Hints and Troubleshooting for DLDs

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User Manual for Hints and Troubleshooting DLDs
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2.1 Checking the correct Detector Operation before working the first Time

Check that all mounting and cabling is made correctly and that the vacuum conditions are in range.
First tests should be always done in 2D-imaging mode, i.e without any external TDC start signal. Thus, do not connect your external TDC start signal in the beginning and take care, that the system runs with its internal start, which is set by the parameter "Ext_Gpx_Start = 0" in the DLD_GPX3.INI file.
Switch off or attenuate down all particle sources in your experimental setup, so that the expected rate on the detector area is at zero or nearby zero.
Start the DLDGUI program and press the "Expose" button. The software will run now in live exposure mode.
Set the value "Grey level to" from 5 to 1 for the first test (the 3rd parameter on the right of the DLDGUI window), that ensures to observe single hits in the display by eye later on.
Drive the detector high voltage slowly up following the manuals recommended timing scheme for the first HV operation at the detector. The procedure can be accelerated when it was already carried out without problems before and no important system status has been changed in between (slow procedure is recommended for the first time after bake-out or venting).
Single event hits will appear in the image display of the DLDGUI program when one approaches the correct detector operational voltage (see specification sheet for the correct individual voltage of your detector).
Before increasing intensity of the source, it is recommended to accumulate an image from the single hits (dark counts) in order to see whether they are homogeneous distributed over the active detector area.
If that works correctly, your detector is ready to use, you may increase the intensity slowly while checking the CPS window to stay in the operating range that is valid for your DLD, observe all changes in live mode.

2.2 In Order to keep your Detector on good Health

Never work with any unknown rate of particle hits going onto the detector, remember, the device is a single counting device, and it responds completely unreliable when you operate it over the limit! In case of any doubt, start without any source and drive up intensity slowly from zero to the wanted operational range.
Never operate the detector further, when you observe an unexpected rise of vacuum pressure when applying high voltage (the pressure raises always with the detector load, but it needs some experience to distinguish between normal and dangerous behavior).
Never compensate too high count-rates by driving the detector voltage down! Delayline detectors need the high voltage within a very narrow operational window range; driving HV down screws up the correct detector operation completely. Always reduce the incoming particle rate from the experiment to go into the needed operation range!

Do never over-expose detector local area parts for a time longer than a second. Overexposed areas are appearing locally dark in the image, while they get so much intensity that the delay line read-out cannot see complete sets of events from that regions anymore, so the response is zero rate on such positions! Overexposing ages the micro-channel plates locally, such an aging can later not be compensated by electronics, only by an expensive replacement of the damaged MCP stack.
Never expose the detector on limited areas only within the first some hundred hours of operation (burn-in phase). All MCP pores degrade in amplification linearly with the particle loads within the burn-in phase. The time averaged load on all available pores must be nearly homogeneous within the burn-in phase to avoid nonuniform amplifications in different detector areas. If once happened, the only solution is an expensive MCP replacement as well.
Never operate the detector while the MCP temperature may be above room temperature.

2.3 About Start Signals for Time Measurements

The TDC generates an internal start signal which is used for pure 2D(x, y) measurements. This internal start signal has no time correlation to any external clock and therefore also not to the incoming stops. An eternal start signal must be provided to the TDC for real time resolved measurements. The external start signal must be applied as a LVTTL (low voltage TTL) signal to the "TTL Start" input (BNC socket). The start signal must always be in 50Ohm technique and the minimum amplitude must be at least +2.1V amplitude at 50Ohms (this condition is really important, as the "TTL Start" input is terminated with 50Ohms internally within the TDC). Also the rise time of the start signal is of great importance, the faster the rise time, the better the time resolution. The maximum frequency of the start pulse must not exceed 9MHz.

Additionally the internal start signal must be turned off. This is received by switching on (ticking) the box named "Ext. GPX Start" within the DLD GUI main window (see the GUI - DLD software manual), otherwise there will be an interference of the external start signal with the internal start signal and the results of the time resolved measurements are not trust able. Tick again the box named "Ext. GPX Start" within the DLD GUI main window to switch back to the internal start signal.

! Note

Do not forget to remove the hardware connection to the TTL Start when switching back to the internal start signal.
Take care that measurements are performed either with the internal start signal switched on and no signal applied to the "TTL Start" input (BNC socket) or with an external start signal applied to the "TTL Start" input. In all other cases the TDC is not working correctly.

Alternatively one can also change the "Ext_Gpx_Start" switch from "0" to "1" in the dld_gpx3.ini file (in the folder of the end-user software, e.g. of the GUI software) (see **Figure 1**). Change the "Ext_Gpx_Start" back to "0" when working without any external start signal again.
Do not forget to save the dld_gpx3.ini after any changes are made and to restart the software.

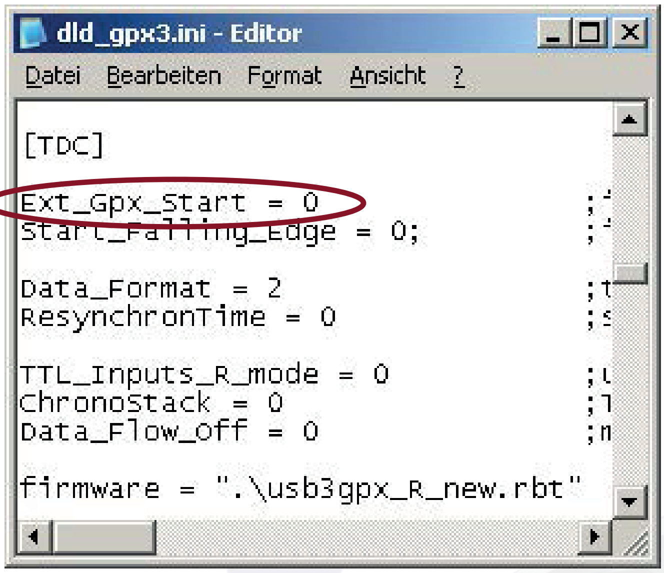


Figure 1: Screenshot of dld_gpx3.ini file (opened with MS editor software), showing the switch to turn on (=0)/ off (=1) the internal TDC start signal.

Note

Take care that measurements are performed either with the internal start signal (Ext_Gpx_Start = 0) and no signal applied to the TTL Start input (BNC socket) or with an external start signal (Ext_Gpx_Start = 1) applied to the TTL Start input.
In all other cases the TDC is not working correctly.

Note

The Quad Channel USB2.0-TDC is not working with start signals of frequencies larger than 9MHz. Therefore larger start pulse frequencies must be divided down with an appropriate frequency divider (e.g. divider with factor of 16 for 80MHz start pulse frequency).

Note

Do not forget to save the dld_gpx3.ini after any changes you make and restart the software. For further information check the software manual.

2.3.1 Checking the Quality of your Time Reference Signal wired to the TTL Start Input

Note

The temporal resolution is influenced mainly by the quality of the start signal because the TDC measures the time in a leading edge determination. Therefore, if the start signal is varying in time, one needs to process it by means of a constant-fraction-discriminator or similar external electronics components.

A few preparations before measuring time resolved:
Take care that you can provide a TTL signal as external TDC start signal, which is in phase with the cycle of nyour excitation source. Its time period must be larger than 120ns! If your source runs with any smaller period duration, a frequency divider must be used to fulfill that specification. The TDC start signal must be of very good quality in order to measure with sufficiently good time resolution.

Be sure that this signal can be loaded by 50Ohms and reaches with such a load at least 2.1V for the "high" state. For most DLD systems, the rising edge is used for relative time measurements; its quality may strongly limit the achievable time resolution of your system. The faster the rise time and the smaller the jitter on that edge, the less limitations will take place on the time resolution.
Check your signal at the end of your cable with an oscilloscope which provides at least 100MHz bandwidth and is able to terminate its input by 50Ohms. Always use good cables only which are specified for 50Ohms only for bandwidths up to the GHz range and are not longer than 3m from the source of your reference signal. A longer cable may still work, but the risk of quality loss is already significant. Be aware that your start signal electronics and your cable length can delay your signal remarkably with respect to the time your pulsed excitation hits your sample. In case this delay is too long, the start signal may arrive too late at the TDC, i.e. later than the particles which you like to measure with respect to that reference. In such a case you may get time of flight results from the device which is entirely not trustful, even when they look partially correct for a rough evaluation.
Prepare yourself to think cyclic; the detector collects time resolved histograms over thousands or millions of cycles of your excitation source. It may be that some results at the beginning of an observed time histogram cycle length must be considered to be correctly at the end of the considered cycle window!

! Note

Be sure, that the external TDC start signal comes in each excitation cycle earlier into the TDC than the stop results from the belonging measured events. This requires understanding, how and when in your source cycle your external TDC start signal is generated and how long the excited particles need to get onto the detector.

Check or calculate independently on the DLD, that your reference start signal goes into the TDC at least a few ns before the particles hit the detector, let's call this delay the "Tdexp". On the other hand, never use Tdexp greater than 200ns for getting a good time resolution. The DLD hardware ads fixed an internal delay of 200ns up to 800ns to any time measurement, depending on the release layout of the used device. Thus, if you get time distributions measured, that are starting with higher time zero than 800ns + Tdexp, then most likely your start signal is seen by the TDC too late, i.e. later than the particle hits from the detector. It also may appear that you connect the start cable to the TDC while it was switched on. This may work, but it also may give some trouble: The TDC can get a burst of pulses into its start which de-synchronizes the very sensitive ring oscillator that is internally used for time measurements. To re-synchronize it, the device must be switched off and on again with some seconds delay.

Caution

Caution: It is only save for getting stable working conditions when connecting the TTL start input only while the TDC device is switched off.
The TTL start input can be damaged, when the input voltage exceeds 5 volts.

Make sure, that the rising edge of your start signal has a fast rise time of at least or less than 2ns and is not coming with kinks or other distortions on the leading edge. Prevent any kind of multiple pulsing after the actual start pulse; it will screw up your time measurements completely. For instance, any mismatch apart from 50Ohms can produce signal reflections and they will produce such multiple trailing pulses leading to entirely wrong time measurements.
Figure 2 shows an example of a good start pulse and one for a non-sufficient quality due to reflections (It is no problem when the pulse is any longer, but any multiple pulsing is).

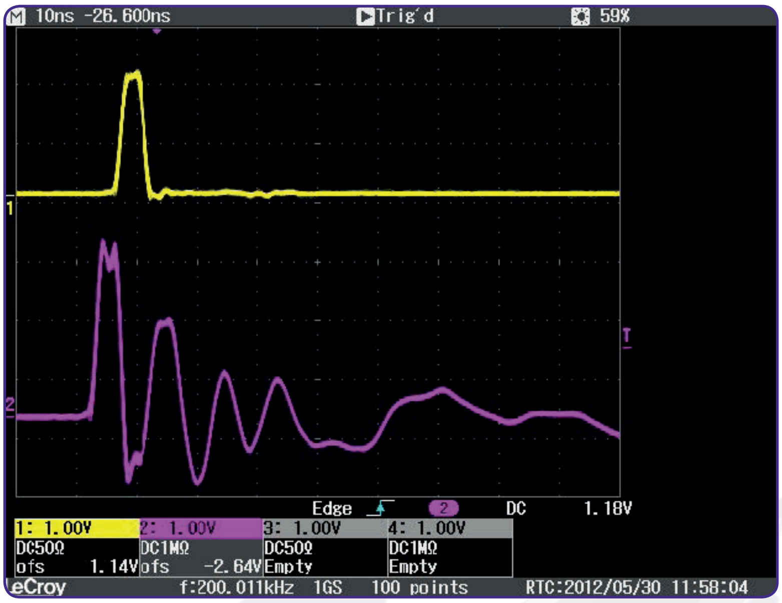


Figure 2: Example of a good start pulse and of one with a non-sufficient quality due to reflections.

Note

The DLD hardware cannot work correctly with an external TDC start signal acting in parallel with the internal TDC start, which is used for 2D-imaging. Therefore, the "Ext_Gpx_Start" parameter in the DLD_GPX3.INI file must be switched to 1, when working with the external TDC start signal connected on.

Caution

Caution: When the "Ext_Gpx_Start" switch is 1 and the device does not recognize the provided external TDC start signal for any reason, the entire detector system will responds with 0 count rate recognized, independently how many events are going onto the detector area!

2.4 About the Trigger for Synchronization IN/OUT

Image acquisition of the DLD can be synchronized to an external trigger signal. The trigger signal has to be applied as TTL/ LVTTL (low voltage TTL) signal to the "SYNC IN" BNC socket of the Quad Channel USB2.0-TDC. The value of the variable named "ext_trigger" in the dld_gpx3.ini file must be set to "1" (see **Figure 3**), otherwise the TDC ignores external trigger signals. The TDC provides a TTL signal on the "SYNC OUT" BNC socket after each acquisition, independent on settings in the dld_gpx3.ini file.
Do not mistake the external trigger for the external start signal from the section before, they are entirely decoupled from each other and they operate different functionality.

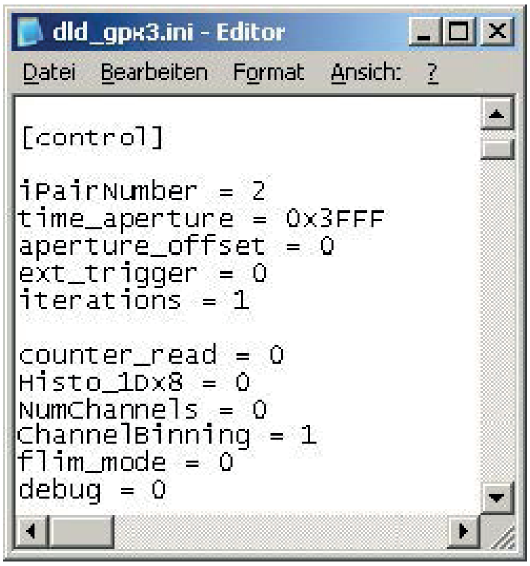


Figure 3: Screenshot of dld_gpx3.ini file (opened with MS editor software), showing the switch to allow (=1) measurement synchronization to an external synchronization signal.

Note

Do not forget to save the dld_gpx3.ini after any changes you make and restart the software. For further information check the software manual.

Note

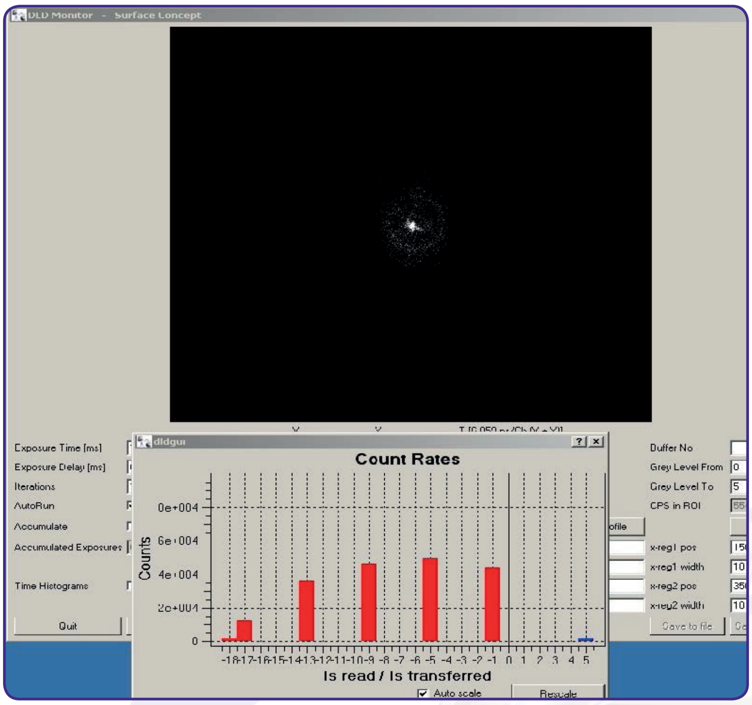
The trigger synchronization is not necessarily implemented in a third party DLD software (e.g. the SpecsLab software).

2.5 Noise Problems with Delayline Detectors

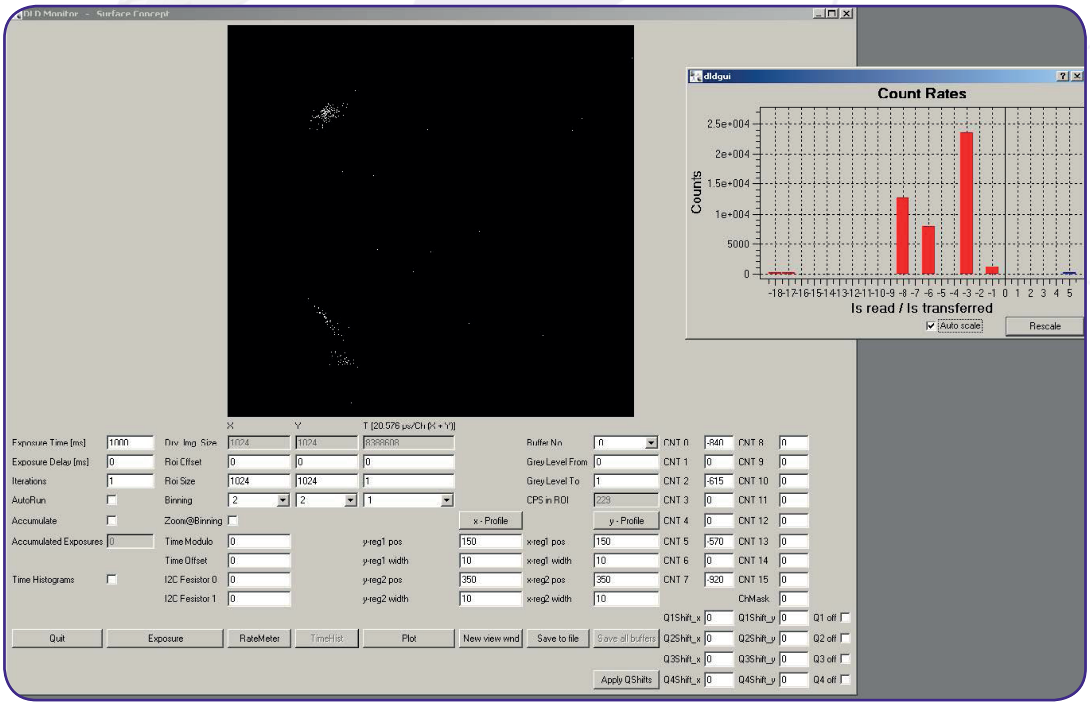
In some cases, delay line detectors may deliver pseudo count-rates and even pseudo-images when the detector system is disturbed by radio frequency (RF) noise from outside. The detector head itself is to some extent an efficient RF receiver that is part of its functionality. All is done that in normal laboratory conditions it should not receive such signals from outside, but if so, it disturbs the normal operation remarkably.

You can recognize such a noise receiving situation by checking the detector response for no high voltage or very small high voltage applied, such that the detector can still not amplify true particle hits.

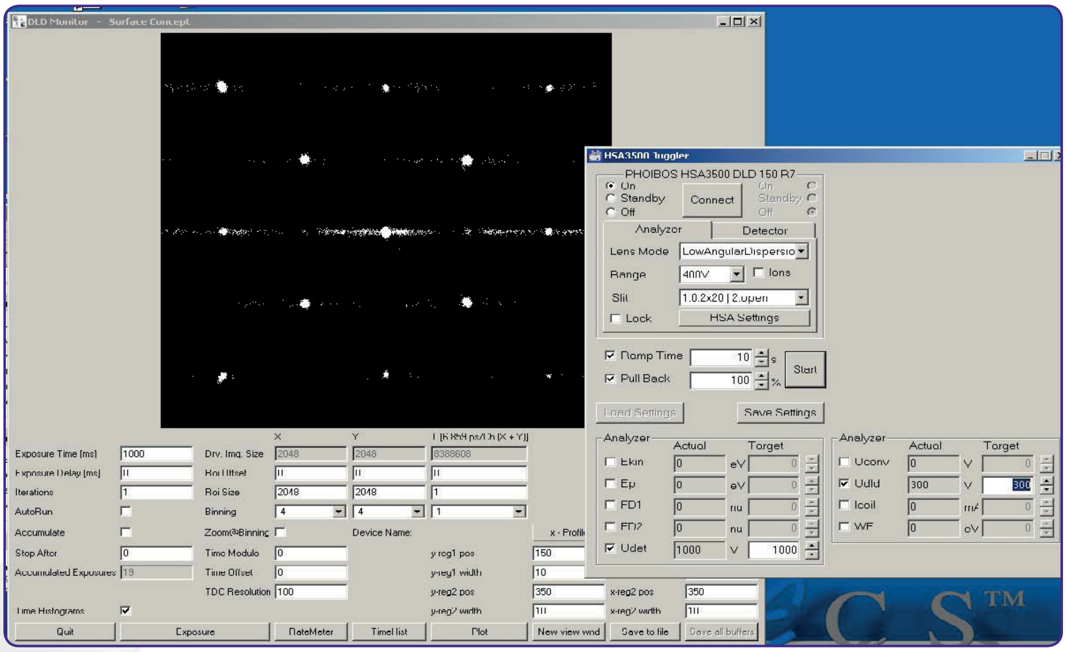
If you get any signals with no HV or very small HV at the detector, the DLD receives such RF noise and it will be necessary to find the RF source and its path into the detector system.
Some examples how such noise may look like (with no HV at the detector) are shown on the next page:



Example 1: Very often RF leads to an artificial peak in the middle or a few peaks in the image, the countrate ratios of single lines do not fit to the found four fold coincidences. This RF was generated by the HV power supply even at 0V output.



Example 2: Artificial peaks in the image, single line count rates are very high and strongly inhomogeneous. The appearance was independent from any voltage at the HV lines, while the receiving path was clearly the HV cabling. Source was another sparking HV in the laboratory in a distance of about two meters.



Example 3: Artificial peak patterns in the image, which appeared due to a HV source which went into an oscillation when turning on to a little fraction of its max. voltage. Input path to the detector was again the HV cabling to the detector.

2.5.1 RF Input Paths

The main input paths for receiving RF noise are the high voltage terminals (SHV) at the DLD flange. If the noise disappears when disconnecting these terminals: the noise path is found, but not the source.

RF noise often couples more or less strong when the unavoidable ground loops around the detector wiring are moved or displaced. The shielding of all cables is an important part of the existing ground loops. Therefore, one may observe influence of the cable positions on the noise response of the detector when shaking any shielded cable or displace cables to different positions. In general, one cannot conclude from such an observation, that the cable is damaged (although it could). That is, because RF noise phases are mainly influenced by the positioning of the involved ground loops and remembers that the cable shields are an important part of the ground loop system! Nevertheless, if the noise source cannot be found or cannot be eliminated, the optimization in positioning of all cables might be the only way in order to suppress RF noise peaks in the detector response. Another way will be to use an adapted RF filter system near by the HV terminals of the detector.
The delivery package may contain a general purpose filter box for RF rejection which should be placed in, but it may not filter efficiently for certain very high RF amplitudes. All DLD systems are tested to reject moderate RF noise signals, thus if the filter is not sufficient, the noise source must be identified and eliminated or at least sufficiently suppressed.

Typical RF noise sources are:

- Fast switching generators.
- Switching power supplies.
- Damaged or interrupted grounding or any open circuit on cables.
- HV sparks or leakage currents in cables or in devices, on insulators, or in vacuum, even when a few
- meters apart.

In case you need to use your own power supply for operating the detector HV, RF noise could appear when the HV device does not sufficiently filter its RF transients internally.
Many commercial high voltage (HV) power supplies are generating a lot of RF noise, which can disturb the DLD operation when such supplies are in use for the primary DLD voltages. A simple RC filter in each HV connector line of the DLD helps to avoid or at least reduce disturbances of the DLD operation.

2.6 Inhomogeneous Detector Images (some Examples)

The DLD is a counting system that works in a laterally resolving sense by detecting four pulses from the four ends of the delay line meanders in a fourfold coincidence. It only works correctly within a certain range of the supply voltage. The MCP voltage has to exceed an operation threshold for the detector otherwise the pulse detection is not possible. This is due to the induced pulses on the delay line which have to reach a certain amplitude to be detected by the electronics, independent on the intensity of the electron source (e.g. mercury lamp). On the other hand, if the MCP voltage and/or the intensity of the electron source are too high, the detector overloads and again pulse detection is not possible. Saturation effects of the MCPs limit the amount of electrons provided by single pulses. An intensity increase of the electron source leads to an increased number of hits on the MCP. The current per bunch and therefore the amplitude for the single pulses decreases. There are two kinds of overloads: local and global. A local overload (locally high intensity on the MCP) leads to reduced count rate within this local area and to “darkened” areas in the images. An intensity too high and homogeneously distributed over the whole MCP first leads to diffuse images and then (with further increasing intensity) to randomly distributed artificial structures up to nearly no count rate at all (global overload). **Figure 4** shows examples of a partial and a global overload. Pulse amplitudes that are too low to be detected by the electronics are the explanation for the effects for a local overload. The explanation for those overload effects is mainly the loss of the fourfold coincidence condition of an incoming event and a fitting fourfold coincidence of random pulses, respectively. High intensities on the MCPs always lead to a significant pressure increase. Therefore an observed pressure increase can always be taken as an indicator for an overload of the detector, when problems with the functionality of the DLD occur.

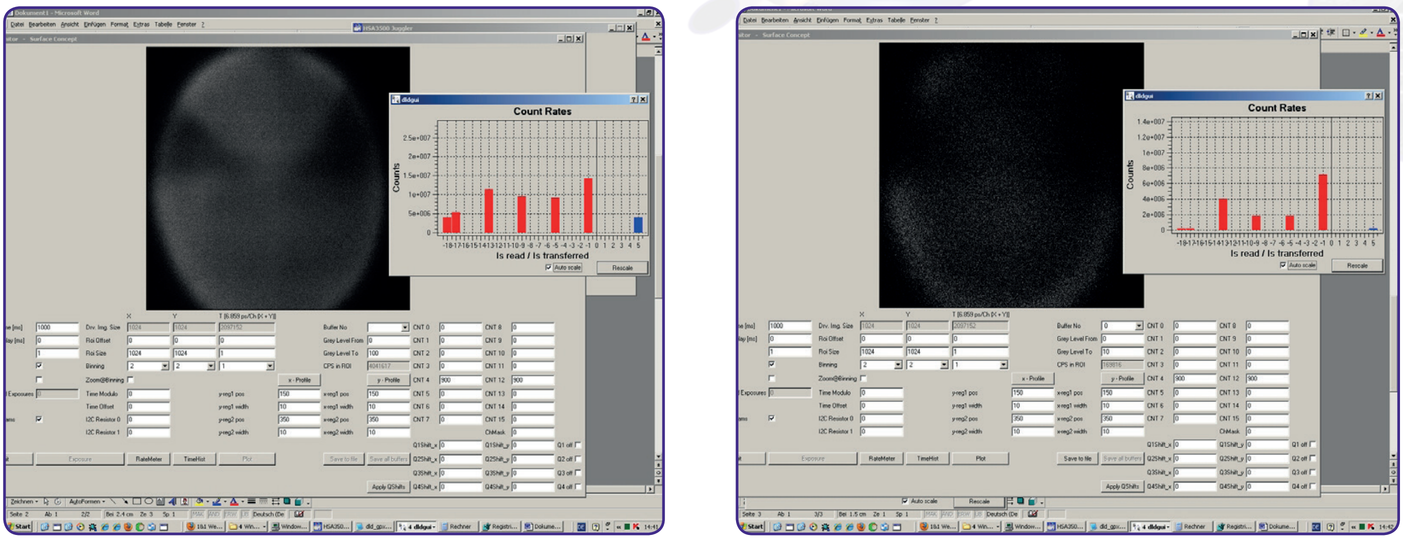


Figure 4: Example of a) a partial overload and b) a heavy (global) overload.

Note

It is easy to mistake a massive global overload for no signal at all. To distinguish between these two, check the pressure. A pressure increase indicates an overload.

The DLD has been calibrated for an optimized MCP voltage and it is strongly advised to use this optimized voltage value for operation. It is given in the specification sheet. A change of the MCP voltage can lead to artifacts within the images (see **Figure 5**). The MCP voltage should only be increased to compensate a decrease in amplification of the MCP stack do to degradation. MCPs degradation is recognizable by a slow permanent decrease of the count rate and happens either due to overloads or due to the normal behavior in the burn-in phase. In such a case a new detector working voltage should be determined by making a detector voltage scan or in the worst case: the MCPs must be replaced.

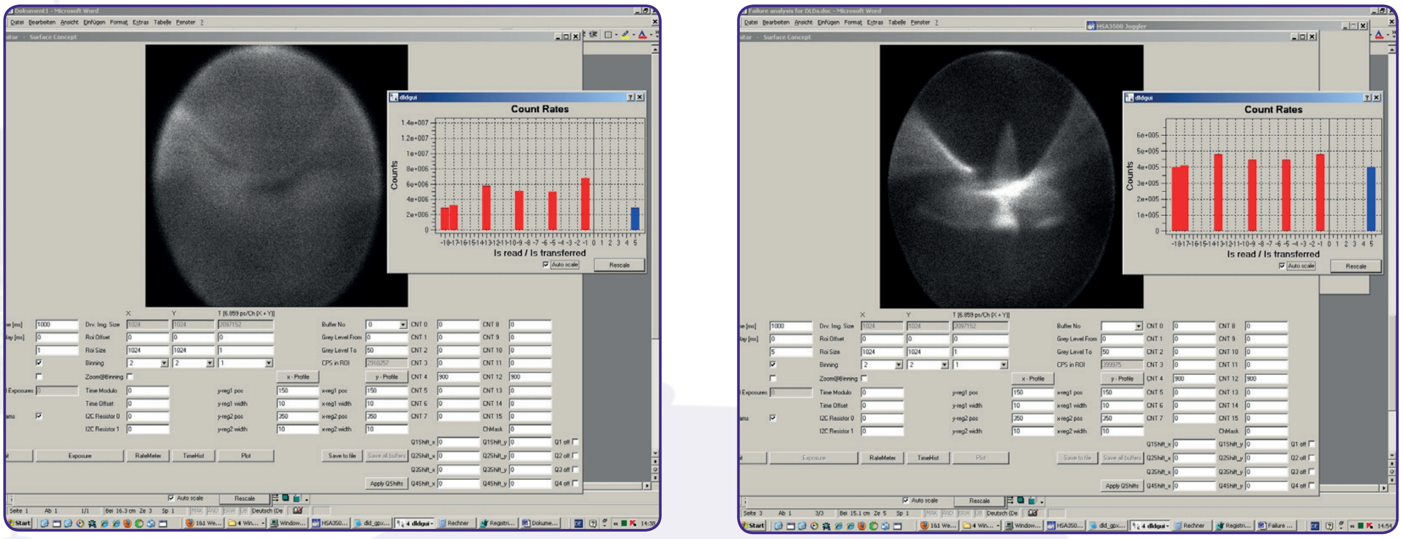


Figure 5: Example of a) an overvoltage on the MCPs and b) an under voltage at high count rates.

2.7 No measurable Count Rate at all anymore

The TDC and the software are running, but the detector delivers no count rate at all. The rate meter shows no counts in none of the channels (please refer to the software manual in cases that the software is not starting correctly).

2.7.1 Check for a correct Cabling

- Is the HDMI cable connected? Check for a proper connection of the HDMI cable. Also check the rate meter when joggling the HDMI cable.

Result Interpretation and further Steps

The HDMI cable was connected properly.	**Proceed with testing.**
The HDMI cable was **not** connceted properly.	Reconnect the HDMI cable and test the DLD operation again. **Proceed with testing, if there is still no proper operation.**

2.7.2 External Start Signal Check

The DLD (or more precisely the TDC) is supposed to be operated by an external start signal but that signal is not recognized by the device.

- Check first whether the operation is possible without the external start signal. This is received by switching off (ticking) the box named "Ext. GPX Start" within the DLD GUI main window (see the GUI - DLD software manual), Alternatively one can also change the "Ext_Gpx_Start" switch from "0" to "1" in the dld_gpx3.ini file. In addition the external start signal cable MUST be disconnected from the TDC box (see **Chapter 2.3** for further details).

I`m not working with an external start and an external start signal was not connected to the TDC.	The problem has nothing to do with a missing external start signal. **Proceed with testing.**
The detector is still not working after changing back to the operation with the internal TDC start.	The problem has nothing to do with a missing external start signal. **Proceed with testing.**
The detector is working again after changing back to the operation with the internal TDC start.	Either the external start signal is not within the specifications or the TDC input "TTL start" is damaged. Check the external start signal at an appropriate oscilloscope; **NOTE:** the input **MUST** be terminated by 50Ohms in order to fulfill the specifications for such fast signals. The pulse length must be min. 2ns, no reflections, and the amplitude min. +2.1V.
An appropriate external start signal to the "TTL start" input has been applied and the detector was tested again with the TDC operation set to external start signal measurement in case that the start signal did not fit to the specifications before. The detector is still not producing any signal. The start signal did fit to the specifications from the beginning.	The TTL start input may be broken (it can only break when an over voltage of >> 5V once was applied) and needs to be repaired. **Contact Surface Concept for further assistance.**

2.7.3 High Voltage Check

- Turn off the high voltage of the DLD, if still in operation.
- Check that the high voltage is properly connected to all HV connectors as specified in the detector manual.
- Disconnect all HV cables from the DLD.
- Disconnect the ACU from the DLD.
- Check that all HV supplies provide the correct output voltage.

Warning: Hazardous voltages are present, which can cause serious or fatal injuries. Therefore only persons with the appropriate training are allowed to check the operation voltage/s of the DLD.

Result Interpretation and further Steps

The high voltage is properly connected and the HV supply delivers the correct output voltage.	There seems to be no problem with the high voltage supply. **Proceed with testing.**
The high voltage was not properly connected to the DLD, but the HV supply delivers the correct output voltages.	Reconnect the DLD to the HV supply properly and test the DLD operation again. **Proceed with testing, if there is still no proper operation.**
The high voltage is properly connected to the DLD but the HV supply does not deliver the correct output voltage.	**Contact Surface Concept for further assistance.** **Warning: Hazardous voltages are present. Do not try to repair the HV supply on your own.**

2.7.4 Check of DLD Resistances

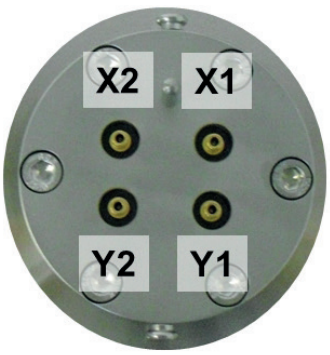
- Turn off all high voltages of the DLD and of the spectrometer and disconnect all HV cables from the DLD, if not already done.
- Check the resistances of the high voltage connections of the DLD between each other and towards the ground potential of the DLD mounting flange and compare the results with the resistance values given in the specification sheet of the DLD.

Check between:	**Typical values** (explicit values are given in the DLD specification sheet)
MCP Front and MCP Back	~ 15 – 40MΩ (Resistance of MCP Stack)
MCP Front and Anode Potential (when connected separately)	> 2GΩ
MCP Back and Anode Potential (when connected separately)	> 2GΩ
MCP Front and DLD Mounting Flange (GND)	> 2GΩ
MCP Back and DLD Mounting Flange (GND)	> 2GΩ
Anode Potential and DLD Mounting Flange (GND)	> 2GΩ

- Check the resistances of the 4 signal outputs on the 4-fold SMB feedthrough between each other and towards the ground potential of the DLD mounting flange and compare the results with the resistance values given in the specification sheet of the DLD (an adapter cable for measurement might be helpful, e.g. from SMB to BNC).
- Check also the resistance of the SMB ground (outer SMB shell) and the ground potential of the DLD mounting flange.
- Compare the results with the resistance values given below and in the specification sheet of the DLD respectively

Caution

Be careful not to damage the fine inner pins of the SMB feedthroughs. An adapter cable for measurement might be helpful (e.g. from SMB to BNC).

Check between:		**Typical values** (explicit values are given in the DLD specification sheet)
	X1 and X2	~ 9 – 15Ω
	Y1 and Y2	~ 5 – 10Ω
	X1 and Y1	kΩ range or higher
	X1 and Flange (GND)	kΩ range or higher
	Y1 and Flange (GND)	kΩ range or higher
	X1 SMB Shell (signal GND) and Flange (GND)	~ 1Ω
	X2 SMB Shell (signal GND) and Flange (GND)	~ 1Ω
	Y1 SMB Shell (signal GND) and Flange (GND)	~ 1Ω
	Y2 SMB Shell (signal GND) and Flange (GND)	~ 1Ω

Result Interpretation and further Steps

All resistance values are within the specified range/correspond to the values given within the DLD specification sheet.	The DLD vacuum head seems to have no principle problem. **Proceed with testing.**
Single or more resistance values vary dramatically from the specified range/from the values given within the DLD specification sheet.	The DLD vacuum head shows internal connection/ shortcut/missing ground connection problems. **Contact Surface Concept for further assistance.**

2.7.5 Check of DLD Raw Pulses with 2-Channel Oscilloscope

To check the DLD raw pulses one needs a 2-channel oscilloscope and 2x adapter cables SMB socket-to-BNC.

Note

The input channels of the oscilloscope must be terminated with 50Ohms, otherwise reflections of the raw pulses at the input channels of the oscilloscope will occur and will lead to wrong test results of the DLD.
The 50Ohm termination of the input channel can either by made by setting the termination within the oscilloscope itself if possible or by an external terminated directly at the input channel (e.g. with a BNC T connector and a 50Ohm termination).

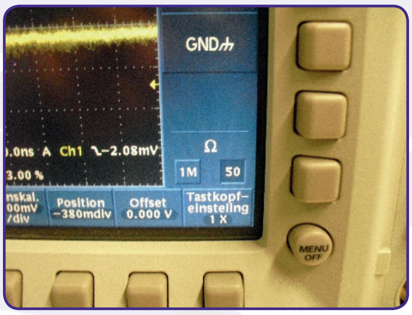


Figure 6: 50Ohm termination setting of oscilloscope input channel.

- Turn off all high voltages of the DLD, if not already done.
- Disconnect the ACU from the DLD.
- Connect the two adapter cables to the flange with the SMB feedthroughs and to the oscilloscope as shown in the image below.
- Turn back on all high voltages of the DLD and operate the detector with a low count rate.

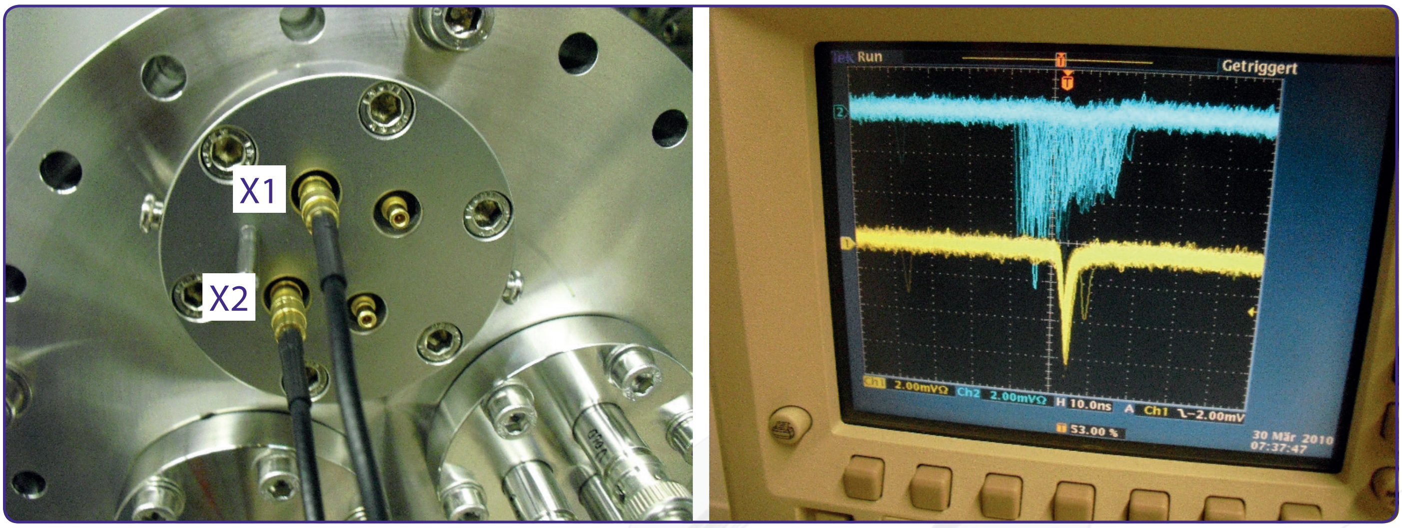


Figure 7: Cable connection (SMB-BNC) for rawpulse measurement of the x line of a DLD and oscilloscope measurement of the raw pulses.

In this setup the raw pulses from the x meander are monitored. The screenshot of the oscilloscope monitor shows a typical example for the raw pulses from the x meander from a DLD4040 (typ. FWHM is 2ns, typ. pulse height distribution is 1mV – 8mV and more). The second oscilloscope channel (blue colored) shows the time distribution of the raw pulses caused by the travel time along the meander (depending on hitting position) while triggering happens on the first oscilloscope channel (yellow colored).

- Now connect the two adapter cables to the other both SMB feedthroughs as shown below.

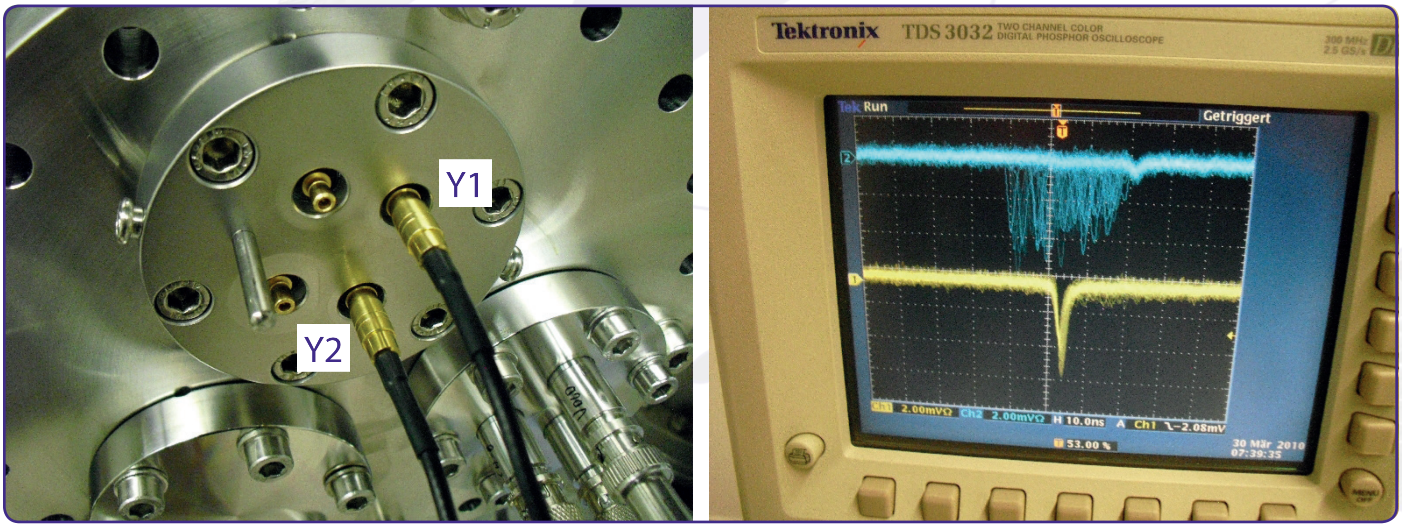


Figure 8: Cable connection (SMB-BNC) for rawpulse measurement of the y line of a DLD and oscilloscope measurement of the raw pulses.

In this setup the raw pulses from the y meander are monitored. The screenshot of the oscilloscope monitor shows a typical example for the raw pulses from the y meander from a DLD4040 (typ. FWHM is 2ns, typ. pulse height distribution is 1mV – 8mV and more). The second oscilloscope channel (blue colored) shows the time distribution of the raw pulses caused by the travel time along the meander (depending on hitting position) while triggering happens on the first oscilloscope channel (yellow colored).

- The following screenshot shows an example of raw pulses with reflected pulse components (e.g. caused by a wrong termination of the input channels of the oscilloscope or by a broken/missing contact within the vacuum – although in such a case one channel would not deliver any pulses at all).

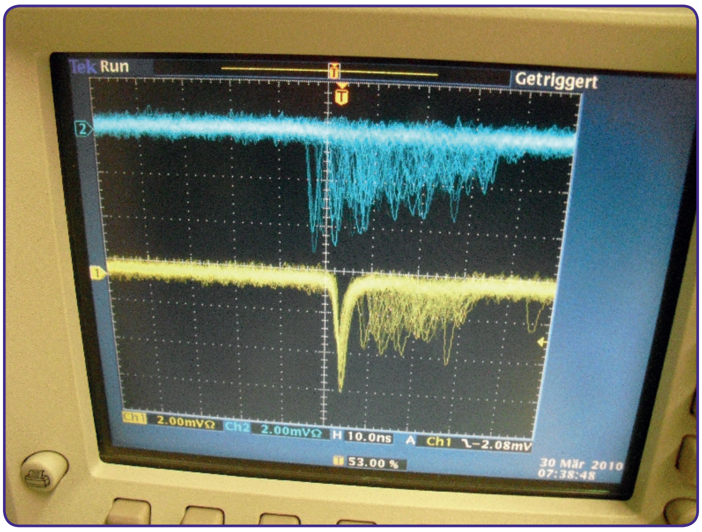


Figure 9: Oscilloscope measurement showing raw pulses from a DLD with refelected pulse components.

Result Interpretation and further Steps

All four detector outputs show raw pulses which resemble the examples given above without any reflected pulse.	The DLD vacuum head is working. **Proceed with testing.**
All four detector outputs show raw pulses, but some or all of them show reflected pulses.	Check for the correct (50Ohm) termination of the input channels of your oscilloscope.
All four detector outputs show raw pulses, but some or all of them show reflected pulses although the input channels of your oscilloscope are terminated with 50Ohms and/or One or more of the four detector outputs do not show any raw pulses at all while the other outputs show raw pulses with reflections or not.	There seems to be a problem with the in-vacuum connection of the meander (e.g. broken contact). **Contact Surface Concept for further assistance.**

2.7.6 Test of DLD Readout Electronics (ACU & TDC)

The following passage contains a description for a primary functionality test of the complete Delayline Detector (DLD) readout electronics, consisting of analogue readout electronics (ACU) and Time-to-Digital Converter (TDC). The Surface Concept GUI software is needed for this test.

Getting Started

- Connect the ACU to the TDC with the DLD readout (HDMI) cable, if not already connected.
- Turn on the TDC.

- Start the GUI software by starting the dldlgui.exe file.
- Start exposure by pressing the exposure button in the main window of the GUI software.
- Open the GUI rate meter window by pressing the rate meter button in the main window of the GUI software.

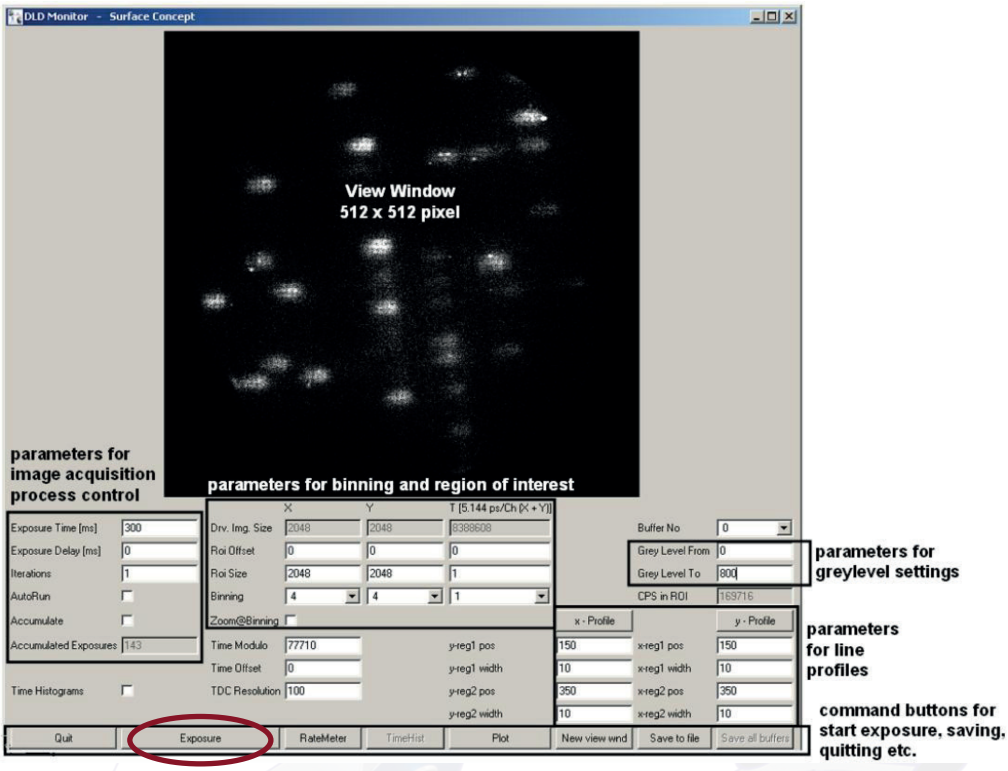


Figure 10: Screenshot of the GUI-1 software main window.

Testing the ACU

The primary functioning of the ACU can be tested by touching each of the 4 signal inputs (SMB sockets) with a small blank piece of metal, which can function as an antenna (e.g. a blank wire, a screwdriver or a paper-clip).
For example: Using a paper-clip as "antenna" for testing

- Unbend the paper-clip as shown in the figures below.

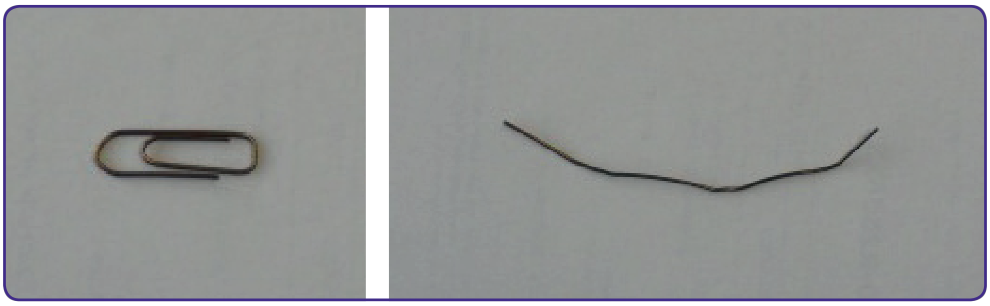


Figure 11: A bended paper-clip can be used for ACU test.

- Ground the ACU by e.g. holding the ACU to the mounting flange of the DLD (IMPORTANT).
- Touch the inner pin of the signal inputs (SMB sockets) with the un-bended paper-clip. Hold the paper-clip in your bare fingers, as this works best. Do not wear gloves or something similar. See the following figure for details.

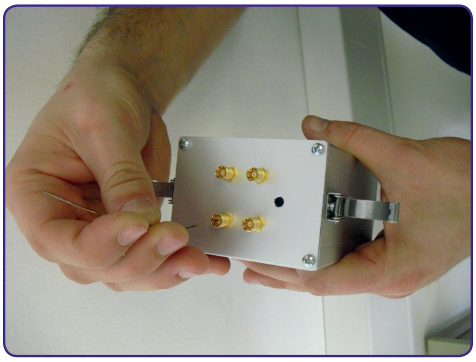


Figure 12: Demonstration of the ACU test.

- Observe the response in the rate meter of the GUI software. A significant increase in count rate (rise of single red channel bars) should be observable in the single readout channels (either -1, -5, -9 or -13), if the ACU is working correctly.
- Check each of the 4 signal inputs of the ACU for a response in the same way.

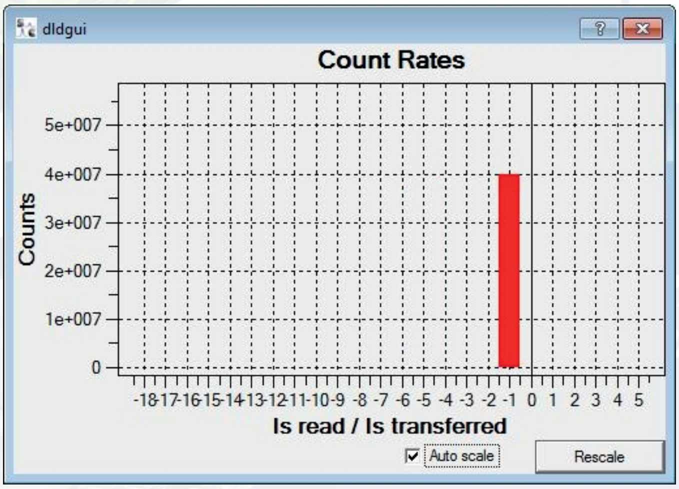


Figure 13a: Response for paper-clip test in channel X1

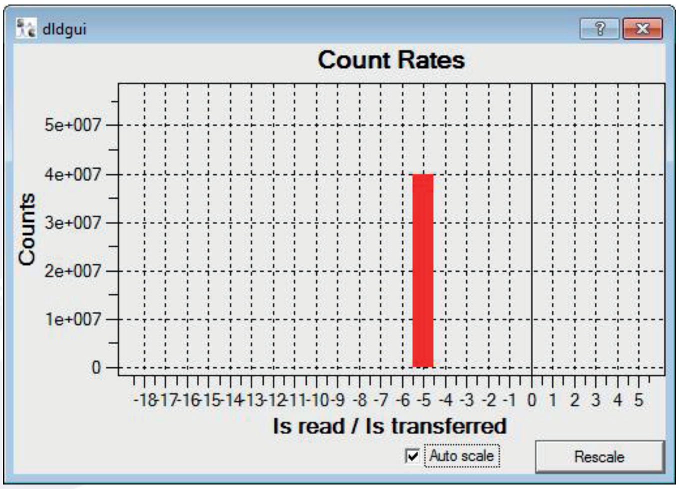


Figure 13b: Response for paper-clip test in channel X2

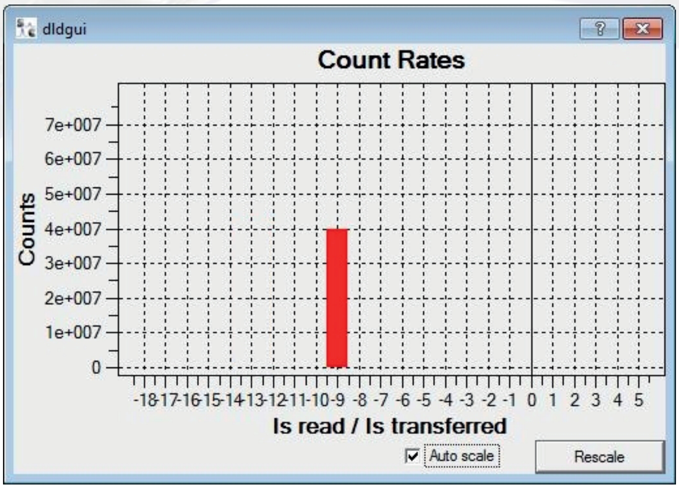


Figure 13c: Response for paper-clip test in channel Y1

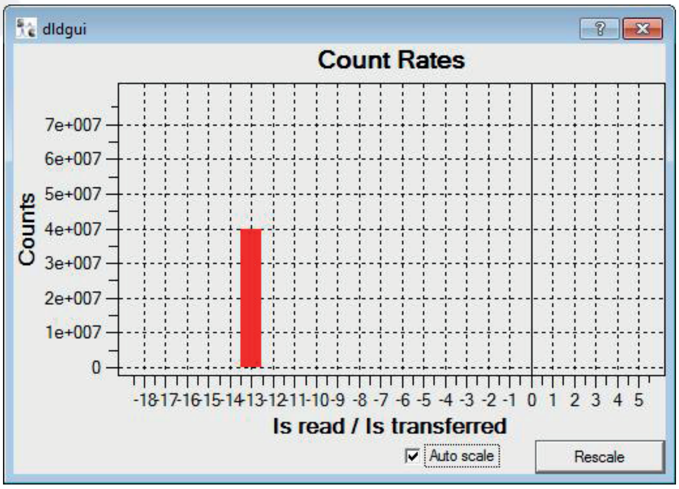


Figure 13d: Response for paper-clip test in channel Y2

Schematic Layout of Test Procedure

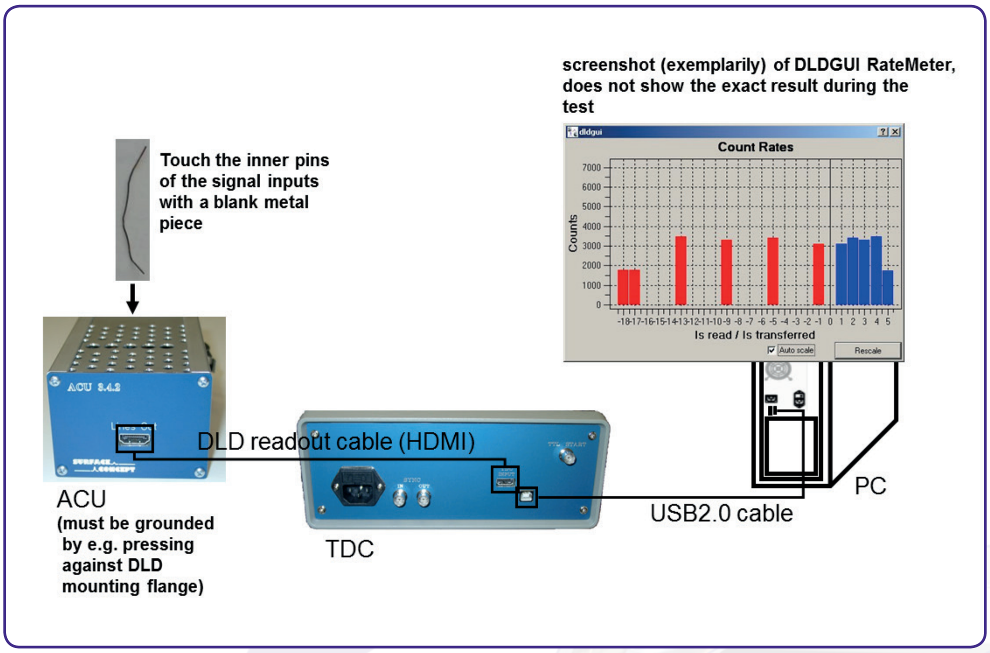


Figure 14: Schematic setup of the different components necessary for the ACU test.

Result Interpretation and further Steps

Each of the 4 channels respond when touching the corresponding signal input of the ACU.	Principal functioning of the ACU and the TDC. **Contact Surface Concept for further assistance, if the DLD is still not functioning.**
Count rate response only of some or even of none of the 4 channels when touching the corresponding signal input of the ACU.	Single readout lines or even all readout lines seem to be damaged. **Contact Surface Concept for further assistance.**