AliVATA

Getting Started Guide

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Alibava Systems

This guide describes the different parts of the AliVATA systems and how to connect them. It also describes how to configure the VATA GP7 ASIC from IDEAS and provides estimates of the ASIC calibration.

Table of Contents

1. Introduction

This manual, together with the software for the data acquisition software can be found in the Alibava Systems web page (https://www.alibavasystems.com) by clicking on Downloads followed by AliVata Software. The full link is shown below:

> https://www.alibavasystems.com/downloads-alibava-systems/alivata-software.html

2. The AliVATA system description

The AliVata System consists of two parts: the Mother Board and the Daughter Board(s). Each Mother Board can handle up to 4 Daughter Boards.

The Daughter Boards host the detectors and the readout ASICs while the Motherboard is in charge of the data acquisition and communication with the computer.

The connection between Mother and Daughter Board is made using two flat cables for each Daughter Board, one is labeled as Digital and the other as Analog.

There is still another connection needed to bias the sensors. This is done with in the LEMO connector in the daughter board (see Figure 5).
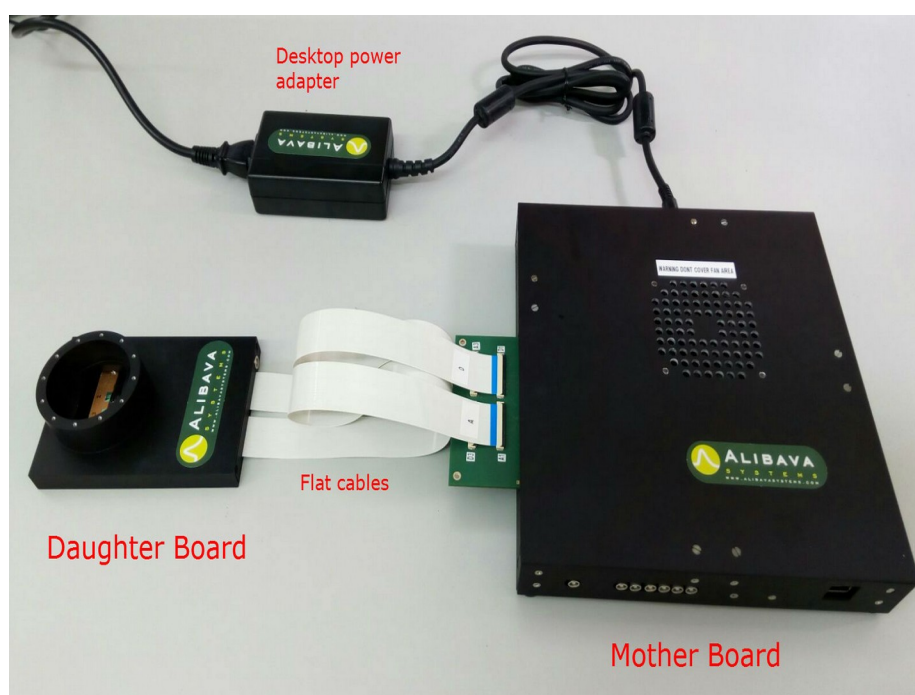
Figure 1: Complete system consisting of a Mother Board and a Daughter Board connected via two flat cables.

The Mother Board has a printed circuit board which is accessible from outside the aluminum box, providing access to the flat connectors also labeled as Analog (A) and Digital (D) as can be seen in Figure 1.
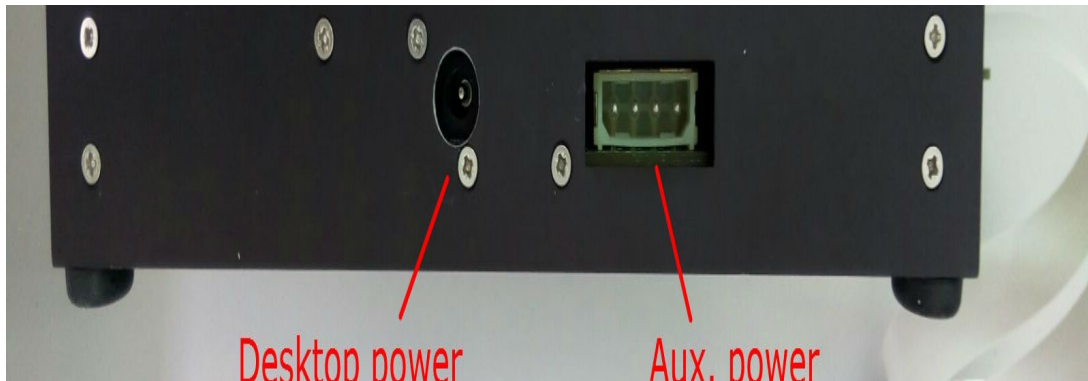
Figure 2: Power connectors. The desktop power adapter is plugged into the round connector. Auxiliary power connector is reserved for future uses.
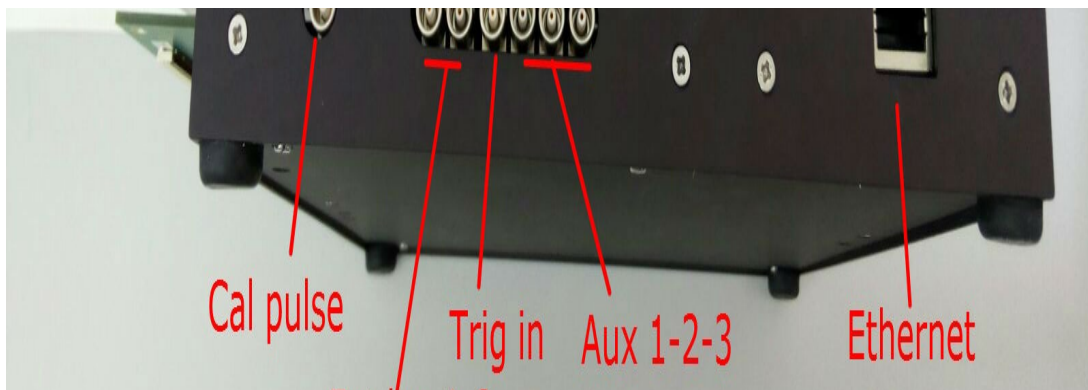

Figure 3: LEMO and Ethernet connectors

Ethernet connector and power connector are also accessible from the sides of the box as it is shown in the Figure 2 and Figure 3.

Seven LEMO connector are provided:

1. Test. Analog input for calibration purposes. 0 to 4V pulse can be injected.
2. Ext_log1. Digital Input. For future uses
3. Ext_log2. Digital Input. For future uses
4. Trig_in. Digital Input. Trigger input port. This input is used as trigger when EXT trigger mode is selected in the software. This port is LVTTL standard (3.3V logic)
5. Aux1. LVTTL. For future use
6. Aux2. LVTTL. For future use
7. Aux3. LVTTL. For future use

3. Basic connections and initialization of the system

This section describes how the different components (Mother board and detector board) are connected and powered. It will also describe how to connect the mother board to the computer with the ethernet cable.

3.1. Connecting components

There are a number of very easy steps required to get the system ready. Please read section 4 or, eventually, the Alibava GUI manual first to have the data acquisition software properly installed and ready. Then, proceed with the following steps.

1- Connect the daughterboard(s) to the motherboard. Open the flat connector by gently pulling the black flap of the connector. Carefully insert the flat cable into the connector and close the flap by pressing it while holding the other side of the board in order to avoid damaging it.

> **WARNING**: Each cable is labeled either Digital (D) or Analog (A) as well as each connector in the Mother Board. Connecting Digital cables to Analog connectors and vice versa would cause short circuit in the system and would damage the electronics permanently. See Figure 4

2- Connect the desktop power supply to the motherboard in order to power the system. The AliVata board would start up and the fan inside the box would turn on.

> **WARNING**: 12V 5A power supply is used. Connecting different voltage supplies might result in permanent damage of the electronics.

3- Connect the RJ-45 Ethernet cable to the corresponding connector. Connect the Ethernet cable to the appropriate connector of the Mother Board and to the computer using the USB-Ethernet converter.

At this point the system is ready and the Software will be able to communicate with the AliVata System.

> **WARNING**: Don't cover the fan area during operation. Don't use the Mother Board inside a closed box. Preventing the cooling of the system may damage the electronics.
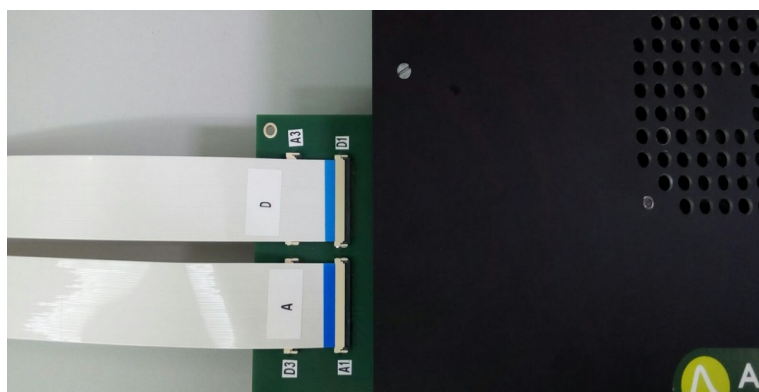
Figure 4.Detail of the flat cables of the Daughter Board connected to the Mother Board in slot 1. Notice that cable labeled as A is coupled with a connector A-type and the cable D is coupled with D-type connector. Connecting cables in the incorrect place may result in permanent damage of the system.
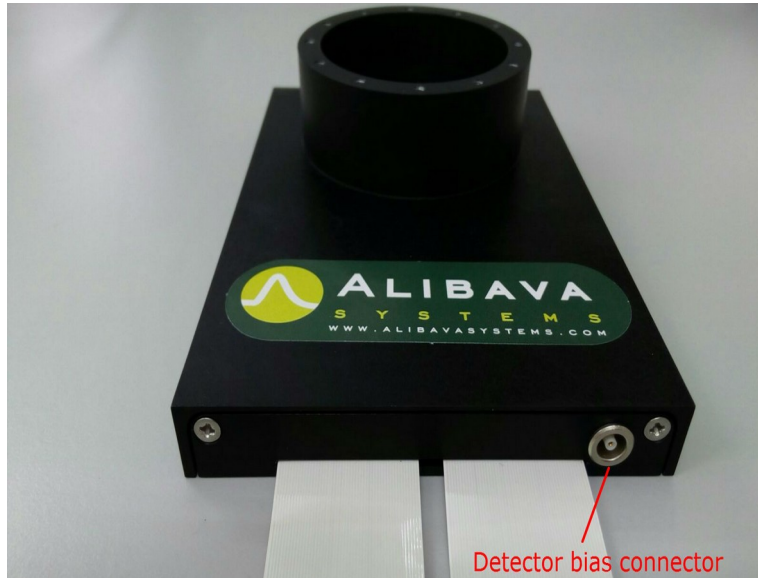
Figure 5. Detector board. The picture shows the LEMO connector used to bias the sensors.

4-Power must be provided to the detector. An external supply must be used to bias the detectors. Connect the output of the power supply to the HV connector of the Daughter Board. User must know the optimum operating voltage for the detector. It is recommended to set the current compliance in order to avoid damage in the detector due to high currents.

3.2. Connecting the Motherboard to the computer.

The motherboard has to be connected with an ethernet cable to the computer. The easiest is, probably use an ethernet-USB converter that will allow to have dedicated settings for the connection. AliVATA sends/receives UDP packets via the port 12345. One should check that this port is allowed by the system firewall for UDP packets.

The system needs some special settings to work. These settings are described below.

> Mac Address: 00:1C:C0:B0:10:C0
> Speed/Duplex: 100/Full Duplex
> IPV4 Settings:
>> IP: 11.254.254.253
>> Network mask 255.0.0.0
>> Gateway: 0.0.0.0

Change those settings for your connection to the computer. We provide here some hints on how to do it in the main Operative Systems: Windows, Linux and Mac OSX.
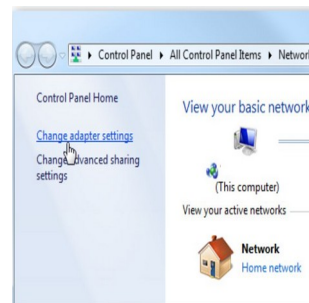
3.2.1. Windows 7, 8 and 10

This section will explain how to change it in the windows system.

To change the IP address, type "network and sharing" into the Search box in the Start Menu and select Network and Sharing Center when it comes up.
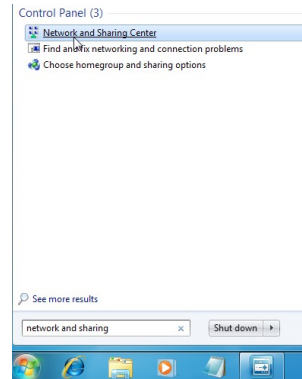
When the Network and Sharing Center opens, click on "Change adapter settings".

Look for your adapter in the window. If not yet plugged, connect the USB-Ethernet adapter to the computer. A new network adapter will be shown in this window. Right click on it and select properties.

In the Local Area Connection Properties window click on "Internet Protocol Version 4 (TCP/IPv4)" and then click the Properties button.
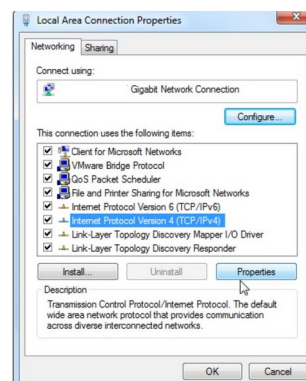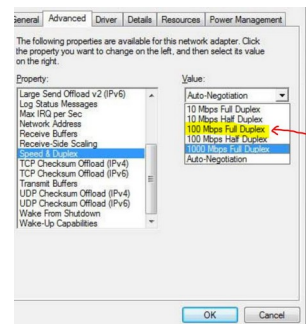
Now select the radio button "Use the following IP address" and enter in the specified IP and Subnet mask. Leave Default gateway blank. Click OK.
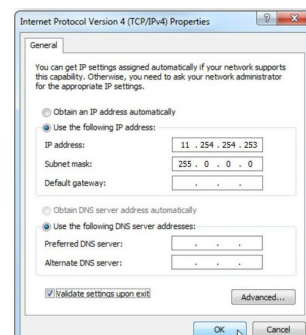
To configure speed and duplex, click the Configure button in the Local Area Connection properties dialog box. A new window will pop up. Look for Speed & Duplex and select the 100 Mbps Full duplex option and click OK,

To set the clone MAC address, open again the Configure window from the Local Area Connection properties dialog box and search for NetworkAddress. Set the value 001CC0B010C0.
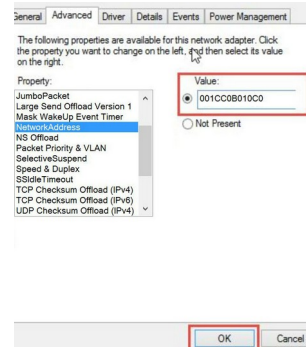
3.2.2. Linux/Ubuntu

To set the network properties in Ubuntu, right click on the network icon on the top menu in the screen and select Edit Connections. A new window will pop-up, select the connection associated to the network card you use for AliVATA and click on Edit.

Set the name of the connection to something you will easily recognize in the future (AliVATA, for instance).

On the Ethernet tab, set the clone MAC address.
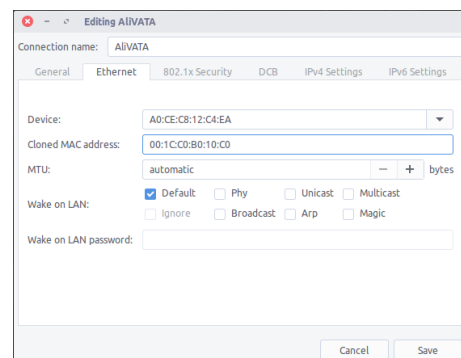
On the IPv4 settings, set the method to manual and click on Add button to enter the IP address and the network mask. Click on check button at the bottom.
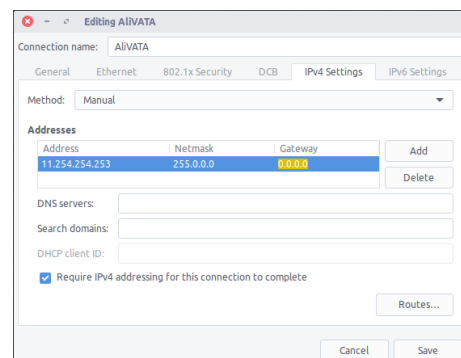
Click on Save and that should be it.

Ubuntu does not allow to set the speed and duplex from the GUI. There are two alternatives to that. First is to use the `ethtool` command as

```
sudo ethtool -s XXX autoneg off speed 100 duplex full
```

Where XXX is the interface name that can be retrieved from the `ifconfig` command on a terminal. To find your device look for the original MAC address of your adaptor. Note, however, that sometimes this change is not permanent.

```
[ethernet]
cloned-mac-address=00:1C:C0:B0:10:C0
auto-negotiated=false
duplex=full
speed=100
mac-address=<the true one of your adapter>
mac-address-blacklist=

[ipv4]
address1=11.254.254.253/8
dns-search=
may-fail=false
method=manual
```

Figure 6: Linux connection configuration file

To be sure that the settings are permanent, assuming that you named the connection AliVATA, be sure that the file /etc/NetworkManager/system-connections/AliVATA has in the ethernet and IPv4 sections at least the lines shown in Figure 6.

Still, some versions of ubuntu do not allow to make permanent the `autoneg=off` option. To remedy this, create a file in /etc/NetworkManager/dispatcher.d/ named 50-ethtool-autoneg-off and put the following contents in it. Note you should change XXX to the name of the interface found with `ifconfig`.

```
#!/bin/sh
myname=${0##*/}
log() { logger -p user.info -t "${myname}[$$]" "$*"; }
IFACE=$1
ACTION=$2

case ${IFACE} in
    XXX)
        case ${ACTION} in
            up)
                log "Disabling auto-negotation on $IFACE"
                ethtool -s $IFACE autoneg off speed 100 duplex full
                ;;
        esac
        ;;
esac
```
Figure 7: Network configuration file

The file should be at least read/execute for root, and writable makes it easier to update without having to change permissions or force your editor to save:

```
  sudo chmod 0744 /etc/NetworkManager/dispatcher.d/50-ethtool-autoneg-off
```

3.2.3. Mac OSX

Click on the Apple a the upper left corner of the screen and select System Preferences. There find the Network settings and follow the instructions.

Find your adapter from the list and set to configure IPv4 manually. Type the corresponding IP address and subnet mask as shown.
Click on the Advanced button. A new window will popup.
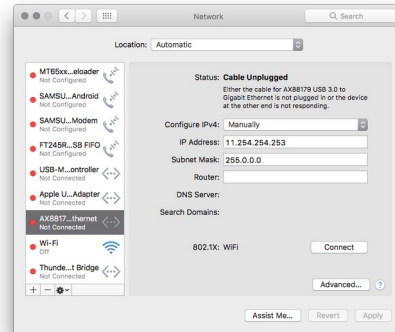
Select the Hardware tab and set it to be configured manually. Also change the speed to 100 Mbps and the Duplex to Full Duplex. Click OK.
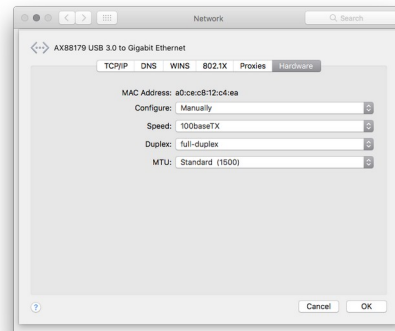
Click Apply in the Network configuration window.

Mac OSX does not allow to set the clone MAC address through the GUI configuration. It is usually not a problem but to be on the save save, open a terminal and type the command:

```
sudo ifconfig XXX ether 00:1C:C0:B0:10:C0 media 100baseTX mediaopt full-duplex
```

XXX can be obtained by typing first ifconfig and selecting the interface from there. To find the correct interface search for the original MAC address. Note that with this command you set all the parameters.

4. Configuring the AlibavaVDaq program and the GP7 chips

This sections gives a very short description on how to configure the data acquisition program AlibavaVDaq and the GP7 chips in the AliVATA detector modules.

Remember that the data acquisition program can be downloaded from the Alibava Systems web page. Download and install the software. There are versions for the main OS (Windows, Mac OSX and Linux).

4.1. Configuring the AlibavaVDaq program

To start using the program, connect the AliVATA motherboard to the computer with the ethernet cable and power it with the power adaptor delivered with the system. If you need to use another one, please

check that it provides the correct voltage and current.

Start the DAQ software. If you already have a configuration file, open it with the Open item in the application menu. If you do have a configuration file or the you you have does not work he following instructions are for you.

To configure the system for the first time, click on Plugins and then properties on the application menu. A new window will pop up like the one in Figure 8 but with no plugin listed. Click on add. A dialog window will ask you for the plugin name and element name. Set any you find sensible. In the example we used `alivata` and `vata`.

A new line will appear in the plugin configuration window with `alibava` as name and `vata` as element. Select the line of the plugin and click on the Hook button. Another window will popup like the one in Figure 9. Write there maddaq.so (or maddaq.dll if in windows) as the library name, then click on the Find Symbols button and select create_MadDAQ. Click OK. You should have something like Figure 8, where all the columns are now filled. Click OK in the Plugin settings window.
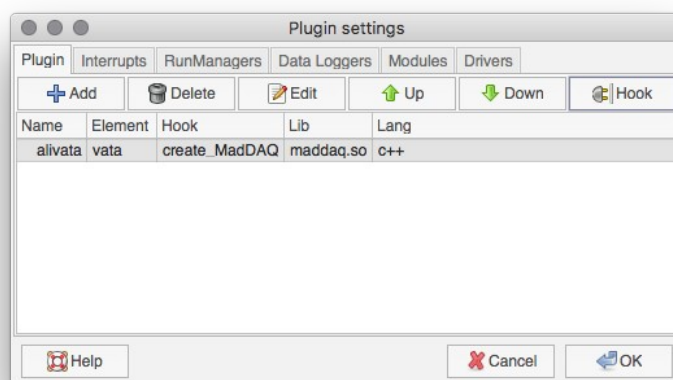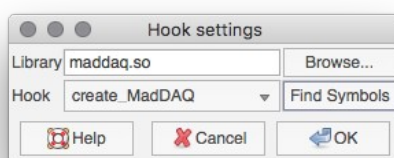

Figure 8. Plugin properties dialog box.

Figure 9. Hook definition window.

If everything went you should get another pop-up window in your screen like the one in Figure 10, where we must specify the type of chip (GP7_1 in our case), the number of hybrids (detector boards, 1 in our case) the number of chips in the detector board, and 1000, which tell us that we have connected the board in the slot 1 of the mother board.
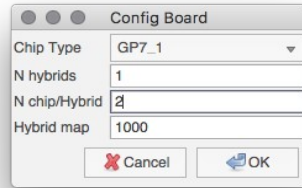
Figure 10: Configuration of the detector board plugged into the mother board.

If everything worked properly, you should see something like Figure 11, where you can see a small square labelled as "11", which is the identifier given to the detector module.

At this stage, the wisest thing to do is to save the current configuration by clicking on Save from the File application menu item.
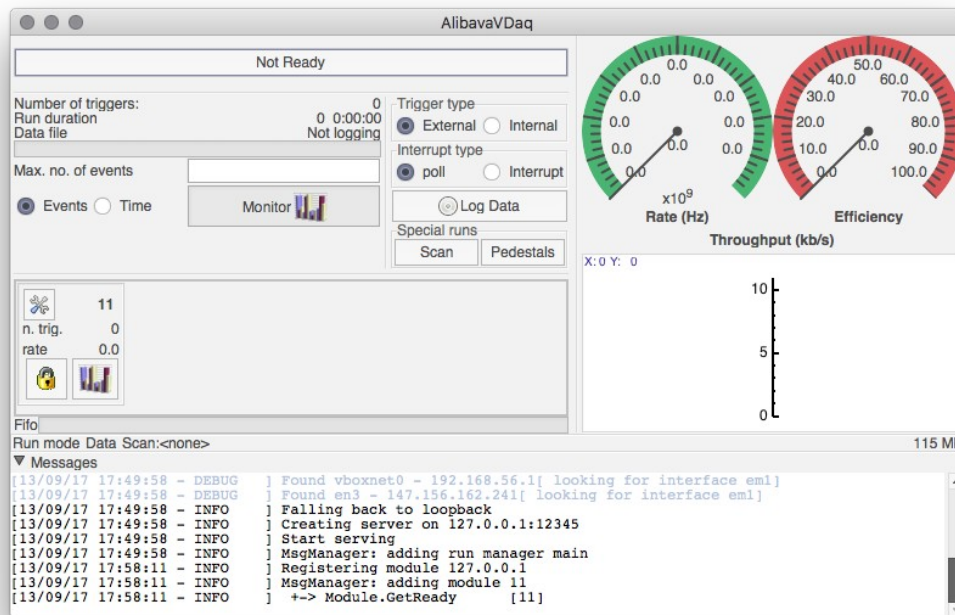

Figure 11. Main window of the data acquisition program

4.2. Configuring the GP7 chips

The AliVata system is based in the GP7 chips by IDEAS. This are chips specialized in reading out silicon detectors and the nice thing about them is that they provide a self trigger to start the acquisition. The chip provides the data in twp different ways: serial and sparse with adjacent channels. In serial, the chip gives, on each trigger, a stream with the analogue date of each channel. In sparse mode, it only returns the data of the channel that triggered plus as many neighbors as selected. So, most of the time, one only needs to

1. configure the read out mode (serial or sparse),
2. the trigger mode (real or software),
3. the threshold for the trigger and

4. the channels that are not allowed to provide a trigger.

This can be configured by clicking on the configuration button in the small square representing the module (see Figure 11). A window will pop up like the one shown in Figure 12.

The picture on the right shows the general settings where you can choose the read out mode and the number adjacent channels, the trigger mode (FORx is for data triggers and SW for software generated triggers, others are not used very often) and the threshold for the trigger. The threshold is in units of mV and the conversion to energy units need to be calibrated (see section Error: Reference source not found) and the effect of changing it is immediate (no need to click Apply nor OK).
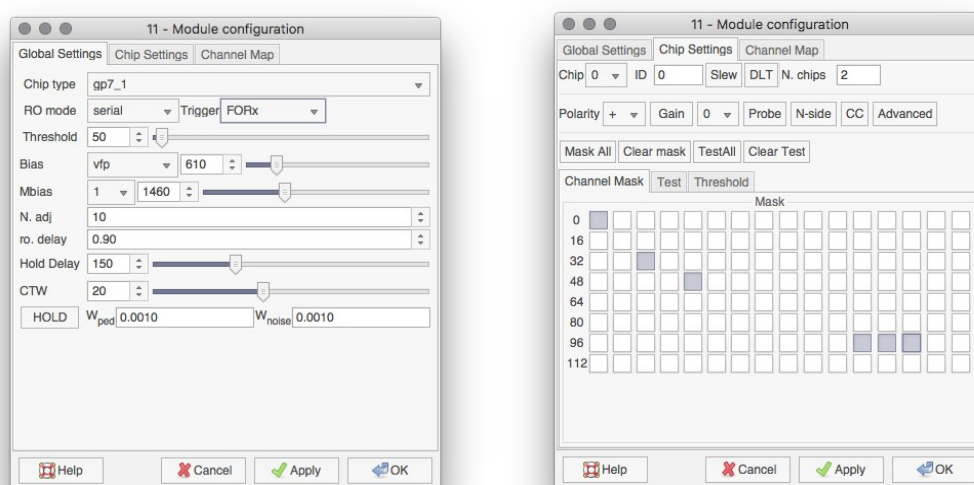

Figure 12. Module configuration window. The left picture shows the general settings while the right figure shows the setting specific to the ASIC.

The picture on the left show the settings specific for the ASIC. There is a combo box at the upper right corner that allows to select the chip to be configured. Most of the times one is only interested in masking noisy channels to prevent them from triggering the system. This is done selecting the channels on the button matrix at the bottom.

4.3. Calibration of the chips.

The ASICs have been calibrated with two radioactive sources [241]Am [133]Ba source which provide several peaks (30, 60, 80 and 356 keV). The results are shown in Figure 13, where also a linear trend line is shown. The slope and intercept of the trend line are shown in the figures.

The threshold DAC has also been calibrated using the [133]Ba source and Figure 14 shows the energies at which the spectrum was truncated for a number of threshold settings. For completeness, also the inverse curve is shown. The slope and intercept of the trend line are shown in the figures.
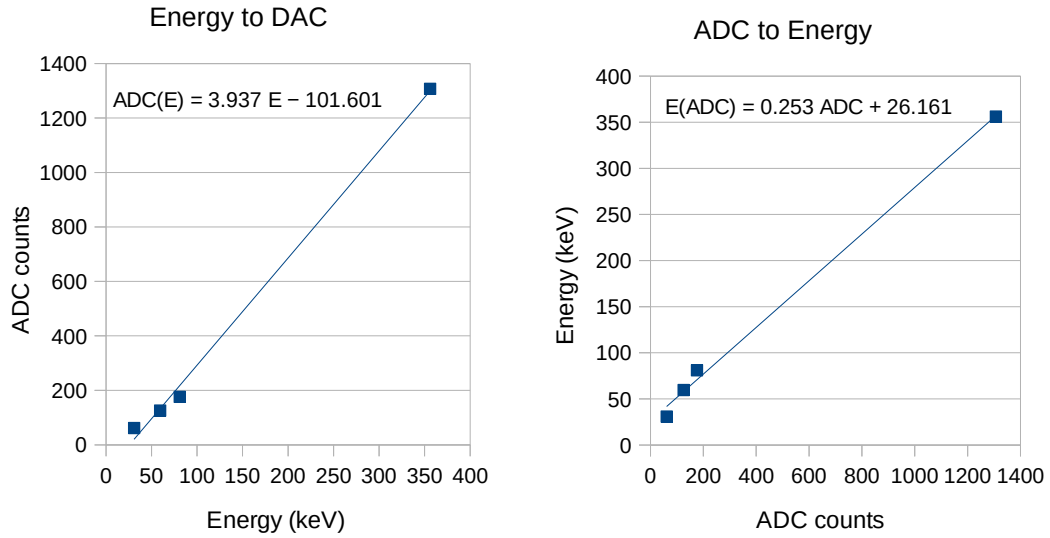
Figure 13: Calibration of the system. The left curve shows how to pass from energy to ADC counts and the right curve the other.
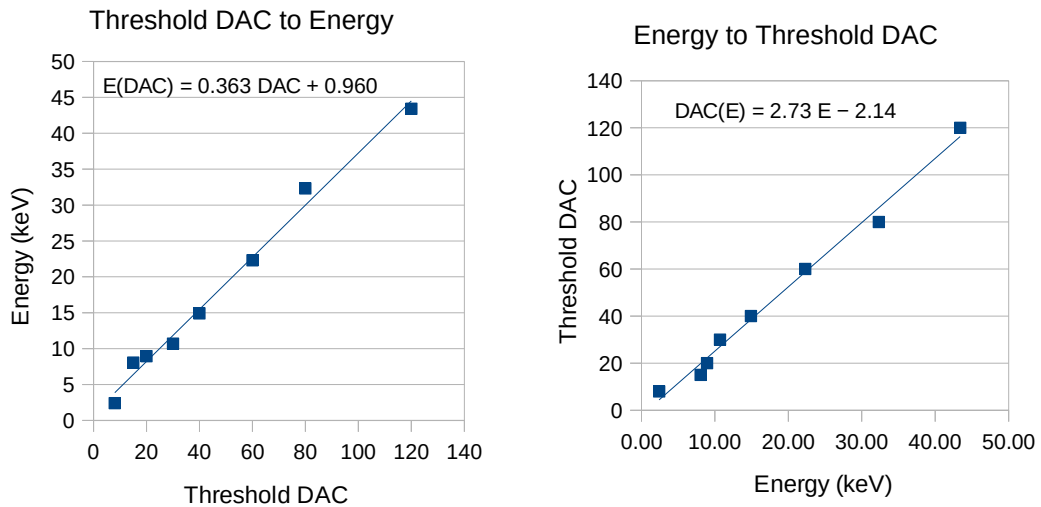

Figure 14. Calibration of the chip threshold DAC.

4.4. The response curve of the GP7 chip

AliVATA allows to inject calibration pulses into the ASICs. This, together with the energy calibration allows to build the response curve of the ASIC. This is shown in Figure 15, where one can see the ASIC is linear up to about 400 keV and saturates at about 500 keV.
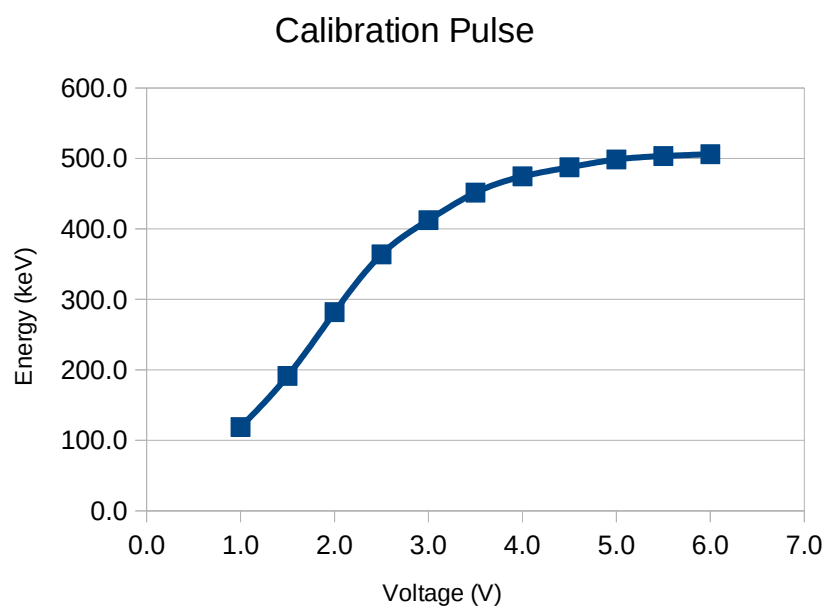
Calibration Pulse

Figure 15: ASIC response curve