How to do the Light Injection

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Yes indeed.

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1 Settings

The first thing to do is to make sure that all the settings are correct. These can be found in:

minos@daqrc:/home/minos/daqdev/config

There are 3 files that we are interested in: li.config, varc.config and runType.config. For normal runs, don't touch the last two.

1) Open li.config in emacs

2) Most of the options are self explanatory and have comments next to them

3) When editing the file ensure that the default settings are not removed. Copy the original and comment them out with '//' instead

4) Go down to <calib> liBoxFull#I This is the number of pulser boxes to pulse in a full drift run. This will normally be set to all boxes (i.e. 0,1,2,3,4,5 etc)

5) liLedFull#I is the sequence of LEDs to flash in a full drift run. Normally all 20 LEDs should be set.

6) liLedDrift#I sets the LEDs to be flashed in a short drift point run. This should normally be set to all 20 LEDs.

7) liCalHeight#I this is the sequence of pulse heights to use in a full drift run. For gain curve runs these need to be set to a range of low values (0 to 100 at intervals of 5 for example) A normal full drift run wants to go from 0 to 1000 at intervals of about 100.

8) Short Drift runs only flash at one pulse height setting. Set this to around 400 unless you're doing something wierd.

9) Width, Frequency, Number of Pulses - I'd leave all these alone if I were you. Decrease the number of pulses if you're doing some kind of test and don't care too much about the data. The frequency can be increased a bit but will overload the DAQ if set too high. If you're only reading out a few planes it can be set higher.
varc.config sets the varcs that will read-out. Someone else must have written about that somewhere. Sometimes you may be asked to do an unsparsified run (i.e. gain

curve runs): this can be set here.
In runType.config: <LightInjectionDrift> and <LightInjectionFull>you can change triggerMask#I (binary) to output the whole time frame (1) or raw light injection data (2). Normally it should be set to 0 which is LI summary data only.

2 DAQ

If you make changes to the li.config, it's best to quit then restart limaster. This is on daqfpc:/home/minos/bin/

Type ps -aux

find liMaster and kill it

Type ./liMaster to restart it (You may not need to do this soon)

Go to the DAQ Gui. If you can Ping the FPC and the BRPs before you try this, do so. Select Prepare Run and then Pedestal. Type a comment and then Start Run. It takes about 12 seconds. Then go to minos@daqrc:/home/minos/daqdev/config/fee-tables
Do ls -l and look at the recentPedestalTable_rop files. The timestamp should be a set to a few moments ago. Use emacs or more to look at a few of them. The tables of numbers are the HV settings. If there is an error we see this in these tables as the same number repeated in blocks. A value over 1000 is also an error. A block of 22x6 1's is normal. My personal favourite is rop1. At the end of the file there are 22x5 1's interrupted by a one line of values. These values are the Trigger PMT and is normal.
Next select 'Prepare Run' again in the DAQ Gui and choose 'LightInjectionDrift'. After it has thought a bit, you'll be given the option to 'Start Run' which will start the run. It should all go nice and green and take data. If the ROPs or the MBRPs go red get the DAQ guys to sort it out. If the FPC goes red, it may be because you forgot to restart liMaster after altering the settings. Kill liMaster and restart it. Click on the red FPC button and select 'connect'. It should go a nice colour and the run will work.
Try to do a drift run once every 2/3 days or so, unless drift runs are being taken interspersed in a RunSequence in which case you may never have to do them! Do a LightInjectionFull run once every month or so. A drift runs takes about 15 minutes per pair of pulser boxes used (depending on the settings) and a full run takes about 2 hours per pair of boxes.
Hooray! You've done some LI!

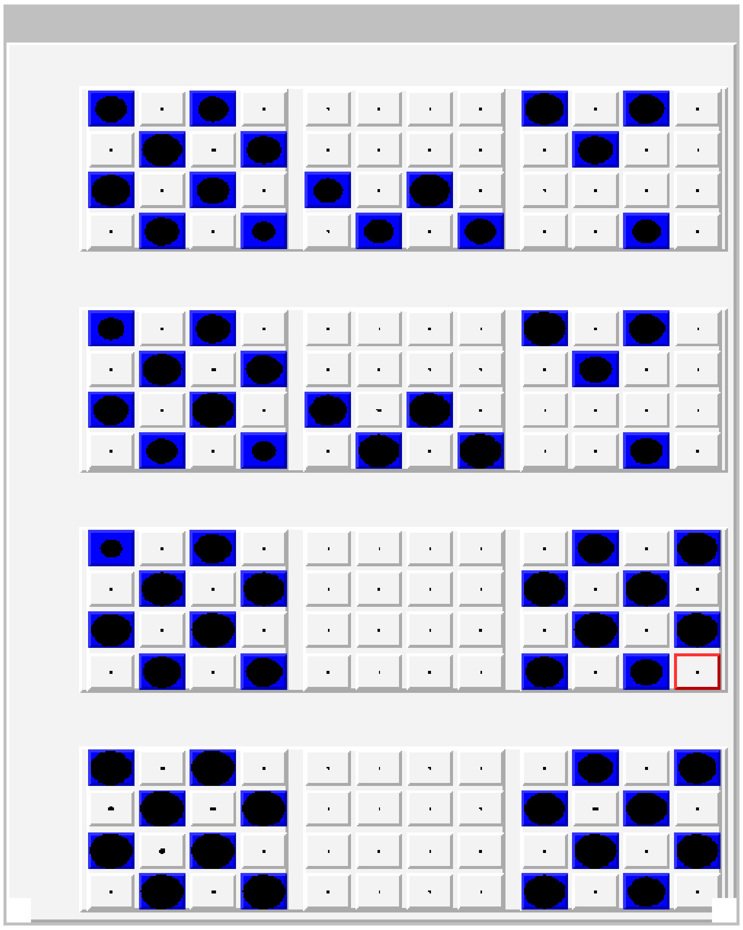
3 Looking for LI cabling Problems

This is done using 'Gryfindor'. This is not a widely available program, so if you are the Light Injection Expert then get in touch with me (lj@hep.ucl.ac.uk) or the author (r.morse@sussex.ac.uk) to get access to a copy from: http://minoserv.maps.sussex.ac.uk/code/
Normally you just want to look at the latest drift run that has been created. If you want to look at an older one, you need to use the CRL to examine the logs and identify the runs that are drift runs. As the LI expert its probably easiest for you if you just keep a little record somewhere of which run numbers correspond to drift runs and what date they were done to help you if you're doing cable swaps etc.
A root file in a special format needs to be used. To do this it is neccesary to upload drift runs to offline@minoserv.sussex.ac.uk to run be 'looned' there. Passwords will be given to LI experts as required. Look at
http://www-soudan.minos-soudan.org/soudan_comp.html
to find out how to get access to data files at Fermilab for older data. Recent files (less than a day or so) are still on the minosdaq machines at the mine. Files need to be sent to minos@minoserv.maps.sussex.ac.uk:/data/fardet_data/ Then cd to /home/minos/LISummary/ Rm any existing analysed.root file then type:
loon -bqx summary.jcm /data/fardet_data/F0000XXXX_0000.mdaq.root
This will process the datafile. This outputs an file called analysed.root which you should probably rename to drift_XXXX.root and copy back to your laptop at Soudan. After you process the datafile, the display sometimes goes weird - you can't see what you're typing on the screen! So type slowly and carefully!

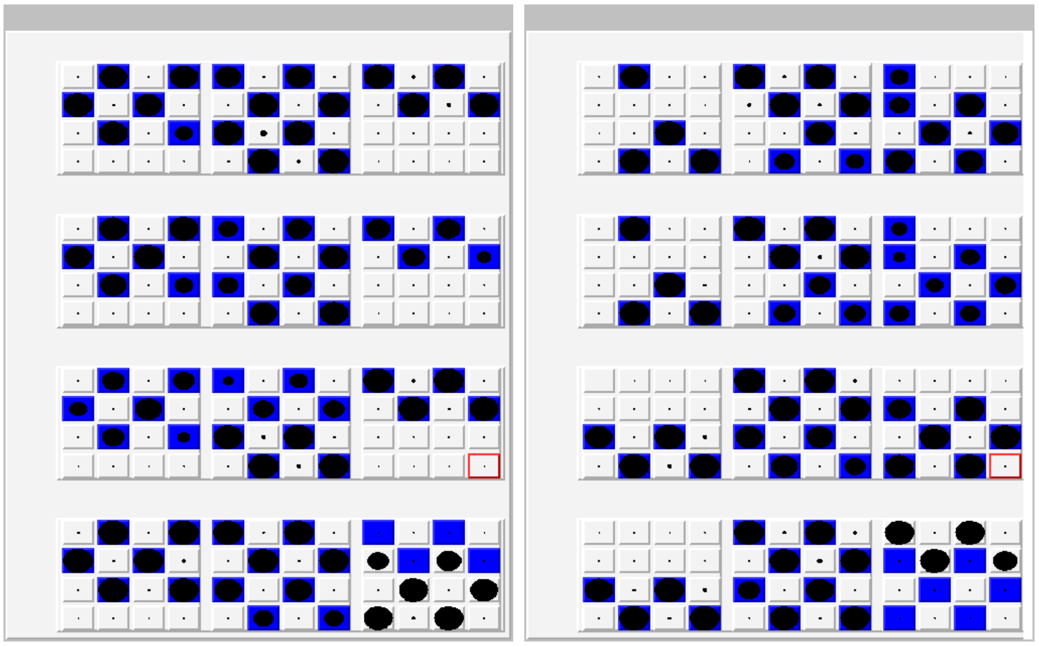
3.1 Using Gryfindor

The file to be run on must be named drift.root. If lots of files are to be examined, I find it easiest to change all the files names available to have the run number as an extension i.e. drift_6059.root and simply 'cp' the relevant file to 'drift.root' as necessary.
The program displays groups of 4 planes together as seen at the mux box. At the beginning you must enter the first plane of the group of 4 you want to look at (i.e. 1,5,9,13 etc) The top plot shows plane 2 and 4 on the east side and the two underneath show planed 1 and 3 on the east side. The bottom two plots show planes 2 and 4 then 1 and 3 on the west side. Next you can enter the number of the LED that you want to look at. The first number entered is the LED output seen and the second is the LED output expected. So if you type the same number twice and the blue squares match up with all the black circles then everything is OK.

- Fibres in the right place look like this...

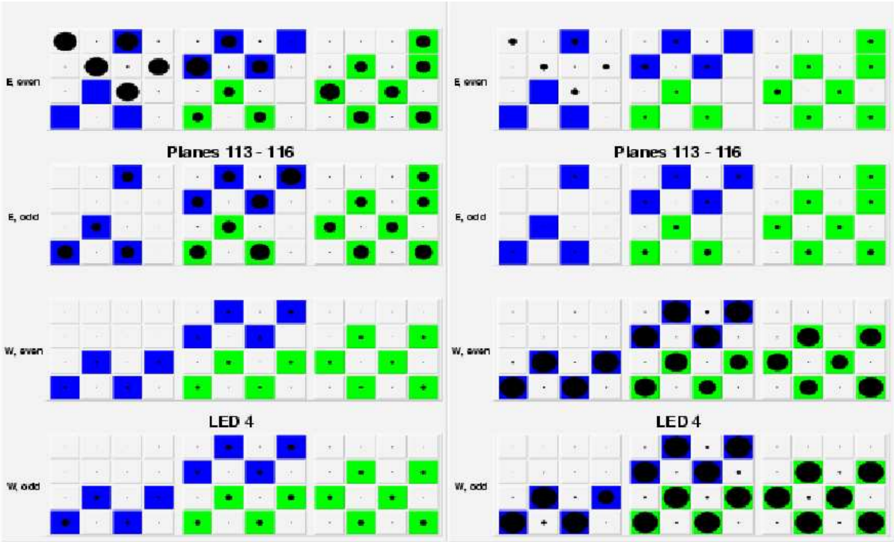


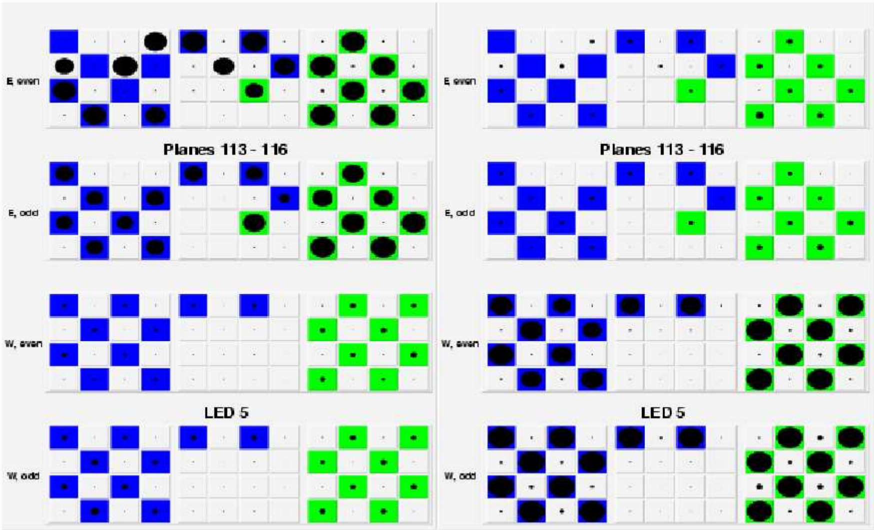
- Fibres in the wrong place look like this...

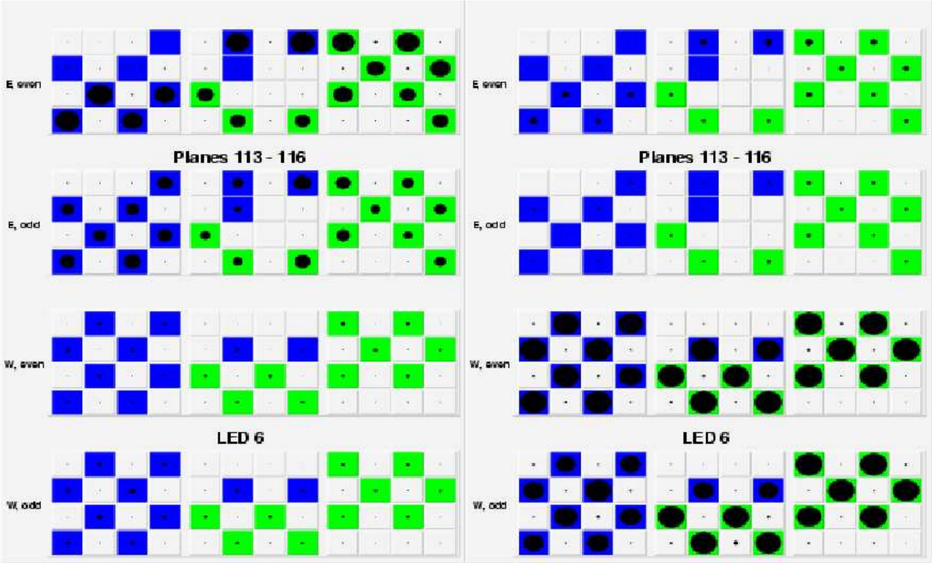


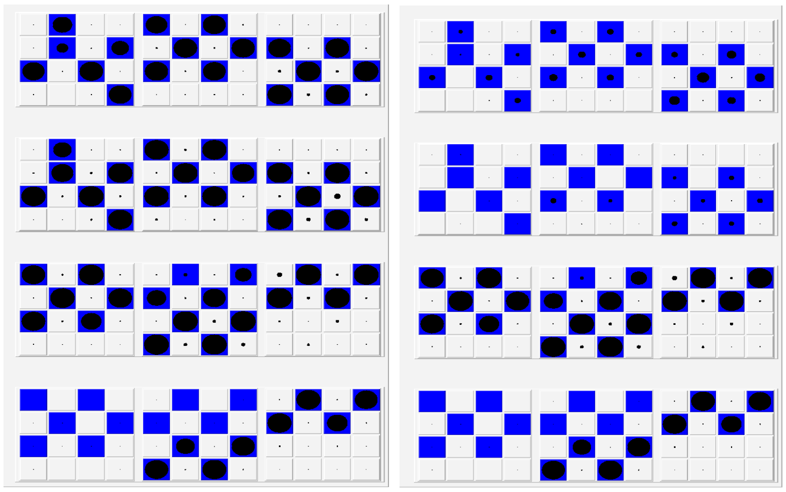
You can see that if you swap the two outputs of these fibres over, they match perfectly. A way of doing this in the program is to type these numbers into the 'expected' and 'seen' inputs in the program. That particular plane should then look correct - but dont forget that the rest should look wrong since you swapped them over! The crew check the cables as they are plugged so hopefully this wont happen too often but sometimes mistakes are made or the fibres are incorrectly labelled in the first place.

A slightly more complicated problem is shown in the next three plots. No permutation of swapping fibres will make this look correct. If you see this in 3 or 4 planes of a given set of 4 it means that the clear fibre to the mux box from the planes are plugged in the wrong way round.


E, even
Planes 113 - 116
E, odd
W, even
LED 4
W, odd
E, even
Planes 113 - 116
E, odd
W, even
LED 4
W, odd

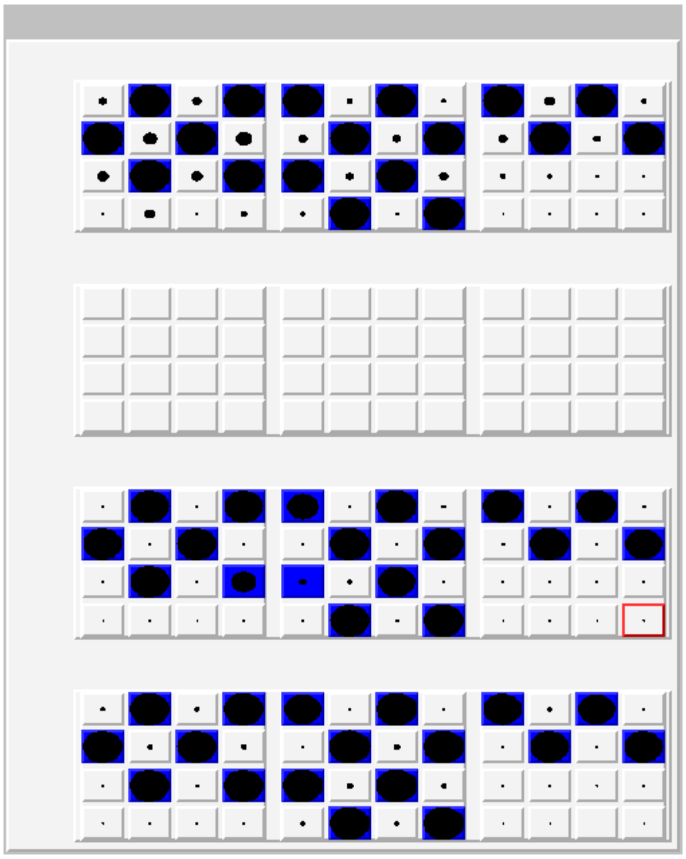

E, even
Planes 113 - 116
E, odd
W, even
LED 5
W, odd
E, even
Planes 113 - 116
E, odd
W, even
LED 5
W, odd





The diagram directly above is indicative of an LI cable having slipped out of the LIM. Some are loose and need to be taped down to make sure they don't fall out. The diagram on the right is produced in the same way using the program 'Gryfindor_one'.
Top two plots (left diagram,Gryfindor) = East = 0
Bottom two plots (left diagram,Gryfindor) = West = 1
Gryfindor_zero and Gryfindor_one are supplementary programs for a more detailed analysis. If you see a problem in Gryfindor on the west side, use Gryfindor_one for further analysis and Gryfindor_zero for further analysis on the east side. The bottom two halves in this case are exactly the same thing. The top plot on the right

shows the output from the LI system on the same side as is being flashed. When using Gryfindor_zero the top two halves will represent the same thing. The pixel maps on top and bottom from Gryfindor_zero and _one do not correspond directly (as you can probably tell from the fact the pixels are not in the same places) so analysis from pixel to pixel is not easily possible.
In this example, you can see that no light passes through the system in the same place on both sides. This indicates that it is likely that no light ever entered the system and the problem is with the light injection fibres or box - in this case the fibres. A problem only seen seen on one side might indicate a problem with the readout or fibres through the detector.



The plot above suggests an electronics problem. Notice that there is not even any noise. This effect was seen on all LEDs for planes 41 and 43 east. In this case the ribbon cable from the varc to the front-end board was connected incorrectly.
If this effect is seen over a large number of planes on the west side, it is more than likely that the cause was the HV tripping at some point during the run.
At 23rd July 2002, the status of mis-cabled LI fibres can be found at:

http://www.hep.ucl.ac.uk/ lj/minos.htm
This may or may not be up to date when you look at it.

4 Other exciting things to do as a light injection expert

Checking in Fibres - as light injection fibres arrive from OMC you have to open the boxes and ensure that each one contains what it says it should; 4 cables, east and west of two consecutive planes. Take the invoices from the top of the boxes and put them in the Light Injection folder in the metal filing cabinet in the control room. Next the LI fibre database has to be updated. Load 'fibredatabase' into gnumeric. Add to the columns in the following pattern: fibre number, data of arrival, date of checking and four empty columns denoted by
. Occasionally a fibre is broken by the mine crew or one or more fibres is too long or short. If this occurs the fibre has to be replaced using a 'spare' and the broken fibre sent back to OMC in th UK. Replacement fibres must be selected according to a special list since the last two planes in every four have a different LED configuration. If a spare fibre is used, note it in the fibredatabase here.
Save the file as a text file export (.csv) Add the sheet to sheets to export and make sure it never quotes. When you're done, upload the file to
minos@minoserv.maps.sussex.ac.uk : .
The result can be viewed at:
http : //minoserv.maps.sussex.ac.uk/inventory/inventory.html

Checking Pulser boxes - every now and again a pulser box arrives. A laptop and the program 'pulser' have to be used to check the boxes are OK. First the outputs of the boxes have to checked by eye to ensure that there are no LEDs that are obviously not flashing. After that the light levels of a selection of connectors have to be read out with a scope and recorded on a sheet of paper. Typing './a.out' will run the code pulseloop.C which flashes the LEDs sequentially. This is done via a serial cable from a laptop to the pulser box. You need to login as 'ROOT' to access the serial port. Expect variation of up to 100% between LEDs, but any reading below 100mV should probably be reported to Peter Smith or someone. To stop the pulser box flashing you need to type 'cntrl-z' to break out of the program and 'kill %[num]'. Then type './pulse -s' to reset the pulser box. Put the data you collected in the LI drawer in the control room.

Plugging in cables - most of the LI fibres are plugged into the pulser boxes by

the mine crew. The light injection expert should label the connectors on the pulser boxes so the mine crew can easily identify where the cables go. Look at the back of a pulser box to see how it goes. It is slightly different on the east and west side. The last two boxes of each supermodule are also slightly different. They plug in roughly as follows. The numbers show the sequence, with the lowest plane numbers denoted by the lowest number. Each number refers to a 'strip' of 8 connectors.
West 1243 East 3421 Even planes - top to bottom
West 1243 East 3421 Odd planes - bottom to top
In addition, the pin diode fibres and trigger pmt fibres need to be connected. These are found in boxes on the east side on the middle level. The trigger pmt fibres are single, long fibres. One of these goes from each pulser box to the first mux box on the top level west. They connect into a strip near the ground. Excess cable should be tidied away in the cable trays. Each pulser box has two extra connectors labelled hi-gain and lo-gain. These are for the pin diodes. Find the relevant pin diode cable. Unravel it carefully, using cable ties to clump the fibres together as you unroll it at intervals of around 40cm. Divide the two bundles from the two cables into ones labelled 1-10 and 11-20. On the east side send the cables marked 'hi-gain' at the pulser box up to the top east mux boxes and the 'lo-gain' fibre down to the bottom east mux boxes. On the west side send the 'hi-gain' fibre down to the bottom west mux boxes and the 'lo-gain' fibre up to the top west mux boxes. Note that the labelling 'hi-gain' and 'low-gain' on the pulser box is misleading - half of each of the cable bundles marked 'hi' and 'lo' go to the high and low gain pin diodes on the front end boards. Each pulser box has four mux box crates associated with it; two on the top level and two below. Each front end board takes two fibres. Starting on the west, plug 1-10 into the five top mux boxes of the first FEE crate on the top then 11-20 into the top five mux boxes of the second mux crate. Note number of the fibre and whether it is in slot zero or one in the front end board. Repeat the same process on the bottom mux crate pair making sure that all the fibre numbers that were in the top slot (zero) of the boards on the top level are now in the bottom slots (one). Repeat this process on the east side. It doesn't matter if the numbering on the east corresponds to the numbering on the west or not as long as no two fibres with the same number are both in either a top slot on a board or a bottom slot, on the top and bottom set of two FEE crates. Add the data to the 'pin-diode-locations' database in gnumeric. When this is done, the boxes are ready to be included in the light injection sequence. Look on the RPS above the pulser box on the middle levels for an IP number. This number needs to be included in the li.config at the EDAS number# line and the new boxes have to be added to the box number line. Don't forget to plug the green serial cables into the back of the RPS boxes. You may as well put a label on the front of the pulser boxes when they have been checked out so people know whats going on.

Note: When ANY Light Injection Cabling is being done, make absolutely sure that the HV is switched OFF. Black plastic cover connectors should also be on all the connectors on the back of the pulser boxes as well. Normal light levels in the MINOS cavern may be high enough to break phototubes and it may be possible for light to enter pulser boxes through exposed connectors and travel through the boxes and out to PMTs!

HV is switched off at the DCS machine in the control room using the command 'zero', or 'dis' to switch off the HV and disable the power supplies. Put up the 'Light Injection' sign to alert other users and switch the power buttons manually on the HV supplies on the middle level. The HV can be adjusted remotely, so this precaution prevents someone in the UK destroying all the PMTs, for example. The power supplies can be re-enabled with 'ena' and 'set' ramps up to the nominal voltages. 'sta' checks the status of the supplies - an error on HV 2 is, in fact OK. Normal data taking cannot be done while Light Injection cabling is happening since the HV must be down. Therefore it is important to negotiate with the DAQ people to get some downtime every now and again for LI.

5 Broken Fibres

Sometimes fibres are cut or broken during installation. It's just one of those things. Find the fibre repair kit in the control room on the shelf near the sussex LI laptop. The two ends of the fibre should be filed flat using the superfine emery paper. Look at the ends of the fibres with light glancing off them at a high angle (the face looks lit up if you're doing it right) to see imperfections. Put some epoxy on the ends of the fibre about 4mm from the face. Put the two ends into a brown barrel. Leave to cure and wrap with black tape. Hope for the best.

6 Email

If you get in deep trouble, here are some people you can get hold of:
P.G.Harris@sussex.ac.uk - any 'catastrophic' level light injection issues
P.N.Smith@sussex.ac.uk - light injection fibre issues (i.e. OMC have messed it up)
pa@hep.ucl.ac.uk - software/drift points/pin diodes/stability
lj@hep.ucl.ac.uk - your first point of call for any problem. I probably won't be much help but I know someone who is

Good luck. I'm outta here