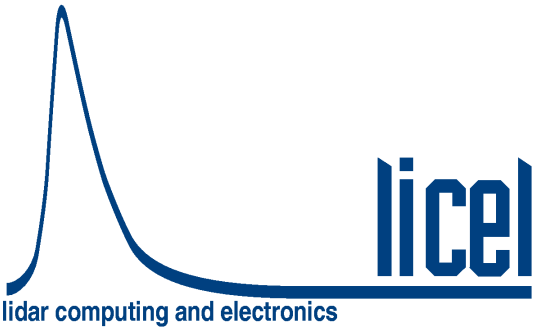


Licel Ethernet Controller – Installation and Reference Manual

Licel GmbH

November 17, 2005

Contents

Chapter 1

Introduction

The ethernet-based control modules for Licel detection systems open the path for truly remote controlled experiments. The Licel Ethernet Control Modules use a TCP/IP based protocol with a syntax similiar to conventional GPIB based instruments. Each module use an ASCII command set with a structure similiar to SCPI in order to be compatible with common measurement devices. A LabVIEW driver library for easy integration is supplied. The modules can either be operated using a static IP address or a dynamically assigned IP address (DHCP).

In the next chapter the control modules currently available at Licel are introduced. Then the installation of the software and setup of the network is described. The following chapter gives an introduction to the acquisiton software. After that acquisition tutorial further software control modules are described. Finally the appendix contains information about the TCP/IP command set, the file format, initialization files, and the LabVIEW TCP/IP driver library.

The most up to date version of this manual can be found at http://www.licel.com/software.htm.

Chapter 2

Licel Control Modules

Currently four modules are available, one which controls up to 16 transient recorders, 2 modules for PMT and APD control, and a laser trigger / gating pulse generator.

2.1 The Transient Recorder Control Module

The Licel transient recorder control module can control up to 16 transient recorders. It translates the ASCII based commands received using TCP/IP into low level transient recorder commands. The data from the transient recorder is then sent back to the PC. This eliminates the need of a special interface card to control the transient recorder. The typical data transfer rate is 150 kb/sec. This is lower than for a PCI-DIO-32HS but offers a cost sensitive solution for small systems.

The transient recorder ethernet control module introduces a new data transfer mode: the push mode. In push mode the transient recorders get their start, stop, and readout commands from the ethernet controller without any direct interaction with the PC. The ethernet controller then pushes the data to the PC. At the PC level, a periodic task reads the data when it becomes available from the TCP/IP buffer. This frees the PC from controlling the transient recorders by itself and reduces the communication load. The advantages of the push mode are important for single shot acquisitions.

2.2 The Photomultiplier High Voltage Control Module

The Licel photomultiplier high voltage control module can control up to 8 PMT modules. The control voltage ranges between 0 and 1V, which is generated by a precision DAC and monitored. PMTs with an activated high voltage are indicated by a LED. The control module is equipped with a twisted pair ethernet connector which allows for 10/100 Mbit network based access.

2.3 The APD High Voltage Control Module

The Licel APD high voltage control module can control up to 4 APD modules. The control voltage ranges between 0 and 1.8V, (which corresponds to 0 to 450V APD HV), which is generated by a precision DAC and monitored. APDs with an activated high voltage are indicated by a LED (1-4). The thermoelectrical cooler can also be remotely activated. Once a stable temperature is reached the T_{Set} LED is activated.

2.4 The Licel Trigger Module

The Licel Trigger Module incorporates one trigger input and 4 different outputs to build up compact detection systems. The triggger input can be used to synchronize the system to an external laser flash lamp or Q-switch trigger. The module can also run internally triggered. The module is able to generate:

- a lamp trigger
- a pretrigger for the transient recorder

- a Q-Switch trigger
- and a Gating trigger for gated PMT-Modules.

All timings are derived from a quarz based oszillator ensuring nanosecond timing stability.

Chapter 3

Software Installation

Licel provides a package of software modules for setting up the Licel Ethernet Controller for network operation, and for operating the Licel Control Modules. These software modules are written in LabVIEW's G language. The software is provided as LabVIEW source for users who have LabVIEW (beginning with version 6.0) installed, or alternatively as a set of Windows applications. The Windows applications come within a Windows Installer package for an easy installation on your Windows (95/98|NT|2000|XP) computer. Licel provides the software on a CD ROM and for download (http://www.licel.com/software.htm).

3.1 Preparation

Windows Application Users

If you have used older versions of Licel Windows applications it is recommended to backup existing initialization files (*.ini).

Search the installation directory of the older version of Licel Windows applications (standard: <Program Files Directory>\Licel) and backup all files with the ending *.ini to an archive file (zip, ARJ, TAR, etc...) or onto a CD ROM.

LabVIEW Users

If you have used older versions of Licel LabVIEW libraries it is necessary to remove and backup older versions.

1. Backup all your current Licel software libraries, in case you want to restore them, by either compressing them (zip, ARJ, TAR, etc...) or burning them onto a CD ROM.
2. Scan your disks to find all versions of the following files and delete them once you have made backups of them

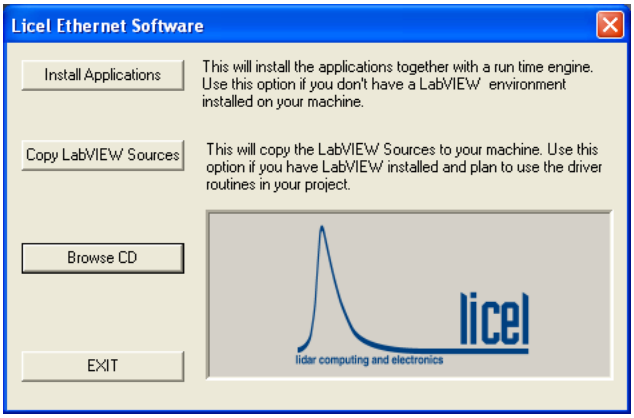
   ```
   Advanced Viewer.llb
   ControlAPD.llb
   ControlPMT.llb
   datafile.llb
   Globals.llb
   Postan.llb
   Licel TCPIP.llb
   Licel Util.llb
   TCPIP-Acquis.llb
   TCPIP-Live_display.llb
   TCPIP-Pulse.llb
   TCPIP-Track.llb
   Licel Module.llb
   ```

   Please note: Licel may have provided individual software solutions with additional or less LabVIEW library files than noted in the list above.
3. Search the directory your older version of Licel LabVIEW libraries reside and backup all initialization files (*.ini).

3.2 The Licel CD ROM

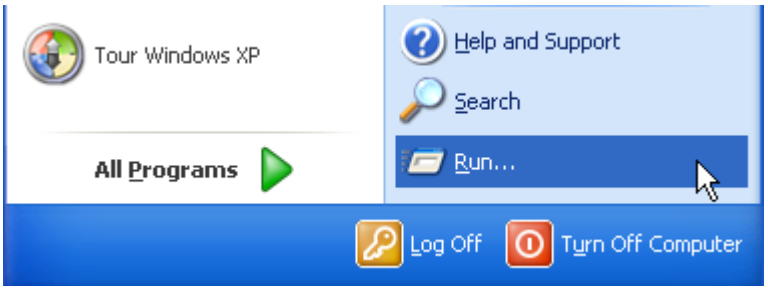
The standard CD ROM provided by Licel contains both, the LabVIEW sources and the Windows Installer for installing the Windows applications, and a documentation folder. Licel may add customer specific components on the CD ROM.

1. Insert the Licel CD into your CD ROM drive.
2. The following selection dialog should appear automatically:

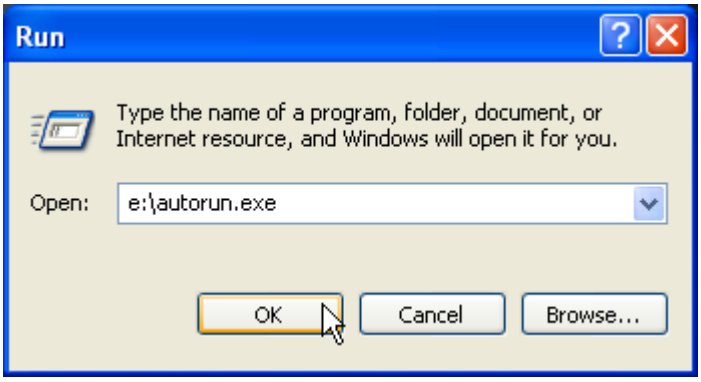


   - Press *Install Applications* to start the Windows Installer which will guide you through the installation of the Licel Applications. Please proceed to the section 3.4.
   - Press *Copy LabVIEW Sources* to copy the LabVIEW source files from the CD ROM to a folder of your choice on your computer. Please note the remarks according to existing LabVIEW library files. Please refer to the section 3.5 for further details.
   - Press *Browse CD* to inspect the content of the CD ROM
   - Press *Exit* to exit the dialog without any further action.

3. If the selection dialog does not come up, please press the start button, select **Run** in the upcoming menu:



   In the dialog box enter <`CD drive letter`>:\`autorun.exe` where `CD drive letter` is the letter corresponding to your CD ROM drive (E in the picture), and press *OK*.



   The selection dialog from above should now be started, you will be able to select one of the installation options.

3.3 Download

The Licel software is frequently maintained. The most recent version is available on the download page (`http://www.licel.com/software.htm`). Licel provides both packages described in this chapter, the LabVIEW sources as well as the Windows installer to deploy the Windows applications. The packages come as zipped archive files, `TREthernet.zip` contains the LabVIEW sources, while `LVInstaller.zip` is the corresponding zip archive with the Windows installer. Note that you may have changed these files names while downloading the archives.

Unpacking the Windows Installer

If you downloaded the Windows Installer package (`LVInstaller.zip`) please unzip all files to a temporary directory. Locate the setup routine `setup.exe` in that directory and run it by double-clicking the program entry in the Windows Explorer. Please proceed to the section 3.4.

Unpacking the LabVIEW Sources

The Licel LabVIEW libraries and initialization files contained in the zip file `TREthernet.zip` may directly be unzipped to a destination folder of your choice. Please note the remarks according to existing LabVIEW library files. Please refer to the section 3.5 for further details.

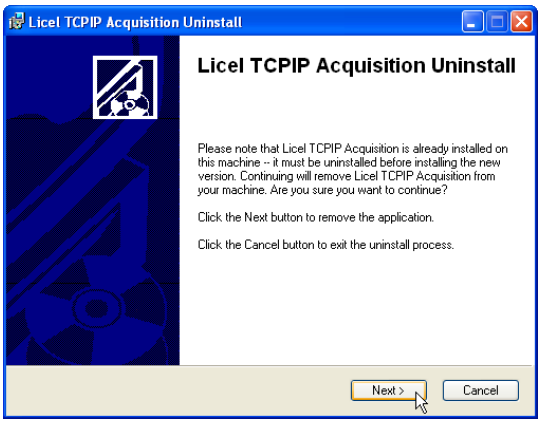
3.4 Installing the Windows Applications

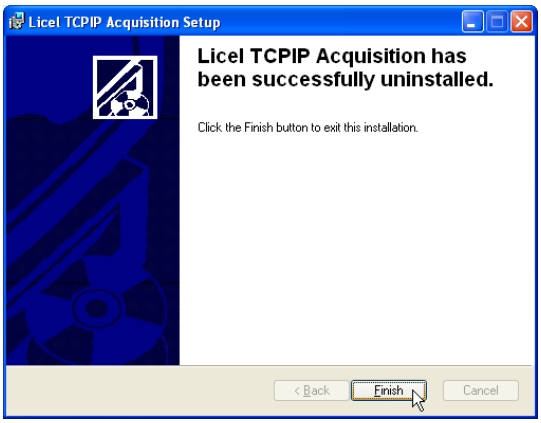
This subsection describes the installation process for the Licel Windows applications. To operate the Licel Windows applications a LabVIEW runtime environment needs to be installed, as well. The Windows applications together with the LabVIEW runtime environment come as a Windows Installer package. For the installation of the LabVIEW runtime part of the installer package local administrator privileges are required.

The following items describe the installation process after starting the Windows Installer's setup routine (`setup.exe`). The setup program is automatically started when using the CD ROM and pressing **Install Applications** in the setup selection dialog. `setup.exe` is located on the Licel CD ROM in the subdirectory `Installer` or in the temporary directory you unzipped the downloaded Licel Installer package. You may directly start the setup routine from the corresponding directories.

The Windows Installer dialogs will guide you through the installation process.

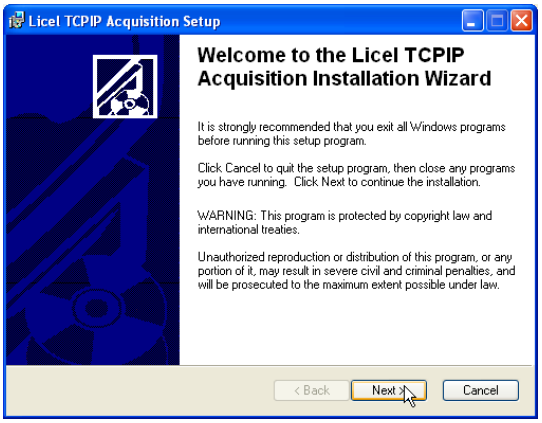
1. If an older version of the Licel software is detected, the install utility will first remove the old components.

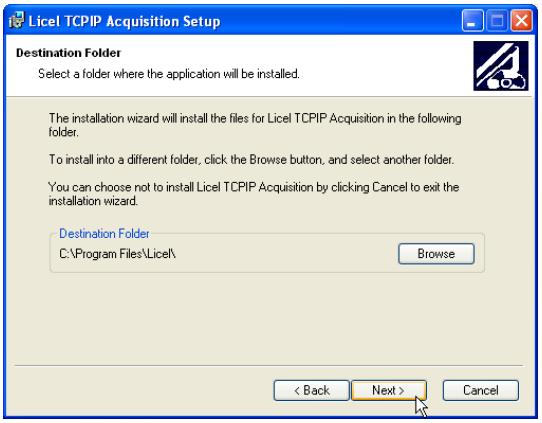




   Click **Next**, and after the uninstall process has terminated **Finish**. Then, you will have to run `setup.exe` again.

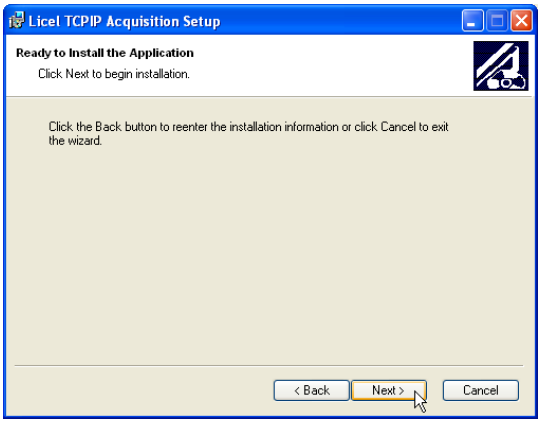
2. If no older version is detected a welcome screen will appear. Please click **Next** to proceed. On the next screen you may choose the installation directory (standard: `<Program Files Directory>\Licel`).

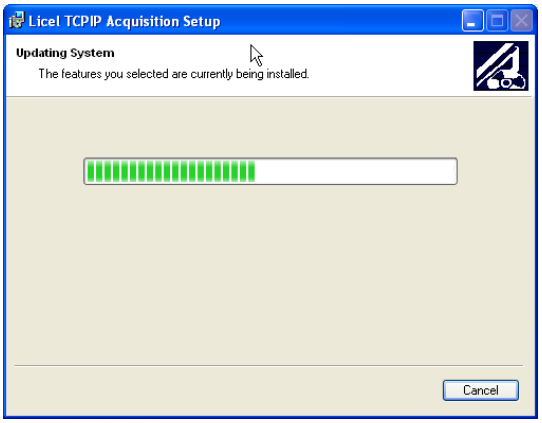




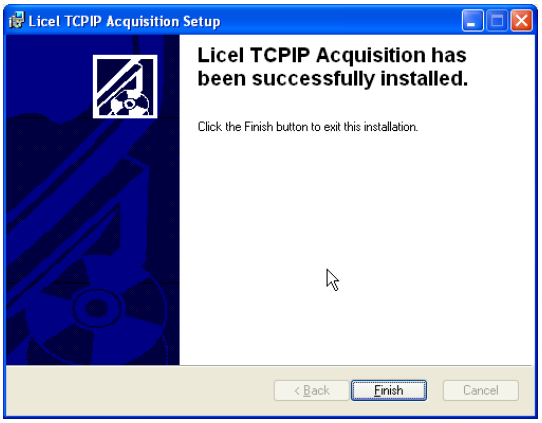
If you would like to change the installation directory click **Browse** and choose or create a directory of your choice. Click **Next** to proceed.

3. Confirm the next dialog by clicking **Next** or click **Back** to change your installation settings. After starting the installation progress is indicated by a progress bar.

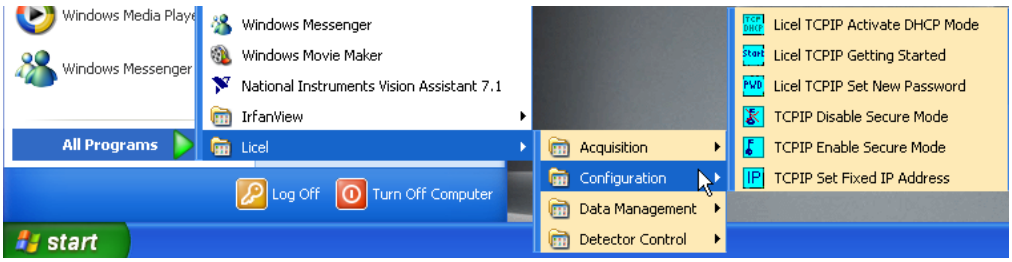




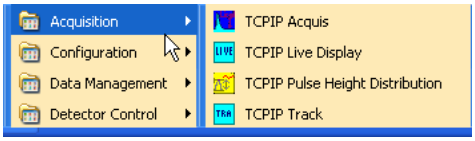
4. A successfull installation will be shown in the next screen. Please click **Finish** to proceed.

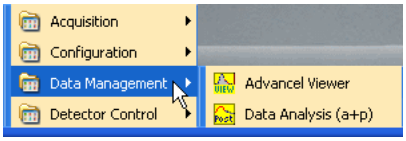


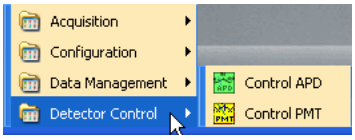
5. After the installation has successfully been completed you are able to start the Windows applications through the corresponding entry in the program group **Licel** in the Windows start menu:



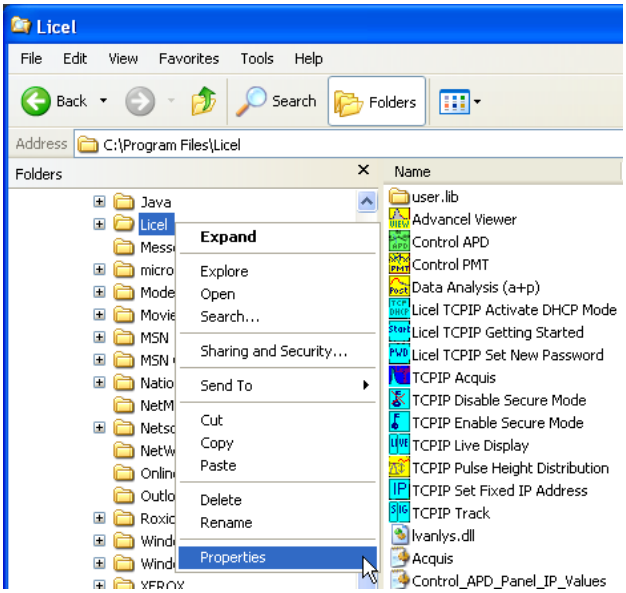
The links to the applications are grouped into the subfolders **Configuration**, **Acquisition**, **Data Management**, and **Detector Control**.

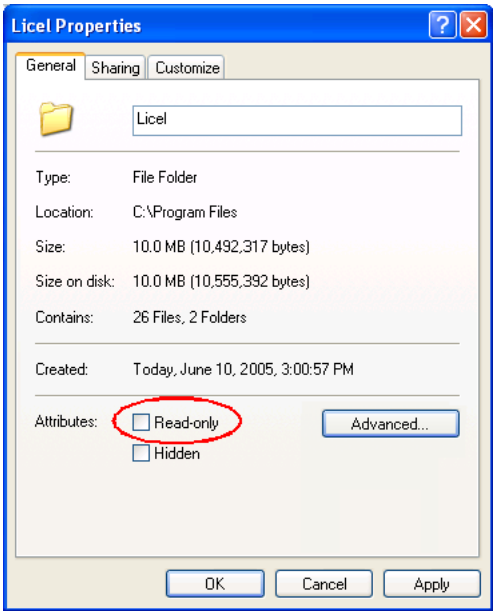




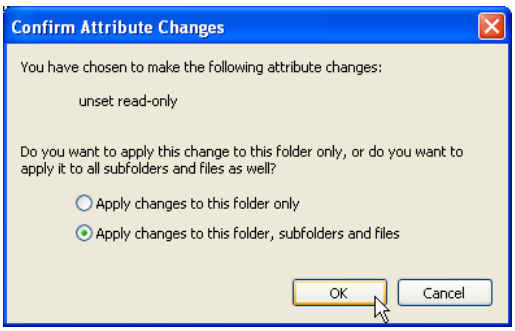


6. Please note that the Licel software needs write permissions for the initialization files located in the installation directory. If any problems indicating missing permissions occur select the directory and right-click on it. Select **Properties** from the context menu.





Verify that the `"Read-only"` attribute is not checked, uncheck it if necessary. Click *OK* and check in the next dialog **Apply changes to this folder, subfolders and files**. Leave the dialog by clicking *OK*



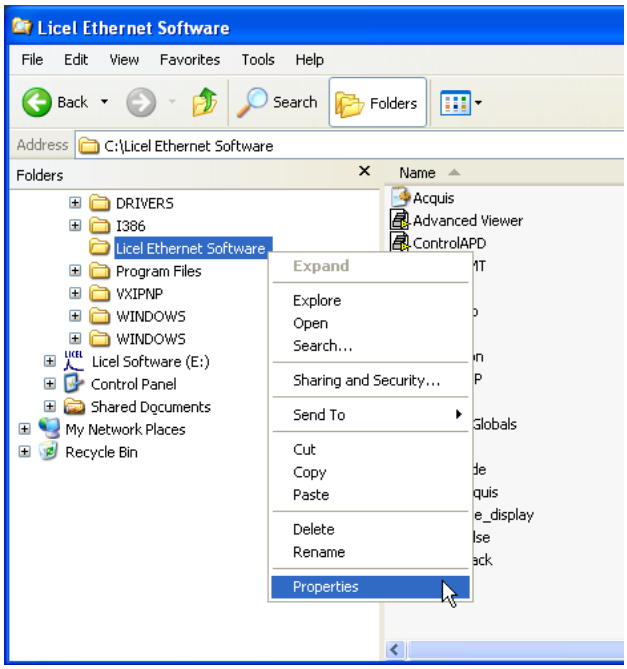
7. If you have backuped your initialization files from an older version of Licel Ethernet Software you may copy the TCP/IP parameters from the corresponding old initialization files to the files of the current installation. Please note that copying information from older to new initialization files should be done value by value (line by line).

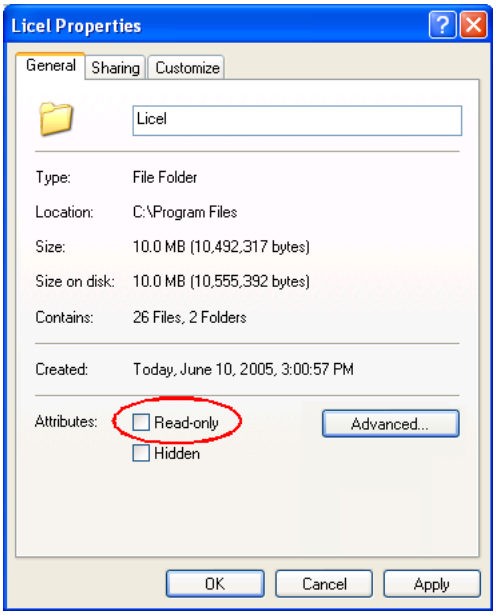
3.5 Installing the Licel LabVIEW Libraries

To install the Licel LabVIEW libraries you may choose between the following options:

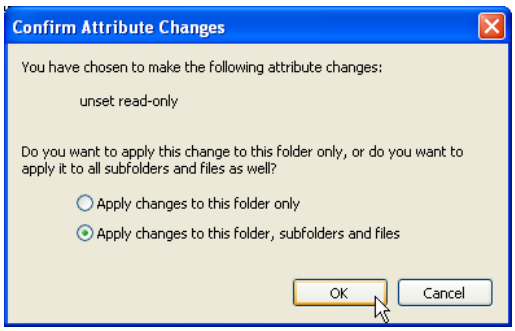
- The Licel LabVIEW Libraries will be copied automatically from the Licel CD ROM by pressing **Copy LabVIEW Source** in the setup selection dialog. You will be asked to select or create a target folder.
- You may manually copy all files contained in the directory `LabVIEW Files` on the CD ROM to a directory of your choice.
- If you downloaded the Licel software from http://www.licel.com/software.htm please unpack the content from the downloaded zip file and copy it to a directory of your choice.

Please note that in the case the software is copied from a CD you may have to unselect the `"Read-only"` attribute for the destination folder. This is done by selecting the the directory and right-clicking on it. Select **Properties** from the context menu.



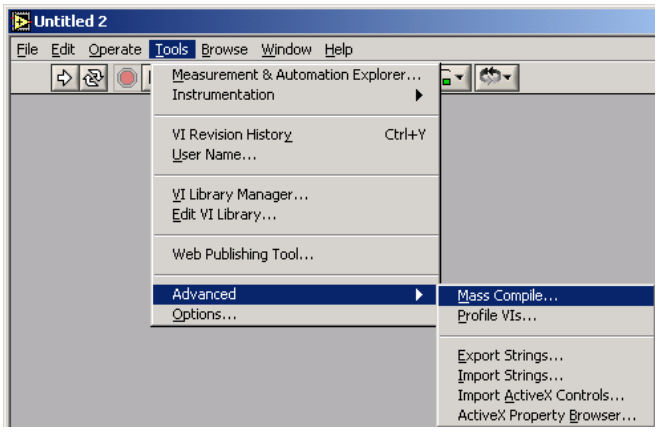


Verify that the `"Read-only"` attribute is not checked, uncheck it if necessary. Click *OK* and check in the next dialog *Apply changes to this folder, subfolders and files*. Leave the dialog by clicking *OK*

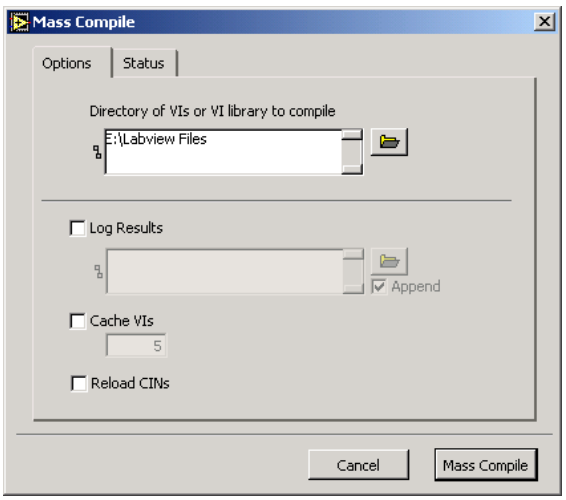


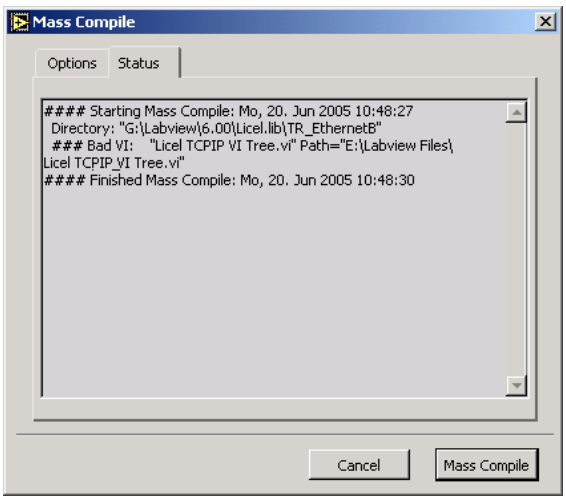
Now you should be able to run all the files. If you are still having problems, apply a mass compile to the directory where the software was extracted to:

1. Start LabVIEW, press on *New VI*.
2. Select the menu **Tools**, then **Advanced**, and finally **Mass Compile...**.



3. You will be asked to select a directory, select the target directory of the LabVIEW source files.
4. Press *Mass Compile* in the next dialog.





5. Later the mass compile status will be shown. Please ignore that the vi `Licel TCPIP VI Tree` is indicated to be a ”bad vi”.

Please note that the removal of older libraries is a necessity, since LabVIEW often links to various libraries with the same name. As a result, if a library is installed twice, one can not be certain which library is actually being used.
If you still have any problems, please contact Licel for further assistance.

Chapter 4

Setting up the Network

4.1 Network Information

The Licel Ethernet Controller is shipped with a default static IP address. The default parameters are:

IP address	10.49.234.234
network mask	255.255.255.0
gateway	
port	2055

The network parameters should be according to your local network environment. Before doing this, the system administrator should be contacted. He should provide the following information:

1. Should the ethernet controller use a dynamically assigned IP address (DHCP)
   (a) If yes, the network parameters will be set by a DHCP server residing in your LAN. Refer to the subsection DHCP Mode (4.3.2) to enable the Licel Ethernet Controller to automatically receive the network parameters from the DHCP server.
   (b) If a static address configuration is to be used,
      i. the IP address,
      ii. the network mask,
      iii. and the gateway

      should be set by yourself. Refer to to the subsection Fixed IP Address (4.3.1).
2. The default ports used by the ethernet controller are 2055 and 2056. Can these ports be used?
3. Is it necessary to change the configuration of any firewall in the case you need to access the controller outside of the LAN boundaries?

4.2 Network Preparation

After having installed the Licel Windows applications or the Licel LabVIEW modules on your PC you are ready to change the network configuration parameters of the Licel Ethernet Controller according to the local network settings described in the previous section.

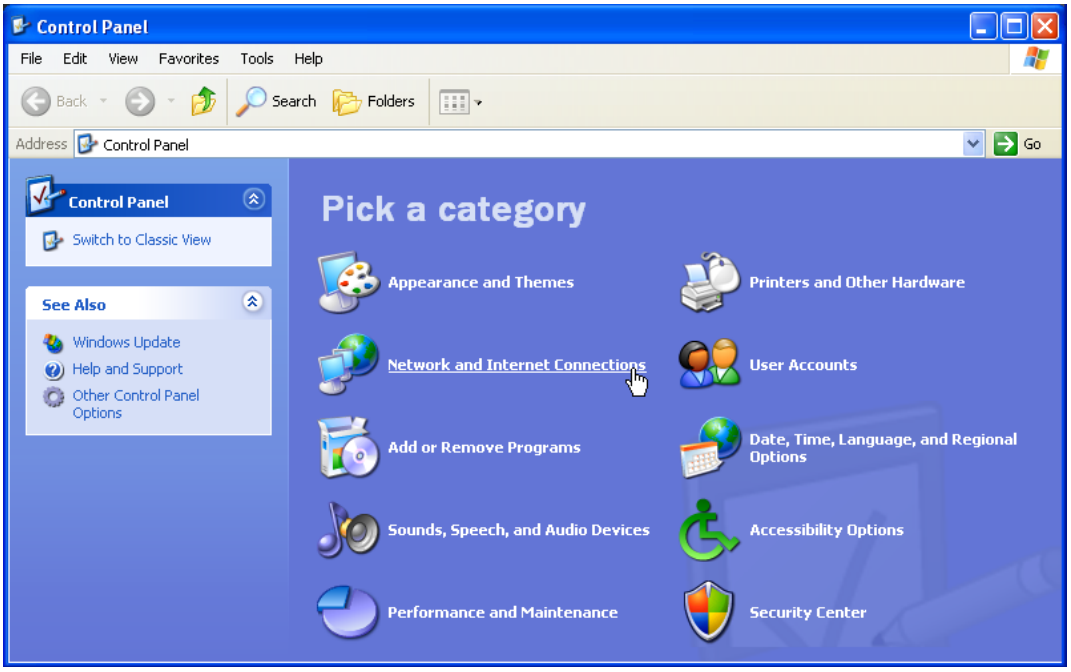
4.2.1 Establish the Connection

A straight-forward way to do this is the following procedure. You will need local adminstrator rights on your PC for the following steps:

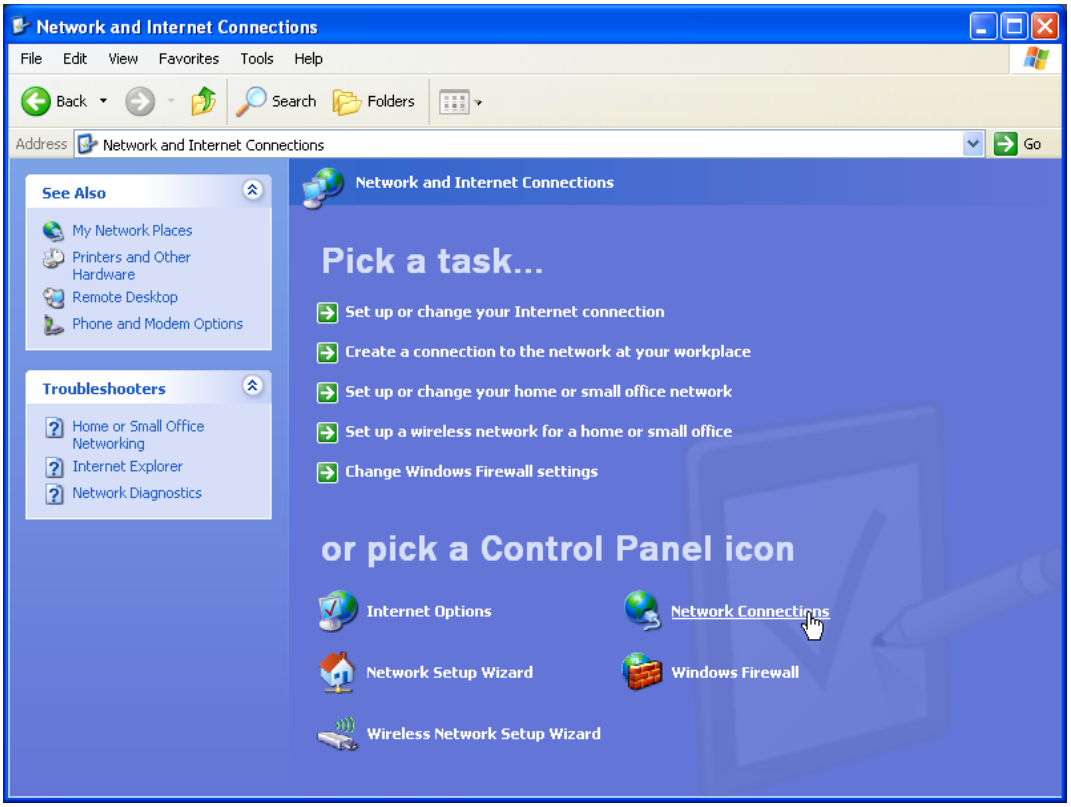
1. Disconnect the PC from the local network.
2. Open the **Properties** dialog of the network connection your ethernet adapter is assigned to. Usually you will find the appropriate network connection by opening **Network Connections** from the Windows start menu or the System Settings. The following list shows the steps to follow on a Windows XP operating system:

(a) Click on the start button, and then on *Control Panel*.

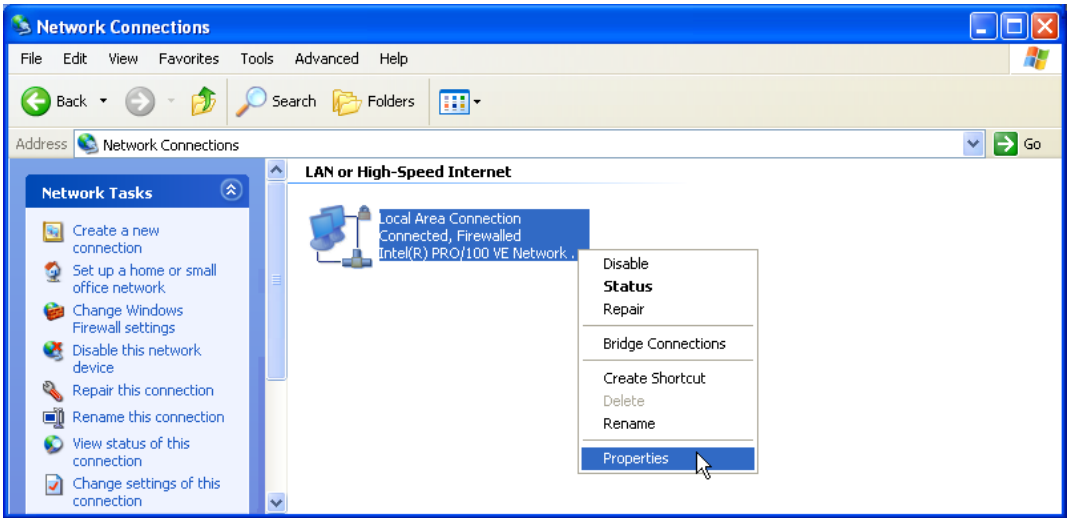
(b) Once the control panel has come up click on *Network and Internet Connections*.



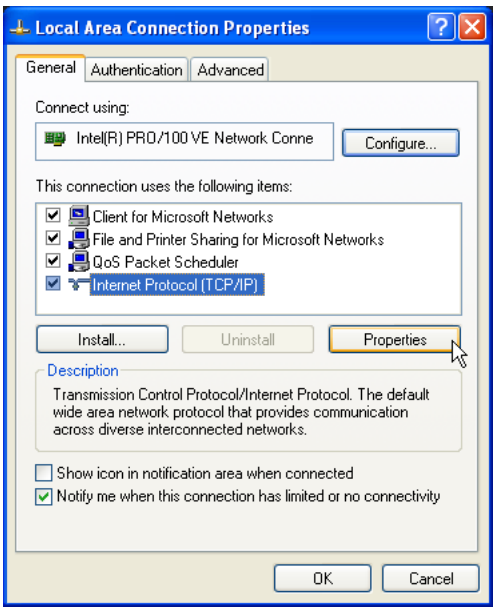
(c) In the next window click on *Network Connections*.



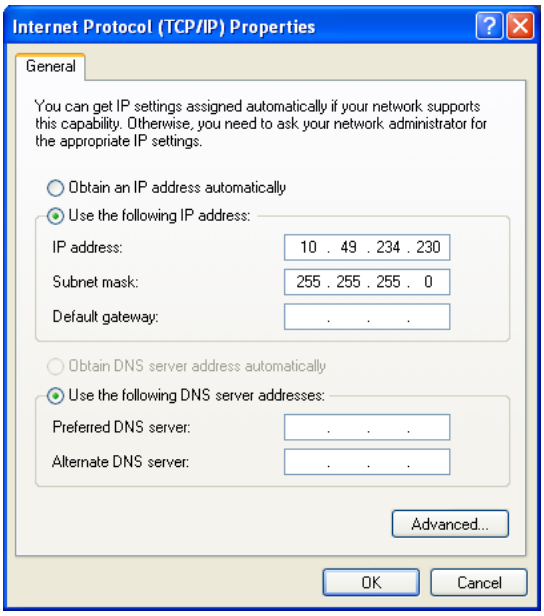
(d) The installed network connections will be shown, right-click on the local ethernet connection to be used with the Licel Ethernet Controller and choose **Properties** from the context menu.



3. Click on the TCP/IP protocol entry in the lists of components used by the assigned ethernet adapter card / LAN connection and press the *Properties* button.



4. Write down your current TCP/IP settings. You will need this information to reconfigure your PC to access the LAN again.



5. If activated disable DHCP (checkbox *Obtain an IP address automatically*) and manually assign an IP address within the default address range of the Licel Ethernet Controller. A good choice would be `10.49.234.230`.
6. Quit the dialog by pressing *OK*.
7. Reboot your PC.
8. Power up the rack with the Licel Ethernet Controller and connect the PC with the controller using the red **crosslink cable** shipped together with your hardware.

Now you should be able to access the Licel Ethernet Controller via your ethernet card. Please test this first connection with the methods given in the next section.

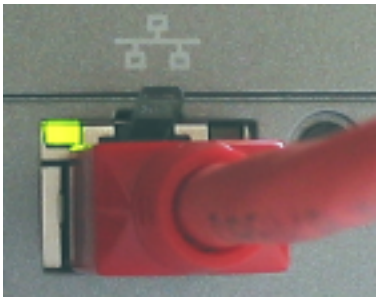
4.2.2 Diagnostics

Please carry out the following steps to verify that the connection of the Licel Ethernet Controller with the PC is established.

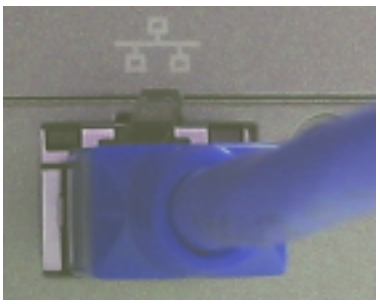
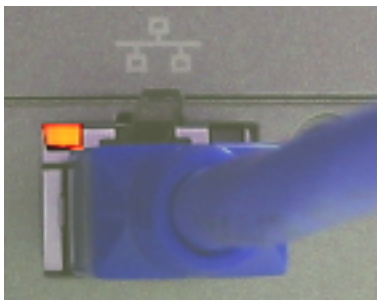
1. Verify that the green **LNK** LED lights up indicating a correct electrical connection.
2. Verify that in case of a 100Mbit ethernet connection the **Spd** ligths up.
3. Verify that the network settings of your PC have changed according to your settings:
   (a) Open a command prompt window (DOS box).
   (b) Type `ipconfig` and press enter. At least one of the ethernet adapters should show the address that you previously set (`10.49.234.230`). The response should be simular to the following:

```
1 Ethernet Adapter :
        IP-Address. . . . . . . . . : 10.49.234.230
        Subnet Mask . . . . . . . . : 255.255.255.0
        Standard-Gateway. . . . . . :
```

4. Verify that the Licel Ethernet Controller is accessable via the network now:
   (a) Open a command prompt window (DOS box) or use the one from above.
   (b) Type `ping 10.49.234.234` and press enter. The Licel Ethernet Controller should respond without loss of any packet. If the controller is not responding check if the network cable is correctly mounted and that an appropriate cable is used, i.e. a crosslink cable when working with a direct connection from the computer. Most ethernet adapters indicate a correct connection with a green LED:



A non-existent or incorrect connection is often identified by an unlighted LED (left) or red LED (right).

Please note that these indicators may be different on your PC.

   (c) If the network cable connection is correct and the controller is still not responding execute a hardware reset and repeat the procedure with the default IP address.

4.3 Network Setup

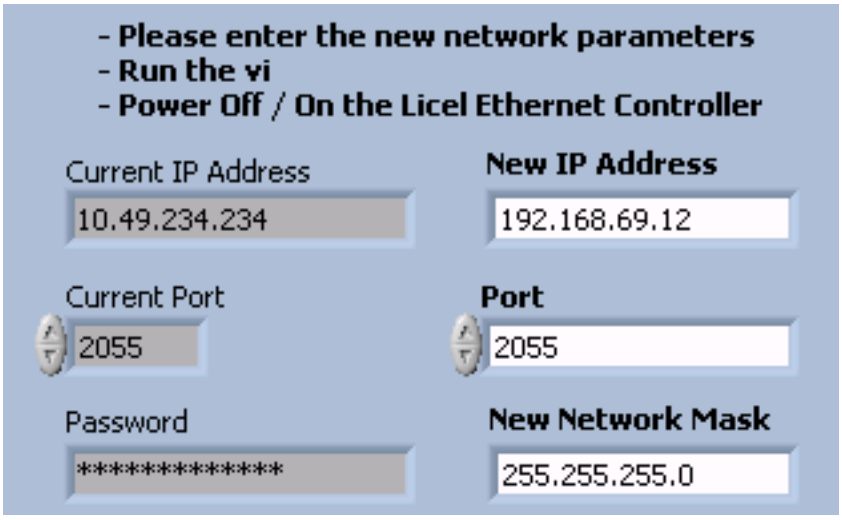
In order to configue the ethernet controller, you need either to set the controller to a fixed IP address or invoke the DHCP Mode. Whether a fixed or dynamic (DHCP) mode is used or not will depend upon your network type. Dependent on this, please refer either to the subsection Fixed IP Address or DHCP Mode and skip the corresponding other subsection. Please contact your administrator if you have not yet requested the information described in the above subsection Network Setup.

Once you have set the **IP Address** and **Port** for the Licel Ethernet Controller you should define these values to be used by the software.

4.3.1 Fixed IP Address

If you need to set the controller to a fixed IP address carry out the following steps. Skip the steps described in next subsection DHCP Mode.

1. Open `Licel TCPIP Set New Fixed IP Address.vi` or the corresponding Windows application from the Windows start menu.

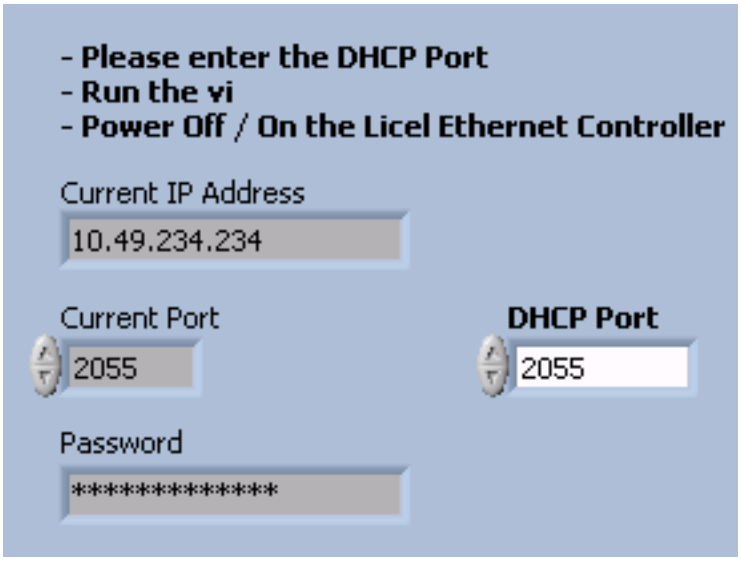


2. Set the desired network parameters in the fields **New IP Address**, **Port**, and **New Network Mask**.
3. Do not forget to enter the correct administrator **Password**.
4. Run the vi by pressing the start button. It should finish without opening an error message dialog.
5. Turn the Licel Ethernet Controller off and switch it on again. Wait **approximately 20 – 30 seconds**.
6. A `ping 10.49.234.234` executed from a command prompt (DOS box) should now time-out.

4.3.2 DHCP Mode

In order to configure the Licel Ethernet Controller for DHCP operation carry out the following steps. You must have skipped the steps described in the last subsection Fixed IP Address.

1. Open `Licel TCPIP Activate DHCP Mode.vi` or the corresponding Windows application from the Windows start menu.



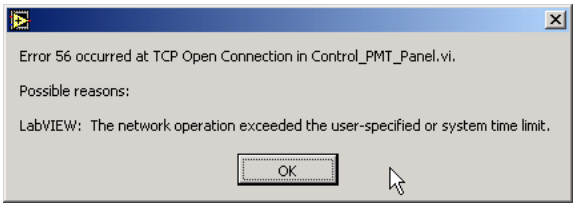
2. Set the desired **DHCP Port** number.

3. Do not forget to enter the administrator administrator **Password**.
4. Run the vi by pressing the start  button. It should finish without opening an error message dialog.
5. Turn the Licel Ethernet Controller off and switch it on again. Wait **approximately 20 – 30 seconds**.
6. A `ping 10.49.234.234` executed from a command prompt (DOS box) should now time-out.

4.3.3 Normal Network Operation

After you successfilly configured the Licel Ethernet Controller the following last steps have to be carried out.

1. Reconnect the PC to the local network.
2. Open the **Properties** dialog of the network connection your ethernet adapter is assigned to. A more detailed instruction has been given above.
3. Open the **Properties** dialog of the TCP/IP protocol entry in the lists of components used by the assigned ethernet adapter card.
4. Reset your current TCP/IP settings to the values you recorded while processing the subsection to establish a network connection.
5. Quit the dialog by pressing *OK*.
6. Reboot your PC.
7. Connect the Licel Ethernet Controller with your local network through a hub or switch using an **ordinary patch cable**.
8. Execute a `ping` command from a command prompt (DOS box). Use the IP adress you assigned to the Licel Ethernet Controller. If the ethernet controller is in DHCP mode, you need to ask your system admininstrator for the assigned network address. The `ping` command's response should indicate a correctly working connection.
9. Test the access using `Licel TCPIP Getting Started.vi` or the corresponding Windows application to be started from the Windows start menu.
10. A TCP/IP timeout error with LabVIEW's error code 56 may be caused by a wrong IP address.

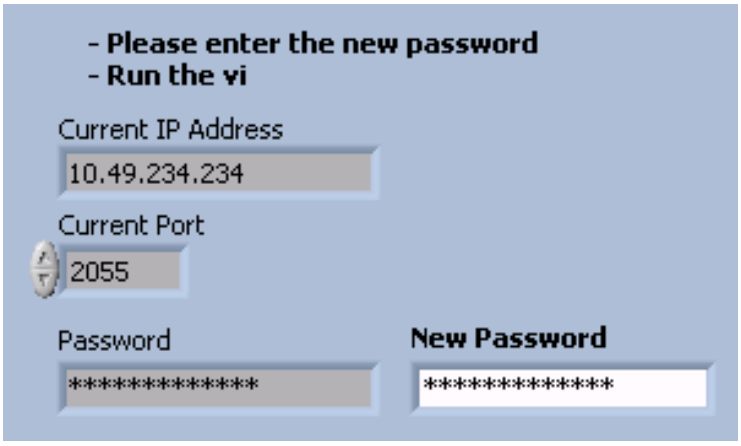


Please check carefully that the values for **IP Address** and **Port** match with the parameters set at the Licel Ethernet Controller. Set the correct values as defaults for future operation. Other reasons for errors with code 56 are non-existing connections (check if the cable in use is correct) or unstable network operation.

4.3.4 Changing the Administrator Password

The Licel Ethernet Controller is shipped with the default administrator password "'*Administrator*"'. In order to change this password which grants administrative access to the controller, please carry out the following steps:

1. Open `Licel TCPIP Set New Password.vi` or the corresponding Windows application from the Windows start menu.



2. Enter the Current administrator **Password**.
3. Enter the **New Password**.
4. Run the vi by pressing the start button. It should finish without opening an error message dialog. Please note that the password is case sensitive.

4.4 TCP/IP Connection Parameters

To work properly with the Licel Ethernet Controller both the Windows applications and the LabVIEW software must be able to establish a TCP/IP connection. The user of the software must define the **IP Address** and **Port** – these values must be equal to the parameters that have been for the Licel Ethernet Controller following the network setup section.

Defining the **IP Address** and **Port** is different for the Windows applications and the LabVIEW sources.

Windows Applications: Initialization Files

The Windows applications communicating with the Licel Ethernet Controller use initialization files to read their TCP/IP parameters **IP Address** and **Port**.

An example for an initialization file holding the TCP/IP information is given below:

```
[IP_Configuration]
Use_Ini_File_Values=TRUE
IP_Address=10.49.234.234
Port=2055
```

You may edit this file using a text editor like `Notepad` which is installed by default when setting up a Windows operating system. You may use `Notepad` as well to create a required initialization file if it does not exist in the installation directory. Make sure that you save the file before leaving the editor. You must change the values for IP address and port to the values you will set following the Instructions in the network setup section.

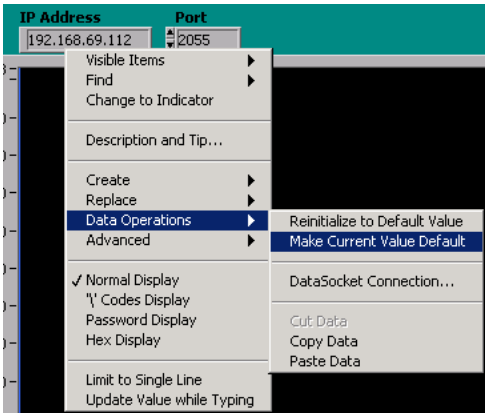
Here is an overview of the initialization file names used by the Licel Windows applications for reading the TCP/IP information:

Windows Application	**Initialization File**
`Control APD.exe`	`Control_APD_Panel_IP_Values.ini`
`Control PMT.exe`	`Control_PMT_Panel_IP_Values.ini`
`TCPIP Acquis.exe`	`TCPIP-Acquis_IP_Values.ini`
`TCPIP Live Display.exe`	`TCPIP Live Diplay TCPIP_IP_Values.ini`
`TCPIP Pulse Height Distribution.exe`	`TTCPIP-Pulse heigth-disribution_IP_Values.ini`
`TCPIP Track.exe`	`TCPIP Track_IP_Values.ini .`
`Control APD-PMT.exe`	`Control_APD-PMT_Panel_IP_Values.ini`

LabVIEW: Setting Default TCP/IP Parameters

The initialization files described above are necessary for the Windows applications because there it is not possible to set specific values as default values for control fields. However, when running the software within a LabVIEW development environment, default values can be defined for controls on the panel of a LabVIEW vi. This is especially convenient and recommended for the TCP/IP parameters **IP Address** and **Port**. Change the values to the values you set following the Instructions in the network setup section.

1. Open the vi using LabVIEW, do not run the vi.
2. Enter the value for the IP address into the control named **IP Address**.
3. Right-click on the control **IP Address** ⟶ the context menu opens.
4. Select **Data Operations** ⟶ a sub menu opens.
5. Select **Make Current Value Default**.



6. Repeat this procedure for **Port**.
7. Save the vi.

4.5 Network Security

The Licel Ethernet Controller might be the target of an attack. The best protection against this is to run the controller with a private IP address beyond a firewall. Firewalls are designed to protect against various types of attacks that can not be covered by the ethernet controller. Licel strongly recommends the use of a firewall/router combination to prevent unauthorized use of the hardware.

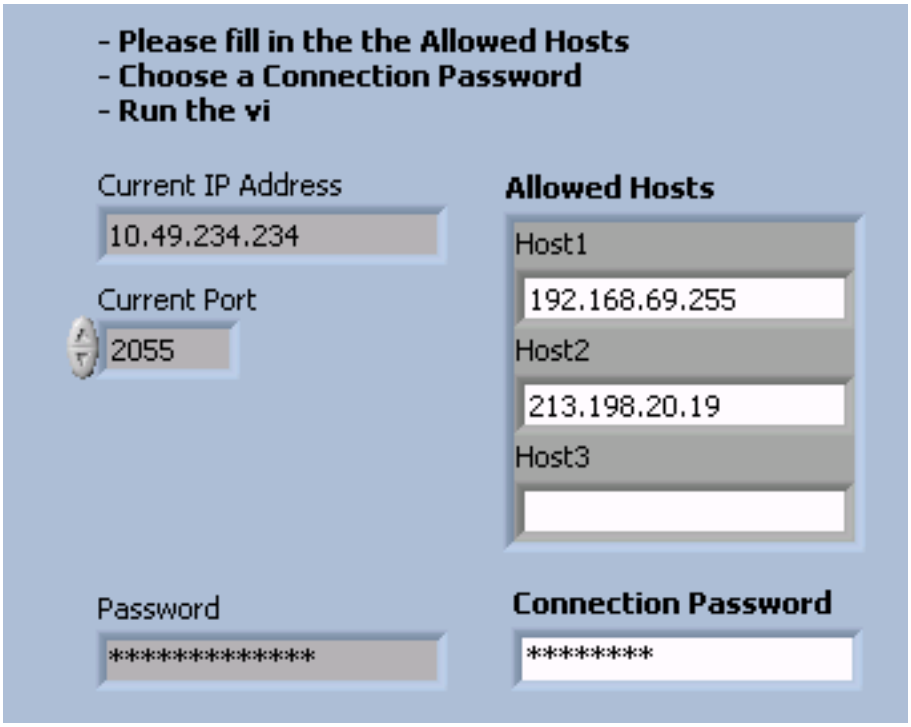
Starting with firmware versions from 2005-02-22 (`state53`) the Licel Ethernet Controller has an additional level of security that can be additionally used.

This secure mode combines whitelisting of allowed hosts with an encrypted password transmission scheme.

4.5.1 Enabling the Secure Mode

In order to enable the Secure Mode for the Licel Ethernet Controller carry out the following steps:

1. Open `Licel TCPIP Enable Secure Mode.vi` or the corresponding Windows application from the Windows start menu.



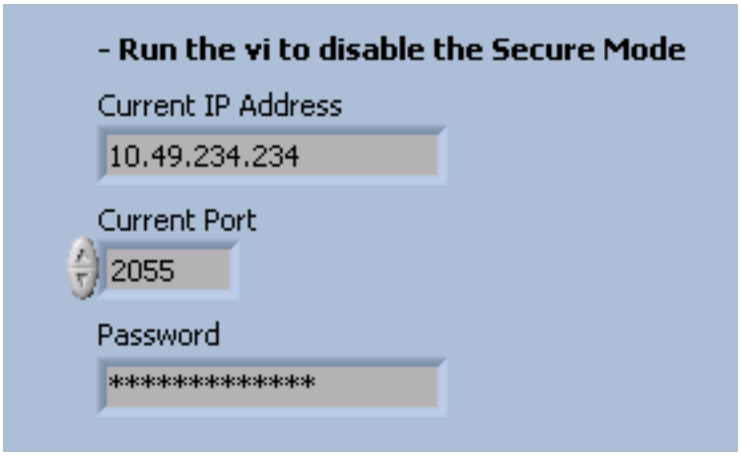
2. Set the desired whitelist of allowed host IP addresses or address ranges. An entry in the list of **Allowed Hosts** is either
   - a host specified by its IP address `xx.xx.xx.xx` ,
   - an IP address range `xx.xx.xx.255` ranging from 0 to 255, or
   - empty .

   At least one valid entry must be submitted. Do not forget to include the IP address of the PC you are currently using.
3. Set the **Connection Password**. This password must be used by clients accessing the Licel Ethernet Controller as long as the secure mode is enabled. Refer to the `LOGON` command for further details. Please note that the password is case sensitive.
4. Do not forget to enter the administrator **Password**.
5. Run the vi by pressing the start  button. It should finish without opening an error message dialog.
6. The vi will write an initialization file `LicelTCPIP.ini` with appropriate keys and values. These values are used by the sample applications while establishing a connection to the controller. Distribute the initialization file to all PCs the sample programs are installed on.
7. Test the access using `Licel TCPIP Getting Started.vi` or the corresponding Windows application to be started from the Windows start menu.

4.5.2 Disabling the Secure Mode

In order to disable the Secure Mode for the Licel Ethernet Controller carry out the following steps:

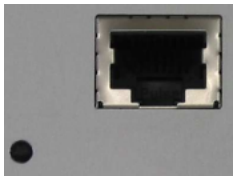
1. Open `Licel TCPIP Disable Secure Mode.vi` or the corresponding Windows application from the Windows start menu.



2. Do not forget to enter the administrator administrator **Password**.
3. Run the vi by pressing the start button. It should finish without opening an error message dialog. Note that this vi can only be used if the Licel Ethernet Controller is running in secure mode and if a valid initialization file `LicelTCPIP.ini` is located in the directory where the vi's library resides.
4. The vi will update the initialization file `LicelTCPIP.ini` with appropriate keys and values. These values are used by the sample applications while establishing a connection to the controller. Distribute the initialization file to all PCs the sample programs are installed on.

4.6 Hardware Reset

A reset is performed by pressing the reset switch while powering up the controller. The reset switch is located inside a hole close to the RJ45 connector.



To reset the system

- turn off the controller unit
- press the switch inside the hole with a small screw driver, allen key or anything similar
- turn the rack on while keeping the switch pressed, release the switch 5 seconds after switching the unit on, wait for 45 seconds.

After a reset

- the controller has the default IP address
- the port number is reset to the default value
- the controller operates in its fixed IP address mode
- the password is reset to the default password.

Chapter 5

Transient Recorder Software Tutorial

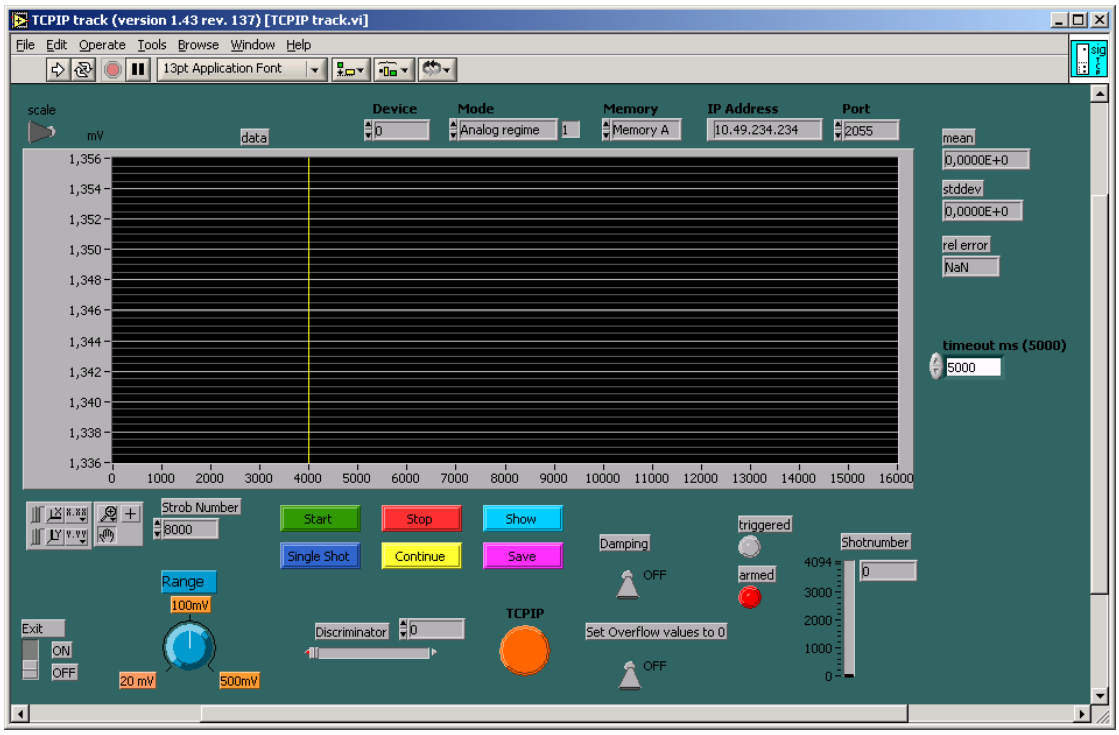
5.1 Overview

This sofware tutorial describes how to use the data acquisition software as well as the functions of the individual controls and indicators. In order to actually try the information in this tutorial, the hardware and network setup must be completed. This tutorial is broken into two parts. The quick tour gives a brief introduction to recording spectra with the software module TCPIP Track and TCPIP Live Display. The First Acquisitions contains instructions for recording your first spectra using TCPIP Acquis.

5.2 Quick Tour

5.2.1 TCPIP-Track

You can load TCPIP Track by either double clicking on the `TCPIP-Track.llb` or by selecting the virtual instrument `TCPIP-Track.vi` in `TCPIP-Track.llb`. If you installed the Windows applications please start the program by selecting the corresponding entry in the Licel section of the Windows Start menu. After doing so, you should see a screen similar to the one below. TCPIP-Track is a program that can be used to access all the individual functions of the transient recorders. It allows you to control one individual recorder at a time.



If you have completed the hardware setup and configured the network you should be ready to experiment with the software. Do the following steps to get a brief introduction of the software TCPIP-Track.

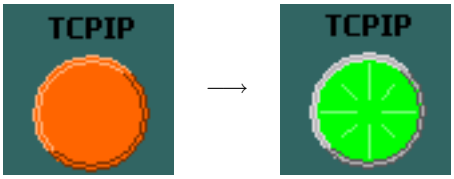
1. Before you start please enter the correct values for the **IP Address** and **Port**. You should already have set these values for the Licel Ethernet Controller following the network setup section above.

   - Using the LabVIEW vi, just enter the required values and save them as defaults.
   - If you RUN the Windows application you must set the values in the initialization file `TCPIP Track_IP_Values.ini`. You will see the full path of the file in a file path indicator.

2. To start the program press the **Run** button at the top left of the screen.

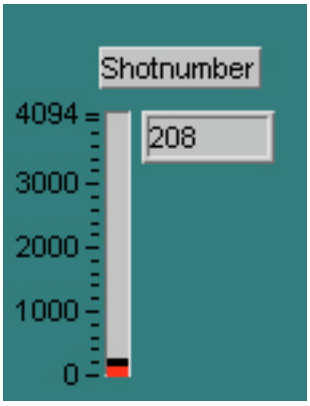
   The Windows application will start automatically when called for the first time.

3. After a short time the **TCPIP** indicator should change its color from red to green indicating a successfull connection with the Licel Ethernet Controller. If the indicator remains red and/or an error is indicated, please check the values for **address** and **Port**, change them (on the program's panel or in the initialization file) if necessary. Check if the Licel Ethernet Controller is running and that all network connections are correct. The LED of the transient recorder should be lit up.



4. Press the **Start** button directly below the waveform graph.

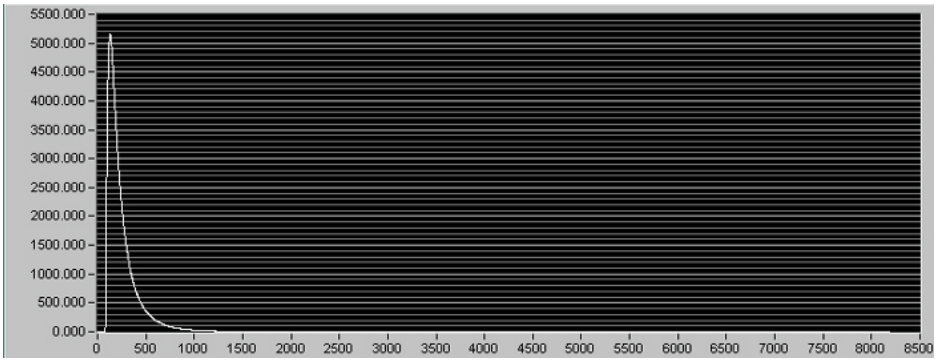
5. After pressing Start, the **Shotnumber** should start increasing from 0 towards 4094. The shotnumber is increased by one for every trigger pulse that is recieved.



6. Press the **Stop** button after a few seconds to stop the acquisition

7. Press the **Show** button to display the results.

8. You will see the acquired signal in the graph window. Your signal will differ depending upon your system configuration. The example below is the simulation of a well aligned low noise system.



9. The data set that is displayed after pressing the **Show** button is selected by the **Mode** switch at the top of the waveform graph.

When **Photon Counting** is chosen, the accumulated data from the counting chain is displayed. When the **Analog** is selected, the ADC data is displayed. The data set is further specified by the **Memory** switch. The Memory A corresponds to acquisitions which were triggered by Trigger A, and the Memory B corresponds to acquisitions triggered at input B. If only one trigger input is connected to the trigger source, only one memory can hold data different from 0.

10. Press **Continue** to continue accumulation without clearing the memory. Pressing **Start**would clear both memories.

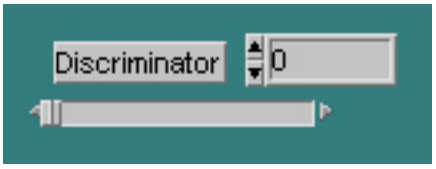
11. After a few seconds press the **Stop** button followed by the **Show** button and notice how the signal-to-noise ratio has improved.

12. Change the input sensitivity with the **Range** knob located at the bottom left.

The three displayed millivolt values indicate the full scale negative voltages.

13. Take a new acquisition by repeating steps 1 through 7 to see the influence of the input range.
14. Press the **Stop** button to stop the acquisition.
15. Connect a photomultiplier to the signal input on the transient recorder and switch to photon counting mode.

16. Using the **Discriminator** slide, you can set the discriminator level between 0 and 63.



Change to the photon counting mode and make a few acquisitions to see how the count rate is influenced by the discriminator setting.

17. Change back to analog mode
18. Turn the **Damping** switch on and make a new acquisition

This reduces the counting rate since the discrimator level is set four times as high.

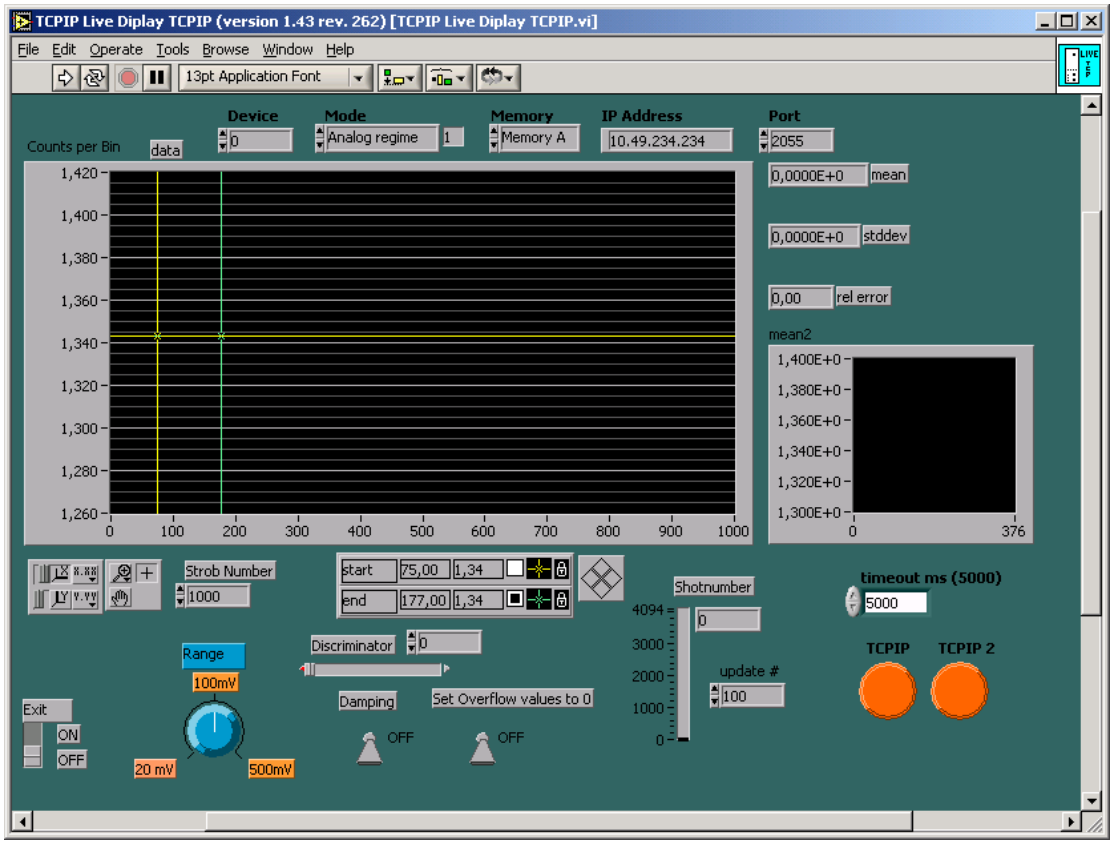
19. The **triggered** lamp is turned on if a shot is acquired while the program makes a status request. The **armed** lamp below the trigger lamp lights up when the transient recorder is waiting for the next trigger event while the program makes a status request.

20. Slide the **Exit** switch to *On* to stop the program.

That's the end of the short introduction into the capabilities of the data acquisition software TCPIP-Track.

5.2.2 TCPIP-Live Display

TCPIP-Live Display allows you to operate the transient recorder in an oscilloscope mode, where the display is updated every X number of shots. This mode is very useful when you are trying to align the optics on your system and would like to see how the changes affect the signal. To load TCPIP-Live Display, either double click on the `TCPIP-Live Display.llb` or open the file `TCPIP-Live Display Main.vi` in the `TCPIP-Live Display.llb`. If you installed the Windows application please start the program by selecting the corresponding entry in the Licel section of the Windows Start menu. After this the following interface appears:



As you can see, the interface is quite similar to that of TCPIP-Track. The main difference is that the button controls start, stop, show, single shot, continue and save buttons are missing. Instead, there is an **update #** control and a second graph called **mean2**.

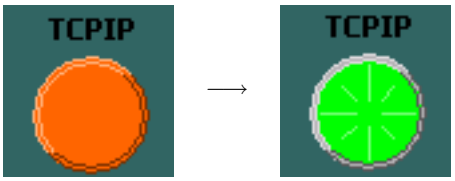
1. Before you start please enter the correct values for the **IP Address** and **Port**. You should already have set these values for the Licel Ethernet Controller following the instructions in the network setup section.

   - Using the LabVIEW vi, just enter the required values and save them as defaults.
   - If you use the Windows applications you must set the values in the initialization file `TCPIP Live Diplay TCPIP_IP_Values.ini`. You will see the full path of the file in a file path indicator.

2. To start the program press the **Run** button at the top left of the screen.

The Windows application will start automatically when called for the first time.

3. After a short time the **TCPIP** indicator should change its color from red to green indicating a successfull connection with the Licel Ethernet Controller. If the indicator remains red and/or an error is indicated, please check the values for **address** and **Port**, change them (on the program's panel or in the initialization file) if necessary. Check if the Licel Ethernet Controller is running and that all network connections are correct. The second TCPIP indicator should change to a green color after some time, too. This second connection is used to directly tranfer data from the transient recorders to the acquisition computer if the **update** # is smaller than 15.

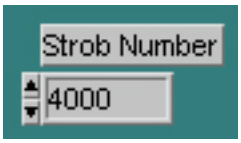


4. Notice that the **Shotnumer** indicator immediately starts to increase. When **Shotnumber** is equal to **update** #, the signal data is read from the transient recorders and displayed.

5. Set the **update** # to 100.

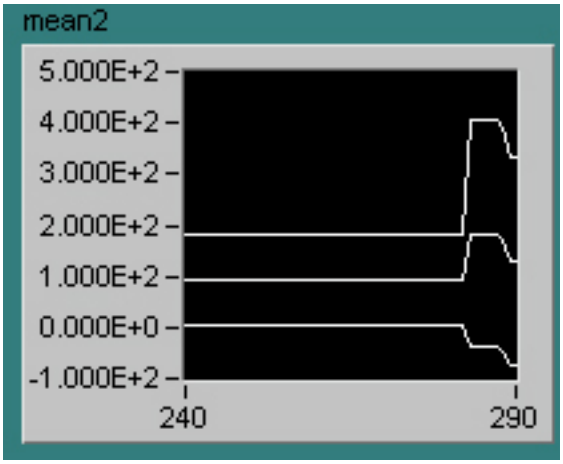
If your trigger is operating at 10Hz, the data display will now be updated every ten seconds. By changing this value, you decide how many shots will be taken between subsequent updates of the display.

6. Set the Strob Number to 4000



notice that the length of the signal on the x-axis is now 4000. This indicates that only the first 4000 bins of the transient recorder memory are being read out and displayed.

7. Move the cursors to select part of the signal on the waveform graph. The region between the two cursors is averaged and displayed in mean2. Additionally the +/- one standard deviation lines are shown as well.



If you have questions about the other controls, please consult the previous section about TCPIP-Track.

5.3 First Acquisitions

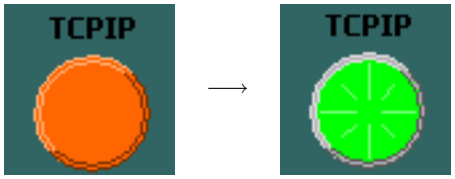
In this section, you will be introduced to the TCPIP-Acquis software module. Before starting acquisitions, you should configure the default global information to correspond to geographical details of your location, so that this information can be properly included into the headers of the data files. After that, you will set up the Transient Information which is specific to your data sets. If you have already aligned these parameters, you can directly jump to the TCPIP-Acquis section to make an acquisition. Please note that `TCPIP-Acquis` uses the initialization file `acquis.ini`.

5.3.1 Configuring The System

In this section you will learn how to configure the system parameters. To do so, you need to load TCPIP-Acquis. To load TCPIP-Acquis, either double click on the `TCPIP-Acquis.llb` or open the file `TCPIP-Acquis.vi` in the `TCPIP-Acquis.llb`. If you installed the Windows applications please start the program by selecting the corresponding entry in the Licel section of the Windows Start menu.

1. Before you start please enter the correct values for the **IP Address** and **Port**. You should already have set these values for the Licel Ethernet Controller following the instructions in the network setup section.
   - Using the LabVIEW vi, just enter the required values and save them as defaults.
   - If you use the Windows application you must set the values in the initialization file `TCPIP-Acquis_IP_Values.ini`.
2. To start the program press the **Run** button at the top left of the screen.

   The Windows application will start automatically when called for the first time.
3. After a short time the **TCPIP** indicator should change its color from red to green indicating a successfull connection with the Licel Ethernet Controller. If the indicator remains red and/or an error is indicated, please check the values for **address** and **Port**, change them (on the program's panel or in the initialization file) if necessary. Check if the Licel Ethernet Controller is running and that all network connections are correct.



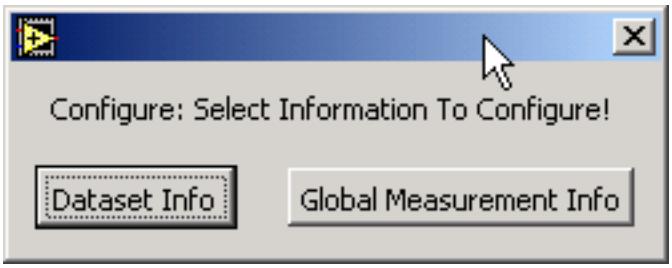
If the program is already running and not acquiring data then continue. Otherwise press the **Stop** button and then you may continue with the following steps.

5.3.2 The Global Information

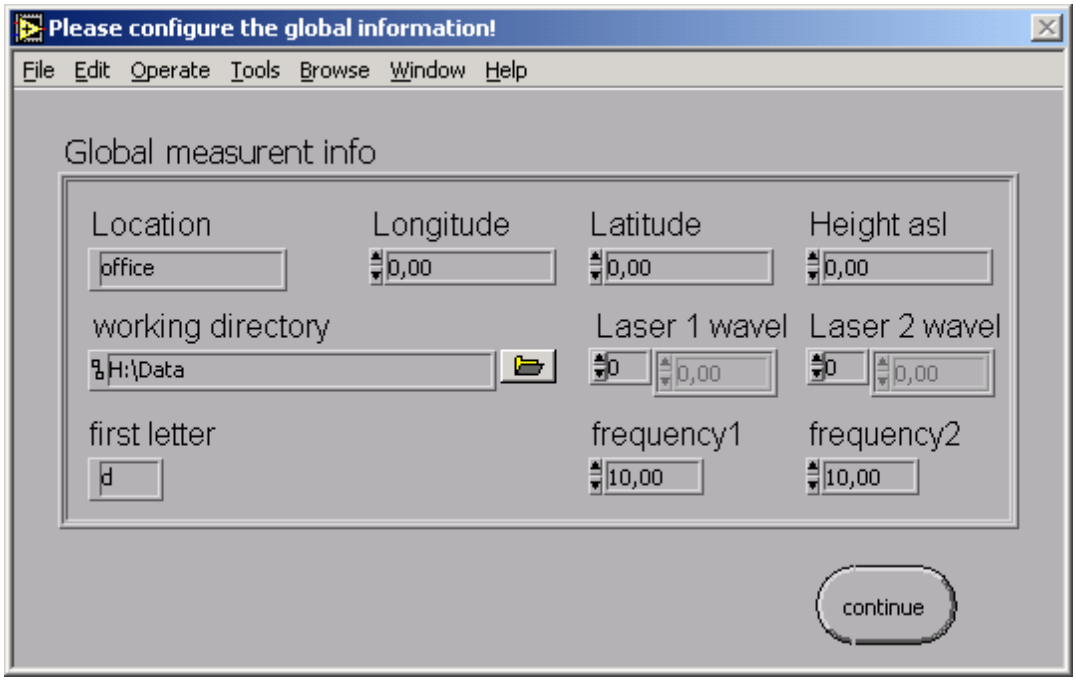
The global information allows you to set values that are stored in the data file headers which will tell you later about what sort of conditions were existent at the time the data was acquired. These are global values which usually do not vary from measurement to measurement and so it is named *Global measurement info*.

1. The global information is accessed by pressing the **Config** button.

2. After pressing the configuration button, the following screen is displayed



3. Select **Global Measurement Info** and the following screen appears



The **working directory** is the location where you want data files to be stored and the **first letter** is a letter that will be used as a prefix for the file names. Directly enter the path of the **working directory** into the control field or browse your file system using the browse button. The **first letter** is used to generate the file name of the data files. The format of the file names is

`?YYMDDhh.mmssxx`

where `?` is the **first letter**, `YY` is the year of the century, where `M` is the month (hexadecimal, 0 – C), `DD` is the day of the month, `hh` is the current hour of the day, `mm` are the minutes, `ss` the seconds, and xx the first 2 decimal places of the seconds.

For example the filename

`a0552011.281650`

is a file that would have been taken on May 20, 2005 (or 2105...). The operator set a to be the first letter (as in the screenshot) and the time was 11:28:16.50.

The other information above has no effect on the program execution, it is only stored in the data file headers for later reference. The fields available are your current **Location** (e.g. Berlin), the **Longitude** and **Latitude** of your location, the **Height asl** (above sea level) of the location of your acqusition system, and the repetition rates and wavelengths of your lasers (**frequency1**, **Laser 1 wavel**, **frequency2**, **Laser 2 wavel**).

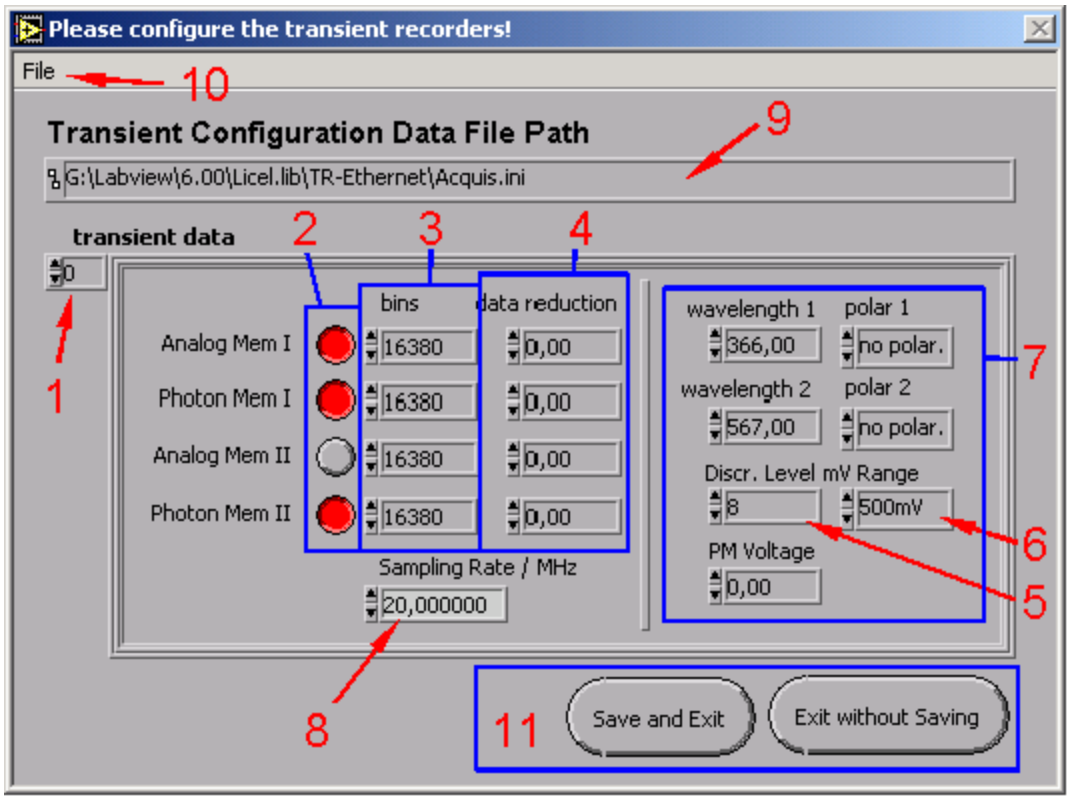
Upon starting, the program preloads the information that it finds in the file `global info.ini` that is located in the same directory as the libraries or the Windows applications, respectively. The changes you make here will be saved there when leaving the dialog by pressing **Continue**.

5.3.3 Configuring the Transient Recorders

If the program is not currently running then please start the program by pressing the start arrow. If the program is running and not acquiring data then please continue. Otherwise press the *Stop* button and continue with the following steps.

The data set information contains all the information needed to configure the transient recorders. To access it, press **Config** and select **Dataset Info**.

After doing this, the default transient information found in the file `Acquis.ini` is preloaded and the user is given the possibility of configuring the transient recorder information using the interface shown below



1. At position one, you see an index number that allows you to set the parameters for each transient recorder. The number shown here refers corresponds to the rack ID number of the transient recorder (valid values are 0-7 or 0-15 depending upon your equipment). You should completely configure a transient recorder before changing the index, although this is not necessary.

2. Position two shows which memory banks are active or inactive. If the button is red, then the memory bank has been activated, otherwise it is gray. The four memory banks are Analog Memory A, Photon Memory A, Analog Memory B, and Photon Memory B.

3. Position 3 determines the number of bins to be read out. The maximum number of bins is given by 16380/($2^{datareduction}$)

4. In position four you can set the data reduction which allows for binning. A data reduction level of 0,1 and 2 corresponds to a height resolution of $1\times$, $2\times$7.5m, and $4\times$ the length corresponding to a primary bin. For a 20 MHz transient digitizer these values correspond to 7.5 m, 15 m, and 30 m, respectively. Each increasing in value reduces the height resolution by 1/2 and doubles the number of bins that are combined together to make a superbin. Thus the levels 0,1,2 correspond to 1 , 2, and 4 bins per data point, respectively.

5. Position 5 is where you can set the discriminator level for the transient recorder. There are 64 discriminator levels (values 0 – 63) which correspond to either a range of 0 – 24 mV without gain reduction or 0 – 96mV with gain reduction.

6. In position 6, the range values of the transient recorder can be set. Valid values are 0 – 20 mV, 0 – 100mV and 0 – 500mV.

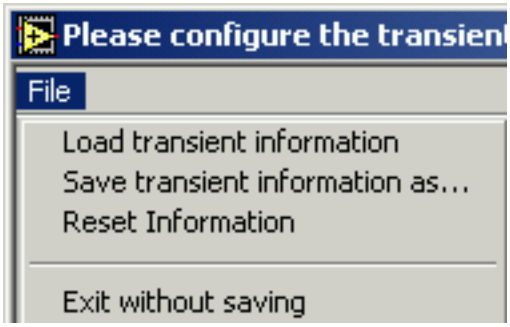
7. The other parameters in region 7 allow to enter further parameters which indicate the type of equipment that is used in this channel. This information is stored as a header in the data files, so that the user (or whoever has to evaluate the data) can see what parameters were used to take the data. The fields are used for the laser wavelengths (**wavelength 1,2**) and the corresponding polarizations (**polar1,2**), and the

photomultiplier voltage (**PM Voltage**). The information entered in these fields has no effect whatsoever upon the data acquisition. It is used purely to store information about the experimental setup in the data files.

8. The **Sampling Rate** is the sampling rate of the transient recorder. This value defaults to 20 MHz. Enter 40 into this field if you are using a 40 MHz TR.

9. At the top of the screen, point 8 shows the complete file path for the data that is currently being displayed.

10. The menu item file contains four sub-items that the user can choose from.



If you would like to edit an existing file, choose **Load transient information** and select a file. After doing this, the information including the file path as shown in point 8 will be updated to the new data that has been read from the file. After you have edited the data and are satisfied with the configuration, you can save the information by choosing **Save transient information as...** and either choose the same file name, which overwrites the old file, or give it a new name. If you have edited the data and have made a mistake, you can reload the original information by pressing Reset Information.

11. After you have finished configuring the transient recorders, you can exit the configuration program by either pressing the *Save and Exit* button, if you would like to save the information to the actual file path as shown, or, aternatively, you can press *Exit without Saving* or choose File→Exit in the pull down menu, if you would like to exit without saving your changes. Please note that when you exit the program without saving, any unsaved data is lost! Thus if you have configured the data and wish to keep it, you need to either choose Save and Exit or choose File→Save transient information as... from the pull down menu before you exit the program.

12. **If you want the current transient recorder configuration to be used as the default transient recorder information, you must save this data as acquis.ini in the directory where TCPIP-Acquis.llb or the Windows applications, respectively, are located.**

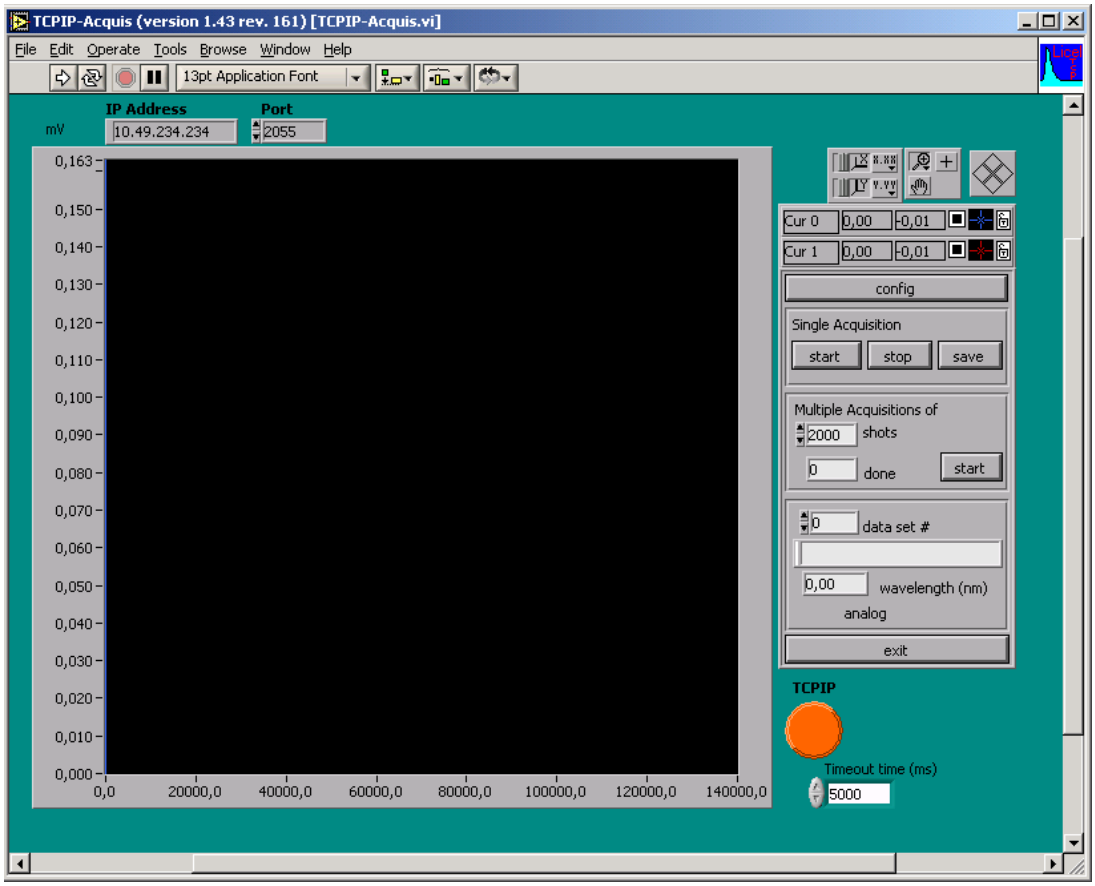
If you have followed the steps above, your transient recorders should now be configured for use with TCPIP-Acquis.

5.3.4 The TCPIP-Acquis Software Module

Now that the global and transient recorder information files are configured, it is time to take the first acquisitions with TCPIP-Acquis.

To load TCPIP-Acquis, either double click on the `TCPIP-Acquis.llb` or open the file `TCPIP-Acquis.vi` in the `TCPIP-Acquis.llb`.

If you installed the Windows applications please start the program by selecting the corresponding entry in the Licel section of the Windows Start menu. After doing so, you should see a screen similar to the one below.

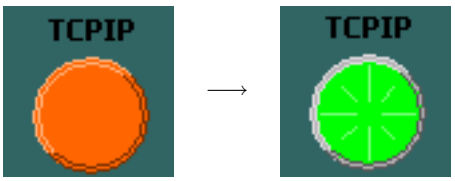


1. Before you start please enter the correct values for the **IP Address** and **Port**. You should already have set these values for the Licel Ethernet Controller following the instructions in the network setup section.
   - Using the LabVIEW vi, just enter the required values and save them as defaults.
   - If you use the Windows application you must set the values in the initialization file `TCPIP-Acquis_IP_Values.ini`. You will see the full path of the file in a file path indicator.

2. To start the program press the **Run** button at the top left of the screen.

   The Windows application will start automatically when called for the first time.

3. After a short time the **TCPIP** indicator should change its color from red to green indicating a successfull connection with the Licel Ethernet Controller. If the indicator remains red and/or an error is indicated, please check the values for **address** and **Port**, change them (on the program's panel or in the initialization file) if necessary. Check if the Licel Ethernet Controller is running and that all network connections are correct.



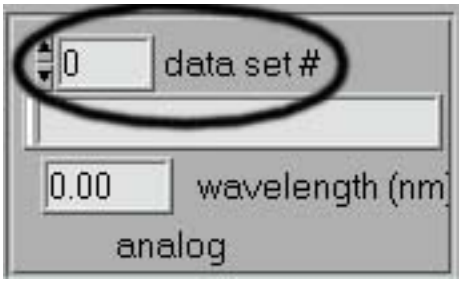
4. Press the **start** button in the single acquisition group.

The transient recorders, in which you have activated data sets, should now acquire data if a sufficient trigger signal is connected to the input. If the acquisition has been started, the **number of shots done** in the multiple acquisitions group should start increasing.

The data acquisition of the individual transient recorders can be checked by seeing if the Acquire LED of the specified transient recorder is brightly lit up. If not, the trigger is either insufficient, or the data sets are not activated as described in the section Changing the Transient Recorder Information.

5. Stop the acquisition in the same group by pressing the corresponding button.

6. By changing the **data set number**, you can now view the various data sets that were acquired. For each data set the wavelength and the acquisition mode (analog/photon counting) are indicated.



7. If you are satisfied with the data press **save**. The file is now renamed from temp.dat to a unique identifier.

8. In order to automatically make multiple acquisitions, you must first set first *number of shots* which will be acquired for each file. The **number of shots** to acquire should be so large that files are not saved faster than every 10 seconds (this requirement comes from the naming convention). If your laser is operating at a 10 Hz pulse rate, for example, you should acquire at least 100 shots per acquisition.

9. To start an automatic series of acquisitions, press the **start button** in the multiple acquisition group. This button then turns into a **stop button**.

The number of shots **done** will now start increasing and when the number *done* is equal to the number of **shots**, the data sets will be written to a file. After this, the program automatically starts acquiring the next data sets.

10. This process of automatically acquiring data sets of n shots continues until you press the **stop button**, which ends the multiple acquisition process.

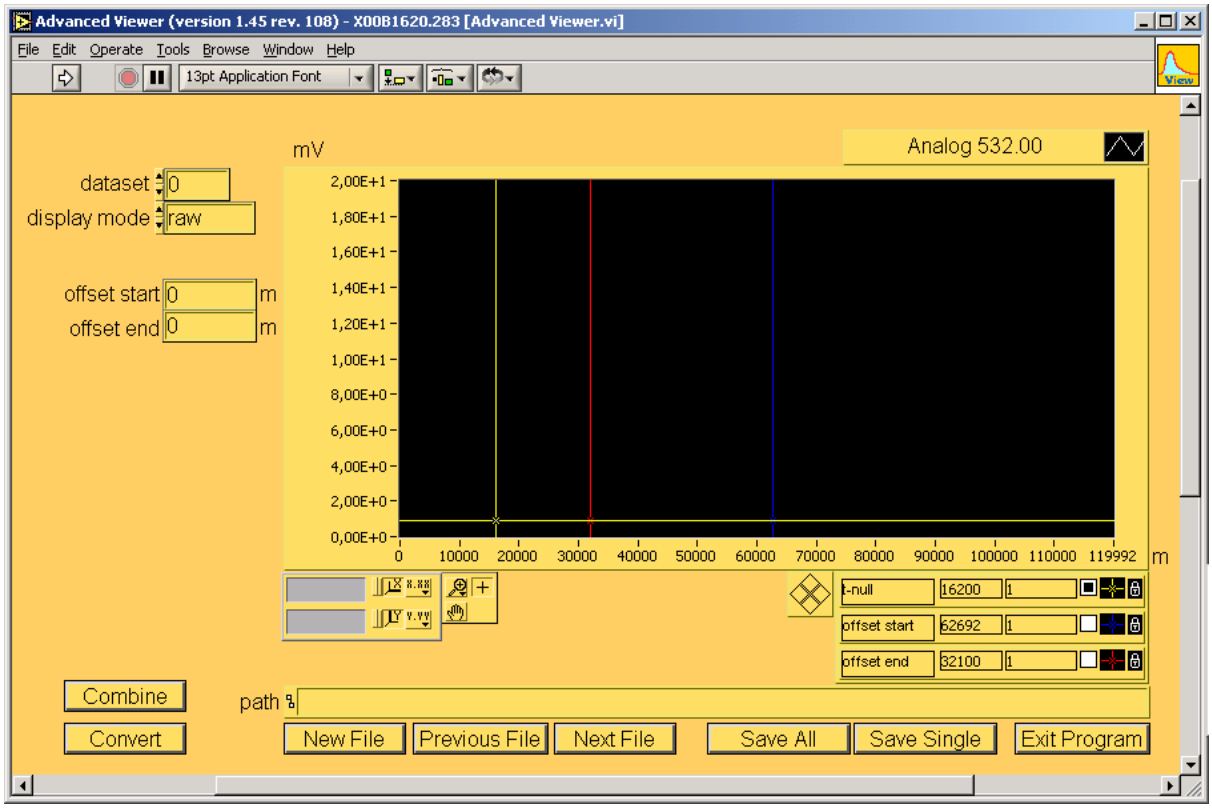
11. You can change the data set configuration or global information by pressing the **config button**. The changes to the data set configuration are applied to any acquisitions that you make after changing the configuration.

12. If you are done taking data and want to leave the program, press the *exit* button.

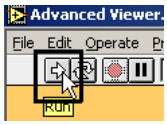
You should now have a first impression of the capabilities of the Licel data acquisition software and the capabilities of the transient recorders. You can use all vi's as raw material for your acquisition software.

5.4 Advanced Viewer

The Advanced Viewer is designed for reading data files created by Licel acquisition software like `TCPIP Acquis`. In order to demonstrate the capabilities of this program, you must already have acquired at least one dataset and saved it. For more information about acquiring data, please refer to the manuals for Acquis, Track and Live Display. After opening the `Advanced Viewer.vi` located in the `Advanced Viewer.llb`, you should see the following screen:

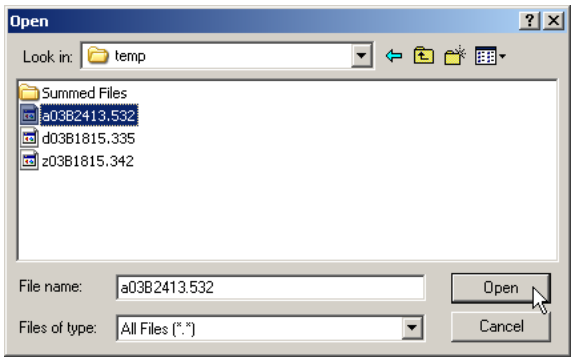


Press the run arrow to start the program.

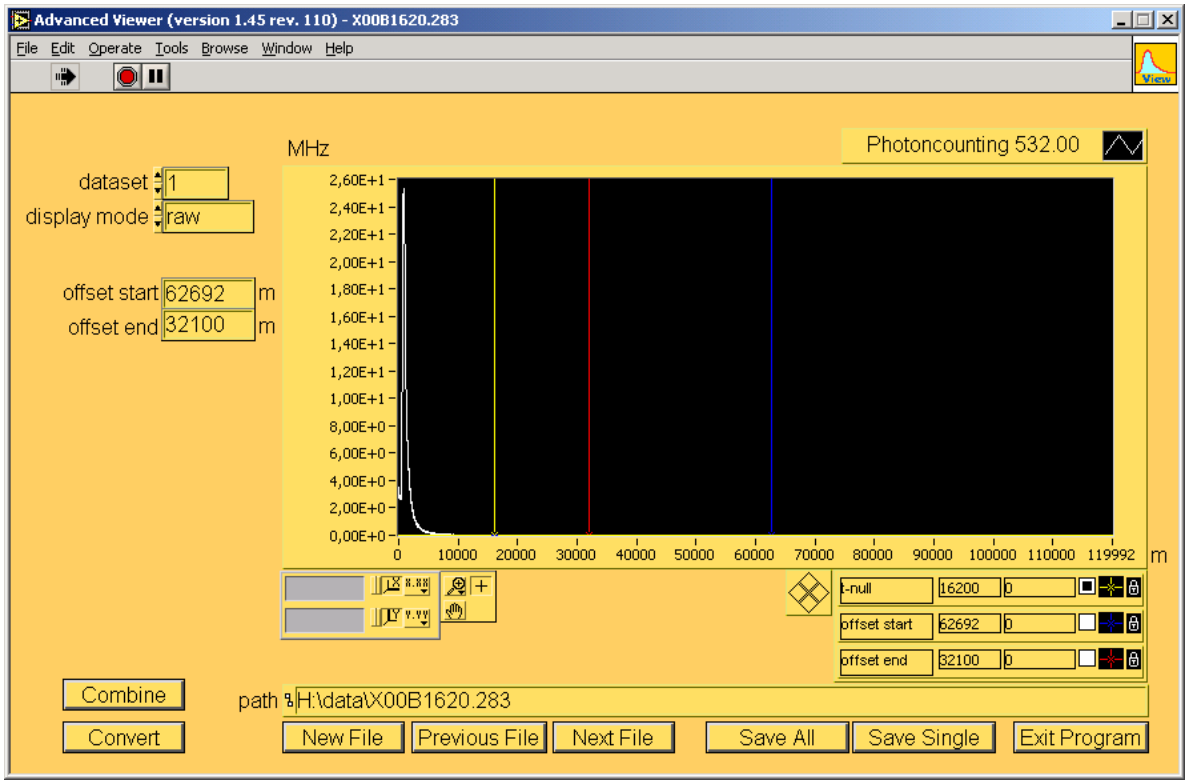


If a valid file was entered into the **path** control, the file will be loaded. Otherwise, load the desired file by pressing the **New File** button

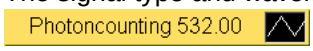
After pressing this button, a file dialog should appear and you will be asked which file you would like to load.



Select a valid file, press open and the dataset number specified by the **dataset** control should appear in the graph indicator.

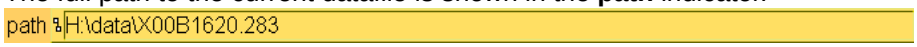


The signal type and wavelength are displayed in the graph legend

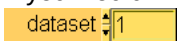


and the units used for the y-axis, which can be either megahertz or millivolts, are displayed in the upper left hand corner of the graph

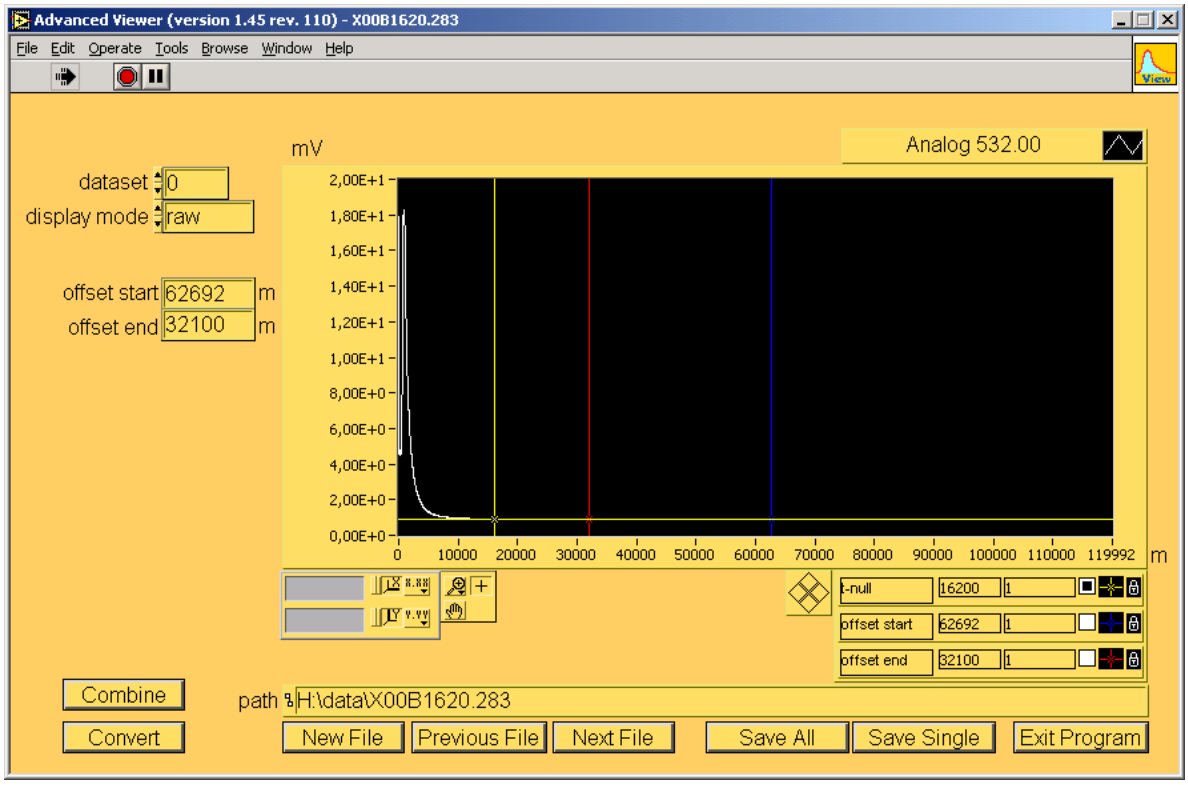
The full path to the current datafile is shown in the **path** indicator.



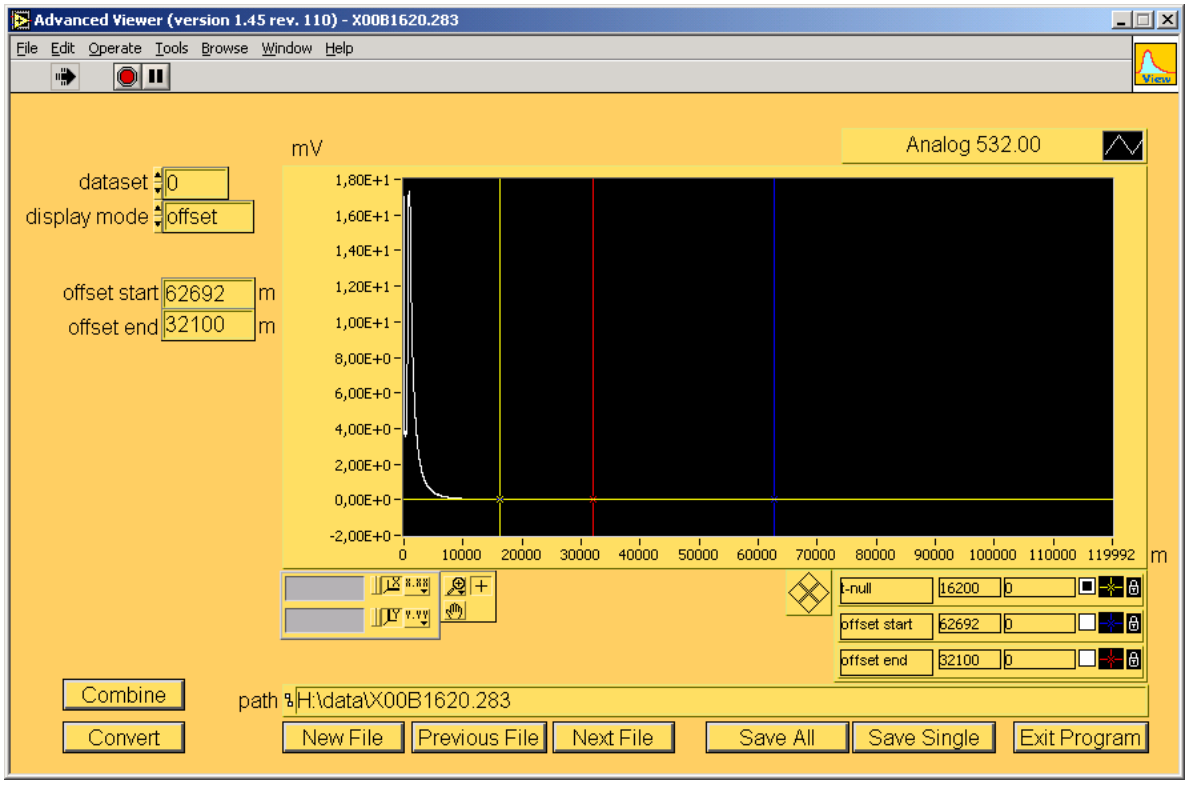
If you would like to see a different dataset which is in the file, use the **dataset** control to choose it.



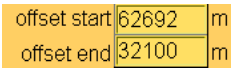
In this example, by switching to dataset number 0 in this file, the analog 532nm channel is displayed.

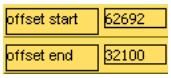


Note that the legend has changed to Analog 532 and the units have changed to millivolts. Currently the data is being shown in raw mode and we see that in the example above, that the baseline appears to have a value of about 1000. The **offset 1** and **offset 2** cursors can be used to correct for the baseline offset. If the **display mode** *offset corr.* is used, then the mean value of the signal between these two cursors will be subtracted from the signal in order to create a baseline corrected signal. Use the cursor controls to move the blue and red cursors (offset 1 and offset 2) to a region which will be evaluated to generate the new baseline. Change the **display mode** to *offset corr.* and observe that the baseline of the signal changes.

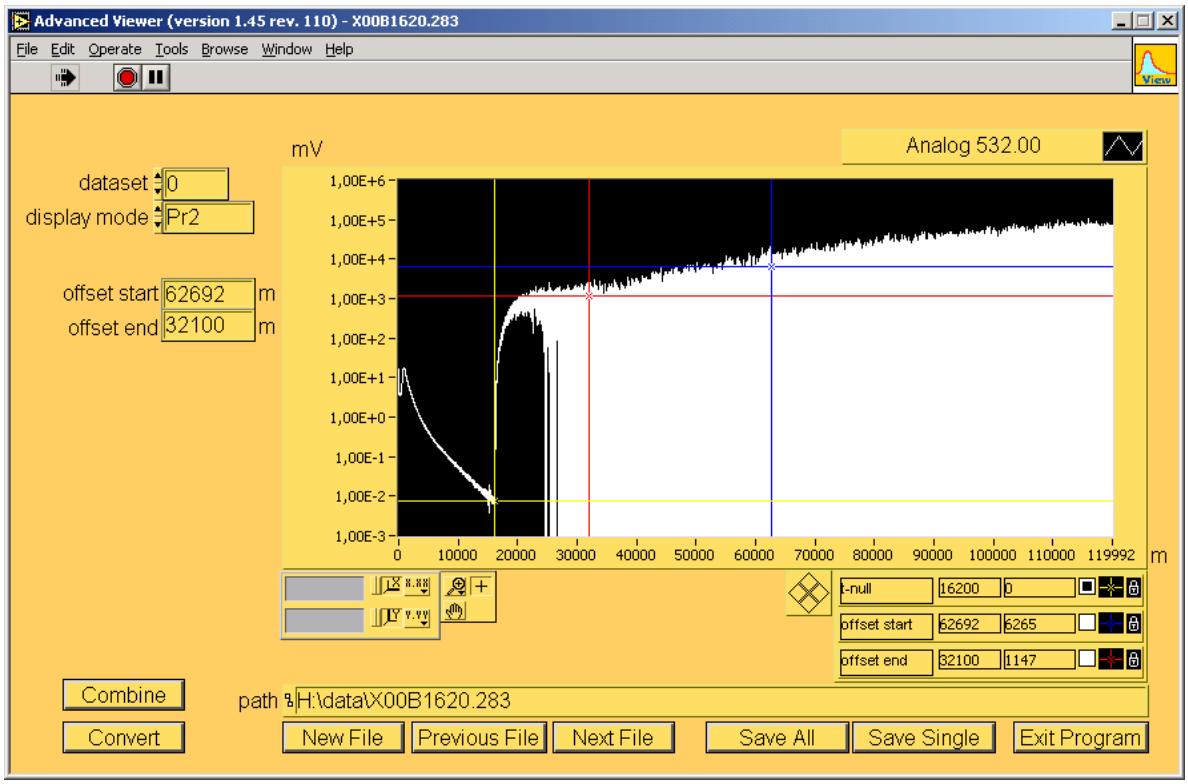


In the image above, you can see that the baseline is now close to zero. The end values of the region to be used to evaluate the baseline are shown in the **offset 1** and **offset 2** indicators as well as in the cursor controls.

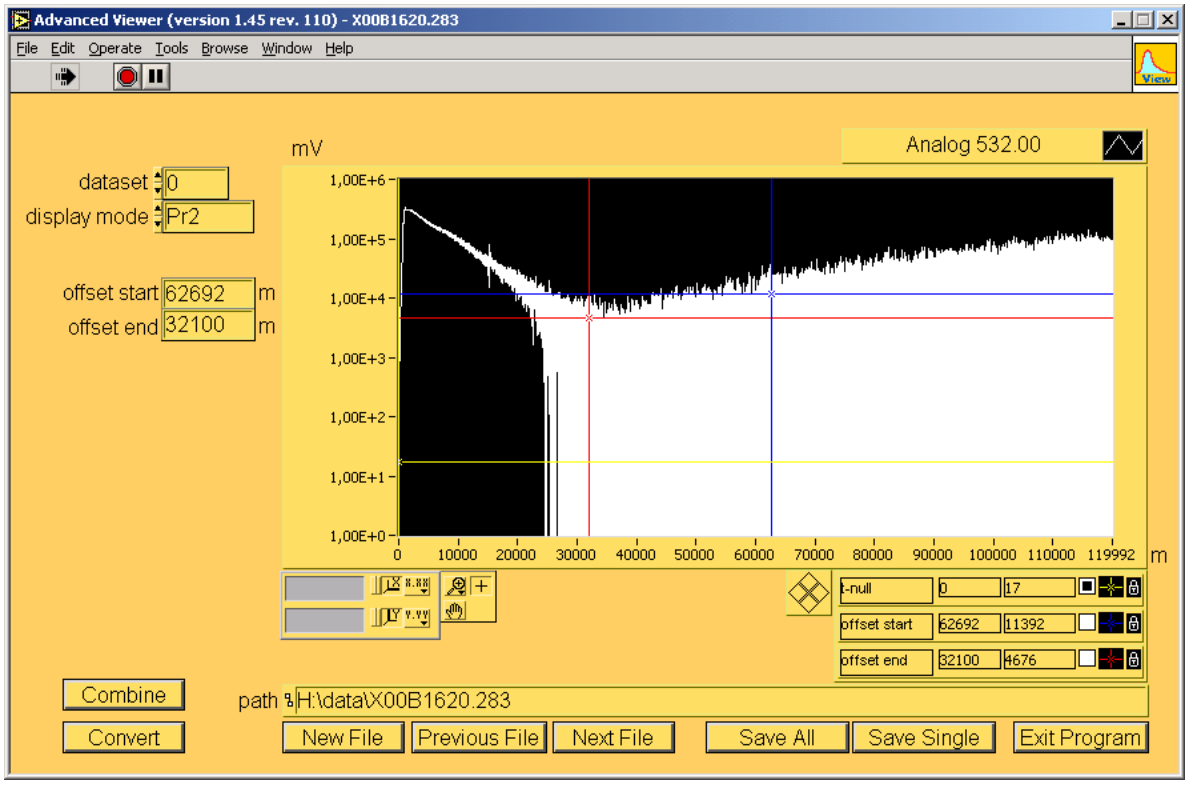




The data can also be displayed in the *Pr2* mode which corrects for the power loss due to the length of travel of the signal. The key parameter for the *Pr2* mode is **t-null** which defines the starting point of the signal. When switching to the *Pr2* mode, the data will look similar to the following.



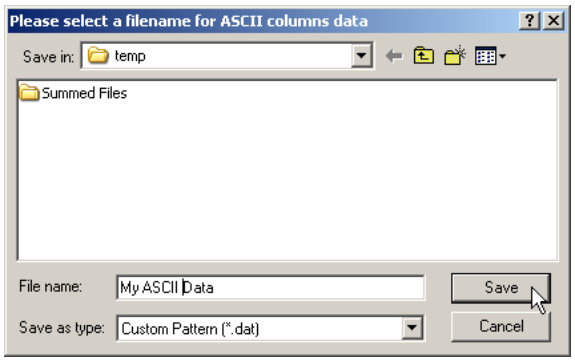
Note that the signal is only corrected for power loss after the yellow cursor, which is the t-null point. All values before **t-null** are left unchanged and those after **t-null** are corrected for the power loss due to distance. The difference in the display is due to the fact that the scaling has been changed to a logarithmic scale for easier viewing. After moving the cursor to the new t-null point, the signal changes to represent the new start time of the signal.



Please remember that the *Pr2* signal is offset corrected, as well.

Once you have adjusted your signal and would like to save it to a file in ASCII format as it is displayed, then press the **Save Single** button.

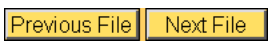
A file dialog appears asking you to name the ASCII file.



Enter the desired file name press **Save**. The file extension `.dat` will automatically be added to the file name unless you choose a different extension. Afterwards the data is saved in ASCII format as a column and can be imported into other programs for further evaluation.

converts all datasets contained in the actual data file to an ASCII format file and appends the extension `.dat` to the end of the actual file's name. The whole file can then be imported into other programs.

If you would like to load the next file or previous file in a time series, this can be done by pressing the **Previous File** or **Next File** buttons.



By pressing one of these buttons, either the file acquired before or after the current file will be displayed if it exists in the same directory. One can then manipulate the data using the aforementioned capabilities of `Advanced Viewer` and save the data from the new datasets to ASCII if desired.

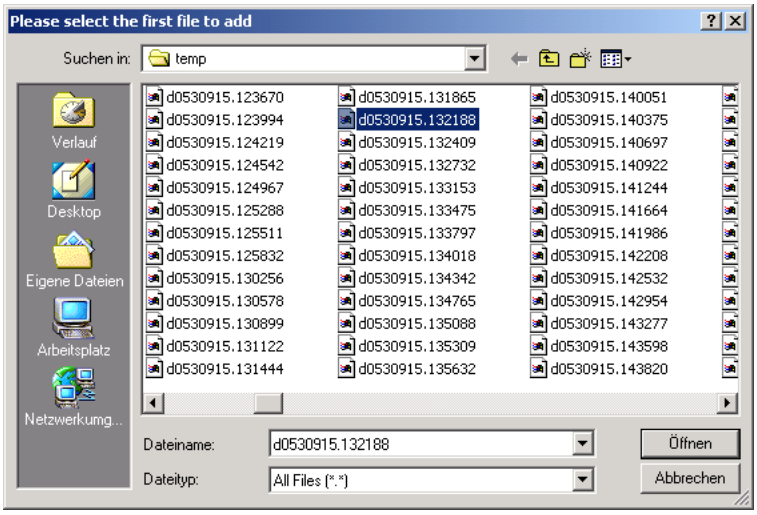
Two data file utilities may be called from the `Advanced Viewer`, one to sum the data values of several files to one single file (`Datafile Addfiles Interface.vi`), and another to convert the data from several files to corresponding ASCII files (`Datafile Batch Converter.vi`).

By pressing **Combine** `Datafile Addfiles Interface.vi` is interactively called to sum the data contained in a set of subsequently recorded data files.

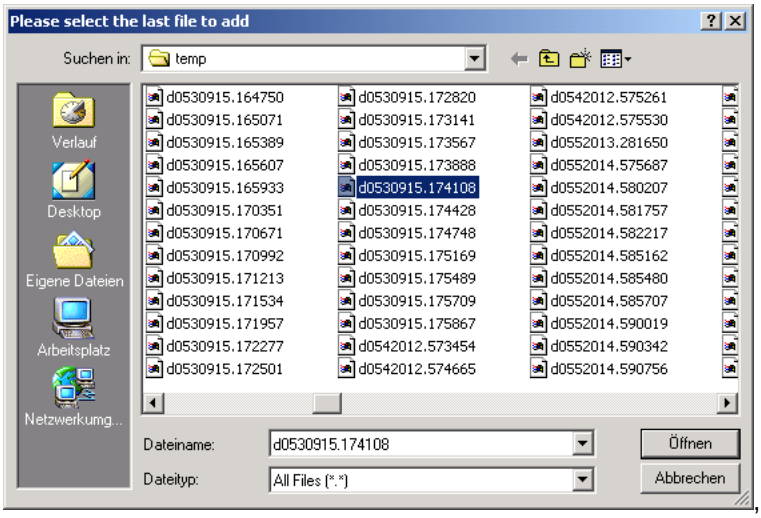
Combine

You will have to specify:

1. the name of the first file to add

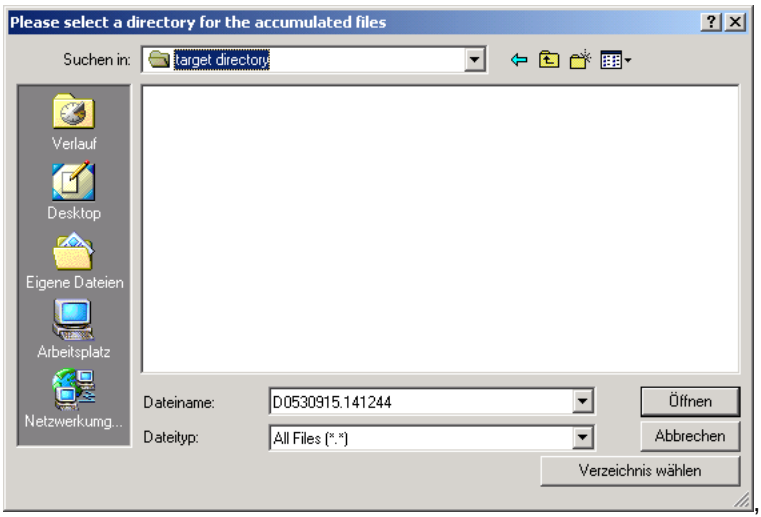


2. the name of the last file to add



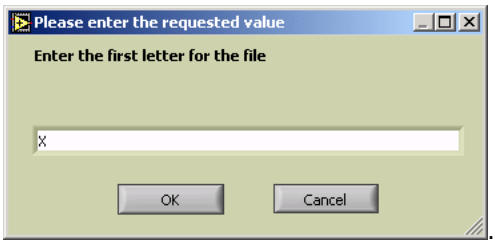
,

3. the name of the target directory for the file containing the summed data.



, and

4. the first letter of the file name



Both the first and the last file must reside in the same directory. The data from the files with acquisition dates/times lying between the first and the last files (including them) are summed and written to a target file into the target directory. The target file's name begins with the first letter, and the rest of the name is taken from the first selected file.

By pressing **Convert** `Datafile Batch Converter.vi` is interactively called to convert the data contained in a set of subsequently recorded data files to ASCII files.

The selection mechanism to select the first file, the last file, and the target directory is the same as for the sum operation.

Both the first and the last file must reside in the same directory. The data from the files with acquisition dates/times lying between the first and the last files (including them) are converted as described above for the **Save All** operation. Each data file will result in an ASCII file named by the original file name with the additional extension `.txt`.

The `Advanced Viewer` is terminated by pressing the **Exit Program** button.

5.5 Further Data Analysis

The analysis of the acquired data depends strongly on the individual application of Licel detection systems. Therefore, we do not provide a complete data analysis package.

In an appendix we provide a strategy and an example to combine analog and photon counting data acquired with Licel transient recorders. Then a dynamic range of more than 5 orders of magnitude can be achieved.

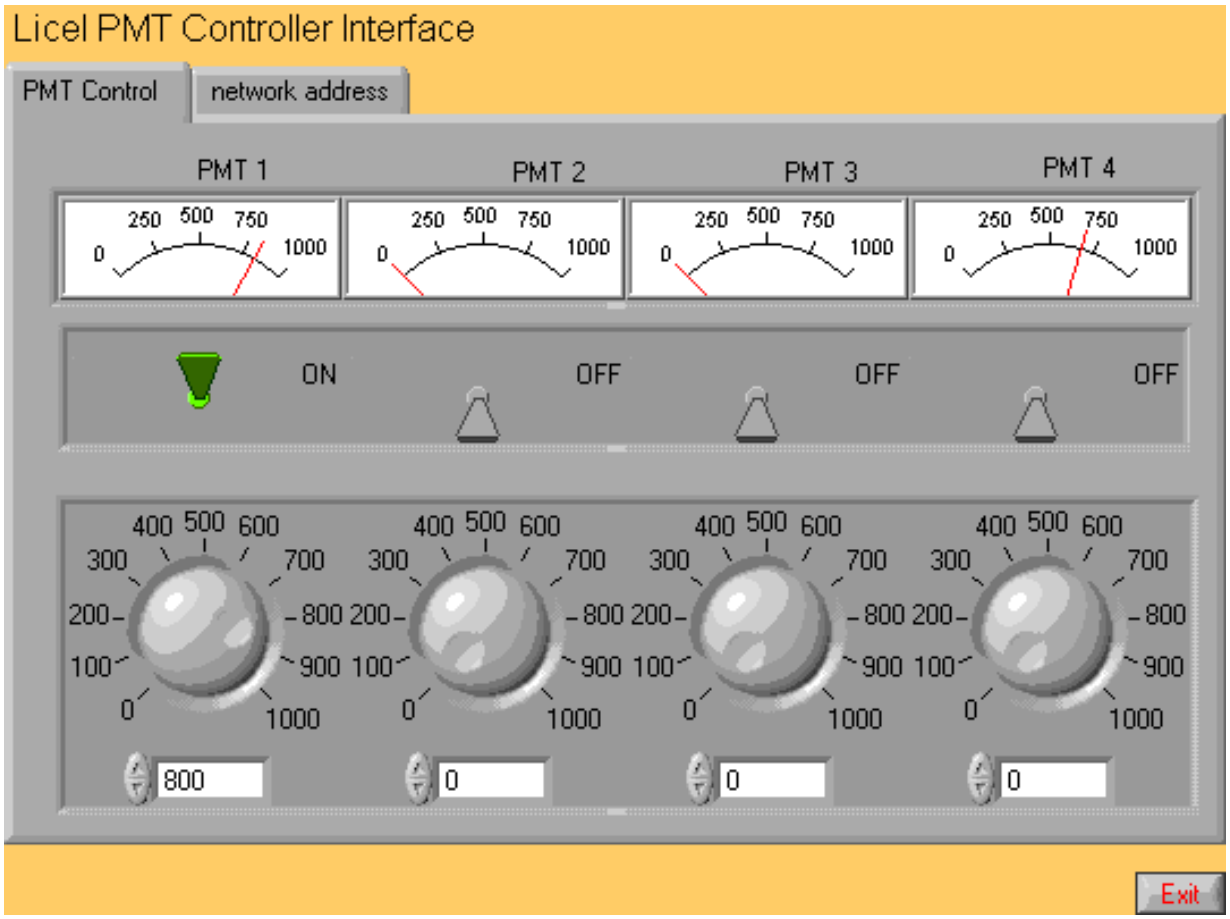
The data file format is described in an appendix.

Chapter 6

Detector and Timing Control Utilities

6.1 The PMT Control Panel

A sample application `ControlPMT.llb/Control_PMT_Panel.vi` is provided, which demonstrates the use of the driver VI's. The corresponding Windows application is started directly from the start menu in the subfolder `Licel\Detector Control`. After opening it you should see a screen like the following:



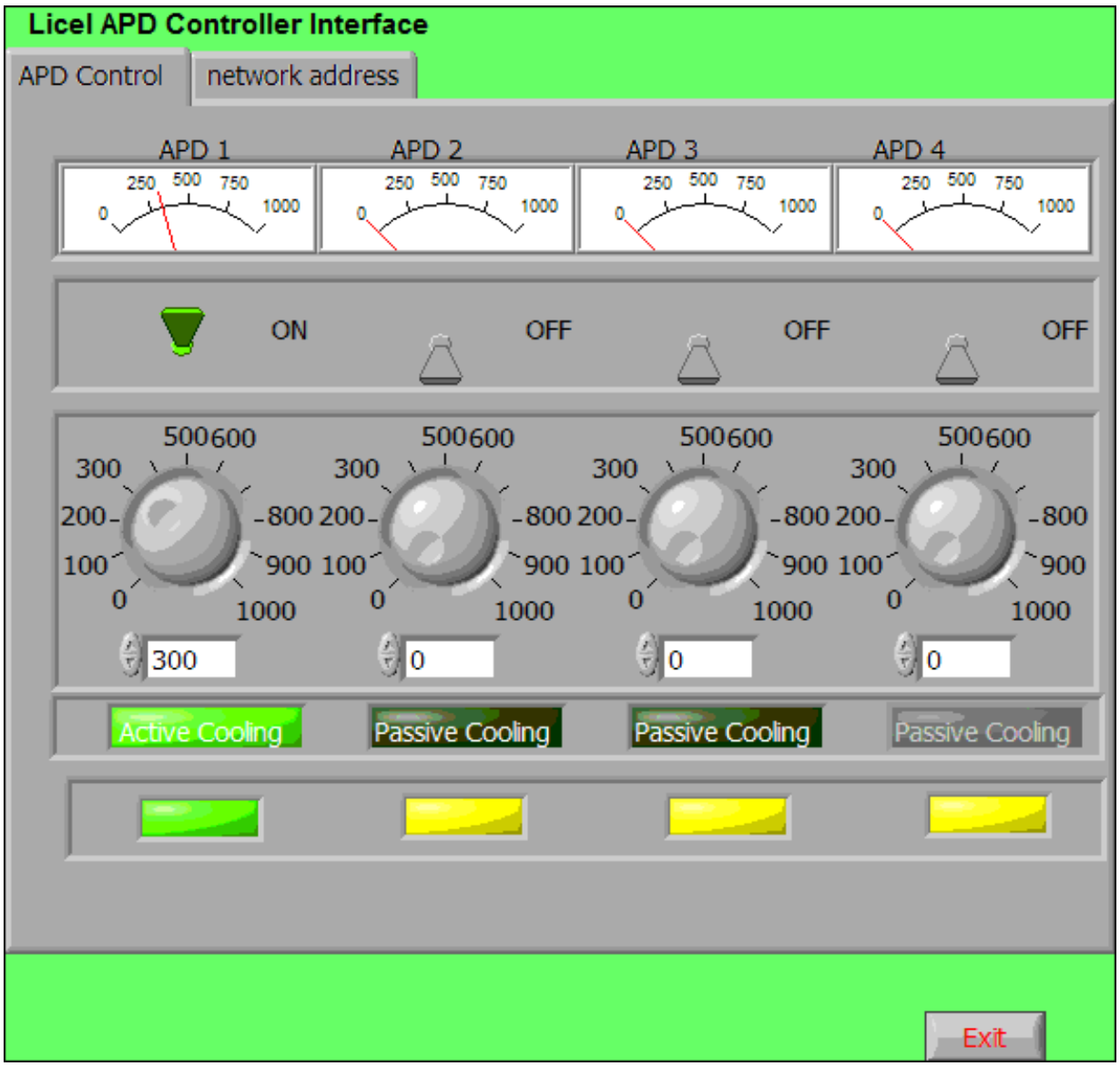
1. Before you start please enter the correct values for the **IP Address** and **Port**. You should already have set these values for the Licel Ethernet Controller following the network setup section above.
   - Using the LabVIEW vi, just enter the required values and save them as defaults.
   - If you use the Windows application you must set the values in the initialization file `Control_PMT_Panel_IP_Values.ini`.
2. To start the program press the **Run** button at the top left of the screen.

The Windows application will start automatically when called for the first time.

The voltage can be set via the knobs at the bottom. The displays at the top show the actual voltages. Turning the switches on, will set the desired voltages at the PMT.

6.2 The APD Control Panel

The sample application `ControlAPD.llb/Control_APD_Panel.vi` is similiar to the PMT control panel. The corresponding Windows application is started from the start menu in the subfolder `Licel\Detector Control`. After opening it, you should see a screen like the following:



1. Before you start please enter the correct values for the **IP Address** and **Port**. You should already have set these values for the Licel Ethernet Controller following the network setup section above.

    - Using the LabVIEW vi, just enter the required values and save them as defaults.

- If you use the Windows application you must set the values in the initialization file `Control_APD_Panel_IP_Values.ini`.

2. To start the program press the **Run** button at the top left of the screen.

The Windows application will start automatically when called for the first time.

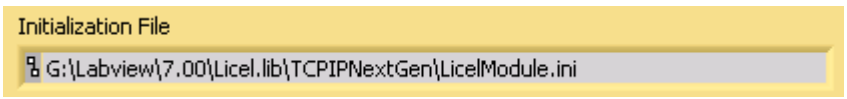
The voltages can be set via the knobs at the bottom. The displays at the top show the actual voltages. Turning the switches on, will set the desired voltages at the APD. After switching from the passive to the active cooling mode the cooling status indicator will first turn red indicating that the APD temperature is not in range later will become green when the temperature is stabilized.

6.3 The Trigger Module Control Panel

A sample application `ControlTiming.llb/Control Timing.vi` is provided to control the timing parameters of the trigger module. After opening it you should see a screen like the following:

6.3.1 Starting the Application

1. Before you start please enter the correct values for the **IP Address** and **Port**. You should already have set these values for the Licel Ethernet Controller following the network setup section above.
   - Using the LabVIEW vi, just enter the required values on the *TCP/IP* page and save them as defaults.
   - If you use the Windows application you must set the values in the initialization file `Timing.ini`. You will see the full path of the file in a file path indicator on the *TCP/IP* page.

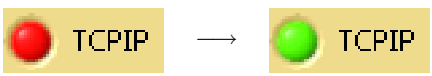


   - If you run `Control Timing` within a sub panel on a page from `Licel Module Control` the latter is responsible for the TCP/IP parameters.

2. To start the program press the **Run** button at the top left of the screen.

The Windows application will start automatically when called for the first time.

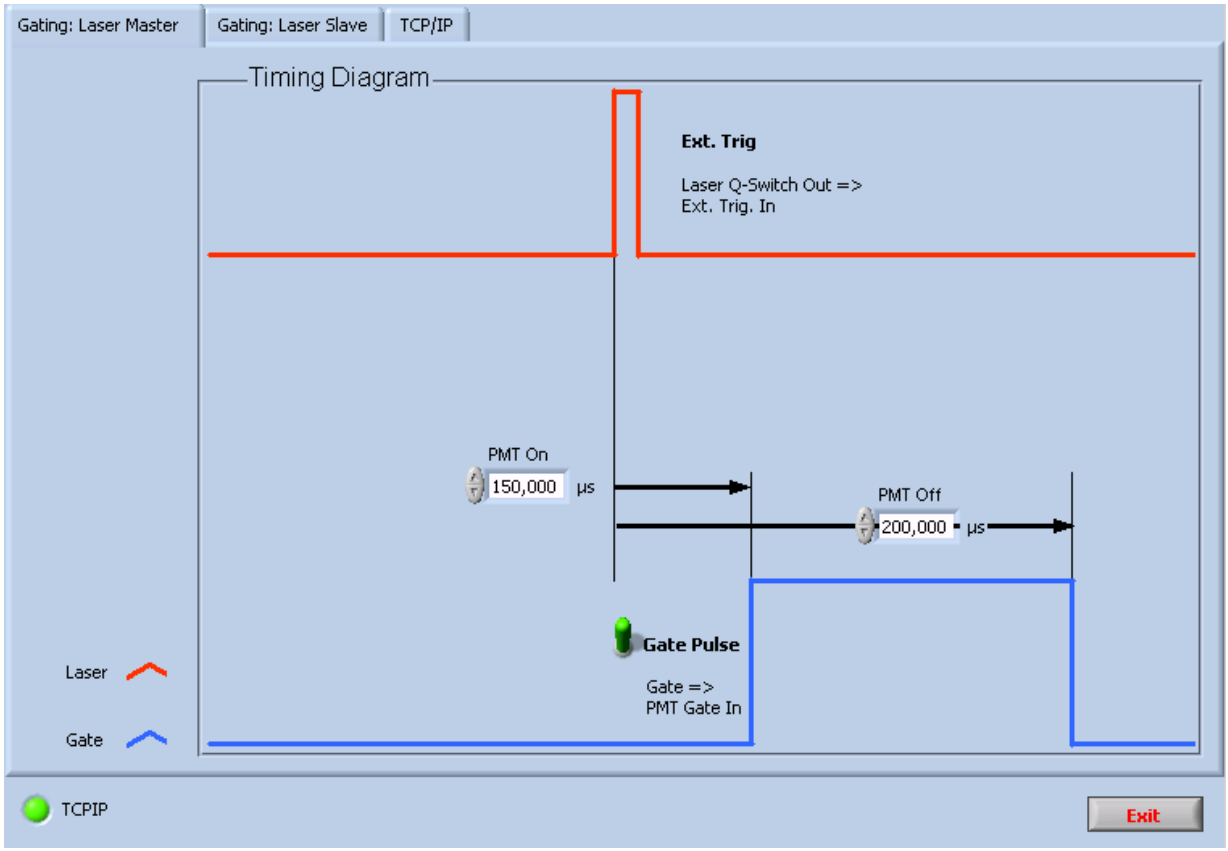
3. After a short time the **TCPIP** indicator should change its color from red to green indicating a successfull connection with the Licel Ethernet Controller. If the indicator remains red and/or an error is indicated, please check the values for **address** and **Port**, change them (on the program's panel or in the initialization file) if necessary. Check if the Licel Ethernet Controller is running and that all network connections are correct.



Note that in each of the following scenarios the pretrigger pulses are only generated if the corresponding switches are in the *On* position.

6.3.2 Gating: Laser Master

Use this scenario if the laser's Q-switch output is used as the trigger source. Then the gate pulse is characterized by its start and end times with respect to the external trigger.



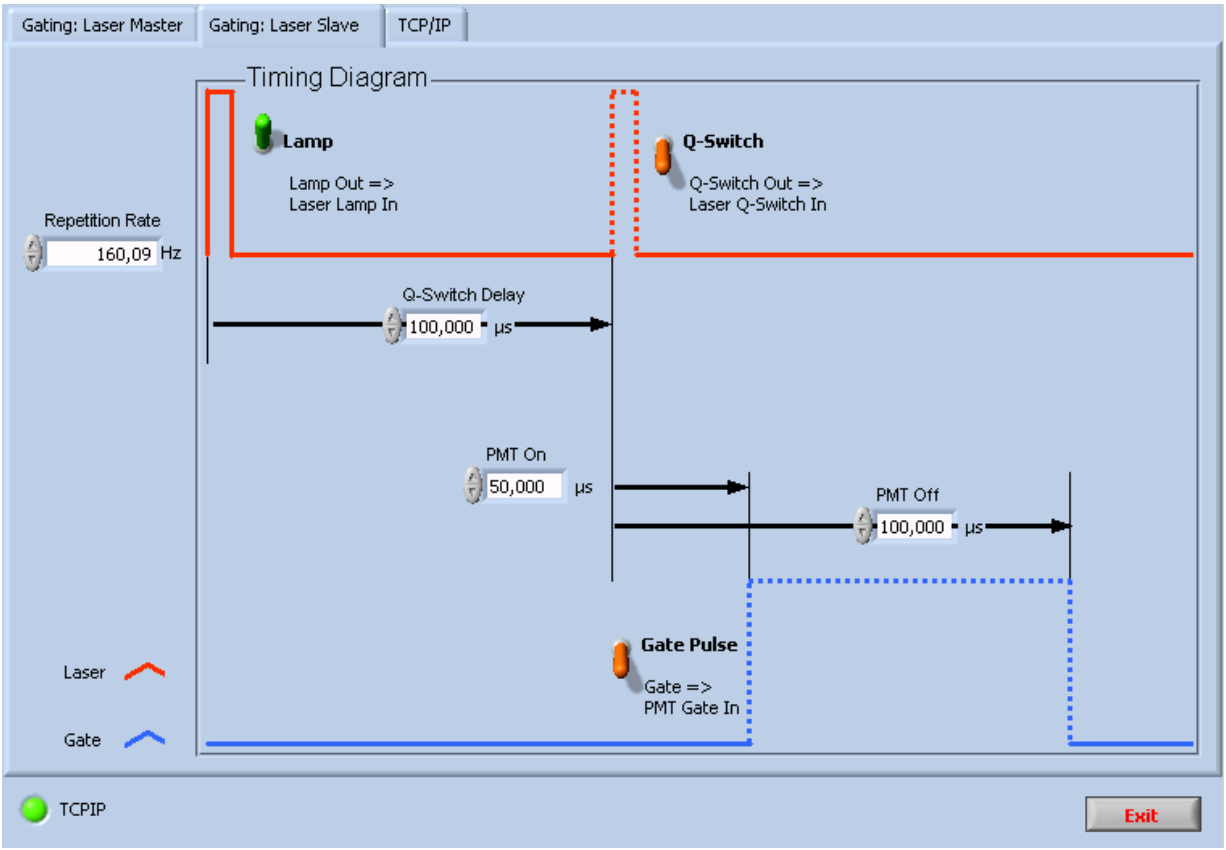
The following parameters may be set:

- **Gate On**: Gate pulse start time with respect to the external trigger (laser Q-switch out)
- **Gate Off**: Gate pulse stop time with respect to the external trigger (laser Q-switch out).

Gating needs to be set *On* to enable the gate pulse output.

6.3.3 Gating: Laser Slave

Use this scenario to trigger the laser lamp and the Q-switch from the Licel Trigger Module. Then the gate pulse is characterized by its start and end times with respect to the Q-switch pulse.



The following parameters may be changed or set:

- **Repetition Rate**: Frequency in Hz of the internally generated trigger pulses, i.e. of the laser **Lamp**, **Q-Switch**, and **Gating** pulses.
- **Q-Switch Delay**: Time in microseconds between the lamp trigger output and the Q-Switch output
- **Gate On**: Gate pulse start time with respect to the Q-switch out
- **Gate Off**: Gate pulse stop time with respect to the Q-switch out.

Lamp, **Q-Switch**, and **Gating** have to be set *On* to generate the corresponding trigger pulses.

Chapter 7

Appendices

7.1 TCP/IP Command List and Syntax

This section lists and describes the TCP/IP command syntax for Licel TCP/IP Ethernet Controllers. Most commands can be sent either in a short form or a long form. In this description the abbreviations TR, PMT, and APD are used to denote a Licel transient recorder, a Licel photomultiplier module, or a Licel avalanche photodiode, respectively. <CRLF> is carriage return line feed. All commands sent to the TR should end with <CRLF>, and all replies from the Licel TCP/IP controller end with <CRLF> which will not explicitly be shown in this document.
If the controller detects an unknown command it will return the string

```
<command> unknown command
```

back to the caller where <command> is the command originally sent.

The following commands are available dependent on the Licel Ethernet Controller you ordered.

Short	Long
	ACCESS
APD?	APDSTAT?
APDT	APDTEMPERATURE
APDG	APDGAIN
CAP?	CAP?
CLE	CLEAR
CONT	CONTINUE
DATA	DATA
DISC	DISCRIMINATOR
*IDN?	IDENTIFICAT?
	LOGON
MCL	MCLEAR
MCON	MCONTINUE
MPUS	MPUSH
MSTA	MSTART
MSTO	MSTOP
MWA	MWAIT
PASS	PASS
PMT?	PMTSTAT?
PMTG	PMTGAIN
PUSH	PUSH
RANG	RANGE
SEL	SELECT
SING	SINGLE
SLAV	SLAVE
STAR	START
STAT?	STATUS

TCPIP TCPIP
THR TRESHOLD
TRIGGERMODE
TRIGGERTIME
WHITELIST

ACCESS <LIMIT "Password" "Connection Password" | FREE "Password">

Switches the secure mode on or off.
If used with the keyword `LIMIT` the secure mode is switched on. The administrator password (`"Password"`) and the password for client connections (`"Connection Password"`) have to be transmitted together with the `LIMIT` keyword. Access to the controller is limited to clients operating from hosts specified with the `WHITELIST` command. After establishing his TCPIP connection a client must use the `LOGON` command to login in secure mode. The example

```
ACCESS LIMIT "Administrator" "ConnectMe"
```

will start the secure mode with the `Connection Password ConnectMe` (if the current controller password equals `Administrator`). In case of a non-correct controller password or bad command syntax the controller will return

```
ACCESS not accepted
```

, other wise the return value is

```
ACCESS Limited
```

.
If the ACCESS command is used with the keyword FREE the secure mode is switched off. The administrator password (`"Password"`) has to be transmitted together with the `LIMIT` keyword. The response of the controller after a successfull ACCESS command is

```
ACCESS Unlimited
```

.
Note that one has to establish a secure mode connection using the `LOGON` command (i.e. one has to know the `Connection Password`) before switching the secure mode off with the ACCESS command. The only other way to disable the secure mode is a hardware reset.

APDSTAT? <Device Number>

APD? <Device Number>

Returns the current status of the APD with the given `Device Number`. For example to get the status of APD number 3 send

```
APD? 3
```

to the controller. The reply is of the following form:

```
APD <Voltage> <HV control state> <temperature regulation> <T in range?>
<T control state>
```

with the values

`Voltage`	`HV voltage`
`HV control state`	`HV_local` | `HV_remote`
`temperature regulation`	`T_on` | `T_off`
`T in range?`	`T_in_range` | `T_out_of_range`
`T control state`	`T_local` | `T_remote` .

`Voltage` is the gain voltage and indicates whether the power supply of the APD is switched on or off. The `HV control state` indicates whether the APD HV is being controlled locally (`HV_local`) or remotely (`HV_remote`). Valid answers for the `temperature regulation` are `T_on` and `T_off`. If the temperature is in range, then the `T in range?` value is `T_in_range`, otherwise `T_out_of_range` is returned. The `T control state` reruns `T_local` or `T_remote`. An example of a reply is

```
APD 750 HV_local T_on T_in_range T_remote
```

.
In this case the gain voltage is 750 volts, the APD HV is controlled locally, and the temperature is being regulated, is in range and remotely controlled. If the APD with the specified device number is not installed the reply is

```
APD 3 is not available
```

where the number 3 is the device number of the non-existent APD. Valid values for the device number are 0-3. APDSTAT? works in both remote and local control modes.

APDT <Device Number> <on|off>

APDTEMPERATURE <Device Number> <on|off>

Turns the temperature regulation for the APD specified by <device number> either on or off. For example to turn on the temperature regulation on the APD with device number 3, send

APDT 3 on

to the controller. The reply is

APDT executed

If the APD with the specified device number is not installed the reply is

APD 3 is not available

where the number 3 is the device number of the non-existent APD. Valid values for the device number are 0-3. The long form breaks the SCPI convention since it is longer than 12 characters.

APDG <Device Number> <HV Voltage>

APDGAIN <Device Number> <HV Voltage>

Sets the gain voltage for the specified APD to the given <HV Voltage > value. For example to set the gain of APD with device number 3 to 300 Volts, send

APDG 3 300

to the controller. A successfull execution is indicated by the reply

APDG executed .

If the APD with the specified device number is not installed the reply is

APD 3 is not available .

where the number 3 is the device number of the non-existent APD. Valid values for the device number are 0-3.

CAP?

Requests the control capabilities of the controller.

The controller's response is

CAP: [List of Capabilities] ,

where List of Capabilities is a space-seperated list with on or more of the following items:

TR	for controlling transient recorder
APD	for APD remote control
PMT	for PMT remote control
TIMER	for the trigger timing controller
CLOUD	for transient recorder controller cloud mode
BORE	Boresight alignment system .

A response could be

CAP: TR

for a controller which is able to control transient recorders, only, while

CAP: APD PMT TIMER

indicates a controller capable of controlling APDs PMTs and the timing generator.

CLEAR

CLE

Clears both memories (A and B) of the previously selected transient recorder, if the TR is in SLAVE mode. After sending this command, the controller replies with the string

CLEAR executed .

If this command is sent while PUSH or MPUSH mode is active, the reply is

CLEAR ignored due to active PUSH mode .

If the selected TR does not answer, the response will be:

CLE failed for TR <TR#>, Can't write .

CLE failed for TR <device number >, <Can't clear Memory >

indicates a memory access error to Memory (A or B).

CONTINUE

CONT

Continues data acquisition without clearing the memory of the selected transient recorder if the TR is in SLAVE mode. After sending this command the controller replies with the string

`CONTINUE executed.`

If this command is sent while PUSH or MPUSH mode is active, the reply is

`CONTINUE ignored due to active PUSH mode.`

The error message

`CONTINUE failed for TR <Device Number>, Can't write`

is sent if the transient recorder identified by `Device Number` is not responding.

DATA? <Device Number> <Number to Read> <Signal Type> <Memory>

DATA? <Device Number> <Number to Read> <Signal Type> <Memory>

Requests data from the transient recorder with the corresponding `Device Number` if the TR is in SLAVE mode. The `Number to Read` determines the number of bins to be read. The `Signal Type` can be either be `PC`, `MSW`, or `LSW` for photon counting, analog MSW, or analog LSW, respectively. Analog LSW is the default value. The `Memory` can be either `A` or `B`, for memory A or memory B, respectively. As an example, we could have

`DATA? 6 8000 PC B`

which would return the first 8000 bins of the photon counting Memory B of transient recorder #6. The controller replies to the DATA? request by returning the data. As the transient recorder's data is an array of 16-bit numbers the returned number of bytes equals twice the number of requested bins. If this command is sent while PUSH or MPUSH mode is active, the reply is

`DATA? ignored due to active PUSH mode.`

If `Device Number` is not in range the reply is

`Device ID <Device Number> is currently not supported.`

The error message

`DATA failed for TR <Device Number>, Can't write`

is sent if the transient recorder #`Device Number` is not responding.

DISCRIMINATOR <Integer>

DISC <Integer>

Sets the discriminator level. Valid values for the descriminator are 0–63. To set the discriminator level to 16, send

`DISCRIMINATOR 16`

to the controller. The reply is

`DISCRIMINATOR set to 16.`

If the `Integer` value is out of range the reply is

`DISCRIMINATOR value is out of range.`

The error message

`DISCRIMINATOR failed for TR <Device Number>, Can't write`

is sent if the transient recorder #`Device Number` is not responding.

IDENTIFICAT?

*IDN?

Asks the controller to send its identity and firmware revision. The reply from the controller is e.g.

`Licel Virtual Transient Recorder Software Firmware Rev. 1.0.`

LOGON <"Encrypted Hexcode">

Is used to log in while the secure mode is active. Directly after establishing the TCP/IP connection with the controller the latter will send two 4 byte unsigned integer numbers in a hex-encoded string. The client has to decode these numbers from the hexadecimal string and use them to encrypt the connection password set by the ACCESS command using the Blowfish encryption algorithm. The resulting two 4 byte unsigned integer numbers have to be converted to a hexadecimal string and sent to the controller with the `LOGON` command. While secure mode is active the controller will close the TCP/IP connection without any comment if it does not receive the correct code within 20 seconds.

MCLEAR

MCL

Clears all memories of the SELECTed transient recorderss, if the TR is in SLAVE mode. The answer is
`MCLEAR executed .`
If this command is sent while PUSH or MPUSH mode is active, the reply is
`MCLEAR ignored due to active PUSH mode .`
If a selected TR does not answer, the response will be:
`MCLEAR failed for TR <TR#>, Can't write .`
`MCLEAR failed for TR <device number >, <Can't clear Memory >`
indicates a memory access error to `Memory` (A or B).

MCONTINUE

MCON

Restarts the SELECTed transient recorders without clearing the memories, if the TRs are in SLAVE mode. The reply is
`MCONTINUE executed .`
If this command is sent while PUSH or MPUSH mode is active, the reply is
`MCONTINUE ignored due to active PUSH mode .`
The error message
`MCONTINUE failed for TR <Device Number>, Can't write`
is sent if the transient recorder #`Device Number` is not responding.

MPUSH <Shots> <Device Number> <Number to Read> <Signal Type> <Memory> [<Device Number> <Number to Read> <Signal Type> <Memory>[...]]

MPUS <Shots> <Device Number> <Number to Read> <Signal Type> <Memory> [<Device Number> <Number to Read> <Signal Type> <Memory>[...]]

Causes the controller to enter a state where data of `Signal Type Memory` is directly pushed from the transient recorder(s) `Device Number` to the computer. The `Signal Type` can be either `PC`, `MSW`, or `LSW` for photon counting, analog MSW, or analog LSW, respectively. The `Memory` can be either `A` or `B`, for memory A or memory B, respectively. The transient recorders aquire n shots, n is given by `Shots` and is limited to a maximum of 14.

After having acquired the requested number of `Shots` the controller reads `Number to Read` bins from the corresponding `Memory` and `Signal Type` from each transient recorder with the given `Device Number` and sends them to the computer. As the transient recorder's data is an array of 16-bit numbers the returned number of bytes equals twice the number of requested bins. The data have a header consisting of 2 marker bytes `0xFF`, and the data sets for each transient recorder are preceded by the number of shots as a 16-bit number. Note that the number of shots has an offset of 2 causes by the clear shots. The length of each device-specific data set has to be known by the acquiring computer.

Then, the transient recorders automatically continue to collect data sets for pushing them to the computer. The SLAVE command stops the MPUSH command. The example
`MPUSH 5 1 8000 PC B 4 6000 LSW A`

would cause the data from the transient recorders 1 and 4 to be pushed to the data acquisition computer after recording 5 shots. From device 1, 8000 bins of the photon counting Memory B will be sent. From device 4, 6000 bins of analog LSW memory A will be sent. Having sent the data the TRs will automatically be restarted by the controller and the next set of data will be acquired and sent. The reply is

`MPUSH executed` .

If the command syntax is not correct the controller replies

`MPUSH syntax is wrong` ,

if the PUSH mode is active the controller will return

`MPUSH ignored due to active PUSH mode` .

If the number of shots is not in range the controller returns

`Illegal Push shot number` .

MSTART

MSTA

starts the SELECTed multiple TRs, if the TRs are in SLAVE mode. As an example

`MSTART`

would start selected Devices. The reply is

`MSTART executed` .

If this command is sent while PUSH or MPUSH mode is active, the reply is

`MSTART ignored due to active PUSH mode` .

The error message

`MSTART failed for TR <Device Number>, Can't write`

is sent if the transient recorder #`Device Number` is not responding,

`MSTART failed for TR <device number >, <Can't clear Memory >`

indicates a memory access error to `Memory` (A or B).

MSTOP

MSTO

Stops the SELECTed multiple TRs, if the TRs are in SLAVE mode.

`MSTOP`

will stop the currently selected devices. The reply is

`MSTOP executed` .

If this command is sent while PUSH or MPUSH mode is active, the reply is

`MSTOP ignored due to active PUSH mode` .

The error message

`MSTOP failed for TR <Device Number>, Can't write`

is sent if the transient recorder #`Device Number` is not responding.

MWAIT <Timeout in ms>

MWA <Timeout in ms>

Waits until all SELECTed TRs stop or until the timeout time is exceeded. The range for `Timeout in ms` is beween 0 and 400. If all TRs are ready within the timeout limit, the reply is

`MWAIT executed` .

If `Timeout in ms` is not in range the controller replies

`MWAIT failed delay: <Timeout in ms> should be beween 0 and 400ms` .

If a selected TR does not answer, the response will be:

`MWAIT failed for TR <TR#>, Can't write` .

PASSWORD <"Old Password"> <"New Password"> <"New Password">

PASS <"Old Password"> <"New Password"> <"New Password">

Changes the password for the controller. The actual password is required to change the IP configuration of the transient recorder. The user needs to enter the old password and then the new password twice. The default password is "'*Administrator*"'. The password will be reset to this if a hardware reset is executed on the controller. For example

`PASS "Administrator" "MyPassword" "MyPassword"`

will change the password to MyPassword. The controller replies with

`PASSWORD set to "MyPassword"` ,

if an error occurrs (wrong `Old Password`, nonequal `New Password` entries, or empty `New Passwords`) the reply is

`PASSWORD not set` .

PMT? <Device Number>

PMTSTAT? <Device Number>

Returns the status of the PMT with the specified device number. The reply parameters are <HV value in Volts> <HV on/off> <local/remote>. For example for requesting the status of the PMT with the device number 5 send

`PMT? 5`

to the controller. An example of a reply is

`PMT 970 on remote`

which indicates that the PMT is in remote mode, the HV power supply is on and is set to 970 Volts. Another example would be

`PMT 30 off local` :

here, the PMT is being controlled locally, the HV power supply is off and it is set to 30 volts, which is the default return value when the PMT is off. If the PMT with the specified device number is not installed the reply is

`PMT 5 is not available`

where the number 5 is the device number of the non-existent PMT. Valid values for the device number are 0-7.

PMTG <Device Number> <Voltage>

PMTGAIN <Device Number> <Voltage>

This command sets the gain voltage applied to the dynodes of the PMT with the specified device number. For example

`PMTG 3 980`

will set the gain voltage to 980 volts. The reply is

`PMTG executed` .

If the PMT with the specified device number is not installed the reply is

`PMT 3 is not available`

where the number 3 is the device number of the non-existent PMT. Valid values for the device number are 0-7.

PUSH <Shots> <Number to Read> <Signal Type> <Memory>

PUSH <Shots> <Number to Read> <Signal Type> <Memory>

Causes the controller to enter a state where data from `Signal Type` `Memory` is directly pushed from the SELECTed transient recorder to the computer. The `Signal Type` can either be `PC`, `MSW`, or `LSW`, for photon counting, analog MSW (default), or analog LSW, respectively. The `Memory` can either be `A` (memory A) or `B` (memory B). The example

`PUSH 3 8000 PC B`

would return the first 8000 bins of the photon counting Memory `B` after 3 shots have been acquired. The controller will start an acquisition of n `Shots`. n is limited to a maximum value of 14. After having acquired the requested number of `Shots` the controller reads `Number to Read` bins from the corresponding `Memory` and `Signal Type` from the transient recorder and sends them to the computer. As the transient recorder's data is an array of 16-bit numbers the returned number of bytes equals twice the number of requested bins. These

data have a header consisting of 2 marker bytes `0xFF` followed by the number of shots as a 16-bit number. Note that the number of shots has an offset of 2 causes by the clear shots. Then, the controller forces the TR to collect the next data for pushing it to the computer. The SLAVE command stops the PUSH command. The reply is

`PUSH executed` .

if the MPUSH mode is active the controller will return

`PUSH ignored due to active MPUSH mode` .

If data from more than one transient recorder should be pushed to the acquisition computer the MPUSH command should be used.

If the number of shots is not in range the controller returns

`Illegal Push shot number` .

RANGE <0|1|2>

RANG <0|1|2>

Sets the input range to either -500mV (0), -100mV (1), or -20mV (2). The command

`RANGE 0`

sets the input range ot -500mV. The TR replies with

`RANGE set to -500mV` .

If an illegal value for the range is submitted to the controller the reply is

`Illegal Range Value` .

The error message

`RANGE failed for TR <Device Number>, Can't write`

is sent if the transient recorder #`Device Number` is not responding.

SELECT <Device Number List>

SEL <Device Number List>

Selects or unselects the active transient recorders. <`Device Number List`> is a comma-seperated list of transient recorder numbers or -1 to unselect all selected transient recorders. For example to activate transient recorder #8, send

`SELECT 8`

If a TR with the given device number is available the answer by the controller is

`SELECT 8 executed`

To select more than one TR, separate the transient recorder numbers with a comma. For example, to select the transient recorders 1, 3, 8, and 12, send

`SELECT 1, 3, 8, 12`

Note that the separator is a comma and the empty spaces between the TRs will be ignored. Thus,

`SELECT 1,3,8,12`

is equivalent to the previous command. The answer by the controller is

`SELECT 1, 3, 8, 12 executed`

if any device number is out of range, the controller does not execute the command while repliing

`Device ID %d is currently not supported` ,

where %d is the first illegal device number. To unselect the active transient recorders send

`SELECT -1`

to the controller, the reply is

`SELECT executed` .

SINGLE

SING

Clears the TR memory and causes the transient recorder to take a single shot. The reply is

`SINGLE executed`

If this command is sent while PUSH or MPUSH mode is active, the reply is

`SINGLE ignored due to active PUSH mode` .

An access error at a transient recorder with the device number <`device number`> is indicated by

`SINGLE failed for TR <device number>, Can't write.`

SLAVE

SLAV

Ends the PUSH or MPUSH mode. The reply is
`SLAVE executed.`

START

STAR

Clears the memories and starts the data acquisition of the selected transient recorder, if the TR is in Slave mode. After sending this command, the controller replies with
`START executed.`
If this command is sent while PUSH or MPUSH mode is active, the reply is
`START ignored due to active PUSH mode.`
The error message
`START failed for TR <Device Number>, Can't write`
is sent if the transient recorder #`Device Number` is not responding,
`START failed for TR <device number >, <Can't clear Memory >`
indicates a memory access error to `Memory` (A or B).

STATUS?

STAT?

Returns the current status of the SELECTed transient recorder. If more than one TR is selected, the Status of the selected TR with the lowest device number is returned (e.g. when 5, 7, 12, 14 are selected, then `STAT?` returns the status of TR #5). The values returned are the `shotnumber`, the `acquisition state`, the `recording` state, and the transient recorder's summation memory of the last acquistion. The shotnumber is returned as an integer. The acquisition state can be either armed or disabled, hence the string `<em>Armed</em>` is returned if the TR is armed, otherwise an empty string is returned. Whether or not the TR recorder is collecting data is shown by the recording state. If the TR is storing data in its memory the string `<em>Acquiring </em>`is returned or an empty string. The summation memory can either be Memory A or Memory B. If Memory B has been used for the last acquisition `MemB`, otherwise an empty string is returned. An example reply would be
`Shots 8032 Armed Acquiring`
indicating that the TR has acquired 8032 shots, is armed and currently accumulating data. Another example is
`Shots 8032 Armed`,
here, TR has acquired 8032 shots of data, is armed and is not storing data.
The error message
`STAT? failed for TR <Device Number>, Can't write`
is sent if the transient recorder #`Device Number` is not responding,

STOP

Stops the data acquisition of the selected transient recorder, if the TR is in Slave mode. After sending this command, the controller replies with the string
`STOP executed.`
If this command is sent while PUSH or MPUSH mode is active, the reply is
`STOP ignored due to active PUSH mode.`
The error message
`STOP failed for TR <Device Number>, Can't write`
is sent if the transient recorder #`Device Number` is not responding.

TCPIP <”ip#”> <”subnet mask”> <”Gateway”> <”Port”> <”Password”>

TCP <”ip#”> <”subnet mask”> <”Gateway”> <”Port”> <”Password”>

Sets the IP adress, subnet mask, gateway and Ports that are used for TCP connections. Please note that the port number and port number+1 are used by the controller. This command will only be executed if the password corresponds with the controller's internally stored password. The defaults are

IP Address	10.49.234.234
Subnet Mask	255.255.255.0
Gateway	empty
Port	2055 .

In this case port 2055 and port 2056 are used by default. Port 2055 is used for the bidirectional communication with the controller. The communication on port 2056 is monodirectional and contains the data that is pushed to the acquisition computer when it is in PUSH or MPUSH mode. In order to restore the default values, the reset button needs to be pressed when powering up the controller (hardware reset). The default password is ”Administrator.” To change the password, see the PASS command. For example

```
TCPIP "197.13.17.23" "250.250.250.29" " " "2013" "Administrator"
```

will change the IP Address to 197.13.17.23, the Subnet mask to 250.250.250.39, the gateway would be empty and the ports 2013 and 2014 would be used. The controller replies

```
IP "197.13.17.23" Subnet "250.250.250.39" Gateway " " Port "2013" executed .
```

If the password is incorrect, then the reply is

```
TCPIP failed due to invalid password .
```

TCPIP ”DHCP” <”Port”> <”Password”>

TCP ”DHCP” <”Port”> <”Password”>

Enable DHCP mode on the network controller. The controller will listen at the specified port and at Port+1. This command will only be executed if the password corresponds with the controller's internal password. If not

```
TCPIP failed due to invalid password
```

will be returned. If the command is successfully executed the controller replies

```
DHCP activated .
```

The controller comes with the defaults described for the TCPIP IP command. A hardware reset will disable the DHCP mode.

THRESHOLD <0|1>

THR <0|1>

Sets the damping state to either on or off. If a value of 1 is sent then damping is turned on. If a value of 0 is sent, the damping is turned off. To turn Damping on, send

```
THRESHOLD 1 ,
```

to turn the damping back off, send

```
THRESHOLD 0 .
```

The controller replies with either

```
THRESHOLD executed :  Damping on
```

or

```
THRESHOLD executed :  Damping off .
```

The error message

```
THRESHOLD failed for TR <Device Number>, Can't write
```

is sent if the transient recorder #`Device Number` is not responding.

TRIGGERMODE <mode >

Enable/Disable the trigger in and outputs
Mode is a bitfield where for every set bit the corresponding output is enabled:

0x01 Laser Lamp trigger
0x02 Pretrigger
0x04 Q-Switch
0x08 Gating
0x10 Master Trigger .

If the Master trigger bit is set an external trigger will be accepted, if not the internal trigger will be used. The internal trigger will be controlled via the repetitionRate. If successful the controller will return:
Note that if Master Trigger (0x10) is set Laser Lamp trigger should not be set because an asynchronous trigger signal would be generated.

TRIGGERMODE executed

otherwise the returned string is

TRIGGERMODE failed .

If the parameter is out of the range (not a byte) the reply is:

TRIGGERMODE: invalid parameter .

TRIGGERTIME <repetitionRate> <Pretrigger> <PretriggerLength> <QSwitch> <QswitchLength>

Set the timing parameter in ns

repetitionRate	in internal mode delay between two pulses in ns.
Pretrigger	delay between internal or external trigger and pretrigger in ns
PretriggerLength	length in ns of the pretrigger pulse
QSwitch	delay between pretrigger start and Q-Switch start in ns
QswitchLength	length in ns of the Q-Switch pulse .

If successful the controller will return:

TRIGGERTIME executed ,

in the case that the parameters cannot be interpreted the reply is

TRIGGERTIME: incorrect or invalid parameters .

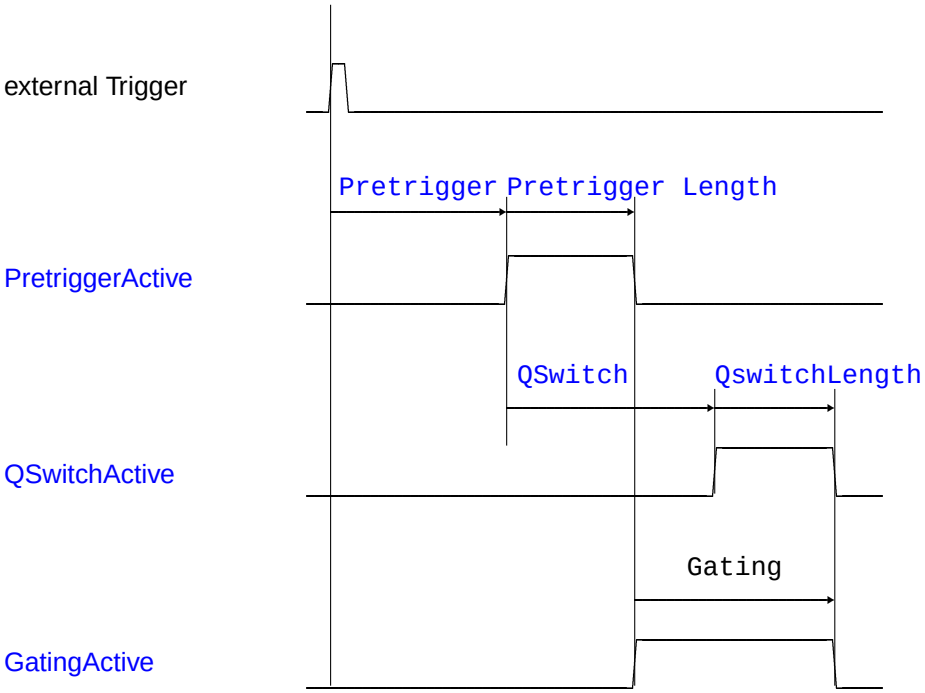
The Gatingpulse will be high from the end of the Pretrigger pulse till the end of the QSwitch Pulse. The duration is

Gate = QSwitch + QswitchLength - PretriggerLength.

Timing Parameter Explanation

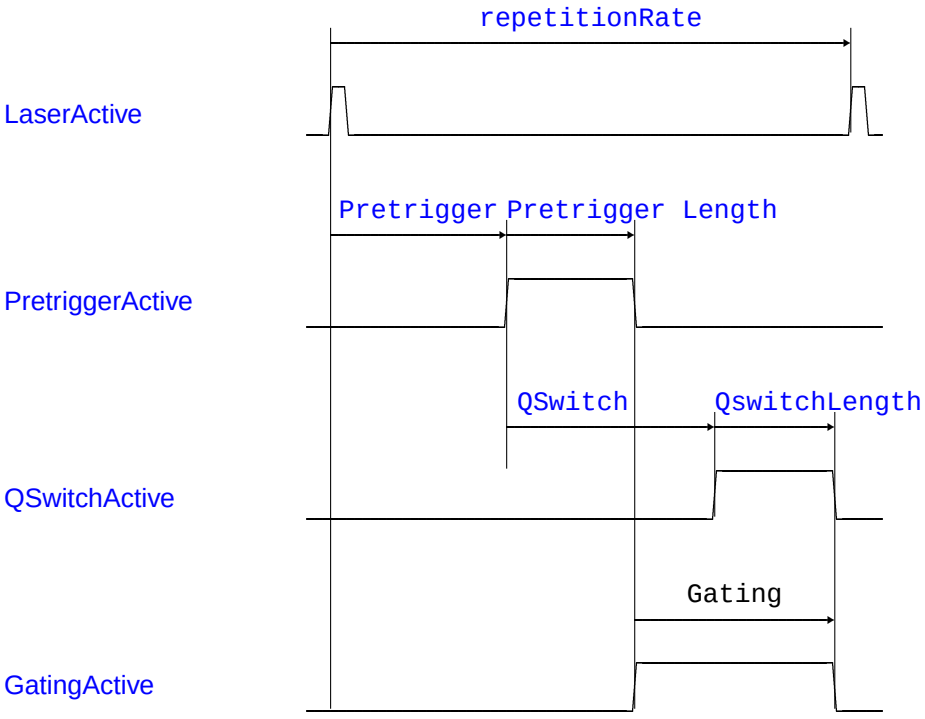
External trigger

MasterTrigger = True



Internal trigger

MasterTrigger = False



The Laser Lamp pulse has a fixed length of 5μs.

WHITELIST <”Password”> <”Host1”> <”Host2”> <”Host3”>

Sets the allowed hosts for secure mode operation. `Password` is the controller password, and `Host#` is either

- a host specified by its IP address `xx.xx.xx.xx` ,
- an IP address range `xx.xx.xx.255` ranging from 0 to 255, or
- empty .

The example
`WHITELIST "Administrator" "192.168.69.255" "213.198.20.19" ""`
grants secure mode access to clients operating from IP addresses lying in the range between `192.168.69.0` to `192.168.69.255` and furthermore from the IP address `213.198.20.19`. If successful the controller will return:
`WHITELIST executed` ,
in case of an invalid password or syntax the reply is
`WHITELIST not accepted` .
The secure mode must be enabled after specifying the allowed hosts using the `ACCESS` command. Clients will have to log in using `LOGON`.

7.2 Data File format

This describeds the file format written by `TCPIP Acquis`. The files are interoperable between the different platforms. The file format is a mixed ascii-binary format where the first lines describe the measurement situation, below follow the dataset description and then raw data as 32-bit integer values itself.

7.2.1 Sample file header

```
a9981017.204152
Berlin   10/08/2004 17:20:36 10/08/2004 17:20:41 0015 0015.0 0053.0 00
0000000 0010 0002000 0005 02
1 0 2 08000 1 1600 07.5   286.o 0 0 00 000 12 002000 0.100 BT1
1 1 2 08000 1 1600 07.5   286.o 0 0 00 000 00 002000 0.793 BC1
```

Line 1

Filename — *string.*
Format: `?YYMDDhh.mmssxx`

- `?` - *The first letter can be choosen freely.*
- `yy` - *two numbers showing the years in the century*
- `M` - *one number containing the month as a hexadecimal number (December ≡ C)*
- `DD` - *two numbers containing the day of month*
- `hh` - *two numbers containing the hours since midnight*
- `mm` - *two numbers containing the minutes*
- `ss` - *two numbers containing the seconds*
- `xx` - *two numbers containing the first 2 decimal places of the seconds*

Line 2

Location	*String with 8 Letters*
Start Time	*`dd/mm/yyyy hh:mm:ss`*
Stop Time	*`dd/mm/yyyy hh:mm:ss`*
Hight asl.	*four digits (meter)*
Longitude	*four digits (including - sign). one digit for decimal grades.*
Lattitude	*four digits (including - sign). one digit for decimal grades.*
zenith angle	*two digits in degrees*

Line 3

Laser 1 Number of shots	*integer 7 digits*
Pulse repetition frequency for Laser 1	*integer 5 digits*
Laser 2 Number of shots	*integer 7 digits*
Pulse repetition frequency for Laser 2	*integer 5 digits*
number of datasets in the file	*integer 2 digits*

Dataset description

Active	*1 if dataset is present, 0 otherwise*
Analog/Photoncounting	*Analog ≡ 0, Photoncounting ≡ 1*
Laser source	*one digit Laser 1 ≡ 1, Laser 2 ≡ 2.*
Number of bins	*5 digits*
1	
PMT highvoltage	*four digits in Volt*
binwidth	*in meter two digits before . and 2 digits after the dot*
Laser wavelength	*in nm, three digits dot*
Polarisation	*one letter, o ≡ no polarisation, s ≡ perpendikular, l ≡ parrallel*
0 0 00 000	*backward compatibility*
number of ADC bits	*in case of an anlog dataset, otherwise 0*
number of shots	*6 digits*
analog input range/discriminator level	
	analog input range in Volt in case of analog dataset , discriminator level in case of photon counting, one digit dot 3 digits.
Dataset descriptor	*BT ≡ analog dataset, BC ≡ photoncounting, the number is the address of the transient recorder as a hexadecimal.*

The data set description is followed by an extra CRLF. The datasets are 32bit integer values. Datasets are separated by CRLF. The last dataset is followed by a CRLF. These CRLF are used as markers and can be used as check points for file integrity.

7.3 The Initialization File `acquis.ini`

The initialization file `acquis.ini` contains definition blocks for each transient recorder. The data here corresponds to the values set while configuring the transient recorders. The data entries may appear in a different order within a block.

```
[TR0]
Discriminator=0
Range=0
PM=0
WavelengthA=532.000000
PolarisationA=0
AnalogA=TRUE
A-binsA=16000
A-reductA=0
PC A=TRUE
P-binsA=16000
P-reductA=0
WavelengthB=1024.000000
polarisationB=0
Analog B=FALSE
A-binsB=0
A-reductB=0
PC B=FALSE
PC-binsB=0
PC-reductB=0
SamplingRate=20
```

A block always begin with `[TR<n>]` where n indicates the address of the transient recorder.

`Discriminator` Discriminator level between 0 and 63.

`Range` Input range of the transient recorder. Valid values are

Range Value	Imnput Range
0	0 – 500 mV
1	0 – 100 mV
2	0 – 20 mV

`PM` Photomultiplier voltage.

`WavelengthA` Wavelength 1.

`PolarisationA` corresponding polarization 1. Valid values are

Range Value	Imnput Range
0	no polarization
1	parallel
2	crossed

`AnalogA` (`TRUE` | `FALSE`) Enable or disable analog acquisition for memory A.

`A-binsA` Corresponding number of bins to be read out. The maximum number of bins is given by $16380/(2^{datareduction})$

`A-reductA` Corresponding data reduction level.

`PC A` (`TRUE` | `FALSE`) Enable or disable photon counting acquisition for memory A.

`P-binsA` Corresponding number of bins to be read out. The maximum number of bins is given by $16380/(2^{datareduction})$

`P-reductA` Corresponding data reduction level.

`WavelengthB` Wavelength 2.

`polarisationB` Corresponding polarization 2. Valid values are as above for `PolarisationA`.

`Analog B`	(TRUE | FALSE) Enable or disable analog acquisition for memory B.
`A-binsB`	Corresponding number of bins to be read out. The maximum number of bins is given by 16380/($2^{datareduction}$)
`A-reductB`	Corresponding data reduction level.
`PC B`	(TRUE | FALSE) Enable or disable photon counting acquisition for memory B.
`PC-binsB`	Corresponding number of bins to be read out. The maximum number of bins is given by 16380/($2^{datareduction}$)
`PC-reductB`	Corresponding data reduction level.
`SamplingRate`	Sampling rate of the transient recorder.

To completely disable a transient recorder `Analog`A, `PC A`, `Analog B`, and `PC B` must be set to FALSE.

7.4 Analysis Example: Gluing Analog and Photon Counting Data

Abstract

The algorithm for combining analog and photon counting data (gluing) is described. A discussion when the signals need to be combined is followed by stepwise procedure to do this with real data.

7.4.1 Introduction

The Licel transient recorder systems have a parallel analog and photoncounting detection chain. The combination of both signals gives the high linearity of the analog signal for strong signals and the high sensitivity of the photon counting for weak optical signals. The integration of both detection mechanism into a single device avoids ground loops and other problems that make the combination otherwise cumbersome. The main idea of the signal combination is that there is a region where both signals are valid and have a high signal to noise ratio. For typical Mini-PMT that region extends from 0.5 to 10 MHz in the photon counting. To combine (glue) both signals, the photon counting needs a dead time correction. There are two typical deadtime scenarios, while the Licel photon counter can be best described as nonparalyzable.

7.4.2 Paralyzable System

$$N = S\exp(-S\tau_d) \tag{7.1}$$

Where:
- N - is the observed countrate
- S - is the true countrate
- τ_d - is the system dead time

7.4.3 Nonparalyzable System

$$N = \frac{S}{1 + S * \tau_d} \tag{7.2}$$

- N - is the observed countrate
- S - is the true countrate
- τ_d - is the system dead time

While the paralyzable case is nonlinear equation, the nonparalyzable case can be easily inverted to

$$S = \frac{N}{1 - N * \tau_d} \tag{7.3}$$

As both cases are only a theoretical model, they are valid for lower countrates but fail when $S * \tau_d$ becomes larger than one. From a numerical point of view Eq. 7.3 can be only applied to a signal as long as

$$N < \tau_d \tag{7.4}$$

As an example the correction factor for a time constant of 4ns and a observed count rate of 5 MHz is 1.02. As typical averaged maximum observed countrate is 160MHz the correction factor would be 2.77. This would imply an maximum count rate of 470MHz. The glued profiles however show a virtual countrate in the 2GHz region for a 20mV peak.

7.4.4 The glueing algorithm

In the valid region of both signals between the lower toggle rate (typical 0.5MHz) and the upper toggle rate (typical 10MHz) one seeks the linear regression coefficients to transfer the analog data into photon counting data:

$$\sum_{i=1}^{n} (PC(z_i) - (a * Analog(z_i) + b))^2 = min \tag{7.5}$$

The coefficients a and b are applied to the analog signal and above the upper toggle rate the scaled analog is used and below the photon counting data.

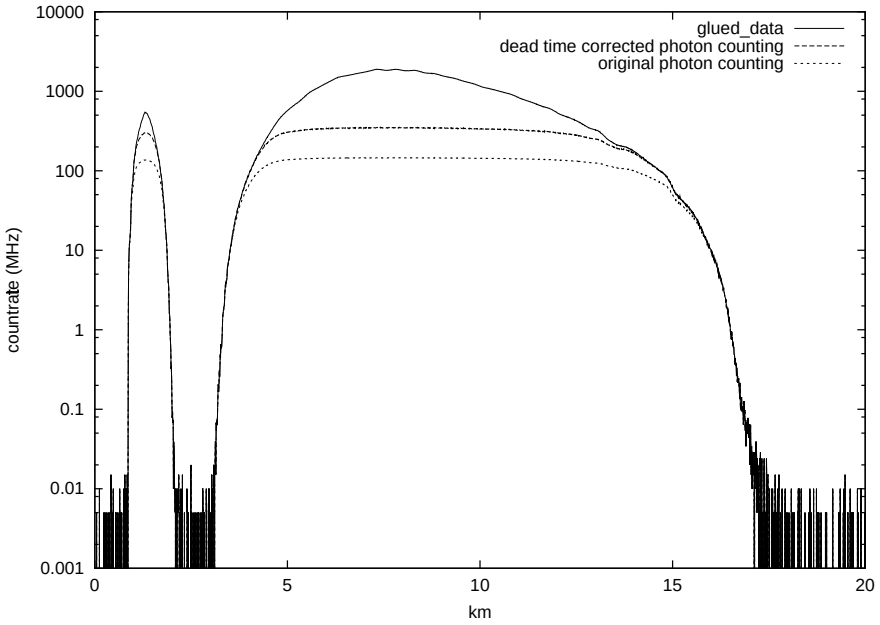


Figure 7.1: Glued data

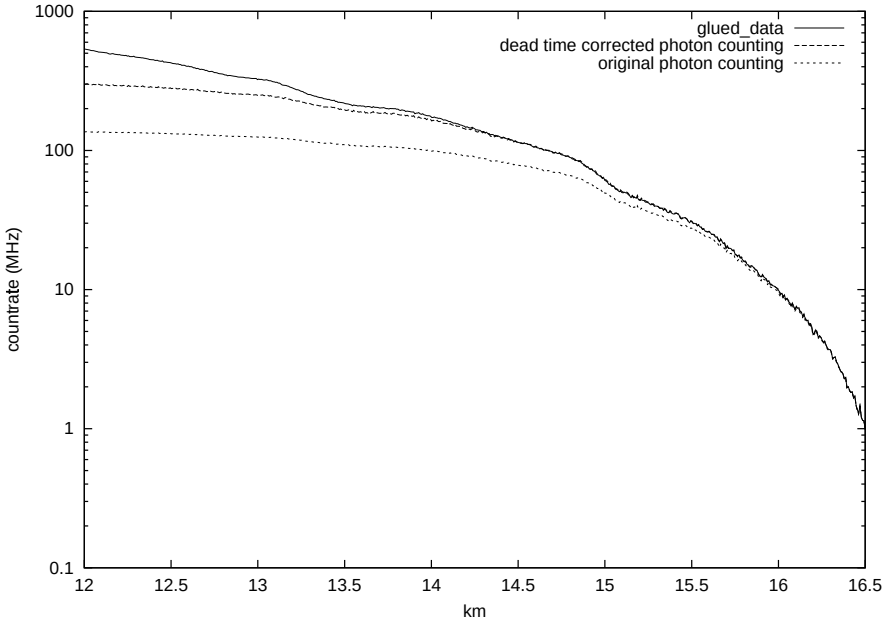


Figure 7.2: Zoomed plot

The zoomed plot shows that the dead time correction function is valid up to 130 MHz.

If one varies the upper toggle frequency between 5 and 10 MHz the standard deviation for the signal maximum is only 3MHz or 0.1%. This proves the numerical stability of the proposed algorithm.

The figure below shows the necessity of applying the dead-time correction first. Without correction the signal maximum becomes stronger dependent from the max. toggle rate.

Figure 7.4 demonstrates the advantages of the photon counting in the low light level region. While the analog signal shows the noise coming from the ADC, the photon counting is still able to follow the input signal and extends the dynamic signal range from the analog signal by another 2 orders of magnitude.

7.4.5 Gluing strategy

In principle one should glue two signals only if it is necessary. The only scenario when one really need to glue is when:

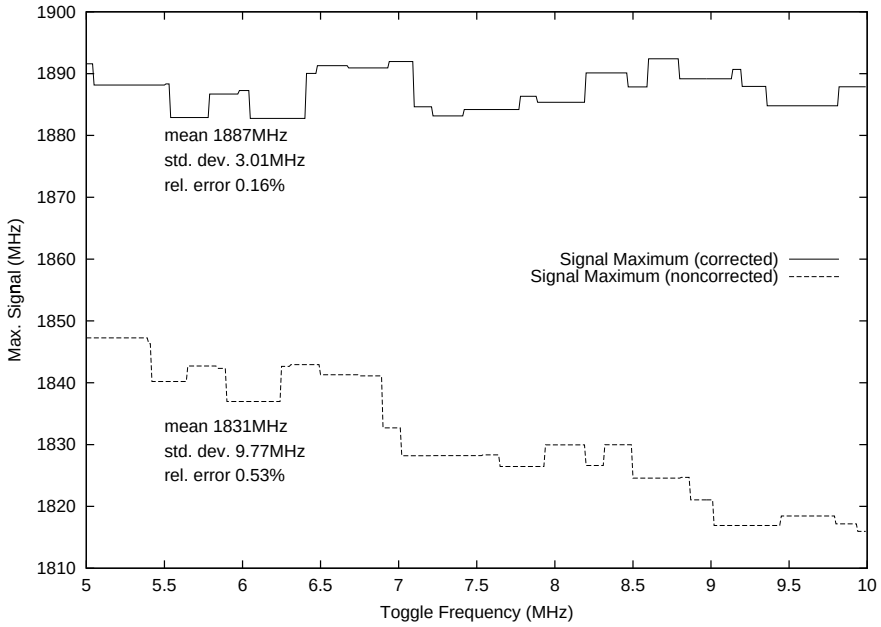


Figure 7.3: Signal maximum for different max. toggle frequencies without dead-time correction

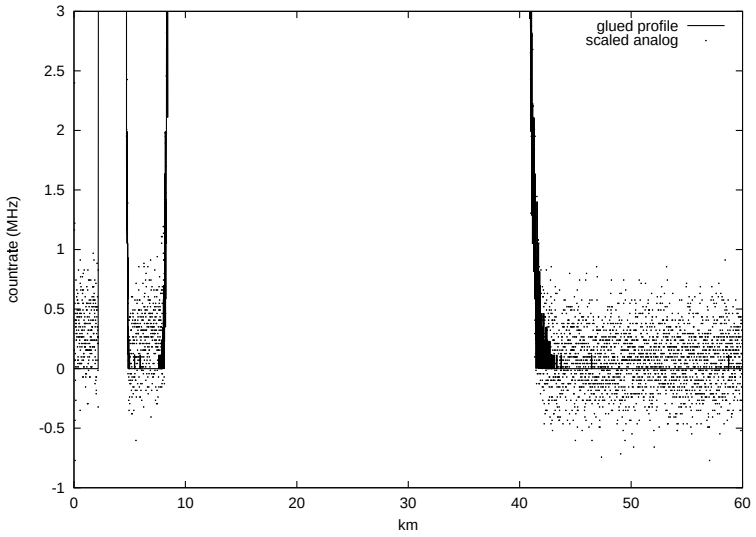
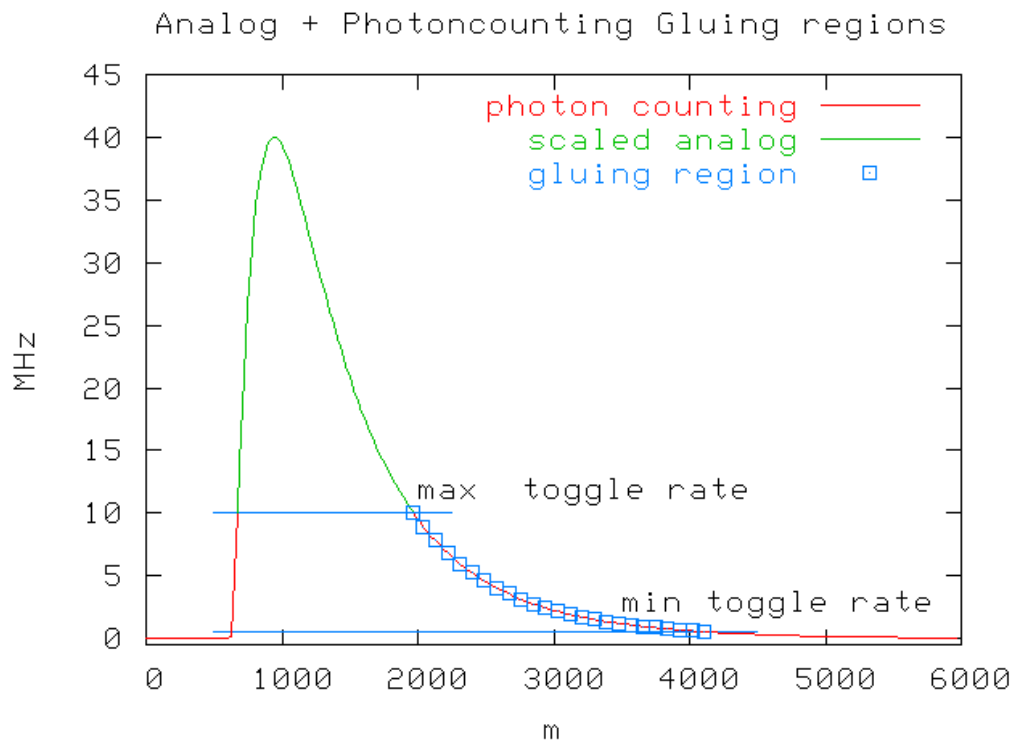


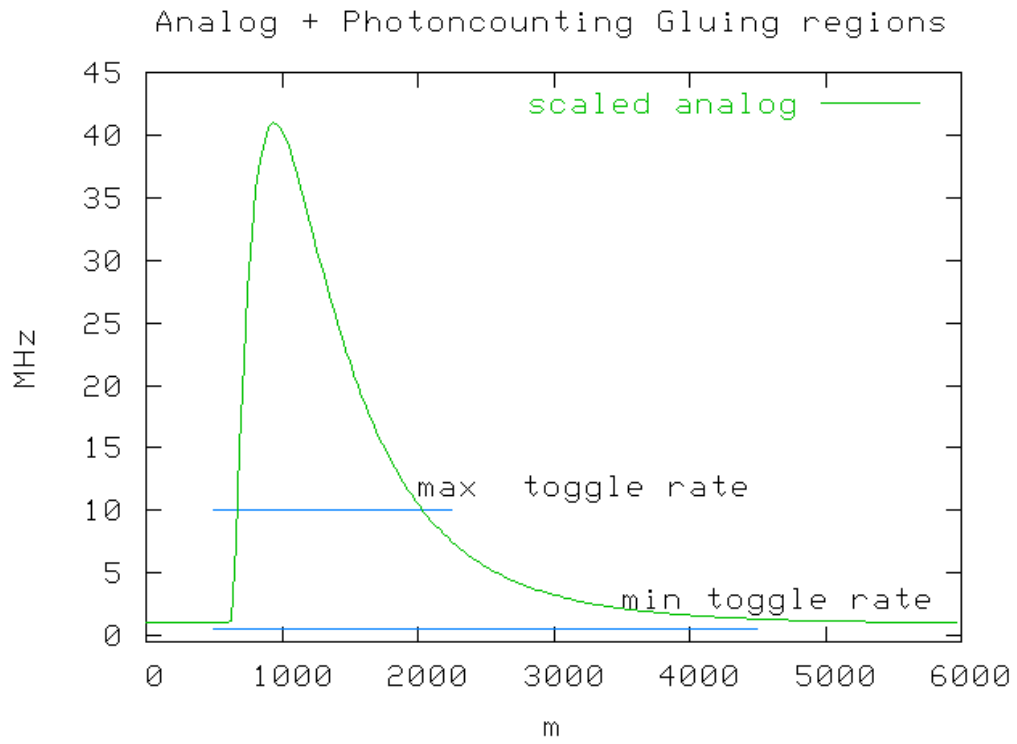
Figure 7.4: Increased dynamic range under low light level conditions

1. the peak value of the deadtime corrected photon counting is above the maximum toggle rate and
2. the background of the deadtime corrected photon counting is below the minimum toggle rate.

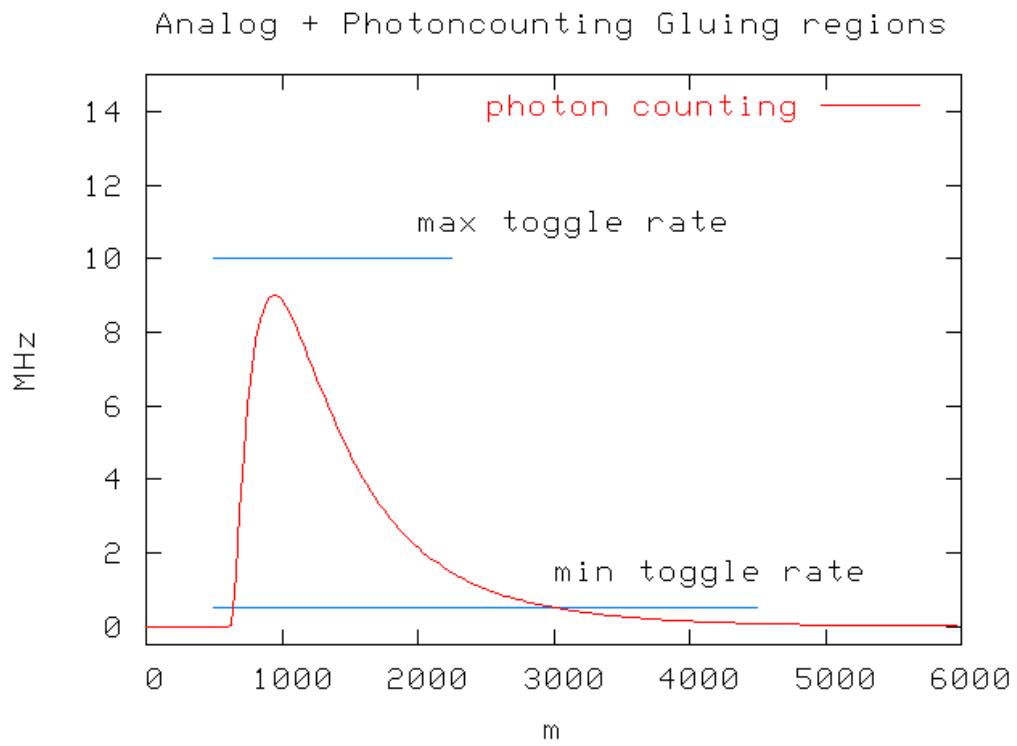
This situation is shown below:



If one assumes that the analog is valid enough to compute a regression curve then there is no need to compute a regression if the photon counting background exceeds the minimum toggle rate. In this case one can use the scaled analog.



If the peak countrate does not exceed the max. toggle rate there is no need to glue either and the deadtime corrected photon counting should be used.



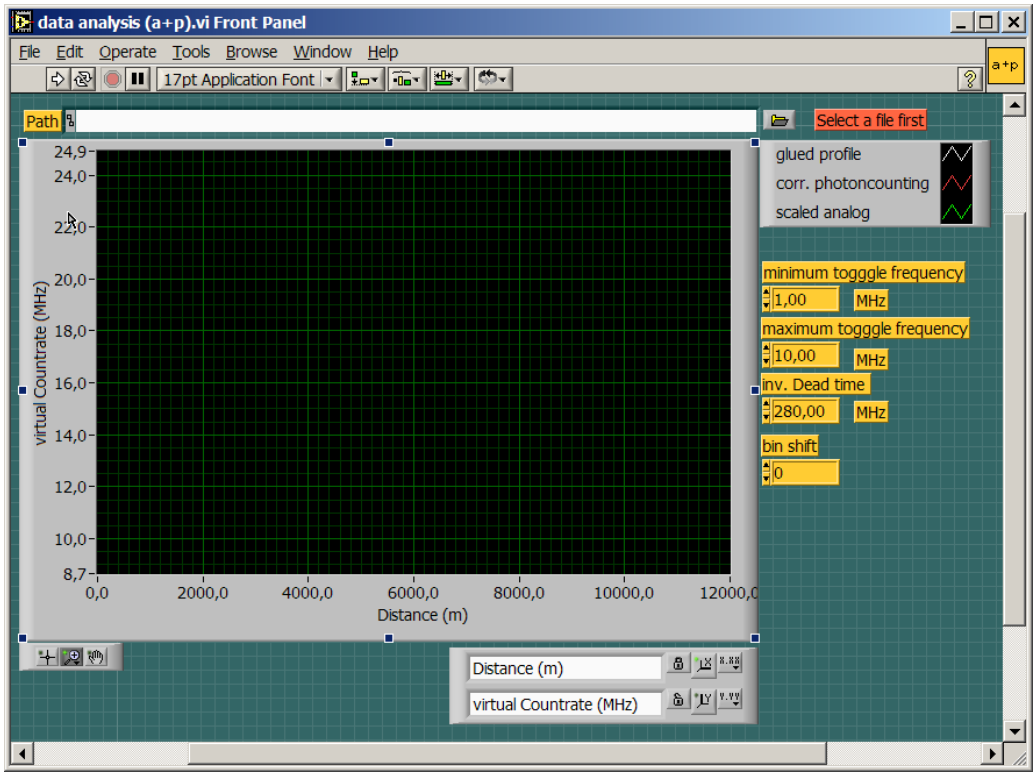
The use of a glued profile instead of a pure photon counting profile if the peak value is only slightly above the max. toggle rate. say at 12 MHz for 10MHz max. toggle rate could also be avoided.

7.4.6 Tutorial

Licel provides a sample code in LabVIEW for combining analog and photon counting data. The sample code assumes that the provided data has been previously recorded with the Acquis Software. One needs a LabVIEW license to look into the code. Reuse of this code in your projects is desired and permitted.

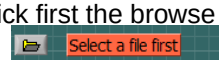
Loading the VI

Please open the `data analysis (a+p).vi` from the `Postan.llb` or the corresponding Windows application from the Windows start menu.



Selecting a data file

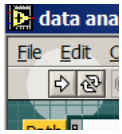
Click first the browse button



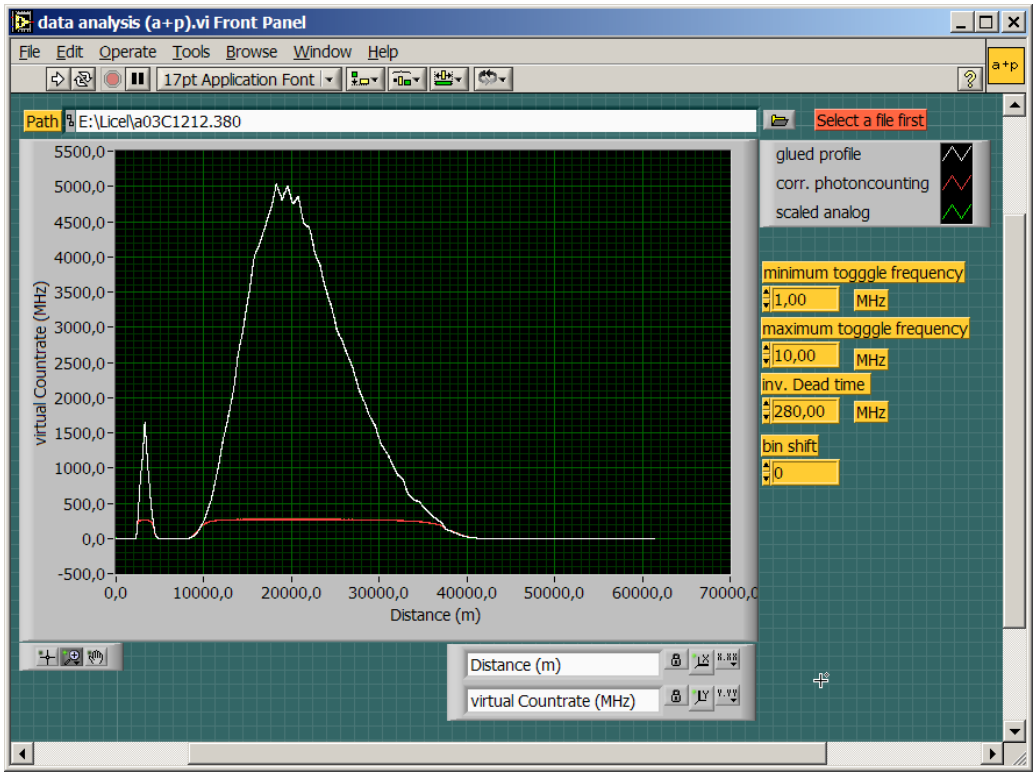
in the upper left part of the vi and select a data file that has previously been recorder with the Acquis-Module. At `http://www.licel.com/download/gluetestfile.zip` one can find the data file which has been used for this demonstration.

First Run

Press the run button in the upper right corner



and one should see the following curves



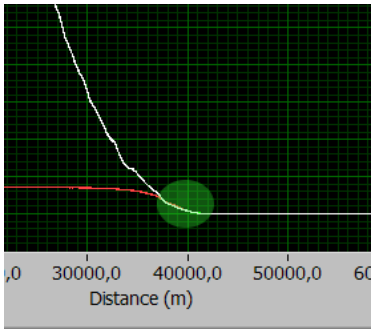
The white curve shows the combined signal.

Bin shift

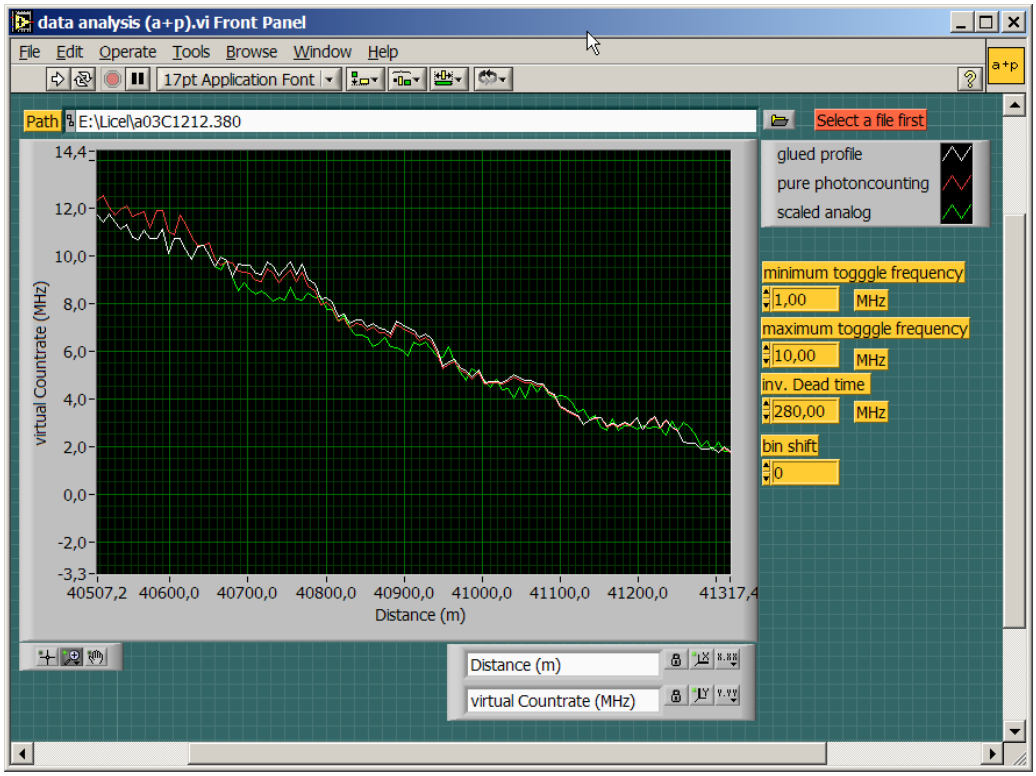
The analog and the photoncounting data has a fixed shift between them. This is a result of two factors

1. Analog Bandwith, the preamplifier contains a antialias filter which has a bandpass of half the sampling frequency this delays the analog signal with respect to the photon counting by 2 bins
2. ADC pipelining, modern ADCs sample the voltage in a multiple step process so that the sample result will be available several clock cycles later after the actual sampling took place.

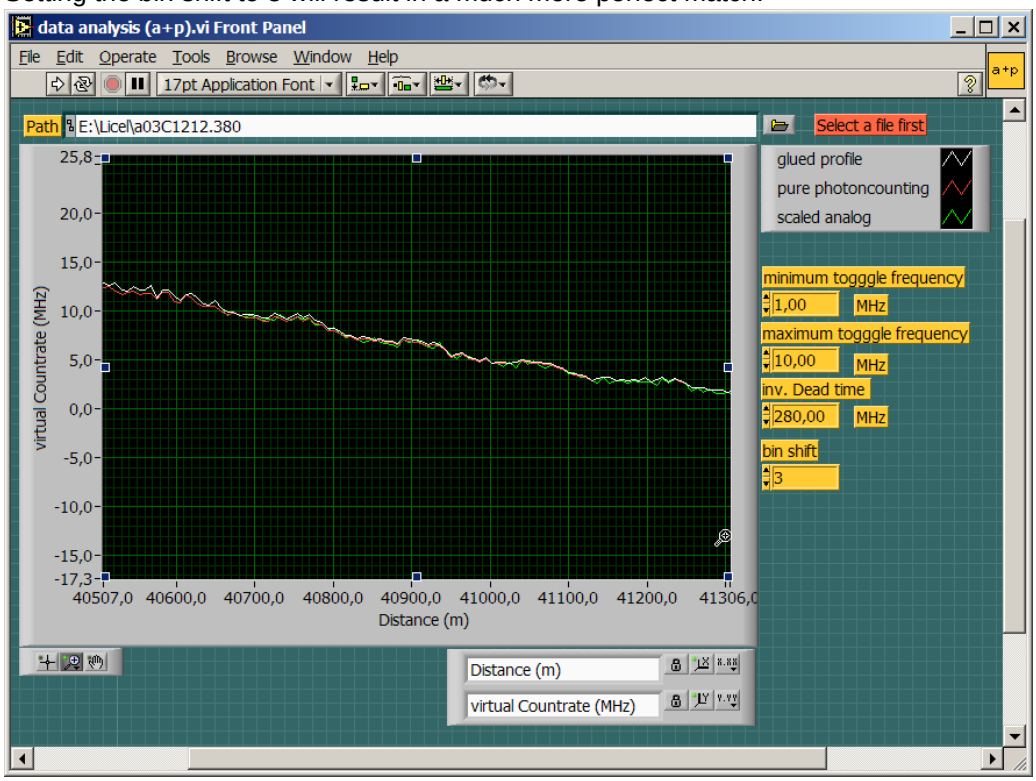
To demonstrate this zoom into the profile



There is a shift of the scaled analog signale versus the photon counting data (the green vs. white curve)

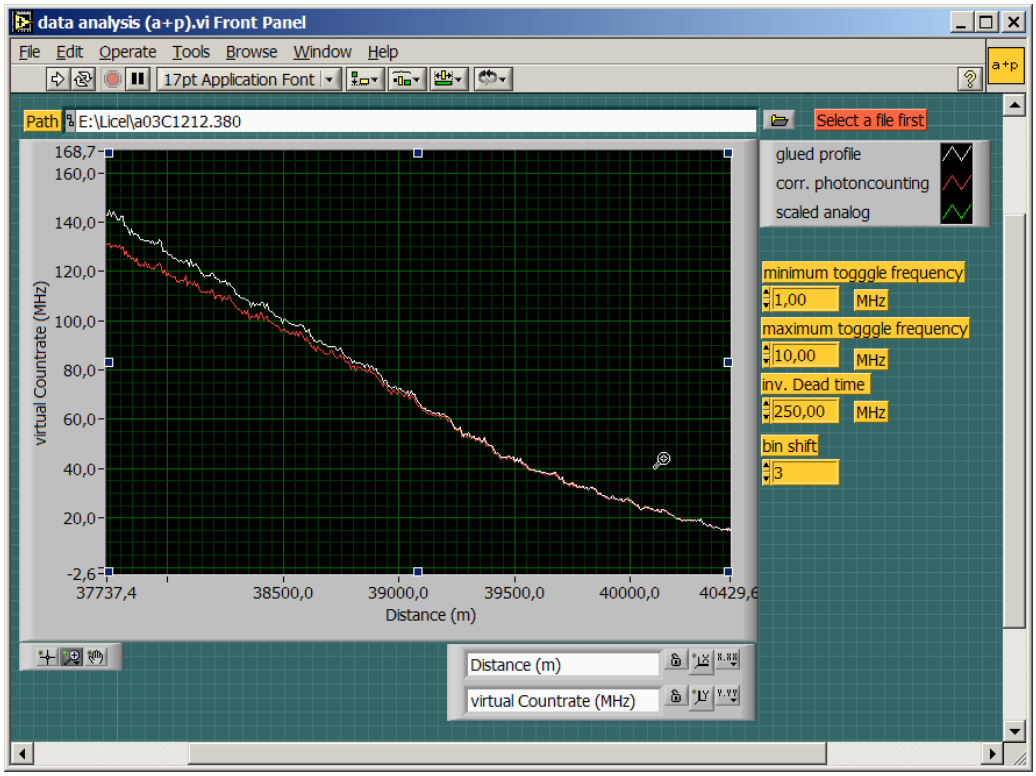


Setting the bin shift to 3 will result in a much more perfect match.



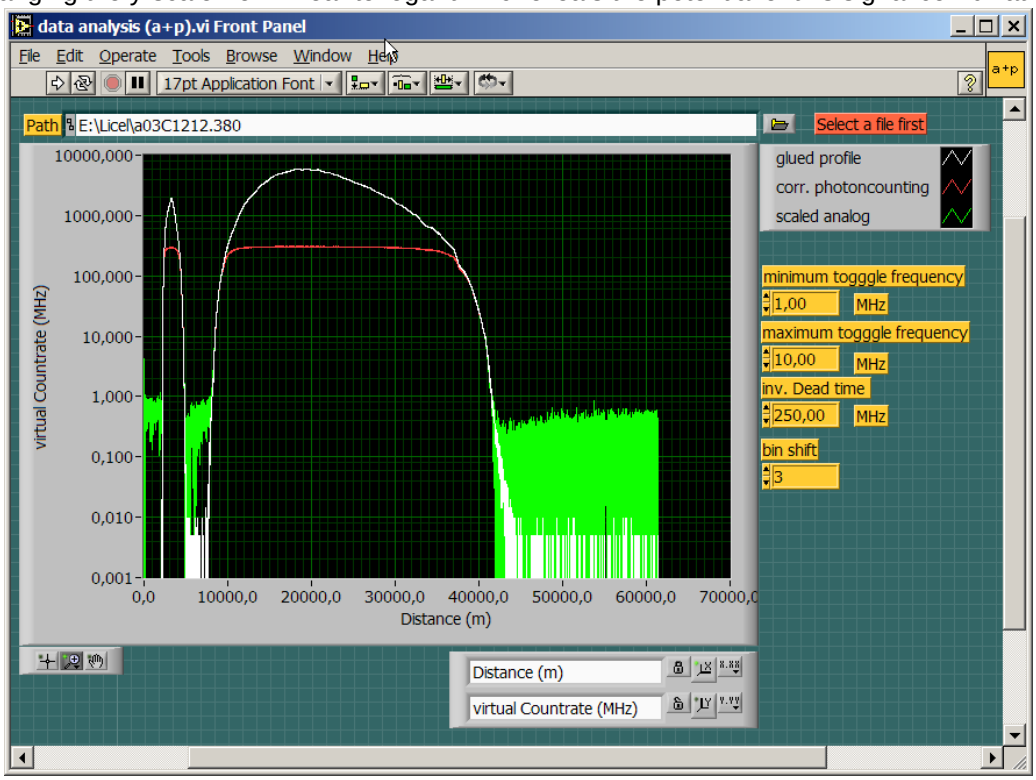
Photon counting deadtime correction

The default value of 280MHz is rather conservative approach for the deadtime correction. Lowering this value increases the deadtime correction. In the region above the max toggle rate a perfect deadtime correction will show a longer region where the glued curve and the deadtime corrected photoncounting coincide.



5 Orders of magnitude

Changing the y-scale from linear to logarithmic reveals the potential of this signal combination.



The red curve shows that the photon counting becomes nonlinear and saturates. The green curve shows that signals which are close to the analog baseline are difficult to distinguish. But the combination of both signal prevents the nonlinearity for strong signals and gets the good baseline from the photon counting.

Next steps

Code similiar to `data analysis (a+p).vi` needs to be integrated into the data retrieval software. Experience shows that recording background file without a laser signal and substracting the averaged background from real signals will improve the analog background flattness and give more consistent gluing results. Once the transfer coefficients are found one could use them instead of searching in every signal for a new set of coeeficients. The coefficient should stay constant if the detector has the same applied high voltage.

7.5 LabVIEW TCPIP Driver vi Tree

In this subsection an overview about the provided LabVIEW vis is given.

7.5.1 Top Level VI's

Licel TCPIP VI Tree.vi

Go to the diagram (Ctrl-E) to view the VI Tree Hierarchy and to quickly open any of the VI's included.

Licel TCPIP Activate DHCP Mode.vi

This VI is used to activate DHCP for the transient recorder controller.

This VI uses the default password **Administrator** and the default port **2055**. If the port has been changed, you must change the **current port** to the proper value. The **DHCP port** is the port that will be used for DHCP communication. After DHCP mode has been set, communication will be lost until the acquisition computer is configured for DHCP communication as well.

Licel TCPIP Disable Secure Mode.vi

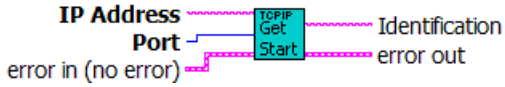
This VI is used to disable the Secure Mode of the Licel Ethernet Controller. The initialization file LicelTCPIP.ini is modified to allow future access without using the Secure Mode login.

Licel TCPIP Enable Secure Mode.vi

This VI is used to enable the Secure Mode of the Licel Ethernet Controller. The initialization file LicelTCPIP.ini is modified to allow future access using the Secure Mode login. This file should be copied to the same directory where Licel TCPIP.llb resides on all PCs from where access is allowed.

Licel TCPIP Getting Started.vi

This VI gets the identification information from the transient recorder controller.



Licel TCPIP Set Fixed IP Address.vi

This VI is used for setting the new IP configuration for the transient recorder controller.

Licel TCPIP Set New Password.vi

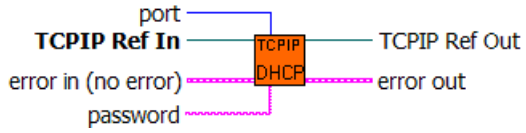
This VI is used for setting the new password for the Licel Ethernet Controller.

7.5.2 Controller related VI's

Licel TCPIP Activate DHCP.vi

This VI is used to activate the DHCP mode of the transient recorder controller.

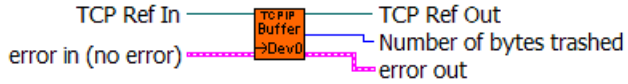
In order to do so, the user must enter the proper password and port number for the controller. After DHCP mode has been set, communication will be lost until the acquisition computer is configured for DHCP communication as well.



Licel TCPIP Dump TCPIP Buffer.vi

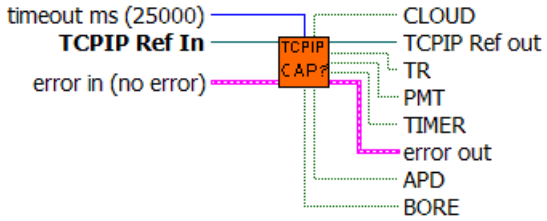
This VI empties the TCPIP buffer by reading all the data that is available in the buffer.

The **Number of bytes trashed** shows how many bytes were read from the buffer and disposed of.



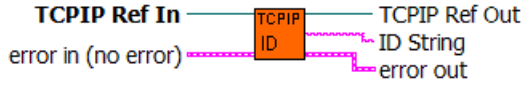
Licel TCPIP Get Capabilities.vi

The vi enables or disables the trigger mode for the Lamp, Pretrigger, Q-Switch, and Gating. The user can also switch between the internal and an external trigger using the External Trigger control.



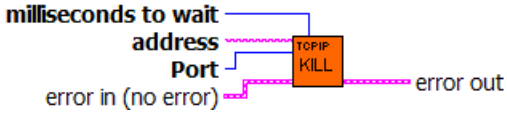
Licel TCPIP Get ID.vi

gets the identification string from the transient recorder controller.



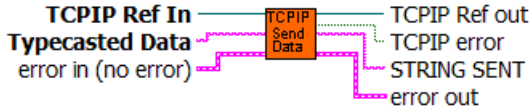
Licel TCPIP Kill Sockets.vi

This VI opens a new connection to the TR and sends the command to close down and reset all TCPIP connections. After doing this, the VI shuts down its TCPIP connection and waits the specified number of milliseconds, **milliseconds to wait**, before returning.



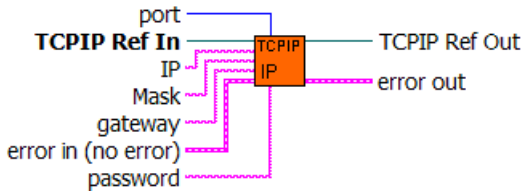
Licel TCPIP Send Data.vi

adds a CRLF to the end of the string and sends it via TCPIP using the TCPIP reference input



Licel TCPIP Set IP Parameter.vi

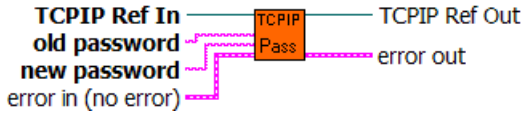
This VI is used to configure the transient recorder controller for static IP communication. With it, the values of the **IP** address, **port** number, subnet **mask**, and **gateway** can be set.



Licel TCPIP Set Password.vi

This VI is used for setting the password of the transient recorder controller.

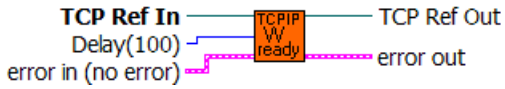
This password must be given in order to change the IP configuration of the controller.



7.5.3 Transient recorder

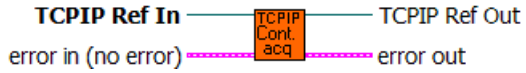
Licel TCPIP Wait For Ready.vi

Waits for return of the device from the armed state. If the waiting time is longer than the time specified by delay than the device remains armed and will be return to the idle state with next reading of binary data



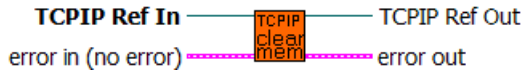
Licel TCPIP Continue Acquisition.vi

Continues the recording process for the specified device without reinitializing the memory.



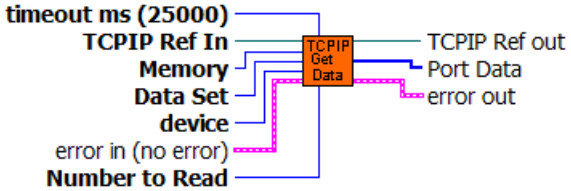
Licel TCPIP Clear Memory.vi

Clears both memories (A and B) of the specified device.



Licel TCPIP Get Datasets.vi

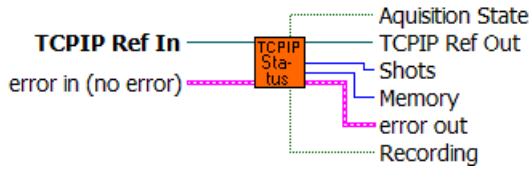
is a vi for reading raw data sets (analog LSW, analog MSW or photon counting) from the specified device.



Licel TCPIP Get Status.vi

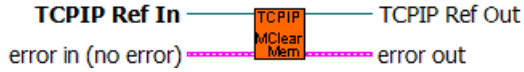
Returns the status information for the specified device (cycles,memory,acquisition state and whether the device is just recording).

If an error parsing the status information occurs, the VI returns an error 5765.



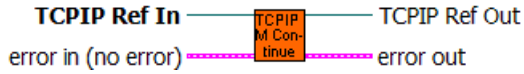
Licel TCPIP Multiple Clear Memory.vi

Clears both memories (A and B) of the currently selected devices.



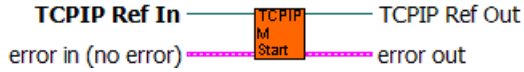
Licel TCPIP Multiple Continue Acqusition.vi

The acquisition process of the selected multiple devices will be restarted without clearing their memories.



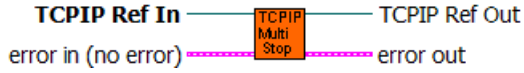
Licel TCPIP Multiple Start.vi

The acquisition process will be started after the next received trigger for multiple devices



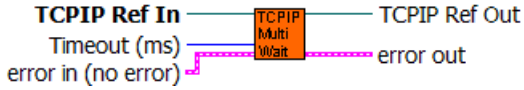
Licel TCPIP Multiple Stop Acqusition.vi

The acquisition process will be stoped after the next received trigger for multiple devices



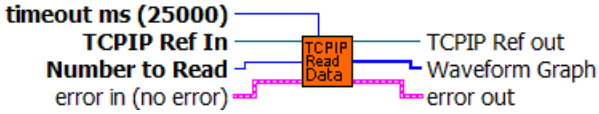
Licel TCPIP Multiple Wait For Ready.vi

The vi waits until all devices returned from the armed state.



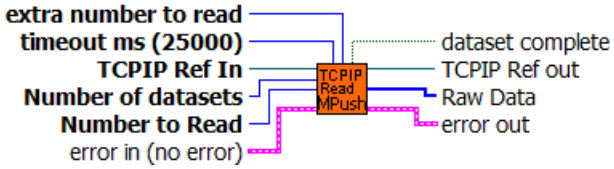
Licel TCPIP Read Data.vi

This VI waits until the the number of scans defined by **Number to Read** is available and reads them or returns a timeout error if the **timeout ms** is exceeded.



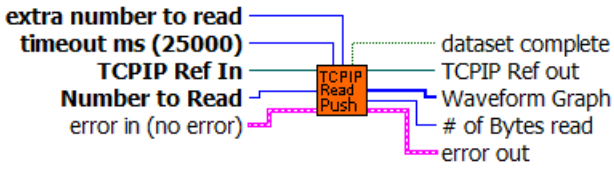
Licel TCPIP Read MPushed Data.vi

This VI reads the pushed data from multiple transient recorders at once. The data from the various transient recorders is concatenated together and must still be separated.



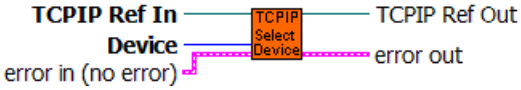
Licel TCPIP Read Pushed Data.vi

This VI is used for reading a single pushed data set.



Licel TCPIP Select Device.vi

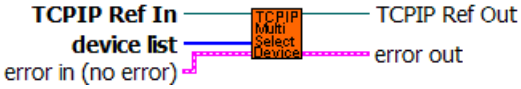
selects the device specified by the input **device number**. Selecting a device makes it active for all future commands that do not have a required **device number** input. The previously selected devices become deselected when this command is issued.



Licel TCPIP Select Multiple Devices.vi

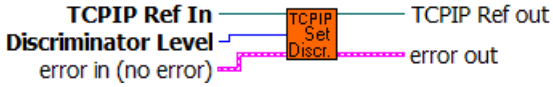
This VI is used to select multiple transient recorders.

The devices corresponding to the numbers in the **device list** array will be selected which means that they will become sensitive to all future commands that do not require a **device number** input. The devices will be deselected if another **select** command is issued.



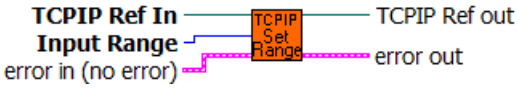
Licel TCPIP Set Discriminator Level.vi

Set discr.vi set the discriminator level between 0 and 63 for the selected transient recorders.



Licel TCPIP Set Input Range.vi

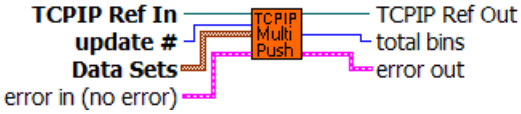
The vi changes the input voltage range.



Licel TCPIP Set Multiple Push Mode.vi

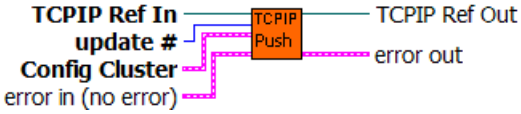
This VI is used to start the push mode for one or more devices.

This VI takes the **Data Sets** information and the **update** #, which is the number of laser pulses to acquire, as input parameters. Based upon these inputs, the VI generates and sends a command to start the push mode for the transient recorders specified by **Data Sets**.



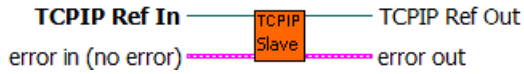
Licel TCPIP Set Push Mode.vi

sets the push mode for the currently selected transient recorder.



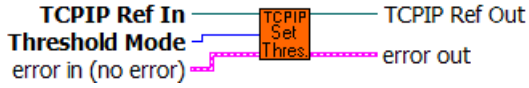
Licel TCPIP Set Slave Mode.vi

This VI stops the push mode and sets the transient recorder controller back in to the slave mode.



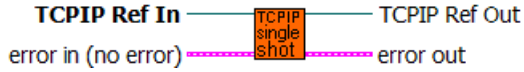
Licel TCPIP Set Threshold Mode.vi

Set Threshold Mode sets the scale of the discriminator level. In the low threshold mode the disciminator level 63 corresponds to -25mV while in the high threshold mode it corresponds to -100mV.



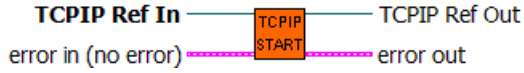
Licel TCPIP Single Shot.vi

Acquires one shot with the currently selected device.



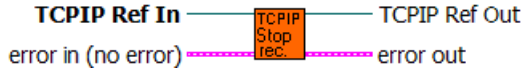
Licel TCPIP Start.vi

starts the currently selected transient recorder.



Licel TCPIP Stop Acqusition.vi

This VI stops the acquisition process after the next received trigger.

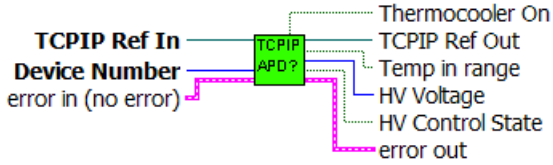


7.5.4 APD

Licel TCPIP APD Get Status.vi

This VI gets the status of the APD with the corresponding device number.

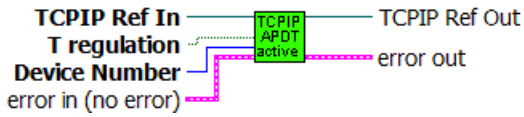
The values that are returned are the
HV Voltage : this is the actual gain voltage
On : this boolean is true if the gain voltage power supply is on,
otherwise it is false
control state : if true, the APD is being controlled remotely,
if false, then the APD is being controlled locally
T regulation: if true, then the cooling has been activated
if false, then the cooling is inactive; i.e. passive



Licel TCPIP APD Set Cooling State.vi

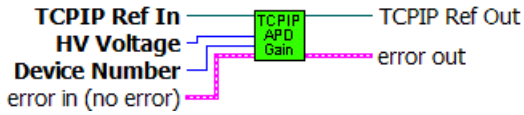
This VI sets the cooling state for the APD with the corresponding device number.

True=the current to the peltier cooling will be activated
False=the cooling will not be activated. Only passive cooling occurs.



Licel TCPIP APD Set Gain.vi

Sets the Gain Voltage for the APD specified by the **Device Number** to the value specified by **HV Voltage**.



7.5.5 PMT

Licel TCPIP PMT Get Status.vi

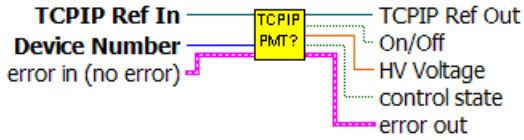
This VI gets the status of the PMT with the corresponding device number.

The values that are returned are the

HV Voltage : this is the actual gain voltage

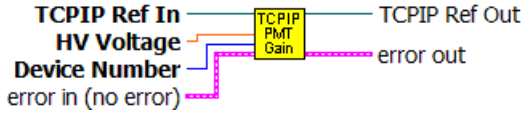
On : this boolean is true if the gain voltage power supply is on, otherwise it is false

control state : if true, the PMT is being controlled remotely, if false, then the PMT is being controlled locally



Licel TCPIP PMT Set Gain.vi

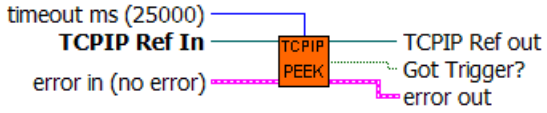
Sets the Gain Voltage for the PMT specified by the Device Number to the value specified by HV Voltage



7.5.6 Trigger

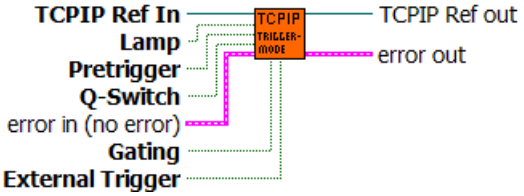
Licel TCPIP Peek Trigger.vi

The vi enables or disables the trigger mode for the Lamp, Pretrigger, Q-Switch, and Gating. The user can also switch between the internal and an external trigger using the External Trigger control.



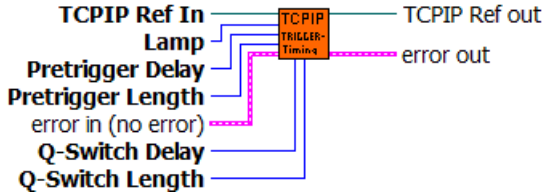
Licel TCPIP Set Trigger Mode.vi

The vi enables or disables the trigger mode for the Lamp, Pretrigger, Q-Switch, and Gating. The user can also switch between the internal and an external trigger using the External Trigger control.



Licel TCPIP Set Trigger Timing.vi

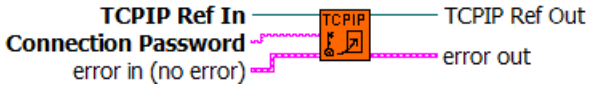
The vi allows the user to set the times in ns for the Lamp, pretrigger delay, pretrigger length, Q-Switch delay and Q-switch length



7.5.7 Network Security

Licel TCPIP Login Secure Mode.vi

Send the LOGON command to work in secure mode. Reads a string from TCPIP, attemps to convert the string to 2 U32 numbers used to encrypt the password to 2 output U32 numbers using the Blowfish encryption algorithm. These output numbers are converted to a hexadecimal string to be used in the LOGON command. If the LOGON command fails the controller will close the connection without any notification.

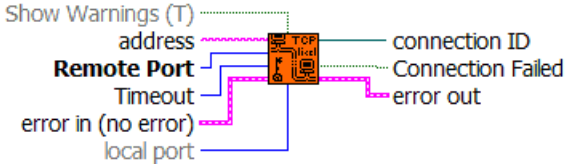


Licel TCPIP Open Secure Mode.vi

Open a TCP/IP connection to the Licel controller in secure mode. The vi tries to open the initialization file LicelTCPIP.ini to read the values for the keys UseSecureMode and SecureModePWD from the SecureMode section:

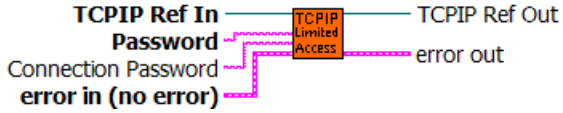
```
[SecureMode]
UseSecureMode=TRUE
SecureModePWD=ConnectMe
```

If the initialization file is found and UseSecureMode is true and SecureModePWD is found the vi will send the password using the LOGON command (Licel TCPIP Login Secure Mode.vi). Otherwise just the TCP/IP connection will be opened.



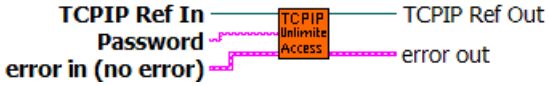
Licel TCPIP Set Access Limited.vi

Enables the limited access to the controller, i.e. activates the secure mode. Access is granted only for IP addresses as specified with the WHITELIST command. Moreover the connection password is specified.



Licel TCPIP Set Access Unlimited.vi

Disables the limited access to the controller, i.e. deactivates the secure mode. Access is granted for everybody.



Licel TCPIP Set Whitelist.vi

This VI is used to to set the allowed hosts at the controller. In order to do so, the user must enter the appropriate password and 3 host strings to allowed IP addresses or IP address ranges. Such a string must be specified in the following format:

xx.xx.xx.xx	a single IP address,
xx.xx.xx.255	an IP address range (0:255),
	or may be empty.