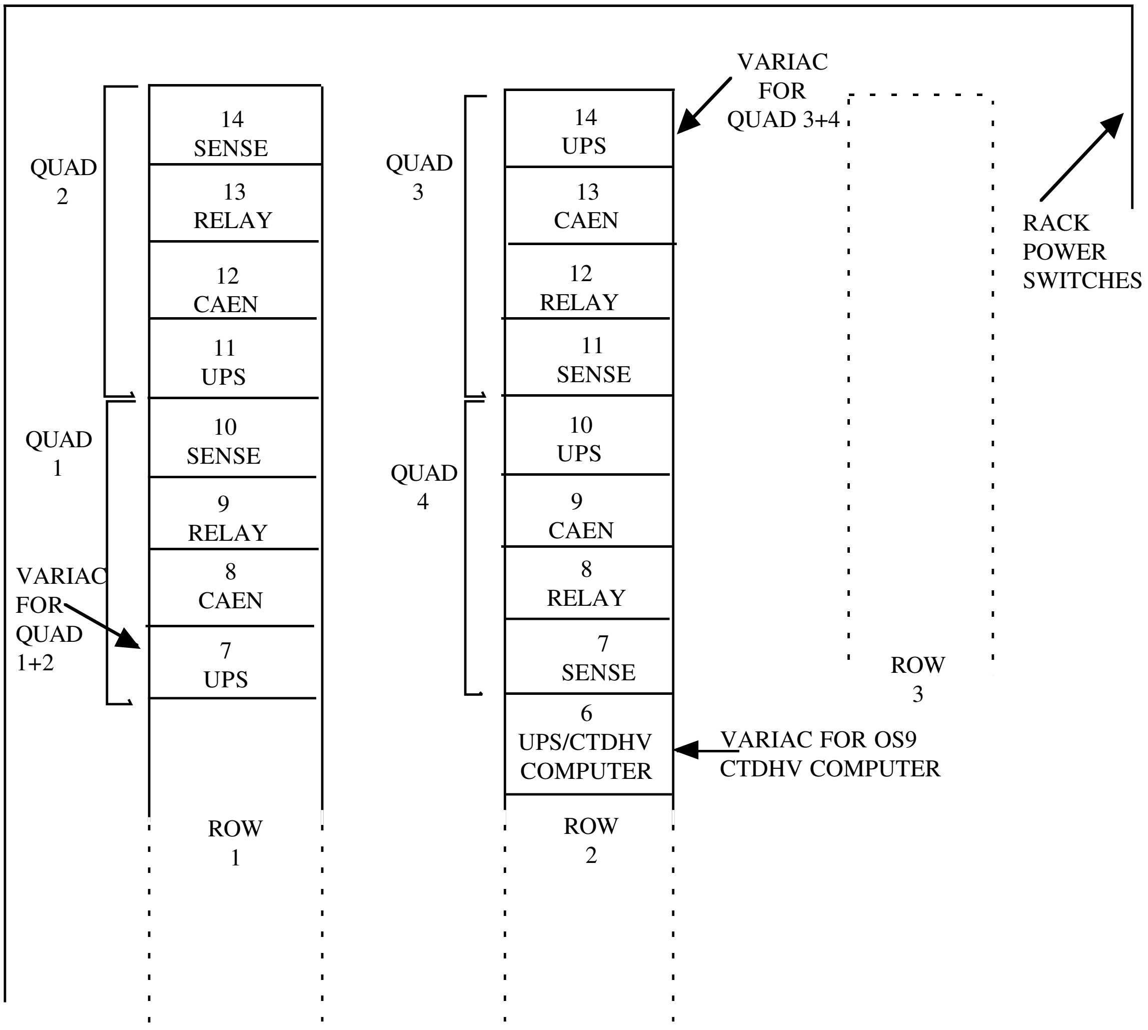


Figure 4: hv supply to one cell



Ground Floor - level A

HV Equipment is always at top of racks (except mains supply variacs which are at waist level)

° VARIAC = Variable Transformer to get right mains voltage

° UPS = Battery back up mains supply

° CAEN = HV supply crate

° SENSE = Current --> frequency converter for superlayer 1 sense currents

Figure 5: ctdhv layout in the rucksack

Quick checks on the CTD HV control system for normal running.

Everything is OK if:

- The display in the control room is being refreshed (about every 20 seconds)
- There are no “alarms” displayed (on a single line about 2/3 of the way down the display screen) and the “STATUS” displayed on this line is “normal”.
- There are no new warning messages displayed on the lower part of the screen below the “status” line.
- It is also worth checking occasionally in the rucksack that in each of the four (quadrant) sections of HV hardware that:

Each UPS crate has a green LED lit on the front of the (protruding) UPS itself, and a small green LED lit near the bottom right hand side of the UPS crate front panel and a large orange light lit near the middle right hand side of the UPS crate front panel.

and Each CAEN SY127 HV power supply has it’s crate number light (situated towards the top right hand side (nos 01 ... 04 for quadrants 1 ... 4)) lit STEADILY (not flashing)

and Each relay crate has it’s NORMAL display in the row of green LEDs (“normal” = a row of 18 green LEDs for quadrants 2 and 4, and 20 green LEDs for quadrants 1 and 3) and none of the middle row of 10 (red) LEDs lit.

For the control system in rack A2,06 check that the UPS crate has the three lights on it’s front panel lit. (the UPS itself is different from the UPS for the 4 CAENs. The UPS LED is rectangular, but hidden behind a ribbon cable from floor level and the rectangular LED should be green). “Status” and “run” on the MVME147S processor module are flashing (around 2 Hz) and that the (rather dim) “data” and “ack” LEDs on the A200 (red coloured) module in the VME crate are flashing (several Hz, except for quiet periods of about 2 seconds every twenty seconds)

Interpretation of condition if deviations from normal are observed in the state of the system.

For the four quadrant UPS for CAENs and relay crates

(Top of racks A1,07, A1,12, A2,14 and A2,10 for quads 1 to 4 respectively).

These four UPS are all HO600 UPS from ONDYNE. They are mounted inside a 4U high crate, with the front panel of the UPS itself sticking out through a square hole in the front panel of the crate. The front of the UPS sticking out has a red or green LED, and a square latching on/off button.

1. If the LED on the UPS front panel is neither green nor red then -
   (a) UPS is not switched on, press in the square pushbutton on the UPS front panel just below the LED (it should latch in) or
   (b) UPS mains power input failed several hours ago and the internal battery has run down. Get the AC mains back onto it, which will begin recharging the internal battery and give immediately AC power output to the system it is supplying. This is supplied from a large variac (variable transformer) in rack A1,07 for UPS1 and UPS2, and rack A2,14 for UPS3 and UPS4: The input power for these two variacs is supplied from the Hager box at the top of the same rack that the variac is situated in.

2. UPS LED shows red. The AC mains power input to the UPS has failed. Fix it!. If this is not part of a general power failure then maybe the circuit breaker at the back of the rack containing the variac has tripped out. This is the "Hager box" towards the top of the back of the rack; the UPS are always supplied through the left hand 10 amp circuit breaker. The switch should be up.

   If this is not the cause there could be a fuse blown in the UPS. The input fuse to each UPS is 3.15amp slow-blow. The fuse carrier is towards the bottom right hand corner of the back of the UPS crate. Spare fuses are taped to the back of the UPS crate. It may be worthwhile to temporarily bypass the UPS for power by connecting the CAEN SY127 and relay crates supplied by this UPS direct to the mains in their own racks - see under UPS in section 3.

3. UPS LED green OK, but orange light at the right hand side of the UPS crate not lit - this signifies that the UPS is not supplying AC power out but has good AC mains input. If the green LED below this orange light is also not lit then this is consistent with the fault being lack of drive for the internal AC POWER relay switch. There are several possible faults responsible for this:

   (a) The mains power failed for more than 3 minutes, and was then restored. After a failure lasting 6 minutes the whole HV system is shut down and must be restarted. See notes in section 4 on the computer system.
   (b) The relay drive reaches the back of the UPS crate via a 34-way cable from the back of the computer UPS in rack A2,06. Perhaps this cable has been damaged, or unplugged.

(c) Perhaps the relay drive circuits inside the computer UPS crate have failed, or have lost their power supply (This comes from the upper Wiener VME crate in rack A2,06 to the electronics inside the computer UPS crate via a 10-way ribbon cable).

UPS for the HV control computer in rack A2,06.

The UPS for the OS9 computer and its VME crate is different from the rest - new in June '93 is driven from a small variac at the back of rack A2,06.

In particular if there is a long mains failure (more than 6 minutes) it can get into a state which needs special action to restart it.

[This is due to a feature it has which the 4 old quadrant UPS don′t have. If it drives its output into a zero load it switches off, (After its mains input lives failed), after just 30 seconds of zero load. It can easily reach this state during a long power outage - when the power is restored to its rack, it finds no load because its output AC relay will have opened, so after 30 seconds with AC restored to its input, if it has zero load, it will switch off again, apparently mysteriously, because it has good AC mains input. So the trick is to get load onto its output before the 30 seconds is up !]

1. There is a rectangular LED on the front panel of the actual UPS itself. The UPS is mounted (on its side) inside a crate just above head level in rack A2,06 (sorry the LED is so difficult to see).

   If this LED is GREEN, the UPS has good mains input and is giving good AC power out.

   If this LED is RED, the mains input has failed, but the UPS is providing AC power out while the program automatically runs down the HV.

   If the LED is NOT LIT, then the UPS has switched off - either after supplying AC power for 6 minutes during a power outage, or because it came on again when its input mains was restored but then switched off 30 seconds later because it found no load on its output.

2. If the LED is RED - fix the mains input before the 6 minutes is up and the LED will turn to GREEN and the computer and the HV VME crate should operate without interuption.

3. If the LED is OFF because the UPS has no mains input -
   switch the "normal/ start-up-override" key switch on the computer UPS crate front panel to the "override" position, and fix the mains input to the rack.

   (a) The UPS should come on with the LED GREEN -

   (b) You do this in the usual way using the Wiener module to the RHS of the HV VME crate (which is at shoulder height in A2,06). On this module, Press down and release the lowest switch "go to local" till the small round LED "local" lights green; then press up and release the top "power" switch. Power should come on to the crate and there should then be no problem with the UPS cutting out because of zero load.

       Now follow 5.

   (c) (Occasionally the VME crate does not power up properly, but the red leds giving volts etc. on the middle of the RH module go into a mode in which they flash at about 2 Hz. Try "resetting" the RH (Wiener) module pressing the "VME SYSRES" switch inside the hole at the top of the rhs module front panel with a ball point pen, then repeat the above from 3).

If the UPS switches off and the LED goes out with good mains input to the UPS, follow 4. below, then 5.

4. If the rectangular LED on the UPS is out, due to zero load for more than 30 seconds - get ready by switching the "normal/override" key switch on the UPS crate from panel to "override". then momentarily remove the mains input from the UPS (do this by e.g. by switching off (up) then on (down) again the UPS mains power overload trip (the "Hager switch" second from the left at the top of the back of the rack); or by pulling out the mains input cable (white mains cable at the right hand side on the back panel of the UPS crate) and plugging it back in again. An interuption of about a second is enough.

   Now the rectangular LED on the front of the UPS itself should be green, and you have 30 seconds to follow through the procedure from 3a. above.

5. Now reboot the computer. This begins automatically when the power comes on to the VME crate. [Occasionally the system tries to access the hard disc before it is up to speed. This results in a message appearing on the terminal (in the control room) "can't access the disc. Do you want the debugger enabled? y/n/q ?.

   Don't choose any of these options but wait for about 30 seconds and restart the booting by pressing the "RESET" button (lower button) on the front panel of the MVME47S module in the VME crate.]

   This should work ok (if it doesn't try again after another 30 seconds wait). It takes about 90 seconds to complete the booting once properly started, then when invited by the messages on the screen, a keyboard "return" will initiate login.

   During this booting a program is run which switches on the output relays of all the 5 UPS. On all 5 UPS the small green LED on the front panel of each should light, and if that UPS itself is switched on, the orange light above this green LED should light, and the CAEN HV crate and relay box it drives can come on. If they already have their mains switches on at this time, the power-on surge may cause the Hager overload trip at the back of the rack of the associated variac to trip (or maybe a fuse to blow). It is a good idea to check at this point that all the UPS are producing power with good mains input and that, if desired, the CAEN HV crates and relay crates are on ok.

   In particular, after booting, the small round green LED on lower right hand corner of the front panel of the computer UPS should be lit.

   <u>DON'T FORGET -</u>

6. At this point, having checked that the small round green LED in the lower right hand corner of the computer UPS crate front panel is lit, turn the "normal/override" key switch (on the front panel of the computer UPS crate) back to "normal" (If you don't, next time there is a mains fail affecting the computer UPS, its battery will drain because the program cannot switch off the power to the VME crate when it is no longer needed once the HV has been run down and the 6 minutes warning is up).

<u>NORMAL STATE FOR THE HV SYSTEM LEFT FOR LONG PERIODS WITHOUT USE</u>

1. All five UPS must have active mains input, otherwise over a period of a month or so the internal drain on their batteries will run them down and damage them. (In the case of a

long shutdown with no power in the rucksack, we will make provision to have power to all UPS for one working day per week to charge the batteries).

The four “quadrant” UPS must have their square front panel “on” buttons latched in (otherwise they are not on charge), (but only if A/C power is available to charge them. If there is no AC power this square button MUST BE OUT.

2. The HV VME crate must be powered up and the computer running. The high voltage program should be exited. In this case a background program “UPS_CARE98x” automatically run at boot time will switch on the AC output relays for all five UPS and look after them if the power fails.

3. This program also sets “injection enabled” and “no BBL3 data taking inhibit” so that there should be no interference with test runs of other components.

4. The four CAEN crates and four relay boxes should have their mains input switches “off” and the red CTDHV emergency off button should be latched in.

CAEN SY127 HV supply crates.

If the CAEN SY127 crate is off, look to see if the neighbouring UPS is delivering power - i.e. with it’s orange light at the right hand side lit. If not - fix this. Maybe the power cable from the UPS output to the CAEN SY127 has become unplugged at either end at the back of the racks.

The CAEN has a 6 amp fuse at the top left hand side of it‘s front panel. If the power is on but it seems not to be delivering HV, look at the the red LED labelled “kill”, the second top LED of a vertical group of five LEDs towards the left hand side at the front of the SY127 crate. If this is lit, then the large red “emergency off” button high on rack A2,06 is pressed in, or the 50 ohm coax cable from this button to the “interlock” socket is broken somewhere. This cable has two branches from the emergency off button to the CAEN crates. One branch runs from the red button along the front of the racks in row A2 daisy chained to CAEN4 and CAEN3; the other branch runs from the pushbutton through the 1 U high feedthrough panel in rack A2,06/ under the floor to the back of UPS1/ through the front panel of UPS1 crate/ then daisy chained along the front of the racks in row A1 to CAEN1 and CAEN2. This coax is NOT terminated. As an aid to identification its Lemo 00 plugs and sockets are marked with white paint. The red “EMERGENCY OFF” button merely isolates the “interlock” socket of each CAEN from ground when pressed in. Thus a broken cable prevents the HV coming on.

Fix the break, or as a temporary measure, plug a 50 ohm terminator plug into the “interlock” socket of the CAEN crate(s). This should allow the HV power on this crate to come on again.

If the crate number light (towards the top and right of the crate) is flashing, then one or more HV channels is TRIPPED in this crate. One of the row of ten red LEDs on the horizontal centre line of the front panel of the corresponding relay crate ought then to be lit. “Clear” the “trip” from the computer keyboard in the usual way. (Recent versions of the HV control program can also CLEAR trips by typing the HVON command).

Any problem with the internal power supply in the CAEN crate should show up on four small LEDs toward the left hand side labelled “ +70, +12, -12, +5”.

If the CAEN SY127 is misbehaving under program control but otherwise seems normal, suspect:

the “CAENET” 50 ohm coax from the A200 CAENET controller in the upper VME crate in rack A2,06 is broken somewhere. This is daisy chained from the A200 controller to the front panel of each of the four CAEN SY127 crates in order. The path is:

from the A200 in the upper VME crate in rack A2,06/ short coax to a 1 U high panel of feedthroughs just above the VME computer crate in this rack/ long cable under the floor from rack row A2 to rack row A1, emerging at the back of UPS1 (A1,07)/ through the front panel of UPS1/ coax to front panel of CAEN1 /daisy chained along the front of the racks to CAEN2/ back to a feedthrough on the front panel of UPS1/ through the front panel of UPS1/ back under the floor, emerging behind the 1 U feedthrough panel in rack A2,06/ through the feedthrough panel/ along the front of rack row A2 to CAEN3 (in A2,13)/ back along the front of the racks to CAEN4. The daisy chain stops here and the “terminator” switch of CAEN4 must be to the left, and the red “term” LED lit. The terminator switches of CAEN1, 2 and 3 must be to the right (and their “term” LED unlit).

If there is trouble here a temporary additional or parallel loop of extra 50 ohm cable with Lemo 00 plugs could replace all (or some) of this daisy chain while the fault is fixed.

CAEN HV modules.

It maybe that a single one (or more) plug - in HV module fails in a CAEN SY127 crate. This would be indicated by the program, otherwise operating OK, not being able to operate a HV channel, or group of HV channels all residing in one module.

There are a small number of unused HV channels in each CAEN crate, and it may be possible to swop channels to continue by using a spare channel. It will then be ESSENTIAL to modify the ASCII file “/h0/caeninit/map.dat” on the hard disc and restart the program. This file describes the assignement of the HI-, LO- and sense+ HV crate and channels to the superlayers and quadrants. For how to do this, see section “Map.dat” in part four of this document.

There may not be enough spare channels of the right sort available in a CAEN crate to swop for a faulty channel, so replacement of the faulty module is required. There are four spare CAEN modules in the HV cupboard on level 6. There are two A333 for negative supplies HI- and LO- and IES and OES (inner electrostatic screen and outer electrostatic screen) and two A434 for positive supplies (for sense wires). Be sure to use the right one, and send the faulty one to be repaired. The agents for CAEN in Germany are FIRMA HANS WIENER GmH & Co., Hd Herm Plein, Mullersbaum 18-20, 5093 Burscheid-Hilgen.

Shipping to Wiener from DESY can be arranged by Herr Kurt Hoelzer of the DESY electronic purchasing group (Room 107 in building 11 telephone 3631, office is above the Gaesteburo).

The faulty module can be removed without removing the SY127 crate from the rack. Shut off the power and disconnect the HV cables (SHV plugs) necessary to gain access to the module (keep a note of how they were connected) and the twisted pair “trip” wiring (also keep a note see also figs 2.1 and 2.2). Insert the replacement module. But before reconnecting the HV cables and trip daisy chains, you must set up a single adjustment for each channel, the “hardware maximum voltage limit” on each channel of the new module.

Adjusting hardware maximum voltage limit.

Make sure the relay crate corresponding to this SY127 crate has it’s power off so that any volts generated by mistake on other channels cannot reach the CTD.

There should be no HV cables in the new module to be adjusted. Switch on the CAEN SY127 again and using the keyboard on the front panel of the CAEN SY127, select the channel number "N" of the first channel of the new module. See the figure 2.2 giving the layout of the channel numbers.

Select the channel by pressing the following sequence of keys: F 0 # N #.

Now set into this channel the required voltage limit. It is recommended that a value 5% above the working voltage is used. The working voltages are given in the current file /h0/caeninit/voltages.dat on the HV OS9 computer. Table 1 lists this file at a certain date (it may change) and also gives voltages = 105% of these working voltages for use as maximum voltage values. NOTE THAT FOR SENSE WIRE CHANNELS, the voltage is measured and displayed in 1/2 volt units. Thus to set in a positive sense wire voltage of 1234 volts, you would type in, and read back out on the front panel display, the figures 2468. Negative voltages are typed in, and displayed in 1 volt units, without a negative sign.

To set the "voltage" abcd in, type F1 # a b c d #.

Now you must type in a non zero trip current limit. For all channels a value of 100 should prevent the channel tripping during the adjustment - so type F2 # 1 0 0 #.

You must also ensure that there is a suitable "ramp rate" for operation of this channel. During operation with the ctd the ramp rates are calculated and set at about 20 (volts per second). This is too slow to be convenient for this hardware limit adjustment. A rate of about 100 to 250 volts per second is recommended [the maximum possible is 512 volts/seconds]. It is convenient to have the ramp down rate. The ramp up rate is set in the selected channel by F8 # 100 # (to set 100 volts per second) and F9 # 100 # to set the ramp down rate to 100 volts per second.

Now turn the channel ON by typing F10 #. The channel should raise it's output voltage to (within a few volts of) the voltage abcd typed in above. If it trips, raise the current limit from 100 suggested above to a higher value.

The channel may switch on but not reach the value abcd because the hardware limit is already set below this limit. In this case the voltage remains at a lower (non-zero) value than required with the UNV LED lit on the CAEN SY127 crate front panel, to the left of the keyboard.

The hardware maximum voltage limit is set by turning the multi-turn potentiometer situated close to the output high voltage socket for this channel at the back of the module, see figure 3.1. The potentiometer is turned by means of a very small flat-bladed screwdriver. The limit is increased by turning the adjustment clockwise, decreased anticlockwise. So now increase or decrease this adjustment until the output voltage is free to rise just to the limit set in on the keyboard as above, without bringing on the UNV LED on the SY127 front panel. This is a two person job, with one watching the front panel calling to the person behind turning the screwdriver.

Now switch this channel off: F11 # [or better a general "kill" F12 #], and deal with the next channel in the module.

When the module(s) is finished carefully replace the twisted pair trip wiring (remember always green wire of twisted pair to the right) and then the HV cables into the correct sockets. A view of the "standard" wiring of the CAEN back panels is shown in figure 1, but of course the one you are fixing may have become non-standard. A table of cable numbers for the whole of the initial system is given in the section on cables.

This process of recabling is very prone to error; it is advisable to have it completely checked by an independent person who understands the system, and also to switch on the HV through this part of the system carefully, looking for possible unconnected or swopped cables. BEWARE!

Relay crates.

If the AC power is not on, check the UPS and the power connexions to the relay crate. The UPS may be bypassed if it has serious problems and it is reckoned worth the risk of running without the protection of an UPS. The power in this case would come from the left hand 6 amp Hager circuit breaker at the back of the relay crate rack.

The relay crate has two fuses, a mains input fuse of 3amp and a fuse of 10amp for the 12.5 volts power line.

There is a spare +12 volts power supply for relay crates in the HV cupboard on level 6. The +5 volt logic power is derived from the +12 volt supply.

Each relay crate deals with the supply of HV to the 9 superlayers of one quadrant; crate 1 and 3 in addition deal with IES/OES respectively.

The relay crates are organised into 5 plugs in modules each of which deals independently with the HV switching for two superlayer of this quadrant. All the modules are identical and interchaneable. A schematic diagram for 1/2 of one module (i.e. one superlayer quadrant) is shown in figure 3.3.

- The three HV supplies for one superlayer - quadrant comming from a neighbouring SY127 are subdivided into two superlayer - octants. Each octant is switch independently by 3 ganged HV relays, driven by signals from the HV control computer. The ganging of the three relays required for one octant is done by connecting the relay control coils in parallel. The driving signal from the computer indicated by a green LED illuminated on the top row of LEDs on front panel of the crate (modules are counted 1 to 9 from the left as seen from the back, the LEDs and switches on the front panel also count from the left).
- Each octant has an override switch which, when down, interupts the relay drive circuit and prevents the octant being switched on by the computer. When the override switch is down, a corresponding red LED lights near the bottom of the relay crate front panel. The override switches can be covered with a lockable cover to prevent their unauthorised operation. The position (up - down) of the override switch is read back to the computer. If set, the computer avoids trying to switch that superlayer - octant on.
- The superlayer - quadrant has three ganged crowbar relays which when activated discharged the HV cables to ground within $\sim$ 500 microseconds, to try to minimise damage due to discharge in the chamber. The drive for each set of crowbar comes from either the combined "TRIP" signals of the SY127 channels supplying the HV to this superlayer quadrant, or from a separate computer drive. Both octants of one quadrant share

crowbars because it would not be feasible to separate the two octants and then crowbar separately in a short time. A red LED in the central row of 10 LEDS on the front panel is lit when a set of crowbars is closed for a superlayer - quadrant. The state of the crowbar driving signal is read back into the computer, this is an alternative way of knowing whether any superlayer - quadrant is tripped.

- When the HV switches are open, the two field resistor chain cables leading to the CTD HI- and LO- are held at ground potential by the field and shape wire resistor chains to ground on the CTD end plates. There is no such resistor on the preamps for the sense cables, so they have a 10 G ohm to ground permanently.

  A schematic diagram for one superlayer - quadrant is shown in figure 3.3. A sketch of the rear panel of one of the 5 switching modules is shown in figure 3.4 and a sketch of the relay front panel in figure 3.5.

A program test_ups_ints on the OS9 is available for checking out the working of any relay input or output channel, as well as the channels devoted to UPS control and sensing, and gas and both HERA IN and HERA OUT interlock signals. See a description in section 4.

Technical description of the hardware of the system.

If the observed faults do not fall in to the “obvious” categories given in section 2, it may be helpful to read this fuller description of the intended manner of operation, as an aid to diagnosing faults.

A detailed description of the layout of the HV electronics in the rucksack is given here. In essence the system has five parts; four of which are identical to one another, one for each quadrant of the CTD; the fifth part is the control system.

The four identical parts each associated with one of the four CTD quadrants each consists of:

1. An UPS (= Uninteruptable Power Supply) which will supply AC mains power to this part of the HV system only, for a short time when the AC mains fails in the rucksack.
2. A CAEN SY127 HV crate (the front panel is coloured dark red) which generates and monitors the three different HVs required for each of the nine CTD superlayers in this quadrant (quadrant 1 and quadrant 3 also supply additionally the HV for the inner and outer electrostatic screens respectively) and
3. a crate of HV-switching-and crowbar-relays. The switching relays subdivide the HV supplied to each superlayer-quadrant into two separate superlayer octants (to minimise the size of the part of the chamber which will be lost due to a fault); the crowbar relays shunt the stored electrostatic energy in the HV cables to ground in a fault situation (to minimise the chance of internal damage in the CTD).

These crates are all in the top position of the following racks:

	UPS	CAEN SY127 crate	Relay crate
quadrant 1	rack A1,07	rack A1,08	rack A1,09
quadrant 2	rack A1,11	rack A1,12	rack A1,13
quadrant 3	rack A2,14	rack A2,13	rack A2,12
quadrant 4	rack A2,10	rack A2,09	rack A2,08

Control System

The fifth part is the actual control system for the rest; all of it is situated in rack A2,06.

The crates in rack A2,06 from the top down are :

- a 1U high rack monitoring module
- a 4U high fan unit (These are not part of the HV system as such)
- a 4U crate containing, at the left hand side from the the front an “EXPERT 1000” UPS by ONDYNE, visible through an aperture on the front panel of the crate, and internally, on the right hand side from the front, electronics associated with the mains fail signals and AC mains output relays for both the local EXPERT 1000 UPS and the four H0600 UPS, one for each HV quadrant as listed in the table above.

- Next below is a 4U high crate containing a hard disc (at the back) and a floppy disc (accessible from , the front of the crate). These communicate with the MVME 147S VME "processor" via a 50 way SCSI flat ribbon cable. The right hand side of this crate contains eight "swap boards" which have no active components, but merely :

1. Take 8 50 way ribbon cables, each of which contain signals for the four quadrant relay boxes, and also signals for the four quadrant UPS and some interlock signals through to the inside of the rack, where :

2. the relay signals continue on DIFFERENT wires of 8 other 50 way cables to the relay boxes, and UPS signals (1 to and 1 from the computer for each of five UPS) are taken off/on the 50 way connectors at the front of the crate to a single 34 way ribbon cable to the back of the computer-UPS electronics crate immediately above and then in 4 34 way ribbon cables individually to the four quadrant UPS.

3. Signals to and from the "interlocks" are taken off/ merged onto the 50 way ribbon cables at the front of this crate and a second 34 way cable at the back marked "INTERLOCKS TO COMP" which goes to the "INTERLOCK" module in the VME crate below. (These signal paths are described in more detail in the "swapboard" part of section 3)

  - Below this DISC and SWAP BOARD crate is a 1U high front panel with several Lemo 00 feed throughs, which allows coax cable signals originating at the front of the racks access to the interior of the racks and under the floor.

  - Below this is a 2U high fan unit.

  - Below this is a 2U blank panel with a cable track fixed to its front.

  - Below this is a 6U VME crate (Wiener with no internal fans, see manual in HV cupboard on level 6). This crate is crate A-2-06-03 GPIB address 23. This Wiener VME crate contains the following modules : from left to right as seen from the front, a MVME712M I/O module (which has an ethernet cable number 100025 plugged into it, as well as a ribbon cable plugged into "serial port 1/console and a SCSI bus for the hard and floppy discs), an MVME147S processor module, an "HVON INTERLOCK" module; a CAEN model A200 SY127 controller, four Themis TSVME405 parallel I/O modules and a special VME module for two way communication with the HV terminal in the control room.

  - Below this VME crate is a 2U high fan unit and then several other crates which are not part of the CTD HV system.

UPS

There are two types of UPS in use in the HV system; each quadrant (CAEN SY127 and relay crate) has an "H0600", and the control computer has an "Expert 1000". Both types from ONDYNE.

The AC mains in the rucksack sometimes fails. This can cause the voltages inside the CTD to change suddenly in an uncontrolled way, and may lead to damage. The UPS provides short term power in this situation.

If the AC mains fail, or the AC mains voltage falls below a value of about 200 volts, the UPS automatically switches over to generate 50 Hz 232 volt AC output from its internal sealed lead-acid batteries.

Mains input to the 5 UPS

In Summer 1994 it was found necessary to raise the mains voltage into the input of the UPS. The prime cause was a series of evacuation alarms caussing the system to be left delivering power for several hours with no main's input. Althought the mains output was switched off by the relays on the output side of the UPS, the internal electronics drain the UPS within 8 hours. A sequence of such alarms occured within a few days. When the mains comes back on the low mains voltage in the rucksack did not recharge the batteries quickly and all UPS, particularly the EXPERT 1000 for the computer, behaved very peculiarly.

A variac was fitted to the input side of each UPS. UPS 1 and UPS 2 share a variac situated on a shelf half way up the back of rack A1,07, fed from a 10amp Hager in rack A1,07. There is a mains cable below the floor feeding mains to UPS 2 in A1,10.

Similarly UPS 3 and UPS 4 share a variac at the back of rack A2,13, with input from a 10amp Hager in this rack, with UPS 4 being fed by an underfloor mains cable to rack A2,10.

The former mains feeds to UPS 2 and UPS 4 from their local racks are now disconnected, but are left in place for emergency use.

A small variac is also installed at the back of rack A2,06 for the computer UPS. This is not shared.

All 3 variacs have their output mains voltage monitored by r.m.s. AC volt meter fixed nearby. The ratio adjustment handles have a (screw driver required) locking mechanism. They seem to operate satisfactorily with a registered output voltage of approximately 235 volts (230→240 volts). Previously the UPS mains input voltage could be as low as 228 volts.

The four "quadrant" UPS

There are two 12 volt batteries in series in each UPS. The original batteries were HITACHI HP 6.5-12 (12m6.5) 12volt, 6.5 Ah sealed lead acid batteries. New batteries STECO "Saphir 6.5" 12 volt 6.5 Ah were obtained from EUROTRONIK near Cambridge (see address at end). Suitable batteries are now available also in the R.S. catalogue.

A signal is continuously sent from each UPS to the control computer giving the status of the AC mains into the UPS. This signal is an open circuit if the mains is ok, or a short circuit between two wires if the mains fails. Connection to the UPS is via a 3.5 mm stereo (3 wire) jack. This signal is merged on to the 34 way ribbn cable plugged into the back of the UPS crate.

If the main input into one (or more) quadrant UPS is seen to fail, the control computer will automatically immediately run down all the HV supplied by this UPS. If the power fails for more than 3 minutes, then the HV on all the rest of the CTD is also run down, leaving the CTD in a safe state. If power continues to be lost for a further 3 minutes, then the system is switched off by program. (This is to save long term discharge of the lead-acid batteries inside the UPS. These may be damaged by deep discharges; they would also then have no back-up capacity for any further faults immediately following a long term discharge). If the UPS supplying the computer is seen to fail then the HV for all 4 quadrants is run down, and six minutes later all power is cut off.

If the mains reappears during the first three minutes after it failed, then the HV for the rest of the CTD is not run down; if it reappears during the second three minute wait, then the power is not cut. In these cases the HV is not raised again automatically - it is left down and a message on the control screen draws attention to this state, and waits for operator intervention.

The front panel of the H0600 (quadrant) UPS projects through the front panel of it's crate. Each UPS has a green/red LED near the centre-left of it‘s front panel. Normally this should be green meaning that AC mains power is being delivered through the UPS to the load. If it is red, then the AC mains has failed at the input to the UPS. The UPS will continue to provide AC power from its internal lead-acid batteries.

If this mains failure is a local problem, check that the Hager overload trip at the back of the rack containing the variac for that UPS is switched on. This is the left hand 10 amp cutout. The switch should be UP.

If the light on the UPS front is neither green nor red (but beware because the LEDs at the front of the UPS in quadrants 2 and 3 are quite dim) this means that the UPS itself is not switched on. To switch it on, press the large square button on the front of the UPS - it pushes in and latches in.

If the LED always shows red even when the mains input is known to be OK, then suspect that a fuse has blown on the input of the UPS. On the crate back panel, on the right hand side of the crate, there is a 3.15 amp, 20mm slow-blow mains fuse. Replacement fuses should be found taped onto the back panel of the UPS crate nearby.

In addition the mains input socket at the back of the UPS chassis itself is an IEC 3 pin mains socket. This is accessible only when the back panel of the UPS crate is removed. Immediately below this is a small compartment containing a 5 amp 20mm slow-blow fuse. Make sure the fuseholder is replaced the right way up! (it has 240 volt and 110 volt orientations). The original 3.15 amp 20mm slow- blow principle fuse has now been removed from this inaccessible position (all quadrant UPS) and is now installed at the bottom righthand corner of the back panel in a screw fit fuse holder. There are normally spare fuses taped onto UPS back panel. A yellow box of spare fuses is kept in the HV cupboard on level 6.

Towards the right of the UPS crate front panel is a large orange light - illuminated when power is available at the UPS output (from mains or battery back-up).

Underneath this large orange light is a small green led which is illuminated when the control program calls for the relay switching the mains output to be closed. If this green led is off, then the orange light would not be lit, and no power would be available for the corresponding CAEN SY127 and the relay crate.

The drive (12 volt DC) for the AC mains output relay (and the green LED) comes via a 34 way ribbon cable to the back of the UPS crate from the back of the computer UPS in rack A2,06. This 34-way cable also carries the mains fail signal from the UPS to the computer. WARNING: A disconnected cable gives no drive to the relay (or green LED), but is still seen as a “mains input OK” signal by the computer. Also if the jack circuit into the back of the

UPS is disconnected, this open circuit is also seen as an "UPS-OK" signal.

Mains fail signals and mains output relay drive signals for all four quadrant UPS (and the computer UPS) run in a single 34 way ribbon cable from the back of the computer UPS crate to a 34 way socket at the back of the disc crate (containing the "swap boards"). A bundle of eight 5 way ribbon cables connect these signals into/out of the eight 50 way ribbon cables leading to the 4 TSVME I/O modules in the VME crate and hence connect to the controlling computer. This system is described in the "swap board" part of section 3 and in the "control system" introduction at the beginning of section 3.

The AC mains output from the UPS is distributed from two paralleled IEC output sockets through two grey AC mains cables to the back of the corresponding CAEN SY127 HV crate and HV switching relay crate. Thus the HV crate and relay crate normally take their AC power indirectly from the UPS rack rather than the racks in which the HV or relay crates actually sit.

If there are problems with the UPS, the CAEN SY127 crate and the relay crate can be powered locally from the AC power available in their own racks. A short cable with an IEC socket is wired from a Hager circuit breaker/isolator (always the left hand circuit breaker, looking at the back of the rack) in each rack containing a CAEN crate or relay crate. This normally just dangles, but can be plugged into the main′s input to the CAEN or relay but if required.

Computer UPS

The UPS near the top of rack A2,06 driving the control system is different from the UPS in the four quadrants. It can also be bypassed so that power is supplied to the control system straight from the mains if it gives trouble. The AC mains input comes from the second-from-the-left (10 amp) Hager cut-out. Only one of the UPS two IEC output sockets is used to drive the upper Wiener VME crate in rack A2,06. The power supplies in the Wiener crate in turn supply the low voltage (+5V, -5V and -12V through thick, coloured twisted wires) to the disc drives, OMTI 5400 SCSI disc drive interface card in the disc drive crate and the UPS mains fail and UPS output mains relay driver circuitry which is inside the computer UPS crate.

This "computer UPS" crate also contains internally the electronics associated with all 5 UPS mains fail and AC power output relays drives. For this purpose it communicates with the four "quadrant UPS" via four 34-way ribbon cables from the back panel of the "computer UPS" under the floor to the back panel of each separate "quadrant UPS".

There is an additional 34-way cable at the back of the computer UPS (the left hand 34-way socket looking from the back). This runs to the back of the disc drive crate in rack A2,06, taking the combined "mains fail" logic signals to, and "UPS AC mains relay drive" logic signals from, the Themis TSVME 405 boards in the computer crate.

These signals are merged via a bundle of eight 5-way ribbon cables which carry the UPS signals (and also the interlock signals, see interlock section) on to the eight "SWAP" p.c.b.s at the left hand side from the back of the disc drive crate. These signals (UPS and interlocks) are merged on these boards with the signals in the 50-way ribbon cables to and from the HV switching relay crate in each quadrant.

The order of the 34-way cables looking at the back of the computer UPS crate is, from left to right:

- combined logic signals for 5 UPS to/from computer (via a 34 cable merged in to the 50-way relay cables to TSVME 405 boards)
- UPS in quadrant 1
- UPS in quadrant 2
- UPS in quadrant 3
- UPS in quadrant 4

Also on the back panel of the computer UPS, towards the left hand side, is a ten-way ribbon cable which supplies power to the UPS AC power relay drive and mains fail logic from the Wiener VME crate.

In a start-up from scratch with no power on the system, the computer UPS power relay will not be driven. To get the system started, a front panel key switch on the front panel of the computer UPS crate must be set to the "manual-override" position (clockwise). This switch is in parallel with the computer UPS AC power relay, and by-passes the open power relay in the computer UPS crate to supply AC mains from the UPS to the Wiener VME crate, and all $it's$ associated hardware, to allow the control system to start.

Once the HV control program has started, it will drive all the UPS power relays closed - the green LEDs "mains request" on the four quadrant UPS and the control system UPS should light - and the power by-pass key switch on the computer UPS crate should then be returned to the "normal" (anticlockwise) position. If it is kept in the "override" position, and there is a long mains failure, the UPS will continue to drive the computer beyond the six minute period after which the program cuts the power relays (having run-down all the CTD HV first). Deep discharges may damage the UPS batteries, and certainly reduce their capability for proper back-up operation for several hours after they begin recharging.

The four quadrant UPS are all model H0 600, with "Novell mains failure detection".

They were all supplied by Powersolve (Electronics) Ltd, 9 The Paddock, Hambridge Road, Newbury Berkshire, UK, RG14 5TQ. Telephone 00 44 635 521 858. It was difficult obtaining information and supplies after delivery from Powersolve.

A better service was obtained from ONDYNE's agents directly, from Peter Canham, ONDYNE (UK) Ltd. 6 Parnell Court, East Portway Industrial Estate, Andover Hampshire, SP10 3BR, tel (0044) 264-366-688.

The firm Eurotronik Associates Industries (Unit 17, Dry Drayton Industries, Scotland Road, Dry Drayton, Cambridgeshire, UK CB3 8AT. Mr. Peter Pirie, Tel. no. 0954 211 931) deals in various UPS and was very helpful. We bought replacement batteries from them.

A short descriptive leaflet is kept in the HV cupboard on level 6.

CAEN127 HV supplies.

Each CAEN crate can contain up to 10 HV modules (at the back of the crate, see figures 1.1 and 2.2). Each module contains four separate HV channels, all of the same type. We use only two different module types : For negative voltages these are type A333 modules set to give up to 4KV at 2ma current, for positive voltages these are A434 modules giving 2KV at 200microamp.

HV is output from each channel on SHV sockets. The HV cables from the CAEN SY127 supplies to the neighbouring relay crates have SHV plugs on the end in the SY127 racks and Lemo 1 (HI- and LO-) or Lemo 0 (+ve sense voltage) at the ends in the relay racks.

Each superlayer quadrant in the CTD requires two negative voltage supplies to drive two taps on the "field and shaper" wire resistor chains, and one positive supply to drive the sense wires in that quadrant. The group of three HV channels for one superlayer - quadrant supply usually reside in different HV modules in the quadrant HV crate (see figures 3.1 and 3.2).

CAEN hardware TRIP signals

The three channels for one superlayer - quadrant have daisy chained "trip" signals so that if one HV channel of the three trips, then the other two are forced to trip also. This is the function of the short twisted pair wiring at the back of the back of the SY127 crates. NOTE that the green wire of each of these twisted pairs is a GROUND line - the small rectangular two pin sockets at the ends of these twisted pairs must always be inserted in the square holes with the green wire to the right. The four pins located inside the square hole constitute two paralleled two pin plugs. The top two are in parallel with the bottom two, left pin with left pin (trip signal) and right pin with right pin (ground). Spare twisted pairs of different lengths with two pin sockets attached are available in the HV cupboard on level 6 (See figure 3.1).

This hardware-generated superlayer-quadrant trip signal ("trip" = 0 volt, no trip = 2.5 volts) is propagated to the crowbar relays in the corresponding relay crate to drive the (set of three separate) crowbar relays for the six HV cables which take these 3 HVs to the two octants of this superlayer - quadrant. These ten trip signals go via a bundle of ten 50ohm coax cables (with colour coded Lemo 00 plugs) from the back of the CAEN SY127 crates down the rack, under the floor and up the next rack to the back of the relay crates.

This crowbar action depends only on local electronic hardware, not computers. The HV supply oscillator is switched off within one microsecond, and the crowbars close in about 500microsecond, discharging most of the stored electrostatic energy in the HV cables before it can discharge internally in the CTD through the resistors in the path to the CTD wires (minimum 47K, but for most wires around several Mohm), minimising the possibility of internal damage to the CTD. Hardware 0K of caen trip signals.

CAEN hardware voltage limit

Each separate HV channel has a hardware imposed variable upper limit for $it's$ output voltage. This is controlled by a small screwdriver-driven multiturn potentiometer next to the HV output socket at the back of the HV module. The hardware voltage limits are set to about 5% above the normal maximum output voltage.

The HV are normally controlled via a single serial signal coax "CAENET" daisy-chained from the CAEN A200 controller plugged into the VME computer crate in rack A2,06. This passes along the front of the racks and is connected to the front panel of the HV crates in the order quadrant 1, 2, 3 to 4.

A manual EMERGENCY OFF button is fixed at a high level on rack A2,06. This is also daisy chained, round the front of the SY127 crates, in several segments. The red button under the floor to crate 1, crate 1 to crate 2, back under the floor to crate 3, from crate 3 to crate 4, and finally to an input socket on the " interlock" module in the VME crate in A2,06. When pressed, this brings all HV in an uncontrolled way - only use in absolute emergency.

The HV is normally controlled and monitored via the serial CAENET signal line from the A200 in the VME crate. Each CAEN also has a manual keyboard and numerical readout. These are not for normal use. In particular BEWARE: if a manual keyboard command is left incomplete (basically the final # button not pressed), then the computer will not have control over the HV channels of that CAEN crate.

The CAEN SY127 HV crate system is described in "High Voltage Line - Model SY127 High Voltage System Technical Information Manual" and the A200 VME controller is described in the "VME Line Model A200 HV CAENET VME Controller Technical Information Manual". A copy of each is kept in the HV cupboard on level 6.

Relay crates.

The AC power connexions for the relay crates are described above in the section on UPS.

Each relay crate contains 5 plug-in modules (plugged in from the back of the crate). Each module deals with two complete superlayer-quadrants of the CTD. Each relay crate has control of nine superlayer-quadrants, leaving one spare place in each relay crate. In the relay crates for quadrants 1 and 3, part of these spare places are used for the inner (quad 1) and outer (quad 3) electrostatic screens inside the CTD. In quadrants 2 and 4 one complete space is unused in the relay crates. All plug-in modules are identical and inter-changeable.

The modules are numbered by position left to right looking from the back of the crates. There are a number of indicator lights and control switches on the front of each relay crate; these are also numbered for increasing channel number from left to right as seen from the front of the crate. An inversion is incorporated in the crate internal wiring. Figure 3.5 shows a sketch of the relay crate front panel.

Each half-plug-in module is for one superlayer-quadrant. The three HV supplies come from the CAEN SY127 for one superlayer in a bundle of three HV cables tied together. The sense wire cable has a LEMO 0 sized HV plug, and is also numbered; the two field wire voltages come with LEMO 1 sized HV plugs, they must be distinguished carefully one from the other by their numbers. A complete list of cable numbers is given in the section on cables in Appendix 1.

The back panel of each plug-in-module is very cramped: for one half of a module backpanel (= one superlayer) the "HI" negative voltage cable from the CAEN plugs into the top socket; the two sockets below are the outputs, via HV switching relays, for the two "HI" cables to the two octants of this quadrant, with octant A/B being the upper/lower of the two sockets. Similarly the "LO" negative voltage from the CAEN plugs into the fourth socket from the top, and the two split "LO" outputs to the two octants are the two sockets below, octant A/B being the upper/lower of the two. The smaller Lemo O sense plug fits into the top of the group of three smaller sockets, and octant A/B sense outputs are the upper/lower of the remaining small sockets. The "trip" signal cable for this superlayer-quadrant is connected to the Lemo 00 socket at the bottom of the half-module back panel. The Lemo 00 plugs on the 10 trip cables are colour coded. (See figure 3.4)

Each input HV cable is branched inside the module into two, through HV relays. i.e. for one superlayer of this quadrant the input cable "HI-" forks through HV switching relays to "OUT HI-oct A" and "OUT HI-oct B" and similarly for "LO-" and "sense". The three relays switching to octant A out are all (HI-, LO- and SENSE) driven simultaneously by the same circuit; a separate circuit simultaneously drives the three relays switching to octant B of this superlayer.

Although the HV supplies for the two octants are switched independently, the three crowbar relays (one each for "HI-", "LO-" and "sense") are shared between octant A and octant B. This is because the need is to discharge the stored electrostatic energy in the HV cables as quickly as possible when there is a problem in the chamber or CAEN hv channel; there is not enough time to open the switching relays to isolate one octant from the other. A schematic outline of this system is shown in fig. 3.3.

The switching relays are driven, via the lower ("B") cable of two 50 way ribbon cable from the computer. Ten superlayers each with two octants gives 20 sets of 3 parallel HV switches driven by 20 signals output from the computer.

The crowbar relays (only 10 sets of three, one set per superlayer-quadrant) can be driven from two sources. The normal source of drive is a direct hardware connexion through a bundle of ten 50 ohm coax cables (brown covered, with colour coded Lemo 00 plugs at each end) from the back of the CAEN modules where the 9 superlayers (and in quadrant 1 and 3, an additional channel for the CTD electrostatic screens IES and OES) have the TRIP outputs of their sets of three high voltage channels daisy chained together. Each superlayer-quadrant (and electrostatic screen) trip signal is connected from a panel at the right hand side at the back of the CAEN SY127 crate, into a Lemo 00 socket at the bottom of the back panel of its corresponding switching relays/crowbars module.

The second source for the driving signal for the crowbar relays is the controlling computer, where 10 further parallel logic signals (in the same 50- way ribbon cable ("B") as the HV switching relay logic signals) for each quadrant are dedicated to driving the quadrants crowbars. This is used in the controlling program ,normally only at the initialisations to ensure that the HV cables are discharged.

A second 50 way parallel ribbon cable ("A") is used for each quadrant to send signals from the relay crate back to the computer. These signals are: ten giving the state of the ten crowbar and hence of the CAEN "TRIPS" (one for each superlayer in the quadrant) and 20 giving the state of 20 "manual-override" switches, one per octant for all the superlayers in this quadrant. If these switches are set down, then internal hardware connexions prevent the computer closing the HV switching relays of the corresponding octant. The state of these "manual override" switches can also be read by the program.

For each relay crate the input 50-way cable ("B") ("from the computer") is connected to the bottom 50-way socket; the output 50-way cable ("A") ("to computer") is connected to the top 50-way socket at the top left hand side at the back of the relay crate.

These cables pass under the floor to the back of the disk drive crate in rack A2,06 where they are connected to eight 50-way sockets in the order, left to right as seen from the back:

quadrant 1 "A" from computer = to relays 1
quadrant 1 "B" to computer = from relays 1

quadrant 2 “A” from computer = to relays 2
quadrant 2 “B” to computer = from relays 2
quadrant 3 “A” from computer = to relays 3
quadrant 3 “B” to computer = from relays 3
quadrant 4 “A” from computer = to relays 4
quadrant 4 “B” to computer = from relays 4

The signals pass through this DISC DRIVE AND“SWAPBOARD” crate (changing pin numbers, and with a smaller number of ground lines at the front than the back, and also merging in/out a few signals for the UPS controls and gas and HERA interlocks. See the sections on “swap boards” and CTD interlocks) to appear on the front as eight 50-way plugs . The order of connexions, from left to right as seen from the front is:

quadrant 4 “B” to computer = from relays 4
quadrant 4 “A” from computer = to relays 4
quadrant 3 “B” to computer = from relays 3
quadrant 3 “A” from computer = to relays 3
quadrant 2 “B” to computer = from relays 2
quadrant 2 “A” from computer = to relays 2
quadrant 1 “B” to computer = from relays 1
quadrant 1 “A” from computer = to relays 1

From the front of this crate, short 50-way cables lead from these sockets to the front of the Themis TSVME405 parallel I/O boards plugged into the VME computer crate. All the computer outputs (from computer = to relays (“A”), also to UPS and to HERA interlock VME module) are through the top plug on each 405 board; all the computer inputs (to computer = from relays(“B”), also from UPS and from HERA interlock and from CTD gas system on ground level) are through the bottom plug on each 405 board.

Each 405 board deals with inputs from and outputs to one quadrant. The order of quadrants from left to right as seen from the front of the 405 boards is quad 1, 2, 3 and 4.

The Themis TSVME405 boards are described in the “Themis TSVME 405 parallel input/output board - Users manual”, a copy of which is kept in the HV cupboard on level 6.

Information on how the boards are used in the control program are contained in the commented program listing kept in a folder in the HV cupboard on level 6. Particularly relevant are the functions “get_relay_data()”, “init_relays()” and the section of code “th405inits”. A short description of the computer program will eventually be given in section 4.

A test program “test_UPS_ints” is available for checking the operation of all the relay signals and drives, as well as the UPS and interlock signals.

A BRIEF DESCRIPTION OF THE NEW CTD HV PROGRAM

Don Miller - March '99

7 Introduction.

This is an outline description of the new ctd hv program written since Spring and Summer '95. The code is stored in the ctdhv directory /ho/fhv/ a makefile contained therein gives the relevent source files. While the program is incomplete some extra development files also are stored in ctdhv /ho/working.

This document is simply a rough guide to the program.

The source listings contain many comments which give a fairly complete and accurate description of the action of the code; this note concentrates on the overall action and layout of the code and the system.

8 Naming of variables and functions, dimensions.

Function names are intended to help in identifying the purpose of the function and hence tend to be long. Each function has its own source file (almost true) which is usually of the "function_name" version-number.c where version number (eg. 9t) is the name of the version of the hv program that was current when the source code was last changed. But then some file names exceed the os9 limit of length, and shortened file names are used.

There are sometimes alternative or test function files; the proper current versions are found in the file named "makefile" in ho/fhv where the source file name is got by substituting .r by .c in "file_name.r" in the definition of "$ (OBJS)".

A single method of variable naming has been used. I hope that it is sufficiently transparent. Variable names try to make it clear what the variable is used for and means.

Many array variables are used referring to related quantities for different superlayers, quadrants and octants of the ctd, and often also the inner and outer electrostatic cylinders of the ctd.

Consistently the inner electrostatic screen (IES) is referred to as superlayer 0, the nine superlayers of the ctd are superlayer 1 (innermost) to 9 (outermost) and the outer electrostatic screen (OES) (outside everything) is referred to as superlayer 10.

Thus arrays referring to quantities which share a common aspect over these ranges (eg. voltages) are dimensioned to[11], with [0] referring to the IES, [1] to [9] referring to superlayers 1 to 9, and[10] referring to the OES.

The four basic quadrants of the ctd are numbered 1 to 4; arrays covering the four quadrants are dimensioned [5] with the index 1, 2, 3 and 4 referring to quadrants 1, 2, 3 and 4. (The remaining index here [0] is never used).

Similarly there are four caen crates and four relay crates, so arrays referring to them are dimensioned [5]. [1] to [4] refer to caen hv crates or relay crates 1 to 4 with [0] never used. Each relay crate contains 10 plug-in relay switching modules numbered 1 to 10; the relay modules are dimensioned [11] with modules [1] to [10] referring to modules 1 to 10, and module [0] is never referred to.

The variable names are meant to be mnemonic. Quantities for "field high" "sense wire" and "field low" quantities are given the fli, sense and flo abbreviated names rather than using an anonymous index to distinguish between the field high, sense and field low quantities.

Examples of these array names and dimensions are:

fhi_ramp_rate [11] [5] containing the ramp up rate (in volts per second) for 11 superlayers (IES = [0], sl 1 to sl 9 = [1] to [9], and OES = [10]), each with 4 quadrants indexed 1 to 4, with all fhi_ramp_rate[N][0] quantities being meaningless, since quadrant 0 does not exist.

Note that the IES and OES are complete cylinders, not divided into quadrants so (anomalously in this scheme) fhi_ramp_rate [0 or 10] [2, 3 and 4] do not exist and are meaningless. For the IES and OES quadrant 1 is the only meaningful quadrant (1 by convention).

Thus sense_ramp_rate[11][5] refers straight forwardly to the sense wires of superlayers 1 to 9, but the sense wire values for the IES and OES are meamingless; similarly the flo_ramp_rate[11][5] have meaning only when referring to flo_ramp_rate[0 or 10][1] superlayers 0 and 10 quadrant 1 (the IES and OES)

hv_switches [11] [5] [3] describe the state of the hv switching relays which can cut off one octant of a superlayer from the hv supplies. The [11] is for superlayers ([0] = IES, [10] = OES) the [5] is for quadrant within that superlayer - quadrants [1] to [4], with [0] never used). The [3] denotes the octant number within that quadrant - octant "A" (the most anticlockwise, seen from the RTD end) = 1, octant "B" = 2. Octant = [0] is meaningless in this scheme and is never used.

8.1 Lists of variables

This scheme has its oddities and is may be not the best, but is used consistently.

There is an alphabetically arranged list of all extern quantities in "definitions_of_externs version number.h" (where version number refers to the program version number that was current last time the list was changed (which is used only to declare every variable with its dimensions, which is going to be an extern variable.)

In definitions_of_externsxx.h each variable is on a separate single line and has a comment giving its meaning for the possible range of values.

8.2 Program organisation.

The program begins with a phase of initialisation, followed by a running loop which is left only when the program is exited.

8.3 Initialisation

8.3.1 Program structure.

Most of main () is concerned with the initialisation phase, organising calls to other functions to perform the initialisation tasks. A diagram of the flow of control for initialisation is appendix 1.

main () begins by including definitions_of_externs.h each variable of which is then declared an extern inside main (). There is a list of all externs in appendix 2 for convenience.

The function keyboard_signal_handler() is also declared so that it can be used as an argument for intercept () which controls the os9 “signals” used by the keyboard input.

This is followed by a short list of non_extern variables local to main.

This is followed by initialisations for many of the non_array extern variables.

8.3.2 Uniqueness of the process.

The code proper begins by looking for the presence of, and value of two os9 “events” which, control access to the single caenet serial data line to the caen crates and the parallel data links through the TSVME 405 parallel I/O boards. Access from multiple processes could be dangerous to the safety of the ctd. If the events already exists with non zero values the program exits with appropriate messages; if it does not exist the event is created with the correct value to claim the right of unique access to the caen crates and the relay crates.

8.3.3 Disk data files

Next a series of file names are copied into extern char arrays for use across the program. The standard data input files are in /ho/ctdhv_files/

Input data files:	
caen_map.dat	descriptions of the disposition of the superlayer-quadrants among the caen crate/channels.
relay_map.dat	description of the disposition of the superlayer-quadrants among the relay crates/modules.
voltages_for_pressures.dat	give the working voltages for different ctd gas pressures.
sense_ramping_trips.dat	give the trip current for the sense wires during a ramping up phase.
sense_running_trips.dat	give the sense trip currents to use when the hv is successfully up.
system_description.dat	a 64 character ascii description of important changes to the system; this is copied to the environmental records.
debug_flags.dat	give a list of the values of various debug flags which control debug output and actions . These are read near the beginning of the program so debug is controllable early in the initialisation phase. These can be dynamically altered later during program running by keyboard command.
output data files:	
debugs.dat	is the standard ascii file of debug output under the control of debug flags.
run_start_date.dat	is a standard output file always produced in the initialisation phase.
run_log_date.dat	is a standard log file which is always produced and records an entry for most standard operations and happenings.
caenet_log_date.dat	a file where glitches and errors in reading/writing of caen crate data are recorded.

8.3.4 Debug flags

debug_flags.dat is read to set up the values of debug flags which control the output of debug information. Since the file of debug flags is editable, the debug information available can be controlled right from near the beginning of the program running. The debug information is also dynamically controllable from keyboard commands (in the “expert” state) once the program is running.

8.3.5 initialisation of arrays

The program then initialises a few arrays and sets up “keyboard_signal_handler()” as the recipient of keyboard signals.

8.3.6 memory mapped i/o

i/o for the caen crates and relay crates is memory mapped to fixed absolute vme addresses, as is also the large “2tp” memory bank which can be read by the standard ctd data output processor as a source of part of the environmental records etc. There is also a small memory mapped area for access to the zeus "global first level trigger accept number" (gflt) used synchronic with zeus data acquisition. The program is given access to these non os9 standard addresses by FPermit (). Calls to FPermit () follow in the initialisation phase of main (). Since the program is intended to run under a non-super-user group_user number, this entails changeing temporarily to group_user 0.

8.3.7 "system_description"

Next a 64 character "system description" array is accessed and displayed on the screen. This is later passed through to the environmental records to record important changes to the state of the hardware of the system.

8.3.8 hv switching and crowbar relays

Next the hv switching and crowbar relay system is initialised. The hv can be cut off from each octant of a superlayer of the ctd independently by controlling the hv switching relays (actually three relays in parallel for fhi sense and flo hv connections all activated by parallel circuits). If a trip is sensed then some of the electrostatic stored energy in the electrically charged hv cables can be discharged outside the ctd by rapidly closing short circuit relays ("crowbar relays") to ground connected to each of the three hv cables. Again the three crowbar relays for each superlayer octant are operated in parallel.

init_relays() sets up the four parallel i/o boards, one to operate with each of the four relay crates, and sets up the software map of which superlayer-quadrant is controlled by which relay crate/module. The editable ascii file with this map is described in more detail in appendix 3.

8.3.9 hv voltage

A disk file voltage_for_pressures is read and ckecked. This gives the precalculated hv supply voltages ("field high, sense and field low" for each superlayer quadrant). The calculation is done so that a nominal drift field is maintained inside each ctd cell, together with a nominal sense wire surface field, which controls the gas gain. The disk file contains several different sets of voltages which all have the same drift field but different sense wire surface fields and hence different gas gains. As the atmospheric pressure changes, the pressure inside the ctd follows (at least approximately). The gas gain decreases as the pressure increases. To keep the electronic pulse height out of the ctd approximately constant, a set of hv voltages is chosen as the current working set with such a sense wire surface field to compensate for the changes in atmospheric pressure.

This choice is made in functions called by "initialise_for_hvon()."

If the ctd conditions change (higher/lower gas gain required, or a different gas mixture to be used) then this disk file will require regeneration/editing.

Calculated sets of voltages for different drift an surface fields are in /ho/ctdhv.files/. A master file for drift field = 1.22 kv/cm and surface fields of 182 and 183 kv/cm for the current gas are in /ho/ctdhv_files/master_pvolts_100pc.dat. These can be scaled to lower voltages by the program "make_new_pvolts". Precalculated sets of low (sided) voltages are in /ho/ctdhv_files/archive/pvolts_xxpc.dat/ where xx = percentage of the proper working volts.

The file is described in detail in appendix 4.

8.3.10 field wire resistor chain resistances.

The hv supplies provide the voltages for the sense wires and also to (approximately) the inner and outer ends of the field wire planes in each ctd cell. The 19 field wires in each field wire plane must also have calculated voltages to maintain the required drift field between the field wire planes. These voltages are generated by a current flowing down a resistor chain for each field wire plane, between the field hi and field low voltage supplies. There is also, for each field wire plane, another resistor chain between field low and ground which provides the voltages for the "shaper" wires which improve the uniformity of the drift field by closing off the inner and outer ends of each cell.

All the field wire and shaper wire resistor chains in each octant are connected in parallel and supplied by single field_hi and field_lo hv supplies. Each octant of one superlayer is identical in this respect; of course each superlayer is different from other superlayers.

The current circulating in the resistor chains and the current drawn from the supplies for one octant can be calculated using ohm's law once the operating voltages are known. This is used, taking into account also the number of octants (0, 1 or 2) switched on in each quadrant (each hv supply is for one quadrant = 2 octants in parallel) to set trip currents for the field_hi and field_lo supplies at 1.2 * the calculated currents.

set_up_field_resistances() initialises these resistance values by straight C code; they are not read from disk files.

8.3.11 initial setting of the caen hv crates

check_caen_crates() writes a fixed 'protection word" into each of the four caen crates. (see the caen manuals for the SY127 hv crates and the manual for the A200 caenet-vme interface).

This is to make sure that the crate is initialised properly (front panel keyboard enabled, power_on_reset and password disabled, and also clear any trips initially in the crate), and that the caen crate has mains power on and its 'hv_enable switch" up, so that hv can come on.

8.3.12 disposition of caen crate/channels to superlayer /quadrant/fhi, sense, flo.

get_caen_map() reads from caen_map.dat which caen crate/channel is used to supply hv to which superlayer/quad/fhi, sense and flo. Any possible arrangement is allowed.

If this disposition changes (eg because of faulty hv modules) then caen_map.dat will require changing. A full description of the file is given in appendix 5.

get_caen_map() also checks that the map is complete and self-consistent, and then reads the type (positive supply type A434P, negative supply type A333N) of caen module resident in each crate/module to check that this is also consistent.

8.3.13 first selection of hv set to use, voltage ramp rates and current trips.

The atmospheric pressure is read (available from the ctd gas system) and initial selection of the corresponding hv set is made by a call to initialise_for_hv_on().

initialise_for_hvon() is also called at every "setup" and "active" run_control message seen, to choose the hv set to use according to the pressure (if available) and set the voltages, ramp rates and current trips into the caen hv crates.

Having made this choice in choose_volts_from_pressure(), initialise_for_hvon() loops round all superlayers and quads (and IES and OES) to calculate and set into the appropriate channels of the caen crates, the voltage ramp_rates and current trip levels, to get ready for the volts being raised by an "hvon" command.

8.3.14 initialisation of the "quick_check" system

Finally initialise_quick_all_system_check() is called to read the 4 relay_crate_input words. These words contain information on many parameters of the system, and since they can be read in microseconds, this information can be available every 1 second, with the 1 second time scale being set by the much slower fetching of information from the caen crates.

If a part of the ctd hv system is bad (eg. a broken hv cable) then the corresponding "manual_override_switch" can be set down. This is recognised at this initialisation, and is recorded that this part is permanently off for the rest of this particular run. hv is never applied to this part, and the hvbad[ ] and hvon[ ] words are correspondingly modified.

Also any initial trips are noted for the same reasons, as well as the initial state of all the alarms.

The initial state of the relay words is recorded as it is easier to see changes rather than check through everything in the 1 second monitoring cycle.

8.4 Running loop phase.

The program then enters a loop from which it exits only when "exit" is typed.

In this loop a single superlayer quadrant is selected for monitoring via caenet and the caen crates.

The time is updated, the current state of the suoerlayer-quad state is read from the caen crate and then quick_all_system_check() called.

This reads the 4 caen crate words and by comparing with the values read last time 1(1 sec ago) identifies changed bits in the 32 bit words, including separately, bits changing from 1 to 0 and

0 to 1. Thses are then analysed in quick_trip_check() for new trips, in quick_override_check() for changes to the positions of the override switches, in quick_alarm_check() for changes to the alarms (including auto_hvon operations if auto_hvon_flag is set true).

quick_run_control_check() is then called to look for new run_control commands (still with the 1 second loop repetition rate) i.e. "setups", "activates", "ends" and "aborts" and act on them. quick_run_control check() also organises the sending of alarms and summary hv data to the slow control system when necessary.

Then update_2tp_memory() is called to record the newly monitored data about the current superlayer-quadrant in the memory accessible for environmental records and also, if necessary, any other update of the environmental record.

Then a new superlayer-quad is selected for monitoring and the process repeated.

8.5 selection of the next superlayer-quadrant for slow monitoring

There are three basic types of superlayer-quadrant monitoring: "regular", "priority" (or "special-action") scans and "expert" (or "expert-action") scans.

Regular scans are done in increasing superlayer-quadrant order when not superceded by either of the other two types of scans. Since each takes around 1 second to complete (basically defined by the slow operation of caenet in reading from the caen crates) the regular scan will take (9 superlayers * 4 quadrants + 2 (IES + OES)) /2 = 40 seconds to do a complete scan of the whole hv system.

Several types of important transitions in the hv system are intrinsically slow e.g. ramping up/down the hv - rapid changes in potential might damage the ctd, the voltages should change proportional to each other at all times so that the electrostatic forces inside the ctd remain balanced, and switching on and off the separate hv channels is also intrinsically slow because of deficiencies in the design of the caenet network for reading and writing parameters in the caen hv crates. Thus it is sometimes important to concentrate on scanning the superlayer-quadrants which have not yet finished the last requested transition.

This is done by marking the superlayer-quadrants in transition for "priority" scans by setting special_action[superlayer][quad] > 0. The actual value set is determined by the particular transition, and determines what to do for that particular superlayer-quadrant once the transition is complete.

When any priority scans exist, regular and expert scans are suppressed, normally the last superlayer-quadrant to make the transition will have the entire scanning capability of the system concentrated on it and its transition will be recognised almost immediately.

Thus for transitions involving ramping up to working level (either all superlayer-quarants, or just a few after recovery from a trip) will have their completion recognised immediately and the data taking veto dropped immediately. Similarly the last voltages ramping down will be seen tp go below the safe volts level immediately, and so the injection inhibit can be dropped without having to scan round the complete hv system. Of course quick_all_system_check() is called after every priority scan too, to look for trips, etc.

Provision is also made for non_standard "expert" system operations with "expert" scans. Normally these operations are made with some part only of the ctd. (like old o* commands). The displays associated with these old o* commands were not updated often because they were only considered in the old system after each complete scan of the hv system. In this new system they are given equal priority with the regular scans (alternating) for the superlayer-quadrants with non-zero expert_scan [superlayer][quad], so are updated about every second. The quick_all_system_checks() are also performed after every expert scan, so they continue at about the normal rate of ~ 1/second.

8.6 regular scans

Theses are executed only when no priority scans are active, and if expert scans are active, regular scans are executed on alternate scans. Regular scans are the normal scanning mode of the system.

On a regular scan check_sl_quad() reads the voltage of the three (one for IES and OES) fhi, sense and flo hv channels. If it is normal working voltages it assumes that the 3 channels are switched on and not tripped. It then measures the currents and any other quantities required according to the "display" set.

8.7 priority scans

Priority scans are associated with system transition states. These are defined by value of "hv_stage" as defined in appendix 6. The relevant values of hv_stage for this description of priority scans are:

8.7.1 switching on hv channels

hv_stage = 2 for transitions between OFF but initialised (hv_stage = 1) to STANDBY (hv_stage = 3) and also for the recovery of tripped superlayer quadrants (when hvstage would normally be 5 (hvon) but could be 4. The standard requirement is to switch on the individual hv channels with vsel = 0, so low hv v0 voltages are selected in the caen hv crates.
However if this is recovering from a trip, hvstage will already by 5(hvon) a 4 rampage up so that the channels involved in this transition have special action initially set = 2. check_sl_quad() then tries to switch on the hv channels for this superlayer quad and sets special_action [ ][ ] = 3. Switching on the hv channels is a rather hit/miss action.
Also the cases in which only some hv channels out of the triplet of channels (for fhi, sense and flo) succeed in switching on must be dealt with safely.
The next entry to check_sl_quad() finds special_action [ ][ ] = 3.
It then reads the channel status word to find if it has switched on.
If all 3 (or 1 for IES and OES) hv channels are on, it sets special_action [ ][ ] = 0, thus cancelling its priority scan status;
if one or more relevant hv channels for this superlayer-quadrant are not ON, it repeats the switch on action for them and waits to test time whether it now has all hv channels switched on.
Before returning from check_sl_quad() a check is made of the number of priority scan channels by county up special_action [ ][ ] over all superlayers and quadrants.
On the last entry in which all special_action [ ][ ] has gone back to 0, if hv_stage was 2 it is now set to 3 (STANDBY) i.e. all channels switched on, but vsel = 0 so low v0 volts are selected in the caen hv crates.

8.7.2 switching off hv channels

hv_stage = 7 This transition (from STANDBY, with vsel = 0, to OFF) means switching off the triplet of hv channels (fhi, sense and flo) for each superlayer_quadrant for which it is requested, ie has special_action[sl][quad] = 7.
This action, like switching on he hv channels described above, is prone to lack of response in the caen hardware, and may have to be repeated many times. A similar strategy to that for switching on works.
On the first entry to check_sl_quad() after the software has set special_action[sl][quad] = 7 for all the superlayer quadrants to be switched off, a switch off command is sent to all 3 hv channels (fhi, sense anf flo) for each superlayer-quad, and special_action[ ][ ] is set to 1.
On the second and subsequent entries, if check_sl_quad() sees hv_stage = 7 and special_action [ ][ ] = 1, it reads the three channel status words for that sl_quad. If all are now off it sets special_action[ ][ ] = 0 cancelling its priority scan status.
If at least one channel is not off, it repeats the off command for the channel(s) still on and leaves special_action[ ][ ] set to 1, and this is repeadted until all the channels of this superlayer-quad are off.
When the last channel is successfully switched off, hv_stage is set to 1 (OFF).

Appendix 3

Current relay_map.dat file (July '95) from /h0/ctdhv_files/relay_map.dat

This describes which superlayer-quadrant is plugged into which hv switching relay-crate/module.

If the allocation changes for any reason, this file will have to be edited to reflect the new allocation.

The first two lines are merely title lines and should not need altering. The first line is read as "%s %s %s", i.e. as four blocks of characters, and each block MUST NOT CONTAIN ANY SPACES ! Similarly the second line is read with the format "%s %s %s", i.e. three blocks of charecters and again any spaces within any block will upset the count of blocks and hence the reading of the rest of the data.

The rest of the file is read with the format "%d %d %d, i.e. 4 decimal numbers per line. The data can be arranged in any order, but probably best to keep the order shown for easy human checking. The blank line separating superlayers is only to aid reading.

Interpretation: e.g. the first line indicates that the hv cables sets of three cables for each octant superlayer 1 quadrant1 (i.e. both octants of this quadrant, and field-high, sense and field-low hv) are plugged into hv switching relay crate number 1 and into module number 1 in this crate.

Superlayer 0 is the inner electrosyactic screen (IES) and superlayer 10 is the outer electrostatic screen (OES). The IES and OES have only one quadrant, which must be quadrant 1. All real superlayers must have 4 quadrant.

The end of the data file is marked by superlayer = -1.

The program makes comprehensive checks on repetitions and incompleteness as it reads the data and will stop with an appropriate error message on the screen if it finds errors.

A listing of the data file is below:

super layer	quadrant	relay crate	relay module
1	1	1	1
1	2	2	1
1	3	3	1
1	4	4	1
2	1	1	2
2	2	2	2
2	3	3	2
2	4	4	2
3	1	1	3
3	2	2	3
3	3	3	3
3	4	4	3
4	1	1	4
4	2	2	4
4	3	3	4
4	4	4	4
5	1	1	5
5	2	2	5
5	3	3	5
5	4	4	5
6	1	1	6
6	2	2	6
6	3	3	6
6	4	4	6
7	1	1	7
7	2	2	7
7	3	3	7
7	4	4	7
8	1	1	8
8	2	2	8
8	3	3	8
8	4	4	8
9	1	1	9
9	2	2	9
9	3	3	9
9	4	4	9
0	1	1	10
10	1	3	10
−1	−1	−1	−1

Appedix 4

The current voltages_for_pressures.dat (July '95) from /ho/ctdhv_files/voltages_for_pressures.dat

The overall format is:

a title line, a line giving the c number of complete ctd voltage sets that follow, with a voltage set number to use if the value of the atmospheric pressure is not available.

These different voltage all have sets for the same electrostatic drift field in the ctd cells, but have different sense wire surface fields - as the ctd pressure increase, higher sense wire surface fields are needed to maintain the same gas gain and hence track output pu.

This sequence of sets MUST be ordered in increasing sense wire surface field, and increasing minimum valid pressure tube height.

Title line:

The first title is importamnt. All 80 characters of this line are actually read, but only the first 64 are passed on to the environmental record. Thus the first 64 characters must contain the important information. This includes:

1.	The composition of the ctd gas	e.g. 85% Ar 8% CO2 7% ethane
2.	The nominal drift field	e.g. 1.22 kv/cm
3.	The range of sense wire surface fields for the sets of voltages that follow	e.g. Es183 to 184 kv/cm
4.	the date the file was made	e.g. 8/3/94
5.	(The final field here means this is a test set with just 5% volts	e.g. 5%)

second line:

The second line is read (skipping over any blank lines) with the format "%s %d %d". Thus there must be no blanks embedded in "no_of_sets=" or "default_set=".

The two numbers give the number of complete sets of hv for the ctd (here 2, but up to (and including) 9 sets are possible) and the number of the default set to use when there is no value of atmospheric pressure available to make a proper choice.

format of data for each complete set of ctd volts:

The first line of each set is read with the format "%s %d %s %d %s %d %s %d". Thus there must not be any blanks inside the "min_press=", "Es=", "IES=" or "OES=".

The min pressure is the pressure in millibars below which the program must not use this voltage set. The Es is just a label to distinguish this voltage set from the others. It must be different from the Es of other voltage sets; it is passed through to the environmental records.

The IES and OES numbers are the voltages for the inner and outer electrostatic screens for this voltage set.

Then follows a header line read with the format "%s %s %s", so again each volume header must not contain any blanks.

This is followed by a list, one superlayer per line, of the superlayer number (expected in increasing numerical order from 1 to 9), the field-high voltage, sense voltage, field-low voltage. Note that ALL OF THESE ARE IN UNITS OF VOLTS. (the sense voltages are converted to units of 1/2 volts internally, as used by the caens hv supplies).

The program knows when each voltage set is finished (9 superlayers read) and also knows how many sets to read.

The program does as much checking as possible on the values as it reads them in, and will stop with an error message on the first error seen.

A listing of the current file follows:

ar/co2/eth 85/8/7 Edl.22 Es183 → Es184 8/3/94 5%

no_of_sets= 2 default_set= 2

min_press= 900 Es= 183 IES= 62 OES= 50

sl_no fhi sense flo

<u>APPENDIX A:</u> HV CABLES FROM THE RUCKSACK TO THE CTD SERVICES RING. NON - STANDARD (NON - “SUPERLAYER - OCTANT”) CTD HV CABLES BETWEEN RUCKSACK AND SERVICES RING.

Services Ring feed through label	“Clock” position on SR	Cable no/type Lemo 1=Field Lemo 0=Sense	Position of end in Rucksack	Resist. to ground	Comments
“IES”	11 o’clock	135 Lemo 1	Q2	∞	Inner Electrostatic screen. Cable 501 to A1,09 diecast box with 22MΩ then cable 503 $\rightarrow$SL10 oct A HI.
“OES”	11 o’clock	113 Lemo 1	Q2	∞	Outer Electrostatic screen. Cable 502 to Q3 (A2,12) to 22MΩ in diecast box then cable 504 to SL10, Q3, octant A = OES.
“EXTRA1”	10 o’clock	93 Lemo 1 cable 93 not now spare	Q1	∞	Not used, connexion through to FTD end. 11/12/93 cable 93 (and its ext. cable 358) now used to replace cable 123 for sl2 oct1 LO$^-$.
“EXTRA2”	8 o’clock	81* (18) Lemo 1 (extended at the SR end into EXTRA2 by cable 327)	Q1	∞	Put in for possible use for isolated shaper wire, but not used. This cable must be cable 81*-not 18. Marked thus 20/9/93, but beware of ambiguity!
Spare	4.30	12 Lemo 1	Q3		
“	3 o’clock	77 Lemo 0	Q3		
“	8 o’clock	24 Lemo 0	Q1		
Now not spare	2 o’clock	8 Lemo 0	Q2		6/12/92, changed to lemo 1 and used instead of cable 143 for SL7, quad 2, octantB.
Spare	2 o’clock	58 Lemo 1	Q2		
“	10 o’clock	58 Lemo 0	Q1		
“	6.30	4 Lemo 0	Q2		
“	6.30	57 Lemo 0	Q4		
“	4.30	2 Lemo 0	Q3		
“	5 o’clock	9 Lemo 1	Q4		
“	5 o’clock	38 Lemo 0	Q4		
Now not spare	?6.30?	55 Lemo 1	Q2		9/12/94 used for SL7 OCT4 instead of cable 8 (gone bad)
spare	4.30	68 Lemo 1	Q3		
Bad cable don‘t use	7 o’clock	61 Lemo 1	Q4		
“	10 0’clock	143 Lemo 1	Q2		bad, replaced 16/12/93 by cable 8
“	?	102 no plug	Q2		
“	?	154 no plug	Q3		
“	?	89(or 68?) no plug	Q4		

IES =
(inner electrostatic screen) cable is no. 135 from lemo 1 feed through marked “IES” between lemo 1 sockets 42 and 43 at 12 o’cock on the services ring to quadrant 2 (behind rack A1,13 in the rucksack)

OES =
(outer electrostatic screen) cable 113 from lemo 1 feed through marked “OES” between lemo1 feed throughs 42 and 43 at 12 o’clock on the services ring to quadrant 2 (behind rack A1,13 in the rucksack).

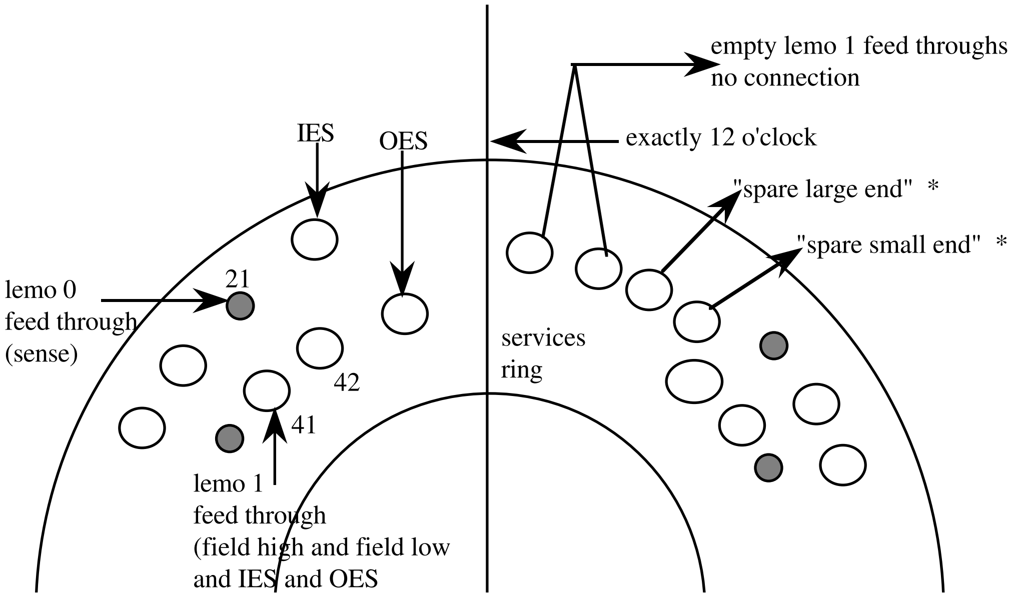


figure 1A.1

On the services ring the IES/OES sockets are arranged as in figure 1A.1

∗"Spare large end"
Cable 93 (extended at the SR by cable 358 (about 1 metre long) was originally plugged into this feedthrough. Now, 11/12/93 93(&358) unplugged on SR, & used for sl2 oct 1 LO^- instead of faulty cable 123). Rucksack end of cable 93 is behind rack. A1,09 (Q1 relay box)

∗"Spare small end"
Cable 81 (extended at the SR end by cable 327 (about 1 metre long)) is still (11/12/93) plugged into this feed through.
Behind the SR both "spare large end" & "spare small end" extend to the FTD end, but nothing is connected to them. Their resistance to ground is infinity.

HV cables in the drag chain

The HV cables from the rucksack to the services ring exit via a numbered window in the rucksack, are laid in groups in the drag-chain, and up the "trellis" just inside the RCAL to the CTD services ring.

These HV cables are approximately 40 metres long.

Drag chain section number original arrangement may be different now-see fig.3	Range of signal cables on the services ring in this section. Adjacent HV cables also	Number of signal cables	Estimated number of HV cables in this section	"window" in rucksack through which the cables pass	Cable description
on services ring, starting from bottom going anticlockwise					
18	36A - 32B	34	9	1	signal + HV
17	32C - 30D	18	9	1	signal + HV
21	30E - 26F	34	18	1	signal + HV
20	26G - 24H	18	12	1	signal + HV
24	23A -18D	39	8	1/2	signal + HV
23	18E - 16F (?18A - 16B?)	18	21	2	signal + HV
27	16G - 14H (?16C - 14H?)	18	12	2	signal + HV
27	special	9	0	2	crate on yoke 1 S25, OPBUS, Gas-alarm
on services ring, starting from bottom, going clockwise					
26	37A - 41B	34	18	2	signal + HV
25	41C - 45D	34	24	2	signal + HV
23	45E - 1D	16	12	2	signal + HV
22	1E -5F	34	18	2	signal + HV
20	5G - 7F	16	12	2	signal + HV
19	7G - 11H	34	8	3	signal + HV
17	12A - A3H	16	14	3	signal + HV
16	Field monitor	0	0	3	

Cross-section of original drag chain to illustrate disposition of CTD signal and HV cables. Drawn looking at the section sitting on the floor, looking AWAY from ZEUS.

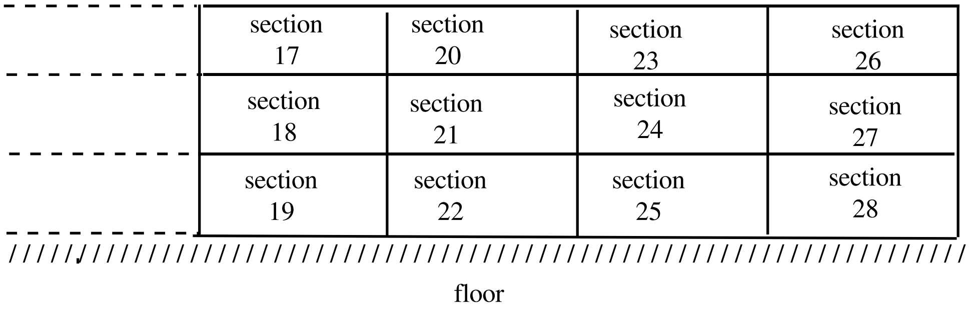


figure 1A.2

A new drag chain was installed in early 1993. The disposition of the cables in it are not known.

Arrangement of CTD cables in the drag chain between the rucksack and the services ring. The arrangement shown inside the compartments of the drag chain itself are the original ones of August 1990; this drag chain damaged many cables as it moved and was replaced in early 1993. The assignment of cables to the sections of the new drag chain is not known; the other information in this table should still be good.

Notes that the the two "field" HV cables for each cell have lemo 1 HV plugs, the single "sense" HV cable each cell has lemo 0 HV plugs at each end of the cable. At both the rucksack end and at the services ring end the three HV cables for one cell are tied together with a cable tie. The cables are all numbered at each end with a hand written number on a sleeve.

Note that cable number "N" often exists in two forms - a lemo 1 field cable and a lemo 0 sense cable. Be careful to distinguish.

DATE : 12/6/91
PEOPLE : Don & Ash

OCTANT 1

SL		SRS	RESISTANCE AT SR	CABLE NO.	RESISTANCE AT RS	COMMENTS
			HG: 5.38		HG: 5.37	
9	H	2	HL: 1.44	64	HL: 1.44	
	L	1	LG: 3.95	1	LG: 3.95	
	S	1	SG:∞	29	SG:∞	
			HG: 5.12		HG: 5.11	
8	H	4	HL: 1.45	96	HL: 1.45	
	L	3	LG: 3.67	86	LG: 3.68	
	S	2	SG:∞	41	SG:∞	
			HG: 5.21		HG: 5.22	
7	H	6	HL: 1.50	157	HL: 1.51	
	L	5	LG: 3.74	112	LG: 3.73	
	S	3	SG:∞	66	SG:∞	
			HG: 5.40		HG: 5.41	
6	H	8	HL: 1.72	98	HL: 1.72	
	L	7	LG: 3.72	8	LG: 3.70	
	S	4	SG:∞	30	SG:∞	
			HG: 5.35		HG: 5.35	
5	H	10	HL: 1.73	108	HL: 1.74	
	L	9	LG: 3.64	107	LG: 3.64	
	S	5	SG:∞	50	SG:∞	
			HG: 5.47		HG: 5.47	
4	H	12	HL: 1.96	166	HL: 1.96	
	L	11	LG: 3.54	160	LG: 3.53	
	S	6	SG:∞	59	SG:∞	
			HG: 5.81		HG: 5.80	
3	H	14	HL: 2.13	119	HL: 2.13	
	L	13	LG: 3.70	97	LG: 3.70	
	S	7	SG:∞	17	SG:∞	
			HG: 6.43		HG: 6.43	20/9/93, fault, cable 93
2	H	16	HL: 2.55	142	HL: 2.54	instead of bad cable 123
	L	15	LG: 3.91	123	LG: 3.91	see notes 1,2 and 3 at end.
				93		
	S	8	SG:∞	39	SG:∞	
			HG: 5.52		HG: 5.52	5.48M OK, 20.9.93 Don, Dick,

1	H	18	HL: 2.91	72	HL: 2.91	Graham
	L	17	LG: 2.63	66	LG: 2.63	2.61M OK.
	S	9	SG:∞	55	SG:∞	

INPUT of crate

NOTE:	HG:	denotes	HI	to	GRND
	HL:	"	HI	to	LOW
	LG:	"	LOW	to	GRND
	SG:	"	SENSE	to	GRND

SL = SUPER LAYER
SRS = SERVICES RING SOCKET
RSR = RESISTANCE AT SERVICES RING
RRS = RESISTANCE AT RUCKSACK

1. Superlayer 2, octant1. 20/9.93 bad cable? LG resistance 13.58K instead of 3.91 M. HG resistance 2.55M. Timming - hint of dip at $\frac{370}{2}$=185ns from input. Main reflection is at 480ns. Cut off plug on cable 123 in rucksack - cable is still bad, plug is ok.
2. Superlayer 2, octant1 11/10/93 checked again cable 123 in rucksack still 13.8K.
3. Superlayer 2, octant1 11/12/93 access to SR on CTD. Cable 123 still bad, plug cut off at SR end also - cable still bad, feed through into CTD seems ok so only fault is in cable 123. Relaced cable 123 by cable 93 which was plugged into "EXTRA1" on SR, though not used. This cable 93 not quite long enough at SR end, so extended by lemo coupler and 1 metre long cable 358 to reach socket on SR. LG is now 3.91M again, HV on CTD ok.

DATE : 12/6/91
PEOPLE : Don & Ash

OCTANT 2

SL		SRS	RESISTANCE AT SR	CABLE NO.	RESISTANCE AT RS	COMMENTS
			HG: 5.37		HG: 5.37	
9	H	20	HL: 1.44	139	HL: 1.44	
	L	19	LG: 3.92	125	LG: 3.95	
	S	10	SG:∞	21	SG:∞	
			HG: 5.13		HG: 5.13	
8	H	22	HL: 1.46	78	HL: 1.45	
	L	21	LG: 3.68	44	LG: 3.69	
	S	11	SG:∞	1	SG:∞	
			HG: 5.23		HG: 5.23	
7	H	24	HL: 1.51	100	HL: 1.51	
	L	23	LG: 3.74	90	LG: 3.74	
	S	12	SG:∞	37	SG:∞	
			HG: 5.41		HG: 5.41	
6	H	26	HL: 1.73	151	HL: 1.73	
	L	25	LG: 3.69	134	LG: 3.70	
	S	13	SG:∞	40	SG:∞	
			HG: 5.34		HG: 5.34	
5	H	28	HL: 1.73	95	HL: 1.75	
	L	27	LG: 3.63	83	LG: 3.63	
	S	14	SG:∞	31	SG:∞	
			HG: 5.48		HG: 5.47	
4	H	30	HL: 1.96	153	HL: 1.96	
	L	29	LG: 3.52	114	LG: 3.54	
	S	15	SG:∞	60	SG:∞	
			HG: 5.81		HG: 5.79	
3	H	32	HL: 2.13	74	HL: 2.12	
	L	31	LG: 3.68	52	LG: 3.69	
	S	16	SG:∞	28	SG:∞	
			HG: 6.43		HG: 6.42	20.9.93, 6.40M OK
2	H	34	HL: 2.54	155	HL: 2.54	
	L	33	LG: 3.90	106	LG: 3.90	3.88M OK
	S	17	SG:∞	44	SG:∞	
			HG: 5.53		HG: 5.53	20.9.93, 5.51M OK

1	H	36	HL: 2.92	129	HL: 2.92	
	L	35	LG: 2.64	127	LG: 2.64	2.61M OK
	S	18	SG:∞	42	SG:∞	

INPUT of crate 1

NOTE :	HG:	denotes	HI	to	GRND
	HL:	“	HI	to	LOW
	LG:	“	LOW	to	GRND
	SG:	“	SENSE	to	GRND

SL = SUPER LAYER
SRS = SERVICES RING SOCKET
RSR = RESISTANCE AT SERVICES RING
RRS = RESISTANCE AT RUCKSACK

DATE : 12/6/91
PEOPLE : Don & Ash

OCTANT 3

SL		SRS	RESISTANCE AT SR	CABLE NO.	RESISTANCE AT RS	COMMENTS
			HG: 5.36		HG: 5.38	
9	H	38	HL: 1.44	141	HL: 1.44	
	L	37	LG: 3.90	138	LG: 3.95	
	S	19	SG:∞	51	SG:∞	
			HG: 5.10		HG: 5.11	
8	H	40	HL: 1.45	159	HL: 1.46	
	L	39	LG: 3.69	158	LG: 3.68	
	S	20	SG:∞	81	SG:∞	
			HG: 5.23		HG: 5.23	
7	H	42	HL: 1.50	49	HL: 1.50	
	L	41	LG: 3.74	45	LG: 3.73	
	S	21	SG:∞	23	SG:∞	
			HG: 5.42		HG: 5.41	
6	H	44	HL: 1.73	101	HL: 1.73	
	L	43	LG: 3.70	17	LG: 3.70	17 is slightly damaged
	S	22	SG:∞	6	SG:∞	$\sim$ 30cm from relay end
			HG: 5.35		HG: 5.34	
5	H	46	HL: 1.74	82	HL: 1.74	
	L	45	LG: 3.63	94	LG: 3.63	
	S	23	SG:∞	71	SG:∞	
			HG: 5.48		HG: 5.48	
4	H	48	HL: 1.96	33	HL: 1.96	
	L	47	LG: 3.54	42	LG: 3.54	
	S	24	SG:∞	62	SG:∞	
			HG: 5.80		HG: 5.79	
3	H	50	HL: 2.13	26	HL: 2.13	
	L	49	LG: 3.68	29	LG: 3.69	
	S	25	SG:∞	48	SG:∞	
			HG: 6.43		HG: 6.43	
2	H	52	HL: 2.54	30	HL: 2.54	
	L	51	LG: 3.90	60	LG: 3.90	
	S	26	SG:∞	67	SG:∞	
			HG: 5.54		HG: 5.54	

1	H	54	HL: 2.91	20	HL: 2.91
	L	53	LG: 2.64	25	LG: 2.64
	S	27	SG:∞	27	SG:∞

NOTE :	HG:	denotes	HI	to	GRND
	HL:	“	HI	to	LOW
	LG:	“	LOW	to	GRND
	SG:	“	SENSE	to	GRND

SL = SUPER LAYER
SRS = SERVICES RING SOCKET
RSR = RESISTANCE AT SERVICES RING
RRS = RESISTANCE AT RUCKSACK

DATE : 12/6/91
PEOPLE : Don & Ash

OCTANT 4

SL		SRS	RESISTANCE AT SR	CABLE NO.	RESISTANCE AT RS	COMMENTS
			HG: 5.38		HG: 5.36	
9	H	56	HL: 1.44	145	HL: 1.44	
	L	55	LG: 3.93	150	LG: 3.94	
	S	28	SG:∞	13	SG:∞	
			HG: 5.12		HG: 5.12	
8	H	58	HL: 1.46	27	HL: 1.46	
	L	57	LG: 3.68	116	LG: 3.67	
	S	29	SG:∞	9	SG:∞	
			HG: 5.24		HG: 5.23	5.23M, 16.12.92
7	H	60	HL: 1.51	(143)8	HL: 1.51	← bad cable. Replaced
	L	59	LG: 3.73	161	LG: 3.74	cable 143 with cable 8 (changing
	S	30	SG:∞	75	SG:∞	lemo 0 to lemo 1) then OK.
						9/12/94 bad cable
						replaced again.
						See note at end.
			HG: 5.41		HG: 5.41	
6	H	62	HL: 1.73	88	HL: 1.73	
	L	61	LG: 3.70	137	LG: 3.70	
	S	31	SG:∞	33	SG:∞	
			HG:5.79/5.79		HG: 5.54	5.54
!5	H	64	HL:1.98/1.98	10	HL: 1.73	1.74
	L	63	LG:3.82/3.83	79	LG: 3.82	3.84
	S	32	SG:∞/∞	14	SG:∞	∞
			HG: 5.48		HG: 5.48	
4	H	66	HL: 1.96	76	HL: 1.96	
	L	65	LG: 3.52	131	LG: 3.53	
	S	33	SG:∞	35	SG:∞	
			HG: 5.80		HG: 5.80	
3	H	68	HL: 2.13	54	HL: 2.13	
	L	67	LG: 3.69	57	LG: 3.69	
	S	34	SG:∞	54	SG:∞	
			HG: 6.43		HG: 6.43	
2	H	70	HL: 2.55	87	HL: 2.55	
	L	69	LG: 3.90	117	LG: 3.89	

	S	35	SG:∞	70	SG:∞
			HG: 5.51		HG: 5.51
1	H	72	HL: 2.91	56	HL: 2.91
	L	71	LG: 2.62	59	LG: 2.62
	S	36	SG:∞	46	SG:∞

NOTE :	HG:	denotes	HI	to	GRND
	HL:	"	HI	to	LOW
	LG:	"	LOW	to	GRND
	SG:	"	SENSE	to	GRND

INPUTS for crate 4(SRS)
! 5.34 = - 0.45
1.74 = - 0.24
3.62 = - 0.21
5.80 & 5.36

SL = SUPER LAYER
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RRS = RESISTANCE AT RUCKSACK

Note 9/12/94 SL7Q2 OCTANT 4 FIELD HIGH cable no 8 went bad (3.2 ohm to ground about 1/2 way from rucksack to CTD). This had in turn replaced original cable 143 which went bad in Summer '92.
Field High of SL7 Octant 4 is now cable 55 (formerly) lemo 0 spare with end at the back of the quadrant 2 rack). Cable 55 is extended by new hv cable 1934 at the SR end, from about 6.30 to 1.30 on SR clock face position. Cable 1934 is about 1.8 metres long.
For this superlayer-octant resistances measured in the rucksack are now

55	HG :5.26 M ohm	Slightly odd $\sim$ 1% diff. from expected, but works ok.
	HL : 1.508 M ohm	
161	LG :3.71 M ohm	
75	SG : ∞	

DATE : 12/6/91
PEOPLE : Don & Ash

OCTANT 5

SL		SRS	RESISTANCE AT SR	CABLE NO.	RESISTANCE AT RS	COMMENT 19/6/91
			HG: 5.38		HG: 5.38	
9	H	74	HL: 1.44	110	HL: 1.44	
	L	73	LG: 3.94	148	LG: 3.95	
	S	37	SG:∞	52	SG:∞	
			HG: 5.12		HG: 5.12	
8	H	76	HL: 1.46	69	HL: 1.46	
	L	75	LG: 3.68	77	LG: 3.68	
	S	38	SG:∞	36	SG:∞	
			HG: 5.23		HG: 5.23	
7	H	78	HL: 1.51	32	HL: 1.51	
	L	77	LG: 3.74	41	LG: 3.74	
	S	39	SG:∞	16	SG:∞	
			HG: 5.41		HG: 5.41	
6	H	80	HL: 1.73	92	HL: 1.73	
	L	79	LG: 3.70	163	LG: 3.70	
	S	40	SG:∞	73	SG:∞	
			HG: 5.34		HG: 5.34	
5	H	82	HL: 1.74	13	HL: 1.74	
	L	81	LG: 3.63	19	LG: 3.63	
	S	41	SG:∞	43	SG:∞	
			HG: 5.49		HG: 5.48	
4	H	84	HL: 1.96	4	HL: 1.96	
	L	83	LG: 3.55	5	LG: 3.54	
	S	42	SG:∞	34	SG:∞	
			HG: 5.81		HG: 5.81	
3	H	86	HL: 2.14	118	HL: 2.13	
	L	85	LG: 3.70	165	LG: 3.70	
	S	43	SG:∞	72	SG:∞	
			HG: 6.44		HG: 6.44	6.44
2	H	88	HL: 2.55	130	HL: 2.55	2.55
	L	87	LG: 3.91	133	LG: 3.91	3.92
	S	44	SG:∞	5	SG:∞	∞
			HG: 5.52		HG: 5.52	5.53

1	H	90	HL: 2.91	84	HL: 2.91	2.92
	L	89	LG: 2.63	146	LG: 2.63	2.63
	S	45	SG:∞	63	SG:∞	∞

Note :	HG:	denotes	HI	to	GRND
	HL:	“	HI	to	LOW
	LG:	“	LOW	to	GRND
	SG:	“	SENSE	to	GRND

SL = SUPER LAYER
SRS = SERVICES RING SOCKET
RSR = RESISTANCE AT SERVICES RING
RRS = RESISTANCE AT RUCKSACK

DATE : 12/6/91
PEOPLE : Don & Ash

OCTANT 6

SL		SRS	RESISTANCE AT SR	CABLE NO.	RESISTANCE AT RS	COMMENT
			HG: 5.38		HG: 5.36	
9	H	92	HL: 1.45	43	HL: 1.44	
	L	91	LG: 3.95	48	LG: 3.95	
	S	46	SG:∞	49	SG:∞	
			HG: 5.13		HG: 5.13	
8	H	94	HL: 1.46	34	HL: 1.46	
	L	93	LG: 3.69	111	LG: 3.68	
	S	47	SG:∞	45	SG:∞	
			HG: 5.24		HG: 5.23	
7	H	96	HL: 1.51	75	HL: 1.51	
	L	95	LG: 3.75	18	LG: 3.75	20.9.93, Ambiguity! 18 or 81 ?
	S	48	SG:∞	74	SG:∞	marked today <u>18</u> in rucksack.
			HG: 5.40		HG: 5.41	
6	H	98	HL: 1.72	140	HL: 1.72	
	L	97	LG: 3.70	46	LG: 3.70	
	S	49	SG:∞	61	SG:∞	
			HG: 5.34		HG: 5.34	
5	H	100	HL: 1.74	62	HL: 1.74	
	L	99	LG: 3.62	99	LG: 3.62	
	S	50	SG:∞	80	SG:∞	
			HG: 5.47		HG: 5.48	
4	H	102	HL: 1.96	11	HL: 1.96	
	L	101	LG: 3.53	14	LG: 3.54	
	S	51	SG:∞	64	SG:∞	
			HG: 5.81		HG: 5.81	
3	H	104	HL: 2.13	121	HL: 2.13	
	L	103	LG: 3.70	85	LG: 3.70	
	S	52	SG:∞	7	SG:∞	
			HG: 6.44		HG: 4.43	
2	H	106	HL: 2.55	147	HL: 2.55	
	L	105	LG: 3.91	136	LG: 3.91	
	S	53	SG:∞	79	SG:∞	
			HG: 5.52		HG: 5.52	

1	H	108	HL: 2.91	91	HL: 2.91
	L	107	LG: 2.63	67	LG: 2.63
	S	54	SG:∞	25	SG:∞

NOTE :	HG:	denotes	HI	to	GRND
	HL:	“	HI	to	LOW
	LG:	“	LOW	to	GRND
	SG:	“	SENSE	to	GRND

SL = SUPER LAYER
SRS = SERVICES RING SOCKET
RSR = RESISTANCE AT SERVICES RING
RRS = RESISTANCE AT RUCKSACK

DATE : 12/6/91
PEOPLE : Don & Ash

OCTANT 7

SL		SRS	RESISTANCE AT SR	CABLE NO.	RESISTANCE AT RS	COMMENT 19/6/91
			HG: 5.38		HG: 5.37	5.37
9	H	110	HL: 1.44	40	HL: 1.44	1.44
	L	109	LG: 3.96	132	LG: 3.95	3.96
	S	55	SG:∞	69	SG:∞	∞
			HG: 5.11		HG: 5.11	5.11
8	H	112	HL: 1.46	3	HL: 1.46	1.46
	L	111	LG: 3.68	7	LG: 3.67	3.67
	S	56	SG:∞	3	SG:∞	∞*
			HG: 5.23		HG: 5.23	5.23
7	H	114	HL: 1.51	28	HL: 1.51	1.51
	L	113	LG: 3.74	80	LG: 3.74	3.74
	S	57	SG:∞	65	SG:∞	∞
			HG: 5.41		HG: 5.41	5.41
6	H	116	HL: 1.72	37	HL: 1.72	1.72
	L	115	LG: 3.71	6	LG: 3.71	3.71
	S	58	SG:∞	10	SG:∞	∞
			HG: 5.34		HG: 5.34	5.34
5	H	118	HL: 1.74	70	HL: 1.74	1.74
	L	117	LG: 3.62	47	LG: 3.62	3.62
	S	59	SG:∞	76	SG:∞	∞
			HG: 5.46		HG: 5.47	5.46
4	H	120	HL: 1.96	144	HL: 1.96	1.96
	L	119	LG: 3.53	105	LG: 3.53	3.53
	S	60	SG:∞	78	SG:∞	∞
			HG: 5.81		HG: 5.80	5.80
3	H	122	HL: 2.13	31	HL: 2.13	2.13
	L	121	LG: 3.70	21	LG: 3.72	3.70
	S	61	SG:∞	15	SG:∞	∞
			HG: 6.43		HG: 6.42	6.43
2	H	124	HL: 2.54	50	HL: 2.54	2.54
	L	123	LG: 3.90	38	LG: 3.91	3.90
	S	62	SG:∞	18	SG:∞	∞
			HG: 5.51		HG: 5.50	5.51

1	H	126	HL: 2.90	71	HL: 2.91	2.90
	L	125	LG: 2.63	23	LG: 2.63	2.63
	S	63	SG:∞	22	SG:∞	∞

NOTE :	HG:	denotes	HI	to	GRND
	HL:	"	HI	to	LOW
	LG:	"	LOW	to	GRND
	SG:	"	SENSE	to	GRND

*Small Lemo Connector 3 does not click into socket - loose - OK after further tests.

SL = SUPER LAYER
SRS = SERVICES RING SOCKET
RSR = RESISTANCE AT SERVICES RING
RRS = RESISTANCE AT RUCKSACK

DATE : 12/6/91
PEOPLE : Don & Ash

OCTANT 8

SL		SRS	RESISTANCE AT SR	CABLE NO.	RESISTANCE AT RS	COMMENT 19/6/91
			HG: 5.38		HG: 5.37	5.38
9	H	128	HL: 1.44	109	HL: 1.44	1.44
	L	127	LG: 3.94	35	LG: 3.94	3.95
	S	64	SG:∞	11	SG:∞	∞
			HG: 5.12		HG: 5.11	5.11
8	H	130	HL: 1.46	149	HL: 1.46	1.46
	L	129	LG: 3.69	126	LG: 3.68	3.69
	S	65	SG:∞	12	SG:∞	∞
			HG: 5.22		HG: 5.23	5.23
7	H	132	HL: 1.51	36	HL: 1.51	1.51
	L	131	LG: 3.74	16	LG: 3.74	3.74
	S	66	SG:∞	20	SG:∞	∞
			HG: 5.40		HG: 5.41	5.41
6	H	134	HL: 1.72	51	HL: 1.72	1.72
	L	133	LG: 3.71	39	LG: 3.7	3.70
	S	67	SG:∞	32	SG:∞	∞
			HG: 5.34		HG: 5.34	5.34
5	H	136	HL: 1.74	104	HL: 1.74	1.74
	L	135	LG: 3.62	53	LG: 3.62	3.62
	S	68	SG:∞	53	SG:∞	∞
			HG: 5.47		HG: 5.47	5.47
4	H	138	HL: 1.95	103	HL: 1.96	1.96
	L	137	LG: 3.55	2	LG: 3.54	3.54
	S	69	SG:∞	19	SG:∞	∞
			HG: 5.81		HG: 5.81	5.81
3	H	140	HL: 2.13	164	HL: 2.13	2.13
	L	139	LG: 3.70	156	LG: 3.70	3.70
	S	70	SG:∞	26	SG:∞	∞
			HG: 6.43		HG: 6.42	6.43
2	H	142	HL: 2.54	65	HL: 2.54	2.54
	L	141	LG: 3.90	15	LG: 3.90	3.90
	S	71	SG:∞	47	SG:∞	∞
			HG: 5.57		HG: 5.57	5.57

1	H	144	HL: 2.95	89	HL: 2.95	2.94
	L	143	LG: 2.64	73	LG: 2.64	2.64
	S	72	SG:∞	56	SG:∞	∞

NOTE :	HG:	denotes	HI	to	GRND
	HL:	“	HI	to	LOW
	LG:	“	LOW	to	GRND
	SG:	“	SENSE	to	GRND

SL = SUPER LAYER
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Appendix B: HV cables fixed on outside of CTD between the services ring and the miniservices ring.

Octant	Super	SR Socket no.			HV cable no.		
	layer	sense	field low	field high	sense	field low	field high
1	9	1	1	2	1	1	2
	8	2	3	4	2	3	4
	7	3	5	6	3	5	6
	6	4	7	8	4	7	8
	5	5	9	10	5	9	10
	4	6	11	12	6	11	12
	3	7	13	14	7	13	14
	2	8	15	16	8	15	16
	1	9	17	18	9	17	18
2	9	10	19	20	10	19	20
	8	11	21	22	11	21	22
	7	12	23	24	12	23	24
	6	13	25	26	13	25	26
	5	14	27	28	14	27	28
	4	15	29	30	15	29	30
	3	16	31	32	16	31	32
	2	17	33	34	17	33	34
	1	18	35	36	18	34	36
3	9	19	37	38	19	37	38
	8	20	39	40	20	39	40
	7	21	41	42	21	41	42
	6	22	43	44	22	43	44
	5	23	45	46	23	45	46
	4	24	47	48	24	47	48
	3	25	49	50	25	49	50
	2	26	51	52	26	51	52
	1	27	53	54	27	53	54
4	9	28	55	56	28	55	56
	8	29	57	58	29	57	58
	7	30	59	60	30	59	60
	6	31	61	62	31	61	62
	5	32	63	64	32	63	64
	4	33	65	66	33	65	66
	3	34	67	68	34	67	68
	2	35	69	70	35	69	70
	1	36	71	72	36	71	72
5	9	37	73	74	37	73	74
	8	38	75	76	38	75	76
	7	39	77	78	39	77	78
	6	40	79	80	40	79	80
	5	41	81	82	41	81	82
	4	42	83	84	42	83	84
	3	43	85	86	43	85	86
	2	44	87	88	44	87	88
	1	45	89	90	45	89	90

Octant	Super layer	SR Socket no. sense	SR Socket no. field low	SR Socket no. field high	HV cable no. sense	HV cable no. field low	HV cable no. field high
6	9	46	91	92	46	91	92
	8	47	93	94	47	93	94
	7	48	95	96	48	95	96
	6	49	97	98	49	97	98
	5	50	99	100	50	99	100
	4	51	101	102	51	101	102
	3	52	103	104	52	103	104
	2	53	105	106	53	105	106
	1	54	107	108	54	107	108
7	9	55	109	110	55	109	110
	8	56	111	112	56	111	112
	7	57	113	114	57	113	114
	6	58	115	116	58	115	116
	5	59	117	118	59	117	118
	4	60	119	120	60	119	120
	3	61	121	122	61	121	122
	2	62	123	124	62	123	124
	1	63	125	126	63	125	126
8	9	64	127	128	64	127	128
	8	65	129	130	65	129	130
	7	66	131	132	66	131	132
	6	67	133	134	67	133	134
	5	68	135	136	68	135	136
	4	69	137	138	69	137	138
	3	70	139	140	70	139	140
	2	71	141	142	71	141	142
	1	72	143	144	72	143	144

Appendix C: HV cables in the rucksack between CAEN SY127 and corresponding relay crate.

		HV cables		
quadrant	superlayer	sense	field low	field high
1	1	9	17	18
	2	8	15	16
	3	7	13	14
	4	6	11	12
	5	5	9	10
	6	4	7	8
	7	3	5	6
	8	2	3	4
	9	1	1	2
				IES 445
2	1	18	35	36
	2	17	33	34
	3	16	31	32
	4	15	29	30
	5	14	27	28
	6	13	25	26
	7	12	23	24
	8	11	21	22
	9	10	19	20
3	1	27	53	54
	2	26	51	52
	3	25	49	50
	4	24	47	48
	5	23	45	46
	6	22	43	44
	7	21	41	42
	8	20	39	40
	9	19	37	38
				OES 440
4	1	36	71	72
	2	35	69	70
	3	34	67	68
	4	33	65	66
	5	32	63	64
	6	31	61	62
	7	30	59	60
	8	29	57	58
	9	28	55	56

Appendix C. HV cables in the rucksack - between the CAEN HV crates and the HV inputs into the relay boxes. There are 3 HV cables (sense, field low and field high) for each superlayer-quadrant. (both octants for 1 quadrant are supplied by one set of these cables). The 3 cables in the set for one superlayer quadrant are tied together at each end with a cable tie. At the CAEN crate end all cables are fitted with SHV plugs; at the relay box end the two field HV cables have lemo 1 HV plugs and the single sense cable has lemo 0 plugs. The cables are al labout 7 metres long, down one rack, under the floor and up the next rack. The cables have numbered sleeves on each end.

Note that (at least for crate 1) two different types of cables have the same number (number 1 to 9). At the relay crate end there is no ambiguity because one cable of each number is a lemo 1 (large) hv plug, and the other has a lemo 0 (small) hv plug. At the back of the caen crates all cables have the same SHV plugs. The ambiguity is removed here by every field hi SHV plug has a dot of blue paint, every fieldlo plug has a dot of yellow paint and every sense HV plug has a dot of red paint

Appendix E

Maintenance log for UPS batteries

Spare UPS batteries : voltage log (not charged for previous 12hrs)

		date 13/7/95	date 5/1/95		date 4/2/95		date 12/2/95	
Bat. no.	d/bought	volts	volts	hrs chgd	volts	hrs chgd	volts	hrs chgd
101	1/6/93	13.07	12.81	5	12.91		12.96	23
102	1/6/93	13.07	12.79	37	13.03		13.00	
105	18/2/94	12.36	12.88		12.83	32	12.94	
106	7/8/92	12.66	12.52	48	13.04		13.03	
108	7/8/92	12.65	12.50	48	13.04		13.03	
112	?original?	12.65	12.45	8	12.91		12.89	25
117	1/7/94	12.73	12.51	8	12.92		12.91	25
118	1/6/93	12.31	12.14	22	12.88	23	12.94	22
119	1/6/93	12.27	12.15	22	12.85	23	12.91	22
120	1/7/94	12.76	12.53	16	12.97		12.96	23
121	1/7/94	12.73	12.51	16	12.92	9	12.99	
122	1/7/94	12.77	12.55	33	12.98		12.96	
123	18/2/94	12.36	12.91		12.86	23	12.97	

charging log

battery no.	date-hours	date-hours	date-hours	date-hours
101	9/1/95 5hrs	14/2/95 23hrs		
102	9/1/95 5hrs	22/1/95 32hrs		
105	4/2/95 23hrs	6/2/95 9.5hrs	14/9/95 23hrs	
106	6/1/95 48hrs			
108	6/1/95 48hrs			
112	8/1/95 8hrs	12/2/95 25hrs	13/9/93 23hrs	
117	8/1/95 8hrs	12/2/95 25hrs		
118	5/1/95 22hrs	5/2/95 23hrs	13/2/95 22hrs	
119	5/1/95 22hrs	5/2/95 23hrs	13/2/95 22hrs	13/9/95 23hrs
120	8/1/95 15hrs	23/1/95 1hr	14/2/95 23hrs	
121	8/1/95 15hrs	23/1/95 1hr	6/2/95 9.5hrs	
122	9/1/95 1hr	22/1/95 32hrs	14/9/95 23hrs	
123	4/2/95 23hrs			

* These two must run down originally, least successful in recharging. Leave all for a longish period to compare discharge rates. Looks like 0.01vol 6/weeks

Spare UPS batteries : voltage log (not charged for previous 12hrs)

	date		date		date		date
	18/2/95		13/9/95		14/9/95		
Bat.		hrs		hrs		hrs	
no.	volts	chgd	volts	chgd	volts	chgd	volts
101	13.03	0	12.80				
102	12.99	0	12.79				
105	12.92	0	12.71				
106	13.02	0	12.82				
108	12.02	0	12.81				
112	13.07	0	12.70	23	13.08		
117	13.06	x					
118	12.96	x					
119	12.93	0	12.71	23	13.00		
120	13.04	0	12.74				
121	12.98	x					
122	12.95	0	12.73				
123	12.95	x					

x = stolen on 21/2/95

charging log

battery no.	date-hours	date-hours	date-hours	date-hours
101	00/00/95 5hrs	00/00/95 23hrs		
102				
105				
106				
108				
112				
117				
118				
119				
120				
121				
122				
123				

<u>**Note:**</u> 14/9/95 In recharging 122 & 105 together, the volts across 105 reached 14.08 by the time the volts across 122 reached 13.18. This is within ~ 2 minutes of beginning charging.

Appendix F

Caen hv modules in Caen SY127 crates and spares in hv cupboard in level 6

Serial numbers of CAEN HV modules (4 hv channels each) installed in the SY127 HV crates. There are 8 modules per crate, in the 8 left most positions (as seen from the back. The negative HV modules are

all A333 type, the positive modules are

all A434 type

positive 1(-)	crate 1	crate 2	crate 3	crate 4
(left)	# 463	# 462	# 368	# 366
2 (+)	# 33 (was # 88)	# 28	# 26	# 89
3 (-)	# 460	# 461	# 451	# 457
4 (-)	# 466	# 450	# 452 (is#465) (was #464,#452)	# 458
5 (+)	# 23	# 24	# 22	# 25
6 (-)	# 467?	# 449 (was # 464)	# 454	# 456
7 (-)	# 459	# 453	# 455	# 367
8 (right most)	# 28	# 31	# 29	# 30

There are two spare negative modules in the cupboard on level 6 [#464 and #465] and two spare positive modules [#... and # ...].

Note August/September 1995

The -ve module #452 in caen crate 3 became faulty and was replaced by #464 from level 6. #452 was sent to Wiener for repair.

On 12th September #464 module which had been inserted in crate 3 also became faulty, and was replaced by #465.

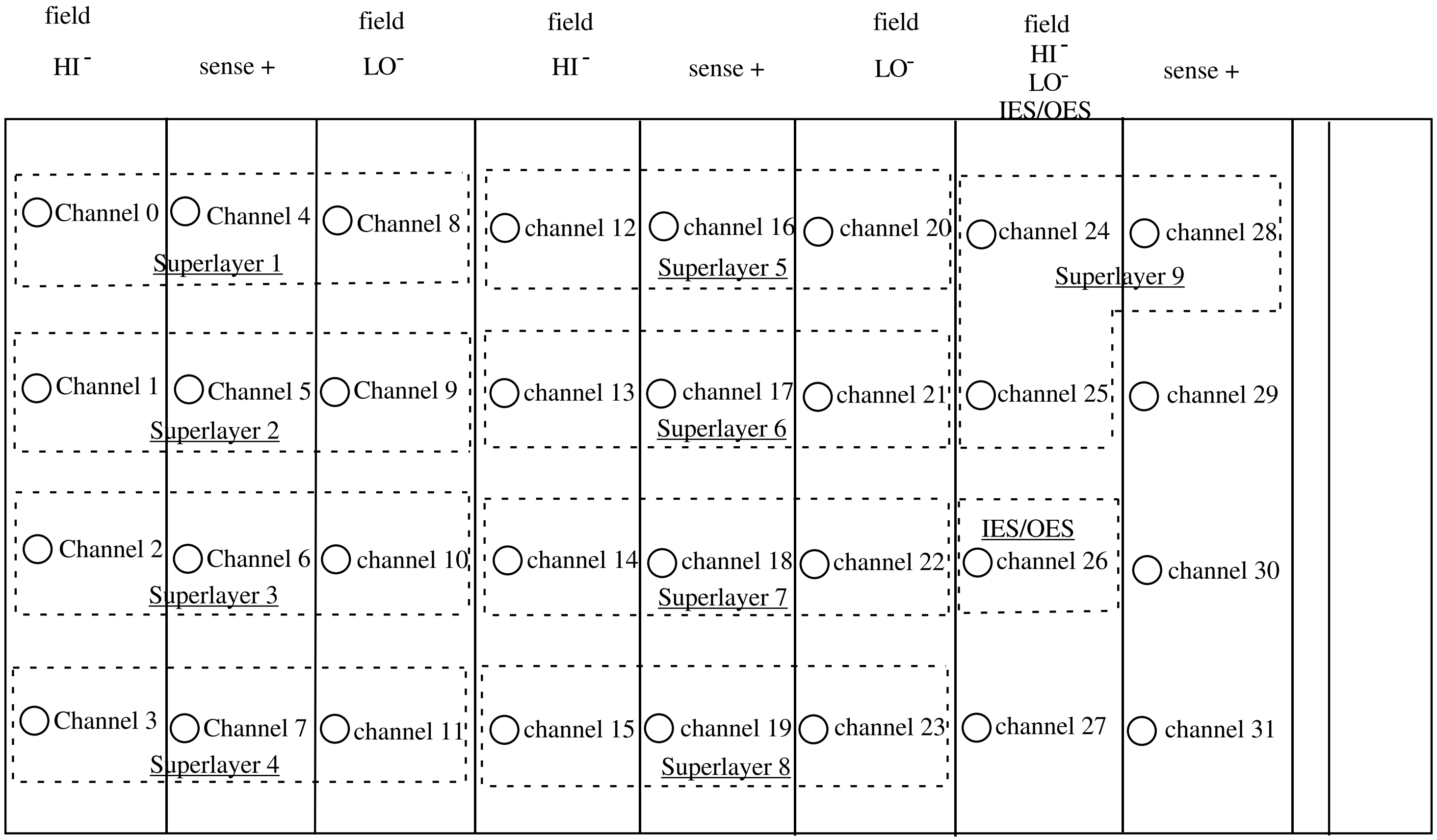
#464 was not immediately sent for repair (because it has 3 working channels A, B and D, and without it being at DESY we have no spare -ve modules till #452 is got back.)

Appendix G

Adjusting "Hardware Voltage limits" on CAEN Channels.

Each individual CAEN channel has its own manually adjustable hardware imposed max voltage limit. This note describes how to adjust this for the sense voltage - similar process for field voltages.

Each CAEN crate has a similar channel layout - back of crate sketched on next page, with 8 plug-in modules for one quadrant.



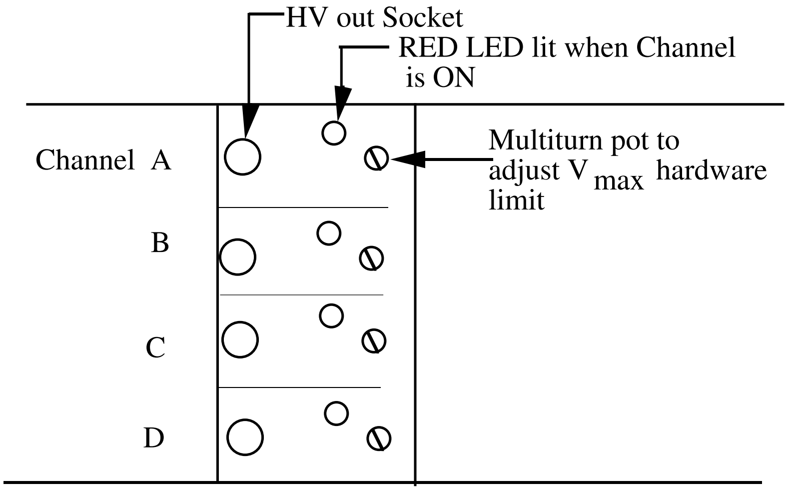
Numbering of HV channels as seen at the back of a CAEN crate

Negative channels 26 (on quadrant 2 and 4, used for IES/OES on quadrant 1 and 3) and 27 and positive channels 29, 30 and 31 are spare.

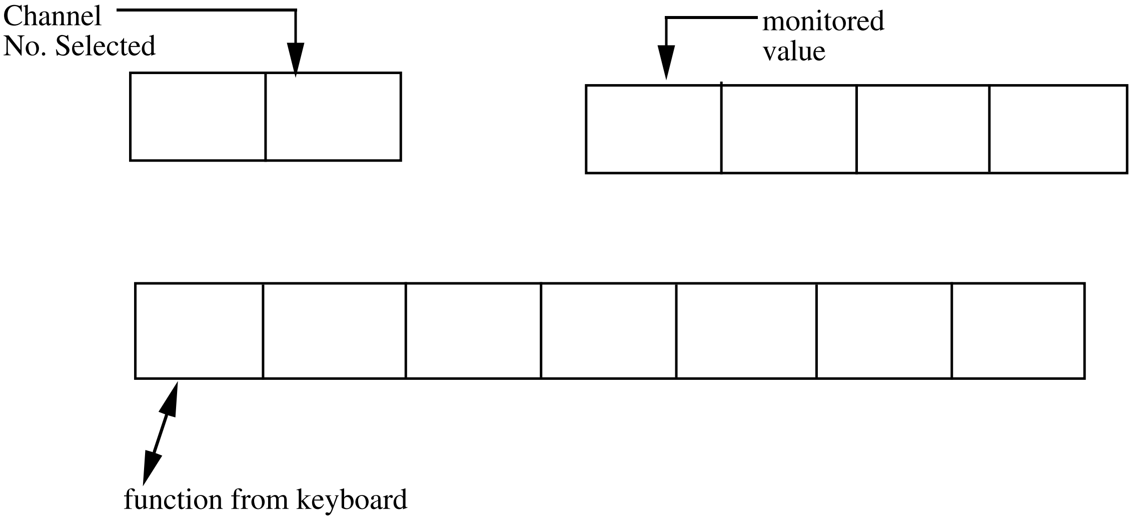
- = negative modules type A333
+ = positive modules type A434

fig 3.2

Each module (visible only at the back of crate) looks like



The front of the crate has a key board and 3 led digital displays



Each "function" is got by keying F to begin, then some digits and a # to end. It is not finished until # is pushed. If problems, or mistakes in keying in, just push #, then begin again with F, etc.

Functions needed are

- Select CAEN channel no.
  FO#
  then 2 digit channel no.
  e.g. "16", then #
- For each channel need to set up 3 standard values for test

  - Set current limit to 100 ("10")
    F2# 100#
  - Set trip to 4 (or 500 if it trips repeatedly with "OVC" led lit on front panel)
    F4# 4# (or F# 500#)
  - Set ramp up rate to 400
    F8# 400#
  - Set ramp down rate to 400
    F9# 400#

Then for each channel we need to set in the voltage limit desired, generally 4 decimal digits W X Y Z (This in "V 0")

F1# W X Y Z #

For field voltages (and IES/OES) the units are volts, <u>BUT FOR SENSE VOLTS THE UNITS ARE 1/2 VOLTS, i.e. to set in 1234 volts, NEED TO KEY IN F1# 2468 # !</u>

Also need the <u>"switch on selected channel</u> command F10#
and the "switch off all channels" ("kill") command F12#

<u>**SAFETY**</u> Keep all relay boxes switched off (i.e. no AC mains power). The opens all the switching relays, so no volts get through to the chamber, but for safety, always unplug the HV cable from the channel being adjusted (only channel on), & don't plug it back till the volts back down.

Have only 1 HV cable unpluged at a time, then they will not get mixed up.

Volts for this adjustment

All sense channels only. Each CAEN crate (quadrant) to same values.

Neville's $E_d = 1.22$, $E_s = 200$ values.

SENSE CHANNELS ONLY

SL No.	Max. Sense Volts	Max. X 1.05 Volts	x2 for 1/2 Volt Units	CAEN CRATE CHANNEL No.
1	1504	1579	3158	4
2	1537	1614	3228	5
3	1497	1572	3144	6
4	1515	1591	3182	7
5	1494	1569	3138	16
6	1512	1588	3176	17
7	1493	1568	3136	18
8	1502	1580	3160	19
9	1492	1567	3134	28

PROCEDURE

2 PEOPLE - 1 back of crate to plug/unplug HV cable & adjust pot,
1 front of crate to work keyboard & observe monitor display.

<table>
<tr><th>At Back</th><th>At Front</th></tr>
<tr><td colspan="2">Exit CTD HV Prog., turn off relay boxes
release red button</td></tr>
<tr><td colspan="2">Agree on next channel</td></tr>
<tr><td>3. Unplug its HV Cable</td><td></td></tr>
<tr><td>4.</td><td>Select channel (F0#)
Set current trip 100 (F2#
Set trip 4 (or 5000) (F4#)
Set ramp up 400 (F8#)
Set ramp down 400 (F9#)
Set desired limit (F1#)</td></tr>
<tr><td>5.</td><td>When ready, switch on (F10#)</td></tr>
<tr><td>6. Make sure right led comes on</td><td></td></tr>
<tr><td>7.</td><td>Observe monitored volts
a) if doesn't reach desired level, ask back to raise manual level
b) if does reach level, ask back to lower manual level</td></tr>
<tr><td>8. Adjust as requested
up = clockwise turns O
down = anticlockwise turns O</td><td></td></tr>
<tr><td>9.</td><td>Stop when hardware limit will just allow requested volts & no more. [often reads consistently 2 - 3 volts less than requested]</td></tr>
<tr><td>10.</td><td>When OK “kill” (F12#)
tell person at back when volts are down</td></tr>
<tr><td>11. When volts down, plug back cable</td><td></td></tr>
<tr><td colspan="2">Repeated from (2)</td></tr>
</table>

Appendix H

"Reformatting" eeproms on CAEN SY127.

The CAEN SY127 HV crates contains certain control values (and parts of their internal control program ?) in eeproms. On two occasions now this data/program has been corrupted by unusual electrical events. (On both occasions not while luminosity running was taking place). This caused (different) unusual faults in the operation of the system, but on both occasions recovery was possible by "reformatting" the eeproms according to the procedure given in the CAEN SY127 manual (annotated copy in the hv cupboard on level 6). This procedure is summarised here with some helpful practical hints) in case it becomes necessary again.

The reformatting returns the CAENS to the standard condition expected by the os9 hv control programs. The reformatting is done, one SY127 crate at a time, using only a terminal plugged into the A128 communications controller, (to be sure, probably best to unplug the caenet. The interlock needs a short circuiy to ground (a 50 Ω termination will do) for testing by ramping up volts).

Some manual digital switches accessible only by removing the A128 communications controller need to be set. They were set last time the reformatting was done and left that way. Probably do not need to change these - try the procedure below first, and only worry about the switches if the reformatting procedure will not work.

The three switches are DS1 (decimal crate number - don't change unless you use a new A128), DS2 (password override switch) and DS3. (see page 13 and figs 2.7, 2.8 and fig 2.9 in the SY127 manual. In the following list of standard position R (right = 0) and L (left = 1) are as seen looking on to the switch on the A128 board.

DS1	1.L	0011 = crate number 3 least significant decimal digit	at top
	2.L		
	3.R		
	4.R		
	5.R		
	6.R	0000 = 0 most significant decimal digit	at bottom
	7.R		
	8.R		
DS2	1.R	normally to R switch to L ONLY if have set password enable bit in the protection word, and forgotten the password. There is normally <u>no</u> password. Switch to left (if you have enabled a password) to (no password condition) enable reformatting in this state to the standard conditions	
	2.R	not used switch to right.	
		Least significant digit at top	

DS3	1.R = 0	1110	
	2.L = 1	DS3 1 → 4 are to get	
	3.L = 1	9600 baud rate to match terminal	
	4.L = 1		
		most significant digit at bottom	
	5.R = 0	Parity disabled	at top
	6.R = 0	odd parity	
	7.R = 0	7 bit characters	
	8.L = 1	2 stop bits (try changing to R = 0 = 1 stop bit if problem)	
			at bottom

The terminal needs to be set-up to be in “VT52” mode.

On the “Falco infinity” terminal which is normally in the rucksack press “setup” then press F12.

The arrow keys then select the terminal option & press enter till “VT52” is selected, then type “setup” again.

When all is OK, with the terminal connected to the CAEN crate, switch on the power to the CAEN crate and the main menu of the CAEN software system displays on the screen (make sure there are no unfinished commands on the crate keyboard if the menu does not appear, i.e. press # on the keyboard). The software is version 6.0.

In the main menu select “C” for the format menu, then when the format menu is displayed select “Q” reformat.

In reply to “are you sure [NO]” type “YES”. There is a delay of about 30 secs, then the main menu reappears. This reformatting process also sets every channel parameter to 0, except ramp-up-rates and ramp-down-rates to 100.

<u>Note</u> that it has been found that a single reformat as described above does not always work. If this is so try several reformats, and/or switch off mains power to the SY127 and switch on again.

It is not known what exactly you have to do in these circumstances. If you have had to manually override the password enable with switch D2, set it back now to the left.

Test the crate by using the crate keyboard, and also the programs CAEN-read 2 and CAEN-set 2 which operate via caenet (after connecting up caenet again).

If still problems, then contact CAEN directly by phone. 00-39-584 3883 98 and ask for DIMEED or Giovanni GRIECO or VIVALDI who will (hopefully) give advice on the phone.

Appendix I

List of spare field/guard wire hv cards in the hv cupboard on level 6. (These are mounted directly on the ctd end plates.)

Superlayer no.	Cards
1	1R63, 1R65, 1F64, 1F65
2	2R72, 2R73, 2F74, 2F75
3	3R62, 3R63, 3F75, 3F76
4	4R61, 4R62, 4F61, 4F62
5	5R102, 5R105, 5F134, only
6	6R119, 6R121, 6F102, 6F103
7	7R122, 7R129, 7F101, 7F102
8	8R101, 8R102, 8F103, 8F104
9	9R111, 9R112, 9F110, 9F111

NOTE: Cards labelled “R” are for the FTD end, and those labelled “F” are for the RTD end.

There are also spare connectors from the top edge of the card to the “guard wire” feed throughs.

There are more spare good cards at IC.

appendix J:

os9 error err 217 “segment list full”

26/3/99

Hi Ash,

“segment list full” is a relatively mild problem, but your disk needs some cleaning.

Each file can consist of a finite number of separate pieces, typically 100 (99 for disk sector size 512, 48 for disk sector size 256 etc). When this number is exceeded, you get this error. This may happen when you keep adding info to the file over a long period of time. The system always tries to extend the last segment, but when this is not possible, it has to start a new one. Eventually it may run out of place for noting down where are all the segments.

How to cure your disk? First, please find which file is guilty. I wrote a small utility to check this. You can find it on os9dev in /h0/cmds/howfrag. Then run it on the file (or group of files) that you suspect. For instance

howfrag *.log

It will tell you the number of segments in each file and the possible maximum for your setup.

Once you find the file, the simplest way do defragment it is to copy it. The OS-9 “copy” utility is smart and tries to make the resulting file in one piece (or in the minimum number of pieces).

For instance, you may type

copy great.ctd.log.file temp

del great.ctd.log.file

rename temp great.ctd.log.file

This is all you need.

Regards

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