



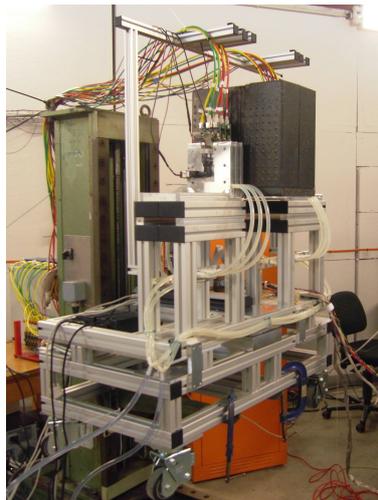
EUDET Pixel Telescope Data Taking Manual - Updated Version for M26

EUDET JRA1 Group

June 15, 2010

Abstract

This manual is intended to help users to take data using the EUDET pixel telescope. You will find detailed explanation on how to power up the telescope, how to start the run control and pictures of important items. This newer version is for the final telescope using the Mimosas26 (system of 2010).



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1 Introduction

The aim of this document is to help users to take data with the EUDET pixel telescope. It is intended to provide all necessary information in a simple way and to provide help in case of known problems. Thus no technical details are explained here. For this please refer to our EUDET JRA1 webpage.

In **Section 2** it is explained how the hardware of the telescope is switched on. **Section 3** describes the DAQ software while the topic of **Section 4** is the TLU control utility. In Section 5 we added a few informations on the XY table, how to start systems etc.

Here the status of the telescope in May 2010 is described. Since the development of the hardware and the DAQ software is still in progress, changes to the presented information are possible. Please report comments to *ingrid.gregor@desy.de*. The data manual from September 2009 or earlier is obsolete and should not be used anymore.

Important: We ask **ALL** the telescope user groups to document the data taking in an electronic logbook. If this is not done, the possibilities that we give support during the data analysis is limited. The usual logbooks include a list of the runs, DUT(s), run type (pedestal, beam, ...), date and a comment. Please write down any changes to the system, any problems etc. We usually use a simple Google spreadsheet, but this is up to the user groups as long as we (EUDET support group) have access to the information.

2 Overview of the Hardware

In order to run the telescope successfully, it is good to have a rough idea what are the parts and what they are for. In Figure 1 you can see a drawing of the items and how they are connected.

Mimosa26 The heart of the telescope are the Mimosa26 sensors within the separate sensor boxes. Each of the six planes consists of 576×1152 pixels with a pitch of $18.5 \mu\text{m}$. The active area is $10.6 \times 21.2 \text{ mm}^2$. In each pixel the amplification and correlated double sampling is included. On the sensor chip also the zero suppression is done.

EUDRB The EUDRBs are the DAQ boards sitting in the VME crate. They receive the digital data from the Mimosa26 and pass them on to the DAQ system.

MVME is the VME board computer MVME6100 to read the EURDBs in the VME crate. It is booted from the main linux computer.

BBLA These are the blue box level adapters which are needed to adjust the level of LVDS signals from the EUDRB boards to the sensors. Each BBLA has a led to show if they are powered.

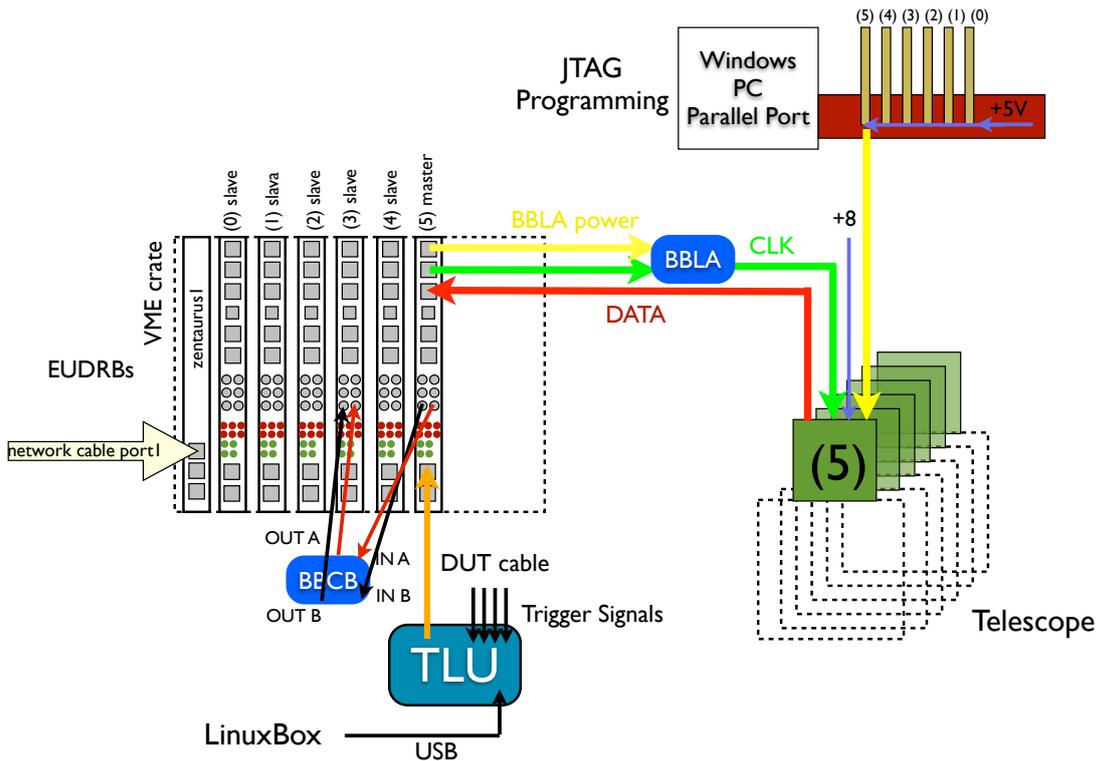


Figure 1: Schematical overview on all the cable connections within the EUDET telescope

BBCB One little blue box for buffering the clock has to be cabled to the EUDRBs.

JTAG The MIMOSA26 is programmed via JTAG chain. Details can be found in Section 3.4.

TLU The trigger logic unit distributes the trigger to the EUDET telescope and the connected DUTs.

Cooling The sensors of the telescope are cooled to keep them at a stable temperature.

3 Switching ON the hardware

In general the telescope is already turned on when you start data taking, but there might be the situation that the hardware is partially or completely turned off. Especially in summer power outs or just glitches are rather frequent. Then you can refer to this section to make sure that you do it the right way. Please also turn on the hardware in the order as described here!

3.1 Computers

In the beam area are two computers used to run the telescope. One Linux box (zenpixell3) for the communication with the TLU and (at DESY only) to run the EUDAQ. The second computer is a Windows box for the JTAG programming, the steering of the XY table and for monitoring the currents of the MIMOSA26. After starting these computers, (at DESY only) the DHCP server needs to be started on the Linux computer.

3.2 VME-Crate

After a power cut check if the VME-Crate is turned on. They also house the CPU communicating to the rest of the telescope. The VME crate should be turned on first. The power switch of the VME-Crates are located at the front sides of the devices. If the VME crate is still on after a power glitch, you can check if it is ok by trying "ssh zentaurus1" from zenpixell2 (DESY setup) or "ssh mvme6100" from eudetmac001 (CERN setup). If this is not possible, the VME crate needs to be rebooted.

3.3 Power supplies for Sensors

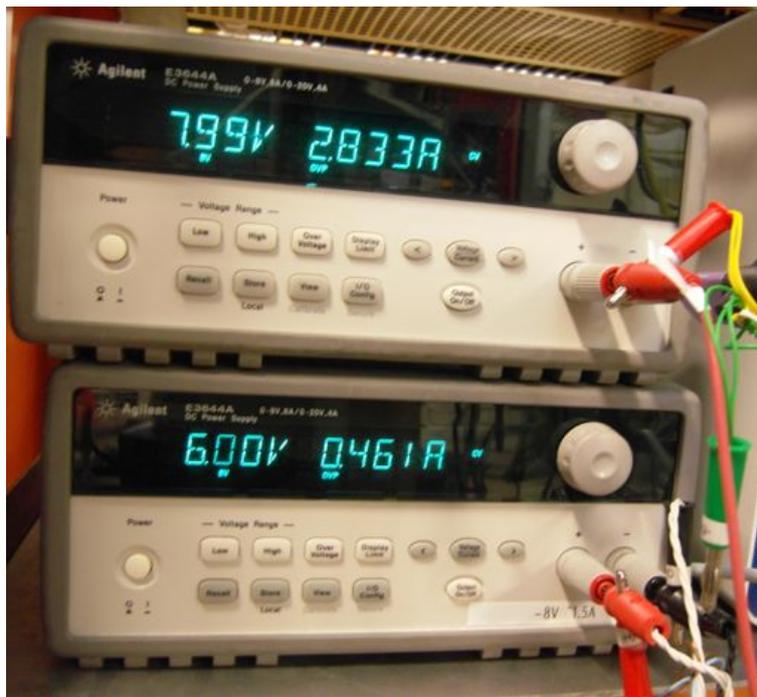


Figure 2: Power supplies for the sensors. Please check them after a power cut or glitch.

The power for the telescope sensors is provided by two AGILENT E3644A power supplies. The upper power supply provides the +8V for the MIMOSA sensors, the lower one the +5V for the JTAG boards. The current drawn by the +8V should be around

2.84 A if everything is ok. If it is below this value, like 2.6 A, the sensors should be reprogrammed (see Section 3.4). To monitor the currents from remotely, we installed a web cam (the remote control of the power supplies via GPIB will be done soon).

To switch on the power supplies follow this procedure:

- Press the **Power** button.
- Press the button **Recall** three times. Otherwise the default values would be wrong.
- Press the **Set Limits** button. Upper supply 3.5A, lower supply 1A.
- Enable the output using the **Output On/Off** button.

3.4 JTAG Programming

The Mimosa26 are programmed via JTAG using the parallel port of the Windows computer in the beam area. For each sensor one little JTAG board is connected to the chain as displayed in Figure 3.

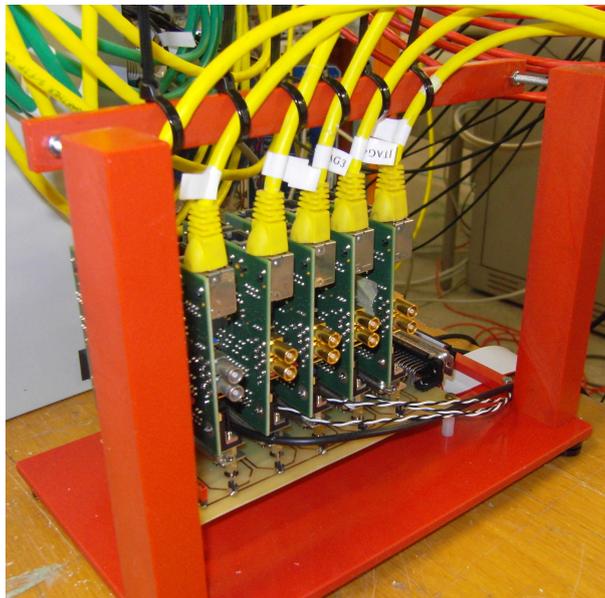


Figure 3: JTAG cards in support frame. For each connected sensor one yellow cable should be connected (cables are labeled). The JTAG chain is powered via the lower power supply with +5V (0.461A).

In case the sensors and or the computer was completely off, please call a telescope expert to check why this is the case. After starting the Windows computer you will find an icon in the upper right corner of the desktop "Shortcut to M26.exe". When starting this JTAG programming tool, two windows will open, the Mimosa26 JTAG Programmer main window (Figure 4) and a second window with all the register settings (Figure 5).

The Master configuration with the ending thresh8.mcf should be selected; select only threshold 10 if really necessary! By increasing the threshold you reduce the efficiency of the sensors. Do not change any of the number as the settings of the registers has to be done very careful. If the current of the +8V supply is not between 2.7A and 2.8A, we recommend to reprogram the sensors:

Reprogramming the sensors should only be done if the EUDAQ is stopped, otherwise the EUDAQ can crash. But the VME crate has to be on as the Clk signal from the VME is necessary to program the sensors. In the master window you first have to press "All" (wait 4 seconds), then "read" (wait 4 seconds and check if the number of errors is 0) and then "Start". Please check in the second window if any numbers appear in red, that is a clear indication that something went wrong (usually one forgot to turn on the sensor power).

Table 1: Current consumption for different situations

Status	Current
VME off	$\leq 1.3A$
VME on (clock send), Mimosa 26 not programmed	1.33 A
After press "All"	2.2 A
After press "read"	2.19 A
M26 programmed	2.84 A

If the programming is not working (numbers appear red or current is not correct), please check the following items:

- Is the VME crate turned on?
- Is the power supply for the JTAG turned on (+5V; 0.461A)?
- Are all yellow JTAG cables connected to the little JTAG boards (sitting in red plastic frames)?
- Is the parallel port cable attached to the JTAG distribution board?

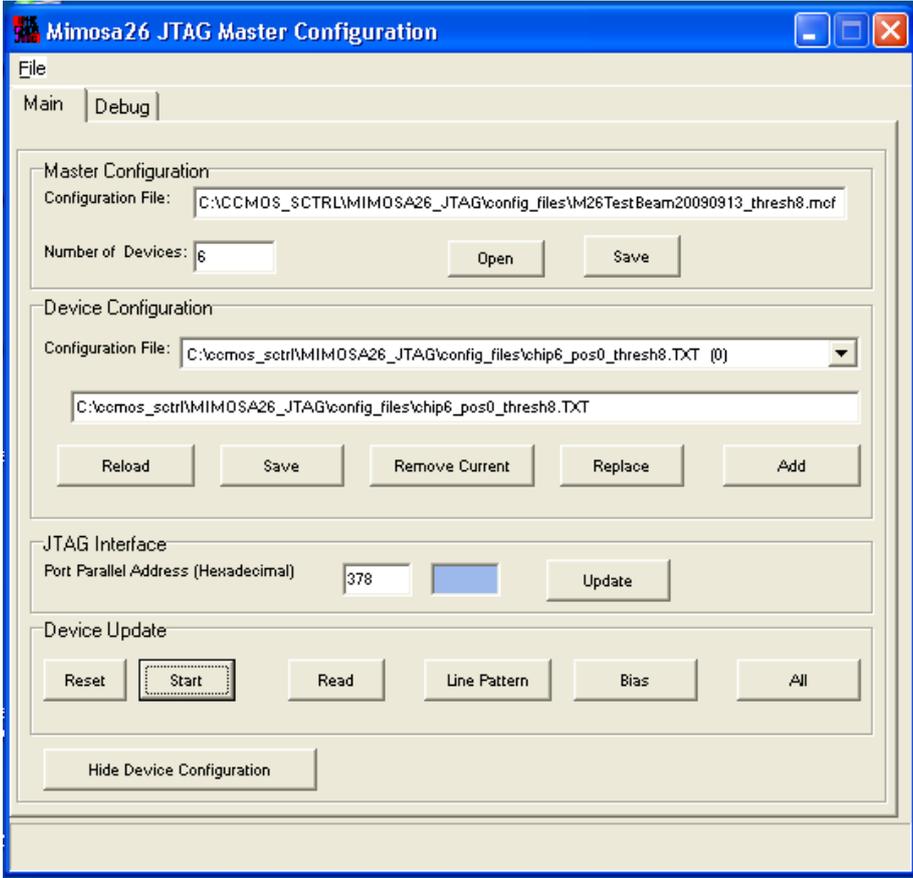


Figure 4: JTAG programming. Master configuration.

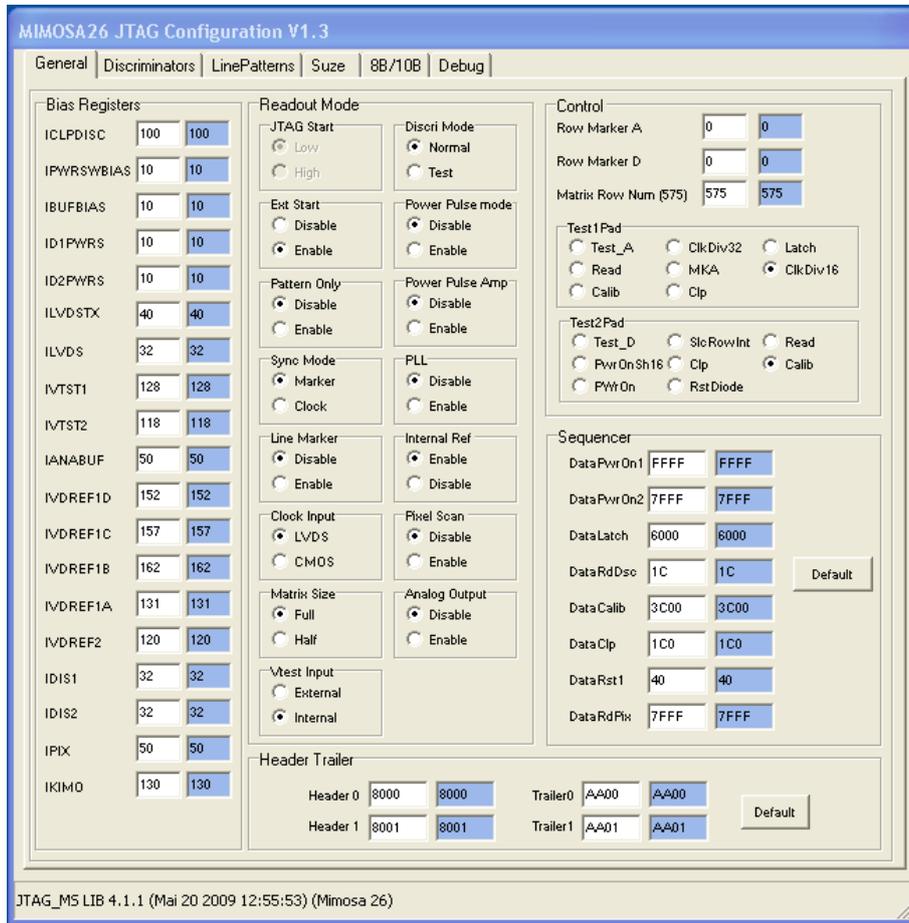


Figure 5: JTAG programming. Register settings - DO NOT CHANGE THESE SETTINGS.

3.5 Cooling



Figure 6: The Huber cooling device

A **Huber** cooling device, as shown in Figure 6, is used for the pixel telescope. The cooling device uses water as cooling liquid. A typical operating temperature is 14° C. At room temperature it takes about 20 minutes until the telescope is cooled after the cooling system is switched on. Please do not reduce the temperature to avoid condensation water and corrosion. This is especially a problem in summer at CERN.

These steps need to be followed to switch the Huber on:

- Switch on the power of the cooling device.
- Press the button **Set**.
- Adjust the temperature using the wheel to 14° C. Probably it is already set to this value.
- Press the button **Set** again.
- To start the pump press the rightmost of the three blue buttons.

Please also check the water level inside the cooling device once a week. The device stops cooling if the level is too low and will start an alarm noise. But the sound is probably not audible in the control room.

4 Running the DAQ software

The DAQ software is running on the main computer. At DESY this is the linux box in the beam area over a VNC connection from the control room. At CERN we usually have a MAC in the control room. In the first subsection a short tutorial is given how to take a run. The further subsections list the available configurations and a description of the geometry.

4.1 Starting EUDAQ

- If necessary login as user **eudet**. Standard password!
- Open a shell and enter the directory $\tilde{\text{eudaq}}$. The software can be started by the command **./STARTRUN**. In the STARTRUN file it is defined what producers should be started. Please be careful when editing this file.
- Several windows are opening. The data taking is controlled in the window **eudaq Run Control** which is shown in figure 8.

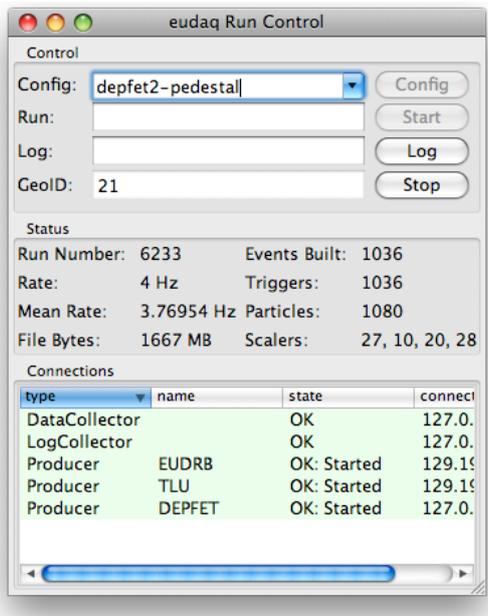


Figure 7: The EUDAQ Run Control window. You can select the configuration from many different possibilities. In the status part you can see the Run number, the current trigger rate and the scaler numbers (0-3 from left to right). In the lowest part of the window you can see the state of all the different producers. In case of a problem the underlying colour changes to grey.

- Choose a configuration and click on the button **Config**. Wait until the state of the TLU and EUDRB producers is “Configured”. This is necessary after any changes of the setup. Some configurations are listed in subsection 4.3.
- Runs can be started by hitting the button **Start** and are stopped using the button **Stop**. Please be patient and don’t press too fast the next button. Also don’t forget to change the GeoID if the geometry of the setup was changed. See below what numbers are needed for the geometry file.
- In the run control window status you can see the Run number, the current trigger rate and also the scaler numbers. In the lowest part of the window you can see the state of all the different producers.
- Log messages are displayed in the window **EUDAQ Log Collector**. In case of a problem the underlying colour changes to red. The user can add own log messages by typing some text in the run control window after **Log:** and then press the **Log** button.
- The data quality can be monitored in the window **EUDAQ Root Monitor**. Plots are shown for the whole telescope and for the individual boards. Some plots need a certain number of events to be filled. Hence they typically appear after a few minutes. If the window was closed and needs to be restarted, please read 8.0.2.
- Before the size of the output files reaches the limit of 2 GB, the output file is changed automatically and the data taking continues with a new run number.

4.2 RootMonitor

The Root Monitor is automatically started when EUDAQ is started. In order to speed up the monitoring, it is programmed such a way that only preselected plots are displayed. You can select from the categories ”Main Histogram”, ”CDS Lego Plot” and ”Board Displays”. In Main Histograms all you can find for example correlation plots, needed during data taking.

4.3 Available configurations

Data can be taken using different configurations. The configuration files are stored in /conf. We usually create config files with a self explaining files names, i.e. a config file for the running with DEPFET has DEPFET in the file name. The setting which lead to problems are for example the DUT mask defining the TLU DUT ports in use and the AND mask defining which PMTs are used for the trigger.

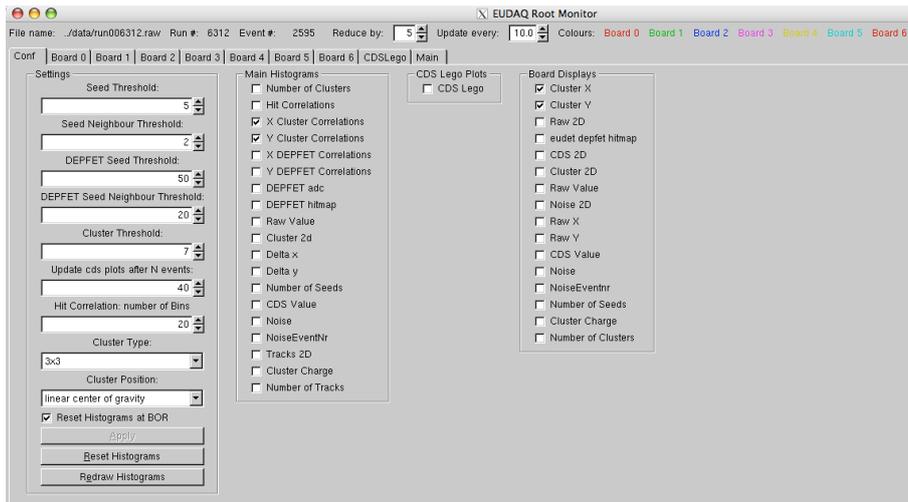


Figure 8: The Root Monitor. Please select the plots you want to have displayed and press "Apply". You might have to expand the window to see all options!

4.4 Telescope Position

The telescope is positioned on one of the big green DESY XY tables. The current position was optimised and should not be touched. If the hit multiplicity is too high the selection of a different beam file or reduction by closing the shutter is better than moving the telescope. Whenever you change the telescope an new alignment run should be done. That means as soon you wiggle the telescope by mounting some stuff or when moving your DUT.

Any access to the beam area should be mentioned in your log book and changes should be indicated by increasing the GeoID number. Make sure that the right GEOM file is created (EUDET expert).

In Figure 9 the geometry of the telescope is sketched. It is important to measure the distance between each plane. For the DUT gap you should measure between the surfaces of the planes 2 and 3 and then add 15mm (a+b) the take into account the distance between the aluminium foil and the sensor. Please note: in the geometry of 2010 all sensors are oriented in the same direction!

5 The TLU Control Utility

The program TLUcontrol.exe allows to control the trigger logic unit and to run it stand alone. This can be useful for test purposes. In the following, it is described how to start this utility.

- The EUDAQ program should be exited (`./KILLRUN`)
- Log in as super user.

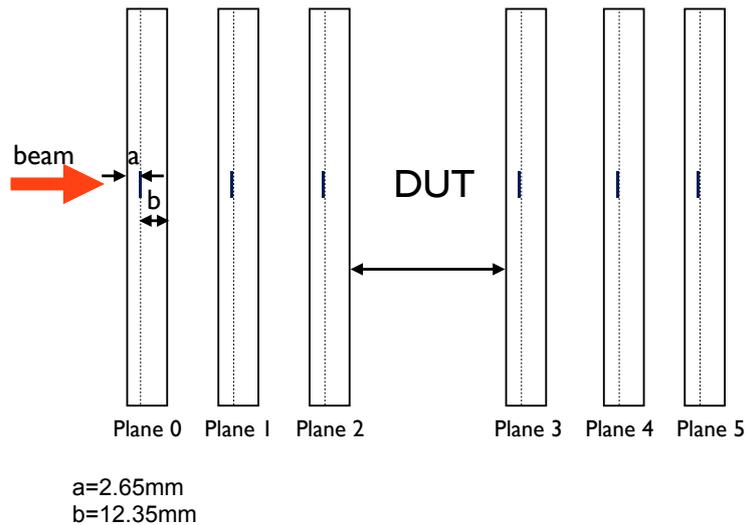


Figure 9: Schematic of the telescope geometry.

- Enter the directory `/home/eudet/eudaq/tlu`.
- Help is available typing the command `./TLUcontrol.exe -h`.
- The control utility can be started by the command `./TLUcontrol.exe -d [x] -a [y]`. Here `x` is the mask for enabling DUT connections and `y` is the mask for coincidence of external triggers. To calculate the masks add the following numbers: 1 for PMT1, 2 for PMT2, 4 for PMT3 and 8 for PMT4. For detailed configuration issues check the helpfile.
- The program can be stopped by `Ctrl-c`.

6 Checking the Telescope

Before you take data with the telescope, you should make sure everything is ok. For this you can use the internal trigger or the beam trigger.

6.1 Telescope without beam

Important: Please take every couple of days when there is no beam for some time a run of at least 10k events and note this carefully in the logbook. We think with this information we can ease the analysis later on. This should also be done after turning on the telescope or if a problem occurred, in order to should be checked if the telescope is still working ok.

For this one should take a run with the internal TLU trigger and no beam. The configuration file to be used is `"eudet2-test-6boards-in1crate.conf"`.

Please select a signal threshold of 0 in the ROOT setting window and "Number of Clusters" in the Board Display. This will show you a histograms of the number of hits per event (Fig. 10). Please keep in mind that we have 650k pixels per plane and that 20 hits per event is then a rather normal number.

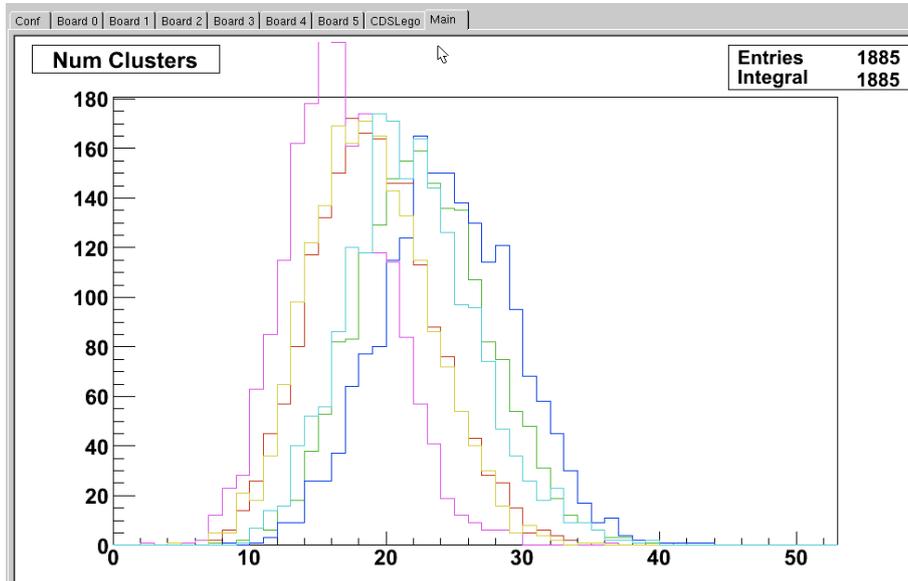


Figure 10: The number of clusters for each board shows if the telescope is working ok. The peaks should be below or around 20 hits. (this plot looks a bit strange with the protruding peak, to be repeated)

6.1.1 Beam Data

As soon you take data with the beam on, you should check if really everything is ok. The quickest way to see that this is the case is the correlation plots. For this select "X Cluster correlations" in the Root Monitor. In Figure 11 the X Cluster Correlation plots for board 0 to 5 are shown. This is an example taken at the DESY test beam at 4GeV. The darker area indicates each time the beam spot (15 mm in the used configuration). For this plot only clusters with more than 2 pixels were shown. The line indicates the correlation between the hits in X of the one board versus the hits in x on the next board. The fifth plot is the correlation between the first and the last board. The wider correlation line is due to the multiple scattering (only seen at DESY or when a lot of material was inserted).

7 PI-XY Table

In order to move the DUT a XY table is provided with the EUDET telescope. This is only for smaller DUTs and a maximal load of 10kg should not be exceeded. In case you

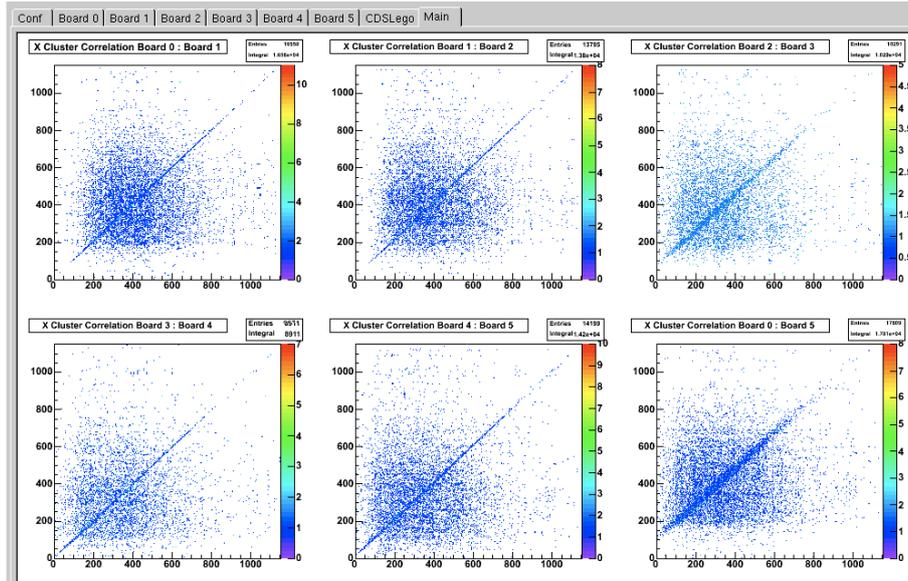


Figure 11: X Cluster Correlation plots for all boards. The line indicates the correlation between the hits in X of the first board versus the hits in x on the second board.

are using the ϕ stage as well, the load should be less than 5kg. Please keep in mind that this stage is for high mechanical precision and should be treated with care.

The program to steer the XY table is running on the Windows box. The icon for starting the program is called "PIMikroMove" and can be launched with the typical double click. When PIMikroMove starts, the Start up Controller dialog is displayed at the first step, please connect the controller and close the dialog. In the second dialog you can see if the right tables are selected. For stage 1 (X-axis) we have a M-521-DD; for stage 2 (Y-axis) it is a M-511-DD.

In case you are starting the program the first time, you should select the unreferenced stages and move to the reference switch. **This should only be done when you are watching the DUT as both stages will move to the end switch! Watch your cables!!**. If the DUT is already in its correct position and you have to restart the programme (power glitch or somebody closed it by accident, skip this step).

Now you can move the stages one by one. Be careful when moving larger steps, then it is recommended to reduce the velocity.

8 Troubleshooting

In the following subsections instructions are given how to solve simple problems during data taking.

8.0.2 Restart Root Monitor

In case the Root Monitor window was closed, it can be restarted from the command line. Therefore go to the directory `home/eudaq/bin/`. To restart the Root Monitor type `RootMonitor.exe -f [run number]`. During data taking the run number can be found in the `eudaq Run Control` window. It is also possible to connect the Root Monitor to the run control. Therefore type `./RootMonitor.exe -r eudet.local` at the command line.

8.0.3 Problems with the DAQ software

By debugging, we hope to have reduced the DAQ crashes quite a bit. It seems also that doing things in the right order and with a bit of patience, crashes can be reduced as well. Some of the crashes are imposed by the DUT in the system, so we can not cover all possibilities here.

- If the EUDAQ is crashing, the first step to try is a simple restart of the software by typing `./STARTRUN` again. This kills all previous processes and starts a new process.
- If you just accessed the area, make sure that you turned the telescope sensors back on.
- If this is not helping, it might be that the MVME controlling the EUDRBs is stuck. This should be checked by trying to ssh the MVME (`ssh zentaurus1 (DESY)` or `ssh mvme6100 (CERN)`). Just sending a ping is not enough to find out if everything is ok.
- A clear indication that the VME needs to be restarted is an error message including "TSI ..." in the EUDRB produced.

Please send any known problems, error message etc. (and its solution!) to `ingrid.gregor@desy.de` to make sure that they get included in this manual.

Acknowledgement

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